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Warner Instruments, Inc.
Single Channel Heater Controller
Model TC-324B



Warner Instruments, Inc.
1125 Dixwell Avenue, Hamden, CT 06514
(800) 599-4203 / (203) 776-0664
(203) 776-1278 - fax

Warner Instruments, Inc.

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The **TC-324B** Single Channel Automatic Heater Controller from Warner Instruments is a versatile and simple to use thermal control device. Although designed for use with Warner **Series 20** chambers or in-line solution heaters, this instrument can be easily adapted for use with custom-built equipment according to the requirements of the user.

Total automatic control of heating power is provided in *automatic mode*, while manual control is available in *manual mode*. A loop-speed selector is used to optimize the response of the system to accommodate the thermal delay characteristics intrinsic to the environment.

Features of the **TC-324B** include

- ✓ Dual thermistor design
- ✓ Automatic and manual modes
- ✓ Selectable loop speed optimizes system speed and stability
- ✓ Simultaneous monitoring of system temperature and a separate point of interest
- ✓ Optimized for use with Warner perfusion and imaging chambers
- ✓ Compatible with **SH-27B** In-line Solution Heater
- ✓ Provides 18 W of heating power into a 8 Ω load

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FOR USE ON HUMAN SUBJECTS

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NOMENCLATURE

Text conventions

This manual refers to amplifier controls at two functional levels; specific controls and settings of these controls. To minimize the potential for confusion, we have employed several text conventions which are specified below. Since our goal is to provide clarity rather than complexity, we welcome any feedback you may wish to provide.

- Warner Instrument product numbers are presented using **bold type**.
- References to controls are specified using SMALL CAPS.
- References to control settings are specified using *italic type*.
- Special comments and warnings are presented in highlighted text.

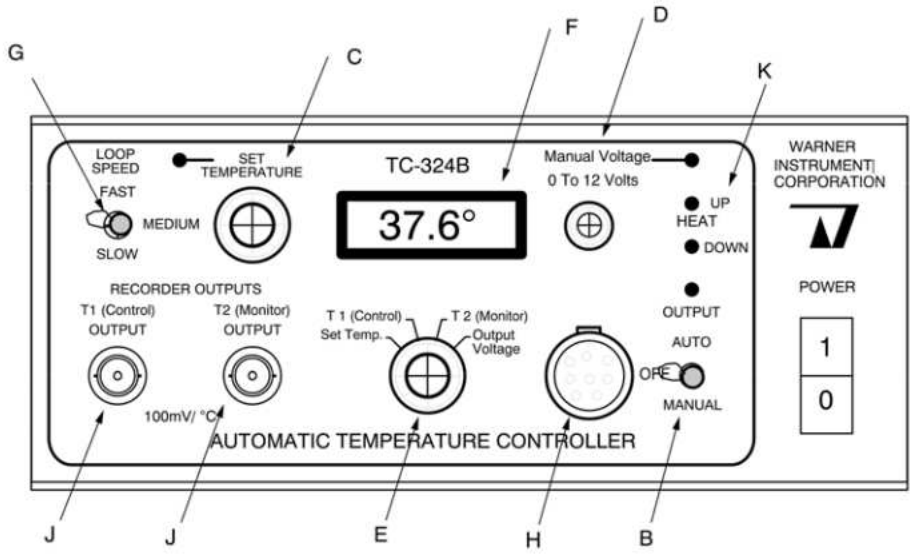
Any other formatting should be apparent from context.

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CONTROL DESCRIPTION

Front panel

A schematic of the face panel of the **TC-324B** is shown below. Important components are identified by letter (B-H, J). Please refer to this diagram as an aid in identification of described components.



Power Switch

Located directly under the Warner logo. Supplies power to the **TC-324B**.

Output Switch (Item B)

Supplies or removes power to the OUTPUT CONNECTOR (Item H). Selects between *Automatic Mode*, *Manual Mode*, or *center-off*. The associated green LED is lit when output power is *on* (*auto* or *manual* mode selected).

Set Temperature Control (Item C)

Used to adjust the set point of the automatic control system. The associated green LED is *on* when the controller is set to *Automatic Mode* on the OUTPUT SWITCH (item B).

Manual Voltage Control (item D)

Used to manually set the voltage output to the heater device. The associated green LED is *on* when the controller is set to *Manual Mode* on the OUTPUT SWITCH (item B).

Meter Selector Switch and Meter (Item E)

SELECTOR SWITCH selects the parameter that the METER (Item F) will display. Options include *Set Temperature*, *T1 (Control)*, *T2 (Monitor)*, and *Output Voltage*.

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Meter (Item F)

Displays the parameter selected by the METER SELECTOR SWITCH (Item E). The METER also provides an indication that the MAIN POWER is *on*.

Loop Speed Switch (Item G)

Sets the feedback loop speed for the heater/sensor system when the device is used in *automatic mode*. Options include *fast, medium,* and *slow*. Optimally set to *fast* for most applications, but can be set to *medium* or *slow* for systems with longer thermal delay characteristics.

Output Connector (Item H)

Connects the **TC-324B** to attached heater blocks and sensor thermistors. When used with **Series 20** chambers and platforms the **CC-28** heater cable connects here. The in-line solution heaters also connect here.

Thermistor Recorder Outputs (Items J)

BNC connectors are provided to send thermistor readings (T1 and T2 output signals) to a data acquisition system or chart recorder. Outputs are calibrated to 100 mV/°C .

Up / Down LED's (Item K)

Red and yellow LED's indicate relative power applied to heater.

Rear panel

T2 Input

Used as an optional thermistor input for those configurations where a T2 (Monitor) thermistor is not included in the normal setup (such as with an **In-line Heater**). Sensed thermistor readings can be displayed on the METER and sent to a recording device via the standard T2 OUTPUT BNC on the front panel.

NOTE: Do not use this input if a T2 (Monitor) thermistor is currently connected to the OUTPUT CONNECTOR (Item H) on the front panel.

Ground Terminals

Provides separate connections for *chassis* and *circuit ground*. Banana jacks are bridged when shipped from the factory.

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SETUP

The **TC-324B** can be used to drive the heater blocks for Warner **Series 20** chambers or for providing power to other devices such as our **In-line Solution Heaters**.

NOTES:

a. Please refer to the front panel schematic on page 6 for orientation.

b. Turn both the SET TEMPERATURE control (Item C) and the MANUAL VOLTAGE control (Item D) fully counterclockwise to zero.

Series 20 Chamber Setup

The **CC-28** cable assembly is used to connect **Series 20** chambers to the **TC-324B** heater controller. The chamber end of the cable includes two connectors that attach to the resistive heaters in the heater platform. Two thermistors are also provided, one for feedback and one for monitoring the bath temperature. The connector end plugs directly into the **TC-324B** OUTPUT connector (Item H).

Assembly instructions

1. Assemble the **Series 20** chamber as described in the instructions supplied with the chamber.
2. Connect the outboard end of the **CC-28** cable to the **Series 20** platform.
   a. First, attach the two blue 3-pin connectors on the cable to the heater resistors on the platform.
   b. Next, insert the larger thermistor (white wires or white band) on the cable into the small hole in the side of the platform.

   HINT: To assure good thermal contact between the thermistor and platform, place a drop of mineral or immersion oil in the thermistor hole prior to insertion.
3. Place the small bead thermistor into the chamber reservoir.

   NOTE: You will most likely need to restrain the cable and thermistor bead as the bead must be completely submerged for accurate temperature measurements.
4. Fill the solution bath to the desired level.

   HINT: For accurate temperature control, protect the microscope stage from drafts. The solution surface offers a large surface area for heat exchange and minimizing air flow in the immediate vicinity will ease your temperature control requirements.
5. Turn the controller POWER *on*.
6. Switch the METER SELECTOR switch (Item E) to *Set Temp* and adjust the SET TEMPERATURE control (Item C) to the desired temperature. Observe setting on METER.
7. Set the LOOP SPEED switch (item G) to *fast*.
8. Switch the METER SELECTOR switch (Item E) to *T1 (Control)*.

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9. Set the OUTPUT switch (Item B) to *auto*. The OUTPUT LED will be lit to indicate that power is being applied to the heater. Observe the METER to assure that the temperature is approaching the set temperature. The HIGH and LOW LED'S indicate the direction of heating control.

   NOTE: If the system is setup properly, this is all that is needed to maintain a constant temperature in the chamber.

10. Allow time for the system to stabilize at the desired temperature. Set the METER switch (Item E) to *T2 (Monitor)*. This will display the reading of the monitor thermistor submerged in solution. This reading will most likely be lower than the platform set temperature due to the thermal gradient between the platform and the solution. The temperature at the sample (T2 thermistor reading) can be adjusted to the desired setting by increasing the SET TEMPERATURE setting as described in step 6 above. This is an example of static solution warming and is the simplest form of temperature control.

    Temperature control is more complex in a system where solution continuously flows across the bath. The best method for providing stable temperature control for a flowing solution is to pre-heat the solution with an in-line heater in conjunction with platform heating.

Operating With Other Equipment

The **TC-324B** can be used to power other Warner equipment such as the **SH-27B** and **SF-28 Slow-Flow** solution heaters. In addition, the controller can be used as an independent device to power third-party equipment as long as the following considerations are met.

Load Resistance

The **TC-324B** heater controller will work well with many other heating devices. To obtain maximum heating power, the resistance of the heating element should be between 8-12 Ω, but any element that works at a maximum of 12 V and 1.5 A will also work with the **TC-324B**.

Thermistor Considerations

The **TC-324B** heater controller was designed to accommodate Unical thermistors from Thermometrics (Edison, New Jersey). This family of thermistors can be interchanged without recalibration of the instrument. The nominal resistance of Unical thermistors is 10.0 kΩ at 25 °C.

Other thermistors may be used with the **TC-324B** if the nominal resistance also is 10.0 kΩ at 25 °C. The use of thermistors with other characteristics may not be possible, or will require recalibration of the **TC-324B**.

OPERATION

The main use of a heater control device such as the **TC-324B** is to maintain a constant bath temperature with minimum deviation from a set temperature. This is usually achieved by using a heated chamber/platform, an in-line solution heater, or a combination of both.

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Automatic Mode

In *Automatic Mode*, the **TC-324B** maintains the temperature of the connected heater/thermistor system at the value set by the user. The selectable LOOP SPEED control (Item G) is used to adjust the speed of the feedback loop in the heater/thermistor system, which controls the rate of change of its output voltage. Non-Warner heater systems with feedback thermistors can be used in *automatic mode* provided they are compatible with the **TC-324B** requirements.

LOOP SPEED is normally set to *fast* to provide the shortest time between the application of power to the heater element and the sensing of temperature at the thermistor. For heater/thermistor systems with long response times, the *fast* setting will cause the measured temperature to overshoot the target by a large amount resulting in system oscillation. For this condition, try *medium* or *slow* settings to find the optimum feedback rate.

If the temperature of the CONTROL THERMISTOR is more than 0.5 °C above the *set temperature*, the voltage applied to the heater element will be immediately set to 0 V, removing power to the heater. The output voltage will remain at 0 V until the temperature of the CONTROL THERMISTOR becomes less than 0.5 °C above the *set temperature,* at which point power will be gradually re-applied to disallow the system temperature to fall too far below the temperature set point. It is normal for some overshoot to occur while the temperature is stabilizing, and these features prevent the temperature from reaching very high or very low levels during this time.

Manual Mode

In *manual mode*, the MANUAL VOLTAGE control (Item D) is used to set the output voltage to a fixed value. The voltage setting can be viewed with the METER when the METER SELECTOR switch (ITEM E) is set to *Output Voltage*. In *manual mode*, the SET TEMPERATURE control (Item C) is disconnected, as is the feedback system of the **TC-324B**. The instrument now operates as a 0-12 VDC power supply that can provide up to 1.5 A of current to a device. Use this mode with heater systems that will operate properly with a fixed voltage and lack feedback thermistors.

Connection To External Devices

In-Line Heaters

The **SH-27A** and **SF-28** in-line solution heaters connect directly into the **TC-324B** Output connector (Item H). For these devices the temperature of the solution is monitored by a thermistor placed at the outflow end of the in-line heater. This is the T1 (CONTROL) thermistor. The T1 RECORDER OUTPUT BNC (Item J) on the **TC-324B** front panel can be used to measure the temperature of this thermistor at a scale factor of 100 mV/°C. A second thermistor, plugged into the T2 INPUT on the instrument rear panel, can be used to measure the temperature at any other point of interest.

Using Other Devices

A **CC-35** cable assembly is required for connecting other external devices to the **TC-324B** heater controller. See the Appendix for **CC-35** pin designations.

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APPENDIX

Specifications

Maximum Output Voltage	12 VDC
Maximum Output Current	1.5 A
Minimum Load Resistance	8.0 Ω
Manual Voltage Range	0.0 to 12.0 VDC
Maximum Output Power	16 W into a 9 Ω load
Power Requirements	100-130 or 200-260 VAC, 50/60 Hz
Power Fuse (3AG Size)	1.0 A Slo-Blo for 100-130 VAC 0.5 A Slo-Blo for 200-260 VAC
Front Panel Recorder Outputs	T1 (control), T2 (monitor) BNC reporting 100 mV/°C
Rear Panel Input	T2 thermistor (monitor) BNC input calibrated at 10.0 kΩ at 25 °C
Temperature Range	Ambient to 50 °C
Meter Display	3.5 digit LED display of °C or V
Meter Readouts	Set temperature T1 (control) temperature T2 (monitor) temperature Output voltage(to heater)
Enclosure	17.0 x 3.5 x 12.0 in (W x H x D)

Accessories and replacement parts

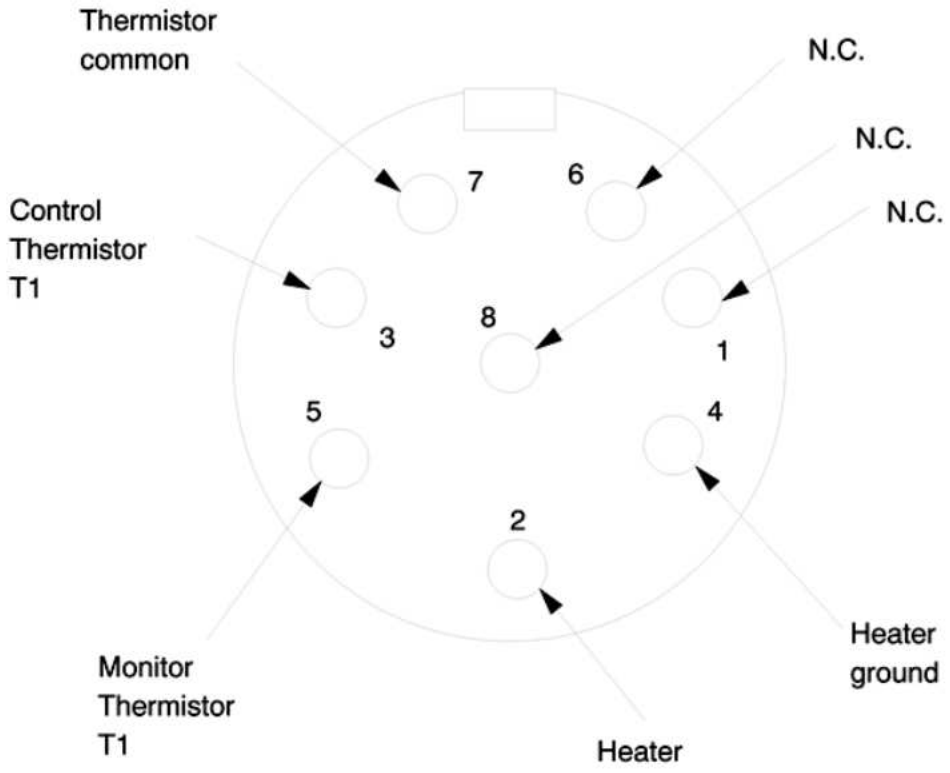
CC-28 Cable assembly for Series 20 heater platforms

CC-35 Cable assembly with unterminated outboard ends

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CC-35 Connector pin designations

Pin	Color	Designation	Pin	Color	Designation
1		No connection	5	White	T2 (Monitor)
2	Red	Heater power	6		No connection
3	Black	T1 (Control)	7	Green	Thermistor common
4	Shield	Heater ground	8		No connection



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Warranty and service

Warranty

The model **TC-324B** is covered by our Warranty to be free from defects in materials and workmanship for a period of two years from the date of shipment. If a failure occurs within this period, we will either repair or replace the faulty component(s). This warranty does not cover instrument failure or damage caused by physical abuse or electrical stress (inputs exceeding specified limits).

In the event that instrument repairs are necessary, shipping charges to the factory are the customer's responsibility. Return charges will be paid by Warner Instruments, Inc.

Normal business hours are 8:30 AM to 5:30 PM (EST), Monday through Thursday and 8:30 AM to 5:00 PM on Friday. Our offices are located at 1125 Dixwell Avenue, Hamden, CT 06514, and we can be reached by phone at (800) 599-4203 or (203) 776-0664. Our fax number is (203) 776-1278. In addition, we can be reached by e-mail at **support@warneronline.com** or through our Web page at **http://www.warneronline.com**.

Service notes

Please refer all questions regarding service to our Engineering Department.

A) If the instrument POWER light fails to light, check the fuse at the rear panel (located in the black POWER INPUT MODULE). If the fuse is found to be defective replace it with a 5x20 mm, 0.5 A slow-blow fuse (0.25 A for facilities using 220-240 V line voltages). If the replacement fuse also fails, please call Warner Instruments for assistance.

B) Occasionally, a knob on the front panel will loosen after long use. These are "collet" style knobs and are tightened with a screw located under the knob cap. To gain access to the adjustment screw, pry the cap off with a thin bladed screwdriver or similar tool.

C) Should service be required, please contact the factory. The problem may often be corrected by our shipping a replacement part. Factory service, if required will be expedited to minimize the customer inconvenience.

D) Instruments are inspected immediately upon receipt and the customer is notified if the repair is not covered by the warranty. Repairs can often be completed in 1-2 days from our receipt of the instrument.

E) If factory service is required, please observe the following instructions:

1) Package the instrument with at least 3 inches of cushioning on all sides. Use the original shipping carton if it is available.
2) Insure the shipment for its full value.
3) Include with the shipment an explanation of the problem experienced.

IMPORTANT - CUSTOMERS OUTSIDE OF THE U.S.: Please be sure to contact us before return shipping any goods. We will provide instructions so that the shipment will not be delayed or subject to unnecessary expense in clearing U.S. Customs.

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EMC

Declaration of Conformity

CE MARKING (EMC)

Application of Council Directive: 89/336/EEC

Standards To Which Conformity Is Declared	EN55022 Class A EN61000-3-2 EN61000-3-3 EN50082-1:1992 EN61000-4-2 EN61000-4-3 ENV50204 EN610000-4-4 EN610000-4-8 EN610000-4-11
Manufacturer's Name: Manufacturer's Address:	Warner Instrument Corp. 1125 Dixwell Avenue Hamden, CT 06514 Tel: (203) 776-0664
Equipment Description:	Heater Controller
Equipment Class:	ITE-Class A
Model Numbers:	TC-324B and TC-344B

I the undersigned, hereby declare that the equipment specified above, conforms to the above Directive(s) and Standard(s).

Place: Hamden, Connecticut USA

Signature: _____

Full Name: Burton J. Warner

Position: President

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LVD

Declaration of Conformity

CE MARKING (LVD)

Application of Council Directive: 73/23/EEC

Standards To Which Conformity Is Declared	EN61010-1:1993
Manufacturer's Name:	Warner Instrument Corp.
Manufacturer's Address:	1125 Dixwell Avenue Hamden, CT 06514 Tel: (203) 776-0664
Equipment Description:	Heater Controller Safety requirements for electrical equipment for measurement and laboratory use
Equipment Class:	Class I
Model Numbers:	TC-324B and TC-344B

I the undersigned, hereby declare that the equipment specified above, conforms to the above Directive(s) and Standard(s).

Place: Hamden, Connecticut USA

Signature: Burton J. Warner

Full Name: Burton J. Warner

Position: President

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