OPERATION & CALIBRATION MANUAL

GWV5 SERIES WATT & VAR TRANSDUCERS

BY DAVID W. MILLER

OHIO SEMITRONICS, INCORPORATED

August 1998

Preface to the GWV5 Operation and Calibration Manual

By William D. Walden
Ohio Semitronics, Inc.

The GWV5 Transducers

The GWV5 series of transducers are true four quadrant multipliers for calculating both electric power in watts and reactive power in VARS. The output signals are bi-directional. If the direction of power flow reverses as it may in a facility that has co-generation, the sign of the output reverses. The same is true for reactive power. If the nature of the load goes from inductive to capacitive, the output polarity for reactive power will reverse. A positive output for VARS represents the more common situation of an inductive load. A negative output for VARS represents a capacitive load.

Combination watt and VAR transducers are available from Ohio Semitronics, Inc. in 1, 2, 2 ½, and 3 element versions and with output signals of 0 to ±1 mADC, 0 to ±10 volts DC, 4 to 20 mADC (unidirectional only) or 4 to 12 to 20 mADC where 4 mADC represents – full scale, 12 mADC represents 0, and 20 mADC represents + full scale.

Mr. David W. Miller

Davis W. Miller is Vice President of Ohio Semitronics, Inc. He has been with the company since its founding in 1964. Mr. Miller personally designed most of the transducers that Ohio Semitronics, Inc. is presently manufacturing.

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GWV5CAL-898

TABLE OF CONTENTS

WATT & VAR TRANSDUCER
GWV5 SERIES

1-1 DESCRIPTION

This series of transducers completely consists of solid state devices utilizing electronic circuitry for the instantaneous multiplication of the voltage and the current on a continuous basis. The Watt and VAR transducers provide the following measuring function:

$P = E \times I \times \cos\theta$ For 1 Phase 2 Wire
$P = E \times I \times \sqrt{3} \times \cos\theta$ For 3 Phase 3 Wire
$P = E \times I \times 3 \times \cos\theta$ For 3 Phase 4 Wire Loads
$VAR = E \times I \times \sin\theta$ For 1 Phase 2 Wire
$VAR = E \times I \times \sqrt{3} \times \sin\theta$ For 3 Phase 3 Wire
$VAR = E \times I \times 3 \times \sin\theta$ For 3 Phase 4 Wire Loads
P = Power
VAR = Reactive Power E = Voltage
I = Current
θ = Phase angle shift between current and voltage.
PF = Power Factor (Also $\cos\theta$)
$\sqrt{3}$ = The square root of 3 or approximately 1.732.
$\approx$ Proportional to.

1-2 VOLTAGE INPUTS

The GWV5 Transducer is designed for a nominal input of 120V, 240/277, or 480VAC. The effective range at the specified accuracy is 0 to 150VAC, 0 to 300VAC, and 0 to 600VAC. In the event the transducer is specified with internal instrument power listed as option A, Y10, CX5, or C, then the effective range would be limited to ± 15% of the nominal input.

1-3 CURRENT INPUTS

Standard range is 0 to 5 amperes AC. Accuracy is specified from 0 to 5 amperes AC.

1-4 OUTPUTS

All GWV5 Transducers have a standard output of 1mA, 5V, 10V, or 4-20mA. The suffix letter in the model number indicates these. Check the specification sheet for your particular model output. An optional ± 10V output is available with the letter D substituted for the letter B in the model number.

2-1 GENERAL

The wattmeter Standard must be capable of the desired range of input voltage and current required to calibrated the particular transducer. Since all GWV5 Transducers are calibrated on a single-phase source, the actual wattmeter Standard reading will be ½ of the total specified output on 2 elements, ¼ on 2½ elements and 1/3 of the total specified output on 3 element transducers.

> ***Example I:*** A GWV5-004B 3 Phase 3 Wire transducer has a specified output of 1mA ≈ 1KW and 1mA ≈ 1KVAR. Using the single phase calibration method, the wattmeter Standard is set at 500 rated watts and the GWV5 would be calibrated for 1mA output at the 500 watt point on the wattmeter Standard.

> ***Example II:*** GWV5-007B 3-phase 4-Wire has a specified output of 1mA ≈ 1.5KW. Using the single-phase calibration method, the wattmeter Standard would be set at 500 watts and the GWV5-007B would be calibrated for 1mA output at the 500W point on the wattmeter Standard. In each case, each element of GW5-007B is measuring the full-scale current and voltage.

2-2 RECALIBRATION

Instrumentation used for calibration is traceable to N.I.S.T. (National Institute of Standards and Technology). All GWV5 Transducers are factory calibrated and checked 100% for voltage, current, linearity, power factor, initial set point, and dielectric breakdown. Temperature is checked on random samples.

All GWV5 Transducers are calibrated on a single-phase source with the current coils in series and voltage potential transformers in parallel. Polarities are chosen to produce a positive output on

terminals 2 and 2A with terminal 1 common to both on the transducer. Ideally, the transducer is energized from a precision instrument calibrator (a regulated source of current and voltage in phase) but a single-phase 0.02% wattmeter Standard can be used. The wattmeter Standard current circuit is connected in series with the current coils of the watt transducer under test. The voltage potentials are connected in parallel.

Refer to Figure 10 and 11 on page 10.

1 Choose the method of calibration and make the necessary connections between the calibrator and transducer under test.

2 Check the specification sheet for the input voltage, current, "Watts and VARs at Rated Output" and the number of elements pertaining to the transducer. All illustrations will be shown using option B 1mA output.

3 Remove the transducer from its case, by removing four screws from the lid. Pull the lid away from the case by grasping the lid terminal strip and case.

4 Allow 30 minutes for the calibrator to stabilize and 5 minutes for the transducer to stabilize.

5 All transducers will be calibrated on a single-phase source, so actual input wattage levels will be lower for all elements except single phase.
(A) 2 Element input will be 1/2
(B) 2 1/2 Element input will be 1/4
(C) 3 Element input will be 1/3

6 Overall calibration adjustments are located through the lid underneath the plastic caps. All other adjustments are located on the circuit board. Balance and power factor adjustments for 1, 2, 2½, and 3 elements are located inside the can. Refer to page 8 for location.

7 All illustrations will be shown using option B 1 mA Output.

8 Refer to page 7 Test Equipment

9 *Power factor and balance adjustments are internal adjustments, which normally do not require changing, unless the circuitry has been altered. Step 5 below can be skipped if desired.*

3.1 1 PHASE 2 WIRE, 1 ELEMENT

The following information is for the calibration of Watt-VAR Transducers.

STEP 1
Connect the GWV5 to the calibrator as shown in Figure 1 on page 9. Put a 1000-ohm lab standard resistor across terminals 1 and 2, and across terminals 1 and 2A.

STEP 2 - ZERO
Apply 115VAC-instrument power, allow 5 minutes to stabilize or have the unit on a 115VAC-power source. For internal power units apply rated voltage to terminals 3 & 4.

STEP 3
Adjust the internal "Zero" trimpot P8 for watts and P9 for VARS for zero output, less than ± 0.1-millivolt, at terminals 1 & 2 for watts and 1 & 2A for VARs.

STEP 4
Set the calibrator for the "Rated Watts" see Figure 5, and adjust the "Cal" trimpot for 1 volt.

STEP 5-POWER FACTOR Set the calibrator potential input for the nominal voltage 120V, 240V or 480VAC, 60Hz ±0.01Hz. Adjust or set the calibrator to the "Rated Watts", see Figure 5 on page 6. Now, set or shift the phase for a power factor of 0 (90°). Adjust the #1 PF trimpot for an output less than ±0.5 millivolts on terminals 1 & 2.

Please refer to drawing A-9A3-170 on page 8 for adjustments.

STEP 6 - CALIBRATION (WATTS)
Adjust zero offset P8 if necessary. Set the calibration for the nominal voltage and the "Rated Watts" at unity power factor (0°). Adjust "Cal" trimpot P7 for a 1.0000-volt output. Check linearity in 1/5 steps as shown in Figure 6 on page 7.

STEP 6A - FINAL CALIBRATION (VARS)
Set the calibrator for the nominal 60.0Hz voltage and the "Rated Watts". Recheck the zero offset at a unity power factor (0°). Now, set or shift the phase for a zero power factor (90.0°). Adjust the "Cal" trimpot P6 for a 1.0000-volt output. Check the linearity in steps shown in Figure 7 on page 7.

STEP 7
Install unit in can with fish paper on all 5 sides. Install and tighten the (4) 6-32 x 1/4 machine screws in the side of the lid. This completes calibration.

4-1 3 PHASE 3 WIRE, 2 ELEMENT

The following information is for watts and VARS calibration, use only the steps pertaining to the type of transducer under test, when indicated.

STEP 1
Connect the transducer to the calibrator as shown in Figure 2. Switches are used for the ease of calibration. Direct connection can be made if desired.

Figure 2 - See Page 9

STEP 2
Apply 115VAC-instrument power. Allow 5 minutes to stabilize. For internal power units apply rated voltage to -V+ input.

STEP 3
Adjust the "Zero" trimpots P8 and P9 for a zero output, less than ±0.01 millivolt, at terminals 1 and 2, and 1 and 2A.

STEP 4 - POWER FACTOR
Switch SWT1 "FOR", SWT2 "ON" AND SWT3 "OFF". Set the calibrator voltage potential for nominal 120V, 240V or 480V input. Set the watt input for the "Rated Watts", Figure 5. Now, set or shift the phase for zero power factor (90°). Adjust trimpot #1 for an output less than ± 0.5 millivolts on terminal 1 & 2, balance between lead and lag. Repeat STEP 7 except change SWT2 "OFF" and SWT3 "ON". Adjust trimpot #2, see Drawing A-9A3-170 on page 8.

STEP 5 - BALANCE (WATTS)
Set the calibrator for the "Rated Watts", switch SWT1 "REV", SWT2 & SWT3 "ON". Adjust the internal B1 balance trimpot Drawing A-9A3-170 on page 8 for a zero output ± 0.1 millivolts, with the rated watts applied.

STEP 6 - FINAL CALIBRATION (WATTS)
Place all switches in standard positions forward, on and on. Adjust zero offset trimpot P8 if necessary. Set the calibration for the nominal voltage and "Rated Watts" at unity power factor (0°). Adjust "Cal" trimpot P7 for a 1.0000V output. Check linearity as shown in Figure 6 on page 7.

STEP 6A - FINAL CALIBRATION (VARS)
Place all switches in standard positions forward, on and on. Set the calibration for the nominal 60.0Hz voltage and the "Rated Watts." Now, set or shift the phase for a zero power factor (90.0°), adjust "Cal" trimpot P9 for 1.0000 volt output. Check the linearity as shown in Figure 7 on page 7.

STEP 7
Install unit in can with fish paper on all 5 sides, install and tighten (4) 6-32 x 1/4 machine screws in the side of the lid. This completes calibration.

5-1 3 PHASE 4 WIRE, 3 ELEMENT

Electronic WATT/VAR Transducer

The following information is for both the calibration of Watts and Vars. Use only the steps pertaining to the type of transducer under test when indicated.

STEP 1

Connect the transducer to the calibrator as shown in Figure 3.

Figure 3 - See Page 9

STEP 2

Apply 115VAC-instrument power to terminals 6A & 12A. Allow 5 minutes to warm up or have the unit on a 115VAC-power source. For internal power units apply rated voltage to -V+ input.

STEP 3

Adjust the "Zero" trimpots P8 and P9 for a zero output or less than ±0.1 millivolt at terminals 1 and 2., and 1 and 2A. (See Drawing A-9A3-170 on page 8 for the trimpot locations.)

STEP 4

Set the calibrator for the "Rated Watts," consult Figure 5 on page 6. With all switches in standard position, adjust "Cal" trimpot for 1V output on terminal 1 & 2, watts.

STEP 5A - POWER FACTOR

Set the calibrator potential input for nominal voltage, either 120V, 240V, or 480V, 60Hz ± 0.01Hz. Adjust or set the calibrator to the "Rated Watts," see Figure 5 on page 6. Now, set or shift the phase for a zero power factor (90°). The following chart (Chart 2 below) is set up for adjusting Power Factor.

To use the chart, with the "Rated Watts" adjust the power factor setting to unit.y Adjust the PF trimpot #1 for a zero output of less than ± 0.5 millivolts balance between lead or lag. Repeat the same steps for each phase. Refer to Figure Drawing A-9A3-170 on page 8 for trimpot location.

CHART 1 - Step 5

PHASE	SWT1	SWT2	SWT3	SWT4	ADJ PF TRIMPOTS
A	ON	FOR	OFF	OFF	#1
B	OFF	FOR	ON	OFF	#2
C	OFF	FOR	OFF	ON	#3

CHART 2 - Step 5A

PHASE	SWT1	SWT2	SWT3	SWT4	ADJ PF TRIMPOTS
A	ON	FOR	OFF	OFF	#1
B	OFF	FOR	OFF	ON	#2
C	OFF	FOR	ON	OFF	#3

STEP 6 - BALANCE (WATTS)
Switch SWT1 "ON", SWT2 "REV", SWT3 "ON", and SWT4 "OFF". Set the calibrator for the "Rated Watts" at unity power factor, 0°, Figure 5 on page 6. Adjust the B1 balance trimpot, Drawing A-9A3-170 on page 8, for less than ± 0.1 millivolt output. Next, set switches SWT1 "ON", SWT2 "REV", SWT3 "OFF" and SWT4 "ON". Now adjust the B2 trimpot for a less than ± 1-millivolt output.

STEP 7 - FINAL CALIBRATION (WATTS)
Place all switches in standard positions forward, on and on. Adjust zero offset if necessary. Set the calibration for the nominal voltage and "Rated Watts" at unity power factor, 0°. Adjust "Cal" trimpot P7 for a 1.0000V output. Check linearity as shown in Figure 6 on page 7.

STEP 7A - FINAL CALIBRATION (VARS)
Place all switches in standard positions forward, on and on. Set the calibration for the nominal 60.0Hz voltage and the "Rated Watts". Now, set or shift the phase for a zero power factor (90.0°), adjust "Cal" trimpot P6 for 1.0000 volt output.

STEP 7B - FINAL CALIBRATION (VARS)
Check the linearity as shown in Figure 7 on page 7.

STEP 8
Install unit in can with fish paper on all 5 sides. Install and tighten (4) 6-32 x 1/4 machine screws in the side of the lid. This completes calibration.

6-1 3 PHASE 4 WIRE, 2½ ELEMENT

Electronic Watt/VAR Transducers
The following information is for both the calibration of Watts and VARs. Use only the steps pertaining to the type of transducer under test when indicated.

STEP 1
Connect the transducer to the calibrator as shown in Figure 4. Switches are used for the ease of calibration. Direct connections may be made if desired.

Figure 4 - See Page 9

STEP 2
Apply 115VAC-instrument power. Allow 5 minutes to stabilize.

STEP 3
Adjust the "Zero" trimpot for a zero output, less than ± 0.1 millivolt, at terminals 1 & 2.

STEP 4 - POWER FACTOR
Switch SWT1 "NOMINAL", SWT2 "ON", SWT3 "OFF" and SWT4 to "ON". Set the calibrator voltage for a nominal input of 120VAC 60.0Hz. Set the watt input to the "Rated Watts".

Consult Figure 5 on page 6. Now, set or shift the phase for a unity power factor (90°). Adjust trimpot #1, Drawing A-9A3-170 on page 8, for an output less than ± 0.5 millivolts. Balance between lead and lag. Repeat STEP 4A except change SWT2 "OFF", SWT4 "OFF" and adjust trimpot #2, in Drawing A-9A3-170, for less than ± 0.5 millivolts.

STEP 5 - BALANCE (WATTS)
Set the calibrator for the "Rated Watts" switches SWT1 "REV", SWT2 "ON", SWT3 "ON" and SWT4 "OFF". Now, set or shift the phase for unity power factor (0°). Adjust the internal B1 balance trimpot, Drawing A-9A3-170 on page 8, for a zero output of less than ±0.2 millivolts.

STEP 6 - FINAL CALIBRATION (WATTS)
Place all switches in standard position. Adjust zero if necessary. Set the calibrator for the nominal voltage of 120VAC and "Rated Watts" at unity power factor (0°). Adjust "Cal" trimpot P7 for a 1.0000V output. Check linearity as shown in Figure 6 on page 7.

STEP 6A - FINAL CALIBRATION (VARS)
Place all switches in standard position as shown in Figure 4. Set the calibrator for the nominal voltage of 120VAC 60.0Hz and "Rated Watt" at zero power factor (90.0°). Adjust "Cal" trimpot P6 for a 1.000V output. Check linearity as shown in Figure 7 on page 7.

STEP 7
Install unit in can with fish paper on all 5 sides. Install and tighten (4) 6-32 x 1/4 machine screws in the side of the lid. This completes calibration.

7-1

Figure 5

GWV5	NOMINAL VOLTS	AMPS	RATED WATTS	ELEMENTS
001B	120	5	500	1
002B	240	5	1K	1
003B	480	5	2K	1
004B	120	5	500	2
005B	240	5	1K	2
006B	480	5	2K	2
007B	120	5	500	3
7.5B	120	5	375	2 1/2
008B	277	5	1K	3
009B	480	5	2K	3
010B	120	10	1K	1
011B	240	10	2K	1
012B	480	10	4K	1
013B	120	10	1K	2
014B	240	10	2K	2
015B	480	10	4K	2
016B	120	10	1K	3
017B	277	10	2K	3
018B	480	10	4K	3
019B	120	20	2K	1
020B	240	20	4K	1
021B	480	20	8K	1
022B	120	20	2K	2
023B	240	20	4K	2
024B	480	20	8K	2
025B	120	20	2K	3
026B	277	20	4K	3
027B	480	20	8K	3

The above chart is for calibration purposes only. Actual ratings are listed on the specification sheet in this manual.

TEST EQUIPMENT

8-1 METHOD 1 - CALIBRATOR

(Refer To Figure 10)

- Precision Watt Calibrator - Model 800 Rotek (Or Equivalent)
- Precision Resistor - 1K Ω 0.02%
- Digital Voltmeter - Model 179 Keithley (Or Equivalent)

8-2 METHOD 2 - CALIBRATOR

(Refer to Figure 11)

- Sine Wave Source - Provides 60Hz nominal voltage and rated current for unit under test.
- Precision 90° phase shifter - Model 402Dynatronics (Or Equivalent) Standard - Model 2885-20
- Yokogawa (Or Equivalent).
- Precision Resistor Divider - 1K Ω 0.02%.
- Voltmeter - 0.1%
- Frequency Counter

9-1 WATTS

FIGURE 6

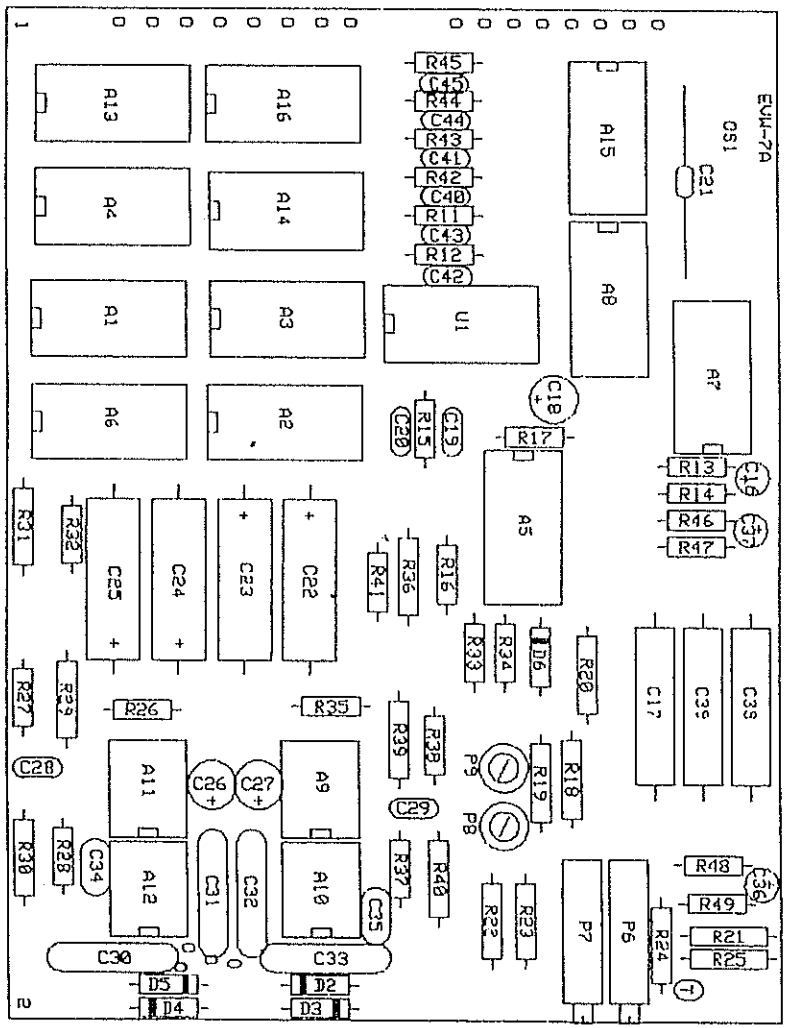
FULL SCALE "RO"	1.0000 ± .0024V
4/5	0.8000 ± .0020V
3/5	0.6000 ± .0016V
2/5	0.4000 ± .0012V
1/5	0.2000 ± .0008V
0	0.0000 ± .0004V
"RO" 0.5 LEAD	0.5000 ± .0024V
0.5 LAG	0.5000 ± .0024V
0 LEAD/LAG	0.0000 ± .0024V

9-2 VARS

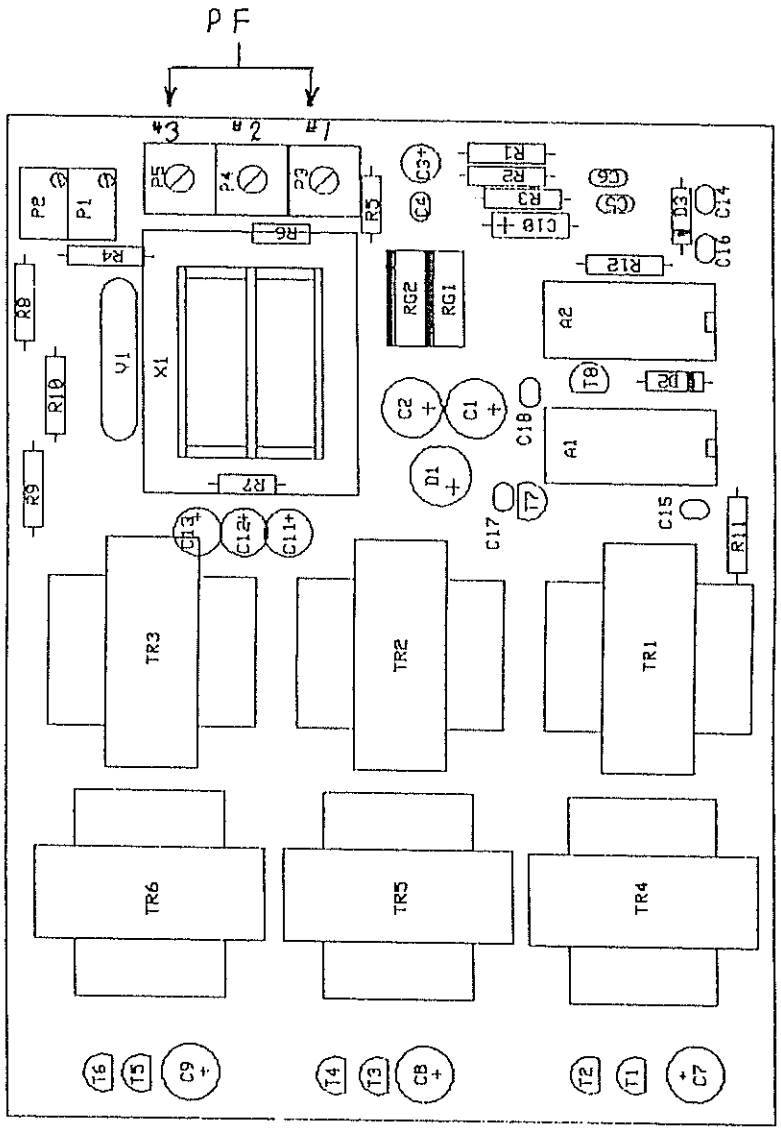
FIGURE 7

POWER FACTOR	PHASE ANGLE	RATED OUTPUT
ZERO PF	90°	1.000V ± .0024V
0.5 PF	60°	0.8667V ± .0022V
0.8	36.869°	0.6000V ± .0016V
1	0°	0.0000V ± .0004V

Accuracy of ±0 .2% reading and ± 0.04% of rated output must be maintained over the effective range of volts, current and watts.



MAIN BOARD



E OPTION INST. PWR. PCB

NOTE 1. COMPONENT ASSEMBLY DRAWING OF ELCTRONIC WATT-VAR TRANSDUCER EWV5 SERIES E OPTION

NOTE 2. COMPONENT LABELING: R=RESISTOR, C=CAPACITOR, A=AMPLIFIER, P=POTENTIOMETER, RG=REGULATOR, D=RECTIFIER, TR=TRANSFORMER, U=IC FLIP-FLOP, T=TRANSISTOR

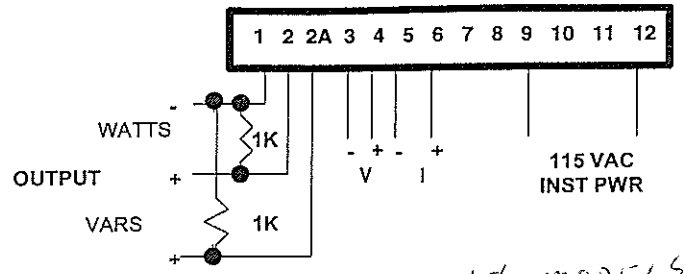
OHIO SEMITRONICS, INC.

APPROVAL	DATE
ENGINEERING	
APPROVED	

ASSEMBLY
WATT-VAR TRANSDUCER
GWV5 SERIES E OPTION

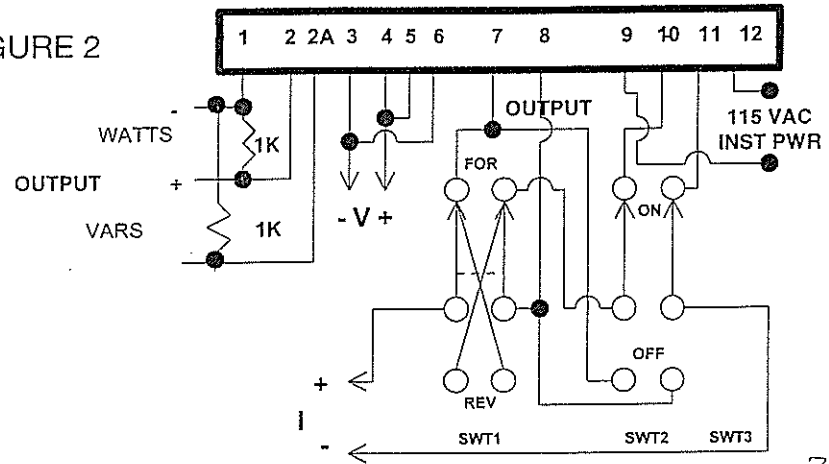
DRAWN	DATE	DRAWING NO.
Dennis Wellman	2-8-93	A-9A3-170

FIGURE 1



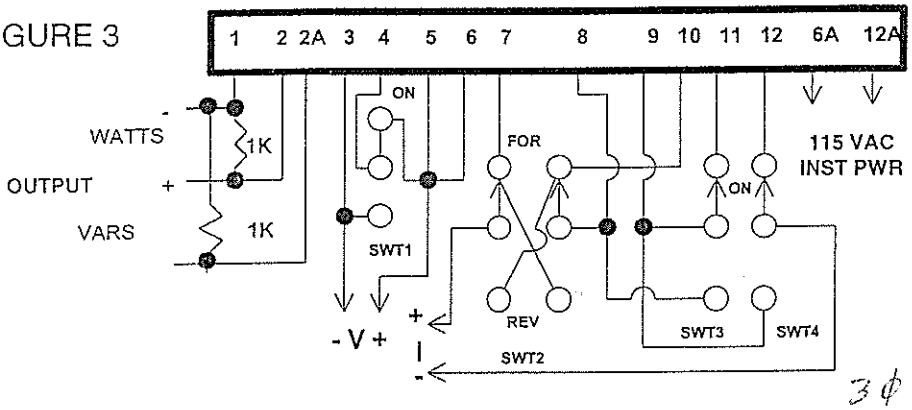
1Ø MODELS

FIGURE 2



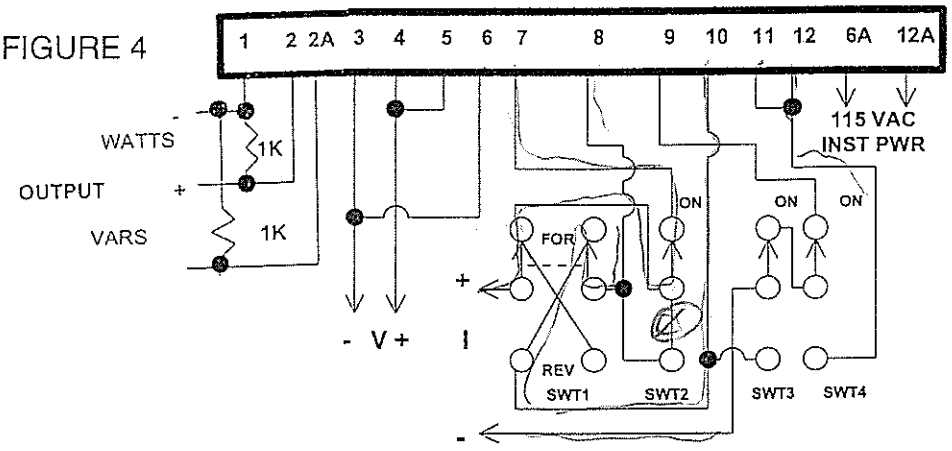
3Ø 3W MODELS 2 ELEMEN

FIGURE 3



3Ø 4W MODELS 3 ELEMEN

FIGURE 4



3Ø4W MODELS 2½ ELEMEN

FIGURE 10

CALIBRATOR METHOD #1

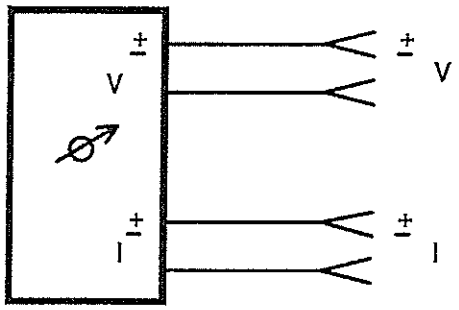
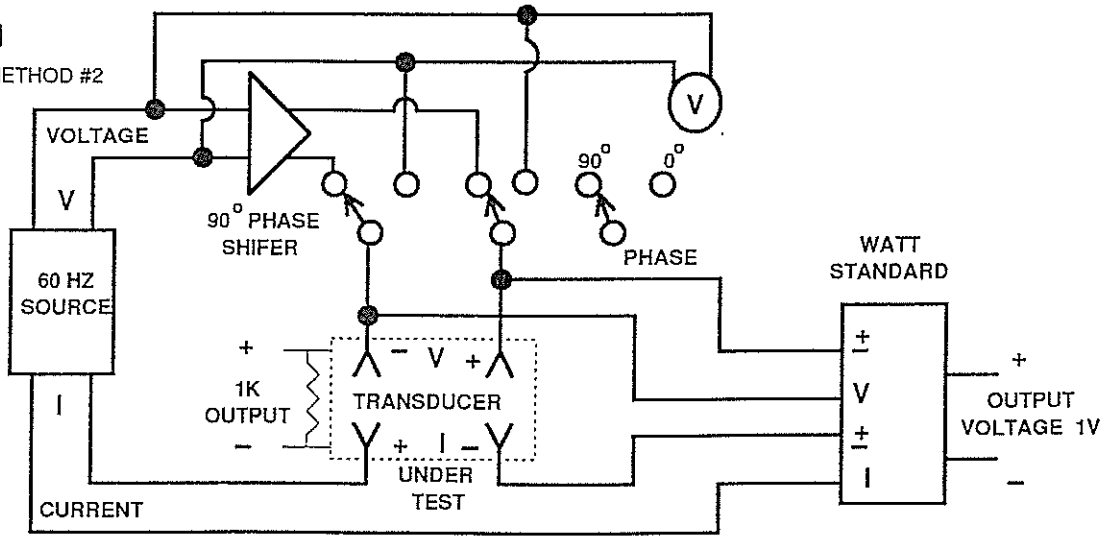


FIGURE 11

CALIBRATOR METHOD #2



PRECISION WATT/VAR TRANSDUCER MODEL GWV5

ACCURATE TO 0.2% OF READING

FEATURES

- Available in 1, 2, or 3 element configurations. Provides bi-directional operation.
- Accuracy maintained over wide temperature range, calibration traceable to **NIST**.

APPLICATIONS

- Integration into energy management systems, or a variety of sub-metering applications.
- Measurement using direct-connection, current transformers, and/or potential transformers.

SINGLE AND THREE PHASE MODELS-INTEGRAL SENSOR

INPUTS		F.S. IN	NO.	PHASE	OPTIONAL OUTPUTS (WATT AND VAR) MODEL NUMBER GWV5-				
VOLTAGE	CURRENT	(WATTS)	ELEMENTS	CONN.	* ± 1mA	± 1mA	4-20mA	± 10Vdc	± 5Vdc
0 to 150	0 to 5.0	500	1	1 Ph.-2 W	001A	001B	001E	001D	001X5
	0 to 5.0	1000	2	3 Ph.-3 W	004A	004B	004E	004D	004X5
	0 to 5.0	1500	3	3 Ph.-4 W	007A	007B	007E	007D	007X5
0 to 300	0 to 5.0	1000	1	1 Ph.-2 W	002A	002B	002E	002D	002X5
	0 to 5.0	2000	2	3 Ph.-3 W	005A	005B	005E	005D	005X5
	0 to 5.0	3000	3	3 Ph.-4 W	008A	008B	008E	008D	008X5
0 to 600	0 to 5.0	2000	1	1 Ph.-2 W	003A	003B	003E	003D	003X5
	0 to 5.0	4000	2	3 Ph.-3 W	006A	006B	006E	006D	006X5

Can be used with customer's existing current transformers.
All units require 85-135VAC instrument power, (60 Hz.).
50 HERTZ MODELS-Add suffix "**-50**" to part number.
NOTE: Output converters must be ordered separately.

ORDERING INFORMATION
Example: Three-phase, three wire 120V, 5A input with 0-1mA output.
GWV5-004B

* Denotes self-powered unit, limiting input voltage ranges to:
85-135 For 150V Models
200-280 For 300V Models
380-550 For 600V Models

MODEL GWV5 SPECIFICATIONS

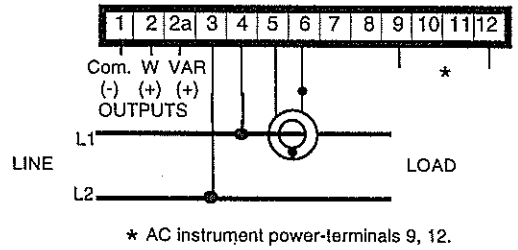
INPUT

VOLTAGE:	See Table
CURRENT:	0 to 5A
FREQUENCY:	60 Hz standard; Optional 50 Hz
POWER FACTOR:	Any
BURDEN:	
Voltage:	Less than 0.1VA per phase
Current:	Less than 0.28VA per phase
OVERLOAD:	
Voltage (cont.):	175V, 350V, 600V
Current (cont.):	10A
DIELECTRIC TEST (Input/Output/Case):	1800VAC
SURGE:	Withstands IEEE SWC test
OPERATING HUMIDITY:	0-95% non-condensing

OUTPUT

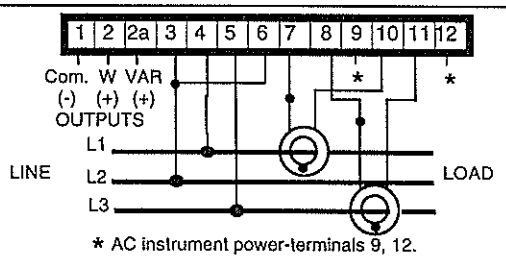
OUTPUT Watts, VAR:	See Table
OUTPUT LOADING (OHMS):	0-10K (1mA) 0-500 (4-20mA)
RESPONSE TIME (99%):	Less than 400 milliSeconds
FIELD ADJUSTABLE CAL.:	± 2% min
COMPLIANCE VOLTAGE:	11Vdc min
OPEN CIRCUIT VOLTAGE:	± 15Vdc
ACCURACY ± 0.2% RDG.;	**± 0.05% FS**
Includes combined effects of voltage, current, load and power factor.	
TEMPERATURE EFFECT (-20° to +60°C):	
Watt:	± 0.005% per degree C
VAR:	± 0.009% per degree C
INSTRUMENT POWER (STD.):	85-135VAC, 60Hz

CONNECTION DIAGRAMS - CASE DIMENSIONS



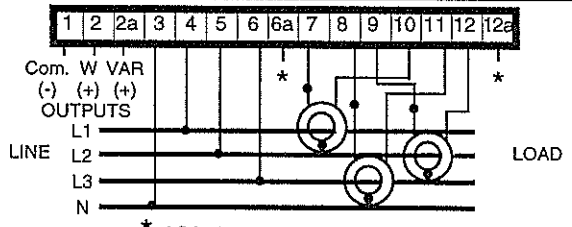
* AC instrument power-terminals 9, 12.

SINGLE PHASE



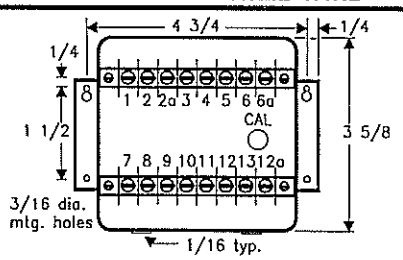
* AC instrument power-terminals 9, 12.

THREE PHASE THREE WIRE



* AC instrument power-terminals 6a, 12a.

THREE PHASE FOUR WIRE



Case height 6 3/8

ALL DIMENSIONS IN INCHES

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