Shark 100-S

Electronic Submeter with Advanced WIFI Ethernet Capability

Installation & Operation Manual
Revision 1.11

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"The Leader in Power Monitoring and Control"

Shark® 100-S Submeter
User Manual
Version 1.10

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Founded in 1973 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. A few of our many **Technology Firsts** include:

1978: First microprocessor-based power monitor
1986: First PC-based power monitoring software for plant-wide power distribution analysis
1994: First 1 Meg Memory high performance power monitor for data analysis and recording
1999: NexusTM Series generation power monitoring with industry-leading accuracy
2000: First low profile socket meter with advanced features for utility deregulation

Today

Over thirty years later, Electro Industries/GaugeTech, the leader in Web-Accessed Power Monitoring, continues to revolutionize the industry with the highest quality, cutting edge power monitoring and control technology on the market today. An ISO 9001:2000 certified company, EIG sets the standard for web-accessed power monitoring, advanced power quality, revenue metering, artificial intelligence reporting, industrial submetering and substation data acquisition and control. EIG's products can be found on site at virtually all of today's leading manufacturers, industrial giants and utilities.

World Leader

In fact, EIG products are used globally and EIG is accepted as the world leader in power monitoring and metering technology. With direct offices in the United States, Turkey, Brazil, Mexico, Guatemala, Croatia and the Phillipines, EIG support is available in most regions around the world. Our worldwide support, advanced technology and quality manufacturing standards make EIG the superior choice when dependable, reliable service is paramount.

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Chapter 1
Three-Phase Power Measurement

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

1.1: Three-Phase System Configurations

Three-phase power is most commonly used in situations where large amounts of power will be used because it is a more effective way to transmit the power and because it provides a smoother delivery of power to the end load. There are two commonly used connections for three-phase power, a wye connection or a delta connection. Each connection has several different manifestations in actual use. When attempting to determine the type of connection in use, it is a good practice to follow the circuit back to the transformer that is serving the circuit. It is often not possible to conclusively determine the correct circuit connection simply by counting the wires in the service or checking voltages. Checking the transformer connection will provide conclusive evidence of the circuit connection and the relationships between the phase voltages and ground.

1.1.1: 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 wye (Y). Fig. 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).

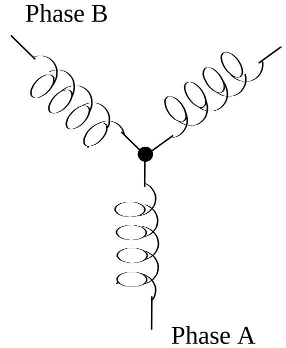


Figure 1.1: Three-Phase Wye Winding

- The three voltages are separated by 120^o electrically. Under balanced load conditions with unity power factor the currents are also separated by 120^o. However, unbalanced loads and other conditions can cause the currents to depart from the ideal 120^o 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.

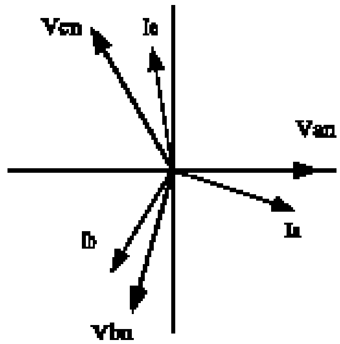


Fig 1.2: Phasor diagram showing Three-phase Voltages and Currents

- The phasor diagram shows the 120º 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 1.1: 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 Fig. 1.1). The neutral wire is typically tied to the ground or center point of the wye (refer to Figure 1.1).

  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 1.1, 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.

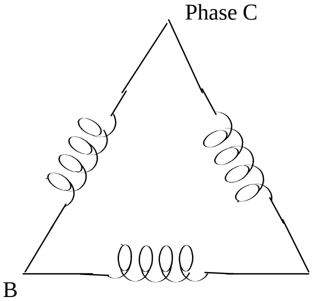


Figure 1.3: Three-Phase Delta Winding Relationship

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.

Fig. 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.

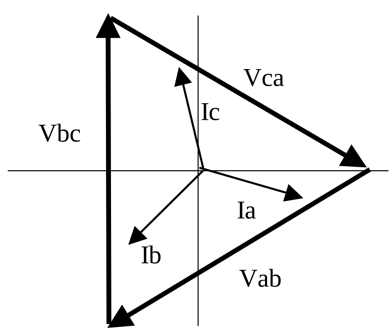


Figure 1.4: Phasor diagram showing three-phase voltages, currents delta connected.

- 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.

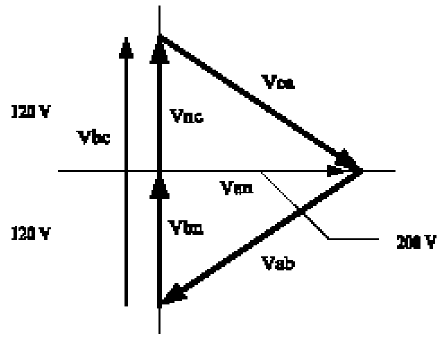


Fig 1.5: Phasor diagram showing Three-phase, Four-wire Delta Connected System

1.1.3: Blondell's Theorem and Three Phase Measurement

In 1893 an engineer and mathematician named Andre E. Blondell set forth the first scientific basis for poly phase 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 Blondell'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, Blondell'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 calculate 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 combines 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.

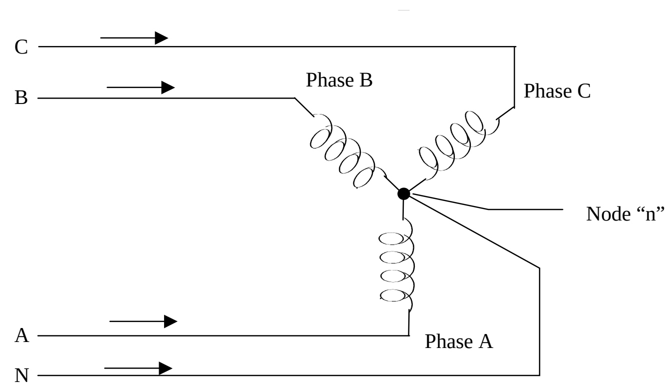


Figure 1.6: Three-Phase Wye Load illustrating Kirchhoff’s Law and Blondell’s Theorem

Blondell'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. Krichhoff's Laws hold 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 Blondell'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 ¼ of that total or one kWh.

- Figure 1.7 shows a graph of power and the resulting energy that would be transmitted as a result of the illustrated power values. For this illustration, it is assumed that the power level is held constant for each minute when a measurement is taken. Each bar in the graph will represent the power load for the one-minute increment of time. In real life the power value moves almost constantly.

- The data from Figure 1.7 is reproduced in Table 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).

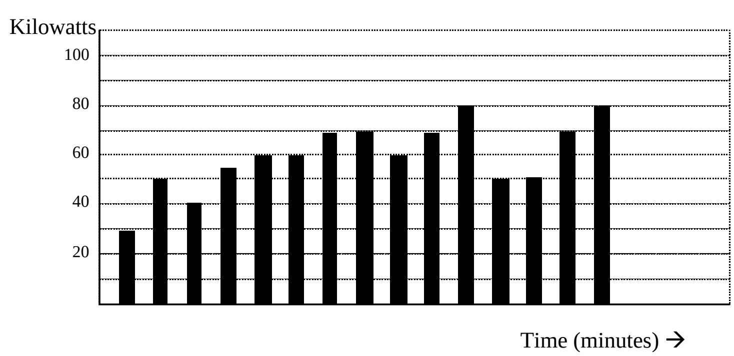


Figure 1.7: Power use over time

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.

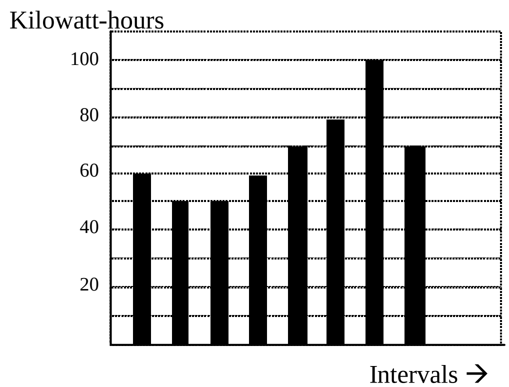


Figure 1.8: Energy use and demand

- 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 90º or perpendicular) to the voltage. Figure 1.9 shows a single-phase voltage and current and breaks the current into its in-phase and quadrature components.

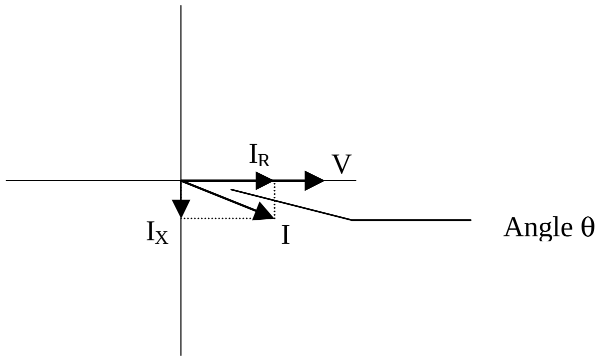


Figure 1.9: Voltage and complex current

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

  The quadrature current may be lagging the voltage (as shown in Figure 1.9) or it may lead the voltage. When the quadrature current lags the voltage the load is requiring both real power (watts) and reactive power (VARs). When the quadrature current leads the voltage the load is requiring real power (watts) but is delivering reactive power (VARs) back into the system; that is VARs are flowing in the opposite direction of the real power flow.

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

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

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

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

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

Displacement PF = cos θ,   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.

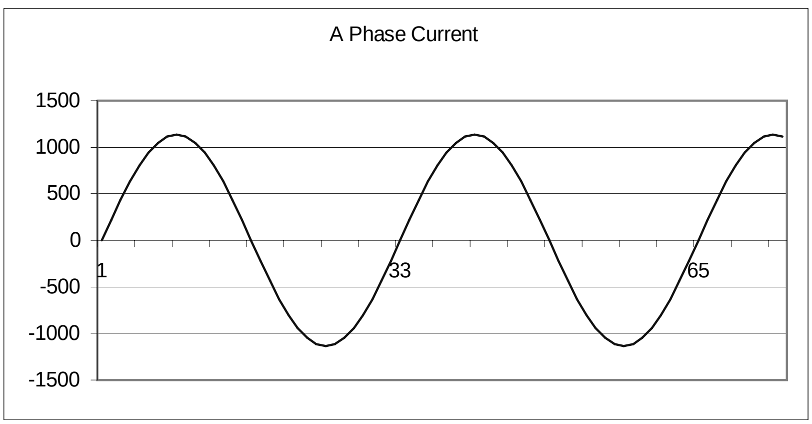


Figure 1.10: Non-distorted current waveform

- 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.

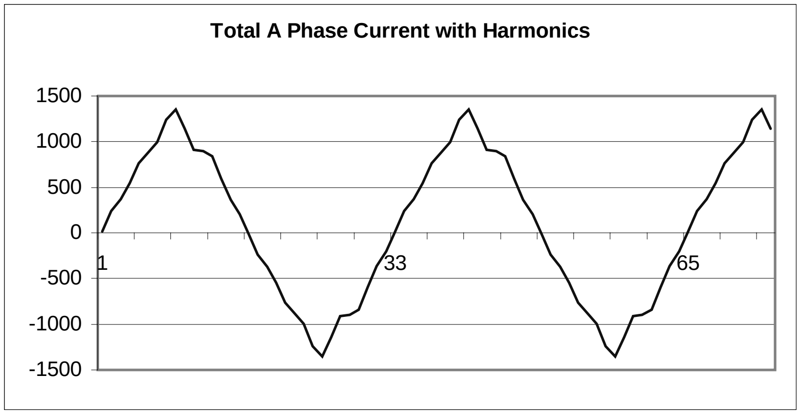


Figure 1.11: Distorted current wave

- 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.

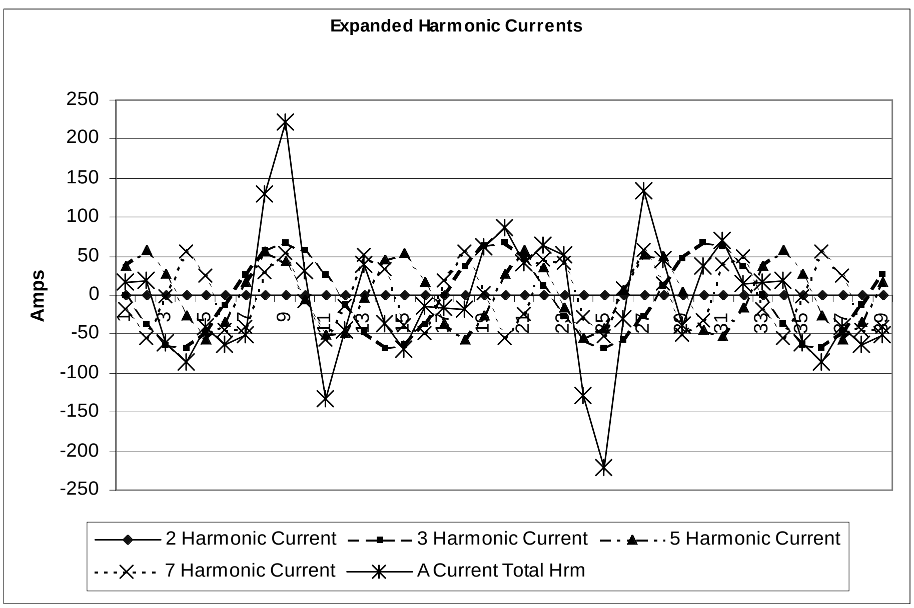


Figure 1.12: Waveforms of the harmonics

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.

  $X_L = j\omega L$ 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 different in 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 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 below.

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 second or longer duration	System protection Circuit breakers Fuses Maintenance
Undervoltage / Overvoltage	RMS voltage, steady state, multiple second 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 may 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.

Chapter 2
Shark® 100-S Submeter Overview and Specifications

2.1: Hardware Overview

■ The Shark® 100-S multifunction submeter is designed to measure revenue grade electrical energy usage and communicate that information via various communication media. The unit supports RS485, RJ-45 Ethernet or IEEE 802.11 Wi-Fi Ethernet connections. This allows the unit to be placed anywhere within a complex and it communicates back to central software quickly and easily. The unit also has an IrDA Port for direct PDA interface.

The unit is designed with advanced meaurement capabilities, allowing it to achieve high performance accuracy. The Shark® 100-S meter is specified as a 0.2% class energy meter for billing applications. To verify the submeter's performance and calibration, power providers use field test standards to ensure that the unit's energy measurements are correct. The Shark® 100-S meter is a traceable revenue meter and contains a utility grade test pulse to verify rated accuracy.

Figure 2.1: Shark 100-S Submeter

■ **Shark® 100-S Meter Features** detailed in this manual are:

- 0.2% Class Revenue Certifiable Energy and Demand Submeter
- Meets ANSI C12.20 (0.2%) and IEC 687 (0.2%) Classes
- Multifunction Measurement including Voltage, Current, Power, Frequency, Energy, etc.
- Power Quality Measurements (%THD and Alarm Limits)
- 3 Line 0.56" Bright Red LED Display
- **V-Switch™ Technology** - Field Upgrade without Removing Installed Meter
- Percentage of Load Bar for Analog Meter Perception
- Modbus RTU and Modbus TCP (Over Ethernet)
- Serial RS485 Communication
- Ethernet and Wireless Ethernet (Wi-Fi)
- Easy to Use Faceplate Programming
- **IrDA Port** for PDA Remote Read
- Direct Interface with Most Building Management Systems
- DNP 3.0

The unit 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: Voltage Inputs

- **Universal Voltage Inputs**
  Voltage Inputs allow measurement to 416 Volts Line-to-Neutral and 721 Volts Line-to-Line. This insures proper meter safety when wiring directly to high voltage systems. One unit will perform to specification on 69 Volt, 120 Volt, 230 Volt, 277 Volt, 277 Volt and 347 Volt power systems.

2.1.2: Model Number plus Option Numbers

Model	Frequency	Current Class	V-Switch™ Key Pack	Power Supply	Communication Format
Shark® 100-S Submeter	- 50 50 Hz System	- 10 5 Amp Secondary	- V3 Default with Energy Counters	- D2 (90 - 400)V ac (100 - 370)V dc	- 485 RS-485
	- 60 60 Hz System	- 2 1 Amp Secondary	- V4 Above with Harmonics & Limts		-WIFI Wireless and LAN Based Ethernet (also configurable for RS-485)
Example:					
Shark 100-S	**- 60**	**- 10**	**- V3**	**- D2**	**- 485**

2.1.3: V-Switch™ Technology

The Shark® 100-S meter is equipped with EIG's exclusive V-Switch™ technology. V-Switch™ technology is a virtual firmware-based switch that allows you to enable meter features through communication, allowing the unit to be upgraded after installation to a higher model without removing the unit from service.

- **Available V-Switch™ Keys**

V-Switch™ key 3 (-V3): Volts, Amps, kW, kVAR, PF, kVA, Freq., kWh, kVAh, kVARh & DNP 3.0
V-Switch™ key 4 (-V4): Volts, Amps, kW, kVAR, PF, kVA, Freq., kWh, kVAh, kVARh, %THD Monitoring, Limit Exceeded Alarms & DNP 3.0

2.1.4: Measured Values

The Shark® 100-S meter provides the following Measured Values all in Real Time and some additionally as Avg, Max and Min values.

Shark 100-S Measured Values				
Measured Values	Real Time	Avg	Max	Min
Voltage L-N	X		X	X
Voltage L-L	X		X	X
Current Per Phase	X	X	X	X
Current Neutral	X			
Watts	X	X	X	X
VAR	X	X	X	X
VA	X	X	X	X
PF	X	X	X	X
+Watt-Hr	X			
- Watt-Hr	X			
Watt-Hr Net	X			
+VAR-Hr	X			
-VAR-Hr	X			
VAR-Hr Net	X			
VA-Hr	X			
Frequency	X		X	X
%THD	X		X	X
Voltage Angles	X			
Current Angles	X			
% of Load Bar	X			

2.1.5: Utility Peak Demand

The Shark® 100-S 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)V ac @50/60Hz or (100 to 370)V dc
- Power Consumption: 16 VA Maximum

■ **Voltage Inputs (Measurement Category III)**

- Range: Universal, Autoranging up to 416V AC L-N, 721V AC 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: 10V AC
- Connection: Screw terminal (Diagram 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, (0-11) Amp
- Class 2: 1A Nominal Secondary, (0-2) Amp
- Burden: 0.005VA Per Phase Max at 11 Amps
- Pickup Current: 0.1% of Nominal
- Connections: Screw terminal - #6-32 screws (Diagram 4.1)
- Fault Withstand: 20A/10sec., 60A/3sec., 100A/1sec.
- Reading: Programmable Full Scale to any CT Ratio

■ **Isolation**

- All Inputs and Outputs are galvanically isolated and tested to 2500V AC

■ **Environmental Rating**

- Storage: $(-40 \text{ to } +85)^0$ C
- Operating: $(-30 \text{ to } +70)^0$ C
- Humidity: to 95% RH Noncondensing
- Faceplate Rating: NEMA12 (Water Resistant)

■ Measurement Methods

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

■ Update Rate

- Watts, VAR and VA: 100 milliseconds (Ten times per second)
- All other parameters: 1 second

■ Communication Format

1. RS485
2. IrDA Port through Face Plate

- Protocols: Modbus RTU, Modbus ASCII, DNP 3.0, Modbus TCP (Ethernet)
- Com Port Baud Rate: 9600 to 57,600 b/s
- Com Port Address: 001-247
- Data Format: 8 Bit, No Parity

■ Wireless Ethernet (Optional)

- 802.11b Wireless or 10/100BaseT Ethernet WiFi or RJ-45 Connection
- 128 bit WEP Encryption 128 bit Wireless Security
- Modbus TCP Protocol

■ Mechanical Parameters

- Dimensions: (H7.9 x W7.6 x D3.2) inches, (H200.1 x W193.0 x D81.3) mm
- Weight: 4 pounds

2.3: Compliance

- IEC 687 (0.2% Accuracy)
- ANSI C12.20 (0.2% Accuracy)
- ANSI (IEEE) C37.90.1 Surge Withstand
- ANSI C62.41 (Burst)
- IEC1000-4-2: ESD
- IEC1000-4-3: Radiated Immunity
- IEC1000-4-4: Fast Transient
- IEC1000-4-5: Surge Immunity
- UL Listed

Meter Accuracy by Measured Parameters

Measured Parameters	Accuracy % of Reading*	Display Range
Voltage L-N	0.1%	0-9999 V or kV Autoscale
Voltage L-L	0.1%	0-9999 V or kV Autoscale
Current Phase	0.1%	0-9999 A or kA Autoscale
Current Neutral (Calculated)	2.0% F.S.	0-9999 A or kA Autoscale
+/- Watts	0.2%	0-9999 Watts, kWatts, MWatts
+/- Wh	0.2%	5 to 8 Digits Programmable
+/- VARs	0.2%	0-9999 VARs, kVARs, MVARs
+/- VARh	0.2%	5 to 8 Digits Programmable
VA	0.2%	0-9999 VA, kVA, MVA
VAh	0.2%	5 to 8 Digits Programmable
PF	0.2%	+/- 0.5 to 1.0
Frequency	+/- 0.01 Hz	45 to 65 Hz
% THD	2.0% F.S.	0 to 100%
% Load Bar	1 - 120%	10 Segment Resolution Scalable

* Accuracy stated for 5 amp secondary WYE or Delta connections. For 1 amp secondary or 2.5 element connections, add 0.1% of Full Scale + 1 digit to accuracy specification.

Chapter 3
Mechanical Installation

3.1: Overview

- The Shark® 100-S meter can be installed on any wall The various models use the same installation. See Chapter 4 for wiring diagrams.

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

3.2: Install the Base

1. Determine where you want to install the submeter.

2. Then, 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.

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.

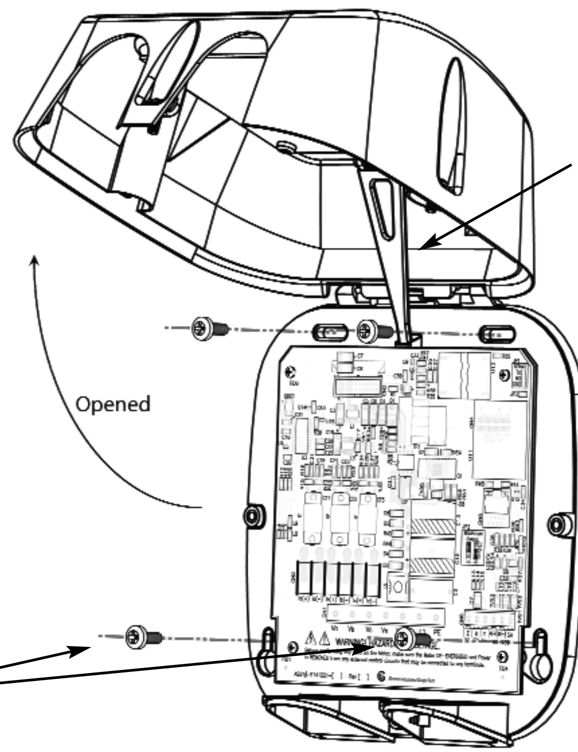


Figure 3.1: Shark® 100-S Meter Opened

3. Find the 4 Installation Slots and insert screws through each slot into the wall or panel. Fasten securely. DO NOT overtighten.

3.2.1: Mounting Diagrams

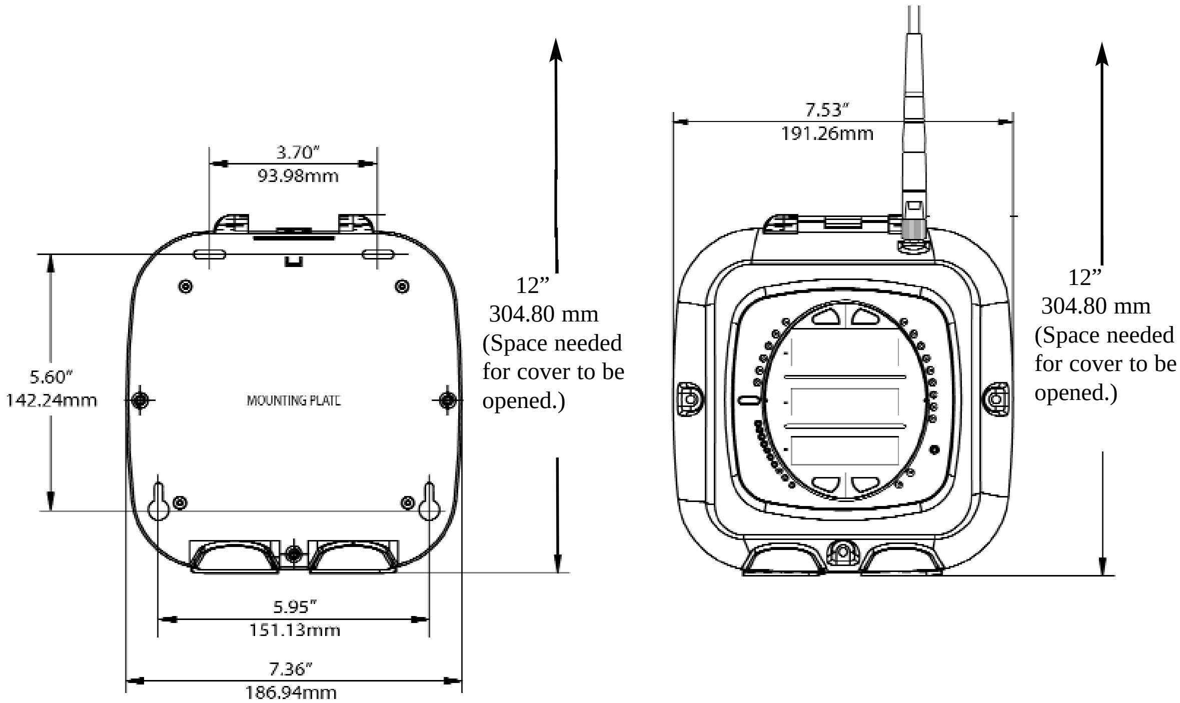


Figure 3.2: Mounting Dimensions

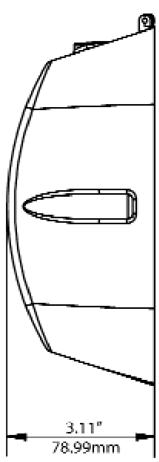


Figure 3.3: Side View

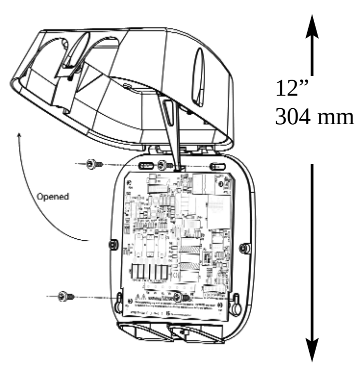


Figure 3.4: Open Cover View

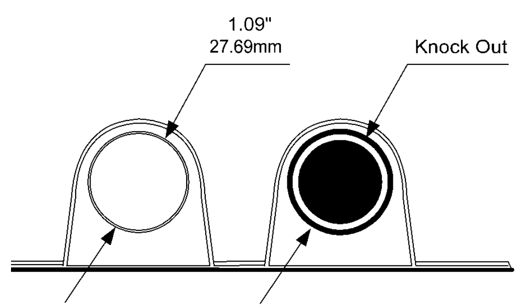


Figure 3.5: Bottom View with Access Holes

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.

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).

   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.

3. Reattach the antenna, if appropriate.

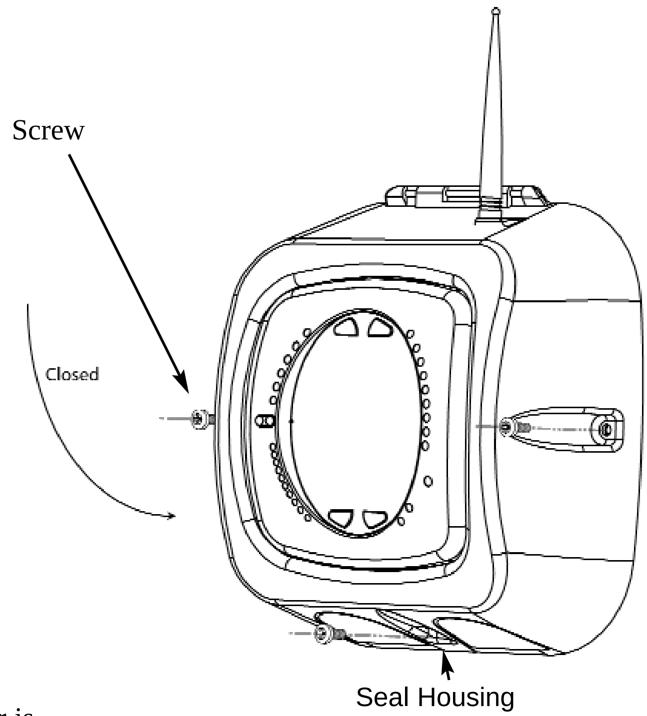


Figure 3.5: Shark® 100-S Meter Closed

■ **Recommended Tools for Shark® 100-S Meter Installation:** #2 Phillips screwdriver and wire cutters.

Chapter 4
Electrical Installation

4.1: Considerations When Installing Meters

- Installation of the Shark® 100-S meter must be performed by only qualified personnel who follow standard safety precautions during all procedures. Those personnel should have appropriate training and experience with high voltage devices. Appropriate safety gloves, safety glasses and protective clothing are recommended.

- During normal operation of the Shark® 100-S meter, dangerous voltages flow through many parts of the meter, including: Terminals and any connected CTs (Current Transformers) and PTs (Potential Transformers), all I/O Modules (Inputs and Outputs) and their circuits. All Primary and Secondary circuits can, at times, produce lethal voltages and currents. Avoid contact with any current-carrying surfaces.

- Do not use the meter or any I/O Output Device for primary protection or in an energy-limiting capacity. The meter can only be used as secondary protection. Do not use the meter for applications where failure of the meter may cause harm or death. Do not use the meter for any application where there may be a risk of fire.

- All meter terminals should be inaccessible after installation.

- Do not apply more than the maximum voltage the meter or any attached device can withstand. Refer to meter and/or device labels and to the Specifications for all devices before applying voltages. Do not HIPOT/Dielectric test any Outputs, Inputs or Communications terminals.

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

NOTE: IF THE EQUIPMENT IS USED IN A MANNER NOT SPECIFIED BY THE MANUFACTURER, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED.

NOTE: 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.

4.2: Electrical Connections

- All wiring for the Shark® 100-S meter 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.

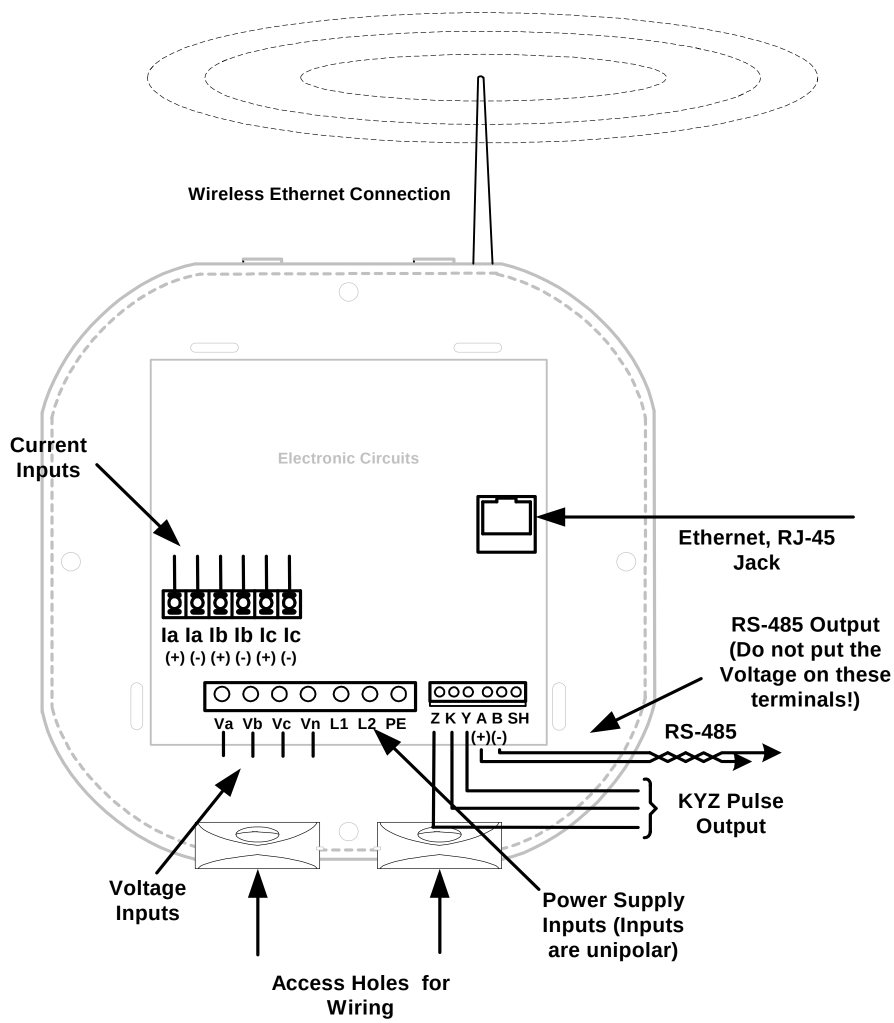


Figure 4.1: Submeter Connections

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

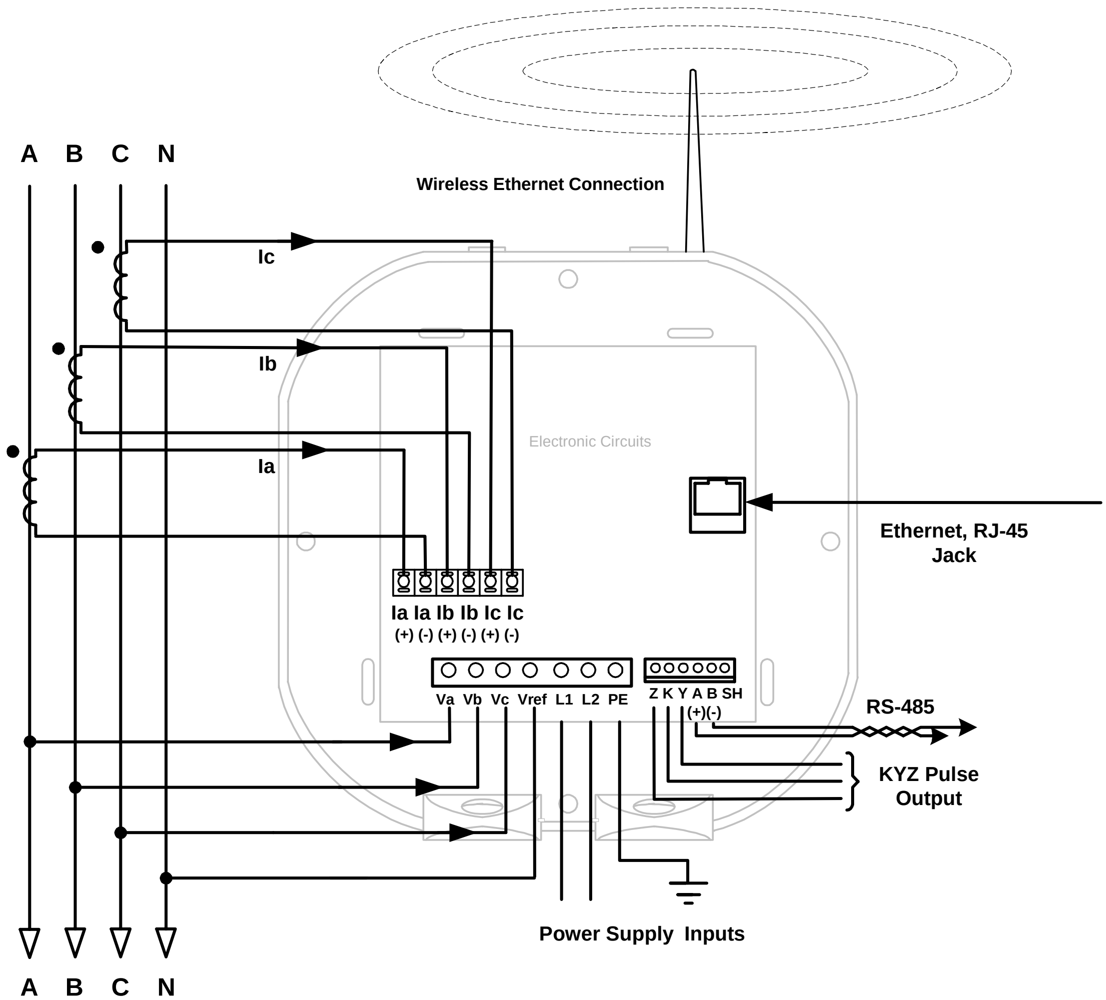
Use a 0.1 Amp fuse on each voltage input.
Use a 3 Amp fuse on the power supply.

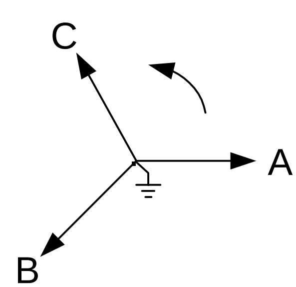
4.5: Electrical Connection Diagrams

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
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)

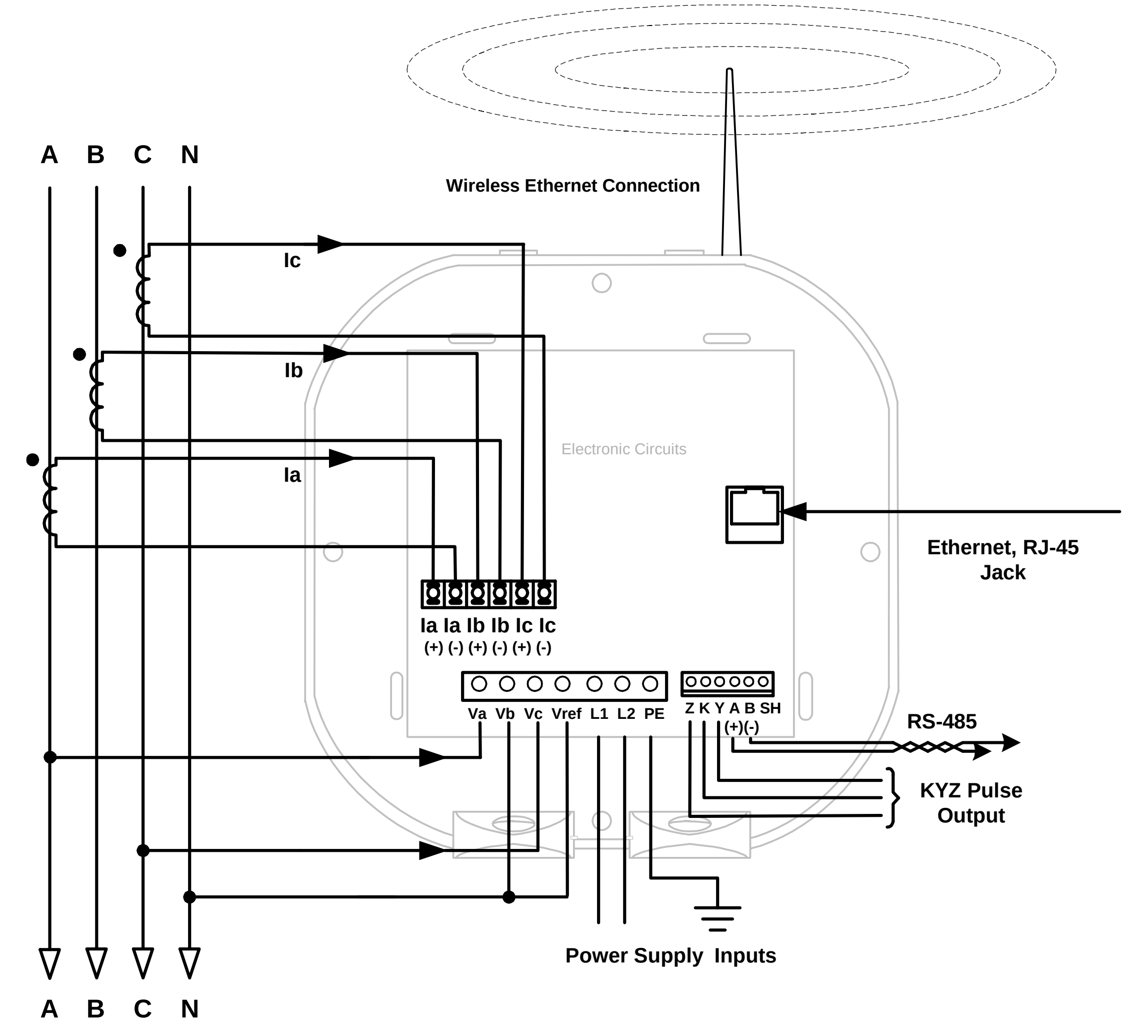
1. Service: WYE, 4-Wire with No PTs, 3 CTs

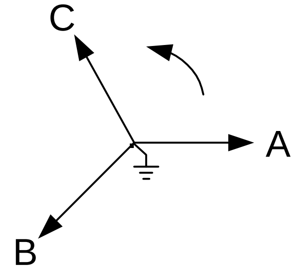




Select: “3 EL WYE” (3 Element Wye) in Meter Programming setup.

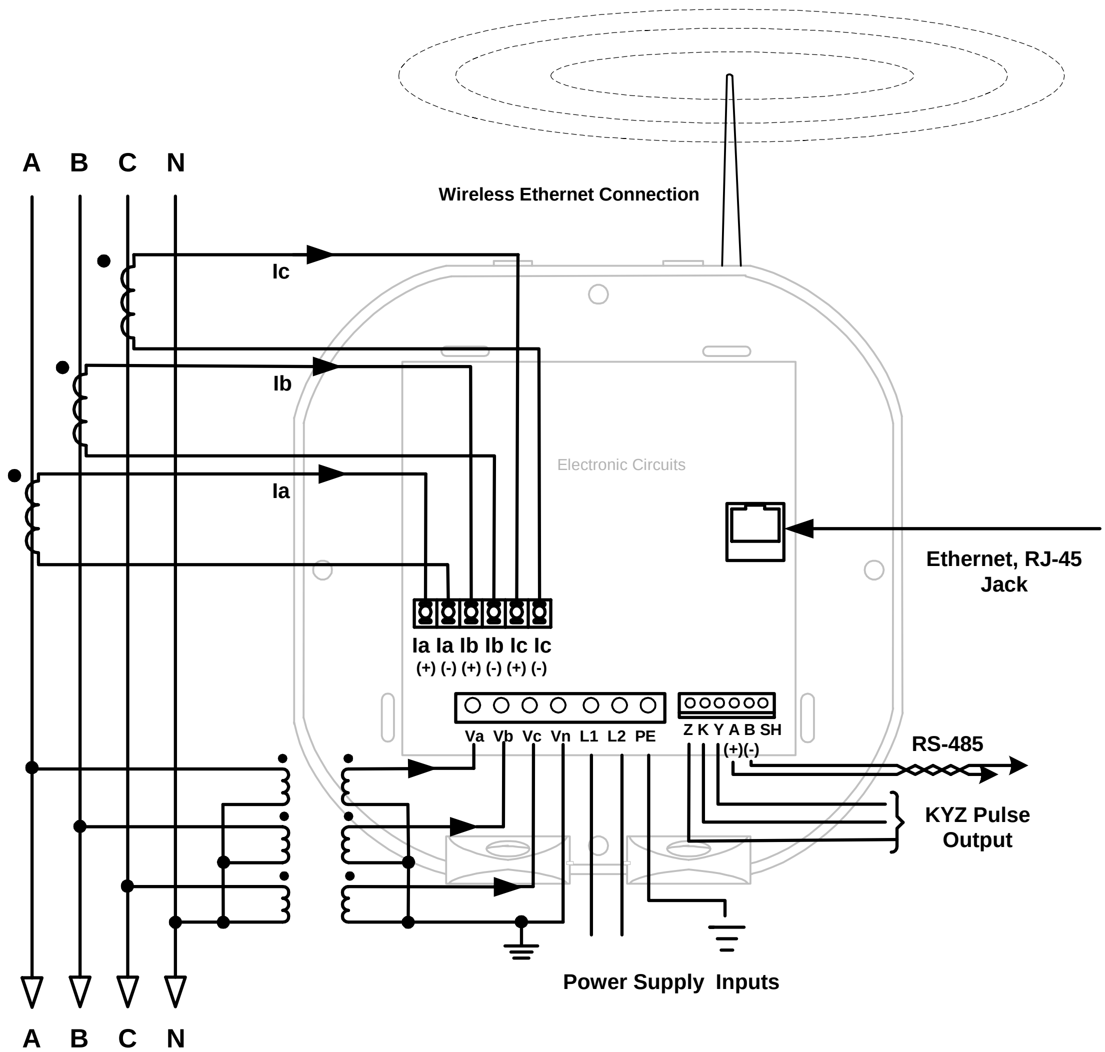
2. Service: 2.5 Element WYE, 4-Wire with No PTs, 3 CTs

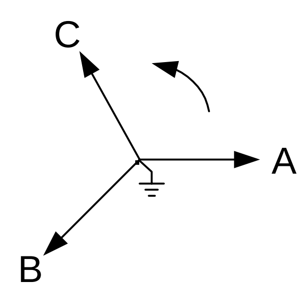




Select: “2.5 EL WYE” (2.5 Element Wye) in Meter Programming setup.

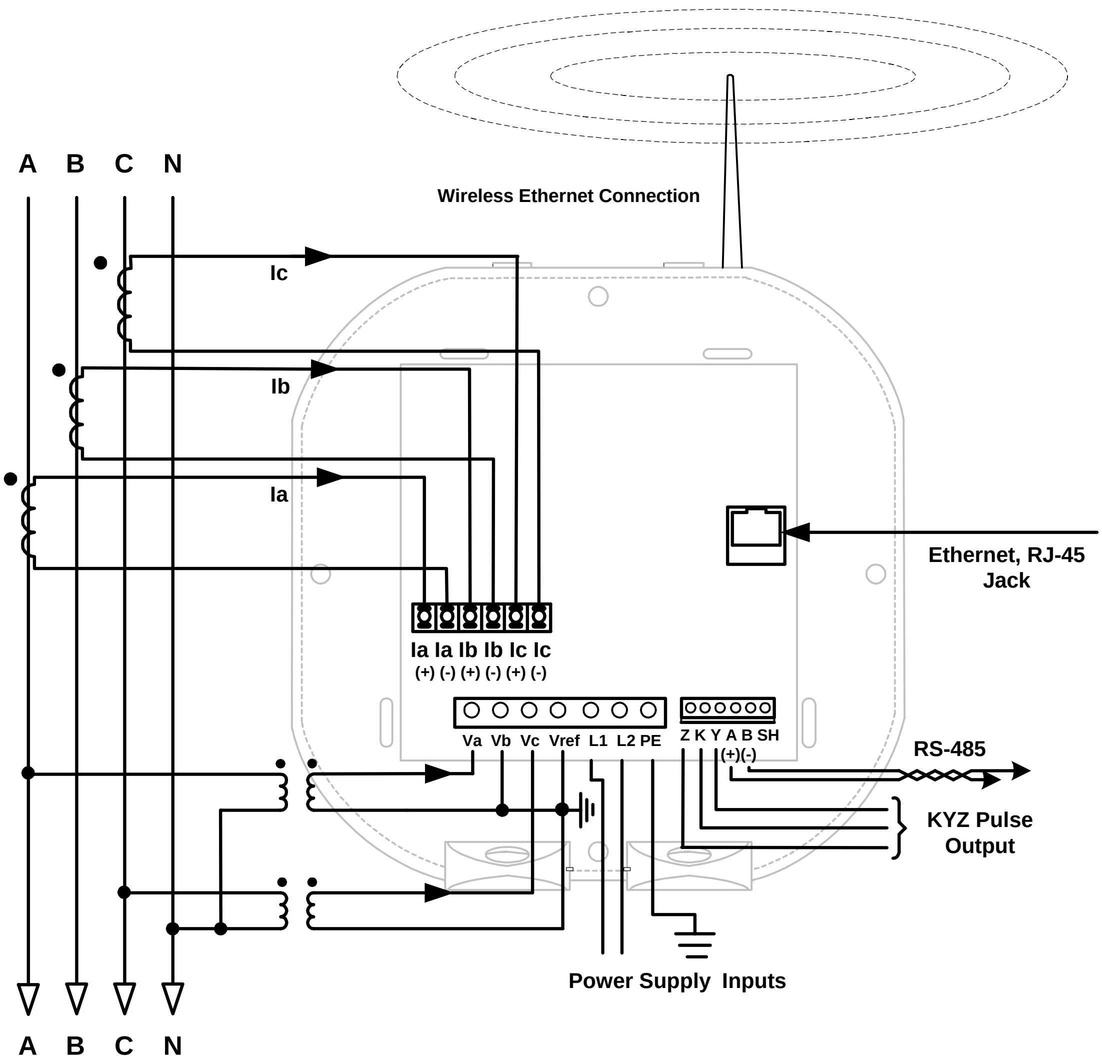
3. Service: WYE, 4-Wire with 3 PTs, 3 CTs

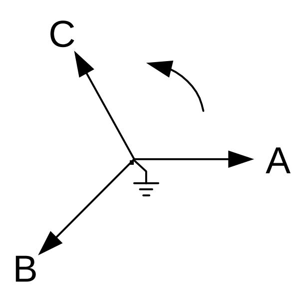




Select: “3 EL WYE” (3 Element Wye) in Meter Programming setup.

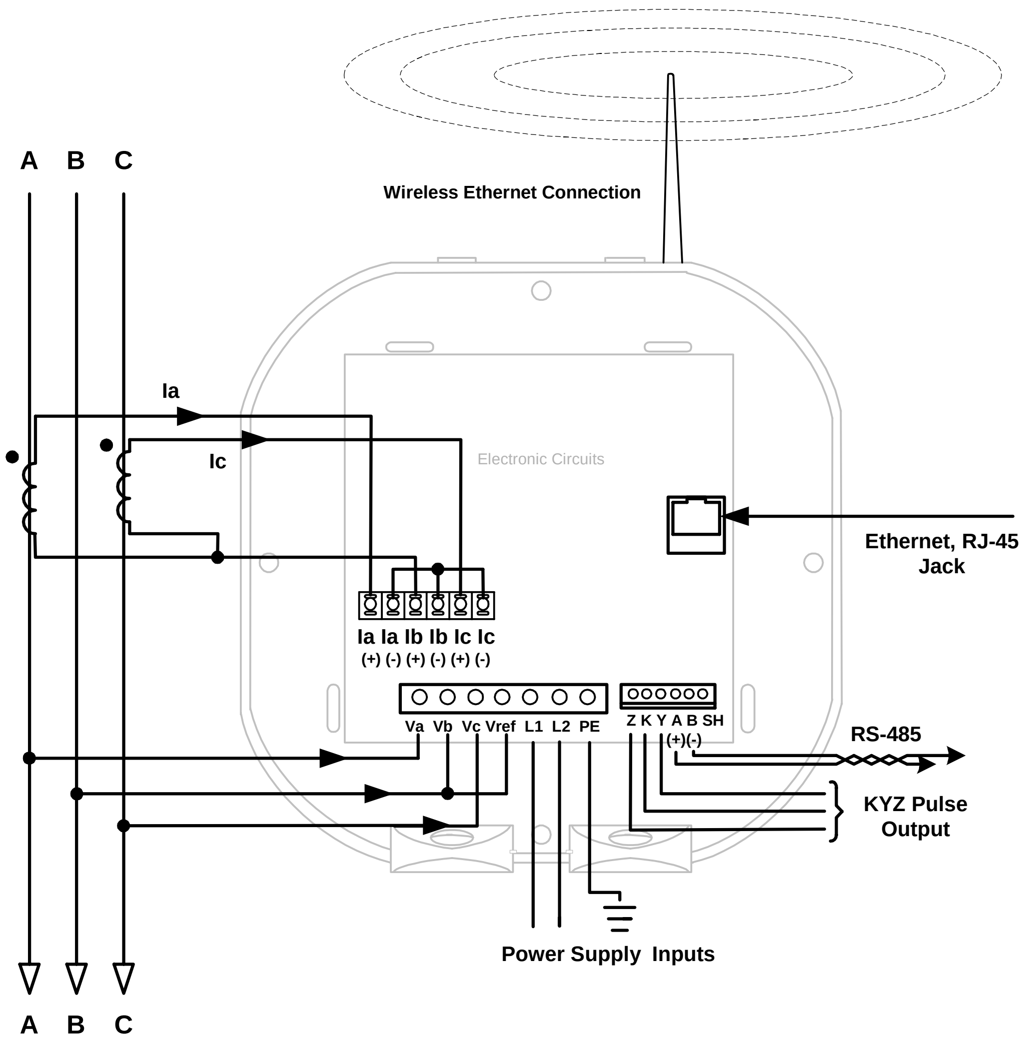
4. Service: 2.5 Element WYE, 4-Wire with 2 PTs, 3 CTs

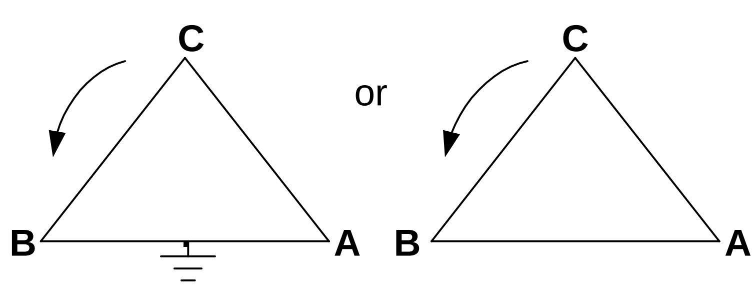




Select: "2.5 EL WYE" (2.5 Element Wye) in Meter Programming setup.

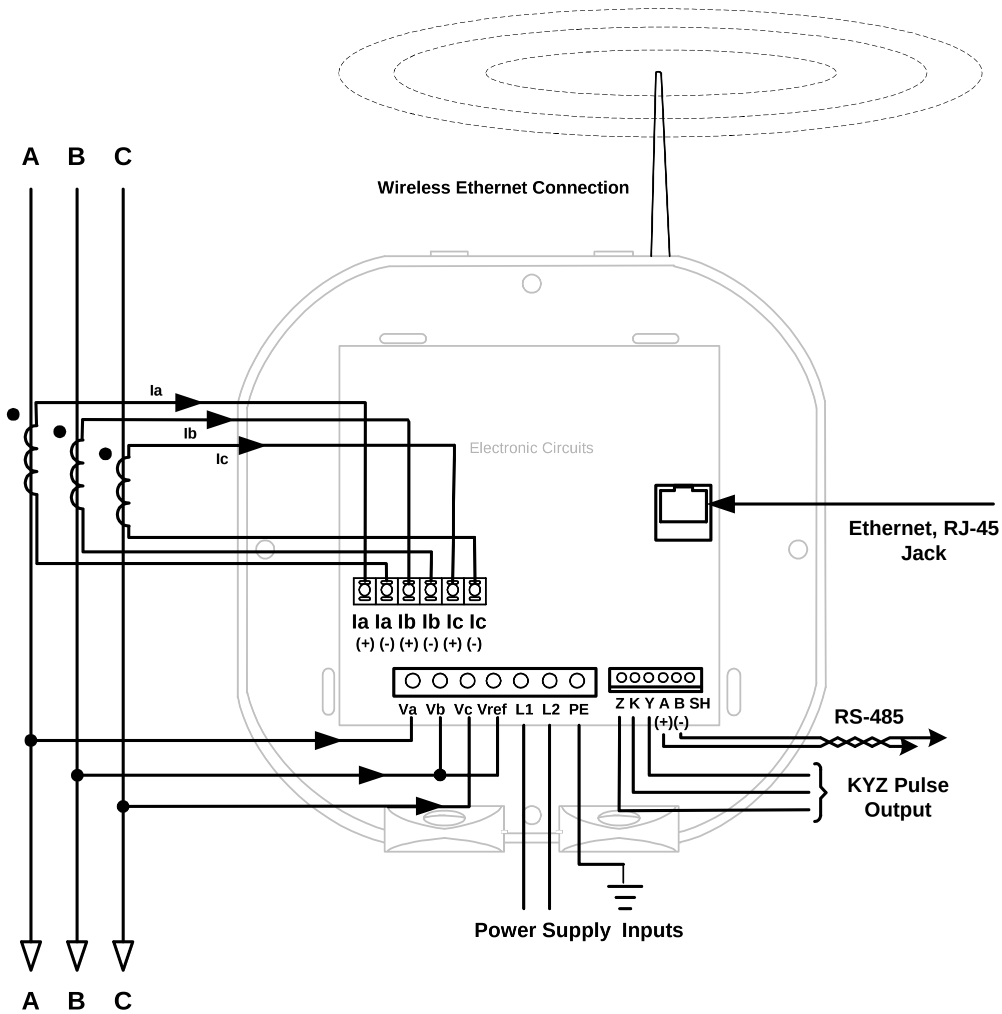
5. Service: Delta, 3-Wire with No PTs, 2 CTs

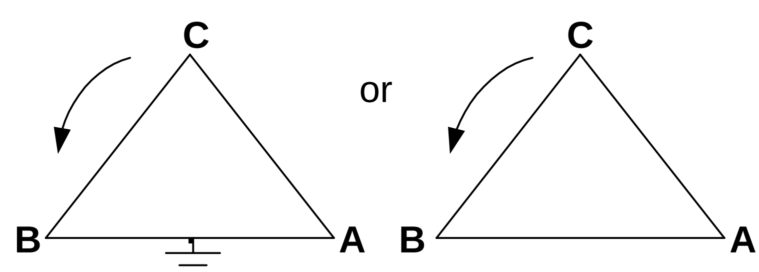




Select: "2 Ct dEL" (2 CT Delta) in Meter Programming setup.

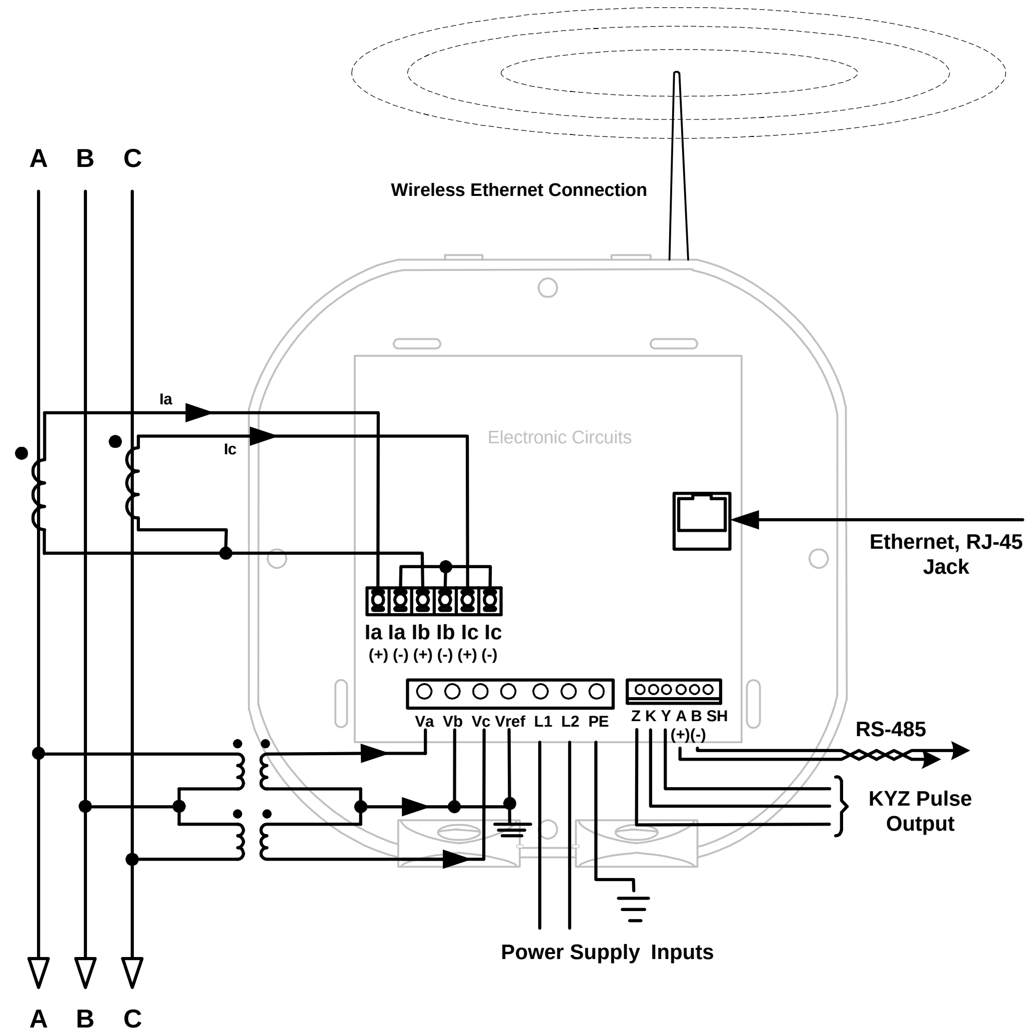
6. Service: Delta, 3-Wire with No PTs, 3 CTs

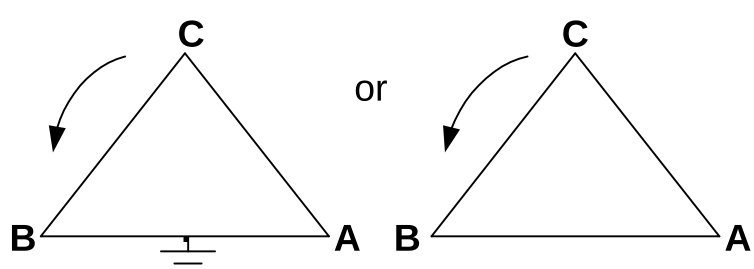




Select: “2 Ct dEL” (2 CT Delta) in Meter Programming setup.

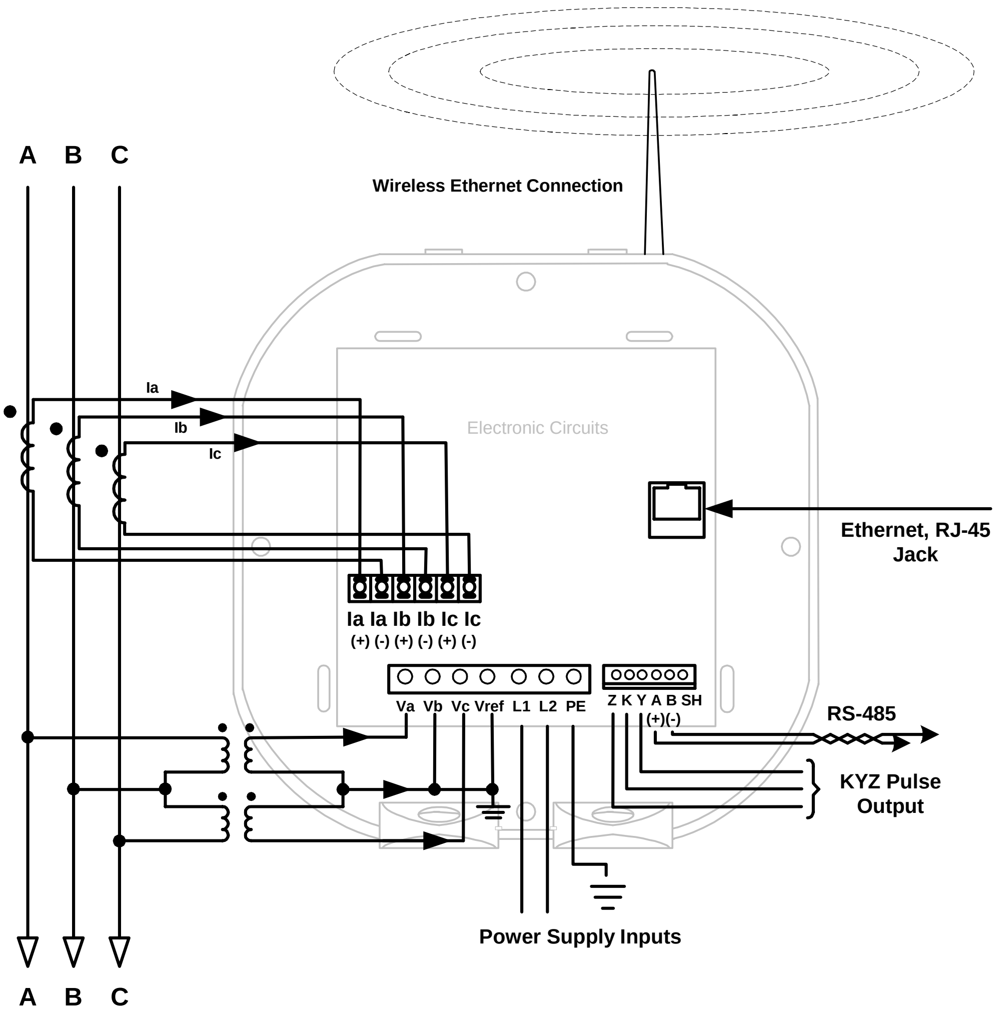
7. Service: Delta, 3-Wire with 2 PTs, 2 CTs

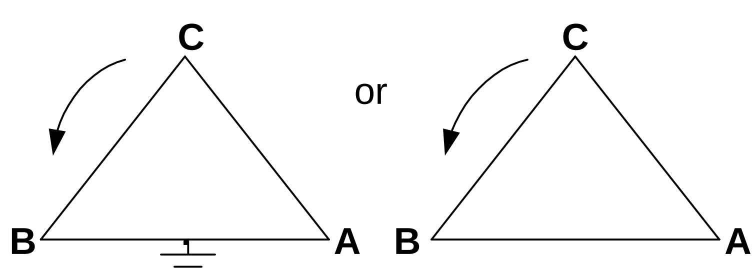




Select: "2 Ct dEL" (2 CT Delta) in Meter Programming setup.

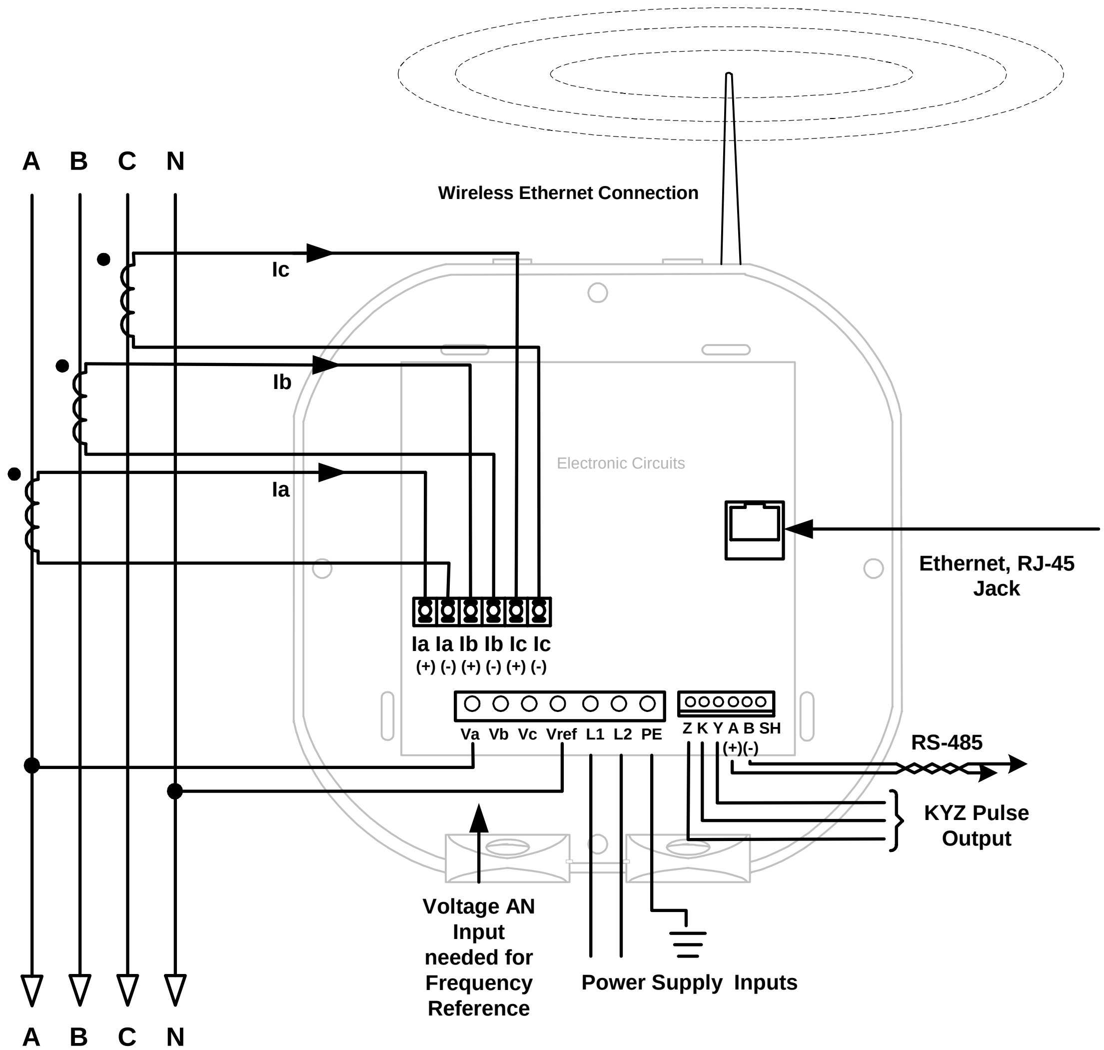
8. Service: Delta, 3-Wire with 2 PTs, 3 CTs





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

9. Service: Current Only Measurement (Three Phase)

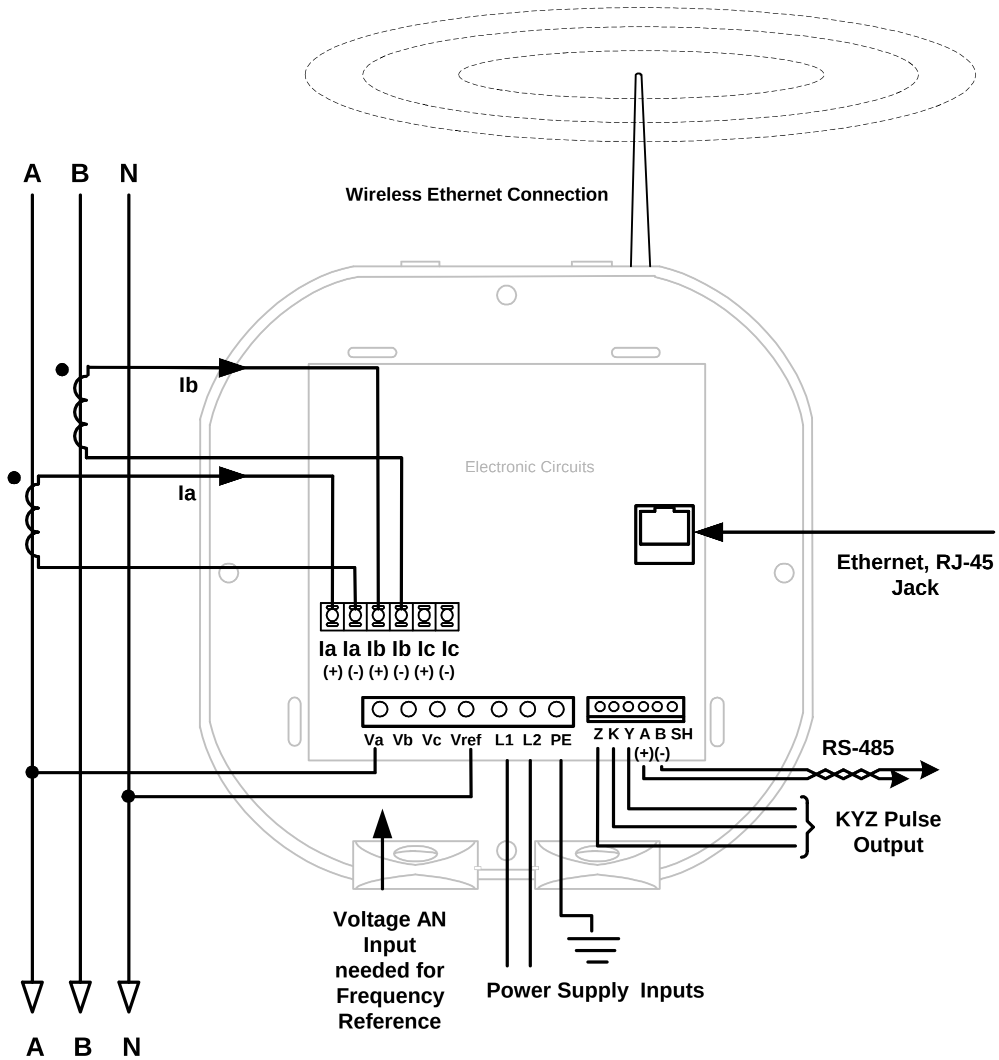


Select: “3 EL WYE” (3 Element Wye) in Meter Programming setup.

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)

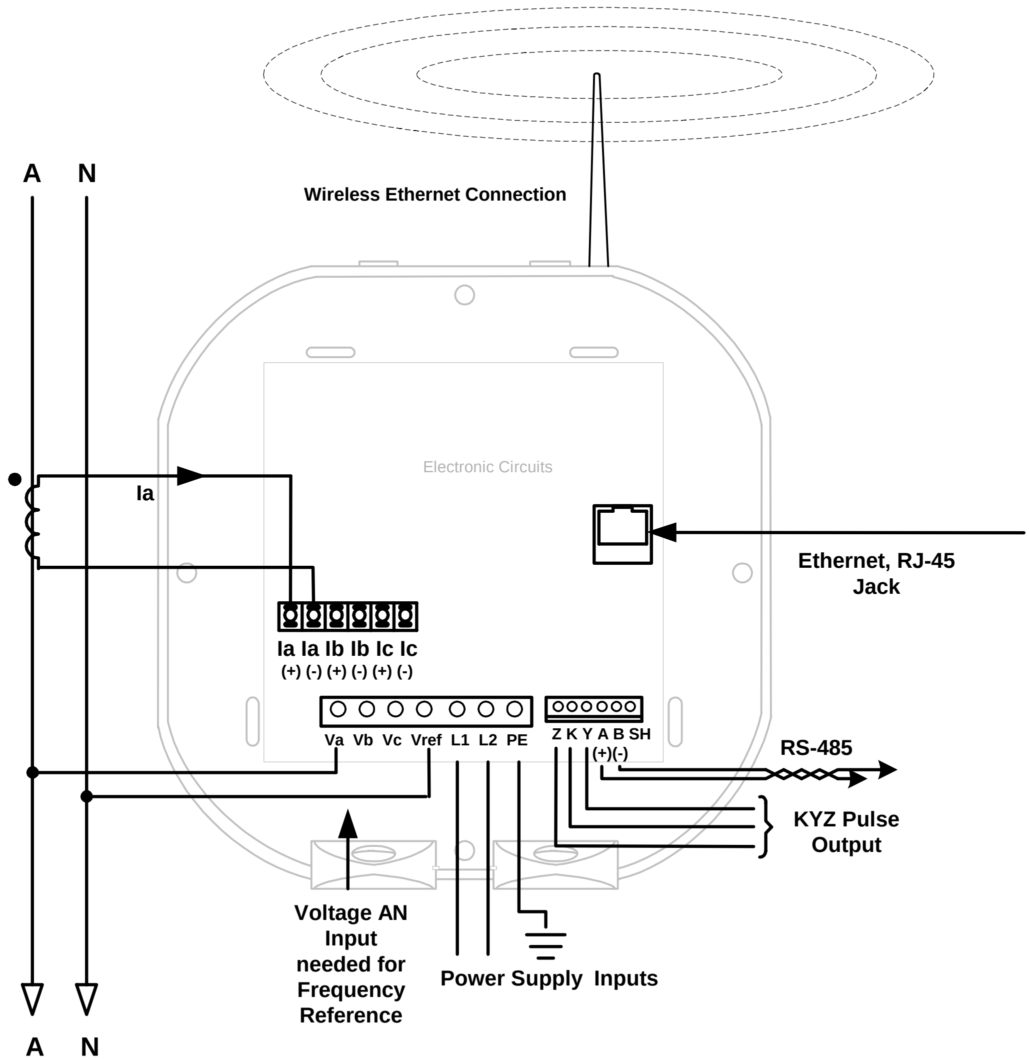


Select: “3 EL WYE” (3 Element Wye) in Meter Programming setup.

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.

Chapter 5
Communication Installation

5.1: Shark® 100-S Communication

■ The Shark® 100-S submeter provides two independent Communication Ports plus KYZ Pulse Output. (For information on Ethernet configuration, see Chapter 6.) The first port, Com 1, is an IrDA Port, which uses Modbus ASCII. The second port, Com 2, provides RS-485 or RJ-45 Ethernet or WI-FI Ethernet Communication.

5.1.1: IrDA Port (Com 1)

■ The Shark® 100-S submeter's Com 1 IrDA Port is 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, including a PDA with CoPilot, some laptops and USB/IrDA wands (such as the USB to IrDA Adapter [CAB6490] described in Appendix E). Just point at the meter with an IrDA-equipped PC or PDA and configure it.

■ Communicator EXT CoPilot is a Windows Mobile software package for a PDA that can communicate with the meter to configure settings and poll readings. Refer to the Communicator EXT User's Manual for details on programming and accessing readings.

■ IrDA port settings are:

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

Figure 5.1: Simultaneous Dual Communication Paths

5.1.1.1: USB to IrDA Adapter

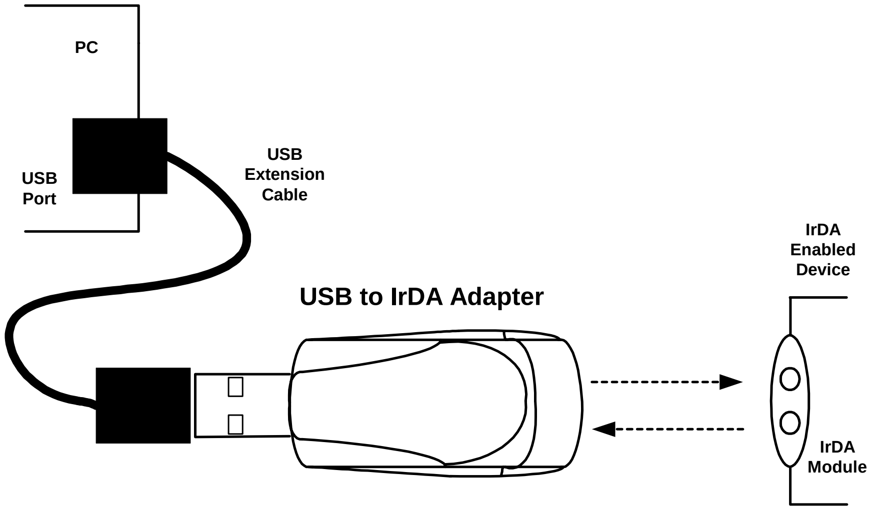


Figure 5.2: USB to IrDA Adapter

- 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 Shark. 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.

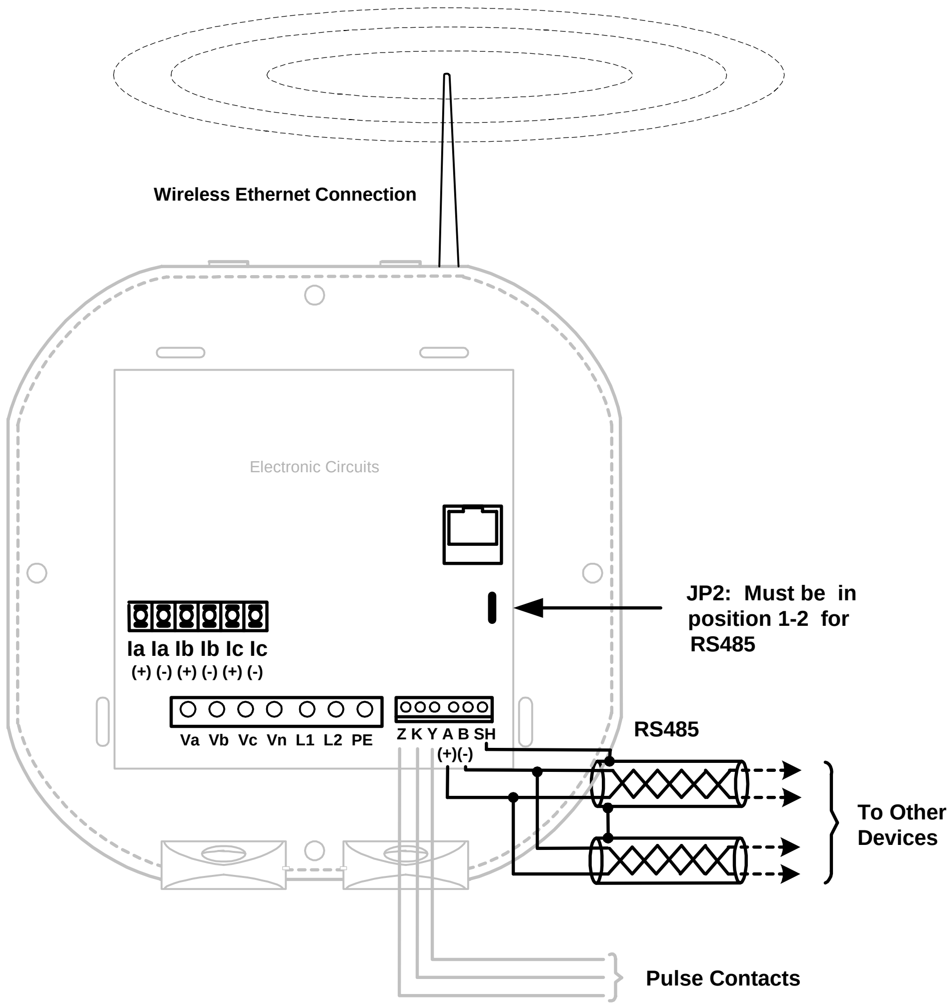
- **System Requirements:** IBM PC 100 MHz or higher (or compatible system), available USB port, CD-ROM drive, Windows® 98, ME, 2000 or XP.

- See Appendix E for instructions on using the USB to IrDA Adapter.

5.1.2: RS485 Communication Com 2 (485 Option)

■ The Shark® 100-S 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.

■ Care should be taken to connect + to + and - to - connections.



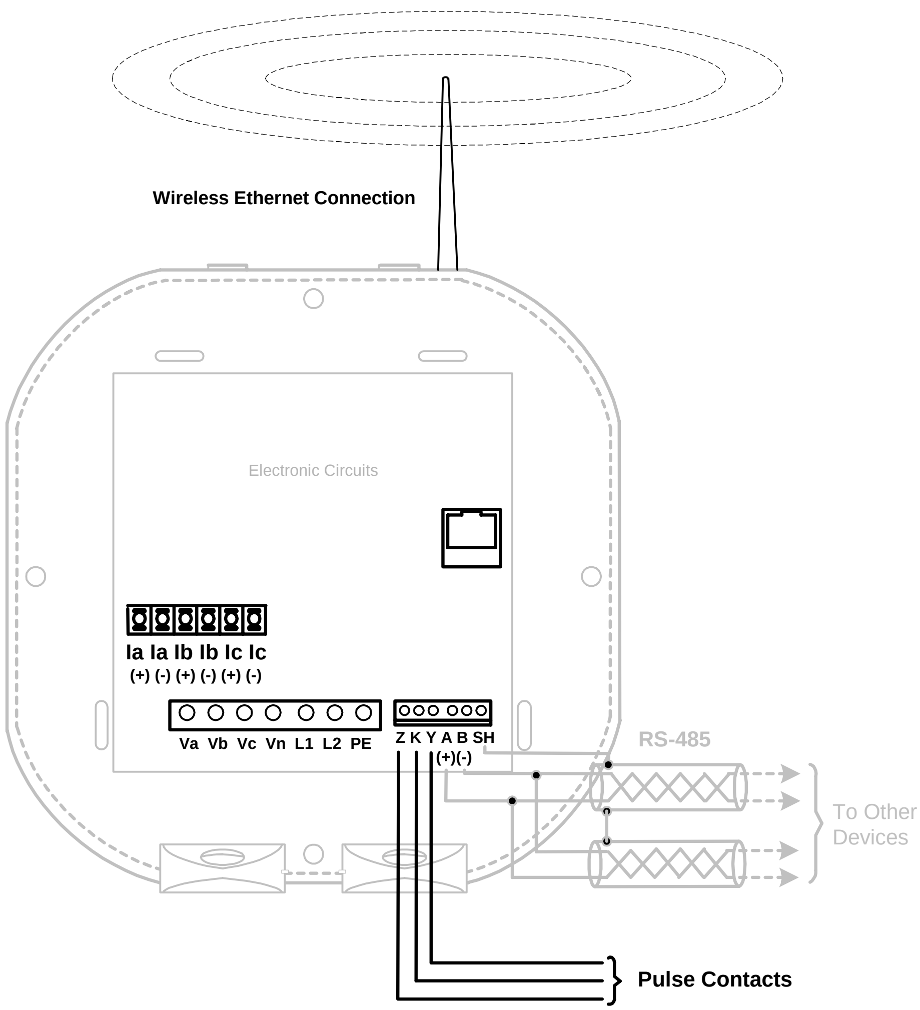
■ The Shark® 100-S submeter's RS485 can be programmed with the buttons on the face of the meter or by using Communicator EXT software.

Standard RS485 Port Settings:

Address:	001 to 247
Baud Rate:	9.6, 19.2, 38.4 or 57.6
Protocol:	Modbus RTU, Modbus ASCII, DNP 3.0

5.1.3: KYZ Output

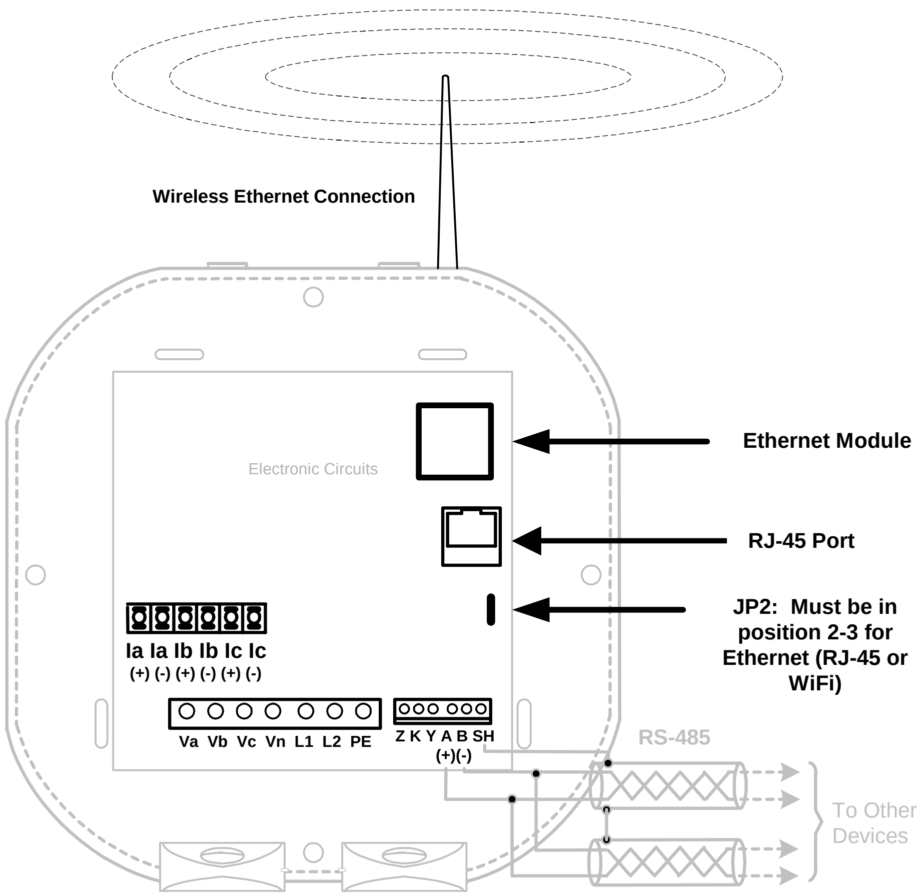
- The KYZ Pulse Output provides pulsing energy values that verify the submeter's readings and accuracy.
- The KYZ Pulse Output is located on the face of the meter, under the cover and just below the RS485 connection.
- See section 2.2 for the KYZ Output Specifications.
  See section 7.3.1 for Pulse Constants.



5.1.4: Ethernet Connection

In order to use the Ethernet capability of the Shark® 100-S submeter, 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 Wi-Fi.

- For wired Ethernet, use Standard RJ-45 10/100Base T cable to connect to the Shark® 100-S submeter. The RJ-45 line is inserted into the RJ-45 Port of the meter.
- For Wi-Fi connections, make sure you have the correct antenna attached to the meter.



Refer to Chapter 6 of this manual, *Ethernet Configuration*, for instructions on how to set up the Network Module for the Shark® 100-S Submeter.

5.2: Meter Communication and Programming Overview

- Programming and communication can utilize the RS485 connection as shown in Section 5.1.2 or the RJ-45/Wi-Fi connection as 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(-).

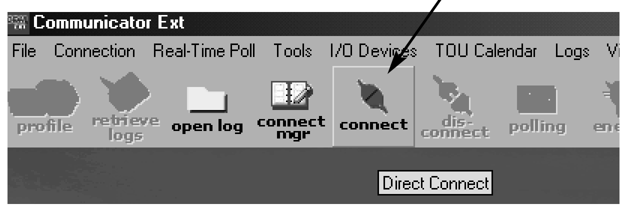
The RS485 cable attaches to SH, B(-) and A(+) as shown in Section 5.1.2.

5.2.1: How to Connect

Connect Button

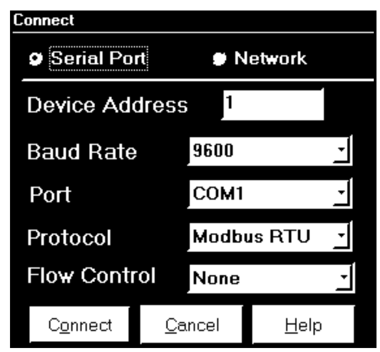
1. Open **Communicator EXT** software.

2. Click the **Connect** button on the Icon bar.

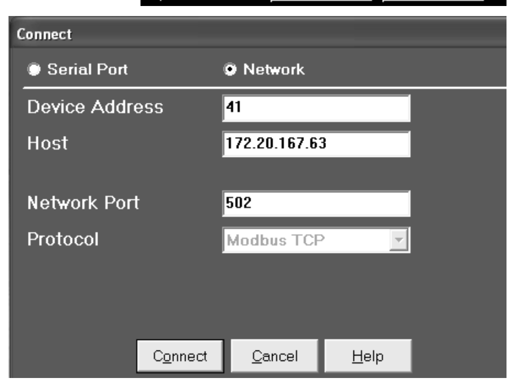


The **Connect** screen opens, showing the Initial settings. Make sure your settings are the same as those shown here. **NOTE:** The settings you make will depend on whether you are connecting to the meter via Serial Port or Network. Use the pull-down windows to make any necessary changes.

Serial Port Connection



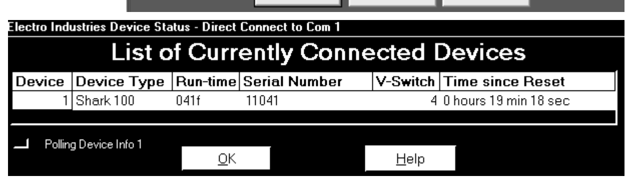
Network Connection



3. Click the **Connect** button on the screen. You may have to Disconnect power, Reconnect power and then click Connect.

The **Device Status** screen appears, confirming a connection.

Click **OK**.



The main screen of Communicator EXT software reappears.

Profile
Button

4. Click the **Profile** button on the toolbar.

You will see the Shark® meter's **Profile** screen.

5.2.2: Shark® Meter Device Profile Settings

Click the tabs to access the settings for the Shark® meter's Device Profile.

- **Communication Settings**

  COM1 (IrDA)

  Response Delay (0-750 msec)

  COM2:

  (For RS485)

  Address (1-247)

  Protocol (Modbus RTU, ASCII or DNP)

  Baud Rate (9.6 to 57.6)

  Response Delay (0-750 msec)

  (For Ethernet)

  Address (1)

  Protocol (Modbus RTU)

  Baud Rate (57600)

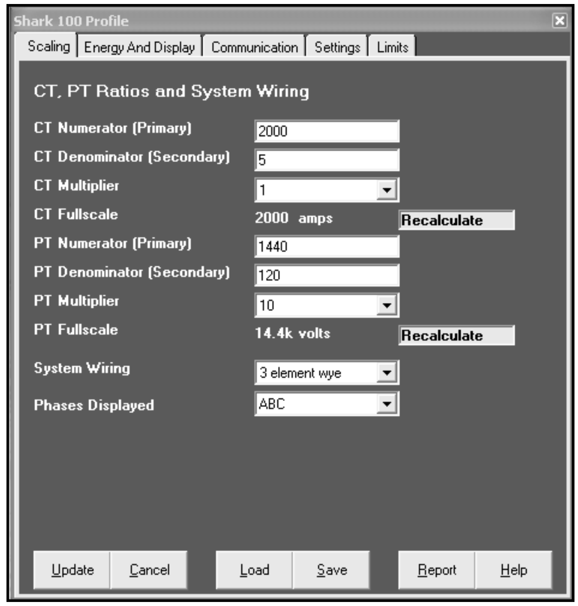
  Response Delay (No Delay)

  Use pull-down menus to change settings, if desired.

6. When changes are complete, click the **Update** button to send the new profile to the Shark® meter.

7. Click **Cancel** to exit the Profile; click other tabs to update other settings of the Profile.

- **Scaling (CT, PT Ratios and System Wiring)**
  CT Numerator:
  CT Denominator:
  CT Multiplier:
  CT Face Plate Value:
  Calculation Based on Selections
  PT Numerator:
  PT Denominator:
  PT Multiplier:
  PT Face Plate Value
  Calculation Based on Selections
  System Wiring:
  Number of Phases: One, Two or Three



NOTE: VOLTS FULL SCALE = PT Numerator x PT Multiplier

Example:

A 14400/120 PT would be entered as:

Pt Numerator	1440
Pt Denominator	120
Pt Multipler	10

This example would display a 14.40kV.

WARNING: You must specify Primary and Secondary Voltage in Full Scale. Do not use ratios!

- **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:**

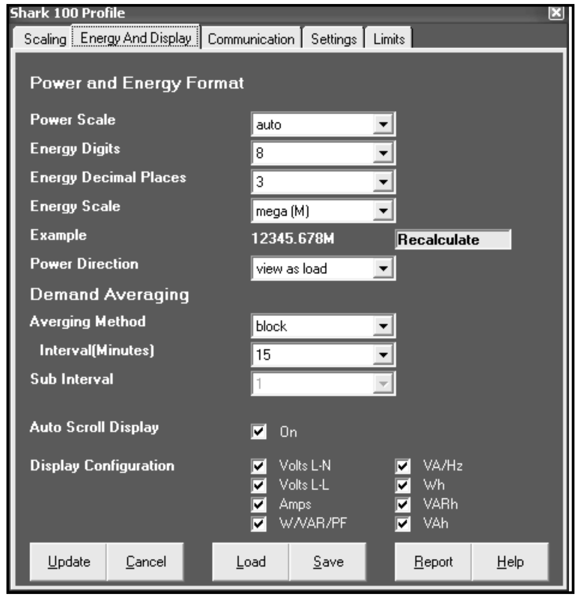
277/277 Volts	Pt-n value is 277, Pt-d value is 277, Pt-Multiplier value is 1.
14,400/120 Volts:	Pt-n value is 1440, Pt-d value is 120, Pt-Multiplier value is 10.
138,000/69 Volts:	Pt-n value is 1380, Pt-d value is 69, Pt-Multiplier value is 100.
345,000/115 Volts:	Pt-n value is 3450, Pt-d value is 115, 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.

- **Energy and Display**
  Power and Energy Format
  Power Scale
  Energy Digits
  Energy Decimal Places
  Energy Scale
  (Example Based on Selections)
  Power Direction: View as Load
  Demand Averaging
  Averaging Method: Block or Rolling
  Interval (Minutes)
  Sub Interval

  Auto Scroll: Click to Activate

  Display Configuration:
  Click Values to be displayed.
  NOTE: You MUST have at lease ONE selected.

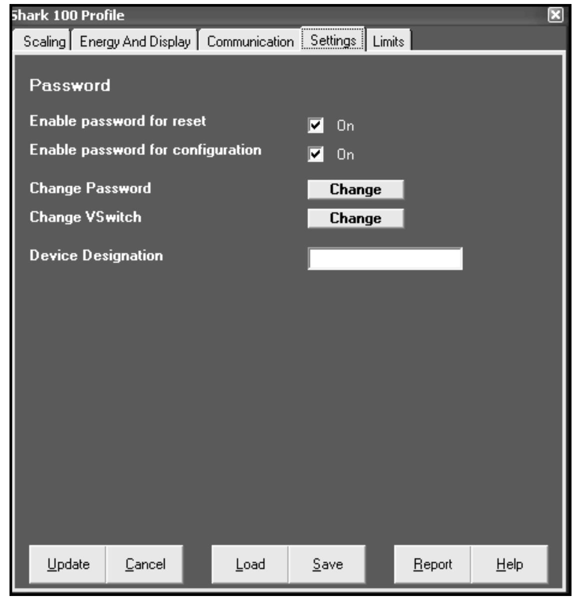


NOTE: If incorrect values are entered on this screen the following message appears:
WARNING: Current, CT, PT and Energy Settings will cause invalid energy accumulator values. Change the inputted settings until the message disappears.

- **Settings**
  Password
  (Meter is shipped with Password Disabled and there is NO DEFAULT PASSWORD)
  Enable Password for Reset
  Enable Password for Configuration
  Change Password

  Change VSwitch
  (Call Electro Industries for Update Information)

  Change Device Designation



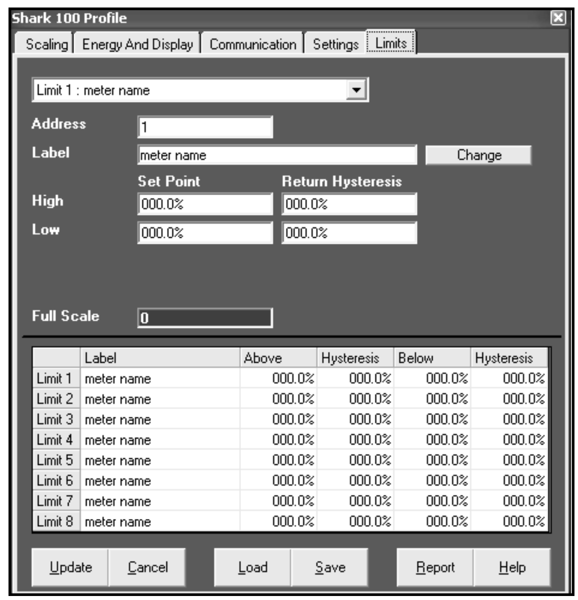
- **Limits (VSwitch™ Key 4 Only)**
  For up to 8 Limits, Set:
  Address: Modbus Address (1 based)
  Label: Your Designation
  High Set Point: % of Full Scale
  Example: 100% of 120VFS = 120V
  90% of 120V FS = 108V

  Return Hysteresis: Point to go back in Limit
  Example: High Set Point = 110%
  (Out of Limit at 132V)
  Return Hysteresis = 105%
  (Stay Out until 126V)

  Low Set Point: % of Full Scale
  Return Hysteresis: Point to go back in Limit

  Settings appear in the Table at the bottom of the screen

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



Click **Update** to send a new Profile.
NOTE: If the Update fails, the software will ask you if you want to try again to Update.
Click **Cancel** to Exit the Profile.

Use Communicator EXT to communicate with the device and perform required tasks.

NOTE: Refer to the *Communicator EXT User's Manual* for more details and additional instructions.

Chapter 6
Ethernet Configuration

6.1: Introduction

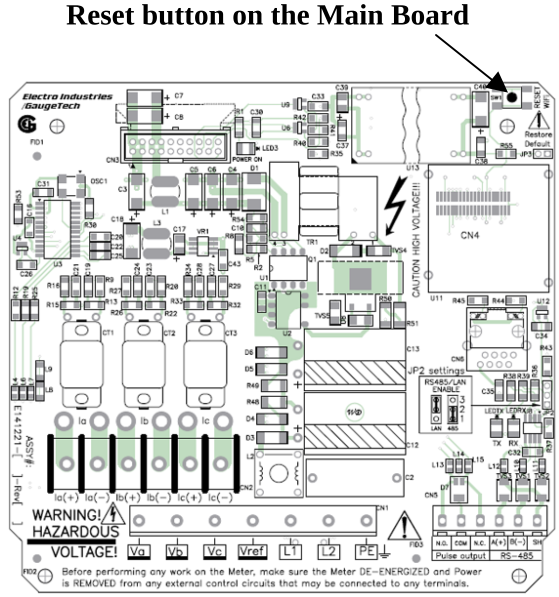
■ The Shark® 100-S submeter has an option for a Wi-Fi (Wireless) or RJ-45 Ethernet connection. This option allows the submeter to be set up for use in a LAN (Local Area Network), using standard Wi-Fi base stations. Configuration for these connections is easily accomplished through your PC using Telnet connections. Then you can access the submeter to perform meter functions directly through any computer on your LAN: the Shark® 100-S meter does not need to be directly connected (wired) to these computers for it to be accessed.

This chapter outlines the procedures you use to set up the Shark® 100-S submeter to function via its Ethernet configuration.

IMPORTANT!

- **These instructions are for Shark® 100-S meters that have a Reset button, located on the main board**. You can easily tell whether or not your meter has a Reset button: open the front cover of the Shark® 100-S meter. The **Reset** button is located at the top, right of the main board. Refer to the figure below.
- **Some earlier versions of the Shark® 100-S meter are not equipped with a Reset button**. The instructions for Ethernet configuration are slightly different for these meters. If your meter does not have a Reset button, please call EIG's Technical Support department (at 516-334-0870) to obtain configuration instructions for your meter's Ethernet connection.

Reset button on the Main Board



6.2: Factory Default Settings

The settings shown in Section 6.2.1 are the default settings for your Shark® 100-S meter: they are the settings programmed into your meter when it is shipped to you. You may need to modify some of these settings when you set up your Ethernet configuration.

NOTES:

- **Change Settings 1 and 6 ONLY. Settings 2, 3, and 4 must be the same as shown in Section 6.2.1.** If they are not, reset them to the values shown in Section 6.2.1.
- If setting 3 is not **CP0..! Defaults (In)**, the procedure for Network Module Hardware Initialization (Section 6.3.4) will not work.

6.2.1: Modbus/TCP to RTU Bridge Setup

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) 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……………. AdHoc, Country: US, Channel: 11
   Security……………… none
   TX Data rate………… 11 Mbps auto fallback
   Power management….. not supported in ad hoc mode

D)efault settings, S)ave, Q)uit without save
Select Command or parameter set (1..6) to change:

6.3: Configure Network Module

These procedures detail how to set up the Shark® 100-S meter on the Network Module.

Only one person at a time can be logged into the network port. This eliminates the possibility of several people trying to configure the Ethernet interface simultaneously.

6.3.1: Configuration Requirements

- You may want to consult your network administrator before performing these procedures. Some functions may be restricted to the network administrator.
- If you have only one Ethernet adapter (network card), the screen displays only that configuration. You will use this Ethernet adapter to access the Shark® 100-S meter's Network Module. You may have to configure the Ethernet adapter in order to use it with the Shark® 100-S meter's Network Module, using the instructions in Section 6.4.2.
- If you have multiple Ethernet adapters (network cards) installed on your computer, you must choose, configure and use the correct one to access the Network Module.
- The Ethernet Adapter must be set up for point-to-point connection in order for it to connect to the Shark® 100-S meter's Network module, as follows:

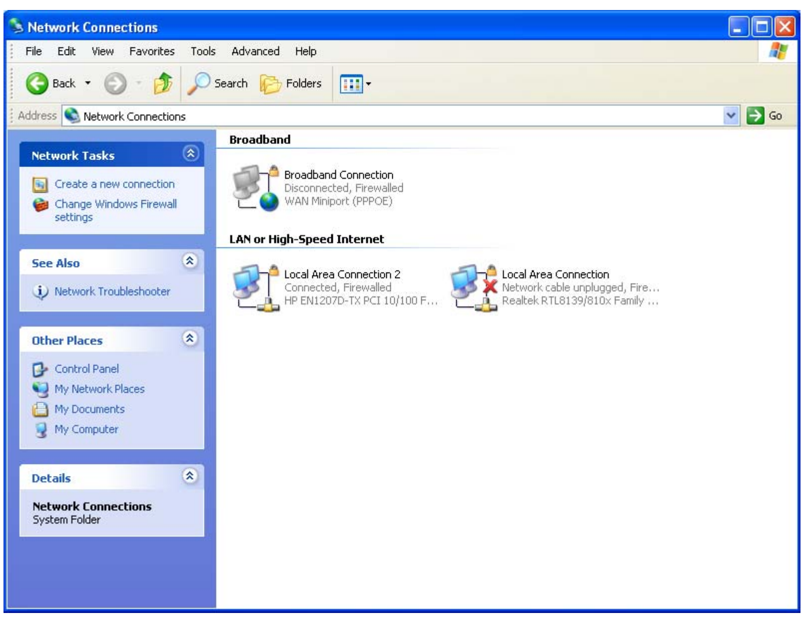
  IP Address should be **10.0.0.2**

  Subnet Mask should be **255.255.255.0**

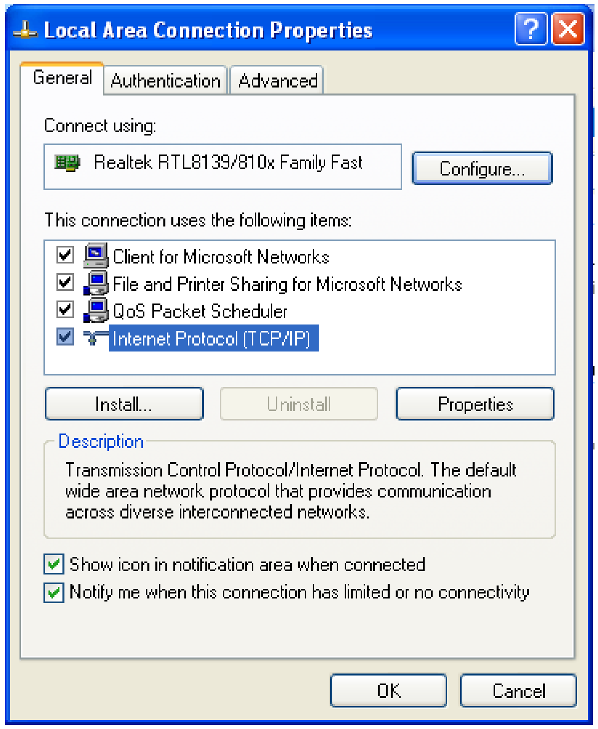
  These settings can be made in the Ethernet Adapter. Follow the procedure in Section 6.3.2.

6.3.2: Configuring the Ethernet Adapter

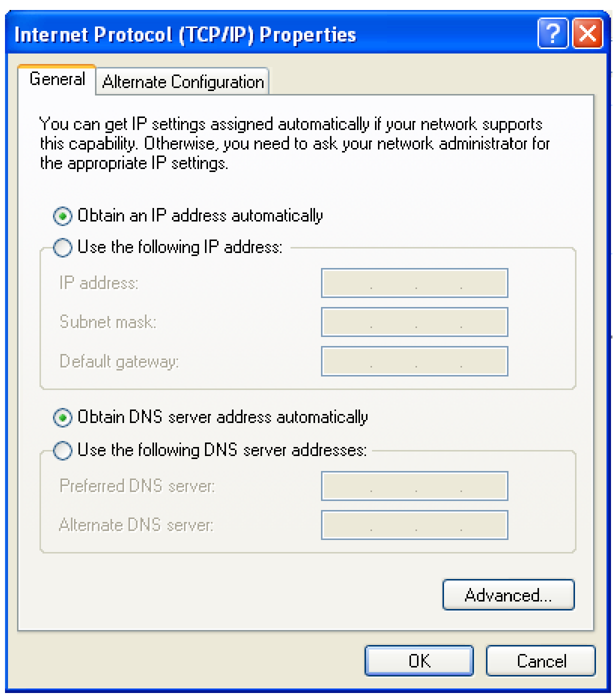
1. From the **Start** Menu, select **Settings**>**Network Connections**. You will see the screen shown below.



2. Right click on the Local Area Network Connection you will be using to connect to the Shark® 100-S meter, and select **Properties** from the pull-down menu. You will see the screen 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 below.



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.

5. Click the **Okay** button.

6. You can now close the **Local Area Connection Properties** and **Network Connection** windows.

6.3.3: Detailed Configuration Parameters

Certain parameters must be configured before the Ethernet Interface can function on a network. The Ethernet Interface can be locally or remotely configured using the following procedures:

Use a Telnet connection to configure the unit over the network. The Ethernet Interface's configuration is stored in memory and is retained without power. The configuration can be changed at any time. The Ethernet Interface performs a reset after the configuration has been changed and stored.

As mentioned above, to configure the Ethernet Interface over the network, establish a Telnet connection to port 9999. Follow this procedure:

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.

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

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

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

The following parameters appear; for example:

```
Serial Number 5415404  MAC Address  00:20:4A:54:3C:2C
Software Version V01.2 (000719)
Press Enter to go into Setup Mode
```

4. Press **ENTER** again quickly.

   After entering Setup Mode (confirm by pressing Enter), you can configure the parameters for the software you are using by entering one of the numbers on the Change Setup Menu, or you can confirm default values by pressing Enter. Be sure to store new configurations when you are finished. The Ethernet Interface will then perform a power reset.

5. The Factory Default Settings will display again (refer to Section 6.2.1).

6.3.4: Setup Details

This section illustrates how each Section of settings appears on the screen, if you press Y (Yes) to change one or more of the settings.
NOTE: Change Settings 1 and 6 ONLY. Settings 2, 3, and 4 must be the same as shown in Section 6.2.1. If they are not, reset them to the values shown in Section 6.2.1.

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

  Network Mode: 0=Wired only, 1=Wireless Only <0> ? 1
  IP Address <010> 192.<000> 168.<000> .<000> .<001>
  Set Gateway IP Address <N> ? Y
  Gateway IP Address : <192> .<168> .<000> .<001>
  Set Netmask <N for default> <Y> ? Y
  <255> .<255> .<255> .<000>
  Change telnet config password <N> ? N

- Serial & Mode Settings (2) (**Make sure these settings match those shown in Section 6.2.1**.)

  Attached Device (1=Slave 2=Master) (1) ? 1
  Serial Protocol (1=Modbus/RTU 2=Modbus/ASCII) (1) ? 1
  Use serial connector (1=CH1 2=CH2) (1) ? 1
  Interface Type (1=RS232 2=RS422/RS485+4-wire 3=RS485+2-wire) (1) ? 1
  Enter serial parameters (57600,8,N,1) 57600, 8, N, 1

- Modem/Configurable Pin Settings (3) (**Make sure these settings match those shown in Section 6.2.1**.)

  CAUTION! You must configure this setting correctly in order to be able to use the Network Module Hardware Initialization procedure (Section 6.3.4).

  Press 3. The following appears on the screen:

  ```
  CP0 Function (hit space to toggle) GPIO (In)
  ```

  Press the Space bar until the following appears on the screen:

  ```
  CP0 Function (hit space to toggle) Defaults(In)
  ```

  Press Enter. The following appears on the screen:

  ```
  Invert (active low) (Y) ?
  ```

  Press Y.

  Ignore other settings (press Enter through the rest of Setting 3).

- Advanced Modbus Protocol settings (4) (**Make sure these settings match those shown in Section 6.2.1**.)

  Slave address (0 for auto, or 1..255 fixed otherwise) (0) ? 0
  Allow Modbus Broadcasts (1=Yes 2=No) (2) ? 2
  Use MB/TCP 00BH/00AH Exception Responses (1=No 2=Yes) (2) ? 2
  Disable Modbus/TCP pipeline (1=No 2=Yes) (1) ? 1
  Character Timeout (0 for auto, or 10-6950 msec) (50) 50
  Message Timeout (200-65000 msec) (5000) 5000
  Serial TX delay after RX (0-1275 msec) (0) 0
  Swap 4x/0H to get 3x/1x (N) ? N

  Local slave address for GPIO (0 to disable, or 1..255) (0) ? 0

- **WLAN Settings Detail (6)**
  (The settings shown are recommended by EIG for use with Shark® 100-S meter.)

  Topology: 0=Infrastructure, 1=Ad-Hoc <1> ? 0
  Network name <SSID> <LTRX_IBSS> ? EIG_SHARKS
  Security suite: 0=none, 1=WEP, 2=WPA, 3=WPA2/802.11i <0> ? 0
  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 <3> ? 7
  Enable power management <N> ? Y

IMPORTANT NOTES:

- The settings for the Wireless Access Point should be IDENTICAL to the settings for LWAN above. For programming, see the User's Manual for the Wireless Access Point in use.
- See Section 6.3.4.1 for information on using an Encryption key.

- **Exiting the screen**

  CAUTION! DO NOT PRESS 'D.'

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

6.3.4.1: Encryption Key

EIG recommends that you use 128-bit encryption when setting up your Ethernet configuration. In the WLAN Settings (6), set Security WEP (1), Authentication shared (1), WEP128 (1) and Change Key (Y).

When Change Key (Y) is entered, you are required to enter an Encryption Key. You can manually enter 26 hexadecimal characters (required for 128-bit encryption) or you can use a WEP Key provider online (example: www.powerdog.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.**
   Remember your Passphrase.

2. Click the Generate Keys button.

   Your Hexadecimal WEP Keys appear.

```
PASSPHRASE TO HEXADECIMAL WEP KEYS

   Enter the passphrase below.
                        1009egbck001036ab

                        Generate keys
```

```
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
```

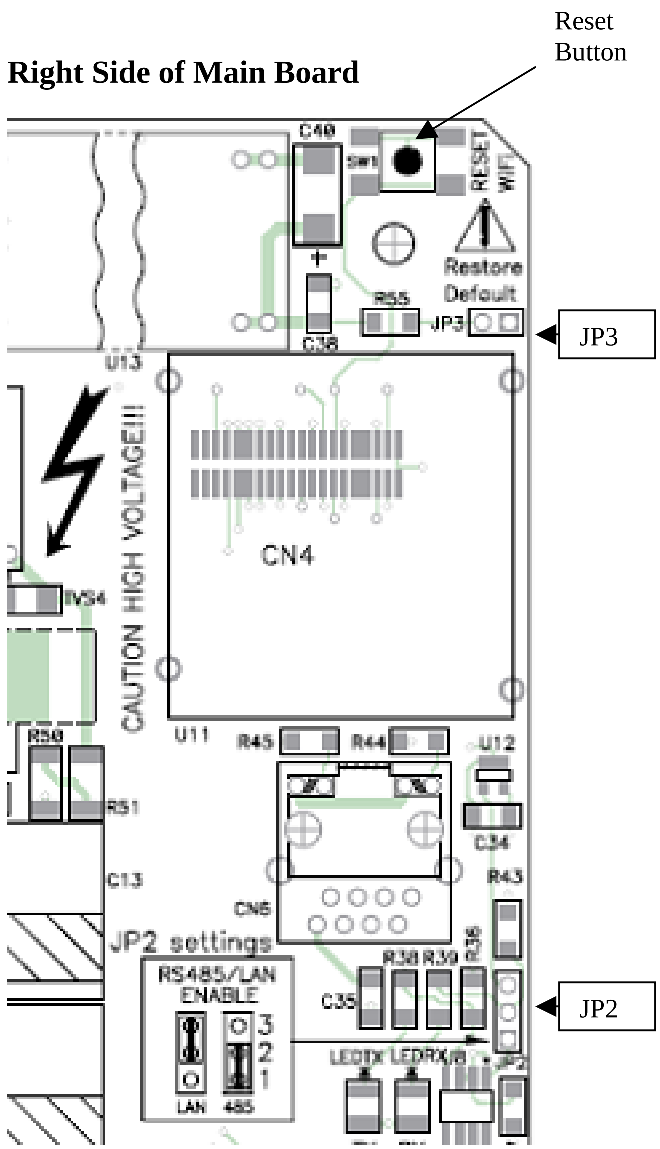
3. Input the 128-bit Key in the Change Key section of the WLAN Settings (6). Continue inputting settings.

4. Press '**S**' to Save your settings.

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.

Right Side of Main Board



1. Place a shorting block on JP3 and press the **Reset** button on the main board.
   NOTE: JP3 is located at 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 above.

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

3. Make sure your settings are the same as those in Section 6.2.1. Follow the steps in Section 6.3 to configure the Network Module.

Chapter 7
Using the Submeter

7.1: Introduction

■ The Shark® 100-S Submeter can be configured and a variety of functions can be accomplished simply by using the Elements and the Buttons on the submeter face. This chapter will review Front Panel Navigation. Complete Navigation Maps can be found in Appendix A of this manual.

7.1.A: Submeter Face Elements

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

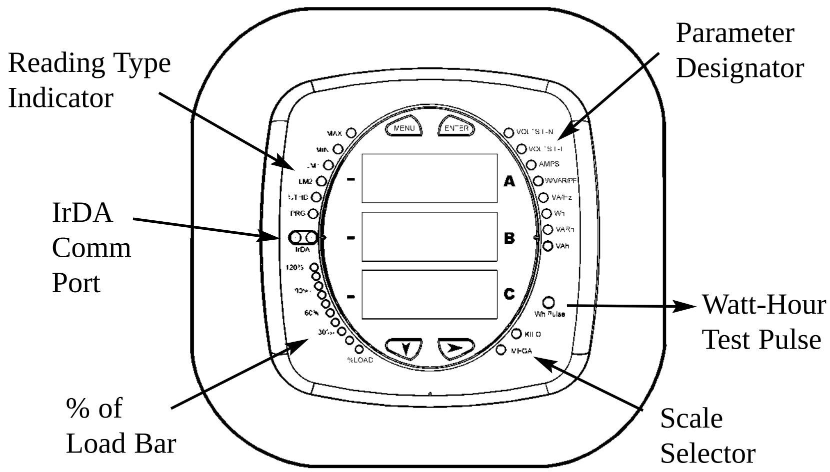


Figure 7.1: Face Plate of 100-S with Elements

7.1.B: Submeter Face Buttons

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

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

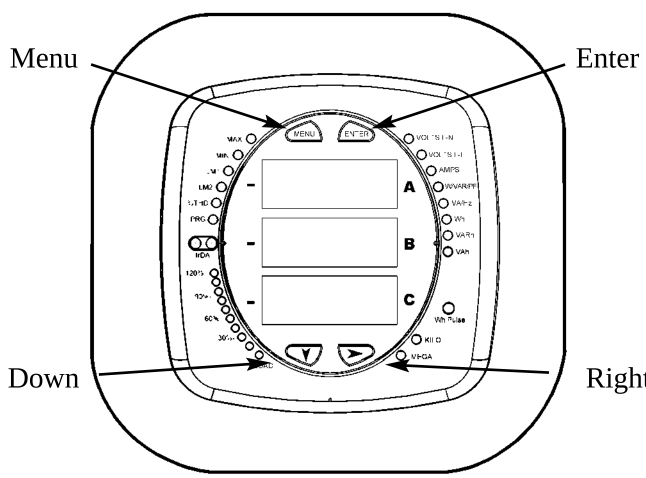


Figure 7.2: Face Plate of 100-S with Buttons

- **Enter Button:** Press and release to enter one of four Display Modes
  Operating Mode (Default),
  Reset Mode (ENTER once, then Down)
  Settings Mode (ENTER twice, then Down) and
  Configuration Mode (ENTER three times, then Down)

- **Menu Button:** Press and release to navigate Config Menu, return to Main Menu

- **Right Button:** Operating Mode - Max, Min, %THD, Del kW, Net kW, Total kW
  Reset Mode - Yes, No
  Settings Mode - On, Off, Settings
  Config Mode - Password Digits, Available Values, Digits

- **Down Button:** Scroll DOWN through Mode menus

- **Use Buttons in Modes of Operation**:
  Operating Mode (default): View Parameter Values
  Reset Mode: Reset Stored Max and Min Values
  Settings Mode: View Submeter Setting Parameters and Change Scroll Setting
  Configuration Mode: Change Submeter Configuration (Can be Password Protected)

NOTE: The above is a brief overview of the use of the Buttons. For Programming, refer to Chapter 8. For complete Navigation Maps, refer to Appendix A of this manual.

7.2: % of Load Bar

- The 10-segment LED bargraph at the bottom of the submeter display provides a graphic representation of Amps. The segments light according to the load in the %Load Segment Table below. When the Load is over 120% of Full Load, all segments flash "On" (1.5 secs) and "Off" (0.5 secs).

% Load Segment Table	
Segments	**Load >= % Full Load**
none	no load
1	1%
1 - 2	15%
1 - 3	30%
1 - 4	45%
1 - 5	60%
1 - 6	72%
1 - 7	84%
1 - 8	96%
1 - 9	108%
1 - 10	120%
All Blink	>120%

7.3: Watt-Hour Accuracy Testing (Verification)

- The Shark® 100-S meter has a Watt-Hour Test Pulse on the face of the submeter. This is an infrared pulse that can be read easily to test for accuracy.

- To be certified for revenue metering, power providers and utility companies have to verify that the billing energy submeter will perform to the stated accuracy. To confirm the submeter's performance and calibration, power providers use field test standards to ensure that the unit's energy measurements are correct. Since the Shark® 100-S meter is a traceable revenue submeter, 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 and submeters.

Refer to Figure 5.2 below for an example of how this process works.
Refer to the Table below for the Wh/Pulse Constant for Accuracy Testing.

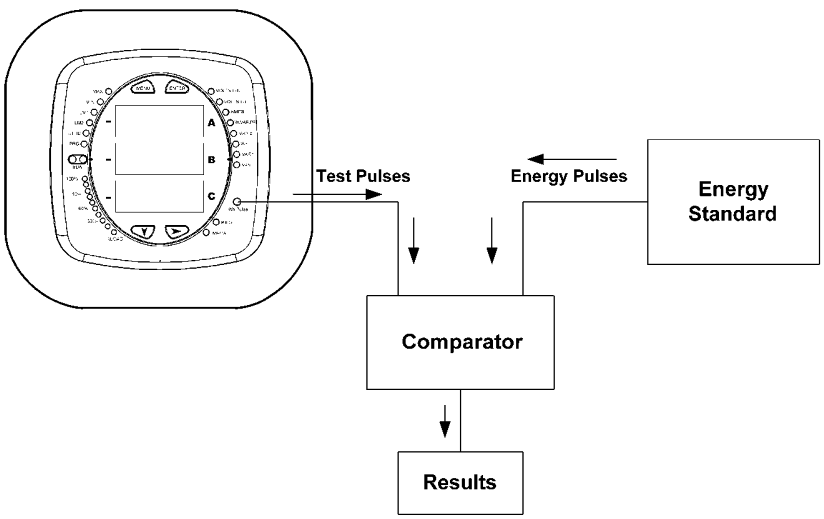


Figure 7.3: Using the Watt-Hour Test Pulse

7.3.1: KYZ Pulse Constants

Infrared & KYZ Pulse Constants for Accuracy Testing		
Voltage Level	**Class 10 Models**	**Class 2 Models**
Below 150V	0.2505759630	0.0501151926
Above 150V	1.0023038521	0.2004607704

7.4: Upgrade the Submeter Using V-Switch™ Technology

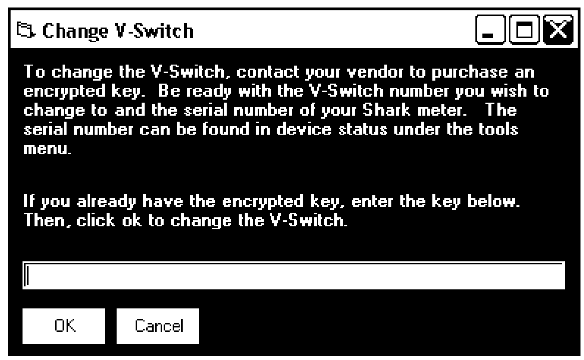
■ The Shark® 100-S meter is equipped with V-Switch™ technology. V-Switch™ technology is a virtual firmware-based switch that allows you to enable submeter features through communication. This allows the unit to be upgraded after installation to a higher model without removing the unit from service.

■ Available V-Switch™ keys

V-Switch 3 (-V3): Volts, Amps, kW, kVAR, PF, kVA, Freq., kWh, kVAh, kVARh & DNP 3.0
V-Switch 4 (-V4): Volts, Amps, kW, kVAR, PF, kVA, Freq., kWh, kVAh, kVARh, %THD Monitoring, Limit Exceeded Alarms & DNP.3.0

■ To change the V-Switch™ key, follow these simple steps:

1. Install Communicator EXT 3.0 in your computer.
2. Set up the Shark® 100-S submeter to communicate with your computer (see Chapter 5); power up your submeter.
3. Log on to Communicator EXT 3.0 software.
4. Click on the Profile Icon. A set of screens appears.
5. The first screen is the Settings screen.
Click CHANGE V-SWITCH.
A small screen appears that requests a code (shown here).
7. Enter the code which EIG provides.
7. Click OK.
The V-Switch™ key has been changed and the submeter resets.



NOTE: For more details on software configuration, refer to the *Communiator EXT 3.0 User Manual*.

■ **How do I get a V-Switch™ key?**

V-Switch™ keys are based on the particular serial number of the ordered submeter. To obtain a higher V-Switch™ key, you need to provide EIG with the following information:

1. Serial Number or Numbers of the submeters for which you desire an upgrade.
2. Desired V-Switch™ key upgrade.
3. Credit Card or Purchase Order Number.

Contact EIG's inside sales staff with the above information at **sales@electroind.com** or (516) 334-0870 (USA) and EIG will issue you the Upgrade Code.

Chapter 8
Configuring the Shark® 100-S Meter with the Front Panel

8.1: Overview

- The Shark® 100-S meter's front panel can be used to configure the submeter. The front panel has three MODES:
  Operating Mode (Default),
  Reset Mode and
  Configuration Mode.
  The MENU, ENTER, DOWN and RIGHT buttons navigate through the MODES and navigate through all the SCREENS in each mode.

  In this chapter, a typical set up is demonstrated. Other settings are possible. The complete Navigation Map for the Display Modes is in Appendix A of this manual. The submeter can also be configured with software (see *Communicator EXT 3.0 Manual*).

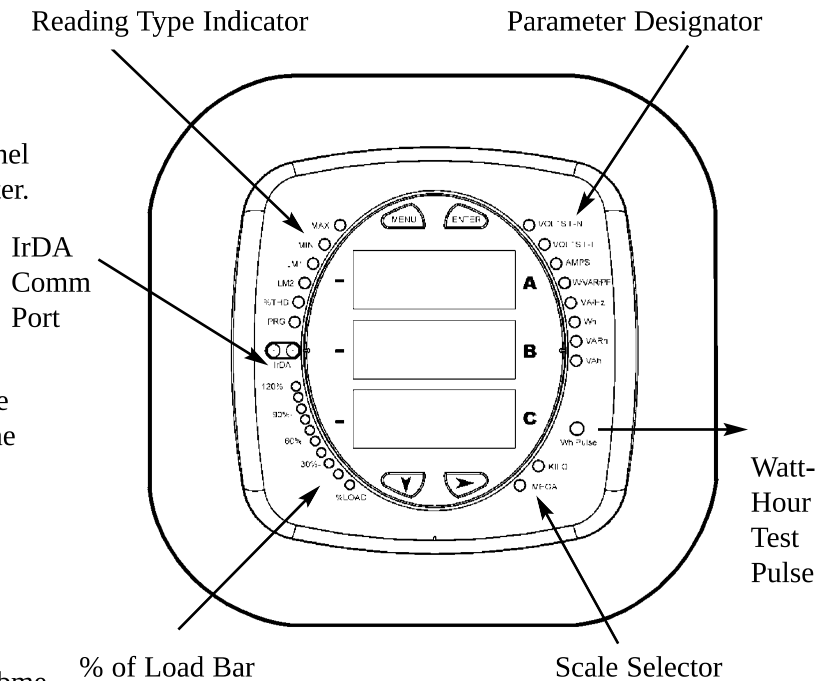


Figure 8.1: Shark® 100-S Meter Label

8.2: Start Up

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

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

  The Shark® 100-S meter will then automatically Auto-Scroll the Parameter Designators on the right side of the front panel. Values are displayed for each parameter.
  The **KILO or MEGA LED** lights, showing the scale for the Wh, VARh and VAh readings.
  An example of a Wh reading is shown here.

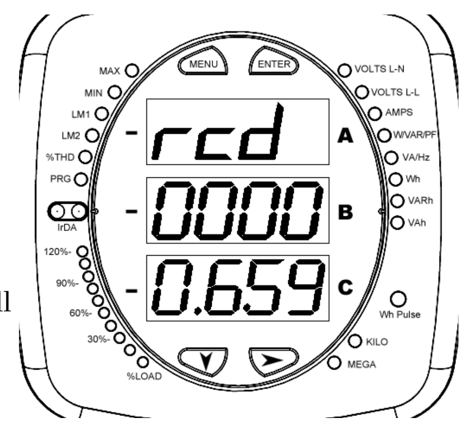


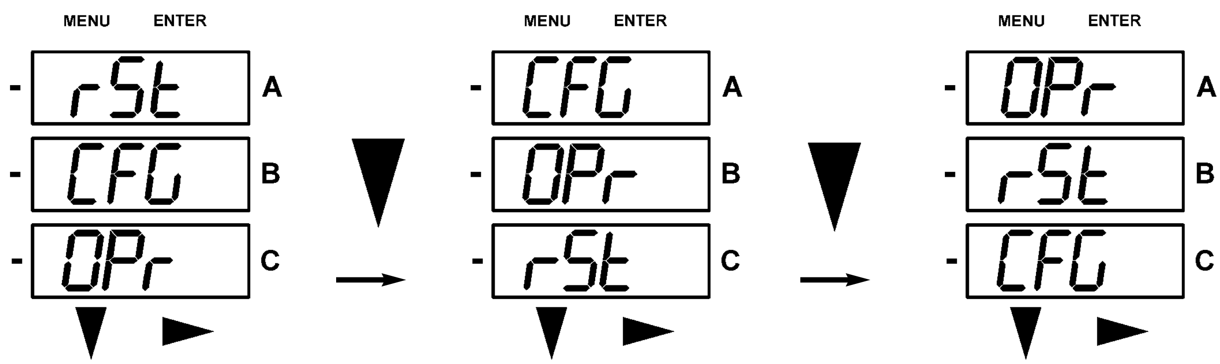
Figure 8.2: Wh Reading Detail

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

8.3: Configuration

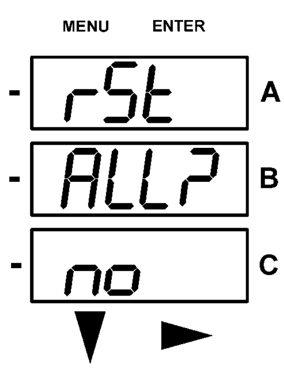
8.3.1: Main Menu

- Push **MENU** from any of the Auto-Scrolling Readings. The MAIN MENU Screens appear.
  The String for **Reset Mode** (rSt) appears (blinking) in the A Screen.
  If you push **DOWN**, the MENU scrolls and the String for **Configuration Mode** (CFG) appears (blinking) in the A Screen.
  If you push **DOWN** again, the String for **Operating Mode** (OPr) appears (blinking) in the A Screen.
  If you push **DOWN** again, the MENU scrolls back to Reset Mode (rSt).
  If you push **ENTER** from the Main Menu, the submeter enters the Mode that is in the A Screen and is blinking. See *Appendix A* for the Navigation Map.



8.3.2: Reset Mode

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

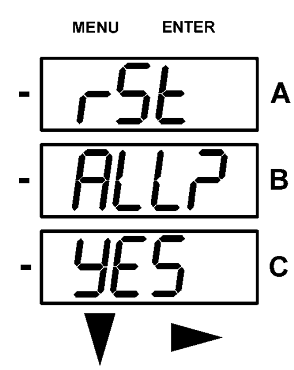


If you push **ENTER** again, the Main Menu continues to scroll. The DOWN button does not change the screen.

If you push the **RIGHT** button, the RESET All? YES screen appears.

To Reset All, you must enter a 4-digit Password, **if Enabled** in the software.

Push **ENTER**; the following Password screen appears.



8.3.2.1: Enter Password (ONLY IF ENABLED IN SOFTWARE)

- To enter a Password:

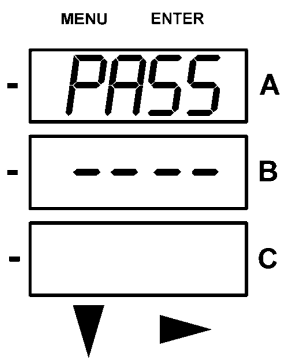
  If PASSWORD is Enabled in the software (see Communicator EXT section 5.22 to Enable/ Change Password), a screen appears requesting the Password. **PASS** appears in the A Screen and **4 dashes** in the B Screen. The LEFT digit is flashing.

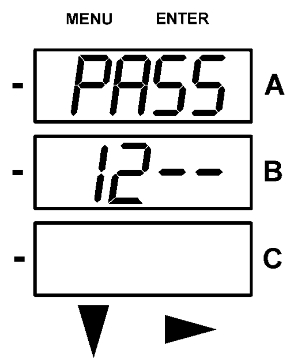
  Use the **DOWN** button to scroll from 0 to 9 for the flashing digit. When the correct number appears for that digit, use the **RIGHT** button to move to the next digit.

  Example: On the Password screens below:

  On the left screen, four dashes appear and the left digit is flashing.

  On the right screen, 2 digits have been entered and the third digit is flashing.





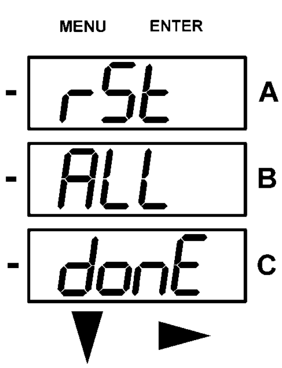
- **PASS or FAIL**

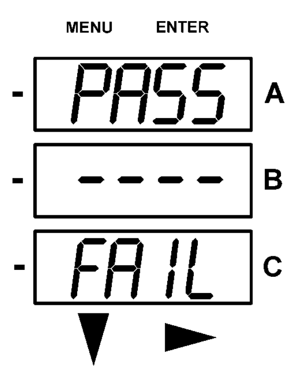
  When all 4 digits have been entered, push **ENTER**.

  If the **correct Password** has been entered, “rSt ALL donE” appears and the screen returns to Auto-Scroll the Parameters.

  (In other Modes, the screen returns to the screen to be changed. The left digit of the setting is flashing and the Program (PRG) LED flashes on the left side of the submeter face.)

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





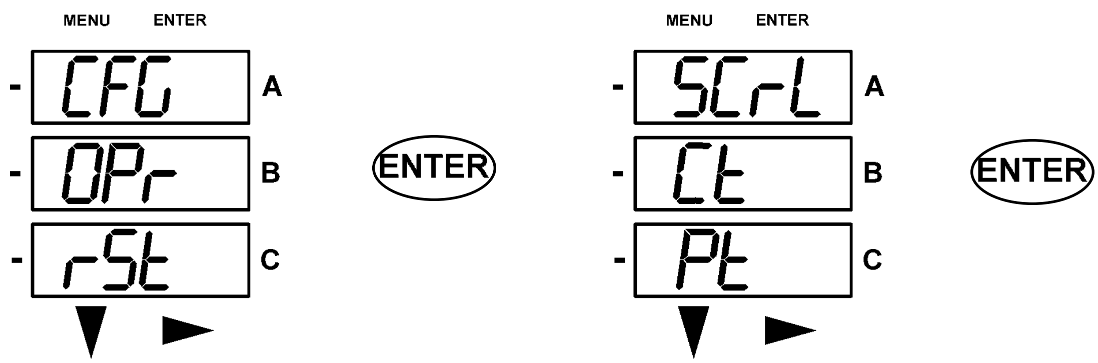
8.3.3: Configuration Mode

- The next Mode on the Main Menu is **Configuration Mode**. See *Appendix A* for Navigation Map.

  To reach Configuration Mode, push the **MENU** Button from any of the Auto-Scrolling Readings, then push the **DOWN** button to reach the String for Configuration Mode (CFG).

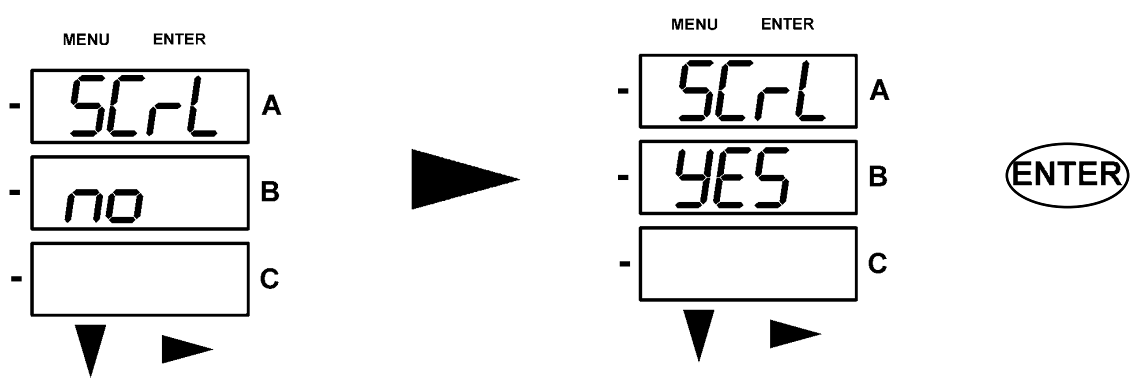
  Push **ENTER** and the Configuration Parameters scroll, starting at the “SCROLL, Ct, Pt” screen.

  Push the **DOWN** Button to scroll all the parameters: Scroll, CT, PT, Connection (Cnct) and Port. The ‘Active” parameter is in the A Screen and is flashing.



8.3.3.1: Configure Scroll Feature

Push **ENTER** and the **Scroll no** screen appears.
Push **RIGHT** and changes to **Scroll YES.**



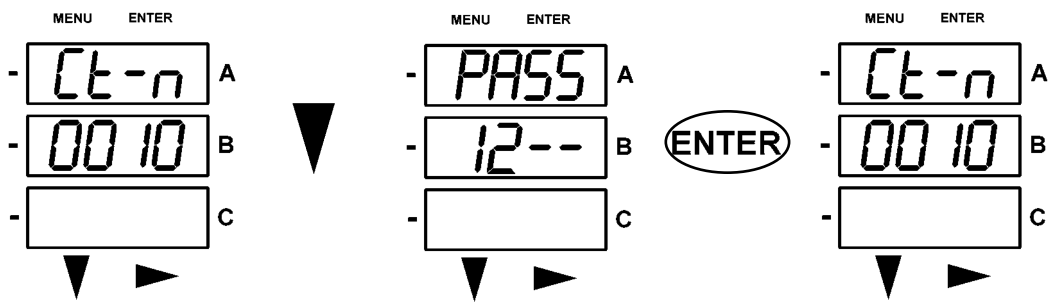
When in Scroll Mode, the unit scrolls each parameter for 7 seconds on and 1 second off. The submeter can be configured through software to display only selected screens. If that is the case, it will only scroll the selected display. Additionally, the submeter will only scroll the display enabled by the V-Switch that is installed.

Push **ENTER** (YES or no) and the screen scrolls to the Ct Parameters.

8.3.3.2: Program Configuration Mode Screens

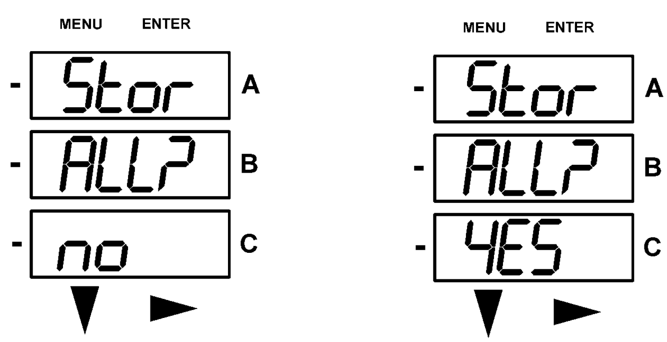
- To program the screens in Configuration Mode, other than SCROLL:

1. Push **DOWN or RIGHT** button (Example Ct-n screen below).
2. The Password screen appears, if Enabled (see section 5.22). Use the DOWN and RIGHT buttons to enter the PASSWORD. See section 8.3.2.1 for all Password steps.
   Once the correct password is entered, push **ENTER**. The Ct-n screen reappears. The Program (PRG) LED flashes on the left side of the submeter face.
   The first digit of the setting will also flash.



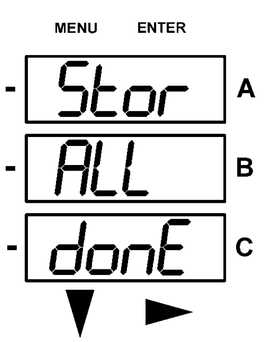
3. Use the **DOWN** button to change the digit.
   Use the **RIGHT** Button to move to the next digit.

4. When the new setting is entered, push **MENU twice**.
   The **STORE ALL** screen appears.



5. Use the **RIGHT** Button to scroll from **YES** to **no**.

6. While in STORE ALL YES, push **ENTER** to change the setting.



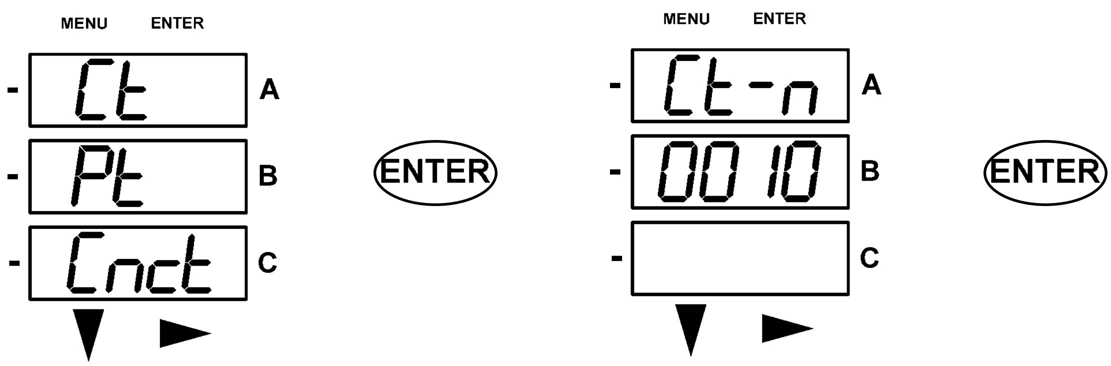
Store All Done appears.
Then, the submeter RESETS.

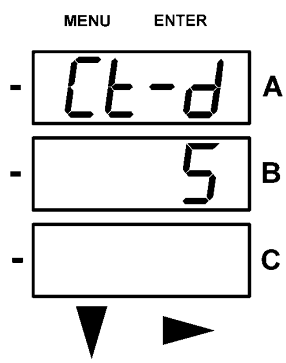
8.3.3.3: Configure CT Setting

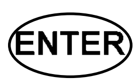
Push the **DOWN** Button to scroll all the parameters in Configuration Mode: Scroll, CT, PT, Connection (Cnct) and Port. The 'Active" parameter is in the A Screen and is flashing.
Push **ENTER** when CT is the 'Active' parameter and the **Ct-n (Numerator)** screen appears.
Push **ENTER** and the screen changes to **Ct-d (Denominator).**

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

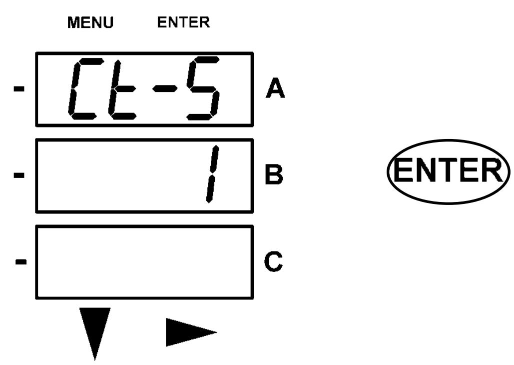
ENTER again changes the screen to **Ct-S (Scaling).** The Ct-S setting can be '1', '10' or '100'.
To program these settings (except Ct-d), see section 8.3.3.2 above.







NOTE: Ct-d is FIXED to a 5 or 1 Amp Value.



Example 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.

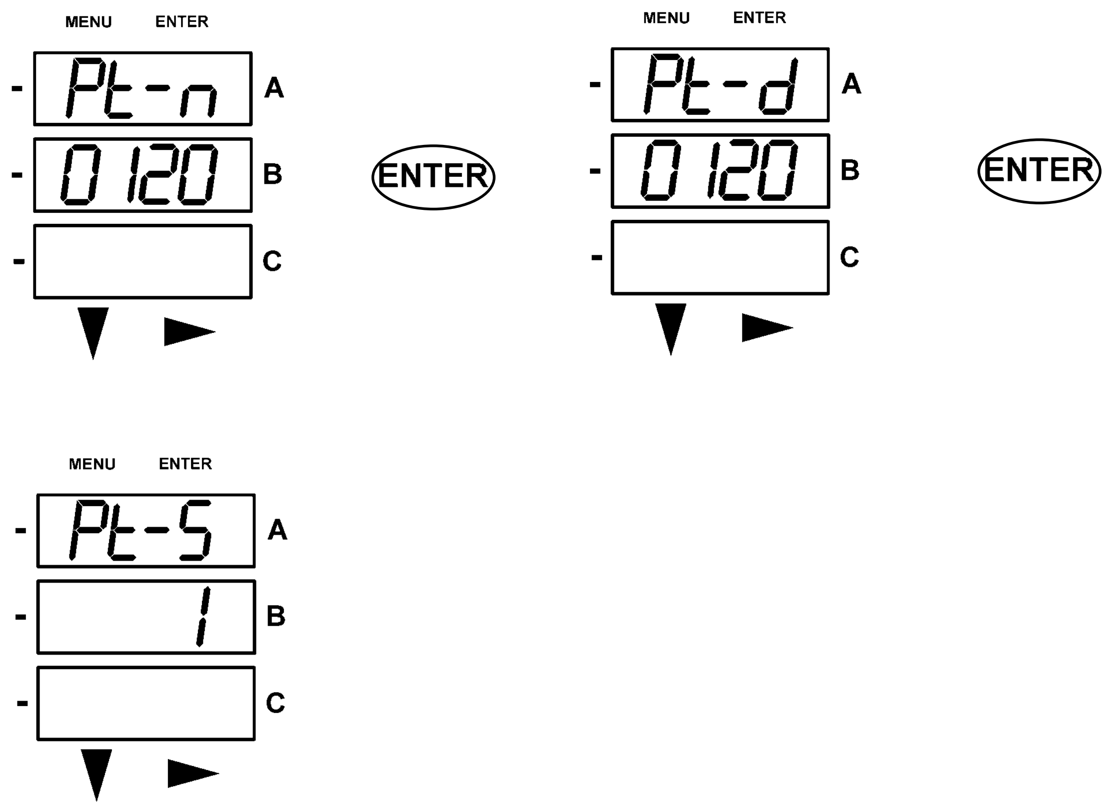
NOTE: The value for Amps is a product of the Ct-n value and the Ct-S value.

- Push **ENTER** and the screen scrolls through the other CFG parameters.
  Push **DOWN or RIGHT** and the Password screen appears (see section 8.3.2.1).
  Push **MENU** and you will return to the MAIN MENU.

NOTE: Ct-n and Ct-S are dictated by Primary Current.
Ct-d is Secondary Current.

8.3.3.4: Configure PT Setting

Push the **DOWN** Button to scroll all the parameters in Configuration Mode: Scroll, CT, PT, Connection (Cnct) and Port. The ‘Active” parameter is in the A Screen and is flashing.
Push **ENTER** when PT is the ‘Active’ parameter and the **Pt-n (Numerator)** screen appears.
Push **ENTER** and the screen changes to **Pt-d (Denominator).**
ENTER again changes the screen to **Pt-S (Scaling).** The Pt-S setting can be ‘1’, ‘10’ or ‘100’.
To program any of these settings, see section 8.3.3.2 above.



Example Settings:

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.
345,000/115Volts:	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.

- Push **ENTER** and the screen scrolls through the other CFG parameters.
  Push **DOWN or RIGHT** and the Password screen appears (see section 8.3.2.1).
  Push **MENU** and you will return to the MAIN MENU.

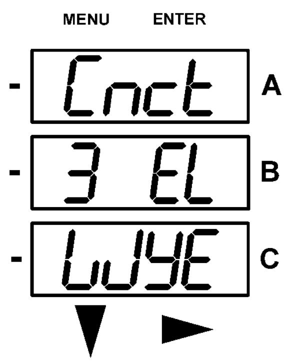
NOTE: Pt-n and Pt-S are dictated by Primary Voltage.
Pt-d is Secondary Voltage.

8.3.3.5: Configure Connection (Cnct) Setting

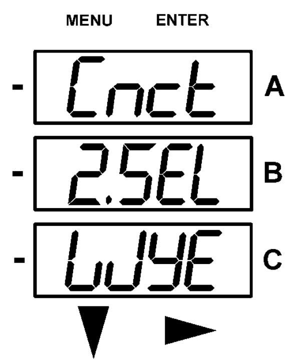
Push the **DOWN** Button to scroll all the parameters in Configuration Mode: Scroll, CT, PT, Connection (Cnct) and Port. The 'Active" parameter is in the A Screen and is flashing.
Push **ENTER** when **Cnct** is the 'Active' parameter and the **Connection** screen appears for your submeter. To change this setting, use the RIGHT button to scroll through the three settings. Select the setting that is right for your submeter.

- The possible Connection configurations include:

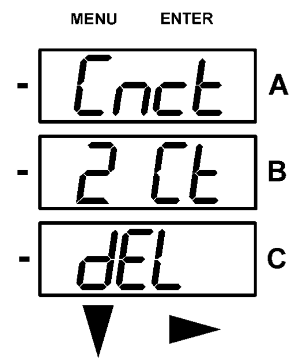
    - 3 Element WYE
    - 2.5 Element WYE
    - 2 CT Delta



3 Element Wye



2.5 Element Wye



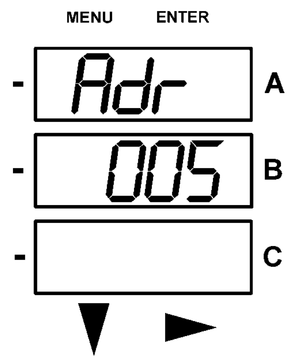
2 CT Delta

- Push **ENTER** and the screen scrolls through the other CFG parameters.
  Push **DOWN or RIGHT** and the Password screen appears (see section 8.3.2.1).
  Push **MENU** and you will return to the MAIN MENU.

8.3.3.6: Configure Communication Port Setting

Push the **DOWN** Button to scroll all the parameters in Configuration Mode: Scroll, CT, PT, Connection (Cnct) and Port. The 'Active" parameter is in the A Screen and is flashing.
Push **ENTER** when **PORT** is the 'Active' parameter and your submeter's **POrt** screens appear.

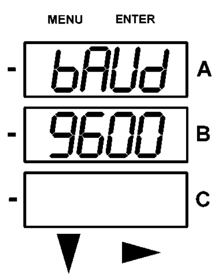
- To program the PORT screens, see section 8.3.3.2.
- The possible PORT configurations include:
  - Address (Adr) (Three digit number)
  - BAUD (bAUd) 9600, 19.2, 38.4, 57.6
  - Protocol (Prot): DNP 3.0 (dnP)
    - Modbus (Mod) RTU (rtU)
    - Modbus (Mod) ASCII (ASCI)
- The first PORT screen is **Address (Adr)**.
  The current Address appears on the screen.
  Follow the Programming steps in section 8.3.3.2 to change the Address.



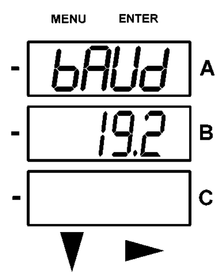
Address 005

- The **Baud Rate (bAUd)** appears next. The current Baud Rate appears on the screen. To change the setting, follow the Programming steps in section 8.3.3.2. Possible screens appear below.
- The **Protocol (Prot)** appears next. The current Protocol appears on the screen. To change the setting, follow the Programming steps in section 8.3.3.2. Possible screens appear below.

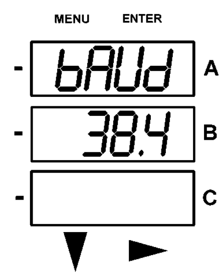
NOTE: JP2 must be in positions 1-2 for RS485 or positions 2-3 for Ethernet. Refer to Chapter 5 of this manual, sections 5.1.2, 5.1.4, and 5.2.2 for related Communication instructions.



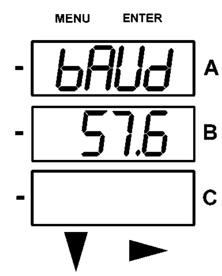
Baud Rate 9600



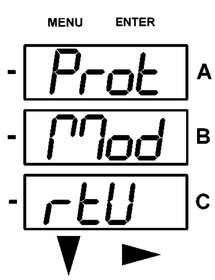
Baud Rate 19,200



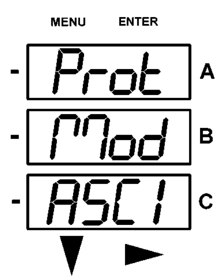
Baud Rate 38,400



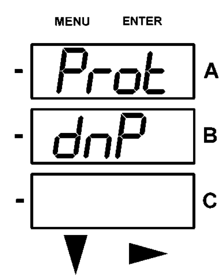
Baud Rate 57,600



Modbus RTU Protocol



Modbus ASCII Protocol



DNP 3.0 Protocol

- Push **ENTER** and the screen scrolls through the other CFG parameters.
  Push **DOWN or RIGHT** and the Password screen appears (see section 8.3.2.1).
  Push **MENU** and you will return to the MAIN MENU.

8.3.4: Operating Mode

- Operating Mode is the Shark® 100-S submeter's Default Mode. After Start Up, the submeter automatically scrolls through these parameter screens, if scrolling is enabled. The screen changes every 7 seconds. Scrolling is suspended for 3 minutes after any button is pressed.

- Push the **DOWN** Button to scroll all the parameters in Operating Mode.
  The 'Active" parameter has the Indicator light next to it on the right face of the submeter..
  Push the **RIGHT** Button to view additional readings for that Parameter.
  A Table of the possible readings for Operating Mode is below.
  See *Appendix A (Sheet 2)* for the Operating Mode Navigation Map.

OPERATING MODE PARAMETER READINGS						
Parameter Designator Available by V-Switch Key	**Possible Readings**					**V4 Only**
VOLTS L-N V1-4	VOLTS_LN	VOLTS_LN_MAX	VOLTS_LN_MIN			VOLTS_LN_THD
VOLTS L-L V1-4	VOLTS_LL	VOLTS_LL_MAX	VOLTS_LL_MIN			
AMPS V1-4	AMPS	AMPS_NEUTRAL	AMPS_MAX	AMPS_MIN		AMPS_THD
W/VAR/PF V2-4	W_VAR_PF	W_VAR_PF_MAX_POS	W_VAR_PF_MIN_POS	W_VAR_PF_MAX_NEG	W_VAR_PF_MIN_NEG	
VA/Hz V2-4	VA_FREQ	VA_FREQ_MAX	VA_FREQ_MIN			
Wh V3-4	KWH_REC	KWH_DEL	KWH_NET	KWH_TOT		
VARh V3-4	KVARH_POS	KVARH_NEG	KVARH_NET	KVARH_TOT		
VAh V3-4	KVAH					

NOTE: Reading or Groups of readings are skipped if not applicable to the submeter type or hookup, or if explicitly disabled in the programmable settings.

NOTE: AMPS_NEUTRAL (Neutral Current) appears for Wye hookups only.

Appendix A
Navigation Maps for the Shark® 100-S Meter

A.1: Introduction

■ The Shark® 100-S meter can be configured and a variety of functions performed using the Buttons on the meter face.

- An Overview of the Elements and Buttons on the meter face can be found in Chapter 7.
- An Overview of Programming using the Buttons can be found in Chapter 8.
- The meter can also be programmed using software (see the *Communicator EXT 3.0 User Manual*).

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

■ The Shark® 100-S meter's Navigation Maps begin on the next page.

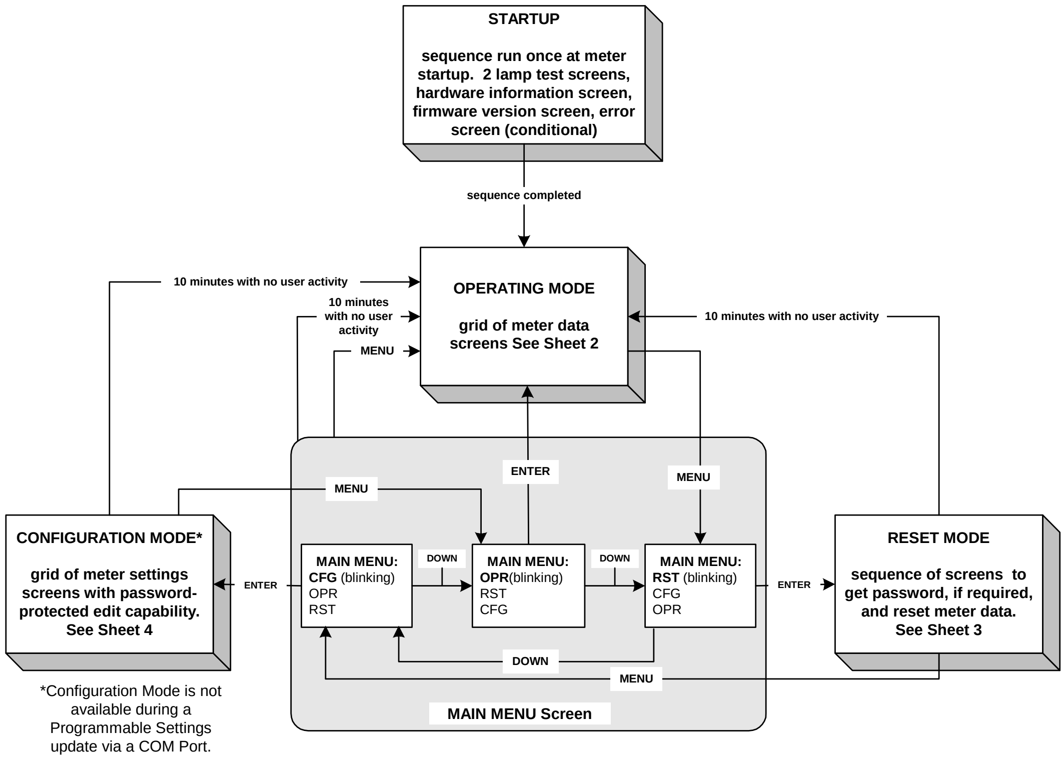
They illustrate how to move from one screen to another, and from one Display Mode to another, using the buttons on the face of the meter.

NOTE: After 10 minutes without user activity, the display automatically returns to **Operating Mode**

■ Shark® 100-S meter Navigation map titles:

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

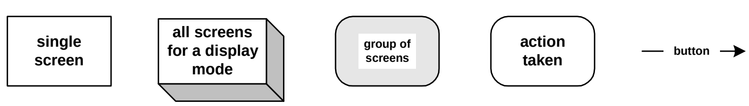
Main Menu Screens (Sheet 1)



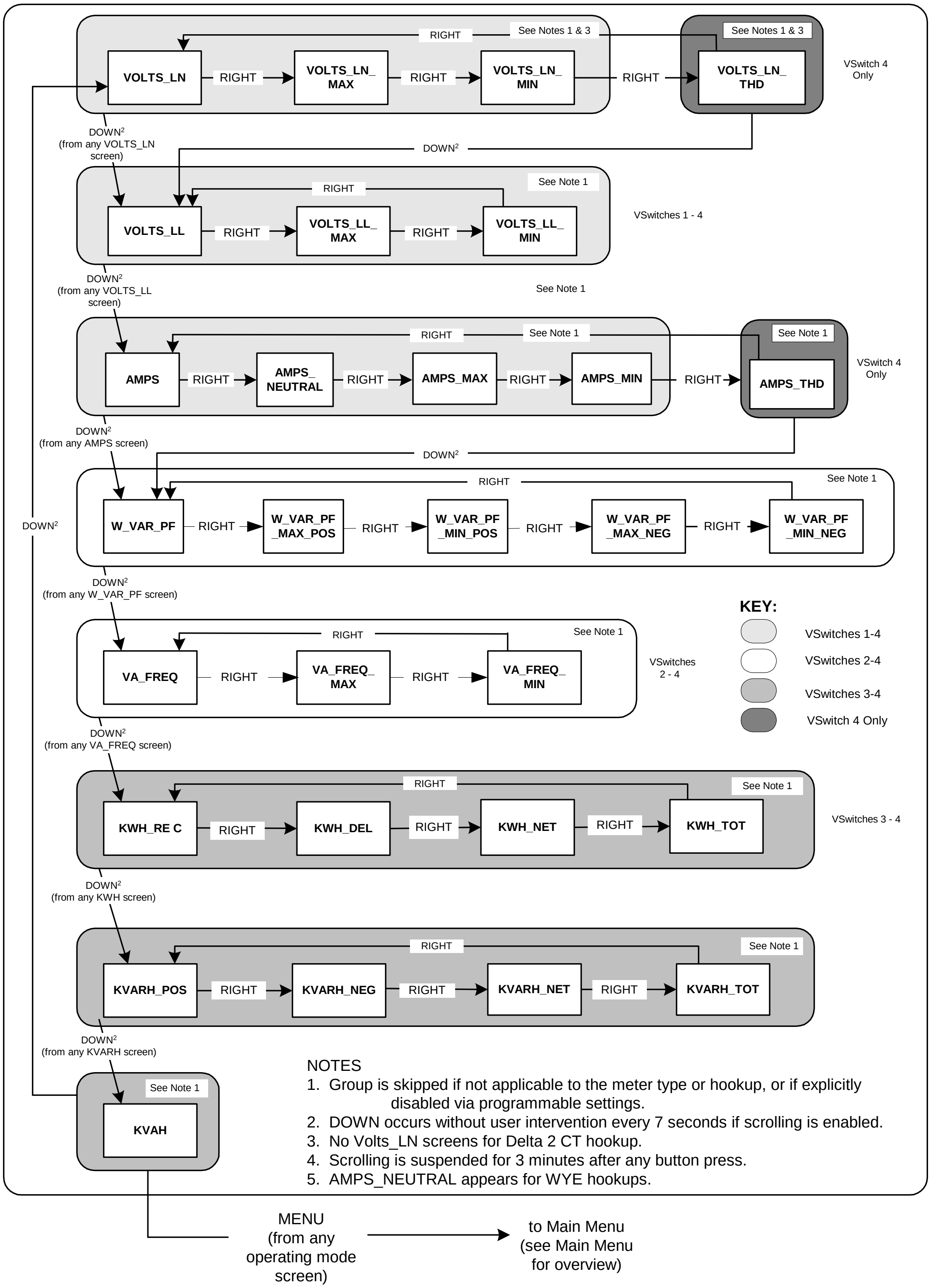
MAIN MENU screen scrolls through 3 choices, showing all 3 at once. The top choice is always the "active" one, which is indicated by the blinking legend.

BUTTONS

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

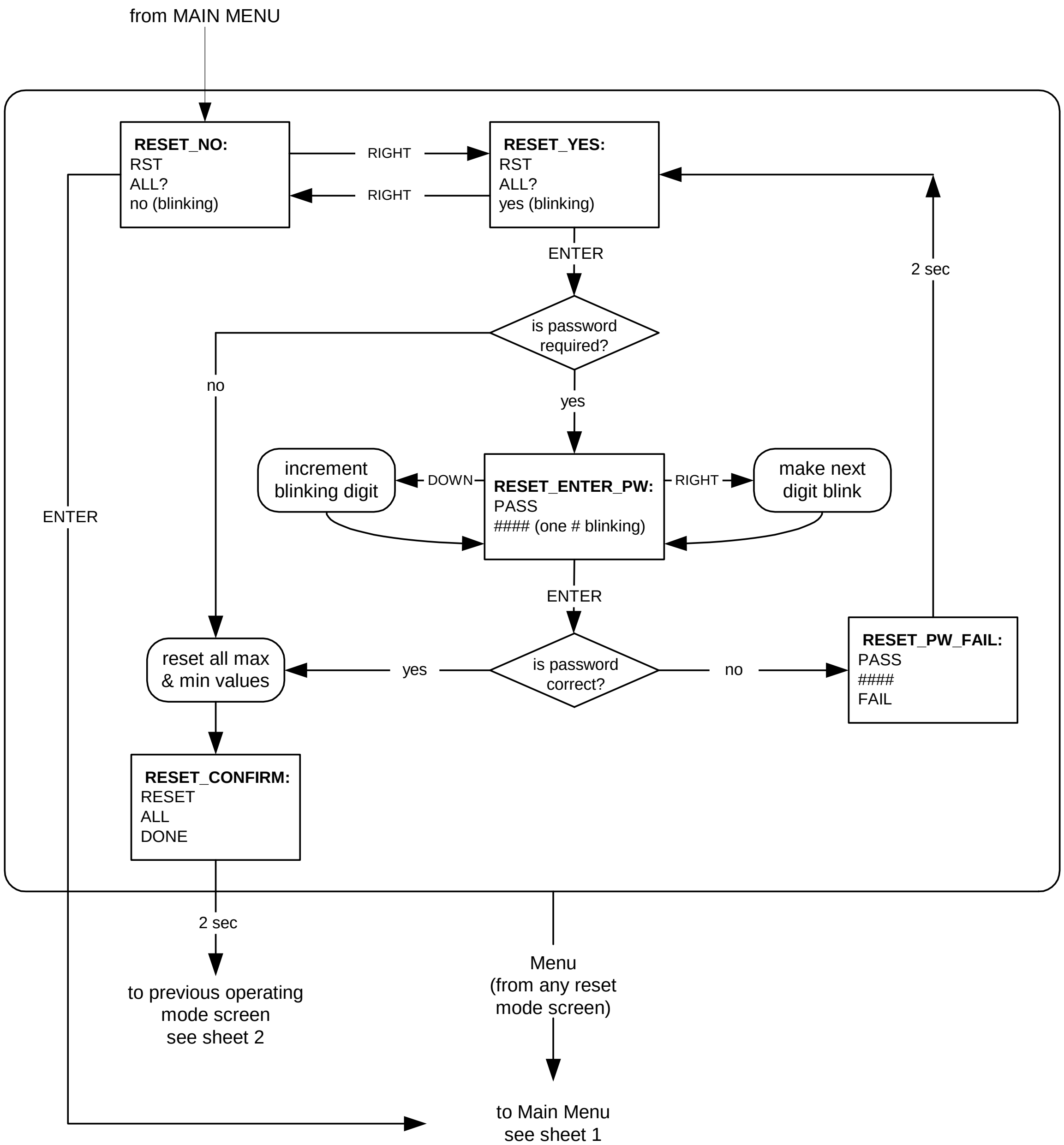


Operating Mode Screens (Sheet 2)

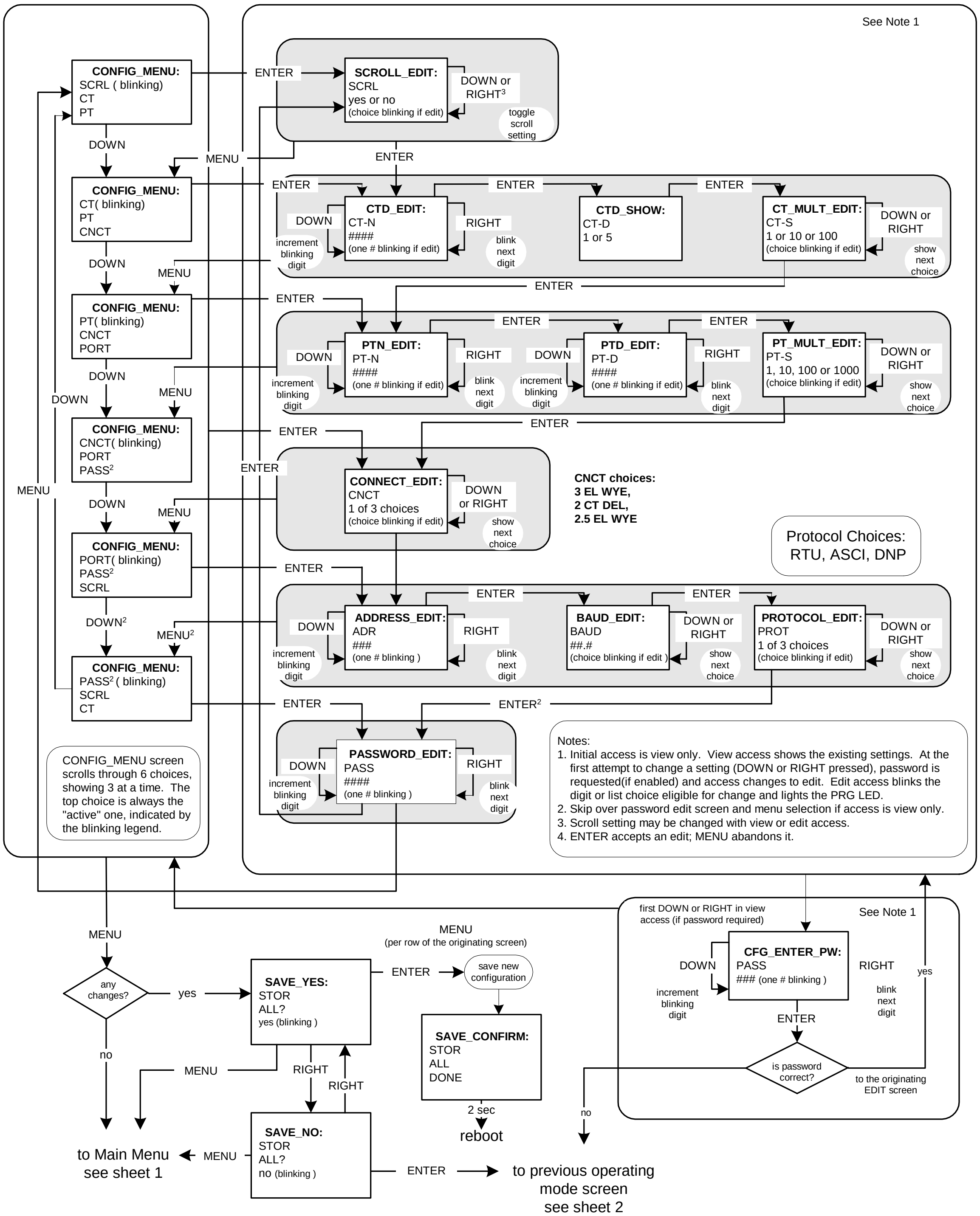


NOTES
1. Group is skipped if not applicable to the meter type or hookup, or if explicitly disabled via programmable settings.
2. DOWN occurs without user intervention every 7 seconds if scrolling is enabled.
3. No Volts_LN screens for Delta 2 CT hookup.
4. Scrolling is suspended for 3 minutes after any button press.
5. AMPS_NEUTRAL appears for WYE hookups.

Reset Mode Screens (Sheet 3)



Configuration Mode Screens (Sheet 4)



Appendix B
Modbus Mapping for Shark® 100-S Meter

B.1: Introduction

- The Modbus Map for the Shark® 100-S meter gives details and information about the possible readings of the meter and about the programming of the meter. The Shark® 100-S meter can be programmed using the buttons on the face plate of the meter (Chapter 8). The meter can also be programmed using software. For a Programming Overview, see section 5.2 of this manual. For further programming details, see the *Communicator EXT 3.0 User Manual*.

B.2: Modbus Register Map Sections

- The Shark® 100-S meter's Modbus Register Map includes the following sections:

  Fixed Data Section, Registers 1- 47, details the Meter's Fixed Information described in Section 8.2.

  Meter Data Section, Registers 1000 - 5003, details the Meter's Readings, including Primary Readings, Energy Block, Demand Block, Maximum and Minimum Blocks, THD Block, Phase Angle Block and Status Block. Operating Mode readings are described in Section 8.3.4.

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

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

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

B.3: Data Formats

- **ASCII**: ASCII characters packed 2 per register in high, low order and without any termination charcters.
  Example: "Shark 100" would be 4 registers containing 0x5378, 0x6172, 0x6B31, 0x3030.

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

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

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

B.4: Floating Point Values

- Floating Point Values are represented in the following format:

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

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

$-1^{sign} x 2^{137-127} x 1{\bullet}11000010001110110111001$

$-1 x 2^{10} x 1.75871956$

-1800.929

Register	0x0C4E1																0x01DB9															
Byte	0x0C4								0x0E1								0x01D								0x0B91							
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).C23B72 (hex).

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

Decimal equivalent: -1800.929

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

B.5: Modbus Register Map (MM-1 to MM-8)

- The Shark® 100-S meter's Modbus Register Map begins on the following page.

Modbus Address Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
Fixed Data Section							
Identification Block						read-only	
0000 - 0007	1 - 8	Meter Name	ASCII	16 char	none		8
0008 - 000F	9 - 16	Meter Serial Number	ASCII	16 char	none		8
0010 - 0010	17 - 17	Meter Type	UINT16	bit-mapped	-------t -----vvv	t = transducer model (1=yes, 0=no), vvv = V-switch(1 to 4)	1
0011 - 0012	18 - 19	Firmware Version	ASCII	4 char	none		2
0013 - 0013	20 - 20	Map Version	UINT16	0 to 65535	none		1
0014 - 0014	21 - 21	Meter Configuration	UINT16	bit-mapped	-------- --ffffff	ffffff = calibration frequency (50 or 60)	1
0015 - 0015	22 - 22	ASIC Version	UINT16	0-65535	none		1
0016 - 0026	23 - 39	Reserved					17
0027 - 002E	40 - 47	GE Part Number	ASCII	16 char	none		8
						Block Size:	47
Meter Data Section[2]							
Primary Readings Block, 6 cycles (IEEE Floating Point						read-only	
0383 - 0384	900 - 901	Watts, 3-Ph total	FLOAT	-9999 M to +9999 M	watts		2
0385 - 0386	902 - 903	VARs, 3-Ph total	FLOAT	-9999 M to +9999 M	VARs		2
0387 - 0388	904 - 905	VAs, 3-Ph total	FLOAT	-9999 M to +9999 M	VAs		2
						Block Size:	6
Primary Readings Block, 60 cycles (IEEE Floating Point)						read-only	
03E7 - 03E8	1000 - 1001	Volts A-N	FLOAT	0 to 9999 M	volts		2
03E9 - 03EA	1002 - 1003	Volts B-N	FLOAT	0 to 9999 M	volts		2
03EB - 03EC	1004 - 1005	Volts C-N	FLOAT	0 to 9999 M	volts		2
03ED - 03EE	1006 - 1007	Volts A-B	FLOAT	0 to 9999 M	volts		2
03EF - 03F0	1008 - 1009	Volts B-C	FLOAT	0 to 9999 M	volts		2
03F1 - 03F2	1010 - 1011	Volts C-A	FLOAT	0 to 9999 M	volts		2
03F3 - 03F4	1012 - 1013	Amps A	FLOAT	0 to 9999 M	amps		2
03F5 - 03F6	1014 - 1015	Amps B	FLOAT	0 to 9999 M	amps		2
03F7 - 03F8	1016 - 1017	Amps C	FLOAT	0 to 9999 M	amps		2
03F9 - 03FA	1018 - 1019	Watts, 3-Ph total	FLOAT	-9999 M to +9999 M	watts		2
03FB - 03FC	1020 - 1021	VARs, 3-Ph total	FLOAT	-9999 M to +9999 M	VARs		2
03FD - 03FE	1022 - 1023	VAs, 3-Ph total	FLOAT	-9999 M to +9999 M	VAs		2
03FF - 0400	1024 - 1025	Power Factor, 3-Ph total	FLOAT	-1.00 to +1.00	none		2
0401 - 0402	1026 - 1027	Frequency	FLOAT	0 to 65.00	Hz		2
0403 - 0404	1028 - 1029	Neutral Current	FLOAT	0 to 9999 M	amps		2
						Block Size:	30
Primary Energy Block						read-only	

Modbus Address							
Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
044B - 044C	1100 - 1101	W-hours, Received	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format	* Wh received & delivered always have opposite signs	2
044D - 044E	1102 - 1103	W-hours, Delivered	SINT32	0 to 99999999 or 0 to -99999999	Wh per energy format	* Wh received is positive for "view as load", delivered is positive for "view as generator"	2
044F - 0450	1104 - 1105	W-hours, Net	SINT32	-99999999 to 99999999	Wh per energy format		2
0451 - 0452	1106 - 1107	W-hours, Total	SINT32	0 to 99999999	Wh per energy format	* 5 to 8 digits	2
0453 - 0454	1108 - 1109	VAR-hours, Positive	SINT32	0 to 99999999	VARh per energy format	* decimal point implied, per energy format	2
0455 - 0456	1110 - 1111	VAR-hours, Negative	SINT32	0 to -99999999	VARh per energy format	* resolution of digit before decimal point = units, kilo, or mega, per energy format	2
0457 - 0458	1112 - 1113	VAR-hours, Net	SINT32	-99999999 to 99999999	VARh per energy format		2
0459 - 045A	1114 - 1115	VAR-hours, Total	SINT32	0 to 99999999	VARh per energy format		2
045B - 045C	1116 - 1117	VA-hours, Total	SINT32	0 to 99999999	VAh per energy format	* see note 10	2
						Block Size:	18
Primary Demand Block (IEEE Floating Point)						**read-only**	
07CF - 07D0	2000 - 2001	Amps A, Average	FLOAT	0 to 9999 M	amps		2
07D1 - 07D2	2002 - 2003	Amps B, Average	FLOAT	0 to 9999 M	amps		2
07D3 - 07D4	2004 - 2005	Amps C, Average	FLOAT	0 to 9999 M	amps		2
07D5 - 07D6	2006 - 2007	Positive Watts, 3-Ph, Average	FLOAT	-9999 M to +9999 M	watts		2
07D7 - 07D8	2008 - 2009	Positive VARs, 3-Ph, Average	FLOAT	-9999 M to +9999 M	VARs		2
07D9 - 07DA	2010 - 2011	Negative Watts, 3-Ph, Average	FLOAT	-9999 M to +9999 M	watts		2
07DB - 07DC	2012 - 2013	Negative VARs, 3-Ph, Average	FLOAT	-9999 M to +9999 M	VARs		2
07DD - 07DE	2014 - 2015	VAs, 3-Ph, Average	FLOAT	-9999 M to +9999 M	VAs		2
07DF - 07E0	2016 - 2017	Positive PF, 3-Ph, Average	FLOAT	-1.00 to +1.00	none		2
07E1 - 07E2	2018 - 2019	Negative PF, 3-PF, Average	FLOAT	-1.00 to +1.00	none		2
						Block Size:	20
Primary Minimum Block (IEEE Floating Point)						**read-only**	
0BB7 - 0BB8	3000 - 3001	Volts A-N, Minimum	FLOAT	0 to 9999 M	volts		2
0BB9 - 0BBA	3002 - 3003	Volts B-N, Minimum	FLOAT	0 to 9999 M	volts		2
0BBB - 0BBC	3004 - 3005	Volts C-N, Minimum	FLOAT	0 to 9999 M	volts		2
0BBD - 0BBE	3006 - 3007	Volts A-B, Minimum	FLOAT	0 to 9999 M	volts		2
0BBF - 0BC0	3008 - 3009	Volts B-C, Minimum	FLOAT	0 to 9999 M	volts		2
0BC1 - 0BC2	3010 - 3011	Volts C-A, Minimum	FLOAT	0 to 9999 M	volts		2
0BC3 - 0BC4	3012 - 3013	Amps A, Minimum Avg Demand	FLOAT	0 to 9999 M	amps		2
0BC5 - 0BC6	3014 - 3015	Amps B, Minimum Avg Demand	FLOAT	0 to 9999 M	amps		2
0BC7 - 0BC8	3016 - 3017	Amps C, Minimum Avg Demand	FLOAT	0 to 9999 M	amps		2
0BC9 - 0BCA	3018 - 3019	Positive Watts, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	watts		2
0BCB - 0BCC	3020 - 3021	Positive VARs, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	VARs		2
0BCD - 0BCE	3022 - 3023	Negative Watts, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	watts		2
0BCF - 0BD0	3024 - 3025	Negative VARs, 3-Ph, Minimum Avg Demand	FLOAT	0 to +9999 M	VARs		2
0BD1 - 0BD2	3026 - 3027	VAs, 3-Ph, Minimum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2
0BD3 - 0BD4	3028 - 3029	Positive Power Factor, 3-Ph, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2

Modbus Address							
Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
0BD5 - 0BD6	3030 - 3031	Negative Power Factor, 3-Ph, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2
0BD7 - 0BD8	3032 - 3033	Frequency, Minimum	FLOAT	0 to 65.00	Hz		2
						Block Size:	34
Primary Maximum Block (IEEE Floating Point)						read-only	
0C1B - 0C1C	3100 - 3101	Volts A-N, Maximum	FLOAT	0 to 9999 M	volts		2
0C1D - 0C1E	3102 - 3103	Volts B-N, Maximum	FLOAT	0 to 9999 M	volts		2
0C1F - 0C20	3104 - 3105	Volts C-N, Maximum	FLOAT	0 to 9999 M	volts		2
0C21 - 0C22	3106 - 3107	Volts A-B, Maximum	FLOAT	0 to 9999 M	volts		2
0C23 - 0C24	3108 - 3109	Volts B-C, Maximum	FLOAT	0 to 9999 M	volts		2
0C25 - 0C26	3110 - 3111	Volts C-A, Maximum	FLOAT	0 to 9999 M	volts		2
0C27 - 0C28	3112 - 3113	Amps A, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2
0C29 - 0C2A	3114 - 3115	Amps B, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2
0C2B - 0C2C	3116 - 3117	Amps C, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2
0C2D - 0C2E	3118 - 3119	Positive Watts, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	watts		2
0C2F - 0C30	3120 - 3121	Positive VARs, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	VARs		2
0C31 - 0C32	3122 - 3123	Negative Watts, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	watts		2
0C33 - 0C34	3124 - 3125	Negative VARs, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	VARs		2
0C35 - 0C36	3126 - 3127	VAs, 3-Ph, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2
0C37 - 0C38	3128 - 3129	Positive Power Factor, 3-Ph, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2
0C39 - 0C3A	3130 - 3131	Negative Power Factor, 3-Ph, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2
0C3B - 0C3C	3132 - 3133	Frequency, Maximum	FLOAT	0 to 65.00	Hz		2
						Block Size:	34
THD Block[7, 13]						read-only	
0F9F - 0F9F	4000 - 4000	Volts A-N, %THD	UINT16	0 to 9999, or 65535	0.1%		1
0FA0 - 0FA0	4001 - 4001	Volts B-N, %THD	UINT16	0 to 9999, or 65535	0.1%		1
0FA1 - 0FA1	4002 - 4002	Volts C-N, %THD	UINT16	0 to 9999, or 65535	0.1%		1
0FA2 - 0FA2	4003 - 4003	Amps A, %THD	UINT16	0 to 9999, or 65535	0.1%		1
0FA3 - 0FA3	4004 - 4004	Amps B, %THD	UINT16	0 to 9999, or 65535	0.1%		1
0FA4 - 0FA4	4005 - 4005	Amps C, %THD	UINT16	0 to 9999, or 65535	0.1%		1
0FA5 - 0FA5	4006 - 4006	Phase A Current 0th harmonic magnitude	UINT16	0 to 65535	none		1
0FA6 - 0FA6	4007 - 4007	Phase A Current 1st harmonic magnitude	UINT16	0 to 65535	none		1
0FA7 - 0FA7	4008 - 4008	Phase A Current 2nd harmonic magnitude	UINT16	0 to 65535	none		1
0FA8 - 0FA8	4009 - 4009	Phase A Current 3rd harmonic magnitude	UINT16	0 to 65535	none		1
0FA9 - 0FA9	4010 - 4010	Phase A Current 4th harmonic magnitude	UINT16	0 to 65535	none		1
0FAA - 0FAA	4011 - 4011	Phase A Current 5th harmonic magnitude	UINT16	0 to 65535	none		1
0FAB - 0FAB	4012 - 4012	Phase A Current 6th harmonic magnitude	UINT16	0 to 65535	none		1
0FAC - 0FAC	4013 - 4013	Phase A Current 7th harmonic magnitude	UINT16	0 to 65535	none		1
0FAD - 0FAD	4014 - 4014	Phase A Voltage 0th harmonic magnitude	UINT16	0 to 65535	none		1
0FAE - 0FAE	4015 - 4015	Phase A Voltage 1st harmonic magnitude	UINT16	0 to 65535	none		1

Modbus Address Hex	Modbus Address Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
0FAF - 0FAF	4016 - 4016	Phase A Voltage 2nd harmonic magnitude	UINT16	0 to 65535	none		1
0FB0 - 0FB0	4017 - 4017	Phase A Voltage 3rd harmonic magnitude	UINT16	0 to 65535	none		1
0FB1 - 0FB8	4018 - 4025	Phase B Current harmonic magnitudes	same as Phase A Current 0th to 7th harmonic magnitudes				8
0FB9 - 0FBC	4026 - 4029	Phase B Voltage harmonic magnitude	same as Phase A Voltage 0th to 3rd harmonic magnitudes				4
0FBD - 0FC4	4030 - 4037	Phase C Current harmonic magnitudes	same as Phase A Current 0th to 7th harmonic magnitudes				8
0FC5 - 0FC8	4038 - 4041	Phase C Voltage harmonic magnitude	same as Phase A Voltage 0th to 3rd harmonic magnitudes				4
						Block Size:	42
Phase Angle Block[14]						**read-only**	
1003 - 1003	4100 - 4100	Phase A Current	SINT16	-1800 to +1800	0.1 degree		1
1004 - 1004	4101 - 4101	Phase B Current	SINT16	-1800 to +1800	0.1 degree		1
1005 - 1005	4102 - 4102	Phase C Current	SINT16	-1800 to +1800	0.1 degree		1
1006 - 1006	4103 - 4103	Angle, Volts A-B	SINT16	-1800 to +1800	0.1 degree		1
1007 - 1007	4104 - 4104	Angle, Volts B-C	SINT16	-1800 to +1800	0.1 degree		1
1008 - 1008	4105 - 4105	Angle, Volts C-A	SINT16	-1800 to +1800	0.1 degree		1
						Block Size:	6
Status Block						**read-only**	
1387 - 1387	5000 - 5000	Meter Status	UINT16	bit-mapped	--exnpch ssssssss	exnpch = EEPROM block OK flags (e=energy, x=max, n=min, p=programmable settings, c=calibration, h=header), ssssssss = state (1=Run, 2=Limp, 10=Prog Set Update via buttons, 11=Prog Set Update via IrDA, 12=Prog Set Update via COM2)	1
1388 - 1388	5001 - 5001	Limits Status[7]	UINT16	bit-mapped	87654321 87654321	high byte is setpt 1, 0=in, 1=out low byte is setpt 2, 0=in, 1=out	1
1389 - 138A	5002 - 5003	Time Since Reset	UINT32	0 to 4294967294	4 msec	wraps around after max count	2
						Block Size:	4
Commands Section[4]							
Resets Block[9]						**write-only**	
4E1F - 4E1F	20000 - 20000	Reset Max/Min Blocks	UINT16	password[5]			1
4E20 - 4E20	20001 - 20001	Reset Energy Accumulators	UINT16	password[5]			1
						Block Size:	2
Meter Programming Block						**read/conditional write**	
55EF - 55EF	22000 - 22000	Initiate Programmable Settings Update	UINT16	password[5]		meter enters PS update mode	1
55F0 - 55F0	22001 - 22001	Terminate Programmable Settings Update[3]	UINT16	any value		meter leaves PS update mode via reset	1
55F1 - 55F1	22002 - 22002	Calculate Programmable Settings Checksum[3]	UINT16			meter calculates checksum on RAM copy of PS block	1

Modbus Address Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
55F2 - 55F2	22003 - 22003	Programmable Settings Checksum[3]	UINT16			read/write checksum register; PS block saved in EEPROM on write[8]	1
55F3 - 55F3	22004 - 22004	Write New Password[3]	UINT16	0000 to 9999		write-only register; always reads zero	1
59D7 - 59D7	23000 - 23000	Initiate Meter Firmware Reprogramming	UINT16	password[5]			1
						Block Size:	6
Other Commands Block						**read/write**	
61A7 - 61A7	25000 - 25000	Force Meter Restart	UINT16	password[5]		causes a watchdog reset, always reads 0	1
						Block Size:	1
Encryption Block						**read/write**	
658F - 659A	26000 - 26011	Perform a Secure Operation	UINT16			encrypted command to read password or change meter type	12
						Block Size:	12
Programmable Settings Section							
Basic Setups Block						**write only in PS update mode**	
752F - 752F	30000 - 30000	CT multiplier & denominator	UINT16	bit-mapped	dddddddd mmmmmmmm	high byte is denominator (1 or 5, read-only), low byte is multiplier (1, 10, or 100)	1
7530 - 7530	30001 - 30001	CT numerator	UINT16	1 to 9999	none		1
7531 - 7531	30002 - 30002	PT numerator	UINT16	1 to 9999	none		1
7532 - 7532	30003 - 30003	PT denominator	UINT16	1 to 9999	none		1
7533 - 7533	30004 - 30004	PT multiplier & hookup	UINT16	bit-mapped	mmmmmmmm MMMMhhhh	MMMMmmmmmmmm is PT multiplier (1, 10, 100, 1000), hhhh is hookup enumeration (0 = 3 element wye[9S], 1 = delta 2 CTs[5S], 3 = 2.5 element wye[6S])	1
7534 - 7534	30005 - 30005	Averaging Method	UINT16	bit-mapped	--iiiiii b----sss	iiiiii = interval (5,15,30,60) b = 0-block or 1-rolling sss = # subintervals (1,2,3,4)	1
7535 - 7535	30006 - 30006	Power & Energy Format	UINT16	bit-mapped	pppp--nn -eee-ddd	pppp = power scale (0-unit, 3-kilo, 6-mega, 8-auto) nn = number of energy digits (5-8 --> 0-3) eee = energy scale (0-unit, 3-kilo, 6-mega) ddd = energy digits after decimal point (0-6) See note 10.	1

Modbus Address							
Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
7536 - 7536	30007 - 30007	Operating Mode Screen Enables	UINT16	bit-mapped	00000000 eeeeeeee	eeeeeeee = op mode screen rows on(1) or off(0), rows top to bottom are bits low order to high order	1
7537 - 753D	30008 - 30014	Reserved					7
753E - 753E	30015 - 30015	User Settings Flags	UINT16	bit-mapped	---g--nn srp--wf-	g = enable alternate full scale bargraph current (1=on, 0=off) nn = number of phases for voltage & current screens (3=ABC, 2=AB, 1=A, 0=ABC) s = scroll (1=on, 0=off) r = password for reset in use (1=on, 0=off) p = password for configuration in use (1=on, 0=off) w = pwr dir (0-view as load, 1-view as generator) f = flip power factor sign (1=yes, 0=no)	1
753F - 753F	30016 - 30016	Full Scale Current (for load % bargraph)	UINT16	0 to 9999	none	If non-zero and user settings bit g is set, this value replaces CT numerator in the full scale current calculation.	1
7540 - 7547	30017 - 30024	Meter Designation	ASCII	16 char	none		8
7548 - 7548	30025 - 30025	COM1 setup	UINT16	bit-mapped	----dddd -0100110	dddd = reply delay (* 50 msec) ppp = protocol (1-Modbus RTU, 2-Modbus ASCII, 3-DNP) bbb = baud rate (1-9600, 2-19200, 4-38400, 6-57600)	1
7549 - 7549	30026 - 30026	COM2 setup	UINT16	bit-mapped	----dddd -ppp-bbb		1
754A - 754A	30027 - 30027	COM2 address	UINT16	1 to 247	none		1
754B - 754B	30028 - 30028	Limit #1 Identifier	UINT16	0 to 65535		use Modbus address as the identifier (see notes 7, 11, 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 "belov 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

Modbus Address Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
7569 - 756D	30058 - 30062	Limit #7	SINT16				5
756E - 7572	30063 - 30067	Limit #8	SINT16				5
						Block Size:	68
12-Bit Readings Section							
12-Bit Block						read-only except as noted	
9C40 - 9C40	40001 - 40001	System Sanity Indicator	UINT16	0 or 1	none	0 indicates proper meter operatio	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		1
9C50 - 9C50	40017 - 40017	CT multiplier	UINT16	1, 10, 100	none	CT = numerator * multiplier / denominator	1
9C51 - 9C51	40018 - 40018	CT denominator	UINT16	1 or 5	none		1
9C52 - 9C52	40019 - 40019	PT numerator	UINT16	1 to 9999	none		1
9C53 - 9C53	40020 - 40020	PT multiplier	UINT16	1, 10, 100	none	PT = numerator * multiplier / denominator	1
9C54 - 9C54	40021 - 40021	PT denominator	UINT16	1 to 9999	none		1
9C55 - 9C56	40022 - 40023	W-hours, Positive	UINT32	0 to 99999999	Wh per energy format	* 5 to 8 digits	2
9C57 - 9C58	40024 - 40025	W-hours, Negative	UINT32	0 to 99999999	Wh per energy format	* decimal point implied, per energy format	2
9C59 - 9C5A	40026 - 40027	VAR-hours, Positive	UINT32	0 to 99999999	VARh per energy format	* resolution of digit before decimal point =	2
9C5B - 9C5C	40028 - 40029	VAR-hours, Negative	UINT32	0 to 99999999	VARh per energy format	units, kilo, or mega, per energy format	2
9C5D - 9C5E	40030 - 40031	VA-hours	UINT32	0 to 99999999	VAh per energy format	* see note 10	2
9C5F - 9C5F	40032 - 40032	Neutral Current	UINT16	0 to 4095	amps	see Amps A/B/C above	1
9C60 - 9CA2	40033 - 40099	Reserved	N/A	N/A	none		67
9CA3 - 9CA3	40100 - 40100	Reset Energy Accumulators	UINT16	password[5]		write-only register; always reads as 0	1
						Block Size:	100

Modbus Address		Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
Hex	Decimal						
		End of Map					

Data Formats

ASCII	ASCII characters packed 2 per register in high, low order and without any termination characters. For example, "Shark100" would be 4 registers containing 0x5378, 0x6172, 0x6B31, 0x3030.
SINT16 / UINT16	16-bit signed / unsigned integer.
SINT32 / UINT32	32-bit signed / unsigned integer spanning 2 registers. The lower-addressed register is the high order half.
FLOAT	32-bit IEEE floating point number spanning 2 registers. The lower-addressed register is the high order half (i.e., contains the exponent).

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 Not applicable to Shark 100, V-Switch 1, 2, or 3

8 Writing this register causes data to be saved permanently in EEPROM. If there is an error while saving, a slave device failure exception is returned and programmable settings mode automatically terminates via reset.

9 Reset commands make no sense if the meter state is LIMP. An illegal function exception will be returned.

10 Energy registers should be reset after a format change.

11 Entities to be monitored against limits are identified by Modbus address. Entities occupying multiple Modbus registers, such as floating point values, are identified by the lower register address. If any of the 8 limits is unused, set its identifier to zero. If the indicated Modbus register is not used or is a non-sensical entity for limits, it will behave as an unused limit.

12 There are 2 setpoints per limit, one above and one below the expected range of values. LM1 is the "too high" limit, LM2 is "too low". The entity goes "out of limit" on LM1 when its value is greater than the setpoint. It remains "out of limit" until the value drops below the in threshold. LM2 works similarly, in the opposite direction. If limits in only one direction are of interest, set the in threshold on the "wrong" side of the setpoint. Limits are specified as % of full scale, where full scale is automatically set appropriately for the entity being monitored:

current FS = CT numerator * CT multiplier
voltage FS = PT numerator * PT multiplie
power FS = CT numerator * CT multiplier * PT numerator * PT multiplier * 3 [* SQRT(3) for delta hooku
frequency FS = 60 (or 50)
power factor FS = 1.0
percentage FS = 100.0
angle FS = 180.0

13 THD not available shows 65535 (=0xFFFF) in all THD and harmonic magnitude registers for the channel when V-switch=4. THD may be unavailable due to low V or I amplitude, or delta hookup (V only).

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

Appendix C
DNP Mapping for Shark® 100-S Meter

C.1: Introduction

- The DNP Map for the Shark® 100-S meter shows the client-server relationship in its use of DNP Protocol.

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

- The Shark® 100-S meter's DNP Point Map begins on the third page of this chapter.

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

  Internal Indication is described on Page 2.

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
Binary Output States								Read via Class 0 only
10	0	2	Reset Energy Counters	BYTE	Always 1	N/A	none	
10	1	2	Change to Modbus RTU Protocol	BYTE	Always 1	N/A	none	
Control Relay Outputs								
12	0	1	Reset Energy Counters	N/A	N/A	N/A	none	Responds to Function 5 (Direct Operate), Qualifier Code 17x or 28x, Control Code 3, Count 0, On 0 msec, 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.
Binary Counters (Primary)								Read via Class 0 only
20	0	4	W-hours, Positive	UINT32	0 to 99999999	multiplier = $10^{(n-d)}$, where n and d are derived from the energy format. n = 0, 3, or 6 per energy format scale and d = number of decimal places.	W hr	example:
20	1	4	W-hours, Negative	UINT32	0 to 99999999		W hr	energy format = 7.2K and W-hours counter = 1234567
20	2	4	VAR-hours, Positive	UINT32	0 to 99999999		VAR hr	n=3 (K scale), d=2 (2 digits after decimal point), multiplier = $10^{(3-2)} = 10^1 = 10$, so energy is 1234567 * 10 Whrs, or 12345.67 KWhrs
20	3	4	VAR-hours, Negative	UINT32	0 to 99999999		VAR hr	
20	4	4	VA-hours, Total	UINT32	0 to 99999999		VA hr	
Analog Inputs (Secondary)								Read via Class 0 only
30	0	5	Meter Health	SINT16	0 or 1	N/A	none	0 = OK
30	1	5	Volts A-N	SINT16	0 to 32767	(150 / 32768)	V	Values above 150V secondary read 32767.
30	2	5	Volts B-N	SINT16	0 to 32767	(150 / 32768)	V	
30	3	5	Volts C-N	SINT16	0 to 32767	(150 / 32768)	V	
30	4	5	Volts A-B	SINT16	0 to 32767	(300 / 32768)	V	Values above 300V secondary read 32767.
30	5	5	Volts B-C	SINT16	0 to 32767	(300 / 32768)	V	
30	6	5	Volts C-A	SINT16	0 to 32767	(300 / 32768)	V	
30	7	5	Amps A	SINT16	0 to 32767	(10 / 32768)	A	Values above 10A secondary read 32767.
30	8	5	Amps B	SINT16	0 to 32767	(10 / 32768)	A	
30	9	5	Amps C	SINT16	0 to 32767	(10 / 32768)	A	

Object	Point	Var	Description	Format	Range	Multiplier	Units	Comments
30	10	5	Watts, 3-Ph total	SINT16	-32768 to +32767	(4500 / 32768)	W	
30	11	5	VARs, 3-Ph total	SINT16	-32768 to +32767	(4500 / 32768)	VAR	
30	12	5	VAs, 3-Ph total	SINT16	0 to +32767	(4500 / 32768)	VA	
30	13	5	Power Factor, 3-Ph total	SINT16	-1000 to +1000	0.001	none	
30	14	5	Frequency	SINT16	0 to 9999	0.01	Hz	
30	15	5	Positive Watts, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	(4500 / 32768)	W	
30	16	5	Positive VARs, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	(4500 / 32768)	VAR	
30	17	5	Negative Watts, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	(4500 / 32768)	W	
30	18	5	Negative VARs, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	(4500 / 32768)	VAR	
30	19	5	VAs, 3-Ph, Maximum Avg Demand	SINT16	-32768 to +32767	(4500 / 32768)	VA	
30	20	5	Angle, Phase A Current	SINT16	-1800 to +1800	0.1	degree	
30	21	5	Angle, Phase B Current	SINT16	-1800 to +1800	0.1	degree	
30	22	5	Angle, Phase C Current	SINT16	-1800 to +1800	0.1	degree	
30	23	5	Angle, Volts A-B	SINT16	-1800 to +1800	0.1	degree	
30	24	5	Angle, Volts B-C	SINT16	-1800 to +1800	0.1	degree	
30	25	5	Angle, Volts C-A	SINT16	-1800 to +1800	0.1	degree	
30	26	5	CT numerator	SINT16	1 to 9999	N/A	none	CT ratio = (numerator * multiplier) / denominator
30	27	5	CT multiplier	SINT16	1, 10, or 100	N/A	none	
30	28	5	CT denominator	SINT16	1 or 5	N/A	none	
30	29	5	PT numerator	SINT16	1 to 9999	N/A	none	PT ratio = (numerator * multiplier) / denominator
30	30	5	PT multiplier	SINT16	1, 10, or 100	N/A	none	
30	31	5	PT denominator	SINT16	1 to 9999	N/A	none	
30	32	5	Neutral Current	SINT16	0 to 32767	(10 / 32768)	A	For 1A model, multiplier is (2 / 32768) and values above 2A secondary read 32767.
Internal Indication								
80	0	1	Device Restart Bit	N/A	N/A	N/A	none	Clear via Function 2 (Write), Qualifier Code 0.

Appendix D
DNP 3.0 Protocol Assignments for Shark®100-S Meter

D.1: DNP Implementation

- **PHYSICAL LAYER**
  The Shark® 100-S submeter is capable of using RS485 as the physical layer. This is accomplished by connecting a PC to the Shark® 100-S meter with the RS485 connection on the face of the submeter.

- **RS485**
  RS485 provides multi-drop network communication capabilities. Multiple submeters may be placed on the same bus, allowing for a Master device to communicate with any of the other devices. Appropriate network configuration and termination should be evaluated for each installation to insure optimal performance.

- **Communication Parameters**
  Shark® 100-S submeters communicate in DNP 3.0 using the following communication settings:
  - 8 Data Bits
  - No Parity
  - 1 Stop Bit

- **Baud Rates**
  Shark® 100-S submeters are programmable to use several standard baud rates, including:
  - 9600 Baud
  - 19200 Baud
  - 38400 Baud
  - 57600 Baud

D.2: Data Link Layer

- The Data Link Layer as implemented on Shark® submeters is subject to the following considerations:

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

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

- **Function Codes**
  Shark® 100-S submeters support all of the Function Codes for DNP 3.0. Specific notes follow.

  Reset of Data Link (Function 0)
  Before confirmed communication with a master device, the Data Link Layer must be reset. This is necessary after a submeter has been restarted, either by applying power to the submeter or reprogramming the submeter. The submeter must receive a RESET command before confirmed

communication may take place. Unconfirmed communication is always possible and does not require a RESET.

User Data (Function 3)
After receiving a request for USER DATA, the submeter will generate a Data Link CONFIRMATION, signaling the reception of that request, before the actual request is processed. If a response is required, it will also be sent as UNCONFIRMED USER DATA.

Unconfirmed User Data (Function 4)
After receiving a request for UNCONFIRMED USER DATA, if a response is required, it will be sent as UNCONFIRMED USER DATA.

Address
DNP 3.0 allows for addresses from 0 - 65534 (0x0000 - 0xFFFE) for individual device identification, with the address 65535 (0xFFFF) defined as an all stations address. Shark 100-S submeters' addresses are programmable from 0 - 247 (0x0000 - 0x00F7) and will recognize address 65535 (0xFFFF) as the all stations address.

D.3: Transport Layer

The Transport Layer as implemented on Shark® submeters is subject to the following considerations:

Transport Header
Multiple-frame messages are not allowed for Shark® 100-S submeters. Each Transport Header should indicate it is both the first frame (FIR = 1) as well as the final frame (FIN = 1).

D.4: Application Layer

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

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

- **Application Control Field**
  Multiple-fragment messages are not allowed for Shark® 100-S submeters. Each Application Header should indicate it is both the first fragment (FIR = 1) as well as the final fragment (FIN = 1). Application-Level confirmation is not used for Shark® 100-S submeters.

- **Function Codes**
  The following Function codes are implemented on Shark® 100-S submeters.

Read (Function 1)
Objects supporting the READ function are:
- Binary Outputs (Object 10)
- Counters (Object 20)
- Analog Inputs (Object 30)
- Class (Object 60)

These Objects may be read either by requesting a specific Variation available as listed in this document, or by requesting Variation 0. READ request for Variation 0 of an Object will be fulfilled with the Variation listed in this document.

Write (Function 2)
Objects supporting the WRITE function are:

- Internal Indications (Object 80)

Direct Operate (Function 5)
Objects supporting the DIRECT OPERATE function are:

- Control Relay Output Block (Object 12)

Direct Operate - No Acknowledgment (Function 6)
Objects supporting the DIRECT OPERATE - NO ACKNOWLEDGMENT function are:

- Change to MODBUS RTU Protocol

Response (Function 129)
Application responses from Shark® 100-S submeters use the RESPONSE function.

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

D.4.1: Object and Variation

The following Objects and Variations are supported on Shark® 100-S submeters:

- Binary Output Status (Object 10, Variation 2) †
- Control Relay Output Block (Object 12, Variation 1)
- 32-Bit Binary Counter Without Flag (Object 20, Variation 5) †
- 16-Bit Analog Input Without Flag (Object 30, Variation 4) †
- Class 0 Data (Object 60, Variation 1) †
- Internal Indications (Object 80, Variation 1)

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

D.4.1.1: Binary Output Status (Obj. 10, Var. 2)

Binary Output Status supports the following functions:

Read (Function 1)
A READ request for Variation 0 will be responded to with Variation 2.

Binary Output Status is used to communicate the following data measured by Shark® submeters:

- **Energy Reset State**

  Change to MODBUS RTU Protocol State

  Energy Reset State (Point 0)
  Shark® 100-S submeters accumulate power generated or consumed over time as Hour Readings, which measure positive VA Hours and positive and negative W Hours and VAR Hours. These readings may be reset using a Control Relay Output Block object (Obj. 12). This Binary Output Status point reports whether the Energy Readings are in the process of being reset, or if they are accumulating. Normally, readings are being accumulated and the state of this point is read as '0'. If the readings are in the process of being reset, the state of this point is read as '1'.

  Change to Modbus RTU Protocol State (Point 1)
  Shark® 100-S submeters are capable of changing from DNP Protocol to Modbus RTU Protocol. This enables the user to update the Device Profile of the submeter. This does not change the Protocol setting. A submeter reset brings you back to DNP. Status reading of "1" equals Open, or de-energized. A reading of "0" equals Closed, or energized.

D.4.1.2: Control Relay Output Block (Obj. 12, Var. 1)

Control Relay Output Blocks support the following functions:

Direct Operate (Function 5)

Direct Operate - No Acknowledgment (Function 6)

Control Relay Output Blocks are used for the following purposes:

- **Energy Reset**
  Change to MODBUS RTU Protocol

  Energy Reset (Point 0)
  Shark® 100-S submeters accumulate power generated or consumed over time as Hour Readings, which measure positive VA Hours and positive and negative W Hours and VAR Hours. These readings may be reset using Point 0.

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

- **Change to Modbus RTU Protocol (Point 1)**
  Shark® 100-S submeters are capable of changing from DNP Protocol to Modbus RTU Protocol. This enables the user to update the Device Profile of the submeter. This does not change the Protocol setting. A submeter reset brings you back to DNP.

  Use of the DIRECT OPERATE - NO ACKNOWLEDGE (Function 6) function will operate only with the settings of Pulsed ON (Code = 1 of Control Code Field) once (Count = 0x01) for ON 1 millisecond and OFF 0 milliseconds.

D.4.1.3: 32-Bit Binary Counter Without Flag (Obj. 20, Var. 5)

Counters support the following functions:

Read (Function 1)
A READ request for Variation 0 will be responded to with Variation 5.

Counters are used to communicate the following data measured by Shark 100-S submeters:

Hour Readings

■ **Hour Readings (Points 0 - 4)**

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

* These readings may be cleared by using the Contol Relay Output Block.

D.4.1.4: 16-Bit Analog Input Without Flag (Obj. 30, Var. 4)

Analog Inputs support the following functions:

Read (Function 1)
A READ request for Variation 0 will be responded to with Variation 4.

Analog Inputs are used to communicate the following data measured by Shark 100-S submeters:

- Health Check
- Phase-to-Neutral Voltage
- Phase-to-Phase Voltage
- Phase Current
- Total Power
- Three Phase Total VAs
- Three Phase Power Factor Total
- Frequency
- Three Phase +Watts Max Avg Demand
- Three Phase + VARs Max Avg Demand
- Three Phase -Watts Max Avg Demand
- Three Phase -VARs Max Avg Demand
- Three Phase VAs Max Avg Demand
- Angle, Phase Power
- Angle, Phase-to-Phase Voltage
- CT Numerator, Multiplier, Denominator
- PT Numerator, Multiplier, Denominator

■ **Health Check (Point 0)**
The Health Check point is used to indicate problems detected by the Shark 100-S submeter. A value of zero (0x0000) indicates the submeter does not detect a problem. Non-zero values indicate a detected anomaly.

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

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

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

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

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

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

■ **Phase Current (Points 7 - 9)**

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

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

■ **Total Power (Points 10 - 11)**

Point	Reading
10	Total Watt
11	Total VAR

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

■ **Total VA (Point 12)**

Point	Reading
12	Total VA

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

- **Power Factor (Point 13)**

Point	Reading
13	Power Factor Total

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

- **Frequency (Point 14)**

Point	Reading
14	Frequency

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

- **Maximum Demands of Total Power (Points 15 - 19)**

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

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

Phase Angle (Points 20 - 25)

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

These points are formatted as 2's complement integers. They represent angles from -180.0^{0} (0x0F8F8) to +180.0^{0} (0x00708).

CT & PT Ratios (Points 26 - 31)

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

These points are formatted as 2's complement integers. They can be used to convert from units in terms of the Secondary of a CT or PT into units in terms of the Primary of a CT or PT. The ratio of Numerator divided by Denominator is the ratio of Primary to Secondary.
Shark 100-S submeters typically use Full Scales relating Primary Current to 5 Amps and Primary Voltage to 120 V. However, these Full scales can range from mAs to thousands of kAs, or mVs, to thousands of kVs. Following are example settings:

CT Example Settings:

200 Amps:	Set the Ct-n value for 200 and the Ct-S value for 1.
800 Amps:	Set the Ct-n value for 800 and the Ct-S value for 1.
2,000 Amps:	Set the Ct-n value for 2000 and the Ct-S value for 1.
10,000 Amps:	Set the Ct-n value for 1000 and the Ct-S value for 10.

NOTE: CT Denominator is fixed at 5 for 5 ampere unit.
CT Denominator is fixed at 1 for 1 ampere unit.

PT Example Settings:

120 Volts (Reads 14,400 Volts):	Pt-n value is 1440, Pt-d value is 120, Pt-S value is 10.
69 Volts (Reads 138,000 Volts):	Pt-n value is 1380, Pt-d value is 69, Pt-S value is 100.
115 Volts (Reads 347,000 Volts):	Pt-n value is 3450, Pt-d value is 115, Pt-S value is 100.
69 Volts (Reads 347,000 Volts):	Pt-n value is 345, Pt-d value is 69, Pt-S value is 1000.

D.4.1.5: Class 0 Data (Obj. 60, Var. 1)

Class Data support the following functions:

Read (Function 1)

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

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

D.4.1.6: Internal Indications (Obj. 80, Var. 1)

Internal Indications support the following functions:

· **Write (Function 2)**

Internal Indications may be indexed by Qualifier Code 0.

■ **Device Restart (Point 0)**

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

Appendix E
Using the USB to IrDA Adapter (CAB6490)

E.1: Introduction

Com 1 of the Shark® 100-S submeter 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® 100-S meter's data from a PC. This Appendix contains instructions for installing the USB to IrDA Adapter.

E.2: Installation Procedures

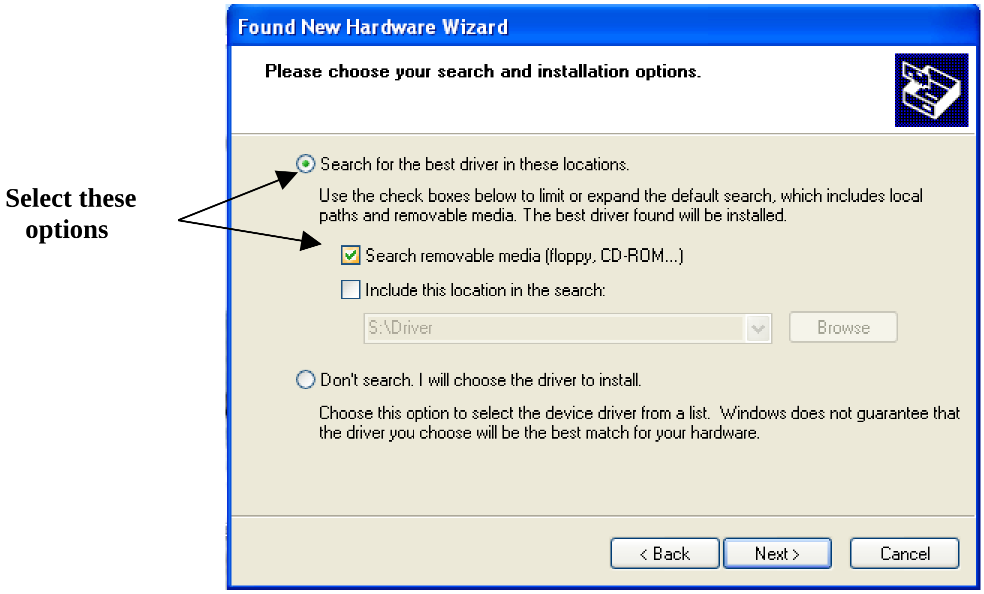
The **USB to IrDA Adapter** comes packaged with a **USB cable** and an **Installation CD**. Follow this procedure to install the Adapter on your PC.

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.

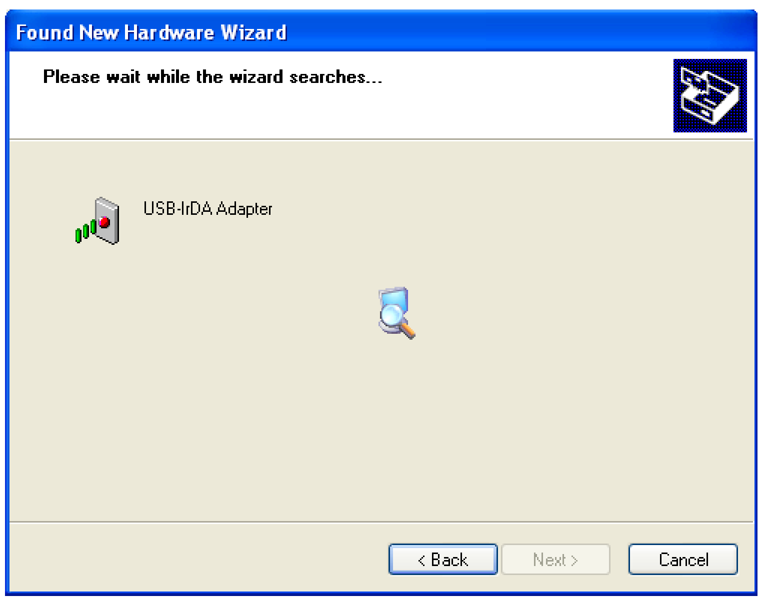
3. You will see the screen shown below. The **Found New Hardware Wizard** allows you to install the software for the Adapter. Click the Radio Button next to **Install from a list or specific location.**

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

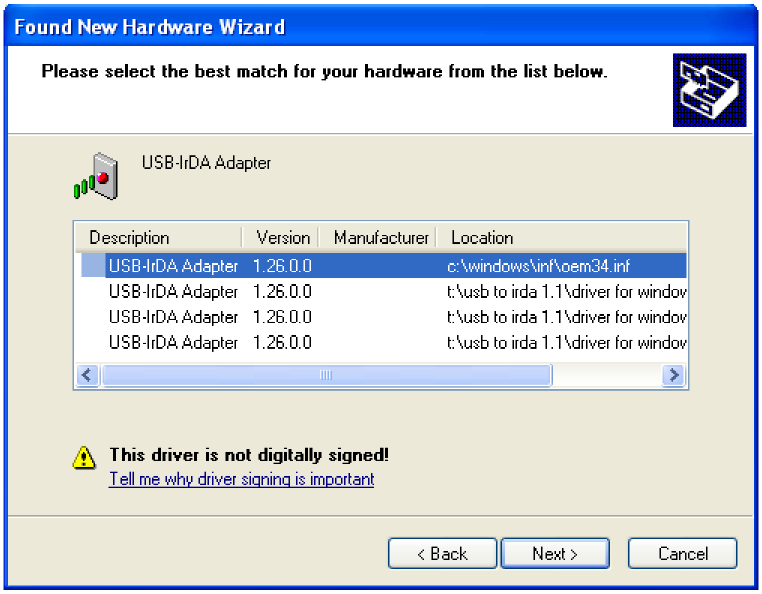


5. Make sure the **first Radio Button** and the **first Checkbox** are selected, as shown in the above screen. These selections allow the Adapter's driver to be copied from the Installation disk to your PC.

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

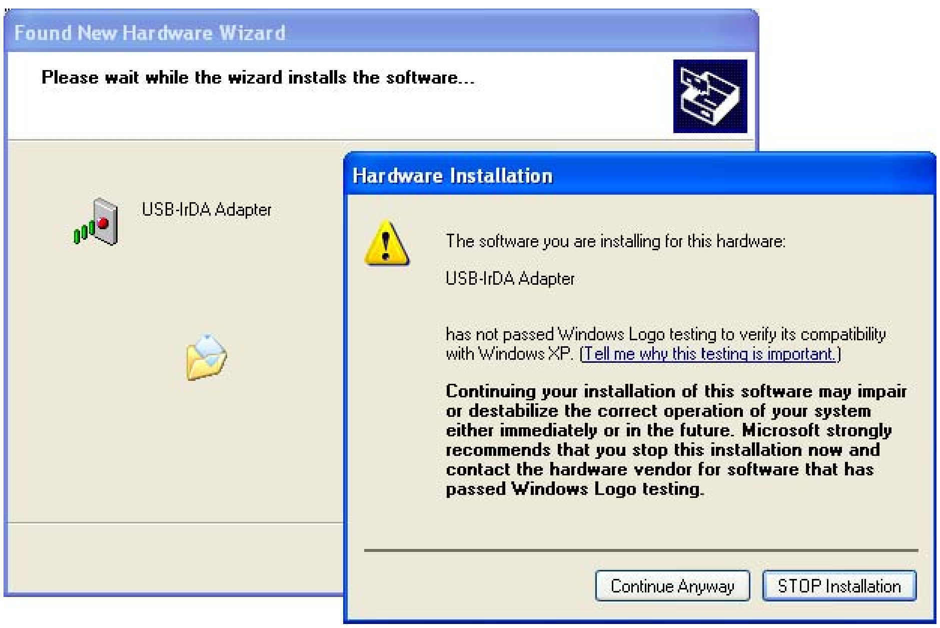


7. When the **driver** for the **Adapter** is found, you will see the screen shown on the next page.

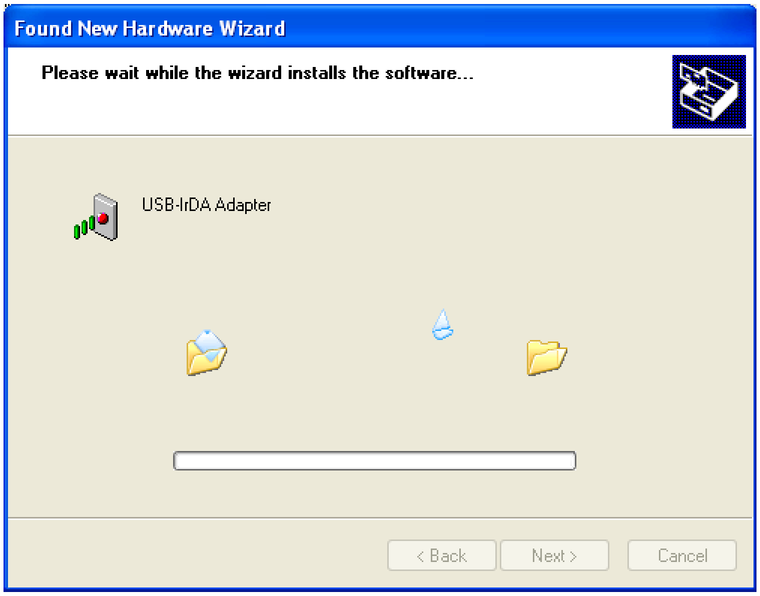


8. You do not need to be concerned about the message on the bottom of the screen. Click **Next** to **continue** with the installation.

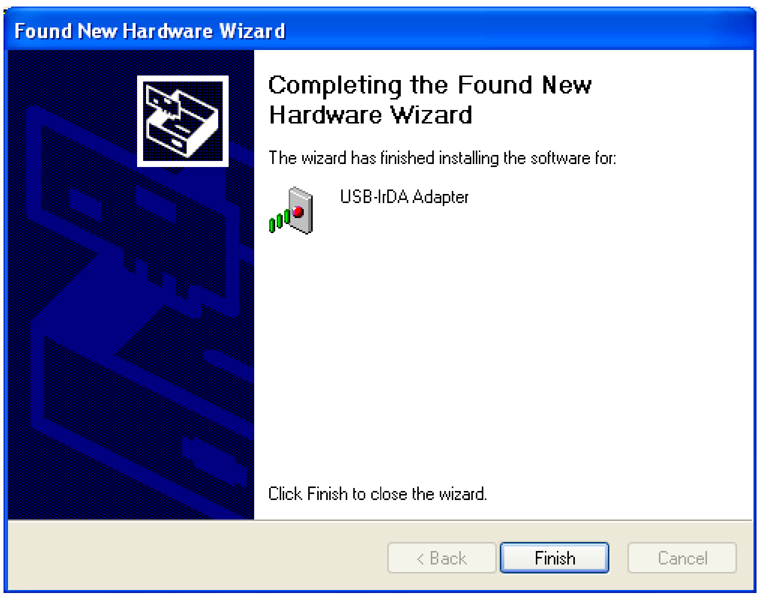
9. You will see the two windows shown below. Click **Continue Anyway**.



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



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



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

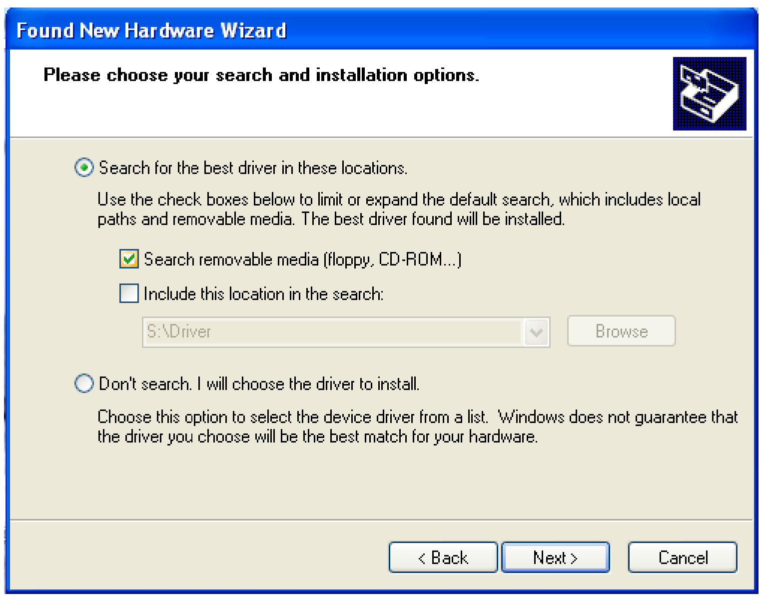
IMPORTANT! Do NOT remove the Installation CD until the entire procedure has been completed.

13. Position the **USB to IrDA Adapter** so that it points directly at the **IrDA** on the front of the Shark® 100-S submeter. It should be as close as possible to the meter, and not more than 15 inches/38 cm away from it.

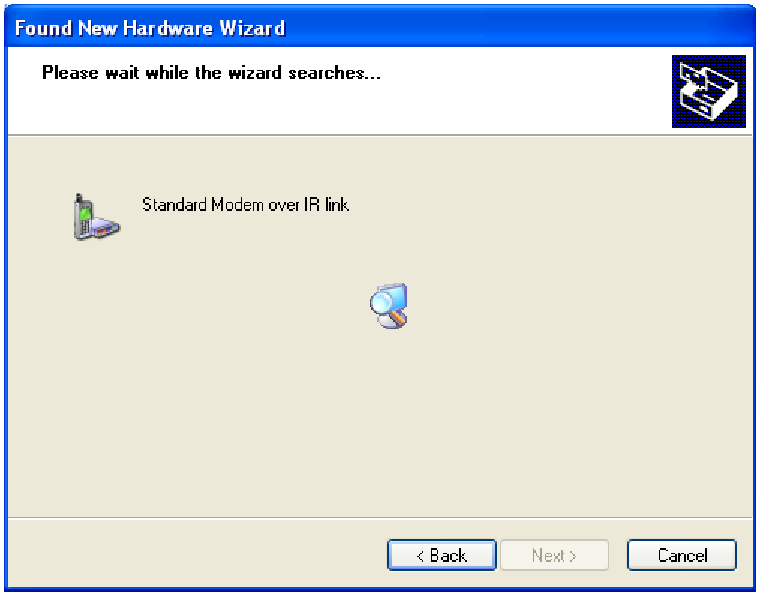
14. The **Found New Hardware Wizard** screen opens again.

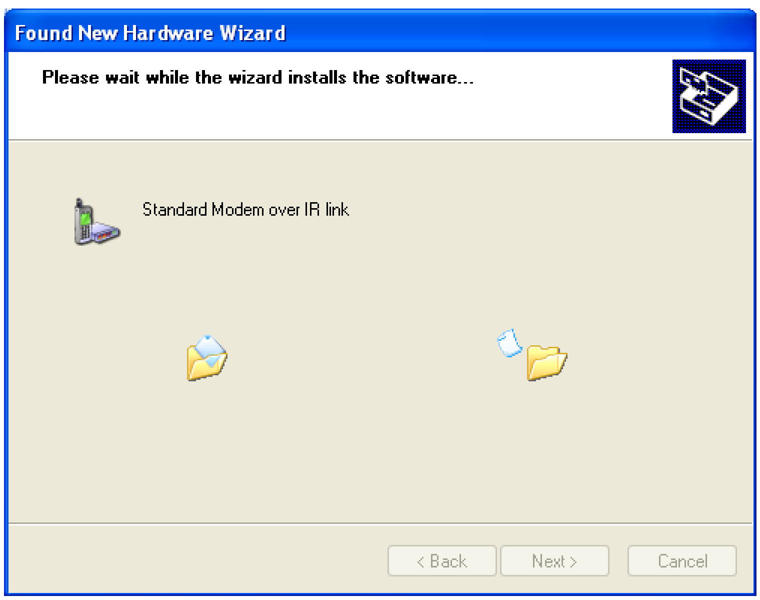
This time, click the Radio Button next to **Install the software automatically**.

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

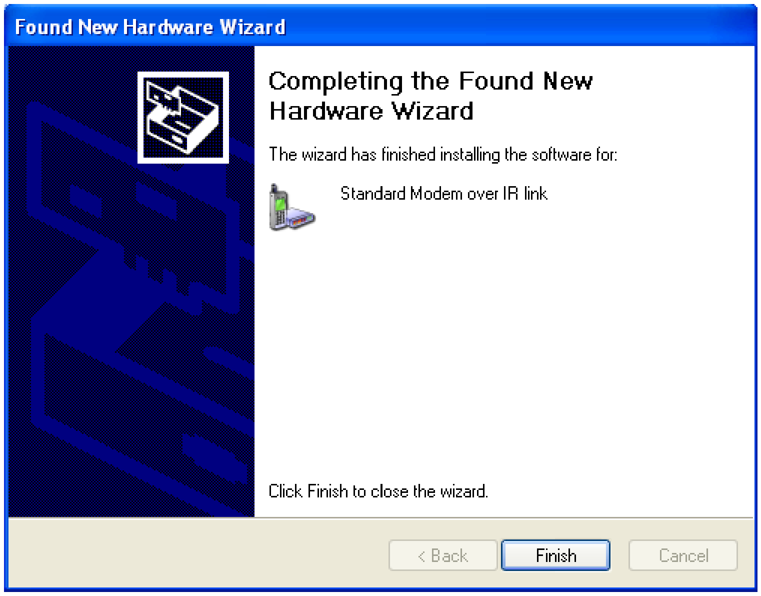


16. Make sure the **first Radio Button** and the **first Checkbox** are selected, as shown in the above screen. Click **Next**. You will see the two screens shown on the next page.



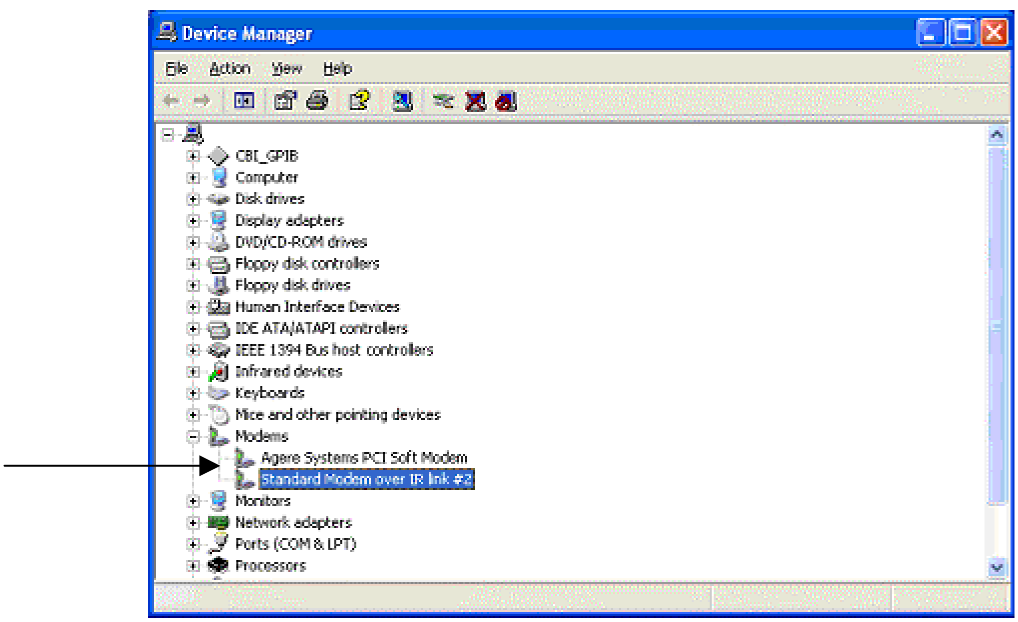


17. When the **installation** is **complete**, you will see the screen shown on the next page.



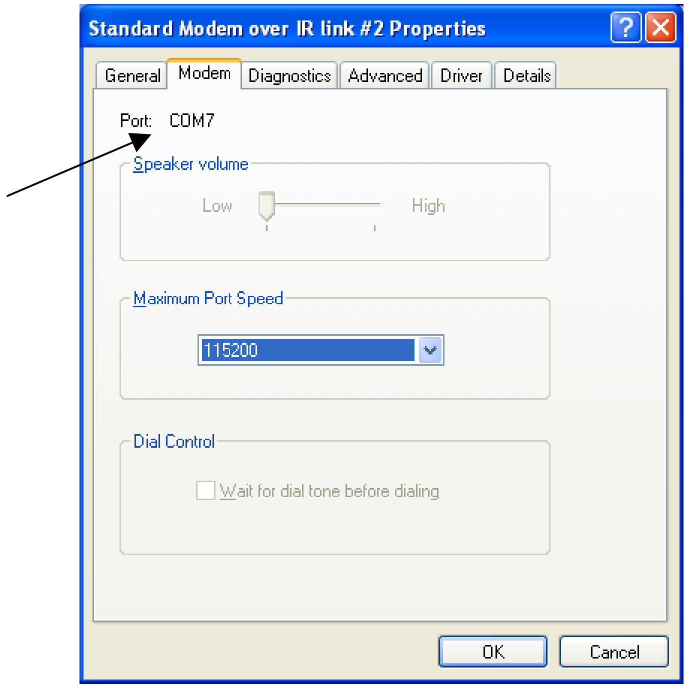
Click **Finish** to close the **Found New Hardware Wizard**.

18. 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 below.
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.



19. 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.

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



21. Use this **Com Port** to connect to the meter from your PC, using the **Communicator EXT** software. Refer to Chapter 5 of the *Communicator EXT 3.0 User's Manual* for detailed connection instructions.