

# ***WATTNODE<sup>®</sup> LOGGER***

for LONWORKS<sup>®</sup>

## Installation and Operation Manual

- WNC-3Y-208-FT10-L
- WNC-3Y-400-FT10-L
- WNC-3Y-480-FT10-L
- WNC-3Y-600-FT10-L
- WNC-3D-240-FT10-L
- WNC-3D-400-FT10-L
- WNC-3D-480-FT10-L



Rev 3.67b

**(M9)**

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Printed in the United States of America.

Document Number: WNC-FT10-L-3.67b

Revision Date: November 30, 2011

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## **FCC Information**

This equipment has been tested and complies with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

The FCC limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician to help.

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## Overview

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Congratulations on your purchase of the WattNode® Logger for LONWORKS® watt/watt-hour transducer. The WattNode offers precision energy and power measurements in a compact package. The WattNode enables you to make power and energy measurements within existing electric service panels avoiding the costly installation of subpanels and associated wiring. It is designed for use in demand side management (DSM), sub-metering, and energy monitoring applications. Models are available for single-phase, three-phase wye, and three-phase delta configurations for voltages from 120 VAC to 600 VAC at 50 and 60 Hz.

The WattNode® Logger for LONWORKS is LONMARK® 3.4 certified, ensuring plug-and-play interoperability on LONWORKS networks.

Continental Control Systems also provides a free LNS plug-in for use with the WattNode. The WattNode plug-in simplifies configuration and browsing. For WattNode Logger models, the plug-in required to download log data.

## Measurements

The WattNode Logger transducer measures the following:

- True RMS Power: (Watts) Phase A, Phase B, Phase C, Sum
- Reactive Power: (VARs) Phase A, Phase B, Phase C, Sum
- Power Factor: Phase A, Phase B, Phase C, Average
- True RMS Energy: (Kilowatt-hours) Phase A, Phase B, Phase C, Sum
- Reactive Energy: (kVAR-hours) Sum
- AC Frequency: (Hertz)
- RMS Voltage: (Volts) Phase A, Phase B, Phase C
- RMS Current: (Amps) Phase A, Phase B, Phase C
- Demand and Peak Demand: (Watts)

## Logging

The WattNode Logger meter stores all measurements to flash memory at a configurable interval from one minute to 12 hours. The log stores 24186 records; at the default 15 minute log interval, this provides more than eight months of storage.

The WattNode Logger includes a highly accurate clock with battery backup to maintain accurate date and time, so that log records have accurate timestamps. The clock is accurate to  $\pm 2$  minutes per year. The battery should last at least five years; typically ten years or more.

## Communication

The WattNode meter communicates on a LONWORKS TP/FT-10 free topology twisted-pair network using Echelon's® LonTalk® network protocol. Network variables interface the WattNode to the network. Each device on the network may have both input and output network variables. Output network variables may be polled or bound (connected) to input network variables of the same type. Whenever an output network variable is updated, the new value is propagated over the network, and all devices which have input network variables bound to the updated output will update their internal copies of the variable.

## Options

The WattNode for LonWorks meter can be ordered with several options. For more details and documentation, see article [WattNode Plus for LonWorks - Options](#) on our website.

- **Option CT=xxx** - Factory configure xxx as the ***nciCtAmps*** value.

- **Option PT** - Improves support for potential transformers (PTs), making it easier to use the WattNode meter with medium voltage services. Specifically, Option PT adds a configuration property **UCPTptRatio** which configures the ratio of the external PT, allowing the meter to automatically scale the voltage, power, and energy readings. See [WattNode LonWorks - Option PT](#).
- **Option B** - Emulates the interface and behavior of the original WNB series WattNode Plus models (model numbers WNB-xx-xxx-FT10).
- **Option BI** - Emulates the interface and behavior of the original WNB series WattNode Plus models (model numbers WNB-xx-xxx-FT10) with 16 bit integer network variables (SNVTs).

## Current Transformers

The WattNode meter uses solid-core (toroidal), split-core (opening), and bus-bar style current transformers (CTs) with a full-scale voltage output of 0.33333 Vac. Split-core and bus-bar CTs are easier to install without disconnecting the circuit being measured. Solid-core CTs are more compact, generally more accurate, and less expensive, but installation requires that you disconnect the circuit to install the CTs.

## Additional Literature

- Continental Control Systems, LLC website
  - [http://www.ccontrols.com/w/WattNode\\_Plus\\_for\\_LonWorks](http://www.ccontrols.com/w/WattNode_Plus_for_LonWorks) - main page.
  - [http://www.ccontrols.com/w/Category:WattNode\\_for\\_LonWorks](http://www.ccontrols.com/w/Category:WattNode_for_LonWorks) - support articles.
- [WattNode Plug-in for LNS - Installation and Operation Manual](#)
- Handbook for Electricity Metering: Edison Electric Institute
- The Echelon® LONWORKS® Products Databook: Echelon Corporation
- FTT-10A Free Topology Transceiver User's Guide, chapter 4: Network Cabling and Connection: Echelon Corporation

## Front Label

This section describes the connections, information, and symbols used on the front label.

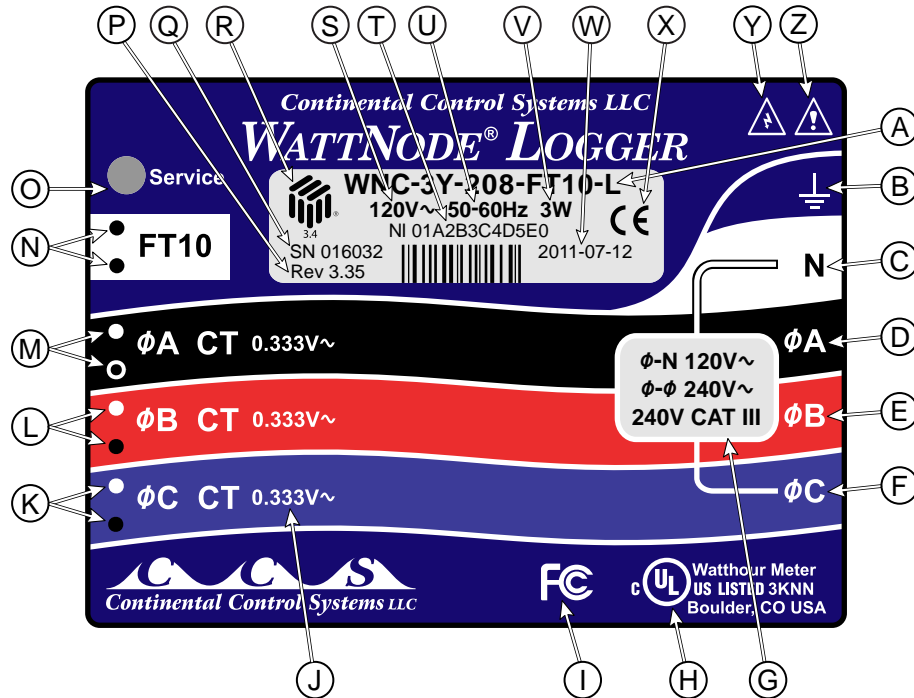


Figure 1: Front Label Diagram

- A: WattNode model number.** The “WNC” indicates a third generation WattNode meter. The “3” indicates a three phase model. The “Y” or “D” indicates wye (four-wire) or delta (three-wire) models, although delta WattNode meters can measure wye circuits (the difference is in the power supply). The “208” (or other value) indicates the nominal line-to-line voltage. Finally, the “FT10-L” indicates LONWORKS FT-10 network output with logging.
- B: Functional ground.** This terminal should be connected to earth ground if possible. It is not required for safety grounding, but the accuracy of the meter may be reduced if this terminal is not connected.
- C: Neutral.** On wye models, this terminal must be connected to neutral. On delta models, it is good practice to connect this terminal to the safety ground terminal using a short jumper wire.
- D, E, F: Mains line inputs.** One or more of these terminals are connected to the mains lines. For three phase measurement, the  $\phi A$  (phase A),  $\phi B$  (phase B), and  $\phi C$  (phase C) terminals are used for the three phases. On wye WattNode models, the meter is powered from the N and  $\phi A$  terminals. On delta models, the meter is powered from the  $\phi A$  and  $\phi B$  terminals.
- G: Line voltage measurement ratings.** This block lists the nominal line-to-neutral “ $\phi-N 120V\sim$ ” voltage, line-to-line “ $\phi-\phi 240V\sim$ ” voltage, and the rated measurement voltage and category “240V CAT III” for this model. See [Specifications – Electrical \(p. 42\)](#) for more information about the measurement voltage and category.
- H: UL Listing mark.** This shows the UL and cUL (Canadian) listing mark and number “3KNN”.
- I: FCC Mark.** This logo indicates that the meter complies with part 15 of the FCC rules.
- J: Current transformer (CT) voltage rating.** These markings “0.333V~” indicate that the meter must be used with CTs that generate a full-scale output voltage of 0.33333 Vac (333.33 millivolts AC).

**K, L, M: Current transformer (CT) inputs.** These indicate CT screw terminals. Note the white and black circles at the left edge of the label: these indicate the color of the CT wire that should be inserted into the corresponding screw terminal. The terminals marked with black circles are connected together internally.

**N: FT10 wiring terminals.** These connect to the LONWORKS FT-10 network. They are polarity insensitive.

**O: LONWORKS service LED.** The LONWORKS service LED indicates network status; see **Service LED (p. 20)**. Immediately below the LED on the side of the housing is the service button, used to identify the WattNode meter on the LONWORKS network.

**P: Firmware version.** This indicates the WattNode meter's firmware version.

**Q: Serial number.** This shows the WattNode meter's serial number.

**R: LonMark.** This logo indicates that the meter meets LonMark interoperability guidelines, v3.4.

**S: Mains supply rated voltage.** This is the rated supply voltage for this model. The **V~** indicates AC voltage. For wye models, this voltage should be applied between the **N** and **φA** terminals. For delta models, this voltage should be applied between the **φA** and **φB** terminals.

**T: Neuron ID.** This is the Neuron® ID (prefixed by "NI"), which is a unique 64 bit hexadecimal number assigned to each LonWorks device.

**U: Mains frequencies.** This indicates the rated mains frequencies for the meter.




**V: Maximum rated power.** This is the maximum power consumption (watts) for this model.

**X: CE Mark.** This symbol indicates that the WattNode meter complies with the regulations of the European Union for Product Safety and Electro-Magnetic Compatibility.

**Y: Caution, risk of electrical shock.** This symbol indicates that there is a risk of electric shock when installing and operating the meter if the installation instructions are not followed correctly.

**Z: Attention - consult Manual.** This symbol indicates that there can be danger when installing and operating the meter if the installation instructions are not followed correctly.

## Symbols

	Attention - Consult Installation and Operation Manual	Read, understand, and follow all instructions in this Installation and Operation Manual including all warnings, cautions, and precautions before installing and using the product.
	Caution – Risk of Electrical Shock	Potential Shock Hazard from Dangerous High Voltage.
	CE Marking	Complies with the regulations of the European Union for Product Safety and Electro-Magnetic Compatibility. <ul style="list-style-type: none"> <li>• Low Voltage Directive – EN 61010-1: 2001</li> <li>• EMC Directive – EN 61327: 1997 + A1/1998 + A2/2001</li> </ul>



# Installation

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## Precautions



### DANGER – HAZARDOUS VOLTAGES

**WARNING** - These installation/servicing instructions are for use by qualified personnel only. To avoid electrical shock, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

Always adhere to the following checklist:

- 1) Only qualified personnel or **licensed electricians** should install the WattNode meter. The mains voltages of 120 Vac to 600 Vac can be lethal!
- 2) Follow all applicable local and national electrical and safety codes.
- 3) Install the meter in an electrical enclosure (panel or junction box) or in a limited access electrical room.
- 4) Verify that circuit voltages and currents are within the proper range for the meter model.
- 5) Use only UL recognized current transformers (CTs) with built-in burden resistors, that generate 0.333 Vac (333 millivolts AC) at rated current. **Do not use current output (ratio) CTs such as 1 amp or 5 amp output CTs: they will destroy the meter and may create a shock hazard.** See [Current Transformers \(p. 43\)](#) for CT maximum input current ratings.
- 6) Ensure that the line voltage inputs to the meter are protected by fuses or circuit breakers (not needed for the neutral wire). See [Circuit Protection \(p. 18\)](#) for details.
- 7) Equipment must be disconnected from the HAZARDOUS LIVE voltages before access.
- 8) The terminal block screws are **not** insulated. Do not contact metal tools to the screw terminals if the circuit is live!
- 9) Do not place more than one line voltage wire in a screw terminal; use wire nuts instead. You may use more than one CT wire per screw terminal.
- 10) Before applying power, check that all the wires are securely installed by tugging on each wire.
- 11) Do not install the meter where it may be exposed to temperatures below  $-30^{\circ}\text{C}$  or above  $55^{\circ}\text{C}$ , excessive moisture, dust, salt spray, or other contamination. The meter requires an environment no worse than pollution degree 2 (normally only non-conductive pollution; occasionally, a temporary conductivity caused by condensation must be expected).
- 12) Do not drill mounting holes using the meter as a guide; the drill chuck can damage the screw terminals and metal shavings can fall into the connectors, causing an arc risk.
- 13) If the meter is installed incorrectly, the safety protections may be impaired.

## Electrical Service Types

Below is a list of service types, with connections and recommended models. Note: the ground connection improves measurement accuracy, but is not required for safety.

Model	Type	Line-to-Neutral	Line-to-Line	Electrical Service Types
WNC-3Y-208-FT10-L	Wye	120 Vac	208-240 Vac	1 Phase 2 Wire 120V with neutral 1 Phase 3 Wire 120V/240V with neutral 3 Phase 4 Wire Wye 120V/208V with neutral
WNC-3Y-400-FT10-L	Wye	230 Vac	400 Vac	1 Phase 2 Wire 230V with neutral 3 Phase 4 Wire Wye 230V/400V with neutral
WNC-3Y-480-FT10-L	Wye	277 Vac	480 Vac	3 Phase 4 Wire Wye 277V/480V with neutral 1 Phase 2 Wire 277V with neutral
WNC-3Y-600-FT10-L	Wye	347 Vac	600 Vac	3 Phase 4 Wire Wye 347V/600V with neutral
WNC-3D-240-FT10-L	Delta or Wye	120-140 Vac	208-240 Vac	1 Phase 2 Wire 208V (no neutral) 1 Phase 2 Wire 240V (no neutral) 1 Phase 3 Wire 120V/240V with neutral 3 Phase 3 Wire Delta 208V (no neutral) 3 Phase 4 Wire Wye 120V/208V with neutral 3 Phase 4 Wire Delta 120/208/240V with neutral
WNC-3D-400-FT10-L	Delta or Wye	230 Vac	400 Vac	3 Phase 3 Wire Delta 400V (no neutral) 3 Phase 4 Wire Wye 230V/400V with neutral
WNC-3D-480-FT10-L	Delta or Wye	277 Vac	480 Vac	3 Phase 3 Wire Delta 480V (no neutral) 3 Phase 4 Wire Wye 277V/480V with neutral 3 Phase 4 Wire Delta 240/415/480V with neutral

\*The wire count does NOT include ground. It only includes neutral (if present) and phase wires.

Table 1: WattNode Models

### Single-Phase Two-Wire with Neutral

This configuration is most often seen in homes and offices. The two conductors are neutral and line. For these models, the meter is powered from the **N** and  $\phi A$  terminals.

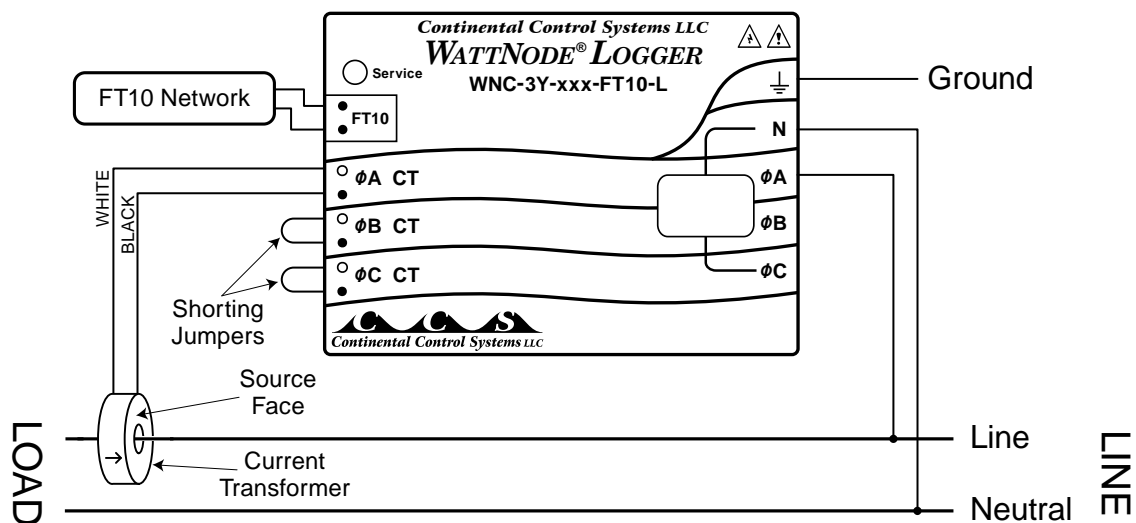


Figure 2: Single-Phase Two-Wire Connection

### Recommended WattNode Models

The following table shows the WattNode models that should be used, depending on the line to neutral voltage.

Line to Neutral Voltage	WattNode Model
120 Vac	WNC-3Y-208-FT10-L
230 Vac	WNC-3Y-400-FT10-L
277 Vac	WNC-3Y-480-FT10-L

### Single-Phase Three-Wire (Mid-Point Neutral)

This configuration is seen in North American residential and commercial service with 240 Vac for large appliances. The three conductors are a mid-point neutral and two line voltage wires with AC waveforms 180° out of phase; this results in 120 Vac between either line conductors (phase) and neutral, and 240 Vac (or sometimes 208 Vac) between the two line conductors (phases).

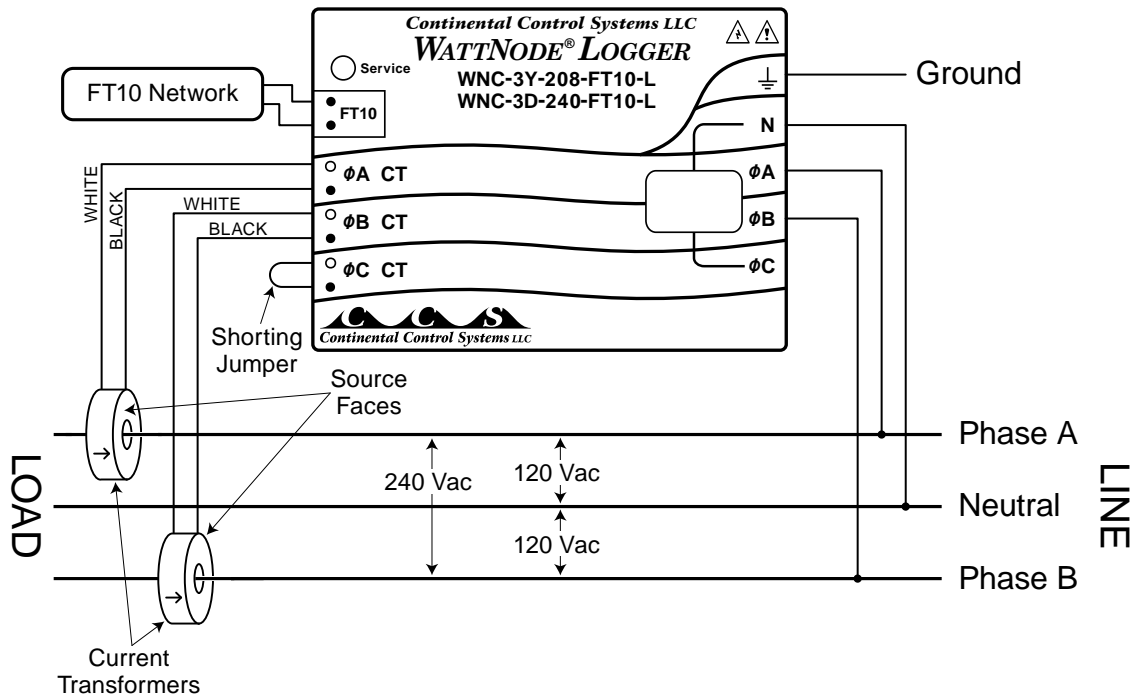


Figure 3: Single-Phase Three-Wire Connection

### Recommended WattNode Models

The following table shows the WattNode models that can be used. If neutral may or may not be present, you should use the WNC-3D-240-FT10-L (see [Single-Phase Two-Wire without Neutral](#) below). If neutral is present, it must be connected for accurate measurements. If phase B may not be present, you should use the WNC-3Y-208-FT10-L (see [Single-Phase Two-Wire with Neutral](#) above).

Meter Power Source	WattNode Model
<b>N</b> and <b>ΦA</b> (Neutral and Phase A)	WNC-3Y-208-FT10-L
<b>ΦA</b> and <b>ΦB</b> (Phase A and Phase B)	WNC-3D-240-FT10-L

## Single-Phase Two-Wire without Neutral

This is seen in residential and commercial service with 208 to 240 Vac for large appliances. The two conductors have AC waveforms 120° or 180° out of phase. Neutral is not used. For this configuration, the meter is powered from the  $\phi A$  and  $\phi B$  (phase A and phase B) terminals.

For best accuracy, we recommend connecting the **N** (neutral) terminal to the ground terminal. This will not cause ground current to flow because the neutral terminal does not power the meter.

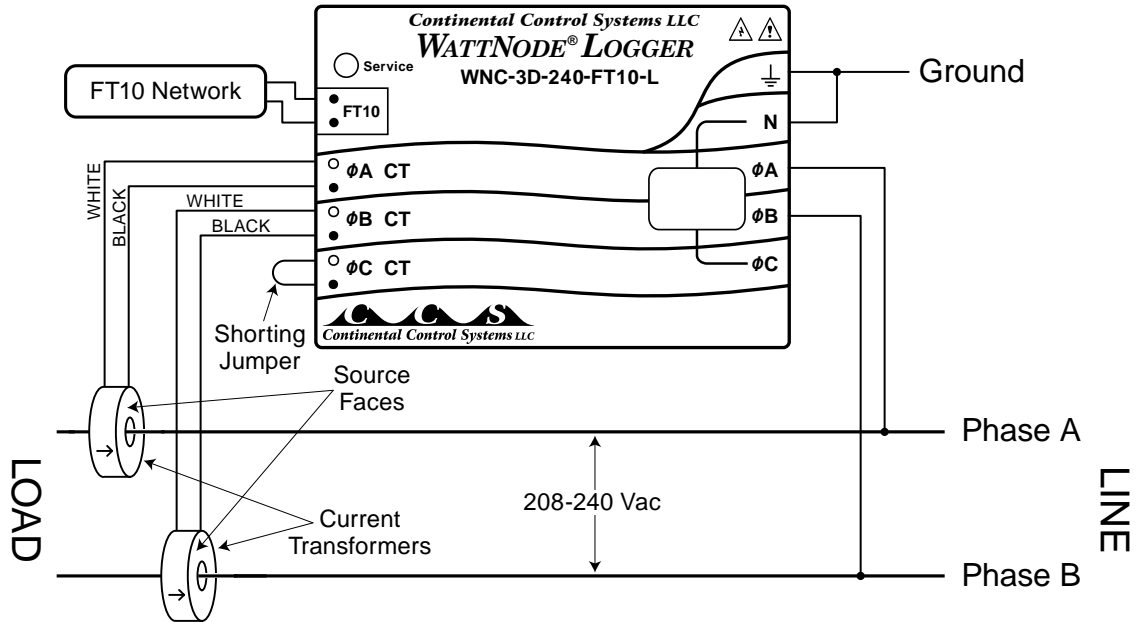


Figure 4: Single-Phase Two-Wire without Neutral Connection

### Recommended WattNode Model

This configuration is normally measured with the following WattNode model.

Line-to-Line Voltage	WattNode Model
208 - 240 Vac	WNC-3D-240-FT10-L

If neutral is available, you may also use the WNC-3Y-208-FT10-L model. If you use the WNC-3Y-208-FT10-L, you will need to hook up the meter as shown in section [Single-Phase Three-Wire \(Mid-Point Neutral\)](#) and connect neutral. You will need two CTs.

If one of the conductors (phase A or phase B) is grounded, see [Grounded Leg Service](#) below for recommendations.

## Three-Phase Four-Wire Wye

This is typically seen in commercial and industrial environments. The conductors are neutral and three power lines with AC waveforms shifted 120° between phases. The line voltage conductors may be connected to the  $\phi A$ ,  $\phi B$ , and  $\phi C$  terminals in any order, **so long as the CTs are connected to matching phases**. It is important that you connect **N** (neutral) for accurate measurements. For wye “-3Y” models, the meter is powered from the **N** and  $\phi A$  terminals.

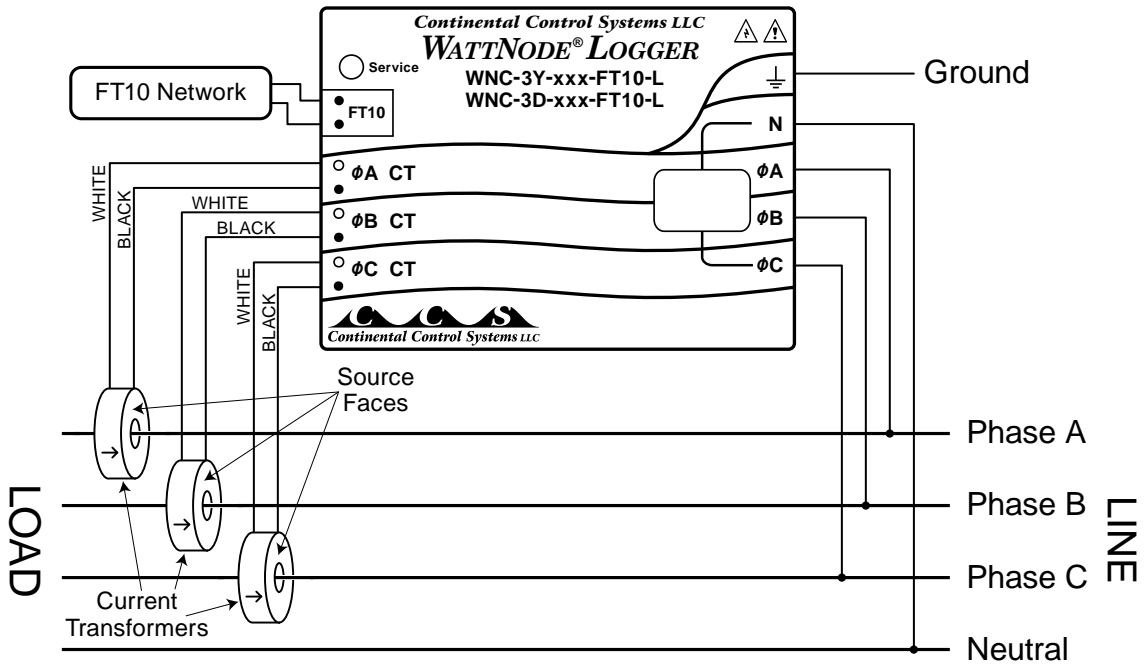


Figure 5: Three-Phase Four-Wire Wye Connection

### Recommended WattNode Models

The following table shows the WattNode models that should be used, depending on the line-to-neutral voltage and line-to-line voltage (also called phase-to-phase voltage).

Line-to-Neutral Voltage	Line-to-Line Voltage	WattNode Model
120 Vac	208 Vac	WNC-3Y-208-FT10-L
230 Vac	400 Vac	WNC-3Y-400-FT10-L
277 Vac	480 Vac	WNC-3Y-480-FT10-L
347 Vac	600 Vac	WNC-3Y-600-FT10-L

Note: you may also use the following delta WattNode models to measure three-phase four-wire wye circuits. The only difference is that delta WattNode models are powered from  $\phi A$  and  $\phi B$ , rather than **N** and  $\phi A$ . If neutral is present, it must be connected for accurate measurements.

Line-to-Neutral Voltage	Line-to-Line Voltage	WattNode Model
120 - 140 Vac	208 - 240 Vac	WNC-3D-240-FT10-L
230 Vac	400 Vac	WNC-3D-400-FT10-L
277 Vac	480 Vac	WNC-3D-480-FT10-L

## Three-Phase Three-Wire Delta Without Neutral

This is typically seen in manufacturing and industrial environments. There is no neutral wire, just three power lines with AC waveforms shifted 120° between the successive phases. With this configuration, the line voltage wires may be connected to the  $\phi A$ ,  $\phi B$ , and  $\phi C$  terminals in any order, **so long as the CTs are connected to matching phases**. For these models, the meter is powered from the  $\phi A$  and  $\phi B$  (phase A and phase B) terminals. Note: all delta WattNode models provide a neutral connection **N**, which allows delta WattNode models to measure both wye and delta configurations.

For best accuracy, we recommend connecting the **N** (neutral) terminal to earth ground. This will not cause ground current to flow because the neutral terminal is not used to power the meter.

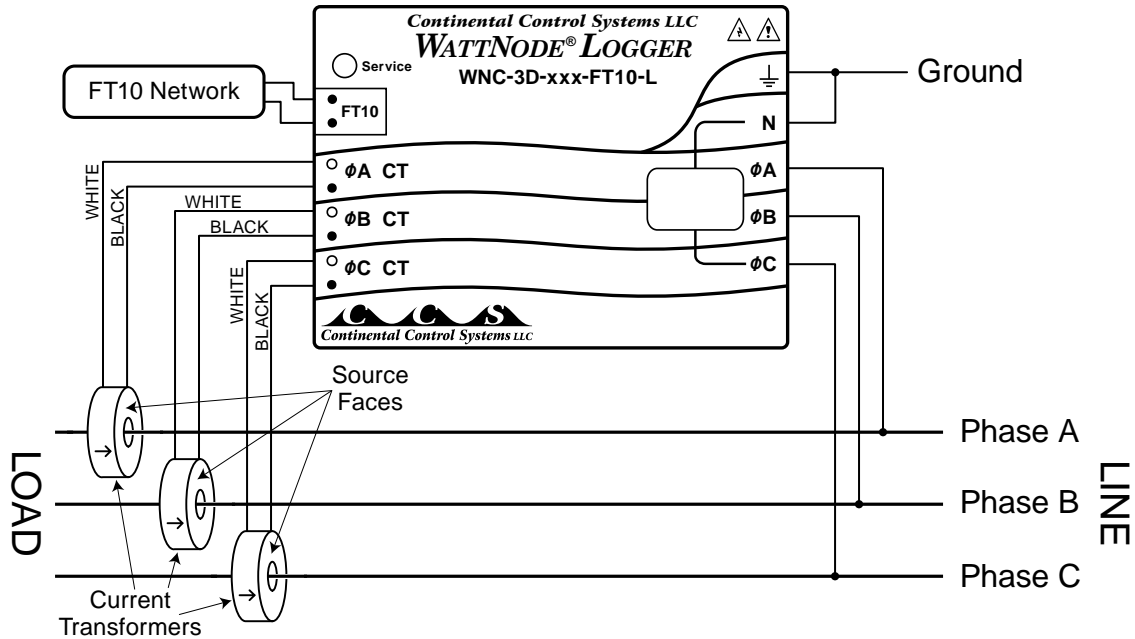


Figure 6: Three-Phase Three-Wire Delta Connection

### Recommended WattNode Models

The following table shows the WattNode models that should be used, depending on the line-to-line voltage (also called phase-to-phase voltage).

Line-to-Line Voltage	WattNode Model
208 - 240 Vac	WNC-3D-240-FT10-L
400 Vac	WNC-3D-400-FT10-L
480 Vac	WNC-3D-480-FT10-L

## Three-Phase Four-Wire Delta (Wild Leg)

The uncommon four-wire delta electrical service is a three-phase delta service with a center-tap on one of the transformer windings to create a neutral for single-phase loads.

See [http://www.ccontrols.com/w/Four\\_Wire\\_Delta\\_Circuits](http://www.ccontrols.com/w/Four_Wire_Delta_Circuits) for details.

## Grounded Leg Service

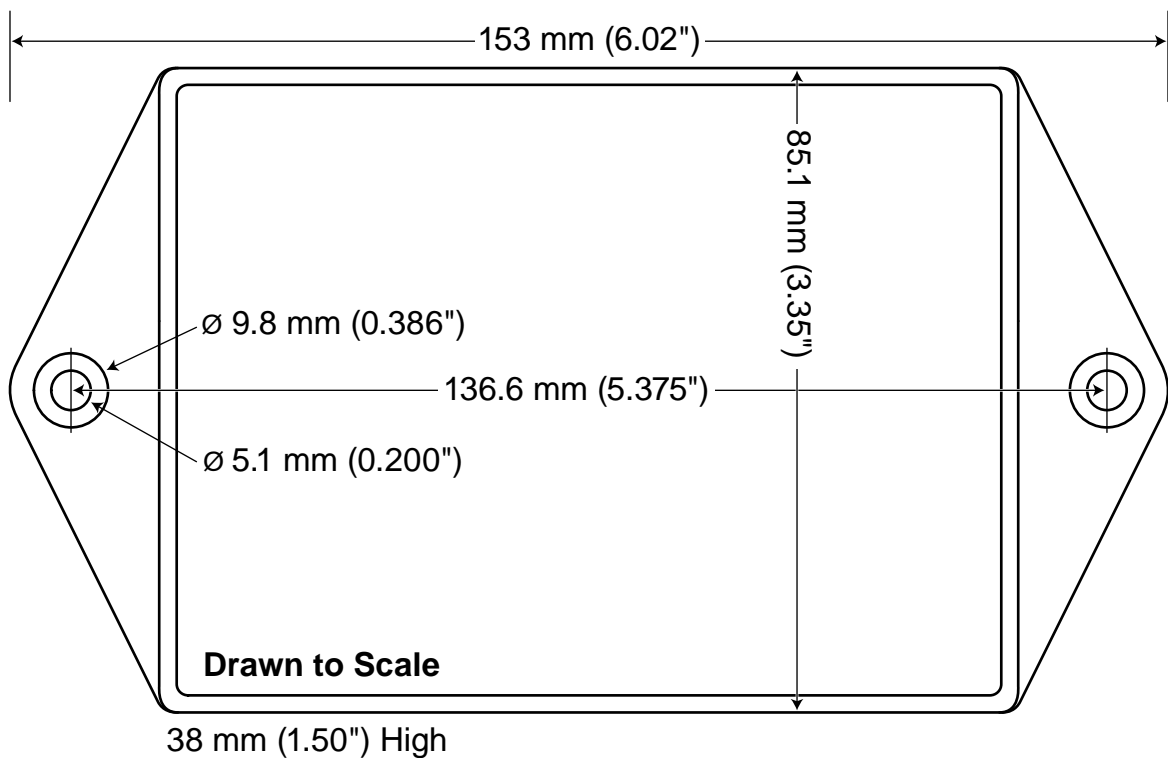
In rare cases with delta services or single-phase two-wire services without neutral, one of the phases may be grounded. You can check for this by using a multimeter (DMM) to measure the voltage between each phase and ground. If you see a reading between 0 and 5 Vac, that leg is probably grounded (sometimes called a “grounded delta”).

The WattNode meter will correctly measure services with a grounded leg, but the measured voltage and power for the grounded phase will be zero.

For optimum accuracy with a grounded leg, you should also connect the **N** (neutral) terminal on the meter to the ground terminal; this will not cause any ground current to flow because the neutral terminal is not used to power the meter. If you have a grounded leg configuration, you can save money by removing the CT for the grounded phase, since all the power will be measured on the non-grounded phases. We recommend putting the grounded leg on the **ΦB** or **ΦC** inputs and attaching a note to the meter indicating this configuration for future reference.

## Mounting

Protect the WattNode meter from moisture, direct sunlight, high temperatures, and conductive pollution (salt spray, metal dust, etc.) If moisture or conductive pollution may be present, use an IP 66 or NEMA 4 rated enclosure to protect the meter. Due to its exposed screw terminals, the meter must be installed in an electrical service panel, an enclosure, or an electrical room. The meter may be installed in any orientation, directly to a wall of an electrical panel or junction box.



**Figure 7: WattNode Meter Dimensions**

The WattNode meter has two mounting holes spaced 5.375 inches (137 mm) apart (center to center). These mounting holes are normally obscured by the detachable screw terminals. Remove the screw terminals by pulling outward while rocking from end to end. The meter or **Figure 7** may be used as a template to mark mounting hole positions, but **do not drill the holes with the meter in the mounting position** because the drill may damage the connectors and leave drill shavings in the connectors.

You may mount the meter with the supplied #8 self-tapping sheet metal screws using 1/8 inch pilot hole (3.2 mm). Or you may use hook-and-loop fasteners. If you use screws, avoid over-tightening which can crack the case. If you don't use the supplied screws, the following sizes should work (**bold** are preferred); use washers if the screws could pull through the mounting holes

Screw Style	U.S.A. UTS Sizes	Metric Sizes
Pan Head or Round Head	#6, #8, #10	M3.5, M4, M5
Truss Head	#6, #8	M3.5, M4
Hex Washer Head (integrated washer)	#6, #8	M3.5, M4
Hex Head (add washer)	#6, #8, #10	M3.5, M4, M5

Table 2: Mounting Screws

## Selecting Current Transformers

The rated full-scale current of the CTs should normally be chosen somewhat above the maximum current of the circuit being measured (see **Current Crest Factor** below for more details). In some cases, you might select CTs with a lower rated current to optimize accuracy at lower current readings. Take care that the maximum allowable current for the CT can not be exceeded without tripping a circuit breaker or fuse; see **Current Transformers (p. 43)**.

We only offer CTs that measure AC current, not DC current. Significant DC current can saturate the CT magnetic core, reducing the AC accuracy. Most loads only have AC current, but some rare loads draw DC current, which can cause measurement errors. See our website for more information: [http://www.ccontrols.com/w/DC Current and Half-Wave Rectified Loads](http://www.ccontrols.com/w/DC%20Current%20and%20Half-Wave%20Rectified%20Loads).

CTs can measure lower currents than they were designed for by passing the wire through the CT more than once. For example, to measure currents up to 1 amp with a 5 amp CT, loop the wire through the CT five times. The CT is now effectively a 1 amp CT instead of a 5 amp CT. The effective current rating of the CT is the labeled rating divided by the number of times that the wire passes through the CT.

All the CTs used with a WattNode Logger meter should have the same rated amps. You cannot readily mix two different current ratings (say two 200 A CTs and one 50 A CT), because there is a single *nciCtAmps* configuration variable that applies to all phases.

### Current Crest Factor

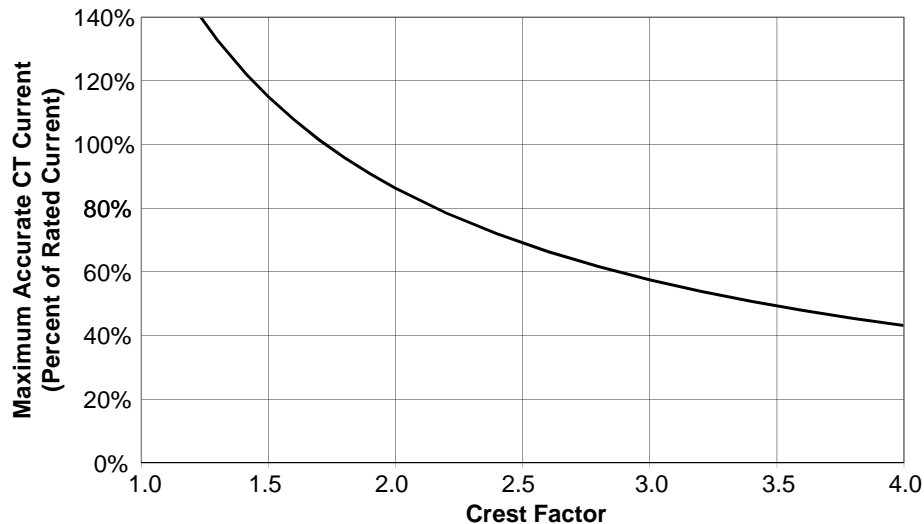
The term “current crest factor” is used to describe the ratio of the peak current to the RMS current (the RMS current is the value reported by multimeters and the WattNode meter). Resistive loads like heaters and incandescent lights have nearly sinusoidal current waveforms with a crest factor near 1.4. Power factor corrected loads such as electronic lighting ballasts and computer power supplies typically have a crest factor of 1.4 to 1.5. Battery chargers, VFD motor controls, and other nonlinear loads can have current crest factors ranging from 2.0 to 3.0, and even higher.

High current crest factors are usually not an issue when metering whole building loads, but can be a concern when metering individual loads with high current crest factors. If the peak current is too high, the meter’s CT inputs can clip, causing inaccurate readings.

This means that when measuring loads with high current crest factors, you may want to be conservative in selecting the CT rated current. For example, if your load draws 10 amps RMS, but has a crest factor of 3.0, then the peak current is 30 amps. If you use a 15 amp CT, the meter will not be able to accurately measure the 30 amp peak current. Note: this is a limitation of the meter measurement circuitry, not the CT.

The following graph shows the maximum RMS current for accurate measurements as a function of the current waveform crest factor. The current is shown as a percentage of CT rated current. For example, if you have a 10 amp load with a crest factor of 2.0, the maximum CT current is approximately 85%. Eighty-five percent of 15 amps is 12.75, which is higher than 10 amps, so your measurements should be accurate. On the other hand, if you have a 40 amp load with a crest factor of 4.0, the maximum CT current is 42%. Forty-two percent of a 100 amp CT is 42 amps, so you would need a 100 amp CT to accurately measure this 40 amp load.





**Figure 8: Maximum CT Current vs. Crest Factor**

You frequently won't know the crest factor for your load. In this case, it's generally safe to assume the crest factor will fall in the 1.4 to 2.5 range and select CTs with a rated current roughly 150% of the expected RMS current. So if you expect to be measuring currents up to 30 amps, select a 50 amp CT.

## Connecting Current Transformers

- Use only UL recognized current transformers (CTs) with built-in burden resistors that generate 0.33333 Vac (333.33 millivolts AC) at rated current. See [Current Transformers \(p. 43\)](#) for the maximum input current ratings.
- **Do not** use ratio (current output) CTs such as 1 amp or 5 amp output CTs: they will **destroy** the meter and present a shock hazard! These are commonly labelled with a ratio like 100:5.
- Find the arrow or label "THIS SIDE TOWARD SOURCE" on the CT and face toward the current source: generally the utility meter or the circuit breaker for branch circuits. If CTs are mounted backwards or with their white and black wires reversed the measured power will be negative.
- Be careful to match up the current transformers to the voltage phases being measured. Make sure the **ΦA CT** is measuring the line voltage connected to **ΦA**, and the same for phases B and C. Use the supplied colored labels or tape to identify the wires.
- To prevent magnetic interference, the CTs on different phases should be separated by 1 inch (25 mm). The line voltage conductors for each phase should be separated by at least 1 inch (25 mm) from each other and from neutral.
- For best accuracy, the CT opening shouldn't be much larger than the conductor. If the CT opening is much larger, position the conductor in the center of the CT opening.
- Because CT signals are susceptible to interference, we recommend keeping the CT wires short and cutting off any excess length. It is generally better to install the meter near the line voltage conductors instead of extending the CT wires. However, you may extend the CT wires by 300 feet (100 m) or more by using shielded twisted-pair cable and by running the CT wires away from high current and line voltage conductors.
- OPTIONAL: if you see spurious readings on unused phases, jumper the unused CT inputs.

To connect CTs, pass the wire to be measured through the CT and connect the CT to the meter. **Always remove power before disconnecting any live wires.** Put the line conductors through the CTs as shown in the section [Electrical Service Types \(p. 10\)](#). You may measure generated power by treating the generator as the source.

For solid-core CTs, disconnect the line voltage conductor to install it through the CT opening.

Split-core and bus-bar CTs can be opened for installation around a wire by pulling the removable section straight away from the rest of the CT or unhooking the latch; it may require a strong pull. Some CT models include thumb-screws to secure the opening. The removable section may fit only one way, so match up the steel core pieces when closing the CT. If the CT seems to jam and will not close, the steel core pieces are probably not aligned correctly; **DO NOT FORCE** together. Instead, reposition or rock the removable portion until the CT closes without excessive force. A nylon cable tie can be secured around the CT to prevent inadvertent opening.

Some split-core CT models have flat mating surfaces. When installing this type of CT, make sure that mating surfaces are clean. Any debris between the mating surfaces will increase the gap, decreasing accuracy.

Next, connect the CT lead wires to the meter terminals labeled **ΦA CT**, **ΦB CT**, and **ΦC CT**. Route the twisted black and white wires from the CT to the meter. We recommend cutting off any excess length to reduce the risk of interference. Strip 1/4 inch (6 mm) of insulation off the ends of the CT leads and connect to the six position black screw terminal block. Connect each CT lead with the white wire aligned with the white dot on the label, and the black wire aligned with the black dot. Note the order in which the phases are connected, as the voltage phases **must** match the current phases for accurate power measurement.

Finally record the CT rated current as part of the installation record for each meter. If the conductors being measured are passed through the CTs more than once, then the recorded rated CT current is divided by the number of times that the conductor passes through the CT.

## Circuit Protection

The WattNode meter is considered “permanently connected equipment”, because it does not use a conventional power cord that can be easily unplugged. **Permanently connected equipment must have overcurrent protection and be installed with a means to disconnect the equipment.**

- A switch, disconnect, or circuit breaker may be used to disconnect the meter and must be as close as practical to the meter. If a switch or disconnect is used, then there must also be a fuse or circuit breaker of appropriate rating protecting the meter.
- WattNode meters only draw 10-30 milliamps; CCS recommends using circuit breakers or fuses rated for between 0.5 amps and 20 amps and rated for the line voltages and the current interrupting rating required.
- The circuit breakers or fuses must protect the ungrounded supply conductors (the terminals labeled **ΦA**, **ΦB**, and **ΦC**). If neutral is also protected (this is rare), then the overcurrent protection device must interrupt neutral and the supply conductors simultaneously.
- Any switches or disconnects should have at least a 1 amp rating and must be rated for the line voltages.
- The circuit protection / disconnect system must meet IEC 60947-1 and IEC 60947-3, as well as all national and local electrical codes.
- The line voltage connections should be made with wire rated for use in a service panel or junction box with a voltage rating sufficient for the highest voltage present. CCS recommends 14 or 12 AWG (1.5 mm<sup>2</sup> or 2.5 mm<sup>2</sup>) stranded wire, rated for 300 or 600 volts. Solid wire may be used, but must be routed carefully to avoid putting excessive stress on the screw terminal.
- The WattNode meter has an earth connection, which should be connected for maximum accuracy. However, this earth connection is not used for safety (protective) earthing.

## Connecting Voltage Terminals

**Always turn off or disconnect power** before connecting the voltage inputs to the meter. Connect each phase voltage to the appropriate input on the green terminal block; also connect ground and neutral (if required).

The voltage inputs to the meter do not need to be powered from the same branch circuit as the load being monitored. In other words, if you have a three-phase panel with a 100 A three-pole breaker powering a motor that you wish to monitor, you can power the meter (or several meters) from a separate 20 A three-pole breaker installed in the same, or even adjacent panel, so long as the load and voltage connections are supplied from the same electric service.

The green screw terminals handle wire up to 12 AWG (2.5 mm<sup>2</sup>). Strip the wires to expose 1/4" (6 mm) of bare copper. When wiring the meter, do not put more than one wire under a screw. If you need to distribute power to other meters, use wire nuts or a power distribution block. The section **Electrical Service Types (p. 10)** shows the proper connections for the different meter models and electrical services. **Verify that the voltage line phases match the CT phases.**

If there is any doubt that the meter voltage rating is correct for the circuit being measured, unplug the green terminal block (to protect the meter), turn on the power, and use a voltmeter to compare the voltages (probe the terminal block screws) to the values in the white box on the meter front label. After testing, plug in the terminal block, making sure that it is pushed in all the way.

The WattNode meter is powered from the voltage inputs: **ΦA** (phase A) to **N** (neutral) for wye “-3Y” models, or **ΦA** to **ΦB** for delta “-3D” models. If the meter is not receiving at least 80% of the nominal line voltage, it may stop operating. Since the meter consumes a small amount of power itself (typically 1-3 watts), you may wish to power the meter from a separate circuit or place the current transformers downstream of the meter, so its power consumption is not measured.

For best accuracy, always connect the **N** (neutral) terminal on the meter. If you are using a delta meter and the circuit has no neutral, then jumper the earth ground to the **N** (neutral) terminal.

## Connecting LonWorks Network Wiring

CCS recommends that an experienced LonWorks network installer be consulted for network design, particularly for the areas of topology, repeaters, wiring, and termination.

The FT-10 twisted pair network is not polarized, so either network wire can be connected to either screw terminal. When connecting to a network, there is a maximum permissible stub length. The stub is the length of the ‘T’ branch wire connecting the main network to the meter. If the main network wiring is connected directly to the meter, the effective stub length is zero.

Connect the network wiring to the two circuit black terminal block labeled **FT10**. Strip 6 mm (1/4") of insulation off the ends of the wires, insert the wires into the terminals and tighten the screws.

If the meter is connected without a stub, then two wires can be installed in each terminal. If this is done, we recommend twisting the wires together, inserting them all the way into terminal slot, and securely tightening. Any loose wires can disable an entire section of the network.

After the network wiring has been connected, check that all the wires are securely installed by gently tugging on each wire in turn. Also check that the terminal block connectors are fully seated. At this point power may be applied to the meter. Note: there is no harm in applying power before making the network connections.

### LonWorks TP/FT-10 Free Topology Network

Traditional multidrop network wiring systems such as RS-485 require a daisy-chain or bus wiring configuration to prevent interference from signal reflections. The LonWorks TP/FT-10 free topology network transceivers include signal processing to cancel out reflections, allowing the network to be wired in arbitrary configurations: bus, star, ring, or some combination. In free topology

configurations, one network terminator is recommended. In bus configurations, both ends of the bus should be terminated and stub lengths must be limited to 3m.

The following table list some recommended cables. The maximum lengths for free topology networks includes two numbers: the first is the maximum node-to-node distance, the second is the maximum total cable length. The length limits can be doubled by adding a TP/FT-10 repeater.

Description	AWG	Pairs	Shielded?	Insulation	Max Length Bus	Max Length Free Topology
CAT 5	24	4	Optional	300 V	900 m	250 m / 450 m
NEMA Level IV	22	1, 2	Optional	300 V	1400 m	400 m / 500 m
Belden 8471	16	1	No	300 V	2700 m	400 m / 500 m
Belden 85102	16	1	No	300 V	2700 m	500 m / 500 m

**Table 3: Recommended FT-10 Cabling**

- Since the FT-10 wiring may be located near line voltage wiring, use wires or cables rated for the highest voltage present, generally 300 or 600 volt rated wire.
- If this cable will be in the presence of bare conductors, such as bus-bars, it should be double insulated or jacketed.
- Use twisted-pair cable (unshielded or shielded) to prevent interference.

## Wiring

Once you've planned the network and run the cable, you can connect the meters.

- The meter's **FT10** outputs are completely isolated from all dangerous voltages, so you can connect them at any time with the meter powered.
- You may put two sets of wires in each screw terminal to make it easier to daisy-chain the network from one WattNode meter to the next. If you do this, we recommend that you twist the wires tightly together before putting them into the screw terminal to ensure that one wire doesn't pull free, causing communication problems.

## Installation Summary

- 1) Mount the WattNode meter.
- 2) Turn off power before installing solid-core (non-opening) CTs or making voltage connections.
- 3) Mount the CTs around the line voltage conductors being measured. Take care to orient the CTs facing the source of power.
- 4) Connect the twisted white and black wires from the CT to the six position black terminal block on the meter, matching the wire colors to the white and black dots on the front label.
- 5) Connect the voltage wires including ground and neutral (if present) to the green terminal block, and check that the current (CT) phases match the voltage measurement phases.
- 6) Connect your FT-10 network to the black FT10 terminals of the WattNode meter.
- 7) Apply power to the meter.
- 8) Verify that the service LED lights correctly and does not indicate an error condition.

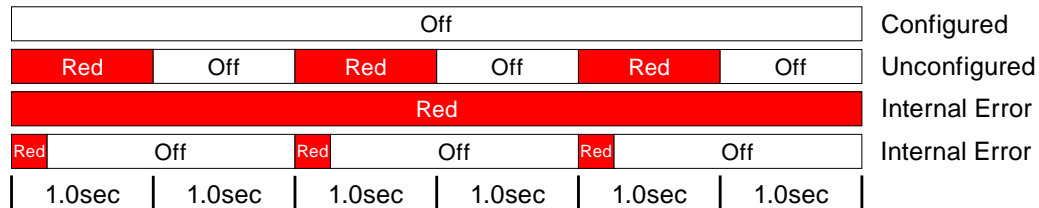
## Service LED

The LonWORKS service LED indicates the network configuration status of the WattNode. The LED should always light while the service button is being pressed: this can test that the WattNode is powered.

Many problems can be diagnosed by observing the service LED. The figure below shows the different behaviors of the WattNode service LED after power up. During normal operation, after the initial power up and network configuration, the LED should remain OFF. During some network

management actions, the service LED may light or flash until the action is complete. The following terms describe the various states of the WattNode.

- **Unconfigured:** The WattNode is operating properly, but has not yet been configured (installed) by network management software.
- **Configured:** The WattNode is operating properly and has been configured by network management software. The LED may flash very briefly when power is first applied, but otherwise will stay off unless you press the service button.
- **Internal Error:** The WattNode is not functioning correctly and must be returned for service.



**Figure 9: Service LED Behaviors**

Any pattern of LED flashing not described by the figure above should also be treated as an internal error, and the WattNode returned for service. Before returning the WattNode, try cycling power at least once and observing the LED carefully. If possible, note the LED behavior, as this will help with diagnosing the problem.

## Communication Troubleshooting

If you cannot configure the WattNode with your monitoring software or the WattNode stops communicating, you may have one of the following problems:

- **No power or damaged WattNode:** Test the meter by pressing the service button and verifying that the LED lights while the button is pressed. If the service LED does not light, check the AC voltage supplied to the meter to ensure power is present.
- **Wiring problem:** Check for any loose or disconnected wires. If possible, try to use a laptop computer to communicate with the WattNode meter at close range. If this works, then the problem may be a bad connection.
- **Excessive bus length:** Depending on the cable type and termination, the maximum bus length can range from 250 meters to 2700 meters. See the **Echelon LonWorks FTT-10A Transceiver User's Guide** for recommendations.
- **Missing termination:** Except for very short runs, Echelon recommends one or two network terminators to prevent reflections and reduce susceptibility to interference.
- **Too many nodes:** Each TP/FT-10 subnet should be limited to 64 devices including WattNode meters and other node types. Exceeding this will cause unreliable communication.
- **Electrical interference:** In some cases, electrically noisy equipment may interfere with the LONWORKS network. This can generally be determined either by noting that communication fails whenever a certain device is active, such as a high power variable speed motor drive, or by disconnecting the normal network wiring and running a very short length of wire from the WattNode to a laptop to verify that communication works. If this is the problem, you may need to use shielded network cabling, limit the length of the cabling, add terminators at both ends of the cable, or use FT-10 repeaters.
- **Damaged FT-10 transceiver:** In rare cases, the FT-10 transceiver in the meter can be damaged. If the meter will not communicate even with a very short direct cable, then the transceiver may be damaged and you will probably need to return the meter for service.

## Measurement Troubleshooting

There are a variety of possible measurement problems. The following procedure should help narrow down the problem. This assumes you can communicate with the meter and read network variables.

### Voltage

Start by checking the reported voltage (*nvoVoltsA*, *nvoVoltsB*, *nvoVoltsC*) for active (connected) phases. Make sure the voltages match the expected line-to-neutral voltages (or line-to-ground for delta circuits). You should check the actual voltages present at the WattNode meter with a DMM (multimeter) if possible.

- If all voltages (and other readings) are zero, then the meter may be in the “Offline” or “Soft-Offline” state. This is a special network management state used during configuration, such as binding SVNTs and writing configuration properties. When the WattNode meter is offline, it cannot perform any measurements and will report zero values. You must use your network management tool to set the state back to “Online”.
- If one or more voltages are zero, then you either have a wiring problem or something is wrong with the meter. Verify the actual voltages with a DMM (multimeter). In rare cases, with delta circuits, one phase may be grounded and will read zero volts.
- If one or more voltages are too low (by more than 5%), then make sure you have the correct model. For example, a WNC-3Y-208-FT10-L expects line-to-neutral voltages of 120 Vac and can measure up to about 150 Vac. If you apply 208 Vac line-to-neutral, the WattNode meter will read a voltage in the 150 Vac to 180 Vac range.
- If any voltages read high, then check your wiring. If the wiring is correct, contact support.
- If the voltages are close to the measured (or expected) values, continue with the next step.

### Power

Next, check the measured power for each active phase (*nvoPowerA*, *nvoPowerB*, *nvoPowerC*). If possible, estimate or measure the actual power. Also, make sure the load you are measuring is currently on.

- If one or more active phases are reporting zero power, then the problem is probably one of the following:
  - There is no active power (the load is off) or the power is too low to measure (generally less than 1/1000th of full-scale).
  - CT wires are not securely connected.
  - The *nciCtAmps* is set to zero (some network management tools zero configuration variables on installation).
  - The CT or its wires are damaged.
  - There is strong electrical interference, as might occur if the meter is in very close proximity to a variable speed drive (also called variable frequency drive or inverter).
  - The meter is not working correctly: try swapping it with a replacement WattNode meter.
- If one or more active phases are reporting negative power:
  - The current transformer has been installed backward on the wire being measured. CTs are marked with either an arrow or a label saying “This side toward source”. If the arrow or label are not oriented toward the source of power (generally the panel or breaker), then the measured current will be inverted and the power negative. This can be fixed either by flipping the CT or by swapping the white and black wires where they enter the meter.
  - The current transformer white and black wires have been swapped where they enter the WattNode meter (at the black screw terminal block).

- The line voltage phases (green screw terminals) are not matched up with the current phases (black screw terminals). For example, the phase A CT is around the phase B wire.
- This may be normal if you are measuring in an environment where power may be consumed or generated, such as a house with PV panels.
- If one or more phases are reporting low or high power:
  - Make sure the **nciCtAmps** configuration is set correctly for your current transformers.
  - Some LNS tools, such as LonMaker®, may select units of **btu/hr** for power instead of **watts**. This results in readings that appear to be 3.4X too high. See application note **AN-120 Configuring LonMaker Power Units** for more information.
  - The current transformers may have a rated current too high or too low for your application. CTs should be used between 10% and 100% of their rated current for best results. They generally work with reduced accuracy as low as 0.5% to 0.1% of rated current.
  - The CTs may not be installed properly. Check for: CTs touching each other or pre-existing CTs; CT opening too large for the conductor being measured.
  - The voltage phases (green screw terminal block) are not matched up with the current phases (black screw terminal block). The easiest way to determine this is to skip ahead to the next troubleshooting section: **Power Factor and Reactive Power**.
  - Interference from a variable frequency or variable speed drive: VFD, VSD, inverter, or the like. Generally, these drives should not interfere with the WattNode meter, but if they are in very close proximity, or if the CT leads are long, interference can occur. Try moving the WattNode meter at least three feet (one meter) away from any VFDs. Use short CT leads if possible. **NEVER** install the meter downstream of a VFD: the varying line frequency and extreme noise will cause problems!
  - Our current transformers can only measure AC currents. Furthermore, strong DC currents will saturate the magnetic core of the CT, preventing an accurate measurement of the AC current. The overwhelming majority of AC powered electric devices do not draw significant DC current, so this is a rare occurrence.
  - Loads with a high current crest factor (ratio of the peak current to the RMS current) can cause clipping in the measurement circuitry, resulting in lower than expected readings. You can check for this with a handheld power quality analyzer that can measure crest factor (CF) or by trying a CT with a higher rated current, which should allow the meter to measure the peak current accurately.
  - In rare cases, the CTs are defective or mislabeled. If possible, use a current clamp to verify the current, then use a DMM (multimeter) to measure the AC voltage between the white and black wires from the CT (leave them connected to the meter during this test). At rated current, the CT output voltage should equal 0.333 Vac (333 millivolts AC). At lower currents, the voltage should scale linearly, so at 20% of rated current, the output voltage should be  $0.20 * 0.333 = 0.0666$  Vac (66.6 millivolts AC).
  - If possible, verify the expected power with a handheld power meter. Current clamps can be useful to very roughly estimate the power, but since they measure current, not power, the estimated power (voltage times current) may be off by 50% or more.

## Power Factor and Reactive Power

The measured power factor and reactive power are very useful in determining if there is a phasing mismatch between the voltage and current measurement phases on the meter. For example, if the phase A CT is around the phase B wire.

However, this troubleshooting is complicated because different loads have different typical power factors and the power factor can vary significantly for some devices, like motors, as a function of the mechanical load on the motor. Here are some general guidelines:

- **Motors, idling or with a light load:** power factor from 0.1 to 0.6, positive reactive power.
- **Motors, normal or heavy load:** power factor from 0.5 to 0.8, positive reactive power.

- **Motor with VSD:** power factor between 0.5 and 0.9.
- **Incandescent lighting:** power factor near 1.0, small negative reactive power.
- **Florescent lighting:** power factor between 0.4 and 1.0.
- **Electrical heating:** power factor near 1.0.
- **Office equipment:** power factor between 0.6 and 1.0, reactive power may be positive or negative.

Negative power factor values either indicate you are generating power (as with a PV system) or that the CTs are reversed.

If the measured power factor or reactive power appears to be outside the normal ranges, this most commonly indicates that the voltage and current phases on the meter are not connected properly, although some loads fall outside the normal ranges. Check the following:

- The CT connected to the **ΦA CT** terminal is installed around the line wire being measured by the **ΦA Vac** terminal (green terminal block).
- The CT connected to the **ΦB CT** terminal is installed around the line wire being measured by the **ΦB Vac** terminal (green terminal block).
- The CT connected to the **ΦC CT** terminal is installed around the line wire being measured by the **ΦC Vac** terminal (green terminal block).

If this doesn't solve your problem, contact technical support for more assistance.

## Network Configuration

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### Identifying the WattNode

The WattNode for LonWorks meter supports three network identification methods.

- Press the meter's service button when requested by the network installation software.
- Use the meter's unique Neuron ID to identify the WattNode.
- Use the network wink command to light the meter's service LED.

Service button installation requires that the network management computer be near the meter during installation or that a second person can be near the meter to press the service button. If this technique is used, follow the procedure for installing a new node on the network in the network management software. When the software prompts you to press the service pin, press the small button beside the black network connector (while pressed, the Service LED will light). If the network management software does not respond within several seconds, then there is probably some problem with the network; see [Communication Troubleshooting \(p. 21\)](#) above.

Neuron ID installation is performed by manually entering the meter's Neuron ID into the network management software during node installation. This technique allows an electrician to install and record the location and Neuron IDs of several meters. Once the meters are physically installed, they can be configured remotely. The Neuron ID (NI) is printed on the front label.

Wink installation can be used when several meters—and possibly other nodes—have been physically installed and need to be identified for the network. The network management software must be able to find unconfigured nodes on the network. When an unconfigured node is found, the network management software will be instructed to send the wink command to the node. By observing which meter responds to the wink command by lighting its service LED solidly for 15 seconds, the physical location of the meter may be matched with the network address.

The wink command may also be used after a meter has been configured on the network to verify its network communication and/or its physical location.



## Network Reinitialization

The WattNode meter may be reinitialized to clear its configuration settings. Reinitialization can be used when the meter is installed in a new location or on a new network, or to restore all configuration network variables to the factory default values.

To reinitialize the WattNode meter, first remove power. Then, while holding the service button pressed, restore power. Continue holding the service button for five seconds after power is restored, then release. After a few seconds, the service LED should begin to flash (one second ON, one second OFF). Now the meter is unconfigured and ready to be installed.

Reinitialization deletes all network configuration, returning the meter to the unconfigured state. The service LED flashes slowly when the meter is unconfigured. All network variable bindings will be deleted and all of the configuration network variables will be restored to factory default values, except the calibration values and ***nciCtAmps***. This does not clear log data, the accumulated energy or reactive energy.

# Operating Instructions

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## Quick Start

To start communicating with a WattNode meter, you'll need to complete the following steps:

- Make sure you have a working LNS based network management software tool like LonMaker® with an FTT-10A network interface like the Echelon U10.
- We recommend installing the [LNS Plug-in for WattNode](#). This will install the XIF and resource files for the WattNode for LonWorks meters. Alternatively, you can download the XIF and resource files separately or use self-discovery.
- Add the WattNode meter to your network using the network management tool and commission the meter.
- Use the LonMaker browser, LNS Plug-in, or similar tool to browse the network variables.
- Verify that the readings are reasonable and perform basic configuration.
- **Note:** if you are not familiar with any LNS LonWorks network management tool, you will generally need the assistance of a LonWorks network integrator or you will need to attend a training class.

Now you should be able to browse variables on the WattNode meter and perform configuration, like setting the CT rated amps.

## WattNode Basic Configuration

- Set the *nciCtAmps* to the correct rated CT amps of your current transformers. For example, if you are using 100 A CTs, write 100 to *nciCtAmps*.
- Set the date and time with *nviTimeSet*, so that logged data timestamps and the peak demand timestamp will be correct.
- If you are planning on using demand measurements and you don't want to use the default 15 minute interval, you should set the *nciDemPerMins* as well.

## Verify Operation

You should be able to read several variables to check that the meter is correctly installed and measuring power and energy. Verify variables in the following sequence:

- *nvoFreq* (power line frequency): should be near 50 or 60 Hz.
- *nvoVoltA*, *nvoVoltB*, *nvoVoltC*: should match your line-to-neutral voltage.
- *nvoPowerA*, *nvoPowerB*, *nvoPowerC*: should be positive (unless you are measuring something that can generate power like a PV system) and in a reasonable range for the load being measured (make sure your load is ON).
- If you don't get reasonable results, check [Measurement Troubleshooting \(p. 22\)](#) above.

## Measurement Overview

The WattNode meter performs measurements every five seconds. The measurements are used to update three types of variables:

- **Energy variables:** These accumulate up (or sometimes down) based on the consumed energy during each measurement period. Energy values are preserved across power failures.
- **Instantaneous variables:** These are non-accumulating values, like power, volts, current, etc. These are not preserved across power failures.
- **Demand variables:** these accumulate data from each measurement, but the reported demand values only update at the completion of a demand interval (or subinterval), which is typically every 15 minutes. Only the peak demand and peak demand timestamp are preserved across power failures.

## Network Variables

The WattNode meter uses LONMARK® interoperable SNVTs (Standard Network Variable Type) and is programmed with self-documentation information. It is supplied with an external interface file (XIF), which defines all of the network variables and transceiver parameters. The XIF file may be requested by network management software during installation and is particularly useful if you wish to configure the network software for a meter before physically installing it.

WattNode meter network variable names are prefixed with three letters indicating the type:

- **nvi** - Input to the meter, but may also be read.
- **nvo** - Output from the meter.
- **nci** - Configuration network variable; normally inputs to the meter, but may be read to determine the current configuration. Configuration variables are preserved during power outages.

## Authentication

For installations where the WattNode will be used for billing, the network variables **nviTimeSet**, **nciCtAmps**, **nviResetEnergy**, **nciLogMinutes**, **nviResetPkDemand**, **nciDemPerMins**, and **nciDemSubints** should be protected from unauthorized tampering. The LonTalk protocol supports authentication to prevent unauthorized access for specified variables. You must enable authentication with your network management software. Once protected, the authentication key is required to access these variables, so be sure to record the key securely.

Name	SNVT Type	Units	SNVT#	Description
<b>General Variables (NodeObject)</b>				
nciCtAmps*	SNVT_amp_ac	1 amp	0	CT rated current
nciLogMinutes*	SNVT_count	1 minute	1	Logging interval. Default 15 minutes
nviRequest	SNVT_obj_request		2	LONMARK object request
nviTimeSet*	SNVT_time_stamp		3	Set current date/time
nviFileReq	SNVT_file_req		4	File transfer request
nviFilePos	SNVT_file_pos		5	File transfer position
nviResetEnergy	SNVT_count		6	Write "1" to zero all resettable energy variables
nvoStatus	SNVT_obj_status		7	LONMARK object status
nvoFileStat	SNVT_file_status		8	File transfer status
<b>Energy Variables</b>				
nvoEnergySum*	SNVT_elec_kwh_l	0.1 kWh	15	Total net (bidirectional) energy
nvoEnergySumNR*	SNVT_elec_kwh_l	0.1 kWh	16	Total net (bidirectional) energy - non-resettable
nvoEngyPosSum*	SNVT_elec_kwh_l	0.1 kWh	17	Total positive energy
nvoEngyPosSumNR*	SNVT_elec_kwh_l	0.1 kWh	18	Total positive energy - non-resettable
nvoEnergyA*	SNVT_elec_kwh_l	0.1 kWh	19	Net energy, phase A
nvoEnergyB*	SNVT_elec_kwh_l	0.1 kWh	20	Net energy, phase B
nvoEnergyC*	SNVT_elec_kwh_l	0.1 kWh	21	Net energy, phase C
nvoReacEngySum*	SNVT_elec_kwh_l	0.1 kVARh	22	Total net reactive energy
<b>Power Variables</b>				
nvoPowerSum	SNVT_power_f	watts	34	Real power, sum of phases
nvoPowerA	SNVT_power_f	watts	35	Real power, phase A
nvoPowerB	SNVT_power_f	watts	36	Real power, phase B
nvoPowerC	SNVT_power_f	watts	37	Real power, phase C

Name	SNVT Type	Units	SNVT#	Description
<b>Demand Variables (DemandMeas)</b>				
nciDemPerMins*	SNVT_count	1 minute	9	Demand period: 5-720 minutes. Default 15 minutes
nciDemSubints*	SNVT_count		10	Rolling demand subinterval count: 1-8. Default 1 subinterval
nviResetPkDemand	SNVT_count		11	Write "1" to reset peak demand
nvoDemand	SNVT_power_f	watts	12	Demand power (average power over demand period)
nvoDemandPk*	SNVT_power_f	watts	13	Peak demand power
nvoPeakDemT*	SNVT_time_stamp		14	Date/time of peak demand
<b>Voltage Variables</b>				
nvoVoltsA	SNVT_volt_f	volts	23	RMS voltage, phase A
nvoVoltsB	SNVT_volt_f	volts	24	RMS voltage, phase B
nvoVoltsC	SNVT_volt_f	volts	25	RMS voltage, phase C
<b>Frequency Register</b>				
nvoFreq	SNVT_freq_f	Hz	26	Line frequency
<b>Current Registers</b>				
nvoCurrentA	SNVT_amp_f	amps	27	RMS current, phase A
nvoCurrentB	SNVT_amp_f	amps	28	RMS current, phase B
nvoCurrentC	SNVT_amp_f	amps	29	RMS current, phase C
<b>Power Factor Registers</b>				
nvoPfAvg	SNVT_pwr_fact_f		30	Power factor, total
nvoPfA	SNVT_pwr_fact_f		31	Power factor, phase A
nvoPfB	SNVT_pwr_fact_f		32	Power factor, phase B
nvoPfC	SNVT_pwr_fact_f		33	Power factor, phase C
<b>Reactive Power Registers</b>				
nvoReacPwrSum	SNVT_power_f	VAR	38	Reactive power, sum of phases
nvoReacPwrA	SNVT_power_f	VAR	39	Reactive power, phase A
nvoReacPwrB	SNVT_power_f	VAR	40	Reactive power, phase B
nvoReacPwrC	SNVT_power_f	VAR	41	Reactive power, phase C

\*These network variables are preserved across power failures. The WattNode Logger logs most variables, including variables that are otherwise not preserved across power failures. See [Data Logging \(p. 37\)](#).

Table 4: Network Variables

## General Variables (NodeObject)

### *nciCtAmps*

Use *nciCtAmps* to specify the rated current of the attached current transformers (CTs).

To measure very low currents more accurately, you may loop the conductor being measured through the CT more than once. In this case, the effective CT amps is divided by the number of times the conductor passes through the CT. For example, if you pass the wire through a 30A CT three times, the effective CT amps becomes 10A.

In other cases, you may want to use two or more CTs in parallel on each phase. If you do this, the parallel CTs must be the same model. The effective CT amps is the rated CT amps multiplied by the number of CTs in parallel, so two 100A CTs in parallel is equivalent to a 200A CT.

## ***nciLogMinutes***

The ***nciLogMinutes*** controls the logging interval. The default value is 15 minutes, which provides more than eight months of log capacity in the flash memory. The interval can be set from one minute to 12 hours.

The WattNode meter keeps the logging interval synchronized to the time of day, so if the logging interval is 15 minutes, the meter will log at 12:00, 12:15, 12:30, etc. After a power failure, the meter will log at the first 15 minute synchronized time, so if power fails from 2:02 PM until 3:14 PM, the meter will log data at 3:15 PM.

## ***nviRequest / nviStatus***

The WattNode meter provides basic request and status features to meet the LONMARK requirements. The request variable ***nviRequest*** is used to request information from the meter. The RQ\_NORMAL, RQ\_UPDATE\_STATUS, and RQ\_REPORT\_MASK requests are supported. You can make a request of the entire meter with using the ***NodeObject*** or one of the functional blocks.

In response to each request, the object's status is returned in ***nvoStatus***. The status variable ***nvoStatus*** also indicates if the request was made of an invalid object number, or if the object doesn't support the request made of it. The meter supports the following status fields:

- ***object\_id***: The number of the object whose status is being reported (0 = NodeObject).
- ***invalid\_id***: Indicates that a request was made with an invalid object number.
- ***invalid\_request***: Indicates that the object does not support the requested operation.

## ***nviTimeSet***

The date and time are set with ***nviTimeSet***. The meter uses the date and time to synchronize demand measurements to the hour, to timestamp log data, and to timestamp peak demand. You can read the meter's current date and time by reading this variable. The meter only sets ***nviTimeSet*** to the nearest five seconds and only updates the value every five seconds.

The WattNode Logger meter includes a real-time clock with battery backup to maintain accurate date and time. The clock is accurate to  $\pm 2$  minutes per year, so it should only be necessary to update ***nviTimeSet*** once a month or even once a year. ***nviTimeSet*** may be updated by a monitoring computer or it may be bound to a separate clock node on the network. The battery should last at least five years and typically ten years or more. The battery will last longest if the meter is in service (AC power applied) and at room temperature. Storing the meter for extended periods or operating at very cold or hot temperatures will shorten the battery life. See the **Warranty (p. 45)** below for the battery warranty.

The meter cannot monitor the battery, so the only way to detect a drained battery is after a power failure, when the meter will report an error #10 "Real-time clock oscillator stopped. May indicate dead battery". In this case, the meter will recover the date and time from immediately before the power failure, and will continue updating the date and time. All other functionality, including data logging, will operating normally, but with the old date and time.

To avoid a battery failure, you should plan to replace the battery at least every ten years, perhaps as often as every five years if you are operating at temperature extremes or if a failure could cause problems.

Tampering with ***nviTimeSet*** can affect the timing of demand measurements or logging that may be used for billing. To prevent unauthorized tampering, authentication can be enabled for ***nviTimeSet***.

## ***nviFileReq / nvoFileStat / nviFilePos***

These file transfer network variables are used by LNS<sup>®</sup> network management tools to configure the meter and by the WattNode Plug-in for LNS to download logged data. These variables should never be directly manipulated by the operator.

## ***nviResetEnergy***

The energy variables ***nvoEnergySum***, ***nvoEngyPosSum***, ***nvoEnergyA***, ***nvoEnergyB***, ***nvoEnergyC***, and ***nvoReacEngySum*** are all reset to zero kilowatt-hours whenever “1” is written to ***nviResetEnergy***. As a security measure, two variables—***nvoEnergySumNR*** and ***nvoEngyPosSumNR***—are non-resettable.

If you wish to make sure energy cannot be accidentally reset or reset by an unauthorized person, enable LonTalk authentication for ***nviResetEnergy***. See [Authentication \(p. 27\)](#) for details.

## **Energy Variables**

Commonly known as kWh (kilowatt-hours), the energy is the integral of power over time. Many installations will only use the energy measurement. It is commonly used for billing or sub-metering. Because energy is an accumulated value, it can be used on networks that are accessed infrequently (like a utility meter that only needs to be read once a month). All energy variables are preserved through power failures.

All energy SNVTs are reported as a SNVT\_elec\_kwh\_I with a resolution of 0.1 kWh. All energy registers wrap around to zero when they reach 100,000,000 kWh (100 GWh) or negative 100 GWh (only some energy registers allow negative values).

During a power outage, the energy consumed will not be measured. Whenever the line voltage drops below 60–80% of nominal, the meter will shut down until power is restored. To preserve the energy measurement across power outages, the meter writes the energy to non-volatile memory. When power returns, the last stored value is recovered.

For bidirectional applications, such as installations with PV panels, the WattNode meter measures the net energy sum: ***nvoEnergySum*** can count both up and down, depending on whether you are consuming (importing) or generating (exporting) energy. The WattNode meter also provides the positive energy sum: ***nvoEngyPosSum*** only counts up, so that you can see the total energy consumed. From these two values, you can compute the negative energy sum—the total energy generated—using the following formula (the resulting value will be positive):

$$\text{EnergyNegSum} = \text{nvoEngyPosSum} - \text{nvoEnergySum}$$

### ***nvoEnergySum***

This is the energy (kWh) sum of phase A, B, and C energies. This variable can count both up and down for bidirectional or net metering applications. If you want an energy value that can only count up, use ***nvoEngyPosSum*** instead. ***nvoEnergySum*** can be reset to zero with ***nviResetEnergy***.

### ***nvoEnergySumNR***

This is same as ***nvoEnergySum***, but can never be reset to zero (non-resettable).

### ***nvoEngyPosSum***

This is the **positive** energy (kWh) sum of phase A, B, and C energies. This variable only counts up. This is updated every five seconds by adding the net energy for phases A, B, and C for the last five seconds; if this combined total is positive, then it is added to ***nvoEngyPosSum***. ***nvoEngyPosSum*** can be reset to zero with ***nviResetEnergy***.

### ***nvoEngyPosSumNR***

This is same as ***nvoEngyPosSum***, but can never be reset to zero (non-resettable).

### ***nvoEnergyA / nvoEnergyB / nvoEnergyC***

These are the per-phase energies (kWh). These values can count both up and down for bidirectional or net metering applications. These variables can be reset to zero with ***nviResetEnergy***.

### ***nvoReacEngySum***

This is the reactive energy (kVARh) sum of phase A, B, and C reactive energies. This variable can count both up and down. Generally positive reactive energy indicates an inductive load like a motor or transformer (this may not be true if you are using a variable speed drive or inverter), while negative reactive energy indicates a capacitive load. ***nvoReacEngySum*** can be reset to zero with ***nviResetEnergy***.

This is the reactive energy: also known as kVAR-hours. Inductive loads—like motors—generate positive reactive power and energy, while capacitive loads generate negative reactive energy. This variable is a bidirectional register that can count up or down depending on the sign of the reactive power.

The WattNode meter only measures the fundamental reactive energy, not including harmonics.

***nvoReacEngySum*** can be reset to zero by writing “1” to ***nviResetEnergy***.

## **Power Variables**

The power variables report the real power for each phase and for the sum of all phases. They are measured every five seconds. The WattNode meter measures power by sampling and multiplying the instantaneous voltage and current waveforms at 5 kHz, so the power measurements are accurate even in the presence of harmonics and non-unity power factor.

Power measurements can indicate positive or negative values. Unless you are measuring power generation (as in a house with PV panels), negative power may indicate an installation problem; see [Measurement Troubleshooting \(p. 22\)](#)

### ***nvoPowerSum***

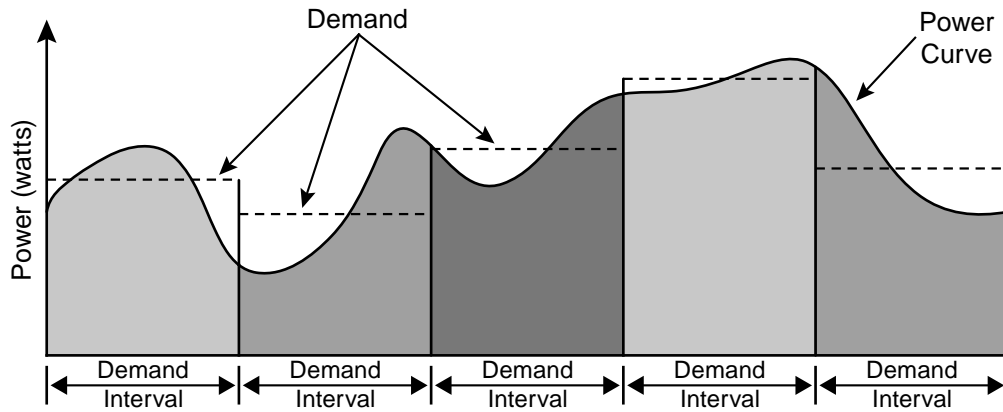
The power sum is the sum of the power for all active phases in watts. If one or more phases are negative, they will subtract from the total.

### ***nvoPowerA / nvoPowerB / nvoPowerC***

These are the real power values in watts for each phase.

## **Demand Variables (DemandMeas)**

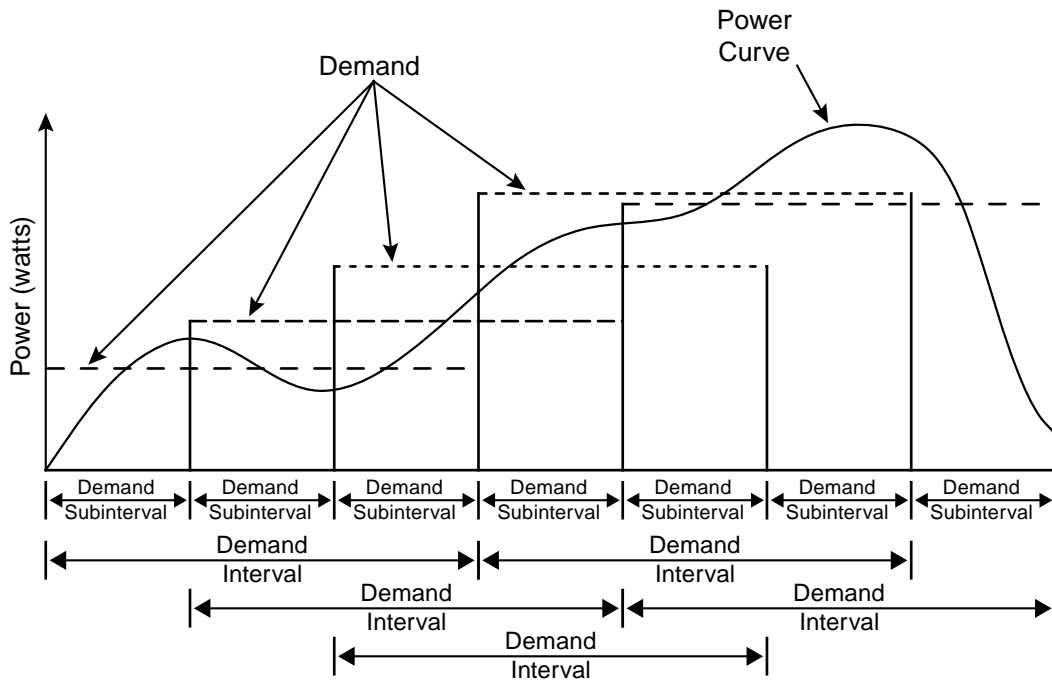
Demand is defined as the average power over a specified time interval. The average can include positive and negative power, and the reported demand may be positive or negative; however, negative demand should only occur with net metering or when energy is being generated. Typical demand intervals are 5, 10, 15 (default), 30, 60, etc. up to 720 minutes, but the WattNode meter supports arbitrary demand intervals from 5 to 720 minutes (12 hours). The meter records the peak demand with a time stamp for metering applications where the measurements may only be accessed weekly or monthly.



**Figure 10: Demand Measurement**

The WattNode meter also supports rolling demand (also called “sliding window”), in which the demand intervals are evenly divided into a fixed number of subintervals. At the end of each subinterval, the average power over the demand interval is computed and output. This results in better accuracy, especially for demand peaks which would not have lined up with the demand interval without subintervals. From 1 to 8 subintervals are supported, provided that the subinterval duration is at least one minute. A subinterval count of one (or zero) results in the standard demand measurement without rolling demand.

The meter synchronizes demand measurements to the time-of-day, so if the demand period is 15 minutes, demand measurements will complete at 11:00, 11:15, 11:30, etc. If the meter clock is changed (say from 11:01 to 12:01 because of daylight savings time), the meter will find the next synchronized time (12:15 for our example) to complete the demand measurement, so that the demand period is as close as possible to the target demand period.



**Figure 11: Rolling Demand with Three Subintervals**



### ***nciDemPerMins / nciDemSubints***

The variable ***nciDemPerMins*** sets the demand interval in minutes (default 15 minutes), and ***nciDemSubints*** sets the number of demand intervals (default 1). The time period of each subinterval is the demand interval divided by the number of subintervals. Setting ***nciDemSubints*** to 1 disables subinterval computations. The demand period cannot be longer than 12 hours (720 minutes), and a demand subinterval must be a multiple of one minute. The ***nciDemSubints*** can be set from 1 to 8. If you specify an invalid combination of ***nciDemPerMins*** and ***nciDemSubints*** then the meter will adjust the values.

An example configuration could use a demand period of 60 minutes with 4 subintervals. This would result in a subinterval period of fifteen minutes. Every fifteen minutes, the average power over the last hour would be computed and reported.

### ***nviResetPkDemand***

Writing a 1 to ***nviResetPkDemand*** will zero the peak demand (***nvoDemandPk***) and the peak demand timestamp (***nvoPeakDemT***). If you wish to make sure peak demand cannot be reset by an unauthorized person, enable LonTalk authentication for ***nviResetPkDemand***. See [Authentication \(p. 27\)](#) for details.

### ***nvoDemand***

The ***nvoDemand*** variable is updated at the end of every subinterval with the average real power over a full demand interval. If the average power is negative, the reported demand will also be negative.

The demand measurement is cleared to zero by power failures and by changes to ***nciDemPerMins*** or ***nciDemSubints***. After the demand is cleared, you will not see any new readings until the end of the next demand interval or subinterval. For example, if you have configured a fifteen minute demand period and no subintervals, you may have to wait fifteen minutes to see the first demand reading. If you configure five subintervals, then the first demand reading will appear in approximately three minutes ( $15 / 5 = 3$ ).

### ***nvoDemandPk***

This is the largest measured positive demand value. It is preserved across power failures. ***nvoDemandPk*** and ***nvoPeakDemT*** can both be reset to zero by writing 1 to ***nviResetPkDemand***.

For more detailed information on demand peaks, consider using logged data, which can show every demand measurement in the log. This will allow you to easily see the peak demand for each day and month.

### ***nvoPeakDemT***

This is the date and timestamp at which the peak demand value was measured. This is cleared whenever ***nvoPeakDemT*** is reset to zero with ***nviResetPkDemand***.

If ***nvoDemandPk*** or ***nvoPeakDemT*** are bound, they are both updated over the network whenever a new value is computed for ***nvoDemand***, even if the values haven't changed. This is done because otherwise the values may not update for days, which can cause timeouts for systems that expect regular updates.

## **Voltage Variables**

### ***nvoVoltsA / nvoVoltsB / nvoVoltsC***

These are the RMS AC voltages for each phase. These are measured relative to the neutral connection on the meter. If neutral is not connected, then these are measured relative to the ground connection on the meter. The WattNode meter does not measure line-to-line voltages.

Voltage phases that are not connected may report small random voltages, but the meter treats any phase reporting less than 20% of the nominal Vac as inactive and will not measure power or energy on inactive phases.

## Frequency Register

### *nvoFreq*

The WattNode measures the AC line frequency in Hertz. All active phases must have the same line frequency; otherwise this value will be erratic or incorrect.

## Current Registers

### *nvoCurrentA / nvoCurrentB / nvoCurrentC*

The WattNode estimates the RMS current for each phase. This is an indirect measurement and does not include all harmonic content, so the current is not as accurate as the power and energy measurements. The reported current will always be positive.

## Power Factor Registers

The power factor is the ratio of the real power to the apparent power. Resistive loads, like incandescent lighting and electric heaters, should have a power factor near 1.0. Power-factor corrected loads, like computers, should be near 1.0. Motors can have power factors from 0.2 to 0.9, but are commonly in the 0.5 to 0.7 range.

If the power for a phase is negative, the power factor will also be negative. The reported power factor will be 1.0 for any phases measuring zero power, and will be 0.0 for any inactive phases (line voltage below 20% of nominal Vac).

The WattNode meter measures the displacement or fundamental power factor, which does not include harmonics.

### *nvoPfAvg*

This is the total power factor for all phases:  $nvoPfAvg = nvoPowerSum / ApparentPowerSum$

*Note: the ApparentPowerSum is an internally computed value. There are no network variables for apparent power.*

### *nvoPfA / nvoPfB / nvoPfC*

These are the power factor values for each phase.

## Reactive Power Registers

Reactive power is also known as VARs. Inductive loads, like motors, generate positive reactive power, while capacitive loads generate negative reactive power. Reactive power transfers no net energy to the load and generally is not metered by the utility. Loads with high reactive power relative to the real power will tend to have lower power factors.

### *nvoReacPwrSum*

The *nvoReacPwrSum* is the sum of the reactive power of active phases. This can include negative values, so if one phase is negative, it will reduce the reported *nvoReacPwrSum*.

### *nvoReacPwrA / nvoReacPwrB / nvoReacPwrC*

These are the per-phase reactive power measurements.

## Configuration Properties

The WattNode meter also includes configuration properties (CPs), which are similar to “*nci*” network variables (NVs), but consume fewer resources. The meter uses CPs for less commonly accessed quantities, including factory calibration. These are preserved over power outages.

For convenience, there are a few variables that can be accessed as either an NV or a CP: ***nciCtAmps***, ***nciLogMinutes***, ***nciDemPerMins***, and ***nciDemSubints***. These variables are documented above as network variables and have entries in the “NV Name” column below.

The rest of the CPs can only be accessed if you have installed the CCS LONMARK® resource files; these files are provided on the CCS website and are automatically installed by installing the WattNode Plug-in for LNS. Niagara<sup>AX</sup>® users can access CPs by using a LON® XML (LNML) file or JAR module available on the CCS website.

Calibration related CPs are normally hidden and not changed except by the factory.

Name	CP Type Name	Units / Type	Description
<b>General Configuration (NodeObject)</b>			
nciCtAmps	UCPTctAmps	1 amp / SNVT_amp_ac	CT rated current, amps
nciLogMinutes	UCPTlogIntervalMins	1 minute / SNVT_count	Logging interval. Default 15 minutes
	SCPTlocation	string	Meter location, 30 character string
	SCPTdevMajVer	integer	Meter firmware, major version
	SCPTdevMinVer	integer	Meter firmware, minor version
	UCPTmodel	string	WattNode meter model
	UCPTserialNumber	integer	WattNode meter serial number
<b>Measurement Configuration</b>			
	SCPTmaxSndT	SNVT_elapsed_tm	Update rate for measurement SNVTs. Default 5 seconds.
<b>Demand Configuration (DemandMeas)</b>			
nciDemPerMins	UCPTdemand PeriodMins	1 minute / SNVT_count	Demand period: 5-720 minutes. Default 15 minutes
nciDemSubints	UCPTdemand Subintervals	1 subinterval / SNVT_count	Rolling demand subinterval count: 1-8. Default 1 subinterval
<b>Calibration (WattnodeCal)</b>			
	UCPTfactoryCommand	integer	Factory calibration commands
	UCPTcalPowerA	integer	Power calibration, phase A
	UCPTcalPowerB	integer	Power calibration, phase B
	UCPTcalPowerC	integer	Power calibration, phase C
	UCPTcalReactiveA	integer	Reactive power calibration, phase A
	UCPTcalReactiveB	integer	Reactive power calibration, phase B
	UCPTcalReactiveC	integer	Reactive power calibration, phase C
	UCPTcalVoltA	integer	Voltage calibration, phase A
	UCPTcalVoltB	integer	Voltage calibration, phase B
	UCPTcalVoltC	integer	Voltage calibration, phase C
	UCPTphaseAdjA	integer	Phase angle adjustment, phase A
	UCPTphaseAdjB	integer	Phase angle adjustment, phase B
	UCPTphaseAdjC	integer	Phase angle adjustment, phase C
	UCPTcreepLimit	integer	Creep limit
	UCPTnominalVolt	1 volt / SNVT_volt	Nominal line-to-neutral Vac
	UCPTminVolt	1 volt / SNVT_volt	Minimum line-to-neutral Vac for active phases

Table 5: Configuration Properties

### **SCPTlocation**

This read/write property can hold a 30 character string describing the meter's location or other useful information.

### **SCPTdevMajVer / SCPTdevMinVer**

These are the major and minor version numbers of the meter firmware. For example, if **SCPTdevMajVer** = 3 and **SCPTdevMinVer** = 37 67, then the firmware version is 3.37 3.67.

### **UCPTmodel**

This read-only string indicates the WattNode model. Example: WNC-3Y-208-FT10-L.

### **UCPTserialNumber**

This is the meter's serial number.

### **SCPTmaxSndT**

This property is used to configure the rate at which the meter updates bound measurement network variables, such as **nvoPowerSum**. The update rate for all measurements except demand are controlled by **nciMaxSendT**. This setting only applies to bound network variables, because it controls the rate at which network variable updates are transmitted over the network.

The polled values for most variables will update every five seconds, regardless of the value of **nciMaxSendT**.

The default update rate is five seconds, which is also the fastest update rate. The slowest update rate is limited to 12 hours. **nciMaxSendT** is actually a data structure containing fields for days, hours, minutes, seconds, and milliseconds. If the time is set to less than five seconds, the update rate will be five seconds. If the interval is set to more than 12 hours, the meter will set it to the default five second interval and will log an error 20 "Invalid maximum send time".

### **UCPTcreepLimit**

Creep refers to the situation where the wheel on an traditional electro-mechanical energy meter moves even though there is no power being consumed. The WattNode meter has no wheel, but all electrical systems have some noise, which can cause small readings in the absence of any power consumption. In order to prevent readings due to noise, the meter forces the measured power and reactive power values to zero if the readings fall below a certain fraction of full-scale power. This also forces the associated energy values to zero for the measurement interval. This is performed independently for each measurement phase using the following equation.

$$\text{MinimumPower} = \text{FullScalePower} / \text{CreepLimit}$$

Any measured power or reactive power below *MinimumPower* is forced to zero. *FullScalePower* is defined as the nominal line-to-neutral Vac multiplied by the full-scale (rated) CT current. See **Specifications – Models (p. 40)** for nominal voltages.

Generally, the default value of 1500 (which sets the creep limit to 1/1500th of full-scale power) works fine. Sometime, however, in electrically noisy environments, you may see non-zero power readings when you are certain the power is zero. You can adjust the creep limit upward to eliminate this problem. For example, if you want to adjust the creep limit to 1/500th of full-scale (0.2%), just set **CreepLimit** to 500.

### **UCPTptRatio**

This appears only on models with **Option PT**, and is used to configure the potential transformer ratio. See [WattNode LonWorks - Option PT](#) and [MS-20-WNC-LonWorks-Option-PT.pdf](#) for more details.

## Calibration Configuration Properties

All the other configuration properties (CPs) are for calibration or factory use only. Most network management tools will hide them, because they are flagged for manufacturer use only. They are protected from being changed in the field.

## Data Logging

The WattNode Logger adds two features not found in the WattNode Plus: a 2MB flash memory and a real-time clock to ensure accurate timestamps for log data. The flash memory holds 24186 log records. Each record stores the following fields:

- **Record Number\***: Every log record is assigned a unique number starting with “1” and counting up. This helps uniquely identify each log record, even if the clock is changed (as for daylight savings). The maximum value is two billion, so the record number would take 4000+ years to overflow.
- **Status\***: The status field can indicate if one or more of the following events occurred during the log interval:
  - **Power failure**: this is the first log record after a power failure.
  - **Clock change**: the date / time was changed with *nviTimeSet*.
  - **Calibration change**: the calibration was changed: this should never occur in the field.
  - **Configuration change**: one of the following was changed: *nciDemPerMins*, *nciDemSubints*, *nciLogMinutes*, *nciCtAmps*, *nciCreepLimit*.
  - **WattNode online**: The WattNode was brought online by a network management tool.
  - **WattNode reset**: The WattNode was reset, generally by a network management tool.
  - **Internal error**: The WattNode experienced an internal error or warning. Use the WattNode Plug-in or your network management tool to check the last error. See [WattNode Errors \(p. 38\)](#).
- **Date / Time\***: This stores the date and time at the completion of the log interval.
- **Log Seconds\***: This records the number of seconds of data included in the log record. Normally, this should match the log interval (i.e. if the log interval is 15 minutes, the log seconds should be 900 seconds). However, if the clock is changed with *nviTimeSet* or this is the first log record after a power failure, the log seconds may be different.
- **Demand\***: This stores the most recent demand measurement. Generally you will want to configure *nciLogMinutes* to match *nciDemPerMins*, so that demand intervals and log intervals occur at the same time. If you do this, the WattNode will keep them synchronized so that every time a new demand value is computed, the WattNode will immediately create a log record with the new demand value.
- **Energy Sum\***: Value of *nvoEnergySum* at the log time.
- **Energy Positive Sum**: Value of *nvoEngyPosSum* at the log time.
- **Energy A, B, C**: Values of *nvoEnergyA*, *nvoEnergyB*, and *nvoEnergyC* at the log time.
- **Reactive Energy Sum**: Value of *nvoReacEngySum* at the log time.
- **Volts A, B, C**: Values of *nvoVoltsA*, *nvoVoltsB*, and *nvoVoltsC* at the log time.
- **Frequency**: Value of *nvoFreq* at the log time.
- **Power A, B, C**: Values of *nvoPowerA*, *nvoPowerB*, and *nvoPowerC* at the log time.
- **Reactive Power A, B, C**: Values of *nvoReacPwrA*, *nvoReacPwrB*, and *nvoReacPwrC* at the log time.
- **CRC**: This is a cyclic redundancy check, used to ensure that the log record isn't corrupt.

All fields are stored in the flash, but records can be retrieved as “Full” or “Short” records. Short records only include the fields above marked with “\*”. It is about three times faster to retrieve short records, so if you don't need the extra fields, you should retrieve short records.

The WattNode never deletes log records, except when the log fills up, at which point, the WattNode will start overwriting the oldest log records with new data. So at any time, the WattNode will have the last 24186 log records in its flash (unless it hasn't been in service long enough to fill the log).

The WattNode synchronizes logging to the time of day. For example, if you specify a 15 minute log interval with **nciLogMinutes**, the WattNode will log at 1:00, 1:15, 1:30, 1:45, 2:00, etc. If power fails and then recovers, the WattNode will log at the next synchronized time. So if power fails at 2:08 and recovers at 2:26, the WattNode will log data at 2:30 (there will be no log record for 2:15 because power was off at that time).

The following table shows the total log capacity as the log interval varies. It also shows the download time for one month of log data for both full and short log records.

Log Interval (Minutes)	Log Capacity	Log Records per Month	Download Time, Month of Short Records	Download Time, Month of Full Records
1 minute	2.4 weeks	24186 <sup>†</sup>	28 minutes <sup>†</sup>	88 minutes <sup>†</sup>
2 minutes	4.8 weeks	21960	25 minutes	80 minutes
5 minutes	12 weeks	8784	10 minutes	32 minutes
10 minutes	5.5 months	4392	5 minutes	16 minutes
15 minutes	8.2 months	2928	3.4 minutes	11 minutes
30 minutes	16.5 months	1464	1.7 minutes	6 minutes
1 hour	33 months	732	1 minute	3 minutes
2 hours	5.5 years	366	26 seconds	1.5 minutes
4 hours	11 years	183	13 seconds	40 seconds
6 hours	16.5 years	122	9 seconds	27 seconds
12 hours	33 years	61	5 seconds	14 seconds

**Table 6: Log Capacity vs. Log Interval**

<sup>†</sup>Note: At a one minute log interval, the log can only hold 2.4 weeks of data, so the "Records per Month" and download times are for 2.4 weeks of data, not a full month of data.

Log data is retrieved using the WattNode Plug-in for LNS, which in turn uses the LonTalk file transfer protocol to download the data. The file transfer protocol over the TP/FT-10 transceiver is relatively slow (~22kB per minute), so downloading a full log with 24186 records takes roughly 30 minutes if you are downloading short records and 90 minutes for full records. Therefore, you may want to select the longest reasonable log interval to minimize log download times. The plug-in can automatically download only new records, making the download much faster if you download regularly.

## WattNode Errors

The WattNode tracks internal errors and warnings. The most recent error is logged and preserved over power failures so that it can be recovered by the WattNode Plug-in or by any network management tool. With LonMaker you can check the "Error Log" using the Manage / Test command. If you see error #10, contact CCS about having the real-time clock battery replaced. For errors, contact CCS, because the WattNode may need service. Warnings can generally be disregarded unless they occur repeatedly. Note: there is no way to read errors using network variables.

- **0:** No error
- **1:** Error: Could not recover non-volatile data; energy and peak demand lost.
- **7:** Warning: Attempted to set **nviTimeSet** to invalid date/time.
- **10:** Error: Real-time clock oscillator stopped. This generally indicates a dead real-time clock battery.

- **11, 12:** Error: Real-time clock not responding.
- **13:** Error: Real-time clock write verify failed.
- **14:** Error: Real-time clock initialize verify failed.
- **15:** Error: Bad CRC on real-time clock extra data. Date may be corrupt.
- **16:** Warning: Missed one or more ticks from real-time clock.
- **17:** Error: Unrecognized logging flash version response.
- **18:** Error: Could not recover log status information; logging disabled.
- **19:** Warning: Could not recover calibration from FRAM - used EEPROM backup copy.
- **20:** Error: Invalid *nciMaxSendT* specified
- **21:** Warning: *nvoDemand* updated failed. Will retry four times
- **22:** Warning: *nvoDemandPk* updated failed. Will retry four times
- **23:** Warning: *nvoPeakDemT* updated failed. Will retry four times
- **24-26:** Error: Peak demand data in FRAM corrupted
- **27:** Error: Calibration FRAM update pending
- **28-30:** Error: Energy data in FRAM corrupted
- **34:** Error: Tried to set the PT ratio too small or too large
- **31-33:** Error: Log info FRAM corrupted
- **59-61:** Error: Internal firmware error. Contact support.

## Maintenance and Repair

The WattNode meter requires no routine maintenance other than replacing the real-time clock battery every 5-10 years. There are no fuses in the meter. There are no diagnostic tests that can be performed by the user, other than checking for errors via the LONWORKS interface and with the service LED.

The WattNode Logger meter contains a lithium battery to maintain the date and time during power failures. This battery can be replaced by the user as follows:

- 1) Replace battery with Panasonic, part number BR2325 only. Use of another battery may present a risk of fire or explosion.
- 2) **Caution:** battery may explode if mishandled. Do not charge, disassemble, or dispose in fire.
- 3) Disconnect the meter from hazardous line voltage **before** replacing the battery.
- 4) Use ESD (electro-static discharge) precautions to avoid damaging meter circuitry.
- 5) Remove the four screws holding the enclosure together and remove the top cover.
- 6) The battery will be clearly visible in a black plastic holder next to the DIP switch. Tip the end of the old battery up and slide out of the holder. A small flat blade screwdriver may help.
- 7) Install the new battery with the “+” marking facing up.
- 8) Reassemble the enclosure with the four screws.
- 9) Reconnect the meter to line voltages.
- 10) Update the date and time in the WattNode meter.
- 11) If you wish to test that the new battery is working, turn off power for 30 seconds, then reapply power and verify that the date and time are correct and that no errors are indicated.

The meter should not normally need to be cleaned, but if cleaning is desired, power must be disconnected first and a dry cloth or brush should be used.

The WattNode meter is not user serviceable. In the event of any failure, the meter must be returned for service. In the case of a new installation, follow the instructions in sections **Service LED (p. 20)** and **Measurement Troubleshooting (p. 22)** before returning the WattNode for service, to ensure that the problem is not connection related.

# Specifications

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## Models

Model	Nominal Vac Line-to-Neutral	Nominal Vac Line-to-Line	Phases	Wires
WNC-3Y-208-FT10-L	120	208–240	3	4
WNC-3Y-400-FT10-L	230	400	3	4
WNC-3Y-480-FT10-L	277	480	3	4
WNC-3Y-600-FT10-L	347	600	3	4
WNC-3D-240-FT10-L	120*	208–240	3	3–4
WNC-3D-400-FT10-L	230*	400	3	3–4
WNC-3D-480-FT10-L	277*	480	3	3–4

\*Note: the delta models have an optional neutral connection that may be used for measuring wye circuits. In the absence of neutral, voltages are measured with respect to ground. Delta WattNode models use the phase A and phase B connections for power.

**Table 7: WattNode Models**

## Model Options

WattNode for LonWorks models are available with the following options. See the CCS website [WattNode Logger for LonWorks - Options](#) page for details.

**Option CT=xxx:** Pre-assign **xxx** as the global **CtAmps** value of the attached current transformers.

**Option PT or Option PT=xxx:** Improves support for potential transformers (PTs), by adding a configuration property **UCPTptRatio** which configures the ratio of the external PT. Optionally pre-assign **xxx** as the PT ratio.

**Option B:** Emulates the WNB series WattNode Plus for LonWorks models. **Note:** this option is not available on WattNode Logger models.

**Option BI:** Emulates the WNB series WattNode Plus for LonWorks models with integer outputs. **Note:** this option is not available on WattNode Logger models.

## Firmware

**Firmware Version:** 3.67

**XIF file:** WNC-FT-Log-367.XIF

**LONWORKS Program ID:** 8:00022:1500:0A:04:0A

**LONMARK Certification Version:** 3.4

### *With Option PT*

**Firmware Version:** 3.70

**XIF file:** WNC-FT-Log-PT-370.XIF

**LONWORKS Program ID:** 9:00022:1500:0A:04:0D

**LONMARK Certification Version:** not certified

## Accuracy

The following accuracy specifications do not include errors caused by the current transformer accuracy or phase angle errors. “Rated current” is the current that generates a CT output voltage of 0.33333 Vac.



### **Condition 1 - Normal Operation**

**Line voltage:** -20% to +15% of nominal

**Power factor:** 1.0

**Frequency:** 48 - 62 Hz

**Ambient Temperature:** 25°C

**CT Current:** 5% - 100% of rated current

**Accuracy:**  $\pm 0.5\%$  of reading

### **Condition 2 - Low CT Current**

All conditions the same as Condition 1 except:

**CT Current:** 1% - 5% of rated current

**Accuracy:**  $\pm 1.0\%$  of reading

### **Condition 3 - Very Low CT Current**

All conditions the same as Condition 1 except:

**CT Current:** 0.2% - 1% of rated current

**Accuracy:**  $\pm 3.0\%$  of reading

### **Condition 4 - High CT Current**

All conditions the same as Condition 1 except:

**CT Current:** 100% - 120% of rated current

**Accuracy:**  $\pm 1.0\%$  of reading

### **Condition 5 - Low Power Factor**

All conditions the same as Condition 1 except:

**Power factor:** 0.5 ( $\pm 60$  degree phase shift between current and voltage)

**Additional Error:**  $\pm 0.5\%$  of reading

### **Condition 6 - Temperature Variation**

All conditions the same as Condition 1 except:

**Ambient Temperature:** -30°C to +55°C

**Additional Error:**  $\pm 0.75\%$  of reading

## **Measurement**

**Creep Limit:** 0.067% (1/1500th) of full-scale. Whenever the power or reactive power for a phase drops below the creep limit, the power or reactive power for the phase will be forced to zero. Also, if the line voltage for a phase drops below 20% of nominal Vac, the output power for the phase will be set to zero. These limits prevent spurious readings due to measurement noise.

**Update Rate:** 5.0 seconds. Internally, all measurements are performed at this rate.

**Current Transformer Phase Angle Correction:** 1.0 degree leading. Current transformers (CTs) typically have a leading phase angle error ranging from 0.2 degrees to 2.5 degrees. The WattNode meter is normally programmed to correct for a 1.0 degree phase lead to provide good accuracy with typical CTs.

**Over-Voltage Limit:** 125% of nominal Vac. Extended over-voltage operation can damage the WattNode and void the warranty.

**Over-Current Limit:** 120% of rated current. Exceeding 120% of rated current will not harm the WattNode meter but the current and power will not be measured accurately.

## Electrical

**Power Consumption:** The following table shows typical power consumption and power factor values with all three phases powered at nominal line voltages. The power supply draws most of the total power consumed, while the measurement circuitry draws 1-10% of the total (6-96 milliwatts per phase, depending on the model). Due to the design of the power supply, WattNode meters draw slightly more power at 50 Hz.

Model	Active Power at 60 Hz	Active Power at 50 Hz	Power Factor	Rated Power*	Power Supply Range	Power Supply Terminals
WNC-3Y-208-FT10-L	1.5 W	1.8 W	0.79	3 W	96 – 138 Vac	<b>N</b> and <b>ΦA</b>
WNC-3Y-400-FT10-L	1.6 W	1.8 W	0.73	3 W	184 – 264 Vac	<b>N</b> and <b>ΦA</b>
WNC-3Y-480-FT10-L	1.6 W	2.0 W	0.69	4 W	222 – 318 Vac	<b>N</b> and <b>ΦA</b>
WNC-3Y-600-FT10-L	1.0 W	1.3 W	0.76	3 W	278 – 399 Vac	<b>N</b> and <b>ΦA</b>
WNC-3D-240-FT10-L	1.2 W	1.5 W	0.70	4 W	166 – 276 Vac	<b>ΦA</b> and <b>ΦB</b>
WNC-3D-400-FT10-L	1.1 W	1.4 W	0.67	3 W	320 – 460 Vac	<b>ΦA</b> and <b>ΦB</b>
WNC-3D-480-FT10-L	1.2 W	1.6 W	0.70	4 W	384 – 552 Vac	<b>ΦA</b> and <b>ΦB</b>

**Table 8: Power Supply Characteristics**

*\*Note: This is the maximum rated power at 115% of nominal Vac at 50 Hz. This is the same as the rated power that appears on the front label of the meter.*

**Maximum Operating Power Supply Voltage Range:** -20% to +15% of nominal (see table above). For the WNC-3D-240-FT10-L, this is -20% of 208 Vac (166 Vac) to +15% of 240 Vac (276 Vac).

**Operating Frequencies:** 50/60 Hz

**Measurement Category:** CAT III

Measurement category III is for measurements performed in the building installation. Examples are measurements on distribution boards, circuit-breakers, wiring, including cables, bus-bars, junction boxes, switches, socket-outlets in the fixed installation, and equipment for industrial use and some other equipment, for example, stationary motors with permanent connection to the fixed installation.

The line voltage measurement terminals on the meter are rated for the following CAT III voltages (these ratings also appear on the front label):

Model	CAT III Voltage Rating
WNC-3Y-208-FT10-L WNC-3D-240-FT10-L	240 Vac
WNC-3Y-400-FT10-L WNC-3D-400-FT10-L	400 Vac
WNC-3Y-480-FT10-L WNC-3D-480-FT10-L	480 Vac
WNC-3Y-600-FT10-L	600 Vac

**Table 9: WattNode CAT III Ratings**

**Current Transformer Inputs:**

**Nominal Input Voltage (At CT Rated Current):** 0.33333 Vac RMS

**Absolute Maximum Input Voltage:** 5.0 Vac RMS

**Input Impedance at 50/60 Hz:** 23 kΩ

## Certifications

**Safety:** UL 61010-1; CAN/CSA-C22.2 No. 61010-1-04; IEC 61010-1

**Immunity:** EN 61326: 2002 (Industrial Locations)

**Electrostatic Discharge:** EN 61000-4-2: 4 kV contact, 8 kV air: (B) Self-Recovering

**Radiated RF Immunity:** EN 61000-4-3: 10 V/m: (A) No Degradation

**Electrical Fast Transient / Burst:** EN 61000-4-4: 2 kV: (B) Self-Recovering

**Surge Immunity:** EN 61000-4-5: 1 kV I/O, 4 kV AC: (B) Self-Recovering

**Conducted RF Immunity:** EN 61000-4-6: 3 V: (A) No Degradation

**Voltage Dips, Interrupts:** EN 61000-4-11: (B) Self-Recovering

**Emissions:** FCC Part 15, Class B; EN 55022: 1994, Class B

## Environmental

**Operating Temperature:** -30°C to +55°C (-22°F to 131°F)

**Altitude:** Up to 2000 m (6560 ft)

**Operating Humidity:** non-condensing, 5 to 90% relative humidity (RH) up to 40°C, decreasing linearly to 50% RH at 55°C.

**Pollution:** POLLUTION DEGREE 2 - Normally only non-conductive pollution; occasionally, a temporary conductivity caused by condensation must be expected.

**Indoor Use:** Suitable for indoor use.

**Outdoor Use:** Suitable for outdoor use when mounted inside an electrical enclosure (Hammond Mfg., Type EJ Series) that is rated NEMA 3R or 4 (IP 66).

## Mechanical

**Enclosure:** High impact, ABS and/or ABS/PC plastic

**Flame Resistance Rating:** UL 94V-0, IEC FV-0

**Size:** 153 mm × 85 mm × 38 mm (6.02 in × 3.35 in × 1.50 in)

**Weight:** 317 gm (11.2 oz) 314 gm (11.1 oz)

**Connectors:** Euroblock style pluggable terminal blocks

**Green:** up to 12 AWG (2.5 mm<sup>2</sup>), 600 V

**Black:** up to 12 AWG (2.5 mm<sup>2</sup>), 300 V

## Current Transformers

WattNode meters use CTs with built-in burden resistors generating 0.33333 Vac at rated AC current. The maximum input current rating is dependent on the CT frame size (see the tables below). Exceeding the maximum input current rating may damage CTs, but should not harm the meter.

None of these CTs measure DC current and the accuracy can be degraded in the presence of DC currents, as from half-wave rectified loads. The solid-core CTs are most susceptible to saturation due to DC currents.

WattNode meters should only be used with UL recognized current transformers, which are available from Continental Control Systems. Using non-approved transformers will invalidate the meter UL listing. The following sections list approved UL recognized current transformers.

## Common CT Specifications

**Type:** voltage output, integral burden resistor

**Output Voltage at Rated Current:** 0.33333 Vac (one-third volt)

**Standard CT Wire Length:** 2.4 m (8 feet)

**Optional CT Wire Length:** up to 30 m (100 feet)

## Split-Core CTs

Also called “opening” current transformers. These are UL recognized under UL file numbers E96927 or E325972: CTM-0360-**xxx**, CTS-0750-**xxx**, CTS-1250-**xxx**, CTS-2000-**xxx**, where **xxx** indicates the full scale current rating between 0005 and 1500 amps.

The accuracy of the split-core CTs are specified from 10% to 100% of rated AC current. The phase angle is specified at 50% of rated current (amps). Some low current split-core CTs have unspecified phase angle errors.

Model	Inside Diameter	Rated Amps (-xxx)	Accuracy / Phase Angle	Maximum Amps
CTM-0360-xxx	0.30" (7.5 mm)	5, 15, 30, 50, 70	±1% / <2°	100
CTS-0750-xxx	0.75" (19.0 mm)	5, 15, 30, 50	±1% / not spec.	200
CTS-0750-xxx	0.75" (19.0 mm)	70, 100, 150, 200	±1% / <2°	200
CTS-1250-xxx	1.25" (31.7 mm)	70, 100	±1% / not spec.	600
CTS-1250-xxx	1.25" (31.7 mm)	150, 200, 250, 300, 400, 600	±1% / <2°	600
CTS-2000-xxx	2.00" (50.8 mm)	600, 800, 1000, 1200, 1500	±1% / <2°	1500

Table 10: Split-core CTs

## Split-Core Bus Bar CTs

These current transformers are referred to as “bus bar” CTs because they are available in larger and custom sizes appropriate for use with bus bars or multiple large conductors. These are UL recognized under UL file number E325972: CTB-**wwwXhhh-xxx**, where **www** and **hhh** indicate the width and height in inches, and **xxx** indicates the full scale current rating.

The accuracy of the split-core bus bar CTs is specified from 10% to 100% of rated current. The phase angle is specified at 50% of rated current (amps).

Model	Opening	Rated Amps	Accuracy / Phase Angle	Maximum Amps
CTB-1.5x3.5-0600	1.5" x 3.5" (38.1 mm x 88.9 mm)	600	±1.5% / <1.5°	750
CTB-4.0x4.0-0800	4.0" x 4.0" (101.6 mm x 101.6 mm)	800	±1.5% / <1.5°	1000
CTB-4.0x4.0-1200	4.0" x 4.0" (101.6 mm x 101.6mm)	1200	±1.5% / <1.5°	1500
CTB-4.0x4.0-2000	4.0" x 4.0" (101.6 mm x 101.6 mm)	2000	±1.5% / <1.5°	2500
CTB-4.5x4.0-3000	4.5" x 4.0" (114.3 mm x 101.6 mm)	3000	±1.5% / <1.5°	3750
CTB- <b>wwwXhhh-xxxx</b>	Custom ( <b>www</b> by <b>hhh</b> inches)	<b>xxxx</b>	±1.5% / <1.5°	4000

Table 11: Split-core Bus Bar CTs

## Solid-Core CTs

Also called “toroid” or “donut” current transformers. These are UL recognized under UL file number E96927: CTT-0750-100N, CTT-1250-400N, CTT-0300-030N, CTT-0500-060N, CTT-1000-200N, CTT-0300-005N, CTT-0300-015N, CTT-0500-050N, CTT-0500-030N, CTT-0500-015N, CTT-0750-070N, CTT-0750-050N, CTT-0750-030N, CTT-1000-150N, CTT-1000-100N, CTT-1000-070N, CTT-1000-050N, CTT-1250-300N, CTT-1250-250N, CTT-1250-200N, CTT-1250-150N, CTT-1250-100N, CTT-1250-070N.

The accuracy of the solid-core CTs is specified from 10% to 100% of rated current. The phase angle error is specified at 50% of rated current. The CT suffix **xxx** is the rated current. The “N” at the end of the part number indicates a nickel core material, which is the only core material available for our solid-core CTs.

Model	Inside Diameter	Rated Amps (-xxx)	Accuracy / Phase Angle	Maximum Amps
CTT-0300-xxxN	0.30" (7.6mm)	5, 15, 20, 30	±1% / <1°	30
CTT-0500-xxxN	0.50" (12.7mm)	15, 20, 30, 50, 60	±1% / <1°	60
CTT-0750-xxxN	0.75" (19.0mm)	30, 50, 70, 100	±1% / <1°	100
CTT-1000-xxxN	1.00" (25.4mm)	50, 70, 100, 150, 200	±1% / <1°	200
CTT-1250-xxxN	1.25" (31.7mm)	70, 100, 150, 200, 250, 300, 400	±1% / <1°	400

**Table 12: Solid-core CTs**

## Warranty

All products sold by Continental Control Systems, LLC (CCS) are guaranteed against defects in material and workmanship for a period of five years from the original date of shipment. CCS’s responsibility is limited to repair, replacement, or refund, any of which may be selected by CCS at its sole discretion. CCS reserves the right to substitute functionally equivalent new or serviceable used parts.

WattNode Logger models include a lithium battery to preserve the date and time during power failures. CCS will replace or provide a replacement battery at no charge if the battery fails within five years from the original date of shipment.

This warranty covers only defects arising under normal use and does not include malfunctions or failures resulting from: misuse, neglect, improper application, improper installation, water damage, acts of nature, lightning, product modifications, alterations or repairs by anyone other than CCS.

**Except as set forth herein, CCS makes no warranties, expressed or implied, and CCS disclaims and negates all other warranties, including without limitation, implied warranties of merchantability and fitness for a particular purpose.**

## Limitation of Liability

**In no event shall CCS be liable for any indirect, special, incidental, punitive or consequential damages of any kind or nature arising out of the sale or use of its products whether such liability is asserted on the basis of contract, tort or otherwise, including without limitation, lost profits, even if CCS has been advised of the possibility of such damages.**

**Customer acknowledges that CCS’s aggregate liability to Customer relating to or arising out of the sale or use of CCS’s products, whether such liability is asserted on the basis of contract, tort or otherwise, shall not exceed the purchase price paid by Customer for the products in respect of which damages are claimed. Customer specifically acknowledges that CCS’s price for the products is based upon the limitations of CCS’s liability set forth herein.**