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LC-22C

March, 2000

MF-9010 INSTRUCTION MANUAL

Temperature Controllers
for Liquid Chromatography

Bioanalytical
Systems, Inc

2701 Kent Avenue
West Lafayette
Indiana 47906

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Section 1. PREFACE

The Bioanalytical Systems LC-22C Temperature Controller and LC-23A and LC-23C Column Heating Compartments are versatile tools for the experimenter who desires precise, reproducible temperature control for liquid chromatography.

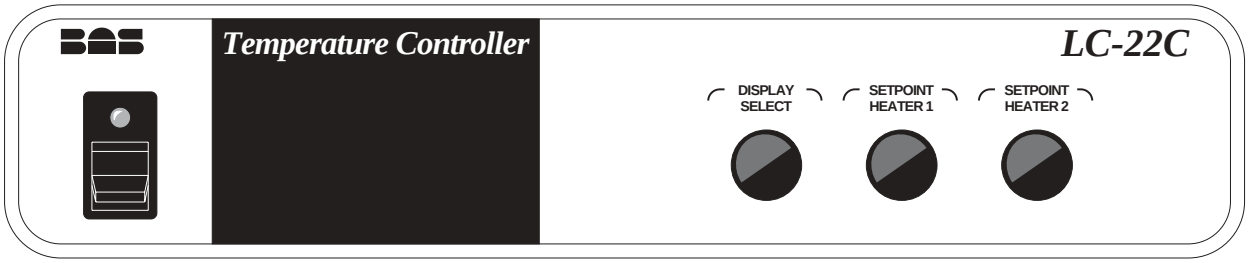
The LC-22C Dual Channel Temperature Controller is a general purpose instrument capable of regulating two independent devices, such as heating mantles, heat tapes, electrochemical cell preheaters, and column heating blocks. The temperature control point is set with a multi-turn front-panel potentiometer and the power applied to the heating unit is regulated by a temperature sensor located in the device being controlled. In heating devices of BAS manufacture, the temperature sensor is built into the instrument. To control other devices, a universal probe (part no. EW-8116) is available for separate purchase.

The LC-23A Column Heating Compartment is used in conjunction with the LC-22C. This instrument is simple in design and extremely durable. It accepts most commercially available 15, 25 or 30 cm analytical columns. A solid aluminum inner compartment, thermally isolated from the outer cover, encloses the entire column. A preheater coil is included with each unit. The LC-23A can, in some instances, be altered to accommodate wider diameter columns. This alteration would involve an additional charge for customization. If you require modifications, please contact BAS customer service for a quotation.

The LC-23C Cartridge Column Heating Compartment accommodates two cartridge format columns up to 15cm in length. The LC-23C can be mounted within the BAS CC-5 Chromatography Compartment, which is part of the BAS 480 Liquid Chromatographs and LC-44 Electrochemical Detectors. The LC-23C is also sold with or without the CC-5, the latter as an upgrade to existing BAS detectors or BAS 480 systems.

The Cell Preheater option for BAS electrochemical detectors is also controlled by an LC-22C. The preheater coil can accommodate the heating of stainless steel tubing between the column and cell inlet.

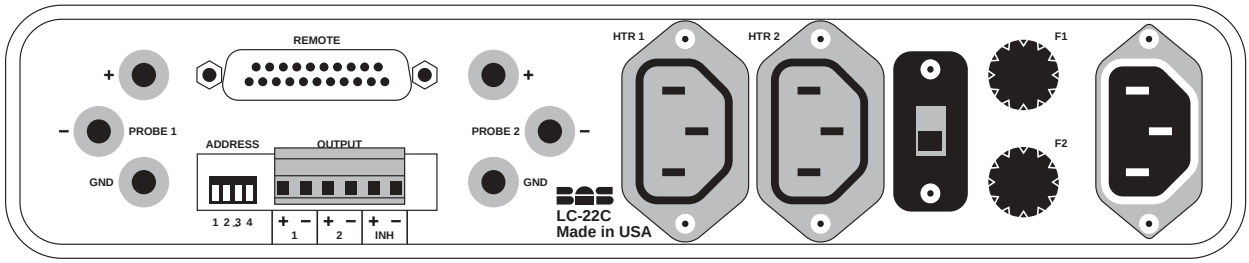
Figure 1. LC-22C Front Panel.



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Section 2. POWER REQUIREMENTS

Figure 2. LC-22C Back Panel.



LC-22C CONTROLLER

This instrument can be operated from either 115V/50-60Hz or 230V/50-60Hz. The line voltage selector for 115V or 230V operation is on the back chassis panel. The line voltage must be selected before applying power to the controller.

A 3-prong power cable on the LC-22C must be connected to a standard, grounded power outlet for safety. If the instrument is operated from a power outlet without a ground connection, an appropriate adapter should be used and the ground connection of this adapter should be securely fastened to an earth ground.

LC-23A and LC-23C HEATING COMPARTMENTS

The LC-23A and LC-23C compartments are designed specifically for use with the LC-22C Controller. Two cables (one for heater power and the other for the temperature sensor) connect to the LC-22C to each heating device. If you have purchased a heating compartment for use with an older model LC-22A, you may be unable to make the connection directly to the controller without an additional adapter. A change in design converted this from a 3-prong male plug to the current female plug. The adapter (EF-1575) is available from BAS at an additional charge.

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Section 3. INSTALLATION

LC-22C CONTROLLER

This section concerns installation for stand-alone operation of the LC-22C with the optional universal probe. For operation of the other accessories, see subsequent sections.

1. Use the cable adapter (EF-1575) to convert the special safety receptacle on the back panel of the LC-22C to a standard 3-prong socket. Plug the device to be controlled (e.g., heating mantle, tape, etc.) into this socket. If you only wish to measure temperature and do not need to control it, you can skip this step.

2. Plug the cable leads from the stainless steel UNIVERSAL PROBE (EW-8116) into the red, yellow, and black jacks on the back panel of the LC-22C labeled “PROBE 1" or ”PROBE 2". The black jack provides grounding for the instrument and must be connected for safety purposes.

3. The liquid probe is usually accurate to within 1°C of the actual set-point when shipped. The reproducibility or precision of the temperature set-point is ± 0.1°C regardless of the actual temperature. If greater accuracy is desired, follow the calibration procedure.

   To perform the calibration, first remove the top cover of the LC-22C by removing the four screws located on the sides of the top cover. Since both channel 1 and channel 2 are identical, calibrating instructions will be given for channel 1 adjustments, while channel 2 adjustments will appear in parentheses ().

   To calibrate the probe, place it in an ice bath and connect the probe leads to the “PROBE 1" (”PROBE 2") jacks on the back panel. Turn the main power on and rotate the display selector knob to “SENS 1" (”SENS 2"). Using a small screwdriver, rotate the adjusting screw on the top of the potentiometer R45 (R56) for a reading of 00.0° on the front-panel digital readout. Remove the probe from the ice bath. If a two-point calibration is desired, go to step 5.

4. This completes the single-point calibration of the liquid probe. The top cover should be reinstalled using the four retaining screws on the sides of the cover.

5. A two-point calibration can be made by placing the probe in boiling water and adjusting R46 (R55) first to a display reading of 99.9, then to 00.0 (indicating 100.0°C) with the center decimal point on. There could be a very slight interaction between the freezing and boiling point adjustments, so additional adjustments to R45 and R46 (R56 and R55) could be needed to obtain the highest degree of accuracy. Remove the probe from the high temperature bath.

6. This completes the two-point calibration of the liquid probe. The top cover should be reinstalled using the four retaining screws on the sides of the cover.

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LC-23A COLUMN HEATING COMPARTMENT

1. Place the LC-23A heating Compartment in the desired location. Six holes with captive 6-32 threads are provided for secure mounting on your liquid chromatograph, if desired. The holes are positioned to fit early model (pre 1986) BAS liquid chromatography support stands.

2. Connect the LC-23A heater power cable to the power socket on the back panel of the LC-22C Controller.

3. Connect the red, black and yellow plugs on the probe cable to the jacks marked “PROBE 1" or ”PROBE 2" on the LC-22C back panel.

4. Remove the cover on the LC-23A Column Heater by unscrewing the two cap screws. Place the column in the recessed cavity and route the inlet and outlet tubing out of the top and bottom slots. A special preheater block (EW-8146) is also supplied. Under certain circumstances, dramatic band broadening may result if the preheater is not utilized. Typically this becomes obvious when the temperature differential between ambient and the desired set point exceeds 20-25°C.

   If you plan to use several different styles of column endfittings, it is best to use removable plastic fittings. BAS recommends a 2-piece PEEK finger-tight seal as provided in BAS part no. MR-4409 (this includes a nut and ferrule). One piece plastic fittings tend to loosen at higher temperatures.

Figure 3. Position of Mounting Points on LC-23A Heater.

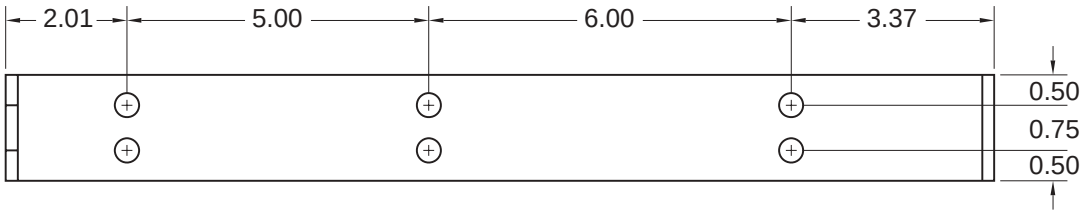
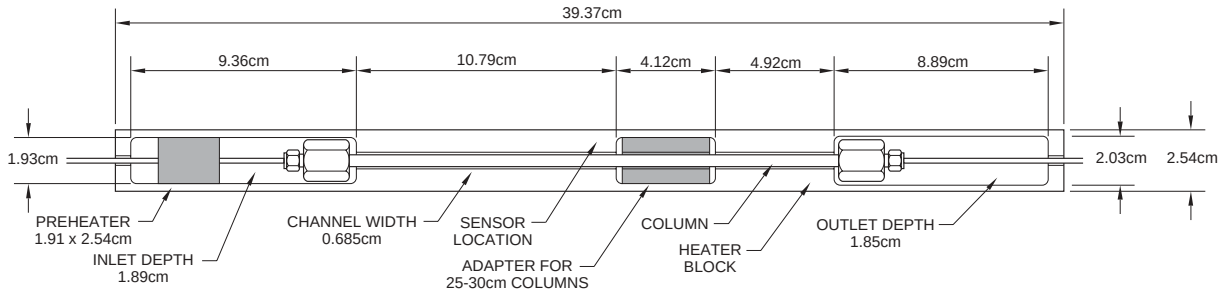


Figure 4. LC-23A Column Heater with LC-23PH Preheater Installation.



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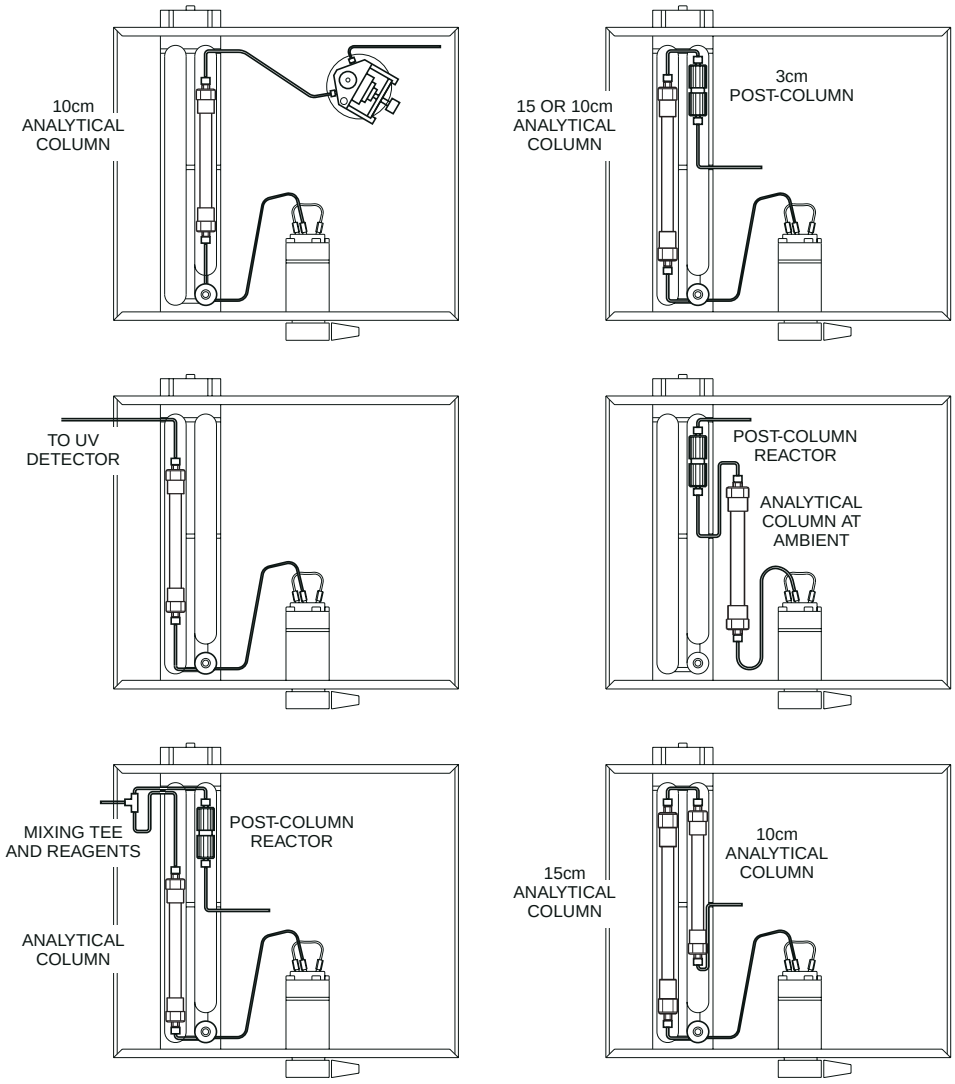
LC-23C COLUMN HEATING COMPARTMENT

The LC-23C is specifically designed to fit within the BAS CC-5 Column Compartment. The CC-5 is pre-drilled to accept a Rheodyne injection valve on the front panel. It has several grooves on both sides for convenient access to external detectors.

If you are installing the LC-23C as an upgrade to a BAS electrochemical detector or BAS 480 Liquid Chromatograph, and already have a cell preheater installed in the CC-5, you may wish to remove it. Routing the tubing from the LC-23C to the cell preheater and then to the detector is difficult due to space limitations. The LC-23C alone will provide satisfactory temperature control for the electrochemical cell if you keep the cover closed during operation.

Before installing the LC-23C, give some thought to the configurations of the column(s) you intend to use. Some configuration using compact BAS cartridge columns are diagrammed in Figure 5. You can also leave the analytical column outside the LC-23C (at room temperature) and heat a post-column reactor (tubing coil, packed bed) within the LC-23C.

Figure 5. Combinations of Column Formats Within the LC-23C.



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Installing the LC-23C in a CC-5 Compartment

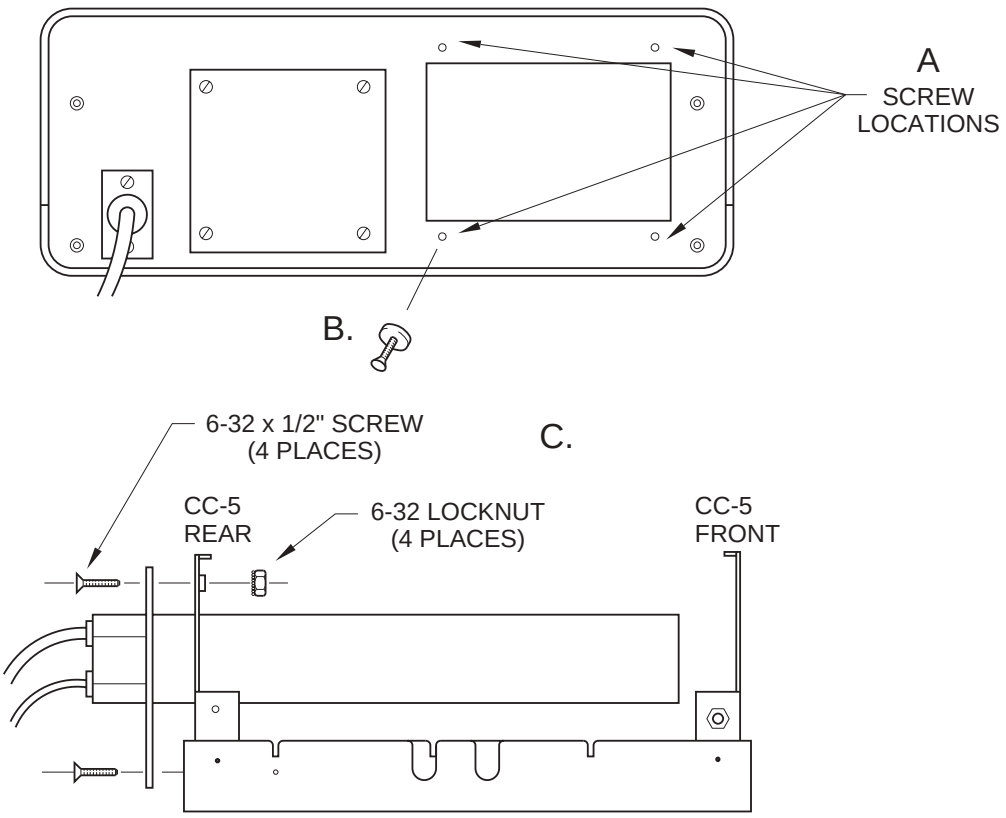
1. Lower the CC-5 lid and remove the utility cover from the back panel of the CC-5 cabinet (four screws).

2. On some models, pressed-in, threaded nuts will be located on the outside of the back panel (Figure 6). These must be removed. DO NOT REMOVE IF THEY ARE ON THE INSIDE OF THE CABINET. To remove external nuts, screw a long machine screw (6-32 thread) into the nut from the rear until it protrudes through the nut. Use pliers for leverage and gently work the screw from side to side until the nut comes loose.

3. Remove the LC-23C cover and set aside. Push the heater block through the now open utility access in the CC-5 back panel. On some models, the two registration posts on the CC-5 inner panel will engage the LC-23C block for support.

4. Secure the LC-23C to the cabinet using four 6-32 x 1/2" machine screws and four 6-32 lock nuts. The lock nuts are not necessary if pressed-in nuts are available on the inside of the CC-5 cabinet. The mounting plate should now be flush with the outside of the back panel on the CC-5 cabinet.

Figure 6. Installation of the LC-23C in a BAS 480 or CC-5 Electrochemical Detector. (A) Location of four screws (B) Breaking off the pressed-in nuts (C) Left Side View of Attachment Hardware.



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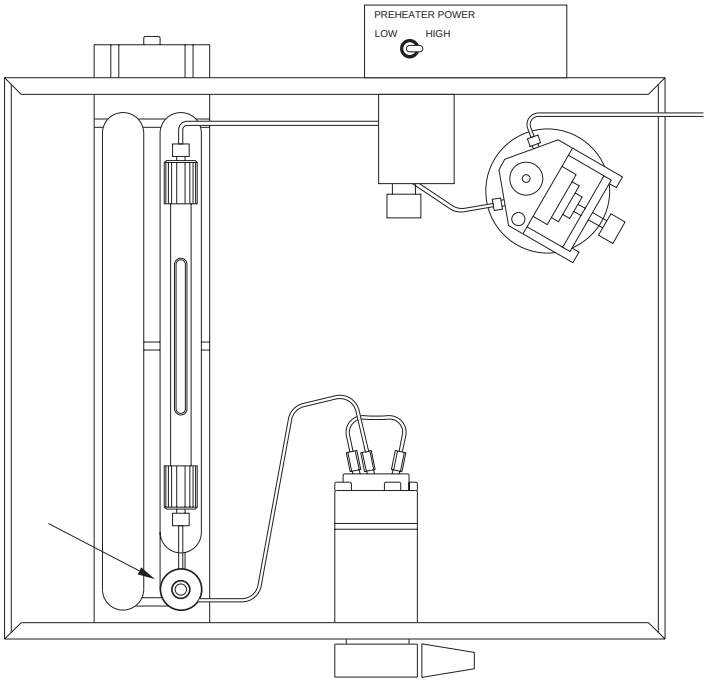
Making Plumbing Connections

For simple arrangements, use the innermost trough of the LC-23C. This location minimizes detector and valve hookup tubing. If you are coupling columns together, the longer trough will be more useful.

A special coil of tubing is provided with each LC-23C (see Figure 7). At your option, it may be installed between the injection valve and column. The coil functions as a mobile phase preheater, so that large temperature gradients at the head of the column are minimized. The coil may be removed by unscrewing the central cap screw (5/32" hex).

It is advisable not to use a permanent ferrule on the outlet end of the preheater coil. A removable high-pressure fitting provides an equivalent seal without irreversible attachment. Use BAS part no. MR-4409.

Figure 7. Column Preheater Coil Installed in LC-23C. This Unit is Part of a BAS 480 Liquid Chromatography System with the Electrochemical Cell and Cell Preheater Options Installed.



Leaks

Make sure that all fittings are leak-tight at the usual operating pressure before mounting the insulating top cover.

Insulating Top Cover

The U-shaped top cover is insulated on three sides with a foam polymer. The cover is asymmetric; the notch in the cover goes along the right side. Mount the cover at the rear first and then drop the front in place.

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Section 4. OPERATION

For purposes of instruction, we will reference channel 1, although channel 2 is identical.

1. With the heater and probe cables disconnected, turn on the main power to the LC-22C.

2. Rotate the display selector knob to illuminate “SET 1" in the red display window.

3. Using the “SETPOINT HEATER 1" knob, select the desired temperature, which is between ambient and 99.9°C.

4. Turn off the main power to the LC-22C and connect the heater to “HTR-1" and the red, yellow and black probe plugs to the same color jacks of ”PROBE-1" on the back panel.

5. Turn on the main power to the LC-22C. The heater indicator LED will remain constantly illuminated until the set point is reached, then it will dim or blink intermittently to indicate maintenance at the desired temperature. You can also observe the measured probe temperature by changing the display select switch to “SENS 1".

TEMPERATURE MEASUREMENT/CONTROL MODE

LC-23A or LC-23C Column Heaters and Electrochemical Cell Preheater

1. Ensure that the three (3) leads from the column heaters or cell preheater are plugged into the jacks marked “PROBE 1" or ”PROBE 2"

2. Turn on the LC-22C. Set the desired temperature (at least 5°C above ambient).

3. The measured temperature can be read on the front panel digital display of the LC-22C by using the display selector knob. The temperature is also available as an analog voltage at the screw terminals marked “OUTPUT + 1 -” or “OUTPUT + 2 -”, depending upon the channel used. Each 100 mV (0.1 volt) is equivalent to 1°C. For example:
   +8.92 volts = +89.2°C
   -0.36 volts = - 3.6°C

   This voltage may be recorded using a strip chart recorder. Set the full scale input of the recorder to 10 volts and observe the marked polarity on the back panel.

4. The LED light will stay on continuously until the heater achieves the setpoint and then will flash intermittently while maintaining this temperature. The actual temperature (within the absolute accuracy of the probe) at any point in time will be displayed on the front panel digital display of the LC-22C or the recording device.

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Universal Liquid Probe

1. Ensure that the stainless steel probe is plugged into the jacks marked “PROBE 1" or "PROBE 2" and observe the color code used on the jacks.

2. Turn the main power on to the LC-22C. Rotate the display selector knob to “SENS 1" or "SENS 2", depending upon which channel is being used for measurement. The digital display will read the probe temperature in degrees C.

3. The measured temperature is available as an analog voltage at the “OUTPUT” screw terminals on the back panel. This six position terminal strip is detachable: pull straight back for release. Probe 1 outputs are the labeled “+ 1 -”, probe 2 outputs are labeled “+ 2 -” on the back panel.

4. An analog voltage of 100 mV (0.1 volt) is equivalent to 1°C. For example:
   +8.92 volts = +89.2°C
   -0.36 volts = - 3.6°C

This voltage may be recorded using a strip chart recorder. Set the full scale input of the recorder to 10 volts. Observe the marked polarity.

5. To control the temperature while measuring it, first turn off the main power to the LC-22C. Connect the power cable of the heating device (75 watts maximum) to the appropriate heater jack, i.e., “HTR 1" if "PROBE 1" is the corresponding sensor channel.

   Turn the main power on and select the corresponding channel setpoint LED. Rotate the setpoint heater knob to obtain the desired control temperature. The actual probe temperature can be observed by changing the display selector knob to the controlled channel’s sensor LED, marked “SENS 1" or "SENS 2".

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Section 5. SAFETY AND MAINTENANCE CHECKS

The LC-22C, LC-23A, LC-23C and cell preheater are all essentially maintenance free instruments. BAS does advise that you attempt to keep these pieces in good condition by following these suggestions:

1. Avoid corrosive laboratory environments.

2. Don't stack heavy items on signal cables or allow them to become crimped during use or storage.

3. Clean up spills inside column heaters immediately.

4. Avoid contact of organic solvents with the insulating material inside the LC-23C cover.

The Universal Probe is based on a reliable solid state device capable of generating a predictable current related to the temperature of its environment. To check the integrity of this probe, apply the following test:

1. Expose probe to ambient temperature and disconnect any heating devices from the LC-22C.

2. Turn on the LC-22C power.

3. Set the temperature setpoint to a value greater than ambient (allow at least 1°C difference). The "HTR" LED indicator on the LC-22C should be on continuously.

4. An open circuit anywhere in the probe, cable or across its input jacks will automatically shut down the heater circuit. This feature was incorporated to protect against thermal "runaway" and should be tested periodically. Perform the following check:

    A. Plug in the probe, expose to ambient air temperature and turn on the power to the LC-22C.

    B. Create an open circuit in the probe by unpluging the red or yellow lead from the chassis jacks on the LC-22C. Using the digital display selector knob, illuminate the tested channel "SENS 1" or "SENS 2" LED. A digital reading of approximately .3.9.8 degrees (-13.98 volts at the OUTPUT screw terminals) will be shown. Note that the left, center and right decimal points are illuminated indicating an open circuit.

    C. Remove the probe entirely and place a jumper cable across the red and yellow PROBE INPUT jacks to create a closed circuit. A digital reading of approximately 2.7.9 degrees (+12.79 volts at the OUTPUT screw

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terminals) will be shown. Note that the center and right decimal points are illuminated indicating a closed circuit.

If your unit fails either step 3 or 4, please contact the BAS Service Coordinator to return both the LC-22C and the probe used to make these tests for service. Do not return any equipment without first obtaining a Return Authorization number from BAS.

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Section 6. SPECIFICATIONS

Temperature Setpoint
0.00°C to 99.9°C in 0.1°C increments

Temperature Measurement
-50°C to 115°C

Readout
Front panel LED

Max. Load
75 watts, each channel

Repeatability
0.1°C with the same temperature probe.

Output Temperature Calibration
Output is calibrated to 100 mV per °C.

Rear Panel
Probe input jacks, output temperature jack,
output power socket heaters, line voltage selector.

Heater Power
Heater power is controlled by zero crossing,
solid state relays for noise-free operation.

Fuses
For 115V, 2A Slo Blow,
For 230V, 1A Slo Blow

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