Application Note   AN0306

Using the WattsOn Universal Power Transducer
In Single Phase Two-Wire ("Split-Phase") Applications
With An Auxiliary 240V Load/Source

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Associated Product: WattsOn

Summary

The WattsOn power transducer features three inputs for voltage and current. In split phase applications, only two voltages and two currents are required to properly measure the consumption of the system, thus leaving a third input unused.

The third input may be used for an auxiliary load, or when specially configured, a 240V load or source. This application lends itself perfectly to monitoring the power and energy output of a 240V inverter or generator. The following application note discusses the necessary wiring and configuration required to monitor this type of configuration.

Wiring

In this type of configuration the wiring should be configured as shown in figure 1:
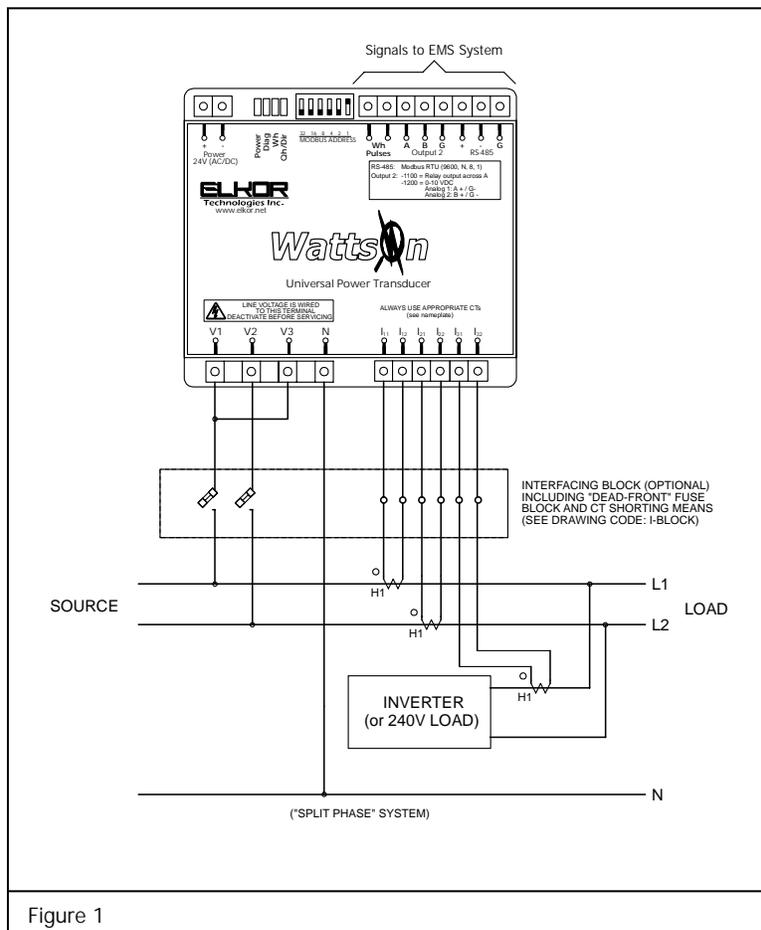
Figure 1

The wiring diagram shows that each circuit has its own associated current transformer. In addition, voltage signals from L1 and L2 are brought into the WattsOn via fuses for safety and disconnect purposes. The V3 input of the WattsOn must be tied to either the L1 or L2 voltage signal (it may be jumpered via a short wire from the V1 or V2 terminals of the WattsOn to avoid use of a separate fuse).

Although whether L1 or L2 are brought into the V3 terminal is irrelevant to the WattsOn metering accuracy, it will affect the sign of the power measurement ("direction" of power flow). This is also related to the wiring and polarity of the current transformer. Because it is difficult to tell with 240V loads which line "sources" current, it will be up to the installer to verify the expected direction of power in the 240V load. If the direction of power differs from what is expected, the issue may be resolved by one of the following methods:

1) Change the input into V3 from L1 to L2 (or vice-versa)
2) Change the orientation of the CT on the wire
3) Change the polarity of the CT into the WattsOn terminal
4) For power direction insensitive applications, the "Reverse W" or "Absolute W" bits may be set in the configuration word. Note however, these bits operate on ALL three measurement channels simultaneously.

WattsOn Software Configuration

Firmware version 2.6 of the WattsOn transducer is equipped with a configuration bit which sets up the WattsOn for the "Split Phase + 240V Load" mode of operation. This bit is accessible via Modbus Register 0x8E (40141). When bit 16 of this register is set, the WattsOn will apply a special algorithm to the calculations in **phase C only**. The Voltage, Power (W, VA, VAR), and energy in this phase will be computed based upon the line-to-line voltage in the system.

This method assumes that it is a typical single phase two-wire ("split-phase" 120/240V) configuration, in where the two hot lines are in phase, but 180° apart in relation to neutral (typical North American residential/commercial wiring). This algorithm will not work properly on "two-phase" systems, in which only two legs of a three leg system are brought in (the phases are 120° apart – ie: 120/208V).

Figure 2 shows the configuration word bit mapping.

Data Interpretation

With the wiring completed and configuration bit set, the WattsOn will apply the correct scaling to all **Phase C** registers. This includes the voltage, power and energy measurements. The current measurement for phase C, will indicate the current consumed (or generated) by the 240V load. The scaling of the integer registers should proceed as with the other phases (see the WattsOn manual for specifics). If the CT and PT ratios are properly set, the floating point registers will not require further scaling.

It is important to note that the placement of the phase A and B CTs will influence the phase A and B measurements. In the wiring shown in figure 1, it is assumed that CTs A & B are wired on the input to the distribution panel. Therefore, the power/energy measurements will include the power consumed/generated by the 240V load/source. In source (inverter/generator) applications, phase A & B the power/energy readings will be a net (consumed-generated) reading. Phase C will show only the power/energy of the 240V device. In this arrangement any "export" reading in phase A/B will indicate power export to the grid (ie: generated power exceeds consumed power within the installation).

These factors should be taken into consideration when planning the wiring of the system. Specifically in source applications, the placement of the A/B/C CTs will influence the data represented. For example, if the inverter is wired BEFORE the A/B CTs, then the A/B measurements will only show power consumed within the installation. C measurements will show only the power generated. This type of wiring will not indicate the net consumption/generation.

Bit	Name	Description	Default
1	Output #2 Selection *(-1100 model only)*	0=output #2 represents VARh accumulation. 1=output #2 represents direction of power flow (closed relay represents "negative" power).	0
2	Reverse W Sign	Setting this bit reverses the sign of the real power (W) calculation, and thus energy accumulation.	0
3	Reverse VAR Sign	Setting this bit reverses the sign of the apparent power (VAR) calculation, and thus the sign of the power factor as well as energy accumulation.	0
4	Reverse Sequence	0=expected sequence is ACB 1=expected sequence is ABC This bit effects the sequence error flag as well as the diagnostic LED.	0
5	Disable Sequence	Setting this bit disables the use of the diagnostic LED as sequence error detection. This bit should be set for single/split phase systems (phase sequence has no relevance in these systems).	1
6	Force W Absolute	Performs W calculation without sign. WARNING: This setting applies to accumulation of Wh and pulse signaling.	0
7	Force VAR Absolute	Performs VAR calculation without sign. WARNING: This settings applies to accumulation of VARh, pulse signaling and PF calculations also.	0
8	Force PF Absolute	When set, Performs PF calculation without sign.	0
9	Pulse on +Wh	When set, sends pulses (output #1) on accumulation of +Wh	1
10	Pulse on –Wh	When set, sends pulses (output #1) on accumulation of -Wh	0
11	Pulse on +VARh	When set, sends pulses (output #2) on accumulation of +VARh	1
12	Pulse on –VARh	When set, sends pulses (output #2) on accumulation of –VARh	0
13	No Voltage LED Flash	When set, indicates presence of low voltage (<20Vac) on voltage input terminals by diag LED fast flashing.	1
14	32-bit Word Order	When set, 32-bit registers are sent LSB-MSB, when clear (default) order is MSB-LSB	0
15	V/I Average	0=Vavg / Iavg are calculated as averages: Vavg=(Va+Vb+Vc)/3; Iavg=(Ia+Ib+Ic)/3 1=Vavg / Iavg are calculated as totals: Vavg=Va+Vb+Vc; Iavg=Ia+Ib+Ic	0
16	Split+240V Load	When set, applies algorithm to channel C to determine line-to-line voltage, power and energy.	0
Figure 2: WattsOn Configuration Word			

By default, the configuration word settings are as follows:

Bit Location	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Default (bit)	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0
Default (hex)	1				5				1				0			

Setting bit 16 to "1" turns on the "Split + 240V" mode of operation.

For example, to change a "default" WattsOn to Split+240V mode, write the value 0x9510 to the Configuration Word.