



User's Guide

Only model 869C has
CE certification



P/N: OM-29A Rev E
Publication Date: March 2015



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868F and 869C Handheld RTD Thermometers

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WARNING: These products are not designed for use in, and should not be used for, patient connected applications.

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SECTION 1 INTRODUCTION

1.1 GENERAL DESCRIPTION

The OMEGA® Model 868 and 869 Digital Thermometers are designed to use 100 ohm ($\alpha = .00385$) platinum RTD (resistance temperature detector) sensors for high accuracy and long-term temperature stability. The Model 868 has two switch-selectable ranges: from -199.9° to +199.9°F with 0.1°F resolution, and between -360° and +1100°F with 1°F resolution. The Model 869 measures between -199.9° and +199.9°C with 0.1°C resolution, or between -220° and +630°C with 1°C resolution. Both instruments are designed for use with probes conforming to the DIN 43760 standard.

1.2 FEATURES

- Platinum RTD Based Temperature Measurements. A chief advantage of the platinum RTD sensor is platinum's predictable resistance change with temperature, resulting in high accuracy.
- Easily Selected Three or Four Wire Measurements. The unit may be used with either three wire or four wire temperature probes. An internal jumper provides easy selection.
- Rugged case of high impact plastic.
- Long Battery Life. Because of low power consumption, an alkaline battery will typically last for 500 hours of continuous operation.

SECTION 2 INSTALLATION

2.2 UNPACKING

Remove the Packing List and verify that all equipment has been received. If there are any questions about the shipment, please call OMEGA Customer Service Department.

Upon receipt of shipment, inspect the container and equipment for any signs of damage. Take particular note of any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE

The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing contents, save packing material and carton in the event reshipment is necessary.

2.2 BATTERY INSTALLATION

A nine volt battery is supplied with the instrument but is not installed, to avoid possible damage due to leakage during storage or shipment. Install the battery as follows:

1. Remove the instrument back cover.
2. Insert the battery in place; make sure correct polarity is observed and battery terminals are contacting the battery clips.
3. Install back cover.

SECTION 3 OPERATION

3.1 SAFETY PRECAUTION AND NOTES

WARNING

Do not subject the probe to a voltage more than 30 V RMS, 42.4 V peak above earth ground, or a shock hazard may result.

NOTE

Use only 100 ohm platinum RTD sensors that conform to the DIN 43760 standard ($\alpha = .00385$). Other type sensors will give inaccurate results. Maximum allowable lead resistance for rated accuracy is 50 ohms per lead (four wire) or 10 ohms per lead (three wire).

NOTE

For best accuracy, it is recommended that the instruments be used in the four wire configuration with a suitable four wire probe. If three wire probes are used with the instrument in the four wire mode, noisy readings will result (the displayed reading will jump around).

3.2 CONTROL AND DISPLAY

Figure 3-1 shows the control layout and nomenclature. The following paragraphs contain information on probe connection, three and four wire selection, range selection, and basic temperature measuring procedures.

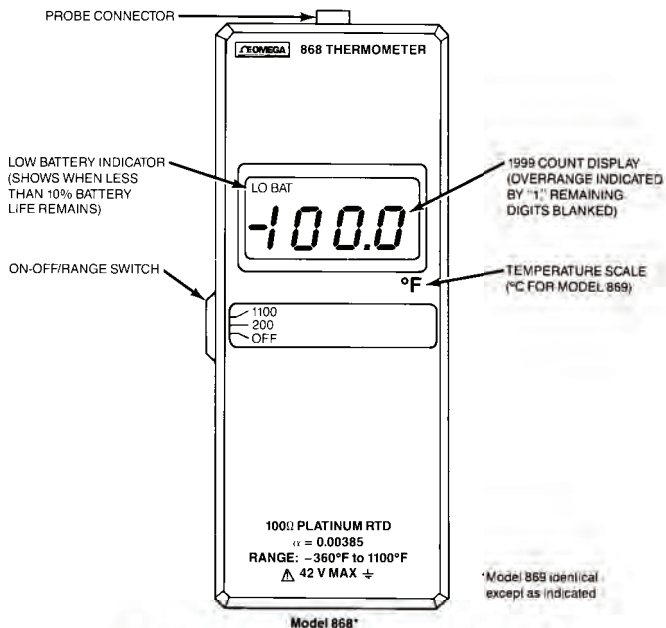


Figure 3-1. Control Layout, Model

3.3 OPERATING PROCEDURE

NOTE

The instrument is factory set for four wire operation. It can be easily changed for three wire use. Refer to paragraph 3.5.

1. Connect the temperature probe to the input connector at the top of the instrument.
2. Place the temperature range switch in the desired position. Use the lower range, when possible, for best resolution and accuracy. Power is automatically turned on when the range is selected.
3. Place the probe tip on or in the material to be measured.
4. The display will indicate the temperature at the tip of the probe in °F (model 868) or °C (model 869). An overrange condition (a "1" followed by blanked digits) may indicate the need to switch to a higher range, or show that the temperature is outside the measuring range of the instrument, or that the probe is open.

5. When the measurement is complete, place the ON-OFF/RANGE switch in the OFF position to conserve the battery.

3.4 ACCURACY CONSIDERATIONS

Model	Setting	Range	Accuracy
868F	200 °F	-100.0 °F to 199.9 °F -199.9 °F to -100.1 °F	± 0.4 °F ± 1.0 °F
	1100 °F	-100 °F to 1100 °F -360 °F to -101 °F	± 2 °F ± 4 °F
869C	200 °C	-100.0 °C to 199.9 °C -199.9 °C to -100.1 °C	± 0.3 °C ± 1.5 °C
	630 °C	-100 °C to 630 °C -220 °C to -101 °C	± 1 °C ± 2 °C

Keep in mind that these accuracy figures are for four wire probe operation with a lead resistance of less than 50 ohms (each lead). Three wire RTDs will afford the same accuracy if the lead resistance is kept below 10 ohms (each lead). Particularly in an acid fume environment, contact resistance for three wire RTDs should be compensated for by calibrating at 32°F (0°C) with the probe used.

Accuracy figures do not include possible probe errors, which could affect overall measurement accuracy. Probe errors near 32°F for the Model 868, and near 0°C for the Model 869, can be minimized by recalibrating the instrument for use with a specific probe. For probe calibration procedures, refer to paragraph 5.2.

The operating temperature of the instrument itself can affect accuracy. The accuracy figures given above are for an instrument operating in the range of 65° to 82°F (18° to 28°C). For operating environments between 14° and 65°F (-10° and 18°C) and between 82° and 122°F (28° and 50°C), a temperature coefficient of less than ±0.15 °F/°F (±0.15°C/°C) can be expected.

3.5 THREE WIRE OR FOUR WIRE OPERATION

The instrument has been set for four wire operation at the factory, but the mode of operation may be changed as follows:

1. Remove the back cover.
2. Set the 3 WIRE/4 WIRE jumper (see Figure 3-2) to the desired position, as indicated in figure 3-2.
3. Replace the back cover.

NOTE

Figure 3-3 shows wiring schematics for three wire and four wire probe connections.

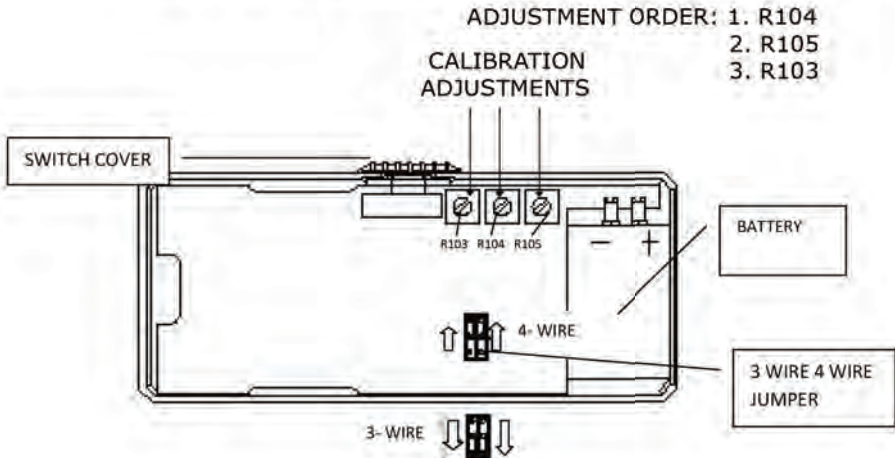


Figure 3-2. Component Locations

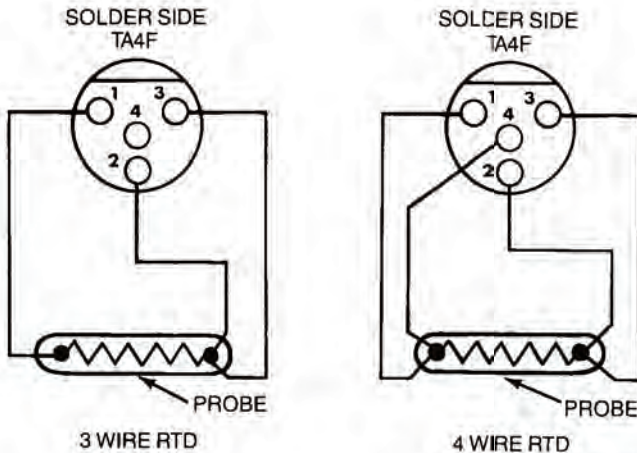


Figure 3-3. Three Wire and Four Wire Probe Connections

SECTION 4 THEORY OF OPERATION

This section contains a brief description of operation that should help a technician in understanding instrument operation during a measurement, to aid in isolating possible malfunctions. Detailed schematics of each model are provided at the end of the manual.

4.1 THREE WIRE SIGNAL CONDITIONING

Two phases are necessary to condition the signal for digitization. Each of these phases has a period of one-half the A/D converter back plane (BP) period. These two phases are called the zero phase and the signal phase, respectively. During each phase, appropriate FETs are switched on to configure the circuit as required.

4.1.1 Zero Phase

During the zero phase, certain FETs are switched on to configure the circuit shown in Figure 4-1. This circuit operates similarly to a sample-and-hold circuit, in which voltage levels are capacitively stored for later use. The following summarizes this function.

1. C_R is connected across R_R . The voltage charged on C_R is equal to $I R_R$.
2. C_Z is connected across $R_Z + L$ through L_Z . The voltage charge on C_Z is equal to $I[R_Z + L]$.

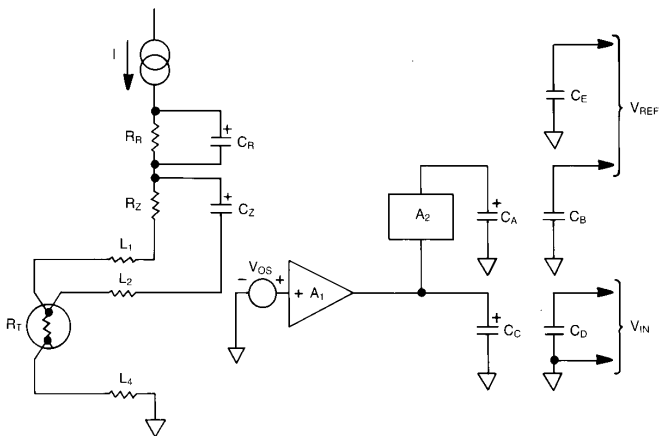


Figure 4-1. Three Wire Zero Phase

3. The input of A_1 is connected to ground. The output of A_1 is equal to $[A_1V_{os}]$.
4. C_C is connected between the output of A_1 and common. The voltage charged on C_C is equal to the output voltage of A_1 or $[A_1V_{os}]$.
5. C_A is connected between the output of the A_2 network and common. The voltage charged on C_A is equal to the output voltage of A_1 attenuated by A_2 or $[A_1A_2V_{os}]$.

4.1.2 Signal Phase

During the signal phase, the FET switching configuration changes so that the voltages developed during the zero phase are connected to the A/D converter. The configuration during the signal phase is shown in Figure 4-2. The following discussion assumes that the circuit has gone through more than one charge transformation:

1. C_R is connected across C_E and after a sufficient number of zero and signal phases the voltage on C_E approaches that stored on C_R . That voltage is equal to IR_R .
2. C_Z is connected between L_2 and the input of A_1 in a way that opposes the voltage drop across R_T and L_4 . Since the voltage charged on C_Z is $I(R_Z + L_1)$ the voltage at the output of A_1 is

$$[A_1(I(R_T + L_4) - I(R_Z + L_2) + V_{os})]$$

or

$$[A_1(I(R_T - R_Z + L_4 - L_1) + V_{os})]$$

R_Z is made to equal the value of R_T at 0° . This action eliminates the offset of R_T (100Ω at $0^\circ C$).

3. C_C is connected between the output of A_1 and the top of C_D in such a way that opposes the output of A_1 . The voltage charged on C_D is

$$A_1(I(R_T - R_Z + L_4 - L_1) + V_{os}) - A_1V_{os}$$

or

$$A_1I(R_T - R_Z + L_4 - L_1)$$

If L_4 exactly equals L_1 then this reduces to $A_1I(R_T - R_Z)$.

4. C_A is connected between the output of the A_2 network and the top of C_B in such a way that opposes the output of A_2 . The voltage charged on C_B is

$$A_1A_2(I(R_T - R_Z + L_4 - L_1) + V_{os}) - A_1A_2V_{os}$$

or

$$A_1A_2I(R_T - R_Z + L_4 - L_1)$$

If L_4 exactly equals L_1 then this reduces to $A_1A_2I(R_T - R_Z)$.

Due to this two phase measurement V_{OS} and lead resistance effects are eliminated provided the lead and contact resistances are equal. The voltages developed across C_B , C_D and C_E are digitized by the A/D converter. The basic dual slope converter transfer function for $3\frac{1}{2}$ digits is

$$\text{DISPLAY} = 1000 (V_{in_H} - V_{in_L}) / (V_{ref_H} - V_{ref_L})$$

V_{ref_H} is equal to the voltage charged on C_E or

$$V_{ref_H} = IR_R$$

V_{ref_L} is equal to the voltage charged on C_B or

$$V_{ref_L} = A_1 A_2 I (R_T - R_Z)$$

$V_{in_H} - V_{in_L}$ is equal to the voltage charged on C_D or

$$V_{in_H} - V_{in_L} = A_1 I (R_T - R_Z)$$

The display is then given by the transfer function.

$$\text{DISPLAY} = 1000 A_1 I (R_T - R_Z) / (IR_R - A_1 A_2 I (R_T - R_Z))$$

$$\text{DISPLAY} = 1000 A_1 (R_T - R_Z) / (R_R - A_1 A_2 (R_T - R_Z))$$

Note that the value of the divider current (I) is not critical.

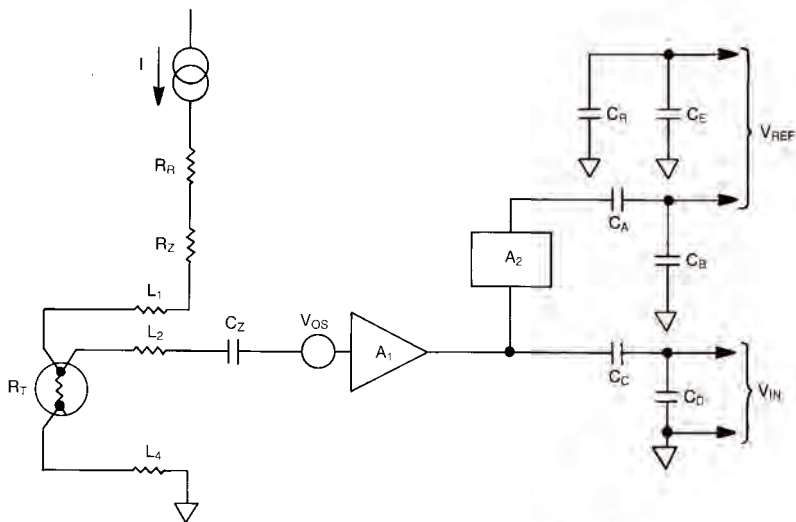


Figure 4-2. Three Wire Signal Phase

4.2 FOUR WIRE SIGNAL CONDITIONING

There are two phases necessary to condition the signal for digitization. Each phase lasts for a period equal to one-half of the back plane period of the A/D converter. These are called the zero and signal phase.

4.2.1 Zero Phase

During the zero phase, FETs are switched to configure the circuit shown in Figure 4-3. The fourth wire adds an additional attenuation that slightly increases the offset voltage at the input to amplifier A_1 .

1. C_R is connected across R_R . The voltage charged on C_R is equal to IR_R .
2. C_Z is connected across R_Z . The voltage charge in C_Z is equal to IR_Z .
3. The input of A_1 is connected through L_3 . Since, ideally, zero current flows into A_1 the voltage at the output of A_1 is equal to $[A_1(IL_4 + Vos)]$.
4. C_C is connected between the output of A_1 and common. The voltage charged on C_C is equal to the output voltage of A_1 or $[A_1(IL_4 + Vos)]$.
5. C_A is connected between the output of the A_2 network and common. The voltage charged on C_A is equal to the output voltage of A_1 attenuated by A_2 or $[A_1A_2(IL_4 + Vos)]$.

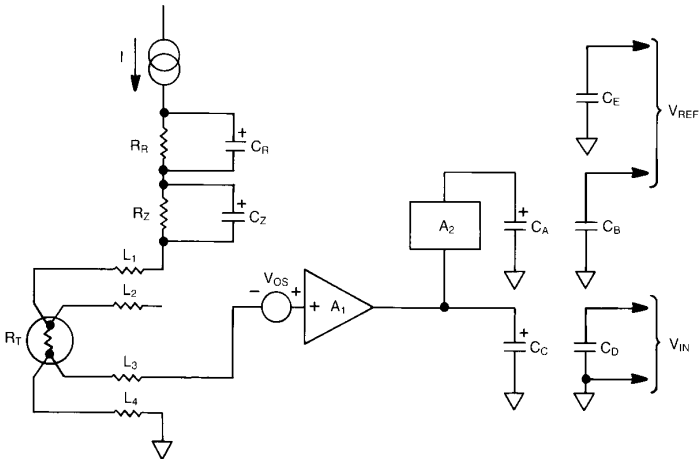


Figure 4-3. Four Wire Zero Phase

4.2.2 Signal Phase

During the signal phase the 4 charged values of voltage are transferred to other parts of the circuit (refer to simplified Figure 4-4). The following explanations assume more than one charge transfer has taken place.

1. C_R is connected across C_E and after a sufficient number of zero and signal phases the voltage on C_E approaches that stored on C_R . That voltage is equal to IR_R .
2. C_Z is connected between L_2 and the input of A_1 in a way that opposes the voltage drop across R_T and L_4 . Since the voltage charged on C_Z is IR_Z the voltage at the output of A_1 is

$$[A_1(I(R_T + L_4) - IR_Z + Vos)]$$

or

$$A_1(I(R_T - R_Z + L_4) + IR_Z + Vos)$$

R_Z is made to equal the value of R_T at $0^\circ C$. This action eliminates the offset of R_T (100Ω at $0^\circ C$).

3. C_D is connected between the output of A_1 and the top of C_D in such a way that opposes the output of A_1 . The voltage charge on C_D is

$$A_1(I(R_T - R_Z + L_4) + Vos) - A_1(IL_4 + Vos)$$

or

$$A_1(I(R_T - R_Z))$$

4. C_A is connected between the output of the A_2 network and the top of C_B in such a way that opposes the output of A_2 . The voltage charged on C_B is

$$A_1A_2(I(R_T - R_Z + L_4) + Vos) - A_1A_2(IL_4 + Vos)$$

or

$$A_1A_2(I(R_T - R_Z))$$

Due to this two phase measurement Vos and lead resistance effects are eliminated.

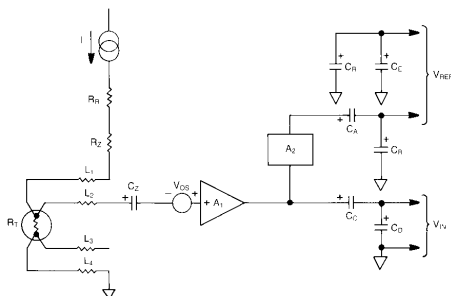


Figure 4-4. Four Wire Signal Phase

The voltages developed across C_B , C_D and C_E are digitized by the A/D converter. The basic dual slope converter transfer function for $3\frac{1}{2}$ digits is

$$\text{DISPLAY} = 1000 (V_{in_H} - V_{in_L}) / (V_{ref_H} - V_{ref_L})$$

V_{ref_H} is equal to the voltage charged on C_E or

$$V_{ref_H} = IR_R$$

V_{ref_L} is equal to the voltage charged on C_B or

$$V_{ref_L} = A_1 A_2 I (R_T - R_Z)$$

$V_{in_H} - V_{in_L}$ is equal to the voltage charged on C_D or

$$V_{in_H} - V_{in_L} = A_1 I (R_T - R_Z)$$

The display is then given by the transfer function.

$$\text{DISPLAY} = 1000 A_1 I (R_T - R_Z) / (IR_R - A_1 A_2 I (R_T - R_Z))$$

$$\text{DISPLAY} = 1000 A_1 I (R_T - R_Z) / (R_R - A_1 A_2 I (R_T - R_Z))$$

Note that the value of the divider current (I) is not critical.

4.3 ANALOG-TO-DIGITAL (A/D) CONVERTER

The A/D converter (display driver) consists of the IC U102 and external resistors and capacitors as shown in the applicable schematic. The network forms a dual-slope, integrating voltage-to-display converter. The instrument battery is connected to U102 terminal 1 (+) and terminal 26 (-) and controlled by switch S101B. The A/D reference voltage is derived from capacitors C_R/C_E (see Figure 4-1). The temperature reading input is the IN HI signal derived from capacitors C_C/D_D and is processed to drive the display. If IN HI voltage falls below REF HI, a sign signal is output to the external polarity detector and to the display to light the negative (-) indicator.

4.4 POLARITY DETECTOR

The polarity detector decodes the sign signal supplied by the A/D converter by using an EXOR gate U101D. The output is filtered by R101 and C101 to eliminate unwanted race conditions. This signal controls the state of MUX gate U104A which modifies the A_2 attenuation constant on negative readings for better conformity.

4.5 FET DRIVERS

The FETs control the zero and signal phases of the measurement cycle. These analog switch FETs are controlled by U104B and U104C. A FET is turned on by placing the gate at analog common. Conversely, each FET is turned off by placing the gate at -V potential. U104B drives the FETs used for the zero phase, while U104C drives the FETs used for the signal phase.

4.6 LOW-BATTERY DETECTOR

Low-battery detection is accomplished by comparing the regulated voltage between V+ and common to the output of the voltage divider (R107 and R110), which is connected across the battery. When the battery voltage decreases, the output of the voltage divider rises above analog common, causing comparator U103A to change state. This action enables the LO BAT annunciator on the display.

SECTION 5 SERVICE INFORMATION

5.1 DISASSEMBLY

The instrument must be opened to replace the battery, to select three or four wire operation, or for calibration. Troubleshooting or parts replacement may require more complete disassembly (see Figure 5-1). The sequence below describes the basic procedure for disassembling the instrument.

1. Remove the back cover.
2. At this point, you obtain access to replace the battery, select three wire or four wire operation, or perform calibration. Replace cover.
3. To remove the PC board, unscrew the standoff securing the board to the front case. The board may now be pulled free, although the wires to the probe jack will still be attached. When the board becomes free of the case, the switch cover will pull free as well. If necessary, the board can be pulled completely free by detaching the wires at the board end. The probe jack may then be removed, if necessary, by removing the nut securing it to the case and pushing the jack free from the inside.

CAUTION

Handle the PC board only at the edges, whenever possible, to avoid possible contamination, which could degrade instrument performance.

4. The LCD assembly may be removed from the PC board by carefully spreading the clips that secure the display to the board. Once the assembly is free of the board, the various parts will be loose, so handle the LCD with care.

CAUTION

Do not touch the elastomer contact strips or mating surfaces on the PC board. Also, use care when spreading the clips to avoid breaking them.

5. The instrument may be reassembled by reversing the above procedure, using Figure 5-1 as a guide. When assembling the instrument, take special note of the following points:
 - A. If the LCD was removed, be sure it is aligned properly on the board, with the clips fitted properly into the notch on each side of the board.
 - B. If the probe jack was disconnected, make certain the wires are connected properly. The wire colors are marked on the PC board.
 - C. Make sure the PC board is properly secured to the front case with the standoff. The switch cover should be placed on the switch when installing the PC board.
 - D. Once the rear cover is in place, secure it with the attachment screws.

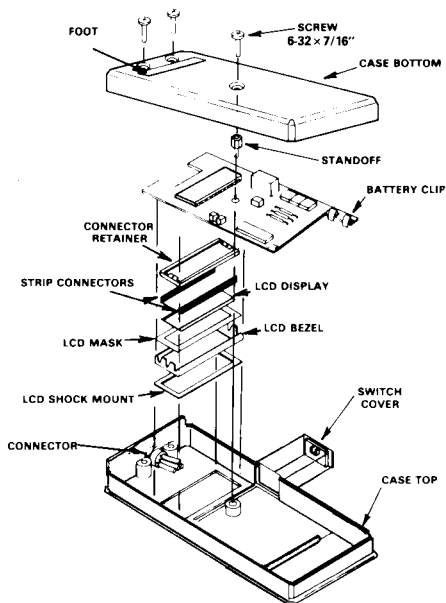


Figure 5-1. Exploded View

5.1 CALIBRATION

Calibration should be performed yearly or whenever the instrument is known to be out of specification. Calibration should be done at an ambient temperature of $23 \pm 1^\circ\text{C}$ at a relative humidity of less than 80%. Normal instrument calibration is performed by substituting precision resistors of known value for the temperature probe and adjusting calibration potentiometers for specified readings on the display. The instrument may also be calibrated to compensate for probe errors near 0°C (32°F). Both procedures are covered in this section.

Equipment Required:

Precision decade resistor box, $\pm 0.01\%$ tolerance

Female four wire instrumentation connector (supplied with instrument)

The following items are necessary only for probe compensation:

Distilled ice water bath in dewar flask or Thermos[®].

100 Ohm ($\alpha = .00385$) Platinum RTD immersion probe.

1. Connect the precision decade resistor box to the instrument as shown in Figure 5-2.
2. Remove the rear cover as described in the disassembly instructions. Note that it is not necessary to remove the PC board to perform calibration.
3. Check to see that the 3 WIRE/4 WIRE jumper is in the 4 WIRE position.
4. Turn on the instrument power and verify that the LO BAT indicator is not displayed. If it is, replace the battery before beginning the calibration procedure.
5. Refer to Table 5-1. Calibration procedures are outlined here. Perform each step in the procedure in the order shown, by setting the decade box to the precise value listed and then adjusting the associated calibration potentiometer for the required reading on the display. Potentiometer locations are shown in Figure 3-2.
6. If probe compensation is required, proceed to the next paragraph; otherwise dismantle the test fixture and replace the back cover.

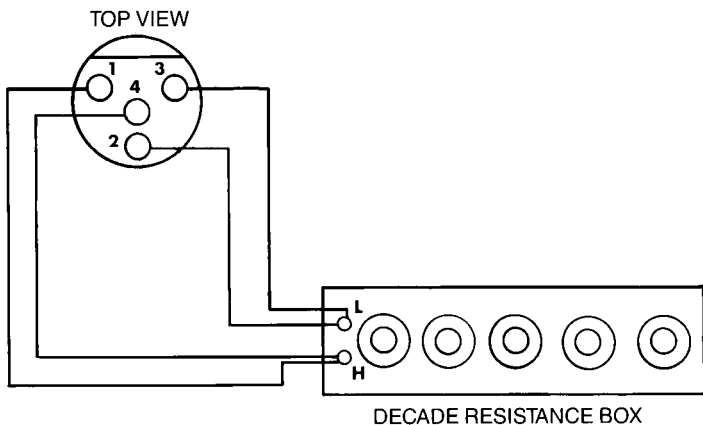


Figure 5-2.
Connections for Performance Verification and Calibration

Table 5-1
Calibration

MODEL 868				
STEP	ADJUSTMENT POTENTIOMETER	(°F) RANGE	CALIBRATION RESISTOR VALUE (Ω)	DESIRED READING
1	R104	200°F	93.03 Ω	00.0
2	R105	200°F	134.91 Ω	195.0
3	R103	1100°F	311.45 Ω	1100.0

MODEL 869				
STEP	ADJUSTMENT POTENTIOMETER	(°C) RANGE	CALIBRATION RESISTOR VALUE (Ω)	DESIRED READING
1	R104	200°C	100.00 Ω	00.0
2	R105	200°C	174.00 Ω	195.0
3	R103	630°C	313.59 Ω	600.0

5.3 PROBE COMPENSATION

The procedure outlined in the last paragraph provides accurate absolute instrument calibration, but it cannot compensate for probe inaccuracy. Probe errors near 32°F (0°C) can be minimized by using the following procedure.

1. Make up an ice water bath by firmly packing a dewar flask or Thermos with pea-size ice cubes made of distilled water and then filling the container with distilled water. Replace melted ice with new ice while removing excess water during the calibration procedure.
2. Connect the probe to be compensated to the instrument.
3. Drill a hole in the flask or Thermos cap just large enough to accommodate the probe. Place the cap on the bath container and pass the probe through the hole until the probe tip rests at the center of the ice water bath.
4. Allow 20 minutes for the test fixture temperature to stabilize. With the model 868 on the 200°F range, adjust R104 for a reading of 32.0 on the display. For the Model 869, R104 should be adjusted for a reading of 00.0 with the instrument on the 200°C range.

NOTE

Using this method of probe calibration will uncalibrate the instrument slightly when used with other probes.

5.4 TROUBLESHOOTING

The troubleshooting information, along with appropriate schematics and parts lists, are included to serve as a guide to enable equipment repair. The schematics and parts lists may vary slightly from actual production units and are to be used as a guide only. Likewise, the troubleshooting section is a guide only and cannot cover all possible contingencies that may occur.

Each Model 868 and 869 is covered by a 13 month warranty as described on the inside front cover of this manual. Warranty will be void if the unit shows evidence of having been tampered with.

To gain access to the PC board for troubleshooting, the rear cover and internal shield must be removed, as described in the disassembly instructions. When troubleshooting or replacing components, handle the PC board only by the edges to avoid possible contamination.

Recommended Equipment: Digital Multimeter (DMM) with 10 megohm input resistance, $\pm 0.05\%$ basic accuracy; triggered sweep oscilloscope with dc to 10 MHz bandwidth.

5.4.1 Voltage Checks

Several voltage checks can be made simply by connecting a DMM to various A/D converter IC pins. Table 5-2 summarizes these voltage readings.

**TABLE 5-2
VOLTAGE CHECKS**

STEP	ITEM/COMPONENT	REQUIRED CONDITION	COMMENTS
1	Connect DMM HI to +V		Leave connected for all voltage checks.
2	Connect DMM LO to U102, pin 26 (-V)	$>7.2\text{ V dc}$	Battery voltage
3	Connect DMM LO to U102, pin 37 (TEST)	$5\text{V} \pm 1\text{V dv}$	Digital Common
4	Connect DMM LO to U102, pin 30	$\approx 3\text{ V}$	IN LO (COM)

5.4.2 A/D Converter Checks

A/D converter operation can be checked by measuring the input and reference voltages and then comparing the displayed reading to a value calculated from these input voltages.

1. Connect a temperature probe to the instrument; make sure the temperature remains stable while making voltage measurements.
2. Connect the DMM LO terminal to analog common (pin 32 of U102).
3. Connect the DMM HI terminal to pin 31 (IN HI) of U102 and record the reading.
4. Connect the DMM HI terminal to pin 30 (IN LO) of U102 and record the reading.
5. Connect the DMM HI terminal to pin 35 (REF HI) of U102 and record the voltage.
6. Connect the DMM HI terminal to pin 36 (REF LO) and record the reading

Using the measured values above, calculate the displayed reading (neglecting the decimal point) as follows:

$$\text{Display} = 1000 \frac{(\text{IN HI} - \text{IN LO})}{(\text{REF HI} - \text{REF LO})}$$


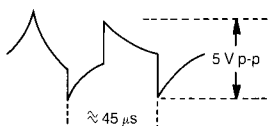

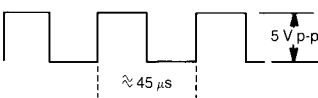

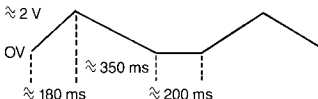

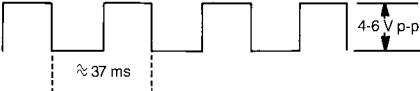
If the displayed value does not agree with the calculated value to within a few digits, the A/D converter is not functioning properly.

5.4.3 Waveform Checks

Several A/D converter waveform checks can be made using an oscilloscope along with the information in Table 5-3.

1. Connect the oscilloscope LO input to analog common U102, pin 32.
2. Connect the oscilloscope HI input to the A/D converter pin indicated in the table.
3. Select an appropriate time base, input attenuator setting, and trigger mode to stabilize the display.
4. Compare the displayed waveform with the corresponding drawing in Table 5.3.

**TABLE 5-3
WAVEFORM CHECKS**

CONNECTIONS	WAVEFORM
Pin 40 to (OSC 1) 	
Pin 39 to (OSC 2)  Pin 38 same as 39 (OSC 3)	
Pin 27 to  (with — full scale input of about 1900 counts (integrator)	
Pin 21 to (Backplane) 	

5.5 STATIC-SENSITIVE PARTS

MOS devices are designed to operate at very high impedance levels. As a result, any normal static charge that builds up on your person or clothing may be sufficient to destroy these devices if they are not handled properly. Table 5-4 lists those parts used in the Models 868 and 869 that might be destroyed by static charge. When handling these devices, use the following precautions:

1. Transport and handle these parts only in containers designed to prevent static build-up. Typically, these parts will be received in static-protected containers of plastic or foam. Keep these devices in their original containers until ready for installation.
2. Remove the devices from their protective containers only at a properly grounded work station. Also ground yourself with a suitable wrist strap.
3. Handle the devices only by the body; do not touch the terminals or pins.
4. Any PC board into which the device is to be installed must also be properly grounded.
5. Use only anti-static type solder suckers.
6. Use only grounded soldering irons.
7. Once the device is installed on the PC board, it is normally adequately protected, and normal handling may resume.

CAUTION

This assembly contains electrostatic sensitive devices which can be damaged by static discharge when touched. Observe precaution when handling.

TABLE 5-4
STATIC-SENSITIVE PARTS

SCHEMATIC DESIGNATION
Q101, Q102, Q105-Q113, Q115, Q116, U101, Q102, U103, U104

5.6 PERFORMANCE VERIFICATION

This performance verification procedure should be accomplished after any parts replacement or circuit repair, or to check instrument operation at any time incorrect operation is indicated.

Performance verification is performed by connecting precise resistors to the instrument in place of a temperature probe and checking to see that the displayed reading falls within a prescribed range. The following procedure should be performed at an ambient temperature between 65° and 82°F (18° and 28°C) at a relative humidity of less than 80%. If the instrument has been stored outside these limits, allow at least 24 hours for operating conditions to stabilize.

Required Equipment:

Precision decade resistance box, $\pm 0.01\%$ tolerance

Female four wire instrumentation connector (supplied with instrument).

NOTE

The following procedure must be performed with the instrument in the four wire mode. See Figure 3-2 for the location of the 3 WIRE/4 WIRE jumper which sets the appropriate mode. Access to the jumper requires rear cover removal as described in the disassembly instructions.

1. Connect the precision resistance box to the instrumentation connector as shown in Figure 5-2. Plug the connector into the instrument.
2. Turn on the instrument and verify that the LO BAT indicator is not displayed.
3. Refer to Table 5-5, which lists the verification procedure for both instruments covered by this manual. To verify instrument performance at each of the points, set the resistance box to the required value; with the instrument on the prescribed range, verify that the displayed reading falls within the necessary limits.
4. If the displayed reading is out of tolerance at any of the points, refer to the calibration section for the correct procedure to bring the instrument within tolerance.

**TABLE 5-5
PERFORMANCE VERIFICATION**

MODEL 868		
RANGE °F	RESISTANCE VALUE (Ω)	ALLOWABLE READING (65° TO 82°F)
1100°F	11.29 Ω	-362 to -358
200°F	71.00 Ω	-100.4 to 99.6
200°F	93.03 Ω	-0.4 to +0.4
200°F	114.68 Ω	99.6 to 100.4
200°F	134.95 Ω	194.6 to 195.4
1100°F	311.45 Ω	1098 to 1102

**TABLE 5-5
PERFORMANCE VERIFICATION
(continued)**

MODEL 869		
RANGE °C	RESISTANCE VALUE (Ω)	ALLOWABLE READING (18° to 28°C)
630°C	9.9 Ω	-221 to -219
200°C	60.26 Ω	-100.3 to -99.7
200°C	100.00 Ω	-0.3 to +0.3
200°C	138.51 Ω	99.7 to 100.3
200°C	174.01 Ω	194.7 to 195.3
630°C	313.71 Ω	599 to 601

SECTION 6 SPECIFICATIONS

MODEL 868

TEMPERATURE SENSOR TYPE: Three wire or four wire 100 Ω platinum RTD (alpha = .00385)

4 WIRE ACCURACY*			
SETTING	RANGE	RESOLUTION	(18°C TO 28°C; 1 Year)
200 °F	-100.0 °F to 199.9 °F	0.1	± 0.4 °F
	-199.9 °F to -100.1 °F	0.1	± 1 °F
1100 °F	-100 °F to 1100 °F	1	± 2 °F
	-360 °F to -101 °F	1	± 4 °F

***ACCURACY:** Three wire accuracy is the same if contact resistance errors are removed by calibration of instrument plus probe at 32°F. Includes DIN 43760 (ITS-90) conformity, repeatability, temperature coefficient (65° to 82°F), time stability (one year) and errors with up to 50 Ω of lead resistance (each lead). Excludes probe errors; however, probe errors around 32°F may be compensated by an internal adjustment.

REPEATABILITY: 0.2 °F Typical for one week at constant ambient temperature.

TEMPERATURE COEFFICIENT: 65 °F to 82 °F; included in accuracy specification. From 14 °F to 65 °F, and 82 °F to 122 °F: less than ±0.015 °F/°F.

MAXIMUM LEAD RESISTANCE:

(each lead): Four wire: 50 Ω
Three wire: 10 Ω

SENSOR CURRENT: 500 μA max.

SPECIFICATIONS continued

MODEL 869

TEMPERATURE SENSOR TYPE: Three wire or four wire 100 Ω platinum RTD ($\alpha = .00385$)

SETTING	RANGE	RESOLUTION	4 WIRE ACCURACY*	
			(18 °C TO 28 °C)	(1 Year)
200 °C	-100.0 °C to 199.9 °C	0.1		± 0.3 °C
	-199.9 °C to -100.1 °C	0.1		± 1.5 °C
630 °C	-100 °C to 630 °C	1		± 1 °C
	-220 °C to -101 °C	1		± 2 °C

***ACCURACY:** Three wire accuracy is the same if contact resistance errors are removed by calibration of instrument plus probe at 0°C. Includes DIN 43760 (ITS-90) conformity, repeatability, temperature coefficient (18° to 28°C), time stability (one year) and errors with up to 50 Ω of lead resistance (each lead). Excludes probe errors; however, probe errors around 0°C may be compensated by an internal adjustment.

REPEATABILITY: 0.1 °C Typical for one week at constant ambient temperature.

TEMPERATURE COEFFICIENT: 18° to 28°C; included in accuracy specification. From -10° to 18°C, and 28° to 50°C: less than $\pm 0.015^\circ\text{C}/^\circ\text{C}$.

MAXIMUM LEAD RESISTANCE:

(each lead): Four wire: 50 Ω
Three wire: 10 Ω

SENSOR CURRENT: 500 μA max.

MODELS 868 AND 869

GENERAL SPECIFICATIONS:

DISPLAY: $3\frac{1}{2}$ digit LCD, 0.5" (13 mm) height. Polarity and decimal point indication

CONVERSION RATE: 1.5 readings per second.

OVERRANGE AND OPEN

SENSOR INDICATION: Three least significant digits blanked.

SPECIFICATIONS continued

MAXIMUM COMMON MODE VOLTAGE:

42 V peak to earth.

COMMON MODE REJECTION (Model 868):

Less than 0.001°F/volt at dc, 50 and 60 Hz (100 Ω unbalance, LO driven).

COMMON MODE REJECTION (Model 869):

Less than 0.001°C/volt at dc, 50 and 60 Hz (100 Ω unbalance, LO driven).

ENVIRONMENTAL LIMITS FOR OPERATING (Model 868):

14° to 122°F, less than 80% relative humidity up to 95°F; linearly derate 1.5% RH/°F from 95° to 122°F.

ENVIRONMENTAL LIMITS FOR OPERATING (Model 869):

-10° to 50°C, less than 80% relative humidity up to 35°C; linearly derates 3% RH/°C from 35° to 50°C.

ENVIRONMENTAL LIMITS FOR STORAGE (Model 868):

-30° to 140°F, less than 90% relative humidity up to 95°F; linearly derate 1.5% RH/°F from 95° to 140°F.

ENVIRONMENTAL LIMITS FOR STORAGE (Model 869):

-35° to 60°C, less than 90% relative humidity up to 35°C; linearly derate 3% RH/°C from 35° to 60°C.

RTD LINEARIZATION:

Ratiometric dual-slope A/D with continuous linearization.

INPUT CONNECTION:

Four pin miniature instrumentation connector.

POWER:

9 V alkaline or carbon-zinc (NEDA 1604) battery

BATTERY LIFE, CONTINUOUS:

500 hours typical with alkaline battery; 300 hours typical with carbon-zinc battery.

BATTERY INDICATOR:

Display indicates "LO BAT" when less than 10% of life remains.

DIMENSIONS:

H: 6.3" (160 mm) x W: 2.7" (69 mm) x D: 1.2" (31 mm).

WEIGHT:

Net weight 7.50 oz (210 gm).

CONSTRUCTION:

Heavy duty ABS plastic housing.

6.1 PARTS LIST FOR MODELS 868 AND 869

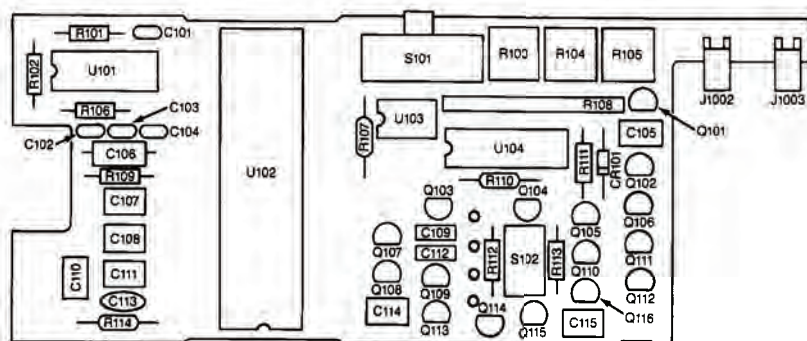
SCHEMATIC DESIG.	DESCRIPTION	SCHEMATIC LOCATION
BA101	Battery, 9 V, NEDA 1604	G1
C101	Capacitor, 0.1 μ F, 50 V, Ceramic Film	E4
C102	Capacitor, 0.1 μ F, 50 V, Ceramic Film	G1
C103	Capacitor, 0.1 μ F, 50 V, Ceramic Film	F1
C104	Capacitor, 0.1 μ F, 50 V, Ceramic Film	G1
C105	Capacitor, 0.22 μ F, 63 V, Metalized Polyester	B1
C106	Capacitor, 0.047 μ F, 50 V, Metalized Polypropylene	E3
C107	Capacitor, 0.33 μ F, 63 V, Metalized Polyester	E2
C108	Capacitor, 0.33 μ F, 63 V, Metalized Polyester	F1
C109	Capacitor, 0.1 μ F, 63 V, Metalized Polyester	D2
C110	Capacitor, 0.22 μ F, 63 V, Metalized Polyester	D1
C111	Capacitor, 0.22 μ F, 63 V, Metalized Polyester	E3
C112	Capacitor, 0.1 μ F, 63 V, Metalized Polyester	E2
C113	Capacitor, 47pF, 500 V, Silver Mica or Ceramic	E2
C114	Capacitor, 0.22 μ F, 63 V, Metalized Polyester	E1
C115	Capacitor, 0.22 μ F, 63 V, Metalized Polyester	B2
CR101	Diode, Silicon 1N4148	B1
DS101	Display, LCD	H4
J1001	Connector, 4-terminal Connector (mates with J1001)	A3
J1002	Connector, Battery	G1
J1003	Connector, Battery	G1
J1004	Connector, Pin	A3
J1005	Connector, Pin	A3
J1006	Connector, Pin	A4
J1007	Connector, Pin	A4
P1004	Terminal	A3
P1005	Terminal	A3
P1006	Terminal	A4
P1007	Terminal	A4
Q101	JFET, N-Channel	B1
Q102	JFET, N-Channel	B2
Q103	Transistor, NPN, Silicon, 2N3904	B4
Q104	Transistor, NPN, Silicon, 2N3904	B4
Q105	JFET, N-Channel	C3
Q106	JFET, N-Channel	C1
Q107	JFET, N-Channel	E2
Q108	JFET, N-Channel	D2
Q109	JFET, N-Channel	E3
Q110	JFET, N-Channel	B3
Q111	JFET, N-Channel	C2
Q112	JFET, N-Channel	C3
Q113	JFET, N-Channel	E2
Q114	Transistor, NPN, Silicon, 2N3904	B4

PARTS LIST (continued)

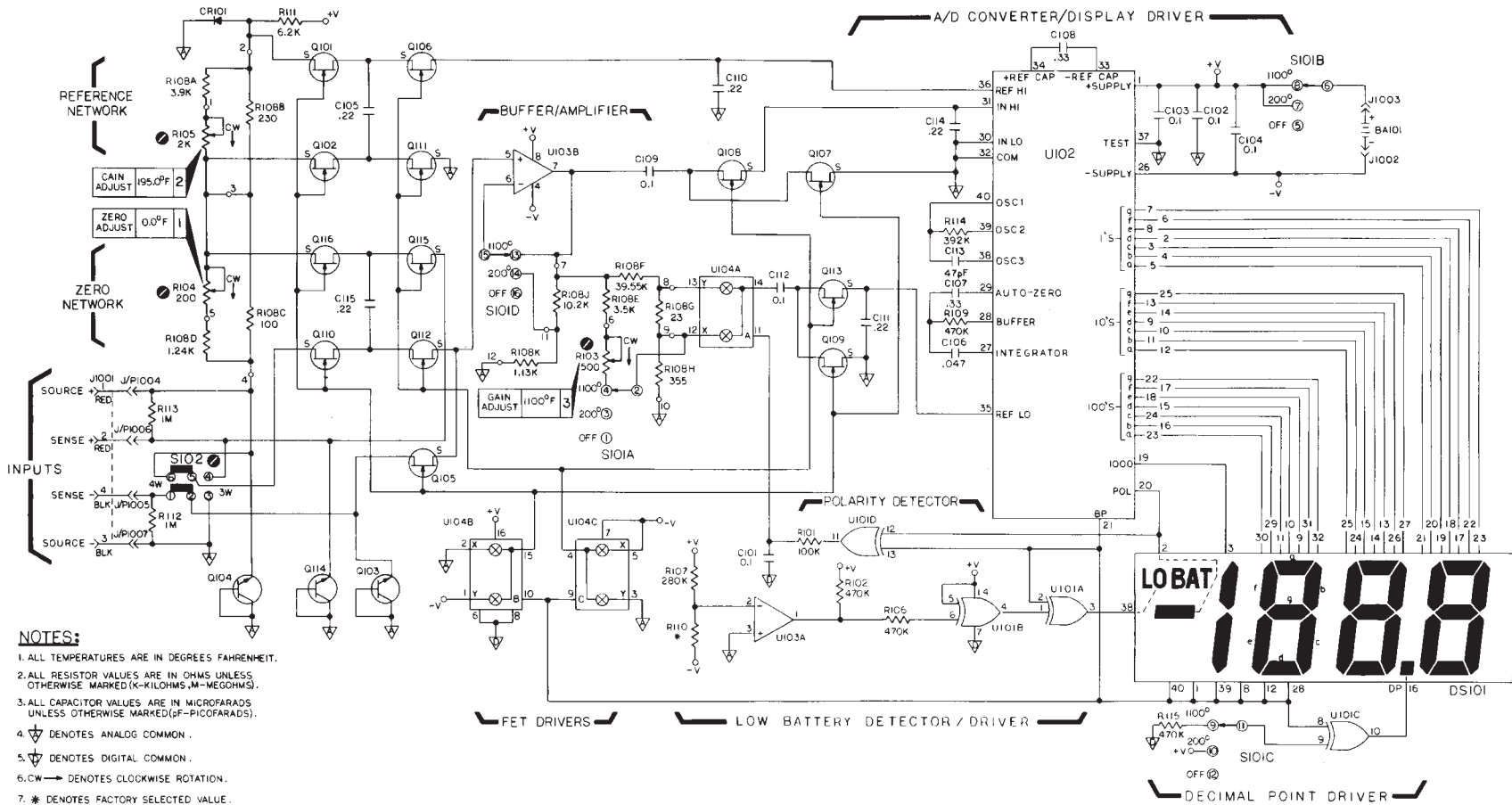
SCHEMATIC DESIG.	DESCRIPTION	SCHEMATIC LOCATION
Q115	JFET, N-Channel	C2
Q116	JFET, N-Channel	B2
R101	Resistor, 100 K Ω 5%, 1/4W, Composition	E4
R102	Resistor, 470 K Ω , 5% \pm O, 1/4W, Composition	E4
R103*	Potentiometer, 500 Ω	D3
R103**	Potentiometer, 1K Ω	D3
R104	Potentiometer, 200 Ω	B2
R105	Potentiometer, 2 K Ω	B1
R106	Resistor, 470 K Ω , 5%, 1/4W, Composition	E4
R107	Resistor, 280 K Ω , 1%, 1/8W, Metal Film	D4
R108*	Resistor, Thick Film	SE V
R108**	Resistor, Thick Film	SE V
R109*	Resistor, 470 K Ω , 5%, 1/4W, Composition	E2
R109**	Resistor, 750 K Ω , 5%, 1/4W, Composition	E2
R110	Resistor, Selected	D4
R111	Resistor, 6.2 K Ω , 5%, 1/4W, Composition	B1
R112	Resistor, 1 M Ω , 5%, 1/4W, Composition	A4
R113	Resistor, 1 M Ω , 5%, 1/4W, Composition	A3
R114	Resistor, 392 K Ω , 1%, 1/8W, Metal Film	E2
S101	Switch, 4P3T, Slide	SE V
S102	Jumper strip	A3
U101	IC, CMOS Quad EXOR Gate, 4070	SE V
U102	IC, 3-1/2 Digit Low Power A/D Converter ICL7136CPL	F1
U103	IC, Dual Low Power JFET Op Amp, LF442CN	SE V
U104	IC, Triple 2 Channel Multiplexer, 4053	SE V

*Model 868

**Model 869



Models 868 and 869 Component Layout



NOTES:

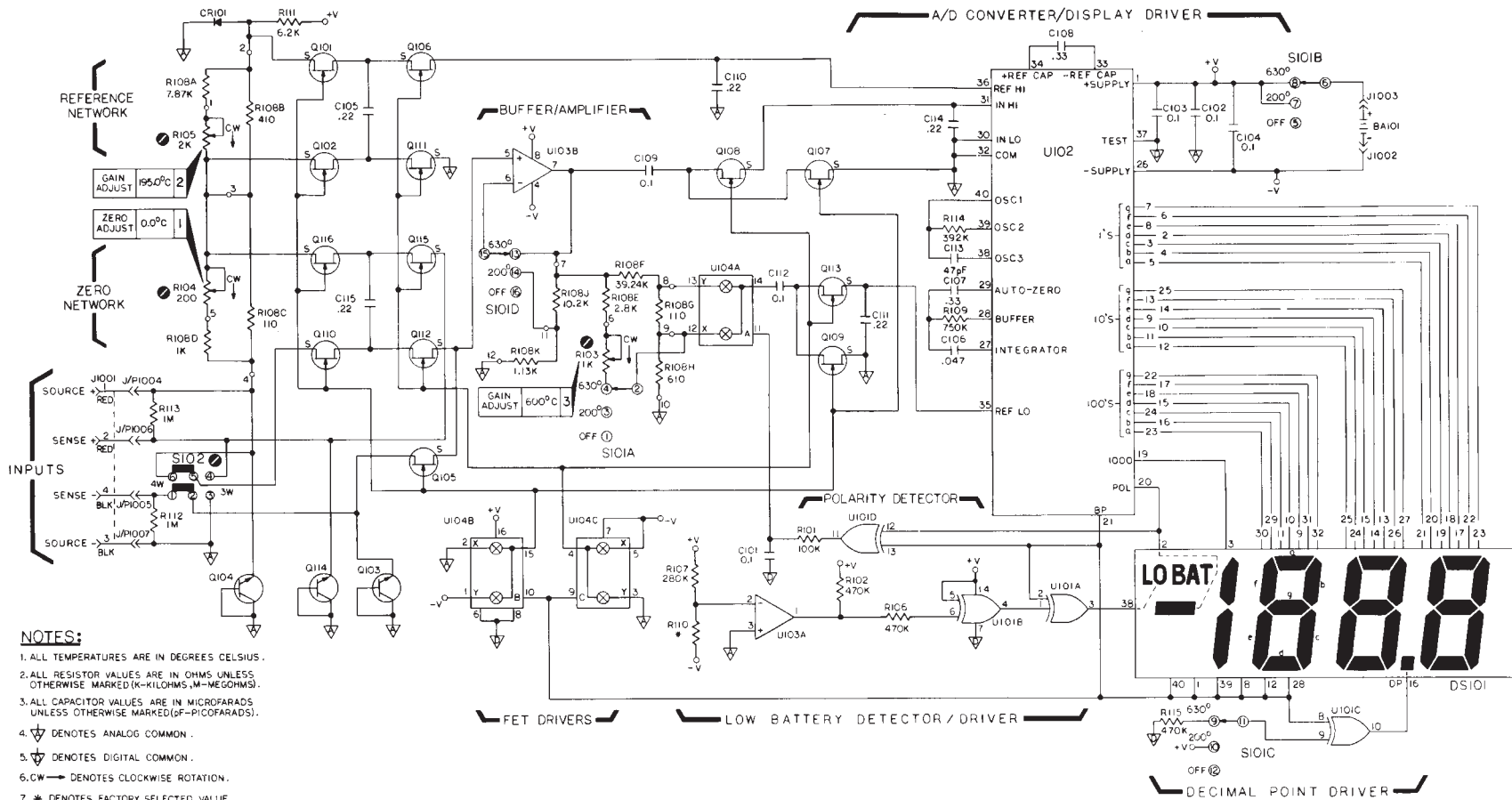
1. ALL TEMPERATURES ARE IN DEGREES FAHRENHEIT.
2. ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE MARKED (K-KILOHMS, M-MEGOHMS).
3. ALL CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE MARKED (P-PICOFARADS).
4. ∇ DENOTES ANALOG COMMON.
5. ∇ DENOTES DIGITAL COMMON.
6. CW \rightarrow DENOTES CLOCKWISE ROTATION.
7. * DENOTES FACTORY SELECTED VALUE.
8. \odot DENOTES INTERNAL ADJUSTMENT.
9. S101 AND S102 ARE SHOWN IN 1100PF RANGE AND 4 WIRE POSITION RESPECTIVELY.

10.

1	2	3
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 DENOTES CALIBRATION ADJUSTMENT.

Model 868 Schematic



NOTES:

1. ALL TEMPERATURES ARE IN DEGREES CELSIUS.
2. ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE MARKED (K=KILOHMS, M=MEG OHMS).
3. ALL CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE MARKED (P=PICOFARADS).
4. ∇ DENOTES ANALOG COMMON.
5. ∇ DENOTES DIGITAL COMMON.
6. CW \rightarrow DENOTES CLOCKWISE ROTATION.
7. * DENOTES FACTORY SELECTED VALUE.
8. \odot DENOTES INTERNAL ADJUSTMENT.
9. S101 AND S102 ARE SHOWN IN 630°C RANGE AND 4 WIRE POSITION RESPECTIVELY.

10. 1 2 3
DENOTES CALIBRATION ADJUSTMENT.

Model 869 Schematic

NOTES

NOTES



WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit should malfunction, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear are not warranted, including but not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by it will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS / INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. **BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS).** The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. P.O. number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. P.O. number to cover the COST of the repair,
2. Model and serial number of product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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- ☑ Wire: Thermocouple, RTD & Thermistor
- ☑ Calibrators & Ice Point References
- ☑ Recorders, Controllers & Process Monitors
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- ☑ Transducers & Strain Gauges
- ☑ Load Cells & Pressure Gauges
- ☑ Displacement Transducers
- ☑ Instrumentation & Accessories

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- ☑ Rotameters, Gas Mass Flowmeters & Flow Computers
- ☑ Air Velocity Indicators
- ☑ Turbine/Paddlewheel Systems
- ☑ Totalizers & Batch Controllers

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- ☑ Benchtop/Laboratory Meters
- ☑ Controllers, Calibrators, Simulators & Pumps
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- ☑ Communications-Based Acquisition Systems
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- ☑ Heating Cable
- ☑ Cartridge & Strip Heaters
- ☑ Immersion & Band Heaters
- ☑ Flexible Heaters
- ☑ Laboratory Heaters

ENVIRONMENTAL MONITORING AND CONTROL

- ☑ Metering & Control Instrumentation
- ☑ Refractometers
- ☑ Pumps & Tubing
- ☑ Air, Soil & Water Monitors
- ☑ Industrial Water & Wastewater Treatment
- ☑ pH, Conductivity & Dissolved Oxygen Instruments