Model 710, 712, and 790 Fluoroptic Thermometer User Manual

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1.0 Introduction

This chapter provides an overview of the Model 710, 712, and 790 LUXTRON Fluoroptic thermometers. It also describes the major components and default settings of the instruments. Figure 1.1 shows a typical rack mount installation of the instrument.

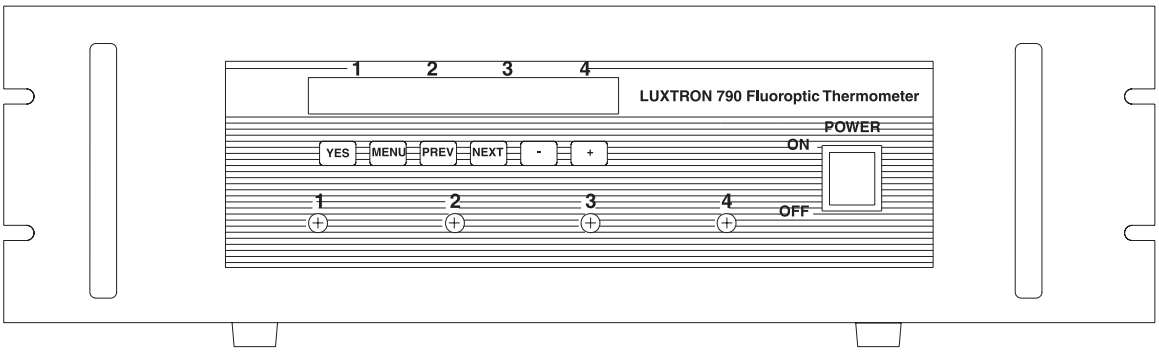


Figure 1.1 Rack Mount Four Channel Fluoroptic Thermometer—Model 790

System Overview

The Fluoroptic thermometer is a temperature measurement instrument. The probes used with the instrument are designed to be minimally disturbing and capable of functioning in otherwise hostile environments.

The instruments may be used for many applications, including the following:

- Microwave food and packaging development
- Electronics testing
- Semiconductor manufacturing
- High-voltage and electrical-power environments

Features

The instrument provides the latest technology in Fluoroptic thermometers. It provides many features, including the following:

- Digital signal processing (provides less noise and makes the signal easier to control)
- Programmable gain (each channel is controlled separately)
- MS-DOS® operating system and PC bus
- RS-232 serial port
- Analog output ±5 V standard

Options

The following options are available:

- IEEE-488 General Purpose Interface Bus (GPIB) interface
- Analog output ±10 V range—replaces ±5 V analog output
- Analog current loop (4 to 20 mA)—replaces ±5 V analog output

Note

The instrument may physically have both an RS-232 port and an IEEE-488 interface. However, only one may be active at any time.

Major Components

The instrument consists of the following components:

- The main unit, which contains the optical, analog, and digital electronics of the instrument, and a flashlamp
- The probes, each consisting of a fiber-optic cable with a temperature sensor at one end and a connector at the other end
- The system firmware, which is programmed into the main unit and uses a DOS-based operating system

Temperature data is collected when the sensor attached to the probe is activated by a burst of light from the flashlamp (which is mounted inside the instrument). The sensor then sends back an optical signal which is processed by the analog and digital electronics of the instrument to determine temperature.

Temperature data is sent to the front panel display, the analog outputs, and the digital output port (RS-232 port or optional IEEE-488 interface).

Main Unit

The electronics and flashlamp are in the main unit of the instrument. The electronics of the main unit include a CPU board for computation and a system board for data storage and control.

The display panel of the main unit can display system status messages and temperature data, using up to 24 alphanumeric characters.

Probes

The instrument is designed to function with a wide variety of probes designed and produced by LUXTRON Corporation. Each probe consists of a fiber-optic cable with a connector at one end and temperature sensor mounted at the other end. Contact the LUXTRON Sales Department for more information.

Firmware

The instrument is set up, operated, and maintained using its built-in, menu-driven firmware. It can be controlled locally or remotely:

- **Locally, from the front of the instrument.** The front panel of the instrument front panel has a single-line display of 24 characters and a set of six keys for running the firmware.
- **Remotely, from the RS-232 or IEEE-488 interface on the back of the instrument.** The instrument may be set up and controlled by an external computer or modem.

Main Menu and Menu Hierarchy

The Main menu provides access to the three major modes—RUN, CAL, and SETUP. Press the **YES**, **PREV**, or **–** (minus) buttons to select `RUN`, `CAL`, or `SETUP`, respectively (see Figure 1.2).

Figure 1.2 Main Menu

The Calibration and Setup menus are organized in hierarchical form:

- **First level menu selections**

  These selections are available only in Calibration and Setup modes. In Calibration mode (see the section, “Calibration Mode”), they indicate a procedure. In Setup mode, the selections describe an instrument parameter or function that may be accessed, followed by a question mark (?). However, the question mark is not included when the parameter or function is already 24 characters in length (such as the `CHANGE TEMPERATURE UNITS` parameter.

- **Second level menu selections**

  These selections are found in Setup mode (see the section, “Setup Mode”). The selections allow you to change an instrument parameter or function, and are usually followed by a colon (`:`), and sometimes by a question mark (?).

Setup and Calibration mode, as well as Run mode, are described in Chapter 3, “Using the Instrument.”

Default Setup Parameters

Table 1.1 lists the default Setup parameters.

Setup Parameter	Default Values	
	Model 710, 712	Model 790
SAMPLES/MEASUREMENT	*8*	*8*
UPDATE TIME	*CONTINUOUS*	*CONTINUOUS*
BRIGHTNESS	*4*	*4*
TEMPERATURE UNITS	*°C*	*°C*
LOW/HIGH LIMIT (Temp)	*-199.9 to 449.9 °C*	*-199.9 to 449.9 °C*
DATASAVE FEATURE	*OFF*	*OFF*
SELECT PORT (Digital)	*RS-232*	*RS-232*
RS-232 BAUD RATE	*9600*	*9600*
DIGITAL FORMAT	*ABBR*	*FULL*
ENABLE TIME STAMPS	*OFF*	*OFF*
IEEE DEVICE ADDRESS	*1*	*1*
mV PER DEGREE	*100*	*100*
ANALOG OFFSET	*0.0 °C*	*0.0 °C*

Table 1.1 Default Setup Parameters

Information describing how to change parameters for particular applications are provided in Chapter 3, “Using the Instrument.”

How to Use this Manual

This manual explains how the LUXTRON Model 710, 712, and 790 Fluoroptic® thermometers work and provides information on how to set up, operate, and maintain these thermometers.

These Fluoroptic Thermometer models, despite their advanced technology, are simple to use. The setup and operating instructions provide information that average users might need, with a minimum of technical details. Contact the LUXTRON Sales or Customer Service Department for additional information.

The manual is organized into the following chapters and appendices:

Chapter 1, "Introduction," provides an overview of the instruments and describes major components and default settings of the instruments.

Chapter 2, "Unpacking and Installing the Instrument," describes how to unpack, assemble, and test the instrument.

Chapter 3, "Using the Instrument," describes how to use the front panel buttons and Setup, Calibration, and Run modes.

Chapter 4, "Theory of Operation," discusses the temperature sensor and how the instrument calculates temperature measurements.

Chapter 5, "Maintenance and Troubleshooting," discusses how to maintain the instrument and troubleshoot problems.

Appendix A, "Specifications," defines specifications for the accuracy, precision, and performance of the instrument.

Appendix B, "Instrument Probes," discusses how to use and care for probes supplied with the instrument.

Appendix C, "RS-232 Serial Output Port," discusses the serial port of the instrument, as well as complete setup and diagnostics.

Appendix D, "Optional IEEE-488 Interface," discusses the optional IEEE-488 interface, as well as complete setup and diagnostics.

Appendix E, "Analog Output Options," discusses the Analog Output Voltage (AOV) ±5 V Standard and ±10 V option, as well as the Analog Output Current (AOC) option.

Appendix F, "Warranty and Service," documents warranty and service information for the instrument.

Stylistic Conventions Used in this Manual

This manual uses the following conventions:

- **Buttons**

  All buttons are represented in **UPPER CASE BOLD FACE** type.

- **Display and instrument error messages**

  All display and instrument error messages are indented and shown in UPPER CASE MONOTYPE.

- **Operating modes**

  Operating modes are shown in Normal type, with the first letter capitalized (for example, Remote mode).

- **Menu names**

  Menu names are shown in Normal type, with the first letter capitalized (for example, Main menu) unless a reference is made to select it (see next bullet).

- **Menus, parameters, and variables**

  All menus and parameters are shown in UPPER CASE MONOTYPE to match the display (such as "Select SETUP from the Main menu"). Variables are shown in *italics* (toggle between °*C* and °*F*).

Notes, Cautions, and Warnings appear throughout the manual. The format and contents are as follows:

Note

Used when information is sufficiently important to require special attention.

Caution

Used when information is sufficiently critical to avoid instrument damage.

Warning

Used when information is critical to avoid personal injury.

Warning

Used when information is critical to avoid personal injury when an electrical hazard is present.

2.0 Unpacking and Installing the Instrument

This chapter describes how to unpack, assemble, and test the instrument.

Unpacking the Instrument

When the instrument is received, inspect the container in which it is packaged prior to opening to ensure there is no obvious damage which may have occurred during shipping. If you have reason to suspect that it may have been damaged in shipping, you must immediately file a claim with the carrier before contacting LUXTRON.

Open the shipping container and carefully remove the instrument from its packaging material, at which time you should assemble and test it.

Each system component should be checked against the enclosed packing list and inspected for signs of visible damage. The standard instrument is shipped with the following items:

- One Fluoroptic Thermometer instrument
- One user manual
- One grounded three-conductor power cord
- Various Fluoroptic temperature probes and other supply items, as ordered
- One shielded RS-232 cable

Contact the LUXTRON Customer Service Department immediately if there is any visible damage to the instrument or probes or if any items are missing. If everything is in order, save the packing material for possible future use.

In the event of a later service question, see Appendix F, “Warranty and Service.”

Installing the Instrument

The rack-mount version of this equipment is designed to be mounted in a standard 19-inch equipment rack. Note that the four plastic mounting feet can be removed without loosening or removing any hardware inside the instrument. This equipment can be used in any location, as long as the environmental requirements are met, as listed in Appendix A, “Specifications.”

Caution

This equipment is designed to be used with a grounded three-conductor power cord. Ensure that you have an adequately grounded power source before proceeding.

To install the instrument

1. If rack mounting the instrument, remove the four plastic mounting feet and secure instrument in the rack, using the four sets of screws, washers, and nuts.
2. Plug socket end of power cord into receptacle on back panel of instrument, and the other end into grounded power outlet rated as follows:
   - **Input voltage** 90 to 250 V
   - **Input frequency** 47 to 63 Hz
3. Power-on and test instrument per instructions in the section, "Testing the Instrument."
4. Remove black vinyl caps from front panel probe connectors (caps are shipped on the instrument to prevent dust contamination). Save the caps and place them on front-panel probe connectors when instrument is not in use.
5. Unpack a probe and remove the red vinyl protective cap from a connector.

Note

Do not uncoil the probe until instrument power-on testing is complete.

6. Screw probe metal connector into a front panel probe connector.

Figure 2.1 shows the front view of the stand alone installation of the instrument (Model 790 only). Figure 2.2 shows the front view of the rack mount installation of the instrument (all models). Figure 2.3 shows the rear view of the instrument. An overall view of each model is provided in Appendix A, “Specifications.”

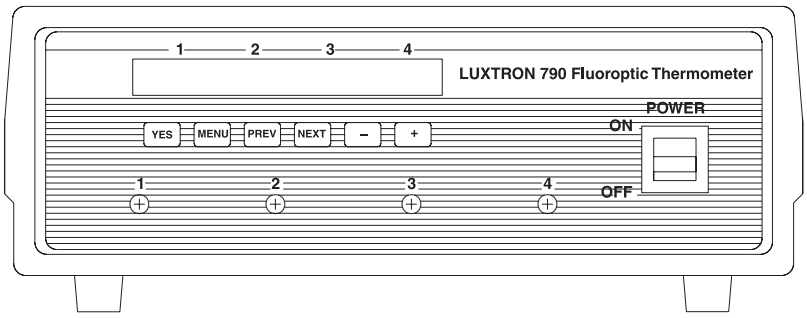


Figure 2.1 Front Panel—Stand Alone, Model 790

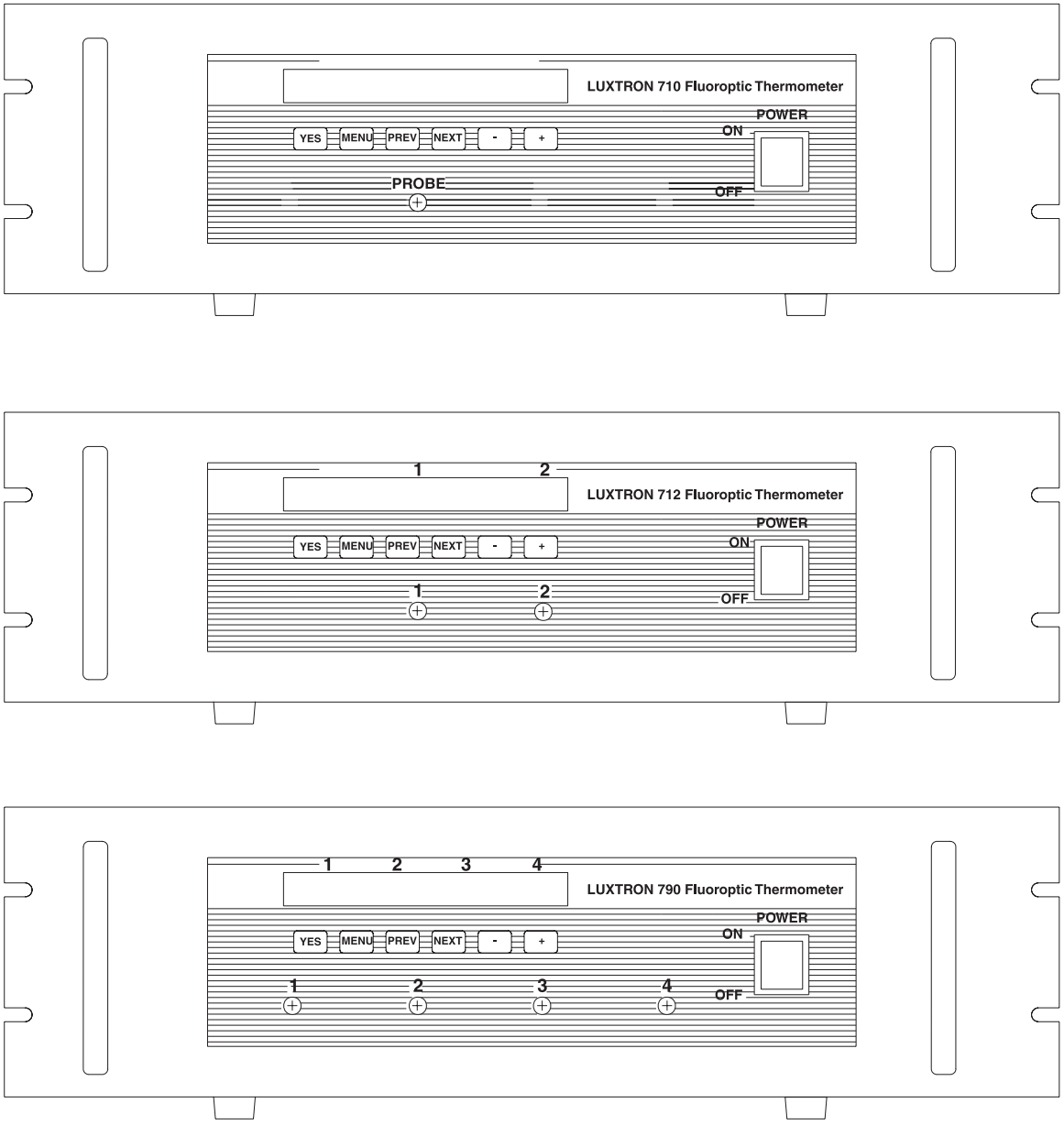
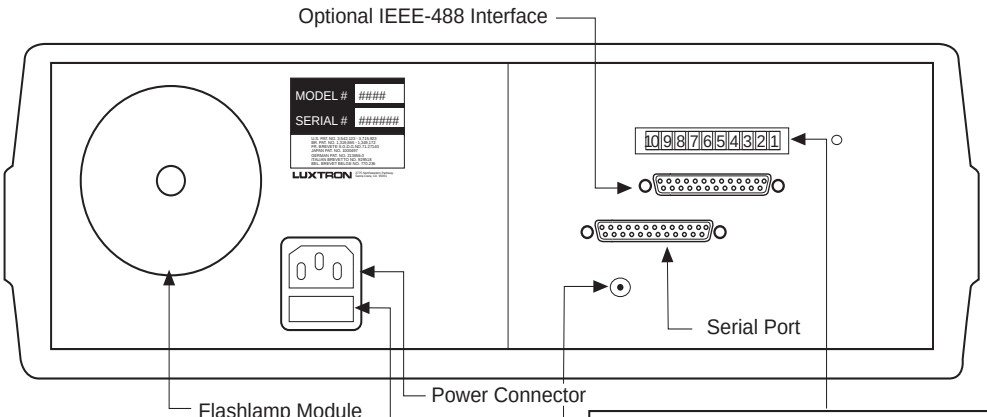


Figure 2.2 Front Panel—Rack Mount, All Models



Analog Output Connector			
	Function		
Pin	710	712	790
1	Sensor 1	Sensor 1	Sensor 1
2	Sensor 1 Return	Sensor 1 Return	Sensor 1 Return
3	Not Used	Sensor 2	Sensor 2
4	Not Used	Sensor 2 Return	Sensor 2 Return
5	Not Used	Not Used	Sensor 3
6	Not Used	Not Used	Sensor 3 Return
7	Not Used	Not Used	Sensor 4
8	Not Used	Not Used	Sensor 4 Return
9	Chassis Ground	Chassis Ground	Chassis Ground
10	Chassis Ground	Chassis Ground	Chassis Ground

Figure 2.3 Sample Back Panel—All Models

Testing the Instrument

After installing the instrument, power-on and test it to ensure it is working properly.

To test the instrument

1. Power-on the instrument, using the power switch on the front panel.

   The display scrolls through the following single-line messages, in the order listed:

```
          LUXTRON CORPORATION
(MODEL NUMBER)        (C) COPYRIGHT
(PART NUMBER)         (FIRMWARE VERSION)
RUN       CAL     SETUP    *
```

Note

Instrument warm-up time is 15 minutes from a cold start or initial power-on. For minimum warm-up time and maximum equipment life, keep the system powered on at all times, even when it is not in use.

The instrument is now ready to use, as indicated by the blinking asterisk ("*") at the far right of the display. The Main menu lists the following three modes of operation:

- RUN
- CAL
- SETUP

2. Press **YES** to automatically begin taking temperature measurements.
3. Press any button to stop taking measurements and return to Main menu.

Setup, calibration, operation, and diagnostics are run from the Main menu, as discussed in Chapter 3, "Using the Instrument." Select menu items by pressing the appropriate buttons below the front panel display or by using a computer connected to the instrument, as discussed in Appendix C, "RS-232 Serial Output Port."

Probe Use and Handling

Handled properly, probes should last indefinitely. Appendix B, "Instrument Probes," discusses how to care for and maintain the probes.

Observe the following precautions when using the probes:

- **Flexibility**

  Each probe is made from a single strand of silica fiber or plastic-clad silica (PCS) fiber. These fibers are flexible. However, any fiber may be damaged or broken if it is bento too sharply.

- **Temperature range**

  Using a probe outside its intended temperature range or in chemical environments may shorten the life span of the probe.

- **Care and storage**

  Each probe is supplied with a red vinyl cap over the connector. Replacing this cap when the probe is not in use prevents dirt from accumulating on the open fiber end. Occasionally clean the connector with spectrograde isopropyl alcohol or methanol.

3.0 Using the Instrument

This chapter describes how to use the front panel buttons, as well as how to use Setup, Calibration, and Run modes.

Setup Mode

Setup mode allows displaying and changing setup parameter values. Use Setup mode for initial setup or for when the application changes and different types of probes or system devices are required. Access Setup mode by pressing **–** at the Main menu.

Table 3.1 lists the use for each front panel button. Figure 3.1 illustrates the Setup mode menu tree. Table 3.2 defines each Setup menu selection and describes how to change the parameters of each.

Action	**Procedure**
Proceed to next first level menu selection without changing parameter values.	Press **NEXT**.
Save parameter changes and proceed to next first-level menu.	Press **NEXT**.
Return to previous first level menu selection without making parameter changes.	Press **PREV**.
Display second level menu selection.	Press **YES**.
Enter new parameter value and proceed to next selection.	Press **YES**.
Save parameter changes and return to Main menu.	Press **MENU**.
Toggle parameter on or off.	Press *button* located directly under parameter value.
Scroll up or down to select a parameter value.	Press **– or** +. Hold down to increase scrolling speed.

Table 3.1 Front Panel Button Actions

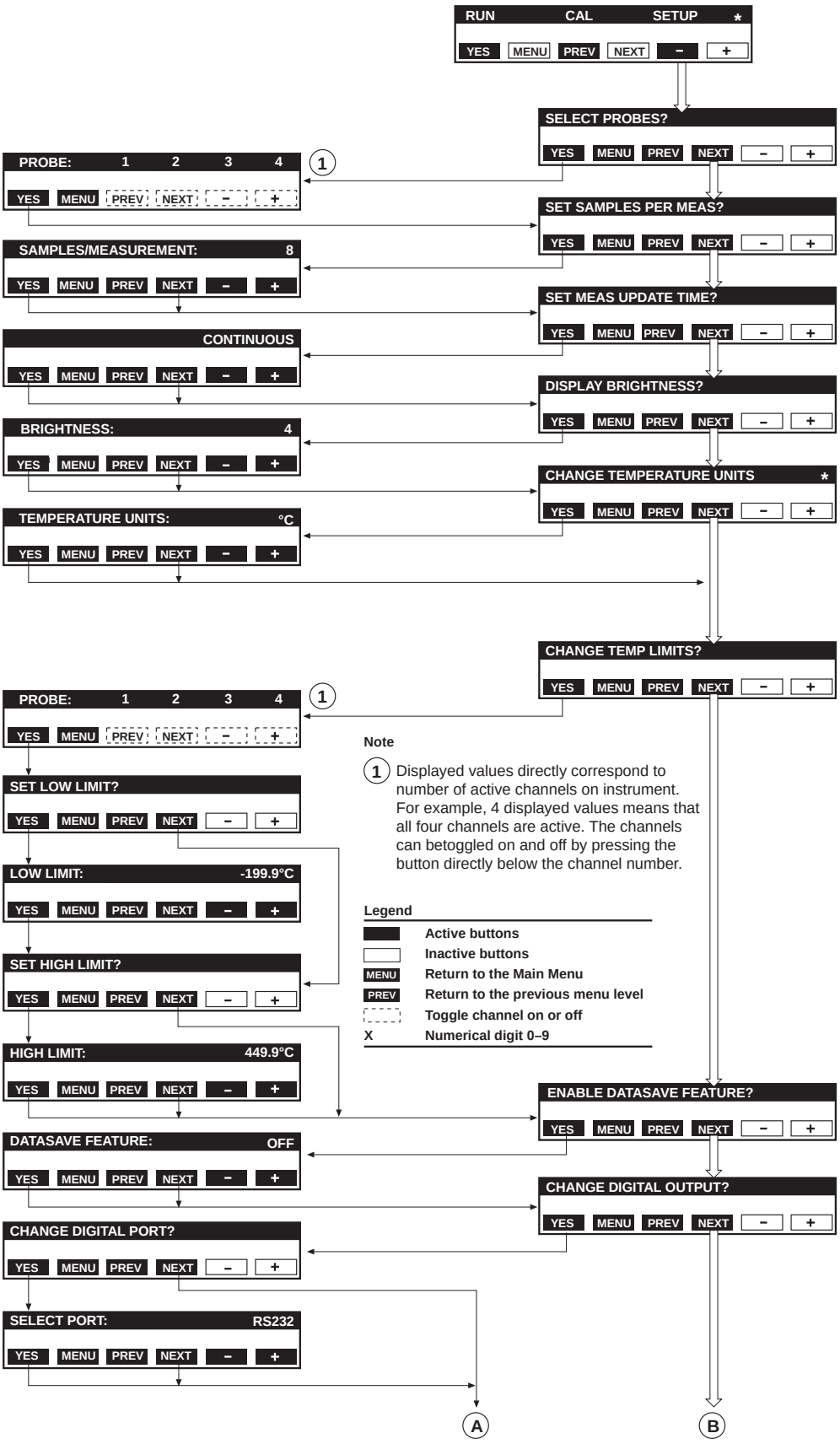


Figure 3.1 Setup Mode Menu Tree

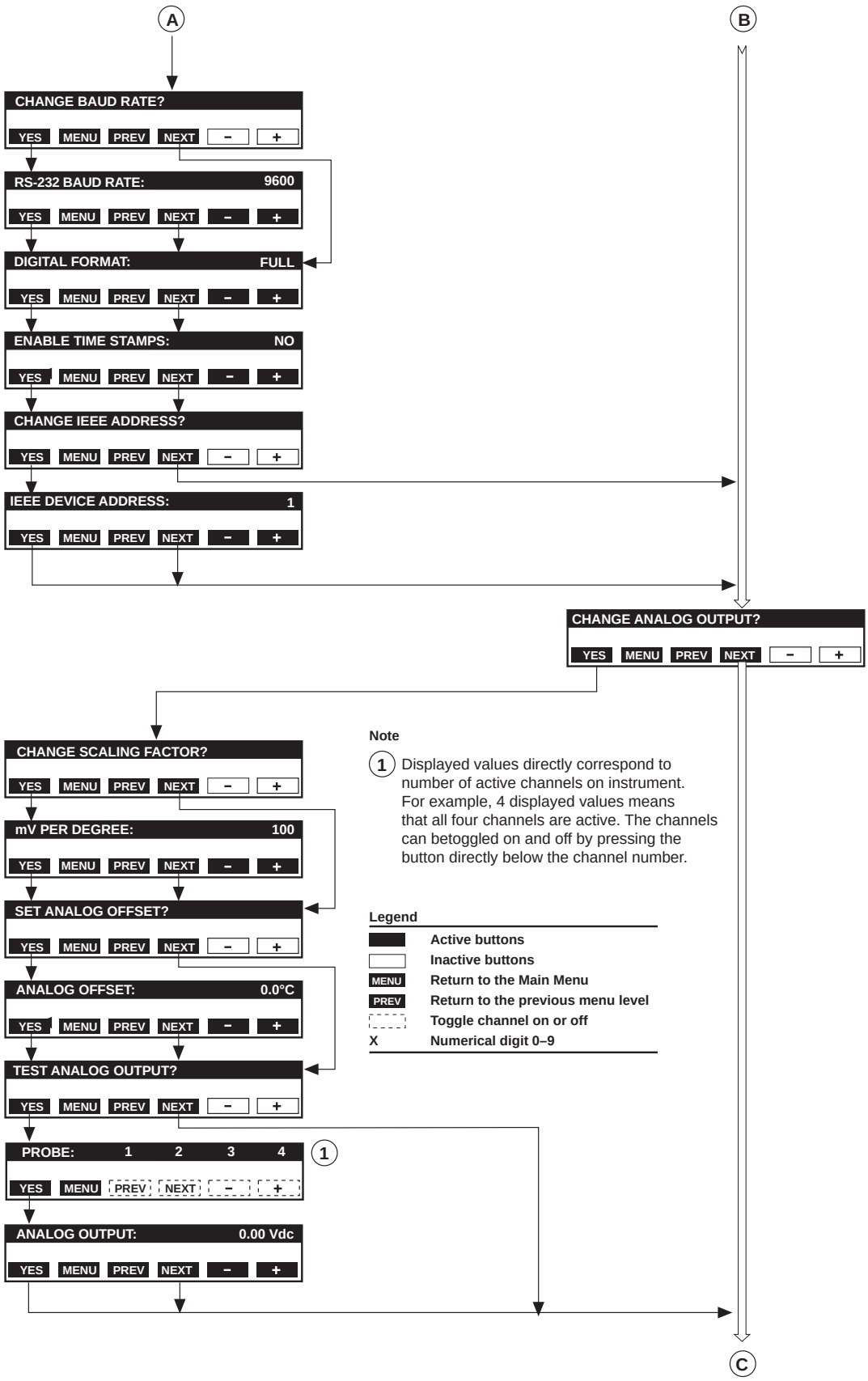


Figure 3.1 Setup Mode Menu Tree (continued)

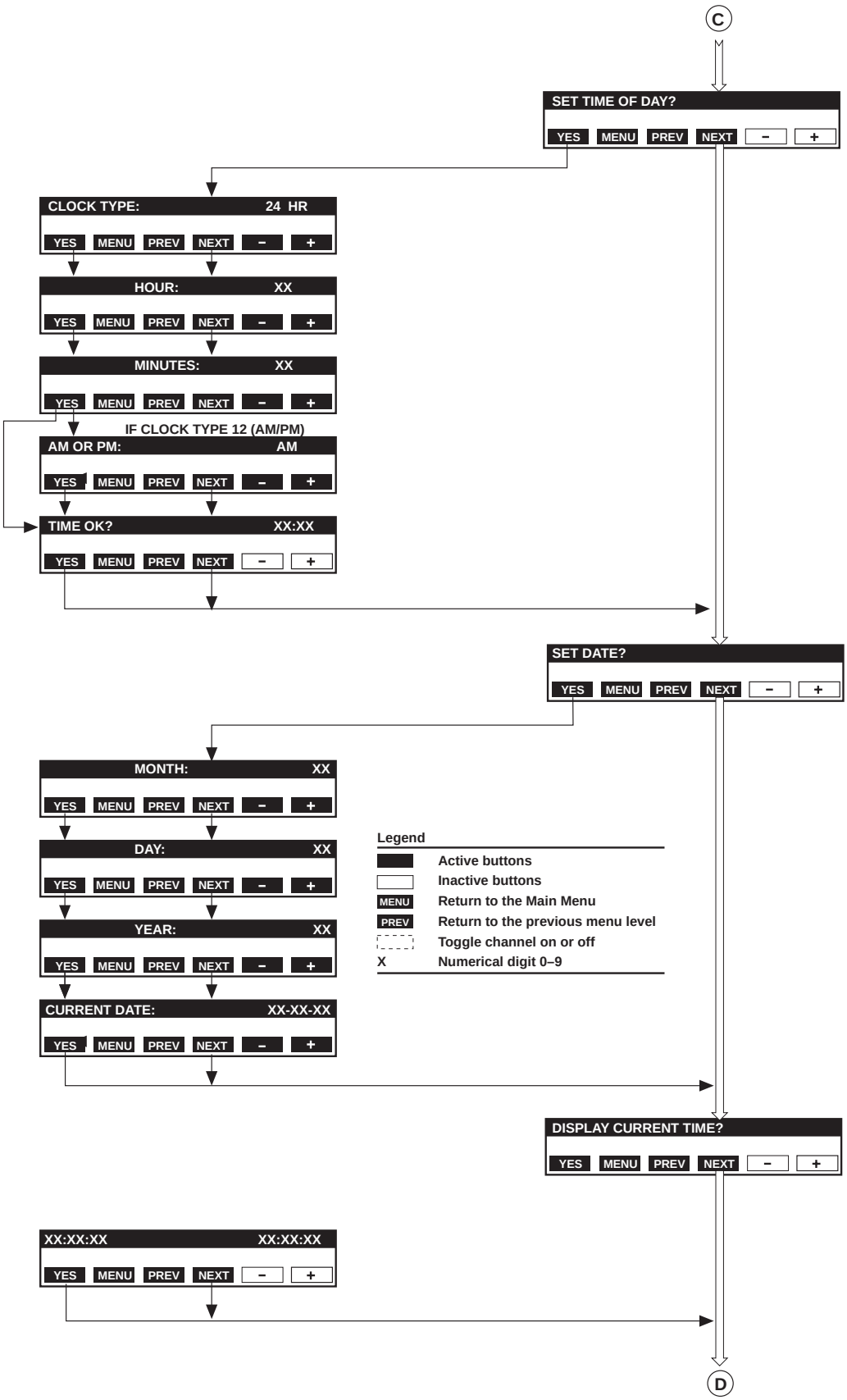


Figure 3.1 Setup Mode Menu Tree (continued)

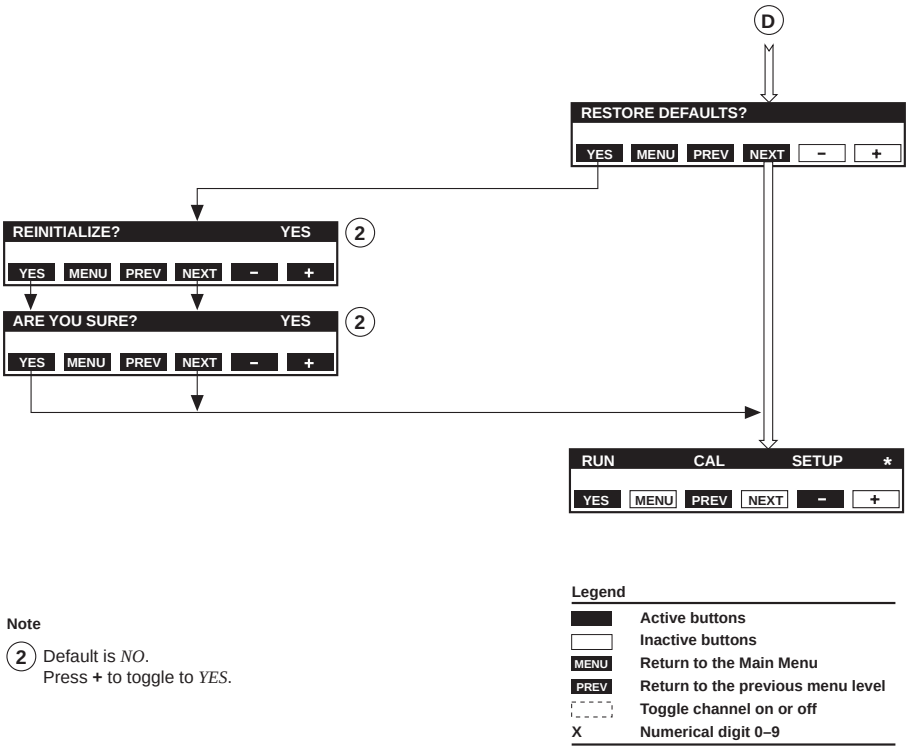


Figure 3.1 Setup Mode Menu Tree (continued)

Step	First-Level Message and Definition	Procedure
1.	RUN CAL SETUP *	**To setup the instrument** a. Press **–** at Main menu.
2.	SELECT PROBES? Enables or disables probes. Disabled probes indicated by *OFF*. **Note** Displayed values directly correspond to number of active channels on instrument.	**To specify where probes are connected to the front panel** a. Press **YES**. The message "PROBE: 1 2 3 4" appears. b. Press *button* below each probe channel to turn on/off associated probe. c. Press **YES** to save selection and continue.

Table 3.2 Setup Menu First-Level Messages and Definitions

Step	First-Level Message and Definition	Procedure
3.	SET SAMPLES PER MEAS? Specifies number of samples or data acquisitions to be taken before calculating a measurement. Increasing this number improves accuracy of the reading because more samples are averaged together to obtain a measurement. See the section, "How Temperature Measurements are Calculated" in Chapter 4, "Theory of Operation." **Note** For best results, use maximum number of samples per measurement for the time available.	**To specify the number of samples or data acquisitions per measurement** a. Press **YES**. The message "SAMPLES/MEASUREMENT:" appears. b. Press **–** and/or **+** to enter number between *1* and *999*. c. Press **YES** to save selection and continue.
4.	SET MEAS UPDATE TIME? Specifies frequency at which to update displayed temperature readings. Time can be set from continuous (every 1/4 second) to once every 999 hours. See the section, "How Temperature Measurements are Calculated," in Chapter 4, "Theory of Operation." **Note** Instrument uses a rolling (or "boxcar") average when calculating measurements.	**To set the time between measurements or displayed temperature readings** a. Press **YES.** The message "UPDATE TIME:" appears. b. Press **YES** to select *CONTINUOUS*. Press **–** and/or **+** to scroll through the number of seconds, minutes, or hours. c. Press **YES** to save selection and continue.
5.	DISPLAY BRIGHTNESS? Increases or decreases brightness level of front panel display (for use in dimly lit environments).	**To increase or decrease the brightness of the front panel display** a. Press **YES**. The message "BRIGHTNESS:" appears. b. Press **–** and/or **+** to scroll through the brightness levels (*1* = less bright, *7* = most bright). c. Press **YES** to save selection and continue.

Table 3.2 Setup Menu First-Level Messages and Definitions (continued)

Step	First-Level Message and Definition	Procedure
6.	CHANGE TEMPERATURE UNITS Specifies whether to display temperature data in Celcius (°C) or Fahrenheit (°F).	**To specify the temperature units** a. Press **YES** . The message "TEMPERATURE UNITS:" appears. b. Press **–** and/or **+** to toggle between °*C* and °*F*. c. Press **YES** to save selection and continue.
7.	CHANGE TEMP LIMITS? Enables instrument to be used as a controller in a closed loop temperature control system. Use to set probe upper and lower temperature limit (trip) points. When limit is exceeded, display flashes and an alarm is sent to the digital output (the RS-232 port or optional IEEE-488 interface), analog output, and front panel. **Notes** Only one low and high limit can be assigned to selected channels. Therefore, if only Channel 2 is selected and low and high limits (such as -100 and 300 °C) are assigned and saved, then try to set different low and high limits for another channel, the limits specified for Channel 2 are changed to match the new limits specified for the other channel. Channels toggled off during this step retain the low and high limits of -199.9 to 449.9 °C as default. To turn the probe on, toggle channel on, as described in Step 2, "SELECT PROBES?"	**To change temperature units** a. Press **YES**. The message "PROBE: 1 2 3 4" appears. b. If necessary, press *button* below each probe channel to turn on/off associated probe that needs/does not need temperature limit changed. c. Press **YES**. The message "SET LOW LIMIT?" appears. d. Press **YES**. The message "LOW LIMIT:" appears. e. Press **–** and/or **+** to scroll through range of values: • -199.9 to 449.9 °C • -327.8 to 841.8 °F f. Press **YES**. The message "SET HIGH LIMIT:" appears. g. Press **YES**. The message "HIGH LIMIT:" appears. h. Press **–** and/or **+** to scroll through range of values: • -199.9 to 449.9 °C • -327.8 to 841.8 °F i. Press **YES** to save selection and continue.

Table 3.2 Setup Menu First-Level Messages and Definitions (continued)

Step	First-Level Message and Definition	Procedure
8.	ENABLE DATASAVE FEATURE? Enables instrument to store measurements internally. **Note** Although this option is available for selection, it is currently nonfunctional.	**To use the DATASAVE feature** a. Press **NO** to continue.
9.	CHANGE DIGITAL OUTPUT? Specifies temperature at which to transfer data to RS-232 or IEEE-488 port for use by a peripheral device, such as a computer (see Appendix C, "RS-232 Serial Output Port," or Appendix D, "IEEE-488 Output Port Option"). **Note** Only one digital output may be installed in the system at any given time. CHANGE DIGITAL PORT Specifies whether to use RS-232 or IEEE-488 port. CHANGE BAUD RATE? Specifies rate at which instrument transmits data.	**To change a digital output option** a. Press **YES** to display first menu selection. The message "CHANGE DIGITAL PORT?" appears. b. Press **YES**. The message "SELECT PORT:" appears. c. Press **–** and/or **+** to toggle between *RS232* and *IEEE*. d. Press **YES** to save selection and continue. The message "CHANGE BAUD RATE?" appears. e. **IEEE-488 Output:** Press **NEXT.** Proceed to Step 9h. **RS-232 Output:** Press **YES**. The message "RS-232 BAUD RATE:" appears. f. Press **–** or **+** to scroll through available values—*2400*, *4800*, *9600*, and *19200*. g. Press **YES** to save selection and continue.

Table 3.2 Setup Menu First-Level Messages and Definitions (continued)

Step	First-Level Message and Definition	Procedure
9. (cont'd)	DIGITAL FORMAT? Specifies full format outputs for channels of data to be compatible with earlier versions of instrument. • *FULL* = All channels • *ABBR* = Only currently selected channels • *IEEE* = Output to GPIB/IEEE-488 standards ENABLE TIMESTAMPS? Outputs time and date stamp to output port. CHANGE IEEE ADDRESS? Specifies IEEE address to be used by device using this port.	The message "DIGITAL FORMAT:" appears. h. Press **–** or **+** to toggle between *FULL*, *ABBR*, and *IEEE*. i. Press **YES** to save selection and continue. The message "ENABLE TIMESTAMPS:" appears. j. Press **–** or **+** to toggle between *NO* and *YES*. k. Press **YES** to save selection and continue. The message "CHANGE IEEE ADDRESS?" appears. l. **RS-232 Output:** Press **NEXT.** Proceed to Step 10. **IEEE-488 Output:** Press **YES**. The message "IEEE DEVICE ADDRESS:" appears. m. Press **–** or **+** to scroll through the list of values between *0* and *30*. n. Press **YES** to save selection and continue.

Table 3.2 Setup Menu First-Level Messages and Definitions (continued)

Step	First-Level Message and Definition	Procedure
10.	CHANGE ANALOG OUTPUT? Improves resolution by increasing scale factor. Also reduces temperature range because range is restricted by output limit of ±5 V. CHANGE SCALING FACTOR? When increased, improves resolution and reduces temperature range. When reduced, increases temperature range and reduces resolution. SET ANALOG OFFSET? Specifies temperature at which to output 0 V. TEST ANALOG OUTPUT? Tests analog output.	**To change an analog output option** a. Press **YES** to display first menu selection. The message "CHANGE SCALING FACTOR?" appears. b. Press **YES**. The message "mV PER DEGREE:" appears. c. Press **–** or **+** to scroll through available values—*10*, *20*, *50*, *100*, *200*, and *500*. d. Press **YES** to save selection and continue. The message "SET ANALOG OFFSET?" appears. e. Press **YES**. The message "ANALOG OFFSET:" appears. f. Press **–** and/or **+** to scroll through range of values: • -199.9 to 449.9 °C • -327.8 to 841.8 °F g. Press **YES** to save selection and continue. The message "TEST ANALOG OUTPUT?" appears. h. Press **YES**. The message "PROBE: 1 2 3 4" appears. i. Press *button* located below the probe channels to turn off probes not to be tested. j. Press **YES** to begin test. The message "ANALOG OUTPUT: 0.00 Vdc" appears. k. Press **+** to increase, or **–** to decrease, output voltage. l. Press **YES** to save selection and continue.

Table 3.2 Setup Menu First-Level Messages and Definitions (continued)

Step	First-Level Message and Definition	Procedure
11.	SET TIME OF DAY? Establishes time clock to be used by instrument. CLOCK TYPE: Specifies whether to use 24 hours/day or 12 hour AM/PM display. HOUR: Specifies hour of day. MINUTES: Specifies minutes corresponding to hour of day. AM OR PM: Specifies AM or PM if 12 hour AM/PM display was selected. TIME OK? Displays time values entered in previous steps and provides option of approving specified time.	**To set the time of day** a. Press **YES** to display first menu selection. The message "CLOCK TYPE:" appears. b. Press **–** or **+** to select *24 HR* or *12 HR*. c. Press **YES** to save selection and continue. The message "HOUR:" appears. d. Press **–** and/or **+** until current hour of day appears. e. Press **YES** to save selection and continue. The message "MINUTES:" appears. f. Press **–** or **+** until minutes corresponding to current hour of day appear. g. Press **YES** to save selection and continue. h. **12 HR Only:** If selected in Step 11b, the message "AM OR PM:" appears. Press **–** or **+** to select *AM* or *PM*. Press **YES** to save selection and continue. The message "TIME OK?" appears. i. Press **YES** to display time as entered (for example, 2:30 PM for 12 HR format or 14:30 for 24 HR format). j. If the time is incorrect, press **PREV.** Repeat steps 11b–11i. Otherwise, press **YES** to save selection and continue.

Table 3.2 Setup Menu First-Level Messages and Definitions (continued)

Step	First-Level Message and Definition	Procedure
12.	SET DATE? Establishes date to be used by instrument. MONTH: Specifies current month. DAY: Specifies current day. YEAR: Specifies current year. CURRENT DATE: Displays date values entered in previous steps and provides the option of approving the specified date.	**To set the date** a. Press **YES** to display first menu selection. The message "MONTH:" appears. b. Press **–** and/or **+** to scroll through list of values until current month appears. c. Press **YES** to save selection and continue. The message "DAY:" appears. d. Press **–** and/or **+** until current day appears. e. Press **YES** to save selection and continue. The message "YEAR:" appears. f. Press **–** and/or **+** to scroll through list of values until last one or two digits of current year appear. g. Press **YES** to save selection and continue. The message "CURRENT DATE:" appears. h. Press **YES** to display date as entered. i. If the date is incorrect, press **PREV.** Repeat steps 12b–12h. Otherwise, press **YES** to save selection and continue.

Table 3.2 Setup Menu First-Level Messages and Definitions (continued)

Step	First-Level Message and Definition	Procedure
13.	DISPLAY CURRENT TIME? Displays current date and time on front panel of instrument.	**To display current date and time on front panel display** a. Press **YES** to display time, as well as previously entered date information.
14.	RESTORE DEFAULTS? Restores factory default settings or keeps and records the new values. **This is the final step in Setup mode.**	**To complete Setup mode and accept changed settings** a. Press **NEXT**. Instrument returns control to Main menu.
		To restore default settings a. Press **YES**. The message "REINITIALIZE:" appears. b. Press **–** or **+** to toggle to *YES*. c. Press **YES**. The message "ARE YOU SURE?" appears. d. Press **–** or **+** to toggle to *YES*. e. Press **YES**. Instrument restores default values and briefly displays the the message "SETTINGS RESTORED", at which time instrument returns control to Main menu.

Table 3.2 Setup Menu First-Level Messages and Definitions (continued)

Calibration Mode

The instrument may be calibrated after completing setup. Calibration increases measurement accuracy and can be done using an independent temperature reference standard (such as a constant temperature bath). Use Calibration mode for initial setup or when the application changes and different types of probes or system devices are required.

Notes

This calibration feature is normally off (disabled). If the probes have been changed, and/or the application is changing, recalibration may be necessary. For applications where an absolute accuracy of ±2 °C (±3.6 °F) is sufficient, it is not necessary to calibrate most probes. (The Micro-Tip [SMT] probe is an exception.)

Uncalibrated, the instrument is accurate to ±2 °C.

Once calibrated, the instrument provides an accuracy to ±0.1 °C (±0.18 °F) at the calibration temperature and a precision (repeatability) of ±0.1 °C root mean square (RMS) at eight samples per measurement.

Once the instrument is calibrated, accuracy can be traced through the National Institute of Science and Technology (NIST) if the temperature reference instrument itself is NIST-calibrated and the following conditions are met:

- The probes have not been disconnected from the instrument since being calibrated against a NIST-traceable reference standard
- The instrument has not been recalibrated since the NIST-traceable calibration

Notes

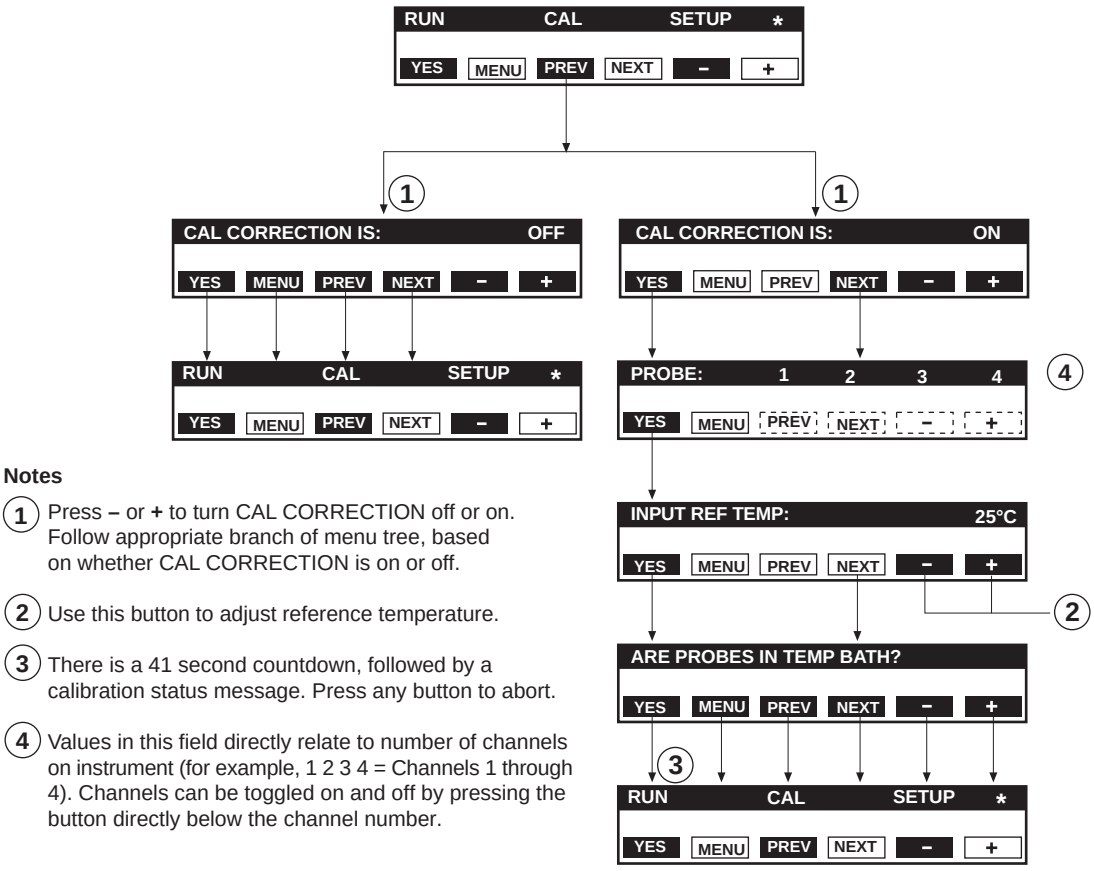
SEL probe cannot be callibrated in a temperature bath.

For maximum accuracy, calibrate the instrument:

- When operating the probe at temperatures greater than ±8 °C (±46 °F) from the original calibration point
- If a probe is bent more sharply than a 51 mm (2 in) radius
- If a probe is replaced with a new or different probe

To select Calibration mode, press **PREV** on the front panel of the instrument.

Figure 3.2 illustrates the Calibration mode menu tree. Table 3.3 defines each CAL menu selection and describes how to change the parameters of each.



Notes

1. Press **–** or **+** to turn CAL CORRECTION off or on. Follow appropriate branch of menu tree, based on whether CAL CORRECTION is on or off.
2. Use this button to adjust reference temperature.
3. There is a 41 second countdown, followed by a calibration status message. Press any button to abort.
4. Values in this field directly relate to number of channels on instrument (for example, 1 2 3 4 = Channels 1 through 4). Channels can be toggled on and off by pressing the button directly below the channel number.

Legend

- **Active buttons**
- **Inactive buttons**
- **Toggle channel on or off**

Figure 3.2 Calibration Mode Menu Tree

Step	First-Level Message and Definition	Procedure
1.	RUN CAL SETUP *	**To calibrate instrument** a. Place probe(s) into independent temperature-reference media. b. Press **PREV** at Main menu.
2.	CAL CORRECTION IS: Must be activated to calibrate instrument. If *OFF* is selected, display returns to Main menu.	**To activate Cal Correction feature and continue calibration** a. Press – or **+** to toggle to *ON*. b. Press **YES** to save selection and continue.
3.	PROBE: 1 2 3 4 Cal Correction must be activated to calibrate specifed probes. **Note** Probe values listed—1, 1 and 2, or 1 through 4—directly correspond to number of probes/channels.	**To specify probe(s) to calibrate** a. Press *button* located below probe channels to turn off probes not to be tested. b. Press **YES** to save selection and continue.
4.	INPUT REF TEMP: Specifies exact temperature reference media. Value must be near temperature of intended application.	**To enter temperature of independent reference** a. Press **–** and/or **+** to scroll through range of values until required temperature appears. b. Press **YES** to save selection and continue.

Table 3.3 Calibration Menu Display Messages and Definitions

Step	First-Level Message and Definition	Procedure
5.	ARE PROBES IN TEMP BATH? Confirms probe is in reference media and media temperature is stabilized. Allow one minute for probe to come to equilibrium at reference temperature. Calibration process takes less than one minute.	**To proceed with calibration** a. Ensure probe(s) is in reference media and media temperature is stabilized. b. Press **YES** to begin calibration. Instrument displays status message during calibration. If a probe fails calibration, instrument displays error message, and probe is automatically deselected. When calibration is complete, display returns to Main menu.

Table 3.3 Calibration Menu Display Messages and Definitions (continued)

Run Mode

In Run mode, the instrument displays the temperature reading from each of the connected probes after an appropriate number of samples are taken, as specified in Setup mode. The temperature data is also transmitted to the analog output and RS-232 port, or to the analog output and optional IEEE-488 interface. Use Run mode for day-to-day processes.

If SAMPLES/MEASUREMENT value is set overly high, system displays the message "ONE MOMENT . . ." until it takes the required number of samples per measurement. A small blinking asterisk ("*") provides a visual indication that it is functioning normally. If an error message appears, see the section, "Error and Informational Messages," in Chapter 5, "Maintenance and Troubleshooting," for further instructions.

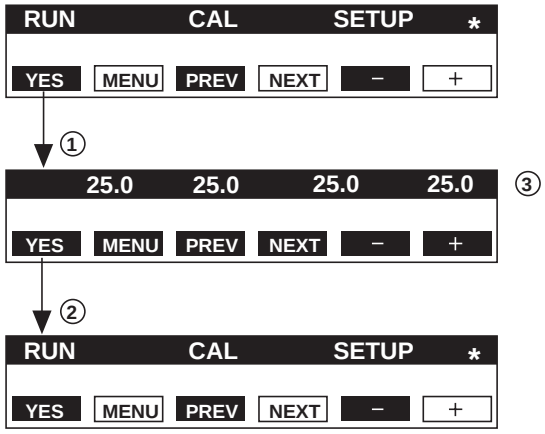
To select Run mode using current setup parameters and calibration settings

Press **YES** on front panel of instrument. The system briefly displays the unit of measure (°C or °F), then automatically begins acquiring data and displaying temperature values.

To exit Run mode

Press any button on the front panel.

Figure 3.3 illustrates the Run mode menu tree.



Notes

① Temperature units are displayed briefly. Press any button to return to Main menu.

The message "ONE MOMENT…" displays until required number of samples per measurement are achieved.

② Press any button to return to Main menu.

③ Displayed values directly correspond to number of active channels on instrument. For example, four displayed values mean that all four channels are active.

Legend

Active buttons

Inactive buttons

Figure 3.3 Run Mode Menu Tree

4.0 Theory of Operation

This chapter discusses the temperature sensor and how the instrument calculates temperature measurements.

Temperature Sensor

The temperature sensor is the key element in the system. It is mounted on the end of the probe. The sensor consists of a small amount of a temperature sensitive phosphor, which is manganese-activated magnesium fluorogermanate. When excited with blue-violet light, the phosphor exhibits a deep red fluorescence.

Figure 4.1 illustrates the temperature spectrum of the phosphor, along with the transmission of the filters used to isolate the exciting and fluorescent radiation. The spectrum is measured at room temperature. The dashed lines in the figure show the passbands of source and detector filters.

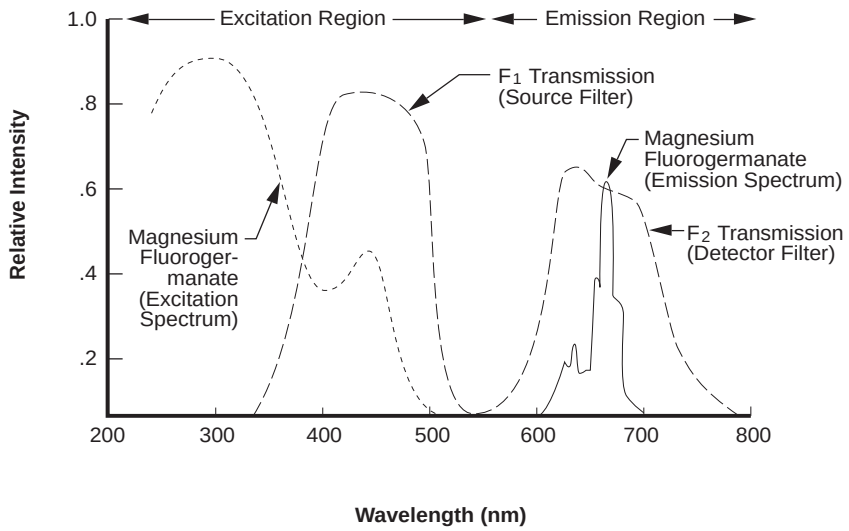


Figure 4.1 Temperature Spectrum of Magnesium Fluorogermanate

The filtered-xenon flashlamp in the main unit provides the pulse of blue-violet light which excites the phosphor to fluoresce. Figure 4.2 illustrates a general diagram of the optics of the instrument.

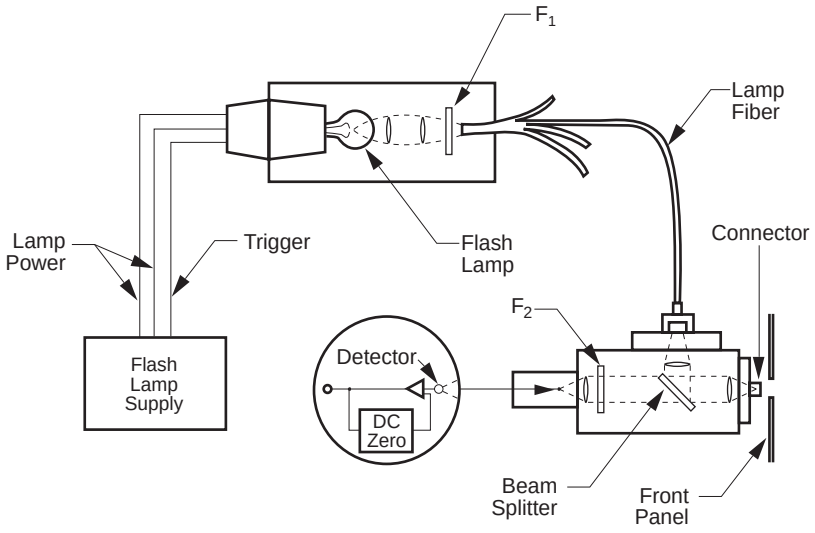


Figure 4.2 Cross-Sectional View of the Optics

After the excitation pulse ends, the intensity of fluorescent radiation decays. The fluorescent decay time is measured and then correlated with the phosphor temperature by comparing the measured decay time with a digital look-up table, as illustrated in Figure 4.3.

Figure 4.4 schematically illustrates the method for measuring the decay time of the phosphor sensor. Individual Data Points are used to perform a mathematical curve fit to calculate *t*. The measured value of time is then compared with the values stored in the calibration table and the corresponding temperature is displayed. The temperature data is transmitted to the front panel display, the analog output, and the digital output (RS-232 port or optional IEEE-488 interface).

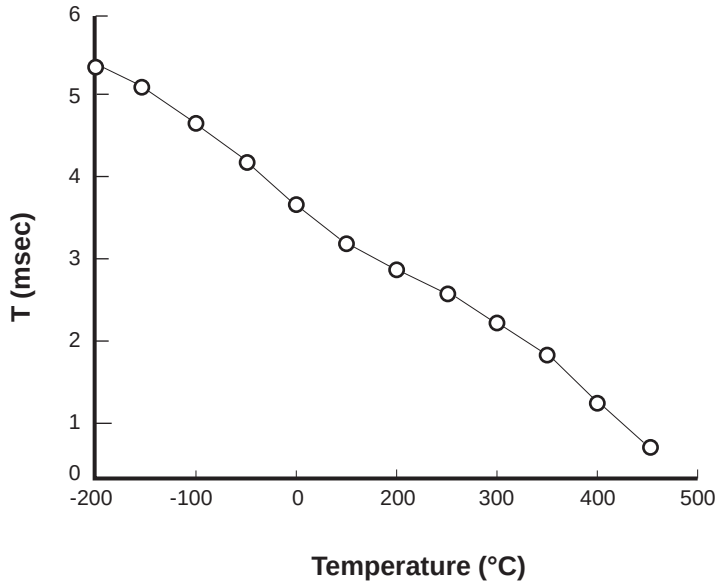


Figure 4.3 Time/Temperature Plot of Magnesium Fluorogermanate

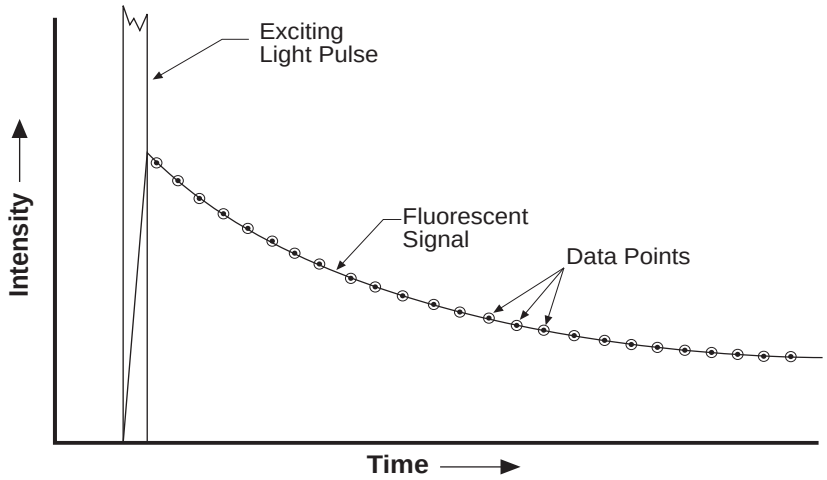


Figure 4.4 Plot Representation of Method for Extracting Fluorescent Decay Time

How Temperature Measurements are Calculated

The instrument calculates temperatures based on the SET SAMPLES PER MEAS and SET MEAS UPDATE TIME Setup parameters. Figures 4.5 through 4.7 illustrate three examples of temperature measurement.

Slow Temperature Measurement

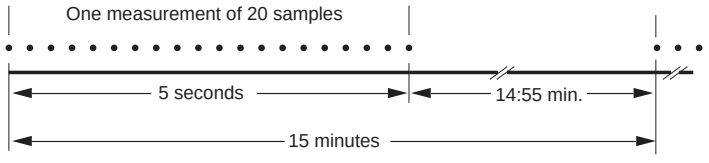
Parameter Values

```
SAMPLES/MEASUREMENT       = 20
MEASUREMENT UPDATE TIME   = 15
```

Description

The flashlamp, which flashes at a rate of 4 flashes per second, takes 5 seconds to gather the 20 samples required for a measurement (5 sec x 4 flashes/sec = 20 samples). Increasing the measurement update time increases the life of the flashlamp bulb.

After taking the samples, the flashlamp is inactive for 14:55 minutes, until the next measurement period (15 min - 5 sec = 14:55 minutes).



Measurement Update Time

Figure 4.5 Example of Slow Temperature Measurement

Temperature Measurement Using the Default Setup Values

Parameter Values

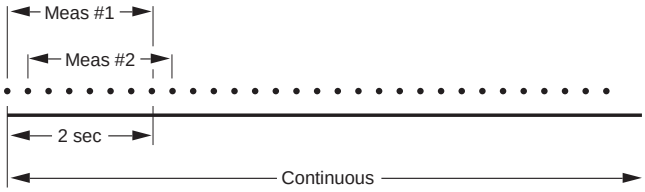
```
SAMPLES/MEASUREMENT        = 8
MEASUREMENT UPDATE TIME    = CONTINUOUS
```

Description

The flashlamp, which flashes at a rate of 4 flashes per second, takes 2 seconds to gather the 8 samples required for a measurement (2 sec x 4 flashes/sec = 8 samples).

Because the measurement update time is continuous, the second measurement begins with the second sample, as shown below.

The instrument updates four times per second because it uses a rolling, or “boxcar,” average.



Measurement Update Time

Figure 4.6 Example of Temperature Measurement using the Setup Default Values

Fast Temperature Measurement

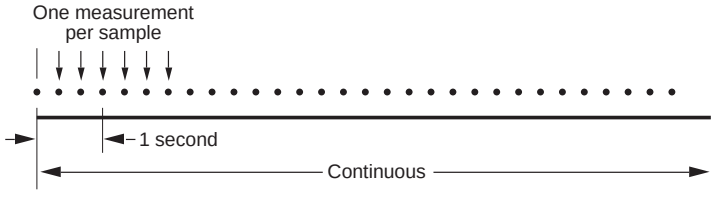
Parameter Values

```
SAMPLES/MEASUREMENT        = 1
MEASUREMENT UPDATE TIME    = CONTINUOUS
```

Description

The instrument takes each sample as a measurement.

The instrument updates four times per second, with no averaging. For increased accuracy and precision, increase the SAMPLES/MEASUREMENT value.



Measurement Update Time

Figure 4.7 Example of Fast Temperature Measurement

5.0 Maintenance and Troubleshooting

This chapter discusses the following:

- Equipment maintenance
- Probe and connector maintenance
- Technical information
- Troubleshooting
- Error and informational messages
- Instrument reinitialization
- Flashlamp replacement

Equipment Maintenance

The instrument is shipped with black vinyl caps over the front panel probe connectors to prevent dust contamination. Remove and save the caps before using instrument. Replace caps on the front panel probe connectors when instrument is not in use.

Probe and Connector Maintenance

Maintenance of the instrument essentially involves keeping the probes clean to ensure accurate temperature readings. Each probe is supplied with a red cap over the connector. Replacing this cap when the probe is not in use prevents dirt from accumulating on the open fiber end. Dirty fibers reduce transmission quality and performance.

If the polished fiber end in the center of the connector is dirty, wipe it with a cotton swab moistened with spectrograde isopropyl alcohol or methanol. For more information, including sterilization procedures, see Appendix B, “Instrument Probes.”

Technical Information

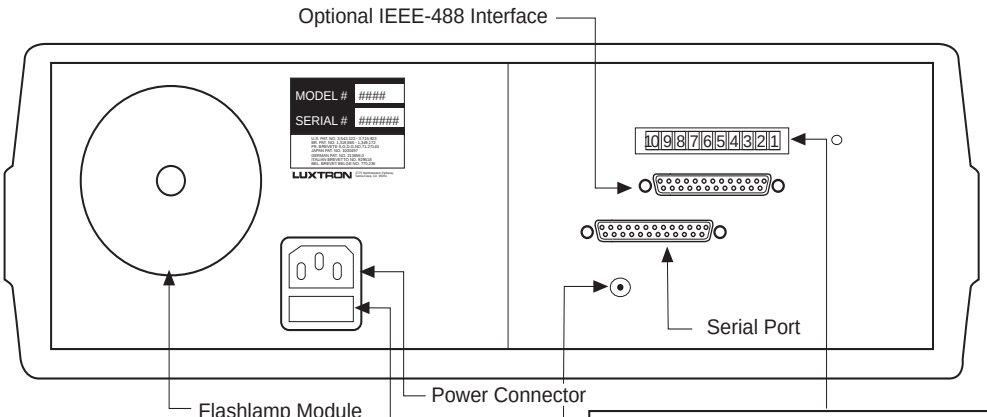
LUXTRON Corporation makes available, upon request, circuit diagrams, component parts lists, descriptions, and calibration instructions to assist the user’s technical personnel to repair those parts of the equipment that LUXTRON designates as repairable. Information for contacting LUXTRON is provided in Appendix F, “Warranty and Service.”

Troubleshooting

Table 5.2 lists troubleshooting symptoms and the corrective action required to resolve them. Additional information is provided in the sections, "System Messages," and "Status Messages."

Symptom	Corrective Action
Instrument display is blank	a. Check front panel power switch to ensure power is on. b. Ensure power cord is securely plugged into instrument and a grounded wall outlet. c. Ensure wall outlet works by plugging something else into it. d. Power-off instrument, then unplug it. e. Check and replace fuse, as necessary (see Figure 5.1 for fuse location). Instrument uses a 250 V AC fuse (250 V~ rating). Fuse time lag is 2.5 A (rating T2.5A). Fuse size is 5 x 20 mm (.2 x .79 in).
Information not updated on display	a. Check MEASUREMENT UPDATE TIME parameter in Setup menu. Decrease time value, if necessary. b. Check probe(s) to ensure connected and not broken, cut, or otherwise damaged. c. Restore default Setup settings.
Unstable readings	a. Increase SAMPLES PER MEAS parameter in Setup menu.
Communication errors	a. Check CHANGE DIGITAL OUTPUT parameter in Setup menu to ensure correct digital port is selected. b. If error persists, restore default Setup settings and try again.
No analog output as indicated by lack of activity on analog output device	a. Check CHANGE ANALOG OUTPUT parameter in Setup menu to ensure scaling factor is not set overly high or low. b. Use TEST ANALOG OUTPUT message to verify proper operation. (Connect a voltmeter to the analog output and check displayed voltage against voltmeter reading.)

Table 5.2 Troubleshooting Symptoms and Corrective Action



Analog Output Connector			
	Function		
Pin	710	712	790
1	Sensor 1	Sensor 1	Sensor 1
2	Sensor 1 Return	Sensor 1 Return	Sensor 1 Return
3	Not Used	Sensor 2	Sensor 2
4	Not Used	Sensor 2 Return	Sensor 2 Return
5	Not Used	Not Used	Sensor 3
6	Not Used	Not Used	Sensor 3 Return
7	Not Used	Not Used	Sensor 4
8	Not Used	Not Used	Sensor 4 Return
9	Chassis Ground	Chassis Ground	Chassis Ground
10	Chassis Ground	Chassis Ground	Chassis Ground

Figure 5.1 Sample Back Panel with Analog Pin Out—All Models

Error and Informational Messages

Error and informational messages may appear on the front panel display, the analog output, and the digital output port (RS-232 port or optional IEEE-488 interface). Table 5.3 lists the temperature-related error messages and Table 5.4 lists other system messages.

Error Message	Condition and Corrective Action
P-Err PE	**Probe Error.** Appears when signal from a particular channel is abnormal. Caused by a probe signal level that is high or low (such as a probe not properly attached to the connector). P-Err displays on instrument front panel. PE displays over the digital output port (RS-232 port or optional IEEE-488 interface).
P-HI	**Probe High.** Appears on front panel of instrument when signal from probe is overly strong. Can be corrected by slightly unscrewing probe connector from instrument, or bending probe into a loop (reduces transmission of the fiber-optic cable).
P-LOW	**Probe Low.** Appears on front panel of instrument when signal from a particular channel is overly low. a. Ensure probe is attached. b. Check condition of probe. Probe should not show any breaks, tears, or sharp bends. Clean probe connector with spectrograde isopropyl alcohol or methanol. Replace if necessary. c. Check for use of extension cables designed to extend probe length. Additional connections can reduce signal.
CAL ERRORS ON: # (1, 1 2, 1 2 3, or 1 2 3 4) U# (U1, U1 U2, U1 U2 U3, or U1 U2 U3 U4) **Note** Displayed probe values directly correspond to number of active channels on instrument.	**Calibration Error (on Probe #).** Appears when one or more channels developed an error during calibration. Reference temperature was not stable and drifted beyond acceptable limits during calibration, preventing instrument from locking on and calibrating to unstable temperature. CAL ERRORS ON: # displays on instrument front panel. U# (probe number) displays on instrument front panel and appears over digital output port (RS-232 port or optional IEEE-488 interface). Calibration correction is set to zero when an error occurs, and channels with calibration errors are deselected. Instrument uses internal reference table for conversion with no calibration correction offsets added to displayed temperature. a. Place probe(s) in stable, independent temperature-reference instrument. b. Recalibrate instrument.

Table 5.3 Temperature Related System Error Messages

Message	Description
NO PROBES SELECTED	All probes are deselected. During probe selection process, all probes may have inadvertently been turned off. Select one or more probes.
CAL OK	No errors occurred during calibration and correct temperature offsets are now added to displayed temperature. Displayed temperature is now correctly calibrated.
HL LL	**High Limit and Low Limit.** Appears only over digital output port (RS-232 port or optional IEEE-488 interface) when temperature measurement does not fall within HIGH or LOW LIMIT specified in Setup mode. Does not indicate problem with instrument, but rather with values specified in Setup mode under CHANGE TEMP LIMITS parameter. Correct value specified for HIGH and/or LOW LIMIT.

Table 5.4 System Messages

Instrument Reinitialization

Reinitialize the instrument if the screen appears to be frozen (possibly because a long period is specified for the UPDATE TIME parameter), or to restore the factory default setup parameter values of the instrument (see Table 1.1, "Default Setup Parameters," in Chapter 1, Introduction").

To reinitialize instrument and restore factory default settings

1. Press **–** at Main menu to access Setup mode.
2. Press **NEXT** until screen displays the message, "RESTORE DEFAULTS?"
3. Press **YES** to display the message: "REINITIALIZE:".
4. Press **–** or **+** to toggle to *YES*.
5. Press **YES** to display the message, "ARE YOU SURE?"
6. Press **–** or **+** to toggle to *YES*.
7. Press **YES**.

   Instrument restores its default values and briefly displays the message "SETTINGS RESTORED", followed by the Main menu.

Flashlamp Replacement

Although the flashlamp is designed to last one or more years in normal use, it may eventually need to be replaced. You can extend the life of the flashlamp by increasing the `MEASUREMENT UPDATE TIME` Setup parameter, as described in Figure 4.5, "Example of Slow Temperature Measurement," in Chapter 4, "Theory of Operation."

The flashlamp bulb requires replacement when

- Bulb does not flash
- Bulb flashes erratically
- Connector does not emit a visible blue-violet light while in Run mode (check by disconnecting a probe and look straight into the instrument connector)

Caution

Flashlamp bulb replacement requires realignment of the flashlamp assembly to optimize the signal level, followed by instrument calibration. Return the unit to LUXTRON for flashlamp bulb replacement.

Appendix A: Specifications

This appendix defines the specifications for the accuracy, precision, and performance of the instrument. Table A.1 lists the basic performance specifications. Supplemental information provided in sections to follow.

Spec/Feature	Value		Comments
Accuracy	Uncalibrated	±2.0 °C (±3.6 °F)	Over range of instrument.
	Calibrated	±0.1 °C (0.18 °F) RMS at point of calibration	
		±0.5 °C (0.9 °F) RMS within ±50 °C (90 °F) of calibration point	
		±1.0 °C (1.8 °F) RMS within ±100 °C (180 °F) of calibration point	
Temperature Range	-199.9 to 449.9 °C (-327.8 to 841.8 °F)		
Repeatability	8 samples per measurement	±0.1 °C (0.18 °F) RMS	See the section, “Precision or Repeatability.”
	More than 8 samples per measurement	< ±0.1 °C (0.18 °F) RMS	
Temperature Resolution	Display	0.1 °C (0.18 °F)	Finest temperature division possible for some system components. Analog output value valid at default settings.
	RS-232	0.01 °C (0.02 °F)	
	IEEE-488 option	0.01 °C (0.02 °F)	
	Analog Output	0.0244 °C (0.04 °F)	
Response Time	250 ms (typical probe)		See the section, “Response Time.”
Input Power	40 W		
	90 to 250 V AC		
	47 to 63 Hz		

Table A.1 Basic Performance Specifications

Spec/Feature	Value		Comments
Output Ports	RS-232		
	Analog Voltage (±5 V)		
Optional Outputs	IEEE-488		
	Analog Voltage Option (±10 V)		
	Analog Current Loop (4 to 20 mA)		
Display	24 character LED display		
Sampling Rate	4 samples/second (max)		
Dimensions	Rack mount	.48 W x .13 H x .34 D m (19 W x 5.25 H x 13.5 D in)	Stand alone is for Model 790 only; RF Shielded cabinet—see the section, “RF Shielding.”
	Stand alone	.34 W x .13 H x .32 D m (13.5 W x 5.1 H x 12.5 D in)	
Environmentally Hardened	Storage temperature	-55 to 75 °C (-67 to 167 °F)	If instrument passes through dew point after storage at subfreezing temperatures, ensure electronics are dry before power-on.
	Operating temperature	10 to 60 °C (50 to 140 °F)	
	Relative Humidity	95% (maximum) noncondensing	
Front Panel	Probe Connections		
	Power Switch		

Table A.1 Basic Performance Specifications (continued)

Instrument Warm-Up Time

The warm-up time of the instrument is 15 minutes from cold start or initial power-on.

Note

For minimum warm-up time and maximum instrument life, keep the system powered on at all times, even when not in use.

Precision or Repeatability

Root mean square (RMS) and Standard Deviation are equivalent terms that describe a statistical method for quantifying the spread of the distribution curve for measurement data. The following briefly defines these terms, relative to the specification of the instrument.

In practical terms:

- 68 percent of all measurements fall within one standard deviation of the mean
- 95 percent of all measurements fall within two standard deviations of the mean
- Nearly 100 percent of all measurements fall within three standard deviations of the mean

Figure A.1 illustrates the precision of the instrument in graph form.

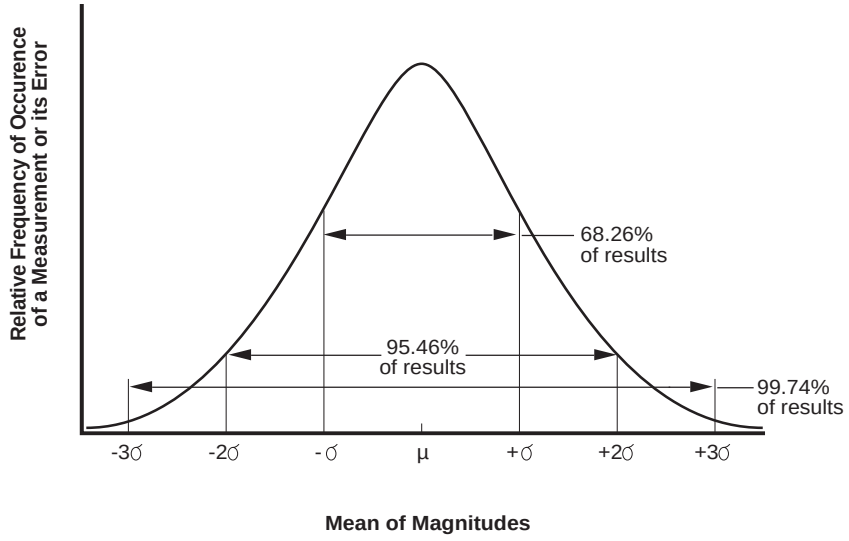


Figure A.1 Measurement Data Distribution

Response Time

The response time of the instrument is restricted by the system flash rate, 250 ms. The response time of the system is probe limited.

Table A.2 lists the typical response time of the standard (SFF) immersion probes to a step change in temperature.

Probes Immersed in	63% of Final Temperature	99% of Final Temperature
Stirred Liquid	250 ms	1 sec
Still Air	500 ms	2 sec

Table A.2 Typical Response Times of the SFF Immersion Probes

Some probes respond more rapidly. The SEL probe, for example, reaches equilibrium in less than 100 ms when touched to a heated or cooled surface.

RF Shielding

The instrument meets FCC Class A requirements for emission of electromagnetic radiation by a computer system.

Caution

Use a shielded RS-232 cable with this instrument to ensure compliance with the pertinent RF emission limits governing this instrument.

Note

This instrument has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the instrument is operated in a commercial environment.

This instrument generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the user manual, may cause harmful interference to radio communications. Operation of this instrument in a residential area is likely to cause harmful interference, in which case users must correct the interference at their own expense.

Overall View

Figures A.2 through A.5 provide an overall view of each instrument model.

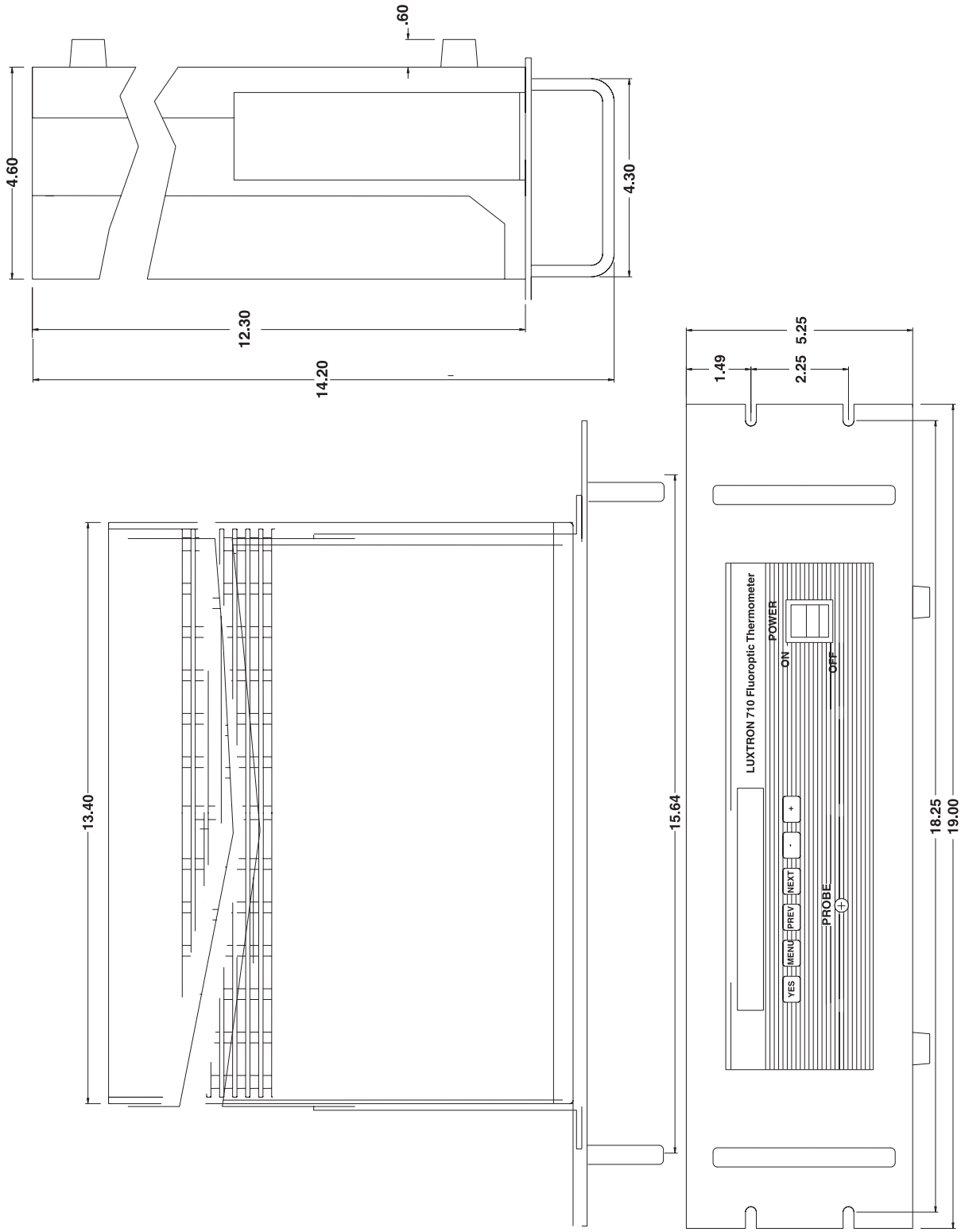


Figure A.2 Overall View—Model 710 (Available Only as Rack Mount)

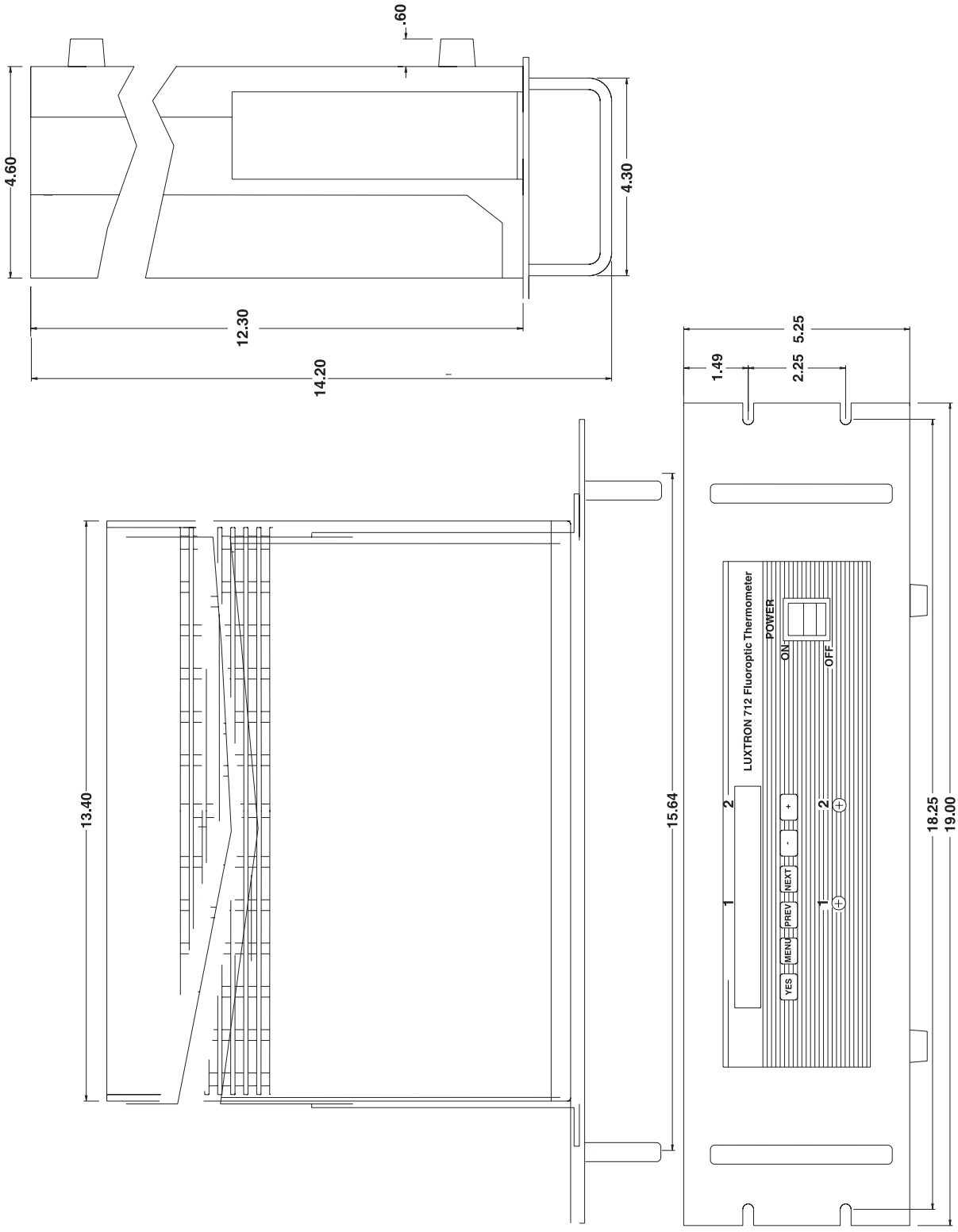


Figure A.3 Overall View—Model 712 (Available Only as Rack Mount)

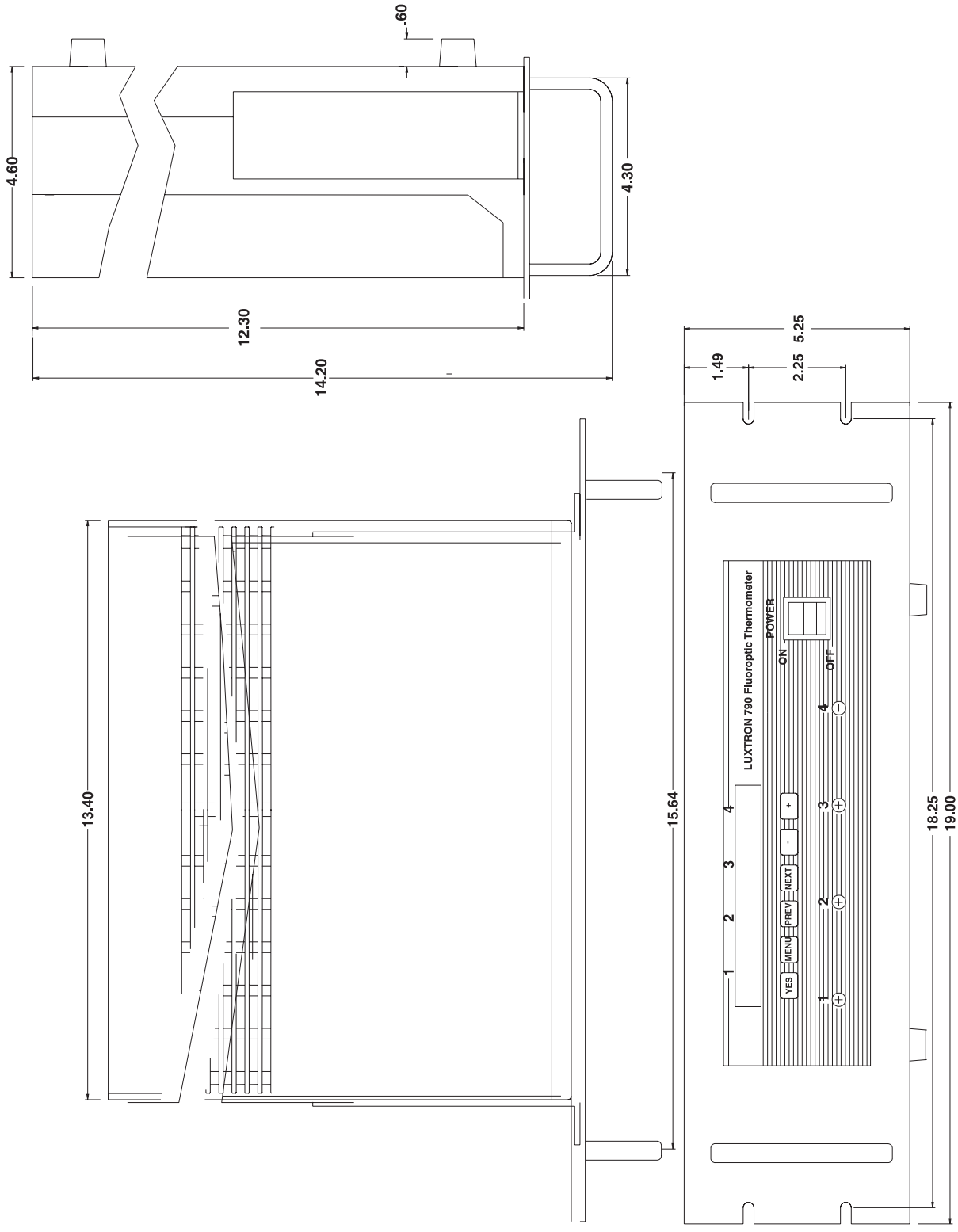


Figure A.4 Overall View—Model 790—Rack Mount

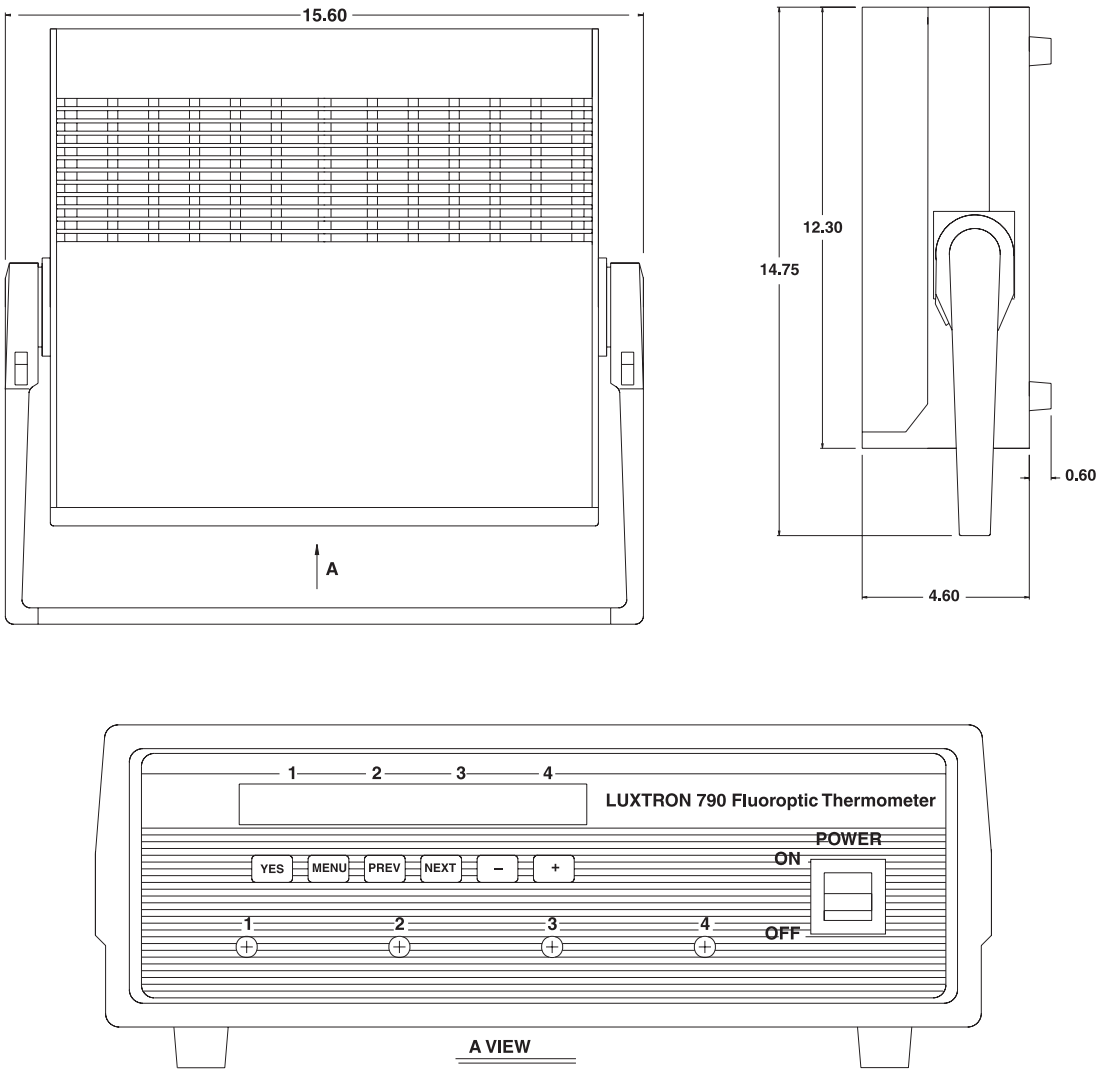


Figure A.5 Overall View—Model 790—Stand Alone

Appendix B: Instrument Probes

This appendix discusses how to use and care for probes supplied with the Fluoroptic thermometers.

Overview

The instrument is designed to function with a wide variety of probes designed and produced by LUXTRON Corporation. Each probe consists of a fiber-optic cable with a connector at one end and temperature sensor mounted at the other end. Contact the LUXTRON Sales Department for more information.

The instrument uses both immersion and surface measurement (industrial) probes, depending on the application.

Note

Immersion probes may be used to measure surface temperatures, but there is an unavoidable offset. For more information, see the section, "Using Immersion Probes for Surface Measurement."

Using Immersion Probes for Surface Measurement

Immersion probes may be used to measure surface temperatures; however, there is an unavoidable offset. Typical offsets are as follows, depending on the probe:

- -5 to -7 °C at 100 °C (-9 to -12.6 °F at 212 °F)
- -10 to -15 °C at 200 °C (-18 to -27 °F at 392 °F)

For vacuum measurements, these offsets are roughly doubled. For best results when measuring surface temperatures with these immersion probes, make contact with the *side* of the probe tip.

Industrial Probe Use and Handling

Fiber-optic probes last indefinitely if handled properly. The following sections provide guidelines for using the probes.

Caution

Use and care for the probes as outlined in this appendix to avoid causing damage to the probe and/or to the instrument.

Probe Flexibility

Each probe is made from a single strand of all-silica or plastic-clad silica (PCS) fiber. These fibers exhibit varying degrees of flexibility, based on probe materials and thickness. Fibers may be damaged or broken if sharply bent.

The majority of probes are cabled with Kevlar fiber, which significantly strengthens them. Bending uncabled probes to a radius of less than one inch is not recommended.

All-silica fiber probes are stiffer and more susceptible to signal losses, caused by bending, than other fibers.

Probe Temperature Range

Using a probe outside its intended temperature range or chemical environments may shorten its life. Probe upper temperature limit is restricted by the materials used in the jacket and cladding. Cladding of the PCS fiber oxidizes and deteriorates if exposed to temperatures above 200 °C (392 °F) for an extended period. The perfluoroalkoxy (PFA) jacket melts at 300 °C (572 °F).

The lower limit of operation of each probe type is set primarily by the optical transmission of the fiber used. Only all-silica fibers (used in some probes) have acceptable transmission at very low temperatures.

Caring for Probe When Not in Use

Each probe is supplied with a cap over the connector. Replacing this cap when the probe is not in use prevents dirt from accumulating on the open fiber end.

A dirty connector reduces transmission and performance of the probe. If the polished fiber end in the center of the connector requires cleaning, wipe it with a cotton swab moistened with spectrograde isopropanol or methanol.

Probe Length

Signal level decreases as the fiber length increases. The losses experienced vary by fiber type. The use of multiple connectors and extensions also reduces signal level. A good rule of thumb is that the signal level is reduced by half for each additional connection.

The lower the signal, the worse the signal-to-noise ratio. This increases the number of samples per measurement needed to achieve a specific level of precision. Increasing the number of samples per measurement improves the precision and accuracy of the reading because more samples are averaged together to obtain a measurement. However, excessively low signal levels may fall outside the normal operating range of the instrument, resulting in a `P-LOW` error message.

Appendix C: RS-232 Serial Output Port

This appendix discusses the serial port of the instrument, as well as complete setup and diagnostics for this feature.

Overview

The serial port on the instrument meets Electronics Industry Association (EIA) standard RS-232. This port is used for communication with another digital instrument (such as a serial printer, terminal, or computer). It can be used as an output port for logging measurements or as an input port for remote control of the system. When used in the latter mode, the system is controllable from a computer or terminal as it is from the front panel.

Note

The instrument may physically have both an RS-232 port and an IEEE-488 interface. However, only one may be active at any time.

RS-232 Port Setup

Using a computer to control the instrument provides the ability to automate the data acquisition process, and allows totally remote operation of the instrument. Setting up the instrument for computer control involves use of a complex command structure; however, once done, it provides an exceedingly fast operating environment.

The following sections describe the following parameters as they relate to the RS-232 setup:

- RS-232 BAUD RATE
- SAMPLES/MEASUREMENT and MEASUREMENT UPDATE TIME
- DATASAVE FEATURE (not available for use)

RS-232 Baud Rate

The first setup parameter for the RS-232 port is the baud rate. Baud rate is the number of bits transmitted per second over the serial port. Values are *2400*, *4800*, *9600*, or *19200* (default is *9600*). Set the baud rate to correspond to the baud rate of the peripheral device.

To change the baud rate

1. Press **–** at Main menu to access Setup mode.
2. Repeatedly press **NEXT** until screen displays the message, "CHANGE DIGITAL OUTPUT?"
3. Repeatedly press **YES** until screen displays the message, "CHANGE BAUD RATE?"
4. Press **YES** to display the message, "RS-232 BAUD RATE:" and currently-selected value.
5. Press **–** or **+** to scroll through available rates (*2400*, *4800*, *9600*, and *19200*). Default is *9600*. Stop scrolling when desired rate appears.
6. Press **YES** to save selection.
7. Press **MENU** to return to Main menu.

SAMPLES/MEASUREMENT and MEASUREMENT UPDATE TIME

It is important to understand the relationship between the SAMPLES/MEASUREMENT and MEASUREMENT UPDATE TIME parameters when setting up the RS-232 port:

- SAMPLES/MEASUREMENT sets the number of samples taken for each measurement (default is *8*)
- MEASUREMENT UPDATE TIME sets how often the measurement is updated or the time between measurements (default is *CONTINUOUS*)

DATASAVE Feature

Although this option is available for selection, it is currently nonfunctional.

Hardware Configurations for the RS-232 Port

To use the RS-232 port of the instrument, use a shielded RS-232 cable that is wired straight through (for example, pin 1 to pin 1, pin 2 to pin 2, pin 3 to pin 3, and so forth).

It is recommended that a fully shielded RS-232 cable be used in electrically noisy environments. Inside the instrument, each data line on the RS-232 port is capacitively filtered to reduce electromagnetic interference (EMI) and radio frequency interference (RFI) noise susceptibility.

Caution

Use the shielded RS-232 cable provided with this instrument to ensure compliance with the pertinent RF emission limits governing this instrument.

The RS-232 port of the instrument is configured as data communications equipment (DCE). Table C.1 describes the active pins of the RS-232 port.

Pins	Signal	Description
2	RX	Received Data
3	TX	Transmit Data
4	CTS	Clear to Send
5	RTS	Request to Send
6	DTR	Data Terminal Ready
7	SG	Signal Ground
8 and 20	DSR	Data Set Ready

Table C.1 RS-232 Port Active Pins

Character Bits

Characters are composed of 10 bits per character. The bit pattern is standard and configured as follows:

- One start bit
- Eight data bits in ASCII character format, with the eighth bit set to logic 1
- One stop bit

FULL and ABBR Digital Output Message Formats

The output message has a preconfigured format. Figure C.1 shows the FULL output message format for each instrument type.

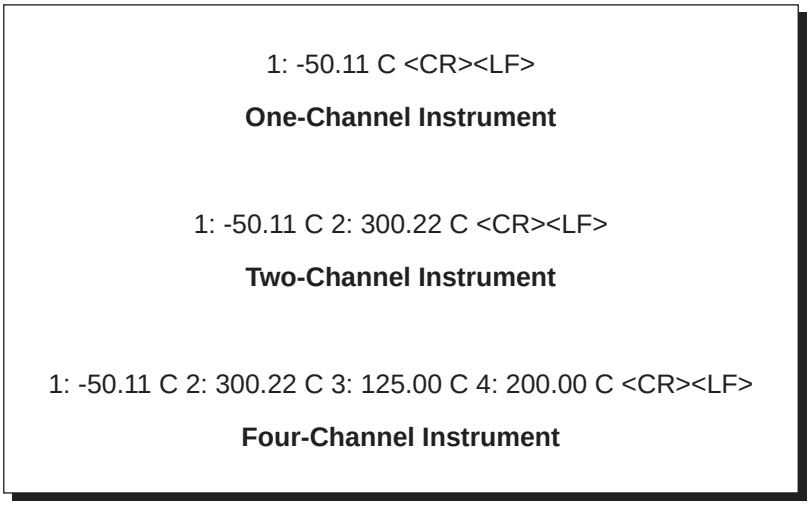


Figure C.1 Output Message Format—FULL

The messages in Figure C.1 are shown exactly as they appear on a monitor display or printer. A carriage return and line feed, <CR><LF>, are normally transmitted at the end of each line. FULL is the default format for Model 790.

In the abbreviated (ABBR) format, only the channels selected are transmitted. Thus, if channels 1 and 2 are selected, the output message has the following format (see Figure C.2 and Table C.2).

Figure C.2 Output Message Format—ABBR

Field	Hex Code	Description
FIELD 1	—	First channel selected (such as Channel 1).
FIELD 2	—	Second channel selected (such as Channel 2).
FIELD T	20h20h 0Dh 0Ah	Four-character field consisting of the following: • Spaces (two) • Carriage return • Line feed Transmits regardless of the number of channels selected in ABBR format.

Table C.2 Output Message Format, ABBR Format Field Descriptions

Notes

With the exception of LL and HL, errors are shown as a minus or dash (2Dh) in positions 6 through 12 and the two digit error code appears in positions 13 and 14.

Model 710 is a one-channel instrument and only shows data for FIELD 1 and FIELD T in ABBR format.

Each temperature measurement is sent in Fields 1 through 2, each of which has 14 characters. Table C.3 lists the complete message format.

Position	Hex Code/Char	Application/Comments
1	20h	Space
2	20h	Space
3	—	Probe Number • 1 Model 710 • 1 2 Model 712 • 1 2 3 4 Model 790
4	3Ah	: (colon)
5	20h	Space **Note** During remote calibration, position may be occupied by • C if probe is calibrated • U if probe is unstable
6	20h	Space (positive temperatures)
	2Dh	– (negative temperatures)
7	—	Temperature 100s digit with leading zero suppression
8	—	Temperature 10s digit with leading zero suppression
9	—	Temperature 1s digit with leading zero suppression
10	2Eh	. (period)
11	—	Temperature 10s digit
12	—	Temperature 100s digit
13	20h	Space (normal operation)
	P	Probe error detected (first character of PE error)
	L	Lower temperature limit exceeded (second character of LL error)
	H	Higher temperature limit exceeded (second character of HL error)
14	43h	Temperature units in C (normal operation)
	46h	Temperature units in F (normal operation)
	E	Probe error detected (second character of PE error)
	L	Lower temperature limit exceeded (second character of LL error)
	L	Higher temperature limit exceeded (second character of HL error)

Table C.3 Temperature Message Format

Command Set

The RS-232 serial port can be used to control or program the instrument by sending the proper control character. Each control character or command is echoed back from the instrument. If the command is not allowed or the system is currently in that mode, the instrument returns a "?" character.

This forms a positive handshake. Table C.4 lists the command set available through the RS-232 port.

Instrument Function	Control Key Sequence	Hex Code
Standby	CTRL-T	14h
Run	CTRL-R	12h
Enable transmission	CTRL-Q	11h
Disable transmission	CTRL-S	13h
Buffer refresh and enable transmission	CTRL-F	06h
Lockout front panel display and buttons	CTRL-L	0Ch
Unlock front panel display and buttons	CTRL-U	15h
Remote enable	CTRL-E	05h
Remote disable	CTRL-D	04h
Initiate reading	CTRL-I	09h
Start calibration	CTRL-K	0Bh
Abort calibration	CTRL-A	01h
Reset instrument	CTRL-X	18h

Table C.4 RS-232 Command Set

Control Commands for Run Mode

Run mode can be accessed by RS-232 port. Table C.5 lists the standard control commands for Run mode.

Instrument Function	Control Key Sequence	Hex Code
Return to Standby mode	CTRL-T	14h
Run	CTRL-R	12h

Table C.5 Run Mode Control Commands

Control Commands to Test System

To test the system

1. Send CTRL-T (14h) to confirm the instrument is in Standby mode.

   This assures instrument is in Standby mode at the Main menu and not running. If the instrument is already in Standby mode, it echoes "?" instead of "CTRL-T".

2. Send CTRL-R (12h) to enable Run mode.

   The instrument display now shows temperature data.

3. Send CTRL-T (14h) to return to Standby mode and return to the Main menu.

   Repeat steps 2 and 3, as required.

Control Commands for Disabling the Front Panel Buttons

Disabling the control panel through the serial port disables the front panel display and buttons. Once disabled, the instrument can be controlled only through the RS-232 port. Table C.6 lists the front panel control commands.

Instrument Function	Control Key Sequence	Hex Code
Lockout front panel display and buttons	CTRL-L	0Ch
Unlock front panel display and buttons	CTRL-U	15h

Table C.6 Front Panel Control Commands

Control Commands for Remote Mode

The serial port controls the instrument in Remote mode. In Remote mode, the front panel buttons are locked, and control is available only through the RS-232 port. The instrument echoes all commands when it is ready to receive another command, thus forming a positive handshake.

The remote enable command (CTRL-E, 05h) is acknowledged only when the instrument is displaying the Main menu. After receipt of this command, the instrument enters Remote Run mode. The instrument continues to display the Main menu with the front panel buttons locked, awaiting further commands. Table C.7 lists the Remote mode control commands.

Instrument Function	Control Key Sequence	Hex Code
Remote enable	CTRL-E	05h
Remote disable	CTRL-D	04h
Initiate reading	CTRL-I	09h

Table C.7 Remote Mode Control Commands

While the instrument is in Remote Run mode, the Initiate Reading command starts a measurement cycle and disables the transmission of digital output.

For example, to take a single measurement using the remote enable command, follow the sequence described below.

To take a single measurement using the remote enable command

1. Send CTRL-T (14h) to confirm instrument is in Standby mode.

   This assures the instrument is in Standby mode at the Main menu and not running. If the instrument is in Standby mode, it echoes "?" instead of "CTRL-T".

2. Send CTRL-E (05h) to enable Remote mode.

   This places the instrument in Remote mode and locks out the front panel buttons. The only way to control the instrument at this point is through the serial port.

3. Send CTRL-R (12h) to enable Remote Run mode.

   Instrument is now ready to take measurements.

4. Send CTRL-I (09h) to initiate reading.

   This starts one measurement cycle, stores the information in the buffer, and generates a CTRL-S (13h) to disable transmission of digital output.

5. Send CTRL-Q (11h) to enable output to the RS-232 port.

   This sends the temperature information currently stored in the buffer.

6. Repeat steps 4 and 5, as required.

7. Send CTRL-T (14h) to return to Standby mode.

8. Send CTRL-D (04h) to disable Remote mode and return to the Main menu.

Once in Remote mode, data from the instrument can be controlled on a per-character basis with the commands listed in Table C.8.

Instrument Function	Control Key Sequence	Hex Code
Enable transmission	CTRL-Q	11h
Disable transmission	CTRL-S	13h
Buffer refresh and enable transmission	CTRL-F	06h

Table C.8 Remote Mode Control Commands for Instrument Control

Note

CTRL-F flushes the buffer and starts transmissions with new data. In contrast, CTRL-Q outputs the existing data in the buffer at the time it was disabled, then continues with the new data.

Remote Instrument Calibration

Remote calibration enables a host computer to be used to calibrate the instrument. For a host system to execute the calibration sequence, the program must follow the sequence outlined below.

To execute the calibration sequence from a host computer

1. Send CTRL-T (14h) to confirm the instrument is in Standby mode.

   This assures the instrument is in Standby mode at the Main menu and not running. If the instrument is in Standby mode, it echoes "?" instead of "CTRL-T".

2. Use the PS remote setup command to select the probes to calibrate.
3. Use the CT remote setup command to change the calibration temperature (see Table C.12).
4. Place probes to be calibrated in a stable temperature reference.
5. Send CTRL-K (0Bh) to start calibration sequence. The calibration sequence is completely automatic.

   If it becomes necessary to abort the calibration sequence, send CTRL-A (01h) during the sequence.

Upon completion, the instrument returns to the Main menu and displays one of the following messages on the front panel and as output on the serial port:

- `U` means the temperature is unstable. The temperature readings were unstable during the calibration period and prevented the instrument from calibrating. The internal reference table is used for temperature conversion for this channel only. When this error occurs, ensure the temperature reference is not drifting and recalibrate, as necessary. See the section, "Calibration Mode," in Chapter 3, "Using the Instrument," for calibration instructions.
- `C` means that calibration completed successfully without any errors. The instrument is ready for use.

These codes appear in character position 5 of each data field. If a `U` appears for a channel, that channel is automatically deselected.

The calibration offset used for data display is the last set of calibration data. If calibration is performed at the wrong temperature, recalibrate the instrument.

Remote Setup and Command Syntax

Remote setup has two basic functions:

- Configure the system for a measurement
- Query the existing configuration

Remote setup is available only when the instrument is displaying the Main menu. Therefore, the instrument must be displaying the Main menu prior to remote setup.

All remote setup commands sent to the instrument are echoed back to the sender. All ASCII Carriage Returns (0Dh) that are echoed are normally followed by an ASCII line feed (0Ah). An invalid command results in a single "?" character (3Fh) being returned.

Figure C.3 shows the syntax for configuring the system. Figure C.4 shows the syntax for querying the system status. Tables C.9 and C.10 describe each of the fields for the configuration and query command syntax, respectively. Embedded spaces in the commands are ignored.

To set up system, send

Figure C.3 Remote Setup—System Setup Command

Field	Hex Code	Description
<ESC>	1Bh	ESC character
command	—	Two-letter command (see Table C.12)
=	3Dh	Equal sign
configuration parameters	—	String information associated with command (see Table C.12)
<CR>	0Dh	Carriage return

Table C.9 Remote Setup—System Setup Command Field Descriptions

To query system status, send

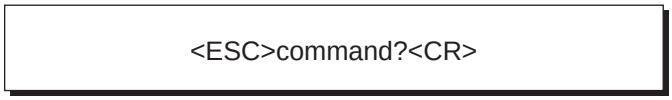


Figure C.4 Remote Setup—Query System Status Command

Field	Hex Code	Description
<ESC>	1Bh	ESC character
command	—	Two-letter command (see Table C.12)
?	3Fh	Question mark
<CR>	0Dh	Carriage return

Table C.10 Remote Setup—Query System Status Command Field Descriptions

Figure C.5 shows the response provided by the instrument to a query. Table C.11 describes each field.

Figure C.5 Remote Setup—Query System Status Response

Field	Hex Code	Description
command	—	Two-letter command (see Table C.12)
=	3Dh	Equal sign
	20h	Spaces, on each side of equal sign
configuration parameters	—	String information associated with command (see Table C.12)
<CR>	0Dh	Carriage return
<LF>	0Ah	Line feed

Table C.11 Remote Setup—Query System Status Response

Table C.12 lists the remote setup commands and the required syntax. For clarity, the <ESC> character and the <CR> following the parameters are not shown.

Notes for Table C.12

The probe or channel values listed (quantity of one, two, or four) in Table C.12 directly correspond to the number of active channels on the instrument.

Remote calibration automatically enables calibration correction.

Command	Syntax	Default Value	Value Definition
Probe Selected			Number of the active probes.
	PS=x	PS=1	Model 710
	PS=x,x	PS=1,2	Model 712
	PS=x,x,x,x	PS=1, 2, 3, 4	Model 790
Set Lower Temp (Trip) Limits	LL=xxxx.x, xxxx.x, xxxx.x, xxxx.x	LL=-199.9, -199.9, -199.9, -199.9	Value between -199.9 and 449.9 °C (-327.8 and 841.8 °F) for active channels.
Set Upper Temp (Trip) Limits	HL=xxxx.x, xxxx.x, xxxx.x, xxxx.x	HL=449.9, 449.9, 449.9, 449.9	Value between -199.9 and 449.9 °C (-327.8 and 841.8 °F) for active channels.
Sample per Measurement	SM=xxx	SM=8	Value between 1 and 999.
Measurement Update Time	MU=1S	MU=C	Once every 1 to 999 seconds.
	MU=1M		Once every 1 to 999 minutes.
	MU=1H		Once every 1 to 999 hours.
	MU=C		Continuous
Digital Format	DF=x, xx	DF=F, NH	x is *F* (FULL), *A* (ABBR), or *I* (IEEE). xx is *HD* (to enable time/date stamps) or *NH* (to disable time/date stamps).
Enable Analog Output			Unique channel number.
	AE=x	AE=1	Model 710
	AE=x,x	AE=1,2	Model 712
	AE=x,x,x,x	AE=1, 2, 3, 4	Model 790
Analog Output Scale Factor	AS=xxx	AS=100	*10*, *20*, *50*, *100*, *200*, or *500* mV/degree.
Analog Output Zero Offset	AO=xxx.x	AO=0	Value between -199.9 and 449.9 °C (-327.8 and 841.8 °F).
Units Celsius or Fahrenheit	UN=x	UN=C	*C* (Celsius) or *F* (Fahrenheit).
Calibration Temperature	CT=xxx.xx	CT=25.0	Value between -199.9 and 449.9 °C (-327.8 and 841.8 °F).
Enable/Disable CAL Correction	CC=x	CC=D	*E* (enable CAL correction) or *D* (disable CAL correction).

Table C.12 Remote Setup Commands

Sample Remote Setup Commands

The RS-232 port echoes each command it receives, with a carriage return and a line feed. Embedded spaces are ignored. Table C.13 lists six sample setup commands.

Action	Procedure
Select Probe 1 only	<ESC>PS=1<CR><LF>
Set samples per measurement to 20	<ESC>SM=20<CR><LF>
Set measurement update time to once per minute	<ESC>MU= 60<CR><LF> or <ESC>MU=1M<CR><LF>
Set displayed units to Celsius	<ESC>UN=C<CR><LF>
Enable analog output on Channel 1	<ESC>AE=1<CR><LF>
Set analog output scale factor to 200 mV/degrees	<ESC>AS=200<CR><LF>

Table C.13 Remote Setup—Sample Commands

Sample Remote Query Commands

Table C.14 lists six sample remote query commands and the corresponding instrument response. If the setup parameters are established as listed in Table C.13, the responses are as follows (embedded spaces are ignored).

Query Commands	Instrument Response
<ESC> PS? <CR><LF>	PS = 1 <CR><LF>
<ESC> SM? <CR><LF>	SM = 20 <CR><LF>
<ESC> MU? <CR><LF>	MU = 1M <CR><LF>
<ESC> UN? <CR><LF>	UN = C <CR><LF>
<ESC> AE? <CR><LF>	AE = 1 <CR><LF>
<ESC> AS? <CR><LF>	AS = 200 <CR><LF>

Table C.14 Remote Setup—Query Commands and Syntax

Appendix D: Optional IEEE-488 Interface

This appendix discusses the optional IEEE-488 interface, as well as complete setup and diagnostics for this option. The IEEE-488 option is used for communicating with other computers. It can be used as an output port for logging measurements, and/or as an input port for remote setup or control.

Note

The instrument may have an RS-232 port and IEEE-488 interface. However, only one may be active at any time.

IEEE-488 Overview

In the early 1970s, Hewlett Packard defined an interface called the "HPIB" (HP Interface Bus). This became an IEEE standard in 1975, with minor revisions added since, and is now know as the IEEE-488 Interface Bus or General Purpose Interface Bus (GPIB). The electrical, mechanical, and functional requirements of the bus are defined in IEEE Standard 488.1-1987 (Reaff 1994), *IEEE Standard Digital Interface for Programmable Instrumentation*.

The IEEE-488 standard(pr oduct number SH11346) is available from the IEEE by contacting the IEEE Service Center by way of the following:

- **Mail:** 445 Hoes Lane
PO Box 1331
Piscataway, NJ 08855
- **Telephone:** (800) 678-4333
(908) 981-0060
- **Website:** http://www.ieee.org/bookstore

Note

Only IEEE members may place orders over the telephone.

The IEEE-488 interface allows the simultaneous connection of several different instruments on a common bus. There is usually a system controller, either a dedicated piece of equipment, or a personal computer (PC). The IEEE-488 interface hardware and firmware for the instrument were tested using an IBM-compatible PC with a National Instrument GPIB-PCII controller card.

How the IEEE-488 Interface Works

The controller sends commands to the instrument to change its operating parameters, and directs the instrument to take measurements. The results of the measurements are either displayed locally by the controller, sent to a printer, or saved on a disk for later processing.

IEEE-488 Interface Specifications

Table D.1 lists the basic IEEE-488 interface specifications.

Specification	Limitations
Maximum number of instrument or device inputs	15
Maximum cable length between a group of devices	2 m (6.56 ft) times the number of devices or 20 m (65.62 ft), whichever is less
Maximum data transfer rate	1 MB per second

Table D.1 IEEE-488 Specifications

Apply power to at least 50 percent of the units on the IEEE-488 interface for the bus to operate reliably.

Setup for the IEEE-488 Interface

Before connecting the instrument into an IEEE-488 system, determine the unique device address to be used by the instrument.

Note

The instrument must use a unique address on the IEEE bus or it conflicts with other devices using the same address.

Table D.2 lists the digital output settings that LUXTRON sets prior to shipping an instrument with the optional IEEE-488 interface.

Parameter	Setting
IEEE Device address	*01*
Digital format	*IEEE*
SELECT PORT	*IEEE*

Table D.2 IEEE-488 Option Digital Output Settings

If default settings have been restored (as described in the section, "Reinitializing the Instrument," in Chapter 5, "Maintenance and Troubleshooting"), reprogram Setup parameters as follows.

To reprogram Setup parameters

1. Press **–** to select SETUP from the Main menu.
2. Repeatedly press **NEXT** until the message, "CHANGE DIGITAL OUTPUT?" appears.
3. Press **YES** to display the first option, "CHANGE DIGITAL PORT?"
4. Press **YES** to display the message, "SELECT PORT:".
5. Press **–** or **+** to select *IEEE*, then press **YES** to continue.
6. Press **NEXT** to display next option, "DIGITAL FORMAT:" (bypasses the "CHANGE BAUD RATE?" option).
7. Press **–** or **+** to toggle to *IEEE*, then press **YES** to continue.

   Option, "ENABLE TIME STAMPS:", appears
8. Press **–** or **+** to toggle between *NO* and *YES*, then press **YES** to continue.

   Option, "CHANGE IEEE ADDRESS?", appears.
9. Press **YES** to display the message, "IEEE DEVICE ADDRESS:".
10. Press **–** or **+** to increment or decrement to device address of the instrument (choose an appropriate address between 0 and 30).
11. Press **YES** to save changes, then repeatedly press **NEXT** until Main menu appears.

Remote Instrument Operation

The instrument must be in Standby mode to send and receive data or commands. The instrument enters standby mode when powered on. The blinking asterisk in the display indicates the instrument is in Standby mode.

The instrument can be controlled or programmed by sending the proper control character. Table D.3 lists the commands available through the IEEE interface.

Instrument Function	Control Key Sequence	Hex Code	Listen or Talk
Standby	CTRL-T	14h	L
Operate	CTRL-R	12h	T/L
Send output	CTRL-Q	11h	T
Flush output buffer	CTRL-F	06h	L
Lockout front panel controls	CTRL-L	0Ch	L
Unlock front panel controls	CTRL-U	15h	L
Remote enable	CTRL-E	05h	L
Remote disable	CTRL-D	04h	L
Initiate reading	CTRL-I	09h	L
Start calibration	CTRL-K	0Bh	L
Abort calibration	CTRL-A	01h	L
Reset instrument	CTRL-X	18h	L

Table D.3 IEEE-488 Command Set

Control Commands

There are two ways to control the instrument over the digital port:

- Run the instrument continuously
- Take measurements on the command of the controller

To run the instrument in Continuous mode

1. Send CTRL-T (14h) to confirm instrument is in Standby mode.

   This assures the instrument is in Standby mode at the Main menu and not running. If the instrument is in Standby mode, it echoes "?" instead of "CTRL-T".

2. Send CTRL-R (12h) to enable Operate mode. This causes the instrument to run continuously and take temperature readings at the Measurement Update rate selected in the Setup menu.

3. Wait for an SRQ from the instrument (see the section, "Serial Poll Status Byte"). Do a serial poll and verify the instrument has a measurement ready (MEAS bit set in the serial poll status register).

4. Wait for the controller to read data from the instrument before overwriting data with the next measurement.

5. Send CTRL-T (14h) listen command to stop the instrument and return to Standby mode.

To take measurements one at a time

1. Send CTRL-T (14h) to confirm instrument is in Standby mode.

2. Send CTRL-E (05h) to enable Remote mode and lock out front panel buttons. The only way to control the instrument at this point is through the digital port.

3. Send CTRL-R (12h) to enable Operate mode. This causes the instrument to run continuously and take temperature readings at the Measurement Update rate selected in the Setup menu.

4. Send CTRL-I (09h) to initiate temperature reading. This causes the instrument to flash until it achieves the specified number of samples per measurement. The SAMPLES/MEASUREMENT parameter can be changed in the Setup menu.

5. Wait for an SRQ from the instrument. Do a serial poll and verify instrument is ready. When the RDY bit is set, the instrument has acquired a measurement and is waiting for transmit instructions.

6. Send CTRL-Q (11h) talk command to enable output, then wait for an SRQ from the instrument. Perform a serial poll, and verify that the instrument has a measurement (MEAS bit set in the serial poll status register).

7. Wait for the controller to read the measurement.

   Repeat steps 4 through 7 as required. Subsequent CTRL-I submissions cause the instrument to start another measurement.

8. When finished, return instrument to Standby mode by sending CTRL-T (14h), followed by CTRL-D (04h) remote disable command.

Remote Instrument Calibration

A host controller can calibrate the instrument by using the Remote calibration feature. For a host system to execute the calibration sequence, the program must follow the sequence outlined below.

To execute the calibration sequence from a host computer

1. Send CTRL-T (14h) to confirm instrument is in Standby mode.

   This assures the instrument is in Standby mode at the Main menu and not running. If the instrument is in Standby mode, it echoes "?" instead of "CTRL-T".

2. Use the remote programming commands, PS and CT, to select the probes and set calibration temperature (see Table D.9).

3. Put the probes in a temperature reference (such as a water bath), then bring probes to equilibrium

4. Send CTRL-K (0Bh) to start the calibration sequence. Calibration takes less than a minute, is completely automatic, and returns to Standby mode when complete. The instrument posts an SRQ when calibration is complete. Perform a serial poll and verify the instrument has a measurement (the MEAS bit is set in the serial poll status register). The controller must then perform a read operation obtain calibration results.

   If you need to abort the calibration sequence, send CTRL-A (01h) during the sequence.

After calibration, one of the following codes is sent as part of the status subfield for each probe being calibrated:

- CU means unstable. The temperature readings were unstable during the calibration period and prevented the instrument from calibrating. When this error occurs, ensure the temperature reference is not drifting and recalibrate, as necessary. See the section, "Calibration Mode," in Chapter 3, "Using the Instrument," for calibration instructions.
- CC means that calibration completed successfully without any error. The instrument is ready for use.

Figure D.1 shows a typical calibration result string.

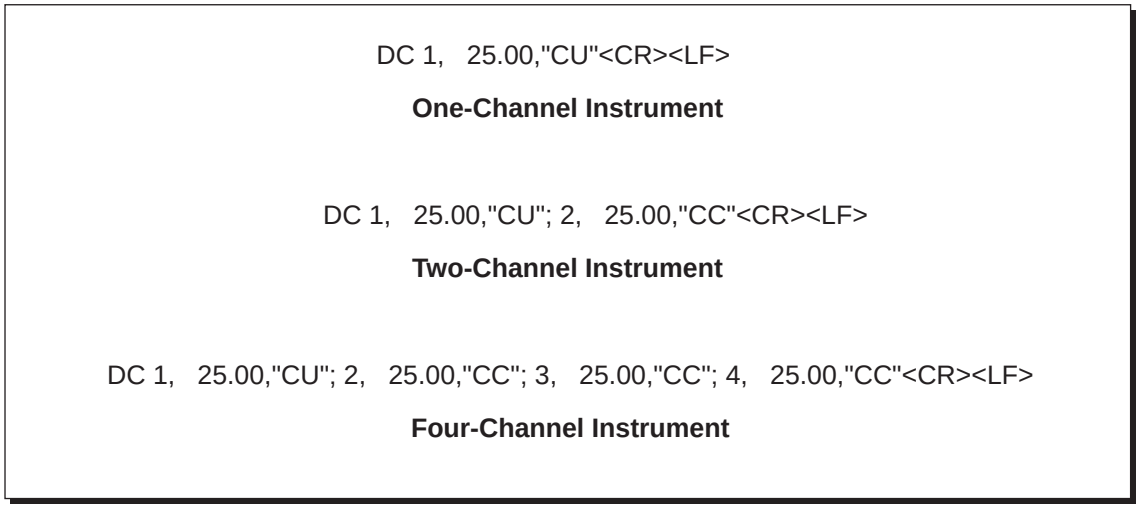


Figure D.1 Remote Calibration Result String

The strings in Figure D.1 show the calibration temperature to be 25 °C (77 °F). Channel 1 calibrated with an error and all other channels calibrated successfully.

Note

Remote calibration automatically turns on calibration correction and turns off any probe that calibrated with an error.

Serial Poll Status Byte

After performing a remote measurement or a remote calibration, the instrument indicates that a measurement is complete by asserting the service request (SRQ) lead. This acts as an "interrupt" to the controller, causing it to poll active bus devices to determine the source of the request.

Table D.4 lists the serial poll, status byte definitions.

Bit	Hex Code	Definition	Description/Comment
0	1	MEAS	Instrument has a measurement or the result of a calibration in its internal buffer, ready to be read.
1	2	PROG	Instrument has an answer to a programming query ready.
2	4	TIME	A time/date stamp is available to be read by the controller. If time/date stamps are enabled, the serial poll status register has two bits set (MEAS and TIME = 45h). The controller should perform two reads: a. Get the measurement b. Get the time/date header
3	8	RDY	Instrument has completed a reading and is waiting for instructions to transmit the measurement.
4	10h	—	Not used.
5	20h	—	Not used.
6	50h	SRQ	Service request. Set the instrument when requesting service.
7	80h	—	Not used.

Table D.4 Serial Poll Status Byte Definitions

Table D.5 lists typical serial poll status responses.

Serial Poll Status Byte	Response	Comments
41h	MEAS	Measurement or calibration result is ready and waiting to be read by the controller.
42h	PROG	Instrument is responding to a query by the controller and answer is ready to be read.
45h	MEAS and TIME	Measurement and a time/date stamp are ready to be read by the controller. The controller should perform two reads: a. Measurement b. Time/date header
48h	RDY	Instrument has completed a reading and awaits instructions to transmit the measurement.

Table D.5 Typical Serial Poll Status Responses

Remote Instrument Programming

Remote programming has two basic functions:

- Programing system for a measurement
- Querying existing configuration

Remote Programming mode is available only during Standby mode. Therefore, the instrument must be placed in Standby prior to programming.

Figure D.2 shows the syntax for programming the system. Figure D.3 shows the syntax for querying the existing configuration. Tables D.6 and D.7 describe each of the fields for the programming and query command syntax, respectively. Embedded spaces in the commands are ignored.

To set up the system, send

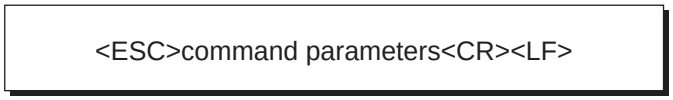


Figure D.2 Remote Programming—Command String

Field	Hex Code	Description
<ESC>	1Bh	ESC character
command		Two-letter command (see Table D.9)
space	20h	Space
?	3Fh	Question mark
<CR>	0Dh	Carriage return
<LF>	0Ah	LIne feed

Table D.6 Remote Programming—Command String Field Descriptions

To query the system, send

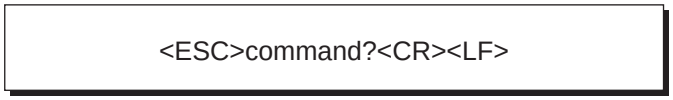


Figure D.3 Remote Programming—Query String

Field	Hex Code	Description
<ESC>	1Bh	ESC character
command		Two-letter command (see Table D.9)
space	20h	Space
?	3Fh	Question mark
<CR>	0Dh	Carriage return
<LF>	0Ah	LIne feed

Table D.7 Remote Programming—Query String Field Descriptions

The instrument posts an SRQ when it has a response to a query. Perform a serial poll and verify that instrument responds (that is, that the PROG bit is set in the serial poll status register). The controller must then perform a read operation to obtain response.

Figure D.4 shows the response provided by the instrument to a query. Table D.8 describes each field.

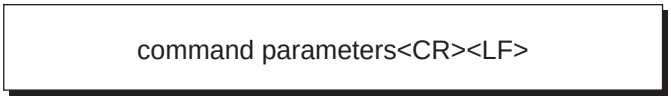


Figure D.4 Remote Programming—Query Response

Field	Hex Code	Description
command		Two-letter command (see Table D.9)
space	20h	Space
parameters		String information associated with the command (see Table D.9)
<CR>	0Dh	Carriage return
<LF>	0Ah	LIne feed

Table D.8 Remote Programming—Query Response Field Descriptions

Table D.9 lists the remote programming commands and the required syntax. For clarity, the <ESC> character and the <CR><LF> following the parameters are not shown.

Notes for Table D.9

The probe or channel values listed (quantity of one, two, or four) in Table D.9 directly correspond to the number of probes/channels used by the instrument.

Remote Calibration automatically enables calibration correction.

Command	Syntax	Default Value	Value Definition
Probe Selected			Number of active probes.
	PS x	PS 1	Model 710
	PS x,x	PS 1,2	Model 712
	PS x,x,x,x	PS 1, 2, 3, 4	Model 790
Set Lower Temp (Trip) Limits	LL xxxx.x,xxxx.x, xxxx.x,xxxx.x	LL -199.9,-199.9, -199.9,-199.9	Value between -199.9 and 449.9 °C (-327.8 and 841.8 °F) for active channels.
Set Upper Temp (Trip) Limits	HL xxxx.x,xxxx.x, xxxx.x,xxxx.x	HL 449.9,449.9, 449.9,449.9	Value between -199.9 and 449.9 °C (-327.8 and 841.8 °F) for active channels.
Sample per Measurement	SM xxx	SM 8	Value between 1 and 999.
Measurement Update Time	MU 1S	MU C	Once every 1 to 999 seconds.
	MU 1M		Once every 1 to 999 minutes.
	MU 1H		Once every 1 to 999 hours.
	MU C		Continuous
Digital Format	DF x, xx	DF I, NH	x is *F* (FULL), *A* (ABBR), or *I* (IEEE). xx is *HD* (to enable time/date stamps) or *NH* (to disable time/date stamps).
Enable Analog Output			Unique channel number.
	AE x	AE 1	Model 710
	AE x,x	AE 1,2	Model 712
	AE x,x,x,x	AE 1, 2, 3, 4	Model 790
Analog Output Scale Factor	AS xxx	AS 100	*10*, *20*, *50*, *100*, *200*, or *500* mV/degree.
Analog Output Zero Offset	AO xxx.x	AO 0	Value between -199.9 and 449.9 °C (-327.8 and 841.8 °F).
Units Celsius or Fahrenheit	UN x	UN C	*C* (Celsius) or *F* (Fahrenheit).
Calibration Temperature	CT xxx.xx	CT 25.0	Value between -199.9 and 449.9 °C (-327.8 and 841.8 °F).
Enable/Disable CAL Correction	CC x	CC D	*E* (enable CAL correction) or *D* (disable CAL correction).

Table D.9 Remote Programming Commands

Command	Syntax	Default Value	Value Definition
Set Date	DA xx/yy/zz	—	xx is the day, yy the year, and zz the year (for example, 06/23/97).
Set Time	TI xx:yy z	—	xx is the hour, yy the minutes, and z is P (PM) or A (AM) (for example, 10:56 A).

Table D.9 Remote Programming Commands (continued)

Sample Remote Programming Commands

The IEEE-488 port echoes each command it receives, with a carriage return and a line feed. Embedded spaces are ignored. Table D.10 shows six sample programming commands.

Action	Procedure
Select Probe 1 only	<ESC>PS 1<CR><LF>
Set samples per measurement to 20	<ESC>SM 20<CR><LF>
Set measurement update time to once per minute	<ESC>MU 60<CR><LF> or <ESC>MU 1M<CR><LF>
Set displayed units to Celsius	<ESC>UN C<CR><LF>
Enable analog output on Channel 1	<ESC>AE 1<CR><LF>
Set analog output scale factor to 200 mV/degrees	<ESC>AS 200<CR><LF>

Table D.10 Remote Programming—Sample Commands

Sample Remote Query Commands

Table D.11 shows sample remote query commands. The instrument posts an SRQ when it receives a response to a query. Perform a serial poll and verify the instrument received a response (that is, the PROG bit is set in the serial poll status register). The controller must then perform a read operation to obtain the response.

If the setup parameters are established as illustrated in Table D.10, the responses are as follows (embedded spaces are ignored).

Query Commands	Instrument Response
<ESC> PS? <CR><LF>	PS 1 <CR><LF>
<ESC> SM? <CR><LF>	SM 20 <CR><LF>
<ESC> MU? <CR><LF>	MU 1M <CR><LF>
<ESC> UN? <CR><LF>	UN C <CR><LF>
<ESC> AE? <CR><LF>	AE 1 <CR><LF>
<ESC> AS? <CR><LF>	AS 200 <CR><LF>

Table D.11 Remote Programming—Query Commands and Syntax

Digital Output Formats

The instrument supports three different digital output formats—IEEE, FULL, and ABBR. The format used is a matter of preference.

The following discusses digital output formats.

IEEE Digital Output Format

Recommended data formats are presented in the IEEE-488.1-1987 standard, *IEEE Recommended Practice for Code and Format Conventions*. To order a copy of this standard (product number SH15446), see the section, "IEEE-488 Overview," for information on contacting the IEEE.

Figure D.5 shows the IEEE digital output format used by the instrument.

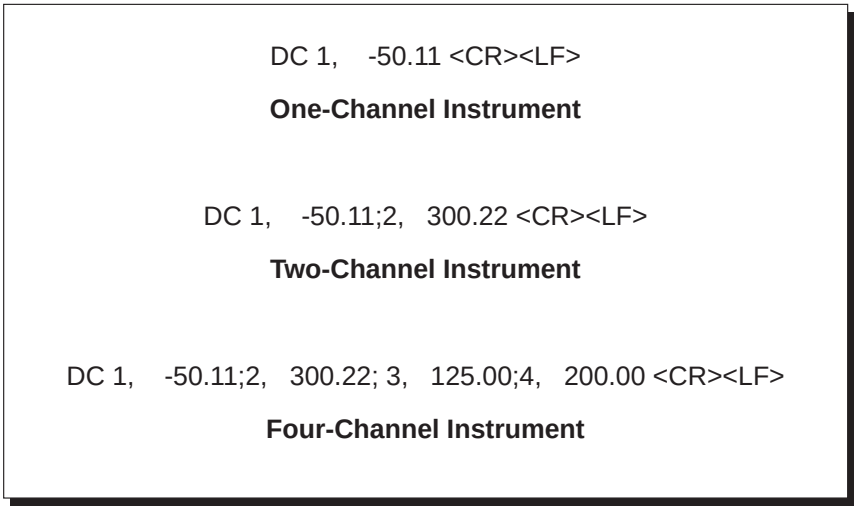


Figure D.5 IEEE Digital Output Format

The messages in Figure D.5 are shown exactly as they appear on a monitor or printer. A carriage return and line feed, <CR><LF>, are normally transmitted at the end of each line.

All measurement output messages consist of a three-character header, followed by a carriage return and line feed, <CR><LF> (see Figure D.6):

- DC (for Degrees Celsius) or DF (for Degrees Fahrenheit)
- One space (20h)
- One to four data fields, of up to 17 characters each

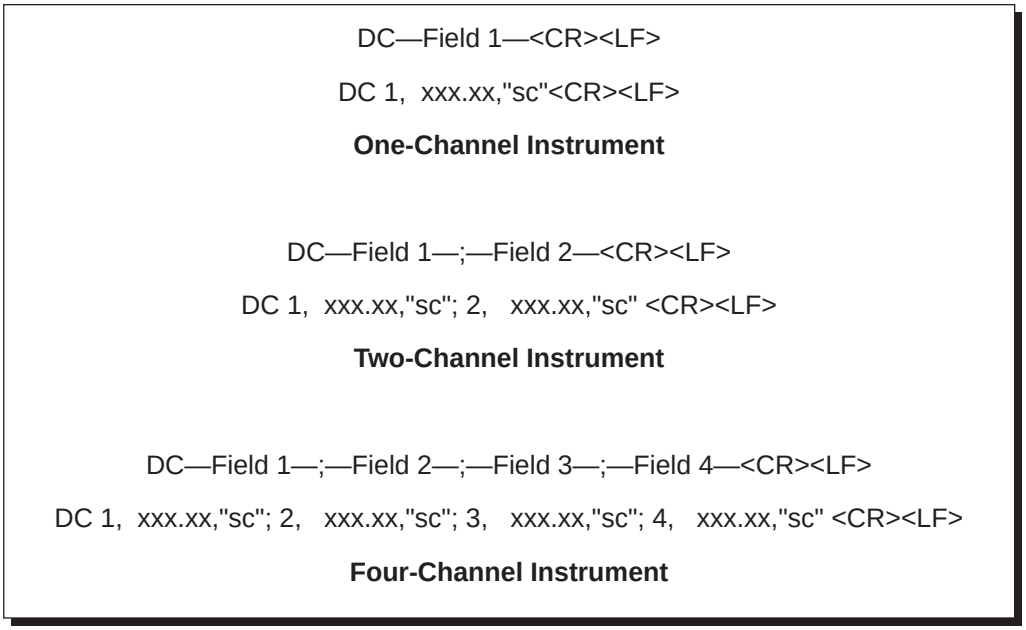


Figure D.6 IEEE Measurement Output Message Format

The temperature for each active probe is sent in the appropriate data field, 1 to 4. If a probe is not selected, the field is entirely omitted . Each field, except the last, has a semicolon (3Bh) at the end of it to separate the measurement results for each probe.

Figure D.7 shows the measurement result when only Probe 1 is active.

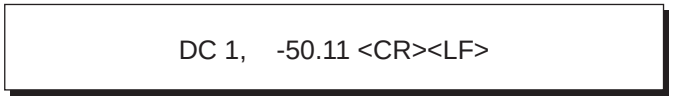


Figure D.7 IEEE Measurement Output Message Format with Only Probe 1 Active

Each data field consists of three subfields, separated by commas (2Ch), as shown in Figure D.8. Table D.12 describes each field. Embedded spaces are ignored.

```
pn, temp, "status"<CR><LF>
```

Figure D.8 IEEE Measurement Output Message Data Fields

Field	Description
pn	Two-character probe number. The first character is a space (20h), followed by the probe number (1, 2, 3, or 4, as applicable).
temp	Seven-character field that contains the actual temperature measurement (in °C or °F). The temperature is an optionally signed, fixe- point number with up to three digits to the left of the decimal point, and two on the right (-xxx.xx). If the number is positive, the minus sign is replaced by an ASCII space character (20h). Leading zeros are replaced by spaces, except for the digit immediately preceding the decimal point (sss0.xx, where “s” represents spaces). The minus sign (2Dh), if present, immediately precedes the first displayed digit if the number (ss-x.xx).
status	Additional information regarding the measurement (such as error codes, limits exceeded, or calibration complete. This subfield is preceded by and followed by quotation marks (22h) (for example, “PE”). One or more two-letter status codes may appear between the quotation marks, such as: • PE for probe error • LL for exceeding lower temperature limit • HL for exceeding higher temperature limit • CC for calibration complete (without errors) • U for calibration error (unstable)
<CR>	Carriage return (0Dh)
<LF>	Line feed (0Ah)

Table D.12 IEEE Measurement Output Message Data Field Descriptions

Figure D.9 shows a sample error message that includes temperature information. In this example, the high temperature limit was exceeded.

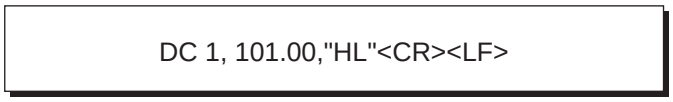


Figure D.9 IEEE Digital Output Format—High Temperature Exceeded

If a temperature is not included in the error message, the output does not include the temperature subfield. The status subfield immediately follows the channel number (see Figure D.10).

Figure D.10 IEEE Digital Output Format—Probe Error

If there is no status to report, the status subfield is not included in the output. The next measurement immediately follows the temperature subfield (see Figure D.11).

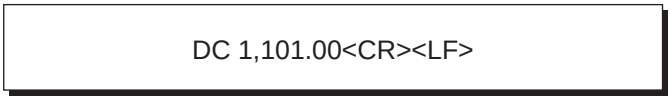


Figure D.11 IEEE Digital Output Format—No Status to Report

FULL and ABBR Digital Output Message Formats

When using the FULL or ABBR digital output formats, all remote programming commands use the equal sign ("=") instead of a space between the command and parameters.

<ESC>MU=2S<CR><LF>

Figure D.12 Remote Programming Command Format for FULL or ABBR Digital Output Formats

For more information, see the section, "FULL and ABBR Digital Output Message Formats," in Appendix C, "RS-232 Serial Output Port."

Time Stamps

An optional time and date string is available on the digital output. This can be turned on or off from the front panel, or over the digital port (using the DF command). When enabled, a time/date SRQ occurs once a minute, or immediately after the next measurement update (whichever is longer). See the section, "Serial Poll Status Byte," for additional information. Figure D.13 shows a sample time/date string.

[TM = 8:57:17A; DT = 8/08/96 SM = 4; MU = 20S]<CR><LF>

Figure D.13 Sample Time/Date String

The string includes the current `SAMPLES/MEASUREMENT` and `MEASUREMENT UPDATE TIME` parameter values. However, the measurement update time is included only if the value is **not** set to *CONTINUOUS*.

Appendix E: Analog Output Options

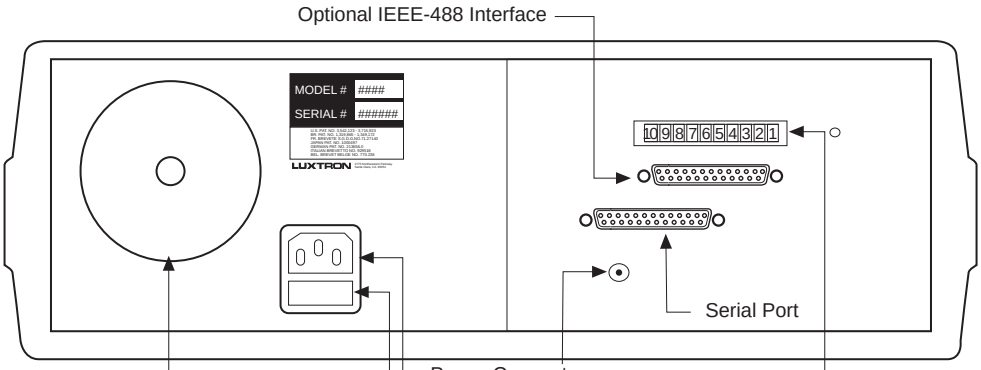
This appendix discusses the following options:

- Analog Output Voltage (AOV) ±5 V Standard and ±10 V option
- Analog Output Current (AOC) option

Analog Output Voltage (AOV)

This option, which is programmable from the Setup menu (see the section, "Setup Mode," in Chapter 3, "Using the Instrument"), provides an analog output voltage for each channel. You can control both the scale factor (mV/degree) and offset temperature (the temperature at which the analog output voltage is 0 V). The analog output voltage has a full scale range of ±5 V, with a resolution of approximately 2.5 mV.

Figure E.1 provides a view of the back panel and analog output pinout.



Analog Output Connector

Pin	Function 710	712	790
1	Sensor 1	Sensor 1	Sensor 1
2	Sensor 1 Return	Sensor 1 Return	Sensor 1 Return
3	Not Used	Sensor 2	Sensor 2
4	Not Used	Sensor 2 Return	Sensor 2 Return
5	Not Used	Not Used	Sensor 3
6	Not Used	Not Used	Sensor 3 Return
7	Not Used	Not Used	Sensor 4
8	Not Used	Not Used	Sensor 4 Return
9	Chassis Ground	Chassis Ground	Chassis Ground
10	Chassis Ground	Chassis Ground	Chassis Ground

Figure E.1 Sample Back Panel View with Analog Output Pinout

When the instrument is in Standby mode at the Main menu, the analog output is set to 0 V. In Run mode, the analog output is offset by the measured temperature. For relative measurements, this initial offset can be set to zero. The analog offset sets the temperature at which the analog output outputs 0 V. This temperature can be set anywhere in the operating range. No offset means the output voltage is zero when the temperature is 0 °C or 0 °F.

Figure E.2 shows the formula for calculating the output voltage range, using the highest and lowest measured temperatures as input. Table E.1 lists the definitions for each variable.

$$V_{out}(mV) = SF * (T_{meas} - T_{off})$$

Figure E.2 Formula for Calculating the Voltage Output

Variable	Definition
SF	Scale factor in mV/degree
T_{meas}	Measured temperature
T_{off}	Analog offset temperature

Table E.1 Voltage Output Formula Variable Definitions

Because the temperature range is restricted by the output limit of ±5 V, use the 10 mV/degree scale to cover the entire range of the instrument. For better resolution, use the highest possible scale factor. Table E.2 lists the relationship between scale factor, temperature range, and resolution.

Scale Factor (mV/°C)	Temperature Range		Resolution	
	°C	°F	°C	°F
10	±500	±932	0.244	0.44
20	±250	±482	0.122	0.44
50	±100	±212	0.049	0.44
100 (default)	±50	±122	0.024	0.44
200	±25	±77	0.0122	0.44
500	±10	±50	0.0049	0.44

Table E.2 AOV ±5 V Relationship between Scale Factor, Temperature Range, and Resolution

If the instrument detects an error during operation, the analog output is set to 0 V. See Chapter 5, "Maintenance and Troubleshooting," for more information.

If the temperature trip limits are enabled, a high limit trip sets the output to +5 V, and a low limit trip sets the output to -5 V. These signals can be used to power relays or other control devices.

Analog Output Voltage—±10V Range Option

The ±10 V option is similar to the ±5 V range, except for the scale factor, as listed in Table E.3.

Scale Factor (mV/°C)	Temperature Range		Resolution	
	°C	°F	°C	°F
20	±500	±932	0.244	0.44
40	±250	±482	0.122	0.44
100	±100	±212	0.049	0.44
200 (default)	±50	±122	0.024	0.44
400	±25	±77	0.0122	0.44
1000	±10	±50	0.0049	0.44

Table E.3 AOV ±10 V Relationship between Scale Factor, Temperature Range, and Resolution

Note

Units with the standard ±5 V range must be returned to LUXTRON for conversion to the ±10 V range.

Analog Output Current (AOC) Option

The AOC option provides a 4 to 20 mA current loop for each channel. This "Loop Powered" option requires an external power supply, as shown in Figure E.3.

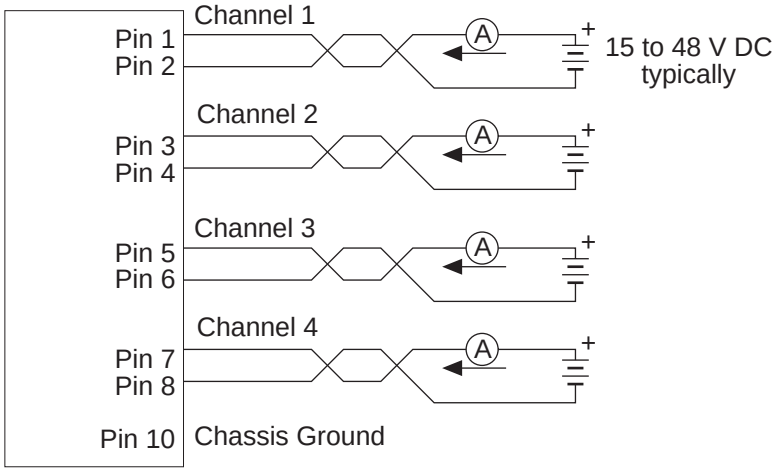


Figure E.3 AOC Option—External Power Supply Pin Diagram

Notes

Model 710: Pins 3 through 8 are not used.

Model 712: Pins 5 through 8 are not used.

The current loop option replaces the analog voltage output and must be installed by LUXTRON.

The user has control of both the scale factor (μA/degree) and offset temperature (the temperature at which the analog current is 4 mA).

When the instrument is in Standby mode, the analog is set to 4 mA. In Run mode, analog current is offset by measured temperature. For relative measurements, this initial offset can be set to zero. The analog offset sets the temperature that is equivalent to 4 mA. No offset means the current is 4 mA when temperature is 0 °C or 0 °F.

Figure E.4 shows the formula for calculating the range of the current, using the highest and lowest measured temperatures as input. Table E.4 lists the definitions for each variable.

$$I_{out}(mA) = SF * (T_{meas} - T_{off}) + 4\ mA$$

Figure E.4 Formula for Calculating the Current

Variable	Definition
SF	Scale factor in µA/degree
T_{meas}	Measured temperature
T_{off}	Analog offset temperature

Table E.4 Current Formula Variable Definitions

Because the temperature range is restricted by the 4 to 20 mA constraint, use the 32 µA/degree scale to cover the entire range of the instrument. For better resolution, use the highest possible scale factor.

Table E.5 lists the relationship between scale factor, maximum temperature, and resolution.

Scale Factor (µA/degree)	Temperature Range		Resolution	
	°C	°F	°C	°F
16	100	212	0.244	0.44
32	500	932	0.122	0.44
80	200	392	0.049	0.44
160 (default)	100	212	0.024	0.44
320	50	122	0.0122	0.44
800	20	68	0.0049	0.44

Table E.5 AOC Relationship between Scale Factor, Maximum Temperature, and Resolution

If the instrument detects an error during operation, the analog current is set to 4 mA for the duration of the error. See Chapter 5, "Maintenance and Troubleshooting," for more information.

Appendix F: Warranty and Service

This appendix documents the warranty and service information for the Model 710, 712, and 790 Fluoroptic thermometers.

Limited Warranty

LUXTRON Corporation warrants each LUXTRON instrument to be free from defects in material and workmanship under normal use and service for the period of one year from date of shipment. This warranty extends only to the original purchaser. It does not apply to fuses, lamps, or probes, nor any products or parts that have been subject to misuse, neglect, accident or abnormal conditions of operation.

In the event of failure of the instrument covered by this warranty, L**UXTRON Corporation** will repair and calibrate the instrument if it is returned to LUXTRON within one year of the original shipment, provided an examination discloses that the product is defective. LUXTRON may, at its option, replace the unit in lieu of repair. The repairs or replacement will be made without charge if the instrument is returned within one year of the original shipment date.

If the fault has been caused by misuse, neglect, accident, or abnormal conditions of operation, repairs will be billed at current service rates. In such case, a purchase order number is required prior to the start of any repair. If requested, an estimate of the service charges will be given prior to the start of any repair.

The foregoing warranty is in lieu of all other warranties, express or implied, including, but not limited to, any implied warranty of merchantability, fitness, or adequacy for any particular purpose or use. LUXTRON Corporation shall not be liable for any special, incidental, or consequential damages, whether in contract, tort, or otherwise.

Damage in Shipment for the Original Purchaser

The instrument should be thoroughly inspected immediately upon delivery to purchaser. All material in the container should be checked against the enclosed packing list. LUXTRON cannot be responsible for shortages against the packing list unless a claim is filed with the carrier immediately. Final claim and negotiations with the carrier must be completed by the customer.

What to Do in Case of a Fault

Notify the **LUXTRON Customer Service Department** with details of the problem. Include the instrument model number and serial number. On receipt of this information, Customer Service will attempt to locate the fault and, if possible, solve the problem over the telephone.

If Customer Service concludes that the instrument must be returned to LUXTRON for repair, a Return Material Authorization (RMA) Number will be issued. Upon receipt of the RMA number, the instrument should be returned, transportation prepaid.

Shipments to LUXTRON for Repair

All shipments of LUXTRON instruments should be made prepaid and insured by way of **United Parcel Service** or **Best Way**. For overseas customers, units should be shipped air freight, priority one. The instrument must be shipped in the original packing container or its equivalent. LUXTRON is not responsible for freight damage to instruments that are improperly packed.

Shipping Address

LUXTRON Corporation

3033 Scott Blvd.

Santa Clara, CA 95054-3316 USA

Additional Contact Information

Phone:	(408) 727-1600
FAX:	(408) 727-1677 FAX
Email:	info@luxtron.com
Website:	http://www.luxtron.com