Bitronics

Single Phase
Power Measurement Instruments

User Manual

November, 2009
Single Phase Document, Revision 2

No. ASAIE2	Ammeter
No. VSAIE2	Volt Meter
No. GSWIE1	Volt / Amp Meter
No. HSWIE1	Watt / Power Factor Meter
No. WSWIE1	Watt Meter
No. RSWIE1	VAR Meter
No. QSWIE1	Watt / VAR Meter
No. PSWIE1	1Φ Power Factor Meter
No. PSWIE2	1Φ DELTA Power Factor Meter

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CERTIFICATION

Bitronics, LLC certifies that the calibration of its products are based on measurements using equipment whose calibration is traceable to the United States National Institute of Standards Technology (NIST).

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INSTALLATION AND MAINTENANCE

Bitronics' products are designed for ease of installation and maintenance. As with any product of this nature, however, such installation and maintenance can present electrical hazards and should only be performed by properly trained and qualified personnel. If the equipment is used in a manner not specified by Bitronics, the protection provided by the equipment may be impaired.

WARRANTY AND ASSISTANCE

Products manufactured by Bitronics, LLC are warranted against defects in materials and workmanship for a period of thirty-six (36) months from the date of their original shipment from the factory. Products repaired at the factory are likewise warranted for eighteen (18) months from the date the repaired product is shipped, or for the remainder of the product's original Warranty, whichever is greater. Obligation under this warranty is limited to repairing or replacing, at Bitronics' factory, any part or parts which Bitronics' examination shows to be defective. Warranties only apply to products subject to normal use and service. There are no warranties, obligations, liabilities for consequential damages, or other liabilities on the part of Bitronics except this Warranty covering the repair of defective materials. The warranties of merchantability and fitness for a particular purpose are expressly excluded.

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1.0 DESCRIPTION

1.1 Introduction

Volts, Amps, Watts, VARs and Power Factor are essential fundamental quantities which must be measured accurately in order to optimize the control and delivery of electric power. State of the art technology makes it possible to measure these functions very accurately over a wide range of input signal quantities and qualities. The Bitronics brand range of Single Phase Power Measurement Instruments are made up of rugged electronic instruments designed specifically for use in the harsh electrical environment common to many utility and industrial applications. These Power Measurement Instruments are ideally suited to applications where reliable, precise measurements are required, but where current and voltage transients or steady state distortion degrades the performance of conventional instruments. The family consists of dual display Volt/Amp meters, Watt/Power Factor and Watt/VAR meters, as well as single display Ammeters, Volt, Watt, VAR or Power Factor meters. True RMS measurement of all input signals is standard. This makes it possible to display volts, amps, watts, VARs and power factor very accurately, not only for ideal signals, but also for distorted signals through the 7th harmonic. The use of state-of-the-art microprocessor technology assures digital accuracy and repeatability across the entire range of input signal levels and qualities. These Bitronics Power Measurement Instruments are modular in design, with push-button rescaling in order to display primary values when using any combination of standard instrument transformers. Rescaling can be done in the field, in a matter of minutes, without removing the instrument from the panel or the need for any calibration equipment. Physical dimensions are those of the industry standard four inch diameter, round case with overall length of 4.7 inches (Meters with Universal Power, Option DOVD7, are 6.5 inches long).

1.2 Features

- Displays single-phase true RMS quantities. PSWIE1 & PSWIE2 display true power factor.
- Push-button rescaling in the field accommodates all common CT and PT ratios. Displays primary or secondary values. (Non-standard ratios are available. Please consult the factory.)
- Field-changeable modular design for easy maintenance.
- Single push button selects CT/PT setting, and also resets the microprocessor.
- Non-volatile memory backup of CT/PT settings. No batteries are needed.
- Rugged metal housing fits standard 4" round cutout.
- True RMS measurements are standard.
- 3½ digit high efficiency LEDs for easy reading of bidirectional values on HSWIE1, RSWIE1, WSWIE1, QSWIE1 and PSWIE1. Full four digit high efficiency LEDs on unidirectional ASAIE2, VSAIE2, and GSWIE1.
- Optional 0-1mA dc current output proportional to volts and amps, for connecting to SCADA or other monitoring/control equipment. Optional bidirectional 0 to +/- 1mA output is available proportional to WATTs, VARs or PF.
- Watchdog timer maximizes system reliability.

1.3 Specifications

Input Signals

Current:	0-5A ac nominal, (0.25 to 5A for PSWIE1/2). Continuous overload to 10A ac, 400A ac for 2 seconds. 1500V ac isolation, minimum.
Voltage:	0-150V ac nominal, (50V ac to 150V ac for PSWIE1/2). 1500V ac isolation, minimum.

Signal Burden

Current:	4mV ac at 5A ac input (0.02 VA).

Voltage:	<1 mA ac at 120V ac input (0.1 VA).
Display:	0.56" High Efficiency 7-Segment AlGaAs Red LED Display (2x4 or 1x4) ASAIE2, VSAIE2, GSWIE1: 0000 to 9999. HSWIE1, WSWIE1, QSWIE1, RSWIE1: 000 to +/- 1999. Decimal position is determined automatically by the instrument, based on the CT and PT ratios selected. PSWIE1, PSWIE2: .000 to +/-1.000 (+ = Lead, - = Lag)
Scaling:	User selectable using internal CT/PT tables.
Accuracy:Exceeds	0.25% Class (ANSI Std 460-1988).
Signal Frequency:	50 Hz to 450 Hz (including superimposed harmonic distortion).
Current Output (Optional):	0 to +/- 1mA into 10K ohms or less; 0.4% ripple p-p or less. Calibrated for 1 mA corresponds to: 500 W (watt meter), 500 VARs (VAR meter), 5A (ammeter) or 150V (volt meter). Overload up to 2mA into 5K ohms or less. Power Factor calibrated at 0.0mA corrresponds to 1.000PF, +0.5mA = +0.500PF Lead, +1.0mA = +0.000PF Lead, -0.5mA = -0.500PF Lag, -1.0mA = -0.000PF Lag (Linear with PF). Passive 4-20mA or 4-12-20mA output also available.
Power Requirements:	115 V ac +/- 20%, 6 VA. (230 V ac optional) (Universal 55-200V ac or 20-280V dc optional)
Fuse:	1.5 Ampere, non-time delay (M) fuse, UL listed located in the ungrounded (hot) side of the line, external to meter.
Operating Temperature:	-30C to 70C. Humidity: 0-95% Non-condensing
Installation Category:	IC III

Weight:2.0 pounds (0.9 kilograms)

2.0 PRINCIPLES OF OPERATION

2.1 Modular Construction

The Bitronics Power Measurement Instruments are composed of two major modules, as shown in the exploded view of the meter (Figure 1). The BASE MODULE consists of the case tube, the back panel and the Current Transformer/Potential Transformer/Power Supply Board. The Base Module contains primarily passive components (transformers, connectors, etc.) and cannot be serviced without removal from the panel. The ELECTRONICS MODULE consists of the Analog Processing Board, Microcontroller Board and the LED Display Board. Ninety percent of the active electronics (Integrated Circuits, diodes, etc.) are contained within the three boards comprising the Electronics Module. This module can easily be removed for maintenance without removing the meter from the panel, or removing the meter from service (see section 4.4).

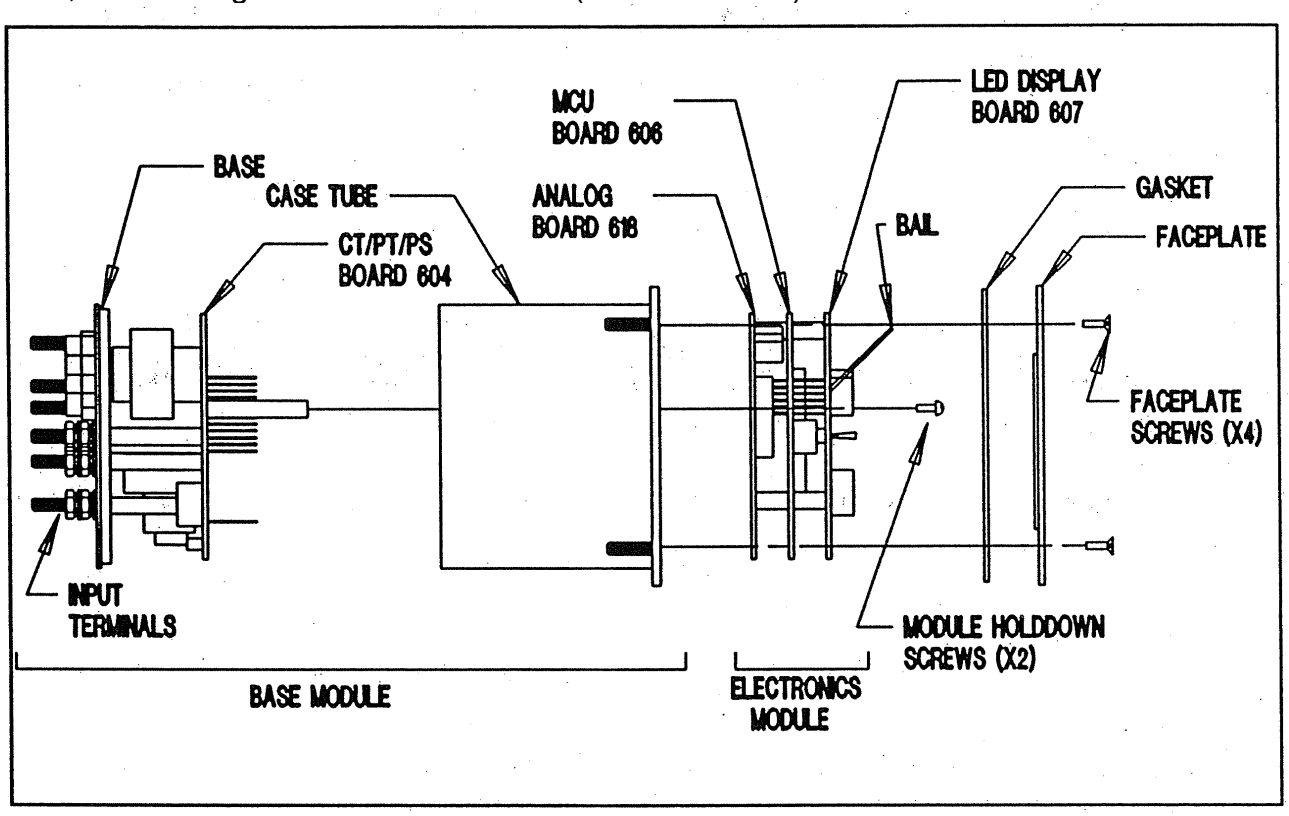


Figure 1 - Exploded View

2.2 Input Signal Connections

The Power Measurement Instruments have two independent signal inputs, one current and one voltage. Current and voltage signals are connected directly to #10-32 nickel plated

brass studs on the rear panel of the instrument. WARNING - DO NOT overtighten the nuts on the input connections, HAND tighten with a standard nut-driver, 12 inch-pounds is recommended, MAXIMUM torque is 15 inch-pounds. The instrument can be connected directly to current transformer (CT) or potential transformer (PT) circuits. The input impedance at the current input terminals is nearly a short circuit (2 milliohms). The input impedance at the voltage input terminals is greater than 100 K-ohms. These ideal impedances provide very low burden loads for the CT or PT circuits supplying the signals. The polarity of the applied signals is important to the function of the instrument, and the signal terminals are labeled LO or HI to aid in wiring the units into substation or control panels. Grounding of PT and CT signals per ANSI/IEEE C57.13.3-1983 is strongly recommended.

Power is applied to two #10-32 nickel plated brass studs, which are also located on the rear cover of the instrument. WARNING - DO NOT overtighten the nuts on the input connections, HAND tighten with a standard nut-driver, 12 inch-pounds is recommended, MAXIMUM torque is 15 inch-pounds. Because of the solid state design, the total load required to operate the unit is only three watts. It is therefore possible to power the Power Measurement Instruments with AC station power or an auxiliary PT, provided the voltage remains above 90 volts. Units are normally shipped configured for 115V ac, however they may be special ordered with a 230V ac supply.

2.3 Current and Potential Transformer/Power Supply Board (CT/PT/PS Board)

The current and potential transformer/power supply (CT/PT/PS) board contains secondary transformers which provide electrical isolation for each of the signal input channels. Current from the current terminals flows though a silver-soldered shunt of negligible resistance to assure that the user's external CT circuit can never open-circuit, even under extreme fault conditions. Potential voltages are carried through 10-32 studs directly to the CT/PT board to guarantee reliable connections to the high-impedance secondary transformer circuits. The use of transformer isolation on all input leads provides excellent isolation (1500V ac) between the inputs at any output.

The power supply circuit is a conservative, conventional design. Low drop rectifiers and a low drop-out solid state regulator minimize internal power dissipation. Filter capacitors are operated at a fraction of their voltage and temperature ratings, and should provide years of trouble-free service under extreme environmental conditions.

Bitronics Power Measurement Instruments provide for complete interchangeability among signal processing and display modules. Compensation for normal variations in input circuits is achieved by storing calibration constants in a non-volatile memory (EEPROM) which resides on the CT/PT/PS board. These constants are factory-programmed to provide identical signal gain (attenuation) in each of the isolated signal input paths. The CT and PT settings for scaling the display to the user's CTs and PTs are also stored in this EEPROM. Checksums are incorporated into the EEPROM which are read periodically by

the microcontroller to check the integrity of the calibration constants and the CT and PT setting.

2.4 Analog Processing Board (AP Board)

The first function of Analog Processing board is to sample and digitize the low level AC signals provided by the CT/PT/PS board, and to provide a digital number to the microcontroller (MCU) for further processing. Signal processing begins with the low level AC signal supplied from the CT/PT board which is about one volt ac RMS for a full scale input signal. Pure sine wave inputs or complex, distorted, periodic waveforms are handled equally well - a major advantage when computing WATTs and VARs for unknown current and voltage waveforms. This design frees the user from concern about errors which will otherwise occur during the measurement of distorted waveforms with non-true RMS instruments. Voltage is sampled first, followed by the current. Samples are accumulated for 0.5 seconds, at which time the MCU calculates the VOLTs, AMPs, WATTs, VARs and VAs where required. The VARs and POWER FACTOR are derived from a power triangle calculation where the WATTs and VAs are known. This technique provides a "true" measure of VARs or Power Factor even with distorted waveforms. Zero offset is also adjusted for each signal channel every 0.5 seconds by the MCU. Calibration constants stored in both the CT/PT/PS EEPROM and the EEPROM located on this board provide drift-free calibration, and complete interchangeability of Analog Processing boards. Checksums are incorporated into both EEPROMs which are read periodically by the microcontroller to check the integrity of the calibration constants and the CT and PT setting (See section 4.3). A "Master Gain" trimpot is also located on the AP board to provide the user with fine tuning capability if it is necessary to match other devices on the power system. Once the WATTs and VARs have been calculated, the MCU scales the values by the external PT and CT ratios which have been selected by the user, and displays the values.

A second function of the AP board is to provide the optional 0 to +/-1 milliamp transducer output(s). This is accomplished with a 12-bit digital to analog converter (DAC), one for each output channel. Constants stored in the EEPROM on the analog board are read by the MCU and used to compensate for gain and offset of each output channel. This technique provides stable calibrations for the output(s). Additional circuitry converts the output of the DAC to the 0 to +/-1 milliamp current. This additional circuitry is powered from a +15volt and a -15volt supply also located on the AP module. The output has a +/-10 volt compliance, and can drive a +/-1.0mA into a 10k ohm load, with a reduced load the output can drive up to +/-2.0mA. An independent +5 volt power supply which provides an electrically "quiet" supply for all the analog circuitry, and a high precision low drift reference are also present on the AP board. Both the reference and 5volt supply are shared by the ADC and DAC circuitry.

2.5 Microcontroller Board (MCU Board)

The microcontroller board consists of an Intel 80C51FA microcontroller (MCU), address latch, EEPROM memory and a watchdog timer. All the data acquisition, signal processing and display manipulation are controlled by the microcontroller. Communications to the other boards is accomplished via a serial data link comprising a set of three lines common to all the other devices (ADC, 2 DACs, 2 EEPROMs, 2 Display Drivers). Individual select lines for each individual device, allow the MCU to communicate with one device at a time. The watchdog timer prevents the MCU from "locking up" in the event of a transient or other type of interference. The watchdog timer also provides a reset on power-up or when resuming from a brownout (low supply). The watchdog timer can be triggered manually, by entering the CT/PT set mode (See section 4.1) and holding down the select push button for approximately 1.2 seconds. In the unlikely event of a microcontroller failure, the watchdog circuit will continuously attempt to restart the processor. A positive indication of this condition is provided by having the watchdog flash the LED displays on the front panel. The CT/PT switch and the select pushbutton are also mounted on the MCU board.

2.6 LED Display Board (LED Board)

The LED Display board consists of one or two 4 digit displays comprised of high efficiency red LED seven segment common cathode displays. Each 4 digit display is driven in a multiplexed fashion by an MC14499 seven segment decoder driver chip, which accepts serial data from the MCU, and decodes the data into the seven segment and digit select outputs necessary for the multiplexed display. The high current cathode drive is provided by a MC1472 driver for each pair of digits. On power up or any other time the MCU is reset, a display test will be conducted that displays +1.8.8.8 on the top display, followed by +1.8.8.8 on the bottom display if present. The display test can be initiated by entering and then leaving the CT/PT set mode (see section 4.1).

3.0 INSTALLATION

WARNING - INSTALLATION AND MAINTENANCE SHOULD ONLY BE PERFORMED BY PROPERLY TRAINED OR QUALIFIED PERSONNEL.

3.1 Initial Inspection

Bitronics brand instruments are carefully checked and "burned in" at the factory before shipment. Damages can occur, however, so please check the instrument for shipping damage as it is unpacked. Notify Bitronics immediately if any damage has occurred, and save any damaged shipping containers.

3.2 Power Requirements

Power Measurement Instruments are normally configured for 115V ac, 50/60Hz power. 230V ac, 50/60Hz and Universal (AC/DC) are available when requested at the time of order. Power is connected to the two labeled terminals at the rear of the case as shown in Figures 4 thru 10. Both terminals are electrically isolated from the meter case and from the electronic circuitry. Variations of the auxiliary supply voltage that are within the supply specifications will not affect the performance of the instrument. The power supply and regulators provide constant dc power to the modules independent of variations in auxiliary supply voltage over this range. If the supply voltage drops below the point at which the regulators can function properly, the watchdog timer will cause the displays to flash as described previously.

Figure 2 - Mounting Dimensions

3.3 Overcurrent Protection

A UL listed 1.5 Ampere non-time delay (M) fuse is to be series connected in the ungrounded (hot) side of mains input as part of installation of this product.

3.4 Mains Disconnect

Equipment shall be provided with a Mains Disconnect, that can be actuated by the operator and simultaneously open both sides of the mains input line. The Disconnect shall be UL Recognized and acceptable for the application.

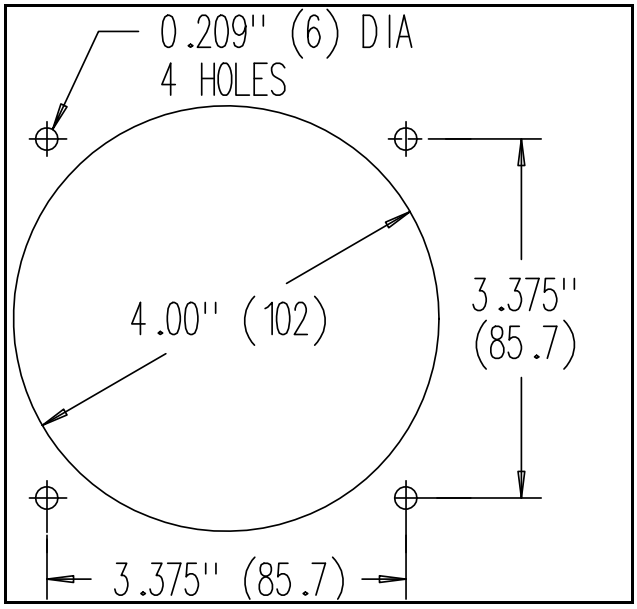


Figure 2 - Mounting Dimensions

3.5 Instrument Mounting

The instrument may be mounted into a standard 4" panel opening as shown in Figure 2. Adapter plates are available for larger panel openings. Figure 3 shows the overall dimensions of the Power Measurement Instruments. WARNING - DO NOT overtighten the nuts on the mounting studs, HAND tighten with a standard nut driver, 12 inch-pounds is recommended, MAXIMUM torque is 15 inch-pounds.

3.6 Surge Protection

It is recommended that a metal oxide varistor (MOV) be placed across the power supply input to protect the meter in the event of high voltage surges or lightning strikes. Power Measurement Instruments are shipped with a transient suppression network already attached as a standard design. An MOV provides an added measure of protection against heavy switching transients occasionally experienced in the field. The MOV is designed to clamp applied power voltages above 270V ac RMS. A single MOV protects the meter Line to Line, and two high voltage capacitors are provided to protect each Line to Ground. To avoid damaging the MOV protector, maintain continuously applied power voltages within the ratings of the instrument. The GREEN lead of the MOV assembly should be connected to a good earth ground. In most instances, this is usually accomplished by connecting the GREEN lead to the panel via the indicated front mounting stud. This mounting stud is a safety ground for the instrument, and should be connected to a protective earth circuit (refer to Figure 3). Although the Line to Ground capacitors are 3kV and UL rated, users of DC power may not want the transient protection connected from the DC supply to earth ground. In this case the GREEN lead of the MOV assembly can be clipped at the board, or the GREEN lead may be connected to either of the meter power studs. Mounting of the MOV board external to the instrument allows easy access so that the MOV and Caps may be readily inspected for damage. If the unit is to be powered from a PT, it is recommended that one side of the PT be grounded at the instrument following ANSI/IEEE C57.13.3-1983. The MOV board voltage rating is indicated on the MOV board, and must match the voltage supply rating of the instrument.

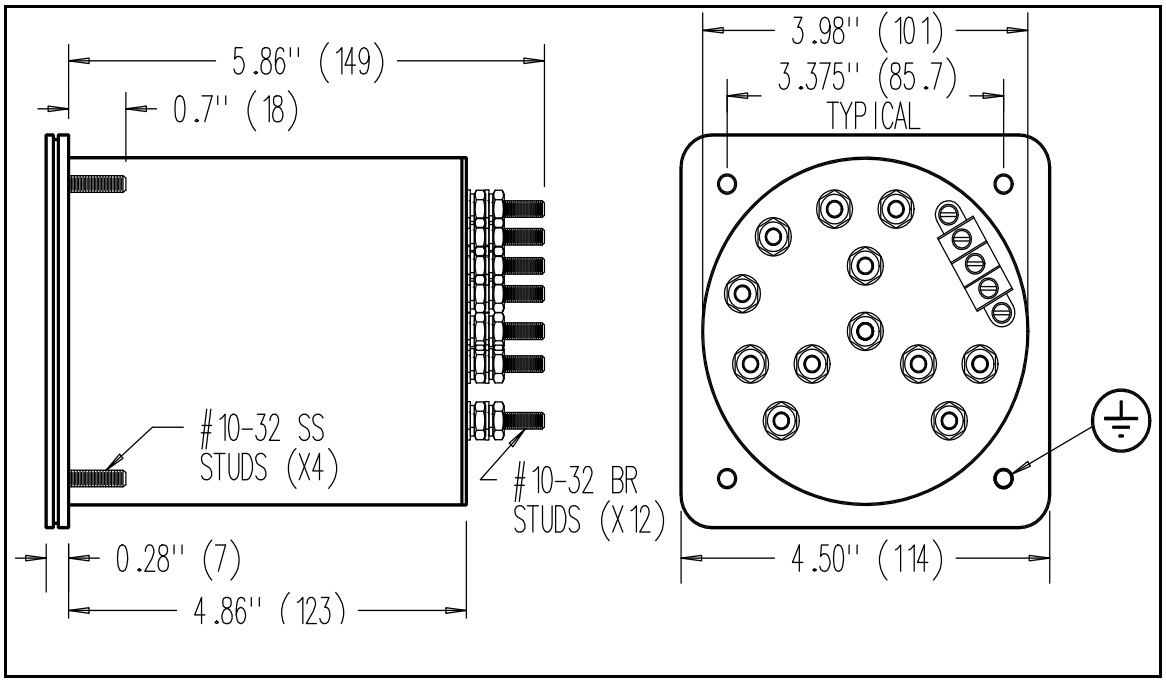


Figure 3 - Outside Dimensions

4.0 FIELD ADJUSTMENTS

WARNING - INSTALLATION AND MAINTENANCE SHOULD ONLY BE PERFORMED BY PROPERLY TRAINED OR QUALIFIED PERSONNEL.

Bitronics Power Measurement Instruments have been factory calibrated to display 000 plus or minus one digit for zero signal input. PT and CT values are set to customer values if specified, or to 5:5 CT and 1:1 PT otherwise.

4.1 Rescaling

One of the most powerful features of the Bitronics Power Measurement Instruments is the extreme ease of rescaling on the bench or in the field. Recalibration of the instrument is not needed. Even though the units are factory scaled to customer CT/PT ratios, these ratios may be changed in the field as transformers are "tapped down". Rescaling is simple and is carried out in the panel as follows:

1. With the meter under power, remove the four screws holding the front panel to the meter case, and then remove the front cover and gasket.

2. Flip the small toggle on the left of the meter UP for CT set (DOWN for PT set). On the GSWIE1, QSWIE1 and the HSWIE1, the top display will show the present CT setting, and the bottom display will show the present PT setting. On ASAIE2, VSAIE2, WSWIE1 and RSWIE1 instruments only the selected setting (CT or PT) will be shown on the single display. All CT ratios are assumed to have 5 amps as their secondary nominal maximum outputs. Therefore 10.0 on the display corresponds to a 10:5 CT. PTs are represented by a ratio to 1, so 20.0 on the display would correspond to a 20:1 PT. Powers of ten are set as the decimal point moves from left to right by using the select button.

3. Step through the list of available CT/PT ratios by repeatedly pushing the select button. A momentary push of the button will cause the display to increment to the next power of ten, or to the next ratio. Holding the push button down longer than 1.2 seconds will cause the watchdog timer to reset the MCU, indicated by the display test, followed by the version number of the instrument software, followed by the display of the current CT and PT ratios. This is not a problem, and can be used to reset the MCU, check for proper watchdog operation, check software version number, or return to the current CT and PT ratio. Be sure to observe the proper position of the decimal point. The ASAIE2, VSAIE2, and GSWIE1, which have a full four-digit display, can always be read directly. But the following convention is used to read CT or PT ratios in bidirectional instruments (HSWIE1, WSWIE1, and QSWIE1) which have three-and-a-half digit displays so as to accommodate the plus and minus signs. For ratios higher than 999, imagine the number expressed in "kilo" units, that is, the ratios should have the decimal point

following the first significant digit. For example a PT of 4350:1 would be displayed as 4.35, and a CT of 3000:5 would be displayed as 3.00. Stop when you see the correct one. The tables of CT ratios for both types of instrument are listed on the next page.

CT Ratios for HSWIE1, WSWIE1 QSWIE1, RSWIE1	CT Ratios for ASAIE2,GSWIE1
1.00, 10.0, 100.	1.000, 10.00, 100.0, 1000.
1.10, 11.0, 110.	1.100, 11.00, 110.0, 1100.
1.20, 12.0, 120.	1.200, 12.00, 120.0, 1200.
1.40, 14.0, 140.	**1.400, 14.00, 140.0, 1400. ***
1.50, 15.0, 150.	1.500, 15.00, 150.0, 1500.
1.60, 16.0, 160.	1.600, 16.00, 160.0, 1600.
1.70, 17.0, 170.	**1.700, 17.00, 170.0, 1700. ***
1.80, 18.0, 180.	**1.800, 18.00, 180.0, 1800. ***
2.00, 20.0, 200.	2.000, 20.00, 200.0, 2000.
2.20, 22.0, 220.	2.200, 22.00, 220.0, 2200.
2.40, 24.0, 240.	2.400, 24.00, 240.0, 2400.
2.50, 25.0, 250.	2.500, 25.00, 250.0, 2500.
2.80, 28.0, 280.	**2.800, 28.00, 280.0, 2800. ***
3.00, 30.0, 300.	3.000, 30.00, 300.0, 3000.
3.20, 32.0, 320.	**3.200, 32.00, 320.0, 3200. ***
3.40, 34.0, 340.	**3.400, 34.00, 340.0, 3400. ***
3.50, 35.0, 350.	3.500, 35.00, 350.0, 3500.
3.60, 36.0, 360.	**3.600, 36.00, 360.0, 3600. ***
3.80, 38.0, 380.	**3.800, 38.00, 380.0, 3800. ***
4.00, 40.0, 400.	4.000, 40.00, 400.0, 4000.
4.20, 42.0, 420.	**4.200, 42.00, 420.0, 4200. ***
4.40, 44.0, 440.	**4.400, 44.00, 440.0, 4400. ***
4.50, 45.0, 450.	4.500, 45.00, 450.0, 4500.
4.60, 46.0, 460.	**4.600, 46.00, 460.0, 4600. ***
4.80, 48.0, 480.	**4.800, 48.00, 480.0, 4800. ***
5.00, 50.0, 500.	5.000, 50.00, 500.0, 5000.
	0.500, 05.00, 050.0, 0500. Expanded 5.000 range for 2X overload
	5.500, 55.00, 555.0, 5500.
	0.550, 05.50, 055.0, 0550. Expanded 5.500 range for 2X overload
6.00, 60.0, 600.	6.000, 60.00, 600.0, 6000.
	0.600, 06.00, 060.0, 0600. Expanded 6.000 range for 2X overload
	7.000, 70.00, 700.0, 7000.
	0.700, 07.00, 070.0, 0700. Expanded 7.000 range for 2X overload
7.50, 75.0, 750.	7.500, 75.00, 750.0, 7500.
	0.750, 07.50, 075.0, 0750. Expanded 7.500 range for 2X overload
8.00, 80.0, 800	8.000, 80.00, 800.0, 8000.
	0.800, 08.00, 080.0, 0800. Expanded 8.000 range for 2X overload
9.00, 90.0, 900	9.000, 90.00, 900.0, 9000.
	0.900, 09.00, 090.0, 0900. Expanded 9.000 range for 2X overload

***** Ratios in **BOLD** are found in AJAX Magnethermic instruments only

4. Return the toggle to the center position. You will see a digit check (1888 or 888 displayed) and the new CT ratio will be "locked" into the meter.

5. Repeat steps 2 through 4 with the CT/PT switch in the down position to set the PT ratio. The tables of PT ratios are listed below:

PT Ratios for HSWIE1, WSWIE1 QSWIE1, RSWIE1	**PT Ratios for GSWIE1, VSAIE2**
1.00, 10.0, 100.	1.000, 10.00, 100.0, 1000.
	1.039, 10.39, 103.9, 1039.
1.10, 11.0, 110.	**1.100, 11.00, 110.0, 1100. ***
1.15, 11.5, 115.	1.155, 11.55, 115.5, 1155. relay ratio
1.20, 12.0, 120.	1.200, 12.00, 120.0, 1200.
	1.375, 13.75, 137.5, 1375
1.40, 14.0, 140.	1.400, 14.00, 140.0, 1400.
1.50, 15.0, 150.	1.500, 15.00, 150.0, 1500.
1.73, 17.3, 173.	1.732, 17.32, 173.2, 1732. relay ratio
1.75, 17.5, 175.	1.750, 17.50, 175.0, 1750.
1.80, 18.0, 180.	1.800, 18.00, 180.0, 1800.
2.00, 20.0, 200.	2.000, 20.00, 200.0, 2000.
2.31, 23.1, 231.	2.309, 23.09, 230.9, 2309. relay ratio
2.40, 24.0, 240.	2.400, 24.00, 240.0, 2400.
2.50, 25.0, 250.	2.500, 25.00, 250.0, 2500.
2.51, 25.1, 251.	2.511, 25.11, 251.1, 2511. relay ratio
3.00, 30.0, 300.	3.000, 30.00, 300.0, 3000.
3.46, 34.6, 346.	3.464, 34.64, 346.4, 3464. relay ratio
3.50, 35.0, 350.	3.500, 35.00, 350.0, 3500.
	3.750, 37.50, 375.0, 3750.
3.83, 38.3, 383.	**3.833, 38.33, 383.3, 3833. ***
4.00, 40.0, 400.	4.000, 40.00, 400.0, 4000.
4.35, 43.5, 435.	4.350, 43.50, 435.0, 4350.
4.50, 45.0, 450.	4.500, 45.00, 450.0, 4500.
4.79, 47.9, 479.	**4.792, 47.92, 479.2, 4792. ***
5.00, 50.0, 500.	5.000, 50.00, 500.0, 5000.
5.77, 57.7, 577.	5.774, 57.74, 577.4, 5774. relay ratio
6.00, 60.0, 600.	6.000, 60.00, 600.0, 6000.
	6.250, 62.50, 625.0, 6250.
6.93, 69.3, 693.	6.928, 69.28, 692.8, 6928. relay ratio
7.00, 70.0, 700.	7.000, 70.00, 700.0, 7000.
7.50, 75.0, 750.	7.500, 75.00, 750.0, 7500.
8.00, 80.0, 800.	8.000, 80.00, 800.0, 8000.
8.08, 80.8, 808.	8.080, 80.80, 808.0, 8080. relay ratio

* Ratios in **BOLD** are found in AJAX Magnethermic instruments only. Relay ratios are not found in AJAX Magnethermic instruments

Non-AJAX Magnethermic GSWIE1 and VSAIE2 meters also contain a second set of PT ratios which include a square-root of 3 factor, which allows the user to display the L-N voltage in L-L units. **WARNING: This is a scaled value only, and does not represent the true line-to-line voltage, except under ideal conditions.**

Scaled PT ratios for displaying L-N voltages in **SCALED** L-L units:

	(5774*sqrt(3))	USE 1000 in L-N Table
1.039, 10.39, 103.9, 1039.	(6000*sqrt(3))	
	(6350*sqrt(3))	USE 1100 in L-N Table
1.150, 11.50, 115.0, 1150.	(6642*sqrt(3))	
	(6928*sqrt(3))	USE 1200 in L-N Table
1.212, 12.12, 121.2, 1212.	(7000*sqrt(3))	
1.386, 13.86, 138.6, 1386.	(8000*sqrt(3))	
	(8080*sqrt(3))	USE 1400 in L-N Table
	(1000*sqrt(3))	USE 1732 in L-N Table
	(1155*sqrt(3))	USE 2000 in L-N Table
2.078, 20.78, 207.8, 2078.	(1200*sqrt(3))	
2.425, 24.25, 242.5, 2425.	(1400*sqrt(3))	
2.598, 25.98, 259.8, 2598.	(1500*sqrt(3))	
	(1732*sqrt(3))	USE 3000 in L-N Table
3.031, 30.31, 303.1, 3031.	(1750*sqrt(3))	
3.118, 31.18, 311.8, 3118.	(1800*sqrt(3))	
3.464, 34.64, 346.4, 3464.	(2000*sqrt(3))	
	(2309*sqrt(3))	USE 4000 in L-N Table
4.157, 41.57, 415.7, 4157.	(2400*sqrt(3))	
4.330, 43.30, 433.0, 4330.	(2500*sqrt(3))	
	(2511*sqrt(3))	USE 4350 in L-N Table
5.196, 51.96, 519.6, 5196.	(3000*sqrt(3))	
	(3464*sqrt(3))	USE 6000 in L-N Table
6.062, 60.62, 606.2, 6062.	(3500*sqrt(3))	
6.928, 69.28, 692.8, 6928.	(4000*sqrt(3))	
7.534, 75.34, 753.4, 7534.	(4350*sqrt(3))	
7.794, 77.94, 779.4, 7794.	(4500*sqrt(3))	
8.660, 86.60, 866.0, 8660.	(5000*sqrt(3))	

6. Replace gasket, front cover and four cover screws. Done!!

The position of the decimal point for the display is automatically calculated by the microcontroller; this provides up to three decades of range. With the standard Watt/Power Factor faceplate, for example, maximum displays from 19.99 watts to 1999 watts can be accommodated. For measurements outside this range, alternate faceplates are available with units of Kilowatts or Megawatts.

4.2 Calibration

Because of the nature of the digital signal processing method used by the Power Measurement Instruments, scheduled periodic recalibration is not required, or recommended. Some minute amount of drift or aging may cause slight errors after several years of use, however. Additionally, users may wish to have the Power Measurement Instrument conform to some other instruments already in use. To accommodate both these instances, a "Master Gain" trim-pot has been provided. This trim adjusts the overall scale factor up to +/-10%, and is accessed in the following manner:

1. Remove the four cover screws, and remove the front cover and gasket.

2. Remove calibration seal located in upper right-hand corner of the display board, this will allow access to the trim-pot located on the Analog Processing board.

3. Insert a small screwdriver through the opening, and into the slot of the screw on the trim-pot.

4. With the meter powered, AND WITH A PRECISION KNOWN INPUT, rotate the screw clockwise to increase the measurement, or counter-clockwise to decrease the indicated measurement.

5. Remove the screwdriver, and replace the calibration seal.

6. Replace gasket, front cover and four cover screws. The optional 0-1mA output will track the display, so recalibrating the display automatically recalibrates the 0-1mA output. The 0-1mA output cannot be calibrated independently.

4.3 Self Test Modes

Bitronics Power Measurement Instruments are based on a microcontroller, and therefore can capitalize on the power of such a device. One of the areas where the power of the microcontroller enhances the overall performance of the instrument is in the area of self-testing. Bitronics Power Measurement Instruments have several self tests built in to assure that the instrument is performing accurately. Table I lists possible faults that would be detected by the self tests, how the fault is indicated, the effects of the fault and any necessary corrective actions.

4.4 Electronics Module Removal

The Electronics Module consists of the Analog Processing Board (AP), the Microcontroller Board (MCU) and LED Display Board (LED). In the unlikely event of a board failure, it may be necessary to remove the Electronics Module from the instrument. Bitronics has designed the Power Measurement Instruments in a modular fashion to facilitate this repair in the field, by allowing the module to be removed with the meter remaining powered, in the panel. The procedure is as follows:

1. Remove the four screws holding the front panel to the meter, and remove the front panel and gasket.

2. Remove the two roundhead screws located at 3 o'clock and at 9 o'clock (labeled "REMOVE").

3. A wire bail is located at the top of the module, pull gently on the bail, and the Electronics Module will pull out (a slight rocking motion may be required). Be careful not to bend any of the connector pins in the Base Module. CAUTION - when the Electronics Module is removed with the instrument powered, instrument power (115V ac or 230V ac) is present on the circuit boards that remain in the Base Module. DO NOT touch or insert metallic objects into the Base Module while the instrument is powered.

4. To reinsert the Electronics Module, align the two quarter inch round guide rails with the two holes in the bottom board of the Electronics Module. Gently push the Electronics Module in until the module is fully seated (DO NOT FORCE!!).

5. Replace the two roundhead screws located at 3 o'clock and at 9 o'clock. Push the wire bail back into the meter.

6. Replace the gasket, front cover and four cover screws.

4.5 Cleaning

Cleaning the exterior of the instrument shall be limited to the wiping of the instrument using a soft damp cloth applicator with cleaning agents that are not alcohol based, and are nonflammable, nonexplosive.

TABLE I - SELF TEST RESULT SUMMARY FOR 1-PHASE WATT/VAR/V/A/PF METERS

Fault	Fault Indication	Effects of Fault	Corrective Action
1. Display Overflow	Display flashes +1999 or -1999 (QSWIE1, WSWIE1, RSWIE1).	Measured quantity is too large to be displayed. Transducer output may still be accurate, if overload does not exceed transducer output ratings.	Correct fault external to instrument.
Input out of range (PF)	Display flashes 1.999	Input signal(s) is too large or too small to accurately determine Power Factor. Transducer output indicates unity PF.	Correct fault external to instrument.
2. CT/PT ratio checksum error	Top display alternately displays 3 dashes (---) and fault code 1 (--1). Bottom display* displays 3 dashes (---).	Scaling of the display cannot occur due to the loss of the CT and/or PT ratios. The transducer outputs are still functional and accurate.	Attempt to reset the CT&PT ratios. If Fault continues, replace CT/PT/PS Board or Base Module.
3. CT/PT board calibration checksum error	Top display alternately displays reading and fault code 2 (--2). Bottom display* alternates with 3 dashes (---).	Calibration constants for the CT/PT/PS Board are in error. The display and the transducer output are reduced in accuracy to approximately +/-3%.	Replace CT/PT/PS Board and recalibrate the instrument, or replace the Base Module.
4. Analog board calibration checksum error	Top display alternately displays reading and fault code 3 (--3). Bottom display* alternates with 3 dashes (---).	Calibration constants for the Analog Processing Board are in error. The display and the transducer output are reduced in accuracy to approximately +/-3%.	Replace Analog Processing Board or the Electronics Module.
5. Watchdog timer timeout	Displays alternately display readings and blanks.	The watchdog timer is attempting to reset the microcontroller due to low supply voltage, or a fault in the microcontroller. Displayed values and transducer output are inaccurate.	Check input supply voltage to verify it is within specifications. If supply is OK, replace Microcontroller Board, or replace Electronics Module.

* Does not apply to single display meters (ASAIE2, VSAIE2, WSWIE1 RSWIE1 and PSWIE1/2).

5.0 QUESTIONS AND ANSWERS

1. What happens if the applied CT signal exceeds 5A?

   Power Measurement Instruments are accurate to twice the normal full scale limit (to 10A). The unit will operate at 100% overload without damage, however on some CT/PT settings the display will over-range, causing the display to flash with 1999. The Optional 0-1 milliamp output is still accurate even if the display overanges, provided the load resistance is low enough to support the increased current.

2. Can modules be removed under power?

   Yes. Neither input signals nor power need be disconnected to remove or rescale the Electronics Module. Removing the module DOES NOT open the CTs or PTs.

3. How often should the meter be calibrated?

   Because of the nature of the digital signal processing method used by these Power Measurement Instruments, periodic recalibration is not required nor recommended. Experience shows that more problems have been caused by improper calibration than by the minute amount of drift that may have occurred since original calibration at the factory. An annual calibration check in the field should provide adequate reassurance of the accuracy of the instrument. Any question of the meter's accuracy may also be resolved simply by exchanging the Electronics Module with one from another meter.

4. HI and LO are marked on the inputs. Does polarity matter?

   Yes! Correct wiring with proper polarity is essential for proper operation on HSWIE1, WSWIE1, QSWIE1, RSWIE1, PSWIE1 and PSWIE2. Polarity is not critical on the ASAIE2, VSAIE2, and GSWIE1.

5. Is phase sequence important when using a delta power factor meter (PSWIE2)?

   Yes! But ONLY on the PSWIE2. Incorrect sequence connection will invert the sign of the power factor meter.

6. Can I put the Bitronics Power Measurement Instrument in an outdoor cabinet?

   Yes. Many BiT meters are installed that way. The temperature range of -20C to 70C covers most applications. The case is gasketed, but not waterproof, so it must be placed within an enclosure that provides ingress protection acceptable for the application in accordance with IEC 529, UL 840 or the equivalent NEMA Standard.

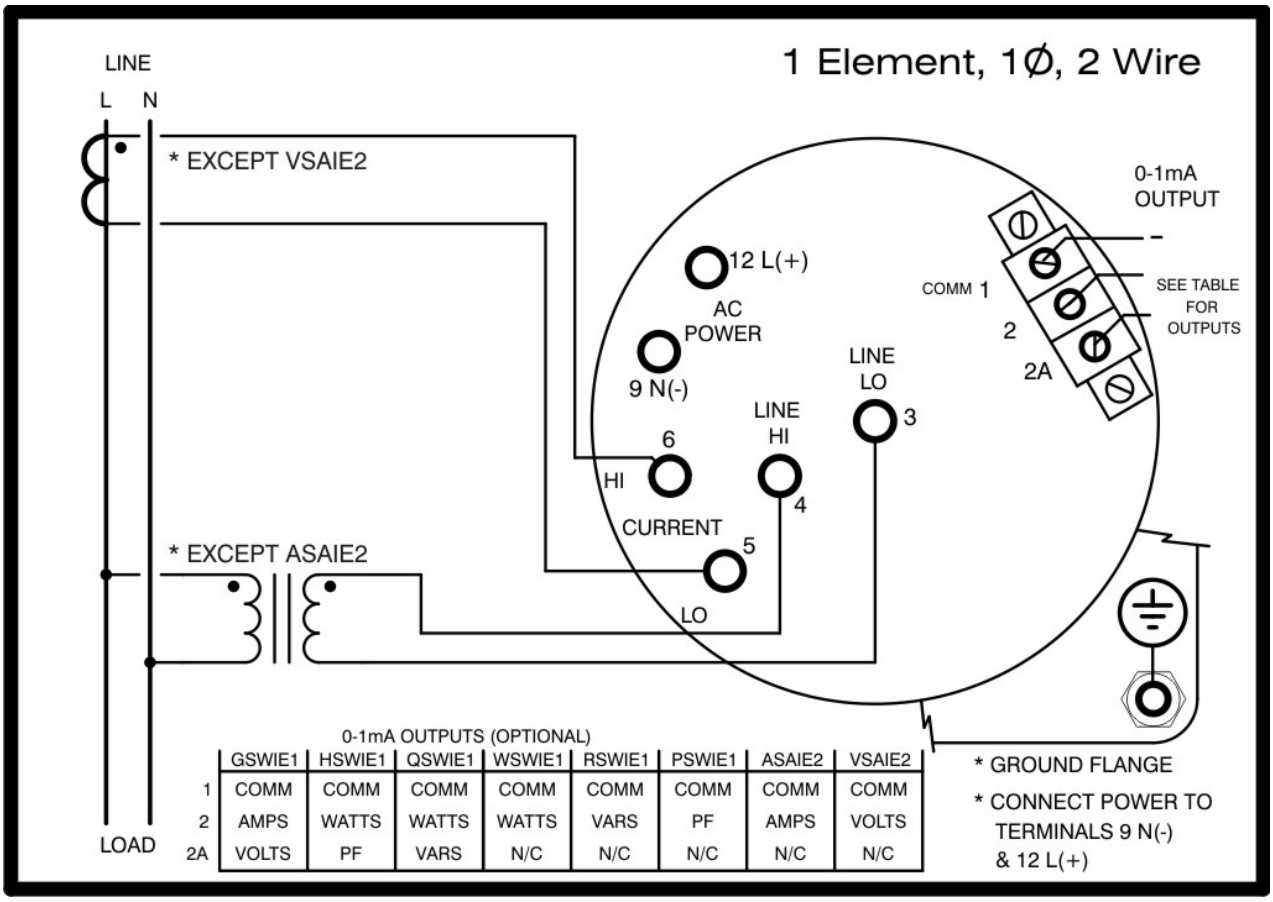
7. How long will the Power Measurement Instrument save the CT/PT ratio without power?

The data is saved in a nonvolatile memory (EEPROM) which does not require battery backup. Retention is estimated by the manufacturer to exceed 10 years without refreshing. In any event, long enough to exceed an outage, or inactive storage period.

8. I have a low voltage circuit. Can I operate the meter without the use of CTs and PTs?

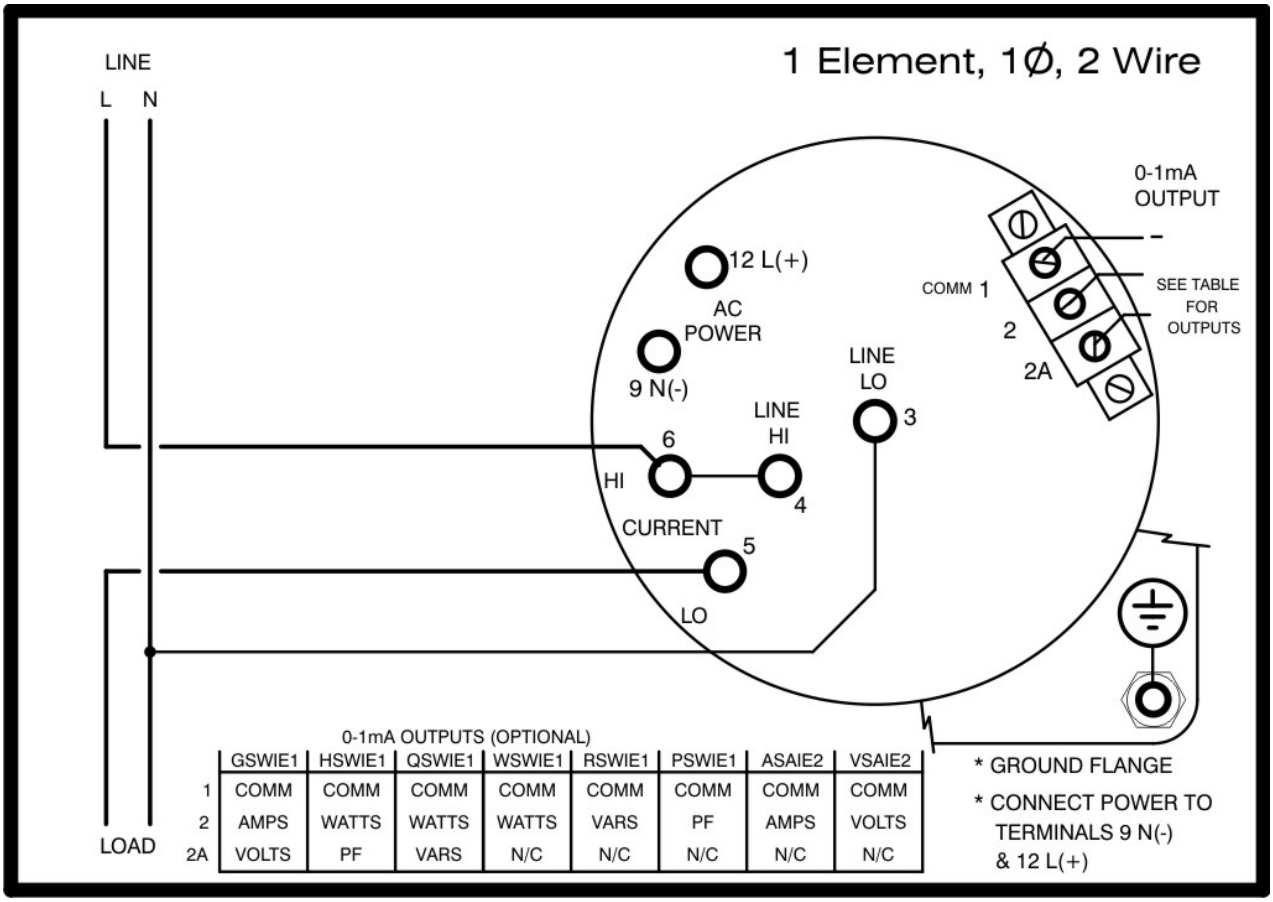
   Although the Power Measurement Instruments have been optimized for use with CTs and PTs, they may be connected directly to a load, provided that the voltages and currents do not exceed the rating of the device. The internal CT should be set to 5 (5:5) and the internal PT should be set to 1 (120:120).

6.0 CONNECTION DIAGRAMS



	GSWIE1	HSWIE1	QSWIE1	WSWIE1	RSWIE1	PSWIE1	ASAIE2	VSAIE2
1	COMM	COMM	COMM	COMM	COMM	COMM	COMM	COMM
2	AMPS	WATTS	WATTS	WATTS	VARS	PF	AMPS	VOLTS
2A	VOLTS	PF	VARS	N/C	N/C	N/C	N/C	N/C

Figure 4 - Typical connection diagram for 1 Element RSWIE1, WSWIE1, QSWIE1, GSWIE1, HSWIE1 and PSWIE1



	GSWIE1	HSWIE1	QSWIE1	WSWIE1	RSWIE1	PSWIE1	ASAIE2	VSAIE2
1	COMM	COMM	COMM	COMM	COMM	COMM	COMM	COMM
2	AMPS	WATTS	WATTS	WATTS	VARS	PF	AMPS	VOLTS
2A	VOLTS	PF	VARS	N/C	N/C	N/C	N/C	N/C

Figure 5 - Typical connection diagram for 1 Element RSWIE1, WSWIE1, QSWIE1, GSWIE1, HSWIE1 AND PSWIE1 in standalone mode (No CTs or PTs)

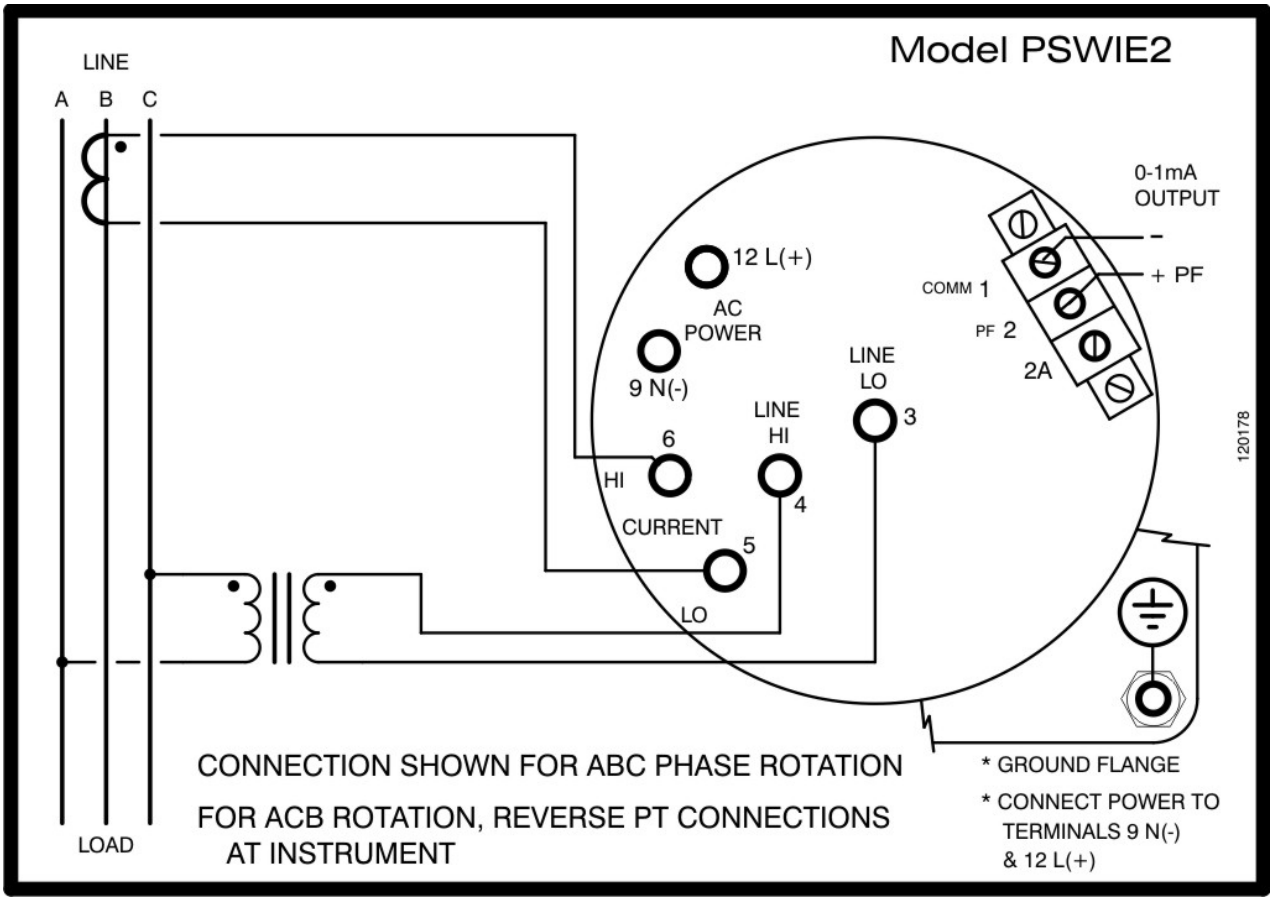


Figure 6 - Typical connection diagram for Model PSWIE2 Power Factor meter

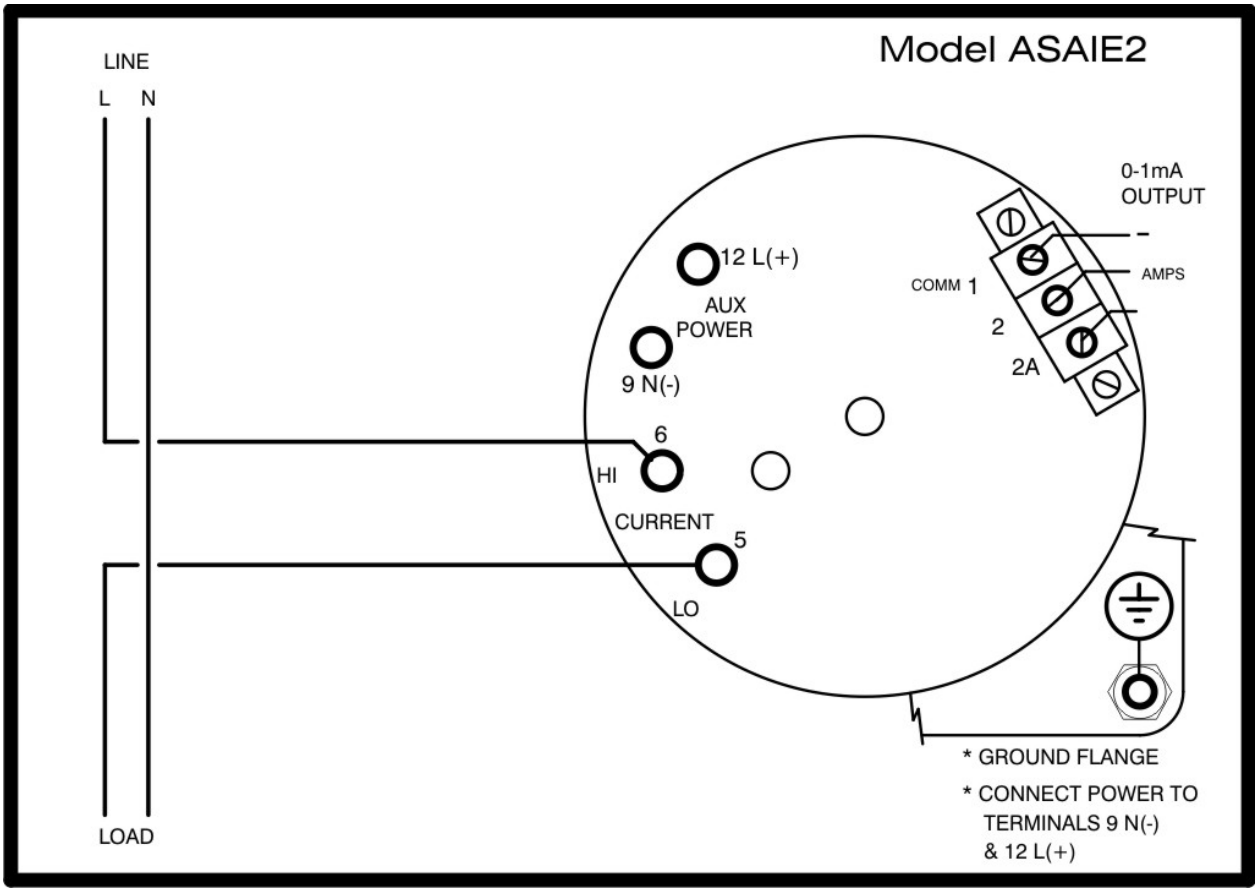


Figure 7 - Typical connection diagram for Model ASAIE2 ammeter

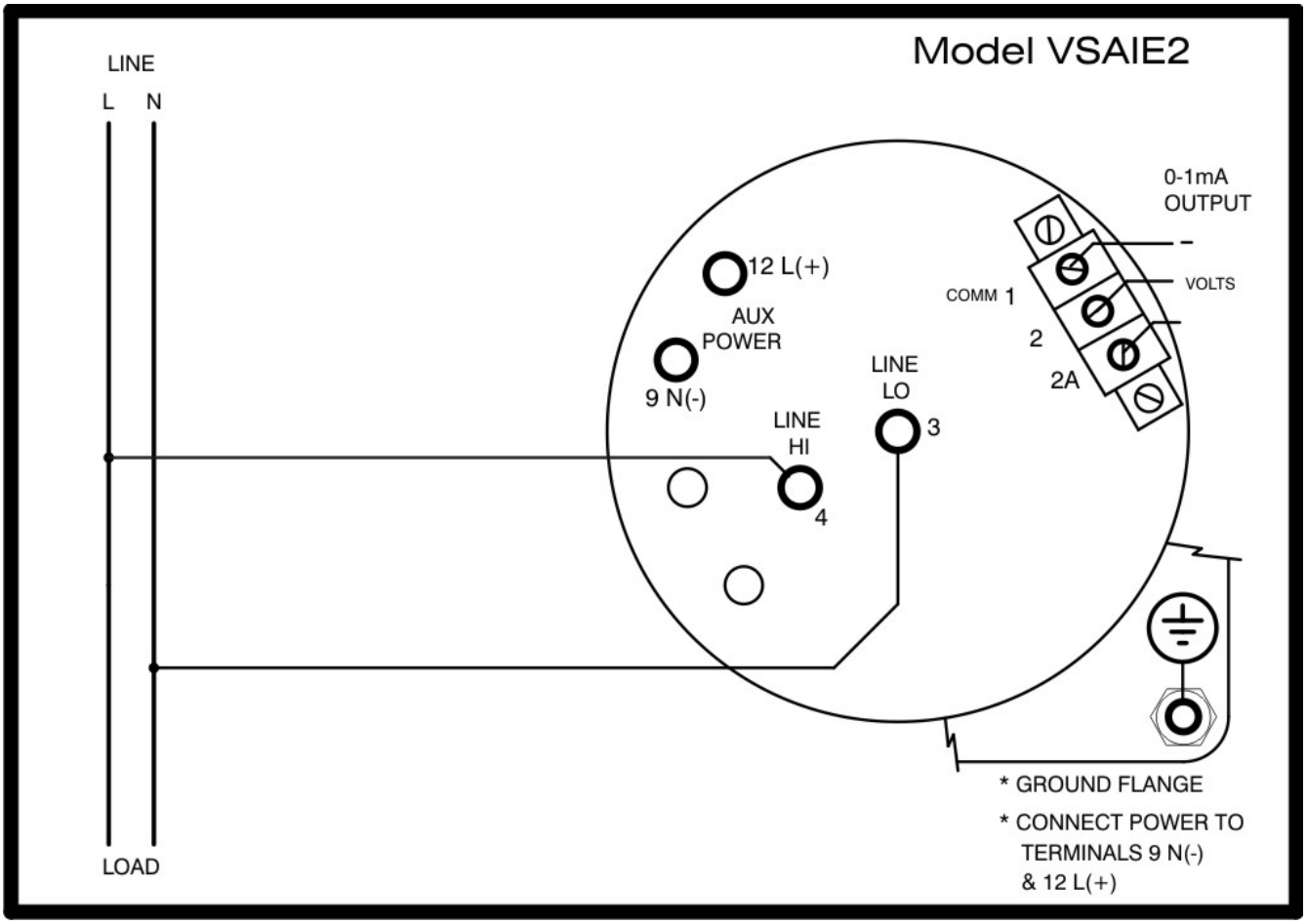


Figure 8 - Typical connection diagram for Model VSAIE2 volt meter

Revision	Date	Changes	By
A	01/30/2009	Update Bitronics Name, Logo	E. Demicco
B	11/17/2009	Updated logos and cover page	MarCom
C			

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