W- SERIES WATT & WATT-HOUR TRANSDUCERS
Operational Testing and Calibration

Valid for all W- series models manufactured after February/2001.
Refer to W-MANUAL Drawing A7004-07 Rev. A December 1998 for previous version.

All W- series models manufactured at Ohio Semitronics, Inc. are calibrated with equipment that is traceable to the National Institute of Standards and Technology (NIST).

OSI offers post-sale calibration services on all manufactured products.
This guide contains test wiring and adjustment locations to cover all single-phase and three-phase models for testing and adjustments made outside of OSI.

CAUTION: Use of this manual by qualified electrical personnel only. Do not apply line current through the window of a current transformer with the secondary leads open. Severe shock to the installer or damage to the current transformer may result.

REQUIRED TEST EQUIPMENT:

WATTMETER CALIBRATOR
ROTEK 8100

PRECISION MULTIMETER
AGILENT 34401A

UNIVERSAL COUNTER
HP 5315A

Fig. 1

Examples are typical and are not limited to the make/model shown.

ORIGINAL CALIBRATION DATE:

Date coding of W- series transducers is contained within the serial number.
8 digit serial numbers: 1st two = year. 2nd two = month.
7 digit serial numbers: 1st digit = year. 2nd two = month. (pre-date this manual).
5 digit serial numbers (ink stamp) = 1980's (pre-date this manual).

Refer to the standard W- series product specification sheet along with this guide to determine the number of elements, analog output type, relay count rate along with voltage, current and watt input range for your model. Some of this information is contained within the "top-label" text that is attached to the W- unit.

DETERMINE THE NUMBER OF ELEMENTS AND THE CURRENT RANGE:

Refer to the W- series product specification sheet. Model numbers are divided into tables by the number of elements and the method by which the current is measured (sensed).

1 element = 1 voltage and 1 current input (to a watt transducer).

2 elements = 2 voltages and 2 current inputs.

3 elements = 3 voltages and 3 current inputs.

2.5 elements = 2 voltages and 3 current inputs.

Current sensing:

Internal sensors = directly connecting current source to the W- terminals.

External Sensors = Calibrated with one or more Current transformers (**CT's**) depending on the number of elements that the W- model has.

ANALOG DC OUTPUT (WATTS) AND AC INSTRUMENT POWER:

A portion of the model number indicates the type of analog output along with how the W- unit is powered ("Instrument Power").

Indicator letter(s):

A = 1mAdc F.S. output and self powered.

B = 1mAdc F.S. output and separate instrument power.

C = 10Vdc F.S. output and self powered.

D = 10Vdc F.S. output and separate instrument power.

CX5 = 5Vdc F.S. output and self powered.

X5 = 5Vdc F.S. output and separate instrument power.

E = 4-20mAdc output and separate instrument power.

Voltage outputs are connected direct to a precision voltmeter set to DC volts.

Current output models 1mAdc or 4-20mAdc are recommended to be loaded with a precision resistor.

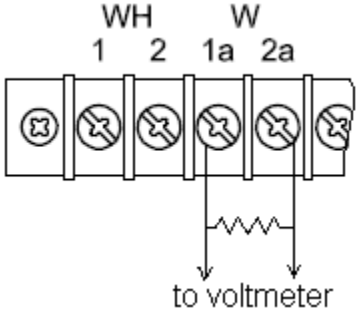
The voltage across the resistor is measured with the DC volt-meter for test (see Fig. 2).

Recommended resistor values (Watt Output) at terminal 1A & 2A loading:

1mAdc models: 1kΩ (0.1%)

4-20mAdc models: 250Ω (0.1%)

(To determine the voltage across the resistor chosen, use ohms law).



converting 1mAdc and 4-20mAdc outputs into a voltage using a resistor.

Fig. 2

Instrument power types:

Self Powered models A, C, CX5 derive instrument power voltage from the measurement line (wattmeter calibrator source). For proper operation, this voltage range is limited:
103-135Vac (for listed 0-150Vac W- models). Nominal volts = 120Vac.
215-280Vac (for listed 0-300Vac W- models). Nominal volts = 240Vac.
395-550Vac (for listed 0-600Vac W- models). Nominal volts = 480Vac.

External power models B, D, X5, E require a separately supplied voltage source applied to terminals marked *INST POWER shown on the specification sheet connections diagram. Standard models require 120Vac. For -22 models use 230Vac to power the transducer.

RELAY OUTPUT:

Standard W- series contact closure relay output at terminals 1 & 2 operates at a closure duration of 200mS and indicates watt-hours (energy usage) when totalized. This output is also referred to as a "pulse" and is available as a "-T" option for a 5Vdc TTL signal also at 200mS duration (high). Both relay types can be monitored with a universal counter (frequency counter) or totalizer.

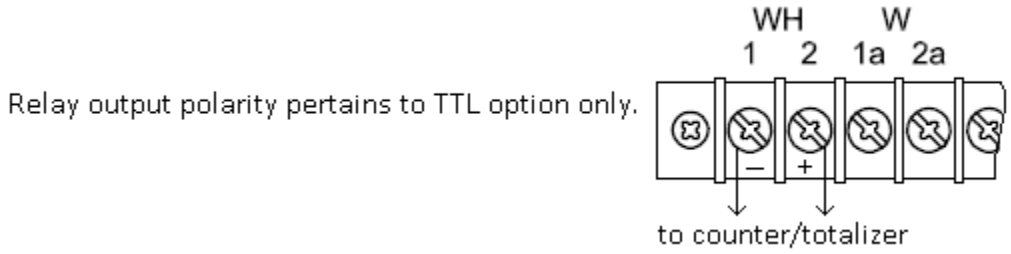


Fig. 3

SYMBOLS AND MARKINGS USED IN THIS MANUAL:

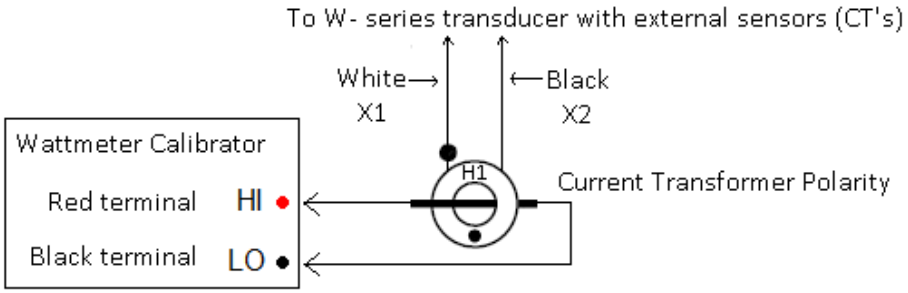
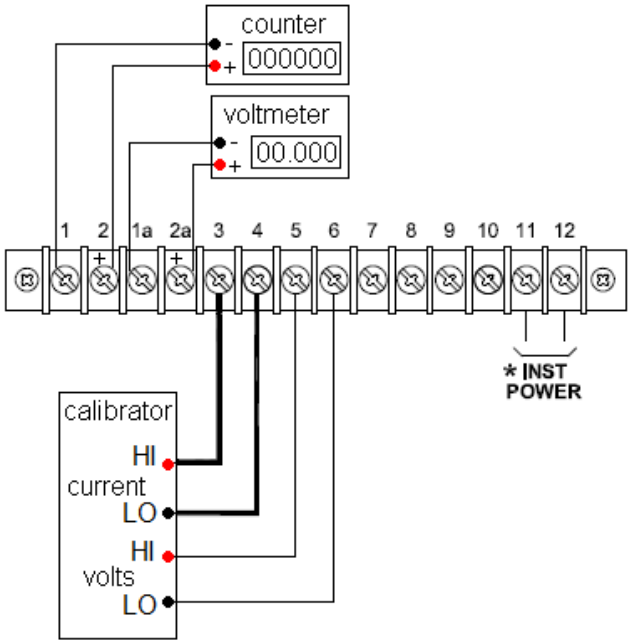


Fig. 4

WH = Watt-Hour. HI = High. LO = Low. F.S. = Full Scale. TP = Test Point.
CT = Current Transformer. H1 = CT polarity mark (face towards HI on Calibrator).

TESTING SINGLE-PHASE TWO-WIRE (ONE ELEMENT):

USING INTERNAL SENSOR (DIRECT)



USING EXTERNAL SENSOR (CT)

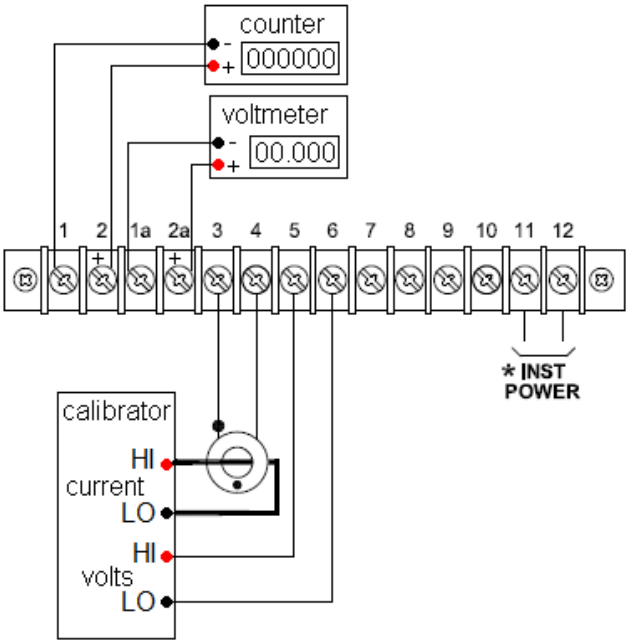


Fig. 5

One-Element W- series transducers:

Set the wattmeter calibrator to the exact watt rating of the W- model.

Set calibrator to nominal voltage input EX: 120V, 240V, or 480V depending on the W- model.

To find the nominal current value, take F.S. watts and divide by the nominal voltage.

This process is best explained by showing the procedure using a random catalog W- model.

Example model: W-019E.

Rated watts = 1500W, Nominal volts = 120Vac. (1500 ÷ 120 = 12.50A).

Set calibrator to 1500W, 120V, 12.50A, Power Factor = 1 (do not power on yet).

Attach 250Ω resistor to output terminals 1a & 2a. Connect DC voltmeter to 1a & 2a.

(4-20mAdc output = 1Vdc to 5Vdc output).

Apply 120Vac "external power" to terminals 11 & 12. (DC voltmeter = 1Vdc).

Let unit warm up for approximately 5 minutes.

Switch ON calibrator power for input watts. (DC voltmeter = 5Vdc).

Check linearity at 20% increments by reducing input current.

Set calibrator back to F.S., set Power Factor to 0.5Lag and 0.5Lead (DC meter = 3Vdc).

Calibrator settings: 1500W, 120V, 12.50A, Power Factor = 1.

W-019E specified WH relay count rate = 1500 counts per hour at F.S. input.

Check counter for 25 counts after 1 minute. Run 5 minutes if preferred.

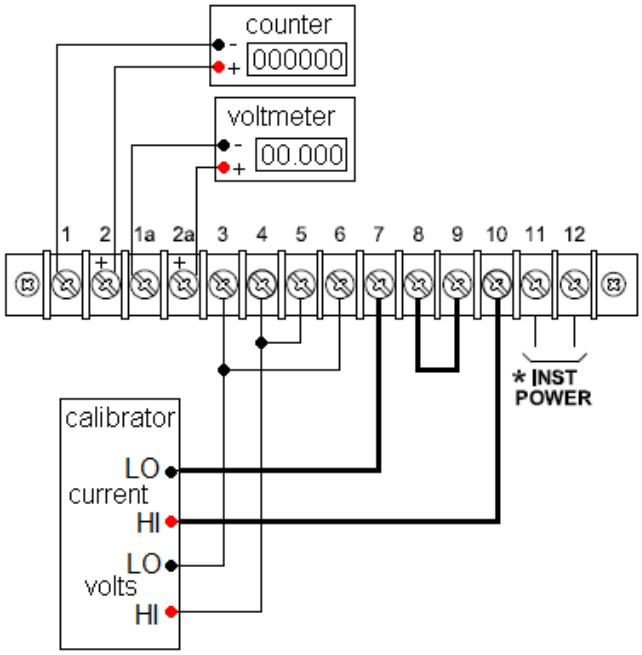
Accuracy is rated for ±0.5% F.S. for all tests.

If any outputs are out of tolerance then see the section that covers "**ADJUSTMENTS**".

All input power to "OFF".

THREE-PHASE THREE-WIRE (TWO ELEMENT):

USING INTERNAL SENSOR (DIRECT)



USING EXTERNAL SENSORS (CT's)

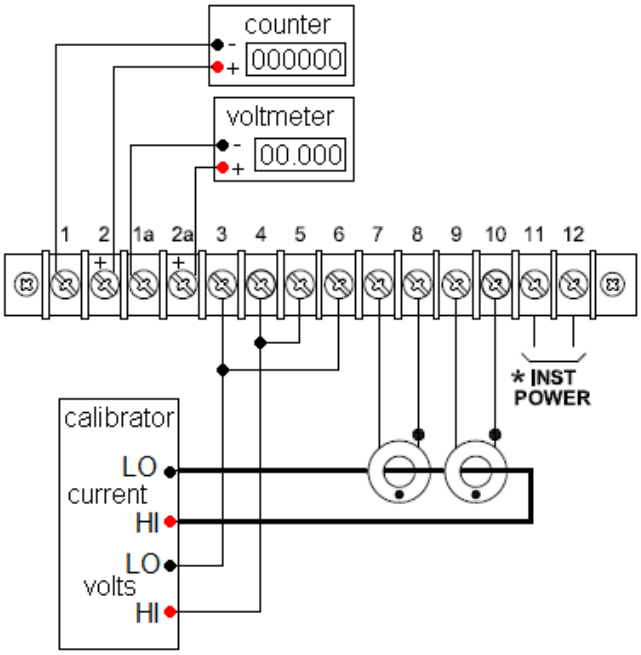


Fig. 6

Two-Element W- series transducers:

Set the wattmeter calibrator to 1/2 of the watt rating of the W- model. This is due to the fact that the wattmeter calibrator is a single-phase source that is sharing through both elements (series currents and parallel voltages). Relay counts per hour remains the same as specified.

Set calibrator for nominal voltage input EX: 120V, 240V, or 480V depending on the W- model.

To find the nominal current value, take **F.S. watts and divide by 2** and then divide by the nominal voltage. This process is best explained by showing the procedure using a random catalog W- model.

Example model: W-063C.

Rated watts = 80kW, Nominal volts = 480Vac. (**80kW ÷ 2 = 40kW** ÷ 480V = 83.33A).

Final calibrator settings: 40kW, 480V, 83.33A, Power Factor = 1.

Connect DC voltmeter to 1a & 2a. (0-10Vdc F.S. output).

Example model is "self powered". No connections to terminals 11 & 12.

Apply 480V input to terminals 3(6) & 4(5) as shown in Fig. 6 (from calibrator).

No current supplied from calibrator yet. (DC voltmeter = 00.000Vdc).

Let unit warm up for approximately 5 minutes.

Switch ON calibrator power for input volts and current (DC voltmeter = 10Vdc).

Check linearity at 20% increments by reducing input current.

Set calibrator back to F.S., set Power Factor to 0.5Lag and 0.5Lead (DC meter = 5Vdc).

Calibrator settings: 40kW, 480V, 83.33A, Power Factor = 1.

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W-063C specified WH relay count rate = 8000 counts per hour at F.S. input.
Check counter for 133.33 counts after 1 minute. Run 5 minutes if preferred.
Accuracy is rated for ±0.5% F.S. for all tests.
If any outputs are out of tolerance then see the section that covers "**ADJUSTMENTS**".
All input power to "OFF".

NOTE ABOUT HIGH CURRENT:
In the Two-Element test example the model W-063C uses 2 current transformers that are rated for a ratio 100:5 (100 amps stepped down to 5A).
Not all wattmeter calibrators have the capability to drive 83.33A with 1 amp-turn through the CT's.
Optional: Run 5 amp-turns through the 100:5 CT's to create a new ratio of 20:5.
Calibrator current is 83.33A ÷ 5 = **16.66A**.
Divide the test watts by five 40kW ÷ 5 = **8kW**.
Calibrator settings: 8kW, 480V, 16.66A, Power Factor = 1.
W-063C test: 0-8kW = 0-10Vdc (watts) with 8000 relay counts per hour (watt-hours).
(133.33 counts per minute).

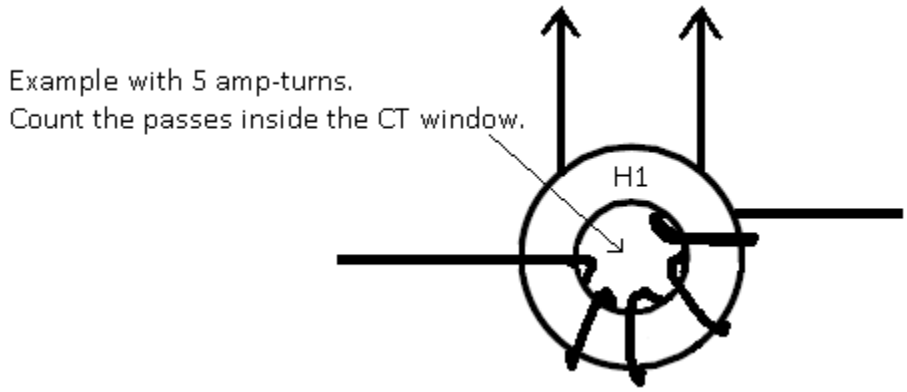


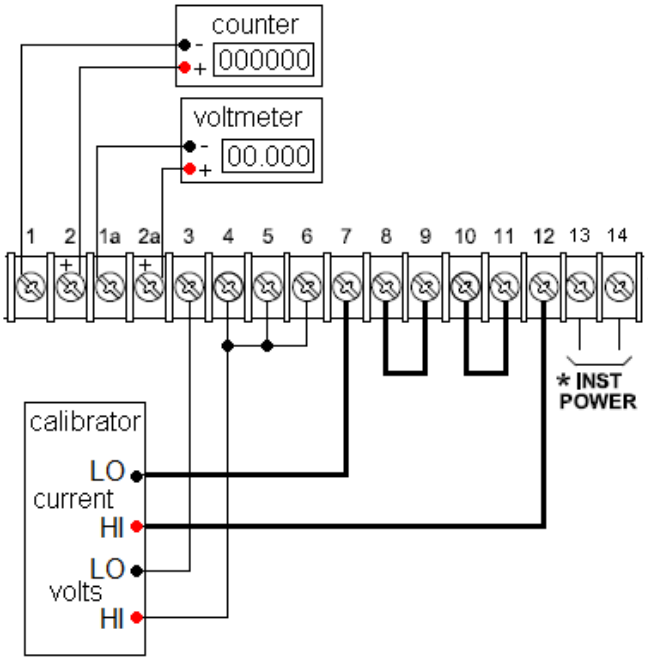
Fig. 7

Review:
Wattmeter calibrators produce a limited output current range and in the case of W- units with CT's it may be necessary to run AMP-TURNS through the primary of the CT's for maximum transducer output.

Current (test) range = CT full scale range ÷ number of amp-turns.
Watts (test) range = Calculated Calibrator F.S. watts ÷ number of amp-turns.

THREE-PHASE FOUR-WIRE (THREE ELEMENT):

USING INTERNAL SENSOR (DIRECT)



USING EXTERNAL SENSORS (CT's)

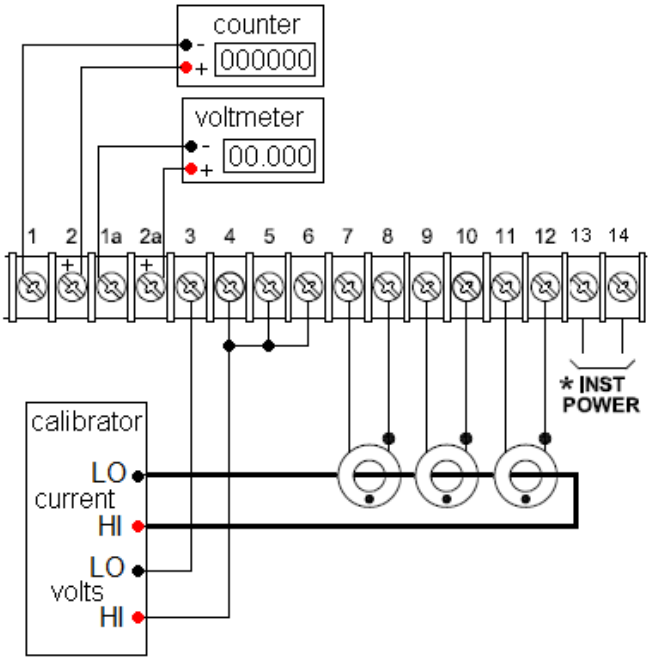


Fig. 8

Three-Element W- series transducers:

Set the wattmeter calibrator to 1/3 of the watt rating of the W- model. This is due to the fact that the wattmeter calibrator is a single-phase source that is sharing through three elements (series currents and parallel voltages). Relay counts per hour remains the same as specified.

Set calibrator for nominal voltage input EX: 120V, 240V, or 480V depending on the W- model.

To find the nominal current value, take **F.S. watts and divide by 3** and then divide by the nominal voltage. This process is best explained by showing the procedure using a random catalog W- model.

Example model: W-008B.

Rated watts = 3kW, Nominal volts = 240Vac. (**3kW ÷ 3 = 1kW** ÷ 240V = 4.166A).

Final calibrator settings: 1kW, 240V, 4.166A, Power Factor = 1.

Attach 1kΩ resistor to output terminals 1a & 2a. Connect DC voltmeter to 1a & 2a.

(0-1mAdc through 1kΩ = 0Vdc to 1Vdc F.S. at voltmeter).

Apply 120Vac "external power" to terminals 13 & 14. (DC voltmeter = 0Vdc).

Let unit warm up for approximately 5 minutes.

Switch ON calibrator power for input watts. (DC voltmeter = 1Vdc).

Check linearity at 20% increments by reducing input current.

Set calibrator back to F.S., set Power Factor to 0.5Lag and 0.5Lead (DC meter = 0.5Vdc).

Calibrator settings: 1kW, 240V, 4.166A, Power Factor = 1.

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W-008B specified WH relay count rate = 3000 counts per hour at F.S. input.
Check counter for 50 counts after 1 minute. Run 5 minutes if preferred.
Accuracy is rated for ±0.5% F.S. for all tests.
If any outputs are out of tolerance then see the section that covers "**ADJUSTMENTS**".
All input power to "OFF".

ADJUSTMENTS:

When adjustments to the watt-hour or watt output are necessary it is important to know that the watt-hour circuit must be calibrated before the watt adjustments. This requires that the unit be removed from the enclosure to access the internal adjustment potentiometers along with access to a test point (TP1) to be measured with a Universal Counter (Frequency Counter). See fig. 11.

Internal adjustments should be made with the W- unit outside of the enclosure for a minimal amount of time. The temperature compensation circuit does rely on the unit being closed up and some amount of unwanted drift may occur as the unit operates outside the enclosure.

Caution: *Care must be taken to insure that all input power is off when removing the unit from its enclosure and when reinstalling back into its enclosure after adjustments are performed.*

To remove unit from enclosure, cut any existing seal between the top lid and the enclosure housing. Remove the 4 outer Phillips-head screws.
Note: There is an arrangement of dielectric paper inside the unit. Do not discard paper.
When placing unit back into enclosure observe and prevent any internal wires from getting pinched between the lid and the enclosure.

Top pre-view of calibration potentiometer hole locations:

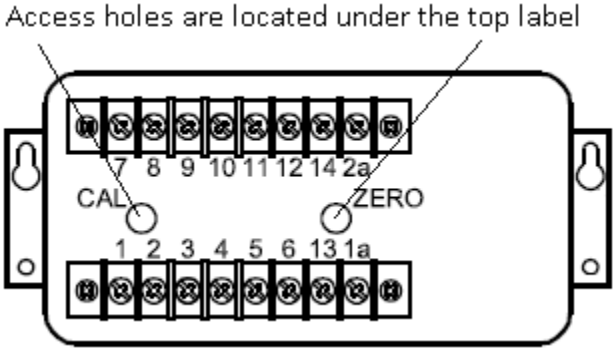

Fig. 9

Guidelines for calibration:

a) See standard specification sheet and note W- model F.S. counts per hour.

b) Determine your W- model F.S. frequency at test point 1 (TP1) based on Table in Fig. 10.

c) Verify pre-set factory internal switch setting (S1) Fig. 10.

F.S.COUNTS PER HOUR	TP1 FREQUENCY	S1 SETTINGS
100	3641 Hz	3 on
200	3641 Hz	2 on
250	4551 Hz	2 on
300	5461 Hz	2 on
400	3641 Hz	1 on
500	4551 Hz	1 on
600	5461 Hz	1 on
750	6827 Hz	1 on
800	3641 Hz	7 on 8 on
1000	4551 Hz	7 on 8 on
1200	5461 Hz	7 on 8 on
1500	6827 Hz	7 on 8 on
1600	3641 Hz	6 on 8 on
1800	4096 Hz	6 on 8 on
2000	4551 Hz	6 on 8 on

F.S. COUNTS PER HOUR	TP1 FREQUENCY	S1 SETTINGS
2400	5461 Hz	6 on 8 on
2500	5689 Hz	6 on 8 on
3000	6827 Hz	6 on 8 on
3200	3641 Hz	5 on 8 on
3600	4096 Hz	5 on 8 on
4000	4551 Hz	5 on 8 on
4500	5120 Hz	5 on 8 on
4800	5461 Hz	5 on 8 on
5000	5689 Hz	5 on 8 on
6000	6827 Hz	5 on 8 on
7500	4267 Hz	4 on 8 on
8000	4551 Hz	4 on 8 on
9000	5120 Hz	4 on 8 on
10000	5689 Hz	4 on 8 on
12000	6827 Hz	4 on 8 on

Fig. 10

d) Wattmeter Calibrator inputs wired to W- model and voltmeter connected to terminals 1A & 2A.

e) Remove unit from enclosure Fig. 11.

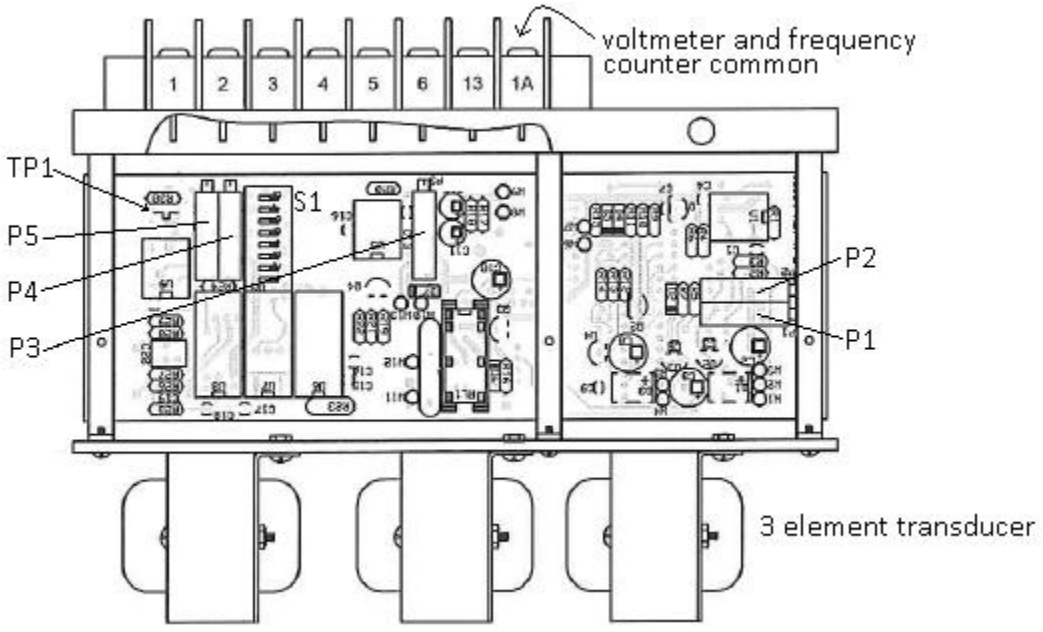

Fig. 11

f) Connect Universal Frequency counter to terminal 1A (negative) and TP1(positive).
g) Apply instrument power/calibrator power to “ON”.
h) Adjust P4 potentiometer (fine adjust) or P5 (course adjust) to the TP1 frequency listed on table in Fig. 10.
i) Apply 10% input power and observe Frequency Counter for 10% frequency.
Note: To keep the watt-hour relay from occasional triggering at no input watts, adjust the 10% frequency reading 1 or 2 Hertz below standard reading.
j) Apply F.S. Calibrator power and re-check TP1 frequency.
k) Check DC analog output at terminal 1A & 2A for F.S. volts (Voltmeter). Adjust P2 as needed.
l) Power off Calibrator input with instrument power to the W- unit only and check voltmeter for 0.000Vdc. Adjust P1 as needed.
m) Repeat F.S. input if the watts output zero needed adjusted significantly.

BALANCE ELEMENTS:

2 element and 3 element transducers include balance potentiometers that provide equal summation values from each of the elements before entering the watt and watt-hour portion of the circuit. These are factory adjusted at original calibration and should not need consideration especially if the total calibration of the unit is not far out of tolerance.
All F.S. calibrator settings remain the same.

Balance 2 element W- models:

All voltage and current “OFF”. Reverse current input at terminals 9 & 10.
Instrument power/input power “ON”.
Adjust balance potentiometer to show zero output on voltmeter (terminals 1A & 2A).

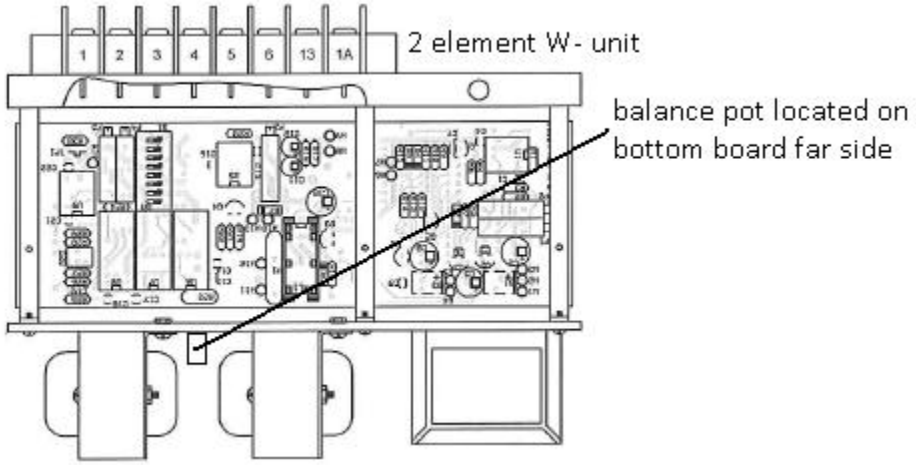

Fig. 12

Note: If significant adjustment is made with the balancing then it is necessary to recalibrate full scale values. Remember to power “off” and re-wire current.

Balance 3 element W- models:

All voltage and current “OFF”. Reverse current input at terminals 9 & 10.
Remove current input from terminals 11 & 12.
Instrument power/input power “ON”.
Adjust balance potentiometer (element 2) to show zero output on voltmeter (terminals 1A & 2A).

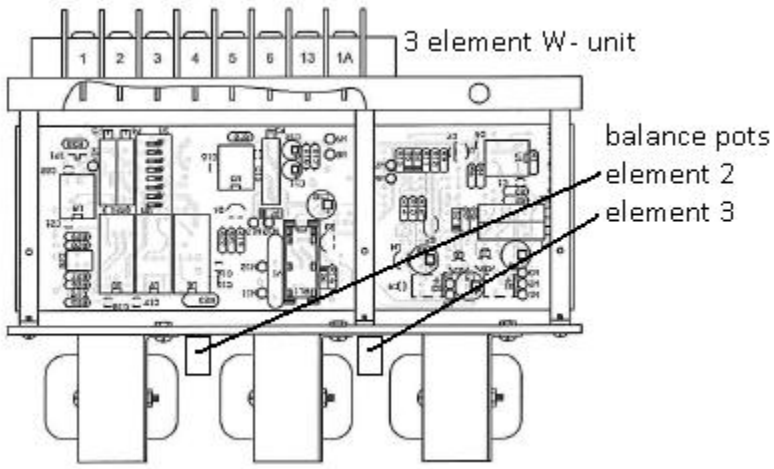

Fig. 13

All voltage and current “OFF”. Reverse current input at terminals 11 & 12.
Remove current input from terminals 9 & 10.
Instrument power/input power “ON”.
Adjust balance potentiometer (element 3) to show zero output on voltmeter (terminals 1A & 2A).
Note: If significant adjustment is made with the balancing then it is necessary to recalibrate full scale values. Remember to power “off” and re-wire current.

Note: 2.5 element models are not covered in this manual.

Worksheet:

Model W-_____ Number of elements_____ Full Scale input watts_____
Nominal input voltage_____ Nominal input current_____
External Instrument Power (B, D, X5, E models only)_____ Watt Output type_____
Watt-Hour Output type_____Full Scale Counts Per Hour_____
TP1 Frequency_____ S1 Settings_____

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