USER'S MANUAL

Model 200
Temperature Monitor

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LIMITED WARRANTY

Lake Shore Cryotronics, Inc. (henceforth Lake Shore), the manufacturer, warrants this product for a period of twelve (12) months from the date of shipment. During the warranty period, under authorized return of instruments or component parts to Lake Shore freight prepaid, the company will repair, or at its option replace, any part found to be defective in material or workmanship, without charge to the Owner for parts, service labor or associated customary shipping cost. Replacement or repaired parts will be warranted for only the unexpired portion of the original warranty.

All products are thoroughly tested and calibrated to published specifications prior to shipment. Calibration Certifications are offered for six month periods only. Where such documentation must be updated, a re-certification service is offered by Lake Shore at a reasonable cost.

LIMITATION OF WARRANTY

This warranty is limited to Lake Shore products purchased and installed in the United States. This same protection will extend to any subsequent owner during the warranty period. It does not apply to damage caused by accident, misuse, fire, flood, or acts of God, from failure to properly install, operate, or maintain the product in accordance with the printed instructions provided. This warranty does not apply to defects resulting from improper or inadequate maintenance, unauthorized modification or misuse, operation outside of the environmental specifications for any product or part or buyer-supplied software interfacing.

THIS WARRANTY IS IN LIEU OF ANY OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHICH ARE EXPRESSLY EXCLUDED. THE OWNER AGREES THAT LAKE SHORE'S LIABILITY WITH RESPECT TO THIS PRODUCT SHALL BE SET FORTH IN THIS WARRANTY, AND INCIDENTAL OR CONSEQUENTIAL DAMAGES ARE EXPRESSLY EXCLUDED.

CERTIFICATION

Lake Shore certifies that this product has been inspected and tested in accordance with its published specifications and that this product met its published specifications at the time of shipment. The accuracy and calibration of this product at the time of shipment are traceable to the United States National Institute of Standards and Technology (NIST); formerly known as the National Bureau of Standards (NBS), or to a recognized natural standard.

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.0 GENERAL

The Model 200 was designed and manufactured in the United States of America by Lake Shore Cryotronics, Inc. The Model 200 features the following:

- Bright 4-Digit LED Display of Temperature in K or °C
- Temperature Range: 1.4 K to 475 K (–271 °C to 202 °C)
- Resolution of ±0.1 K or °C
- Overall Accuracy with Calibrated Sensor of ±0.25 K
- Standard Temperature Response Curves, Plus Memory for Precision Curve Option for a Calibrated Sensor
- Sensor Connections made to Screw Terminal Adapter
- Flexible Power Supply Requirement

We welcome comments on this manual. Although we try to keep it error-free, some may occur. To report an error, describe it briefly and include the appropriate paragraph, figure, table, and page number. Send comments to Lake Shore Cryotronics, Attn: Technical Publications, 575 McCorkle Blvd., Westerville, Ohio 43082-8888. This manual is subject to change without notice.

1.1 MODEL 200 SYSTEM DESCRIPTION

The Model 200 Temperature Monitor is a microcontroller-based instrument which measures temperature. It is designed to use Lake Shore DT-470 Series and TG-120 Series diode sensors. The Model 200 displays the temperature reading of one diode sensor. The Model 200-S has two inputs and one display. The user selects the input to display by means of a front panel switch. The diode sensors must conform to the same temperature response curve. The Model 200-D has two inputs and two displays. The readings of both diode sensors continuously display. Each sensor can have its own temperature response curve. See Figure 1-1.

The Model 200 Temperature Monitor, coupled with the DT-470 Series or TG-120 Series diode sensors, offers outstanding performance and advantages over traditional thermocouple solutions. In the cryogenic temperature range, the diode sensor offers a much higher signal and better sensitivity, repeatability, and *accuracy* than a thermocouple. The DT-470 Series sensors follow the same temperature response curve, Curve 10. In most applications they are interchangeable with no need to reconfigure monitors. TG-120 Series sensors, which are more sensitive than DT-470 Series sensors at temperatures below 50 K, are recommended for magnetic fields up to 5 tesla.

Model 200 System Description (Continued)

Diode sensors come in several packaging formats for easy mounting. Unlike a thermocouple, the lead wire in a diode measurement is not the active sensor component; using an additional connector to bring out the sensor signal from a cryogenic and/or vacuum system does not degrade the measurement. Finally, the diode sensor does not require any room temperature compensation.

The Model 200 excites the diode sensor with a 10 µA current source. An analog-to-digital converter reads the sensor voltage and sends the reading to a microcontroller. The microcontroller uses the selected temperature response curve stored in memory to convert sensor voltage to temperature. The computed temperature displays on the bright front panel LED display.

The Model 200 comes with several standard temperature response curves. In applications where additional accuracy of a calibrated sensor is required, order the Model 200 with a factory installed precision temperature response curve. TG-120 diode sensors require a Model 200 with the precision calibration option.

Mounting the Model 200 is simple since it is packaged in a 1/8 DIN aluminum panel mount box. The 200-S and 200-D Temperature Monitors are packaged in 1/4 DIN aluminum panel mount boxes.

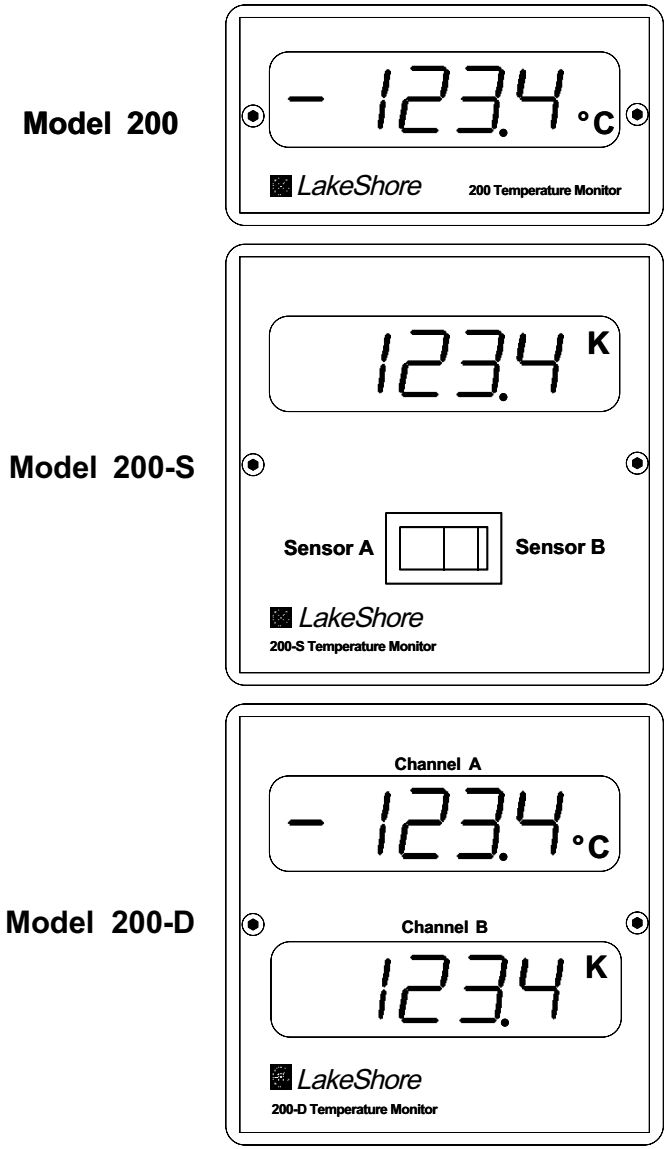

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Figure 1-1. Model 200 Temperature Monitor Series

Table 1-1. Model 200 Specifications

THERMOMETRY		
Input/Display:	Model 200	One input, one display
	Model 200-S	Two inputs, one display
	Model 200-D	Two inputs, two displays
Measurement type:	Two-lead	
Sensor Type:	Silicon or GaAlAs Diode	
Input Voltage Range:	5 Volts	
Sensor Excitation:	10 µA ±0.2%	
Temperature Range:	1.4–475 K with DT-470 Series Silicon Diodes, 4.0–325 K with TG-120P or PL Diodes, 4–500 K with TG-120-SD	
Electronic Accuracy with Silicon Diode Sensor:	±0.1 degree typical, ±0.2 degree maximum	
Accuracy with Calibrated Sensor: ±0.25 K		
Sensor Curves:	Curve 10, D-Curve, CTI-Curve, and Precision Option Curve. One CalCurve for 200/200-S, two for 200-D (factory installed).	
DISPLAY		
Type:	4-Digit Red LED Display, 14.2 mm (0.56 in.) high, and unit annunciators	
Resolution:	0.1 K or °C	
Units:	K or °C	
Update Rate:	3 updates per second	
REAR PANEL CONNECTORS AND SWITCHES		
Sensor Input:	Screw terminal	
Power Input:	Power jack accepts power plug compatible to Switchcraft S-760 or S-765 or screw terminal	
Configuration Switch:	4-position DIP Switch to Select Curve and Temperature Unit	
GENERAL		
Ambient Temperature Range: 15–35 °C		
Power Requirements:	20–35 VDC or 15–24 VAC (50-60 Hz), 3.5 Watts (Maximum)	
Size:	Model 200 = 96 x 48 x 146 mm (3.78 x 1.89 x 5.75 in.); Model 200-S & 200-D = 96 x 96 x 146 mm (3.78 x 3.78 x 5.75 in.)	
Panel Mount Cutout Dimensions:	Model 200 = 91 x 44 mm (3.58 x 1.72 in.); Model 200-S & 200-D = 91 x 96 mm (3.58 x 3.58 in.)	

CHAPTER 2

INSTALLATION

2.0 GENERAL

This chapter covers Inspection and Unpacking (Paragraph 2.1), Repackaging for Shipment (Paragraph 2.2), Front and Rear Panel Definitions (Paragraph 2.3), Sensor Installation Recommendations (Paragraph 2.4), Sensor Definitions (Paragraph 2.5), Power Connections (Paragraph 2.6), Panel Mounting (Paragraph 2.7), and Initial Setup and Checkout (Paragraph 2.8)

2.1 INSPECTION AND UNPACKING

Inspect shipping containers for external damage. Make all claims for damage (apparent or concealed) or partial loss of shipment in writing to Lake Shore within five (5) days from receipt of goods. If damage or loss is apparent, please notify the shipping agent immediately.

Open the shipping containers. Use the packing list included with the system to verify receipt of the instrument, sensor, accessories, and manual. Inspect for damage. Inventory all components supplied before discarding any shipping materials. If there is freight damage to the instrument, file proper claims promptly with the carrier and insurance company and notify Lake Shore. Notify Lake Shore immediately of any missing parts. Lake Shore cannot be responsible for any missing parts unless notified within 60 days of shipment. See the standard Lake Shore Warranty on the A Page (immediately behind the title page).

2.2 REPACKAGING FOR SHIPMENT

To return the Model 200 or accessories for repair or replacement, obtain a Return Goods Authorization (RGA) number from Technical Service in the United States, or from the authorized sales/service representative from which the product was purchased. Instruments may not be accepted without a RGA number. When returning an instrument for service, Lake Shore must have the following information before attempting any repair.

1. Instrument model and serial number.
2. User name, company, address, and phone number.
3. Malfunction symptoms.
4. Description of system.
5. Returned Goods Authorization (RGA) number.

Repack the system in its original container (if available). Affix shipping labels and FRAGILE warnings. Write RGA number on the outside of the container or on the packing slip. If not available, consult Lake Shore for shipping and packing instructions.

2.3 FRONT AND REAR PANEL DEFINITIONS

This paragraph defines front and rear panels of the Model 200 (Paragraph 2.3.1), Model 200-S (Paragraph 2.3.2), and Model 200-D (Paragraph 2.3.3).

2.3.1 Model 200 Definitions

The Model 200 has no front panel controls. The 4-digit red LED displays the temperature in Kelvin (K) or degrees Celsius (°C). Select temperature units with the rear panel DIP switch. See Figure 2-1.

Figure 2-1. Model 200 Front Panel

The rear panel consists of the 24 Volt power input connector, DIP Switch, CAL trimpot, and screw-terminal connector. See Figure 2-2.

24 Volt Power Input Connector. The line cord from the wall mounted power supply has a power plug that inserts into the Model 200 rear panel. The Model 200 is off when not plugged in, and on when plugged in. Make sensor connections before applying power to the instrument.

DIP Switch. The DIP switch controls temperature display and curve selection. The first switch, labeled K/C, selects Kelvin or degrees Celsius for display. The next two switches select the proper sensor curve as shown in the table below. The four curve types are defined in Paragraph 2.5. The fourth switch is not used.

CURVE 1	CURVE 0	SETTING
OPEN	OPEN	DT-470
OPEN	CLOSE	CTI-Curve
CLOSE	OPEN	D-Curve
CLOSE	CLOSE	Precision Option

Model 200 Definitions (Continued)

CAL Trimpot. The CAL trimpot adjusts instrument calibration. See Paragraph 4.4 for details.

Screw-Terminal Connector. The diode terminals are marked **+** for the anode and **–** for the cathode. VREF and Shield are used during unit calibration. See Paragraph 4.4 for details. Shield also terminates the diode sensor cable shield. Finally, the power for multiple Model 200's can be ganged together to a common on/off switch using the Optional Power input, which is the first two inputs on the screw-terminal connector. This is an input only, and can not be used as a voltage tap.

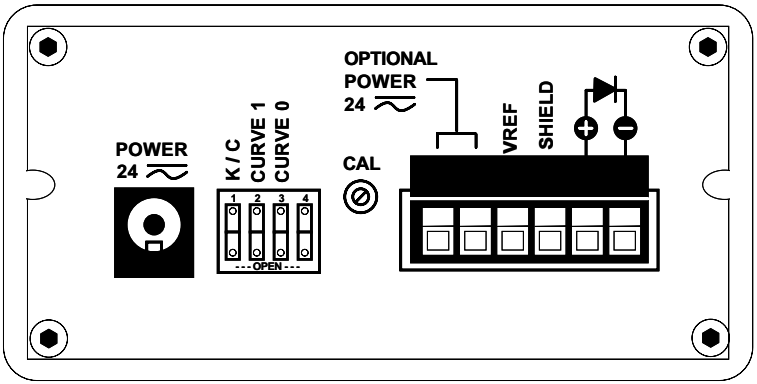

Figure 2-2. Model 200 Rear Panel

2.3.2 Model 200-S Definitions

The Model 200-S has one front panel control. The Sensor A/Sensor B switch selects which sensor data to display. Both sensors must conform to the same temperature response curve. The 4-digit red LED displays the selected temperature in Kelvin (K) or degrees Celsius (°C).

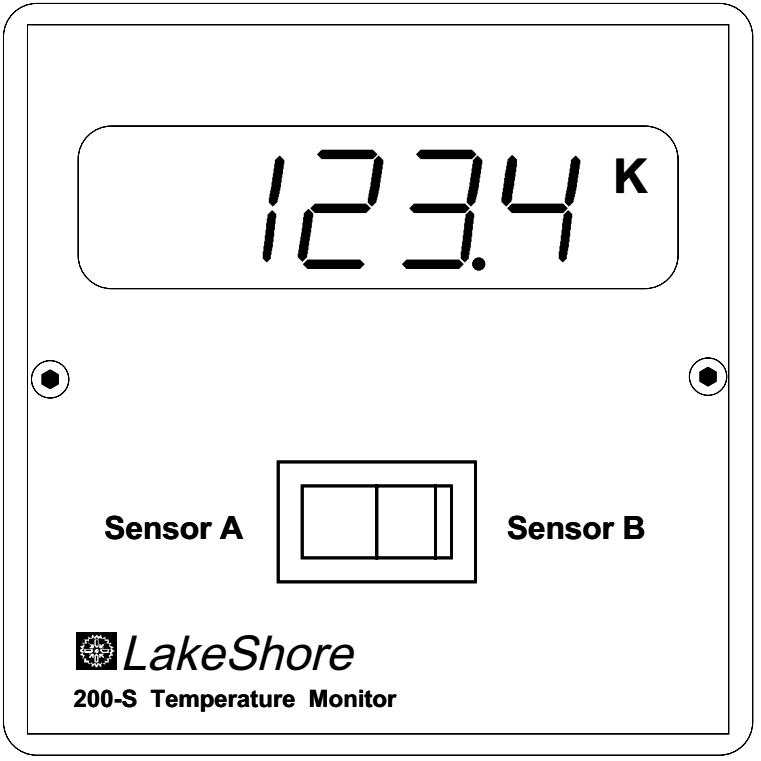

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Figure 2-3. Model 200-S Front Panel

Model 200-S Definitions (Continued)

The Model 200-S rear panel is the same as the Model 200 except: The upper screw-terminal connector applies to Sensor A. The lower screw-terminal connector applies to Sensor B. The front panel switch selects between the two sensors. Both sensors must conform to the same temperature response curve selected by the CURVE 1 and CURVE 0 DIP switches. There is only one POWER connector and DIP Switch (see Paragraph 2.3.1).

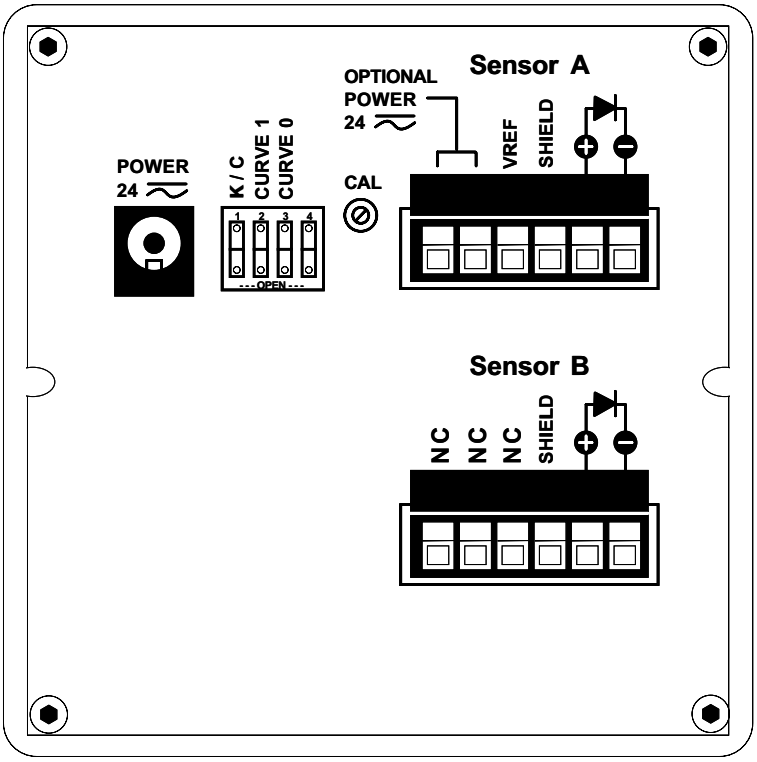


Figure 2-4. Model 200-S Rear Panel

2.3.3 Model 200-D Definitions

The Model 200-D has no front panel controls. Two 4-digit red LEDs simultaneously display temperatures in Kelvin (K) or degrees Celsius (°C). In essence, the Model 200-D operates as two independent Model 200 units with a common power supply.

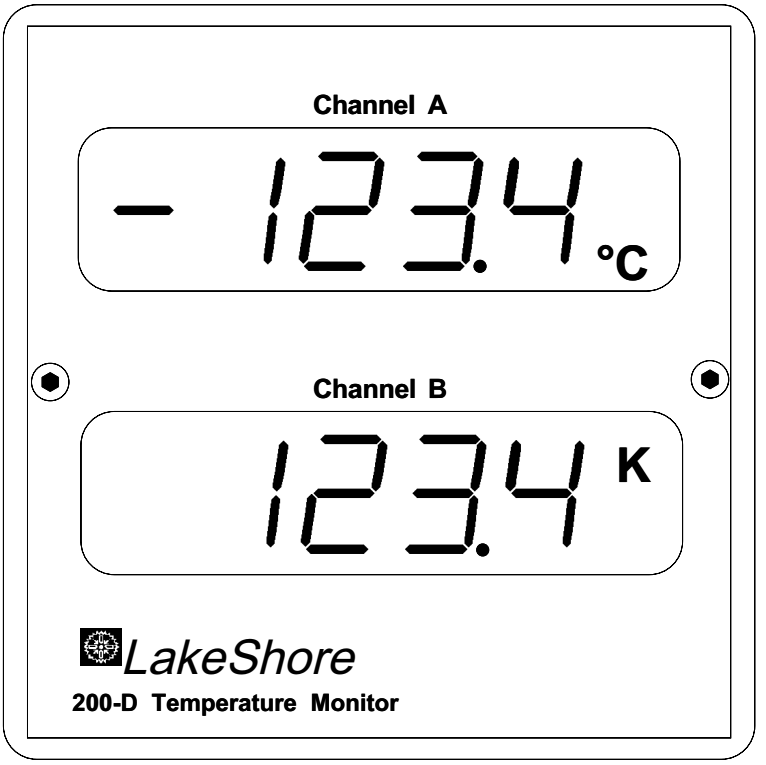


Figure 2-5. Model 200-D Front Panel

Model 200-D Definitions (Continued)

Descriptions of the Model 200-D rear panel are the same as the Model 200 except two complete sets of DIP switches (see Paragraph 2.3.1), CAL trimpots, and screw-terminal connectors are provided. The upper set applies to Channel A. The lower set applies to Channel B. The unit simultaneously displays the temperatures of both sensors. There is only one POWER connector.

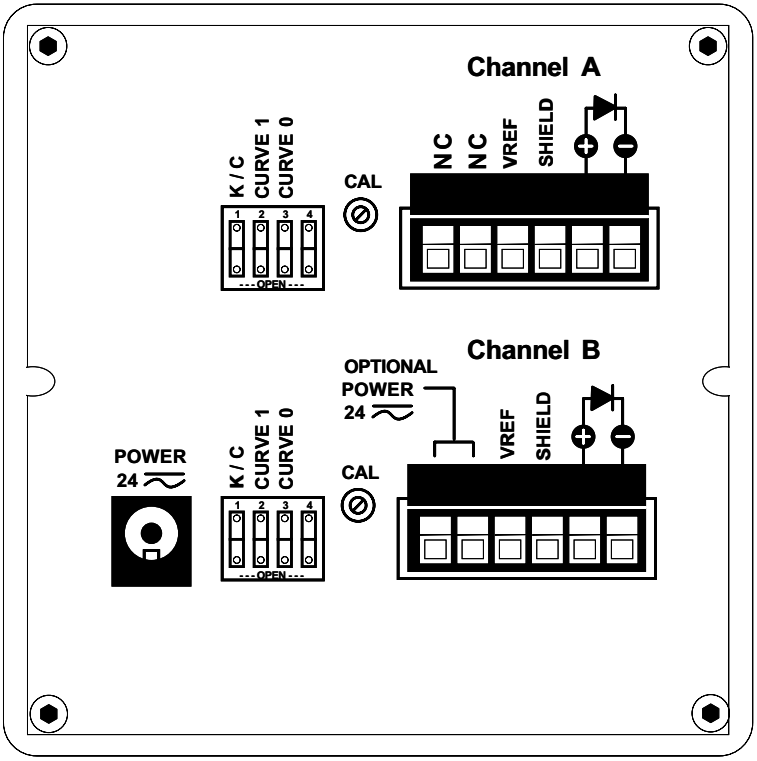


Figure 2-6. Model 200-D Rear Panel

2.4 SENSOR INSTALLATION RECOMMENDATIONS

Abbreviated sensor installation recommendations for the Model 200 are included in this section. Please refer to the Lake Shore Product Catalog for installation details and sensor specifications. Call Lake Shore for copies of application notes or with questions or comments concerning sensor installation.

1. Do not ground the sensor.
2. Shield leads and connect shield wire to SHIELD on screw terminal connector only. Do not connect shield at other end of cable.
3. Keep leads as short as possible.
4. Use twisted-pair wire. Use Lake Shore Duo-Twist™ wire (or equivalent) for two-wire, or Quad-Twist™ wire (or equivalent) for four-wire applications.
5. Thermally anchor lead wires.

2.4.1 Two-Lead Measurement Considerations

In two-lead measurement, the leads measuring sensor voltage are also the current carrying leads. The resultant voltage measured at the instrument is the sum of the temperature sensor voltage and the IR voltage drop within the two current leads. In a cryogenic environment, the heat flow down the leads is of critical concern, so wire of small diameter and significant resistance per foot is preferred to minimize heat flow. Consequently, a voltage drop within the leads may exist.

Expect some loss in accuracy since the voltage measured at the voltmeter is the sum of the sensor voltage and the voltage drop across the connecting leads. The exact measurement error depends on sensor sensitivity and variations resulting from changing temperature. For example, a 10 Ω lead resistance results in a 0.1 mV voltage error. The resultant temperature error at liquid helium temperature is only 3 mK, but because of the lower sensitivity (dV/dT) of the diode at higher temperatures, it becomes 10 mK at liquid nitrogen temperature.

2.4.2 Connecting Leads To The Sensor

Excessive heat flow through connecting leads to any temperature sensor may differ the temperature between the active sensing element and the sample to which the sensor mounts. This reflects as a real temperature offset between what is measured and the true sample temperature. Eliminate such temperature errors with proper selection and installation of connecting leads.

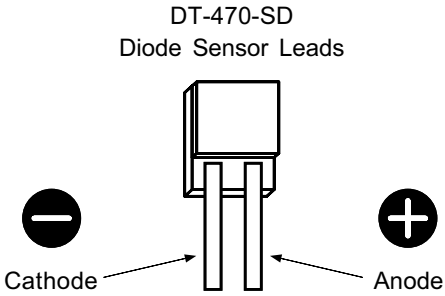
To minimize heat flow through the leads, select leads of small diameter and low thermal conductivity. Phosphor-bronze or Manganin wire is commonly used in sizes 32 or 36 AWG. These wires have a fairly low thermal conductivity, yet electrical resistance is not large enough to create measurement problems.

Connecting Leads To The Sensor (Continued)

Thermally anchor lead wires at several temperatures between room temperature and cryogenic temperatures to guarantee no heat conduction through the leads to the sensor.

2.4.3 Sensor Mounting

Before installing a diode sensor, identify which lead is the anode and which is the cathode. When viewed with the base down and the leads towards the observer, the anode is on the right and the cathode is on the left. The Lake Shore DT-470-SD silicon diode sensor lead configuration is shown to the right. For other sensors, read accompanying literature or consult the manufacturer to positively identify sensor leads. Lead identification should remain clear even after sensor installation. Record the sensor serial number and location.



On the DT-470-SD, the base is the largest flat surface. It is sapphire with gold metalization over a nickel buffer layer. The base is electrically isolated from the sensing element and leads; make all thermal contact to the sensor through the base. A thin braze joint around the sides of the SD package electrically connect to the sensing element. Avoid contact to the sides with any electrically conductive material.

When installing the sensor, make sure there are no electrical shorts or current leakage paths between the leads or between the leads and ground. If IMI-7031 varnish or epoxy is used, it may soften varnish-type lead insulations so that high resistance shunts appear between wires if *sufficient time for curing is not allowed*.

Slide Teflon® spaghetti tubing over bare leads when the possibility of shorting exists. Avoid putting stress on the device leads and allow for thermal contractions that occur during cooling which could fracture a solder joint or lead if installed under tension at room temperature.

For temporary mounting in cold temperature applications, apply a thin layer of Apiezon® N Grease between the sensor and sample to enhance thermal contact under slight pressure. The preferred method for mounting the DT-470-SD sensor is the Lake Shore CO Adapter.

Sensor Mounting (Continued)

CAUTION: Lake Shore will not warranty replace any device damaged by user-designed clamps or solder mounting.

For semi-permanent mountings, use Stycast epoxy instead of Apiezon® N Grease.

NOTE: Do not apply Stycast epoxy over the DT-470-SD package: sensor stress may shift the readings. In all cases, periodically inspect the sensor mounting to verify good thermal contact to the mounting surface is maintained.

2.4.4 Current Source Dependence

This paragraph addresses the effects of current source accuracy on temperature measurement accuracy. Although the Model 200 has an accurate internal current source, it is important to understand the relationship between current variation and measurement accuracy.

Diode sensors possess a non-linear forward current-voltage characteristic. Consequently, the forward voltage variation with changing current for diodes is smaller than for resistance temperature sensors, which have linear current-voltage characteristics.

Below 30 K, the sensitivity (dV/dT) of Lake Shore diode temperature sensors increases by an order of magnitude over sensitivities at higher temperatures. The slope (dV/dI) of the I-V curves stays relatively constant. Both characteristics reduce even further the effect of any change in forward bias current on temperature measurement accuracy. Refer to Tables 2-1 and 2-2.

Table 2-1. Effect of Current Variation on Diode Temperature Measurement Accuracy

T (K)	∆I, µA*	Acc. (%)*	Range (µA)*	Error (K)
300	0.5 0.05 0.005	5 0.5 0.05	9.5 to 10.5 9.95 to 10.05 9.995 to 10.005	1 0.1 0.01
150	1 0.1 0.01 0.005	10 1 0.1 0.05	9 to 11 9.9 to 10.1 9.99 to 10.01 9.995 to 10.005	1 0.1 0.01 0.005
50	3 0.3 0.03 0.005	30 3 0.3 0.05	7 to 13 9.7 to 10.3 9.97 to 10.03 9.995 to 10.005	1 0.1 0.01 0.005

* With current source (I≈10 µA).

Current Source Dependence (Continued)

If the output from a current source is not precisely 10 µA, the error in temperature can be calculated by this relationship between the dV/dT and dV/dI values: **DT = (DI • dV/dI) / (dV/dT)**

Note values dV/dI and dV/dT are derived at same temperature (T).

Table 2-2. Typical DT-470 dV/dI Values for Selected Temperatures

T (K)	dV/dI (approx.)
300	3000 Ω
77	1000 Ω
4.2	2800 Ω

2.4.5 Measurement Errors Due To AC Noise

Poorly shielded leads or improperly grounded measurement systems can introduce AC noise into the sensor leads. In diode sensors, the AC noise shifts the DC voltage measurement due to the diode non-linear current/voltage characteristics. When this occurs, measured DC voltage is too low and the corresponding temperature reading is high. The measurement error can approach several tenths of a Kelvin. To determine if this problem exists, perform either procedure below.

1. Place a capacitor across the diode to shunt induced AC currents. Capacitor size depends on the noise frequency. If noise is related to power line frequency, use a 10 microfarad capacitor. If AC-coupled digital noise is suspected (digital circuits or interfaces), use a 0.1 to 1 microfarad capacitor. In either case, if measured DC voltage increases, there is induced noise in the measurement system.

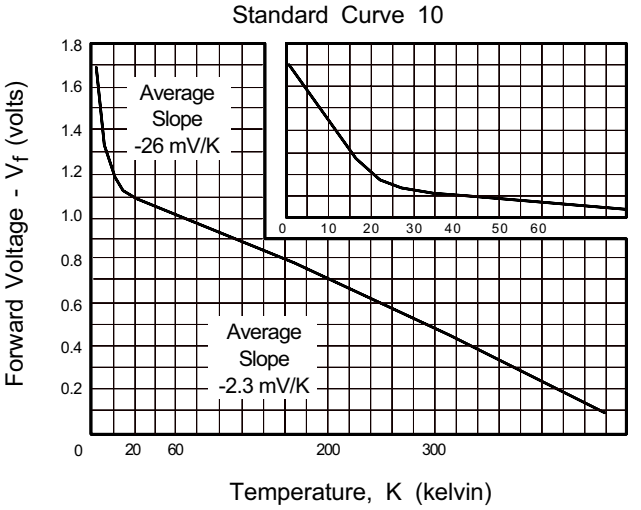
2. Measure AC voltage across the diode with an AC voltmeter or oscilloscope. Most voltmeters do not have the frequency response to measure noise associated with digital circuits or interfaces (which operate in the MHz range). For a thorough discussion of this potential problem, and the magnitude of error which may result, request the paper "Measurement System-Induced Errors In Diode Thermometry," J.K. Krause and B.C. Dodrill, Rev. Sci. Instr. 57 (4), 661, April, 1986 from Lake Shore.

To greatly reduce potential AC noise, connect twisted leads (pairs) between the measurement instruments and the diode sensors. Use 32 or 36 AWG Lake Shore Duo-Twist™ Cryogenic Wire, which features phosphor bronze wire twisted at 3.15 twists per centimeter (8 twists per inch). See the Lake Shore Product Catalog or contact Lake Shore for further information.

2.5 SENSOR CURVE DEFINITION

Sensor curves available with the Model 200 include Curve 10, CTI-Curve, D-Curve, and a factory installed Precision Option for a calibrated sensor. After selecting the proper curve, set the Model 200 rear panel DIP switch (see Paragraph 3.2).

Curve 10. Lake Shore DT-470 Series silicon diodes follow the same standard temperature response Curve 10 and are interchangeable. Curve 10 is programmed into all Lake Shore Temperature Controllers, digital thermometers, and temperature monitors. DT-470 Series sensors come in five bands of tracking accuracy.



CTI-Curve. For Customer convenience, the Model 200 also supports the standard curve for CTI-Cryogenics diodes.

D-Curve. Users of older Lake Shore DT-500 Series diode sensors can still use the Model 200 when set to D-Curve.

Precision Option. The Precision Option is the easiest way to combine the additional performance of a Lake Shore calibrated sensor with the Model 200 Temperature Monitor. This option is a read-only memory chip (PROM) with specific sensor calibration stored on it. It improves combined sensor/instrument accuracy to within ±0.25K or better over the calibrated temperature range of the sensor.

The factory installs the 8001-200 Precision Option on instruments ordered with a calibrated sensor. To use the instrument with an existing Lake Shore calibrated sensor, Lake Shore requires the sensor model and serial numbers at the time of order. The Model 8002-200 is for field installations of the Precision Option in an existing Model 200.

Sensor Curve Definition (Continued)

The Precision Option is required for Lake Shore TG-120 Series Gallium-Aluminum-Arsenide Diode Temperature Sensors.

2.6 POWER CONNECTIONS

The Model 200 accepts a broad power supply AC or DC voltage range from any polarity power supply. If the Model 200 is ordered with a wall-mount power supply, a 24 Volt AC power supply is included. The line cord from the wall mounted power supply has a power plug that inserts into the 24 Volt Connector on the Model 200 rear panel. The Model 200 is off when not plugged in, and on when plugged in. Make sensor connections before applying power to the instrument.

The power for multiple Model 200s can be ganged together to a common on/off switch using the Optional 24-Volt Power Input, being the first two inputs on the screw-terminal connector. This is an input only, and should not be used as a voltage tap.

2.7 PANEL MOUNTING

1. Panel mount cutout dimensions: Model 200 = 91 x 44 mm (3.58 x 1.72 in.); Model 200-S & 200-D = 91 mm square (3.58 in. square).
2. Unplug the unit.
3. Use 1/16 inch hex wrench to remove two headless screws.
4. Remove two panel mount brackets by sliding towards rear of unit.
5. Place unit in panel cutout.
6. Slide two panel mount brackets into unit case.
7. Use 1/16 inch hex wrench to install two headless screws.

2.8 INITIAL SETUP AND CHECKOUT PROCEDURE

This procedure verifies basic unit operation.

1. Verify proper wall-mount power supply is used. A wall-mounted power supply is available that accommodates 90-130 VAC or 200-250 VAC operation. The Model 200 requires a 24 Volt input.

CAUTION: Connect temperature sensor(s) to unit rear before applying power. Sensor damage may occur if connected with power on.

2. Install temperature sensor(s) per recommendations in Paragraph 2.4. Route wiring to Model 200.

3. Connect power plug to 24 Volt receptacle at unit rear, then plug wall-mounted power supply into power connection.

4. Upon power up, the unit displays one of the following codes, depending upon the curve selected:

   "CU0" = DT-470
   "CU1" = CTI
   "CU2" = D-Curve
   "CU3" = Precision Option

5. If sensor connections are correct and exhibit no opens or shorts, the temperature displays and the decimal point blinks. (The rate of the blinking corresponds to the update cycle.)

   Sensor connection problems cause one of two messages display:

   "OPEN" = Sensor connection loose, polarity backward, or not connected.
   "SHORT" = Wiring is shorted at some point between unit and sensor.

   Upon successful completion of this abbreviated checkout procedure, the unit is ready for normal operation.

CHAPTER 3

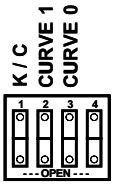
OPERATION

3.0 GENERAL

This chapter describes the front panel controls for each of the three models in Paragraphs 3.1 thru 3.3.

3.1 TEMPERATURE UNIT SELECTION

The temperature scale displayed on the front panel is selected by a DIP Switch labeled **K/C** on the rear panel. Depress the top portion of the switch (closed) to select degrees Celsius. Depress the bottom portion of the switch (open) to select Kelvin.



3.2 DIODE CURVE SELECTION

Sensor curves available with the Model 200 include Curve 10, CTI-Curve, D-Curve, and a factory installed Precision Option. See Paragraph 2.5 for a definition of sensor curves.

The diode curve selected by the position of the two DIP Switches labeled **CURVE 1** and **CURVE 0** on the rear panel. Depress the top portion of the switch to select closed and the bottom portion of the switch to select open.

CURVE 1	CURVE 0	SETTING
OPEN	OPEN	DT-470
OPEN	CLOSE	CTI-Curve
CLOSE	OPEN	D-Curve
CLOSE	CLOSE	Precision Option

3.3 BLINKING DECIMAL POINT

The best indicator of a correctly functioning unit is a blinking decimal point. The decimal point blinks at a rate corresponding to the unit update rate; about 3 times per second.

3.4 FRONT PANEL OPERATION

The Model 200 has no front panel controls. The 4-digit red LED displays the temperature in Kelvin (K) or degrees Celsius (°C). See Figure 2-1.

The Model 200-S has one front panel control. The Sensor A/Sensor B switch is used to select which of two sensors temperature data is displayed. Both sensors must conform to the same diode curve. The 4-digit red LED displays the selected temperature in Kelvin (K) or degrees Celsius (°C). See Figure 2-3.

The Model 200-D has no front panel controls. Two 4-digit red LEDs simultaneously display temperatures in Kelvin (K) or degrees Celsius (°C). In essence, the Model 200-D operates as two independent Model 200 units with a common power supply. See Figure 2-5.

CHAPTER 4

SERVICE

4.0 GENERAL

This chapter cover General Troubleshooting (Paragraph 4.1), Operating Software Replacement (Paragraph 4.2), the Model 200 Printed Circuit Board (PCB) (Paragraph 4.3), and Calibration (Paragraph 4.4).

4.1 GENERAL TROUBLESHOOTING

If there is no power, first verify that 24 VAC is present. Next, check the fuse. Open unit, remove fuse, and test fuse with ohmmeter. Do not rely on visual inspection of fuse. See Figure 4-1. The fuse rating is 200 mA, Slow-Blow, 5 mm by 20 mm.

Upon power up, the sensor curve displays, where "CU0" = DT-470, "CU1" = CTI, "CU2" = D-Curve, or "CU3" = Precision Option. If sensor connections are correct, the temperature displays and the decimal point blinks. If there is a problem, one of two messages display: **"OPEN"** = sensor connection is loose, polarity backward, or not connected; or **"SHORT"** = wiring is shorted at some point between unit and sensor.

4.2 Operating Software Replacement

The microprocessor IC (U10) contains the Model 200 operating software. See Item 10 in Figure 4-1. Use the following procedure to replace the operating software IC.

CAUTION: To avoid damaging the unit, disconnect unit from power supply before performing this procedure.

1. Disconnect power plug and screw terminal connector from unit rear.
2. Remove four screws attaching rear panel to unit.
3. Note location of PCB(s) in slots. Ensure DIP switch remains attached to socket.
4. Locate IC U10 on main circuit board. Note orientation of existing EPROM (circular notch on front of IC).
5. Use IC puller to remove existing IC from socket.
6. Noting orientation of new IC, use IC insertion tool to place new IC into socket.
7. Slide PCB(s) into appropriate slot and replace rear panel.
8. Reconnect power plug and screw terminal connector to unit rear.

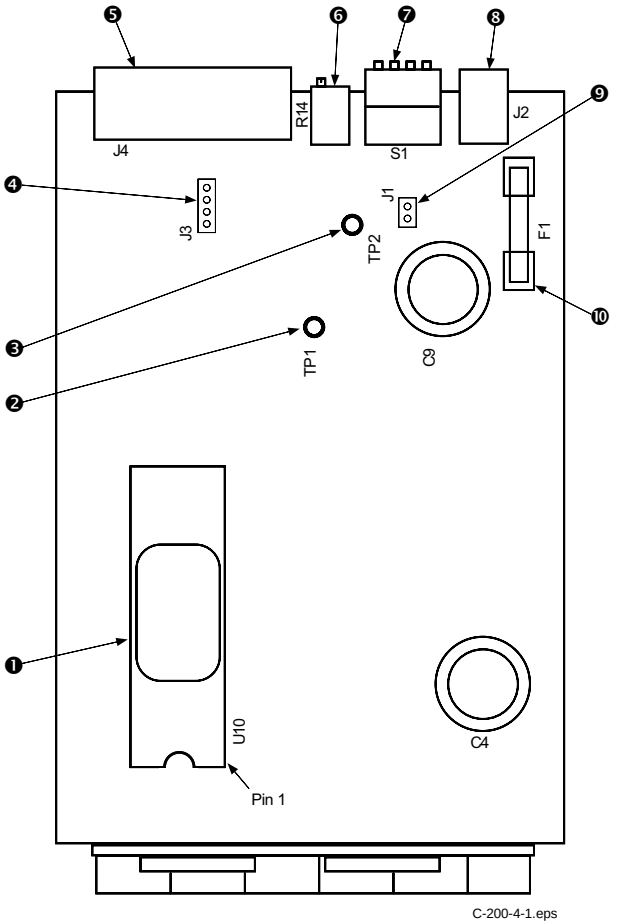


Figure 4-1. Location of Fuse and Jumpers

4.3 MODEL 200 PCB DESCRIPTION

Below is a brief description of major components on the Model 200 Printed Circuit Board (PCB). See Figure 4-1.

1. Microprocessor/ROM (U10). This integrated circuit is a combination microprocessor, program memory, and Precision Option Curve (if present). Note orientation notch in Figure 4-1.
2. Test Point 1 (TP1) – Corresponds to the Shield pin on the rear panel connector (J4).
3. Test Point 2 (TP2) – Corresponds to the VREF pin on the rear panel connector (J4).
4. Connector (J3) – 4-pin jumper connection (for Model 200-S only).
5. Connector (J4) – Screw terminal connector.
6. Trimpot (R14) – Calibration trimpot. Accessible from rear panel.
7. DIP Switch (S1) – Accessible from rear panel. Selects temperature units and curve settings. The fourth switch is not used.
8. Connector (J2) – Power jack used to connect an external 24 Volt power supply.
9. Connector (J1) – 2-pin jumper connection (for Model 200-D only).
10. Fuse (F1) – 200 mA, Slow Blow, 5 mm by 20 mm.

4.4 CALIBRATION

Calibrate the unit from the rear panel. Monitor the voltage between VREF and Shield on the rear panel screw terminals with a good quality high input impedance voltmeter. Adjust the CAL trimpot for a reading of 2.500 VDC. Alternatively, a bare PCB may also be calibrated by monitoring TP1 (Shield) and TP2 (VREF).

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APPENDIX A

MODEL 200 CURVE TABLES

Table A-1. Lake Shore Standard Diode Curves

Break-point No.	D-Curve		DT-470 Curve 10	
	Temp.(K)	Voltage	Temp.(K)	Voltage
1	499.9	0.00000	499.9	0.00000
2	365.0	0.19083	475.0	0.09032
3	345.0	0.24739	460.0	0.12536
4	305.0	0.36397	435.0	0.18696
5	285.0	0.42019	390.0	0.29958
6	265.0	0.47403	340.0	0.42238
7	240.0	0.53960	280.0	0.56707
8	220.0	0.59455	230.0	0.68580
9	170.0	0.73582	195.0	0.76717
10	130.0	0.84606	165.0	0.83541
11	090.0	0.95327	140.0	0.89082
12	070.0	1.00460	115.0	0.94455
13	055.0	1.04070	095.0	0.98574
14	040.0	1.07460	077.4	1.02044
15	034.0	1.09020	060.0	1.05277
16	032.0	1.09700	044.0	1.08105
17	030.0	1.10580	036.0	1.09477
18	029.0	1.11160	031.0	1.10465
19	028.0	1.11900	028.0	1.11202
20	027.0	1.13080	027.0	1.11517
21	026.0	1.14860	026.0	1.11896
22	025.0	1.17200	025.0	1.12463
23	023.0	1.25070	024.0	1.13598
24	021.0	1.35050	020.0	1.21555
25	017.0	1.63590	015.5	1.29340
26	015.0	1.76100	012.0	1.36687
27	013.0	1.90660	009.0	1.44850
28	009.0	2.11720	003.8	1.64112
29	003.0	2.53660	002.0	1.68912
30	001.4	2.59840	001.4	1.69808
31	000.0	6.55360	000.0	6.55360

Table A-2. CTI Diode Curve

Break-point No.	CTI Curve	
	Temp.(K)	Voltage
1	320.0	0.2968
2	305.0	0.3382
3	295.0	0.3640
4	285.0	0.3911
5	280.0	0.4050
6	270.0	0.4341
7	250.0	0.4896
8	195.0	0.6408
9	165.0	0.7255
10	140.0	0.7971
11	130.0	0.8245
12	125.0	0.8376
13	115.0	0.8625
14	110.0	0.8769
15	100.0	0.9049
16	095.0	0.9184
17	090.0	0.9314
18	085.0	0.9440
19	077.4	0.9626
20	065.0	0.9958
21	060.0	1.0100
22	036.0	1.0747
23	020.0	1.1162
24	019.0	1.1290
25	018.0	1.1500
26	014.0	1.3161
27	012.0	1.3656
28	011.0	1.3850
29	010.0	1.4000

NOTES

Lake Shore

is a technology leader in the development of cryogenic temperature sensors, precision low temperature measurement and control instrumentation, and magnetic measurement and test systems. Since 1968, Lake Shore physicists, material scientists, and engineers have dedicated themselves to the development of tomorrow's technology today. Lake Shore serves a worldwide network of Customers including university and national laboratories, aerospace and other industries, as well as many of the premier companies around the world.