

Operator's Guide
PowerScoutTM **3 *plus***

Modbus – BACnet
Power Meter



PowerScout™ 3 Plus 2.53
December 1, 2011

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SECTION I: INTRODUCTION

Product Description


The PowerScout™ 3 Plus monitors the voltage, current, power, energy and many other electrical parameters on single and three-phase electrical systems. The PowerScout meter uses direct connections to each phase of the voltage, and uses current transformers to monitor each phase of the current. Information on energy use, demand, power factor, line frequency and more are derived from the voltage and current inputs.

The communications interface to the unit is an RS-485 serial connection that uses the BACnet Master Slave Token Passing (MS/TP) protocol or Modbus protocol for sending commands and retrieving data. A separate BACnet client (Data Logger, or Building Management and Control System) is usually connected to the PowerScout for BACnet. A separate remote terminal unit (RTU), Data Logger, or Building Management and Control System is usually connected to the PowerScout for Modbus mode. This separate unit provides data recording and trend logging plus a human interface or display.

Up to 127 PowerScout 3 Plus meters may be connected to a single BACnet client for monitoring and recording power usage at multiple locations within a single site. Up to 254 meters may be connected to Modbus.



PowerScout™ 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>Conforms to UL Std 61010-1 Certified to CSA Std C22.2 No. 61010-1</p>
<p>The PowerScout is an Over-Voltage Category III device.</p>		
<p>CAUTION: THIS METER MAY CONTAIN LIFE THREATENING VOLTAGES. QUALIFIED PERSONNEL MUST DISCONNECT ALL HIGH VOLTAGE WIRING BEFORE USING OR SERVICING THE METER.</p>		



WARNING

Use of this device in a manner for which it is not intended may impair its means of protection.

SYMBOLS ON EQUIPMENT



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



When connecting the PowerScout to an AC load, follow these steps in sequence to prevent a shock hazard.

1. De-energize the circuit to be monitored.
2. Connect the CTs to the phases being monitored.
3. Connect the voltage leads to the different phases. Use proper safety equipment (gloves and protective clothing) as required for the voltages monitored.



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



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



USE ONLY CURRENT TRANSFORMERS (CTs) SUPPLIED.

Do not use other CTs. Serious shock hazard and meter damage can occur if other CTs are used.



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

No accessories are approved for use with the PowerScout 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.

Phone: 541.388.4774 Email: techhelp@DENTinstruments.com

PowerScout™ RÉSUMÉ DE SÉCURITÉ ET SPÉCIFICATIONS

Cette information de sécurité est destinée à être utilisée à la fois par l'opérateur de l'enregistreur et le personnel de service. DENT Instruments, Inc n'assume aucune responsabilité pour l'utilisateur qui ne respecte pas les directives en matière de sécurité.		Conforme à UL Std 61010-1 Certifié CSA Std C22.2 No. 61010-1
Le PowerScout est un appareil de surtension de catégorie III.		
ATTENTION: CE METER PEUT CONTENIR DE HAUTES TENSIONS QUI PEUVENT ÊTRE DANGEREUSES. UN PERSONNEL QUALIFIÉ DOIT DÉBRANCHER TOUS LES CÂBLES À HAUTE TENSION AVANT D'UTILISER OU DE RÉPARER DU METER.		



ATTENTION

L'utilisation de cet appareil d'une manière pour laquelle il n'est pas destiné peut annuler ses moyens de protection.

SYMBOLES DES EQUIPEMENTS



Signifie prudence. Voir le manuel pour une description de la signification.



En faisant la connexion du PowerScout à une prise de courant alternatif, suivez ces étapes en ordre pour empêcher un risque de choc.

1. Décharger le circuit à contrôler.
2. Connectez le TC aux phases à surveiller.
3. Connectez les fils de tension à des phases différentes. Utiliser des équipements de sécurité (gants et des vêtements de protection) qui sont nécessaires pour les tensions surveillées.



INDIQUE HAUTE TENSION. RISQUE DE CHOC ÉLECTRIQUE. HAUTES TENSIONS PEUVENT ÊTRE PRÉSENTES QUI METTENT LA VIE EN DANGER. PERSONNEL QUALIFIÉ UNIQUEMENT.



NE PAS DEPASSER 600V. Ce compteur peut contrôler les charges jusqu'à 600V. Le dépassement de cette tension peut causer des dommages à l'appareil et du danger pour l'utilisateur. Utiliser toujours le potentiel transformateur (PT) pour des charges de plus de 600V. Le PowerScout est un appareil à 600 V de surtension de catégorie III.



UTILISEZ SEULEMENT TRANSFORMATEURS DE COURANT (TC) FOURNIS.

Ne pas utiliser d'autres TC. Un sérieux risque de choc et de dommages au compteur peut se produire si d'autres TC sont utilisés.



L'équipement protégé en double isolation (IEC 536 Classe II).

Pas d'accessoires approuvés pour une utilisation avec le PowerScout sauf ceux spécifiés par DENT Instruments dans ses documentations sur les produits et également sur les prix.

Si le compteur semble endommagé ou défectueux, tout d'abord déconnecter le pouvoir de l'appareil. Alors s'il vous plaît appelez 541.388.4774 ou contacter par courriel l'assistance technique (techhelp@DENTinstruments.com), pour obtenir de l'aide.

PowerScout 3 Plus™ Technical Specifications

Specification	Description
Service Types	Single Phase, Three Phase-Four Wire (WYE), Three Phase-Three Wire (Delta)
3 Voltage Channels	80-346 Volts AC Line-to-Neutral, 600V Line-to-Line, CAT III
Current Channels	3 channels 0-5,000+ Amps depending on current transducer
Maximum Current Input	175% of current transducer rating
Measurement Type	True RMS using high-speed digital signal processing (DSP)
Line Frequency	50/60/400Hz
Waveform Sampling	12 kHz
Parameter Update Rate	500 milliseconds
Measurements	Volts, Amps, kW, kWh, kVAR, kVARh, kVA, kVAh, Apparent Power Factor (aPF), Displacement Power Factor (dPF). All parameters for each phase and for system total.
Accuracy	Better than 1% (<0.5% typical) for V, A, kW, kVAR, kVA, PF
Resolution	0.01 Amp, 0.1 Volt, 0.01 watt, 0.01 VAR, 0.01 VA, 0.01 Power Factor depending on scalar setting
LEDs	Bi-color LEDs (red and green): 1 LED to indicate communication, 3 LEDs for correct phasing (PhaseChek: Green when voltage and current on the on the same phase; Red when incorrectly wired.), 2 Digital Channel indicators
Pulse Output	Open Collector, 75mA max current, 40V max open voltage
Communication	
Direct	User Selectable Modbus or BACnet Master Slave Token Passing protocol (MS/TP) over RS-485
Max Communication Length	1200 meters with Data Range of 100K bits/second or less
Communication Rate (baud)	9600 (Modbus Default), 19200, 38400, 57600, 76800 (BACnet default), 115200
Data Bits	8
Parity	None, Even, Odd
Stop Bit	2, 1, 0
Data Formats	Modbus Protocol OR BACnet Master Slave / Token Passing (MS/TP) protocol
Power	From L1 Phase to L2 Phase. 80-600VAC CAT III 50/60Hz 70mA Max. Non-user replaceable .5 Amp internal fuse protection
Mechanical	
Operating Temperature	-7 to + 60 °C (-20 to 140 °F)
Humidity	5% to 95% non-condensing
Enclosure	ABS plastic, 94-V0 flammability rating
Weight	357 g (12.6 ounces), exclusive of CTs
Dimensions	21.8 x 5.8 x 4.0 cm (8.6" x 5.8" x 1.6")
ViewPoint™ Minimum System Requirements	
Operating System	Windows® 7 (32 or 64 bit), Vista (32 or 64 bit), XP or 2000
Communications Port	One USB port or serial port
Hard Drive	50 MB minimum available
Processor	Pentium Class 1 GHz or more recommended

SECTION II: BACnet METERS

SECTION II.A: Quick Start Guide - BACnet

This section details the quick start setup for a PowerScout 3 Plus connected to a third party BACnet client. As BACnet clients differ in user interfaces this section is generic to all third party BACnet clients.



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



Haute tension peut être présente. Risque de choc électrique. Tensions dangereuses peuvent être présentes. Personnel qualifié uniquement.

1. Connect the PowerScout 3 Plus to the BACnet MS/TP client with three-conductor wire (positive (+), negative (-), and System Common (S)).
2. Set the rotary switches to the desired BACnet MS/TP master address (1-127 decimal).
3. Verify that the PowerScout 3 Plus can be discovered through the BACnet client.
4. Securely mount the PowerScout 3 Plus using the two mounting tabs at each end of the case.
5. Mount each current transformer (CT) on the wire to be monitored. Next, connect the CT leads to the terminal block on the PowerScout. Verify the CTs are correctly oriented on the wires with the orientation pointed toward the load (away from the breaker). Note that:
The CT on the L1 voltage phase wire is connected to the PowerScout's CT 1 input
The CT on the L2 voltage phase is connected to the CT 2 input
The CT on the L3 voltage phase is connected to the CT 3 input
 - Refer to the end of *Section II.B: Field Installation* to review common wiring diagrams.
6. Connect the voltage leads on the PowerScout 3 Plus to the appropriate voltage phases. Connect the neutral wire to the neutral bus or to ground if using a three-phase Delta service. The PowerScout 3 Plus is powered from L1 and L2 voltage connections.
7. Verify the PhaseChek™ LEDs are all flashing green.
8. On the BACnet client, write the desired **CT Type** (MilliVolt = 1, Rogowski = 2) to the present value of **object identifier 12130** and **CT Value** (in Amps) to the present value of **object identifier 12010**.
9. Clear the stored accumulated and demand data by writing to **object identifier 10140 "Clear Accumulated Values"** present value 1234.0
10. View the current values of voltage (**object instances 3000 to 4000**), current (**object instances 4000-5000**) and power (**object instances 1000 to 2000**) and verify that the readings are correct.

PowerScout 3 Plus Diagram

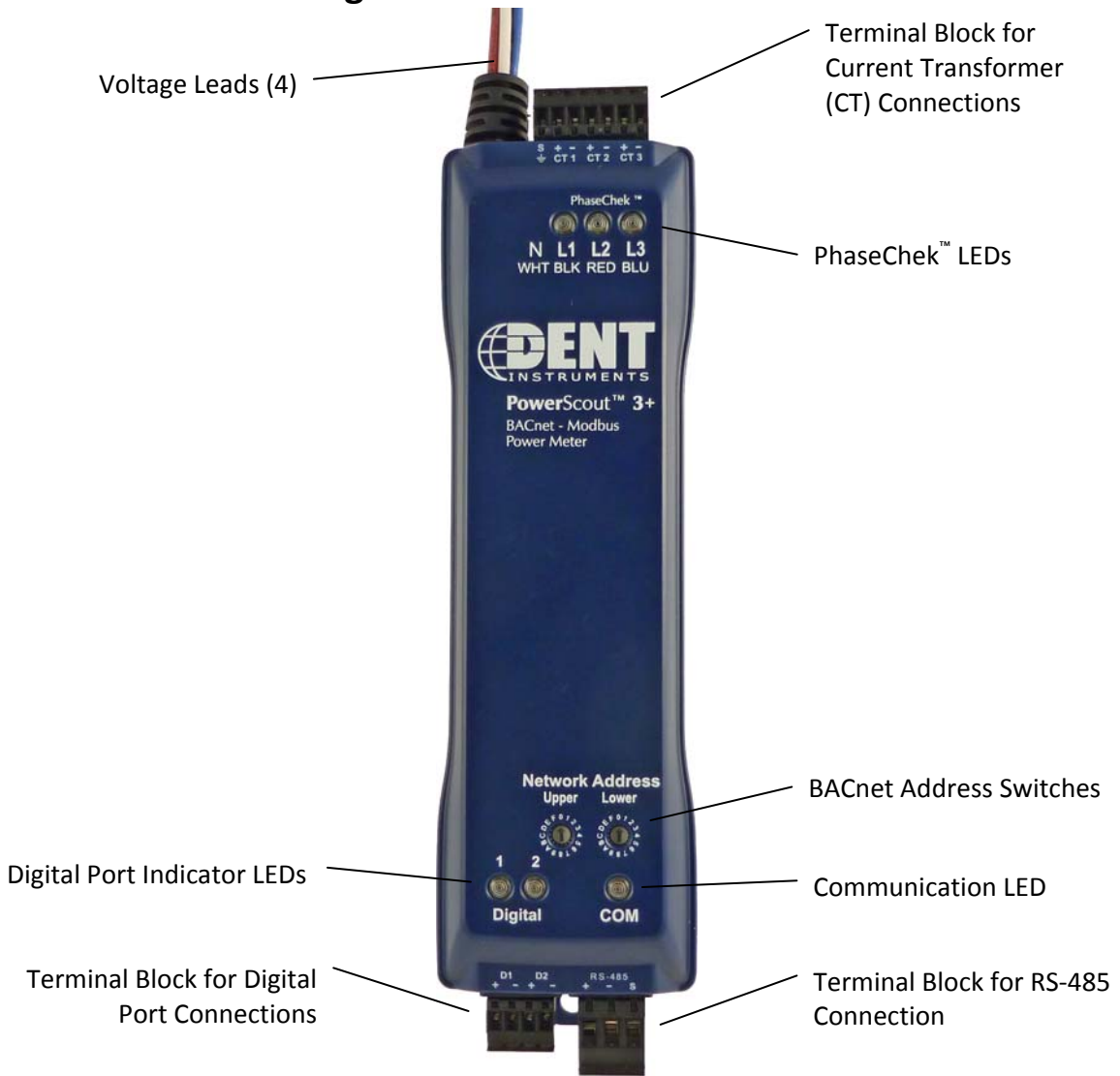


Figure II-1: PowerScout 3 Plus Layout – US voltage wire colors shown

SECTION II.B: Field Installation – BACnet



WARNING! REMOVE THE METER FROM ALL SOURCES OF VOLTAGE BEFORE MOUNTING.

Mounting the PowerScout™ 3 Plus

The PowerScout 3 must be installed in an approved electrical panel or enclosure using proper installation practices according to the local electrical codes.

- To mount the PowerScout 3 Plus use the two tabs provided at each end of the case. Securely mount the PowerScout near a dedicated circuit disconnect breaker.

Connecting the PowerScout 3 Plus

The PowerScout 3 Plus has the following connections:

- A three-wire connector for the RS-485 BACnet/ModBus link.
- Four voltage wire leads for connecting to voltage sources (L1, L2, L3, and Neutral). The PowerScout 3 Plus is self-powered from L1 and L2.
- Up to three current transducers (CTs).

Completing the Wiring Connections – RS-485, Voltage Leads and CTs

1. Connect the RS-485 adapter to the computer using the USB cable by inserting each white ferrule into the appropriate opening on the PowerScout 3 Plus. The red wire inserts in (+), the black wire in (-) and the green wire in (S).
2. Connect the CTs on the PowerScout 3 Plus connections labeled CT 1, CT 2 and CT 3. Place the CTs on the phase wires of the load to be monitored and corresponding to the phase of the voltage leads. The CT labeled CT 1 must be placed on L1 phase voltage wire, CT 2 must be on the L2 voltage and CT 3 on the L3 voltage. Refer to *PhaseChek™* in Section III for information about the CT LEDs and verifying the CT installation.
3. Connect the PowerScout's 14 AWG THHN (or equivalent) wires, after a building-installed, dedicated circuit disconnect breaker, as close as possible to the breaker. Mark the breaker as the disconnect for the PowerScout 3 Plus. Refer to the wiring diagrams in this chapter for specifics of the wiring connections.
Follow local electrical codes during this installation.

Note: *The PowerScout 3 Plus has an internal, non-user replaceable .5 Amp internal fuse protection.*

Powering the PowerScout 3 Plus

The PowerScout 3 Plus is self-powered from the L1 and L2 lines. When 80 – 600VAC or DC is placed across the L1 and L2 wires, the three phasing LEDs begin to flash in sequence.

PowerScout 3 Plus Single-Phase Connections

The PowerScout 3 Plus can be used to monitor single-phase loads. There are several guidelines to keep in mind about this type of connection:

1. The PowerScout 3 Plus is powered from a potential between L1 and L2. This can be phase-to-phase (230V) or phase-to-neutral (115V). With a single-phase 230V panel, the L1 and L2 voltage leads are connected between the L1 and L2 voltage sources. With a 115V circuit, the L1 voltage lead is connected to the L1 “hot lead,” and the L2 voltage lead is connected to neutral.
2. Each CT must be paired with the correct voltage source. The current and voltage need to be in-phase for accurate measurements. For instance, CT 1 would monitor branch circuit supplied by voltage source L1, and so on.
3. The neutral must be connected because the PowerScout 3 Plus uses line-to-neutral measurements for all calculations.

On the US version of the PowerScout 3 Plus, the voltage leads are color coded: Black/L1, Red/L2, Blue/L3, and White/neutral. On international PowerScout 3 Plus instruments, the voltage leads are black and labeled L1, L2, L3, and N.

A Typical 230V Single-Phase Panel Setup

Connect the Black L1 voltage lead to Voltage L1, Red L2 voltage lead to L2 voltage, White Neutral voltage lead to neutral. CT1 would monitor L1 loads and CT2 would monitor L2 loads. Based on the above guidelines, CT3 can be used if the Blue L3 voltage lead is connected to either L1 or L2. As long as voltage lead L3 and CT3 are in-phase, the PowerScout 3 Plus will provide correct kW readings. If the Blue L3 voltage lead was connected to L2 voltage source, then CT3 could monitor any L2 branch circuit. Or, if the Blue L3 voltage lead was connected to L1 voltage source, then CT3 could monitor any L1 branch circuit.

A Typical 115V Single-Phase Panel Setup

Connect the Black L1 voltage lead to Voltage L1 (hot), Red L2 voltage lead to Neutral, and White N voltage lead to neutral. CT1 would monitor the L1 load. CT3 can be used if the Blue L3 voltage Lead is connected to L1. CT3 could then monitor any L1 branch circuit.

System Values

System values are the sum of L1 + L2 + L3 measurements. System values may not be meaningful since two different devices or loads can be monitored by a single PowerScout 3 Plus element.

When paired with the right voltage phase, each CT provides individual kW/kWh readings for that CT channel.

PhaseChek™

PhaseChek¹ is a unique feature of the PowerScout 3 Plus that simplifies installation by ensuring proper CT-to-phase installation and avoiding faulty data collection. The PowerScout 3 Plus automatically adjusts for CT orientation—reducing set-up time and nearly eliminating installation errors.

Verifying the PowerScout Setup Using the LEDs

The PowerScout 3 Plus has three bi-color PhaseChek LEDs. These LEDs provide the following information:

- All LEDs are green — the system power factor is greater than 0.55 and the CTs are properly placed on the corresponding voltage phases.
- Any one LED is red — there is a phasing connection error.
- Two LEDs are red and one is green — two CTs are reversed.
- All three LEDs are red —all CTs are incorrectly connected.

Note: *If the total system power factor is less than 0.55, the LEDs will be red even if connected properly. This situation is rare but could occur if, for example, the load to be monitored is a lightly loaded electric motor where it is common for the power factor to be less than 0.55 and the corresponding LEDs will be red.*

The following table describes the PhaseChek error conditions and the appropriate correction.

L1	L2	L3	Error Description	Correction
●	●	●	Setup is correct and the system power factor is greater than 0.55. -or- All CTs are disconnected.	Connect the CTs.
●	●	●	All CTs are incorrectly connected, -or- The system power factor is less than 0.55.	Rotate the CT connections by one position by move CT 1 to CT 2, CT 2 to CT3 and CT3 to CT1, until all LEDs are green. The system power factor is less than 0.55 but the CTs are connected properly indicating a light load.
●	●	●	CT 2 and CT 3 are reversed.	Switch the position of the CTs flashing red.
●	●	●	CT 1 and CT 2 are reversed.	Switch the position of the CTs flashing red.
●	●	●	CT 1 is swapped with either CT 2 or CT 3.	Switch CT 1 with CT 2. -or- Switch CT 1 with CT 3.
●	●	●	CT 2 is swapped with either CT 1 or CT 3.	Switch CT 2 with CT 1. -or- Switch CT 2 with CT 3.

¹ Patent No. 7,612,552. U.S. Patent and Trademark Office.

L1	L2	L3	Error Description	Correction
●	●	●	CT 3 is swapped with either CT 1 or CT 2.	Switch CT 3 with CT 1. -or- Switch CT 3 with CT 2.
●	●	●	CT 1 and CT 3 are reversed.	Switch the position of the CTs flashing red.

Table II-2: PhaseChek LED Error Resolution

Setting the Network Address Switches

There are two rotary network address switches on the PowerScout 3 Plus, labeled Upper and Lower. These two switches are used to select the BACnet MAC address the computer or BACnet client uses to communicate with the PowerScout.

The rotary switches are 16-position, hexadecimal switches. The default factory setting is hex 01. The BACnet MAC address is a hexadecimal (hex) value, represented by the digits 0 through 9 and letters A through F. For example, a network address of 100 in decimal is converted to 64 hexadecimal and set on the PowerScout 3 Plus by:

1. Upper switch – select 6
2. Lower switch – select 4

In some cases the hex value may need to be converted to decimal when entered into the RTU or data logger. See the Appendix for a hexadecimal conversion table.

Hexadecimal Address	Address Availability
00	Reserved for resetting the PowerScout 3 Plus to Modbus mode with 9600 baud, 8 bit, 1 stop bit and no parity.
01-7F	Available (01 is the factory default setting).
80-FE	Reserved for BACnet slave devices
FF	Reserved for network wide broadcast. The rotary switches can be used to configure the communication protocol to BACnet 2004 or Modbus as well as changing the baud rate if unsure of the current settings.

Table II-3: BACnet Hexadecimal Address Availability

Establishing Communication (BACnet)

The PowerScout 3 Plus communicates with the BACnet client using the BACnet MS/TP protocol on a RS-485 hardware interface. To establish communication, the Modbus settings must meet the following requirements:

1. The BACnet address on the PowerScout 3 Plus and in the BACnet client must be set to the same value.
2. The PowerScout 3 Plus meter's default serial parameters are:

Parameter	Setting
Baud	76800
Data bits	8
Parity	None
Stop Bit	1

Table II-4: Communication Settings

The supported baud rates include 9600, 19200, 38400, 57600, 76800, 115200.

3. The baud rate on the BACnet client must match the PowerScout 3 Plus.

PowerScout 3 Plus Wiring Diagrams

The PowerScout 3 can be wired using any one of the following five common wiring setups. These diagrams will assist you in properly connecting your PowerScout 3 Plus for the setup desired. ALL WIRE COLORS ARE U.S. STANDARD.



WARNING! DO NOT EXCEED 600Vac PHASE TO PHASE CAT III.

When complete, close the enclosure cover, if equipped.



Attention: NE PAS DEPASSER UNE PHASE A 600VAC CAT III.

Une fois terminé, fermer le couvercle, s'il y en a un.



CAUTION: THE POWERSCOUT™ 3 Plus SHOULD ONLY BE WIRED BY QUALIFIED PERSONNEL. HAZARDOUS VOLTAGES EXIST.



ATTENTION: LE POWERSCOUT™ 3 PLUS NE DOIT ETRE BRANCHE QUE PAR UN PERSONNEL QUALIFIE. TENSIONS DANGEREUSES SONT PRÉSENTES.



DANGER! THE UNENCLOSED POWERSCOUT BOARD REQUIRES EXTRA CAUTION WHEN CONNECTING. LIFE THREATENING VOLTAGES EXCEEDING 600 VOLTS MAY EXIST ON THE BOARD. THE RISK OF SERIOUS INJURY OR DEATH SHOULD NOT BE UNDERESTIMATED.



DANGER! LA PLAQUETTE DE CIRCUITS IMPRIMES SANS COUVERCLE EXIGE UN REDOUBLEMENT DE PRUDENCE QUAND ON FAIT LA CONNEXION. LES TENSIONS DEPASSANT 600 VOLTS PEUVENT EXISTER SUR LA PLAQUETTE ET PEUVENT METTRE LA VIE EN DANGER. LE RISQUE DE BLESSURES GRAVES OU DE MORT NE DOIT PAS ETRE SOUS-ESTIME.

Figure IV-1: Single Phase, Two Wire



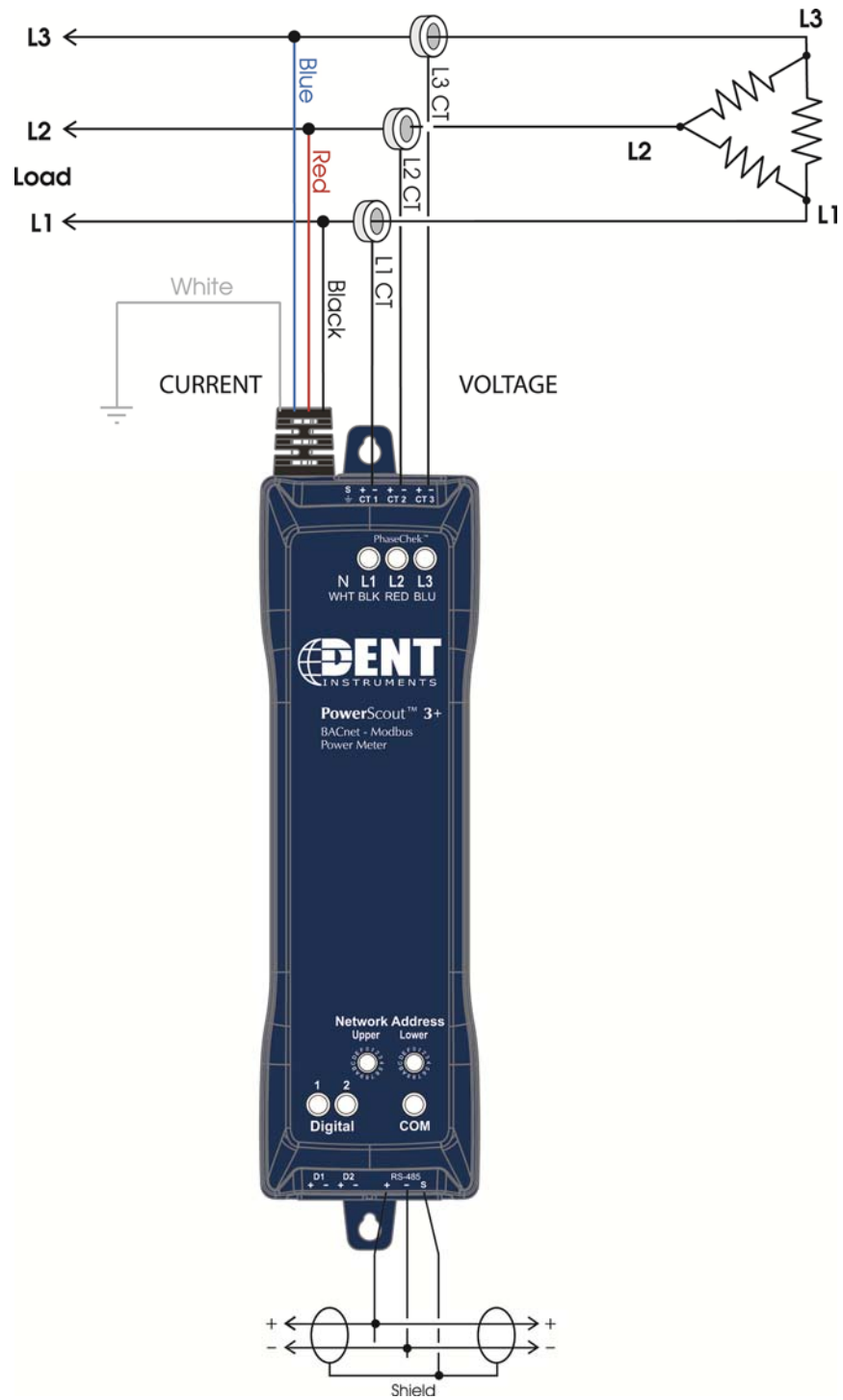
N = white
 L1 = black
 L2 = red
 L3 = blue

Figure IV-2: Single Phase, Three Wire



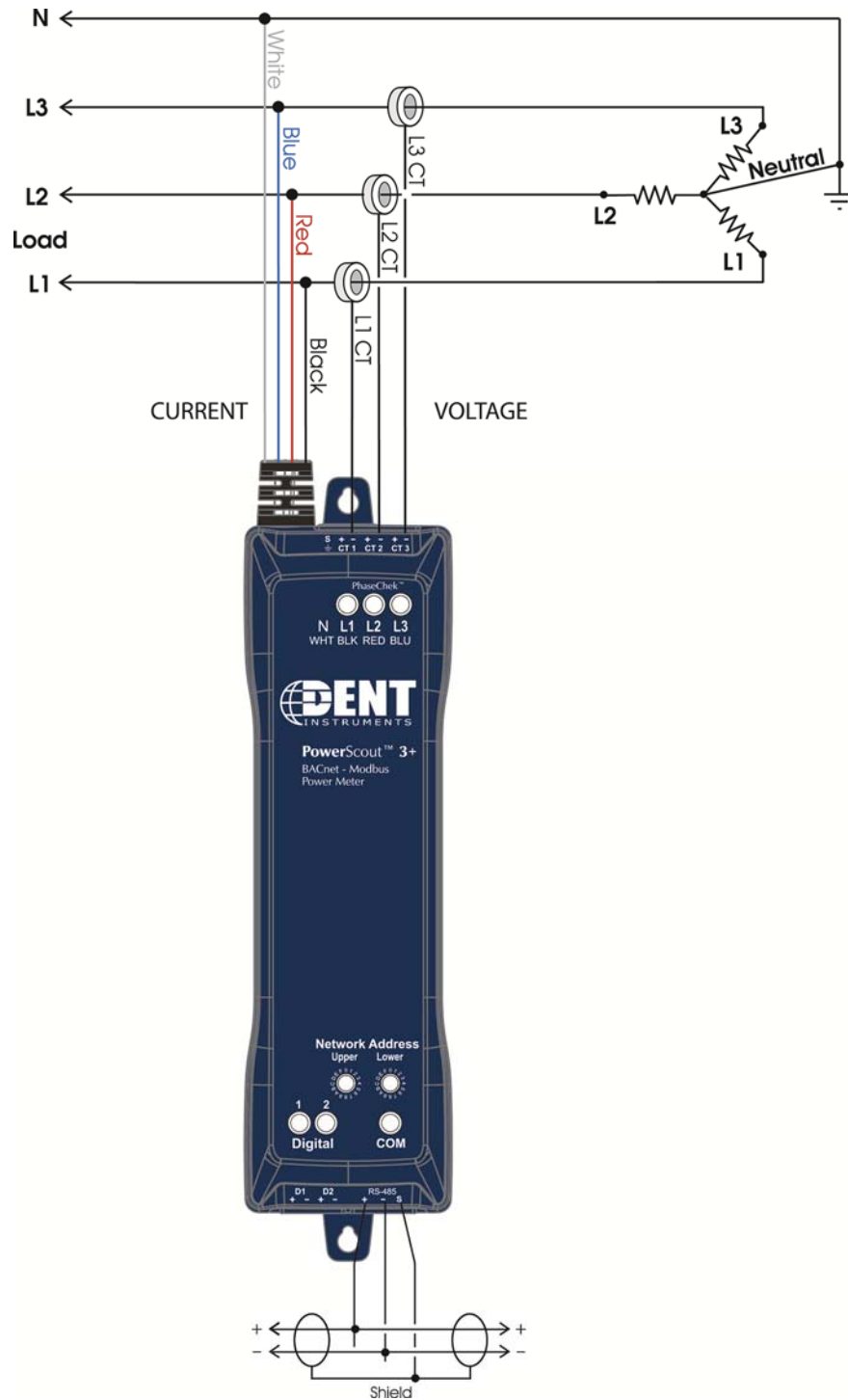
N = white
 L1 = black
 L2 = red
 L3 = blue

Figure IV-3: Three Phase, Three Wire Delta



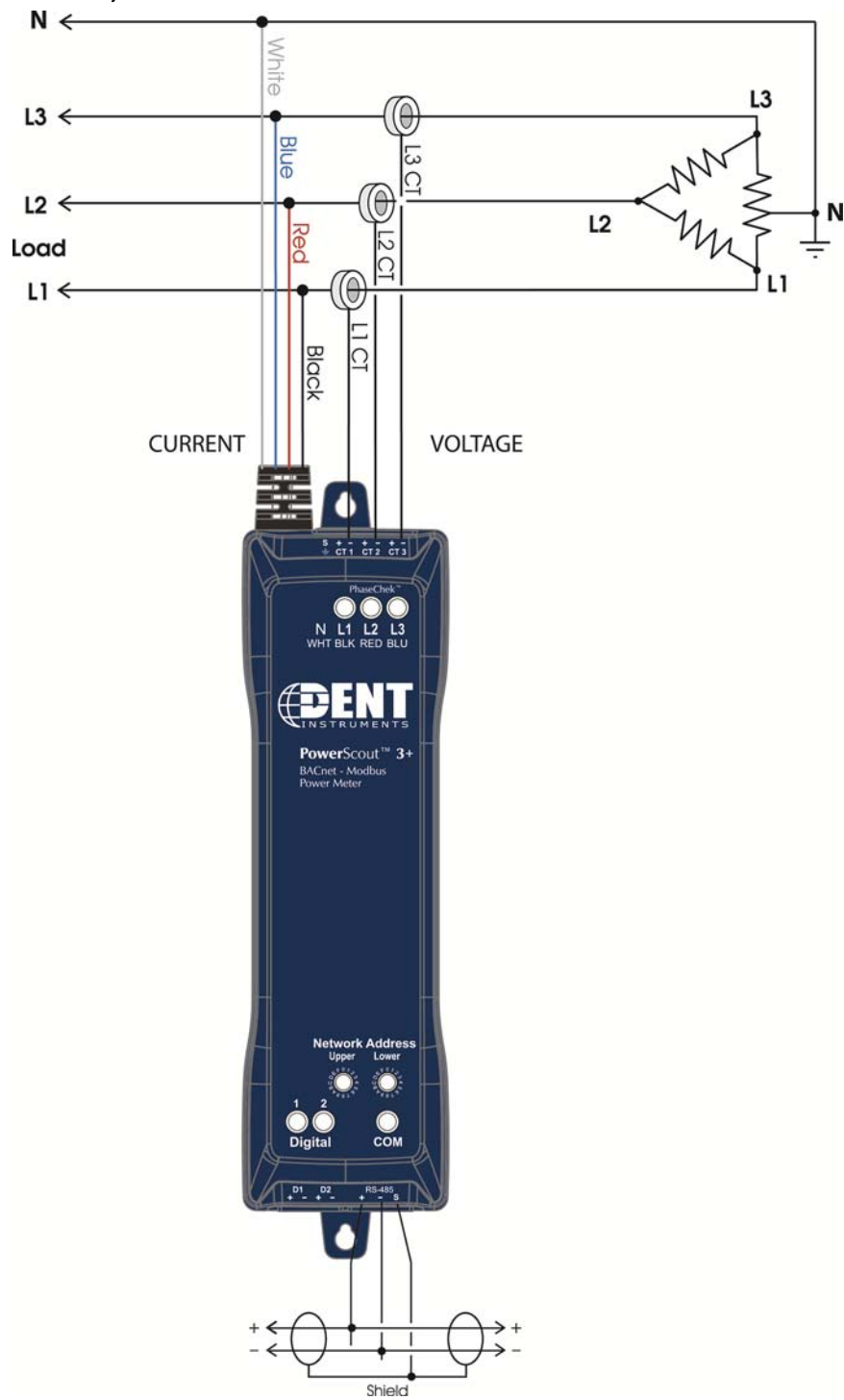
N = white
 L1 = black
 L2 = red
 L3 = blue

Figure IV-4: Three Phase, Four Wire Wye



N = white
 L1 = black
 L2 = red
 L3 = blue

Figure IV-5: Three Phase, Four Wire Delta



N = white
 L1 = black
 L2 = red
 L3 = blue

SECTION II.C: Other Functions - BACnet

Resetting BACnet objects

Many of the PowerScout™ 3 Plus objects are real-time values such as instantaneous watts or power factor. However, some objects are accumulated values such as kWh, kVARh, kVAh and various Peak Demand (kW) values. To reset all these registers at once:

Write to **object identifier 10140 “Clear Accumulated Values”** current value 1234.0

The tables in Section II.D Appendix A list all of the objects available on the PowerScout 3 Plus.

Digital Output Port Function

The PowerScout 3 Plus has two configurable output ports. The ports can be used to output kWh, kVARh, or kVAh pulses to external devices, or to toggle on and off to control a remote device or relay.

Pulse Output

Pulse output is used to generate pulses for external devices such as data loggers that can accept pulses but do not have BACnet capability. The PowerScout 3 Plus can generate pulses based on accumulated value(s) such as system kWh, system kVARh, and system kVAh. When a pulse is generated by the PowerScout 3 Plus, the orange and green LEDs both will briefly flash, otherwise they will remain dark.

The pulse output is scaled by the same data scalar register (44602) as are the Modbus registers. For example, when the data scalar is set to 3, each pulse will represent .1 kWh, .1kVAh and .1kVARh.

For system pulse output:

kWh pulse output – write 44001 into the pulse output configuration object.

kVAh pulse output – write 44011 into the pulse output configuration object.

kVARh pulse output – write 44008 into the pulse output configuration object.

Output Port Registers

Refer to the following two tables to configure the PowerScout 3’s two output ports.

Object Identifier	Name	Detailed Description
13020	Port 1 output control when used as an on/off - open/closed switch	0 = output LOW (closed) 1 = output HIGH (open) [default] Object 13100 present value must = 0 to use
13100	Digital Port 1 Configuration Turns pulses on/off	0 = No pulses, Port may be used as an on/off – open/closed switch 44001 = System kWh pulses 44008 = System kVAh pulses 44011 = System kVARh pulses
13110	Port 1 pulse output relay type	0 = normally open (HIGH) 1 = normally closed (LOW)

Table II-5: Digital Port 1 Pulse Output

Object Identifier	Name	Detailed Description
13030	Port 2 output control when used as an on/off - open/closed switch	0 = output LOW (closed) 1 = output HIGH (open) [default] Object 13150 present value must = 0 to use
13150	Digital Port 2 Configuration Turns pulses on/off	0 = No pulses, Port may be used as an on/off – open/closed switch 44001 = System kWh pulses 44008 = System kVAh pulses 44011 = System kVARh pulses
13160	Port 2 pulse output relay type	0 = normally open (HIGH) 1 = normally closed (LOW)

Table II-6: Digital Port 2 Pulse Output

Connecting to a BACnet MS/TP Network

This section describes setting up a BACnet MS/TP network with multiple PowerScout 3 Plus instruments using the BACnet MS/TP serial communication protocol. A network can support up to 127 PowerScout 3 Plus instruments.

BACnet MS/TP Communication Protocol

BACnet is a standard communications protocol that allows for communication between a BACnet client and multiple devices connected to the same network. RS-485 is the protocol standard used by the PowerScout 3 Plus as the hardware’s serial interface while BACnet is the communication protocol.

Daisy Chain Layout for RS-485 Network

When multiple devices are connected the devices need to be connected in a daisy chain. A daisy chain means that all plus (+) connections are chained together and all minus (-) connections are chained together across the network.

A BACnet MS/TP network containing multiple devices requires a unique address for each device. This allows the master device to identify and communicate with each slave. The BACnet MS/TP network administrator must assign a unique network address to each PowerScout 3 Plus.

Other network layouts are not recommended when using the RS-485 standard.

Networking Using the BACnet MS/TP Option

1. Install the BACnet MS/TP cable.
2. Set a unique BACnet MS/TP MAC address for each device using the table in Appendix A. Locate the number of the slave device in the “Decimal” column. Move right to the “Hex” column to find the converted address value of this device. For example, for device 1, the upper BACnet MAC address switch is set to 0, the lower BACnet MAC address switch is set to 1.

Updating Firmware

The PowerScout 3 Plus must be in Modbus mode when updating firmware. For more information, see *BACnet Appendix B—Switching Between BACnet and Modbus Mode and Modbus Appendix B—Installing Firmware Updates for the PowerScout 3 Plus*.

SECTION II.D: Appendices – BACnet

BACnet Appendix A – PowerScout 3 Plus BACnet Object Tables

Object Identifier	Name	Description
1000	kW Demand System Maximum	System Maximum Demand (peak demand) (Unsigned/Absolute)
1010	kW Demand System Now	Average Power (kW) for most recent demand window (Unsigned/Absolute)
1020	kW Demand System Minimum	Min Average power window (kW) (Unsigned/Absolute)
1030	kW System	System true Power (kW). Unsigned absolute value of (kW L1) + (kW L2) + (kW L3)
1031	kW System Net	System Power (kW) Signed net value of (kW L1) + (kW L2) + (kW L3)
1060	kW System Average	Equals kWh System / (Time Since Reset /3600 seconds/Hr) (resettable)
1080	kW System Average Positive	Equals kWh System Positive / (Time Since Reset /3600 seconds/Hr) (resettable) (Signed Net)
1090	kW System Average Negative	Equals kWh System Negative / (Time Since Reset /3600 seconds/Hr) (resettable) (Signed Net)
1100	kW System Maximum	System Highest Instantaneous Draw Since Reset (kW)
1110	kW System Maximum Positive	System Highest Instantaneous Positive Draw Since Reset (kW)
1120	kW System Maximum Negative	System Highest Instantaneous Negative Draw Since Reset (kW)
1130	kW System Minimum	System Lowest Instantaneous Draw Since Reset (kW, resettable)
1140	kW System Minimum Positive	System Lowest Instantaneous Positive Draw Since Reset (kW, resettable)
1150	kW System Minimum Negative	System Lowest Instantaneous Negative Draw Since Reset (kW, resettable)
1160	kW L1	Individual Phase True Power (kW) (Signed)
1190	kW L2	“
1220	kW L3	“
2000	kWh System Total	System True Energy (kWh) (Unsigned/Absolute)
2010	kWh System Total Positive	System True Energy (kWh) (Signed Net)
2020	kWh System Total Negative	“
2040	kWh L1 Positive	Individual Phase True Energy (kWh) (Signed)
2050	kWh L1 Negative	“
2070	kWh L2 Positive	“
2080	kWh L2 Negative	“
2100	kWh L3 Positive	“
2110	kWh L3 Negative	“
3000	Volts Line to Line Average	Voltage Line to line Average
3010	Volts Line to Neutral Average	Voltage Line to neutral Average
3020	Volts L1 to L2	Individual Phase to Phase Voltages
3030	Volts L2 to L3	“
3040	Volts L1 to L3	“
3050	Volts L1 to Neutral	Individual Phase to Neutral Voltages (V)

Object Identifier	Name	Description
3060	Volts L2 to Neutral	"
3070	Volts L3 to Neutral	"
4010	Amps System Average	Average of all phases.
4020	Amps L1	Individual Phase Currents (A)
4030	Amps L2	"
4040	Amps L3	"
5000	kVAR System	System Total Reactive Power (kVAR). Unsigned absolute value of (kVAR L1) + (kVAR L2) + (kVAR L3)
5001	kVAR System Net	System Total Reactive Power (kVAR). Signed net value of (kVAR L1) + (kVAR L2) + (kVAR L3)
5030	kVAR L1	Individual Phase Reactive Energy LSW (kVARh) (signed)
5060	kVAR L2	"
5090	kVAR L3	"
5120	kVAR Demand System Max	System Maximum Instantaneous kVAR Demand (kVA, resettable). It displays the default value after a CAM until 1 demand window elapses. After a power cycle or CPU reset the value is not reset but it does not update again until 1 demand window elapses. (Unsigned/Absolute)
5130	kVAR Demand System Now	Average kVAR demand for most recent window (resettable). Displays the default value after a CAM or reset, or power cycle. Updates every min thereafter. True demand value takes a demand period to get to actual value. (Unsigned/Absolute)
6010	kVARh System	System Total Reactive Energy (Unsigned/Absolute)
6020	kVARh Sys Positive	System Total Reactive Energy (Signed Net)
6030	kVARh Sys Negative	"
6050	kVARh L1 Positive	Individual Phase Reactive Energy (kVARh) (Signed)
6060	kVARh L1 Negative	"
6080	kVARh L2 Positive	"
6090	kVARh L2 Negative	"
6110	kVARh L3 Positive	"
6120	kVARh L3 Negative	"
7000	kVAh System Total	System Total Apparent Energy (Unsigned/Absolute)
7020	kVAh L1 Positive	Individual Phase Apparent Energy LSW (kVAh) (Signed)
7030	kVAh L1 Negative	"
7050	kVAh L2 Positive	"
7060	kVAh L2 Negative	"
7080	kVAh L3 Positive	"
7090	kVAh L3 Negative	"
8000	kVA System	System Total Apparent Power (kVA). Unsigned absolute value of (kVA L1) + (kVA L2) + (kVA L3)
8001	kVA System Net	System Net Apparent Power (kVA). Signed net value of (kVA L1) + (kVA L2) + (kVA L3)
8010	kVA L1	Individual Phase Apparent Powers (kVA) (signed)
8020	kVA L2	"
8030	kVA L3	"

Object Identifier	Name	Description
8040	kVA Demand System Max	System Maximum Instantaneous kVA Demand (kVA, resettable). It displays the default value after a CAM until 1 demand window elapses. After a power cycle or CPU reset the value is not reset but it does not update again until 1 demand window elapses. (Unsigned/Absolute)
8050	kVA Demand System Now	Average kVA for most recent demand window (resettable). Displays the default value after a CAM or reset, or power cycle. Updates every min thereafter. True demand value takes a demand period to get to actual value. (Unsigned/Absolute)
9000	Displacement PF System	System Total Power Factor (PF) (Signed)
9030	Apparent PF System	System Total Power Factor (PF) (Signed)
9060	Displacement PF L1	Individual Phase displacement Power Factor (PF)
9090	Displacement PF L2	"
9120	Displacement PF L3	"
9150	Apparent PF L1	Individual Phase apparent Power Factors (PF)
9180	Apparent PF L2	"
9210	Apparent PF L3	"
10000	Measured Line Frequency	Line Frequency (Hz)
10010	Time Since Reset	Seconds since accumulator registers were reset.
10020	Data acquisition tick	A 1 millisecond counter that is used as a "heartbeat" to verify communications.
10140	Clear Accumulated Measurements	Writing 1234.0 to the present value will reset all the accumulator objects (kWh, kVAh, kVARh)
10150	PowerScout Element ID	Used to determine which element is being read & total number of elements available. Element index multiplied by 256 + number of elements.
10190	Communications protocol	Used to change between BACnet 2004 and Modbus communications protocols.
10200	Maximum number of MSTP masters	Maximum number of MS/TP masters on the bus (1-127). If network congestion / slowness is occurring reduce this to the highest numbered MAC address
10210	Maximum Info Frames	Value of max info frames specifies the maximum number of information frames that the node may send before it passes the token.
12000	CT Phase Shift	CT phase shift (degrees)
12010	CT Value	CT Value
12030	Pulse Scalar	Changes the scaling of the output pulses
12040	Demand Window	Demand window size in minutes; default is 15 min
12050	Volts Multiplier	Multiply volts values by this scalar. For use with stepdown transformer. Affects all parameters that use volts.
12060	Amps Multiplier	Multiply amps values by this scalar. For use with stepdown transformer. Affects all parameters that use amps.

Object Identifier	Name	Description
12070	Com Settings	Baud: 900=9600, 1900=19200, 3800=38400, 5700=57600, 7600=76800, 11500=115200 Parity: Add 00 = NO, Add 10 = ODD, Add 20 = EVEN Stop bit: Add 0 = 1 (UART does not permit 0 stop bits), Add 1 = 1, Add 2 = 2 e.g., 901 = 9600 baud, no parity, 1 stop bit
12080	Service Type	A value of 1 configures the meter for Delta. A value of 0 configures the meter for Wye.
12090	Line Frequency	Line frequency setting for metering. 50 = 50 Hz, 60 = 60 Hz, 400 = 400 Hz
12100	Snap mV Threshold	Snap to 0 threshold for millivolt CTs. BACnet value is percentage of CT rating.
12110	Snap Rogowski Threshold	Snap to 0 threshold for Rogowski CTs. BACnet value is percentage of Rogowski 3000A rating.
12120	Snap Volt Threshold	Snap to 0 threshold for volts. e.g. 10 is = 10 volts snap
12130	CT Type	1 = MilliVolt, 2 = Rogowski
13020	Output Port 1 Control	0 = output LOW (closed) 1 = output HIGH (open) (present value is set to default (1))
13030	Output Port 2 Control	0 = output LOW (closed) 1 = output HIGH (open) (present value is set to default (1))
13100	Pulse Output 1 Conf.	0 = No pulse output (kWh = 44001, kVARh=44011 or kVAh=44008)
13110	Pulse Output 1 Relay Type	0 = normally open (HIGH) 1 = normally closed (LOW)
13150	Pulse Output 2 Conf.	0 = no pulse output (kWh, kVARh or kVAh = Register number)
13160	Pulse Output 2 Relay Type	0 = normally open (HIGH) 1 = normally closed (LOW)

Configuration Objects (12000-13000)

Object Identifier	Name	Description
12000	CT Phase Shift	CT phase shift (degrees)
12010	CT Value	CT Value
12030	Pulse Scalar	Changes the scaling of the output pulses
12040	Demand Window	Demand window size in minutes; default is 15 min
12050	Volts Multiplier	Multiply volts values by this scalar. For use with stepdown transformer. Affects all parameters that use volts.
12060	Amps Multiplier	Multiply amps values by this scalar. For use with stepdown transformer. Affects all parameters that use amps.
12070	Com Settings	Baud: 900=9600, 1900=19200, 3800=38400, 5700=57600, 7600=76800, 11500=115200 Parity: Add 00 = NO, Add 10 = ODD, Add 20 = EVEN Stop bit: Add 0 = 1 (UART does not permit 0 stop bits), Add 1 = 1, Add 2 = 2

Object Identifier	Name	Description
		E.g., 901 = 9600 baud, no parity, 1 stop bit
12080	Service Type	A value of 1 configures the meter for Delta. A value of 0 configures the meter for Wye.
12090	Line Frequency	Line frequency setting for metering. 50 = 50 Hz, 60 = 60 Hz, 400 = 400 Hz
12100	Snap mV Threshold	Snap to 0 threshold for millivolt CTs. BACnet value is percentage of CT rating.
12110	Snap Rogowski Threshold	Snap to 0 threshold for Rogowski CTs. BACnet value is percentage of Rogowski 3000A rating.
12120	Snap Volt Threshold	Snap to 0 threshold for volts. e.g. 10 is = 10 volts snap
12130	CT Type	1=MilliVolt, 2=Rogowski

Writable Registers

Object Identifier	Name	Description
10140	Clear Accumulated Measurements	Writing 1234.0 to the present value will reset all the accumulator objects (kWh, kVAh, kVARh)
10190	Communications protocol	Used to change between BACnet 2004 and Modbus communications protocols.
10200	Maximum number of MSTP masters	Maximum number of MS/TP masters on the bus (1-127). If network congestion / slowness is occurring reduce this to the highest numbered MAC address
10210	Maximum Info Frames	Value of max info frames specifies the maximum number of information frames that the node may send before it passes the token.

Non-Writable Registers

Object Identifier	Name	Description
10150	PowerScout Element ID	Used for ViewPoint to determine which element is being read & total number of elements available. Element index multiplied by 256 + number of elements.
10030	Hardware ID	Hardware revisions.
10040	Features	New features.

Positive Power/Energy Accumulator Objects

Object Identifier	Name	Description
2010	kWh System Total Positive	System True Energy (kWh) Positive
1110	kW System Maximum Positive	System Highest Instantaneous Positive Draw Since Reset (kW)

Object Identifier	Name	Description
1140	kW System Minimum Positive	System Lowest Instantaneous Positive Draw Since Reset (kW, resettable)
2040	kWh L1 Positive	Individual Phase True Energy (kWh)
2070	kWh L2 Positive	"
2100	kWh L3 Positive	"
6010	kVARh System	System Total Reactive Energy
6050	kVARh L1 Positive	Individual Phase Reactive Energy (kVAR)
6080	kVARh L2 Positive	"
6110	kVARh L3 Positive	"
7020	kVAh L1 Positive	Individual Phase Apparent Energy LSW (kVAh)
7050	kVAh L2 Positive	"
7080	kVAh L3 Positive	"
1080	kW System Average Positive	Equals kWh System Positive / (Time Since Reset /3600 seconds/Hr) (resettable)

Negative Power/Energy Accumulator Objects

Object Identifier	Name	Detailed Description
2020	kWh System Total Negative	System True Energy (kWh) Negative
1120	kW System Maximum Negative	System Highest Instantaneous Negative Draw Since Reset (kW)
1150	kW System Minimum Negative	System Lowest Instantaneous Negative Draw Since Reset (kW, resettable)
2050	kWh L1 Negative	Individual Phase True Energy (kWh)
2080	kWh L2 Negative	"
2110	kWh L3 Negative	"
6030	kVARh Sys Negative	System Total Reactive Energy
6060	kVARh L1 Negative	Individual Phase Reactive Energy (kVARh)
6090	kVARh L2 Negative	"
6110	kVARh L3 Negative	"
7030	kVAh L1 Negative	Individual Phase Apparent Energy LSW (kVAh)
7060	kVAh L2 Negative	"
7090	kVAh L3 Negative	"
1090	Negative kW System Average	Equals kWh System Negative / (Time Since Reset /3600 seconds/Hr) (resettable)

BACnet Appendix B – Switching between BACnet and Modbus Mode

Changing Communication Mode Between Modbus and BACnet Using ViewPoint

Using ViewPoint is the preferred way to change communications modes between Modbus and BACnet.

Note that the baud rate and serial settings may need to change between Modbus and BACnet.

If communication fails, see the section *Changing Baud Rate or Communication Mode using address switches (between Modbus and BACnet)* below.

Changing the PowerScout 3 Plus from Modbus to BACnet mode:

1. Connect to the PowerScout 3 Plus using ViewPoint™.
2. Go to the Read/Write Registers tab in ViewPoint™.
3. Enter 44612 into the “Set Modbus Register” field.
4. In the “To Value:” field enter either 1833 to change to BACnet 2004 mode. Click on the “Set Modbus Register” button.
5. The status should say “Writing Register...”
6. Eventually the status should report “Communications Error”
7. At this point the PowerScout 3 Plus should be in BACnet mode. Connect using a BACnet client.

If the PowerScout 3 Plus is in BACnet mode:

Note that the user interface will differ on BACnet clients and may require other actions to write the present value property in the BACnet object.

Also note that the baud rate and serial settings may need to change between BACnet and Modbus.

If communication fails, see the section *Changing Baud Rate or Communication Mode using address switches (between Modbus and BACnet)* on the next page.

1. Connect to the PowerScout 3 using a BACnet client (RTU).
2. For object identifier 10190 (Communications protocol), write to the present value attribute: 375 (177 hex) to change to Modbus mode; 1833 (729 hex) to change to BACnet 2004 mode.
3. If changing to Modbus mode: This will cause a loss of communication between the BACnet client and the PowerScout 3 Plus. Connect using Viewpoint.

Changing Baud Rate or Communication Mode using address switches (between Modbus and BACnet)

Note that this is only required if *Changing Communication Mode using software (between Modbus and BACnet)* fails and the PowerScout 3 Plus needs to be returned to a particular communications protocol and baud rate.

1. Power down the PowerScout 3 Plus (disconnect all voltage leads).
2. Set the rotary “Network Address” switches to “F” & “F”.
3. Power up the PowerScout 3 Plus (connect the black & red voltage leads to power).
4. Set Switch 1 “Network Address Lower” to one of the following:

Network Address Switch 1 “Lower”	Communication Mode	Digital 1 LED	Digital 2 LED
1	Modbus*	Red On	Off
2	BACnet 2004	Off	Red On

*Factory Default

5. Next Set Switch 2 (“Network Address Upper”) to one of the following Baud Rates:

Network Address Switch 2 “Upper”	Baud Rate	PhaseChek™ LED L1	PhaseChek™ LED L2	PhaseChek™ LED L3
1	9600	Off	Off	Green
2	19200	Off	Green	Off
3	38400	Off	Green	Green
4	57600	Green	Off	Off
5	76800*	Green	Off	Green
6	115200	Green	Green	Off

*Factory Default

After powering up the PowerScout 3 Plus, you will have 10 seconds to make changes. However, every time a rotary switch is changed, the 10 second timer resets. After 10 seconds of no switch action, the settings take effect and the switches revert to the Modbus Address selector if in Modbus mode or MAC Address if in BACnet mode.

SECTION III: MODBUS METERS

SECTION III.A: Quick Start Guide (Modbus)



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



Haute tension peut être présente. Risque de choc électrique. Tensions dangereuses peuvent être présentes. Personnel qualifié uniquement.

1. Install the RS-485 driver on the computer using the accompanying CD. Connect the USB cable to the computer's USB port and to the RS-485 adapter.
 - See the section *Installing the RS-485 Adapter* for detailed instructions.
2. Using the CD included with the PowerScout™ 3 Plus, install the ViewPoint™ software onto the computer.
 - See the section *Installing the ViewPoint Software and Communicating with the PowerScout*.
3. Start ViewPoint™ and complete the following on the Communications screen: In the PC COM Port field, select the RS-485 isolated COM Port from the drop-down menu. Set the Modbus address to the desired address. The default Modbus Base Address Switches is set to 01, Data Bits is 8N1 and Baud Rate is 9600.
 - See *Section III.D: Using the ViewPoint Software* for additional information about setting the Modbus address.Set the computer aside.
4. Securely mount the PowerScout™ 3 Plus using the two mounting tabs at each end of the case.
5. Mount each current transformer (CT) on the wire to be monitored. Next, connect the CT leads to the terminal block on the PowerScout. Verify the CTs are correctly oriented on the wires with the orientation pointed toward the load (away from the breaker). Note that:
The CT on the L1 voltage phase wire is connected to the PowerScout's CT 1 input
The CT on the L2 voltage phase is connected to the CT 2 input
The CT on the L3 voltage phase is connected to the CT 3 input
 - Refer to the end of *Section III.C: Field Installation* to review common wiring diagrams.
6. Connect the voltage leads on the PowerScout 3 Plus to the appropriate voltage phases. Connect the neutral wire to the neutral bus or to ground if using a three-phase Delta service. The PowerScout is powered from L1 and L2 voltage connections.
7. Verify the PhaseChek™ LEDs are all flashing green.
8. Plug the RS-485 adapter into the PowerScout 3 Plus.

9. In ViewPoint™, on the **Communications** tab, click the **Connect** button to establish communication between the PowerScout 3 Plus and the computer.
10. On the **CT Values** tab configure the **CT Type** and **CT Amperage Rating**. Clear accumulated and demand data.
11. Select the **Real-time Values** tab for a table of current meter readings and verify the voltage, current and power readings are correct.
12. In ViewPoint, click the **Communications** tab and change communication settings, if necessary, for the RS-485 network.
13. Remove the RS-485 adapter from the PowerScout 3 Plus. Connect the PowerScout 3 Plus to the Modbus network.
14. Configure the RTU/data logging equipment to receive data from the PowerScout 3 Plus.
 - For more information on this step, consult the instruction manual for RTU/data logger.

PowerScout 3 Plus Diagram

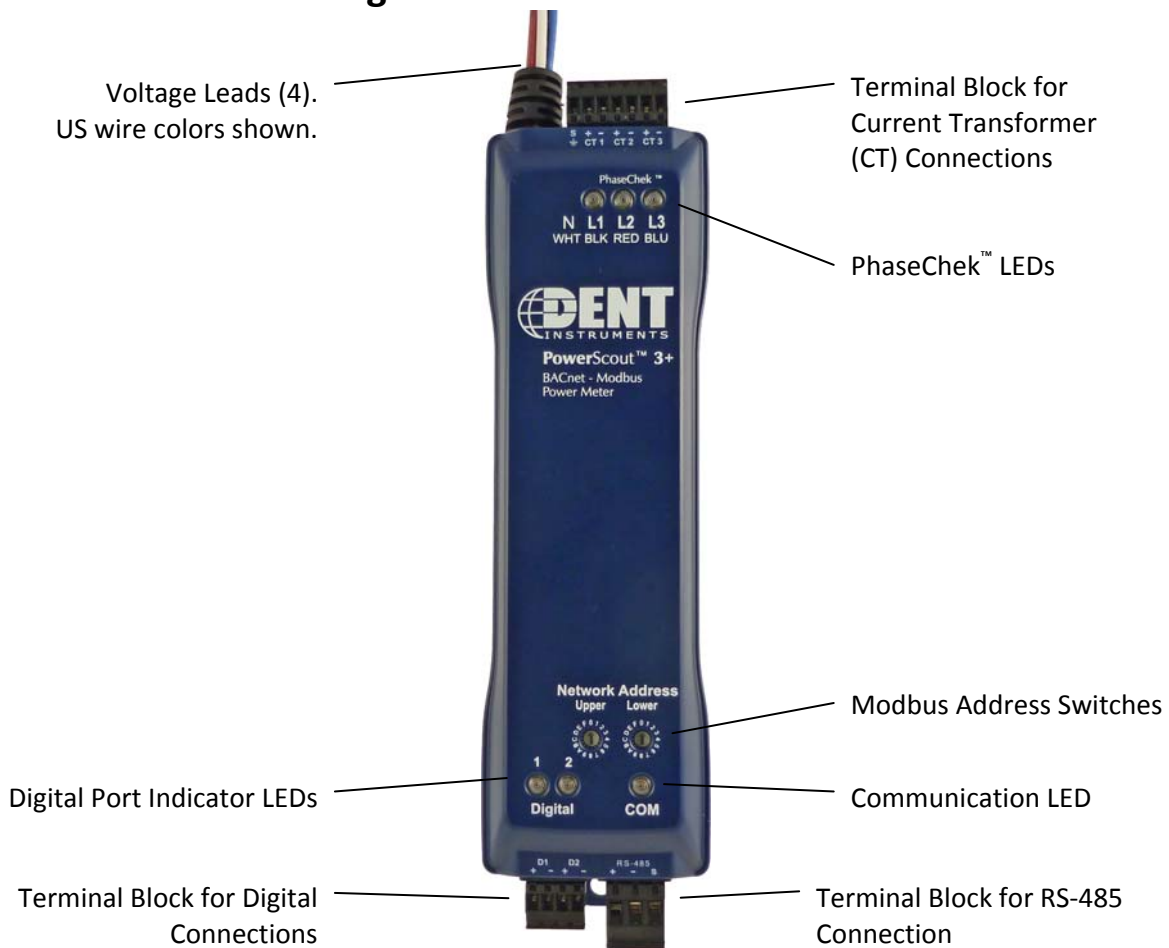


Figure III-1: PowerScout 3 Plus Layout

SECTION III.B: Before Installation of a Modbus Meter

Installation of the RS-485 adapter and the ViewPoint™ software can be completed and tested with the PowerScout™ 3 Plus prior to the field installation of the meter.

Installing the RS-485 Adapter to a Computer

1. Insert the CD that came with the USB to RS-485 adapter into your computer.
2. Plug the USB to RS-485 cable into a USB port on the computer with the other end inserted into the adapter. Refer to figure III-3 for the cable location on the adapter.

The **Found New Hardware Wizard** window appears.

3. The window states “This wizard helps you install software for: Model USOPTL4”, and asks “What do you want the wizard to do?”
4. Select **Install the software automatically** and click **Next**.
5. Click **Finish** when the installation is complete.
6. Remove the CD from your computer.
7. Verify that the dip switches on the back of the USB to RS-485 adapter are set to: RS-485, Echo Off, 2 Wire, 2 Wire as shown in Figure III-2.

The adapter is ready to be connected to the PowerScout 3 Plus.

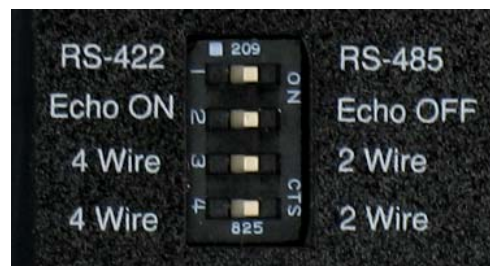
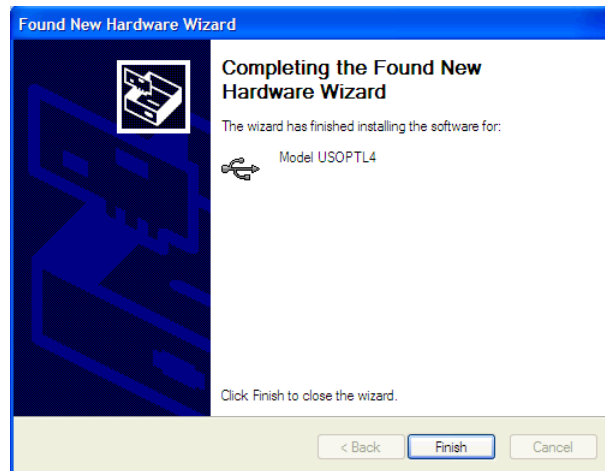
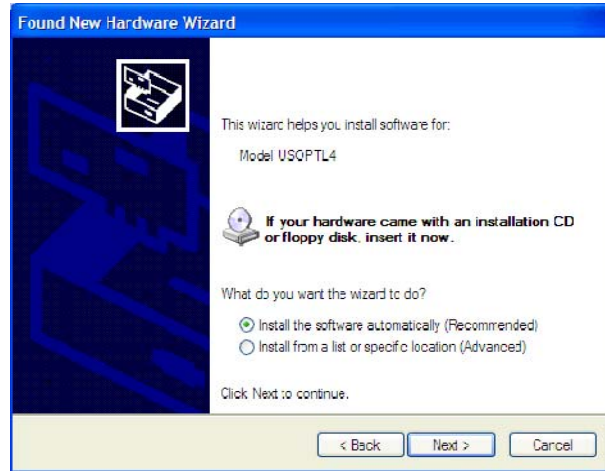


Figure III-2: Dip switches on back of RS-485 Adapter

Connecting the RS-485 Adapter to the PowerScout 3 Plus



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Haute tension peut être présente. Risque de choc électrique. Tensions dangereuses peuvent être présentes. Personnel qualifié uniquement.

To complete the connection between the PowerScout 3 Plus and the computer, the three wires coming from the RS-485 adapter are plugged into the PowerScout 3 Plus.

1. Insert each white ferrule into the appropriate RS-485 connection on the PowerScout. The red wire inserts in (+), the black wire in (-) and the green wire in GND.

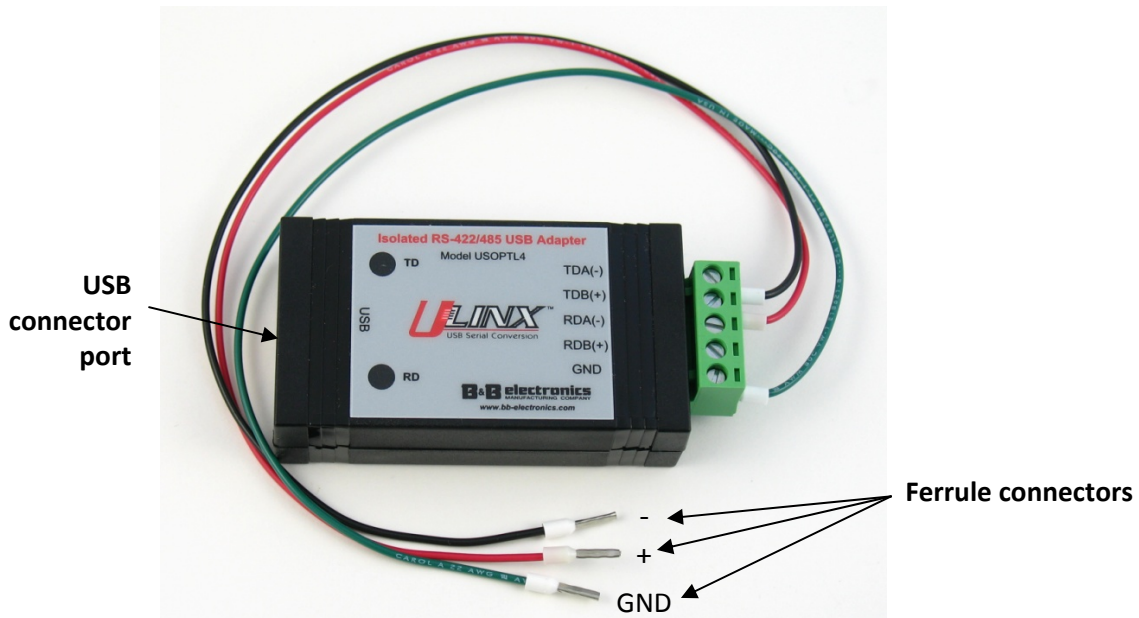


Figure III-3: RS-485 Adapter

This completes connecting the PowerScout 3 Plus to the computer using the RS-485 adapter.

Installing the ViewPoint Software and Communicating with the PowerScout 3 Plus

The ViewPoint software is designed to let you easily configure the PowerScout 3 Plus for different current transformers, check readings and verify correct setup. ViewPoint is compatible with Windows® 7 (32 or 64 bit), Vista (32 or 64 bit), XP or 2000.

1. Insert the ViewPoint CD into the CD-ROM drive.

The installer starts automatically. If it does not, browse to the CD and locate the ViewPointSetup.exe program. Start the installer by double-clicking ViewPointSetup.exe.

2. ViewPoint starts and displays the **Communications** tab that requires two values.

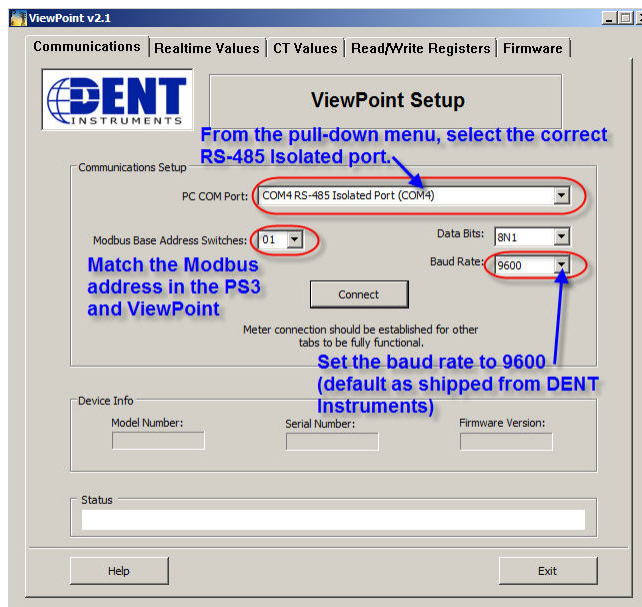
PC COM Port: Using the drop-down menu select **RS-485 isolated COM Port**.

If ViewPoint was installed first, it needs to be restarted following a RS485 driver installation. If a RS485 port does not appear in the drop-down menu, the RS-485 is not installed correctly.

Modbus Base Address Switches: Contains a hexadecimal value that should match the switches on the PowerScout. This field is pre-configured with the default value of **01**, matching the factory's default switch settings on the PowerScout. If these two values match your current configuration, this completes the Modbus Base Address setting.

The default settings are used for the two remaining fields: **Data Bits** is 8N1 and the **Baud Rate** is 9600.

NOTE: The RS-485 driver must be installed on your computer and power applied to the PowerScout.



3. Next click the **Connect** button to establish a connection between the computer and the PowerScout.
 - When the PowerScout is in the process of connecting to the computer, the COM LED flashes briefly followed by a solid green.

- If the PowerScout 3 Plus cannot connect to the computer, the COM LED flashes red and returns to a solid green. Change the ViewPoint hardware settings and click **Connect** again.

4. ViewPoint fills the **Device Info** fields when the computer communicates with the PowerScout 3 Plus.

This completes the ViewPoint software installation and establishing a connection with the PowerScout 3 Plus. For more information on using ViewPoint, see Section IV: *ViewPoint Software*.

COM – Communications LED

The PowerScout’s COM LED that signals the following communication information.

COM LED	Description
Steady ●	Power is applied to the PowerScout 3 Plus.
Flashing ●	PowerScout 3 Plus is communicating.
Steady ●	Communications failure.
Flashing ●	PowerScout 3 Plus is receiving communication on the bus for a PowerScout 3 Plus at another address.

Table III-1: COM LED Descriptions

Using ViewPoint

The PowerScout 3 Plus installation can be verified using ViewPoint. Refer to Section V, *Using the ViewPoint Software*, for more information.

SECTION III.C: Field Installation – Modbus



WARNING! REMOVE THE METER FROM ALL SOURCES OF VOLTAGE BEFORE MOUNTING.

Mounting the PowerScout™ 3 Plus

The PowerScout 3 Plus must be installed in an approved electrical panel or enclosure using proper installation practices according to the local electrical codes.

- To mount the PowerScout 3 Plus use the two tabs provided at each end of the case. Securely mount the PowerScout near a dedicated circuit disconnect breaker.

Connecting the PowerScout 3 Plus

The PowerScout 3 Plus has the following connections:

- A three-wire connector for the Modbus link.
- Four voltage wire leads for connecting to voltage sources (L1, L2, L3, and Neutral). The PowerScout 3 Plus is self-powered from L1 and L2.
- Up to three current transducers (CTs).

Completing the Wiring Connections – RS-485, Voltage Leads and CTs

1. Connect the RS-485 adapter to the computer using the USB cable by inserting each white ferrule into the appropriate opening on the PowerScout 3 Plus. The red wire inserts in (+), the black wire in (-) and the green wire in (S).
2. Connect the CTs on the PowerScout 3 Plus connections labeled CT 1, CT 2 and CT 3. Place the CTs on the phase wires of the load to be monitored and corresponding to the phase of the voltage leads. The CT labeled CT 1 must be placed on L1 phase voltage wire, CT 2 must be on the L2 voltage and CT 3 on the L3 voltage. Refer to *PhaseChek™* in Section III for information about the CT LEDs and verifying the CT installation.
3. Connect the PowerScout's 14 AWG THHN (or equivalent) wires, after a building-installed, dedicated circuit disconnect breaker, as close as possible to the breaker. Mark the breaker as the disconnect for the PowerScout 3 Plus. Refer to the wiring diagrams in this chapter for specifics of the wiring connections.

Note: *The PowerScout 3 Plus has an internal, non-user replaceable .5 Amp internal fuse protection.*

Follow local electrical codes during this installation.

Powering the PowerScout 3 Plus

The PowerScout 3 Plus is self-powered from the L1 and L2 lines. When 80 – 600VAC or DC is placed across the L1 and L2 wires, the three phasing LEDs begin to flash in sequence.

PowerScout 3 Plus Single-Phase Connections

The PowerScout 3 Plus can be used to monitor single-phase loads. There are several guidelines to keep in mind about this type of connection:

1. The PowerScout 3 Plus is powered from a potential between L1 and L2. This can be phase-to-phase (230V) or phase-to-neutral (115V). With a single-phase 230V panel, the L1 and L2 voltage leads are connected between the L1 and L2 voltage sources. With a 115V circuit, the L1 voltage lead is connected to the L1 “hot lead,” and the L2 voltage lead is connected to neutral.
2. Each CT must be paired with the correct voltage source. The current and voltage need to be in-phase for accurate measurements. For instance, CT 1 would monitor branch circuit supplied by voltage source L1, and so on.
3. The neutral must be connected because the PowerScout 3 Plus uses line-to-neutral measurements for all calculations.

On the US version of the PowerScout 3 Plus, the voltage leads are color coded: Black/L1, Red/L2, Blue/L3, and White/neutral. On international PowerScout 3 Plus instruments, the voltage leads are black and labeled L1, L2, L3, and N.

A Typical 230V Single-Phase Panel Setup

Connect the Black L1 voltage lead to Voltage L1, Red L2 voltage lead to L2 voltage, White Neutral voltage lead to neutral. CT1 would monitor L1 loads and CT2 would monitor L2 loads. Based on the above guidelines, CT3 can be used if the Blue L3 voltage lead is connected to either L1 or L2. As long as voltage lead L3 and CT3 are in-phase, the PowerScout 3 Plus will provide correct kW readings. If the Blue L3 voltage lead was connected to L2 voltage source, then CT3 could monitor any L2 branch circuit. Or, if the Blue L3 voltage lead was connected to L1 voltage source, then CT3 could monitor any L1 branch circuit.

A Typical 115V Single-Phase Panel Setup

Connect the Black L1 voltage lead to Voltage L1 (hot), Red L2 voltage lead to Neutral, and White N voltage lead to neutral. CT1 would monitor the L1 load. CT3 can be used if the Blue L3 voltage Lead is connected to L1. CT3 could then monitor any L1 branch circuit.

System Values

System values are the sum of L1 + L2 + L3 measurements. System values may not be meaningful since two different devices or loads can be monitored by a single PowerScout 3 Plus element.

When paired with the right voltage phase, each CT provides individual kW/kWh readings for that CT channel.

PhaseChek™

PhaseChek¹ is a unique feature of the PowerScout 3 Plus that simplifies installation by ensuring proper CT-to-phase installation and avoiding faulty data collection. The PowerScout 3 Plus automatically adjusts for CT orientation—reducing set-up time and nearly eliminating installation errors.

Verifying the PowerScout 3 Plus Setup Using the LEDs

The PowerScout 3 Plus has three bi-color PhaseChek LEDs. These LEDs provide the following information:

- All LEDs are green — the system power factor is greater than 0.55 and the CTs are properly placed on the corresponding voltage phases.
- Any one LED is red — there is a phasing connection error.
- Two LEDs are red and one is green — two CTs are reversed.
- All three LEDs are red —all CTs are incorrectly connected.

Note: If the total system power factor is less than 0.55, the LEDs will be red even if connected properly. This situation is rare but could occur if, for example, the load to be monitored is a lightly loaded electric motor where it is common for the power factor to be less than 0.55 and the corresponding LEDs will be red.

The following table describes the PhaseChek error conditions and the appropriate correction.

L1	L2	L3	Error Description	Correction
●	●	●	Setup is correct and the system power factor is greater than 0.55. -or- All CTs are disconnected.	Connect the CTs.
●	●	●	All CTs are incorrectly connected, -or- The system power factor is less than 0.55.	Rotate the CT connections by one position by move CT 1 to CT 2, CT 2 to CT3 and CT3 to CT1, until all LEDs are green. The system power factor is less than 0.55 but the CTs are connected properly indicating a light load.
●	●	●	CT 2 and CT 3 are reversed.	Switch the position of the CTs flashing red.
●	●	●	CT 1 and CT 2 are reversed.	Switch the position of the CTs flashing red.
●	●	●	CT 1 is swapped with either CT 2 or CT 3.	Switch CT 1 with CT 2. -or- Switch CT 1 with CT 3.
●	●	●	CT 2 is swapped with either CT 1 or CT 3.	Switch CT 2 with CT 1. -or- Switch CT 2 with CT 3.

¹ Patent No. 7,612,552. U.S. Patent and Trademark Office.

L1	L2	L3	Error Description	Correction
●	●	●	CT 3 is swapped with either CT 1 or CT 2.	Switch CT 3 with CT 1. -or- Switch CT 3 with CT 2.
●	●	●	CT 1 and CT 3 are reversed.	Switch the position of the CTs flashing red.

Table III-2: PhaseChek LED Error Resolution

Setting the Network Address Switches

There are two rotary network address switches on the PowerScout 3 Plus, labeled Upper and Lower. These two switches are used to select the Modbus address the client uses to communicate with the PowerScout.

The rotary switches are 16-position, hexadecimal switches. The default factory setting is hex 01. The network address is a hexadecimal (hex) value, represented by the digits 0 through 9 and letters A through F. For example, a Modbus address of 100 in decimal is converted to 64 hexadecimal and set on the PowerScout 3 Plus by:

1. Upper switch – select 6
2. Lower switch – select 4

Hexadecimal Address	Address Availability
00	Reserved for resetting the PowerScout 3 Plus to Modbus mode with 9600 baud, 8 bit, 1 stop bit, and no parity.
01-FE	Available (01 is the factory default setting).
FF	Reserved for the synchronize command. The rotary switches can be used to configure the communication protocol to BACnet 2004 or Modbus as well as changing the baud rate if unsure of the current settings.

Table III-3: Modbus Hexadecimal Address Availability

Establishing Communication (Modbus)

The PowerScout 3 Plus communicates with the RTU or data logger using the Modbus data protocol on a RS-485 hardware interface. To establish communication, the Modbus settings must meet the following requirements:

1. The Modbus address on the PowerScout 3 Plus and in the ViewPoint software must be set to the same value. Refer to Section III.D, *Using the ViewPoint Software* to set the Modbus address on the **Communications** tab and establish a connection.

2. The PowerScout's default serial parameters are:

Parameter	Setting
Baud	9600
Data bits	8
Parity	None
Stop Bit	1

Table III-4: Communication Settings

The supported baud rates include 9600, 19200, 38400, 57600 76800, and 115200.

3. The baud rate set in ViewPoint must match the PowerScout's setting. The baud rate can be changed from ViewPoint. If this setting is different, the PowerScout cannot communicate with ViewPoint.

PowerScout 3 Plus Wiring Diagrams

The PowerScout 3 Plus can be wired using any one of the following five common wiring setups. These diagrams will assist you in properly connecting your PowerScout for the setup desired. ALL WIRE COLORS ARE U.S. STANDARD.



WARNING! DO NOT EXCEED 600Vac PHASE TO PHASE CAT III.

When complete, close the enclosure cover, if equipped.



Attention: NE PAS DEPASSER UNE PHASE A 600VAC CAT III.

Une fois terminé, fermer le couvercle, s'il y en a un.



CAUTION: THE POWERSCOUT™ 3 Plus SHOULD ONLY BE WIRED BY QUALIFIED PERSONNEL. HAZARDOUS VOLTAGES EXIST.



ATTENTION: LE POWERSCOUT™ 3 PLUS NE DOIT ETRE BRANCHE QUE PAR UN PERSONNEL QUALIFIE. TENSIONS DANGEREUSES SONT PRÉSENTES.



DANGER! THE UNENCLOSED POWERSCOUT BOARD REQUIRES EXTRA CAUTION WHEN CONNECTING. LIFE THREATENING VOLTAGES EXCEEDING 600 VOLTS MAY EXIST ON THE BOARD. THE RISK OF SERIOUS INJURY OR DEATH SHOULD NOT BE UNDERESTIMATED.



DANGER! LA PLAQUETTE DE CIRCUITS IMPRIMES SANS COUVERCLE EXIGE UN REDOUBLEMENT DE PRUDENCE QUAND ON FAIT LA CONNEXION. LES TENSIONS DEPASSANT 600 VOLTS PEUVENT EXISTER SUR LA PLAQUETTE ET PEUVENT METTRE LA VIE EN DANGER. LE RISQUE DE BLESSURES GRAVES OU DE MORT NE DOIT PAS ETRE SOUS-ESTIME.

Figure IV-1: Single Phase, Two Wire



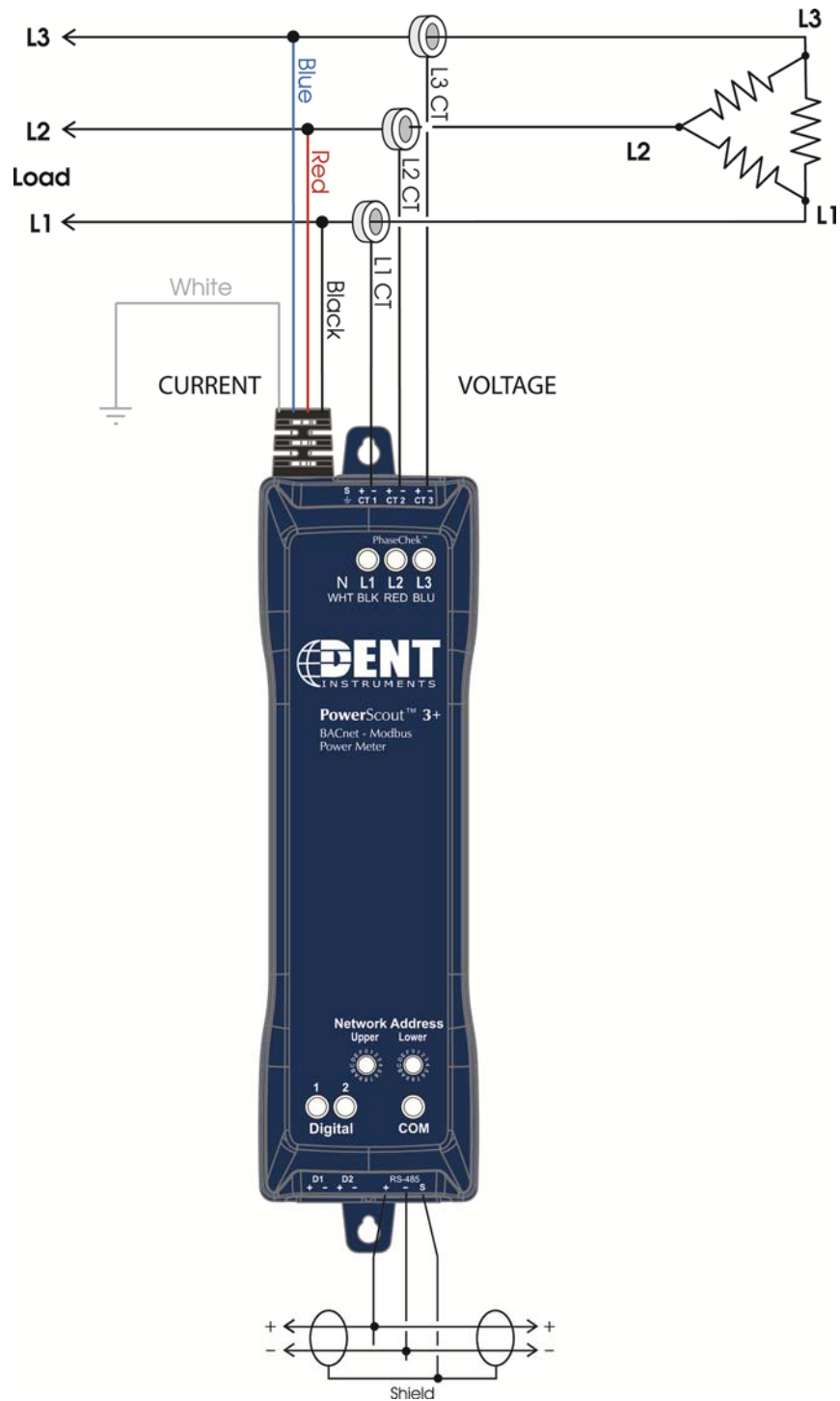
N = white
 L1 = black
 L2 = red
 L3 = blue

Figure IV-2: Single Phase, Three Wire



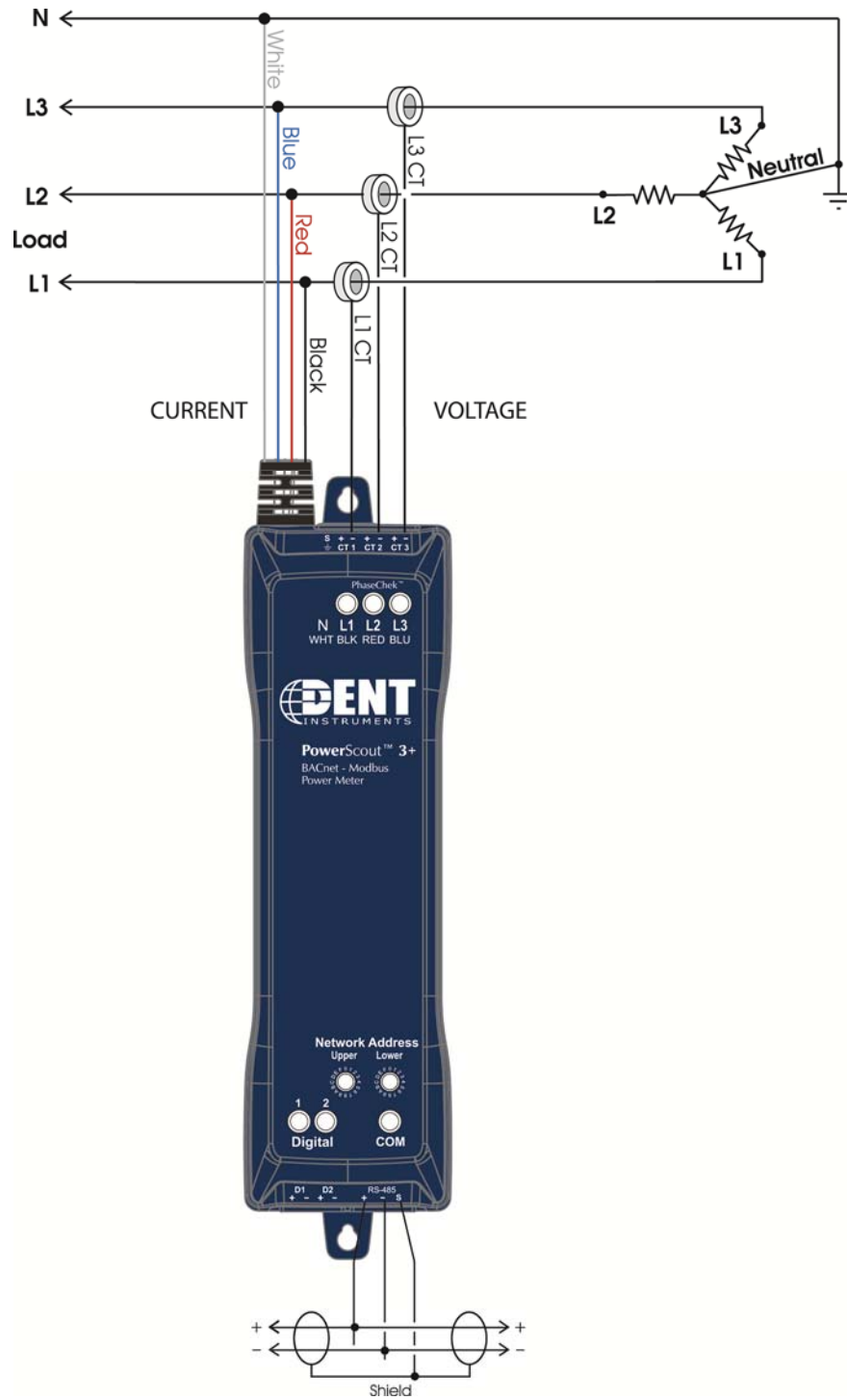
N = white
 L1 = black
 L2 = red
 L3 = blue

Figure IV-3: Three Phase, Three Wire Delta



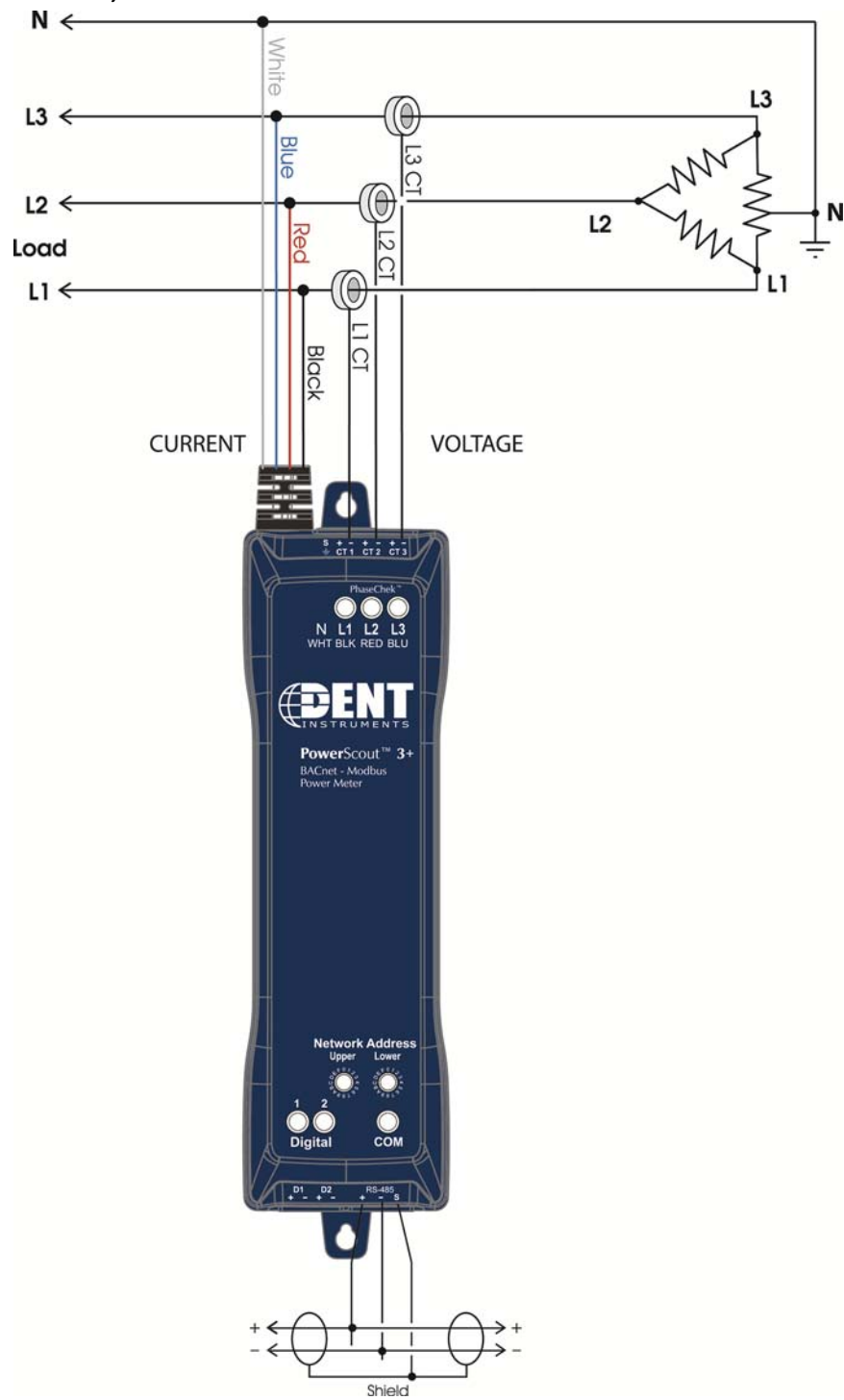
N = white
 L1 = black
 L2 = red
 L3 = blue

Figure IV-4: Three Phase, Four Wire Wye



N = white
 L1 = black
 L2 = red
 L3 = blue

Figure IV-5: Three Phase, Four Wire Delta



N = white
 L1 = black
 L2 = red
 L3 = blue

SECTION III.D: Using the ViewPoint™ Software (Modbus only)

For ViewPoint 2.1 and Later

Overview of the ViewPoint Screens

ViewPoint has five screens accessed by tabs. Click each tab to display the screen.

Communications

The **Communications** screen provides the setup parameters that allow ViewPoint to communicate with the PowerScout™ 3 Plus.

PC COM Port – Enter the port on the computer connected to the PowerScout 3 Plus. The field populates using the addresses entered to function as a drop-down menu.

Modbus Base Address Switches – Enter the Modbus address set on the PowerScout’s upper and lower Modbus address switches. Available are Modbus addresses from 01 (hex 01) to 254 (hex FE). The 00 setting is reserved for factory use.

Data Bits – Default setting is 8N1.

Baud Rate – Default setting 9600.

Click the **Connect** button to connect ViewPoint with the PowerScout. The **Device Info** section of the screen displays the **Model Number**, **Serial Number** and **Firmware Version** of the PowerScout.

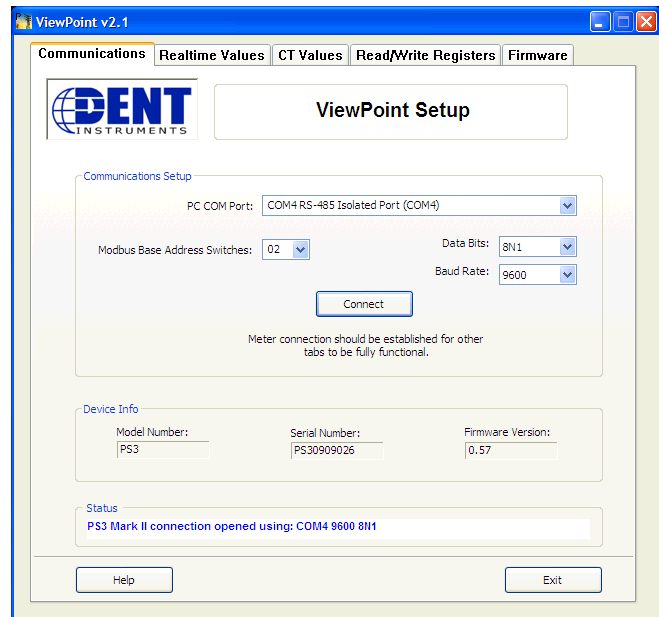
The **Status** window displays communication messages.

Communication Error

If ViewPoint is unable to communicate with the PowerScout, the **Status** window displays with the message “Error communicating with meter. Check settings and meter switches.” To resolve this communications error, try the following:

- No RS-485 option available in the **PC COM Port** drop-down menu - This indicates the PowerScout is not properly connected or the required software driver is not installed.
- **Modbus Base Address Switch** does not match the selected upper and lower switch settings on the PowerScout.
- The selected Baud Rate does not match the PowerScout’s baud rate.

For more information, refer to the Appendix *Troubleshooting Communication Issues*.



Real-time Values

The **Real-time Values** screen displays the current readings for verifying the system is configured properly.

Element – The PowerScout 3 Plus is a single meter and cannot be changed from Element A.

The table in the middle section of the screen displays the **Phase A**, **Phase B** and **Phase C** for the real-time values of Volts, Amps, KW and others for Phase A, Phase B and Phase C.

You may view, in real time, values such as **Volts**, **Amps** and **KW**. This screen also displays the current Data Scalar Value, the CT Type connected to the PowerScout 3 Plus and CT Value.

Data Scalar – A scalar is used to multiply the raw data value to convert information read from the Modbus registers. Refer to Table III-1 for a list of values. Example: If the scalar value in register 44602 is set to 3 and the total true power for the system (kW) is read from Modbus register 44003 (Offset 4002) and a value of 3465 is returned, the true system kW is:

$$3465 \times 0.1 = 346.5 \text{ kW}$$

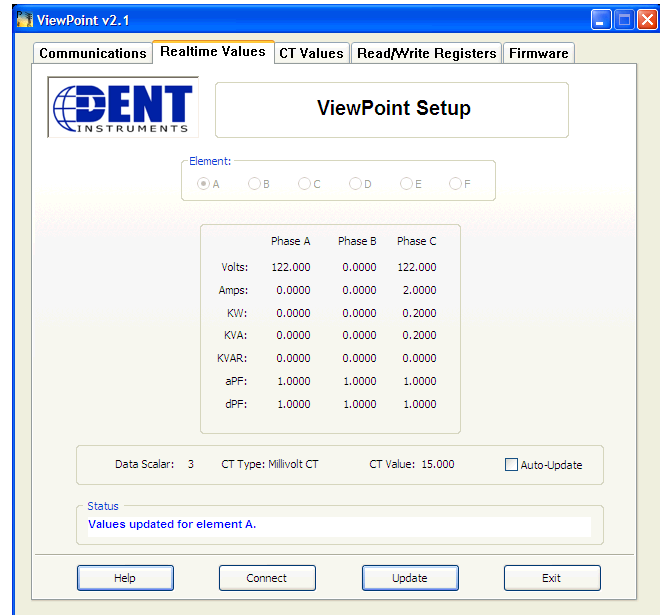
CT Type – Displays the CT selected on the **CT Values** screen. This needs to match the CT connected to the PowerScout.

CT Amperage Rating – Displays the amperage rating entered on the **CT Values** screen.

Auto Update – Select the checkbox to automatically update approximately every 15 seconds.

Update button retrieves the values from the PowerScout 3 Plus.

The **Status** window displays communication messages.



CT Values

The **CT Values** screen allows the type of current transformer (CT) and the amperage rating to be changed.

Set – Select the checkbox to send the settings to the meter.

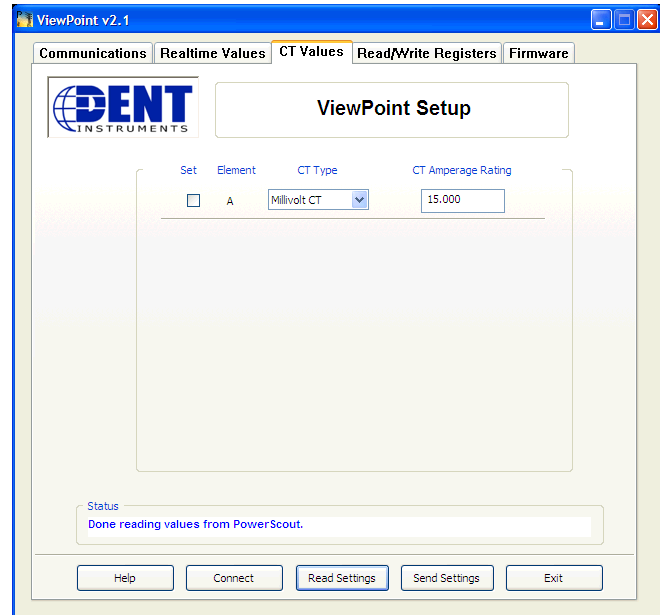
Element – Indicator for the meter to send settings to. The PowerScout 3 Plus is a single meter so only Element A is available.

CT Type – Use the drop-down menu to select the type of CT attached to the PowerScout.

CT Amperage Rating – Enter the amperage rating.

Read Settings button – Reads the values from the PowerScout.

Send Settings button – Sends the settings specified in ViewPoint to the meter with the Set checkbox selected.



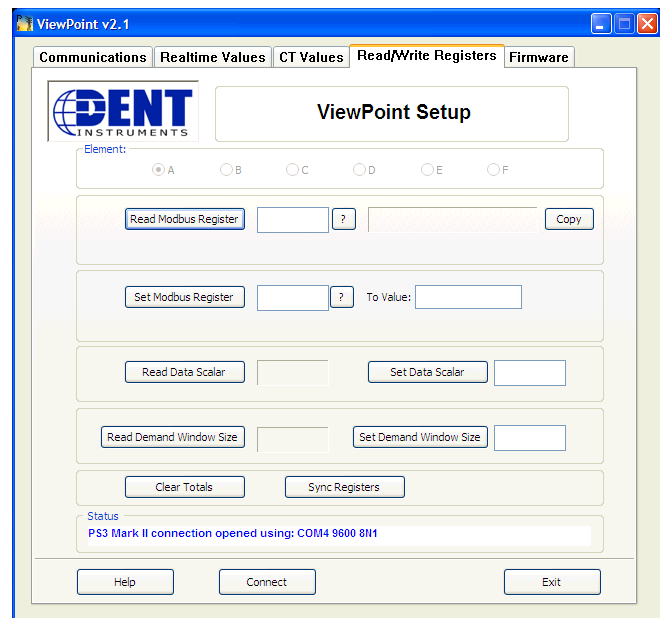
Read/Write Registers

The **Read/Write Registers** screen provides diagnostic and special configuration options, allowing the changing or viewing of the value of any PowerScout registers. Its use is not required for a basic setup.

Element - The PowerScout 3 Plus is a single meter and cannot be changed from Element A.

Read Modbus Register - Reads a specified Modbus register by typing the register address in the box and pressing the button. Use the **Copy** button to copy the register address to the box next to the **Set Modbus Register** button. The **?** button provides a list of common registers. Refer to the **Register Picker** menu below.

Set Modbus Register – Enter a register address to write to. In the **To Value** box, type the value to write to the register address. The **?** button provides a list of common registers.



Read Data Scalar – Retrieves the PowerScout’s data scalar setting. For more information about Data Scaling, see *Interpreting the PowerScout Registers—Data Scaling* section of this manual.

Set Data Scalar – Sends the data scalar setting to the PowerScout.

Read Demand Window Size – Read the demand window size setting on the PowerScout.

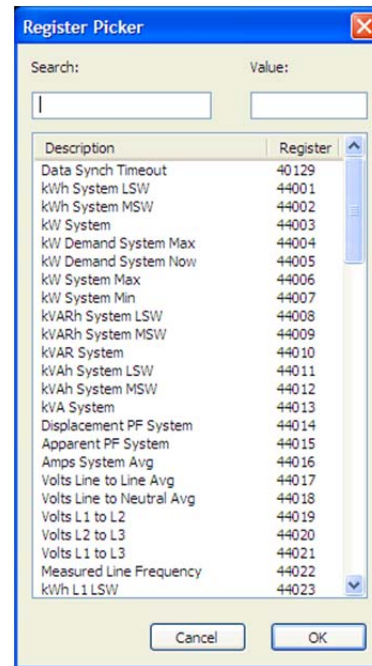
Set Demand Window Size – Set the demand window size. The window can be between 1 and 60 minutes.

Clear Totals – Clears accumulated data.

Sync Registers – Locks all register readings for a maximum of one hour. Data is still continuously collected in the background.

The final section states the status of the logger.

Refer to Appendix E for a list of Modbus registers and their descriptions.



Firmware

The **Firmware** screen verifies the current firmware version and updates the PowerScout 3 internal firmware.

Element - The PowerScout 3 Plus is a single meter and cannot be changed from Element A.

Firmware Update File – The file containing the new firmware version can be entered using the box or located with the **Browse** button.

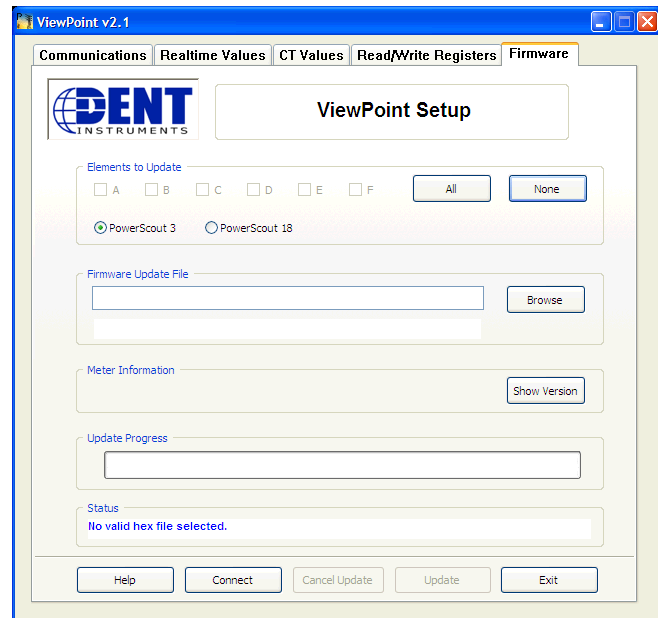
Meter Information – To verify the current firmware version of the PowerScout Plus, click the **Show Version** button. The firmware version information displays.

Update Progress – Displays the installation progress of the new firmware version.

Status - Provides the status of the meter.

Cancel Update button – Cancels a firmware update while it is in progress.

Update button – Starts the firmware update.



ViewPoint Buttons

The ViewPoint screens include a row of buttons at the bottom. The available buttons vary depending on the current screen.

Cancel Update— Cancels a firmware update while it is in progress.

Connect – Establishes a connection between ViewPoint and the PowerScout 3 Plus. If a connection is not established, a message displays in the **Status** window.

Help – Displays the help information for the current screen. The help information uses a web browser to display the information for the current screen.

Exit – Closes the ViewPoint software.

Read Settings – Reads the current values from the PowerScout 3 Plus.

Send Settings – Sends new settings set in the ViewPoint screen to the PowerScout 3 Plus.

Update – On the **Real-time Values** screen, the **Update** button retrieves the values from the PowerScout 3 Plus. On the **Firmware** screen, the **Update** button starts the installation of the new firmware.

Communication and Status Messages

Refer to Appendix D, *Troubleshooting Communication Issues*.

Using ViewPoint to Verify Setup

ViewPoint can be used to verify the connection setup of the PowerScout 3 Plus.

1. Start the ViewPoint software.
2. Select the PowerScout 3 Plus settings on the **Communications** screen and click the **Connect** button. The Status window displays the message “PS3 Mark II connection opened using: COM4 9600 8N1”, when communication is established.
3. Click the **Real-time Values** tab and click the **Update** button.

Note: *The status message displays the communication parameters specific to the setup.*

The table in the middle of the screen updates. The values display for Volts, Amps, KW, etc., and should make sense, meaning the values in the table are relevant for the service being measured. This indicates the PowerScout 3 Plus is verified.

It may also be useful to use a handheld amp meter to test the current and compare its readings to the values provided on the **Real-time Values** screen in ViewPoint.

SECTION III.E: Other Functions – Modbus

Resetting Modbus Registers

Many of the PowerScout™ 3 Plus registers are real-time values such as instantaneous watts or power factor. However, some registers are accumulated values such as kWh, kVARh, kVAh and various Peak Demand (kW) values.

Accumulating registers can be reset using the ViewPoint™ **Read/Write Registers** screen.

1. In the data entry box next to the **Set Modbus Register** button, enter or select 44066. This is Modbus register, Reset Acc Measurements.
2. In the **To Value** box type 1234.
3. Click the **Set Modbus Register** button. The accumulating registers are reset to 0.

The tables in Appendix E list all of the data registers available on the PowerScout. Note that following the Modbus protocol, the actual register address requested is offset from the base Modbus register by 40001.

Data Scaling – Interpreting the PowerScout 3 Plus Registers

The use of Modbus protocols limits the data registers to a maximum of two bytes (16 bits) or a maximum decimal value of 65535. Modbus requires that the data be unsigned (positive) integer values. To overcome these limitations some measured (and stored) values must be *scaled* to fit into the Modbus registers. The raw value read from the Modbus registers is multiplied by a scalar to convert the raw data. The following table lists the data scalars and the respective values for the PowerScout.

Data Scalar	Scalar Value					
	kW/kWh Demand	kVAR/kVARh	kVA/kVAh	Power Factor	Amps	Volts
0	.00001	.00001	.00001	.01	.01	.1
1	.001	.001	.001	.01	.1	.1
2	.01	.01	.01	.01	.1	.1
3	.1	.1	.1	.01	.1	.1
4	1	1	1	.01	1	1
5	10	10	10	.01	1	1
≥6	100	100	100	.01	1	1

Table III-5: Data Scalars and Values for Registers 44001 thru 44061

The data scalar is stored in register 44602.

When selecting a data scalar, the following guidelines need to be considered:

- If the data scalar selected is too low, an incorrect data result is returned from the register.
- If the data scalar selected is too high, the significant digits following the decimal point are removed.

After selecting a data scalar, the formula for calculating the actual value is:

$$\text{register value} \times \text{scalar value} = \text{actual value}$$

Or, another way to state this formula is:

$$\text{actual value} / \text{scalar value} = \text{register value}$$

NOTE: The register value must be less than 65,535.

Selecting a Scalar

The following table is an example when selecting a data scalar for 3-phase loads based on the CT size or maximum current. These are the minimum recommended scalar settings.

CT Size or Max. Current	3-phase Loads	
	230 volts	460 volts
50	Scalar 1	Scalar 2
100	Scalar 2	Scalar 2
200	Scalar 2	Scalar 2
400	Scalar 2	Scalar 2
600	Scalar 2	Scalar 3
1000	Scalar 3	Scalar 3
3000	Scalar 3	Scalar 3

Table III-6: Data Scalar Selection

Examples Using a Data Scalar

The following examples use kW throughout.

For example 1, the following data is used:

$$\text{Volts} \times \text{amps} = \text{watts}$$

$$480 \text{ volts} \times 100 \text{ amps} = 48,000 \text{ watts}$$

$$\text{Watts} \times 3 = \text{system watts}$$

$$48,000 \text{ watts} \times 3 = 144,000 \text{ watts (144kW)}$$

Check the register's value using the data scalar 2 value of .01:

$$\text{System kW} / \text{scalar value} = \text{register value}$$

$$144\text{kW} / .01 = 14,400$$

Since 14,400 is less than 65,535, using data scalar 2 is a good choice for this example.

For example 2, the following data is used:

$$480 \text{ volts} \times 1000 \text{ amps} = 480,000 \text{ watts}$$

$$480,000 \text{ watts} \times 3 = 1,440,000 \text{ watts (1,440kW)}$$

Check the register's value using the data scalar 1 value of .001:

$$1,440\text{kW} / .001 = 1,440,000$$

Since 1,440,000 is greater than 65,535, using data scalar 1 returns an incorrect result. Data scalar 1 is not an appropriate choice.

Reviewing this example using the data scalar 3 value of .1 provides the following result:

$$1,440\text{kW} / .1 = 14,400$$

Since 14,400 is less than 65,535, using data scalar 3 is a good choice for this example.

Values Requiring Two Registers

Additionally, some values (e.g., kilowatt hours) may cover a dynamic range that is larger than 65535 and require two Modbus registers. Any parameter in the Modbus Register Assignment tables, in Appendix D, that shows two registers (identified by the terms MSW (Most Significant Word) and LSW (Least Significant Word)) are examples of this wide-ranging parameter.

To interpret the values contained in these registers, the steps are:

1. Multiply the MSW register by 65536.
2. Add the result to the value found in the corresponding LSW register.
3. Multiply the result by the appropriate scalar value from Table IV-1.

For example, assume that System Total True Energy (kWh) is desired and the value of 5013 is read from register 44001 (LSW) and 13 is read from register 44002 (MSW) and that the register 44602 data scalar is set to 3.

To calculate the total kWh recorded:

Multiply the MSW by 65536: $13 \times 65536 = 851968$

Add the LSW: $851968 + 5013 = 856981$

Multiply by the scalar 3 value of 0.1: $856981 \times 0.1 = 85698.1 \text{ kWh}$

TECH TIP: When reading two register values, ViewPoint automatically calculates the total value.

Pulse Output Port Function

The PowerScout 3 Plus has two configurable output ports. The ports can be used to output kWh, kVARh, or kVAh pulses to external devices, or to toggle on and off to control a remote device or relay.

Pulse Output

Pulse output is used to generate pulses for external devices such as data loggers that can accept pulses but do not have Modbus capability. The PowerScout 3 Plus can generate pulses based on accumulated value(s) such as system kWh, system kVARh, and system kVAh. When a pulse is generated by the PowerScout, the orange and LED for that output will briefly flash, otherwise they will remain dark.

The pulse output is scaled by the same data scalar register (44602) as are the Modbus registers. For example, when the data scalar is set to 3, each pulse will represent .1 kWh, .1kVAh and .1kVARh.

For system pulse output:

kWh pulse output – write 44001 into the Digital Port Configuration register.

kVAh pulse output – write 44011 into the Digital Port Configuration register.

kVARh pulse output – write 44008 into the Digital Port Configuration register.

Output Port Registers

Refer to the following two tables to configure the PowerScout's two digital output ports.

Modbus Register	Offset	Register Name	Detailed Description
44402	4401	Port 1 output control when used as an on/off - open/closed switch	0 = output LOW (closed) 1 = output HIGH (open) [default] Register 45110 must = 0 to use
45110	5109	Digital Port 1 Configuration Turns pulses on/off	0 = No pulses, Port may be used as an on/off – open/closed switch 44001 = System kWh pulses 44008 = System kVAh pulses 44011 = System kVARh pulses
45111	5110	Port 1 pulse output relay type	0 = normally open (HIGH) 1 = normally closed (LOW)

Table III-7: Digital Port 1 Pulse Output

Modbus Register	Offset	Register Name	Detailed Description
44403	4402	Port 2 output control when used as an on/off - open/closed switch	0 = output LOW (closed) 1 = output HIGH (open) [default] Register 45210 must = 0 to use
45210	5209	Digital Port 2 Configuration Turns pulses on/off	0 = No pulses, Port may be used as an on/off – open/closed switch 44001 = System kWh pulses 44008 = System kVAh pulses 44011 = System kVARh pulses
45211	5210	Port 2 pulse output relay type	0 = normally open (HIGH) 1 = normally closed (LOW)

Table III-8: Digital Port 2 Pulse Output

Lock/Synchronize Function

Multiple PowerScout 3 Plus meters can be installed on a single Modbus network. A snapshot of the power or voltage can be obtained simultaneously for meters on a network. Usually, the RTU reads the values from each meter sequentially, thus readings from meters can vary by several seconds.

The Lock/Synchronize function allows reading from multiple meters at the same time. To use this function, a write command is sent to all meters using a common broadcast Modbus address, FF. All meters on the network receive the command simultaneously. This freezes, or locks the current readings into the Modbus registers. Now the RTU can take read each register, one after another, knowing the retrieved values were recorded just before the lock command was sent by the RTU. The command contains the number of seconds, timeout, needed to read from the meters.

Note: During the lock period, no data is lost. The meter continues to gather and record data during the timeout. The values are held in internal memory. At the end of the lock period, these values are moved into the appropriate Modbus register, ensuring no energy measurements are lost during synchronization.

Using the Lock/Synchronize Command

1. Send a standard write command for register 40129 (offset 128) with a data value that includes the number of seconds to remain locked, also known as the timeout value. The maximum timeout value is one hour (3600 seconds).
If the provided timeout value is longer than needed, it can be canceled once all the registers are read.
2. Read all the registers needed for the snapshot.
3. Wait until the number of requested seconds has passed or send another write command to register 40129 (offset 128) with a value of zero which cancels the lock. Now the meters begin updating.

Note: For decimal-based equipment refer to Appendix A for a hexadecimal conversion table.

Connecting to a Modbus Network

This section describes setting up a Modbus network with multiple PowerScouts using the Modbus serial communication protocol. A network can support up to 254 PowerScout 3 Plus instruments.

Modbus Communication Protocol

Modbus is a standard communications protocol that allows for communication between a Modbus master and multiple devices connected to the same network. RS-485 is the protocol standard used by the PowerScout 3 Plus as the hardware's serial interface while Modbus is the communication protocol.

Daisy Chain Layout for RS-485 Network

When multiple devices are connected to a single Modbus master device, the multiple devices need to be connected in a daisy chain. A daisy chain means that all plus (+) connections are chained together and all minus (-) connections are chained together across the network.

A Modbus network containing multiple devices requires a unique address for each device. This allows the master device to identify and communicate with each slave. The Modbus network administrator must assign an unique Modbus address to each PowerScout 3 Plus.

Other network layouts are not recommended when using the RS-485 standard.

Networking Using the Modbus Option

1. Install the Modbus cable.
2. Set a unique Modbus address for each device using the table in Appendix A. Locate the number of the slave device in the "Decimal" column. Move right to the "Hex" column to find the converted address value of this device. For example, for device 1, the upper Modbus address switch is set to 0, the lower Modbus address switch is set to 1.

SECTION III.F: Appendices – Modbus

Modbus Appendix A – VERIS H8035/H8036 Emulation

The PowerScout™ 3 Plus meter can be used as a direct replacement for the Veris, Inc. H8035/H8036 series of networked power meters. This mirroring of the Veris Modbus register assignments makes replacement with a PowerScout 3 Plus simple. However, because the number of parameters that the Veris meters measure is less than half of what the PowerScout 3 Plus can measure, the other Modbus registers described in the table need to be used to utilize the additional capabilities of the PowerScout 3 Plus.

Writing a 1 to register 44526 sets the Slave ID to Veris mode and ViewPoint™ lists the Veris registers in the ViewPoint **Read/Write Registers** tab.

When register 44526 contains a 1 for Veris mode, the Slave ID command format is:

91hFFh(Veris type), Full-Data, Modbus, (CT value) Amp

The following is an example command with CT set for 100A:

91hFFhVeris H8036-0100-2, Full-Data, Modbus, 100 Amp

Example command explanation:

- 91h = version control
- FFh = standard for active

The 91h and FFh are 4 bytes in front of the string that are not displayed in the RTU.

CT Amperage Rating	Veris Model Number
CT ≤ 100A	Veris Type = H8036-0100-2 CT Value = 100A
100A < CT ≤ 300A	Veris Type = H8036-0300-2 CT Value = 300A
300A < CT ≤ 400A	Veris Type = H8036-0400-3 CT Value = 400A
400A < CT ≤ 800A	Veris Type = H8036-0800-3 CT Value = 800A
800A < CT ≤ 1600A	Veris Type = H8036-1600-4 CT Value = 1600A
CT >1600A	Veris Type = H8036-2400-4 CT Value = 2400A

Table B-1: CT Amp Rating to Veris Models

Modbus Register	Offset	ViewPoint Name	Description
40001	0	kWh System LSW	System True Energy (kWh, Resettable)
40002	1	kWh System MSW	System True Energy (kWh, Resettable)

Modbus Register	Offset	ViewPoint Name	Description
40003	2	kW System	System True Power (kW)
40004	3	kVAR System	System Reactive Power (kVAR)
40005	4	kVA System	System Apparent Power (kVA)
40006	5	Apparent PF System	System Apparent Power Factor (PF)
40007	6	Volts Line to Line Avg	Average Line to Line Voltage
40008	7	Volts Line to Neutral Avg	Average Line to Neutral Voltage
40009	8	Amps System Avg	Average current of all phases
40010	9	kW L1	Individual Phase True Powers (kW, 3 values)
40011	10	kW L2	"
40012	11	kW L3	"
40013	12	Apparent PF L1	Individual Phase Apparent Power Factors (PF, 3 values)
40014	13	Apparent PF L2	"
40015	14	Apparent PF L3	"
40016	15	Volts L1 to L2	Individual Phase to Phase Voltages (Volts, Delta, 3 values)
40017	16	Volts L2 to L3	"
40018	17	Volts L1 to L3	"
40019	18	Volts L1 to Neutral	Individual Phase to Neutral Voltages (Volts, Wye, 3 values)
40020	19	Volts L2 to Neutral	"
40021	20	Volts L3 to Neutral	"
40022	21	Amps L1	Individual Phase Currents (Amps, 3 values)
40023	22	Amps L2	"
40024	23	Amps L3	"
40025	24	kW System Avg	Equals KWH_SYSTEM_L&M ÷ (TimeSinceReset_L&M seconds /3600 seconds/Hr) (resettable)
40026	25	kW Demand System Min	System Minimum Demand (kW, resettable), It displays the default value after a CAM until 1 demand window elapses. After a power cycle or CPU reset the value is not reset but it does not update again until 1 demand window elapses.
40027	26	kW Demand System Max	System Max Demand (kW, resettable). Behaves as 40026.

Table B-2: ViewPoint Register Descriptions

Address	Units	≤ 100A	101 – 400A	401 – 800A	801 – 1600A	1601 – 32,000A
40001	kWH LSB	7.8125exp-3	0.03125	0.0625	0.125	0.25
40002	kWH MSB	512	2048	4096	8192	16384
40003	kW	0.004	0.016	0.032	0.064	0.128
40004	kVAR	0.004	0.016	0.032	0.064	0.128

Address	Units	≤ 100A	101 – 400A	401 – 800A	801 – 1600A	1601 – 32,000A
40005	kVA	0.004	0.016	0.032	0.064	0.128
40006	aPF	3.0518exp-5	3.0518exp-5	3.0518exp-5	3.0518exp-5	3.0518exp-5
40007	VOLTS L-L	0.03125	0.03125	0.03125	0.03125	0.03125
40008	VOLTS L-L	0.015625	0.015625	0.015625	0.015625	0.015625
40009	AMPS	3.9063exp-3	0.015625	0.03125	0.0625	0.125
40010	kW L1	0.001	0.004	0.008	0.016	0.032
40011	kW L2	0.001	0.004	0.008	0.016	0.032
40012	kW L3	0.001	0.004	0.008	0.016	0.032
40013	aPF L1	3.0518exp-5	3.0518exp-5	3.0518exp-5	3.0518exp-5	3.0518exp-5
40014	aPF L2	3.0518exp-5	3.0518exp-5	3.0518exp-5	3.0518exp-5	3.0518exp-5
40015	aPF L3	3.0518exp-5	3.0518exp-5	3.0518exp-5	3.0518exp-5	3.0518exp-5
40016	VOLTS L1-L2	0.03125	0.03125	0.03125	0.03125	0.03125
40017	VOLTS L2-L3	0.03125	0.03125	0.03125	0.03125	0.03125
40018	VOLTS L3-L1	0.03125	0.03125	0.03125	0.03125	0.03125
40019	VOLTS L1-N	0.015625	0.015625	0.015625	0.015625	0.015625
40020	VOLTS L2- N	0.015625	0.015625	0.015625	0.015625	0.015625
40021	VOLTS L3- N	0.015625	0.015625	0.015625	0.015625	0.015625
40022	AMPS L1	3.9063exp-3	0.015625	0.03125	0.0625	0.125
40023	AMPS L2	3.9063exp-3	0.015625	0.03125	0.0625	0.125
40024	AMPS L3	3.9063exp-3	0.015625	0.03125	0.0625	0.125
40025	kW	0.004	0.016	0.032	0.064	0.128
40026	kW	0.004	0.016	0.032	0.064	0.128
40027	kW	0.004	0.016	0.032	0.064	0.128

Table B-3: Veris Multipliers for Integer Registers 40001-40027

Per the Veris implementation, to obtain true engineering units, the values returned from the registers in Table B-2 must be multiplied by the scaling values listed in Table B-3.

For example, if the PowerScout 3 Plus has 100A CTs connected to it, the system reactive power (kVAR) is calculated by:

- Read register 40004
- Multiply the value returned from register 40004 by 0.004

Modbus Appendix B – Installing Firmware Updates for the PowerScout™ 3 Plus

PowerScout 3 Plus firmware updates are available from DENT Instruments, typically contained in a zip file that can be downloaded, unzipped and installed using ViewPoint™. The PowerScout 3 Plus requires ViewPoint 2.1 or later.

Contact DENT Instruments to obtain access to a firmware update at:

Phone: 541-388-4774 or 1-800-388-0770

Email: info@DENTinstruments.com

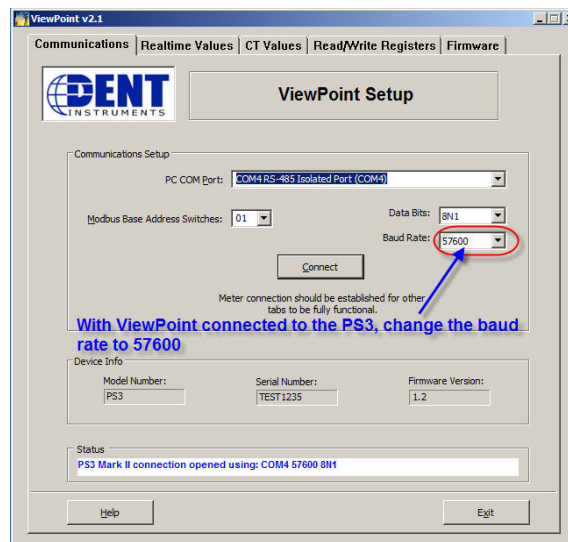
A username and password obtained from DENT Instruments is required to download firmware.

NOTE: The PowerScout 3 Plus must be in Modbus mode before firmware can be updated.

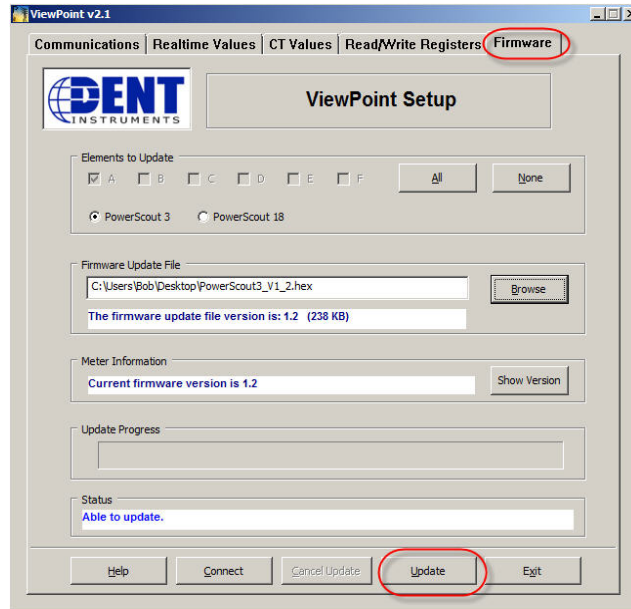
Downloading and Installing Firmware

1. Download the zip file containing the firmware. Extract the zip file to a folder on the computer.
2. Connect the computer to the PowerScout 3 Plus. Refer to Section III, *Installing the ViewPoint Software and Communicating with the PowerScout* for additional information.
If connectivity fails with the 9600 baud rate, refer to the *Troubleshooting* section at the end of this appendix.
3. Select the baud rate for loading the firmware to the PowerScout 3 Plus.
A baud rate of 9600 downloads the firmware to the PowerScout 3 Plus in approximately six minutes. A faster baud rate can be selected to reduce the time by approximately 2.5 minutes.

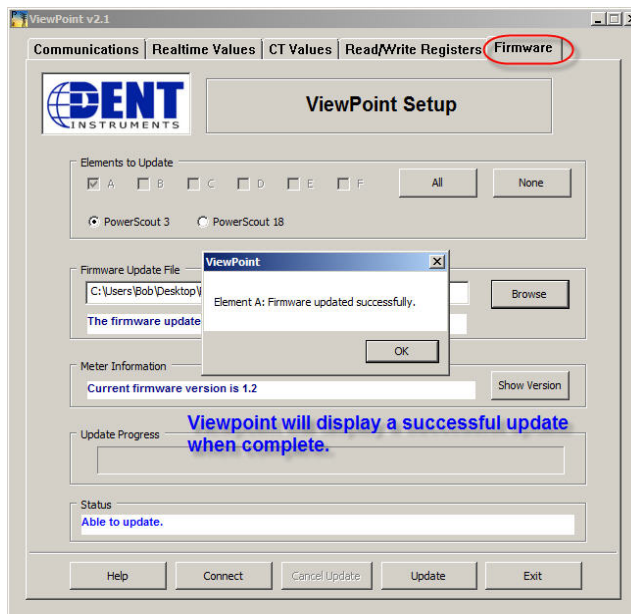
Change the baud rate using the **Communications** tab. Select the desired baud rate. The baud rate is synchronized between ViewPoint and the PowerScout 3 Plus by clicking the **Connect** button.



4. Select the **Firmware** tab in ViewPoint. Click **Browse** to locate the extracted firmware files. Click **Update** to start the firmware update.



5. When the update completes, ViewPoint displays a message window confirming a successful update.



6. If the baud rate was changed for the firmware update, restore the baud rate to its original setting.

OPTIONAL: When the firmware update completes and if the digital connections are not in use counting generating output pulses, the Digital LEDs turns on. This behavior is due to the new control feature for the Digital channels in this firmware version. Having the Digital LEDs on for unused Digital channels does not affect meter operation. To turn off the LEDs, complete the following steps:

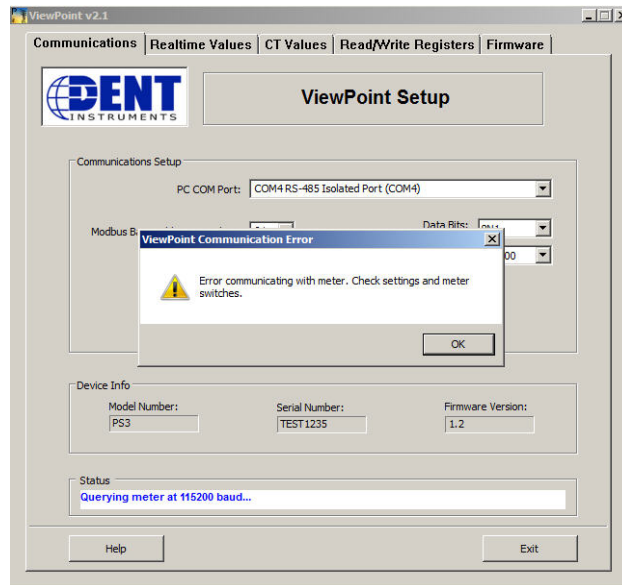
Set the control output to disable the LED:

- Set register 44402 = 1 (for I/O 1), 44403 = 1 (for I/O 2).
- Wait 60 seconds before power cycling the PowerScout 3 Plus, to save the settings.

This completes the firmware update for the PowerScout 3 Plus.

Modbus Appendix C – Troubleshooting Communication Issues

The following headings provide possible solutions for communication errors.



Baud Rate Communications Error

When the baud rate on the ViewPoint **Communications** screen and the PowerScout 3 Plus do not match, communication fails. To correct a baud rate communications error, use the following steps:

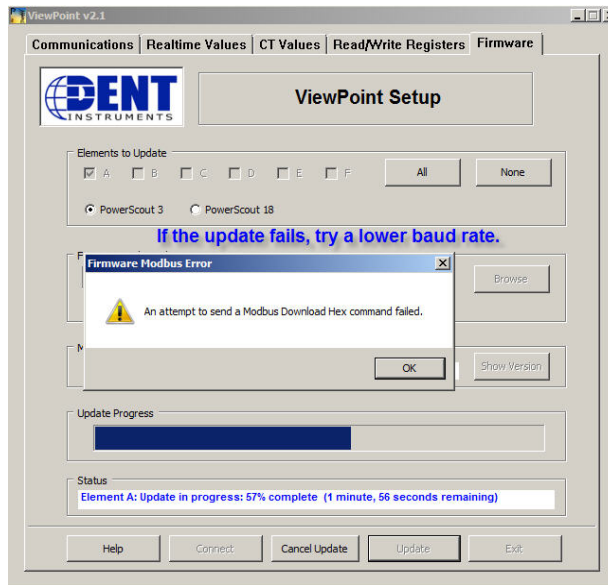
1. In ViewPoint, set the **Modbus Base Address Switches** field to 00.
2. On the PowerScout 3, set both the upper and lower Modbus address switches to 0.
3. Press the **Connect** button. With both settings at 00, ViewPoint and the PowerScout 3 Plus will communicate at a 9600 baud rate regardless of a baud rate mismatch. Communications is established.
4. Next, select the desired baud rate in ViewPoint from the **Baud Rate** drop-down menu. This synchronizes the baud rates between ViewPoint and the PowerScout 3 Plus.
5. Click **Connect** to reconfirm communications.

Port Error

If the **PC COM Port** drop-down menu does not contain a RS-485 port, the RS-485 adapter driver is not installed or the device is not connected to the computer's USB port. Check that the adapter is connected to a live USB port or move the USB cable to another USB port.

Firmware Update Fails

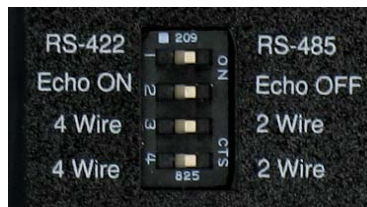
When the firmware update fails, select a slower baud rate and retry the update.



Other Communication Failures

The following items can also cause a communication failure.

- Check for wiring and cabling issues with the RS-485 adapter. Check for polarity, frayed wires, and/or pinched insulation.
- Verify that the dip switches on the back of the USB to RS-485 adapter are set to the following:



- Reboot the computer. Click **Connect** on the Communications tab to reestablish communications.

Modbus Appendix D – PowerScout 3 Plus Modbus Register Assignment Tables

Modbus Register Assignments

Offset refers to a base of 40001.

Modbus	Offset	Register	Description
44001	4000	kWh System LSW	System Total Net True Energy LSW (kWh)
44002	4001	kWh System MSW	System Total Net True Energy MSW (kWh)
44003	4002	kW System	System Total True Power (kW)
44004	4003	kW Demand System Max	System Maximum Demand (peak demand).
44005	4004	kW Demand System Now	Average Power (kW) for most recent demand window
44006	4005	kW System Max	System Maximum Instantaneous kW (Highest 500mS kW)
44007	4006	kW System Min	System Minimum Instantaneous kW (Lowest 500mS kW)
44008	4007	kVARh System LSW	System Total Net Reactive Energy LSW (kVARh)
44009	4008	kVARh System MSW	System Total Net Reactive Energy MSW (kVARh)
44010	4009	kVAR System	System Total Reactive Power (kVAR)
44011	4010	kVAh System LSW	System Total Apparent Energy LSW (kVAh)
44012	4011	kVAh System MSW	System Total Apparent Energy MSW (kVAh)
44013	4012	kVA System	System Total Apparent Power (kVA)
44014	4013	Displacement PF System	System Total Power Factor (PF)
44015	4014	Apparent PF System	System Total Power Factor (PF)
44016	4015	Amps System Avg	Average of all phases.
44017	4016	Volts Line to Line Avg	Voltage Line to line (Volts) Average.
44018	4017	Volts Line to Neutral Avg	Voltage Line to neutral (volts) Average.
44019	4018	Volts L1 to L2	Individual Phase to Phase Voltages
44020	4019	Volts L2 to L3	“
44021	4020	Volts L1 to L3	“
44022	4021	Line Frequency	Line Frequency (Hz)
44023	4022	kWh L1 LSW	Individual Phase True Energy LSW (kWh)
44024	4023	kWh L1 MSW	Individual Phase True Energy MSW (kWh)
44025	4024	kWh L2 LSW	“
44026	4025	kWh L2 MSW	“
44027	4026	kWh L3 LSW	“
44028	4027	kWh L3 MSW	“
44029	4028	kW L1	Individual Phase True Powers (kW)
44030	4029	kW L2	“
44031	4030	kW L3	“
44032	4031	kVARh L1 LSW	Individual Phase Reactive Energy LSW (kVARh)
44033	4032	kVARh L1 MSW	Individual Phase Reactive Energy MSW (kVARh)
44034	4033	kVARh L2 LSW	“
44035	4034	kVARh L2 MSW	“
44036	4035	kVARh L3 LSW	“
44037	4036	kVARh L3 MSW	“
44038	4037	kVAR L1	Individual Phase Reactive Powers (kVAR)
44039	4038	kVAR L2	“
44040	4039	kVAR L3	“

Modbus	Offset	Register	Description
44041	4040	kVAh L1 LSW	Individual Phase Apparent Energy LSW (kVAh)
44042	4041	kVAh L1 MSW	Individual Phase Apparent Energy MSW (kVAh)
44043	4042	kVAh L2 LSW	"
44044	4043	kVAh L2 MSW	"
44045	4044	kVAh L3 LSW	"
44046	4045	kVAh L3 MSW	"
44047	4046	kVA L1	Individual Phase Apparent Powers (kVA)
44048	4047	kVA L2	"
44049	4048	kVA L3	"
44050	4049	Displacement PF L1	Individual Phase displacement Power Factor (PF)
44051	4050	Displacement PF L2	"
44052	4051	Displacement PF L3	"
44053	4052	Apparent PF L1	Individual Phase apparent Power Factors (PF)
44054	4053	Apparent PF L2	"
44055	4054	Apparent PF L3	"
44056	4055	Amps L1	Individual Phase Currents (A)
44057	4056	Amps L2	"
44058	4057	Amps L3	"
44059	4058	Volts L1 to Neutral	Individual Phase to Neutral Voltages (V)
44060	4059	Volts L2 to Neutral	"
44061	4060	Volts L3 to Neutral	"
44062	4061	Time Since Reset LSW	Seconds since KWH register was reset. LSW
44063	4062	Time Since Reset HSW	Seconds since KWH register was reset. MSW
44080	4079	kW System Average	Equals KWH_SYSTEM_L&M ÷ (TimeSinceReset_L&M seconds /3600 seconds/Hr) (resettable)
44081	4080	kW Demand System Min	Min Average power window (kW)
44082	4081	kVA Demand System Max	System Maximum Instantaneous kVA Demand (kVA, resettable). It displays the default value after a CAM until 1 demand window elapses. After a power cycle or CPU reset the value is not reset but it does not update again until 1 demand window elapses.
44083	4082	kVA Demand System Now	System Average kVA Demand For the most recent (current) Demand Window.(resettable) Displays the default value after a CAM or reset, or power cycle. Updates every min thereafter. True demand value takes a demand period to get to actual value. Similar to 44005
44084	4083	kVAR Demand System Max	System Maximum kVAR Demand (kVAR, resettable). It displays the default value after a CAM until 1 demand window elapses. After a power cycle or CPU reset the value is not reset but it does not update again until 1 demand window elapses.
44600	4599	CT Integer	CT Integer Value
44601	4600	CT Decimal	CT Decimal Value x 1000
44602	4601	Data Scalar	A Value of 0-6 that changes the scaling of certain registers
44603	4602	Demand Window Size	Demand window size in minutes; default is 15 min

Configuration Registers

Modbus	Offset	Register	Description
44525	4524	CT Type	1=mV, 2=Rogowski (RoCoil)
44526	4525	Slave ID	!1=DENT, 1=Veris; Sets SLAVE_ID to Veris or DENT
44599	4598	CT Phase Shift	CT Phase Shift X 100 +/-
44604	4603	Volts Multiplier	Multiply volts values by this scalar. Use with Step-down Transformer. Affects all parameters that use volts (i.e., kW)
44605	4604	Amps Multiplier	Multiply amps value by this scalar. For use with x:5A CTs and single let monitoring of a three phase load. Affects all parameters that use amps (i.e, kW)
44606	4605	Communication Setting	Baud: 900=9600, 1900=19200, 3800=38400, 5700=57600, 7600 =76800, 11500=115200 Parity: Add 00 = NO, Add 10 = ODD, Add 20 = EVEN Stop bit: Add 0 = 1 (UART does not permit 0 stop bits), Add 1 = 1, Add 2 = 2 E.g., 901 = 9600 baud, no parity, 1 stop bit
44607	4606	Service Type	A value of 0x0001 configures the PowerScout for DELTA A value of 0x0000 configures the PowerScout for WYE
44609	4608	Set Line Frequency	Line frequency setting for metering: 50=50 Hz, 60=60Hz, 400=400 Hz
44612	4611	Communications Settings	Write 1883 to change to BACnet 2004 mode

Writable Registers

Modbus	Offset	Register	Description
40129	128	Synchronize Register	Multiple PowerScout's synchronization register
44066	4065	Clear Accumulated Measurements	Writing 1234 resets all 'C' registers, accumulated PowerScout data (kWh, kWh, etc) stored in flash to CAM Default value

Non-Writable Registers

Modbus	Offset	Register	Description
44201	4200	Model Number 1 st 2 bytes	Model Name 10 bytes (ASCII Alpha-Numeric)
44202	4201	Model 2	"
44203	4202	Model 3	"
44204	4203	Model 4	"
44205	4204	Model Number last 2 bytes	"
44206	4205	Serial Number 1 st 2 bytes	Serial Number 10 bytes (ASCII Alpha-Numeric)
44207	4206	Serial 2	"
44208	4207	Serial 3	"
44209	4208	Serial 4	"
44210	4209	Serial Number last 2 bytes	"

Modbus	Offset	Register	Description
44220	4219	PowerScout Element ID	Used by ViewPoint to determine which element is being read & total number of elements available. Element index multiplied by 256 + number of elements.
44511	4510	Hardware ID	Hardware revisions.
44069	4068	Firmware Major Revision	Major Revision Level (big software releases)
44070	4069	Firmware Minor Revision	Minor Revision Level (small software changes)

Positive Power/Energy Measurement Registers

Modbus	Offset	Register	Description
46001	6000	Positive kWh System LSW	System Positive True Energy LSW (kWh, resettable)
46002	6001	Positive kWh System MSW	System Positive True Energy MSW (kWh, resettable)
46003	6002	Positive kW System	System Positive Instantaneous Positive True Power (kW) (net sum of all individual kW, if sum is negative value=0)
46005	6004	kW Demand System Now	Average Power (kW) for most recent demand window
46006	6005	Positive kW System Max	System Highest Instantaneous Positive Draw Since Reset (kW, resettable)
46007	6006	Positive kW System Min	System Lowest Instantaneous Positive Draw Since Reset (kW, resettable)
46008	6007	Positive kVARh System LSW	System Positive Reactive Energy LSW (kVARh, resettable)
46009	6008	Positive kVARh System MSW	System Positive Reactive Energy MSW (kVARh, resettable)
46010	6009	Positive kVAR System	System Instantaneous Positive Reactive Power (kVAR) (net sum of all individual kVARs, if sum is negative value=0)
46014	6013	Positive Displacement PF System	System Positive Displacement Power Factor (dPF); Register is 100x actual value (If the System dPF (44014) is positive, this register will contain that value else it will be zero)
46015	6014	Positive Apparent PF System	System Positive Apparent Power Factor (aPF); Register is 100x actual value (If the System aPF (44015) is positive, this register will contain that value else it will be zero)
46023	6022	Positive kWh L1 LSW	Individual Phase Positive True Energy LSW (kWh, resettable)
46024	6023	Positive kWh L1 MSW	Individual Phase Positive True Energy MSW (kWh, resettable)
46025	6024	Positive kWh L2 LSW	"
46026	6025	Positive kWh L2 MSW	"
46027	6026	Positive kWh L3 LSW	"
46028	6027	Positive kWh L3 MSW	"
46029	6028	Positive kW L1	Individual Phase Instantaneous Positive True Powers (kW)
46030	6029	Positive kW L2	"

Modbus	Offset	Register	Description
46031	6030	Positive kW L3	"
46032	6031	Positive kVARh L1 LSW	Individual Phase Positive Reactive Energy LSW (kVARh, resettable)
46033	6032	Positive kVARh L1 MSW	Individual Phase Positive Reactive Energy MSW (kVARh, resettable)
46034	6033	Positive kVARh L2 LSW	"
46035	6034	Positive kVARh L2 MSW	"
46036	6035	Positive kVARh L3 LSW	"
46037	6036	Positive kVARh L3 MSW	"
46038	6037	Positive kVAR L1	Individual Phase Positive Instantaneous Reactive Powers (kVAR)
46039	6038	Positive kVAR L2	"
46040	6039	Positive kVAR L3	"
46050	6049	Positive Displacement PF L1	Individual Phase Positive Displacement Power Factors (dPF); Register is 100x actual value (If the Individual dPF (44050) is positive, this register will contain that value else it will be zero)
46051	6050	Positive Displacement PF L2	"
46052	6051	Positive Displacement PF L3	"
46053	6052	Positive Apparent PF L1	Individual Phase Positive Apparent Power Factors (aPF); Register is 100x actual value (If the Individual aPF(44053) is positive, this register will contain that value else it will be zero)
46054	6053	Positive Apparent PFL2	"
46055	6054	Positive Apparent PF L3	"
46080	6079	Positive kW System Average	Equals Positive KWH_SYSTEM_L&M ÷ (TimeSinceReset_L&M seconds /3600 seconds/Hr) (resettable)
46081	6080	Positive kW Demand System Minimum	Min Average power window (kW)

Negative Power/Energy Measurement Registers

Modbus	Offset	Register	Detailed Description
47001	7000	Negative kWh System LSW	System Negative True Energy LSW (kWh, resettable)
47002	7001	Negative kWh System MSW	System Negative True Energy MSW (kWh, resettable)
47003	7002	Negative kW System	System Negative Instantaneous Negative True Power (kW) (net sum of all individual kW, if sum is positive value=0)
47005	7004	kW Demand System Now	Average Power (kW) for most recent demand window
47006	7005	Negative kW System Max	System Highest Instantaneous Negative Draw Since Reset (kW, resettable)
47007	7006	Negative kW System Min	System Lowest Instantaneous Negative Draw Since Reset (kW, resettable)

Modbus	Offset	Register	Detailed Description
47008	7007	Negative kVARh System LSW	System Negative Reactive Energy LSW (kVARh, resettable)
47009	7008	Negative kVARh System MSW	System Negative Reactive Energy MSW (kVARh, resettable)
47010	7009	Negative kVAR System	System Instantaneous Negative Reactive Power (kVAR) (net sum of all individual kVARs, if sum is positive value=0)
47014	7013	Negative Displacement PF System	System Negative Displacement Power Factor (dPF); Register is 100x actual value (If the System dPF (44014) is Negative, this register will contain that value else it will be zero)
47015	7014	Negative Apparent PF System	System Negative Apparent Power Factor (aPF); Register is 100x actual value (If the System aPF (44015) is Negative, this register will contain that value else it will be zero)
47023	7022	Negative kWh L1 LSW	Individual Phase Negative True Energy LSW (kWh, resettable)
47024	7023	Negative kWh L1 MSW	Individual Phase Negative True Energy MSW (kWh, resettable)
47025	7024	Negative kWh L2 LSW	"
47026	7025	Negative kWh L2 MSW	"
47027	7026	Negative kWh L3 LSW	"
47028	7027	Negative kWh L3 MSW	"
47029	7028	Negative kW L1	Individual Phase Instantaneous Negative True Powers (kW)
47030	7029	Negative kW L2	"
47031	7030	Negative kW L3	"
47032	7031	Negative kVARh L1 LSW	Individual Phase Negative Reactive Energy LSW (kVARh, resettable)
47033	7032	Negative kVARh L1 MSW	Individual Phase Negative Reactive Energy MSW (kVARh, resettable)
47034	7033	Negative kVARh L2 LSW	"
47035	7034	Negative kVARh L2 MSW	"
47036	7035	Negative kVARh L3 LSW	"
47037	7036	Negative kVARh L3 MSW	"
47038	7037	Negative kVAR L1	Individual Phase Negative Instantaneous Reactive Powers (kVAR)
47039	7038	Negative kVAR L2	"
47040	7039	Negative kVAR L3	"
47050	7049	Negative Displacement PF L1	Individual Phase Negative Displacement Power Factors (dPF); Register is 100x actual value (If the Individual dPF(44050) is Negative, this register will contain that value else it will be zero)
47051	7050	Negative Displacement PF L2	"
47052	7051	Negative Displacement PF L3	"

Modbus	Offset	Register	Detailed Description
47053	7052	Negative Apparent PF L1	Individual Phase Negative Apparent Power Factors (aPF); Register is 100x actual value (If the Individual aPF (44053) is Negative, this register will contain that value else it will be zero)
47054	7053	Negative Apparent PFL2	“
47055	7054	Negative Apparent PF L3	“
47080	7079	Negative kW System Average	Equals Negative KWH_SYSTEM_L&M ÷ (TimeSinceReset_L&M seconds /3600 seconds/Hr) (resettable)
46081	7080	Negative kW Demand System Minimum	Min Average power window (kW)

Modbus Appendix E – Modbus Commands

The Modbus messaging protocol used for communication follows the Modbus RTU protocol described in this section. Each register read from or written to the PowerScout 3 Plus is a 16-bit unsigned, positive integer value. The PowerScout 3 Plus supports the following 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.

Table F-1: Supported Modbus Commands

The following guidelines are used for these Modbus commands:

- All values are hexadecimal, spaces are not included.
- The address is the value of the address switch on the PowerScout 3 Plus. This must be different for each PowerScout on a single Modbus network.
- The register’s high-order and low-order bits are the 16-bit value of a single, or first, register to be accessed for a read or write.
- The CRC is the 16-bit CRC value. Note that the CRC's LSB and MSB are reversed in comparison to those for the registers and data.

Read Holding Registers

This command reads the contents of a contiguous block of holding registers containing data values from the PowerScout 3 Plus. When a read command is received, the PowerScout 3 Plus sends a response that includes the values of the requested registers.

Command Information	Command Layout	Example Command
PowerScout address	nn	37
Command number	03	03
First register to read – high order bits	xx	00
First register to read – low order bits	xx	0C
Number of registers to read – high order bits	xx	00
Number of registers to read – low order bits	xx	01
CRC low order bits	xx	41
CRC high order bits	xx	9F

Table F-2: Format for Modbus Command 03

Example Command

This command reads from a PowerScout 3 Plus with an address switch setting of 37 hex (55 in decimal), reading one byte starting at register offset 0C hex (12 in decimal). Note that offset 12 corresponds to Modbus register 40013. All values are hexadecimal; spaces are not sent.

Example Request Field Name	Command (Hex)	Response Field Name	Response (Hex)
PowerScout address	37	PowerScout address	37
Command	03	Command	03
Starting register address to read– high order bits	00	Byte count	02
Starting register address to read– low order bits	0C	Register value –high order bits	00
Number of registers to read – high order bits	00	Register value – low order bits	00
Number of registers to read – low order bits	01	CRC low order bits	70
CRC low order bits	41	CRC high order bits	40
CRC high order bits	9F		

Table F-3: Format for Modbus Command 03

Command: 3703000C0001419F

Response: 37030200007040

The response is from the PowerScout 3 Plus at address 37. Two bytes were read from the requested register, 000C. The value of the registers read was 0000. The CRC value was 4070. The number of registers read must be between 1 and 125 inclusive.

Note: The value sent as the register address in the read and write Modbus commands is not the register listed in the table, instead an abbreviated version is sent. The actual register address sent is the Modbus register value minus 40001. For example, the address sent in the command message for register 40025 is actually 0024 (0018 hexadecimal), and the address sent for register 44062 is actually 4061 (0FDD hexadecimal).

Write Single Register

This command writes to a single holding register of the PowerScout 3 Plus. The normal response is an echo of the request, returned after the register contents are written.

Command Information	Command Layout	Example Command
PowerScout address	nn	37
Command number	06	06
Register to write – high order bits	xx	00
Register to write – low order bits	xx	00
Register value to write – high order bits	xx	00
Register value to write – low order bits	xx	00
CRC low order bits	xx	8C
CRC high order bits	xx	5C

Table F-4: Format for Modbus Command 06

Example Command

This command writes to a PowerScout 3 Plus with an address switch setting of 37 hex (55 in decimal), writing one byte at register 000C, and writing a value of 00 to clear the KWH registers. The data value of 0 is sent to register 0. Note that offset 0 corresponds to Modbus register 40001. The CRC is 5C8C. All values are hexadecimal; spaces are not sent.

Example Request Field Name	Command (Hex)	Response Field Name	Response (Hex)
PowerScout address	37	PowerScout address	37
Command number	06	Command number	06
Register to write – high order bits	00	Register written to – high order bits	00
Register to write – low order bits	00	Register written to – low order bits	00
Register value to write – high order bits	00	Register value written – high order bits	00
Register value to write – low order bits	00	Register value written – low order bits	00
CRC low order bits	8C	CRC low order bits	8C
CRC high order bits	5C	CRC high order bits	5C

Table F-5: Format for Modbus Command 03

Command: 3706000000018C5C

Response: 3706000000018C5C

The response is from the PowerScout 3 Plus at address 37. One byte was written to at the requested register, 0000. The value written was 0000. The CRC value was 5C8C. An echo of the original command after the contents are written is a valid response.

Error Response

If the first register in this write command is not in the valid range of registers, the PowerScout 3 Plus returns an error message.

Report Slave ID

This command is used to read the description, the current status and other information specific to a remote device. A normal response includes the data contents specific to the device.

Command Information	Command Layout	Example Command
PowerScout address	nn	37
Command number	11	11

Table F-6: Format for Modbus Command 11 (17 in decimal)

Example Command

Example Request Field Name	Command (Hex)	Response Field Name	Response (Hex)
PowerScout address	37	PowerScout address	37
Command number	11	Command number	11
CRC low order bits	D7	Byte count	
CRC high order bits	8C	Slave ID	
		Run indicator status	
		Additional data	

Table F-7: Format for Modbus Command 11 (17 in decimal)

Slave ID

The PowerScout 3 Plus uses the following default format for the slave ID:

00hFFhDENT Instruments PowerScout 3, Serial Number, FW Rev Major Revision. Minor Revision, Scalar X

Example:

00hFFhDENT Instruments PowerScout 3, PS3912001, FW Rev 1.0, Scalar 3

The 00h is used for version control and the FFh indicates the meter is active. The 00h and FFh are two bytes in front of the string that are not displayed on the RTU.

SECTION IV: Frequently Asked Questions – FAQs

What is the maximum distance for BACnet MS/TP or Modbus (RS-485) communication?

BACnet MS/TP or Modbus (RS-485) can reach a distance up to 1200 meters (4000') with data rates at 100 kbps.

One (or more) of the PhaseChek™ LEDs is red. What does this mean?

Any number of red lights indicates the PowerScout™ 3 Plus is wired incorrectly. Review the table in *PhaseChek* in Section III of this manual for a description of the indicator lights.

How is the PowerScout 3 Plus powered?

All PowerScout instruments are line-powered. An internal power supply attached between L1 and L2 provides power to the unit.

Can the PowerScout 3 Plus be used to monitor single-phase loads?

The PowerScout 3 Plus can be used to monitor single-phase loads. Refer to section II.B or III.C for detailed setup information.

How many PowerScout 3 Plus instruments can be connected together?

Up to 127 PowerScout 3 Plus meters can be connected together on a BACnet MS/TP network.
Up to 254 PowerScout 3 Plus meters can be connected together on a Modbus network.

How is hexadecimal (HEX) to decimal converted?

Use the Hexadecimal to Decimal conversion table in the Appendix section of this manual.

What is true RMS?

RMS stands for "Root-Mean-Square." True RMS is the power from AC voltage/current that will produce the equivalent amount of heat in a resistor as a DC voltage/current, whether sinusoidal or not. For example, if a resistive heating element is rated at 15 kW of heat at 240VAC RMS, then the heat would be the same if we applied 240V of DC instead of AC. A meter without true RMS will incorrectly read distorted waveforms. All DENT Instruments meters measure true RMS.

How accurate is the PowerScout 3 Plus?

The PowerScout 3 Plus accuracy is better than 1%.

What is the lead length for RoCoil CTs?

The maximum lead length for the RoCoils is 30 meters (100').

Can a 3-phase balanced load be monitored with one CT?

This is not the best way to measure a three phase load as it ignores imbalances in voltage and power factor. However, if desired there is an Amp Multiplier Modbus register (44605) that can be set for three which will multiply the current by three and therefore amps, watts, VA, VARs will be 3X greater.

How can I switch the PowerScout 3 Plus from BACnet to Modbus mode?

Use the BACnet client (RTU) to write 375 to the present value of object identifier 10190 (Com Interface). See BACnet Appendix B for more details.

How can I switch the PowerScout 3 Plus from Modbus to BACnet mode?

Using a PC running ViewPoint™ (or an RTU that can write to Modbus registers), write to register 44612 the value 1833 (to change to BACnet 2004). See also BACnet Appendix B for more details.

How can I fix BACnet network timing errors / slowness?

There are two objects that can be changed if network timing or slowness is present. Object identifier 10200 Maximum number of MSTP master should be set to the highest MAC address present on the network. Object identifier 10210

What is the purpose of setting a scalar value?

Each Modbus register is only 16 bits wide and is in integer format without any fixed number of decimal points. Simply putting a value directly into one of these registers would limit the smallest number to be 1, and only allow for a maximum value of 65535. To handle larger numbers, or numbers with better resolution, we use a scalar value that is used to apply a factor in multiples of 10 to the 16 bit data register value.

How do I update the firmware in BACnet mode?

Currently, the PowerScout 3 Plus must be in Modbus mode in order to use ViewPoint to update the firmware (either through the software switch or the rotary switches).

Glossary

Analog Value	A type of BACnet object that is a floating point number. On the PowerScout, Analog Value objects are used to represent the electrical measurements.
BACnet	B uilding A utomation C ontrol n etworks. A communications protocol that allows building automation and control devices and their association properties (objects) to be automatically discovered.
Discovery	In BACnet devices and the objects they expose can be found through a discovery process. This means that devices and objects do not need to be manually added if a BACnet client supports discovery.
Falling edge	Transition of the input signal from high to low.
Hexadecimal	In mathematics and computer science, hexadecimal (or hex) is a numeral system with a radix, or base, of 16. It uses sixteen distinct symbols, most often the symbols 0–9 to represent values zero to nine, and A, B, C, D, E, F (or a through f) to represent values ten to fifteen.
LSW	(Modbus mode only) Least Significant Word. Unit of data with the low-order bytes at the right.
Object	A BACnet object is a standard data structure that on the PowerScout 3 Plus represents electrical measurements.
MS/TP	Master-Slave / Token Passing is a model of communication used by BACnet where

one device (the master node) has unidirectional control of the RS-485 serial bus. The token is passed from master node to master node to allow a master node to send frames over the bus.

MSW	(Modbus mode only) Most Significant Word. Unit of data with the high-order bytes at the left.
PhaseChek™	PhaseChek™ is a unique feature of the PowerScout™ and greatly simplifies installation and, at a glance, verifies correct CT orientation during installation. The PowerScout automatically adjusts for CT orientation—greatly reducing set-up time and all but eliminating installation errors. It is common for an individual phase power factor to be less than 0.55 and the corresponding LED will be red.
Power Factor	The power factor of the AC electric power system is defined as the ratio of the real power flowing to the load to the apparent power, and is a number between 0 and 1 (frequently expressed as a percentage, e.g. 0.5 pf = 50% pf). Real power is the capacity of the circuit for performing work in a particular time. Apparent power is the product of the root mean squared current and root mean squared voltage of the circuit. Due to energy stored in the load and returned to the source, or due to a non-linear load that distorts the wave shape of the current drawn from the source, the apparent power can be greater than the real power.
Rising edge	Transition of the input signal from low to high.
RMS	Root-Mean-Square. True RMS is the AC voltage/current that produces the equivalent amount of heat in a resistor as a DC voltage/current, whether sinusoidal or not. All DENT Instruments meters measure true RMS.
RS-485	EIA-485 is used as the physical layer underlying many standard and proprietary automation protocols used to implement Industrial Control Systems, including BACnet / Modbus.
RTU	A Remote Terminal Unit (RTU) is a microprocessor controlled electronic device which interfaces objects in the physical world to a distributed control system or SCADA system by transmitting telemetry data to the system and/or altering the state of connected objects based on control messages received from the system.
SCADA	SCADA stands for Supervisory Control And Data Acquisition. It generally refers to an industrial control system: a computer system monitoring and controlling a process.
Service	A BACnet service is a message that the PowerScout must respond to. In BACnet these include Whols, I-Am, and ReadProperty.

Release Notes

Firmware update 2.53 provides the following enhancements:

- This is the first release of BACnet MS/TP functionality.
- The register 44612 is added to switch between BACnet and Modbus mode.

SECTION V: General Appendices

Appendix A – Decimal to Hexadecimal Conversion Table

Decimal values are used for the PowerScout™ addresses. The hex value is the corresponding value set on the upper and lower rotary network address switches on the PowerScout.

- Upper rotary network address switch = high (first) digit
- Lower rotary network address switch = low (second) digit

Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex
1	01	44	2C	87	57	130	82	173	AD	216	D8
2	02	45	2D	88	58	131	83	174	AE	217	D9
3	03	46	2E	89	59	132	84	175	AF	218	DA
4	04	47	2F	90	5A	133	85	176	B0	219	DB
5	05	48	30	91	5B	134	86	177	B1	220	DC
6	06	49	31	92	5C	135	87	178	B2	221	DD
7	07	50	32	93	5D	136	88	179	B3	222	DE
8	08	51	33	94	5E	137	89	180	B4	223	DF
9	09	52	34	95	5F	138	8A	181	B5	224	E0
10	0A	53	35	96	60	139	8B	182	B6	225	E1
11	0B	54	36	97	61	140	8C	183	B7	226	E2
12	0C	55	37	98	62	141	8D	184	B8	227	E3
13	0D	56	38	99	63	142	8E	185	B9	228	E4
14	0E	57	39	100	64	143	8F	186	BA	229	E5
15	0F	58	3A	101	65	144	90	187	BB	230	E6
16	10	59	3B	102	66	145	91	188	BC	231	E7
17	11	60	3C	103	67	146	92	189	BD	232	E8
18	12	61	3D	104	68	147	93	190	BE	233	E9
19	13	62	3E	105	69	148	94	191	BF	234	EA
20	14	63	3F	106	6A	149	95	192	C0	235	EB
21	15	64	40	107	6B	150	96	193	C1	236	EC
22	16	65	41	108	6C	151	97	194	C2	237	ED
23	17	66	42	109	6D	152	98	195	C3	238	EE
24	18	67	43	110	6E	153	99	196	C4	239	EF
25	19	68	44	111	6F	154	9A	197	C5	240	F0
26	1A	69	45	112	70	155	9B	198	C6	241	F1
27	1B	70	46	113	71	156	9C	199	C7	242	F2
28	1C	71	47	114	72	157	9D	200	C8	243	F3
29	1D	72	48	115	73	158	9E	201	C9	244	F4
30	1E	73	49	116	74	159	9F	202	CA	245	F5
31	1F	74	4A	117	75	160	A0	203	CB	246	F6
32	20	75	4B	118	76	161	A1	204	CC	247	F7
33	21	76	4C	119	77	162	A2	205	CD	248	F8
34	22	77	4D	120	78	163	A3	206	CE	249	F9
35	23	78	4E	121	79	164	A4	207	CF	250	FA
36	24	79	4F	122	7A	165	A5	208	D0	251	FB
37	25	80	50	123	7B	166	A6	209	D1	252	FC
38	26	81	51	124	7C	167	A7	210	D2	253	FD

Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex
39	27	82	52	125	7D	168	A8	211	D3	254	FE
40	28	83	53	126	7E	169	A9	212	D4	255	---
41	29	84	54	127	7F	170	AA	213	D5		
42	2A	85	55	128	80	171	AB	214	D6		
43	2B	86	56	129	81	172	AC	215	D7		

Table A-1: Decimal to Hexadecimal Conversion Table

Appendix B – CT Wire Lead Polarity

CT Type	CT Lead +	CT Lead -
Rogowski (RōCoil)	White	Brown
Split Core mV	White	Black
Clamp On mV	Red	Black

Table G-1: CT Polarity

Note: The directionality for Rogowski CTs is the arrow points toward the load (e.g. motor).