GE VERNOVA

Multilin™ EPM 7000/7000T
Power Quality Meter

Instruction Manual

Software Revision: 1.10

Manual Part Number: 1601-0266-A6

EPM 7000 Power Quality Meter Instruction Manual for product revision 1.10.

Part number: 1601-0266-A6 (March 2026)

⚠CAUTION

General Safety Precautions

- 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 significant issues and practices that are not related to personal injury.

NOTE

Indicates general information and practices, including operational information and practices, 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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Markham, Ontario
Canada L6C 0M1
Worldwide telephone: +1 905 927 7070
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America toll-free: 1 800 547 8629
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Worldwide e-mail: multilin.tech@gevernova.com
Europe e-mail: multilin.tech.euro@gevernova.com
Website: https://www.gevernova.com/grid-solutions/multilin

Warranty

For products shipped as of 1 October 2013, GE Vernova warrants most of its manufactured products for 10 years. For warranty details including any limitations and disclaimers, see our Terms and Conditions at https://www.gevernova.com/grid-solutions/multilin/warranty.htm

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

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EPM 7000 Power Quality 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).

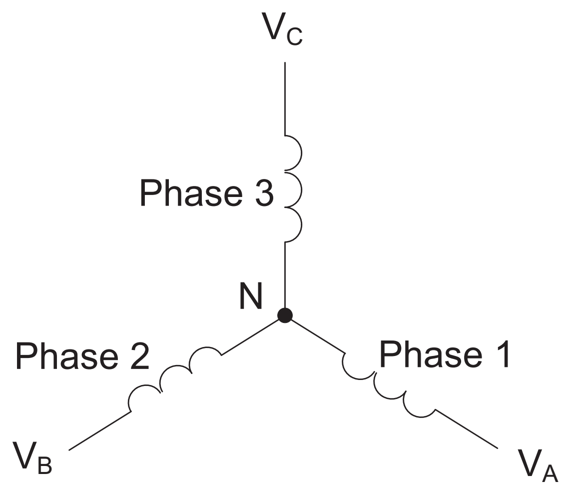


Figure 1-1: Three-phase Wye Winding

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.

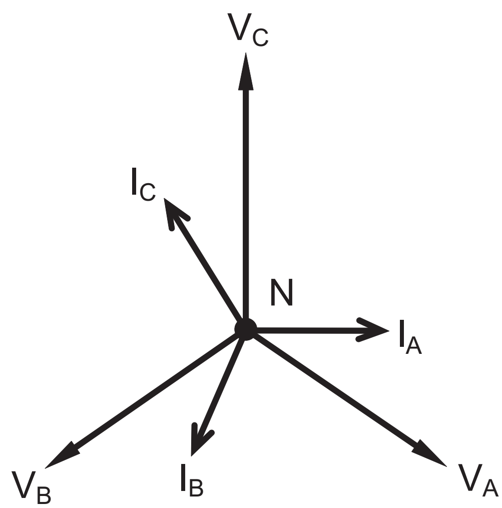


Figure 1-2: Phasor Diagram Showing Three-phase Voltages and Currents

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.

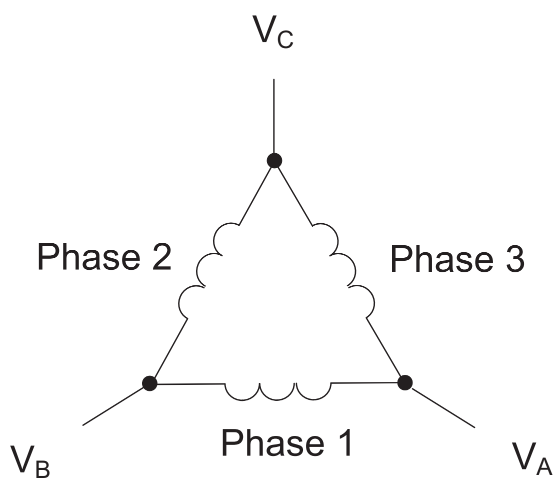


Figure 1-3: Three-phase Delta Winding Relationship

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.

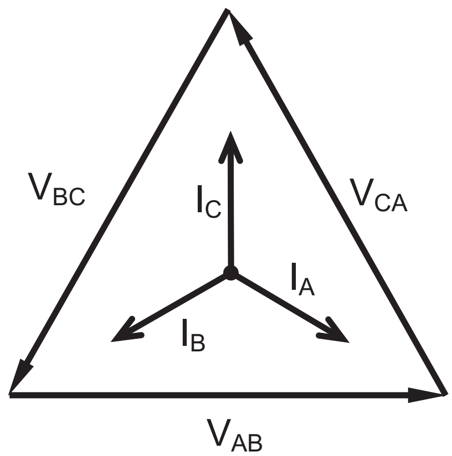


Figure 1-4: Phasor Diagram, Three-Phase Voltages and Currents, Delta-Connected

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.

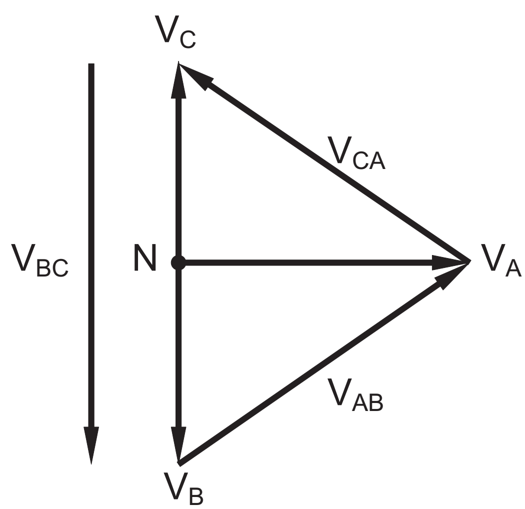


Figure 1-5: Phasor Diagram Showing Three-phase Four-Wire Delta-Connected System

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.

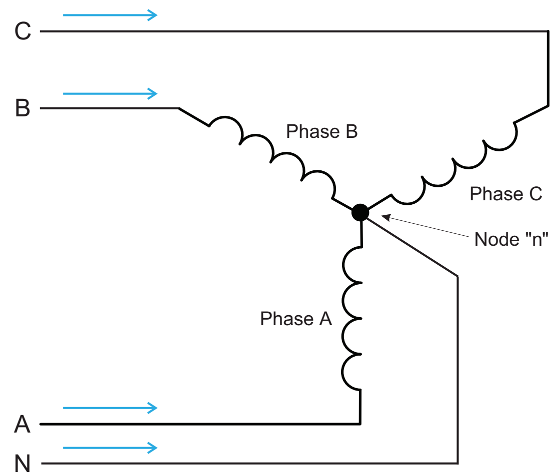


Figure 1-6: Three-Phase Wye Load Illustrating Kirchoff's Law and Blondel's Theorem

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).

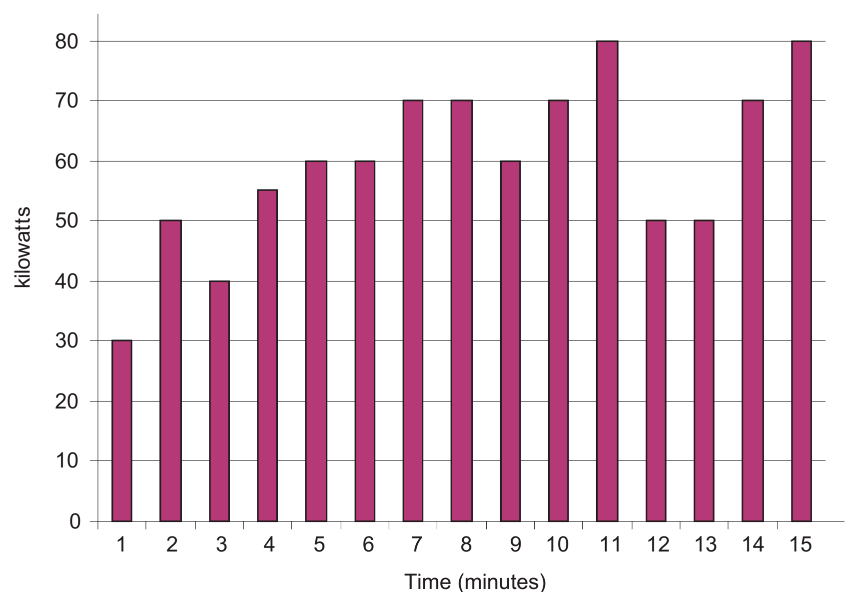


Figure 1-7: Power Use over Time

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
7	70	1.17	6.09

Table 1.2: Power and Energy Relationship over Time

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

As in Table 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.

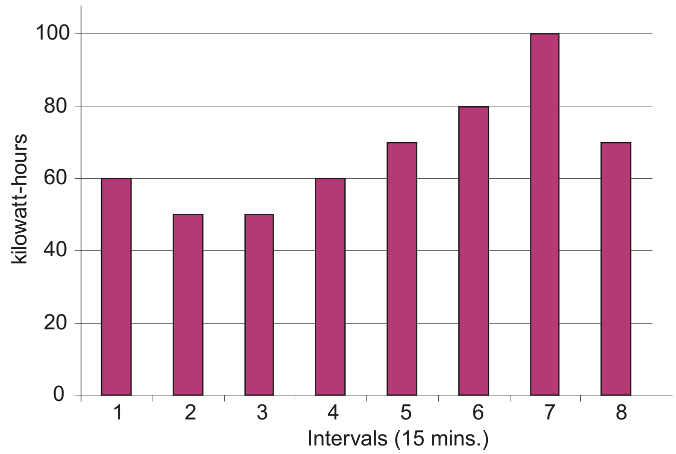


Figure 1-8: Energy Use and Demand

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.

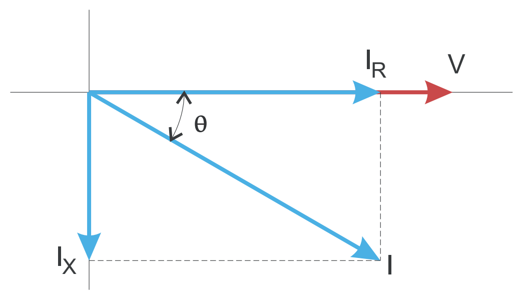


Figure 1-9: Voltage and Complex Current

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.

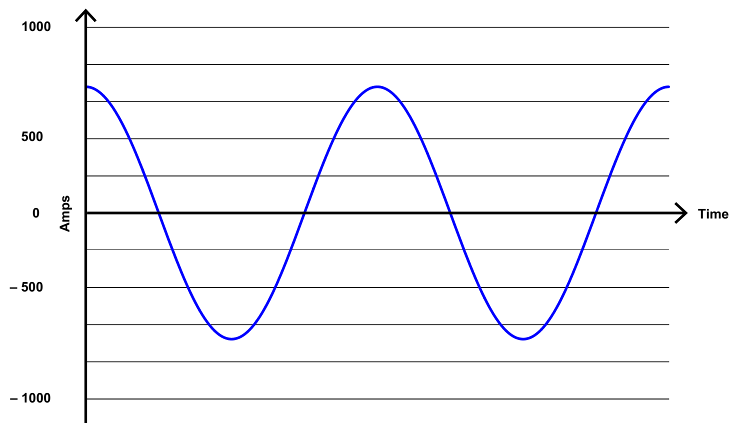


Figure 1-10: Nondistorted Current Waveform

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.

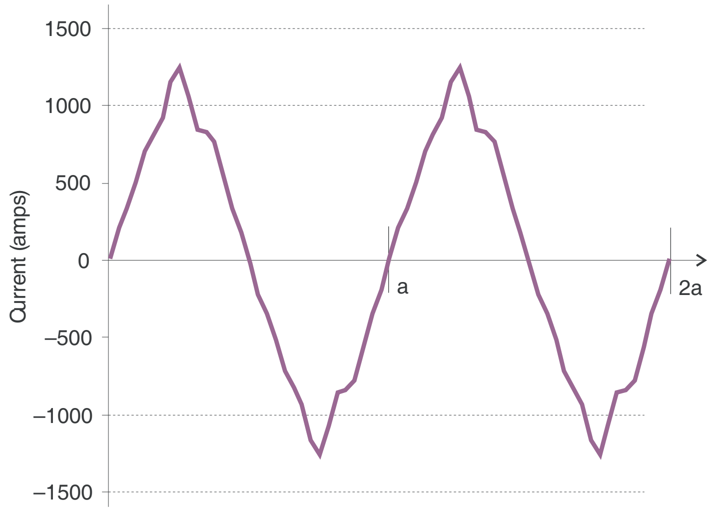


Figure 1-11: Distorted Current Waveform

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.

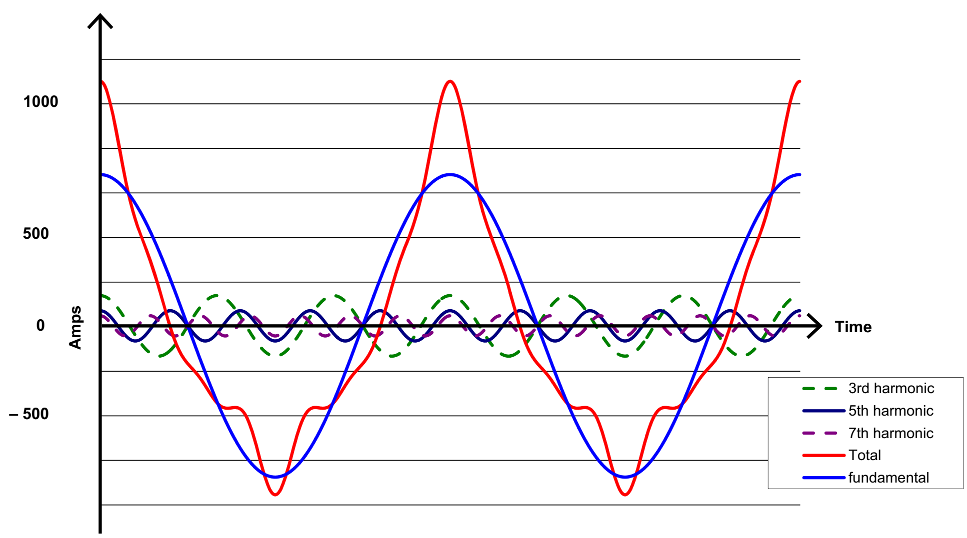


Figure 1-12: Waveforms of the Harmonics

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 7000 Power Quality Meter

Chapter 2: Meter 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 Multilin™ EPM 7000 Meter Overview

The EPM 7000 meter is a multifunction, data logging, power and energy meter with waveform recording capability, designed for use with and/or within Industrial Control Panels in electrical substations, panel boards, as a power meter for OEM equipment, and as a primary revenue meter, due to its high performance measurement capability. The unit provides multifunction measurement of all electrical parameters and makes the data available in multiple formats via display, communication systems, and analog retransmits. The unit also has data logging and load profiling to provide historical data analysis, and waveform recording that allows for enhanced power quality analysis.

The EPM 7000 meter offers up to 4 MegaBytes of flash memory. The unit provides you with up to seven logs: three historic logs, a log of limit alarms, a log of I/O changes, a waveform log, and a sequence of events log.

The purposes of these features include historical load profiling, voltage analysis, and recording power factor distribution. The EPM 7000 meter's real-time clock allows all events to be time-stamped.

Optional 100BaseT Ethernet capability is available for the meter. When it is equipped with an Ethernet card, the meter's real-time clock can be synchronized with an outside Network Time Protocol (NTP) server (see the *GE Communicator Instruction Manual* for instructions on using this feature.) An EPM 7000 meter with an Ethernet card also becomes a Web server. See Chapter 8 for more information on this feature.

The EPM7000 meter has an optional KEMA certified IEC 61850 Protocol Ethernet Network card, which allows it to be seamlessly integrated into an IEC 61850 network. For detailed information on this option, see Appendix D.

The EPM 7000 meter is designed with advanced measurement capabilities, allowing it to achieve high performance accuracy. It is specified as a 0.2% class energy meter for billing applications as well as a highly accurate panel indication meter.

The EPM 7000 meter provides additional capabilities, including standard RS485, Modbus and DNP 3.0 Protocols, an IrDA Port for remote interrogation, and Option cards that can be added at any time.

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 Compliance Section (2.3).

Features of the EPM 7000 meter include:

- 0.2% Class revenue certifiable Energy and Demand metering
- Meets ANSI C12.20 (0.2%) and IEC 687 (0.2%) classes
- Multifunction measurement including Voltage, current, power, frequency, energy, etc.
- Optional secondary voltage display (see the *GE Communicator Instruction Manual* for instructions on setting up this feature)
- Power quality measurements (%THD and Alarm Limits) - for meters with Software Options C to F, symmetrical components, voltage unbalance, and current unbalance are also available and can be used with the Limits functionality (see *GE Communicator Instruction Manual* for instructions on using this feature)
- Software Options - field upgradable without removing installed meter
- Percentage of Load Bar for analog meter reading
- 0.001% Frequency measurement for Generating stations
- Interval energy logging
- Line frequency time synchronization
- Easy to use faceplate programming
- IrDA Port for laptop PC remote read
- RS485 communication
- Optional I/O Cards - field upgradable without removing installed meter; relay control though DNP over Ethernet is enabled with the Ethernet Option card.
- Sampling rate of up to 512 samples per cycle for waveform recording
- Transformer/Line Loss compensation (see *GE Communicator Instruction Manual* for instructions on using this feature).
- CT/PT Compensation (Software Options C to F: see *GE Communicator Instruction Manual* for instructions on using this feature).

NOTE

Access the *GE Communicator Instruction Manual* from the GE Communicator CD or by clicking **Help>Contents** from the GE Communicator Main screen.

In addition to the Multilin EPM 7000 meter/transducer configuration, an Multilin EPM 7000T transducer configuration is available. The Multilin EPM 7000T transducer is a digital transducer-only unit, providing RS485 communication via Modbus RTU, Modbus ASCII or DNP 3.0 protocols. The unit is designed to install using DIN Rail Mounting (see Section 3.4 for Multilin EPM 7000T transducer mounting information).

Figure 2-1: EPM 7000T

2.1.1 Voltage and Current Inputs

Universal Voltage Inputs

Voltage Inputs allow measurement up to Nominal 576 VAC (Phase to Reference) and 721 VAC (Phase to Phase). This insures proper meter safety when wiring directly to high voltage systems. One unit will perform to specification on 69 Volt, 120 Volt, 230 Volt, 277 Volt, and 347 Volt power systems.

NOTE

Higher voltages require the use of potential transformers (PTs).

Current Inputs

The unit supports a 5 Amp or a 1 Amp secondary for current measurements.

NOTE

The secondary current must be specified and ordered with the meter.

The current inputs are only to be connected to external current transformers.

The EPM 7000 meter's Current Inputs use a unique dual input method:

Method 1: CT Pass Through

The CT passes directly through the meter without any physical termination on the meter. 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 Ordering Information

Table 2.1: EPM 7000 Order Codes

	PL7000	*	– *	– *	– *	– *	– *	*	
Base Unit	**PL7000**		|	|	|	|	|	|	EPM 7000 Power Quality Meter
Enclosure		**ENC120**	|	|	|	|	|	|	NEMA1 Rated - Indoor, Single Meter Enclosure, 120V
		ENC277	|	|	|	|	|	|	NEMA1 Rated - Indoor, Single Meter Enclosure, 277V
		XXXXXX	|	|	|	|	|	|	None
Frequency			5	|	|	|	|	|	50 Hz AC frequency system
			6	|	|	|	|	|	60 Hz AC frequency system
Current Input				1A	|	|	|	|	1 A secondary
				5A	|	|	|	|	5 A secondary
Software					A	|	|	|	Multimeter function only
					B	|	|	|	Data Logging, 2 MB memory
					C	|	|	|	Power Quality Harmonics, 2 MB memory
					D	|	|	|	Limits and Control, 2 MB memory
					E	|	|	|	64 samples/cycle Waveform Recording, 3 MB memory
					F	|	|	|	512 samples/cycle Waveform Recording, 4 MB memory
Power Supply						HI	|	|	90 to 265 VAC; 100 to 370 VDC
						LDC	|	|	18 to 60 VDC
I/O Modules							X	X	None
							E1	E1	100BaseT Ethernet (see Note below)
							E2	E2	100BaseT Ethernet with IEC 61850 Protocol (see Note below)
							C1	C1	Four Channel Bi-directional 0 to 1 mA Outputs
							C20	C20	Four Channel Bi-directional 0 to 20 mA Outputs
							RS1	RS1	Two Relay Status Outputs / Two Status Inputs
							PS1	PS1	Four Pulse Outputs / Four Status Inputs
							F1	F1	Fiber Optic Interface with ST Terminations
							F2	F2	Fiber Optic Interface with Versatile Terminations

Table 2.2: EPM 7000T Order Codes

	PL7000T –	* –	* –	* –	* –	*	*	
Base Unit	**PL7000T**							EPM 7000T Power Quality Meter - no display
Frequency		5						50 Hz AC frequency system
		6						60 Hz AC frequency system
Current Input			1A					2 A secondary
			5A					10 A secondary
Software				A				Multimeter function only
				B				Data Logging, 2 MB memory
				C				Power Quality Harmonics, 2 MB memory
				D				Limits and Control, 2 MB memory
				E				64 samples/cycle Waveform Recording, 3 MB memory
				F				512 samples/cycle Waveform Recording, 4 MB memory
Power Supply					HI			90 to 265 VAC; 100 to 370 VDC
					LDC			18 to 60 VDC
I/O Modules						X	X	None
						E1	E1	100BaseT Ethernet (see Note below)
						E2	E2	100BaseT Ethernet with IEC 61850 Protocol (see Note below)
						C1	C1	Four Channel Bi-directional 0 to 1 mA Outputs
						C20	C20	Four Channel Bi-directional 0 to 20 mA Outputs
						RS1	RS1	Two Relay Status Outputs / Two Status Inputs
						PS1	PS1	Four Pulse Outputs / Four Status Inputs
						F1	F1	Fiber Optic Interface with ST Terminations
						F2	F2	Fiber Optic Interface with Versatile Terminations

2.1.3 EPM Accessories

This section describes accessories for the EPM 7000 which are available separately from the meter.

Expandable Input/Output (I/O) Cards

The following table describes the expandable communication cards available for the EPM 7000 for specific slots.

Table 2.3: Input/Output (I/O) Cards

Part Number	Description	I/O Module Slot
PL7000-ACC-E1X	100BaseT Ethernet	Slot 1 or Slot 2
PL7000-ACC-E2X	61850 Communications card	Slot 1 or Slot 2
PL7000-ACC-C1X	Four Channel Bi-directional 0-1mA Outputs	Slot 1 or Slot 2
PL7000-ACC-C20	Four Channel 4-20mA Outputs	Slot 1 or Slot 2
PL7000-ACC-RS1	Two Relay status Outputs / Two Status Inputs	Slot 1 or Slot 2
PL7000-ACC-PS1	Four Pulse Outputs / Four Status Inputs	Slot 1 or Slot 2
PL7000-ACC-F1X	Fiber Optic Interface with ST terminations	Slot 1 or Slot 2
PL7000-ACC-F2X	Fiber Optic Interface with Versatile Terminations	Slot 1 or Slot 2

Mounting Brackets

The following mounting brackets are available for the EPM 7000.

Table 2.4: Mounting Brackets

Part Number	Description
PL7000-ACC-DIN	DIN Mounting Bracket

2.1.4 Measured Values

The EPM 7000 meter provides the following Measured Values all in Real-Time Instantaneous, and some additionally as Average, Maximum and Minimum values.

Table 2.5: EPM 7000 Meter's Measured Values

Measured Values	Instantaneous	Avg	Max	Min
Voltage L-N	X		X	X
Voltage L-L	X		X	X
Current per Phase	X	X	X	X
Current Neutral	X	X	X	X
WATT(A,B,C,Tot.)	X	X	X	X
VAR (A,B,C,Tot.)	X	X	X	X
VA (A,B,C,Tot.)	X	X	X	X
PF (A,B,C,Tot.)	X	X	X	X
+Watt-Hour (A,B,C,Tot.)	X			
-Watt-Hour (A,B,C,Tot.)	X			
Watt-Hour Net	X			
+VAR-Hour (A,B,C,Tot.)	X			
-VAR-Hour (A,B,C,Tot.)	X			
VAR-Hour Net (A,B,C,Tot.)	X			
VA-Hour (A,B,C,Tot.)	X			
Frequency	X		X	X
Harmonics to the 40th Order	X			
%THD	X		X	X
Voltage Angles	X			
Current Angles	X			
% of Load Bar	X			
Waveform Scope	X			

2.1.5 Utility Peak Demand

The EPM 7000 meter provides user-configured Block (Fixed) Window or Rolling Window Demand modes. This feature enables you to set up a customized Demand profile. Block Window Demand mode records the average demand for time intervals that you define (usually 5, 15 or 30 minutes). Rolling Window Demand mode functions like multiple, overlapping Block Window Demands. You define the subintervals at which an average of demand is calculated. An example of Rolling Window Demand mode would be a 15-minute Demand block using 5-minute subintervals, thus providing a new demand reading every 5 minutes, based on the last 15 minutes.

Utility Demand Features can be used to calculate Watt, VAR, VA and PF readings. Voltage provides an Instantaneous Max and Min reading which displays the highest surge and lowest sag seen by the meter. All other parameters offer Max and Min capability over the user-selectable averaging period.

2.2 Specifications

POWER SUPPLY

Range: .... **HI Option**: Universal, 90 to 265 VAC @50/60Hz; 100 to 370 VDC
LDC Option: 18 to 60 VDC

Power Consumption: .... 5 to 10 VA, 3.5 to 7 W - depending on the meter's hardware configuration

Connection: .... 3-pin 0.300" pluggable terminal block
Torque: 3.5 lb-in
AWG #12 to 24, solid or stranded

VOLTAGE INPUTS

(For Accuracy Specifications, see Section 2.4.)

Absolute Maximum Range: ...... Universal, Auto-ranging:
.... Phase to Reference: Va, Vb, Vc to Vref: 20 to 576 VAC
.... Phase to Phase: Va to Vb, Vb to Vc, Vc to Va: 0 to 721VAC

Supported hookups: .... 3 Element Wye, 2.5 Element Wye, 2 Element Delta, 4 Wire Delta

Input Impedance: .... 1M Ohm/Phase

Burden: .... 0.36VA/Phase Max at 600 Volts;
0.014VA at 120 Volts

Pickup Voltage: 20VAC

Connection: .... 7 Pin 0.400" Pluggable Terminal Block
AWG#12 -26/ (0.129 -3.31) mm^2

Torque: .... 5 lb-in

Transient Withstand: .... Meets IEEE C37.90.1 (Surge Withstand Capability)

Reading: .... Programmable Full Scale to any PT Ratio

CURRENT INPUTS

(For Accuracy Specifications, see Section 2.4.)

Class 10: ....5A Nominal, 10A Maximum

Class 2: ....1A Nominal, 2A Maximum

Burden: ....0.005VA Per Phase Max at 11 Amps

Pickup Current: ....0.1% of nominal (0.2% of nominal if using Current Only mode, that is, there is no connection to the voltage inputs.)

Connections: ....O Lug or U Lug Electrical Connection (Figure 4.1)
Tighten with #2 Phillips screwdriver
Torque- 8 Lb-In
Pass-through Wire, 0.177" / 4.5mm maximum diameter
Quick Connect, 0.25" Male Tab

Fault Withstand (at 23^{O} C): ....100A/10sec., 300A/3sec.
500A/1sec.

Reading: ....Programmable Full Scale to any CT Ratio

Continuous Current Withstand:20 Amps for Screw Terminated or Pass Through Connections

KYZ/RS485 PORT SPECIFICATIONS

RS485 Transceiver; meets or exceeds EIA/TIA-485 Standard:

Type: ....Two-wire, half duplex

Min. Input Impedance: ....96 kΩ

Max. Output Current: ....±60 mA

WH PULSE

KYZ output contacts (and infrared LED light pulses through face plate):
(See Section 6.4 for Kh values.)

Pulse Width:.................................... 90ms
Full Scale Frequency: .... ~3Hz
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

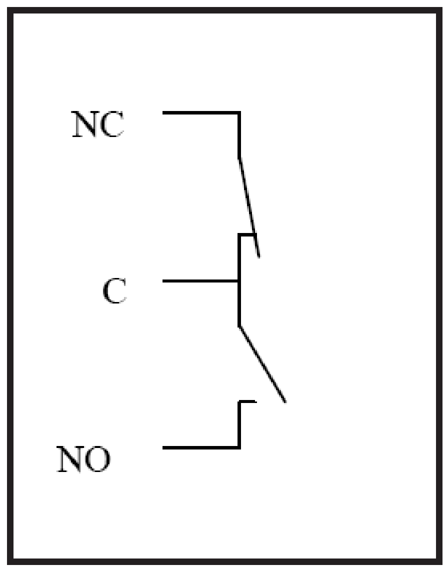


Figure 2-2: Internal Schematic

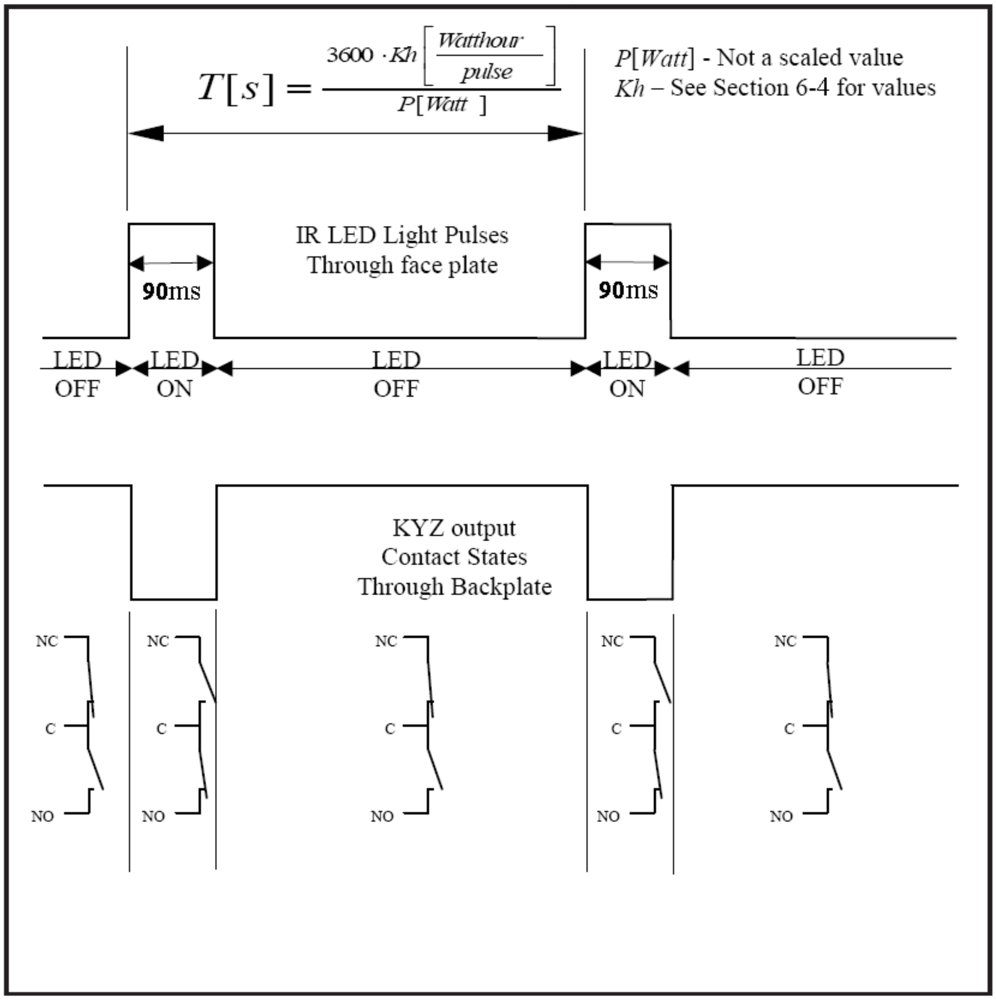


Figure 2-3: Output timing

ISOLATION

All Inputs and Outputs are galvanically isolated to 2500 VAC

ENVIRONMENTAL RATING

Storage:...-20 to +70° C
Operating: ....-20 to +70° C
Humidity: ....to 95% RH Non-condensing
Faceplate Rating:...........................NEMA1 (Water Resistant), Mounting Gasket Included
Measurement Methods
Voltage, Current: ....True RMS
Power: ....Sampling at over 400 Samples per Cycle on All Channels
Update Rate
Watts, VAR and VA:.......................Every 6 cycles (e.g., 100ms @ 60 Hz)
All other parameters:...................Every 60 cycles (e.g., 1 s @ 60 Hz)
1 second for current only measurement, if reference voltage is not available

COMMUNICATION

Standard: .... RS485 Port through Back Plate
IrDA Port through Face Plate
Energy Pulse Output through Back Plate and Infrared LED through Faceplate

Optional, through I/O Card Slot 1:100BaseT Ethernet Card
100 Base Ethernet with IEC 61850 protocol
Four Channel Bi-directional 0 to 1 mA Outputs
Four Channel Bi-directional 0 to 20 mA Outputs
Two Relay Status Outputs/Two Status Inputs
Four Pulse Outputs/Two Status Inputs
Fiber Optic Interface ST Terminated Card
Fiber Optic Interface Versatile Link Terminated Card

Protocols: .... Modbus RTU, Modbus ASCII, DNP 3.0, IEC 61850

Com Port Baud Rate:.................. 9,600 to 57,600 bps
RS485 only: 1200, 2400, 4800*
*with Runtime Firmware version 26 or higher

Com Port Address: .... 001 to 247; DNP ONLY - 001 - 65520

Data Format:.................................. 8 Bit, No Parity (RS485: also Even or Odd Parity* with runtime version 26 or higher)

EPM 7000T Transducer .... Default Initial Communication Baud 9600 (See Chapter 5)

MECHANICAL PARAMETERS

Dimensions: .... see *Chapter 3*.

Weight (without Option card):. 2 pounds/ 0.9kg (ships in a 6"/152.4mm cube container)

2.3 Compliance

Test	Reference Standard	Level/Class
IEC62053-22 (0.2% Accuracy)		
ANSI C12.20 (0.2% Accuracy)		
Electrostatic Discharge	EN/IEC61000-4-2	Level 3
RF Immunity	EN/IEC61000-4-3	10 V/min
Fast Transient Disturbance	EN/IEC61000-4-4	Level 3
Surge Immunity	EN/IEC61000-4-5	Level 3
Conducted RF Immunity	EN/IEC61000-4-6	Level 3
Radiated and Conductive Emissions	EN/IEC61000-6-4 CISPR 11	Class A
Voltage Dip & Interruption	EN/IEC61000-4-11	0, 40, 70, 100% dips, 250/300 cycle interrupts

APPROVALS

CE Compliance	Low Voltage Directive	EN61010-1
	EMC Directive	EN61326-1 EN61000-6-2 EN61000-6-4
North America	cULus Listed	UL61010-1 (PICQ) C22.2. No 61010-1 (PICQ7) File E200431
KEMA	Certified	IEC 61850
ISO	Manufactured under a registered quality program	ISO9001

2.4 Accuracy

(For full Range specifications see Section 2.2.)

Multilin EPM 7000 Clock Accuracy: Max. +/-2 seconds per day at 25^{o}C.

For 23^{o} 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 Range1
Voltage L-N [V]	0.1% of reading	(69 to 480)V
Voltage L-L [V]	0.2% of reading [2]	(120 to 600)V
Current Phase [A]	0.1% of reading [1, 3]	(0.15 to 5) A
Current Neutral (calculated) [A]	2% 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 [Hz]	+/- 0.007 Hz	(45 to 65) Hz
Total Harmonic Distortion [%]	+/- 2% [1, 4]	(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 the accuracy to 0.4% of reading.

3: With reference voltage applied (VA, VB, or VC). Otherwise, degrade accuracy to 0.2%. See hookup diagrams 8, 9, and 10 in Chapter 4.

4: At least one voltage input (minimum 20 VAC) must be connected for THD measurement on current channels.

EPM 7000 Power Quality Meter

Chapter 3: Mechanical Installation

3.1 Introduction

The EPM 7000 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 them with the EPM 7000 meter. See Section 3.4 for Multilin EPM 7000T transducer installation. See Chapter 4 for wiring diagrams.

WARNING

POTENTIAL ELECTRICAL EXPOSURE - The EPM 7000/7000T must be installed in an electrical enclosure where any access to live electrical wiring is restricted only to authorized service personnel.

NOTE

The drawings shown below and on the next page give you the meter dimensions in inches and centimeters [cm shown in brackets]. Tolerance is +/- 0.1" [.25 cm].

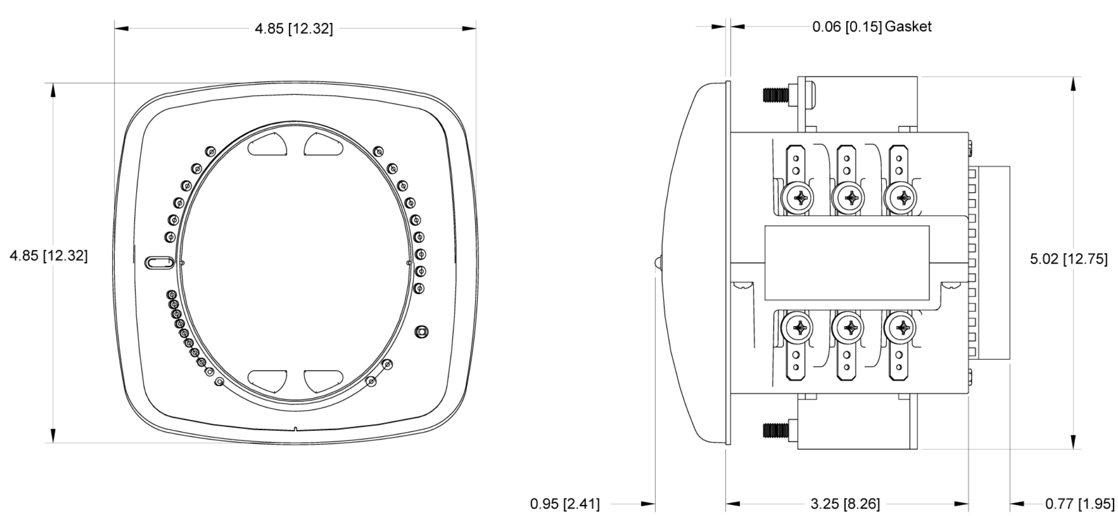


Figure 3-1: Meter Front and Side Dimensions

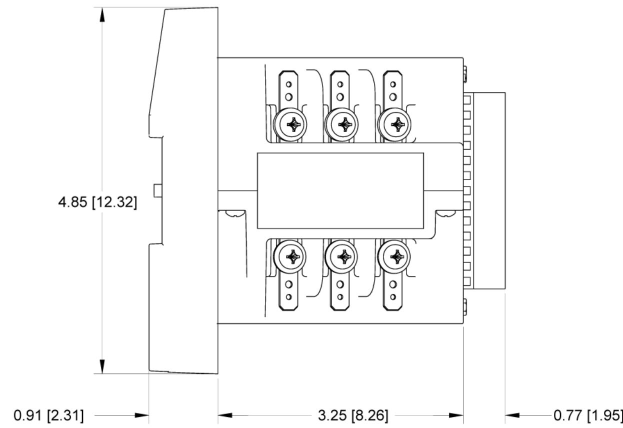


Figure 3-2: EPM 7000T Dimensions

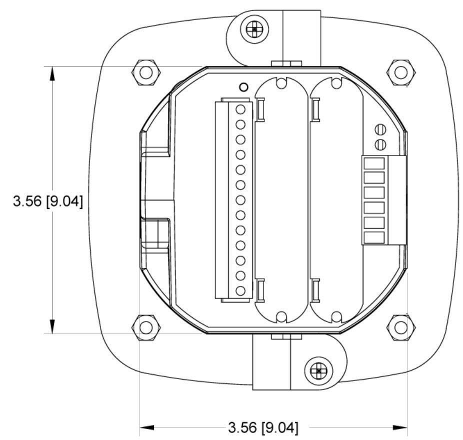


Figure 3-3: Meter Back Dimensions

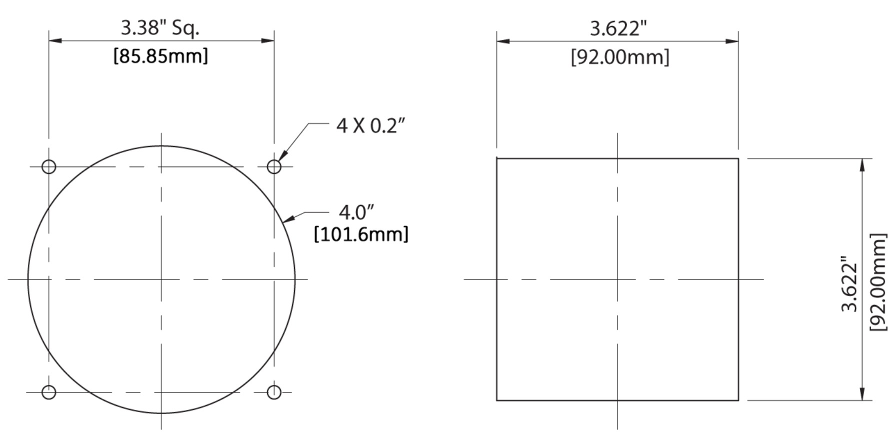


Figure 3-4: ANSI and DIN Cutout Dimensions

Recommended Tools for EPM 7000 Meter Installation:

- #2 Phillips screwdriver

- Small adjustable wrench
- Wire cutters

The EPM 7000 meter is designed to withstand harsh environmental conditions; however it is recommended you install it in a dry location, free from dirt and corrosive substances. (See *Environmental Specifications in Chapter 2*.)

3.2 ANSI Installation Steps

1. Slide meter with Mounting Gasket into panel.
2. 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).

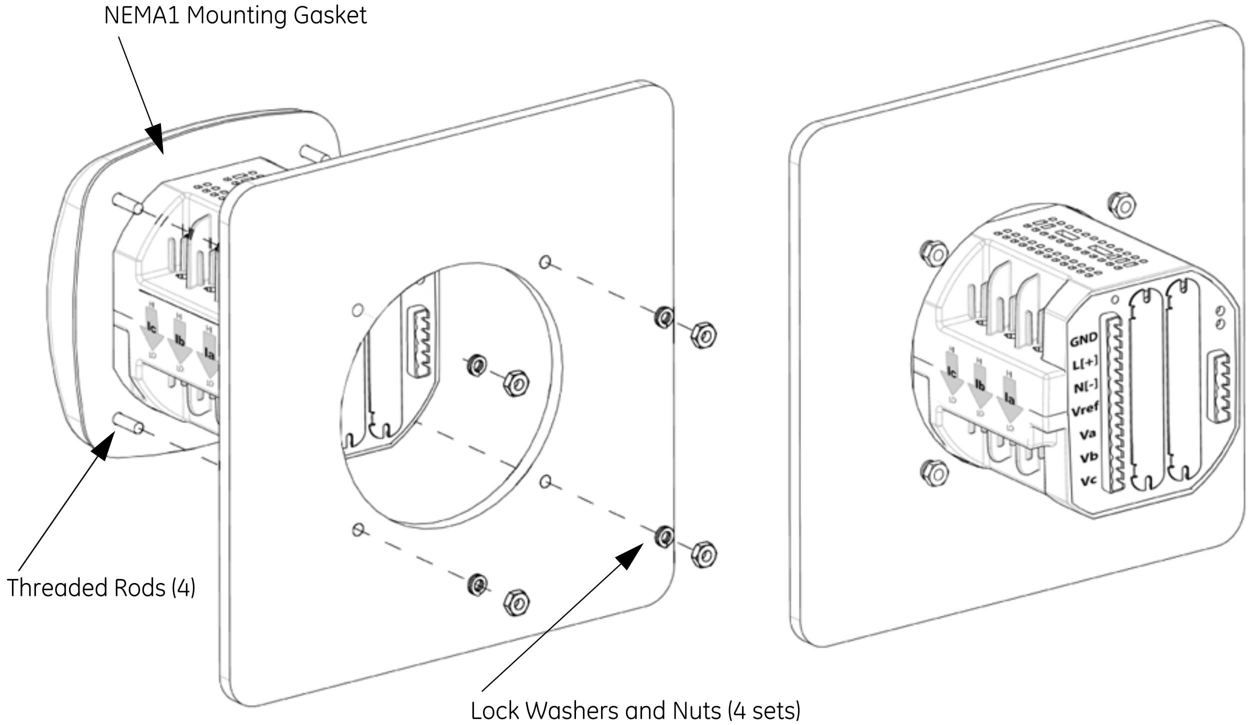


Figure 3-5: ANSI Installation

3.3 DIN Installation Steps

1. Slide meter with NEMA 1 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)

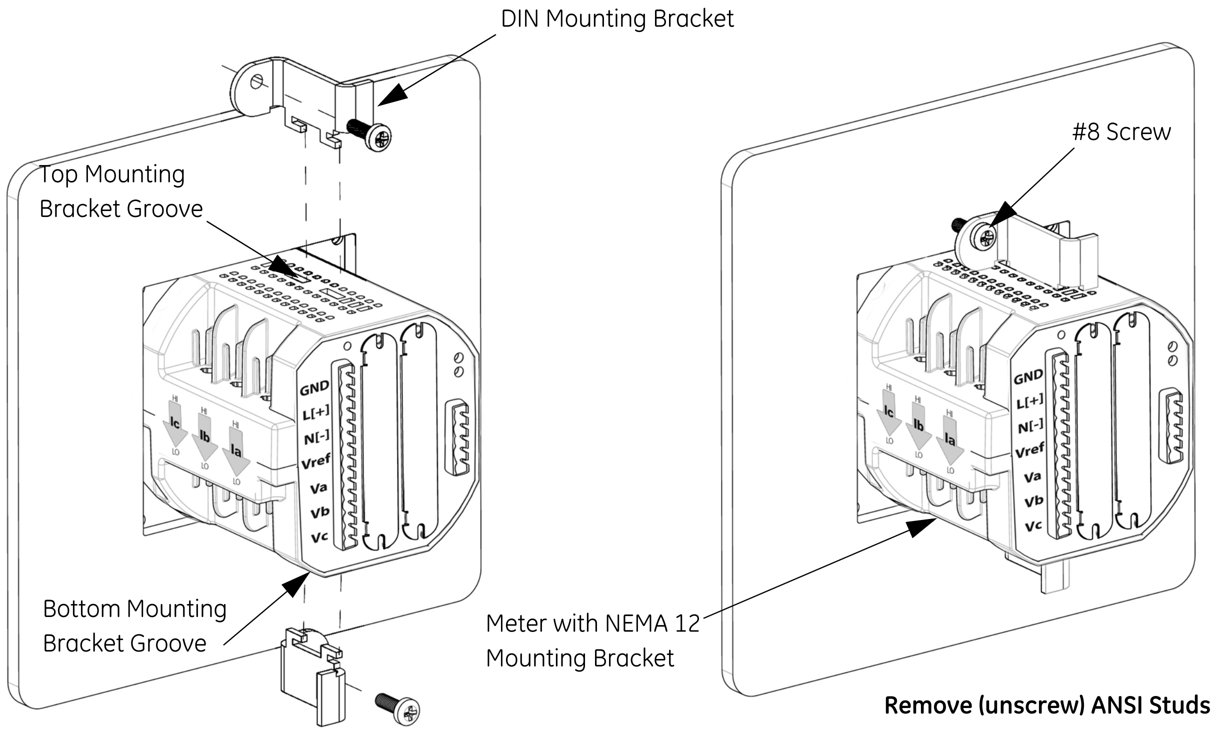


Figure 3-6: DIN Installation

3.4 Transducer installation

Use DIN Rail mounting to install the Multilin EPM 7000T transducer.

Specs for DIN Rail Mounting

International Standards DIN 46277/3

DIN Rail (Slotted) Dimensions

0.297244” x 1.377953” x 3” /.755cm x 3.5cm x 7.62cm

1. Slide top groove of meter onto the DIN Rail.

2. Press gently until the meter clicks into place.

NOTE

- To remove the meter from the DIN Rail, pull down on the Release Clip to detach the unit from the rail (see Figure 3.7).
- If mounting with the DIN Rail provided, use the black rubber stoppers, also provided (see Figure 3.8).

NOTE

DIN RAILS: 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 electrolytically plated cold rolled steel and are also available in aluminum, PVC, stainless steel and copper.

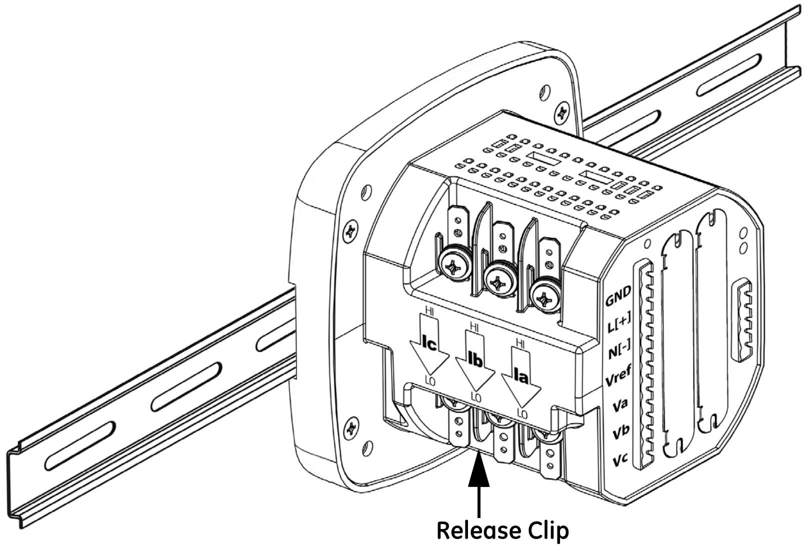


Figure 3-7: Transducer on DIN rail

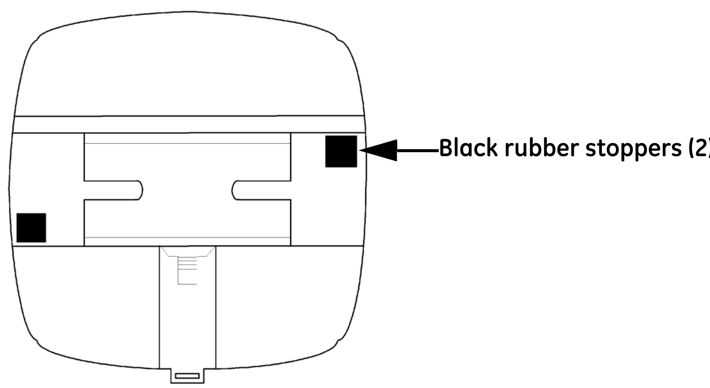


Figure 3-8: DIN rail detail

EPM 7000 Power Quality Meter

Chapter 4: Electrical Installation

4.1 Considerations When Installing Meters

⚠WARNING

POTENTIAL ELECTRICAL EXPOSURE - The EPM 7000/7000T must be installed in an electrical enclosure where any access to live electrical wiring is restricted only to authorized service personnel.

⚠CAUTION

- **Installation of the EPM 7000 meter must be performed by only 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 7000 meter, dangerous voltages are present in many parts of the meter, including: Terminals, CTs, PTs, I/O Modules. 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.

NOTICE

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

⚠WARNING

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

4.2 CT Leads Terminated to Meter

The EPM 7000 meter is designed to have Current Inputs wired in one of three ways. Diagram 4.1 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 and RS485/KYZ Connection is shown in Figure 4.4.

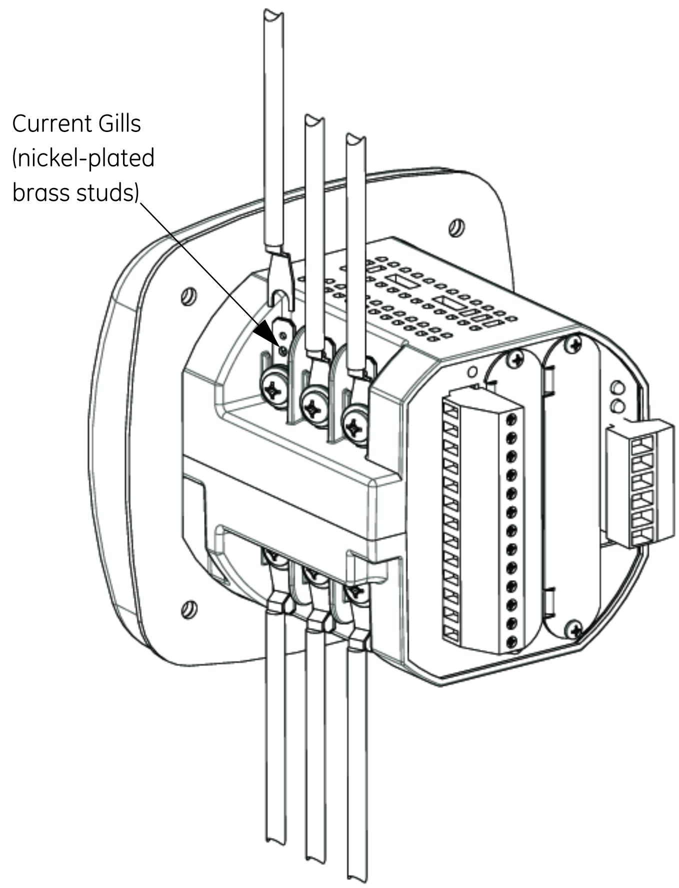


Figure 4-1: CT Leads terminated to Meter, #8 Screw for Lug Connection

Wiring Diagrams are shown in section 4.6 of this chapter.

Communications Connections are detailed in Chapter 5.

4.3 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 accommodates up to 0.177" / 4.5mm maximum diameter CT wire.

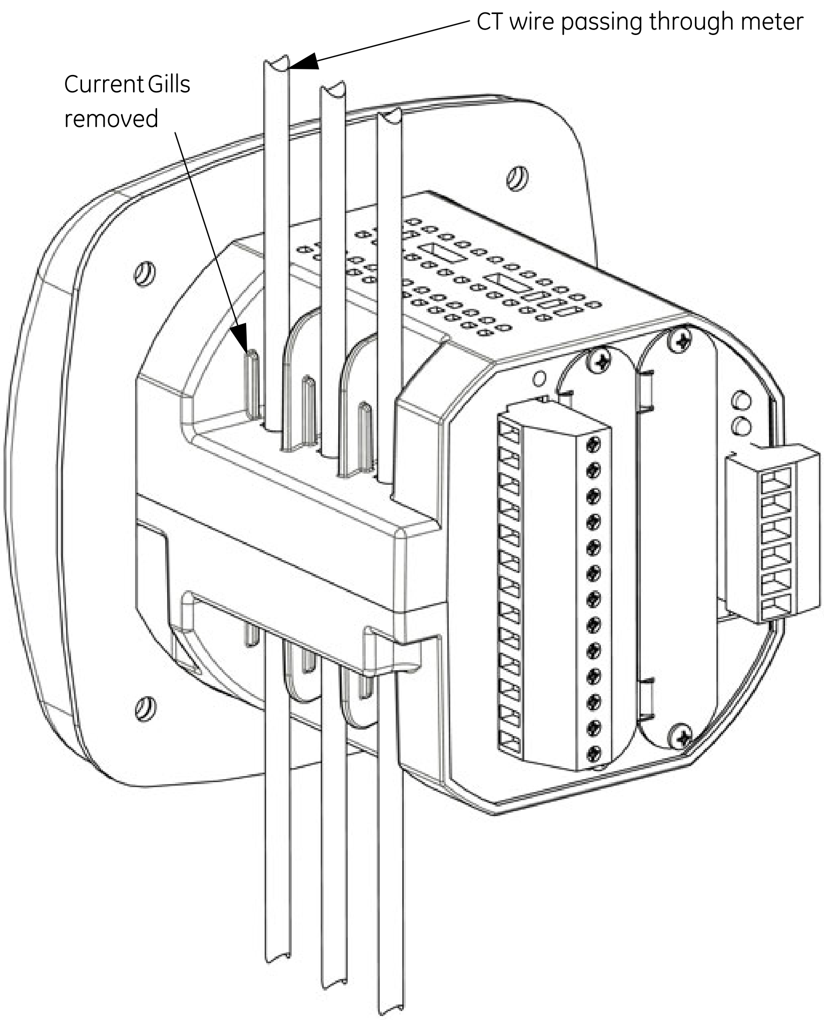


Figure 4-2: Pass-through Wire Electrical Connection

4.4 Quick Connect Crimp-on Terminations

For quick termination or for portable applications, 0.25" Quick Connect Crimp-on Connectors can also be used

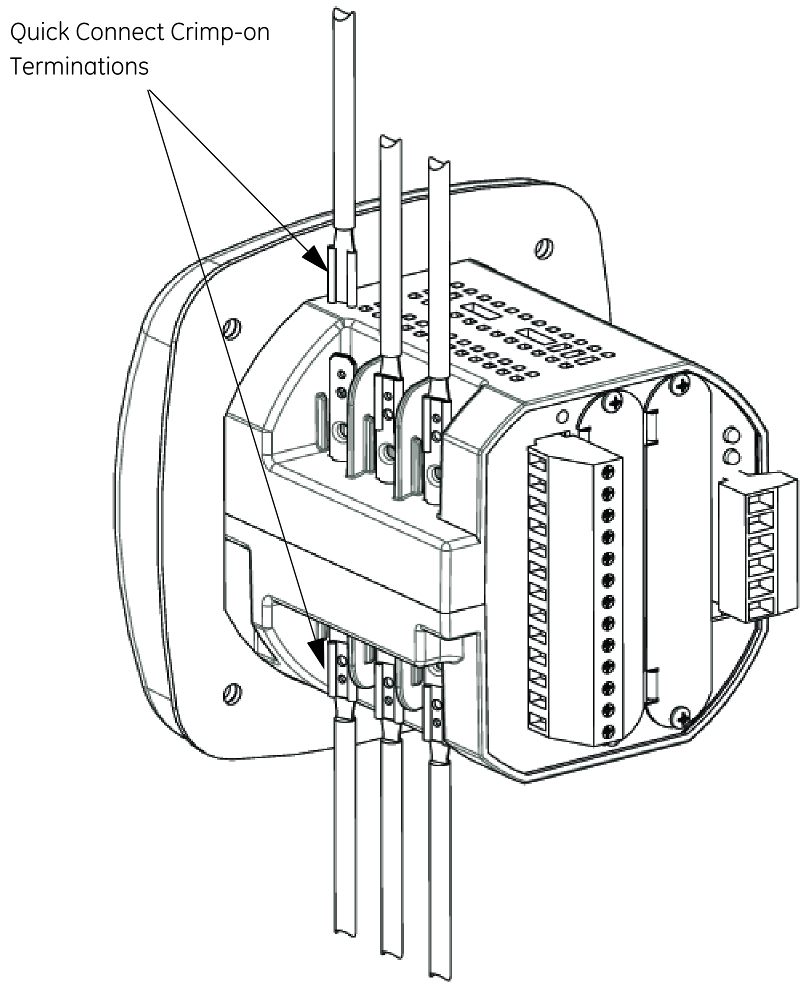


Figure 4-3: Quick Connect Electrical Connection

4.5 Voltage and Power Supply Connections

Voltage Inputs are connected to the back of the unit via a optional wire connectors. The connectors accommodate AWG# 12 -26/ (0.129 - 3.31)mm^2.

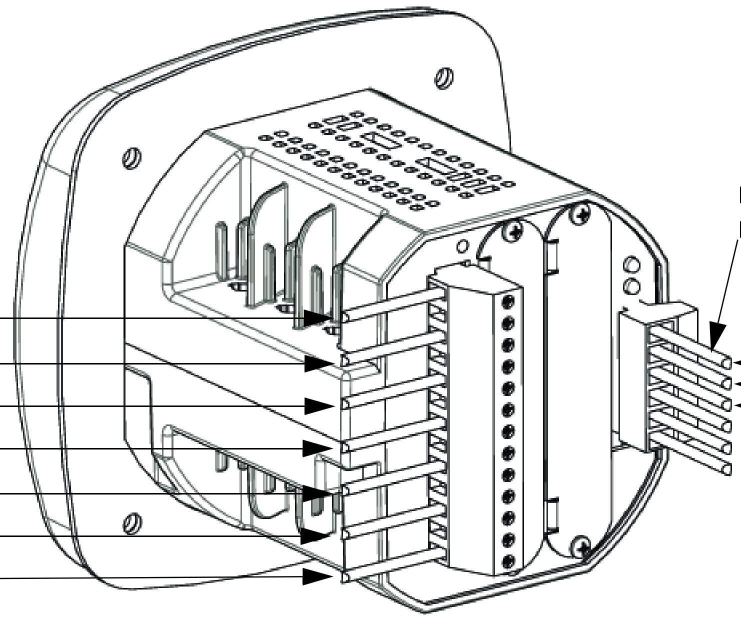


Figure 4-4: Meter Connection

4.5.1 Ground Connections

The meter's Ground Terminals should be connected directly to the installation's protective earth ground. Use AWG# 12/2.5 mm^2 wire for this connection.

4.5.2 Voltage Fuses

GE Digital Energy recommends the use of fuses on each of the sense voltages and on the control power, even though the wiring diagrams in this chapter do not show them.

- Use a 0.1 Amp fuse on each voltage input.
- Use a 3 Amp Slow Blow fuse on the power supply.

4.6 Electrical Connection Diagrams

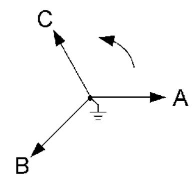
The following pages contain electrical connection diagrams for the EPM 7000 meter. Choose the diagram that best suits your application. Be sure to maintain the CT polarity when wiring.

The diagrams are presented in the following order:

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

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

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



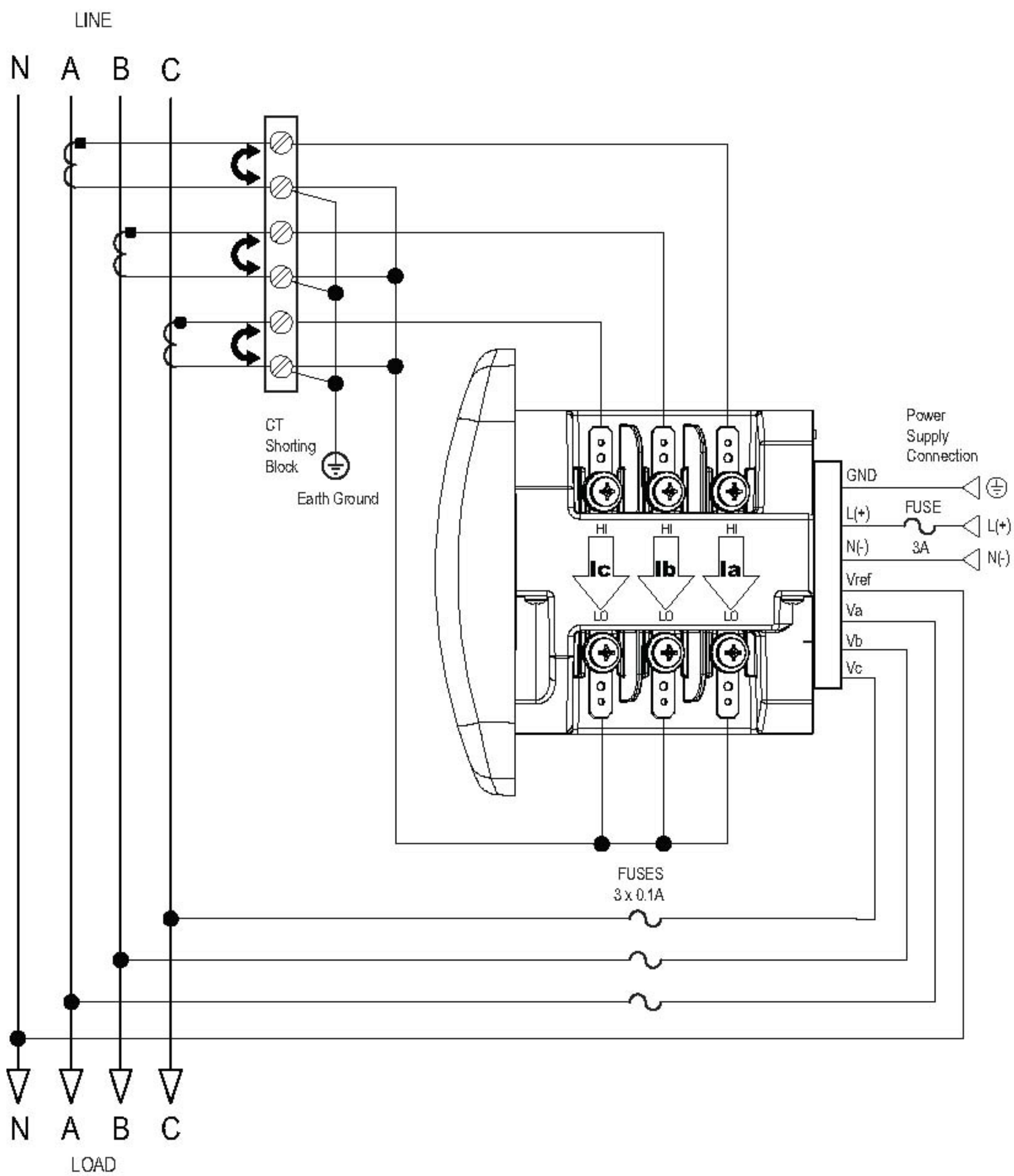


Figure 4-5: 4-Wire Wye with no PTs and 3 CTs, 3 Element

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

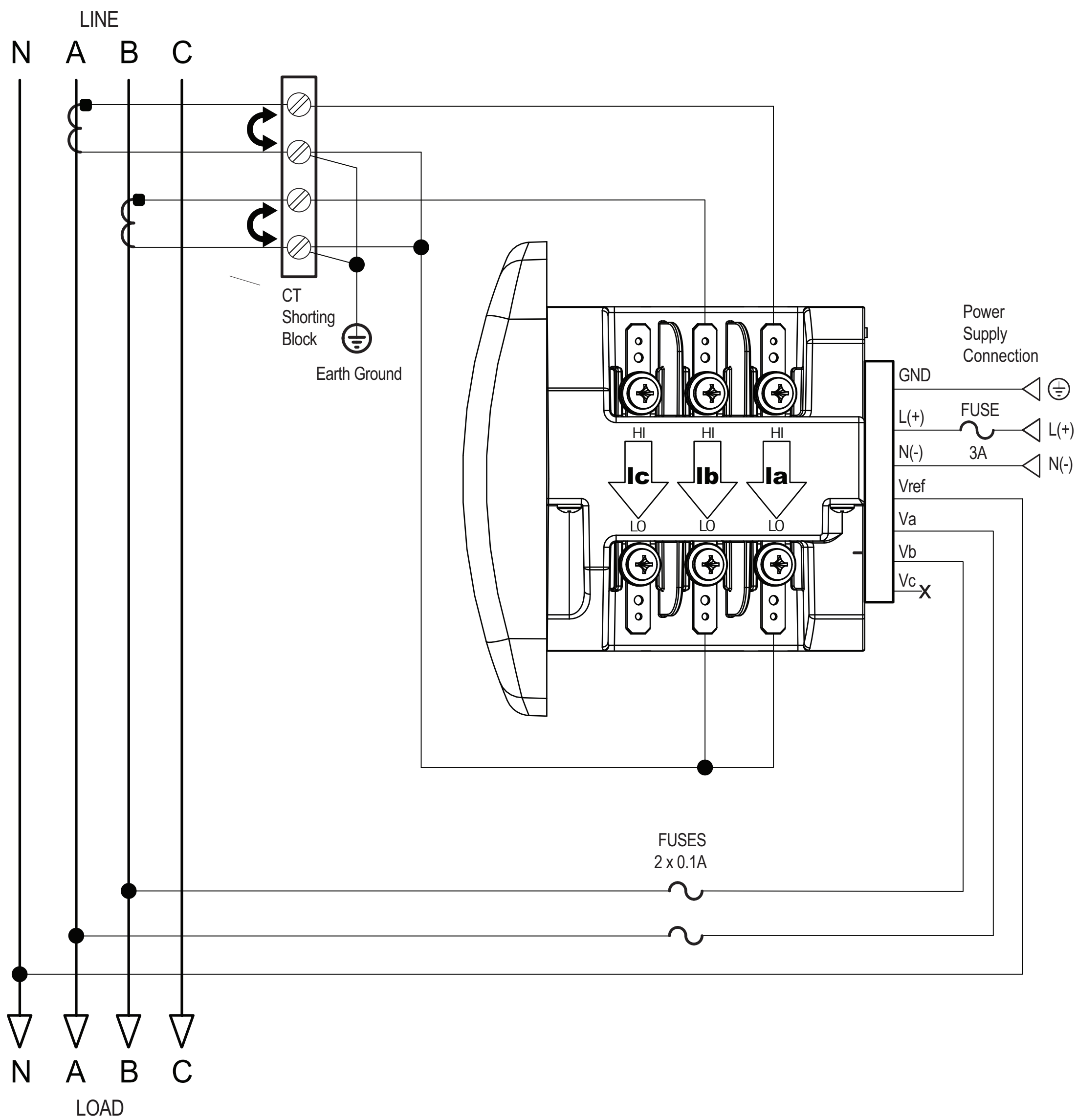


Figure 4-6: (1a) Dual Phase Hookup

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

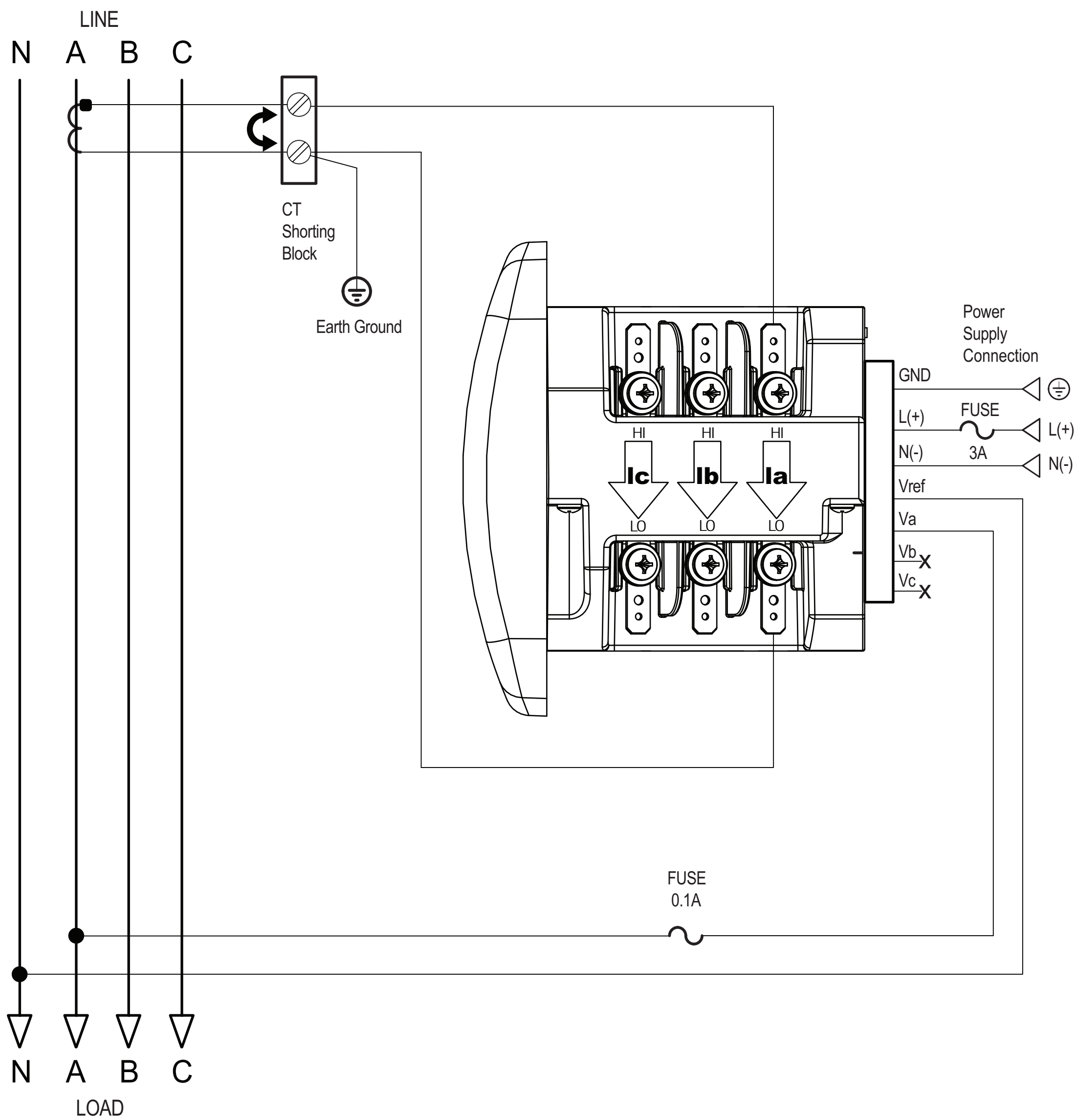
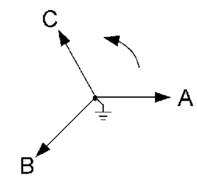


Figure 4-7: (1b) Single Phase Hookup

4.6.2 (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.



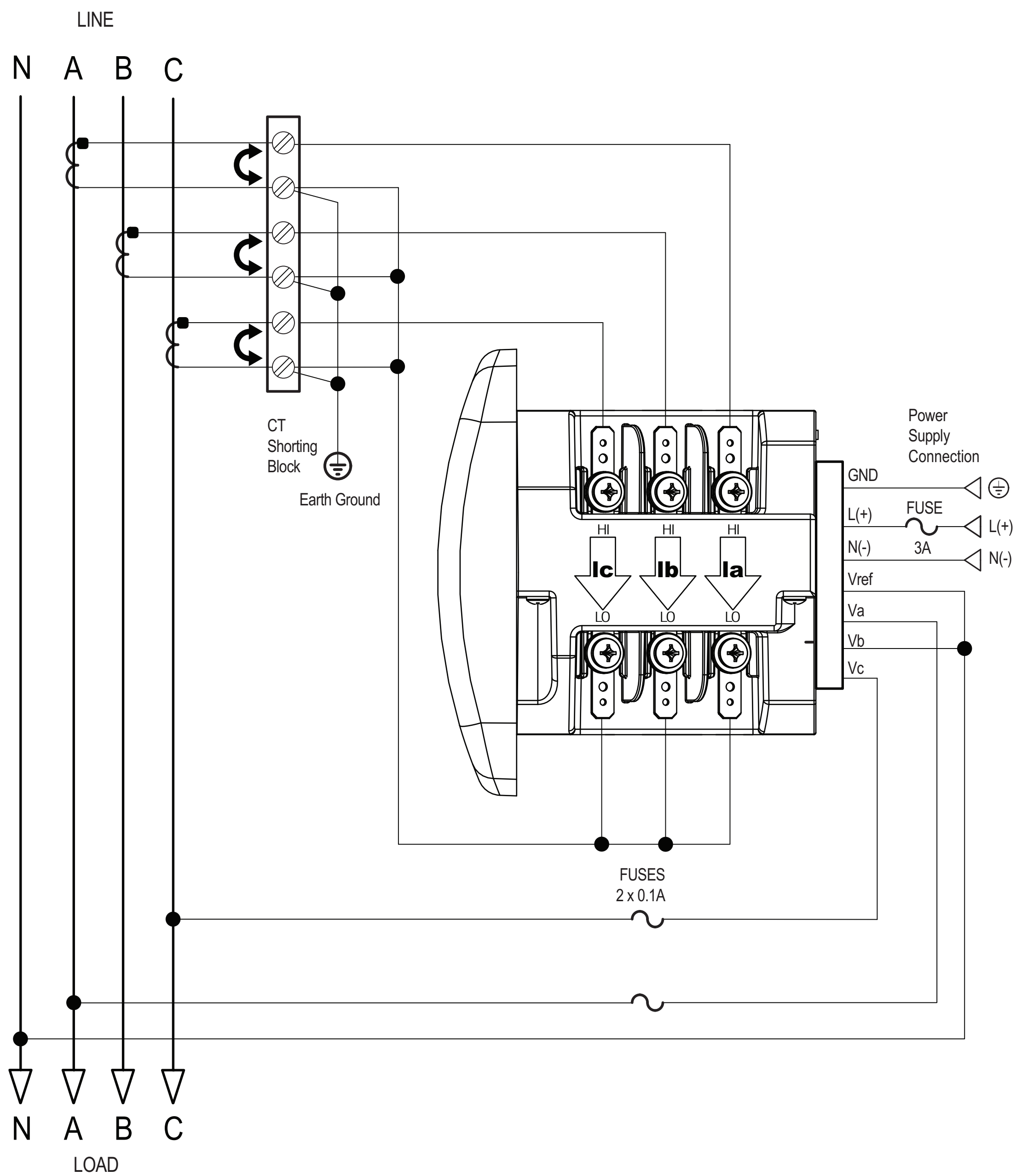
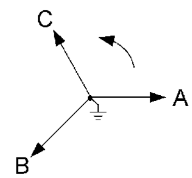


Figure 4-8: 4-Wire Wye with no PTs and 3 CTs, 2.5 Element

4.6.3 (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.



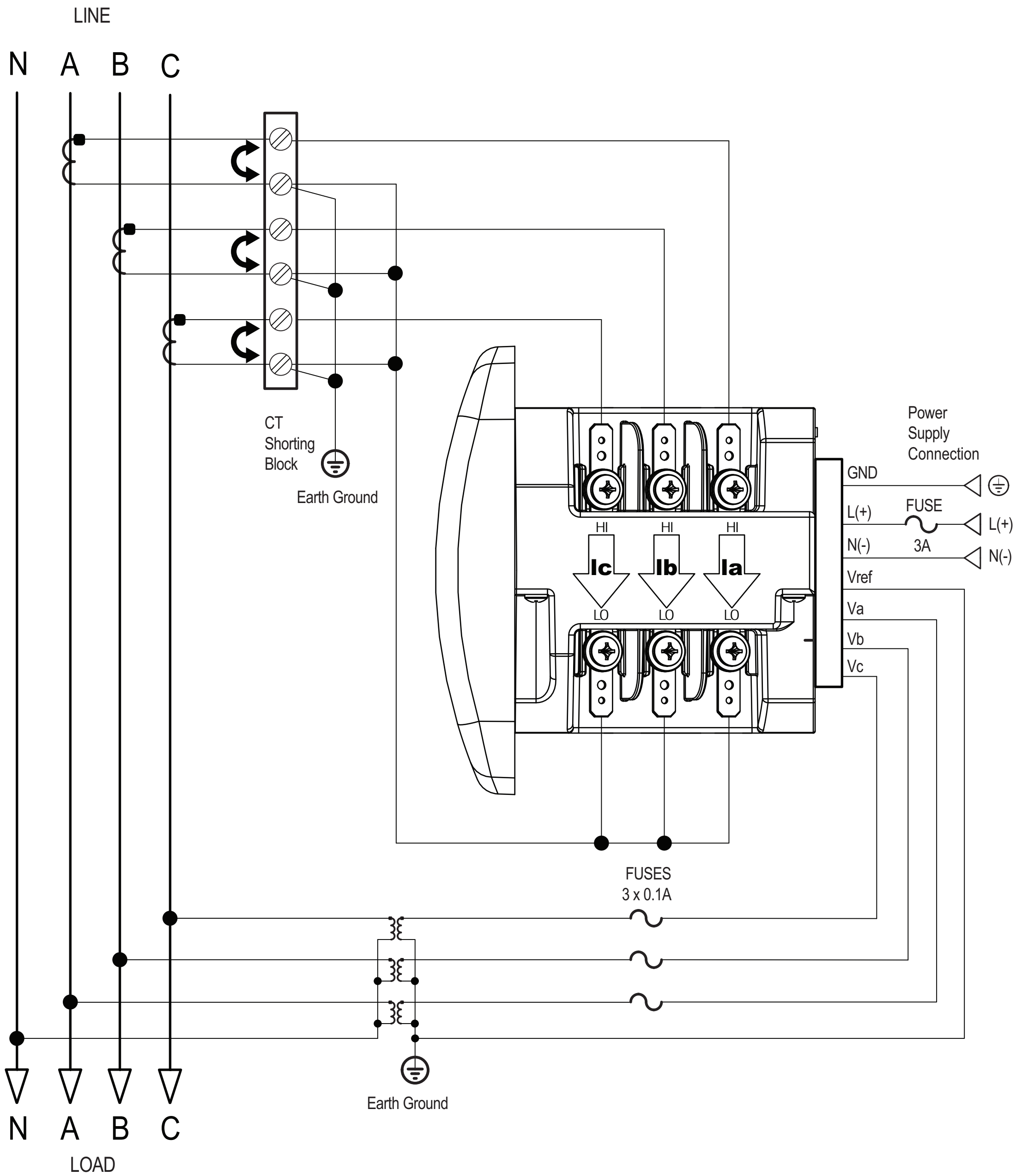
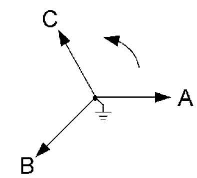


Figure 4-9: 4-Wire Wye with 3 PTs and 3 CTs, 3 Element

4.6.4 (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.



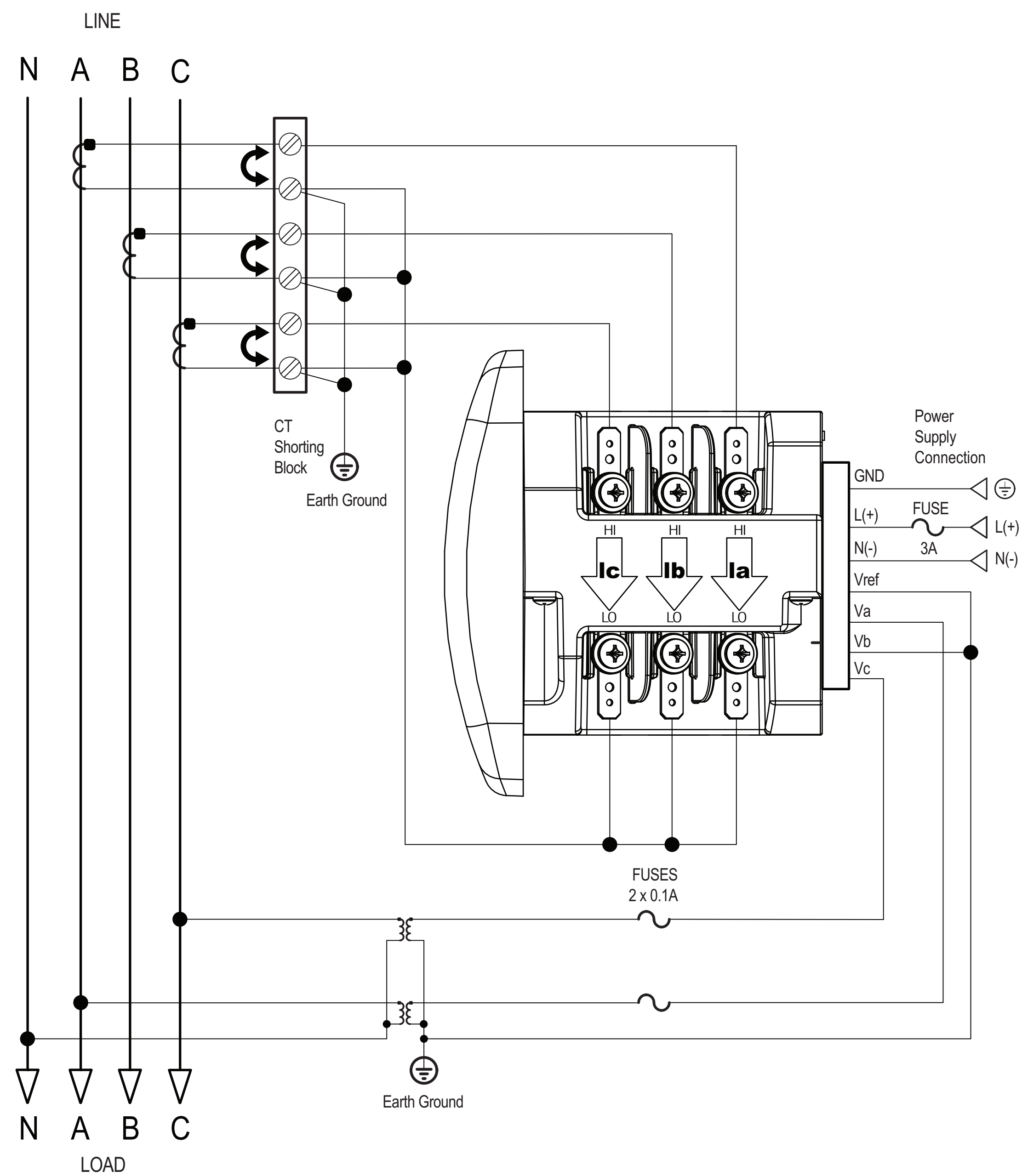
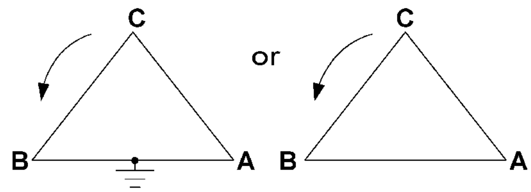


Figure 4-10: 4-Wire Wye with 2 PTs and 3 CTs, 2.5 Element

4.6.5 (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.



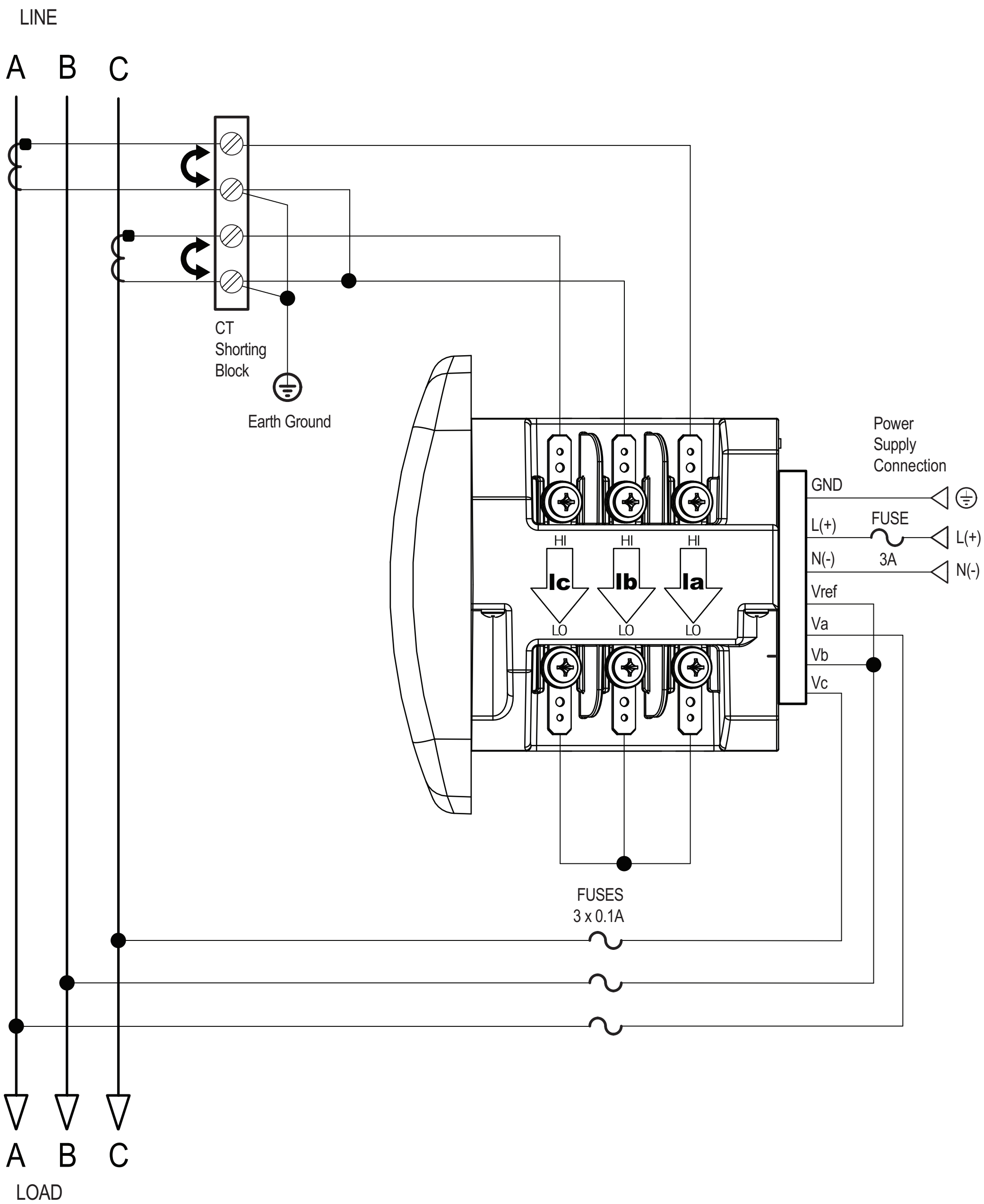
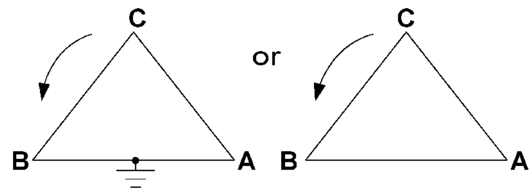


Figure 4-11: 3-Wire Delta with no PTs and 2 CTs

4.6.6 (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.



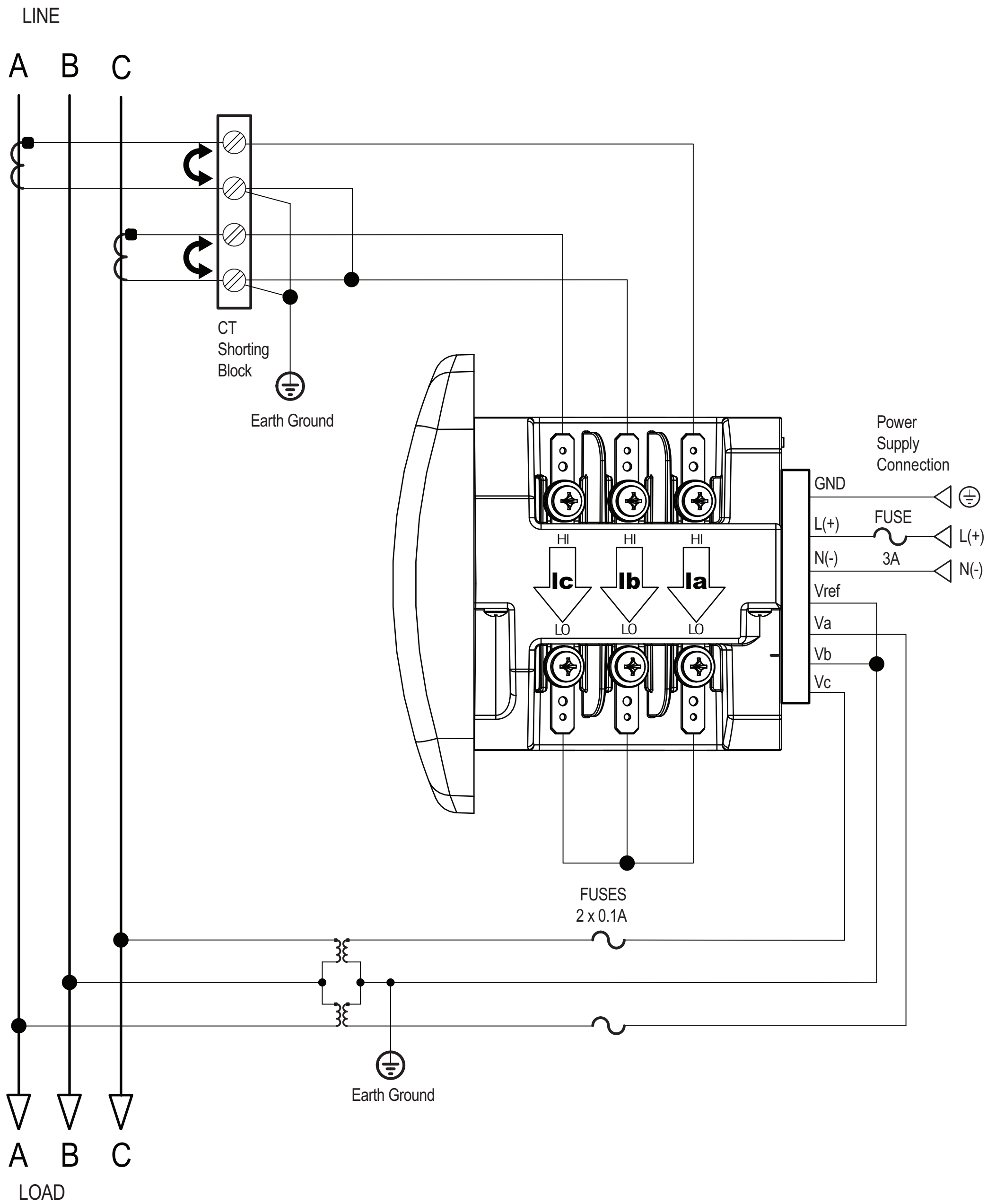
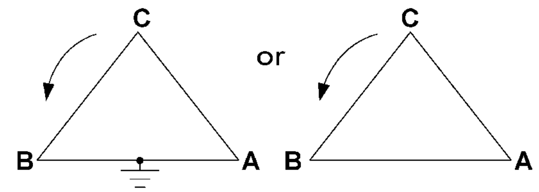


Figure 4-12: 3-Wire Delta with 2 PTs and 2 CTs

4.6.7 (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.



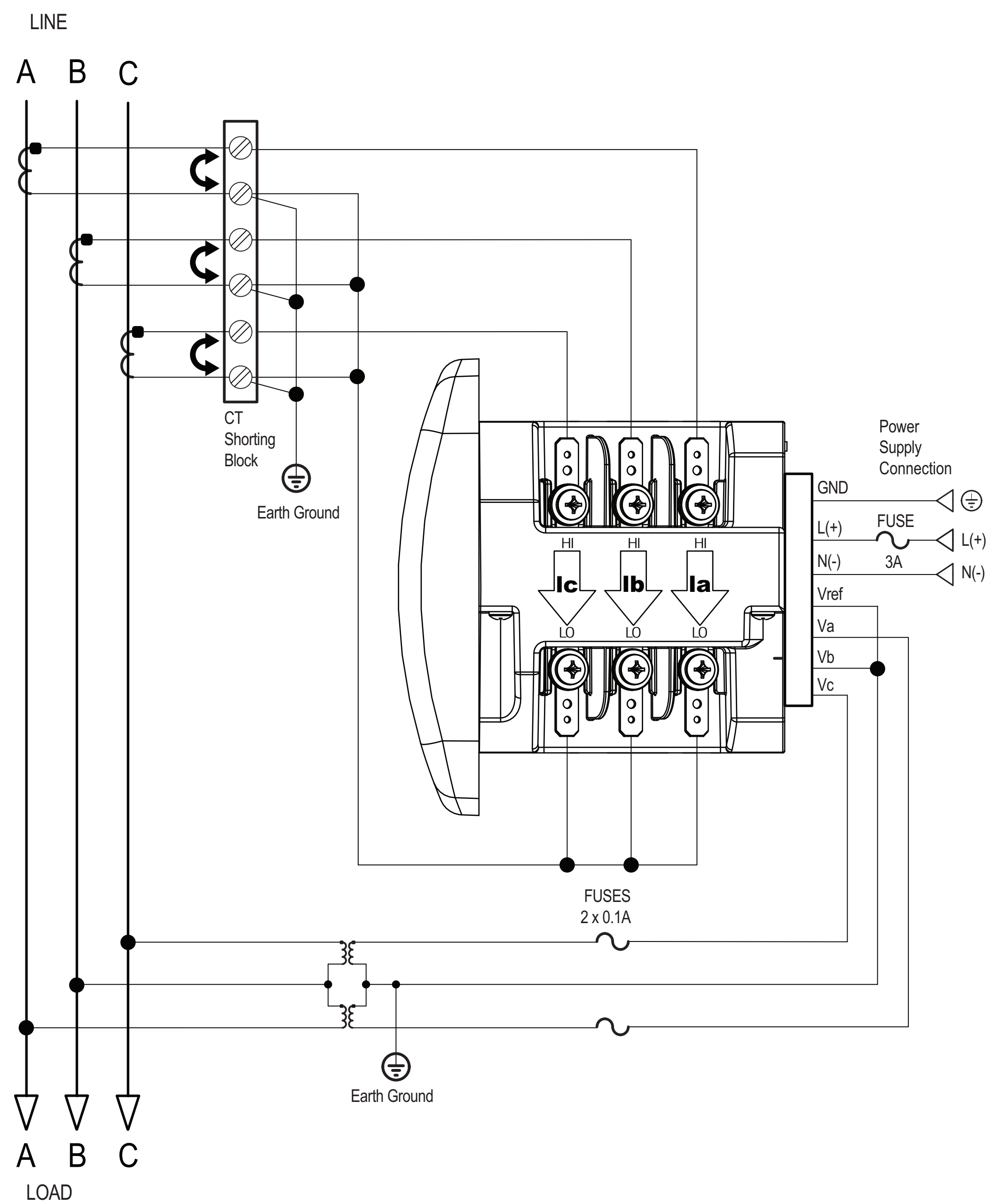


Figure 4-13: 3-Wire Delta with 2 PTs and 3 CTs

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

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

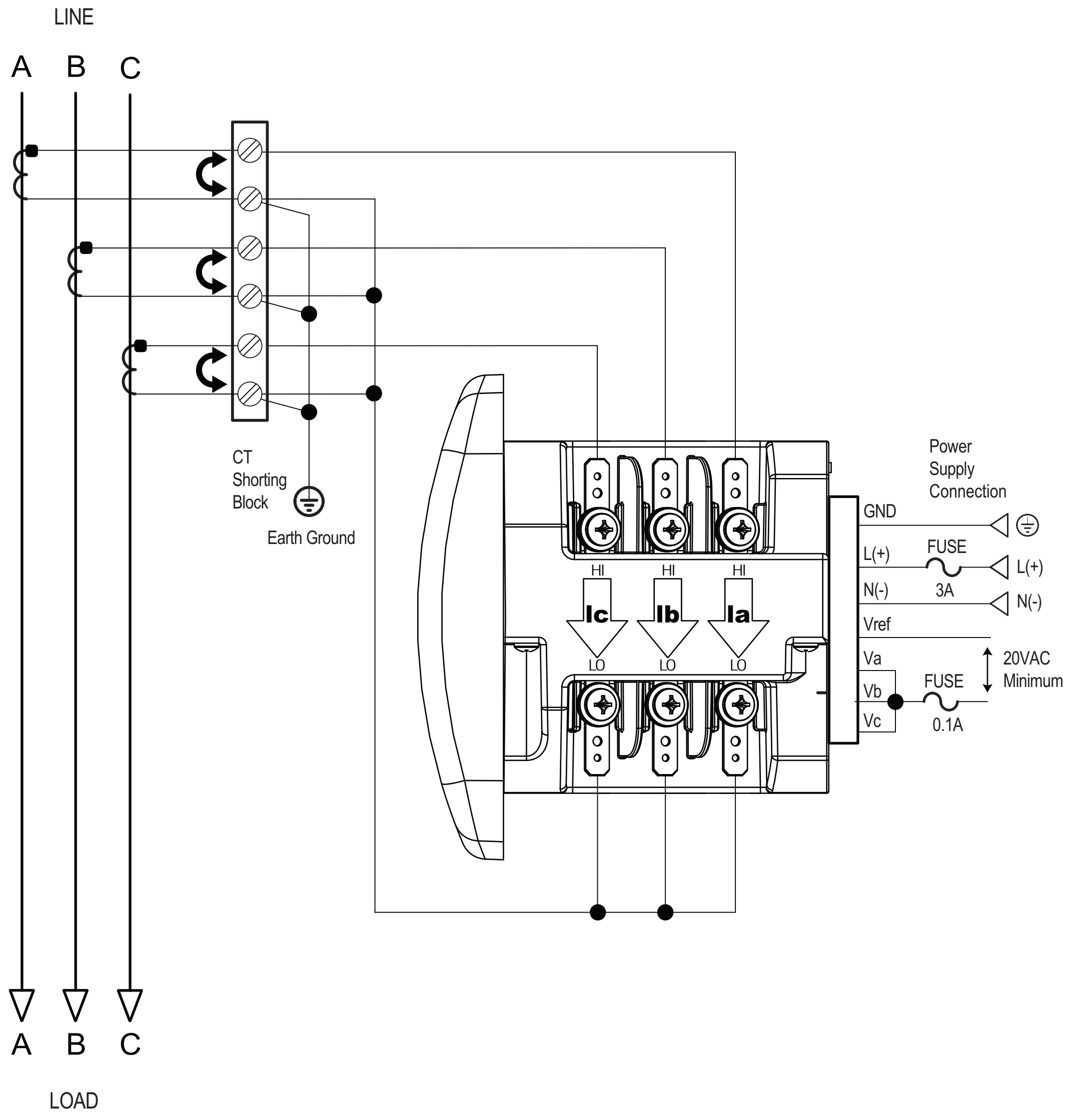


Figure 4-14: Current-Only Measurement (Three-Phase)

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.

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

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

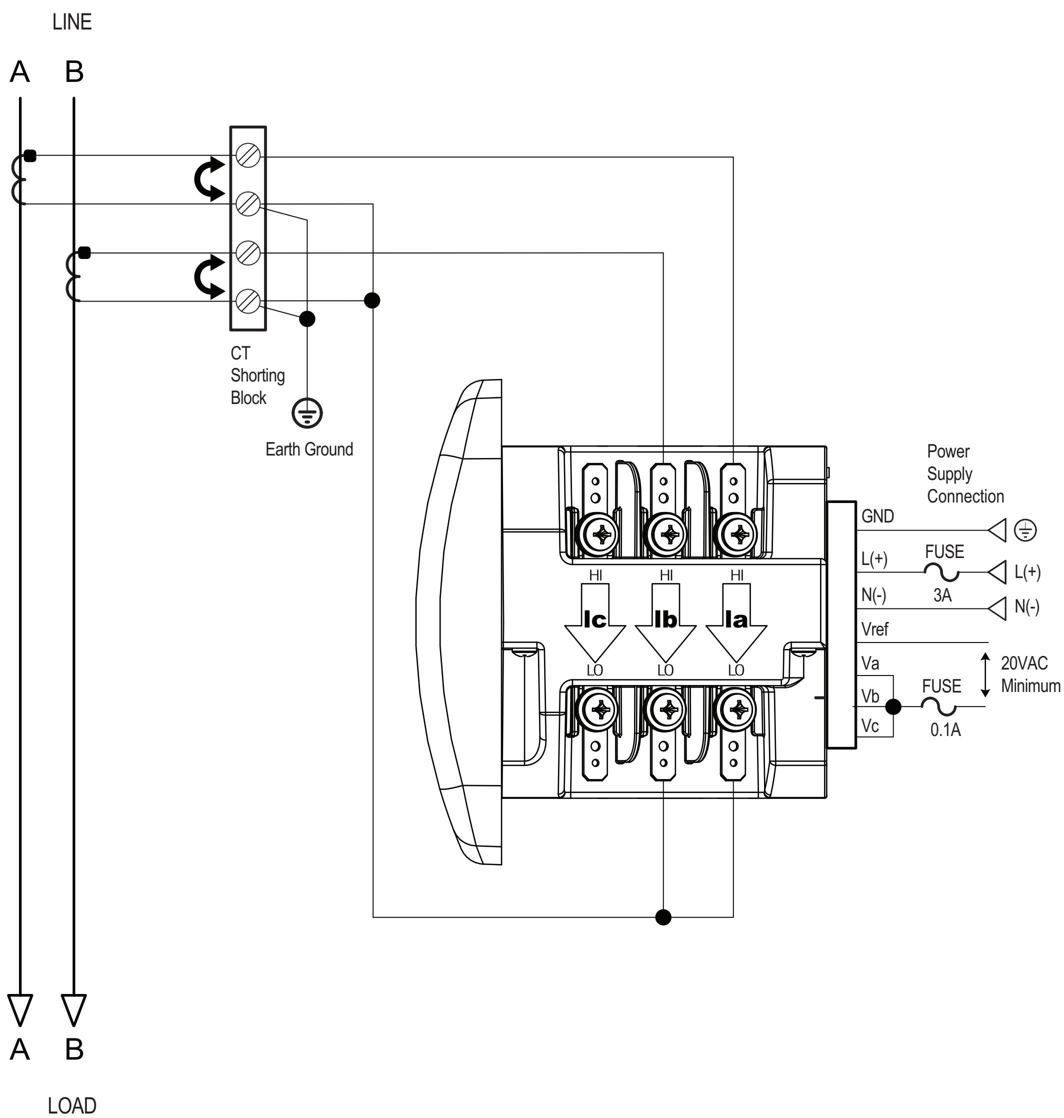


Figure 4-15: Current-Only Measurement (Dual-Phase)

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.

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

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

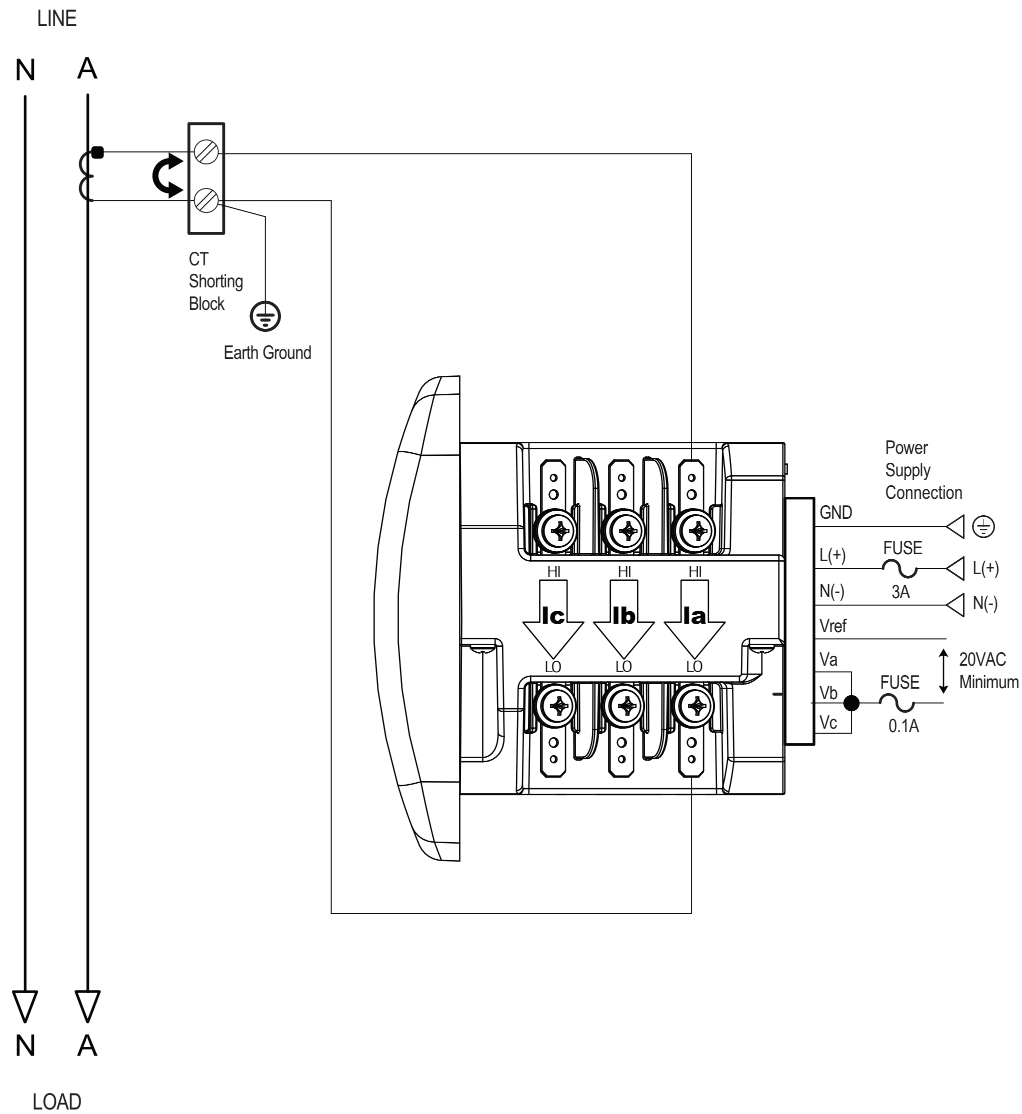


Figure 4-16: Current-Only Measurement (Single-Phase)

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 7000 Power Quality Meter

Chapter 5: Communication Installation

5.1 Multilin™ EPM 7000 Meter Communication

The EPM 7000 meter provides two independent Communication Ports. The first port, COM 1, is an Optical IrDA Port. The second port, COM 2, provides RS485 communication speaking Modbus ASCII, Modbus RTU, and DNP 3.0 protocols. Additionally, the EPM 7000 meter has two optional communication cards: the Fiber Optic Communication Card and the 10/100BaseT Ethernet Communication Card. See *Chapters 7 and 8* for more information on these options.

5.1.1 IrDA Port (COM 1)

The EPM 7000 meter's COM 1 IrDA Port is on the face of the meter. The IrDA Port allows the unit to be read and programmed without the need of a communication cable. Just point at the meter with an IrDA-equipped laptop PC to configure it.

NOTE

- Settings for COM 1 (IrDA Port) are configured using GE Communicator software.
- This port only communicates via Modbus ASCII Protocol.

5.1.2 RS485 / KYZ Output (COM 2)

COM 2 provides a combination RS485 and an Energy Pulse Output (KYZ pulse).

See Chapter 2, Section 2.2 for the KYZ Output Specifications; see Chapter 6, Section 6.4 for Pulse Constants.

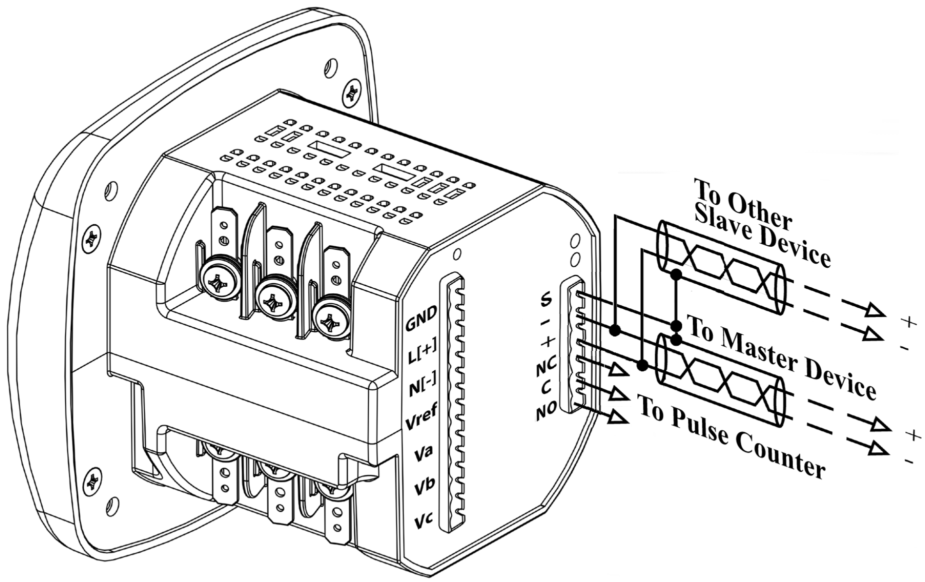


Figure 5-1: EPM 7000 Meter Back with RS485 Communication Installation

RS485 allows you to connect one or multiple EPM 7000 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).

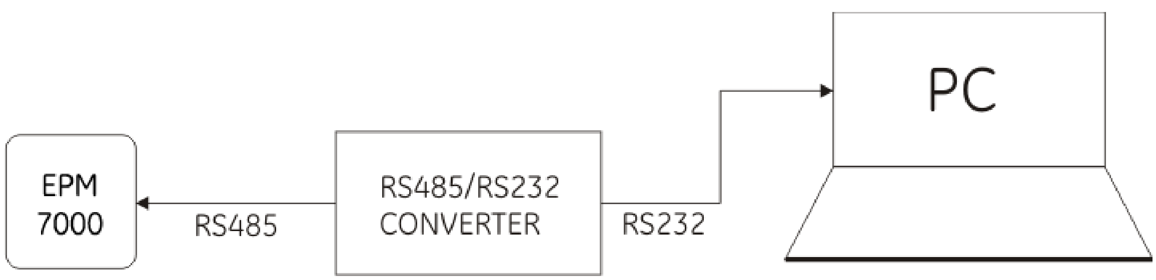


Figure 5-2: EPM 7000 Meter Connected to a PC via RS485 bus

As shown in Figure 5.2, to connect a EPM 7000 meter to a PC, you need to use an RS485 to RS232 converter.

Figure 5.3 shows the detail of a 2-wire RS485 connection.

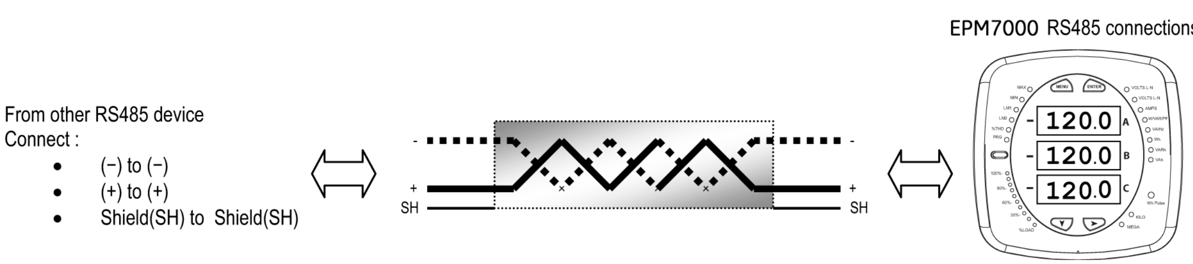


Figure 5-3: 2-wire RS485 Connection

NOTICE

For All RS485 Connections:

- Use a shielded twisted pair cable and ground the shield, preferably at one location 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 have 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 5.5).
- No more than two cables should be connected at any one point on an RS485 network, whether the connections are for devices, converters, or terminal strips.
- Include all segments when calculating the total cable length of a network. If you are not using an RS485 repeater, the maximum length for cable connecting all devices is 4000 feet (1219.20 meters).
- Connect shield to RS485 Master and individual devices as shown in Figure 5.4. 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 5.4 below, shows a representation of an RS485 Daisy Chain connection.

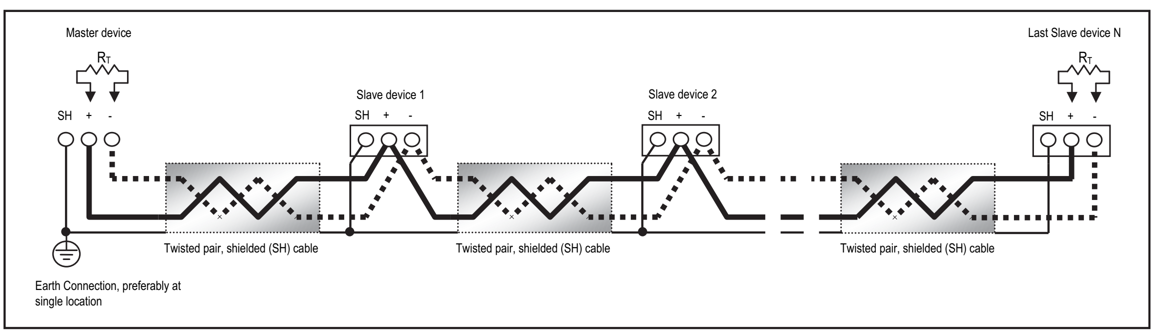


Figure 5-4: RS485 Daisy Chain Connection

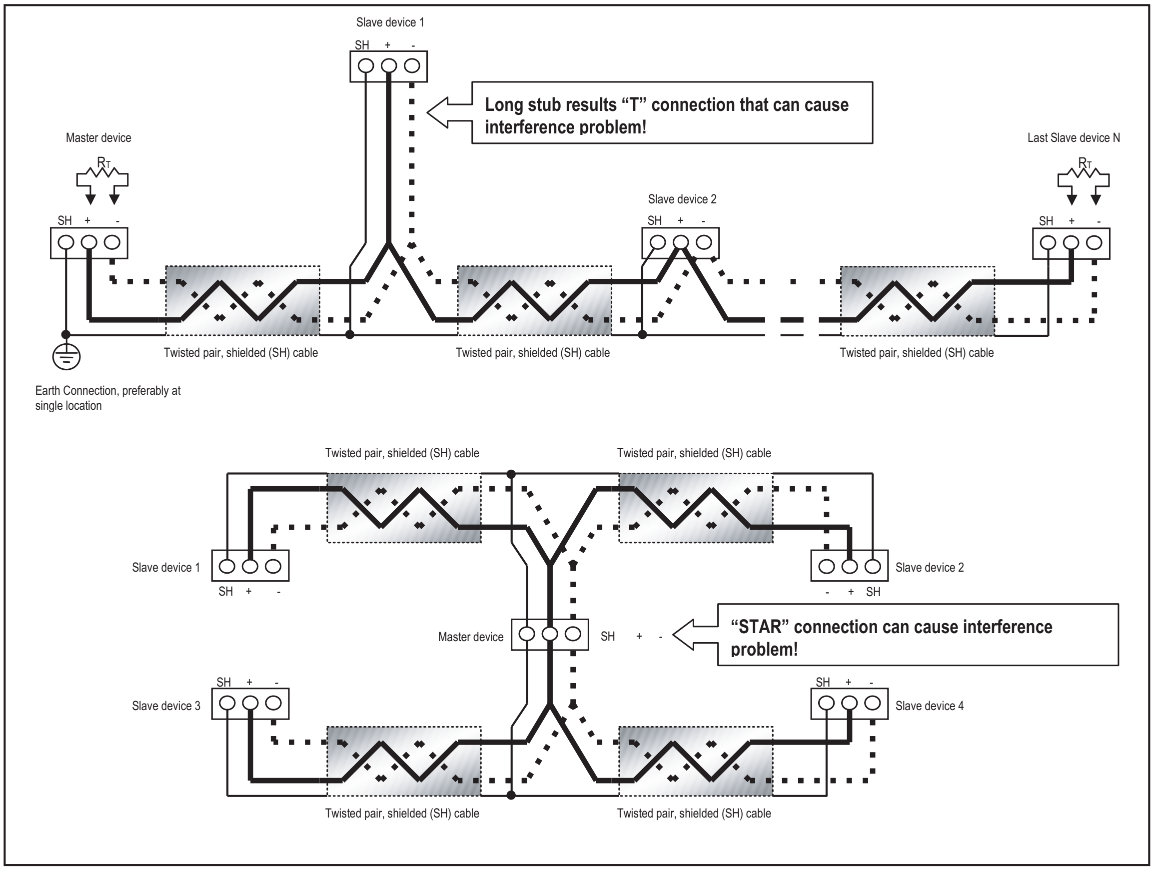


Figure 5-5: Incorrect "T" and "Star" Topologies

5.2 EPM 7000T Transducer communication and programming overview

The Multilin EPM 7000T transducer does not include a display on the front face of the meter; there are no buttons or IrDA Port on the face of the meter. Programming and communication utilize the RS485 connection on the back of the meter as shown in Figure 5.1. Once a connection is established, GE Communicator software can be used to program the meter and communicate to Multilin EPM 7000T transducer slave devices.

Meter Connection

To provide power to the meter, attach an Aux cable to GND, L(+) and N(-). Refer to Section 4.6, Figure 1.

The RS485 cable attaches to SH, - and + as shown in Figure 5.1.

5.2.1 Accessing the Meter in Default Communication Mode

You can connect to the EPM 7000T in Default Communication mode. This feature is useful in debugging or if you do not know the meter's programmed settings and want to find them. For 5 seconds after the EPM 7000T is powered up, you can use the RS485 port with Default Communication mode to poll the Name Register. You do this by connecting to the meter with the following default settings (see Section 5.2.2):

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 5 minutes of no activity, the meter reverts to the programmed Device Profile settings.

NOTICE

Important: In Normal operating mode the initial factory communication settings are:

Baud Rate: 57,600

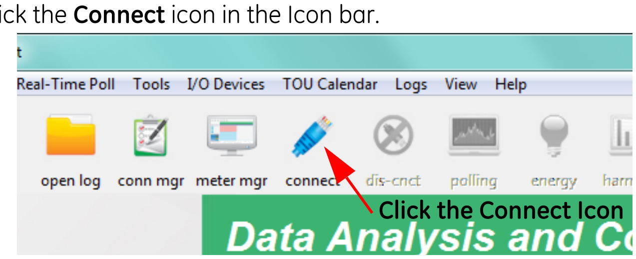
Address: 001

Protocol: Modbus RTU

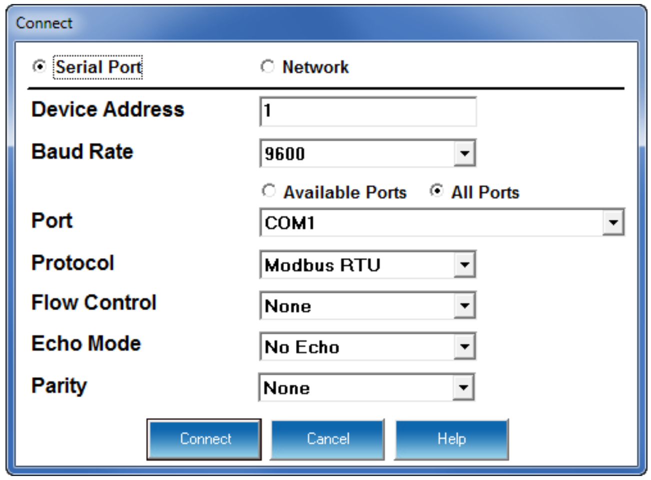
5.2.2 Connecting to the Meter through GE Communicator

How to Connect:

1. Open the GE Communicator software.
2. Click the **Connect** icon in the Icon bar.

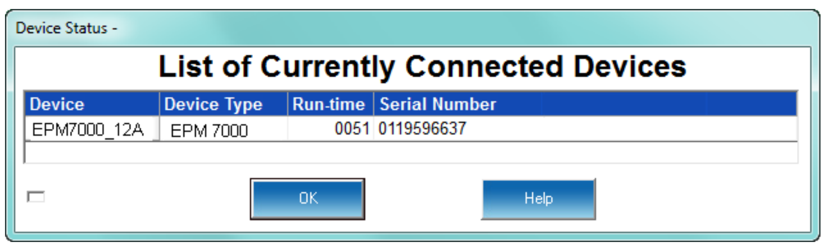


3. The Connect screen opens, showing the Default settings. Make sure your settings are the same as shown here. Use the pull-down menus to make any necessary changes to the settings.



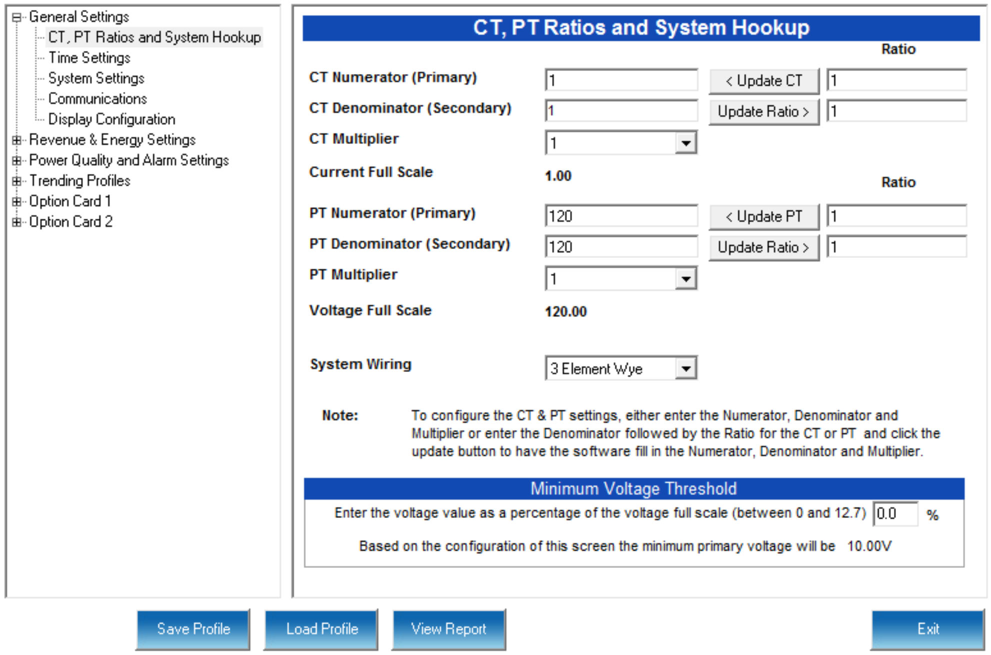
4. Click the **Connect** button. If you have a problem connecting, you may have to disconnect power to the meter, then reconnect power and click the Connect button, again.

5. You will see the Device Status screen, confirming connection to your meter. Click **OK**.

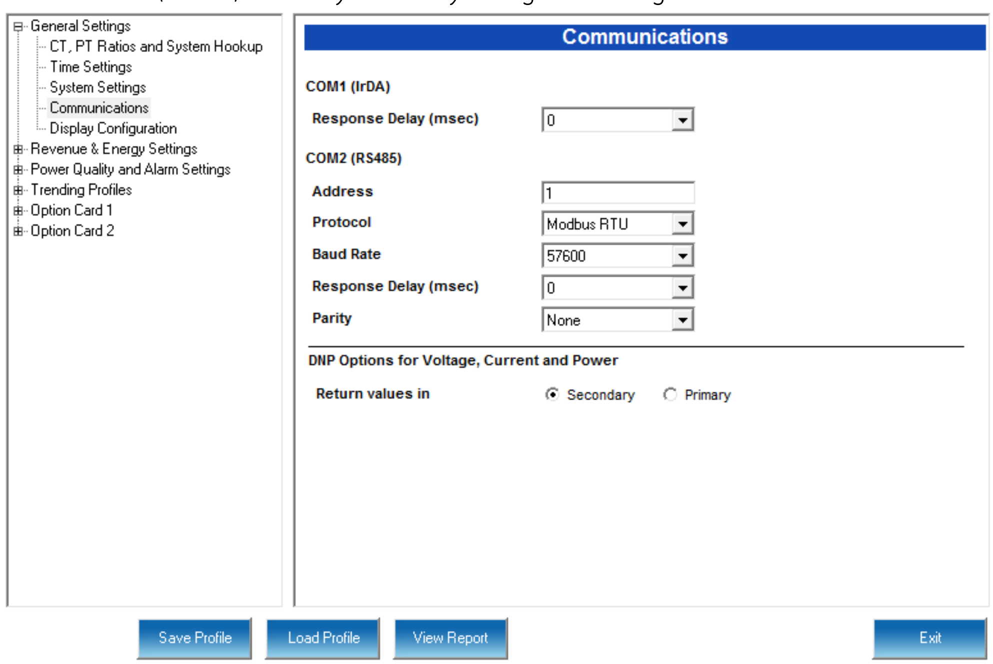


6. Click the **Profile** icon in the Title Bar.

7. You will see the EPM 7000 meter's Device Profile screen. The Menu on the left side of the screen allows you to navigate between settings screens (see below).



Click **Communications**. You will see the screen shown below. Use this screen to enter communication settings for the meter's two on-board ports: the IrDA Port (COM 1) and RS485 Port (COM 2) Make any necessary changes to settings



Valid Communication Settings are as follows:

COM1	(IrDA)
Response Delay	(0-750 msec)
COM2	(RS485)

Address	(1-247; for DNP ONLY 1 - 65520)
Protocol	(Modbus RTU, Modbus ASCII or DNP)
Baud Rate	(1200 to 57600)*
Response Delay	(0-750 msec)
Parity	(Odd, Even, or None)

* Your meter must have Runtime Firmware version 26 or higher to set Baud rates of 1200, 2400, and 4800, and to set Parity.

DNP Options for Voltage, Current, and Power: These fields allow you to choose Primary or Secondary Units for DNP, and to set custom scaling if you choose Primary. See the *GE Communicator Instruction Manual* for more information.

NOTE

You must set the DNP polling software to multiply by the divisor amount before showing the final value.

8. When changes are complete, click the **Update Device** button to send a new profile to the meter.
9. Click **Exit** to leave the Device Profile or click other menu items to change other aspects of the Device Profile (see following section for instructions).

5.3 Multilin™ EPM 7000 Meter Device Profile Settings

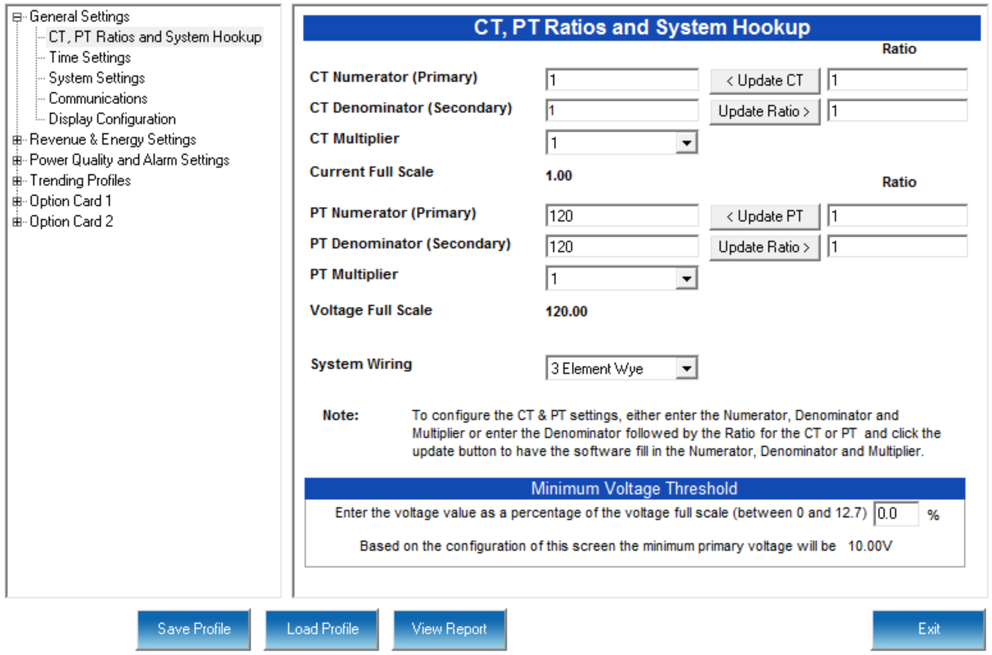
NOTE

Modification to the Device Profile may cause improper Option Card operation due to changed Scaling, etc. Verify or update Programmable Settings related to any Option Cards installed in the EPM 7000 meter.

NOTE

Only the basic EPM 7000 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 Hookup:



IMPORTANT! You have two options for entering the CT and PT settings. You can either enter CT/PT Numerator, Denominator, and Multiplier manually (see instructions below), or you can enter the Ratios for CT/PT Numerator and Denominator and click the Update CT/ Update PT buttons to let the software calculate the Numerator, Denominator, and Multiplier for you. You can then empty the Ratio fields and click the Update Ratio buttons to confirm the calculated settings: you will see the same ratios you initially entered.

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.

Either CT Multiplier (Scaling): 1, 10 or 100 and click **Update Ratio**

OR Ratio: the ratio to be applied, and click **Update CT**

Current Full Scale: Display only.

PT Ratios:

PT Numerator (Primary): 1 - 9999

PT Denominator (Secondary): 40 - 600

PT Multiplier: 1, 10, 100, or 1000

Voltage Full Scale: Display only.

System Wiring:

3 Element Wye; 2.5 Element Wye; 2 CT Delta

Example Settings:

For a CT of 2000/5A, set the following CT Ratios in the entry fields:

CT Numerator (Primary) 2000

CT Denominator (Secondary) 5

CT Multiplier 1

The Current Full Scale field will read 2000.

NOTE

You can obtain the same Current Full Scale by entering a CT Numerator of 200 and a CT Multiplier of 10.

For a system that has 14400V primary with a 120V secondary line to neutral (PT Ratio of 120:1), set the following PT Ratios in the entry fields:

PT Numerator (Primary) 1440

PT Denominator (Secondary) 120

PT Multiplier 10

The Voltage Full Scale field will read 14.4k.

Use the box at the bottom of the screen to enter the minimum voltage threshold, which is a percentage of the voltage full scale. Enter a percentage between 0 and 12.7 in the % entry field. The minimum primary voltage based on the percentage you entered is displayed at the bottom of the screen.

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-Multiplier value is 100

345,000/115 Volts: Pt-n value is 3450, 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

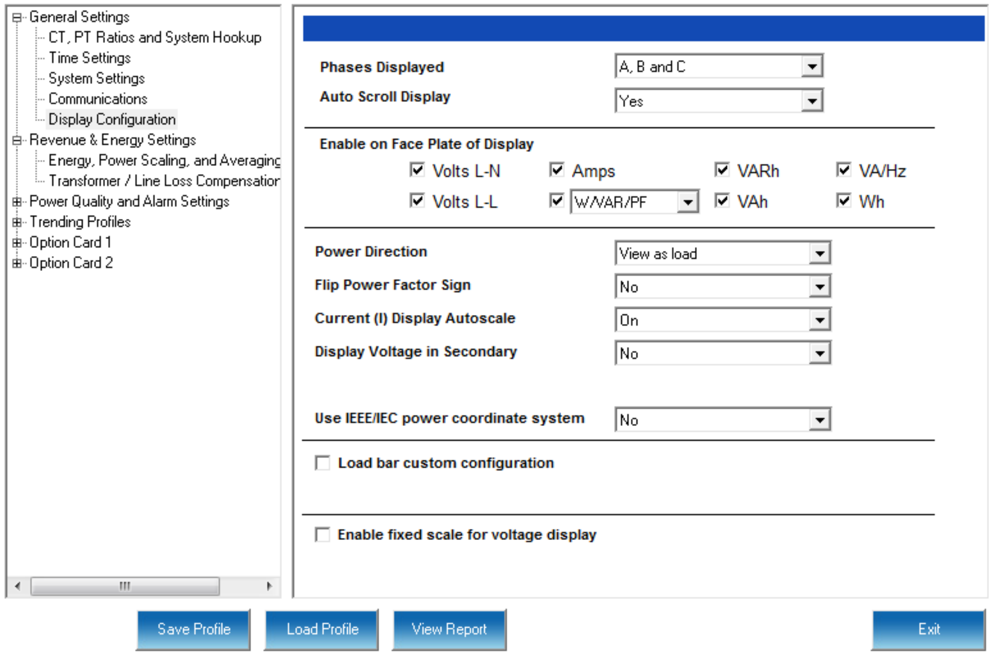
Settings are the same for Wye and Delta configurations.

Display Configuration

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

NOTE

For an EPM 7000T transducer, the Display Configuration setting does not apply as there is no display.



The screen fields and acceptable entries are as follows:

Phases Displayed: A; A and B; A, B, and C. This field determines which phases display on the faceplate. For example, if you select A and B, only those two phases will be displayed on the faceplate.

Auto Scroll Display: Yes or No. This field enables/disables the scrolling of selected readings on the faceplate. If enabled, the readings scroll every 5 seconds.

Enable on Face Plate of Display: Check the boxes of the Readings you want displayed on the faceplate of the meter. You must select at least one reading.

Power Direction: View as Load or View as Generator; this controls how energy is accumulated in the EPM 7000. View as Load means the energy readings are accumulated as Whrs Received, View as Generator means the energy readings are accumulated as Whrs Delivered.

Flip Power Factor Sign: Yes or No.

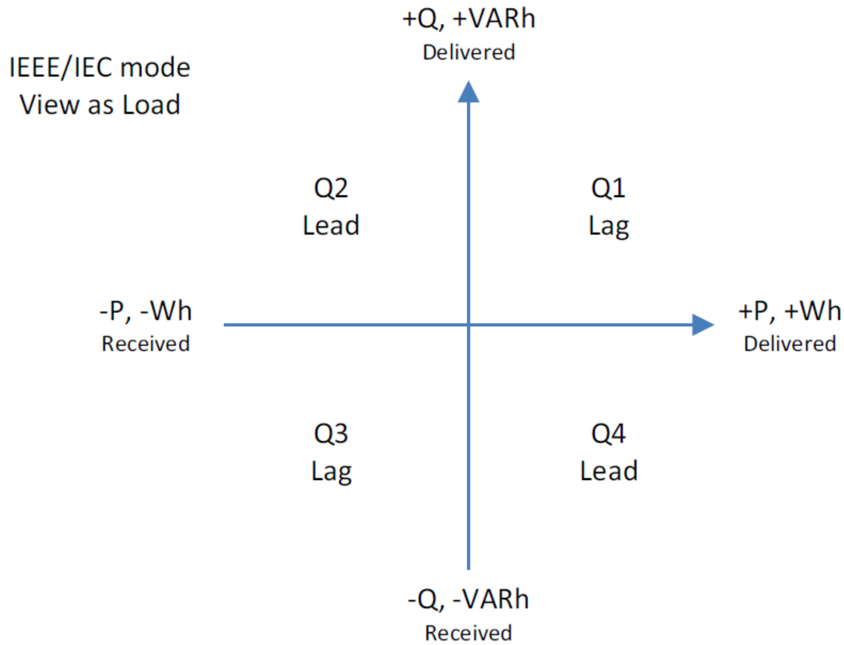
Current (I) Display Autoscale: On to apply scaling to the current display or Off (No decimal places).

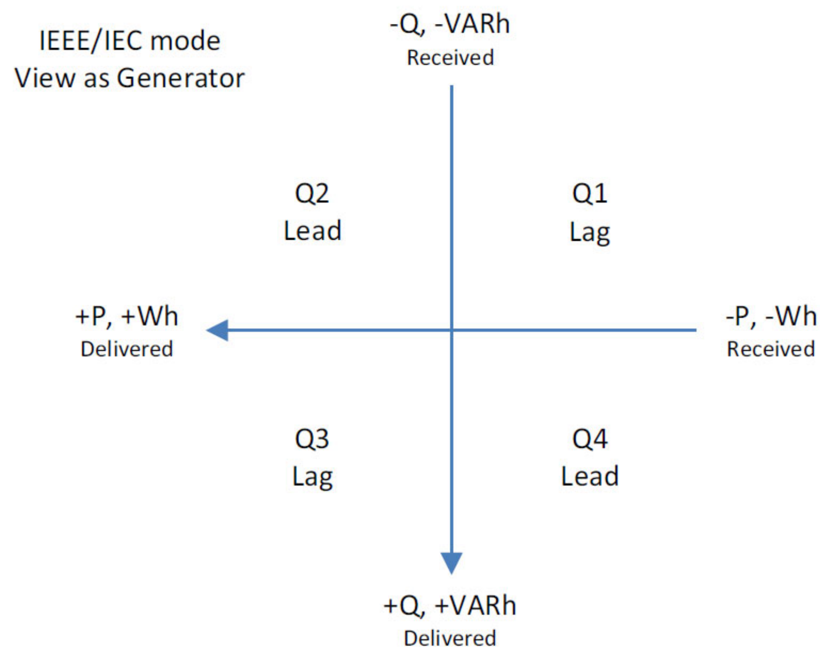
Display Voltage in Secondary: Yes or No.

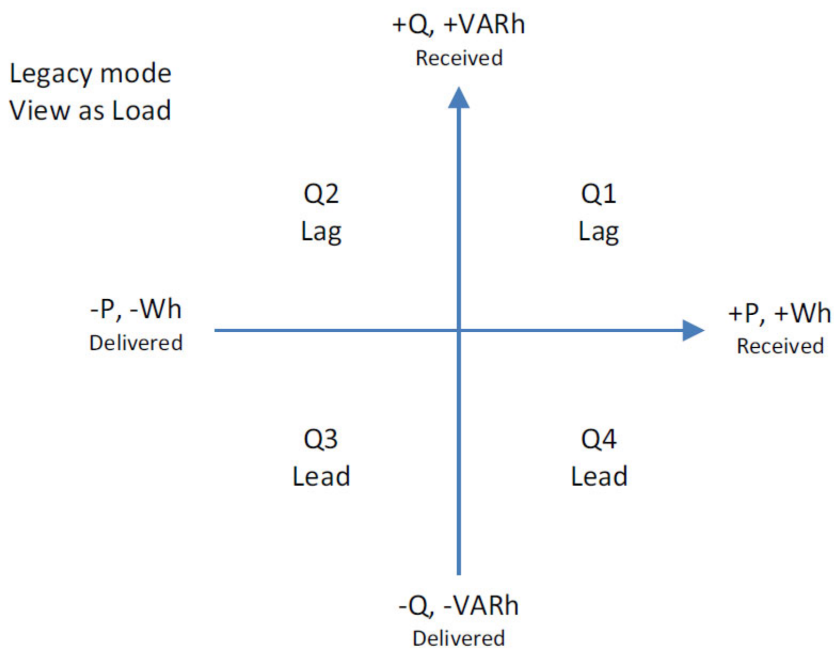
NOTE

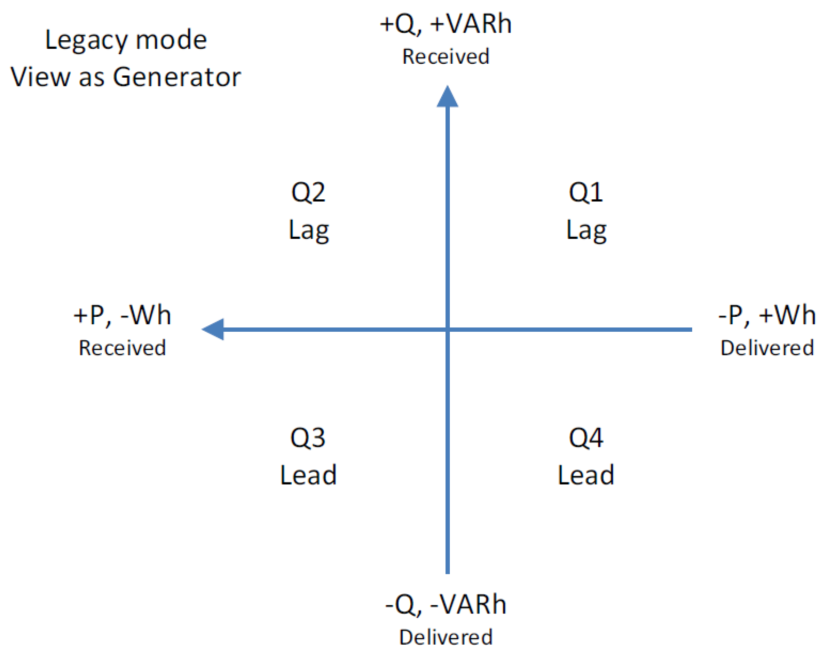
There are two methods available to address power generation applications where the power sign might need to be changed. There is the IEEE/IEC method and the EPM 7000 legacy method. They are both readily available by selecting the appropriate programmable setting. The next two pages show examples of the result of choosing either method.

Use IEEE/IEC Power Coordinate System: Yes or No. Select Yes to use the IEEE/ IEC system shown in the charts below. Select No if you want to use the legacy system shown in the charts on the next page.

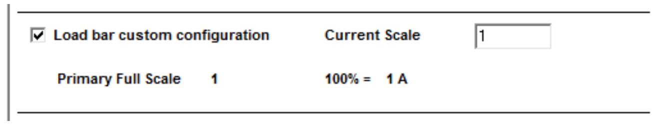





Legacy mode
View as Load
+Q, +VARh
Received
Q2
Lag
Q1
Lag
-P, -Wh
Delivered
+P, +Wh
Received
Q3
Lead
Q4
Lead
-Q, -VARh
Delivered


Legacy mode
View as Generator
+Q, +VARh
Received
Q2
Lag
Q1
Lag
+P, -Wh
Received
-P, +Wh
Delivered
Q3
Lead
Q4
Lead
-Q, -VARh
Delivered

Load Bar Custom Configuration: To enter scaling for the Load Bar, click the Load Bar Custom Configuration checkbox. Fields display on the screen that allow you to enter a Scaling factor for the display. See the figure below

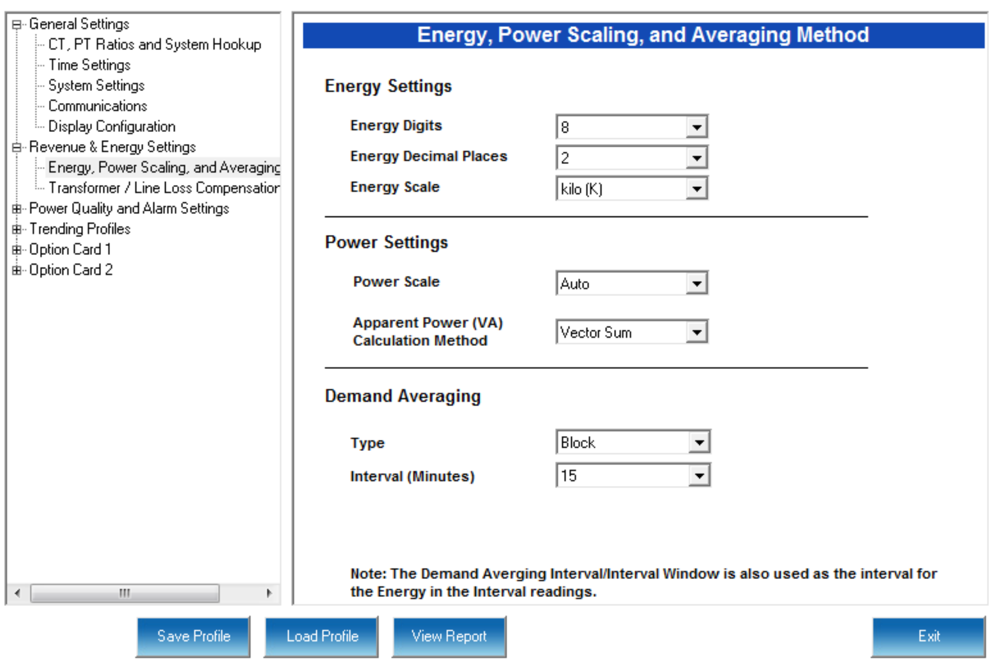


Enter the scaling factor you want in the Current Scale field. This field is multiplied by the CT Multiplier set in the CT, PT Ratios, and System Hookup screen (see Section 5.3.3.1) to arrive at the Primary Full Scale. Make sure you set the CT multiplier correctly.

Enable Fixed Scale for Voltage Display: To enter a scaling factor for the Voltage display, click the checkbox next to Enable Fixed Scale for Voltage Display. The screen changes - see the figure below.

Select the scaling you want to use from the pull-down menu. The options are: 0, 100.0kV, 10.00kV, 0r 0kV.

Energy, Power Scaling, and Averaging



The screen fields and acceptable entries are as follows:

Energy Settings

Energy Digits: 5; 6; 7; 8

Energy Decimal Places: 0 - 6

Energy Scale: unit; kilo (K); Mega (M)

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

00123.456k

Power Settings

Power Scale: Auto; unit; kilo (K); Mega (M)

Apparent Power (VA) Calculation Method: Arithmetic Sum; Vector Sum

Demand Averaging

Type: Block or Rolling

Interval (Block demand) or Sub-Interval (Rolling demand) in minutes: 5; 15; 30; 60

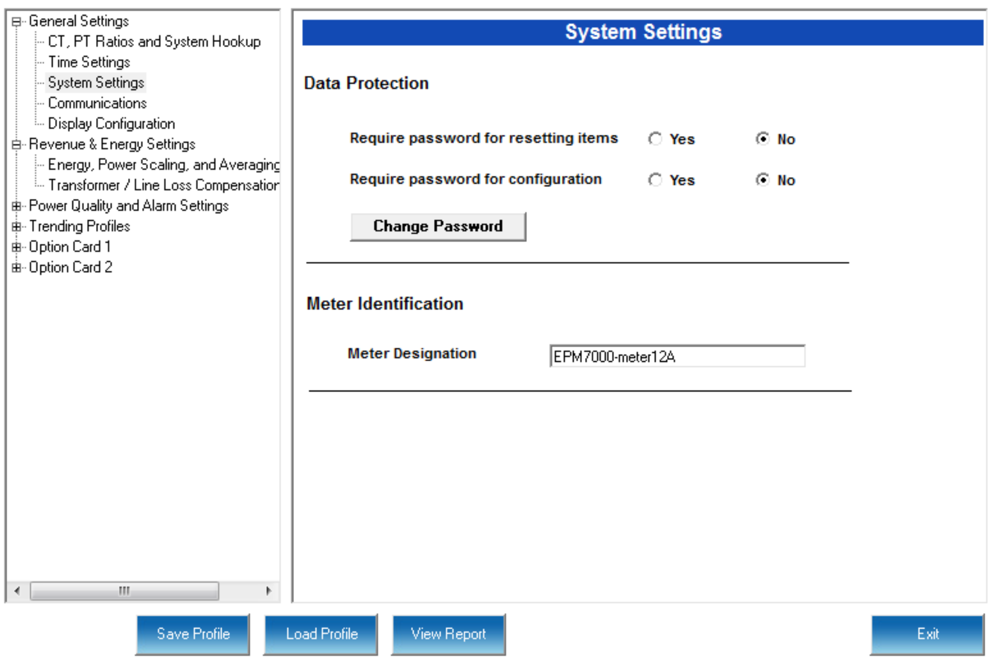
Number of Subintervals: 1; 2; 3; 4

Interval Window: This field is display only. It is the product of the values entered in the Sub-Interval and Number of Subintervals fields.

NOTE

You will see the Number of Subintervals and Interval Window fields only if you select Rolling Demand.

System Settings



From this screen, you can do the following:

Enable or Disable Password for Reset (Reset Max/Min Energy Settings, Energy Accumulators, and the Individual Logs) **and/or Configuration** (Device Profile): click the radio button next to Yes or No.

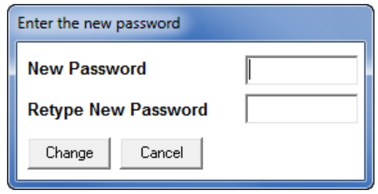
NOTE

- If you enable a Password for Reset, you must also enable it for Configuration.
- The meter's default is Password Disabled.
- Enabling Password protection prevents unauthorized tampering with devices. When a user attempts to make a change that is under Password protection, GE Communicator opens a screen asking for the password. If the correct Password is not entered, the change does not take place.

NOTE

You must set up a password before enabling Password Protection. Click the **Change** button next to Change Password if you have not already set up a password.

Change the Password: Click the **Change** button. You will see the "Enter the New Password" screen.



1. Type in the new password (0 - 9999).
2. Retype the password.
3. Click Change.
   The new password is saved and the meter restarts.

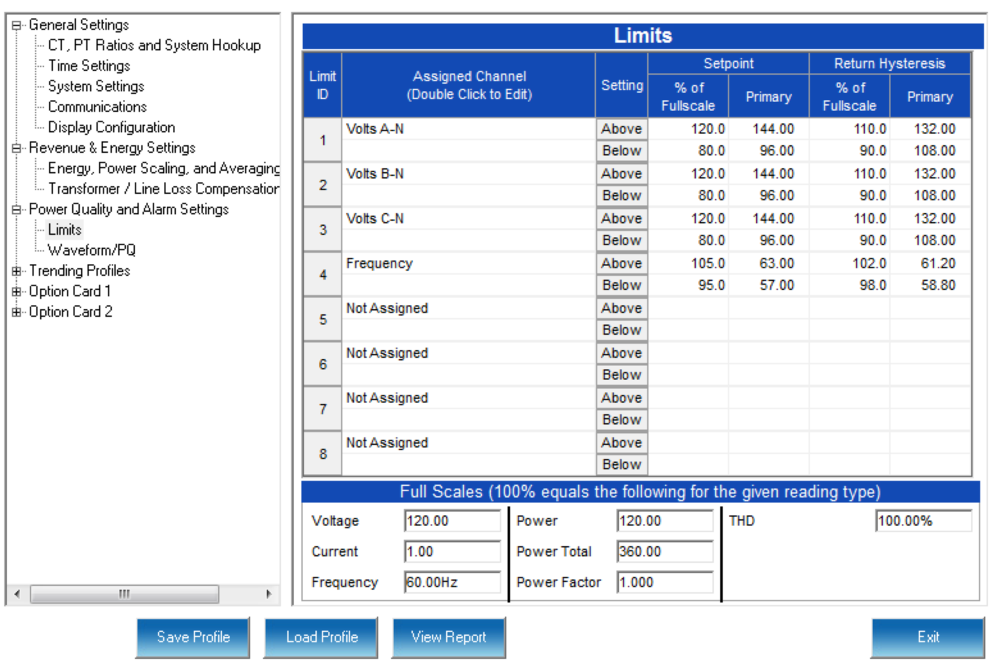
NOTE

If Password Protection has already been enabled for Configuration and you attempt to change the password, you will see the Enter Password screen after you click **Change**. Enter the old password and click **OK** to proceed with the password change..

Change the Meter Designation: input a new meter designation into this field.

Limits

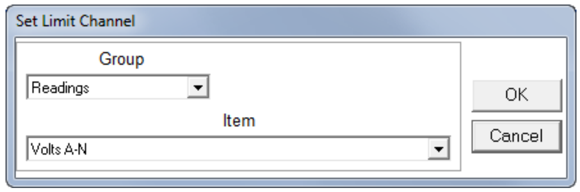
Limits are transition points used to divide acceptable and unacceptable measurements. When a value goes above or below the limit, an out-of-limit condition occurs. Once they are configured, you can view the out-of-Limits (or Alarm) conditions in the Limits Log or Limits Polling screen. You can also use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



The current settings for Limits are shown in the screen. You can set and configure up to eight Limits for the EPM 7000 meter.

To set up a Limit:

1. Select a limit by double-clicking on the Assigned Channel field.
2. You will see the screen shown below.
   Select a Group and an Item for the Limit.



3. Click **OK**.

To configure a Limit:

Double-click on the Field to set the following values:

Above and Below Set Point: % of Full Scale (the point at which the reading goes out of limit)

Examples:

100% of 120V Full Scale = 120V

90% of 120V Full Scale = 108V

Above and Below Return Hysteresis: (the point at which the reading goes back within limit)

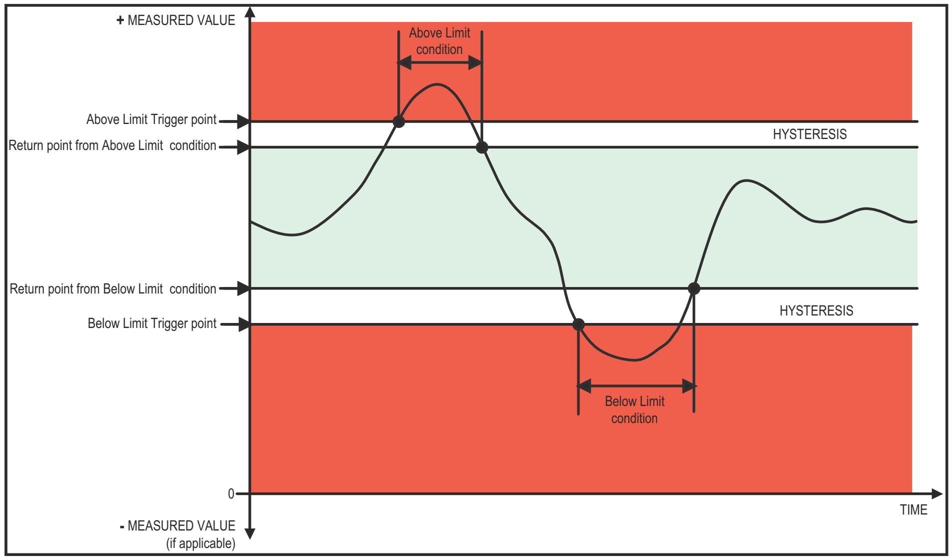
Examples:

Above Set Point = 110%; Below Set Point = 90%

(Out of Limit above 132V);(Out of Limit below 108V)

Above Return Hysteresis = 105%; Below Return Hysteresis = 95%

(Stay Out of Limit until below 126V)(Stay Out of Limit until above 114V).



Primary Fields: These fields are display only. They show what the set point and return hysteresis value are for each limit.

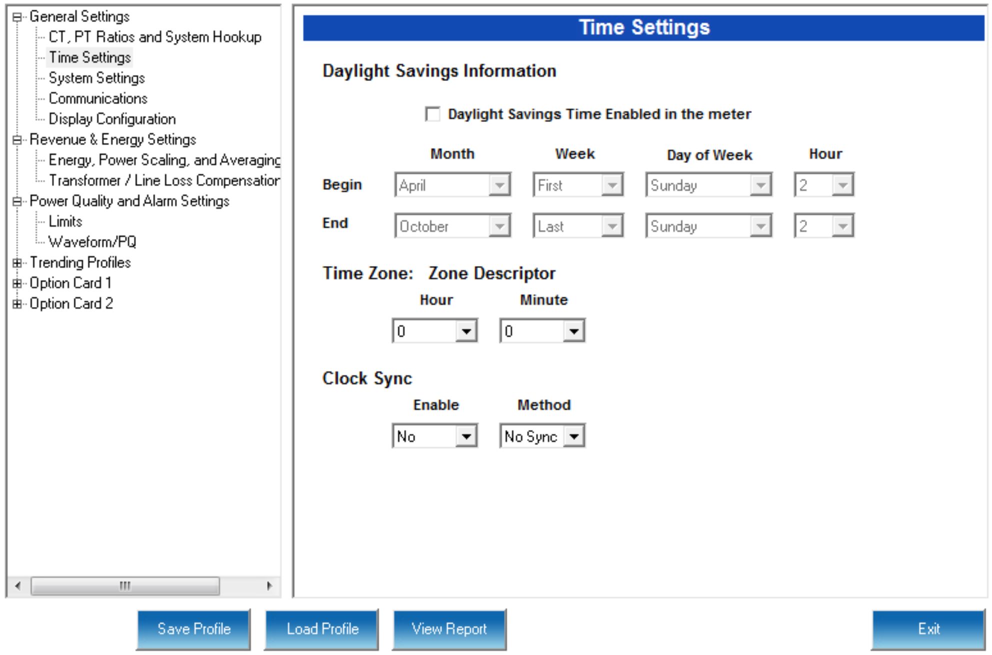
NOTE

- If you are entering negative limits, be aware that the negative value affects the way the above and below limits function, since negative numbers are processed as signed values.
- If the Above Return Hysteresis is greater than the Above Set Point, the Above Limit is Disabled; if the Below Return Hysteresis is less than the Below Set Point, the Below Limit is Disabled. You may want to use this feature to disable either Above or Below Limit conditions for a reading.

Time Settings

Use this setting to enable or disable Daylight Savings Time for the meter, to set the beginning and ending times for Daylight Savings Time, and to set up Time Zone information and clock synchronization information.

From the Tree Menu, click **General Settings >Time Settings**.



Check the box to Enable Daylight Savings time, or un-check it to Disable Daylight Savings Time.

Use the entry fields to set the start and end times for the Daylight Savings Time feature, if enabled. Select the values you want from the Month, Week, Day of the Week, and Hour fields.

NOTE

The Hour field uses a 24-Hour clock. The other fields on the screen are used to set up clock synchronization for the meter.

There are two available clock synchronization methods:

1. If your meter has the Network Option card, you can use the card to access a Network Time Protocol (NTP) Server for clock synchronization.

2. You can use line frequency synchronization (Line Sync) for clock synchronization. Line Sync synchronizes the clock to the AC frequency. This a very common synchronizing method.

Use these fields to set up NTP clock synchronization:

1. **Time Zone: Zone Descriptor** - Select the hour and minute of your time zone in relation to Greenwich Mean Time. For example, if your time zone is Eastern Standard time, you would select -5 from the pull-down Hour menu and leave the Minutes field at 0.

2. Under **Clock Sync** select:
   - **Yes** from the **Enable** pull-down menu
   - **NTP** from the **Method** pull-down menu
   - The location of the Network Option card - select either **Option Card in Slot 1** or **Option Card in Slot 2** from the **Interface** pull-down menu.

NOTE

You also need to set up the NTP server information when you configure the Network card's settings. See Chapter 5 of the Communicator Manual for instructions.

Use these fields to set up Line Frequency clock synchronization:

Under Clock Sync select:

- **Yes** from the **Enable** pull-down menu
- **Line** (line frequency synchronization) from the **Method** pull-down menu
- **50Hz** or **60Hz** from the **Line Frequency** pull-down menu

IMPORTANT!

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

NOTE

Refer to the *Communicator Instruction Manual* for additional instructions on configuring the EPM 7000 meter settings, including Transformer and Line Loss Compensation, CT and PT Compensation, Option card configuration, Secondary Voltage display, Symmetrical Components, Voltage and Current Unbalance, and scaling Primary readings for use with DNP.

EPM 7000 Power Quality Meter

Chapter 6: Using the EPM 7000

6.1 Introduction

You can use the Elements and Buttons on the EPM 7000 meter's face to view meter readings, reset and/or configure the meter, and perform related functions. The following sections explain the Elements and Buttons and detail their use.

6.1.1 Understanding Meter Face Elements

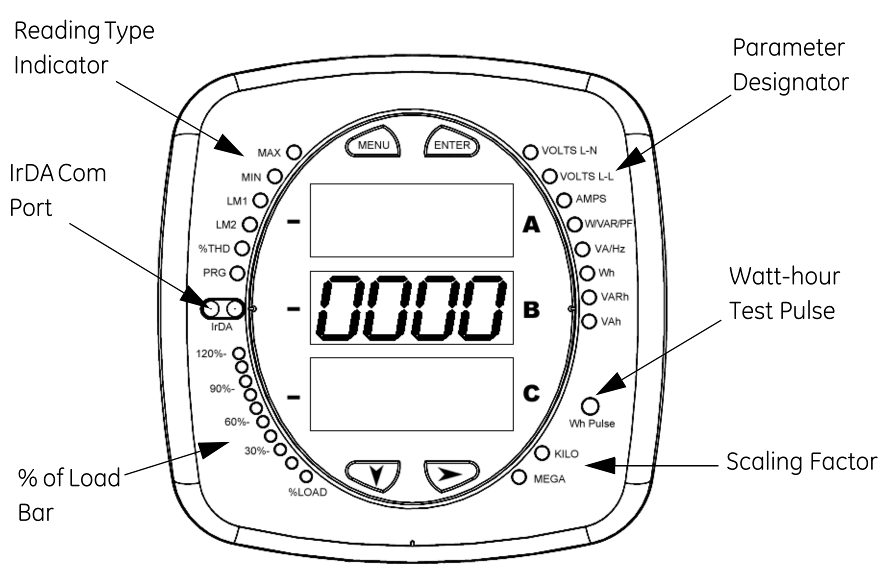


Figure 6-1: Face Plate with Elements

The meter face features the following elements:

- Reading Type Indicator: e.g., Max

- Parameter Designator: e.g., Volts L-N
- Watt-Hour Test Pulse: Energy pulse output to test accuracy
- Scaling Factor: Kilo or Mega multiplier of displayed readings
- % of Load Bar: Graphic Display of Amps as % of the Load (Refer to Section 6.3 for additional information.)
- IrDA Communication Port: Com 1 port for wireless communication

6.1.2 Understanding Meter Face Buttons

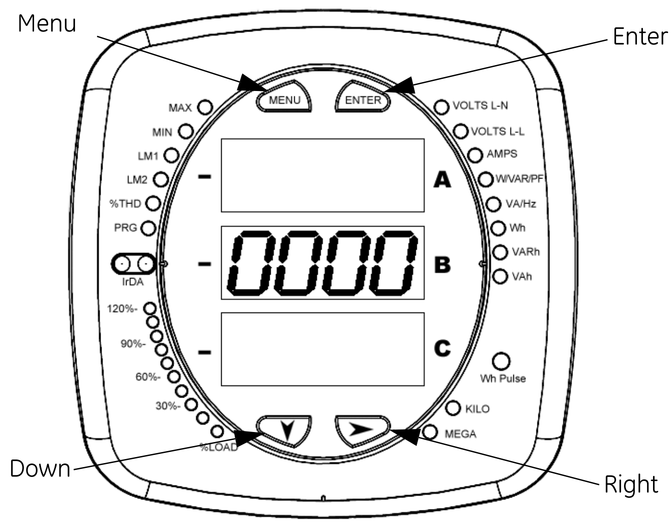


Figure 6-2: Face Plate with Buttons

The meter face has **Menu**, **Enter**, **Down** and **Right** buttons, which let you perform the following functions:

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

6.2 Using the Front Panel

You can access four modes using the EPM 7000 meter's front panel buttons:

- Operating Mode (Default)
- Reset Mode
- Configuration Mode
- Information Mode. Information Mode displays a sequence of screens that show model information, such as Frequency, Amps, Software Options, etc.

Use the Menu, Enter, Down and Right buttons to navigate through each mode and its related screens.

NOTE

- See *Appendix A* for the complete display mode Navigation maps.
- The meter can also be configured using software; see Chapter 5 and the *GE Communicator Instruction Manual* for instructions.

6.2.1 Understanding Startup and Default Displays

Upon Power Up, the meter displays a sequence of screens:

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

After startup, if auto-scrolling is enabled, the EPM 7000 meter scrolls the parameter readings on the right side of the front panel. The Kilo or Mega LED lights, showing the scale for the Wh, VARh and VAh readings. Figure 6.3 shows an example of a Wh reading.

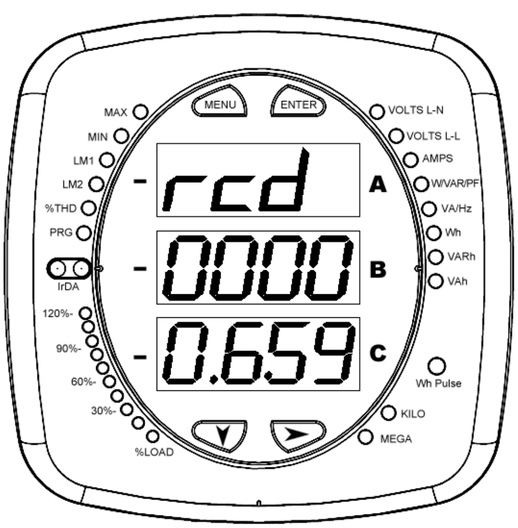
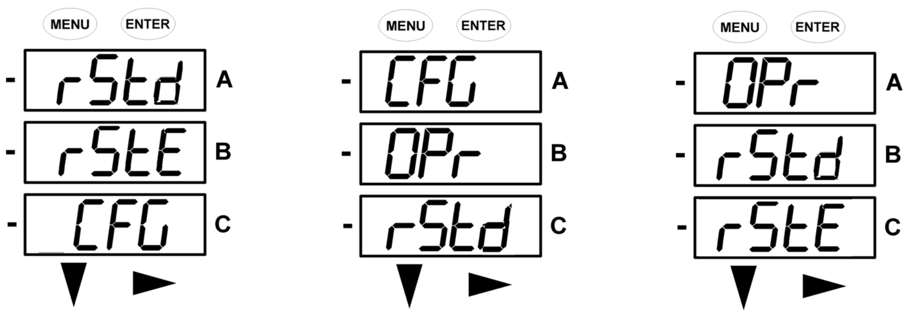


Figure 6-3: Display Showing Watt-hr Reading

The EPM 7000 meter continues to provide scrolling readings until one of the buttons on the front panel is pressed, causing the meter to enter one of the other Modes.

6.2.2 Using the Main Menu

1. Press the **Menu** button. The Main Menu screen appears.
   - The Reset: Demand mode (rStd) appears in the A window. Use the Down button to scroll, causing the Reset: Energy (rStE), Configuration (CFG), Operating (OPr), and Information (InFo) modes to move to the A window.
   - The mode that is currently flashing in the A window is the “Active” mode, which means it is the mode that can be configured.

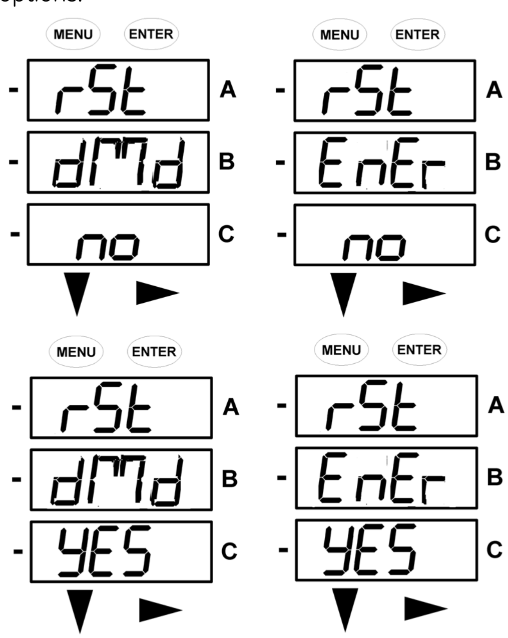


For example: Press Down Twice - CFG moves to A window. Press Down Twice - OPr moves to A window.

2. Press the **Enter** button from the Main Menu to view the Parameters screen for the mode that is currently active.

6.2.3 Using Reset Mode

Reset Mode has two options:



- Reset: Demand (rStd): resets the Max and Min values.

- Reset: Energy (rStE): resets the energy accumulator fields.

  1. Press the Enter button while either rStd or rStE is in the A window. The Reset Demand No or Reset Energy No screen appears.
     - If you press the **Enter** button again, the Main Menu appears, with the next mode in the A window. (The **Down** button does not affect this screen.)
     - If you press the **Right** button, the Reset Demand YES or Reset Energy YES screen appears. Press **Enter** to perform a reset.

NOTE

If Password Protection is enabled for Reset, you must enter the four digit Password before you can reset the meter. (See Chapter 5 for information on Password Protection.) To enter a password, follow the instructions in Section 6.2.4.

CAUTION

Reset Demand YES resets **all** Max and Min values.

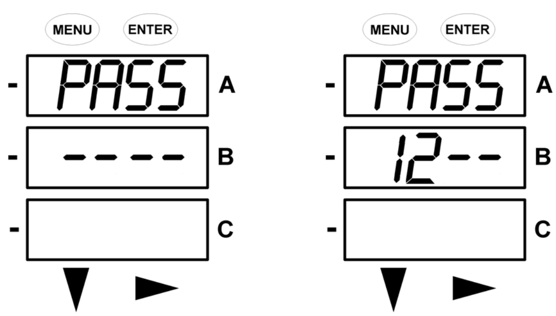
  2. Once you have performed a reset, the screen displays either "rSt dMd donE" or "rSt EnEr donE"and then resumes auto-scrolling parameters.

6.2.4 Entering a Password

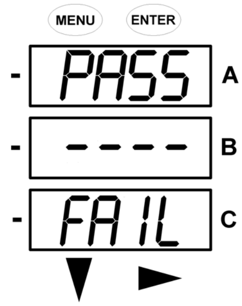
If Password Protection has been enabled in the software for Reset and/or Configuration (see Chapter 5 for more information), a screen appears requesting a Password when you try to reset the meter and/or configure settings through the front panel. PASS appears in the A window and 4 dashes appear in the B window. The left-most dash is flashing.

1. Press the **Down** button to scroll numbers from 0 to 9 for the flashing dash. When the correct number appears for that dash, use the **Right** button to move to the next dash.

Example: The left screen, below, shows four dashes. The right screen shows the display after the first two digits of the password have been entered.



2. When all 4 digits of the password have been selected, press the **Enter** button.
   - If you are in Reset Mode and you enter the correct Password, "rSt dMd donE" or "rSt EnEr donE"appears and the screen resumes auto-scrolling parameters.
   - If you are in Configuration Mode and you enter the correct Password, the display returns to the screen that required a password.
   - If you enter an incorrect Password, "PASS ---- FAIL" appears...



and:

- The previous screen is re-displayed, if you are in Reset Mode.
- The previous Operating Mode screen is re-displayed, if you are in Configuration Mode.

6.2.5 Using Configuration Mode

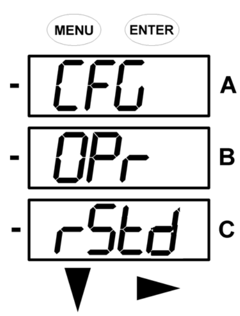
Configuration Mode follows Reset: Energy on the Main Menu.

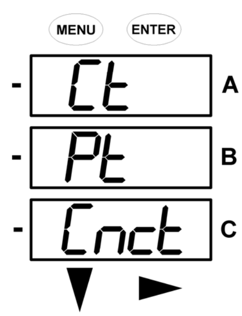
To access Configuration Mode:

1. Press the **Menu** button while the meter is auto-scrolling parameters.
2. Press the **Down** button until the Configuration Mode option (CFG) is in the A window.
3. Press the **Enter** button. The Configuration Parameters screen appears.
4. Press the **Down** button to scroll through the configuration parameters: Scroll (SCrL), CT, PT, Connection (Cnct) and Port. The parameter currently 'Active," i.e., configurable, flashes in the A window.
5. Press the **Enter** button to access the Setting screen for the currently active parameter.

NOTE

You can use the **Enter** button to scroll through all of the Configuration parameters and their Setting screens, in order.





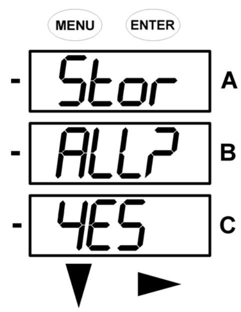
6. Press **Enter** when CFG is in A window - Parameter screen appears -
7. Press **Down**- Press **Enter** when the parameter you want is in the A window. The parameter screen appears, showing the current settings. To change the settings:
   - Use either the **Down** button or the **Right** button to select an option.

- To enter a number value, use the **Down** button to select the number value for a digit and the **Right** button to move to the next digit.

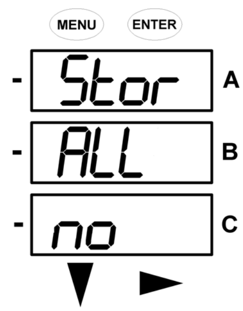
NOTE

When you try to change the current setting and Password Protection is enabled for the meter, the Password screen appears. See Section 6.2.4 for instructions on entering a password.

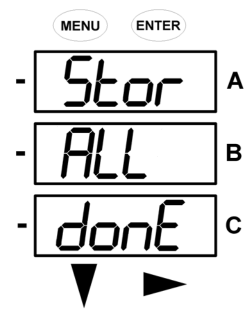
8. Once you have entered the new setting, press the **Menu** button twice. The Store ALL YES screen appears. You can either:
   - Press the **Enter** button to save the new setting.
   - Press the **Right** button to access the Store ALL no screen; then press the **Enter** button to cancel the Save.
9. If you have saved the settings, the Store ALL done screen appears and the meter resets.



Press the **Enter** button to save the settings. Press the **Right** button for **Stor All no** screen.



Press the **Enter** button to Cancel the Save.



The settings have been saved.

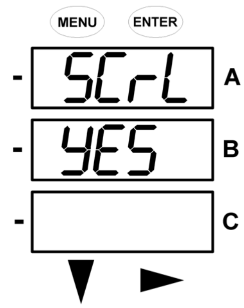
Configuring the Scroll Feature

When in Auto Scroll mode, the meter performs a scrolling display, showing each parameter for 7 seconds, with a 1 second pause between parameters. The parameters that the meter displays are determined by the following conditions:

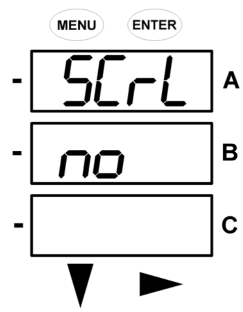
- They have been selected through software. (Refer to the *GE Communicator Instruction Manual* for instructions.)
- They are enabled by the installed Software Option(s). Refer to Section 2.1.3 for information on Software Options.

To enable or disable Auto-scrolling:

1. Press the **Enter** button when SCrl is in the A window. The Scroll YES screen appears



2. Press either the **Right** or **Down** button if you want to access the Scroll no screen. To return to the Scroll YES screen, press either button.



3. Press the **Enter** button on either the Scroll YES screen (to enable auto-scrolling) or the Scroll no screen (to disable auto-scrolling).
4. The CT- n screen appears (this is the next Configuration mode parameter).

NOTE

- To exit the screen without changing scrolling options, press the **Menu** button.
- To return to the Main Menu screen, press the **Menu** button twice.
- To return to the scrolling (or non-scrolling) parameters display, press the **Menu** button three times.

Configuring CT Setting

The CT Setting has three parts: Ct-n (numerator), Ct-d (denominator), and Ct-S (scaling).

1. Press the **Enter** button when Ct is in the A window. The Ct-n screen appears. You can either:
   - Change the value for the CT numerator.
   - Access one of the other CT screens by pressing the **Enter** button: press **Enter** once to access the Ct-d screen, twice to access the Ct-S screen.

NOTE

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

2. To change the value for the CT numerator:

   From the Ct-n screen:
   - Use the Down button to select the number value for a digit.
   - Use the Right button to move to the next digit.
3. To change the value for CT scaling

From the Ct-S screen:

- Use the **Right** button or the **Down** button to choose the scaling you want. The Ct-S setting can be 1, 10, or 100.

NOTE

If you are prompted to enter a password, refer to Section 6.2.4 for instructions on doing so.

4. When the new setting is entered, press the **Menu** button twice.
5. The Store ALL YES screen appears. Press **Enter** to save the new CT setting.

Example CT Settings:

200/5 Amps: Set the Ct-n value for 200 and the Ct-S value for 1.

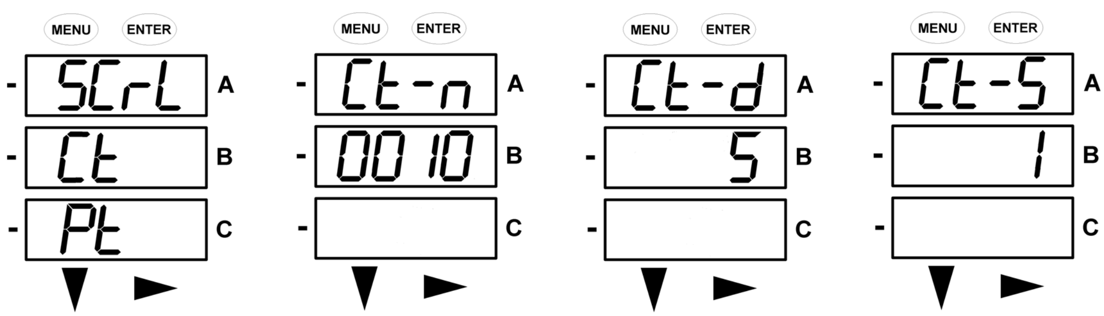
800/5 Amps: Set the Ct-n value for 800 and the Ct-S value for 1.

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

10,000/5 Amps: 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 value and the Ct-S value.
- Ct-n and Ct-S are dictated by primary current; Ct-d is secondary current.



Press **Enter** | Use buttons to set Ct-n | Ct-d cannot be changed | Use buttons to select scaling

Configuring PT Setting

The PT Setting has three parts: Pt-n (numerator), Pt-d (denominator), and Pt-S (scaling).

1. Press the **Enter** button when Pt is in the A window. The PT-n screen appears. You can either:
   - Change the value for the PT numerator.
   - Access one of the other PT screens by pressing the **Enter** button: press **Enter** once to access the Pt-d screen, twice to access the Pt-S screen.
2. To change the value for the PT numerator or denominator:

   From the Pt-n or Pt-d screen:
   - Use the **Down** button to select the number value for a digit.
   - Use the **Right** button to move to the next digit.
3. To change the value for the PT scaling:

   From the Pt-S screen:
   - Use the **Right** button or the **Down** button to choose the scaling you want. The Pt-S setting can be 1, 10, 100, or 1000.

NOTE

If you are prompted to enter a password, refer to Section 6.2.4 for instructions on doing so.

4. When the new setting is entered, press the **Menu** button twice.
5. The STOR ALL YES screen appears. Press **Enter** to save the new PT setting.

Example PT Settings:

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

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

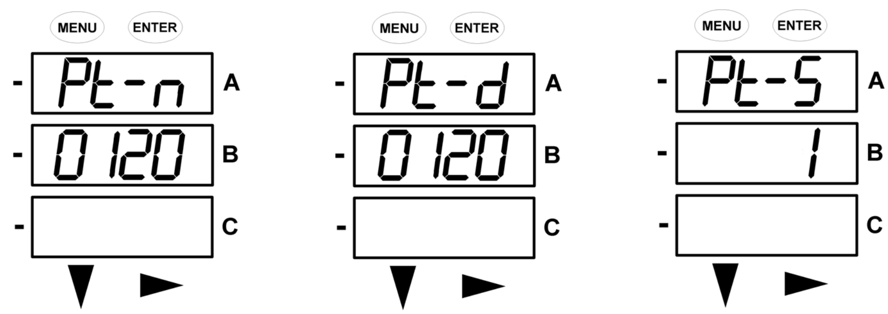
138,000/69 Volts: Pt-n value is 1380, Pt-d value is 69, Pt-S value is 100.

345,000/115 Volts: Pt-n value is 3450, Pt-d value is 115, Pt-S value is 100.

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

NOTICE

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



Use buttons to set Pt-n Use buttons to set Pt-d Use buttons to select scaling

Configuring Connection Setting

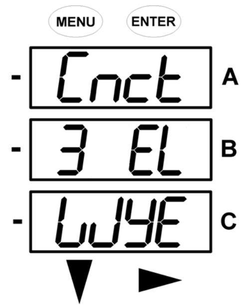
1. Press the **Enter** button when Cnct is in the A window. The Cnct screen appears.
2. Press the **Right** button or **Down** button to select a configuration. The choices are:
   - 3 Element Wye (3 EL WYE)
   - 2.5 Element Wye (2.5EL WYE)
   - 2 CT Delta (2 Ct dEL)

NOTE

If you are prompted to enter a password, refer to Section 6.2.4 for instructions on doing so.

3. When you have made your selection, press the **Menu** button twice.

4. The STOR ALL YES screen appears. Press **Enter** to save the setting.



Use buttons to select configuration.

Configuring Communication Port Setting

Port configuration consists of: Address (a three digit number), Baud Rate (9600; 19200; 38400; or 57600), and Protocol (DNP 3.0; Modbus RTU; or Modbus ASCII).

1. Press the **Enter** button when POrt is in the A window. The Adr (address) screen appears. You can either:
   - Enter the address.
   - Access one of the other Port screens by pressing the **Enter** button: press **Enter** once to access the bAUd screen (Baud Rate), twice to access the Prot screen (Protocol).
2. To enter the Address

   From the Adr screen:
   - Use the **Down** button to select the number value for a digit.
   - Use the **Right** button to move to the next digit.

NOTE

Using the faceplate you can enter addresses between 1 and 247; if you want to enter a DNP address over 247, you need to enter the address through software settings. Refer to Section 5.2.2.

3. To select the Baud Rate:

   From the bAUd screen:
   - Use the **Right** button or the **Down** button to select the setting you want.
4. To select the Protocol:

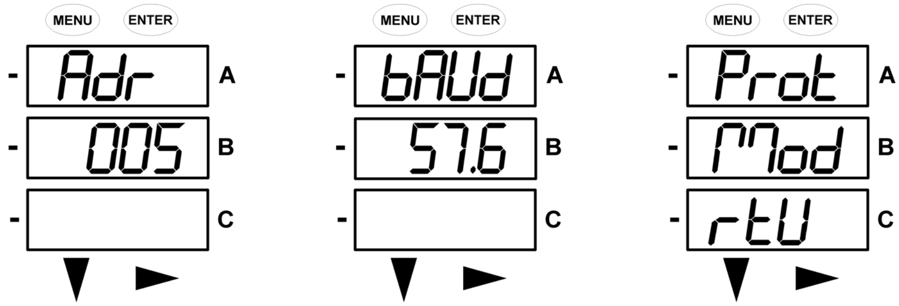
   From the Prot screen:
   - Press the **Right** button or the **Down** button to select the setting you want.

NOTE

If you are prompted to enter a password, refer to Section 6.2.4 for instructions on doing so.

5. When you have finished making your selections, press the **Menu** button twice.

6. The STOR ALL YES screen appears. Press **Enter** to save the settings.



Use buttons to enter Address

Use buttons to select Baud Rate

Use buttons to select Protocol

6.2.6 Using Operating Mode

Operating Mode is the EPM 7000 meter's default mode, that is, the standard front panel display. After starting up, the meter automatically scrolls through the parameter screens, if scrolling is enabled. Each parameter is shown for 7 seconds, with a 1 second pause between parameters. Scrolling is suspended for 3 minutes after any button is pressed.

1. Press the **Down** button to scroll all the parameters in Operating Mode. The currently "Active," i.e., displayed, parameter has the Indicator light next to it, on the right face of the meter.
2. Press the **Right** button to view additional readings for that parameter. The table below shows possible readings for Operating Mode. Sheet 2 in *Appendix A* shows the Operating Mode Navigation map.

NOTE

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

Table 6.1: Operating Mode Parameter Readings - Possible Readings

VOLTS L-N	VOLTS_LN	VOLTS_LN_MAX	VOLTS_LN_MIN		VOLTS_LN_THD
VOLTS L-L	VOLTS_LL	VOLTS_LL_MAX	VOLTS_LL_MIN		
AMPS	AMPS	AMPS_NEUTRAL	AMPS_MAX	AMPS_MIN	AMPS_THD
W/VAR/PF	W_VAR_PF	W_VAR_PF_MAX _POS	W_VAR_PF_MIN _POS	W_VAR_PF_MIN _NEG	
VA/Hz	VA_FREQ	VA_FREQ_MAX	VA_FREQ_MIN		
Wh	KWH_REC	KWH_DEL	KWH_NET	KWH_TOT	
VARh	KVARH_POS	KVARH_NEG	KVARH_NET	KVARH_TOT	
VAh	KVAH				

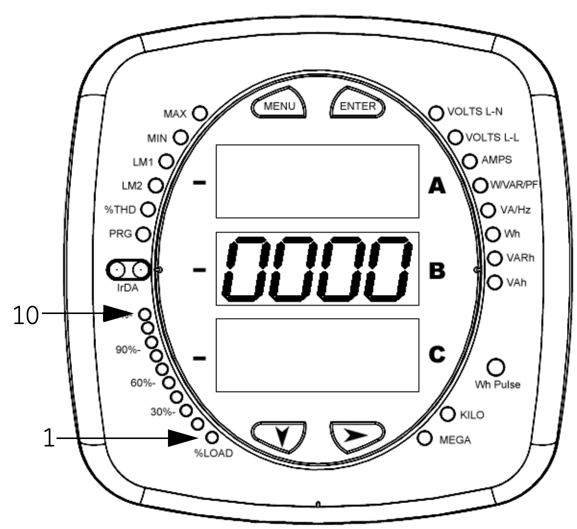
6.3 Understanding the % of Load Bar

The 10-segment LED bar graph at the bottom left of the EPM 7000 meter's front panel provides a graphic representation of Amps. The segments light according to the load, as shown in the 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: % of Load Segment Table

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%



6.4 Performing Watt-Hour Accuracy Testing (Verification)

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. Since the EPM 7000 meter 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.

- Refer to Figure 6.5 for an example of how this process works.
- Refer to Table 6.1 for the Wh/Pulse Constants for Accuracy Testing.

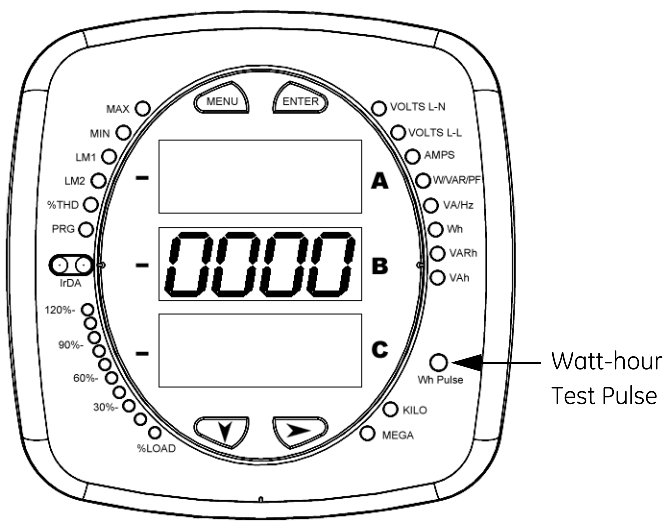


Figure 6-4: Watt-hour Test Pulse

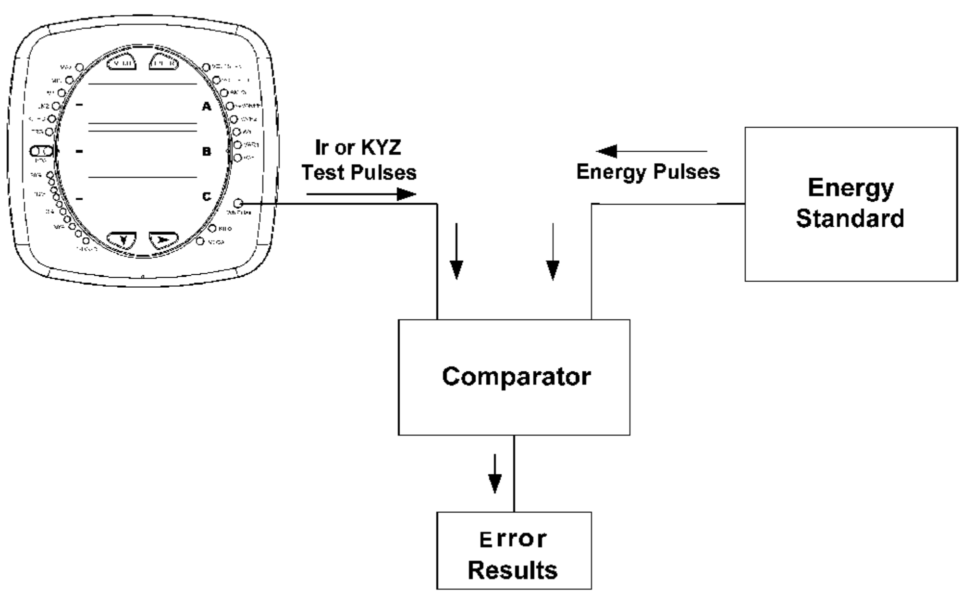


Figure 6-5: Using the Watt-hour Test Pulse

Table 6.3: Infrared & KYZ Pulse Constants for Accuracy Testing - Kh Watthour per pulse

Input Voltage Level	Class 10 Models	Class 2 Models
Below 150V	0.500017776	0.1000035555
Above 150V	2.000071103	0.400014221

NOTICE

- Minimum pulse width is 90 milliseconds.
- Refer to Chapter 2, Section 2.2, for Wh Pulse specifications.

EPM 7000 Power Quality Meter

Chapter 7: Using the I/O Option Cards

7.1 Overview

The EPM 7000 meter offers extensive I/O expandability. Using the two universal Option Card slots, the unit can be easily configured to accept new I/O Option cards even after installation, without your needing to remove the meter. The EPM 7000 meter auto-detects any installed Option cards. Up to 2 cards of any type outlined in this chapter can be used per meter.

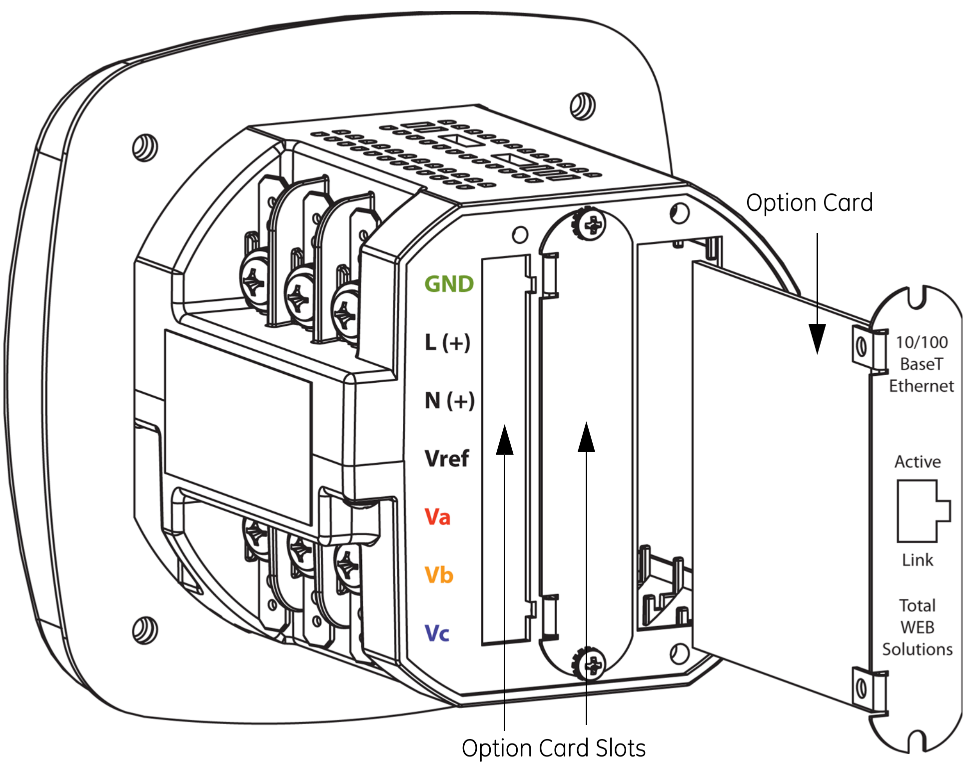


Figure 7-1: EPM 7000 Meter Back, Showing Option Card Slots and I/O Card

7.2 Installing Option Cards

The Option Cards are inserted in one of the two Option Card slots in the back of the EPM 7000 meter.

⚠CAUTION

Remove Voltage Inputs and power supply terminal to the meter before performing card installation.

1. Remove the screws at the top and the bottom of the Option Card slot covers.
2. There is a plastic “track” on the top and the bottom of the slot. The Option card fits into this track.

WARNING!

For safety, remove ALL these connections before installing Option Cards (GND, L, N, Vref, Va, Vb, Vc).

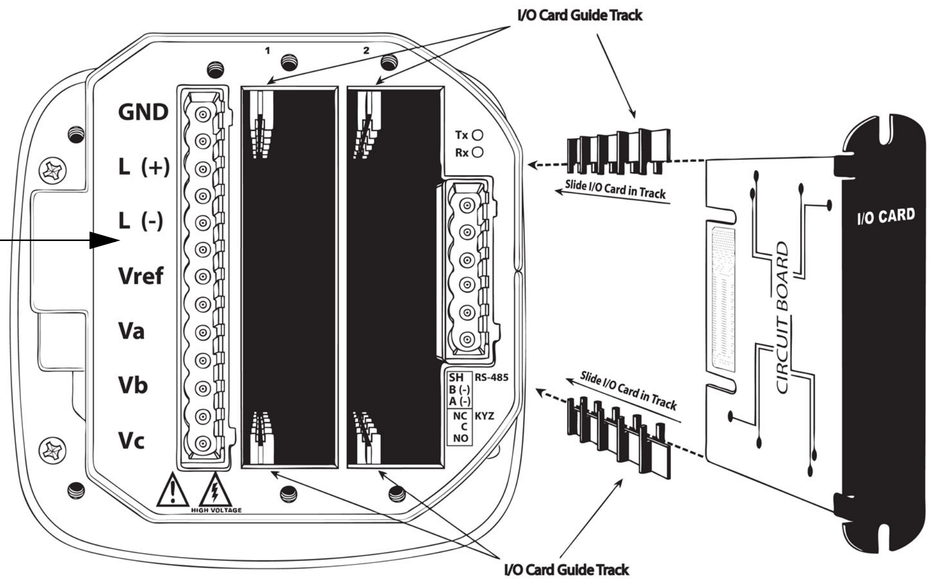


Figure 7-2: Detail of Guide Track

3. Slide the card inside the plastic track and insert it into the slot. You will hear a click when the card is fully inserted. Be careful, it is easy to miss the guide track.

⚠CAUTION

- **Make sure the I/O card is inserted properly into the track to avoid damaging the card’s components.**
- **For proper card fit, and to avoid damaging the unit, insert components in the following order:**
  - Option Card 1
  - Option Card 2
  - Detachable terminal block 1
  - Detachable terminal block 2
  - Communication connection for Port 2

7.3 Configuring Option Cards

⚠CAUTION

FOR PROPER OPERATION, RESET ALL PARAMETERS IN THE UNIT AFTER HARDWARE MODIFICATION.

The EPM 7000 meter auto-detects any Option cards installed in it. You configure the Option cards through GE Communicator software. Refer to the *GE Communicator Instruction Manual* for detailed instructions.

The following sections describe the available Option cards.

7.4 1mA Output Card (C1)

The 1mA card transmits a standardized bi-directional 0-1mA signal. This signal is linearly proportional to real-time quantities measured by the EPM 7000 meter. The outputs are electrically isolated from the main unit.

7.4.1 Specifications

The technical specifications at 25° C at 5k load are as follows:

Number of outputs:	4 single ended
Power consumption:	1.2 W internal
Signal output range:	-1.2 to +1.2 mA
Max. load impedance:	10 k
Hardware resolution:	12 bits
Effective resolution:	14 bits with 2.5 kHz PWM
Update rate per channel:	100ms
Output accuracy:	± 0.1 % of output range (2.4 mA)
Load regulation	± 0.06 % of output range (2.4 mA) load step of 5 k @ ± 1 mA
Temperature coefficient	± 30 nA/°C
Isolation:	AC 2500 V system to outputs
Reset/Default output value:	0 mA

The general specifications are as follows:

Operating temperature:	-20 to +70 °C
Storage temperature:	-40 to +80 °C
Relative air humidity:	Maximum 95%, non-condensing
EMC - Immunity Interference:	EN61000-4-2
Weight:	1.6 oz
Dimensions (inch) W x H x L:	0.72 x 2.68 x 3.26

External connection:	AWG 12-26/(0.29 - 3.31) mm^2 5 pin, 0.200" plug-able terminal block

7.4.2 Default Configuration

The EPM 7000 meter automatically recognizes the installed option card during Power Up. If you have not programmed a configuration for the card, the unit will default to the following outputs:

Channel 1	+Watts, +1800 Watts => +1mA
	-Watts, - 1800 Watts => -1mA
Channel 2	+VARs, +1800 VARs => +1mA
	- VARs, -1800 VARs => -1mA
Channel 3	Phase A Voltage WYE, 300 Volts => +1mA
	Phase A Voltage Delta, 600 Volts => +1mA
Channel 4	Phase A Current, 10 Amps => +1mA

7.4.3 Wiring Diagram

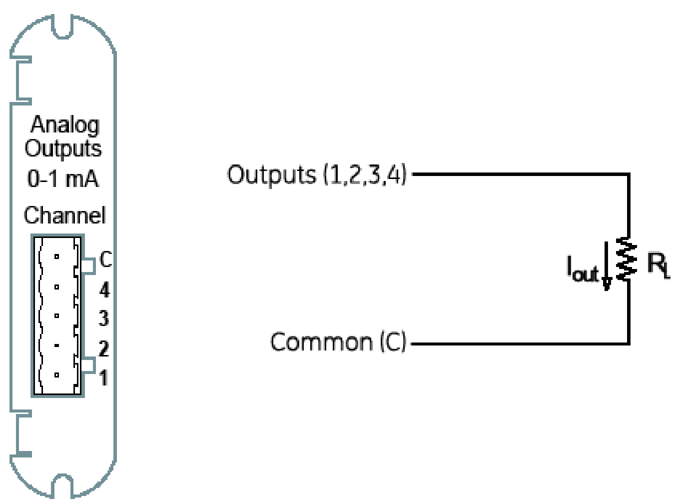


Figure 7-3: 4-Channel 0 - 1mA Output Card

7.5 20mA Output Card (C20)

The 20mA card transmits a standardized 0-20 mA signal. This signal is linearly proportional to real-time quantities measured by the EPM 7000 meter. The current sources need to be loop powered. The outputs are electrically isolated from the main unit.

7.5.1 Specifications

The technical specifications at 25° C at 500 Ohm load are as follows:

Number of outputs:	4 single ended
Power consumption:	1W internal
Signal output range:	(0 to 24)mA
Max. load impedance:	850 @ 24VDC
Hardware resolution:	12 bits
Effective resolution:	14 bits with 2.5kHz PWM
Update rate per channel:	100ms
Output accuracy:	± 0.1% of output range (24mA)
Load regulation:	± 0.03% of output range (24mA) load step of 200 @ 20mA
Temperature coefficient	± 300n A/°C
Isolation:	AC 2500V system to outputs
Maximum loop voltage:	28VDC max.
Internal voltage drop:	3.4VDC @ 24mA
Reset/Default output value:	12mA

The general specifications are as follows:

Operating temperature:	(-20 to +70) °C
Storage temperature:	(-40 to +80) °C
Relative air humidity:	Maximum 95%, non-condensing
EMC - Immunity interference:	EN61000-4-2
Weight:	1.6oz
Dimensions (inch) W x H x L:	0.72 x 2.68 x 3.26
External connection:	AWG 12-26/(0.129 - 3.31)mm^2 5 pin, 0.200" plug-able terminal block

7.5.2 Default Configuration

The EPM 7000 meter automatically recognizes the installed option card during Power Up. If you have not programmed a configuration for the card, the unit will default to the following outputs:

Channel 1	+Watts, +1800 Watts => 20mA
	-Watts, -1800 Watts => 4mA
	0 Watts => 12mA
Channel 2	+VARs, +1800 VARs => 20mA
	- VARs, -1800 VARs => 4mA
	0 VARs => 12mA

Channel 3	Phase A Voltage WYE, 300 Volts => 20mA
	0 Volts => 4 mA
	Phase A Voltage Delta, 600 Volts => 20mA
Channel 4	Phase A Current, 10 Amps => 20mA
	0 Phase A Current, 0 Amps => 4 mA

7.5.3 Wiring Diagram

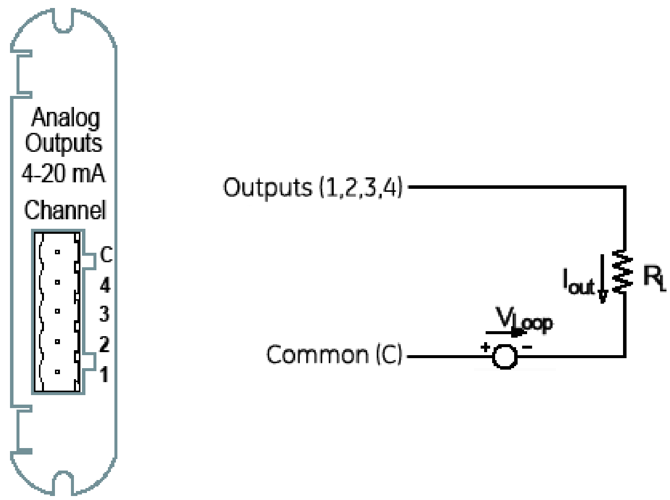


Figure 7-4: 4-Channel 0 - 20mA Output Card

7.6 Digital Output (Relay Contact) / Digital Input Card (RS1)

The Digital Output/Input card is a combination of relay contact outputs for load switching and dry/wet contact sensing digital inputs. The outputs are electrically isolated from the inputs and from the main unit.

7.6.1 Specifications

The technical specifications at 25 °C are as follows:

Power consumption:	0.320W internal
Relay outputs:	
Number of outputs:	2
Contact type:	Changeover (SPDT)

Relay type:	Mechanically latching
Switching voltage:	AC 250V / DC 30V
Switching power:	1250VA / 150W
Switching current:	5A
Switching rate max.:	10/s
Mechanical life:	5 x 10^7 switching operations
Electrical life:	10^5 switching operations at rated current
Breakdown voltage:	AC 1000V between open contacts
Isolation:	AC 3000V / 5000V surge system to contacts
Reset/Power down state:	No change - last state is retained

Inputs:

Number of Inputs:	2
Sensing type:	Wet or dry contact status detection
Wetting voltage:	DC (12-24)V, internally generated
Input current:	2.5mA – constant current regulated
Minimum input voltage:	0V (input shorted to common)
Maximum input voltage:	DC 150V (diode protected against polarity reversal)
Filtering:	De-bouncing with 50ms delay time
Detection scan rate:	100ms
Isolation:	AC 2500V system to inputs

The general specifications are as follows:

Operating temperature:	-20 to +70 °C
Storage temperature:	-40 to +80 °C
Relative air humidity:	Maximum 95%, non-condensing
EMC - Immunity Interference:	EN61000-4-2
Weight:	1.5oz
Dimensions (inch) W x H x L:	0.72 x 2.68 x 3.26
External Connection:	AWG 12-26/(0.129 - 3.31) mm^2 9 pin, 0.200” plugable terminal block

7.6.2 Wiring Diagram

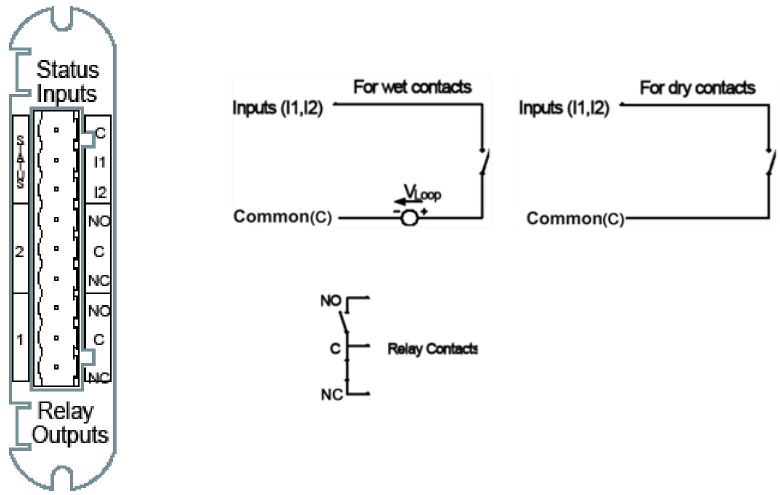


Figure 7-5: Relay Contact (2) / Status Input (2) Card

7.7 Pulse Output (Solid State Relay Contacts) / Digital Input Card (PS1)

The Pulse Output/Digital Input card is a combination of pulse outputs via solid state contacts and dry/wet contact sensing digital inputs. The outputs are electrically isolated from the inputs and from the main unit.

7.7.1 Specifications

The technical specifications at 25 °C are as follows:

Power consumption:	0.420W internal
Relay outputs:	
Number of outputs:	4
Contact type:	Closing (SPST - NO)
Relay type:	Solid state
Peak switching voltage:	DC ±350V
Continuous load current:	120mA
Peak load current:	350mA for 10ms
On resistance, max.:	35
Leakage current:	1μA@350V
Switching Rate max.:	10/s
Isolation:	AC 3750V system to contacts

Reset/Power down state:	Open contacts

Inputs:

Number of inputs:	4
Sensing type:	Wet or dry contact status detection
Wetting voltage:	DC (12-24)V, internally generated
Input current:	2.5mA – constant current regulated
Minimum input voltage:	0V (input shorted to common)
Maximum input voltage:	DC 150V (diode protected against polarity reversal)
Filtering:	De-bouncing with 50ms delay time
Detection scan rate:	100ms
Isolation:	AC 2500V system to inputs

The general specifications are as follows:

Operating Temperature:	(-20 to +70) °C
Storage Temperature:	(-40 to +80) °C
Relative air humidity:	Maximum 95%, non-condensing
EMC - Immunity Interference:	EN61000-4-2
Weight:	1.3oz
Dimensions (inch) W x H x L:	0.72 x 2.68 x 3.26
External Connection:	AWG 12-26/(0.129 - 3.31) $mm^2$13 pin, 3.5mm plug-able terminal block

7.7.2 Default Configuration:

The EPM 7000 meter automatically recognizes the installed option card during Power Up. If you have not programmed a configuration for the card, the unit will default to the following outputs:

Status Inputs	Defaulted to Status Detect
Pulse Outputs	Defaulted to Energy Pulses
Pulse Channel 1	1.8 +Watt-hrs per pulse
Pulse Channel 2	1.8 -Watt-hrs per pulse
Pulse Channel 3	1.8 +VAR-hrs per pulse
Pulse Channel 4	1.8 -VAR-hrs per pulse

7.7.3 Wiring Diagram

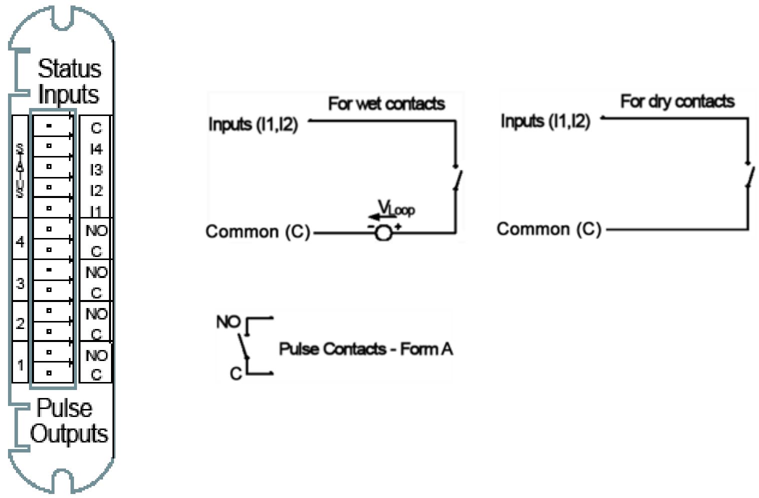


Figure 7-6: Pulse Output (4) / Status Input (4) Card

7.8 Fiber Optic Communication Card (F1; F2)

The Fiber Optic Communication card provides a standard serial communication port via a fiber optic connection. An echo switch is available to enable messages bypassing the unit. This feature can be used in a daisy chained network topology.

7.8.1 Specifications

The technical specifications at 25 °C are as follows:

Number of Ports:	1
Power consumption:	0.160W internal
Fiber connection:	ST® (F1) or Versatile Link (F2) – as per order
Optical fiber details:	Multimode
ST® (F1)	50/125 µm, 62.5/125 µm, 100/140 µm,
	200µm Hard Clad Silica (HCS®)
Versatile Link (F2):	200µm Hard Clad Silica (HCS®)
	1mm Plastic Optical Fiber (POF)
Baud rate:	Up to 57.6kb/s – pre-programmed in the main unit
Diagnostic feature:	LED lamps for TX and RX activity

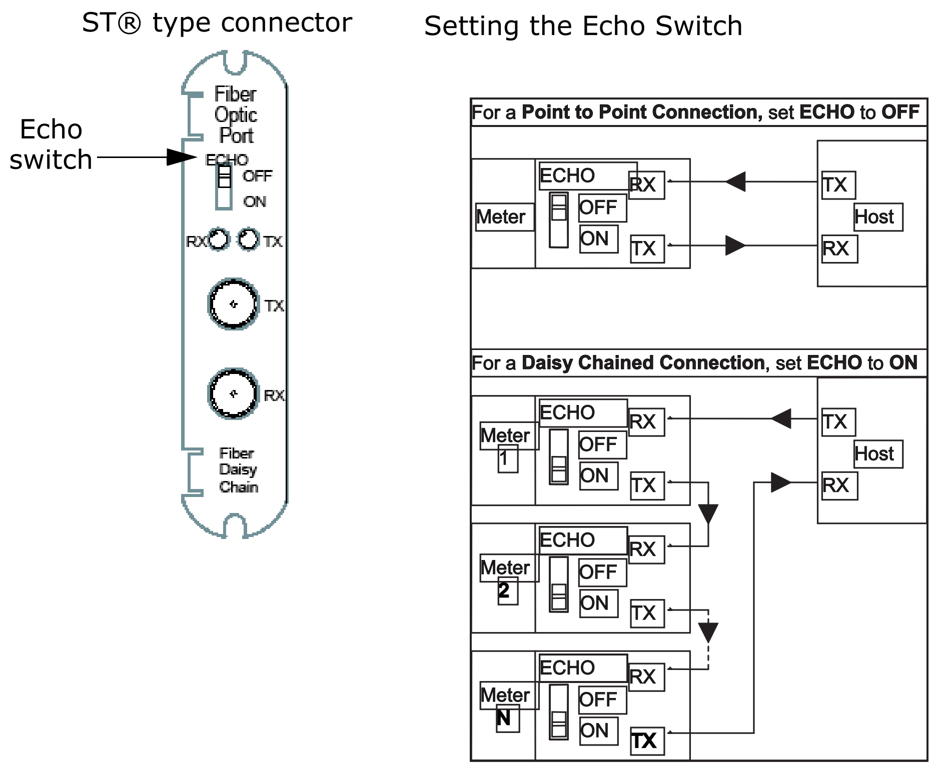
The general specifications are as follows:

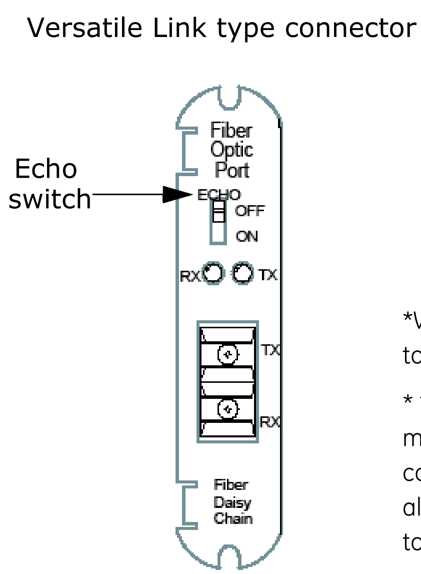
Operating Temperature:	-20 to +70 °C
Storage Temperature:	-40 to +80 °C
Relative air humidity:	Maximum 95%, non-condensing
EMC - Immunity Interference:	EN61000-4-2
Weight:	1.2oz
Dimensions (inch) W x H x L:	0.72 x 2.68 x 3.26
Fiber Connection:	ST® (F1T) or Versatile Link (F2) – as per order

HCS® is a registered trademark of SpecTran Corporation.

ST® is a registered trademark of AT&T.

7.8.2 Wiring Diagram





*When a Fiber Optic Com Card is used in point to point connection, set the Echo Switch to OFF.

* *When a Fiber Optic Com Card is installed in a meter that is part of a Daisy Chained connection, set the Echo Switch to ON. this allows messages not for this meter to continue to the next meter in sequence.

Figure 7-7: Fiber Optic Communication Card

7.9 10/100BaseT Ethernet Communication Card (E1)

The 10/100BaseT Ethernet Communication card provides the EPM 7000 meter with Ethernet capability. See Chapter 8 for details and instructions.

NOTE

Refer to the *GE Communicator Instruction Manual* for instructions on performing Network configuration.

7.9.1 Specifications

The technical specifications at 25 °C are as follows:

Number of Ports:	1
Power consumption:	2.1W internal
Baud rate:	10/100Mbit
Diagnostic feature:	Status LEDs for LINK and ACTIVE
Number of simultaneous Modbus connections:	12

The general specifications are as follows:

Operating Temperature:	-20 to +70°C
Storage Temperature:	-40 to +80°C
Relative air humidity:	Maximum 95%, non-condensing
EMC - Immunity Interference:	EN61000-4-2
Weight:	1.7oz
Dimensions (inch) W x H x L:	0.72 x 2.68 x 3.26
Connection Type:	RJ45 modular (Auto-detecting transmit and receive)

7.9.2 Default Configuration

The EPM 7000 meter automatically recognizes the installed option card during Power Up. If you have not programmed a configuration for the card, the unit will default to the following:

IP Address: 10.0.0.2

Subnet Mask: 255.255.255.0

Default Gateway: 0.0.0.0

7.9.3 Wiring Diagram

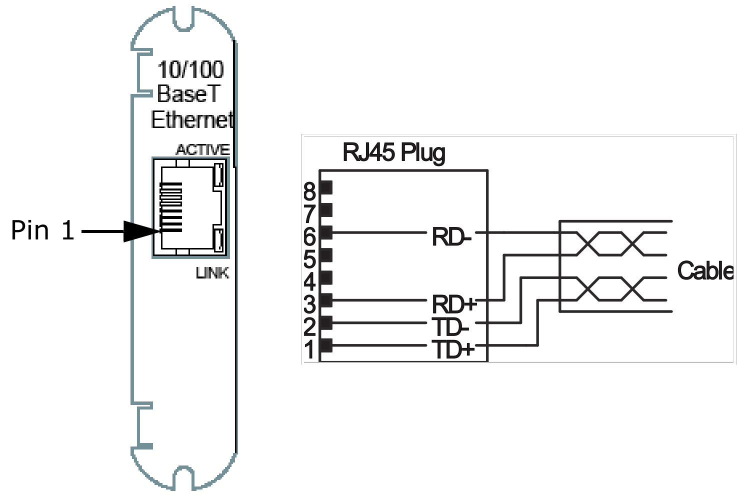


Figure 7-8: 10/100BaseT Ethernet Card

NOTE

The E1 Module uses an auto-detecting circuit that automatically switches the transmit and receive in order to properly align communication. Because of this, when you are communicating directly to a meter with a PC or a switch, a straight cable can be used.

7.10 IEC 61850 Protocol Ethernet Network Card (E2)

The IEC 61850 Protocol Ethernet Network card provides the EPM 7000 meter with IEC 61850 as well as Modbus protocol, to allow it to operate in any IEC 61850 application. See Appendix D for details and instructions.

7.10.1 Specifications

The technical specifications at 25 °C are as follows:

Number of Ports:	1
Power consumption:	2.1W internal
Baud rate:	10/100Mbit
Diagnostic feature:	Status LEDs for LINK and ACTIVE
Number of simultaneous Modbus connections:	12
Number of simultaneous MMS clients:	5

The general specifications are as follows:

Operating Temperature:	-20 to +70°C
Storage Temperature:	-40 to +80°C
Relative air humidity:	Maximum 95%, non-condensing

EMC - Immunity Interference:	EN61000-4-2
Weight:	1.7oz
Dimensions (inch) W x H x L:	0.72 x 2.68 x 3.26
Connection Type:	RJ45 modular (Auto-detecting transmit and receive)

7.10.2 Default Configuration

The EPM 7000 meter automatically recognizes the installed option card during Power Up. If you have not programmed a configuration for the card, the unit will default to the following:

IP Address: 10.0.0.2

Subnet Mask: 255.255.255.0

Default Gateway: 0.0.0.0

7.10.3 Wiring Diagram

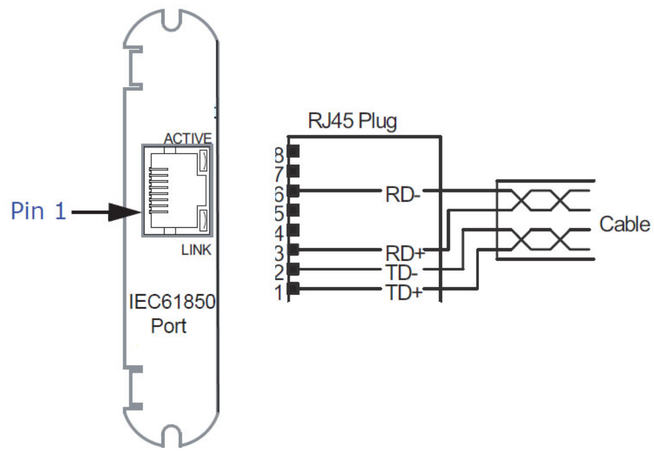


Figure 7-9: IEC61850 Protocol Ethernet Network Card

IMPORTANT!

The E2 uses an auto-detecting circuit that automatically switches the transmit and receive in order to properly align communication. Because of this, when you are communicating directly to a meter with a PC or a switch, a straight cable can be used.

EPM 7000 Power Quality Meter

Chapter 8: Using the Ethernet Card

8.1 Overview

When you install the optional Ethernet card in your EPM 7000 meter, you gain the capability of communicating over the Ethernet medium using GE's communications technology.

8.2 Hardware Connection

The Ethernet card fits into either of the two Option Card slots in the back of the EPM 7000 meter. Refer to the Chapter 7 for card installation instructions.

Use a standard RJ45 10/100BaseT cable to connect to the Ethernet card. The card auto-detects cable type and will work with either straight or crossover cable.

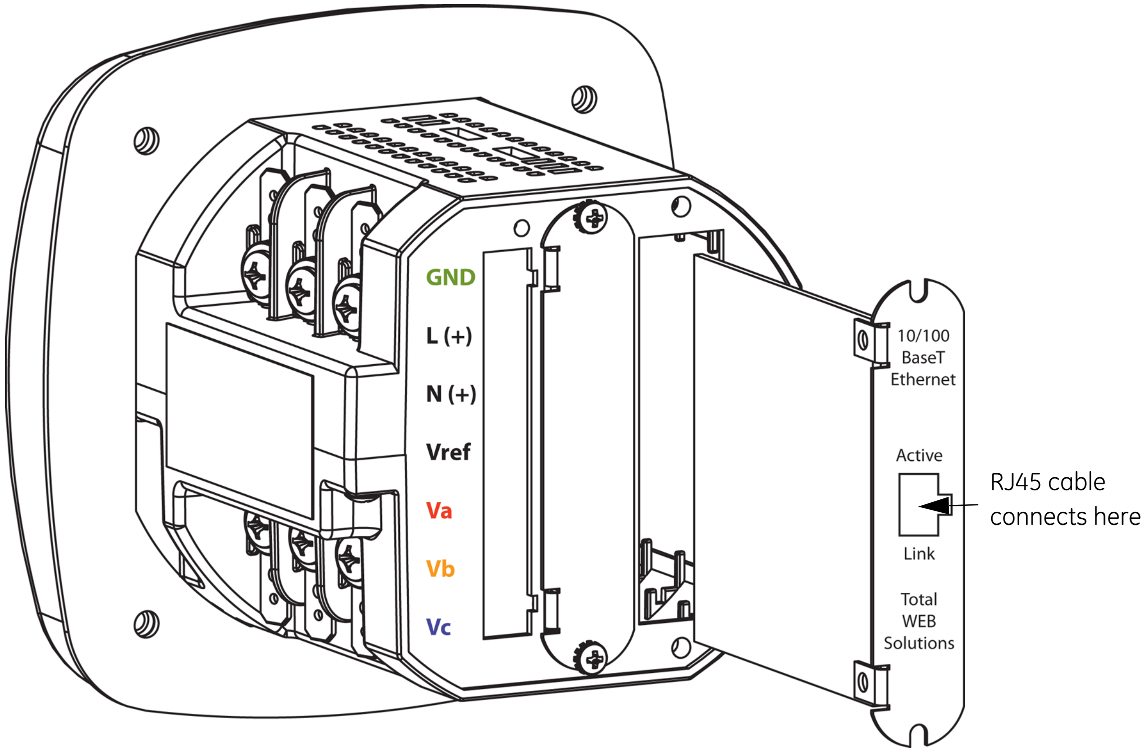


Figure 8-1: Meter with Ethernet Card

8.3 Performing Network Configuration

As with the other Option cards, the EPM 7000 meter auto-detects the presence of an installed Ethernet card. Configure the Ethernet card through GE Communicator. Refer to the *GE Communicator Instruction Manual* for instructions. You can open the manual online by clicking **Help>Contents** from the GE Communicator Main screen.

8.4 Ethernet Card Features

The E1 Ethernet card gives your meter the following capabilities:

- Ethernet Communication
- Embedded Web Server
- NTP Time Server Synchronization
- Alarm and notification emails, with meter readings

8.4.1 Ethernet Communication

The 100BaseT Ethernet, or "E2" which also adds IEC 61850 protocol support, communication card enables high-speed Ethernet communication with up to 12 simultaneous connections for Modbus TCP. The card supports a static IP address and is treated like a node on the network.

8.4.2 Embedded Web Server

The Ethernet card gives the meter a Web server that is viewable over the Ethernet by almost all browsers. The EPM 7000 web pages allow you to see the following information for the EPM 7000 meter:

- Voltage and Current Readings
- Power and Energy Readings
- Power Quality Information
- General Meter Information. You can also upgrade the Ethernet (Network) Card's firmware from the Meter Information web page.

The E1 card also supports the "keep alive" feature - see Section 8.4.5.

Follow these steps to access the Multilin EPM 7000 meter's web pages:

1. Open a standard web browser from your PC.
2. Type the Ethernet Card's IP address in the address bar, preceded by http://.
   For example: http://172.20.167.99
3. You will see the EPM 7000 Power Quality Meter Introduction web page shown below.

4. To view Voltage and Current Readings, click Volts/Amps on the left side of the web page. You will see the web page shown below:

Multilin™ EPM7000
POWER METERING SYSTEM

home volts/amps power/energy power quality meter info

volts/amps

➔ Meter Name 0126443424 Date/Time : 2016-02-16 15:44:38

➔ Voltage/Frequency			
	Instantaneous	Maximum	Minimum
Volts AN	0.000	137.510	0.000
Volts BN	0.000	121.717	0.000
Volts CN	0.000	121.714	0.000
Volts A-B	0.000	137.510	0.000
Volts B-C	0.000	129.976	0.000
Volts C-A	0.000	137.510	0.000
Frequency	0.00	60.06	0.00

➔ Current			
	Instantaneous	Maximum	Minimum
Amps A	0.000	3.601	0.000
Amps B	0.000	3.602	0.000
Amps C	0.000	3.602	0.000
Amps N (calculated)	0.000	1.905	0.000

5. To view Power and Energy Readings, click Power/Energy on the left side of the web page. You will see the web page shown below:

Multilin™ EPM7000
POWER METERING SYSTEM

home volts/amps power/energy power quality meter info

power/energy

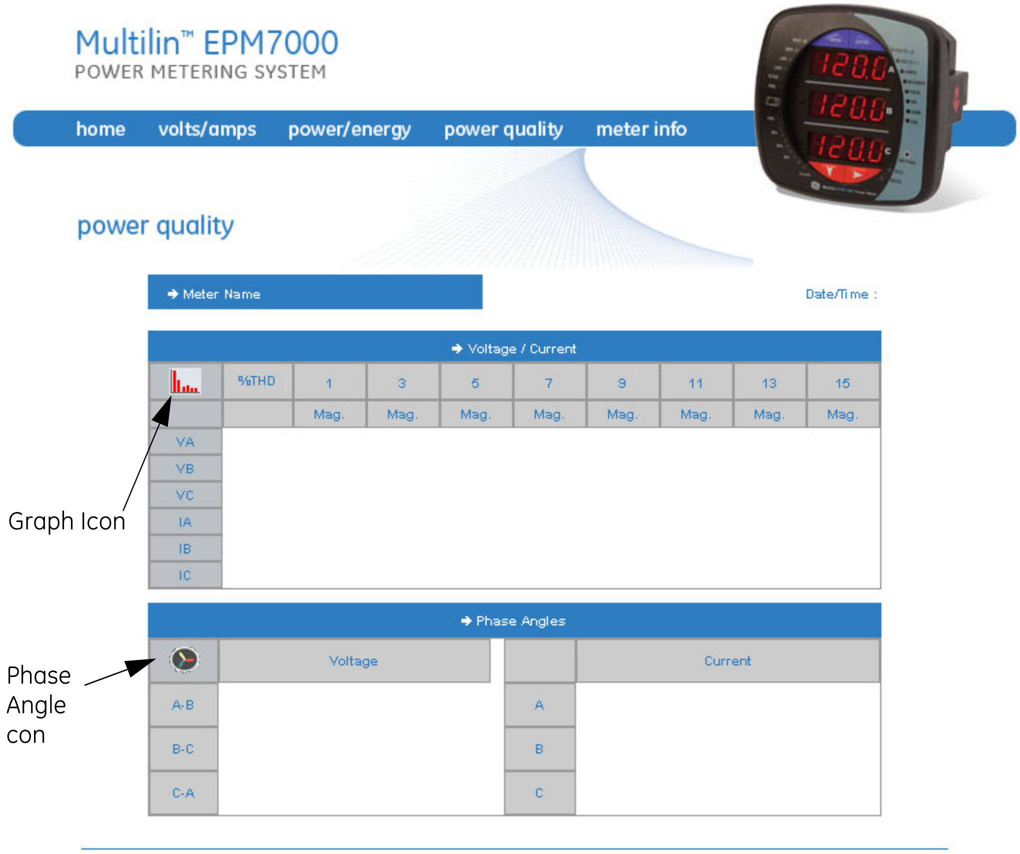
➔ Meter Name 0126443424

Date/Time : 2016-02-16 15:45:13

➔ Real Time			
	Instant	Pos Average	Neg Average
Watts	0.000	0.000	0.000
VARS	0.000	0.000	0.000
PF	0.000	1.000	1.000
	Instant	Average	
VA	0.000	0.000	

➔ Energy	
	Primary
Watt Hours Received	0.39K
Watt Hours Delivered	0.00K
Watt Hours Net	0.39K
Watt Hours Total	0.39K
VAR Hours Positive	0.25K
VAR Hours Negative	-0.05K
VAR Hours Net	0.20K
VAR Hours Total	0.30K
VA Hours Total	0.71K

6. To view Power Quality Information, click Power Quality on the left side of the web page. You will see the web page shown below:



7. To view a graphical representation of the voltage and current magnitudes, click the **Graph** icon (shown above) in the corner of the Voltage/Current box.
8. To view a graphical representation of the phase angles, click the **Phase Angles** icon in the corner of the Phase Angles box.
9. Click Power Quality on the menu at the top of the web page to return to the previous screen.

10. To view Meter Information, or to upgrade the Network Card's firmware, click Meter Information on the menu at the top of the web page.

NOTE

- The firmware runtime version, displayed in the Run Ver field of this webpage, determines the default password for Network card upgrading and resetting.
- Any special characters (i.e., any of the following characters * :" | \ < > ? /) used in the meter name or any other designator string in the meter, are displayed as '_' (underscore) in the webpage.
- In addition to information about the meter and its firmware, this webpage gives you access to the following functions:
  - Upgrading the Ethernet card's firmware (see Section 8.4.2.1).
  - Resetting the Ethernet card (see Section 8.4.2.2).
  - Configuring Email Notification (see Section 8.4.2.3).

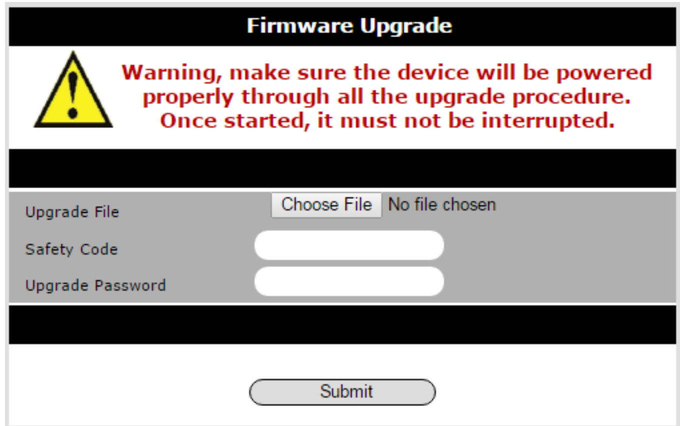
Upgrading the Ethernet Card's Firmware

From one of the EPM 7000 meter's web pages:

1. Click **Meter Information** on the menu at the top of the web page.
2. Click **Upgrade Network Card** (bottom right).
   You will see the window shown below.

NOTE

In order to upgrade the Network (Ethernet) Card, you must be using the PC on which the upgrade file is stored.



3. Click **Browse** to locate the Upgrade file.
4. Enter the **Safety Code** (supplied with the Upgrade file) and the password: *manager*.
5. Click **Submit**. The upgrade will start immediately (it may take several minutes to complete). Once the upgrade is complete, you will see a confirmation message.

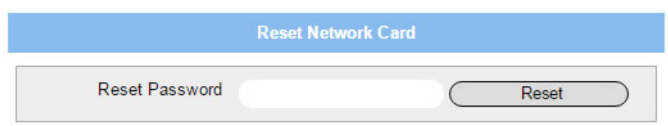
CAUTION

Note the Warning message on the screen. If there is a power interruption during upgrade, please call the GE Grid Solutions Technical Support department for assistance.

Resetting the Ethernet Card

From one of the EPM 7000 meter's webpages:

1. Click **Meter Information** on the left side of the webpage.
2. Click **Reset Network Card** (bottom right). You will see the webpage shown below.



3. Enter the Reset password: the default is **adminR35et** for firmware runtime version 3.35 or later; and **r2d2andc3po** for earlier firmware runtime versions. See the note on page 8-6.
4. Click **Reset**.

NOTE

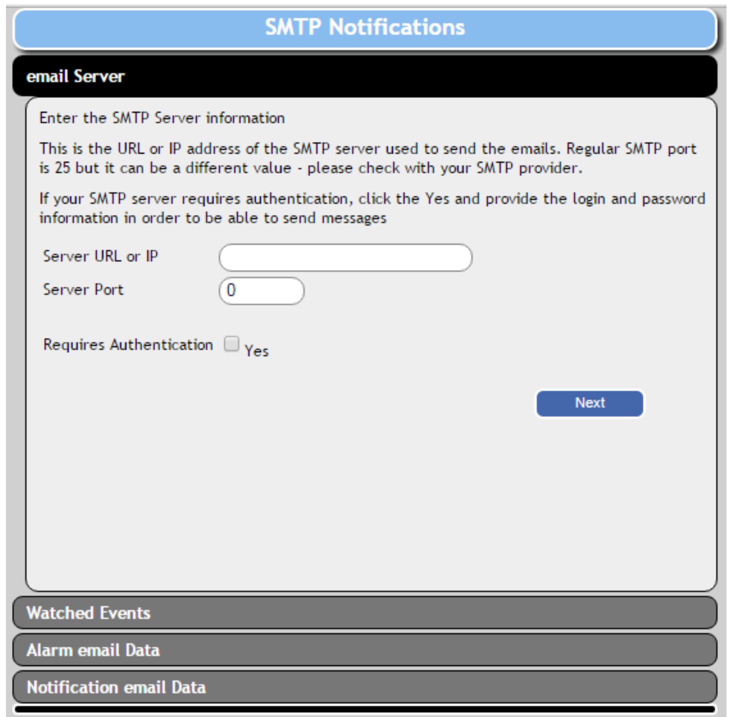
As a result of the reset, the communication link with the card will be lost and must be re-established.

8.4.3 Email Notification

The E1 Ethernet card can be configured to send either alarm or periodic notification emails and to send meter data along with either type of email. The Firmware version of the Ethernet card must be 3.37 or higher for this feature to be available. See page 8-6 for information on finding the firmware version.

From one of the EPM 7000 meter's web pages:

1. Click **Meter Information** on the menu at the top of the web page.
2. Click **Email Notification** (bottom right).
   You will see the window shown below.

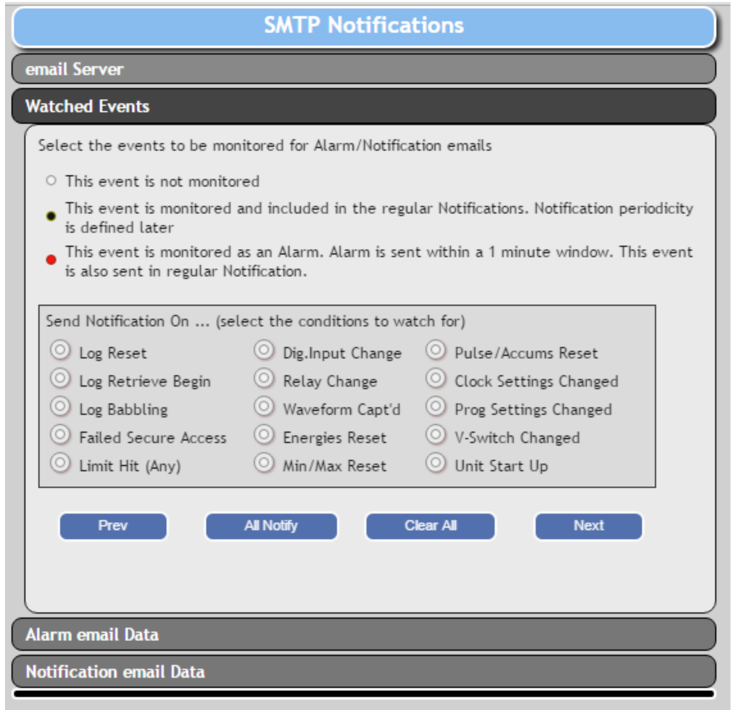


3. Configure the **email Server** screen.

   This screen lets you set up the SMTP email server that the Network card will use to send the emails.

   - **Server URL or IP**: Enter the url or IP address of the email server you will be using.
   - **Server Port**: Enter the Server port. Usually this is 25, but check with your system administrator in case you are using a different port.
   - **Requires Authentication**: If your email server requires authorization, click the checkbox next to Yes and enter the Username and Password.
   - Click **Next**.

4. Configure the **Watched Events** screen.



This screen lets you select the conditions that will cause an alarm or notification email to be sent, e.g, Relay Change or Unit Startup.

Select an event by clicking on the button next to it:

- To select a condition that will cause a Notification email to be sent, click once on the button next to the condition. The button will turn black.
- To select a condition that will cause an Alarm email to be sent, click twice on the button next to the condition. The button will turn red.

NOTE

Note that when you designate a condition as an alarm, an alarm email will be sent out within a minute after the condition occurs and a notification email will also be sent out at the next notification period. If you have not set up any notification emails, then only the alarm email will be sent.

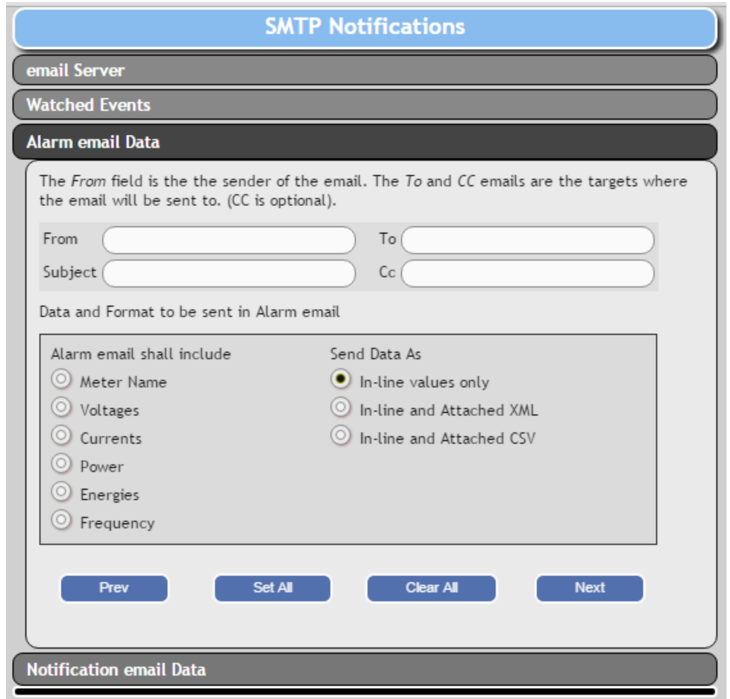
NOTE

There are some conditions which cannot be set as alarms, but only as notifications. These conditions are Programmable Settings Change, Software Option Changed, and Unit Start Up.

- To de-select a condition, click on the button until it is empty, again - not black or red.

You can select multiple conditions for alarms and notifications. When you are done, click **Next**.

5. Configure the **Alarm Email Data** screen.



This screen lets you designate to whom the alarm email will be sent, any data you want sent with the email, and the format the data should be in. If you are not setting up an alarm email, just click the Next button and go to step 6.

From: Enter the email address of the person sending the email.

Subject: Enter the email subject line - the default is Alarm Email.

To: Enter the email address of the person receiving the email.

Cc: Enter the email address of anyone you want to receive a copy of the email.

Alarm email shall include: Select any data you want included in the email from the list, by clicking on the button next to it. Note that these values are taken about one second after the alarm condition occurred. You can click Set All to select all of the values at one time, or Clear All to clear all of your selections.

Send Data As: Select the format for the data from the Send Data As field: In line Values only - just in the body of the email; In line and Attached XML - in the body of the email and in an XML file that will be attached to the email; or In Line and Attached CSV - in the body of the email and in a .csv file that will be attached to the email.

Click **Next**.

6. Configure the **Notification Email Data** screen.

This screen lets you designate to whom the periodic notification email will be sent, any data you want sent with the email, and the format the data should be in. You will also set up the notification period, which is the amount of time between periodic notification emails. If you are not setting up a notification email, go to step h.

From: Enter the email address of the person sending the email.

Subject: Enter the email subject line - the default is Notification Email.

To: Enter the email address of the person receiving the email.

Cc: Enter the email address of anyone you want to receive a copy of the email.

Notification Shall Include: Select any data you want included in the email from the list, by clicking on the button next to it. Note that these values are taken about one second after the notification condition occurred. You can click Set All to select all of the values at one time, or Clear All to clear all of your selections.

Send Data As: Select the format for the data: In line Values only - just in the body of the email; In line and Attached XML - in the body of the email and in an XML file that will be attached to the email; or In Line and Attached CSV - in the body of the email and in a .csv file that will be attached to the email.

Notification Period: Enter the interval you want between notification emails, in minutes,. For example, to set up notification emails every 15 minutes, enter 15 in this field. Any notification conditions that occur in the interval will be saved and sent in the next notification email. Valid entries is in this field are between 15 minutes and 10800 minutes (72 hours).

Change Password: Enter the Password in the Change Password field. The default password is **n07!fY**. You need to enter this password in order to implement your selections.

7. Click **Submit** to save your settings.

   The Network card will reset.

NOTE

Note that any pending emails will be canceled.

8.4.4 NTP Time Server Synchronization

The network card can be configured to perform time synchronization through a Network Time Protocol (NTP) server. This feature lets you synchronize the EPM 7000 meter's real-time clock with this outside source. See the *GE Communicator Instruction Manual* for configuration instructions (Configuring the Network Card section). You can view the manual online by clicking **Help > Contents** from the GE Communicator Main screen.

NOTE

- The SNTP/NTP client protocol used in the network card is version 4, backward compatible to version 3.
- After the meter boots up, it may take up to 20 seconds for the first time synchronization request to be made.

8.4.5 Modbus and DNP over Ethernet

The E1 card enables up to 12 simultaneous sockets of Modbus TCP/IP and up to 5 simultaneous sockets of DNP 3.0 over Ethernet. This means that multiple users can poll the meter using Modbus and/or DNP at the same time. For configuration instructions, refer to the Network card settings section of Chapter 5 in the Communicator Manual.

Using DNP over Ethernet you can control Relay outputs and Status inputs, if you also have a Relay Output/Status Input Option card installed in your meter.

8.4.6 Keep-Alive Feature

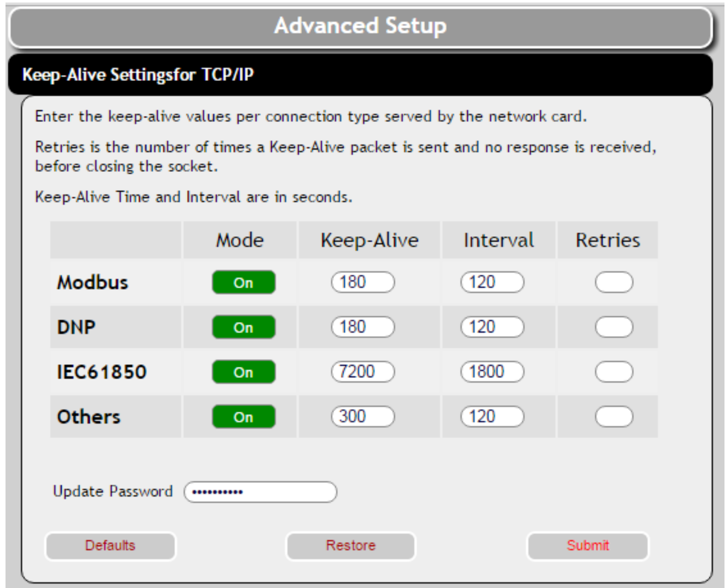
The E1 and E2 Network option cards support user configurable Keep-Alive timing settings. The Keep-Alive feature is used by the TCP/IP layer for detecting broken connections. Once detected, the connection is closed in the Network card, and the server port is freed. This prevents the card from running out of server connections due to invalid links.

The Keep-Alive settings can be configured differently for each protocol group: Modbus TCP/IP, DNP over Ethernet, IEC61850, and others.

WARNING

Only modify these settings if you are knowledgeable about them, since setting them incorrectly can lead to unstable connections.

To access the Keep-Alive setting screen, key the following into your web browser's address bar: http://xx.xx.xx.xx/sys/setup_keepalive_ssi.htm, where xx.xx.xx.xx is your E1 card's IP address. You will see the screen shown below.



- You can click on the On button to turn off the keep-alive feature for a protocol. The button will turn red and say Off.
- For each protocol, you can enter a keep-alive time and interval in seconds.
- For each protocol, you can enter the number of retries, in the event of communication failure, before the communication socket is closed.
- Enter the password (the default is chgK339@).
- Click Submit to implement your entries; click Restore to change back to previous settings; click Default to revert to the default system settings.

⚠WARNING

IMPORTANT! You should not make changes to the settings unless you are sure of what you are doing, since even small changes to the values on this screen can render the network connection unstable. GE is not responsible for instability of the network link when values other than the default are set.

EPM 7000 Power Quality Meter

Chapter 9: Data Logging

9.1 Overview

Software Options C to F give the EPM 7000 meter additional memory for extensive data logging (see section 9.2 below). The EPM 7000 meter can log historical trends, limit alarms, I/O changes, sequence of events, and waveforms (Options E and F only). In addition, the meter has a real-time clock that allows all events to be time-stamped when they occur.

9.2 Available Logs

The following logs are available for an EPM 7000 meter equipped with Software Options B through D. These meters have 2 MegaBytes of flash memory for data logging.

- Historical Logs: The EPM 7000 meter has three Historical Logs. Each log can be independently programmed with individual trending profiles, that is, each can be used to measure different values. You can program up to 64 parameters per log. You also have the ability to allocate available system resources between the three logs, to increase or decrease the size of the individual historical logs. See the *GE Communicator Instruction Manual* for additional information and instructions.
- Limit/Alarm Log: This log provides the magnitude and duration of events that fall outside of configured acceptable limits. Time stamps and alarm value are provided in the log. Up to 2,048 events can be logged. See the *GE Communicator Instruction Manual* for additional information and instructions.
- I/O Change Log: This log is unique to the EPM 7000 meter. The I/O Change Log provides a time-stamped record of any Relay Output/Digital Input or Pulse Output/ Digital Input Card output or input status changes. Up to 2,048 events can be logged. Refer to the *GE Communicator Instruction Manual* for additional information and instructions.
- System Events Log: In order to protect critical billing information, the EPM 7000 meter records and logs the following information with a timestamp:

- Demand resets
- Password requests
- System startup
- Energy resets
- Log resets
- Log reads
- Programmable settings changes.
- Critical data repairs

An EPM 7000 meter equipped with Options B, C, and D, has 2 MB of additional memory for data logging: Option E gives the meter 3 Megabytes of flash memory, and Option F gives the meter 4 MegaBytes of flash memory. These meters also have waveform recording capabilities, and the following additional log:

- Waveform Log: This event-triggered log records a waveform when a user-programmed value goes out of limit and when the value returns to normal.

All of the EPM 7000 meter Logs can be viewed through the Log Viewer. Refer to the *GE Communicator Instruction Manual* for additional information and instructions regarding Logs and the Log Viewer.

EPM 7000 Power Quality Meter

Appendix A: EPM 7000 Meter Navigation Maps

A.1 Introduction

You can configure the EPM 7000 meter and perform related tasks using the buttons on the meter face. Chapter 6 contains a description of the buttons on the meter face and instructions for programming the meter using them. The meter can also be programmed using software (see Chapter 5 and the *GE Communicator Instruction Manual*).

A.2 Navigation Maps (Sheets 1 to 4)

The EPM 7000 meter's Navigation maps begin on the next page. The maps 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 automatically return to Operating Mode after 10 minutes with no user activity.

EPM 7000 Meter Navigation Map Titles:

- *Main Menu Screens* (Sheet 1)
- *Operating Mode Screen* (Sheet 2)
- *Reset Mode Screens* (Sheet 3)
- *Configuration Mode Screens* (Sheet 4)

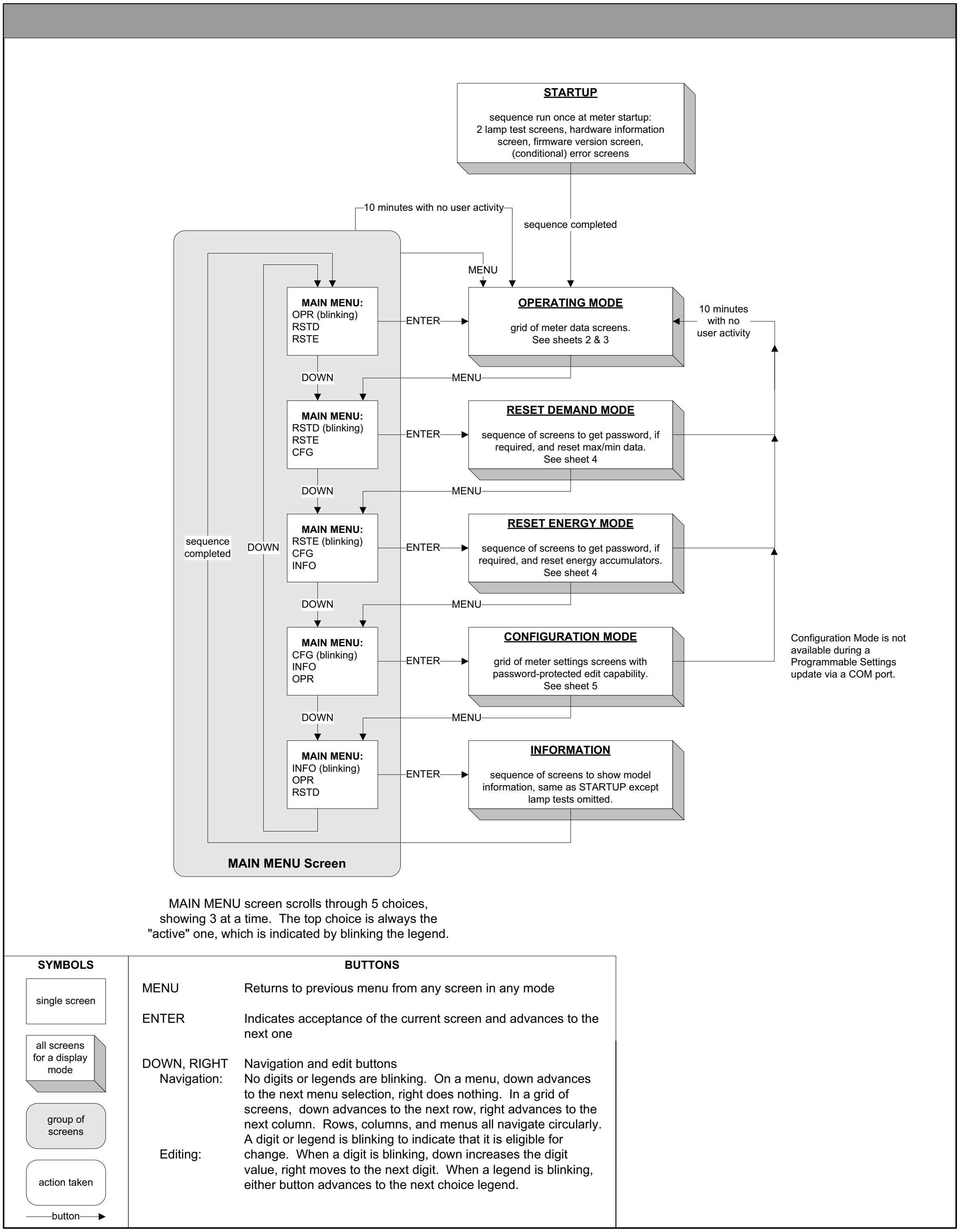


Figure A-1: Main Menu Screens

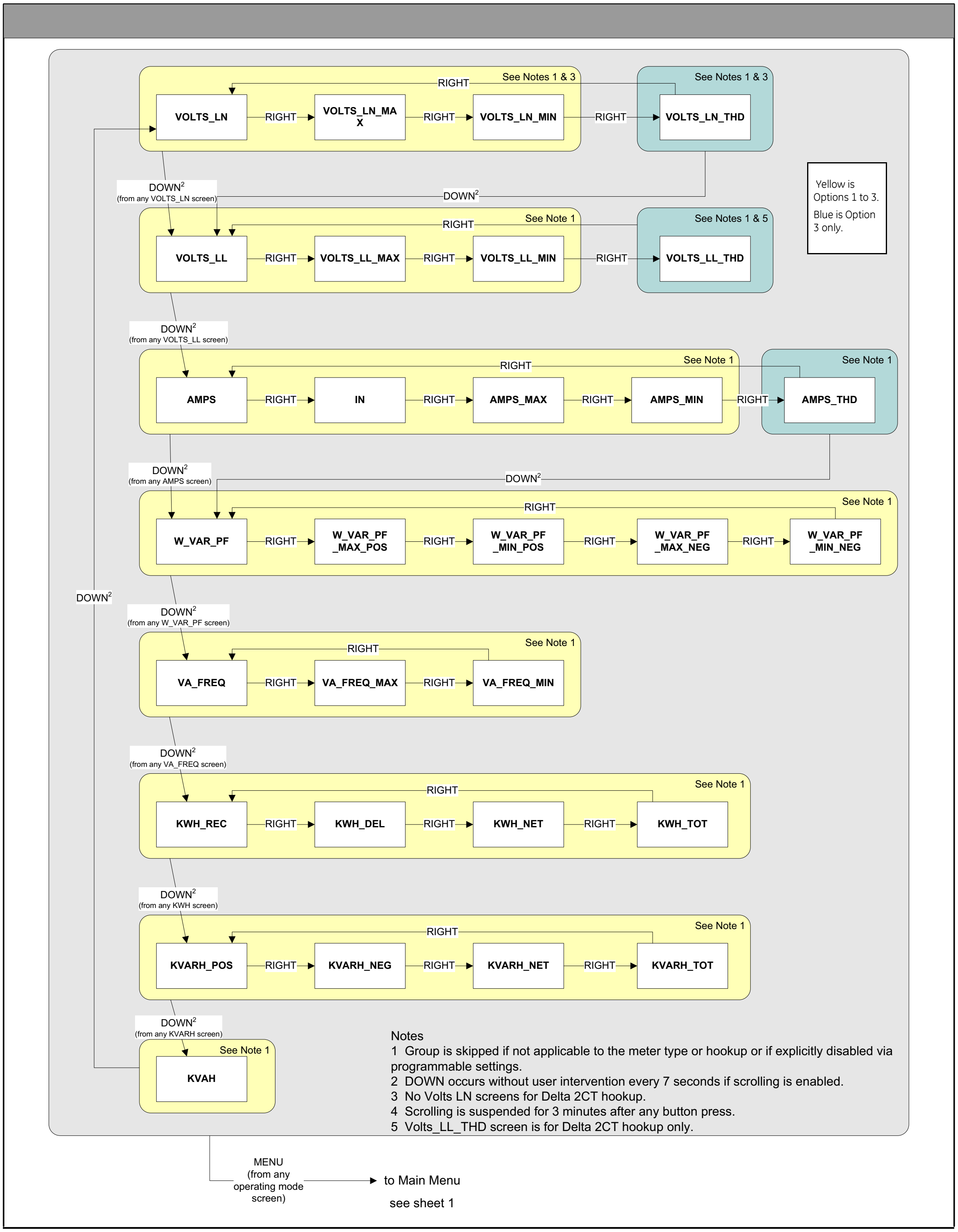


Figure A-2: Operating Mode Screen

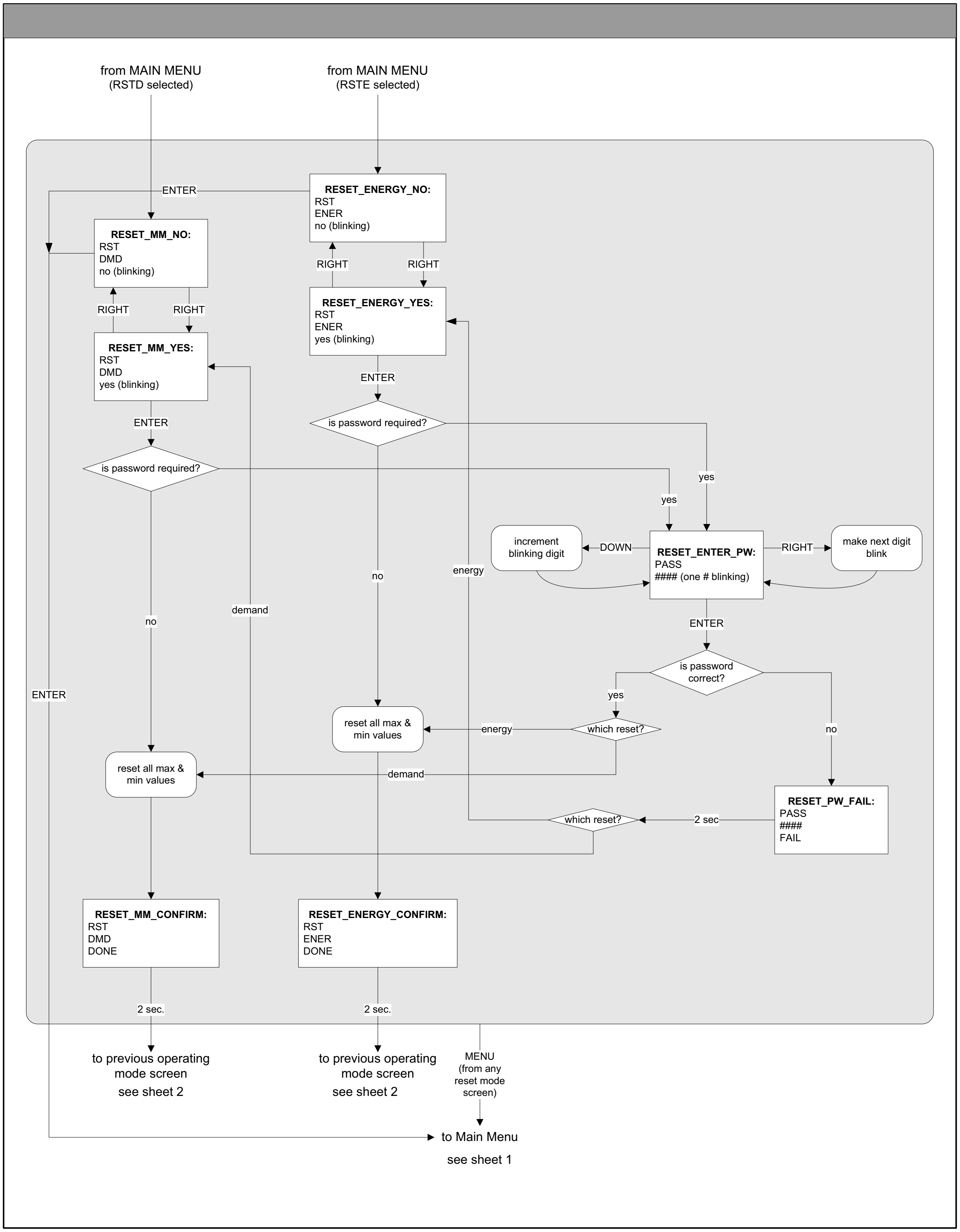


Figure A-3: Reset Mode Screens

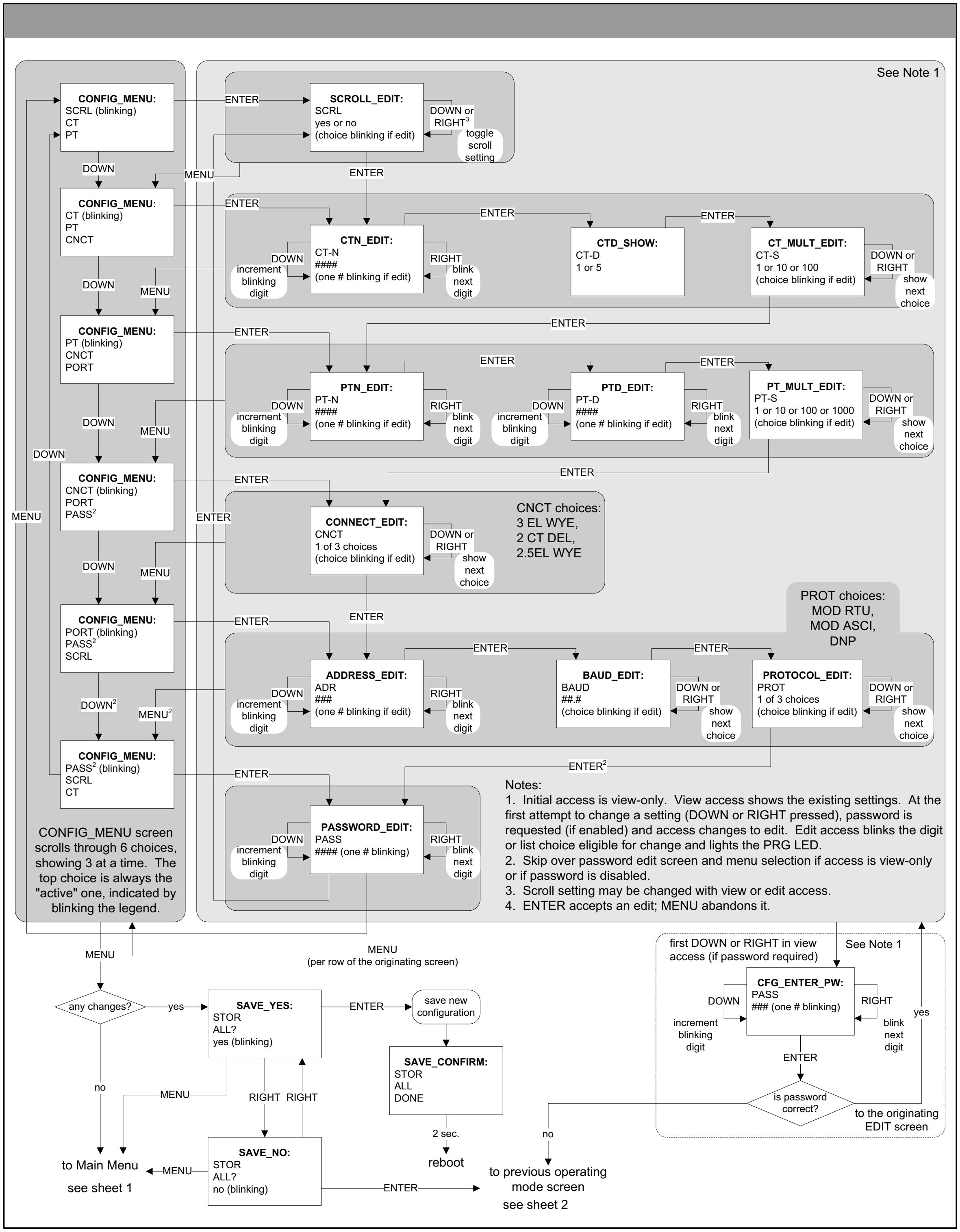


Figure A-4: Configuration Mode Screens

EPM 7000 Power Quality Meter

Appendix B: Modbus Map and Retrieving Logs

B.1 Introduction

The Modbus Map for the EPM 7000 Meter gives details and information about the possible readings of the meter and its programming. The EPM 7000 meter can be programmed using the buttons on the face of the meter (Chapter 6), or by using software. For a programming overview, see section 5.2 of this manual. For further details see the *GE Communicator Instruction Manual*.

B.2 Modbus Register Map Sections

The EPM 7000 meter's Modbus Register Map includes the following sections:

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

Meter Data Section, Registers 1000 - 12031, details the Meter's Readings, including Primary Readings, Energy Block, Demand Block, Phase Angle Block, Status Block, THD Block, Minimum and Maximum in Regular and Time Stamp Blocks, Option Card Blocks, and Accumulators. Operating Mode readings are described in Section 6.2.6.

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

Programmable Settings Section, Registers 30000 - 33575, details all the setups you can program to configure your meter.

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

Log Retrieval Section, Registers 49997 - 51095, details Log Retrieval. See Section B.5 for instructions on retrieving logs.

B.3 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 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:

$-1^{sign} \times 2^{\,exponent-127} \times 1.mantissa = 0x0C4E11DB9$

$-1^{sign} \times 2^{\,137-127} \times 1 \cdot 10000100011101101110001$

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

-1800.929

Register	0x0C4E1																0x01DB9															
Byte	0x0C4								0x0E1								0x01D								0x0B9v							
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								0b01100001000111011011 1001																						

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 127. So, the Exponent value is 10.

The Mantissa is 11000010001110110111001 binary.

With the implied leading 1, the Mantissa is (1).611DB9 (hex).

The Floating Point Representation is therefore -1.75871956 times 2 to the 10.

Decimal equivalent: -1800.929

NOTE

- Exponent = the whole number before the decimal point.
- Mantissa = the positive fraction after the decimal point.

B.5 Retrieving Logs Using the EPM 7000 Meter's Modbus Map

This section describes the log interface system of the EPM 7000 meter from a programming point of view. It is intended for Programmers implementing independent drivers for Log Retrieval from the meter. It describes the meaning of the meter's Modbus Registers related to Log Retrieval and Conversion, and details the procedure for retrieving a log's records.

NOTE

- All references assume the use of Modbus function codes 0x03, 0x06, and 0x10, where each register is a 2 byte MSB (Most Significant Byte) word, except where otherwise noted.
- The carat symbol (^) notation is used to indicate mathematical "power." For example, 2^8 means 2^8; which is 2 x 2 x 2 x 2 x 2 x 2 x 2 x 2, which equals 256.

B.5.1 Data Formats

Timestamp: Stores a date from 2000 to 2099. Timestamp has a Minimum resolution of 1 second.

Byte	0	1	2	3	4	5
Value	Year	Month	Day	Hour	Minute	Second
Range	0-99 (+2000)	1-12	1-31	0-23	0-59	0-59
Mask	0x7F	0x0F	0x1F	0x1F	0x3F	0x3F

The high bits of each timestamp byte are used as flags to record meter state information at the time of the timestamp. These bits should be masked out unless needed.

B.5.2 EPM 7000 Meter Logs

The EPM 7000 meter has 7 logs: System Event, Alarm (Limits), 3 Historical, I/O Change, and Waveform. Each log is described below.

1. **System Event (0)**: The System Event log is used to store events which happen in, and to, the meter. Events include Startup, Reset Commands, Log Retrievals, etc. The System Event Log Record takes 20 bytes, 14 bytes of which are available when the log is retrieved.

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Value	timestamp						Group	Event	Mod	Chan	Param1	Param2	Param3	Param4

NOTE

The complete Systems Events table is shown in Section B.5.5, step 1.

2. **Alarm Log (1):** The Alarm Log records the states of the 8 Limits programmed in the meter.
   - Whenever a limit goes out (above or below), a record is stored with the value that caused the limit to go out.
   - Whenever a limit returns within limit, a record is stored with the "most out of limit" value for that limit while it was out of limit.

The Alarm Log Record uses 16 bytes, 10 bytes of which are available when the log is retrieved.

Byte	0	1	2	3	4	5	6	7	8	9
Value	timestamp						direction	limit#	Value%	

The limit # byte is broken into a type and an ID.

Bit	0	1	2	3	4	5	6	7
Value	type	0	0	0	0	Limit ID		

3. **Historical Log 1 (2)**: The Historical Log records the values of its assigned registers at the programmed interval.

NOTE

See Section B.5.3, Number 1, for details on programming and interpreting the log.

Byte	0	1	2	3	4	5	6	-	-	N
Value	timestamp						values . . .			

4. **Historical Log 2 (3)**: Same as Historical Log 1.
5. **Historical Log 3 (4)**: Same as Historical Log 1.
6. **I/O Change Log (5)**: The I/O Change Log records changes in the input and output of Digital I/O Type Option Cards (Relay and Pulse).

:

Table B.1: I/O Change Log tables

Byte	0	1	2	3	4	5	6	7	8	9
Value	Timestamp						Card 1 Changes	Card 1 States	Card 2 Changes	Card 2 States

Table B.2: Card Change Flags

Bit	7	6	5	4	3	2	1	0
Value	Out 4 Change	Out 3 Change	Out 2 Change	Out 1 Change	In 4 Change	In 3 Change	In 2 Change	In 1 Change

Table B.3: Card Current States

Bit	7	6	5	4	3	2	1	0
Value	Out 4 State	Out 3 State	Out 2 State	Out 1 State	In 4 State	In 3 State	In 2 State	In 1 State

7. PQ Event Log (10): The Power Quality Event log records the information regarding EPM 7000 meter trigger conditions, including the cause of the trigger, conditions at the time of the trigger, and duration of the event.
8. Waveform Log (11): The waveform log records the waveform samples of a capture, along with information about the capture. Due to the large amount of data involved in a waveform capture (approximately 24kb), a single waveform capture is split over 26 log records. All 26 of these records must be retrieved to build up the single capture. Every waveform record contains a: record header, capture number, record number and record payload.

B.5.3 Block Definitions

This section describes the Modbus Registers involved in retrieving and interpreting a EPM 7000 Meter Log. Other sections refer to certain 'values' contained in this section. See the corresponding value in this section for details.

NOTE

- “Register” is the Modbus Register Address in 0-based Hexadecimal notation. To convert it to 1-based decimal notation, convert from hex16 to decimal10 and add 1. For example: 0x03E7 = 1000.
- “Size” is the number of Modbus Registers (2 byte) in a block of data.

Historical Log Programmable Settings:

The Historical Logs are programmed using a list of Modbus Registers that will be copied into the Historical Log record. In other words, Historical Log uses a direct copy of the Modbus Registers to control what is recorded at the time of record capture.

To supplement this, the programmable settings for the Historical Logs contain a list of descriptors, which group registers into items. Each item descriptor lists the data type of the item, and the number of bytes for that item. By combining these two lists, the Historical Log record can be interpreted.

For example: Registers 0x03E7 and 0x03E8 are programmed to be recorded by the historical log. The matching descriptor gives the data type as float, and the size as 4 bytes. These registers program the log to record "Primary Readings Volts A-N."

Historical Log Blocks:

Start Register: 0x7917 (Historical Log 1)

0x79D7 (Historical Log 2)

0x7A97 (Historical Log 3)

Block Size: 192 registers per log (384 bytes)

The Historical Log programmable settings are comprised of 3 blocks, one for each log. Each is identical to the others, so only Historical Log 1 is described here. All register addresses in this section are given as the Historical Log 1 address (0x7917).

Each Historical Log Block is composed of 3 sections: The header, the list of registers to log, and the list of item descriptors.

Header:

Registers: 0x7917 - 0x7918

Size: 2 registers

Byte	0	1	2	3
Value	# Registers	# Sectors		Interval

- # Registers: The number of registers to log in the record. The size of the record in memory is [12 + (# Registers x 2)]. The size during normal log retrieval is [6 + (# Registers x 2)]. If this value is 0, the log is disabled. Valid values are {0-117}.
- # Sectors: The number of Flash Sectors allocated to this log. Each sector is 64kb, minus a sector header of 20 bytes. 15 sectors are available for allocation between Historical Logs 1, 2, and 3. The sum of all Historical Logs may be less than 15. If this value is 0, the log is disabled. Valid values are {0-15}.
- Interval: The interval at which the Historical Log's Records are captured. This value is an enumeration:

0x01	1 minute
0x02	3 minute
0x04	5 minute
0x08	10 minute
0x10	15 minute
0x20	30 minute
0x40	60 minute
0x80	End of Interval (EOI) Pulse*

* Setting the interval to EOI causes a record to be logged whenever an EOI pulse event is generated. This is most commonly used in conjunction with the Digital I/O Option Cards.

NOTE: The interval between records will not be even (fixed), and thus should not be used with programs that expect a fixed interval.

Register List:

Registers: 0x7919 - 0x798D

Size:	1 register per list item, 117 list items

The Register List controls what Modbus Registers are recorded in each record of the Historical Log. Since many items, such as Voltage, Energy, etc., take up more than 1 register, multiple registers need to be listed to record those items.

For example: Registers 0x03E7 and 0x03E8 are programmed to be recorded by the historical log. These registers program the log to record "Primary Readings Volts A-N."

- Each unused register item should be set to 0x0000 or 0xFFFF to indicate that it should be ignored.
- The actual size of the record, and the number of items in the register list which are used, is determined by the # registers in the header.
- Each register item is the Modbus Address in the range of 0x0000 to 0xFFFF.

Item Descriptor List:

Registers:	0x798E - 0x79C8
Size:	1 byte per item, 117 bytes (59 registers)

While the Register List describes what to log, the Item Descriptor List describes how to interpret that information. Each descriptor describes a group of register items, and what they mean.

Each descriptor is composed of 2 parts:

- Type: The data type of this descriptor, such as signed integer, IEEE floating point, etc. This is the high nibble of the descriptor byte, with a value in the range of 0-14. If this value is 0xFF, the descriptor should be ignored.

0	ASCII: An ASCII string, or byte array
1	Bitmap: A collection of bit flags
2	Signed Integer: A 2's Complement integer
3	Float: An IEEE floating point
4	Energy: Special Signed Integer, where the value is adjusted by the energy settings in the meter's Programmable Settings.
5	Unsigned Integer
6	Signed Integer 0.1 scale: Special Signed Integer, where the value is divided by 10 to give a 0.1 scale.
7-14	Unused
15	Disabled: used as end list marker.

- Size: The size in bytes of the item described. This number is used to determine the pairing of descriptors with register items.

For example: If the first descriptor is 4 bytes, and the second descriptor is 2 bytes, then the first 2 register items belong to the 1st descriptor, and the 3rd register item belongs to the 2nd descriptor.

NOTE

As can be seen from the example, above, there is not a 1-to-1 relation between the register list and the descriptor list. A single descriptor may refer to multiple register items.

Register Items	Descriptors
0x03C7/ 0x03C8	Float, 4 byte
0x1234	Signed Int, 2 byte

NOTE

The sum of all descriptor sizes must equal the number of bytes in the data portion of the Historical Log record.

Log Status Block:

The Log Status Block describes the current status of the log in question. There is one header block for each of the logs. Each log's header has the following base address:

Log	Base Address
Alarms:	0xC737
System:	0xC747
Historical 1:	0xC757
Historical 2:	0xC767
Historical 3:	0xC777
I/O Change:	0xC787
PQ Event:	0xC797
Waveform:	0xC7A7

Bytes	Value	Type	Range	# Bytes
0-3	Max Records	UINT32	0 to 4,294,967,294	4
4-7	Number of Records Used	UINT32	1 to 4,294,967,294	4
8-9	Record Size in Bytes	UINT16	4 to 250	2
10-11	Log Availability	UINT16		2
12-17	Timestamp, First Record	TSTAMP	1Jan2000 - 31Dec2099	6
18-23	Timestamp, Last Record	TSTAMP	1Jan2000 - 31Dec2099	6
24-31	Reserved			8

- Max Records: The maximum number of records the log can hold given the record size, and sector allocation. The data type is an unsigned integer from 0 to 2^32.
- Records Used: The number of records stored in the log. This number will equal the Max Records when the log has filled. This value will be set to 1 when the log is reset. The data type is an unsigned integer from 1 to 2^32.

NOTE

The first record in every log before it has rolled over is a "dummy" record, filled with all 0xFF's. When the log is filled and rolls over, this record is overwritten.

- Record Size: The number of bytes in this record, including the timestamp. The data type is an unsigned integer in the range of 14 to 242.

- Log Availability: A flag indicating if the log is available for retrieval, or if it is in use by another port.

0	Log Available for retrieval
1	In use by COM1 (IrDA)
2	In use by COM2 (RS485)
3	In use by COM3 (Option Card 1)
4	In use by COM4 (Option Card 2)
0xFFFF	Log Not Available - the log cannot be retrieved. This indicates that the log is disabled.

NOTE

To query the port by which you are currently connected, use the Port ID register:

Register:	0x1193
Size:	1 register

Description: A value from 1-4, which enumerates the port that the requestor is currently connected on.

NOTE

When Log Retrieval is engaged, the Log Availability value will be set to the port that engaged the log. The Log Availability value will stay the same until either the log has been disengaged, or 5 minutes have passed with no activity. It will then reset to 0 (available).

NOTE

Each log can only be retrieved by one port at a time.

NOTE

Only one log at a time can be retrieved.

- First Timestamp: Timestamp of the oldest record.
- Last Timestamp: Timestamp of the newest record.

Log Retrieval Block:

The Log Retrieval Block is the main interface for retrieving logs. It is comprised of 2 parts: the header and the window. The header is used to program the particular data the meter presents when a log window is requested. The window is a sliding block of data that can be used to access any record in the specified log.

Session Com Port:

The EPM 7000 meter's Com Port which is currently retrieving logs. Only one Com Port can retrieve logs at any one time.

Registers:	0xC34E - 0xC34E
Size:	1 register
0	No Session Active
1	COM1 (IrDA)

2	COM2 (RS-485)
3	COM3 (Communications Capable Option Card 1)
4	COM4 (Communications Capable Option Card 2)

To get the current Com Port, see the NOTE on querying the port, on the previous page.

Log Retrieval Header:

The Log Retrieval Header is used to program the log to be retrieved, the record(s) of that log to be accessed, and other settings concerning the log retrieval.

Registers:	0xC34F - 0xC350
Size:	2 registers

Bytes	Value	Type	Format	Description	# Bytes
0-1	Log Number, Enable, Scope	UINT16	nnnnnnnn esssssss	nnnnnnnn - log to retrieve, e - retrieval session enable sssssss - retrieval mode	2
2-3	Records per Window, Number of Repeats	UINT16	wwwwwwww nnnnnnnn	wwwwwwww - records per window, nnnnnnnn - repeat count	2

- Log Number: The log to be retrieved. Write this value to set which log is being retrieved.

0	System Events
1	Alarms
2	Historical Log 1
3	Historical Log 2
4	Historical Log 3
5	I/O Change Log
10	PQ Event Log
11	Waveform Log

- Enable: This value sets if a log retrieval session is engaged (locked for retrieval) or disengaged (unlocked, read for another to engage). Write this value with 1(enable) to begin log retrieval. Write this value with 0(disable) to end log retrieval.

0	Disable
1	Enable

- Scope: Sets the amount of data to be retrieved for each record. The default should be 0 (normal).

0	Normal

1	Timestamp Only
2	Image

- Normal [0]: The default record. Contains a 6-byte timestamp at the beginning, then N data bytes for the record data.
- Timestamp [1]: The record only contains the 6-byte timestamp. This is most useful to determine a range of available data for non-interval based logs, such as Alarms and System Events.
- Image [2]: The full record, as it is stored in memory. Contains a 2-byte checksum, 4-byte sequence number, 6-byte timestamp, and then N data bytes for the record data.

- Records Per Window: The number of records that fit evenly into a window. This value is set-able, as less than a full window may be used. This number tells the retrieving program how many records to expect to find in the window.

(RecPerWindow x RecSize) = #bytes used in the window.

This value should be ((123 x 2) \ recSize), rounded down.

For example, with a record size of 30, the RecPerWindow = ((123 x 2) \ 30) = 8.2 ~= 8

- Number of Repeats: Specifies the number of repeats to use for the Modbus Function Code 0x23 (35). Since the meter must pre-build the response to each log window request, this value must be set once, and each request must use the same repeat count. Upon reading the last register in the specified window, the record index will increment by the number of repeats, if auto-increment is enabled. Section B.5.4.2 has additional information on Function Code 0x23.

NOTE

Note that this must be set to 4 for waveform retrieval.

0	Disables auto-increment
1	No Repeat count, each request will only get 1 w.
2-8	2-8 windows returned for each Function Code 0x23 request.

Bytes	Value	Type	Format	Description	# Bytes
0-3	Offset of First Record in Window	UINT32	ssssssss nnnnnnnn nnnnnnnn nnnnnnnn	ssssssss - window status nn...nn - 24-bit record index number.	4
4-249	Log Retrieve Window	UINT16			246

Log Retrieval Window Block:

The Log Retrieval Window block is used to program the data you want to retrieve from the log. It also provides the interface used to retrieve that data.

Registers:	0xC351 - 0xC3CD
Size:	125 registers

- Window Status: The status of the current window. Since the time to prepare a window may exceed an acceptable modbus delay (1 second), this acts as a state flag, signifying when the window is ready for retrieval. When this value indicates that the window is not ready, the data in the window should be ignored. Window Status is Read-only, any writes are ignored.

0	Window is Ready
0xFF	Window is Not Ready

- Record Number: The record number of the first record in the data window. Setting this value controls which records will be available in the data window.
  - When the log is engaged, the first (oldest) record is "latched." This means that record number 0 will always point to the oldest record at the time of latching, until the log is disengaged (unlocked).
  - To retrieve the entire log using auto-increment, set this value to 0, and retrieve the window repeatedly, until all records have been retrieved.

NOTE

When auto-increment is enabled, this value will automatically increment so that the window will "page" through the records, increasing by RecordsPerWindow each time that the last register in the window is read.

When auto-increment is not enabled, this value must be written-to manually, for each window to be retrieved.

- Log Retrieval Data Window: The actual data of the records, arranged according to the above settings.

B.5.4 Log Retrieval

Log Retrieval is accomplished in 3 basic steps:

1. Engage the log.
2. Retrieve each of the records.
3. Disengage the log.

Auto-Increment

In the traditional Modbus retrieval system, you write the index of the block of data to retrieve, then read that data from a buffer (window). To improve the speed of retrieval, the index can be automatically incremented each time the buffer is read.

In the EPM 7000 meter, when the last register in the data window is read, the record index is incremented by the Records per Window.

Modbus Function Code 0x23

QUERY

Field Name	Example (Hex)
Slave Address	01
Function	23
Starting Address Hi	C3

Starting Address Lo	51
# Points Hi	00
# Points Lo	7D
Repeat Count	04

RESPONSE

Field Name	Example (Hex)
Slave Address	01
Function	23
# Bytes Hi	03
# Bytes Lo	E0
Data	...

Function Code 0x23 is a user defined Modbus function code, which has a format similar to Function Code 0x03, except for the inclusion of a "repeat count." The repeat count (RC) is used to indicate that the same N registers should be read RC number of times. (See the Number of Repeats bullet below.)

NOTE

- By itself this feature would not provide any advantage, as the same data will be returned RC times. However, when used with auto-incrementing, this function condenses up to 8 requests into 1 request, which decreases communication time, as fewer transactions are being made.
- Keep in mind that the contents of the response data is the block of data you requested, repeated N times. For example, when retrieving log windows, you normally request both the window index, and the window data. This means that the first couple of bytes of every repeated block will contain the index of that window.
- In the EPM 7000 meter repeat counts are limited to 8 times for Modbus RTU, and 4 times for Modbus ASCII.

The response for Function Code 0x23 is the same as for Function Code 0x03, with the data blocks in sequence.

NOTICE

Before using function code 0x23, always check to see if the current connection supports it. Some relay devices do not support user defined function codes; if that is the case, the message will stall. Other devices don't support 8 repeat counts.

Log Retrieval Procedure

The following procedure documents how to retrieve a single log from the oldest record to the newest record, using the "normal" record type (see **Scope**). All logs are retrieved using the same method. See Section B.5.4.4 for a Log Retrieval example.

NOTE

- This example uses auto-increment.
- In this example, Function Code 0x23 is not used.
- You will find referenced topics in Section B.5.3. Block Definitions.
- Modbus Register numbers are listed in brackets.

1. Engage the Log:
    - Read the Log Status Block.
        - Read the contents of the specific logs' status block [0xC737+, 16 reg] (see Log Headers).
            - Store the # of Records Used, the Record Size, and the Log Availability.
            - If the Log Availability is not 0, stop Log Retrieval; this log is not available at this time. If Log Availability is 0, proceed to step 1b (Engage the log).

        This step is done to ensure that the log is available for retrieval, as well as retrieving information for later use.
    - Engage the log: write log to engage to Log Number, 1 to Enable, and the desired mode to Scope (default 0 (Normal)) [0xC34F, 1 reg]. This is best done as a single-register write.

        This step will latch the first (oldest) record to index 0, and lock the log so that only this port can retrieve the log, until it is disengaged.
    - Verify the log is engaged: read the contents of the specific logs' status block [0xC737+, 16 reg] again to see if the log is engaged for the current port (see Log Availability). If the Log is not engaged for the current port, repeat step 1b (Engage the log).
    - Write the retrieval information.
        - Compute the number of records per window, as follows: RecordsPerWindow = (246 \ RecordSize)
            - If using 0x23, set the repeat count to 2-8. Otherwise, set it to 1.
            - Since we are starting from the beginning for retrieval, the first record index is 0.
    - Write the Records per window, the Number of repeats (1), and Record Index (0) [0xC350, 3 reg].

        This step tells the EPM 7000 meter what data to return in the window.
2. Retrieve the records:
    - Read the record index and window: read the record index, and the data window [0xC351, 125 reg].
        - If the meter Returns a Slave Busy Exception, repeat the request.
        - If the Window Status is 0xFF, repeat the request.
        - If the Window Status is 0, go to step 2b (Verify record index).

NOTE

- We read the index and window in 1 request to minimize communication time, and to ensure that the record index matches the data in the data window returned.
- Space in the window after the last specified record (RecordSize x RecordPerWindow) is padded with 0xFF, and can be safely discarded.

    - Verify that the record index incremented by Records Per Window. The record index of the retrieved window is the index of the first record in the window. This value will increase by Records Per Window each time the window is read, so it should be 0, N, N x 2, N x 3. . . for each window retrieved.

- If the record index matches the expected record index, go to step 2c (Compute next expected record index).
- If the record index does not match the expected record index, then go to step 1d (Write the retrieval information), where the record index will be the same as the expected record index. This will tell the EPM 7000 meter to repeat the records you were expecting.

- Compute next Expected Record Index.
    - If there are no remaining records after the current record window, go to step 3 (Disengage the log).
    - Compute the next expected record index by adding Records Per Window, to the current expected record index. If this value is greater than the number of records, re-size the window so it only contains the remaining records and go to step 1d (Write the retrieval information), where the Records Per Window will be the same as the remaining records.

3. Disengage the log: write the Log Number (of log being disengaged) to the Log Index and 0 to the Enable bit [0xC34F, 1 reg].

Log Retrieval Example

The following example illustrates a log retrieval session. The example makes the following assumptions:

- Log Retrieved is Historical Log 1 (Log Index 2).
- Auto-Incrementing is used.
- Function Code 0x23 is not used (Repeat Count of 1).
- The Log contains Volts-AN, Volts-BN, Volts-CN (12 bytes).
- 100 Records are available (0-99).
- COM Port 2 (RS485) is being used (see Log Availability).
- There are no Errors.
- Retrieval is starting at Record Index 0 (oldest record).
- Protocol used is Modbus RTU. The checksum is left off for simplicity.
- The EPM 7000 meter is at device address 1.
- No new records are recorded to the log during the log retrieval process.

1. Read [0xC757, 16 reg], Historical Log 1 Header Block.

Send: 0103 C757 0010

Command:

Register Address: 0xC757

Registers: 16

Receive: 010320 00000100 00000064 0012 0000

060717101511 060718101511 0000000000000000

Data:

Max Records: 0x100 = 256 records maximum.

Num Records:	0x64 = 100 records currently logged.
Record Size:	0x12 = 18 bytes per record.
Log Availability:	0x00 = 0, not in use, available for retrieval.
First Timestamp:	0x060717101511 = July 23, 2006, 16:21:17
Last Timestamp:	0x060717101511 = July 24, 2006, 16:21:17

NOTE

This indicates that Historical Log 1 is available for retrieval.

2. Write 0x0280 -> [0xC34F, 1 reg], Log Enable.

Send:	0106 C34F 0280
Command:	
Register Address:	0xC34F
# Registers:	1 (Write Single Register Command)
Data:	
Log Number:	2 (Historical Log 1)
Enable:	1 (Engage log)
Scope:	0 (Normal Mode)

Receive:	0106C34F0280 (echo)

NOTE

This engages the log for use on this COM Port, and latches the oldest record as record index 0.

3. Read [0xC757, 16 reg], Availability is 0.

Send:	0103 C757 0010
Command:	
Register Address:	0xC757
# Registers:	16

Receive: 0002	010320 00000100 00000064 0012 060717101511 060718101511 0000000000000000
Data:	
Max Records:	0x100 = 256 records maximum.

Num Records:	0x64 = 100 records currently logged.
Record Size:	0x12 = 18 bytes per record.
Log Availability:	0x02 = 2, In use by COM2, RS485 (the current port)
First Timestamp:	0x060717101511 = July 23, 2006, 16:21:17
Last Timestamp:	0x060717101511 = July 24, 2006, 16:21:17

NOTE

This indicates that the log has been engaged properly in step 2. Proceed to retrieve the log.

4. Compute #RecPerWin as (246\18)=13. Write 0x0D01 0000 0000 -> [0xC350, 3 reg] Write Retrieval Info. Set Current Index as 0.

Send: 0110 C350 0003 06 0D01 00
000000

Command:

Register Address:	0xC350
# Registers:	3, 6 bytes

Data:

Records per Window:	13. Since the window is 246 bytes, and the record is 18 bytes, 246\18 = 13.66, which means that 13 records evenly fit into a single window. This is 234 bytes, which means later on, we only need to read 234 bytes (117 registers) of the window to retrieve the records.
# of Repeats:	1. We are using auto-increment (so not 0), but not function code 0x23.
Window Status:	0 (ignore)
Record Index:	0, start at the first record.

Receive: 0110C3500003 (command ok)

NOTE

- This sets up the window for retrieval; now we can start retrieving the records.
- As noted above, we compute the records per window as 246\18 = 13.66, which is rounded to 13 records per window. This allows the minimum number of requests to be made to the meter, which increases retrieval speed.

5. Read [0xC351, 125 reg], first 2 reg is status/index, last 123 reg is window data. Status OK.

Send: 0103 C351 007D

Command:

Register Address:	0xC351
# Registers:	0x7D, 125 registers
--	
Receive:	0103FA 00000000
	060717101511FFFFFFFFFFFFFFFFFFFFFFF
	0607171016004 2FAAACF42FAAD1842FAA9A8 . . .
Data:	
Window Status:	0x00 = the window is ready.
Index:	0x00 = 0, The window starts with the 0'th record, which is the oldest record.
Record 0:	The next 18 bytes is the 0'th record (filler).
Timestamp:	0x060717101511, = July 23, 2006, 16:21:17
Data:	This record is the "filler" record. It is used by the meter so that there is never 0 records. It should be ignored. It can be identified by the data being all 0xFF. **NOTE:** Once a log has rolled over, the 0'th record will be a valid record, and the filler record will disappear.
Record 1:	The next 18 bytes is the 1'st record.
Timestamp:	0x060717101600 July 23, 2006, 16:22:00
Data:	
Volts AN:	0x42FAAACF, float = 125.33~
Volts BN:	0x42FAAD18, float = 125.33~
Volts CN:	0x42FAA9A8, float = 125.33~
. . .13 records	

NOTE

- This retrieves the actual window. Repeat this command as many times as necessary to retrieve all of the records when auto-increment is enabled.
- Note the filler record. When a log is reset (cleared) in the meter, the meter always adds a first "filler" record, so that there is always at least 1 record in the log. This "filler" record can be identified by the data being all 0xFF, and it being index 0. If a record has all 0xFF for data, the timestamp is valid, and the index is NOT 0, then the record is legitimate.
- When the "filler" record is logged, its timestamp may not be "on the interval." The next record taken will be on the next "proper interval," adjusted to the hour. For example, if the interval is 1 minute, the first "real" record will be taken on the next minute (no seconds). If the interval is 15 minutes, the next record will be taken at :15, :30, :45, or :00 - whichever of those values is next in sequence.

6. Compare the index with Current Index.

NOTE

- The Current Index is 0 at this point, and the record index retrieved in step 5 is 0: thus we go to step 8.
- If the Current Index and the record index do not match, go to step 7. The data that was received in the window may be invalid, and should be discarded.

7. Write the Current Index to [0xC351, 2 reg].

Send:	0110 C351 0002 04 00 00000D
Command:	
Register Address:	0xC351
# Registers:	2, 4 bytes
Data:	
Window Status:	0 (ignore)
Record Index:	0x0D = 13, start at the 14th record.

Receive:	0110C3510002 (command ok)

NOTE

- This step manually sets the record index, and is primarily used when an out-of-order record index is returned on a read (step 6).
- The example assumes that the second window retrieval failed somehow, and we need to recover by requesting the records starting at index 13 again.

8. For each record in the retrieved window, copy and save the data for later interpretation.
9. Increment Current Index by RecordsPerWindow.

NOTE

- This is the step that determines how much more of the log we need to retrieve.
- On the first N passes, Records Per Window should be 13 (as computed in step 4), and the current index should be a multiple of that (0, 13, 26, . . .). This amount will decrease when we reach the end (see step 10).
- If the current index is greater than or equal to the number of records (in this case 100), then all records have been retrieved; go to step 12. Otherwise, go to step 10 to check if we are nearing the end of the records.

10. If number records - current index < RecordsPerWindow, decrease to match.

NOTE

- Here we bounds-check the current index, so we don't exceed the records available.
- If the number of remaining records (#records - current index) is less than the Records per Window, then the next window is the last, and contains less than a full window of records. Make records per window equal to remaining records (#records-current index). In this example, this occurs when current index is 91 (the

8'th window). There are now 9 records available (100-91), so make Records per Window equal 9.

11. Repeat steps 5 through 10.

NOTE

Go back to step 5, where a couple of values have changed.

Pass	CurIndex	FirstRecIndex	RecPerWindow
0	0	0	13
1	13	13	13
2	26	26	13
3	39	39	13
4	52	52	13
5	65	65	13
6	78	78	13
7	91	91	9
8	100	------	-------

- At pass 8, since Current Index is equal to the number of records (100), log retrieval should stop; go to step 12 (see step 9 Notes).

12. No more records available, clean up.
13. Write 0x0000 -> [0xC34F, 1 reg], disengage the log.

Send:	0106 C34F 0000
Command:	
Register Address:	0xC34F
# Registers:	1 (Write Single Register Command)
Data:	
Log Number:	0 (ignore)
Enable:	0 (Disengage log)
Scope:	0 (ignore)

Receive: 0106C34F0000 (echo)

NOTE

- This disengages the log, allowing it to be retrieved by other COM ports.
- The log will automatically disengage if no log retrieval action is taken for 5 minutes.

B.5.5 Log Record Interpretation

The records of each log are composed of a 6 byte timestamp, and N data. The content of the data portion depends on the log.

System Event Record:

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13
Value	timestamp						Group	Event	Mod	Chan	Param1	Param2	Param3	Param4

Size: 14 bytes (20 bytes image).

Data: The System Event data is 8 bytes; each byte is an enumerated value.

- Group: Group of the event.
- Event: Event within a group.
- Modifier: Additional information about the event, such as number of sectors or log number.
- Channel: The port of the EPM 7000 meter that caused the event.

0	Firmware
1	COM 1 (IrDA)
2	COM 2 (RS485)
3	COM 3 (Option Card 1)
4	COM 4 (Option Card 2)
7	User (Face Plate)

Param 1-4: These are defined for each event (see table below).

NOTE

The System Log Record is 20 bytes, consisting of the Record Header (12 bytes) and Payload (8 bytes). The Timestamp (6 bytes) is in the header. Typically, software will retrieve only the timestamp and payload, yielding a 14-byte record. The table below shows all defined payloads.

Group (Event group)	Event (Event within group)	Mod (Event modifier)	Channel (1-4 for COMs, 7 for USER, 0 for FW)	Parm1	Parm2	Parm3	Parm4	Comments
0								Startup
	0	0	0	FW version				Meter Run Firmware Startup
	1	slot#	0	class ID	card status	0xFF	0xFF	Option Card Using Default Settings
1								Log Activity
	1	log#	1-4	0xFF	0xFF	0xFF	0xFF	Reset
	2	log#	1-4	0xFF	0xFF	0xFF	0xFF	Log Retrieval Begin
	3	log#	0-4	0xFF	0xFF	0xFF	0xFF	Log Retrieval End
2								Clock Activity
	1	0	1-4	0xFF	0xFF	0xFF	0xFF	Clock Changed
	2	0	0	0xFF	0xFF	0xFF	0xFF	Daylight Time On
	3	0	0	0xFF	0xFF	0xFF	0xFF	Daylight Time Off
	4	sync method	0	0xFF	0xFF	0xFF	0xFF	Auto Clock Sync Failed

Group (Event group)	Event (Event within group)	Mod (Event modifier)	Channel (1-4 for COMs, 7 for USER, 0 for FW)	Parm1	Parm2	Parm3	Parm4	Comments
	5	sync method	0	0xFF	0xFF	0xFF		Auto Clock Sync Resumed
0xFF								
3								System Resets
	1	0	0-4, 7	0xFF	0xFF	0xFF	0xFF	Max & Min Reset
	2	0	0-4, 7	0xFF	0xFF	0xFF	0xFF	Energy Reset
	3	slot#	0-4	1 (inputs) or 2 (outputs)	0xFF	0xFF	0xFF	Accumulators Reset
4								Settings Activity
	1	0	1-4, 7	0xFF	0xFF	0xFF	0xFF	Password Changed
	2	0	1-4	0xFF	0xFF	0xFF	0xFF	Software Option Changed
	3	0	1-4, 7	0xFF	0xFF	0xFF	0xFF	Programmable Settings Changed
	4	0	1-4, 7	0xFF	0xFF	0xFF	0xFF	Measurement Stopped
5								Boot Activity
	1	0	1-4	FW version				Exit to Boot
6								Error Reporting & Recovery
	4	log #	0	0xFF	0xFF	0xFF	0xFF	Log Babbling Detected
	5	log #	0	# records discarded		time in seconds		Babbling Log Periodic Summary
	6	log #	0	# records discarded		time in seconds		Log Babbling End Detected
	7	sector#	0	error count		stimulus	0xFF	Flash Sector Error
	8	0	0	0xFF	0xFF	0xFF	0xFF	Flash Error Counters Reset
	9	0	0	0xFF	0xFF	0xFF	0xFF	Flash Job Queue Overflow
	10	1	0	0xFF	0xFF	0xFF	0xFF	Bad NTP Configuration
0x88								
	1	sector#	0	log #	0xFF	0xFF	0xFF	acquire sector
	2	sector#	0	log #	0xFF	0xFF	0xFF	release sector
	3	sector#	0	erase count				erase sector
	4	log#	0	0xFF	0xFF	0xFF	0xFF	write log start record

- log# values: 0 = system log, 1 = alarms log, 2-4 = historical logs 1-3, 5 = I/O change log
- sector# values: 0-63

- slot# values: 1-2

NOTE

- The clock changed event shows the clock value just before the change in the Mod and Parm bytes. Parms are bit-mapped:
  - b31 - b28 month
  - b27 - b23 day
  - b22 daylight savings time flag
  - b20 - b16 hour
  - b13 - b8 minute
  - b5 - b0 second
  - unused bits are always 0
- Sync method: 1 = NTP.
- Stimulus for a flash sector error indicates what the flash was doing when the error occurred: 1 = acquire sector, 2 = startup, 3 = empty sector, 4 = release sector, 5 = write data
- Flash error counters are reset to zero in the unlikely event that both copies in EEPROM are corrupted.
- The flash job queue is flushed (and log records are lost) in the unlikely event that the queue runs out of space.
- A "babbling log" is one that is saving records faster than the meter can handle long term. When babbling is detected, the log is frozen and no records are appended until babbling ceases. For as long as babbling persists, a summary of records discarded is logged every 60 minutes. Normal logging resumes when there have been no new append attempts for 30 seconds. Onset of babbling occurs when a log fills a flash sector in less than an hour (applies only to Alarm, I/O Change, Historical, and Power Quality logs), when the log fills or wraps around in less than two minutes (applies only to Waveform log), when the number of unassigned sectors becomes dangerously low (applies only to Waveform log), or when a log grows so far beyond its normal bounds that it is in danger of crashing the system. This applies to all logs except the System log, which does not babble. While possible for the other logs during an extended log retrieval session, it is extremely unlikely to occur for any logs except the Waveform log.
- Logging of diagnostic records may be suppressed via a bit in programmable settings.

Alarm Record:

Byte	0	1	2	3	4	5	6	7	8	9
Value	timestamp						direction	limit#	Value%	

Size: 10 bytes (16 bytes image)

Data: The Alarm record data is 4 bytes, and specifies which limit the event occurred on, and the direction of the event (going out of limit, or coming back into limit).

- Direction: The direction of the alarm event: whether this record indicates the limit going out, or coming back into limit.

1	Going out of limit

2	Coming back into limit

Bit	0	1	2	3	4	5	6	7
Value	type	0	0	0	0	Limit ID		

- Limit Type: Each limit (1-8) has both an above condition and a below condition. Limit Type indicates which of those the record represents.

0	High Limit
1	Low Limit

- Limit ID: The specific limit this record represents. A value in the range 0-7, Limit ID represents Limits 1-8. The specific details for this limit are stored in the programmable settings.
- Value: Depends on the Direction:
  - If the record is "Going out of limit," this is the value of the limit when the "Out" condition occurred.
  - If the record is "Coming back into limit," this is the "worst" value of the limit during the period of being "out": for High (above) limits, this is the highest value during the "out" period; for Low (below) limits, this is the lowest value during the “out" period.

Byte	0	1	2	3	4	5	6	7	8	9
Value	Identifier		Above Setpoint		Above Hyst.		Below Setpoint		Below Hyst.	

Interpretation of Alarm Data:

To interpret the data from the alarm records, you need the limit data from the Programmable Settings [0x754B, 40 registers].

There are 8 limits, each with an Above Setpoint, and a Below Setpoint. Each setpoint also has a threshold (hysteresis), which is the value at which the limit returns "into" limit after the setpoint has been exceeded. This prevents "babbling" limits, which can be caused by the limit value fluttering over the setpoint, causing it to go in and out of limit continuously.

- Identifier: The first modbus register of the value that is being watched by this limit. While any modbus register is valid, only values that can have a Full Scale will be used by the EPM 7000 meter.
- Above Setpoint: The percent of the Full Scale above which the value for this limit will be considered "out".
  - Valid in the range of -200.0% to +200.0%
  - Stored as an integer with 0.1 resolution. (Multiply % by 10 to get the integer, divide integer by 10 to get %. For example, 105.2% = 1052.)
- Above Hysteresis: The percent of the Full Scale below which the limit will return "into" limit, if it is out. If this value is above the Above Setpoint, this Above limit will be disabled.
  - Valid in the range of -200.0% to +200.0%.

  - Stored as an integer with 0.1 resolution. (Multiply % by 10 to get the integer, divide integer by 10 to get %. For example, 104.1% = 1041.)
- Below Setpoint: The percent of the Full Scale below which the value for this limit will be considered "out".
  - Valid in the range of -200.0% to +200.0%.
  - Stored as an integer with 0.1 resolution. (Multiply % by 10 to get the integer, divide integer by 10 to get %. For example, 93.5% = 935.)
- Below Hysteresis: The percent of the Full Scale above which the limit will return "into" limit, if it is out. If this value is below the Below Setpoint, this Below limit will be disabled.
  - Valid in the range of -200.0% to +200.0%.
  - Stored as an integer with 0.1 resolution. (Multiply % by 10 to get the integer, divide integer by 10 to get %. For example, 94.9% = 949.)

NOTE

The Full Scale is the "nominal" value for each of the different types of readings. To compute the Full Scale, use the following formulas:

Current	[CT Numerator] x [CT Multiplier]
Voltage	[PT Numerator] x [PT Multiplier]
Power 3-Phase (WYE)	[CT Numerator] x [CT Multiplier] x [PT Numerator] x [PT Multiplier] x 3
Power 3-Phase (Delta)	[CT Numerator] x [CT Multiplier] x [PT Numerator] x [PT Multiplier] x 3 x sqrt(3)
Power Single Phase (WYE)	[CT Numerator] x [CT Multiplier] x [PT Numerator] x [PT Multiplier]
Power Single Phase (Delta)	[CT Numerator] x [CT Multiplier] x [PT Numerator] x [PT Multiplier] x sqrt(3)
Frequency (Calibrated at 60 Hz)	60
Frequency (Calibrated at 50 Hz)	50
Power Factor	1.0
THD, Harmonics	100.0%
Angles	180°

- To interpret a limit alarm fully, you need both the start and end record (for duration).
- There are a few special conditions related to limits:
  - When the meter powers up, it detects limits from scratch. This means that multiple "out of limit" records can be in sequence with no "into limit" records. Cross- reference the System Events for Power Up events.
    - This also means that if a limit is "out," and it goes back in during the power off condition, no "into limit" record will be recorded.
    - The "worst" value of the "into limit" record follows the above restrictions; it only represents the values since power up. Any values before the power up condition are lost.

Historical Log Record:

Byte	0	1	2	3	4	5	6	-	-	N
Value	timestamp						values . . .			

Size: 6+2 x N bytes (12+2 x N bytes), where N is the number of registers stored.

Data: The Historical Log Record data is 2 x N bytes, which contains snapshots of the values of the associated registers at the time the record was taken. Since the meter uses specific registers to log, with no knowledge of the data it contains, the Programmable Settings need to be used to interpret the data in the record. See Historical Logs Programmable Settings for details.

I/O Change Record:

Table B.4: I/O Change Log tables

Byte	0	1	2	3	4	5	6	7	8	9
Value	Timestamp						Card 1 Changes	Card 1 States	Card 2 Changes	Card 2 States

Table B.5: Card Change Flags

Bit	7	6	5	4	3	2	1	0
Value	Out 4 Change	Out 3 Change	Out 2 Change	Out 1 Change	In 4 Change	In 3 Change	In 2 Change	In 1 Change

Table B.6: Card Current States

Bit	7	6	5	4	3	2	1	0
Value	Out 4 State	Out 3 State	Out 2 State	Out 1 State	In 4 State	In 3 State	In 2 State	In 1 State

Size: 10 bytes (16 bytes)

Data: The states of the relay and digital inputs at the time of capture for both Option cards 1 and 2. If the option card does not support I/O Change Records (no card or not a Digital Option Card), the value will be 0.

NOTE

- An I/O Change log record will be taken for each Relay and Digital Input that has been configured in the Programmable Settings to record when its state changes.
- When any one configured Relay or Digital Input changes, the values of all Relays and Digital Inputs are recorded, even if they are not so configured.

Waveform Log Record:

Byte	0	1	2	3	4	5	6	7	8	-	-	969

Value	timestamp	capture #	record #	record payload

Size: 970 bytes

Data: Each waveform record is 970 bytes, which contains the timestamp, the capture number it is associated with (all 26 will have the same capture #), its own record number (numbered 0-25) and the payload.

NOTE

The waveform records must be in sequential order. Verify that the record numbers are sequential, and if they are not, the retrieval of that capture must be restarted.

PQ Event Record:

Byte	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	...	31	32	...	43	44	...	57
Value	timestamp						present states		event channels		capture #	flags	event cycle tag		worst execution RMS			sample calibrations			not used (0X0)		

Size: 58 bytes

Data: See the first table in the PQ Event Log Retrieval section for detailed information about the data.

NOTE

The "not used" section of the PQ Event record byte-map is simply 0.

B.5.6 Examples

Log Retrieval Section:

send: 01 03 75 40 00 08 - **Meter designation**

recv: 01 03 10 4D 65 74 72 65 44 65 73 69 6E 67 5F 20 20 20 20 00 00

send: :01 03 C7 57 00 10 - **Historical Log 1 status block**

recv: :01 03 20 00 00 05 1E 00 00 05 1E 00 2C 00 00 06 08 17 51 08
00 06 08 18 4E 39 00 00 00 00 00 00 00 00 00 00 00

send: :01 03 79 17 00 40 - **Historical Log 1 PS settings**

recv: :01 03 80 13 01 00 01 23 75 23 76 23 77 1F 3F 1F 40 1F 41 1F
42 1F 43 1F 44 06 0B 06 0C 06 0D 06 0E 17 75 17 76 17 77 18
67 18 68 18 69 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

00 00 00 00 00 00 00 00 00 00 00 00 00

send: :01 03 79 57 00 40 - ""

recv: :01 03 80 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 62 62 62 34 34 34 44
44 62 62 62 62 62 62 00 00 00 00 00 00

send: :01 03 75 35 00 01 - **Energy PS settings**

recv: :01 03 02 83 31 00 00

send: :01 03 11 93 00 01 **- Connected Port ID**

recv: :01 03 02 00 02 00 00

send: :01 03 C7 57 00 10 - **Historical Log 1 status block**

recv: :01 03 20 00 00 05 1E 00 00 05 1E 00 2C 00 00 06 08 17 51 08
00 06 08 18 4E 39 00 00 00 00 00 00 00 00 00 00 00

send: :01 03 C3 4F 00 01 - **Log Retrieval header**

recv: :01 03 02 FF FF 00 00

send: :01 10 C3 4F 00 04 08 02 80 05 01 00 00 00 00 - **Engage the log**

recv: :01 10 C3 4F 00 04

send: :01 03 C7 57 00 10 - **Historical Log 1 status block**

recv: :01 03 20 00 00 05 1E 00 00 05 1E 00 2C 00 02 06 08 17 51 08
00 06 08 18 4E 39 00 00 00 00 00 00 00 00 00 00 00

send: :01 10 C3 51 00 02 04 00 00 00 00 - **Set the retrieval index**

recv: :01 10 C3 51 00 02

send: :01 03 C3 51 00 40 - **Read first half of window**

recv: :01 03 80 00 00 00 00 06 08 17 51 08 00 00 19 00 2F 27 0F 00

00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 03
E8 00 01 00 05 00 00 00 00 00 00 06 08 17 51 09 00 00 19 00
2F 27 0F 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 03 E8 00 01 00 04 00 00 00 00 00 00 06 08 17 51 0A
00 00 19 00 2F 27 0F 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 03 E8 00 00 00 00

send: :01 03 C3 91 00 30 - **Read second half of window**

recv: :01 03 60 00 05 00 00 00 00 00 00 06 08 17 51 0B 00 00 19 00
2F 27 0F 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 03 E8 00 01 00 04 00 00 00 00 00 00 06 08 17 51 0C
00 00 19 00 2F 27 0F 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 03 E8 00 01 00 04 00 00 00 00 00 00 00
00

send: :01 03 C3 51 00 40 - **Read first half of last window**

recv: :01 03 80 00 00 05 19 06 08 18 4E 35 00 00 19 00 2F 27 0F 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 03
E8 00 01 00 04 00 00 00 00 00 00 06 08 18 4E 36 00 00 19 00
2F 27 0F 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 03 E8 00 01 00 04 00 00 00 00 00 00 06 08 18 4E 37
00 00 19 00 2F 27 0F 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 03 E8 00 00 00 00

send: :01 03 C3 91 00 30 - **Read second half of last window**

recv: :01 03 60 00 05 00 00 00 00 00 00 06 08 18 4E 38 00 00 19 00
2F 27 0F 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 03 E8 00 01 00 04 00 00 00 00 00 00 06 08 18 4E 39
00 00 19 00 2F 27 0F 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 03 E8 00 00 00 05 00 00 00 00 00 00 00
00

send: :01 06 C3 4F 00 00 - **Disengage the log**

recv: :01 06 C3 4F 00 00

Sample Historical Log 1 Record:

Historical Log 1 Record and Programmable Settings

13|01|00 01|23 75|23 76|23 77|1F 3F 1F 40|1F 41

1F 42|1F 43 1F 44|06 0B 06 0C|06 0D 06 0E|17 75|

17 76|17 77|18 67|18 68|18 69|00 00 . . . . . .

62 62 62 34 34 34 44 44 62 62 62 62 62 62 . . .

These are the Descriptions:

Item Values: Type and Size:

13 - # registers

01 - # sectors

01 - interval

23 75	6 2	- (SINT 2 byte) Volts A THD Maximum
23 76	6 2	- (SINT 2 byte) Volts B THD Maximum
23 77	6 2	- (SINT 2 byte) Volts C THD Maximum
1F 3F 1F 40	3 4	- (Float 4 byte) Volts A Minimum
1F 41 1F 42	3 4	- (Float 4 byte) Volts B Minimum
1F 43 1F 44	3 4	- (Float 4 byte) Volts C Minimum
06 0B 06 0C	4 4	- (Energy 4 byte) VARhr Negative Phase A
06 0D 06 0E	4 4	- (Energy 4 byte) VARhr Negative Phase B
17 75	6 2	- (SINT 2 byte) Volts A 1st Harmonic Magnitude
17 76	6 2	- (SINT 2 byte) Volts A 2nd Harmonic Magnitude
17 77	6 2	- (SINT 2 byte) Volts A 3rd Harmonic Magnitude
18 67	6 2	- (SINT 2 byte) Ib 3rd Harmonic Magnitude
18 68	6 2	- (SINT 2 byte) Ib 4th Harmonic Magnitude
18 69	6 2	- (SINT 2 byte) Ib 5th Harmonic Magnitude

Sample Record

06 08 17 51 08 00|00 19|00 2F|27 0F|00 00 00 00|00

00 00 00|00 00 00 00|00 00 00 00|00 00 00 00|03 E8|

00 01|00 05|00 00|00 00|00 00 . . .

`11 08 17 51 08 00 - August 23, 2011 17:08:00`

00 19 - 2.5%

00 2F - 4.7%

27 0F - 999.9% (indicates the value isn't valid)

00 00 00 00 - 0

00 00 00 00 - 0

00 00 00 00 - 0

00 00 00 00 - 0
00 00 00 00 - 0

03 E8 - 100.0% (Fundamental)

00 01 - 0.1%

00 05 - 0.5%

00 00 - 0.0%

00 00 - 0.0%

00 00 - 0.0%

B.5.7 Waveform Log Retrieval

The waveform log is unique among the logs in that each capture is composed of 26 waveform records, and each record requires 4 windows to retrieve. For more information on record retrieval, see Section B.5.4.3. The 26 waveform records adhere to the following byte-map.

Size	Content	Notes	Offset
6 bytes	timestamp	All 26 records have the same timestamp	0
1 byte	capture number	All 26 records have the same capture number	6
1 byte	record number	Records are numbered 0-25	7
962 bytes	record payload	Waveform record payload. All 26 waveform record payloads combined create a waveform capture	8

A single waveform capture is the aggregation of all 26 waveform record payloads, thus totaling 25,012 bytes in size. The resulting waveform capture contains the following byte structure:

Bytes	Block
36	Header
388	Reserved (0xFF)
4098	Channel AN (Wye) or AB (Delta)
4098	Channel IA
4098	Channel BN (Wye) or BC (Delta)
4098	Channel IB
4098	Channel CN (Wye) or CA (Delta)
4098	Channel IC

NOTE

The order of the channels is not fixed. The channel ID (first 2 bytes of the 4098 bytes) must be used to determine which channel block is being presented.

Breaking the waveform capture down further, the specific blocks (Header and Channel

Blocks) are as follows:

(NOTE: 1b = 1 byte, 2b = 2 bytes.)

Table B.7: Header Block Definition - 36 Bytes

Trigger Source (2b)		SmpRate (1b)	Flags (1b)
Trigger Type	**TrigCap#**	**Trigger Cycle Tag (2b)**	
First sample tag		Last sample tag	
Trigger cycle RMS Va		Trigger cycle RMS Ia	
Trigger cycle RMS Vb		Trigger cycle RMS Ib	
Trigger cycle RMS Vc		Trigger cycle RMS Ic	
Sample Calibration Va		Sample Calibration Ia	
Sample Calibration Vb		Sample Calibration Ib	
Sample Calibration Vc		Sample Calibration Ic	

Table B.8: Header Block Definition - 36 Bytes

Trigger Type	TrigCap#
Sample 2 (2b)	Sample 3 (2b)
Sample 4 (2b)	Sample 5 (2b)
...	...
Sample 2046 (2b)	Sample 2047 (2b)
Sample 2048 (2b)	

Parsing a Waveform Capture

To parse the waveform capture, follow this procedure:

1. Download the entire capture. When engaging the log for retrieval, the number of records will always be 1, and the repeat count will always be 4. Because of the large records (970 bytes), you must use Function Code 0x23, with 4 repeat counts. An example request message would be: 0123C351007C04. See Section B.5.4.3 for details.

   It may take a while to get a response, so if you get a Slave Busy Modbus exception, try again.

2. The data that comes back will be the window index and window data, repeated 4 times. For each block, you must check that the window status and window index are correct.

   If the window status is 0xFF, then the data is not ready, and you should request that record again. See Section B.5.4.4 for an example of this point.

3. Once you know you have the right data, check the waveform record header to make sure you have received the correct record and then parse the data by copying out the window data and skipping the window indices.

You should be receiving waveform records sequentially, from 0 to 25. If the number is out of order, or invalid, then the waveform may be corrupt, and you should retrieve the waveform capture from the beginning by manually setting the record index to start at.

Once you know you have the right record, from window index 0 the first 8 bytes (the timestamp and record info) must be skipped. This will result in a stripping of the Record Header, Capture and Record Numbers which will leave only the Waveform Record Payload (see the table on B-43). You only need to store the timestamp from the first record, as each of the 26 records have the same timestamp.

4. Copy the record data (record payload) to the output (e.g., an array of byte arrays - each byte array representing a waveform record) and repeat this stripping process for all 26 waveform records. Once done, combine all 26 header-stripped records into a single byte array thus creating the waveform capture:

```
const uint RECORD_PAYLOAD_SIZE = 962;

const uint MAX_WAVEFORM_CAPTURE_SIZE = 25012;

...

byte[] waveform_capture = new byte[MAX_WAVEFORM_CAPTURE_SIZE];

...
```

// combine all binary data from waveform records to create waveform capture

```
for (int i = 0; i < 26; ++i)

{

waveform_record[i].CopyTo(waveform_capture, RECORD_PAYLOAD_SIZE * i);

}
```

Here is an example of the beginning of a waveform capture from the above instruction:

// Snippet starts from header block (address 0x00) and ends some bytes

past first channel block

```
00000000 01 80 06 00 00 47 02 00 00 00 07 FF 07 4C 00 26

00000010 00 21 00 20 00 22 00 25 D3 21 19 6C 1C B0 02 64

00000020 D3 AA 1A F3 FF FF FF FF FF FF FF FF FF FF FF FF

...

000001a0 FF FF FF FF FF FF FF FF 41 4E 00 00 1A 70 19 50 //414E = "AN"

000001b0 18 88 17 78 16 60 15 80 14 98 13 70 12 E0 12 10

000001c0 11 18 10 68 0F 90 0E 90 0E 00 0D 68 0C D8 0C D0

000001d0 0C A8 0C 48 0C 70 0C 68 0C 30 0C 60 0C 98 0D 00

...

waveform_capture[424] // 41 = 'A'

waveform_capture[425] // 4E = 'N'
```

Processing a Waveform Capture

Once the waveform capture has been created, you can use the waveform capture byte-map (see tables earlier in this section) to extract the RMS and channel sample data values desired. Take note that the waveform capture byte-map is in MSB (hibyte, lo-byte) form.

The following is an example snippet in which we first parse the waveform capture header values and then each waveform capture channel block using a predefined function.

NOTE

We assume the channel blocks to be in order in this example, e.g. AN, IA, BN, IB, CN, IC. These channels can be in any order and it is up to you to check which channel ID values you are currently processing.

// HEADER BLOCK PARSING - Get Waveform Capture header values (hi-byte, lo-byte)

```
trigger_source = BitConverter.ToUInt16(new byte[2] { waveform_capture[
0], waveform_capture[1] }, 0);
sample_rate = waveform_capture[2];
flags = waveform_capture[3];
...
rms_va = BitConverter.ToUInt16(new byte[2] { waveform_capture[12],
waveform_capture[13] }, 0);
rms_ia = BitConverter.ToUInt16(new byte[2] { waveform_capture[14],
waveform_capture[15] }, 0);
...
calibration_va = BitConverter.ToUInt16(new byte[2] { waveform_capture[24],
waveform_capture[25] }, 0);
calibration_ia = BitConverter.ToUInt16(new byte[2] { waveform_capture[26],
waveform_capture[27] }, 0);
...
```

// CHANNEL BLOCK PARSING - predefined function

```
public static List<int> GetChannelSampleData(byte[] waveform_capture, int start_byte)
{
int temp;
int begin = start_byte + 2; // skip Channel ID (e.g.
"AN","IA",etc) and get data start
int end = start_byte + 4098;
List<int> list = new List<int>();
for (int i = begin; i < end; i += 2)
{
// hi-byte, lo-byte
temp = BitConverter.ToUInt16(new byte[2] { waveform_capture[i], waveform_capture[i+1]
}, 0);
```

```
list.Add(temp);
}
return list;
}
// store the starting byte positions of the channel blocks
public enum Channel_ID
{
VOLTS_AN = 424,
CURRENT_IA = 4522,
VOLTS_BN = 8620,
CURRENT_IB = 12718,
VOLTS_CN = 16816,
CURRENT_IC = 20914
}
// CHANNEL BLOCK PARSING - get sample values from capture
List<int>volts_an=GetChannelSampleData(waveform_capture,(int)Channel_ID.VOLTS_AN);
List<int> current_ia = GetChannelSampleData(waveform_capture,
(int)Channel_ID.CURRENT_IA);
List<int> volts_bn = GetChannelSampleData(waveform_capture,
(int)Channel_ID.VOLTS_BN);
List<int> current_ib = GetChannelSampleData(waveform_capture,
(int)Channel_ID.CURRENT_IB);
List<int> volts_cn = GetChannelSampleData(waveform_capture,
(int)Channel_ID.VOLTS_CN);
List<int> current_ic = GetChannelSampleData(waveform_capture,
(int)Channel_ID.CURRENT_IC);
```

To convert the acquired RMS and channel sample data values into their primary values, the following formula must be applied:

$$primary\ value = \left(\frac{ADC\ value * calibration}{1000000}\right) * ratio$$

- ADC Value is the primary value desired to be acquired. Can refer to either:
  - RMS values (Trigger Cycle RMS, Trigger Cycle RMS, etc.)
  - Sample values (Volts AN, Current IA, Volts BN, etc.)
- Calibration is the sample calibration value for corresponding channel.
- Ratio is either PT Ratio or CT Ratio (acquired from Programmable Settings)
  - PT Ratio for voltage
  - CT Ratio for current

For example, if you are looking for the primary Trigger RMS Va value and given the following:

PT Numerator = 1200V

PT Denominator = 120V

CT Numerator = 1000A

CT Denominator = 5A

Trigger Cycle RMS Va = 4505

Trigger Cycle RMS Ia = 30133

Trigger Cycle RMS Vb = 5408

Sample Calibration Va = 42049

Sample Calibration Ia = 7329

Sample Calibration Vb = 29183

The desired result would be:

Primary RMS Va = ((4505 * 42049) / 1000000) * (1200V/120V) = 1894.3V

```
// Convert rms values to primary values
public static double GetPrimaryValue(int adc_value, double calibration, double ratio)
{
return ( (adc_value * calibration) / 1000000 ) * ratio;
}
double primary_rms_va = GetPrimaryValue(rms_va, calibration_va, pt_ratio);
double primary_rms_ia = GetPrimaryValue(rms_ia, calibration_ia, ct_ratio);
double primary_rms_vb = GetPrimaryValue(rms_vb, calibration_vb, pt_ratio);
double primary_rms_ib = GetPrimaryValue(rms_ib, calibration_ib, ct_ratio);
double primary_rms_vc = GetPrimaryValue(rms_vc, calibration_vc, pt_ratio);
double primary_rms_ic = GetPrimaryValue(rms_ic, calibration_ic, ct_ratio);
// Convert raw sample data values to primary values
public static List<double> GetPrimaryValues(int[] adc_value, double calibration,
double ratio)
{
double temp;
List<double> list = new List<double>();
for (int i = 0; i < adc_value.Length; ++i)
{
temp = ((adc_value[i] * calibration) / 1000000) * ratio;
```

```
list.Add(temp);
}
return list;
}
List<double> primary_an = GetPrimaryValues(volts_an.ToArray(), calibration_va, pt_ratio);
List<double> primary_ia = GetPrimaryValues(current_ia.ToArray(), calibration_ia, ct_ratio);
List<double> primary_bn = GetPrimaryValues(volts_bn.ToArray(), calibration_vb, pt_ratio);
List<double> primary_ib = GetPrimaryValues(current_ib.ToArray(), calibration_ib, ct_ratio);
List<double> primary_cn = GetPrimaryValues(volts_cn.ToArray(), calibration_vc, pt_ratio);
List<double> primary_ic = GetPrimaryValues(current_ic.ToArray(), calibration_ic, ct_ratio);
```

Additional Waveform Processing

Waveform trigger condition information can also be collected from the waveform capture.

As processed in the previous section, the following header values will be used for

the trigger conditions:

```
trigger_source = BitConverter.ToUInt16(new byte[2] { waveform_capture[0],
waveform_capture[1] }, 0);
sample_rate = waveform_capture[2];
trigger_type= waveform_capture[4];
trigger_capture_num = waveform_capture[5];
trigger_cycle_tag = BitConverter.ToUInt16(new byte[2] { waveform_capture[6],
waveform_capture[7] }, 0);
```

The trigger source value acquired from the waveform capture header must be parsed to get the specific trigger condition error string (for example, voltage surge or voltage sag).

```
bool deltaHookup; // hookup flag
...
int[] trigger_state = new int[16]; // to represent 16 individual "bits"
Array.Clear(trigger_state, 0, trigger_state.Length); // set all "bits" to 0
// set the individual trigger_state bit flags using trigger_- source from waveform capture
for (int i = 0; i < trigger_state.Length; ++i)
{
trigger_state[i] = (trigger_source / (2 ^ i)) & 1;// remember hi-byte+lo-byte order
}
...
String triggered_str = "";
for (int i = 0; i < trigger_state.Length; ++i)
```

```
{
if (trigger_state[i] > 0)
{
switch (i)
{
case 0:
if (deltaHookup)
triggered_str = triggered_str + "Vab=Surge";
else
triggered_str = triggered_str + "Van=Surge";
break;
case 1:
if (deltaHookup)
triggered_str = triggered_str + "Vab=Surge";
else
triggered_str = triggered_str + "Van=Surge";
break;
case 2:
if (deltaHookup)
triggered_str = triggered_str + "Vcb=Surge";
else
triggered_str = triggered_str + "Vcn=Surge";
break;
case 3:
triggered_str = triggered_str + "Ia=Surge";
break;
case 4:
triggered_str = triggered_str + "Ib=Surge";
break;
case 5:
triggered_str = triggered_str + "Ic=Surge";
break;
case 6:
if (deltaHookup)
triggered_str = triggered_str + "Vab=Sag";
else
```

```
triggered_str = triggered_str + "Van=Sag";
break;
case 7:
if (deltaHookup)
triggered_str = triggered_str + "Vbc=Sag";
else
triggered_str = triggered_str + "Vbn=Sag";
break;
case 8:
if (deltaHookup)
triggered_str = triggered_str + "Vcb=Sag";
else
triggered_str = triggered_str + "Vcn=Sag";
break;
case 15:
triggered_str = triggered_str + "Manual Trigger";
break;
}
}
}
```

The trigger cycle tag value from the waveform capture header provides the specific cycle within the waveform capture on which the trigger condition occurred. To give an example of what the trigger cycle tag provides, the following is a snippet from a CSV generated output of the raw sample values (non-primary values) from a waveform capture. The index at which the samples are located within the CSV file is specified in the first column. With a trigger cycle tag of 512 and the following table:

Samples						
Index	**Volts AN**	**Current IA**	**Volts BN**	**Current IB**	**Volts CN**	**Current IC**
27	0	0	0	0	0	0
28	6768	6792	5840	6800	5784	6880
29	6480	6736	5872	6816	5792	6936
30	6280	6776	5864	6872	5816	6960
31	6008	6784	5872	6792	5768	6904
32	5728	6736	5864	6864	5856	6960
536	7408	6712	5832	6808	5800	6984
537	7248	6776	5880	6848	5848	6984
538	7000	6776	5896	6864	5848	6928
539	6712	6752	5864	6808	5800	6976
540	6536	6776	5888	6848	5856	6976

Samples						
Index	Volts AN	Current IA	Volts BN	Current IB	Volts CN	Current IC
541	6280	6840	5920	6920	5880	6832
542	5960	6752	5856	6800	5776	6912

Seeing as the samples began being recorded at index 27 within the CSV output, that value has to be added to the trigger cycle tag value as an offset to get the exact cycle of where the trigger condition occurred, which would be at index 539.

Sample Rate is the number of samples in a single cycle at a nominal 60 Hertz. For example, at a sample rate of 512, there are 512 samples in a single nominal (time locked) cycle. Note that this means that there are 512 samples every 16.6~ms.

The sample rate also affects the duration of the capture. Since the capture records a fixed number of samples, the number of cycles recorded is dynamic based off the sampling rate. For example, at 512 samples per cycle, 4 cycles can be record. At 32 samples per cycle, 64 cycles can be recorded.

To calculate the duration of the capture, in milliseconds, the following formula must be applied:

$$duration = \left(\frac{number\ of\ samples * 1000}{sample\ rate * 60}\right)$$

- number of samples is number of samples in the capture per channel (2048 samples)

For example, given a sample rate of 1024, the duration would be:

((2048 * 1000) / (1024 * 60)) = (2048000 / 61440) = 33.333 ms

B.5.8 PQ Event Log Retrieval

The following is a detailed breakdown of the PQ Event Record byte-map:

Table B.9: PQ Event Record Definition 1

SIZE	CONTENT	NOTES	OFFSET
6 bytes	Timestamp	Timestamp of the record	0
2 bytes	Present States	Bit mapped per trigger events. 0 indicates an untriggered state.	6
2 bytes	Event Channels	Bit mapped per trigger events. 1 indicates a channel changed state and that the change to the present state caused the event.	8
1 byte	Capture Number	0 if cycle was not captured, 1-255 if all or part of the cycle was captured	10
1 byte	Flags	Always 0	11
2 bytes	Event Cycle Tag	Tag of the last sample in the event cycle	12
18 bytes	Worst Excursion RMS	For events ending a surge or sag episode (e.g. return to normal), RMS of the channel is the worst excursion (highest surge, lowest sag) for the episode. 0 for other channels. Same units as Waveform Records	14

Table B.9: PQ Event Record Definition 1

SIZE	CONTENT	NOTES	OFFSET
12 bytes	Sample Calibrations	Same as sample calibrations in waveform log non-sample capture summary	32
14 bytes	not used	Always 0	44

Here is a visual layout of the PQ Event Record definition above (with the timestamp stripped):

NOTE

NOTE: 1b = 1 byte, 2b = 2 bytes, 6b = 6 bytes

Table B.10: PQ Event Record Definition 2, Size: 52 bytes

<table>
<tr><th colspan="4">Timestamp (6b)</th></tr>
<tr><th colspan="2">Present States (2b)</th><th colspan="2">Event Channels (2b)</th></tr>
<tr><th>Capture (1b)</th><th>Flags (1b)</th><th colspan="2">Event Cycle Tag (2b)</th></tr>
<tr><td colspan="2">Worst Excursion RMS - Va surge</td><td colspan="2">Worst Excursion RMS - Vb surge</td></tr>
<tr><td colspan="2">Worst Excursion RMS - Vc surge</td><td colspan="2">Worst Excursion RMS - Ia surge</td></tr>
<tr><td colspan="2">Worst Excursion RMS - Ib surge</td><td colspan="2">Worst Excursion RMS - Ic surge</td></tr>
<tr><td colspan="2">Worst Excursion RMS - Va sag</td><td colspan="2">Worst Excursion RMS - Vb sag</td></tr>
<tr><td colspan="2">Worst Excursion RMS - Vc sag</td><td colspan="2">Sample Calibration Va (2b)</td></tr>
<tr><td colspan="2">Sample Calibration Ia (2b)</td><td colspan="2">Sample Calibration Vb (2b)</td></tr>
<tr><td colspan="2">Sample Calibration Ib (2b)</td><td colspan="2">Sample Calibration Vc (2b)</td></tr>
<tr><td colspan="2">Sample Calibration Ic (2b)</td><td>unused</td><td>unused</td></tr>
<tr><td>unused</td><td>unused</td><td>unused</td><td>unused</td></tr>
<tr><td>unused</td><td>unused</td><td>unused</td><td>unused</td></tr>
<tr><td>unused</td><td>unused</td><td>unused</td><td>unused</td></tr>
</table>

NOTE

Byte order is in MSB.

Parsing a PQ Event Record

Use the table above to parse the PQ Event Record values you need. The following is an example binary snippet of a PQ Event Record (with a table map of the contents):

Table B.11: PQ Event Record Binary Content Mapping

Superscript #	Content	Superscript #	Content
1	timestamp	13	Va sag
2	present states 1	4	Vb sag
3	event channels	15	Vc sag
4	capture number	16	Va calibration
5	flags	17	Ia calibration
6	event cycle tag	18	Vb calibration
7	Va surge	19	Ib calibration

Superscript #	Content	Superscript #	Content
8	Vb surge	20	Vc calibration
9	Vc surge	21	Ic calibration
10	Ia surge	22	not used
11	Ib surge	23	padded zeroes
12	Ic surge	-	-

[0C 04 1E 4B 10 24]1 [01 C0]2 [01 C0]3 [00]4 [00]5 [00 00]6 [00 00]7
[00 00]8 [00 00]9 [00 00]10 [00 00]11 [00 00]12 [00 00]13 [00 00]14 [00 00]15
[D3 21]16 [19 6C]17 [1C B0]18 [02 64]19 [D3 AA]20 [1A F3]21 [00 00 00 00
00 00 00 00 00 00 00 00 00 00]22 [00 00 00 00 00 00]23

From the above content, the values would be as follows:

timestamp= 2012/04/30 11:16:36 AM

present_states = 0000 0001 1100 0000 (**see table above for bit breakdown**)

Volts C Sag

Volts B Sag

Volts A Sag

event_channels = 0000 0001 1100 0000 (**see table above for bit breakdown**)

Volts C Sag

Volts B Sag

Volts A Sag

capture_num = 0

flags= 0

event_cycle_tag = 0

we_rms_va_surge = 0

we_rms_vb_surge = 0

we_rms_vc_surge = 0

...

we_rms_va_sag = 0

we_rms_vb_sag = 0

we_rms_vc_sag = 0

calibration_va = 54049

calibration_ia = 6508

...

calibration_ic = 6899

Processing a PQ Event Record

The worst excursion RMS values are specified as ADC values, and to convert them to primary, you use the same primary value formula provided under Processing a Waveform Capture on page B-47.

PQ events come with numerous PQ records. From this numerous set, normally there exists a specific pair of PQ records (special cases will be discussed later), one that is created at the beginning of the PQ event and one created at the end of the PQ event - an Out and Return PQ record. Using these two records along with all the other PQ records in between them, you will be able to calculate the duration of the PQ event.

To further elaborate, whenever an "out" event happens (i.e., when a voltage surge or sag occurs), the "Out" PQ Record for that PQ event is created. Likewise, when this said "out" event returns (i.e., the voltage surge or sag returns to normal levels), the "Return" PQ Record for that PQ event is created. From these two particular PQ

records, calculating the difference of their timestamps will provide the duration of the PQ event. However, neither of the two PQ records (i.e., the Out and Return) know of each other. In order to find a particular Out and Return PQ record pair, the present states and event channel byte arrays from all the PQ records, including and in between the Out and Return PQ records themselves, must be used (see instructions for Parsing a PQ Event Record).

Here is the bitmap for both the present states and event channel byte arrays:

Table B.12: Present State/Event Channel Definition (2 bytes)

bit	-
0	Volts A Surge
1	Volts B Surge
2	Volts C Surge
3	Current A Surge
4	Current B Surge
5	Current C Surge
6	Volts A Sag
7	Volts B Sag
8	Volts C Sag
9	not used
10	not used
11	not used
12	not used
13	not used
14	not used
15	Manual Trigger

For example, a value of 0x0081 (00000000 10000001) in MSB indicates a Surge on

Volts A, and a sag on Volts B.

Both the present states and event channels use their bits as a series of TRUE/FALSE flags to signify change. The present states byte array flags tell whether or not an out event has occurred (e.g. been triggered) on a specific channel (see table above). In normal cases, after the Out PQ record, all the succeeding PQ records up until the Return PQ record will all have triggered present states (e.g., TRUE flags) for that same channel. The Return PQ record, which represents the end of a PQ event, will end the TRUE sequence by having its flag set to FALSE for that channel.

From the event channel byte array perspective, whenever a change occurred within the present states byte array, it sets its flag for that channel to TRUE. Whenever that channel reverts back to its previous state, then the event channel flag will be triggered again (set to TRUE) for that channel.

The following is a snippet of the present state and event channel byte arrays:

NOTE

x = TRUE, empty = FALSE)

Table B.13:

Preset State (snippet)					Event Channel (snippet)				
PQ Record	Va Surge	Vb Surge	Vc Surge	Timestamp	PQ Record	Va Surge	Vb Surge	Vc Surge	Timestamp
0				2013/04/01 02:10:13 PM					2013/04/01 02:10:13 PM
1				2013/04/01 02:10:14 PM					2013/04/01 02:10:14 PM
2		x		2013/04/01 02:10:15 PM			x		2013/04/01 02:10:15 PM
3	x	x		2013/04/01 02:10:16 PM					2013/04/01 02:10:16 PM
4		x	x	2013/04/01 02:10:17 PM				x	2013/04/01 02:10:17 PM
5		x	x	2013/04/01 02:10:18 PM					2013/04/01 02:10:18 PM
6		x		2013/04/01 02:10:19 PM					2013/04/01 02:10:19 PM
7		x		2013/04/01 02:10:20 PM					2013/04/01 02:10:20 PM
8		x		2013/04/01 02:10:21 PM			x		2013/04/01 02:10:21 PM
9				2013/04/01 02:10:22 PM					2013/04/01 02:10:22 PM
10		x		2013/04/01 02:10:23 PM			x		2013/04/01 02:10:23 PM

Only the first 3 bits are being shown for the present states and event channel byte arrays (along with their timestamps) in the example provided and from the snippet above, three different example scenarios can be observed. The following example explanations serve only to show the behavior of the two byte arrays as well as show how to calculate the duration by determining the Out and Return PQ records in the given situations.

The surge occurring on Channel Vb is an example of a normal PQ event where both the beginning (Out) and end (Return) can easily be determined. It is shown to have surged starting from PQ record 2. All the subsequent PQ records continued to surge on the same channel until reaching PQ record 8. Looking at the event channel byte array, a change had occurred on both PQ records 2 and 8. Using the information from both byte arrays, it is easy to see that PQ record 2 is the Out Record and PQ record 8 is the Return Record. Thus the PQ event duration is simply the timestamp difference between those two records (e.g., 6 seconds).

The following examples describe error conditions which may occur in the PQ records when PQ trigger conditions are missed. For example, if a surge comes back into limit while the meter is resetting, it may not record the return to normal event. Channel Va shows an example of a special case where the surge on PQ record 3 is not recorded under the Event Channel for that same record. This shows a discrepancy where a PQ record or numerous PQ records may be missing before the entry of PQ record 3. Under these situations, it may not be possible to find the Out Record (the beginning of a PQ event). This can be detected by an Out condition in the Present states table, with no matching change in the Event Channel table.

Channel Vc shows an example of a special case where the surge on PQ records 4-5 do not show a return to normal condition in the Event Channel in record 6. This shows a discrepancy where a PQ record or numerous PQ records may be missing between records 5 and 6. Under these situations, it may not be possible to find the Return to Normal Record (the end of a PQ event). This can be detected by an Out condition in the Present states table, followed by a normal condition in the Present states table, with no matching change in the Event Channel table.

B.6 Important Note Concerning the EPM 7000 Meter's Modbus Map

In depicting Modbus Registers (Addresses), the EPM 7000 meter's Modbus map uses Holding Registers only.

B.6.1 Hex Representation

The representation shown in the table below is used by developers of Modbus drivers and libraries, SEL 2020/2030 programmers and Firmware Developers. The EPM 7000 meter's Modbus map also uses this representation.

Hex	Description
0008 - 000F	Meter Serial Number

B.6.2 Decimal Representation

The EPM 7000 meter's Modbus map defines Holding Registers as (4X) registers. Many popular SCADA and HMI packages and their Modbus drivers have user interfaces that require users to enter these Registers starting at 40001. So instead of entering two separate values, one for register type and one for the actual register, they have been combined into one number.

The EPM 7000 meter's Modbus map uses a shorthand version to depict the decimal fields, i.e., not all of the digits required for entry into the SCADA package UI are shown. For example:

You need to display the meter's serial number in your SCADA application. The EPM 7000 meter's Modbus map shows the following information for meter serial number:

Decimal	Description
9 - 16	Meter Serial Number

In order to retrieve the meter's serial number, enter 40009 into the SCADA UI as the starting register, and 8 as the number of registers.

- In order to work with SCADA and Driver packages that use the 40001 to 49999 method for requesting holding registers, take 40000 and add the value of the register (Address) in the decimal column of the Modbus Map. Then enter the number (e.g., 4009) into the UI as the starting register.
- For SCADA and Driver packages that use the 400001 to 465536 method for requesting holding registers take 400000 and add the value of the register (Address) in the decimal column of the Modbus Map. Then enter the number (e.g., 400009) into the UI as the starting register. The drivers for these packages strip off the leading four and subtract 1 from the remaining value. This final value is used as the starting register or register to be included when building the actual modbus message.

B.7 Modbus Register Map (MM-1 to MM-32)

Modbus Address Hex	Modbus Address Decimal	Description (Note 1)	Format	Range (Note 6)	Units or Resolution	Comments	# Reg	Option Board Default Value
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	-------st -----vvv	t = transducer model (1=yes, 0=no), s= submeter model(1=yes,0=no), vvv = Software Option: 81 = Option A, 82 = Option B, 83 = Option C, 84 = Option D, 85 = Option E , 86 = Option F	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	-----ccc --ffffff	ccc = CT denominator (1 or 5), ffffff = calibration frequency (50 or 60)	1	

0015	-	0015	22	-	22	ASIC Version	UINT16	0-65535	none		1	
0016	-	0017	23	-	24	Boot Firmware Version	ASCII	4 char	none		2	
0018	-	0018	25	-	25	Option Slot 1 Usage	UINT16	bit-mapped	same as register 10000 (0x270F)		1	
0019	-	0019	26	-	26	Option Slot 2 Usage	UINT16	bit-mapped	same as register 11000 (0x2AF7)		1	
001A	-	001D	27	-	30	Meter Type Name	ASCII	8 char	none		4	
001E	-	0026	31	-	39	Reserved				Reserved	9	
0027	-	002E	40	-	47	Reserved				Reserved	8	
002F	-	0115	48	-	278	Reserved				Reserved	231	
0116	-	0130	279	-	305	Integer Readings Block occupies these registers, see below						
0131	-	01F3	306	-	500	Reserved				Reserved	194	
01F4	-	0203	501	-	516	Reserved				Reserved	16	

METER DATA SECTION (NOTE 2)												
Readings Block (Integer values)										read-only		
0116	-	0116	279	-	279	Volts A-N	UINT16	0 to 9999	volts	1.Use the settings from Programmable settings for scale and decimal point location. (see User Settings Flags) 2. Per phase power and PF have values only for WYE hookup and will be zero for all other hookups. 3. If the reading is 10000 that means that the value is out of range. Please adjust the programmable settings in that case. The display will also show '----' in case of over range.	1	
0117	-	0117	280	-	280	Volts B-N	UINT16	0 to 9999	volts		1	
0118	-	0118	281	-	281	Volts C-N	UINT16	0 to 9999	volts		1	
0119	-	0119	282	-	282	Volts A-B	UINT16	0 to 9999	volts		1	
011A	-	011A	283	-	283	Volts B-C	UINT16	0 to 9999	volts		1	
011B	-	011B	284	-	284	Volts C-A	UINT16	0 to 9999	volts		1	
011C	-	011C	285	-	285	Amps A	UINT16	0 to 9999	amps		1	
011D	-	011D	286	-	286	Amps B	UINT16	0 to 9999	amps		1	
011E	-	011E	287	-	287	Amps C	UINT16	0 to 9999	amps		1	
011F	-	011F	288	-	288	Neutral Current	UINT16	-9999 to +9999	amps		1	
0120	-	0120	289	-	289	Watts, 3-Ph total	SINT16	-9999 to +9999	watts		1	
0121	-	0121	290	-	290	VARs, 3-Ph total	SINT16	-9999 to +9999	VARs		1	
0122	-	0122	291	-	291	VAs, 3-Ph total	UINT16	0 to +9999	VAs		1	
0123	-	0123	292	-	292	Power Factor, 3-Ph total	SINT16	-1000 to +1000	none		1	
0124	-	0124	293	-	293	Frequency	UINT16	0 to 9999	Hz		1	
0125	-	0125	294	-	294	Watts, Phase A	SINT16	-9999 M to +9999	watts		1	
0126	-	0126	295	-	295	Watts, Phase B	SINT16	-9999 M to +9999	watts		1	
0127	-	0127	296	-	296	Watts, Phase C	SINT16	-9999 M to +9999	watts		1	
0128	-	0128	297	-	297	VARs, Phase A	SINT16	-9999 M to +9999 M	VARs		1	
0129	-	0129	298	-	298	VARs, Phase B	SINT16	-9999 M to +9999 M	VARs		1	
012A	-	012A	299	-	299	VARs, Phase C	SINT16	-9999 M to +9999 M	VARs		1	
012B	-	012B	300	-	300	VAs, Phase A	UINT16	0 to +9999	VAs		1	
012C	-	012C	301	-	301	VAs, Phase B	UINT16	0 to +9999	VAs		1	
012D	-	012D	302	-	302	VAs, Phase C	UINT16	0 to +9999	VAs		1	
012E	-	012E	303	-	303	Power Factor, Phase A	SINT16	-1000 to +1000	none		1	
012F	-	012F	304	-	304	Power Factor, Phase B	SINT16	-1000 to +1000	none		1	
0130	-	0130	305	-	305	Power Factor, Phase C	SINT16	-1000 to +1000	none		1	
										Block Size:	27	
Primary Readings Block										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	
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	
0405 - 0406	1030	-	1031	Watts, Phase A	FLOAT	-9999 M to +9999 M	watts	Per phase power and PF have values only for WYE hookup and will be zero for all other hookups.	2	
0407 - 0408	1032	-	1033	Watts, Phase B	FLOAT	-9999 M to +9999 M	watts		2	
0409 - 040A	1034	-	1035	Watts, Phase C	FLOAT	-9999 M to +9999 M	watts		2	
040B - 040C	1036	-	1037	VARs, Phase A	FLOAT	-9999 M to +9999 M	VARs		2	
040D - 040E	1038	-	1039	VARs, Phase B	FLOAT	-9999 M to +9999 M	VARs		2	
040F - 0410	1040	-	1041	VARs, Phase C	FLOAT	-9999 M to +9999 M	VARs		2	
0411 - 0412	1042	-	1043	VAs, Phase A	FLOAT	-9999 M to +9999 M	VAs		2	
0413 - 0414	1044	-	1045	VAs, Phase B	FLOAT	-9999 M to +9999 M	VAs		2	
0415 - 0416	1046	-	1047	VAs, Phase C	FLOAT	-9999 M to +9999 M	VAs		2	
0417 - 0418	1048	-	1049	Power Factor, Phase A	FLOAT	-1.00 to +1.00	none		2	
0419 - 041A	1050	-	1051	Power Factor, Phase B	FLOAT	-1.00 to +1.00	none		2	
041B - 041C	1052	-	1053	Power Factor, Phase C	FLOAT	-1.00 to +1.00	none		2	

041D	-	041E	1054	-	1055	Symmetrical Component Magnitude, 0 Seq	FLOAT	0 to 9999 M	volts	Voltage unbalance per IEC6100-4.30	2	
041F	-	0420	1056	-	1057	Symmetrical Component Magnitude, + Seq	FLOAT	0 to 9999 M	volts	Values apply only to WYE hookup and will be zero for all other hookups.	2	
0421	-	0422	1058	-	1059	Symmetrical Component Magnitude, - Seq	FLOAT	0 to 9999 M	volts		2	
0423	-	0423	1060	-	1060	Symmetrical Component Phase, 0 Seq	SINT16	-1800 to +1800	0.1 degree		1	
0424	-	0424	1061	-	1061	Symmetrical Component Phase, + Seq	SINT16	-1800 to +1800	0.1 degree		1	
0425	-	0425	1062	-	1062	Symmetrical Component Phase, - Seq	SINT16	-1800 to +1800	0.1 degree		1	
0426	-	0426	1063	-	1063	Unbalance, 0 sequence component	UINT16	0 to 65535	0.01%		1	
0427	-	0427	1064	-	1064	Unbalance, - sequence component	UINT16	0 to 65535	0.01%		1	
0428	-	0428	1065	-	1065	Current Unbalance	UINT16	0 to 20000	0.01%		1	
										Block Size:	66	
Primary Energy Block										read-only		

05DB - 05DC	1500 - 1501	W-hours, Received	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format	* Wh received & delivered always have opposite signs * Wh received is positive for	2	
05DD - 05DE	1502 - 1503	W-hours, Delivered	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format	"view as load", delivered is positive for "view as generator"	2	
05DF - 05E0	1504 - 1505	W-hours, Net	SINT32	-99999999 to 99999999	Wh per energy format	* 5 to 8 digits	2	
05E1 - 05E2	1506 - 1507	W-hours, Total	SINT32	0 to 99999999	Wh per energy format	* decimal point implied, per energy format	2	
05E3 - 05E4	1508 - 1509	VAR-hours, Positive	SINT32	0 to 99999999	VARh per energy format	* resolution of digit before	2	
05E5 - 05E6	1510 - 1511	VAR-hours, Negative	SINT32	0 to -99999999	VARh per energy format	decimal point = units, kilo, or mega, per energy format	2	
05E7 - 05E8	1512 - 1513	VAR-hours, Net	SINT32	-99999999 to 99999999	VARh per energy format	* see note 10	2	
05E9 - 05EA	1514 - 1515	VAR-hours, Total	SINT32	0 to 99999999	VARh per energy format		2	
05EB - 05EC	1516 - 1517	VA-hours, Total	SINT32	0 to 99999999	VAh per energy format		2	
05ED - 05EE	1518 - 1519	W-hours, Received, Phase A	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2	
05EF - 05F0	1520 - 1521	W-hours, Received, Phase B	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2	
05F1 - 05F2	1522 - 1523	W-hours, Received, Phase C	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2	
05F3 - 05F4	1524 - 1525	W-hours, Delivered, Phase A	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2	
05F5 - 05F6	1526 - 1527	W-hours, Delivered, Phase B	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2	
05F7 - 05F8	1528 - 1529	W-hours, Delivered, Phase C	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2	
05F9 - 05FA	1530 - 1531	W-hours, Net, Phase A	SINT32	-99999999 to 99999999	Wh per energy format		2	
05FB - 05FC	1532 - 1533	W-hours, Net, Phase B	SINT32	-99999999 to 99999999	Wh per energy format		2	
05FD - 05FE	1534 - 1535	W-hours, Net, Phase C	SINT32	-99999999 to 99999999	Wh per energy format		2	
05FF - 0600	1536 - 1537	W-hours, Total, Phase A	SINT32	0 to 99999999	Wh per energy format		2	
0601 - 0602	1538 - 1539	W-hours, Total, Phase B	SINT32	0 to 99999999	Wh per energy format		2	
0603 - 0604	1540 - 1541	W-hours, Total, Phase C	SINT32	0 to 99999999	Wh per energy format		2	
0605 - 0606	1542 - 1543	VAR-hours, Positive, Phase A	SINT32	0 to 99999999	VARh per energy format		2	
0607 - 0608	1544 - 1545	VAR-hours, Positive, Phase B	SINT32	0 to 99999999	VARh per energy format		2	
0609 - 060A	1546 - 1547	VAR-hours, Positive, Phase C	SINT32	0 to 99999999	VARh per energy format		2	
060B - 060C	1548 - 1549	VAR-hours, Negative, Phase A	SINT32	0 to -99999999	VARh per energy format		2	
060D - 060E	1550 - 1551	VAR-hours, Negative, Phase B	SINT32	0 to -99999999	VARh per energy format		2	
060F - 0610	1552 - 1553	VAR-hours, Negative, Phase C	SINT32	0 to -99999999	VARh per energy format		2	
0611 - 0612	1554 - 1555	VAR-hours, Net, Phase A	SINT32	-99999999 to 99999999	VARh per energy format		2	

0613 - 0614	1556 - 1557	VAR-hours, Net, Phase B	SINT32	-99999999 to 99999999	VARh per energy format		2	
0615 - 0616	1558 - 1559	VAR-hours, Net, Phase C	SINT32	-99999999 to 99999999	VARh per energy format		2	
0617 - 0618	1560 - 1561	VAR-hours, Total, Phase A	SINT32	0 to 99999999	VARh per energy format		2	
0619 - 061A	1562 - 1563	VAR-hours, Total, Phase B	SINT32	0 to 99999999	VARh per energy format		2	
061B - 061C	1564 - 1565	VAR-hours, Total, Phase C	SINT32	0 to 99999999	VARh per energy format		2	
061D - 061E	1566 - 1567	VA-hours, Phase A	SINT32	0 to 99999999	VAh per energy format		2	
061F - 0620	1568 - 1569	VA-hours, Phase B	SINT32	0 to 99999999	VAh per energy format		2	
0621 - 0622	1570 - 1571	VA-hours, Phase C	SINT32	0 to 99999999	VAh per energy format		2	
0623 - 0624	1572 - 1573	W-hours, Received, rollover count	UINT32	0 to 4,294,967,294		These registers count the number of times their corresponding energy accumulators have wrapped from +max to 0. They are reset when energy is reset.	2	
0625 - 0626	1574 - 1575	W-hours, Delivered, rollover count	UINT32	0 to 4,294,967,294			2	
0627 - 0628	1576 - 1577	VAR-hours, Positive, rollover count	UINT32	0 to 4,294,967,294			2	
0629 - 062A	1578 - 1579	VAR-hours, Negative, rollover count	UINT32	0 to 4,294,967,294			2	
062B - 062C	1580 - 1581	VA-hours, rollover count	UINT32	0 to 4,294,967,294			2	

062D - 062E	1582 - 1583	W-hours in the Interval, Received	SINT32	"0 to 99999999 or 0 to -99999999	"Wh per energy format	* Wh received & delivered always have opposite signs * Wh received is positive for "view as load" , delivered is positive for "view as generator" * 5 to 8 digits * decimal point implied, per energy format * resolution of digit before decimal point = units, kilo, or mega, per energy format * see note 10		
062F - 0630	1584 - 1585	W-hours in the Interval, Delivered	SINT32	"0 to 99999999 or 0 to -99999999	"Wh per energy format		2	
0631 - 0632	1586 - 1587	VAR-hours in the Interval, Positive	SINT32	0 to 99999999	VARh per energy format		2	
0633 - 0634	1588 - 1589	VAR-hours in the Interval, Negative	SINT32	0 to -99999999	VARh per energy format		2	
0635 - 0636	1590 - 1591	VA-hours in the Interval, Total	SINT32	0 to 99999999	VAh per energy format		2	
0637 - 0638	1592 - 1593	W-hours in the Interval, Received, Phase A	SINT32	"0 to 99999999 or 0 to -99999999	"Wh per energy format		2	
0639 - 063A	1594 - 1595	W-hours in the Interval, Received, Phase B	SINT32	"0 to 99999999 or 0 to -99999999	"Wh per energy format		2	
063B - 063C	1596 - 1597	W-hours in the Interval, Received, Phase C	SINT32	"0 to 99999999 or 0 to -99999999	"Wh per energy format		2	
063D - 063E	1598 - 1599	W-hours in the Interval, Delivered, Phase A	SINT32	"0 to 99999999 or 0 to -99999999	"Wh per energy format		2	
063F - 0640	1600 - 1601	W-hours in the Interval, Delivered, Phase B	SINT32	"0 to 99999999 or 0 to -99999999	"Wh per energy format		2	
0641 - 0642	1602 - 1603	W-hours in the Interval, Delivered, Phase C	SINT32	"0 to 99999999 or 0 to -99999999	"Wh per energy format		2	
0643 - 0644	1604 - 1605	VAR-hours in the Interval, Positive, Phase A	SINT32	0 to 99999999	VARh per energy format		2	
0645 - 0646	1606 - 1607	VAR-hours in the Interval, Positive, Phase B	SINT32	0 to 99999999	VARh per energy format		2	
0647 - 0648	1608 - 1609	VAR-hours in the Interval, Positive, Phase C	SINT32	0 to 99999999	VARh per energy format		2	
0649 - 064A	1610 - 1611	VAR-hours in the Interval, Negative, Phase A	SINT32	0 to -99999999	VARh per energy format		2	
064B - 064C	1612 - 1613	VAR-hours in the Interval, Negative, Phase B	SINT32	0 to -99999999	VARh per energy format		2	
063D - 064E	1614 - 1615	VAR-hours in the Interval, Negative, Phase C	SINT32	0 to -99999999	VARh per energy format		2	
064F - 0650	1616 - 1617	VA-hours in the Interval, Phase A	SINT32	0 to 99999999	VAh per energy format		2	
0651 - 0652	1618 - 1619	VA-hours in the Interval, Phase B	SINT32	0 to 99999999	VAh per energy format		2	
0653 - 0654	1620 - 1621	VA-hours in the Interval, Phase C	SINT32	0 to 99999999	VAh per energy format		2	
						Block Size:	122	
Primary Demand Block						read-only		

07CC - 07CE	1997 - 1999	Demand Interval End Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec	Ex. Timestamp hh:mm:ss is 03:15:00 and interval size is 15 minutes. Demand interval was 3:00:00 to 3:15:00. Note: Timestamp is zero until the end of the first interval after meter startup.	2	
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	
07E3 - 07E4	2020 - 2021	Neutral Current, Average	FLOAT	0 to 9999 M	amps		2	
07E5 - 07E6	2022 - 2023	Positive Watts, Phase A, Average	FLOAT	-9999 M to +9999 M	watts		2	
07E7 - 07E8	2024 - 2025	Positive Watts, Phase B, Average	FLOAT	-9999 M to +9999 M	watts		2	
07E9 - 07EA	2026 - 2027	Positive Watts, Phase C, Average	FLOAT	-9999 M to +9999 M	watts		2	
07EB - 07EC	2028 - 2029	Positive VARs, Phase A, Average	FLOAT	-9999 M to +9999 M	VARs		2	
07ED - 07EE	2030 - 2031	Positive VARs, Phase B, Average	FLOAT	-9999 M to +9999 M	VARs		2	
07EF - 07F0	2032 - 2033	Positive VARs, Phase C, Average	FLOAT	-9999 M to +9999 M	VARs		2	
07F1 - 07F2	2034 - 2035	Negative Watts, Phase A, Average	FLOAT	-9999 M to +9999 M	watts		2	
07F3 - 07F4	2036 - 2037	Negative Watts, Phase B, Average	FLOAT	-9999 M to +9999 M	watts		2	
07F5 - 07F6	2038 - 2039	Negative Watts, Phase C, Average	FLOAT	-9999 M to +9999 M	watts		2	
07F7 - 07F8	2040 - 2041	Negative VARs, Phase A, Average	FLOAT	-9999 M to +9999 M	VARs		2	
07F9 - 07FA	2042 - 2043	Negative VARs, Phase B, Average	FLOAT	-9999 M to +9999 M	VARs		2	
07FB - 07FC	2044 - 2045	Negative VARs, Phase C, Average	FLOAT	-9999 M to +9999 M	VARs		2	
07FD - 07FE	2046 - 2047	VAs, Phase A, Average	FLOAT	-9999 M to +9999 M	VAs		2	
07FF - 0800	2048 - 2049	VAs, Phase B, Average	FLOAT	-9999 M to +9999 M	VAs		2	
0801 - 0802	2050 - 2051	VAs, Phase C, Average	FLOAT	-9999 M to +9999 M	VAs		2	
0803 - 0804	2052 - 2053	Positive PF, Phase A, Average	FLOAT	-1.00 to +1.00	none		2	
0805 - 0806	2054 - 2055	Positive PF, Phase B, Average	FLOAT	-1.00 to +1.00	none		2	
0807 - 0808	2056 - 2057	Positive PF, Phase C, Average	FLOAT	-1.00 to +1.00	none		2	
0809 - 080A	2058 - 2059	Negative PF, Phase A, Average	FLOAT	-1.00 to +1.00	none		2	
080B - 080C	2060 - 2061	Negative PF, Phase B, Average	FLOAT	-1.00 to +1.00	none		2	

080D - 080E	2062 - 2063	Negative PF, Phase C, Average	FLOAT	-1.00 to +1.00	none		2	
						Block Size:	64	
Uncompensated Readings Block						read-only		
0BB7 - 0BB8	3000 - 3001	Watts, 3-Ph total	FLOAT	-9999 M to +9999 M	watts		2	
0BB9 - 0BBA	3002 - 3003	VARs, 3-Ph total	FLOAT	-9999 M to +9999 M	VARs		2	
0BBB - 0BBC	3004 - 3005	VAs, 3-Ph total	FLOAT	-9999 M to +9999 M	VAs		2	
0BBD - 0BBE	3006 - 3007	Power Factor, 3-Ph total	FLOAT	-1.00 to +1.00	none		2	
0BBF - 0BC0	3008 - 3009	Watts, Phase A	FLOAT	-9999 M to +9999 M	watts	Per phase power and PF have values only for WYE hookup and will be zero for all other hookups.	2	
0BC1 - 0BC2	3010 - 3011	Watts, Phase B	FLOAT	-9999 M to +9999 M	watts		2	
0BC3 - 0BC4	3012 - 3013	Watts, Phase C	FLOAT	-9999 M to +9999 M	watts		2	
0BC5 - 0BC6	3014 - 3015	VARs, Phase A	FLOAT	-9999 M to +9999 M	VARs		2	
OBC7 - 0BC8	3016 - 3017	VARs, Phase B	FLOAT	-9999 M to +9999 M	VARs		2	
0BC9 - 0BCA	3018 - 3019	VARs, Phase C	FLOAT	-9999 M to +9999 M	VARs		2	
0BCB - 0BCC	3020 - 3021	VAs, Phase A	FLOAT	-9999 M to +9999 M	VAs		2	
0BCD - 0BCE	3022 - 3023	VAs, Phase B	FLOAT	-9999 M to +9999 M	VAs		2	
0BCF - 0BD0	3024 - 3025	VAs, Phase C	FLOAT	-9999 M to +9999 M	VAs		2	
0BD1 - 0BD2	3026 - 3027	Power Factor, Phase A	FLOAT	-1.00 to +1.00	none		2	
0BD3 - 0BD4	3028 - 3029	Power Factor, Phase B	FLOAT	-1.00 to +1.00	none		2	
0BD5 - 0BD6	3030 - 3031	Power Factor, Phase C	FLOAT	-1.00 to +1.00	none		2	
0BD7 - 0BD8	3032 - 3033	W-hours, Received	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format	* Wh received & delivered always have opposite signs * Wh received is positive for "view as load", delivered is positive for "view as generator" * 5 to 8 digits * decimal point implied, per energy format * resolution of digit before decimal point = units, kilo, or mega, per energy format * see note 10	2	
0BD9 - 0BDA	3034 - 3035	W-hours, Delivered	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2	
0BDB - 0BDC	3036 - 3037	W-hours, Net	SINT32	-99999999 to 99999999	Wh per energy format		2	
0BDD - 0BDE	3038 - 3039	W-hours, Total	SINT32	0 to 99999999	Wh per energy format		2	
0BDF - 0BE0	3040 - 3041	VAR-hours, Positive	SINT32	0 to 99999999	VARh per energy format		2	
0BE1 - 0BE2	3042 - 3043	VAR-hours, Negative	SINT32	0 to -99999999	VARh per energy format		2	
0BE3 - 0BE4	3044 - 3045	VAR-hours, Net	SINT32	-99999999 to 99999999	VARh per energy format		2	
0BE5 - 0BE6	3046 - 3047	VAR-hours, Total	SINT32	0 to 99999999	VARh per energy format		2	
0BE7 - 0BE8	3048 - 3049	VA-hours, Total	SINT32	0 to 99999999	VAh per energy format		2	
0BE9 - 0BEA	3050 - 3051	W-hours, Received, Phase A	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2	
0BEB - 0BEC	3052 - 3053	W-hours, Received, Phase B	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2	

0BED - 0BEE	3054 - 3055	W-hours, Received, Phase C	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2	
0BEF - 0BF0	3056 - 3057	W-hours, Delivered, Phase A	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2	
0BF1 - 0BF2	3058 - 3059	W-hours, Delivered, Phase B	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2	
0BF3 - 0BF4	3060 - 3061	W-hours, Delivered, Phase C	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format		2	
0BF5 - 0BF6	3062 - 3063	W-hours, Net, Phase A	SINT32	-99999999 to 99999999	Wh per energy format		2	
0BF7 - 0BF8	3064 - 3065	W-hours, Net, Phase B	SINT32	-99999999 to 99999999	Wh per energy format		2	
0BF9 - 0BFA	3066 - 3067	W-hours, Net, Phase C	SINT32	-99999999 to 99999999	Wh per energy format		2	
0BFB - 0BFC	3068 - 3069	W-hours, Total, Phase A	SINT32	0 to 99999999	Wh per energy format		2	
0BFD - 0BFE	3070 - 3071	W-hours, Total, Phase B	SINT32	0 to 99999999	Wh per energy format		2	
0BFF - 0C00	3072 - 3073	W-hours, Total, Phase C	SINT32	0 to 99999999	Wh per energy format		2	
0C01 - 0C02	3074 - 3075	VAR-hours, Positive, Phase A	SINT32	0 to 99999999	VARh per energy format		2	
0C03 - 0C04	3076 - 3077	VAR-hours, Positive, Phase B	SINT32	0 to 99999999	VARh per energy format		2	
0C05 - 0C06	3078 - 3079	VAR-hours, Positive, Phase C	SINT32	0 to 99999999	VARh per energy format		2	
0C07 - 0C08	3080 - 3081	VAR-hours, Negative, Phase A	SINT32	0 to -99999999	VARh per energy format		2	
0C09 - 0C0A	3082 - 3083	VAR-hours, Negative, Phase B	SINT32	0 to -99999999	VARh per energy format		2	
0C0B - 0C0C	3084 - 3085	VAR-hours, Negative, Phase C	SINT32	0 to -99999999	VARh per energy format		2	
0C0D - 0C0E	3086 - 3087	VAR-hours, Net, Phase A	SINT32	-99999999 to 99999999	VARh per energy format		2	
0C0F - 0C10	3088 - 3089	VAR-hours, Net, Phase B	SINT32	-99999999 to 99999999	VARh per energy format		2	
0C11 - 0C12	3090 - 3091	VAR-hours, Net, Phase C	SINT32	-99999999 to 99999999	VARh per energy format		2	
0C13 - 0C14	3092 - 3093	VAR-hours, Total, Phase A	SINT32	0 to 99999999	VARh per energy format		2	
0C15 - 0C16	3094 - 3095	VAR-hours, Total, Phase B	SINT32	0 to 99999999	VARh per energy format		2	
0C17 - 0C18	3096 - 3097	VAR-hours, Total, Phase C	SINT32	0 to 99999999	VARh per energy format		2	
0C19 - 0C1A	3098 - 3099	VA-hours, Phase A	SINT32	0 to 99999999	VAh per energy format		2	
0C1B - 0C1C	3100 - 3101	VA-hours, Phase B	SINT32	0 to 99999999	VAh per energy format		2	
0C1D - 0C1E	3102 - 3103	VA-hours, Phase C	SINT32	0 to 99999999	VAh per energy format		2	
						Block Size:	104	
Phase Angle Block						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		
1193 - 1193	4500 - 4500	Port ID	UINT16	1 to 4	none	Identifies which EPM 7000 COM port a master is connected to; 1 for COM1, 2 for COM2, etc.	1	
1194 - 1194	4501 - 4501	Meter Status	UINT16	bit-mapped	mmmpch-- tffeeccc	"mmm = measurement state (0=off, 1=running normally, 2=limp mode, 3=warmup, 6&7=boot, others unused) See note 16. pch = NVMEM block OK flags (p=profile, c=calibration, h=header), flag is 1 if OK t - CT PT compensation status. (0=Disabled,1=Enabled) ff = flash state (0=initializing, 1=logging disabled by Software Option, 3=logging) ee = edit state (0=startup, 1=normal, 2=privileged command session, 3=profile update mode) ccc = port enabled for edit(0=none, 1-4=COM1-COM4, 7=front panel)"	1	
1195 - 1195	4502 - 4502	Limits Status	UINT16	bit-mapped	87654321 87654321	high byte is setpt 1, 0=in, 1=out low byte is setpt 2, 0=in, 1=out see notes 11, 12, 17	1	
1196 - 1197	4503 - 4504	Time Since Reset	UINT32	0 to 4294967294	4 msec	wraps around after max count	2	
1198 - 119A	4505 - 4507	Meter On Time	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
119B - 119D	4508 - 4510	Current Date and Time	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
119E - 119E	4511 - 4511	Clock Sync Status	UINT16	bit-mapped	mmm0 0ppe 0000 000s	mmm00ppe = configuration per programmable settings (see register 30011, 0x753A) s = status: 1=working properly, 0=not working	1	
119F - 119F	4512 - 4512	Current Day of Week	UINT16	1 to 7	1 day	1=Sun, 2=Mon, etc.	1	
						Block Size:	13	
THD Block (Note 13)						read-only		
176F - 176F	6000 - 6000	Volts A-N, %THD	UINT16	0 to 10000	0.01%		1	
1770 - 1770	6001 - 6001	Volts B-N, %THD	UINT16	0 to 10000	0.01%		1	
1771 - 1771	6002 - 6002	Volts C-N, %THD	UINT16	0 to 10000	0.01%		1	
1772 - 1772	6003 - 6003	Amps A, %THD	UINT16	0 to 10000	0.01%		1	
1773 - 1773	6004 - 6004	Amps B, %THD	UINT16	0 to 10000	0.01%		1	
1774 - 1774	6005 - 6005	Amps C, %THD	UINT16	0 to 10000	0.01%		1	

1775 - 179C	6006 - 6045	Phase A Voltage harmonic magnitudes	UINT16	0 to 10000	0.01%	In each group of 40 registers, the first register represents the fundamental frequency or first harmonic, the second represents the second harmonic, and so on up to the 40th register which represents the 40th harmonic. Harmonic magnitudes are given as % of the fundamental magnitude. Thus the first register in each group of 40 will typically be 9999. A reading of 10000 indicates invalid.	40	
179D - 17C4	6046 - 6085	Phase A Voltage harmonic phases	SINT16	-1800 to +1800	0.1 degree		40	
17C5 - 17EC	6086 - 6125	Phase A Current harmonic magnitudes	UINT16	0 to 10000	0.01%		40	
17ED - 1814	6126 - 6165	Phase A Current harmonic phases	SINT16	-1800 to +1800	0.1 degree		40	
1815 - 183C	6166 - 6205	Phase B Voltage harmonic magnitudes	UINT16	0 to 10000	0.01%		40	
183D - 1864	6206 - 6245	Phase B Voltage harmonic phases	SINT16	-1800 to +1800	0.1 degree		40	
1865 - 188C	6246 - 6285	Phase B Current harmonic magnitudes	UINT16	0 to 10000	0.01%		40	
188D - 18B4	6286 - 6325	Phase B Current harmonic phases	SINT16	-1800 to +1800	0.1 degree		40	
18B5 - 18DC	6326 - 6365	Phase C Voltage harmonic magnitudes	UINT16	0 to 10000	0.01%		40	
18DD - 1904	6366 - 6405	Phase C Voltage harmonic phases	SINT16	-1800 to +1800	0.1 degree		40	
1905 - 192C	6406 - 6445	Phase C Current harmonic magnitudes	UINT16	0 to 10000	0.01%		40	
192D - 1954	6446 - 6485	Phase C Current harmonic phases	SINT16	-1800 to +1800	0.1 degree		40	
1955 - 1955	6486 - 6486	Wave Scope scale factor for channel Va	UINT16	0 to 32767		Convert individual samples to volts or amps: V or A = (sample * scale factor) / 1,000,000 Samples update in conjunction with THD and harmonics; samples not available (all zeroes) if THD not available.	1	
1956 - 1956	6487 - 6487	Wave Scope scale factors for channel Ib	UINT16	0 to 32767			1	
1957 - 1958	6488 - 6489	Wave Scope scale factors for channels Vb and Ib	UINT16	0 to 32767			2	
1959 - 195A	6490 - 6491	Wave Scope scale factors for channels Vc and Ic	UINT16	0 to 32767			2	
195B - 199A	6492 - 6555	Wave Scope samples for channel Va	SINT16	-32768 to +32767			64	
199B - 19DA	6556 - 6619	Wave Scope samples for channel Ia	SINT16	-32768 to +32767			64	
19DB - 1A1A	6620 - 6683	Wave Scope samples for channel Vb	SINT16	-32768 to +32767			64	
1A1B - 1A5A	6684 - 6747	Wave Scope samples for channel Ib	SINT16	-32768 to +32767			64	
1A5B - 1A9A	6748 - 6811	Wave Scope samples for channel Vc	SINT16	-32768 to +32767			64	
1A9B - 1ADA	6812 - 6875	Wave Scope samples for channel Ic	SINT16	-32768 to +32767			64	
						Block Size:	876	

Short term Primary Minimum Block						read-only		
1F27 - 1F28	7976 - 7977	Volts A-N, previous Demand interval Short Term Minimum	FLOAT	0 to 9999 M	volts	Minimum instantaneous value measured during the demand interval before the one most recently completed.	2	
1F29 - 1F2A	7978 - 7979	Volts B-N, previous Demand interval Short Term Minimum	FLOAT	0 to 9999 M	volts		2	
1F2B - 1F2C	7980 - 7981	Volts C-N, previous Demand interval Short Term Minimum	FLOAT	0 to 9999 M	volts		2	
1F2D - 1F2E	7982 - 7983	Volts A-B, previous Demand interval Short Term Minimum	FLOAT	0 to 9999 M	volts		2	
1F2F - 1F30	7984 - 7985	Volts B-C, previous Demand interval Short Term Minimum	FLOAT	0 to 9999 M	volts		2	
1F31 - 1F32	7986 - 7987	Volts C-A, previous Demand interval Short Term Minimum	FLOAT	0 to 9999 M	volts		2	
1F33 - 1F34	7988 - 7989	Volts A-N, Short Term Minimum	FLOAT	0 to 9999 M	volts	Minimum instantaneous value measured during the most recently completed demand interval.	2	
1F35 - 1F36	7990 - 7991	Volts B-N, Short Term Minimum	FLOAT	0 to 9999 M	volts		2	
1F37 - 1F38	7992 - 7993	Volts C-N, Short Term Minimum	FLOAT	0 to 9999 M	volts		2	
1F39 - 1F3A	7994 - 7995	Volts A-B, Short Term Minimum	FLOAT	0 to 9999 M	volts		2	
1F3B - 1F3C	7996 - 7997	Volts B-C, Short Term Minimum	FLOAT	0 to 9999 M	volts		2	
1F3D - 1F3E	7998 - 7999	Volts C-A, Short Term Minimum	FLOAT	0 to 9999 M	volts		2	
						Block Size:	24	
Primary Minimum Block						read-only		
1F3F - 1F40	8000 - 8001	Volts A-N, Minimum	FLOAT	0 to 9999 M	volts		2	
1F41 - 1F42	8002 - 8003	Volts B-N, Minimum	FLOAT	0 to 9999 M	volts		2	
1F43 - 1F44	8004 - 8005	Volts C-N, Minimum	FLOAT	0 to 9999 M	volts		2	
1F45 - 1F46	8006 - 8007	Volts A-B, Minimum	FLOAT	0 to 9999 M	volts		2	
1F47 - 1F48	8008 - 8009	Volts B-C, Minimum	FLOAT	0 to 9999 M	volts		2	
1F49 - 1F4A	8010 - 8011	Volts C-A, Minimum	FLOAT	0 to 9999 M	volts		2	
1F4B - 1F4C	8012 - 8013	Amps A, Minimum Avg Demand	FLOAT	0 to 9999 M	amps		2	
1F4D - 1F4E	8014 - 8015	Amps B, Minimum Avg Demand	FLOAT	0 to 9999 M	amps		2	
1F4F - 1F50	8016 - 8017	Amps C, Minimum Avg Demand	FLOAT	0 to 9999 M	amps		2	
1F51 - 1F52	8018 - 8019	Positive Watts, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	watts		2	
1F53 - 1F54	8020 - 8021	Positive VARs, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	VARs		2	
1F55 - 1F56	8022 - 8023	Negative Watts, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	watts		2	

1F57 - 1F58	8024 - 8025	Negative VARs, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	VARs		2	
1F59 - 1F5A	8026 - 8027	VAs, 3-Ph, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2	
1F5B - 1F5C	8028 - 8029	Positive Power Factor, 3-Ph, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2	
1F5D - 1F5E	8030 - 8031	Negative Power Factor, 3-Ph, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2	
1F5F - 1F60	8032 - 8033	Frequency, Minimum	FLOAT	0 to 65.00	Hz		2	
1F61 - 1F62	8034 - 8035	Neutral Current, Minimum Avg Demand	FLOAT	0 to 9999 M	amps		2	
1F63 - 1F64	8036 - 8037	Positive Watts, Phase A, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2	
1F65 - 1F66	8038 - 8039	Positive Watts, Phase B, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2	
1F67 - 1F68	8040 - 8041	Positive Watts, Phase C, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2	
1F69 - 1F6A	8042 - 8043	Positive VARs, Phase A, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2	
1F6B - 1F6C	8044 - 8045	Positive VARs, Phase B, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2	
1F6D - 1F6E	8046 - 8047	Positive VARs, Phase C, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2	
1F6F - 1F70	8048 - 8049	Negative Watts, Phase A, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2	
1F71 - 1F72	8050 - 8051	Negative Watts, Phase B, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2	
1F73 - 1F74	8052 - 8053	Negative Watts, Phase C, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2	
1F75 - 1F76	8054 - 8055	Negative VARs, Phase A, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2	
1F77 - 1F78	8056 - 8057	Negative VARs, Phase B, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2	
1F79 - 1F7A	8058 - 8059	Negative VARs, Phase C, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2	
1F7B - 1F7C	8060 - 8061	VAs, Phase A, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2	
1F7D - 1F7E	8062 - 8063	VAs, Phase B, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2	
1F7F - 1F80	8064 - 8065	VAs, Phase C, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2	
1F81 - 1F82	8066 - 8067	Positive PF, Phase A, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2	
1F83 - 1F84	8068 - 8069	Positive PF, Phase B, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2	

1F85 - 1F86	8070 - 8071	Positive PF, Phase C, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2	
1F87 - 1F88	8072 - 8073	Negative PF, Phase A, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2	
1F89 - 1F8A	8074 - 8075	Negative PF, Phase B, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2	
1F8B - 1F8C	8076 - 8077	Negative PF, Phase C, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2	
1F8D - 1F8D	8078 - 8078	Volts A-N, %THD, Minimum	UINT16	0 to 9999	0.01%		1	
1F8E - 1F8E	8079 - 8079	Volts B-N, %THD, Minimum	UINT16	0 to 9999	0.01%		1	
1F8F - 1F8F	8080 - 8080	Volts C-N, %THD, Minimum	UINT16	0 to 9999	0.01%		1	
1F90 - 1F90	8081 - 8081	Amps A, %THD, Minimum	UINT16	0 to 9999	0.01%		1	
1F91 - 1F91	8082 - 8082	Amps B, %THD, Minimum	UINT16	0 to 9999	0.01%		1	
1F92 - 1F92	8083 - 8083	Amps C, %THD, Minimum	UINT16	0 to 9999	0.01%		1	
1F93 - 1F94	8084 - 8085	Symmetrical Component Magnitude, 0 Seq, Minimum	FLOAT	0 to 9999 M	volts		2	
1F95 - 1F96	8086 - 8087	Symmetrical Component Magnitude, + Seq, Minimum	FLOAT	0 to 9999 M	volts		2	
1F97 - 1F98	8088 - 8089	Symmetrical Component Magnitude, - Seq, Minimum	FLOAT	0 to 9999 M	volts		2	
1F99 - 1F99	8090 - 8090	Symmetrical Component Phase, 0 Seq, Minimum	SINT16	-1800 to +1800	0.1 degree		1	
1F9A - 1F9A	8091 - 8091	Symmetrical Component Phase, + Seq, Minimum	SINT16	-1800 to +1800	0.1 degree		1	
1F9B - 1F9B	8092 - 8092	Symmetrical Component Phase, - Seq, Minimum	SINT16	-1800 to +1800	0.1 degree		1	
1F9C - 1F9C	8093 - 8093	Unbalance, 0 sequence, Minimum	UINT16	0 to 65535	0.01%		1	
1F9D - 1F9D	8094 - 8094	Unbalance, - sequence, Minimum	UINT16	0 to 65535	0.01%		1	
1F9E - 1F9E	8095 - 8095	Current Unbalance, Minimum	UINT16	0 to 20000	0.01%		1	
						Block Size:	96	
Primary Minimum Timestamp Block						read-only		
20CF - 20D1	8400 - 8402	Volts A-N, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
20D2 - 20D4	8403 - 8405	Volts B-N, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
20D5 - 20D7	8406 - 8408	Volts C-N, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
20D8 - 20DA	8409 - 8411	Volts A-B, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	

20DB - 20DD	8412 - 8414	Volts B-C, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
20DE - 20E0	8415 - 8417	Volts C-A, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
20E1 - 20E3	8418 - 8420	Amps A, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
20E4 - 20E6	8421 - 8423	Amps B, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
20E7 - 20E9	8424 - 8426	Amps C, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
20EA - 20EC	8427 - 8429	Positive Watts, 3-Ph, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
20ED - 20EF	8430 - 8432	Positive VARs, 3-Ph, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
20F0 - 20F2	8433 - 8435	Negative Watts, 3-Ph, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
20F3 - 20F5	8436 - 8438	Negative VARs, 3-Ph, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
20F6 - 20F8	8439 - 8441	VAs, 3-Ph, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
20F9 - 20FB	8442 - 8444	Positive Power Factor, 3-Ph, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
20FC - 20FE	8445 - 8447	Negative Power Factor, 3-Ph, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
20FF - 2101	8448 - 8450	Frequency, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2102 - 2104	8451 - 8453	Neutral Current, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2100	1 sec		3	
2105 - 2107	8454 - 8456	Positive Watts, Phase A, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2108 - 210A	8457 - 8459	Positive Watts, Phase B, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
210B - 210D	8460 - 8462	Positive Watts, Phase C, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
210E - 2110	8463 - 8465	Positive VARs, Phase A, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2111 - 2113	8466 - 8468	Positive VARs, Phase B, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2114 - 2116	8469 - 8471	Positive VARs, Phase C, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2117 - 2119	8472 - 8474	Negative Watts, Phase A, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
211A - 211C	8475 - 8477	Negative Watts, Phase B, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
211D - 211F	8478 - 8480	Negative Watts, Phase C, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2120 - 2122	8481 - 8483	Negative VARs, Phase A, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2123 - 2125	8484 - 8486	Negative VARs, Phase B, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	

2126 - 2128	8487 - 8489	Negative VARs, Phase C, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2129 - 212B	8490 - 8492	VAs, Phase A, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
212C - 212E	8493 - 8495	VAs, Phase B, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
212F - 2131	8496 - 8498	VAs, Phase C, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2132 - 2134	8499 - 8501	Positive PF, Phase A, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2135 - 2137	8502 - 8504	Positive PF, Phase B, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2138 - 213A	8505 - 8507	Positive PF, Phase C, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
213B - 213D	8508 - 8510	Negative PF, Phase A, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
213E - 2140	8511 - 8513	Negative PF, Phase B, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2141 - 2143	8514 - 8516	Negative PF, Phase C, Min Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2144 - 2146	8517 - 8519	Volts A-N, %THD, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2147 - 2149	8520 - 8522	Volts B-N, %THD, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
214A - 214C	8523 - 8525	Volts C-N, %THD, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
214D - 214F	8526 - 8528	Amps A, %THD, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2150 - 2152	8529 - 8531	Amps B, %THD, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2153 - 2155	8532 - 8534	Amps C, %THD, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2156 - 2158	8535 - 8537	Symmetrical Comp Magnitude, 0 Seq, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2159 - 215B	8538 - 8540	Symmetrical Comp Magnitude, + Seq, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
215C - 215E	8541 - 8543	Symmetrical Comp Magnitude, - Seq, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
215F - 2161	8544 - 8546	Symmetrical Comp Phase, 0 Seq, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2162 - 2164	8547 - 8549	Symmetrical Comp Phase, + Seq, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2165 - 2167	8550 - 8552	Symmetrical Comp Phase, - Seq, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2168 - 2170	8553 - 8555	Unbalance, 0 Seq, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2171 - 2173	8556 - 8558	Unbalance, - Seq, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	

2174 - 2176	8559 - 8561	Current Unbalance, Min Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
						Block Size:	162	
Short term Primary Maximum Block						read-only		
230F - 2310	8976 - 8977	Volts A-N, previous Demand interval Short Term Maximum	FLOAT	0 to 9999 M	volts	Maximum instantaneous value measured during the demand interval before the one most recently completed.		
2311 - 2312	8978 - 8979	Volts B-N, previous Demand interval Short Term Maximum	FLOAT	0 to 9999 M	volts			
2313 - 2314	8980 - 8981	Volts C-N, previous Demand interval Short Term Maximum	FLOAT	0 to 9999 M	volts			
2315 - 2316	8982 - 8983	Volts A-B, previous Demand interval Short Term Maximum	FLOAT	0 to 9999 M	volts			
2317 - 2318	8984 - 8985	Volts B-C, previous Demand interval Short Term Maximum	FLOAT	0 to 9999 M	volts			
2319 - 231A	8986 - 8987	Volts C-A, previous Demand interval Short Term Maximum	FLOAT	0 to 9999 M	volts			
231B - 231C	8988 - 8989	Volts A-N, Maximum	FLOAT	0 to 9999 M	volts	Maximum instantaneous value measured during the most recently completed demand interval.	2	
231D - 231E	8990 - 8991	Volts B-N, Maximum	FLOAT	0 to 9999 M	volts		2	
232F - 2320	8992 - 8993	Volts C-N, Maximum	FLOAT	0 to 9999 M	volts		2	
2321 - 2322	8994 - 8995	Volts A-B, Maximum	FLOAT	0 to 9999 M	volts		2	
2323 - 2324	8996 - 8997	Volts B-C, Maximum	FLOAT	0 to 9999 M	volts		2	
2325 - 2326	8998 - 8999	Volts C-A, Maximum	FLOAT	0 to 9999 M	volts		2	
						Block Size:	12	
Primary Maximum Block						read-only		
2327 - 2328	9000 - 9001	Volts A-N, Maximum	FLOAT	0 to 9999 M	volts		2	
2329 - 232A	9002 - 9003	Volts B-N, Maximum	FLOAT	0 to 9999 M	volts		2	
232B - 232C	9004 - 9005	Volts C-N, Maximum	FLOAT	0 to 9999 M	volts		2	
232D - 232E	9006 - 9007	Volts A-B, Maximum	FLOAT	0 to 9999 M	volts		2	
232F - 2330	9008 - 9009	Volts B-C, Maximum	FLOAT	0 to 9999 M	volts		2	
2331 - 2332	9010 - 9011	Volts C-A, Maximum	FLOAT	0 to 9999 M	volts		2	
2333 - 2334	9012 - 9013	Amps A, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2	
2335 - 2336	9014 - 9015	Amps B, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2	

2337 - 2338	9016 - 9017	Amps C, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2	
2339 - 233A	9018 - 9019	Positive Watts, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	watts		2	
233B - 233C	9020 - 9021	Positive VARs, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	VARs		2	
233D - 233E	9022 - 9023	Negative Watts, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	watts		2	
233F - 2340	9024 - 9025	Negative VARs, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	VARs		2	
2341 - 2342	9026 - 9027	VAs, 3-Ph, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2	
2343 - 2344	9028 - 9029	Positive Power Factor, 3-Ph, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2	
2345 - 2346	9030 - 9031	Negative Power Factor, 3-Ph, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2	
2347 - 2348	9032 - 9033	Frequency, Maximum	FLOAT	0 to 65.00	Hz		2	
2349 - 234A	9034 - 9035	Neutral Current, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2	
234B - 234C	9036 - 9037	Positive Watts, Phase A, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2	
234D - 234E	9038 - 9039	Positive Watts, Phase B, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2	
234F - 2350	9040 - 9041	Positive Watts, Phase C, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2	
2351 - 2352	9042 - 9043	Positive VARs, Phase A, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2	
2353 - 2354	9044 - 9045	Positive VARs, Phase B, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2	
2355 - 2356	9046 - 9047	Positive VARs, Phase C, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2	
2357 - 2358	9048 - 9049	Negative Watts, Phase A, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2	
2359 - 235A	9050 - 9051	Negative Watts, Phase B, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2	
235B - 235C	9052 - 9053	Negative Watts, Phase C, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	watts		2	
235D - 235E	9054 - 9055	Negative VARs, Phase A, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2	

235F	-	2360	9056	-	9057	Negative VARs, Phase B, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2	
2361	-	2362	9058	-	9059	Negative VARs, Phase C, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VARs		2	
2363	-	2364	9060	-	9061	VAs, Phase A, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2	
2365	-	2366	9062	-	9063	VAs, Phase B, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2	
2367	-	2368	9064	-	9065	VAs, Phase C, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2	
2369	-	236A	9066	-	9067	Positive PF, Phase A, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2	
236B	-	236C	9068	-	9069	Positive PF, Phase B, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2	
236D	-	236E	9070	-	9071	Positive PF, Phase C, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2	
236F	-	2370	9072	-	9073	Negative PF, Phase A, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2	
2371	-	2372	9074	-	9075	Negative PF, Phase B, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2	
2373	-	2374	9076	-	9077	Negative PF, Phase C, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2	
2375	-	2375	9078	-	9078	Volts A-N, %THD, Maximum	UINT16	0 to 9999	0.01%		1	
2376	-	2376	9079	-	9079	Volts B-N, %THD, Maximum	UINT16	0 to 9999	0.01%		1	
2377	-	2377	9080	-	9080	Volts C-N, %THD, Maximum	UINT16	0 to 9999	0.01%		1	
2378	-	2378	9081	-	9081	Amps A, %THD, Maximum	UINT16	0 to 9999	0.01%		1	
2379	-	2379	9082	-	9082	Amps B, %THD, Maximum	UINT16	0 to 9999	0.01%		1	
237A	-	237A	9083	-	9083	Amps C, %THD, Maximum	UINT16	0 to 9999	0.01%		1	
237B	-	237C	9084	-	9085	Symmetrical Component Magnitude, 0 Seq, Maximum	FLOAT	0 to 9999 M	volts		2	
237D	-	237E	9086	-	9087	Symmetrical Component Magnitude, + Seq, Maximum	FLOAT	0 to 9999 M	volts		2	
237F	-	2380	9088	-	9089	Symmetrical Component Magnitude, - Seq, Maximum	FLOAT	0 to 9999 M	volts		2	
2381	-	2381	9090	-	9090	Symmetrical Component Phase, 0 Seq, Maximum	SINT16	-1800 to +1800	0.1 degree		1	
2382	-	2382	9091	-	9091	Symmetrical Component Phase, + Seq, Maximum	SINT16	-1800 to +1800	0.1 degree		1	

2383 - 2383	9092 - 9092	Symmetrical Component Phase, - Seq, Maximum	SINT16	-1800 to +1800	0.1 degree		1	
2384 - 2384	9093 - 9093	Unbalance, 0 Seq, Maximum	UINT16	0 to 65535	0.01%		1	
2385 - 2385	9094 - 9094	Unbalance, - Seq, Maximum	UINT16	0 to 65535	0.01%		1	
2386 - 2386	9095 - 9095	Current Unbalance, Maximum	UINT16	0 to 20000	0.01%		1	
						Block Size:	96	
Primary Maximum Timestamp Block						read-only		
24B7 - 24B9	9400 - 9402	Volts A-N, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24BA - 24BC	9403 - 9405	Volts B-N, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24BD - 24BF	9406 - 9408	Volts C-N, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24C0 - 24C2	9409 - 9411	Volts A-B, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24C3 - 24C5	9412 - 9414	Volts B-C, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24C6 - 24C8	9415 - 9417	Volts C-A, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24C9 - 24CB	9418 - 9420	Amps A, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24CC - 24CE	9421 - 9423	Amps B, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24CF - 24D1	9424 - 9426	Amps C, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24D2 - 24D4	9427 - 9429	Positive Watts, 3-Ph, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24D5 - 24D7	9430 - 9432	Positive VARs, 3-Ph, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24D8 - 24DA	9433 - 9435	Negative Watts, 3-Ph, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24DB - 24DD	9436 - 9438	Negative VARs, 3-Ph, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24DE - 24E0	9439 - 9441	VAs, 3-Ph, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24E1 - 24E3	9442 - 9444	Positive Power Factor, 3-Ph, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24E4 - 24E6	9445 - 9447	Negative Power Factor, 3-Ph, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24E7 - 24E9	9448 - 9450	Frequency, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24EA - 24EC	9451 - 9453	Neutral Current, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2100	1 sec		3	
24ED - 24EF	9454 - 9456	Positive Watts, Phase A, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24F0 - 24F2	9457 - 9459	Positive Watts, Phase B, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24F3 - 24F5	9460 - 9462	Positive Watts, Phase C, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	

24F6 - 24F8	9463 - 9465	Positive VARs, Phase A, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24F9 - 24FB	9466 - 9468	Positive VARs, Phase B, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24FC - 24FE	9469 - 9471	Positive VARs, Phase C, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
24FF - 2501	9472 - 9474	Negative Watts, Phase A, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2502 - 2504	9475 - 9477	Negative Watts, Phase B, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2505 - 2507	9478 - 9480	Negative Watts, Phase C, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2508 - 250A	9481 - 9483	Negative VARs, Phase A, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
250B - 250D	9484 - 9486	Negative VARs, Phase B, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
250E - 2510	9487 - 9489	Negative VARs, Phase C, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2511 - 2513	9490 - 9492	VAs, Phase A, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2514 - 2516	9493 - 9495	VAs, Phase B, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2517 - 2519	9496 - 9498	VAs, Phase C, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
251A - 251C	9499 - 9501	Positive PF, Phase A, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
251D - 251F	9502 - 9504	Positive PF, Phase B, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2520 - 2522	9505 - 9507	Positive PF, Phase C, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2523 - 2525	9508 - 9510	Negative PF, Phase A, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2526 - 2528	9511 - 9513	Negative PF, Phase B, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2529 - 252B	9514 - 9516	Negative PF, Phase C, Max Avg Dmd Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
252C - 252E	9517 - 9519	Volts A-N, %THD, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
252F - 2531	9520 - 9522	Volts B-N, %THD, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2532 - 2534	9523 - 9525	Volts C-N, %THD, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2535 - 2537	9526 - 9528	Amps A, %THD, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2538 - 253A	9529 - 9531	Amps B, %THD, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
253B - 253D	9532 - 9534	Amps C, %THD, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
253E - 2540	9535 - 9537	Symmetrical Comp Magnitude, 0 Seq, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	

2541 - 2543	9538 - 9540	Symmetrical Comp Magnitude, + Seq, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2544 - 2546	9541 - 9543	Symmetrical Comp Magnitude, - Seq, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2547 - 2549	9544 - 9546	Symmetrical Comp Phase, 0 Seq, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
254A - 254C	9547 - 9549	Symmetrical Comp Phase, + Seq, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
254D - 254F	9550 - 9552	Symmetrical Comp Phase, - Seq, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2550 - 2552	9553 - 9555	Unbalance, 0 Seq, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2553 - 2555	9556 - 9558	Unbalance, - Seq, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
2556 - 2558	9559 - 9561	Current Unbalance, Max Timestamp	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
						Block Size:	159	
OPTION CARD 1 SECTION								
Card Identification and Configuration Block (Note 14)						read-only		
270F - 270F	10000 - 10000	Class ID and card status	UINT16	bit-mapped	undv-----cccctttt	Flags active if bit is set: u=unsupported card; n=card need configuration; d=card is using default configuration; v=communication with card is ok Field: cccc=class of installed card. Field tttt=type of card. See note 22	1	
2710 - 2710	10001 - 10001	Reserved				Reserved	1	
2711 - 2718	10002 - 10009	Card name	ASCII	16 char	none	ASCII name of the installed card	8	
2719 - 2720	10010 - 10017	Serial number	ASCII	16 char	none	Serial Number in ASCII of the installed card	8	
2721 - 2722	10018 - 10019	Version	ASCII	4 char	none	Version in ASCII of the hardware of the installed card.	2	
2723 - 2746	10020 - 10055	Reserved				Reserved	36	

2747 - 274A	10056 - 10059	Firmware Version	ASCII	4 char	none	Firmware versions for option cards. Each version is a 4 character string, left justified and padded with spaces. Interpretation depends on the specific card in the slot: Analog uses the second 2 registers for its version. The first 2 registers are zero. Network uses the first 2 registers for its RUN version, the second 2 for its BOOT version. No other cards report versions; both registers are zero.	2	
274B - 274E	10060 - 10063	Reserved				Reserved	4	
						Block Size:	64	
Current Communication Settings for Option Card 1						Read-only		
274F - 274F	10064 - 10064	Current speed and format	UINT16	bit-mapped	-abcde-- fghijklm	Bps: a=57600; b=38400; c=19200; d=14400; e=9600 Stop bits 'f': cleared 1 stop bit, set 2 stop bits Parity: g=even; h=odd; i=none Data bits: j=8; k=7; l=6; m=5	1	
2750 - 2750	10065 - 10065	Reserved	UINT16	bit-mapped		Reserved	1	
2751 - 2751	10066 - 10066	Current protocol	UINT16	bit-mapped	-------- -----ppp-	ppp=protocol 100=DNP3; 010=Ascii Modbus; 001=Rtu Modbus	1	
2752 - 2752	10067 - 10067	Current reply delay	UINT16	0 to 65535	milliseconds	Delay to reply to a Modbus transaction after receiving it.	1	
2753 - 2756	10068 - 10071	Reserved				Reserved	4	
						Block Size:	8	
Data and Control Blocks for Option Card 1						read-only		
2757 - 2790	10072 - 10129	Data and Control Block for Option Card 1. Meaning of registers depends on installed card. -- see below				Register assignments depend on which type of card is in the slot. See overlays below.	58	
						Block Size:	66	
EXPANSIONS FOR DATA AND CONTROL BLOCK FOR OPTION CARD 1								
Data and Control Block -- Digital I/O Relay Card Overlay (Note 15)						read-only except as indicated		
2757 - 2757	10072 - 10072	Digital Input States	UINT16	bit-mapped	-------- 22221111	Two nibble fields: (2222) for input#2 and (1111) for input #1. Lsb in each nibble is the current state of the input. Msb in each nibble is the oldest registered state.	1	

2758 - 2758	10073 - 10073	Digital Relay States	UINT16	bit-mapped	-------- --ab--cd	If "a" is 1 then state of Relay#2 is unknown, otherwise state of Relay#2 is in "c": (1=tripped, 0=released). If "b" is 1 then state of Relay#1 is unknown, otherwise state of Relay#1 is in "d": (1=tripped, 0=released).	1	
2759 - 2759	10074 - 10074	Turn relay on	UINT16	bit-mapped	-------- ------21	Writing a 1 in bit N turns relay N+1 ON (this register is writeable only in privileged session)	1	
275A - 275A	10075 - 10075	Turn relay off	UINT16	bit-mapped	-------- ------21	Writing a 1 in bit N turns relay N+1 OFF (this register is writeable only in privileged session)	1	
275B - 275B	10076 - 10076	Trip/Release delay timer for Relay 1	UINT16	0 to 9999	0.1 sec	time to trip or release	1	
275C - 275C	10077 - 10077	Trip/Release delay timer for Relay 2	UINT16	0 to 9999	0.1 sec	time to trip or release	1	
275D - 275E	10078 - 10079	Reserved				Reserved	2	
275F - 275F	10080 - 10080	Input 1 Accumulator, Scaled	UINT16	0 to 9999	resolution is 1, 10, 100, 1000, 10000, or 100000 counts	Disabled accumulators always read 0.	1	
2760 - 2760	10081 - 10081	Input 2 Accumulator, Scaled	UINT16	0 to 9999			1	
2761 - 2762	10082 - 10083	Reserved				Reserved	2	
2763 - 2763	10084 - 10084	Relay 1 Accumulator, Scaled	UINT16	0 to 9999	resolution is 1, 10, 100, 1000, 10000, or 100000 counts	Disabled accumulators always read 0.	1	
2764 - 2764	10085 - 10085	Relay 2 Accumulator, Scaled	UINT16	0 to 9999			1	
2765 - 2790	10086 - 10129	Reserved				Reserved	44	
						Block Size:	58	
Data and Control Block -- Digital I/O Pulse Output Card Overlay (Note 15)						read-only except as indicated		
2757 - 2757	10072 - 10072	Digital Input States	UINT16	bit-mapped	dddd cccc bbbb aaaa	Nibble "dddd" for input#4, "cccc" for input#3, "bbbb" for input#2 and "aaaa" for input#1. Within each field, rightmost bit is the current state (1=closed, 0=open), and bits at left are the older states 100ms apart. (historical states) Example: xxxx xxxx xxxx 0011 Current state of input#1 is closed, before that it was closed too, before that it was open and the oldest state known is open.	1	
2758 - 2758	10073 - 10073	Digital Output States	UINT16	bit-mapped	-------- ----4321	One bit for each output. Bit 4 is for output #4, and bit 1 is for output #1. If a bit is set the output is closed, otherwise it is opened.	1	

2759 - 2759	10074 - 10074	Pulse Output Test Select	UINT16	bit-mapped	-------- ----4321	Write 1 to a bit to set its corresponding Pulse Output into test mode. Write 0 to restore it to normal operation. A privileged session is required to write the bits. Reading this register reports the mode for each output (1=under test, 0=normal).	1	
275A - 275A	10075 - 10075	Pulse Output Test Power	UINT16	bit-mapped	ddvvvvvv vvvvvvvv	This register is Writeable in privileged session only. Simulates constant Power for the Pulse Output under test. Format is same as Kt settings for Pulse Output. "V" is raw value in Wh/pulse from 0 to 9999. "dd"=decimal point position: 00=0.XXXX, 01=X.XXX, 10=XX.XX, 11= XXX.X	1	
275B - 275E	10076 - 10079	Reserved				Reserved	4	
275F - 275F	10080 - 10080	Input 1 Accumulator, Scaled	UINT16	0 to 9999	resolution is 1, 10, 100, 1000, 10000, or 100000 counts	Disabled accumulators always read 0.	1	
2760 - 2760	10081 - 10081	Input 2 Accumulator, Scaled	UINT16	0 to 9999			1	
2761 - 2761	10082 - 10082	Input 3 Accumulator, Scaled	UINT16	0 to 9999			1	
2762 - 2762	10083 - 10083	Input 4 Accumulator, Scaled	UINT16	0 to 9999			1	
2763 - 2763	10084 - 10084	Output 1 Accumulator, Scaled	UINT16	0 to 9999			1	
2764 - 2764	10085 - 10085	Output 2 Accumulator, Scaled	UINT16	0 to 9999			1	
2765 - 2765	10086 - 10086	Output 3 Accumulator, Scaled	UINT16	0 to 9999			1	
2766 - 2766	10087 - 10087	Output 4 Accumulator, Scaled	UINT16	0 to 9999			1	
2767 - 2790	10088 - 10129	Reserved				Reserved	42	
						Block Size:	58	
Data and Control Block--Analog Out 0-1mA / Analog Out 4-20mA (Note 15)						read-only		
2757 - 2757	10072 - 10072	Status of card	UINT16	bit-mapped	----cf-- --------	Flag fields: c=calibration not good; f=configuration error	1	
2758 - 2790	10073 - 10129	Reserved				Reserved	57	
						Block Size:	58	
Data and Control Block -- Network Card Overlay (Note 15)						read-only		

2757 - 2757	10072 - 10072	Card and Network Status	UINT16	bit-mapped	rhp----- sfw-m-ii	Flags: r=run mode; h=card is healthy; p=using last good known programmable settings Server flags: s=smtp ok; f=ftp ok; w=web server ok; m=modbus tcp/ip ok. IP Status ii: 00=IP not valid yet, 01=IP from p.settings; 10=IP from DHCP;11=using last good known IP.	1	
2758 - 2758	10073 - 10073	Reserved				Reserved	1	
2759 - 275B	10074 - 10076	MAC address in use by the network card	UINT16	bit-mapped	6 bytes	These 3 registers hold the 6 bytes of the card's ethernet MAC address	3	
275C - 275F	10077 - 10080	Current IP Address	UINT16			These 4 registers hold the 4 numbers (1 number each register) that make the IP address used by the card.	4	
2760 - 2760	10081 - 10081	Current IP Mask Length	UINT16	0 to 32		Number of bits that are set in the IP address mask, starting from the Msb of the 32 bit word. Example 24 = 255.255.255.0; a value of 2 would mean 192.0.0.0	1	
2761 - 2762	10082 - 10083	Firmware Version	ASCII	4 char	none	Version of the BOOT firmware of the card, left justified and padded with spaces. Blank for boards without embedded firmware.	2	
2763 - 2764	10084 - 10085	Firmware Version	ASCII	4 char	none	Version of the RUN firmware of the card, left justified and padded with spaces. Blank for boards without embedded firmware.	2	
2765 - 2790	10086 - 10129	Reserved				Reserved for Extended Nw Status	44	
2791 - 27F2	10130 - 10227	Reserved	UINT16			Reserved for email Notification	98	
						Block Size:	156	
				OPTION CARD 2 SECTION				
Card Identification and Configuration Block (Note 14)						read-only		
2AF7 - 2AF7	11000 - 11000	Class ID and card status	UINT16	bit-mapped	undv-----cccctttt	Flags active if bit is set: u=unsupported card; n=card need configuration; d=card is using default configuration; v=communication with card is ok Field: cccc=class of installed card. Field tttt=type of card. See note 22	1	
2AF8 - 2AF8	11001 - 11001	Reserved				Read only	1	
2AF9 - 2B00	11002 - 11009	Card name	ASCII	16 char	none	ASCII name of the installed card	8	
2B01 - 2B08	11010 - 11017	Serial number	ASCII	16 char	none	Serial Number in ASCII of the installed card	8	
2B09 - 2B0A	11018 - 11019	Version	ASCII	4 char	none	Version in ASCII of the hardware of the installed card.	2	

2B0B - 2B28	11020 - 11055	Reserved				Reserved	36	
2B2F - 2B32	11056 - 11059	Firmware Versions	ASCII	4 char	none	Firmware versions for option cards. Each version is a 4 character string, left justified and padded with spaces. Interpretation depends on the specific card in the slot: Analog uses the second 2 registers for its version. The first 2 registers are zero. Network uses the first 2 registers for its RUN version, the second 2 for its BOOT version. No other cards report versions; both registers are zero.	2	
2B33 - 2B36	11060 - 11063	Reserved				Reserved	4	
						Block Size:	64	
Current Communication Settings for Option Card 2						Read-only		
2B37 - 2B37	11064 - 11064	Current speed and format	UINT16	bit-mapped	-abcde-- fghijklm	Bps: a=57600; b=38400; c=19200; d=14400; e=9600 Stop bits 'f': cleared 1 stop bit, set 2 stop bits Parity: g=even; h=odd; i=none Data bits: j=8; k=7; l=6; m=5	1	
2B38 - 2B38	11065 - 11065	Reserved	UINT16	bit-mapped		Reserved	1	
2B39 - 2B39	11066 - 11066	Current protocol	UINT16	bit-mapped	-------- -----ppp-	ppp=protocol 100=DNP3; 010=Ascii Modbus; 001=Rtu Modbus	1	
2B3A - 2B3A	11067 - 11067	Current reply delay	UINT16	0 to 65535	milliseconds	Delay to reply a Modbus transaction after receiving it.	1	
2B3B - 2B3E	11068 - 11071	Reserved				Reserved	4	
						Block Size:	8	
Data and Control Blocks for Option Card 2						read-only		
2B3F - 2B78	11072 - 11129	Data and Control Block for Option Card 2 Meaning of registers depend on installed card. -- see below				Register assignments depend on which type of card is in the slot. See overlays below.	58	
						Block Size:	66	
EXPANSIONS FOR DATA AND CONTROL BLOCK FOR OPTION CARD 2								
Data and Control Block -- Digital I/O Relay Card Overlay (Note 15)						read-only except as indicated		
2B3F - 2B3F	11072 - 11072	Digital Input States	UINT16	bit-mapped	-------- 22221111	Two nibble fields: (2222) for input#2 and (1111) for input #1. Lsb in each nibble is the current state of the input. Msb in each nibble is the oldest registered state.	1	

2B40 - 2B40	11073 - 11073	Digital Relay States	UINT16	bit-mapped	-------- --ab--cd	If "a" is 1 then state of Relay#2 is unknown, otherwise state of Relay#2 is in "c": (1=tripped, 0=released). If "b" is 1 then state of Relay#1 is unknown, otherwise state of Relay#1 is in "d": (1=tripped, 0=released).	1	
2B41 - 2B41	11074 - 11074	Turn relay on	UINT16	bit-mapped	-------- ------21	Writing a 1 in bit N turns relay N+1 ON (this register is writeable only in privileged session)	1	
2B42 - 2B42	11075 - 11075	Turn relay off	UINT16	bit-mapped	-------- ------21	Writing a 1 in bit N turns relay N+1 OFF (this register is writeable only in privileged session)	1	
2B43 - 2B43	11076 - 11076	Trip/Release delay timer for Relay 1	UINT16	0 to 9999	0.1 sec	time to trip or release	1	
2B44 - 2B44	11077 - 11077	Trip/Release delay timer for Relay 2	UINT16	0 to 9999	0.1 sec	time to trip or release	1	
2B45 - 2B46	11078 - 11079	Reserved				Reserved	2	
2B47 - 2B47	11080 - 11080	Input 1 Accumulator, Scaled	UINT16	0 to 9999	resolution is 1, 10, 100, 1000, 10000, or 100000 counts	Disabled accumulators always read 0.	1	
2B48 - 2B48	11081 - 11081	Input 2 Accumulator, Scaled	UINT16	0 to 9999			1	
2B49 - 2B4A	11082 - 11083	Reserved				Reserved	2	
2B4B - 2B4B	11084 - 11084	Relay 1 Accumulator, Scaled	UINT16	0 to 9999	resolution is 1, 10, 100, 1000, 10000, or 100000 counts	Disabled accumulators always read 0.	1	
2B4C - 2B4C	11085 - 11085	Relay 2 Accumulator, Scaled	UINT16	0 to 9999			1	
2B4D - 2B78	11086 - 11129	Reserved				Reserved	44	
						Block Size:	58	
Data and Control Block -- Digital I/O Pulse Output Card Overlay (Note 15)						read-only except as indicated		
2B3F - 2B3F	11072 - 11072	Digital Input States	UINT16	bit-mapped	dddd cccc bbbb aaaa	Nibble "dddd" for input#4, "cccc" for input#3, "bbbb" for input#2 and "aaaa" for input#1. Within each field, right most bit is the current state (1=closed, 0=open), and bits at left are the older states 100ms apart. (historical states) Example: xxxx xxxx xxxx 0011 Current state of input#1 is closed, before that it was closed too, before that it was open and the oldest state known is open.	1	
2B40 - 2B40	11073 - 11073	Digital Output States	UINT16	bit-mapped	-------- ----4321	One bit for each output. Bit 4 is for output #4, and bit 1 is for output #1. If a bit is set the output is closed, otherwise it is opened.	1	

2B41 - 2B41	11074 - 11074	Pulse Output Test Select	UINT16	bit-mapped	-------- ----4321	Write 1 to a bit to set its corresponding Pulse Output into test mode. Write 0 to restore it to normal operation. A privileged session is required to write the bits. Reading this register reports the mode for each output (1=under test, 0=normal).	1	
2B42 - 2B42	11075 - 11075	Pulse Output Test Power	UINT16	bit-mapped	ddvvvvvv vvvvvvvv	This register is Writeable in privileged session only. Simulates constant Power for the Pulse Output under test. Format is same as Kt settings for Pulse Output. "V" is raw value in Wh/pulse from 0 to 9999. "dd"=decimal point position: 00=0.XXXX, 01=X.XXX, 10=XX.XX, 11= XXX.X	1	
2B43 - 2B46	11076 - 11079	Reserved				Reserved	4	
2B47 - 2B47	11080 - 11080	Input 1 Accumulator, Scaled	UINT16	0 to 9999	resolution is 1, 10, 100, 1000, 10000, or 100000 counts	Disabled accumulators always read 0.	1	
2B48 - 2B48	11081 - 11081	Input 2 Accumulator, Scaled	UINT16	0 to 9999			1	
2B49 - 2B49	11082 - 11082	Input 3 Accumulator, Scaled	UINT16	0 to 9999			1	
2B4A - 2B4A	11083 - 11083	Input 4 Accumulator, Scaled	UINT16	0 to 9999			1	
2B4B - 2B4B	11084 - 11084	Output 1 Accumulator, Scaled	UINT16	0 to 9999			1	
2B4C - 2B4C	11085 - 11085	Output 2 Accumulator, Scaled	UINT16	0 to 9999			1	
2B4D - 2B4D	11086 - 11086	Output 3 Accumulator, Scaled	UINT16	0 to 9999			1	
2B4E - 2B4E	11087 - 11087	Output 4 Accumulator, Scaled	UINT16	0 to 9999			1	
2B4F - 2B78	11088 - 11129	Reserved				Reserved	42	
						Block Size:	58	
Data and Control Block--Analog Out 0-1mA / Analog Out 4-20mA (Note 15)						read-only		
2B3F - 2B3F	11072 - 11072	Status of card	UINT16	bit-mapped	----cf-- --------	Flag fields: c=calibration not good; f=configuration error	1	
2B40 - 2B78	11073 - 11129	Reserved	UINT16			Reserved	57	
						Block Size:	58	
Data and Control Block -- Network Card Overlay (Note 15)						read-only		

2B3F - 2B3F	11072 - 11072	Card and Network Status	UINT16	bit-mapped	rhp----- sfw-m-ii	Flags: r=run mode; h=card is healthy; p=using last good known programmable settings Server flags: s=smtp ok; f=ftp ok; w=web server ok; m=modbus tcp/ip ok. IP Status ii: 00=IP not valid yet, 01=IP from p.settings; 10=IP from DHCP;11=using last good known IP.	1	
2B40 - 2B40	11073 - 11073	Reserved				Reserved	1	
2B41 - 2B43	11074 - 11076	MAC address in use by the network card	UINT16	bit-mapped	6 bytes	These 3 registers hold the 6 bytes of the card's Ethernet MAC address.	3	
2B44 - 2B47	11077 - 11080	Current IP Address	UINT16			These 4 registers hold the 4 numbers (1 number each register) that make the IP address used by the card.	4	
2B48 - 2B48	11081 - 11081	Current IP Mask Length	UINT16	0 to 32		Number of bits that are set in the IP address mask, starting from the Msb of the 32 bit word. Example 24 = 255.255.255.0; a value of 2 would mean 192.0.0.0	1	
2B49 - 2B4A	11082 - 11083	Firmware Version	ASCII	4 char	none	Version of the BOOT firmware of the card, left justified and padded with spaces. Blank for boards without embedded firmware.	2	
2B4B - 2B4C	11084 - 11085	Firmware Version	ASCII	4 char	none	Version of the RUN firmware of the card, left justified and padded with spaces. Blank for boards without embedded firmware.	2	
2B4D - 2B78	11086 - 11129	Reserved				Reserved for Extended Nw Status	44	
2B79 - 2BDA	11130 - 11227	Reserved	UINT16			Reserved for email Notification	98	
						Block Size:	156	
Accumulators Block						read-only		
2EDF - 2EE0	12000 - 12001	Option Card 1, Input 1 Accumulator	UINT32	0 to 999999999	number of transitions	These are unscaled counts. See option card section for scaled versions. Input accumulators count either or both transitions; output accumulators count both transitions. Unused accumulators always read 0.	2	
2EE1 - 2EE6	12002 - 12007	Option Card 1, Inputs 2-4 Accumulators	UINT32	0 to 999999999	number of transitions		6	
2EE7 - 2EE8	12008 - 12009	Option Card 1, Output or Relay 1 Accumulator	UINT32	0 to 999999999	number of transitions		2	
2EE9 - 2EEE	12010 - 12015	Option Card 1, Output or Relays 2-4 Accumulators	UINT32	0 to 999999999	number of transitions		6	
2EEF - 2EF6	12016 - 12023	Option Card 2 Inputs Accumulators	UINT32	0 to 999999999	number of transitions		8	
2EF7 - 2EFE	12024 - 12031	Option Card 2 Outputs Accumulators	UINT32	0 to 999999999	number of transitions		8	
						Block Size:	32	

COMMANDS SECTION (NOTE 4)								
Resets Block (Note 9)						write-only		
4E1F - 4E1F	20000 - 20000	Reset Max/Min Blocks	UINT16	password (Note 5)			1	
4E20 - 4E20	20001 - 20001	Reset Energy Accumulators	UINT16	password (Note 5)			1	
4E21 - 4E21	20002 - 20002	Reset Alarm Log (Note 21)	UINT16	password (Note 5)		Reply to a reset log command indicates that the command was accepted but not necessarily that the reset is finished. Poll log status block to determine this.	1	
4E22 - 4E22	20003 - 20003	Reset System Log (Note 21)	UINT16	password (Note 5)			1	
4E23 - 4E23	20004 - 20004	Reset Historical Log 1 (Note 21)	UINT16	password (Note 5)			1	
4E24 - 4E24	20005 - 20005	Reset Historical Log 2 (Note 21)	UINT16	password (Note 5)			1	
4E25 - 4E25	20006 - 20006	Reset Historical Log 3 (Note 21)	UINT16	password (Note 5)			1	
4E26 - 4E26	20007 - 20007	Reset I/O Change Log (Note 21)	UINT16	password (Note 5)			1	
4E27 - 4E27	20008 - 20008	Reset Power Quality Log	UINT16	password (Note 5)			1	
4E28 - 4E28	20009 - 20009	Reset Waveform Capture Log	UINT16	password (Note 5)			1	
4E29 - 4E2A	20010 - 20011	Reserved				Reserved	2	
4E2B - 4E2B	20012 - 20012	Reset Option Card 1 Input Accumulators	UINT16	password (Note 5)			1	
4E2C - 4E2C	20013 - 20013	Reset Option Card 1 Output Accumulators	UINT16	password (Note 5)			1	
4E2D - 4E2D	20014 - 20014	Reset Option Card 2 Input Accumulators	UINT16	password (Note 5)			1	
4E2E - 4E2E	20015 - 20015	Reset Option Card 2 Output Accumulators	UINT16	password (Note 5)			1	
						Block Size:	16	
Privileged Commands Block						conditional write		
5207 - 5207	21000 - 21000	Initiate Meter Firmware Reprogramming	UINT16	password (Note 5)			1	
5208 - 5208	21001 - 21001	Force Meter Restart	UINT16	password (Note 5)		causes a watchdog reset, always reads 0	1	
5209 - 5209	21002 - 21002	Open Privileged Command Session	UINT16	password (Note 5)		meter will process command registers (this register through 'Close Privileged Command Session' register below) for 5 minutes or until the session is closed, whichever comes first.	1	
520A - 520A	21003 - 21003	Initiate Programmable Settings Update	UINT16	password (Note 5)		meter enters PS update mode	1	
520B - 520B	21004 - 21004	Calculate Programmable Settings Checksum (Note 3)	UINT16	0000 to 9999		meter calculates checksum on RAM copy of PS block	1	
520C - 520C	21005 - 21005	Programmable Settings Checksum (Note 3)	UINT16	0000 to 9999		read/write checksum register; PS block saved in nonvolatile memory on write (Note 8)	1	
520D - 520D	21006 - 21006	Write New Password (Note 3)	UINT16	0000 to 9999		write-only register; always reads zero	1	

520E - 520E	21007 - 21007	Terminate Programmable Settings Update (Note 3)	UINT16	any value		meter leaves PS update mode via reset	1	
520F - 5211	21008 - 21010	Set Meter Clock	TSTAMP	1Jan2000 - 31Dec2099	1 sec	saved only when 3rd register is written	3	
5212 - 5212	21011 - 21011	Manually Trigger Waveform Capture	UINT16	any value		applies to EPM 7000 300 only; returns busy exception if blocked by another capture in progress	1	
5213 - 5219	21012 - 21018	Reserved				Reserved	7	
521A - 521A	21019 - 21019	Close Privileged Command Session	UINT16	any value		ends an open command session	1	
						Block Size:	20	
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								
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	
7533 - 7533	30004 - 30004	PT multiplier & hookup	UINT16	bit-mapped	mmmmmmmm mmmmhhhh	mm...mm = PT multiplier (1, 10, 100, or 1000) hhhh = 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	ppppiinn feee-ddd	pppp = power scale (0-unit, 3-kilo, 6-mega, 8-auto) ii = power digits after decimal point (0-3), applies only if f=1 and pppp is not auto nn = number of energy digits (5-8 --> 0-3) eee = energy scale (0-unit, 3-kilo, 6-mega) f = decimal point for power (0=data-dependant placement, 1=fixed placement per ii value) ddd = energy digits after decimal point (0-6) See note 10.	1	

7536 - 7536	30007 - 30007	Operating Mode Screen Enables	UINT16	bit-mapped	-------x eeeeeeee	eeeeeeee = op mode screen rows on/off, rows top to bottom are bits low order to high order x = set to suppress PF on W/VAR/PF screens	1	
7537 - 7537	30008 - 30008	Daylight Saving On Rule	UINT16	bit-mapped	hhhhhwww -dddmmmm	applies only if daylight savings in User Settings Flags = on; specifies when to make changeover hhhhh = hour, 0-23 www = week, 1-4 for 1st - 4th, 5 for last ddd = day of week, 1-7 for Sun - Sat mmmm = month, 1-12 Example: 2AM on the 4th Sunday of March hhhhh=2, www=4, ddd=1, mmmm=3	1	
7538 - 7538	30009 - 30009	Daylight Saving Off Rule	UINT16	bit-mapped	hhhhhwww -dddmmmm		1	
7539 - 7539	30010 - 30010	Time Zone UTC offset	UINT16	bit-mapped	z000 0000 hhhh hhmm	mm = minutes/15; 00=00, 01=15, 10=30, 11=45 hhhh = hours; -23 to +23 z = Time Zone valid (0=no, 1=yes) i.e. register=0 indicates that time zone is not set while register=0x8000 indicates UTC offset = 0	1	
753A - 753A	30011 - 30011	Clock Sync Configuration	UINT16	bit-mapped	0000 0000 mmm0 0ppe	e = enable automatic clock sync (0=no, 1=yes) pp = port performing synchronization (2-3 = COM3-COM4) mmm = sync method (1=NTP, all other values=no sync)	1	
753B - 753B	30012 - 30012	Reserved				Reserved	1	
753C - 753C	30013 - 30013	User Settings 2	UINT16	bit-mapped	-------- -------s	s = display secondary volts (1=yes, 0=no)	1	
753D - 753D	30014 - 30014	DNP Options	UINT16	bit-mapped	-------- ww-i-vvp	p selects primary or secondary values for DNP voltage, current and power registers (0=secondary, 1=primary) vv sets divisor for voltage scaling (0=1, 1=10, 2=100) i sets divisor for current scaling (0=1, 1=10) ww sets divisor for power scaling in addition to scaling for Kilo (0=1, 1=10, 2=100, 3=1000) Example: 120KV, 500A, 180MW p=1, vv=2, i=0, and ww=3 voltage reads 1200, current reads 500, watts reads 180	1	

753E - 753E	30015 - 30015	User Settings Flags	UINT16	bit-mapped	vvkgeinn srpdywfa	vv = number of digits after decimal point for voltage display. 0 - For voltage range (0 - 9999V) 1 - For voltage range (100.0kV - 999.9 kV) 2 - For voltage range (10.00kV - 99.99 kV) 3 - For voltage range (0kV - 9.999 kV) This setting is used only when k=1. k = enable fixed scale for voltage display. (0=autoscale, 1=unit if vv=0 and kV if vv=1,2,3) g = enable alternate full scale bar graph current (1=on, 0=off) e = enable ct pt compensation (0=Disabled, 1=Enabled). i = fixed scale and format current display 0=normal autoscaled current display 1=always show amps with no decimal places nn = number of phases for voltage & current screen (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) d = daylight saving time changes (0=off, 1=on) y = diagnostic events in system log (1=yes, 0=no) w = power direction (0=view as load, 1=view as generator) f = flip power factor sign (1=yes, 0=no) a = apparent power computation method (0=arithmetic sum, 1=vector sum)	1	
753F - 753F	30016 - 30016	Full Scale Current (for load % bar graph)	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. (See Note 12)	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)	1	
7549 - 7549	30026 - 30026	COM2 setup	UINT16	bit-mapped	----dddd -ppp-bbb	ppp = protocol (1-Modbus RTU, 2-Modbus ASCII, 3-DNP) bbb = baud rate (1-9600, 2-19200, 4-38400, 6-57600)	1	
754A - 754A	30027 - 30027	COM2 address	UINT16	(Modbus) 1 to 65520 (DNP)	none		1	
754B - 754B	30028 - 30028	Limit #1 Identifier	UINT16	0 to 65535		use Modbus address as the identifier (see notes 7, 11, 12)	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	
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	
7573 - 7582	30068 - 30083	Reserved				Reserved	16	
7583 - 75C2	30084 - 30147	Reserved				Reserved	64	
75C3 - 75C3	30148 - 30148	watts loss due to iron when watts positive	UINT16	0 to 99.99	0.01%		1	
75C4 - 75C4	30149 - 30149	watts loss due to copper when watts positive	UINT16	0 to 99.99	0.01%		1	
75C5 - 75C5	30150 - 30150	var loss due to iron when watts positive	UINT16	0 to 99.99	0.01%		1	
75C6 - 75C6	30151 - 30151	var loss due to copper when watts positive	UINT16	0 to 99.99	0.01%		1	
75C7 - 75C3	30152 - 30152	watts loss due to iron when watts negative	UINT16	0 to 99.99	0.01%		1	
75C8 - 75C48	30153 - 30153	watts loss due to copper when watts negative	UINT16	0 to 99.99	0.01%		1	
75C9 - 75C9	30154 - 30154	var loss due to iron when watts negative	UINT16	0 to 99.99	0.01%		1	
75CA - 75CA	30155 - 30155	var loss due to copper when watts negative	UINT16	0 to 99.99	0.01%		1	
75CB - 75CB	30156 - 30156	transformer loss compensation user settings flag	UINT16	bit-mapped	-------- ----cfwv	c - 0 disable compensation for losses due to copper, 1 enable compensaion for losses due to copper f - 0 disable compensation for losses due to iron, 1 enable compensaion for losses due to iron w - 0 add watt compensation, 1 subtract watt compensation v - 0 add var compensation, 1 subtract var compensation	1	

75CC - 75E5	30157 - 30182	Reserved				Reserved	26	
75E6 - 75E6	30183 - 30183	Programmable Settings Update Counter	UINT16	0-65535		Increments each time programmable settings are changed; occurs when new checksum is calculated.	1	
75E7 - 7626	30184 - 30247	Reserved for Software Use				Reserved	64	
7627 - 7627	30248 - 30248	A phase PT compensation @ 69V (% error)	SINT16	-15 to 15	0.01%		1	
7628 - 7628	30249 - 30249	A phase PT compensation @ 120V (% error)	SINT16	-15 to 15	0.01%		1	
7629 - 7629	30250 - 30250	A phase PT compensation @ 230V (% error)	SINT16	-15 to 15	0.01%		1	
762A - 762A	30251 - 30251	A phase PT compensation @ 480V (% error)	SINT16	-15 to 15	0.01%		1	
762B - 762B	30252 - 30255	B phase PT compensation @ 69V, 120V, 230V, 480V (% error)	SINT16	-15 to 15	0.01%		4	
762F - 762F	30256 - 30259	C phase PT compensation @ 69V, 120V, 230V, 480V (% error)	SINT16	-15 to 15	0.01%		4	
7633 - 7633	30260 - 30260	A phase CT compensation @ c1 (% error)	SINT16	-15 to 15	0.01%	For Class 10 unit c1=0.25A c2=0.5A c3=1A c4=5A For Class 2 unit c1=0.05A c2=0.1A c3=0.2A c4=1A	1	
7634 - 7634	30261 - 30261	A phase CT compensation @ c2 (% error)	SINT16	-15 to 15	0.01%		1	
7635 - 7635	30262 - 30262	A phase CT compensation @ c3 (% error)	SINT16	-15 to 15	0.01%		1	
7636 - 7636	30263 - 30263	A phase CT compensation @ c4 (% error)	SINT16	-15 to 15	0.01%		1	
7637 - 7637	30264 - 30267	B phase CT compensation @ c1, c2, c3, c4 (% error)	SINT16	-15 to 15	0.01%		4	
763B - 763E	30268 - 30271	C phase CT compensation @ c1, c2, c3, c4 (% error)	SINT16	-15 to 15	0.01%		4	
763F - 7642	30272 - 30275	A phase PF compensation @ c1, c2, c3, c4	SINT16	-50 to 50			4	
7643 - 7646	30276 - 30279	B phase PF compensation @ c1, c2, c3, c4	SINT16	-50 to 50			4	
7647 - 764A	30280 - 30283	C phase PF compensation @ c1, c2, c3, c4	SINT16	-50 to 50			4	
						Block Size:	284	
Log Setups Block						write only in PS update mode		
7917 - 7917	31000 - 31000	Historical Log #1 Sizes	UINT16	bit-mapped	eeeeeeee ssssssss	high byte is number of registers to log in each record (0-117), low byte is number of flash sectors for the log (see note 19) 0 in either byte disables the log	1	

7918 - 7918	31001 - 31001	Historical Log #1 Interval	UINT16	bit-mapped	00000000 hgfedcba	only 1 bit set: a=1 min, b=3 min, c=5 min, d=10 min, e=15 min, f=30 min, g=60 min, h=EOI pulse	1	
7919 - 7919	31002 - 31002	Historical Log #1, Register #1 Identifier	UINT16	0 to 65535		use Modbus address as the identifier (see note 7)	1	
791A - 798D	31003 - 31118	Historical Log #1, Register #2 - #117 Identifiers	UINT16	0 to 65535		same as Register #1 Identifier	116	
798E - 79D6	31119 - 31191	Historical Log #1 Software Buffer				Reserved for software use.	73	
79D7 - 7A96	31192 - 31383	Historical Log #2 Sizes, Interval, Registers & Software Buffer	same as Historical Log #1				192	
7A97 - 7B56	31384 - 31575	Historical Log #3 Sizes, Interval, Registers & Software Buffer	same as Historical Log #1				192	
7B57 - 7B57	31576 - 31607	Waveform Log Sample Rate & Pretrigger	UINT16	bit-mapped	ssssssss pppppppp	High byte is samples/60Hz cycle = 5(32), 6(64), 7(128), 8(256), or 9(512) Low byte is number of pretrigger cycles.	1	
7B58 - 7B58	31577 - 31577	Power Quality Log Triggers	UINT16	bit-mapped	-------8 76543210	Set bits to enable PQ events/waveform captures. 2,1,0 = Voltage Surge, channel C, B, A 5,4,3 = Current Surge, channel C, B, A 8,7,6 = Voltage Sag, channel C, B, A	1	
7B59 - 7B59	31578 - 31578	Waveform Log Triggers	UINT16	bit-mapped	-------8 76543210		1	
7B5A - 7B5A	31579 - 31579	Waveform & PQ Log Sizes	UINT16	bit-mapped	pppppppp wwwwwwww	High byte is number of flash sectors for PQ log, Low byte is number of flash sectors for waveform log	1	
7B5B - 7B5B	31580 - 31580	Reserved				Reserved	1	
7B5C - 7B5C	31581 - 31581	Channel A Voltage Surge Threshold	UINT16	0 to 3276.7	0.1% of full scale	Thresholds are % of full scale, see note 12	1	
7B5D - 7B5D	31582 - 31582	Channel A Current Surge Threshold	UINT16	0 to 3276.7	0.1% of full scale		1	
7B5E - 7B5E	31583 - 31583	Channel A Voltage Sag Threshold	UINT16	0 to 3276.7	0.1% of full scale		1	
7B5F - 7B61	31584 - 31586	Reserved				Reserved	3	
7B62 - 7B67	31587 - 31592	Channel B Surge & Sag Thresholds	same as Channel A				6	
7B68 - 7B6D	31593 - 31598	Channel C Surge & Sag Thresholds	same as Channel A				6	
7B6E - 7B76	31599 - 31607	Reserved				Reserved	9	
						Block Size:	608	
PROGRAMMABLE SETTINGS FOR OPTION CARD 1								
Option Card 1 Setups Block						write only in PS update mode		
7CFF - 7CFF	32000 - 32000	Class ID of the Option Card 1 Settings	UINT16	bit-mapped	-------- cccctttt	Which class (cccc) and type(tttt) of card the Option Settings for Card 1 apply to. See note 22.	1	
7D00 - 7D3E	32001 - 32063	Settings for Option Card 1, First Overlay -- see below	Register assignments depend on which type of card is in the slot. See overlays below.				63	

7D3F - 7F3E	32064 - 32575	Settings for Option Card 1, Second Overlay -- see below	Register assignments depend on which type of card is in the slot. See overlays below.				512	
						Block Size:	576	
		OVERLAYS FOR OPTION CARD 1 PROGRAMMABLE SETTINGS						
Settings Registers for any communication capable card, including network and analog cards					First Overlay	write only in PS update mode		
7D00 - 7D00	32001 - 32001	Slave address	UINT16	1~247 (for Modbus) 1~65534 (for DNP)	none	Slave address of the unit. The communication capable card is always a master. Set to 0 when an analog board is installed.	1	0x0001 for analog and network cards (non configurable) 0x0001 Fiber cards
7D01 - 7D01	32002 - 32002	Speed and format	UINT16	bit-mapped	-abcde--fghijklm	Bps: a=57600; b=38400; c=19200; d=14400; e=9600 Stop bits 'f': cleared 1 stop bit, set 2 stop bits Parity: g=even; h=odd; i=none Data bits: j=8; k=7; l=6; m=5 Set to 0 when an analog board is installed.	1	Don't care for analog card and network cards 0x0418 for fiber cards (57600 N-8-1)
7D02 - 7D02	32003 - 32003	Reserved				Reserved	1	
7D03 - 7D03	32004 - 32004	Protocol	UINT16	bit-mapped	-------- -----ppp-	ppp= 100 =DNP3; 010=Ascii Modbus; 001=Rtu Modbus Set to 0 when an analog board is installed.	1	0x0002 for all cards (Modbus Rtu)
7D04 - 7D04	32005 - 32005	Reply delay	UINT16	0 to 65535	milliseconds	Delay to reply to a Modbus transaction after receiving it. Set to 0 when an analog board is installed	1	0x0000
7D05 - 7D3E	32006 - 32063	Reserved				Reserved	58	
						Block Size:	63	
Settings Registers for Digital I/O Relay Card					First Overlay	write only in PS update mode		

7D00 - 7D00	32001 - 32001	Input#1 - 2 bindings & logging enables	UINT16	bit-mapped	-------- 2222 1111	One nibble for each input. Assuming "abcc" as the bits in each nibble: "a": select this input for EOI (End Of Interval)pulse sensing. "b": log this input when pulse is detected "cc": Input event trigger mode - Contact sensing method; 00 = none; 01 = open to close; 10 = close to open; 11 = any change. Every input has an associated internal accumulator (See input Accumulator Scaling), which is incremented every time the input changes according with the trigger mode crieteria "cc"	1	0x0000 (No EOI, No Log, No change detection)
7D01 - 7D01	32002 - 32002	Relay #1 Delay to Operate	UINT16	0.1 second units		Delay to operate the relay since request.	1	0x000a (1 second)
7D02 - 7D02	32003 - 32003	Relay #1 Delay to Release	UINT16	0.1 second units		Delay to release the relay since request.	1	0x000a (1 second)
7D03 - 7D08	32004 - 32009	Reserved	UINT16			Set to 0.	6	
7D09 - 7D09	32010 - 32010	Relay #2 Delay to Operate	UINT16	0.1 second units		Delay to operate the relay since request.	1	0x000a (1 second)
7D0A - 7D0A	32011 - 32011	Relay #2 Delay to Release	UINT16	0.1 second units		Delay to release the relay since request.	1	0x000a (1 second)
7D0B - 7D20	32012 - 32033	Reserved	UINT16			Set to 0.	22	
7D21 - 7D21	32034 - 32034	Input Accumulators Scaling	UINT16	bit-mapped	-------- 22221111	4 bits per input or output accumulator The nibble informs what should be the scaling of the accumulator 0=no-scaling, 1=0.1, 2=0.01, 3= 1m, 4=0.1m, 5=0.01m, 6=1u, 7=0.1u; the value 15 disable the accumulator. Example: suppose that the internal input accumulator #1 is 12345, and its corresponding scaling setting is "0011" (3 decimal). Then, the accumulator will be read as: Scaling 3, means 1m or 0.001. Scaled accumulator = 12345 * 0.001 = 12 (Twelve).	1	0xFFFF (accumulators disabled)
7D22 - 7D22	32035 - 32035	Relay Accumulators Scaling	UINT16	bit-mapped	-------- 22221111		1	0xFFFF (accumulators disabled)
7D23 - 7D23	33036 - 33036	Fast pulse input selector	UINT16	bit-mapped	p------- -----nnn	When value 'nnn' is non-zero, it determines which of the card inputs will be a fast pulse detection input. The polarity bit 'P' tells the event to be detected: 1=open-to-close; 0=close-to-open. There is no "any-change" detection mode.	1	Default is 0 (no fast input assigned)
7D24 - 7D3E	32037 - 32063	Reserved				Set to 0.	27	
						Block Size:	63	

Settings Registers for Digital I/O Pulse Output Card					First Overlay	write only in PS update mode		
7D00 - 7D00	32001 - 32001	Input#1 - 4 bindings & logging enables	UINT16	bit-mapped	44443333 22221111	One nibble for each input. Assuming "abcc" as the bits in each nibble: "a": select this input for EOI (End Of Interval)pulse sensing. "b": log this input when pulse is detected "cc": Input event trigger mode - Contact sensing method; 00 = none; 01 = open to close; 10 = close to open; 11 = any change. Every input has an associated internal accumulator (See input Accumulator Scaling), which is incremented every time the input changes according with the trigger mode crieteria "cc"	1	0x0000 (No EOI, No Log, No change detection)
7D01 - 7D01	32002 - 32002	Source for Pulse Ouput#1	UINT16	enumeration	-----ppp ----vvvv	"ppp" (Phase) : 000 = none, 001 = Phase A, 010 = Phase B, 011 = Phase C, 100 = All Phases, 101 = Pulse from EOI(End Of Interval). "vvvv"(Value) : 0000= none, 0001 = Wh, 0010 = +Wh, 0011 = -Wh, 0100= Varh, 0101 = +Varh, 0110 = -Varh, 0111 = VAh, 1000= Received Wh, 1001= Delivered Wh, 1010= Inductive Varh, 1011 = Capacitive Varh	1	0x0402 (+Wh total)
7D02 - 7D02	32003 - 32003	Kt [Wh/pulse] factor for Pulse Output#1	UINT16	bit-mapped	ddVVVVVV VVVVVVVV	"V...V" = not scaled energy value per pulse, from 0 to 9999. "dd"= decimal point position: 00=0.XXXX, 01=X.XXX, 10=XX.XX, 11= X.XXX.	1	0x4708 (1.800 Wh)
7D03 - 7D04	32004 - 32005	Output#2 Assignment and Kt	UINT16	same as Output #1			2	0x0403 (-Wh total) 0x4708 (1.800 Wh)
7D05 - 7D06	32006 - 32007	Output#3 Assignment and Kt	UINT16	same as Output #1			2	0x0405 (+VARh total) 0x4708 (1.800 VARh)
7D07 - 7D08	32008 - 32009	Output#4 Assignment and Kt	UINT16	same as Output #1			2	0x0406 (-VARh total) 0x4708 (1.800 VARh)
7D09 - 7D09	32010 - 32010	Input Accumulators Scaling	UINT16	bit-mapped	44443333 22221111	see Relay Card above	1	
7D0A - 7D0A	32011 - 32011	Output Accumulators Scaling	UINT16	bit-mapped	44443333 22221111		1	

7D0B - 7D0B	32012 - 32012	Fast pulse input selector	UINT16	bit-mapped	p------- -----nnn	When value 'nnn' is non-zero, it determines which of the card inputs will be a fast pulse detection input. The polarity bit 'P' tells the event to be detected: 1=open-to-close; 0=close-to-open. There is no "any-change" detection mode.	1	Default is 0 (no fast input assigned)
7D0C - 7D3E	32013 - 32063	Reserved				Reserved	51	
						Block Size:	63	
Settings Registers for Digital I/O Relay Card					Second Overlay	write only in PS update mode		
7D3F - 7D46	32064 - 32071	Input#1 Label	ASCII	16 char			8	16 spaces (char 0x20)
7D47 - 7D4E	32072 - 32079	Input#1 Low State Name	ASCII	16 char			8	16 spaces (char 0x20)
7D4F - 7D56	32080 - 32087	Input#1 High State Name	ASCII	16 char			8	16 spaces (char 0x20)
7D57 - 7D6E	32088 - 32111	Input#2 Label and State Names	same as Input#1				24	
7D6F - 7D9E	32112 - 32159	Reserved				Reserved	48	
7D9F - 7DA6	32160 - 32167	Relay#1 Label	ASCII	16 char			8	16 spaces (char 0x20)
7DA7 - 7DAE	32168 - 32175	Relay#1 Open State Name	ASCII	16 char			8	16 spaces (char 0x20)
7DAF - 7DB6	32176 - 32183	Relay#1 Closed State Name	ASCII	16 char			8	16 spaces (char 0x20)
7DB7 - 7DCE	32184 - 32207	Relay#2 Label and State Names	same as Relay#1				24	
7DCF - 7DFE	32208 - 32255	Reserved				Reserved	48	
7DFF - 7E06	32256 - 32263	Input#1 Accumulator Label	ASCII	16 char			8	16 spaces (char 0x20)
7E07 - 7E0E	32264 - 32271	Input#2 Accumulator Label	ASCII	16 char			8	16 spaces (char 0x20)
7E0F - 7E1E	32272 - 32287	Reserved				Reserved	16	
7E1F - 7E1F	32288 - 32288	Input#1 Accumulator Kt	UINT16	bit-mapped	ddVVVVVV VVVVVVVV	KT power factor for the Pulse Output	1	
7E20 - 7E20	32289 - 32289	Input#2 Accumulator Kt	UINT16	bit-mapped	ddVVVVVV VVVVVVVV	"V" is raw power value in Wh/pulse from 0 to 9999. "dd"=decimal point position: 00=0.XXXX, 01=X.XXX, 10=XX.XX, 11= X.XXX.	1	
7E21 - 7F3E	32290 - 32575	Reserved				Reserved	286	
						Block Size:	512	

Settings Registers for Digital I/O Pulse Output Card					Second Overlay	write only in PS update mode		
7D3F - 7D46	32064 - 32071	Input#1 Label	ASCII	16 char			8	16 spaces (char 0x20)
7D47 - 7D4E	32072 - 32079	Input#1 Low State Name	ASCII	16 char			8	16 spaces (char 0x20)
7D4F - 7D56	32080 - 32087	Input#1 High State Name	ASCII	16 char			8	16 spaces (char 0x20)
7D57 - 7D6E	32088 - 32111	Input#2 Label and State Names	same as Input#1				24	16 spaces (char 0x20)
7D6F - 7D86	32112 - 32135	Input#3 Label and State Names	same as Input#1				24	16 spaces (char 0x20)
7D87 - 7D9E	32136 - 32159	Input#4 Label and State Names	same as Input#1				24	16 spaces (char 0x20)
7D9F - 7DA6	32160 - 32167	Output#1 Label	ASCII	16 char			8	16 spaces (char 0x20)
7DA7 - 7DAE	32168 - 32175	Output#1 Open State Name	ASCII	16 char			8	16 spaces (char 0x20)
7DAF - 7DB6	32176 - 32183	Output#1 Closed State Name	ASCII	16 char			8	16 spaces (char 0x20)
7DB7 - 7DCE	32184 - 32207	Output#2 Label and State Names	same as Output#1				24	16 spaces (char 0x20)
7DCF - 7DE6	32208 - 32231	Output#3 Label and State Names	same as Output#1				24	16 spaces (char 0x20)
7DE7 - 7DFE	32232 - 32255	Output#4 Label and State Names	same as Output#1				24	16 spaces (char 0x20)
7DFF - 7E06	32256 - 32263	Input#1 Accumulator Label	ASCII	16 char			8	16 spaces (char 0x20)
7E07 - 7E0E	32264 - 32271	Input#2 Accumulator Label	ASCII	16 char			8	16 spaces (char 0x20)
7E0F - 7E16	32272 - 32279	Input#3 Accumulator Label	ASCII	16 char			8	16 spaces (char 0x20)
7E17 - 7E1E	32280 - 32287	Input#4 Accumulator Label	ASCII	16 char			8	16 spaces (char 0x20)

7E1F - 7E1F	32288 - 32288	Input#1 Accumulator Kt	UINT16	bit-mapped	ddVVVVVV VVVVVVVV	KT power factor for the accumulator input "V" is raw power value in Wh/pulse from 0 to 9999. "dd"=decimal point position: 00=0.XXXX, 01=X.XXX, 10=XX.XX, 11= X.XXX.	1	
7E20 - 7E20	32289 - 32289	Input#2 Accumulator Kt	UINT16	bit-mapped	ddVVVVVV VVVVVVVV		1	
7E21 - 7E21	32290 - 32290	Input#3 Accumulator Kt	UINT16	bit-mapped	ddVVVVVV VVVVVVVV		1	
7E22 - 7E22	32291 - 32291	Input#4 Accumulator Kt	UINT16	bit-mapped	ddVVVVVV VVVVVVVV		1	
7E23 - 7F3E	32292 - 32575	Reserved				Reserved	284	
						Block Size:	512	
Settings Registers for Analog Out 0-1mA / Analog Out 4-20mA Cards					Second Overlay	write only in PS update mode		
7D3F - 7D3F	32064 - 32064	Update rate	UINT16	0 to 65535	milliseconds	Fixed -- see specifications.	1	100 ms
7D40 - 7D40	32065 - 32065	Channel direction - 1mA Card only!	UINT16	bit-mapped	-------- ----4321	Full range output for 0-1mA card only: A bit set(1) means full range (-1mA to +1mA); a bit cleared(0) means source only (0mA to +1mA).	1	0x0003 (0-1) 0x0000 (4-20)
7D41 - 7D41	32066 - 32066	Format parameter for output #1	UINT16	bit-mapped	-------- ---f suwb	Format of the polled register:f=float 32; s=signed 32 bit int; u=unsigned 32 bit int; w=signed 16 bit int; b=unsigned 16 bit int.	1	0x0010 (float)
7D42 - 7D42	32067 - 32067	Source register for Output#1	UINT16	0 to 65535		This register should be programmed with the address of the register whose value is to be used for current output. In different words, the current level output of analog board will follow the value of the register addressed here.	1	0x03F9 (watts total)
7D43 - 7D44	32068 - 32069	High value of source register for output#1	Depends on the format parameter			Value read from the source register at which High nominal current will be output. Example: for the 4-20mA card, if this register is programmed with 750, then the current output will be 20mA when the value read from the source register is 750.	2	1800 W
7D45 - 7D46	32070 - 32071	Low value of source register for output#1	Depends on the format parameter			Value read from the source register at which Low nominal current will be output. Example: for the 4-20mA card, if this register is programmed with 0, then the current output will be 4mA when the value read from the source register is 0.	2	-1800 W
7D47 - 7D4C	32072 - 32077	Analog output#2 format, register, max & min	Same as analog output#1				6	0x0010 (float) 0x03FB (VAR total) +1800 VAR -1800 VAR

7D4D - 7D52	32078 - 32083	Analog output#3 format, register, max & min	Same as analog output#1				6	0x0010 (float) WYE DELTA 0x03E7 (Van) 0x03ED (Vab) 300V 600 V 0 V 0 V
7D53 - 7D58	32084 - 32089	Analog output#4 format, register, max & min	Same as analog output#1				6	0x0010 (float) 0x03F3 (Ia) 10 A 0 A
7D59 - 7F3E	32090 - 32575	Reserved				Reserved	486	
						Block Size:	512	
Settings Registers for Network Cards					Second Overlay	write only in PS update mode		
7D3F - 7D3F	32064 - 32064	General Options		bit-mapped	-------- ---s cwme	W=Web server:0=Enabled, 1=Disable T=Silentmode:0=Disabled, 1=Enabled (When enabled TCP/Reset is not sent when connection is attempted to an unbound port) G=Modbus Tcp/Ip Gateway:0=normal,1=disable D=DNP-Tcp/Ip-rapper: 0=Disabled, 1=enabled. E=IEC61850 disabled(1), or enabled(0)	1	0x0000
7D40 - 7D40	32065 - 32065	DHCP enable		bit-mapped	-------- -------d	DHCP: d=1 enabled, d=0 disabled (user must provide IP configuration).	1	0x0000
7D41 - 7D48	32066 - 32073	Host name label	ASCII			16 bytes (8 registers)	8	0x4531 3439 2020 2020 2020 2020 2020 2020 = E149
7D49 - 7D4C	32074 - 32077	IP card network address	UINT16	0 to 255 (IPv4)		These 4 registers hold the 4 numbers (1 number each register) that make the IP address used by the card.	4	0x000A, 0x0000, 0x0000, 0x0002 = 10.0.0.2
7D4D - 7D4D	32078 - 32078	IP network address mask length	UINT16	0 to 32		Number of bits that are set in the IP address mask, starting from the Msb of the 32 bit word. Example 24 = 255.255.255.0; a value of 2 would mean 192.0.0.0	1	0x00FF, 0x0000, 0x0000, 0x0000 = 255.0.0.0
7D4E - 7D51	32079 - 32082	IP card network gateway address	UINT16	0 to 255 (IPv4)		These 4 registers hold the 4 numbers that make the IP gateway address on network.	4	0x000A, 0x0000, 0x0000, 0x0001 = 10.0.0.1

7D52 - 7D55	32083 - 32086	IP card network DNS #1 address	UINT16	0 to 255 (IPv4)		IP address of the DNS#1 on the network.	4	0x0000, 0x0000, 0x0000, 0x0000 = 0.0.0.0
7D56 - 7D59	32087 - 32090	IP card network DNS #2 address	UINT16	0 to 255 (IPv4)		IP address of the DNS#2 on the network.	4	0x0000, 0x0000, 0x0000, 0x0000 = 0.0.0.0
7D5A - 7D5A	32091 - 32091	TCP/IP Port – Modbus Gateway Service	UINT16	32-65534		Port for the Gateway service (modbus tcp/ip) when enabled. If this value is ZERO (0), the default address 502 will be used.	1	0x1F6
7D5B - 7D5B	32092 - 32092	TCP/IP Port – WebService	UINT16	32-65534		"Port for the Web service (html viewer) when enabled If this value is ZERO (0), the default address 80 will be used.	1	0x0050
7D5C - 7D5C	32093 - 32093	DNP Wrapper Server Port	UINT16	10-65534		Port number where the DNP Server will listen for connections.	1	- 6x0000...
7D5D - 7D5D	32094 - 32094	DNP Device number unit	UINT16	1-65534		Slave number under DNP protocol. This value is not currently used by the network card.	1	- 5x0000...
7D5E - 7D61	32095 - 32098	DNP Accepted IP Address Start	UINT16	0 to 255 (IPv4)		These are 4 words representing the 4 numbers of an IPv4 address. This address defines the start address for a range of accepted address. Any client trying to connect from an address outside this range, will be rejected. To disable the start checking, use 0.0.0.0.	4	- 4x0000...
7D62 - 7D65	32099 - 32102	DNP Accepted IP Address End	UINT16	0 to 255 (IPv4)		These are 4 words representing the 4 numbers of an IPv4 address. This address defines the end address for a range of accepted address. Any client trying to connect from an address outside this range, will be rejected. To disable the end checking, use 255.255.255.255	4	- 3x0000...
7D66 - 7D66	32103 - 32103	DNP Accepted IP Start Tcp/Ip Port	UINT16	1-65534		DNP Safety: This number defines the start port, within a range of ports to be allowed to connect to the DNP server. Any client trying to connect from a port outside this range, will be rejected. To disable start, use 0.	1	- 2x0000...
7D67 - 7D67	32104 - 32104	DNP Accepted IP End Tcp/Ip Port	UINT16	1-65534		DNP Safety: This number defines the end port, within a range of ports to be allowed to connect to the DNP server. Any client trying to connect from a port outside this range, will be rejected. To disable enter 65535.	1	- 1x0000...

7D66 - 7D66	32103 - 32103	DNP Accepted IP Start Tcp/Ip Port	UINT16	1-65534		DNP Safety: This number defines the start port, within a range of ports to be allowed to connect to the DNP server. Any client trying to connect from a port outside this range, will be rejected. To disable start, use 0.	1	- 2x0000…
7D68 - 7D6C	32105 - 32109	Reserved – must be set to 0				Reserved. Set these regs to zero.	5	0x0000…
7D6D - 7D8C	32110 - 32141	NTP1 URL or IP(string)	ASCII			IP address (as string) or URL string, for the NTP server the EPM 7000 will connect to. This string must be null-terminated.	32	0x0000
7D8D - 7DAC	32142 - 32173	Reserved – must be set to 0				Set these to regs to zero. EPM 7000 uses only 1 NTP	32	0x0000
7DAD - 7F3E	32174 - 32575	Reserved – must be set to 0				Reserved. Set these regs to zero.	402	0x0000…
						Block Size:	512	
PROGRAMMABLE SETTINGS FOR OPTION CARD 2								
Option Card 2 Setups Block						write only in PS update mode		
80E7 - 80E7	33000 - 33000	Class ID of the Option Card 2 Settings	UINT16	bit-mapped	-------- cccctttt	Which class (cccc) and type(tttt) of card the Option Settings for Card 2 apply to. See note 22	1	
80E8 - 8126	33001 - 33063	Settings for Option Card 2, First Overlay -- see below	Register assignments depend on which type of card is in the slot. See overlays below.				63	
8127 - 8326	33064 - 33575	Settings for Option Card 2, Second Overlay -- see below	Register assignments depend on which type of card is in the slot. See overlays below.				512	
						Block Size:	576	

OVERLAYS FOR OPTION CARD 2 PROGRAMMABLE SETTINGS								
Settings Registers for any communication capable card, including network and analog cards					First Overlay	write only in PS update mode		
80E8 - 80E8	33001 - 33001	Slave address	UINT16	1~247 (for Modbus) 1~65534 (for DNP)	none	Slave address of the unit. The communication capable card is always a master. Set to 0 when an analog board is installed.	1	0x0001 for analog and network cards (non configurable) 0x0001 Fiber cards
80E9 - 80E9	33002 - 33002	Speed and format	UINT16	bit-mapped	-abcde--fghijklm	Bps: a=57600; b=38400; c=19200; d=14400; e=9600 Stop bits 'f': cleared 1 stop bit, set 2 stop bits Parity: g=even; h=odd; i=none Data bits: j=8; k=7; l=6; m=5 Set to 0 when an analog board is installed.	1	Don't care for analog card and network cards 0x0418 for fiber cards (57600 N-8-1)
80EA - 80EA	33003 - 33003	Reserved	UINT16	bit-mapped		Reserved	1	
80EB - 80EB	33004 - 33004	Protocol	UINT16	bit-mapped	-------- -----ppp-	ppp= 100 =DNP3; 010=Ascii Modbus; 001=Rtu Modbus Set to 0 when an analog board is installed.	1	0x0002 for all cards (Modbus Rtu)
80EC - 80EC	33005 - 33005	Reply delay	UINT16	0 to 65535	milliseconds	Delay to reply to a Modbus transaction after receiving it. Set to 0 when an analog board is installed	1	0x0000
80ED - 8126	33006 - 33063	Reserved				Reserved	58	
						Block Size:	63	
Settings Registers for Digital I/O Relay Card					First Overlay	write only in PS update mode		
80E8 - 80E8	33001 - 33001	Input#1 - 2 bindings & logging enables	UINT16	bit-mapped	-------- 2222 1111	One nibble for each input. Assuming "abcc" as the bits in each nibble: "a": select this input for EOI (End Of Interval)pulse sensing. "b": log this input when pulse is detected "cc": Input event trigger mode - Contact sensing method; 00 = none; 01 = open to close; 10 = close to open; 11 = any change. Every input has an associated internal accumulator (See input Accumulator Scaling), which is incremented every time the input changes according with the trigger mode crieteria “cc”	1	0x0000 (No EOI, No Log, No change detection)
80E9 - 80E9	33002 - 33002	Relay #1 Delay to Operate	UINT16	0.1 second units		Delay to operate the relay since request.	1	0x000a (1 second)

80EA - 80EA	33003 - 33003	Relay #1 Delay to Release	UINT16	0.1 second units		Delay to release the relay since request.	1	0x000a (1 second)
80EB - 80F0	33004 - 33009	Reserved	UINT16			Set to 0.	6	
80F1 - 80F1	33010 - 33010	Relay #2 Delay to Operate	UINT16	0.1 second units		Delay to operate the relay since request.	1	0x000a (1 second)
80F2 - 80F2	33011 - 33011	Relay #2 Delay to Release	UINT16	0.1 second units		Delay to release the relay since request.	1	0x000a (1 second)
80F3 - 8108	33012 - 33033	Reserved	UINT16			Set to 0.	22	
8109 - 8109	33034 - 33034	Input Accumulators Scaling	UINT16	bit-mapped	-------- 22221111	4 bits per input or output accumulator The nibble informs what should be the scaling of the accumulator 0=no-scaling, 1=0.1, 2=0.01, 3= 1m, 4=0.1m, 5=0.01m, 6=1u, 7=0.1u; the value 15 disable the accumulator. Example: suppose that the internal input accumulator #1 is 12345, and its corresponding scaling setting is “0011” (3 decimal). Then, the accumulator will be read as: Scaling 3, means 1m or 0.001. Scaled accumulator = 12345 * 0.001 = 12 (Twelve).	1	0xFFFF (accumulators disabled)
810A - 810A	33035 - 33035	Relay Accumulators Scaling	UINT16	bit-mapped	-------- 22221111		1	0xFFFF (accumulators disabled)
810B - 810B	33036 - 33036	Fast pulse input selector	UINT16	bit-mapped	p-------- -----nnn	When value 'nnn' is non-zero, it determines which of the card inputs will be a fast pulse detection input. The polarity bit 'P' tells the event to be detected: 1=open-to-close; 0=close-to-open. There is no “any-change” detection mode.	1	Default is 0 (no fast input assigned)
810C - 8126	33037 - 33063	Reserved				Reserved	27	
						Block Size:	63	
Settings Registers for Digital I/O Pulse Output Card					First Overlay	write only in PS update mode		
80E8 - 80E8	33001 - 33001	Input#1 - 4 bindings & logging enables	UINT16	bit-mapped	44443333 22221111	One nibble for each input. Assuming "abcc" as the bits in each nibble: "a": select this input for EOI (End Of Interval)pulse sensing. "b": log this input when pulse is detected "cc": Input event trigger mode - Contact sensing method; 00 = none; 01 = open to close; 10 = close to open; 11 = any change. Every input has an associated internal accumulator (See input Accumulator Scaling), which is incremented every time the input changes according with the trigger mode crieteria “cc”	1	0x0000 (No EOI, No Log, No change detection)

80E9 - 80E9	33002 - 33002	Source for Pulse Ouput#1	UINT16	enumeration	-----ppp ----vvvv	"ppp" (Phase) : 000 = none, 001 = Phase A, 010 = Phase B, 011 = Phase C, 100 = All Phases, 101 = Pulse from EOI(End Of Interval). "vvvv"(Value) : 0000= none, 0001 = Wh, 0010 = +Wh, 0011 = -Wh, 0100= Varh, 0101 = +Varh, 0110 = -Varh, 0111 = VAh, 1000= Received Wh, 1001= Delivered Wh, 1010= Inductive Varh, 1011 = Capacitive Varh	1	0x0402 (+Wh total)
80EA - 80EA	33003 - 33003	Kt [Wh/pulse] factor for Pulse Output#1	UINT16	bit-mapped	ddVVVVVV VVVVVVVV	"V...V" = not scaled energy value per pulse, from 0 to 9999. "dd"= decimal point position: 00=0.XXXX, 01=X.XXX, 10=XX.XX, 11= X.XXX.	1	0x4708 (1.800 Wh)
80EB - 80EC	33004 - 33005	Output#2 Assignment and Kt	UINT16	same as Output #1			2	0x0403 (-Wh total) 0x4708 (1.800 Wh)
80ED - 80EE	33006 - 33007	Output#3 Assignment and Kt	UINT16	same as Output #1			2	0x0405 (+VARh total) 0x4708 (1.800 VARh)
80EF - 80F0	33008 - 33009	Output#4 Assignment and Kt	UINT16	same as Output #1			2	0x0406 (-VARh total) 0x4708 (1.800 VARh)
80F1 - 80F1	33010 - 33010	Input Accumulators Scaling	UINT16	bit-mapped	44443333 22221111	see Relay Card above	1	
80F2 - 80F2	33011 - 33011	Output Accumulators Scaling	UINT16	bit-mapped	44443333 22221111		1	
80F3 - 80F3	33012 - 33012	Fast pulse input selector	UINT16	bit-mapped	p------- -----nnn	When value 'nnn' is non-zero, it determines which of the card inputs will be a fast pulse detection input. The polarity bit 'P' tells the event to be detected: 1=open-to-close; 0=close-to-open. There is no "any-change" detection mode.	1	Default is 0 (no fast input assigned)
80F4 - 8126	33013 - 33063	Reserved				Reserved	51	
						Block Size:	63	
Settings Registers for Digital I/O Relay Card					Second Overlay	write only in PS update mode		
8127 - 812E	33064 - 33071	Input#1 Label	ASCII	16 char			8	16 spaces (char 0x20)

812F - 8136	33072 - 33079	Input#1 Low State Name	ASCII	16 char			8	16 spaces (char 0x20)
8137 - 813E	33080 - 33087	Input#1 High State Name	ASCII	16 char			8	16 spaces (char 0x20)
813F - 8156	33088 - 33111	Input#2 Label and State Names	same as Input#1				24	
8157 - 8186	33112 - 33159	Reserved					48	
8187 - 818E	33160 - 33167	Relay#1 Label	ASCII	16 char			8	16 spaces (char 0x20)
818F - 8196	33168 - 33175	Relay#1 Open State Name	ASCII	16 char			8	16 spaces (char 0x20)
8197 - 819E	33176 - 33183	Relay#1 Closed State Name	ASCII	16 char			8	16 spaces (char 0x20)
819F - 81B6	33184 - 33207	Relay#2 Label and State Names	same as Relay#1				24	
81B7 - 81E6	33208 - 33255	Reserved					48	
81E7 - 81EE	33256 - 33263	Input#1 Accumulator Label	ASCII	16 char			8	16 spaces (char 0x20)
81EF - 81F6	33264 - 33271	Input#2 Accumulator Label	ASCII	16 char			8	16 spaces (char 0x20)
8208 - 8208	33289 - 33289	Input#2 Accumulator Kt	UINT16	bit-mapped	ddVVVVVV VVVVVVVV		1	
8209 - 8326	33290 - 33575	Reserved					286	
						Block Size:	512	
Settings Registers for Digital I/O Pulse Output Card					Second Overlay	write only in PS update mode		
8127 - 812E	33064 - 33071	Input#1 Label	ASCII	16 char			8	16 spaces (char 0x20)
812F - 8136	33072 - 33079	Input#1 Low State Name	ASCII	16 char			8	16 spaces (char 0x20)
8137 - 813E	33080 - 33087	Input#1 High State Name	ASCII	16 char			8	16 spaces (char 0x20)
813F - 8156	33088 - 33111	Input#2 Label and State Names	same as Input#1				24	16 spaces (char 0x20)

8157 - 816E	33112 - 33135	Input#3 Label and State Names	same as Input#1				24	16 spaces (char 0x20)
816F - 8186	33136 - 33159	Input#4 Label and State Names	same as Input#1				24	16 spaces (char 0x20)
8187 - 818E	33160 - 33167	Output#1 Label	ASCII	16 char			8	16 spaces (char 0x20)
818F - 8196	33168 - 33175	Output#1 Open State Name	ASCII	16 char			8	16 spaces (char 0x20)
8197 - 819E	33176 - 33183	Output#1 Closed State Name	ASCII	16 char			8	16 spaces (char 0x20)
819F - 81B6	33184 - 33207	Output#2 Label and State Names	same as Output#1				24	16 spaces (char 0x20)
81B7 - 81CE	33208 - 33231	Output#3 Label and State Names	same as Output#1				24	16 spaces (char 0x20)
81CF - 81E6	33232 - 33255	Output#4 Label and State Names	same as Output#1				24	16 spaces (char 0x20)
81E7 - 81EE	33256 - 33263	Input#1 Accumulator Label	ASCII	16 char			8	16 spaces (char 0x20)
81EF - 81F6	33264 - 33271	Input#2 Accumulator Label	ASCII	16 char			8	16 spaces (char 0x20)
81F7 - 81FE	33272 - 33279	Input#3 Accumulator Label	ASCII	16 char			8	16 spaces (char 0x20)
81FF - 8206	33280 - 33287	Input#4 Accumulator Label	ASCII	16 char			8	16 spaces (char 0x20)
8207 - 8207	33288 - 33288	Input#1 Accumulator Kt	UINT16	bit-mapped	ddVVVVVV VVVVVVVV	KT power factor for the accumulator input "V" is raw power value in Wh/pulse from 0 to 9999. "dd"=decimal point position: 00=0.XXXX, 01=X.XXX, 10=XX.XX, 11= X.XXX.	1	
8208 - 8208	33289 - 33289	Input#2 Accumulator Kt	UINT16	bit-mapped	ddVVVVVV VVVVVVVV		1	
8209 - 8209	33290 - 33290	Input#3 Accumulator Kt	UINT16	bit-mapped	ddVVVVVV VVVVVVVV		1	
820A - 820A	33291 - 33291	Input#4 Accumulator Kt	UINT16	bit-mapped	ddVVVVVV VVVVVVVV		1	
820B - 8326	33292 - 33575	Reserved				Reserved	284	
						Block Size:	512	
Settings Registers for Analog Out 0-1mA / Analog Out 4-20mA Cards					Second Overlay	write only in PS update mode		
8127 - 8127	33064 - 33064	Update rate	UINT16	0 to 65535	milliseconds	Fixed -- see specifications.	1	100 ms
8128 - 8128	33065 - 33065	Channel direction - 1mA Card only!	UINT16	bit-mapped	-------- ----4321	Full range output for 0-1mA card only: A bit set(1) means full range (-1mA to +1mA); a bit cleared(0) means source only (0mA to +1mA).	1	0x0003 (0-1) 0x0000 (4-20)

8129 - 8129	33066 - 33066	Format parameter for output #1	UINT16	bit-mapped	-------- ---f suwb	Format of the polled register:f=float 32; s=signed 32 bit int; u=unsigned 32 bit int; w=signed 16 bit int; b=unsigned 16 bit int.	1	0x0010 (float)
812A - 812A	33067 - 33067	Source register for Output#1	UINT16	0 to 65535		This register should be programmed with the address of the register whose value is to be used for current output. In different words, the current level output of analog board will follow the value of the register addressed here.	1	0x03F9 (watts total)
812B - 812C	33068 - 33069	High value of source register for output#1	Depends on the format parameter			Value read from the source register at which High nominal current will be output. Example: for the 4-20mA card, if this register is programmed with 750, then the current output will be 20mA when the value read from the source register is 750.	2	1800 W
812D - 812E	33070 - 33071	Low value of source register for output#1	Depends on the format parameter			Value read from the source register at which Low nominal current will be output. Example: for the 4-20mA card, if this register is programmed with 0, then the current output will be 4mA when the value read from the source register is 0.	2	-1800 W
812F - 8134	33072 - 33077	Analog output#2 format, register, max & min	Same as analog output#1				6	0x0010 (float) 0x03FB (VAR total) +1800 VAR -1800 VAR
8135 - 813A	33078 - 33083	Analog output#3 format, register, max & min	Same as analog output#1				6	0x0010 (float) WYE DELTA 0x03E7 (Van) 0x03ED (Vab) 300V 600 V 0V 0 V
813B - 8140	33084 - 33089	Analog output#4 format, register, max & min	Same as analog output#1				6	0x0010 (float) 0x03F3 (Ia) 10 A 0 A
8141 - 8326	33090 - 33575	Reserved				Reserved	486	
						Block Size:	512	
Settings Registers for Network Cards					Second Overlay	write only in PS update mode		

8127 - 8127	33064 - 33064	General Options		bit-mapped	-------- ---s cwme	W=Web server:0=Enabled, 1=Disable T=Silentmode:0=Disabled, 1=Enabled (When enabled TCP/Reset is not sent when connection is attempted to an unbound port) G=Modbus Tcp/Ip Gateway:0=normal,1=disable D=DNP-Tcp/Ip-rapper: 0=Disabled, 1=enabled. E=IEC61850 disabled(1), or enabled(0)	1	0x000E
8128 - 8128	33065 - 33065	DHCP enable		bit-mapped	-------- -------d	DHCP: d=1 enabled, d=0 disabled (user must provide IP configuration).	1	
8129 - 8130	33066 - 33073	Host name label	ASCII			16 bytes (8 registers)	8	0x4531 3439 2020 2020 2020 2020 2020 2020 = E149
8131 - 8134	33074 - 33077	IP card network address	UINT16	0 to 255 (IPv4)		These 4 registers hold the 4 numbers (1 number each register) that make the IP address used by the card.	4	0x000A, 0x0000, 0x0000, 0x0002 = 10.0.0.2
8135 - 8135	33078 - 33078	IP network address mask length	UINT16	0 to 32		Number of bits that are set in the IP address mask, starting from the Msb of the 32 bit word. Example 24 = 255.255.255.0; a value of 2 would mean 192.0.0.0	1	0x00FF, 0x0000, 0x0000, 0x0000 = 255.0.0.0
8136 - 8139	33079 - 33082	IP card network gateway address	UINT16	0 to 255 (IPv4)		These 4 registers hold the 4 numbers that make the IP gateway address on network.	4	0x000A, 0x0000, 0x0000, 0x0001 = 10.0.0.1
813A - 813D	33083 - 33086	IP card network DNS #1 address	UINT16	0 to 255 (IPv4)		IP address of the DNS#1 on the network.	4	0x0000, 0x0000, 0x0000, 0x0000 = 0.0.0.0
813E - 8141	33087 - 33090	IP card network DNS #2 address	UINT16	0 to 255 (IPv4)		IP address of the DNS#2 on the network.	4	0x0000, 0x0000, 0x0000, 0x0000 = 0.0.0.0
8142 - 8142	33091 - 33091	TCP/IP Port – Modbus Gateway Service	UINT16	32-65534		Port for the Gateway service (modbus tcp/ip) when enabled. If this value is ZERO (0), the default address 502 will be used.	1	0x1F6
8143 - 8143	33092 - 33092	TCP/IP Port – WebService	UINT16	32-65534		"Port for the Web service (html viewer) when enabled If this value is ZERO (0), the default address 80 will be used.	1	0x0050
8144 - 8144	33093 - 33093	DNP Wrapper Server Port	UINT16	10-65534		Port number where the DNP Server will listen for connections.	1	- 6x0000...
8145 - 8145	33094 - 33094	DNP Device number unit	UINT16	1-65534		Slave number under DNP protocol. This value is not currently used by the network card.	1	- 5x0000...

8146 - 8149	33095 - 33098	DNP Accepted IP Address Start	UINT16	0 to 255 (IPv4)		These are 4 words representing the 4 numbers of an IPv4 address. This address defines the start address for a range of accepted address. Any client trying to connect from an address outside this range, will be rejected. To disable the start checking, use 0.0.0.0.	4	- 4x0000...
814A - 814D	33099 - 33102	DNP Accepted IP Address End	UINT16	0 to 255 (IPv4)		These are 4 words representing the 4 numbers of an IPv4 address. This address defines the end address for a range of accepted address. Any client trying to connect from an address outside this range, will be rejected. To disable the end checking, use 255.255.255.255	4	- 3x0000...
814E - 814E	33103 - 33103	DNP Accepted IP Start Tcp/Ip Port	UINT16	1-65534		DNP Safety: This number defines the start port, within a range of ports to be allowed to connect to the DNP server. Any client trying to connect from a port outside this range, will be rejected. To disable start, use 0.	1	- 2x0000...
814F - 814F	33104 - 33104	DNP Accepted IP End Tcp/Ip Port	UINT16	1-65534		DNP Safety: This number defines the end port, within a range of ports to be allowed to connect to the DNP server. Any client trying to connect from a port outside this range, will be rejected. To disable enter 65535.	1	- 1x0000...
8150 - 8154	33105 - 33109	Reserved – must be set to 0				Reserved. Set these regs to zero.	5	0x0000...
8155 - 8174	33110 - 33141	NTP1 URL or IP(string)	ASCII			IP address (as string) or URL string, for the NTP server the EPM 7000 will connect to. This string must be null-terminated.	32	0x0000
8175 - 8194	33142 - 33173	Reserved – must be set to 0				Set these to regs to zero. EPM 7000 uses only 1 NTP	32	0x0000
8195 - 8326	33174 - 33575	Reserved – must be set to 0				Reserved. Set these regs to zero.	402	0x0000...
						Block Size:	512	
SECONDARY READINGS SECTION								
Secondary 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) / 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=65ormore 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, 1000	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	
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 - 9C60	40032 - 40033	W-hours, Positive, Phase A	UINT32	0 to 99999999	Wh per energy format		2	
9C61 - 9C62	40034 - 40035	W-hours, Positive, Phase B	UINT32	0 to 99999999	Wh per energy format		2	
9C63 - 9C64	40036 - 40037	W-hours, Positive, Phase C	UINT32	0 to 99999999	Wh per energy format		2	
9C65 - 9C66	40038 - 40039	W-hours, Negative, Phase A	UINT32	0 to 99999999	Wh per energy format		2	
9C67 - 9C68	40040 - 40041	W-hours, Negative, Phase B	UINT32	0 to 99999999	Wh per energy format		2	
9C69 - 9C6A	40042 - 40043	W-hours, Negative, Phase C	UINT32	0 to 99999999	Wh per energy format		2	
9C6B - 9C6C	40044 - 40045	VAR-hours, Positive, Phase A	UINT32	0 to 99999999	VARh per energy format		2	
9C6D - 9C6E	40046 - 40047	VAR-hours, Positive, Phase B	UINT32	0 to 99999999	VARh per energy format		2	
9C6F - 9C70	40048 - 40049	VAR-hours, Positive, Phase C	UINT32	0 to 99999999	VARh per energy format		2	
9C71 - 9C72	40050 - 40051	VAR-hours, Negative, Phase A	UINT32	0 to 99999999	VARh per energy format		2	
9C73 - 9C74	40052 - 40053	VAR-hours, Negative, Phase B	UINT32	0 to 99999999	VARh per energy format		2	
9C75 - 9C76	40054 - 40055	VAR-hours, Negative, Phase C	UINT32	0 to 99999999	VARh per energy format		2	

9C77 - 9C78	40056 - 40057	VA-hours, Phase A	UINT32	0 to 99999999	VAh per energy format		2	
9C79 - 9C7A	40058 - 40059	VA-hours, Phase B	UINT32	0 to 99999999	VAh per energy format		2	
9C7B - 9C7C	40060 - 40061	VA-hours, Phase C	UINT32	0 to 99999999	VAh per energy format		2	
9C7D - 9C7D	40062 - 40062	Watts, Phase A	UINT16	0 to 4095	watts		1	
9C7E - 9C7E	40063 - 40063	Watts, Phase B	UINT16	0 to 4095	watts		1	
9C7F - 9C7F	40064 - 40064	Watts, Phase C	UINT16	0 to 4095	watts		1	
9C80 - 9C80	40065 - 40065	VARs, Phase A	UINT16	0 to 4095	VARs	0= -3000, 2047= 0, 4095= +3000	1	
9C81 - 9C81	40066 - 40066	VARs, Phase B	UINT16	0 to 4095	VARs	watts, VARs, VAs =	1	
9C82 - 9C82	40067 - 40067	VARs, Phase C	UINT16	0 to 4095	VARs	3000 * (register - 2047) / 2047	1	
9C83 - 9C83	40068 - 40068	VAs, Phase A	UINT16	2047 to 4095	VAs		1	
9C84 - 9C84	40069 - 40069	VAs, Phase B	UINT16	2047 to 4095	VAs		1	
9C85 - 9C85	40070 - 40070	VAs, Phase C	UINT16	2047 to 4095	VAs		1	
9C86 - 9C86	40071 - 40071	Power Factor, Phase A	UINT16	1047 to 3047	none	1047= -1, 2047= 0, 3047= +1	1	
9C87 - 9C87	40072 - 40072	Power Factor, Phase B	UINT16	1047 to 3047	none	pf = (register - 2047) / 1000	1	
9C88 - 9C88	40073 - 40073	Power Factor, Phase C	UINT16	1047 to 3047	none		1	
9C89 - 9CA2	40074 - 40099	Reserved	N/A	N/A	none	Reserved	26	
9CA3 - 9CA3	40100 - 40100	Reset Energy Accumulators	UINT16	password (Note 5)		write-only register; always reads as 0	1	
						Block Size:	100	
LOG RETRIEVAL SECTION								
Log Retrieval Block						read/write except as noted		
C34C - C34D	49997 - 49998	Log Retrieval Session Duration	UINT32	0 to 4294967294	4 msec	0 if no session active; wraps around after max count	2	
C34E - C34E	49999 - 49999	Log Retrieval Session Com Port	UINT16	0 to 4		0 if no session active, 1-4 for session active on COM1 - COM4	1	
C34F - C34F	50000 - 50000	Log Number, Enable, Scope	UINT16	bit-mapped	nnnnnnnn esssssss	high byte is the log number (0-system, 1-alarm, 2-history1, 3-history2, 4-history3, 5-I/O changes, 10-PQ, 11-waveform e is retrieval session enable(1) or disable(0) sssssss is what to retrieve (0-normal record, 1-timestamps only, 2-complete memory image (no data validation if image)	1	
C350 - C350	50001 - 50001	Records per Window or Batch, Record Scope Selector, Number of Repeats	UINT16	bit-mapped	wwwwwwww snnnnnnn	high byte is records per window if s=0 or records per batch if s=1, low byte is number of repeats for function 35 or 0 to suppress auto-incrementing; max number of repeats is 8 (RTU) or 4 (ASCII) total windows, a batch is all the windows	1	

C351 - C352	50002 - 50003	Offset of First Record in Window	UINT32	bit-mapped	ssssssss nnnnnnnn nnnnnnnn nnnnnnnn	ssssssss is window status (0 to 7-window number, 0xFF-not ready); this byte is read-only. nn...nn is a 24-bit record number. The log's first record is latched as a reference point when the session is enabled. This offset is a record index relative to that point. Value provided is the relative index of the whole or partial record that begins the window.	2	
C353 - C3CD	50004 - 50126	Log Retrieve Window	UINT16	see comments	none	mapped per record layout and retrieval scope, read-only	123	
						Block Size:	130	
Log Status Block						read only		
		Alarm Log Status Block						
C737 - C738	51000 - 51001	Log Size in Records	UINT32	0 to 4,294,967,294	record		2	
C739 - C73A	51002 - 51003	Number of Records Used	UINT32	1 to 4,294,967,294	record		2	
C73B - C73B	51004 - 51004	Record Size in Bytes	UINT16	14 to 242	byte		1	
C73C - C73C	51005 - 51005	Log Availability	UINT16		none	0=available, 1-4=in use by COM1-4, 0xFFFF=not available (log size=0)	1	
C73D - C73F	51006 - 51008	Timestamp, First Record	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
C740 - C742	51009 - 51011	Timestamp, Last Record	TSTAMP	1Jan2000 - 31Dec2099	1 sec		3	
C743 - C746	51012 - 51015	Reserved				Reserved	4	
						Individual Log Status Block Size:	16	
C747 - C756	51016 - 51031	System Log Status Block		same as alarm log status block			16	
C757 - C766	51032 - 51047	Historical Log 1 Status Block		same as alarm log status block			16	
C767 - C776	51048 - 51063	Historical Log 2 Status Block		same as alarm log status block			16	
C777 - C786	51064 - 51079	Historical Log 3 Status Block		same as alarm log status block			16	
C787 - C796	51080 - 51095	I/O Change Log Status Block		same as alarm log status block			16	
C797 - C7A6	51096 - 51111	Power Quality Log Status Block		same as alarm log status block			16	
C7A7 - C7B6	51112 - 51127	Waveform Capture Log Status Block		same as alarm log status block			16	
						Block Size:	128	

Data Formats	
ASCII	ASCII characters packed 2 per register in high, low order and without any termination characters. For example, "EPM7000" would be 4 registers containing 0x5378, 0x6172, 0x6B32, 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).
TSTAMP	3 adjacent registers, 2 bytes each. First (lowest-addressed) register high byte is year (0-99), low byte is month (1-12). Middle register high byte is day(1-31), low byte is hour (0-23 plus DST bit). DST (daylight saving time) bit is bit 6 (0x40). Third register high byte is minutes (0-59), low byte is seconds (0-59). For example, 9:35:07AM on October 12, 2049 would be 0x310A, 0x0C49, 0x2307, assuming DST is in effect.

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 (since it doesn't exist).
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 exception if a write is attempted.
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	Each identifier is a Modbus register. For entities that occupy multiple registers (FLOAT, SINT32, etc.) all registers making up the entity must be listed, in ascending order. For example, to log phase A volts, VAs, voltage THD, and VA hours, the register list would be 0x3E7, 0x3E8, 0x411, 0x412, 0x176F, 0x61D, 0x61E and the number of registers (0x7917 high byte) would be 7.
8	Writing this register causes data to be saved permanently in nonvolatile memory. Reply to the command indicates that it was accepted but not whether or not the save was successful. This can only be determined after the meter has restarted.
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 nonsensical 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 monitored: current: FS = CT numerator * CT multiplier voltage: FS = PT numerator * PT multiplier 3 phase power: FS = CT numerator * CT multiplier * PT numerator * PT multiplier * 3 [* SQRT(3) for delta hookup] single phase power: FS = CT numerator * CT multiplier * PT numerator * PT multiplier [* SQRT(3) for delta hookup] frequency frequency: FS = 60 (or 50) power factor: FS = 1.0 percentage: FS = 100.0 angle: FS = 180.0
13	THD not available shows 10000 in all THD and harmonic magnitude and phase registers for the channel. THD may be unavailable due to low V or I amplitude, delta hookup (V only), or Software Option setting.
14	Option Card Identification and Configuration Block is an image of the EEPROM on the card

15 A block of data and control registers is allocated for each option slot. Interpretation of the register data depends on what card is in the slot.

16 Measurement states: Off occurs during programmable settings updates; Run is the normal measuring state; Limp indicates that an essentail non-volatile memory block is corrupted; and Warmup occurs briefly (approximately 4 seconds) at startup while the readings stabilize. Run state is required for measurement, historical logging, demand interval processing, limit alarm evaluation, min/max comparisons, and THD calculations. Resetting min/max or energy is allowed only in run and off states; warmup will return a busy exception. In limp state, the meter reboots at 5 minute intervals in an effort to clear the problem.

17 Limits evaluation for all entites except demand averages commences immediately after the warmup period. Evaluation for demand averages, maximum demands, and minimum demands commences at the end of the first demand interval after startup.

18 Autoincrementing and function 35 must be used when retrieving waveform logs.

19 Depending on the Option selected, there are 15, 29, or 45 flash sectors available in a common pool for distribution among the 3 historical and waveform logs. The pool size, number of sectors for each log, and the number of registers per record together determine the maximum number of records a log can hold.
S = number of sectors assigned to the log,
H = number of Modbus registers to be monitored in each historical record (up to 117),
R = number of bytes per record = (12 + 2H) for historical logs
N = number of records per sector = 65516 / R, rounded down to an integer value (no partial records in a sector)
T = total number of records the log can hold = S * N
T = S * 2 for the waveform log.

20 Only 1 input on all digital input cards may be specified as the end-of-interval pulse.

21 Logs cannot be reset during log retrieval. Waveform log cannot be reset while storing a capture. Busy exception will be returned.

22 Combination of class and type currently defined are:

0x23 = Fiber cards
0x24 = Network card
0x29 = IEC 61850 Card (Network)
0x41 = Relay card
0x42 = Pulse card
0x81 = 0-1mA analog output card
0x82 = 4-20mA analog output card.

EPM 7000 Power Quality Meter

Appendix C: DNP Mapping

C.1 Overview

This Appendix describes the functionality of the EPM 7000 meter's version of the DNP protocol. A DNP programmer must follow this information in order to retrieve data from the EPM 7000 meter. The DNP used by the EPM 7000 is a reduced set of the Distributed Network Protocol Version 3.0 subset 2; it gives enough functionality to get critical measurements from the EPM 7000 meter.

The EPM 7000 meter's DNP version supports Class 0 object/qualifiers 0,1,2,6, only. No event generation is supported. The EPM 7000 meter always acts as a secondary device (slave) in DNP communication.

An important feature allows DNP readings in primary units with user-set scaling for current, voltage, and power. (See the *GE Communicator Instruction Manual* for instructions.)

C.2 Physical Layer

DNP uses both Network (TCP/IP) and serial communication. DNP3 serial communication can be assigned to Port 2 (RS485 compliant port) or any communication capable option board. Serial Speed and data format are transparent for DNP: they can be set to any supported value. The IrDA port cannot use DNP. DNP3 over Ethernet is supported along with Modbus via a DNP3-enabled Network card. DNP packets should be directed to the port assigned for DNP during the meter’s Device Profile configuration (see the *GE Communicator Instruction Manual* for instructions). The DNP implementation is identical, regardless of the physical layer being used.

C.3 Data Link Layer

The EPM 7000 meter can be assigned with a value from 1 to 65534 as the target device address for DNP. The data link layer follows the standard frame FT3 used by the DNP Version 3.0 protocol, but only 4 functions are implemented: Reset Link, Reset User, Unconfirmed User Data, and Link Status, as depicted in the following table.

Table C.1: Supported Link Functions

Function	Function Code
Reset Link	0
Reset User	1
Unconfirmed User Data	4
Link Status	9

Refer to Section C.7 for more detail on supported frames for the data link layer.

In order to establish a clean communication with the EPM 7000 meter, we recommend you perform the Reset Link and Reset User functions. The Link Status is not mandatory, but if queried, it will be attended to. The inter-character time-out for the EPM 7000 meter's DNP version is 1 second. If this amount of time, or more, elapses between two consecutive characters within a FT3 frame, the frame will be dropped.

C.4 Application Layer

In the EPM 7000 meter, the EPM 7000 meter's DNP version supports the Read, Write, Select, Operate, Direct Operate and Direct Operate Unconfirmed functions. All Application layer requests and responses follow the DNP standard.Some sample requests and responses are included in this Appendix (see Section C.8).

- The Read function (code 01) provides a means for reading the critical measurement data and status from the meter. This function code, depending upon the qualifier, cab be used to read an individual object and point, a group of points within an object, or all points within an object. It is also used to read Object 60, variation 1, which will read all the available Class 0 objects from the DNP register map (see the Object map in Section C.6). In order to retrieve all objects with their respective variations, the qualifier must be set to ALL (0x06). See Section C.7 for an example showing a Read Class 0 request-data from the meter.
- The Write function (code 02) provides a mean for clearing the Device restart bit in the Internal Indicator register only. This is mapped to Object 80, point 0 with variation 1. When clearing the restart-device indicator use qualifier 0. Section C.7 shows the supported frames for this function.
- The Select function (code 03) provides a means of selecting a Control Relay Output Block (CROB) (Object 12). This function can be used to select the Energy or Demand counters, or to select a Relay if there are any installed in the device.
- The Operate function (code 04) provides the means for repeating the operation of a previously selected CROB (Object 12) device. This function can be used to reset the

Energy or Demand counters, or to operate a Relay if there are any installed in the device. The device must have been previously selected by the request immediately preceding the Operate command, and be received within the specified time limit (the default is 30 seconds). This function uses the same operation rules as a Direct Operate function.

- The Direct Operate function (code 05) provides the means for the direct operation of a CROB (Object 12) device. This function can be used for resetting the Energy and Demand counters (minimum and maximum energy registers) or controlling relays if there are any installed in the device. The relay must be operated (On) in 0 msec and released (Off) in 1 msec, only. Qualifiers 0x17 or x28 are supported for writing the energy reset. Sample frames are shown in Section C.7.
- The Direct Operate Unconfirmed (or Unacknowledged) function (code 06) is intended for asking the communication port to switch to Modbus RTU protocol from the EPM 7000 meter's DNP version. This switching is seen as a control relay mapped into Object 12, point 1 in the meter. The relay must be operated with qualifier 0x17, code 3 count 0, with 0 millisecond on and 1 millisecond off, only. After sending this request the current communication port will accept Modbus RTU frames only. To make this port go back to DNP protocol, the unit must be power-recycled. Section C.7 shows the constructed frame to perform DNP to Modbus RTU protocol change.

NOTE

This function has no effect when requested via a Network card.

C.5 Error Reply

In the case of an unsupported function, or any other recognizable error, an error reply will be generated from the EPM 7000 meter to the Primary station (the requester). The Internal Indicator field will report the type of error: unsupported function or bad parameter.

The broadcast acknowledge and restart bit, are also signaled in the internal indicator but they do not indicate an error condition.

C.6 Object Specifics

- Object 1 - Binary Input Status with Flags - These data points are mapped to the Digital Inputs on any Digital Relay Cards (RO1S) installed in the EPM 7000 meter. They are only available if at least one Digital Relay Card is installed in the meter. The inputs on a card in Slot 1 are mapped to Points 0 and 1. The inputs on a card in Slot 2 are mapped to Points 2 and 3. If there is no card installed in a slot, those points will return a status with the "Offline" bit set.
- Object 10 - Binary Output States - These data points are mapped to the Digital Relays on any Digital Relay Cards (RO1S) installed in the EPM 7000 meter. Data Points 3 through 6 are only available if there is at least one Digital Relay Card (RO1S) installed in the meter. The relays on a card in Slot 1 are mapped to Points 3 and 4. The relays on a card in Slot 2 are mapped to Points 5 and 6. If there is no card installed in a slot, those points will return a status with the "Offline" bit set.

- Object 12 - Control Relay Outputs - Points 0-2 reference internal controls. Points 3 to 6 are mapped to the Digital Relays on any Digital Relay Card (RO1S) installed in the EPM 7000 meter. Control requests to relays not installed will return an unknown object response. See Section C.4 for specific control mechanisms. Any relays that have been Assigned to a limit cannot be controlled via this command: the response status code will be 10 - Automation Inhibit, and no action will be taken.
- Object 20 - Binary Counters (Primary Readings) - Points 0 to 4 are mapped to Primary Energy readings, Points 5 to 8 are mapped to the Digital Inputs on any Digital Relay Card (RO1S) installed in the EPM 7000. If the digital inputs are set up as accumulators they can be read via this request; if they are not set up as accumulators the response will always be zero.
- Object 30 - Analog Inputs - These points may be either primary or secondary readings per a user setup option.
- Object 50 - Date and Time - This object supports the reading of the device's time, only.
- Object 60 - Class Objects - Class 0 requests, only, are supported.
  - Objects are returned, in the response, in the following order:
    - Object 20 all points (0-8) 32 bit values
    - Object 30 all points (count depends on settings) 16 bit values
    - Object 1 all points (0-3) 8 bit values
    - Object 10 all points (0-6) 8 bit values
- Object 80 - Internal Indicators - This request supports the clearing of the Restart bit. This is a write function, only, which should be done as soon as possible anytime the device has been restarted, as indicated by the restart bit being set in a response. The response will always be zero.

C.7 The Register Map for the EPM 7000 Meter's DNP Version

Object 1 - Binary Input Status with Flags

Read with Object 1, Var 2, and Qualifiers 0, 1, 2 or 6. (Included in Class 0 responses.)

Table C.2: Object 1 - Binary Input Status with Flags

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
1	0	2	Read Digital Input 1 RO1S Status 1 (expansion port 1)	BYTE	Bit Flags	N/A	None	Returns the Status and State of the Input in the Flags.
1	1	2	Read Digital Input 2 RO1S Status 2 (expansion port 1)	BYTE	Bit Flags	N/A	None	Returns the Status and State of the Input in the Flags.
1	2	2	Read Digital Input 3 RO1S Status 1 (expansion port 2)	BYTE	Bit Flags	N/A	None	Returns the Status and State of the Input in the Flags.
1	3	2	Read Digital Input 4 RO1S Status 2 (expansion port 2)	BYTE	Bit Flags	N/A	None	Returns the Status and State of the Input in the Flags.

Supported Flags:
Bit 0: ONLINE (0=Offline, 1=Online) (If the Input is not present it will be shown as Offline.)
Bit 1: RESTART (1=The Object is in the Initial State and has not been updated since Restart.)
Bit 7: STATE (0=Off, 1=On)

Object 10 - Binary Output States

Read with Object 10, Var 2, and Qualifiers 0, 1, 2 or 6. (Included in Class 0 responses.)

Table C.3: Object 10 - Binary Output States

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
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	
10	2	2	Reset Demand Counters (Max / Min)	BYTE	Always 1	N/A	None	
10	3	2	Read Relay 1 State RO1S Relay 1 (expansion port 1)	BYTE	Always 1	N/A	None	Returns the Status and State of the Relay in the Flags.
10	4	2	Read Relay 2 State RO1S Relay 2 (expansion port 1)	BYTE	Always 1	N/A	None	Returns the Status and State of the Relay in the Flags.
10	5	2	Read Relay 3 State RO1S Relay 1 (expansion port 1)	BYTE	Always 1	N/A	None	Returns the Status and State of the Relay in the Flags.
10	6	2	Read Relay 4 State RO1S Relay 2 (expansion port 2)	BYTE	Always 1	N/A	None	Returns the Status and State of the Relay in the Flags.

Supported Flags:
Bit 0: ONLINE (0=Offline, 1=Online) (If the Input is not present it will be shown as Offline.)
Bit 1: RESTART (1=The Object is in the Initial State and has not been updated since Restart.)
Bit 7: STATE (0=Off, 1=On)

Object 12 - Control Relay Outputs

(Responds to Function 3 - Select, 4 - Operate, or 5 - Direct Operate; Count of 1 Only.)
(Control code 3 or 4, Qualifiers 17x or 28x, On - 0 msec; Off - 1 msec.)
(Only one control object at a time may be specified.)

Table C.4: Object 12 - Control Relay Outputs

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
12	0	1	Reset Energy Counters	N/A	N/A	N/A	none	Control Code 3 only

Table C.4: Object 12 - Control Relay Outputs

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
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, Off 1 msec ONLY.
12	2	1	Reset Demand Counters (Max / Min)	N/A	N/A	N/A	none	Control Code 3 only
12	3	1	Control Relay 1 RO1S Relay 1 (expansion port 1)	N/A	N/A	N/A	none	Control Code 3 only
12	4	1	Control Relay 2 RO1S Relay 2 (expansion port 1)	N/A	N/A	N/A	none	See Section C.4 for operation rules and parameters.
12	5	1	Control Relay 3 RO1S Relay 1 (expansion port 2)	N/A	N/A	N/A	none	See Section C.4 for operation rules and parameters.
12	6	1	Control Relay 4 RO1S Relay 2 (expansion port 2)	N/A	N/A	N/A	none	See Section C.4 for operation rules and parameters.

Object 20 - Binary Counters (Primary Readings)

Read with Object 20, Var 5, and Qualifiers 0, 1, 2, or 6. (Included in Class 0 responses.)

Table C.5: Object 20 - Binary Counters (Primary Readings) - Read via Class 0 or with qualifier 0, 1, 2, or 6

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
20	0	5	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.	Whr	example: energy format = 7.2K and W-hours counter = 1234567 n=3 (K scale), d=2 (2 digits after decimal point), multiplier = 10(3-2) = 101 = 10, so energy is 1234567 * 10 Whrs, or 12345.67 KWhrs
20	1	5	W-hours, Negative	UINT32	0 to 99999999		Whr	
20	2	5	VAR-hours, Positive	UINT32	0 to 99999999		VARhr	

Table C.5: Object 20 - Binary Counters (Primary Readings) - Read via Class 0 or with qualifier 0, 1, 2, or 6

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
20	3	5	VAR-hours, Negative	UINT32	0 to 99999999		VARhr	
20	4	5	VA-hours, Total	UINT32	0 to 99999999		VAhr	
20	5	5	Digital Input 1 RO1S Accumulator 1 (expansion port 1)	UINT32	0 to 9999			
20	6	5	Digital Input 2 RO1S Accumulator 2 (expansion port 1)	UINT32				
20	7	5	Digital Input 3 RO1S Accumulator 1 (expansion port 2)	UINT32				
20	8	5	Digital Input 4 RO1S Accumulator 2 (expansion port 2)	UINT32				

Object 30 - Analog Inputs (Secondary Readings)

Read with Object 30, Var 4, and Qualifiers 0, 1, 2, or 6. (Included in Class 0 responses.)

NOTE

Object 30 may be either primary or secondary readings per a user setup option. See the page C-13 for the primary version of Object 30.

Table C.6: Object 30 - Analog Inputs (Secondary Readings) - Read via Class 0 or with qualifier 0, 1, 2, or 6

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
30	0	4	Meter Health	sint16	0 or 1	N/A	None	0 = OK
30	1	4	Volts A-N	sint16	0 to 32767	(150 / 32768)	V	Values above 150V secondary read 32767.
30	2	4	Volts B-N	sint16	0 to 32767	(150 / 32768)	V	
30	3	4	Volts C-N	sint16	0 to 32767	(150 / 32768)	V	
30	4	4	Volts A-B	sint16	0 to 32767	(300 / 32768)	V	Values above 300V secondary read 32767.
30	5	4	Volts B-C	sint16	0 to 32767	(300 / 32768)	V	
30	6	4	Volts C-A	sint16	0 to 32767	(300 / 32768)	V	

Table C.6: Object 30 - Analog Inputs (Secondary Readings) - Read via Class 0 or with qualifier 0, 1, 2, or 6

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
30	7	4	Amps A	sint16	0 to 32767	(10 / 32768)	A	Values above 10A secondary read 32767.
30	8	4	Amps B	sint16	0 to 32767	(10 / 32768)	A	
30	9	4	Amps C	sint16	0 to 32767	(10 / 32768)	A	
30	10	4	Watts, 3-Ph total	sint16	-32768 to +32767	(4500 / 32768)	W	
30	11	4	VARs, 3-Ph total	sint16	-32768 to +32767	(4500 / 32768)	VAR	
30	12	4	VAs, 3-Ph total	sint16	0 to +32767	(4500 / 32768)	VA	
30	13	4	Power Factor, 3-Ph total	sint16	-1000 to +1000	0.001	None	
30	14	4	Frequency	sint16	0 to 9999	0.01	Hz	
30	15	4	Positive Watts, 3-Ph, Maximum Avg Demand	sint16	-32768 to +32767	(4500 / 32768)	W	
30	16	4	Positive VARs, 3-Ph, Maximum Avg Demand	sint16	-32768 to +32767	(4500 / 32768)	VAR	
30	17	4	Negative Watts, 3-Ph, Maximum Avg Demand	sint16	-32768 to +32767	(4500 / 32768)	W	
30	18	4	Negative VARs, 3-Ph, Maximum Avg Demand	sint16	-32768 to +32767	(4500 / 32768)	VAR	
30	19	4	VAs, 3-Ph, Maximum Avg Demand	sint16	-32768 to +32767	(4500 / 32768)	VA	
30	20	4	Angle, Phase A Current	sint16	-1800 to +1800	0.1	degree	
30	21	4	Angle, Phase B Current	sint16	-1800 to +1800	0.1	degree	
30	22	4	Angle, Phase C Current	sint16	-1800 to +1800	0.1	degree	
30	23	4	Angle, Volts A-B	sint16	-1800 to +1800	0.1	degree	
30	24	4	Angle, Volts B-C	sint16	-1800 to +1800	0.1	degree	

Table C.6: Object 30 - Analog Inputs (Secondary Readings) - Read via Class 0 or with qualifier 0, 1, 2, or 6

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
30	25	4	Angle, Volts C-A	sint16	-1800 to +1800	0.1	degree	
30	26	4	CT numerator	sint16	1 to 9999	N/A	none	CT ratio = (numerator * multiplier) / denominator
30	27	4	CT multiplier	sint16	1, 10, or 100	N/A	none	
30	28	4	CT denominator	sint16	1 or 5	N/A	none	
30	29	4	PT numerator	SINT16	1 to 9999	N/A	none	PT ratio = (numerator * multiplier) / denominator
30	30	4	PT multiplier	SINT16	1, 10, or 100	N/A	none	
30	31	4	PT denominator	SINT16	1 to 9999	N/A	none	
30	32	4	Neutral Current	SINT16	0 to 32767	(10 / 32768)	A	For 1A model, multiplier is (2 / 32768) and values above 2A secondary read 32767
30	33	4	PowerFactor, Phase A	SINT16	-1000 to +1000	0.001	None	
30	34	4	PowerFactor, Phase B	SINT16	-1000 to +1000	0.001	None	
30	35	4	PowerFactor, Phase C	SINT16	-1000 to +1000	0.001	None	
30	36	4	Watts, Phase A	SINT16	-32768 to +32767	(4500/32768)	W	
30	37	4	Watts, Phase B	SINT16	-32768 to +32767	(4500/32768)	W	
30	38	4	Watts, Phase C	SINT16	-32768 to +32767	(4500/32768)	W	
30	39	4	VARs, Phase A	SINT16	-32768 to +32767	(4500/32768)	VAR	
30	40	4	VARs, Phase B	SINT16	-32768 to +32767	(4500/32768)	VAR	
30	41	4	VARs, Phase C	SINT16	-32768 to +32767	(4500/32768)	VAR	

Object 30 - Analog Inputs (Primary Readings)

Read with Object 30, Var 4, and Qualifiers 0, 1, 2, or 6. (Included in Class 0 responses.)

NOTE

Multipliers for Volts, Amps, and Power points are per user setup options.

Table C.7: Object 30 - Analog Inputs (Primary Readings)

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
30	0	4	Meter Health	SINT16	0 or 1	N/A	None	0 = OK
30	1	4	Volts A-N	SINT16	0 to 32767	1, 10, or 100	V	Point value = Actual Volts/ divisor
30	2	4	Volts B-N	SINT16	0 to 32767	1, 10, or 100	V	
30	3	4	Volts C-N	SINT16	0 to 32767	1, 10, or 100	V	
30	4	4	Volts A-B	SINT16	0 to 32767	1, 10, or 100	V	
30	5	4	Volts B-C	SINT16	0 to 32767	1, 10, or 100	V	
30	6	4	Volts C-A	SINT16	0 to 32767	1, 10, or 100	V	
30	7	4	Amps A	SINT16	0 to 32767	1 or 10	A	Point value = Actual Amps/ divisor
30	8	4	Amps B	SINT16	0 to 32767	1 or 10	A	
30	9	4	Amps C	SINT16	0 to 32767	1 or 10	A	
30	10	4	Watts, 3-Ph total	SINT16	-32768 to +32767	1, 10, 100 or 1000	W	Point value = Actual kWatts/ divisor
30	11	4	VARs, 3-Ph total	SINT16	-32768 to +32767	1, 10, 100 or 1000	VAR	
30	12	4	VAs, 3-Ph total	SINT16	0 to +32767	1, 10, 100 or 1000	VA	
30	13	4	Power Factor, 3-Ph total	SINT16	-1000 to +1000	0.001	None	
30	14	4	Frequency	SINT16	0 to 9999	0.01	Hz	
30	15	4	Positive Watts, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	1, 10, 100 or 1000	W	
30	16	4	Positive VARs, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	1, 10, 100 or 1000	VAR	
30	17	4	Negative Watts, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	1, 10, 100 or 1000	W	
30	18	4	Negative VARs, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	1, 10, 100 or 1000	VAR	
30	19	4	VAs, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	1, 10, 100 or 1000	VA	
30	20	4	Angle, Phase A Current	SINT16	-1800 to +1800	0.1	degree	

30	21	4	Angle, Phase B Current	SINT16	-1800 to +1800	0.1	degree	
30	22	4	Angle, Phase C Current	SINT16	-1800 to +1800	0.1	degree	
30	23	4	Angle, Volts A-B	SINT16	-1800 to +1800	0.1	degree	
30	24	4	Angle, Volts B-C	SINT16	-1800 to +1800	0.1	degree	
30	25	4	Angle, Volts C-A	SINT16	-1800 to +1800	0.1	degree	
30	26	4	CT numerator	SINT16	1 to 9999	N/A	none	CT ratio = (numerator * multiplier)/ denominator
30	27	4	CT multiplier	SINT16	1, 10, or 100	N/A	none	
30	28	4	CT denominator	SINT16	1 or 5	N/A	none	
30	29	4	PT numerator	SINT16	1 to 9999	N/A	none	PT ratio = (numerator * multiplier) / denominator
30	30	4	PT multiplier	SINT16	1, 10, or 100	N/A	none	
30	31	4	PT denominator	SINT16	1 to 9999	N/A	none	
30	32	4	Neutral Current	SINT16	0 to 32767	(10 / 32768)	A	Point value = Actual Amps/ divisor
30	33	4	PowerFactor, Phase A	SINT16	-1000 to +1000	0.001	none	
30	34	4	PowerFactor, Phase B	SINT16	-1000 to +1000	0.001	none	
30	35	4	PowerFactor, Phase C	SINT16	-1000 to +1000	0.001	none	
30	36	4	Watts, Phase A	SINT16	-32768 to +32767	(4500/32768)	W	
30	37	4	Watts, Phase B	SINT16	-32768 to +32767	(4500/32768)	W	
30	38	4	Watts, Phase C	SINT16	-32768 to +32767	(4500/32768)	W	
30	39	4	VARs, Phase A	SINT16	-32768 to +32767	(4500/32768)	VAR	
30	40	4	VARs, Phase B	SINT16	-32768 to +32767	(4500/32768)	VAR	
30	41	4	VARs, Phase C	SINT16	-32768 to +32767	(4500/32768)	VAR	

Object 80 - Internal Indicator

Table C.8: Object 80 - Internal Indicator

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
80	7	1	Device Restart Bit	N/A	N/A	N/A	none	Clear via Function 2 (Write), Qualifier Code 0.

C.8 DNP Message Layouts

Legend

All numbers are in hexadecimal base. In addition the following symbols are used.

dst	16 bit frame destination address
src	16 bit frame source address
crc	DNP Cyclic redundant checksum (polynomial $x^{16}+x^{13}+x^{12}+x^{11}+x^{10}+x^{7}+x^{6}+x^{5}+x^{2}+1$)
x	transport layer data sequence number
y	application layer data sequence number

Link Layer related frames

Reset Link

Request	05	64	05	C0	dst	src	crc
Reply	05	64	05	00	src	dst	crc

Reset User

Request	05	64	05	C1	dst	src	crc
Reply	05	64	05	00	src	dst	crc

Link Status

Request	05	64	05	C9	dst	src	crc
Reply	05	64	05	0B	src	dst	crc

Application Layer related frames

Clear Restart

Request	05	64	0E	C4	dst		src		crc		
	Cx	Cy	02	50	01	00	07	07	00	crc	
Reply	05	64	0A	44	src		dst		crc		
	Cx	Cy	81	int. ind.		crc					

Class 0 Data

Request	05	64	0B	C4	dst	src	crc									
	Cx	Cy	01	3C	01	06	crc									
Request (alternate)	05	64	14	C4	dst	src	crc									
	Cx	Cy	01	3C	02	06	3C	03	06	3C	04	06	3C	01	06	crc
Reply (same for either request)	05	64	A1	44	src	dst	crc									
	Cx	Cy	81	int. ind.	14	05	00	00	08	pt 0	pt 1	crc				
	pt 1	pt 2	pt 3	pt 4	pt 5	crc										
	pt 5	pt 6	pt 7	pt 8	1E	04	crc									
	00	00	29	pt 0	pt 1	pt 2	pt 3	pt 4	pt 5	pt6	crc					
	pt 6	pt 7	pt 8	pt 9	pt 10	pt 11	pt 12	pt 13	pt 14	crc						
	pt 14	pt 15	pt 16	pt 17	pt 18	pt 19	pt 20	pt 21	pt 22	crc						
	pt 22	pt 23	pt 24	pt 25	pt 26	pt 27	pt 28	pt 29	pt 30	crc						
	pt 30	pt 31	pt 32	pt 33	pt 34	pt 35	pt 36	pt 37	pt 38	crc						
	pt 38	pt 39	pt 40	pt 41	01	02	00	00	00	03	0	1	2	3	crc	
	0A	02	00	00	06	0	1	2	3	02	4	5	6	crc		

Reset Energy

Request	05	64	18	C4	dst	src	crc										
	Cx	Cy	05	0C	01	17	01	00	03	00	00	00	00	00	01	00	crc
	00	00	00	crc													
Reply	05	64	1A	44	src	dst	crc										
	Cx	Cy	81	int. ind.	0C	01	17	01	00	03	00	00	00	00	00	crc	
	01	00	00	00	00	crc											

Request (alternate)	05	64	1A	C4	dst	src	crc										
	Cx	Cy	05	0C	01	28	01	00	00	00	03	00	00	00	00	00	crc
	01	00	00	00	00	crc											
Reply	05	64	1C	44	src	dst	crc										
	Cx	Cy	81	int. ind.	0C	01	28	01	00	00	00	03	00	00	00	crc	
	00	00	01	00	00	00	00	crc									

Switch to Modbus

Request	05	64	18	C4	dst	src	crc										
	Cx	Cy	06	0C	01	17	01	01	03	00	00	00	00	00	01	00	crc
	00	00	00	crc													
No Reply																	

Reset Demand (Maximums & Minimums)

Request	05	64	18	C4	dst	src	crc										
	Cx	Cy	05	0C	01	17	01	02	03	00	00	00	00	00	01	00	crc
	00	00	00	crc													
Reply	05	64	1A	44	src	dst	crc										
	Cx	Cy	81	int. ind.	0C	01	17	01	02	03	00	00	00	00	00	crc	
	01	00	00	00	00	crc											

Request (alternate)	05	64	1A	C4	dst		src		crc								
	Cx	Cy	05	0C	01	28	01	02	00	00	03	00	00	00	00	00	crc
	01	00	00	00	00	crc											
Reply	05	64	1C	44	src		dst		crc								
	Cx	Cy	81	int. ind.		0C	01	28	01	02	00	00	03	00	00	00	crc
	00	00	01	00	00	00	00	crc									

Error Reply

Reply	05	64	0A	44	src		dst		crc
	Cx	Cy	81	int. ind.		crc			

C.9 Internal Indication Bits

Bits implemented in the EPM 7000 meter are listed below. All others are always reported as zeroes.

Bad Function

Occurs if the function code in a User Data request is not Read (0x01), Write (0x02), Direct Operate (0x05), or Direct Operate, No Ack (0x06).

Object Unknown

Occurs if an unsupported object is specified for the Read function. Only objects 10, 20, 30, and 60 are supported.

Out of Range

Occurs for most other errors in a request, such as requesting points that don't exist or direct operate requests in unsupported formats.

Buffer Overflow

Occurs if a read request or a read response is too large for its respective buffer. In general, if the request overflows, there will be no data in the response while if the response overflows at least the first object will be returned. The largest acceptable request has a length field of 26, i.e. link header plus 21 bytes more, not counting checksums. The largest possible response has 7 blocks plus the link header.

Restart All Stations

These 2 bits are reported in accordance with standard practice.

EPM 7000 Power Quality Meter

Appendix D: Using the IEC 61850 Protocol Ethernet Network Card (E2)

D.1 Overview of IEC 61850

When the IEC 61850 Protocol Ethernet Network card (E2) is added to the EPM 7000 meter, the unit becomes an advanced intelligent Device that can be networked on a IEC 61850 standard network within an electrical distribution system.

IEC 61850 is a standard for the design of electrical substation automation, including the networking of substation devices. The IEC 61850 standard is part of the International Electrotechnical Commission's (IEC) Technical Committee 57 (TC57). It consists of a suite of protocols (MMS, SMV, etc.) and abstract definitions that provide a standardized method of communication and integration to support intelligent electronic devices from any vendor, networked together to perform protection, monitoring, automation, metering and control in a substation environment. For more information on IEC 61850 go to http://iec61850.ucaiug.org/.

IEC 61850 was developed to:

- Specify a design methodology for automation system construction.
- Reduce the effort for users to construct automation systems using devices from multiple vendors.
- Assure interoperability between components within the automation system.
- “Future-proof” the system by providing simple upgrade paths as the underlying technologies change.
- Communicate information rather than data that requires further processing. The functionality of the components is moved away from the clients (requesters) toward the servers (responders).

IEC 61850 differs from previous standards in that:

- It specifies all aspects of the automation system from system specifications, through device specifications, and then through the testing regime.

- The IEC 61850 standard specifies a layered approach to the specification of devices. The layered approach allows “future-proofing” of basic functionality by allowing individual “stack” components to be upgraded as technology progresses.
- The individual objects within devices are addressed through a hierarchy of names rather than numbers.
- Each object has precise, standard terminology across the entire vendor community.
- Devices can provide an online description of their data model.
- A complete (offline) description language defines the way all of the parts of the system are handled, giving a consistent view of all components within the system.

The IEC 61850 standard was developed for electrical substation automation, but has been applied to Distributed Energy resources, distribution line equipment, hydro-electric power plants, and wind power plants.

D.1.1 Relationship of Clients and Servers in IEC 61850

The understanding of the roles of clients and servers and publishers and subscribers is key to the use of IEC 61850 devices.

A client is the requester (sink) of information while the server is the responder (source) of information. Information generally flows on a request-response basis with the client issuing the request and the server issuing the response. However, the concept of servers is extended to provide autonomous transmissions when “interesting” events occur within the server. This information flow is always to the client requesting this “interesting information.” Clients are the devices or services which “talk” to IEC 61850 servers. The function of the client is to configure the server “connection,” set up any dynamic information in the server, enable the reporting mechanisms, and possibly interrogate specific information from the server. Most clients are relatively passive devices which await information from the server but perform little direct ongoing interactions with them except for control operations.

Some clients are used for diagnostic purposes. These devices generally perform ongoing direct interrogation of the servers. A specific example is the “desktop client,” where the engineer remotely diagnoses system problems or retrieves data which is not normally sent from the server (for example, power quality information).

IEC 61850 clients are highly interoperable with IEC 61850 servers. Clients are able to retrieve the server object directory (when needed) and then perform any allowable operation with that server.

Example clients include: Omicron IED scout, SISCO AX-S4 61850, TMW Hammer, KalkiTech gateway, Siemens DIGSI.

An example of the object model display on a diagnostic client is shown in the following figure.

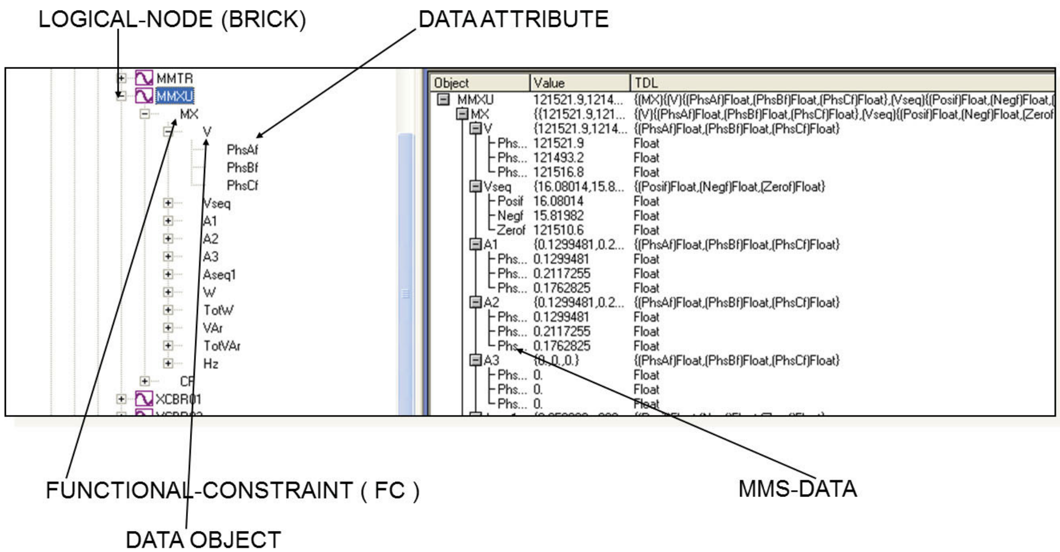


Figure D-1: Object Model Display on a Diagnostic Browser

NOTE

There is an additional relationship in IEC 61850, known as publisher and subscriber. The publisher/subscriber relationship differs from the client/server in that there is no explicit one-to-one relationship between the information producer and consumer. Publishers issue data without knowledge of which devices will consume the data, and whether the data has been received. Subscribers use internal means to access the published data. From the viewpoint of IEC 61850, the publisher/subscriber mechanism uses the Ethernet multicast mechanism (i.e. multicast MAC addresses at layer 2). The communication layer of the system is responsible for transmitting this information to all interested subscribers and the subscribers are responsible for accepting these multicast packets from the Ethernet layer. The publish/subscribe mechanism is used for GOOSE and Sampled Value services. Note that GOOSE and Sampled Value services are not available with the EPM 7000 meter's IEC 61850 Protocol Ethernet Network card.

D.1.2 Structure of IEC 61850 Network

As mentioned before, IEC 61850 lets you set up an automated communication structure for devices from any vendor. In order to set up this network, IEC 61850 renames devices (e.g., meters), measured parameters (e.g., Phase to Phase Voltage), and functions (e.g., reporting) into a specific language and file structure. This way all of the elements of the network can function together quickly and effectively. The language that the IEC 61850 network uses is structured, that is it is very specific in how the system information is entered, and hierarchical, which means that it has different levels for specific information; for example, meter information is entered on one level, and the information about the actual physical connection between meters and other hardware is entered on another level.

The structure of the IEC 61850 network is composed of different kinds of files, each containing information that the system needs in order to function. IEC 61850 configuration uses text-based (XML) files known as the System Configuration Language (SCL). SCL files use the concept of an XML schema, which defines the structure and content of an XML file. The schema used by SCL files describes most (though not all) of the restrictions required to ensure a consistent description file. An SCL file superficially looks like an HTML file. It consists of 6 parts:

- Prologue: XML declaration, (XML) namespace declarations, etc.
- Header element: Names the system and contains the file version history
- Substation element: defines the physical structure of the system
- Communication element: defines all device-to-device communication aspects
- IED element: defines the data model presented by each communicating device
- DataTypeTemplates element: contains the detailed definition of data models

After it is written, the XML file can be checked by "validators" against the schema using freely available tools.

The IEC 61850 network uses four types of SCL files, each with identical structure:

• SSD - System Specification Description: used during the specification stage of a system to define physical equipment, connections between physical equipment, and Logical Nodes which will be used by each piece of equipment.

• ICD - IED Capability Description: this is provided by the communication equipment vendor to specify the features of the equipment and the data model published by the equipment. Each of the devices in the network has an ICD file which describes all of the information about the device, for example, IP address on the network and Com ports. The (vendor supplied) ICD variation of the SCL file contains a Communication section specifying the lower-layer selectors and default addressing and also an IED section containing the data model of the device. See Section E.4.2 for information on the EPM 7000 meter’s .icd file.

• SCD - System Configuration Description: a complete description of the configured automation system including all devices (for example, meters, breakers, and relays) and all needed inter-device communications (for example, the measured parameters and the actions to be performed, such as turning on a relay when a certain reading is obtained). It can also include elements of the SSD file. The SCD file is created by a System Configurator, which is a software application that takes the information from the various devices along with other configuration parameters and generates the SCD file.

• CID - Configured IED Description: the file used to configure an individual device. It is a pure subset of the SCD file. The device may also have a CID file, which is a smaller subset of the device’s ICD file. The CID file describes the exact settings for the device in this particular IEC 61850 network. The EPM 7000 meter’s IEC 61850 Protocol Ethernet Network card uses a CID file. See Section E.4.2 for information on uploading the EPM 7000 meter’s .cid file.

Each type of SCL file has different required elements with only the prologue and Header element required in every file type.

Elements of an IEC 61850 Network

- A physical device has a name (IEDname) and consists of one or more AccessPoints.
- An AccessPoint has an IP address and consists of one or more Logical Devices
- A Logical Device contains LLN0 and LPHD1 and optional other Logical Nodes.

- LLN0 (Logical Node Zero) is a special object which "controls" the Logical Device. It contains all of the datasets used for unsolicited transmission from the device. It also contains the report, SV, and GOOSE control blocks (which reference the datasets).
- LPHD1 (Physical Device) represents the hardware "box" and contains nameplate information.
- Logical Nodes (LNs) are standardized groups of "Data Objects" (DOs). The grouping is used to assemble complex functions from small groups of objects (think of them as building blocks). The standard defines specific mandatory and optional DOs for each LN. The device may instantiate multiple LNs of the same type differentiated by either a (named) prefix or (numerical) suffix.
- Data Objects represent "real-world" information, possibly grouped by electrical object. The IEC 61850 standard has specific semantics for each of the DOs. For example, the DO named "PhV" represents the voltage of a point on a three-phase power system. The DOs are composed of standardized Common Data Classes (CDCs) which are groups of low-level attributes of the objects. For example, the DO named "Hz" represents system frequency and is of CDC named "MV" (Measurement Value).
- Common Data Classes (CDCs) consists of standardized groups of "attributes" (simple data types). For example, the attribute "instMag" represents the instantaneous magnitude of the underlying quantity. The standard specifies mandatory and optional attributes for each CDC. For example, the DO named "Hz" in Logical Node class MMXU contains a mandatory attribute named "mag" which represents the deadbanded value of the frequency. The physical device contains a database of data values which map to the various structures described above. The database values are manipulated by the device to perform actions such as deadbanding (holding a constant value until the underlying value changes by more than a specified amount) or triggering of reports.

D.1.3 Steps in Configuring an IEC 61850 Network

1. The first thing needed is the SSD for physical connections, then the vendor-provided ICD files which are combined into a SCD file by a vendor-independent System Configurator. The System Configurator assigns addresses to the equipment and sets up datasets, reports, etc. for inter-device communication. The system configurator will create an "instance" of the configured device by applying the following information:
   - The name of the device
   - The IP address, subnet mask, and IP gateway of the device
   - Datasets: the user must decide which information within the IED will be included in reports, etc. and place this information into datasets. The System Configurator should allow the selection of information using a "pick list" from information within the ICD file.
2. The resulting SCD file is then imported by vendor-specific tools into the various devices. Some vendors add the additional step of filtering the SCD file into a smaller file containing only information needed by the specific device, resulting in a CID file which is used to configure the device. The actual configuration of the device is left unspecified by IEC 61850 except to require that the SCD file remains the source of the configuration information. In this way, consistency of the information across the whole system is maintained.

See Figure E-2 for a graphical illustration of the process.

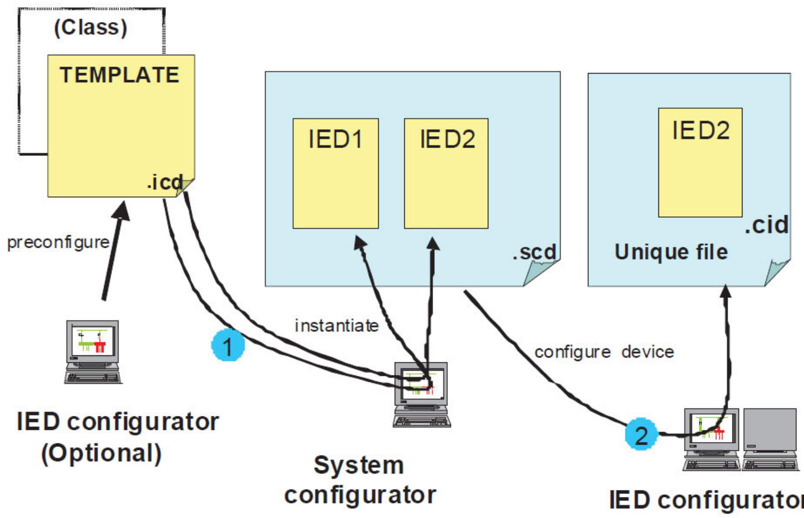


Figure D-2: Configuration Process

Referring to Figure E-2:

In step 1, the IED template is provided by the vendor (or sometimes created by a vendor tool). This file is imported into the vendor-independent tool, the System Configurator, along with other device templates. The System Configurator uses these templates to set up the correct number of IEDs in the system and then provides configuration information. The configuration information consists of providing addresses for all IEDs in the system, creation of datasets, configuring control blocks, and setting individual device parameters such as analog deadbands. The System Configurator then creates a SCD file with a consistent view of the entire system.

In step 2, the SCD file is used to configure each device using vendor-supplied tools. Vendors are free to choose the configuration mechanism, but the configuration information MUST be derived from the SCD file.

NOTE

In the EPM 7000 meter's IEC 61850 Protocol Ethernet network card implementation, every service and object within the server is defined in the standard (there is nothing non-standard in the device).

Also in step 2, the user sets up report control blocks, buffered and unbuffered, for each of the clients. Setup information includes the dataset name, a report identifier, the optional fields to be used in the report, the trigger options, buffer time (delay from first event to report issuance), and integrity time (server periodic reports of all data in the dataset). The decision whether to use buffered or unbuffered must be decided by the user.

Finally, in step 2 the System Configurator performs a consistency check and then outputs the SCD file. The SCD file is imported by the "ScdToCid" tool where the user specifies the device name.

The resulting CID file is then imported into the target device.

D.1.4 General Electric's Implementation of the IEC 61850 Server

Following are features of GE Digital Energy's IEC 61850 implementation:

- The lower-level addressing uses PSEL=00000001, SSEL=0001, and TSEL=0001.
- At the server level, each implements a single Logical Device name formed by concatenating the IED name (chosen by the System Configurator) and "Meas" (eg., "MyDeviceMeas").
- The Logical Nodes implemented within the Logical Device include the standard LLN0 and LPHD1 with optional standard logical nodes in the "M" class (ex, "MMXU") and "T" class (eg., "TVTR"). Each Logical Node contains only standardized objects of standardized types (Common Data Class, CDC). The device is based upon the first edition of the IEC 61850 standards.
  Examples of Logical Nodes within the EPM 7000 family include eneMMTR1 (energy metering) and nsMMXU1 (normal speed Measurement Unit).
- The EPM 7000 device gets its IED name from the first <IED> section in the configuration file (.cid). This name is used for accessing its access point (IP address) and its single Logical Device named "Meas". The IED name can be composed of any string of up to 32 (alphanumeric only) characters.
- The logical nodes implemented in the EPM 7000 meter are listed below:
  - The node "LLN0" keeps common information for the entire logical device. In this node Datasets and Reports can be defined, based on the limitations provided in the ICD file: the EPM 7000 meter supports up to 8 datasets with up to 256 attributes, and up to 16 report control blocks. The report control blocks and datasets must be configured in the CID file, although the options, triggers and integrity period can be dynamically configured by IEC client. (The EPM 7000 meter does not support Goose nor Journals.)
  - The node LPHD1 defines physical parameters such as vendor, serial number, device name plate and the software revision number.
  - The node "nsMMXU1" contains the "normal-speed" basic electrical measurements such as Volts / Amps / Watts / VARs / Frequency / Power Factor / etc. The electrical measurements are data objects in hierarchical structure as per the IEC 61850 specifications.
    For example, Phase A voltage:
    - which is in the object "PhV"
    - which is of type "WYE_ABC_mag_noDC"
    - which in turn has the object "phsA"
    - which again has an attribute named "instVal" to represent instantaneous values, and also the "mag" attribute, which represents the magnitude as an analog magnitude, with the attribute "f" to get the value in 32-bit floating point.

    Thus the voltage of phase A, would be referred in this nested structure as "Meas/nsMMXU1.PhV.phsA.instVal.mag.f".
  - The node "nsMHAI1" groups together the THD per phase measurements taken at normal speed.
    Following the previous example, the THD for phase A would be referred as "Meas/nsMHAI1.ThdPhV.phsA.instCVal.mag.f".
  - The node "eneMMTR1" groups together all measurements related to energy counters, like +/- Watt;hours, +/- VAr-hours and Total VA-hours.
  - The nodes "setTCTR1", "setTCTR2", "setTCTR3" and "setTCTR4" contain the ratio of the current used by the measuring device, for phases A,B,C and Neutral,

respectively. In this way, the user can take the IEC measurements (primary) and convert them to Secondary using the ratios contained in these nodes.

- The nodes "setTVTR1", "setTVTR2" and "setTVTR3" contain the ratio of the voltage used by the measuring device.

- Any of the defined objects/ attributes can be placed within a dataset.
- The normal-speed in the EPM 7000 meter is measurements taken every second. The energy counters are also updated every second.

The configuration of the devices takes place by converting the SCD file exported by the System Configuration tool into a CID file. This CID file contains all of the information from the SCD file which is needed for configuration by the GE device. The tool is named "SCDtoCIDConverter" and is a simple, publicly available program. The resulting CID file is then sent to the GE device using HTTP file transfer.

EPM 7000 Server Configuration

The configuration file (CID) must be stored in the EPM 7000 meter in order to configure the server. At power up the server reads the file, parses it and configures all the internal settings for proper functionality.

Storing the CID file in the EPM 7000 meter is accomplished through its webpage. The webpage allows the user to locate the CID file, and submit it to the EPM 7000 meter for storage.

The EPM 7000 meter does not need to be reset in order to accept the new configuration, unless the IP address has been changed.

After storing the CID file, access the EPM 7000 meter’s webpage again, to make sure that the file has been stored, and to see if there is any problem with it, by checking its status.

- A common problem that can occur is IP mismatch (the IP address in the CID file does not match the IP configured in the EPM 7000 meter’s device profile). In this case the EPM 7000 meter uses the IP address from its device profile, and the IEC Server will work only with that address.
- If there is a critical error in the stored CID file, which prevents the IEC Server from running, the CID file will not be used, and instead the Default CID file (embedded in the server) will be used. The webpage will alert you to this situation.
- If further details are needed, for example, information on the reason the CID storage failed, the web server provides a link to the system log. In the system log screen you can view messages from the IEC 61850 parser, and you can take actions to correct the error. See Section E.2 for instructions on configuring the EPM 7000 meter’s IEC 61850 Protocol Ethernet Network card.

D.1.5 Reference Materials

Following is a list of background information on IEC 61850 that is available on the Internet:

- http://www.sisconet.com/downloads/IEC61850_Overview_and_Benefits_Paper_General.pdf
- http://www.sisconet.com/downloads/CIGRE%202004%20Presentations.zip (IEC618650 Presentation IEC 61850 û Data Model and Services.pdf)

- http://www.ucaiug.org/Meetings/Austin2011/Shared%20Documents/IEC_61850-Tutorial.pdf (pages 24 to 32 and 40 to 161)
- http://brodersensystems.com/wordpress/wp-content/uploads/DTU-Master-Thesis-RTU32.pdf (pages 9 to 36)

Additionally, there is a good article on the predecessor to IEC 61850 (UCA 2.0) at http://www.elp.com/index/display/article-display/66170/articles/utility-automation-engineering-td/volume-5/issue-2/features/uca-20-for-dummies.html.

Another good article on multi-vendor IED integration can be found at http://www.gedigitalenergy.com/smartgrid/Aug07/EIC61850.pdf.

D.1.6 Free Tools for IEC 61850 Start-up

The Internet also provides some free IEC 61850 configuration tools:

- Schema validation tools: http://notepad-plus-plus.org/go to plug-in manager and install XML tools (however, there is no (legal) public copies of the schema available). However, a web search file see the filename SCL_Basetypes.xsd turns up many copies and the entire set of XSD file is often nearby.
- http://opensclconfig.git.sourceforge.net/Apparent open-source project, not tested
- http://www.sisconet.com/downloads/SCDtoCIDConverter0-9.exe filters SCD file to a CID file
- http://www.sisconet.com/downloads/skunkworks2-8.exe Ethernet analyzer

D.1.7 Commercial Tools for IEC 61850 Implementation

Following is a list of tools for IEC 61850 configuration which you can purchase:

- http://www.sisconet.com/ax-s4_61850.htm
  Client for IEC 61850
- http://products.trianglemicroworks.com/documents/TMW%2061850%20Test%20Suite%20Combined.pdf
  Clients and servers for IEC 61850
- http://www.omicron.at/en/products/pro/communication-protocols/iedscout/test client
- http://kalkitech.com/products/sync-6000-series-scl-manager--iec61850-substation-design-tool
  SCL editing tool

D.2 Using the EPM 7000 Meter's IEC 61850 Protocol Ethernet Network Card

This section contains instructions for understanding and configuring the EPM 7000 meter's IEC 61850 Protocol Ethernet Network Option card.

D.2.1 Overview

The IEC 61850 Protocol Ethernet Network card is a EPM 7000 standard I/O board. The IEC 61850 Protocol Ethernet Network card has the following features:

- Standard Ethernet 10/100 Mbps connector is used to link the unit into an Ethernet network.
- Standard operation port 102, which can be reconfigured to any valid TCP/IP port.
- Up to 5 simultaneous connections can be established with the unit.
- Configurable via the .CID file (XML formatted)
- Embedded Capabilities File (.ICD downloadable from the unit)
- Supports MMS protocol.
- Supports the following Logical Nodes:
    - LLN0 (with predefined Sets and Reports)
    - LPHD (Identifiers)
    - MMXU with
        - Phase-to-N Voltages
        - Phase-to-Phase Voltages
        - Phase Currents
        - Per Phase VA
        - Total VA
        - Per Phase Var
        - Total Var
        - Per Phase W
        - Total W
        - Per Phase PF
        - Total PF
        - Frequency
    - MHAI with Per Phase THD
    - MMTR with
        - Demand Wh
        - Supplied Wh
        - Demand Varh
        - SuppliedVArh
        - Total VAh
- Supports polled (Queried Requests) operation mode.
- Supports Buffered Reports
- Supports Unbuffered Reports

D.2.2 Installing the IEC 61850 Protocol Ethernet Network Card

The IEC 61850 Protocol Ethernet Network card can be installed in either I/O card slot #1 or slot#2. Make sure the EPM 7000 unit is powered down when installing the IEC 61850 Protocol Ethernet Network card. Follow the procedure in Chapter 7.

Connect the network card to a Hub/Switch with a Cat5 Ethernet cable. Both ends must be firmly placed in the RJ45 receptacles.

Turn on the EPM 7000 unit. After about 10 seconds, the Link LED near the RJ45 Ethernet connector on the IEC 61850 Protocol Ethernet Network card will light, which means a link has been established to your network, and the EPM 7000 meter has correctly identified the IEC 61850 Protocol Ethernet Network card. (The first time you connect, it may take up to 30 seconds for the link to be established.)

D.2.3 Configuring the IEC 61850 Protocol Ethernet Network Card

The IEC 61850 Protocol Ethernet Network card must be configured for communication, both from the standpoint of the device (the Device Profile) and of the network (the SCL configuration file, which is a .cid file uploaded to the meter.)

Configuring the Device Profile IEC 61850 Protocol Ethernet Network Card Settings

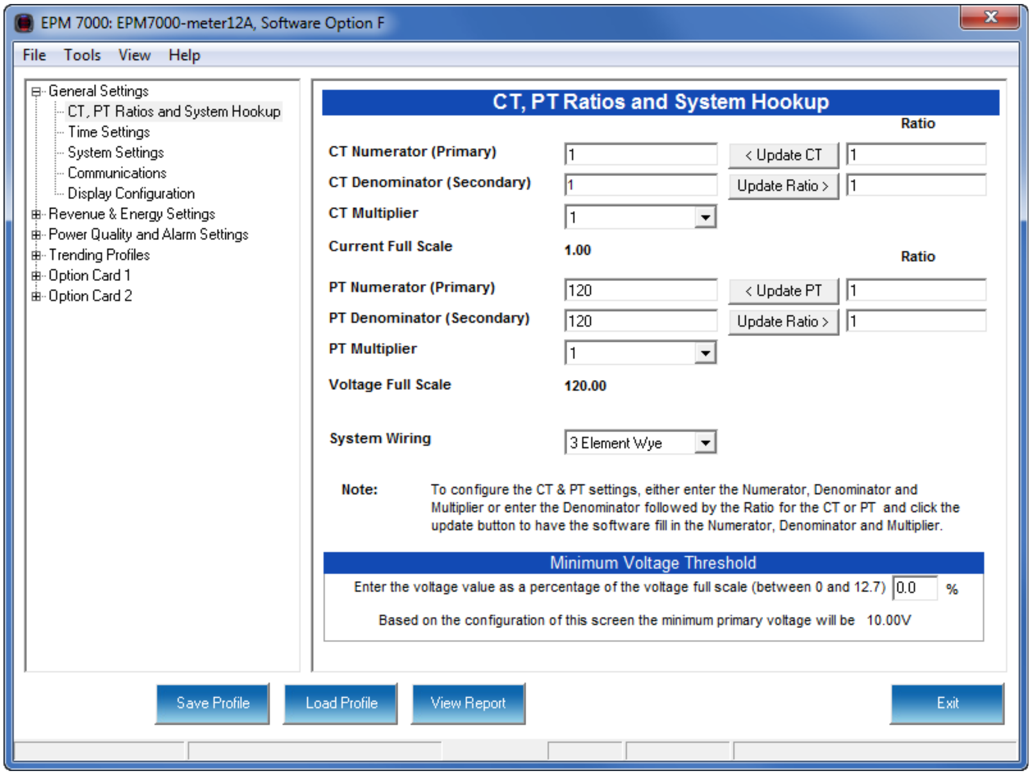
Use the GE Communicator application to set the card's network parameters. Basic instructions are given here, but the user can refer to the *GE Communicator Instruction Manual* for additional information. The user can view the manual online by clicking **Help>Contents** from the GE Communicator software main screen.

The following information is required:

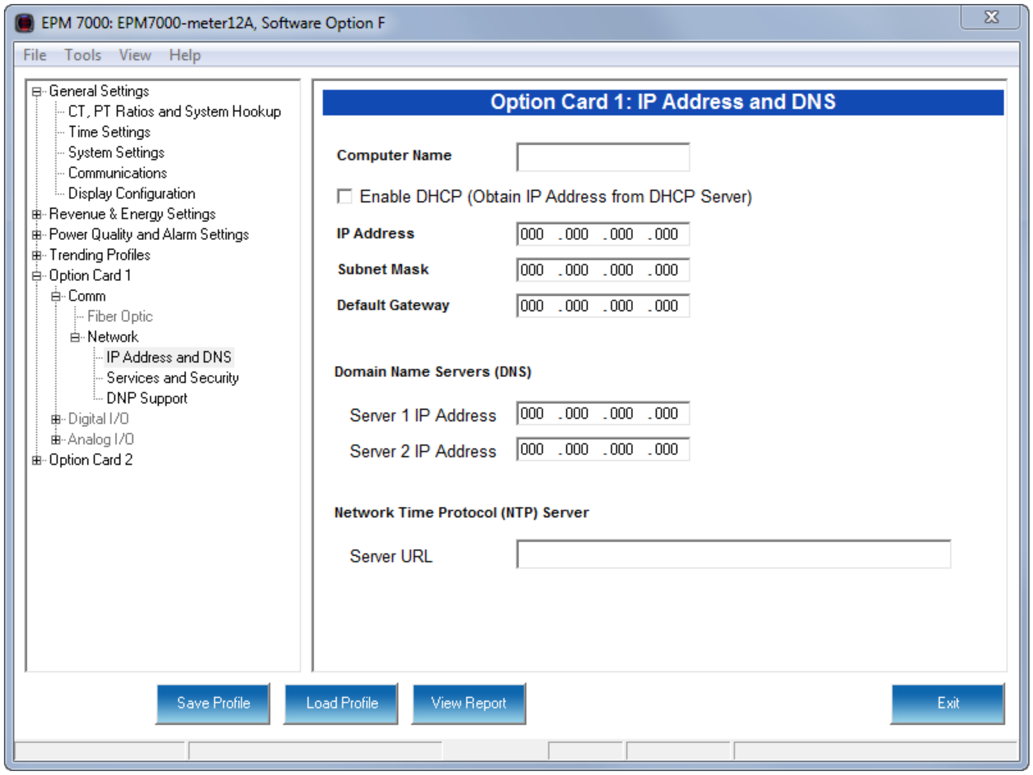
- The IP address to be assigned to the card
- The Network Mask used on your network
- The IP address of the Gateway on your network (you can use 0.0.0.0 if you don't have a gateway IP address)
- The IP address of the DNS (Domain Name Server) on your network (only needed if you plan to use URLs instead of IP addresses for the NTP (Network Time Protocol); if it is not needed you can leave this field blank)
- The IP address of the NTP server on your network, or the URL if you configured the DNS in the previous entry field

1. Using the GE Communicator software, connect to the meter through its RS485 serial port, or through an E1 Network Card if one is installed in the other Option card slot (see Chapter 5 for instructions on connecting to your meter with the GE Communicator software).

2. Click the Profile icon to open the meter's Device Profile screen The profile is retrieved from the EPM 7000 meter.



3. From the Tree menu on the left side of the screen, click on the + sign next to the IEC 61850 Protocol Ethernet Network Option card (Option Card 1 or Option Card 2), then click Comm>Network>IP Addresses and DNS.



4. Fill in the information on this screen.
   - Computer Name: the name of the device on the network (accessed through the Network card)
   - IP Address: the IP v4 address for the unit on the network.
   - Subnet Mask: the IP v4 mask, which identifies the sub-network to which the unit belongs.
   - Default Gateway: the IP v4 address of the gateway device on the network.
   - Domain Name Server 1 and 2: if DNS is used, the IP addresses of the DNS server(s) on the network.
   - Network Time Protocol (NTP) server: the url of the NTP server, if one is being used for time synchronization.

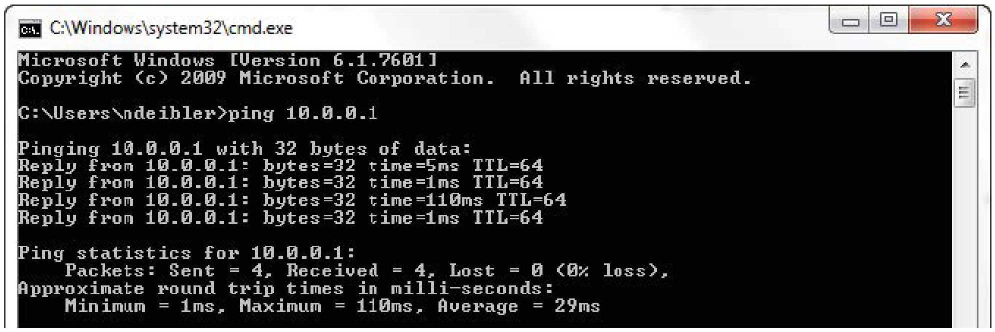
NOTE

- The IEC 61850 Protocol Ethernet Network card needs time information to work properly. The time can be provided either by a Network Time Protocol (NTP) server or by the EPM 7000 meter itself (via Line Sync, which is selected and enabled through the Time Settings screen). If you enter an NTP server on this screen, you still need to enable it in the Time Settings screen (see the instructions in Chapter 5). See Section 8.4.3 for additional information on NTP.
- All of these parameters must be properly set up in order to allow the EPM 7000 meter to communicate on the network. After configuration, a simple "ping" test can be performed to see if the EPM 7000 meter is correctly connected to the network:

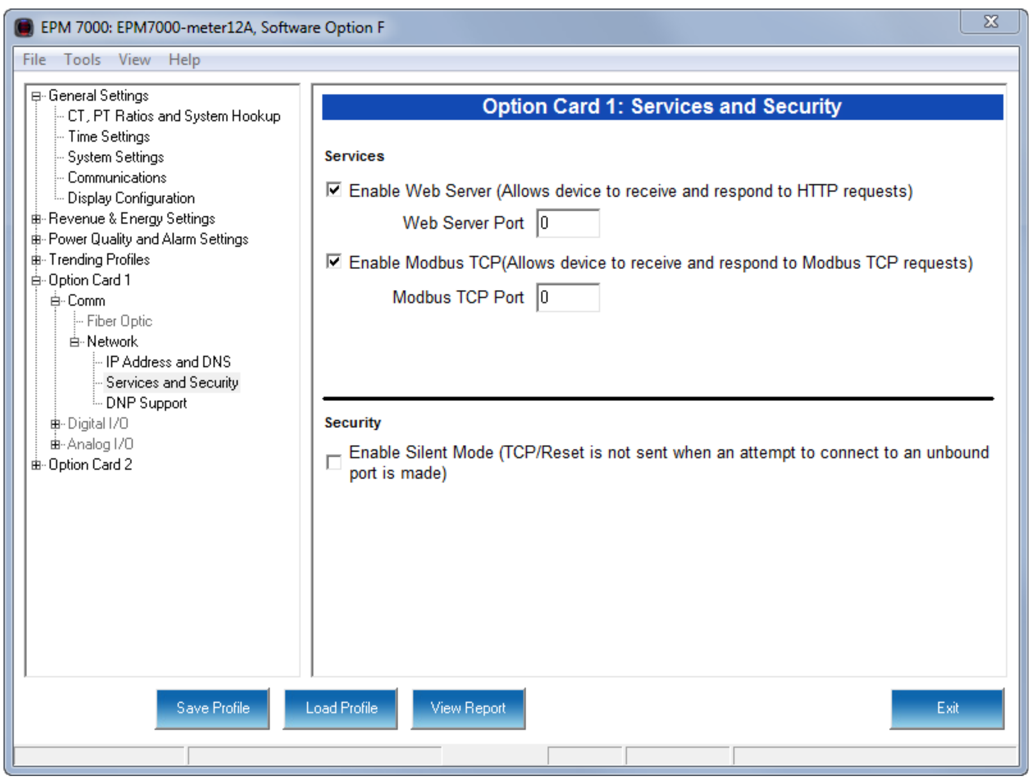
a. From the Start menu, type **run** and press **Enter**.

b. In the Run window, type **cmd** and click **OK**.

c. In the command window type **ping Network Card's IP address**. See the example screen.



5. From the Tree menu, click **Services and Security**.



6. Check the Enable Web server box, and set the Web server port to 80 (this is the default).

7. Click Update Device to send the settings to the EPM 7000 meter. The meter will reboot. The IEC 61850 Protocol Ethernet Network card is now configured properly to work on an IEC 61850 network.

Configuring the Meter on the IEC 61850 Network

The System Integrator must configure the EPM 7000 meter within the substation IEC 61850 network. To do this, the System Integrator needs the EPM 7000 capabilities file (.icd) (as well as information about the rest of the devices in the network).

This .icd file, as mentioned earlier, is the SCL file that contains the IEC 61850 nodes, objects, and parameters implemented in the EPM 7000 meter, including the Network IP address.

This .icd file will be processed with the rest of the system (clients, other meters, switches, breakers, etc., in the network) and the resulting file, which will be uploaded to the meter to configure it, is the Configured IED Description file (.cid file).

The IP address for the EPM 7000 meter is contained in the Communication section of this .cid file. See the example Communication section, below.

NOTE

If the CID file to be uploaded has more than one IED definition block, the EPM 7000 meter will take the first one in the file.

```
<Communication>
 <SubNetwork name="Subnet_MMS" type="8-MMS">
  <BitRate unit="b/s" multiplier="M">10</BitRate>
  <ConnectedAP iedName="EPM7000IEC" apName="S1">
   <Address>
    <P type="OSI-PSEL" xsi:type="tP_OSI-PSEL">00000001</P>
    <P type="OSI-SSEL" xsi:type="tP_OSI-SSEL">0001</P>
    <P type="OSI-TSEL" xsi:type="tP_OSI-TSEL">0001</P>
    <P type="IP" xsi:type="tP_IP">172.20.167.199</P>
   </Address>
  </ConnectedAP>
 </SubNetwork>
</Communication>
```

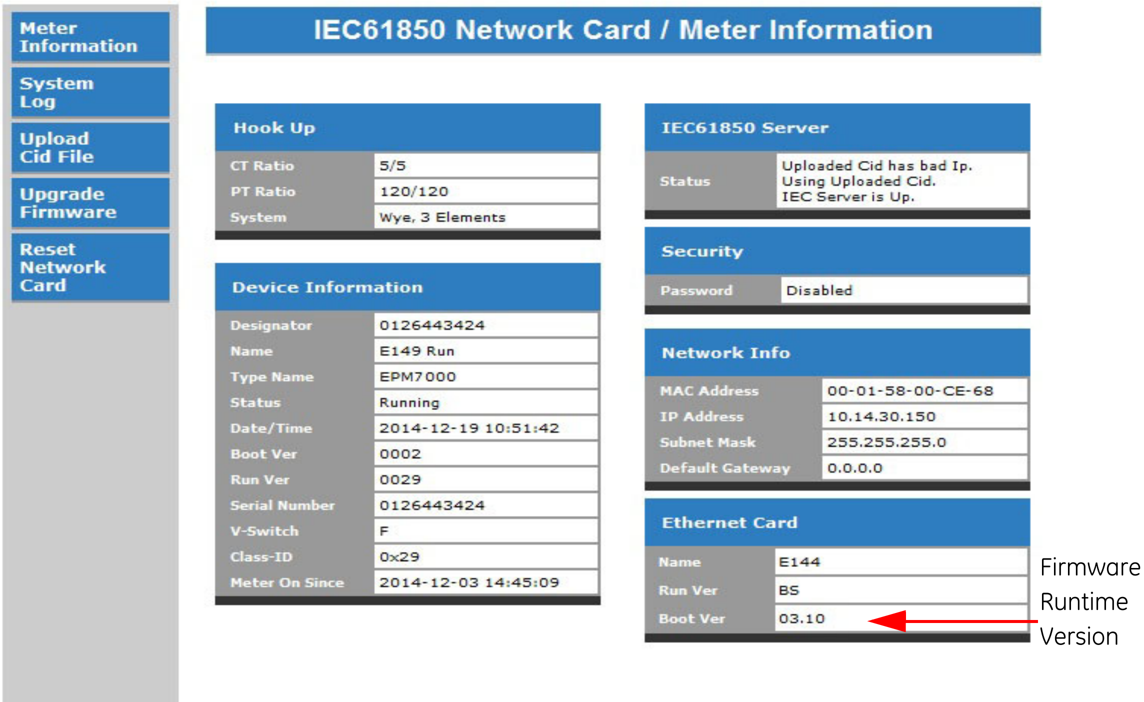
The node <P type="IP" xsi:type="tP_IP"> (bolded in the example above) defines the meter's IP address. This IP address must be the same as the IP address configured in the meter's Device Profile (see step 4 in Section E.4.1) for each IEC 61850 Protocol Ethernet Network card in the meter.

Also, make sure that the iedName field in the ConnectedAp section (underlined in the example) is the same as the name field defined in the IED section.

This is how the unit is assigned its name and IP address.

1. The EPM 7000 meter's .icd file can be downloaded directly from the EPM 7000 unit. To do this, use a web browser and key:
   http://aa.bb.cc.dd/

where aa.bb.cc.dd is the IP address assigned to the IEC 61850 Protocol Ethernet Network card (see Section E.4.1).

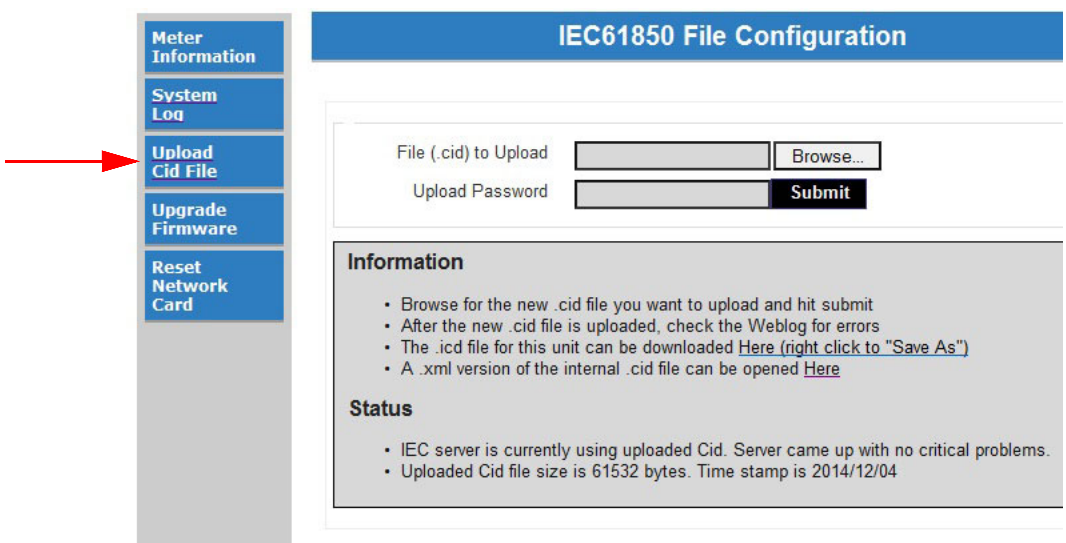


The Meter Information webpage is displayed.

NOTE

The firmware runtime version which is displayed in the Run Ver field of this webpage determines the default password for Network card upgrading, uploading the .cid file, and resetting the Network card.

2. From the left side of the screen, click Upload Cid File.



3. The Information area contains instructions for downloading an xml version of the ".icd" file. Right-click the "Here (right click to "Save As")" link, and save a copy of the .icd file on your computer. An example of a downloaded .icd file is shown below.


```
<?xml version="1.0" encoding="UTF-8"?>
<SCL xmlns="http://www.iec.ch/61850/2003/SCL" xmlns:xsi="http://www.w3.org/
2001/ XMLSchema-instance" xsi:schemaLocation="http://www.iec.ch/61850/2003/
SCL SCL.xsd" xmlns: ext="//nari-relays.com">
<Header id="EPM 7000 ICD" name Structure="IEDName" version="1.0" revision="">
 <History>
  <Hitem version="1.0" revision="13" when="9-May-2012" who="BAM" what="initial
draft" why="initial ICD">
  </Hitem>
 </History>
</Header>
<Communication>
 <SubNetwork name="Subnet_MMX" type="8-MMS">
  <BitRate unit="b/s" multiplier="M">10</BitRate>
  <ConnectedAP iedName="EPM 7000IEC" apName="S1">
   <Address>
    <P type="OSI-PSEL" xsi:type="tP_OSI-PSEL">00000001</P>
    <P type="OSI-SSEL" xsi:type="tP_OSI-SSEL">0001</P>
    <P type="OSI-TSEL" xsi:type="tP_OSI-TSEL">0001</P>
    <P type="IP" xsi:type="tP_IP">10.0.0.24</P>
   </Address>
  </ConnectedAP>
 </SubNetwork>
</Communication>
<IED name="EPM 7000IEC" desc="General Electric EPM 7000" type="E7000"
manufacturer="GeneralElectric" configVersion="1.00">
<Service>
 <DynAssociation>
```


4. Once the System Integrator has processed the EPM 7000 meter's .icd file and the information of the other devices on the network (using either automated tools or manually), the final result is a configuration file with the extension ".cid". This file must now be uploaded to the EPM 7000 meter's IEC 61850 Protocol Ethernet network card.
5. To upload the .cid file, go to the IEC 61850 File Configuration screen shown in step 2.
6. Click the Browse button to locate the .cid file you want to upload.

7. Fill in the upload password: the default is **manager** for firmware runtime version 3.35 and later; and **genet2009** for earlier firmware runtime versions. See the note on page D-20.
8. Click Submit. The upload process begins. When the upload is finished a report is shown on the screen.

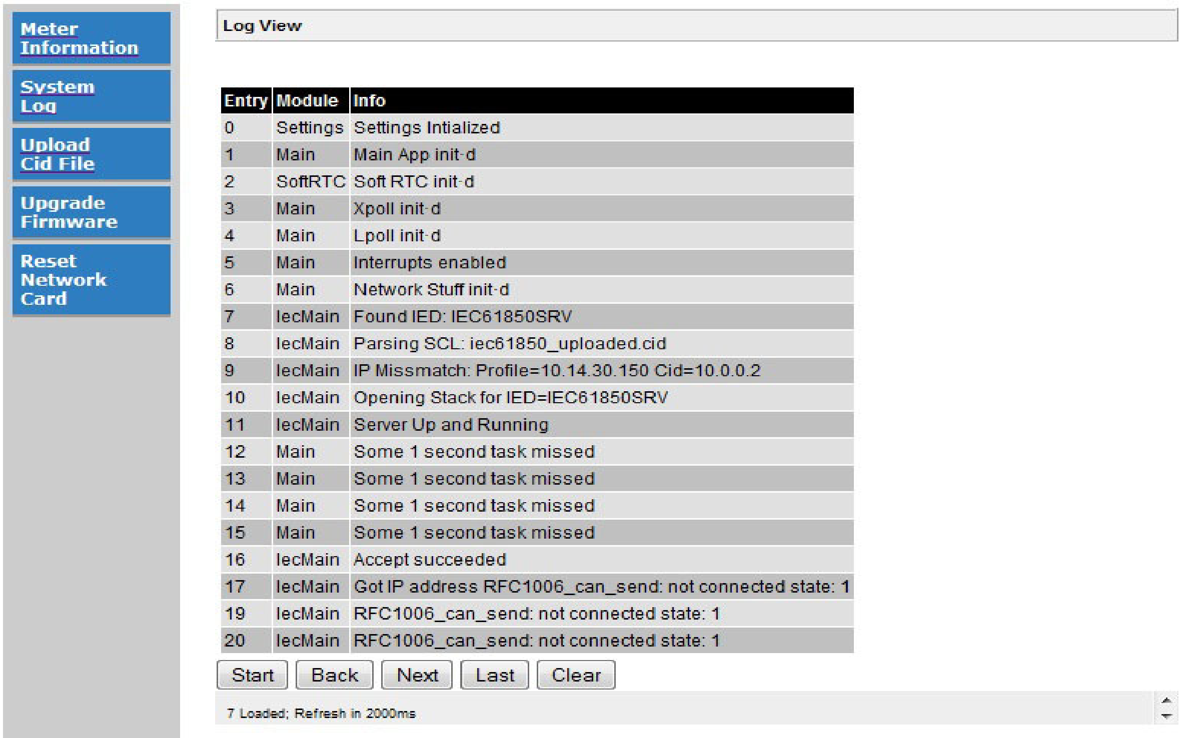
IMPORTANT NOTES!

- The IP address configured into the IEC 61850 Protocol Ethernet Network card with the GE Communicator software must be the same as the IP address configured in the .cid file. This is necessary to insure proper communication. If there is a communication problem it will be reported on the IEC 61850 Protocol Ethernet Network card's Meter Information screen, shown in step 1 on page D-20.
- The maximum size of the .cid file is 250KB. Avoid putting too many comments or unnecessary historical information into the file. If the file is bigger than 250KB it will be rejected by the IEC 61850 Protocol Ethernet Network card.
- The sAddr fields in each object of the .icd file must be preserved when generating the .cid file. Do not change these, because they are used internally by the IEC 61850 server.
- If the .cid file has more than one IED definition block, the first one in the file will be used by the network.
- Do not use non-ASCII characters in your .cid file (such as punctuation marks). Non-ASCII characters can cause the parsing of the .cid file to fail.
- You do not need to reboot the Network Card or the EPM 7000 meter when the .cid file is uploaded, unless the IP address has changed.
- If the uploaded .cid file has non-critical errors, the IEC 61850 Protocol Ethernet Network card will use the file anyway and will start up. Any errors can be seen in the Start Up log (see instructions below).
- If the uploaded .cid file has critical errors, the IEC 61850 will use the default .cid file (not the uploaded file) and it will start up. The errors can be seen in the Start Up log (instructions follow).
- The default .cid in the IEC 61850 Protocol Ethernet Network card is for demonstration only. It must be modified to suit the actual application needs.
- The default .cid in the IEC 61850 Protocol Ethernet Network card has an arbitrary IED name, which must be replaced by the user's own name.

D.3 Viewing the IEC 61850 Protocol Ethernet Network Card's System Log

The IEC 61850 Protocol Ethernet Network card's main webpage (Meter Information webpage) has general information on the status of the card (e.g., version, healthy, serial number) and the status of the IEC 61850 server (e.g., ok, errors in the uploaded.cid file).

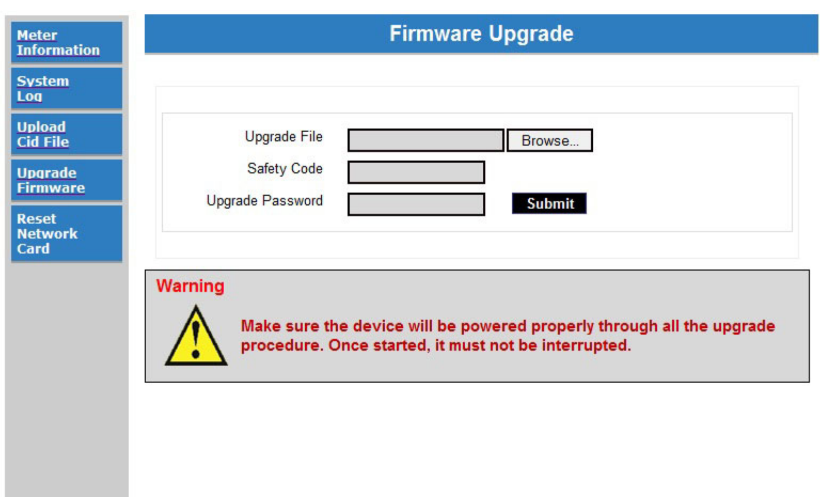
In addition to this information there is a System log, which contains events (e.g., errors and warnings) from the IEC 61850 protocol layer, including problems found when parsing the .cid file. To view the System log's webpage, click System Log from the left side of the Meter Information webpage.



A screen will be shown that is similar to the one shown above. Oldest messages appear first on the screen. The buttons at the bottom of the screen let you navigate through the message pages (Start, Back, Next, Last) or remove all of the messages (Clear).

D.4 Upgrading the IEC 61850 Protocol Ethernet Network Card's Firmware

To upgrade the IEC 61850 Protocol Ethernet Network card's firmware, click Upgrade Firmware from the left side of the webpage.



You will see a screen similar to the to the one shown.

1. Click the Browse button to locate the Upgrade file. Make sure that you select the E2 option card upgrade file. If you upgrade with the E1 upgrade file, the card will work, but most IEC 61850 features will be disabled. In that case, perform the upgrade again, using the correct E2 upgrade file.
2. Enter the Safety Code.
3. Enter the Upgrade Password: the default is **manager** for firmware runtime version 3.35 and later; and **genet2009** for earlier firmware runtime versions.
4. Click Submit. Be sure to keep the meter powered during the firmware upgrade. After the upgrade process is complete, the Network card will reset.

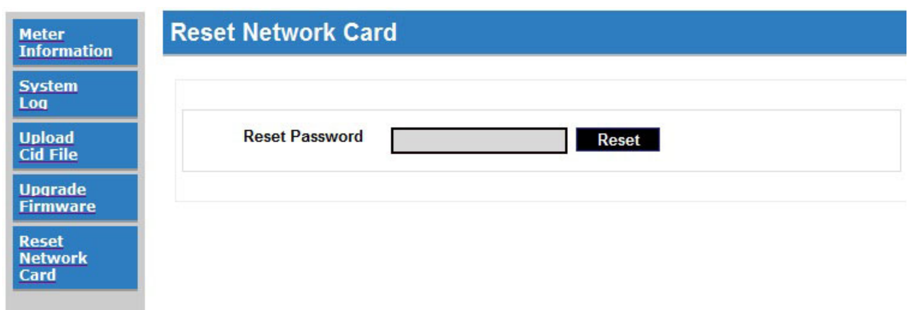
NOTE

As a result of the reset, the communication link with the card will be lost and must be re-established.

D.5 Resetting the IEC 61850 Protocol Ethernet Network Card

If you need to reset the IEC 61850 Protocol Ethernet Network card, you can either do a hardware reset (see Section 8.4) or use the Reset Network Card webpage.

1. Click **Reset Network Card** from the left side of the webpage.



2. You will see a screen similar to the one shown above. Enter the Reset Password: the default is adminR35et for firmware runtime version 3.35 or later; and r2d2andc3po for earlier firmware runtime versions. See the note on page A-21.
3. Click the Reset button. The Network card will reset.

NOTE

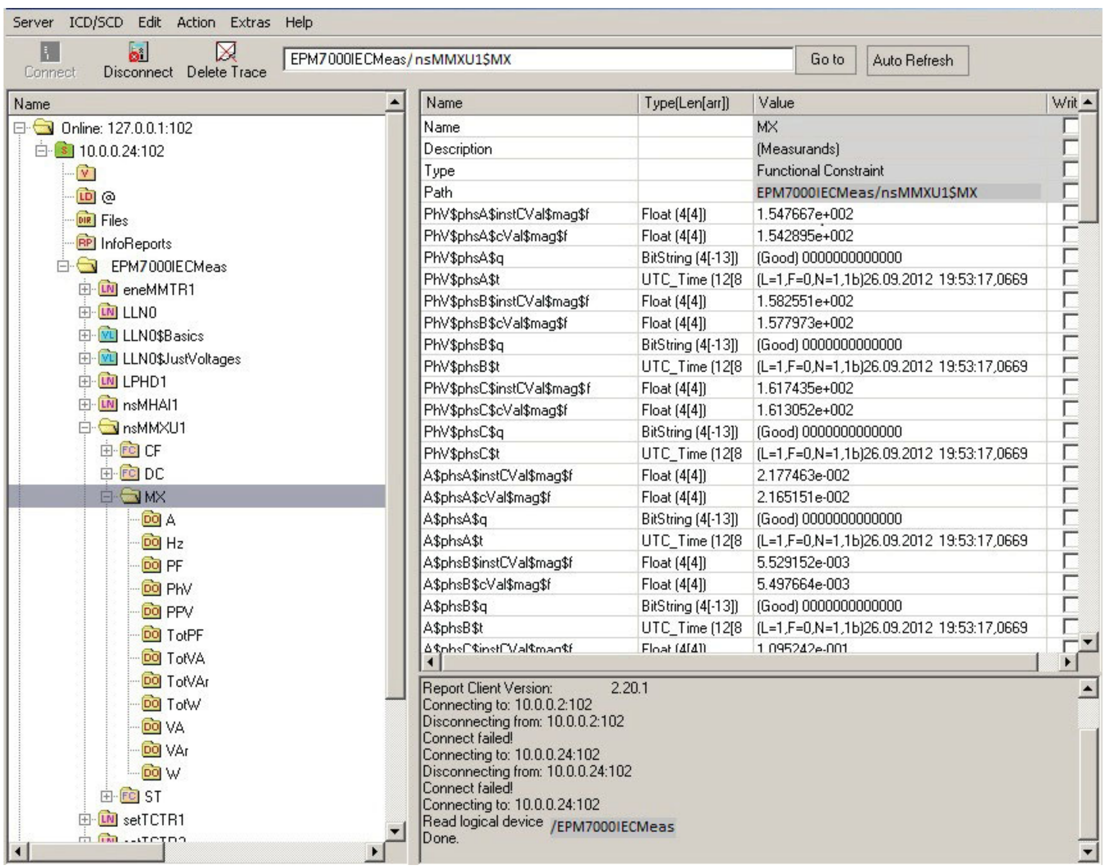
As a result of the reset, the communication link with the card will be lost and must be re-established.

D.6 Keep-Alive Feature

The E2 card supports user configurable Keep-Alive timing settings. The Keep-Alive feature is used by the TCP/IP layer for detecting broken connections. Once detected, the connection is closed in the Network card, and the server port is freed. This prevents the card from running out of server connections due to invalid links. See Section 8.4.5 for instructions on configuring this feature.

D.7 Testing

The user can use any IEC 61850 certified tool to connect to the EPM 7000 meter and test out the IEC 61850 protocol (see example screen next). There are numerous commercial tools available for purchase.



D.8 Error Codes

The following table lists possible Error codes present if there is a problem uploading a .CID file, along with the meaning of the code and the action required to correct the error.

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Code	Name	Description	Required Action
20561	BADPASS	The Upload password is incorrect.	Use the correct password: check product documentation for the correct password.
21325	TOOSMALL	The uploaded file is too small: it does not contain the minimum necessary description.	Check to ensure the file is not trimmed. Sometimes an illegal character (non-ASCII) makes the file look smaller. Verify that the entire file can be read.
16969	TOOBIG	The uploaded file is too big: it does not fit in the reserved area for the CID file.	Check to ensure the file is correct. Try to delete large comment sections or historical sections. Sometimes secondary IED descriptions are in the same file - delete those from the file, and leave just the ones necessary to configure the E2.
18766	INVALID	The .CID file is not a valid xml file, or it is not UTF-8 encoded.	The .CID file is a text file that needs to begin with "<?xml". Check to ensure that the codification of the text file is UTF-8; Multibyte codification will also cause this error.
17985	FAILED	The upload failed. This can be because of network linkage problems or failed integrity in storage.	Try to upload the file again: DO NOT click the back button on the browser if the update is not completed. Assure that the network link is stable. If the problem persists, contact GE's technical support.

EPM 7000 Power Quality Meter

Appendix E: Manual Revision History

E.1 Revision History

Table E.1: Release Dates

MANUAL	GE PART NO.	RELEASE DATE
GEK-113584	1601-0266-A1	September 2011
GEK-113584A	1601-0266-A2	April 2012
GEK-113584B	1601-0266-A3	July 2014
GEK-113584C	1601-0266-A4	December 2014
GEK-113584D	1601-0266-A5	September 2016
N/A	1601-0266-A6	January 2022

Table E.2: Major Updates for 1601-0266-A6

CHAPTER	DESCRIPTION
Title	Manual part number to 1601-0266-A6.
B.7	Updated Modbus memory map to display rows between 0612 and 0623.
2	Frequency [Hz] accuracy updated.

E.2 GE Vernova Device Warranty

E.2.1 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.gevernova.com/grid-solutions/multilin/warranty.htm

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