Shark® 50

Electrical multifunction power meter

Installation & Operation Manual
Revision 1.01

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Electro Industries/GaugeTech

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"The Leader in Power Monitoring and Control"

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Customer Service and Support

Customer support is available 9:00 am to 4:30 pm, eastern standard time, Monday through Friday. Please have the model, serial number and a detailed problem description available. If the problem concerns a particular reading, please have all meter readings available. When returning any merchandise to EIG, a return materials authorization number is required. For customer or technical assistance, repair or calibration, phone 516-334-0870 or fax to 516-338-4741.

Product Warranty

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

To exercise this warranty, fax or call our customer-support department. You will receive prompt assistance and return instructions. Send the instrument, transportation prepaid, to EIG at 1800 Shames Drive, Westbury, NY 11590. Repairs will be made and the instrument will be returned.nnnn

Limitation of Warranty

This warranty does not apply to defects resulting from unauthorized modification, misuse, or use for any reason other than electrical power monitoring. The Shark® 50 meter is not a user-serviceable product.

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

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. ELECTRO INDUSTRIES/GAUGETECH SHALL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL OR CONSEQUENTIAL DAMAGES ARISING FROM ANY AUTHORIZED OR UNAUTHORIZED USE OF ANY ELECTRO INDUSTRIES/GAUGETECH PRODUCT. LIABILITY SHALL BE LIMITED TO THE ORIGINAL COST OF THE PRODUCT SOLD.

Statement of Calibration

Our instruments are inspected and tested in accordance with specifications published by Electro Industries/GaugeTech. The accuracy and a calibration of our instruments are traceable to the National Institute of Standards and Technology through equipment that is calibrated at planned intervals by comparison to certified standards.

Disclaimer

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

This symbol indicates that the operator must refer to an explanation in the operating instructions. Please see Chapter 4, Electrical Installation, for important safety information regarding installation and hookup of the Shark 50 Meter.

About Electro Industries/GaugeTech

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

1981: First micro-processor based power monitor
1986: First PC-based power monitoring software for plant-wide power distribution analysis
1994: First 1 Megabyte memory high-performance power monitor for data analysis and recording
1999: Nexus® Series generation for power monitoring with industry-leading accuracy
2000: First low-profile socket meter with advanced features for utility deregulation.
2001: First auto-calibrating meter under glass
2005: Shark® 100 Sub-meter and Shark® 100-S wireless sub-meter
2007: Shark® 200 data-logging sub-meter with optional I/O
2008: Nexus® 1500 transient recorder and power meter with advanced PQ and comunication
2009: Shark® 200-S wireless data-logging sub-meter
2010: Total Web Solutions web server for Nexus® Series meters

Thirty years since its founding, Electro Industries/GaugeTech, the leader in power monitoring and control, continues to revolutionize the industry with the highest quality, cutting edge power monitoring and control technology on the market today. An ISO 9001:2000 certified company, EIG sets the industry standard for advanced power quality and reporting, revenue metering and substation data acquisition and control. EIG products can be found on site at virtually all of today's leading manufacturers, industrial giants and utilities.

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

Applications:

- Web-Accessed Multifunction Power Monitoring and Control
- Single and Multifunction Power Monitoring
- Power Quality Monitoring
- Onboard Data Logging for Trending Power Usage and Quality
- Disturbance Analysis
- Revenue Metering and Billing

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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).

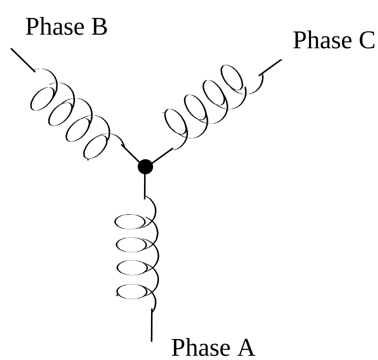

Figure 1.1: Three-Phase Wye Winding

- 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.

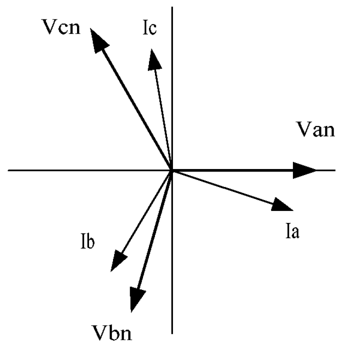

Fig 1.2: Phasor diagram showing Three-phase Voltages and Currents

- 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.

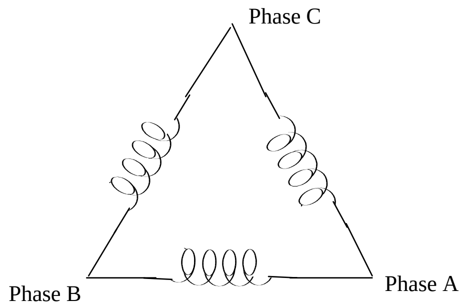

Figure 1.3: Three-Phase Delta Winding Relationship

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.

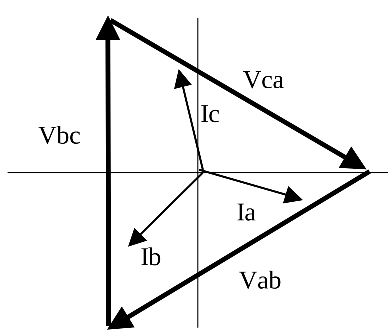

Figure 1.4: Phasor diagram showing three-phase voltages, currents delta connected.

- 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.

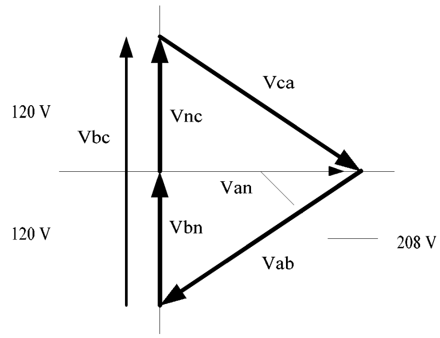

Fig 1.5: Phasor diagram showing Three-phase, Four-wire Delta Connected System

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.

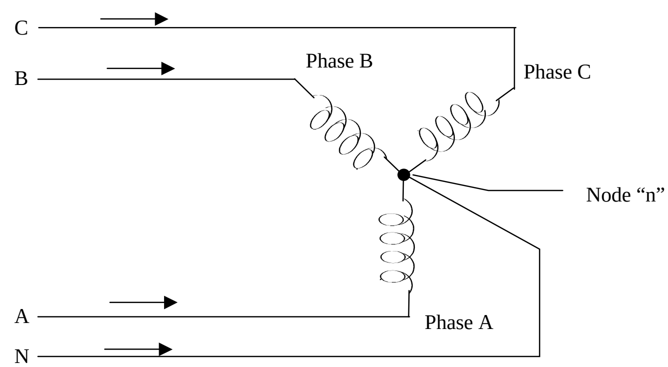

Figure 1.6: Three-Phase Wye Load illustrating Kirchhoff's Law and Blondell's Theorem

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).

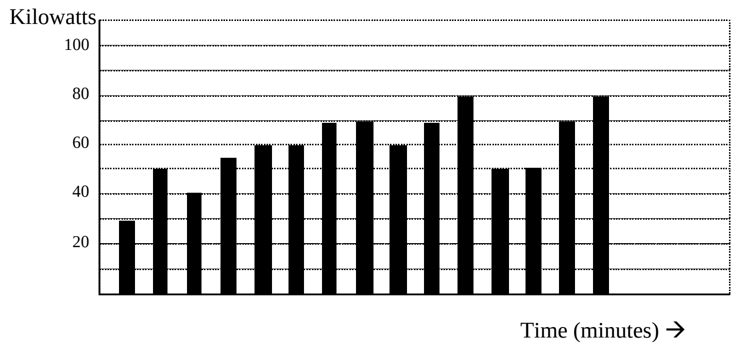

Figure 1.7: Power use over time

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.

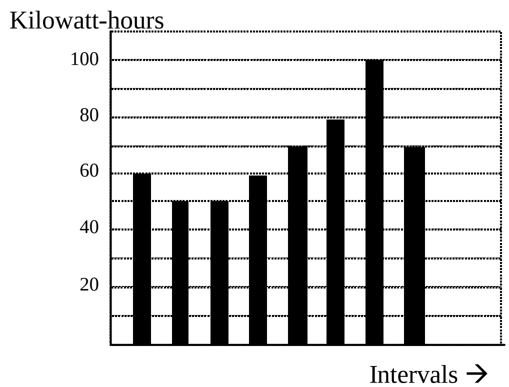

Figure 1.8: Energy use and demand

- 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.

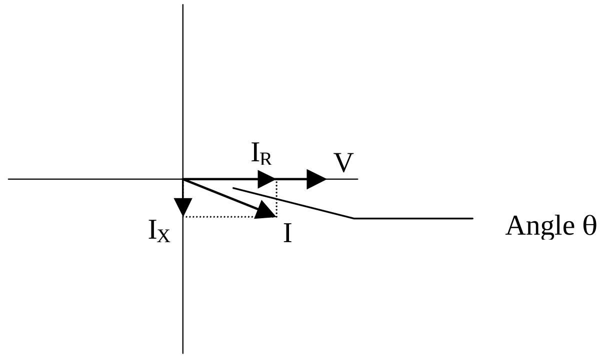

Figure 1.9: Voltage and complex current

- 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.

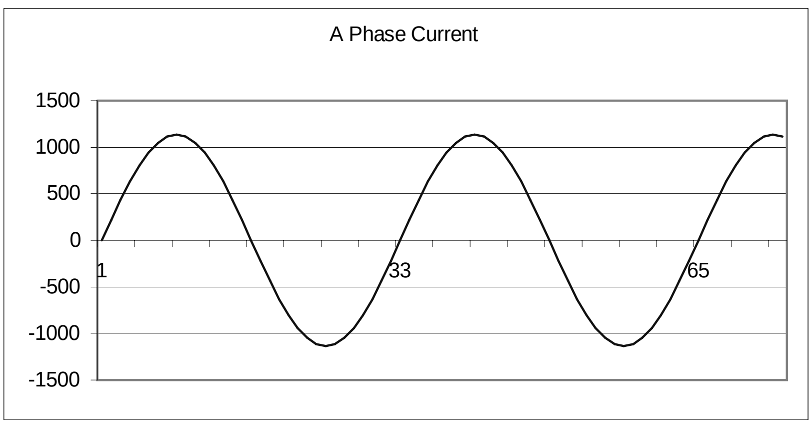

Figure 1.10: Non-distorted current waveform

- 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.

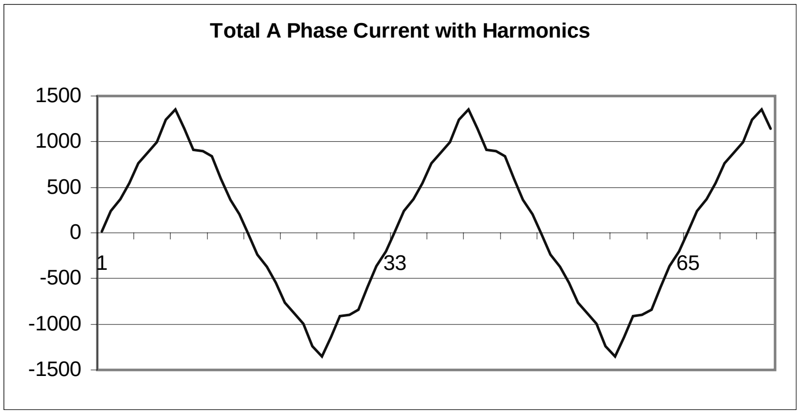

Figure 1.11: Distorted current wave

- 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.

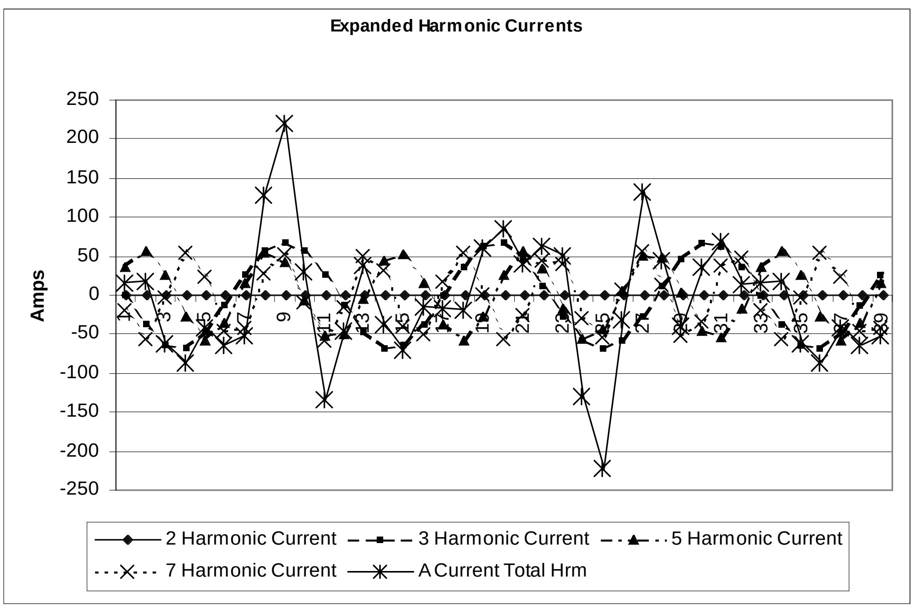

Figure 1.12: Waveforms of the harmonics

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 (5^{th} 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 3^{rd}, 5^{th}, 7^{th}, and 9^{th}. 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.

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Chapter 2
Shark ® Overview and Specifications

2.1: Hardware Overview

Figure 2.1: Shark ® 50 Meter / Transducer

- The Shark ® 50 monitor is a 0.5% class electrical panel meter. Using bright and large .56" LED displays, it is designed to be used in electrical panels and swtichgear. The meter has a unique anti-dither algorithm to improve reading stability.

  The Shark ® 50 meter uses high-speed DSP technology with high-resolution A/D conversion to provide stable and reliable measurements.

  The Shark ®50 meter is a meter and transducer in one compact unit. Featuring an optional RS485 port, it can be programmed using the faceplate of the meter or through software. ANSI or DIN mounting may be used.

- Shark ® 50 meter features that are detailed in this manual are as follows:
  - 0.5% Class Accuracy
  - Multifunction Measurement including Voltage, Current, Power, Frequency, Energy, etc.
  - V-Switch™ Technology - Field Upgrade without Removing Installed Meter
  - Percentage of Load Bar for Analog Meter Perception
  - Easy to Use Faceplate Programming
  - RS485 Modbus Communication

2.1.1: Voltage and Current Inputs

- **Universal Voltage Inputs**
  Voltage Inputs allow measurement to 416 Volts Line-to-Neutral and 721 Volts Line-to-Line. 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.

- **Current Inputs**
  The Shark ® 50 meter's Current Inputs use a unique dual input method:

  Method 1: CT Pass Through.
  The CT passes directly through the meter without any physical termination on the meter. This insures that the meter cannot be a point of failure on the CT circuit. This is preferable for utility users when sharing relay class CTs. No Burden is added to the secondary CT circuit.

  Method 2: Current "Gills".
  This unit additionally provides ultra-rugged Termination Pass Through Bars that allow CT leads to be terminated on the meter. This, too, eliminates any possible point of failure at the meter. This is a preferred technique for insuring that relay class CT integrity is not compromised (the CT will not open in a fault condition).

2.1.2: Model Number plus Option Numbers

Model	**V-Switch**	**COM**	**Mounting**
Shark 50 Meter/ Transducer	- V1 (Default) Volts/Amps	- X No Com	- X ANSI Mounting
	- V2 Above with Power and Frequency	- 485P RS485 + Pulse	-DIN DIN Mounting Brackets
	- V3 Above with Energy Counters		

Example:
Shark50 - V2 - X - X

2.1.3: V-Switch™ Technology

EIG's exclusive V-Switch™ Technology is a virtual firmware-based switch that allows you to enable meter features through communication. This allows the Shark ® 50 unit to be upgraded after installation to a higher model without removing the unit from service.

- **Available V-Switch™ Keys**
  V-Switch™ Key 1 (-V1): Volts and Amps Meter - Default
  V-Switch™ Key 2 (-V2): Volts, Amps, kW, kVAR, PF, kVA, Freq
  V-Switch™ Key 3 (-V3): Volts, Amps, kW, kVAR, PF, kVA, Freq, kWh, kVAh, kVARh

2.1.4: Measured Values

The following table lists the measured values available in Real Time, Avg., Max., and Min.

Shark® 50 Meter'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
Voltage Angles	X			
Current Angles	X			
% of Load Bar	X			

2.1.5: Utility Peak Demand

The Shark® 50 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: 115A Option: Universal, (90 to 265) VAC @50/60Hz
- Power Consumption: 5 VA, 3.5W

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

- Range: Universal, Auto-ranging up to 416Vac L-N, 721Vac L-L
- Supported hookups: 3 Element Wye, 2.5 Element Wye, 2 Element Delta, 4 Wire Delta
- Input Impedance: 1M Ohm/Phase
- Burden: 0.0144VA/Phase at 120 Volts
- Pickup Voltage: 10Vac
- Connection: Screw terminal (Diagram 4.4)
- Max Input Wire Gauge: AWG#12 / 2.5mm2
- Fault Withstand: Meets IEEE C37.90.1
- Reading: Programmable Full Scale to any PT Ratio

■ **Current Inputs**

- Class 10: 5A Nominal, 10A Maximum
- Burden: 0.005VA Per Phase Max at 11 Amps
- Pickup Current: 0.1% of Nominal
- Connections: O or U Lug Electrical Connection (Diagram 4.1)
  Pass-through Wire, 0.177" / 4.5mm Maximum Diameter (Diagram 4.2)
  Quick Connect, 0.25" Male Tab (Diagram 4.3)
- Fault Withstand: 100A/10sec., 300A/3sec., 500A/1sec.
- Reading: Programmable Full Scale to any CT Ratio

Isolation

- All Inputs and Outputs are galvanically isolated to 2500 Vac

Environmental Rating

• Storage:	(-40 to +85)^0 C
• Operating:	(0 to +50)^0 C
• Humidity:	to 95% RH Non-condensing
• Faceplate Rating:	NEMA12 (Water Resistant), Gasket Included

Measurement Methods

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

Update Rate

• All parameters:	Up to 1 second

Communication Format

RS485P - RS485 through Back Plate plus KYZ Pulse

• Protocols:	Modbus RTU, Modbus ASCII
• Com Port Baud Rate:	9600 to 57,600 b/s
• Com Port Address:	001-247
• Data Format:	8 Bit, No Parity

Mechanical Parameters

• Dimensions:	(H4.85 x W4.82 x L4.25) inches, (H123.2 x W123.2 x L105.4) mm Mounts in 92mm square DIN or ANSI C39.1, 4" Round Cut-out
• Weight:	2 pounds, 0.907kg (ships in a 6"/152.4mm cube container)

2.3: Compliance

- IEC62053-22 (0.5% Accuracy)
- ANSI C12.20 (0.5% 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

2.4: Accuracy

Meter Accuracy by Measured Parameters		
Measured Parameters	**Accuracy % of Reading***	**Display Range**
Voltage L-N	0.2%	0-9999 V or kV
Voltage L-L	0.4%	0-9999 V or kV Scaleable
Current	0.2%	0-9999 A or kA
+/- Watts	0.5%	0-9999 Watts, kWatts, MWatts
+/- Wh	0.5%	5 to 8 Digits Programmable
+/- VARs	1.0%	0-9999 VARs, kVARs, MVARs
+/- VARh	1.0%	5 to 8 Digits Programmable
VA	1.0%	0-9999 VA, kVA, MVA
VAh	1.0%	5 to 8 Digits Programmable
PF	1.0%	+/- 0.5 to 1.0
Frequency	+/- 0.01 Hz	45 to 65 Hz
% Load Bar	1 - 120%	10 Segment Resolution Scalable
* Accuracy stated for WYE or Delta connections. For 2.5 element connections, add 0.1% of Full Scale +/- 1 digit to accuracy specification.		

Shark 50 accuracy meets the IEC62053-22 Accuracy Standards for 0.5% Class Meters. This standard is shown in the table on the next page.

Value of Current	Power Factor	Percentage Error Limits for Meters of Class 0.5 S
$0.01\ I_n \leq I < 0.05\ I_n$	1	±1.0
$0.05\ I_n \leq I \leq I_{max}$	1	±0.5
$0.02\ I_n \leq I < 0.1\ I_n$	0.5 inductive 0.8 capacitive	±1.0 ±1.0
$0.1\ I_n \leq I \leq I_{max}$	0.5 inductive 0.8 capacitive	±0.6 ±0.6
When specially requested by the user, from: $0.1\ I_n \leq I \leq I_{max}$	0.25 inductive 0.5 capacitive	±1.0 ±1.0

NOTE: In the table above:
In = Nominal (5A)
Imax= Full Scale

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Chapter 3
Mechanical Installation

3.1: Introduction

- The Shark® 50 meter can be installed using a standard ANSI C39.1 (4" Round) or an IEC 92mm DIN (Square) form. In new installations, simply use existing DIN or ANSI punches. For existing panels, pull out old analog meters and replace with the Shark® meter.

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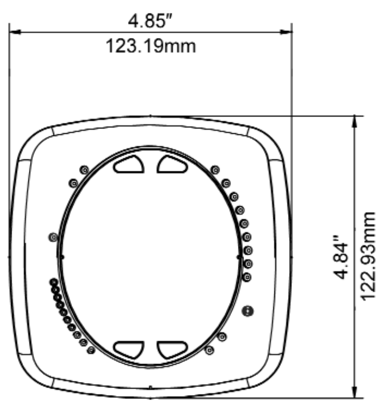

Figure 3.1: Shark 50 Face

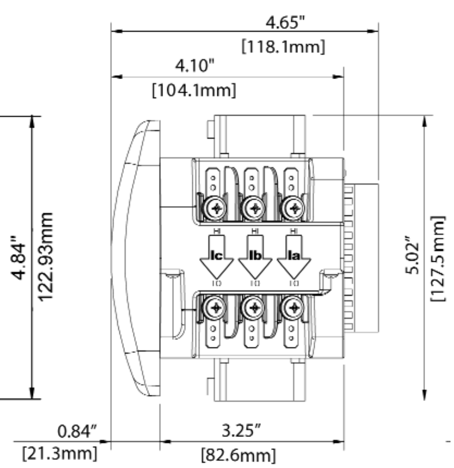

Figure 3.2: Shark 50 Dimensions

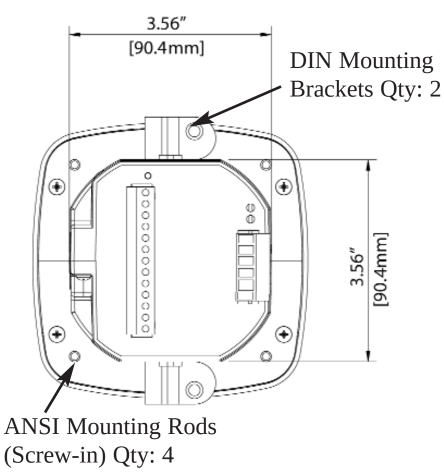

Figure 3.4 Shark 50 Back

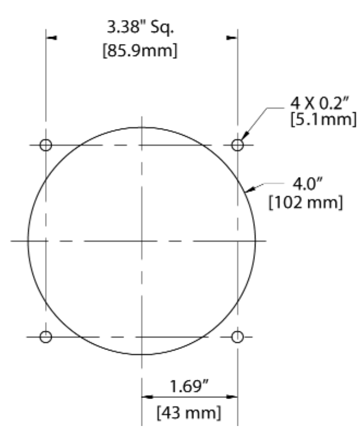

Figure 3.5: ANSI Mounting Panel Cutout

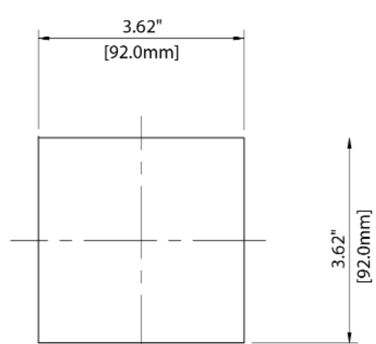

Figure 3.6: DIN Mounting Cutout

- **Recommended Tools for Shark® 50 Meter Installation:** #2 Phillips screwdriver, small wrench and wire cutters.

- Mount the meter in a dry location, which is free from dirt and corrosive substances. The meter is designed to withstand harsh environmental conditions. (See Environmental Specifications in Chapter 2.)

3.2: ANSI Installation Steps

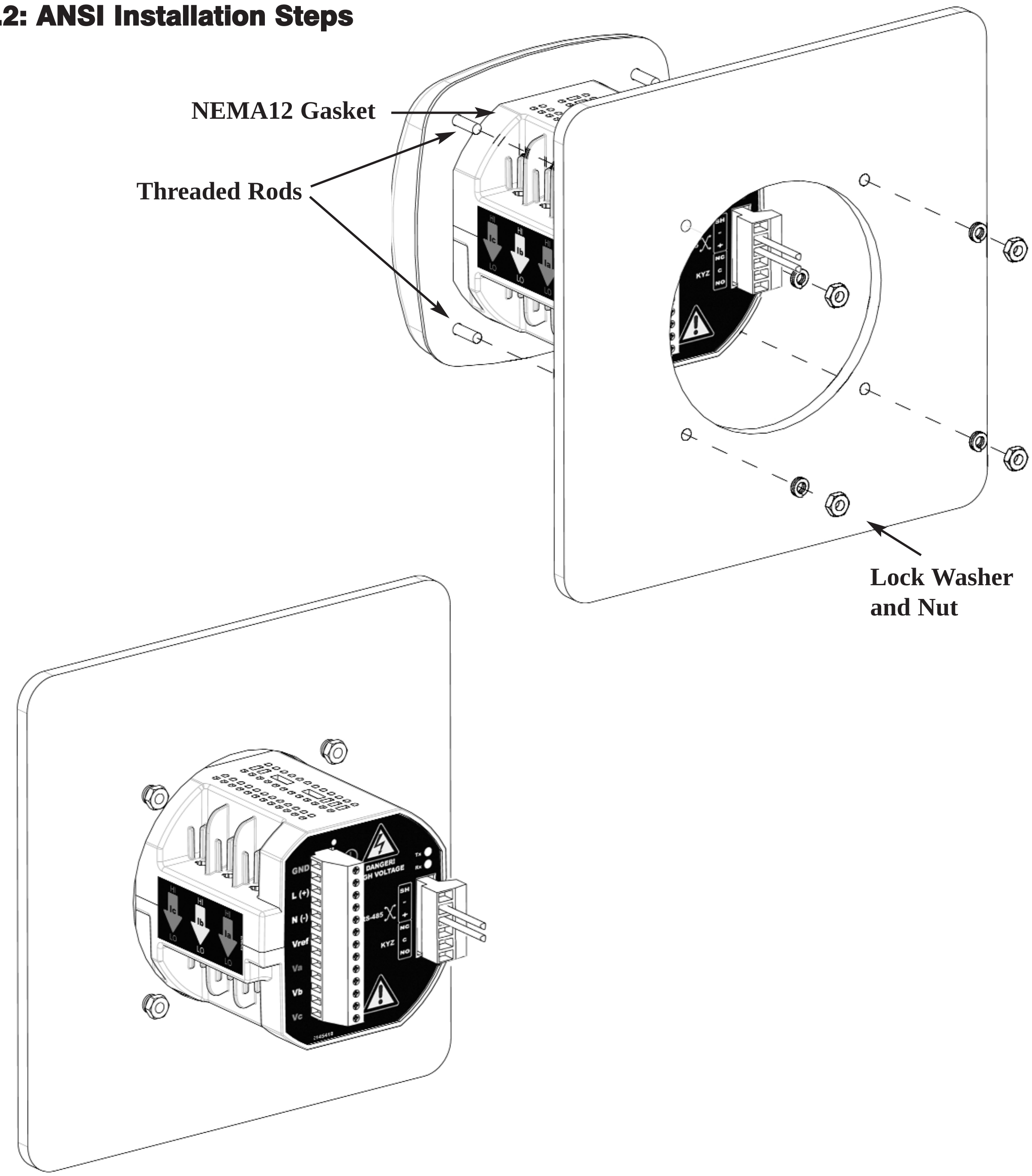

Figure 3.7: ANSI Mounting Procedure

ANSI INSTALLATION STEPS:

1. Insert 4 threaded rods by hand into the back of meter. Twist until secure.
2. Slide NEMA12 gasket onto back of meter with rods in place.
3. Slide meter into panel.
4. Secure from back of panel with lock washer and nut on each threaded rod.
   Use a small wrench to tighten. Do not overtighten. The maximum installation torque is 0.4 Newton-Meter.

3.3: DIN Installation Steps

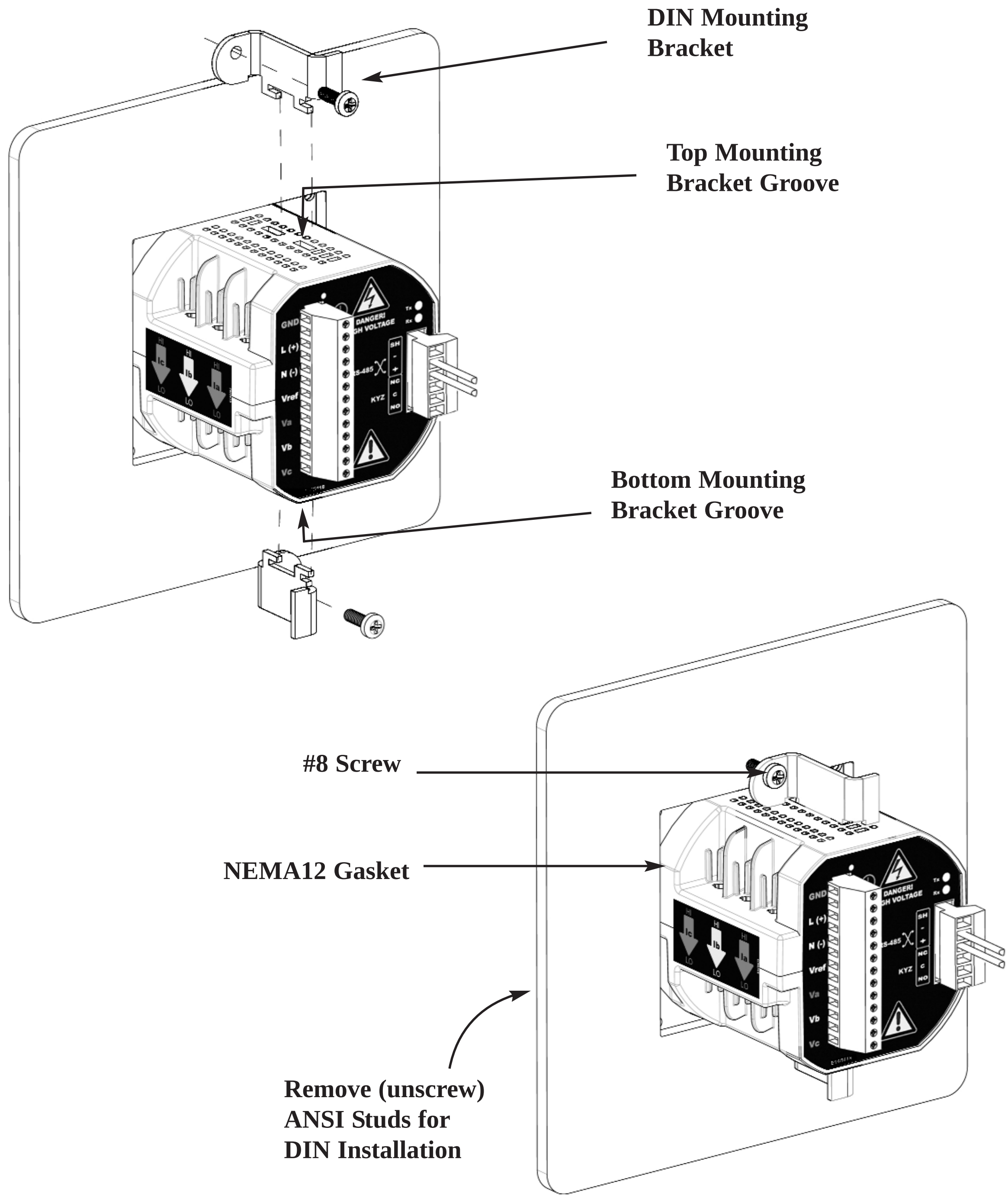

Figure 3.8: DIN Mounting Procedure

DIN INSTALLATION STEPS:

1. Slide meter with NEMA12 gasket into panel. (Remove ANSI Studs, if in place.)
2. From back of panel, slide 2 DIN Mounting Brackets into grooves in top and bottom of meter housing. Snap into place.
3. Secure meter to panel with lock washer and a #8 screw through each of the 2 mounting brackets. Tighten with a #2 Phillips screwdriver. Do not overtighten. The maximum installation torque is 0.4 Newton-Meter.

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Chapter 4
Electrical Installation

4.1: Considerations When Installing Meters

- Installation of the Shark 50 Meter must be performed by only qualified personnel who follow standard safety precautions during all procedures. Those personnel should have appropriate training and experience with high voltage devices. Appropriate safety gloves, safety glasses and protective clothing is recommended.

- During normal operation of the Shark 50 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: CT Leads Terminated to Meter

- The Shark® 50 meter is designed to have Current Inputs wired in one of three ways. Diagram 4.1 shows the most typical connection where CT Leads are terminated to the meter at the Current Gills. This connection uses Nickel-Plated Brass Studs (Current Gills) with screws at each end. This connection allows the CT wires to be terminated using either an “O” or a “U” lug. Tighten the screws with a #2 Phillips screwdriver. The maximum installation torque is 1 Newton-Meter.

  Other current connections are shown in Figures 4.2 and 4.3. A Voltage and RS-485 Connection is shown in Figure 4.4.

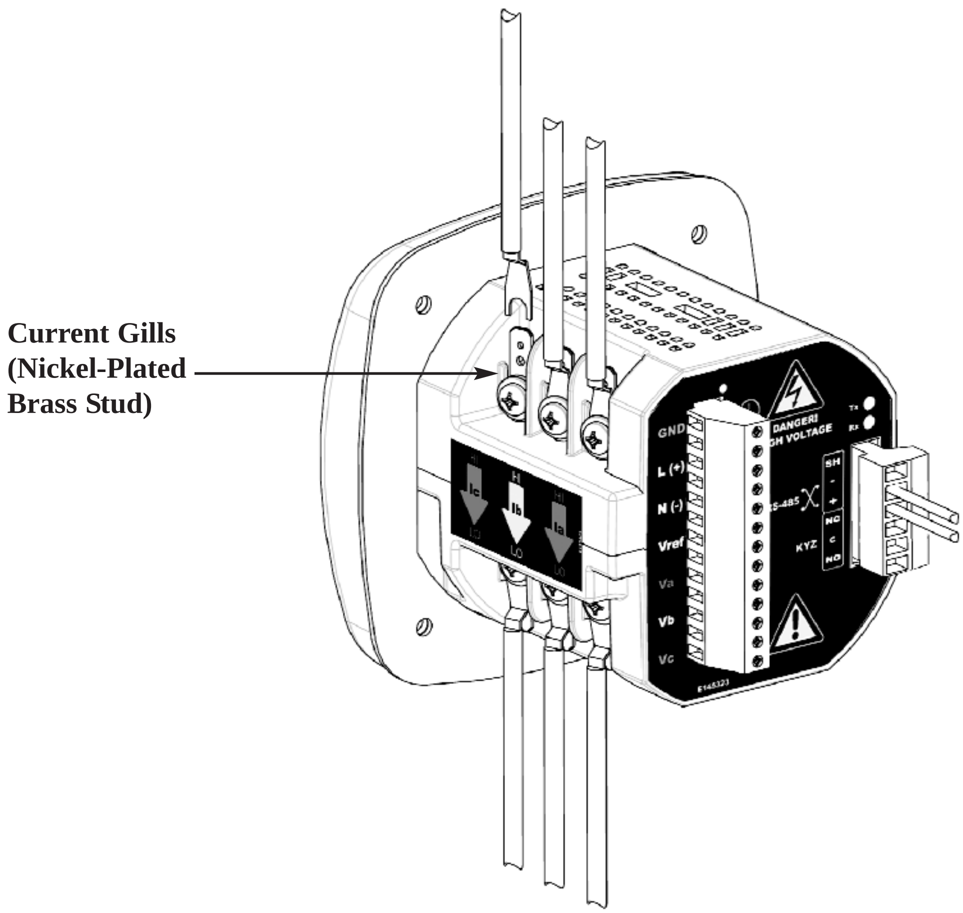


Figure 4.1: CT Leads terminated to Meter, #8 Screw for Lug Connection

Wiring Diagrams are shown in Section 4.8 of this chapter.
Communications Connections are detailed in Chapter 5.

4.3: CT Leads Pass Through (No Meter Termination)

- The second method allows the CT wires to pass through the CT Inputs without terminating at the meter. In this case, remove the Current Gills and place the CT wire directly through the CT opening. The opening will accomodate up to 0.177” / 4.5mm maximum diameter CT wire.

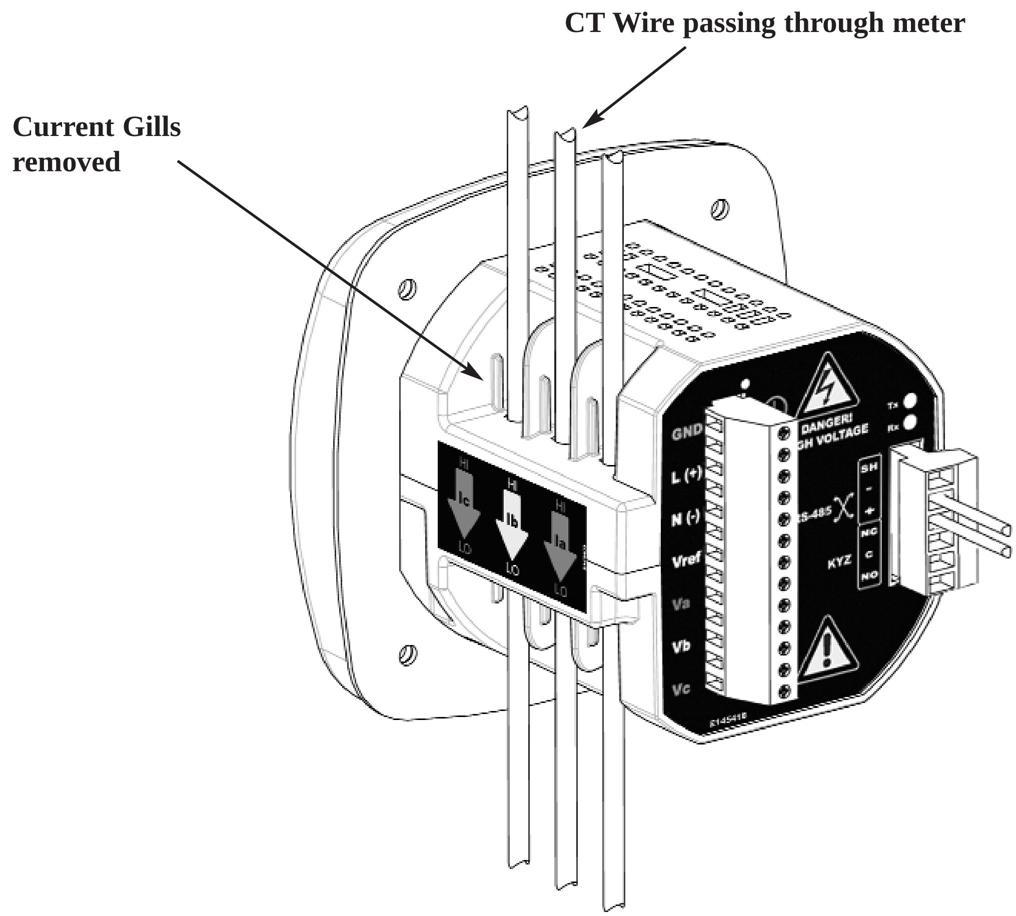


Figure 4.2: Pass-Through Wire Electrical Connection

4.4: Quick Connect Crimp CT Terminations

- For Quick Termination or for Portable Applications, a Quick Connect Crimp CT Connection can also be used.

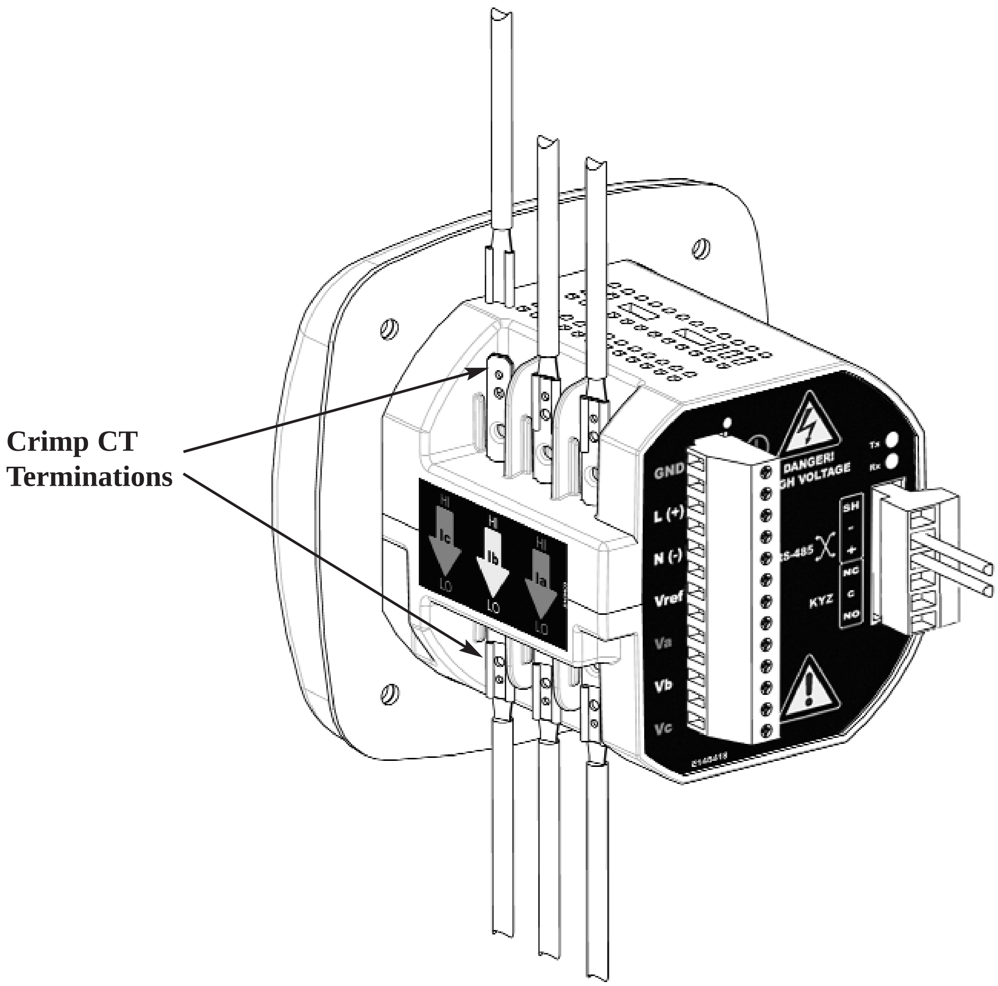


Figure 4.3: Quick Connect Electrical Connection

4.5: Voltage and Power Supply Connections

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

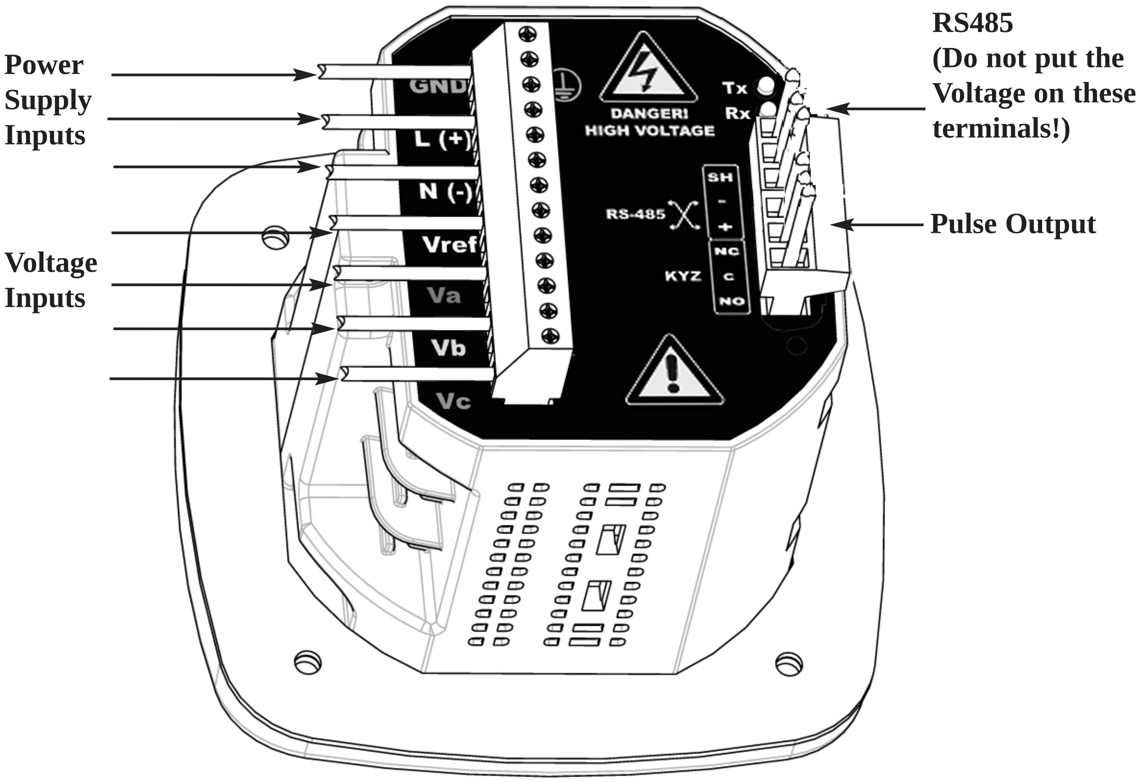


Figure 4.4: Voltage Connection

4.6: Ground Connections

- The meter's Ground Terminals (⏚) should be connected directly to the installation's protective earth ground. Use 2.5mm wire for this connection.

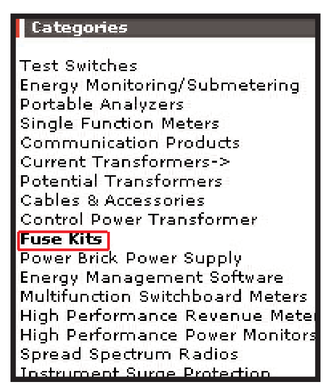
4.7: Voltage Fuses

- 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.

  You can order a fuse kit with both of these fuses from EIG's online store. Order the EI-CP Panel Meter Protective Fuse Kit by going to www.electroind.com/store and selecting Fuse Kits (see figure on the right).

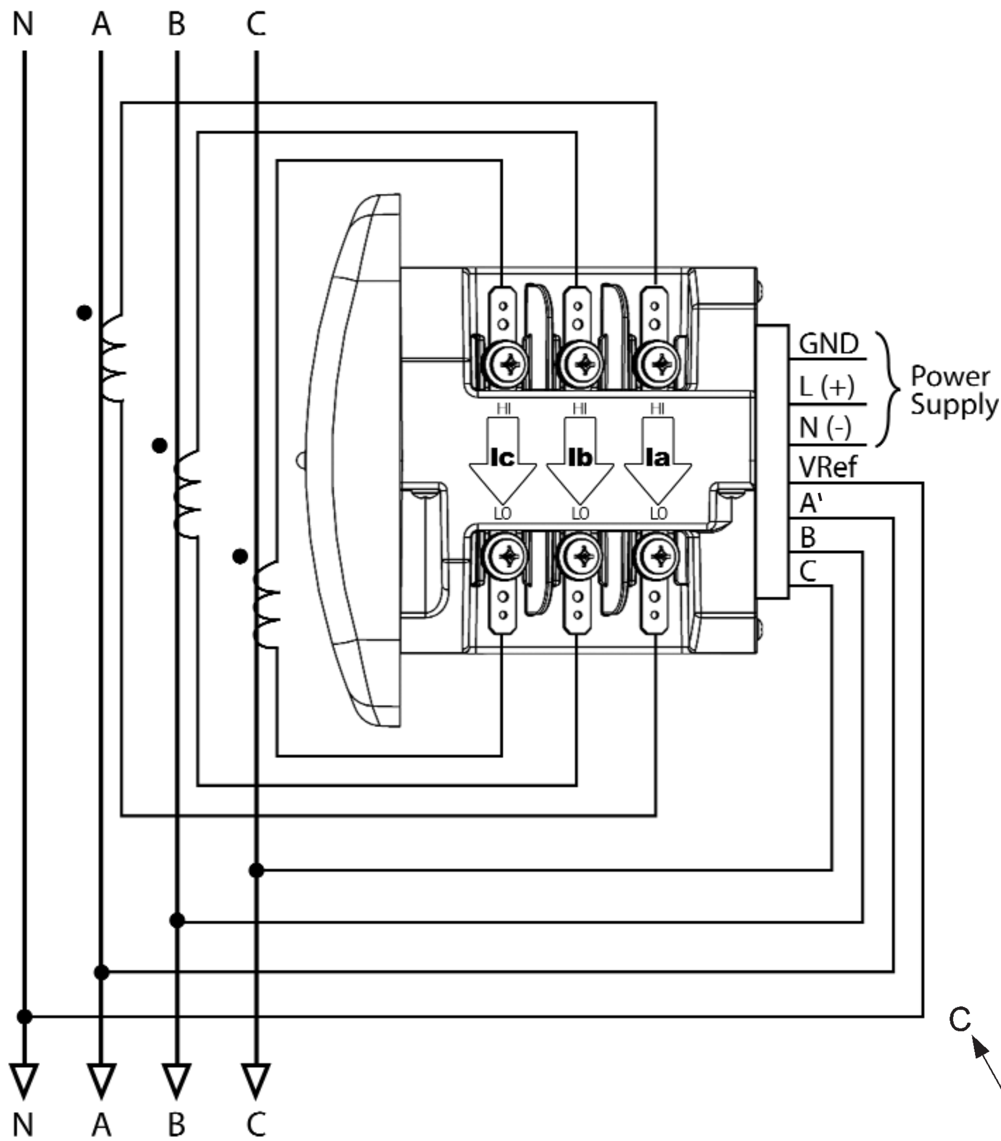


4.8: Electrical Connection Diagrams

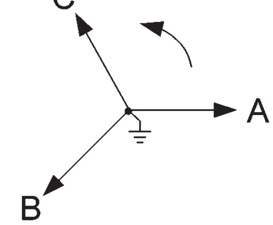
Choose the diagram that best suits your application. Be sure to maintain the CT polarity when wiring.

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
6. Three-Phase, Three-Wire Delta with 2 PTs
7. Three-Phase, Three-Wire Delta with 3 PTs
8. Current Only Measurement (Three Phase)
9. Current Only Measurement (Dual Phase)
10. Current Only Measurement (Single Phase)

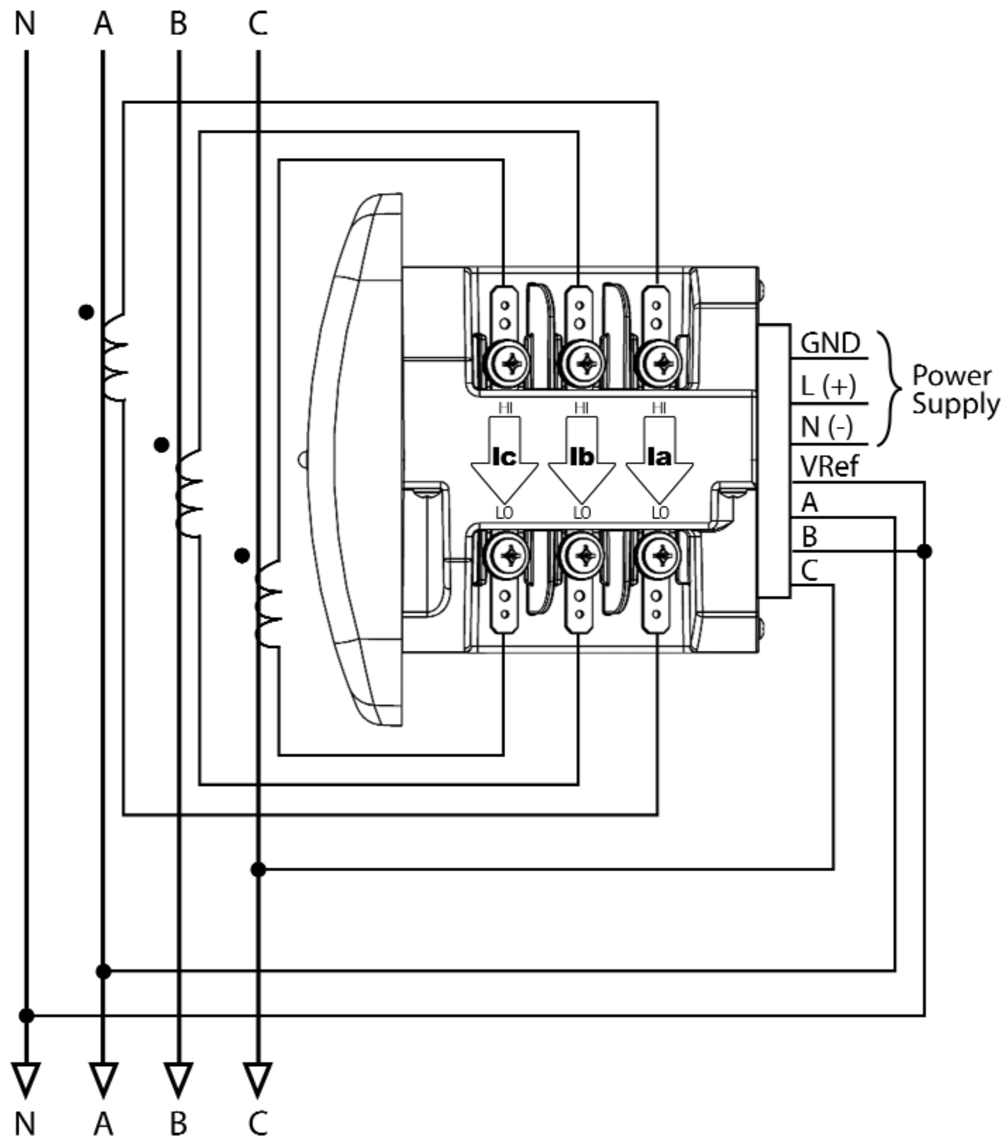
1. Service: WYE, 4-Wire with No PTs, 3 CTs

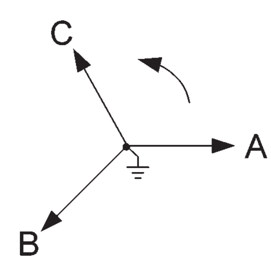


Select: “3 EL WYE” (3 Element Wye) in Meter Programming setup.



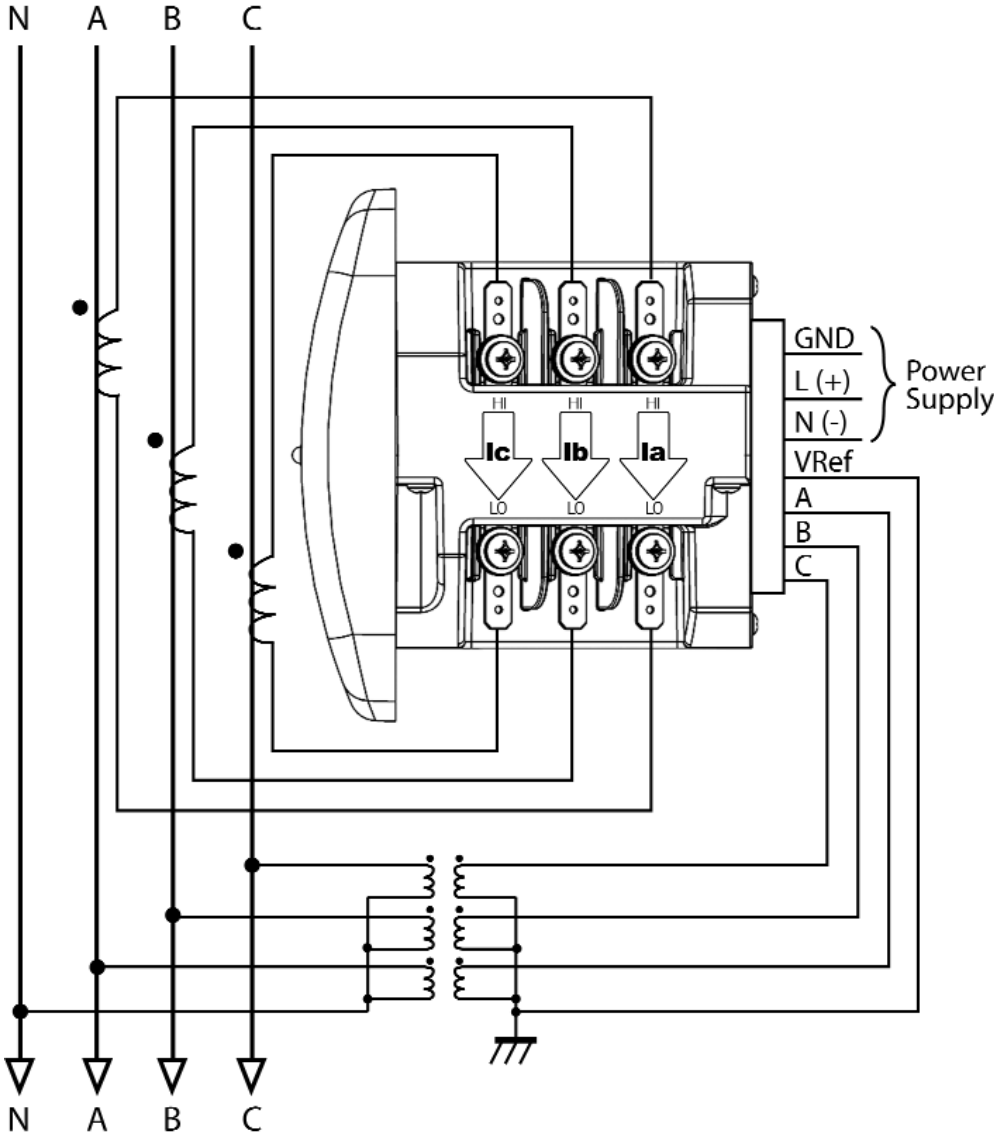
2. Service: 2.5 Element WYE, 4-Wire with No PTs, 3 CTs

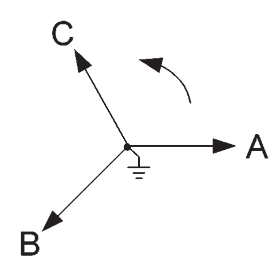




Select: "2.5 EL WYE" (2.5 Element Wye) in Meter Programming setup.

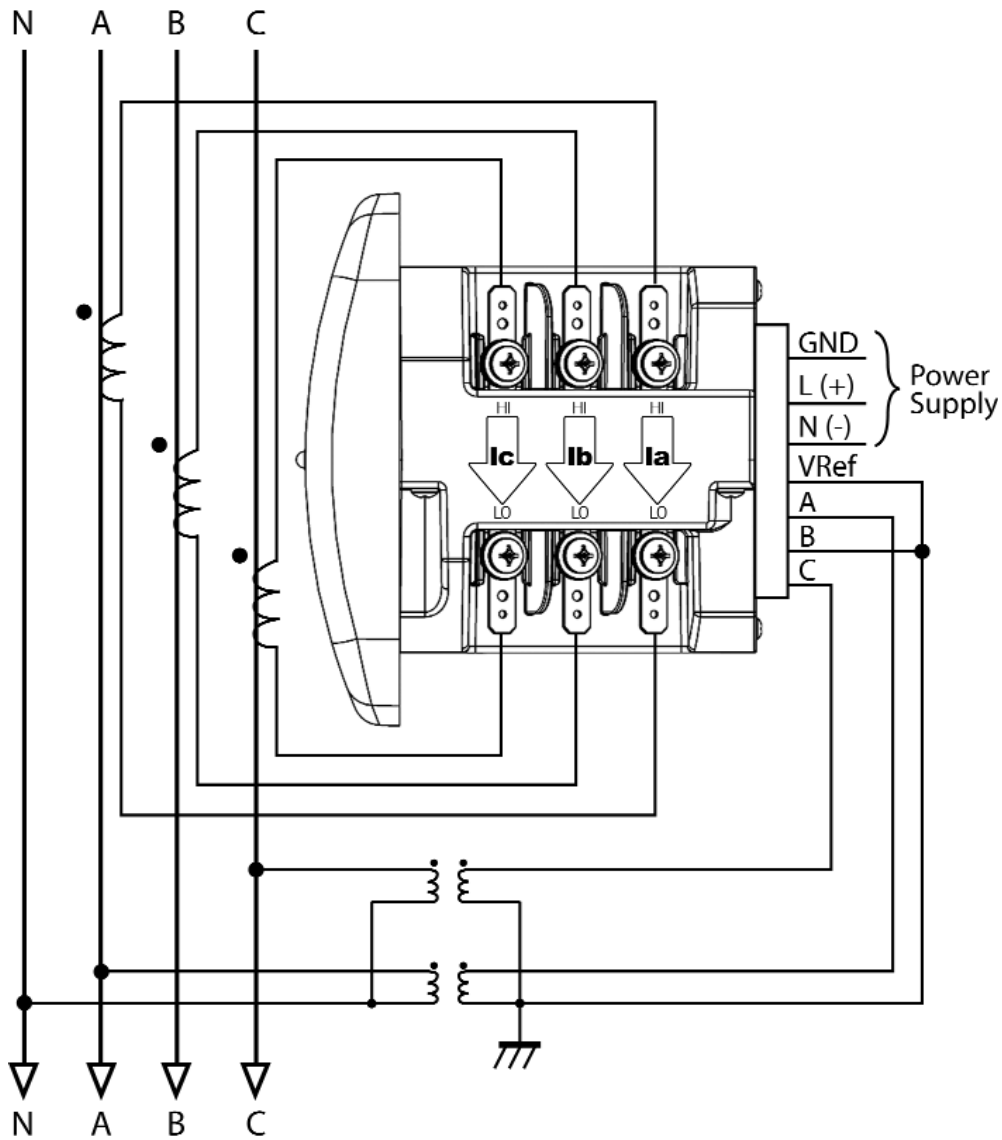
3. Service: WYE, 4-Wire with 3 PTs, 3 CTs

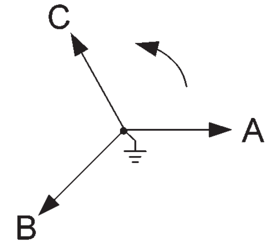




Select: "3 EL WYE" (3 Element Wye) in Meter Programming setup.

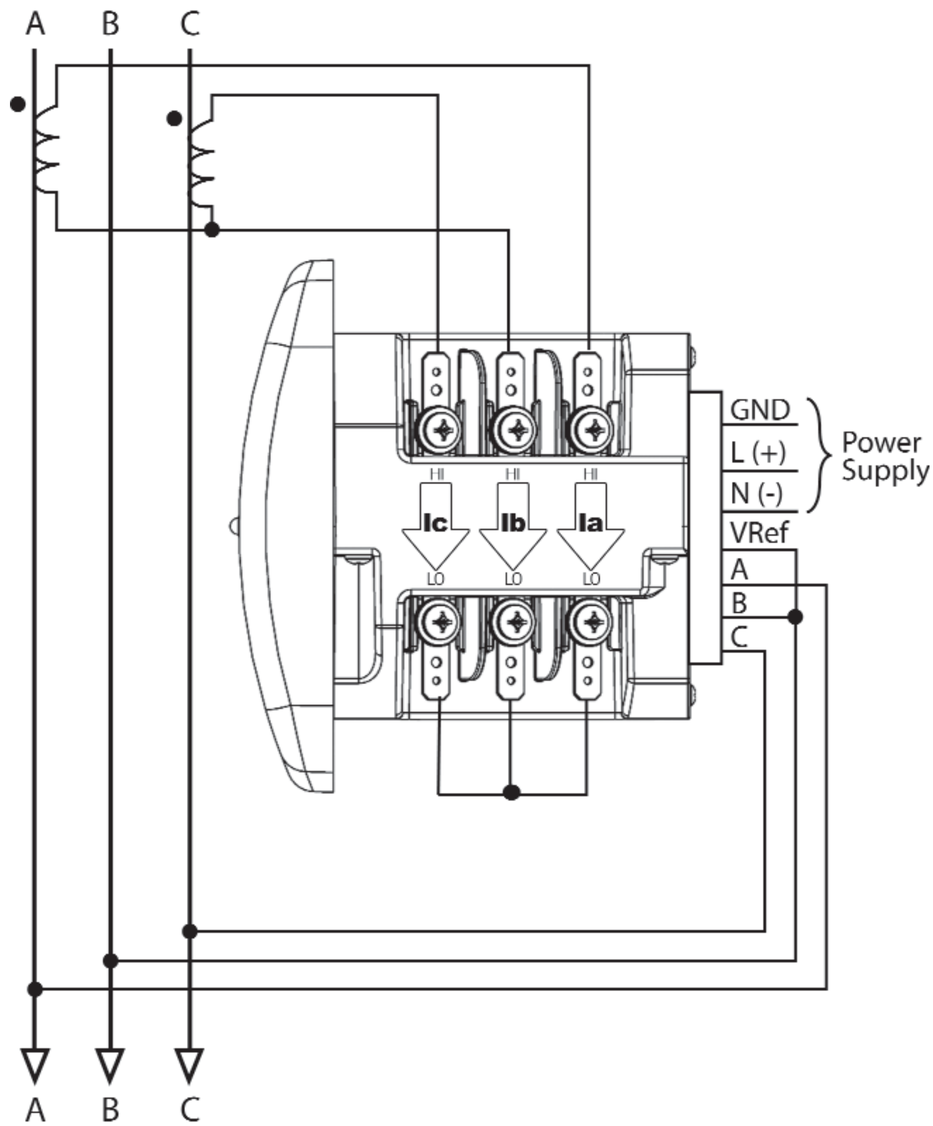
4. Service: 2.5 Element WYE, 4-Wire with 2 PTs, 3 CTs

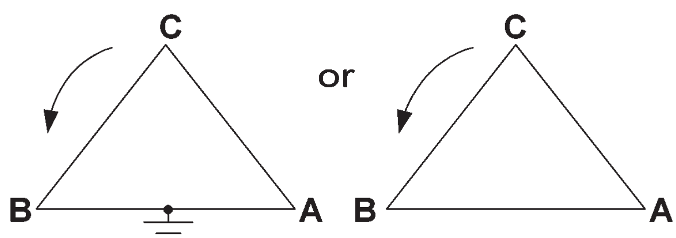




Select: "2.5 EL WYE" (2.5 Element Wye) in Meter Programming setup.

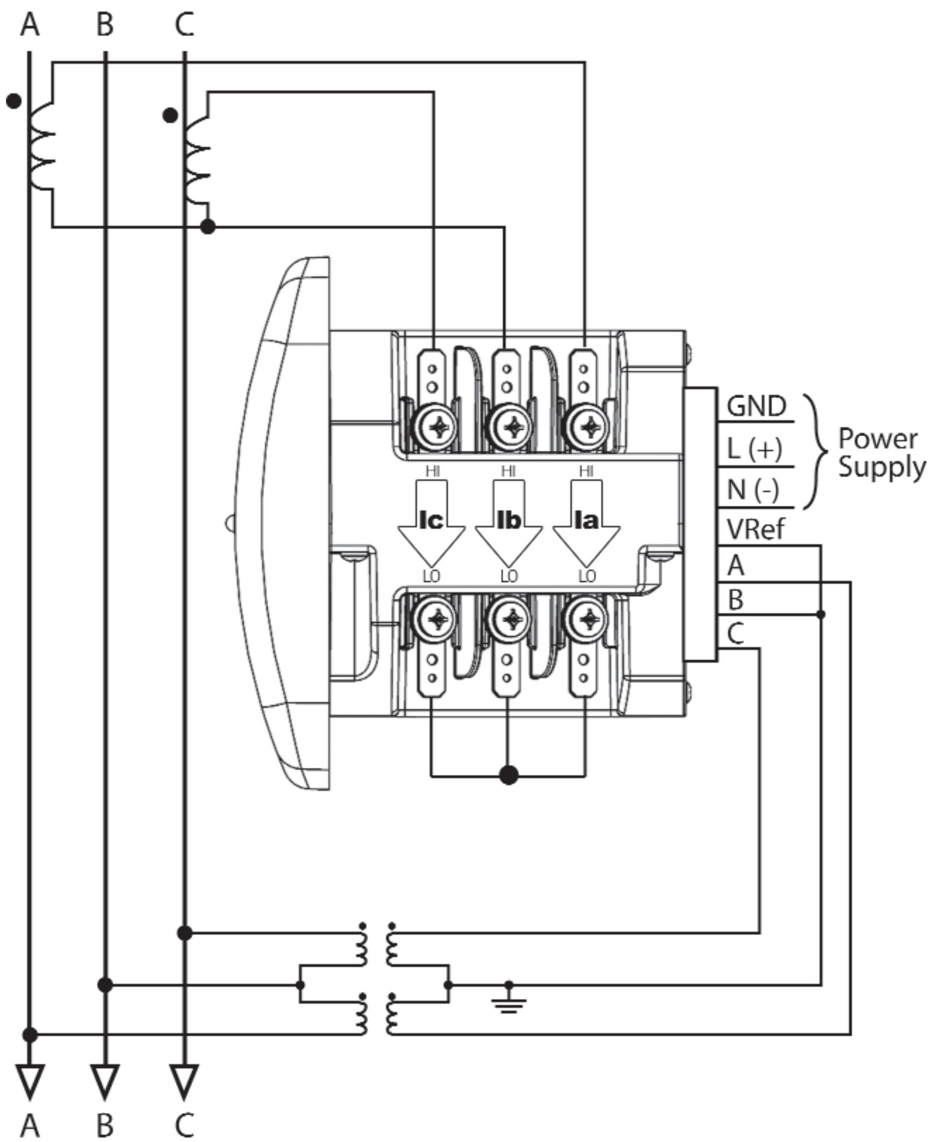
5. Service: Delta, 3-Wire with No PTs, 2 CTs

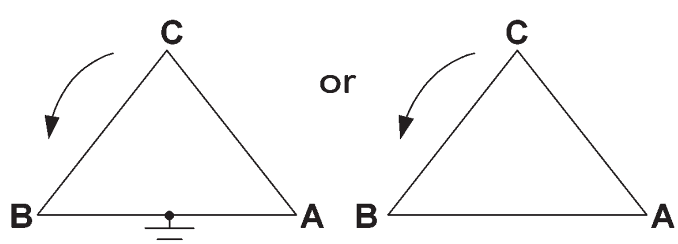




Select: “2 Ct dEL” (2 CT Delta) in Meter Programming setup.

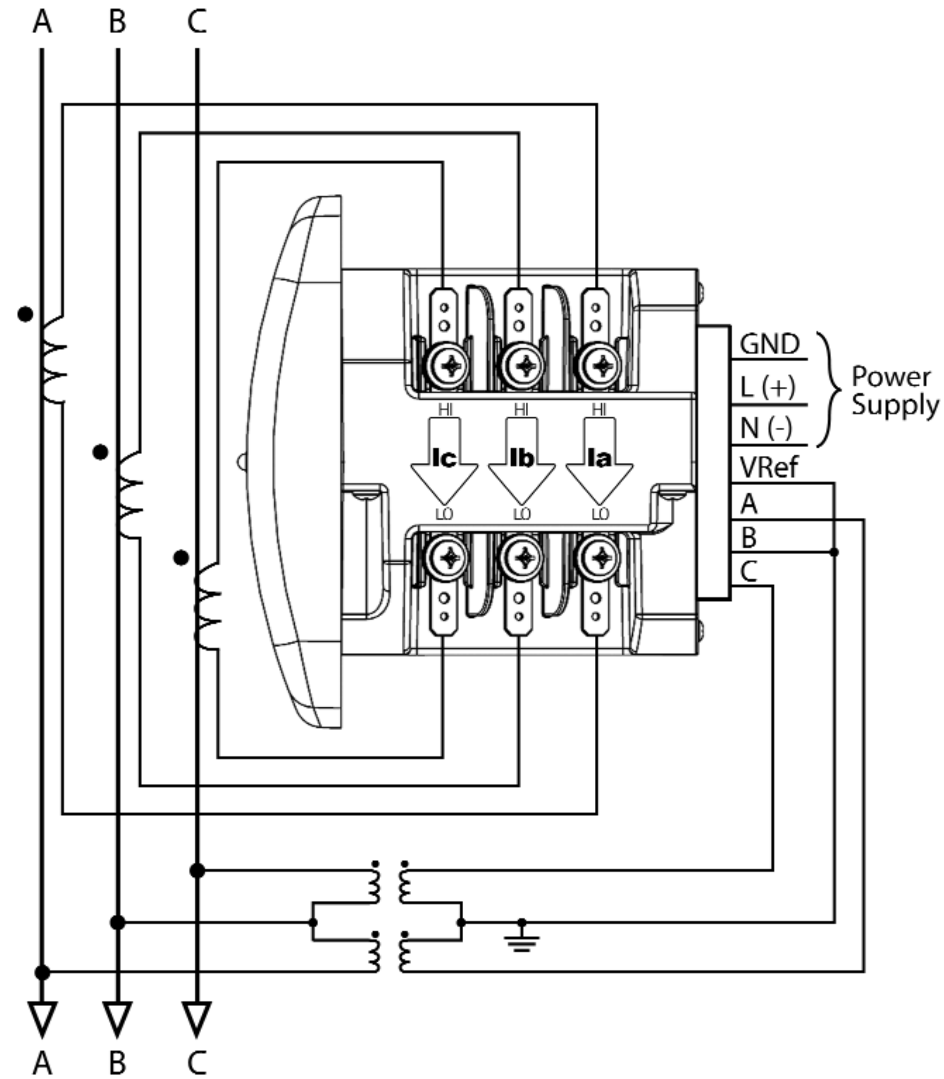
6. Service: Delta, 3-Wire with 2 PTs, 2 CTs

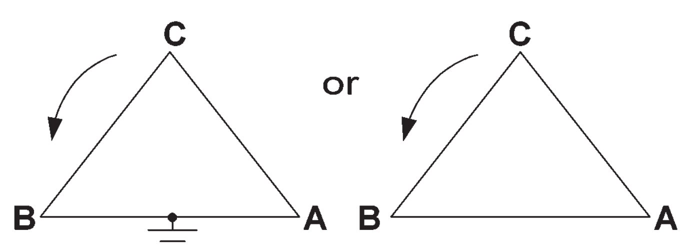




Select: “2 Ct dEL” (2 CT Delta) in Meter Programming setup.

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

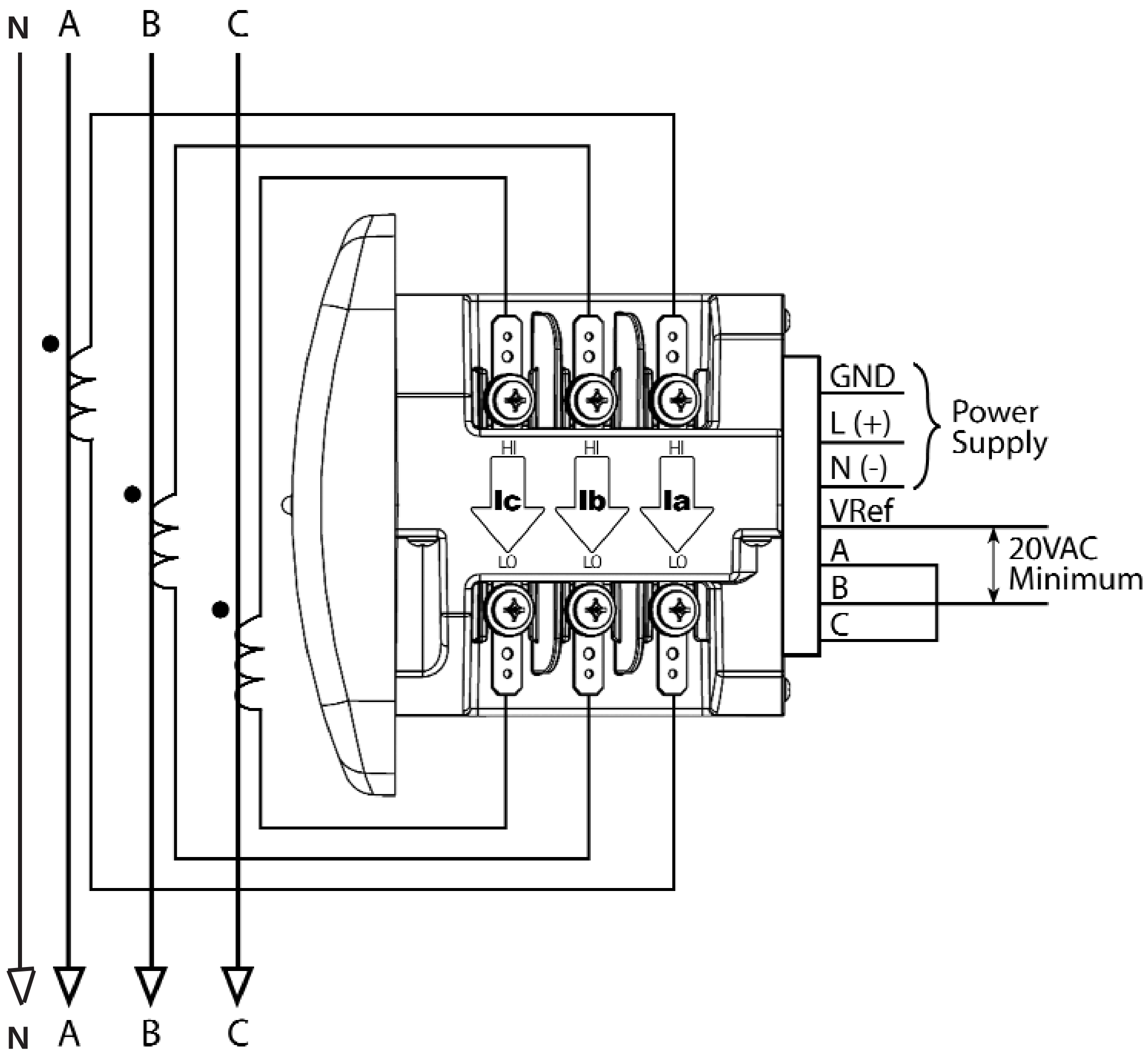




Select: “2 Ct dEL” (2 CT Delta) in Meter Programming setup.

NOTE: The third CT for hookup is optional and is for Current Measurement only.

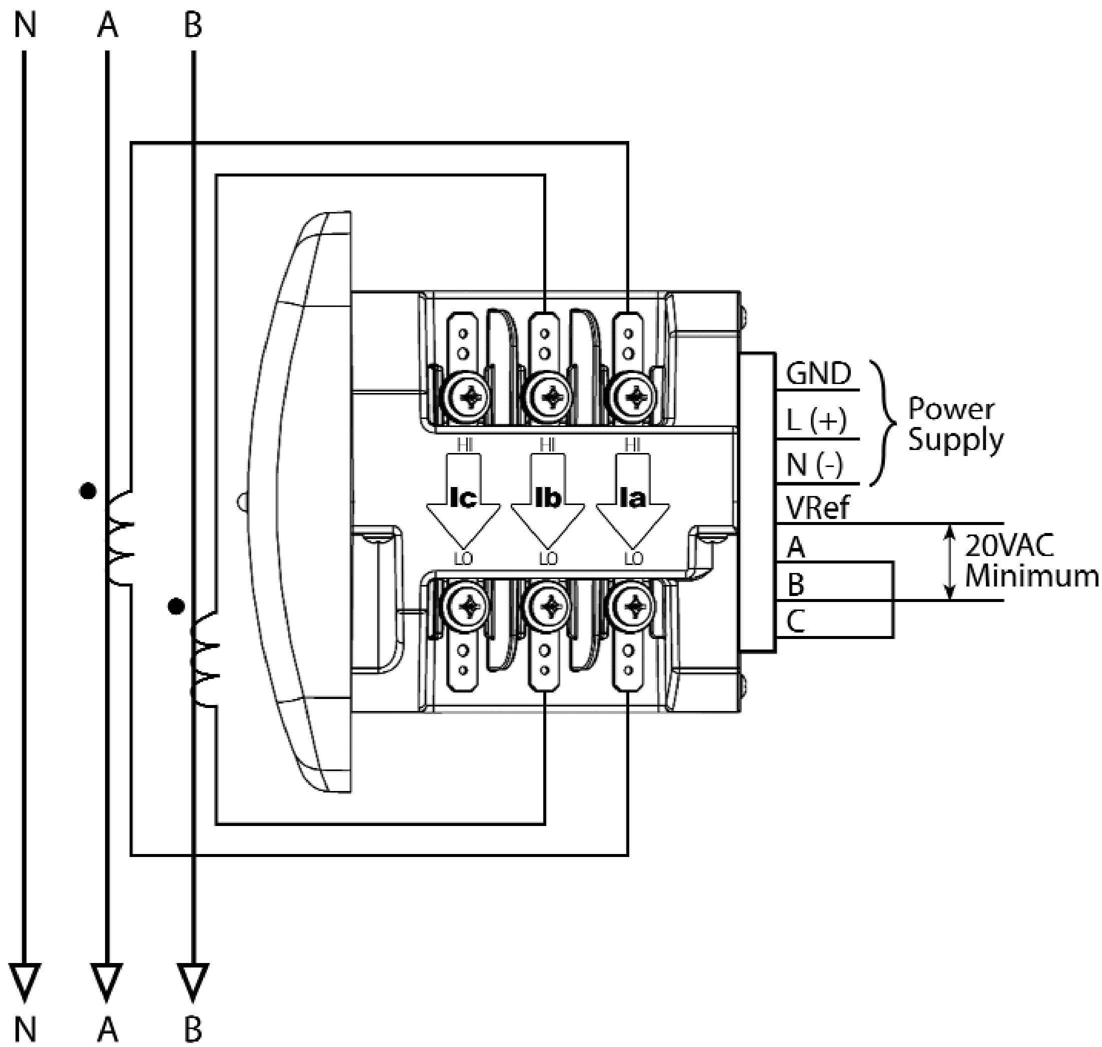
8. Service: Current Only Measurement (Three Phase)



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

* Even if the meter is used for only amp readings, the unit requires a Voltage reference.
Please make sure that the voltage input is attached to the meter.
AC Control Power can be used to provide the Reference Signal.

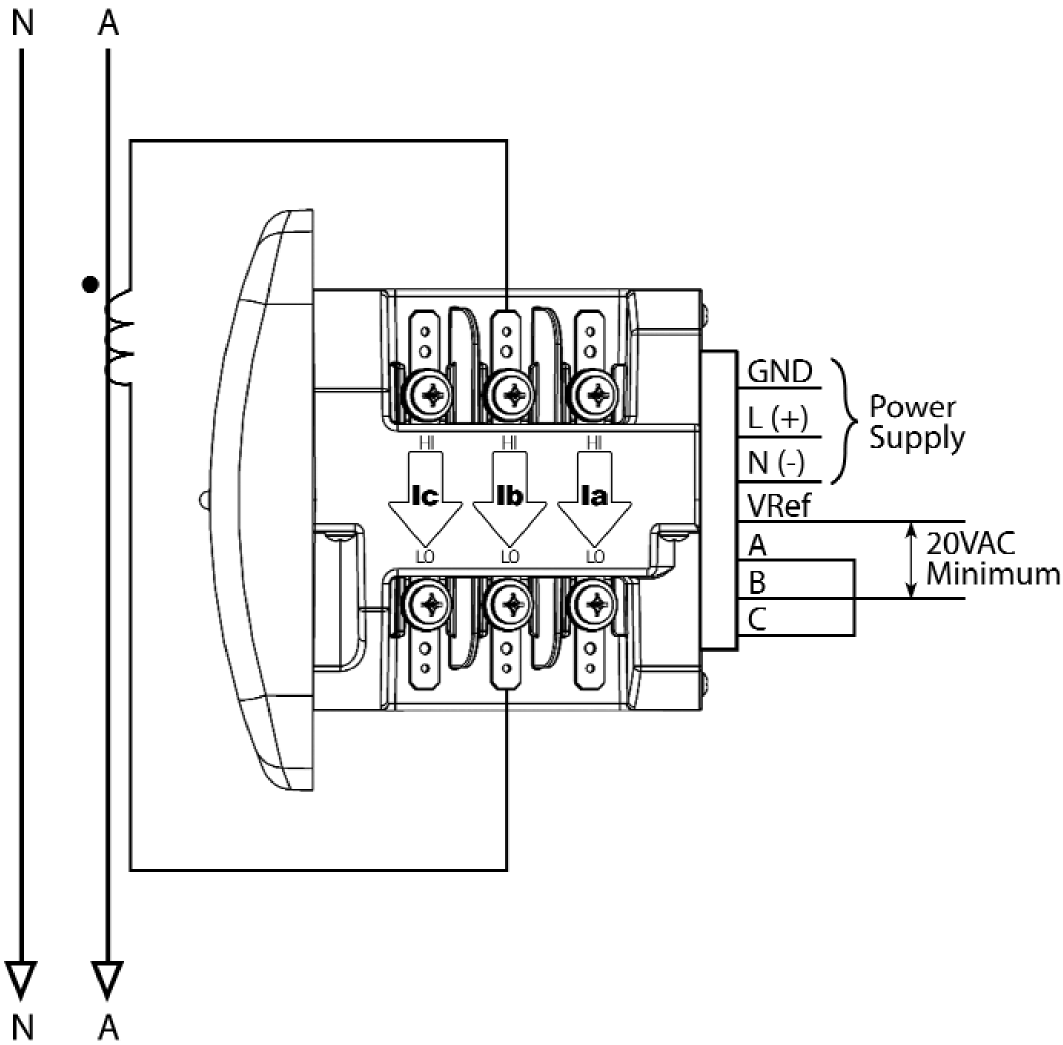
9. Service: Current Only Measurement (Dual Phase)



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

* Even if the meter is used for only amp readings, the unit requires a Voltage 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 (Single Phase)



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

* Even if the meter is used for only amp readings, the unit requires a Voltage reference.
Please make sure that the voltage input is attached to the meter.
AC Control Power can be used to provide the Reference Signal.

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Chapter 5
Communication Installation

5.1: Shark 50 Communication

- Through the 485P option, the Shark 50 meter provides RS485 communication speaking Modbus ASCII and Modbus RTU protocols.

5.1.1: RS485 / KYZ Output Com 2 (485P Option)

- The 485P Option provides a combination RS485 and a KYZ Pulse Output for pulsing energy values. The RS485 / KYZ Combo is located on the terminal section of the meter.
- The Shark 50 meter's RS485 port can be programmed with the buttons on the face of the meter or by using Communicator EXT 3.0 software.

The standard RS485 Port Settings are as follows:

Address:	001 to 247
Baud Rate:	9600, 19200, 38400 or 57600
Protocol:	Modbus RTU, Modbus ASCII

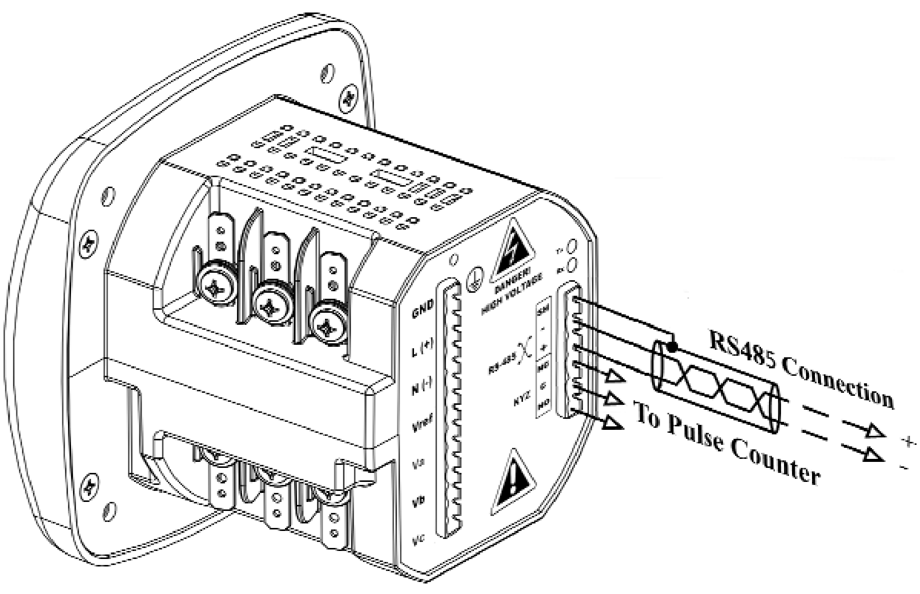


Figure 5.1: 485P Option with RS485 Communication Installation

RS485 allows you to connect one or multiple Shark 50 meters to a PC or other device, at either a local or remote site. All RS485 connections are viable for up to 4000 feet (1219.20 meters).

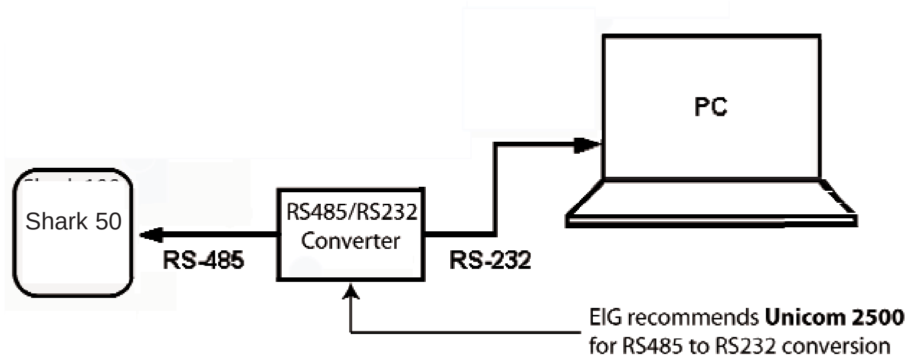


Figure 5.2: Shark 50 Connected to PC via RS485

To connect a Shark 50 to a PC, you need to use an RS485 to RS232 converter, such as EIG's Unicom 2500. See Section 5.1.2 for information on using the Unicom 2500 with the Shark 50.

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

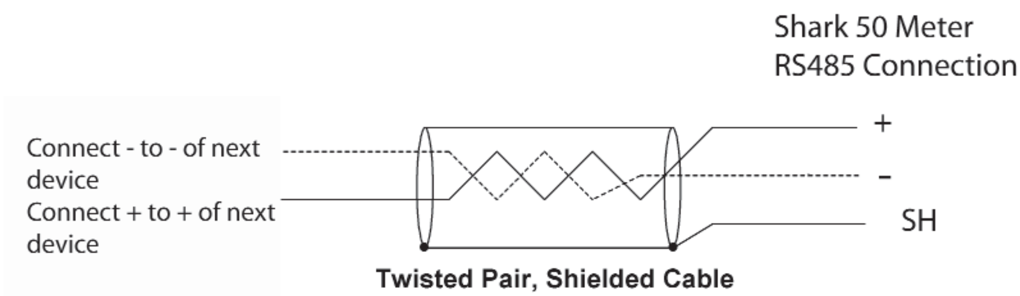


Figure 5.3: 2-wire RS485 Connection

NOTES: For All RS485 Connections:

- Use a shielded twisted pair cable 22 AWG (0.33 mm2) or larger, grounding the shield at one end only.
- Establish point-to-point configurations for each device on a RS485 bus: connect + terminals to + terminals; connect - terminals to - terminals.
- You may connect up to 31 meters on a single bus using RS485. Before assembling the bus, each meter must be assigned a unique address: refer to Chapter 5 of the Communicator EXT User's Manual for instructions.
- Protect cables from sources of electrical noise.
- Avoid both "Star" and "Tee" connections (see Figure 5.5).
- No more than two cables should be connected at any one point on an RS485 network, whether the connections are for devices, converters, or terminal strips.
- Include all segments when calculating the total cable length of a network. If you are not using an RS485 repeater, the maximum length for cable connecting all devices is 4000 feet (1219.20 meters).
- Connect shield to RS485 Master and individual devices as shown in Figure 5.4. You may also connect the shield to earth-ground at one point.

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

Figure 5.4 shows a representation of an RS485 Daisy Chain connection. Refer to Section 5.1.2 for details on RS485 connection for the Unicom 2500.

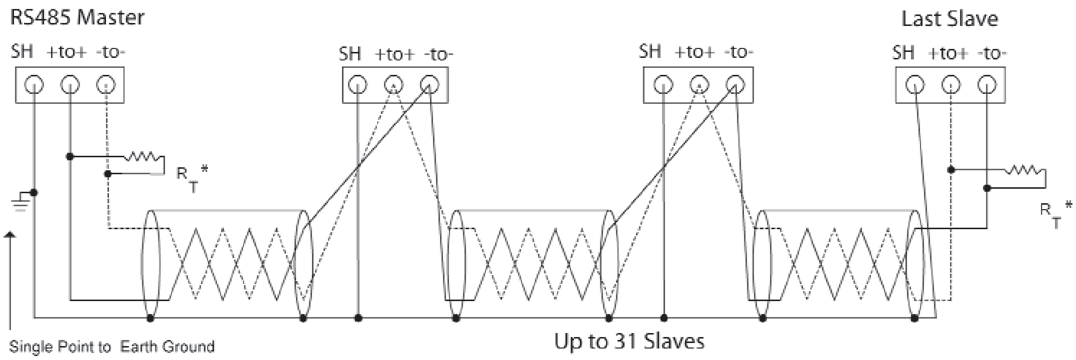
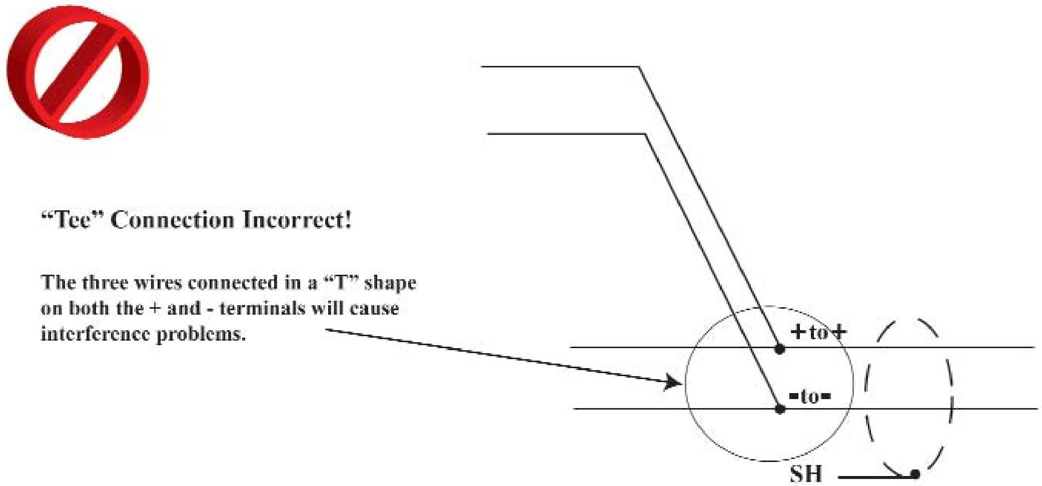


Figure 5.4: RS485 Daisy Chain Connection

Incorrect Configuration: “T”



Incorrect Configuration: “Star”

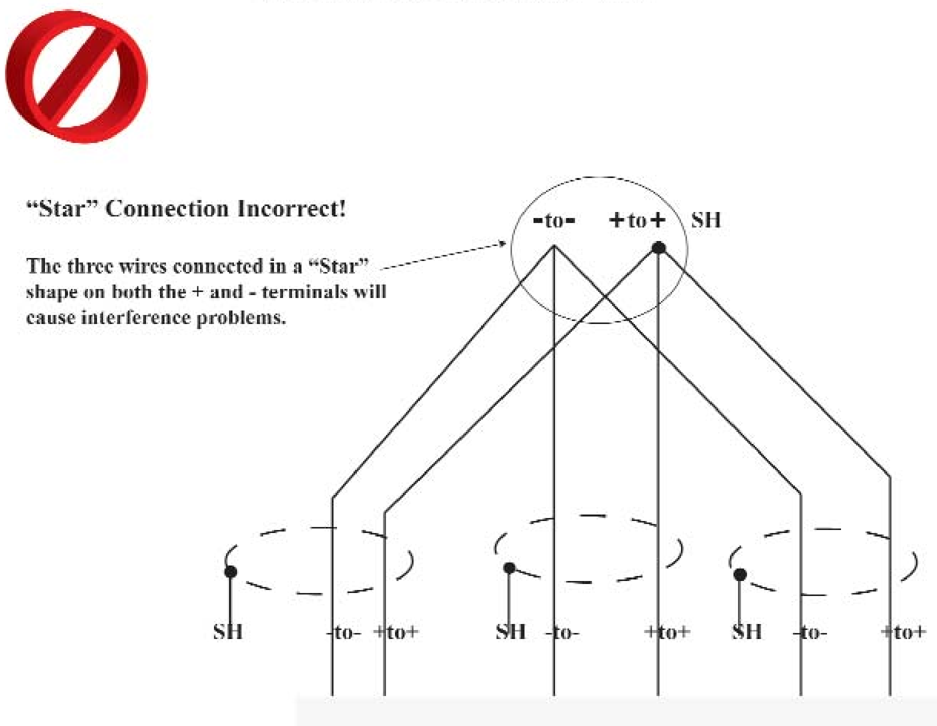
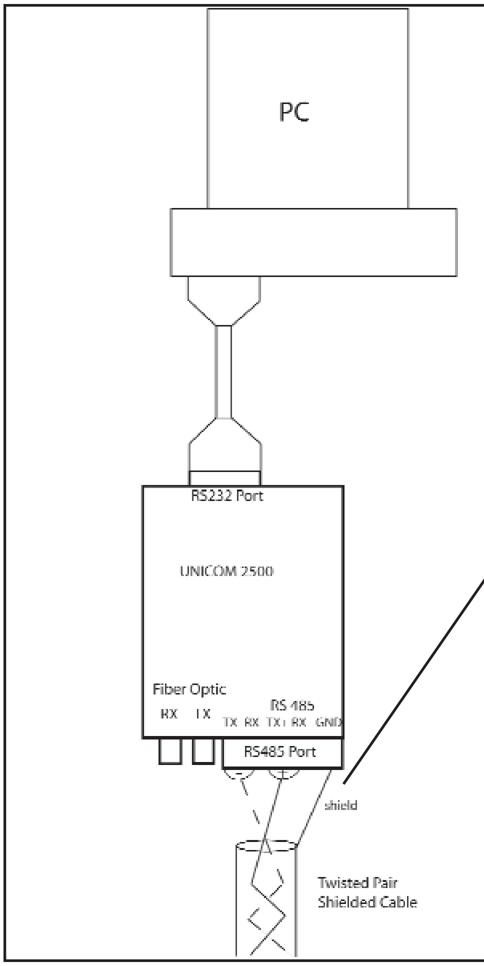


Figure 5.5: Incorrect “T” and “Star” Topologies

5.1.2: Using the Unicom 2500

The Unicom 2500 provides RS485/RS232 conversion, which allows a Shark 50 with the RS485 option to communicate with a PC. See the *Unicom 2500 Installation and Operation Manual* for additional information.

Figure 5.6 illustrates the Unicom 2500 connections for RS485.



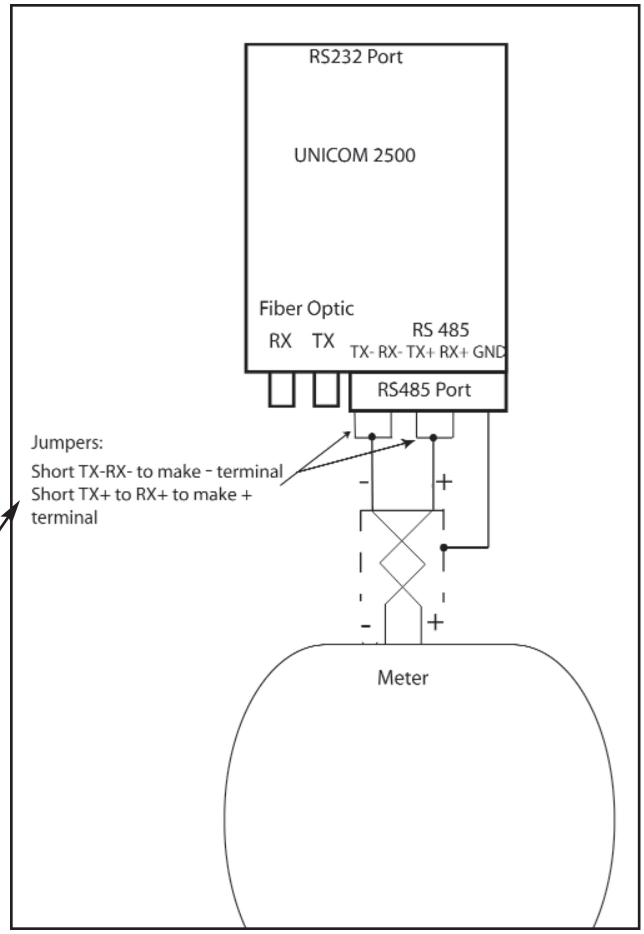


Figure 5.7: Detail of "Jumpers"

Figure 5.6: Unicom 2500 with Connections

The Unicom 2500 can be configured for either 4-wire or 2-wire RS485 connections. Since the Shark 50 uses a 2-wire connection, you need to add jumper wires to convert the Unicom 2500 to the 2-wire configuration.

As shown in Figure 5.7, you connect the "RX -" and "TX -" terminals with a jumper wire to make the "-" terminal,and connect the "RX +" and "TX +" terminals with a jumper wire to make the "+" terminal.

5.2: Communicatior EXT Programming Overview

- The Shark 50 meter can be programmed either through the buttons on the faceplate or through software. Software programming and communication utilize the RS485 connection on the back of the meter, as shown in Section 5.1.1. Once a connection is established, Communicator EXT 3.0 software can be used both to program the meter and to communicate with Shark 50 slave devices.

- **Meter Connection**

  To provide power to the meter, use one of the wiring diagrams in Chapter 4 or attach an Aux cable to GND, L(+) and N(-).
  The RS485 cable attaches to SH, - and + as shown in Section 5.1.1.

5.2.1: Factory Initial Default Settings

- You can connect to the Shark 50 using the Factory Initial Default Settings. This feature is useful in debugging or in any situtation where you do not know the meter's programmed settings and want to find them.

  When the Shark 50 is powered up, you have up to 5 seconds to poll the Name Register as shown in the example below: "How to Connect." You will be connected to the meter with the Factory Initial Default Settings. The meter continues to operate with these default settings for 5 minutes. During this time, you can access the meter's Device Profile to ascertain/change meter information. After the 5 minutes have passed, the meter reverts to the programmed Device Profile settings.

NOTE:

- **Factory Initial Default Settings**

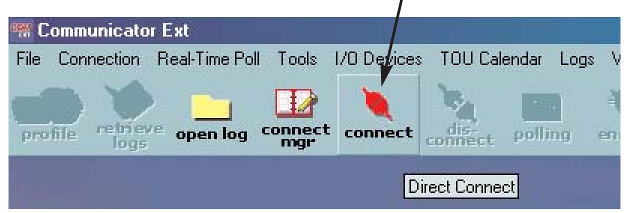
Baud Rate:	9600
Port:	COM1
Protocol:	Modbus RTU

- **How to Connect**

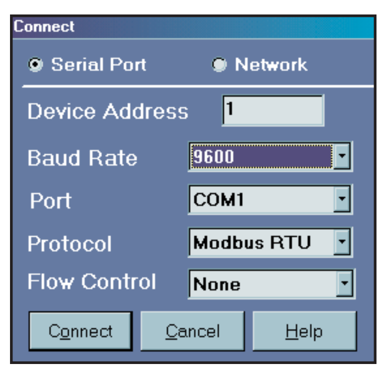
  1. Open Communicator EXT software.

  2. Click the **Connect** icon in the tool bar.

Connect Icon



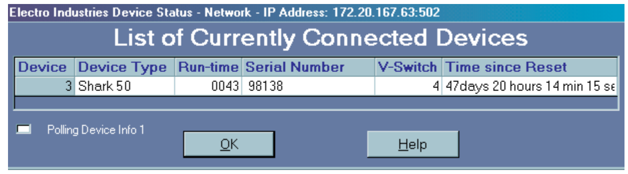
  You will see the Connect screen, with the Default settings. Make sure your settings are the same as shown in the screen on the right. Use the dropl-down windows to make changes, if necessary.

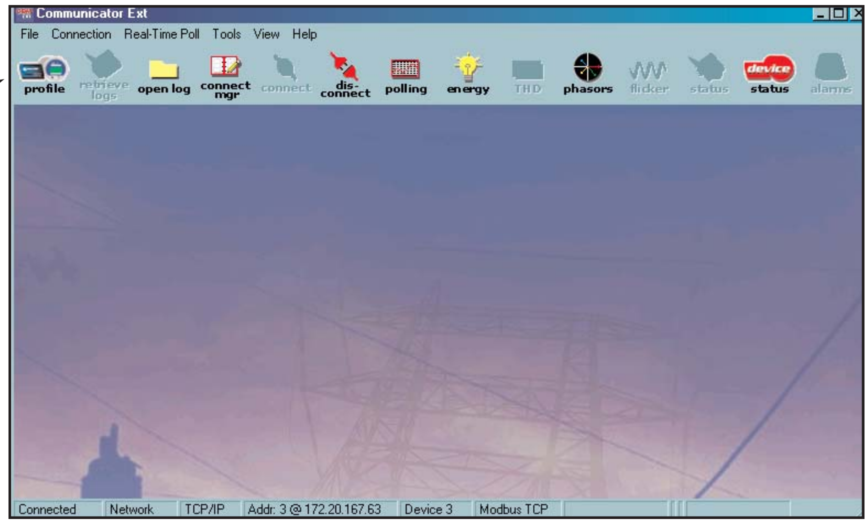


  3. Click the **Connect** button on the screen.
  NOTE If you do not connect with the Factory Initial Default Settings within 5 seconds after powering on the meter, the Device Profile reverts to the programmed Device Profile. In that case, disconnect and reconnect power before clicking the Connect button.

The Device Status screen opens, confirming the connection.

Click **OK**.
You will see the Communicator EXT Main screen again..

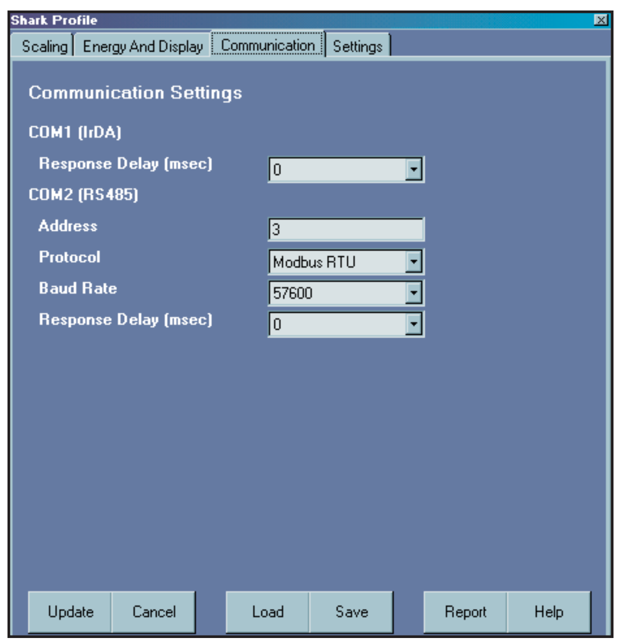




Profile Icon

4. Click the **Profile** icon in the toolbar. You will see the Shark Profile screen, shown below.

5. Click the **Communication** tab. The current Communication Settings are shown. Use the drop-down menus to make any necessary changes.

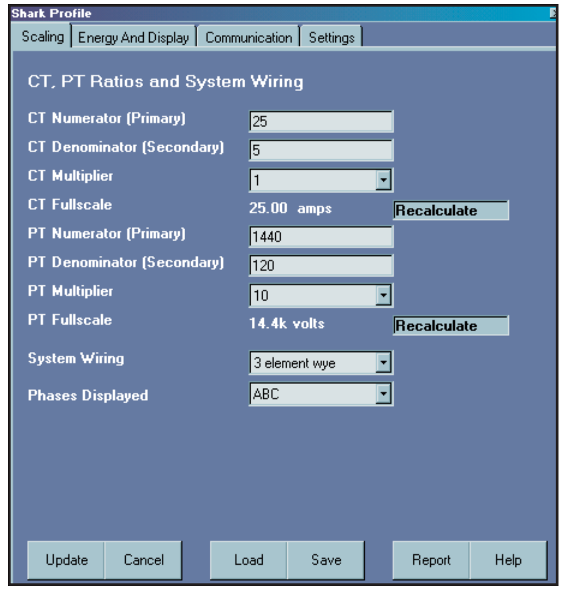


- **Communication Settings**
  COM2 (RS485)
  Address (1-247)
  Protocol (Modbus RTU or Modbus ASCII)
  Baud Rate (9600 to 57600)
  Response Delay (0-750 msec)
  NOTE: COM1 is not used by the Shark 50 meter.

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

7. Click **Cancel** to Exit the Profile or click other tabs to update other aspects of the Device Profile (see Section 5.2.2).

5.2.2: Additional Shark Profile Settings



- **Scaling (CT, PT Ratios and System Wiring)**
  CT Numerator (Primary):
  CT Denominator (Secondary): **5 (Factory-set)**
  CT Multiplier:
  CT Fullscale:
    Calculation Based on Selections
  PT Numerator (Primary):
  PT Denominator (Secondary):
  PT Multiplier:
  PT Fullscale:
    Calculation Based on Selections
  System Wiring:
  Number of Phases: One, Two or Three

NOTE:
VOLTS FULL SCALE = PT Numerator x PT Multiplier

WARNING!
You must specify Primary and Secondary Voltage in Full Scale. Do not use ratios!
The PT Denominator should be the Secondary Voltage level.

Example:
A 14400/120 PT would be entered as:

PT Num:	1440
PT Denom:	120
Multiplier:	10

This example would display a 14.40kV.

- **Example CT Settings:**

200/5 Amps:	Set the Ct-n value for 200, Ct-Multiplier value for 1.
800/5 Amps:	Set the Ct-n value for 800, Ct-Multiplier value for 1.
2,000/5 Amps:	Set the Ct-n value for 2000, Ct-Multiplier value for 1.
10,000/5 Amps:	Set the Ct-n value for 1000, Ct-Multiplier value for 10.

- **Example PT Settings:**

277/277 Volts	Pt-n value is 277, Pt-d value is 277, Pt-Multiplier is 1.
14,400/120 Volts:	Pt-n value is 1440, Pt-d value is 120, Pt-Multiplier value is 10.
138,000/69 Volts:	Pt-n value is 1380, Pt-d value is 69, Pt-Multipier value is 100.
345,000/115 Volts:	Pt-n value is 3470, Pt-d value is 115, Pt-Multiplier value is 100
345,000/69 Volts:	Pt-n value is 345, Pt-d value is 69, Pt-Multiplier value is 1000.

.

NOTE: Settings are the same for Wye and Delta configurations.

- **Energy and Display**

  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)

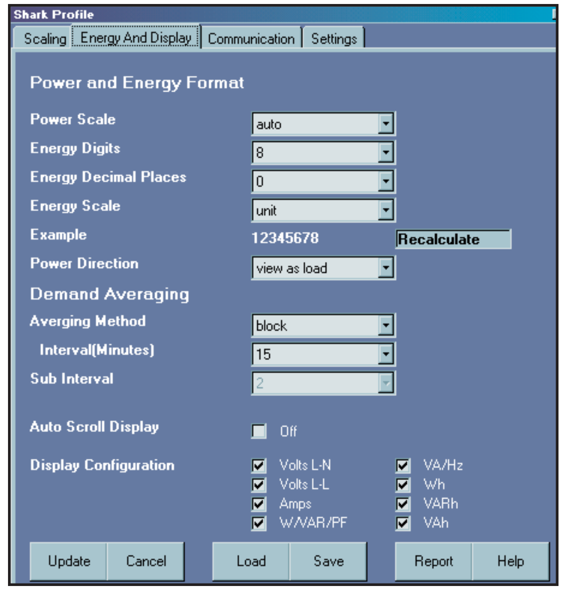
  Sub Interval

  Auto Scroll: Click to Activate

  Display Configuration:

  Click Values to be displayed.

  NOTE: You MUST have at lease ONE selected.



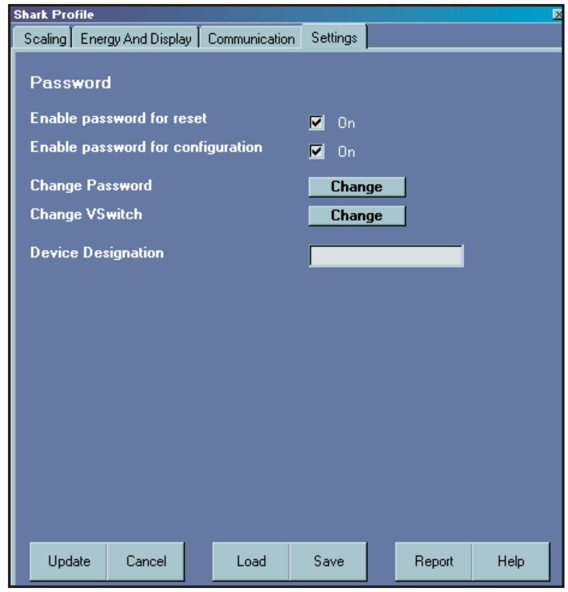
NOTE: If incorrect values are entered on this screen the following message appears:

WARNING! Current, CT, PT and Energy Settings will cause invalid energy accumulator values. Change the inputted settings until the message disappears.

- **Settings**
  Password
  (The meter is shipped with the Password Disabled: there is no Default password)
  Enable Password for Reset
  Enable Password for Configuration
  Change Password

  Change VSwitch
  (Call Electro Industries for Update Information: 516-334-0870 9am - 5pm EST)

  Change Device Designation
  Enter a new Device label in the entry field.



1. After programming the Device Profile, click:
   - **Update** to send the new Profile to the connected meter.
     NOTE: If the Update fails, the software asks if you want to try again to Update.
   - **Save** to save the Device Profile settings in a file.
   - **Cancel** (once you have loaded or saved the Device Profile) to Exit the Shark Profile screen.

   WARNING! If you click Cancel before Save or Update, you will lose any changes you have made to the Device Profile.

2. Use Communicator EXT to communicate with the device and perform required tasks.Refer to the *Communicator EXT User's Manual* for more details. You can access the manual online by clicking **Help>Contents** from the Communicator EXT Main screen.

Chapter 6
Using the Meter

6.1: Introduction

- The Shark® 50 meter can be configured and a variety of functions can be accomplished simply by using the Elements and the Buttons on the meter face. This chapter will review Front Panel Navigation. Complete Navigation Maps can be found in Appendix A of this manual.

6.1.1: Meter Face Elements

- **Reading Type Indicator:**
  Indicates Type of Reading
- **% of Load Bar:**
  Graphic Display of Amps
  as % of the Load
- **Parameter Designator:**
  Indicates Reading Displayed
- **Scale Selector:**
  Kilo or Mega multiplier of
  Displayed Readings

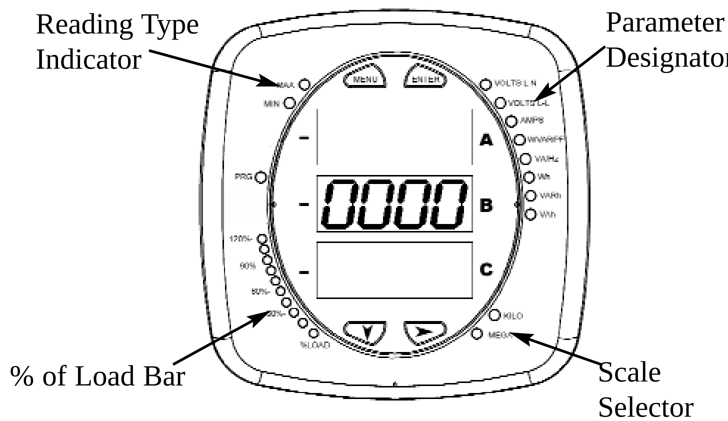


Figure 6.1: Face Plate of Shark® 50 meter with Elements

6.1.2: Meter Face Buttons

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

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

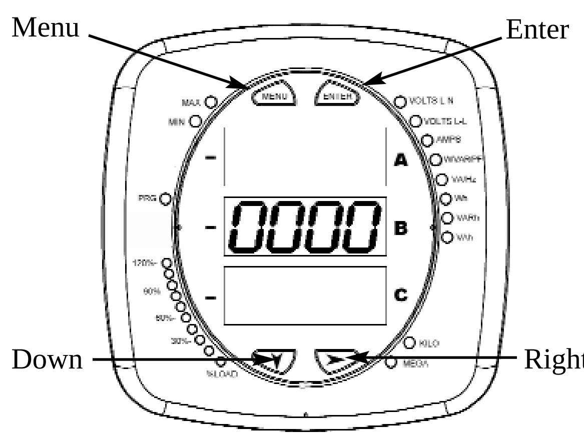


Figure 6.2: Face Plate of Shark® 50 meter with Buttons

- **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, 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 Meter Setting Parameters and Change Scroll Setting
  Configuration Mode: Change Meter Configuration (Can be Password Protected)

NOTE: The above is a brief overview of the use of the Buttons. For Programming, refer to Chapter 7. For complete Navigation Maps, refer to Appendix A of this manual.

6.2: % of Load Bar

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

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

6.3: Upgrade the Meter Using V-Switch™ Technology

- The Shark 50 is equipped with V-Switch™ Technology, a virtual firmware-based switch that allows you to enable meter features through communication. This allows the unit to be upgraded after installation to a higher model without removing the unit from service.

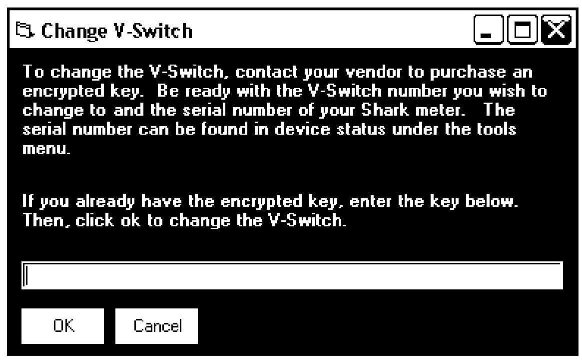
- Available V-Switch™ keys:

  V-Switch 1 (-V1): Volts and Amps Meter - Default
  V-Switch 2 (-V2): Volts, Amps, kW, kVAR, PF, kVA, Freq
  V-Switch 3 (-V3): Volts, Amps, kW, kVAR, PF, kVA, Freq., kWh, kVAh, kVARh

- V-Switch™ keys are based on the specific serial number of the ordered meter. To obtain a higher V-Switch™ key, you need to provide EIG with the following information:
  1. Serial Number or Numbers of the meters you want to upgrade.
  2. Desired V-Switch 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.

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



  1. Install Communicator EXT 3.0 on your computer and set up the Shark 50 to communicate with it (see Chapter 5).
  2. Power up your meter and connect to it with Communicator EXT 3.0 software.
  3. Click the **Profile** icon in the Main screen.. The Shark Profile screen opens, displaying the Settings tab..
  4. Click the **Change** button next to Change V-Switch. A small screen opens, requesting the Upgrade code.
  5. Enter the code provided to you by EIG.
  7. Click **OK**. The V-Switch™ key is changed and the meter resets.

NOTE: For more details on software configuration, refer to the *Communiator EXT 3.0 User's Manual*. You can access the manual online by clicking **Help>Contents** from the Communicator EXT Main screen.

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Chapter 7
Configuring the Shark Using the Front Panel

7.1: Overview

- The Shark 50 front panel can be used to configure the meter. The Shark 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 setup will be demonstrated. Other settings are possible. The complete Navigation Map for the Display Modes is in Appendix A of this manual. The meter can also be configured with software (see Chapter 5 in the *Communicator EXT User Manual*).

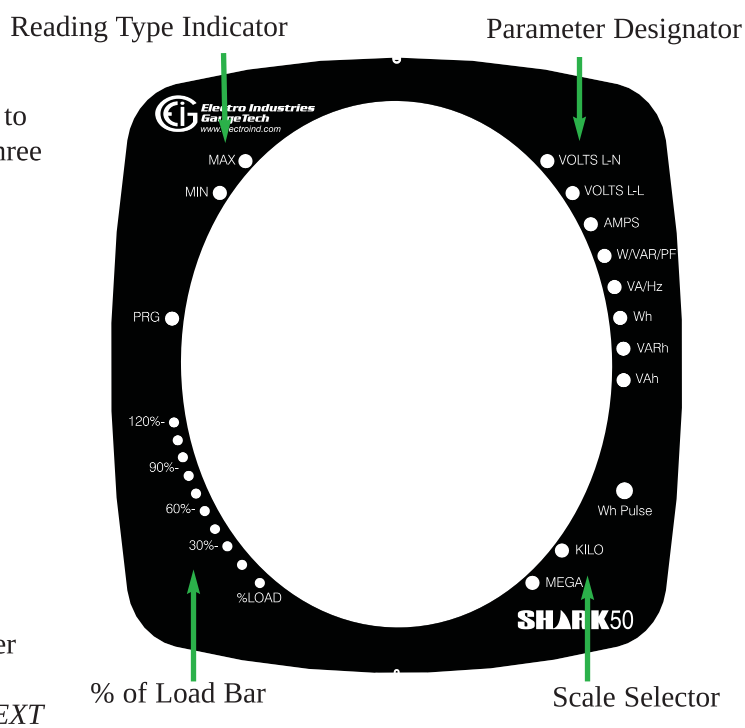


Figure 7.1: Shark Label

7.2: Startup

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

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

  The Shark 50 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.

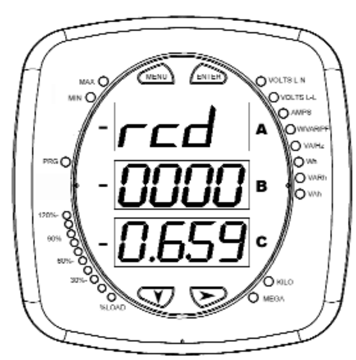


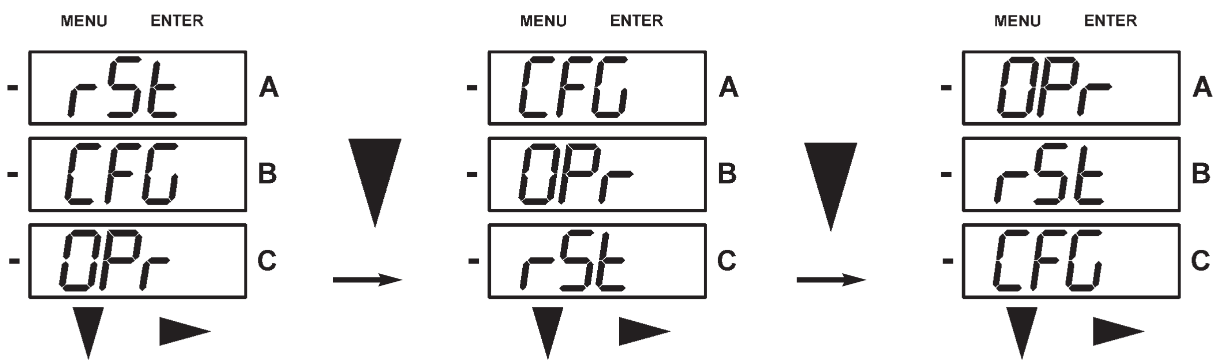
Figure 7.2: Wh Reading

- The Shark 50 will continue to scroll through the Parameter Designators, providing readings until one of the buttons on the front panel is pushed, causing the meter to enter one of the other MODES.

7.3: Configuration

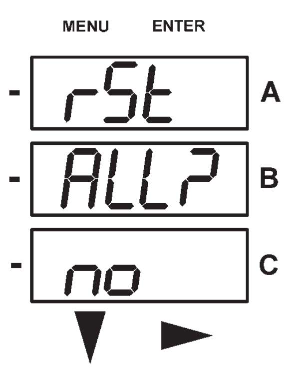
7.3.1: Main Menu

■ 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 meter enters the Mode that is in the A Screen and is blinking. See *Appendix A* for Navigation Map.



7.3.2: Reset Mode

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

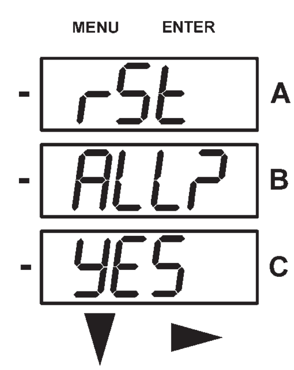


If you push **ENTER** again, the Main Menu continues to scroll. The DOWN button does not change the screen.

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 (see section 5.22).

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



7.3.2.1: Enter Password (only if it has been enabled using meter software)

- To enter a Password:

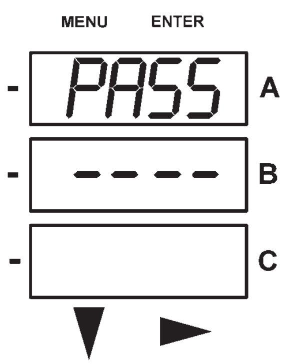
  If PASSWORD is Enabled in the software (see Section 5.2.2 to Enable/Change Password), a screen appears requesting the Password. **PASS** appears in the A Screen and **4 dashes** in the B Screen. The LEFT digit is flashing.

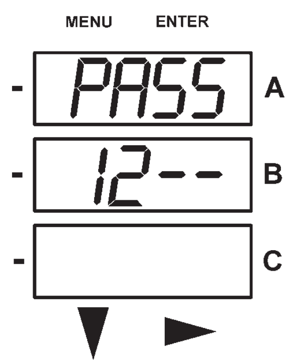
  Use the **DOWN** button to scroll from 0 to 9 for the flashing digit. When the correct number appears for that digit, use the **RIGHT** button to move to the next digit.

Example: On the Password screens below:

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

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





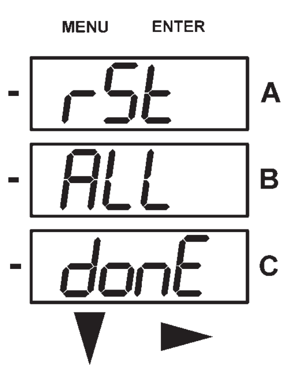
- **PASS or FAIL**

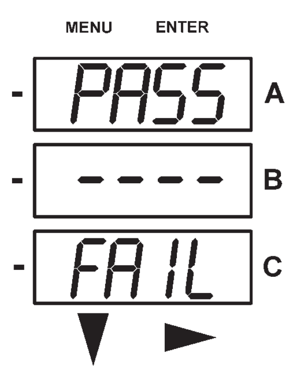
  When all 4 digits have been entered, push **ENTER**.

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

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

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





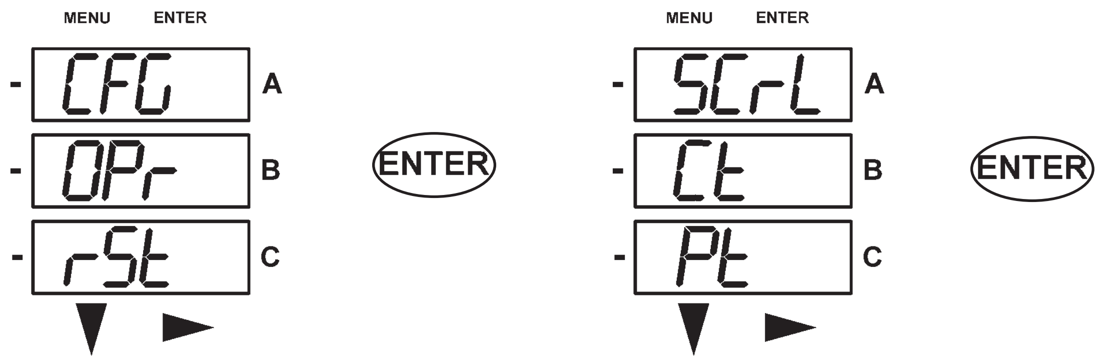
7.3.3: Configuration Mode

■ 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).

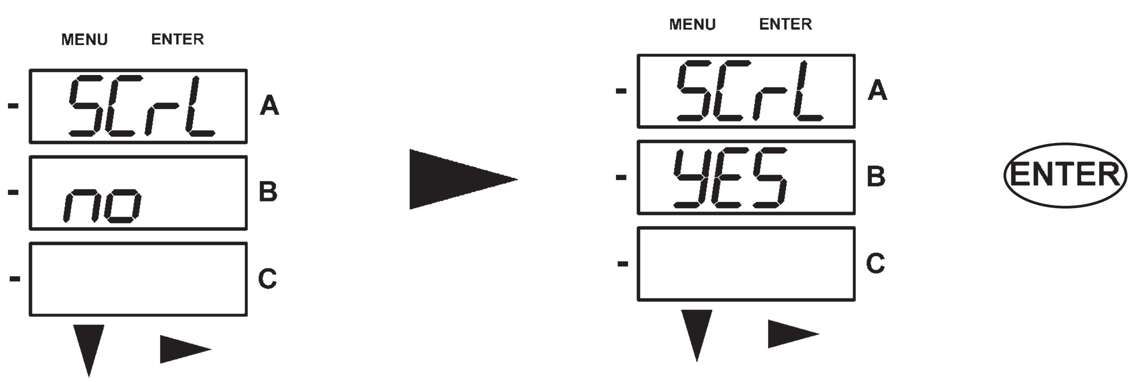
Push **ENTER** and the Configuration Parameters scroll, starting at the "SCROLL, Ct, Pt" screen.

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.



7.3.3.1: Configure Scroll Feature

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



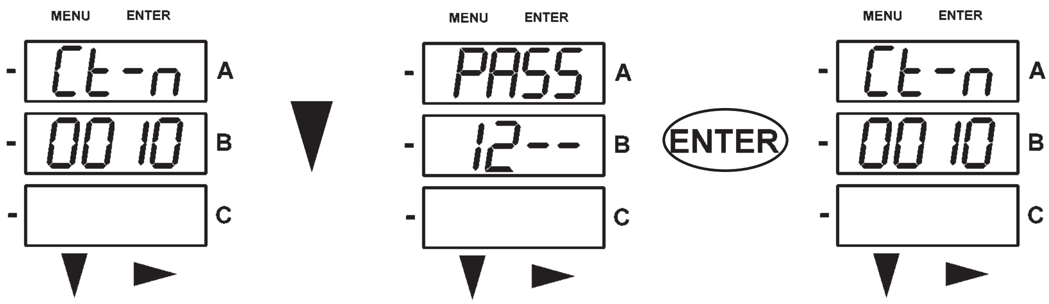
When in Scroll Mode, the unit scrolls each parameter for 7 seconds on and 1 second off. The meter can be configured through software to display only selected screens. If that is the case, it will only scroll the selected display. Additionally, the meter will only scroll the display enabled by the V-Switch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

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

7.3.3.2: Program Configuration Mode Screens

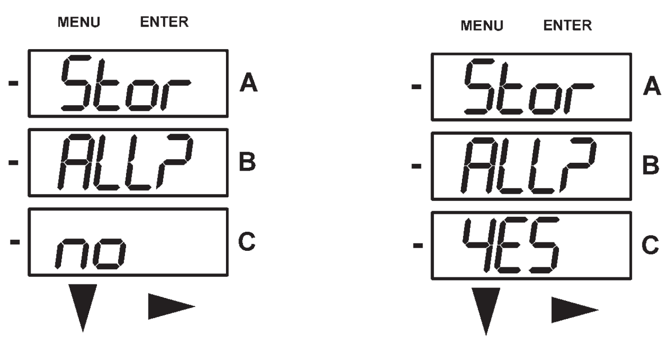
■ To program the screens in Configuration Mode, other than SCROLL:

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 7.3.2.1 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 meter face.
   The first digit of the setting will also flash.



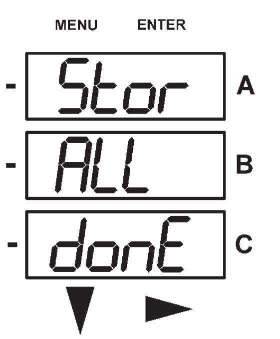
3. Use the **DOWN** button to change the digit.
   Use the **RIGHT** Button to move to the next digit.

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 meter RESETS.

7.3.3.3: 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.

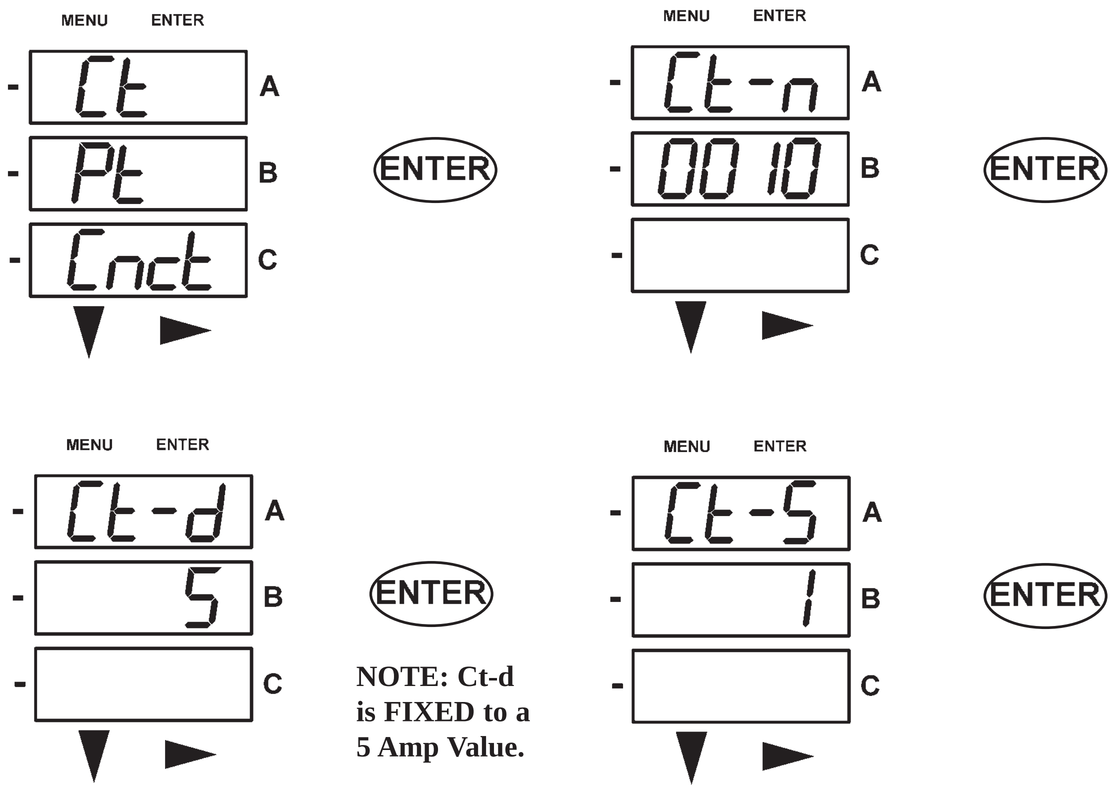
Push **ENTER** when CT is the 'Active' parameter and the **Ct-n (Numerator)** screen appears.

Push **ENTER** and the screen changes to **Ct-d (Denominator).**

The Ct-d screen is PRESET to a 5 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 7.3.3.2.



NOTE: Ct-d is FIXED to a 5 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.

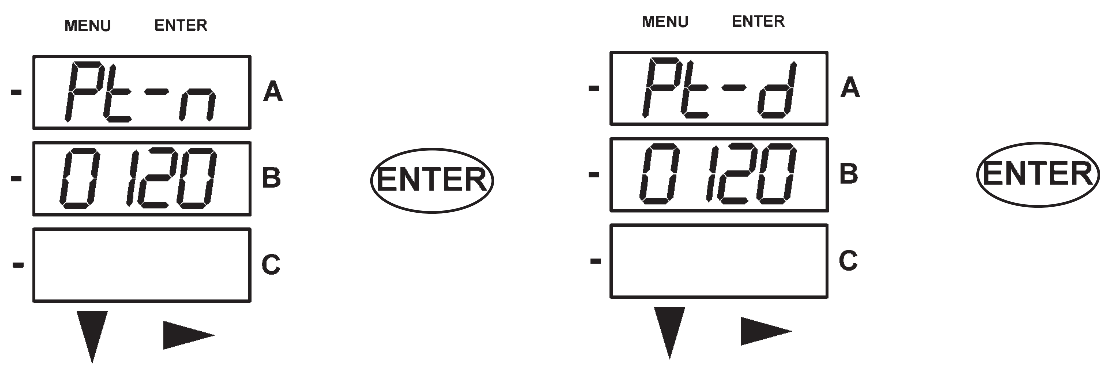
NOTE: The value for Amps is a product of the Ct-n value and the Ct-S value.

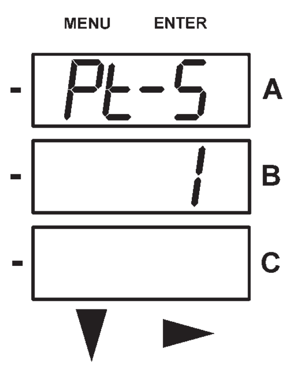
- Push **ENTER** and the screen scrolls through the other CFG parameters.
  Push **DOWN or RIGHT** and the Password screen appears (see section 7.3.2.1).
  Push **MENU** and you will return to the MAIN MENU.

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

7.3.3.4: 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 7.3.3.2.





Example Settings:

277/277 Volts:	Pt-n value is 277, Pt-d value is 277, Pt-Multiplier is 1.
14,400/120 Volts:	Pt-n value is 1440, Pt-d value is 120, Pt-S value is 10.
138,000/69 Volts:	Pt-n value is 1380, Pt-d value is 69, Pt-S value is 100.
345,000/115 Volts:	Pt-n value is 3450, Pt-d value is 115, Pt-S value is 100.
345,000/69Volts:	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 7.3.2.1).
  Push **MENU** and you will return to the MAIN MENU.

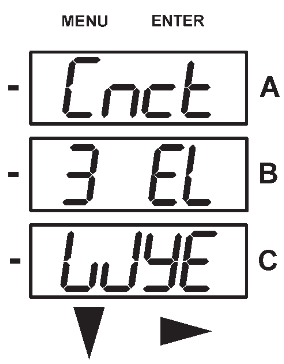
NOTE: Pt-n and Pt-S are dictated by Primary Voltage.
Pt-d is Secondary Voltage.

7.3.3.5: Configure Connection (Cnct) Setting

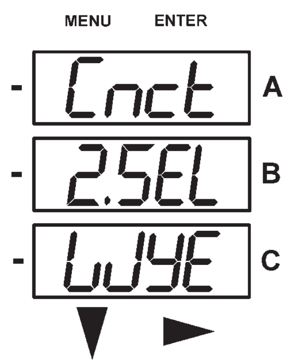
Push the **DOWN** Button to scroll all the parameters in Configuration Mode: Scroll, CT, PT, Connection (Cnct) and Port. The 'Active" parameter is in the A Screen and is flashing.
Push **ENTER** when **Cnct** is the 'Active' parameter and the **Connection** screen appears for your meter. To change this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

■ The possible Connection configurations include:

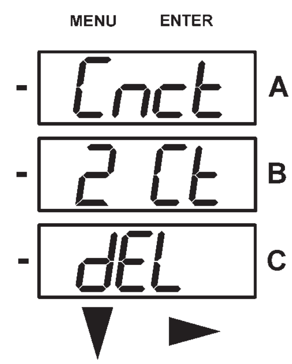
- 3 Element WYE
- 2.5 Element WYE
- 2 CT Delta



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 7.3.2.1).
Push **MENU** and you will return to the MAIN MENU.

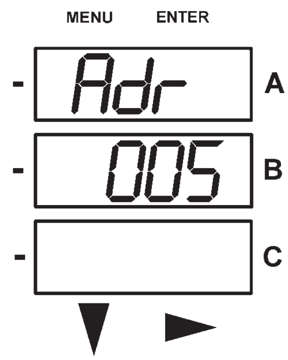
7.3.3.6: Configure Communication Port Setting

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 the **Port** screens appear for your meter.

- To program the PORT screens, see section 7.3.3.2.

- The possible PORT configurations include:
  Address (Adr) (Three digit number)
  BAUD (bAUd) 9600, 19,200, 38,400, 57,600
  Protocol (Prot) Modbus (Mod) RTU (rtU),Modbus (Mod) ASCII (ASCI)

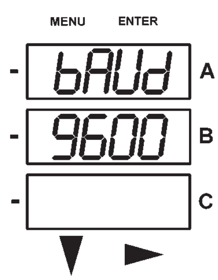
- The first PORT screen is **Address (Adr)**.
  The current Address appears on the screen.
  Follow the Programming steps in Section 7.3.3.2 to change the Address.



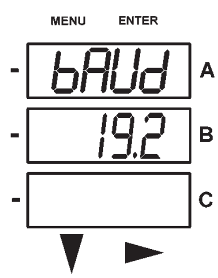
Address 005

- **Baud Rate (bAUd)** appears next. The current Baud Rate appears on the screen. To change the setting, follow the Programming steps in Section 7.3.3.2. Possible screens appear below.

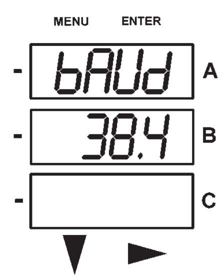
- **Protocol (Prot)** appears next. The current Protocol appears on the screen. To change the setting, follow the Programming steps in Section 7.3.3.2. Possible screens appear below.



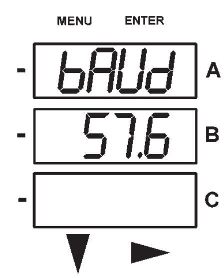
Baud Rate 9600



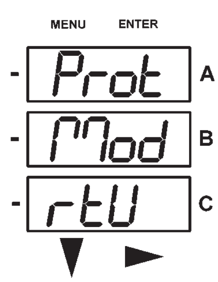
Baud Rate 19,200



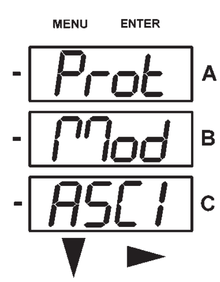
Baud Rate 38,400



Baud Rate 57,600



Modbus RTU Protocol



Modbus ASCII Protocol

- Push **ENTER** and the screen scrolls through the other CFG parameters.
  Push **DOWN or RIGHT** and the Password screen appears (see Section 7.3.2.1).
  Push **MENU** and you will return to the MAIN MENU.

7.3.4: Operating Mode

- Operating Mode is the Shark 50 meter's Default mode. After startup, the meter 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 meter..
  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	**Possible Readings**				
VOLTS L-N V1-3	VOLTS_LN	VOLTS_LN_ MAX	VOLTS_LN_ MIN		
VOLTS L-L V1-3	VOLTS_LL	VOLTS_LL_ MAX	VOLTS_LL_ MIN		
AMPS V1-3	AMPS	AMPS_ NEUTRAL	AMPS_MAX	AMPS_MIN	
W/VAR/PF V2-3	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 V2-3	VA_FREQ	VA_FREQ_ MAX	VA_FREQ_ MIN		
Wh V3	KWH_REC	KWH_DEL	KWH_NET	KWH_TOT	
VARh V3	KVARH_ POS	KVARH_ NEG	KVARH_ NET	KVARH_ TOT	
VAh V3	KVAH				

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

Appendix A
Shark Navigation Maps

A.1: Introduction

- The Shark 50 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 6.
  An overview of programming using the Buttons can be found in Chapter 7.
  The meter can also be programmed using software (see Chapter 5 of the *Communicator EXT User Manual*).

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

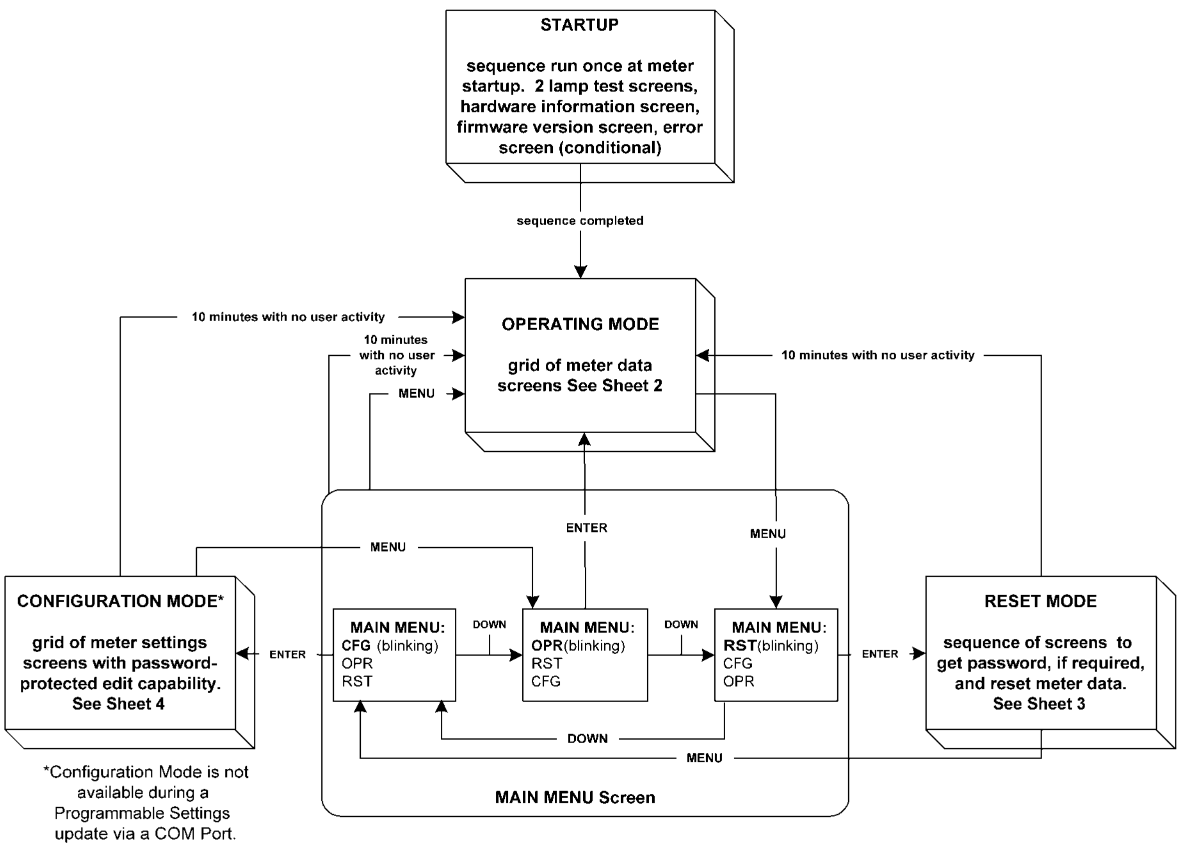
- The Shark Navigation Maps begin on the next page.

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

- **Shark Navigation Map Titles:**

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

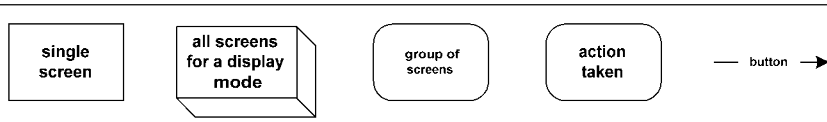
Main Menu Screens (Sheet 1)



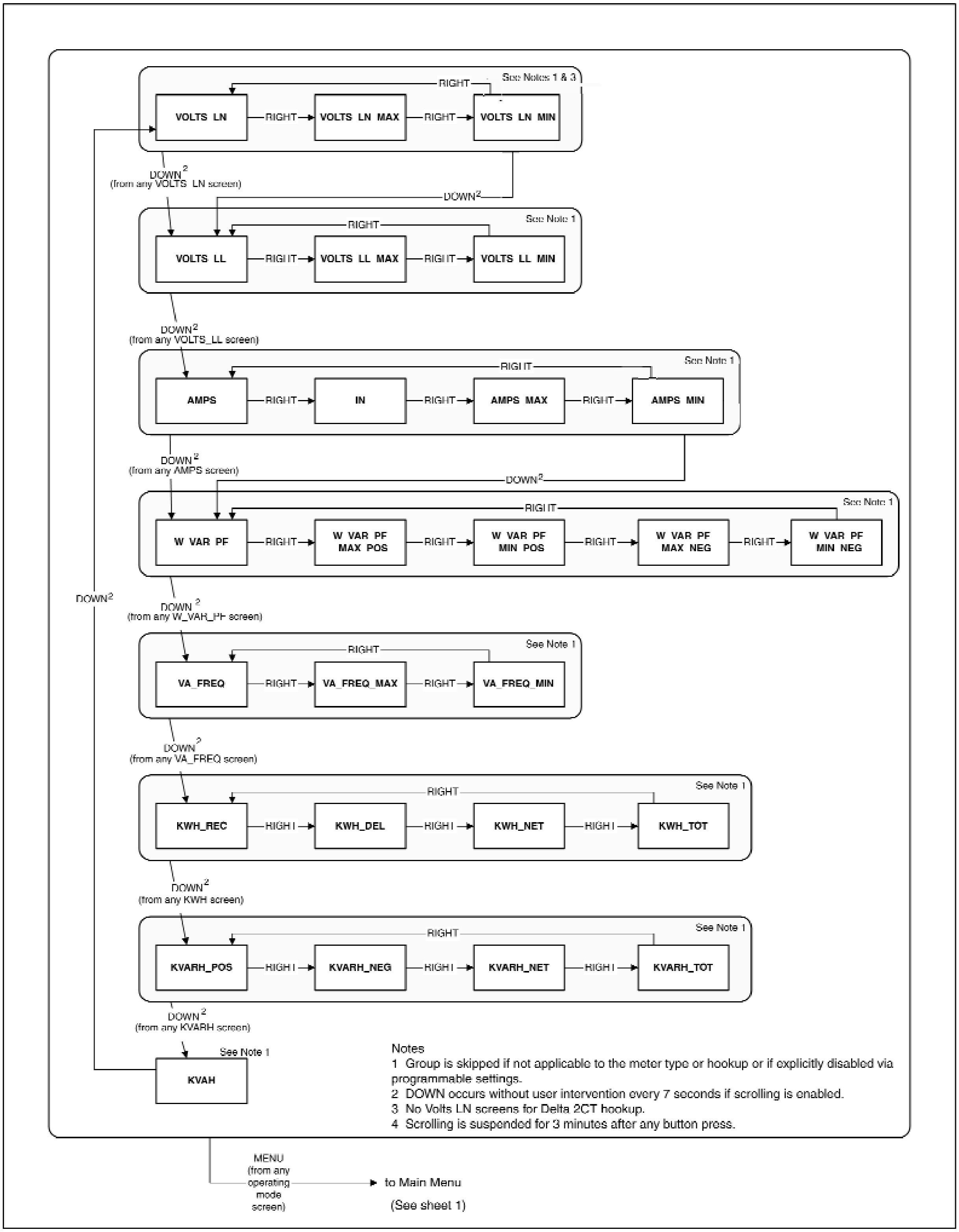
MAIN MENU screen scrolls through 3 choices, showing all 3 at once. The top choice is always the "active" one, which is indicated by the blinking legend.

BUTTONS

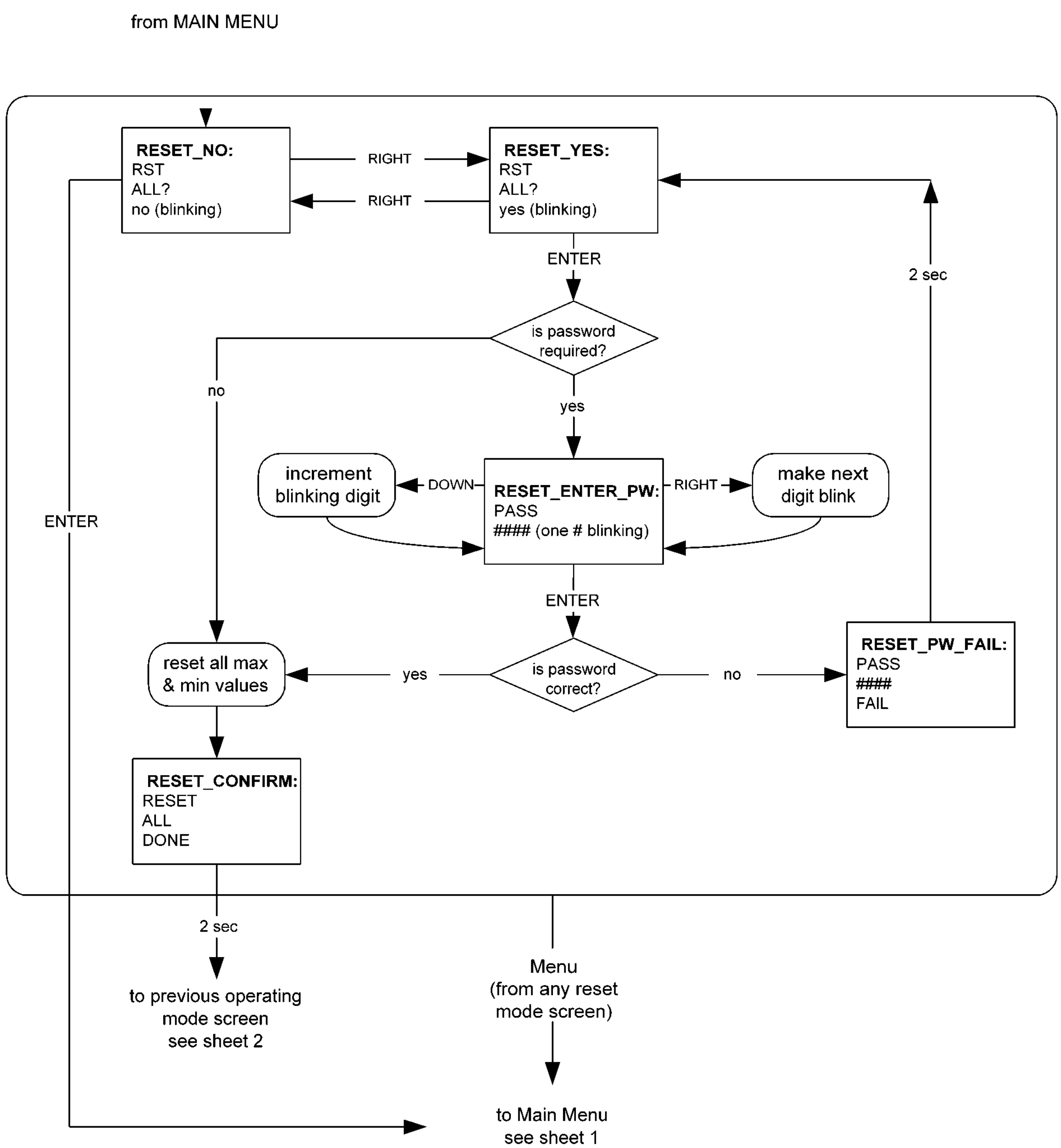
MENU	**Returns to previous menu from any screen in any mode.**
ENTER	**Indicates acceptance of the current screen and advances to the next one.**
DOWN, RIGHT	**Navigation and Edit buttons**
Navigation:	**No digits or legends are blinking. On a menu, DOWN advances to the next menu selection, RIGHT does 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.**



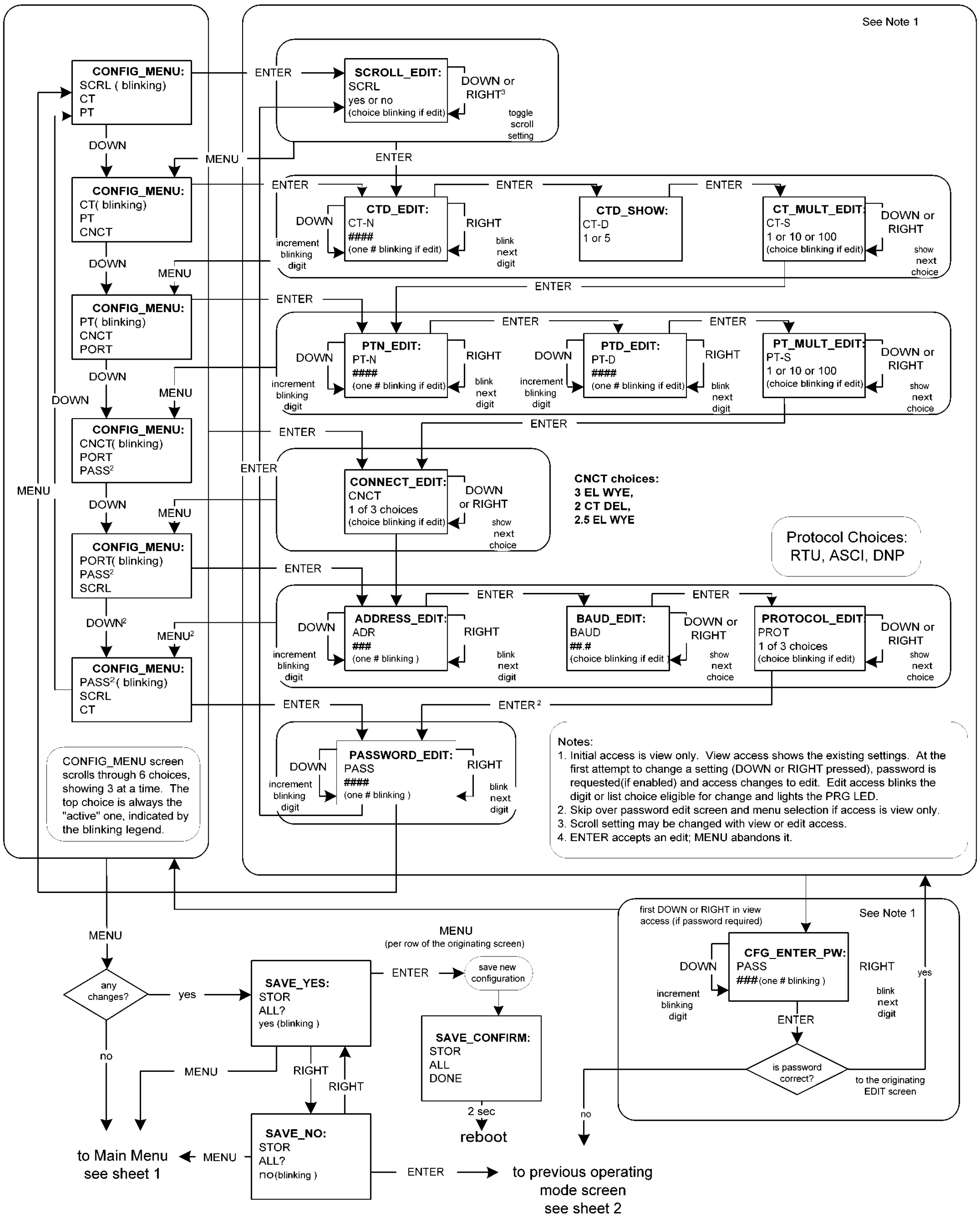
Operating Mode Screens (Sheet 2)



Reset Mode Screens (Sheet 3)



Configuration Mode Screens (Sheet 4)



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Appendix B
Modbus Mapping for Shark

B.1: Introduction

- The Modbus Map for the Shark 50 Meter gives details and information about the possible readings of the meter and about the programming of the meter. The Shark 50 can be programmed using the buttons on the face plate of the meter (Chapter 7). The meter can also be programmed using software. For a Programming Overview, see Section 5.2 of this manual. For further details see the *Communicator EXT User Manual*.

B.2: Modbus Register Map Sections

- The Shark 50 Modbus Register Map includes the following sections:

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

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

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

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

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

B.3: Data Formats

- **ASCII**: ASCII characters packed 2 per register in high, low order and without any termination charcters.
  Example: "Shark 50" would be 4 registers containing 0x5368, 0x6172, 0x6B35, 0x3000.

- **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} x $2^{exponent-127}$x1.mantissa = 0x0C4E11DB9

$-1^{sign} x2^{137-127} x1$□$11000010001110110111001$

$-1x2^{10}x1.75871956$

-1800.929

Register	0x0C4E1																0x01DB9															
Byte	0x0C4								0x0E1								0x01D								0x0B9							
Bit	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
	1	1	0	0	0	1	0	0	1	1	1	0	0	0	0	1	0	0	0	1	1	1	0	1	1	0	1	1	1	0	0	1
Meaning	s	e	e	e	e	e	e	e	e	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
	sign	exponent								mantissa																						
	1	0x089 = 137								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 50 Modbus Register Map begins on the following page.

Modbus Address Hex	Modbus Address 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 (0=no), vvv = V-switch(1 to 3)	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	OEM 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

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

Modbus Address Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
0BD3 - 0BD4	3028 - 3029	Positive Power Factor, 3-Ph, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2
0BD5 - 0BD6	3030 - 3031	Negative Power Factor, 3-Ph, Minimum Avg Demand	FLOAT	-1.00 to +1.00	none		2
0BD7 - 0BD8	3032 - 3033	Frequency, Minimum	FLOAT	0 to 65.00	Hz		2
						Block Size:	34
Primary Maximum Block (IEEE Floating Point)						read-only	
0C1B - 0C1C	3100 - 3101	Volts A-N, Maximum	FLOAT	0 to 9999 M	volts		2
0C1D - 0C1E	3102 - 3103	Volts B-N, Maximum	FLOAT	0 to 9999 M	volts		2
0C1F - 0C20	3104 - 3105	Volts C-N, Maximum	FLOAT	0 to 9999 M	volts		2
0C21 - 0C22	3106 - 3107	Volts A-B, Maximum	FLOAT	0 to 9999 M	volts		2
0C23 - 0C24	3108 - 3109	Volts B-C, Maximum	FLOAT	0 to 9999 M	volts		2
0C25 - 0C26	3110 - 3111	Volts C-A, Maximum	FLOAT	0 to 9999 M	volts		2
0C27 - 0C28	3112 - 3113	Amps A, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2
0C29 - 0C2A	3114 - 3115	Amps B, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2
0C2B - 0C2C	3116 - 3117	Amps C, Maximum Avg Demand	FLOAT	0 to 9999 M	amps		2
0C2D - 0C2E	3118 - 3119	Positive Watts, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	watts		2
0C2F - 0C30	3120 - 3121	Positive VARs, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	VARs		2
0C31 - 0C32	3122 - 3123	Negative Watts, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	watts		2
0C33 - 0C34	3124 - 3125	Negative VARs, 3-Ph, Maximum Avg Demand	FLOAT	0 to +9999 M	VARs		2
0C35 - 0C36	3126 - 3127	VAs, 3-Ph, Maximum Avg Demand	FLOAT	-9999 M to +9999 M	VAs		2
0C37 - 0C38	3128 - 3129	Positive Power Factor, 3-Ph, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2
0C39 - 0C3A	3130 - 3131	Negative Power Factor, 3-Ph, Maximum Avg Demand	FLOAT	-1.00 to +1.00	none		2
0C3B - 0C3C	3132 - 3133	Frequency, Maximum	FLOAT	0 to 65.00	Hz		2
						Block Size:	34
						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

Modbus Address Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
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=programmabl settings, c=calibration, h=header), ssssssss = state (1=Run, 2=Limp, 10=Prog Set Update via buttons, 12=Prog Set Update via COM2)	1
1388 - 1388	5001 - 5001	Not used by Shark 50.	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 coun	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 mod	1
55F0 - 55F0	22001 - 22001	Terminate Programmable Settings Update[3]	UINT16	any value		meter leaves PS update mode via reset	1
55F1 - 55F1	22002 - 22002	Calculate Programmable Settings Checksum[3]	UINT16			meter calculates checksum on RAM copy of PS block	1
55F2 - 55F2	22003 - 22003	Programmable Settings Checksum[3]	UINT16			read/write checksum register; PS block saved in EEPROM on write[8]	1
55F3 - 55F3	22004 - 22004	Write New Password[3]	UINT16	0000 to 9999		write-only register; always reads zero	1
59D7 - 59D7	23000 - 23000	Initiate Meter Firmware Reprogramming	UINT16	password[5]			1
						Block Size:	6
Other Commands Block						read/write	
61A7 - 61A7	25000 - 25000	Force Meter Restart	UINT16	password[5]		causes a watchdog reset, always reads 0	1
						Block Size:	1
Encryption Block						read/write	
658F - 659A	26000 - 26011	Perform a Secure Operation	UINT16			encrypted command to read password or change meter type	12

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

Modbus Address							
Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
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	Not used by Shark 50	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	Not used by Shark 50	UINT16	0 to 65535		use Modbus address as the identifier (see notes 7, 11, 12)	1
754C - 754C	30029 - 30029	Not used by Shark 50	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	Not used by Shark 50	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	Not used by Shark 50	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	Not used by Shark 50	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	Not used by Shark 50	SINT16	same as Limit #1	same as Limit #1	same as Limit #1	5
7555 - 7559	30038 - 30042	Not used by Shark 50	SINT16				5
755A - 755E	30043 - 30047	Not used by Shark 50	SINT16				5
755F - 7563	30048 - 30052	Not used by Shark 50	SINT16				5
7564 - 7568	30053 - 30057	Not used by Shark 50	SINT16				5
7569 - 756D	30058 - 30062	Not used by Shark 50	SINT16				5
756E - 7572	30063 - 30067	Not used by Shark 50	SINT16				5
						Block Size:	68

Secondary Readings Section

Secondary Block						read-only except as noted	
9C40 - 9C40	40001 - 40001	System Sanity Indicator	UINT16	0 or 1	none	0 indicates proper meter 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

Modbus Address							
Hex	Decimal	Description[1]	Format	Range[6]	Units or Resolution	Comments	# Reg
9C49 - 9C49	40010 - 40010	VAs, 3-Ph total	UINT16	2047 to 4095	VAs	3000 * (register - 2047) / 2047	1
9C4A - 9C4A	40011 - 40011	Power Factor, 3-Ph total	UINT16	1047 to 3047	none	1047= -1, 2047= 0, 3047= +1 pf = (register - 2047) / 1000	1
9C4B - 9C4B	40012 - 40012	Frequency	UINT16	0 to 2730	Hz	0= 45 or less, 2047= 60, 2730= 65 or more freq = 45 + ((register / 4095) * 30)	1
9C4C - 9C4C	40013 - 40013	Volts A-B	UINT16	2047 to 4095	volts	2047= 0, 4095= +300	1
9C4D - 9C4D	40014 - 40014	Volts B-C	UINT16	2047 to 4095	volts	volts = 300 * (register - 2047) / 2047	1
9C4E - 9C4E	40015 - 40015	Volts C-A	UINT16	2047 to 4095	volts		1
9C4F - 9C4F	40016 - 40016	CT numerator	UINT16	1 to 9999	none	CT = numerator * multiplier / denominator	1
9C50 - 9C50	40017 - 40017	CT multiplier	UINT16	1, 10, 100	none		1
9C51 - 9C51	40018 - 40018	CT denominator	UINT16	5	none		1
9C52 - 9C52	40019 - 40019	PT numerator	UINT16	1 to 9999	none	PT = numerator * multiplier / denominator	1
9C53 - 9C53	40020 - 40020	PT multiplier	UINT16	1, 10, 100	none		1
9C54 - 9C54	40021 - 40021	PT denominator	UINT16	1 to 9999	none		1
9C55 - 9C56	40022 - 40023	W-hours, Positive	UINT32	0 to 99999999	Wh per energy format	* 5 to 8 digits	2
9C57 - 9C58	40024 - 40025	W-hours, Negative	UINT32	0 to 99999999	Wh per energy format	* decimal point implied, per energy format	2
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

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.

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

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 50.

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 Not applicable to Shark 50.

12 Not applicable to Shark 50.

13 Not applicable to Shark 50.

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

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