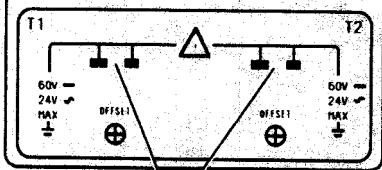
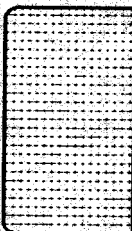
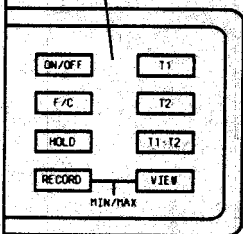
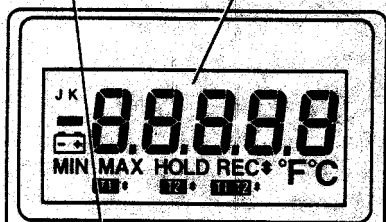


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English

CONTROLS

DISPLAY



THERMOCOUPLE  
INPUT CONNECTORS

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## INTRODUCTION

This instrument is a microprocessor-based, digital thermometer designed to use external K-type or J-type thermocouples as temperature sensors. Temperature indication follows National Bureau of Standards and IEC 584 temperature/voltage tables for K-type and J-type thermocouples. Two K-type thermocouples are supplied with the thermometer.

It is recommended that you read the safety and operating instructions before using the thermometer.

### NOTE

*A quick operating guide is located on page 7 to get you started using the thermometer quickly.*

## SAFETY INFORMATION

### WARNING

**TO AVOID ELECTRICAL SHOCK, DO NOT USE THIS INSTRUMENT WHEN VOLTAGES AT THE MEASUREMENT SURFACE EXCEED 24V AC OR 60V DC.**

### WARNING

**TO AVOID DAMAGE OR BURNS, DO NOT MAKE TEMPERATURE MEASUREMENTS IN MICROWAVE OVENS.**

### CAUTION

**Repeated sharp flexing can break the thermocouple leads. To prolong lead life, avoid sharp bends in the leads, especially near the connectors.**

This instrument has been designed and tested according to IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus. This manual contains information and warnings that must be followed to ensure safe operation and to protect the meter.

The  symbol on the instrument indicates that the operator must refer to an explanation in this manual.

## OPERATIONAL LIMITATIONS

The thermometer is designed to operate within the following conditions:

- **THERMOCOUPLE MEASUREMENT RANGE:**

K-type thermocouple:  $-200^{\circ}\text{C}$  to  $1370^{\circ}\text{C}$  ( $-328^{\circ}\text{F}$  to  $2498^{\circ}\text{F}$ ) (See Appendix A.)

J-type thermocouple:  $-200^{\circ}\text{C}$  to  $760^{\circ}\text{C}$  ( $-328^{\circ}\text{F}$  to  $1400^{\circ}\text{F}$ )

- **INSTRUMENT ENVIRONMENT:**

Temperature:  $0^{\circ}\text{C}$  to  $50^{\circ}\text{C}$  ( $32^{\circ}\text{F}$  to  $122^{\circ}\text{F}$ )

Humidity: 0% to 90% ( $0^{\circ}\text{C}$  to  $35^{\circ}\text{C}$ ) ( $32^{\circ}\text{F}$  to  $95^{\circ}\text{F}$ )

0% to 70% ( $35^{\circ}\text{C}$  to  $50^{\circ}\text{C}$ ) ( $95^{\circ}\text{F}$  to  $122^{\circ}\text{F}$ )

The thermometer displays an error indication (Figure 1) if the thermometer itself is subjected to temperatures outside the instrument environment range listed above. However, if the thermometer is initially at an ambient temperature of  $20^{\circ}\text{C}$  ( $68^{\circ}\text{F}$ ), it will typically provide accurate readings for 5 minutes down to an ambient temperature of  $-26^{\circ}\text{C}$  ( $-15^{\circ}\text{F}$ ).



**Figure 1. Error Indication**

The thermometer is designed to provide accurate readings even when it is subjected to rapid ambient temperature changes (for example, when carried from a cold vehicle to a warm building). For an ambient temperature step change of up to  $35^{\circ}\text{C}$  ( $63^{\circ}\text{F}$ ), readings are within 1 degree of specified accuracy immediately, and within specified accuracy within 10 minutes.

Thermocouple limitations are discussed later in this manual. If you are using another manufacturer's thermocouple, consult the manufacturer's specifications for that thermocouple.

**NOTE**

*Measurement errors may occur if voltages on the measurement surfaces result in*


*potentials greater than 1 V between the two thermocouples. When potential differences are anticipated between the thermocouples, electrically insulated thermocouples are recommended.*

## FEATURES

### Display

Each item in the display is described below and keyed by number to the illustration inside the back cover of this manual.

- 1 **NUMERIC DISPLAY**  
The numeric display indicates the temperature of thermocouple T1, the temperature of thermocouple T2, or the temperature difference between the two thermocouples (T1-T2).
- 2 **°F° C TEMPERATURE SCALE ANNUNCIATOR**  
Either the °C or °F symbol is displayed, indicating whether temperature readings are displayed in degrees Celsius or degrees Fahrenheit.
- 3 **REC RECORD MODE ANNUNCIATOR**  
This symbol indicates that the thermometer is in RECORD mode. (See "RECORD Mode," later in this manual.)
- 4 **↕ STORED-DATA SYMBOL**  
This symbol indicates whether the readings stored in RECORD mode were taken from T1, T2, or T1-T2 input. (The stored-data symbol appears next to T1, T2, or T1-T2 on the display window.)
- 5 **T1 T2 T1 T2 INPUT SELECTION CURSOR**  
The input selection cursor indicates which input is selected for display: thermocouple T1, thermocouple T2, or the difference between the two thermocouples (T1-T2).
- 6 **MAX MAX ANNUNCIATOR**  
This symbol appears when the display shows the maximum reading stored while in RECORD mode.
- 7 **MIN MIN ANNUNCIATOR**  
This symbol appears when the display shows the minimum reading stored while in RECORD mode.

- 8  **LOW BATTERY ANNUNCIATOR**  
This symbol appears when approximately 50 hours of battery life remain. For proper operation, replace the battery as soon as possible. (Refer to "Battery Replacement," later in this manual.)
- 9 **JK THERMOCOUPLE TYPE ANNUNCIATOR**  
This symbol indicates which type of thermocouple (K or J) the thermometer is set up to use.

**NOTE**

*For readings to be correct, be sure that the displayed thermocouple type matches the type of thermocouple you are using.*

- 10 **HOLD HOLD MODE ANNUNCIATOR**  
This symbol indicates that the thermometer is in HOLD mode. (See "HOLD Mode," later in this manual.)

**Controls**

The thermometer's controls are briefly described below and keyed by number to the illustration inside the back cover of this manual.

- 11 **ON/OFF**  
The ON/OFF key turns the thermometer on or off.
- 12 **F/C**  
The F/C key switches between the Celsius ( $^{\circ}\text{C}$ ) and Fahrenheit ( $^{\circ}\text{F}$ ) scales on the display.
- 13 **HOLD**  
Pressing the HOLD key selects HOLD mode. (See "HOLD Mode," later in this manual.) If pressed during power-up, the HOLD key changes the selection of thermocouple type.
- 14 **RECORD**  
Pressing the RECORD key selects RECORD mode. (See "RECORD Mode," later in this manual.)
- 15 **T1**  
The T1 key selects thermocouple T1 as the input. When pressed during power-up, the T1 key changes the display resolution.

16

T2

The T2 key selects thermocouple T2 as the input. When pressed during power-up, the T2 key selects SCAN mode. (See "SCAN Mode," later in this manual.)

17

T1-T2

The T1-T2 key selects differential temperature measurement. This causes the thermometer to measure the temperature of T1 and T2 and display the difference (T1 minus T2). To use this feature, you must connect two thermocouples to the thermometer.

18

VIEW

This key displays the MIN and MAX readings stored in RECORD mode. (See "RECORD Mode," later in this manual.)

19

OFFSET

The OFFSET controls allow you to optimize measurement accuracy for a particular thermocouple (or pair of thermocouples) at a particular temperature. (**IMPORTANT:** Before adjusting these controls, read "Offset Adjustment," later in this manual.)

### Alternate Control Functions

The T1, T2, and HOLD keys have alternate functions when held down during power-up. The T1 key changes the display resolution, the T2 key selects the SCAN mode, and the HOLD key changes the selection of thermocouple type. For reference, these alternate functions are indicated on the back of the instrument.

To select an alternate function, turn the thermometer off. Then, while holding down the T1, T2 or HOLD key, turn the thermometer on. Release the T1, T2, or HOLD key 2 to 3 seconds later.

Any combination of these three keys can be held down during power-up to select combinations of alternate functions. For example, by holding down the T1 and T2 keys with your thumb at power-up, you can change the display resolution and also select SCAN mode.



## Open Thermocouple Indication/Error Indication

The error indication (Figure 1) is displayed if any of the following conditions occur:

1. If no thermocouple is plugged into the selected input.
2. If the thermocouple connected to the selected input is broken or open-circuited.
3. If the thermometer itself is subjected to temperatures outside its specified environmental range.
4. If an attempt is made to display MIN/MAX readings before MIN/MAX readings have been recorded.

While the error indication is displayed, the annunciators still indicate which features have been selected (thermocouple type, temperature scale, etc.).

## QUICK OPERATING GUIDE

The following procedure is intended to familiarize you quickly with the thermometer's operation. Start with both thermocouples disconnected from the thermometer.

1. Press the ON/OFF key. The self-test display appears briefly (see Figure 2). The display then shows the error indication (Figure 1), indicating that no thermocouple is plugged into the selected input. If the thermometer should fail the self-test, the self-test display will flash several times.

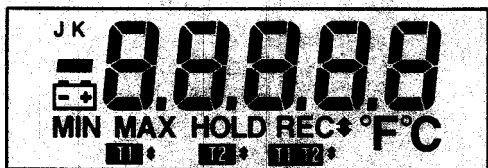


Figure 2. Self-Test Display

At power-up, the thermometer is set up to measure temperatures from the T1 input connector with K-type thermocouples. (To set up the thermometer

for J-type thermocouples, see "Selecting the Thermocouple Type.") The thermometer uses the same temperature scale ( $^{\circ}\text{C}$  or  $^{\circ}\text{F}$ ) that was in use when the thermometer was last turned off.

2. Insert a K-type thermocouple into the T1 input connector. The thermometer will display the temperature of the T1 thermocouple (see Figure 3).

K

20.1  
 $^{\circ}\text{C}$

T1

**Figure 3. Example T1 Temperature Reading**

3. Insert a second K-type thermocouple into the T2 input connector.
4. Press the T2 key to select and display the temperature of the T2 thermocouple.
5. Press the T1-T2 key to select and display the differential temperature (the temperature of T1 minus the temperature of T2) (see Figure 4).

K

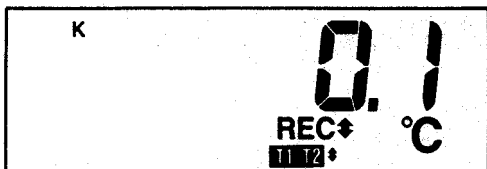
0.1  
 $^{\circ}\text{C}$

T1-T2

**Figure 4. Example T1-T2 Temperature Reading**

6. Press the RECORD key. The thermometer is now in RECORD mode, and the RECORD symbol is displayed (see Figure 5). In addition, the stored-data symbol ( $\blacklozenge$ ) appears next to T1-T2, indicating that MIN/MAX readings are being recorded for T1-T2.

7. Press the T1 key or T2 key to view the temperature of T1 or T2 while still recording the MIN/MAX values of T1-T2.



**Figure 5. Example RECORD Mode Display**

8. Press the VIEW key to display the MAX value of T1-T2. Press the VIEW key again to display the MIN value of T1-T2. Repeatedly pressing the VIEW key toggles between the MAX and MIN displays.
9. Press the T1 key to cancel the MIN/MAX display and to display the temperature of T1. The thermometer continues to update the MIN/MAX values for T1-T2.
10. Press the HOLD key to stop all temperature measurements. The T1, T2, T1-T2, and MIN/MAX values last measured can still be viewed. Press the HOLD key again to continue measurements.
11. Press the RECORD key. The REC annunciator will turn off, indicating that RECORD mode is off.
12. Press the VIEW key. Note that the last MIN/MAX readings are still retained. The stored-data symbol (◆) is still on, indicating which input the MIN/MAX readings were taken from (in this case, T1-T2).
13. Press the RECORD key again, so that the REC annunciator reappears. This resets the MIN/MAX readings and causes the thermometer to begin recording MIN/MAX readings again. If another input has been selected, recording begins on that input.

## **OPERATING INSTRUCTIONS**

The following paragraphs describe the thermometer's operation in detail.

## **Power-Up**

When the thermometer is turned ON, all display segments appear while the thermometer performs a brief self-test (see Figure 2). If the thermometer should fail the self-test, the display will flash several times, and the thermometer will attempt to resume normal operation. If this occurs, contact the nearest Service Center.

After about 3 seconds, the thermometer displays the first temperature reading. If no thermocouple is plugged into the selected input, the thermometer displays the error indication (Figure 1).

## **Connecting the Thermocouples**

The thermometer is used with one or two thermocouples. The thermocouples plug into the T1 and T2 input connectors. Either K-type or J-type thermocouples can be used. Only one type of thermocouple can be used at a time.

For readings to be correct, the thermometer must be set for the type of thermocouples you are using. The setting is indicated on the display by a K or a J.

The thermometer is set at the factory to default to K-type thermocouples. This is the correct setting for the thermocouples included with the thermometer.

To set the thermometer for J-type thermocouples, see "Selecting the Thermocouple Type."

## **Selecting the Temperature Scale**

Readings are displayed in either degrees Celsius ( $^{\circ}\text{C}$ ) or degrees Fahrenheit ( $^{\circ}\text{F}$ ). When the thermometer is turned on, it is set to the temperature scale that was in use when the thermometer was last turned off. To change the temperature scale, press the F/C key.

## **Single-Thermocouple Temperature Measurement**

The thermometer displays the temperature of the thermocouple that is connected to the selected input. Press the T2 key to display the temperature of the thermocouple connected to the T2 input. Press the T1 key to display the temperature of the thermocouple connected to the T1 input. The input selection cursor indicates which input is selected.

If the selected thermocouple is unplugged or open-circuited, the thermometer displays the error indication (Figure 1).

### **Differential Temperature Measurement**

Differential temperature measurement is selected by pressing the T1-T2 key. This causes the thermometer to display the temperature difference between the two thermocouples (the temperature of thermocouple T1 minus the temperature of thermocouple T2). The selection is indicated by the input selection cursor.

If either thermocouple is unplugged or open-circuited, the thermometer displays the error indication (Figure 1). To return to single-thermocouple temperature measurement, press the T1 or T2 key.

#### *NOTE*

*Measurement errors may occur if voltages on the measurement surfaces result in potentials greater than 1V between the two thermocouples. When potential differences are anticipated between the thermocouples, electrically insulated thermocouples are recommended.*

#### *NOTE*

*If the temperature at the measurement surfaces changes faster than 4° C (7° F) per minute, the thermometer may display a temperature difference even when the two thermocouples are at the same temperature. This occurs because the thermometer does not measure T1 and T2 simultaneously.*

Because the thermometer rounds off all measurements before they are displayed, the value displayed for T1-T2 may not always correspond exactly to the difference of the values displayed for T1 and T2.

For example,

| Input  | Actual Temperature | Displayed Temperature |
|--------|--------------------|-----------------------|
| T1:    | 25.14°C            | 25.1°C                |
| T2:    | 25.05°C            | 25.1°C                |
| T1-T2: | 0.09°C             | 0.1°C                 |

In this case, the thermometer rounds off both T1 and T2 to 5.1°C, but still displays the actual temperature difference for T1-T2 (rounded to the nearest tenth of a degree).

### **RECORD Mode**

In RECORD mode, the thermometer continually records and updates the maximum and minimum readings from T1, T2, or T1-T2. When recording on T1 or T2, the thermometer records the maximum and minimum readings on that input. When recording on T1-T2, the thermometer records the maximum and minimum difference between the two inputs. MIN/MAX readings can be stored from only one input at a time.

To select RECORD mode, first select the desired input (T1, T2, or T1-T2), then press the RECORD key. The thermometer then records and updates the minimum and maximum values for that input. The stored-data symbol (◆) appears on the display next to T1, T2, or T1-T2 to indicate which input is being recorded (see Figure 5). (The stored-data symbol remains displayed until the thermometer is turned off.) The other inputs can be displayed, but recording continues on the input indicated by the stored-data symbol (◆) until RECORD mode is cancelled by pressing the RECORD key again.

The stored MIN/MAX readings remain available until RECORD mode is selected again or the instrument is turned off. To restart the MIN/MAX recording, press the RECORD key twice.

#### *NOTE*

*MIN/MAX readings are erased when recording is restarted or when the thermometer is turned off.*

To view the stored maximum reading, press the VIEW key once (the MAX annunciator will appear). To view the stored minimum reading, press the VIEW key again (the MIN annunciator will appear). Additional presses of the VIEW key toggle between the MIN and MAX displays. The stored-data symbol (◆) indicates which input the MIN/MAX readings were recorded from. To cancel the MIN/MAX display, press the T1, T2, or T1-T2 keys.

Pressing the VIEW key does not stop measurement activity; it merely displays the MIN/MAX readings. Using the VIEW key

while in RECORD mode provides a continuously updated display of the minimum or maximum temperatures.

If you attempt to display MIN/MAX readings before MIN/MAX data has been recorded, the thermometer displays the error indication (Figure 1).

### **HOLD Mode**

Pressing the HOLD key selects HOLD mode. When HOLD mode is selected, the thermometer stores the present T1, T2, and T1-T2 readings and stops all further measurements. Each of these readings can still be displayed by pressing the respective key. The MIN/MAX values can also be displayed by pressing the VIEW key. Additionally, all other keys can still be used.

Pressing the HOLD key again cancels HOLD mode, causing the thermometer to resume taking measurements.

### **SCAN Mode**

When SCAN mode is selected, the display continuously cycles between T1, T2, and T1-T2 temperature readings. To select SCAN mode, first turn the thermometer off. Then, while keeping the T2 key pressed, press the ON/OFF key. After 2 to 3 seconds, release the T2 key. The thermometer will then be in SCAN mode.

To leave SCAN mode, turn the thermometer OFF and then ON again. (Remember: Previously recorded MIN/MAX readings are erased when the thermometer is turned off.)

### **Selecting the Thermocouple Type**

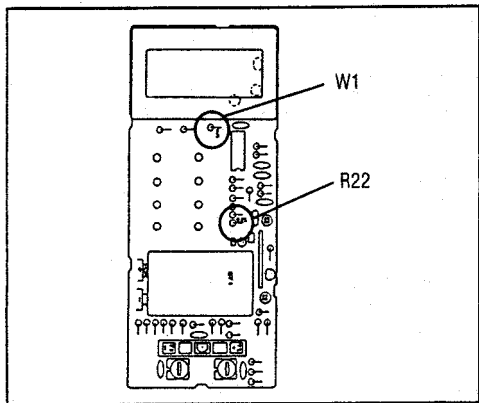
The thermometer accepts either K-type or J-type thermocouples. The thermometer is set at the factory to default to K-type thermocouples at power-up.

To select the alternate type of thermocouple, first turn the thermometer OFF. Then, while keeping the HOLD key pressed, press the ON/OFF key. After 2 to 3 seconds, release the HOLD key. The thermocouple type annunciator will indicate that the alternate thermocouple type has been selected.

#### **NOTE**

*For readings to be correct, be sure that the displayed thermocouple type matches the type of thermocouple you are using.*

To change the default thermocouple type, the case must be opened as described in the Battery Replacement procedure, later in this manual. Jumper W1 (see Figure 4) determines the default selection. When W1 is installed, the default selection is set for K-type thermocouples. When W1 is cut, the default selection is set for J-type thermocouples. REFER TO A QUALIFIED TECHNICIAN TO HAVE THIS MODIFICATION PERFORMED. K-type thermocouples can still be selected by pressing the HOLD key at powerup.



**Figure 6. Selecting the Default Thermocouple Type and Resolution**

### **Selecting the Display Resolution**

The thermometer allows two choices of display resolution:

High resolution: 0.1°C (0.2°F)

Low resolution: 1.0°C (1.0°F)

The thermometer is set at the factory to default to high resolution when it is turned on. To select the alternate display resolution, turn the thermometer OFF. Then, while keeping the T1 key pressed, press the ON/OFF key. After 2 to 3 seconds, release the T1 key. The alternate resolution remains selected until the instrument is turned off.

To change the default resolution, the case must be opened as described in the Battery Replacement procedure. Jumper R22



(see Figure 6) determines the default selection. When R22 is installed, the default is high resolution. When R22 is cut, the default is low resolution. REFER TO A QUALIFIED TECHNICIAN TO HAVE THIS MODIFICATION PERFORMED.

## **OFFSET ADJUSTMENT**

The OFFSET controls are set at the factory to allow for the variations found in standard thermocouples. By adjusting the OFFSET controls, you can optimize measurement accuracy for a particular thermocouple (or pair of thermocouples) at a particular temperature.

### *NOTE*

*To return the OFFSET control to its factory setting, refer to the thermocouple input calibration procedure located on page 3-7 in the 51/52 Service Manual (P/N 768234). The OFFSET controls should be adjusted only when planning to make long-term measurements at a single temperature using a particular thermocouple or pair of thermocouples. The OFFSET controls do not need to be adjusted to obtain the accuracy specified for the thermometer and thermocouples.*

By leaving one of the OFFSET controls untouched, you will be able to return the OFFSET controls to their factory setting. If both OFFSET controls are adjusted, you will still be able to return the OFFSET controls close to their factory setting. (See "Resetting the OFFSET Controls," below.)

The OFFSET controls are adjusted using a small screwdriver. TO ENGAGE EITHER CONTROL, PRESS DOWNWARD GENTLY AS YOU TURN THE SCREWDRIVER. When the limit of their rotation is reached, the OFFSET controls slip with a ratchet-like feeling. Each OFFSET control has a range of approximately  $\pm 3^{\circ}\text{C}$  ( $\pm 5^{\circ}\text{F}$ ).

### **Adjusting for T1 or T2 Measurements**

To adjust the OFFSET controls for optimum T1 or T2 measurements with a particular thermocouple at a particular temperature, perform the following procedure:

1. Connect the thermocouple to the T1 or T2 input connector and turn the thermometer ON. (If using T2, press the T2 key.)
2. Place the thermocouple in a known, stable temperature environment at or near the temperature you wish to measure, and allow the readings to stabilize.
3. Slowly adjust the OFFSET control that corresponds to the selected input (i.e., T1 or T2) so that the thermometer reading matches the temperature of the known environment. Leave sufficient time between adjustments to allow for measurement lag.
4. The calibration of the thermometer-thermocouple combination is now optimized for measurements near the temperature measured in step 2. (Note: It is recommended that you mark down which OFFSET control has been adjusted.)

### **Adjusting for T1-T2 Measurements**

To adjust the OFFSET controls for optimum differential temperature readings with a particular pair of thermocouples at a particular temperature, perform the following procedure:

1. Connect the thermocouples to the input connectors.
2. Turn the thermometer ON and select T1-T2.
3. Place both thermocouples in a stable temperature environment at or near the temperature you wish to measure, and allow the readings to stabilize.
4. Slowly adjust either one (but not both) of the OFFSET controls until the thermometer reads zero. Leave sufficient time between adjustments to allow for measurement lag.
5. The thermometer-thermocouple combination is now optimized for differential temperature measurement near the temperature used in step 3.

### **Resetting the OFFSET Controls**

To return the OFFSET controls to (or close to) their factory

setting without having to recalibrate the thermometer, perform either of the two following procedures.

Procedure 1 (This procedure is preferred but will only work if one of the OFFSET controls was left at its factory setting):

1. Connect a thermocouple in good working order to the input which has NOT been adjusted.
2. Place the thermocouple in an ice-water bath (or other stable temperature environment) and allow the readings to stabilize.

#### NOTE

*To create an ice-water bath, add crushed ice to a styrofoam cup (or other insulated container), fill the cup with water to the top of the ice, and stir during measurement.*

3. Write down the temperature reading.
4. Immediately connect the SAME thermocouple to the other input without disturbing the position of the thermocouple in the temperature environment.
5. Slowly adjust the corresponding OFFSET control to obtain the reading recorded in step 3.

Procedure 2:

1. Connect a thermocouple that is in good working order to the input that is to be adjusted.
2. Place the thermocouple in an ice-water bath and allow the readings to stabilize.
3. Slowly adjust the corresponding OFFSET control until the thermometer reads 0°C (32°F).

### INTERNAL CALIBRATION

The thermometer should be calibrated once a year to ensure its accuracy is within specifications. To calibrate the thermometer, refer to the Service Center nearest you or to the Service Manual listed on page 32.

### MEASUREMENT TECHNIQUES

The following paragraphs present several suggestions for getting the best accuracy from your temperature measurements.

## **Choosing a Thermocouple Probe**

The thermocouples shipped with your thermometer are bead thermocouples, which are designed for general-purpose use. For optimum accuracy, use the style of probe that is appropriate for each type of application. Use an immersion probe for liquid or gel measurements, an air probe for air measurements, a surface probe for surface measurements, etc.

## **Thermocouple Connectors**

Thermocouple connectors are made from the same materials as thermocouple wires. To avoid error, it is important to use a thermocouple connector whose materials matches the thermocouple you are using. The thermocouples included with the thermometer have the correct type of connector already installed.

When attaching a miniature thermocouple plug to a K-type or J-type thermocouple, ensure that the thermocouple connector type matches the thermocouple type. The correct connections are shown in Table 1.

## **Reducing Thermal Error**

In surface temperature measurements, error can result if there is a poor thermal connection between the thermocouple and the material being measured. Here are some suggestions for reducing thermal error:

- Ensure that there is a good connection between the thermocouple and the surface you are measuring. You can do this several ways:
  1. Clean the surface you are measuring.
  2. Use adequate mounting pressure.
  3. Use a thermal conducting compound (such as silicone grease) between the thermocouple and the surface you are measuring. (Use thermal epoxy if you want a permanent connection.)
- When you are measuring above-ambient temperatures, adjust the connection of the thermocouple to the surface until you get the highest temperature reading. Use any of the suggestions given above to do so.
- Similarly, when you are measuring below-ambient temperatures, adjust the connection of the thermocouple

to the surface until you get the lowest temperature reading. Use any of the suggestions given above to do so.

- When measuring near-ambient temperatures, take the reading when the thermometer's display is most stable.

**Table 1. Thermocouple Connections**

|  |   |
|--|---|
| K TYPE<br>(Yellow<br>connector<br>body)  | <b>POSITIVE (+) LEAD:</b><br>NON-magnetic<br>Yellow insulation (if color coded)<br>Chromium-nickel alloy (Chromel)<br>Connects to narrow connector blade<br><br><b>NEGATIVE (-) LEAD:</b><br>Magnetic<br>Red insulation (if color coded)<br>Aluminum-nickel alloy (Alumel)<br>Connectes to wide connector blade |
| J TYPE<br>(Black<br>connector<br>body)   | <b>POSITIVE (+) LEAD:</b><br>Magnetic<br>White insulation (if color coded)<br>Iron<br>Connects to narrow connector blade<br><br><b>NEGATIVE (-) LEAD:</b><br>NON-magnetic<br>Red insulation (if color coded)<br>Copper-nickel alloy (Constantan)<br>Connects to wide connector blade                            |
| <b>NOTE:</b> These color codes are USA standards. Color codes may vary by country. |   |

### Other Sources of Error

Excessive voltage potentials at the measurement surface can cause incorrect readings and/or instrument damage. Use caution when making temperature measurements in the presence of live circuits. To avoid incorrect or noisy readings, do not exceed the 1V maximum allowed voltage potential between T1 and T2.

Strong low-frequency and radio-frequency fields can also cause incorrect temperature readings.

### THERMOCOUPLE LIMITATIONS

Thermocouple performance is subject to environmental and electrical limitations, as well as to the inherent accuracy

limitations of the thermocouples themselves. The limitations for K-type and J-type thermocouples are summarized in Table 2. Appendix A lists the specifications for the thermocouple included with the thermometer.

**Table 2. Thermocouple Characteristics**

| <b>PARAMETER</b>          | <b>J-TYPE THERMOCOUPLES</b>   |
|---------------------------|---|
| Temperature Range         | -200°C to +760°C<br>-328°F to 1400°F  |
| Environmental Limitations | Alloy is brittle below 0°C. OK for reducing or oxidizing atmospheres or in vacuum. Not OK for sulfurous atmospheres above 500°C                 |
| Color Codes               | See Table 1.  |
| Initial Tolerances        | Standard:<br>±2.2°C or 0.75%*<br>(±3.96°F or 0.75%*)<br><br>Special:<br>±1.1°C or 0.38%*<br>(±1.98°F or 0.38%*)                                 |
| <b>PARAMETER</b>          | <b>K-TYPE THERMOCOUPLES</b>   |
| Temperature Range         | -270°C to +1370°C<br>-454°F to 2498°F   |
| Environmental Limitations | OK for clean, oxidizing or inert gas atmospheres. Not OK for vacuum at high temperatures. Corrodes in low-temperature, oxygen-poor atmospheres. |
| Color Codes               | See Table 1.  |
| Initial Tolerances        | Standard:<br>±2.2°C or 0.75%*<br>(±3.96°F or 0.75%*)<br><br>Special:<br>±1.1°C or 0.38%*<br>(±1.98°F or 0.38%*)                                 |
| * whichever is greater    |   |

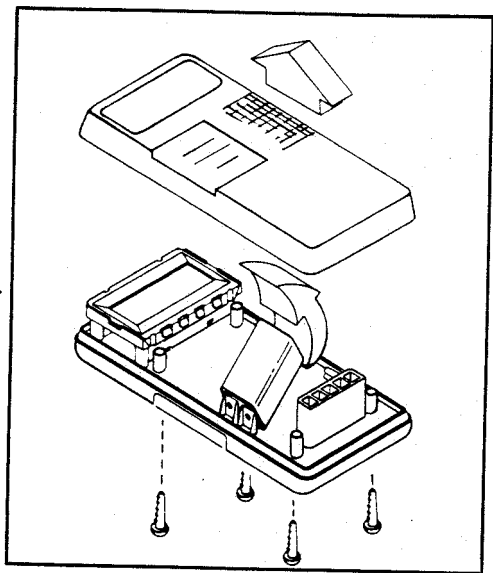
## OPERATOR MAINTENANCE

### WARNING

**TO AVOID POSSIBLE ELECTRICAL SHOCK, DISCONNECT THE THERMOCOUPLE CONNECTORS FROM THE THERMOMETER BEFORE REMOVING THE COVER.**

### Battery Replacement

The thermometer is powered by a single 9V battery (NEDA 1604A, IEC 6LR61). Referring to Figure 7, use the following procedure to replace the battery:



**Figure 7. Battery Replacement**

1. Remove the four case screws with a #2 Phillips screwdriver and separate the case halves by pulling them straight apart.
2. Disengage the battery from the battery contacts by prying the battery away from the clips.

3. Install a fresh battery by squeezing the battery against the battery contacts. Make sure that the battery is fully seated in the contacts.
4. Reassemble the case halves.
5. Install the four case screws with a #2 Phillips screw driver, taking care to tighten the screws only finger tight (6-7 in-lbs).

### **Proper Care of Thermocouples**

To maintain a thermocouple in good condition, observe the following precautions.

- **AVOID EXCESS BENDING**

Bending changes the thermoelectric characteristics to some extent, especially where the wire is subjected to high thermal gradients. Bending can also break the wire. If it is necessary to bend the wire, give the bend a large radius. Be careful not to bend the wire sharply, especially where it exits the connector.

- **DON'T OVERHEAT THE THERMOCOUPLE**

Usually, the first thing to fail on a thermocouple assembly is its insulation, handle, or other supporting material. Almost always, the wire can withstand more heat than its insulation can. See the manufacturer's specifications for the maximum temperature of any thermocouple assembly.

The wire itself can lose its accuracy if it is allowed to operate for extended periods of time near the high limit of its specifications. This is due to annealing and contamination of the wire's composition.

- **AVOID CHEMICAL REACTIONS THAT CAN DAMAGE THE THERMOCOUPLE**

The presence of various gasses and fluids at particular temperatures can contaminate, etch, or chemically combine with the thermocouple wire. Such conditions can affect its accuracy. The manufacturer's publications will show what to watch out for.

### **INSTRUMENT SPECIFICATIONS**

Instrument specifications are shown in Table 3.



**Table 3. Instruction Specifications**

**NBS CONFORMITY**

The thermometer conforms to the temperature/voltage tables of the National Bureau of Standards and to the IEC 584 standards for K-type and J-type thermocouples.

**ELECTRICAL**

**Measurement Range:**

K-type thermocouple: -200°C to +1370°C  
(-328°F to +2498°F)

J-type thermocouple: -200°C to +760°C  
(-328°F to +1400°F)

**NOTE**

This specification applies only to the thermometer and may differ from the thermocouple range. To prevent damage to the thermocouple, check the specification before using (see Appendix A).

**Resolution:** High: 0.1°C or 0.2°F  
Low: 1°C or 1°F

**Accuracy:**

Accuracy is specified for operating temperatures over the range of 18°C to 28°C (64°F to 82°F), for 1 year, not including thermocouple error (see "Thermocouple Limitations").

For single-thermocouple measurements, accuracy is:

K-type thermocouple:  $\pm(0.1\% \text{ of reading} + 0.7^\circ\text{C})$   
( $\pm(0.1\% \text{ of reading} + 1.3^\circ\text{F})$ )

J-type thermocouple:  $\pm(0.1\% \text{ of reading} + 0.8^\circ\text{C})$   
( $\pm(0.1\% \text{ of reading} + 1.4^\circ\text{F})$ )

For T1-T2 measurements, accuracy is typically better than:

K-type thermocouples:  $\pm(0.1\% \text{ of T1-T2 reading} + 1.0^\circ\text{C})$   
( $\pm(0.1\% \text{ of T1-T2 reading} + 1.8^\circ\text{F})$ )

J-type thermocouples:  $\pm(0.1\% \text{ of T1-T2 reading} + 1.2^\circ\text{C})$   
( $\pm(0.1\% \text{ of T1-T2 reading} + 2.2^\circ\text{F})$ )

**Temperature Coefficient** (for ambient temperatures from 0°C to 18°C and 28°C to 50°C [32°F to 64°F and 82°F to 122°F]):

**Table 3. Instrument Specifications (cont)**

For each °C (°F) ambient below 18°C (64°F) or above 28°C (82°F), add to the accuracy specifications:

0.01% of reading + 0.03°C  
(0.01% of reading + 0.03°F)

**Input Protection:**

60V dc or 24V rms ac maximum input voltage on any combination of input pins

**Maximum Differential Common Mode Voltage**

(Maximum voltage between T1 and T2 during measurement):  
1 volt

**Reading Rate:**

One thermocouple plugged in: 1 second per reading  
Two thermocouples plugged in: 1.7 seconds per reading

**ENVIRONMENTAL**

**Ambient Operating Range:**

0°C to 50°C (32°F to 122°F)

Will operate to -26°C (-15°F) for 5 minutes when taken from a 20°C (68°F) environment.

**Storage Temperature:** -40°C to 60°C (-40°F to 140°F)

**Humidity:**

0% to 90% (0°C to 35°C) (32°F to 95°F)

0% to 70% (35°C to 50°C) (95°F to 122°F)

**RF Fields:** Exposure to an RF field interferes significantly with this instrument's capacity to accurately measure temperature with thermocouples. The interference is temporary and the instrument suffers no harm when exposed to an RF field of 3 V/m. Accurate temperature measurements capability is completely restored when the instrument is removed from the RF field.

Common sources of RF fields are handheld walkie-talkies and cellular telephones. If such a source is suspected of interfering with this instrument, either turn off the transmitter or increase the separation between the transmitter and the instrument.

**Table 3. Instrument Specifications (cont)**

**GENERAL**

**Weight:** 280 gm (10 oz)

**External Dimensions:** 2.84 cm x 7.49 cm x 16.64 cm  
(1.12 in x 2.95 in x 6.55 in)

**Battery:** Standard 9V battery (NEDA 1604, 6F22, or 006P)

**Battery life:** 1200 hours. Low battery indicator appears when less than 50 hours of battery life remain.

**Input Connector:** Accepts standard miniature thermocouple connectors (flat blades spaced 7.9 mm or 0.312 inch, center to center).

**Protection:** Class III as defined in IEC 348, Safety Requirements for Electronic Apparatus.

**Accessories:**

80PK-1 K-Type Bead Thermocouple (included)

80PK-2(A) K-Type Immersion/General Purpose Probe

80PK-3 K-Type Surface Probe

80PK-4(A) K-Type Air Probe

80PK-5 K-Type Piercing Probe

80PK-6(A) K-Type Exposed Junction Probe

C50 Soft Case

(See authorized Fluke distributors for other accessories, thermocouple probes and connectors.)

## **SERVICE CENTER REPAIR**

If the thermometer fails, forward it, postage paid, to one of the Fluke Service Centers listed at the back of this manual. Include a description of the difficulty, and pack the instrument securely; Fluke shall assume NO responsibility for damage in transit.

**IN WARRANTY:** Instruments covered by the limited warranty will be promptly repaired or replaced, at Fluke's option, and returned, all at no charge. See the registration card for warranty terms.

**OUT OF WARRANTY (USA AND CANADA):** The instrument will be repaired and returned for a fixed fee. (Repairs needed because of abuse or accidental damage will be quoted.) Contact the nearest Service Center for current prices. Include a check, money order, or purchase order with the instrument.

**OUT OF WARRANTY (OUTSIDE USA AND CANADA):** Service programs may vary by country. Contact the nearest Service Center for information.

# Appendix A

*These specifications apply to the thermocouples included with the thermometer.*

## Thermocouple Specifications

**Type:** K (Chromel vs. Alumel)

**Operational Range:**  $-40^{\circ}\text{C}$  to  $260^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$  to  $500^{\circ}\text{F}$ )  
continuous

### NOTE

*Operational limitations are due primarily to the thermal limitations of the thermocouple's insulation.*

**Initial Tolerances** (with respect to NBS tables):

$\pm 1.1^{\circ}\text{C}$  ( $2^{\circ}\text{F}$ ) over the range of  $0^{\circ}\text{C}$  to  $260^{\circ}\text{C}$  ( $32^{\circ}\text{F}$  to  $500^{\circ}\text{F}$ )

(Typically within  $1.1^{\circ}\text{C}$  or  $2^{\circ}\text{F}$  of NBS tables over the range of  $-40^{\circ}\text{C}$  to  $0^{\circ}\text{C}$  or  $-40^{\circ}\text{F}$  to  $32^{\circ}\text{F}$ )

**Output:**  $25^{\circ}\text{C}$  ( $77^{\circ}\text{F}$ ) corresponds to 1.00 mV (internal reference junction at  $0^{\circ}\text{C}$ )

**Seebeck Coefficient:**  $40.50 \mu\text{V}/^{\circ}\text{C}$  at  $25^{\circ}\text{C}$  ( $22.5 \mu\text{V}/^{\circ}\text{F}$  at  $77^{\circ}\text{F}$ )

**Measurement Time** (Time Constant): 2 seconds (for air at room temperature at one atmosphere of pressure moving with a velocity of 65 ft/sec)

**Maximum Safe Contact Voltage:** 24V ac rms or 60V dc

**Maximum Temperature of Bead:**  $260^{\circ}\text{C}$  ( $500^{\circ}\text{F}$ )

## Thermocouple Specifications (cont)

**Cable length:** 1.2m (4 ft)

**Cable Insulation:**

Material: Teflon

Maximum Temperature: 260°C (500°F)

**CAUTION**

**Repeated sharp flexing can break the lead. To prolong lead life, avoid sharp bends in the lead, especially near the connector.**

**Insulation Rating:** 1 kV between wire and outside of both layers of insulation

**Conductors:**

Type: K

Size: AWG #24 solid

**Polarity and Color Coding:**

Chromel: Yellow (+)

Alumel: Red (-)

**Connector:**

Type: Yellow mini-thermocouple connector with 7.9-mm (0.312-inch) blade spacing

Maximum Temperature: 200°C (392°F)