

OPERATION & CALIBRATION MANUAL

AGW & AGH SERIES WATT & WATT-HOUR TRANSDUCERS

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WATT & WATT-HOUR TRANSDUCERS

AGW & AGH 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 transducers provide the following measuring function:

$$P = E \times I \times \text{Cos}\theta \text{ For 1 Phase 2 Wire}$$

$$P = E \times I \times \sqrt{3} \times \text{Cos}\theta \text{ for 3 Phase 3 Wire}$$

$$P = E \times I \times 3 \times \text{Cos}\theta \text{ for 3 Phase 4 Wire}$$

$$\text{VAR} = E \times I \times \text{Sin } \theta \text{ for 1 Phase 2 Wire}$$

$$\text{VAR} = E \times I \times \sqrt{3} \times \text{Sin}\theta \text{ for 3 Phase 3 Wire}$$

$$\text{VAR} = E \times I \times 3 \times \text{Sin}\theta \text{ for 3 Phase 4 Wire}$$

P Power

VAR Reactive Power

E Voltage

I Current

θ Phase angle shift between current and voltage.

PF Power Factor (Also $\text{Cos}\theta$)

$\sqrt{3}$ The square root of 3 or approximately 1.732.

\approx Proportional to.

1-2 VOLTAGE INPUTS

The AGW and AGH Transducers are designed for a nominal input of 120V, 240/277V or 480VAC. The effective range at the specified accuracy is 0 to 150VAC, 0 to 300VAC, and 0 to 600VAC.

1-3 CURRENT INPUTS

Current range is 0 to 5 amperes

1-4 OUTPUTS

All AGW and AGH Transducers have a standard output of 1mADC, 0 to 10 volts DC or 4-20mADC. The option letter inserted in the model number indicates these. Check the

specification sheet for your particular model's output.

2-1 GENERAL

The wattmeter Standard must be capable of the desired range of input voltage and current required to calibrate the particular transducer. Since all AGW & AGH Transducers will be calibrated on a single phase source, the actual Wattmeter Standard reading will be $\frac{1}{2}$ of the total specified output on 2 elements, $\frac{1}{4}$ on $2\frac{1}{2}$ element and $\frac{1}{3}$ of the total specified output on 3 element transducers. For example, an AGW-004B, 3 Phase 3 Wire has a specified output of 1mA \approx 1KW. Using the single phase calibration method, the Wattmeter Standard would be set at 500 rated watts and the AGW would be calibrated for 1mA output at 500 W point on the Wattmeter Standard.

Second example, AGW-007B 3 phase 4 Wire has a specified output of 1mA \approx 1.5KW. Using the single-phase calibration method, the Wattmeter Standard would be set at 500W and the AGW-007B would be calibrated for 1mA output at the 500W point on the Wattmeter Standard. In each case, each element of AGW-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 AGW & AGH Transducers are factory calibrated and checked 100% for voltage and current linearity, power factor, initial set point, and dielectric breakdown. Temperature is checked on random samples.

All AGW & AGH Transducers are calibrated on single phase with the current coils in series and voltage inputs in parallel. Polarities are chosen to produce a positive output on terminal 2 of 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 6 and 7 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 inputs voltage, current, "Watts at Rated Output" and 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.
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) 2½ Element input will be 1/4
 - (C) 3 Element input will be 1/3
6. Overall calibration and zero adjustments

are located through the lid underneath the plastic caps. Balance and power factor adjustments for 1, 2, 2 ½, and 3 elements are located inside the can. Refer to page 10 for location.

7. All illustrations will be shown using option B 1mA output.
8. Refer to page 6 Test Equipment
9. ***Power factor and balance adjustments are internal adjustments that normally do not require changing, unless the circuitry has been altered. These steps can be eliminated if so desired.***

3-1 1 PHASE 2 WIRE, 1 ELEMENT

The following information is for both the calibration of Watt Transducers. Use only the steps pertaining to the type of transducer under test, when indicated.

STEP 1

Connect the AGW or AGH to the calibrator as shown in Figure 1 on page 8.

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 "Zero" pot for a zero output, less than ± 0.1 millivolt, at terminals 1 & 2.

STEP 4

Set the calibrator for the "Rated Watts" see CHART 3, and adjust the "Cal" trimpot for 1 volt.

STEP 5 — POWER FACTOR (WATTS)

Set the calibrator potential input for the nominal voltage, either 120V, 240V, or

480VAC, adjust or set the calibrator to the "Rated Watts," see CHART 3. Now, set or shift the phase for a zero power factor (90.0°). Adjust the #1 PF trimpot. Figure 5 or 5A for an output less than ± 0.5 millivolts. Balance between lead and lag.

STEP 6 — CALIBRATION (WATTS)

Adjust zero offset if necessary. Set the calibration for the nominal voltage and the "Rated Watts" at unity power factor (0°). Adjust "Cal" trimpot for a 1.0000-volt output. Check linearity in 1/5 steps shown in CHART 4.

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 calibration.

STEP 1

Connect the transducer to the calibrator as shown in Figure 2 on page 8. Switches are used for the ease of calibration. Direct connection can be made if desired.

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" trimpot for a zero output, less than ± 0.01 millivolt, at terminals 1 & 2.

STEP 4 — POWER FACTOR (WATTS)

Switch SWT1 "FOR," SWT2 "ON" AND SWT3 "OFF." Set the calibrator voltage

potential for nominal 120, 240, or 480V input. Set the watt input for the "Rated Watts." Consult CHART 3. Now, set or shift the phase for a zero power factor (90°) Adjust trimpot #1, Figure 5 or 5A for an output less than ± 0.5 millivolts. Balance between lead and lag. Repeat STEP 4 except change SWT2 "OFF" and SWT3 "ON." Adjust trimpot #2 see Figure 5.

STEP 4A — POWER FACTOR (VARs)

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," CHART 3. Now, set or shift the phase for unity power factor (0.00°). Adjust trimpot #1, Figure 5, for an output less than ± 0.5 millivolts, balance between lead and lag. Repeat STEP 7 except change SWT2 "OFF" and SWT3 "ON." Adjust trimpot #2 see Figure 5.

STEP 5 — BALANCE (WATTS)

Set the calibrator for the "Rated Watts," switch SWT1 "REV," SWT2 & SWT3 "ON." Adjust the internal B1 balance trimpot Figure 5 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 if necessary. Set the calibration for the nominal voltage and "Rated Watts" at unity power factor (0°). Adjust "Cal" trimpot for a 1.0000V output. Check linearity as shown in CHART 4.

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 Transducer

The following information is for the calibration of Watt Transducers.

STEP 1

Connect the transducer to the calibrator as shown in Figure 3 on page 8.

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" trimpot for a zero output or less than ± 0.1 millivolt at terminals 1 & 2.

STEP 4

Set the calibrator for the "Rated Watts," consult CHART 3. With all switches in standard position, adjust "Cal" trimpot for 1V output.

STEP 5 — POWER FACTOR (WATTS)

Set the calibrator potential input for nominal voltage, either 120V, 240V or 480VAC. Adjust or set the calibrator to the "Rated Watts," see CHART 3. Now, set or shift the phase for a zero power factor (90°) The following chart (Chart 1 below) is set up for adjusting Power Factor.

To use the chart, with the "Rated Watts" set the power factor set to unit. Adjust the PF trimpot #1 for a zero output of less than ± 0.5 millivolts. Balance between lead and lag. Repeat the same steps for each phase. Refer to Figure 5 to 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)

Switches SWT1 "ON," SWT2 "REV," SWT3

"ON," and SWT4 "OFF." Set the calibrator for the "Rated Watts" at unity power factor (0°),

CHART 3. Adjust the B1 balance trimpot, Figure 5 or 5A, for a 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 for a 1.0000V output. Check linearity as shown in CHART 4.

STEP 8

Install unit in can with fisch 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, 2-1/2 ELEMENT

The following information is for the calibration of 2-1/2 element Watt Transducers.

STEP 1

Connect the transducer to the calibrator as shown in Figure 4 on page 8. Switches are used for the ease of calibration. Direct connections can be made if desired.

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 (WATTS)

Switch SWT1 "FOR," SWT2 "ON," SWT3

"OFF" and SWT4 "ON." Set the calibrator potential input for a nominal voltage of watt input to the "Rated Watts." Consult CHART 3. Now, set or shift the phase for a zero power factor (90.0°). Adjust trimpot #1, Figure 5 or 5A, for an output less than ± 0.5 millivolts, balance between lead and lag. Repeat STEP 4 except change SWT2 "OFF," SWT4 "OFF" and adjust trimpot #2, in Figure 5, 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, Figure 5 or 5, 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 for a 1.0000V output. Check linearity as shown in CHART 4.

STEP 7

Install unit in can with fisch 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.

CHART 3

AGW/AGH	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
007.5B	120	5	375	2½
008B	277	5	1K	3
008.5B	277	5	1K ??	2½

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 6)

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

8-2 METHOD 2 – CALIBRATOR

(Refer to FIGURE 7)

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

9-1 WATTS
CHART 4

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" .5 LEAD	0.5000 ± .0024V
0.5 LAG	0.5000 ± .0024V
0 LEAD/LAG	0.0000 ± .0024V

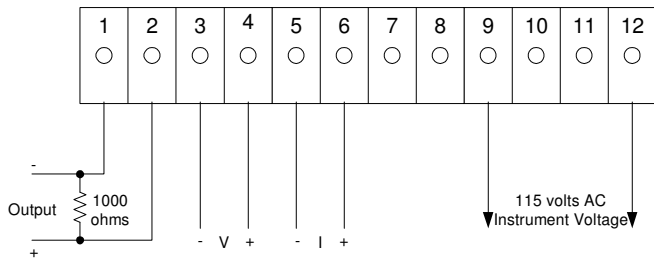


Figure 1

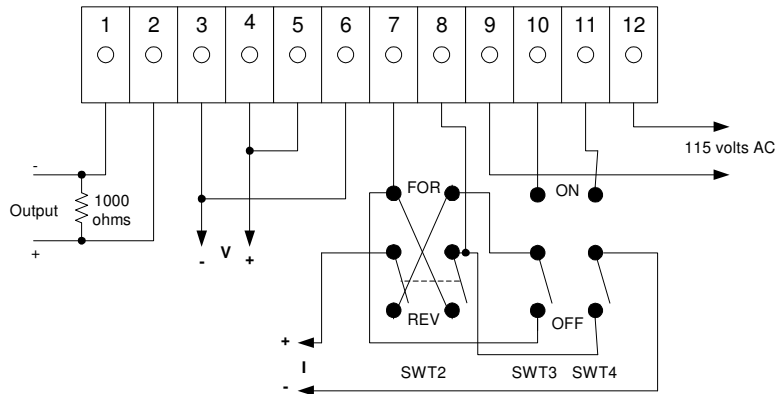


Figure 2

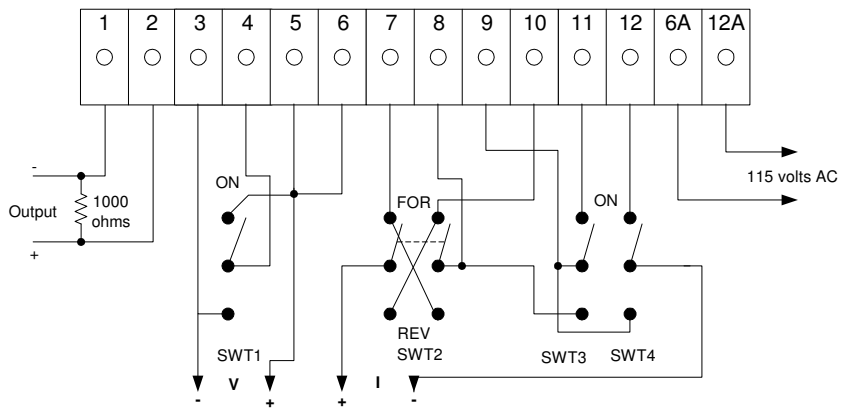


Figure 3

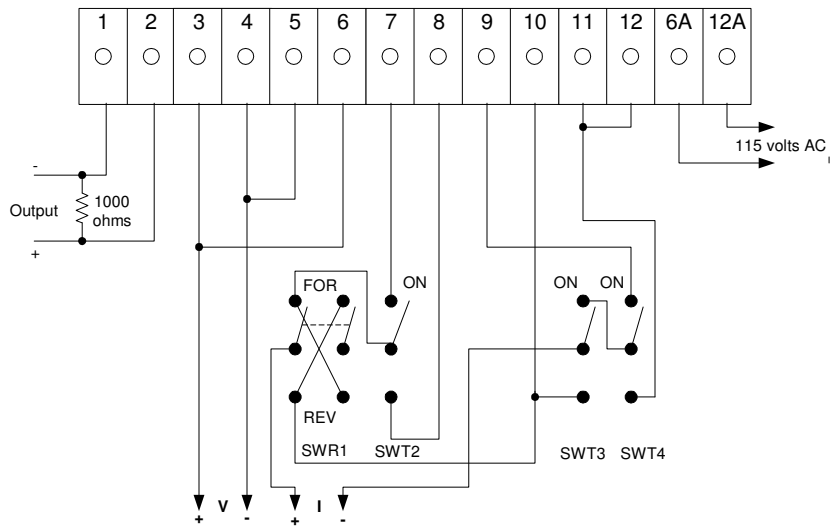


Figure 4

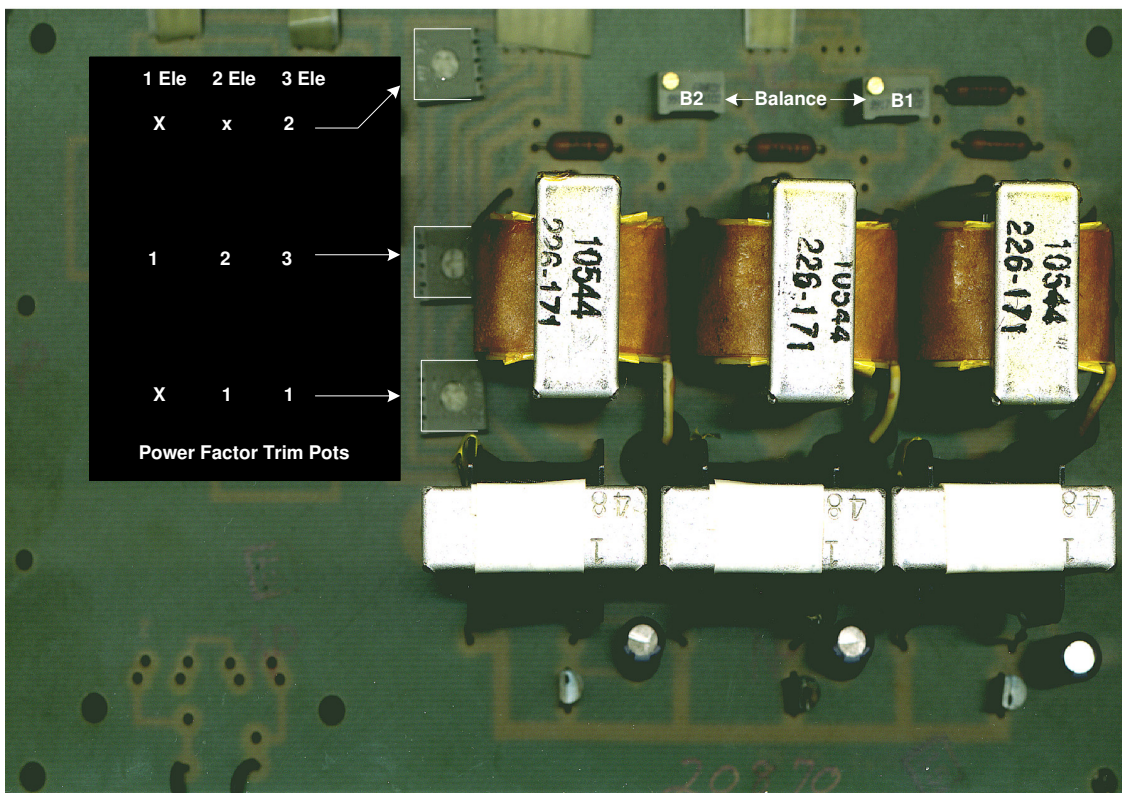


Figure 5

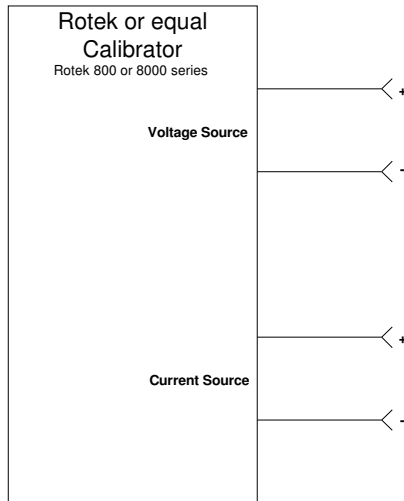


Figure 6
Calibrator Method #1

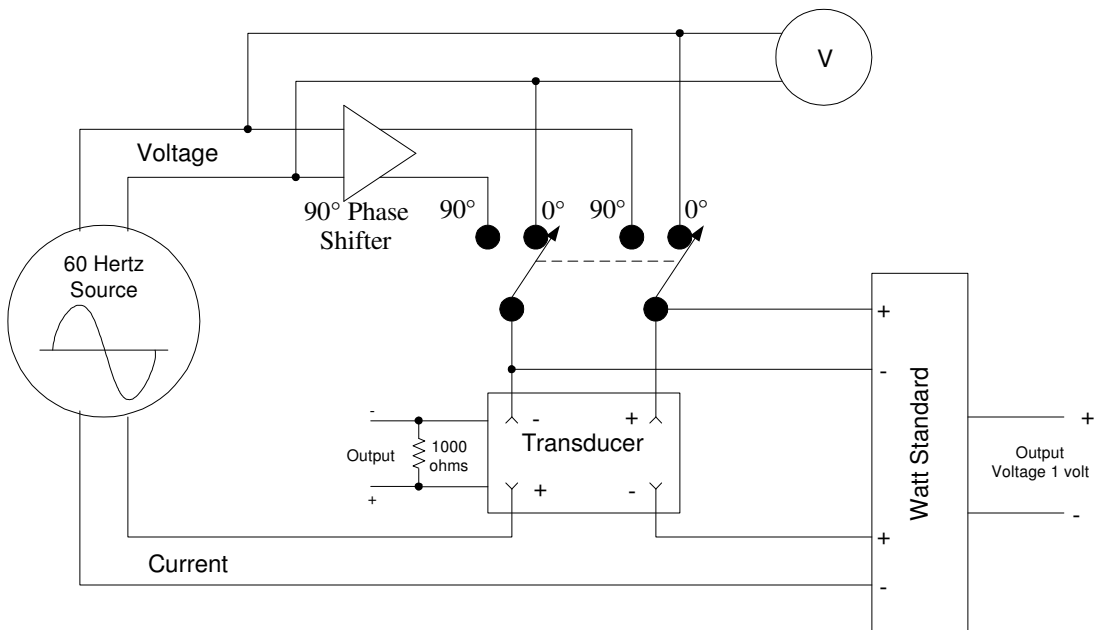


Figure 7
Calibrator Method #2

WATT-HOUR SUPPLEMENT FOR MODELS AGH SERIES

12-1 DESCRIPTION

The AGH Series of watt, watt-hour transducers have two sections to be calibrated, the watt-hour section and watt section. After the calibration of the watt section is completed, maintain the input current and voltage potentials to the unit and refer to section on watt-hour calibration.

This supplement is for the calibration of the watt-hour section of the transducer. Use the provided manual on AGW and for the calibration of the watt section, starting on page 1. In this section of the manual you need to equate AGH - to AGW -. Only the prefix changes. For instance an AGW-007B is the same as an AGH-007B when calibrating the watt section. All specifications listed in Chart 3 page 6 will be related directly to AGH and four-digit number, 007B is the same for both AGW and AGH.

13-1 CALIBRATION WATT-HOUR

Before proceeding with this section, the calibration of the watt section must be completed.

Equipment Required: Frequency counter capable of 0 to 10K Hz with an accuracy ± 0.05 Hz.

Open the unit up, to allow access to the calibration trimpots P8 VFC zero, P9 "Fine Cal" and P10 "Course Cal". To do this, remove the four screws around the perimeter of the lid and separate the lid from the case.

Refer to Figure 12 for location of trimpots and connections.

The only adjustment necessary is to set the frequency of the integrator.

A voltage to pulse integrator controls the watt-hour section of the transducer. The analog signal from the watt section is changed to a series of pulses, which is directly related to the watt signal. This series of pulses are set to give the correct number of output closures or pulse.

Figure 13 lists all the standard counts per hour needed in calibrating this section.

To use the table in Figure 13, refer to the attached specification sheet for AGH series of transducers. Locate the model that you are calibrating and find the number of counts in the "FS Count Per Hr" column (Specification Sheet). Now go back to Figure 13 column "FS Count Per HR"

and find the exact same number. The columns adjacent to it will give you "Cal Frequency in Hertz" and "Switch Position".

NOTE: Figure 13 is for Standard Models only, consult factory for Non-Standard Models that are not shown in Figure 13.

To set the frequency, apply the current and voltage potentials to the full-scale value described in watt section. Connect the frequency counter as shown in Figure 12 to the VFC test point and common.

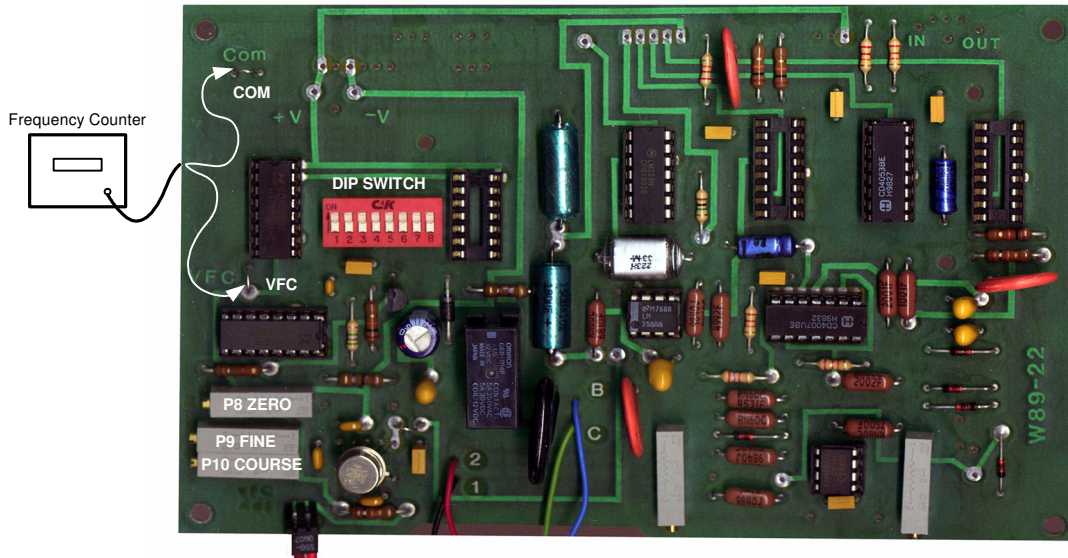
Adjust P9 "Fine" and P10 "Course" for the correct calibrated frequency recorded from listed in Figure 13. Note, this adjustment is made at full scale only for watts. Now reduce the watt input to 10%. For the watt input, adjust P8 to set the frequency to 10% of its original value. Check linearity as required. Accuracy is based on .2% reading \pm 0.04% RO.

14-1 COUNTER OR PULSE OUTPUT CHECK

Connect a counter or monitor to the watt-hour output terminals. Check Figure 13 for the correct switch position. Apply the full-scale watts. Divide the "FS Count Per HR" by 60. This number indicates how many closure or pulses you should record in one minute.

NOTE: This check is to only indicate if the output is operating, not as a calibration point.

This completes the calibration of this unit. Reinstall into case.



CIRCUIT BOARD #13435 FOR THE AGH AND GH WATT-HOUR TRANSDUCERS
Figure 12

FS COUNT PER HR	CAL FREQ IN HERTZ	DIP SWITCH ON
500	2276	5
1000	4551	5
1500	6827	5
2000	4551	4
3000	6827	4
4000	4551	3

Figure 13

NOTE: All standard units are calibrated using the table above in figure 13.