

**Single Channel Control**  
**Automatic Ramping**  
**RS232/IEEE-488**  
**Local Programming**  
**Battery Backed Memory**  
**Dual PID Control**  
**Safety Features:**  
     **Upper Temperature Limit**  
     **Lower Temperature Limit**  
     **Failsafe Input**  
**Variety of Inputs:**  
     **J, K, or T Thermocouple**  
     **RTD Probe**  
     **Solid State Probe**  
     **Voltage Input**  
     **Current Input**  
**Menu Driven Setup Mode**  
**Flexible Control Outputs**  
**Compressor Control**

TC02 IN TENNEY JR.



TC02 IN DELTA 2300



The Model TC02 is a digitally controlled, single-channel, ramping, temperature controller with dual PID control. Programming can be performed from the front panel or remotely. The local program can typically have 100+ segments with looping for cycling. IEEE-488(GPIB) and RS232 remote control are included.

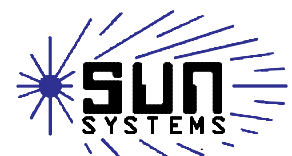
The TC02 was electrically and mechanically designed to be incorporated into temperature chambers manufactured by companies such as Delta Design, Inc. and Tenney Engineering, Inc. The TC02 can also be installed into other temperature chambers and custom systems.

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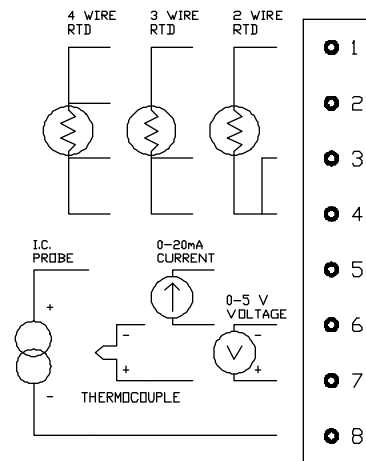
# TC02

The components of the TC02 are shown below: the main controller section, the I/O section, and the remote interface section. The controller section contains the keypad, display, and most of the electronics. The I/O consists of a PC board with a 25 amp solid state relay, two 2 amp solid state relays, a transformer, and two barrier strips for input and output. The remote interface section is a rectangular metal plate with the RS232 connector and the GPIB connector. The I/O board and the remote plate connect to the controller with flat cables. This provides flexibility when installing the TC02. One other item that makes up the TC02 is the sensor. The TC02 accepts thermocouples, RTD's, solid state temperature sensors as well as voltage and current inputs. The sensor plugs into the bottom board of the TC02 and is discussed in Sensor Input below.



Controller, I/O, Remote

### PROBE/SENSOR CONNECTIONS



## Sensor Input

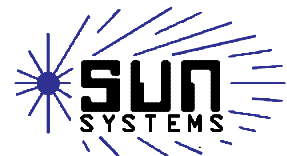
The figure to the right shows the connections for the different kinds of sensors that the TC02 can accommodate. The sensor input has 15 bit accuracy and can detect open and/or shorted probe conditions.

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## Local and Remote Control

The TC02 can be controlled locally using the 22-key keypad and the local programming capabilities. The TC02 has a BASIC-like command set including FOR-NEXT loops for multiple cycles. One local program can either be entered via the front panel or downloaded from a host computer. The local program can also be uploaded to a host computer. Battery backed-up memory is provided so that programs entered will not be lost when the TC02 is turned off or when power is removed from the controller. The local program can be run immediately or programmed to run at a particular time of day.

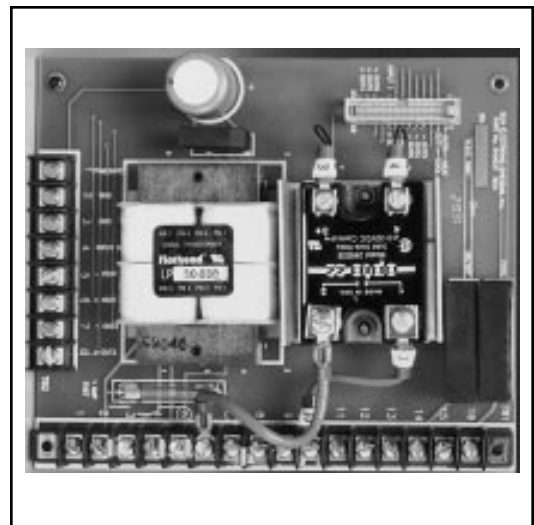
The front panel provides three keys dedicated to entering and examining SET, WAIT, and RATE values. These three keys perform most of the functions needed by most users. The straight forward manner of entering set points, wait times, and ramping rates makes the controller very easy to use.

Remote control of the TC02 is performed by the RS232 or the GPIB (IEEE-488) remote interfaces. Both interfaces come as a standard feature of the TC02 and both support the extensive command set of the TC02. Interrupts, if enabled, will be sent to the active remote interface when the following events occur:

- Single Time Out
- Command Error
- Local Program Timeout
- Local Program Done
- Deviation Setting Exceeded
- Upper Temperature Limit Exceeded
- Lower Temperature Limit Exceeded
- GPIB Lock-up
- Power Going Down
- Power Up
- Local Program Breakpoint Encountered

## Input/Output

The TC02 has 8 bits of on/off output, 2 bits of on/off input, and a failsafe input. (The 8 bits of on/off output and the two bits of on/off input will be referred to as Bit I/O). Of the 8 bits of output, 5 are available to the user through the use of the OUT command. The remaining three are used by the TC02 controller for heat, cool, and power on/off control. The extra outputs are open collector 5V, 100 mA and are capable of controlling TTL or solid state relays. The inputs are available to the user by the use of the IN command. The two inputs can be used to sense TTL or dry relay contacts.

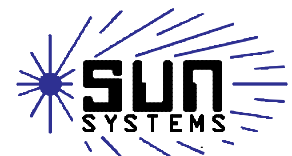


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Also available on the TC02 is one analog output. This port can be configured to drive a chart recorder, output the PID control loop values, or output a voltage from 0-5V. The analog port can be written to using the OUT command.

The Bit I/O and the external failsafe input are located on the I/O board. The analog output is provided on unused pins of the remote RS232 connector.

## Menu

The TC02 contains a menu that is accessed from the front panel to perform the following tasks: calibrate the probe to a standard, change the scale to degrees C, F, or K, enable/disable interrupts, examine the GPIB address, set the baud rate for RS232, set the deviation limit, set the upper temperature limit, set the lower temperature limit, adjust the pulse width modulation period, modify the time of the real time clock, set the line frequency to 50 or 60 Hz, enable/disable the buzzer, and adjust the PID coefficients for heating and cooling.

## Command Set

The command set for the TC02 is a BASIC-like command set which offers many commands to allow for flexibility in controlling temperature profiles.

### Set/Examine Commands

TEMP?	Examine present temperature
SET=NNN.NN	Set SET temperature to NNN.NN
SET?	Examine set temperature
WAIT=HH:MM:SS	Set WAIT time in hours:minutes:seconds
WAIT?	Examine wait time remaining
RATE=NNN.NN	Set RATE to NNN.NN degrees per minute
RATE?	Examine rate
SCALE?	Determine the unit of measure (C, F, or K)

### Power and Enable Commands

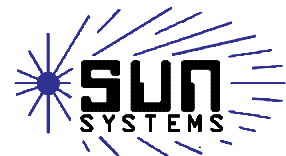
ON	Turn the controller on
OFF	Turn the controller off
CON	Turn the cool enable on
COFF	Turn the cool enable off
HON	Turn the heat enable on
HOFF	Turn the heat enable off

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## Local Program Commands

EDIT	Edit the local program
RUN	Run the local program immediately
RUN TIME=HH:MM:SS	Run the local program at time of day
DEL	Delete local program and delete line when in LP edit
FOR In, KK, MM, [+,-]	In=counter variable (n=0-9), KK=starting loop value, MM=ending loop value, [+,-] indicates if In variable is incremented or decremented
NEXT In	End of matching FOR loop
LIST	Upload local program to host
STORE	Download local program from host

## I/O Commands

OUT0:n,m m=0	Bit I/O command where n=2 through 6 for the address of the output, and or 1 to turn the output on or off (1=on, 0=off)
IN0:n,Im through Im?	Bit I/O command where n=0 or 1 for the address of the input and m=0 9 for the I variable to store the state of the input Read the current value of I variable m, where m=0 through 9
OUT3:nn	Analog port I/O command where nn=8 bit integer from 0-255, where 0=0 V and 255=5 V

## Control Loop Parameters

PIDH=nn,nn,nn	Set the heat PID coefficients
PIDC=nn,nn,nn	Set the cool PID coefficients
PIDH?	Examine present heat PID settings
PIDC?	Examine present cool PID settings
PWMP=nn	Set PID pulse width modulation period (2 to 30 seconds)
PWMP?	Examine PID pulse width modulation period

## Safety Limit Commands

UTL=nnn.n	Set the upper temperature limit
LTL=nnn.n	Set the lower temperature limit
DEVL=nnn.n	Set the deviation limit
UTL?	Examine the upper temperature limit
LTL?	Examine the lower temperature limit
DEVL?	Examine the deviation limit

## TC01 Compatibility Commands

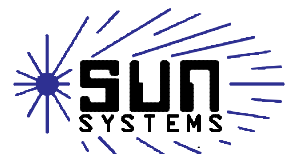
nnn.nC	Set temperature nnn.n in deg C
C	Examine set temperature in deg C
nnn.nM	Set wait time nnn.n in minutes
M	Examine wait time in minutes
T	Examine present temperature in deg C
nnnUTL	Set upper temperature limit nnn
UTL	Examine upper temperature limit

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## Application

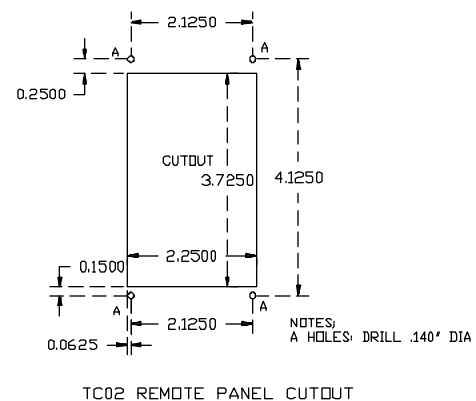
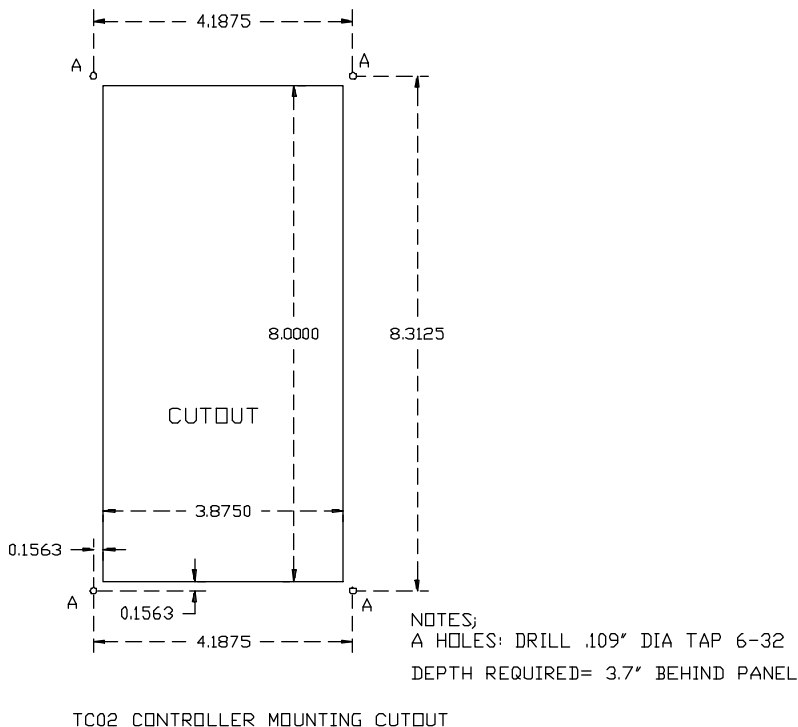
The most common application for the TC02 is that of controlling a temperature chamber. Following is an example hookup for a typical temperature chamber. Drawings for the necessary cutouts to mount the TC02 are also included below.

The schematic shows three solid state relays on the TC02 I/O board. The relay labelled "COOL SSR" drives a 110 VAC valve. This valve controls the flow of coolant into the chamber. The relay labelled "ON SSR" drives a 110 VAC fan motor. This relay will be on at all times when the controller is ON. The relay labelled "HEAT SSR" drives the chamber heaters .

There is also an electro-mechanical failsafe relay in series with the heater circuit. The failsafe relay will trip when the temperature detected by the bi-metal failsafe (shown connected to 1 and 2 of TB2) in the chamber exceeds the failsafe temperature. Pin 1 of TB2 is the / FAILSAFE input. This is an active low input that, when active, will turn off all of the outputs. The relay in series with the heaters is provided to insure that the heaters are turned off even if the HEAT SSR should fail in the on condition. Therefore, if the ON SSR output is off, the relay in series with the heaters will always remove power from the heaters .

## TC02 Cutouts

Shown below are the cutouts necessary for the TC02 in your retrofit application. The cutouts are necessary for the TC02 front panel and the remote interface.

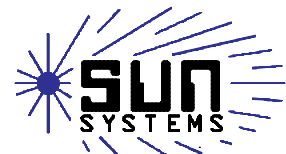


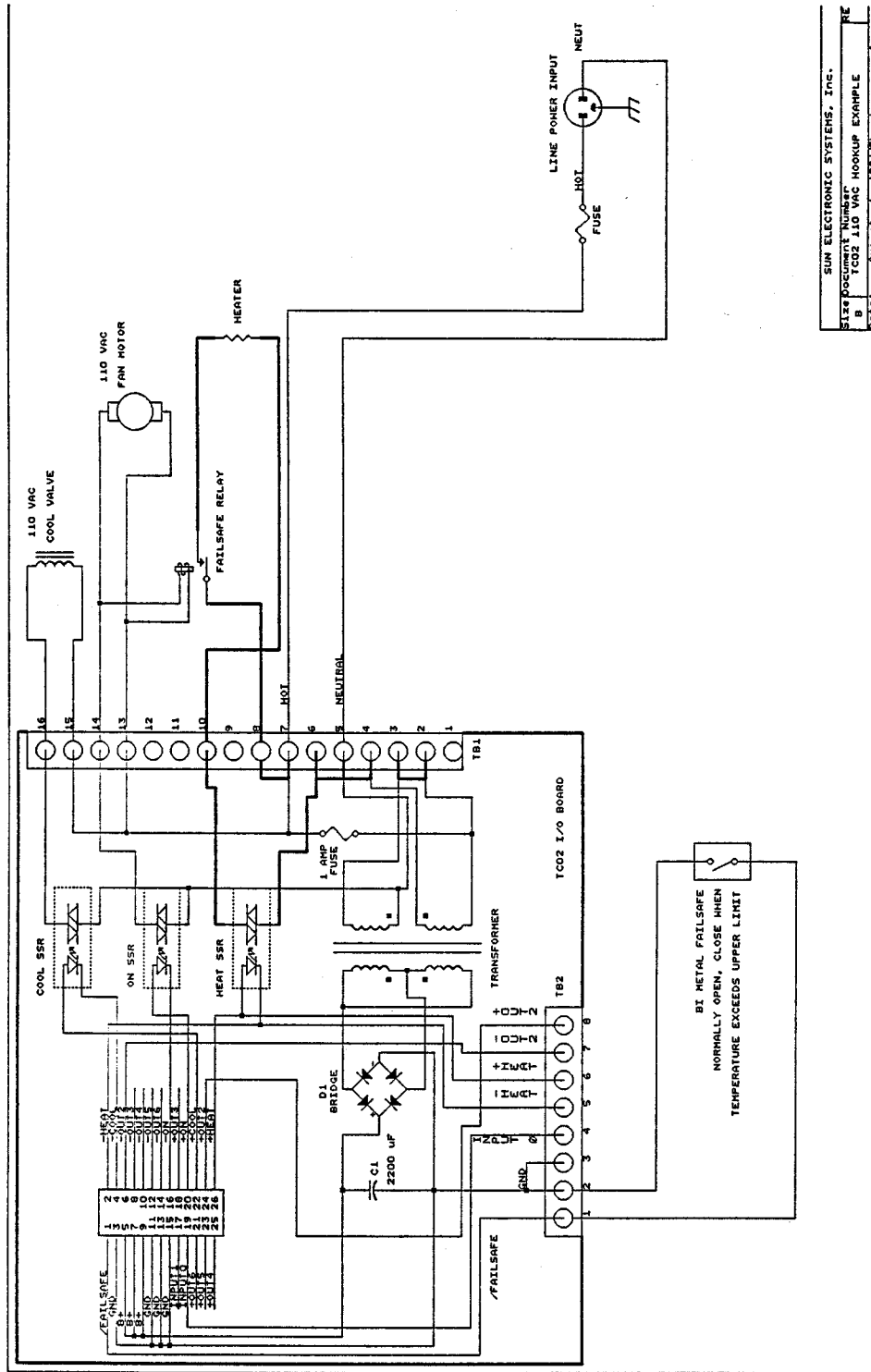
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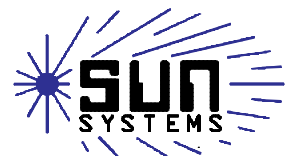
SUN ELECTRONIC SYSTEMS, INC.  
 SIZE DOCUMENT NUMBER  
 B TC02 110 VAC HOOKUP EXAMPLE  
 DATE AUGUST 1, 1991 SHEET 1 OF 1

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## Specifications

Power Requirements	Power consumption: 35 W Voltage: 110/220/240 Frequency: 50/60 Hz 4.75"W x 9"H x 4.5"D
Mechanical Package	Full range of probe selected
Temperature Set Point Range	1 sec to 100 hours or continuous
Time at Temperature Range	Automatically controlled from .01 deg C/min up to the heat/cool rate of change of the system
Temperature Ramping Rate Control	Number of set temperatures and set times limited only by available program memory, but typically 100+ segments
Programmable Set Temps and Times	+/- .25 deg C
Absolute Error (not including probe error)	
Long Term Stability (per month)	+/- .2 deg C
Temperature Resolution	.02 deg C
Line Voltage Sensitivity	+/- .1 deg C for 10 % line change
Local Junction Compensation (5 to 45 deg C)	.05 deg C/deg C
Programmable Temperature Loop Control	1 to 65,535 FOR/NEXT loop executions for 10 loops, nesting supported
Temperature Control Technique	PID algorithm/Pulse width modulated or analog out, programmable from keyboard or remote interfaces
Local Operation	22 key keypad, 2 line 16 characters per line alphanumeric LCD display
Remote Operation	Built in IEEE-488 and RS232 interfaces
Additional I/O Capability	5 auxiliary outputs, 2 auxiliary inputs, 1 analog output channel
Safety Features	Open/short probe detection, adjustable upper and lower temperature limits
Convenience Features	Heat/cool enable/disable switches, battery- backed memory for local program, configuration menu, remote interrupt operation, battery-backed time of day clock

## Sensor Input Ranges

RTD (.385 or .392)	-200 to +325 deg C
J Thermocouple	-200 to +760 deg C
K Thermocouple	-200 to +1250 deg C
T Thermocouple	-200 to +325 deg C
Solid State	-60 to +160 deg C
Voltage	Within 0 to 5 Volt
Current	Within 0 to 20 mA

07/02

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