

MODEL PC10 TEMPERATURE CONTROLLER USER MANUAL

Covers Model PC10.

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Contents

| | |
|---|-----------|
| 1. GENERAL INFORMATION | 5 |
| A. INTRODUCTION | 5 |
| B. LIMITED WARRANTY INFORMATION | 5 |
| C. INITIAL INSPECTION AND UNPACKING | 6 |
| D. LOST OR DAMAGED EQUIPMENT | 6 |
| E. PC10 GENERAL DESCRIPTION | 6 |
| F. MOUNTING AND CONNECTING CONTROLLER | 6 |
| 2. FRONT PANEL DESCRIPTION | 15 |
| A. 7 SEGMENT DISPLAY | 15 |
| B. LED INDICATORS | 15 |
| C. KEYPAD | 15 |
| 3. MENU | 17 |
| A. RESET CONTROLER (SE-9) | 17 |
| B. CALIBRATE PROBES (CALP) | 17 |
| C. MODIFY SCALE (U= C & U= F) | 18 |
| D. SET BAUD RATE (BD=) | 18 |
| E. RS232 ECHO ON/OFF (ECON) | 18 |
| F. COMPRESSOR CTL (CCON) | 18 |
| G. COOL BOOST (CBON) | 18 |
| H. P COEFFICIENT FOR HEAT (P-H) | 18 |
| I. I COEFFICIENT FOR HEAT (I-H) | 19 |
| J. D COEFFICIENT FOR HEAT (D-H) | 19 |
| K. P COEFFICIENT FOR COOL (P-C) | 19 |
| L. I COEFFICIENT FOR COOL (I-C) | 19 |
| M. D COEFFICIENT FOR COOL (D-C) | 19 |
| 4. INPUT/OUTPUT | 20 |
| 5. DETAILED COMMAND DESCRIPTIONS | 21 |
| COFF | 21 |
| CON | 21 |
| CSET | 22 |
| DEVL | 23 |
| HOFF | 23 |
| HON | 24 |
| LLO | 24 |
| LP | 25 |
| LTL | 25 |
| OFF | 26 |
| ON | 26 |
| OUT | 27 |
| PIDC | 27 |
| PIDH | 28 |
| PWMP | 29 |
| RATE | 30 |
| RESET | 31 |
| RTL | 31 |
| SET | 32 |
| SET SEGMENT | 33 |
| STOP | 33 |
| STOP-9 & STOPE9 | 34 |
| TEMP | 34 |
| UTL | 35 |
| WAIT | 36 |

| | |
|---|-----------|
| 6. ERROR MESSAGES | 37 |
| 7. SPECIFICATIONS | 38 |
| 8. REPAIR INFORMATION | 39 |
| 9. REPLACEMENT OR OPTIONAL PARTS | 40 |

1. GENERAL INFORMATION

A. INTRODUCTION

Congratulations on your purchase of the PC10 Temperature Controller!! Your new controller was manufactured under stringent quality control procedures to insure trouble free operation for many years of service. If you should encounter difficulties with the use or operation of your controller, contact Sun Systems' "Customer Service Department" between the hours of 9:00 and 5:00 EST.

As with all Sun Systems products, we would appreciate any comments, suggestions or criticisms that you may have or develop regarding your evaluation of this equipment. Please address your comments to:

Product Service Manager
Sun Electronic Systems, Inc.
1845 Shepard Drive
Titusville, FL 32780
Tel: (321) 383-9400
Fax: (321) 383-9412
Email: sales@sunelectronics.com
Website: www.sunelectronics.com

B. LIMITED WARRANTY INFORMATION

PC10 Temperature Controller

SUN ELECTRONIC SYSTEMS, INC. WARRANTS THIS PRODUCT TO THE ORIGINAL PURCHASER TO BE FREE FROM DEFECTS IN MATERIAL AND WORKMANSHIP AND TO OPERATE WITHIN APPLICABLE SPECIFICATIONS FOR A PERIOD OF TWO (2) YEARS FROM THE DATE OF SHIPMENT, PROVIDED IT IS USED UNDER NORMAL OPERATING CONDITIONS. THIS WARRANTY DOES NOT APPLY TO SEALED ASSEMBLIES WHICH HAVE BEEN OPENED, OR TO ANY ITEM WHICH HAS BEEN REPAIRED OR ALTERED WITHOUT SUN SYSTEMS AUTHORIZATION.

RISK OF LOSS OR DAMAGE TO THE PRODUCT SHALL PASS TO THE CUSTOMER UPON DELIVERY, BY SUN SYSTEMS, TO THE CARRIER AT SUN SYSTEMS PREMISES.

WE WILL REPAIR OR, AT OUR OPTION, REPLACE AT NO CHARGE ANY OF OUR PRODUCTS WHICH IN SUN SYSTEMS JUDGMENT, ARE FOUND TO BE DEFECTIVE UNDER THE TERMS OF THIS WARRANTY. EXCEPT FOR SUCH REPAIR OR REPLACEMENT, SUN SYSTEMS WILL NOT BE LIABLE FOR ANY LOSS OR DAMAGE TO PERSONS OR PROPERTY CAUSED EITHER DIRECTLY OR INDIRECTLY BY USE OF THIS PRODUCT OR FOR ANY INCIDENTAL DAMAGES OR FOR ANY CONSEQUENTIAL DAMAGES, AS THOSE TERMS ARE DEFINED IN SECTION 2-715 OF THE UNIFORM COMMERCIAL CODE. BEFORE USING, PURCHASER SHALL DETERMINE THE SUITABILITY OF THIS PRODUCT VIA THIS DOCUMENT FOR HIS INTENDED USE AND PURCHASER ASSUMES ALL RISK AND LIABILITY WHATSOEVER IN CONNECTION THEREWITH. NO STATEMENT OR RECOMMENDATION NOT CONTAINED HEREIN SHALL HAVE ANY FORCE OR EFFECT UNLESS IN AGREEMENT SIGNED BY AN OFFICER OF SUN ELECTRONIC SYSTEMS, INC.

C. INITIAL INSPECTION AND UNPACKING

Inspect the shipping container for obvious damage. If the shipping container is damaged, then a written note on the bill of lading describing the damage should be made while the delivery person is still on the premises. Unpack the PC10 and save all carton and cushioning material in case the unit needs to be returned. Verify the contents of the carton matches that of the items listed on the packing slip.

D. LOST OR DAMAGED EQUIPMENT

If you determine that the goods described on the packing slip are lost or damaged, first notify the transportation company to obtain the correct procedure for returning merchandise for repair or replacement. Then call Sun Systems for a return material authorization (RMA) number, so that we may best handle the merchandise when it is returned.

E. PC10 GENERAL DESCRIPTION

The Model PC10 is digitally controlled, single-channel ramping temperature controller that comes with a standard RS232 remote control capability.

The PC10 consists of three components: the main controller section, a 20 conductor process I/O cable, and a temperature sensor (See Note below). The controller section contains the keypad, display, and all the electronics. The PC10 was calibrated at the factory using the probe supplied with the controller, if the probe was ordered.

Inspect all shipping material and containers for the items described above. If you have not received all of the items listed, call Sun Electronic Systems for assistance.

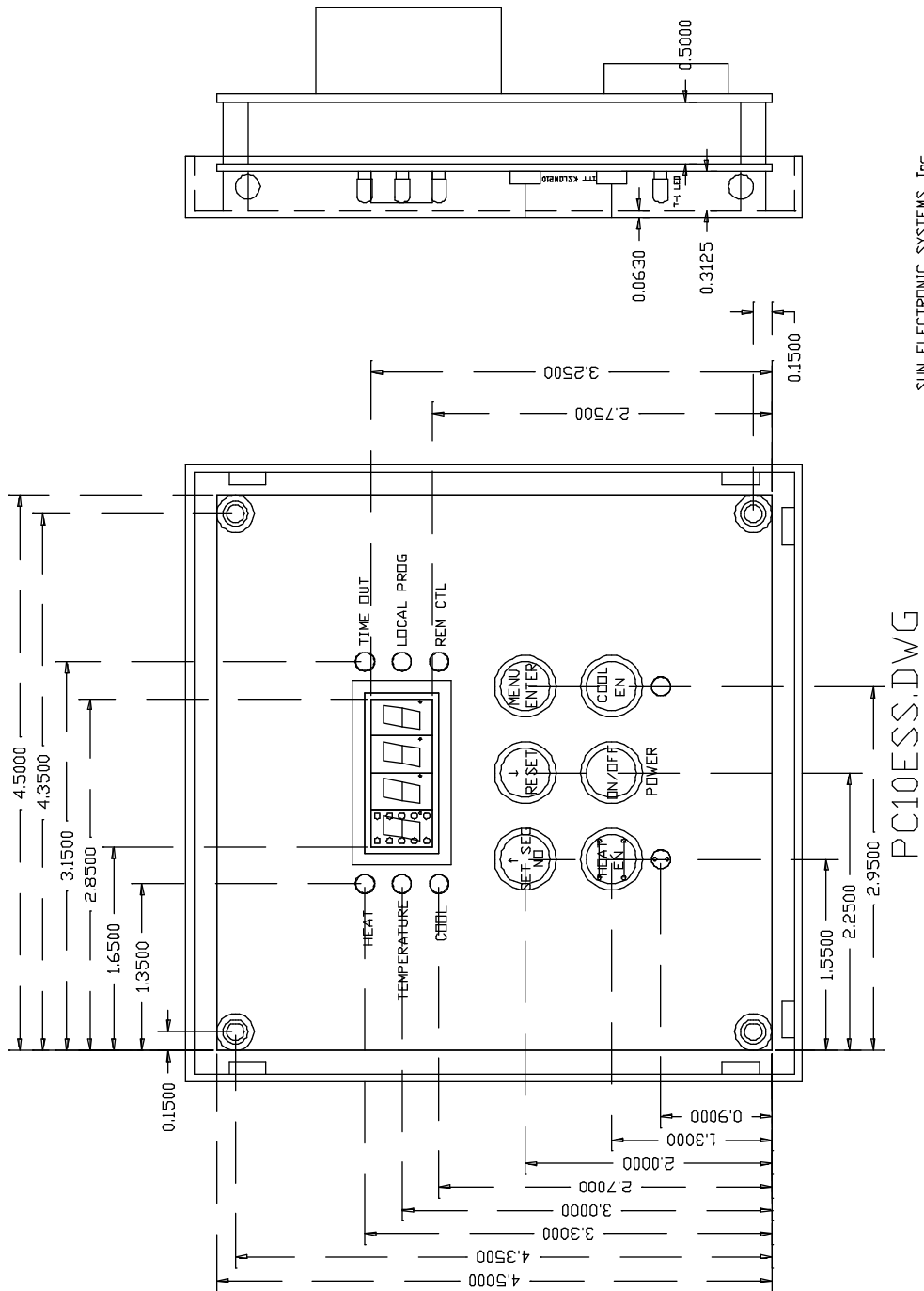
Note: The PC10 comes only with a 4 pin connector and does not include temperature probe unless it was ordered as an option. See Page 9 for sensor hookup information.

F. MOUNTING AND CONNECTING CONTROLLER

First make sure that line power is disconnected from the equipment before work is started.

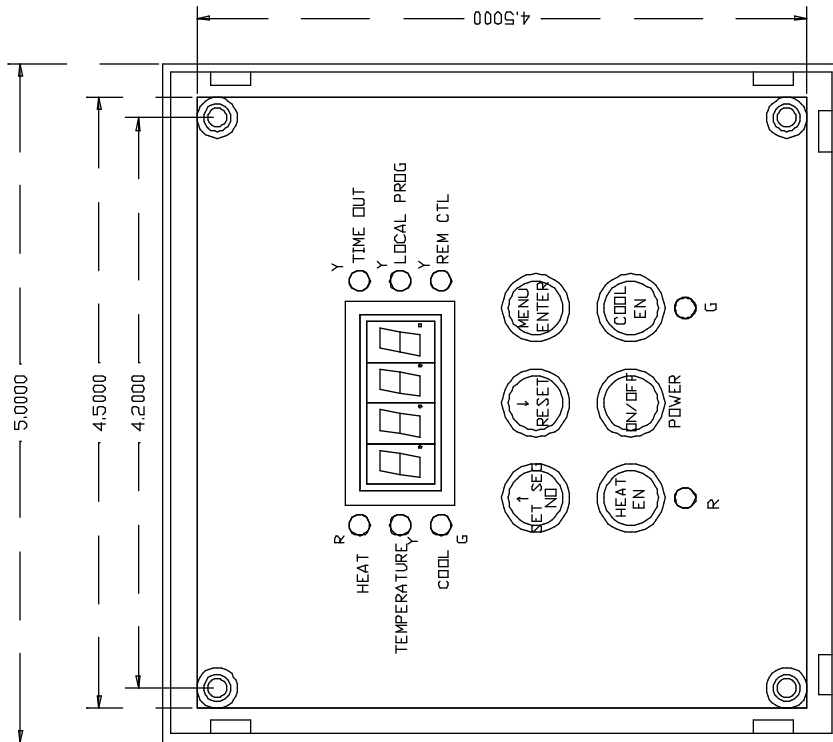
Connection of the PC10 to your equipment involves the following steps. Mounting the main controller, wiring it to your equipment, and finally mounting the temperature sensor.

The PC10 controller mounts into a panel opening shown in figure 1.



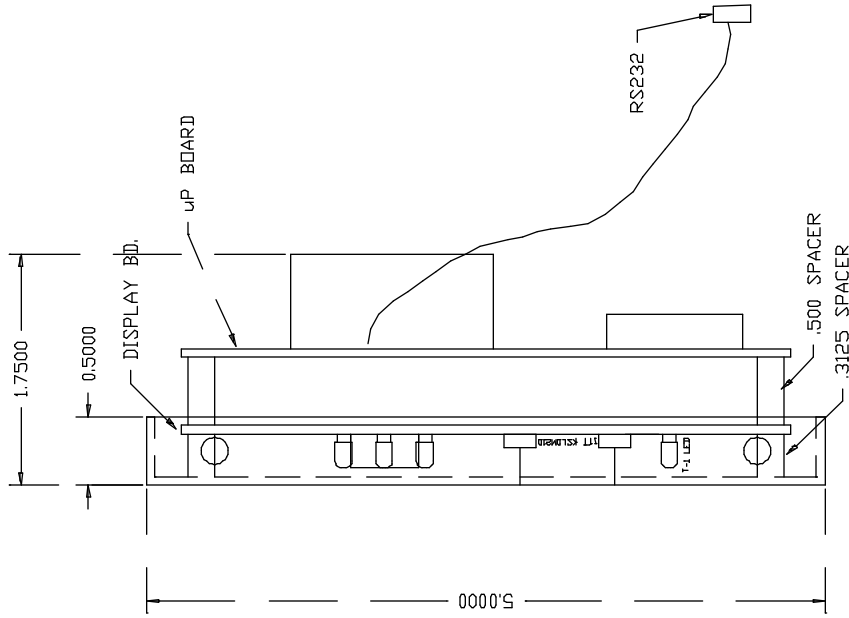
SUN ELECTRONIC SYSTEMS, Inc.
LOW COST TEMPERATURE CONTROLLER FOR ESS GGC 1/95

PC10ESS.DWG



FRONT VIEW

PC10ESS.DWG



RIGHT SIDE VIEW

SUN ELECTRONIC SYSTEMS, Inc.

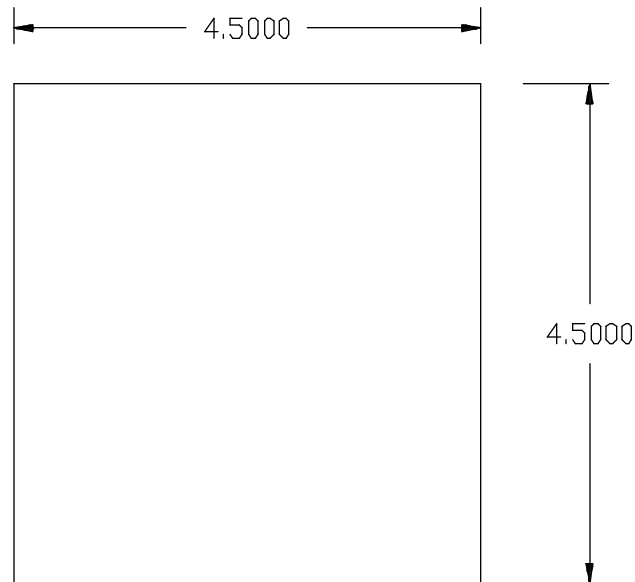


Figure 1. Panel Opening for PC10

AC line voltage is connected directly to the controller at the locations marked HOT, NEUTRAL, and GND. Jumpers are provided on the board for line voltage selection. Install jumpers at locations marked 110 for 110 VAC operation, and at location marked 220 for 220 VAC. The 20 pin process I/O connector provides all of the wiring connections to your equipment. Note that the process outputs cannot drive line powered loads directly. It is mandatory to use a relay between the I/O board and your heater, cool valve, etc. The most commonly used power driver for powering heaters or valves, etc, is a solid state relay module. They are available in a multitude of voltage and current capacities that are easy to use and very reliable. They are controlled by a 3 to 32 volt control signal (provided by I/O board) and typically control a 110/240 VAC load. The line side is isolated from the control side via its internal optical isolator, and the line side turns on at line zero voltage crossings to minimize electrical noise. To connect a process control output bit to a solid state relay (SSR) simply connect the +12 volt output to the relay positive input and connect the open collector bit output to the SSR minus terminal. The SSR should be mounted to a metal panel in your equipment for heat sinking. An example hookup of the process outputs to a temperature chamber is shown in figure 2.

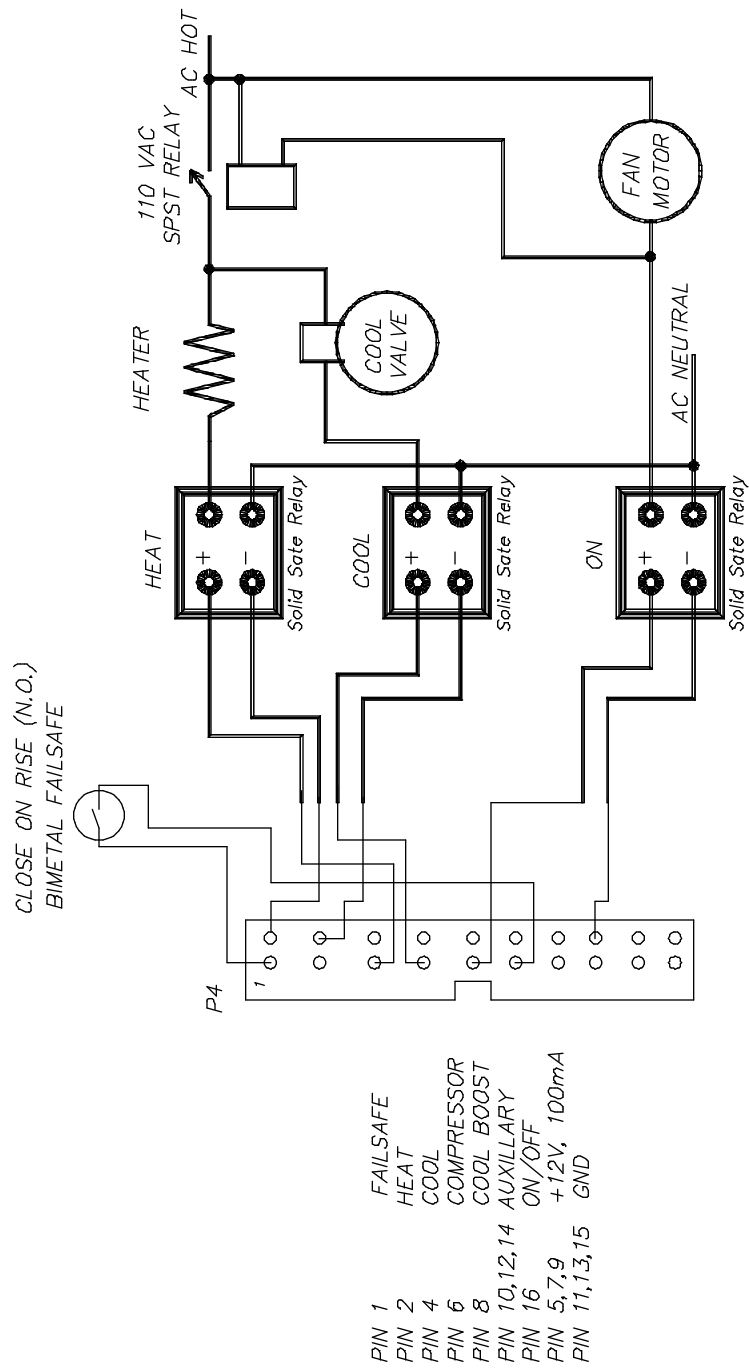
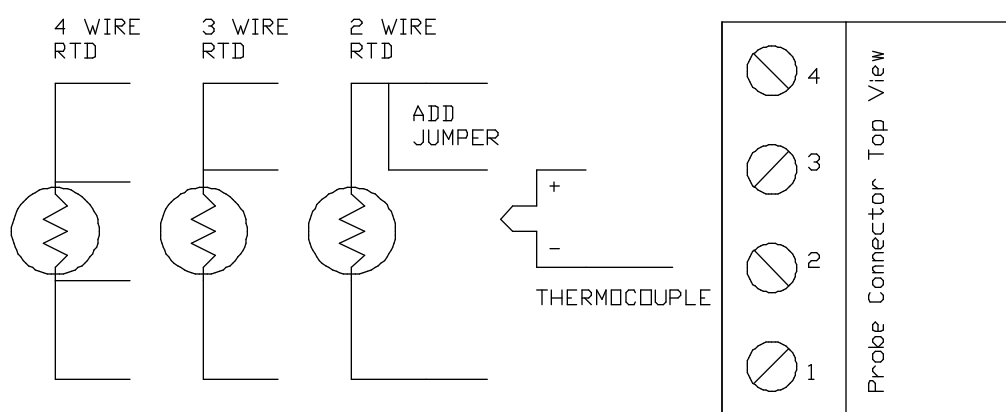


Figure 2. Example Hookup of Process Outputs to a Chamber

Also available is a fail-safe contact closure input, and controller ground connections. Contact closure between the fail-safe input and ground will turn off all of the process control outputs. For safety purpose, a bi-metal over temperature failsafe sensor and a relay should be incorporated in the heating circuit to prevent over heating should the heater solid state relay fail in the on condition. See figure 2.

The last step is to mount the temperature sensors. Your PC10 has been set up for the type of probes requested when ordering the controller. The unit is set for degree C temperature scale by default when shipped. Figure 3 shows the connection diagram for all of the probe types accepted by the PC10. Probe type changing, temperature scale changing, and calibration are covered later in this manual. When locating the temperature probe try to select a location that will minimize the thermal time delay between process temperature variations and the probe's sensed temperature.



PROBE/SENSOR CONNECTIONS

Figure 3. Connection Diagram for Probe / Sensor

At this point make sure that all the cables are plugged into the PC10 and then close up your equipment chassis. Apply power to the controller and press the front panel ON button. The unit will power up and begin displaying the probe temperature. Until a temperature is set, the controller will not turn on your heat or cool loads so the temperature should not change much if the wiring is ok. At this point you should check that the controller can turn on and off your process heating and cooling loads. To check the heater, enable the heat enable by pressing the front panel heat enable key (LED on). Next press the SET SEG key. The PC10 will prompt you with Edit Local Program (E LP), press NO and the controller will display RATE (rA =) on the display. Press NO key to leave it unchanged. Next it prompts with WAIT/SOAK (So =), again press NO key. Then the controller prompts with SET (SP =). Press ENTER button, The controller responds with "nonE" message indicating that a temperature has not been set. Press the UP/DOWN key set a new temperature. Holding a button pressed will change the value faster. Hold the UP key until 50 is reached. Then press ENTER button to set the target temperature for 50 deg C. You may use any other temperature above the probe temperature. You will now see the HEAT LED turn on signifying that the heat process output (Bit 0) is on. If the heater is wired correctly the temperature should move higher. To check the cooling side, press the cool enable and set a low temperature using the SET SEG key as above. If you are using automatic compressor control and/or cool

boost these features must be enabled in the PC10 MENU, (See Section 3). To enable them press the MENU key. Answer NO to each menu question until you reach the parameter you wish to change, then press ENTER key after each prompt to select or NO to go to the next menu item until the menu terminates. Now we can run through the major controller features in a simple example format. First we will run the unit in its simple single temperature mode and then we will create a simple local program from the front panel and run it. Finally we will connect an IBM compatible PC to the RS232 port and run SUN's data logging software, that has been supplied with your PC10, to show remote control features.

Single Temperature Mode Example:

The single temperature mode is the most commonly used mode. You simply set a RATE (rA =) of change in Deg per Minute, set a WAIT/SOAK (So =) at temperature time, then SET (SP =) the target temperature that you want the controller to go to. All three of these parameters are prompted for when the SET SEG key is pressed. First the rA = message is displayed. Pressing ENTER to this will display the current RATE. If you wish to keep the setting then just press ENTER key otherwise use the UP/DOWN keys to change the value and ENTER key to set a new value. Next, the So = message is displayed. Pressing ENTER at this prompt will display the current wait/soak time. Note that 1999 means that the time at temperature counting will not take place. The PC10 will not beep and turn on the time out LED. Use the UP/DOWN keys to enter the new WAIT time, (just the number of minutes) and press ENTER to set or just ENTER for no change. The final prompt is for the set temperature (SP =) that you wish the PC10 to ramp to and control to. Once the above three parameters have been set, and the HEAT and COOL ENABLES are on, the controller will ramp to the SET temperature. As soon as the probe temperature is within +/- 1.0 deg C of the SET temperature the PC10 starts to count down the WAIT/SOAK time. When the wait time reaches zero the TIME OUT LED is turned on and the buzzer beeps. The PC10 continues to hold the SET temperature until you set a new value via the SET SEG key. You can at any time turn off the controlling function by pressing the RESET key or by just disabling the heat and or the cool enables. That is about all there is to the single temp mode.

Shown below is sequence of key inputs to set a target temperature.

| | | |
|---|---|--|
| SETSEG | ; | Enter SET SEGMENT menu |
| E LP | ; | controller responds "Edit Local Program ?" |
| UP | ; | No |
| rA = | ; | Change RATE ? |
| ENTER | ; | Display current rate |
| UP/DOWN | ; | Use up/down keys to change value |
| Note: Holding the key continuously pressed will move the value faster. To slow down give a brief pause between key presses. | | |
| ENTER | ; | Register new RATE |
| So = | ; | WAIT/SOAK TIME? |
| ENTER | ; | Display current WAIT TIME |
| Note: 1999 means WAIT=FOREVER. | | |
| UP/DOWN | ; | Use up/down keys to change value |
| ENTER | ; | Register new WAIT TIME |
| SP = | ; | Change Set Temperature? |
| ENTER | ; | Display current SET TEMP |

Note: nonE indicates no set temp present.

| | | |
|---------|---|----------------------------------|
| UP/DOWN | ; | Use up/down keys to change value |
| ENTER | ; | Register a new SET TEMP. |

After the last step, the controller comes out of the SET SEG menu and displays the current probe temperature on the display. Also note that the TEMPLED lights up only when the controller is displaying the probe temperature. It will be off while displaying any menu item. Now press the Heat and Cool enable keys. The LEDs associated with the keys light up indicating that they are enabled.

Local Program Mode Example:

The local program mode allows the PC10 to cycle through three RATE, WAIT, and SET segments sequentially. The PC10 can loop through the segments up to 255 times. To create a local program you will do the following;

| | | |
|---------|---|--|
| SETSEG | ; | Enter SET SEGMENT menu |
| E LP | ; | controller responds "Edit Local Program ?" |
| ENTER | ; | Yes |
| LP 1 | ; | Edit Loop #1 |
| ENTER | ; | Yes |
| rA = | ; | Change RATE ? |
| ENTER | ; | Display current rate |
| UP/DOWN | ; | Use up/down keys to change value |

Note: Holding the key continuously pressed will move the value faster. To slow down give a brief pause between key presses.

| | | |
|-------|---|------------------------------|
| ENTER | ; | Register new RATE (Say 50.0) |
| So = | ; | WAIT/SOAK TIME? |
| ENTER | ; | Display current WAIT TIME |

Note: 1999 means WAIT=FOREVER.

| | | |
|---------|---|------------------------------------|
| UP/DOWN | ; | Use up/down keys to change value |
| ENTER | ; | Register new WAIT TIME (Say 5 Min) |
| SP = | ; | Change Set Temperature? |
| ENTER | ; | Display current SET TEMP |

Note: nonE indicates no set temp present.

| | | |
|---------|---|--------------------------------------|
| UP/DOWN | ; | Use up/down keys to change value |
| ENTER | ; | Register a new SET TEMP (Say 100.0). |
| LP 2 | ; | Edit Loop #2 |

Repeat the above steps and set RATE=30, WAIT=3, and SET=0.

The above steps are repeated for as many loops as required upto a maximum of three loops. You may select the NO key to stop after any loop. Once the NO key is pressed or after three loops, follow the steps below

| | | |
|-------|---|-------------------------|
| RUN | ; | Run the local program ? |
| ENTER | ; | YES |

Note: You may select NO and exit the Local program menu. The local program however is saved and can be run at any time later.

| | | |
|---------|---|--|
| 0.0 | ; | How many cycles ? (Say 5) |
| UP/DOWN | ; | Use up/down keys to change the # of cycles |
| ENTER | ; | Register the # of cycles |

The program will begin running. The heat and cool enables will turn on and the LOCAL PROG LED will light up. Starting with the current probe temperature, the controller will ramp the temperature to 100 deg at a rate of 50 deg per minute. Once the probe temperature is within 1.0 deg of the set temperature the unit will begin counting down the 5 minute wait time. When the wait time reaches zero the time out LED will blink and the buzzer will beep. The PC10 will then begin its ramp to 0 deg at the rate of 30 deg per minute. After the 3 minutes wait at 0 deg the program will go to the next loop if set or go back to the first loop if more than one cycle is set. Once the controller completes the set number of cycles, the controller disables heat and cool enables, turn off the local program LED and time out LED, and stop all control processes. Again, the program may also be stopped by pressing the RESET key at any time.

2. FRONT PANEL DESCRIPTION

A. 7 SEGMENT DISPLAY

The LED display on the PC10 is a 4 character 7 segment display. When not in the MENU, it displays the sensor temperature reading or any error message. It also displays various responses from the controller. It alternatively displays the sensor temperature and "HOLD" message as long as local program execution is paused.

B. LED INDICATORS

The front panel on the PC10 contains eight LED indicators. The HEAT and the COOL LEDs light when the controller turns on the heat and cool outputs. These LEDs will not light unless the HEAT ENABLE and/or COOL ENABLE are activated. The REM CTL LED lights when RS232 remote control is active. The LOCAL PROG LED lights when a local program is running. The TIME OUT LED lights when the wait time for a set point has timed out. The TEMP LED lights up when the sensor temperature is being displayed. The remaining two LEDs indicate that the heat and/or cool enables are active.

C. KEYPAD

The PC10 controller has six push button switches. Each key is assigned to different functions depending on situation. The function of each key is explained below

UP / SET SEG /

NO

While not in any MENU, the SET SEG becomes active. If you are in a MENU, and if you are scrolling between menu items then NO becomes active. If you are changing the value of a menu item, then UP becomes active. If a local program is currently running, then pressing this key will display the current cycle number, rate, wait time, and set point in sequence.

SET SEG

Allow for easy entry of the RATE, WAIT, and SET values. When the command is entered the controller will display the current setting. The user must then only change the value desired using the UP/DOWN keys or just enter for no change.

UP

Increments the value currently being displayed. Holding the key pressed continuously increments at a faster rate. To slow down, just give a brief pause between key presses.

NO

Just go to the next menu item.

DOWN / RESET

While not in MENU, pressing this button will pause any local program that is currently running or reset any single temperature control process. It also clears the heat / cool enable, time out led, and remote control led. While in a MENU and displaying a numeric value, pressing this key decrements the value. If in Local Program operation, Pressing the RESET key once will pause the local program.

In this mode, the wait time count and local program execution will be suspended. The "HOLD" message with a short beep is displayed periodically until the RESET key is pressed again which will resume the local program execution. If the ENTER key is pressed instead, the controller terminates local program execution in the controller. If running in single temperature mode, then pressing the RESET key terminates the temperature segment and sets SET=NONE and WAIT=FOREVER.

HEAT ENABLE
COOL ENABLE

Used to enable/disable the heat and cool outputs. If the LED is on, the function is enabled. If the LED is off, the function is disabled. The switches operate in a push-on/push-off or alternate action fashion.

ON/OFF

Turns the unit on and off.

MENU / ENTER

The ENTER becomes active only when the MENU is active. MENU causes entry into the PC10 configuration menu. This menu is fully explained in Section 3.

3. MENU

The PC10 contains one menu for configuration. Listed below are the functions contained in the menu. Some of these functions can also be accessed remotely. The menu items are listed in the order of their appearance in the menu.

A. RESET CONTROLLER (SE-9)

This menu provides the means to reset the controller and restore factory default settings from the front panel.

Pressing the MENU key will prompt you with SE-9 message. Pressing RESET key will reset the controller with factory default settings and put the controller into off state. Pressing NO to the above prompt will proceed to the CAL menu.

B. CALIBRATE PROBES (CALP)

The PC10 can be calibrated by placing the probe at 0 and 100 deg C. This can be done only from the front panel. In order to calibrate, you need to connect the required probe type to the connector at the appropriate position as shown in figure 3.

Pressing the MENU key will prompt you with SE-9 (Reset Controller). Answering NO to this will display CALP prompt. Press ENTER if you want to calibrate the probe or press the NO key to go to the next menu item. Choosing the CALP option will prompt you with the ACCESS CODE ? (CODE). At this time you will have to enter MENU-UP-DOWN-UP-ENTER keys in the same sequence to enter the calibration mode. The controller will just skip the CAL mode if a wrong sequence is entered. This prevents unauthorized personnel from inadvertently calibrating the unit. After a correct access code is entered, the controller prompts with various probe type options. Press ENTER to select the probe or press NO to go to the next probe type. The probe types accepted by the PC10 are:

- a) P1 = 2/3/4 Wire RTD, $\alpha = .385$
- b) P2 = 2/3/4 Wire RTD, $\alpha = .392$
- c) P3 = J Thermocouple
- d) P4 = K Thermocouple
- e) P5 = T Thermocouple

After the correct probe type is selected, the PC10 prompts you with 0c (Probe at 0 Deg C ?). At this time you need to place the probe at 0 Deg C (you may use ice water or SUNs TCAL2 probe calibrator) and leave it for a few minutes for stabilization. After sufficient time press ENTER. The controller now displays 100c (Probe at 100 Deg C ?). Now place the probe at 100 Deg C (you may use boiling water or SUNs TCAL2 probe calibrator) and leave it for a few minutes to stabilize. After sufficient time press ENTER. The PC10 now displays the units U= C (unit = Centigrade). Press ENTER if the unit is ok or press NO otherwise. Pressing NO, the controller will display U= F (unit = Fahrenheit). Press ENTER to select and go to next menu item. The display will toggle between U= C and U= F until one of them is selected.

The calibration procedure to calibrate for K Thermocouple is illustrated by the following sequence of key inputs:

| <u>Controller</u> | <u>User Input</u> |
|-------------------|-------------------|
| | MENU |
| SE-9 | NO |

| | |
|------|--|
| CALP | ENTER |
| CODE | MENU-UP-DOWN-UP-ENTER |
| P1 | NO |
| P2 | NO |
| P3 | NO |
| P4 | ENTER |
| 0c | ENTER (After few minutes at 0 Deg C) |
| 100c | ENTER (After few minutes at 100 Deg C) |
| U= C | NO (or ENTER for Deg C) |
| U= F | ENTER (or NO to go back to Deg C) |

C. MODIFY SCALE (U= C & U= F)

Allows changing of temperature scale to deg C, or F. The current unit is displayed first. The user may change it to the other one by pressing NO, and, pressing ENTER when the appropriate unit is displayed.

D. SET BAUD RATE (BD=)

Allows changing of baud rate for the RS232 communication. The PC10 can communicate at 9600, 4800, 2400, or 1200 baud. By default, whenever the unit is reset, the baud rate is set to 9600 baud. After the CAL menu, the next prompt is Bd = . Pressing ENTER will allow you to select the baud rate. The menu cycles through the different options if NO is pressed and selects the appropriate baud rate when ENTER is pressed.

E. RS232 ECHO ON/OFF (ECON)

Allows enabling / disabling the RS232 character echo. Character echo allows you to see what you have typed when communicating from a dumb terminal. When this menu prompt comes up on the display, pressing ENTER will enable and pressing NO will disable the feature.

F. COMPRESSOR CTL (CCON)

This menu item enables the automatic compressor control feature of the PC10. When enabled, Process output bit 2 acts as the control for the compressor. See Section 4 for complete description of the compressor control feature. Pressing ENTER will select this feature and pressing NO will disable it.

G. COOL BOOST (CBON)

This menu item enables the automatic boost cool output control feature. When enabled, Process output bit 3 acts as the control for a boost cooling valve. Boost cooling is used on some closed cycle refrigerated temperature chambers. Pressing ENTER will select this feature and pressing NO will disable it.

NOTE: The PID values for both HEAT & COOL are scaled FOUR times and displayed since very small numbers will be out of range on the 4 character display. However they are scaled back for all internal calculations. (Example: P=.25 will be displayed as 1.0).

H. P COEFFICIENT FOR HEAT (P-H)

This menu item allows examination/modification of the Proportional coefficient of the PID

coefficients for heating. (Factory Default=.250). Press ENTER to display the current value. Once the numeric value is displayed, Press UP/DOWN keys to change the value and finally ENTER to accept the value.

I. I COEFFICIENT FOR HEAT (I-H)

This menu item allows examination/modification of the Integral coefficient of the PID coefficients for heating. (Factory Default=.001). Press ENTER to display the current value. Once the numeric value is displayed, Press UP/DOWN keys to change the value and finally ENTER to accept the value.

J. D COEFFICIENT FOR HEAT (D-H)

This menu item allows examination/modification of the Derivative coefficient of the PID coefficients for heating. (Factory Default=.1). Press ENTER to display the current value. Once the numeric value is displayed, Press UP/DOWN keys to change the value and finally ENTER to accept the value.

K. P COEFFICIENT FOR COOL (P-C)

This menu item allows examination/modification of the Proportional coefficient of the PID coefficients for cooling. (Factory Default=.25). Press ENTER to display the current value. Once the numeric value is displayed, Press UP/DOWN keys to change the value and finally ENTER to accept the value.

L. I COEFFICIENT FOR COOL (I-C)

This menu item allows examination/modification of the Integral coefficient of the PID coefficients for cooling. (Factory Default=.001). Press ENTER to display the current value. Once the numeric value is displayed, Press UP/DOWN keys to change the value and finally ENTER to accept the value.

M. D COEFFICIENT FOR COOL (D-C)

This menu item allows examination/modification of the Derivative coefficient of the PID coefficients for cooling. (Factory Default=.1). Press ENTER to display the current value. Once the numeric value is displayed, Press UP/DOWN keys to change the value and finally ENTER to accept the value.

4.INPUT/OUTPUT

The PC10 has 8 bits of on/off output, and a fail-safe input. Of the 8 bits of output, 5 are available to the user through the use of the OUT0 command. The remaining three (Bit 0,1 &7) are always used by the controller for heat, cool, and power on/off respectively. Some of the 5 remaining outputs may be used if special functions, such as compressor control etc., are enabled in the MENU. The outputs are open collector 12 Volt, 100 mA and are capable of controlling solid state relays or small 12 volt DC relays.

The commands listed below control communication with the output interface:

OUT0:n,m where n=2-6 for the number of the output and m=1 or 0
for on/ off (1=on, 0=off). Bits 0,1, and 7 are used for
heat,cool, and power on/off, respectively.

Compressor Control

Bit 2 of the Bit I/O can be configured to turn on/off the compressor of a compressor based temperature chamber. This feature is enabled via the menu from the front panel. If enabled, bit 2 will be on whenever cooling is required. The bit will remain on to keep the compressor on for a minimum of 4 minutes. If cooling is not required for 4 minutes, bit 2 will be turned off to turn the compressor off. If cooling is required any time, the 4 minute counter is restarted . If bit 2 is to be used for any other purpose, Compressor Control must be disabled from the Menu from the front panel.

The Bit I/O are brought on to the 20 pin edge connector. The pin configuration is as follows:

| | |
|----------------|---------------------------------|
| Pin 1 | Failsafe Input |
| Pin 2 | Heat Output |
| Pin 4 | Cool Output |
| Pin 6 | Compressor / Auxillary 1 Output |
| Pin 8 | Cool Boost / Auxillary 2 Output |
| Pin 10, 12, 14 | Aux 3 - 5 Outputs |
| Pin 16 | ON/OFF |
| Pin 5, 7, 9 | +12V, 100mA |
| Pin 11, 13, 15 | GND |

5.DETAILED COMMAND DESCRIPTIONS

COFF

Function: Disable cooling

Syntax: **COFF**

Description:

The COFF command permits a remote interface to disable cooling by the controller. The front panel COOL switch also disables controller cool function when depressed if cooling was enabled. The local program defaults to CON when the local program begins running.

Restrictions: None

See Also: **CON, HOFF, HON**

Example: COFF« disable cooling

CON

Function: Enable cooling

Syntax: **CON**

Description:

The CON command permits a remote interface to enable cooling operation. The COOL switch located on the front panel can also enable cooling operation if depressed when cooling is disabled. The local program defaults to CON when the local program begins running.

Restrictions: None

See Also: **COFF, HON, HOFF**

Example: CON« Enable cooling operation

CSET

Function: Examine the present control value.

Syntax: **CSET?**

Description:

The CSET command allows for examining the present value that the controller is attempting to control to.

Restrictions: Remote only

See Also: **TEMP?**

Example: assumes scale in degrees C

| | |
|-----------|---|
| RATE=10« | define temperature segment, RATE=10 deg C/m |
| WAIT=30« | wait=30 min. |
| TEMP?« | examine present temperature |
| 25.0 | controller response, 25.0 deg C |
| SET=35.0« | set new final temperature, 35.0 deg C wait 30 seconds |
| CSET?« | examine present ramp target temperature |
| 30.0 | controller response, 30.0 deg C |

DEVL

Function: Set or examine the deviation limit

Syntax : **DEVL=nnn.n** Set deviation limit
 DEVL? Examine deviation limit

Description:

The DEVL command sets the deviation limits for the probe. If the probe temperature varies by more than the set limit, an interrupt (Character "D")will be generated to the RS232 remote interface.

Restrictions: Remote command only. Deviation Limit range is between 0.1 and 300.

See Also: **UTL, LTL**

Example: if SCALE = C

| | |
|------------|--|
| DEVL=2.5« | set deviation limit to 2.5 deg C |
| DEVL?« | examine deviation limit |
| 2.5 | controller response, 2.5 deg C |
| RATE=30« | define temp. segment |
| WAIT=180« | wait for 3 hours |
| SET=-55.0« | set final temp. to -55.0 deg C if after 1 hour, the tempera ture starts to rise, a deviation interrupt "D" will be sent to the RS232 remote interface. |

HOFF

Function: Disable heat output.

Syntax: **HOFF**

Description:

The HOFF command permits a remote interface to disable the heat output. The front panel HEAT switch also disables controller heat function when depressed if heat was enabled. The local program defaults to HON when the local program begins running.

Restrictions: None

See Also: **CON, COFF, HON**

Example: HOFF« disable heat output

HON

Function: Enable heat output

Syntax: **HON**

Description:

The HON command permits a remote interface to disable the heat output. The front panel HEAT switch also disables controller heat function when depressed if heat was enabled. The local program defaults to HON when the local program begins running.

Restrictions: None

See Also: **COFF, CON, HOFF**

Example: HON« Enable heat output

LLO

Function: RS-232 Command to lockout local keyboard

Syntax : **LLO**

Description:

The Local Lockout (LLO) command may be issued from a host processor to lockout the local keyboard. The LLO command only applies to host computers communicating over the RS-232 serial interface. Local keyboard function may be unlocked through the use of the RTL command or removing the power to the unit.

Restrictions:

RS-232 remote interface command only.

See Also: **RTL**

Example: LLO« lockout local keyboard
run sensitive testing
RTL« unlock local keyboard

LP

Function: Examine which local program cycle is currently being executed

Syntax : **LP?**

Description:

If the controller is not in a local program when this command is sent, the controller responds with a command error over the RS232 bus, else it responds with the cycle number currently being executed. This can also be accessed through the front panel by pressing the SETSEG key when a local program is running.

Restrictions: Remote Interface command only.

See Also: Keypad description in section 2.

LTL

Function: Set or examine the lower temperature limit

Syntax : **LTL=nnn.n** Set LTL , variable units
 LTL? Examine LTL, variable units

Description:

The LTL command allows for setting the lower temperature limit below which an interrupt (Character "U") will be generated and the cooling process will be suspended/disabled. The units for the LTL command are those as selected in the MENU for the probe.

Restrictions: Remote command only. Temperature values for the LTL command must range between -200 deg C and the UTL setting.

See Also: **UTL**

Example: If scale is set to deg C
 LTL = -100.0« set LTL to -100 deg C
 LTL? examine LTL
 -100.0 controller response, -100 deg C

OFF

Function: Turn off PC10

Syntax: **OFF**

Description:

The OFF command turns off the PC10. As long as the PC10 is connected to an appropriate line voltage, the controller is still powered on. The OFF command turns off the front panel display, indicators and switch functions, except for the POWER switch. In addition, commands received over the remote interfaces are ignored except for the ON command. Depressing the POWER switch when the controller is ON results in the same function as the OFF command.

Restrictions: Remote interface command only

See Also: **ON**

Example: OFF« Turn OFF PC10

ON

Function: Turn on PC10

Syntax: **ON**

Description:

The ON command enables power and function of the controller. When the controller is plugged in to an appropriate line voltage, the controller is powered on and can accept a power on command from either the front panel by depressing the power switch or from a remote interface by using the ON command.

Restrictions: Remote interface command only

See Also: **OFF**

Example: ON« Turn on PC10

OUT

Function: Output data to the BIT I/O port.

Syntax: **OUT**<device number>:<address>,<data>
 Bit I/O = device 0

Description:

The OUT command permits data to be transferred to an output device such as the Bit I/O. For a complete description on operating with an I/O device, consult the Input/Output Section 8.

Restrictions: Remote Only

Example: OUT0:5,1« set Bit I/O bit 5
 OUT0:5,0 disable bit 5

PIDC

Function: Set or examine PID coefficients for cool control

Syntax: **PIDC**=nnn.n,nnn.n,nnn.n set cool PID coefficients
 PIDC? examine cool PID coefficients

Description:

The PIDC command permits modification and examination of the proportional, integral and derivative (PID) coefficients used in the algorithm which controls the cooling process. PID coefficients may be changed to accommodate varying changes in your system. The PID Application note contains a procedure for tuning PID coefficients to a particular application (Contact Sun for this Application note). PID coefficients are stored in non-volatile memory.

Restrictions:

Remote command only. To change PIDs from the front panel, the MENU must be accessed. **Also see the NOTE in PIDH command description.**

See Also: **PIDH, PWMP**

Example: PIDC=0.5,0.25,0.001« set PID coefficients
 PIDC?« examine PID coefficients
 0.50 controller response, P
 0.25 controller response, I
 0.001 controller response, D

PIDH

Function: Set or examine PID coefficients for heat control

Syntax: **PIDH**=nnn.n,nnn.n,nnn.n set heat PID coefficients
PIDH?« examine heat PID coefficients

Description:

The PIDH command permits modification and examination of the proportional, integral and derivative (PID) coefficients used in the algorithm which controls the heating process. PID coefficients may be changed to accommodate varying changes in your system. The PID Application note contains a procedure for tuning PID coefficients to a particular application (Contact Sun for this Application note). PID coefficients are stored in non-volatile memory.

Restrictions:

Remote command only. To change PIDs from the front panel, the MENU must be accessed.

NOTE: The PID values for both HEAT & COOL are scaled FOUR times and displayed since very small numbers will be out of range on the 4 character display. However they are scaled back for all internal calculations. (Example: P=.25 will be displayed as 1.0).

Hence if you need to enter 0.25, you will have to enter 1.0 instead.

See Also: **PIDC, PWMP**

Example: **PIDH**=0.5,0.25,0.001« set PID coefficients
PIDH?« examine PID coefficients
0.50 controller response, P
0.25 controller response, I
0.001 controller response, D

PWMP

Function: Set or examine the pulse width modulator period

Syntax : **PWMP**=nnn.n set PWM period
 PWMP? examine PWM period

Description:

The PWMP command permits modification of the period allocated to the pulse width modulation algorithm. When controlling temperature, the controller uses a constant period of time of which the controller calculates the portion of time for which heat or cool should be turned on. This is based on the feedback from the probe and the PID coefficients. Shorter periods of time for pulse width modulation translate into faster tracking of changes in your system. When changes are expected to be minimal for an extended time, during long soak periods for example, it is more economical not to adjust quite so frequently. In this case, increasing the PWM period, thus reducing the modulation rate, conserves power and coolant and reduces wear on coolant supply valves.

Restrictions:

Remote only command. Period range from 2 seconds to 30 seconds

See Also: **PIDH, PIDC**

| | | |
|----------|-----------|-------------------------------------|
| Example: | PWMP=2« | set PWM period to 2 seconds |
| | TEMP?« | examine current temperature |
| | 25.0 | controller response |
| | RATE=10« | define new temperature segment |
| | WAIT=5« | set wait for 5 min., stabilize mass |
| | SET=35.0« | set new temp to 35.0 |
| | | after 1 min for ramp and |
| | | after 5 min for wait timeout |
| | PWMP=15« | set PWM period for 15 sec. |
| | WAIT=600« | set long wait period, 10 hrs. |
| | SET=35.0« | again, set temperature |

RATE

Function: Set or examine the current rate of change for ramping

Syntax: **RATE=nnn.n** Set the current ramping rate
RATE? Examine the current ramping rate

Description:

The RATE command allows for setting or examining the rate at which the controller will control the change from one set point to the next set point. Rate is based on the probe and on the units of SCALE set up for the probe in the menu. When setting or examining the rate, nnn.n represents units per minute. Units may be deg F, or C.

Restrictions: Remote only, see SET SEGment in this section for front panel equivalent.
Your system dynamics will limit the maximum ramping rate.

See Also: **SET, WAIT**

Example: If SCALE for the probe is in deg C

| | |
|------------|---|
| RATE=10.0« | set ramping rate for 10.0 deg C/minute |
| RATE?« | examine present ramping rate |
| 10.0 | controller response, 10.0 deg C/min. |
| TEMP?« | read present temperature |
| 25.0 | controller response, for example 25.0 deg C |
| SET=35.0« | set new set point, for example 35 deg C |
| | after waiting 30 seconds |
| TEMP?« | read present temperature |
| 30.0 | controller response, up 5 deg C in one half minute. |

RESET

Function: Terminate local program execution, and terminate single temperature segment execution. This is equivalent to the STOP command.

Syntax: **RESET** key

Description:

If in Local Program operation, Pressing the RESET key once will pause the local program. In this mode, the wait time count and local program execution will be suspended. The "HOLD" message with a short beep is displayed periodically until the RESET key is pressed again which will resume the local program execution. If the ENTER key is pressed instead, the controller terminates local program execution in the controller. If running in single temperature mode, then pressing the RESET key terminates the temperature segment and sets SET=NONE and WAIT=FOREVER.

Restrictions: Front Panel Operation Only.

RTL

Function: RS-232 Command to unlock local keyboard

Syntax: **RTL**

Description:

The Return to Local (RTL) command may be issued from a host processor to unlock the local keyboard. The RTL command only applies to host computers communicating over the RS-232 serial interface. Local keyboard function may be locked through the use of the LLO command.

Restrictions:

RS-232 remote interface command only.

See Also: **LLO**

Example: LLO« lockout local keyboard
run sensitive testing
RTL« unlock local keyboard

SET

Function: Set or examine temperature segment final temperature

Syntax: **SET=nnn.n** Set segment final temperature
 SET? Examine segment final temperature

Description:

The SET command allows for setting or examining the final temperature within a temperature segment. The temperature segment consists of the change of temperature, defined by the RATE command, from the present temperature to the temperature defined by the SET command, plus the time specified by the WAIT command to soak at the temperature defined by the SET command. The units accepted by the SET command are those chosen in the menu. For best results, a temperature segment should be entered as RATE, WAIT then SET.

Restrictions:

Remote only, see SET SEGment in this section for front panel equivalent. The value set by the SET command must range between the values set for the LTL and UTL commands.

See Also: **RATE, WAIT, LTL, UTL**

Example: If SCALE for the probe is in deg C
 RATE=10.0« set ramping rate for 10.0 deg C/minute
 WAIT=5 set wait = 5 minutes
 TEMP?« read present temperature
 25.0 controller response, for example 25.0 deg C
 SET=35.0« set new set point, for example 35 deg C
 SET? examine present set temp.
 35.0 controller response after waiting 30 seconds
 TEMP?« read present temperature
 30.0 controller response, up 5 deg C in one half minute

SET SEGMENT

Function: Allows the user to set the RATE, WAIT, and SET values

Syntax: **SET SEG** key

Description: A1-
allows for easy entry of the RATE, WAIT, and SET values. When the command is entered, the controller responds on the display with the current settings and prompts for new values. The user must then only change the value desired using the UP/DOWN keys or just enter for no change.

Restrictions: Front Panel Operation only.

See Also: **SET, WAIT, RATE.**

STOP

Function: Terminate local program execution, and terminate single temperature segment execution.

Syntax : **STOP**

Description:

If in Local Program operation, the STOP command terminates local program execution in the controller. If running in single temperature mode, then entering the STOP command terminates the temperature segment and sets SET=NONE and WAIT=FOREVER.

Restrictions: Remote Only

STOP-9 & STOPE9

Function: Restores controller to factory default settings.

Syntax: **STOP-9, STOPE9**

Description:

The STOP-9 or the STOPE9 command resets the controller to factory default settings. Calibration information is not affected. The controller will go to the power off mode after this command is executed.

Restrictions: Remote Only

Example: STOP-9« Reset controller to factory default settings.

TEMP

Function: Examine current probe temperature

Syntax: **TEMP?**

Description:

The TEMP command provides the means for a remote interface to read the present value of the probe. This value is normally displayed on the front panel display. The units for the probe are set in the menu for deg F, or C.

Restrictions: Remote Interface command only.

Example: TEMP?« read probe
25.0 controller response, 25.0 units

UTL

Function: Set or examine the upper temperature limit

Syntax : **UTL** TC01 compatible examine UTL in deg C
 UTL=nnn.n Set UTL, variable units
 UTL? Examine UTL, variable units

Description:

The TC01 compatible commands provide for examining the UTL in degrees centigrade only. If temperature units are desired to be the same as that set in the menu , then the UTL=nnn.n and UTL? command formats should be used. If the temperature exceeds the UTL setting, then an over temperature interrupt (Character "O") will be generated to the RS232 remote interface.

Restrictions:

TC01 compatible commands operate from the remote interface only.

See Also: **LTL**

Example: If scale is set to deg F
 UTL« examine UTL in deg C
 150.0 controller response, 150.0 deg C
 UTL?« examine UTL in units, deg F
 302.0 controller response, 302 deg F

WAIT

Function: Set or examine the temperature segment wait period

Syntax: **WAIT=Minutes** set wait in minutes
 WAIT=F(OREVER) set WAIT to forever
 WAIT? examine current wait setting

Description:

The WAIT command determines the time at which the controller will maintain the set temperature after the probe temperature is within +/- 1.0 Deg of the target temperature. Once the wait period begins, the wait time continues regardless of changes in probe temperature. When running a local program, the next loop in the program is executed after the wait period is timed out. In single temperature mode, the controller continues to maintain the set temperature after the wait period timeout. During the wait period, examination of WAIT returns the time remaining in the wait period. After the end of a wait timeout, the WAIT is reset to FOREVER. For best operation the temperature segment should be entered RATE, WAIT then SET.

Restrictions:

Remote only, See SET SEG (SET SEGment in this section for front panel control equivalent). The WAIT time can only be entered in minutes. If it is more than one hour, then, you must convert it into equivalent minutes and enter it.

See Also: **SET, RATE**

| | | |
|----------|-----------|--|
| Example: | RATE=10« | define temperature segment,rate=10 deg C/min |
| | WAIT=10« | wait=10 min |
| | TEMP?« | examine current temperature |
| | 25.0 | controller response, 25.0 deg C |
| | SET=35.0« | set new temperature, 35 deg C |
| | | after 1 minute, set temperature is reached, |
| | | wait period begins; after 1 more minute, |
| | WAIT?« | examine wait setting |
| | 9.0 | controller response, 9 min remaining |

6. ERROR MESSAGES

Several features have been designed into the PC10 controller that provide a measure of protection against damaging or unusual controller operating conditions. While these failsafe features provide the user with a first level failsafe, the controller cannot detect all the failure modes and hence your equipment must have an independent failsafe mechanism.

Error messages are displayed on the display whenever the controller detects any errors. The error messages and their descriptions are listed below:

- | | |
|---------|--|
| 1. PErr | Probe Error!!!. This message is displayed when the controller detects an open thermocouple, or lead compensation error in RTD probe, or when the probe temperature exceed the allowable limit for that type of probe. The heat and cool are disabled whenever this condition occurs. |
| 2. CErr | Calibration Error!!!. This message is displayed when calibration is performed with the thermocouple hooked up backwards. |
| 3. ULer | Upper Limit Error!!!. This message is displayed when the probe temerature exceeds the upper temperature limit setting. The heat and cool are disabled whenever this condition occurs. |
| 4. LLer | Lower Limit Error!!!. This message is displayed when the probe temerature goes below the lower temperature limit setting. The heat and cool are disabled whenever this condition occurs. |
| 5. FSEr | Fail Safe Error!!!. This message is displayed if the failsafe pin on the PWM connector is pulled low. When ever this condition occurs, the controller shuts off all the outputs and it requires power off to reset this condition. |
| 6. PLC | Program Lost Control Error!!!. This message is displayed when the software malfunctions. When this condition occurs, the outputs are disabled and the unit shuts off in a orderly manner. |
| 7. COP | Computer Operating Properly Error!!!. This message is displayed when the software malfunctions. When this condition occurs, the outputs are disabled and the unit shuts off in a orderly manner. |
| 8. CLer | Clock Monitor Error!!!. This message is displayed when the Clock to the microprocessor becomes very low. When this condition occurs, the outputs are disabled and the unit shuts off in a orderly manner. |
| 9. RSEr | RS232 Timeout error!!!. |

7. SPECIFICATIONS

| | |
|----------------------------------|---|
| Power Requirements | Power consumption: 6 W Voltage: 110 / 220 (Jumper Selectable) Frequency: 50 Hz or 60 Hz |
| Mechanical Package | 4.5" x 4.5" x 2.0" |
| Temperature Set Point Range | -200 to +300 Deg C |
| Time at Temperature Range | 6.0 sec to 15 Hours or continuous |
| Temperature Ramping Rate Control | Locally controlled from .1 deg C/min up to the heat/cool rate of change of the system |
| Programmable Set Temps and Times | 3 loops, 1 to 255 cycles |
| Absolute Error | +/- .25 deg C (not including probe error) |
| Long Term Stability (per month) | +/- .2 deg C |
| Temperature Resolution | .02 deg C |
| Line Voltage Sensitivity | +/- .1 deg C for a 10 % line voltage change |
| Local Junction Compensation | .05 deg C/deg C (5 deg C to 45 degC) |
| Temperature Control Technique | PID algorithm/Pulse width modulated, programmable from keyboard or remote interfaces |
| Local Operation | 6 key keypad, 7 Segment display |
| Remote Operation | Built in RS232 interface |
| Additional I/O Capability | 5 auxiliary outputs |
| Safety Features | Open/short probe detection, adjustable upper and lower temperature limits. Fail-safe input |
| Convenience Features | Heat/cool enable/disable switches, temporary memory (for couple of days) for local program, configuration menu, remote interrupt operation. |

8. REPAIR INFORMATION

Due to the test system required, it is not recommended that the PC10 be repaired in the field. If a problem should arise, call Sun directly to resolve the problem over the phone, if possible, or to arrange for the unit to be sent back to Sun for repair.

When calling to return a controller, Sun Systems will issue a Return Material Authorization (RMA) number. This RMA number should be on any paperwork sent with the controller and should also be displayed on the shipping box. If a unit is returned without an RMA number, the repair could be delayed.

Should there ever be a need to replace the software in the PC10 (i. e., with a new version supplied by Sun Systems in an EPROM) the following procedure should be performed:

1. Un-plug the unit. Remove line power to equipment that the PC10 is connected to.
2. Remove the PC10 from the equipment panel.
3. The bottom board contains the firmware EPROM chip.
4. Remove the EPROM carefully and replace it with the new one supplied by Sun Systems.
Check for proper pin orientation when installing IC.
5. Reassemble the unit, re-connect the PC10 rear connectors and remount in equipment panel.
6. Turn the controller on. Next, enter the command STOP-9 from the remote RS232 interface.
This will reset the controller to factory default settings stored in the new EPROM and reboot the controller.

9. REPLACEMENT OR OPTIONAL PARTS

| | |
|--------|-------------------------------|
| 190001 | 3 wire 100 ohm RTD .392 probe |
| 190008 | J thermocouple probe |
| 190009 | K thermocouple probe |
| 190010 | T thermocouple probe |
| 800011 | 3 amp solid state relay |
| 800003 | 25 amp solid state relay |