Chapter 5

MAINTENANCE

5.1 Minor Maintenance of Sensor Optics

Periodically inspect and maintain the M2/E2 sensor optics as described in the following paragraphs. These procedures can be done at any time but are only necessary when the SERVICE indicator lights on the M2, or an "S" appears on the status display of the E2, indicating service is required.

5.1.1 Cleaning the Sensor Mirror

Under normal conditions, the M2/E2 is self-checking and self-balancing. However, there are occasions when particulate matter and water-soluble contaminants reduce sensor mirror reflectance and system accuracy. (See Section 4.8.3 on mirror cleanliness.) Clean the sensor mirror according to the procedure below.

1. Deactivate the sensor cooler by any one of the following actions:
   - Turn the power OFF.
   - Actuate the sensor control HEAT switch.
   - Disconnect the sensor cable.
2. Turn off the sample gas. Make sure the sensor cavity is depressurized before continuing to the next step.
3. Open the sensor by removing the sensor cover.
4. Moisten a cotton swab with a cleaning solution suitable for mirrors, such as the cleaning solution in the General Eastern maintenance kit, or dilute methanol or alcohol. Clean the mirror with a few light wipes. If the sensor has been exposed to significant contamination, clean the other optical surfaces in the sensor and the sensor cavity itself.
5. Replace the sensor cover.
6. Return switches to normal, initiate a PACER cycle, and continue operation.

5.1.2 Balancing the Sensor Optics

If the M2 SERVICE indicator lights after a PACER cycle (or the E2 "S" flag appears), even after performing the mirror cleaning procedure above, check the sensor optics balance adjustment. Improper adjustment of the optical balance is the most common cause of instrument malfunction. Also, new systems may require an optical balance adjustment after one or two months of operation.

Actuate the sensor HEAT switch, wait one minute, then observe the bar graph to the right of the humidity display on the M2/E2. If only the bottom bar is lit, the sensor is properly balanced. Otherwise, balance the sensor according to the procedure below.

1. Clean the mirror as described in Section 5.1.1 above, if you have not already done so. Make sure you replace the sensor cover when checking the balance. If no bars are lit or more than one bar is lit, go to Step 2.

2. If *no bars are lit*, turn the balance screw on the sensor COUNTERCLOCKWISE until only the bottom bar is lit.

   If *more than one bar* is lit, turn the balance screw CLOCKWISE until only the bottom bar is lit. See Figure 5-1.

NOTE: Be sure to cover the mirror cavity while adjusting the balance screw, since ambient light can cause an offset. On the 1111H sensor, the cover should be installed with the side holes closed, not in the open position. On the 1211 and 1311 sensors, you can use your thumb or you can drop a coin over the hole if the sensor is horizontal.

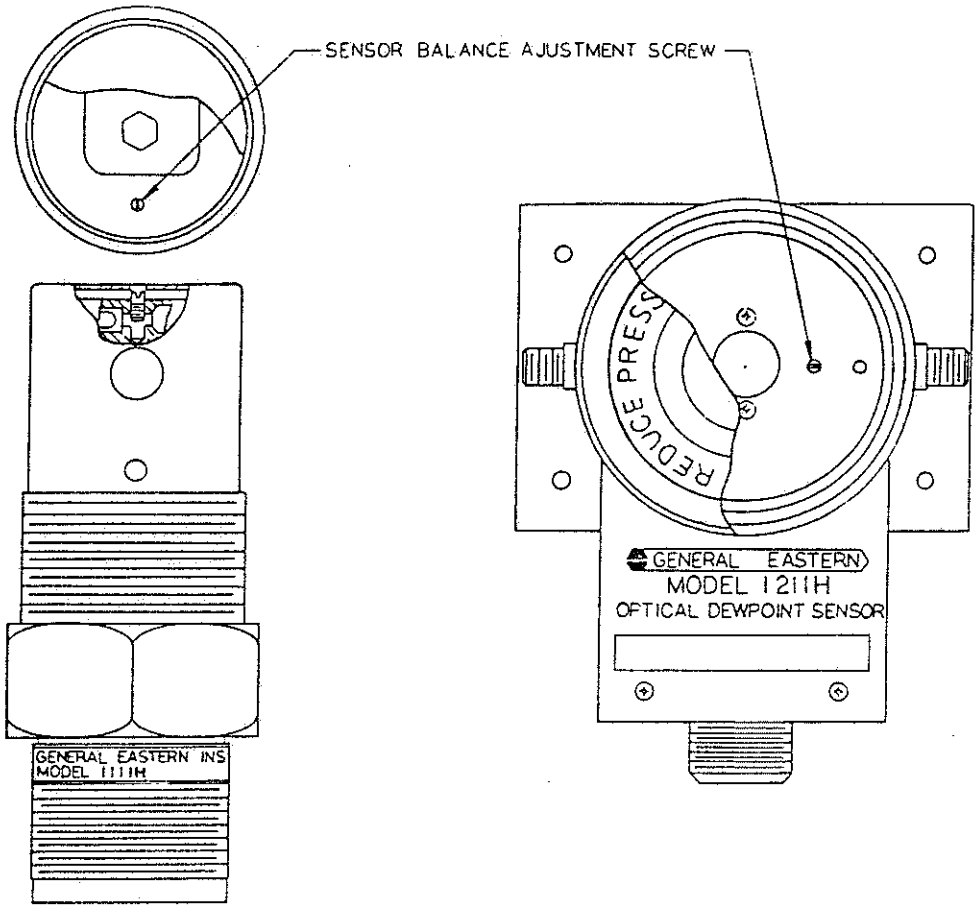


Figure 5-1. Location of Sensor Balance Adjustment Screw

3. The sensor is balanced when one bar is lit. Replace the sensor cover, if necessary, and make sure one bar is still lit. If not, repeat Step 2, since you were allowing some light to enter the cavity. Turn off the sensor control HEAT switch to stop heating the mirror.

4. Initiate a PACER cycle by pressing the PACER control switch. At the completion of the cycle, the M2/E2 is properly balanced. Figure 5-2 diagrams the complete balancing procedure for the M2. Figure 5-3 diagrams the complete balancing procedure for the E2.

5.2 Field Replacement of Sensor Mirrors

One advantage of using a General Eastern chilled mirror dew point sensor is you can replace the mirror yourself. A sensor does not have to go back to the factory for replacement of the reflective surface, but of course you can return it for factory service if desired. A mirror may require replacement for these reasons:

- The mirror is made of silver/rhodium plated copper. Copper provides excellent thermal conductivity to the platinum thermometer. However, some gas constituents, such as sulfur dioxide (SO_2), may react with the copper and eventually pit the surface or form a copper sulfate coating.

- The reflective surface may be gradually abraded by sharp dirt particles in the gas being measured.

- The mirror surface may be accidentally scratched or gouged during use or cleaning.

If the sensor mirror surface reacts with something corrosive in the gas sample, such as an acid or sulfur compound, replace it with a solid platinum mirror so that there is no copper for the gas to attack.

A platinum mirrors has occasionally been the difference between the success and failure of the hygrometer. For example, measurements in tobacco factories and malting houses have drastically improved after this change, since both have sample gas constituents that attack copper. In addition, fine scratches can be buffed out of a solid platinum surface, restoring the mirror to new condition, since it is of solid construction.

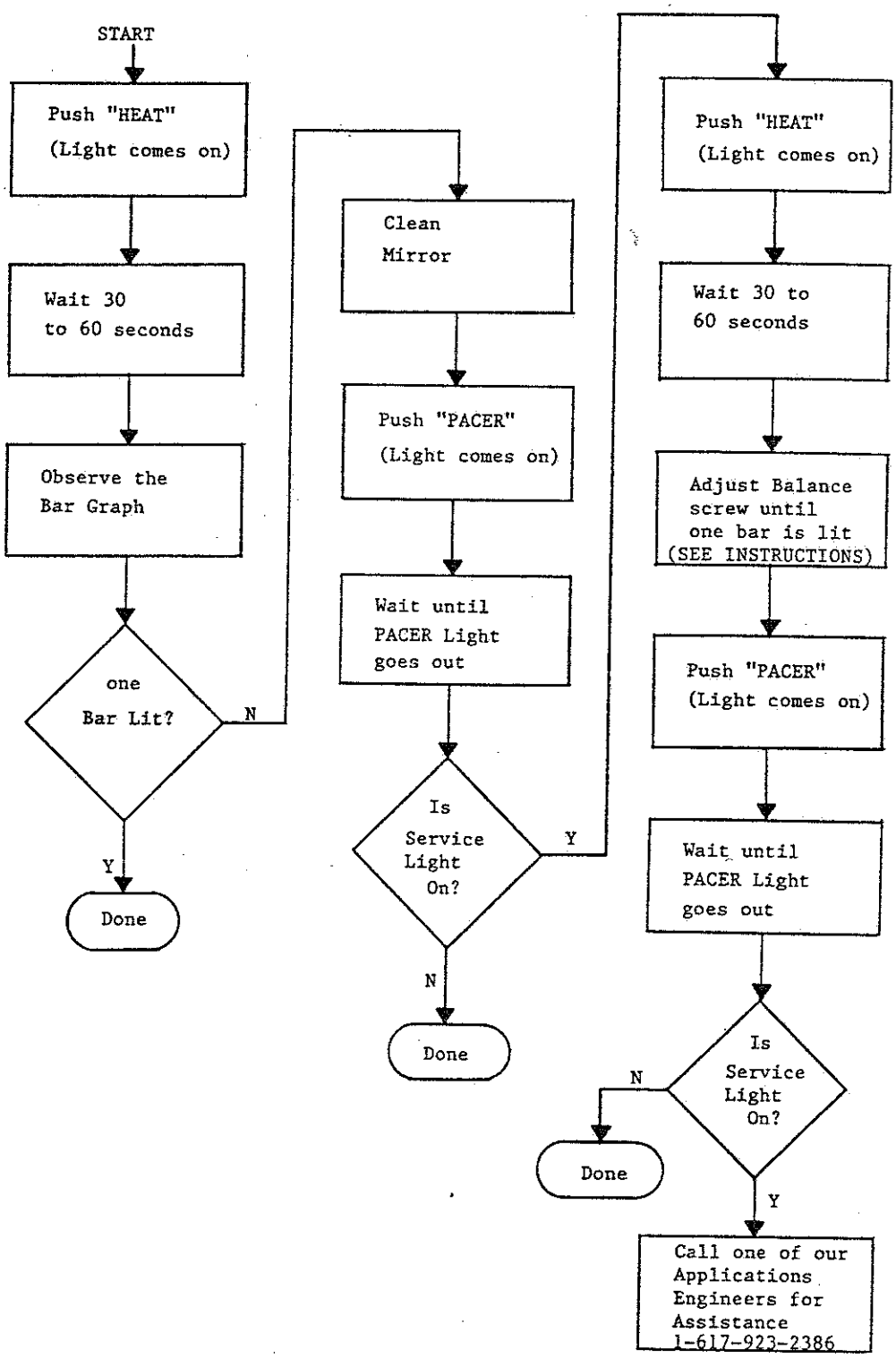


Figure 5-2. Sensor Balance Adjustment Flow Diagram for Hygro-M2

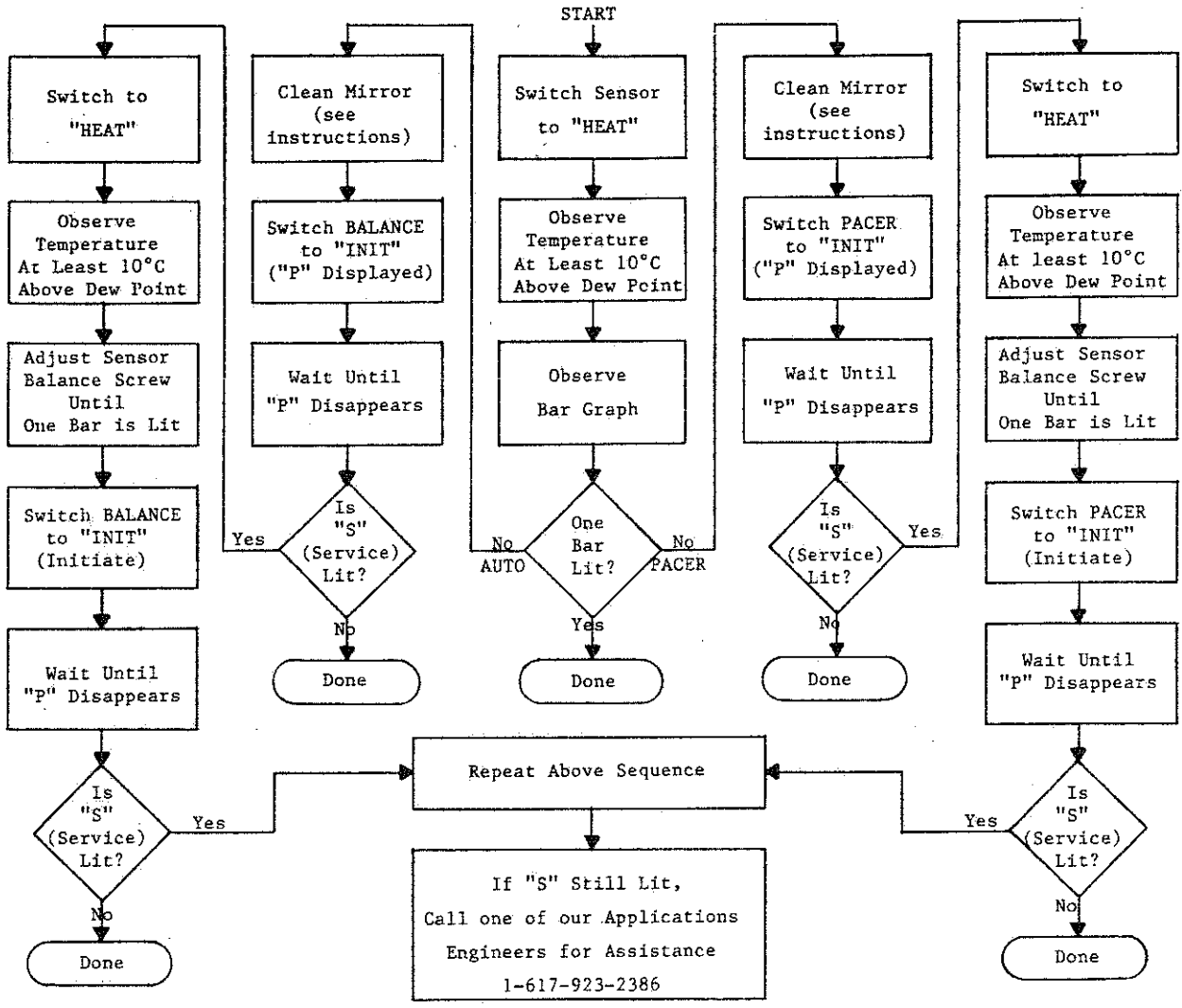


Figure 5-3. Sensor Balance Adjustment Flow Diagram for Hygro-E2

5.2.1 Replacing the Sensor Mirror

Required equipment: Torque wrench set to 20 inch-ounces of torque You can order a General Eastern type TW-1 torque wrench if needed.

1. Open the sensor by removing the sensor cover.

2. Unscrew and discard the old mirror, using a 3/16-inch (0.187) hex socket.

3. The kit supplied by the factory contains the replacement mirror, a container of white thermal compound for proper heat transfer, and (in some models) a mylar washer that goes under the mirror.

4. Use a toothpick or similar tool to place a small amount of thermal compound in the hole into which the mirror is tightened. (Do not apply the compound to the mirror stem.) Do not use an amount large enough to leak out when the mirror is tightened. Do not allow any compound on the mirror surface, as it is very difficult to remove completely.

5. Carefully screw in the new mirror and tighten to the proper torque (20 inch-ounces).

CAUTION

The mirror only protrudes approximately 1/16-inch above the surface. Ensure that the hex socket does not slip off while tightening, as this may mar the new mirror.

6. Carefully clean the mirror surface, using a cotton swab and the General Eastern cleaning solution supplied in the maintenance kit. Alternatively, you can use distilled water or diluted alcohol.

7. Replace the cover and return the sensor to normal operation. Under some circumstances, a new mirror may operate in a somewhat unstable manner for the first one to two hours.

5.2.2 Modification for Platinum Sensor Mirror

If you choose to upgrade from the standard plated copper mirror to the solid platinum mirror in the field, a circuit board change must also be made in the M2/E2. Increase capacitor C4 from 33 microfarads to approximately 68 microfarads, or instability may result.

If you have received a system with the platinum mirror installed at the factory, an additional 33-microfarad capacitor, on nearby pads, has been added in parallel with C4.

If you purchase a platinum mirror to replace a standard mirror, you can return the M2/E2 to the factory for a no-charge circuit board modification. If you prefer to install the modification, General Eastern will supply a field modification kit at no charge. A trained electronics technician with soldering skills is required for proper circuit board modification.

5.3 Test and Calibration for the Hygro-M2

The procedures in this section test and/or calibrate the following aspects of the M2:

- Startup
- Power supply voltage
- Backplane display
- Digital and analog outputs
- Alarms
- PACER board
- High Temperature Interlock

The M2 has been completely tested and calibrated at the factory, and is ready to plug in and operate. As received, it meets all of our published specifications.

When ordered as a complete hygrometer system with a chilled mirror sensor and cable, the M2 is factory-checked at a number of points against a dew point system that has been certified by the U.S. National Institute of Standards and Technology (NIST). A Certificate of Conformance is supplied with the M2 to indicate traceability.

There are no calibration adjustments in the M2 that affect the digital display. The displayed reading is a microprocessor calculation from the platinum Resistance Temperature Detector (RTD) that measures the mirror temperature, which is controlled automatically at the dew point.

Since analog outputs are provided in the M2 for recording or controlling, a digital-to-analog converter is included, which can be adjusted as specified in the analog output calibration procedures of Section 5.3.5.

The following factory test procedures can be performed for incoming inspection or for troubleshooting purposes. They should only be done by a trained electronics technician.

5.3.1 Testing Startup

The following test shows that the M2 CPU and Display boards are operating correctly.

1. Locate the fuse on the M2. See Figure 2-3. Make sure the M2 has the correct fuse rating:
   - 1 A for 115 Vac
   - 0.5 A for 230 Vac

2. With the sensor attached, switch ON the power.

3. For the next 20 seconds, observe that the M2 front panel display is as shown below.

a. The humidity and temperature displays present the following countdown sequence:

999 888 777 666 555 444 333 222 111 000

b. The humidity and temperature displays then show the letters

F
C
H

in sequence, which are the indicators for Fahrenheit, Celsius, and Humidity.

c. The two ALARM indicators flash on and off.

d. The HEAT, COOL, and PACER indicators go on. The PACER indicator remains on until the M2 completes a PACER cycle.

4. When you have observed the above startup sequence, continue to the next procedure for testing the power supply voltage.

5.3.2 Testing Power Supply Voltage

Required equipment: Digital voltmeter.

1. Remove the cover of the M2.

2. Turn on the M2. Observe that the front panel power indicator lights.

3. Locate the Power Supply subassembly, which is mounted on the chassis. Find the J1 connector on the power supply. (See Appendixes G and H for the M2 component layout diagrams and schematics.)

4. J1 serves as Ground. Connect the negative terminal of the voltmeter to pin 6, 7, 8, or 9 of J1 (black wires).

5. Connect the positive terminal of the voltmeter to pin 1, 2, or 3 of J1 (red wires).

6. Observe that the power supply voltage is $+5 \pm 0.25$ Vdc.

7. Relocate the positive terminal of the voltmeter to pin 4 or 5 of J1 (white wires).

8. Observe that the voltage is $+15 \pm 0.75$ Vdc.

5.3.3 Testing the Backplane

Required equipment:

- Digital voltmeter.
- Two precision resistance decade boxes.

1. Connect one of the decade boxes through the dew point input connector, on the rear panel of the M2. (See Figure 2-3 for the location of the dew point input connector.) Use the wiring configuration shown in Figure 5-4.

2. Connect the other decade box through the temperature input connector, on the rear panel of the M2. (See Figure 2-3 for the location of the temperature input connector.) Use the wiring configuration shown in Figure 5-4.

3. After connecting the resistance decade boxes, dial in the following resistance values on each box:

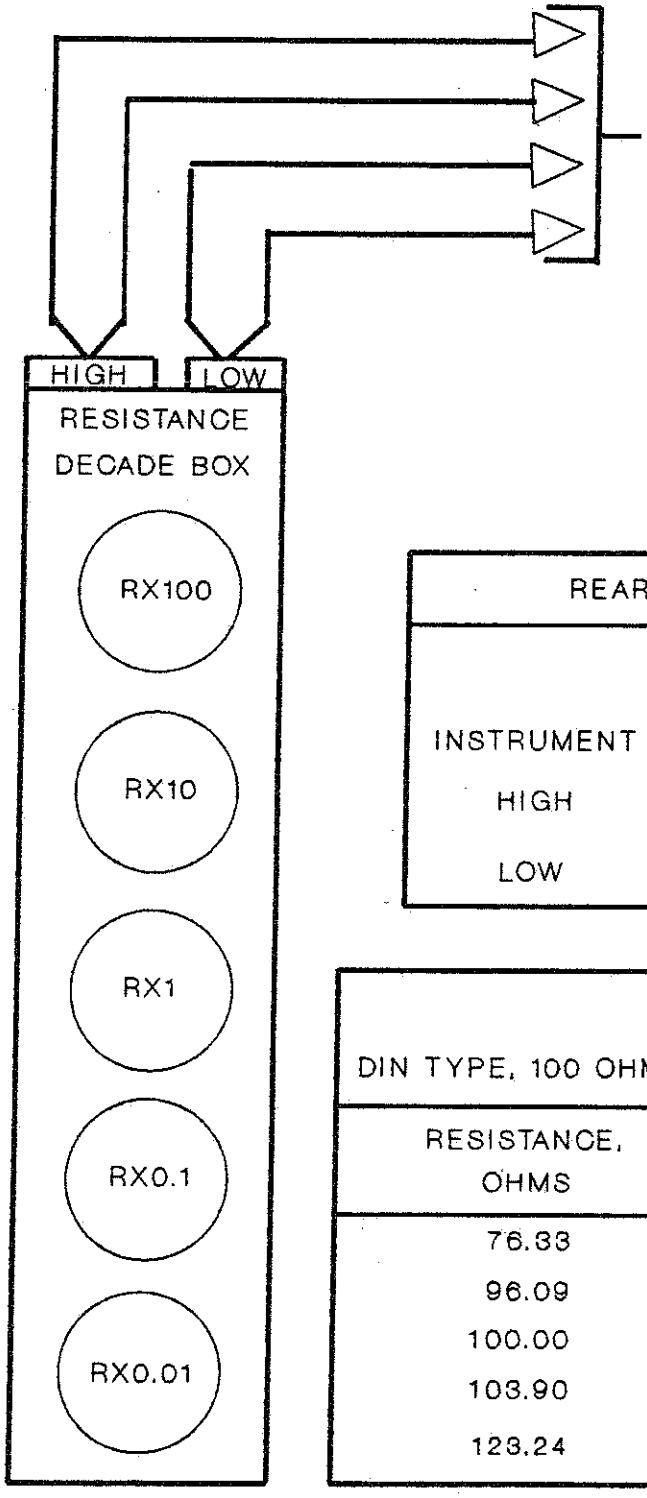
Resistance	Display	
	^{o}C	^{o}F
100.00 ohms	0.0	+32.0
103.90 ohms	+10.0	+50.0
96.09 ohms	-10.0	+14.0
123.24 ohms	+60.0	+140.0
76.33 ohms	-60.0	-76.0

4. The dew point and temperature readings appear on their respective front panel displays. Verify that the Celsius readings are within $\pm 0.1\ ^{o}C$ of the temperatures listed in Step 3 above.

5. Set the dew point display to show Fahrenheit. (Press the C/F switch until "F" appears on the display.) Verify that the Fahrenheit readings are within $\pm 0.18\ ^{o}F$ of the temperatures listed in Step 3 above.

6. Disconnect the cable from the temperature input connector. Observe that the temperature display goes blank. Reconnect the cable.

7. Set both decade boxes for the same resistance, selecting any of the settings shown in Step 3 above. Press the DP/RH selector to select a relative humidity reading (shown by the letter H). Verify that the HUMIDITY display reads 100.0



REAR CONNECTOR PIN NUMBERS		
	DEW POINT	AIR TEMP
INSTRUMENT	M1, M2, M2P, M3	M2 , M3
HIGH	3,15	E,F
LOW	4,14	C,D

RESISTANCE TABLE

DIN TYPE, 100 OHMS AT 0 DEG C, 0.385 OHMS/DEG C

RESISTANCE, OHMS	DISPLAYED READING	
	DEG C(+/-0.1)	DEG F(+/-0.18)
76.33	-60.0	-76.0
96.09	-10.0	14.0
100.00	0.0	32.0
103.90	10.0	50.0
123.24	60.0	140.0

Figure 5-4. Wiring Configuration for Resistance Decade Box

5.3.4 Testing Digital and Analog Outputs

Required equipment:

- Two digital voltmeters.
- Two 100-ohm ±0.01% precision resistors.
- Computer terminal.
- RS-232-C cable to link M2 with computer terminal.

Testing Service Status Voltage

1. Simulate a service condition on the M2 by starting a PACER cycle with no sensor attached.
2. Locate the PACER and SERVICE analog outputs on the Output Terminal Block of the M2. See Figure 2-3.
3. Connect the voltmeter to the PACER output. When the PACER cycle is in progress, the PACER output should be High (3.8 to 4.6 V).
4. Connect the voltmeter to the SERVICE output. When the SERVICE indicator lights on the display, the SERVICE output should be High (3.8 to 4.6 V).
5. During normal operation, observe that the above outputs are Low (less than 1 V).

Scaling Analog Outputs

1. Remove the analog output mating connector on the M2 rear panel.
2. Install the two resistors on the rear panel analog output connector. Connect one resistor between pins 2 and 4 (humidity current output). Connect the other resistor between pins 6 and 8 (temperature current output).
3. Connect the computer terminal to the M2 via the RS-232-C port. See Appendix C for information on configuring and interfacing a computer terminal.
4. Attach both voltmeters as follows:

   Connect the probes of one digital voltmeter across the precision resistor connected to pins 2 and 4 (Step 2).

   Connect the probes of the other digital voltmeter across the precision resistor connected to pins 6 and 8 (Step 2).
5. Turn the M2 on and allow it to go through normal startup.

6. Press ESC on the computer terminal keyboard. The computer displays the following menu:

   1. Scale analog output

   2. Initiate a PACER cycle

   3. Calibrate analog output

NOTE: If you require voltage output (0 to 5 Vdc) instead of current output, simply enter your desired values for the 4 to 20 mA current range on the computer display, i.e., enter a *value* at the 20 mA prompt to apply to 5 Vdc and enter a *value* at 4 mA to apply to 0 Vdc. The 0 to 5 Vdc voltage output scaling is identical to the current scaling.

7. Select "1" and press ENTER. The following menu appears:

   PER CENT RH:
   20 mA = *value*
   4 mA = *value*

   DEW POINT:
   20 mA = *value*
   4 mA = *value*

   AIR TEMPERATURE:
   20 mA = *value*
   4 mA = *value*

   PRESS 1, 2, OR 3 TO UPDATE
   PRESS E TO EXIT

8. To update the percent relative humidity scaling, enter "1".

   All analog output is in the range of 4 to 20 mA (and 0 to 5 Vdc). For the 20 mA value type *100* and press ENTER. This sets 100% relative humidity to 20 mA.

   20 mA = *100*

9. For the 4 mA value type *0* and press ENTER. This sets 0% relative humidity to 4 mA.

   4 mA = *0*

10. To update the dew point scaling, enter "2". If desired, set the dew point range according to the type of sensor your system has. Table 5-1 shows the standard analog output ranges for General Eastern sensors.

TABLE 5-1. Analog Scaling for General Eastern Sensors

Sensor Model No.	Dew Point ^{O}C	Dew Point ^{O}F
1111L, 1111H, 1211H	-40 to +60 ^{O}C	-40 to +140 ^{O}F
SIM-12H	-25 to +100 ^{O}C	-13 to +212 ^{O}F
1311DR, 1311XR	-80 to +20 ^{O}C	-112 to +68 ^{O}F

For example, if you are using the Model 1211H sensor, type *60* (and press ENTER) after the 20 mA prompt. Next type *-40* (and press ENTER) after the 4 mA prompt:

DEW POINT:
20 mA = *60*
4 mA = *-40*

11. To update the air temperature scaling, enter "3".

    For the 20 mA value type *60* and press ENTER. For the 4 mA value type *-40* and press ENTER:

    20 mA = *60*
    4 mA = *-40*

NOTE: The values in Steps 8, 9, 10, and 11 are factory settings. You can change these ranges according to you needs.

5.3.5 Calibrating Analog Outputs

1. Continue with this procedure after completing the analog scaling in Section 5.3.4. To calibrate analog output, type "E" to return to the main menu. Now select "3" from the menu and press ENTER.

    1. Scale analog output
    2. Initiate a PACER cycle
    3. Calibrate analog output

2. The computer asks for "A" or "B". Type "A" and press ENTER.

3. Next, the computer asks for "Slot 2" or "Slot 3". Type "2" and press ENTER.

4. The computer asks for

   Input =

   These are the counts. The digital-to-analog converter is a 10-bit device having 1024 steps (0 to 1023) over the scaled range of 4 to 20 mA and 0 to 5 Vdc.

5. Type *0* and press ENTER.

   Input = *0*

6. Use a small screwdriver to adjust the Zero potentiometer (R9) on the analog output board for a 0.40 ± 0.02 V reading on the voltmeter.

7. Type "E" to return to the input prompt.

8. Type *1023* (5 V) and press ENTER.

   Input = *1023*

9. Adjust the Gain potentiometer (R8) on the analog output board for a 2.00 ± 0.02 V reading on the voltmeter.

10. Type "E" to get the input prompt. Repeat Steps 4 through 9. Adjust the voltage until the output is precise.

11. Switch one set of voltmeter probes to pins 7 and 8 on the analog output connector.

12. Switch the other set of voltmeter probes to pins 3 and 4 on the analog output connector.

13. Perform Steps 4 and 5 above and observe that the voltage is 0.00 ± 0.01 Vdc.

14. Perform Steps 7 and 8 above and observe that the voltage is 5.00 ± 0.025 Vdc.

5.3.6 Testing the Alarms

Required equipment:

- Digital ohmmeter.
- Precision resistance decade box.

Testing the Temperature Alarm

1. Remove the top of the M2.
2. Locate the ALARM relay terminals on the rear panel of the M2.

3. Connect the probes of the ohmmeter to the ALARM terminals: one probe on COM and one probe on NC.

4. Connect the resistance box to the temperature input connector on the rear panel, as shown in Figure 5-4.

5. Locate the Alarm Set switch (protruding through the card cage cover) on top of the analog output board. See Figure 4-1.

6. Press the Alarm Set switch until the front panel display goes blank.

7. Push firmly on the DP/RH selector and keep it depressed until the lower (temperature) display shows °C. The dew point and temperature displays show the following:

Upper display	Lower display
0.0 H	0.0 °C
0.0 °C	32.0 °F
32.0 °F	

8. Release the DP/RH selector when the temperature display indicates °C. (°C is used in this example; °F also can be selected if desired.)

9. Momentarily press the C/F selector until the temperature display goes blank.

10. Using a small screwdriver, turn the Alarm Adjust potentiometer (R5) clockwise and counterclockwise to see that the temperature display ranges from +90 °C to -90 °C.

11. Turn the Alarm Adjust potentiometer fully clockwise. The display should read -95 °C.

12. Set the temperature alarm setpoint by adjusting the Alarm Adjust potentiometer to read the desired alarm setpoint.

13. Press the C/F selector again to return to normal operation.

14. Adjust the decade box so that the temperature display reads above the alarm setpoint. The ALARM indicator should go out. The ohmmeter should read a short (00.0).

15. Continue with the following procedure to check the humidity alarm.

Testing the Humidity Alarm

1. Press the Alarm Set switch until the M2 front panel display goes blank. Observe that the humidity display is blank and the temperature display reads the previous alarm setting.

2. Push firmly on the DP/RH selector and keep it depressed until the upper (humidity) display shows °C. (°C is used in this example; °F or percent RH can also be selected if desired.)

3. Release the DP/RH selector when the humidity display indicates °C.

4. Momentarily press the C/F selector until the humidity display goes blank.

5. Using a small screwdriver, turn the Alarm Adjust potentiometer (R5) fully clockwise. The display should read 100 °C.

6. Set the humidity alarm setpoint by adjusting the Alarm Adjust potentiometer to read the desired alarm setpoint.

7. Adjust the decade box so that the humidity display reads above the alarm setpoint. The ALARM indicator should go on. The ohmmeter should display a short (00.0).

8. Press the C/F selector again to return to normal operation.

5.3.7 Testing the PACER Board

Required equipment: Digital voltmeter.

1. Remove the top of the M2 if it is not already open.

2. Take the PACER board out of the card basket. See Figure 2-1 for the location of the PACER board on the M2.

3. Connect the voltmeter across resistor R2 on the PACER board.

4. Replace the PACER board in the card basket.

5. Set PACER DIP switches 1 and 7 CLOSED (ON). All other switches should be OPEN (OFF). This sets a 3 minute and 42 second PACER cycle duration, with a 12 hour interval. See Table 4-2 for the PACER DIP switch settings.

6. Place a jumper between pins 19 and 20 on the rear panel dew point input connector.

7. Turn the M2 on.

NOTE: The time periods listed below apply when the M2 operates on 60 Hz line frequency. For European (50 Hz) power supplies, increase these time periods by a 6/5 ratio.

8. For the first 30 seconds, observe that the voltmeter reads

   0.23 ± 0.02 Vdc

9. From 30 seconds to 2 minutes 10 seconds, observe that the voltmeter drops to

   0.07 ± 0.02 Vdc

10. From 2 minutes 10 seconds to 2 minutes 40 seconds, observe that the voltage returns to

    0.23 ± 0.02 Vdc

11. From 2 minutes 40 seconds until the PACER cycle completes (PACER indicator goes off), observe that the voltage remains at 0.23 ± 0.02 Vdc.

12. Remove the PACER card from the M2 and disconnect the voltmeter. Return the PACER card to the card basket.

13. Attach a dew point sensor and cable to the M2.

14. Execute a PACER cycle (press the PACER switch on the front panel).

15. Observe that the PACER cycle completes within 220 seconds (3 minutes and 40 seconds).

16. After the PACER indicator goes off, press the HEAT switch. Observe that only the bottom bar of the bar graph is lit. If more than one bar, or less than one bar, is lit, clean the mirror and balance the sensor optics as described in Sections 5.1.1 and 5.1.2.

5.3.8 Testing the High Temperature Interlock

Required equipment:

- Digital voltmeter.
- Precision resistance decade box.

1. Connect the decade box through the M2 rear panel dew point sensor input connector, using the wiring configuration shown in Figure 5-4.

2. Jump pins 17 and 18 on the dew point sensor input connector with a bus wire. Select HEAT mode with the sensor switch.

3. Measure across the R28 0.1 ohm resistor. It should read 0.07 V.

4. Switch to COOL mode and measure again. The R28 should read 0.220 V.

5. Switch the M2 back into HEAT mode.

6. Set the resistance box dial to 140.5 ohms, which is 105.0 ^{o}C. The voltage across the R28 0.1 ohm resistor should go close to 0, activating SHUTDOWN mode.

7. Now decrease the resistance value. When the voltage goes to 0.07 V across R28 (below 103 ^{o}C), the system should reactivate.

8. Remove the jumper on pins 17 and 18. Set the sensor switch to OPERATE.

5.4 Test and Calibration for the Hygro-E2

The procedures in this section test and/or calibrate the following aspects of the E2:

- Startup and power supply voltage
- Normal sensor operation
- Initial and fine calibration
- High temperature interlock
- Digital and analog outputs
- Alarm setpoints

The E2 has been completely tested and calibrated at the factory, and is ready to plug in and operate. As received, it meets all of our published specifications.

When ordered as a complete hygrometer system with a chilled mirror sensor and cable, the E2 is factory-checked at a number of points against a dew point system that has been certified by the U.S. National Institute of Standards and Technology (NIST). A Certificate of Conformance is supplied with the E2 to indicate traceability.

There are no calibration adjustments in the E2 that affect the digital display. The displayed reading is a microprocessor calculation from the platinum Resistance Temperature Detector (RTD) that measures the mirror temperature, which is controlled automatically at the dew point.

Since analog outputs are provided in the E2 for recording or controlling, a digital-to-analog converter is included, which can be adjusted as specified in the analog output calibration procedures of Section 5.4.7.

The following factory test procedures can be performed for incoming inspection or for troubleshooting purposes. They should only be done by a trained electronics technician.

5.4.1 Testing Startup and Power Supply Voltage

Required equipment: Digital voltmeter.

1. Make sure the E2 has the correct fuse rating:

- 1 A for 115 Vac
- 0.5 A for 230 Vac

Locate the fuse on the E2. See Figure 2-4.

2. Set all the display and operating switches to OFF.

   With the sensor attached, switch ON the E2. Monitor the startup voltage across C15. (See Appendix J for E2 component layout diagrams and Appendix K for E2 schematic diagrams.) The voltage should be at least 8.6 V.

3. Disconnect the sensor. While the E2 is ON, measure the power supply voltages after the front display has lit up. Use C15 as ground. Voltages should be as follows:

   BRI (TP1): 10 ± 0.5 V

   Cathode of D2: 18 ± 3 V

   Anode of D4: -8 ± 2 V

   C9 or C20 positive (Digital Supply): 5 ± 0.25 V

   Pin 5 of U2 (LM324): 2.5 ± 0.05 V

5.4.2 Testing Normal Sensor Operation

1. Turn OFF the E2 main power switch.

2. Open the E2 and locate the DIP switch on the main board. See Figure 2-4.

3. Select either the ^{O}F or ^{O}C function, using the DIP switch.

   Set switch 1 ON for ^{O}C.
   Set switch 1 OFF for ^{O}F.

4. Set switch 2 ON. Set switches 3 and 4 OFF. See Table 4-3 for more information on setting the DIP switch.

5. Connect the sensor. Turn ON the power. The front display goes blank, then either ^{O}F or ^{O}C appears on the dew point display, according to the DIP switch setting.

6. Observe the following sequence on the indicator to the right of the main front panel display:

   - One bar appears on the bottom of the indicator.
   - Two more bars appear.
   - A "P" appears on the indicator, indicating that the E2 has started a PACER/AUTO cycle.

7. After the "P" goes off, the sensor is either in CONTROL mode with the green control light on, or an "S" appears on the indicator. If "S" appears, balance the sensor optics as described in Section 5.1.2, or calibrate the E2 according to the next procedure.

5.4.3 Initial Calilbration

Perform this procedure if an "S" appears on the E2 display when you test for normal sensor operation (Section 5.4.2).

Required equipment: Digital voltmeter.

1. Measure between ground (TP5) and pin 1 of U2 (LM324) (R75, right side). If the voltage is not 2.1 ± 0.1 V, place the sensor switch on HEAT and note that the temperature rises.

2. Adjust the voltage for 2.1 ± 0.1 V by using the balance adjustment screw on the sensor. See the optical balance adjustment procedure in Section 5.1.2.

3. After adjusting the voltage, turn off the HEAT cycle and initiate a PACER cycle. At the end of the PACER cycle, the sensor resumes functioning and the "S" disappears. The green control light also comes on.

4. Check the control voltage. It should be between 1.6 and 1.8 V.

5. Start another PACER cycle. Measure the voltage from ground and R35 (top pin) (U23, pin 7). Voltage should be 0.62 ± 0.03 V. When the sensor is balanced, voltage should change rapidly from 0 to 1.

6. Check the control voltage again.

7. Whenever a PACER cycle begins, the sensor cools down until the time voltage on pin 1 drops to 1.5 V or until 90 seconds passes, whichever comes first. The E2 then heats up to 2.6 V, which may take from 4 to 5 minutes, depending on the dew point. When the E2 balances, the following sequence should occur:

   - The voltage reaches 2.1 V ± 0.1 Vdc.
   - The sensor controls within four minutes.
   - The "P" disappears.
   - The green control light comes on.

   If the above sequence does not happen or the dew point display varies more than ± 0.2 ^{o}C, perform the fine calibration procedure below.

5.4.4 Fine Calibration

Perform these fine calibration procedures when initial calibration of the E2 does not produce the results specified above (Section 5.4.3).

Required equipment:

- Digital voltmeter.
- Precision resistance decade box. The resistance decade box simulates the sensor platinum thermometer resistance.

Testing the Thermometry

1. Connect the decade box through the E2 dew point sensor input connector, using the wiring configuration shown in Figure 5-4.

2. After connecting the resistance decade box, check that the following resistance values correspond to the dew point display:

Resistance	^{0}C Display	^{0}F Display
76.33 ohms	-60.0	-76.0
92.16 ohms	-20.0	-4.0
96.09 ohms	-10.0	+14.0
100.00 ohms	0.0	+32.0
103.90 ohms	+10.0	+50.0
123.24 ohms	+60.0	+140.0

Testing the Air Temperature Sensor

1. Turn DIP switch 4 ON to allow measurement of air temperature on the E2. See Table 4-3 for DIP switch settings.

2. Connect the decade box to the following terminals on pin J4 of the E2 air temperature board:

Probe	Pin J4
HIGH	1
HIGH	8
LOW	6
LOW	3

3. After connecting the resistance decade box, check that the following resistance values correspond to the air temperature display:

Resistance	^{0}C Display	^{0}F Display
76.33 ohms	-60.0	-76.0
92.16 ohms	-20.0	-4.0
96.09 ohms	-10.0	+14.0
100.00 ohms	0.0	+32.0
103.90 ohms	+10.0	+50.0
123.24 ohms	+60.0	+140.0

4. Turn DIP switch 4 OFF.

5.4.5 Testing the High Temperature Interlock

Required equipment:

- Digital voltmeter.
- Precision resistance decade box.

1. Connect the decade box through the E2 dew point sensor input connector, using the wiring configuration shown in Figure 5-4.
2. Jump pins 17 and 18 on the dew point sensor input connector with a bus wire. Select HEAT mode with the sensor switch.
3. Measure across the R28 0.1 ohm resistor. It should read 0.07 V.
4. Switch to COOL mode and measure again. The R28 should read 0.220 V.
5. Switch the E2 back into HEAT mode.
6. Set the resistance box dial to 140.5 ohms, which is 105.0 ^{o}C. The voltage across the R28 0.1 ohm resistor should go close to 0, activating SHUTDOWN mode.
7. Now decrease the resistance value. When the voltage goes to 0.07 V across R28 (below 103 ^{o}C), the system should reactivate.
8. Remove the jumper on pins 17 and 18. Set the sensor switch to OPERATE.

Testing Automatic Dew/Frost Point Switching

1. Keep the resistance decade box connected to the E2. Measure the following from C15 (ground) and R16 (bottom pin).
2. Set the resistance box dial to 100.0 ohms (0 ^{o}C). Voltage should be Low (0.160 V $\pm$0.03 V).
3. Select 92.16 ohms (-20 ^{o}C). Voltage should go High (3.62 $\pm$ 0.03 V).
4. Select 97.5 ohms. Voltage stays High.
5. Select 98.5 ohms. Voltage goes Low.

5.4.6 Testing Digital and Analog Outputs

Required equipment:

- Two digital voltmeters.
- Two 100-ohm $\pm$0.01% precision resistors.

- Computer terminal.
- RS-232-C cable to link E2 with computer terminal.

Checking Service Status Voltage

1. Simulate a service condition by starting a PACER cycle with no sensor attached.
2. Locate the PACER and SERVICE outputs in the analog output connector. See Figure 2-4.
3. Connect the voltmeter to the PACER output. When the PACER cycle is in progress, the PACER output should be High (3.8 to 4.6 V).
4. Connect the voltmeter to the SERVICE output. When "S" appears on the display, the SERVICE output should be High (3.8 to 4.6 V).
5. During normal operation, observe that the above outputs are Low (less than 1 V).

Scaling Analog Outputs

1. Remove the analog output mating connector on the main board of the E2.
2. Install the probes of one digital voltmeter between Voltage and Return of J8 on the Humidity analog output of the main board.
3. Install the probes of the other digital voltmeter between Voltage and Return of J1 on the Air Temperature analog output of the air temperature board.
4. Connect the computer terminal to the E2 via the RS-232-C port. See Appendix C for information on configuring and interfacing a computer terminal.
5. Turn the E2 on and allow the it to go through normal startup.
6. Press ESC on the computer terminal keyboard. The computer displays the following menu:

    1. Scale analog output
    2. Initiate a PACER cycle
    3. Calibrate analog output

7. Select "1" and press ENTER. The following menu appears:

PER CENT RH:
20 mA = *value*
4 mA = *value*

DEW POINT:
20 mA = *value*
4 mA = *value*

AIR TEMPERATURE:
20 mA = *value*
4 mA = *value*

PRESS 1, 2, OR 3 TO UPDATE
PRESS E TO EXIT

NOTE: If you require voltage output (0 to 5 Vdc) instead of current output, enter your desired values for the 4 to 20 mA range on the computer display, i.e., enter a *value* at the 20 mA prompt to apply to 5 Vdc and enter a *value* at 4 mA to apply to 0 Vdc. The 0 to 5 Vdc voltage output scaling is identical to the current scaling.

8. To update the percent relative humidity scaling, enter "1". All analog outputs are in the range of 4 to 20 mA (and 0 to 5 Vdc). For the 20 mA value type *100* and press ENTER. This sets 100% relative humidity to 20 mA:

20 mA = *100*

9. For the 4 mA value type *0* and press ENTER. This sets 0% relative humidity to 4 mA:

4 mA = *0*

10. To update the dew point scaling, enter "2". If desired, set the dew point range according to the type of sensor your system has. Table 5-1 shows the standard analog output ranges for General Eastern sensors.

TABLE 5-1. Analog Scaling for General Eastern Sensors

Sensor Model No.	Dew Point ^{O}C	Dew Point ^{O}F
1111L, 1111H, 1211H	-40 to +60 ^{O}C	-40 to +140 ^{O}F
SIM-12H	-25 to +100 ^{O}C	-13 to +212 ^{O}F
1311DR, 1311XR	-80 to +20 ^{O}C	-112 to +68 ^{O}F

For example, if you are using the Model 1211H sensor, type in *60* (and press ENTER) after the 20 mA prompt. Next type in *-40* (and press ENTER) after the 4 mA prompt:

DEW POINT:
20 mA = *60*
4 mA = *-40*

11. To update the air temperature scaling, enter "3".

    For the 20 mA value type *60* and press ENTER. For the 4 mA value type *-40* and press ENTER:

    20 mA = *60*
    4 mA = *-40*

NOTE: The values in Steps 8, 9, 10, and 11 are factory settings. These ranges can be modified as desired.

12. This sets the analog output range. When you type "E", the computer displays the main menu again. Now continue with the next procedure to calibrate the analog output.

5.4.7 Calibrating Analog Outputs

Calibrating Dew Point Analog Output

1. Select "3" from the main menu to calibrate the dew point analog output on the E2. The computer asks for

   Input =

   These are the counts. The digital-to-analog converter is a 10-bit device having 1024 steps (0 to 1023) over the scaled range of 4 to 20 mA and 0 to 5 Vdc.

2. Type *0* and press ENTER.

   Input = *0*

3. Using a small screwdriver, adjust R33 on the main board for 0.00 V output.

4. Press ENTER. The computer prompts for input.

5. Type *1023* (5 V) and press ENTER.

   Input = *1023*

6. Adjust R32 for 5.00 V output.

7. Press ENTER to get the input prompt. Repeat Steps 2 through 5. Adjust the voltage until the 0 to 5 V output is precise.

8. Press ENTER to get the input prompt. Type *511* and press ENTER. The voltmeter displays 2.50 V.

9. Switch the meters to read mA. Connect one meter to the analog output connector (J8) on the main board.

10. Switch the meters to read mA. Connect the other meter to the analog output connector (J1) on the air temperature board, between Current and Return.

11. Press ENTER to get the input prompt. Type *0* (4 mA). Press ENTER.

    Input = *0*

12. Adjust R47 for 4.00 mA output.

13. Press ENTER to get the input prompt. Type *1023* (20 mA). Press ENTER.

    Input = *1023*

14. Adjust R48 for 20.00 mA output.

15. Press ENTER. Repeat Steps 10 through 13. Adjust the current until the 4 to 20 mA output is precise.

16. Press ENTER to get the input prompt. Type *511* and press ENTER. The voltmeter displays 12.00 mA.

17. Type "E" and press ENTER to return to the main menu. The scale analog output menu appears again with the new values. Type "E" to exit the program.

Calibrating Air Temperature Analog Output

1. Select "3" from the main menu to calibrate air temperature analog output on the E2. The computer asks for

   Input =

   These are the counts. The digital-to-analog converter is a 10-bit device having 1024 steps (0 to 1023) over the scaled range of 4 to 20 mA.

2. Type *0* and press ENTER.

   Input = *0*

3. Using a small screwdriver, adjust R12 on the air temperature board for 0.00 V output.

4. Press ENTER. The computer prompts for input.

5. Type *1023* (5 V) and press ENTER.

   Input = *1023*

6. Adjust R11 for 5.00 V output.

7. Press ENTER to get the input prompt. Repeat Steps 2 through 6. Adjust the voltage until the 0 to 5 V output is precise.

8. Press ENTER to get the input prompt. Type *511* and press ENTER. The voltmeter displays 2.50 V.

9. Switch the meter to read mA and connect it to the Current connector on the Output Terminal Block.

10. Press ENTER to get the input prompt. Type *0* (4 mA). Press ENTER.

    Input = *0*

11. Adjust R4 for 4.00 mA output.

12. Press ENTER to get the input prompt. Type *1023* (20 mA). Press ENTER.

    Input = *1023*

13. Adjust R5 for 20.00 mA output.

14. Press ENTER. Repeat Steps 10 through 13. Adjust the current until the 4 to 20 mA output is precise.

15. Press ENTER to get the input prompt. Type *511* and press ENTER. The voltmeter displays 12.00 mA.

16. Type "E" and press ENTER to return to the main menu. The scale analog output menu appears again with the new values. Type "E" again to exit the program.

5.4.8 Testing the Alarm Setpoint

Required equipment:

- Digital ohmmeter.
- Precision resistance decade box.

Testing the Temperature Alarm

1. Open the E2.
2. Locate the ALARM relay terminals on J1 of the air temperature board. See Figure 2-4.
3. Connect the probes of the ohmmeter to the ALARM terminals: one probe on COM and one probe on N.O.
4. Connect the resistance box as shown in Figure 5-4.
5. Locate the Alarm Set switch (SW1) on the analog output board. See Figure 4-2.
6. Place the Alarm Set switch in the ON position. The front panel display will go blank.
7. Hold the SENSOR switch in the COOL position. The following sequence occurs:

   Humidity display shows %RH
   Humidity display shows ^{o}C
   Humidity display shows ^{o}F
   Temperature display shows ^{o}C
   Temperature display shows ^{o}F

8. Release the SENSOR switch when the desired parameter for setting the alarm appears.

NOTE: You can only program the alarm relay for one parameter, either dew point, percent relative humidity, or air temperature.

9. Place the SENSOR switch to the HEAT position.
10. Using a small screwdriver, turn the Alarm Adjust potentiometer to the desired alarm setpoint.
11. Return the SENSOR switch to the OPERATE position.

12. Return the Alarm Set switch to the OFF position.

13. Adjust the decade box so that the display reads above the alarm setpoint. The ALARM indicator should go ON. The ohmmeter should read 0 ohms.