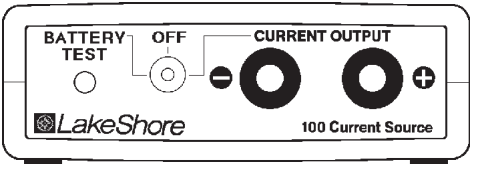
USER'S MANUAL

Model 100/101 Battery Powered Current Source



LakeShore

Rev. 1.4 P/N 119/013 **4 June 2002**

LIMITED WARRANTY

Lake Shore Cryotronics, Inc. (henceforth Lake Shore), the manufacturer, warrants this product to be free from defects in material and workmanship for a period of 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 or 90 days (whichever is greater).

All products are thoroughly tested and calibrated to published specifications prior to shipment. Calibration Certifications are offered for 12-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, or Internationally through our approved distribution agents. This same protection will extend to any subsequent owner during the warranty period. It does not apply to damage resulting from improper or inadequate maintenance, unauthorized modification or misuse, or operation outside of the environmental specifications. It does not apply to damage caused by accident, misuse, fire, flood, or acts of God, or from failure to properly install, operate, or maintain the product in accordance with the printed instruction provided.

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).

DECLARATION OF CONFORMITY

Lake Shore Cryotronics, Inc.
575 McCorkle Blvd. • Westerville, OH 43082-8888

Hereby declares the equipment specified conforms to the following Directives and Standards.

Application of Council Directives:	**89/336/EEC**
Standards to which Conformity is declared:	**EN55022** **EN50082-1**
Type of Equipment:	**Battery-Powered Current Source**
Model Number:	**100 or 101**

May 12, 1997

John M. Swartz
President, Lake Shore Cryotronics, Inc.

Date

INTRODUCTION

Lake Shore Cryotronics, Inc. designed and manufactures the Model 100/101 in the United States of America.

We welcome comments concerning this manual. Although we try to keep it error-free, some may occur. To report a specific problem, describe it briefly and include the appropriate 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.

GENERAL DESCRIPTION

The Models 100 and 101 battery-powered DC current sources provide very stable output current without noise commonly associated with AC line-powered instruments. They combine the convenience of a portable, hand-held device and the performance of a benchtop unit. They are well-suited for field maintenance and periodic sensor monitoring. They are also valuable when even a small amount of line frequency noise will degrade measurements.

The Model 100 and 101 provide constant current through a sensor connected across the output terminals. Monitor voltage across the sensor to derive a corresponding temperature or other property.

Output current is factory-preset at 10 µA for both units, but may be "reprogrammed" to any value between 1 µA and 1 mA by changing a resistor inside the instrument.

The Model 100 2.5 volt compliance is well suited for silicon diode applications including Lake Shore DT-470 Series Diodes. The Model 101 5.0 volt compliance is required for Lake Shore TG-120 GaAlAs diodes, or to connect two DT-470 diode sensors in series.

The Model 100 uses four AA cells to provide maximum battery life. The Model 101 uses a single 9 volt battery. Other features include:

- A Battery Test switch and LED to alert users when battery is low.
- Compact design in a sturdy polystyrene enclosure, with an easily accessible battery compartment.

Model 100/101 Specifications

Output Current: 10 µA factory set; internally programmable from 1 µA to 1 mA.

Accuracy: 0.05% of output (at 10 µA)

Temperature Coefficient: 0.005% of output per °C

Compliance Voltage: 2.5 V (Model 100); 5.0 V (Model 101)

Load Regulation: <0.01% change in output current from 1 to 100% of compliance voltage

Connections: Current output via standard banana jacks

Ambient Temperature Range: 15 – 35 °C (59 – 95 °F)

Battery: 4 AA Alkaline (Model 100); one 9 V Alkaline (Model 101)

Battery Life (Continuous use at 10 µA): 1 year (Model 100); 6 months (Model 101)

Size: 95 × 33 × 158 mm (3.7 × 1.3 × 6.2 inches)

Weight (with batteries): 0.3 kilograms (0.7 pounds)

NOTES

1. Product Specifications are subject to change without notice.
2. The electrical specifications given are for a unit operating at the factory preset 10 µA current output; reprogramming to a different output current may affect some specifications.

INSTALLATION

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).

REPACKAGING FOR SHIPMENT

To return the Model 100/101 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.

BATTERY REPLACEMENT

1. The battery compartment is located on the bottom of the unit. Gently press the ribbed area marked **OPEN** and slide the battery cover in the direction of the arrow.
2. **Model 100 Only**: Install the 4 AA batteries. Match the polarity markings in the battery compartment.
3. **Model 101 Only**: Snap the single 9-volt battery on the battery connector and place it into the battery compartment.

If the Battery Test LED does not light or appears dim when the switch is pushed to the Battery Test position, replace the batteries.

SENSOR INSTALLATION RECOMMENDATIONS

Although the Model 100/101 acts as a current source for any application, it can provide the 10 µA excitation current for Lake Shore 400-Series, 500-Series, and TG-120 Diode Sensors. See the Lake Shore Product Catalog for installation details and sensor specifications. Call Lake Shore for copies of application notes or sensor installation questions.

Although a sensor is not provided with the Model 100/101, below are general recommendations on 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 sensor and lead wires.

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.

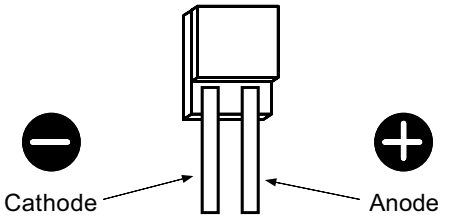
To minimize heat flow through the leads, select leads of small diameter and low thermal conductivity. Phosphor-bronze or Manganin wire is commonly used in sizes 32 or 36 AWG. These wires have a fairly low thermal conductivity, yet electrical resistance is not large enough to create measurement problems.

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

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.

DT-470-SD
Diode Sensor Leads



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.

CAUTION: Use a heat sink when soldering lead wires.

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

NOTE: Do not apply Stycast epoxy over the DT-470-SD package—sensor stress may shift the readings.

For semi-permanent mountings, use Stycast epoxy instead of Apiezon® N Grease. In all cases, periodically inspect the sensor mounting to verify good thermal contact to the mounting surface is maintained.

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 of the following procedures:

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 µF capacitor. If AC-coupled digital noise is suspected (digital circuits or interfaces), use a 0.1 to 1 µF 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). Refer to the Lake Shore Product Catalog or contact Lake Shore for further information.

OPERATION

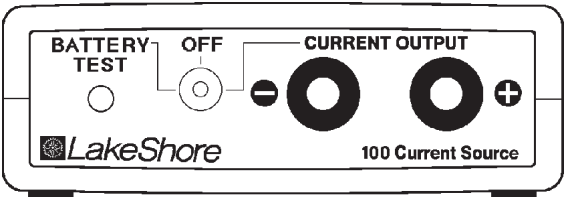
FRONT PANEL FEATURES AND FUNCTIONS

Function Switch. This switch determines the operating state of the instrument. It has three positions:

1. In the center position, the unit is "off" and no current is applied to the output terminals.
2. In the right-hand position, the unit is "on" and operating as a current source.
3. Push and hold the switch in the left-hand position to perform a BATTERY TEST. Results display on the green LED.

BATTERY TEST LED. When a battery test is performed, the green test LED lights if the batteries are acceptable. If the green LED does not light, the batteries are either weak or installed incorrectly.

CURRENT OUTPUT Terminals. These terminals accept a standard dual banana plug for connection to the voltmeter and sensor. The polarity of the terminals is marked on the front panel.

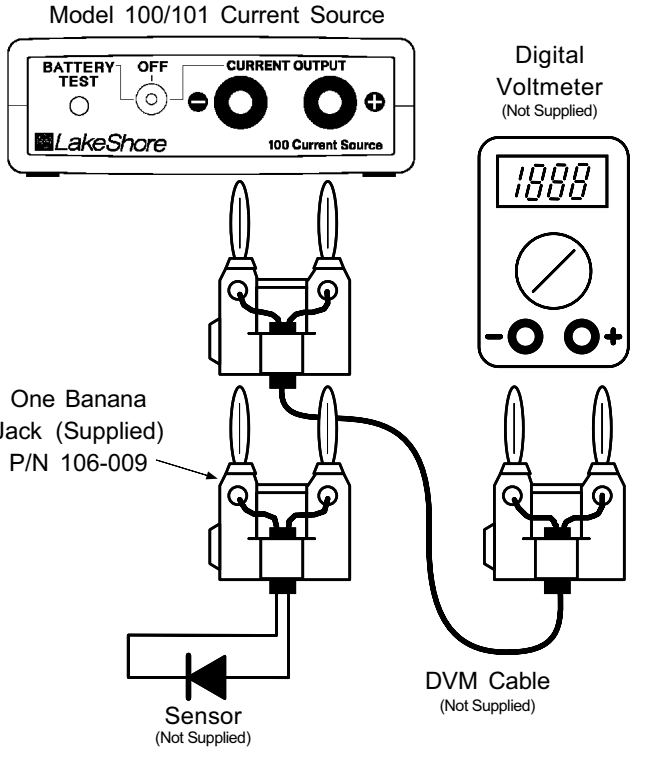


Model 100/101 Front Panel

Operational Notes

The Model 100/101 provides a constant current through the load (i.e., sensor) connected across its output terminals. By monitoring the voltage across the sensor, the corresponding temperature is derived from the response curve supplied with the sensor. The following are additional operational notes.

1. Although factory preset for output of 10 µA, the instrument is programmable to any value between 1 µA and 1 mA. See the procedure in **Output Current Reprogramming**.
2. To ensure accurate voltage readings across the sensor, use a voltmeter with high input impedance to prevent the combined impedance (sensor in parallel with voltmeter) from causing a misleading measurement.
3. The battery-powered Model 100/101 is isolated from noise better than many AC-line powered instruments. However, some AC noise pickup may still occur (from the test leads, AC-powered voltmeters, etc.), possibly affecting system accuracy. See **Measurement Errors Due To AC Noise** for information on reducing AC noise pickup.
4. Unlike other Lake Shore current sources, the Test LED does not function as a compliance indicator. If your voltage measurement across the sensor is above the compliance specification of the current source (2.5 V for the Model 100 or 5.0 V for the Model 101), the unit is *operating out of compliance*. This means the current through the load is no longer at its rated level and the voltage reading is invalid.



Typical Model 100/101 Application

SERVICE

OUTPUT CURRENT REPROGRAMMING

Although the Model 100/101 is factory preset for a current output of 10 µA, it can be set to any value between 1 µA and 1 mA. The equation to determine the value of the new programming resistor is:

$$I_{out} = \frac{1V}{R_{program}}$$

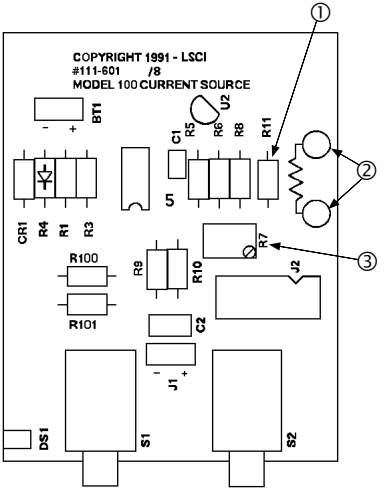
NOTE: Reprogramming output current to higher values significantly reduces battery life.

Use the following procedure to change the programming resistor.

1. To open unit, remove the four rubber feet and four screws from bottom of unit. Gently separate top half of enclosure from bottom half and front panel.
2. Remove factory-installed programming resistor R11 by clipping its leads. See **Model 100/101 PCB Layout**.
3. Install new programming resistor by soldering it to the turrets provided on the circuit board.
4. Recalibrate unit. See **Calibration**.
5. Replace top of enclosure, screws, and feet. Resume normal operation.

CALIBRATION

This instrument has been thoroughly tested and calibrated to published specifications prior to shipment. However, periodic recalibration is recommended every six months to ensure accuracy. Recalibration is also required if the instrument is reprogrammed to a different output current. Either of the following calibration methods are acceptable.



① Programming Resistor (R11)

② Soldering Turrets for New Programming Resistor

③ Current Adjustment Trimpot (R7)

Model 100/101 PCB Layout

Current Calibration

Output current calibration uses the DC Ampere Range of a digital multimeter (DMM) and requires a DMM with 4½-digit resolution (or better) and a 100 kΩ load resistor.

NOTE: If output current has been reprogrammed to other than the factory preset 10 µA, use a load resistor of the same value as the new programming resistor. Calibration accuracy is limited to the DMM current measurement accuracy.

1. To open unit, remove the four rubber feet and four screws from bottom of unit. Gently separate top half of enclosure from bottom half and front panel.
2. Connect one end of load resistor to the front panel **+CURRENT OUTPUT** terminal.
3. Connect the DMM HI terminal to the other end of the load resistor and the DMM LO terminal to the **–CURRENT OUTPUT** terminal.
4. Select DC Amperes on the DMM.
5. Adjust the **CURRENT ADJ** trimpot (R7) on the Model 100/101 circuit board until the DMM reads 10.000 µA.

   NOTE: If output current has been reprogrammed to another value, adjust to that value.
6. Replace top of enclosure, screws, and feet. Resume normal operation.

Voltage Calibration

Output voltage calibration uses the DC Voltage Range of DMM and requires a DMM with 4½-digit resolution (or better) and a 100 kΩ load resistor.

NOTE: If output current has been reprogrammed to other than the factory preset 10 µA, use a load resistor of the same value as the new programming resistor. Calibration accuracy is limited to voltmeter accuracy at 1.0000 volts and the accuracy of the load resistors resistance reading.

1. To open unit, remove the four rubber feet and four screws from bottom of unit. Gently separate top half of enclosure from bottom half and front panel.
2. Using DMM, measure true resistance of load resistor. (If load is a precision resistor accurate to 0.01%, measuring is not necessary.)
3. Place load resistor between the front panel **CURRENT OUTPUT** terminals.
4. Connect the DMM HI terminal to the **+CURRENT OUTPUT** terminal, and the DMM LO terminal to the **–CURRENT OUTPUT** terminal.
5. Select DC Voltage on the DMM.
6. Adjust the **CURRENT ADJ** trimpot on the Model 100/101 circuit board until the DMM reads a voltage equal to:

   V_{load} = (desired current) × (load resistance).

   For example, if desired current is 10 µA and the load resistor was measured at 100.21 kΩ, adjust trimpot until voltage reads 1.0021 V.
7. Replace top of enclosure, screws, and feet. Resume normal operation.

NOTES

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