

Instruction Manual

TC-1000

Temperature Controller



Read instructions carefully before operating this device.

- ❶ *This device is not to be used for Human Life Support applications.*
- ❷ *To avoid possible electrical shock, do not operate this device if it is wet or has had liquids spilled onto it.*
- ❸ *Service or calibration procedures should only be performed by qualified personnel familiar with the electrical hazards of line-powered devices.*



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STATEMENT OF WARRANTY

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Instruments manufactured by CWE, Incorporated are not authorized for use as critical components in human life support devices or systems. "Life support devices or systems", as used herein, are devices or systems whose failure to perform, whether through misuse, failure, or proper operation, can reasonably be expected to result in significant injury to the operator or subject persons.

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1.0 INTRODUCTION

The TC-1000 Temperature Controller is used to monitor and control body temperature of small animals over the range of 25 - 45°C. A linear PID (Proportional-Integral-Derivative) controller smoothly adjusts DC current flow through the heating pad, without the voltage transients associated with simple on/off controllers. It accepts thermistor temperature probes in the Yellow Springs Instruments (YSI) 400 series. A front panel LCD display shows the actual animal probe temperature, the set-point temperature, the alarm band hysteresis, and various status messages. The TC-1000 may be used for measuring and controlling body or bath temperature within the measurement range, using resistive heaters or heating pads. A range of suitable probes and heating pads is available, including rectal probes and other fast-response probes.



Front panel view of TC-1000 Temperature Controller

2.0 PROBE CONNECTION

Plug the thermistor probe into the **THERMISTOR PROBE** input jack. The probe should be one of the YSI Series 400 family, which are terminated with a ¼" phone plug. A variety of probes is available. Normally, probes are inserted rectally (but see Section 8.0 for other possibilities). See Ordering Information at the back of this manual for descriptions of the available probes.

3.0 TEMPERATURE MONITOR OUTPUT

The **TEMPERATURE MONITOR OUTPUT** jack provides an analog voltage corresponding to the displayed temperature measurement. This output can be monitored or recorded on an external instrument if desired. The scaling of this signal is 100mV/°C. For example, 37.0 °C = 3.7V.

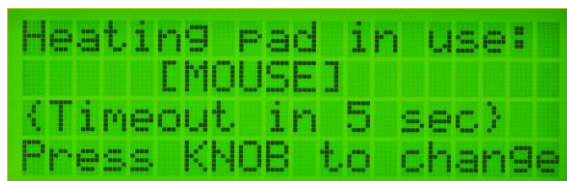
4.0 HEATER CONNECTION

The TC-1000 is intended for use with resistive-type heating elements in the range of approximately 4 - 20 ohms. This corresponds to the mouse-size, rat-size and cat-size heating pads supplied by CWE, Inc. The maximum available heater power is approximately 12VDC at 3.5A. The lower the resistance of the heating element, the higher the heating current that can flow. The heating element is connected to the 5-pin **HEATING PAD** jack on the front panel.

CAUTION! Do not use heating elements with a resistance less than 4 ohms using the internal power supply. Lower resistance (i.e., higher current) heaters can be accommodated using an external power supply. See Section 9.0 for details.

5.0 STARTUP AND PAD SELECTION

When power is switched ON, the following dialog will appear on the LCD display:



```
Heating Pad in use:
[MOUSE]
<Timeout in 5 sec>
Press KNOB to change
```

The display shows the currently configured heating pad; either **MOUSE**, **RAT**, or **CAT**. If the display does not show the pad you are using, press the **TEMP SET** knob repeatedly until the desired type appears. This setting will be stored and automatically applied the next time the TC-1000 is powered on. This dialog will time out in 10 seconds if no operator input is received.

The purpose of this configuration is to optimize the heating properties of the instrument for the size of pad being used.

6.0 SETTING THE TARGET TEMPERATURE AND ALARM BAND

The image shown below is the main operating and control display. The monitored temperature is shown on the first line of the LCD display panel. The second line shows the target (set-point) temperature and alarm hysteresis band:



The SET temperature is the desired body temperature that is to be maintained. Rotate the **SET TEMP** knob until the desired set-point is displayed.

The second number shown on line 2 is the *alarm band hysteresis*. This is the deviation from the set-point that is allowable before the alarm will be activated. In the example above, the alarm band is set to 36.5° - 37.5°. The alarm band is always symmetrical around the set-point temperature. If the measured temperature goes outside these bounds, the temperature alarm will be activated.

To adjust the alarm band hysteresis, push in the **SET TEMP** knob while turning it, until the desired alarm band is displayed on the LCD. Both set-point temperature and alarm settings are saved in non-volatile memory, and will be restored when the unit is next used.

The third line shows the alarm status. In this case, the audible temperature alarm is turned OFF.

The fourth line shows a bar graph of the relative heater being applied. In the bottom right corner is an indicator showing which pad configuration is being used: M = mouse, R = rat, and C = cat.

7.0 ALARMS AND FAULT CONDITION ALERTS

The TC-1000 is equipped with a user-adjustable temperature alarm, and additional fault condition monitors. The various conditions and operator messages are described below.

Temperature Alarm – This is a user-adjustable temperature band that is set up as described in Section 6.0. When triggered by an out-of-temperature condition, the **ALARM** pushbutton switch will be illuminated, and the third line of the LCD display will show the message **Temp Alarm!**

If the audible alarm is active, a short beep will sound every four seconds. To turn off this beep, press the **ALARM** pushbutton switch. The visible alarm light and LCD warning message will be displayed regardless of the audible alarm setting.

Probe Error - The message **Check Temp Probe** indicates that there is a problem with the thermistor probe: it is either unplugged from the TC-1000, broken, or out of the normal operating range. Be sure the probe is connected properly, or replace the probe if necessary. A short beep will sound every 1.5 seconds to alert the user that this condition must be corrected. While this message is displayed, heating power is turned off to avoid overheating of the animal.

Probe-Animal Error - The message **Check Animal/Probe** is displayed if the TC-1000 has been heating the animal for some time (10 minutes), but the animal temperature remains at least 6°C below the desired set point. The most common cause of this condition is that the probe has become disconnected from the animal. A short beep will sound every five seconds to alert the operator to correct this condition. When this message is displayed, heating power is turned off to avoid overheating of the animal.

***NOTE:** After the probe/animal connection is re-established, press the **ADJUST** knob momentarily to reset the alarm condition and re-start the heater. Normally, the animal's body temperature will be sufficient to reset the alarm condition.*

8.0 HOMEOTHERMIC WARMING STRATEGIES

While the operation of the TC-1000 Temperature Controller system is straightforward, some simple considerations will help in achieving good results. Keep in mind that the controller actually works by attempting to keep the thermistor probe at the set temperature.

Strategy 1: Simple, continuous warming --- This is the most common application. It is desired to keep the experimental animal warm during a surgical procedure or other experimental session lasting an indefinite time.

Procedure: Place the animal on the heating pad and insert the probe rectally. Be sure there is some minimal insulation *underneath* the pad to prevent excessive heat loss to surgical table, stereotaxic apparatus, etc. If possible, try to cover the animal with a small drape (or even a paper towel). This reduces heat radiation to the environment, especially in a cold room.

Strategy 2: Intermittent use with one or more animals --- In this situation, the animal is warmed for a while, then removed from the pad (perhaps for a separate test or measurement, etc.), then returned to the pad. A similar situation would be to sequentially warm a series of animals (e.g., during surgery, with the pad being unoccupied between animals).

Procedure: Place the animal on the heating pad as usual and insert the probe rectally. When the pad is not in use (i.e., the time between animals), place the temperature probe *on the surface* of the heating pad. This simple procedure prevents the controller from ramping up its heat output when no animal is present, and prevents overheating the next animal in the sequence.

Strategy 3: Fail-safe simple warming technique --- If the object is to simply keep the animal warm, and it is not too critical to maintain an exact body temperature, then use this procedure.

Procedure: Place the animal on the heating pad as usual, but place the temperature probe underneath the animal, i.e. between the animal and the heating pad. The controller will then keep the surface temperature of the pad at the set temperature. This prevents any possibility of overheating or heat injury to the animal. Researchers who use this technique typically set the target temperature a few degrees above the normal body temperature (say, to 40 ° C) to allow for heat loss to the environment.

Note: This procedure can also be used to keep a number of small animals (e.g., newborn rodents) warm at the same time. Use this technique to create a small incubator by placing the pad on the floor of a small plastic enclosure.

Strategy 4: General hints and suggestions --- Please observe the following suggestions and precautions to enable successful operation of this instrument.

Do not: Place the heating pad directly on a cold table, metal plate, or other heat conducting surface. You will be asking the heating pad to warm a far larger mass than it is capable of, and it will not work!

Do: Place a small insulating layer between the heating pad and the underlying surface. This will serve to isolate the pad/animal thermal system.

Do: If possible, place a small covering over the animal. This limits heat loss to the environment, especially if the area is cold or drafty.

Do: Allow sufficient time for the system to stabilize. It will take a minimum of several minutes for the controller to adapt to the prevailing conditions. The controller is designed not to overshoot the set temperature. Consider the task: the heating pad is radiating and/or conducting heat to the body of the animal, and thus eventually to the thermistor probe. There is a considerable time lag in response, and the controller tries to anticipate the future temperature of the probe/animal,

without applying so much heat that the desired endpoint will be exceeded. Not such an easy task!

9.0 CONNECTING AN EXTERNAL POWER SUPPLY

The TC-1000 is designed for direct use with heating blankets or immersion heaters in the range of 4 – 20 ohms. Lower resistance heaters can be used, but require a higher current power source than is built into the TC-1000.

To use a higher power blanket or other heater (up to 10A, or resistance down to about 1 ohm), an external power supply should be connected to the rear panel binding posts, using the following procedure:

WARNING! Be sure power is turned OFF before connecting or disconnecting an external power supply!

1. Locate the three binding posts on the rear panel of the TC-1000.
2. Remove the jumper that connects the **INTERNAL** (red) and **EXTERNAL** (yellow) binding posts.
3. Connect a suitable power supply to the **EXTERNAL** (yellow) and **GROUND** (white) binding posts, observing correct polarity (positive to yellow, negative to white).

CAUTION: The external power supply or battery should be capable of supplying 12VDC, with a current rating consistent with the heating pad being used. Be sure to remove the jumper between the INTERNAL and EXTERNAL binding posts when using an external power supply. Do not connect any external power source to the INTERNAL (red) binding post!

4. Replace the **HTR POWER FUSE** with a 10A fuse. Be sure to replace this fuse with the original 4A fuse when again using the internal power supply.

10.0 SETTING MAXIMUM PAD HEAT OUTPUT

The controller firmware stores a maximum power output level for each type of heating pad. This value is automatically used when the user sets the “Pad in use” as described in Section 5.0. The purpose of this is to limit the maximum power available during heating, and thus limit the pad surface temperature. It is possible for the user to change this limit using the following procedure:

CAUTION: The factory-set values are carefully determined to prevent excessive heating pad surface temperatures. Do not change these values unless there is a real need to do so. A valid reason would be an unusual heating situation requiring more heat than usual. When using our standard heating pads, you should not need to alter the default values.

To activate this procedure, press the **ALARM** pushbutton briefly while powering the instrument ON. After the usual “Pad in use” screen has appeared and timed out, the following display will appear:



```
Set pad power limit
[MOUSE]
Limit = 3290
(Press KNOB to exit)
```

The display shows which pad will be affected (MOUSE, RAT, or CAT), and the current power level limit. To change the limit, rotate the **SET TEMP** knob. When the desired reading appears, press the **SET TEMP** knob to store the value and exit. This value will be stored internally, and active whenever this pad is being used.

The maximum setting is 4095, which will allow full power to be applied by the controller. Effective settings are within the range 3000 – 4095, with higher values permitting more heat to be delivered to the pad.

Note: If you just want the maximum power, select [CAT] in the “Pad in use” dialog at startup. Because of its large surface area, the cat pad is already configured with the maximum power setting.

11.0 ORDERING INFORMATION

Part No.	Model	Description
08-13000	TC-1000 Mouse	Temperature controller with mouse probe and heating pad
08-13001	TC-1000 Rat	Temperature controller with rat probe and heating pad
08-13099	TC-1000	Temperature controller, main unit only
08-13013	Heating Pad, Mouse	Flexible flat pad, 3 x 6" (7.6 x 15.2cm)
08-13014	Heating Pad, Rat	Flexible flat pad, 5 x 7" (12.7 x 17.8cm)
10-09012	YSI-451	Mouse thermistor probe, 1mm dia.
10-09010	YSI-401	Thermistor probe, cat-size, 4.75mm dia.
10-09020	YSI-402	Thermistor probe, rat-size, 3mm dia.
08-09214	THPROBE-EXT	Thermistor probe extension cable, 12' (3.6m)
08-09215	THPAD-EXT	Heating pad extension cable, 12' (3.6m)