

Dual Channel Heater Controller

Model TC-344C
Order # 64-2401



WARNER
INSTRUMENTS

A Harvard Apparatus Company

WEEE/RoHS Compliance Statement

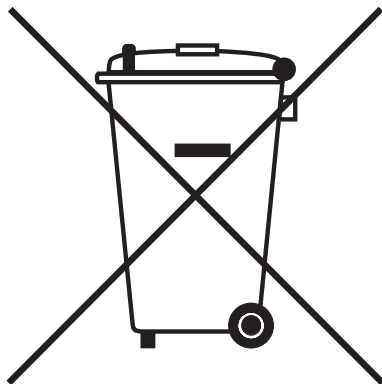
EU Directives WEEE and RoHS

To Our Valued Customers:

We are committed to being a good corporate citizen. As part of that commitment, we strive to maintain an environmentally conscious manufacturing operation. The European Union (EU) has enacted two Directives, the first on product recycling (Waste Electrical and Electronic Equipment, WEEE) and the second limiting the use of certain substances (Restriction on the use of Hazardous Substances, RoHS). Over time, these Directives will be implemented in the national laws of each EU Member State.

Once the final national regulations have been put into place, recycling will be offered for our products which are within the scope of the WEEE Directive. Products falling under the scope of the WEEE Directive available for sale after August 13, 2005 will be identified with a "wheelie bin" symbol.

Two Categories of products covered by the WEEE Directive are currently exempt from the RoHS Directive - Category 8, medical devices (with the exception of implanted or infected products) and Category 9, monitoring and control instruments. Most of our products fall into either Category 8 or 9 and are currently exempt from the RoHS Directive. We will continue to monitor the application of the RoHS Directive to its products and will comply with any changes as they apply.



- **Do Not Dispose Product with Municipal Waste**
 - **Special Collection/Disposal Required**

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Introduction

The **TC-344C** Dual 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-344C** include:

- Dual thermistor design
- Automatic and manual modes
- Control Thermistor fault (open) detection
- Selectable temperature set modes (internal/external)
- 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 22 W of heating power into a 10Ω load (per channel)

THIS EQUIPMENT IS NOT DESIGNED NOR INTENDED
FOR USE ON HUMAN SUBJECTS

Nomenclature

Text Conventions

This manual refers to device 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.

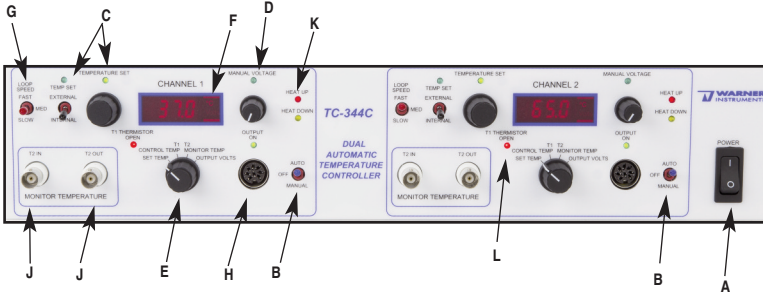
- Warner Instrument product numbers are presented using **bold type**.
- References to controls are specified using SMALL CAPS.
- References to control settings are specified using *italic type*.
- Special comments and warnings are presented in **highlighted text**.

Any other formatting should be apparent from context.

Control Description

Front Panel

A schematic of the face panel of the TC-344C 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 (Item A)

Located directly under the Warner logo. Supplies power to the TC-344C.

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, Internal & External (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. An associated green LED is *on* when the controller is set to *Manual Mode* on the OUTPUT SWITCH (item B).

Meter Selector Switch (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*.

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*.

Control Description (Cont'd)

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-344C 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 Input and Output (Items J)

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

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.

Up / Down LED's (Item K)

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

Open Thermistor LED (Item L)

Should a control thermistor (T1) fail during operation, the open-thermistor warning LED will light indicating the error mode. When an open thermistor is detected, the device output is automatically returned to zero volts. This design feature prevents inadvertent overheating and subsequent damage to the equipment or biological preparations.

NOTE: When an open thermistor is detected the voltage output folds back to ~0.1V as long as the LED indicator is on. Once the fault has been corrected, the LED will turn off and the system will resume heating immediately.

NOTE: In the rare event of an open or shorted OUTPUT fault, the voltage output folds back to ~0.01V to protect the user and equipment. The unit must be completely powered down (30 seconds) and restarted to clear this fault mode and resume normal operation.

Control Description

Rear Panel

115 VAC to 230 VAC Conversion

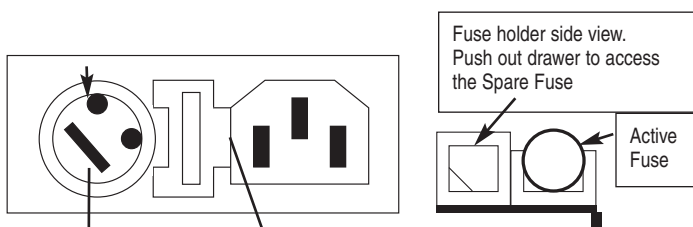
ATTENTION

PLEASE READ BEFORE APPLYING POWER TO YOUR UNIT!!

The unit has been factory set to be used with 115 VAC.

If the operating voltage needs to be changed to 230 VAC, then use the enclosed kit (power cord (1 ea) and 0.5 A fuses (2 ea)) for the conversion. Note that the unit only uses a single fuse; the second fuse is sent as spare.

Power Entry Module



Step 1

Depending on AC Voltage being used, turn VAC selector switch to 110 VAC or 220 VAC

For 90, 110, 115, and 120 VAC use the 110 position.

For 220, 230, 240, and 260 VAC use the 220 position.

Step 2

Carefully, pry open the fuse holder from the right side by using a small flat screwdriver. Replace fuse according to voltage being used.

Item # 64-0101 Model TC-344C use:

For 115 VAC: 1.0 Amp - 5 x 20 mm Slow Blow

For 230 VAC: 0.5 Amp - 5 x 20 mm Slow Blow

Control Description (Cont'd)

6

Rear Panel



T1 Output (Item M)

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

External Temperature Set (Item N)

Input BNC for adjusting the set temperature of the TC-344C. Input functions only when internal/external select switch (Item C) is set to external, and the output mode switch (Item B) is set to auto. Units are 100mV/°C across the temperature range of ambient to 65°C. Can be used for remote or computer control of set temperature.

Ground Terminals (Item O)

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

Setup

The TC-344C 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:

- Please refer to the front panel schematic on page 3 for orientation.
- 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-344C 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-344C 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)*.
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 **HEAT UP** and **HEAT DOWN 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-344C** 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-344C** heater controller will work well with many other heating devices. To obtain maximum heating power, the resistance of the heating element should be between 10-18 Ω , but any element that works at a maximum of 15 V and 1.5 A will also work with the **TC-344C**.

Thermistor Considerations

The **TC-344C** 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 k Ω at 25°C.

Other thermistors may be used with the **TC-344C** if the nominal resistance also is 10.0 k Ω at 25°C. The use of thermistors with other characteristics may not be possible, or will require recalibration of the **TC-344C**.

The main use of a heater control device such as the **TC-344C** 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.

Automatic Mode

In *Automatic Mode*, the **TC-344C** 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-344C** requirements.

Temperature can be set by the controls on the front panel when the device is in "internal" temperature set mode. In "external" temperature set mode, a voltage applied to a rear-panel BNC sets the temperature at 100 mV/°C.

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 levels during this time.

"If the control themistor becomes open-circuit, it will indicate a low temperature. This will cause the Automatic Mode to raise the temperature indefinitely. The **TC-324C** has a circuit that checks for an open thermistor, and removes output power to the heater to prevent overheating. An LED on the front panel will indicate an open thermistor condition."

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-344C. The instrument now operates as a 0-15 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-344C 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-344C back 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 front 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-344C Heater Controller. See the Appendix for CC-35 pin designations.

Specifications

| | |
|-----------------------------------|---|
| Maximum Output Voltage | 15 VDC |
| Maximum Output Current | 1.5 A |
| Minimum Load Resistance | 10.0 Ω |
| Manual Voltage Range | 0.0 to 15.0 VDC |
| Maximum Output Power | 22 W into a 10 Ω load |
| Power Requirements | 95-130 or 200-260 VAC, 50/60 Hz |
| Power Fuse (5 x 20 mm) | 1.0 A Slow Blow for 95-130 VAC and 0.5 A Slow Blow for 200-260 VAC |
| Front Panel Recorder Input/Output | T2 thermistor (monitors) BNC reporting 100 mV/ $^{\circ}$ C |
| Rear Panel Recorder Output | T1 (control) BNC reporting 100 mV/ $^{\circ}$ C |
| Temperature Range | Ambient to 65 $^{\circ}$ C |
| Internal Set Temperature | 22 $^{\circ}$ C to 65 $^{\circ}$ C |
| External Set Temperature | Ambient to 65 $^{\circ}$ C |
| Meter Display | 3.5 digit LED display of $^{\circ}$ C or V |
| Meter Readouts | Set temperature T1 (control) temperature T2 (monitor) temperature Output voltage (to heater) |
| Enclosure (W x H x D) | 43.2 x 8.9 x 30.5 cm (17.0 x 3.5 x 12.0 in) |

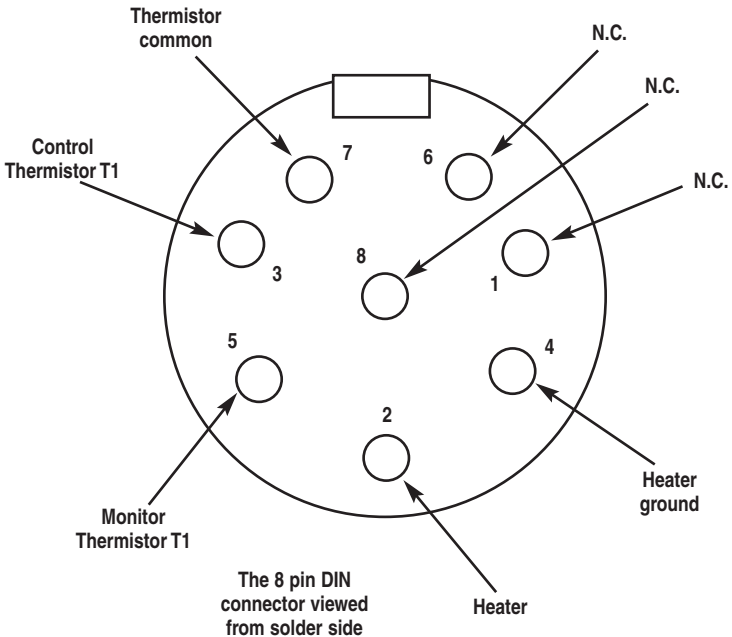
Accessories and Replacement Parts

| Model | Order # | Description |
|-------|---------|--|
| CC-28 | 64-0106 | Cable Assembly for Series 20 Heater Platforms |
| CC-35 | 64-0109 | Cable Assembly with Underminated Outboard Ends |

Appendix (Cont'd)

CC-35 Connector Pin Designations

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



Warranty & Service

Warranty

The model **TC-344C** 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 84 October Hill Rd, Holliston, MA 01746, and we can be reached by phone at (800) 599-4203 or (800) 272-2775. 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 **METER** 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 5 x 20 mm, 0.5 A Slow Blow fuse (0.25 A slow blow fuse for facilities using 200-240 V line voltages).
- 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.

Appendix (Cont'd)

- 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.
- F) Cleaning Instructions: Wipe exterior surfaces with a clean damp cloth.
- G)  High Voltage. Not for clinical use on humans. To avoid risk of electric shock, do not open top panel. There are no internal user-serviceable parts, please contact us for repair. *Haut Voltage. Non conçu pour essais cliniques sur l'humain. Afin d'éviter le risque de choque électrique, ne pas ouvrir le panneau supérieur. L'appareil ne contient aucune pièce pouvant être remplacé par l'utilisateur; veuillez nous contacter pour toutes réparations.*
- H) The device should be operated and stored in a temperature range of 5-35°C (41-95°F) and humidity range of 5-95% noncondensing relative humidity.
- D) Installation Clearances: Instrument shall have 5 cm clearance on both sides when rack mounted and 12 cm side clearances otherwise. Instrument should not be stacked on top of heat producing equipment without a minimum spacing of 9 cm.
- J) This device features a three-prong grounded power cord. Do not remove the ground pin or operate the device when ungrounded.
- K) The two disconnecting devices for this controller are the appliance coupler on the back panel and the outlet plug cap. Both disconnects should remain accessible during operation of the device.
- L) **NOTE: If this equipment is used in a manner not specified by the manufacturer in this user manual, the protection provided by the equipment may be impaired.**

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.

Declaration of Conformity

CE MARKING (EMC) and CB Scheme

We,
 Manufacturer's Name: Harvard Apparatus/Warner Instruments
 Manufacturer's Address: 84 October Hill Road
 Holliston, MA 01746
 Tel: (508) 893-8999

We herewith declare that the following product:

Equipment Description: Heater Controller
 Product Name: TC-344C
 Standards: IEC 61326-1 ed1.0 (2005-12)
 FCC 47CFR Part 15:2013 Subpart B, Class B

To which this declaration relates, is in conformity with the applicable EC Directives, harmonized standards, and other normative requirements:

Safety: IEC 61010-1:2010 (Third Edition)
 EMC Directives (Emission): FCC 47CFR Part 15:2013 Subpart B,
 CISPR 11:2003 Group 1, All Class B)
 Immunity Directive: IEC61000-3-2:2000
 IEC61000-3-3:2002
 IEC61000-4-2:2001
 IEC61000-4-3:2002
 IEC61000-4-4:2004
 IEC61000-4-5:2001
 IEC61000-4-6:2003
 IEC 61000-4-8:1993 +A1:2000)
 IEC61000-4-11:2004

EMC and Safety compliance were evaluated by Intertek.

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

Place: United States
 Date: October 31, 2013



Signature: Beth Bauman
 Beth Bauman
 V.P. Engineering/
 Operations

Notes

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Warner Instruments Dual Channel Heater Controller