I N S T R U C T I O N   B O O K

F O R

M O D E L S   6 0 8 0 A / 8 1 A

R F   C A L O R I M E T E R

Bird Electronic Corporation

30303 Aurora Road, Cleveland, Ohio 44139-2794

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All products manufactured by Seller are warranted to be free from defects in material and workmanship for a period of one (1) year, unless otherwise specified, from date of shipment and to conform to applicable specifications, drawings, blueprints and/or samples. Seller's sole obligation under these warranties shall be to issue credit, repair or replace any item or part thereof which is proved to be other than as warranted; no allowance shall be made for any labor charges of Buyer for replacement of parts, adjustment or repairs, or any other work, unless such charges are authorized in advance by Seller.

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MODELS COVERED IN THIS INSTRUCTION BOOK

6080A
6081A

SAFETY PRECAUTIONS

The following are general safety precautions that are not necessarily related to any specific part or procedure and do not necessarily appear elsewhere in this publication.

Keep away from live circuits.

Operating personnel must at all times observe normal safety regulations. Do not attempt to replace parts or disconnect an RF transmission or any other high voltage line while power is applied. When working with high voltage always have someone present who is capable of rendering aid if necessary. Personnel working with or near high voltage should be familiar with modern methods of resuscitation.

The following will appear in the text of this publication and is shown here for emphasis.

```
**********************************************************
*                      W A R N I N G                     *
*                                                        *
* The following sections of this procedure involve the   *
* application of high power to the load.  The following  *
* precautions must be observed to insure operator safety *
* as severe burn or possibly death may result.           *
*                                                        *
* 1.  Make sure that the coaxial power cable connector   *
* is securely fastened to the load and that the water    *
* is flowing before turning on the ac power source.      *
*                                                        *
* 2.  Ensure that all Y.E.W. meter connections are tight *
* before turning on ac power.                            *
*                                                        *
* 3.  High voltage is present at the terminals of the    *
* Y.E.W. meters when the ac power source is on.  Keep    *
* clear of these terminals.                              *
*                                                        *
* 4.  Completely shut down the ac power source before    *
* changing the Y.E.W. meter connections, turning off the *
* water or removing the power cable from the load input  *
* connector.                                             *
**********************************************************
```

Continued

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**********************************************************
*                    W A R N I N G                       *
*                                                        *
* The potential of electrical shock exists.  Operator    *
* must use caution when performing internal testing or   *
* making adjustments to avoid bodily contact with        *
* potentials.                                            *
**********************************************************

**********************************************************
*                    C A U T I O N                       *
*                                                        *
* Do not apply RF power greater than maximum power level *
* of Load.                                               *
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INTRODUCTION

PURPOSE AND FUNCTION

The Model 6080A/81A dual-range RF Calorimeters are a unique innovation by Bird Electronic Corporation in calorimetric measurement. The need for interpolation of the flow rates, temperature differences, and system constants by the user has been eliminated. The power is directly displayed in kilowatts on a digital meter. Measurement has a ±3% of reading accuracy and is not frequency dependent, as it measures energy transferred into a water medium. The calorimeter is ideal for use as a standard for other wattmeters.

Calibration is performed by one simple adjustment before the power is applied (see Section III - Operating Instructions). Although it was designed for Bird TERMALINE® water cooled loads, it is also applicable to any other water cooled device where power measurements in kilowatts is desired, within the rating of the digital RF calorimeter.

Lightweight and versatile, the calorimeter can be moved within a ten foot radius of the sensor's junction box. Combining this with a bright digital display permits easy-to-read power measurements.

DESCRIPTION

The RF calorimeter is comprised of two main sections: one section consists of sensors and sensor junction box, and the other the control unit. These two sections are connected by ten feet of sensor cable (see Figure 1-1).

Two temperature sensors are used for sensing the temperature difference, and one sensor for monitoring the flow rate. Twenty-two inches of cable connect each of the two temperature sensors and 18 inches of cable connect the flow transducer to the junction box. The temperature sensor units are replaceable.

The control unit is the synthesizer of the system. This consists of all the electronic circuitry needed to process the sensor data into a digitally displayed power measurement. It is enclosed in a rugged structural type aluminum housing that protects the unit from RFI.

SPECIFICATIONS FOR 6080A/81A RF CALORIMETERS

Power Range**	
LOW Range	1-10kW
HI Range	10-80kW
Accuracy	±3% of indicated power
Water Flow	
LOW Power	3-5.25 GPM (11.4 to 20 LPM)
HI Power	6-10.5 GPM (23 to 40 LPM)
Water Input - Output T	
Minimum	1°C (1.8°F)
Maximum	
LOW Power	10°C (18°F)
HI Power	40°C (72°F)
Stabilization Time	5 minutes minimum
Water Purity	Any potable water
Dimensions	
Model 6080A	10-5/16"L x 10-1/8"W x 4-3/64"H (262 x 257 x 102.8mm)
Model 6081A	10-5/16"L x 19"W x 5-7/32"H (262 x 482.6 x 132.6mm)
Weight	
Calorimeter	9 lbs., 4 oz. (4.20 kg)
Control Unit	6 lbs., 2 oz. (2.78 kg)

Flow Indicator: Before power is applied to the calorimeter, make sure that the indicator is registering flow.

Calibration Position: When CAL button is depressed, meter will indicate if T is within the proper indicating range (1.00-10.00 for low range). This will be the value of digital display after stabilization time and insures maximum accuracy of the instrument.

NOTE: AC power requirement for calorimeter is 115V/230Vac, 50/60Hz, 1 Amp. Also available in Model 6081A rack mount version.

** Although the 6080A/81A Calorimeter is capable of power measurement up to 80kW, its capabilities will be limited by the maximum power rating of the RF load supplied or used with the system.

SECTION I - INSTALLATION

1-1. GENERAL

1-2. The purpose of this section is to assist the user with the initial steps that should be performed when receiving and preparing the RF Calorimeter for service. Refer to Figure 1-1 throughout this section.

1-3. UNPACKING

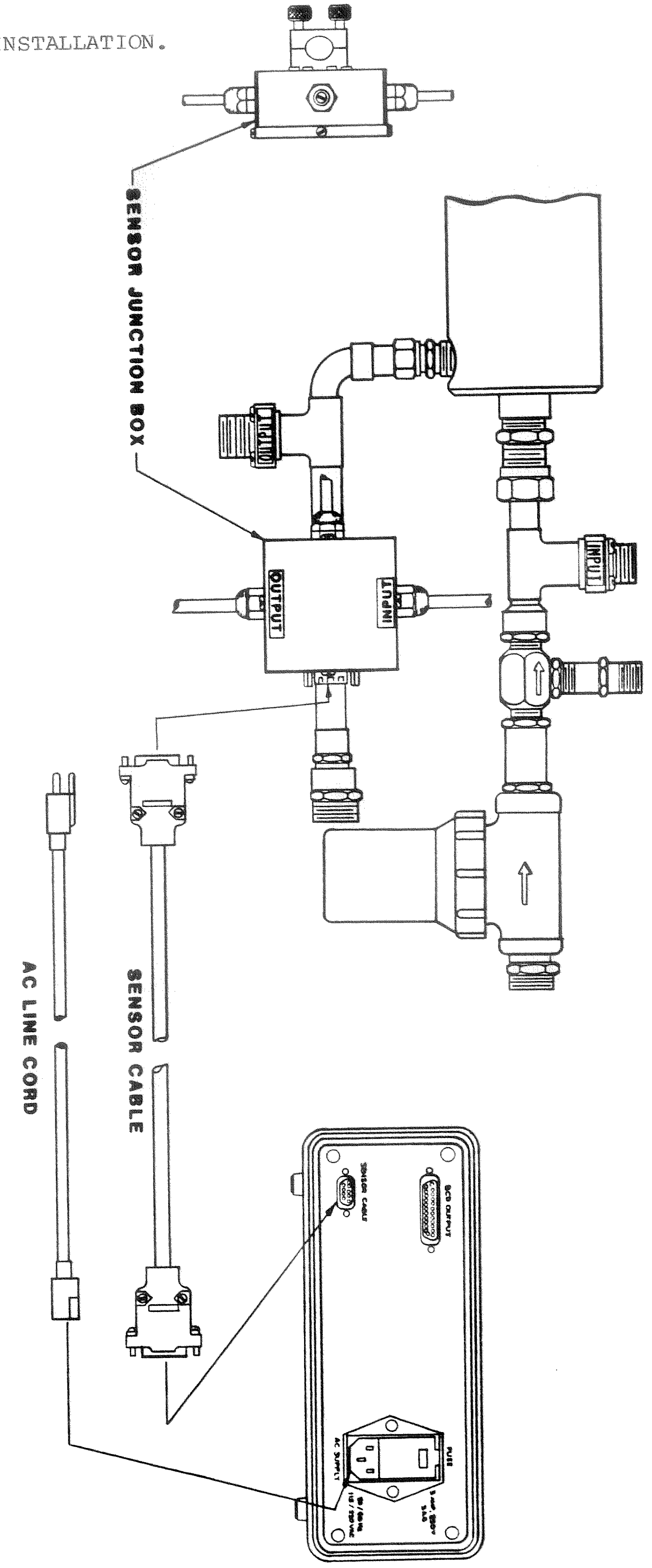
1-4. The Model 6080A/81A Control Unit and sensor assemblies are shipped in separate containers. Included in these containers are:

- 1 6080A/81A Control Unit
- 1 Input Sensor Assembly
- 1 Output Sensor Assembly
- 1 Sensor Junction Box
- 1 AC Line cord
- 1 Sensor Cable
- 1 Instruction Manual

1-5. INITIAL INSPECTION

1-6. All packages are carefully wrapped and inspected by Bird prior to shipment. If the package shows any sign of damage, open and inspect the contents. If any damage is visible, notify the carrier immediately. Retain the shipping container for inspection.

FIGURE 1-1. INSTALLATION.



1-7. <u>CONNECTIONS TO LOAD</u>

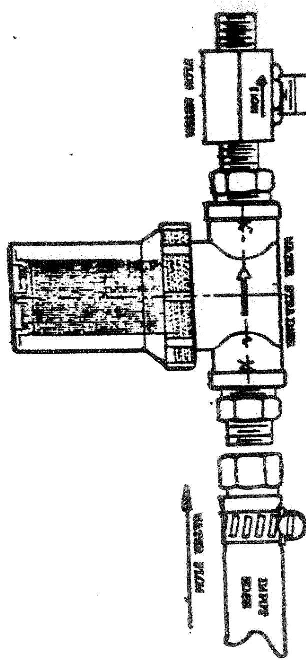
1-8. The Model 6080A/81A Calorimeter is designed for direct attachment to Bird Electronic Series 8700 water cooled loads. A digital panel meter is housed in the calorimeter which connects to a sensor junction box through a ten foot cable. The sensor assemblies, comprised of two plumbing units containing the sensors, attach to the load as shown in Figure 1-1. The input temperature sensor, flow transducer, and water strainer are assembled in one unit that attaches to the center water input of the load. The output temperature sensor is contained in a plumbing unit which attaches to the output on the circumference of the load. In normal assembly, the hose fittings will be removed from the half inch NPT nipples on the load and attached to the opposite ends of the sensor assembly units. These sensor assemblies may also be attached to any other load or system having 1/2 inch threads.

1-9. <u>MOUNTING SENSOR BOX</u>

1-10. The sensor box mounts on the output pipe with a special saddle clamp. The clamp is secured with two 10-32 specially designed thumbscrews. Mount the sensor box to the output pipe in the direction shown in Figure 1-1, with flow sensor lead entering at back. The control unit attaches to the sensor box with an ten foot cable. The control unit can be mounted or remain portable and be stored away in a suitable place when not in use.

1-11. Water supply and drain connections will normally be attached with garden hose having standard 3/4 inch hose fittings. Be sure the water strainer, P/N 5-1648, is in place. Fasten the water supply connector directly to the input of the strainer as shown in Figure 1-2. The strainer prevents entry of particles that might damage the flow meter.

FIGURE 1-2. STRAINER PLACEMENT.



1-12. For maximum accuracy of the readings, it is important that the flow source and flow rate be stable.

1-13. MODEL 6081A MOUNTING

1-14. Unlike the Model 6080A, which is a portable unit and designed to stand free on any vibration-free flat surface, the Model 6081A is designed exclusively for rack panel mounting. This unit may be mounted in any standard 19 inch panel rack and secured with suitable fasteners through the four 1/4 inch slots provided. Sensor cables, longer than the standard ten foot supplied, may be obtained on special order to facilitate remote mounting from the sensor junction box.

1-15. AC LINE CONNECTION

1-16. Model 6080A Calorimeter contains an ac line module located on the rear panel for input of ac power. This module is voltage selectable between 115 Vac or 230 Vac and contains the ac line fuse. The following steps explain voltage selectability and fuse accessibility.

Step 1: Determine the voltage level of the ac line. This may be 115/230 Vac.

Step 2: Compare this voltage level with the number that appears in the ac line select window.

Step 3: The control unit is factory-shipped for 115 Vac operation. Change to 230 Vac, if necessary, by opening cover door and removing voltage selector drum. See Figure 1-3.

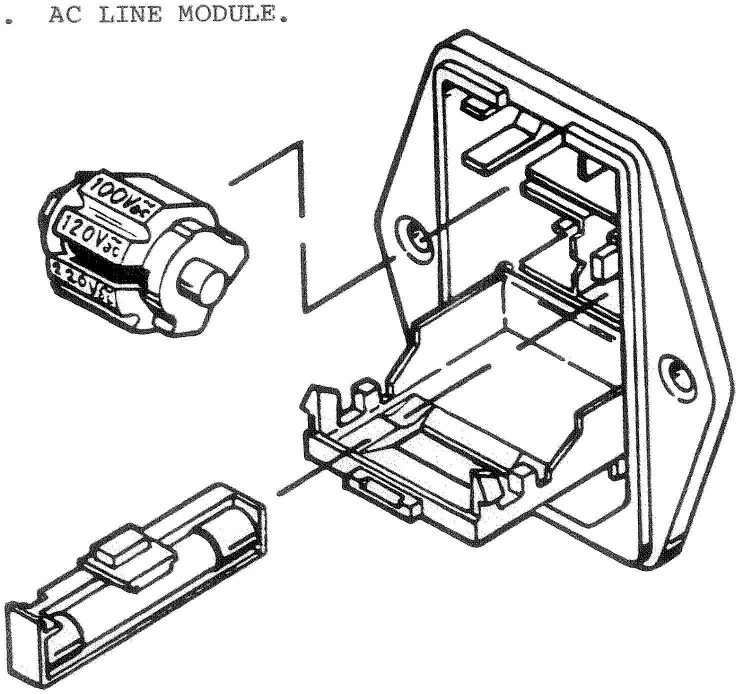
Step 4: Rotate voltage selector drum to desired voltage and reinsert.

Step 5: AC line fuse is also accessible by pulling out fuse drawer.

Step 6: Close cover door.

Step 7: Locate the ac cord. Plug one end at the control unit's ac line module and the other end at the line socket. (Refer to Paragraph 1-17 when connecting to European style sockets.)

FIGURE 1-3. AC LINE MODULE.



1-17. EUROPEAN STYLE CONNECTORS

1-18. In order to make the ac line cord compatible with European style sockets, users must replace the connector at the end of the power cord. Then set the operating voltage selection drum for 230 Vac. If a three wire system is not used, the third wire (coded green) must be connected to a suitable earth ground.

1-19. 6080A CALORIMETER INSTALLATION

1-20. Locate the control unit on a clean flat surface within the radius of the sensor cable. For longer distance remote monitoring, various length sensor cables are available. See Section VII Replacement Parts.

With ac line already connected, the control unit requires only one other connection, the sensor cable. Connect the sensor cable to the control unit as follows:

Step 1: A 9-pin D-shell sensor cable connector is located on the rear panel of the control unit. Correctly align the sensor cable with the sensor cable connector and mate the two parts. (The design does not permit incorrect connection.)

Step 2: Secure the provided screws, but do not overtighten them.

SECTION II - THEORY OF OPERATION

2-1. THEORY OF CALORIMETRY

2-2. The term calorimetry refers to the measurement of quantities of heat. Heat is energy in transition resulting from a temperature differential. This energy in transition may be expressed in ft-lb/h, Btu/min or cal/sec.

2-3. The "First Law" of thermodynamics states that energy can neither be created nor destroyed, but only converted from one form to another. This is the basic concept behind the calorimetric method of measurement. A basic definition should be noted: if a quantity of heat is transferred into one gram of water until the temperature of the water is increased one degree centigrade, it would be called one gram-calorie, more commonly referred to as one calorie. In the English system, if one pound of water will increase its temperature one Fahrenheit degree, one Btu of heat has been transferred into it.

Equation 1.

$$1 \text{ Btu} = 1 \text{ lb.} \times 1^{\circ}\text{F}$$
$$1 \text{ Calorie} = 1 \text{ gram} \times 1^{\circ}\text{C}$$

The relationship of grams to pounds and °C to °F is such that it makes one Btu equal to 251.996 calories.

2-4. Another factor in calorimetric measurement should also be taken into consideration: the specific heat of a substance. It has been proven that different substances having a weight of one pound will require different amounts of energy to increase their temperature one degree Fahrenheit. To compensate for this behavior of different materials, including water, a conversion factor was assigned called specific heat. The units for specific heat are Btu/lb°F. By applying this correction factor to Equation 1, the calorimetric formula for heat thus becomes:

Equation 2.

$$1 \text{ Btu} = 1 \text{ lb.} \times 1^{\circ}\text{F} \times 1 \text{ Btu/lb}^{\circ}\text{F}$$
$$\text{heat} = \text{mass} \times \quad T \times Cp$$

Since 1 Btu of heat is equal to 778.16 ft-lbs. of work, and the time rate of doing work is power, ft-lb/h or Btu/h could be a description of electrical watts or mechanical ft-lb power. Thus, when the time element is introduced into Equation 2, it simply becomes:

Equation 3.

$$\text{Btu/h} = \text{mass (lb/h)} \times \quad T(^{\circ}\text{F}) \times Cp \text{ (Btu/lb}^{\circ}\text{F)}$$

This is the equation of calorimetry. Knowledge of delta T, rate of mass flow, and specific heat would produce Btu/h, equal to power.

2-5. DIGITAL RF CALORIMETER

2-6. Calorimetry as applied to this series calorimeter is essentially the same as described in the preceding paragraphs. The availability of RF loads, such as the Bird Electronic 8700 Series TERMALINE® Load Resistor, with almost 100% transfer of RF power into a cooling liquid, in this case water, has made possible such an arrangement that the elementary calorimetric formula can be utilized.

Equation 4.

$$\text{RF Power} = \text{flow} \times \quad T \times \text{constant} \times C_p$$

The electronic calorimeter synthesizes the flow rate, temperature differential, and conversion factor, displaying the final result in kilowatts on a digital readout.

2-7. To determine the temperature it is necessary to linearly track temperatures between 0°C and 50°C. This is accomplished through electronic thermometers that produce a voltage output as a direct function of temperature in °C. The temperature difference is found by placing an electronic thermometer at the load water input and also at the load drain. Their voltage outputs are fed into a differential amplifier and the resulting output will be the temperature difference.

2-8. Flow rate is measured by a magnetic sensor which is located at the water input of the load. This metering device utilizes a turbine rotor to generate a pulse output. These pulses are then fed into a frequency-to-voltage converter that produces a gallon per minute voltage output. By adjusting the output gain to the systems constant we implement our conversion factor. To synthesize these system variables, an analog multiplier is used. The X input of the multiplier is used for flow rate and the Y input is for temperature difference. By applying the output of the multiplier to a digital panel meter, (DPM) the voltage measured will be the power consumption in kilowatts.

3-1. GENERAL

3-2. This section describes the operation of the Model 6080A/81A Calorimeter. Operator is given a description of front and rear panel features and is guided through a step by step format of how to take measurements. Calorimeter is installed per installation procedures (see Section I - Installation).

3-3. FRONT PANEL LAYOUT

3-4. The following is a description of front panel features (see Figure 3-1).

1. ON/OFF Switch - Controls ac line power

2. FLOW INDICATOR - Gives visual indication of coolant flow in gallons per minutes (GPM). The flow indicator has two ranges, a low power range which indicates a flow of 3 to 5.25 GPM and a high power range which indicates a flow of 6 to 10.5 GPM. These ranges are selectable through the use of the HI/LOW pushbutton.

3. DISPLAY - Gives a visual indication of the present value being measured. This value represents kilowatts of RF power being seen by the load.

4. RF POWER/CAL SWITCH - When not depressed, RF power mode is selected. This mode is implemented during normal operating conditions and is used in conjunction with the HI/LOW range button.

When the button is depressed, CAL mode is selected. Unit is now ready to perform initial system calibration.

5. HI/LOW SWITCH - With unit in RF power mode this button will select between High or Low power and flow ranges. In LOW mode the usable power range is 1 to 10kW and flow range is 3 to 5.25 GPM. In HI power mode the upper power limit is determined by the RF load used. The HI range of the flow sensor is 6 to 10.5 GPM.

With unit in CAL mode the HI/LOW button allows operator to perform initial calibration for both ranges.

6. CAL ADJUST - This is the adjustment potentiometer for nulling power ranges when unit is in CAL mode.

3-5. REAR PANEL LAYOUT

3-6. The following is a description of rear panel features (see Figure 3-2).

a. AC LINE MODULE - The ac line module provides a three function capability:

1. Contains the ac line socket for input of ac power.
2. Provides line voltage selection 115/230 volts.
3. Contains internally, an ac line fuse.

Location of fuse and instructions on line voltage selection are detailed in Section 1-15.

b. SENSOR CABLE - This 9-pin D-shell connector supplies the mating contacts for the sensor cable. Input/Output data passes to and from the control unit via this connector. Pin assignments for this connector are given below:

Pin No.	Function
1	Flow Frequency
2	Sensor Supply Voltage (+15V)
3	Input Voltage Reference (+5V)
4	Input Voltage Ratio
5	Input Temperature Voltage
6	Signal Ground
7	Output Voltage Reference (+5V)
8	Output Voltage Ratio
9	Output Temperature Voltage

c. BCD OUTPUT - This 25-pin D-shell connector supplies a BCD output for remote use. Various applications for this output are described in Section VIII. Pin assignments for this connector are given below:

Pin No.	Function	Pin No.	Function
1	BCD 100	14	BCD Ground
2	BCD 200	15	Hold
3	BCD 400	16	NC
4	BCD 800	17	BCD 1000
5	NC	18	+5V
6	BCD 10	19	OE3 (Tens)
7	BCD 20	20	OE2 (Hundreds)
8	BCD 40	21	OE4 (Units + Overrange)
9	BCD 80	22	OE1 (Thousand + Polarity)
10	BCD 1	23	Overrange
11	BCD 2	24	Polarity
12	BCD 4	25	Data Valid
13	BCD 8		

3-7. START UP

3-8. Before applying ac line power to control unit make certain that ac line module is matched to the available line voltage and all safety precautions are taken.

3-9. Perform the following steps to achieve a proper start up condition:

a. Turn on ac power to calorimeter.

b. Turn on the cooling water to the load. Adjust the flow rate to approximately 3 GPM for low range operation and approximately 7 GPM or higher, determined by the RF load being used, for high range operation. Allow coolant flow to stabilize for a maximum of five minutes.

c. Set RF POWER/CAL switch to CAL mode.

d. Perform an initial calibration on both the HI and LOW power ranges by first selecting the HI range and adjusting the CAL adjustment for a display indication of zero. Now select the LOW range and adjust the CAL adjustment for zero. NEVER CALIBRATE UNIT WITH RF POWER APPLIED.

e. Return RF POWER/CAL switch to RF power mode.

f. If display still doesn't indicate zero a fine adjustment can be made to the CAl adjustment while in RF power mode.

NOTE: If null setting could not be achieved then see maintenance section.

3-10. Series 6080A/81A RF Calorimeter is now ready for normal operation.

3-11. NORMAL OPERATION

```
***********************************************************
*                       C A U T I O N                     *
*                                                         *
* Do not apply RF power greater than maximum power level  *
* of load.                                                *
***********************************************************
```

3-12. With the Model 6080A/81A Calorimeter set in RF power mode, select HI or LOW power range. RF power measurements can now be made.

3-13. Apply RF power. The display will indicate RF power being measured in kilowatts. Wait a minimum of five minutes for the unit to stabilize before taking readings.

3-14. SHUTDOWN

3-15. The following steps apply to 6080A/81A system shutdown:

a. Turn off transmitter power.

b. Allow water to flow for several minutes to cool the load or until the display of the calorimeter indicates zero.

c. Turn off Model 6080A/81A and stop water flow.

3-16. PERFORMANCE NOTE

3-17. We suggest that after a period of about one-half year to one year's usage the 6080A unit be returned to the factory for a power accuracy check.

FIGURE 3-1. FRONT PANEL LAYOUT.

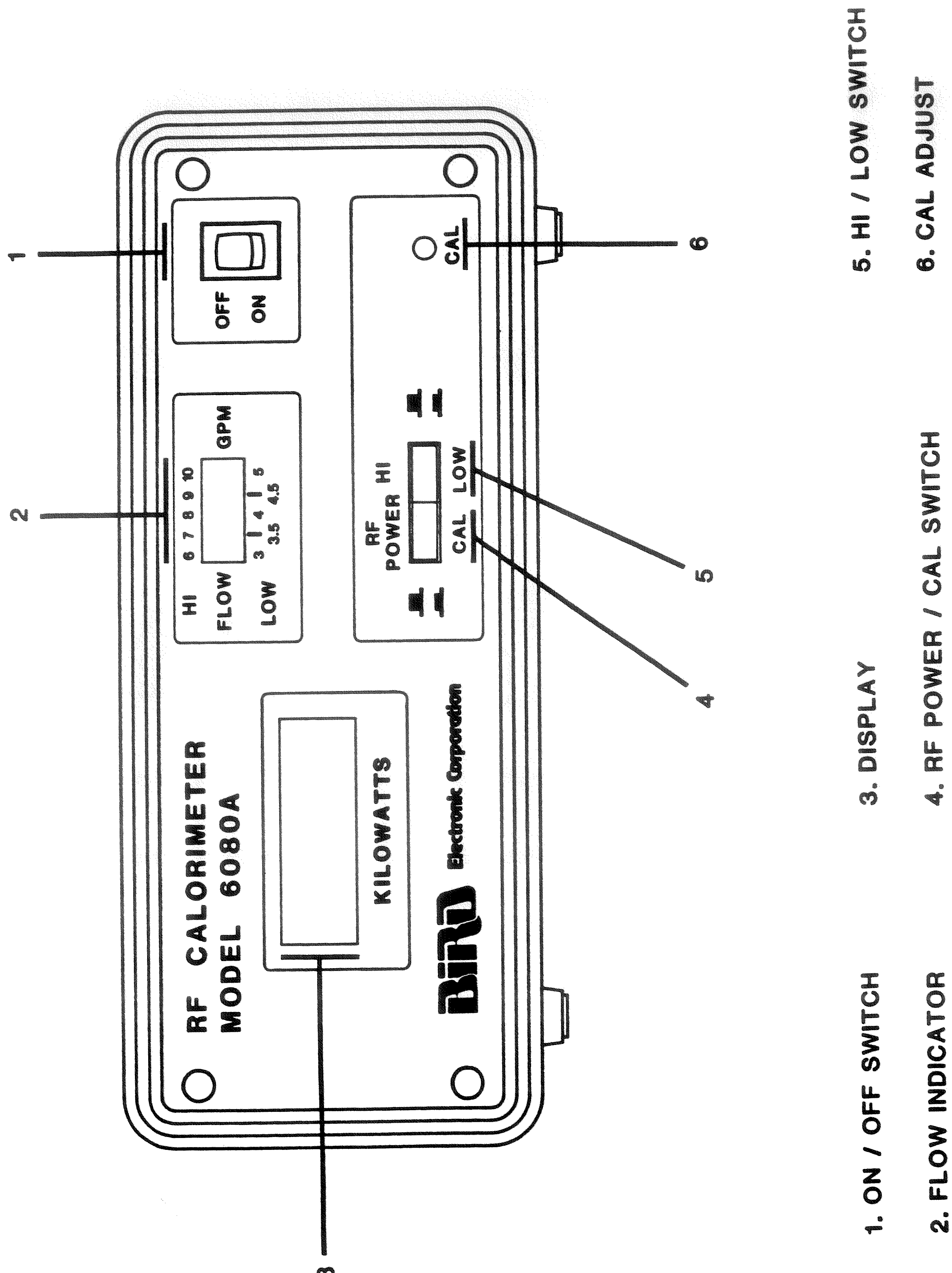
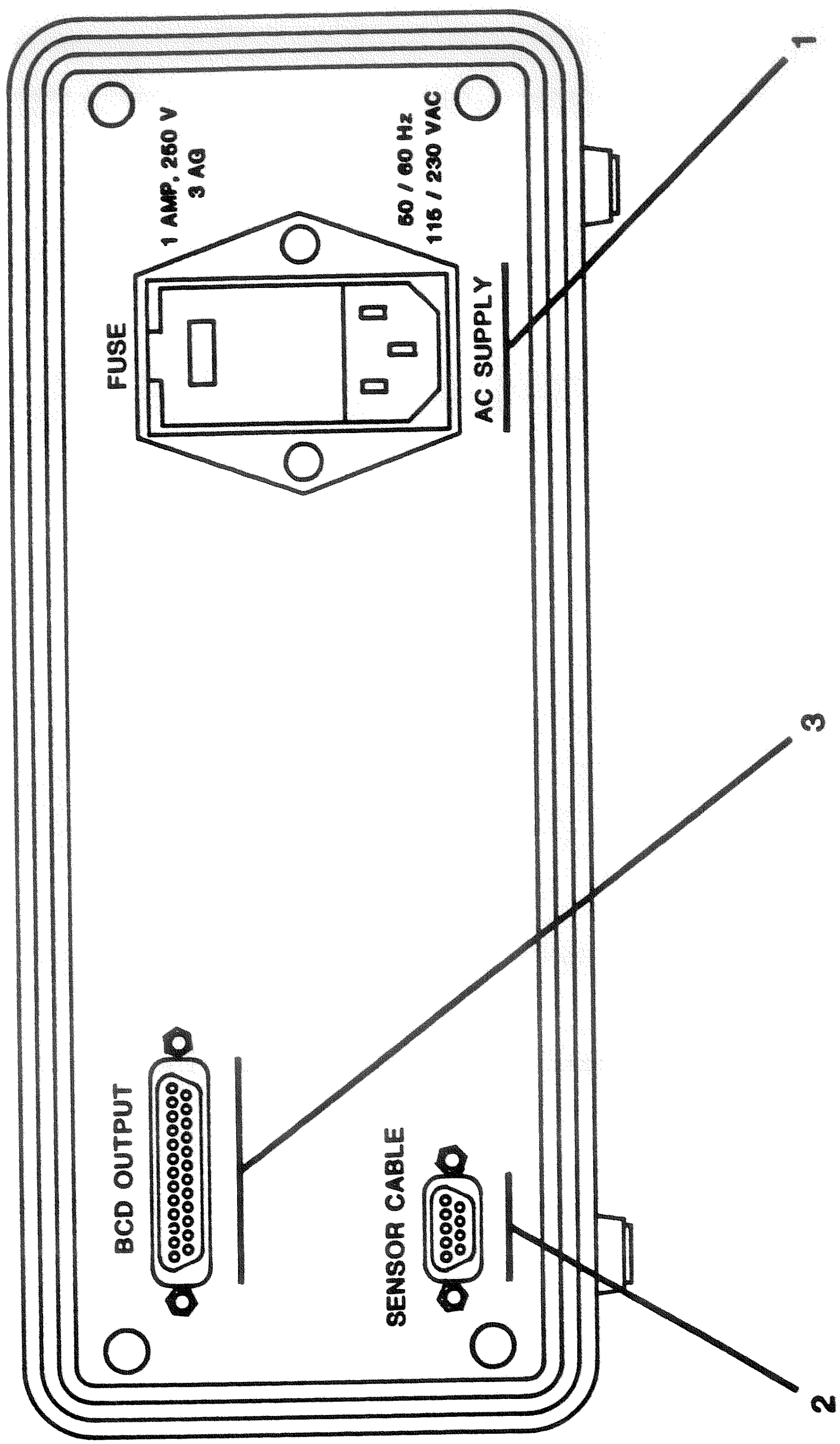


FIGURE 3-2. REAR PANEL LAYOUT.



1. AC LINE SENSOR
2. SENSOR CABLE CONNECTOR
3. BCD OUTPUT CONNECTOR

SECTION IV - MAINTENANCE

4-1. GENERAL

4-2. Only a moderate amount of preventive maintenance is required for the Model 6080A/81A RF Calorimeter. Use reasonable care in handling; do not drop the control unit or electronic sensor assemblies.

4-3. PREVENTIVE MAINTENANCE

Following the routine below will ensure years of failure-free operation.

a. CLEANING

1. A main factor in effective preventive maintenance is cleanliness. For optimum performance and service life the 6080A must be kept in a clean and dust-free condition. When not in use keep the main control unit in a clean, cool environment. The sensor cable connectors must be kept clean. Carefully wipe the metallic contacts and connector bodies. Using a cotton swab stick is helpful. The operating panel should be wiped clean with a soft cloth. Clean the DPM and flow meter face only when necessary.

b. INSPECTION

Periodic inspection should be performed at three to six-month intervals dependent on amount of continuous use.

1. Connections - Inspect all interconnections to sensors and control unit for bent, broken, and missing pins.

c. ROUTINE SERVICE CHECKS

1. The coolant strainer is used to trap any small particles that may hinder the operation of the flow meter or load. This strainer is subject to occasional cleaning or element replacement. If the unit is heavily used the strainer should be checked and cleaned about once a month. This interval may be extended if experience shows that only a small amount of residue is found in the sediment bowl. For cleaning or replacement of strainer see Paragraph 5-5.

SECTION V - TROUBLESHOOTING AND REPAIR

5-1. GENERAL

5-2. Due to its electronic complexity, repair of 6080A/81A Series RF Calorimeter systems is recommended only for certain malfunctions. Table 5-1 contains a list of problems that are commonly experienced with their probable cause and remedy.

Table 5-1. Troubleshooting Chart

CONTROL UNIT

PROBLEM	POSSIBLE CAUSE	REMEDY
Panel meter does not illuminate	Power cord not connected, ON/OFF switch is in OFF position	Check power cord connection. Turn switch on.
AC applied but panel meter not illuminated	Defective fuse	Check fuse.
	Defective ON/OFF switch	Check switch.
	Loose or disconnected wires	Check connections at headers J3 and J5.
	Improper supply voltage	Check the voltage at screw terminal No. 8, located on the lower card of the panel meter. Check connections at screw terminals and check voltage. Should be approximately 5V. If voltage is not present replace PC board.
	Defective meter	Replace meter.

RF CALORIMETER SYSTEM

Refer to Figure 5-1 for location of header J1. J1 will be used as a test header throughout the remainder of the troubleshooting procedures. Figure 5-3 gives the pin functions for header J1.

PROBLEM	POSSIBLE CAUSE	REMEDY
Flow indicator inoperative	Poor cable connection	Check cable connection at sensor junction box and control unit.
	Loose or disconnected wires	Check connection of J1 on flow indicator PC board.

Continued

PROBLEM	POSSIBLE CAUSE	REMEDY
	Faulty flowmeter	Check frequency at pin 8 of header J1. If frequency is not approximately 300Hz at 3GPM and the reading is erratic, then proceed to replace flowmeter.
	Flow circuit defective	Check the voltage at pin 10 and frequency at pin 8 of header J1. The voltage should be approximately 1V and the frequency approximately 300Hz at 3GPM. If these readings are not present proceed to replace PC board.
	Faulty indicator	If all of the above corrections have already been tried, proceed to replace flow indicator PC board.
Display will not zero	Poor cable connection	Check cable connection at sensor junction box and control unit.
	Sensor cable disconnected	Check sensor cable connection at temperature sensors.
	Temperature sensors out of adjustment	Realign temperature sensors. See Paragraph 5-7.
	Input temperature sensor defective	Check the voltage at pin 3 of header J1. If the voltage is not approximately 625mV, replace sensor. See Paragraph 5-9.
	Output temperature sensor defective	Check voltage at pin 12 of header J1. If the voltage is not approximately 625mV, replace sensor. See Paragraph 5-9.

Continued

PROBLEM	POSSIBLE CAUSE	REMEDY
	Temperature sensor circuit defective	Check voltage at pins 4 and 11. They should be the same, approximately 240mV. At 24°C ambient temperature if the voltage levels of the two pins are different and the above corrections have already been tried, proceed to replace PC board.

5-3. SYSTEM REPAIR/REPLACEMENT

5-4. The Series 6080A/81A RF Calorimeters are especially designed for independent, long term, trouble-free operation. Regular mechanical maintenance procedures, other than routine checks and cleaning care described just previously, are not required. In case of malfunction of the unit or replacement of a component, the entire equipment may be returned to the factory. This applies especially to any calorimeter still under the one year warranty. Consult with the factory. Note - Do not tamper with operational settings or do other unauthorized maintenance work during the first year; it could be cause to void the warranty. Replacement of components that might be needed are given in this section:

a. Coolant strainer cleaning or replacement.
b. Temperature sensor replacement
c. Flowmeter replacement

5-5. COOLANT STRAINER CLEANING OR REPLACEMENT

5-6. To clean or replace the screen of the coolant strainer follow the steps below:

a. Disconnect water supply and drain the unit.

b. The sediment bowl has a standard right-handed thread. Grasp the sediment bowl in your hand and remove it by unscrewing it in a counterclockwise direction.

c. When removing the sediment bowl, the filter screen may remain in the strainer body. Remove it for cleaning as well. Rinse the sediment bowl and filter screen under clean running water. If the stainless steel screen should become disfigured or blocked beyond cleaning, it should be replaced.

d. Reassemble the strainer by reversing the above procedures. Position the filter screen in the strainer bowl and be sure the green gasket is properly positioned in place before reassembly.

5-7. TEMPERATURE SENSOR REALIGNMENT

5-8. Each temperature sensor will have a voltage output of 10mV/°C. The sensors should read within 1mV of each other after temperature stabilizes. If sensors are out of calibration, the following procedure for realignment must be performed:

a. Circulate water through the system for at least five minutes or until sensors stabilize. Measure temperature of circulating water and voltage output (pins 4 and 11 of header J1, Figure 6-5) of both sensors. The sensor outputs should read within 1mV, at Header. This output voltage is determined by the water temperature in °C.

Example: Water temperature is 5.5°C.
Output voltage of each sensor then will be adjusted to 10mV x 5.5 = 55mV.

b. To adjust the output voltage, adjust 25K ohm potentiometer(R1 or R2) until proper settings are reached.

5-9. TEMPERATURE SENSOR REPLACEMENT DISASSEMBLY

a. Disconnect the hoses from the water supply and drain unit before disassembly.

b. Unscrew connector collar and detach connector from sensor body.

c. Unscrew sensor in a counterclockwise direction to remove. Be careful not to lose the sealing O-ring.

5-10. TEMPERATURE SENSOR REASSEMBLY

5-11. If the same sensor is to be replaced, clean the sensor of any scales or deposits that may have accumulated on sensor probe. If a new sensor is used a complete calibration is now required (see Section VI).

5-12. Replace the sensor by reversing the procedure in paragraph 5-9. Reconnect the hoses to the unit's plumbing connections and turn on the water supply.

5-13. FLOW SENSOR

5-14. The magnetic flow sensor is a very important but intricate part of the calorimetric system. It is vulnerable to particles such as hairs or scales in the coolant system and therefore is subject to occasional failure. If the flowmeter on the front panel of the control unit registers lower than normal, or if the digital power readings seem incorrect, the flow sensor may need servicing.

5-15. FLOWMETER REPLACEMENT

a. Disconnect water supply and drain the unit.

b. The coolant strainer assembly can be removed from the flowmeter by turning in a counterclockwise direction.

c. The flowmeter can now be removed from the input temperature assembly by turning the flowmeter counterclockwise with a 1-1/8 inch end-wrench.

d. Use Teflon or an equivalent type of plumber's tape on the threads of the flowmeter to insure a proper seal when reinstalling. Note: When applying plumber's tape to threads, take care to start applying tape at a minimum of 1 thread from the end, so no tape can get trapped inside the plumbing and clog flowmeter.

e. Note position of arrow on flowmeter when assembling. Arrow should be pointed towards input temperature assembly. Thread output end of flowmeter into input temperature assembly until snug, then tighten.

f. Replace coolant strainer assembly by reversing the above procedures.

5-16. CONTROL UNIT REPAIR/REPLACEMENT

5-17. This section shows PC board component layout and test points to aid operator. Follow troubleshooting chart while referring to this section.

5-18. Remove the four screws that secure the cover to the calorimetric control unit. This will expose the control unit's internal circuitry.

```
************************************************************
*                      W A R N I N G                        *
*                                                           *
* The potential of electrical shock exists.  Operator       *
* must use caution when performing internal testing or      *
* making adjustments to avoid bodily contact with           *
* potentials.                                               *
************************************************************
```

FIGURE 5-1. MAIN PC BOARD COMPONENT LAYOUT

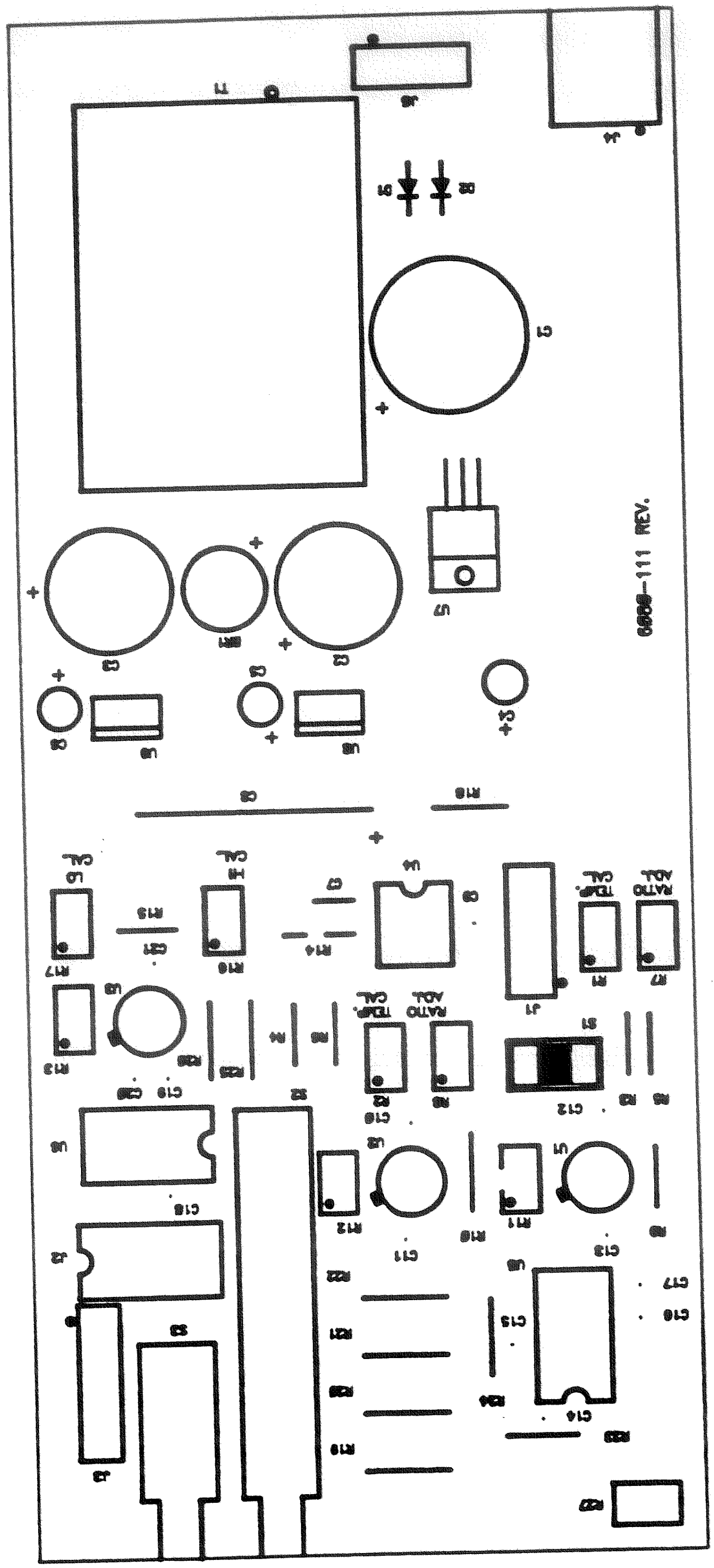


FIGURE 5-2. FLOW INDICATOR PC BOARD COMPONENT LAYOUT.

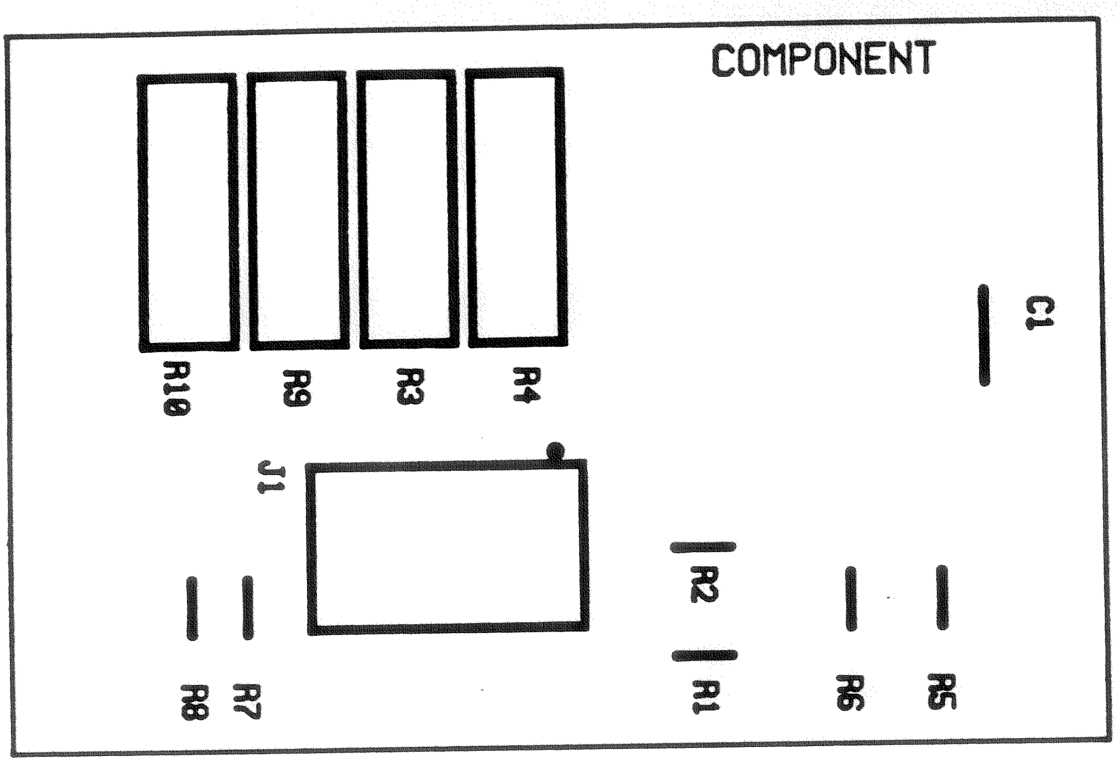
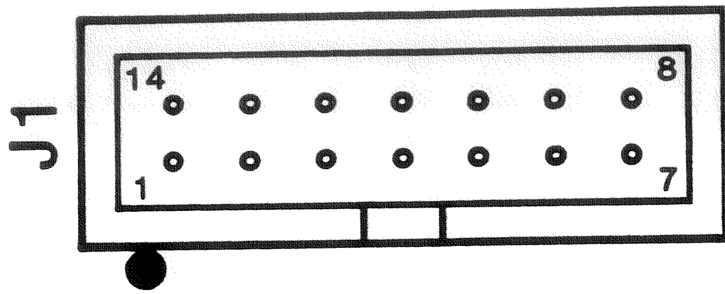


FIGURE 5-3.   TEST HEADER FUNCTIONS.



PIN	1	Input voltage reference +5V
PIN	2	Input voltage ratio
PIN	3	Input temperature voltage
PIN	4	Input temperature
PIN	5	Supply voltage +5V
PIN	6	Supply voltage +15V
PIN	7	Ground
PIN	8	Flow frequency
PIN	9	Supply voltage −15V
PIN	10	Flow voltage
PIN	11	Output temperature
PIN	12	Output temperature voltage
PIN	13	Output voltage ratio
PIN	14	Output voltage reference +5V

5-19. SENSOR CABLE

5-20. Remove sensor cable connectors from mating connectors on both the control unit and sensor junction box. This is done by unscrewing the connector mounting screws and pulling straight back on connector.

5-21. Pin to pin continuity from connector to connector can now be checked using a standard VOM. Refer to Table 5-2 for pin to pin connection. Any shorts or opens contrary to Table 5-2 require replacement of the sensor cable.

TABLE 5-2. SENSOR CABLE PIN CONNECTIONS.

Connector 1 Pin	Connector 2 Pin
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9

Outside connector shells are at system ground and should be electrically connected together.

5-22. CUSTOMER SERVICE

5-23. Bird Electronic Corporation maintains a complete repair and calibration department at our corporate headquarters. This department is set up to provide the best possible service of Bird equipment.

5-24. All instruments returned for service must be shipped prepaid and to the attention of the Customer Service Group.

Bird Electronic Corporation
30303 Aurora Road
Cleveland (Solon), OH 44139-2794
Phone: 216-248-1200
Cable: BIRDELEC
Telex: 706898 Bird Elec UD

5-25. REPACKAGING

5-26. Should you need to return the RF Calorimeter, or associated parts, use the original shipping package if possible. If the original package is not available, use a heavy duty corrugated box with shock-absorbing material around all sides of the unit to provide firm cushion and to prevent movement in container. Container should be properly sealed.

SECTION VI - CALIBRATION AND TEST PROCEDURE

6-1. REQUIRED TEST EQUIPMENT

ITEM	QTY	TYPE UNIT	RECOMMENDATION
1	1	DC Millivoltmeter	Digitec 268 or Equivalent
2	1	DC Power Supply	Sorensen QRD30-1 or Equivalent
3	1	AC Ammeter	Y.E.W., Model 2013-09
4	1	AC Voltmeter	Y.E.W., Model 2013-17
5	1	Potential Transformer	Y.E.W., Model 2261
6	1	Thermometer (Mercury)	0° to 30°C (0.1% accuracy)
7	1	AC Power Source	20kW Output Minimum at 50 or 60Hz

6-2. CALIBRATION PROCEDURE

6-3. Calorimetric Preparation -

a. Connect calorimeter power cord to the appropriate voltage supply of 115V/60Hz or 230V/50Hz.

b. Check the control unit's ac line module for correct selection of line voltage.

c. Turn on control unit by depressing ON/OFF button on front panel.

6-4. TEST EQUIPMENT PREPARATION

a. Turn dc millivolt meter on.

b. Turn dc power supply on.

c. Insert thermometer into the load cooling water output.

d. Connect the calorimeter sensor cable, P/N 6080-320-1, to the connector at the sensor box and to the connector on the back panel of control unit.

e. Connect the ac power source output cable to the load input connector but leave the power source turned off.

f. Connect Y.E.W. meters, if not already connected, as illustrated in Figure 6-1.

g. Leave the above equipment on and with running water for 15 minutes to stabilize before proceeding.

6-5. TEMPERATURE CALIBRATION

a. Assure that the coolant temperature has stabilized by reading the temperature indicated on the thermometer in the coolant then rechecking the thermometer after a few minutes. If the coolant temperature stays constant, the system is stabilized, and you may proceed.

b. Remove four screws from upper cover to expose the control unit's internal circuitry.

c. Short the inputs to the temperature OP Amps by:

1. Disconnecting the calorimeter sensor cable from the sensor box connector.

2. Short pins 3 and 12 of PC board connector J1 to PC board ground. See Figure 6-2 for pin notations.

d. Connect the negative lead of the dc Millivoltmeter to PC board ground and connect the positive lead of the dc Millivoltmeter to the output temperature, pin No. 11 of header J1.

e. Set the dc millivoltmeter to the 200mV range, or lower, and observe the indication on the voltmeter. Then adjust the voltage at (OUTPUT TEMP) by turning the OFFSET NULL adjust potentiometer R12, to read 0.0 ±20uV. For location of adjustment potentiometer see Figure 6-2.

f. Move the positive lead of the dc millivoltmeter to the input temperature pin No. 4 of header J1 and repeat step e. above by adjusting the OFFSET NULL potentiometer R11. This adjusts the OP Amps to produce an output voltage of zero volts when the input voltage is zero volts. Disconnect the shorting jumpers from pins 3 and 12 and reconnect the sensor cable back to the sensor box connector.

g. With the negative lead of the dc millivoltmeter still connected to PC board ground, measure and record the voltages at pin 12 (V TEMP OUT) and Pin 3 (V TEMP IN) of header J1 (see Figure 6-2). Check these values three times to ensure repeatability. Substitute these values into Equation 1 to solve for "r".

Equation 1. $$r = \frac{V_{TEMP}}{10\ (Ta + 273)}$$

Where: r = Temperature calibration ratio.
Ta = Ambient temperature of coolant in °C. (Thermometer Reading)
V_{TEMP} = Voltage measured at (V_{TEMP} IN) and (V_{TEMP} OUT) in millivolts.

Calculate for "r" using both the measured (V_{TEMP} IN) and (V_{TEMP} OUT) values

Example 1: When: Ta = 25°C
(V_{TEMP} IN) = 600mV
(V_{TEMP} OUT) = 610mV

$$r_1 = \frac{V_{TEMP\ IN}}{10\ (Ta + 273)} = \frac{600}{10\ (25 + 273)} = \frac{600}{10 \times 298} = \frac{600}{2980} = 0.2013$$

$$r_2 = \frac{V_{TEMP\ OUT}}{10\ (Ta + 273)} = \frac{610}{10\ (25 + 273)} = \frac{610}{10 \times 298} = \frac{610}{2980} = 0.2046$$

h. V_B may now be determined by Equation 2.

Equation 2. $V_B = r \times 100mV$

Calculate for V_B using r_1 and r_2 for both input and output temperature OP Amps respectively.

Example 2. $r_1 = 0.2013$
$r_2 = 0.2046$

$V_{B1} = r_1 \times 100mV = .2013 \times 100mV = 20.13mV$
$V_{B2} = r_2 \times 100mV = .2046 \times 100mV = 20.46mV$

i. Set the ON/OFF switch of the control unit to OFF. Set switch S1 on PC board to position shown in Figure 6-3. Connect the dc power supply and the dc millivoltmeter as described below:

DC Power Supply: Positive lead to (OUTPUT TEMP) pin No. 11 of header J1.
Negative lead to ground.

DC Millivoltmeter: Positive lead to (OUTPUT TEMP) pin No. 11 of header J1.
Negative lead to ground.

j. Adjust the dc power supply output to 100mV ±10uV on the dc millivoltmeter using the 200mV range. Keeping the voltage at this level in the following adjustments is very critical.

k. When 100mV is stable, remove the positive lead of the dc millivoltmeter and connect to pin No. 13 of header J1. Now adjust

R8, ratio adjust potentiometer, to read the V_{B2} value calculated for output temperature OP Amp. When this is done, reconnect the positive lead of dc millivoltmeter back to pin No. 11 of header J1 (OUTPUT TEMP) to check if the 100mV is still being applied. If not, readjust to 100mV and adjust the V_{B2} value again. This may take a few times to reconcile.

l. Keeping the ON/OFF switch in the OFF position set switch S1 on the PC board to position shown in Figure 6-4. Connect the dc power supply and dc millivoltmeter as shown below.

DC Power Supply: Positive lead to (INPUT TEMP) pin No. 4 of header J1.
Negative lead to ground.

DC Voltmeter: Positive lead to (INPUT TEMP) pin No. 4 of header J1.
Negative lead to ground.

m. Again adjust the dc power supply output to read 100mV ±10uV on the dc millivoltmeter using the 200mV range. Keeping the voltage at this level in the following adjustments is very critical.

n. When 100mV is stable remove positive lead of the dc millivoltmeter and connect to pin No. 2 of header J1. Now adjust R7 (RATIO ADJUST) potentiometer, to read the V_{B1} value. When this is done reconnect the positive lead of dc millivoltmeter back to the, (INPUT TEMP) Pin No. 4 of header J1, to check if the 100mV is still being applied. If not, readjust to 100mV and adjust the V_{B1} value again. This may also take a few minutes to reconcile.

o. Remove dc power supply leads and return switch S1 to its center position and turn the control unit on.

p. Set the dc millivoltmeter selector switch to the 2V range and connect the positive clip lead to the (INPUT TEMP) Pin No. 4 of header J1 and negative lead to ground (see Figure 6-5). Adjust R1 (TEMP CAL) potentiometer to read the same temperature as the thermometer in the coolant. (Using 10mV = 1°C.)

q. Keeping the dc millivoltmeter on the 2V range, move the positive clip lead to the (OUTPUT TEMP) Pin No. 11 of header J1 and leave the negative lead attached to ground. Adjust R2 (TEMP CAL) potentiometer to also read the same temperature as the thermometer in the coolant.

r. Turn off the water supply to the load and wait a few minutes to allow the control unit to stabilize. Short pin 10 of PC board connector J1 to PC board ground. Set dc millivoltmeter on 200mV range and connect the positive clip lead to the side of R26 that is common to pin 6 of OP amp U3 as shown in Figure 6-6. Adjust potentiometer R13 to read zero on the dc millivoltmeter. When this is done, remove all clip leads.

s. Turn on the water supply to the load and check T by pushing in the (CAL) button. Adjust the potentiometer on the front of the Model 6080A/81A until the display reads zero. Then switch the (CAL) button to the out position and if necessary, readjust the front panel potentiometer for a calorimeter reading of zero.

```
**********************************************************
*                    W A R N I N G                       *
*                                                        *
* The following sections of this procedure involve the   *
* application of high power to the load.  The following  *
* precautions must be observed to insure operator safety *
* as severe burn or possibly death may result.           *
*                                                        *
* 1.  Make sure that the coaxial power cable connector   *
* is securely fastened to the load and that the water    *
* is flowing before turning on the ac power source.      *
*                                                        *
* 2.  Ensure that all Y.E.W. meter connections are tight *
* before turning on ac power.                            *
*                                                        *
* 3.  High voltage is present at the terminals of the    *
* Y.E.W. meters when the ac power source is on.  Keep    *
* clear of these terminals.                              *
*                                                        *
* 4.  Completely shut down the ac power source before    *
* changing the Y.E.W. meter connections, turning off the *
* water or removing the power cable from the load input  *
* connector.                                             *
**********************************************************
```

6-6. <u>HI Range AC Power Calibration</u> -

a. Connect Y.E.W. meters as shown in Figure 6-1. Make sure that all connections are tight.

b. Turn on ac power source and adjust the power variance to produce a reading of 17.3 amps on the Y.E.W. ammeter. In this position the ac power source output will be approximately 15kW.

c. Determine the actual power applied to the load coaxial input by reading the Y.E.W. meters and using Equation 3.

Equation 3. Power = V x I x K

Where:
V = voltage read at Y.E.W. voltmeter
I = current read at Y.E.W. ammeter
K = potential transformer ratio (20.067 for 2200V to 110V position)

Example 3:
V = 43.3V I = 17.3 Amps
P = V x I x K = 43.3V x 17.3A x 20.067
P = 15.032kW

d. Adjust R16, (HI CAL) potentiometer, on the control unit's PC board slowly to make the unit indicate the actual power being applied. Only a slight turn of the potentiometer is required to change the reading. Allow the display to stabilize after each slight amount of turn. Repeat steps c. and d. several times, due to power fluctuations, to assure accuracy of the unit to be within ±3% of actual power. The error percentage can be determined by Equation 4.

Equation 4.

$$\% \text{ error} = \frac{\text{Actual Power} - \text{Indicated Power}}{\text{Actual Power}} \times 100$$

Where: Actual Power = Y.E.W. meter reading
Indicating Power = calorimeter reading

e. Turn off ac power source and allow water to flow for several minutes to cool the load and the display of the calorimeter to stabilized at zero.

6-7. LOW Range AC Power Calibration -

a. Turn on the cooling water to the load, if not already on, and adjust the flow rate.

b. Push in button marked HI/LOW on the front of the control unit. Adjust front panel potentiometer for a zero display on the DPM. Then turn on ac power source and adjust power to 10 amps on the Y.E.W. ammeter. In this position the power source output will be approximately 5kW.

c. Again using Equation 3, determine the actual power applied to the load.

Where: V = 25.6V = reading from voltmeter
I = 10 amps = reading from ammeter
K = 20.067 = ratio constant

Example 4: P = 25.6 x 10 x 20.067
P = 5.14kW

d. Adjust R17, (LOW CAL) potentiometer, on control unit's PC board slowly until the display of the DPM indicates the actual power being applied. After each adjustment allow the display to stabilize. The accuracy of the display reading must be ±3% of actual power. If not, readjust R17 until it is within tolerance.

e. Shut off ac power source and let water flow continue for several minutes to allow unit to cool and calorimeter display to stabilize at zero.

6-8. HI RANGE FLOW INDICATOR CALIBRATION

6-9. This section explains calibration of flow indicator HI range. Refer to figure 6-7 while following the steps below.

a. Place the control unit int he HI range by releasing the range selector button. Adjust water flow to approximately 7 GPM.

b. Connect the positive lead of dc millivoltmeter to the common leg of resistors R1 and R2 and negative lead to Pin 2 of J1 on flow indicator PC board. Adjust the voltage between the common leg of R1 and R2 and Pin 2 of J1 on flow indicator PC board to 511mV ±1mV by adjusting R4.

c. Disconnect millivotmeter and connect positive lead of frequency counter to pin 8 of header J1 on the main PC board and negative lead to PC board ground (see Figure 6-2). The frequency output will be approximately 700Hz. Adjust R9 flow indicator PC board until the appropriate LED is lighted based on the expression 100Hz = 1 GPM and that each LED represents 1/2 GPM with the scale starting at 6 GPM.

6-10. LOW RANGE FLOW INDICATOR CALIBRATION

6-11. This section explains calibration of flow indicator LOW range. Refer to Figure 6-7 while following the steps below:

a. Place the control unit in LOW range by depressing the range selector button. Adjust water flow to approximately 3 GPM.

b. Connect the positive lead of dc millivoltmeter to the common leg of resistors R1 and R2 and the negative lead to pin 2 of J1 on flow indicator PC board. Adjust the voltage between the common leg of R1 and R2 and pin 2 of J1 on flow indicator PC board to 687mV ±1mV by adjusting R3.

c. Disconnect milliwvoltmeter and connect positive lead of frequency counter to pin 8 of header J1 on the main PC board and negative lead to PC board ground (see Figure 6-2). The frequency output will be approximately 300Hz. Adjust R10 (flow indicator PC board) until the first LED is lighted, which represents 3.0 GPM.

6-12. TEST PROCEDURES

a. Testing HI Power Range Accuracy -

1. Adjust water flow to approximately 7 GPM. Set HI/LOW switch to HI position on the control unit and adjust the potentiometer, on the front panel, for a display indication of zero.

2. Turn ac power source on and adjust power to read 14 amps on Y.E.W. ammeter to check accuracy at 10kW. Use example formula as follows:

Where : V = 36 volts = reading on voltmeter
I = 14 amps = reading on ammeter
K = 20.067 = ratio constant

Example 5: 36 volts x 14 amps x 20.067 = 10.11kW

The display reading should be within ±3% of actual power being applied. If not, recalibrate HI range per calibration procedure.

3. Now increase the power to approximately 20kW. Check the accuracy at 20kW by comparing the actual power according to the Y.E.W. meters to the power indicated on the display. The calorimeter must still be within ±3% of the actual power.

4. Turn off ac power source and run water through the load for a few minutes to allow unit to cool and calorimeter display to stabilize at zero.

b. Testing LO Power Range Accuracy -

1. Adjust the water flow to approximately 3 GPM. Set the HI/LOW switch to LOW position and adjust front panel potentiometer until the display indicates zero.

2. Turn ac power source on and apply approximately 10kW, 14 amps on Y.E.W. ammeter, check to see that the calorimeter accuracy is within the ±3% specification as described above.

3. Turn off ac power source and allow load to cool.

4. Connect potential transformer and Y.E.W. meters as shown in Figure 6-8.

5. Turn on ac power source and adjust power to read 4.5 amps on Y.E.W. ammeter to check accuracy at approximately 1kW. Use new example formula as follows:

Where: V = 56.9 volts = reading on voltmeter
I = 4.5 amps = reading on ammeter
K = 4 = ratio constant

The display reading should be within ±3% of actual power being applied. If not, recalibrate at LOW range.

6. Turn off ac power source and let water run for several minutes to allow unit to cool.

7. After cooling is complete, disconnect coaxial power line from load and turn off calorimeter.

8. This completes all calibration and unit is now ready for use.

Figure 6-1. Y.E.W. METER CONNECTIONS - HI POWER CALIBRATION.

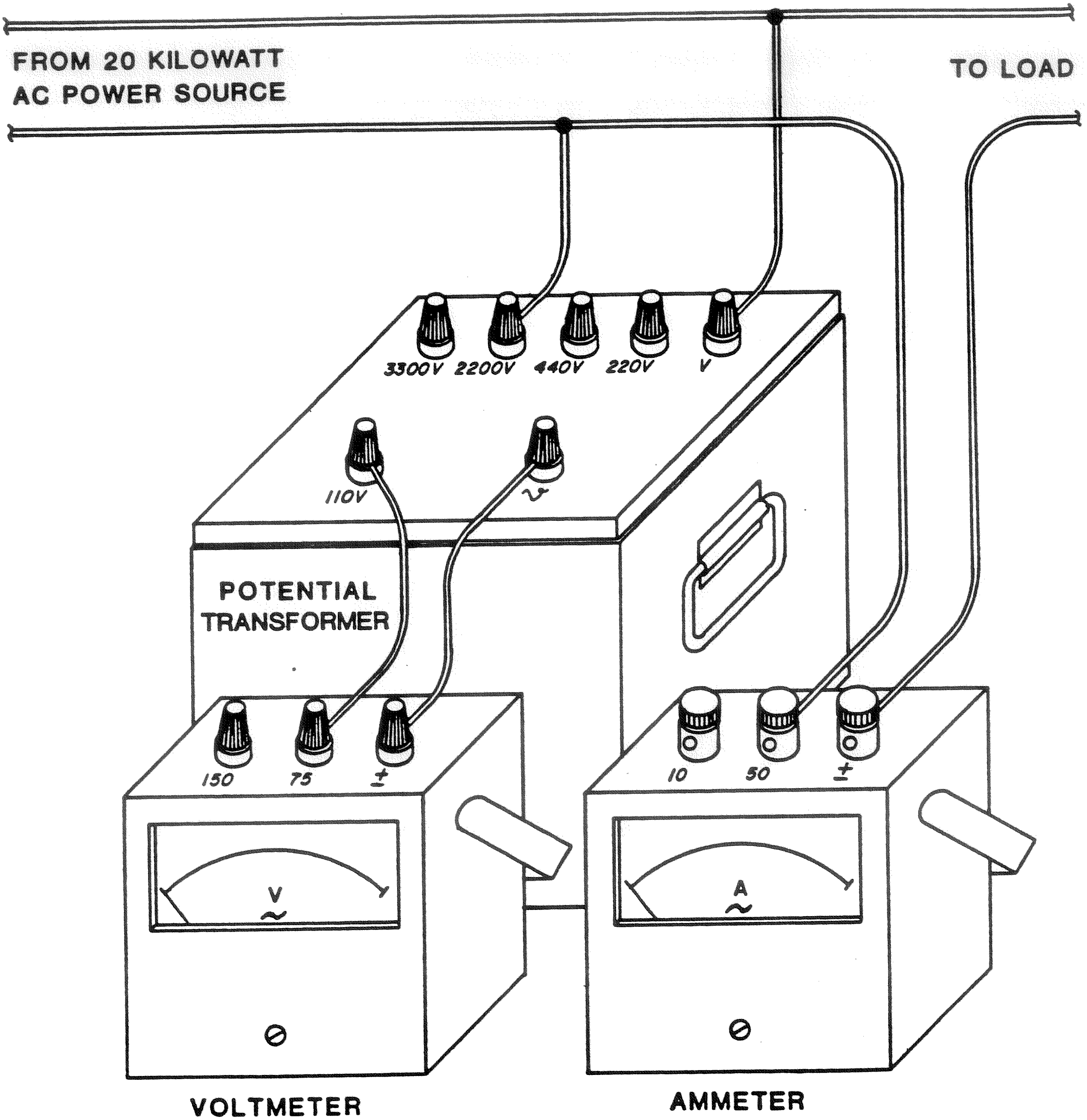


FIGURE 6-2. NULL TEMPERATURE SENSORS.

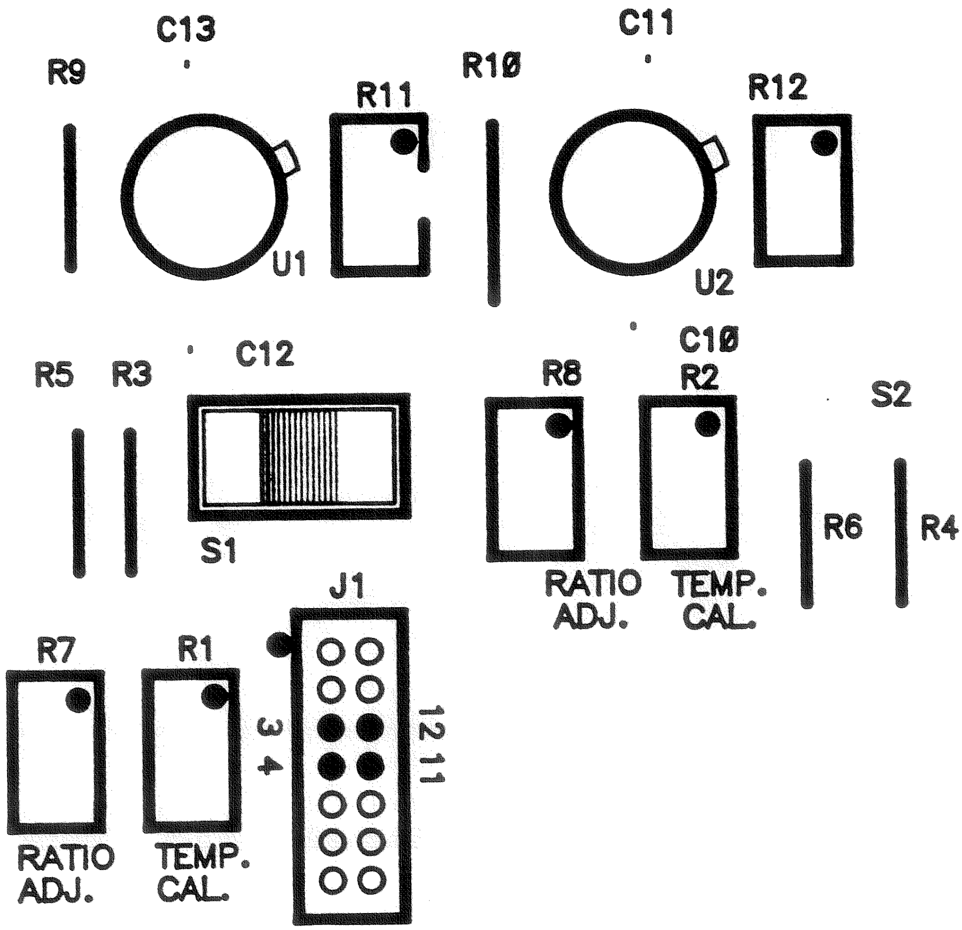


FIGURE 6-3. CALIBRATE OUTPUT TEMPERATURE SENSOR RATIO.

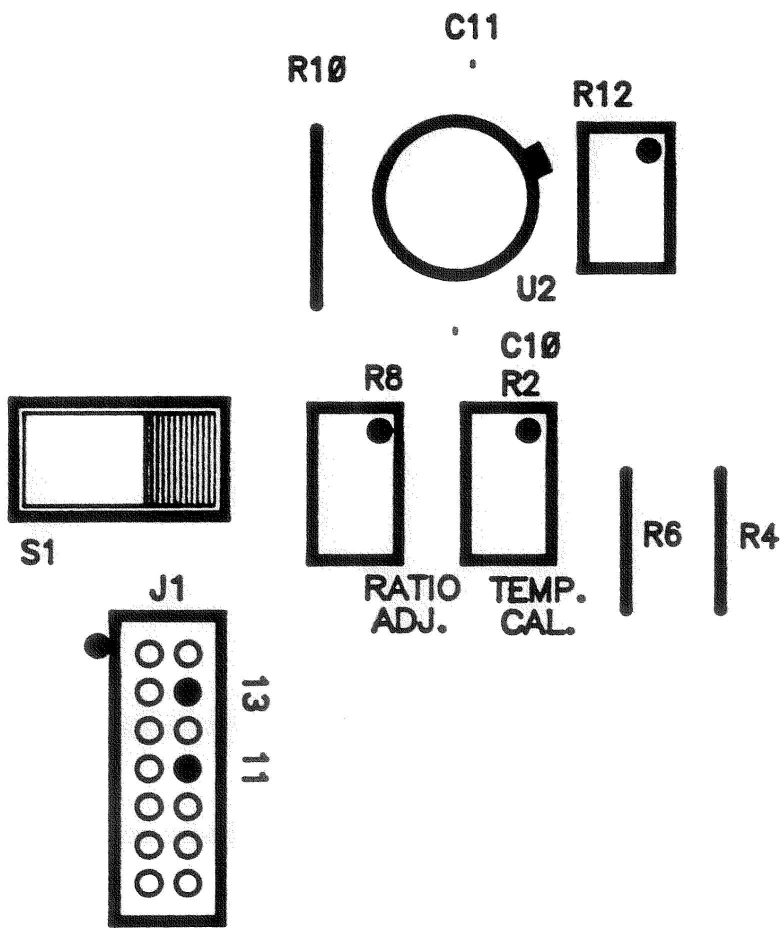


FIGURE 6-4. CALIBRATE INPUT TEMPERATURE SENSOR RATIO.

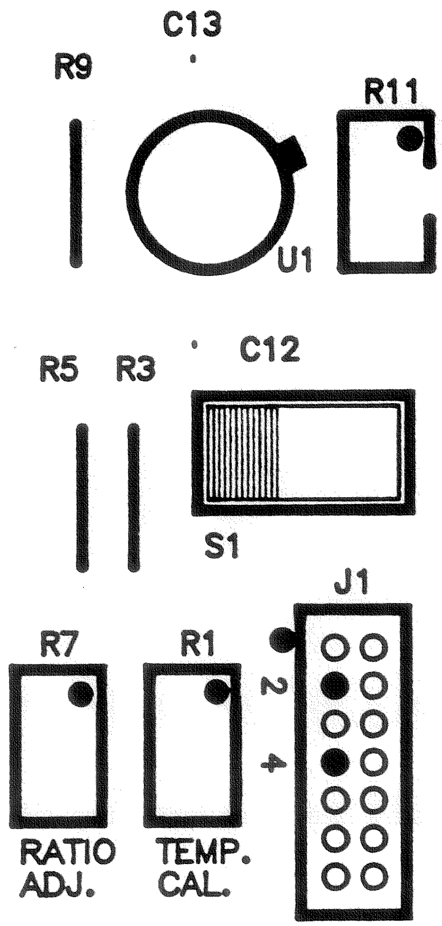


FIGURE 6-5.   CALIBRATE TEMPERATURE SENSORS.

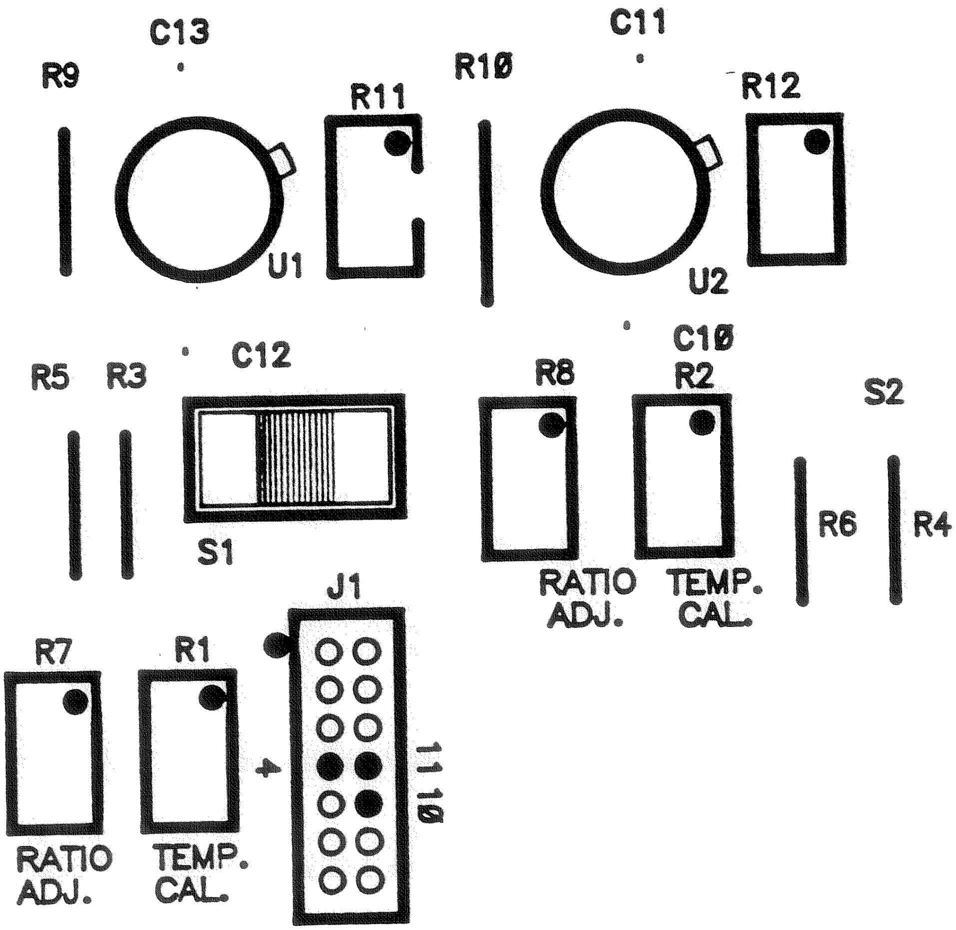


FIGURE 6-6.   UNIT CALIBRATION.

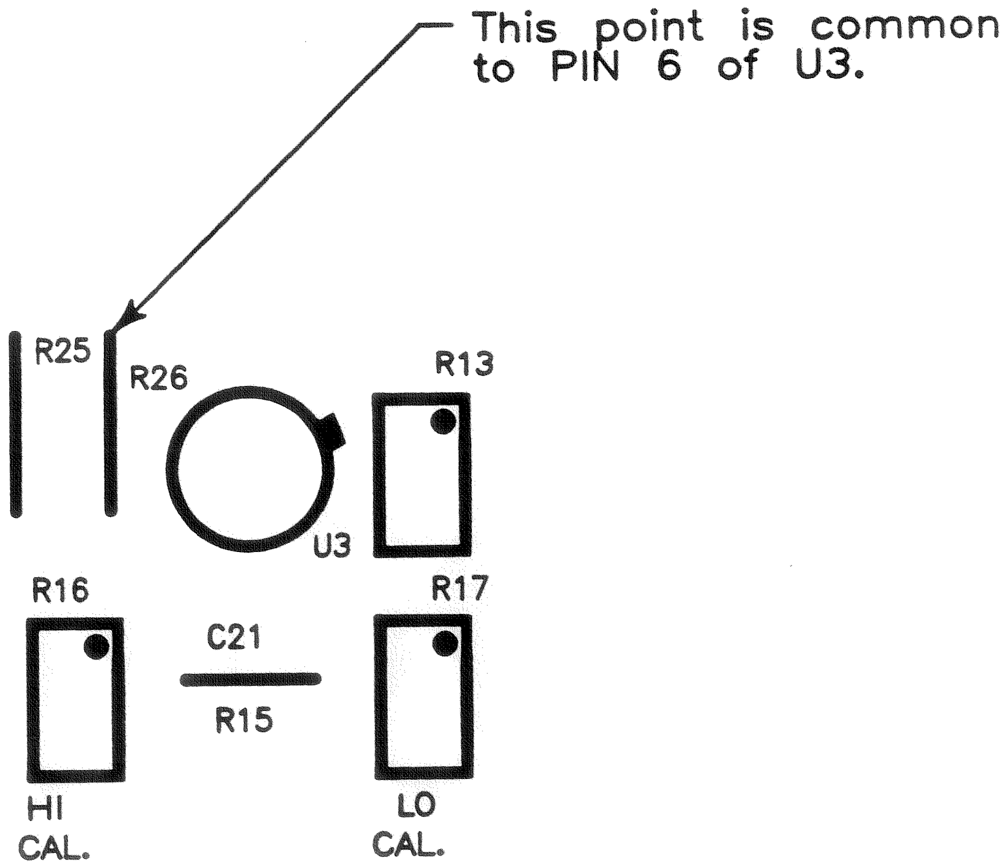


FIGURE 6-7. FLOW INDICATOR CALIBRATION.

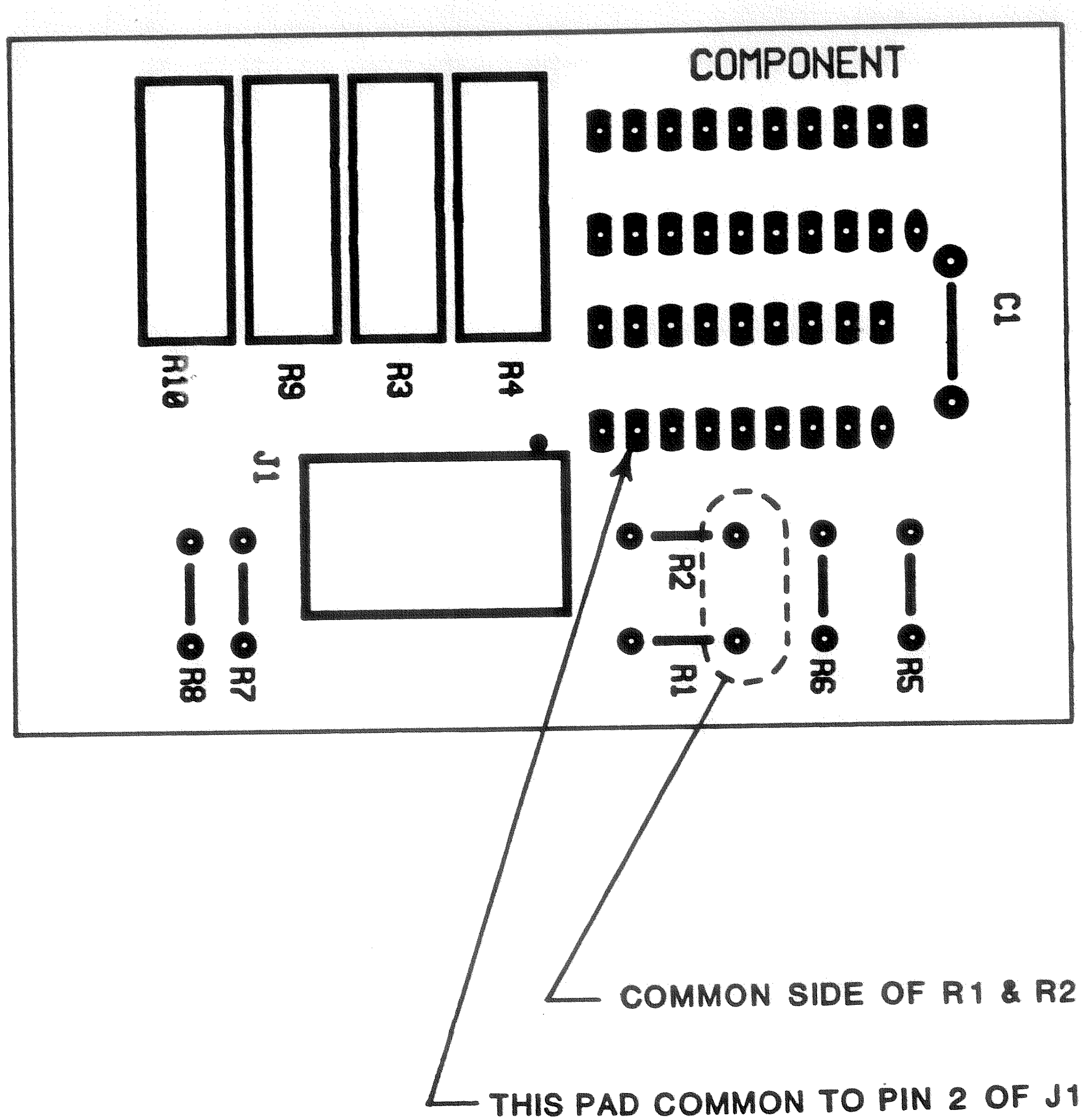
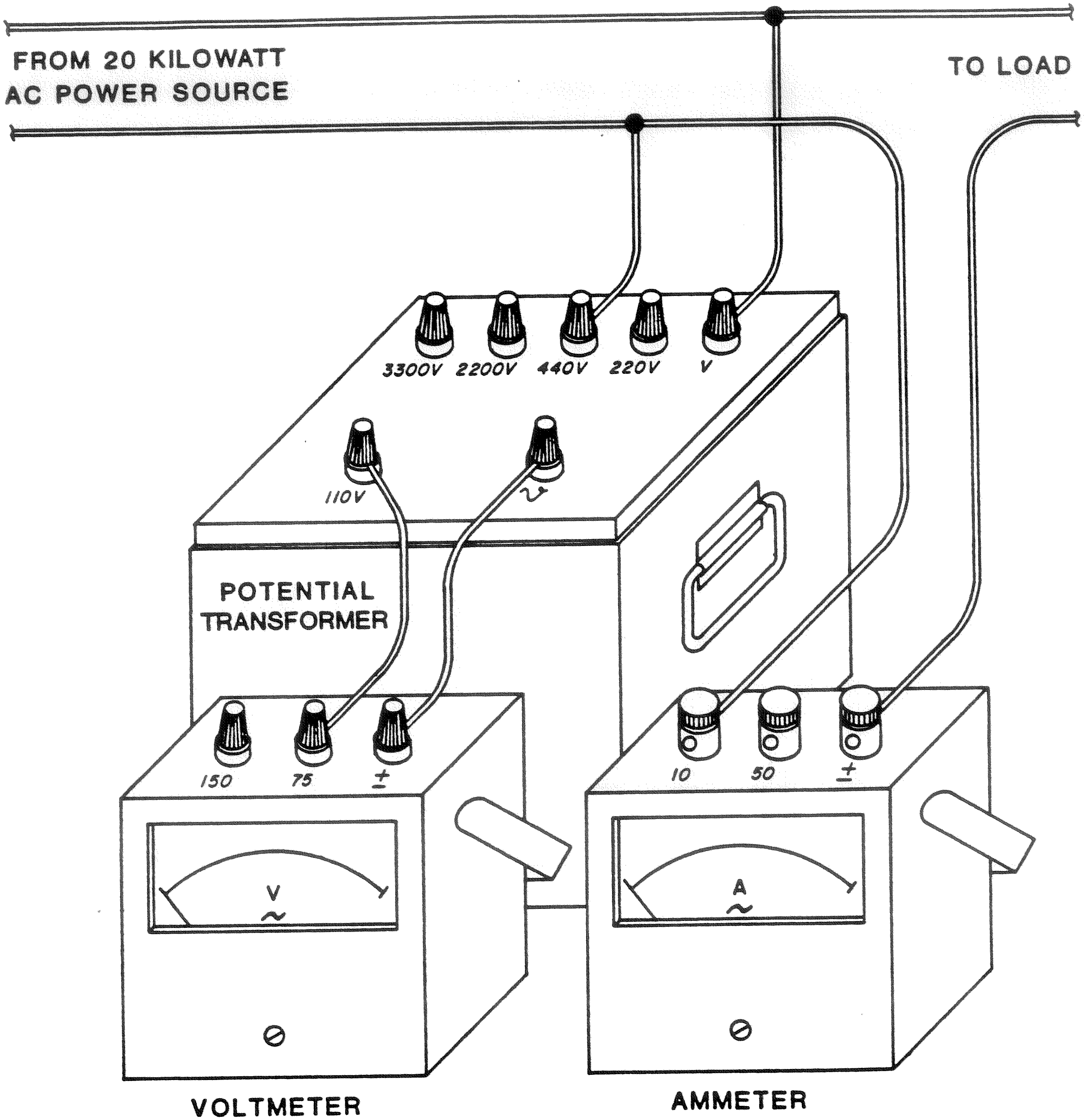


FIGURE 6-8. Y.E.W. METER CONNECTIONS - LOW POWER CALIBRATION.



SECTION VII - REPLACEMENT PARTS LIST

7-1. MODEL 6080A/81A

7-2. Item numbers are shown in Figure 7-1.

ITEM	QUANTITY	DESCRIPTION	PART NUMBER
1	1	Sensor Box Assembly	6080-325
2	1	Output Sensor Sub-Assembly	6080-055
3	1	Input Sensor Sub-Assembly	6080-052
4	1	Flow Sensor Unit	5-1145-1
5	1	Input Assembly	6080-053
6	1	Water-Strainer	5-1648
7	2	Connector, Male	5-607-6
8	1	Temperature Sensor (Input)	6080-095-1
9	1	Temperature Sensor (Output)	6080-095-2
10	1	Cable, Flow Sensor Assembly	6080-025-2
11	2	Sensor Cable Assembly	6080-096-1
12	1	Hose Nipple (Input)	5-903-1

7-3. CALORIMETER PARTS:

7-4. Item numbers are shown in Figure 7-2.

ITEM	QUANTITY	DESCRIPTION	PART NUMBER
1	1	Main PC Board	6080-306
2	1	Flow Indicator PC Board	6080-318
3	1	3-1/2 Digit Panel Meter with optional BCD output	5-1910
4	1	Cable Assembly, BCD Option	6080-315
5	1	Switch, Power Assembly	6080-305
6*	1	AC Line Cord	4421-055
7*	1	Fuse	5-721-6

*Refer to Figures 1-1 and 1-2 for location of these items.

ADDITIONAL PARTS:

ITEM	QUANTITY	DESCRIPTION	PART NUMBER
1	1	Sensor Cable	6080-320-1

NOTE: Sensor cables can be purchased in various lengths. For more information contact Bird Electronic Corporation.

FIGURE 7-1. SENSOR MOUNTING AND COMPONENTS.

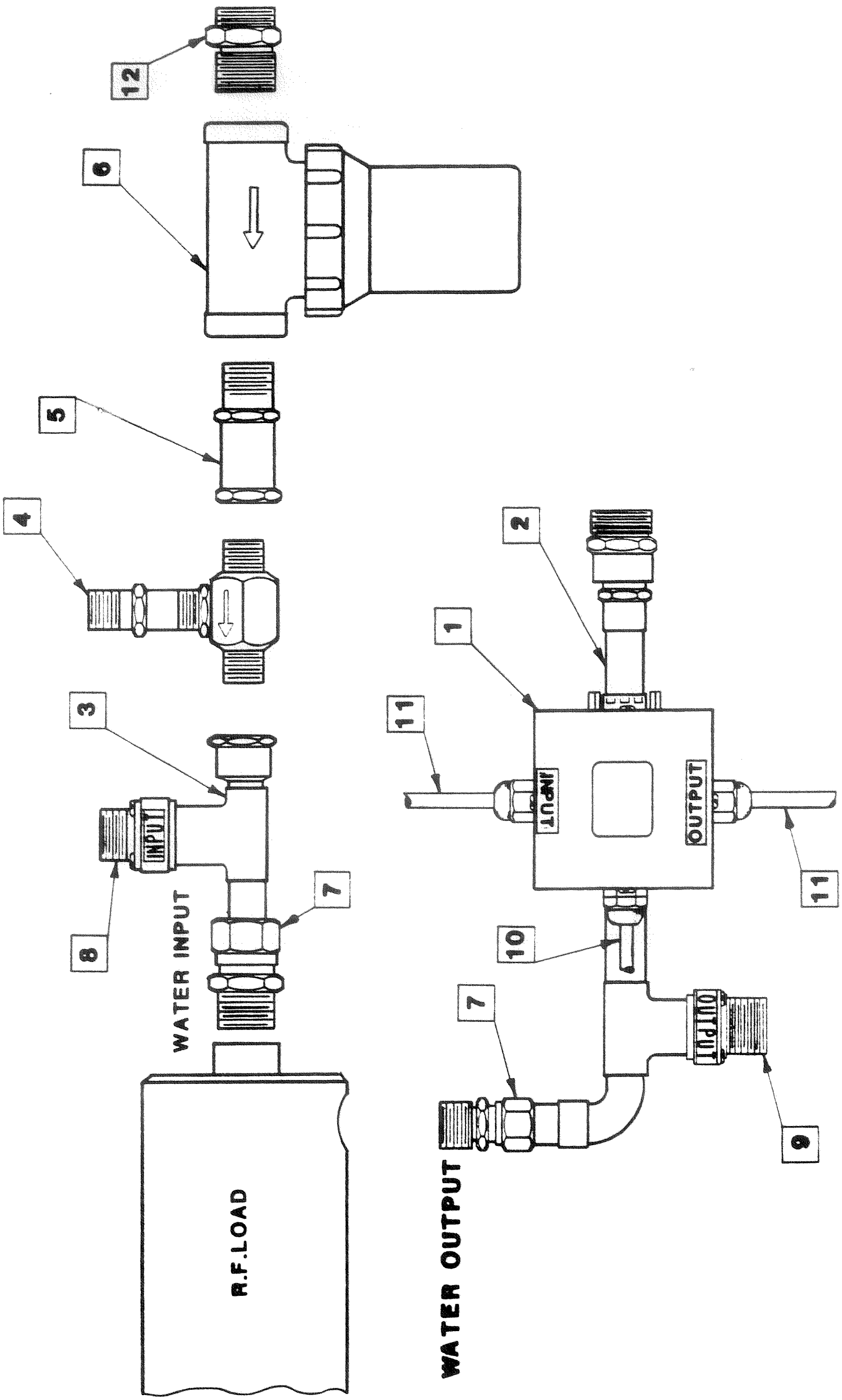
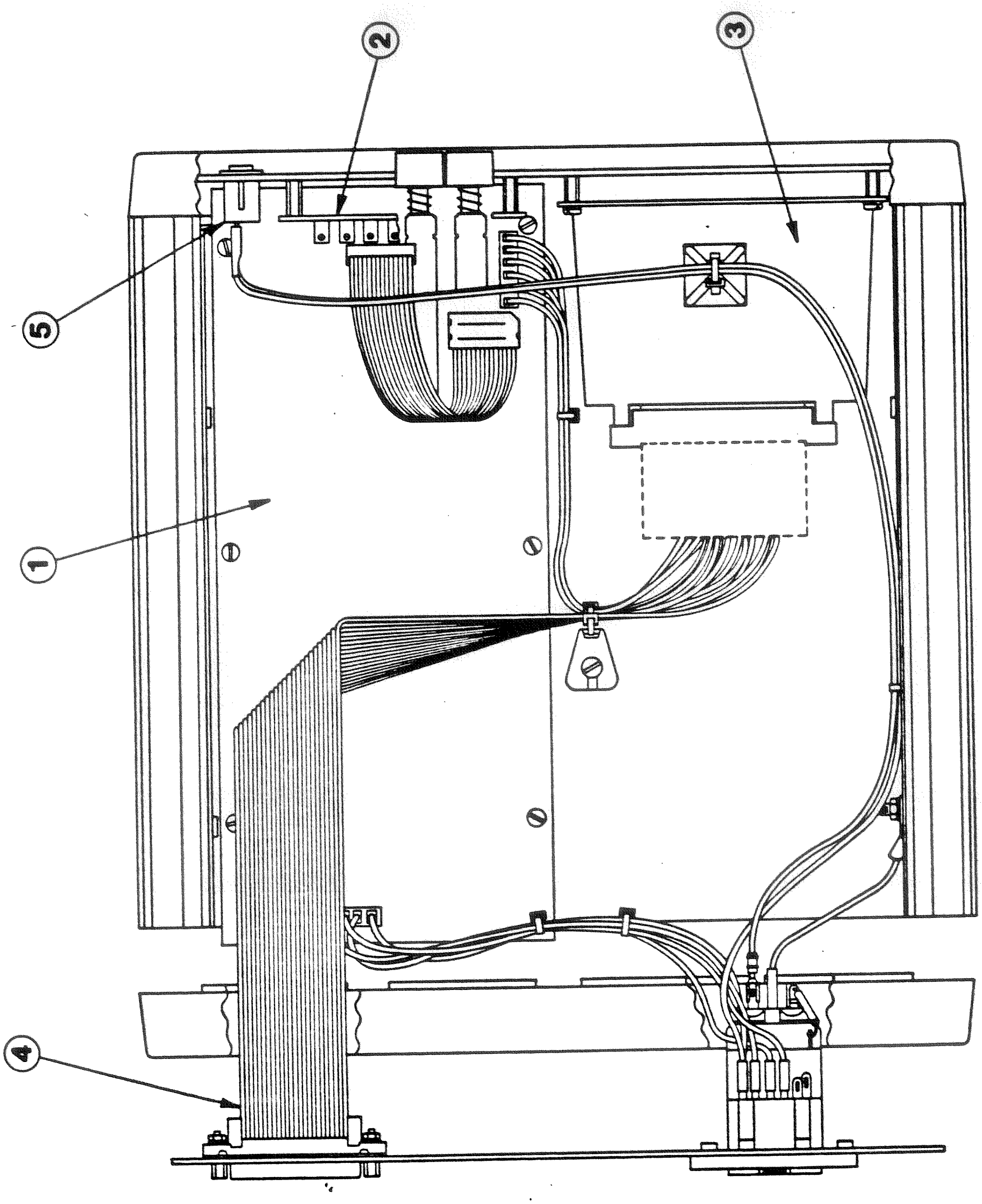


FIGURE 7-2.   REPLACEMENT PARTS ILLUSTRATION CONTROL UNIT SECTION.



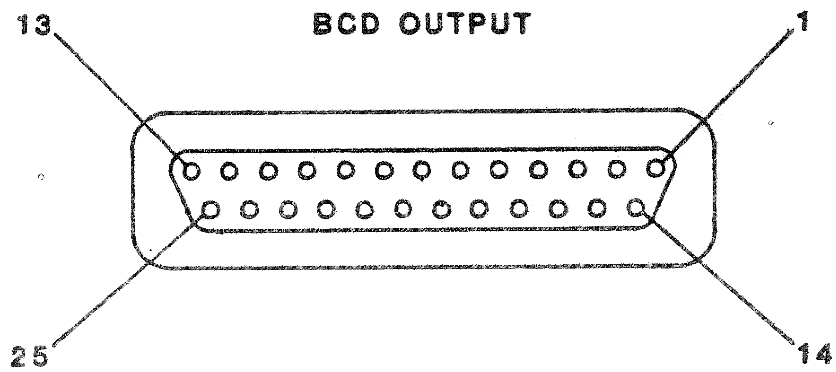
1. MAIN P C BOARD
2. FLOW INDICATOR P C BOARD
3. 3-1/2 DIGIT PANEL METER
4. CABLE ASSEMBLY, BCD OPTION
5. SWITCH, POWER ASSEMBLY

SECTION VIII - BINARY-CODED-DECIMAL (BCD) OUTPUT CONNECTOR

8-1. GENERAL

8-2. A 25-pin D-shell connector for the Binary-Coded-Decimal outputs is provided on the upper left hand portion of back panel of the control unit. A drawing of the pin locations for same, with description of the pin assignments is provided in Figure 8-1.

FIGURE 8-1. BCD CONNECTOR PIN FUNCTIONS.



Pin No.	Function	Pin No.	Function
1	BCD 100	14	BCD Ground
2	BCD 200	15	HOLD
3	BCD 400	16	NC
4	BCD 800	17	BCD 1000
5	NC	18	+5V
6	BCD 10	19	OE3 (Tens)
7	BCD 20	20	OE2 (Hundreds)
8	BCD 40	21	OE4 (Units + Overrange)
9	BCD 80	22	OE1 (Thousand + Polarity)
10	BCD 1	23	Overrange
11	BCD 2	24	Polarity
12	BCD 4	25	Data Valid
13	BCD 8		

8-3. SUPPLY WIRING (See Figure 8-1)

a. Pin 18 must be powered by an external power supply, which must supply a regulated power of +5Vdc @ 6mA.

Pin 14 is connected to the external power supply ground.

IMPORTANT NOTE:

BCD output and logic signals are referenced to the external power supply.

8-4. LOGIC INPUT WIRING (See Figure 8-1)

a. All Output Enable (OE) lines are internally pulled to ground through a 100K ohm resistor.

For a multiplexed BCD output, each digit can be disabled by putting a Logic "1" (+5Vdc) on its OE line, and enabled by disconnecting it or pulling the OE line down to Logic "0" (0Vdc).

b. Putting a Logic "1" (+5Vdc) on Data Hold (Pin 15) locks the present data into the output storage latches until the Data Hold is returned to Logic "0" (0Vdc). With removal of Logic "1", Data Hold will automatically return to Logic "0".

8-5. DATA OUTPUT WIRING

8-6. There are three commonly used output formats compatible with the Model 6080A. Once you have determined which format is required, follow the wiring instructions for that format only.

a. Full Parallel BCD Output Lines (See Figure 8-1):

1. For a fully parallel BCD output, no connections to the four output enable lines are necessary.

2. The Data Valid Signal (Pin 25) is Logic "1" when data is valid. See note at the end of Section 8-5.

b. Multiplexed BCD Output (Bit Parallel, Digit Serial) See Figure 8-1:

1. BCD Output

2^0 - Pin 10
2^1 - Pin 11
2^2 - Pin 12
2^3 - Pin 13

2. Jumpers Required

Pin To Pin	Pin To Pin
12 - 3	10 - 1
3 - 8	1 - 6
8 - 24	6 - 17
13 - 4	11 - 2
4 - 9	2 - 7

3. Each digit will appear at these pins when its OE line is enabled, and all other lines are disabled.

NOTE: Thousand bit will appear at 2^0 (Pin 10).
Polarity bit will appear at 2^2 (Pin 12).

c. 8 Bit Multiplexed (Sometimes used with 8 bit computers) See Figure 8-1:

1. BCD OUTPUT

PIN	OE3 and OE4* LOGIC "0"	OE1 and OE4* LOGIC "0"
10	Units 2^0	Hundreds 2^0
11	2^1	2^1
12	2^2	2^2
13	2^3	2^3
6	Tens 2^0	Thousands
7	2^1	--
8	2^2	Polarity
9	2^3	--
23	Overrange	--

2. Jumpers Required

PIN TO PIN
10 - 1
11 - 2
12 - 3
13 - 4
6 - 17
8 - 24

* All other OE lines must be Logic "1".

3. The Data Valid Signal (Pin 25) is Logic "1" when data is valid.

NOTE: For low input signals (less than 10 counts). Data Valid Signal may not go to Logic "0" when data is updated, because its length is proportional to input signal and may become difficult to detect.