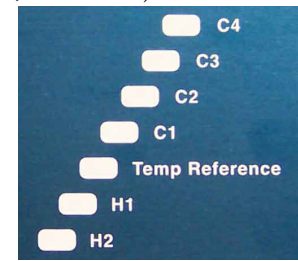


1. Performance

The Tstat24 will automatically coordinate all heating and cooling equipment to maintain temperatures which are chosen by grower. Electricians may view the Tstat 24 as an electronic 6-stage thermostat with high and low alarm output. The relation amongst 2 heating stages, the circulation (Temp Reference) and 3 cooling stages are shown to the right in Figure 1. As the temperature rises, the heating stages (H2 & H1) shut off and the cooling stages (C1, C2, C3 and C4) turn on. An output labeled CIR may be used to activate the HAF fans until C1 turns on.

When the Tstat24 automatically controls heating and cooling equipment, then growers report precise and tighter temperature control. Also, both the first stage of heating and the first stage of cooling will never accidentally run at the same time.

Figure 1. As the temperature rises, the heating stages (H2 & H1) shut off and the cooling stages (C1, C2, C3 and C4) turn on.



2. Installation

A) Mount Tstat24 in dry area at eye level so that switches may be set easily.

B) Connect 120VAC to transformer of the Tstat24 using standard electrical practices. This transformer powers the digital circuitry and powers the relays/contactors which control the heating and cooling equipment. Apply power to the Tstat24. The 24VAC LED should light and the digital display should show about 26°F as its minimum reading and the LED above the Temperature Reference switches should begin to blink once per second. If not, then check the fuse in the Tstat24 and that you have properly wired power to the Tstat24. Figure 2 is the schematic of the Tstat24.

C) Connect the temperature sensor to the Tstat24 using 22-14 gage stranded wire. It is best to use shielded wire. Sensor wires should be run separate from other wires which may be electrically noisy. The sensor may be located 300 feet from the Tstat24. The temperature sensor must be mounted in the air flow and in the shade so that it is NOT heated by the sun. If necessary build shade over the sensor. A piece of plywood (not metal) with a hole in the center may be mounted horizontally in the greenhouse about 1/3 to 1/2 the way down the greenhouse and near the plant height, but out of the spray of any misting systems.

Make the wiring connections using the 3M connectors supplied with the sensor. These connectors are filled with silicone to prevent moisture from causing corrosion. Figure 3a shows the 2 wires inserted into the 3M connector, one wire from the temperature sensor and another wire from the Tstat24. Figure 3b shows pliers ready to squeeze the connector to make the electrical connection. It is best to have the blue side of the connector down so that the wires may be seen through the top of the connector at the end of the passage ways inside the connector.

Figure 4 shows the terminals for connecting the temperature sensor.

D) FANS, vents and heaters must be connected to the Tstat24 by relays and contactors. The relays and contactors must be selected by the electrician. These installation instructions are accompanied by worksheets and a list of relays and contactors which are compatible with the Tstat24. For greenhouses with equipment which is mostly 120VAC or lower, Relay Box #1 may be ordered. It is designed specifically to connect between Tstat24 and heating and cooling equipment.

Figure 4 shows the terminals for connecting the relays and contactors to the Tstat24. These terminals are also shown in the wiring schematic in Figure 2.

E) Lightning damage is a consideration in some areas of the country. Twelve year of field experience indicates that the Tstat24 will survive well. Generally, the lightning strike must be powerful enough that it either damages your phone system or destroys the power company's transformer on the mainline leading to your property. Of course, then the Tstat24 will be the least of your problems.

There is much protection on the circuit board of the Tstat24. But there is one protective step that can be taken. A ground connection may be made to the right terminal of the 24VAC input on the Tstat24. By grounding this terminal, any voltage surges that travel on the power lines to the transformer of the Tstat24 will have a path to ground. This ground path will be preferred by the surges over paths inside the Tstat24. This ground connection will be like a heavy anchor which the surge must lift before it can do damage to the electronic components of the Tstat24.

Installation Completed

Figure 2. Wiring schematic of 120VAC and 24VAC circuits.

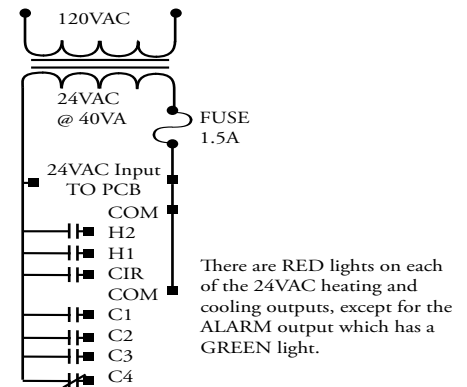


Figure 3a. Temperature sensor, silicone-filled connectors and wires to the Tstat24.

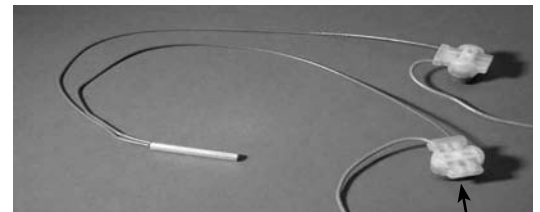


Figure 3b. Pliers are ready to squeeze the connector to complete electrical circuit between temperature sensor and the Tstat24.

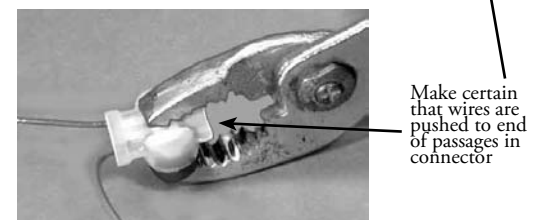


Figure 4: Terminal connections of temperature sensor, relays and transformers to Tstat24.



3. Operating Procedure and programming

A) (Figure 5) Use the **Manual ON** switches to activate and test each stage of heating and cooling. Figure 5 shows that C4 through H2 are pushed to the Auto position. To test each stage, push-ON each stage and verify that the RED light is activated at the terminal strip of the Tstat24 and that the proper piece of heating/cooling equipment is also activated.

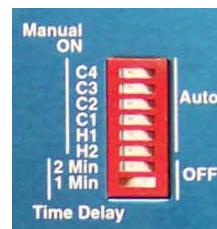


Figure 5: All switches for heating and cooling stages are pushed to the AUTO position. Time-Delay is set to 3 minutes. The 1 Min switch is pushed-ON.

B) (Figure 5) **Time-Delay** controls the rate at which the Tstat24 changes from one heating/cooling stage to another. Typical Time-Delay is 1 to 3 minutes. A maximum Time-Delay of 3 minutes (2+1) is possible. For the following tests, push-OFF all time-delay switches. Then the Tstat24 will change stages once every 15 seconds, if needed. After the following steps, then return to set the Time-Delay.

C) (Figures 6 & 7) The **Temperature Reference** is the main control setting of the Tstat24. The Temperature Reference is NOT the operating temperature of the greenhouse; the Temperature Reference is the temperature around which the Tstat24 makes decisions. During cold nights, the operating temperature of the greenhouse will be near the heating stages. During hot days, the operating temperature of the greenhouse will be near the cooling stages.

To choose the Temperature Reference, first pick the maximum and minimum temperatures that your plants will enjoy. Write these temperatures in pencil in Figure 6 and on the Tstat24. To set the Temperature Reference, choose a temperature half way between these maximum and minimum temperatures, and set this number in the switches in Figure 7. NOTE that the digital display changes as these switches are changed. The digital display is adding the switches which you push-ON to confirm your setting for the Temperature Reference. This is an easy way to check this setting a future time. Figure 7 shows a Temperature Reference of 68°F (=64+4).

Figure 6: This diagram will serve as a worksheet in picking setting for the Tstat23.

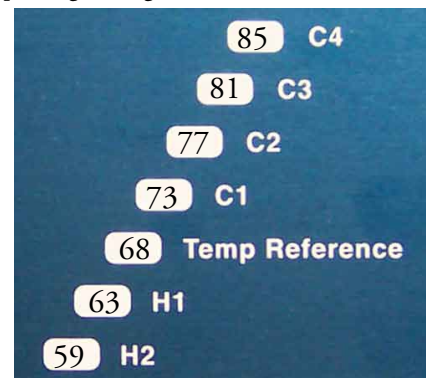
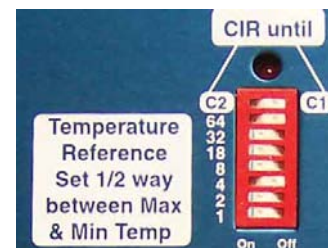


Figure 7: Temperature Reference with RED light which blinks once per second.

D) **Handling Circulation Fans (HAF)**. Circulation fans (HAF) should be shut off when the main fans are activated. Otherwise the circulation fans will be like rocks in a river and create resistance to the effort of the main fans to move air efficiently through the greenhouse.

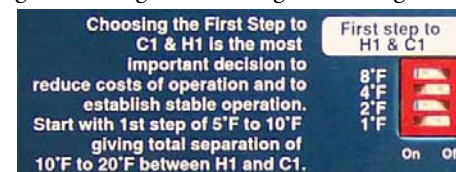
Where the first stage of cooling activates large exhaust fans, push the **CIR Until** switch to the C1 position which will shut off the HAF when C1 activates the large exhaust fans.

Where the first stage of cooling only opens the louvers and small gable fans, push the **CIR Until** switch to the C2 position as shown in Figure 7 which will shut off the HAF when C2 activates the large exhaust fans.



E) (Figure 8) Next, choose the **First Step** from the Temperature Reference to H1 and C1, which are the first stage of heating and the first stage of cooling. This decision will have a great impact on the cost of energy. A small temperature step will cause the Tstat24 to use lots of energy to maintain tight control of the temperature of the greenhouse. Use a setting of 10°F for a total separation of 20°F between C1 and H1, if plants can grow well with such temperature variations. Figure 8 shows a setting of 10°F. Over this 20°F spread, only the low operating cost HAF fans will be active. With 69°F as the Temperature Reference, then C1 will activate at 79°F and H1 will activate at 59°F.

Figure 8: Temperature step from Reference to first stage of heating (H1) and first stage of cooling (C1). 5° is shown in the photo. 5° to C1 and 5° to H1 give a total spread of 10° between first stage of cooling and first stage of heating.



F) (Figure 9) The final programming steps are **choosing the temperature Steps to other heating and cooling stages**. to the second stage of heating (H2) and cooling stages C2 and C3. Figure 9 shows steps of +4°F to between C2, C3 and C4 and a step of -4°F to heating stage H2. Refer to Figure 6 to see the temperatures at which the various stages will activate based on the photos in this manual.



Figure 9: Temperature steps to cooling stages C2 and C3, and to heating stage H2.