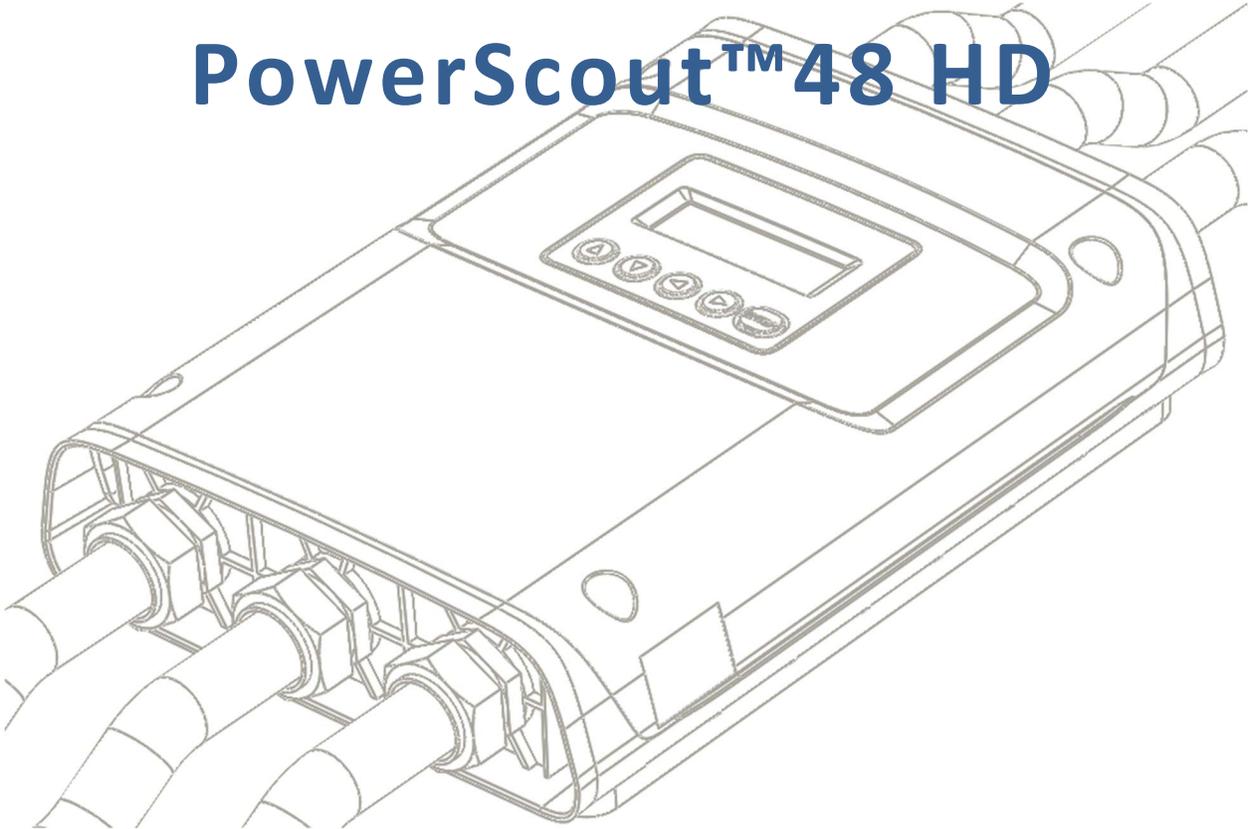


Operator's Guide

PowerScout™ 12 HD PowerScout™ 48 HD



Networked Metering Systems

and

ViewPoint™ HD Software



October 2017

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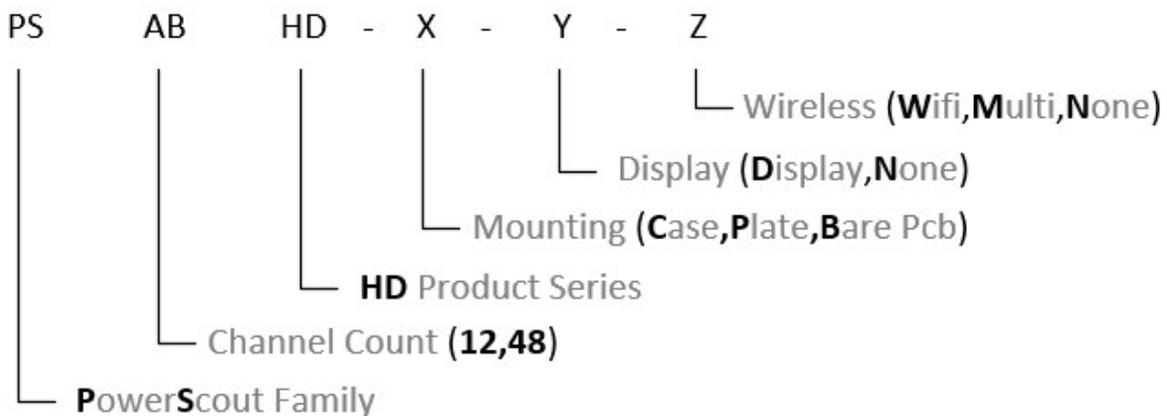
INTRODUCTION

There are two meters in the PowerScout HD Series: the PowerScout 12 HD (PS12HD) and the PowerScout 48 HD (PS48HD). These meters monitor the voltage, current, power, energy, and many other electrical parameters on single and three-phase electrical systems. A PSHD meter uses direct connections to each phase of the voltage and current transformers to monitor each phase of the current. Information on energy use, demand, power factor, line frequency, and more are derived from these voltage and current inputs.

The PSHD meter is not meant to be a standalone energy recorder; rather it is connected as a slave device to a data logger, Remote Terminal Unit (RTU), or Building Management host network. The PSHD meter communication interfaces include Ethernet (LAN), RS-485 serial, or Wi-Fi (under development). BACnet MS/TP and Modbus RTU are the two communication protocols that operate over an RS-485 serial network and BACnet IP and Modbus TCP are supported over Ethernet. A USB port is also provided as the preferred connection for on-site configuration and can be run concurrently with an RTU.

Unpacking the Unit

The PSHD can be ordered with optional product features which are identifiable on the part number label.



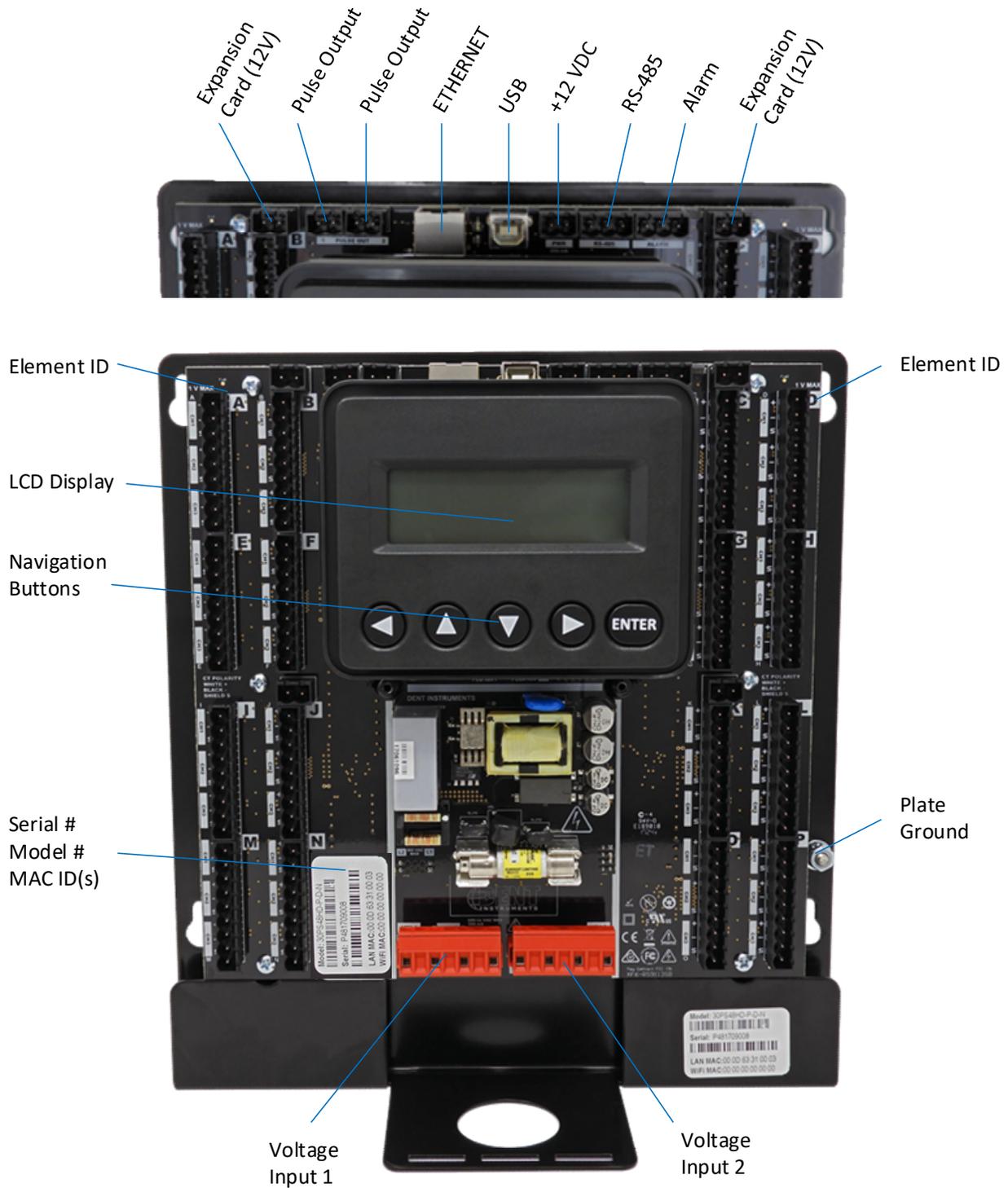
PowerScout HD Part Numbering Scheme

Each PSHD meter shipment also includes the following items:

- Meter with Options Installed – Serial Number, MAC ID, and FCC ID indicated on side label.
- Pluggable Connectors (2 voltage, 50 three-position terminals, 3 two-position terminals)
- Thumb drive containing ViewPoint HD Software, Register List, Manual, Tutorial Videos
- Certificate of Calibration (COC) for each unit

PSHD Anatomy

All user connections are made on the circuit board. Connectors are identified by function and include polarity markers.



PS48HD (mounting plate version shown)

PowerScout HD Meter Safety Summary and Specifications

<p>This general safety information is to be used by both the Logger operator and servicing personnel. DENT Instruments, Inc. assumes no liability for user's failure to comply with these safety guidelines.</p>	 <p>PS12HD-B-y-z, PS12HD-P-y-z PS48HD-B-y-z, PS48HD-P-y-z</p>  <p>PS12HD-C-y-z PS48HD-C-y-z</p>	<p>The PSHD Family conform to the following:</p>  <p>PowerScout HD Series: Conforms to UL Std 61010-1, 3rd Edition Certified to CSA Std C22.2 No. 61010-1, 3rd Edition</p>
<p>PowerScout HD devices need to be installed in a user-supplied UL Listed/ uR Recognized enclosure in order to comply with NEC and local electrical codes.</p>		
<p>The PowerScout HD is an Over-Voltage Category III device. Use approved protection when operating the device.</p>		
<p>CAUTION: THIS METER MAY CONTAIN LIFE THREATENING VOLTAGES. QUALIFIED PERSONNEL MUST DISCONNECT ALL HIGH VOLTAGE WIRING BEFORE SERVICING THE METER WITH THE HIGH VOLTAGE TOUCH SAFE COVER REMOVED.</p>		

Symbols on Equipment



Denotes caution. See manual for a description of the meanings.



DENOTES HIGH VOLTAGE. RISK OF ELECTRICAL SHOCK. LIFE THREATENING VOLTAGES MAY BE PRESENT. QUALIFIED PERSONNEL ONLY.



Equipment protected throughout by double insulation (IEC 536 Class II).

Symbols in Documentation



Contains additional information pertinent to current subject



DO NOT EXCEED 346V Line to Neutral or 600 volts Line to Line. This meter is equipped to monitor loads up to 346V L-N. Exceeding this voltage will cause damage to the meter and danger to the user. Always use a Potential Transformer (PT) for voltages in excess of 346V L-N or 600 volts line to line. The PowerScout HD is a 600 Volt Over Voltage Category III device.

MAINTENANCE

There is no required maintenance with the **PowerScout HD**. Abide by the following items:

Cleaning: No cleaning agents, including water, shall be used on the **PowerScout HD**.

No accessories are approved for use with the PowerScout HD meter other than those specified in the DENT Instruments product literature and price sheets.

If the meter appears damaged or defective, first disconnect all power to the meter. Then call or email technical support for assistance.

DENT Instruments, Inc.

Bend, Oregon USA

Phone: 541.388.4774

DENTinstruments.com

Email: support@DENTinstruments.com

Follow this link to view PowerScout specifications in French: [PowerScout HD Résumé de Sécurité et Spécifications](#)

METER SAFETY



Building Service Safety Requirements (Load Center, etc.)

Equipment intended for use with field-installed **current transformers that could be installed in panel boards or switchgears** shall observe the following:

Always open or disconnect circuit from power-distribution system (or service) of building before installing or servicing current transformers.

A circuit breaker used as a disconnect must meet the requirements of IEC 60947-1 and IEC 60947-3 (Clause 6.11.4.2)

Current transformers may not be installed in equipment where they exceed 75 percent of the wiring space of any cross-sectional area within the equipment.

Current transformers may not be installed in an area where they block ventilation openings.

Current transformers may not be installed in an area of breaker arc venting.

Not suitable for Class 2 wiring method nor intended for connection to Class 2 equipment.

Secure current transformer and route conductors so that they do not directly contact live terminals or bus.

CTs shall be listed to UL2808



Meter Installation Safety Requirements

PSHD meters must be installed in accordance with local electrical codes.

Use copper conductors only.

Connection to the mains terminals shall be made with 14 AWG minimum wire gauge.

External secondary inputs and outputs should be connected to devices meeting the requirements of IEC 60950

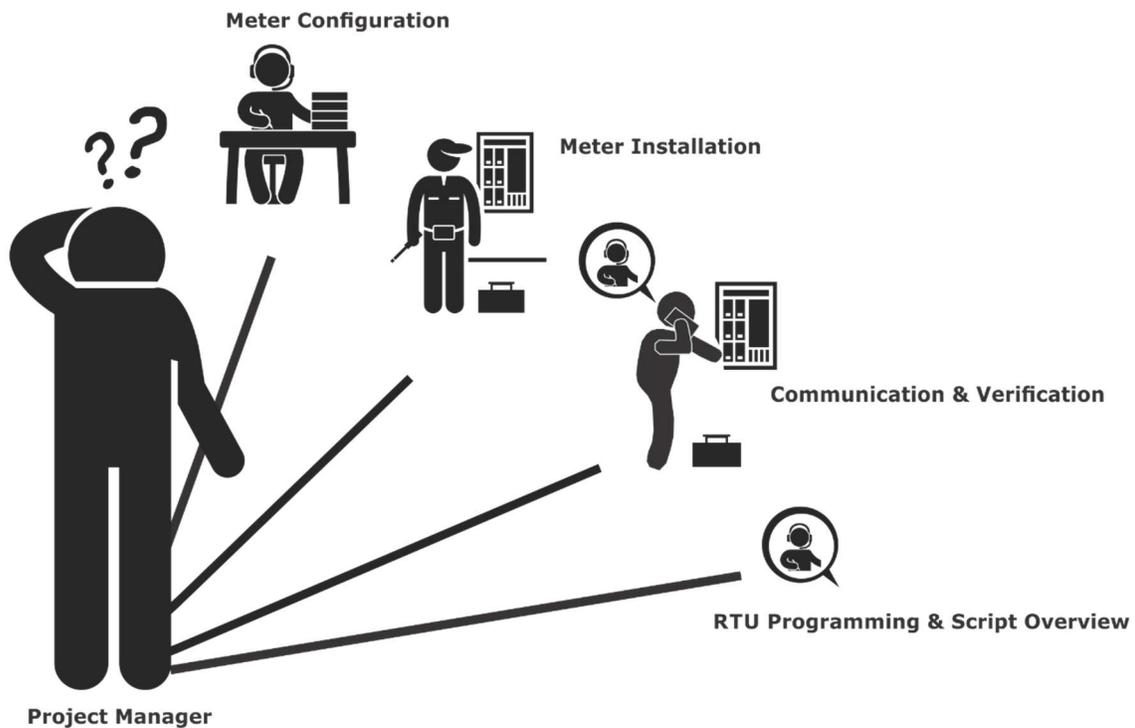
The following additional requirements apply for Recognized board versions of the PSHD meter

- 1) For use only with Listed Energy-monitoring Current Transformers
- 2) Associated leads of the current transformers shall be maintained within the same overall enclosure.
- 3) Unless the current transformers and its leads have been evaluated for REINFORCED INSULATION, the leads must be segregated or insulated from different circuits.
- 4) The current transformers are intended for installation within the same enclosure as the equipment. These may not be installed within switchgears and panel boards” or similar.

PLANNING FOR FIELD INSTALLATION

Project Manager Aspects

Meter installation often includes coordination between individuals or groups of people with different responsibilities. Spend a few minutes considering who will be executing each portion of the installation and what tools are needed at each stage. Things to consider include determining how to communicate with the meter, setting address configuration, installing ViewPoint HD, access to passwords, etc. The more tasks completed before installation means less time in the field. The following section gives an overview of these activities followed by details in the next section.



CONFIGURATION & DATA VIEWING OPTIONS

The PowerScout HD meter has three methods for configuration and data viewing. The most powerful interface is provided with a PC, Laptop or Tablet running Windows and is encouraged for complex installations. The second interface is intended for smart phones or tablets that can connect over USB, Ethernet, or Wi-Fi. The third interface (LCD) is intended for intermittent end user observation and is restricted in capability. The RTU can also be used for configuration if communication settings are already established. The feature set of each interface is summarized next.

INFORMATION ACCESS BY INTERFACE TYPE

DENT Interface Options				Customer
Device	PC or Laptop Running ViewPoint HD	Smart Device or Tablet via WebPage	LCD on Meter (if equipped)	RTU (Host System) Modbus /BACnet
When Used	Meter Setup Field Visit	Field Visit	End User	Building System
Real Time Values	All Meter Parameters Waveform Capture Harmonic Analysis All Element View Phasor Plot	All Meter Parameters Multi Element View	Voltage Current VA VAR kWh Single Element View	All Meter Parameters
Configuration	Entire Meter Visual Guides Copy / Paste	Entire Meter Text Based	Communications Only	Entire Meter Register Based
Security PINs Enforced	Factory Support – Level 3	Read Only – Level 1* Read / Write – Level 2*	Read Only – Level 1* Read / Write Level 2* (limited to communication)	Factory Support – Level 3

* If PINs are configured



Meter Configuration Overview

- Work performed ahead of the installation saves time in the field and results in fewer mistakes!

Tools	Typical Work
<ul style="list-style-type: none"> • Desktop or Laptop PC • USB Type AB Cable (preferred) or Ethernet & USB wall charger (> 500 mA) • Thumb Drive (ViewPoint HD Installer) or access to https://www.dentstruments.com/software-downloads • Electrical Schematics of project 	<ul style="list-style-type: none"> • Installation of ViewPoint HD Software • Connect USB/Ethernet cable from PC to meter • Establish communication with meter • Firmware update (if desired) • Configure software for anticipated meter setup • Field wiring documentation



Meter Installation Overview

- Performed by licensed electrician.

Tools	Typical Work
<ul style="list-style-type: none"> • Mounting hardware (customer supplied) • Wiring & supplies, labels, wire ties • Tablet, Smart Device, or Laptop PC • Multi Meter, Current Clamp • Camera 	<ul style="list-style-type: none"> • Mechanical mounting • Electrical installation • Install voltage cover • Apply power to meter • Confirm basic operation of meter



Verification & Communication Overview

- Can be modified with power applied to the meter.

Tools	Typical Work
<ul style="list-style-type: none"> • Tablet, Smart Device (Web Page Based), or Laptop PC (ViewPoint HD Software) • On site trouble shooting • Multi Meter, Current Clamp • Camera 	<ul style="list-style-type: none"> • Locate the power meter • Confirm RTU device • Add wire terminations (if required) • Confirm meter communication settings • Meter health metrics (check for setup errors) • Analytics (ViewPoint HD) • Correct instrumentation • Set security PINs • Checklist



RTU Programming and Scripting Overview

Tools	Typical Work
<ul style="list-style-type: none"> • Laptop PC (Remote Access to RTU) • Remote trouble shooting • Register List 	<ul style="list-style-type: none"> • Confirm meter communication settings • Confirm communication protocols • Exercise remote connectivity • Run configuration scripting • Confirm data integrity

METER CONFIGURATION - DETAILS



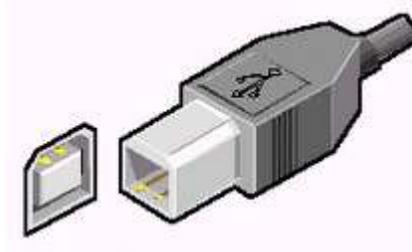
This section is written to support setting up the PSHD in an office environment and configuring the power meter for a pre-determined configuration. In many cases the setup is standardized for an organization or project. In other cases, the setup can be documented and forwarded to an electrician as a wiring schedule. The setup can also be performed on site and reflect “as built” configurations.

Install the Software

Insert the ViewPoint HD thumb drive into the computer or download from <https://www.dentstruments.com/software-downloads>

The installer should start automatically. If it does not, browse the thumb drive and locate the ViewPointInstaller.exe program. Start the installer by double-clicking **ViewPointInstaller.exe** and follow the installer instructions.

Connect the Meter using USB (Power & Communications)



Preferred Connection via USB AB Cable

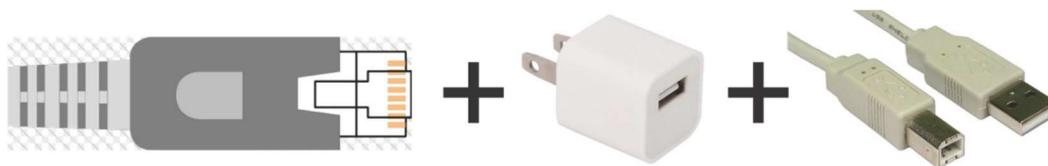
The preferred method for configuring the PSHD meter from a locally connected computer is through the USB interface which provides power to the meter as well as communications. The meter will draw 500mA from the USB port which may overload “out of spec” USB hosts. If the meter fails to power from USB, the alternate method (described below) must be used.

- 1) Plug the meter into the USB port (DENT Instruments will appear on the LCD (if equipped)).
- 2) Launch the ViewPoint HD application and press the “CONNECT USING USB” button on the pop-up window.

The meter should now be communicating. ViewPoint HD is an intuitive application, read the Viewpoint HD overview section (below) or watch the tutorial videos for additional information on configuring the meter.

ALTERNATE CONNECTION

If configuration using USB is not available, the Ethernet connection can also be used provided the meter can be powered from a voltage source such as a customer-supplied USB wall charger (>500mA) or from AC power, if the meter is already installed.

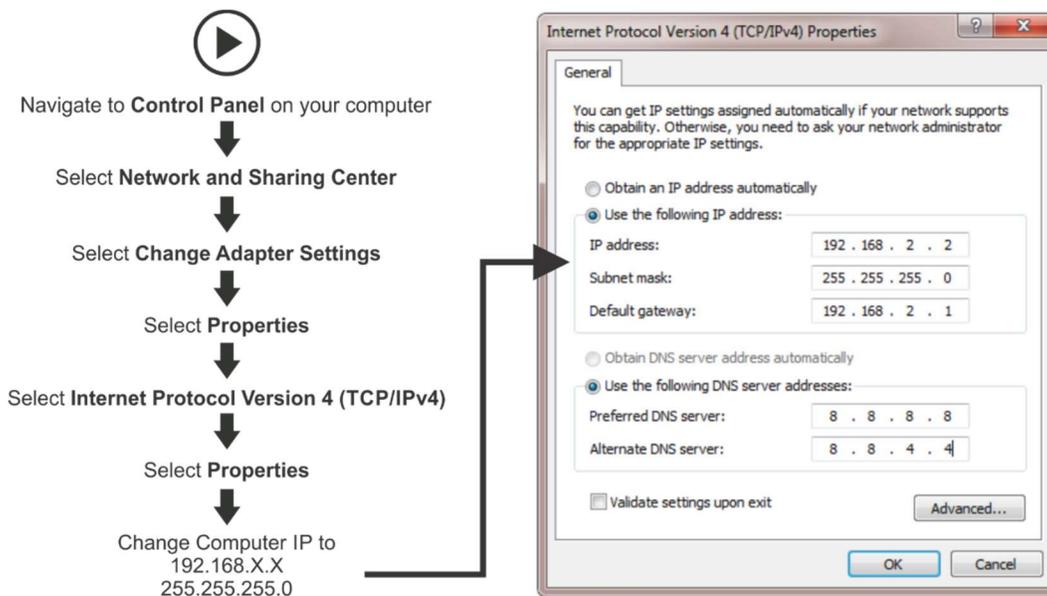


Alternate Connection

- 1) Connect the meter to an Ethernet LAN Router running a DNS Server.
- 2) Apply power to the meter.
- 3) Observe the IP address displayed on the LCD screen (Splash Screen) or navigate to About Meter using the meter push button interface (see Appendix A).



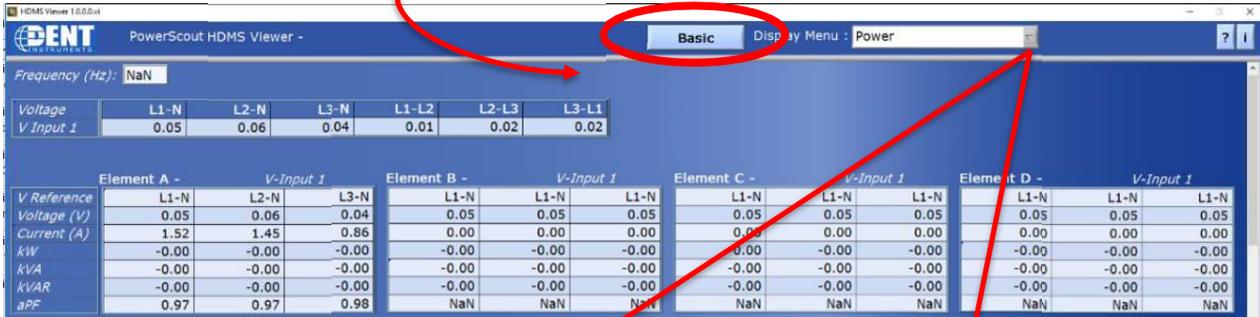
You may also connect directly to a Laptop or Desktop PC, but your IP Address and Subnet must match the meter to connect to it (summarized below).



- 4) Launch the ViewPoint HD application and press the “CONNECT USING ETHERNET” button on the pop up window.
- 5) The meter should now be communicating. ViewPoint HD is an intuitive application; read the ViewPoint HD overview section (below) and/or watch the tutorial videos on the DENT website for additional information on configuring the meter.

ViewPoint HD Software Overview

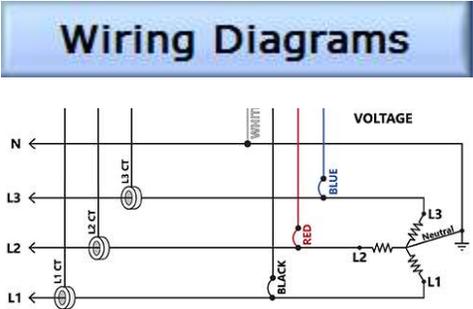
ViewPoint HD is a Windows application and is the most versatile software tool for configuring and verifying a PSMD meter. All functions and menus are accessed under the central drop-down list which has a content **filter** for viewing **basic** metering data or **extended** data that can be helpful in troubleshooting. The information displayed in the drop-down list for each filter setting is summarized below.



Display Data	
Basic	Extended
<p>Real Time Values</p> <ul style="list-style-type: none"> Power Energy Demand 	<p>Real Time Values</p> <ul style="list-style-type: none"> Power Energy Demand Power Factor Waveform Capture Harmonics
<p>Meter Setup</p> <ul style="list-style-type: none"> Communication Setup Connect to Meter Advanced About the Meter 	<p>Meter Setup</p> <ul style="list-style-type: none"> Communication Setup Connect to Meter Advanced About the Meter

ViewPoint HD Documentation

ViewPoint HD is an intuitive and self-describing interface that uses context help to facilitate rapid and accurate configuration via the configuration aids described below.

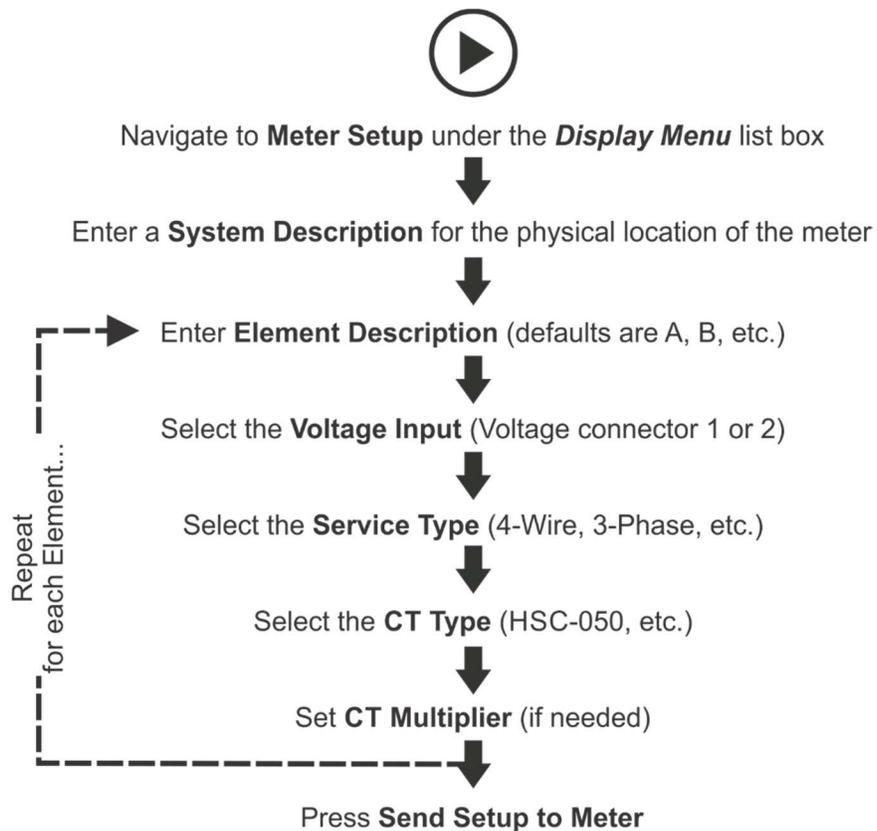
Help Aids	
<p>Information</p> 	<p>This button toggles the context pop-up window which displays the technical description of the parameter or the register number associated with the reported value. The window is resizable and movable.</p>
<p>CT Type</p> 	<p>Current Transformer models are selected in the drop-down list and are identified by a combination of a CT image and the product ratings.</p> <p>The parameters for the selected CT are automatically populated. This information can be edited for custom use.</p>
<p>Service Type</p> 	<p>Select a service type from the drop-down list. A selection populates the fields with pre-configured service type information. User-selectable fields are shown in white. Greyed out fields indicate restrictions imposed by the meter.</p>
<p>Wiring Diagrams</p> 	<p>Diagrams of different wiring configurations, such as illustrated here, are available directly within the software for quick reference.</p>

ViewPoint HD Documentation—Instructional Videos

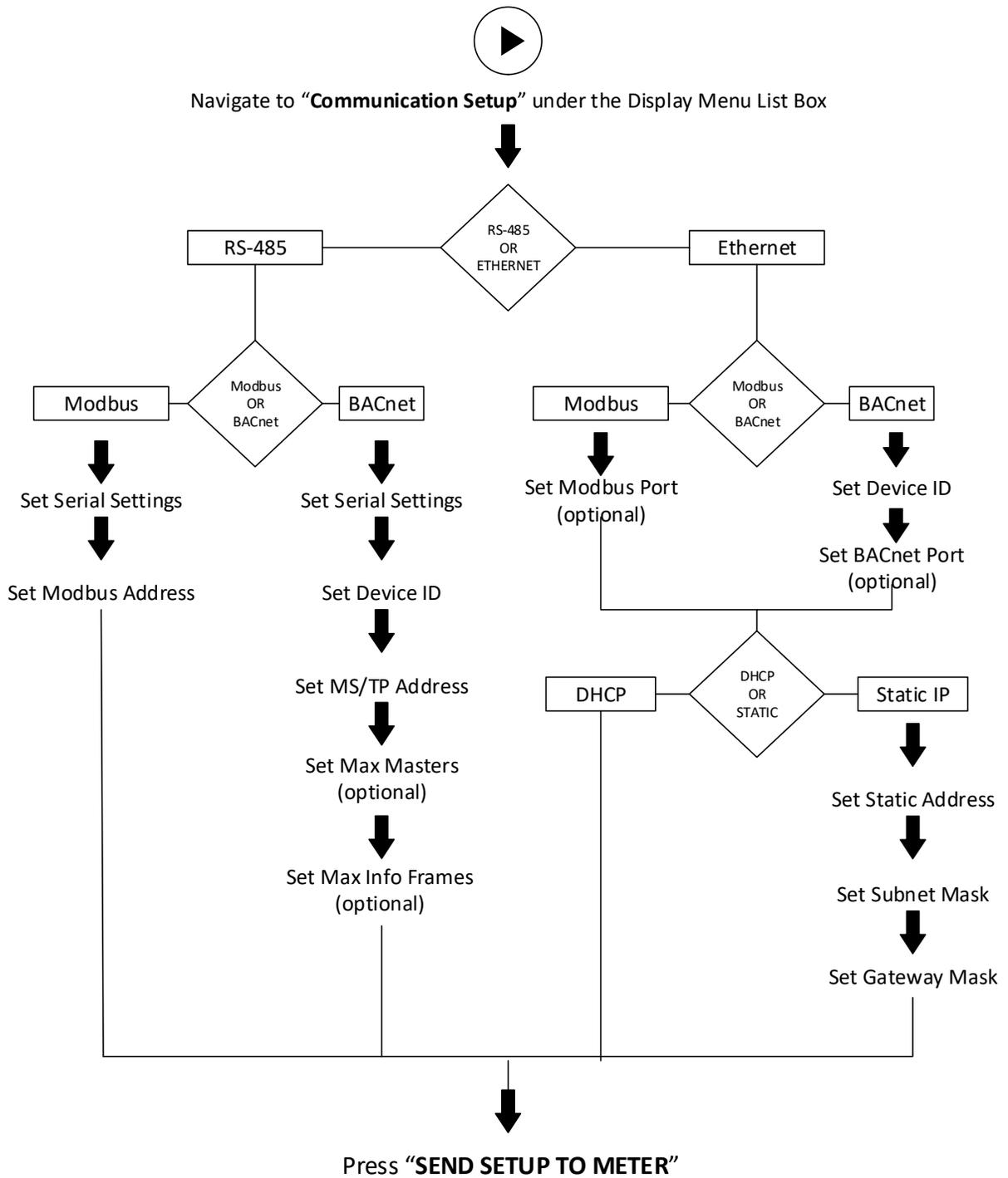
Additional information about the capabilities of ViewPoint HD software are presented in short videos and can be found at www.DENTinstruments.com and on the provided thumb drive.

Video Title	Video Hyperlink
Meter Setup—Electrical	VIDEOS\PSHD Meter Setup\PSHD Meter Setup 8_18_2017.mp4
Waveform Capture & THD	VIDEOS\PSHD Waveform & THD Example\Waveform THD Demo.mp4
Phasor Plot	VIDEOS\PSHD Phasor Plot\Phasor Plot Demo.mp4

Configuring Electrical Components using ViewPoint HD



Configuring Communications using Viewpoint HD



Web Application Overview

The PSHD power meter hosts a Web Application that can be accessed by any smart device running a web browser. The web application can be accessed by using the **USB or Ethernet port** (Wi-Fi connectivity is under development).

CONNECT TO WEB APPLICATION USING USB

- 1) Connect your smart device to the meter
- 2) Open a Web Browser
- 3) Enter <http://169.254.1.5> (this is the static address of the internal web server)

CONNECT TO WEB APPLICATION USING ETHERNET

- 1) Discover the I.P. address of the meter
 - a. Navigate to About Meter on the LCD menu.
 - b. Use a network discovery tool to find the address by connecting and disconnecting the Ethernet cable.
 - c. Set the meter to a static address using another interface.
- 2) Connect your smart device to the same subnet as the PSHD meter
- 3) Open a Web Browser
- 4) Enter the PSHD's Ethernet address into the web browser

AUTHENTICATION

Because the PSHD Web App can be viewed and controlled by any smart device, and communicates in parallel to the host system, the PSHD can be configured to require a PIN# to restrict access the meter.

Enter the PIN#, if assigned, or leave blank, if unassigned, and press the Login button.



Welcome to Power Meter Web App
Please enter Password to login if configured.

DENT Instruments If Read Only Password is not setup, click Login for Read Access. Password: LOGIN

Organizationally, the Web App works much the same as ViewPoint HD, although it has no analytics and operates on a single element at a time.

METER INSTALLATION - DETAILS



This section is intended to support the physical installation of the meter and provide guidance on connecting the current transformers (CTs) correctly within the electrical load center and to the PSHD meter.

Meter Mounting Configurations

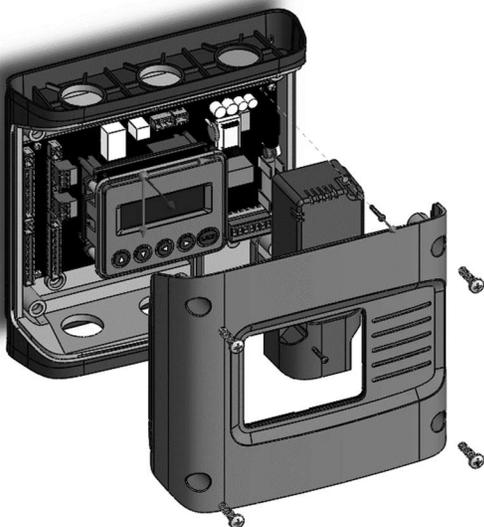
DENT PowerScout HDMS meters are sold in several form factors. Enclosures are designed to be wall mounted and connected to electrical conduit. Plate mounted versions are ready to be mounted inside a customer supplied NEMA enclosure and offer IP20 protection. RAW PCBA's need to be mounted on customer-provided stand offs (0.5" in length or longer) and mounted in a NEMA-rated enclosure. Care should be taken not to flex the circuit board during mounting.

Mounting Options	PS48 HD	PS12 HD
Enclosure		
OEM Plate		Not Yet Available
RAW PCBA	Special Order	Special Order

INSTALLATION SEQUENCE

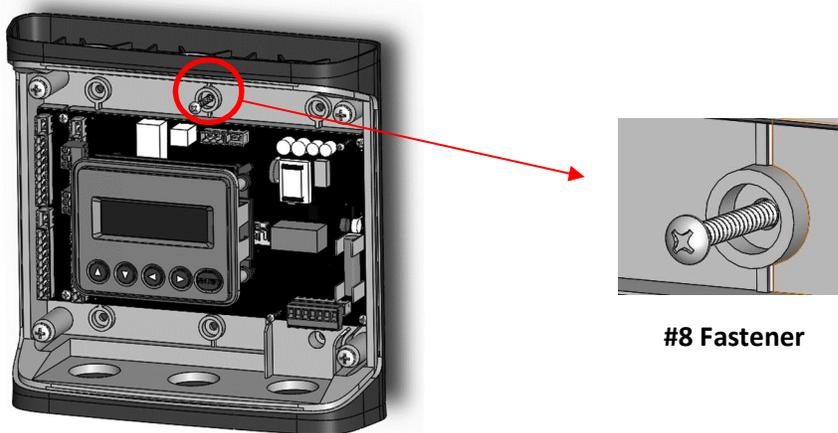
The following section illustrates the PS12HD model. The PS48HD components are slightly different, but follow the same procedure.

STEP 1) Remove top cover screws (4x) and high voltage cover screws (2x) – provided



STEP 2) Locate, mark, and drill wall mounting points (2x–6x—customer supplied)

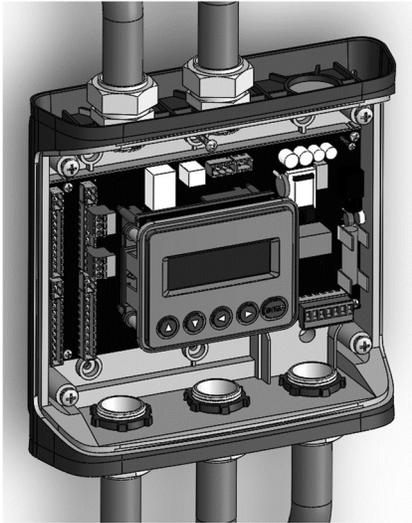
The plastic enclosure itself can be used as a template for marking the drill locations on the wall.



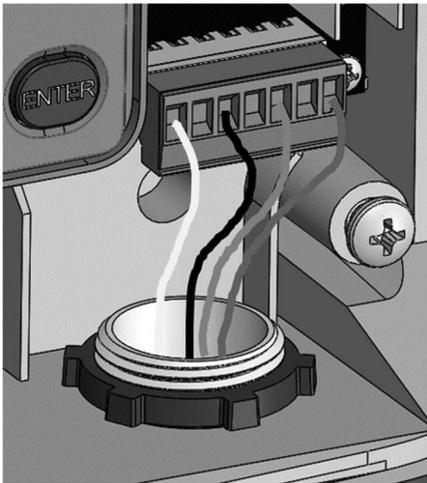
#8 Fastener

If the meter is not available for use as a drill template, a drawing indicating the spacing between mounting holes can be found in the appendix. The centerline holes are intended for fastening to wall studs. If hollow wall fasteners are used, the outer 4 mounting points are recommended.

STEP 3) Mount conduit fittings, conduits, and blanking plugs

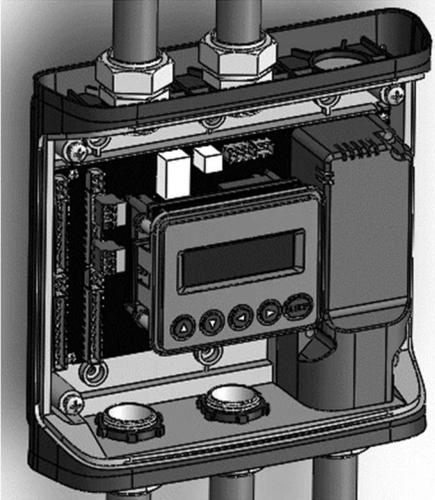


STEP 4) Connect voltage leads



DO NOT ENERGIZE METER WITH VOLTAGE COVER REMOVED

STEP 5) Attach high voltage cover

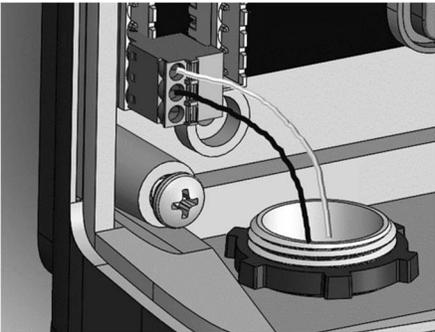


IP30



TOUCH SAFE (with internal cover installed)

STEP 6) Connect CT and Communications Wiring



CONNECTING VOLTAGE

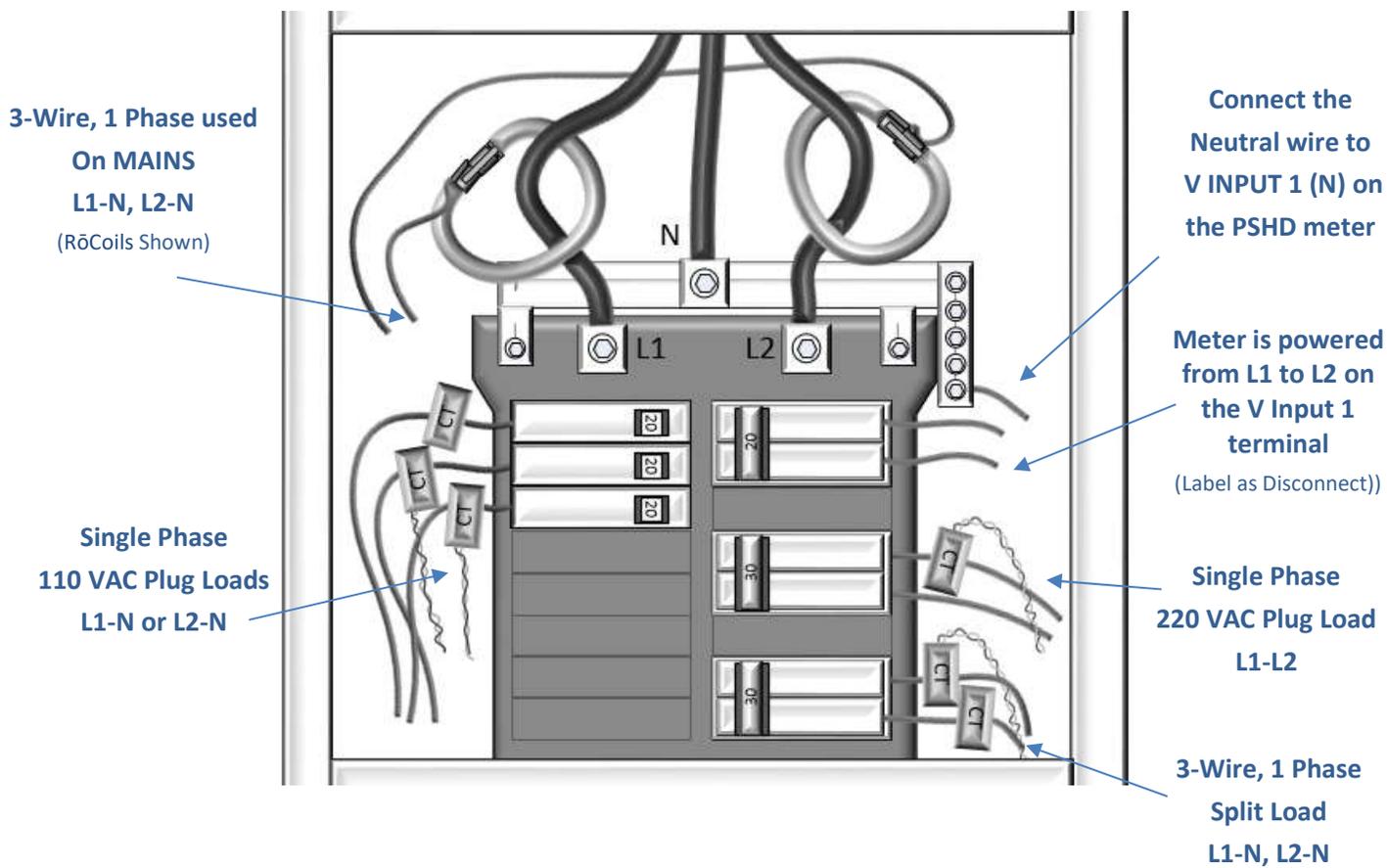
Connect the voltage leads (L1, L2, L3, and N, as necessary) to the meter through a dedicated disconnect or circuit breaker. A voltage lead of **14 AWG THHN Minimum 600VAC rating** (or equivalent) is required.



IMPORTANT: Verify the circuit breaker is marked as the disconnect breaker for the meter.

Wiring the PSHD Meter in a 3-wire, Split ϕ Service Panel

 High voltage MAY BE PRESENT. Risk of electric shock. Life threatening voltages may be present. Qualified personnel only.



Illustrating the intended wiring configuration for each of the Service Types available in the Service drop-down list under “Meter Setup”

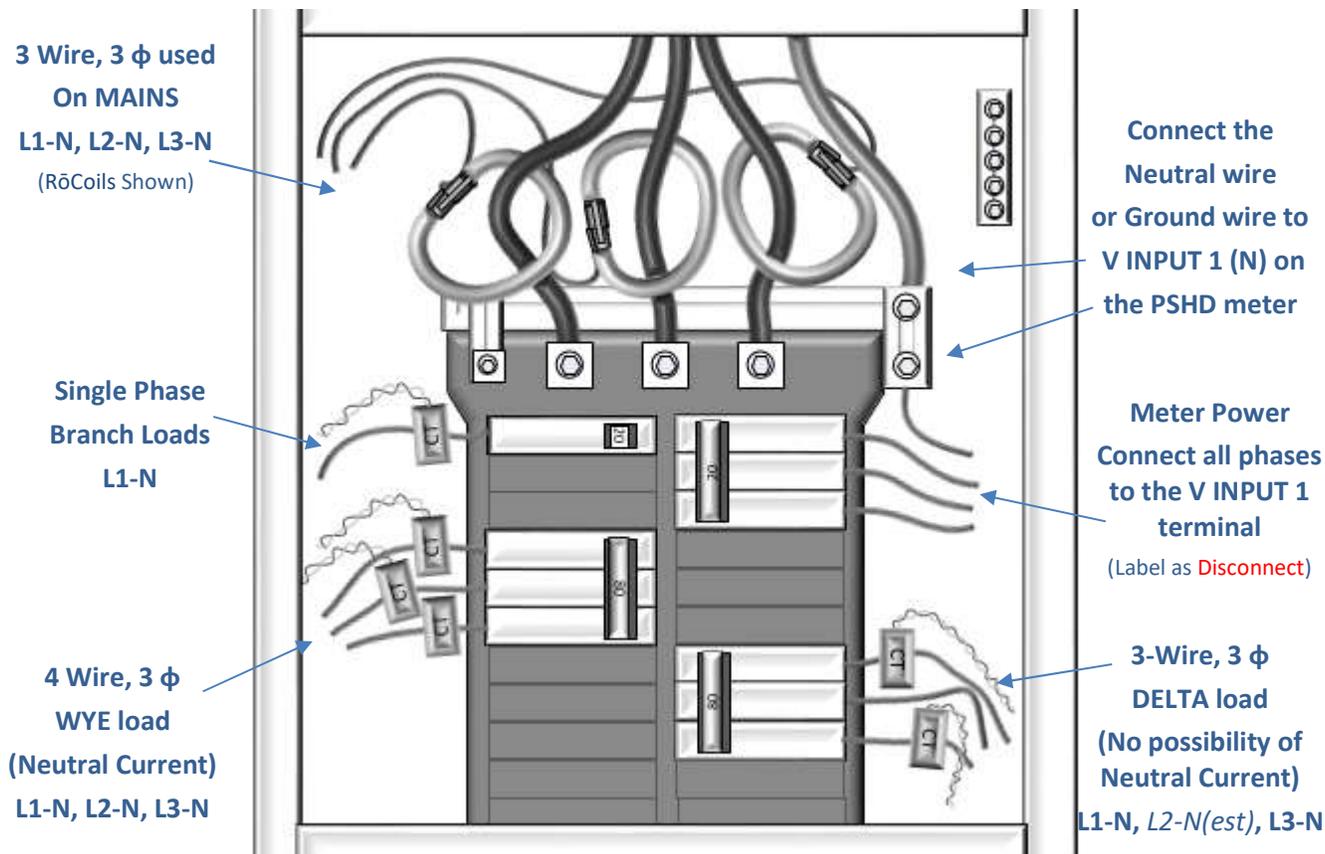
EXAMPLE LOADS:

Single Phase L1-N or L2-N 110 VAC: Lighting, Appliance, Living Zone

Single Phase L1-L2 220 VAC: Water Heater, Clothes Dryer, Equipment with no neutral wire.

Split Phase L1-L2 220 VAC: Service Entrance, Equipment with neutral wire.

Wiring the PSHD Meter in a 4-wire, 3 ϕ Service Panel



Illustrating the intended wiring configuration for each of the Service Types available in the Service drop-down list under “Meter Setup”



Note: The PSHD Meter Series uses the “Neutral” Terminal as a voltage reference. For systems without a neutral conductor, DENT Instruments suggests connecting a ground wire to this terminal. If the neutral terminal is left open, L-L measurements will be accurate, but L-N measurements may not be symmetric. If a ground wire is connected to the Neutral terminal, <2mA will flow into the ground wire.

Current Transformer Basics

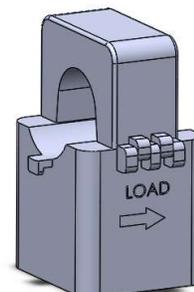
Ensure CTs meet the following criteria:

- 600 VAC UL Rated
- UL2808 Listed
- 1/3 (333 mV) output voltage
- Appropriate range for the circuit (5-120% of CT Rating Recommended)
- Read the label



Ensure CT orientation & placement:

- Arrow points toward load (or as instructed by CT label)
- Arrow points away from Panel (or as instructed by CT label)
- Placed on First Conductor of voltage Reference (L1-L2) circuits are placed on L1
- Observe wiring color and polarity
- Use the Shield wire if provided (connect to PCB terminal marked S)

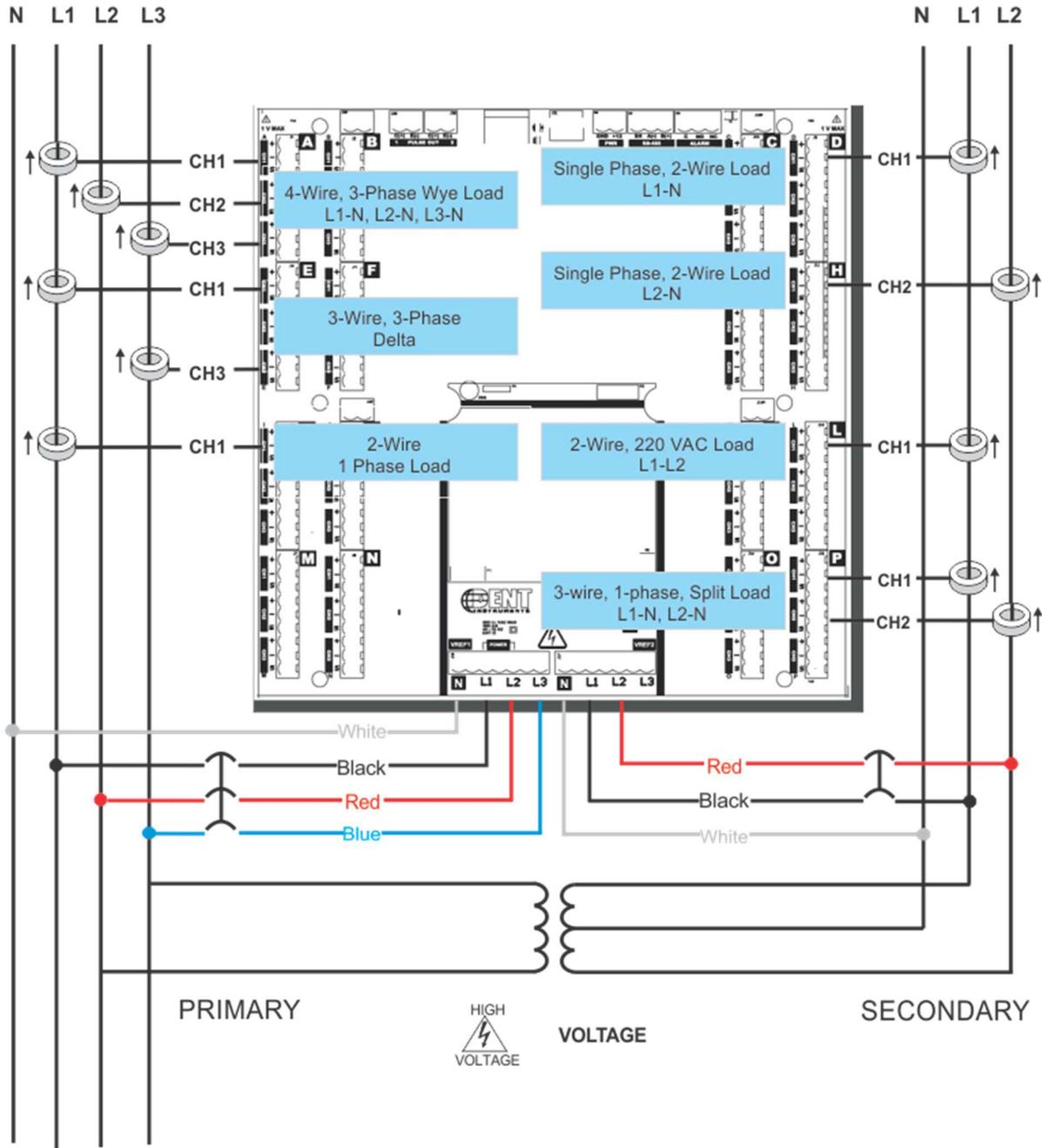


Wiring Guide for CT Types

Split, Hinged, & Solid Core CTs	RōCoil CTs
	
<p>White: Positive Black: Negative (no shield)</p>	<p>White: Positive Brown: Negative Bare Wire: Shield</p>

Wiring the CTs to the PSHD Meter

The image below is the counterpart to the service panel illustration and indicates how to connect CTs to the HDMS meter for each service type. For service types that are not specifically listed, it is recommended to choose “single phase” service and configure each channel individually. Three phase loads are illustrated on the left and split phase loads on the right as an example only. Elements are fully interchangeable on the meter.



COMMUNICATION & VERIFICATION - DETAILS



This section is intended to support the commissioning of the PSHD meter by an instrumentation technician. In many cases, the electrical installation is conducted ahead of the availability of the RTU or was performed by a different installer. Often the technician is working in concert with a remote programmer who is confirming the connectivity with a remote host system. A Digital Multi Meter (DMM) can be used to confirm measurements at the board terminals, if necessary.



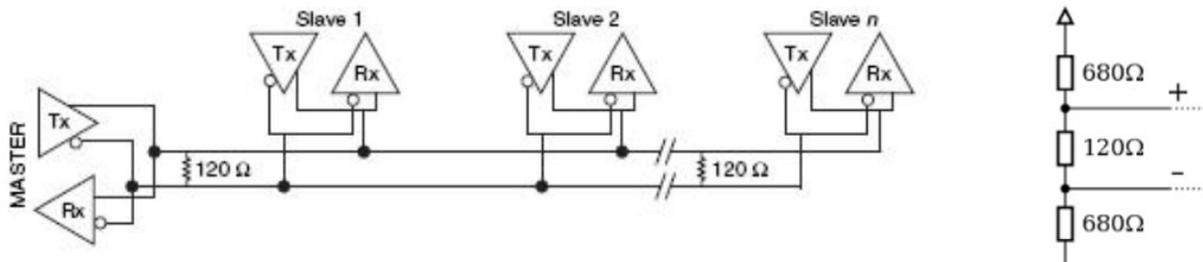
It is assumed that the meter is now powered up from the line voltage. It is safe to touch the meter (including the user buttons) with the top cover removed ONLY IF THE INTERNAL HIGH VOLTAGE COVER IS INSTALLED.



Communications settings and real-time data values can be confirmed quickly using the LCD interface. If significant setup modifications are anticipated, a computer interface is recommended.

Physical Connections on an RS-485 Multidrop Network

The PSHD meter uses a 2-Wire Half Duplex RS-485 Implementation.



2-Wire Multidrop Network using Terminating Resistors

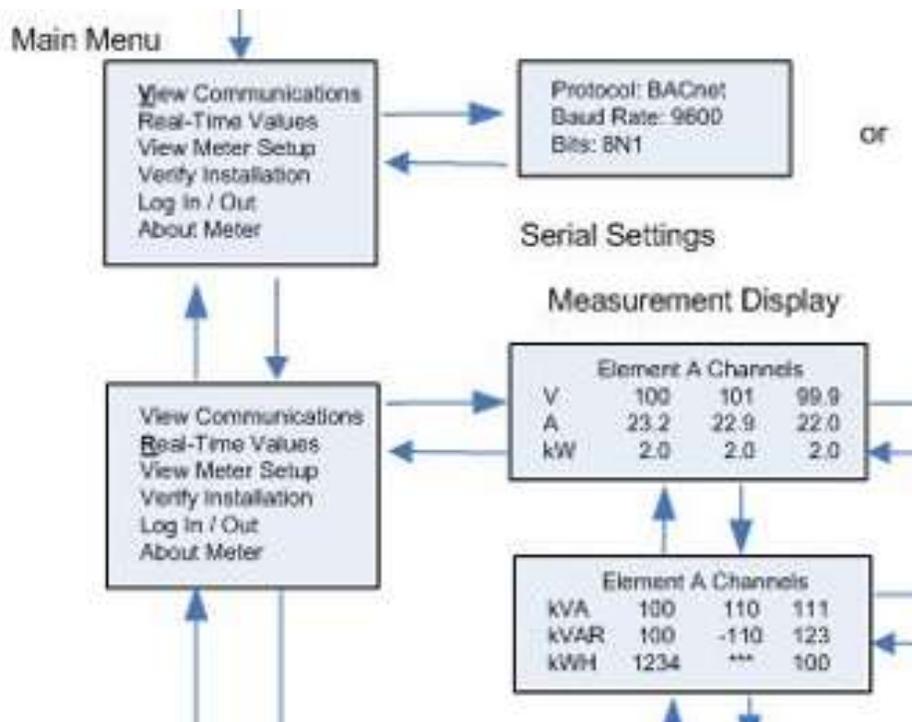
- **Termination Resistors**—are NOT included on the PSHD meter. If the PSHD meter is at the end of a daisy-chain, then connect a 120-ohm leaded resistor between the + and – terminal at the connector.
- **Bias Resistors**—are NOT included on the PSHD meter. Bias resistors are needed if the idle conditions of the bus are in an indeterminate logic voltage. Bias resistors are usually located at the master node and are usually 680 ohms for a RS-485 network.
- **Network Topology**—RS-485 is designed to be implemented as a **daisy chain** (series connections) rather than star or cascade topologies.
- **Signal Names**—Some RS-485 devices use the terminology A/B while others use +/- . Note that A is (-) and B is (+). Many manufacturers incorrectly label the terminals.
- **Bus Loading**—The PSHD meter is a 1/8th unit load allowing up to 256 like devices in parallel.

Communication Verification



Verification includes confirmation of BOTH the physical interface settings (Serial or Ethernet) and the protocol (Modbus or BACnet) settings.

The LCD User interface can be used to quickly confirm the settings required for each combination of interface and protocol. The interface is intuitive and groups together commonly associated registers. The complete interface is presented in Appendix A as a navigational map. Arrows indicate how to move from one menu display to the next. A **Reverse Contrast** entry in the documentation indicates the active menu item in a list which corresponds to a blinking character in the physical LCD. The ENTER button is used to select a property and up / down buttons are used to select among the values supported by the meter. Note that changes to the meter configuration are limited to the communication interface using the LCD. If additional changes (such as CT type) are required they must be made using a software interface.



Example LCD Navigation

VIEWPOINT HD / WEB APPLICATION

If your PSHD model does not include the LCD user interface or if you prefer to verify the installation using software then verification is facilitated through the ViewPoint HD PC application or the Web App which shares a common design. Refer to the section on Configuration Details (starting on page 14) for an overview and list of instructional videos for ViewPoint HD or the PSHD Web App.

Physical Interface Verification

SERIAL SETUP VERIFICATION

In a multidrop serial network, the host data format settings are typically known or specified and the slave is adjusted to match. In some cases (long wiring runs, etc.), it may be necessary to experiment in determining the fastest allowable baud rate for a given wiring configuration by changing BOTH the host and slave devices. Configurations other than 8N1 are rare, it is advised to use this configuration for Data Bits, Parity and Number of Stop bits, if possible.

LAN ETHERNET NETWORK VERIFICATION

The PSHD meter communicates using IEEE 802.3 Ethernet connectivity running at a 10/100 Mbps. Verification of the meter settings over Ethernet include ensuring that the I.P. address of the meter is within a range that allows communication with a host (if static) or set for DHCP allowing the meter to be assigned an address by a DHCP server as described below.

DHCP

If the PSHD meter is configured for Dynamic Host Configuration Protocol (DHCP) when the meter is powered on or the Ethernet cable is inserted the meter is assigned an IP address by the DHCP server. This address appears on the meter LCD or can be found through connection with ViewPoint or the PSHD Web App. The IP address assigned to the meter should be regarded as a **temporary address** as the address may change between power cycles making it difficult for the host system to know how to find the meter on the network. One common approach is to set the PSHD for DHCP so that the address can be assigned by a DHCP server and then change that IP address to static once the connection is made. PSHD meters are set to use DHCP as a default setting to facilitate this approach.

STATIC IP

If the PSHD meter is set to a static I.P. then its address should be assigned by an IT department to avoid multiple devices on the same network. This scheme is usually used when an RTU is expecting to find the meter at a specific IP address.

Protocol Verification

The network protocol is typically specified as part of the installation. BACnet MS/TP and Modbus RTU are the two communication protocols that operate over an RS-485 serial network and BACnet IP and Modbus TCP are the protocols over Ethernet. Each combination of interface and protocol require specific registers settings described below. The scope of this section is to use either the LCD interface or software tools to quickly confirm or change settings to match an existing specification. Further information and optimization tips are covered in the section on RTU programming.

Modbus Settings

MODBUS RTU SETTINGS

Device Address: In a Modbus network each device must be assigned a **unique slave address**. The slave address sets the register address for **ELEMENT A**. Adjacent elements B, C, D, etc. are accessed by incrementing the slave address by 1. The slave address of the PSHD meter needs to be set to match the address expected by the RTU and is normally part of the network specification. The default address for element A is 1.

MODBUS TCP SETTINGS

Modbus Port: The PSHD meter uses the industry standard Port 502 for Modbus. This port number can be changed, although this is considered an advanced setting and should be left at 502 unless this generates a conflict on the host system. The port number can only be changed through a software interface.

BACnet Settings

BACnet Device ID: In a BACnet network each device must be assigned a **unique Device ID and is common to BACnet MS/TP and BACnet IP protocols**. Besides the standard ability to change this from a BACnet explorer tool it may be changed via the Viewer, PSHD Web App, or LCD.

BACNET MSTP

Max Masters: The default setting is 127 and does not usually need to be changed.

Max Info Frame: The default setting is 1 and does not usually need to be changed.

BACNET IP

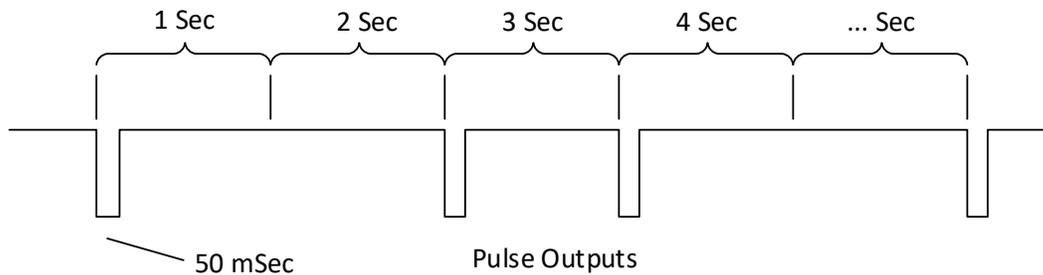
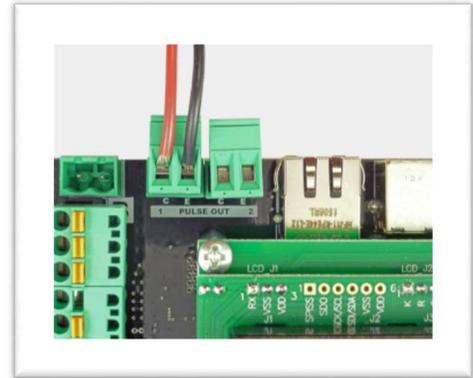
BACnet Port: The BACnet default port is 47808 and does not usually need to be changed

BBMD: The BACnet/IP Broadcast Management Device is set to 0.0.0.0 at default and can be changed through a software tool to allow discovery across networks.

Pulse Outputs

Pulse outputs are available to export energy consumption data to generic accumulators that cannot communicate using a data interface. For example: this interface could be used by a data aggregator that is measuring natural gas and electricity.

The PS48HD meter has two pulse outputs that can be configured to report the total imported energy on any element. The output will produce a 50 mSec duration pulse every time the energy has reached a threshold value. This value is computed based on the meter configuration and reported as a read only register (see the register list Excel file). The pulse output will only be initiated on 1 second intervals.



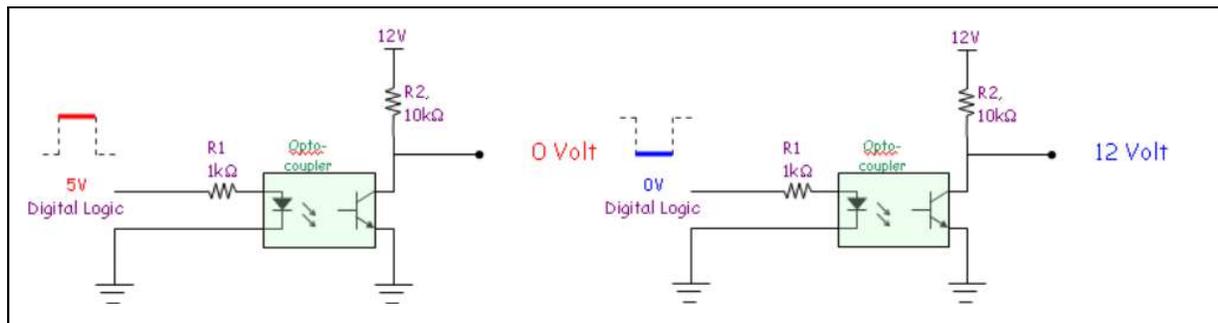
Typical Pulse Sequence

OPEN COLLECTOR OUTPUT

The pulse output is electrically isolated from the meter power supply and requires the user to connect a voltage source (5–30 VDC), a ground wire (connected to the host ground), and a pullup resistor. A 10K resistor is the recommended value. The pullup resistor shall be sized to limit the current through the isolator to 5 mA.



If the collector is connected directly to a source of voltage, the pulse isolator will immediately burn out and become non-responsive.



Output Connections

ALARM (SPDT)

Some models of the PSHD include a single pole double throw electromechanical relay that can be configured to trigger under loss of voltage conditions. This feature will alert building systems to a “loss of phase” condition within 100 mSec of occurrence without being polled. Once triggered this relay will need to be reset via a register command. This feature is under development and is expected to be available in early 2018.

12 Volt Auxiliary Power

The PSHD meter provides an auxiliary 12 volt output that is derived from an auxiliary winding on the PSHD’s line connected power supply. The 12 volt supply voltage is unregulated but protected by a self-resetting fuse. The purpose of the supply is to power external radio equipment or provide supply voltage for analog sensors such as 4-20 ma current loop devices. If full rated current is drawn from this terminal the minimum operating voltage of the L1-L2 power supply is 100 VAC.

Security PIN Protection

The PS48HD has three levels of PIN protection that users can choose to assign for restricting access to meter information. The **default** meter configuration is **NO PIN (code 0000)**. PINs are 4 digits and are stored as a user setting in the non-volatile memory of the meter. PINs are also accessible as registers but are encoded so that reading the value of the register through an RTU does not inform a user what the password is. This feature allows DENT Instruments to support looking up forgotten PINs, if network access is available.

ACCESS RESTRICTION LIMITATIONS

If security levels have been set up in the meter, no data is accessible through the LCD user interface or web page without entering the PIN credentials. Note, however, that protocols such as Modbus do NOT SUPPORT ANY LEVEL OF security such that any network traffic acting as a master can retrieve and write data from the registers. Generally, this will require knowledge of the IP address or slave ID and the register list which discourages casual intrusion. Factory level registers cannot be over-written by the RTU without a factory PIN.

VIEWPOINT HD – UNRESTRICTED ACCESS

The ViewPoint HD software tool can be used to read & write configuration information to the meter without entering credentials.



ViewPoint HD is the preferred tool for setting up access restrictions because it allows users to test the function of the PINs without locking themselves out from the ability to change the PIN, a frustrating catch 22!

USING THE PERMISSION REGISTERS

The PSHD meter uses both a “Read Only” register and a “Read / Write” register to compare against user entries from the LCD keypad or PSHD Web App form entry. Both internal permission registers have a default value of [0000]. A consequence of this is that both PIN registers need to be configured (i.e. changed from defaults) to implement a read only PIN, otherwise the situation may occur where a user is intended to be restricted to Read Only but accidentally promoted to Read /Write because the PIN matches the default response value. ViewPoint HD and the Web App disallow this condition but remote programmers using direct register access may create this condition.

READ ONLY PERMISSION REGISTER

Configuring the meter for a Read Only user allows data or configuration items to be viewed but not changed. This level of authorization might be appropriate for general end users such as building owners who may not be aware of the details of the installation. It is recommended to use ViewPoint HD to configure permissions although it is also possible to set up a Read Only PIN using the Web App if a Read/Write PIN has already been entered (either through the LCD or the Web App itself).

READ/WRITE PERMISSION REGISTER

Read/Write permissions allow users to read and write configuration items and to set new PINs for other users. This level of authorization will be required by any technician or user who needs the ability to correct setup errors in the meter. The default PINs [0000] allow new users to reset the Read / Write PIN from either the PSHD Web App or ViewPoint HD. Permissions cannot be set through the LCD interface.

Verification of CT Installation

Once the PSHD meter is configured and communicating with the RTU, it is a good idea to perform some simple checks to ensure that all the CTs are on the correct voltage phases and that the CTs are facing the correct direction. The following are recommendations that work for typical installations. Special circuit conditions, like unloaded motors, may indicate an installation error when none exists. A Digital Multimeter (DMM) can be used to confirm these cases.

INSTALLATION PHASE VERIFICATION

The PSHD meter includes a PhaseChek™ algorithm that identifies any element that the meter suspects may be incorrectly phased (i.e., the CT is associated with the wrong voltage source or is physically on the wrong wire) based on power factors below 0.55. This feature is accessed using the LCD interface by navigating to “VERIFY INSTALLATION” and pressing the ENTER button. The LCD display will list the elements having at least one channel with a low power factor.

CHECK ELEMENTS

A EF

Use the navigation buttons to highlight a specific element and hit enter or just hit enter and move from element to element using the ← / → keys. Within each element (identified on the top line of the display) the status of each channel is identified as good (PF > 0.55) or bad (PF < 0.55).

ELEMENT F

CH1 Good

CH2 Bad

CH3 Bad

Two “Bad” channels are often an indication that two CTs are inadvertently swapped. When the power factor for all enabled channels is greater than 0.55 then the meter reports

CHECK ELEMENTS

ALL CHANNELS GOOD



PhaseChek™ is only applied for elements that are enabled. VIEW METER SETUP on the LCD screen can be used to ensure that all intended elements are active. PhaseChek™ is advisory only. It is possible that the power factor for a particular load is truly less than 0.55, as may be observed in a free running motor.

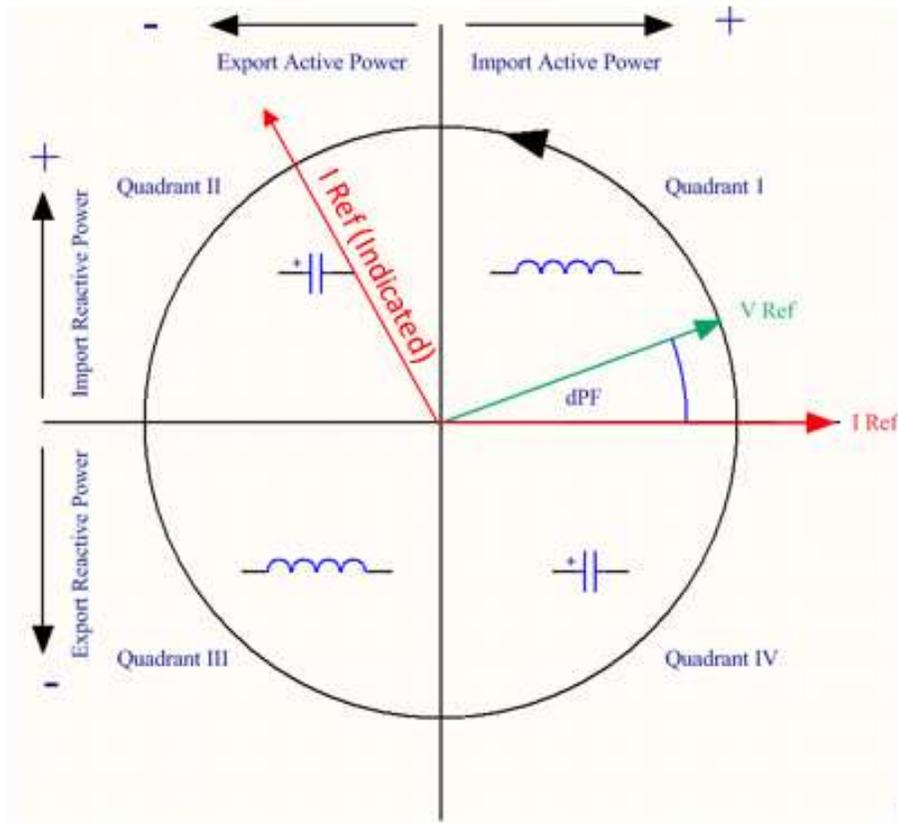
The ViewPoint HD and the PSHD Web App run **PhaseChek™** continuously on all enabled elements and report low power factor in the real time values table by turning the text **RED** or by using a red indicator.

PHASE CHECKING BY PHASER PLOT

When a CT is installed on the incorrect phase, the indicated current vector is pointing either 180 degrees away (a split phase system) or 120 degrees away (a three-phase system) from the true displacement angle. In the latter case, this usually causes a significant decrease in the reported power factor, even if the CT is also on backwards. When the absolute displacement power factor of a load is below 0.55 (an angle greater than 57 degrees between voltage and current) the PSHD meter will flag it as a phasing error. ViewPoint HD has a PhasorPlot feature that can be used to study the voltage and current vectors of a given meter element.

Check for Low Power Factor

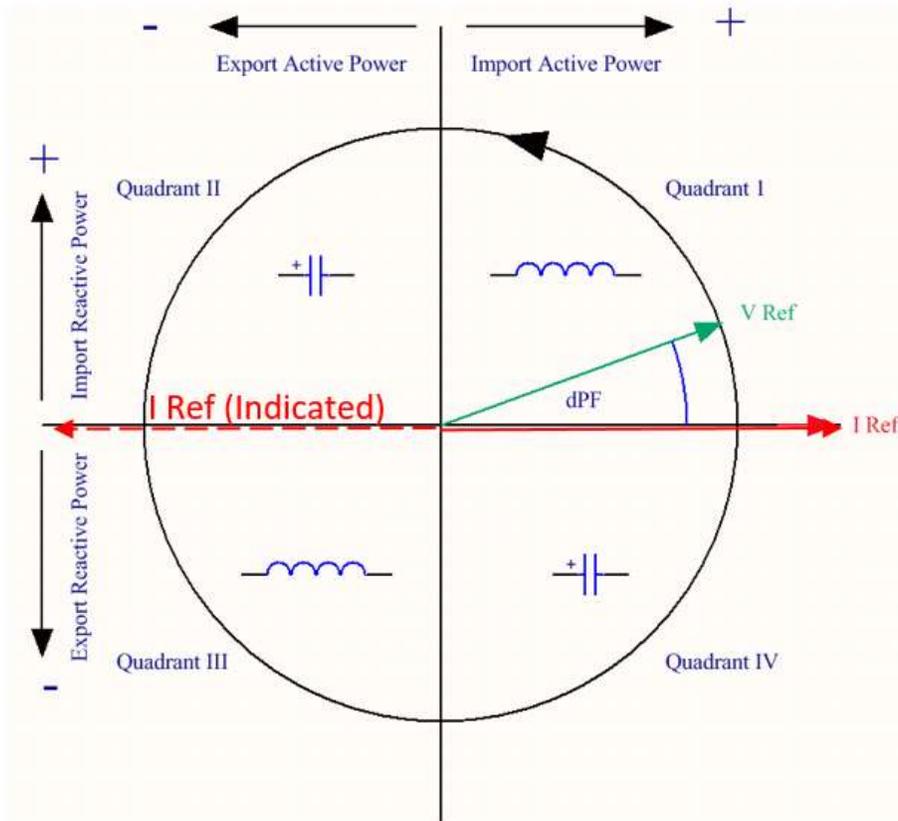
- **ViewPoint HD:** Real Time Values > (All power factors < 0.55 are shown in RED)
- **PSHD Web App:** Real Time Values > (All power factors < 0.55 are shown in RED)
- **LCD:** Verify Installation > (LCD will list all elements having a PF < 0.55)



Electrical Power Quadrants with Incorrect CT Phase shown

CT Orientation Check

The PSHD meter reports power and energy in each electrical quadrant under a different register. When CTs are installed backwards, the indicated current vector is oriented 180 degrees away from the true displacement angle. In accordance with standard definitions, the Wattage and VARs of the effected channel report with a sign opposite from what is expected. Often this means that the import registers will be reading zero while the export registers are showing a value. Note that backward CTs have no impact on the amplitude of the Power Factor. A moderate power factor (>0.7) in concert with a negative power is a clue that the CT is on backwards, but is on the correct phase.



Electrical Power Quadrants with Reversed CT shown

Check that the wattage has the correct sign (Designated + for loads)

- **ViewPoint HD:** Real Time Values > (Confirm Sign of Power For All Elements)
- **PSHD Web App:** Real Time Values > (Confirm Sign of Power For All Elements)
- **LCD:** Real Time Values > (Confirm Sign of Power for Each Element)



If a CT is discovered to be on backwards after the installation is complete, the direction of the CT can be reversed through a user configuration register designed for this purpose, called the “**Flipper**,” located at 2226, 2234, and 2235.

RTU PROGRAMMING AND SCRIPTING - DETAILS



This section is intended for the programmer of the RTU or host system and includes details about meter and element addressing, register locations, data formats and protocol examples.

Register Organization

The PSHD meter communicates through the reading and writing of registers. Registers are organized into functional groups and are compliant with the SunSpec Modbus interface model.

- SunSpec Common Registers
- SunSpec TCP Network Stack Registers
- SunSpec Serial Interface Registers
- SunSpec Energy Meter
- DENT Factory Registers
- DENT User Command Registers
- DENT User Configuration Registers
- DENT Metrology Registers
- DENT Daughter Card Registers
- DENT Waveform Capture Registers

The complete register set is included as an Excel file on the supplied thumb drive or at:

<https://www.dentstruments.com/software-downloads>

ELEMENT VS SYSTEM SCOPE

Element

When reading the value of a register, the scope is defined as belonging to an “Element” if each Modbus Slave Address (or BACnet object instance) contains a unique value. Physically speaking, elements are grouped into sets of threes and given alphabetic assignments (A, B, C, etc.) and are marked on the silk screen of the circuit board. Registers that contain data inclusive of more than one channel are identified as being either SUMS or AVERAGES of the enabled channels within an element.

Channel

Channels are identified on the circuit board as CH1, CH2, or CH3 and represent physical CT inputs. In three phase system configurations, these correspond to a current load on a corresponding line voltage. In single phase configurations, they are just used to identify a CT location. Registers providing data for an individual channel are also described as elements in their scope as a unique value exists for each Slave Address or BACnet object instance.

System

The term “**System**” refers to registers defining the characteristics of the entire circuit board. System registers report the same value independent of the slave address.

CONFIGURING ELEMENT AND CHANNEL REGISTER FOR SERVICE TYPES

The ViewPoint HD software enforces all element configurations to form a valid electrical system. Configurations performed by remote systems may produce unexpected results if configurations are internally inconsistent. The following tables document how to configure element and channel registers for each service type. Every register should be explicitly written.

Red Text indicates Required Values, **Purple Text** Indicates Suggested Defaults if this data is not known.

Modbus Absolute Address/BACnet Object Assignments for Setting up Service Types

REGISTER TEMPLATE						
Service Type	2207					
V_Input	2217					
Description	2617					
Channels	Volt Ref	CT Type	Range	Phase Shift	CT Multiplier	CT Sign
CH1	2220	2223	2224,2225	2224,2225	2221,2222	2226
CH2	2229	2232	2227,2228	2233,2234	2230,2231	2235
CH3	2238	2241	2236,2237	2242,2243	2239,2240	2244

Configurations

4 Wire 3 ϕ (Wye)						
Service Type	1					
V_Input	1 or 2					
Description	31 Char					
Channels	Volt Ref	CT Type	Range	Phase Shift	CT Multiplier	CT Sign
CH1	L1 – N [1]	mV [1] or R \ddot{o} Coil [2]	Any > 0A	-3.0° to +3.0°	Any > 0 [1]	0 or 1
CH2	L2 – N [2]	mV [1] or R \ddot{o} Coil [2]	Any > 0A	-3.0° to +3.0°	Any > 0 [1]	0 or 1
CH3	L3 – N [3]	mV [1] or R \ddot{o} Coil [2]	Any > 0A	-3.0° to +3.0°	Any > 0 [1]	0 or 1

3 Wire 3 ϕ (Delta)						
Service Type	2					
V_Input	1 or 2					
Description	31 Char					
Channels	Volt Ref	CT Type	Range	Phase Shift	CT Multiplier	CT Sign
CH1	L1 – N [1]	mV [1] or R \ddot{o} Coil [2]	Any > 0A	-3.0° to +3.0°	Any > 0 [1]	0 or 1
CH2	L2 – N [2]	mV [1] or R \ddot{o} Coil [2]	Same as 1	Same as 1	Same as 1	0 or 1
CH3	L3 – N [3]	mV [1] or R \ddot{o} Coil [2]	Same as 1	Same as 1	Same as 1	0 or 1

Even though CH2 is calculated internally it is recommended that the CT settings reflect those from CH1 rather than being left at factory default to facilitate configuration validation from the RTU.

2 Wire 1 ϕ (Plug Load)						
Service Type	3					
V_Input	1 or 2					
Description	31 Char					
Channels	Volt Ref	CT Type	Range	Phase Shift	CT Multiplier	CT Sign
CH1	ANY [1-6]	mV [1] or R ϕ Coil [2]	Any > 0A	-3.0° to +3.0°	Any > 0 [1]	0 or 1
CH2	ANY [1-6]	mV [1] or R ϕ Coil [2]	Any > 0A	-3.0° to +3.0°	Any > 0 [1]	0 or 1
CH3	ANY [1-6]	mV [1] or R ϕ Coil [2]	Any > 0A	-3.0° to +3.0°	Any > 0 [1]	0 or 1

Any channel that needs to be turned OFF should set the CT Type to OFF.

3 Wire 1 ϕ (Split Phase)						
Service Type	4					
V_Input	1 or 2					
Description	31 Char					
Channels	Volt Ref	CT Type	Range	Phase Shift	CT Multiplier	CT Sign
CH1	L1 – N [1]	mV [1] or R ϕ Coil [2]	Any > 0A	-3.0° to +3.0°	Any > 0 [1]	0 or 1
CH2	L2 – N [2]	mV [1] or R ϕ Coil [2]	Any > 0A	-3.0° to +3.0°	Any > 0 [1]	0 or 1
CH3	L3 – N [3]	OFF [0]	Any > 0A	-3.0° to +3.0°	Any > 0 [1]	0 or 1

Even though CH3 is not used for computation it is recommended that the CT settings reflect those from CH1 rather than being left at factory default to facilitate configuration validation from the RTU.

Disabled (OFF)						
Service Type	5					
V_Input	1 or 2					
Description	31 Char					
Channels	Volt Ref	CT Type	Range	Phase Shift	CT Multiplier	CT Sign
CH1	L1 – N [1]	OFF [0]	Any > 0A	-3.0° to +3.0°	Any > 0 [1]	0 or 1
CH2	L2 – N [2]	OFF [0]	Any > 0A	-3.0° to +3.0°	Any > 0 [1]	0 or 1
CH3	L3 – N [3]	OFF [0]	Any > 0A	-3.0° to +3.0°	Any > 0 [1]	0 or 1

Even though disabled channels are not used in calculations and report 0.0 they still contain configuration information. It is suggested that they be set to a known value rather than left at defaults to facilitate configuration validation by the RTU.

CONFIGURING SYSTEM REGISTERS

Modbus Absolute Address/BACnet Object Assignment

REGISTER TEMPLATE	
Description	2601
PF Sign Convention	2248
V1 Multiplier	2203,2204
V2 Multiplier	2205,2206

Configurations

System	
Description	31 Char
PF Sign Convention	ANSI [1] or IEEE[2]
V1 Multiplier	Any > 0 [1]
V2 Multiplier	Any > 0 [1]

Modbus Protocol Commands

If configured for Modbus, the PSHD networked power meter family follows the Modbus RTU protocol and supports the following command set.

Supported Modbus Commands		
Command Name	Command Number (Hex)	Description
Read Holding Registers	03	Used to read the data values from the PowerScout.
Write Single Register	06	Used to write a single holding register to a PowerScout.
Report Slave ID	11	Used to read information from the identified PowerScout.

SLAVE ADDRESS

Refer to the section “Serial Protocols” for additional information on setting the Slave Address and finding the address of a specific meter element.

See the Modbus examples document on the DENT Instruments web site or included with your electronic documentation for additional support on programming Modbus. The following online resources are also helpful.

http://Modbus.org/docs/PI_MBUS_300.pdf

<http://www.Modbustools.com/Modbus.html>

<http://www.simplyModbus.ca/TCP.htm>

BACnet

Building Automation and Control Network (BACnet) protocol was developed under the auspices of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and is recognized as an American National, European, and ISO global standard.

BACnet Device ID. All device IDs on a BACnet network must be unique. Refer to the section “Serial Protocols” and refer to the Register List for additional information

Serial



The PSHD Serial version supports writable `max_master` and `max_info_frames` properties in the device object for MS/TP networks. For best network performance, the `max_master` should be set to the highest MS/TP MAC address on the network. The `max_info_frames` does not need to be changed in most installations

Ethernet



Ethernet versions can register as Foreign Devices to a BBMD. **BBMD** stand for *BACnet/IP Broadcast Management Device*. The address also can be written to BACnet object identifiers 14014 (BBMD IP Address LSW) and 14015 (BBMD IP Address MSW).

NOTE: The LSW/MSW are in network order.

For example, to set the BBMD server to 192.168.1.100 you would write:

43200 (0xA8C0) to BBMD IP address LSW object identifier 14014

-and-

25601 to (0x6401) to BBMD IP address MSW object Identifier 14015

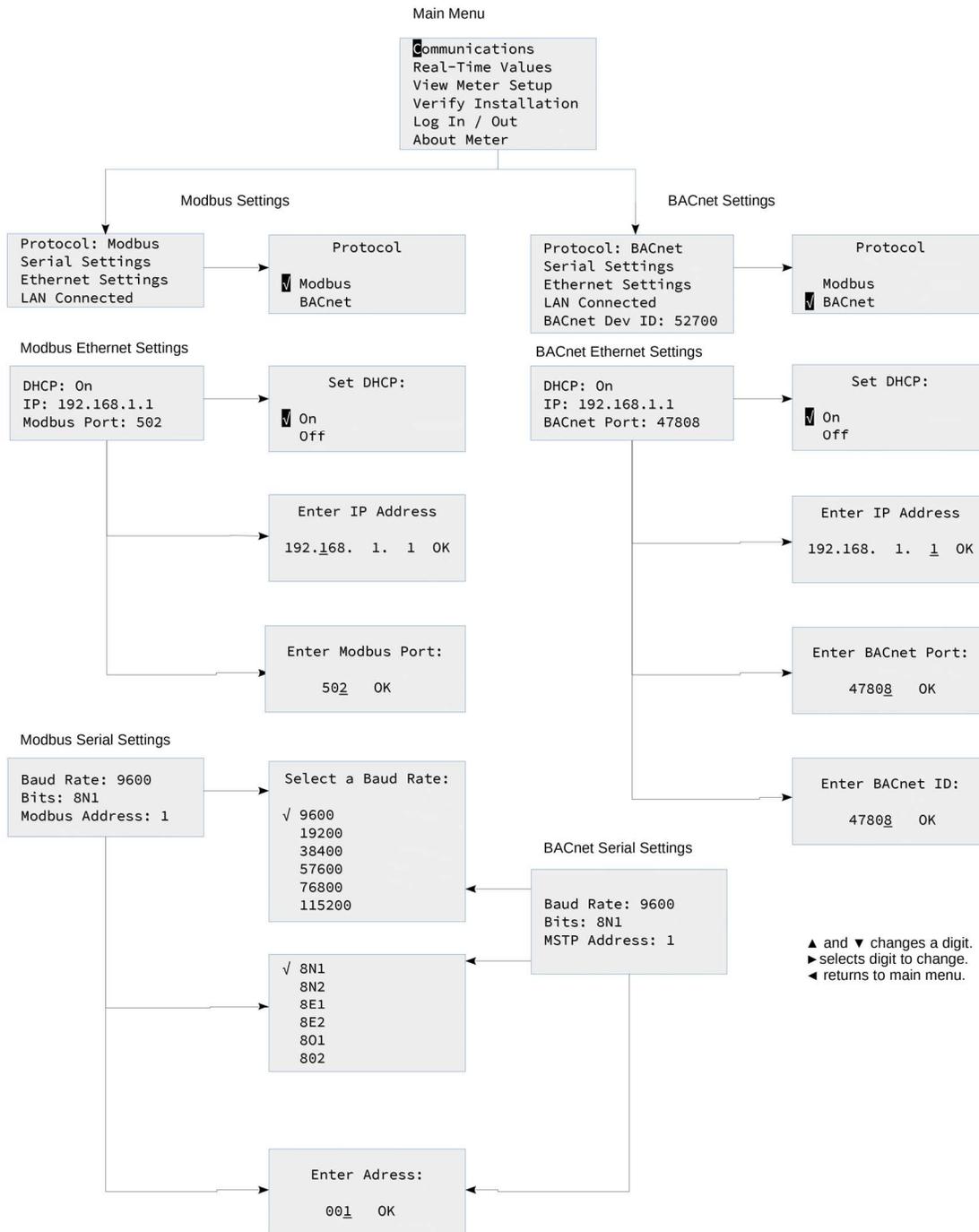
This sends the register as foreign device packet with a Time to Live (TTL) of 60000 seconds.

To disable BBMD foreign device registration write 0 to both BBMD IP address LSW (14014) and BBMD IP address MSW (14015) or simply write 0.0.0.0 to the BBMD field in the ViewPoint Communications tab.

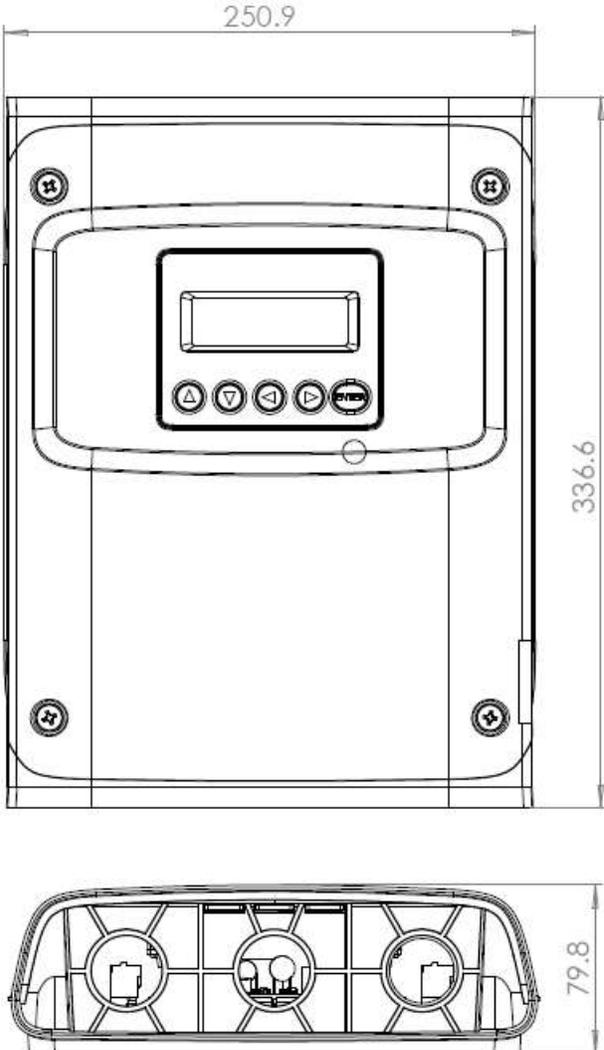
The following online BACnet resources are also helpful.

<http://www.bacnet.org/>

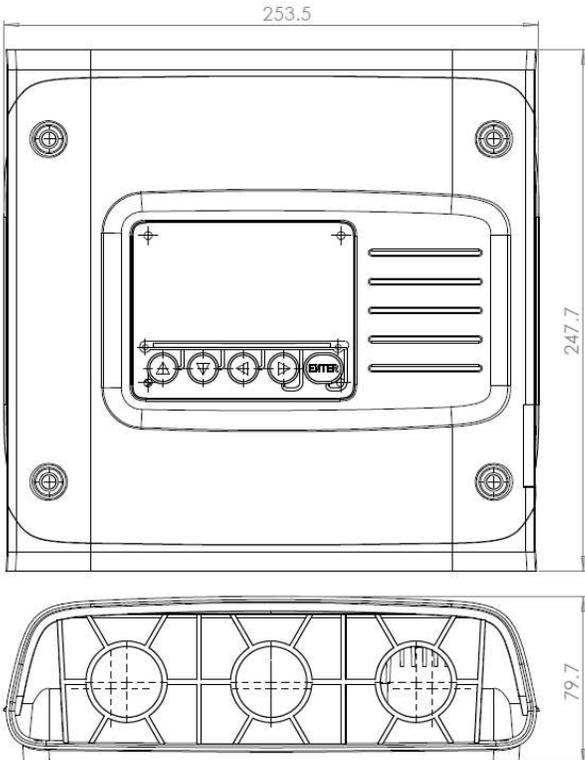
HDMS Communication Settings



APPENDIX B—ENCLOSURE DIMENSIONS

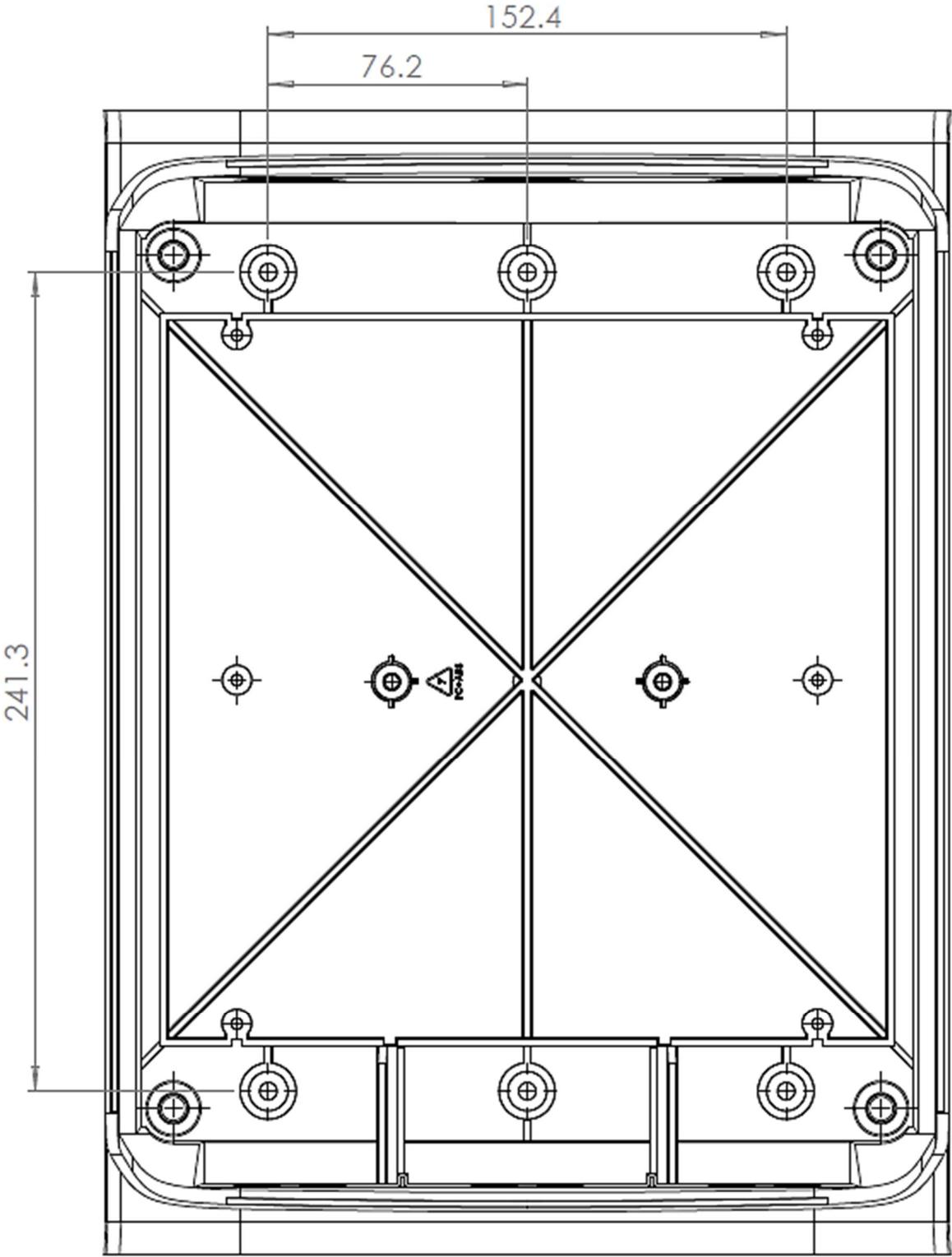


PS48HD Enclosure Dimensions

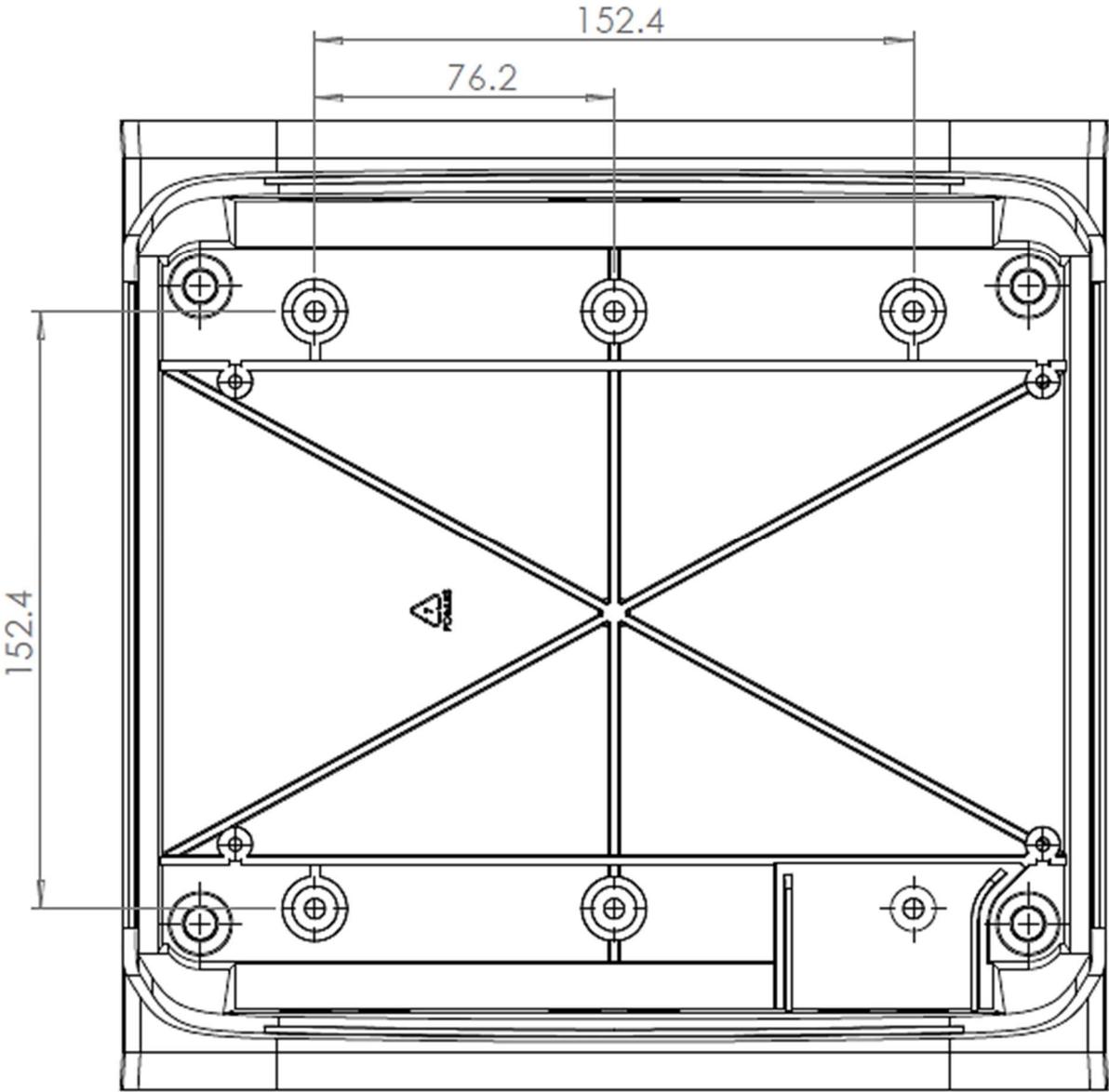


PS12HD Enclosure Dimensions

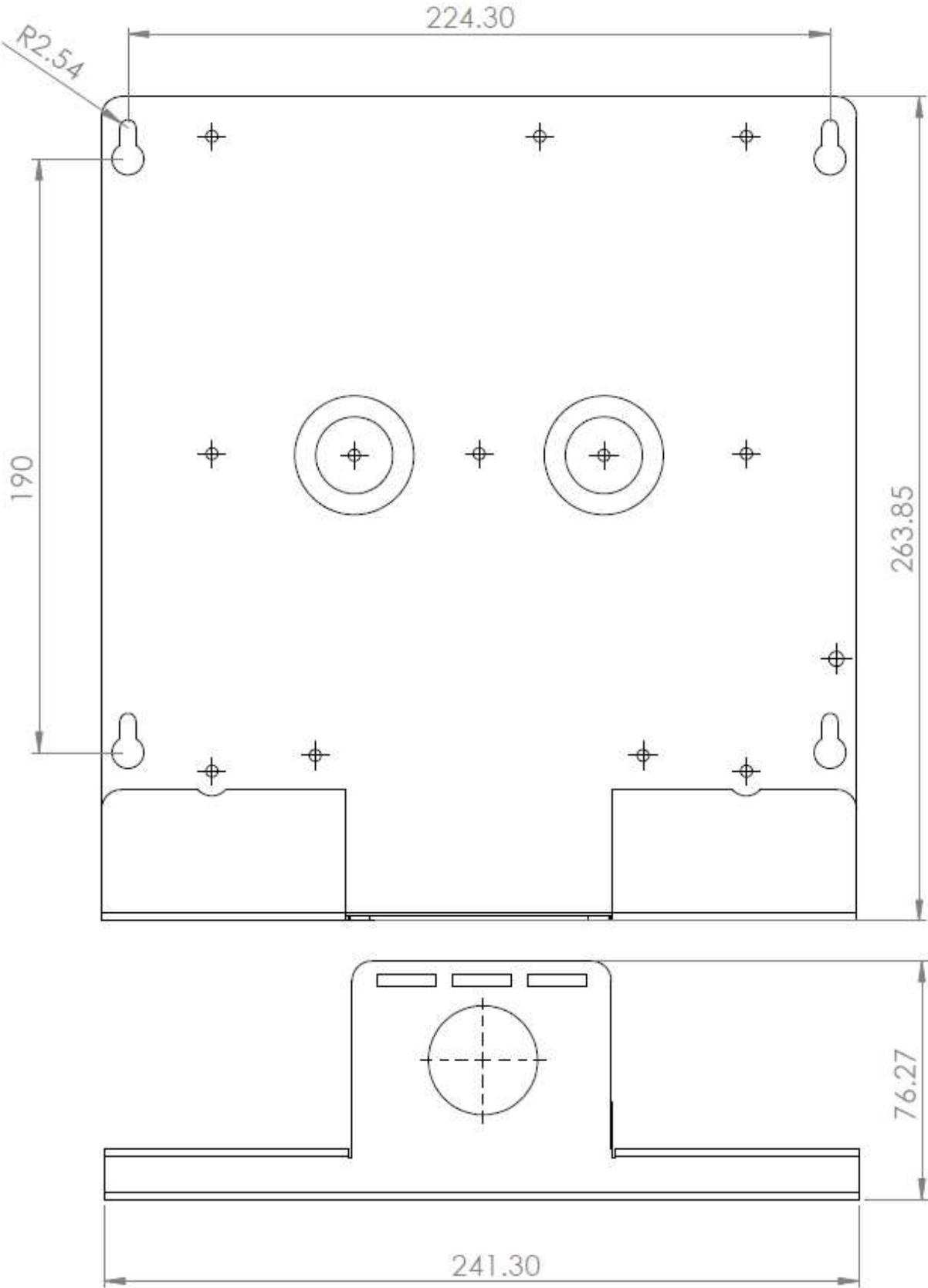
APPENDIX C—MOUNTING TEMPLATES



PS48HD Enclosure Drill Template



PS12HD Enclosure Drill Template



PS48HD Plate Template

APPENDIX D—PSHD TECHNICAL SPECIFICATIONS

Specification	Description
Service Types	Single Phase, Split Phase, Three Phase-Four Wire (WYE), Three Phase-Three Wire (Delta)
Voltage Channels	90-346 Volts AC Line-to-Neutral, 600V Line-to-Line, CAT III. Two voltage reference inputs (PS48HD only)
Current Channels	12 (PS12HD) or 48 (PS48HD) channels, 0.525 VAC max, 333 mV CTs, 0-4,000+Amps depending on current transducer
Maximum Current Input	150% of current transducer rating (mV CTs) to maintain accuracy. Measure up to 4000A with RōCoil CTs.
Measurement Type	True RMS using high-speed digital signal processing (DSP) with continuous sampling
Line Frequency	50-60 Hz
Power	From L1 Phase to L2 Phase. 90-600VAC RMS CAT III 50/60Hz, 500mA AC Max Use of 12 volt auxiliary output requires 100 VAC minimum input voltage.
AC Protection	0.5A Fuse 200kA interrupt capacity
Power Out	Unregulated 12VDC output, 200 mA, self-resetting fuse
Waveform Sampling	1.8 kHz (PS48HD), 3.6 HZ (PS12HD)
Parameter Update Rate	1 second
Measurements	Volts, Amps, kW, kVAR, kVA, aPF, dPF, kW demand, kVA demand, Import (Received) kWh, Export (Delivered) kWh, Net kWh, Import (Received) kVAh, Export (Delivered) kVAh, Net kVAh, Import (Received) kVARh, Export (Delivered) kVARh, Net kVARh, THD, Theta, Frequency. All parameters for each phase and system total.
Accuracy	0.2% ANSI C12.20-2010 Class 0.2
Resolution	Values reported in IEEE-754 single precision floating point format (32 bit).
Indicators	4-line display, tri-color backlight (PhaseChek™)
Pulse Output	Open Collector, 5mA max current, 40V max open voltage
Alarm Output	Voltage Phase Loss Alarm (SPDT Relay - 30 VDC) (PS48HD only)
Communication	
Hardware	RS-485, Ethernet, & USB (for configuration only)
Supported Protocols	Modbus RTU or BACnet Master Slave Token Passing protocol (MS/TP) Modbus (using SunSpec IEEE-754 single precision floating point model)
Max Communication Length	1200 meters with Data Range of 100K bits/second or less
RS-485 Loading	1/8 unit
Communication Rate (baud)	Modbus: 9600 (Default), 19200, 38400, 57600, 76800, 115200 BACnet: 9600 (Default), 19200, 38400, 76800
Data Bits	8

Specification	Description
Parity	None, Even, Odd
Stop Bit	2, 1
Termination	None provided
Data Formats	Modbus, BACnet MS/TP, Modbus TCP or BACnet IP
Mechanical	
Wire Connections	12-22 AWG 600 VAC, Voltage connection must be #14 AWG or larger & 600 VAC rated
Mounting	Enclosure or Panel Mount (PS48 only)
High Voltage Cover	IP40
Mounting Plate	PS48HD Only
Operating Temperature	-20 to + 60° C (-4 to 140° F) (the colder the temperature the more voltage needed to power the board)
Humidity	5% to 95% non-condensing
Enclosure	ABS Plastic, 94-V0 flammability rating, connections sized for 1-inch EMT conduit
Dimensions	(L) 33.7cm x (W) 25.2cm x (H) 8.0 cm (13.3" x 10" x 3.1") (no enclosure version) (L) 24.7cm x (W) 25.2cm x (H) 8.0 cm (9.8" x 10" x 3.1") (no enclosure version)
PCBA Dimensions	(L) 21.6cm x (W) 21.6.0cm x (H) 6.4 cm (8.5" x 8.5" x 2.5")
ViewPoint HD™ Minimum System Requirements	
Operating System	Windows® 7. Windows® 8, Windows® 10
Communications Port	RS-485 & USB standard. Ethernet available. One USB Port required on PC.
Safety	
FCC Compliance	This device has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at user's own expense.
Serial/Ethernet Meters	The following are UL Recognized: PS12HD-B-y-z, PS12HD-P-y-z, PS48HD-B-y-z, PS48HD-P-y-z The following are UL Listed: PS12HD-C-y-z, PS48HD-C-y-z Conforms to UL Std 61010-1, 3rd Edition, UL 61010-2-30:2010 Certified to CSA Std C22.2 No. 61010-1, 3rd Edition

