

Shark[®] 2005

Electronic Submeter With WiFi Ethernet Capability & Data Logging



***Installation &
Operation Manual***
V.1.11
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Electro Industries/GaugeTech
The Leader In Power Monitoring and Smart Grid Solutions

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Shark® 200S Meter Installation and Operation Manual Version 1.11

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Product Warranty

Electro Industries/GaugeTech (EIG) warrants all products to be free from defects in material and workmanship for a period of four years from the date of shipment. During the warranty period, we will, at our option, either repair or replace any product that proves to be defective.

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This warranty does not apply to defects resulting from unauthorized modification, misuse, or use for any reason other than electrical power monitoring. The Shark® 200S meter is not a user-serviceable product.

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Our products are not to be used for primary over-current protection. Any protection feature in our products is to be used for alarm or secondary protection only.

Statement of Calibration

Our instruments are inspected and tested in accordance with specifications published by Electro Industries/GaugeTech. The accuracy and a calibration of our instruments are traceable to the National Institute of Standards and Technology through equipment that is calibrated at planned intervals by comparison to certified standards. For optimal performance, EIG recommends that any metering device, including those manufactured by EIG, be verified for accuracy on a yearly interval using NIST traceable accuracy standards.

Disclaimer

The information presented in this publication has been carefully checked for reliability; however, no responsibility is assumed for inaccuracies. The information contained in this document is subject to change without notice.

Safety Symbols



In this manual, this symbol indicates that the operator must refer to an important WARNING or CAUTION in the operating instructions. Please see Chapter 4 for important safety information regarding installation and hookup of the meter.

Dans ce manuel, ce symbole indique que l'opérateur doit se référer à un important AVERTISSEMENT ou une MISE EN GARDE dans les instructions opérationnelles. Veuillez consulter le chapitre 4 pour des informations importantes relatives à l'installation et branchement du compteur.

The following safety symbols may be used on the meter itself:

Les symboles de sécurité suivante peuvent être utilisés sur le compteur même:



This symbol alerts you to the presence of high voltage, which can cause dangerous electrical shock.

Ce symbole vous indique la présence d'une haute tension qui peut provoquer une décharge électrique dangereuse.



This symbol indicates the field wiring terminal that must be connected to earth ground before operating the meter, which protects against electrical shock in case of a fault condition.

Ce symbole indique que la borne de pose des canalisations in-situ qui doit être branchée dans la mise à terre avant de faire fonctionner le compteur qui est protégé contre une décharge électrique ou un état défectueux.



This symbol indicates that the user must refer to this manual for specific WARNING or CAUTION information to avoid personal injury or damage to the product.

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FCC Information

Regarding the wireless module:

- This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: 1) this device may not cause harmful interference, and 2) this device must accept any interference received, including interference that may cause undesired operation.
- The antenna provided must not be replaced with an different type. Attaching a different antenna will void the FCC approval and the FCC ID can no longer be considered.

About Electro Industries/GaugeTech

Founded in 1975 by engineer and inventor Dr. Samuel Kagan, Electro Industries/GaugeTech changed the face of power monitoring forever with its first breakthrough innovation: an affordable, easy-to-use AC power meter.

Forty years since its founding, Electro Industries/GaugeTech, the leader in power monitoring and control, continues to revolutionize the industry with the highest quality, cutting edge power monitoring and control technology on the market today. An ISO 9001:2008 certified company, EIG sets the industry standard for advanced power quality and reporting, revenue metering and substation data acquisition and control. EIG products can be found on site at mainly all of today's leading manufacturers, industrial giants and utilities.

EIG products are primarily designed, manufactured, tested and calibrated at our facility in Westbury, New York.

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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.

1.1.1: 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).

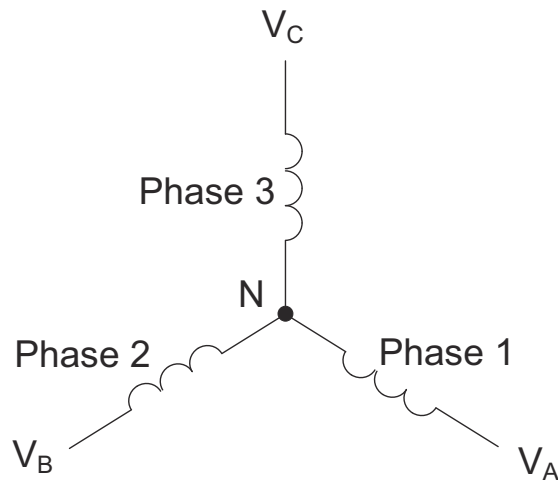


Figure 1.1: Three-phase Wye Winding

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.

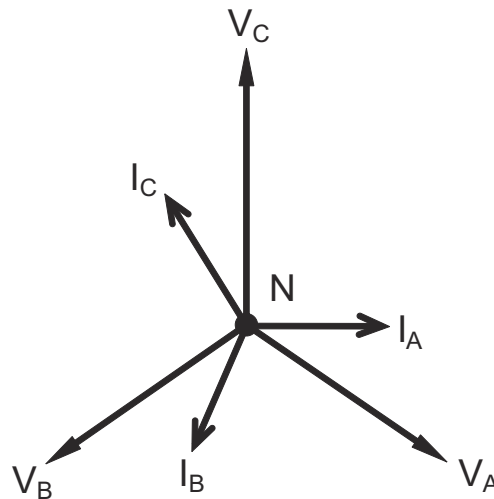


Figure 1.2: Phasor Diagram Showing Three-phase Voltages and Currents

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.

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

Table 1: Common Phase Voltages on Wye Services

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.

1.1.2: 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.

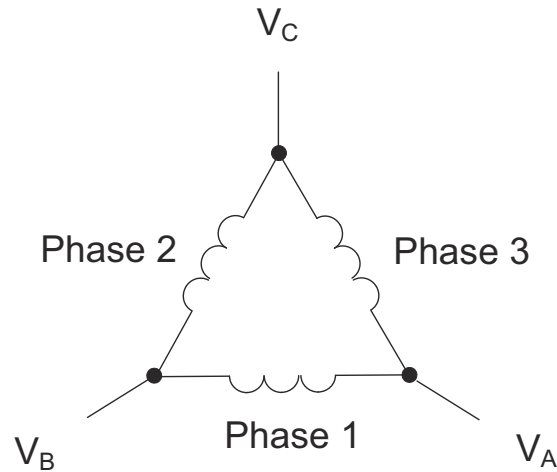


Figure 1.3: Three-phase Delta Winding Relationship

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.

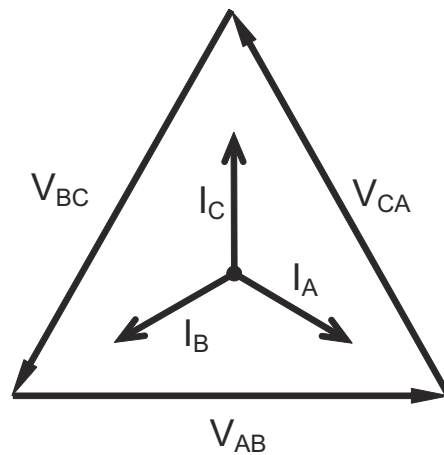


Figure 1.4: Phasor Diagram, Three-Phase Voltages and Currents, Delta-Connected

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.

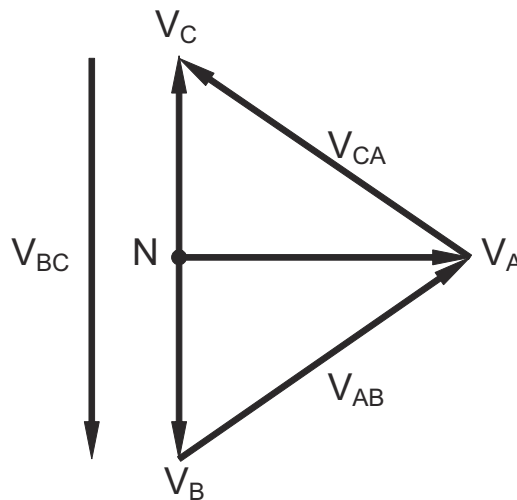


Figure 1.5: Phasor Diagram Showing Three-phase Four-Wire Delta-Connected System

1.1.3: 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.

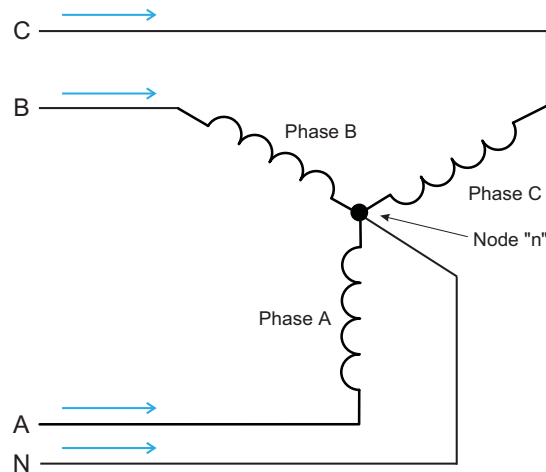


Figure 1.6: Three-Phase Wye Load Illustrating Kirchhoff's Law and Blondel's Theorem

Blondel's Theorem is a derivation that results from Kirchhoff's Law. Kirchhoff'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. Kirchhoff'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 Kirchhoff'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.

1.2: 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 $\frac{1}{4}$ 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 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).

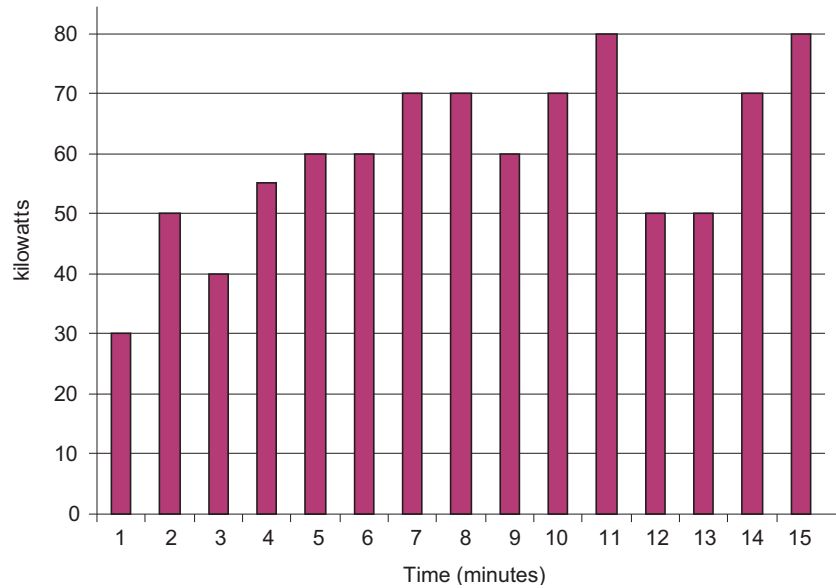


Figure 1.7: Power Use over Time

| 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 |
| 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 |

Table 1.2: Power and Energy Relationship over Time

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.

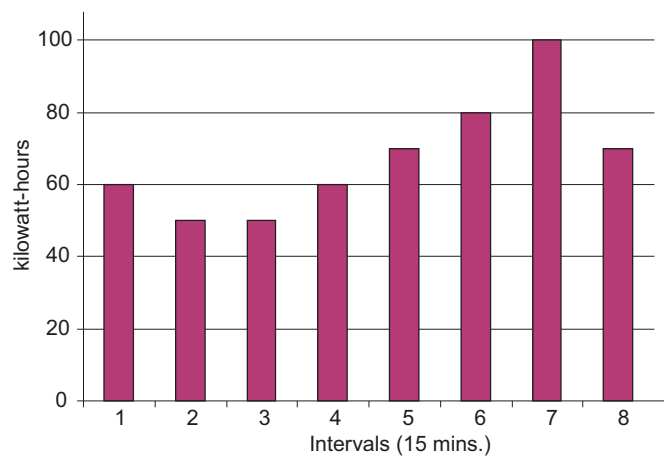


Figure 1.8: Energy Use and Demand

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.

1.3: 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 90° 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.

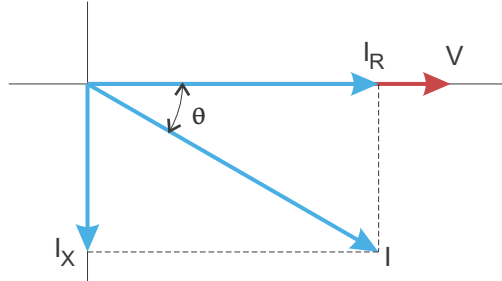


Figure 1.9: Voltage and Complex Current

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 (I_R) are combined to produce the real power or watts. The voltage and the quadrature current (I_X) 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:

$$\text{Total PF} = \text{real power} / \text{apparent power} = \text{watts/VA}$$

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 θ 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.

1.4: 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.

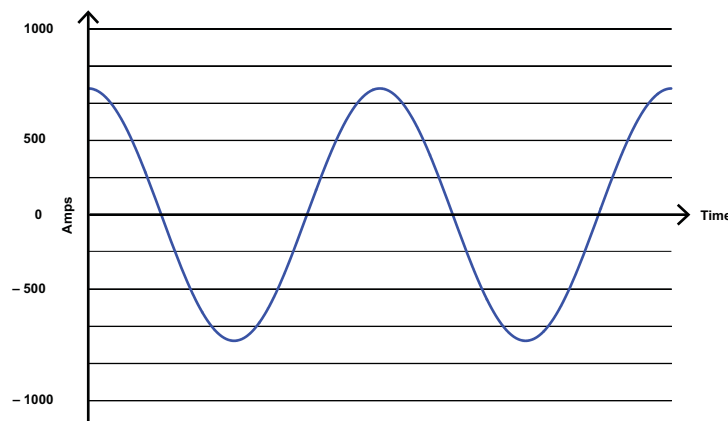


Figure 1.10: Nondistorted Current Waveform

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.

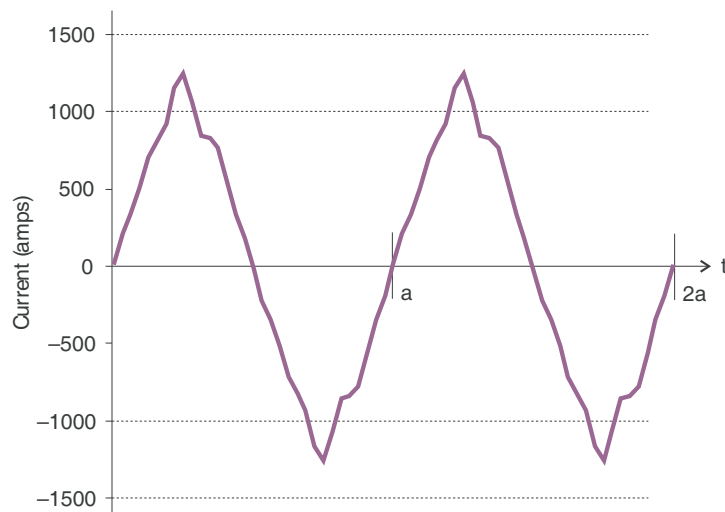


Figure 1.11: Distorted Current Waveform

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.

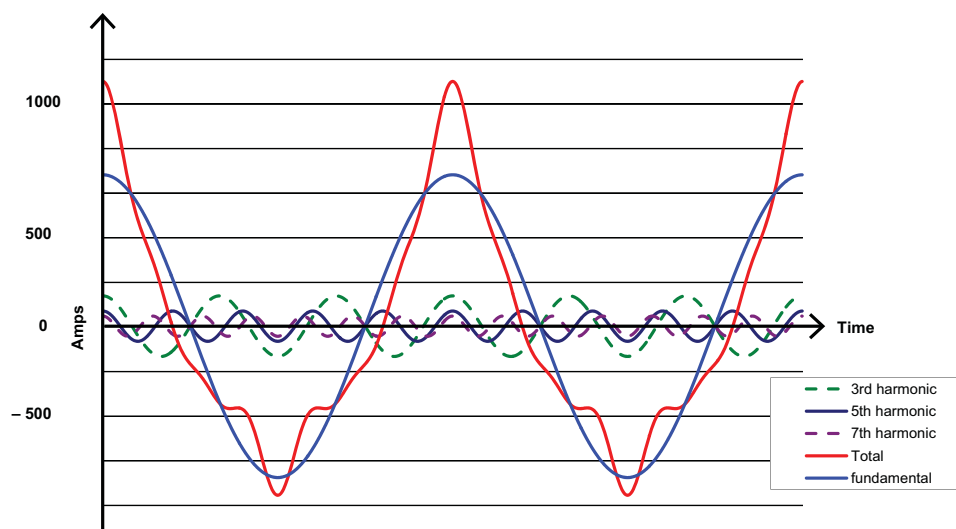


Figure 1.12: Waveforms of the Harmonics

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.

$$X_L = j\omega L \quad \text{and}$$

$$X_C = 1/j\omega C$$

At 60 Hz, $\omega = 377$; but at 300 Hz (5th harmonic) $\omega = 1,885$. 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.

1.5: 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.

| 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 |

Table 1.3: Typical Power Quality Problems and Sources

It is often assumed that power quality problems originate with the utility. While it is true that many 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.

2: Shark® 200S Submeter Overview and Specifications

2.1: Hardware Overview

The Shark® 200S multifunction submeter is designed to measure revenue grade electrical energy usage and communicate that information via various communication media. The unit supports RS485, RJ45 wired Ethernet or IEEE 802.11 WiFi Ethernet connections. This allows the Shark® 200S submeter to be placed anywhere within an industrial or commercial facility and still communicate quickly and easily back to central software. The unit also has a front IrDA port that can be read and configured with an IrDA-equipped device, such as a laptop PC.



The unit is designed with advanced measurement capabilities, allowing it to achieve high performance accuracy. The Shark® 200S meter is specified as a 0.2% class energy meter (Current class 10 only) for billing applications. To verify the submeter's performance and calibration, power providers use field test standards to verify that the unit's energy measurements are correct. The Shark® 200S meter is a traceable revenue meter and contains a utility grade test pulse to verify rated accuracy.

The Shark® 200S meter has up to 2 MegaBytes* for datalogging. It offers three historical logs, a Limits (Alarm) log, and a System Events log.

***NOTE:** Because the memory is flash-based rather than NVRAM (non-volatile random-access memory), some sectors are reserved for overhead, erase procedures, and spare sectors for long-term wear reduction.

Shark® 200S meter features detailed in this manual are:

- 0.2% Class Revenue Certifiable Energy and Demand Submeter (Current Class 10 only)
- Meets ANSI C12.20 (0.2%) and IEC 62053-22 (0.2%) Classes

- Multifunction Measurement including Voltage, Current, Power, Frequency, Energy, etc.
- Three line 0.56" bright red LED Display
- 2 MegaBytes Memory for Datalogging
- Real Time Clock for Time-Stamping of Logs
- Line Frequency Time Synchronization
- 0.001% Frequency Measurement for Generating Stations
- Interval Energy Logging
- Percentage of Load Bar for Analog Meter Perception
- Modbus® RTU (over Serial) and Modbus® TCP (over Ethernet)
- Serial RS485 Communication
- Ethernet and Wireless Ethernet (WiFi)
- Easy to Use Faceplate Programming
- IrDA Port for Laptop PC Remote Read
- Direct Interface with Most Building Management Systems

The Shark® 200S submeter uses standard 5 or 1 Amp CTs (either split or donut). It surface mounts to any wall and is easily programmed in minutes. The unit is designed specifically for easy installation and advanced communication.

2.1.1: Model Number plus Option Numbers

| Model | Frequency | Current Class | V-Switch™ Pack | Power Supply | Communication Format |
|----------------------|---------------------|------------------------|--|-------------------------------------|---|
| Shark® 200S Submeter | -50 50 Hz System | -10 5 Amp Secondary | -V33 Multifunction Meter with 2 MegaBytes Data-logging memory | -D2 (90-400) VAC (100-370)VDC | -485 RS485 |
| | -60 60 Hz System | -2 1 Amp Secondary | | | -WIFI Wireless and LAN Based (Also configurable for RS485) |

Example:

Shark 200S - 60 - 10 - V33 - D2 - 485

which translates to a Shark® 200S submeter with a 60Hz system, Current class 10, Default V-Switch™, D2 power supply, and RS485 communication.

2.1.2: Measured Values

The Shark® 200S meter provides the following measured values all in real time and some additionally as average, maximum and minimum values.

| Shark® 200S Meter Measured Values | | | | |
|-----------------------------------|-----------|---------|---------|---------|
| Measured Values | Real Time | Average | Maximum | Minimum |
| Voltage L-N | X | | X | X |
| Voltage L-L | X | | X | X |
| Current per Phase | X | X | X | X |
| Current Neutral | X | X | | |
| Watts | X | X | X | X |
| VAR | X | X | X | X |
| VA | X | X | X | X |
| PF | X | X | X | X |
| +Watt-hr | X | | | |

| Shark® 200S Meter Measured Values | | | | |
|-----------------------------------|-----------|---------|---------|---------|
| Measured Values | Real Time | Average | Maximum | Minimum |
| -Watt-hr | X | | | |
| Watt-hr Net | X | | | |
| +VAR-hr | X | | | |
| -VAR-hr | X | | | |
| VAR-hr Net | X | | | |
| VA-hr | X | | | |
| Frequency | X | | X | X |
| Voltage Angles | X | | | |
| Current Angles | X | | | |
| % of Load Bar | X | | | |

2.1.3: Utility Peak Demand

The Shark® 200S meter provides user-configured Block (Fixed) window or Rolling window Demand. This feature allows you to set up a customized Demand profile. Block window Demand is Demand used over a user-configured Demand period (usually 5, 15 or 30 minutes). Rolling window Demand is a fixed window Demand that moves for a user-specified subinterval period.

For example, a 15-minute Demand using 3 subintervals and providing a new Demand reading every 5 minutes, based on the last 15 minutes.

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

2.2: Specifications

Power Supply

| | |
|--------|---|
| Range: | Universal, (90 to 400)VAC @50/60Hz or (100 to 370)VDC |
|--------|---|

| | |
|--------------------|---------------|
| Power Consumption: | 16 VA Maximum |
|--------------------|---------------|

Voltage Inputs (Measurement Category III)

| | |
|--------|---|
| Range: | Universal, Auto-ranging up to 576VAC L-N, 721VAC L-L |
|--------|---|

| | |
|--------------------|--|
| 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 600V, 0.0144VA/Phase at 120V |
|---------|---|

| | |
|-----------------|-------|
| Pickup Voltage: | 10VAC |
|-----------------|-------|

| | |
|-------------|---|
| Connection: | Screw terminal - #6 - 32 screws See Figure 4.1 |
|-------------|---|

| | |
|-------------------|--|
| Input Wire Gauge: | AWG#16 - 26 |
| Fault Withstand: | Meets IEEE C37.90.1 (Surge Withstand Capability) |
| Reading: | Programmable Full Scale to any PT Ratio |

Current Inputs

| | |
|--------------------------|---|
| Class 10: | 5A Nominal, 10 Amp Maximum |
| Class 2: | 1A Nominal, 2 Amp Secondary |
| Burden: | 0.005VA Per Phase Max at 11 Amps |
| Pickup Current: | 0.1% of Nominal |
| Connections: | Screw terminal - #6-32 screws (Diagram 4.1) |
| Current Surge Withstand: | 100A/10 seconds at 23° C |
| Reading: | Programmable Full Scale to any CT Ratio |

Isolation

All Inputs and Outputs are galvanically isolated and tested to 2500VAC

Environmental Rating

| | |
|-------------------|--------------------------|
| Storage: | (-20 to +70)° C |
| Operating: | (-20 to +70)° C |
| Humidity: | to 95% RH Non-condensing |
| Faceplate Rating: | NEMA12 (Water Resistant) |

Measurement Methods

| | |
|-------------------|---|
| Voltage, Current: | True RMS |
| Power: | Sampling at 400+ Samples per Cycle on All Channels Measured Readings Simultaneously |
| A/D Conversion: | 6 Simultaneous 24 bit Analog to Digital Converters |

Update Rate

| | |
|-----------------------|---|
| Watts, VAR and VA: | Every 6 cycles, e.g., 100 milliseconds (Ten times per second) @60Hz |
| All other parameters: | Every 60 cycles, e.g, 1 second @60Hz |

Communication Format

1. RS485
2. IrDA Port through Face Plate

| | |
|---------------------|--|
| Protocols: | Modbus RTU, Modbus ASCII, DNP 3.0, Modbus TCP (for Ethernet-enabled) |
| Com Port Baud Rate: | RS485 Only: 1200, 2400, 4800*; All Com Ports: 9600 to 57600 bps |
| Com Port Address: | 001-247 |
| Data Format: | 8 Bit, No Parity (RS485: also Even or Odd Parity*) |

*With Runtime Firmware Version 26 or higher

Wireless Ethernet (Optional)

| | |
|--|---------------------------------|
| 802.11b Wireless or 10/100BaseT Ethernet | WiFi or RJ45 Connection |
| Wireless Security | 64 or 128 bit WEP; WPA; or WPA2 |
| Modbus TCP Protocol | |

Mechanical Parameters

Dimensions: (H7.9 x W7.6 x D3.2) inches,
(H200.7 x W193.0 x D81.3) mm

Weight: 4 pounds/1.814 kilograms

KYZ/RS485 Port Specifications

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

Type: Two-wire, half duplex

Min. Input Impedance: 96k Ω

Max. Output Current: ± 60 mA

Wh Pulse

KYZ output contacts (and infrared LED light pulses through face plate): (See Section 7.4 for Kh values.)

Pulse Width: 90ms

Full Scale Frequency: ~ 3 Hz

Contact type: Solid State – SPDT (NO – C – NC)

Relay type: Solid state

Peak switching voltage: DC ± 350 V

Continuous load current: 120mA

Peak load current: 350mA for 10ms

On resistance, max.: 35 Ω

Leakage current: 1 μ A@350V

Isolation: AC 3750V

Reset State: (NC - C) Closed; (NO - C) Open

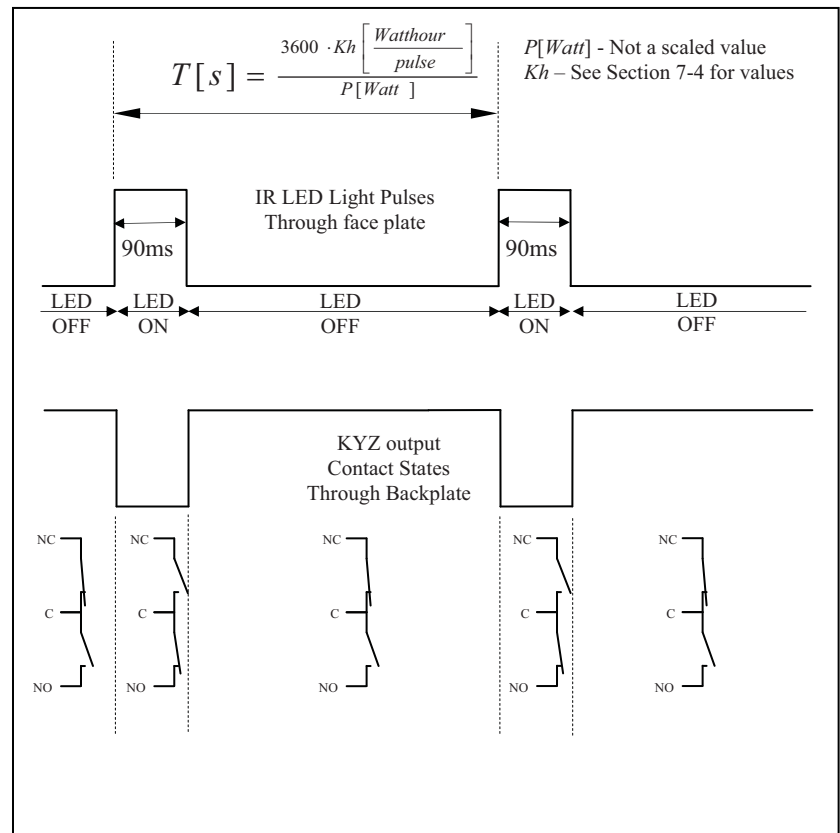
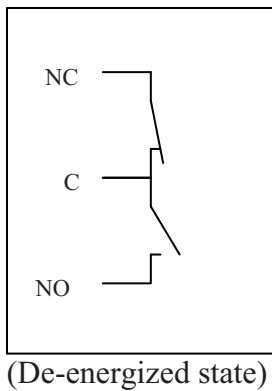
Infrared LED:

Peak Spectral Wavelength: 940nm

Reset State: Off

Internal Schematic:

Output Timing:



2.3: Compliance

- IEC 62053-22 (0.2% Accuracy)
- ANSI C12.20 (0.2% Accuracy)
- ANSI (IEEE) C37.90.1 Surge Withstand
- ANSI C62.41 (Burst)
- EN61000-6-2 Immunity for Industrial Environments: 2005
- EN61000-6-4 Emission Standards for Industrial Environments: 2007
- EN61326-1 EMC Requirements: 2006
- Certified to UL 61010-1 and CSA C22.2 No. 61010-1, UL File: E250818
- CE Compliant

2.4: Accuracy

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

| Parameter | Accuracy | Accuracy Input Range |
|----------------------------------|---------------------------------|--|
| Voltage L-N [V] | 0.1% of reading ² | (69 to 480)V |
| Voltage L-L [V] | 0.1% of reading | (120 to 600)V |
| Current Phase [A] | 0.1% of reading ¹ | (0.15 to 5)A |
| Current Neutral (calculated) [A] | 2.0% of Full Scale ¹ | (0.15 to 5)A @ (45 to 65)Hz |
| Active Power Total [W] | 0.2% of reading ^{1,2} | (0.15 to 5)A @ (69 to 480)V @ +/- (0.5 to 1) lag/lead PF |
| Active Energy Total [Wh] | 0.2% of reading ^{1,2} | (0.15 to 5)A @ (69 to 480)V @ +/- (0.5 to 1) lag/lead PF |
| Reactive Power Total [VAR] | 0.2% of reading ^{1,2} | (0.15 to 5)A @ (69 to 480)V @ +/- (0 to 0.8) lag/lead PF |
| Reactive Energy Total [VARh] | 0.2% of reading ^{1,2} | (0.15 to 5)A @ (69 to 480)V @ +/- (0 to 0.8) lag/lead PF |
| Apparent Power Total [VA] | 0.2% of reading ^{1,2} | (0.15 to 5)A @ (69 to 480)V @ +/- (0.5 to 1) lag/lead PF |
| Apparent Energy Total [VAh] | 0.2% of reading ^{1,2} | (0.15 to 5)A @ (69 to 480)V @ +/- (0.5 to 1) lag/lead PF |

| | | |
|--------------|--------------------------------|---|
| Power Factor | 0.2% of reading ^{1,2} | (0.15 to 5)A @ (69 to 480)V @ +/- (0.5 to 1) lag/lead PF |
| Frequency | +/- 0.001Hz | (45 to 65)Hz |
| Load Bar | +/- 1 segment ¹ | (0.005 to 6)A |

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

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

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

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3: Mechanical Installation

3.1: Overview

The Shark® 200S meter can be installed on any wall. See Chapter 4 for wiring diagrams.

Mount the meter in a dry location, which is free from dirt and corrosive substances.

Recommended Tools for Shark® 200S Installation

- #2 Phillips screwdriver
- Wire cutters



WARNING! During normal operation of the Shark® 200S meter, dangerous voltages flow through many parts of the meter, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O Modules (Inputs and Outputs) and their circuits. All

Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces. **Before performing ANY work on the meter, make sure the meter is powered down and all connected circuits are de-energized.**

AVERTISSEMENT! Pendant le fonctionnement normal du compteur Shark® 200S des tensions dangereuses suivant de nombreuses pièces, notamment, les bornes et tous les transformateurs de courant branchés, les transformateurs de tension, toutes les sorties, les entrées et leurs circuits. Tous les circuits secondaires et primaires peuvent parfois produire des tensions de létal et des courants. Évitez le contact avec les surfaces sous tensions. **Avant de faire un travail dans le compteur, assurez-vous d'éteindre l'alimentation et de mettre tous les circuits branchés hors tension.**

3.2: Install the Base

1. Determine where you want to install the submeter.

2. **With the submeter power off**, open the top of the submeter. Use the front cover support to keep the cover open as you perform the installation (see Figure 3.1).

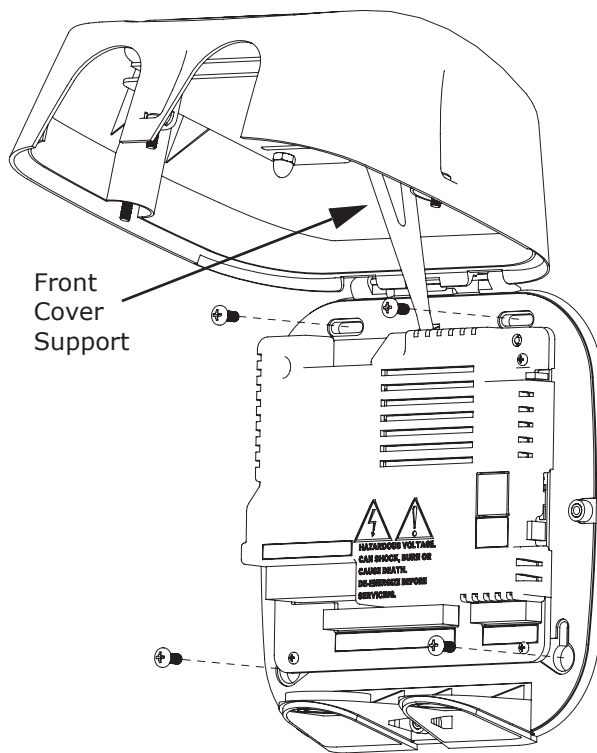


Figure 3.1: Shark Submeter with Cover Open

CAUTIONS!

- Remove the antenna before opening the unit.
 - Only use the front cover support if you are able to open the front cover to the extent that you can fit the front cover support into its base. **DO NOT** rest the front cover support on the inside of the meter, even for a short time - by doing so, you may damage components on the board assembly.
3. Find the 4 Installation Slots and insert screws through each slot into the wall or panel.
 4. Fasten securely - DO NOT overtighten.

3.2.1: Mounting Diagrams

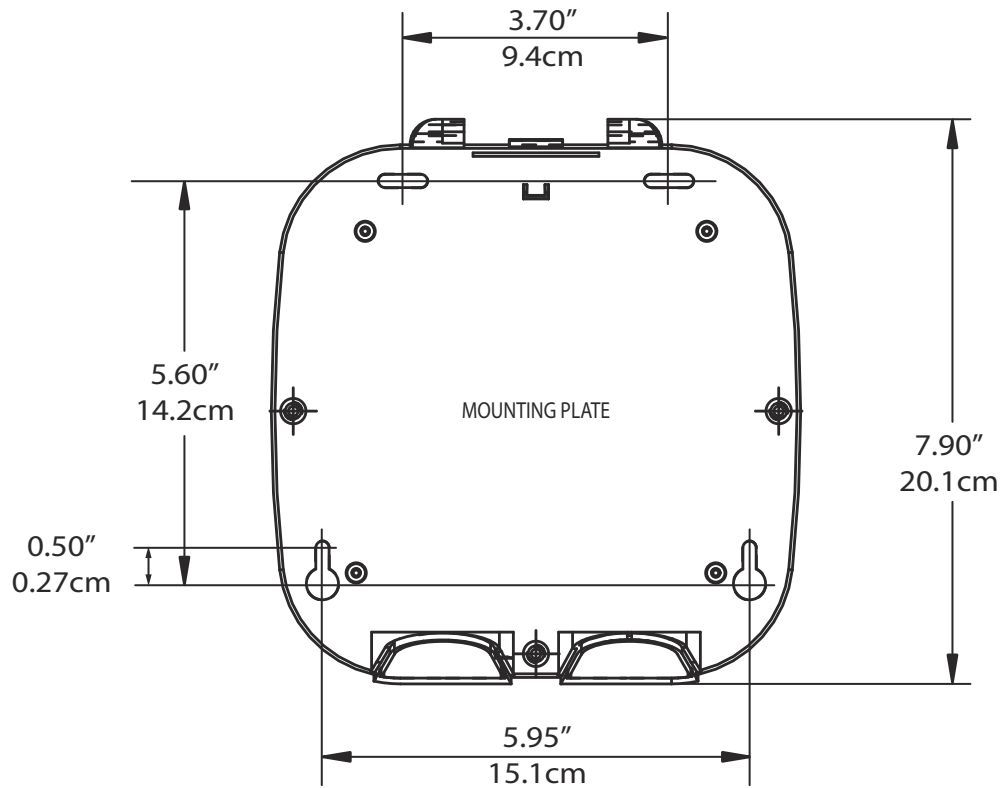
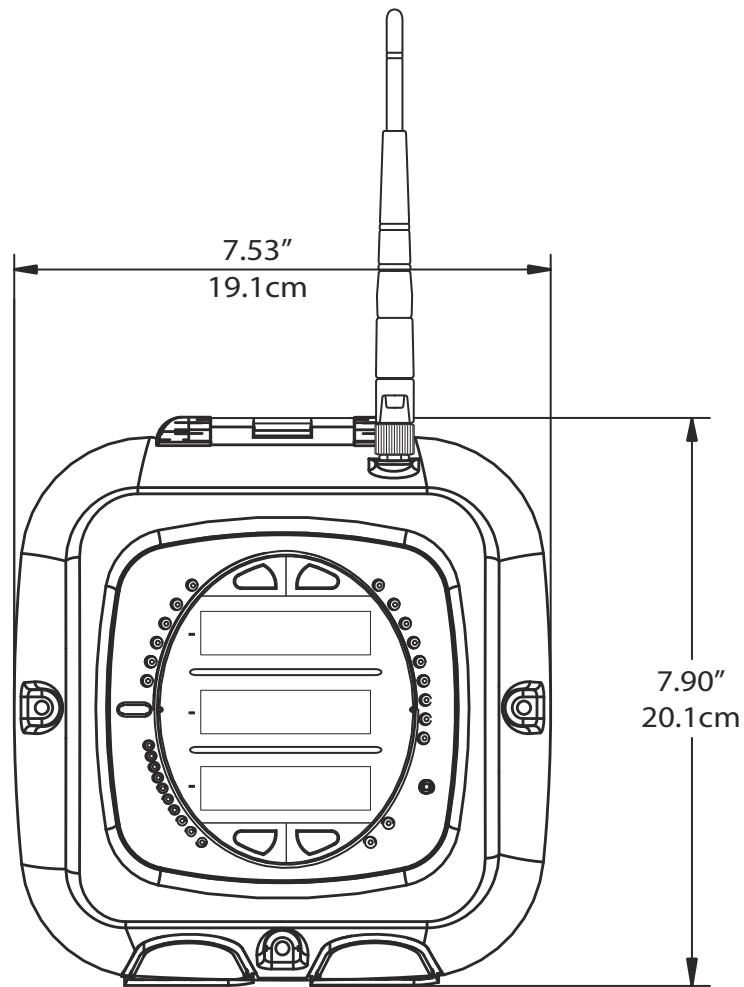


Figure 3.2: Mounting Plate Dimensions



Antenna Length: 4.4" (11.2cm)

Figure 3.3: Front Dimensions

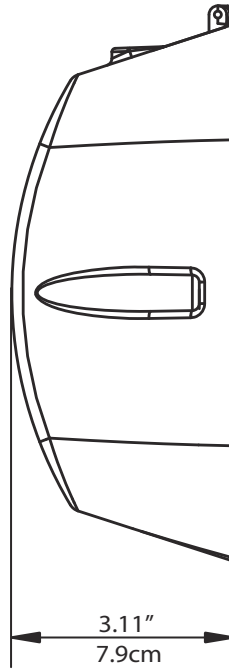


Figure 3.4: Side Dimensions

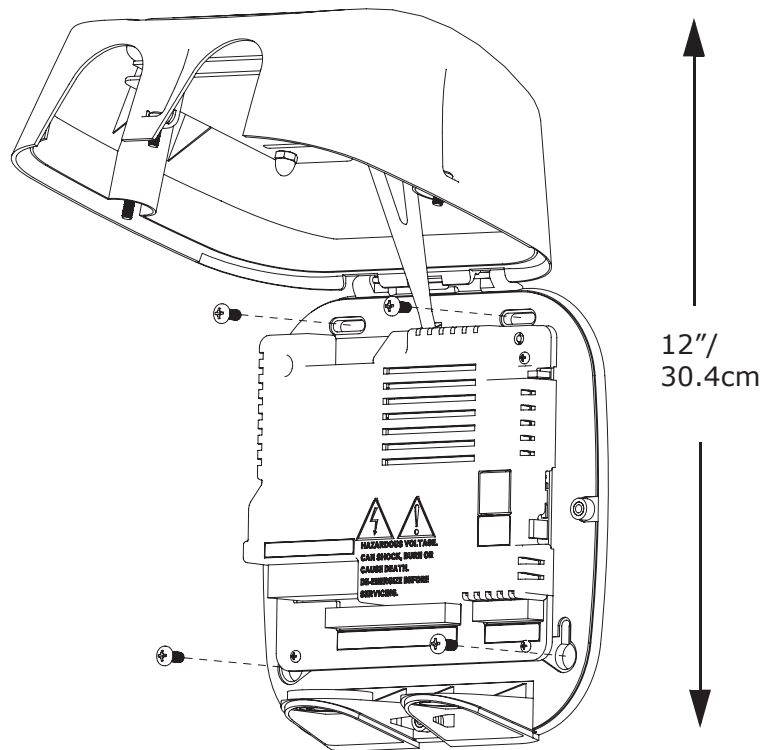


Figure 3.5: Open Cover Dimensions

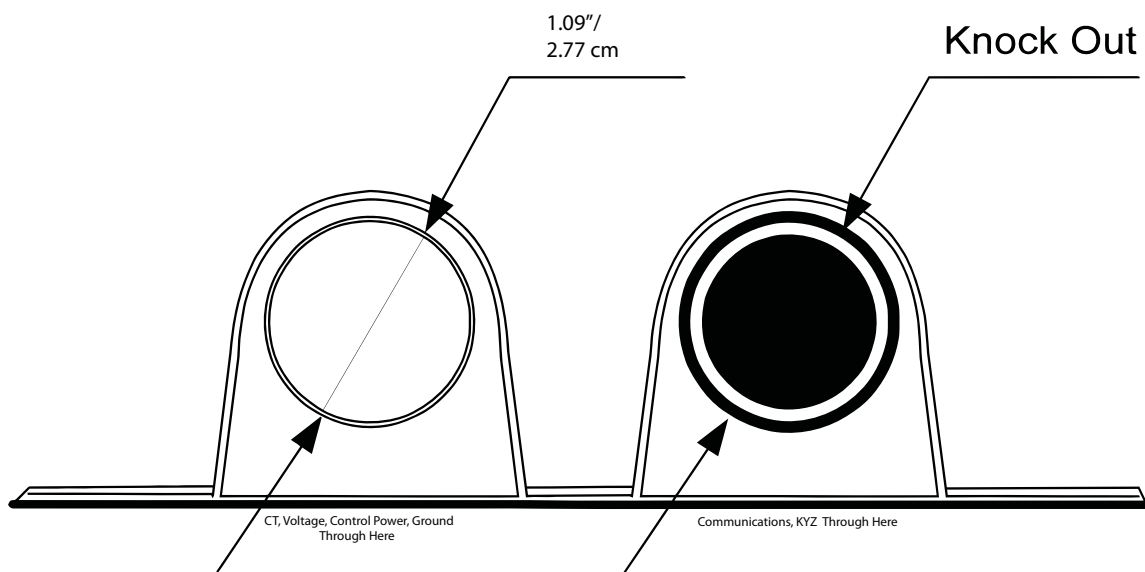


Figure 3.6: Bottom View with Access Holes

3.3: Secure the Cover

1. Close the cover, making sure that power and communications wires exit the submeter through the openings at the base (see Figure 3.6).

CAUTION! To avoid damaging components on the board assembly, make sure the front cover support is in the upright position before closing the front cover.

2. Using the 3 enclosed screws, secure the cover to the base in three places - DO NOT overtighten (you may damage the cover).
3. The unit can be sealed after the front cover is closed. To seal the unit, thread the seal tag through the housing located between the bottom access holes (see figures 3.6 and 3.7).
4. Reattach the antenna, if applicable.

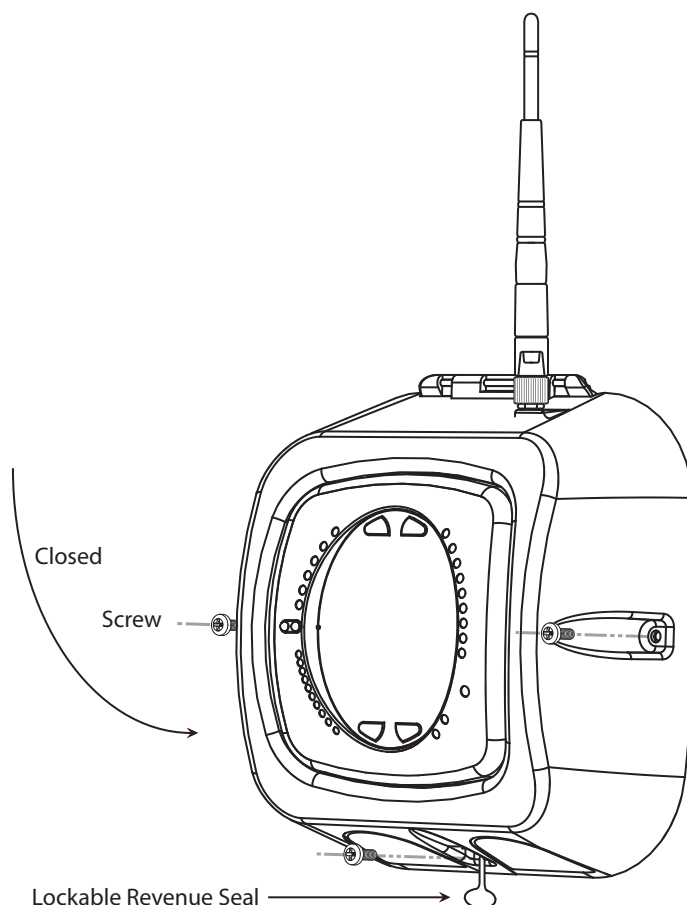


Figure 3.7: Submeter with Closed Cover

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4: Electrical Installation

4.1: Considerations When Installing Meters



Installation of the Shark® 200S meter must be performed only by qualified personnel who follow standard safety precautions during all procedures. Those personnel should have appropriate training and experience with high voltage devices. Appropriate safety gloves, safety glasses and protective clothing is recommended.

WARNING! During normal operation of the Shark® 200S meter, dangerous voltages flow through many parts of the meter, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O Modules (Inputs and Outputs) and their circuits. All Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces.

Before performing ANY work on the meter, make sure the meter is powered down and all connected circuits are de-energized.

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.

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

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



L'installation des compteurs de Shark® 200S doit être effectuée seulement par un personnel qualifié qui suit les normes relatives aux précautions de sécurité pendant toute la procédure. Le personnel doit avoir la formation appropriée et l'expérience avec les appareils de haute tension. Des gants de sécurité, des verres et des vêtements de protection appropriés sont recommandés.

AVERTISSEMENT! Pendant le fonctionnement normal du compteur Shark® 200S des tensions dangereuses suivant de nombreuses pièces, notamment, les bornes et tous les transformateurs de courant branchés, les transformateurs de tension, toutes les sorties, les entrées et leurs circuits. Tous les circuits secondaires et primaires peuvent parfois produire des tensions de léthal et des courants. Évitez le contact avec les surfaces sous tensions. Avant de faire un travail dans le compteur, assurez-vous d'éteindre l'alimentation et de mettre tous les circuits branchés hors tension.

Ne pas utiliser les compteurs ou sorties d'appareil pour une protection primaire ou capacité de limite d'énergie. Le compteur peut seulement être utilisé comme une protection secondaire.

Ne pas utiliser le compteur pour application dans laquelle une panne de compteur peut causer la mort ou des blessures graves.

Ne pas utiliser le compteur ou pour toute application dans laquelle un risque d'incendie est susceptible.

Toutes les bornes de compteur doivent être inaccessibles après l'installation.

Ne pas appliquer plus que la tension maximale que le compteur ou appareil relatif peut résister. Référez-vous au compteur ou aux étiquettes de l'appareil et les spécifications de tous les appareils avant d'appliquer les tensions. Ne pas faire de test HIPOT/diélectrique, une sortie, une entrée ou un terminal de réseau.

Les entrées actuelles doivent seulement être branchées aux transformateurs externes actuels.

EIG nécessite l'utilisation de les fusibles pour les fils de tension et alimentations électriques, ainsi que des coupe-circuits pour prévenir les tensions dangereuses ou endommagements de transformateur de courant si l'unité Shark® 200S doit être enlevée du service. Un côté du transformateur de courant doit être mis à terre.

NOTE: les entrées actuelles doivent seulement être branchées dans le transformateur externe actuel par l'installateur. Le transformateur de courant doit être approuvé ou certifié et déterminé pour le compteur actuel utilisé.

IMPORTANT!

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.



DISCONNECT DEVICE: The following part is considered the equipment disconnect device. A SWITCH OR CIRCUIT-BREAKER SHALL BE INCLUDED IN THE END-USE EQUIPMENT OR BUILDING INSTALLATION. THE SWITCH SHALL BE IN CLOSE PROXIMITY TO THE EQUIPMENT AND WITHIN EASY REACH OF THE OPERATOR. THE SWITCH SHALL BE MARKED AS THE DISCONNECTING DEVICE FOR THE EQUIPMENT.



IMPORTANT! SI L'ÉQUIPEMENT EST UTILISÉ D'UNE FAÇON NON SPÉCIFIÉE PAR LE FABRICANT, LA PROTECTION FOURNIE PAR L'ÉQUIPEMENT PEUT ÊTRE ENDOMMAGÉE.

NOTE: II N'Y A AUCUNE MAINTENANCE REQUISE POUR LA PRÉVENTION OU INSPECTION NÉCESSAIRE POUR LA SÉCURITÉ. CEPENDANT, TOUTE RÉPARATION OU MAINTENANCE DEVRAIT ÊTRE RÉALISÉE PAR LE FABRICANT.



DÉBRANCHEMENT DE L'APPAREIL : la partie suivante est considérée l'appareil de débranchement de l'équipement.

UN INTERRUPTEUR OU UN DISJONCTEUR DEVRAIT ÊTRE INCLUS DANS L'UTILISATION FINALE DE L'ÉQUIPEMENT OU L'INSTALLATION. L'INTERRUPTEUR DOIT ÊTRE DANS UNE PROXIMITÉ PROCHE DE L'ÉQUIPEMENT ET A LA PORTÉE DE L'OPÉRATEUR. L'INTERRUPTEUR DOIT AVOIR LA MENTION DÉBRANCHEMENT DE L'APPAREIL POUR L'ÉQUIPEMENT.

4.2: Electrical Connections

All wiring for the Shark® 200S is done through the front of the unit (lifting the cover with the power to the unit OFF) so that the unit can be surface mounted. Connecting cables exit the unit via two openings in the base plate (see figures 3.5 and 4.1).



WARNING! During normal operation of the Shark® 200S meter, dangerous voltages flow through many parts of the meter, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O Modules (Inputs and Outputs) and their circuits. All Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces.

Before performing ANY work on the meter, make sure the meter is powered down and all connected circuits are de-energized.

AVERTISSEMENT! Pendant le fonctionnement normal du compteur Shark® 200S des tensions dangereuses suivent de nombreuses pièces, notamment, les bornes et tous les transformateurs de courant branchés, les transformateurs de tension, toutes les sorties, les entrées et leurs circuits. Tous les circuits secondaires et primaires peuvent parfois produire des tensions de létal et des courants. Évitez le contact avec les surfaces sous tensions. Avant de faire un travail dans le compteur, assurez-vous d'éteindre l'alimentation et de mettre tous les circuits branchés hors tension.

CAUTION! DO NOT over-torque screws.

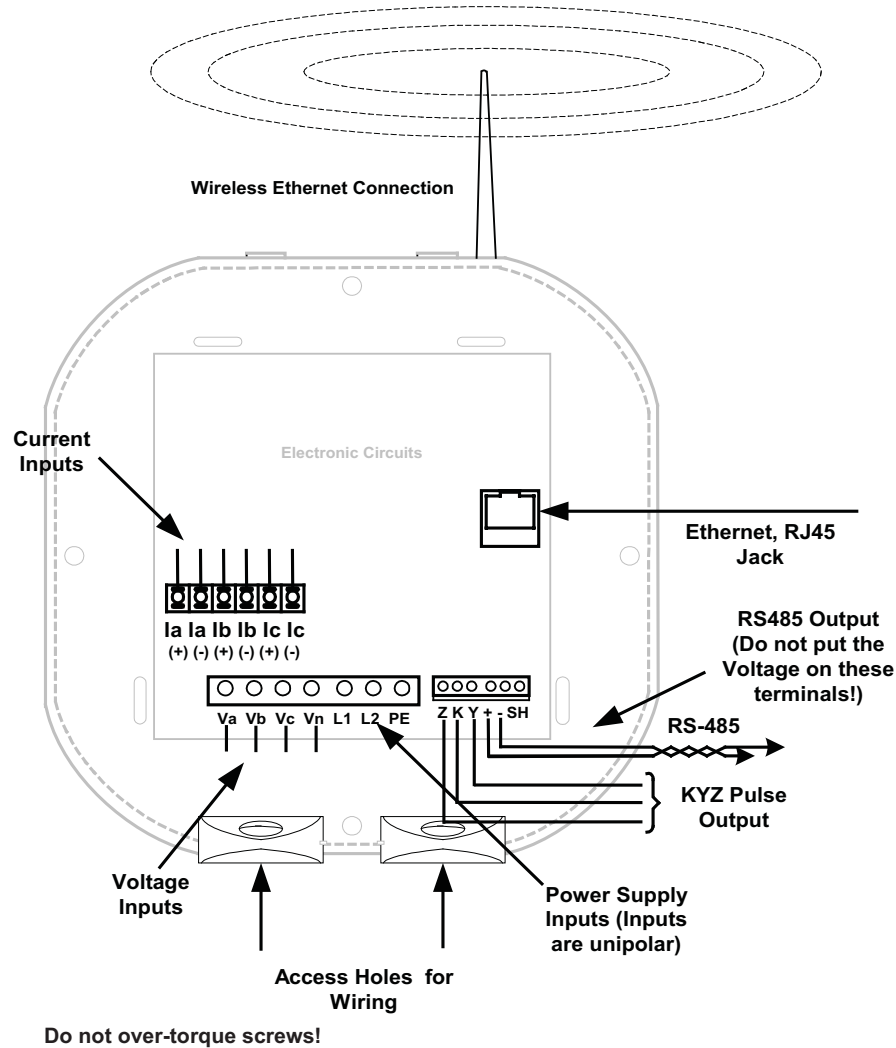


Figure 4.1: Submeter Connections

4.3: Ground Connections

The meter's Ground Terminal (PE) should be connected directly to the installation's protective earth ground.

4.4: Voltage Fuses

EIG requires the use of fuses on each of the sense voltages and on the control power.

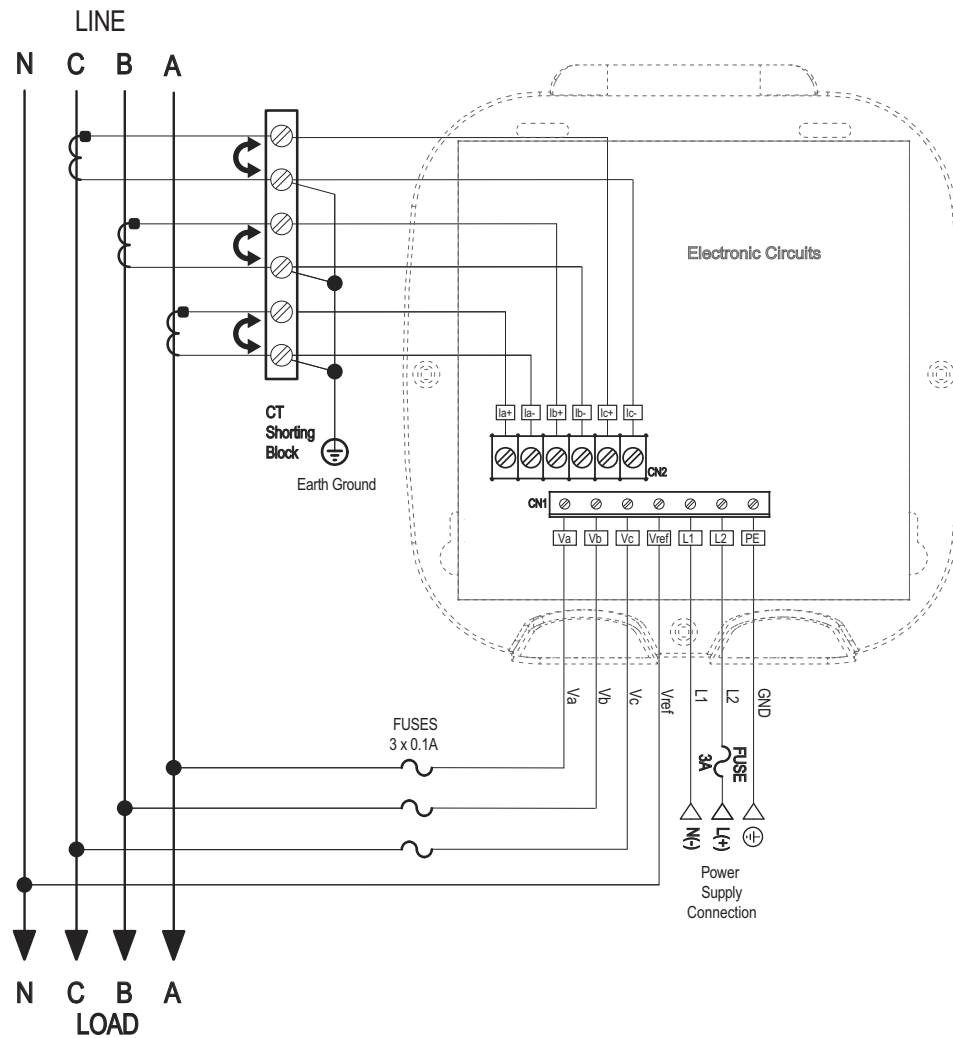
- Use a 0.1 Amp fuse on each Voltage input.
- Use a 3 Amp fuse on the power supply.

4.5: Electrical Connection Diagrams

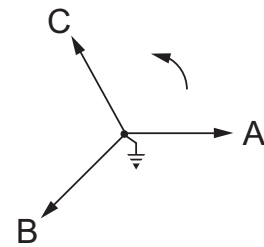
Choose the diagram that best suits your application. Make sure the CT polarity is correct.

1. Three Phase, Four-Wire System Wye with Direct Voltage, 3 Element
 - a. Dual Phase Hookup
 - b. Single Phase Hookup
2. Three Phase, Four-Wire System Wye with Direct Voltage, 2.5 Element
3. Three-Phase, Four-Wire Wye with PTs, 3 Element
4. Three-Phase, Four-Wire Wye with PTs, 2.5 Element
5. Three-Phase, Three-Wire Delta with Direct Voltage (No PTs, 2 CTs)
6. Three-Phase, Three-Wire Delta with Direct Voltage (No PTs, 3 CTs)
7. Three-Phase, Three-Wire Delta with 2 PTs, 2 CTs
8. Three-Phase, Three-Wire Delta with 2 PTs, 3 CTs
9. Current Only Measurement (Three Phase)
10. Current Only Measurement (Dual Phase)
11. Current Only Measurement (Single Phase)

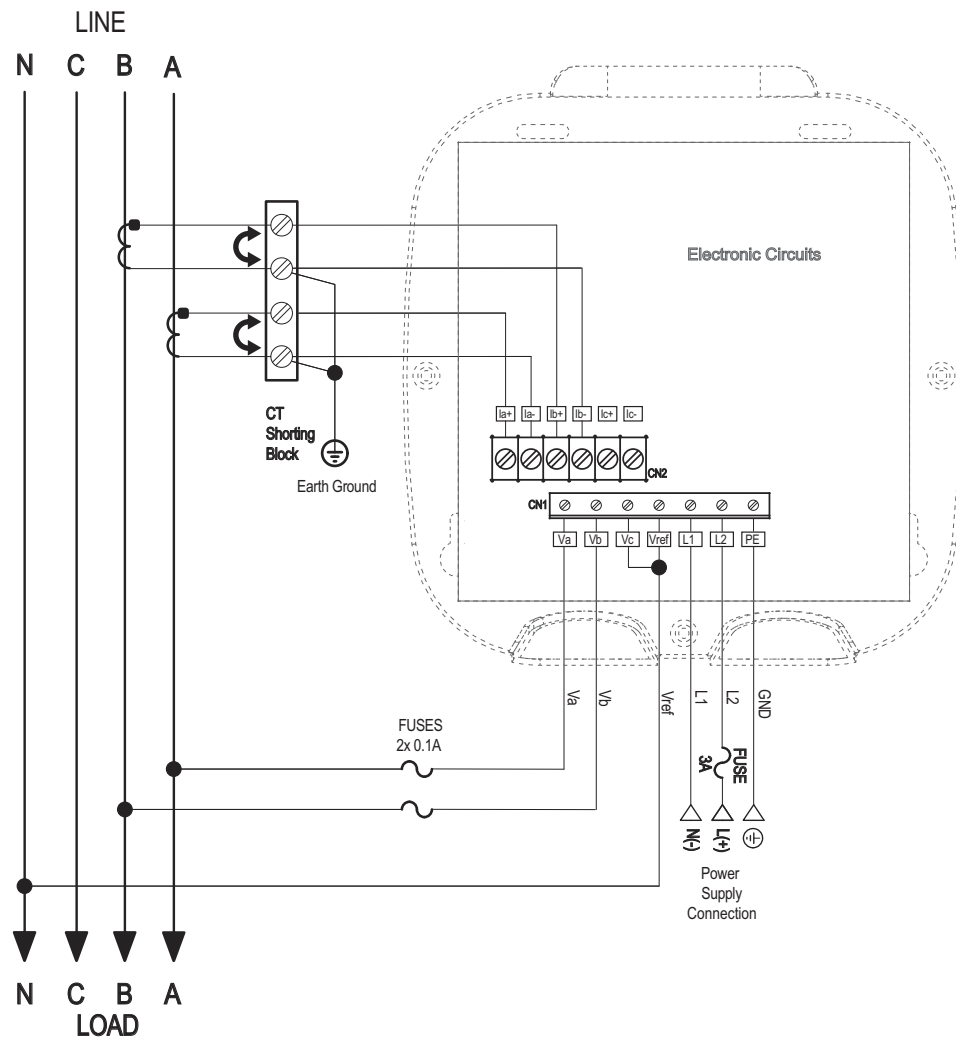
1. Service: WYE, 4-Wire with No PTs, 3 CTs



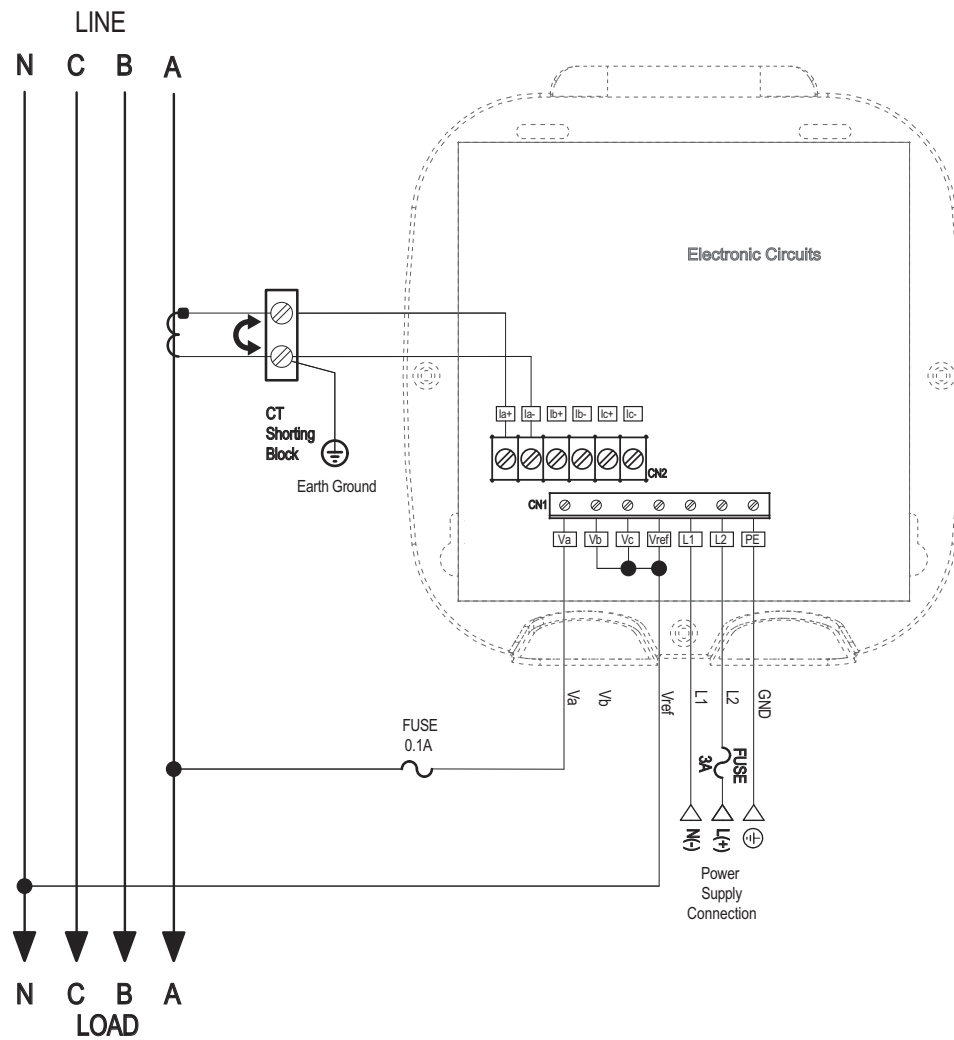
Select: "3 EL WYE" (3 Element Wye) in Meter Programming setup.



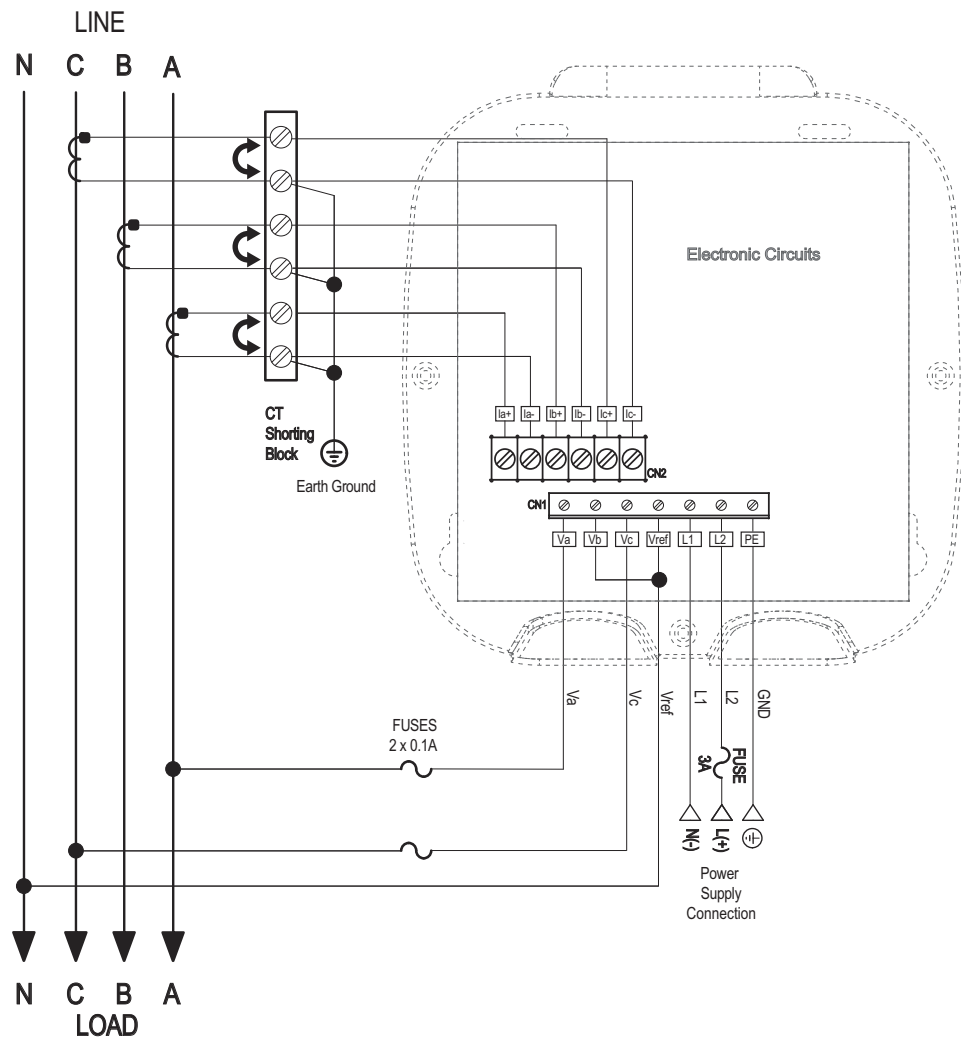
1a. Dual Phase Hookup



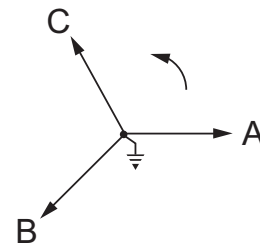
1b. Single Phase Hookup



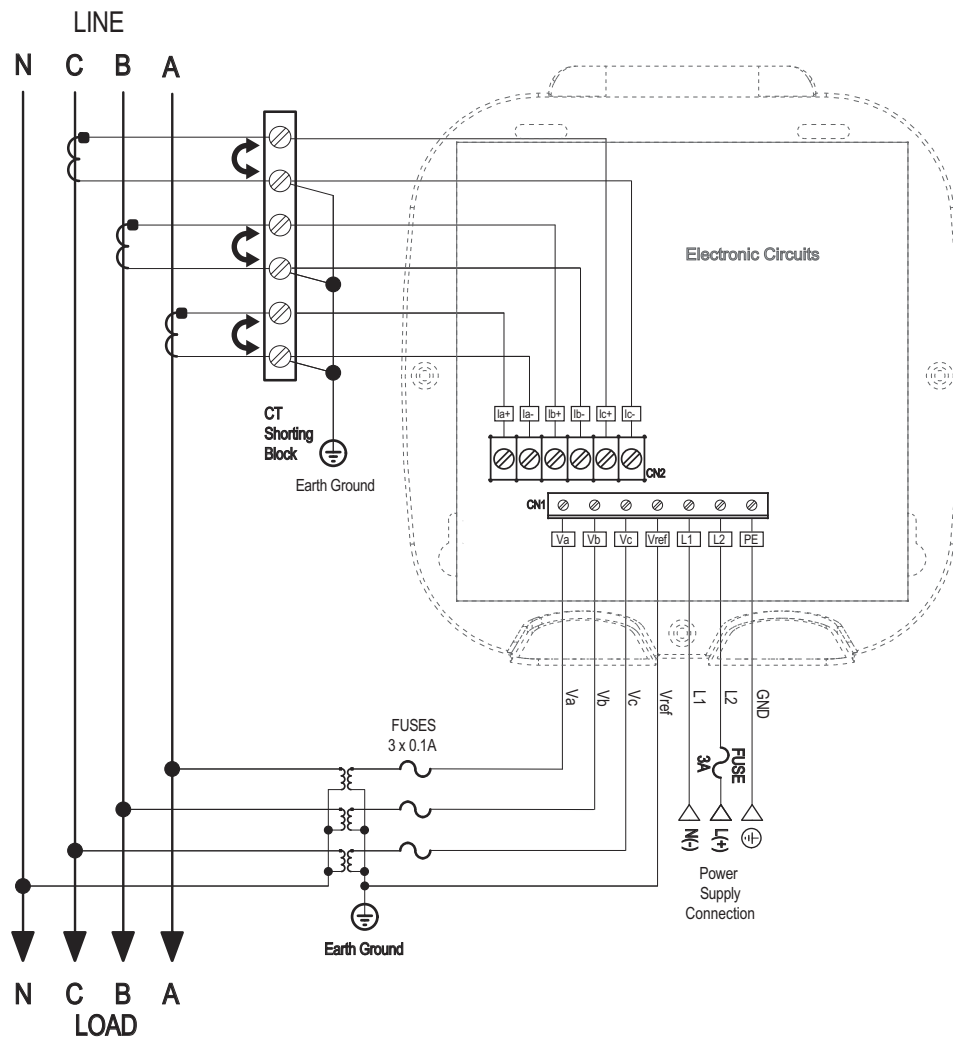
2. Service: 2.5 Element WYE, 4-Wire with No PTs, 3 CTs



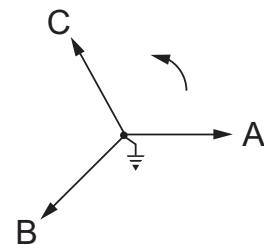
Select: "2.5 EL WYE" (2.5 Element Wye) in Meter Programming setup.



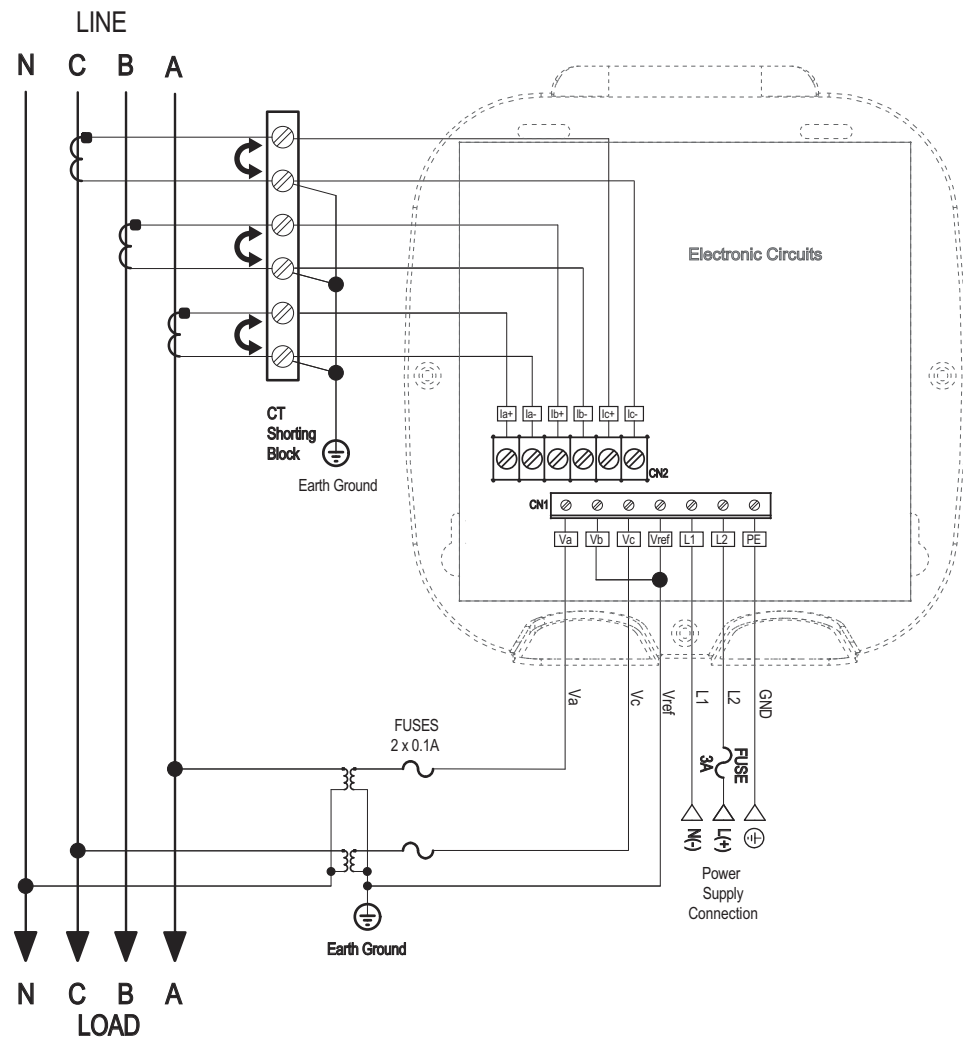
3. Service: WYE, 4-Wire with 3 PTs, 3 CTs



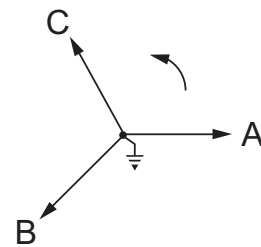
Select: "3 EL WYE" (3 Element Wye) in Meter Programming setup.



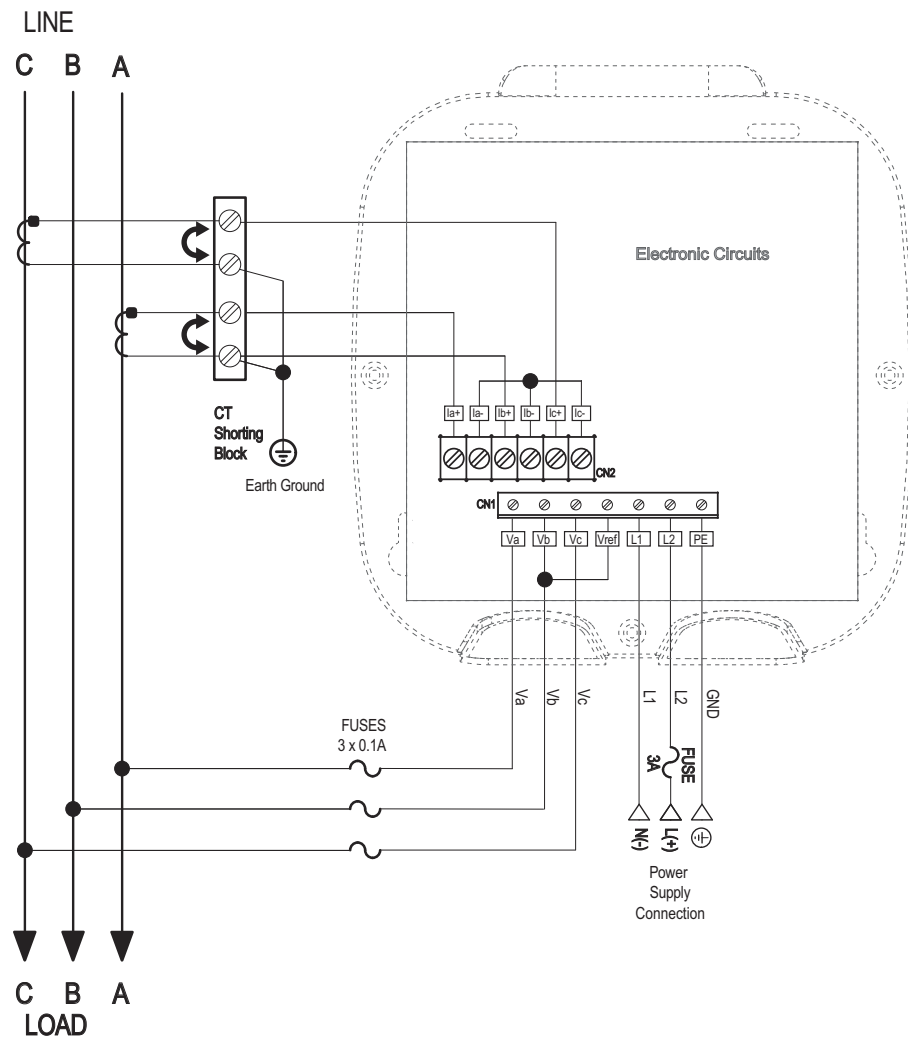
4. Service: 2.5 Element WYE, 4-Wire with 2 PTs, 3 CTs



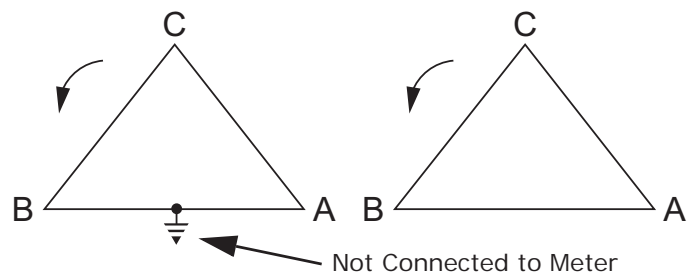
Select: "2.5 EL WYE" (2.5 Element Wye) in Meter Programming setup.



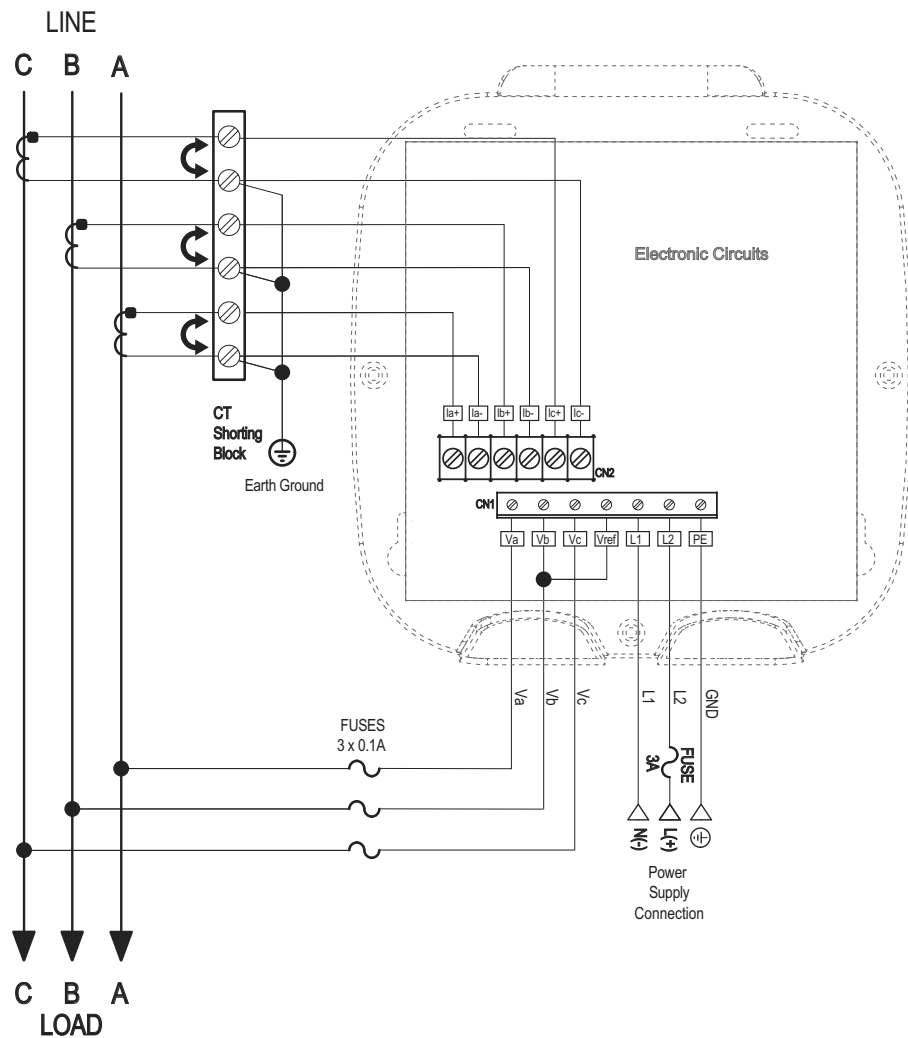
5. Service: Delta, 3-Wire with No PTs, 2 CTs



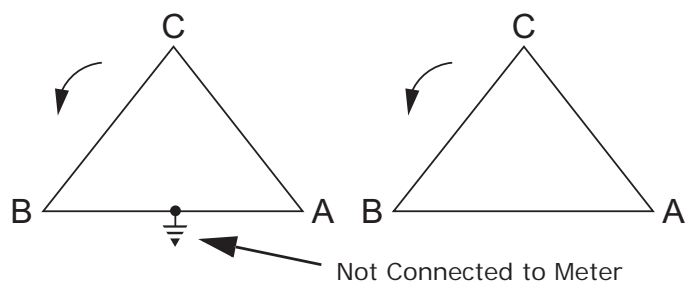
Select: "2 Ct dEL" (2 CT Delta) in Meter Programming setup.



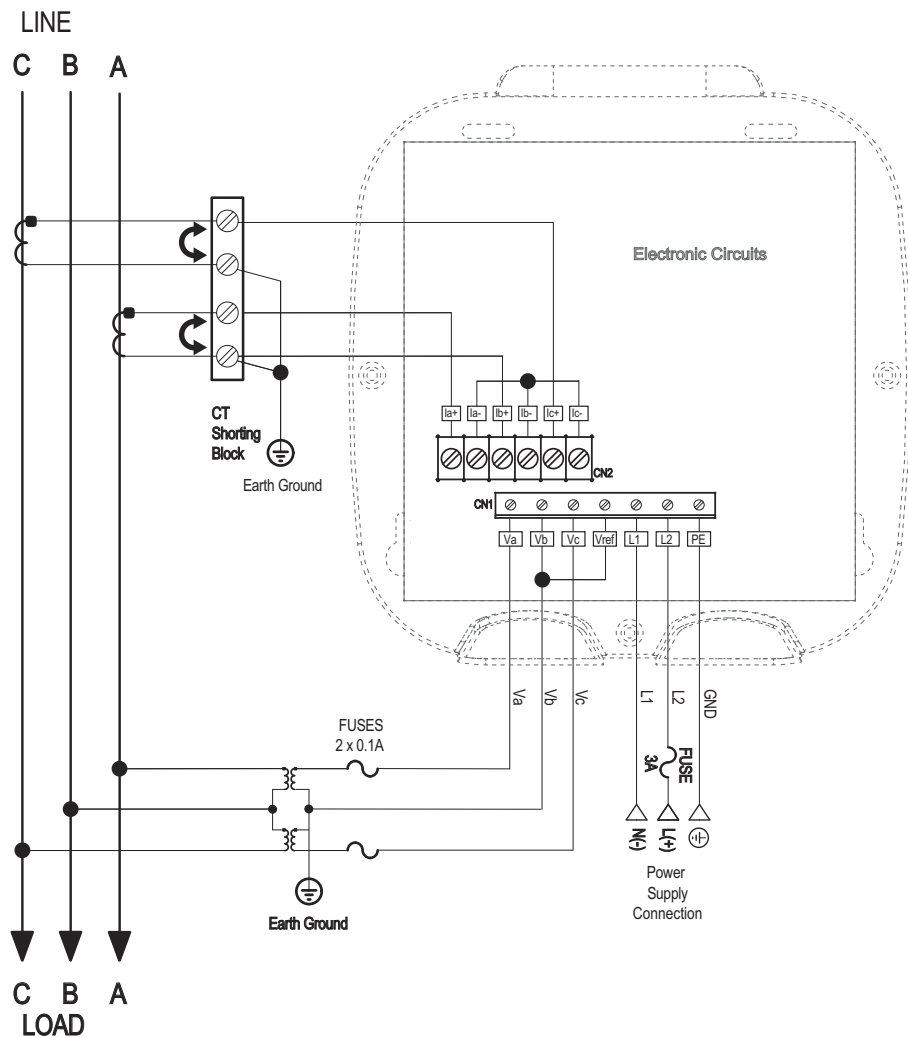
6. Service: Delta, 3-Wire with No PTs, 3 CTs



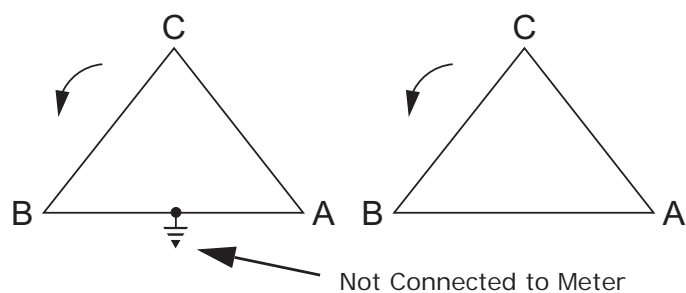
Select: "2 Ct dEL" (2 CT Delta) in Meter Programming setup.



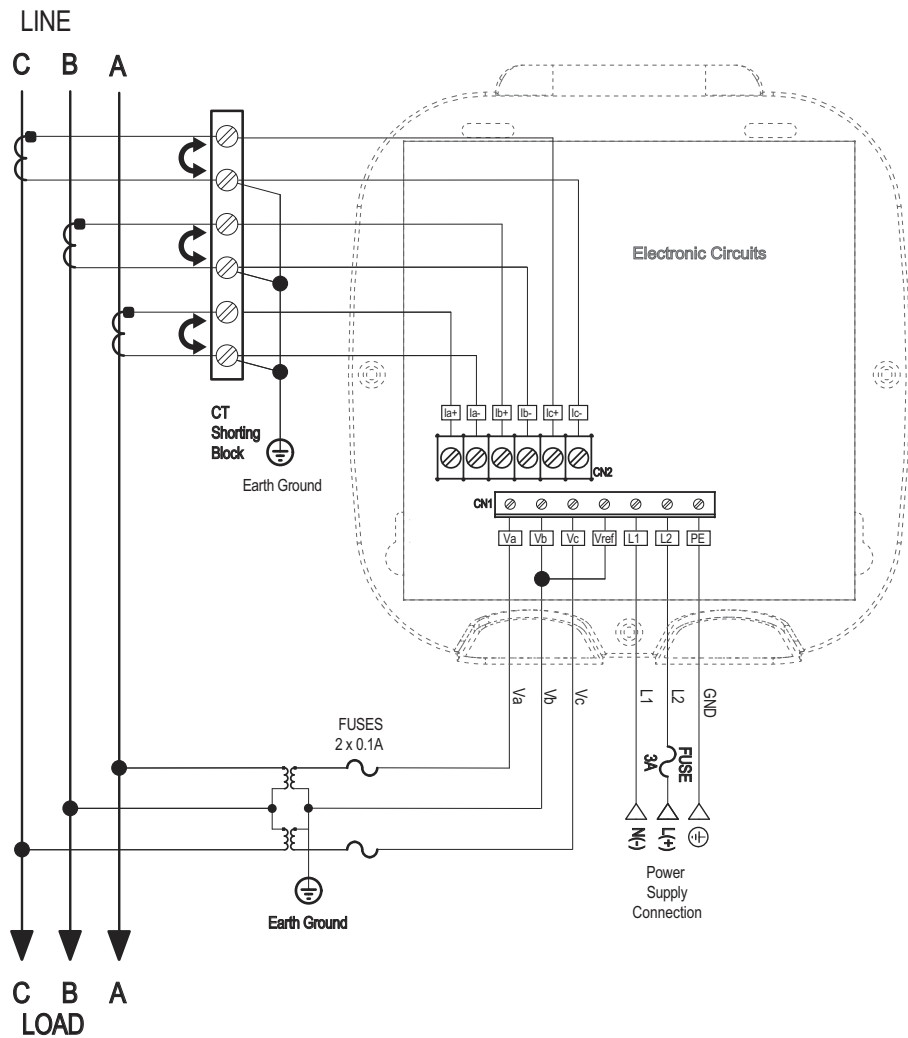
7. Service: Delta, 3-Wire with 2 PTs, 2 CTs



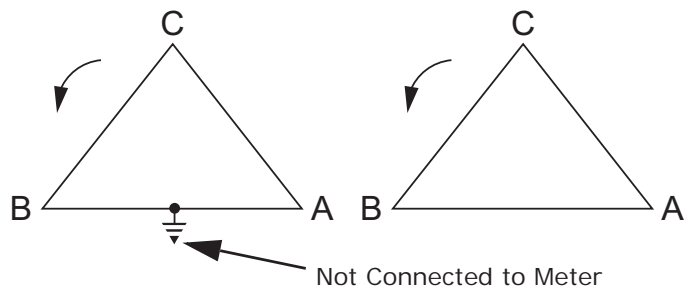
Select: "2 Ct dEL" (2 CT Delta) in Meter Programming setup.



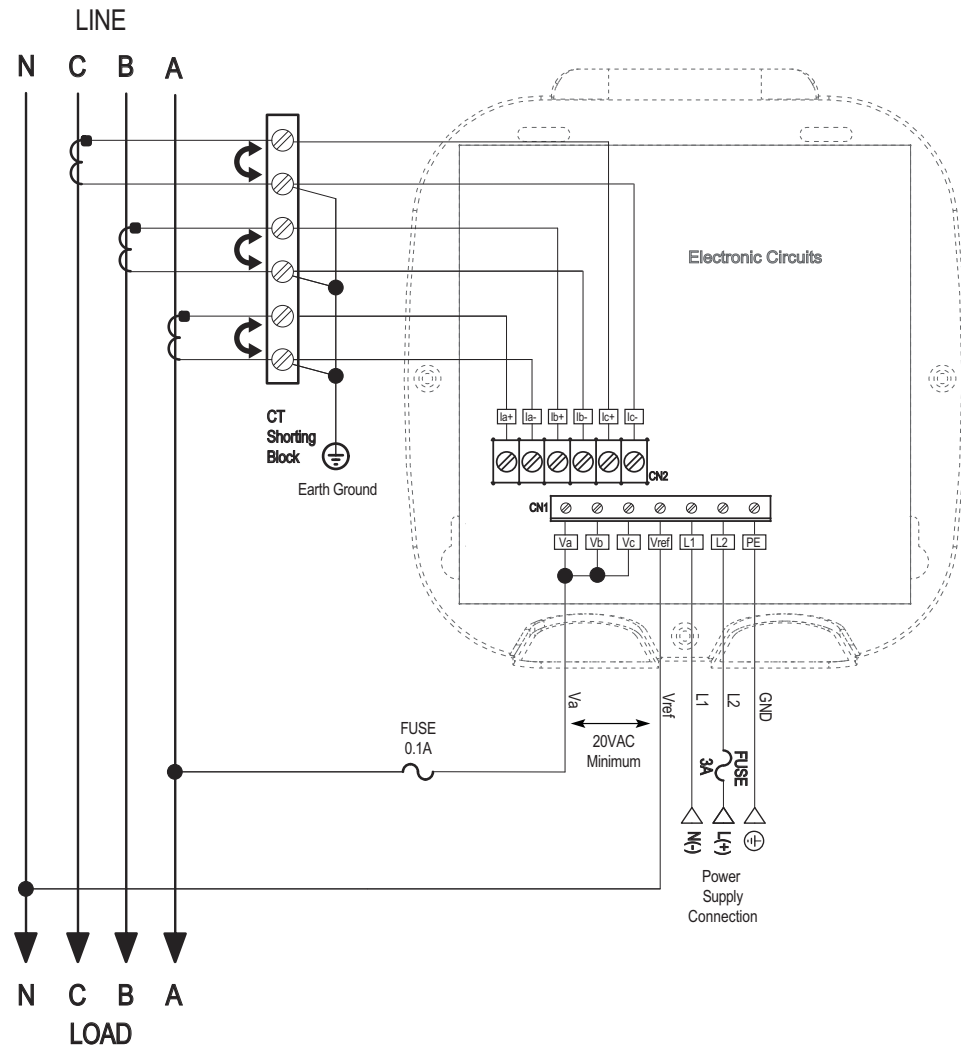
8. Service: Delta, 3-Wire with 2 PTs, 3 CTs



Select: "2 Ct dEL" (2 CT Delta) in Meter Programming setup.



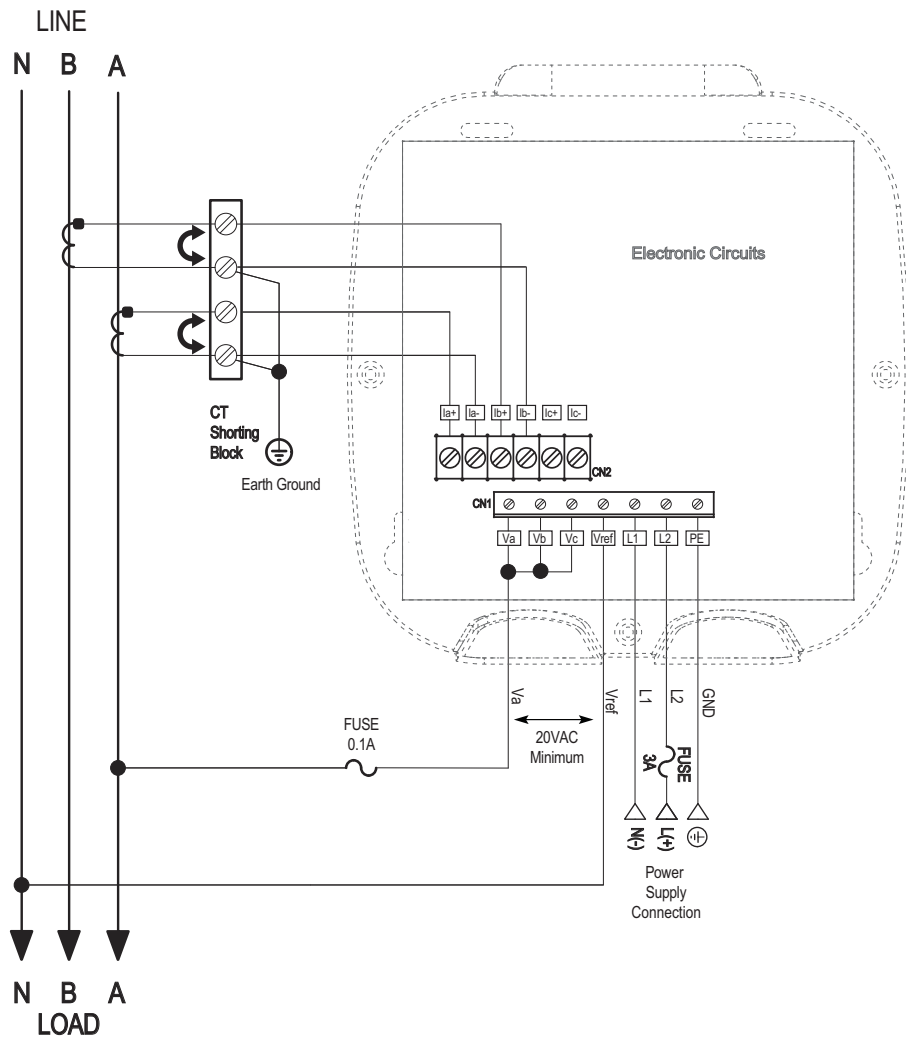
9. Service: Current Only Measurement (Three Phase)



Select: "3 EL WYE" (3 Element Wye) in Meter Programming setup.

NOTE: Even if the meter is used for only Amp readings, the unit requires a Volts AN reference. Please make sure that the Voltage input is attached to the meter. AC Control Power can be used to provide the reference signal.

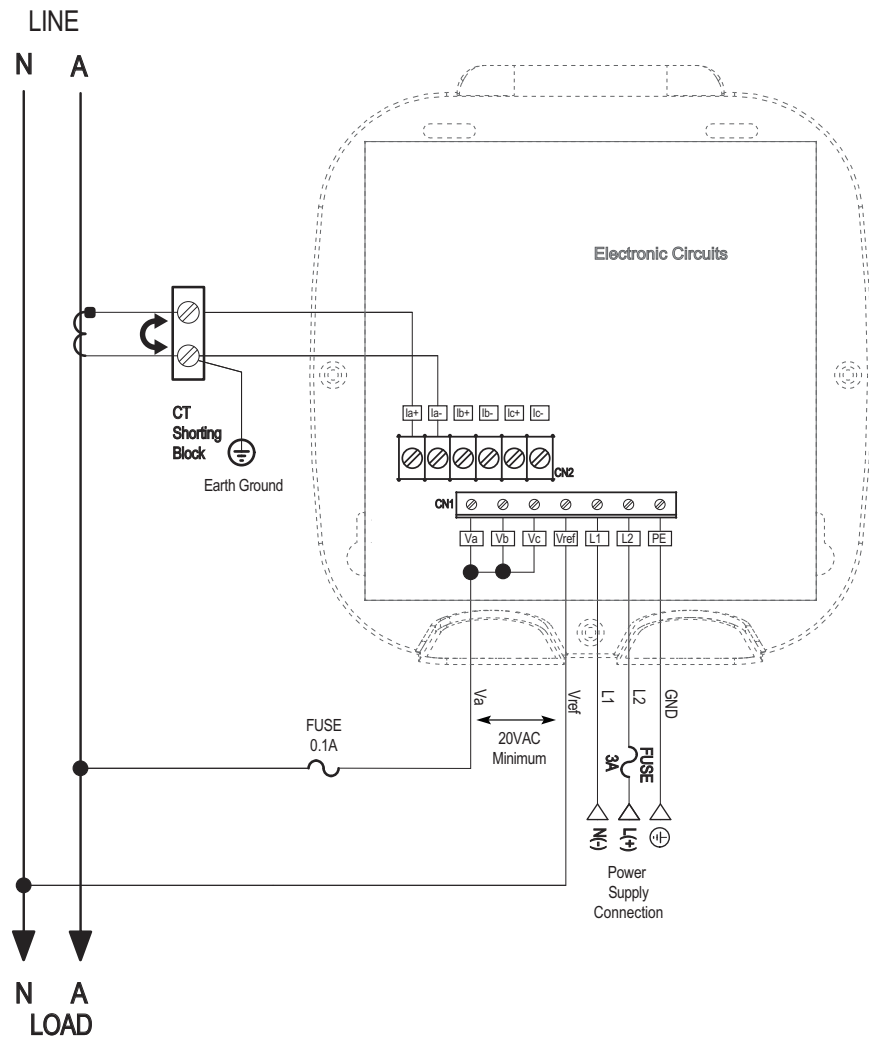
10. Service: Current Only Measurement (Dual Phase)



Select: "3 EL WYE" (3 Element Wye) in Meter Programming setup.

NOTE: Even if the meter is used for only Amp readings, the unit requires a Volts AN reference. Please make sure that the Voltage input is attached to the meter. AC Control Power can be used to provide the reference signal.

11. Service: Current Only Measurement (Single Phase)



Select: "3 EL WYE" (3 Element Wye) in Meter Programming setup.

NOTE: Even if the meter is used for only Amp readings, the unit requires a Volts AN reference. Please make sure that the Voltage input is attached to the meter. AC Control Power can be used to provide the reference signal.

4.6: Extended Surge Protection for Substation Instrumentation

EIG offers a surge protector for applications with harsh electrical conditions. The surge protector is EI-MSB10-400 and it can be ordered from EIG's webstore: www.electroind.com/store.

The EI-MSB10-400 surge protector is designed to protect sensitive equipment from the damaging effects of lightning strikes and/or industrial switching surges in single phase AC networks up to 320VAC (L-N / L-G), and DC networks up to 400 VDC. The protectors are ideal for metering systems, RTUs, PLCs and protective relays. They are used specifically to extend the life and increase reliability of critical control apparatus.

For best protection, it is recommended to use two protectors. These will protect the instrument on the line inputs and on the reference input to ground. The protectors have LED indication to annunciate when the protection has worn out.

The EI-MSB10-400 is connected by wires in parallel with the network to be protected. It can be easily mounted on a wall or plate with self-adhesive tape.

See the wiring diagram below.

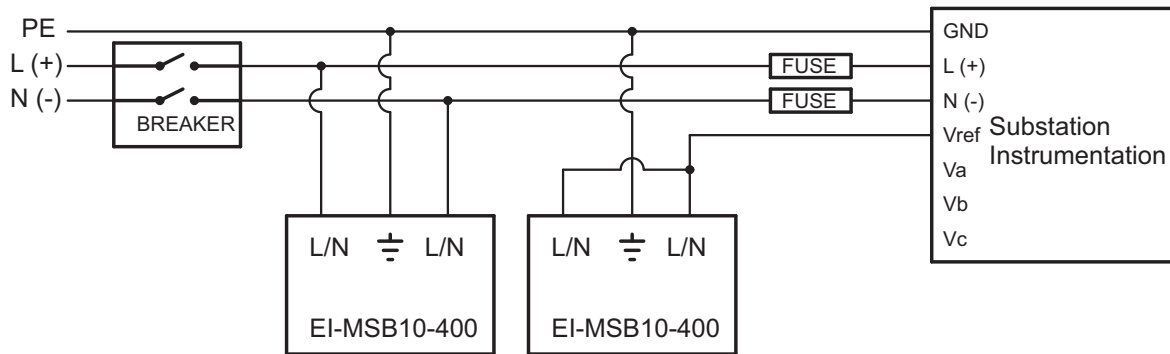


Figure 4.2: Wiring Schematic for Extended Surge Suppression
Suitable for Substation Instrumentation

5: Communication Installation

5.1: Shark® 200S Communication

The Shark® 200S submeter provides two independent communication ports plus a KYZ pulse output. The first port, Com 1, is an IrDA Port, which uses Modbus ASCII. The second port, Com 2, provides RS485 or RJ45 Ethernet or WiFi Ethernet communication (see Chapter 6 for Ethernet communication).

5.1.1: IrDA Port (Com 1)

The Com 1 IrDA port is located on the face of the submeter. The IrDA Port allows the unit to be set up and programmed with any device capable of IrDA communication, such as an IrDA-equipped laptop PC or a USB/IrDA wand (such as the USB to IrDA Adapter [CAB6490] described in Appendix D).

IrDA port settings are

Address: 1

Baud Rate: 57600 Baud

Protocol: Modbus ASCII

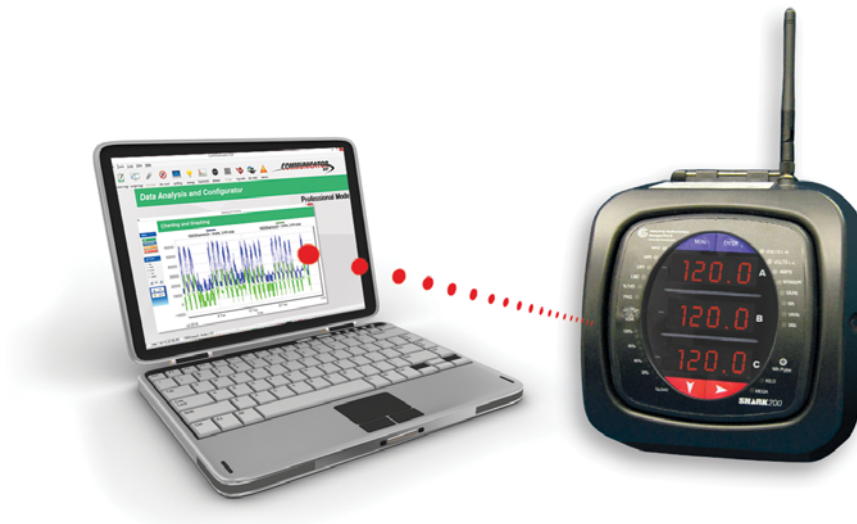


Figure 5.1: IrDA Communication

5.1.1.1: USB to IrDA Adapter

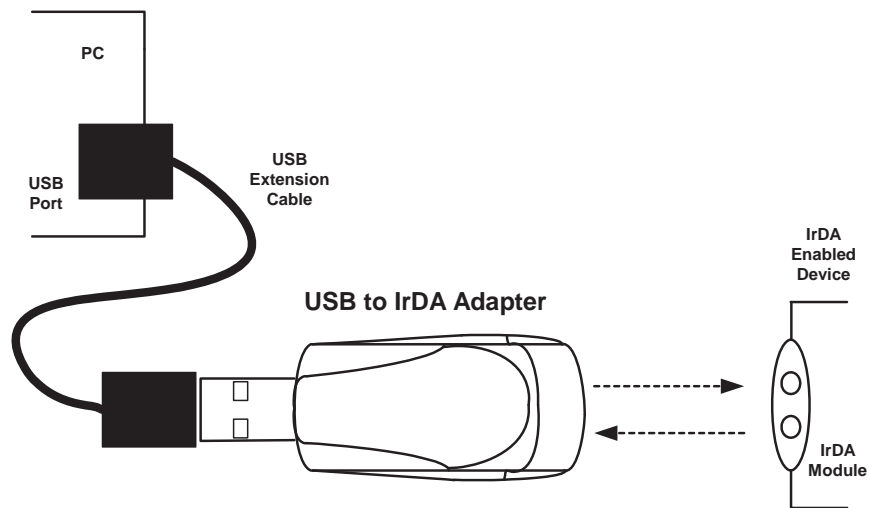


Figure 5.2: USB to IrDA Adapter

The USB to IrDA Adapter (CAB6490) enables IrDA wireless data communication through a standard USB port. The adapter is powered through the USB bus and does not require any external power adapter. The effective data transmission distance is 0 to .3 meters (approximately 1 foot).

The USB to IrDA Adapter enables wireless data transfer between a PC and the submeter. The adapter can also be used with other IrDA-compatible devices. The adapter is fully compatible with IrDA 1.1 and USB 1.1 specifications.

System Requirements

- IBM PC Pentium based computer
- 2 Gigabytes of RAM preferable
- Available USB port
- CD-ROM drive
- Windows® 98, Windows® XP, or Windows® 7 Operating Systems

See Appendix D for instructions on using the USB to IrDA Adapter. You can order CAB6490 from EIG's webstore: www.electroind.com/store. Select Cables and Accessories from the list on the left side of the screen.

5.1.2: RS485 Communication Com 2 (485 Option)

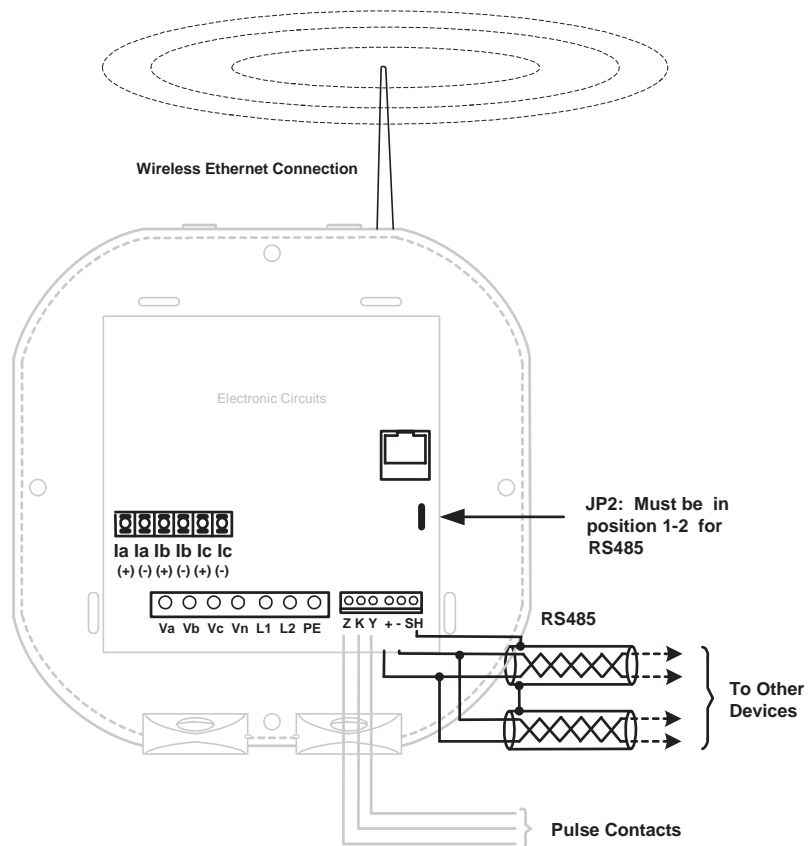
The Shark® 200S submeter's RS485 port uses standard 2-Wire, half duplex architecture. The RS485 connector is located on the front of the meter, under the cover. A connection can easily be made to a Master device or to other slave devices, as shown below.



WARNING! During normal operation of the Shark® 200S meter, dangerous voltages flow through many parts of the meter, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O Modules (Inputs and Outputs) and their circuits. All Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces. **Before performing ANY work on the meter, make sure the meter is powered down and all connected circuits are de-energized.**

AVERTISSEMENT! Pendant le fonctionnement normal du compteur Shark® 200S des tensions dangereuses suivent de nombreuses pièces, notamment, les bornes et tous les transformateurs de courant branchés, les transformateurs de tension, toutes les sorties, les entrées et leurs circuits. Tous les circuits secondaires et primaires peuvent parfois produire des tensions de létal et des courants. Évitez le contact avec les surfaces sous tensions. **Avant de faire un travail dans le compteur, assurez-vous d'éteindre l'alimentation et de mettre tous les circuits branchés hors tension.**

NOTE: Care should be taken to connect + to + and - to - connections.



The Shark® 100S submeter's RS485 connection can be programmed with the buttons on the face of the meter or by using Communicator EXT™ software.

Standard RS485 Port Settings*

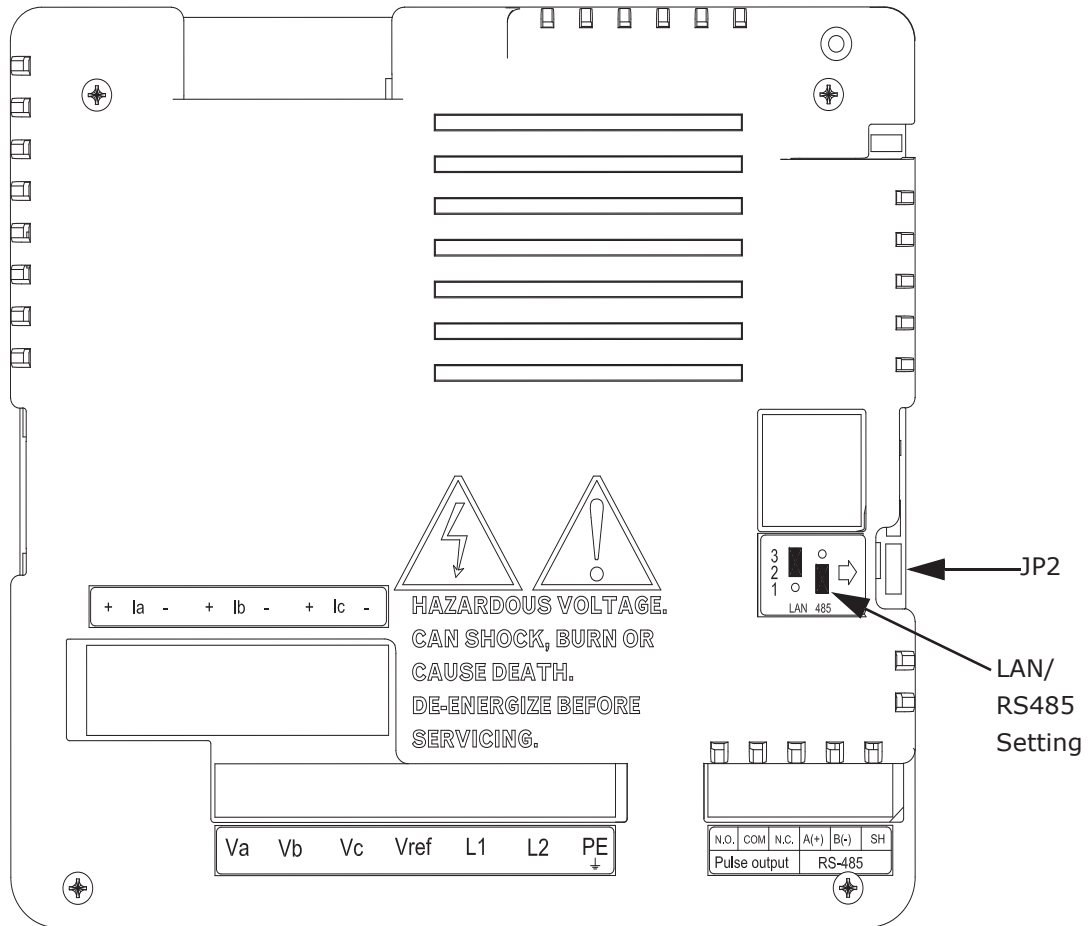
Address: 001 to 247

Baud Rate: 9600, 19200, 38400 or 57600 Baud

Protocol: Modbus RTU, Modbus ASCII, or DNP 3.0

* With Runtime Firmware Version 26 or higher, Baud Rate settings of 1200, 2400, and 4800 and Parity settings (Even, Odd, None) are also available.

IMPORTANT! The position of Jumper 2 (JP2) must be set for either RS485 or Ethernet communication. See the figure on the next page. You put the jumper on positions 2 and 3 for LAN (Ethernet) communication, and on 1 and 2 for RS485 communication.



5.1.3: KYZ Output

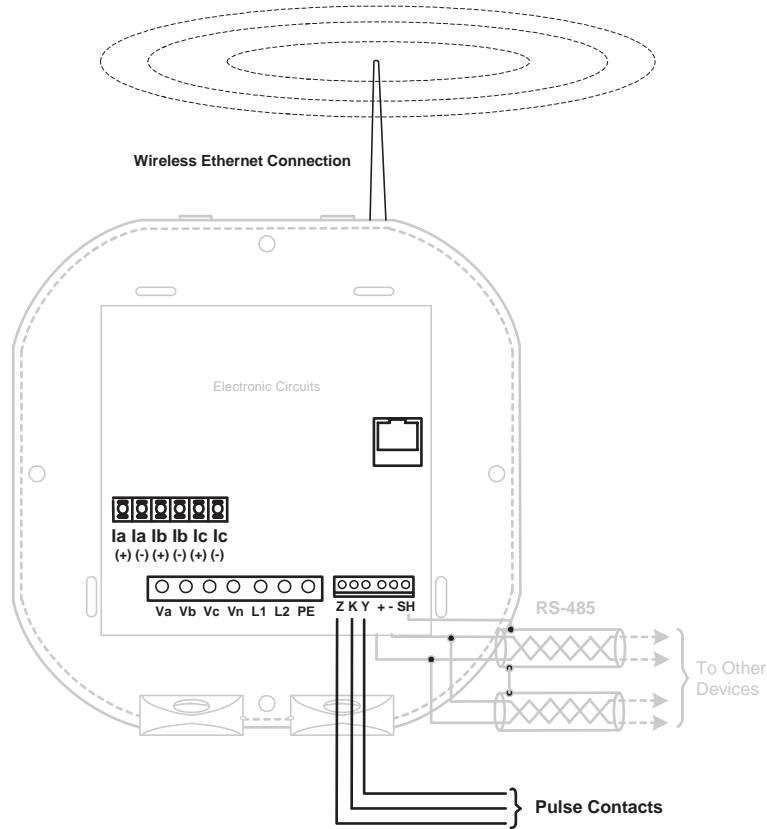
The KYZ pulse output provides pulsing energy values that verify the submeter's readings and accuracy. The KYZ Pulse Output is located on the face of the meter, under the cover and just below the RS485 connection (see figure on the next page).



WARNING! During normal operation of the Shark® 200S meter, dangerous voltages flow through many parts of the meter, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O Modules (Inputs and Outputs) and their circuits. All Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces. **Before performing ANY work on the meter, make sure the meter is powered down and all connected circuits are de-energized.**

AVERTISSEMENT! Pendant le fonctionnement normal du compteur Shark® 200S des tensions dangereuses suivent de nombreuses pièces, notamment, les bornes et tous les transformateurs de courant branchés, les transformateurs de tension, toutes les sorties, les entrées et leurs circuits. Tous les circuits secondaires et primaires peuvent parfois produire des tensions de létal et des courants. Évitez le contact avec les surfaces sous tensions. **Avant de faire un travail dans le compteur, assurez-vous d'éteindre l'alimentation et de mettre tous les circuits branchés hors tension.**

See Section 2.2 for the KYZ output specifications; see Section 7.4 for pulse constants.



5.1.4: Ethernet Connection

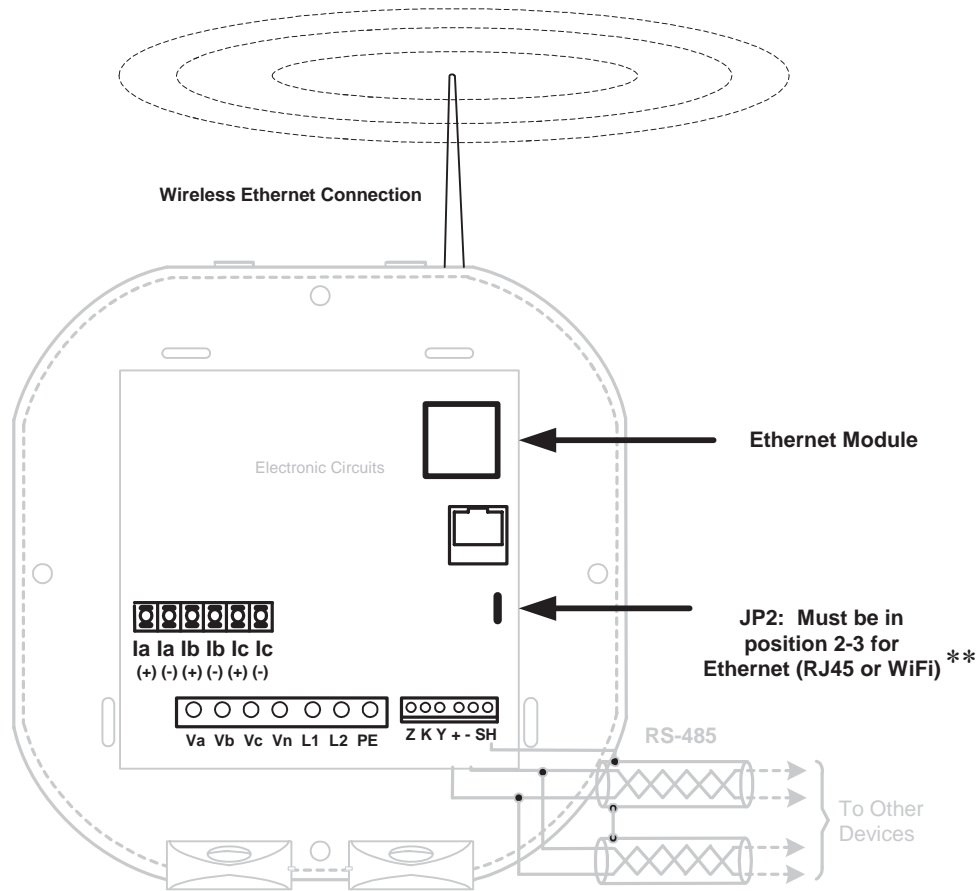
In order to use the Shark® 200S submeter's Ethernet capability, the Ethernet Module must be installed in your meter, and the JP2 must be set to positions 2-3. You can use either wired Ethernet, or WiFi.

- For wired Ethernet, use Standard RJ45 10/100BaseT cable to connect to the Shark® 200S submeter. The RJ45 line is inserted into the RJ45 port of the meter.
- For WiFi connections, make sure you have the correct antenna attached to the meter.



WARNING! During normal operation of the Shark® 200S meter, dangerous voltages flow through many parts of the meter, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O Modules (Inputs and Outputs) and their circuits. All Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces. **Before performing ANY work on the meter, make sure the meter is powered down and all connected circuits are de-energized.**

AVERTISSEMENT! Pendant le fonctionnement normal du compteur Shark® 200S des tensions dangereuses suivent de nombreuses pièces, notamment, les bornes et tous les transformateurs de courant branchés, les transformateurs de tension, toutes les sorties, les entrées et leurs circuits. Tous les circuits secondaires et primaires peuvent parfois produire des tensions de létal et des courants. Évitez le contact avec les surfaces sous tensions. **Avant de faire un travail dans le compteur, assurez-vous d'éteindre l'alimentation et de mettre tous les circuits branchés hors tension.**



Refer to Chapter 6 for instructions on how to set up the Network Module.

** See the JP2 figure and instructions on page 5-5.

5.2: Meter Communication and Programming Overview

Programming and communication can utilize the RS485 connection shown in Section 5.1.2 or the RJ45/WiFi connection shown in Section 5.1.4. Once a connection is established, Communicator EXT™ software can be used to program the meter and communicate to other devices.

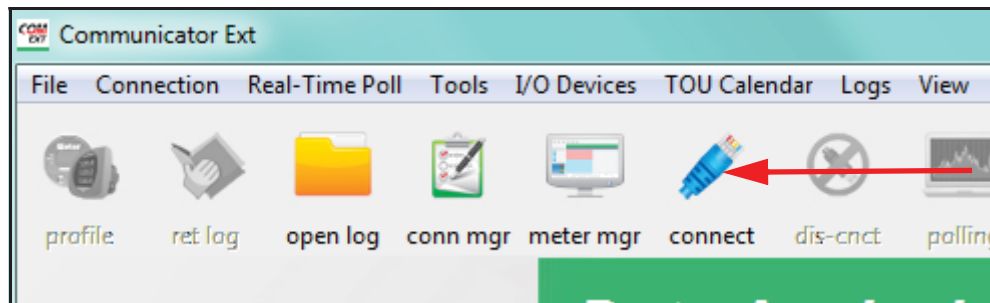
Meter Connection

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

The RS485 cable attaches to SH, - and + as shown in Section 5.1.2.

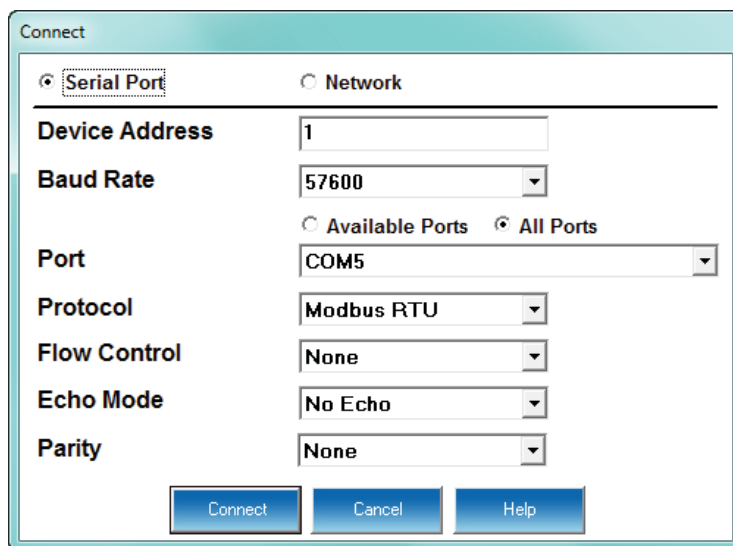
5.2.1: How to Connect to the Submeter

1. Open Communicator EXT™ software.
2. Click the **Connect** icon on the Icon bar.



The Connect screen opens, showing the Initial settings. Make sure your settings are the same as those shown on the next page, except for the IP Address field, which must be your device's IP address. The address shown here is the default Ethernet option address.

NOTE: The settings you make will depend on whether you are connecting to the meter via Serial Port or Network. Use the pull-down menus to make any necessary changes.

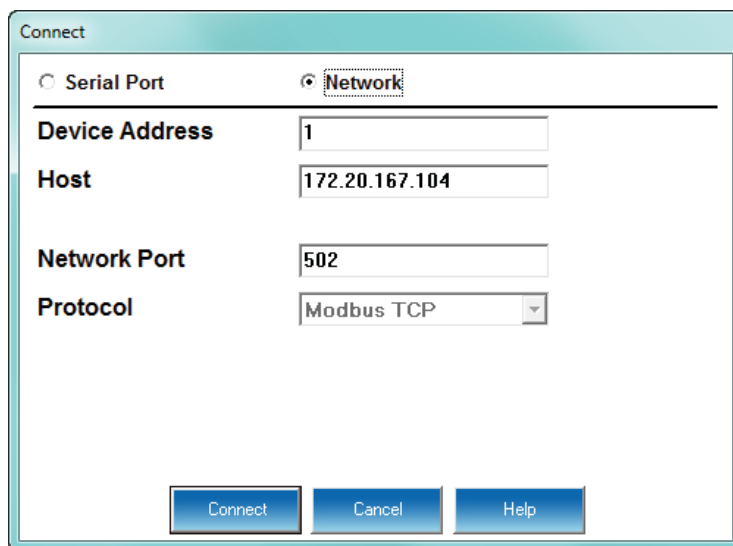


The 'Connect' dialog box shows the 'Serial Port' tab selected. The fields are configured as follows:

| Field | Value |
|----------------|------------|
| Device Address | 1 |
| Baud Rate | 57600 |
| Port | COM5 |
| Protocol | Modbus RTU |
| Flow Control | None |
| Echo Mode | No Echo |
| Parity | None |

Buttons at the bottom: Connect, Cancel, Help.

Serial Port Connection



The 'Connect' dialog box shows the 'Network' tab selected. The fields are configured as follows:

| Field | Value |
|----------------|----------------|
| Device Address | 1 |
| Host | 172.20.167.104 |
| Network Port | 502 |
| Protocol | Modbus TCP |

Buttons at the bottom: Connect, Cancel, Help.

Network Connection

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

NOTE: You may have to disconnect power, reconnect power and then click **Connect**.

The Device Status screen appears, confirming a connection.

- Click **OK**.
- Click the **Profile** icon in the Title Bar.

6. You will see the Shark® 200S meter's Device Profile screen. Use the Tree menu on the left of the screen to navigate between settings screens (see below).

The screenshot shows the 'Shark200: Shark200T_unit1 [Serial Number:0020114210, V-Switch: 4]' window. The left sidebar contains a tree menu with the following items: General Settings, CT, PT Ratios and System Hookup, Time Settings, System Settings, Communications, Display Configuration, Revenue & Energy Settings, Power Quality and Alarm Settings, Trending Profiles, Option Card 1, Comm, Fiber Optic, Option Card 2, Comm, and Network. The main area is titled 'CT, PT Ratios and System Hookup' and contains the following settings:

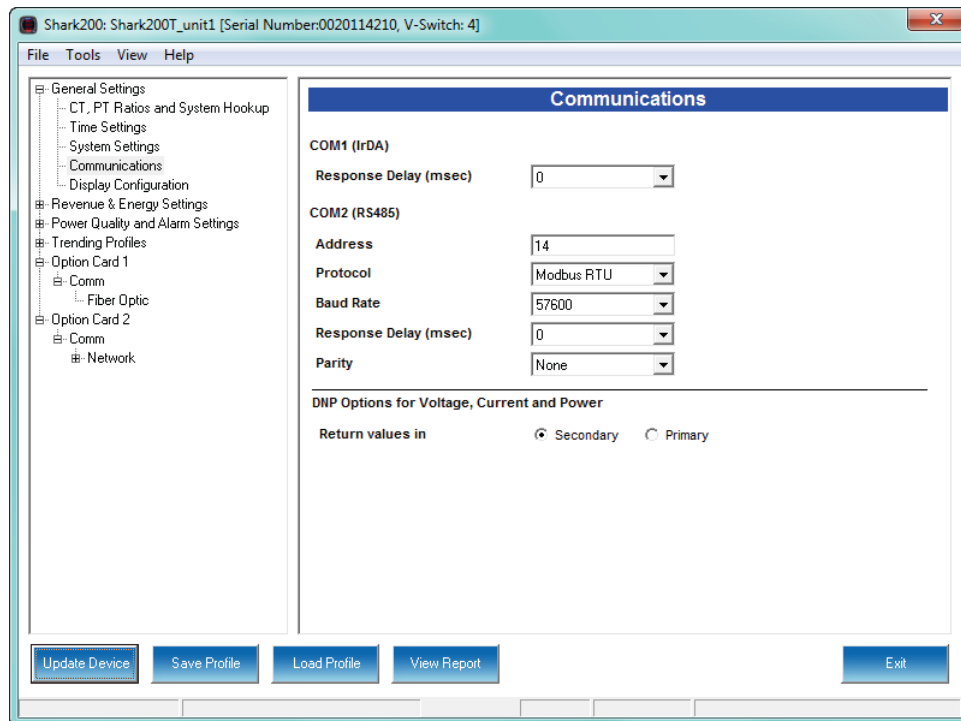
| CT, PT Ratios and System Hookup | | Ratio |
|---------------------------------|---------------|------------------|
| CT Numerator (Primary) | 2000 | < Update CT 400 |
| CT Denominator (Secondary) | 5 | Update Ratio > 1 |
| CT Multiplier | 1 | |
| Current Full Scale | 2000.00 | |
| PT Numerator (Primary) | 1440 | < Update PT 120 |
| PT Denominator (Secondary) | 120 | Update Ratio > 1 |
| PT Multiplier | 10 | |
| Voltage Full Scale | 14.40k | |
| System Wiring | 3 Element Wye | |

Note: To configure the CT & PT settings, either enter the Numerator, Denominator and Multiplier or enter the Denominator followed by the Ratio for the CT or PT and click the update button to have the software fill in the Numerator, Denominator and Multiplier.

Minimum Voltage Threshold
 Enter the voltage value as a percentage of the voltage full scale (between 0 and 12.7) 0.0 %
 Based on the configuration of this screen the minimum primary voltage will be 1200.00V

At the bottom of the window are buttons for 'Update Device', 'Save Profile', 'Load Profile', 'View Report', and 'Exit'.

7. Click the **Communications** tab. You will see the screen shown on the next page. 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)
- Protocol (Modbus RTU, Modbus ASCII or DNP)
- Baud Rate (1200 to 57600) Your meter must have Runtime Firmware Version 26 or higher to set Baud rates of 1200, 2400, and 4800.
- Response Delay (0-750 msec)
- Parity (Odd, Even, or None) Your meter must have Runtime Firmware Version 26 or higher to be able 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 Chapter 8 in the *Communicator EXT™ 4.0 and MeterManager EXT Software User Manual* for more information.

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 the following section for instructions).

5.2.2: Shark® 200S Meter Device Profile Settings

NOTE: Only the basic Shark® 200S meter Device Profile settings are explained in this manual. Refer to Chapter 8 in the *Communicator EXT™ 4.0 and MeterManager EXT Software User 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 Communicator EXT™ Main screen.

CT, PT Ratios and System Hookup

Shark200: Shark200T_unit1 [Serial Number:0020114210, V-Switch: 4]

File Tools View Help

General Settings
 CT, PT Ratios and System Hookup
 Time Settings
 System Settings
 Communications
 Display Configuration
 Revenue & Energy Settings
 Power Quality and Alarm Settings
 Trending Profiles
 Option Card 1
 Option Card 2
 Network

CT, PT Ratios and System Hookup

| | Ratio |
|----------------------------|---------------|
| CT Numerator (Primary) | 2000 |
| CT Denominator (Secondary) | 5 |
| CT Multiplier | 1 |
| Current Full Scale | 2000.00 |
| PT Numerator (Primary) | 1440 |
| PT Denominator (Secondary) | 120 |
| PT Multiplier | 10 |
| Voltage Full Scale | 14.40k |
| System Wiring | 3 Element Wye |

Note: To configure the CT & PT settings, either enter the Numerator, Denominator and Multiplier or enter the Denominator followed by the Ratio for the CT or PT and click the update button to have the software fill in the Numerator, Denominator and Multiplier.

Minimum Voltage Threshold

Enter the voltage value as a percentage of the voltage full scale (between 0 and 12.7) 0.0 %

Based on the configuration of this screen the minimum primary voltage will be 1200.00V

Update Device Save Profile Load Profile View Report Exit

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.

For manual entry: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

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 (Scaling): 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

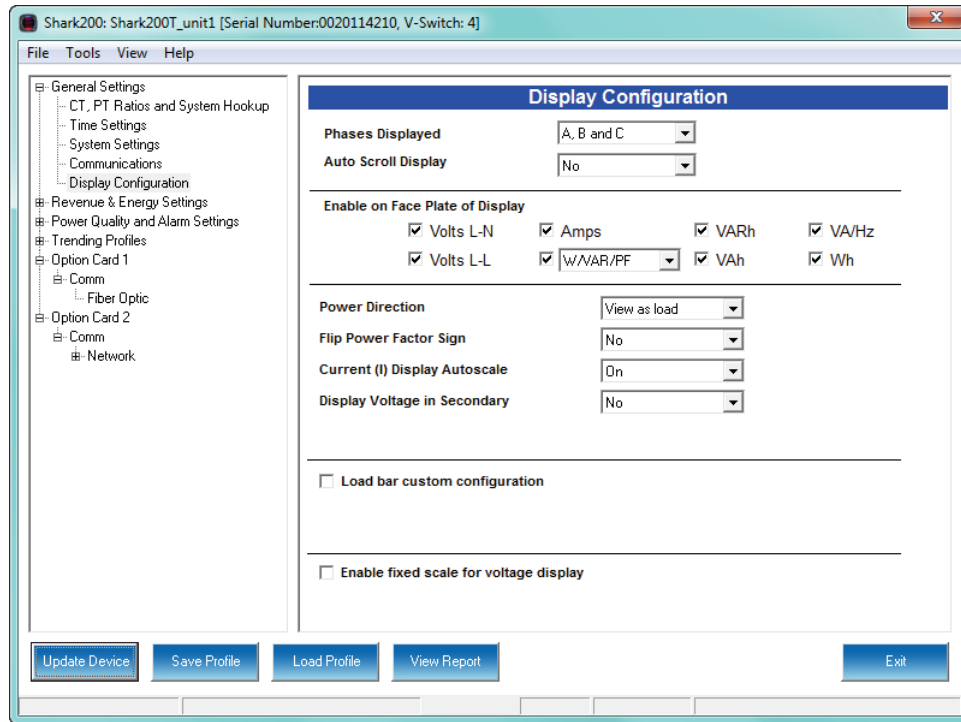
345,000/115 Volts: Pt-n value is 3450, Pt-d value is 115, Pt-Multiplier value is 100

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.



The screen fields and acceptable entries are as follows:

Phases Displayed: A; A and B; A, B, and C. This field determines which phases are displayed 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.

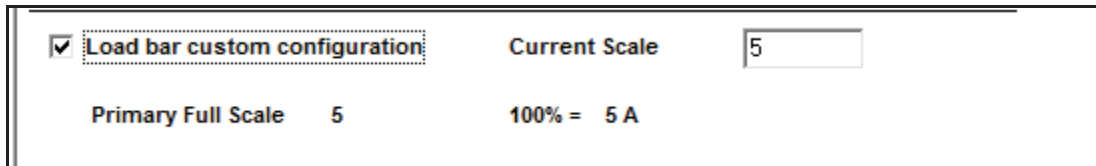
Power Direction: View as Load or View as Generator

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

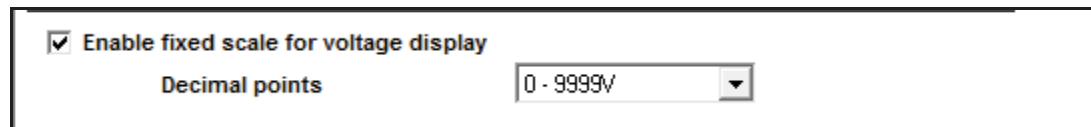
Load Bar Custom Configuration: To enter scaling for the Load Bar, click the Load Bar Custom Configuration checkbox. Fields display on the screen that allow you to enter a Scaling factor for the display. See the figure below.



| | | |
|---|---------------|------------|
| <input checked="" type="checkbox"/> Load bar custom configuration | Current Scale | 5 |
| Primary Full Scale | 5 | 100% = 5 A |

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) to arrive at the Primary Full Scale. Make sure you set the CT multiplier correctly.

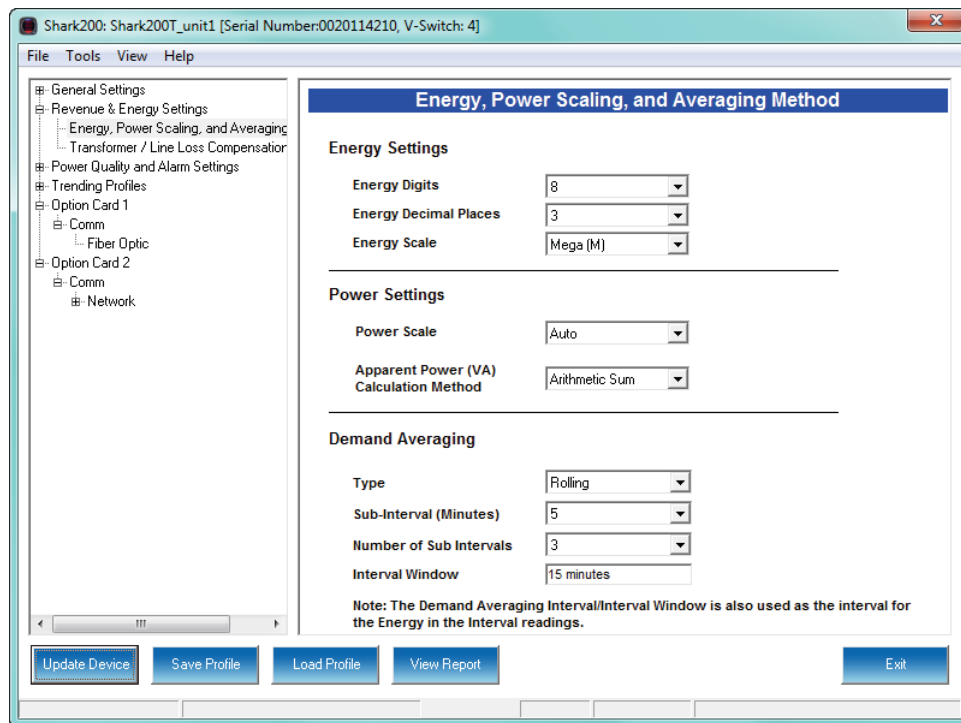
Enable Fixed Scale for Voltage Display: To enter a scaling factor for the Voltage display, click the checkbox next to Enable Fixed Scale for Voltage Display. The screen changes - see the figure below.



| | | |
|--|----------------|---------|
| <input checked="" type="checkbox"/> Enable fixed scale for voltage display | Decimal points | 0.9999V |
|--|----------------|---------|

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

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

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

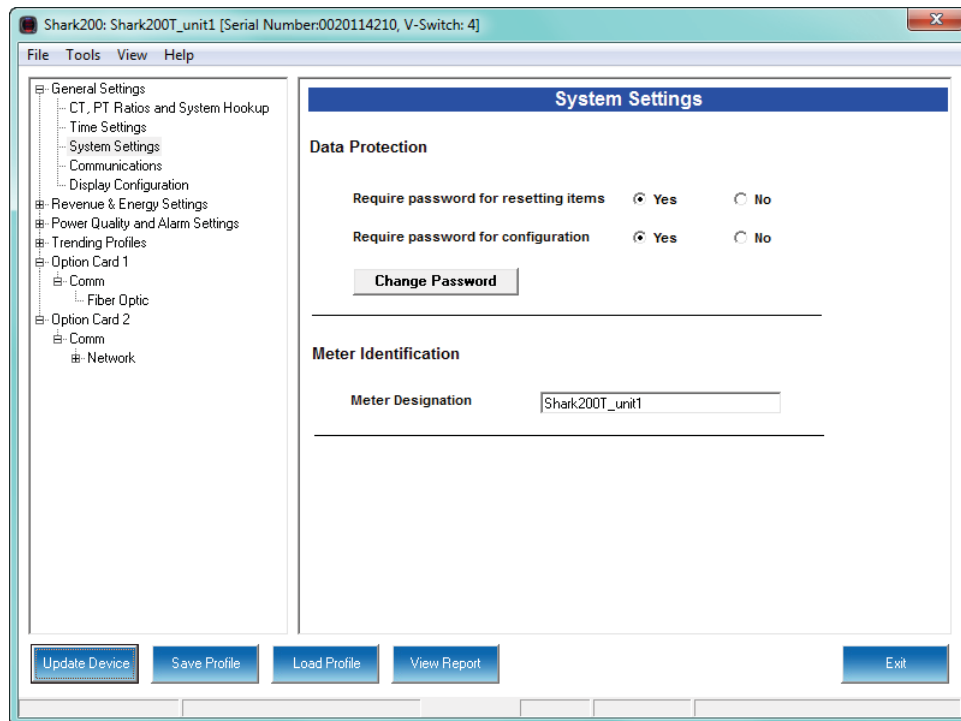
Interval (Block demand) or Sub-Interval (Rolling demand) in minutes: 5; 15; 30; 60

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 only see the Number of Subintervals and Interval Window fields 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.

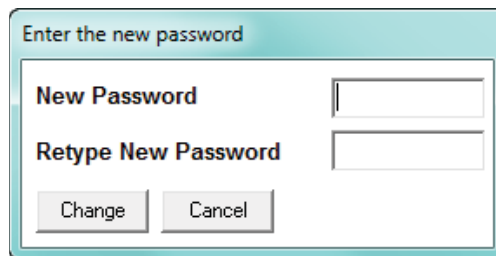
NOTES:

- 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, the

Communicator EXT™ application opens a screen asking for the password. If the correct password is not entered, the change does not take place.

IMPORTANT! 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, shown below.



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

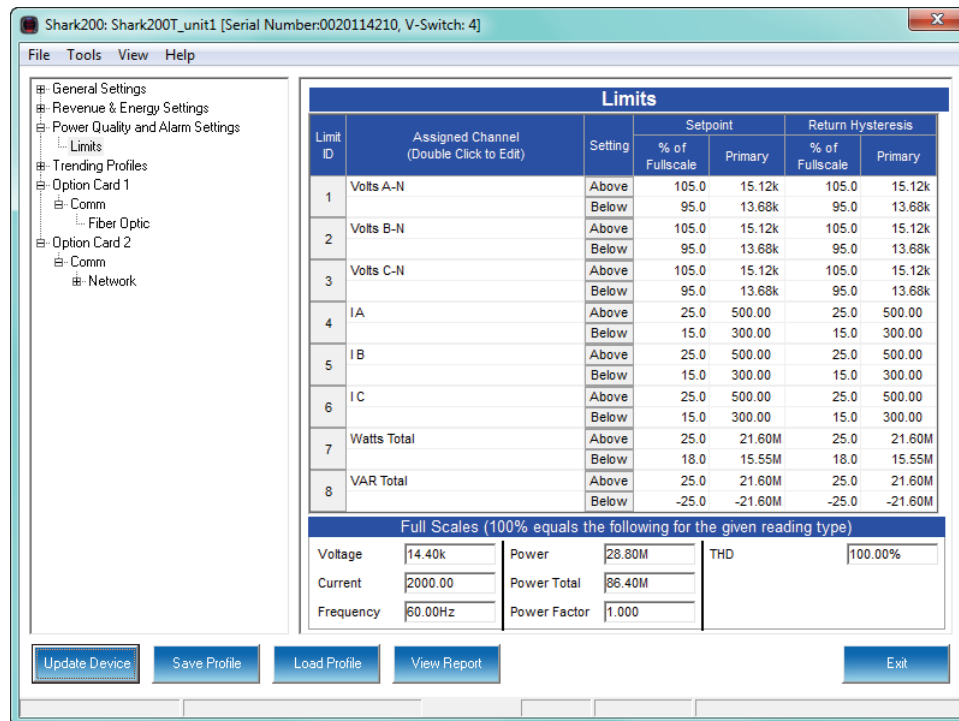
NOTE: If Password protection has already been enabled for configuration and you attempt to change the password, you will see the Enter Password screen after you click **Change**. Enter the old password and click **OK** to proceed with the password change.

- Change the Meter Identification: input a new meter label into the Meter Designation 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

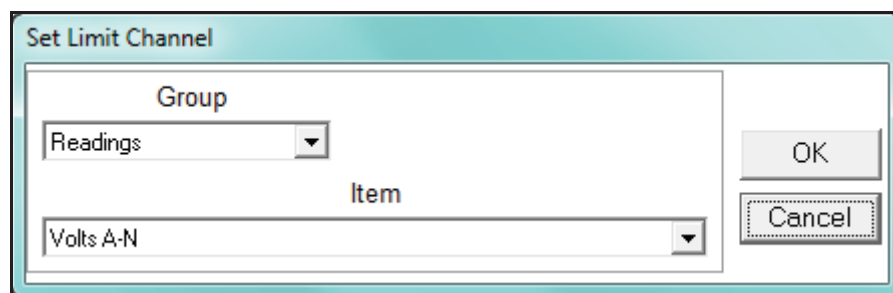
Limits log or Limits polling screen. You can also use Limits to trigger relays. See the *Communicator EXT™ 4.0 and MeterManager EXT Software User Manual* for details.



The current settings for Limits are shown in the screen. You can set and configure up to eight Limits for the Shark® 200S 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 Setpoint: % 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 (see figure below)

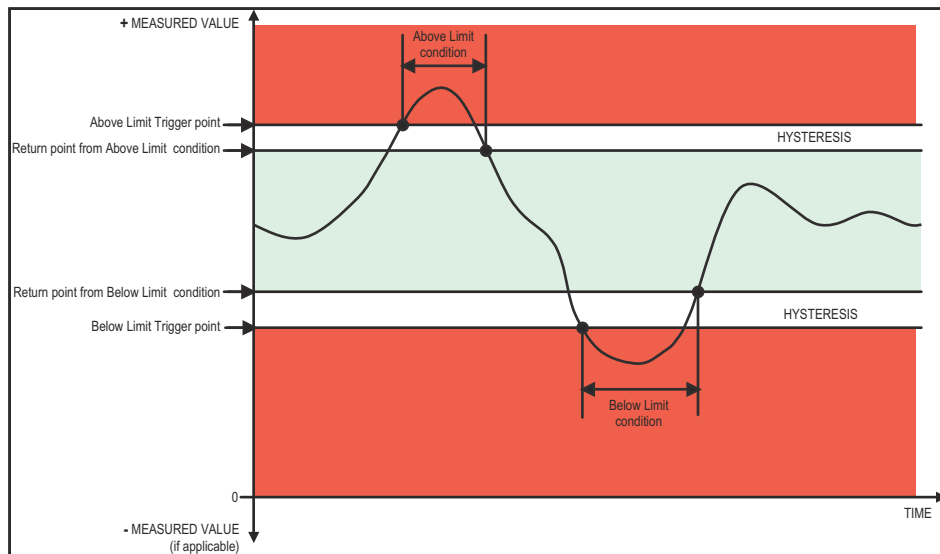
Examples:

Above Setpoint = 110%; Below Setpoint = 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 setpoint and return hysteresis value are for each limit.

NOTES:

- 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 Setpoint, the Above Limit is Disabled; if the Below Return Hysteresis is less than the Below Setpoint, the Below Limit is Disabled. You may want to use this feature to disable either Above or Below Limit conditions for a reading.

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 Chapter 8 of the *Communicator EXT™ 4.0 and MeterManager EXT Software User Manual* for additional instructions on configuring the Shark® 200S meter settings, including Time Setting, Transformer and Line Loss Compensation, CT and PT Compensation, Secondary Voltage display, Symmetrical Components, Voltage and Current Unbalance, and scaling Primary readings for use with DNP.

6: Ethernet Configuration

6.1: Introduction

The Shark® 200S submeter offers an optional WiFi (Wireless) or RJ45 Ethernet connection. This option allows the submeter to be set up for use in a LAN (Local Area Network), using standard WiFi base stations. Configuration for these connections is easily accomplished through your PC using Telnet connections. Then you can access the submeter to perform meter functions directly through any computer on your LAN: the Shark® 200S meter does not need to be directly connected (wired) to these computers for it to be accessed. This chapter outlines the procedures for setting up the parameters for Ethernet communication.

- Host PC setup - Section 6.2
- Shark® 200S submeter setup - Section 6.3

6.2: Setting up the Host PC to Communicate with Shark® 200S Meter

- Consult with your Network Administrator before performing these steps because some of the functions may be restricted to Administrator privileges.
- The Host PC could have multiple Ethernet Adapters (Network Cards) installed. Identify and configure the one that will be used for accessing the Shark® 200S meter.
- The PC's Ethernet Adapter must be set up for point-to-point communication when setting up for the Shark® 200S meter. The Factory Default IP parameters programmed in the Shark® 200S meter are:
IP Address: 10.0.0.1
Subnet Mask: 255.255.255.0
See other parameters in Section 6.3.
- The factory default Ethernet mode is WLAN (WiFi) disabled. This means the meter can be accessed via the RJ45 jack and cable connection only!

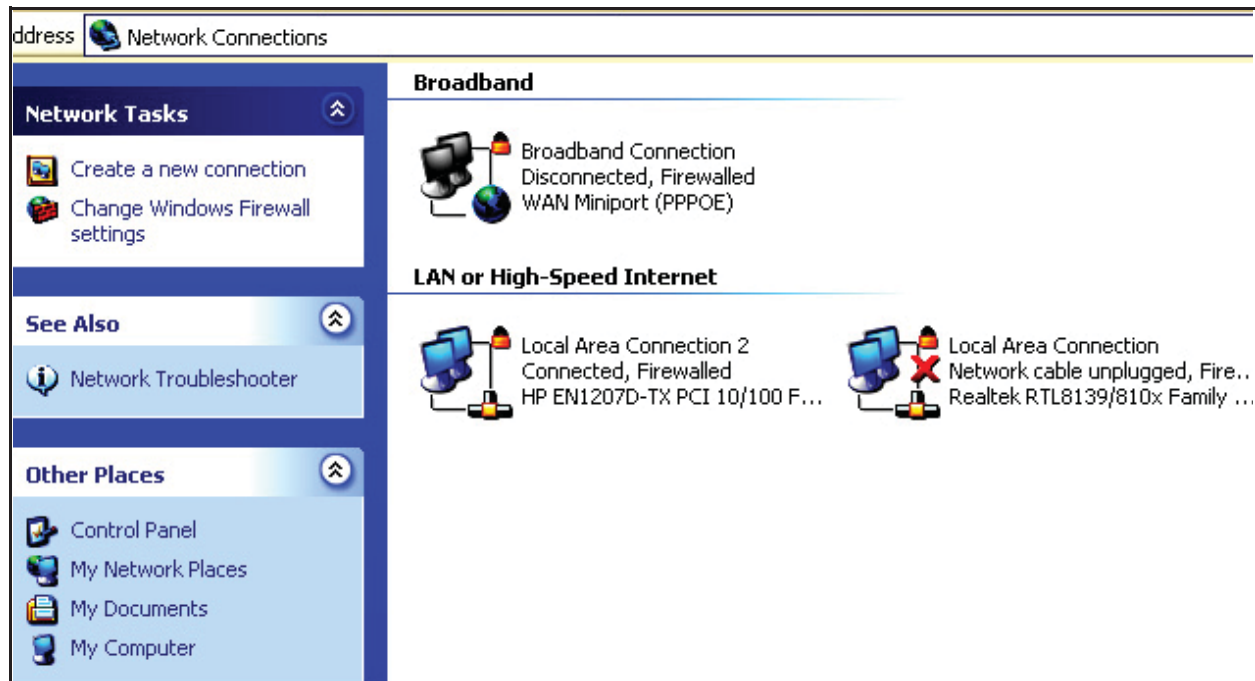


If the settings are lost or unknown in the Shark® 200S meter, follow the procedure in Section 6.4 for restoring Factory Default parameters. Default settings are listed in Section 6.3.

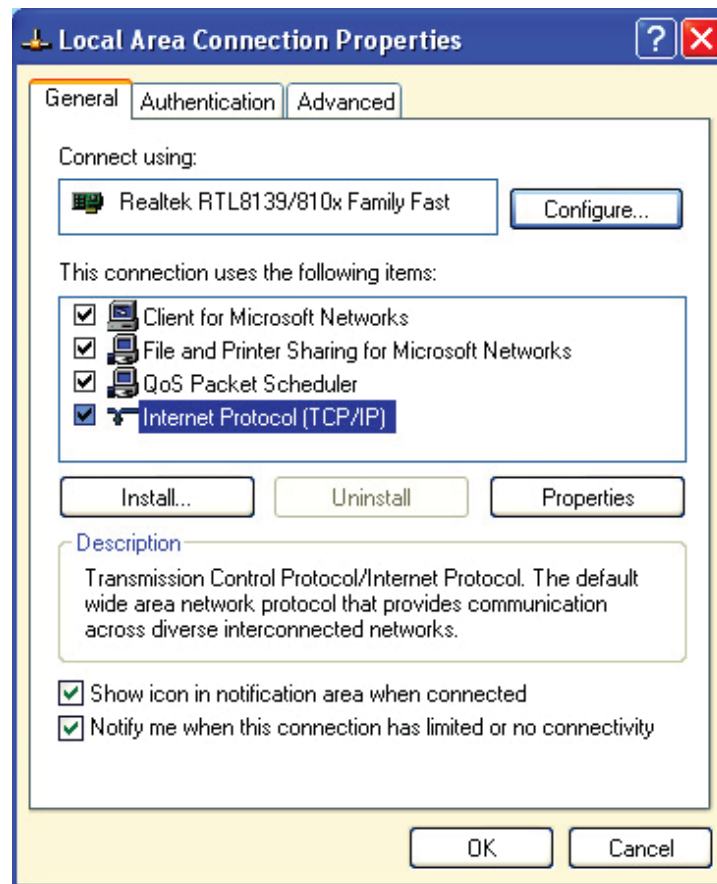
6.2.1: Configuring the Host PC's Ethernet Adapter

The following example shows the PC configuration settings that allow you to access the Shark® 200S meter in default mode. Use the same procedure when the settings are different than the default settings, but are also known to you.

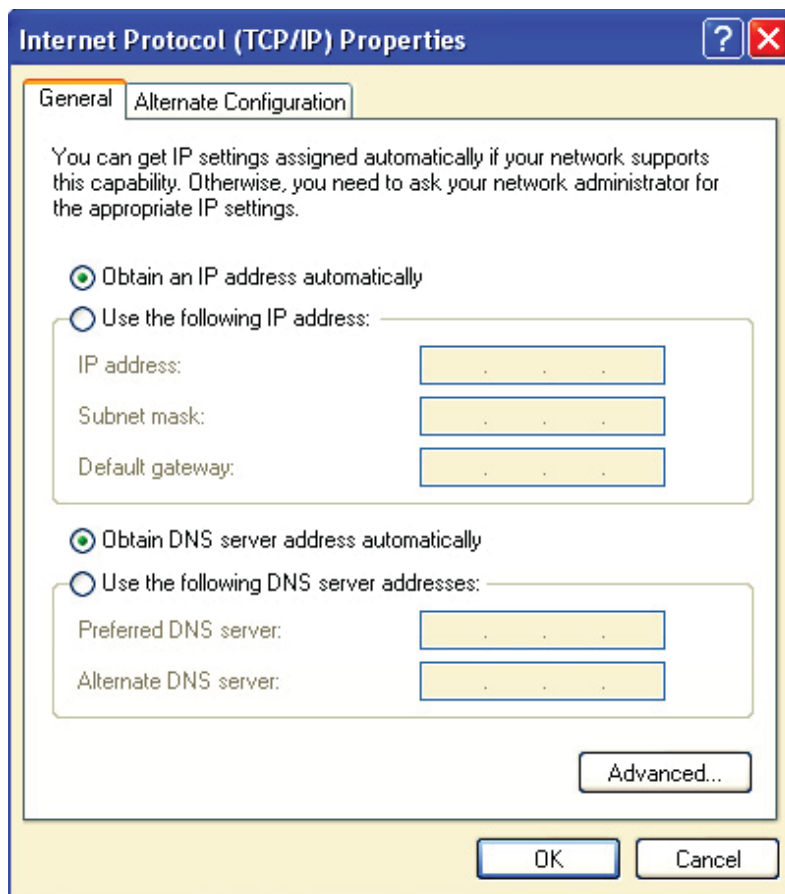
1. From the PC's Start Menu, select **Control Panel>Network Connections** or **Control Panel>Network and Internet>Network and Sharing Center**. You will see a screen showing your network connections. An example is shown below. Depending on your Operating system, the screen you see may look a bit different.



2. Right click on the Local Area Network connection you will be using to connect to the Shark® 200S submeter, and select Properties from the pull-down menu. You will see a screen similar to the one shown on the next page.



3. Select Internet Protocol [TCP/IP] from the middle of the screen and click the Properties button. You will see the screen shown on the next page.



4. Click the Use the Following IP Address radio button. The screen changes to allow you to enter the IP Address and Subnet Mask.
 - a. Enter 10.0.0.2 in the IP Address field.
 - b. Enter 255.255.255.0 in the Subnet Mask field.
3. Click the **OK** button.
4. You can now close the Local Area Connection Properties and Network Connection windows.

6.3: Setting up the Ethernet Module in the Shark® 200S Meter

Below are the Factory Default settings for the Shark® 200S meter's Ethernet Module. These are programmed into the meter before it is shipped out from the factory. Parameters indicated in bold letters (**1, 6, 7**) may need to be altered to satisfy the local Ethernet configuration requirements. Other parameters (2, 3, 4) should not be altered.



Follow the procedure described in Section 6.4 if these Factory Default parameters need to be restored in the meter.

1) Network/IP Settings:

Network Mode.....Wired Only

IP Address.....10.0.0.1

Default Gateway.....--- not set ---

Netmask.....255.255.255.0

2) Serial & Mode Settings:

Protocol.....Modbus/RTU,Slave(s) attached

Serial Interface..... 57600,8,N,1,RS232,CH1

3) Modem/Configurable Pin Settings:

CP0..! Defaults (In) Wired CP1..! GPIO (In) CP2..! GPIO (In)

CP3..! GPIO (In) CP4..! GPIO (In) CP5..! GPIO (In)

CP6..! GPIO (In) CP7..! GPIO (In) CP8..! GPIO (In)

CP9..! GPIO (In) CP10..! GPIO (In)

RTS Output Fixed High/Active

4) Advanced Modbus Protocol settings:

Slave Addr/Unit Id Source... Modbus/TCP header

Modbus Serial Broadcasts....Disabled (Id=0 auto-mapped to 1)

MB/TCP Exception Codes.....Yes (return 00AH and 00BH)

Char, Message Timeout.....00050msec, 05000msec

6) WLAN Settings:

WLAN..... Disabled, network:LTRX_IBSS

Topology..... Infrastructure, Country: US

Security.....none

TX Data rate.....11 Mbps auto fallback

Power management.....Disabled

Soft AP Roaming.....N/A

Ad-hoce merging.....Enabled

WLAN Max failed packets..0

7) Security Settings:

SNMP.....Enabled

SNMP Community Name...public

Telnet Setup.....Enabled

TFTP Download..... Enabled

Port 77FEh..... Enabled

Enhanced Password.....Disabled

D)efault settings, S)ave, Q)uit without save

Select Command or parameter set (1..7) to change:

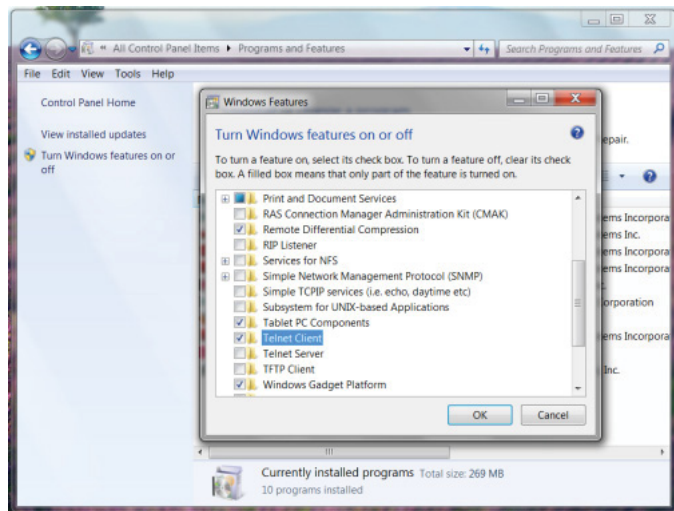
- The Ethernet Module in the Shark® 200S meter can be locally or remotely configured using a Telnet connection over the network.
- The configuration parameters can be changed at any time and are retained when the meter is not powered up. After the configuration has been changed and saved, the Ethernet module performs a Reset.
- Only one person at a time should be logged into the network port used for setting up the meter. This eliminates the possibility of several people trying to configure the Ethernet interface simultaneously.

6.3.1: Configuring the Ethernet Module in the Shark® 200S Meter Using Windows XP® on the Host Computer

Establish a Telnet connection to port 9999:

NOTE: If your PC is running Windows 7, you need to enable Telnet before using it.

1. Open the Control Panel.
2. Select Programs and Features.
3. Select Turn Windows features on or off.
4. Check the box for Telnet Client.
5. Click OK. The Telnet client is now available.



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

NOTE: Be sure to include a space between the IP address and 9999.

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

```

CA> Telnet 172.20.167.125
Modbus Bridge
MAC address 00204ACE7D10
Software version U3.3.25.0RC2 <130212>
Press Enter for Setup Mode

```

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

```

CA> Telnet 172.20.167.125
Modbus Bridge
MAC address 00204ACE7D10
Software version U3.3.25.0RC2 <130212>
Press Enter for Setup Mode
Model: Device Server Plus+! <Firmware Code:GA>
Modbus/TCP to RTU Bridge Setup
1) Network/IP Settings:
   Network mode ..... Wireless Only
   IP Address ..... 172.20.167.125
   Default Gateway ..... 172.20.161.23
   Netmask ..... 255.255.248.0
2) Serial & Mode Settings:
   Protocol ..... Modbus/RTU,Slave(s) attached
   Serial Interface ..... 57600,8,N,1,RS232,CH1
3) Modem/Configurable Pin Settings:
   CP0..!Defaults(In) Wired
   CP2..!GPIO <In>
   CP4..!GPIO <In>
   CP6..!GPIO <In>
   CP8..!GPIO <In>
   CP10..!GPIO <In>
   CP3..!GPIO <In>
   CP5..!GPIO <In>
   CP7..!GPIO <In>
   CP9..!GPIO <In>
   RTS Output ..... Fixed High/Active
4) Advanced Modbus Protocol settings:
   Slave Addr/Unit Id Source .. Modbus/TCP header
   Modbus Serial Broadcasts ... Disabled <Id=0 auto-mapped to 1>
   MB/TCP Exception Codes .... Yes <return 00AH and 00BH>
   Char, Message Timeout ..... 00050msec, 05000msec
6) WLAN Settings:
   WLAN ..... Enabled, network:eigtestdept
   Topology ..... Infrastructure, Country: US
   Security ..... Authentication: shared
   Encryption: WEP64
   TX Key index: 1
   TX Data rate ..... 11 Mbps auto fallback
   Power management ..... Disabled
   Soft AP Roaming ..... Disabled
   WLAN Max failed packets .... 0
7) Security Settings:
   SNMP ..... Enabled
   SNMP Community Name .....
   Telnet Setup ..... Enabled
   TFTP Download ..... Enabled
   Port 77FEh ..... Enabled
   Enhanced Password ..... Disabled
D>default settings, S>ave, Q>uit without save
Select Command or parameter set <1..7> to change:

```

5. Type the number for the group of parameters you need to modify. After the group is selected, the individual parameters display for editing. Either:

- Enter a new parameter if a change is required.
- Press Enter to proceed to the next parameter without changing the current one.



Change Settings 1, 6, and 7 ONLY! Settings 2, 3, and 4 MUST have the default values shown above.

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

6.3.2: Example of Modifying Parameters in Groups 1, 6, and 7

Follow the steps in 6.3.1 to enter Setup Mode.

Network IP Settings Detail (1) (Set device with static IP Address.)

Network Mode: 0=Wired only, 1=Wireless Only <0> ? Key 1 and press Enter for WiFi mode.

IP Address <010> 192.<000> 168.<000> .<000> .<001> You can change the IP address in this setting.

Set Gateway IP Address <N> ? Y (If you want to change the Gateway address.)

Gateway IP Address : <192> .<168> .<000> .<001> (You can change the Gateway address in this setting.)

Set Netmask <N for default> <Y> ? Y (If you want to change the Netmask.)

<255> .<255> .<255> .<000> (You can change the Netmask in this setting.)

Change telnet config password <N> ? N

WLAN Settings Detail (6) (The settings shown are recommended by EIG for use with the Shark® 200S meter. You will only be able to access these settings if you have set Network Mode to "1" (to select Wireless mode) in the Network IP Settings Detail, shown previously.)

Topology: 0=Infrastructure, 1=Ad-Hoc <1> ? 0

Network Name: EIG_SHARKS

Security suite: 0=none, 1=WEP, 2=WPA, 3=WPA2/802.11i <0> ? Enter the number of the encryption method are using, e.g., 3 for WPA2/802.11i.

- **If you select “1” (WEP), you will see the following settings:**

Authentication 0=open/none, 1=shared <0> ? (Enter 1 if you want the encryption key matched with a communication partner before messages are passed through.)

Encryption 1=WEP64, 2=WEP128 <1> 2

Change Key <N> Y

Display Key <N> N

Key Type 0=hex, 1=passphrase <0> 0

Enter Key:

You can manually enter 26 hexadecimal characters (required for 128-bit encryption) or you can use a WEP Key provider online (for example: www.pow-erdog.com/wepkey.cgi). WEP Key providers should note on their website that their encryption algorithm is for the Wired Equivalent Privacy portion of IEEE 802.11b/g.

WEP Key Provider Steps

1. Input 26 alphanumeric characters as your Passphrase.

IMPORTANT! Remember your Passphrase.

PASSPHRASE TO HEXADECIMAL WEP KEYS

Enter the passphrase below.

1009egbck001036ab

Generate keys

2. Click the Generate Keys button. Your Hexadecimal WEP Keys display.

PASSPHRASE TO HEXADECIMAL WEP KEYS

The passphrase 1009egbcke001306ab produces the following keys:

64-BIT (40-BIT KEYS)

1. AA43FB768D
2. 637D8DB9CE
3. AFDE50AF61
4. 0c35E73E25

128-BIT (104-BIT) KEY

041D7773D8B2C1D97BE9531DC

3. Enter the 128-bit Key.

TX Key Index <1> ? 1 (The WEP key used for transmissions - must be a value between 1 and 4.)

TX Data Rate: 0=fixed, 1=auto fallback <1> ? 1

TX Data rate: 0=1, 1=2, 2=5.5, 3=11, 4=18, 5=24, 6=36, 7=54 Mbps <7> ?
Enter data transmission rate, e.g., 7 for 54Mbps.

Minimum Tx Data rate: 0=1, 1=2, 2=5.5, 3=11, 4=18, 5=24, 6=36,
7=54 Mbps <0> ? 0

Enable Power management <N> ? Y

Enable Soft AP Roaming <N> ? N

Max Failed Packets (6-64, 255=disable) <6> ? 6

- **If you select "2" (WPA), you will make the following settings:**

Change Key <N> Y

Display Key <N> N

Key Type 0=hex, 1=passphrase <0> 1

Enter Key: (The maximum length of the passphrase is 63 characters. EIG recommends using a passphrase of 20 characters or more for maximum security.)

Encryption: 0=TKIP, 1=TKIP+WEP <0> ? Set the type to the minimum required security level. The "+" sign indicates that the group (broadcast) encryption method is different from the pairwise (unicast) encryption (WEP and TKIP).

TX Data rate: 0=fixed, 1=auto fallback <1> ? 1

TX Data rate: 0=1, 1=2, 2=5.5, 3=11, 4=18, 5=24, 6=36, 7=54 Mbps <7> ?
Enter data transmission rate, e.g., 7 for 54Mbps.

Minimum Tx Data rate: 0=1, 1=2, 2=5.5, 3=11, 4=18, 5=24, 6=36,
7=54 Mbps <0> ? 0

Enable Power management <N> ? Y

Enable Soft AP Roaming <N> ? N

Max Failed Packets (6-64, 255=disable) <6> ? 6

- **If you select "3" (WPA2/802.11i), you will make the following settings:**

Change Key <N> Y

Display Key <N> N

Key Type 0=hex, 1=passphrase <0> 1

Enter Key: (The maximum length of the passphrase is 63 characters. EIG recommends using a passphrase of 20 characters or more for maximum security.)

Encryption: 0=CCMP, 1=CCMP+TKIP, 2=CCMP+WEP, 3=TKIP, 4=TKIP+WEP
<3> ? (Set the type to the minimum required security level. The "+" sign indicates that the group (broadcast) encryption method is different from the pair-

wise (unicast) encryption. For example, for CCMP+TKIP, CCMP is the pairwise encryption and TKIP is the group encryption. CCMP is the default for WPA2.)

TX Data rate: 0=fixed, 1=auto fallback <1> ? 1

TX Data rate: 0=1, 1=2, 2=5.5, 3=11, 4=18, 5=24, 6=36, 7=54 Mbps <7> ?
Enter data transmission rate, e.g., 7 for 54Mbps.

Minimum Tx Data rate: 0=1, 1=2, 2=5.5, 3=11, 4=18, 5=24, 6=36,
7=54 Mbps <0> ? 0

Enable Power management <N> ? Y

Enable Soft AP Roaming <N> ? N

Max Failed Packets (6-64, 255=disable) <6> ? 6

Security Settings (7)

Disable SNMP <N> ? N

SNMP Community Name <public>: (You can enter an SNMP community name here.)

Disable Telnet Setup <N> ? N (If you change this setting to Y, you will not be able to use Telnet to re-configure the Network card once you save the settings, without resetting the Network card, as shown in Section 6.4. However, you may want to disable Telnet setup and Port 77FEh to prevent users from accessing the setup from the network.)

Disable TFTP Firmware Update <N> ? N

Disable Port 77FEh <N> ? N (For security purposes, you may want to disable Telnet setup and Port 77FEh to prevent users from accessing the setup from the network.)

Enable Enhanced Password <N> ? N

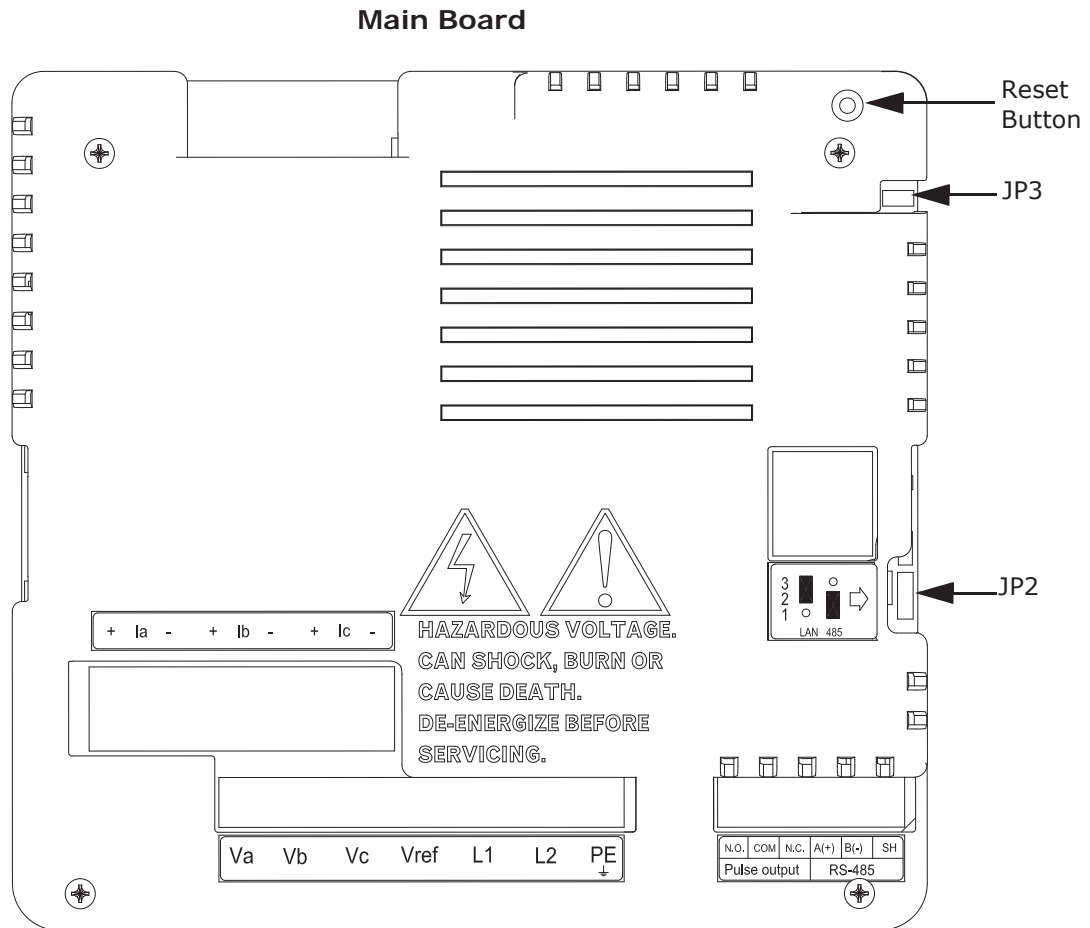
Exiting the screen

CAUTION! DO NOT PRESS 'D': that will restore the Default Settings.

Press 'S' to Save the settings you've entered.

6.4: Network Module Hardware Initialization

If you don't know your current Network Module settings, or if the settings are lost, you can use this method to initialize the hardware with known settings you can then work with.



WARNING! During normal operation of the Shark® 200S meter, dangerous voltages flow through many parts of the meter, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O Modules (Inputs and Outputs) and their circuits. All Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces. **Before performing ANY work on the meter, make sure the meter is powered down and all connected circuits are de-energized.**

AVERTISSEMENT! Pendant le fonctionnement normal du compteur Shark® 200S des tensions dangereuses suivent de nombreuses pièces, notamment, les bornes et

tous les transformateurs de courant branchés, les transformateurs de tension, toutes les sorties, les entrées et leurs circuits. Tous les circuits secondaires et primaires peuvent parfois produire des tensions de léta et des courants. Évitez le contact avec les surfaces sous tensions. **Avant de faire un travail dans le compteur, assurez-vous d'éteindre l'alimentation et de mettre tous les circuits branchés hors tension.**

1. Place a shorting block on JP3 and press the **Reset** button on the main board.

NOTE: JP3 is located on the right hand side, upper corner of the main board. The shorting block can be "borrowed" from JP2, located at the middle, right hand side. See the figure shown on the previous page.

2. After you press the **Reset** button, move the jumper back to JP2.

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7: Using the Submeter

7.1: Introduction

The Shark® 200S submeter can be configured and a variety of functions can be accomplished by using the Elements and the Buttons on the submeter face. This chapter reviews front panel navigation. See Appendix A for complete Navigation maps.

7.1.1: Understanding Submeter Face Elements

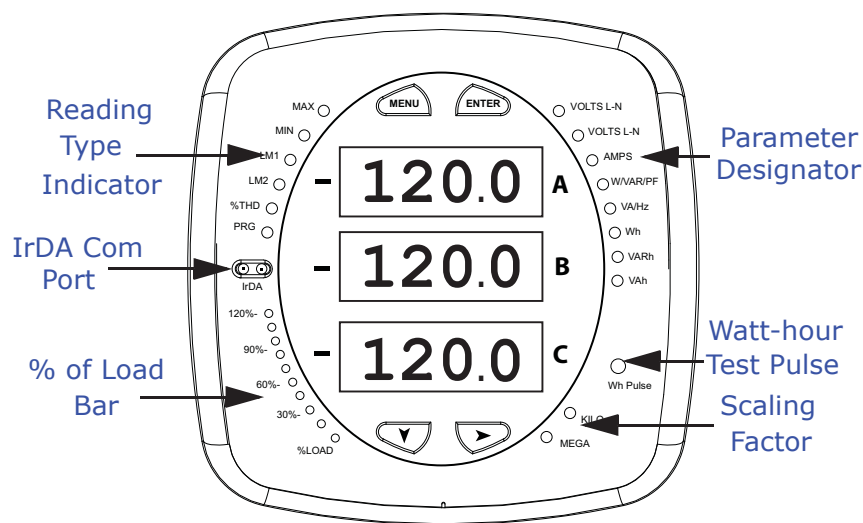


Figure 7.1: Faceplate with Elements

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 7.3 for additional information.)
- IrDA Communication Port: Com 1 port for wireless communication

7.1.2: Understanding Submeter Face Buttons

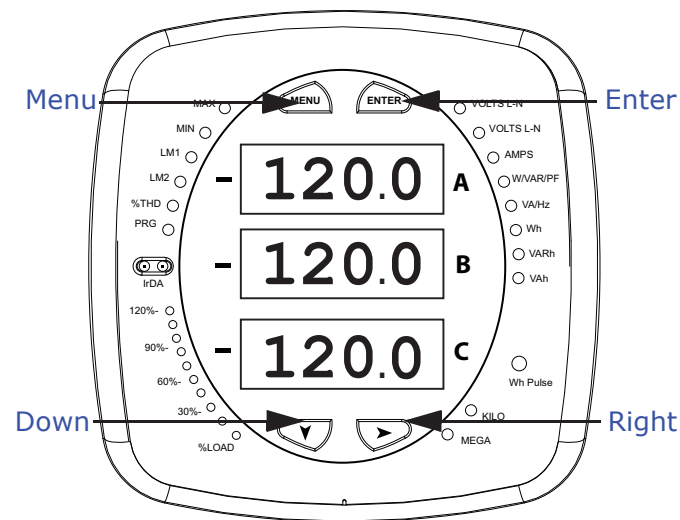


Figure 7.2: Faceplate with Buttons

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

7.2: Using the Front Panel

You can access four modes using the Shark® 200S submeter'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, V-Switch, etc.

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

NOTES:

- See Appendix A for the complete display mode Navigation maps.
- The meter can also be configured using software; see Chapter 5 and the *Communicator EXT™ 4.0 and MeterManager EXT Software User Manual* for instructions.

7.2.1: 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 Shark® 200S 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 7.3 shows an example of a Wh reading.

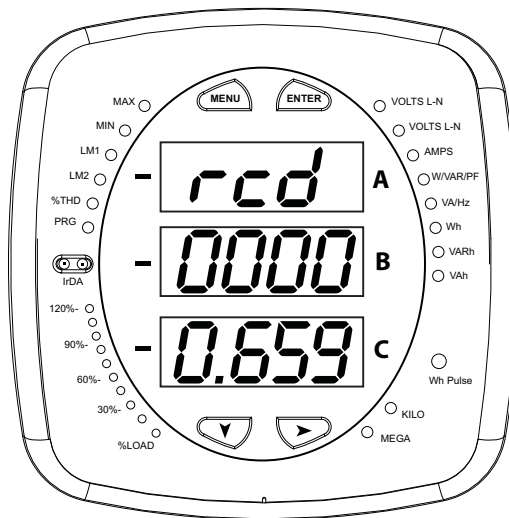


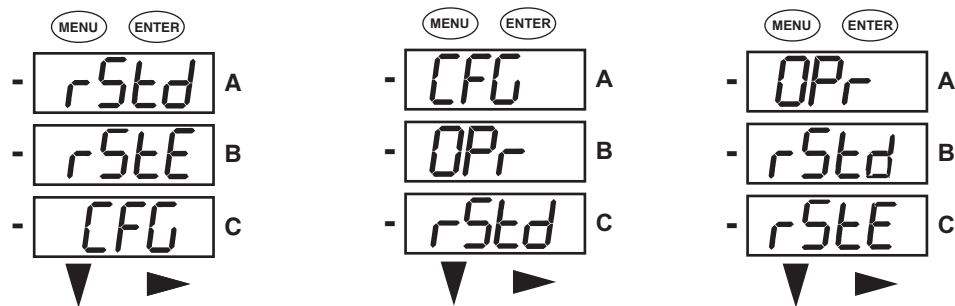
Figure 7.3: Display Showing Watt-hr Reading

The Shark® 200S 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.

7.2.2: 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.

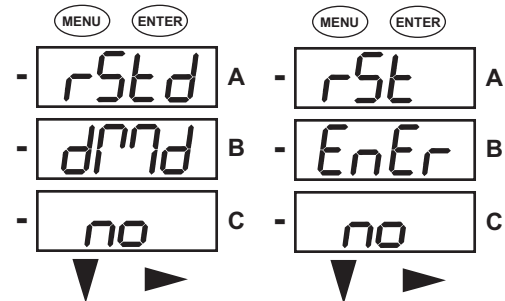
2. Press the **Enter** button from the Main Menu to view the Parameters screen for the mode that is currently active.

7.2.3: Using Reset Mode

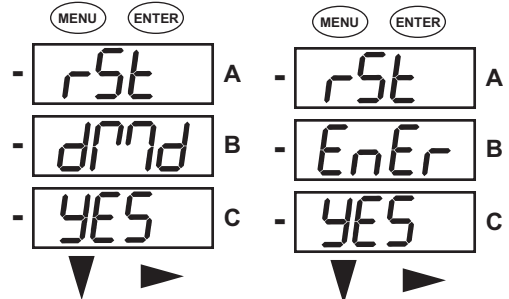
Reset Mode has two options:

- 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 7.2.4.

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

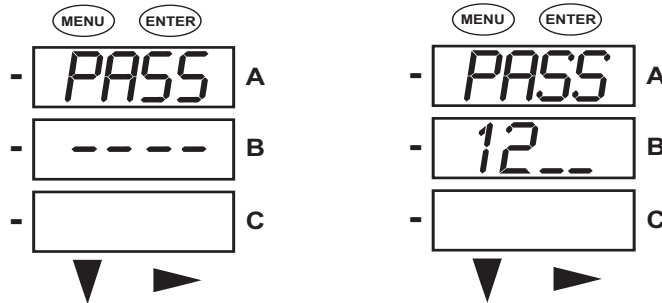
2. Once you have performed a reset, the screen displays either "rSt dMd donE" or "rSt EnEr donE" and then resumes auto-scrolling parameters.

7.2.4: 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 leftmost 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.

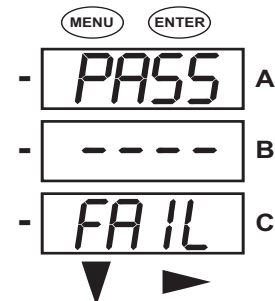
Example: The left screen, below, shows four dashes. The right screen shows the display after the first two digits of the password have been entered.



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.



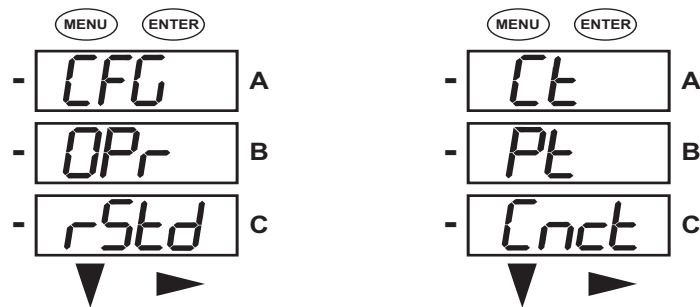
7.2.5: Using Configuration Mode

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.



Press **Enter** when CFG is in A window - Parameter screen appears -

Press **Down**- Press **Enter** when

Parameter you want is in A window

6. 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.

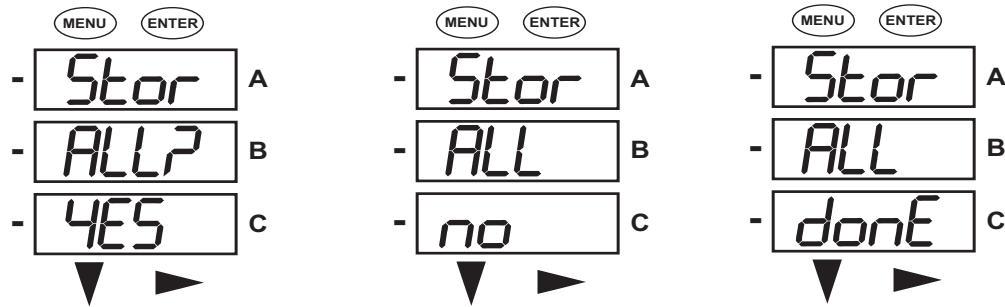
NOTE: When you try to change the current setting and Password protection is enabled for the meter, the Password screen appears. See Section 7.2.4 for instructions on entering a password.

7. Once you have entered the new setting, press the **Menu** button twice.

8. 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.

7.2.5.1: 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 have been selected through software (refer to the *Communicator EXT™ 4.0 and MeterManager EXT Software User Manual* for instructions).

To enable or disable Auto-scrolling:

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

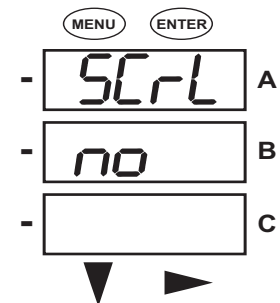
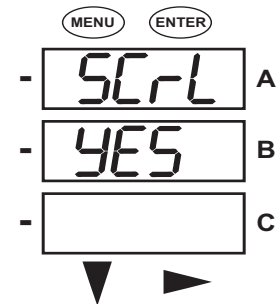
2. Press either the **Right** or **Down** button if you want to access the Scroll no screen. To return to the Scroll YES screen, press either button.

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).

NOTES:

- 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.



7.2.5.2: 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.

a. 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.

b. 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 7.2.4 for instructions on doing so.

2. When the new setting is entered, press the **Menu** button twice.

3. 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.

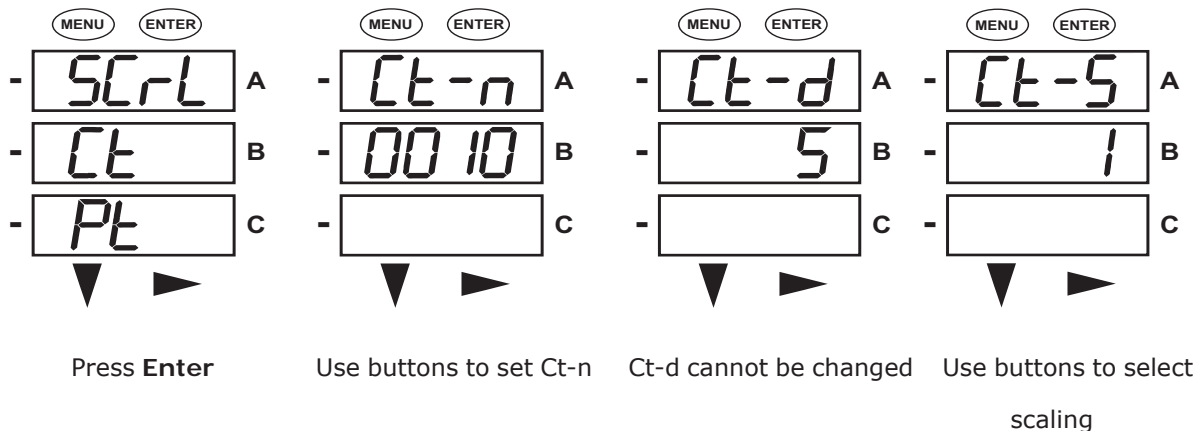
800/5 Amps: Set the Ct-n value for 800 and the Ct-S value for 1.

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.

NOTES:

- 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.



7.2.5.3: 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.

a. 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.

b. 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 7.2.4 for instructions on doing so.

2. When the new setting is entered, press the **Menu** button twice.

3. 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.

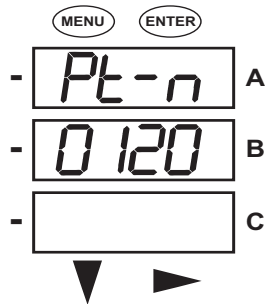
14,400/120 Volts: Pt-n value is 1440, Pt-d value is 120, Pt-S value is 10.

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

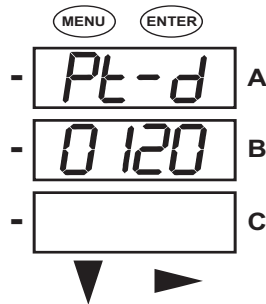
345,000/115 Volts: Pt-n value is 3450, Pt-d value is 115, Pt-S value is 100.

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

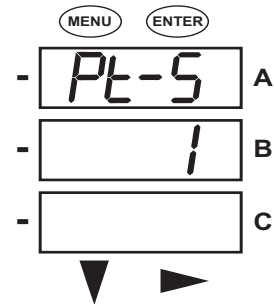
NOTE: Pt-n and Pt-S are dictated by primary voltage; Pt-d is secondary voltage.



Use buttons to set Pt-n



Use buttons to set Pt-d



Use buttons to select scaling

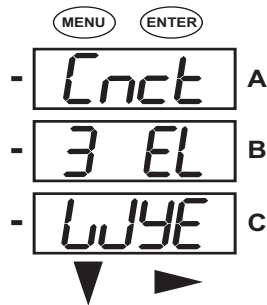
7.2.5.4: Configuring Connection Setting

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 7.2.4 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

7.2.5.5: 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).

a. 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.

b. To select the Baud Rate:

From the bAUd screen:

Use the **Right** button or the **Down** button to select the setting you want.

c. To select the Protocol:

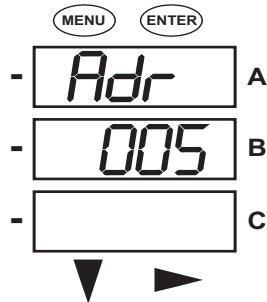
From the Prot screen:

Press the **Right** button or the **Down** button to select the setting you want.

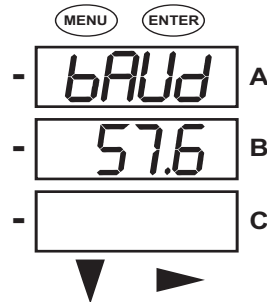
NOTE: If you are prompted to enter a password, refer to Section 7.2.4 for instructions on doing so.

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

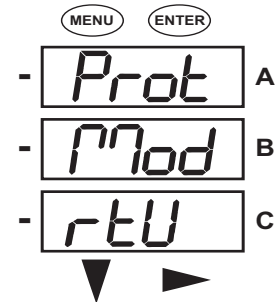
3. The STOR ALL YES screen appears. Press **Enter** to save the settings.



Use buttons to enter Address



Use buttons to select Baud Rate



Use buttons to select Protocol

7.2.6: Using Operating Mode

Operating mode is the Shark® 200S submeter'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.

OPERATING MODE PARAMETER READINGS

POSSIBLE READINGS

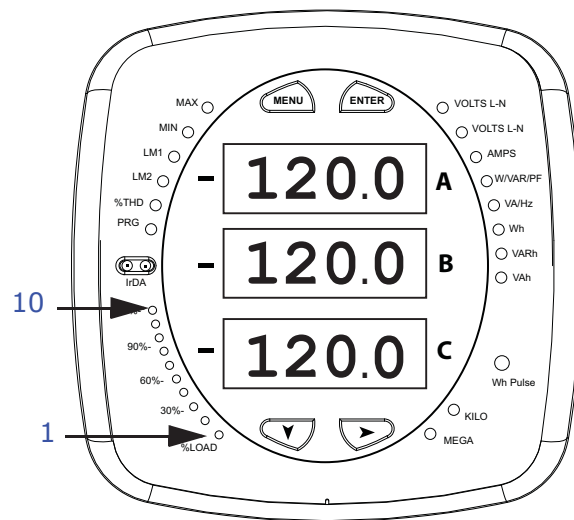
| | | | | | |
|-----------|------------|--------------------|-------------------|-------------------|---------------|
| VOLTS L-N | VOLTS_LN | VOLTS_L-N_MAX | VOLTS_L-N_MIN | | VOLTS_L-N_THD |
| VOLTS L-L | VOLTS_LL | VOLTS_LL_MAX | VOLTS_LL_MIN | | |
| AMPS | AMPS | AMPS_-NEUTRAL | AMPS_MAX | AMPS_MIN | AMPS_THD |
| W/VAR/PF | W_VAR_PF | W_VAR_P-F_MAX_-POS | W_VAR_P-F_MIN_POS | W_VAR_P-F_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 | | | | |

7.3: Understanding the % of Load Bar

The 10-segment LED bar graph at the bottom left of the Shark® 200S 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).

| 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% |



7.4: 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 Shark® 200S submeter 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 7.5 for an example of how this process works.
- Refer to Table 7.1 for the Wh/Pulse constants for accuracy testing.

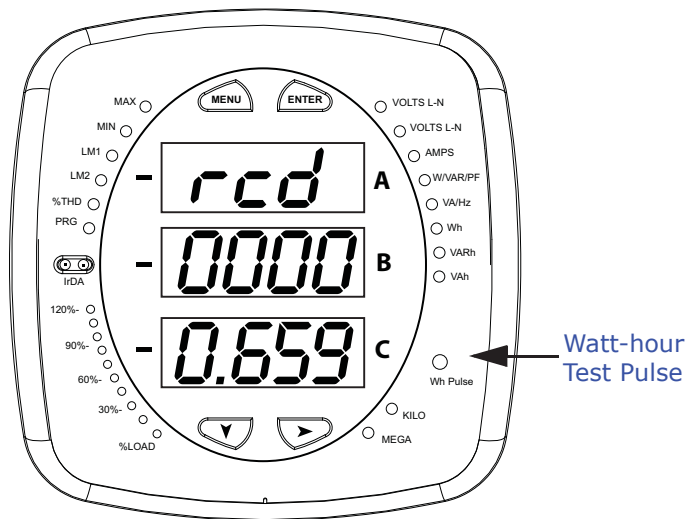


Figure 7.4: Watt-hour Test Pulse

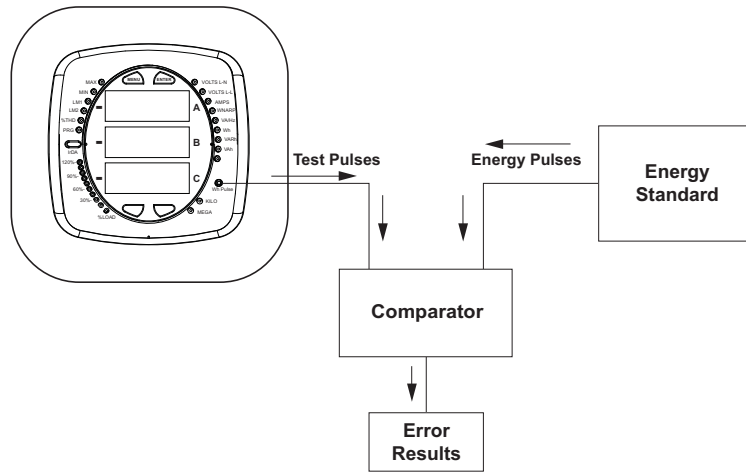


Figure 7.5: Using the Watt-hour Test Pulse

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

Table 7.1: Infrared & KYZ Pulse Constants for Accuracy Testing - Kh Watt-hour per pulse

NOTES:

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

A: Shark® 200S Meter Navigation Maps

A.1: Introduction

You can configure the Shark® 200S meter and perform related tasks using the buttons on the meter face. Chapter 7 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 *Communicator EXT™ 4.0 and MeterManager EXT Software User Manual*).

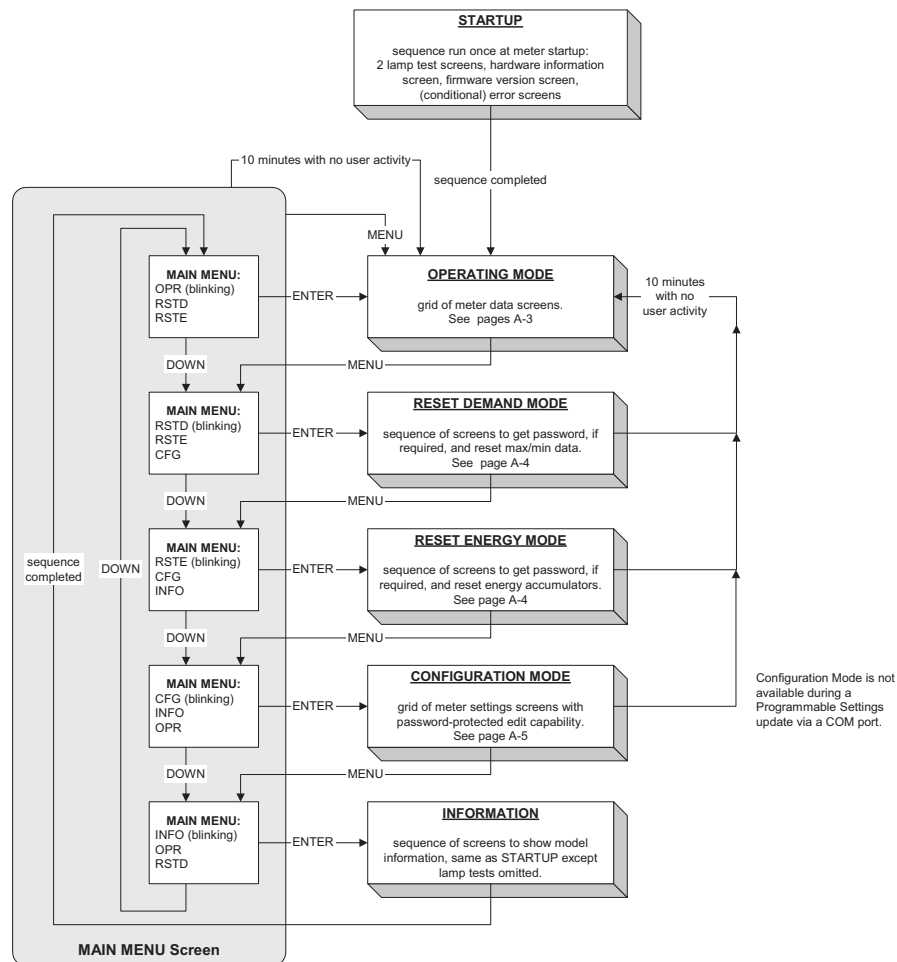
A.2: Navigation Maps (Sheets 1 to 4)

The Shark® 200S 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.

Shark® 200S meter Navigation map titles

- Main Menu Screens (Sheet 1)
- Operating mode screens (Sheet 2)
- Reset mode screens (Sheet 3)
- Configuration mode screens (Sheet 4)

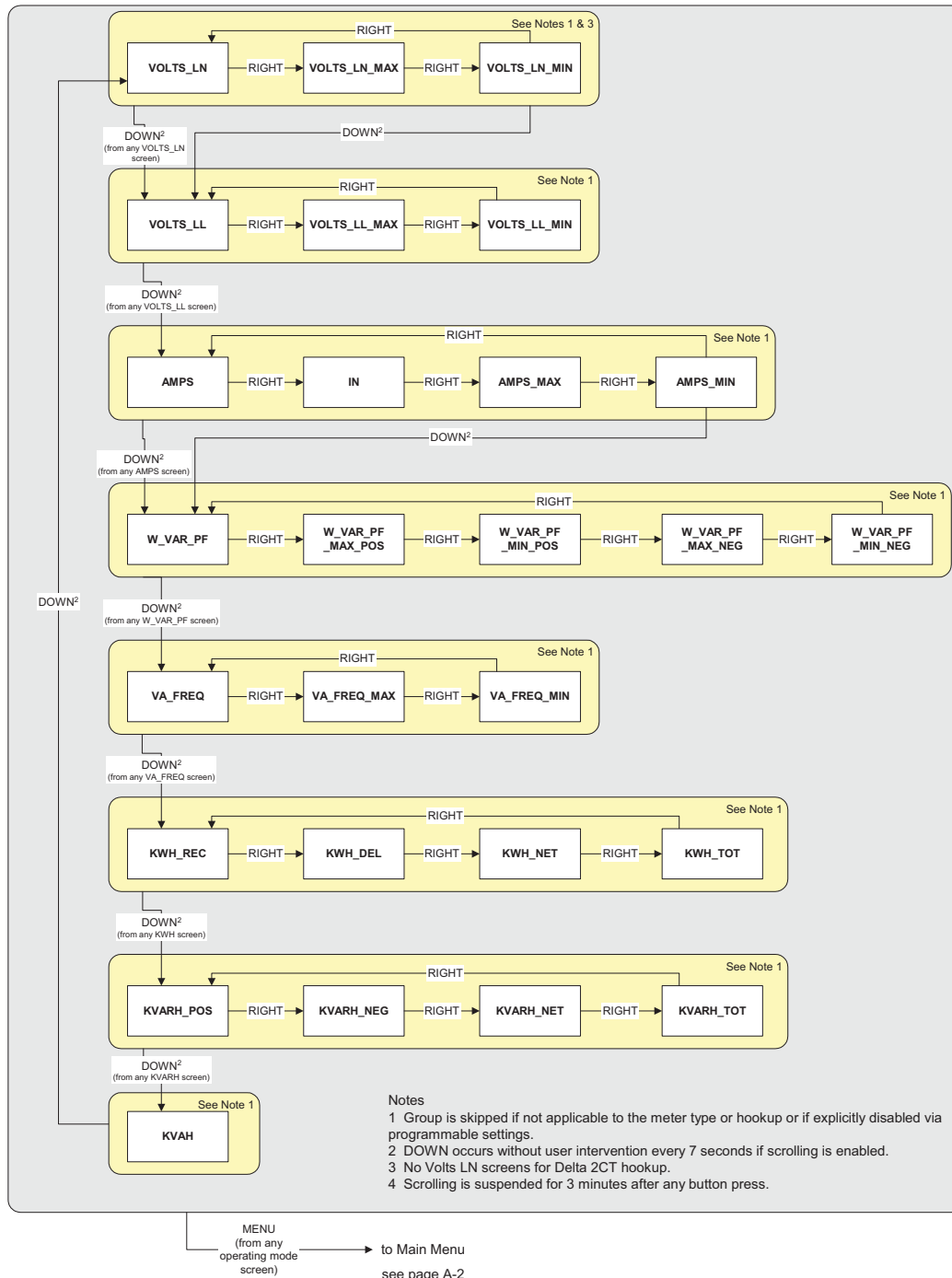
Main Menu Screens (Sheet 1)



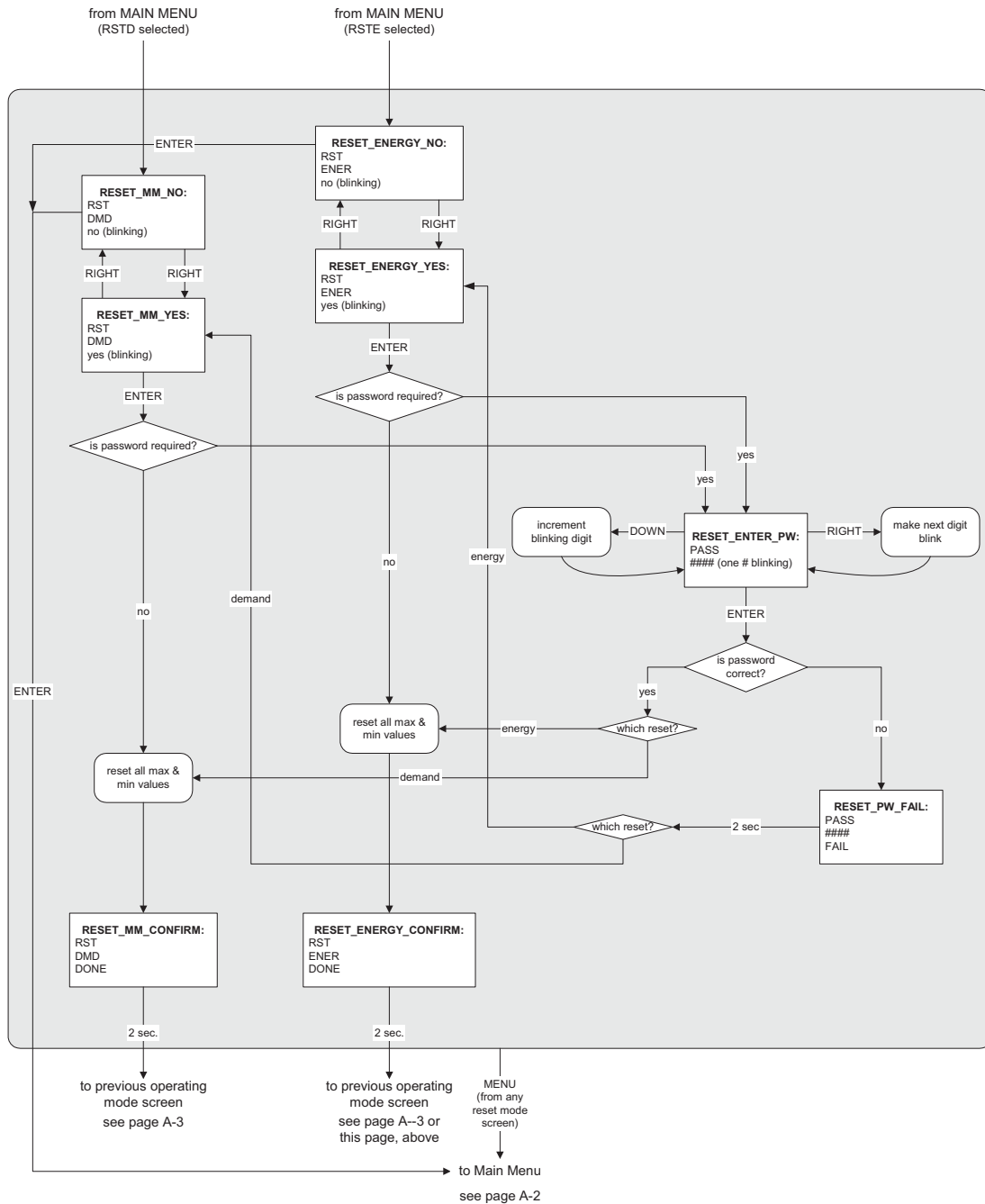
MAIN MENU screen scrolls through 4 choices, showing 3 at a time. The top choice is always the "active" one, which is indicated by blinking the legend.

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

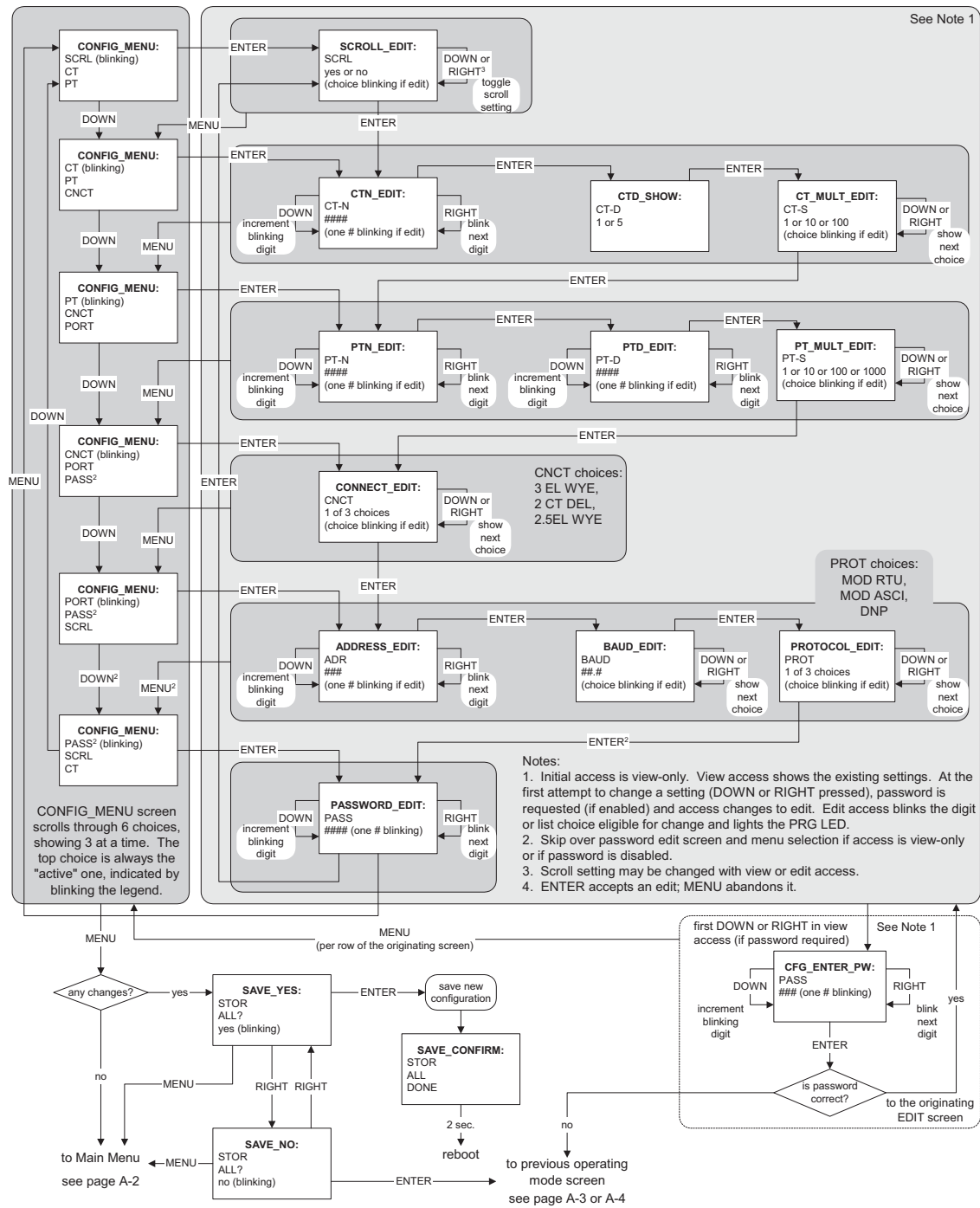
Operating Mode Screens (Sheet 2)



Reset Mode Screens (Sheet 3)



Configuration Mode Screens (Sheet 4)



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B: Modbus Map and Retrieving Logs

B.1: Introduction

The Modbus Map for the Shark® 200S meter gives details and information about the possible readings of the meter and its programming. The Shark® 200S meter can be programmed using the buttons on the face of the meter (Chapter 7), or by using software (Chapter 5).

B.2: Modbus Register Map Sections

The Shark® 200S 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, Minimum and Maximum in Regular and Time Stamp Blocks, and Accumulators. Operating mode readings are described in Section 7.2.6.

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 - 51127, details log and 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 | |
| sign | | exponent | | | | | | | mantissa | | | | | | | | | | | | | | | | | | | | | | | |

The formula to interpret a Floating Point Value is:

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

$$-1^{sign} \times 2^{137-127} \times 1.1000010001110110111001$$

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

$$-1800.929$$

| 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 | | | | | | | | 0b011000010001110110111001 | | | | | | | | | | | | | | | | | | | | | | |

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

NOTES:

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

B.5: Retrieving Logs Using the Shark® 200S Meter's Modbus Map

This section describes the log interface system of the Shark® 200S 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.

NOTES:

- 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 28; 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

Time stamp: Stores a date from 2000 to 2099. Time stamp 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 time stamp byte are used as flags to record meter state information at the time of the time stamp. These bits should be masked out, unless needed.

B.5.2: Shark® 200S Meter Logs

The Shark® 200S meter has 5 logs: System Event, Alarm (Limits), and 3 Historical logs. 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, on page B-19.

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.

B.5.3: Block Definitions

This section describes the Modbus Registers involved in retrieving and interpreting a Shark® 200S Meter Log. Other sections refer to certain 'values' contained in this section. See the corresponding value in this section for details.

NOTES:

- "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:

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.

Historical Log Blocks:

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).

Header:

| | | | | |
|-------|-------------|-----------|---|----------|
| 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 $[12 + (\# \text{ Registers} \times 2)]$. The size during normal log retrieval is $[6 + (\# \text{ Registers} \times 2)]$. 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 |

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 |

| 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 - 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 - 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 - 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)

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.

NOTES:

- 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).
- Each log can only be retrieved by one port at a time.
- 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 Shark® 200S 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)

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 essssss | nnnnnnnn - log to retrieve, e - retrieval session enable ssssss - retrieval mode | 2 |
| 2-3 | Records per Window, Number of Repeats | UINT16 | wwwwwww nnnnnnn | wwwww - records per window, nnnnnn - 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 |

- **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.

$(\text{RecPerWindow} \times \text{RecSize}) = \text{\#bytes used in the window.}$

This value should be $((123 \times 2) \setminus \text{recSize})$, rounded down.

For example, with a record size of 30, the $\text{RecPerWindow} = ((123 \times 2) \setminus 30) = 8.2$
 $\sim = 8$

- **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.

| | |
|-----|---|
| 0 | Disables auto-increment |
| 1 | No Repeat count, each request will only get 1 window. |
| 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.

NOTES:

- 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.

B.5.4.1: Auto-Increment

In EIG's 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 Shark® 200S meter, when the last register in the data window is read, the record index is incremented by the Records per Window.

B.5.4.2: Modbus Function Code 0x23

QUERY

| <u>Field Name</u> | <u>Example (Hex)</u> |
|---------------------|----------------------|
| Slave Address | 01 |
| Function | 23 |
| Starting Address Hi | C3 |
| Starting Address Lo | 51 |
| # Points Hi | 00 |
| # Points Lo | 7D |
| Repeat Count | 04 |

RESPONSE

| <u>Field Name</u> | <u>Example (Hex)</u> |
|-------------------|----------------------|
| 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 on page B-14.)

NOTES:

- 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 Shark® 200S 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.

IMPORTANT! 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.

B.5.4.3: 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.

NOTES:

- 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:

a. Read the Log Status Block.

- i.. Read the contents of the specific logs' status block [0xC737+, 16 reg] (see Log Headers).
- ii. Store the # of Records Used, the Record Size, and the Log Availability.
- iii. 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.

b. 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.

c. 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).

d. Write the retrieval information.

- i. Compute the number of records per window, as follows:

$$\text{RecordsPerWindow} = (246 \setminus \text{RecordSize})$$

- 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.

- ii. Write the Records per window, the Number of repeats (1), and Record Index (0) [0xC350, 3 reg].

This step tells the Shark® 200S meter what data to return in the window.

2. Retrieve the records:

a. 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).

NOTES:

- 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 Record-PerWindow) is padded with 0xFF, and can be safely discarded.
- b. 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 Shark® 200S meter to repeat the records you were expecting.
- c. 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].

B.5.4.4: 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 Shark® 200S 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: 010320 00000100 00000064 0012 0002
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 $(246 \setminus 18) = 13$. 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, $246 \setminus 18 = 13.66$, 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)

NOTES:

- This sets up the window for retrieval; now we can start retrieving the records.
- As noted above, we compute the records per window as $246 \setminus 18 = 13.66$, 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
060717101511FFFFFFFFFFFFFFFFFFFFFFFF
06071710160042FAAACF42FAAD1842FAA9A8 . . .

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

NOTES:

- 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.

NOTES:

- 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)

NOTES:

- 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.

NOTES:

- 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.

NOTES:

- 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.

NOTES:

- 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)

NOTES:

- 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 Shark® 200S meter that caused the event.

| | |
|---|-------------------|
| 0 | Firmware |
| 1 | COM 1 (IrDA) |
| 2 | COM 2 (RS485) |
| 7 | User (Face Plate) |

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

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 (1-2 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 | | | | | | | | 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 |
| | 5 | sync method | 0 | 0xFF | 0xFF | 0xFF | 0xFF | Auto Clock Sync Resumed |
| | | | | | | | | |
| 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 | V-switch Changed |
| | 3 | 0 | 1-4, 7 | 0xFF | 0xFF | 0xFF | 0xFF | Programma- ble 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 Report- ing & 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

NOTES:

- 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, Histori-

cal, and Power Quality logs) 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.

- 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 Shark® 200S 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.)

NOTES:

- 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 | $[CT \text{ Numerator}] \times [CT \text{ Multiplier}]$ |
| Voltage | $[PT \text{ Numerator}] \times [PT \text{ Multiplier}]$ |
| Power 3-Phase (WYE) | $[CT \text{ Numerator}] \times [CT \text{ Multiplier}] \times [PT \text{ Numerator}] \times [PT \text{ Multiplier}] \times 3$ |
| Power 3-Phase (Delta) | $[CT \text{ Numerator}] \times [CT \text{ Multiplier}] \times [PT \text{ Numerator}] \times [PT \text{ Multiplier}] \times 3 \times \sqrt{3}$ |
| Power Single Phase (WYE) | $[CT \text{ Numerator}] \times [CT \text{ Multiplier}] \times [PT \text{ Numerator}] \times [PT \text{ Multiplier}]$ |
| Power Single Phase (Delta) | $[CT \text{ Numerator}] \times [CT \text{ Multiplier}] \times [PT \text{ Numerator}] \times [PT \text{ Multiplier}] \times \sqrt{3}$ |
| Frequency (Calibrated at 60 Hz) | 60 |

Frequency (Calibrated at 50 Hz) 50

Power Factor 1.0

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.

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 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

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 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 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 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 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 03 E8 00 01 00 04 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 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 03 E8 00 01 00 04 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 03 E8 00 01 00 04 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 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 03 E8 00 01 00 04 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 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 03 E8 00 01 00 04 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 03 E8 00 00 00 05 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
Item Values:****These are the
Type and Size:****These are the Descriptions:**

| | | |
|-------------|-----|--|
| 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 1 st Harmonic Magnitude |
| 17 76 | 6 2 | - (SINT 2 byte) Volts A 2 nd Harmonic Magnitude |
| 17 77 | 6 2 | - (SINT 2 byte) Volts A 3 rd Harmonic Magnitude |
| 18 67 | 6 2 | - (SINT 2 byte) Ib 3 rd Harmonic Magnitude |
| 18 68 | 6 2 | - (SINT 2 byte) Ib 4 th Harmonic Magnitude |
| 18 69 | 6 2 | - (SINT 2 byte) Ib 5 th 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.6: Important Note Concerning the Shark ® 200S Meter's Modbus Map

In depicting Modbus Registers (Addresses), the Shark® 200S 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 Shark ® meter's Modbus map also uses this representation.

| Hex | Description |
|-------------|---------------------|
| 0008 - 000F | Meter Serial Number |

B.6.2: Decimal Representation

The Shark ® 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 Shark ® 200S 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 Shark® 200S 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-23)

The Shark® 200S meter's Modbus Register map begins on the following page.

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B: Modbus Map and Retrieving Logs

| Modbus Address | | | | | | | | | |
|----------------------------------|---|---------|-----------|--|--------|--------------------|---------------------|--|-------|
| Hex | | Decimal | | Description (Note 1) | Format | Range (Note 6) | Units or Resolution | Comments | # Reg |
| | | | | | | | | | |
| Fixed Data Section | | | | | | | | | |
| Identification Block | | | | | | | | read-only | |
| 0000 | - | 0007 | 1 - 8 | Meter Name | ASCII | 16 char | none | | 8 |
| 0008 | - | 000F | 9 - 16 | Meter Serial Number | ASCII | 16 char | none | | 8 |
| 0010 | - | 0010 | 17 - 17 | Meter Type | UINT16 | bit-mapped | -----st -----vvv | t = 0 s= 1 vvv = V-switch: V33 = standard 200S | 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 ~fffff | ccc = CT denominator (1 or 5), fffff = 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 | Reserved | | | | | 1 |
| 0019 | - | 0019 | 26 - 26 | Reserved | | | | | 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 | | | | | 194 |
| 01F4 | - | 0203 | 501 - 516 | Reserved | | | | Reserved | 16 |
| | | | | | | | | | |
| Meter Data Section (Note 2) | | | | | | | | | |
| Readings Block (Integer values) | | | | | | | | read-only | |
| 0116 | - | 0117 | 280 - 280 | Volts B-N | UINT16 | 0 to 9999 | volts | | 1 |
| 0117 | - | 0118 | 281 - 281 | Volts C-N | UINT16 | 0 to 9999 | volts | | 1 |
| 0118 | - | 0119 | 282 - 282 | Volts A-B | UINT16 | 0 to 9999 | volts | | 1 |
| 0119 | - | 011A | 283 - 283 | Volts B-C | UINT16 | 0 to 9999 | volts | | 1 |
| 011A | - | 011B | 284 - 284 | Volts C-A | UINT16 | 0 to 9999 | volts | | 1 |
| 011B | - | 011C | 285 - 285 | Amps A | UINT16 | 0 to 9999 | amps | | 1 |
| 011C | - | 011D | 286 - 286 | Amps B | UINT16 | 0 to 9999 | amps | | 1 |
| 011D | - | 011E | 287 - 287 | Amps C | UINT16 | 0 to 9999 | amps | | 1 |
| 011E | - | 011F | 288 - 288 | Neutral Current | UINT16 | -9999 M to +9999 | amps | | 1 |
| 011F | - | 0120 | 289 - 289 | Watts, 3-Ph total | SINT16 | -9999 to +9999 | watts | 1. Use the settings from Programmable settings for scale and decimal point location. (see User Settings Flags) | 1 |
| 0120 | - | 0121 | 290 - 290 | VARs, 3-Ph total | SINT16 | -9999 to +9999 | VARs | | 1 |
| 0121 | - | 0122 | 291 - 291 | VAs, 3-Ph total | UINT16 | 0 to +9999 | VAs | | 1 |
| 0122 | - | 0123 | 292 - 292 | Power Factor, 3-Ph total | SINT16 | -1000 to +1000 | none | 2. Per phase power and PF have values only for WYE hookup and will be zero for all other hookups. | 1 |
| 0123 | - | 0124 | 293 - 293 | Frequency | UINT16 | 0 to 9999 | Hz | | 1 |
| 0124 | - | 0125 | 294 - 294 | Watts, Phase A | SINT16 | -9999 M to +9999 | watts | | 1 |
| 0125 | - | 0126 | 295 - 295 | Watts, Phase B | SINT16 | -9999 M to +9999 | watts | | 1 |
| 0126 | - | 0127 | 296 - 296 | Watts, Phase C | SINT16 | -9999 M to +9999 | watts | | 1 |
| 0127 | - | 0128 | 297 - 297 | VARs, Phase A | SINT16 | -9999 M to +9999 M | VARs | | 1 |
| 0128 | - | 0129 | 298 - 298 | VARs, Phase B | SINT16 | -9999 M to +9999 M | VARs | | 1 |
| 0129 | - | 012A | 299 - 299 | VARs, Phase C | SINT16 | -9999 M to +9999 M | VARs | | 1 |
| 012A | - | 012B | 300 - 300 | VAs, Phase A | UINT16 | 0 to +9999 | VAs | | 1 |
| 012B | - | 012C | 301 - 301 | VAs, Phase B | UINT16 | 0 to +9999 | VAs | | 1 |
| 012C | - | 012D | 302 - 302 | VAs, Phase C | UINT16 | 0 to +9999 | VAs | | 1 |
| 012D | - | 012E | 303 - 303 | Power Factor, Phase A | SINT16 | -1000 to +1000 | none | 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 |



B: Modbus Map and Retrieving Logs

| Modbus Address | | | | | | | |
|------------------------|---------|----------------------|--------|--|----------------|---------------------|-------------|
| Hex | Decimal | Description (Note 1) | | Format | Range (Note 6) | Units or Resolution | Comments |
| 012E | - 012F | 304 | - 304 | Power Factor, Phase B | SINT16 | -1000 to +1000 | none |
| 012F | - 0130 | 305 | - 305 | Power Factor, Phase C | SINT16 | -1000 to +1000 | none |
| 0130 | - 0130 | 305 | - 305 | Power Factor, Phase C | SINT16 | -1000 to +1000 | none |
| | | | | | | | Block Size: |
| | | | | | | | 27 |
| Primary Readings Block | | | | | | | read-only |
| 03E7 | - 03E8 | 1000 | - 1001 | Volts A-N | FLOAT | 0 to 9999 M | volts |
| 03E9 | - 03EA | 1002 | - 1003 | Volts B-N | FLOAT | 0 to 9999 M | volts |
| 03EB | - 03EC | 1004 | - 1005 | Volts C-N | FLOAT | 0 to 9999 M | volts |
| 03ED | - 03EE | 1006 | - 1007 | Volts A-B | FLOAT | 0 to 9999 M | volts |
| 03EF | - 03F0 | 1008 | - 1009 | Volts B-C | FLOAT | 0 to 9999 M | volts |
| 03F1 | - 03F2 | 1010 | - 1011 | Volts C-A | FLOAT | 0 to 9999 M | volts |
| 03F3 | - 03F4 | 1012 | - 1013 | Amps A | FLOAT | 0 to 9999 M | amps |
| 03F5 | - 03F6 | 1014 | - 1015 | Amps B | FLOAT | 0 to 9999 M | amps |
| 03F7 | - 03F8 | 1016 | - 1017 | Amps C | FLOAT | 0 to 9999 M | amps |
| 03F9 | - 03FA | 1018 | - 1019 | Watts, 3-Ph total | FLOAT | -9999 M to +9999 M | watts |
| 03FB | - 03FC | 1020 | - 1021 | VARs, 3-Ph total | FLOAT | -9999 M to +9999 M | VARs |
| 03FD | - 03FE | 1022 | - 1023 | VAs, 3-Ph total | FLOAT | -9999 M to +9999 M | VAs |
| 03FF | - 0400 | 1024 | - 1025 | Power Factor, 3-Ph total | FLOAT | -1.00 to +1.00 | none |
| 0401 | - 0402 | 1026 | - 1027 | Frequency | FLOAT | 0 to 65.00 | Hz |
| 0403 | - 0404 | 1028 | - 1029 | Neutral Current | FLOAT | 0 to 9999 M | amps |
| 0405 | - 0406 | 1030 | - 1031 | Watts, Phase A | FLOAT | -9999 M to +9999 M | watts |
| 0407 | - 0408 | 1032 | - 1033 | Watts, Phase B | FLOAT | -9999 M to +9999 M | watts |
| 0409 | - 040A | 1034 | - 1035 | Watts, Phase C | FLOAT | -9999 M to +9999 M | watts |
| 040B | - 040C | 1036 | - 1037 | VARs, Phase A | FLOAT | -9999 M to +9999 M | VARs |
| 040D | - 040E | 1038 | - 1039 | VARs, Phase B | FLOAT | -9999 M to +9999 M | VARs |
| 040F | - 0410 | 1040 | - 1041 | VARs, Phase C | FLOAT | -9999 M to +9999 M | VARs |
| 0411 | - 0412 | 1042 | - 1043 | VAs, Phase A | FLOAT | -9999 M to +9999 M | VAs |
| 0413 | - 0414 | 1044 | - 1045 | VAs, Phase B | FLOAT | -9999 M to +9999 M | VAs |
| 0415 | - 0416 | 1046 | - 1047 | VAs, Phase C | FLOAT | -9999 M to +9999 M | VAs |
| 0417 | - 0418 | 1048 | - 1049 | Power Factor, Phase A | FLOAT | -1.00 to +1.00 | none |
| 0419 | - 041A | 1050 | - 1051 | Power Factor, Phase B | FLOAT | -1.00 to +1.00 | none |
| 041B | - 041C | 1052 | - 1053 | Power Factor, Phase C | FLOAT | -1.00 to +1.00 | none |
| 041D | - 041E | 1054 | - 1055 | Symmetrical Component Magnitude, 0 Seq | FLOAT | 0 to 9999 M | volts |
| 041F | - 0420 | 1056 | - 1057 | Symmetrical Component Magnitude, + Seq | FLOAT | 0 to 9999 M | volts |
| 0421 | - 0422 | 1058 | - 1059 | Symmetrical Component Magnitude, - Seq | FLOAT | 0 to 9999 M | volts |
| 0423 | - 0423 | 1060 | - 1060 | Symmetrical Component Phase, 0 Seq | SINT16 | -1800 to +1800 | 0.1 degree |
| 0424 | - 0424 | 1061 | - 1061 | Symmetrical Component Phase, + Seq | SINT16 | -1800 to +1800 | 0.1 degree |
| 0425 | - 0425 | 1062 | - 1062 | Symmetrical Component Phase, - Seq | SINT16 | -1800 to +1800 | 0.1 degree |
| 0426 | - 0426 | 1063 | - 1063 | Unbalance, 0 sequence component | UINT16 | 0 to 10000 | 0.01% |
| 0427 | - 0427 | 1064 | - 1064 | Unbalance, -sequence component | UINT16 | 0 to 10000 | 0.01% |
| 0428 | - 0428 | 1065 | - 1065 | Current Unbalance | UINT16 | 0 to 20000 | 0.01% |
| | | | | | | | Block Size: |
| | | | | | | | 66 |

B: Modbus Map and Retrieving Logs

| Modbus Address | | | | | | | | | |
|----------------------|--------|---------|--------|-------------------------------------|--------|---------------------------------|------------------------|---|-------|
| Hex | | Decimal | | Description (Note 1) | Format | Range (Note 6) | Units or Resolution | Comments | # Reg |
| 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 | 2 |
| 05DD | - 05DE | 1502 | - 1503 | W-hours, Delivered | SINT32 | 0 to 99999999 or 0 to -99999999 | Wh per energy format | * Wh received is positive for "view as load", delivered is positive for "view as generator" | 2 |
| 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 decimal point = units, kilo, or mega, per energy format | 2 |
| 05E5 | - 05E6 | 1510 | - 1511 | VAR-hours, Negative | SINT32 | 0 to -99999999 | VARh 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. | |
| 0625 | - 0626 | 1574 | - 1575 | W-hours, Delivered, rollover count | UINT32 | 0 to 4,294,967,294 | | | |
| 0627 | - 0628 | 1576 | - 1577 | VAR-hours, Positive, rollover count | UINT32 | 0 to 4,294,967,294 | | | |
| 0629 | - 062A | 1578 | - 1579 | VAR-hours, Negative, rollover count | UINT32 | 0 to 4,294,967,294 | | | |
| 062B | - 062C | 1580 | - 1581 | VA-hours, rollover count | UINT32 | 0 to 4,294,967,294 | | | |

B: Modbus Map and Retrieving Logs

| Modbus Address | | | | | | | | | |
|----------------------|--------|---------|--------|--|--------|---------------------------------|------------------------|--|-------|
| Hex | | Decimal | | Description (Note 1) | Format | Range (Note 6) | Units or Resolution | Comments | # Reg |
| | | | | | | | | | |
| 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 | |
| 062F | - 0630 | 1584 | - 1585 | W-hours in the Interval, Delivered | SINT32 | 0 to 99999999 or 0 to -99999999 | Wh per energy format | * Wh received is positive for "view as load" , delivered is positive for "view as generator" | |
| 0631 | - 0632 | 1586 | - 1587 | VAR-hours in the Interval, Positive | SINT32 | 0 to 99999999 | VARh per energy format | * 5 to 8 digits | |
| 0633 | - 0634 | 1588 | - 1589 | VAR-hours in the Interval, Negative | SINT32 | 0 to -99999999 | VARh per energy format | | |
| 0635 | - 0636 | 1590 | - 1591 | VA-hours in the Interval, Total | SINT32 | 0 to 99999999 | VAh per energy format | * decimal point implied, per energy format | |
| 0637 | - 0638 | 1592 | - 1593 | W-hours in the Interval, Received, Phase A | SINT32 | 0 to 99999999 or 0 to -99999999 | Wh per energy format | * resolution of digit before decimal point = u | |
| 0639 | - 063A | 1594 | - 1595 | W-hours in the Interval, Received, Phase B | SINT32 | 0 to 99999999 or 0 to -99999999 | Wh per energy format | | |
| 063B | - 063C | 1596 | - 1597 | W-hours in the Interval, Received, Phase C | SINT32 | 0 to 99999999 or 0 to -99999999 | Wh per energy format | | |
| 063D | - 063E | 1598 | - 1599 | W-hours in the Interval, Delivered, Phase A | SINT32 | 0 to 99999999 or 0 to -99999999 | Wh per energy format | | |
| 063F | - 0640 | 1600 | - 1601 | W-hours in the Interval, Delivered, Phase B | SINT32 | 0 to 99999999 or 0 to -99999999 | Wh per energy format | | |
| 0641 | - 0642 | 1602 | - 1603 | W-hours in the Interval, Delivered, Phase C | SINT32 | 0 to 99999999 or 0 to -99999999 | Wh per energy format | | |
| 0643 | - 0644 | 1604 | - 1605 | VAR-hours in the Interval, Positive, Phase A | SINT32 | 0 to 99999999 | VARh per energy format | | |
| 0645 | - 0646 | 1606 | - 1607 | VAR-hours in the Interval, Positive, Phase B | SINT32 | 0 to 99999999 | VARh per energy format | | |
| 0647 | - 0648 | 1608 | - 1609 | VAR-hours in the Interval, Positive, Phase C | SINT32 | 0 to 99999999 | VARh per energy format | | |
| 0649 | - 064A | 1610 | - 1611 | VAR-hours in the Interval, Negative, Phase A | SINT32 | 0 to -99999999 | VARh per energy format | | |
| 064B | - 064C | 1612 | - 1613 | VAR-hours in the Interval, Negative, Phase B | SINT32 | 0 to -99999999 | VARh per energy format | | |
| 063D | - 064E | 1614 | - 1615 | VAR-hours in the Interval, Negative, Phase C | SINT32 | 0 to -99999999 | VARh per energy format | | |
| 064F | - 0650 | 1616 | - 1617 | VA-hours in the Interval, Phase A | SINT32 | 0 to 99999999 | VAh per energy format | | |
| 0651 | - 0652 | 1618 | - 1619 | VA-hours in the Interval, Phase B | SINT32 | 0 to 99999999 | VAh per energy format | | |
| 0653 | - 0654 | 1620 | - 1621 | VA-hours in the Interval, Phase C | SINT32 | 0 to 99999999 | VAh per energy format | | |
| | | | | | | | | Block Size: | 122 |
| | | | | | | | | | |
| Primary Demand Block | | | | | | | | read-only | |
| 07CF | - 07D0 | 2000 | - 2001 | Amps A, Average | FLOAT | 0 to 9999 M | amps | | 2 |
| 07D1 | - 07D2 | 2002 | - 2003 | Amps B, Average | FLOAT | 0 to 9999 M | amps | | 2 |
| 07D3 | - 07D4 | 2004 | - 2005 | Amps C, Average | FLOAT | 0 to 9999 M | amps | | 2 |
| 07D5 | - 07D6 | 2006 | - 2007 | Positive Watts, 3-Ph, Average | FLOAT | -9999 M to +9999 M | watts | | 2 |
| 07D7 | - 07D8 | 2008 | - 2009 | Positive VARs, 3-Ph, Average | FLOAT | -9999 M to +9999 M | VARs | | 2 |
| 07D9 | - 07DA | 2010 | - 2011 | Negative Watts, 3-Ph, Average | FLOAT | -9999 M to +9999 M | watts | | 2 |
| 07DB | - 07DC | 2012 | - 2013 | Negative VARs, 3-Ph, Average | FLOAT | -9999 M to +9999 M | VARs | | 2 |
| 07DD | - 07DE | 2014 | - 2015 | VAs, 3-Ph, Average | FLOAT | -9999 M to +9999 M | VAs | | 2 |
| 07DF | - 07E0 | 2016 | - 2017 | Positive PF, 3-Ph, Average | FLOAT | -1.00 to +1.00 | none | | 2 |
| 07E1 | - 07E2 | 2018 | - 2019 | Negative PF, 3-PF, Average | FLOAT | -1.00 to +1.00 | none | | 2 |
| 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 |

B: Modbus Map and Retrieving Logs

| Modbus Address | | | | | | | | | |
|------------------------------|---|---------|-------------|---------------------------------|--------|---------------------------------|------------------------|--|-------|
| Hex | | Decimal | | Description (Note 1) | Format | Range (Note 6) | Units or Resolution | Comments | # Reg |
| | | | | | | | | | |
| 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 |
| 0BC7 | - | 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 | 2 |
| 0BD9 | - | 0BDA | 3034 - 3035 | W-hours, Delivered | SINT32 | 0 to 99999999 or 0 to -99999999 | Wh per energy format | * Wh received is positive for "view as load", delivered is positive for "view as generator" | 2 |
| 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 | * 5 to 8 digits | 2 |
| 0BDF | - | 0BE0 | 3040 - 3041 | VAR-hours, Positive | SINT32 | 0 to 99999999 | VARh per energy format | * decimal point implied, 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 | * resolution of digit before decimal point = units, kilo, or mega, 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 | * see note 10 | 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 |

B: Modbus Map and Retrieving Logs

| Modbus Address | | | | | | | | | |
|-------------------|--------|---------|--------|------------------------------|--------|-----------------------|------------------------|-------------|-------|
| Hex | | Decimal | | Description (Note 1) | Format | Range (Note 6) | Units or Resolution | Comments | # Reg |
| 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 |



B: Modbus Map and Retrieving Logs

| Modbus Address | | Description (Note 1) | Format | Range (Note 6) | Units or Resolution | Comments | # Reg | |
|----------------------------------|---------|----------------------|--|----------------|----------------------|---------------------|---|----|
| Hex | Decimal | | | | | | | |
| Status Block | | | | | | read-only | | |
| 1193 | - 1193 | 4500 - 4500 | Port ID | UINT16 | 1 to 4 | none | Identifies which Shark 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-- tffecccc | 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 Vswitch, 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 | mmmp pppe 0000 000s | mmmp pppe = 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 |
| 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 |



B: Modbus Map and Retrieving Logs

| Modbus Address | | | | | | | |
|----------------|---------|----------------------|--------|---|----------------|---------------------|----------|
| Hex | Decimal | Description (Note 1) | | Format | Range (Note 6) | Units or Resolution | Comments |
| 1F45 | - 1F46 | 8006 | - 8007 | Volts A-B, Minimum | FLOAT | 0 to 9999 M | volts |
| 1F47 | - 1F48 | 8008 | - 8009 | Volts B-C, Minimum | FLOAT | 0 to 9999 M | volts |
| 1F49 | - 1F4A | 8010 | - 8011 | Volts C-A, Minimum | FLOAT | 0 to 9999 M | volts |
| 1F4B | - 1F4C | 8012 | - 8013 | Amps A, Minimum Avg Demand | FLOAT | 0 to 9999 M | amps |
| 1F4D | - 1F4E | 8014 | - 8015 | Amps B, Minimum Avg Demand | FLOAT | 0 to 9999 M | amps |
| 1F4F | - 1F50 | 8016 | - 8017 | Amps C, Minimum Avg Demand | FLOAT | 0 to 9999 M | amps |
| 1F51 | - 1F52 | 8018 | - 8019 | Positive Watts, 3-Ph, Minimum Avg Demand | FLOAT | 0 to +9999 M | watts |
| 1F53 | - 1F54 | 8020 | - 8021 | Positive VARs, 3-Ph, Minimum Avg Demand | FLOAT | 0 to +9999 M | VARs |
| 1F55 | - 1F56 | 8022 | - 8023 | Negative Watts, 3-Ph, Minimum Avg Demand | FLOAT | 0 to +9999 M | watts |
| 1F57 | - 1F58 | 8024 | - 8025 | Negative VARs, 3-Ph, Minimum Avg Demand | FLOAT | 0 to +9999 M | VARs |
| 1F59 | - 1F5A | 8026 | - 8027 | VAs, 3-Ph, Minimum Avg Demand | FLOAT | -9999 M to +9999 M | VAs |
| 1F5B | - 1F5C | 8028 | - 8029 | Positive Power Factor, 3-Ph, Minimum Avg Demand | FLOAT | -1.00 to +1.00 | none |
| 1F5D | - 1F5E | 8030 | - 8031 | Negative Power Factor, 3-Ph, Minimum Avg Demand | FLOAT | -1.00 to +1.00 | none |
| 1F5F | - 1F60 | 8032 | - 8033 | Frequency, Minimum | FLOAT | 0 to 65.00 | Hz |
| 1F61 | - 1F62 | 8034 | - 8035 | Neutral Current, Minimum Avg Demand | FLOAT | 0 to 9999 M | amps |
| 1F63 | - 1F64 | 8036 | - 8037 | Positive Watts, Phase A, Minimum Avg Demand | FLOAT | -9999 M to +9999 M | watts |
| 1F65 | - 1F66 | 8038 | - 8039 | Positive Watts, Phase B, Minimum Avg Demand | FLOAT | -9999 M to +9999 M | watts |
| 1F67 | - 1F68 | 8040 | - 8041 | Positive Watts, Phase C, Minimum Avg Demand | FLOAT | -9999 M to +9999 M | watts |
| 1F69 | - 1F6A | 8042 | - 8043 | Positive VARs, Phase A, Minimum Avg Demand | FLOAT | -9999 M to +9999 M | VARs |
| 1F6B | - 1F6C | 8044 | - 8045 | Positive VARs, Phase B, Minimum Avg Demand | FLOAT | -9999 M to +9999 M | VARs |
| 1F6D | - 1F6E | 8046 | - 8047 | Positive VARs, Phase C, Minimum Avg Demand | FLOAT | -9999 M to +9999 M | VARs |
| 1F6F | - 1F70 | 8048 | - 8049 | Negative Watts, Phase A, Minimum Avg Demand | FLOAT | -9999 M to +9999 M | watts |
| 1F71 | - 1F72 | 8050 | - 8051 | Negative Watts, Phase B, Minimum Avg Demand | FLOAT | -9999 M to +9999 M | watts |
| 1F73 | - 1F74 | 8052 | - 8053 | Negative Watts, Phase C, Minimum Avg Demand | FLOAT | -9999 M to +9999 M | watts |
| 1F75 | - 1F76 | 8054 | - 8055 | Negative VARs, Phase A, Minimum Avg Demand | FLOAT | -9999 M to +9999 M | VARs |
| 1F77 | - 1F78 | 8056 | - 8057 | Negative VARs, Phase B, Minimum Avg Demand | FLOAT | -9999 M to +9999 M | VARs |
| 1F79 | - 1F7A | 8058 | - 8059 | Negative VARs, Phase C, Minimum Avg Demand | FLOAT | -9999 M to +9999 M | VARs |
| 1F7B | - 1F7C | 8060 | - 8061 | VAs, Phase A, Minimum Avg Demand | FLOAT | -9999 M to +9999 M | VAs |
| 1F7D | - 1F7E | 8062 | - 8063 | VAs, Phase B, Minimum Avg Demand | FLOAT | -9999 M to +9999 M | VAs |
| 1F7F | - 1F80 | 8064 | - 8065 | VAs, Phase C, Minimum Avg Demand | FLOAT | -9999 M to +9999 M | VAs |
| 1F81 | - 1F82 | 8066 | - 8067 | Positive PF, Phase A, Minimum Avg Demand | FLOAT | -1.00 to +1.00 | none |
| 1F83 | - 1F84 | 8068 | - 8069 | Positive PF, Phase B, Minimum Avg Demand | FLOAT | -1.00 to +1.00 | none |
| 1F85 | - 1F86 | 8070 | - 8071 | Positive PF, Phase C, Minimum Avg Demand | FLOAT | -1.00 to +1.00 | none |
| 1F87 | - 1F88 | 8072 | - 8073 | Negative PF, Phase A, Minimum Avg Demand | FLOAT | -1.00 to +1.00 | none |
| 1F89 | - 1F8A | 8074 | - 8075 | Negative PF, Phase B, Minimum Avg Demand | FLOAT | -1.00 to +1.00 | none |
| 1F8B | - 1F8C | 8076 | - 8077 | Negative PF, Phase C, Minimum Avg Demand | FLOAT | -1.00 to +1.00 | none |
| 1F8D | - 1F8D | 8078 | - 8078 | Reserved | | | |
| 1F8E | - 1F8E | 8079 | - 8079 | Reserved | | | |
| 1F8F | - 1F8F | 8080 | - 8080 | Reserved | | | |
| 1F90 | - 1F90 | 8081 | - 8081 | Reserved | | | |
| 1F91 | - 1F91 | 8082 | - 8082 | Reserved | | | |
| 1F92 | - 1F92 | 8083 | - 8083 | Reserved | | | |
| 1F93 | - 1F94 | 8084 | - 8085 | Symmetrical Component Magnitude, 0 Seq, Minimum | FLOAT | 0 to 9999 M | volts |



B: Modbus Map and Retrieving Logs

| Modbus Address | | | | | | | | |
|--|---|---------|-------------|--|--------|----------------------|---------------------|-------------|
| Hex | | Decimal | | Description (Note 1) | Format | Range (Note 6) | Units or Resolution | Comments |
| 1F95 | - | 1F96 | 8086 - 8087 | Symmetrical Component Magnitude, + Seq, Minimum | FLOAT | 0 to 9999 M | volts | |
| 1F97 | - | 1F98 | 8088 - 8089 | Symmetrical Component Magnitude, - Seq, Minimum | FLOAT | 0 to 9999 M | volts | |
| 1F99 | - | 1F99 | 8090 - 8090 | Symmetrical Component Phase, 0 Seq, Minimum | SINT16 | -1800 to +1800 | 0.1 degree | |
| 1F9A | - | 1F9A | 8091 - 8091 | Symmetrical Component Phase, + Seq, Minimum | SINT16 | -1800 to +1800 | 0.1 degree | |
| 1F9B | - | 1F9B | 8092 - 8092 | Symmetrical Component Phase, - Seq, Minimum | SINT16 | -1800 to +1800 | 0.1 degree | |
| 1F9C | - | 1F9C | 8093 - 8093 | Unbalance, 0 sequence, Minimum | UINT16 | 0 to 10000 | 0.01% | |
| 1F9D | - | 1F9D | 8094 - 8094 | Unbalance, -sequence, Minimum | UINT16 | 0 to 10000 | 0.01% | |
| 1F9E | - | 1F9E | 8095 - 8095 | Current Unbalance, Minimum | UINT16 | 0 to 20000 | 0.01% | |
| | | | | | | | | Block Size: |
| | | | | | | | | 96 |
| Primary Minimum Timestamp Block | | | | | | | | |
| 20CF | - | 20D1 | 8400 - 8402 | Volts A-N, Min Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | read-only |
| 20D2 | - | 20D4 | 8403 - 8405 | Volts B-N, Min Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 20D5 | - | 20D7 | 8406 - 8408 | Volts C-N, Min Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 20D8 | - | 20DA | 8409 - 8411 | Volts A-B, Min Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 20DB | - | 20DD | 8412 - 8414 | Volts B-C, Min Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 20DE | - | 20E0 | 8415 - 8417 | Volts C-A, Min Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 20E1 | - | 20E3 | 8418 - 8420 | Amps A, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 20E4 | - | 20E6 | 8421 - 8423 | Amps B, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 20E7 | - | 20E9 | 8424 - 8426 | Amps C, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 20EA | - | 20EC | 8427 - 8429 | Positive Watts, 3-Ph, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 20ED | - | 20EF | 8430 - 8432 | Positive VARs, 3-Ph, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 20F0 | - | 20F2 | 8433 - 8435 | Negative Watts, 3-Ph, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 20F3 | - | 20F5 | 8436 - 8438 | Negative VARs, 3-Ph, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 20F6 | - | 20F8 | 8439 - 8441 | VAs, 3-Ph, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 20F9 | - | 20FB | 8442 - 8444 | Positive Power Factor, 3-Ph, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 20FC | - | 20FE | 8445 - 8447 | Negative Power Factor, 3-Ph, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 20FF | - | 2101 | 8448 - 8450 | Frequency, Min Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 2102 | - | 2104 | 8451 - 8453 | Neutral Current, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2100 | 1 sec | |
| 2105 | - | 2107 | 8454 - 8456 | Positive Watts, Phase A, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 2108 | - | 210A | 8457 - 8459 | Positive Watts, Phase B, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 210B | - | 210D | 8460 - 8462 | Positive Watts, Phase C, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 210E | - | 2110 | 8463 - 8465 | Positive VARs, Phase A, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 2111 | - | 2113 | 8466 - 8468 | Positive VARs, Phase B, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 2114 | - | 2116 | 8469 - 8471 | Positive VARs, Phase C, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 2117 | - | 2119 | 8472 - 8474 | Negative Watts, Phase A, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 211A | - | 211C | 8475 - 8477 | Negative Watts, Phase B, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 211D | - | 211F | 8478 - 8480 | Negative Watts, Phase C, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |
| 2120 | - | 2122 | 8481 - 8483 | Negative VARs, Phase A, Min Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | |



B: Modbus Map and Retrieving Logs

| Modbus Address | | | | | | | | |
|----------------------------------|---------|----------------------|--------|--|----------------|----------------------|-------------|---|
| Hex | Decimal | Description (Note 1) | | Format | Range (Note 6) | Units or Resolution | Comments | # Reg |
| 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 | Reserved | | | | 3 |
| 2147 | - 2149 | 8520 | - 8522 | Reserved | | | | 3 |
| 214A | - 214C | 8523 | - 8525 | Reserved | | | | 3 |
| 214D | - 214F | 8526 | - 8528 | Reserved | | | | 3 |
| 2150 | - 2152 | 8529 | - 8531 | Reserved | | | | 3 |
| 2153 | - 2155 | 8532 | - 8534 | Reserved | | | | 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 | |

B: Modbus Map and Retrieving Logs

| Modbus Address | | | | | | | | | |
|-----------------------|--------|---------|--------|---|--------|--------------------|---------------------|--|-------|
| Hex | | Decimal | | Description (Note 1) | Format | Range (Note 6) | Units or Resolution | Comments | # Reg |
| 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 |



B: Modbus Map and Retrieving Logs

| Modbus Address | | | | | | | |
|---------------------------------|---------|----------------------|--------|--|----------------|----------------------|-------------|
| Hex | Decimal | Description (Note 1) | | Format | Range (Note 6) | Units or Resolution | Comments |
| 2365 | - 2366 | 9062 | - 9063 | VAs, Phase B, Maximum Avg Demand | FLOAT | -9999 M to +9999 M | VAs |
| 2367 | - 2368 | 9064 | - 9065 | VAs, Phase C, Maximum Avg Demand | FLOAT | -9999 M to +9999 M | VAs |
| 2369 | - 236A | 9066 | - 9067 | Positive PF, Phase A, Maximum Avg Demand | FLOAT | -1.00 to +1.00 | none |
| 236B | - 236C | 9068 | - 9069 | Positive PF, Phase B, Maximum Avg Demand | FLOAT | -1.00 to +1.00 | none |
| 236D | - 236E | 9070 | - 9071 | Positive PF, Phase C, Maximum Avg Demand | FLOAT | -1.00 to +1.00 | none |
| 236F | - 2370 | 9072 | - 9073 | Negative PF, Phase A, Maximum Avg Demand | FLOAT | -1.00 to +1.00 | none |
| 2371 | - 2372 | 9074 | - 9075 | Negative PF, Phase B, Maximum Avg Demand | FLOAT | -1.00 to +1.00 | none |
| 2373 | - 2374 | 9076 | - 9077 | Negative PF, Phase C, Maximum Avg Demand | FLOAT | -1.00 to +1.00 | none |
| 2375 | - 2375 | 9078 | - 9078 | Reserved | | | |
| 2376 | - 2376 | 9079 | - 9079 | Reserved | | | |
| 2377 | - 2377 | 9080 | - 9080 | Reserved | | | |
| 2378 | - 2378 | 9081 | - 9081 | Reserved | | | |
| 2379 | - 2379 | 9082 | - 9082 | Reserved | | | |
| 237A | - 237A | 9083 | - 9083 | Reserved | | | |
| 237B | - 237C | 9084 | - 9085 | Symmetrical Component Magnitude, 0 Seq, Maximum | FLOAT | 0 to 9999 M | volts |
| 237D | - 237E | 9086 | - 9087 | Symmetrical Component Magnitude, + Seq, Maximum | FLOAT | 0 to 9999 M | volts |
| 237F | - 2380 | 9088 | - 9089 | Symmetrical Component Magnitude, - Seq, Maximum | FLOAT | 0 to 9999 M | volts |
| 2381 | - 2381 | 9090 | - 9090 | Symmetrical Component Phase, 0 Seq, Maximum | SINT16 | -1800 to +1800 | 0.1 degree |
| 2382 | - 2382 | 9091 | - 9091 | Symmetrical Component Phase, + Seq, Maximum | SINT16 | -1800 to +1800 | 0.1 degree |
| 2383 | - 2383 | 9092 | - 9092 | Symmetrical Component Phase, - Seq, Maximum | SINT16 | -1800 to +1800 | 0.1 degree |
| 2384 | - 2384 | 9093 | - 9093 | Unbalance, 0 Seq, Maximum | UINT16 | 0 to 10000 | 0.01% |
| 2385 | - 2385 | 9094 | - 9094 | Unbalance, - Seq, Maximum | UINT16 | 0 to 10000 | 0.01% |
| 2386 | - 2386 | 9095 | - 9095 | Current Unbalance, Maximum | UINT16 | 0 to 20000 | 0.01% |
| | | | | | | | Block Size: |
| Primary Maximum Timestamp Block | | | | | | | read-only |
| 24B7 | - 24B9 | 9400 | - 9402 | Volts A-N, Max Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| 24BA | - 24BC | 9403 | - 9405 | Volts B-N, Max Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| 24BD | - 24BF | 9406 | - 9408 | Volts C-N, Max Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| 24C0 | - 24C2 | 9409 | - 9411 | Volts A-B, Max Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| 24C3 | - 24C5 | 9412 | - 9414 | Volts B-C, Max Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| 24C6 | - 24C8 | 9415 | - 9417 | Volts C-A, Max Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| 24C9 | - 24CB | 9418 | - 9420 | Amps A, Max Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| 24CC | - 24CE | 9421 | - 9423 | Amps B, Max Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| 24CF | - 24D1 | 9424 | - 9426 | Amps C, Max Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| 24D2 | - 24D4 | 9427 | - 9429 | Positive Watts, 3-Ph, Max Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| 24D5 | - 24D7 | 9430 | - 9432 | Positive VARs, 3-Ph, Max Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| 24D8 | - 24DA | 9433 | - 9435 | Negative Watts, 3-Ph, Max Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| 24DB | - 24DD | 9436 | - 9438 | Negative VARs, 3-Ph, Max Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| 24DE | - 24E0 | 9439 | - 9441 | VAs, 3-Ph, Max Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| 24E1 | - 24E3 | 9442 | - 9444 | Positive Power Factor, 3-Ph, Max Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| 24E4 | - 24E6 | 9445 | - 9447 | Negative Power Factor, 3-Ph, Max Avg Dmd Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| 24E7 | - 24E9 | 9448 | - 9450 | Frequency, Max Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |



B: Modbus Map and Retrieving Logs

| Modbus Address | | | | | | | | |
|----------------|-------------|--|--|--------|----------------------|---------------------|----------|-------|
| Hex | Decimal | Description (Note 1) | | Format | Range (Note 6) | Units or Resolution | Comments | # Reg |
| 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 | | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | | 3 |
| 2526 - 2528 | 9511 - 9513 | Negative PF, Phase B, Max Avg Dmd | | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | | 3 |
| 2529 - 252B | 9514 - 9516 | Negative PF, Phase C, Max Avg Dmd | | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec | | 3 |
| 252C - 252E | 9517 - 9519 | Reserved | | | | | | 3 |
| 252F - 2531 | 9520 - 9522 | Reserved | | | | | | 3 |
| 2532 - 2534 | 9523 - 9525 | Reserved | | | | | | 3 |
| 2535 - 2537 | 9526 - 9528 | Reserved | | | | | | 3 |
| 2538 - 253A | 9529 - 9531 | Reserved | | | | | | 3 |
| 253B - 253D | 9532 - 9534 | Reserved | | | | | | 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 |



B: Modbus Map and Retrieving Logs

| Modbus Address | | | | | | | |
|----------------------------------|---------|----------------------|---------|---|----------------|----------------------|---|
| Hex | Decimal | Description (Note 1) | | Format | Range (Note 6) | Units or Resolution | Comments |
| 2553 | - 2555 | 9556 | - 9558 | Unbalance, - Seq, Max Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| 2556 | - 2558 | 9559 | - 9561 | Current Unbalance, Max Timestamp | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| | | | | | | | Block Size: |
| | | | | | | | 159 |
| Commands Section (Note 4) | | | | | | | |
| Resets Block (Note 9) | | | | | | | write-only |
| 4E1F | - 4E1F | 20000 | - 20000 | Reset Max/Min Blocks | UINT16 | password (Note 5) | |
| 4E20 | - 4E20 | 20001 | - 20001 | Reset Energy Accumulators | UINT16 | password (Note 5) | |
| 4E21 | - 4E21 | 20002 | - 20002 | Reset Alarm Log (Note 21) | UINT16 | password (Note 5) | Reply to a reset log command indicates that the |
| 4E22 | - 4E22 | 20003 | - 20003 | Reset System Log (Note 21) | UINT16 | password (Note 5) | command was accepted but not necessarily that the |
| 4E23 | - 4E23 | 20004 | - 20004 | Reset Historical Log 1 (Note 21) | UINT16 | password (Note 5) | reset is finished. Poll log status block to determine this. |
| 4E24 | - 4E24 | 20005 | - 20005 | Reset Historical Log 2 (Note 21) | UINT16 | password (Note 5) | |
| 4E25 | - 4E25 | 20006 | - 20006 | Reset Historical Log 3 (Note 21) | UINT16 | password (Note 5) | |
| 4E26 | - 4E26 | 20007 | - 20007 | Reserved | | | |
| 4E27 | - 4E2E | 20008 | - 20015 | Reserved | | | Set to 0. |
| 4E29 | - 4E2A | 20010 | - 20011 | Reserved | | | Reserved |
| 4E2B | - 4E2B | 20012 | - 20012 | Reserved | | | |
| 4E2C | - 4E2C | 20013 | - 20013 | Reserved | | | |
| 4E2D | - 4E2D | 20014 | - 20014 | Reserved | | | |
| 4E2E | - 4E2E | 20015 | - 20015 | Reserved | | | |
| | | | | | | | Block Size: |
| | | | | | | | 16 |
| Privileged Commands Block | | | | | | | conditional write |
| 5207 | - 5207 | 21000 | - 21000 | Initiate Meter Firmware Reprogramming | UINT16 | password (Note 5) | |
| 5208 | - 5208 | 21001 | - 21001 | Force Meter Restart | UINT16 | password (Note 5) | causes a watchdog reset, always reads 0 |
| 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. |
| 520A | - 520A | 21003 | - 21003 | Initiate Programmable Settings Update | UINT16 | password (Note 5) | meter enters PS update mode |
| 520B | - 520B | 21004 | - 21004 | Calculate Programmable Settings Checksum (Note 3) | UINT16 | 0000 to 9999 | meter calculates checksum on RAM copy of PS block |
| 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) |
| 520D | - 520D | 21006 | - 21006 | Write New Password (Note 3) | UINT16 | 0000 to 9999 | write-only register; always reads zero |
| 520E | - 520E | 21007 | - 21007 | Terminate Programmable Settings Update (Note 3) | UINT16 | any value | meter leaves PS update mode via reset |
| 520F | - 5211 | 21008 | - 21010 | Set Meter Clock | TSTAMP | 1Jan2000 - 31Dec2099 | 1 sec |
| 5212 | - 5212 | 21011 | - 21011 | Reserved | | | Reserved |
| 5213 | - 5219 | 21012 | - 21018 | Reserved | | | Reserved |
| 521A | - 521A | 21019 | - 21019 | Close Privileged Command Session | UINT16 | any value | ends an open command session |
| | | | | | | | 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 |
| | | | | | | | Block Size: |
| | | | | | | | 12 |



B: Modbus Map and Retrieving Logs

| Modbus Address | | | | | | | | |
|-------------------------------|---------|----------------------|-------------------------------|----------------|---------------------|------------------------------|---|---|
| Hex | Decimal | Description (Note 1) | Format | Range (Note 6) | Units or Resolution | Comments | # Reg | |
| | | | | | | | | |
| 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 mmmmmhhh | 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 hmmm | 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) Line pppp = expected frequency (0=60 Hz, 1=50 Hz) | 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 |

B: Modbus Map and Retrieving Logs

| Modbus Address | | Description (Note 1) | Format | Range (Note 6) | Units or Resolution | Comments | # Reg |
|----------------|---------------|----------------------|--------|----------------|---------------------|---|-------|
| Hex | Decimal | | | | | | |
| 753D - 753D | 30014 - 30014 | DNP Options | UINT16 | bit-mapped | ----- ww-i-vvp | <p>p selects primary or secondary values for DNP voltage, current and power registers (0=secondary, 1=primary)</p> <p>vv sets divisor for voltage scaling (0=1, 1=10, 2=100)</p> <p>i sets divisor for current scaling (0=1, 1=10)</p> <p>ww sets divisor for power scaling in addition to scaling for Kilo (0=1, 1=10, 2=100, 3=1000)</p> <p>Example: 120KV, 500A, 180MW p=1, vv=2, i=0, and ww=3 voltage reads 1200, current reads 500, watts reads 180</p> | 1 |
| 753E - 753E | 30015 - 30015 | User Settings Flags | UINT16 | bit-mapped | vvkgeinn srpdywfa | <p>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.</p> <p>k = enable fixed scale for voltage display. (0=autoscale, 1=unit if vv=0 and kV if vv=1,2,3)</p> <p>g = enable alternate full scale bar graph current (1=on, 0=off)</p> <p>e = enable ct pt compensation (0=Disabled, 1=Enabled).</p> <p>i = fixed scale and format current display 0=normal autoscaled current display 1=always show amps with no decimal places</p> <p>nn = number of phases for voltage & current screen (3=ABC, 2=AB, 1=A, 0=ABC)</p> <p>s = scroll (1=on, 0=off)</p> <p>r = password for reset in use (1=on, 0=off)</p> <p>p = password for configuration in use (1=on, 0=off)</p> <p>d = daylight saving time changes (0=off, 1=on)</p> <p>y = diagnostic events in system log (1=yes, 0=no)</p> <p>w = power direction (0=view as load, 1=view as generator)</p> <p>f = flip power factor sign (1=yes, 0=no)</p> <p>a = apparent power computation method (0=arithmetic sum, 1=vector sum)</p> | 1 |

B: Modbus Map and Retrieving Logs

| Modbus Address | | Description (Note 1) | Format | Range (Note 6) | Units or Resolution | Comments | # Reg |
|----------------|---------------|--|--------|------------------|---------------------|--|-------|
| Hex | Decimal | | | | | | |
| 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 | yy = parity (0-none, 1-odd, 2-even) dddd = reply delay (" 50 msec) ppp = protocol (1-Modbus RTU, 2-Modbus ASCII, 3-DNP) bbbb = baud rate (1-9600, 2-19200, 4-38400, 6-57600, 13=1200, 14=2400, 15=4800) | 1 |
| 7549 - 7549 | 30026 - 30026 | COM2 setup | UINT16 | bit-mapped | ----dddd -ppp-bbb | | 1 |
| 754A - 754A | 30027 - 30027 | COM2 address | UINT16 | 1 to 247 | none | | 1 |
| 754B - 754B | 30028 - 30028 | Limit #1 Identifier | UINT16 | 0 to 65535 | | use Modbus address as the identifier (see notes 7, 11, 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 compensation for losses due to copper f - 0 disable compensation for losses due to iron, 1 enable compensation 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 |

B: Modbus Map and Retrieving Logs

| Modbus Address | | | | | | | | |
|----------------|---------|----------------------|---------|---|----------------|---------------------|--|-------|
| Hex | Decimal | Description (Note 1) | | Format | Range (Note 6) | Units or Resolution | Comments | # Reg |
| 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 | -99.99 to 99.99 | 0.01% | 1 |
| 7628 | - 7628 | 30249 | - 30249 | A phase PT compensation @ 120V (% error) | SINT16 | -99.99 to 99.99 | 0.01% | 1 |
| 7629 | - 7629 | 30250 | - 30250 | A phase PT compensation @ 230V (% error) | SINT16 | -99.99 to 99.99 | 0.01% | 1 |
| 762A | - 762A | 30251 | - 30251 | A phase PT compensation @ 480V (% error) | SINT16 | -99.99 to 99.99 | 0.01% | 1 |
| 762B | - 762B | 30252 | - 30259 | B phase PT compensation @ 69V, 120V, 230V, 480V (% error) | SINT16 | -99.99 to 99.99 | 0.01% | 4 |
| 762F | - 762F | 30256 | - 30259 | C phase PT compensation @ 69V, 120V, 230V, 480V (% error) | SINT16 | -99.99 to 99.99 | 0.01% | 4 |
| 7633 | - 7633 | 30260 | - 30260 | A phase CT compensation @ c1 (% error) | SINT16 | -99.99 to 99.99 | 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 | -99.99 to 99.99 | 0.01% | 1 |
| 7635 | - 7635 | 30262 | - 30262 | A phase CT compensation @ c3 (% error) | SINT16 | -99.99 to 99.99 | 0.01% | 1 |
| 7636 | - 7636 | 30263 | - 30263 | A phase CT compensation @ c4 (% error) | SINT16 | -99.99 to 99.99 | 0.01% | 1 |
| 7637 | - 7637 | 30264 | - 30267 | B phase CT compensation @ c1, c2, c3, c4 (% error) | SINT16 | -99.99 to 99.99 | 0.01% | 4 |
| 763B | - 763E | 30268 | - 30271 | C phase CT compensation @ c1, c2, c3, c4 (% error) | SINT16 | -99.99 to 99.99 | 0.01% | 4 |
| 763F | - 7642 | 30272 | - 30275 | A phase PF compensation @ c1, c2, c3, c4 (% error) | SINT16 | -99.99 to 99.99 | 0.01% | 4 |
| 7643 | - 7646 | 30276 | - 30279 | B phase PF compensation @ c1, c2, c3, c4 (% error) | SINT16 | -99.99 to 99.99 | 0.01% | 4 |
| 7647 | - 764A | 30280 | - 30283 | C phase PF compensation @ c1, c2, c3, c4 (% error) | SINT16 | -99.99 to 99.99 | 0.01% | 4 |
| | | | | | | | Block Size: | 284 |

B: Modbus Map and Retrieving Logs

| Modbus Address | | | | | | | | | |
|----------------------------|---------|----------------------|---------|--|---------------------------|---------------------|------------------------------|---|-----|
| Hex | Decimal | Description (Note 1) | | Format | Range (Note 6) | Units or Resolution | Comments | # Reg | |
| 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 hgfdcbca | 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 |
| | | | | | | | Block Size: | 608 | |
| 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= 65 or more freq = 45 + ((register / 4095) * 30) | 1 |
| 9C4C | - 9C4C | 40013 | - 40013 | Volts A-B | UINT16 | 2047 to 4095 | volts | 2047= 0, 4095= +300 | 1 |
| 9C4D | - 9C4D | 40014 | - 40014 | Volts B-C | UINT16 | 2047 to 4095 | volts | volts = 300 * (register - 2047) / 2047 | 1 |
| 9C4E | - 9C4E | 40015 | - 40015 | Volts C-A | UINT16 | 2047 to 4095 | volts | | 1 |
| 9C4F | - 9C4F | 40016 | - 40016 | CT numerator | UINT16 | 1 to 9999 | none | CT = numerator * multiplier / denominator | 1 |
| 9C50 | - 9C50 | 40017 | - 40017 | CT multiplier | UINT16 | 1, 10, 100 | none | | 1 |
| 9C51 | - 9C51 | 40018 | - 40018 | CT denominator | UINT16 | 1 or 5 | none | PT = numerator * multiplier / denominator | 1 |
| 9C52 | - 9C52 | 40019 | - 40019 | PT numerator | UINT16 | 1 to 9999 | none | | 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 |

B: Modbus Map and Retrieving Logs

| Modbus Address | | | | | | | | | |
|----------------|---|---------|----------------------|------------------------------|----------------|---------------------|------------------------|--|-----|
| Hex | | Decimal | Description (Note 1) | Format | Range (Note 6) | Units or Resolution | Comments | # Reg | |
| 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 | 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 |

B: Modbus Map and Retrieving Logs

| Modbus Address | | | | | | | | | |
|-----------------------|---------|------------------------|---------|---|----------------|--------------------------------|--|--|-----|
| Hex | Decimal | Description (Note 1) | | Format | Range (Note 6) | Units or Resolution | Comments | # Reg | |
| | | | | | | | | | |
| 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 e s s s s s s s | high byte is the log number (0-system, 1-alarm, 2-history1, 3-history2, 4-history3, 5-I/O changes, 11-waveform, (11 reserved for future use) e is retrieval session enable(1) or disable(0) s s s s s s s 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 | www s s s s s s s s n n n n n n n n | 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 | s s s s s s s s n | s s s s s s s s 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 | Reserved | | | | | 16 |
| C7A7 | - C7B6 | 51112 | - 51127 | Waveform Capture Log Status Block | | same as alarm log status block | | | 16 |
| | | | | | | | | Block Size: | 128 |
| End of Map | | | | | | | | | |

B: Modbus Map and Retrieving Logs

| Data Formats | |
|-----------------|---|
| ASCII | ASCII characters packed 2 per register in high, low order and without any termination characters. For example, "Shark200" 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: <div> <div>current</div> <div>FS = CT numerator * CT multiplier</div> <div>voltage</div> <div>FS = PT numerator * PT multiplier</div> <div>3 phase power</div> <div>FS = CT numerator * CT multiplier * PT numerator * PT multiplier * 3 [* SQRT(3) for delta hookup]</div> <div>single phase power</div> <div>FS = CT numerator * CT multiplier * PT numerator * PT multiplier [* SQRT(3) for delta hookup]</div> <div>frequency</div> <div>FS = 60 (or 50)</div> <div>power factor</div> <div>FS = 1.0</div> <div>percentage</div> <div>FS = 100.0</div> <div>angle</div> <div>FS = 180.0</div> </div> |
| 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 V-switch 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 essential 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 entities 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. |

B: Modbus Map and Retrieving Logs

- 18 Autoincrementing and function 35 must be used when retrieving waveform logs.
- 19 Depending on the V-switch setting, 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 = $65536 / R$, 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.

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C: DNP Mapping

C.1: Overview

This Appendix describes the functionality of the Shark® 200S meter's version of the DNP protocol. A DNP programmer needs this information to retrieve data from the Shark® 200S meter. The DNP version used by the Shark 200S is a reduced set of the Distributed Network Protocol Version 3.0 subset 2; it gives enough functionality to get critical measurements from the Shark® 200S meter.

The Shark® 200S meter's DNP version supports Class 0 object/qualifiers 0,1,2,6, only. No event generation is supported. The Shark® 200S meter always acts as a secondary device (slave) in DNP communication.

A new feature allows DNP readings in primary units with user-set scaling for current, Voltage, and power (see Chapter 8 in the *Communicator EXT™ 4.0 and MeterManager EXT Software User Manual* for instructions).

C.2: Physical Layer

The Shark® 200S meter's DNP version uses serial communication. Port 2 (RS485 compliant port) or any communication capable option board can be used. Speed and data format is transparent for the Shark® 200S meter's DNP version: they can be set to any supported value. The IrDA port cannot use DNP.

C.3: Data Link Layer

The Shark® 200S meter can be assigned a value from 1 to 65534 as the target device address. The data link layer follows the standard frame FT3 used by 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.

| Function | Function Code |
|-----------------------|---------------|
| Reset Link | 0 |
| Reset User | 1 |
| Unconfirmed User Data | 4 |
| Link Status | 9 |

Table C.1: Supported Link Functions

[dst] and [src] are the device address of the Shark® 200S meter and Master device, respectively. Refer to Section C.7 for more detail on supported frames for the data link layer.

In order to establish optimal communication with the Shark® 200S meter, we recommend that you perform the Reset Link and Reset User functions. The Link Status is not mandatory, but can be performed as well. The inter-character time-out for DNP 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

The Shark® 200S meter's DNP version supports the Read, Write, Direct Operate and Direct Operate Unconfirmed functions.

- The Read function (code 01) provides a means for reading the critical measurement data from the meter. This function should be posted to read object 60 variation 1, which will read all the available Class 0 objects from the DNP register map. See the register 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 means 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 Direct Operate function (code 05) is intended for resetting the energy counters and the Demand counters (minimum and maximum energy registers). These actions are mapped to Object 12, points 0 and 2, which act as control relays. The relays 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 DNP. This switching acts 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 milliseconds 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 powered down and up. Section C.7 shows the constructed frame to perform DNP to Modbus RTU protocol change.

C.5: Error Reply

In the case of an unsupported function, or any other recognizable error, an error reply is generated from the Shark® 200S 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 field, but they do not indicate an error condition.

C.6: Shark® 200S Meter's DNP Register Map

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 | Read by Class 0 or with qualifier 0, 1, 2, or 6 |
| 10 | 1 | 2 | Change to Modbus RTU Protocol | BYTE | Always 1 | N/A | None | Read by Class 0 or with qualifier 0, 1, 2, or 6 |
| 10 | 2 | 2 | Reset Demand Cntrs (Max / Min) | BYTE | Always 1 | N/A | None | Read by Class 0 or with qualifier 0, 1, 2, or 6 |

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 | Responds to Function 5 (Direct Operate), Qualifier Code 17x or 28x, Control Code 3, Count 0, On 0 msec, Off 1 msec ONLY. |
| 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. |

| Object | Point | Var | Description | Format | Range | Multiplier | Units | Comments |
|--------|-------|-----|-----------------------------------|--------|-------|------------|-------|--|
| 12 | 2 | 1 | Reset Demand Counters (Max / Min) | N/A | N/A | N/A | none | Responds to Function 5 (Direct Operate), Qualifier Code 17x or 28x, Control Code 3, Count 0, On 0 msec, Off 1 msec ONLY. |

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 energyformat. 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 | |
| 20 | 3 | 5 | VAR-hours, Negative | UINT32 | 0 to 99999999 | | VARhr | |
| 20 | 4 | 5 | VA-hours, Total | UINT32 | 0 to 99999999 | | VAhr | |

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 | |

| Object | Point | Var | Description | Format | Range | Multiplier | Units | Comments |
|--------|-------|-----|--|--------|------------------|----------------|--------|---|
| 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 | |
| 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 | |

| Object | Point | Var | Description | Format | Range | Multiplier | Units | Comments |
|--------|-------|-----|------------------|--------|----------------|--------------|--------|--|
| 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 | For 1A model, multiplier is (2 / 32768) and values above 2A secondary read 32767 |

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.7: 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 framesReset 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 framesClear 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 | 72 | 44 | src | | dst | | crc | | | | | | | | | | |
| | Cx | Cy | 81 | int. ind. | | 14 | 05 | 00 | 00 | 04 | pt 0 | | | pt 1 | | crc | | | |
| | pt 1 | | | pt 2 | | | pt 3 | | | pt 4 | | | 1E | | 04 | crc | | | |
| | 00 | 00 | 20 | pt 0 | | pt 1 | | pt 2 | | pt 3 | | pt 4 | | pt 5 | | pt6 | crc | | |
| | | | | | | | | | | | | | | | | | | | |
| | pt6 | | pt 7 | | pt 8 | | pt 9 | | pt 10 | | pt 11 | | pt 12 | | pt 13 | | | crc | |
| | | | | pt 15 | | pt 16 | | pt 17 | | pt 18 | | pt 19 | | pt 20 | | pt 21 | | crc | |
| | | | | pt 23 | | pt 24 | | pt 25 | | pt 26 | | pt 27 | | pt 28 | | pt 29 | | | crc |
| | | | | pt 31 | | pt 32 | | 0A | 02 | 00 | 00 | 02 | pt0 | pt1 | pt2 | 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 | 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 | 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 | 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 | 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.8: Internal Indication Bits

Bits implemented in the Shark® 200S 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.

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D: Using the USB to IrDA Adapter (CAB6490)

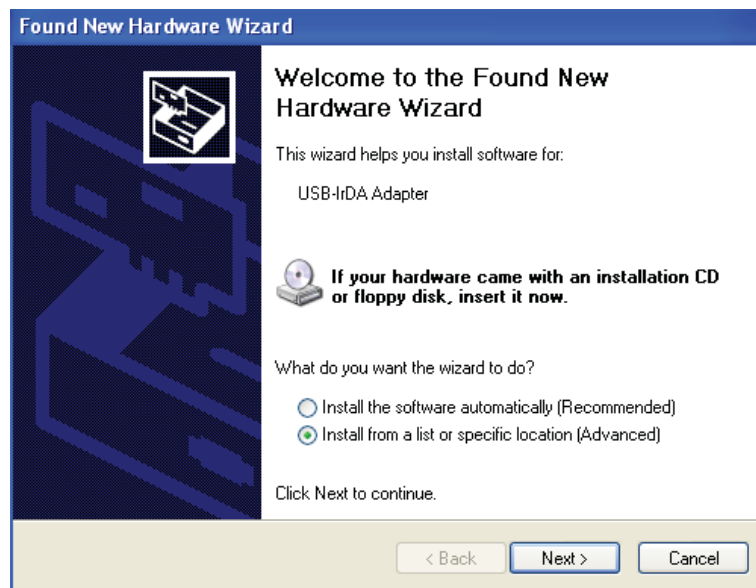
D.1: Introduction

Com 1 of the Shark® 200S meter is the IrDA port, located on the face of the meter. One way to communicate with the IrDA port is with EIG's USB to IrDA Adapter (CAB6490), which allows you to access the Shark® 200S meter's data from a PC. This Appendix contains instructions for installing the USB to IrDA Adapter.

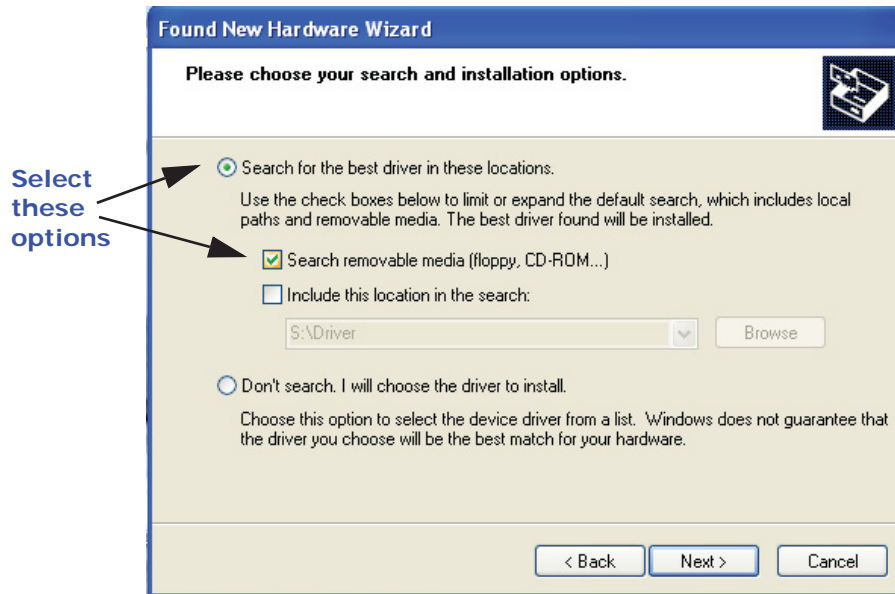
D.2: Installation Procedures

You can order CAB6490 from EIG's webstore: www.electroind.com/store. Select Cables and Accessories from the list on the left side of the screen. The USB to IrDA Adapter comes packaged with a USB cable and an Installation CD. Follow this procedure to install the Adapter on your PC.

1. Connect the USB cable to the USB to IrDA Adapter, and plug the USB into your PC's USB port.
2. Insert the Installation CD into your PC's CD ROM drive.
3. You will see the screen shown below. The Found New Hardware Wizard allows you to install the software for the Adapter. Click the Radio Button next to **Install from a list or specific location**.

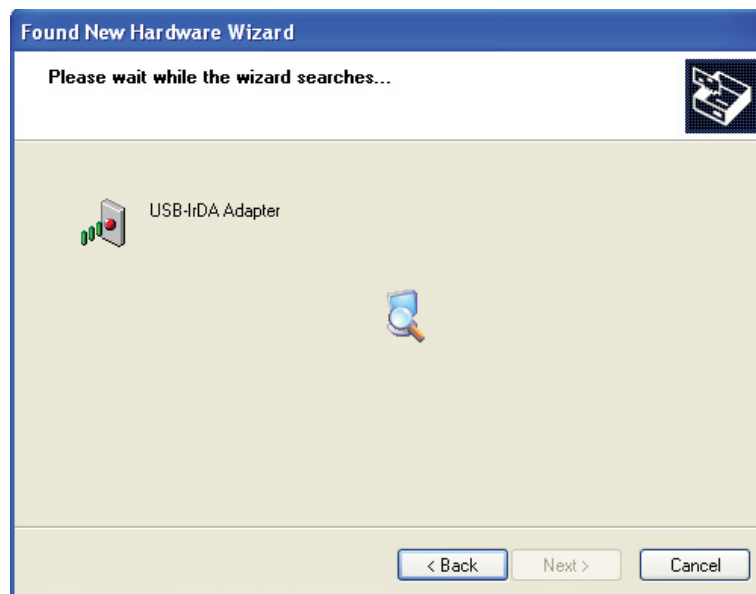


4. Click **Next**. You will see the screen shown on the next page.

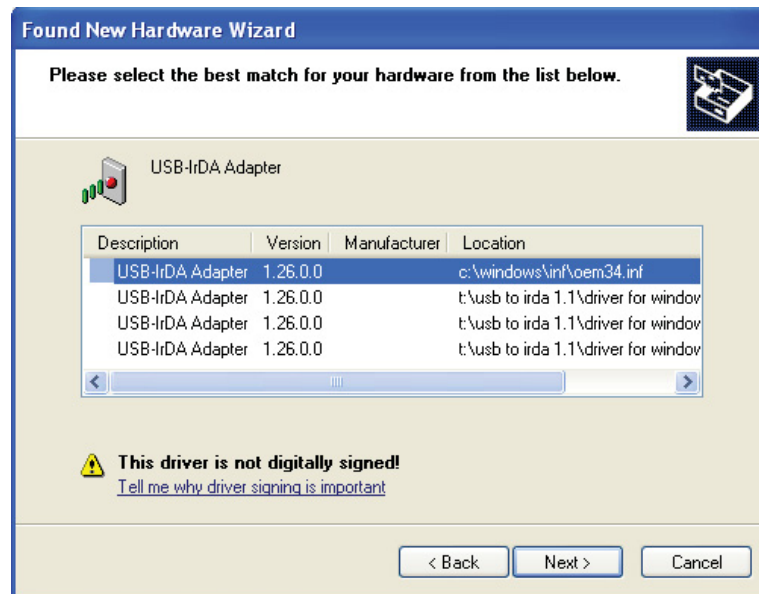


5. Make sure the first Radio Button and the first Checkbox are selected, as shown above. These selections allow the Adapter's driver to be copied from the Installation disk to your PC.

6. Click **Next**. You will see the screen shown below.

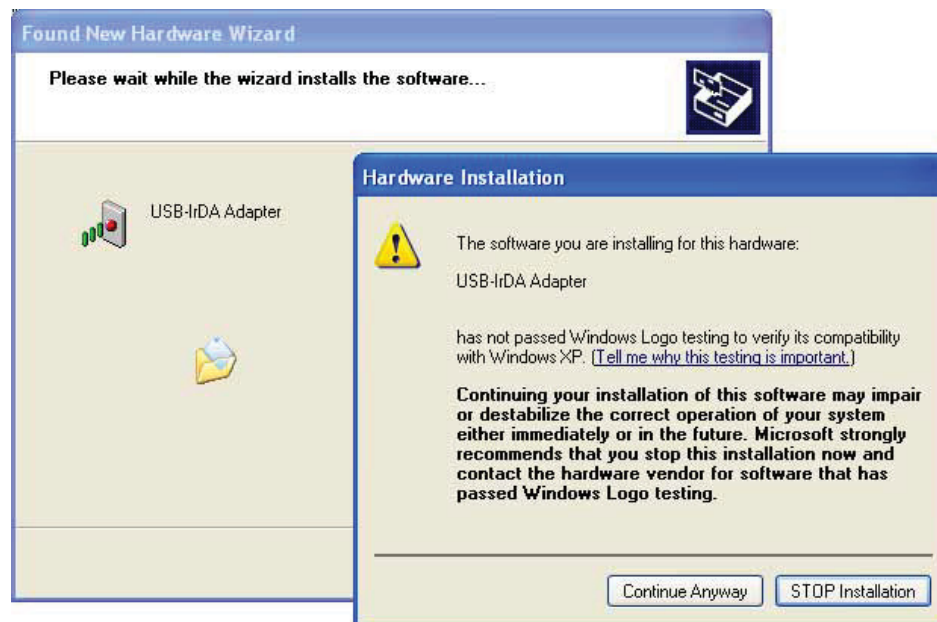


7. When the driver for the Adapter is found, you will see the screen shown on the next page.

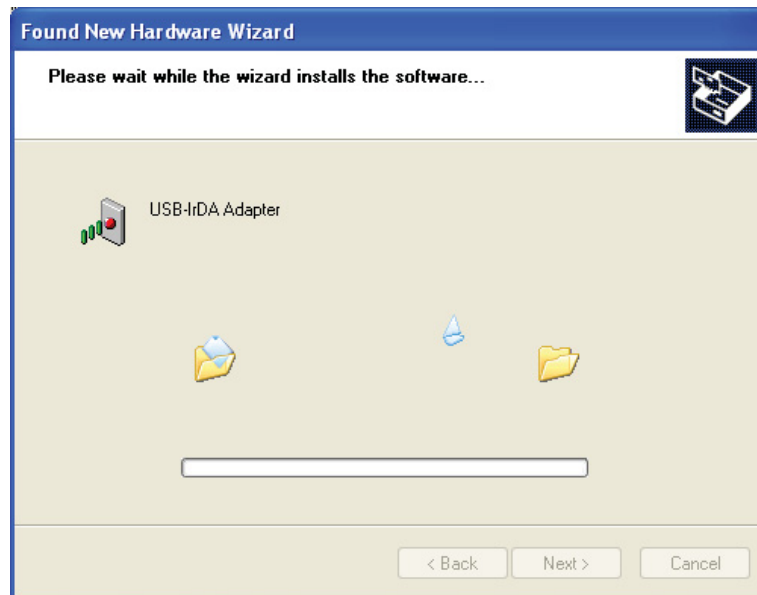


8. You do not need to be concerned about the message on the bottom of the screen. Click **Next** to continue with the installation.

9. You will see the two windows shown below. Click **Continue Anyway**.



10. You will see the screen shown below while the Adapter's driver is being installed on your PC.



11. When driver installation is complete, you will see the screen shown below.



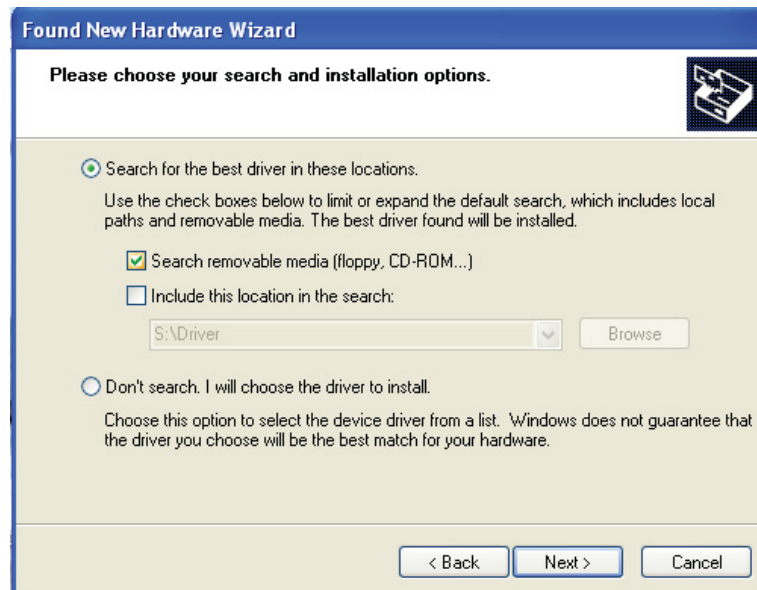
12. Click **Finish** to close the Found New Hardware Wizard.

IMPORTANT! Do NOT remove the Installation CD until the entire procedure has been completed.

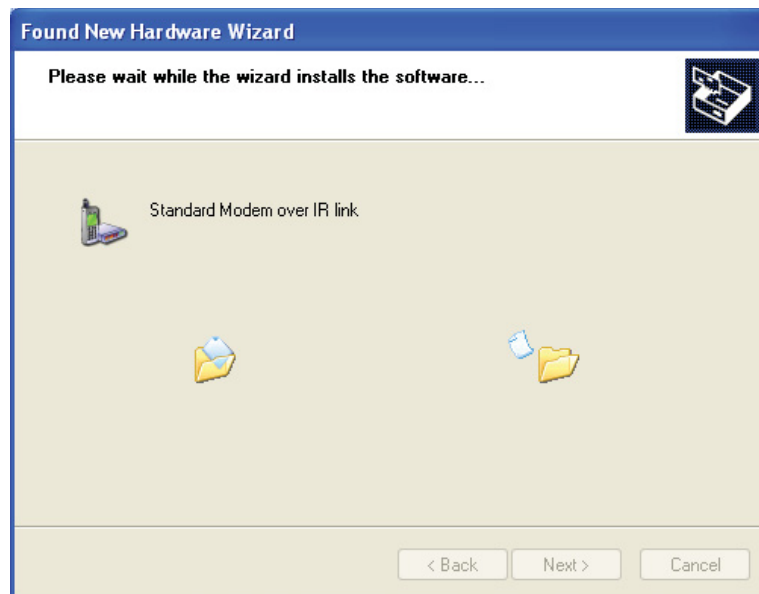
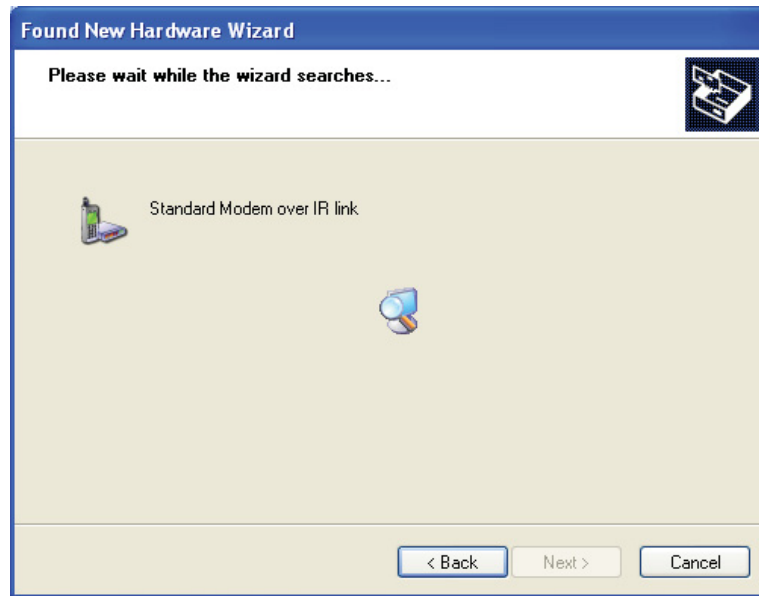
13. Position the USB to IrDA Adapter so that it points directly at the IrDA on the front of the Shark® 200S meter. It should be as close as possible to the meter, and not more than 15 inches/38 cm away from it.
14. The Found New Hardware Wizard screen opens again. This time, click the Radio Button next to Install the software automatically.



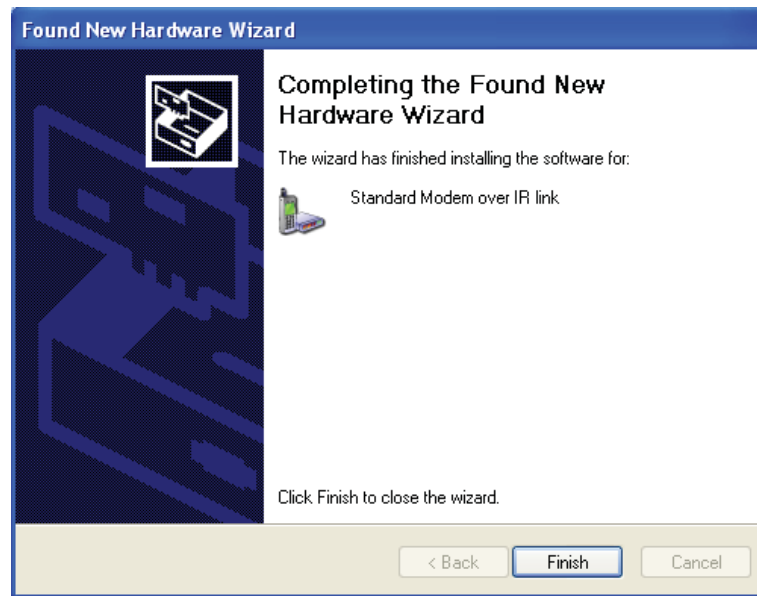
15. Click **Next**. You will see the screen shown below.



16. Make sure the first Radio Button and the first Checkbox are selected, as shown above screen. Click **Next**. You will see the two screens shown on the next page.



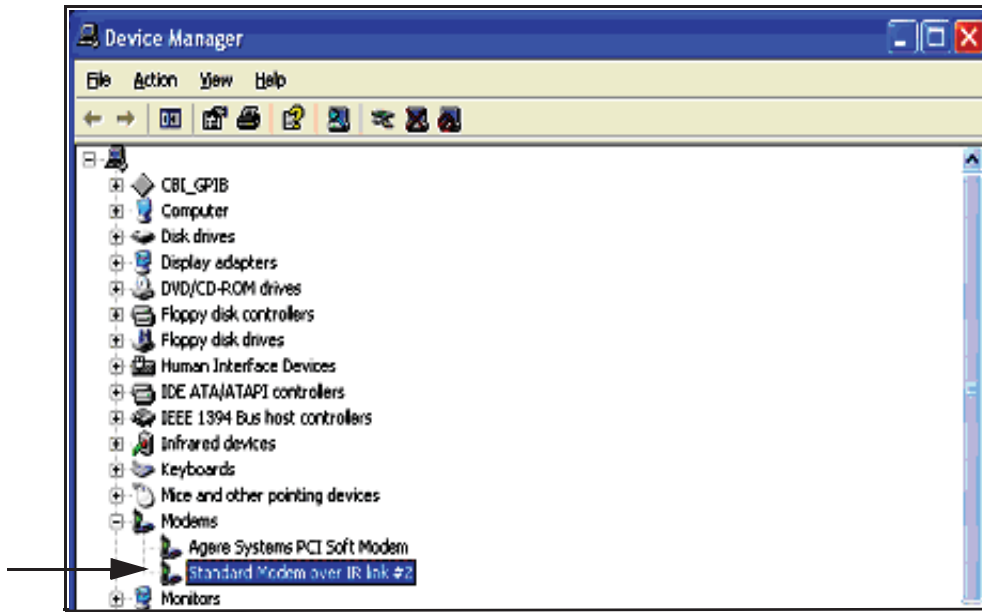
17. When installation is complete, you will see the screen shown below.



18. Click **Finish** to close the Found New Hardware Wizard.

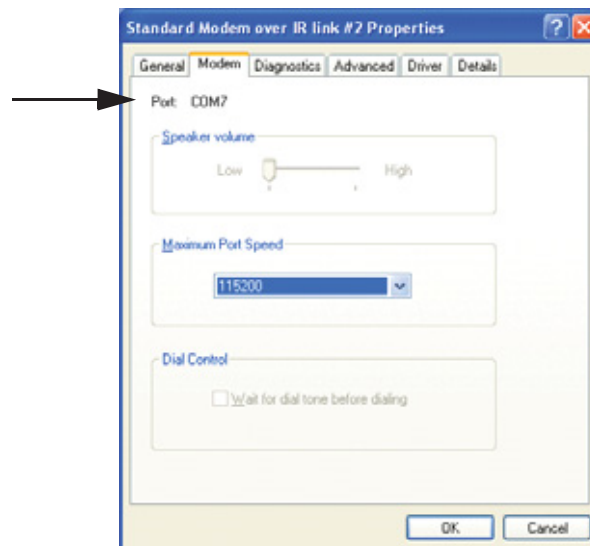
19. To verify that your Adapter has been installed properly, click **Start>Settings>Control Panel>System>Hardware>Device Manager**. The USB to IrDA Adapter should appear under both Infrared Devices and Modems (click on the + sign to display all configured modems). See the example screen on the next page.

NOTE: If the Adapter doesn't show up under Modems, move it away from the meter for a minute and then position it pointing at the IrDA, again.



20. Double-click on the Standard Modem over IR link (this is the USB to IrDA Adapter). You will see the Properties screen for the Adapter.

21. Click the Modem tab. The Com Port that the Adapter is using is displayed in the screen.



22. Use this Com Port to connect to the meter from your PC, using the Communicator EXT™ software. Refer to Chapter 3 of the *Communicator EXT™ 4.0 and MeterManager EXT Software User Manual* for detailed connection instructions.