

# Model CTI-1 Computer-Temperature Interface

Version 1.00

## DESCRIPTION

The Sine Systems model CTI-1 Computer-Temperature Interface is designed to allow a computer to monitor the outside air temperature. It consists of a 2.75" x 3" x 0.75" control module with 8 screw-terminal connections. Three of these connect to the computer's RS-232 port, two are for connection to a wall-plug DC power supply (supplied), and the remaining three connect to the outdoor temperature sensor (supplied).

The CTI-1 allows a temperature range of -50°F to +199°F can be monitored with a resolution of 1°. The temperature sensor may be located up to 200 feet (or more, depending on conditions) from the control module. A weatherproofing kit is included with the sensor. The sensor is pre-calibrated to ±3° and provisions are included to allow the user to "fine-tune" the calibration of the sensor after installation is complete.

The control module communicates with the computer by means of a standard RS-232 connection. The protocol is 8 data bits, one stop bit and no parity (8N1). The baud rate is factory set to 9600, but can be changed to 4800, 2400, 1200, 600 or 300.

## INSTALLATION

### General



### WARNING!

The installation of the CTI-1 is not difficult but it should be performed by a trained technician. This will insure that potentially unsafe conditions can be avoided.

### Materials Required

Most all materials needed in the installation of the CTI-1 are included with it. The two exceptions are a length of Belden 8451 cable (or equivalent) for connecting the sensor to the control module, and an appropriate connector for the RS-232 port on the computer. In most cases, this will be a female 25 pin "D" connector. This is available from Radio Shack or any electronic parts or computer store.

### Tools Required

Wire strippers, a small (red) screwdriver, and a very small (green) screwdriver are the main tools required. A soldering iron and solder are needed if a solder-type "D" connector is used.

## Mechanical Installation

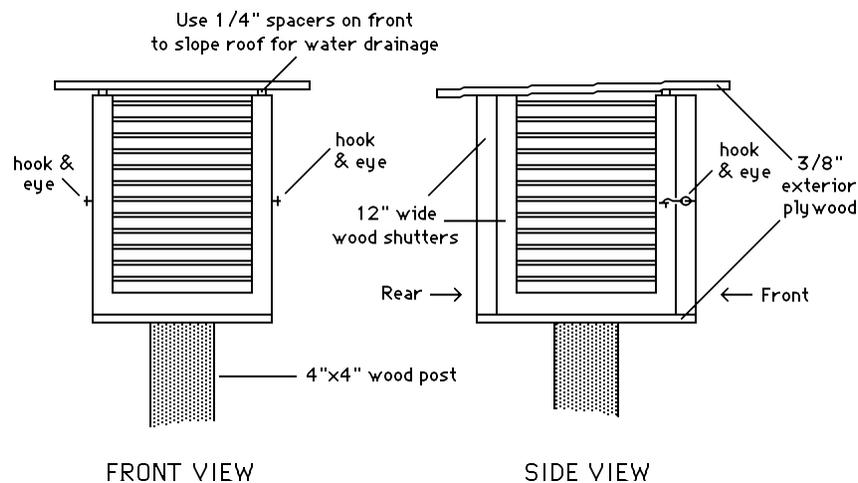
### Control Module

The CTI-1 control module may be located in any convenient indoor location. It is usually most practical to place it somewhere near the computer. It is small enough that it needs no special mounting considerations. It can be rested on a horizontal surface, mounted on a vertical surface using double-stick tape, or it may be simply dangled from its connecting wires.

### Temperature Sensor

The air-temperature sensor for the CTI-1 consists of a small PC board with three screw-terminals. After calibration, this sensor is capable of giving very accurate temperature readings. However, to get readings that give good correlation to readings reported by the nearest NOAA weather station, it is important to measure the temperature the same way they do. Just hanging the sensor out a window will almost surely produce disappointing results.

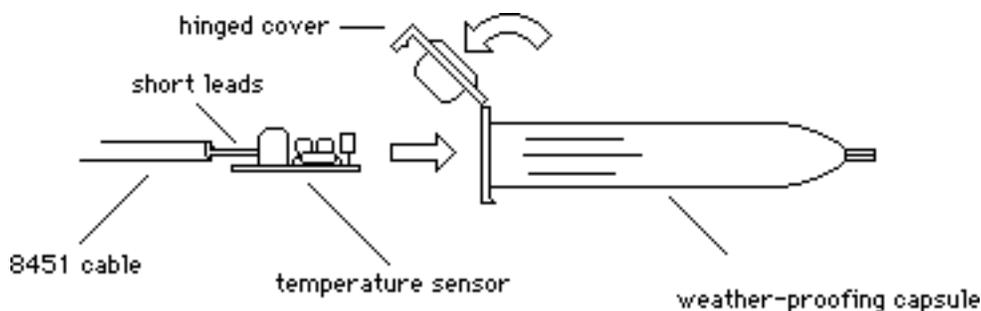
The key to getting good temperature readings is to mount the sensor in a "standard enclosure." The primary raw material is a couple of 12-inch-wide louvered wood shutters. These are available at any home-improvement store. Cut the shutters so you end up with four equal lengths of shutter about 13 to 16 inches long. Depending on the style, a little improvising may be required. Some shutters can be cut along a solid horizontal reinforcement piece and others will require the end louvers to be stabilized with glue or a piece of wood. In either case, you will build a box with the four pieces of shutter using them for the four walls. The floor and roof of the box should consist of 3/8 inch exterior plywood. Here is how the end result will look:



The roof should overhang about 3 inches on all sides. Nail and glue, or screw three of the four sides together and then attach this to the floor. The pieces of shutter should be oriented so the louvers will drain “out.” Attach the roof with a couple of 1/4 inch spacers near the front so that it slopes slightly to the rear. This will prevent water from standing on top. The remaining wall should be attached with two hook-and-eye sets so it can be removed. The enclosure should be mounted on a 4-inch-square wooden post. The floor of the enclosure should be 4.5 to 5 feet above the ground. Don’t forget to drill a small hole in the floor near the edge of the post for the cable to come through. Also, a 1/4 inch hole drilled in one of the walls about an inch above the floor makes an easy way to insert a dial-type calibration thermometer without removing the louvered panel (see section 5.3). When finished, the enclosure should be given at least two coats of white exterior paint inside and out.

The enclosure should be placed at least 20 feet from the nearest building, preferably on grass-covered soil. It should be as far away as possible from concrete and pavement. It should not be placed near air-conditioner compressors nor under trees.

The cable for the sensor should be run up the post and through the hole in the floor. The sensor should be attached to the cable with the leads from the cable made as short as possible. Then, the sensor should be inserted in the open end of the included weather-proofing capsule as shown below:



The capsule contains a clear insulating gel that will protect the sensor from moisture and prevent water from seeping in the end of the cable. The gel also acts as an efficient thermal conductor to insure that the sensor will quickly track the ambient air temperature. Push the temperature sensor in the capsule as far as possible so the gel will cover it and the exposed end of the cable. A pencil or other object can be used to push the sensor in and to work the gel in behind the sensor so the end of the cable is covered. Then close the hinged cap. The cap also serves as a strain relief for the cable.

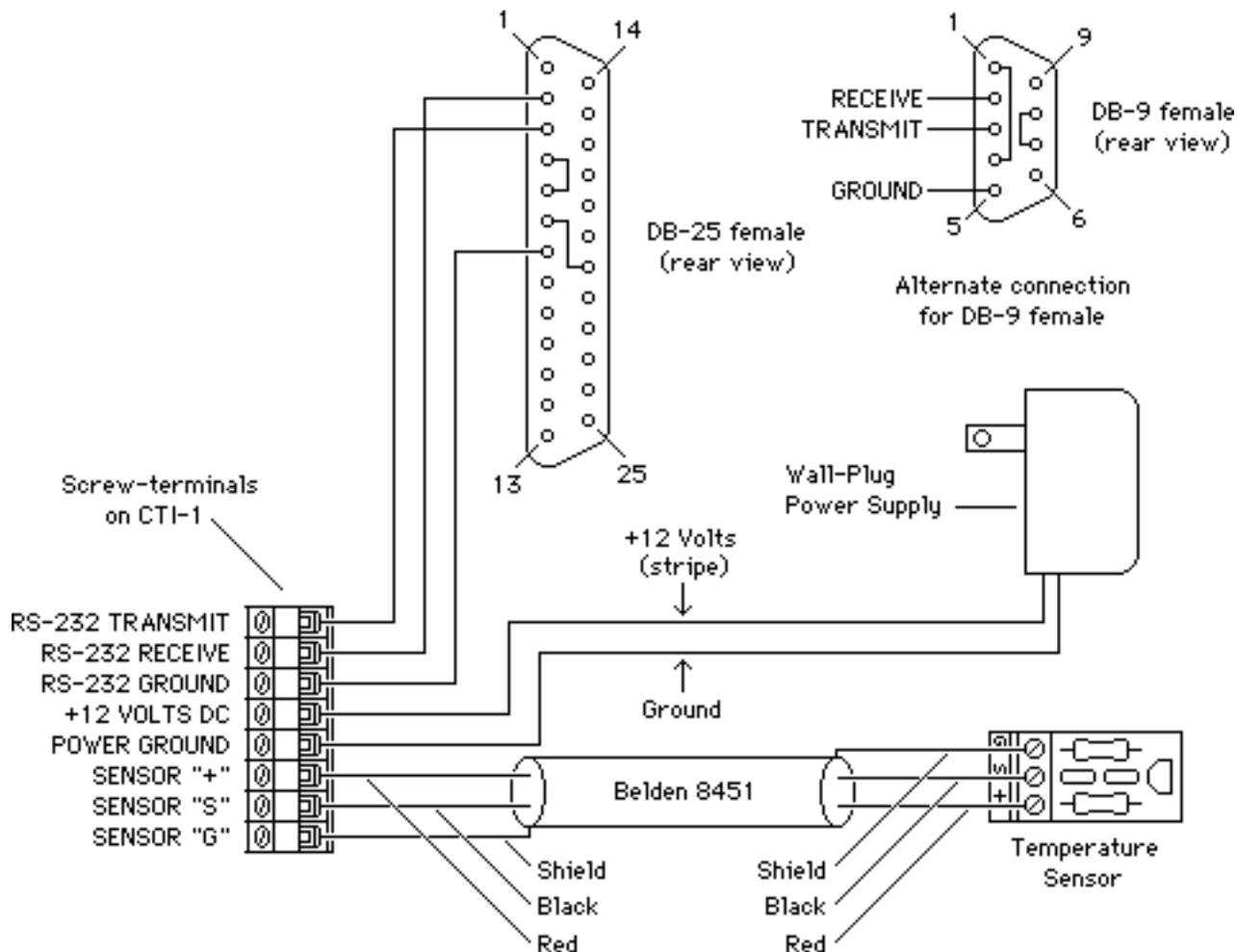
A nylon clamp is included which can be used to mount the capsule, if required. The capsule is made of non-UV resistant nylon. If it is mounted where it is exposed to direct sunlight, it is suggested that it be covered with a length of black heat-shrinkable tubing.

When visiting the enclosure during the summer months you might want to take a can of wasp-and-hornet-killer with you. They just love to build nests in these things.

Calibration of the sensor is discussed in the following section.

## Electrical Installation

All electrical connections to the CTI-1 are made with 8 screw-terminals located on the front panel. The following illustration gives an overview of all the connections. More detailed information about each connection is given in the subparagraphs that follow.



### Temperature Sensor

The temperature sensor consists of a small PC board with three screw-terminals. It may be located up to 200 feet from the main unit. Single-pair foil-shielded cable should be used to connect the sensor to the main unit (Belden 8451 or equivalent). The shield conductor is electrically offset from ground by 0.8 volts so care should be taken that it connect only to the appropriate terminals on each end. Be particularly careful not to cut or puncture the outer insulating jacket of the cable anywhere it is outdoors except where it connects to the sensor.

## Power Supply Connection

The CTI-1 is powered by 12 volts DC. The included wall-plug power supply should be used. If the power supply cord has a connector attached, cut it off and strip the leads. The wire with the white stripe is positive and should be attached to terminal 9. The other wire should be attached to terminal 8.

## RS-232 Connection

The remaining three terminals on the control module are for connection to the computer's RS-232 port. The above diagram shown how to connect a standard 25 pin "D" connector and, alternately, a 9 pin "D" connector. The vast majority of RS-232 interfaces can be made with one of these two connectors.

The two jumper connections shown on the connector can provide CTS and DSR signals back to the computer for applications where this is required.

## Setting Baud Rate

While the factory baud rate of the CTI-1 is set to 9600, it may be changed to any of 5 other values. To change the baud rate of the CTI-1, the host computer (or terminal) must first be set to the baud rate currently programmed for the CTI-1. To change the baud rate, one of the following commands should be sent :

```
9600[CR]
4800[CR]
2400[CR]
1200[CR]
0600[CR]
0300[CR]
```

where [CR] is an ASCII carriage return, or a line-feed/carriage return. The baud rate of the CTI-1 will switch immediately. The baud rate programming is stored in nonvolatile memory and will be retained even if power to the CTI-1 is disconnected for an extended period.

## Sensor Calibration

The CTI-1 temperature sensor is pre-calibrated to  $\pm 3^{\circ}\text{F}$ . It may be field-calibrated to a greater accuracy if an accurate thermometer is available. To do this, a thermometer of known accuracy should first be placed as close as possible to the temperature sensor. Give it about ten minutes to stabilize in temperature. Then read the calibration thermometer and send a text string in the following format to the CTI-1:

```
+072[CR]
```

where [CR] is an ASCII carriage return, or a line-feed/carriage return. In this example, the CTI-1 is set to  $72^{\circ}$ . Use a minus sign for calibrating temperatures below zero. Always use three digits for the temperature. Zero degrees should be calibrated as +000[CR]. The sensor calibration programming is stored in nonvolatile memory and will be retained even if power to the CTI-1 is disconnected for an extended period.

The accuracy of the CTI-1 calibration is limited by the accuracy of the calibration thermometer. Thermometers of known accuracy are available at laboratory supply companies. A dial-type thermometer with an 8-inch stem, a 2-inch dial, a range of 25°F to 125°F and an accuracy of 1% full-scale can be ordered from Edmund Scientific Company.

## **OPERATION**

### **Reading the Temperature**

To read the temperature, the host computer (or terminal) should send an ASCII carriage return or a combination line-feed/carriage return. The CTI-1 will respond with a plus or minus sign followed by three numerals and a carriage return. For example, 72° will be reported as +072[CR]. Zero degrees will be reported as +000[CR].

### **Miscellaneous Commands**

To read the software version contained in the CTI-1, send the string C000[CR]. The CTI-1 will return the version of the resident software, "1.00" for example.

To return the CTI-1 to the factory default temperature calibration, the string C001[CR] should be sent. The CTI-1 will then respond with the temperature as computed with the factory calibration.

To read the current temperature calibration value, send the string C002[CR]. Values from 0000[CR] to 0020[CR] will be returned. 0010 is the factory calibration value and corresponds to "zero" correction of the temperature sensor. The user calibration range is ±10 degrees from this value.

### **Error Codes**

When the CTI-1 receives an invalid command, the string E000[CR] is returned. If there is a problem with the temperature sensor or associated wiring, the CTI-1 will respond with E001[CR] when the temperature is requested. If the user attempts to calibrate the sensor more than 10 degrees from the original sensor calibration, the CTI-1 will return E002.

### **Summary Of All Operating Codes**

[CR]	reads temperature
+072[CR]	sets temperature
9600[CR]	sets baud rate
C000[CR]	reads software version
C001[CR]	sets temperature calibration to factory default
C002[CR]	reads calibration value (0 to 20)

### **Summary Of All Error Codes**

E000[CR] invalid command

E001[CR] sensor error

E002[CR] attempted calibration is out of range