WATTNODE®

Pulse Output

Installation and Operation Manual

Continental Control Systems

http://www.ccontrolsys.com

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FCC INFORMATION

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area can cause harmful interference in which case the user will be required to correct the interference at his own expense.

Contents

Overview

WattNode

Congratulations on your purchase of the WattNode®, the most compact instrumentation-grade watt/watt-hour transducer available. Using state-of-the-art ASIC and surface mount components, the WattNode offers precision energy and power measurements in a compact package. The WattNode enables you to make precise power and energy measurements from within existing electric service panels avoiding the costly installation of subpanels and associated wiring. The WattNode is designed for use in demand side management (DSM), sub-metering, and energy monitoring applications where accuracy at reasonable cost is essential. The WattNode outputs a stream of pulses whose frequency is proportional to the instantaneous power and whose count is proportional to total watt-hours. Models are available for single-phase, three-phase wye and three-phase delta configurations for voltages from 120 VAC to 600 VAC at 50 to 60 Hz.

Current Transformers

The WattNode uses either toroidal or split-core (opening) current transformers (CTs). The WattNode requires CTs with burden resistors generating 0 – 0.333 VAC. Split-core CTs offer greater ease of installation, because they can be installed without disconnecting the circuit being measured (although connecting the voltage terminals on the WattNode requires that at least one circuit in the service panel be turned off). Toroidal CTs are more compact, more accurate and less expensive, but installation requires that the measured circuit be disconnected.

The rated current of the CTs should normally be chosen at or above the maximum current of the circuit being measured. However, if the circuit will normally operate at some fraction of the maximum current and greatest accuracy is desired at the normal operating power levels, then a CT rated somewhat above the normal operating current may be a better choice. Take care that the maximum allowable current for the CT can not be exceeded without tripping a circuit breaker or fuse (see **Table** 4: Scale Factors

Specifications). The WattNode can measure up to 150% of rated maximum power for the chosen voltage range and CT, but accuracy will suffer as the CT's core begins to saturate. CTs are also nonlinear at very low power levels and may report less than the true current.

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, pass the wire through the CT once, then loop back around the outside of the CT, and pass the wire through the CT again. Repeat until the wire passes through the CT 5 times. The CT is now effectively a 1 amp CT instead of a 5 amp CT. In general, the current rating of the CT is divided by the number of times that the wire passes through the CT.

Optoisolator Output

The pulse output of the WattNode passes through an optoisolator to provide 2500 volts of isolation. This allows the WattNode to be interfaced to monitoring or data logging hardware without concern about interference, ground loops, shock hazard, etc.

Installation

Precautions

DANGER — HIGH VOLTAGE HAZARD
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.

Only qualified personnel or electricians should install the WattNode. Different versions of the WattNode measure circuits with voltages from 120 VAC single-phase to 600 VAC three-phase. **These voltages are lethal!** Always adhere to the following checklist:

1) CCS recommends that a **licensed electrician** install the WattNode.
2) CCS recommends that the WattNode be installed either in an electrical enclosure (panel or junction box) or in a limited access electrical room.
3) Verify that circuit voltages and currents are within the proper range for the WattNode model.
4) Ensure that the line voltage inputs to the WattNode have either fuses or circuit breakers on each voltage phase (not needed for the neutral wire).
5) Do not install live voltage wires into screw terminals.
6) Always connect the CTs to the WattNode before connecting the line voltages to the WattNode. Note: in delta configurations the CT screw terminals will be at line voltage when the WattNode is powered.
7) Do not place more than one voltage wire in a screw terminal.
8) Remember that the screw terminals are **not** insulated. Do not contact metal tools to the screw terminals if the circuit is live!
9) Before turning on power to the WattNode, ensure that all the wires are securely installed by tugging on each wire.
10) Do not install the WattNode in an environment where it may be exposed to temperatures below -30°C or above 60°C, excessive moisture, dust or other contamination.

Measurement Configurations

Below is a list of different power measurement configurations, with connections and recommended WattNode models. Note: Ground wires do not carry current except in the case of a malfunction of the circuit being measured and are not used by the WattNode.

Single-Phase Two-Wire

The single-phase two-wire 120 VAC configuration is most often seen in homes and offices. The two wires are neutral and line. Any unused CT inputs must be shorted with an insulated jumper wire. Single-phase two-wire circuits should be measured with models WNA-1P-240-P or WNA-3Y-208-P. If you wish to measure a single phase two wire 220 to 240 VAC circuit, use the WNA-3Y-400-P and connect the two wires to the neutral and phase A terminals.

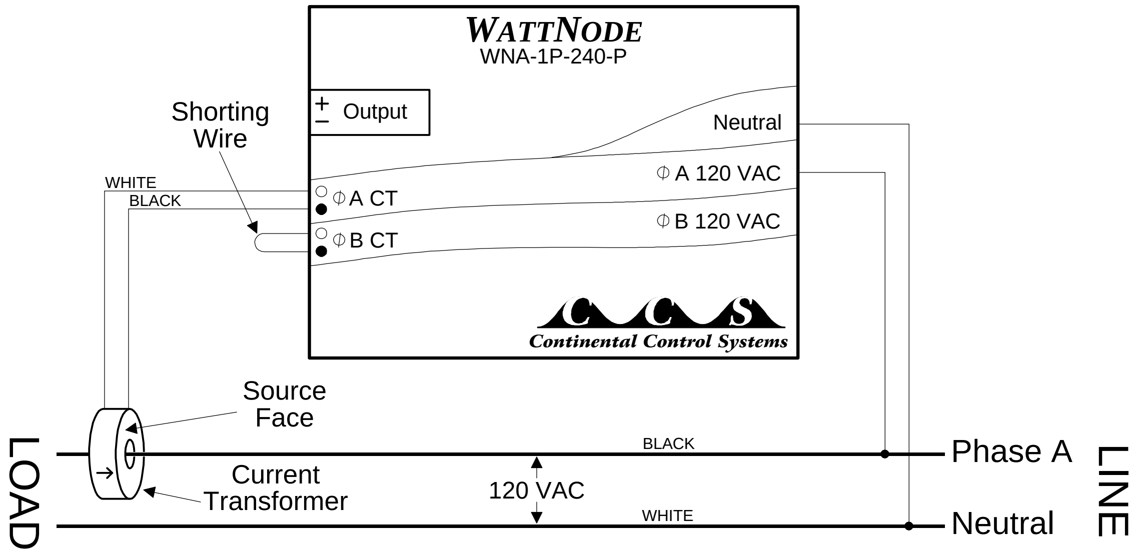

Figure 1: One-Phase Two-Wire Connection

Single-Phase Three-Wire

This is seen in residential and commercial service with 240 VAC for large appliances. The three wires are neutral and two line voltage wires with AC waveforms 180° out of phase. This results in 120 VAC between either line wire and neutral, and 240 VAC (or sometimes 208 VAC) between the two line wires. Any unused CT inputs must be shorted with an insulated jumper wire. Single-phase three-wire circuits should be measured with models WNA-1P-240-P or WNA-3Y-208-P.

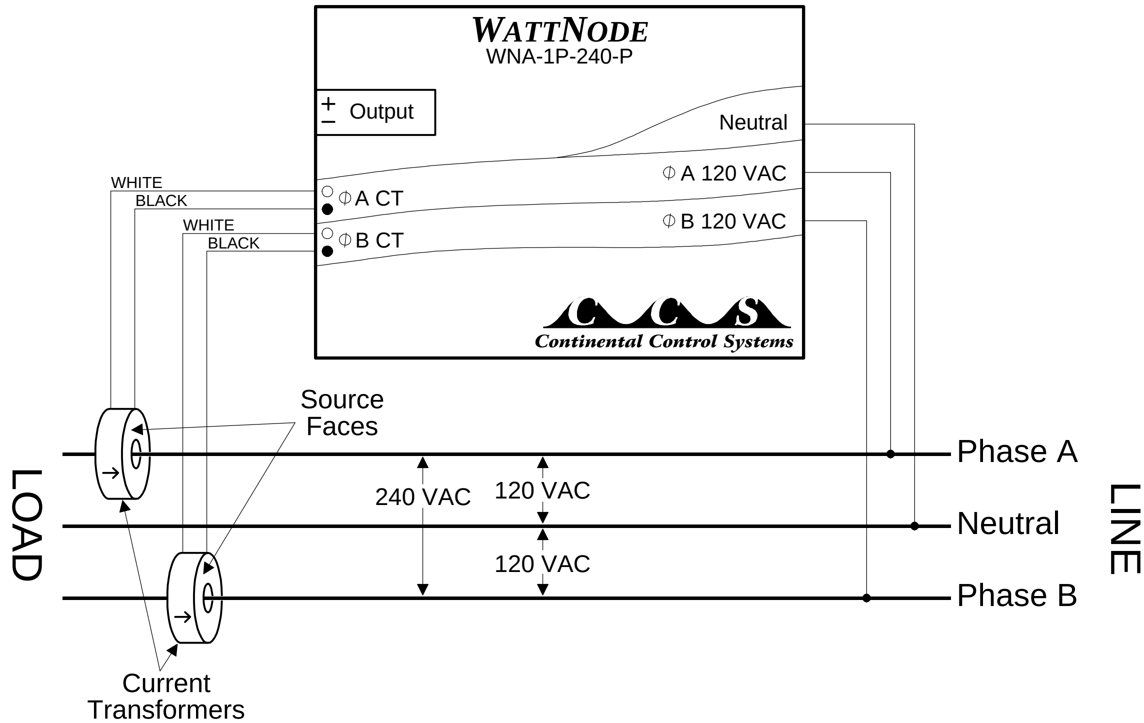

Figure 2: One-Phase Three-Wire Connection

Three-Phase Four-Wire Wye

This is typically seen in commercial and industrial environments. The wires are neutral and three power lines with AC waveforms shifted 120° between the successive phases. With this configuration, the line voltage wires may be connected to the phase A, B and C terminals in any order, **so long as the CTs are connected to matching phases**. It is important, however, that you connect the neutral line correctly. Three-phase four-wire wye circuits should be measured with the WNA-3Y-208-P (208 VAC phase to phase and 120 VAC phase to neutral), the WNA-3Y-400-P (400 VAC phase to phase and 230 VAC phase to neutral), or the WNA-3Y-480-P (480 VAC phase to phase and 277 VAC phase to neutral), depending on the line voltage.

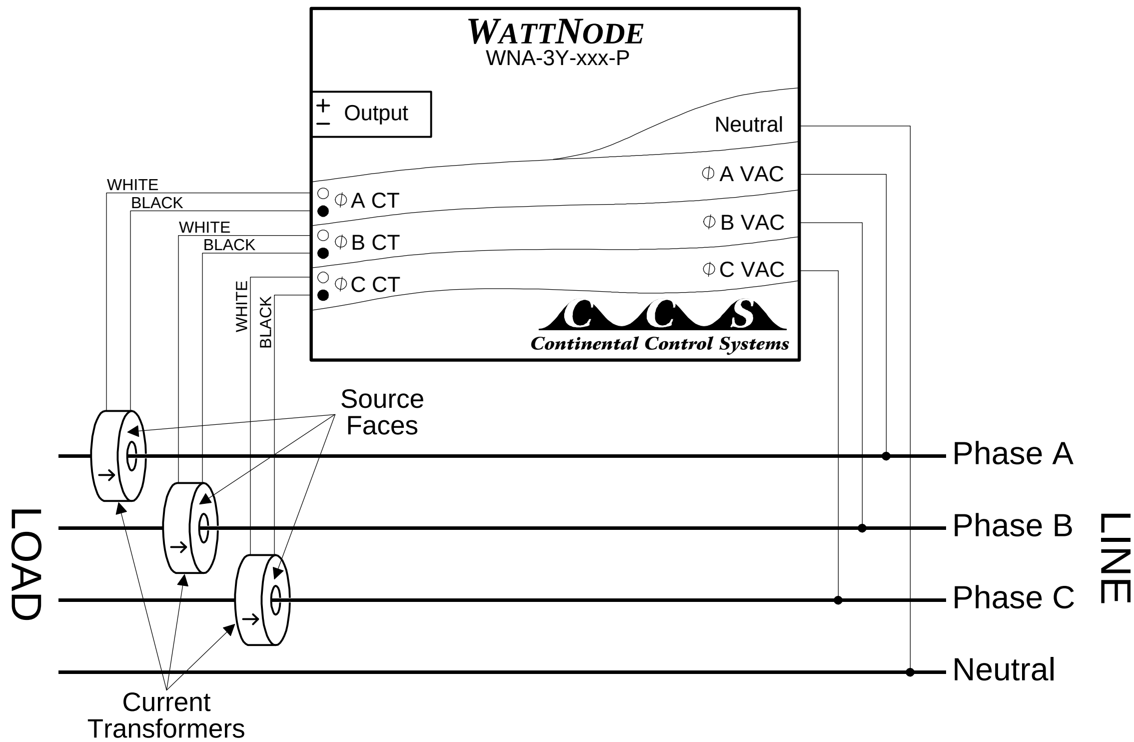

Figure 3: Three-Phase Four-Wire Wye Connection

Three-Phase Three-Wire Delta

WARNING
This configuration is dangerous because there is no neutral wire, and as a result the screw terminals to connect the CTs will have line voltages on them whenever the WattNode is powered. Therefore, for safety, it is critical that the WattNode is not powered while connecting the CTs.

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 phase A, B and C terminals in any order, so long as the CTs are connected to matching phases. Three-phase three-wire delta circuits should be measured with the WNA-3D-240-P or the WNA-3D-480-P.

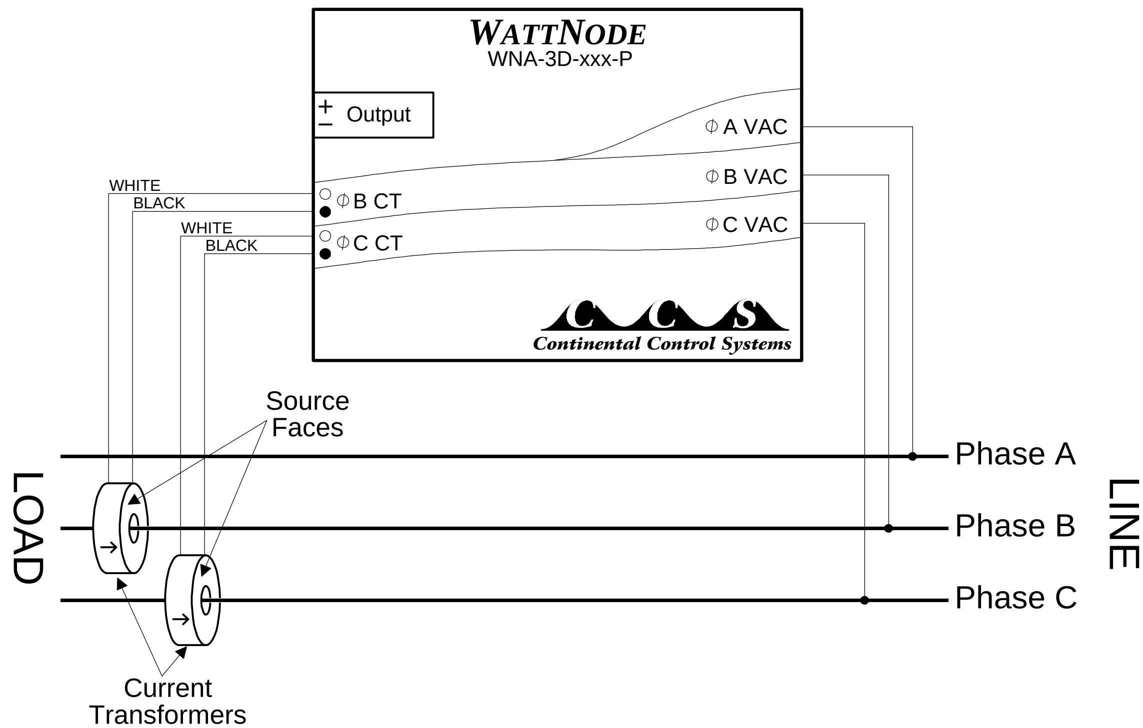

Figure 4: Three-Phase Three-Wire Delta Connection

Mounting

Mount the WattNode so that it is protected from moisture, direct sunlight and high temperatures. Due to its exposed screw terminals, the WattNode should always be installed in an electrical service panel, a junction box, or an electrical closet. The WattNode may be installed in any position.

The WattNode has two 7/32" (5.5 mm) mounting holes spaced 5" (127 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 WattNode or **Figure 5** may be used as a template to mark mounting hole positions, but do not drill the holes with the WattNode in the mounting position because the drill bit or chuck may damage the plastic WattNode housing or connectors.

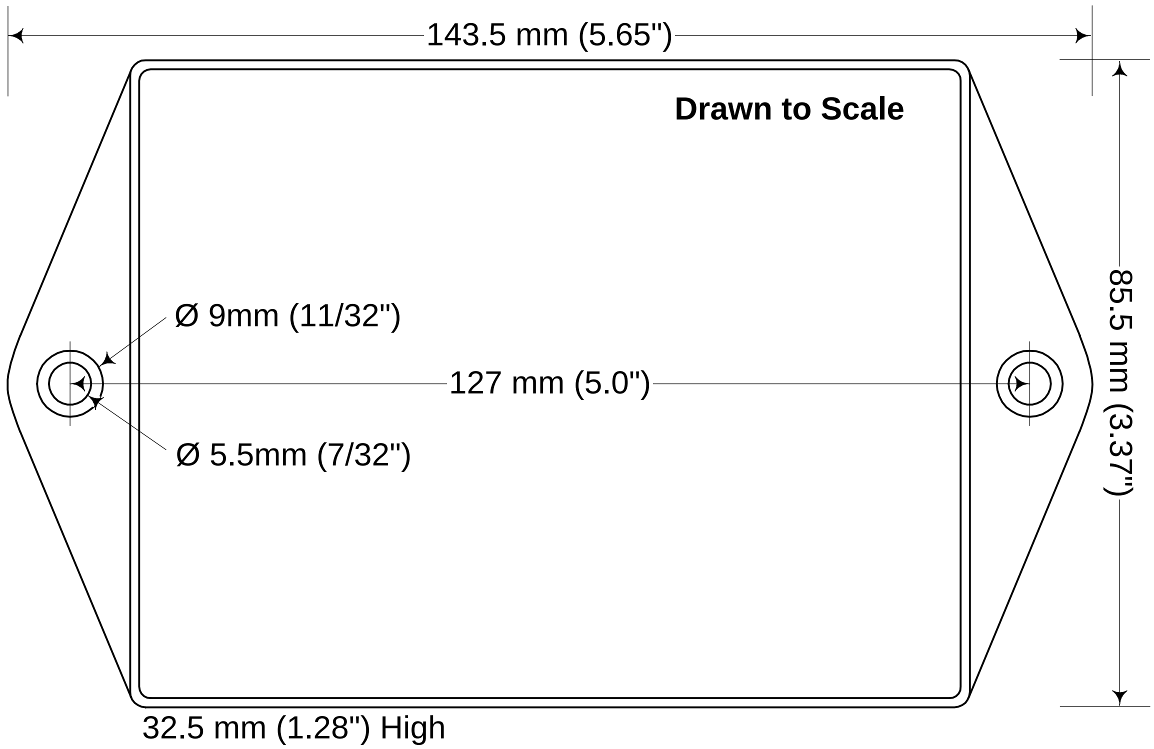

Figure 5: WattNode Dimensions

To protect the WattNode's plastic case, use washers if the mounting screws could pull through the mounting hole or damage the case. Also, take care not to overtighten the mounting screws, as long term stress on the case may cause cracking.

Current Transformers

Approved Current Transformers

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

Manufacturer: Magnelab Corporation

UL File Number: E96927

Approved Models:

CCS Model Number	Magnelabs Part #	Rated Amps	Opening Diameter
CTS-0750-xxx	SCT-0750-xxx	5 – 150	0.75" (19.05mm)
CTS-1250-xxx	SCT-1250-xxx	70 – 600	1.25" (31.75mm)
CTS-2000-xxx	SCT-2000-xxx	600 – 1500	2.00" (50.80mm)
CTT-0300-005	3712-003	5	0.30" (7.62mm)
CTT-0300-015	3825-003	15	0.30" (7.62mm)
CTT-0300-030	2697-003	30	0.30" (7.62mm)
CTT-0500-015	3826-003	15	0.50" (12.70mm)
CTT-0500-030	3827-003	30	0.50" (12.70mm)
CTT-0500-050	3828-003	50	0.50" (12.70mm)
CTT-0500-060	2749-003	60	0.50" (12.70mm)
CTT-0750-030	3829-003	30	0.75" (19.05mm)
CTT-0750-050	3830-003	50	0.75" (19.05mm)
CTT-0750-070	3831-003	70	0.75" (19.05mm)
CTT-0750-100	2685-003	100	0.75" (19.05mm)
CTT-1000-050	3832-003	50	1.00" (25.40mm)
CTT-1000-070	3833-003	70	1.00" (25.40mm)
CTT-1000-100	3834-003	100	1.00" (25.40mm)
CTT-1000-150	3835-003	150	1.00" (25.40mm)
CTT-1000-200	2750-003	200	1.00" (25.40mm)
CTT-1250-070	3836-003	70	1.25" (31.75mm)
CTT-1250-100	3837-003	100	1.25" (31.75mm)
CTT-1250-150	3838-003	150	1.25" (31.75mm)
CTT-1250-200	3839-003	200	1.25" (31.75mm)
CTT-1250-250	3840-003	250	1.25" (31.75mm)
CTT-1250-300	3841-003	300	1.25" (31.75mm)
CTT-1250-400	2686-003	400	1.25" (31.75mm)

Connecting Current Transformers

The WattNode will only work with CTs containing built in burden resistors that produce 0.333 volts output at rated current. The use of any other CTs will result in incorrect power measurements, and may permanently damage the WattNode. CTs with 5 amp output will destroy the WattNode and must not be used.

There are two steps to connecting the current transformers: pass the wire to be measured through the CT and connect the CT to the WattNode. Note: always remove power before disconnecting any live wires. Split-core CTs may be mounted around a wire by opening one side of the CT, sliding the CT around the wire, and then closing the open side of the CT. A split-core CT is opened by pulling the removable section straight away from the rest of the CT; this may require a strong pull. To reinstall the removable portion of the CT, check that the ends mate correctly by looking at the exposed laminated steel core on the CT body and the removable section. When pressing the CT back together, if it seems to jam and will not close, the steel core pieces are probably not aligned correctly. Do not force the CT, instead, reposition or rock the removable portion until the CT closes without excessive force. After a split-core CT has been placed around a wire, a nylon cable tie should be secured around the CT to prevent inadvertent opening.

The WattNode does not measure negative power and will instead indicate zero power. CTs are directional and if mounted backwards or with their wires reversed the power will be negative. In an installation with just one CT, the WattNode would output zero power. In a multiple CT installation, if one CT were backwards and others were mounted correctly, then the reversed CT would cause the power on that phase to be subtracted from the power measured on the other phases, resulting in a plausible, but incorrect reading.

CTs are labeled with either a label which says “THIS SIDE TOWARD SOURCE”, or with an arrow. Mount the CT so the label faces or the arrow points towards the current source—typically the circuit breaker for the circuit being measured or the utility’s meter box. It is also possible to measure generated power by treating the generator as the source.

Start by removing power from wires being measured. Toroidal CTs require that the wire be disconnected before passing it through the opening in the CT. Put the line wires through the CTs as shown in the section **Measurement Configurations**.

Next, connect the CTs to the WattNode. The CT inputs to the WattNode are sensitive to ESD (electrostatic discharge), so you should ground yourself by touching the service panel case or some other grounded metal object before connecting the CTs to the WattNode. Route the twisted black and white wires from the CT to the WattNode. Any excess length may be trimmed from the wires if desired. Strip or trim the wires to expose 1/4" (6 mm) of bare wire. Do not leave more than 5/16" (8 mm) or less than 3/16" (5 mm) of bare wire. The current transformers connect to the black screw terminal block, and it may be easier to install the terminal block on the WattNode before connecting the wires from the CTs. Connect each CT, 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. Any unused CT inputs must be shorted. You may trim short sections off the end of the CT wires to use as jumpers. Be careful to leave insulation on the exposed portion of the jumper(s) to prevent shock or shorting danger.

Finally record the CT full-scale current as part of the installation record for each WattNode. If the wires being measured are passed through the CT(s) more than once, then the recorded full-scale CT current is divided by the number of times that the wire passes through the CT.

Connecting Voltage Terminals

Always disconnect power—by shutting off circuit breaker(s) or removing fuse(s)—before connecting the voltage lines to the WattNode. **The WattNode must be connected to voltage lines which are protected by fuses or circuit breakers.** Connect each voltage phase input to a circuit breaker on the required phase. If there is more than one circuit breaker on a phase, then any one of the circuit breakers may be used. When installing multiple WattNodes at the same site, it may be easier to provide separate circuit breaker(s) for the WattNodes.

When connecting the WattNode, do not place more than one voltage wire in a screw terminal; use separate wire nuts or terminal blocks if needed. The screw terminals handle wire up to 12 AWG. Prepare the voltage wires by stripping the wires to expose 1/4" (6 mm) of bare wire. Do not leave more than 5/16" (8 mm) or less than 3/16" (5 mm) of bare wire. Connect each voltage line to the light gray terminal block as shown in the section **Measurement Configurations**. Double check that the voltage line phases match the phases to which the CTs are connected. After the voltage lines have been connected, make sure both terminal blocks are securely installed on the WattNode.

If there is any doubt that the voltage rating of the WattNode is correct for the circuit being measured, then before applying power to the WattNode, disconnect the light gray screw terminal from the WattNode and then turn on the power. Use a voltmeter to measure the voltage between the top two screw terminals—labeled NEUTRAL and øA on 1P and 3Y models, and labeled øA and øB on 3D models. This voltage should match the value in the VAC column of **Table 2: Power and Energy Parameters**.

The WattNode is powered from the voltage inputs: phase A to neutral, or phase A to phase B for delta models. If the WattNode is not receiving at least 80% of the nominal line voltage, it may stop measuring power. Since the WattNode consumes some power itself, a decision must be made about whether to place the CTs before or after the connection for the WattNode, so as to include or exclude the WattNode's own power consumption (up to 3 watts).

Connecting Output

The outputs of the WattNode are the collector and emitter of an NPN optoisolator transistor whose base is driven by the WattNode's pulse stream. This output may be connected to most devices that expect a contact closure input. The following schematic illustrates a possible connection to the optoisolator.

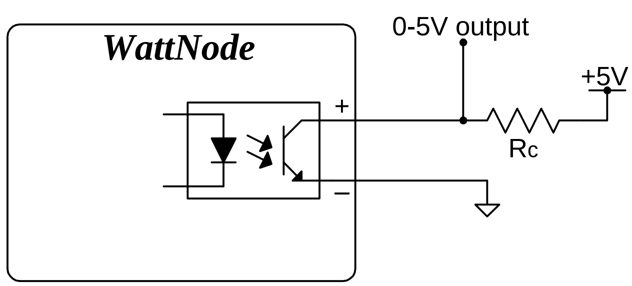

Figure 6: Optoisolator Output

Under no circumstances, should the optoisolator ever be exposed to collector-emitter voltages greater than 35V, or collector-emitter currents greater than 50mA.

The value chosen for R_c depends on the maximum pulse frequency expected from the WattNode. If power consumption is of no concern, then a value around 1KΩ will work for all output frequencies and provide short rise and fall times. For cases where power consumption is a concern and slow rise and fall times may be tolerated, then the following table shows the maximum value of R_c for various maximum pulse frequencies.

Maximum Frequency	Maximum R_c	Risetime to 4.0V
4.0 Hz	2.2 MΩ	70 milliseconds
290 Hz	82 kΩ	1.6 milliseconds
1200 Hz	4.7 kΩ	100 microseconds

Table 1: Collector Resistors vs. Frequency

The output is completely isolated from all dangerous voltages, so it can be connected at any time. For short distances (less than 2 meters), any pair of insulated wires are suitable for connection to the monitoring equipment. For longer distances, a shielded twisted-pair cable is recommended to prevent interference. Since the output wiring will be in the same location as line voltage wiring, it is recommended that the output wiring have a 600V rating.

Installation Summary

1) Mount the WattNode.
2) Turn off power before installing toroidal CTs or making voltage connections.
3) Mount the CTs around the line wires being measured. Take care to orient the CTs correctly.
4) Connect the twisted white and black wires from the CT to the black terminal block on the WattNode, matching the wire colors to the white and black dots on the label of the WattNode.
5) Jumper any unused CT inputs with an insulted shorting wire.
6) Connect the voltage wires to the light gray terminal block of the WattNode, and double check that the current measurement phases match the voltage measurement phases.
7) Connect the output terminals of the WattNode to the monitoring equipment.
8) Apply power to the WattNode.

Installation Troubleshooting

SYMPTOM: The WattNode is reporting zero power.	
<u>Probable Causes</u>	**<u>Corrective Actions</u>**
The WattNode is not receiving the line voltage that it needs.	First, make sure that the light gray voltage connector is firmly seated. Then, using a voltmeter, perform the following checks. For 1P and 3Y models measure the voltage between the NEUTRAL and øA terminals, for 3D models measure the voltage between the øA and øB terminals. This voltage should be within 20% of the values listed in the VAC column of **Table 2: Power and Energy Parameters.**
An unused pair of CT screw terminals has not been jumpered with an insulated shorting wire.	On any unused CT screw terminals, connect the white and the black terminals (indicated by dots on the label) together with a short insulated jumper wire. Strip both ends of the jumper wire to expose 1/4" (5mm) of bare wire.
One or more CT may be installed backwards.	If the CT faces towards the load or the white and black wires have been reversed, then the power for that phase will be negative. To verify the direction of installation, follow **PROCEDURE A** below.
The voltage and CT wires may be wired out of phase.	The best approach is to visually verify that everything is wired correctly, but if that is not a feasible option, then follow **PROCEDURE B** below.
The CT rating may be too large for the application or the load being measured may not be active.	If possible, verify that at least 5% of the CT's rated current is flowing through the CT. Follow **PROCEDURE C** below to check the CTs.
The WattNode is not functioning correctly.	If another WattNode with the same model number is installed and working, a suspect unit may be tested by disconnecting the screw terminals from the working unit, and plugging them into the suspect unit. If the suspect unit works correctly, then most likely it is the wiring to the suspect unit, and not the WattNode that is at fault.

SYMPTOM: The WattNode is reporting an incorrect power.	
<u>Probable Causes</u>	**<u>Corrective Actions</u>**
An unused pair of CT screw terminals has not been jumpered with an insulated shorting wire.	On any unused CT screw terminals, connect the white and the black terminals (indicated by dots on the label) together with a short insulated jumper wire. Strip both ends of the jumper wire to expose 1/4" (5mm) of bare wire.
The CTs do not all have the same full-scale current rating.	Check the current ratings of all the CTs and ensure that they match.
The CT full-scale current is incorrect.	Recheck the CT's full-scale current ratings. If the wire is passed through the CT more than once, then divide the full-scale current rating by the number of times that the wire passes through the CT.

One or more CT may be installed backwards.	If the CT faces towards the load or the white and black wires have been reversed, then the power for that phase will be negative. To verify the direction of installation, follow **PROCEDURE A** below.
The voltage and CT wires may be wired out of phase.	The best approach is to visually verify that everything is wired correctly, but if that is not a feasible option, then follow **PROCEDURE B** below.
The WattNode is not functioning correctly.	If another WattNode with the same model number is installed and working, a suspect unit may be tested by disconnecting the screw terminals from the working unit, and plugging them into the suspect unit. If the suspect unit works correctly, then most likely it is the wiring, and not the WattNode that is at fault.

PROCEDURE A:

1. Either remove power from the WattNode or unplug the CT screw terminals before working with the CT wires.
2. Check each CT in turn. Disconnect all other CTs and jumper their screw terminals with a shorting wire.
3. Check that the power is not zero. If the power is zero, then reverse the CT wires (white to black and black to white) and check again. If the power is still zero, then go to **PROCEDURE B**.

PROCEDURE B:

1. Either remove power from the WattNode or unplug the CT screw terminals before working with the CT wires.
2. Check each CT in turn. Disconnect all other CTs and jumper their screw terminals with a shorting wire.
3. To order the phases correctly, match each CT to the pair of screw terminals that results in the largest power. If the reported power on a pair of screw terminals is zero, then also try reversing the CT wires. Throughout this test, unused CT inputs must be jumpered with a shorting wire between the white and black dots. In addition, if the power level of the load being measured is changing significantly, then this test may not yield correct results.

PROCEDURE C:

1. Since some CTs may produce little or no output below 5% of rated current, verify that at least 5% of the CT's rated current is flowing through the CT. Use a clamp-on style current meter to measure the current in the wire that passes through the CT. If a clamp-on current meter is not available, go on to step 2.
2. Measure AC voltage across the CT wires (probe the screw terminals). If the voltage is less than 3 mV, then a) less then 5% of the CT's rated current is flowing, or b) the CT is defective. If the voltage is more than 333 mV, then a) more than the CT's rated current is flowing, b) the CT is defective, or c) the CT is not a 333 mV output CT. If you suspect that the CT may be defective, then a clamp on current probe may be used to verify the current flowing in the wire. If the clamp-on probe indicates that an AC current ranging from 5% to 100% of the CT's rated current is flowing and yet the voltage across the CT is not in the range of 3 to 333 mV, then the CT is probably bad. As a final test, unplug the CT screw terminals from the WattNode and measure the voltage again. If it is significantly different, then the WattNode may be defective.

Operating Instructions

Power and Energy Computation

The power is a function of the pulse frequency, while the energy is a function of the count of pulses. The variable ***nCTs*** is the maximum number of CTs that the WattNode model can use. The variable ***CTAmps*** is the full-scale current rating of the CTs. Note: If the wires being measured are passed through the CT(s) more than once, then the full-scale CT current is divided by the number of times that the wire passes through the CT. ***VAC*** is the nominal phase voltage of the WattNode model. The variable ***PulseFreq*** is the pulse frequency from the WattNode, while ***Pulses*** is the total accumulated count of pulses. ***FSHz*** is the full-scale pulse frequency printed on the rear label of the WattNode. The values of the constant parameters are in the following table.

WattNode Model(s)	Possible FSHz Values	nCTs	VAC
WNA-1P-240-P	2.667, 193.3, or 773.3 Hz	2	120
WNA-3Y-208-P	4.000, 290.0, or 1160 Hz	3	120
WNA-3Y-480-P	4.000, 290.0, or 1160 Hz	3	277
WNA-3D-240-P	2.667, 193.3, or 773.3 Hz	2	240
WNA-3D-480-P	2.667, 193.3, or 773.3 Hz	2	480

Table 2: Power and Energy Parameters

Below are the equations used to compute the power and energy.

$$Power(W) = \frac{nCTs \cdot VAC \cdot CTAmps \cdot PulseFreq}{FSHz}$$

$$Energy(WH) = \frac{nCTs \cdot VAC \cdot CTAmps \cdot Pulses}{FSHz \cdot 3600}$$

The following table provides an alternate means of computing the power and/or energy being reported by a WattNode.

Model \ Full-scale Pulse Frequency	WattHours per Pulse per CT Rated Amp		
	2.667 or 4.0 Hz	193.3 or 290 Hz	773.3 or 1160 Hz
WNA-1P-240-P	2.500×10^{-2}	3.448×10^{-4}	8.621×10^{-5}
WNA-3Y-208-P	2.500×10^{-2}	3.448×10^{-4}	8.621×10^{-5}
WNA-3Y-480-P	5.771×10^{-2}	7.960×10^{-4}	1.990×10^{-4}
WNA-3D-240-P	5.000×10^{-2}	6.897×10^{-4}	1.724×10^{-4}
WNA-3D-480-P	1.000×10^{-1}	1.379×10^{-3}	3.448×10^{-4}

Table 3: WattHours per Pulse

Example: a WNA-3Y-208-P with 15 amp CTs and a full-scale pulse frequency of 4 Hz will output 1 pulse for every 0.375 WattHours.

$$(2.500\times10^{-2})\bullet(15.0\text{ amps})\bullet(1\text{ pulse}) = 0.375\text{ WattHours}$$

Scale Factors

CT Size (amps)	Pulses Per kilowatt-hour				Watt-hours per pulse			
	1P-240 3Y-208	3D-240 3Y-400	3Y-480	3D-480	1P-240 3Y-208	3D-240 3Y-400	3Y-480	3D-480
5	8000.00	4000.00	3465.70	2000.00	0.125	0.250	0.289	0.500
15	2666.67	1333.33	1155.24	666.667	0.375	0.750	0.866	1.500
30	1333.33	666.667	577.617	333.333	0.750	1.500	1.731	3.000
50	800.000	400.000	346.570	200.000	1.250	2.500	2.885	5.000
60	666.667	333.333	288.809	166.667	1.500	3.000	3.463	6.000
70	571.429	285.714	247.550	142.857	1.750	3.500	4.040	7.000
100	400.000	200.000	173.285	100.000	2.500	5.000	5.771	10.000
150	266.667	133.333	115.523	66.667	3.750	7.500	8.656	15.000
200	200.000	100.000	86.643	50.000	5.000	10.000	11.542	20.000
250	160.000	80.000	69.314	40.000	6.250	12.500	14.427	25.000
300	133.333	66.667	57.762	33.333	7.500	15.000	17.313	30.000
400	100.000	50.000	43.321	25.000	10.000	20.000	23.083	40.000
600	66.667	33.333	28.881	16.667	15.000	30.000	34.625	60.000
800	50.000	25.000	21.661	12.500	20.000	40.000	46.167	80.000
1000	40.000	20.000	17.329	10.000	25.000	50.000	57.708	100.00
1200	33.333	16.667	14.440	8.333	30.000	60.000	69.250	120.00
1500	26.667	13.333	11.552	6.667	37.500	75.000	86.563	150.00
2000	20.000	10.000	8.664	5.000	50.000	100.00	115.42	200.00
3000	13.333	6.667	5.776	3.333	75.000	150.00	173.13	300.00

Table 4: Scale Factors

Specifications

Models

Model	VAC phase to neutral	VAC phase to phase	Phases	Wires
WNA-1P-240-P	115	208–240	1	2 or 3
WNA-3Y-208-P	115	208–240	3	4
WNA-3Y-480-P	277	480	3	4
WNA-3D-240-P	N/A	208–240	3	3
WNA-3D-480-P	N/A	480	3	3

Table 5: WattNode Models

Current Transformers

The WattNode uses CTs with integral burden resistors generating 0.333 VAC at rated current. The maximum allowable current is dependent only on the physical size of the CT, not the rated current. Exceeding the maximum allowable current may damage CTs.

The accuracy of the split-core CTs is rated as 1% from 10% to 130% of rated current, the phase angle error is less then or equal to 2 degrees. The accuracy of the toroidal CTs is rated as 1% from 10% to 130% of rated current, the phase angle error is less than or equal to 1 degree. The following tables show the available split-core and toroidal CTs. The CT suffix (-yyy) is the rated current.

Model	I.D.	Rated Amps	Max. Amps
CTS-0750-yyy	0.75"	5, 15, 20, 30, 50, 70, 100, 150	200
CTS-1250-yyy	1.25"	70, 100, 150, 200, 250, 300, 400, 600	800
CTS-2000-yyy	2.00"	600, 800, 1000, 1200, 1500	2000

Table 6: Split-core CTs

Model	I.D.	Rated Amps	Max. Amps
CTT-0300-yyy	0.30"	5, 15, 20, 30	40
CTT-0500-yyy	0.50"	15, 20, 30, 50, 60	80
CTT-0750-yyy	0.75"	30, 50, 70, 100	130
CTT-1000-yyy	1.00"	50, 70, 100, 150, 200	260
CTT-1250-yyy	1.25"	70, 100, 150, 200, 250, 300, 400	520

Table 7: Toroidal CTs

Accuracy

The WattNode's minimum accuracy is 0.45% of reading plus 0.05% of full-scale. The total system accuracy is subject to CT accuracy.

The WattNode can measure power from 0.1% to 150% of full-scale power at reduced accuracy, which provides extra range for occasional high loads. Due to their nonlinearity, however, the CTs may not produce accurate readings at very low power levels, and may saturate at very high power levels.

Electrical

Power Consumption: up to 3 watts

Maximum Operating Voltage Range: 80% to 120% of nominal

Operating Frequency Range: 48 to 62 Hz

Optoisolator Output:

- **Isolation:** 2500 V
- **Collector–emitter breakdown voltage:** 35 V
- **Maximum collector–emitter current:** 50 mA

Environmental

Temperature: -30° to +60°C

Humidity: 5 to 90% RH (non-condensing)

Mechanical

Enclosure: High impact, ABS plastic

- **Flame Resistance Rating:** 94HB
- **Size:** 143mm × 85mm × 32mm (5.63" × 3.34" × 1.25")

Connectors: Euroblock style pluggable terminal blocks

- **Light gray:** 22 to 12 AWG, 600 V
- **Black:** 26 to 16 AWG, 300 V

Warranty

All products sold by Continental Control Systems, LLC (CCS) are guaranteed against defects in material and workmanship for a period of one year from 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.

This warranty covers only defects arising under normal use and does not include malfunctions or failures resulting from: misuse, neglect, improper application, improper installation, acts of nature, 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. Some states or jurisdictions do not allow limitations on implied warranties, so these limitations may not apply to you.

In no event shall CCS be liable for any indirect, special, incidental, or consequential damages. Some states or jurisdictions do not allow the exclusion or limitation of incidental or consequential damages, so the above exclusion or limitation may not apply to you.