PROCESS CONTROLLER PC1000

Single or Dual Channel
Control Temperature
- **Humidity**
- **Pressure**
- **Flow**

Local or Remote Operation
RS232/RS422/IEEE-488
Expanded I/0 Architecture
Accurate Analog Input:
- **J, K or T Thermocouple**
- **RTD Temperature Probe**
- **IC Temperature Probe**
- **Voltage Input**
- **Current Input**

Menu-Driven Setup Mode
Battery-Backed Memory
Ramping
Dual PID Control
Safety Features
Fully Progammable
15-bit Electrically Isolated Channels
Cascade Control
Flexible Control Outputs

The PC1000 is a state-of-the-art, dual loop, ramping process controller with many control and monitoring capabilities empowering precise control of factors such as temperature, humidity and pressure. A variety of sensor inputs is available for flexible control. The PC1000 offers local programming via the front panel or remote programming via RS232, RS422 or IEEE-488 interfaces. The PC1000's extensive I/0 capabilities permit maximum flexibility and creativity. An extensive command set assists the user in modelling even the most difficult profile.

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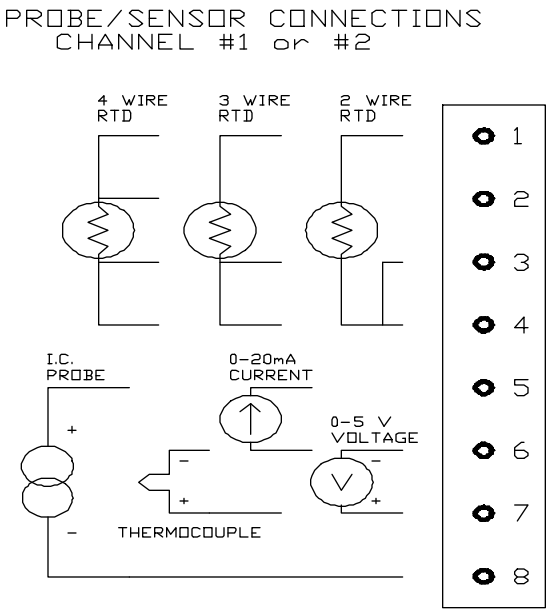
Modes of Operation

The PC1000 can be configured to operate in many ways. In general, the PC1000 can be configured as a single or dual channel process controller. When used as a single channel controller, channel 2 can be used to monitor and also provide limit protection while monitoring. When configured as a dual channel controller, each channel can independently control a process.

Some typical applications would be temperature control on channel 1 and monitor on channel 2, temperature control on channels 1 and 2 (see application #1), temperature and humidity control (see application #2) and temperature and pressure control. The PC1000 is very flexible and will support many control applications.

Sensor Inputs

Connecting sensors to a process controller can be a cumbersome task, but is simplified with the PC1000. The PC1000 accepts input from any of the following sources: RTD, thermocouple, I.C. probe, current and voltage input. The sensors are simply connected to one of the sensor input ports on the back of the PC1000. The sensor type may then be selected via a menu in the PC1000. Each channel can be configured independently. Menus are also present to calibrate the sensors and to select units of measure for each channel. Each channel may be configured for degrees C, F, K, % relative humidity or user units.



SENSOR PORT ON BACK OF PC1000

Local and Remote Control

Programming the PC1000 is made easy with the ability to program locally using the front panel and having the flexibility to program remotely using the IEEE-488, RS232 or RS422 busses (all standard on every PC1000). The PC1000 has a BASIC-like command set including FOR-NEXT loops and GOSUB commands. Local programs can be entered by the front panel or up- or downloaded to/from a host computer. See Command Set section for a detailed description of the PC1000's command set.

Process Control

The PC1000 can control a variety of processes and can fit into most applications. The following features are standard on every PC1000.

• PID Control - The PC1000 has dual PID control for each channel.

• Sensor Inputs - Each input channel is electrically isolated and has 15 bit accuracy as well as the ability to detect open or shorted probe conditions.

• Cascade Control - This method of PID control blends the probe readings of both channels. For example, this PID mode would be used when trying to control the temperature of a device under test while the other channel is controlling the process temperature.

• Staged Control Outputs - Each channel has one staged control output. These outputs enable the user to control power boost heaters, for example, in addition to the normal heater.

• Guaranteed Soak - This requires that the process is within a specified window of the set point before the wait (soak) time begins counting down.

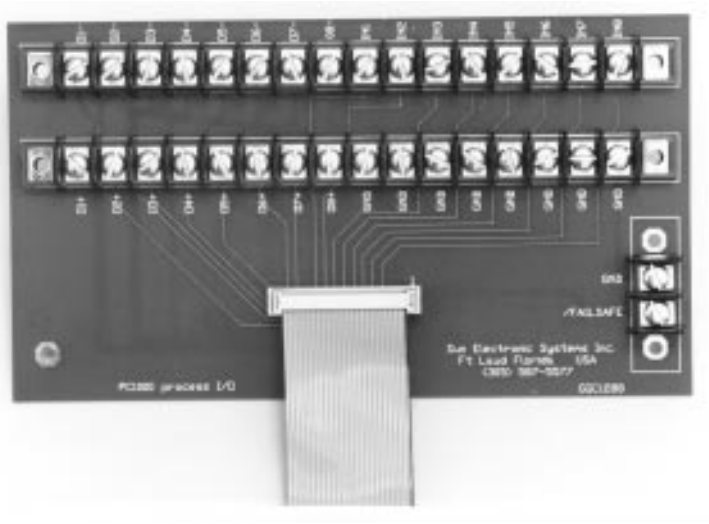
• Time of Day Start - This feature allows the user to preset a time of day that the controller will begin execution of a stored local program.

• Process Limit Alarms - These are alarms that are generated for upper, lower and deviation limits. All can be enabled or disabled by a menu in the PC1000.

I/O

Bit I/0 for On/Off Process Control

Bit 1/0 to control on/off processes consists of eight 100mA open collector drivers capable of driving solid state relays. These are easily accessible via the process I/0 board which is supplied with the PC1000. This is a screw terminal interface card that connects to the PC1000 via a 26 conductor flat cable. Four of the outputs are used for the +/- controls for channels 1 and 2. One is for power on/off and the remaining three can be used for other control with two of these configurable for staged output use. Also on the process I/0 board is a contact input for a failsafe as well as 8 additional contact inputs with internal pull up resistors to 5 Volts. The I/0 on the process I/0 board are accessible with IN/OUT commands (see command set summary).



Analog I/O

In addition to the bit I/0, the PC1000 also provides 4 analog outputs and 4 analog inputs. Two of the analog outputs can be configured to drive a chart recorder, for example. The other two analog outputs can be configured for analog process control with the PID loop control being output. The analog output channels can be configured for -5V to +5V or 0V to +5V. One channel can be configured for 0-2OmA output. The analog input channels accept input from 0-5V with one channel configurable as a 0-20mA current input. All 4 analog inputs and outputs can also be accessed via input and output commands.

Digital Parallel User I/O

This interface provides the user with 16 bits of address and an 8 bit bidirectional data bus. This provides up to 64K of read/write space to be used for accessories or for the users' custom requirements. The user bus is accessible via IN/OUT commands.

High Speed Serial Link I/O

This is a 56K synchronous serial data link which facilitates distributed microprocessor communications. The PC1000 is configured as a master device and the interface levels conform to RS422 levels.

Menus

There are three menus in the PC1000: the CAL, SDEF and SINT menus. These three menus allow great flexibility in setting up the PC1000 for your particular application.

CAL Menu

The CAL menu is used to select/change the probe types, to calibrate the probes, and select/change the units of measurement. The probe types stored in the PC1000 are as follows: RTD with alpha =.3926 or .3850; J, K or T thermocouples; solid state; 0-5 V; or 0-20 mA. After selecting the probe (sensor) type to be used, it is necessary to calibrate the probes. If the RTD, thermocouple or solid state sensors are selected, the PC1000 requires that the probes be at 0ºC and +100ºC to calibrate or the probes may be calibrated to a standard at your facility. If 0-5 V or 0 - 20 mA sensors are used, the PC1000 requires that the probes be at a low and high value and also what readings should correspond to these low and high values (ie, 0V = -200ºC and +5V = +300ºC). After calibrating the sensors, a unit of measure must be selected. The choices are ºC, ºF, ºK or U which is a user's unit. The following is a sample of the CAL menu dialog.

CAL	to enter calibrate menu
CALIBRATE PROBES? (Y/N)	enter yes to calibrate chan 1 or 2; enter no to only change scale(s)
ENTER CAL ACCESS CODE?	specified in SINT menu
CAL CHAN #1 (Y/N)	enter yes to calibrate chan 1
RTD.385 PROBE? (Y/N)	[DIN 43 760]
RTD.392 PROBE? (Y/N)	
J THERM NARROW? (Y/N)	
J THERM WIDE? (Y/N)	
K THERM NARROW? (Y/N)	
K THERM WIDE? (Y/N)	
SOLID STATE T THERMOCOUPLE? (Y/N)	
0 - 5 VOLT IN? (Y/N)	
0 - 20 mA IN? (Y/N)	

If one of the temperature probes was selected:

PROBE AT 0 DEG C (Y/N)	set probe to 0ºC enter yes
PROBE AT 1 00 DEG C (Y/N)	set probe to 100ºC enter yes
TEMPERATURE UNITS?	(1=C, 2=F, 3=K)

If voltage or current was selected:

LOW LEVEL INPUT? (Y/N)	set low end voltage or current
ENTER LOW VALUE:	enter low end process value
HIGH LEVEL INPUT? (Y/N)	set high end voltage or current
ENTER HIGH VALUE:	enter high end process value

SDEF Menu

The SDEF (**S**et **DEF**aults) menu allows configuration of many parameters which are stored in nonvolatile memory. The following are items that are user-configurable via the SDEF menu:

DUAL LOOP CTL? (Y/N)
AUTO RH CHAN #2? (Y/N)
CHAN 2 PROBE? 0=WET, 1 =DEW
GPIB ADDRESS (0-30):
GPIB LOCKUP TIME (2-59 sec):
TIMEOUT PRETIME (0-59 sec):
POW DOWN RESTART (0-59 min):
D/A OUTPUT A (1 =0 to 5, 2=-5 to +5):
D/A OUTPUT B (1=0 to 5, 2=-5 to +5):
D/A OUTPUT C (1=0 to 5, 2=-5 to +5):
D/A OUTPUT D (1=0 to 5, 2=-5 to +5):
SERIAL PORT MODE (1 =232, 2=422):
RS CHAR ECHO ON (Y/N):
BAUD RATE (1 =9600 to 6=300)
RS DTR/CTS ON (Y/N):
BUZZER VOLUME (0=OFF to 3= LOUD):
LINE FREQ (1 =60HZ, 2=50HZ)
CHART CHAN #1 ON A (Y/N)
LOW CHART VALUE?
HIGH CHART VALUE?
CHART CHAN #2 ON B (Y/N)
LOW CHART VALUE?
HIGH CHART VALUE?
PID#l TO C D/A? (Y/N)
PID#2 TO D D/A? (Y/N)
+/- CH#l TRIGGER?
+/- CH#2 TRIGGER?

SINT Menu

The SINT (**S**et **INT**errupts) menu in the PC1000 allows the user to enable/disable interrupts that the PC1000 is capable of generating. These interrupts include audible alarms and also interrupt characters sent to the serial and IEEE-488 communication ports.

INTERRUPTS
BUZZER LOCAL PROGRAM TIMEOUT (Y/N)?
BUZZER LOCAL PROGRAM DONE (Y/N)?
BUZZER SINGLE TIMEOUT (Y/N)?
INTERRUPT LOCAL PROGRAM TIMEOUT (Y/N)?
INTERRUPT LOCAL PROGRAM DONE (Y/N)?
INTERRUPT SINGLE TEMP TIMEOUT (Y/N)?
DEVIATION INTERRUPT (Y/N)?
COMMAND ERROR INTERRUPT (Y/N)?
BKPNT INTERRUPT (Y/N)?
P_POLL (1-8) 0=NO:
ALL RS NTERRRUPTS OFF (Y/N)?
CAL MENU ACCESS NUMBER?

INTERRUPT CHARACTERS	**SERIAL PORT**	**GPIB**	**PORT**
NO INTERRUPT	(N/A)	$$00	0
SINGLE TEMP TIME OUT #1	I	$41	65
SINGLE TEMP TIME OUT #2	J	$51	81
COMMAND ERROR INT	CMD ERROR!!	$42	66
LP TIMEOUT #1	P	$43	67
LP TIMEOUT #2	Q	$53	83
LP DONE	E	$45	69
DEVIATION LIMIT #1	D	$46	70
DEVIATION LIMIT #2	F	$56	86
UPL1 EXCEEDED	O	$47	71
LOL1 EXCEEDED	U	$4A	74
UPL2 EXCEEDED	+	$57	87
LOL2 EXCEEDED	-	$5A	90
GPIB LOCK-UP INT	(N/A)	$4F	79
POWER GOING DOWN	!	(NONE)	
POWER UP NO AUTO CONT.	Z	(NONE)	
POWER UP AUTO CONT.	X	(NONE)	
BKPNT	B	$50	80

Command Set

The command set for the PC1000 is a BASIC-like command set which offers many commands to allow for flexibility in modelling difficult profiles. Some example programs are listed in the applications section which utilize some of the commands listed below.

Set / Examine Commands

C1?	Examine chan #1 value
SET1=nnn.nn	Set value chan #1
SET1?	Examine set point #1
WAIT1=nn:nn:nn	Wait time at set pont #1
WAIT1?	Examine wait time #1
RATE1=nnn.nn	Set ramping rate #1
RATE1?	Examine ramping rate #1
SCALE1?	Examine unit of measure #1

To set or examine process variables for channel 2, simply replace the “1 “ with a “2” for the commands shown above.

Local Program Commands

Many commands are available to make local programming easy and efficient. Below is a sample of some of the commands.

EDIT n	Edit program n (n=0 to 9)
RUN n	Run program n
RUN n TIME-nn:nn:nn	Run program n at time of day
DELL	Delete current line of program
FOR ln=kk,mm,[+/-]	Begin loop kk=starting In value mm=ending value In variable is incremented or decremented form start value
NEXT ln	End of matching FOR loop
GOSUB n	Call program n as subroutine
LIST n	Upload program to host
STORE n	Download program from host

I/0 Commands

These commands provide read and/or write capability to the I/0 ports on the PC1000.

IN0:add, data	Read/Write Bit I/O output line
OUT0:add, data	(add) 3 bit integer, (data)1 bit integer
IN1:add,data	Read/Write digital parallel user port
OUTI:add,data	(add) 16 bit integer, (data) 8 bit integer
IN2:add,data	Read/Write high speed serial link
OUT2:add,data	(add) 16 bit integer, (data) 8 bit integer
IN3:add,data	Read/Write analog I/O
OUT3:add,data	(add) 2 bit integer, (data) 8 bit integer

Control Loop Parameter Commands

The control loop parameter commands allow the user to change the default control loop coefficients to tailor the servo responses of the system.

PID1+=nn,nn,nn	Set PID chan#1 control +
PID1-=nn,nn,nn	Set PID chan#1 control -
PI D1 +?	Examine chan#1 + PID coefficients
PID -?	Examine chan1 - PID coefficients
PWMP=nn	Set PID pulse width modulation period (2-3 sec)

Note: the same value is used for both channels

PWMP?	Examine pulse width modulation period
PIDA=n	Advanced (Cascade) PID control n=0, regular control n=1, probes 1 & 2 readings averaged for channel 1 control n=2, probe 2 reading integrated with channel 1 control
PIDA?	Examine Cascade Control status

Channel 2 PID coefficients are handled with commands that replace the “1“ with a “2”.

Safety Limit Commands

Upper and lower process limit commands guard against command setting errors and process “run away” conditions. If a process variable exceeds the upper or lower limit, the PC1000 automatically turns off the appropriate process control output and provides an audio warning as well as interrupts to the host computer.

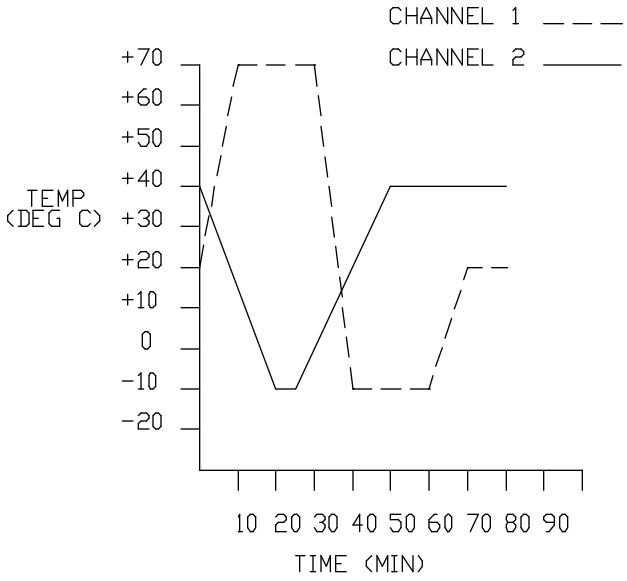
LOL1=nnn.n	Set lower limit chan #1
LOL1?	Examine lower limit chan #l
UPL1 =nnn.n	Set upper limit chan #1
UPL1?	Examine upper limit chan #1
DEVL1=nnn.n	Set deviation limit chan #1
DEVL1?	Examine deviation limit chan #1

To set or examine process limits for channel 2, simply replace the “1“ with a “2” for the commands shown above.

Applications

Example #1: Temperature - Temperature

The first application presented is control of a temperature-temperature process. It is first necessary to put the PC1000 in the dual loop control mode. This is accomplished by accessing the SDEF menu via the front panel. After answering "YES" to the "DUAL LOOP CONTROL" prompt, the PC1000 can control two processes. Next, the sensors to be used must be calibrated. This is done by accessing the CAL menu from the front panel. There are many different sensors to choose from and the CAL menu will prompt for the appropriate inputs to reliably calibrate the sensors. Once the above has been completed, the following profile can be achieved using the program and the schematic shown.



FOR I0=0,3	Cycle profile 3 times
SET=70	Set channel #1 to 70ºC
RATE1=5	5ºC/MIN = 50ºC in 10 min
SET2=-10	Set chan #2 to -10ºC
RATE2=2.5	2.5ºC/minute
WAIT2=5	Soak for 5 minutes
SET2=40	Set channel #2 to 40ºC
RATE2=2	2ºC/minute
WAIT1=5	
OUT0:5,1	Turn on output 5, power DUT
SET1=-10	Set channel #1 to -10ºC
RATE1=8	8ºC/minute
OUT0:5,0	Turn off output 5, power off DUT
SET1=20	Set channel #1 to 20ºC
RATE1=3	3ºC/minute
WAIT1=10	
NEXTI0	Cycle again
END	

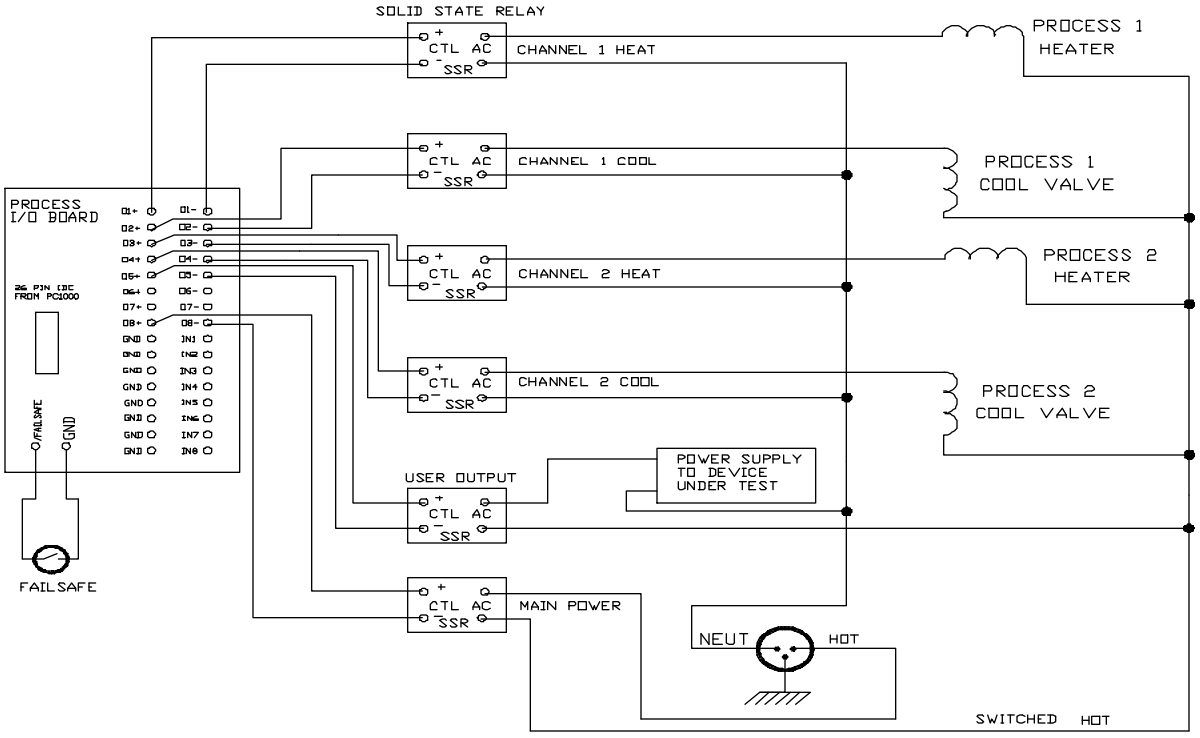


Illustration: Temperature / Temperature Application

Example #2: Temperature-Humidity

This application deals with the control of temperature and humidity using the dry/dew point method. This method is based on the fact that given a particular dry temperature and humidity, a unique dew point can be calculated from a psychometric table. Dew point is defined as the temperature at which the air is saturated or 100% relative humidity. If the saturated air at the dewpoint temperature is then heated to the dry temperature, the desired relative humidity is achieved.

Based on this, the diagram of the chamber can be fully explained. As air slowly passes over the bath of water, that air becomes saturated at the temperature of the bath of water. The temperature of this bath of water is maintained at the dew point temperature associated with the dry temperature and relative humidity desired. This saturated air at the dewpoint temperature then flows up into the top part of the chamber where it is heated to the dry temperature and at the same time establishing the proper relative humidity. The PC1000 controls the dry and dew temperatures based on the values entered for temperature and humidity. Channel 1 outputs must control the dry temperature and channel 1 sensor must be sensing the dry temperature. Channel 2 outputs must control the dew temperature and the channel 2 sensor must be sensing the bath of water. When entering set points, channel 1 set point is the dry temperature and channel 2 is the RH. The dew point is calculated by the PC1000 and it is this temperature that the PC1000 controls.

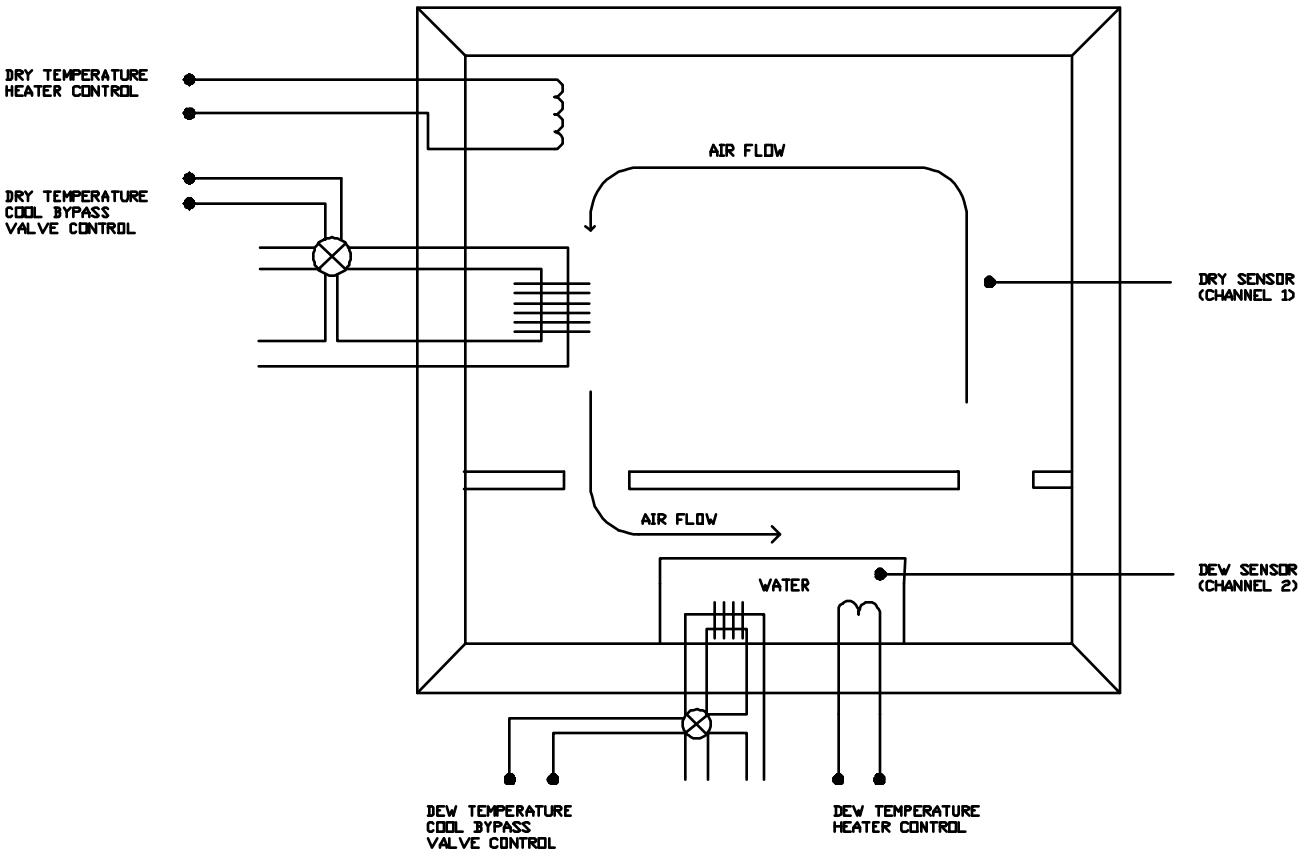
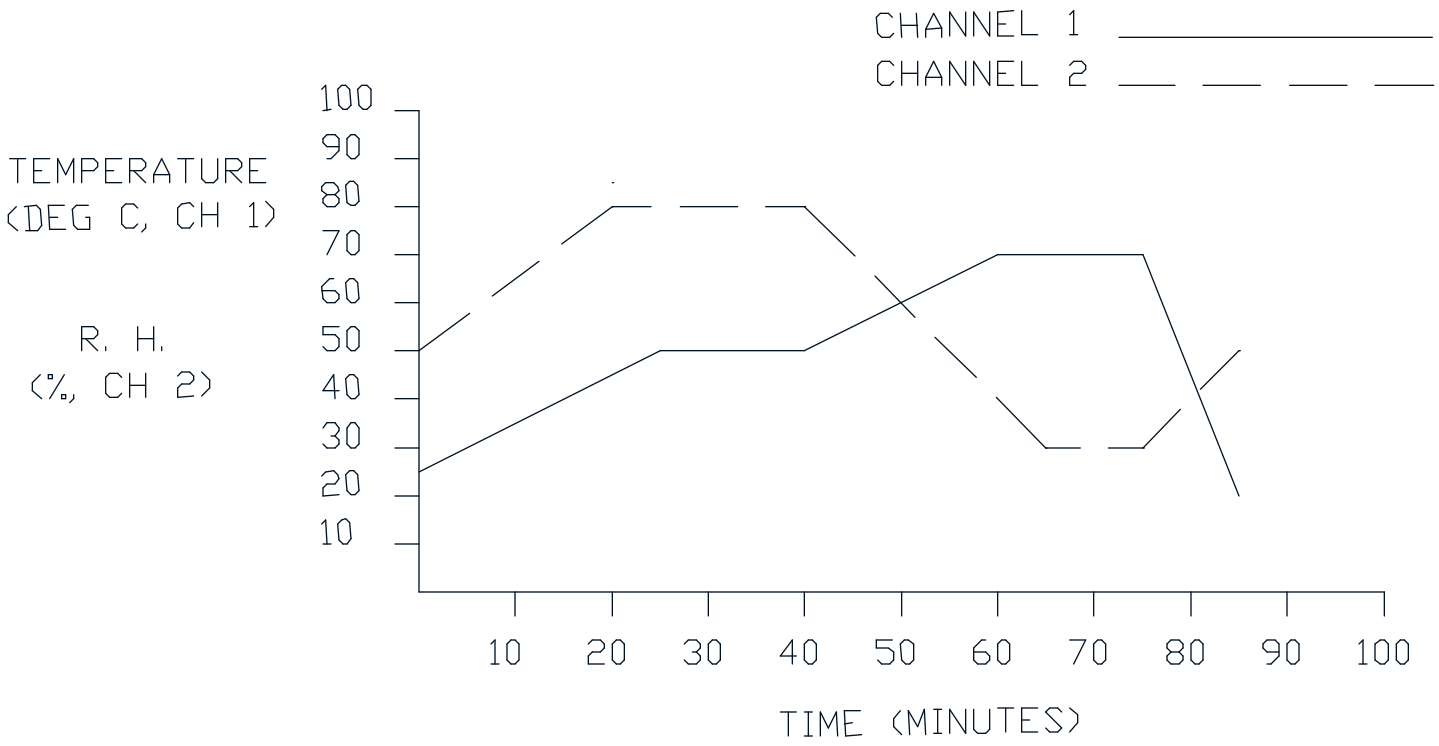


Illustration: Temperature - Humidity Chamber

Since it is desired to control the temperature and humidity, the PC1000 must be in the dual loop mode. This is accomplished by accessing the SDEF menu. The PC1000, still in the SDEF menu, will then ask if auto-RH is desired on channel 2. After responding "YES" to this prompt, the dew mode would then be selected when prompted next. (The other option which could be used to calculate relative humidity is wet bulb.)

After setting up the PC1000 in the previously described manner, and making the proper connections from the process I/0 board, as shown, the desired profile is easily accomplished. The following local program could be downloaded from a host computer or entered locally via the front panel keypad.



OUT 0:5,0	No water drain
OUT0:6,1	Turn on compressor
SET1=25	Start at 25ºC
SET2=50	50% humidity
WAIT1=1	Short 1 minute wait at initial start point
FOR I0=0,3	Do 3 cycles of profile
RATE1 =1	
RATE2=1.5	
SET2=80	Go to 80% RH at 1.5%/minute
SET1=50	Go to 50º at 1ºC/minute
WAIT1=15	Stay at 50ºC for 15 minutes
RATE2=2	
SET2=30	Go to 30% RH at 2%/minute
SET1 =70	Go to 70ºC at 1º/minute
WAIT2=10	Stay at 30% RH for 10 minutes
RATE1=4.5	
SET2=50	Go to 50% RH at 2%/minute
SET1=25	Go to 25ºC at 4.5º/minute
WAIT2=0:0:30	Wait at 50% RH for 30 seconds
NEXT I0	Loop 3 times
OUT0:5,0	Turn off compressor
END	

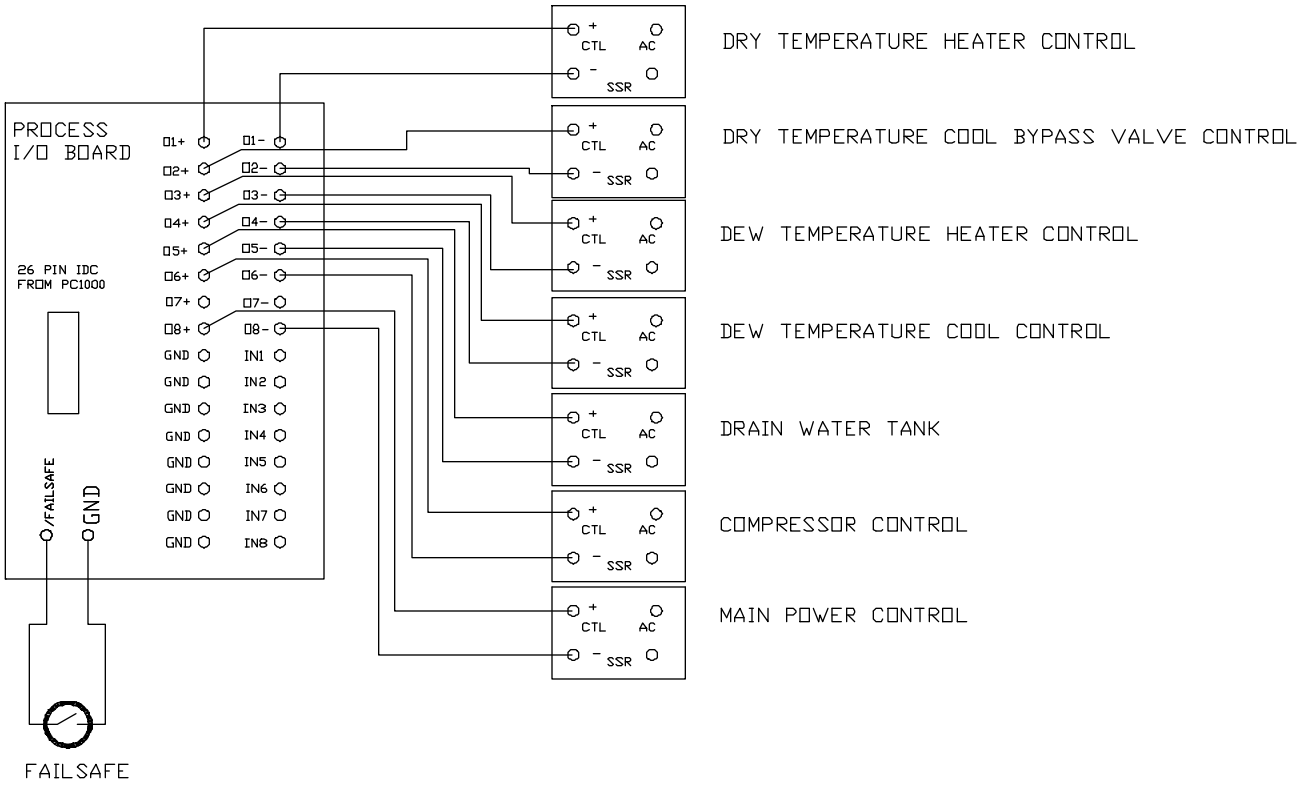
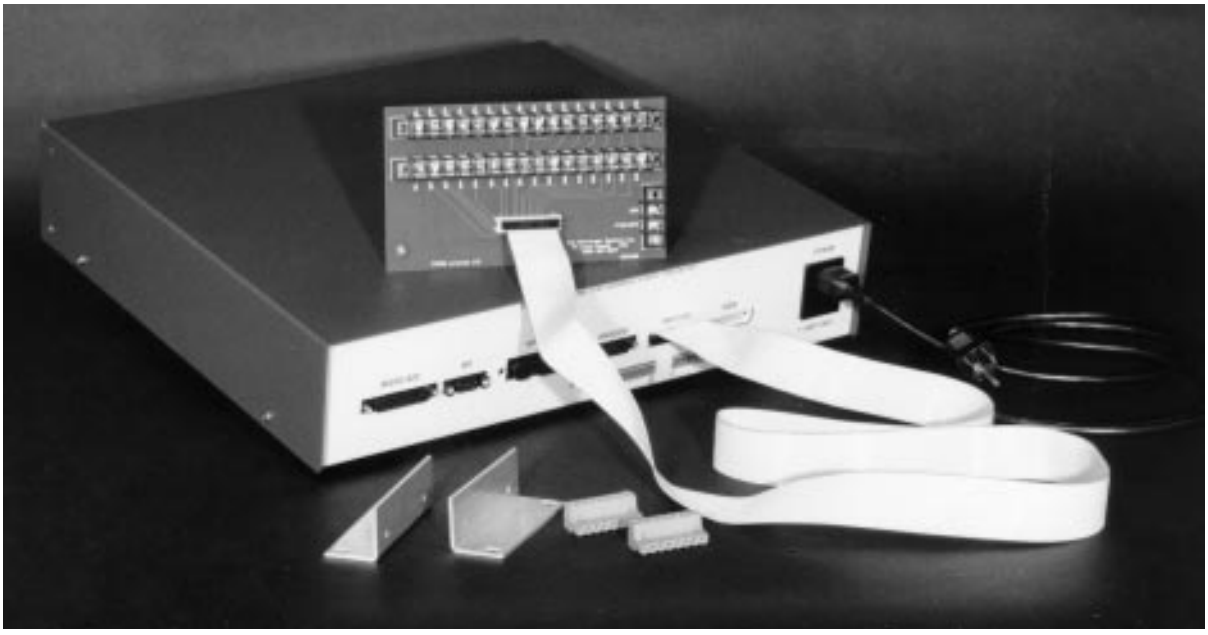


Illustration: Temperature / Humidity Application



Example #3: Cascade Control

The third application involves the use of cascade control. This type of control is useful when controlling the temperature of a device under test. The following application illustrates this type of control using the PC1000.

This method of control requires that the PC1000 be in the single loop mode. This is accomplished by accessing the SDEF menu and responding “NO” to the “DUAL LOOP CONTROL” prompt. “PIDA=n” command must be entered either locally or remotely to put the PC1000 in the advanced PID control mode with n = 0, 1 or 2. When n =2, channel #1 will be controlled until it is at the setpoint and stable. The air temperature will then be slowly adjusted until probe #2 on the DUT is at the set point.

This application is the control of an environmental chamber with channel 1’s sensor being used as the process control sensor and channel 2 as a temperature monitoring sensor. The command used for this setup is PIDA=2.

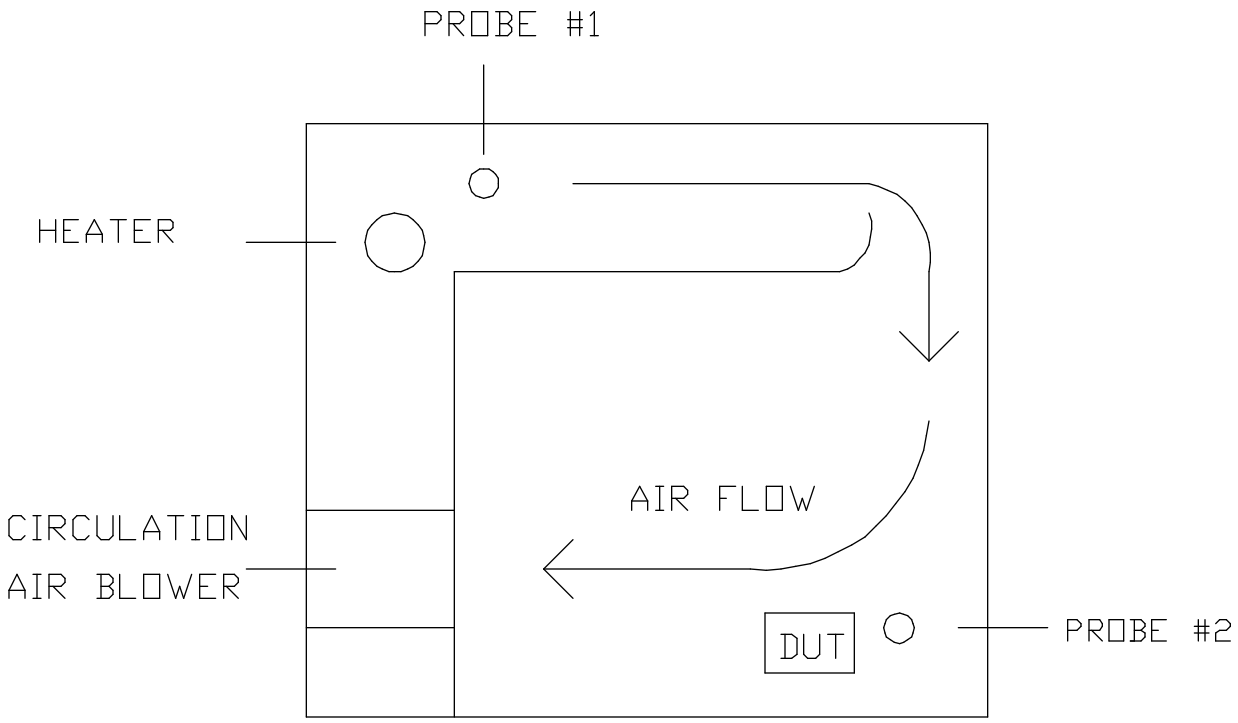


Illustration: Cascade Control

As can be seen from the diagram, probe #1 reading will be different from probe #2 due to the fact that probe #1 is nearer the heat source. Normally, the PC1000 would use only probe #1 readings to control the temperature, thus always having probe #2 temperature lag the probe #1 reading. However, when the PC1000 is in the advanced PID control mode, this problem is eliminated by integrating the probe #2 readings with the PID control parameters of channel #1. The combination of the two readings are used in such a way to achieve good transient response since probe #1 is near the heat source and low steady state error referenced to probe #2.

Specifications

POWER REQUIREMENTS	
POWER CONSUMPTION	35 Watts
INPUT VOLTAGE	110/220 ± 10% Selectable at rear panel input
LINE FREQUENCY	50/60 Hz
MECHANICAL	
PACKAGE	3.5”hx 16.5”w x 15”d 19” Rack mountable
FRONT PANEL	32-key, 32 character LCD
REAR PANEL	Contains all I/O ports
ENVIRONMENTAL	0º to 50ºC ambient local junction comp.
SAFETY	
SENSOR MALFUNCTION	Open/short probe detect
CONTROLLER MALFUNCTION	Hardware watch dog
PROCESS ERRORS	External fail safe input
PROCESS LIMITS	Upper, lower and process deviation limits
LINE VOLTAGE LOSS	Battery-Backed memory & time-of-day clock auto restart after power loss
PROCESS SENSOR INPUT CHANNELS	
RANGES	
RTD (.385 OR.392)	-200º to +325ºC
J	-200º to +760ºC
K	-200º to +1250ºC
T	-200º to +325ºC
Solid State	-60º to +160ºC
Voltage	Within 0 to 5 Volt
Current	Within 0 to 20 mA
RESOLUTION	15 BIT CONVERSION
ABSOLUTE ERROR OVER RANGE	
RTD	± 0.2ºC
J & K narrow	± 0.35ºC
J & K wide	± 0.5ºC
Voltage	± 500 uV
Current	± 2 uA
Electrical Isolation	240 Volt

07/02

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