ELKOR

WattsOn

Universal Power Transducer

USER MANUAL

Installation Considerations
Installation and maintenance of the WattsOn meter should only be performed by qualified, competent personnel who have appropriate training and experience with high voltage and current devices. The WattsOn meter must be installed in accordance with all Local and National Electrical Safety Codes.

WARNING

Failure to observe the following may result in severe injury or death:

- During normal operation of this device, hazardous voltages are present on the input terminal strips of the device and throughout the connected power lines, including any potential transformers (PTs). With their primary circuit energized, current transformers (CTs) may generate high voltage when their secondary windings are open. Follow standard safety precautions while performing any installation or service work (i.e. remove line/ PT fuses, short CT secondaries, etc).

- The meter is not intended for protection applications.

- Do not HIPOT and/or dielectric test any of the digital or analog outputs. Refer to this manual for the maximum voltage level the meter can withstand.

- Do not exceed rated input signals as it may permanently damage the meter.

- The power supply should be connected via a rated 24VAC/VDC power supply and properly isolated from the line voltage.

Danger
Line voltages up to 600 VRMS may be present on the input terminals of the device and throughout the connected line circuits during normal operation. These voltages may cause severe injury or death. **Installation and servicing should be performed only by qualified, properly trained personnel**.

Limitation of Liability
Elkor Technologies Inc. ("Elkor") reserves the right to make changes to its products and/or their specifications without notice. Elkor strongly recommends obtaining the latest version of the device specifications to assure the most current information is available to the customer. Specifications and manual are available at http://www.elkor.net

Elkor assumes no liability for applications assistance, customer's system design, or infringement of patents or copyrights of third parties by/or arising from the use of Elkor's devices.

ELKOR TECHNOLOGIES INC. SHALL NOT BE LIABLE FOR CONSEQUENTIAL DAMAGES SUSTAINED IN CONNECTION WITH ELKOR PRODUCTS, EXCEPT TO THE EXTENT PROHIBITED BY APPLICABLE LAW.FURTHERMORE, ELKOR NEITHER ALLOWS NOR AUTHORIZES ANY OTHER PERSON TO ASSUME FOR IT ANY SUCH OBLIGATION OR LIABILITY.

Although the information contained in this document is believed to be accurate, Elkor assumes no responsibility for any errors which may exist in this publication.

FCC Statement

This device is classified as a Class B digital device.

This device complies with 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

This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations. operation.

Table of Contents

1. INTRODUCTION

1.1 General

1.1.1 Electrical Wiring

Because of possible electrical shock or fire hazards, connection of this equipment should only be made by qualified personnel in compliance with the applicable electrical codes and standards.

1.1.2 Documentation

This document was written and released in November 2013 (rev.4.0).

1.1.3 Disclosure

This publication contains information proprietary to Elkor Technologies Inc. No part of this publication may be reproduced, in any form, without prior written consent from Elkor Technologies Inc.

1.1.4 Warranty

The WattsOn Universal Power Transducer is warranted against defective material and workmanship. During the warranty period Elkor will repair or replace, at its option, all defective equipment that is returned freight prepaid. There will be no charge for repair provided there is no evidence that the equipment has been mishandled or abused. If the equipment is found to be in proper working order, a service fee will be billed to the customer. Warranty claims should be made via the original purchaser.

Standard Warranty duration is one (1) year from date of sale. Extended warranties are available to OEMS.

1.2 Product Description

The WattsOn Universal Power Transducer is a true RMS, three phase device designed for Building Automation and Energy Management applications. The unit measures electrical parameters including voltage, current, power, frequency, power factor and accumulates and stores energy information. The information is available on a *per-phase* basis allowing the use of WattsOn in three single-phase systems (up to three individual loads), one three-phase load, or a combination single/split phase load.

The unit measures true RMS value of voltages and currents and calculates other electrical parameters, including energy and rolling window demand power (WD).

Model variations determine the available output types:

> Model 1100: Two Pulse Outputs (Normally Open Solid State Relay), one representing Wh and the second representing Qh or direction of power flow (import/export).
>
> Model 1200: One Wh Pulse Output (Normally Open, Solid State Relay), and two 0-10VDC Analog Outputs, field programmable via RS-485 (Modbus RTU) to any instantaneous parameter.

All models come equipped with RS-485 Modbus RTU communications capable of delivering over 40 parameters.

The meter is housed in a DIN mount plastic enclosure intended for mounting on a DIN rail inside of an electrical panel or enclosure, close to the electrical equipment being monitored.

Fig.1 illustrates the WattsOn Isolation Layout

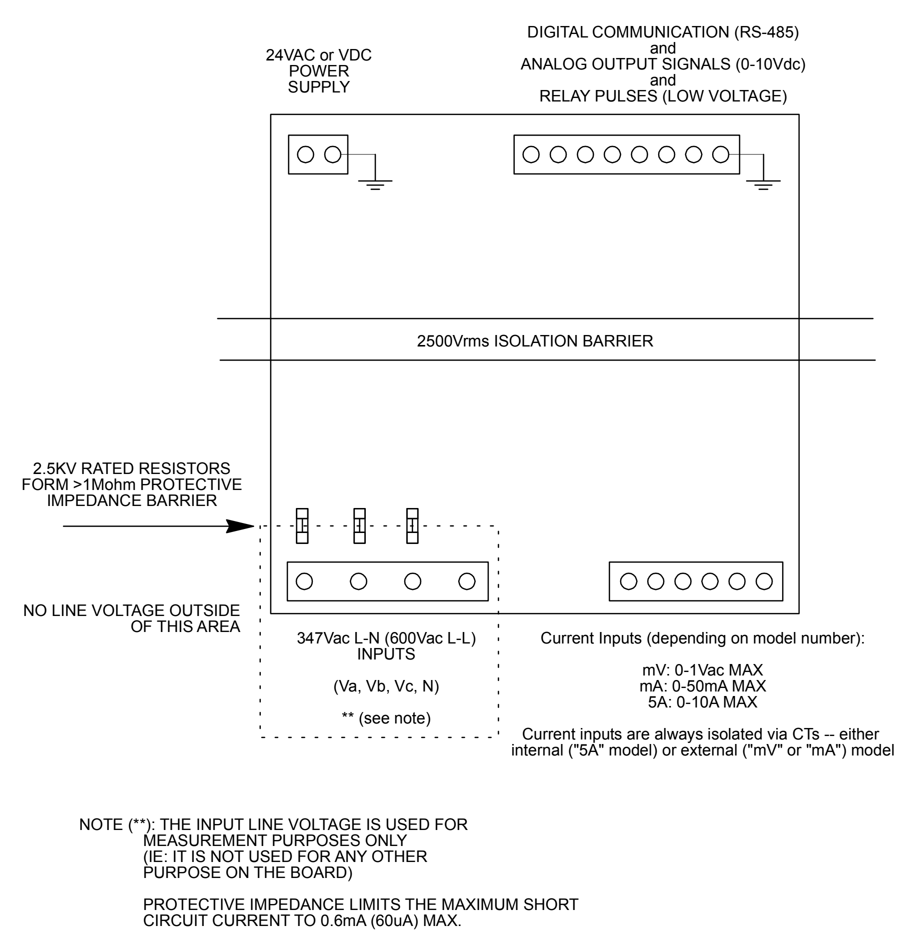


Fig 1. WattsOn Isolation Diagram

1.3 Features

The WattsOn transducer accepts line voltages up to 600 V directly, without the need for Potential Transformers (PTs). The line input circuitry is galvanically isolated from the outputs.

The following table summarizes the output features offered by various WattsOn models:

	WattsOn-1100	WattsOn-1200
Wh Pulses	✓	✓
User Selectable Qh Pulses/Power Direction Relay	✓	
RS-485 Modbus	✓	✓
User Programmable Two 0-10 VDC Analog Outputs		✓

Table 1

2.0 SPECIFICATIONS

2.1 Operating Specifications

Environmental:

Protected Environment
Operating Temperature : -40 to +60 °C
Storage Temperature : -50 to +85 °C
Humidity : 10 to 90% non-condensing

Power Supply Requirements:

19-24 VAC or 20-30 VDC, 100mA (max)

Note: The power supply must be properly isolated from the measurement line to maintain the rated isolation voltage (2500 VAC).

A small dedicated transformer or DIN mount switching power supply is recommended to ensure the best isolation between system components. Contact Elkor to purchase recommended accessories.

Monitored Power System Parameters:

Note: All line inputs are electrically isolated from the outputs and the chassis. Isolation test 2500 V RMS.

Input Impedance:	≥ 1 MΩ
Wiring System Types:	120/208 delta, wye 277/480 delta, wye 347/600 delta, wye Single phase installations up to 347Vrms Split phase (two phase) installations
Frequency:	45 to 65 Hz
Voltage Inputs:	Direct Input Voltage Max. Rated 600 Vrms (line-to-line), 347 Vrms line-to-neutral for 4 wire systems (PTs are required for systems over 600 V); *Input Wire Gauge:* AWG 12-30, of proper insulation rating as per electrical code. AWG 16-22 recommended.
Current Inputs: (model dependent)	**"-5A":** Standard CTs, 0-5 A, 20% continued overload, 10 A absolute maximum; burden 0.005 Ω MAX, **-OR-** **"-mA":** Elkor MCT/MSCT current sensors (Solid/Split Core) **-OR-** **"-mV":** 333mV or 1000mV output CTs *Input Wire Gauge:* AWG 12-24, of proper insulation rating as per electrical code. AWG 12-16 recommended for 5A CTs, AWG 16-22 for all other types.
Absolute Maximum Ratings:	Voltage: 450 V (Line-to-Neutral) = 780V (Line-to-Line) (*) Current: 10 A via CTs (for 5A input versions) (*)
(*) Note: *These are the absolute maximum values that the unit can withstand without damage. They are not intended as operating values. See Product Name Tag on the enclosure for the Rated Operating Line Parameters.*	

2.2 Output Specifications

Output Indicators:

Green LED (PWR): Indicates auxiliary power to the unit

Red LED (Diag.): *Steady*: Power is flowing in "reverse" direction.
Slow Flashing: Sequencing Error (see section 4.5)
Fast Flashing: No voltage detected at input terminals (see section 4.5)
Repeating Double-Flash: Hardware error (contact Elkor for support)

Yellow LED (Wh): Indicates state of output relay #1.

Yellow LED (Qh): Indicates state of output relay #2. In -1200 models, although the output relay is not present, the LED operates as in -1100 models.

Output Signals (depending on model):

Pulse Output #1 - solid state relay; <50V, 150mA maximum load, representing Wh accumulation.

Pulse Output #2 (WattsOn-1100) - solid state relay; <50V, 150mA maximum load, representing Qh accumulation or direction of power flow, may also be used to provide data to the WattsOn-DISP module.

Pulse outputs are Form A (NO) relay contacts, configured for 100ms pulse duration by default (may be changed for "change of state" operation — see section 4.5)

Analog Outputs (WattsOn-1200) - Two 0-10VDC outputs representing any instantaneous measured parameter. Outputs are field configurable via Modbus.

Digital Communication: one RS-485 port, 9600 baud, 8,N,1; Modbus RTU protocol, (see section 4.3 for details);

Information Update Frequency: All outputs and data are updated every 500 ms.

2.3 Accuracy Specification

ANSI C12.20 Class 0.2 Accuracy Certified by NRTL.
All accuracies at 25°C, within 10 to 110% of nominal inputs, PF ≥ 0.5, 5 A Input
Note: Metering grade CTs and PTs are recommended for high accuracy applications.

Parameter	Accuracy (of reading)	Basic Resolution *
Voltage (V)	0.5%	0.1V
Current (A)	0.2%	0.001A (1mA)
Power (W)	0.2%	0.1W (per phase, 1W per total)
Power (VA)	0.5%	0.1VA (per phase, 1VA per total)
Power (VAR)	0.5%	0.1VAR (per phase, 1VAR per total)
Power Factor	0.5%	0.0001
Frequency	0.5%	0.1Hz
Energy	0.2%	1Wh

* Basic resolution must be multiplied by CT and PT ratio for effective resolution per installation.

Analog Output Accuracy: ±0.5% of reading (10 to 100% of output voltage)

3.0 INSTALLATION

3.1 Grounding Considerations

Output signal ground is usually provided by the controller (RTU, DDC, PLC etc). The output common (GND) **IS ISOLATED** (2500VAC) from the input common (N terminal), however the "-" terminal of the input power supply and the output common (GND) are tied together internally.

3.2 Power Supply Wiring

The power supply to the WattsOn meter may be either 19-24 VAC or 20-30 VDC, with at least 100mA of supply current available.

For DC power supplies, the polarity must be observed. For AC power supplies, it must be noted that the output common (GND) and "-" power supply terminal are tied together. Care must be taken if multiple devices are powered using one AC supply to prevent shorting the supply.

3.3 Line Circuits Wiring

The WattsOn meter is a true 'three element' meter that can be used in any electrical system. For four wire systems ('wye', with distributed neutral) the meter requires current and voltage information from each phase which means that three current transformers (CTs) and three line voltages plus the neutral must be wired to the unit.

WattsOn may be used in three wire systems ('delta', without a distributed neutral) as a 'three element' meter (three CTs required). The 5A meter version may be wired as a 'two element' meter utilizing only two CTs (and two PTs). When no neutral is present, the neutral connection should be omitted.

The wiring diagrams for various power system configurations are shown in Appendix 1.

Standard wiring principles for electricity meters apply to the WattsOn meter, as for any other '3 element' electricity meter. The polarity of interfacing transformers should be observed. The left terminal of each current input connector is always associated with the 'X1' wire of the responding CT. Please refer to Appendix 3 for details on CT wiring.

All mV and Elkor mA CTs must be wired independently to the corresponding current inputs (two wires from each CT without and shunts or jumpers). **mA and mV CTs must *NOT* be grounded, or interconnected with each other (or other components) in any way.**

The use of a metering test switch containing fuses for voltage lines and shorting terminals for 5A CTs is recommended. A pre-assembled Elkor *i-Block*™ may be used as a convenient and economical solution.

A CT shorting mechanism is not required for mV and Elkor mA style CTs, since these are voltage clammped, however appropriate protection (fuse or breaker) for input line voltages is requried.

3.4 Fusing of Voltage Sensing Inputs

The input voltage lines should be protected as per electrical code requirements. This is also good practice to facilitate a easy disconnect means for servicing the meter. In some cases, the voltage may be tapped off of existing fuses or breakers. If this is not possible, Elkor recommends a 1A or lower fuse (fast acting) for protection of the installation wiring. The WattsOn voltage inputs are high impedance (> 1.5MΩ) and draw negligible current (less than 0.3mA max).

3.5 Enclosure Mounting

The WattsOn is housed in a plastic enclosure intended for DIN mount installation. All of the input (bottom) and output (top) signals are available on the exterior of the enclosure. The unit does not contain any user serviceable parts and thus should not be accessed by the user.

3.6 Indicators and Jumpers

All indication LEDs are located on top of the PCB. They may be helpful for wiring/operation diagnostics.

- ***PWR*** - Green 'power ON' LED indicates the presence of power supply to the transducer.

- ***DIAG*** - Red Wiring Diagnostic LED, default configuration as follows:

  Steady On : Measured Total Power (sum of all three phases) is negative
  Sporadic Flash: Measured Total Power oscillating around +/- 0W
  Fast Flashing : Absense (<25VAC) of voltage on input terminals.
  Double-Flash : Bootloader error — ensure DIP switch is not set to "zero" (all down), otherwise contact vendor for more details.
- ***Wh*** - Yellow Wh LED indicates the energy pulse relay operation (relay #1).

- ***Qh*** - Yellow Wh LED indicates the state of relay #2 in WattsOn-1100 models. In WattsOn-1200, the LED is for indication only (ie: the relay output is not available).

  If WattsOn-DISP is configured (4.5), relay #2 acts as that data source for the DISP module. As such, the Qh LED will be on / flickering very quickly. This is normal, and should be used as a diagnostic to ensure that the data output is enabled.

- ***Address DIP*** switch allows device address selection (1 to 63) to be used in Modbus communication. (1 is the MSB, 6 is the LSB)

	1	2	3	4	5	6
Bit	"32"	"16"	"8"	"4"	"2"	"1"
Examples:						
1	DOWN	DOWN	DOWN	DOWN	DOWN	UP
5	DOWN	DOWN	DOWN	UP	DOWN	UP
30	DOWN	UP	UP	UP	UP	DOWN

Table 2

3.7 Accumulated Energy Reset Procedure

Jumper J1 (kWh RESET — located beside power terminal) is used to RESET the device accumulators.
WARNING : The reset action will erase all accumulated energies, and is not reversible !!!

The reset procedure for the meter is as follows:

1. *Apply a shunt to short J1.*
2. *Turn power to the meter off, and wait 5 seconds.*
3. *Apply power to the meter. At this point all accumulated energies will be set to 0.*
4. *Wait 5 seconds, and remove the jumper from J1.*

Make sure that the shunt is removed from the J1 position, otherwise all energy data will be reset upon cycling power to the device.

Energy may be reset via software (see section 4.4.4)

4. TRANSDUCER OPERATION

4.1 General

The WattsOn meter is ready in a few seconds after the excitation power supply is applied. Refer to section 3.5 for LED indication and meanings.

4.2 Output Signals

4.2.1 Measurement Rationale

The WattsOn meter may be used in any electrical system provided that the input signals are within specifications. By using the appropriate PTs and CTs, the size of the system measured is virtually limitless. The WattsOn is configured to measure all current inputs as a "5A" full scale. That is; it normalizes all current measurements as 0-5A depending on the actual calibrated full scale. For this reason, every CT type is a "CT Ratio" multiplier of xxx:5, even if the CT type is not a 5A variety. Section 4.4.3 details scaling and data interpretation. Whenever possible, reading that floating point registers is recommended, as the meter does the appropriate scaling in this case.

4.2.2 Energy (Wh) Pulses

The WattsOn transducer offers a Form A ,N.O., solid-state relay output that is triggered after a predefined amount of energy (Wh) is accumulated. These slow pulses can be easily monitored by any standard EMS digital input, or by a pulse totalizer or similar counting device. By default, the relays are configured for a 100ms pulse duration, however they can be set to a "change of state" (see section 4.5).

By default, the amount of Watt-hours per one pulse is set to 1 Wh (x CT Ratio x PT Ratio) . This 1 Wh is the total energy as "seen" by the WattsOn transducer on its inputs. As a result, the appropriate CT and PT ratios must be applied to obtain actual energy consumption. Pulse value may be changed via Modbus (see section 4.4.4).

4.2.3 Analog Output Signals

The WattsOn-1200 offers two independent 0-10VDC analog signals. Each analog output may be configured to represent any instantaneous measured value. Each output may be configured by the user via Modbus registers. The property represented, as well as the scaled value at 0V and at 10V may be changed. This method allows for maximum flexibility and enables the use of analog signals even for positive/negative value measurements by allowing introduction of an offset voltage. See chapter 4.4.4 for more information on configuring analog outputs.

4.2.4 Digital Outputs

The RS-485 digital communication port allows for remote monitoring of all the measured parameters via any Modbus RTU Master device. The communication port is factory configured for 9600, N,8,1. The details of this output are described in chapter 4.3.

4.3 Digital Communications

All WattsOn transducer versions are equipped with digital communications and feature a, RS-485 digital output port compatible with the Modbus RTU specification. The WattsOn functions as a Modbus Slave device, and may be addressed between 1 & 63.

4.3.1 Modbus Protocol Specifications

Communications Protocol: WattsOn utilizes a subset of Modicon's "Modbus RTU" (slave) standard protocol. There must be a repeater installed if more than 30 units are on the communications chain.

Transmission Mode: Modbus RTU, RS-485 Half-Duplex, 9600 bps, N,8,1. (default)

The baud rate may be selected as 9600 or 57600 by using the extended configuration word (0x9E, described on page 20 of this manual).

To change the baud rate, valid communication must be established using the baud rate of the device as configured. If the baud rate is not known, both may be tried in an attempt to establish communication.

Elkor recommends *not* changing the baud rate unless absolutely required. For the majority of applications, 9600 provides sufficient bandwidth to allow for polling of all parameters more than once per second.

Communications Principles: The WattsOn transducer stores all of its available information in register blocks. Modbus function "3" (Read Holding Registers) registers are used to access the data. Some systems denote these registers as "4XXXX" where "XXXX" is the register offset + 1. For example, register "function 3, offset 5" would have an address of 40006.

WattsOn implements function 6 and function 16 for single register writes. Note that function 16 (multiple register writes) is implemented in versions > 2.3, however, only single register writes are supported.

The WattsOn memory map is divided into multiple blocks (addresses provided as offsets):

0x00-0x5A : User data registers (Read Only)
0x80-0x8E : User config registers (Read/Write)
>0x8E *: Factory calibration registers*

Note: the notation used in this manual is decimal, except when prefaced by "0x" designating hexadecimal. ie: 45 = "forty-five" decimal; 0x45 = "forty-five" hex or "sixty-nine" decimal.

4.3.2 Modbus Command Framing

Command Framing: (Function 3; Read Multiple Words) (8 bytes)

Address Field	Function Code	Starting Register	Number of Registers	CRC
1~63	3	0~M	1~N	
(1 byte)	(1 byte)	(2 byte)	(2 byte)	(2 byte)

Response

Address Field	Function Code	Byte Count	Data Field... (register M)		...Data Field (register M+N)		CRC
1~63	3 or 4	0~N	Hi Byte	Lo Byte	Hi Byte	Lo Byte	
(1 byte)	(1 byte)	(1 byte)	(2 bytes per register)				(2 bytes)

Command Framing: (Function 6; Write Single Word) (8 bytes)

Address Field	Function Code	Starting Register	Data Field		CRC
1~63	6	0~N	Hi Byte	Lo Byte	
(1 byte)	(1 byte)	(2 byte)	(2 byte)		(2 byte)

Response

Address Field	Function Code	Starting Register	Data Field		CRC
1~63	6	0~N	Hi Byte	Lo Byte	
(1 byte)	(1 byte)	(2 byte)	(2 byte)		(2 byte)

Table 3

4.3.3 Modbus Protocol Implementation:

- Start of frame: No transmission for at least a 3.5 bit period (3.5ms at 9600bps)
- Address Field: Applicable addresses are 1~63. The address must match the one defined on the units DIP switch.
- Function Code: 3 = Data Registers; 6 = Write to Configuration Registers.
- Starting Register = Contains the number of the first register requested (functions 3), or the register to write to (function 6).
- Data Field: Contains the number of registers requested (functions 3) or the value to write into the appropriate register (function 6).
- CRC: 16 bit CRC

Tables 4.4.1 and 4.4.2 show the registers and their definitions. All registers consist of two bytes (16-bit integer) values.

Specific details pertaining to the Modbus Protocol may be found at http://www.modbus.org

4.4 Modbus Register Function Blocks

4.4.1 Data Registers (integer)

Register	Units	Description	Data Type	Scale
0x00 (40001)	Wh	Total Energy Consumption (hi 16)	32-bit int (signed)	1
0x01 (40002)		Total Energy Consumption (lo 16)		1
0x02 (40003)	W	Total Real Power	16-bit int (signed)	1
0x03 (40004)	VAR	Total Reactive Power	16-bit int (signed)	1
0x04 (40005)	VA	Total Apparent Power	16-bit int (unsigned)	1
0x05 (40006)	Volts	Average Voltage (Line-Neutral)	16-bit int (unsigned)	10
0x06 (40007)	Volts	Average Voltage (Line-Line)	16-bit int (unsigned)	10
0x07 (40008)	Amps	Average Current	16-bit int (unsigned)	1000
0x08 (40009)		Total (System) Power Factor	16-bit int (signed)	10000
0x09 (40010)	Hz	Frequency	16-bit int (unsigned)	10
0x0A (40011)	Volts	Voltage, phase A-N (line-neutral)	16-bit int (unsigned)	10
0x0B (40012)	Volts	Voltage, phase B-N (line-neutral)	16-bit int (unsigned)	10
0x0C (40013)	Volts	Voltage, phase C-N (line-neutral)	16-bit int (unsigned)	10
0x0D (40014)	Volts	Voltage, phase A-B (line-line) *(see 4.4.1)*	16-bit int (unsigned)	10
0x0E (40015)	Volts	Voltage, phase B-C (line-line) *(see 4.4.1)*	16-bit int (unsigned)	10
0x0F (40016)	Volts	Voltage, phase A-C (line-line) *(see 4.4.1)*	16-bit int (unsigned)	10
0x10 (40017)	Amps	Current, phase A	16-bit int (unsigned)	1000
0x11 (40018)	Amps	Current, phase B	16-bit int (unsigned)	1000
0x12 (40019)	Amps	Current, phase C	16-bit int (unsigned)	1000
0x13 (40020)	W	Real Power, phase A	16-bit int (signed)	10
0x14 (40021)	W	Real Power, phase B	16-bit int (signed)	10
0x15 (40022)	W	Real Power, phase C	16-bit int (signed)	10
0x16 (40023)	VAR	Reactive Power, phase A	16-bit int (signed)	10
0x17 (40024)	VAR	Reactive Power, phase B	16-bit int (signed)	10
0x18 (40025)	VAR	Reactive Power, phase C	16-bit int (signed)	10
0x19 (40026)	VA	Apparent Power, phase A	16-bit int (unsigned)	10
0x1A (40027)	VA	Apparent Power, phase B	16-bit int (unsigned)	10
0x1B (40028)	VA	Apparent Power phase C	16-bit int (unsigned)	10
0x1C (40029)		Power Factor, phase A	16-bit int (signed)	10000
0x1D (40030)		Power Factor, phase B	16-bit int (signed)	10000
0x1E (40031)		Power Factor, phase C	16-bit int (signed)	10000
0x1F (40032)	fixed	Software Version	16-bit int (unsigned)	10
0x20 (40033)	Wh	Import Energy (+), phase A	32-bit int (unsigned)	1
0x22 (40035)	Wh	Import Energy (+), phase B	32-bit int (unsigned)	1
0x24 (40037)	Wh	Import Energy (+), phase C	32-bit int (unsigned)	1
0x26 (40039)	Wh	Total Import Energy (+), (A+B+C)	32-bit int (unsigned)	1
0x28 (40041)	Wh	Export Energy (-), phase A	32-bit int (unsigned)	1
0x2A (40043)	Wh	Export Energy (-), phase B	32-bit int (unsigned)	1
0x2C (40045)	Wh	Export Energy (-), phase C	32-bit int (unsigned)	1
0x2E (40047)	Wh	Total Export Energy (-), (A+B+C)	32-bit int (unsigned)	1
0x30 (40049)	Wh	Net Total Energy (+/-), phase A	32-bit int (signed)	1
0x32 (40051)	Wh	Net Total Energy (+/-), phase B	32-bit int (signed)	1
0x34 (40053)	Wh	Net Total Energy (+/-), phase C	32-bit int (signed)	1
0x36 (40055)	Wh	Net Total Energy (+/-) (A+B+C) (same as 0x00)	32-bit int (signed)	1
0x38 (40057)	VARh	Inductive Energy (+), phase A	32-bit int (unsigned)	1
0x3A (40059)	VARh	Inductive Energy (+), phase B	32-bit int (unsigned)	1
0x3C (40061)	VARh	Inductive Energy (+), phase C	32-bit int (unsigned)	1
0x3E (40063)	VARh	Total Inductive Energy (+), (A+B+C)	32-bit int (unsigned)	1
0x40 (40065)	VARh	Capacitive Energy (-), phase A	32-bit int (unsigned)	1
0x42 (40067)	VARh	Capacitive Energy (-), phase B	32-bit int (unsigned)	1
0x44 (40069)	VARh	Capacitive Energy (-), phase C	32-bit int (unsigned)	1
0x46 (40071)	VARh	Total Capacitive Energy (-), (A+B+C)	32-bit int (unsigned)	1
0x48 (40073)	VARh	Net Total VARh (+/-), phase A	32-bit int (signed)	1
0x4A (40075)	VARh	Net Total VARh (+/-), phase B	32-bit int (signed)	1
0x4C (40077)	VARh	Net Total VARh (+/-), phase C	32-bit int (signed)	1
0x4E (40079)	VARh	Net Total VARh (+/-), (A+B+C)	32-bit int (signed)	1
0x50 (40081)	VAh	Apparent Energy, phase A	32-bit int (unsigned)	1
0x52 (40083)	VAh	Apparent Energy, phase B	32-bit int (unsigned)	1
0x54 (40085)	VAh	Apparent Energy, phase C	32-bit int (unsigned)	1
0x56 (40087)	VAh	Total Apparent Energy (A+B+C)	32-bit int (unsigned)	1
0x58 (40089)	WD	Sliding Window Real Power Demand (Total of phases)	16-bit int (signed)	1

4.4.2 Data Registers (32-bit *Floating Point*)

Address	Units	Description	Group
0x300 (40769)	kWh	Total Energy Consumption	1
0x302 (40771)	kW	Total Real Power	
0x304 (40773)	kVAR	Total Reactive Power	
0x306 (40775)	kVA	Total Apparent Power	
0x308 (40777)	V	Average Voltage (L-N)	
0x30A (40779)	V	Average Voltage (L-L)	
0x30C (40781)	A	Average Current	
0x30E (40783)		Total (System) Power Factor	
0x310 (40785)	Hz	Frequency	
0x312 (40787)	kW	Sliding Window Real Power Demand (Total of phases)	
0x314 (40789)	V	Voltage A-N	2
0x316 (40791)	V	Voltage B-N	
0x318 (40793)	V	Voltage C-N	
0x31A (40795)	V	Voltage A-B	
0x31C (40797)	V	Voltage B-C	
0x31E (40799)	V	Voltage A-C	
0x320 (40801)	A	Current A	
0x322 (40803)	A	Current B	
0x324 (40805)	A	Current C	
0x326 (40807)	kW	Real Power A	
0x328 (40809)	kW	Real Power B	
0x32A (40811)	kW	Real Power C	
0x32C (40813)	kVAR	Reactive Power A	
0x32E (40815)	kVAR	Reactive Power B	
0x330 (40817)	kVAR	Reactive Power C	
0x332 (40819)	kVA	Apparent Power A	
0x334 (40821)	kVA	Apparent Power B	
0x336 (40823)	kVA	Apparent Power C	
0x338 (40825)		Power Factor A	
0x33A (40827)		Power Factor B	
0x33C (40829)		Power Factor C	
0x33E (40831)	Fixed	Software Version	
0x340 (40833)	KWh	Import Energy (+) A	3
0x342 (40835)	KWh	Import Energy (+) B	
0x344 (40837)	KWh	Import Energy (+) C	
0x346 (40839)	KWh	Total Import Energy (+) A+B+C	
0x348 (40841)	KWh	Export Energy (-) A	
0x34A (40843)	KWh	Export Energy (-) B	
0x34C (40845)	KWh	Export Energy (-) C	
0x34E (40847)	KWh	Total Export Energy (-) A**+**B+C	
0x350 (40849)	KWh	Net Total Energy (+/-) A	
0x352 (40851)	KWh	Net Total Energy (+/-) B	
0x354 (40853)	KWh	Net Total Energy (+/-) C	
0x356 (40855)	KWh	Net Total Energy (+/-) A+B+C (Same As 0x300)	
0x358 (40857)	kVARh	Inductive Energy (+) A	
0x35A (40859)	KVARh	Inductive Energy (+) B	
0x35C (40861)	KVARh	Inductive Energy (+) C	
0x35E (40863)	KVARh	Total Inductive Energy (+) A+B+C	
0x360 (40865)	KVARh	Capacitive Energy (-) A	
0x362 (40867)	KVARh	Capacitive Energy (-) B	
0x364 (40869)	KVARh	Capacitive Energy (-) C	
0x366 (40871)	KVARh	Total Capacitive Energy (-) A+B+C	
0x368 (40873)	KVARh	Net Total VARh (+/-) A	
0x36A (40875)	KVARh	Net Total VARh (+/-) B	
0x36C (40877)	KVARh	Net Total VARh (+/-) C	
0x36E (40879)	KVARh	Net Total VARh (+/-) A+B+C	
0x370 (40881)	KVAh	Total VAh A	
0x372 (40883)	KVAh	Total VAh B	
0x374 (40885)	KVAh	Total VAh C	
0x376 (40887)	KVAh	Total VAh (A+B+C)	

Group	Description	Basic	Advanced	Detailed	# Points	# Registers (16-bit)
1	System Parameters	X	X	X	10	20
2	Phase Parameters		X	X	22	44
3	Phase Energy Parameters			X	28	56
Total		10	32	60	60	120

4.4.3 User Data Register Details

Data Representation

16-bit registers are transferred in the manner defined by the Modbus Protocol. Since there is no 32-bit format definition in the Modbus specification, 32-bit registers are composed of two 16-bit registers. The method of data storage is for the lower offset register to represent the upper 16-bit word of the 32-bit integer.

For example, if reading the Total Import Energy register (offset 0x26): If 0x26 = 0xABCD and 0x27=0x1234, then the resulting 32-bit value is 0xABCD1234.

Floating Point Values (*WattsOn versions >= 2.2*):

Floating point values are 32-bit and transferred in the same manner as 32-bit integers (MSW followed by LSW). For example, to read the total energy register (0x00), registers 0x00 and 0x01 must be read and concatenated. If 0x00=0x4145 and 0x01=0x70A4, the resulting floating point value is 0x414570A4 which translates to 12.34.

Floating point registers INCLUDE the CT and PT multipliers, (as defined by the registers 0x80—0x83) and are represented in the corresponding engineering units (note "kilo" scaling for power and energy parameters).

For the floating point values to show the correctly scaled values, the CT and PT ratios must be programmed via Modbus.

The word order (MSW/LSW) may be reversed if required (see section 4.5)

Voltages
WattsOn measures all voltages with reference to the "neutral" terminal. Line-to-line voltages are calculated based on the assumption that the three phase system consists of phases 120° apart from each other. These values are calculated regardless of the actual input connections, and may be meaningless for single, split or multi phase systems. For split phase systems, it is correct to sum Va & Vb to obtain the Vab voltage.

Data Scaling
Integer registers must be calculated using appropriate scaling. Many of the registers are represented in engineering units as factors of 10, and require only the insertion of a decimal point. This includes voltage, frequency and power factor. To convert the read value to engineering units simply divide by the scale factor.

For example, to properly scale frequency, read register 0x09 and divide by the Scale Factor "10". If the register reads "602", the actual frequency is "60.2 Hz".

It is EXTREMELY important to understand how current is scaled within the unit. Due to the flexibility of the device to incorporate a wide variety of CTs, all current inputs are scaled to "5A" full scale. This means that if a typical 5A CT is used, the value of the register will be the actual current that the transducer sees x 1000. (ie: 2.5A = "2500").

However, if a mA or mV type CTs are used, the full scale output value (either 333/1000mV in the case of mV output CTs, or full scale current as defined by the configuration in the case of mA CTs) is scaled to represent the number 5000.

This methodology allows for the use of the same scaling formula to perform calculations regardless of the actual type of CT used (5A/mV/mA).

The following table lists some examples:

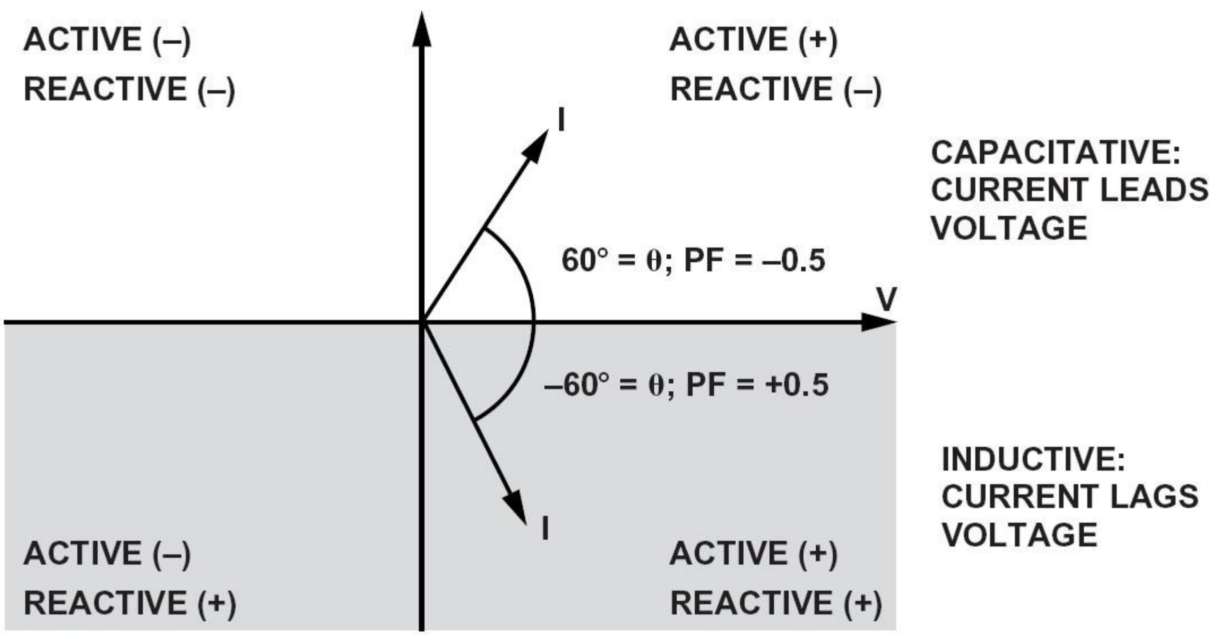
WattsOn Model	CT Type Used (example)	Full Scale	"CT Ratio"	Multiplier
WattsOn-XXXX-5A	"industry standard" (800:5)	800A	800:5	160
WattsOn-XXXX-mV-333	mV Output (200A in = 333mV out)	200A	200:5	40
WattsOn-XXXX-MSCT2-600	mA Output, 600A input (Elkor MSCT2)	600A	600:5	120

Power

Although individual (phase) power (W, VA, VAR) is represented with a resolution of 0.1W, the TOTAL W, VA, VAR is represented with a resolution of 1W. (See register scaling in table 4.4.1). This limitation is due to the 16-bit register size. Proper CT/PT ratio multipliers must be applied just as for the current registers. The sign of the power calculation is defined as in the figure below. The sign may be reversed in the configuration. Alternatively, the sign of the power may be ignored, in cases where it is known that power will always be either imported or exported. The same principles apply for reactive (VAR) calculations.

Power Factor

WattsOn uses the convention of Capacitive (Leading, "-"), and Inductive (Lagging, "+") to generate the sign of the VAR calculation (and thus power factor). The sign of VAR and/or Power factor may be reversed using the Configuration Word bit settings to obtain readings using the opposite convention (see section 4.5).



4.4.4 User Config Registers (Read/Write)

Number	Name	Description	Data Type	Default
0x80 (40129)	PT Ratio (Primary)	Place holders for PT and CT ratios. The values here may be used by the Master to calculate actual engineering units from data received.	16-bit int (unsigned)	1
0x81 (40130)	PT Ratio (Secondary)		16-bit int (unsigned)	1
0x82 (40131)	CT Ratio (Primary)		16-bit int (unsigned)	**
0x83 (40132)	CT Ratio (Secondary)		16-bit int (unsigned)	5
0x84 (40133)	Demand Period	Number of minutes to use for sliding window demand calculations.	16-bit int (unsigned)	15
0x85 (40134)	Debug	Always outputs 12345 (0x3039), for communications debugging routines	16-bit int (unsigned)	12345
0x86 (40135)	Pulse Value	Number of Wh/VARh to accumulate before sending one pulse.	16-bit int (unsigned)	1
0x87 (40136)	Reset Register	Energy Reset Register. See p. 19	16-bit int (unsigned)	0
0x88 (40137)	Output A Source	Source data register for Analog Output A	16-bit int (unsigned)	12345
0x89 (40138)	Output B Source	Source data register for Analog Output B	16-bit int (unsigned)	12345
0x8A (40139)	Output A 0V Value	Data value at 0V (Output A)	16-bit int (signed)	0
0x8B (40140)	Output B 0V Value	Data value at 0V (Output B)	16-bit int (signed)	0
0x8C (40141)	Output A 10V Value	Data value at 10V (Output A)	16-bit int (signed)	12345
0x8D (40142)	Output B 10V Value	Data value at 10V (Output B)	16-bit int (signed)	12345
0x8E (40143)	Configuration Word	See section 4.5	16-bit int (unsigned)	5392
0x95 (40150)	Serial Number	Read only, factory programmed	16-bit (unsigned)	N/A
0x96 (40151)	Scratch Pad [1]	R/W, any arbitrary 16-bit value (user data)	16-bit (user defined)	0
0x97 (40152)	Scratch Pad [2]	R/W, any arbitrary 16-bit value (user data)	16-bit (user defined)	0
0x98 (40153)	Scratch Pad [3]	R/W, any arbitrary 16-bit value (user data)	16-bit (user defined)	0
0x99 (40154)	Scratch Pad [4]	R/W, any arbitrary 16-bit value (user data)	16-bit (user defined)	0
0x9A (40155)	Scratch Pad [5]	R/W, any arbitrary 16-bit value (user data)	16-bit (user defined)	0
0x9B (40156)	Scratch Pad [6]	R/W, any arbitrary 16-bit value (user data)	16-bit (user defined)	0
0x9C (40157)	Scratch Pad [7]	R/W, any arbitrary 16-bit value (user data)	16-bit (user defined)	0
0x9D (40158)	Scratch Pad [8]	R/W, any arbitrary 16-bit value (user data)	16-bit (user defined)	0

*** The default CT ratio is pre-programmed as the full scale rating of the meter to 5. ie: WattsOn-1100-MCTA-100A would have a CT ratio pre-programmed as 100:5 (Primary:Secondary). This is used in calculation of the floating point register values.*

The user accessible configuration registers (0x80-0x8E) are read/write registers and allow the user to modify the parameters of the transducer:

CT/PT Radio (Primary and Secondary): The CT/PT ratio registers may be used as placeholders to store the CT/PT ratio primary and secondary values. This data may be used by the Modbus Master RTU in calculating true engineering units from integer registers, and is used by the WattsOn in floating point register value calculation (which include CT/PT ratio multipliers).

Demand Period: Defines the amount of time used to calculate the demand period. The demand period may be set to between 1 and 45 minutes.

Debug: Contains the (fixed) value 12345 (0x3039) and is read-only. This register is convenient for use when configuring a system, and verifying proper communications.

Pulse Value Register: Configures the number of Wh / VARh required to generate one pulse on the Wh or VARh pulse outputs. ie: if this register is set to 10, ten Wh must accumulate before a pulse is triggered. In this case the pulse value would be 10 Wh / VARh per "click". As with the current and power registers, the proper PT/CT ratio must be applied to the pulse outputs for proper engineering units. Ie: if the meter is designed to output 1 pulse per 10Wh, and the CT ratio is 800:5, the value of one click becomes 10 * 800/5 = 1600 Wh (1.6kWh)

Setting the Pulse Value Register to a value of "0" sets the output pulse value to 0.1 Wh/VARh (x CT/PT ratios) per pulse. Ie: with a CT ratio of 800:5, the pulse is 16 Wh/pulse.

At settings of "1" or higher (>=1Wh/pulse), the pulse output is a 100ms contact closure. At a setting of "0" (0.1Wh/pulse) the pulse duration is 50ms with a minimum 50ms interval between pulses. This may have a bearing on PLC/DDC systems, as some are incapable of detecting short pulse durations.

Reset Register: This register is used to reset all of the accumulated energy within the transducer. To reset the energy, the following sequence must take place:

1. Write the value 0xA5A5 to the reset register
2. Within 1 second, write the value 0x5A5A to the same register

The sequence provides a level of safety to prevent accidental deletion of energy information. This command will set ALL of the accumulated energy (Wh, VAh, VARh) to zero for every phase.

***Energy Reset capabilities may be permanently disabled at the factory by request*

Serial Number: Read-only value representing the serial number of the device (factory programmed).
[WattsOn software versions > 2.0 only]

Scratchpad Registers: Read/Write non-volatile registers available for storage of user data.
[WattsOn software versions > 2.0 only]

Output A/B Source: These registers are used to specify the measured quantity that will be represented on the respective output. The measured quantity is referenced by **INTEGER** Modbus register offset. For example, if "Current, phase A" is to be represented on output A, register 0x88 should be set to the value "0x10".

Note that although ANY Modbus register may be specified into these registers, only instantaneous parameters (voltage, current, power, frequency, power factor) will be of any significance. (ie: Energy is an accumulated parameter, and may not be represented well via the analog output).

Output A/B 0V/10V Values: The analog outputs are fully configurable and may be scaled to represent any span and offset. The data value represented by 0V and by 10V may be entered to define the range of values for a particular quantity. Both positive and negative values may be entered, thus allowing representation of positive/negative quantities
(ie: -5000W = 0V, 5000W = 10V, therefore 0W = 5V)

The values entered into these registers should use the same scaling as is used in the respective data register that is to be represented on the output.

NOTE: When assigning analog outputs, the "integer" registers must be used to define the quantity to be represented on the analog output. Values should be entered WITHOUT CT and PT ratios, but rather as "seen" by the meter. Ie: in a 500A system with 500:5A CTs, the value for current must be "5A", rather than "500A".

For example, if "Frequency" is to be represented on output A, with 0-10V representing 40Hz—60Hz:

1. Register 0x88 = "0x09" (set output A to represent Frequency)
2. Register 0x8A = "400" (set 0V value; 40Hz = 400)
3. Register 0x8C = "600" (set 10V value; 60Hz = 600)

The frequency will now be represented on analog output A.

Example: If a value of 5.5V is measured, the following calculation must be performed:

0V=40Hz; 10V=60Hz; therefore span = 20Hz

5.5V/10V = 0.55 * 20Hz = 11Hz;

Add 0V offset (40Hz) -> 11Hz + 40Hz = **51.0 Hz**

NOTE: Representing Power factor via analog values is slightly more complex. The power factor measurement is not linear in that the values increase as they approach the centre (unity). This is shown in the diagram below:

-0.0	-0.1	-0.2	-0.3	-0.4	-0.5	-0.6	-0.7	-0.8	-0.9	1.0	+0.9	+0.8	+0.7	+0.6	+0.5	+0.4	+0.3	+0.2	+0.1	+0.0
						0V <——————5V——————> 10V														

Each analog output may be configured to measure power factor in any range. Typical scaling is 0-10V = -0.0001 to 1.0 to +0.0001, however customized scale ranges such as 0-10V = -0.6 to 1.0 to +0.6 are also valid. The scale range does not have to be symmetrical, but for ease of calculation, it is recommended that it be configured that way (so that 5V = unity power factor). Note that 0.0001 must be used instead of “zero” to differentiate between leading and lagging “+/-0.0” power factor.

In the above example, 0-10V = -0.6 to 1 to 0.6.
The span is 8 "0.1 pf" units, therefore 10V/8 = 1.25V/unit

The interpretation should take place from the unity power factor value.
In this case unity (centre point) = 5V. If a value of 6.75V is output, this indicates 1.75V above the centre point. This translates to 1.75(V)/1.25(V/unit) = 1.4 "0.1" units = 0.14pf. We need to SUBTRACT this from the unity power factor (centre position) to obtain the PF reading. Therefore, the reading is 1.0-0.14 = +0.86. We know this is a POSITIVE power factor because the output > 5V.

4.5: Configuration Word

The configuration word is used to specify various settings for the transducer.

The configuration word data is manipulated on the bit level, however the register must be read and written on the word (16-bits) level. Ie: to "set" a bit, the master RTU should read the contents of the register, set the bit and write it back to the transducer. ("Setting" a bit means configuring it as a "1".)

Register 0x8E (40143) – Configuration Word Bit Mapping:

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 (see Elkor Application Note AN-306)	0

Configuration Word 0x8E (40143) Default Values

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			

Register 0x9E (40159) – Extended Configuration Word (firmware v4.5 or greater):

Bit	Name	Description	Default
1	Output #2 Display Stream *(-1100 model only)*	0=output #2 acts as pulse/relay (normal operation) 1=output #2 sends output data stream for use with WattsOn-DISP	0
2	Pulse Output Type	0=100ms pulse output 1=change of state pulse output	0
4,3	Baud rate selection	Two bits required for configuration. Shown in order: Bit 4, Bit 3. 0,0 = 9,600 bps *(default)* 0,1 = 57,600 bps 1,0 = 19,200 bps *(firmware v4.8 or greater)* 1,1 = 38,400 bps *(firmware v4.8 or greater)*	0,0
15 to 5	Not used		0
16	Reserved		1

Extended Configuration Word 0x9E (40159) Default Values

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

5. OUTPUT INTERPRETATION

5.1 General

CT and PT ratios are used to calculate and properly scale the floating point registers. The integer registers do NOT include CT and PT ratios and require proper scaling by the user.

When reading the integer registers, the following considerations must be made:
PT ratios must be applied to Voltage, Power (W, VA, VAR), and Energy (Wh, VAh, VARh).
CT ratios must be applied to Current, Power (W, VA, VAR), and Energy (Wh, VAh, VARh).

As such, Elkor strongly recommends the use of the Floating Point registers whenever possible. This limits calculation errors as the meter does all the appropriate math and scaling internally.

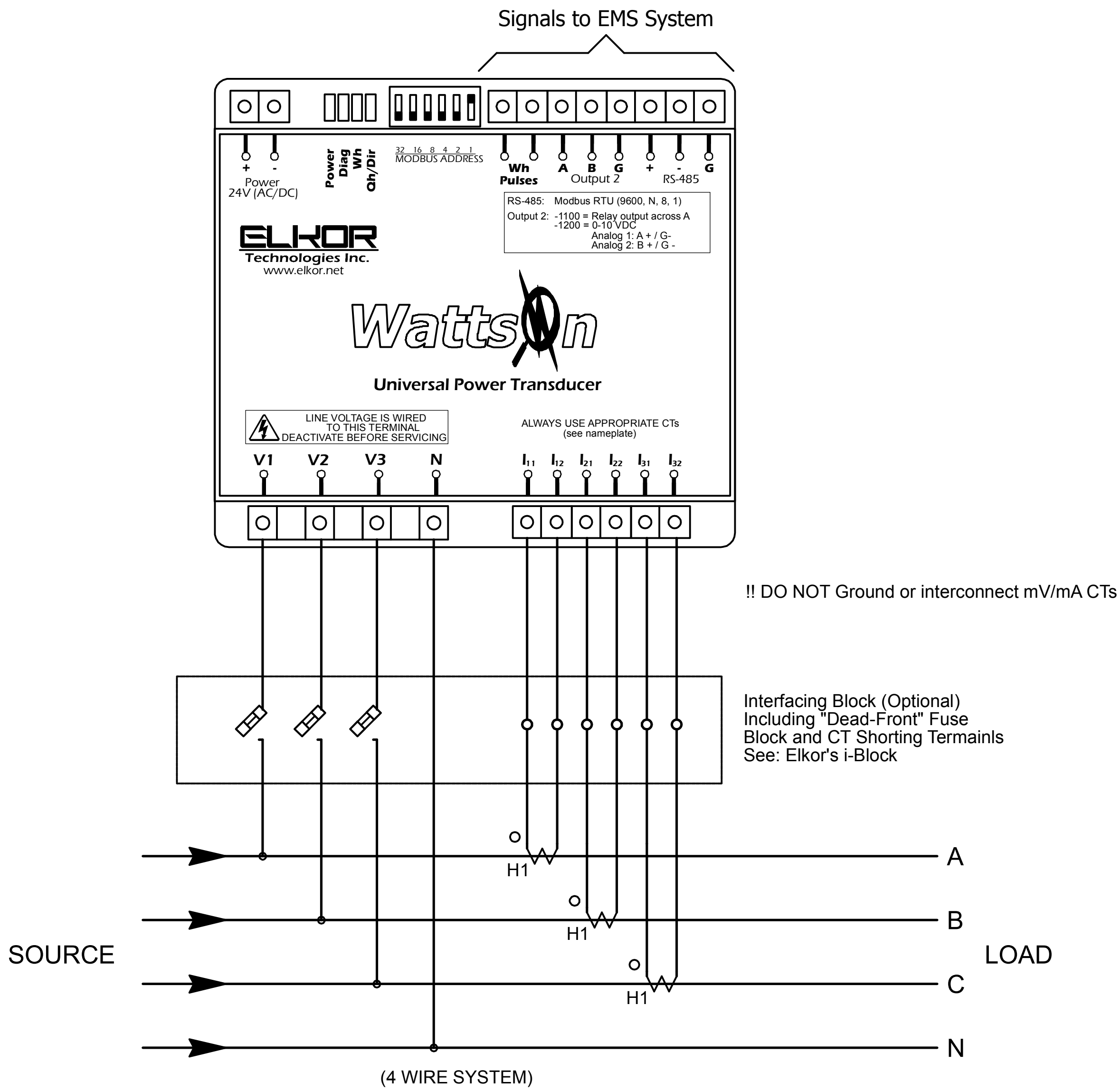
5.2 Unit Calibration Sheet

Each WattsOn meter is shipped with its Unit Calibration Sheet that provides generic, factory defined, full scale (FS) values for all outputs. These FS values are dependent on the nominal voltage/current input and the electrical system configuration (programmed at the factory based on order specifications).

5.3 Analog Output Configuration

WattsOn-1200 versions replace the Qh pulse output with two 0-10VDC analog outputs. The analog outputs may be configured by the user in the field. Each register may represent any available 16-bit Modbus parameter. See section 4.4.4 for more information about configuring and scaling these registers.

Appendix 1A: Four-Wire (Wye) Wiring Diagram



The wiring shown is applicable for all CT types.

In the case of 5A CTs, additional grounding may be required as per local electrical codes.

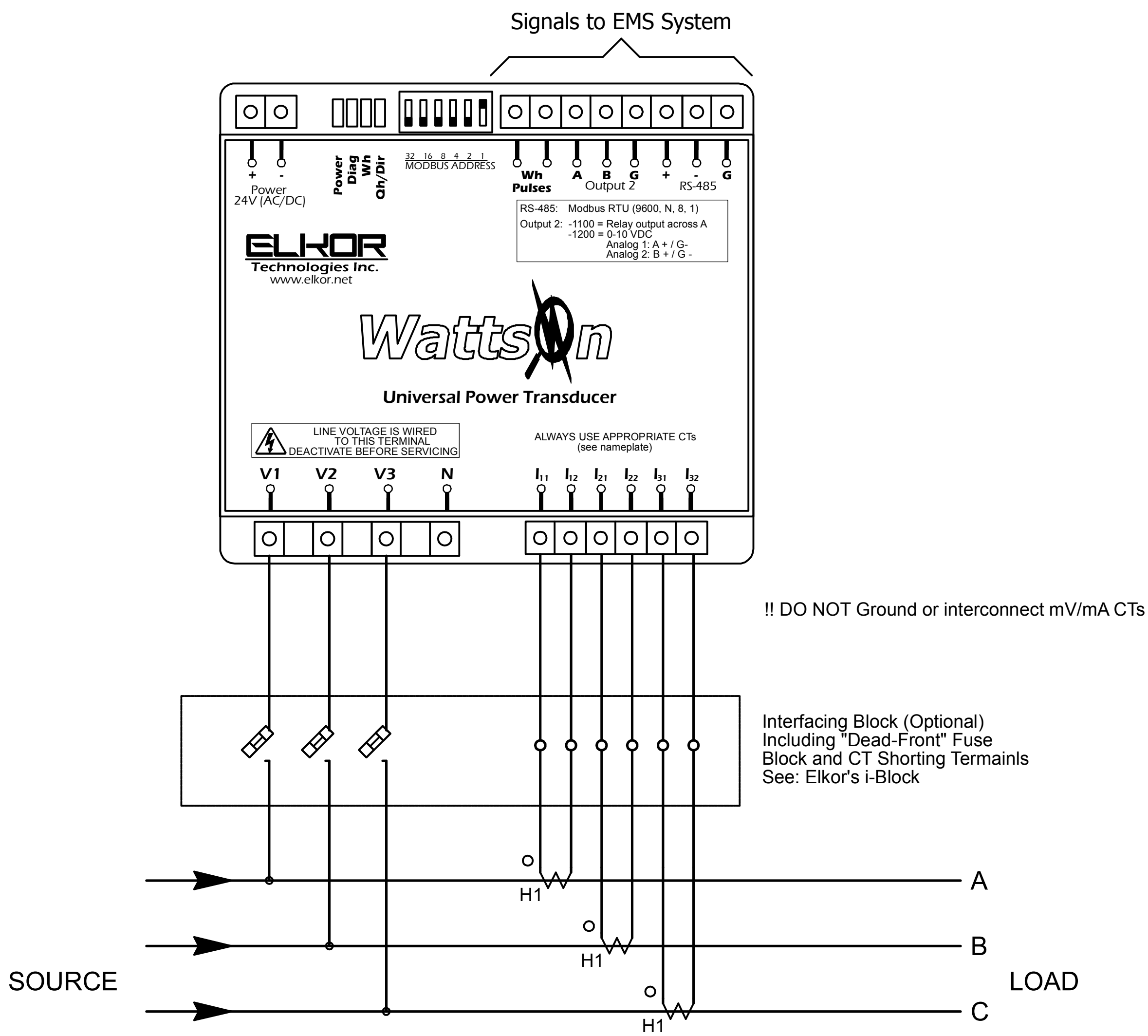
mV and mA CTs **must NOT** be grounded or interconnected in any way.
Each CT wire pair, must be terminated at the corresponding input terminals.
mV and mA CTs must not be used to feed multiple equipment.

mV and Elkor's mA CTs do not require the use of a shorting mechanism. Their outputs are low energy, voltage limited.

CT Orientation (on the conductor), CT Polarity (into the meter) and CT phasing (relationship to voltage phase)
MUST be observed for correct meter operation.

System voltage and CT insulation class (typically 600V) must be observed.

Appendix 1B: Three-Wire (Delta) Wiring Diagram (Three CTs)



(3 WIRE "DELTA" SYSTEM)

The wiring shown is applicable for all CT types.

In the case of 5A CTs, additional grounding may be required as per local electrical codes.

mV and mA CTs **must NOT** be grounded or interconnected in any way.
Each CT wire pair, must be terminated at the corresponding input terminals.
mV and mA CTs must not be used to feed multiple equipment.

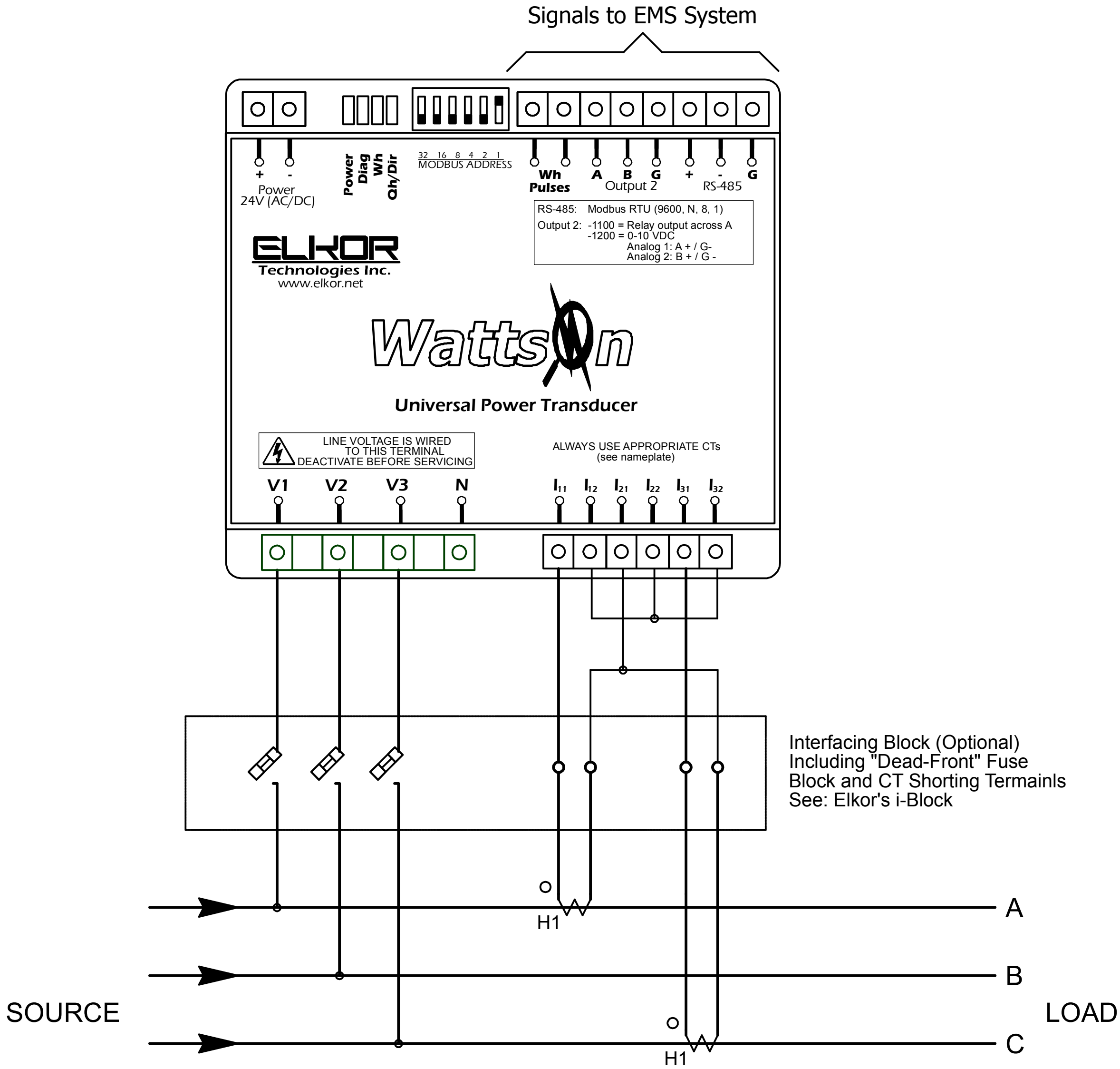
mV and Elkor's mA CTs do not require the use of a shorting mechanism. Their outputs are low energy, voltage limited.

CT Orientation (on the conductor), CT Polarity (into the meter) and CT phasing (relationship to voltage phase)
MUST be observed for correct meter operation.

System voltage and CT insulation class (typically 600V) must be observed.

Appendix 1C: Three-Wire (Delta) Wiring Diagram (Two CTs)

NOTE: This wiring method may only be used with the 5A input versions



(3 WIRE "DELTA" SYSTEM)

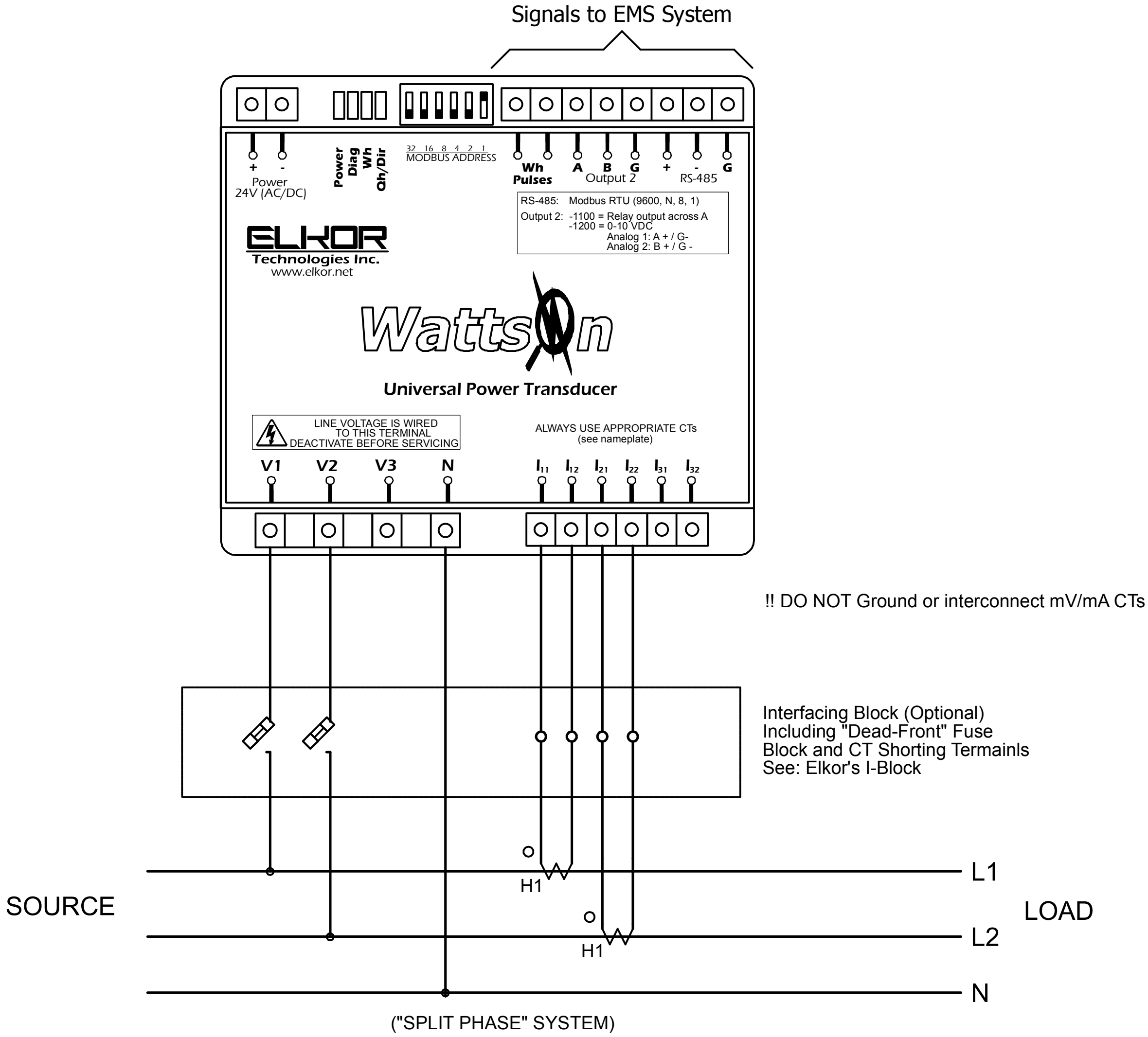
WARNING: This wiring method works only with 5A meters/CTs. When using mV or mA CTs, the 3 wire, 3 CT method must be used as per Appending 1B.

In this configuration, additional grounding may be required as per local electrical codes.

CT Orientation (on the conductor), CT Polarity (into the meter) and CT phasing (relationship to voltage phase) MUST be observed for correct meter operation.

System voltage and CT insulation class (typically 600V) must be observed.

Appendix 1D: Split Phase Wiring Diagram (Two CTs)



The wiring shown is applicable for all CT types.

In the case of 5A CTs, additional grounding may be required as per local electrical codes.

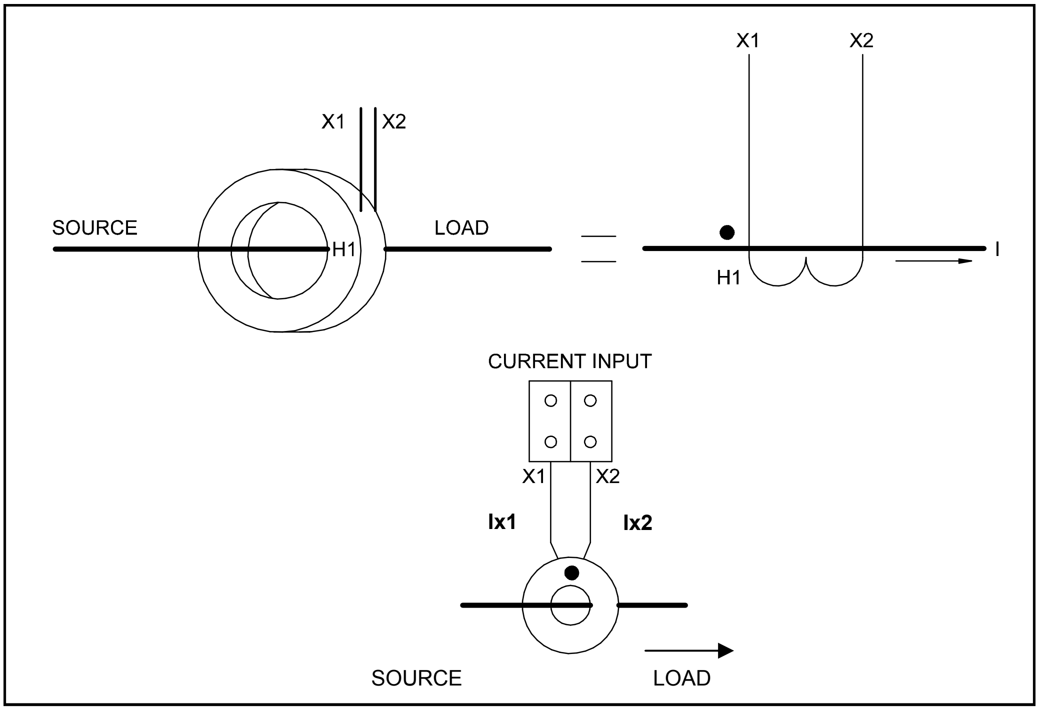
mV and mA CTs **must NOT** be grounded or interconnected in any way.
Each CT wire pair, must be terminated at the corresponding input terminals.
mV and mA CTs must not be used to feed multiple equipment.

mV and Elkor's mA CTs do not require the use of a shorting mechanism. Their outputs are low energy, voltage limited.

CT Orientation (on the conductor), CT Polarity (into the meter) and CT phasing (relationship to voltage phase)
MUST be observed for correct meter operation.

System voltage and CT insulation class (typically 600V) must be observed.

Appendix 2: CT Wiring Notes



Note: Usually, CTs are marked as shown above, where the 'H1' indicates the primary current input and 'X1' the corresponding secondary current terminal (or lead).

- While specifying CTs, one should consider both the electrical and mechanical parameters such as primary wire size, mounting arrangement, insulation level, the expected load current and accuracy requirements.

- If the load is unknown, the bus rating, or better still, the transformer size may be used for the maximum current calculations. CTs can tolerate large over-correct conditions without damage and the WattsOn can accept a 20% continuous input overload.

- 5A CTs are designed to operate with their secondary winding in permanent short, or very close to the short condition. The 5A WattsOn models provide 0.05Ω burden. If the secondary winding is open while a primary current is present, high voltage will be generated on the output. **This voltage may create a hazard to the personnel and in some situations it may damage the CT insulation.** Provisions should be made to short the secondary winding before any re-wiring is performed. We recommend using a metering Test Switch or CT Shunting Blocks to be wired between 5A CTs/PTs and WattsOn meter (ie: Elkor i-Block™).

- mV and Elkor's mA CTs feature voltage limited outputs, and shorting mechanisms may be omitted.

- Grounding may be required for 5A CTs *only*. 5A WattsOn models have isolated current inputs and 5A CT grounding is permissible. For two element systems (3 wires), grounding of CTs and PTs should be carefully observed.

- For mV and mA meter models, CTs must *not* be grounded, or interconnected with each other or any device. Each CT wire pair must be terminated at the corresponding meter current inputs.

- CT Orientation (on the conductor), CT Polarity (into the meter) and CT phasing (relationship to voltage phase) MUST be observed for correct meter operation.

Elkor Technologies Inc.
6 Bainard Street
London, Ontario
N6P 1A8

Tel: 519-652-9959
Fax: 519-652-1057

www.elkor.net