DENT INSTRUMENTS

Metering Project Guide

Power Meter Installation from Start to Finish

Contents

Introduction

Whether this is your first metering project or you're a seasoned facilities manager, it's important to remember that a little planning up front can go a long way in making your project easier. By answering a few questions, the goal, methodology, and other details fall into place. Take 15 minutes to read through this guide before starting your next energy metering project.

Let the objectives define the metering. What do you want to learn?

Before the Site Visit

Before even visiting a project site, there are a number of basic project questions that need to be answered. The more detail, the better! The following list is a good place to start. Keep in mind that each project is different – some of these questions may not apply to you, and that's OK. This is just a general guide to help you get started.

1 Which type of load needs to be monitored?

Examples may be HVAC, lighting, motors, refrigeration, or processes.

2 How many loads need to be monitored?

1. Will there be loads in multiple electrical panels?
2. Do any of the loads share a common voltage source?
3. Are the loads spread across multiple buildings?

3 What do you want to learn about each load?

1. Energy use during a given period: System kWh
2. System kW/Peak Demand: Load Profile
3. Is the load balanced: Phase Amps
4. Power Factor of the load: System PF
5. What are the accuracy requirements for the project?
    - Higher accuracy can increase the cost of the current sensors.

4 How long will the project run?

Project length can determine the communication requirements

1. Will remote data retrieval be required?
2. Is an existing network available?
3. Is periodic on-side data downloading practical?
4. Will Wi-Fi Access Point, Bluetooth, or USB be used?
5. Can the data retrieval wait until the meter is removed at the end of the project?

5 Is the meter to be connected to a Building Management System (BMS)?

If the answer is “yes,” a PowerScout, rather than an ELITEpro XC may be the appropriate choice. A PowerScout is designed for permanent metering and can communicate via the following methods:

- BACnet
- Modbus
- Ethernet
- RS-485

If your measurement study is temporary in nature – such as a load study, M&V, or an energy audit, the ELITEpro XC is the appropriate choice. If you need help selecting the correct meter, please contact DENT Instruments.

6 Review the building's electrical line drawing to determine:

Voltage Service

1. Voltages great than 600VAC will require a potential transformer (PT)
2. Type of service
    - Single Phase
    - Split Phase
    - 3-Phase WYE
    - 3-Phase Delta

Amperage rating of the breaker feeding the load under measurement

1. Use this answer to determine which CTs to use

7

Install the DENT software and any necessary communication device drivers onto the actual laptop to be used in the field.

To ensure there are no compatibility issues, it's best to install any required software ahead of time. This also gives you a chance to become familiar with the software before the installation.

1. If using an ELITEpro XC, install ELOG.
2. If using a PowerScout, install ViewPoint.

8 Select the Current Transformers for your project based on circuit breaker size and required accuracy.

1. Best CT performance occurs when the current flow is between 10% and 100% of the CT full-scale value.
2. With RoCoil CTs (flexible Rogowski coils), current values below 5A may cause the DENT meter to read 0 Amps.
    - If you need to measure less than 50 Amps, it is usually best to select another CT type, such as a Split-Core or Clamp-On.

At the Project Site

Some questions can only be answered once you've visited the project site. Use your time as efficiently as possible by working through the following guide.

1 Locate the electrical panel with the load's breakers.

1. Does the breaker size match the electrical line drawing?
    - If it doesn't match, a different CT may be required.

2 Determine where to install the meter. Keep in mind the length of the project may help determine the best choice.

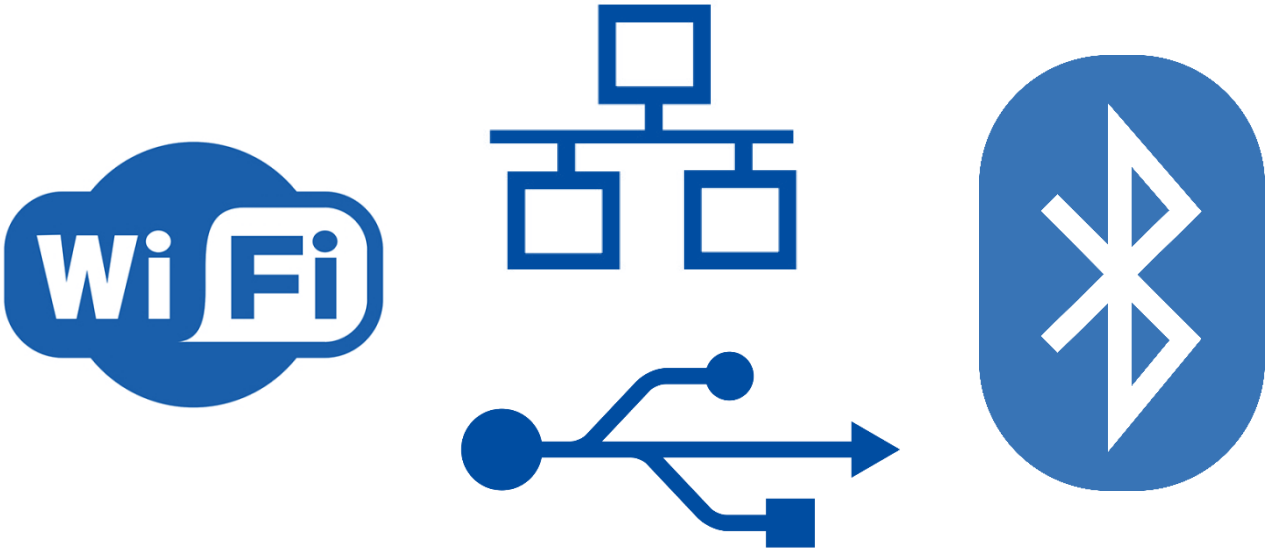
1. Inside the electrical panel
    - This is the best option for long-term measurement studies, especially if wireless or Ethernet access is available.
    - If tampering is a concern, install the meter inside the panel.
2. Outside the electrical panel
    - This choice may be best if the meter is to be left short-term only and tampering is not a concern.
    - Determine the routing of the wiring to the meter
    - Determine the mounting method
    - Decide whether an enclosure is needed
        - Even if the meter is installed inside, dusty or greasy environments may damage the meter.
        - DENT Instruments offers a “weathertight” drop-in enclosure for the ELITEpro XC.

3 Determine the communication implementation. As with installation, the length of the metering project may help determine the best choice.

1. Wired Ethernet
    - Is existing wiring available?
2. Wireless (Wi-Fi)
    - If using the building's network: Verify the Wi-Fi signal is strong enough by connecting the meter to the network.
    - If using the meter in Access Point mode: Verify Wi-Fi communication works while the meter and computer are in the final project location.
    - If using a meter-only Wi-Fi network: Determine a location for the Wi-Fi Access Point/Router near the meters.
        - Verify all meters are in range of the wireless Access Point
        - If the meters are not in range, a second Access Point may be required.

Communication implementation, continued…

3. Bluetooth
    - Determine if the Bluetooth signal is strong enough for the meter to connect to the laptop.
    - Metal and concrete can create interference. Try moving the laptop around for a better signal.
4. USB – Direct Connection
    - Examine the local electrical code to determine if it is legal and feasible to leave a USB cable hanging outside the electrical panel for data retrieval. Always obey all local electrical codes.



4 Verify the breaker actually controls the load you wish to measure.

1. Check the circuit breaker labeling
2. Determine whether the wire size appears appropriate
3. If still in doubt:
    - Measure the current at the breaker and at the load to see how they compare
        - If the current at the breaker is higher than the load, the breaker could either have other loads or it is not the correct breaker
    - If possible, turn the load off and verify that the current at the breaker drops the appropriate amount.
    - Have another person measure current at the load and report back. A two-way radio or cell phone is handy for this step.
4. Use an AC circuit identifier or tracer with a high voltage rating to verify the circuit.

Meter Installation

Once you've determined answers for the previous sections, it's time to install the meter. This is a general outline for meter installation. For specific instructions, please refer to the Operator's Guide for your meter.

1 Mount the meter.

The meter should be mounted either in the electrical panel or right outside. Refer to the previous section for advice on this step.

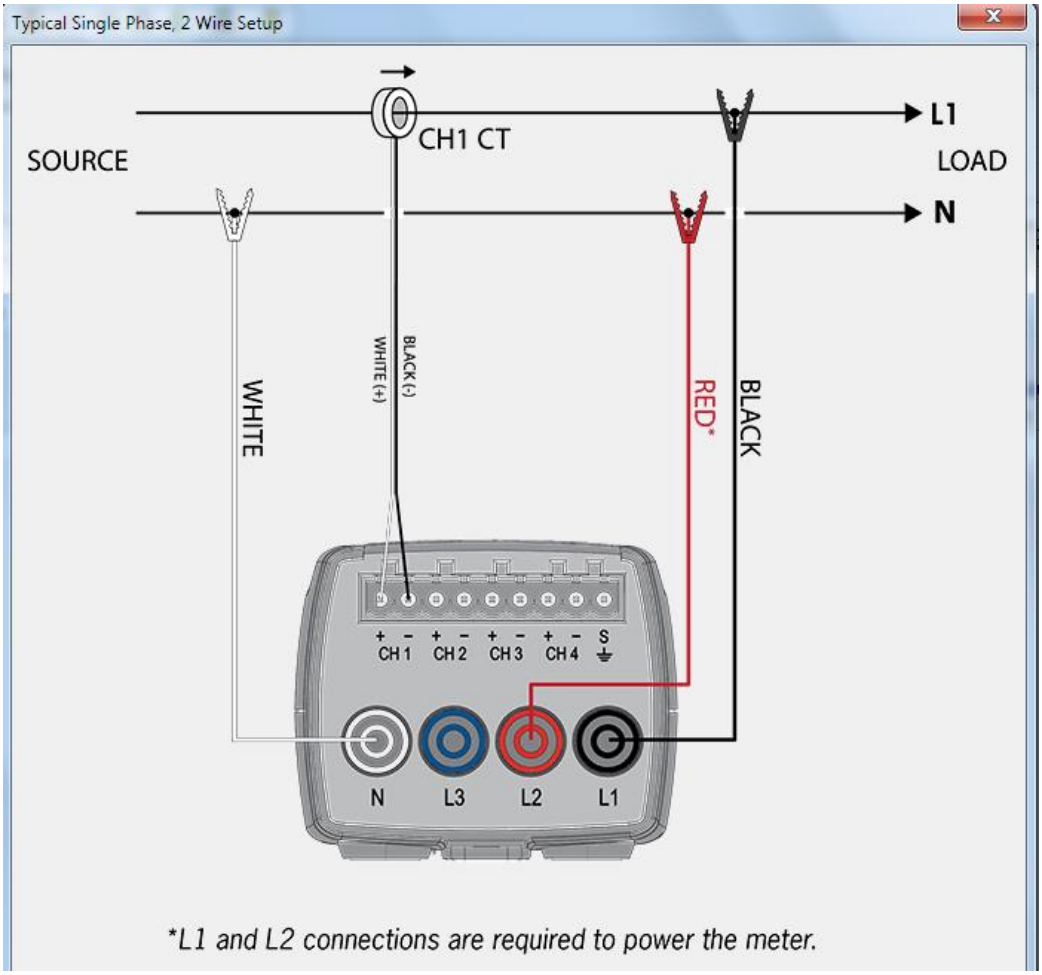
2 If using a wired communication method, run communication wires and connect them to the meter

Wired communication methods include both USB and Ethernet.

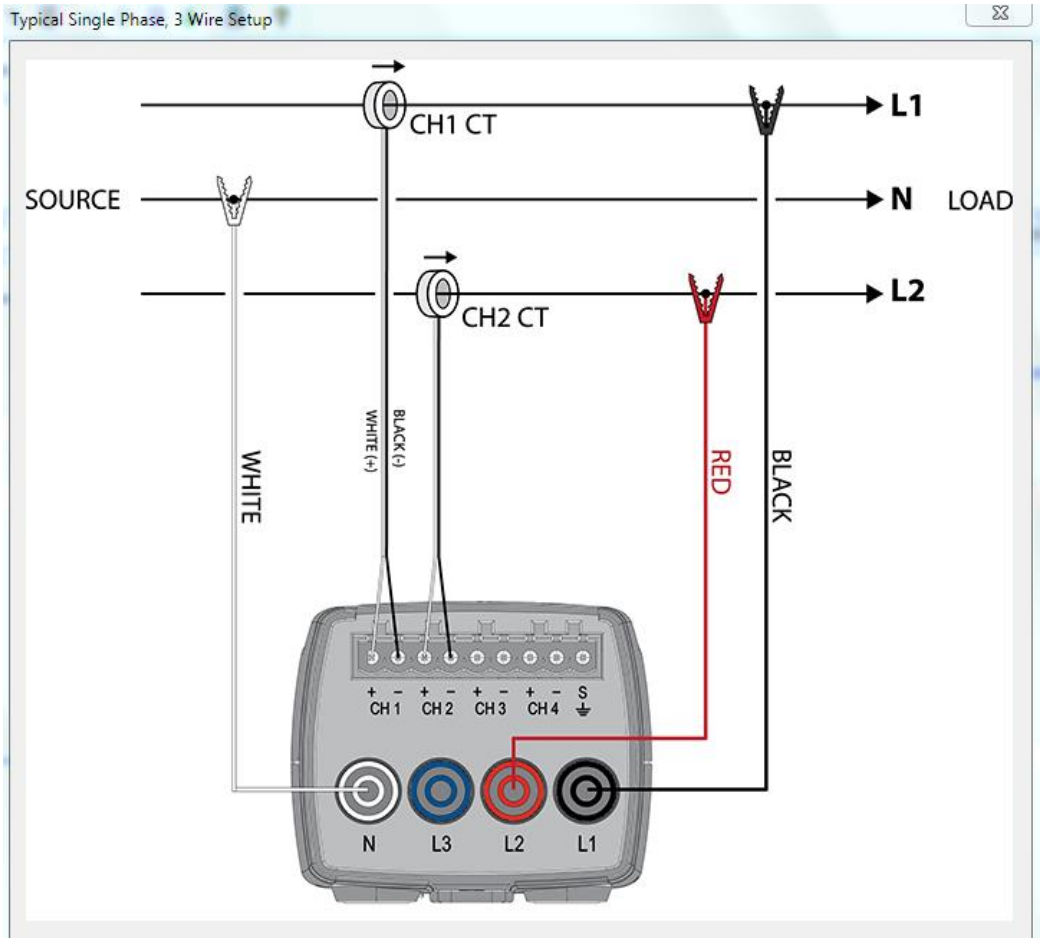
3 Use the following Wiring Diagrams to determine the correct wiring connections for the service being measured.

For further information, please refer to the ELITEpro XC Operator's Guide.

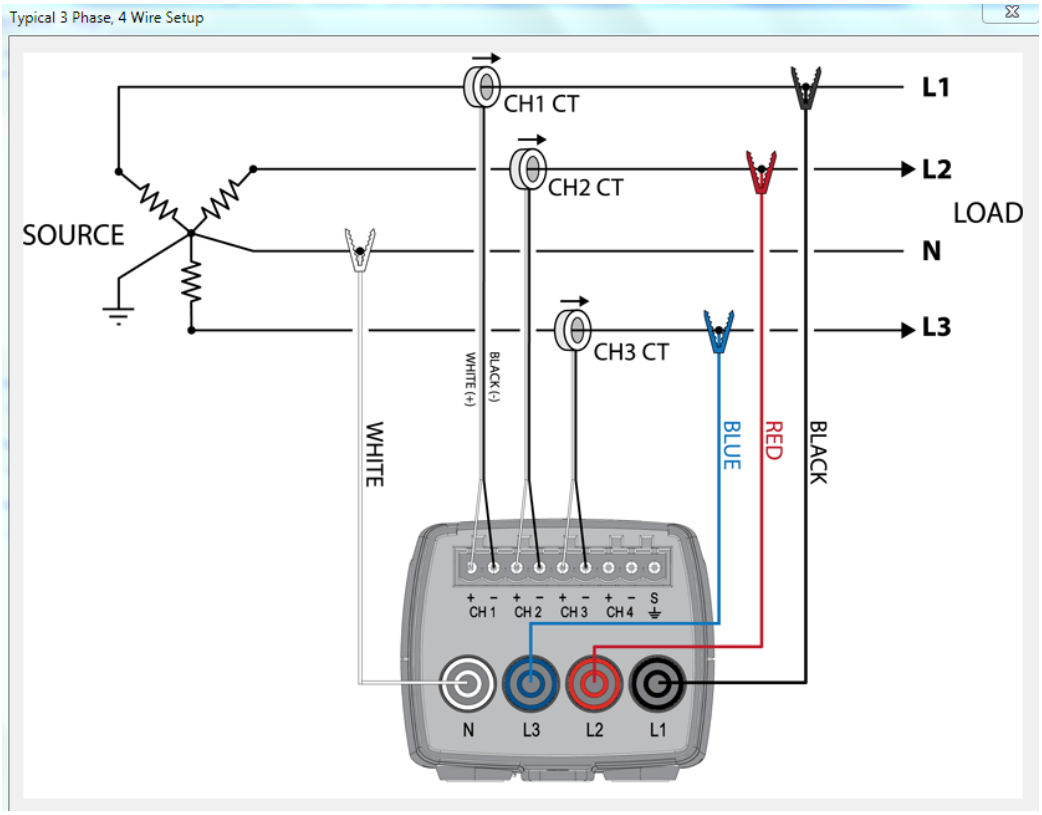
Single-Phase 2-Wire Setup



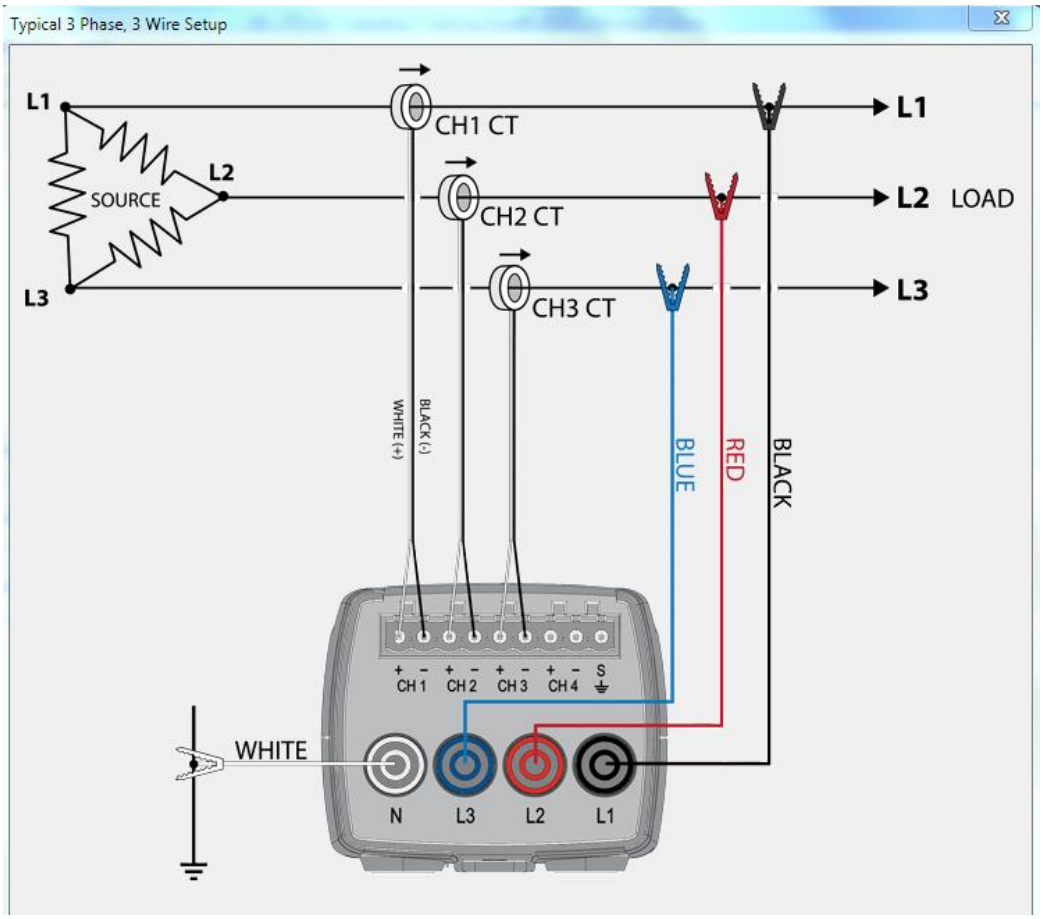
Single-Phase 3-Wire (Split Phase) Setup



Three-Phase 4-Wire (WYE) Setup



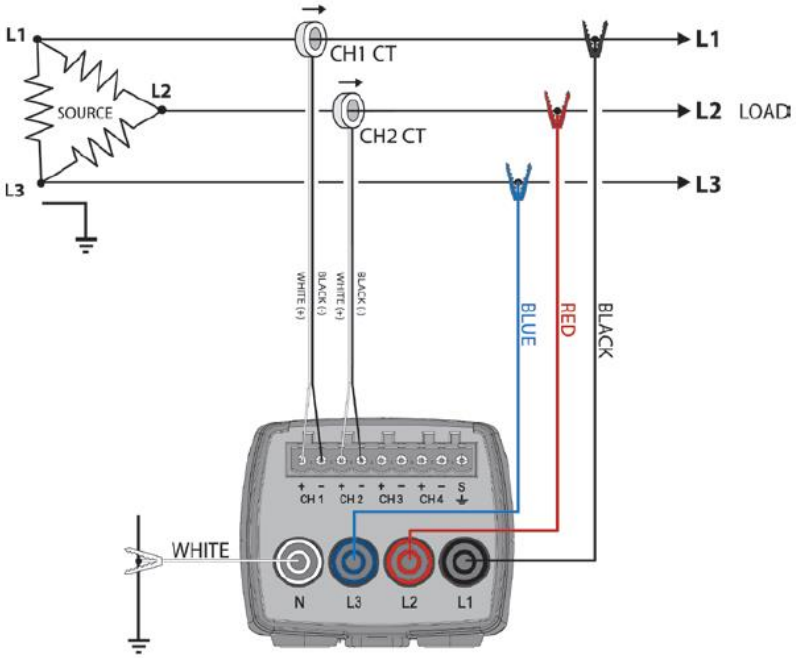
Three-Phase 3-Wire (Delta) Setup Using the 3-CT Method (recommended)



Three-Phase 3-Wire (Delta) Setup Using 2 CTs

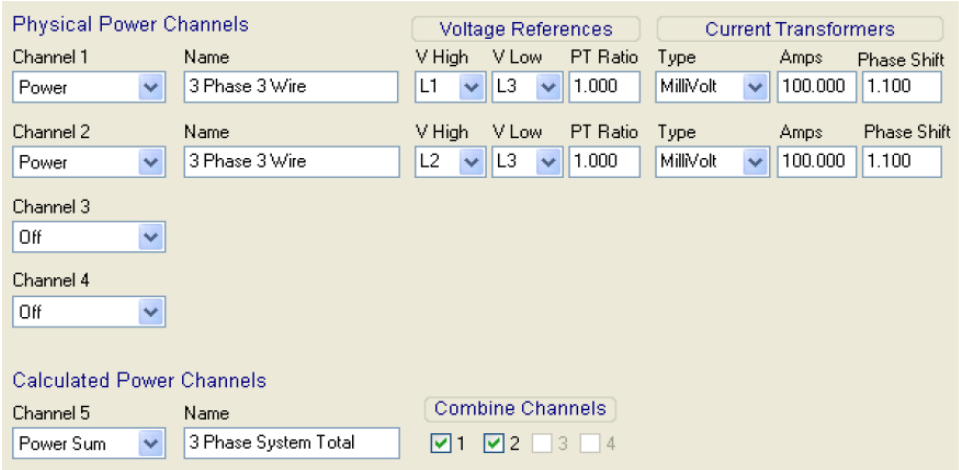
Advantage: You can measure two Delta loads with 4 channels

Disadvantage: It's more difficult to determine if wiring is correct because the phase wattage and PF values will not be the same



2 CT, 3-Wire Delta

Configure the Setup Table as follows:

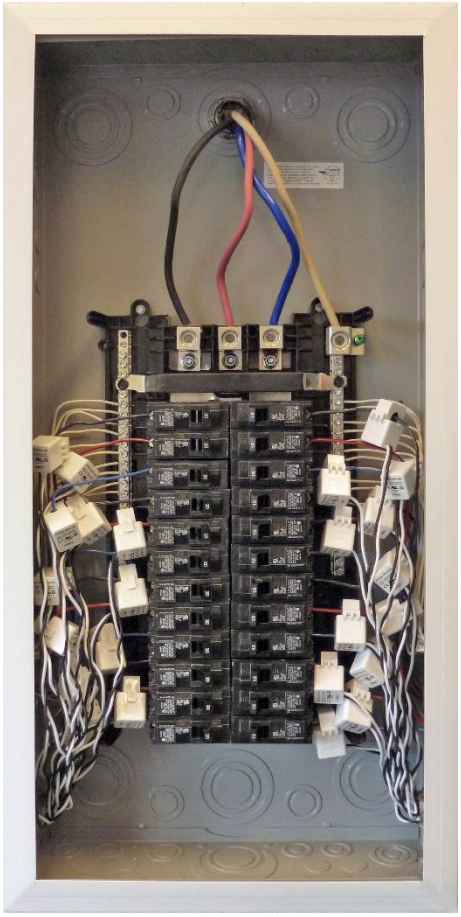


4 Install CTs on the load wires and run the CT output wires to the meter.

1. Be sure the CTs are connected to the correct phases.
    - The CT must match the Setup Table configuration in ELOG software.
        - For example, if the CT is to be installed on the CH2 and CH2 is configured as L2-N (L2=Vhi, N=Vlo), this CT must be installed on L2 of the load, otherwise kW, KVARs, and PF will be INCORRECT.
2. Ensure that all CTs are facing the correct direction.
    - Some CTs point to the Source, while others point to the Load. Refer to the labeling on the CT to determine which direction to face.
    - If a CT is installed backwards, kW and kVAR readings will be negative

CT Installation, Continued…

3. Connect the CT wires to the meter
    - Be sure to follow the CT instructions for polarity.
        - For DENT mV CTs, the white wire is connected to the CT+ terminal and the black wire is connected to the CT- terminal
        - For DENT RōCoil CTs, the white wire is connected to the CT+ terminal, the brown wire is connected to the CT- terminal, and the bare wire is connected to the shield
        - If wired backwards, kW and kVAR readings will be negative



CT Installation, Continued…

4. If running long wire lengths, be sure to label the wires or use color-coded wires to help prevent the CTs from being installed on an incorrect CT channel.
5. Unused current channels can be left open. It is normal for an unused channel to measure values.
    - If reading values on an unused channel is not desired, simply short the CT input with a small wire.

CT Installation Tips

① **Note the maximum distance CT leads can be extended.**
- RōCoils: 100ft
- Split Cores: 500ft

② **Parallel CTs to increase the number of monitored circuits:**
- CTs must all be on the same voltage phase
- CTs must all have the same amperage rating
- CT value in the SUT =
  (Amperage Rating) X (Number of CTs)

5 Connect the meter's voltage inputs to the load's voltage source.

1. Wiring the voltage leads on an energized source is not recommended.
    - All DENT meters have a built-in power supply across L1 and L2. Once L1 or L2 is connected, the other lead will become energized.
    - To avoid shock, disconnect the voltage leads from the ELITEpro XC so the croc-clips/voltage lead with banana plug assembly can be first connected to the voltage source separately from the meter.
2. Be certain the voltage source is the same source that is feeding the load to be measured.
    - There are instances where there are two transformers feeding a building. In this case, it's easy to accidently connect the voltage leads to the incorrect transformer.

IMPORTANT!
Always observe safety best practices while working in a panel. Wear gloves and other protective gear as required.

Connecting the Meter to Voltage, Continued…

3. It is best practice to connect the meter's voltage inputs to a dedicated circuit breaker (one that is fed by the same voltage sources as the load) using bare wires or croc-clips.
    - With the circuit breaker off, connect the L1, L2, and L3 bare wires or croc-clips to the breaker and the Neutral wire to the Neutral buss bar.
4. If a dedicated circuit breaker is not available, choose a breaker that is accessible and is fed by the same voltage source as the load.
    - Connect the L1, L2, and L3 croc-clips (with the wires disconnected from the meter) to a circuit breaker and the Neutral wire to the Neutral buss bar. Connect the banana plugs into the meter.

6 Power the Meter

7 If the meter wasn't configured before the site visit, use ELOG software to now configure it for the current project.

1. Setup Table
    - Select the correct line frequency
    - Select the service type
        - Single Phase
        - Split Phase
        - WYE
        - 2 CT Delta
    - Select which parameters to log
    - Choose a logging interval
2. Verify logging is on

Verifying Meter Installation

Before leaving the job site, it's critical to verify that the meter is installed properly and is recording as expected. After installation, take a few moments to follow the 10 steps of meter verification.

1 Record important information on the installation. Keep this information in a safe place.

1. Date
2. Installer
3. Site Location
4. Meter Serial Number
5. Network Settings
    - Gateway IP Address
    - Meter IP Address
    - Meter Port
6. Description of the monitored load

2 Take pictures of the installation site.

1. Outside the electrical room. This is helpful for any other personnel who need to interface with the meter.
2. Inside the electrical room.
3. The meter itself along with CT installation and voltage connections.

3 Using ELOG software, retrieve the Setup Table from the logger and verify that it is correct.

1. Data interval is set (typical is 15 minutes).
2. Vhi and Vlo match the voltage phases the CTs are installed on.
3. CT type setting matches the CTs used.
4. CT Amp setting matches the CTs used.
5. CT phase shift matches settings outlined in the Operator's Guide.
6. Recorded Values are selected as needed for the project.

4 Using ELOG software, verify the logger's clock is correct.

1. Check the logger clock by either:
    - Viewing Real-Time Values
    - Synchronizing time to the PC
    - Manually setting the clock

5 Are the PhaseChek LEDs green?

1. If any LEDs are blue, the kW will be negative. This is most likely caused by the CT being installed backwards.
2. If any LEDs are red, the PF<0.55. This is most likely caused by the CTs being placed on the wrong phase and not matching the Setup Table. Or, the load's PF<0.55.
3. If LEDs flash red and blue, this indicates the CT is on backwards and on the wrong voltage phase, not matching the Setup Table.
4. **Note: If using the optional Delta 2 CT Connection, it is common for an LED to be red when the system PF is <0.87 and an LED to be blue when the PF<0.5**

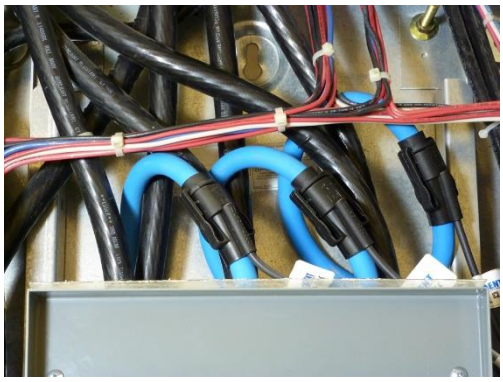
6 Using ELOG software, check Real-Time values to see if the numbers make sense.

1. Are the load current and watt measurements reasonable for the load?
    - **Example 1:** If the current readings are 12 Amps for a 100 HP motor, the readings are obviously too low. This could mean:
        - CTs are on the wrong wire
        - CT value in the Setup Table is incorrect
        - CT type in the Setup Table is incorrect
    - **Example 2:** When using RōCoil CTs, the current reading is zero and the expected current should be 4 Amps. This could mean:
        - The current is too low to measure with a RōCoil CT. RōCoils are designed for high-current use and readings will snap to zero on currents below 5 Amps.

Note: It is best to choose a CT in which the load will be between 10% and 100% of the CT full scale rating.

Checking Real-Time Values, Continued…

2. Are the phase currents relatively close to each other (within 20%) on a load that should be balanced? If not:
    - CTs are on the wrong wire
    - CT value in the Setup Table is incorrect
    - CT type in the Setup Table is incorrect
3. For Wye loads, are the phase watts relatively close to each other (within 20%)? If the phase currents were balanced, check for:
    - CTs being placed on the wrong phase and not matching the Setup Table
    - CT type in the Setup Table is incorrect



Checking Real-Time Values, Continued...

4. Are the phase watts positive? If not:
    - Most likely the CT is installed backwards or the wire connection at the meter is reversed. Check to see if the CT is installed backwards. If you do not want to reverse the CT, reverse the CT wires at the logger connection.
    - **Note:** It is possible when using the 2-CT method on a Delta load that one channel/phase can be negative on loads that have poor PF.
    - **Note:** Negative values could be correct for co-generation applications, such as wind or solar, during power generation.
5. For Wye loads, are the phase PF readings relatively close to each other when monitoring a balanced load? If not:
    - This is most likely caused by the CT being placed on the wrong phase and not matching the Setup Table.

Checking Real-Time Values, Continued…

6. If available, compare to external references. Readings should match within a percent or two (no two meters will read exactly the same).
    - Digital Voltmeters (DVM)
        - Does the Meter Phase voltages match the DVM's reading?
    - Clamp-On Amp Meters (e.g., Amprobe)
        - Do the meter phase currents match the clamp-on Amp meter?
    - Clamp-On Power Meter (e.g., Fluke 41)
        - Do the meter phase watts match the clamp-on power meter?

7 Is the Logging On LED flashing green?

8 If using remote communication, check to ensure communication has been established.

1. Wi-Fi Troubleshooting
    - Verify the port number in the Network Connect window matches the meter setting
    - The laptop's Wi-Fi adapter needs to be in DHCP for use in Access Point mode (this is the default setting)
    - In Access Point mode, the ELITEpro XC's IP address is 192.168.1.1
    - If a password is used in Access Point mode, verify the correct password has been entered. If unsure, re-enter the password using ELOG
    - If communication is lost, try the following:
        - Disconnect the meter from ELOG and reconnect
        - Disconnect the computer Wi-Fi from the meter's Wi-Fi

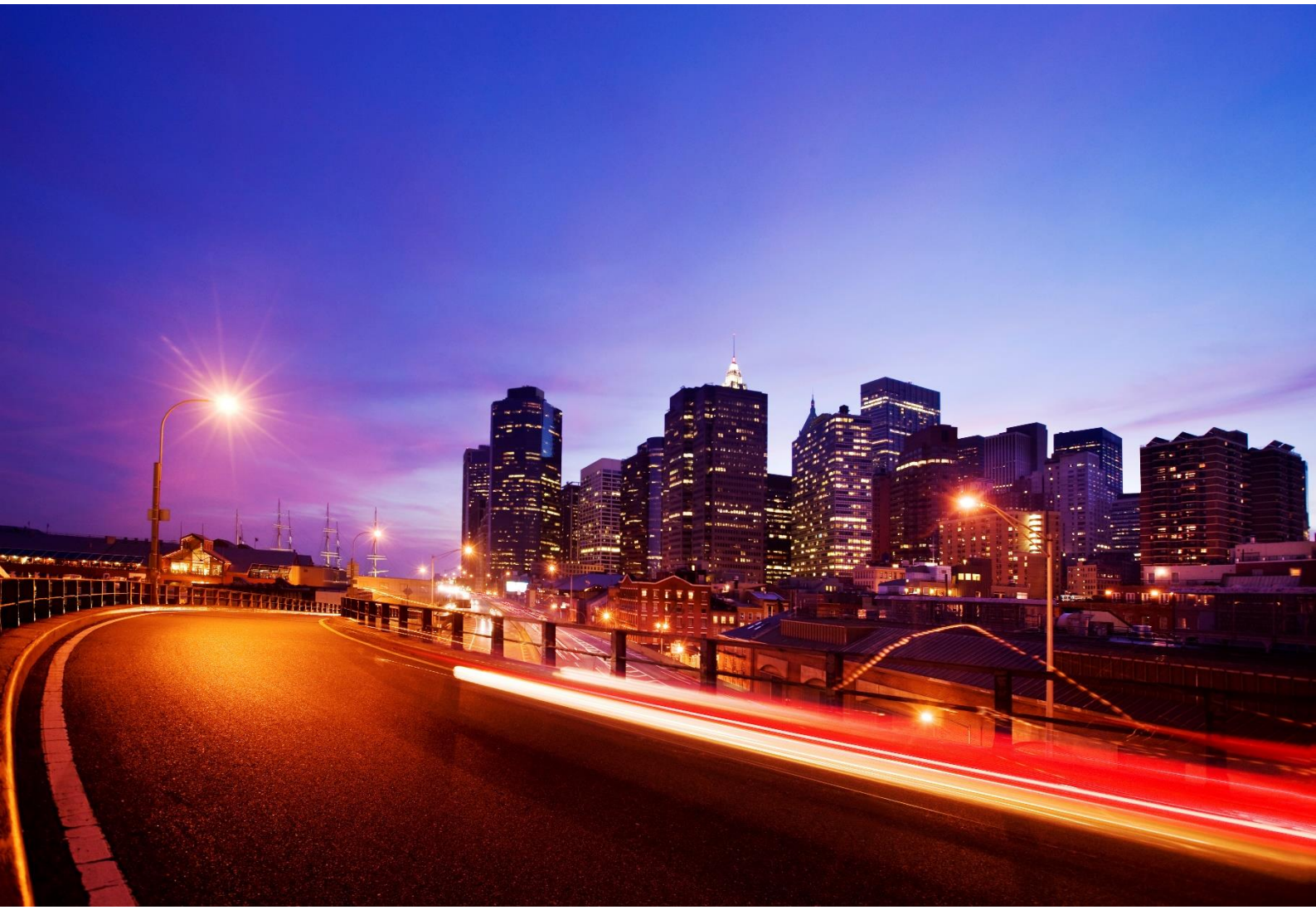
9 Are all cabinet doors closed and locked? Have all screws in the panel been tightened?

10 Has all trash been picked up? Is the site as clean as when you first arrived?

Congratulations!

You've completed the meter setup!

Appendix



Contact Us & Tech Resources

If you need technical help installing your ELITEpro or PowerScout, we are here to help! Please get in touch with DENT Instruments one of the following ways.

Toll Free: 1-800-388-0770
Direct: +1-541-388-4774

www.DENTinstruments.com
techhelp@dentinstruments.com

Software/Firmware

www.DENTinstruments.com/support

Tech Documentation

http://www.dentinstruments.com/tech-support-pdfs-manuals-instructions

Checklist: Before the Site Visit

Print and complete this worksheet prior to visiting the metering site. Refer to Page 4 in the Metering Project Guide for further details on this section.

- ❑ Which type of load needs to be monitored?
- ❑ How many loads need to be monitored?
- ❑ What do you want to learn about each load?
- ❑ How long will the project run?
- ❑ Is the meter going to be connected to a Building Management System (BMS)?
- ❑ Review the building's electrical line drawing.
- ❑ Install the DENT software and any necessary communication device drivers onto the actual laptop to be used in the field.
- ❑ Select the Current Transformers for your project based on circuit breaker size and accuracy requirements.

Checklist: At the Project Site

Print and complete this worksheet at the project site. Refer to Page 11 in the Metering Project Guide for further details on this section.

- ❑ Locate the electrical panel with the load's breakers to see if the breaker size matches the electrical drawing
- ❑ Determine where to install the meter. Keep in mind the length of the project to make the best choice.
- ❑ Determine the communication method: Ethernet, Wireless, Bluetooth, or direct USB connection,
- ❑ Verify the breaker actually controls the load you wish to measure.

Checklist: Meter Installation

Print and complete this worksheet at the metering site. Refer to Page 16 in the Metering Project Guide for further details on this section.

- ❑ Mount the meter.
- ❑ If using a wired communication method, run communication wires and connect them to the meter.
- ❑ Check the wiring diagrams to determine the correct wiring connections for the service being measured.
- ❑ Install CTs on the load wires and run the CT output wires to the meter.
- ❑ Connect the meter's voltage inputs to the load's voltage source.
- ❑ Power the meter.
- ❑ If the meter was configured before the site visit, use ELOG to configure it for the new project now.

Checklist: Verifying Installation

Print and complete this worksheet at the metering site. Refer to Page 28 in the Metering Project Guide for further details on this section.

- ❑ Record important information on the installation & keep in a safe place for future reference.
- ❑ Take pictures of the installation site.
- ❑ Using ELOG, retrieve the Setup Table from the logger and verify that it is correct.
- ❑ Using ELOG, verify the logger's clock is correct.
- ❑ Check to see if the PhaseChek LEDs are green.
- ❑ Using ELOG, check Real-Time values to see if the numbers make sense.
- ❑ If using remote communication, check that communication has been established.
- ❑ Close and lock all cabinet doors; tighten any screws.
- ❑ Pick up all trash to leave the site clean.

Checklist: Final Checklist

The following is a checklist to cover the majority of what needs to be considered or taken into account when installing a DENT Instruments power meter. It is not intended to be all-encompassing as every scenario will be different.

Date:		**Meter Serial Number:**	
Installer:		**Meter Description:**	
Site Location:		**Meter IP Address:**	
Site Number:		**Meter Port:**	
Gateway IP:		**Load Description CT1:**	
		Load CT2 (if different):	
		Load CT3 (if different):	
		Load CT4 (if different):	

Checklist Item	Pass	N/A	Comment
Pictures: Outside of electrical room to aid in locating electrical panel for next visit, inside electrical room, picture of meter installed along with CT installation and Voltage connection	❑	❑	
Using ELOG, verify the logger setup is correct.			
Is the data Interval set (typical is 15 minutes)?	❑	❑	
Does Vhigh and Vlow match the voltage phases the CTs are installed on?	❑	❑	
Does the CT Type setting match the CT used?	❑	❑	
Does the CT Amp setting match the CT used?	❑	❑	

Checklist: Final Checklist

Continued...

Does the CT Phase Shift match the table at bottom of check list for the CT used (also included in the manual)?	❑	❑	
Are the Recorded Values selected as needed for the project?	❑	❑	
Is the logger's time correct?	❑	❑	
Is the Logging On LED flashing green?	❑	❑	
Verify the measurements are correct			
Are the PhaseChek LEDs green?	❑	❑	
Are the currents and watt measurements reasonable for the load (helps to verify the correct load is monitored)?	❑	❑	
Are the phase currents relativity close to each other (within about 20%) on a load that should be balanced?	❑	❑	
For WYE loads, are the phase watts relativity close to each other (within about 20%)?	❑	❑	
For WYE loads, are all the phase watts positive?	❑	❑	
For WYE loads, are the phase PF readings relativity close to each other when monitoring a balanced load?	❑	❑	
If available, compare to external references (within a percent or two, no two meters will read exactly the same).			
Digital Voltmeters (DVM): Does the meter phase voltages match the DVM's?	❑	❑	
Clamp-on Amp meters (e.g., Amprobe): Do the meter phase currents match the clamp-on Amp meter?	❑	❑	
Clamp-on Power Meters (e.g., Fluke 41): Do the meter phase watts match the clamp-on Power Meter?	❑	❑	
Communications with Meter			
If using remote communication, can the meter be communicated with (Wi-Fi, Cellular)?	❑	❑	
Final			
Are all cabinet doors, closed, locked, and all screws in panels tightened?	❑	❑	
Is all trash picked up, leaving site as clean as it was when arrived?	❑	❑	

Checklist: Final Checklist

Current Transformers			Recommended CT Phase Shift Value
	Split Core Small	CT-SCS-0050	2.20°
		CT-SCS-0100	2.20°
	Split Core Medium	CT-SCM-0100	1.75°
		CT-SCM-0200	1.50°
		CT-SCM-0400	1.30°
		CT-SCM-0600	1.30°
	Split Core Large	CT-SCL-0600	0.00°
		CT-SCL-1000	0.00°
	Split Core High Accuracy	CT-SHS-0005	0.50°
	Split Core Hinged	Mini 20A	0.75°
		Mini 50A	0.75°
		Midi 100A	0.12°
		Midi 200A	0.30°

Recommended CT Phase Shift Values

DENT Instruments designs and manufactures data loggers and energy recorders for today's energy professionals. Our products are often the first step in developing strong energy strategies, for maintaining peak operations, and for lowering operating costs. For over 25 years, our company has built a reputation for providing instruments of the highest quality whose robust design, small size and remote data acquisition make them the loggers of choice for companies large and small.

Since the company's emergence in 1988, we have performed energy measurement studies for a wide range of utility, government, and private clients. This unique customer perspective has strongly influenced the design of our products, reflected in their ease of installation and use.

DENT Instruments is headquartered in Bend, Oregon. We are proud to be a locally owned and managed business, and a key contributor to the economic health and well-being of Central Oregon.

DENT INSTRUMENTS

Energy & Power Measurement Solutions