2002 *PLUS!*

Chromalox®

Microprocessor-based Heat/Cool Temperature Controller

Issue Date
January 1990

User's Manual
0037-75122

Warranty and Return

The warranty below complies with the Federal Law applicable to products manufactured after December 31, 1976. This warranty gives you specific legal rights. You may also have other rights which vary from state to state.

Chromalox Warranty

Chromalox Instruments and Controls' products are warranted against defects in workmanship and materials. No other express warranty, written or oral, applies with the exception of a written statement from an officer of Chromalox Instruments and Controls, Edwin L. Wiegand Division, Emerson Electric Co.

Warranty Period

This warranty extends for twelve months from date of shipment from factory or authorized distributor.

Limitations

Products must be installed and maintained in accordance with Chromalox instructions. Users are responsible for the suitability of the products to their application. There is no warranty against damage resulting from corrosion, misapplication, improper specification or other operating conditions beyond our control. Claims against carriers for damage in transit must be filed by the buyer.

Returns

Items returned to Chromalox Instruments and Controls must be accompanied by a Return Authorization Number. This number may be obtained from Chromalox Instruments and Controls, Customer Service Department, Telephone Number (615) 793-3900. Defective items will be repaired or replaced at our option, at no charge.

Return the defective part or product, freight prepaid to:

Chromalox Instruments and Controls
1382 Heil Quaker Blvd.
LaVergne, TN 37086-3536
FAX: (615) 793-3563

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Section 1
General Information

THE BIG PICTURE

The strength of the Chromalox 2002PLUS! temperature and process controller is its unlimited applications flexibility. As illustrated below, the 2002PLUS! is well suited to applications ranging from basic temperature control to complex process control. It is important that you think about "the big picture" - the inputs, outputs and features of your 2002PLUS! and how you plan to use them - before beginning installation and operation of the controller.

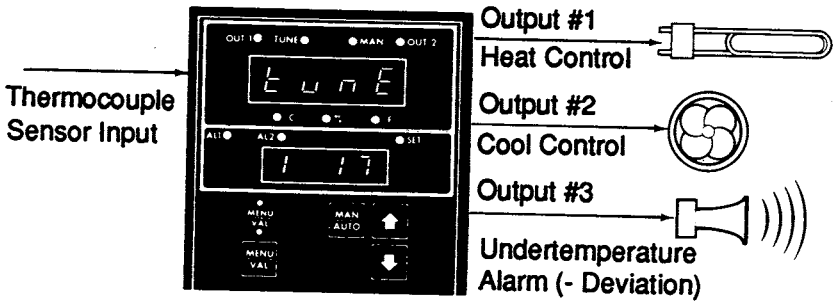


Figure 1.1
Basic Temperature Control Application

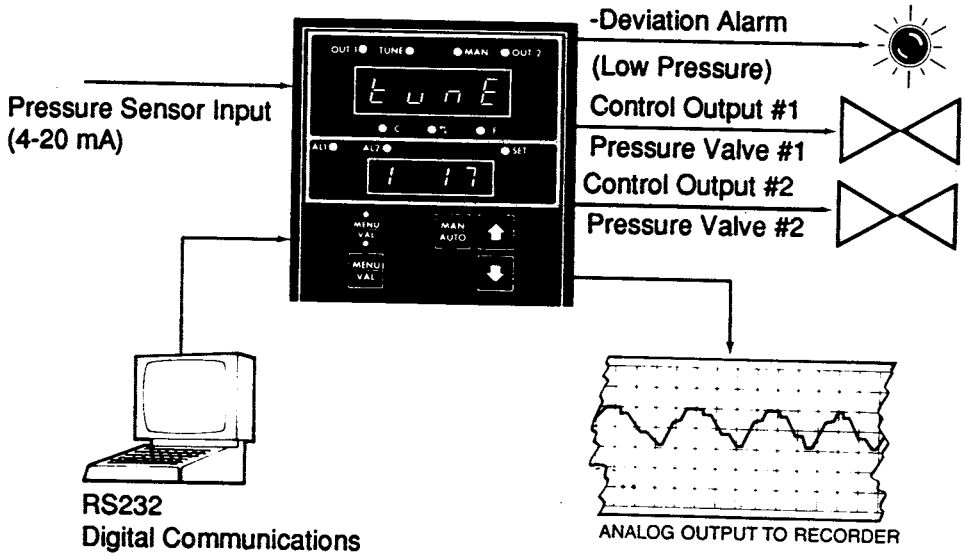


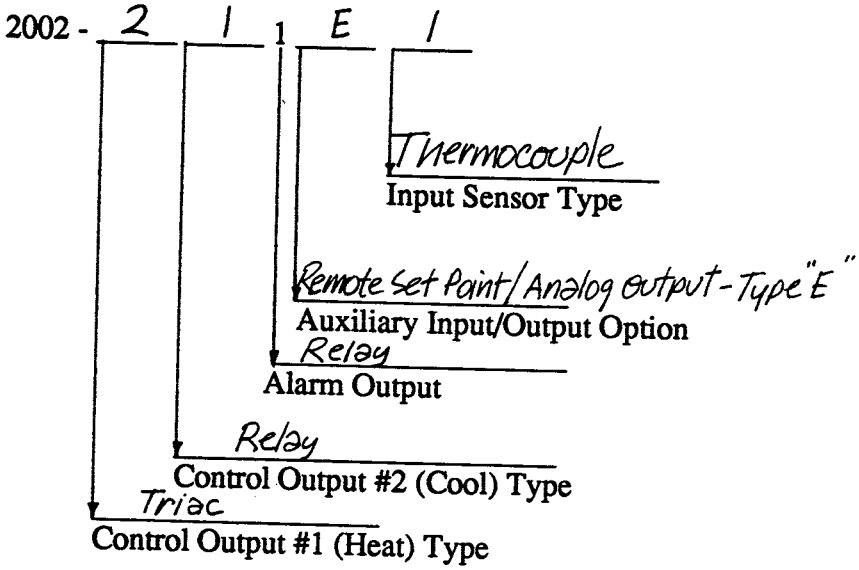
Figure 1.2
Complex Process Control Application

Model Identification

Before beginning the installation process, it is critical that you identify the controller model you have purchased. Both wiring and programming are very specific to the input and output types of the controller. By taking time to properly identify the unit, installation and programming will proceed quickly and easily.

Your controller model number is written on the tag inside the instrument's front door. Write the model number here and following the Model Identification table on the facing page, identify the controller characteristics:

EXAMPLE:



YOUR MODEL NUMBER:

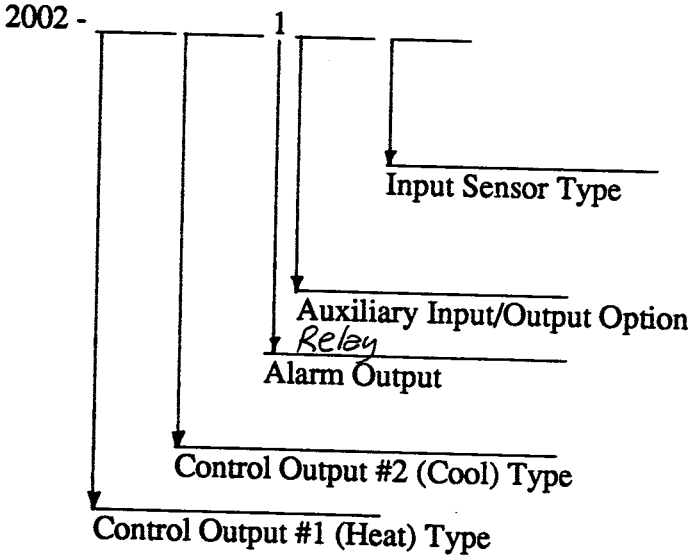


Figure 1.3
Model Identification Table

MODEL	MICROPROCESSOR-BASED 1/4 DIN TEMPERATURE CONTROLLER
2002	Proportional or ON/OFF Control with Dual Outputs, Dual Display of Process and Set Point, Self-Tuning, Auto/Manual Control, Alphanumerics, Scale °F, °C or %, Alarm Relay with Programmable Mode Selection, Ramp/Soak

CODE	HEAT CONTROL OUTPUT #1
1	Relay - 1 N.O. Form A Contact, 5A at 120 Vac, 2.5A at 230 Vac
2	Triac - 1 Amp at 120 or 230 Vac
4	Analog, Field Select 4-20 mA or 1-5 Vdc
7	Solid State Relay Drive - 20 Vdc at 40 mAdc

CODE	COOL CONTROL OUTPUT #2
1	Relay - 1 N.O. Form A Contact, 5A at 120 Vac, 2.5A at 230 Vac
2	Triac - 1 Amp at 120 or 230 Vac
4	Analog, Field Select 4-20 mA or 1-5 Vdc
7	Solid State Relay Drive - 20 Vdc at 40 mAdc

CODE	ALARM OUTPUT #3
1	1 Relay Output - N.O. Form A Contact, rated 5A at 120 Vac, 2.5A at 230Vac

CODE	AUXILIARY INPUT/OUTPUT OPTIONS
0	None
1	Analog Remote Set Point, Field Select 4-20 mA/1-5 Vdc
*	Analog Remote Set Point, 1-5Vdc Analog Process Readout Signal *Specify input sensor type Code:

* Code	Input	* Code	Input
J	J T/C	S	S T/C
K	K T/C	N	N T/C
E	E T/C	D	RTD, .00385 (DIN standard)
T	T T/C	A	RTD, .00392 (American standard)
R	R T/C		

8	Non-Isolated RS232/RS422 Digital Communications
9	Non-Isolated RS232/RS422 Digital Communications, 1-5Vdc Analog Remote Set Point

CODE	SENSOR TYPE
1	Thermocouple,Field Select J -100 to 1400°F -73 to 760°C K -100 to 2100°F -73 to 1149°C E -100 to 1100°F -73 to 593°C T -350 to 750°F -212 to 399°C N -100 to 2300°F -73 to 1260°C Analog, Field Select 4-20 mA or 1-5 Vdc
2	Thermocouple, Field Select R 50 to 3000°F 10 to 1649°C S 50 to 3000°F 10 to 1649°C Analog, Field Select 4-20 mA or 1-5 Vdc
4	RTD,100 ohm Pt, -200 to 1000°F (128 to 538°C), Field Select Alpha = 0.00385 or Alpha = 0.00392 Analog, Field Select 4-20 mA or 1-5 Vdc

2002 -	2	1	1	E	1	Typical Model Number

Model Identification Codes

Throughout the manual you will find references to "codes." This refers to the code number in the model identification, which corresponds to a specific output type, option or input type. For example, when wiring the control output, "code 4" corresponds to Current/Voltage control output.

Control Outputs

Your controller comes to you with one of four output types for each of the two control outputs (Heat and Cool), as indicated by the control output "code." In the programming you will select PID or ON/OFF control type for each output. Should your applications needs change, you may purchase and install a different type of control output module to change the output type.

Alarm Output

Every 2002PLUS! controller is equipped with an Alarm Relay Output. How you choose to use the alarm, as a high, low or deviation alarm, is selected in the programming and may be easily reconfigured at any time. You will also select normally-energized (contact closed on alarm) or normally-deenergized (contact open on alarm), with upper and lower set point limits, if desired.

Event Output

The Alarm Output may be selected to function as an Event Output for Ramp/Soak. If selected as an Event Output, it acts as a normally-deenergized output.

Input Types

The input codes correspond to more than one specific type of input. For example, "Code 1" corresponds to J, K, E, T and N thermocouple types and the 4-20 mA/1-5 Vdc input. In the programming, you will "tell" the 2002PLUS! which sensor type you intend to use.

Auxiliary Input/Output Options

The code for Auxiliary Analog Inputs/Outputs and Digital Communications represents a single option or combination of options. In the programming you will make selections pertinent to the options your controller has.

Programming Structure

The PAGE/MENU programming is structured into groups of like adjustments, function and parameters. These groups of adjustments are called PAGES. There are a total of 4 PAGES of programming selections and adjustments. Each PAGE contains a list of MENU numbers, each MENU number being an individual selection or adjustment. Every parameter has its own PAGE/MENU number "address" that you can go directly to, without stepping through a long list of unnecessary entries. Many of the parameters also have alphanumeric command cues, making it even easier to program the controller and make adjustments later.

Security Levels

The 2002PLUS! PAGE/MENU programming structure is protected by 4 Security Levels. Each of the Security Levels allows **viewing** of certain PAGE/MENU numbers and **adjustment** of certain other PAGE/MENU numbers. The Security Level that you choose for the controller is field selected and may be changed at any time.

IMPORTANT!

Read this manual carefully and thoroughly before attempting installation, programming and operation of the 2002PLUS! controller. Improper wiring, or configuration and selection of parameter values could result in damage to equipment, the controller and possibly even personal injury. It is your reponsibility to assure that the controller is safely installed and configured.

Inspection and Unpacking

On receipt of your 2002PLUS! controller, immediately make note of any visible damage to the shipment packaging and record this damage on the shipping documents. Unpack the controller and carefully inspect it for obvious damage due to shipment. If any damage has occurred, YOU must file a claim with the transporter, as they will not accept a claim from the shipper.

If the controller will not be immediately installed and placed into operation, it should be stored in a cool, dry environment in its original protective packaging until time for installation and operation. Temperature extremes and excessive moisture can damage the instrument.

Removing the 2002PLUS! from its Case

The 2002PLUS! instrument chassis can be easily removed from its case either before or after mounting and wiring. Some applications require internal jumper changes, making it necessary to remove the controller chassis from the case. If the output module is to be changed, it is also necessary to remove the controller from its case.

To remove the chassis, lower the front door flap and loosen the screw. Pull the chassis out from the case to expose the controller circuit cards. See Figure 2.1 below.

Digital Interface Connector

If your controller has the Digital Communications option (Codes 8 or 9), you must first unplug the 5-pin Digital Interface Connector from the rear of the controller before removing the chassis from the case. Plug the Connector back on after reinstalling the controller chassis into the case.

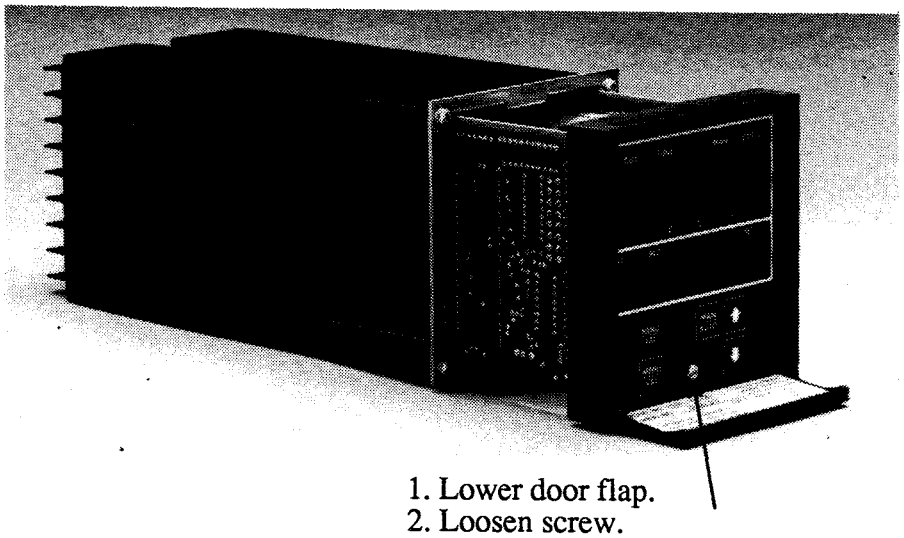


Figure 2.1
Removing the 2002PLUS! Chassis from Case

MOUNTING

The 2002PLUS! controller should be mounted in a location free from excessive dust, oil accumulations and moisture. It may be mounted in any position at ambient temperatures of 30°F to 130°F (0°C to 55°C).

Figure 2.2 gives the mounting dimensions for the controller. Cut out the square mounting hole and install the unit in accordance with the mounting diagram Figure 2.3. Loosen the mounting brackets' captive screws at the rear of the controller, sliding the brackets off the controller, and placing the controller through the square panel cutout. Replace the mounting brackets and tighten the screws to secure the controller firmly against the mounting surface.

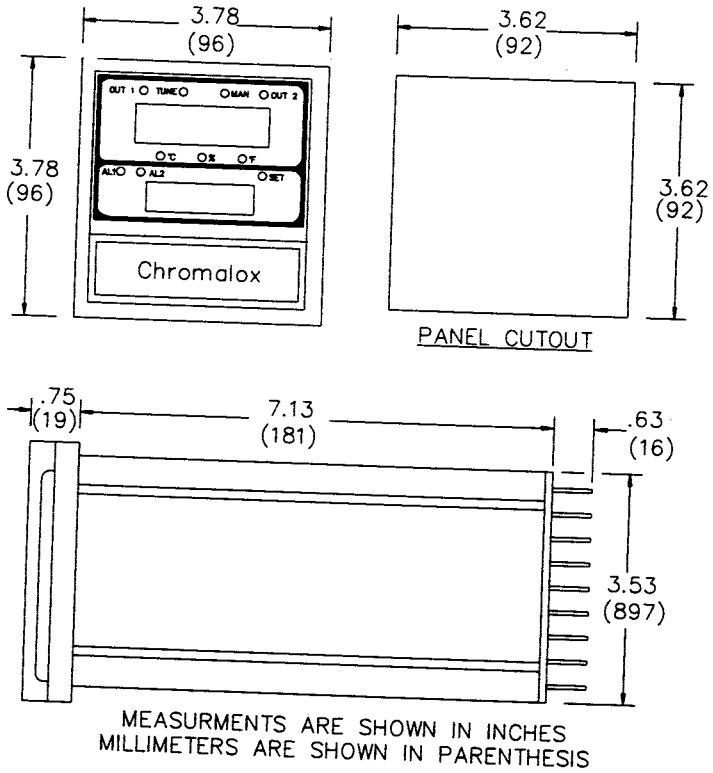


Figure 2.2
Mounting Dimensions

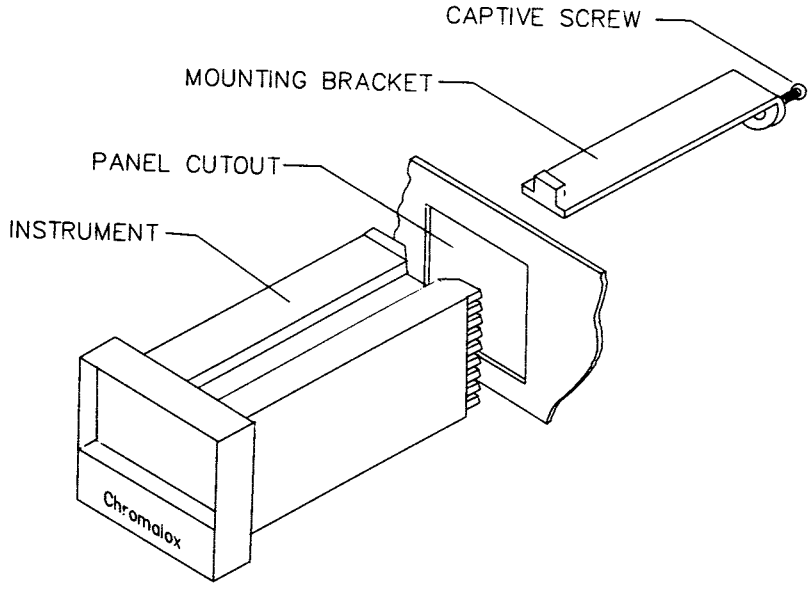


Figure 2.3
Mounting Diagram

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

IMPORTANT WIRING INFORMATION!

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

To insure that the Chromalox 2002PLUS! controller performs optimally, it is imperative that you read this section and become familiar with standard wiring practices critical to eliminating electrical noise. Failure to follow these recommended wiring practices can result in poor temperature measurement and ineffective control.

Snubbers

Snubbers should be used to protect the controller from electrical noise generated by inductive loads such as motors, solenoids, coils and relays operating near the 2002PLUS!. The recommended snubber is a .1uf capacitor (600 Vdc rating) in series with a 100 ohm resistor. Snubbers are available from Chromalox (Part No. 0149-01305).

When using the Alarm Output, or Triac and Relay Control Outputs to drive a contactor coil or other inductive load, the snubbers should be connected in parallel with the contactor coil. Install the snubbers as shown in the individual wiring diagrams.

Good Wiring Practice

Read and follow these Good Wiring Practices when connecting this and any other controller:

1. Do not run sensor leadwires and power leads together in the same conduit or wire tray.

2. When planning the system wiring, be sure to consider the importance of separating wiring into functionally similar bundles - i.e. power leads, sensor leads, output signal lines, etc. If the power leads and sensor leads must cross, they should cross at a 90° angle to each other (perpendicular).

3. Locate all sources of noise in your system - motors, contacts, solenoids, etc. Then design your system such that wiring is separated as far as possible from these noise sources.

4. Shielded, twisted wire should be used for the control circuit signals if they are run in parallel with other control circuit signal wires, or if they are run distances greater than 2-3 feet.

5. To protect against noise, use shielded cables for all low power signal lines.

6. Additional information on good wiring practices is available from IEEE, 345 East 47th St., NY, NY 10017. Request IEEE Standard No. 518-1982.

WIRING

Make all electrical wiring connections on the back of the controller **before** power is applied to the unit.

All wiring must comply with local codes, regulations and ordinances. This instrument is intended for panel mounting and the terminals

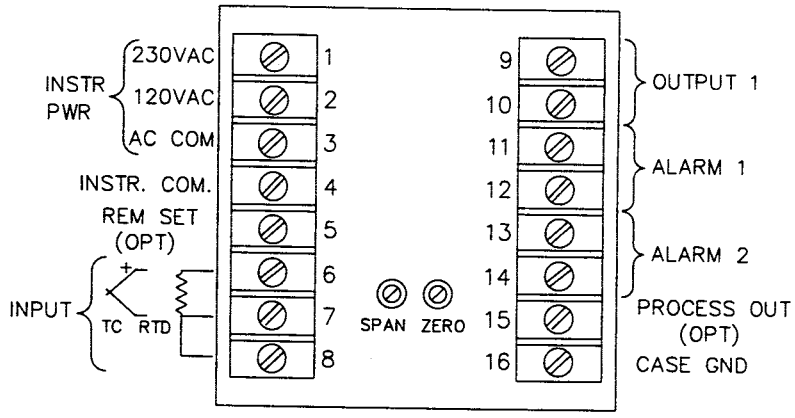
must be enclosed within a panel. Use National Electric Code (NEC) Class 1 wiring for all terminals except the sensor terminals.

Check the wiring decal on the side of the unit to verify the model number. The wiring decal also shows wiring terminations. All wires will be connected to the terminals on the back of the case. Specific wiring instructions for different input and output types are given in this section.

Detailed wiring instructions for Digital Communications, Analog Remote Set Point, and Analog Process Readout Signal options are given in the separate sections covering each of these topics. If you have purchased the Digital Communications option, your controller will have a 5-pin Digital Interface Connector that extends through the rear terminal plate. If you have purchased the Analog Process Readout Signal option, your controller will have two calibration pots on the rear terminal plate, accessible for screwdriver adjustment through two holes.

Using the proper size wire for rated circuits, make the wiring connections as shown in Figure 2.4. Detailed sensor input and control output wiring diagrams follow.

Figure 2.4
Wiring Terminal Identification



SENSOR INPUT WIRING

The model 2002PLUS! controller is supplied with a sensor input, as identified by the unit model number (on the side of the controller and inside the door flap). The last digit in the model number is the sensor input code.

2002 - ****__

Code	Sensor Type
1	Type J, K, E, T, N Thermocouple or 4-20 mA/1-5 Vdc Current/Voltage
2	Type R or S Thermocouple, or 4-20 mA/1-5 Vdc Current/Voltage
4	100 ohm Pt RTD or 4-20 mA/1-5 Vdc Current/Voltage

Notice that all three input codes include the 4-20 mA/1-5 Vdc current/voltage input. When you receive the controller, the J thermocouple input (°F), R thermocouple input (°F), or .00385 RTD (°F) will be selected in the programming (PAGE 1/MENU 19). You will need to make a simple programming selection for your sensor input type that is described in the PAGE/MENU Tables, Section 4. If you are using a Current/Voltage input, an internal jumper move is required, as described on page 13.

NOTE

Sensor leads (thermocouple, RTD, voltage or current) should not be run together in the same conduit as power wiring. Twisted pair shielded wire is recommended for making sensor connections. False process readings can occur if the sensor wire is exposed to electrical noise.

Thermocouple Input Codes 1 & 2

It is important to observe polarity (+,-) when connecting thermocouple leadwires. The table below shows **typical** color coding for the thermocouples used with this instrument.

T/C Type	Material	Polarity Plus (+)	Minus (-)
J	Iron/Constantan	White	Red
K	Chromel/Alumel	Yellow	Red
E	Chromel/Constantan	Purple	Red
T	Copper/Constantan	Blue	Red
R	Plat, 13% Rhodium/Plat	Black	Red
S	Plat, 10% Rhodium/Plat	Black	Red
N*	Nicrosil/Nisil	Orange	Red

*Proposed letter code.

Make the thermocouple wiring connections to terminals 6 and 7 as shown in Figure 2.5.

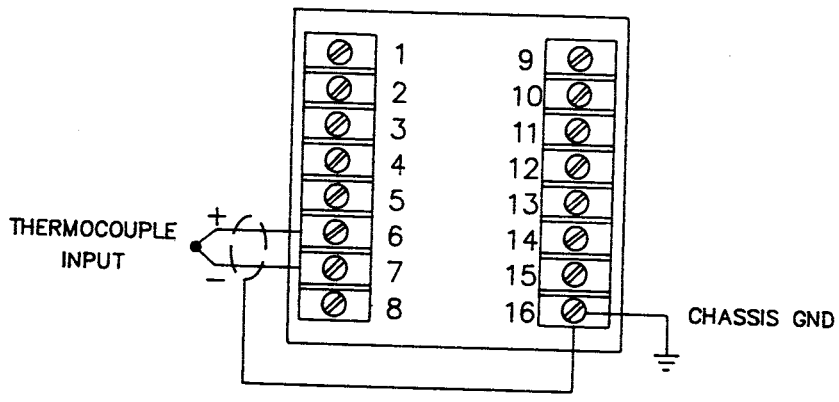


Figure 2.5 Thermocouple Connection

NOTES

1. If thermocouple extension wire is required, it must be the same type as the thermocouple (i.e. if a Type T thermocouple is used, then Type T extension wire must be used).
2. If shielded thermocouple wire is used, the shield must be grounded at one end only, preferably at terminal 16 on the controller, as shown in Figure 2.5.

RTD Input Code 4

The 2002PLUS! gives you the option of using one of two 100 ohm Platinum RTDs: alpha = .00385 (DIN standard) or alpha = .00392 (American standard). This selection will be made in the programming (PAGE 1/MENU 19) when you "tell" the controller which alpha RTD you are using.

3-Wire RTD - When making the 3-wire RTD input connection, it is important to make the resistance of all three extension leadwires equal by using the same gauge of wire for optimum leadwire compensation. Chromalox recommends 3-wire RTD's for greatest accuracy, and standard shielded copper wire for RTD extensions.

Make the wiring connections in accordance with Figure 2.6 below.

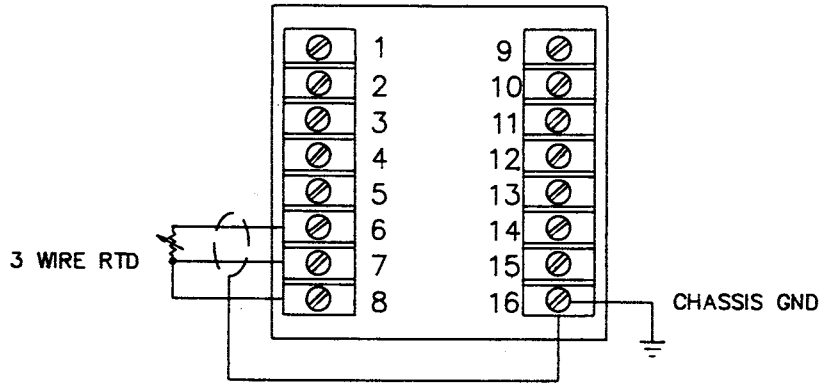


Figure 2.6
Three-Wire RTD Connection

2-Wire RTD - If using a 2-wire RTD input, use heavier gauge leadwires to reduce leadwire resistance, Any leadwire resistance adds directly to sensor resistance, thus adding error to the process temperature measure. It is also necessary to jumper Terminals 7 & 8 on the instrument to complete a 2-wire hook-up. Make the 2-wire RTD connections in accordance with Figure 2.7.

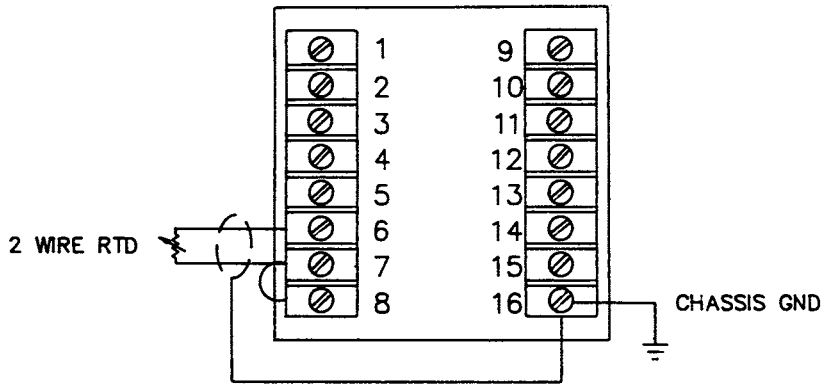


Figure 2.7
2-Wire RTD Connection

Current/Voltage Inputs Codes 1,2,4

All 2002PLUS! controllers have the capability of accepting a 4-20 mA/1-5Vdc input signal. To change the controller from thermocouple/RTD input to current/voltage, you must make a programming selection as explained in Section 4 (PAGE 1/MENU 19). When this programming selection is made, an internal jumper on the input card must be moved. Remove the controller chassis from the case (as instructed on page 9) and locate the Current/Voltage Input jumper illustrated in Figure 2.8 below.

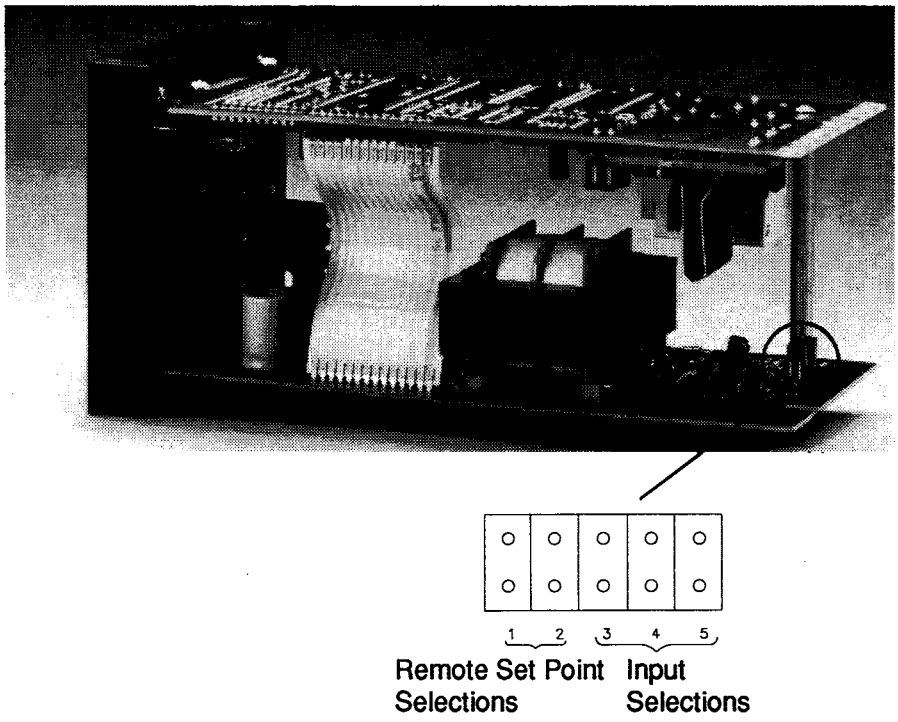
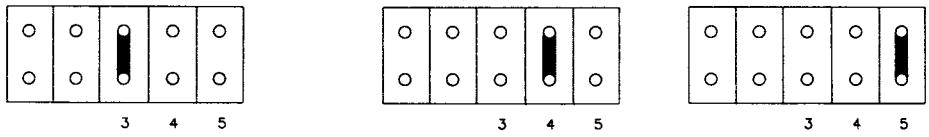


Figure 2.8
Locating Current/Voltage Input Jumper

Figure 2.9 illustrates the three possible jumper positions for the input type selection: 4-20 mA, 1-5 Vdc, and thermocouple/RTD. Place the jumper in the appropriate position for your application.

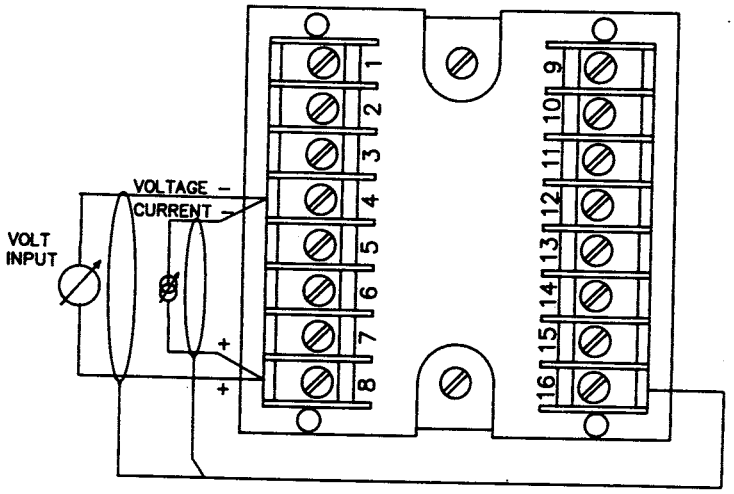


4-20 mA | 1-5Vdc | Thermocouple/RTD (factory setting)

Figure 2.9
Current/Voltage Input Jumper Positions

Make the Current/Voltage input wiring connections as shown in Figure 2.10.

Figure 2.10
Current/Voltage
Input Connections



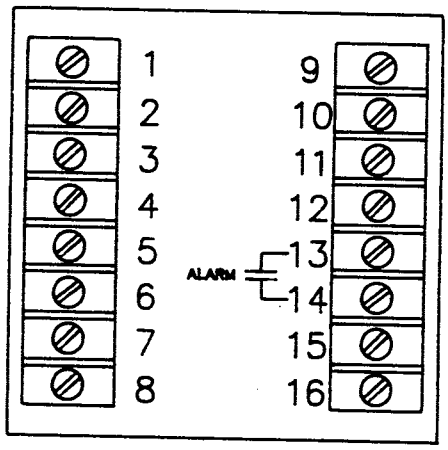
In the programming (PAGE 2/MENU 1-4), you will establish the following parameters for the analog input:

* number of decimal places (significant digits)
* units of indication (°F, °C, %)
* minimum and maximum limits of input range

ALARM OUTPUT WIRING

Each 2002PLUS! has one alarm output contact. Make the wiring connections as shown in Figure 2.11, following the "Good Wiring Practices" discussed earlier and using the recommended snubbers.

Figure 2.11
Alarm Relay Output
Connections



OUTPUT WIRING

Your 2002PLUS! controller has two control outputs, Heat and Cool. One of the four output types will be installed for each output. The two outputs do not have be of the same type. For example, the Heat Output may be a Relay output and the Cool output a 4-20 mA output.

Relay Output Connections
Code 1

A relay output is generally used to drive small resistive loads (<5 amps at 120 volts or <2.5 amps at 230 volts) or a contactor. When driving a contactor coil or other inductive load, we recommend that you install an appropriately rated a.c. snubber circuit (Chromalox Part No. 0149-01305) in parallel with the contactor coil to protect the controller from electrical noise, as discussed earlier in this manual (see page 11).

Make the wiring connections for relay output as shown in Figure 2.12.

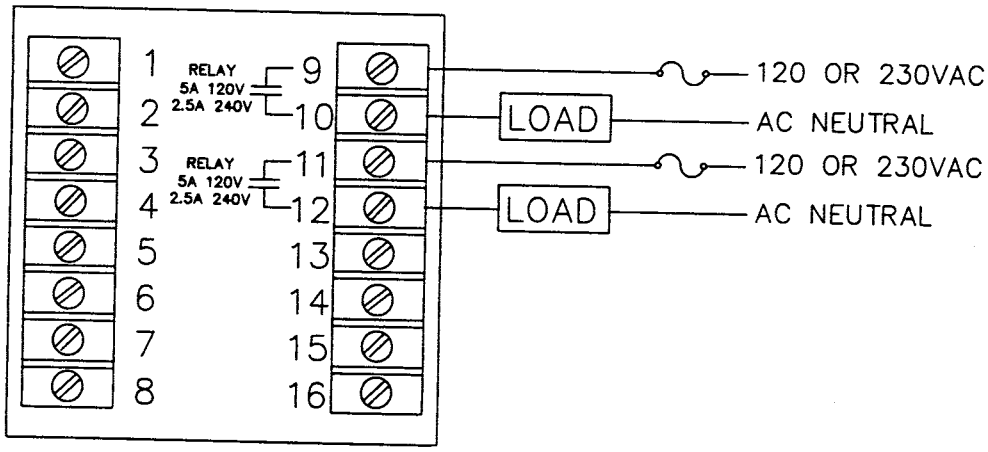


Figure 2.12
Relay Output Connections

Triac Output Connections
Code 2

A triac output generally drives a small load (less than 1 amps) or the coil of a contactor. Since triacs are solid state devices (no contacts), they will perform much longer than a mechanical relay. When driving a small load directly, triacs can cycle faster than a conventional relay to maintain tighter control. See Figure 2.13 for triac output connections.

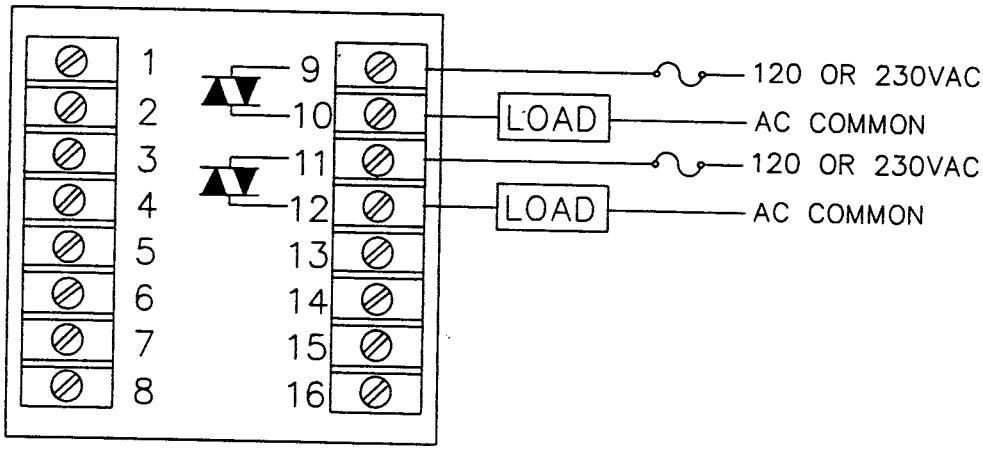


Figure 2.13
Triac Output Connections

Current/Voltage Output Connections Code 4

The 4-20 mA signal is an industrial standard method of transmitting and receiving information. To use this output, it must be connected to a device that accepts a 4-20mA signal and has input impedance of less than 800 ohms. In a similar manner, the 1-5 Vdc voltage output requires that the 2002PLUS! be connected to a device that accepts a 1-5 Vdc signal. See Figure 2.14 for 4-20 mA/1-5 Vdc output connections.

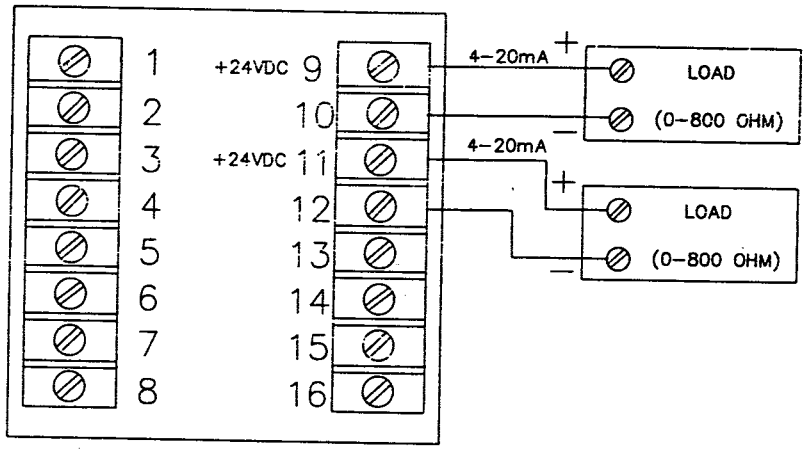


Figure 2.14
4-20 mA/ 1-5Vdc Output Connections

NOTE: When using current/voltage outputs, the cycle time for the output must be set to 0.3 seconds. See p. 80 "Cycle Time" for more complete information.

The output may be changed from a 4-20 mA signal to a 1-5 Vdc signal by simply moving a jumper on the output module. The controller is shipped with the 4-20 mA signal selected. Instructions for selecting the 1-5 Vdc output signal are given on page 20, under "Changing Control Output Modules."

Solid State Relay Output Connections Code 7

The Solid State Relay (SSR) Drive output drives solid state relays, such as the Chromalox 4115 or 4117 Power Modules, which accept 3 to 32 Vdc input ON signals and 0 Vdc OFF signals. See Figure 2.15 for Solid State Relay Drive Output connections.

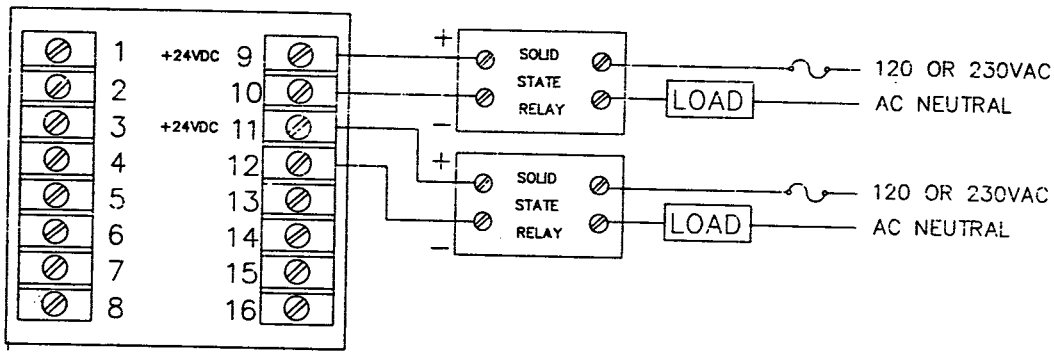
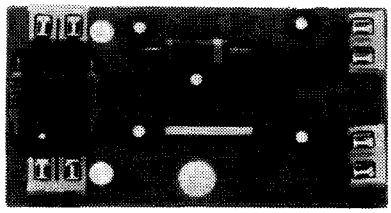


Figure 2.15
Solid State Relay Output Connections

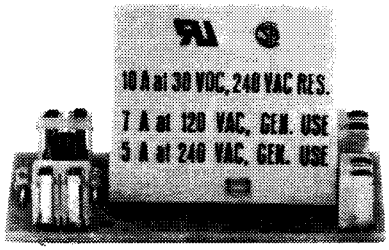
Changing Output Modules

Your 2002PLUS! controller was shipped with two of the 4 types of output modules installed. Each of these output modules is identified in Figure 2.16.

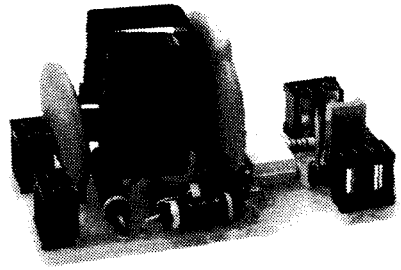


Solid State Relay Drive
Part No. 0149-27007

Current/Voltage
Part No. 0149-27009



Relay
Part No. 0149-27008



Triac
Part No.0149-27006

Figure 2.16
Output Modules

To change an output module, you must remove the instrument chassis from the case as described earlier in this section on page 9. Locate the control output modules as shown in Figure 2.17.

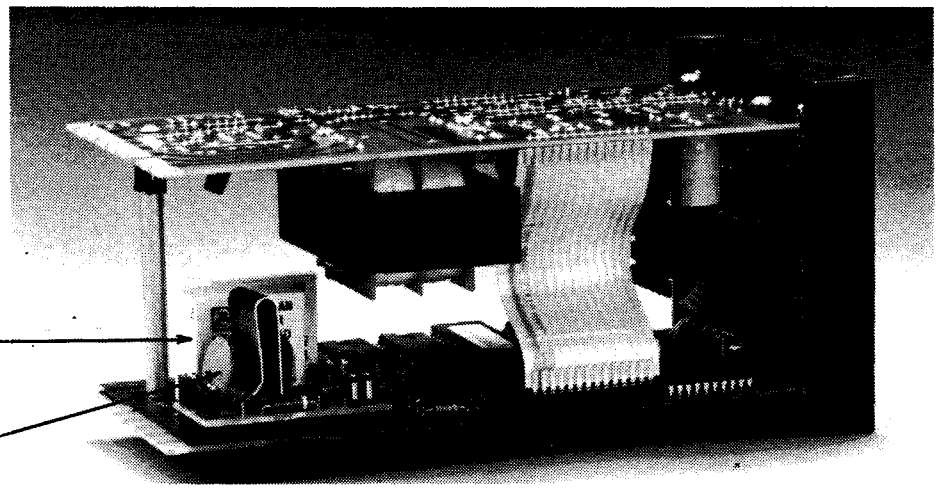


Figure 2.17
Locating the Control Output Modules

After locating the output module to be replaced, unplug it from the 4 connector posts and replace it with the new output module.

After changing an output module, be sure to change the load wiring and any programming output parameters (PAGE 1) before putting the controller back into operation! Damage to the output board can occur if incorrect voltages are supplied.

Current/Voltage Output Jumper Positions

To change the control output from 4-20 mA to 1-5 Vdc, locate the Current/Voltage Output Module as shown previously in Figures 2.16 and 2.17. Move the jumper from its factory configured 4-20 mA position to the 1-5 Vdc position as shown in Figure 2.18.

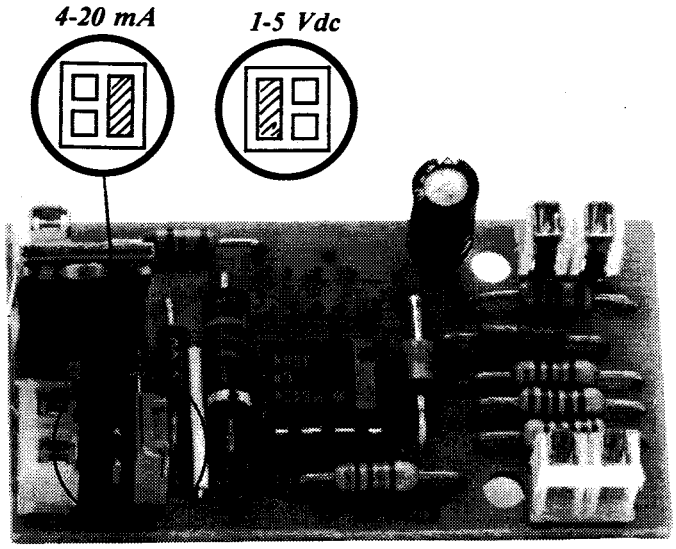


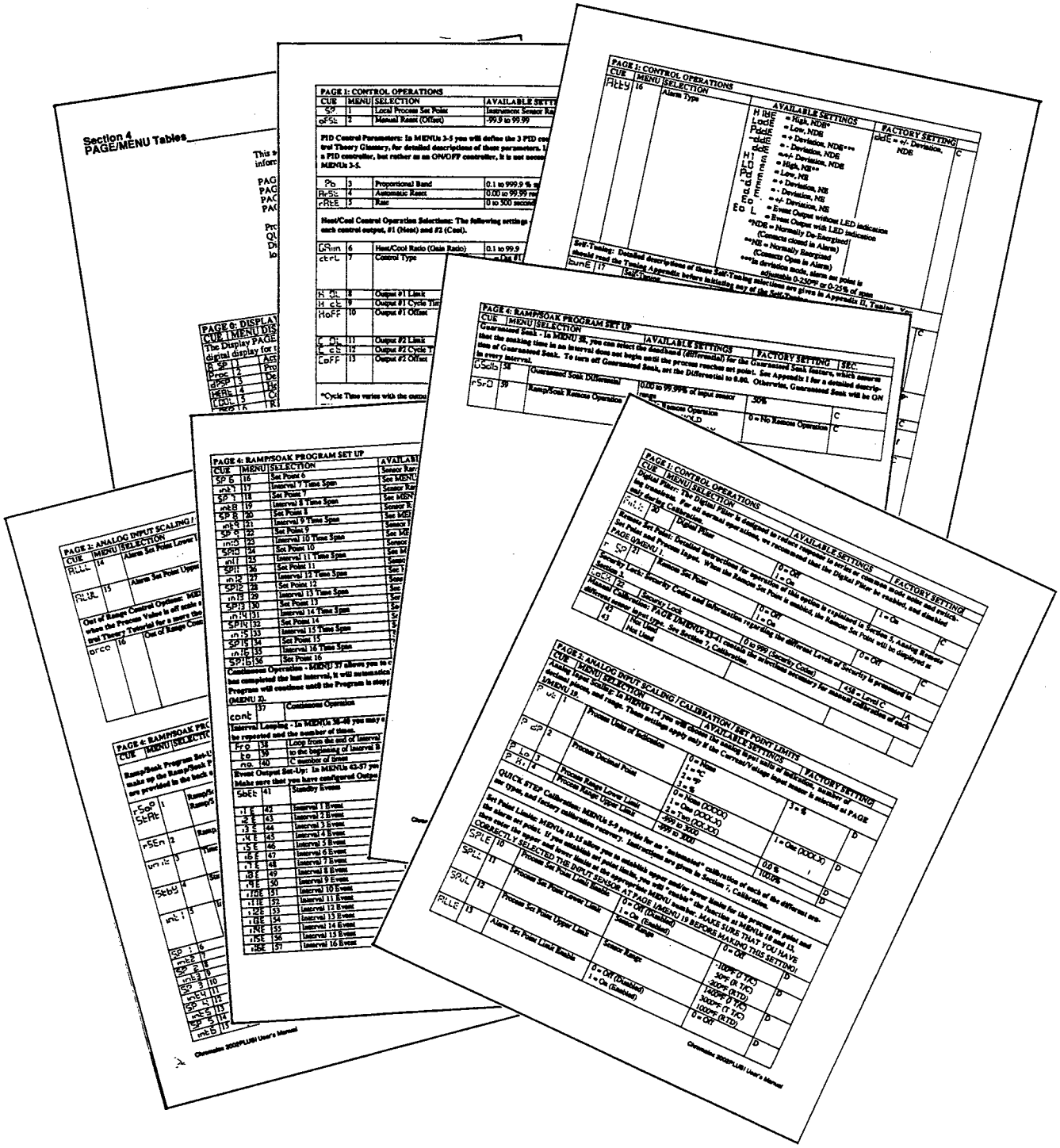
Figure 2.18
Current/Voltage Jumper Positions

OPTIONS WIRING CONNECTIONS

Specific wiring instruction for each of the following options are given in the following pages of the manual:

Option	Page
Remote Set Point	51
Process Output Signal	51
Digital Communications	56

Figure 3.1: PAGE/MENU Programming Concept



PAGE/MENU Programming

All control parameters, selections and calibration procedures for the 2002PLUS! are accomplished through simple MENU selections. These MENU selections are organized into PAGES. On each PAGE you will find a specific set of related functions, and each of these functions has a corresponding MENU number. This organization allows you to go directly to the parameter to be adjusted, without stepping through a long series of unrelated entries.

Figure 3.1 illustrates the concept behind the PAGE/MENU structure, and Figure 3.2 lists the contents of the 5 PAGES in terms of the related functions of the MENU numbers they contain.

Figure 3.2: PAGE/MENU Contents

PAGE 0	PAGE NAME Display (Status Only)	PAGE CONTENTS Select the value to be displayed in the lower digital display during troubleshooting or brief trending periods. Values cannot be changed on this page.
1	Control Operations	Set Point Control Mode Heat and Cool Control Parameters Alarm Parameters Automatic Tuning Auto/Manual Operation Input Sensor Selection Process Units Security Lock Manual Calibration
2	Analog Input/ Calibration Set Point Limits Out of Range	Select Analog Input Units, Range and Decimal Places Calibration Establish Control and Alarm Set Point Limits Control Output Operation when Process Out of Range
3	Digital Communications	Terminal Interface, Automatic Data Logging
4	Ramp/Soak Program	Establish all information as it relates to the Ramp/Soak Program

PAGE/MENU Tables

The detailed contents of each individual MENU number on a PAGE are presented in the PAGE/MENU Tables. These tables give the MENU number, alphanumeric command cue, available settings and factory settings for every adjustment or selection to be made. A sample of part of a PAGE/MENU Table follows:

PAGE 1: CONTROL OPERATIONS					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	
SP	1	Local Process Set Point	Instrument Sensor Range	0	B
oFSt	2	Manual Reset (Offset)	-99.9 to 99.99	0.0	B

PID Control Parameters: In MENUs 3-5 you will define the 3 PID control parameters. See Appendix I, Control Theory Glossary, for detailed descriptions of these parameters. If you will not be using the controller as a PID controller, but rather as an ON/OFF controller, it is not necessary to make MENU selections in MENUs 3-5.

	0 % span	5.0%

Location of PAGE/MENU Tables in this Manual

PAGE 1 and a portion of PAGE 2 contain all of the general parameters and selections necessary to get the controller up and running in your application. These PAGES are detailed in the the next section of the manual, PAGE/MENU Tables. PAGES 2 and 3 are located in sections specific to their functions, such as Calibration and Digital Communications.

What's Next?

It is important that you learn more about the controller Security Levels, and the Pushbuttons and Indications before proceeding with actual programming of your unit. A programming practice is given later in this section to familiarize you with the controller operation before you actually put it into service.

SECURITY LEVELS

As you can see, every parameter or selection to be made has a corresponding PAGE/MENU number. Each PAGE/MENU number is assigned one of four Security Levels, A-D. In each Level you can **view** certain PAGE/MENU numbers, and **adjust** certain PAGE/MENU numbers. This allows you to select the Security Level most appropriate for your operating environment, prohibiting unauthorized access to or accidental changing of control parameters.

Entering the Security Code

The Security Code which "unlocks" the Security Level is entered in PAGE 1/MENU 22 to determine which Levels may be **viewed** and which may be **adjusted.** The controller is set at Security Level C (code 458) when you receive it from Chromalox.

Figure 3.3 defines the PAGE/MENU numbers that correspond to each of the four Security Levels.

Figure 3.3: Security Levels and PAGE/MENU Contents

Security	Allows Adjustment of:	PAGE/MENU
A	Display Selection Security Lock (locks out control adjustments)	P0 / M1-10 P1 / M22
B	Process Set Point and Manual Reset Access to RUN,HOLD, STANDBY and Ramp/Soak Functions	P1 / M1-2 P4 / M1
C	PID Control Parameters, Control Mode, Output Limits, Cycle Time, Deadband, Alarm Parameters, Self-Tuning, Sensor Selection, Digital Filter, Remote Set Point, Digital Communications, Ramp/Soak Profile	P1 / M3-21 P3 / M1-11 P4 / M2-59
D	Manual Calibration, QUICK STEP Calibration, Analog Input Scaling, Set Point Limits	P1 / M21-35 P2 / M1-16

Security Codes

Figure 3.4 lists the four Security Codes for each of the Security Levels, and the Levels which can be **viewed** and **adjusted.**

Figure 3.4
Security Codes and View/Adjust Levels

Security Level	Security Code	View Level	Adjust Level
A	--	A	A
B	123	A,B	A,B
C	458	A,B,C	A,B,C
D	736	A,B,C,D	A,B,C,D

What's Next?

Next, you will learn how to operate the controller to access these PAGE/MENU functions and what the displays will tell you.

Pushbuttons and Indications

All of the program control steps and configuration entries are easily accomplished with the front panel pushbuttons. The digital displays and status lights provide a constant overview of the process. Figure 3.5 shows the controller displays and lights in a normal operating mode, and Figure 3.6 summarizes the functions of the pushbuttons and displays.

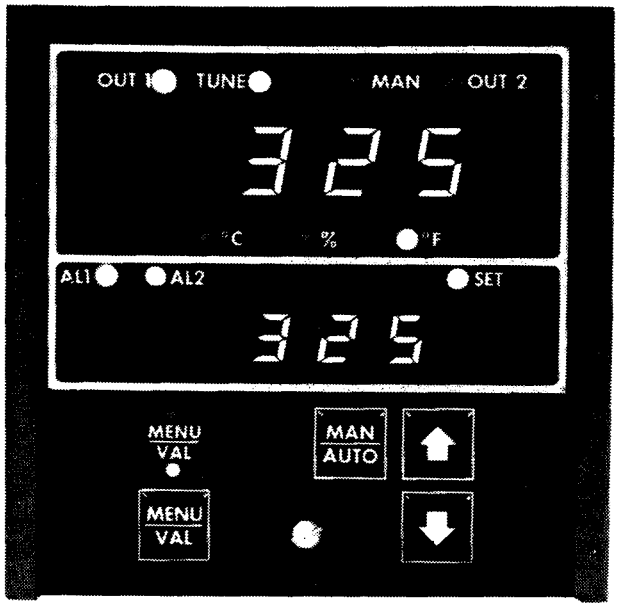
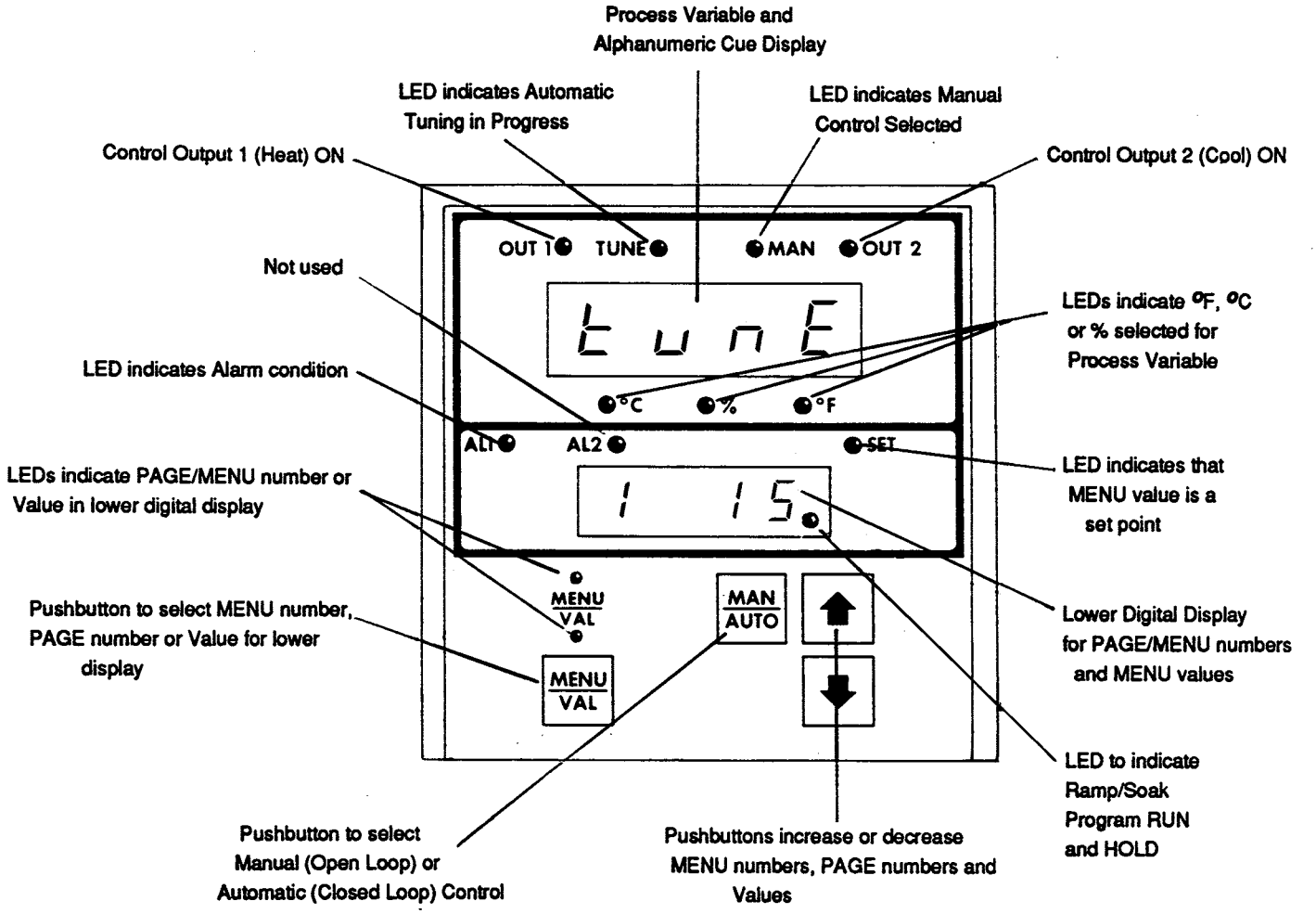


Figure 3.5
Front Panel Displays
During Normal Operation

Figure 3.6
Front Panel Displays and Pushbuttons



Detailed Display and Pushbutton Descriptions

Figure 3.6 summarizes the display and pushbutton functions. Several of these displays/pushbuttons have multiple functions, which are explained in detail in the following paragraphs.

Upper Digital Display - During normal operation, the upper display reflects the measured process variable. The units of this displayed value (°F, °C, %) are indicated by the LEDs directly below the digital display. These units are selected in the PAGE/MENU programming (Sensor Selection PAGE 1/MENU 19 or on PAGE 2 for Analog Sensor Input Scaling).

During programming the upper digital display displays the alphanumeric command cue for the PAGE/MENU selection being adjusted. An example of an alphanumeric command cue is shown in Figure 3.7:

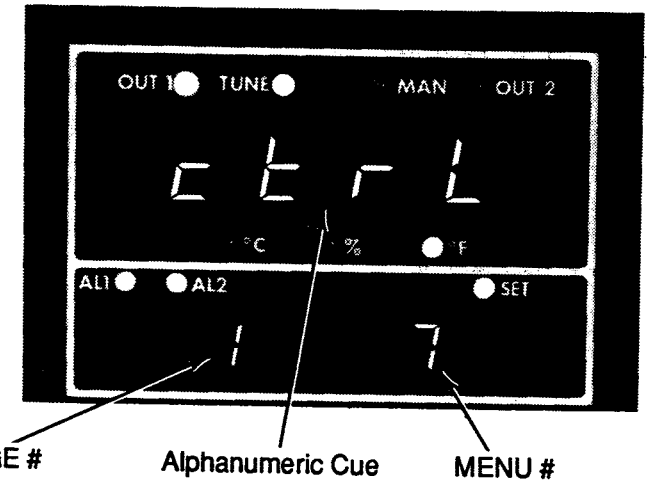


Figure 3.7
Alphanumeric Command Cue
"Control Type"
PAGE 1/MENU 7

This is the cue for the selection of the control type (PID or ON/OFF), PAGE 1/MENU 7.

Lower Digital Display - During normal operation, the digital display will display the process set point value, PAGE 1/MENU 1. For troubleshooting or brief process trending, you may select a value that you want to be displayed via PAGE 0. In the example below, the deviation from process set point (PAGE 0/MENU 3) has been selected for the lower digital display (50.0°F).

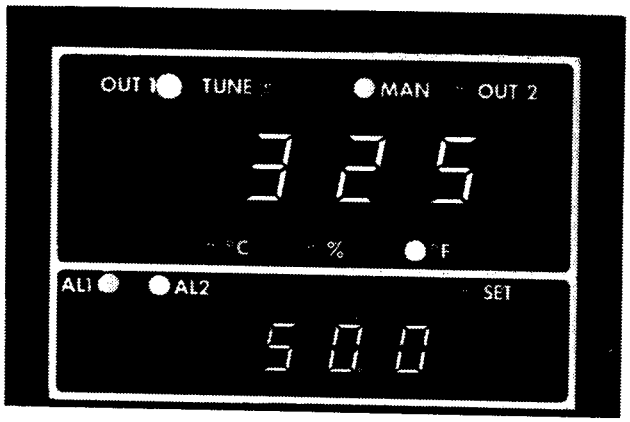


Figure 3.8
Lower Digital Display
Showing Set Point
PAGE 0/MENU 3

During programming, the lower digital display performs the valuable function of indicating which PAGE/MENU numbers you are selecting, and their corresponding values or settings. If the value is a numeric setting (such at a set point or cycle time), then the lower display indicates the value numerically.

If the value is not numeric, such as control type (PID, PID) or Alarm Type (Hide or Lode), the lower display indicates the possible settings as alphanumerics or codes (for example, 1 = On, 0 = Off).
When the controller is operating in the manual mode, the lower display will show the control output command in % of full ON, 0.0 to 100.0%.

MENU/VAL Pushbutton - This pushbutton is used to toggle the lower digital display from PAGE/MENU display to the **value** of that PAGE/MENU number. The LED directly above the pushbutton indicates whether the lower display is a "VAL" or a "MENU."

Programming Practice

Now that you understand the basic PAGE/MENU programming structure, displays and pushbuttons, you are ready for a practice programming.

It is important that you take time to perform this programming practice, since it will teach you how to move between PAGES and MENU numbers, and how to adjust the MENU values.

IMPORTANT!!

DISABLE THE EXTERNAL LOAD CIRCUIT POWER BEFORE PROCEEDING WITH THE PROGRAMMING PRACTICE!

Initial Power-Up

After the 2002PLUS! has been properly installed and power is turned on for the first time, it will begin to operate utilizing the factory settings (as shown in the PAGE/MENU Tables, Section 4). The upper digital display will contain four dashes "----" and the lower display will contain the controller model number "2002."

After a short delay, during which the controller performs self-tests, the upper display will indicate the process variable (in °F) and the lower display will indicate the factory-set set point (0°F). Since the lower display value is a set point, SET will be illuminated. Other LEDs may indicate operating status, such as alarm conditions and control output.

Programming Practice Example Set Up

In the following steps, you will learn how to adjust a PAGE/MENU setting. Assume that you would like to establish upper and lower limits for the process set point. You must first "enable", or turn ON, the set point enable feature at PAGE 2/MENU 10, then enter the set point lower and upper limit values at PAGE 2/MENU 11-12. Assume that the controller is in its "factory shipped" condition and no adjustments have been made to the factory settings.

Parameters:

PAGE/MENU:	**Value to Enter:**	
Set Point Limit Feature	PAGE 2/MENU 10	1 = ON
Lower Set Point Limit	PAGE 2/MENU 11	650°F
Upper Set Point Limit	PAGE 2/MENU 12	750°F

Security: To perform the Programming Practice, you must have LEVEL D Security - Code 736 entered at PAGE 1/MENU 22 (see page 23).

GETTING TO THE PAGE/MENU NUMBER:		
ACTION:	**WHAT HAPPENS:**	**EXPLANATION:**
1. Press MENU/VAL to access the MENU select function.	MENU LED will light Upper Display: alpha cue for set point " SP " Lower Display: Current PAGE "1" flashes in left half, MENU "1" in right half.	The MENU/VAL pushbutton alternately selects the MENU select function and the VALUE select function.
2. Press ▣ until the MENU digits read "0."	Upper Display: alpha cue for PAGE 1, "ctrL"	To move between the PAGE numbers, you must go to MENU 0 on any PAGE.
3. Press MENU/VAL again.	MENU LED remains lit. Upper Display: alpha cue for PAGE 1, "ctrL". Lower Display: "P 1 lights, indicating the current PAGE number is 1.	This puts you in the PAGE select function.
4. Press ▣ until "P 2" is reached.	Upper Display: "CAL" alpha for PAGE 2. Lower Display: "P 2".	You have moved from PAGE 1 to PAGE 2.
5. Press MENU/VAL again.	Lower Display: PAGE "2" flashes in left half of display, MENU "0" on right.	You are now in the MENU select function on PAGE 2 and can advance through the MENU nos.
6. Press ▣ until MENU "10" is reached.	Lower Display: Flashing "2 10" lights.	You are now at PAGE 2/MENU 10 and are ready to enter the new

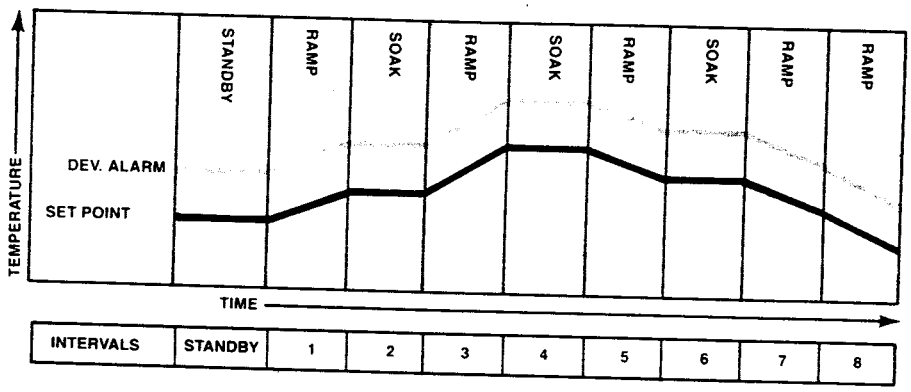
ENTERING NEW MENU VALUE:		
ACTION:	**WHAT HAPPENS:**	**EXPLANATION:**
7. Press MENU/VAL again.	VAL LED will light. Upper Display: Process Variable Lower Display: Current MENU value (set point limit OFF) "0".	You are now in the Value select function.
8. Press ▲ until "1" is displayed in the lower display.*	Lower Display: "1"	The process set point limit enable (1 = ON) is automatically entered into memory. Set point limits are now enabled.
*The ▲ and ▼ pushbuttons increase and decrease the display value faster as they are held pressed.		
GO TO THE NEXT MENU NUMBER TO BE ADJUSTED:		
9. Press MENU/VAL again.	Lower Display "2 10" MENU LED will light.	You have returned to the MENU select function.
10. Press or until the next MENU number to be adjusted is reached.	DISPLAYS SIMILAR TO STEPS 6-9 ABOVE. REPEAT AS NECESSARY TO CHANGE ALL APPROPRIATE MENU VALUES.	
11. Press MENU/VAL to enter the value select function.		
12. Press ▲ or ▼ to adjust the value.		
RETURN THE CONTROLLER TO THE DISPLAY MODE:		
13. Press MENU/VAL again.	Upper Display: Alpha Cue for current PAGE/MENU selected Lower Display: PAGE/MENU no. MENU LED will light.	You have returned to the MENU select function.
14. Press ▼ until MENU 0 is reached.	Upper Display: Alpha Cue for current PAGE. Lower Display: Flashing PAGE #, MENU "0".	Now that you are at MENU 0 you can enter the PAGE select function.
15. Press MENU/VAL again.	MENU LED remains lit. Lower Display: "P #" indicates PAGE you are on.	You are now in the PAGE select function.
16. Press ▼ until you reach PAGE "1".	Upper Display: "ctrL" Lower Display: "P 1"	You are now on PAGE 1 and are ready to enter the MENU select function on the PAGE.
17. Press MENU/VAL again.	Lower Display: Flashing "1 0" MENU LED lights.	You are now in the MENU select function for PAGE 1.
18. Press ▲ until MENU 1 is reached.	Upper Display: Alpha cue for PAGE 1, "ctrL" Lower Display: Flashing "1 1"	You have selected MENU 1 on PAGE 1, which represents the Process Set Point.
19. Press MENU/VAL.	VAL LED lights, SET LED lights Upper Display: Process Variable. Lower Display: Set Point	You are now in the normal operating mode, displaying Process Variable and Set Point.

PROGRAMMING PRACTICE IS COMPLETE!

RAMP/SOAK PROGRAM OPERATION

Intervals

The 2002PLUS! Ramp/Soak Controller features a 16 interval Ramp/Soak Program. Within the program there are 16 intervals plus a standby interval - the time span and set point of each of the 16 intervals being individually adjustable. These 16 intervals constitute what is referred to as the Ramp/Soak Profile. An example of a typical 8 interval Ramp/Soak Profile is shown below.

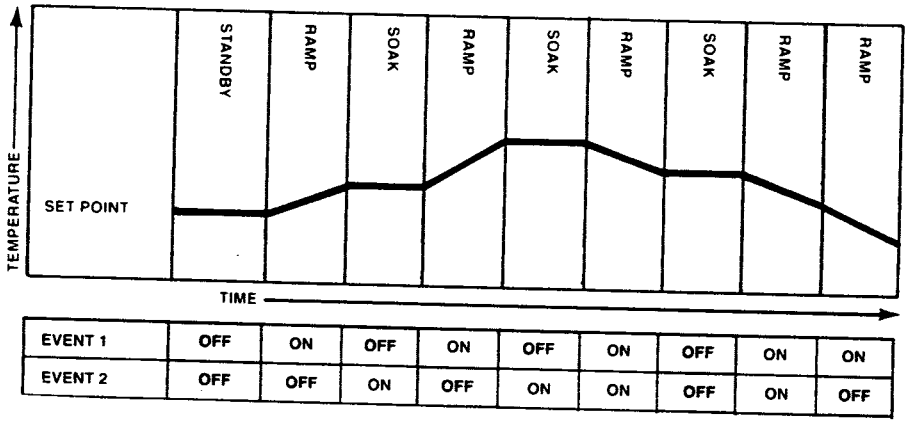


NOTE

Ramp/Soak Profile Graphs similar to this diagram are provided in the back of this manual to make it easier for you to graphically configure your Ramp/Soak process profiles.

Event Outputs

The Alarm/Event Relay Output (Output #3) may be assigned as an Event and configured to be ON or OFF during each of the 16 intervals and the Standby interval. This is illustrated below in an 8 interval example:



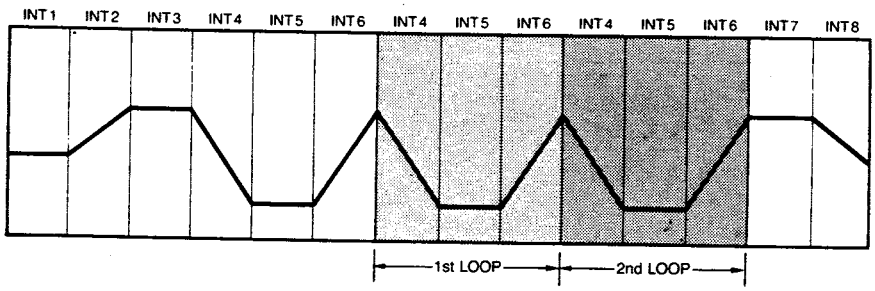
EVENT 1	OFF	ON	OFF	ON	OFF	ON	OFF	ON	ON
EVENT 2	OFF	OFF	ON	OFF	ON	ON	OFF	ON	OFF

When the relay is assigned as an Event Output, it cannot be used as an alarm. The Alarm LED on the front panel of the controller may be used to give visual indication of the ON or OFF status of the Event. Assignment of the relay an alarm or event is made on PAGE 1/MENU 16.

Looping Intervals

To extend the capabilities of the controller, the Programs may be looped. **Looping** means that intervals within the Program may be repeated in a looping fashion. If a loop is inserted in the Program

so that Intervals 4, 5, and 6 will be repeated 2 times in addition to the single Program run of these intervals, the final process profile would look like this:



You would simply tell the controller to "loop from the end of Interval 6 to the beginning of Interval 4, 2 times" when configuring that Program.

Programming the Ramp/Soak Programs

All of the Ramp/Soak Programming is done on PAGE 4. On PAGE 4 you will make the following selections:

Standby Set Point
16 Time Intervals
16 Set Points
Time Units for Intervals (sec/min/hrs)
Interval Loop
Event Outputs ON/OFF during each Interval
Guaranteed Soak ON/OFF and Differential

Profile Graphs and Programming Worksheets

Ramp/Soak Profile Graphs and Programming Worksheets are included in the back of this manual. These "programming tools" are designed to make Program set-up quick and easy, and to provide a permanent record of your Program settings. Worksheets or graphs may be purchased separately (see Part No. in lower right corner of each sheet).

In the following example application, the Profile Graph and Programming Worksheet have been completed to illustrate how to use these programming tools.

Configuring A Ramp/Soak Program

The next several pages of the manual will present a typical set-up of the 2002PLUS! controller's Ramp/Soak capability.

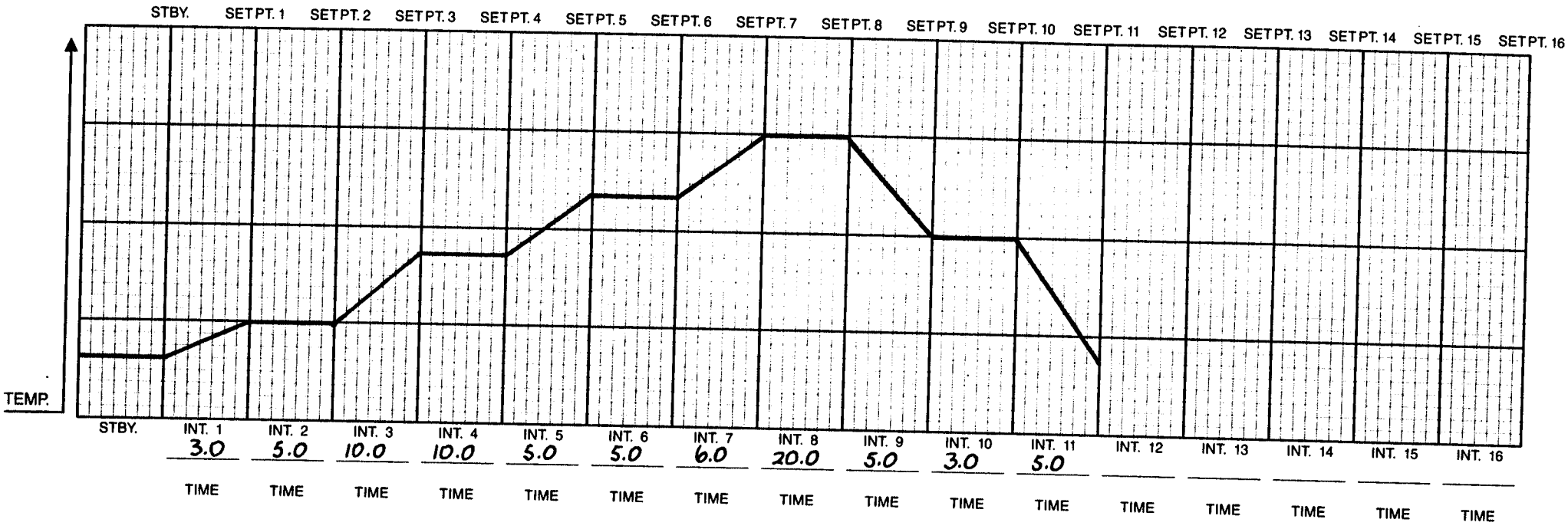
Application Description:
This application is a simple, 4 interval Program. Following this example, you will establish the Ramp/Soak Program using the following set points and time intervals on PAGE 4. Since only 4 of the 16 available intervals will be used in this Program, you should set the Time for interval 5 at 0. This will end the Program at the end of Interval 4.

Selection	Setting	MENU #
Standby Set Point	250°F	MENU 4
Int #1 Time	30.0 min.	MENU 5
Int #1 Set Point	400°F	MENU 6
Int #2 Time	20.0 min.	MENU 7
Int #2 Set Point	400°F	MENU 8
Int #3 Time	60.0 min.	MENU 9
Int #3 Set Point	300°F	MENU 10
Int #4 Time	30.0 min.	MENU 11
Int #4 Set Point	300°F	MENU 12
Int #5	0	MENU 13

Following the programming worksheets, you can see the individual settings and control parameter adjustments that must be configured for the Program. Blank Worksheets are located in the end of this manual.

Chromalox®

2002 *PLUS!* Ramp/Soak Profile Graph



EVENT	STBY.	INT. 1	INT. 2	INT. 3	INT. 4	INT. 5	INT. 6	INT. 7	INT. 8	INT. 9	INT. 10	INT. 11	INT. 12	INT. 13	INT. 14	INT. 15	INT. 16
	OFF	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF	ON	OFF					

LOOP:

Loop from end of Interval	9
to beginning of Interval	5
How many times?	3

GUARANTEED SOAK OFF

Chromalox®

2002 *PLUS!* Programming Worksheet

PAGE 4: Ramp/Soak Program

CUE	MENU	SELECTION	YOUR SETTINGS:		
			Date: 7/3/90	Date:	Date:
rSEn	2	Ramp/Soak Enable	1		
un it	3	Time Units	2		
StbY	4	Standby Set Point	70		
int 1	5	Interval 1 Time Span	3.0		
SP 1	6	Set Point 1	100		
int2	7	Interval 2 Time Span	5.0		
SP 2	8	Set Point 2	100		
int3	9	Interval 3 Time Span	10.0		
SP 3	10	Set Point 3	180		
int4	11	Interval 4 Time Span	10.0		
SP 4	12	Set Point 4	180		
int5	13	Interval 5 Time Span	5.0		
SP 5	14	Set Point 5	230		
int6	15	Interval 6 Time Span	5.0		
SP 6	16	Set Point 6	230		
int7	17	Interval 7 Time Span	6.0		
SP 7	18	Set Point 7	300		
int8	19	Interval 8 Time Span	20.0		
SP 8	20	Set Point 8	300		
int9	21	Interval 9 Time Span	5.0		
SP 9	22	Set Point 9	200		
in 10	23	Interval 10 Time Span	3.0		
SP 10	24	Set Point 10	200		
in 11	25	Interval 11 Time Span	5.0		
SP 11	26	Set Point 11	70		
in 12	27	Interval 12 Time Span	0.0		
SP 12	28	Set Point 12			
in 13	29	Interval 13 Time Span			
SP 13	30	Set Point 13			
in 14	31	Interval 14 Time Span			
SP 14	32	Set Point 14			
in 15	33	Interval 15 Time Span			
SP 15	34	Set Point 15			
in 16	35	Interval 16 Time Span			
SP 16	36	Set Point 16			
cont	37	Continuous Operation	0		
Fro	38	Loop from the end of Interval A	9		
to	39	to the beginning of Interval B	5		
no	40	C number of times	3		
StbE	41	Standby Events	0		
i1 E	42	Interval 1 Events	0		
i2 E	43	Interval 2 Events	1		
i3 E	44	Interval 3 Events	0		
i4 E	45	Interval 4 Events	1		
i5 E	46	Interval 5 Events	0		
i6 E	47	Interval 6 Events	1		
i7 E	48	Interval 7 Events	0		
i8 E	49	Interval 8 Events	1		
i9 E	50	Interval 9 Events	0		
i10E	51	Interval 10 Events	1		
i11E	52	Interval 11 Events	0		
i12E	53	Interval 12 Events			
i13E	54	Interval 13 Events			
i14E	55	Interval 14 Events			
i15E	56	Interval 15 Events			
i16E	57	Interval 16 Events			
GSdb	58	Guaranteed Soak Differential	0		
rSrO	59	Ramp/Soak Remote Operation	0		

ENDS PROGRAM

"0" TURNS OFF GUARANTEED SOAK

Part No. 0037-75127

Now you are ready to enter these Ramp/Soak Program parameters, as described earlier in this section (pages 26-27).

Security Access

Make sure that you have accessed Security Level C (or higher) on PAGE 1/MENU 22 (see page 23).

What's Next?

Now that you have configured the Ramp/Soak Program and entered all of parameters into the controller's memory, you are ready to learn how the Ramp/Soak Operation and Display Mode allows you to use Ramp/Soak control and what the pushbutton and display functions mean.

ENTERING THE RAMP/SOAK OPERATION AND DISPLAY MODE

Enabling Ramp/Soak Control
PAGE 4/MENU 2

If you will be using the Ramp/Soak control feature, you must first "enable" (turn ON) Ramp/Soak control. This is accomplished by going to **PAGE 4/MENU 2** and entering the value "1" = Enabled. When shipped from the factory, the value is "0," meaning that Ramp/Soak control is disabled. When "1" is entered, the controller will begin using the Ramp/Soak Standby Set Point, and the Program will be in the STANDBY state.

Selecting Ramp/Soak Operation and Display Mode

Once you have completed the Ramp/Soak Programming on PAGE 4, you are ready to RUN the Program. **PAGE 4/MENU 1 puts the controller in the Ramp/Soak Operation and Display Mode. YOU DO NOT MAKE ANY MENU SETTINGS AT PAGE 4/MENU 1. PAGE 4/MENU 1 ONLY DISPLAYS THE STATUS OF THE RAMP/SOAK PROGRAM.** Simply go to PAGE 4, select MENU 1, then press MENU/VAL. Both the MENU and VAL LED's will be illuminated, indicating that you are in the Ramp/Soak Operation and Display Mode.

PUSHBUTTONS AND INDICATIONS IN THE RAMP/SOAK OPERATION MODE

Pushbuttons in the Ramp/Soak Mode

The ▲ and ▼ pushbuttons are reassigned to act as Ramp/Soak control pushbuttons when Ramp/Soak control is selected. These pushbuttons give you the following Ramp/Soak commands:

Pushbutton	Ramp/Soak Function
▲	RUN
▼	HOLD
▲ and ▼ pressed simultaneously	STANDBY

Additionally, a red Ramp/Soak status LED is provided to give visual indication of the Program status:

Ramp/Soak LED	Ramp/Soak Status
Steady Illumination	RUN
Blinking	HOLD
Not Illuminated	STANDBY

The pushbuttons and indications are summarized in Figure 3.9. NOTE: The pushbuttons must be held pressed for a minimum of 1/4 second.

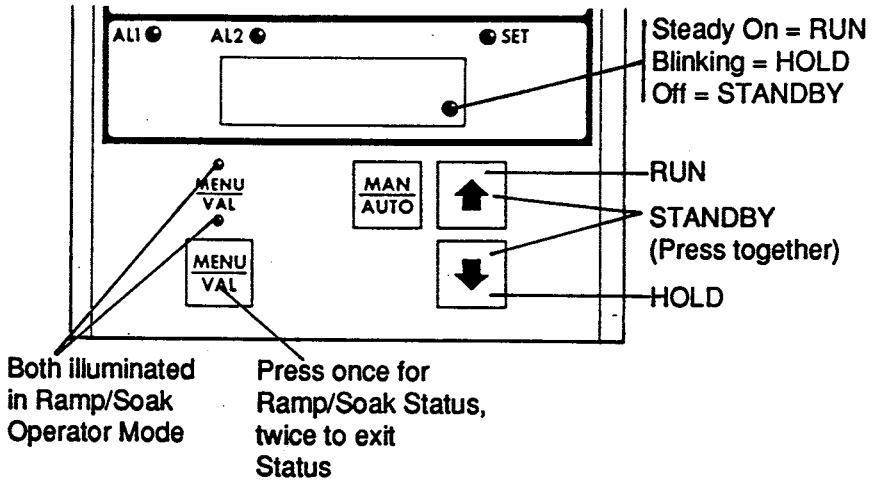


Figure 3.9
Ramp/Soak Pushbuttons and Status Indication

To use the pushbuttons as Ramp/Soak operation pushbuttons, you simply go to PAGE 4/MENU 1, then press [MENU VAL] to enter the operator pushbutton mode. The [▲] and [▼] pushbuttons are then in the Ramp/Soak operation mode (instead of their functions described on page 24). For example, to RUN the Ramp/Soak Program:

Starting the Ramp/Soak Program **RUN**

1. Go to PAGE 4/MENU 1 - Ramp/Soak Control Pushbuttons
2. Press [MENU VAL] to enter the operator pushbutton mode.
3. Press [▲] to RUN the Ramp/Soak Program.
4. The Ramp/Soak LED will illuminate to indicate that the Ramp/Soak Program is running.
5. The set point will begin ramping from Standby Set Point to the Interval #1 Set Point.

When shipped from the factory, Guaranteed Soak is in effect (P4/M58 > 0.00, see page 47). Unless Guaranteed Soak in disabled, each interval of the Program will not continue until the process variable is within the Guaranteed Soak deadband. The Program will pause until the process is within the GS deadband, then start running.

At the completion of the Program, the controller will automatically go to Standby. The Program can be stopped by going to HOLD or STANDBY. If the Ramp/Soak feature is disabled

(PAGE 4/MENU 2) while the program is running, the Program will stop running, and the controller will revert back to using the set point entered at PAGE 1/MENU 1.

Going to Standby
STANDBY

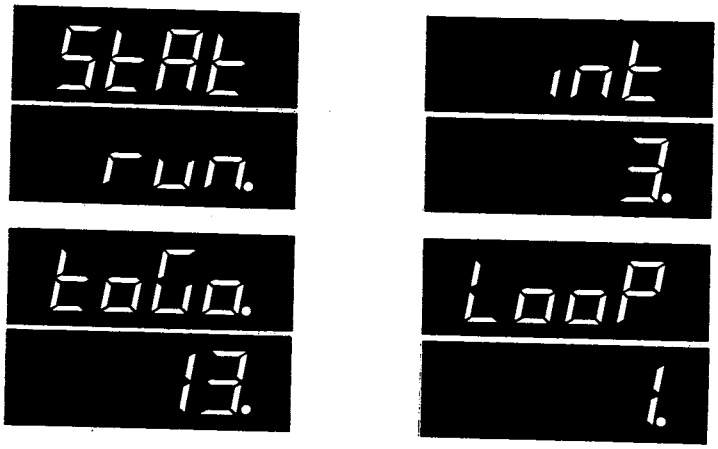
When Standby is selected (by pressing ▲ and ▼ simultaneously), the controller uses the Standby Set Point Value (entered at PAGE 4/MENU 4) until RUN is selected, or the Ramp/Soak feature is disabled (PAGE 4/MENU 2). The Ramp/Soak status LED is not illuminated when the Program is in Standby.

Going to HOLD
HOLD

When HOLD is selected (by pressing the ▼ pushbutton), the Program "freezes". The controller uses the set point that was in effect and retains that time remaining in that interval when HOLD was selected. The Program will stay in HOLD until RUN or STANDBY is selected, or until the Ramp/Soak feature is disabled (PAGE 4/MENU 2). The Ramp/Soak status LED blinks on and off when the Program is in HOLD.

Status Indications in the Ramp/Soak Mode

In addition to the red Ramp/Soak LED described previously, the 2002PLUS! can be instructed to display a sequence of 4 Ramp/Soak Status values. These values tell you information about the Ramp/Soak Program at that point in time - Ramp/Soak Program Status, Current Interval, Time Left in the Interval, Number of Loops left to run. These displays are illustrated below:



To review the Ramp/Soak Status display sequence, simply press MEN/VAL once (while the controller is in the Ramp/Soak Operation Mode PAGE 4/MENU 1), and the controller will automatically present the 4 values. To exit to the MENU mode, press MEN/VAL twice. If you do not press MEN/VAL twice, the controller will automically go back to displaying the Process Value and Set Point, and will remain in the Ramp/Soak Operation Mode (MENU and VAL LED's illuminated).

Guaranteed Soak

When Guaranteed Soak is turned ON (PAGE 4/MENU 58 Guaranteed Soak Differential is set greater than 0), an interval time will stop and the setpoint will not ramp until the process temperature is close to set point. How close to set point is determined

by the guaranteed soak differential. **The red Ramp/Soak LED is illiuminated and does not blink when the controller is in the Guaranteed Soak mode.**

SPECIAL CONDITIONS OF THE RAMP/SOAK PROGRAM OPERATION

Power Loss During Program Run

Should instrument power be lost during the Program RUN, the controller will retain:

Current Interval #
Time Remaining in the Interval
Set Point
Loop #
Ramp/Soak Status - RUN, HOLD, STANDBY

The controller will then resume operation at that point in the Ramp/Soak Program when power is restored. When power is restored, the controller performs a self-test of the Ramp/Soak control parameters to assure that no information was lost during the power failure. It is highly unlikely that any control parameter data would be lost, however, if any control parameters were lost, the controller will begin operating in the Standby state.

Adjusting Ramp/Soak Parameters During Program Run

The Ramp/Soak Parameters may be adjusted while the Program is running, to permit on-line profiling and set-up. If the set point and/or time of an interval is changed while that interval is running, the controller will not begin using the new value until the next time that interval is run.

Manual Override During Program Run

If Manual control is selected during the program run (by pressing the MAN/AUTO pushbutton), the controller will keep running the Ramp/Soak profile and the Event Output will be active, but the control output will be manually controlled. The Ramp/Soak profile does not stop during manual override unless a guaranteed soak limit is exceeded.

The Remote Ramp/Soak Operation feature allows you to connect a remote switch (normally-open, momentary pushbutton) to the controller for one of two types of remote operation. This feature is helpful if the controller is installed inside an enclosure where the operation pushbuttons are inaccessible, or perhaps for an emergency "stop button."

You may select either "RUN-HOLD" or "RUN-STANDBY" operation via the remote operation switch. This means that when the switch is pressed, you toggle between the two functions you have selected in the programming, PAGE 4/MENU 59. For example, if "RUN-HOLD" is selected (value "1" at PAGE 4/MENU 59), and the Ramp/Soak program is already in RUN, when you press the remote switch the Ramp/Soak program will go to HOLD. When you press the switch again, it will go back to RUN, etc.

This feature uses the same wiring terminal as the Analog Remote Set Point Input feature, therefore you cannot have both Remote Ramp/Soak Operation and Analog Remote Set Point Input operating at the same time.

To use the Remote Operation feature, you must:

1. Make the wiring connection to terminal 5 as shown in the following wiring diagram, Figure 3.10.
2. Move the Remote Set Point jumper to the Remote Ramp/Soak Operation position (Figure 3.11).
3. Make the appropriate selection at PAGE 4/MENU 59.

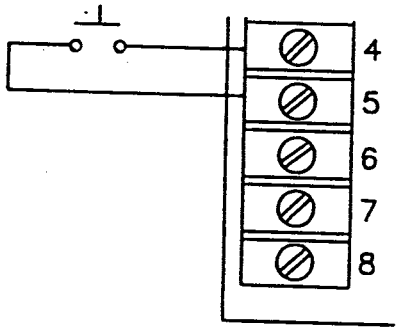


Figure 3.10
Remote Ramp/Soak Operation Wiring Connections

To select the Remote Operation, move the Remote Set Point Jumper as follows:

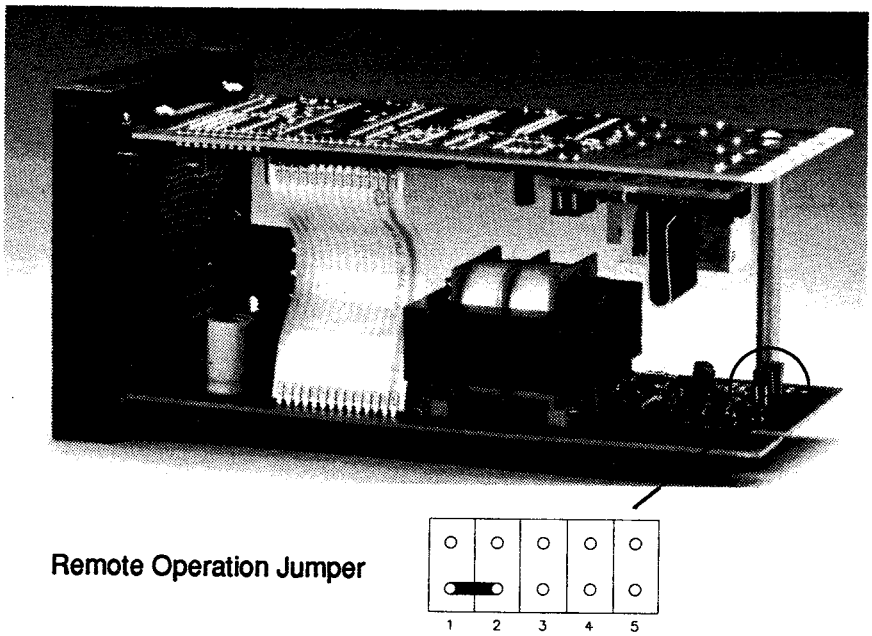
1. Remove instrument power from the controller.

2. Remove the 2002PLUS! chassis from the instrument case (see page 9).

3. Locate the remote set point jumper inside the controller chassis as shown in Figure 3.11, and reposition.

4. Place the controller chassis back in the case and proceed to Wiring.

Figure 3.11
Remote Ramp/Soak Operation Jumper Position



Following the PAGE/MENU Tables, make the appropriate PAGE 4/MENU 59 selection for the type of Remote Ramp/Soak Operation that you need.

AUTO/MANUAL OPERATION

The 2002PLUS! controller can be switched between Automatic and Manual control by pressing the MAN/AUTO pushbutton on the controller front panel. On intial power-up, the controller begins operating in the automatic control mode (closed loop). When the MAN/AUTO pushbutton is pressed, manual control (open loop) is selected. The control output can then be manually raised and lowered with the ▲ and ▼ pushbuttons if PID control is selected on PAGE 1/MENU 7. (The output(s) cannot be driven past the output limits set on PAGE 1/MENU 8, 11). This capability is of particular importance in process applications that must be brought on line manually and to determine optimum control settings. If ON/OFF control is selected on PAGE 1/MENU 7, the ▲ and ▼ pushbuttons force the control output ON and OFF.

Bumpless, Balanceless Transfer

The transfer between Automatic and Manual operation is bumpless and balanceless - when switching from automatic to manual control, the controller assumes the last output command from the automatic mode, and when returning to automatic control, the output is forced to be the last manual mode output command. This eliminates any "bumps" or disruptions to the process when switching modes.

Switching Between Heat and Cool in Manual

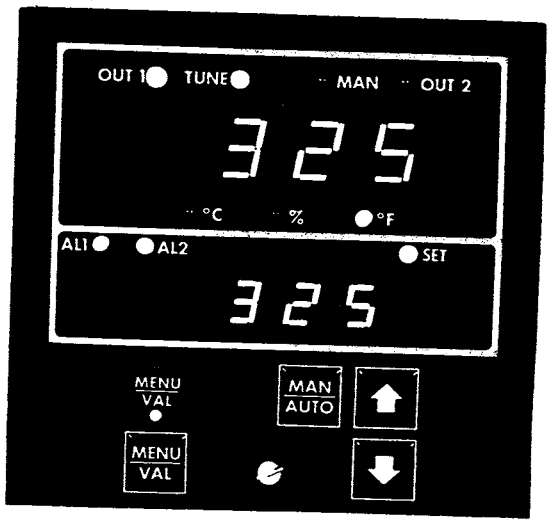
When in the manual mode, you may switch between heat output ON and cool output ON.

1. Press ▼ until the % output = 0.0
2. Press MENU/VAL to toggle between the outputs.
3. Press ▲ until the desired % output is reached.

To enter manual operation:

Figure 3.12
Auto/Manual Operation

1. Press MAN/AUTO
   MAN LED lights
   Output will display
   "%" ON or "ON - OFF" and
   Heat or Cool Output
   in lower display.
2. Adjust the output using
   ▲ and ▼ .
3. Press MAN/AUTO to return to
   automatic control.
   MAN LED will turn off.



The lower display will indicate the output status as illustrated below:

PID Control

Display after adjusting output by pressing ▲.

Display after adjusting output by pressing ▼.

ON/OFF Control

Set Point Display

When exiting from Manual to Auto control, the controller will go back to displaying the set point selected (Local, Remote or Ramp/Soak Set Point):

Local Set Point	PAGE 1/MENU 1
Remote Set Point	PAGE 0/MENU 1
Ramp/Soak Set Point	PAGE 4/MENU 1

What's Next?

You are now ready to proceed with programming your Chromalox 2002PLUS! controller! Following are the PAGE/MENU Tables from which you can make decisions about the settings and parameters for your application. **Be sure to use the Ramp/Profile Graphs and Programming Worksheets in the back of this manual to configure your controller and record your settings.**

This section contains detailed programming information for PAGES 0, 1, 2, 4:

PAGE 0 - Display Page
PAGE 1 - Control Operations
PAGE 2 - Analog Input Scaling and Set Point Limits
PAGE 4 - Ramp/Soak Program Set Up

Programming information for calibration, both Manual and QUICK STEP, is located in the Calibration section (page 65), and Digital Communications programming information (PAGE 3) is located in the Digital Communications section (page 55).

PAGE 0: DISPLAY dISP			
CUE	MENU DISPLAY SELECTION		SECURITY
The Display PAGE allows you to select the value that may be displayed in the lower digital display for troubleshooting or short-term process trending observations.			
A SP	1	Active Set Point (Local, Remote or Ramp/Soak)	A
Proc	2	Process Variable	
dPSP	3	Deviation from Process Set Point	
HEAt	4	Heat Output Command in % of full ON	
COOL	5	Cool Output Command in % of full ON	
rPSP	6	Remote Process Set Point	
StAt	7	Ramp/Soak Operating State	
int	8	Current Interval Number	
toGo	9	Time Left to go in Current Interval	
LOOP	10	Number of Loops Remaining	

PAGE 1: CONTROL OPERATIONS CtrL					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	
SP	1	Local Process Set Point	Instrument Sensor Range	0	B
oFSt	2	Manual Reset (Offset)	-99.9 to 99.99	0.0	B
PID Control Parameters: In MENUs 3-5 you will define the 3 PID control parameters. See Appendix I, Control Theory Glossary, for detailed descriptions of these parameters. If you will not be using the controller as a PID controller, but rather as an ON/OFF controller, it is not necessary to make MENU selections in MENUs 3-5.					
Pb	3	Proportional Band	0.1 to 999.9 % span	5.0%	C
ArSt	4	Automatic Reset	0.00 to 99.99 repeats/minute	0.00	C
rAtE	5	Rate	0 to 500 seconds	0	C
Heat/Cool Control Operation Selections: The following settings define the controller and should be made for each control output, #1 (Heat) and #2 (Cool).					
GAin	6	Heat/Cool Ratio (Gain Ratio)	0.1 to 99.9	1.0	C
ctrL	7	Control Type	!!22P= Out #1 PID, Out #2 PID !o2P= Out #1 ON/OFF, Out #2 PID !!2o= Out #1 PID, Out #2 ON/OFF !o2o= Out #1 ON/OFF, Out #2 ON/OFF	!!.2P = PID, PID	C
H oL	8	Output #1 Limit	0 to 100% ON	100% ON	C
H ct	9	Output #1 Cycle Time*	0.1 to 60.0 seconds	*See note below	C
HoFF	10	Output #1 Offset	0 to 100% ON (PID) 0 to 100°F (ON/OFF) 0.00 to 6.25% (analog input)	0	C
C oL	11	Output #2 Limit	0 to 100% ON	100% ON	C
C ct	12	Output #2 Cycle Time*	0.1 to 60.0 seconds	*See note below	C
CoFF	13	Output #2 Offset	0 to 100% ON (PID) 0 to 100°F (ON/OFF) 0.00 to 6.25% (analog input)	0	C
*Cycle Time varies with the output type of your controller. Refer to Appendix I, Control Theory Tutorial, for recommended Relay, Triac, 4-20 mA, and Solid State Relay Drive Cycle Time settings.					
ON/OFF Control Parameters: In MENU 14 you will make the Deadband setting for ON/OFF control operation. If you will not be using the controller as ON/OFF, it is not necessary to make this selection. This adjustment is always in °F, even if °C has been selected for display of the process temperature.					
db	14	Deadband	1 to 100°F (for temp. inputs) 0.01 to 6.25% span (analog input)	5°F	C
Alarm Set-Up: In MENUs 15 and 16 you will define alarm set point and type. Detailed descriptions of the alarm types are given in Appendix I, Control Theory Tutorial.					
AL5P	15	Alarm Set Point	J T/C -100 to 1400°F K T/C -100 to 2100°F E T/C -100 to 1100°F T T/C -350 to 750°F N T/C -100 to 2300°F R T/C 50 to 3000°F S T/C 50 to 3000°F RTD = -200 to 1000°F Analog (see PAGE 2/MENU 1-4)	J T/C = 250°F	C C

PAGE 1: CONTROL OPERATIONS CtrL					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	
Alty	16	Alarm Type	HidE = High, NDE* LodE = Low, NDE PdiE = + Deviation, NDE*** -diE = - Deviation, NDE diE = +/- Deviation, NDE HI nE = High, NE** LO nE = Low, NE P.d nE = + Deviation, NE -.d nE = - Deviation, NE d. nE = +/- Deviation, NE Eo = Event Output without LED indication Eo L = Event Output with LED indication *NDE = Normally De-Energized (Contacts closed in Alarm) **NE = Normally Energized (Contacts Open in Alarm) ***In deviation mode, alarm set point is adjustable 0-250°F or 0-25% of span for analog process input.	diE = +/- Deviation, NDE	C
Self-Tuning: Detailed descriptions of these Self-Tuning selections are given in Appendix II, Tuning. You should read the Tuning Appendix before initiating any of the Self-Tuning procedures.					
tunE	17	Self-Tuning	0 = Manual (none) 1 = Power-Up, Standard 2 = In Process, Standard 3 = Both, Standard 4 = Power-Up, Overdamped 5 = In Process, Overdamped 6 = Both, Overdamped	0 = Manual	C
Auto/Manual Disintegration Time: This setting applies only if you will be using the Auto/Manual control option. A detailed description of Disintegration Time is given in Appendix I, Control Theory Tutorial. A setting of 0 disables Auto/Manual control.					
Auto	18	Disintegration Time	0 to 100 seconds	10 seconds	C
Sensor Selection: In MENU 19, you will specify the type of input sensor you are using, and the units of indication (°F or °C). If you are using the 4-20 mA/1-5Vdc analog input, you will specify the range and units of indication on PAGE 2/MENU 1-4.					
SEnS	19	Sensor Selection	J °F = J T/C, °F J °C = J T/C, °C K °F = K T/C, °F K °C = K T/C, °C E °F = E T/C, °F E °C = E T/C, °C t °F = T T/C, °F t °C = T T/C, °C n °F = N T/C, °F n °C = N T/C, °C r °F = R T/C, °F r °C = R T/C, °C S °F = S T/C, °F S °C = S T/C, °C rtdF = .00385 RTD, °F rtdC = .00385 RTD, °C 392F = .00392 RTD, °F 392C = .00392 RTD, °C 4-20 = Analog 4-20 mA/1-5 Vdc	J T/C, °F R T/C, °F .00385 RTD, °F	C

PAGE 1: CONTROL OPERATIONS CtrL					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	
Digital Filter: The Digital Filter is designed to reduce response to series or common mode noise and switching transients. For all normal operations, we recommend that the Digital Filter be enabled, and disabled only during Calibration.					
FILt	20	Digital Filter	0 = Off 1 = On	1 = On	C
Remote Set Point: Detailed instructions for operation of this option is explained in Section 5, Analog Remote Set Point and Process Input. When the Remote Set Point is enabled, the Remote Set Point will be displayed at PAGE 0/MENU 1.					
r SP	21	Remote Set Point	0 = Off 1 = On	0 = Off	C
Security Lock: Security Codes and information regarding the different Levels of Security is presented in Section 3.					
LocK	22	Security Lock	0 to 999 (Security Codes)	458 = Level C	A
Manual Calibration: PAGE 1/MENUs 23-41 contain the selections necessary for manual calibration of each different sensor input type. See Section 7, Calibration.					
	42	Not Used			
	43	Not Used			

PAGE 2: ANALOG INPUT SCALING / CALIBRATION / SET POINT LIMITS CAL					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	
Analog Input Scaling: In MENUs 1-4 you will choose the analog input units of indication, number of decimal places, and range. These settings apply only if the Current/Voltage input sensor is selected at PAGE 1/MENU 19.					
P Ut	1	Process Units of Indication	0 = None 1 = °C 2 = °F 3 = %	3 = %	D
P dP	2	Process Decimal Point	0 = None (XXXX) 1 = One (XXX.X) 2 = Two (XX.XX)	1 = One (XXX.X)	D
P Lo	3	Process Range Lower Limit	-999 to 3000	0.0 %	D
P Hi	4	Process Range Upper Limit	-999 to 3000	100.0%	D
QUICK STEP Calibration: MENUs 5-9 provide for an "automated" calibration of each of the different sensor types, and factory calibration recovery. Instructions are given in Section 7, Calibration.					
Set Point Limits: MENUs 10-15 allow you to establish upper and/or lower limits for the process set point and the alarm set point. If you establish set point limits, you will "enable" the function at MENUs 10 and 13, then enter the upper and lower limits at the appropriate MENU number. MAKE SURE THAT YOU HAVE CORRECTLY SELECTED THE INPUT SENSOR AT PAGE 1/MENU 19 BEFORE MAKING THIS SETTING!					
SPLE	10	Process Set Point Limit Enable	0 = Off (Disabled) 1 = On (Enabled)	0 = Off	D
SPLL	11	Process Set Point Lower Limit	Sensor Range	-100°F (J T/C) 50°F (R T/C) -200°F (RTD)	D
SPuL	12	Process Set Point Upper Limit	Sensor Range	1400°F (J T/C) 3000°F (T T/C) 1000°F (RTD)	D
ALLE	13	Alarm Set Point Limit Enable	0 = Off (Disabled) 1 = On (Enabled)	0 = Off	D

PAGE 2: ANALOG INPUT SCALING / CALIBRATION / SET POINT LIMITS					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	
ALLL	14	Alarm Set Point Lower Limit	Instrument Sensor Range	-100°F (J T/C) 50°F (R T/C) -200°F (RTD)	D
ALUL	15	Alarm Set Point Upper Limit	Instrument Sensor Range	1400°F (J T/C) 3000°F (R T/C) 1000°F (RTD)	D
Out of Range Control Options: MENU 16 allows you to determine what action the control output will take when the Process Value is off scale and is typically used with 4-20 mA sensor inputs. See "Appendix I, Control Theory Tutorial for a more thorough explanation.					
orco	16	Out of Range Control Options	0 = Output disabled when Process is above or below range 1 = Output enabled when Process is below range 2 = Output enabled when Process is above range 3 = Output enabled when Process is above or below range	0 = Output Disabled	D

PAGE 4: RAMP/SOAK PROGRAM SET UP rSPG					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	SEC.
Ramp/Soak Program Set-Up: In MENU's 4-36 you will establish the Times and Set Points for each of the 16 intervals that make up the Ramp/Soak Program. Time Units (seconds, minutes, hours) are selected in MENU 3. Graphs and Worksheets are provided in the back of this Manual to help you in configuring and programming the controller.					
rSoP StAt	1	Ramp/Soak Operation Commands Ramp/Soak Status Displays	SEE RAMP/SOAK OPERATION INSTRUCTIONS. NOT A MENU SELECTION - USED TO ENTER RAMP/SOAK OPERATION and DISPLAY MODE		B
rSEn	2	Ramp/Soak Enable	0 = Off (Single Set Point Control) 1 = On (Ramp/Soak Control)	0 = Off	C
unit	3	Time Units	1 = 1 to 9999 seconds 2 = 0.1 to 999.9 minutes 3 = 0.01 to 99.99 hours	1 = seconds	
Stby	4	Standby Set Point	Sensor Range	J,K,E,T,N T/C = 0°F R,S T/C = 50°F RTD = 0°F	
int 1	5	Interval 1 Time Span	0 = Program End 1 to 9999 seconds 0.1 to 999.9 minutes 0.00 to 99.99 hours	1 second	
SP 1	6	Set Point 1	Sensor Range	See MENU 4	
int2	7	Interval 2 Time Span	See MENU 5	1 second	
SP 2	8	Set Point 2	Sensor Range	See MENU 4	
int3	9	Interval 3 Time Span	See MENU 5	1 second	
SP 3	10	Set Point 3	Sensor Range	See MENU 4	
int4	11	Interval 4 Time Span	See MENU 5	1 second	
SP 4	12	Set Point 4	Sensor Range	See MENU 4	
int5	13	Interval 5 Time Span	See MENU 5	1 second	
SP 5	14	Set Point 5	Sensor Range	See MENU 4	
int6	15	Interval 6 Time Span	See MENU 5	1 second	

PAGE 4: RAMP/SOAK PROGRAM SET UP					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	SEC.
SP 6	16	Set Point 6	Sensor Range	See MENU 4	C
int7	17	Interval 7 Time Span	See MENU 5	1 second	
SP 7	18	Set Point 7	Sensor Range	See MENU 4	
int8	19	Interval 8 Time Span	See MENU 5	1 second	
SP 8	20	Set Point 8	Sensor Range	See MENU 4	
int9	21	Interval 9 Time Span	See MENU 5	1 second	
SP 9	22	Set Point 9	Sensor Range	See MENU 4	
inl0	23	Interval 10 Time Span	See MENU 5	1 second	
SPl0	24	Set Point 10	Sensor Range	See MENU 4	
inll	25	Interval 11 Time Span	See MENU 5	1 second	
SPll	26	Set Point 11	Sensor Range	See MENU 4	
inl2	27	Interval 12 Time Span	See MENU 5	1 second	
SPl2	28	Set Point 12	Sensor Range	See MENU 4	
inl3	29	Interval 13 Time Span	See MENU 5	1 second	
SPl3	30	Set Point 13	Sensor Range	See MENU 4	
inl4	31	Interval 14 Time Span	See MENU 5	1 second	
SPl4	32	Set Point 14	Sensor Range	See MENU 4	
inl5	33	Interval 15 Time Span	See MENU 5	1 second	
SPl5	34	Set Point 15	Sensor Range	See MENU 4	
inl6	35	Interval 16 Time Span	See MENU 5	1 second	
SPl6	36	Set Point 16	Sensor Range	See MENU 4	
Continuous Operation - MENU 37 allows you to configure the Ramp/Soak Program to run continuously. When the Program has completed the last interval, it will automatically go to the beginning of the first interval. This continuous running of the Program will continue until the Program is stopped by selecting HOLD, STANDBY, or by disabling the Ramp/Soak feature (MENU 2).					
cont	37	Continuous Operation	0 = Off 1 = On	0 = Off	C
Interval Looping - In MENUs 38-40 you may establish an interval loop, defining which interval or sequence of intervals will be repeated and the number of times.					
Fro	38	Loop from the end of Interval A	A = 1 to 16	1	C
to	39	to the beginning of Interval B	B = 1 to 16	1	
no.	40	C number of times	C = 0 to 9999	0 = No Looping	
Event Output Set-Up: In MENUs 42-57 you may specify whether the Event Output will be ON or OFF in each interval. Make sure that you have configured Output #3 as an Event via PAGE 1/MENU 16.					
SbEt	41	Standby Events	0 = Event OFF 1 = Event 1 ON	0 = Event OFF	C
i1E	42	Interval 1 Event	See MENU 41		
i2E	43	Interval 2 Event			
i3E	44	Interval 3 Event			
i4E	45	Interval 4 Event			
i5E	46	Interval 5 Event			
i6E	47	Interval 6 Event			
i7E	48	Interval 7 Event			
i8E	49	Interval 8 Event			
i9E	50	Interval 9 Event			
i10E	51	Interval 10 Event			
i11E	52	Interval 11 Event			
i12E	53	Interval 12 Event			
i13E	54	Interval 13 Event			
i14E	55	Interval 14 Event			
i15E	56	Interval 15 Event			
i16E	57	Interval 16 Event			

PAGE 4: RAMP/SOAK PROGRAM SET UP					
CUE	**MENU**	**SELECTION**	**AVAILABLE SETTINGS**	**FACTORY SETTING**	**SEC.**
Guaranteed Soak - In MENU 58, you can select the deadband (differential) for the Guaranteed Soak feature, which assures that the soaking time in an interval does not begin until the process reaches set point. See Appendix I for a detailed description of Guaranteed Soak. To turn off Guaranteed Soak, set the Differential to 0.00. Otherwise, Guaranteed Soak will be ON in every interval.					
GSdb	58	Guaranteed Soak Differential	0.00 to 99.99% of input sensor range	.50%	C
rSrO	59	Ramp/Soak Remote Operation	0 = No Remote Operation 1 = RUN and HOLD 2 = RUN and STANDBY	0 = No Remote Operation	C

Section 5
Analog Remote Set Point and Process Output Signal

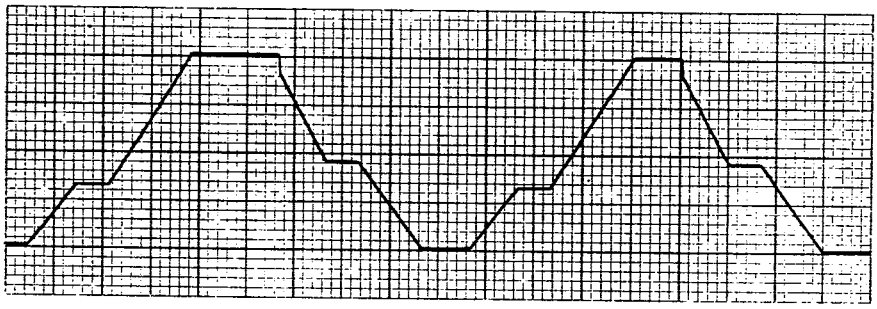
PROCESS OUTPUT SIGNAL

The Process Output Signal Option is found only in controllers with the following model numbers:

2002-***J*	2002-***S*
2002-***K*	2002-***N*
2002-***E*	2002-***D*
2002-***T*	2002-***A*
2002-***R*	

This option allows the process variable to be transmitted to a remote recorder, computer or other device via a 1-5Vdc analog signal. This 1-5Vdc signal follows a linear curve and is factory calibrated over the entire instrument sensor range.

The following is a sample of a chart recording of the process variable, generated using the Process Output Signal Option.



REMOTE SET POINT OPTION

The Remote Set Point Option is found only in controllers with the following model numbers:

2002-***1*	2002-***S*
2002-***J*	2002-***N*
2002-***K*	2002-***D*
2002-***E*	2002-***A*
2002-***T*	2002-***9*
2002-***R*	

The remote set point feature allows the control set point to be adjusted by a remote instrument or device such as a computer. The remote device must be capable of sending either a 4-20 mA or 1-5 Vdc continuous analog set point signal to the controller.

Input Signal Selection - Either a 4-20 mA or 1-5 Vdc input signal can be selected by moving an internal jumper on the input circuit card. The jumper is in the 4-20 mA position when shipped from the factory. To change the unit to accept a 1-5 Vdc signal:
1. Remove instrument power from the controller.

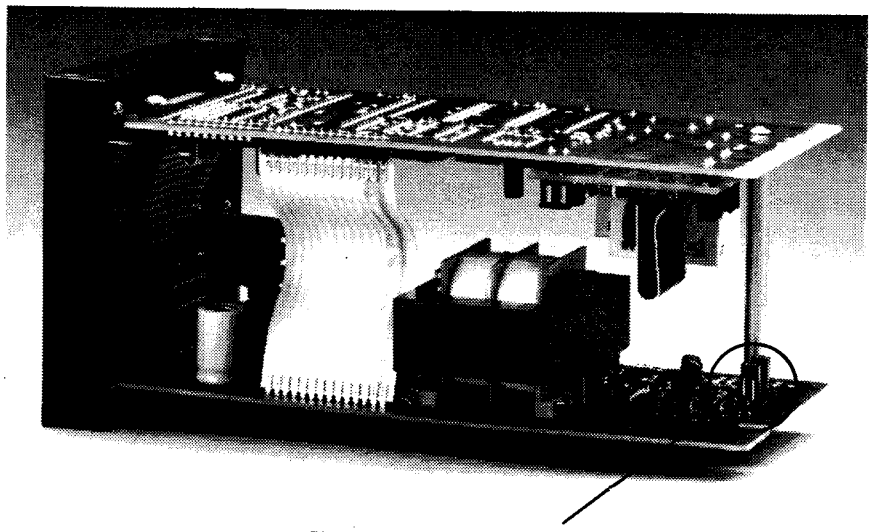
2. Remove the 2002PLUS! chassis from the instrument case (see page 7).

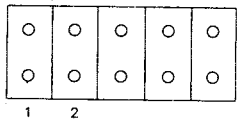
3. Locate the remote set point jumper insides the controller chassis as shown in Figure 5.1.

4. Reposition the jumper as shown in Figure 5.2.

5. Place the controller chassis back in the case and proceed to Wiring.

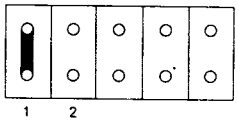
Figure 5.1
Locating the Remote Set Point Jumper



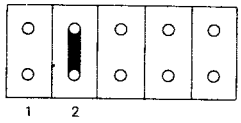


Remote Set Point Jumper

Figure 5.2
Jumper Positioning for Remote Set Point Input Signal Selection



4-20 mA position



1-5 Vdc position

Wiring

Make the wiring connections for both the Remote Set Point and Process Output Signal as shown in Figure 5.3.

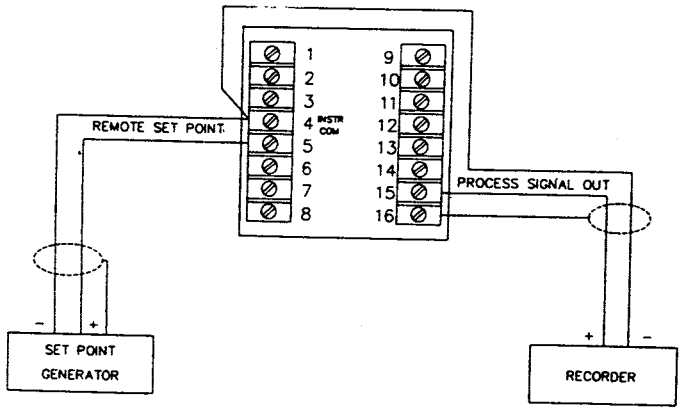


Figure 5.3
Field Wiring for Process Output Signal and Remote Set Point Options

Programming

No programming is necessary to activate the Process Signal Output. To use the Remote Set Point option, it is necessary for you to make the appropriate selection (1 = On) at PAGE 1/MENU 21. This portion of the PAGE/MENU Table is repeated below.

PAGE 1: CONTROL OPERATIONS CtrL					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	SECURITY
r SP	21	Remote Set Point	0 = Off 1 = On	0 = Off	C

When the Remote Set Point is "ON" (PAGE 1/MENU 21 = 1), the remote set point will be displayed on PAGE 0/MENU 1 and on power-up, the controller will start displaying PAGE 0/MENU 1. If Ramp/Soak is enabled (PAGE 4/MENU 2), the Remote Set Point is disabled, even if PAGE 1/MENU 21 has a value of 1.

Calibration of Process Output Signal

The Process Output Signal option is factory calibrated prior to shipment and it is not necessary to recalibrate on receipt and installation. If it should become necessary to recalibrate the controller, following is a calibration procedure. Figure 5.4 presents factory recommended calibration points that have been determined to provide optimum linearity in the most useful portion of each of the sensor ranges. If the control temperature of your application lies outside of the range listed under "Accuracy" on page 73 of the Specifications, recalibration is strongly recommended.

Figure 5.4: Process Output Signal Calibration Table

MODEL NO.	INPUT TYPE	SENSOR RANGE	CALIBRATION FUNCTION	RECOMENDED SENSOR INPUT	Vdc PROCESS OUT
2002-***J*	J T/C	-100 to 1400°F	Zero	200°F	1.800
			Span	900°F	3.667
2002-***K*	K T/C	-100 to 2100°F	Zero	320°F	1.764
			Span	1600°F	4.091
2002-***E*	E T/C	-100 to 1100°F	Zero	300°F	2.333
			Span	900°F	4.333
2002-***T*	T T/C	-350 to 750°F	Zero	-120°F	1.836
			Span	+ 20°F	2.346
2002-***R*	R T/C	50 to 3000°F	Zero	2000°F	3.644
			Span	3000°F	5.000
2002-***S*	S T/C	50 to 3000°F	Zero	2000°F	3.644
			Span	3000°F	5.000
2002-***N*	N T/C	-100 to 2300°F	Zero	800°F	2.500
			Span	2100°F	4.667
2002-***A/D*	RTD	-200 to 1000°F	Zero	-200°F (48.520 ohms)	1.000
			Span	1000°F (293.43 ohms)	5.000

Calibration Procedure

A precision sensor simulator should be substituted for the sensor inputs during calibration.

1. For thermocouple units, connect a thermocouple source to terminals 6 (+) and 7 (-). For RTD input units, connect a decade box to terminals 6 and 7 and a jumper between terminals 7 and 8.

2. Connect a voltmeter to terminals 15 (+) and 4 (-) to measure the Process Output Signal.

3. Set the sensor simulator to the zero value for your input sensor type (from Figure 5.4).

4. Locate the zero and span pots (potentiometers) at the rear of the unit, as shown in Figure 5.5. Adjust the zero pot until the voltmeter reads the Vdc Process Output value from the Calibration Table, Figure 5.4. (For example, if calibrating a K T/C unit, set the input source at 320°F. Adjust the zero pot until the voltmeter read 1.764 Vdc.)

5. Set the sensor simulator to the span value (from Figure 5.4) and adjust the span pot until the voltmeter reads the Vdc Process Output value from the Calibration table.

6. Repeat steps 4 and 5 until both zero and span calibration points equal their respective Vdc Process Output values.

7. After completing the above 6 steps, you may want to calibrate the output at a specific temperature. Set the sensor simulator to that specific value, and adjust the output accordingly using the zero pot. You will need to calculate the Vdc process output value.

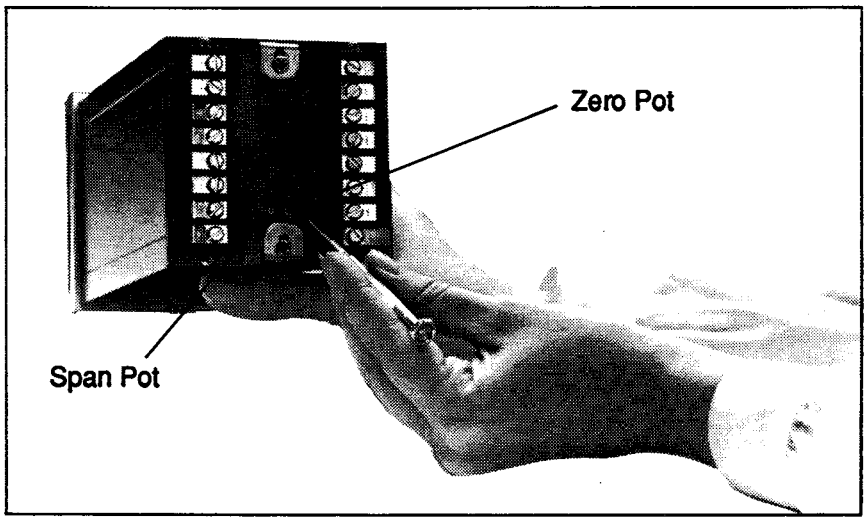


Figure 5.5
Process Output Signal
Zero and Span Calibration Pots

Process Output Signal Ranging

The Process Output Signal is calibrated over 1-5Vdc for the input sensor type of your controller. For some applications, you may want to change the range of the output signal and calibrate it to achieve higher resolution over a wider range of output signals (1-10 mV per °F or °C). Using selection switches located on the process output signal circuit card, you can incrementally increase the switches until the desired resolution is reached.

To adjust the range of the process output signal, start by locating the process output signal circuit card.

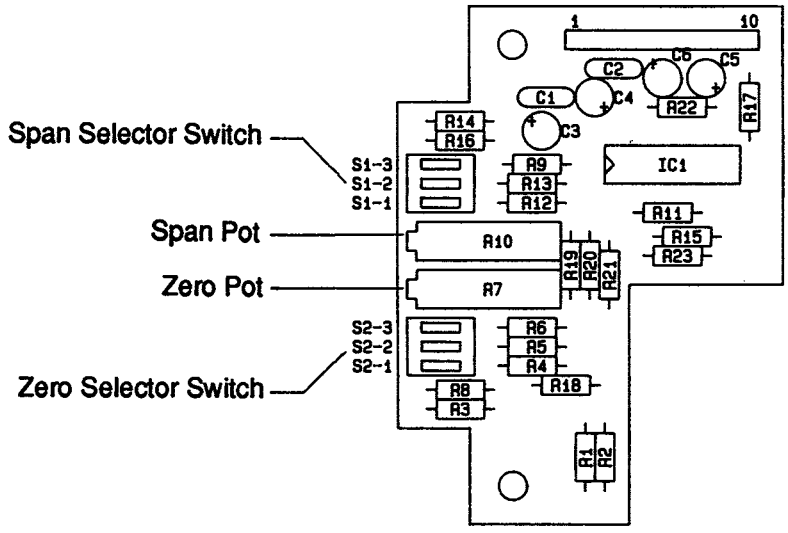
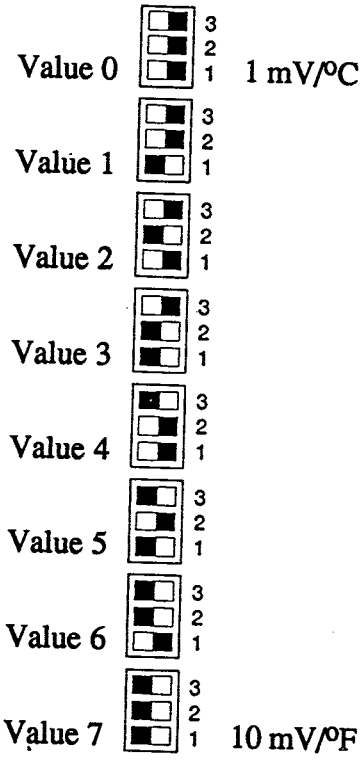


Figure 5.6
Process Output Signal
Circuit Card

As you calibrate the zero and span values using the two calibration pots (as described in steps 1-6 on the previous pages), incrementally increase the switch value until the desired resolution is reached. The switch values are shown in Figure 5.7 on the next page.

Figure 5.7
Process Output Signal Span and Zero Switch Values



The span pot ranges from approximately .5 mV/°F (at Value 0) to 10 mV/°F (at Value 7). A wide temperature range of 0 - 2000°F (0 to 10 Vdc) may require a switch Value 0, whereas a tighter temperature range of 0 - 100°F (0 to 10 Vdc) may require a switch Value 7.

The zero switch moves the **offset** of the temperature/process range. For example, a Value 0 may have a range of 0 to 500°F, and a Value 7 may have a value of 1500 to 2000°F.

After calibrating the zero and span of the new range, be sure to recheck the zero calibration, then the span calibration, to make sure that they equal their respective mV process output values.

Section 6
Digital Communications

The Digital Communications option gives the 2002PLUS! controller the ability to interface with computers, dumb terminals, printers and recorders. This option is found on controllers with the following model numbers:

2002-***8*
2002-***9*

When this option is present, it may be used in one of two modes: ASCII terminal/computer interface mode, or automatic data logging mode. The mode that you choose is selected in the Digital Communications programming, PAGE 3.

TERMINAL/COMPUTER INTERFACE MODE

The ASCII terminal interface mode allows you to change PAGE/MENU settings, view them, and even lock out the controller front panel pushbutton selections. Because all of the software for this function is internally stored in the 2002PLUS! controller, nothing more than an ASCII dumb terminal is required.

Figure 6.1 illustrates a controller connected to a WYSE WY-60* ASCII terminal. Notice that no computer or software is required for this interface.

*Registered trademark of WYSE Corporation.

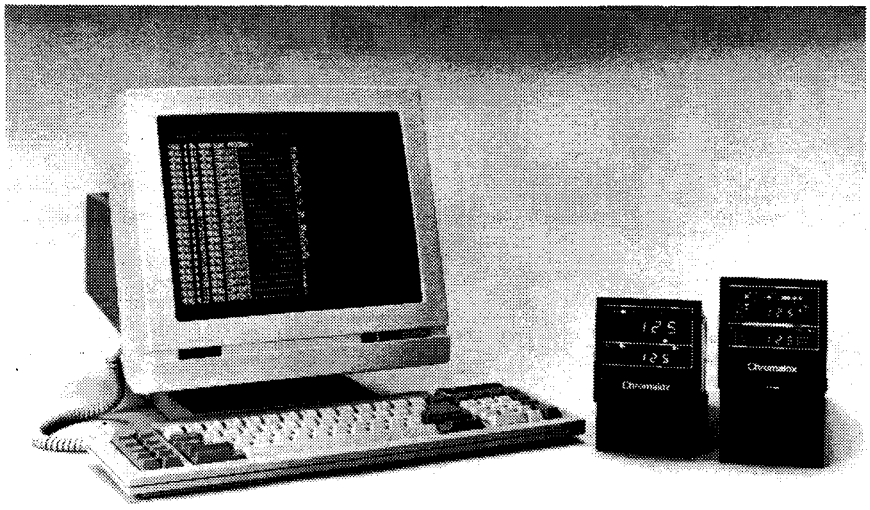


Figure 6.1
2002PLUS! Controller with Dumb Terminal Digital Communications Interface

Wiring and Terminal Connections

Wiring connections for the dumb terminal or computer interface are made on the Digital Interface Connector. Terminal designations for the Digital Interface Connector and wiring diagrams for RS232-C and RS422-A follow.

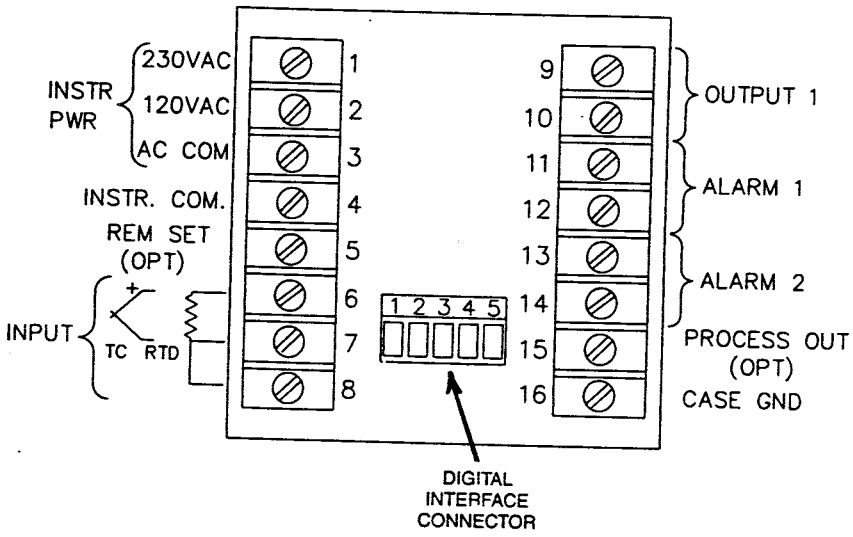


Figure 6.2
Digital Interface Connector

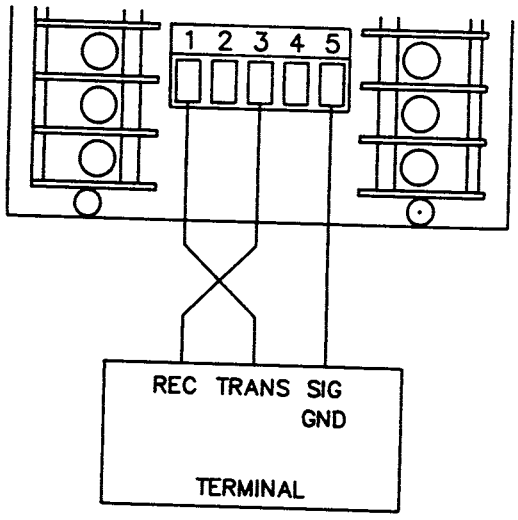
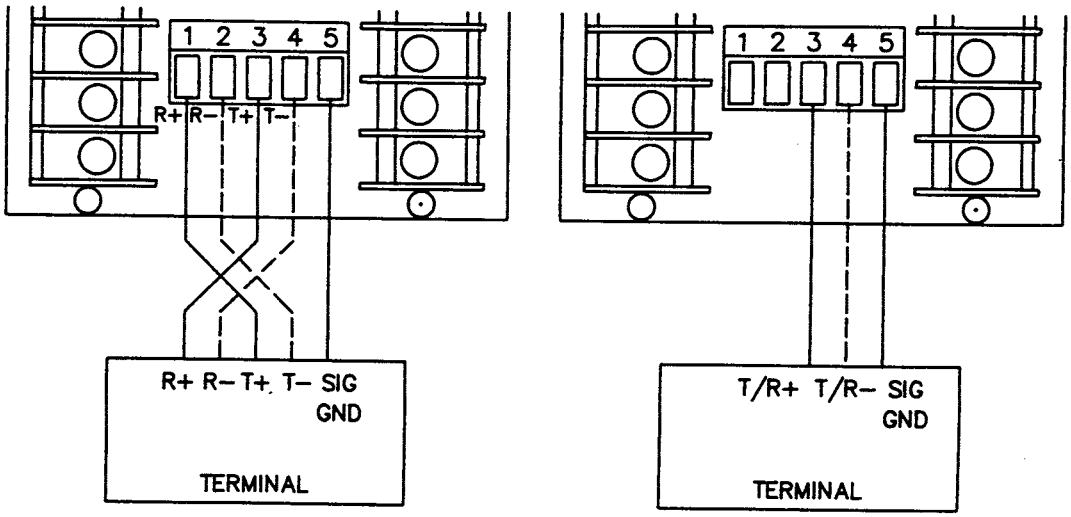


Figure 6.3
Field Wiring for RS232-C Digital Communications

Figure 6.4
Field Wiring for RS422-A Digital Communications



Jumper Positions for RS232-C/RS422-A

When shipped from the factory, the Digital Communications Interface is set for RS232-C. If you are using RS422-A communications, remove the controller from its case, locate the digital communications circuit card (Figure 6.5), and reposition the jumpers as shown in Figure 6.6.

Figure 6.5
Locating the Digital Communications Circuit Card

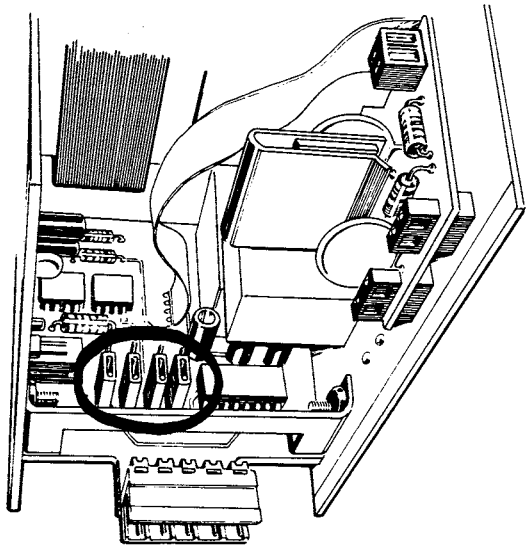
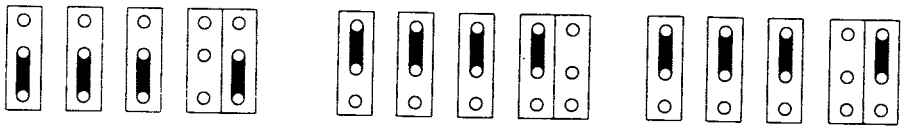


Figure 6.6
RS232-C, RS422-A, RS485 Jumper Positions



RS232-C Positions (as shipped from factory)

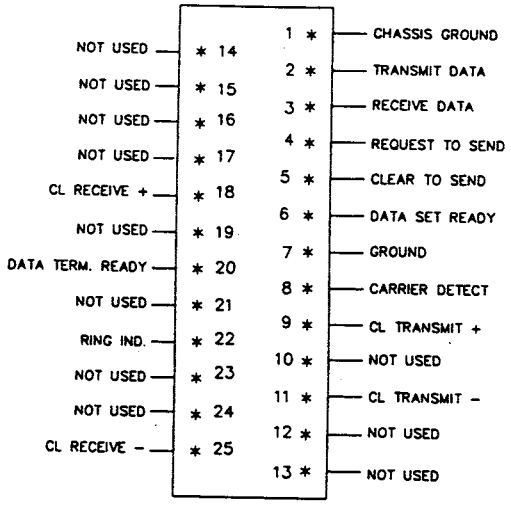
RS422-A Positions (4-wire)

RS485 (2-wire)

Terminal Connections

If the terminal or computer which you are interfacing with uses a DB25 25-pin connector for its RS 232-C interface , you will need a shielded serial interface cable fitted with a male 25-pin connector (DB-25) on the terminal end. Standard Connector pin assignments are given in the diagram below:

Figure 6.7
Standard Connector Pin Assignments for RS232-C



Now that the serial interface connection is complete, plug the DB-25 connector into the **MODEM** or **COMM** port on your terminal. **Be sure that the terminal is turned off before you connect the controller.**

AUTOMATIC DATA LOGGING MODE

The Automatic Data Logging option is designed to provide a record or print out of selected MENU variables. The data logging function works with an ASCII printer or a terminal with a dumb terminal interface.

The Automatic Data Logging print out below was generated with an RS232-C input printer. The MENU variables were selected from PAGE 0, with MENU 1 as the beginning MENU to log, and MENU 4 as the end MENU to log:

MENU 1 = Process Set Point
MENU 2 = Process Variable
MENU 3 = Deviation from Set Point
MENU 4 = Heat Output Command in % Full On

You may select as few as 1 MENU number to log, or as many as all 10 MENU numbers. Details for the Automatic Data Logging Set Up and Operation are given on page 63.

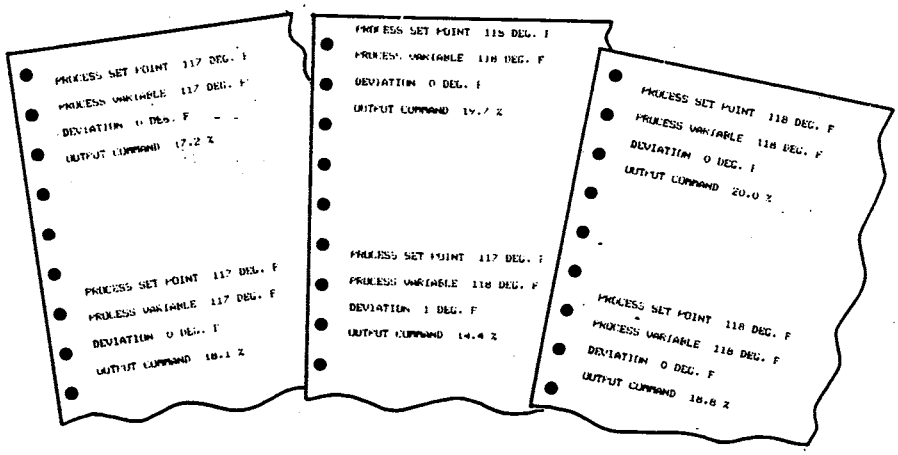


Figure 6.8
Automatic Data Logging Sample Print Out

Terminal Interface Programming

Programming the terminal interface is very simple. Simply go to PAGE 3 and make selections in MENU numbers 1,5,6,7,8,9 and 10 shown below (MENU numbers 2-4 are intentionally omitted and apply only to the automatic data logging mode).

PAGE 3: DIGITAL COMMUNICATIONS dIG					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	SEC.
dIGt	1	Mode Selection	OFF = Off trmL = Terminal Interface ALOG = Automatic Data Logging COMP = Computer Interface LInE = ASCii Line Mode	Off	C
HChr	5	Home Character Code	0 to 255	30	C
CChr	6	Clear Screen Character Code	0 to 255	26	
IntF	7	Interface Selection	r232 = RS232C r422 = RS422A	= RS232C	
bAud	8	Baud Rate	300 600 1200 2400 4800 9600 19200	9600	
PrtY	9	Parity	0 = None 1 = Odd 2 = Even	0 = None	C
rcon	10	Reconfigure Baud and Parity	0 = Finish 1 = Request	0 = Finish	C
Addr	11	Multidrop Address	0 - 255	0	C

Terminal Interface Operation

The 2002PLUS! digital communications interface consists of 7 basic operational commands and a HELP command. After you have powered up the controller, made the digital communications MENU selections on PAGE 3 and turned on the terminal, you should get a prompt (*) on the terminal screen. If you do not, check your terminal/computer manual to make sure that the baud rate and parity settings agree with those you entered on PAGE 3.

In the operational command prompts that you see on the screen, there are 4 abbreviations used:

<CR> = Carriage Return or Enter Key
<LF> = Line Feed or v (down arrow) Key
<SPACE BAR> = Space Bar
^ = Control or Ctrl Key

NOTE

All commands should be entered in all capital letters (upper case). For example," HELP," not "help."

Command: HELP

This command gives you a listing of all of the digital communications interface commands. Type "H" or "HELP" at the prompt and press the Return or Enter key:

Operator Input:
Terminal Displays:

```
*H
C or CHANGE Page#,Menu#
P or PAGE# Page#
S or SHOW Start page#, End page#
D or DISPLAY Start menu#, End menu#
A or ACCESS Security code
L or LOCK
U or UNLOCK
```

Command: ACCESS

This command allows you to adjust the security level access of your terminal. Adjusting the security level via the terminal does **not** affect the security level of the front panel controller pushbuttons. If a sufficient level of access is not entered, you may be able to only view a MENU setting and not change it.

To adjust the access level, simply make one of the following entries at the prompt and press the Return or Enter key:

Operator Input

```
*A 736
```

Command: DISPLAY

The DISPLAY command is designed to display and continuously update a range of MENU numbers on PAGE 0 - the display PAGE. You select and enter the beginning and ending MENU numbers to be displayed (MENU 1 to 9). In the example below, the beginning MENU number is 1 and the ending MENU number is 4:

Operator Input
Terminal Display

```
*D 1,4
DISPLAY PAGE
MENU # 01 PROCESS SET POINT.............150
MENU # 02 PROCESS VARIABLE..............150
MENU # 03 DEVIATION FROM SET POINT......0.0%
MENU # 04 OUTPUT COMMAND................60.0%
```

The controller will continue to scan and update these MENU numbers until you terminate the command by pressing **^X** (control X).

Command: CHANGE

The CHANGE command allows you to view and enter new MENU values on each page via the terminal (assuming that you have the proper Security Level accessed). For instance, to change the contents of PAGE 2/MENU 11:

Operator Input
Terminal Display

```
*C 2,11
CHANGE #02, MENU #11
MENU CONTENTS.............................100
ENTER NEW VALUE (XXXX)
```

A <CR> command will end the CHANGE command, whereas <SPACE> command allows you to go to the previous MENU number. A <LF> or V will increment to the next MENU number. This is helpful if you are changing several MENU settings on the same PAGE.

Command: PAGE

The PAGE command simply lists the PAGE number and the general contents of the MENU numbers on that PAGE. Like the CHANGE command, you can go to the next PAGE number with a <LF> or V command, and to the previous PAGE number with a <SPACE> command. Following is an example of the PAGE command.

Operator Input
Terminal Display

```
*P 0
PAGE# = 00 DISPLAY PAGE
PAGE# = 01 CONTROL
PAGE# = 02 CALIBRATION
PAGE# = 03 DIGITAL COMMUNICATIONS
PAGE# = 02 CALIBRATION
```

Command: SHOW

The SHOW command will allow you to display the complete MENU contents of a PAGE or range of PAGES, by simply specifying the beginning PAGE and the ending PAGE, then pressing the Enter or Return key. (Using the same PAGE number as the beginning and end will show that one PAGE only).

Operator Input
Terminal Display

```
*S 3,3
PAGE # 3 DIGITAL COMMUNICATIONS PAGE
MENU # 01 CONTENTS..........1
MENU # 02 CONTENTS..........1
MENU # 03 CONTENTS..........1
MENU # 04 CONTENTS..........5
MENU # 05 CONTENTS.........30
MENU # 06 CONTENTS.........26
MENU # 07 CONTENTS..........0
MENU # 08 CONTENTS.........2400
MENU # 09 CONTENTS..........0
MENU # 10 CONTENTS..........0
```

At any time during the execution of the SHOW command, you may give the following commands:

^W (Control W) = Pause
^X (Control X) = Abort (returns system back to * prompt)

Striking any key after pause will reinstate the SHOW command.

Command: LOCK

The LOCK command allows you to lock out the 2002PLUS!'s front panel pushbuttons, thus disabling any control adjustments from the controller. Simply type the command "LOCK" at the prompt and press the Return key.

Operator Input

The front panel pushbuttons are enabled at power-up, therefore, if adjustments are to be disabled, the LOCK command must be reentered at each power-up.

Command: UNLOCK

The UNLOCK command simply unlocks the front panel pushbuttons, allowing adjustments to be made from the controller front panel.

Operator Input

Automatic Data Logging Programming

The Automatic Data Logging function is enabled and defined on PAGE 3/MENU 1-4, listed below. Enable the Automatic Data Logging mode, select the time interval and choose the first and last MENU number variables from PAGE 0/MENU 1-15.

The logging interval will always begin 1 minute after power-up of the controller. No operator interface is required for automatic data logging.

PAGE 3: DIGITAL COMMUNICATIONS dIG					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	SEC.
dISt	1	Mode Selection	0 = Off 1 = Terminal Interface 2 = Automatic Data Logging	0 = Off	C
LoGI	2	Automatic Data Log Interval	1 to 9999 minutes	1 minute	C
LoGF	3	First PAGE 0/MENU # to Display	1 to 15	1	C
LoGL	4	Last PAGE 0/MENU # to Display	1 to 15	5	C

When Is Calibration Required?

The 2002PLUS! controller is factory calibrated before shipment to you, therefore, it is not necessary to calibrate the controller when you receive and install it. Periodic calibration checks or adjustments of the unit should not be required under normal operating conditions. Chromalox recommends that you recalibrate the controller in the following instances:

*all instruments in your facility are periodically calibrated to one device (metrology)
*a measurement system component fails

QUICK STEP and Manual Calibration

All calibration except the Process Analog Output Calibration, is performed in the PAGE/MENU programming. A simple "QUICK STEP" calibration of the full range sensor or remote set point input is performed via PAGE 2/MENU 5-9. Manual Calibration, PAGE 1/MENU 24-41, is provided for manual calibration of the sensor inputs and process analog output in applications where the process requires extreme fine tuning over a limited range, or where an "artificial offset" from actual process temperature is desired.

Factory Calibration Recovery

This option allows you to recalibrate the controller back to its factory calibration settings, in the event that it is severely out of calibration due to poor technique or unauthorized calibration. Although the factory calibration settings are recovered, this does not guarantee original calibration accuracy. The Factory Calibration Recovery should be used as a "starting point" for recalibration, should the unit become severly out of calibration.

Factory Calibration Recovery Procedure

Factory Calibration Recovery is performed on PAGE 2/MENU 8-9. This portion of the PAGE 2 PAGE/MENU Table is presented on the following page.

PAGE 2: CALIBRATION CAL					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	SEC.
rECn	8	Factory Calibration Recovery Sensor Selection	0 = None 1 = Cold Junction Cal. 2 = Type J T/C 3 = Type K T/C 4 = Type E T/C 5 = Type T T/C 6 = Type N T/C 7 = Type R T/C 8 = Type S T/C 9 = Not Used 10 = .00385 RTD 11 = .00392 RTD 12 = 4-20 mA/1-5 Vdc 13 = Analog Remote Setpoint	0	D
rECc	9	Recover Factory Calibration	0 = Off 1 = Recover Calibration	0	D

To reestablish the factory calibration constants:

1. **Disconnect load power.**

2. Go to PAGE 2/MENU 8 and select the code (0 through 13) for your sensor type.

3. Advance to PAGE 2/MENU 9, and select the value "1". The controller will automatically recalibrate and the values of both MENU 8 and MENU 9 will be reset to zero.

4. Go to PAGE 2/MENU 0 to exit PAGE 2. Do not change the values of MENU 8 or MENU 9 or the factory calibration recovery will be void.

Important Calibration Notes

1. **Disconnect load power when calibrating.**

2. RTD and Current/Voltage inputs should be calibrated using copper (Cu) wire, and thermocouple inputs should be calibrated using thermocouple extension wire (of the same type as the thermocouple you are calibrating). Thermocouples can be calibrated using copper wire and a vixed millivolt source, but the calibration procedure is more complex. Equivalent millivolt values are used for span minimum and maximum instead of temperature values in °F.

3. Substitute a precision sensor simulator (thermocouple simulator or resistance decade box) for the sensor inputs. The controller should be allowed to warm-up with the appropriate sensor simulator connected for at least one hour prior to calibration.

4. To access the calibration, you will need to be at LEVEL D Security. Enter Security Code "736" at PAGE 1/MENU 22.

Instructions for QUICK STEP Calibration

To perform QUICK STEP calibration, you must first select the QUICK STEP calibration procedure code for your sensor type and the type of wire from the Calibration Procedure Code Table below. Note that for calibration of J,K, E and N T/C you may choose 1 of 3 different wire types - 0-40 mV fixed source, copper wire or thermocouple extension wire. The procedure code will "tell" the controller what sensor type you are using and the calibration range, and will be entered at PAGE 2/MENU 6.

Figure 7.1: QUICK STEP Calibration Procedure Codes

Sensor Type	Wire Type	Code
Cold Junction Comp. J, K, E, N Thermocouple	Copper with 0.000 and 40.000 mV fixed volt. source	1 2
Cold Junction Comp. R and S Thermocouple	Copper with 0.000 and 20.000 mV fixed volt. source	3
J Thermocouple K Thermocouple E Thermocouple T Thermocouple N Thermocouple R Thermocouple S Thermocouple	Copper with variable voltage source	4 5 6 7 8 9 10
J Thermocouple K Thermocouple E Thermocouple T Thermocouple N Thermocouple R Thermocouple S Thermocouple	T/C Extension with T/C Simulator	12 13 14 15 16 17 18
RTD, alpha .00385 RTD, alpha .00392	Copper	20 21
Analog Process Input Analog Remote Set Point	Copper	22 23

QUICK STEP calibration is performed via MENU numbers 5, 6, and 7, as shown in the PAGE/MENU table following.

PAGE 2: QUICK STEP CALIBRATION CAL					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	SEC.
Jnct	5	Cold Junction Temp. at time of calibration	0.0 to 150.0°F	Approx. 75.0°F	D
CALn	6	Quick Step Calibration Numbers (above Figure 7.1)	QUICK STEP Calibration	O = None	
CALC	7	Calibration Commands	0 = None 1 = Calibrate Low End 2 = Calibrate High End 3 = Calibration Finished	0 = None	

Instructions for Cold Junction Compensation Calibration

In most cases, the Cold Junction Compensation (CJC) Calibration is necessary only after repair to the CJC circuit or a drastic change in ambient operating conditions. CJC Calibrations are not required for RTD or Analog inputs.

1. Enter the controller terminal #6 temperature in MENU 5 (measure with an independent and accurate thermometer).

2. Enter a "1" in MENU 6 to select CJC calibration for the cold junction compensation offset based on the temperature entered in MENU 5.

3. Enter a "1" in MENU 7. The upper display will indicate "----" and then revert to the process variable. The lower display will automatically increment to "3", indicating that the cold junction compensation calibration is complete.

Instructions for Sensor Input Calibration

1. Enter the Calibration Procedure Code (obtained earlier in Figure 7.1, p.54) at MENU 6. For example, if you are using a type T thermocouple simulator with thermocouple extension wire, enter the code "15".

2. Set the sensor simulator to the minimum range value for the sensor (sensor "zero") and wait 30 seconds for the electronics to fully stabilize. Sensor ranges are given in Figure 1.3 on page 5.

3. Enter "1" at MENU 7 and wait until the dashes in the upper display disappear, indicating that Step 1 of the calibration is complete (low end calibration complete).

4. Set the sensor simulator to the maximum range value for the sensor (sensor "span"). Wait 30 seconds for the electronics to stabilize.

5. Enter "2" at MENU 7 and wait until the dashes in the upper display disappear and the value in the lower display automatically increments to 3, indicating that Step 2 (high end calibration) of the calibration is complete.

If calibration using a thermocouple simulator (codes 12-18) does not result in an accurate measurement, recalibrate the cold junction compensation (code 1) and retry the sensor calibration. This should result in an accurate tracking of the T/C input.

6. Do not change the MENU 7 value after calibration is complete or the controller will continue to calibrate. Return to the MENU mode (by pressing the MENU/VAL pushbutton) and exit the PAGE.

MANUAL CALIBRATION

If you have already completed the QUICK STEP calibration, you do not need to perform manual calibration unless your application requires calibration over a limited range or an offset from actual process input.

Manual calibration is very much like manual trimmer pot adjustments of other instruments, except that a "pot" is not turned. Instead of turning a "pot", the sensor input value, which is displayed in the upper digital display, is adjusted with the ▲ and ▼ pushbuttons until the sensor input value and the displayed value are equal. For each sensor type there are 2 corresponding MENU numbers - one for zero and one for span. It is usually necessary to repeat the zero and span calibration adjustments several times until the displayed values equal their respective input values.

The PAGE/MENU table gives the MENU numbers and sensor ranges for all sensor input types, as well as the Analog Remote Set Point.

Calibration Reference PAGE 1/MENU 23

This calibration operation updates the electronic component values in the 2002PLUS! memory. **It is not advisable to perform calibration reference unless you are completely recalibrating the controller (Sensor Input, Remote Set Point and Cold Junction).** Calibration reference should be performed immediately prior to the zero and span calibration procedures.

Sensor Input Manual Calibration Instructions

In these instructions, assume that a T thermocouple input is used. From the PAGE/MENU table, PAGE 1 (page 70), you can see that MENU 30 is for zero calibration and MENU 31 is for span calibration.

1. **Perform this step ONLY if you are completely recalibrating the controller.** Access PAGE 1/MENU 23, Calibration Reference. Select the value (press MENU/VAL) to be displayed in the lower display. A "0" will appear. Press and hold ▲ until the display increments up to 4 (1, 2, 3, 4...). Release the ▲ pushbutton. Display will change to "0" indicating that Calibration Reference is completed.

2. Access PAGE 1/MENU 30 and select the value to be displayed in the lower display by pressing MENU/VAL. The "VAL" LED will light.

3. Set the sensor simulator to the zero calibration value of -350°F.* Wait 30 seconds to allow the electronics to stabilize.

4. Press the ▲ or ▼ pushbutton until the upper display value equals the sensor input value.

5. Access PAGE 1/MENU 31 and select the value to be displayed in the lower display by pressing MENU/VAL. The"VAL" LED will light.

6. Set the sensor simulator to the span calibration value of 750°F. Wait 30 seconds to allow the electronics to stabilize.*

7. Press ▲ or ▼ until the upper display equals the sensor input value.

8. Repeat steps 2-7 until **both** values equal their respective sensor input values.

*When performing manual calibration on an RTD input, the equivalent resistance value (ohms) should be used for the zero and span values.

PAGE 1: MANUAL CALIBRATION				
CUE	MENU	SELECTION	AVAILABLE SETTINGS	SECURITY
	23	Calibration Reference	See Sensor Input Manual Calibration Instructions on page 56.	D
	24	J T/C & .00385 RTD Zero	8000 / 7FFF	
	25	J T/C & .00385 RTD Span	0 / FFFF	
	26	K T/C & .00392 RTD Zero		
	27	K T/C & .00392 RTD Span		
	28	Remote Set Point Zero		
	29	Remote Set Point Span		
	30	T T/C Zero		
	31	T T/C Span		
	32	Analog Sensor Input Zero		
	33	Analog Sensor Input Span		
	34	E T/C Zero		
	35	E T/C Span		
	36	N T/C Zero		
	37	N T/C Span		
	38	R T/C Zero		
	39	R T/C Span		
	40	S T/C Zero		
	41	S T/C Span		

Process Output Signal Manual Calibration Instructions

Instructions for manual calibration of the Process Signal Output option are given in Section 5, Analog Remote Set Point and Process Output Signal, page 51.

Section 8
Specifications

CONTROL MODES (Field Selectable)

Automatic	ON/OFF Proportional (P) Proportional with automatic reset/integral and/or rate/derivative (PID, PI, PD)
Manual	Bumpless, balanceless transfer with Proportional Control. Disintegration Time = 1 to 100 seconds

CONTROL ADJUSTMENTS (Field Selectable)

Control Set Point	Instrument Sensor Range (°F, °C, %)
Set Point Limits	Instrument sensor range
Deadband	1 to 100°F
Proportional Band (Gain)	0.1 to 999.9% of span
Manual Reset (Offset)	-99.9 to 99.9
Automatic Reset (Integral)	0.00 to 99.99 repeats per minute
Rate (Derivative)	0 to 500 seconds
Output Cycle Times	0.1 to 60.0 seconds
Output Limits	0 to 100%
Output Offsets	0 to 100% (PID) 0 to 100°F (ON/OFF)
Gain Ratio	0.1 to 99.9

HEAT and COOL CONTROL OUTPUTS (Field Changeable)

Relay	Normally-open contact rated 5.0 amps at 120 Vac or 2.5 amps at 230 Vac (resistive load) Not recommended for driving unsnubbed contactors
Triac	1 amp continuous, 10 amp in-rush current at 120 or 230 Vac
Current/Voltage	4 to 20 mA into 0 to 800 ohm load, field changeable to 1-5 Vdc
Solid State Relay Drive	Transistor output of 20 Vdc nominal at 40 mA

ALARM OUTPUT

Relays	One normally-open contact rated 5.0 amps at 120 Vac, 2.5 amps at 230 Vac (resistive load). Field assignable as normally energized or normally de-energized.
Alarm Modes (Field Selectable)	High, range 100% of span, non-latching Low, range 100% of span, non-latching + Deviation, 0 to 250°F above control set point, non-latching - Deviation, 0 to 250°F below control set point, non-latching +/- Deviation, 0 to 250°F above/below set point, non-latching
Reset Differential	5°F for High and Low Alarms 2°F for Deviation Alarms
Alarm Set Point Limits	Instrument sensor range

INPUT SELECTIONS

Thermocouple	Types J, K, E, T, R, S and N
RTD	100 ohm Platinum, alpha = .00385 (DIN standard) or .00392 (American standard)
Current/Voltage	4-20 mA/1-5 Vdc, field selectable range

INPUT SPECIFICATIONS

Type J Thermocouple	-100 to 1400°F (-73 to 760°C)
Type K Thermocouple	-100 to 2100°F (-73 to 1149°C)
Type E Thermocouple	-100 to 1100°F (-73 to 593°C)
Type R Thermocouple	50 to 3000°F (10 to 1649°C)
Type S Thermocouple	50 to 3000°F (10 to 1649°C)
Type T Thermocouple	-350 to 750°F (-212 to 399°C)
Type N Thermocouple	-100 to 2300°F (-73 to 1260 °C)
100 ohm Pt RTD	-200 to 1000°F (-128 to 538°C)
4-20 mA Current	0.0 to 100.0%, field scaled range, decimal places
1-5 Vdc Voltage	0.0 to 100.0%, field scaled range, decimal places

INPUT SAMPLE RATE — 3 samples per second

READOUT ACCURACY

Thermocouples	
Types J, K, E, N, R, S	+/- 0.3% of span over 100% of span at 77°F
Type T	+/- 0.3% of span at 77°F; temperature >-80°C +/- 0.5% of span at 77°F; temperature = -210°C
RTD	+/- 0.2% of span at 77°F
Voltage/Current	+/- 0.1%
Readout Stability	Typically bettern than +/- 1°F for +/- 10°F change in ambient temperature
Type T	Typically less than 1°C per 10°C change in ambient temperature. For type T thermocouple temperature below -80°C, derate linearly to 4°C per 10°C change in ambient temperature at T thermocouple temperatures of -210°C.
Types R and S	Typically less than 1°C per 10°F change in ambient temp.

OPEN SENSOR CONDITION

Control Output	Off
Alarm Outputs	High Alarms are actuated
Display Indication	"HHHH"

OUT OF RANGE CONDITION

Control Output	Off (programmed PAGE 2/MENU 16)
Display, Over Range	"HHHH"
Display, Under Range	"LLLL"

EFFECT OF INPUT LEADWIRE RESISTANCE

Thermocouples	</= 0.5% of span for less than 150 ohms resistance, operates to 1000 ohm with reduced accuracy
Type T	For type T thermocouple temperature below -80°C, derate linearly to </= 1.5% of span for 150 ohms resistance.
Types R and S	</= 0.25% of span for 15 ohms resistance.
RTD (100 ohm Pt, 3-wire)	</= 0.25% of span for 20 ohm balanced leadwire resistance

ANALOG REMOTE SET POINT (Option)

Input Range 4-20 mA standard, field changeable to 1-5 Vdc by internal jumper change. Both referenced to instrument common

Input Resistance
4-20 mA source, 250 ohms
1-5 Vdc source, 110K ohms

ANALOG RAMP/SOAK REMOTE CONTROL

Accepts normally-open momentary switch, field selectable via an internal jumper. Referenced to instrument common.

ANALOG PROCESS OUTPUT SIGNAL(Option)

Output Signal 1-5 Vdc straight line approximation. Signal referenced to instrument common.
Span field adjustable from 1 mV/°C to 10 mV/°F, including 0-5 Vdc and 0-10 Vdc ranges.
Offset adjustable over 80% of range.

Minimum Load Resistance >/= 100K ohms for <1% error

Accuracy

Type J T/C	</= 1% of span from 0 to 1200°F at 77°F
Type K T/C	</= 1% of span from -100 to 2000°F at 77°F
Type E T/C	</= 1% of span from 200 to 1100°F at 77°F
Type T T/C	</= 0.5% of span from -150 to +50°F at 77°F
Type N T/C	</= 0.5% of span from 600 to 2300°F at 77°F
Type R T/C	</= 0.5% of span from 1800 to 3000°F at 77°F
Type S T/C	</= 0.5% of span from 1800 to 3000°F at 77°F
RTD	</= 0.2% of span from -200 to 1000°F at 77°F

DIGITAL COMMUNICATIONS OPTION

RS232-C, RS422-A Single-drop, non-isolated
Automatic Data Logging 1 to 9999 minute intervals
Baud Rate 300, 600, 1200, 2400, 4800, 9600
Data String ASCII, Asynchronous, one start, one parity, seven data and one stop bit

INSTRUMENT POWER

120 or 230 Vac, +10%, -15%, 50 to 60 Hz
7 VA nominal power consumption

OPERATING ENVIRONMENT

30 to 130°F (0 to 55°C) ambient temperature with relative humidity less than 95%, non-condensing

DIMENSIONS

Panel Cutout 3.6 x 3.6 inches (92 x 92 mm) per DIN 43700
Depth Behind Panel 7.9 inches (200 mm)
Front Panel Projection 0.8 inches (25 mm)

INFLUENCE OF LINE VOLTAGE VARIATION

Thermocouple/RTD +/- 1°F maximum change in readout for +/- 10% nominal line voltage

Current/Voltage +/- 0.1% maximum change in readout for +/-10% nominal line voltage

(continued)

NOISE REJECTION

Common Mode*	Less than +/- 2°F (1°C) with 230 Vac, 60 Hz applied from sensor input to instrument case (with digital filter enabled)
Series Mode*	Less than +/- 2°F (1°C) with 300 mV peak to peak, 60 Hz series mode noise (with digital filter enabled)
Radio-Frequency Interference (RFI)*	Typically less than 0.5% of set point span at a distance of 1 meter (3.1 ft.) from a transmitter (4W at 464 MHz)
*T Thermocouple	Below -80°C, derate common mode linearly to 110Vac at -210°C; Below -80°C, derate series mode linearly to 100 mV peak to peak at -210°C; Below -80°C, derate RFI linearly to 1.5% of span at -210°C.

Section 9
Error Messages and Troubleshooting

The following Troubleshooting Guide gives simple solutions to common problems. Should you have a problem with your controller, it is a good idea to check this Guide for possible corrections before contacting the factory. The Corrections are listed in the order in which they should be performed.

TROUBLESHOOTING GUIDE		
Symptom	**Probable Cause**	**Correction**
Power applied, display does not light and controller does not function.	1. No power applied 2. Power loss transient	1. Check power wiring and fusing 2. Power down and re-power up
Display reads "HHHH" or "LLLL"	1. Open sensor 2. Out of calibration	1. Check sensor wiring (page 10) 2. Check sensor type selected at PAGE 1/MENU 19. 3. Attach sensor simulator and verify calibration (page 65).
Process does not heat up	1. No power being applied to the load. 2. Incorrect control action	1. Verify output wiring (page 14) 2. Verify that load is not open - output module properly installed 3. Check that Heat Output terminals #9 and #10 are used for heat output connection. 4. Check "control type" entered at PAGE 1/MENU 7.
Erratic operation	1. Intermittent sensor connections 2. Controller failure (internal electronics)	1. Check sensor wiring or substitute sensor simulator 2. Power down and re-power up. 3. Contact factory.
Process not in control	1. Not tuned correctly	1. See Tuning, Appendix II, to verify PID parameters entered at PAGE 1/MENU 3-5.
Instrument continually goes through power-up reset	1. Sensor incorrectly wired 2. Internal electronic failure	1. Check sensor wiring (page 10) 2. Contact factory
Err1 displayed	1. Internal RAM failure on power-up self-test	1. Power down and back up to retest RAM 2. Contact factory
Err2 displayed	1. Internal ROM failure on power-up self-test	1. Power down and up to retest ROM 2. Contact factory

TROUBLESHOOTING GUIDE		
Symptom	**Probable Cause**	**Correction**
Err3 displayed with PAGE/MENU number in lower display	1. EEPROM failed redundancy check	1. Power down and back up to retest EEPROM 2. Re-enter settings for PAGE/MENU number shown in lower display, power down, then re-power up to clear error. 3. If PAGE/MENU number is "0 0", contact factory.

APPENDIX I
CONTROL THEORY GLOSSARY

This Tutorial contains detailed descriptions of specific control parameters and other selections made through the PAGE/MENU programming of the 2002PLUS! controller. The purpose of this Tutorial is to help you better understand the selections and settings you are making, thus increasing the applications effectiveness of your controller.

The list is alphabetized for quicker reference, and references to other definitions are made to help you understand the interrelationships of selections/parameters. Notice that "Proportional", "PID" and "ON/OFF" appear below some of the parameters, indicating that these parameters apply only to Proportional, PID or ON/OFF control.

Alarm Set Point
PAGE 1/MENU 15

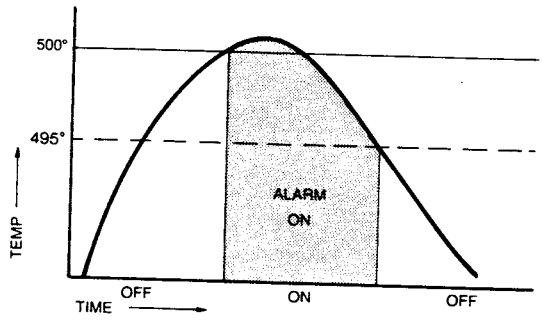
The Alarm Set Point determines at what value of the process variable the alarm will actuate. With High and Low absolute Alarms, the Alarm Set Point is constant. For example, if the High Alarm Set Point is 500°F, the Alarm will always actuate when the process temperature reaches or exceeds 500°F.

With Deviation alarms, the Alarm Set Point determines at what point below or above the process set point the alarm will actuate, as illustrated under **Alarm Types.**

Alarm Types
PAGE 1/MENU 16

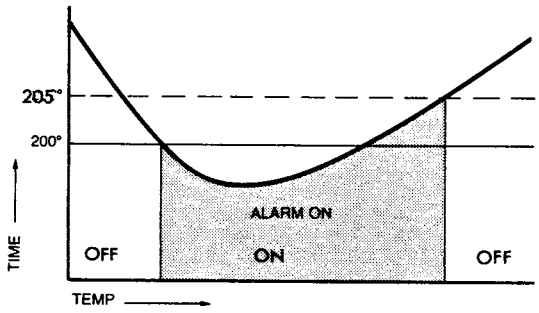
There are 5 alarm types available on the 2002PLUS! controller.

High Alarm: This alarm is a high absolute alarm that actuates when the process temperature is **equal to** or **greater than the Alarm Set Point.**



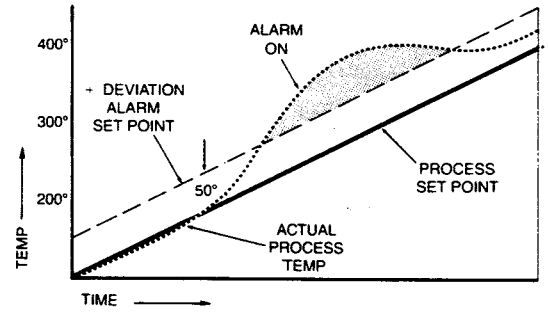
High Alarm Set Point = 500°F
Deadband = 5°F

Low Alarm: The low absolute alarm actuates when the process temperature is **equal to** or **less than** the **Alarm Set Point.**



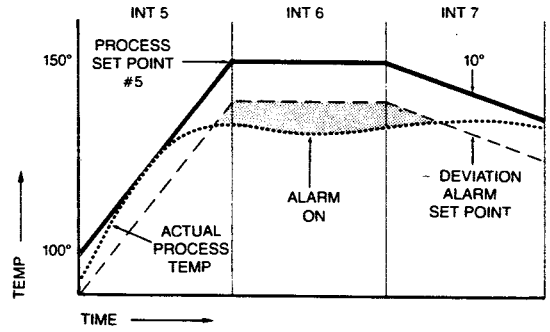
Low Alarm Set Point = 200°F
Deadband = 5°F

+ Deviation Alarm: This alarm actuates when the process temperature is **equal to** or **greater than the Process Set Point plus the Alarm Set Point.** When the Process Set Point is moved, the deviation alarm moves with it, maintaining the same deviation from set point. The deadband for Deviation Alarms is 2°F.



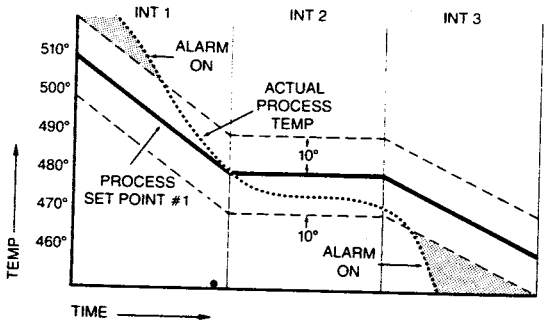
Process Set Point #1 = 200°F
Process Set Point #2 = 300°F
Process Set Point #3 = 400°F
+ Deviation Alarm
Set Point = +50°F

- Deviation Alarm: Similar to the deviation alarm described above, the - deviation alarm actuates when the process variable is **equal to** or **less than the Process Set Point less the Alarm Set Point.**



Process Set Point #5 = 150°F
Process Set Point #6 = 150°F
Process Set Point #7 = 135°F
- Deviation Alarm
Set Point = -10°F

+/- Deviation Alarm: This deviation alarm is actuated whenever the process temperature **deviates from the Process Set Point more than the predetermined (Alarm Set Point) amount in either a positive or negative direction.**



Process Set Point #1 = 480°F
Process Set Point #2 = 480°F
Process Set Point #3 = 460°F
+/- Deviation Alarm = 10°F

Each of these 5 alarm types may be chosen as **normally-energized (NE)** contacts, or **normally-deenergized** (NDE) contacts. For example, a normally-deenergized High Alarm will **close** when actuated (process temperature is equal to or greater than the Alarm set point).

Automatic Reset PID
PAGE 1/MENU 4

Automatic Reset (Integral) is expressed in repeats per minute. A value of 0.00 disables the Automatic Reset function and enables the Manual Reset function (PAGE 1/MENU 2). Adjustment of Automatic Reset should be made while the process is being controlled.

Automatic Reset is basically a control action that automatically eliminates offset between set point and process temperature. An Automatic Reset setting that is too large will cause severe overshoot during start-up if the controller is operating as a PI controller. Likewise, a setting that is too low will not allow the process temperature to return to set point quickly enough. An anti-reset windup feature is incorporated in the 2002PLUS! controller to minimize process overshoot by inhibiting the reset action when the process variable is outside the proportional band.

Control Modes
PAGE 1/MENU 7

To enter the types of control for both outputs, address MENU 7 and select the control types for Heat, Output #1 and Cool, Output #2:

CUE	Output #1 (Heat)	Output #2 (Cool)
!P.2P	PID	PID
!o.2P	ON/OFF	PID
!P.2o	PID	ON/OFF
!o.2o	ON/OFF	ON/OFF

After PID control is selected for either output, P, PI, PD or PID control can be chosen by making appropriate adjustments to Automatic Reset (Integral) MENU 4, and Rate (Derivative) MENU 5.

Cycle Time, Heat Output #1
Proportional/PID
PAGE 1/MENU 9

Output #1 cycle time is functional only if PID control is selected for Output #1 (via MENU 7).

Cycle Time is the time it takes to complete a full ON to OFF to ON cycle in a time proportioning control system. For most processes, a fast cycle time (less than 5 seconds) will produce better control of loads with fast response and little time lag. You should be very careful when setting the cycle time on contactor driven loads, as a faster cycle time will cause added contactor wear. Magnetic contactors should not be switched at cycle times less than 30 seconds.

The cycle time must be set for both time-proportioned output types (relay, triac, solid state relay drive) and analog proportional outputs (4-20 mA/1-5 Vdc). Chromalox recommends the following cycle time settings:

Relay Output - 30.0 seconds
Triac Output - 1.0 seconds (for direct loads), increase time if the triac drives a magnetic contactor
4-20 mA Current Output - 0.3 seconds*
Solid State Relay Drive Output - 1.0 seconds

* The Current Output cycle time **must** be set at 0.3 seconds for correct operation.

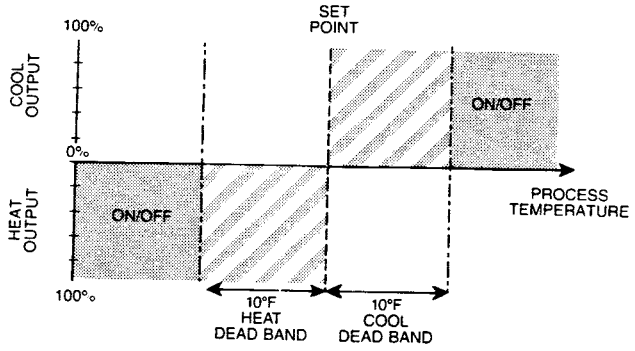
Cycle Time, Cool Output #2
Proportional/PID Control
PAGE 1/MENU 12

Output #2 cycle time is only functional if PID control is selected for Output #2 (via MENU 7). A complete explanation of cycle time and recommended settings is given above.

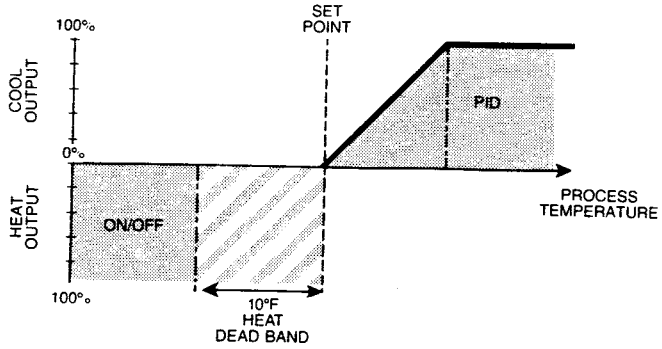
Deadband
ON/OFF
PAGE 1/MENU 14

Deadband applies when ON/OFF control mode is selected for either or both Output #1 and Output #2 (via PAGE 1/MENU 7). The ON/OFF control modes have a deadband (adjustable switching hysteresis) which can be set from 1°F to 100°F. **This adjustment is always in °F, even if °C has been selected for display of the process temperature.** If the process variable is expressed in % (as would be typical with an analog input), the deadband is adjustable from 0 to 6.25% of span.

In ON/OFF control, the deadband represents an area about set point in which no control action takes place, and determines at what temperature the Output switches ON and OFF. The deadband setting selected via MENU 14 applies to either or both control outputs. For example, if both Outputs #1 and #2 are operating in the ON/OFF mode, and a 10°F deadband is entered at MENU 14, the deadband for Output #1 is 10°F and the deadband for Output #2 is 10°F, as illustrated. If only one of the two outputs is operating in the ON/OFF mode, the deadband setting applies to only the ON/OFF output.



DEAD BAND (MENU # 14) = 10°F



DEAD BAND (MENU # 14) = 10°F

Narrow deadband settings give more accurate control but result in more frequent output switching, which can cause early failure of electromechanical contactors.

Disintegration Time Proportional Control
PAGE 1/MENU 18

The Disintegration Time setting applies to the Auto/Manual control function if the output control mode is Proportional only (Automatic Reset = 0). It is designed to allow "bumpless transfer" when going from Manual control to Automatic control. When the switch from Manual to Automatic control is made, the output will gradually change from the last manual output value to the output value calculated by the proportional control calculation. The time required to complete this change is defined as disintegration time.

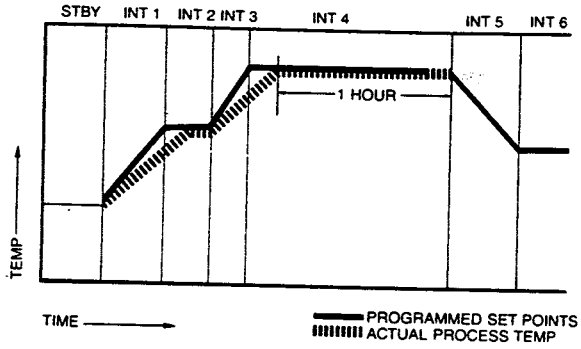
Disintegration time is adjustable from 1 to 100 seconds. The higher setting (longer time), the slower the output changes when going from Manual control to Automatic.

Event Output
PAGE 4/MENU 41-57

The Event Output is a timed output which is either ON or OFF during an entire Ramp/Soak Program interval. If the alarm output is assigned as an Event, it cannot be used as an alarm. Assignment of the relay as an alarm or event is made on PAGE 1/MENU 16.

Guaranteed Soak
PAGE 4/MENU 58

This Ramp/Soak feature assures that the "soaking" time in an interval does not begin until the process reaches set point or is within the Guaranteed Soak Differential band. Only when the process variable is within the Guaranteed Soak Differential will the Interval time begin counting down. To disable the Guarantee Soak feature, simply set the Guaranteed Soak Differential to "0.00". See **Guaranteed Soak Differential** and **Soak Interval** for more information.



Int. 4 = 1 hour
Soak time does not begin until set point reached.

Guaranteed Soak Differential
PAGE 4/MENU 58

The Guaranteed Soak Differential establishes a symmetrical band around the process set point that insures that the interval soaking time does not begin until the process is within this band. This feature works for both soak and ramp intervals. For example, assume that your sensor input is an RTD, with a range of -200 to 1000°F. If the Guaranteed Soak Diffferential is set at 0.1%, the Differential will be +/- 1.2°F. If the "soak" set point for that interval is 100°F, the soak time will not begin until the process temperature reaches 98.8°F (100 - 1.2 = 98.8).

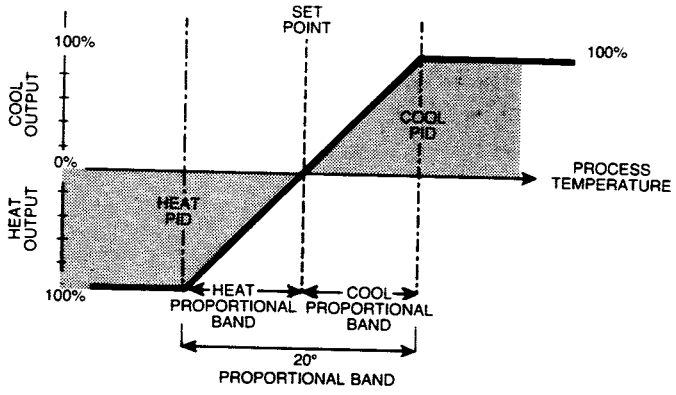
Heat/Cool Ratio (Output #2 - Proportional/PID)
PAGE 1/MENU 6

The Heat/Cool Ratio (Gain Ratio) feature is applied when the Cool Output #2 control mode is Porportional/PID. It allows adjustment of the Cool Output while automatically retaining Heat Output (#1) settings suitable for the process. This balances the heating and cooling capacities of the system, yielding stable process control.

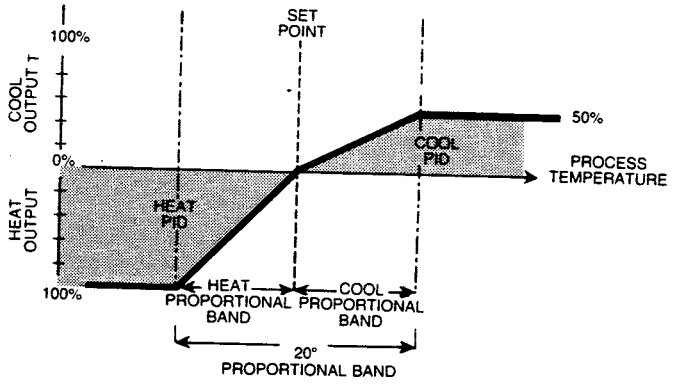
For example, water cooling may remove heat from a process more quickly than an electric heater adds heat to the process. Therefore, the Heat/Cool Ratio (Gain Ratio) would be greater than 1.0.

In the first illustration below, the heating and cooling capacities are basically equal, and the Heat/Cool Ratio is 1.0. In the second illustration the Heat/Cool Ratio setting is 2.0, thus balancing the heating and cooling capacities of the system. Note that the Heat/Cool Ratio creates an "Effective Cool Output Limit" of 50%.

Complete instructions for determining the Heat/Cool Ratio value are given in Appendix 2 - Tuning.



Proportional Band = 20°F
Effective Heat Proportional Band = 10°F
Effective Cool Proportional Band = 10°F
Heat/Cool Ratio = 1.0



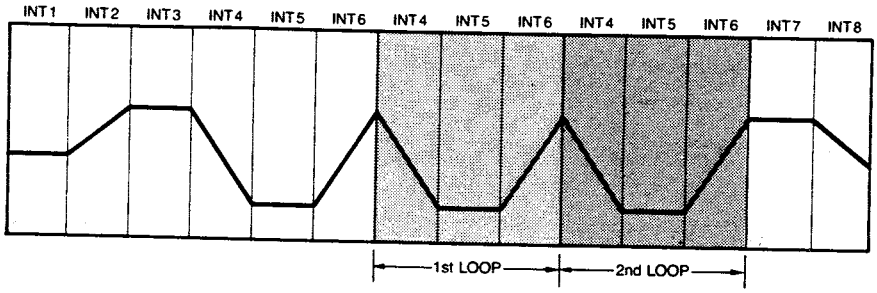
Proportional Band = 20°F
Effective Heat Proportional Band = 10°F
Effective Cool Proportional Band = 10°F
Heat/Cool Ratio = 2.0

Looping Intervals
PAGE 4/MENU 38-40

The Ramp/Soak Looping feature allows you to establish a "loop" within the Ramp/Soak Program. Looping means that an interval or series of intervals within the Program may be repeated in a looping fashion. You simply specify:

Loop the end of Interval _____ to the beginning of Interval _____ and repeat ____number of times.

An example of a Loop within an 8 interval Program is illustrated below:



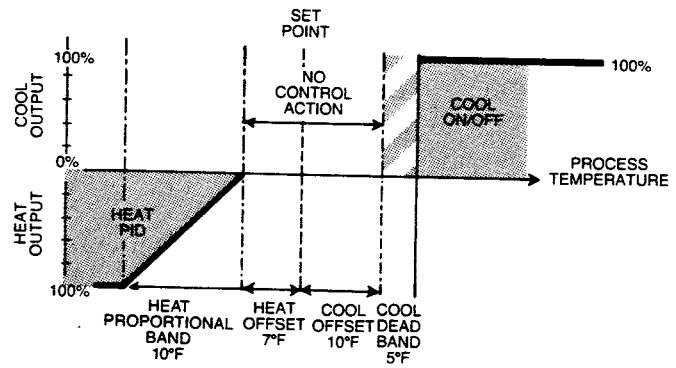
Manual Reset
Proportional Control
PAGE 1/MENU 2

Manual reset applies to Proportional (P) control only. It compensates for deviations from set point resulting from sustained, long term process load changes. Manual reset allows adjustment of the control output in an amount sufficient to return the process variable to the process set point. Increasing the manual reset setting increases temperature, therefore, if the process temperature is stabilizing below set point, increase the manual reset.

Offset, Outputs #1 and #2
PAGE 1/MENU 10, 13

In applications where simultaneous operation of heat and cool outputs, or energization within a specified narrow range about set point is undesirable or inefficient, the Offset feature should be used. The Offset adjustment creates a dead zone between set point and the point at which Output #1 is energized/de-energized, and offsets the proportional band or deadband, as illustrated. Offset is separately adjustable for both Output #1 and Output #2.

The available ranges of Offset settings are 0 to 100% of Proportional Band for PID control, and 0 to 100°F for ON/OFF control (or 0.00 to 6.25% for analog inputs).



Proportional Band = 20°F
Effective Heat Proportional Band = 10°F
Heat Offset = 70%
Dead Band = 5°F
Cool Offset = 10°F

ON/OFF Control

PAGE 1/MENU 7

With ON/OFF control the temperature is controlled about the set point by turning the output 100% ON or 100% OFF at set point. ON/OFF control is recommended for loads that cannot tolerate rapid cycling, such as pumps, air conditioning, etc. See Deadband for more information on ON/OFF control.

Out of Range Control Options

PAGE 2/ MENU 16

The Out of Range Control Option allows you to determine what action the control output will take when the process value is off scale. This feature is particularly useful with 4-20 mA inputs to initially get the process up to set point temperature. For example, if the input sensor scale is:

4 mA = 1000°F
20 mA = 2000°F

At start-up, the process value could be significantly below scale (out of range) and the output would remain off. By selecting "1 = Output enabled when process value is below range" at PAGE 2/MENU 16, the output would come on to bring the process up to temperature.

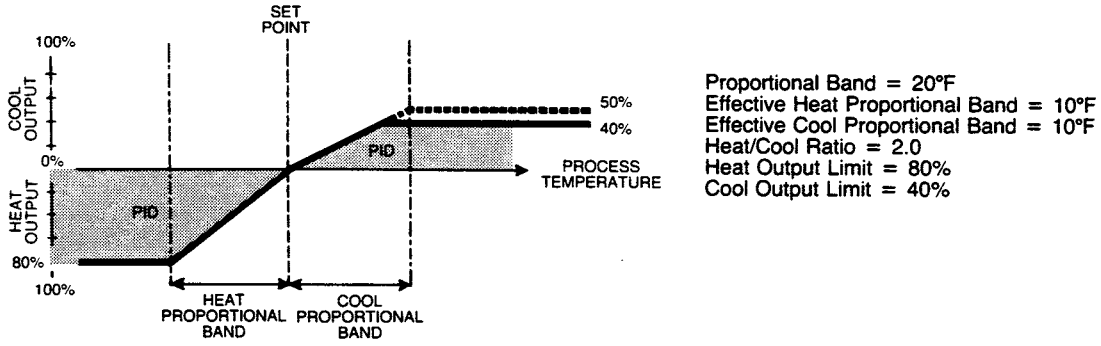
Output Limits Proportional/PID

PAGE 1/MENU 8, 11

The PID control output for Outputs #1 and #2 can be limited by the Output Limit setting. The purpose of Output Limit is to prevent dangerous over-heating (or over-cooling). This limit can be set from 0 to 100% of full ON. If the limit is set at 80.0%, then a time-proportioned output would remain ON no longer than 80% of the time (a 4-20 mA output would never exceed 16.8 mA). A setting of 100% allows full output. The output limit is not applicable in the ON/OFF mode.

The Output Limit setting will affect PID tuning, therefore, tuning should be performed after the Output Limit is set.

In applications where Heat/Cool Ratio is applied, the Cool Output has an "Effective Output Limit" by virtue of the Heat/Cool Ratio. In such applications, the lower limit is in effect, as illustrated below.



NOTE: Setting the Output Limit to 0% should never be used as a method to disable the power to the load for servicing. Interrupt the power to the load using an approved positive disconnect method.

PID Control
PAGE 1/MENU 7

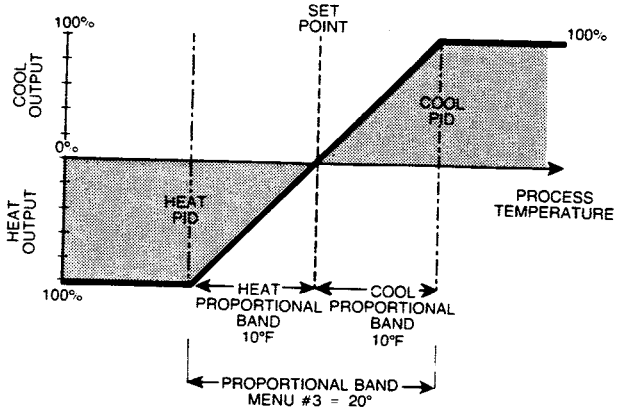
PID control is basic Proportional Control enhanced by Integral Control and Derivative Control. The Integral (I) part of PID control, or automatic reset, automatically eliminates offset between set point and actual process temperature due to long term load changes. Derivative, or rate, is an anticipatory action that allows the controller to react more quickly to sudden changes in the process temperature.

Proportional Band
Proportional/PID
PAGE 1/MENU 3

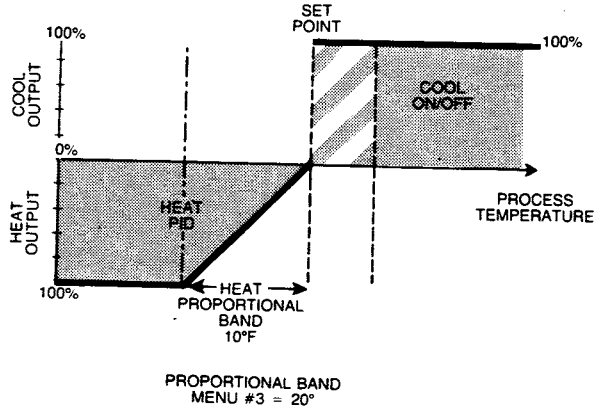
The Proportional Band is the temperature range about set point where the proportional control action is active. It is adjustable from 0.1% to 999.9% of span. Most applications require a Proportional Band setting between 1.0 and 20.0% of temperature span. Complete instructions for determining the Proportional Band Setting are given in Appendix 2, Tuning.

The Proportional Band setting is evenly split between the Heat and Cool outputs. For example, if the Proportional Band setting is 20°, and both heat and cool outputs are Proportional/PID, the effective heat proportional band is 10° and the effective cool proportional band is 10°.

The same principal applies when only one of the two outputs is Proportional/PID. The Proportional Band setting is evenly split, and the non-Proportional portion of Proportional Band is basically replaced by ON/OFF control.



Effective Heat Proportional Band = 10°F
Effective Cool Proportional Band = 10°F



Effective Heat Proportional Band = 10°F

Proportional Control
PAGE 1/MENU 7

A type of control action that proportions its control output instead of merely turning it full ON or full OFF. See Proportional Band and Manual Reset for further information.

Ramp Interval

An interval within a Ramp/Soak program in which the controller action takes the process from one set point to another set point within a specificed amount of time.

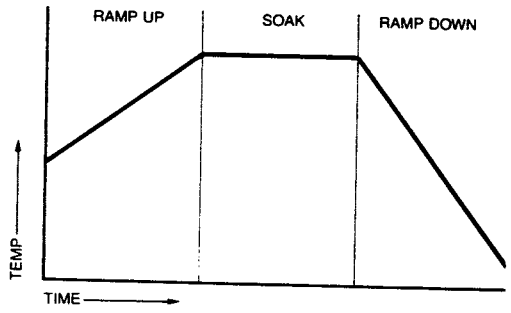
Rate
PID
PAGE 1/MENU 5

Rate (derivative) allows the controller to react more quickly to sudden changes in process temperature. Rate measures the rate of change of the process temperature, anticipates its severity and makes output corrections to maintain a steady return to temperature. If the proportional band, reset and rate are not properly coordinated with the process' characteristics, the process loop may be unstable. Rate can also be used without automatic reset (integral) for PD control with manual reset.

Since Rate is an anticipatory action, it can actually override the cycle time setting. For example, a heating process loop is operating at set point in steady state with an output cycle time of 30 seconds and output at 50% (15 seconds ON, 15 seconds OFF). If the 15 second OFF time has just begun when cold material is added to the process, causing the temperature to drop suddenly, a large enough rate setting will cause the 15 second off-time to immediately end and the output to again turn ON.

Soak Interval

A Soak Interval is an interval in a Ramp/Soak program where the process temperature is held constant over a specified period of time. See **Guaranteed Soak and Guaranteed Soak Differential** for more information on soak intervals.



APPENDIX II
TUNING

The 2002PLUS! controller has Self-Tuning features which you may or may not choose to use. Self-Tuning means that the controller automatically determines PID constants (proportional band, automatic reset and rate) based on the controller's monitoring of the process characterstics. You may choose to go through a Manual Tuning procedure whereby you will observe the process characterstics and manually make calculations of the PID constants. Instructions for both Self-Tuning and Manual Tuning are given in this section.

Ramp/Soak Program - When in the Ramp/Soak mode, the 2002 will self-tune only when in Standby operation. Power-Up and In Process tuning are disabled during the running of a Ramp/Soak program.

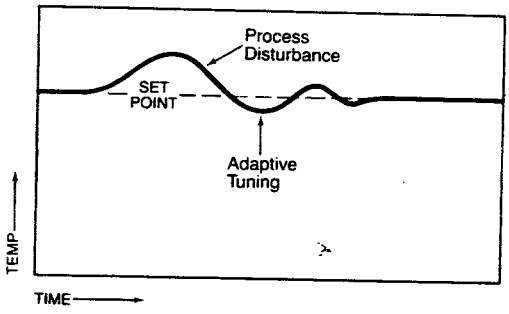
Self-Tuning Definitions

The 2002PLUS! gives you the option of selecting self-tuning for:

-Power-Up (cold start)
-In Process (adaptive)
-Both Power-Up and In Process

Power-Up Self-Tuning: Power-Up Self-Tuning should be used only on initial process start up when there is a significant temperature difference between the "cold" process temperature and the set point (the set point temperature difference must be greater than or equal to 5% of the instrument sensor span). For example, if the input type is a J thermcouple, a difference of 75°F (5% of 1500°) or more would be significant enough to permit Power-Up Self-Tuning (i.e. set point = 150°, and initial process temperature = 75°).

If Power-Up is selected, when power is applied to the controller, the control output will come on 100% (or the maximum output if the output limit is set at less than 100%), and as the temperature rises, the controller will examine the characteristics of the system and calculate the appropriate PID constants. It then loads these constants into memory and begins using them immediately. When these PID constants are being determined, the green TUNE LED is illuminated to give you visual indication that the self-tuning process is active.



In Process Self-Tuning - Sometimes called "adaptive" tuning, this feature instructs the controller to constantly monitor the control response for process upsets and recalculate PID parameters as necessary, based on the response to the last upset. The green TUNE LED comes on when the controller detects such an upset, begins to recalculate the PID constants, and then loads them into memory. In Process Self-Tuning requires 25-45 minutes each time

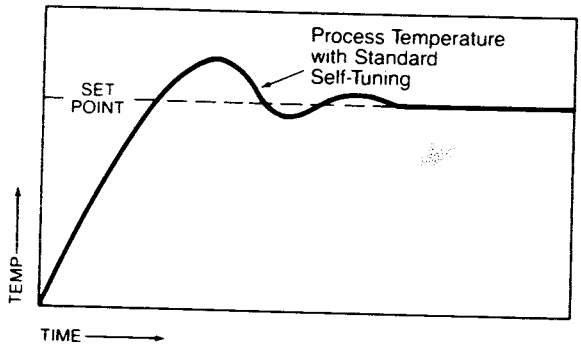
the controller detects a process disturbance. The 2002PLUS! does not retune unless the process experiences a significant disturbance, and does not create a disturbance when it retunes.

Self-Tuning Algorithms

The 2002PLUS! is equipped with two different tuning algorithms from which you must choose: Standard and Overdamped.

Standard Tuning: The Standard tuning algorithm (Ziegler-Nichols' 1/4 decay ratio) establishes PID constants that will bring the process to set point as quickly as possible. An example of this process curve is shown below:

Standard Tuning Process Curve

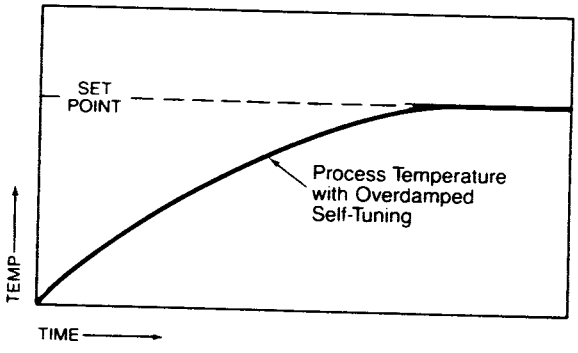


Cold Start Self-Tuning Standard Tuning brings the process to set point as quickly as possible.

This is the algorithm most commonly used, and is practical for most applications. If, however, the process cannot tolerate the overshoot (excursion beyond set point) associated with Standard tuning, then the Overdamped tuning algorithm should be selected.

Overdamped Tuning: Although the Overdamped method takes longer for the process to actually reach set point, it does eliminate the overshoot associated with Standard tuning, as diagrammed below:

Overdamped Tuning Process Curve



Overdamped Tuning slows the process heat up to avoid an overshoot beyond set point.

Power-Up Tuning

The power-up tuning algorithm, if selected, is executed immediately after power-up. It will not occur at any other time.

When power-up tuning starts, the green TUNE LED is turned on and remains illuminated while tuning takes place (see CASES 1 and 2 below). The LED is turned off automatically when the power-up tuning is completed. The controller then begins to control based upon the newly calculated tuning variables. A blinking TUNE LED indicates that self-tuning was not successful, as explained in CASE 3, below.

There are three cases that may occur on power-up:

CASE 1 - Set point is above the process variable. The heat output is turned full ON and the cool output is turned OFF. The heat output is turned OFF when the process variable travels half-way to the set point. When the process variable falls 2°F from the peak temperature, the controller uses the data taken during the tuning cycle to calculate new Proportional Band (P), Automatic Reset (I) and Rate (D) and stores these values in the controller memory. The Heat/Cool Gain Ratio is set to "1" and the controller begins its normal control function.

CASE 2 - Set point is below the process variable. The controller follows the same procedure as CASE 1, except that the heat output is turned OFF and the cool output is turned full ON. The cool output turns OFF when the process variable travels half-way to set point. When the process temperature rises 2°F from the lowest temperature reached, the controller uses the data taken during the tuning cycle to calculate new PID constants. The Gain Ratio is set to "1" and the controller beings its normal control function.

CASE 3 - The TUNE LED blinks. The green TUNE LED blinks if the the power-up self-tuning attempt was not successful. Any of the following situations can prevent the controller from tuning, thus causing the LED to blink:

1. The process variable is too close to setpoint (i.e. $|PV - SP| < 5\%$ of sensor span.
2. The process variable is out-of-range of the sensor span.
3. The PID constants cannot be calculated due to invalid data acquired during the power-up tuning sequence.

The tuning variables (PID constants) do not change in these instances, and the controller continues to operate using the PID constants that were in effect when the self-tune was attempted.

Power-Up Tuning (cont.)

The blinking LED can be turned off by selecting "manual" tuning on PAGE 1/MENU 17, meaning that you have disabled the power-up self-tuning feature and will need to manually determine the optimum PID constants.

Removing or cycling the instrument power will cause the controller to reattempt power-up self-tuning. If it still cannot tune, the green TUNE LED will continue to blink.

In Process Tuning

If in process tuning is selected, tuning will begin <u>after</u> power-up unless power-up tuning is also selected. If power-up tuning is also selected, in process tuning will begin when the power-up tuning is complete.

At the beginning of in process tuning, tuning does not occur immediately. The controller allows the processs to stabilize and takes data to initialize the data tables. After this initialization period, the controller continues to take data until a process disturbance occurs. A process disturbance is defined as follows:

Process Disturbance: Set Point vs. Process Deviation

<u>Transients</u>

Amplitude: The greater of +/- 1.0% of setpoint or +/-10°F
Slope: The greater of +/- 0.05% of setpoint or +/- 0.375°F per second

<u>Oscillation</u>

Amplitude: The greater of +/- 0.5% of setpoint or +/-3°F

Once a disturbance is detected, the green TUNE LED is illuminated and the controller begins to take "post-disturbance" data. A time delay, or lag time (L), is assumed and the data for each output is evaluated to determine if the assumed time delay correlates with (matches) the data. If the data correlates to the assumed time delay, the time delay and data are used to calculate PID constants. If the data does not correlate, a new time delay is assumed and the data is evaluated again. This process repeats until a time delay is found or the assumed time delay reaches a maximum limit.

When the data is complete, the TUNE LED is turned off and the data taken for each output (heat and cool) is used to calculate new PID constants. The controller then begins operation using these new PID constants.

In Process Tuning (cont.)

In process self-tuning requires approximately 25-45 minutes to complete each time the controller detects a disturbance. It should be noted that use of the digital communication during the calculation period could significantly increase this time period.

There are four cases of in process tuning that dictate how the controller will calculate the new PID constants.

CASE 1 - Both heat output (#1) and cool output (#2) correlate to a time delay. Proportional band (PB), Reset and Rate are calculated using output #1 data. The heat/cool gain ratio is calculated from PB_2/PB_1.

CASE 2 - Heat output (#1) correlates to a time delay, cool output (#2) does not. PB, Reset and Rate are calculated using output #1 data. The gain ratio is not changed

CASE 3 - Cool output (#2) correlates to a time delay, heat output (#1) does not. PB_2 is calculated using output #2 data. The gain ratio is calculated using PB_2 and the existing PB, PB_2/PB. PB, Reset and Rate are not changed.

CASE 4 - Neither output correlates to a time delay. If the tuning process was activated by an oscillation disturbance, the PB will be doubled, otherwise no parameters are changed. A limit is placed on how much the PB can be increased if several re-tunes take place. The limit is 20% of the sensor span if power-up tuning did not take place. If a power-up tune was executed, the limit is the lesser of 20% of sensor span or 4 times the PB calculated by the power-up tune.

If both outputs (#1 and #2) are configured to be ON/OFF control, in process tuning will not be initialized to run. If only one of the outputs is configured as ON/OFF, no data will be taken for that output and it will be treated as if it did not correlate (Case 2 or 3 would apply).

A blinking TUNE LED will not occur during in process tuning (as it may during power-up tuning). There are several conditions, however, that will **prevent** the controller from in process tuning:

1) The process set point is adjusted.
2) Manual reset is adjusted and the automatic reset value equals 0.
3) Self-tune is disabled via PAGE 1/MENU 17.
4) Ramp/Soak is activated. In process tuning can occur only during STANDBY, but not during RUN.
5) The Manual mode is entered.
6) The control mode is changed.

If any of the above situations prevent in process tuning, the controller will reinitialize and attempt to tune once the condition is cleared (except for self tune being disabled via PAGE 1/MENU 17). If self-tuning is disabled, in process tuning will start when self-tune is enabled.

SELF-TUNING INSTRUCTIONS

Initiating or Disabling Self-Tuning

1. Decide whether you need Self Tuning for Power-Up, In Process or both.

2. Choose the Tuning algorithm (Standard or Overdamped) most appropriate for your process.

3. With the load power disconnected, go to PAGE 1/MENU 17 and make the appropriate selection, based on the portion of the PAGE/MENU Table repeated below.

4. **Remove the instrument power, connect the load power and re-power up.** It is critical that you power down, then re-power up to initiate the power-up self-tuning feature.

5. If the TUNE LED is blinking, repeat Step 4. A blinking TUNE LED is a message to you that new PID constants could not be calculated. The LED will blink continuously until tuning is achieved or the auto-tuning function is disabled. The controller will retain the PID parameters it was using prior to initiating retuning. If repeated attempts are unsuccessful in achieving tuning, it will require manual selection of the PID constants.

PAGE 1: CONTROL OPERATIONS

CUE MENU SELECTION
17 Self-Tuning

AVAILABLE SETTINGS	FACTORY SETTING	SEC.
0 = Manual (none) 1 = Power-Up, Standard 2 = In Process, Standard 3 = Both, Standard 4 = Power-Up, Overdamped 5 = In Process, Overdamped 6 = Both, Overdamped	0	C

MANUAL TUNING INSTRUCTIONS

The following procedure gives you basic instructions for manual PID tuning. In applications where the 2002PLUS! is being used as a Proportional (P), Proportional with Integral (PI) or Proportional with Integral and Derivative (PID) controller, the following tuning procedure will help you determine the parameter setting(s) that will provide optimum process stability. These parameter values, once determined, are entered on PAGE 1:

Proportional Band	PAGE 1/MENU 3
Automatic Reset	PAGE 1/MENU 4
Rate	PAGE 1/MENU 5
Heat/Cool Gain Ratio	PAGE 1/MENU 6

Definitions of these three parameters are given in Appendix I, Control Theory Glossary.

Tuning Procedure

The Tuning Procedure consists of four steps:

Step 1 - Determining Ultimate Proportional Band
Step 2 - Determining Ultimate Period
Step 3 - Calculating Parameters - Proportional Band (P), Automatic Reset (I), and Rate (D)
Step 4 - Setting the Gain Ratio

Step 1

The controller should be tuned while operating in the process as a Proportional only (P) controller. It is important that Automatic Reset (PAGE 1/MENU 4) and Rate (PAGE 1/MENU 5) be set at 0.00 and 0, respectively.

Following the Step 1 chart, on the next page, the Proportional Band setting is gradually increased/decreased until the process temperature begins a **steady, small oscillation** that is slightly unstable. The Proportional Band setting where this steady, small oscillation occurs is referred to as the Ultimate Proportional Band (expressed in % of span). This slightly unstable condition is the objective of Step 1.

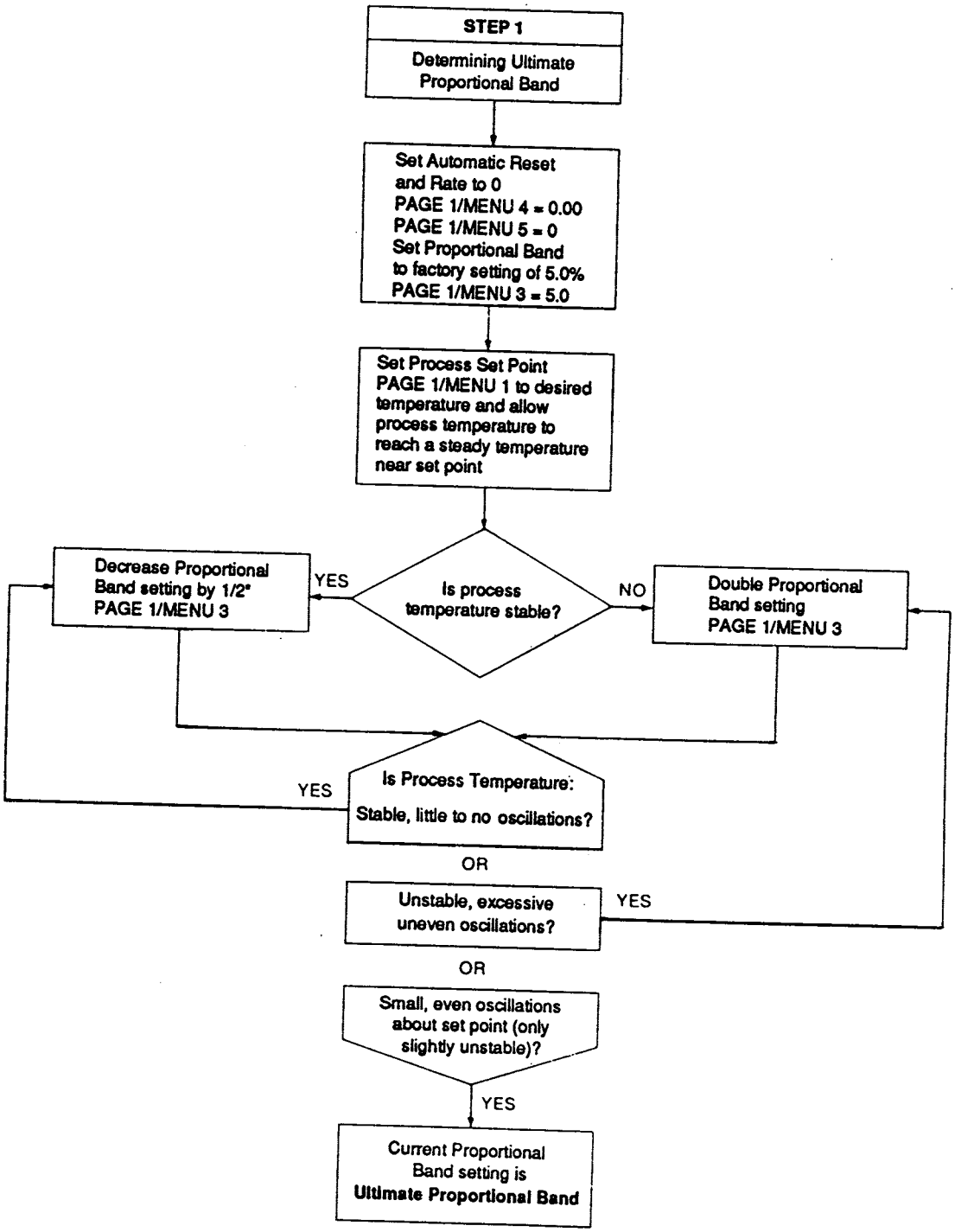
Stable = steady process temperature does not increase or decrease greatly with time, no oscillation (except oscillation due to output cycle time).

Unstable = process temperature has extreme, unstable excursions.

Slightly Unstable = process temperature has steady, small, even oscillations.

The **stable** process temperature is most desirable for normal operation, while **unstable** is the least desirable. The **slightly unstable** condition generated in this flowchart allows determination of Ultimate Proportional Band and Ultimate Period.

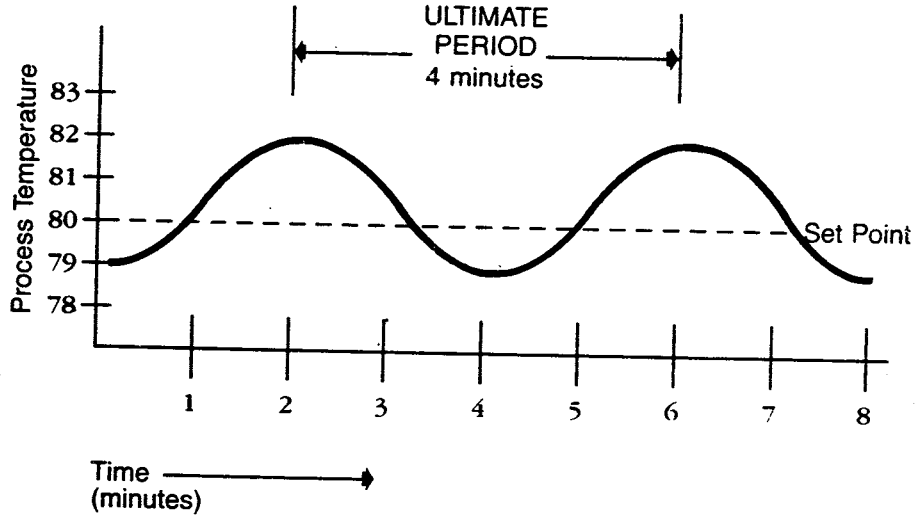
Step 1:
Determining Ultimate Proportional Band



*Note that by simply doubling and halving settings, an optimum "slightly unstable" condition may never be reached. The operator must use discretion in increasing and decreasing settings to reach the optimum slightly unstable condition.

Step 2
Ultimate Period

Once the **Ultimate Proportional Band** setting is determined, and the process temperature is reacting in a steady, small oscillation, the **Ultimate Period** is determined. The **Ultimate Period is the time (in minutes) from peak-to-peak maximum temperature in the process temperature curve.** Graph your process temperature curve like the example shown below to determine your Ultimate Period.



Step 3
Calculating Parameters

The process values **Ultimate Proportional Band (PB)** and **Ultimate Period (Period)** are applied to equations to determine **Proportional Band, Automatic Reset, and Rate.** Select the appropriate control mode for your application (P, PI, PID) in the table below, and follow the equations below the mode to calculate your PID Parameters.

Parameter	P	PI	PID
Proportional Band	2 x PB	2.22 x PB	1.67 x PB
Automatic Reset		$\frac{1.2}{\text{Period (min.)}}$	$\frac{2.0}{\text{Period (min.)}}$
Rate			$\frac{\text{Period(sec)}}{8}$

Step 4
Setting the Gain Ratio

If the setting of PID constants was based upon a set point which primarily required heating, the **Gain Ratio** should be adjusted to compensate for the cooling capacity. The Gain Ratio is primarily a measure of the process' cooling efficiency. A Gain Ratio of 1 indicates that the system cools exactly as fast as it heats. A higher Gain Ratio (i.e. 2.0) indicates that the cooling efficiency is greater than the heating efficiency (i.e. 2.0 = twice as efficient).

Adjust the set point such that cooling will be required and observe the control action. If the controller controls the process temperature reasonably well, leave the gain ratio setting at 1.0. If the process variable changes rapidly when cooling is turned on, in-

crease the gain ratio setting until the process is controlled reasonably well. If large amounts of cooling must be used to change the process variable, lower the gain ratio.

The manual mode may also be used to understand the relationship between the heat and cool outputs. Set the manual control output to both 50% heat and 50% cool. Observe the rate of change (slope) of the process variable in each case (ambient temperature is a good starting point). Calculate the gain ratio:

$$\text{Gain Ratio} = \frac{\text{Cool Rate of change (°F/time)}}{\text{Heat Rate of Change (°F/time)}}$$

Example: If the cool output caused a change of 10°F/minute and the heat output created a slope of 5°F/minute, the gain ratio should be set to 2.0. The cooling capacity of the process is twice the heating capacity.

If the PID constants were set based upon a setpoint that primarily required cooling, set the Gain Ratio to 1.0.

Appendix III
PAGE/MENU Tables, Condensed

This section contains the 5 PAGES of programming information, PAGES 0 - 4, without any of the detailed information or explanations given in the individual Sections of the User's Manual. **This Appendix is intended for your use after you have read the manual completely and fully understand the PAGE/MENU selections.**

PAGE 0: DISPLAY disP			
CUE	MENU	DISPLAY SELECTION	SECURITY
The Display PAGE allows you to select the value that may be displayed in the lower digital display for troubleshooting or short-term process trending observations.			
A SP	1	Active Set Point (Local, Remote or Ramp/Soak)	A
Proc	2	Process Variable	
dPSP	3	Deviation from Process Set Point	
HEAt	4	Heat Output Command in % of full ON	
COOL	5	Cool Output Command in % of full ON	
rPSP	6	Remote Process Set Point	
StAt	7	Ramp/Soak Operating State	
int	8	Current Interval Number	
toGo	9	Time Left to go in Current Interval	
LOOP	10	Number of Loops Remaining	

PAGE 1: CONTROL OPERATIONS CtrL					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	SEC.
SP	1	Local Process Set Point	Instrument Sensor Range	0	B
oFSt	2	Manual Reset (Offset)	-99.9 to 99.99	0.0	B
Pb	3	Proportional Band	0.1 to 999.9 % span	5.0%	C
ArSt	4	Automatic Reset	0.00 to 99.99 repeats/minute	0.00	
rAtE	5	Rate	0 to 500 seconds	0	
GAin	6	Heat/Cool Ratio (Gain Ratio)	0.1 to 99.9	1.0	
ctrL	7	Control Type	PID = Out #1 PID, Out #2 PID onoF = Out #1 ON/OFF, Out #2 PID PIDo = Out #1 PID, Out #2 ON/OFF onoo = Out #1 ON/OFF, Out #2 ON/OFF	PID = PID, PID	
H oL	8	Output #1 Limit	0 to 100% ON	100% ON	
H ct	9	Output #1 Cycle Time*	0.1 to 60.0 seconds	*see note below	
HoFF	10	Output #1 Offset	0 to 100% ON (PID) 0 to 100°F (ON/OFF) 0.00 to 6.25% span (analog input)	0	
C oL	11	Output #2 Limit	0 to 100% ON	100% ON	
C ct	12	Output #2 Cycle Time*	0.1 to 60.0 seconds	*see note below	
CoFF	13	Output #2 Offset	0 to 100% ON (PID) 0 to 100°F (ON/OFF) 0.00 to 6.25% (analog input)	0	

*Cycle Time varies with the output type of your controller. Refer to Appendix I, Control Theory Tutorial, for recommended Relay, Triac, 4-20 mA and Solid State Relay Drive Cycle Time settings.

PAGE 1: CONTROL OPERATIONS CtrL					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	SEC.
db	14	Deadband	1 to 100°F (for temp. inputs) 0.01 to 6.25% span (analog input)	5°F	C
ALSP	15	Alarm Set Point	J T/C -100 to 1400°F K T/C -100 to 2100°F E T/C -100 to 1100°F T T/C -350 to 750°F N T/C -100 to 2300 R T/C 50 to 3000°F S T/C 50 to 3000°F RTD -200 to 1000°F Analog (see PAGE 2/MENU 1-4)	J T/C = 250°F	C
ALtY	16	Alarm Type	HIdE= High, NDE* LodE= Low, NDE PddE= + Deviation, NDE*** -ddE= - Deviation, NDE ddE= +/- Deviation, NDE HI E = High, NE** LO E = Low, NE Pd E= + Deviation, NE -d E= - Deviation, NE d E= +/- Deviation, NE Eo = Event Output without LED indication Eo L= Event Output with LED indication *NDE = Normally De-energized (contacts closed in alarm) **NE = Normally Energized (contacts open in alarm) ***In deviation mode, alarm set point is adjustable 0-250°F or 0-25% of span	ddE= +/- Deviation, NDE	
tunE	17	Self-Tuning	0 = Manual (none) 1 = Power-Up, Standard 2 = In Process, Standard 3 = Both, Standard 4 = Power-Up, Overdamped 5 = In Process, Overdamped 6 = Both, Overdamped	0	
Auto	18	Disintegration Time	0 to 100 seconds	10 seconds	
SEnS	19	Sensor Selection	J, K, E, T, N, R, S Thermocouple .00385 or .00392 RTD Analog 4-20 mA/1-5 Vdc °F or °C	See Section 4	
FiLt	20	Digital Filter	0 = Off 1 = On	1 = On	
r SP	21	Remote Set Point	0 = Off 1 = On	0 = Off	
LocH	22	Security Lock	0 to 999 (Security Codes)	458 = Level C	A
	23-41	Manual Calibration	See page 70, this manual.		D

PAGE 2: ANALOG INPUT SCALING / CALIBRATION / SET POINT LIMITS CAL					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	SEC.
P ut	1	Process Units of Indication	0 = None 1 = °C 2 = °F 3 = %	3 = %	D
P dP	2	Process Decimal Point	0 = None (XXXX) 1 = One (XXX.X) 2 = Two (XX.XX)	1 = One (XXX.X)	
P Lo	3	Process Range Lower Limit	-999 to 3000	0.0 %	
P Hi	4	Process Range Upper Limit	-999 to 3000	100.0%	
	5-9	Quick Step Calibration	See page 67, this manual.		
SPLE	10	Process Set Point Limit Enable	0 = Off (Disabled) 1 = On (Enabled)	0 = Off	
SPLL	11	Process Set Point Lower Limit	Sensor Range	-100°F (J T/C) 50°F (R T/C) -200°F (RTD)	
SPUL	12	Process Set Point Upper Limit	Sensor Range	1400°F (J T/C) 3000°F (T T/C) 1000°F (RTD)	
ALLE	13	Alarm Set Point Limit Enable	0 = Off (Disabled) 1 = On (Enabled)	0 = Off	
ALLL	14	Alarm Set Point Lower Limit	Instrument Sensor Range	-100°F (J T/C) 50°F (R T/C) -200°F (RTD)	
ALUL	15	Alarm Set Point Upper Limit	Instrument Sensor Range	1400°F (J T/C) 3000°F (R T/C) 1000°F (RTD)	
orco	16	Out of Range Control Options	0 = Output disabled when Process is above or below range 1 = Output enabled when Process is below range 2 = Output enabled when Process is above range 3 = Output enabled when Process is above or below range	0 = Output Disabled	

PAGE 3: DIGITAL COMMUNICATIONS / AUTOMATIC DATA LOGGING dIG					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	SEC.
dIGt	1	Operation Mode	OFF = Disabled trnL = Terminal Interface ALOG = Automatic Data Logging CPtr = Computer Interface LinE = ASCii Line Mode	0 = Disabled	C
LoGI	2	Automatic Data Logging Interval	1 to 9999 minutes	1 minutes	
LoGF	3	First PAGE 0/MENU # to Display	1 to 15	1	
LoGt	4	Last PAGE 0/MENU # to Display	1 to 15	5	
HChr	5	Home Character Code	0 to 255	30	
CChr	6	Clear Screen Character Code	0 to 255	26	
IntF	7	Interface Selection	r232 = RS232C r422 = RS422A	r232 = RS232C	

PAGE 3: DIGITAL COMMUNICATIONS / AUTOMATIC DATA LOGGING dIG					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	SEC.
bAud	8	Baud Rate	300 600 1200 2400 4800 9600 19200	9600	C
PrtY	9	Parity	0 = None 1 = Odd 2 = Even	0 = None	
rcon	10	Reconfigure Baud Rate and Parity	0 = Finish 1 = Request	0 = Finish	
Addr	11	Multidrop Address	0 to 255	0	

PAGE 4: RAMP/SOAK PROGRAM SET UP rSPG					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	SEC.
rSoP StAt	1	Ramp/Soak Operation Commands Ramp/Soak Status Displays	SEE RAMP/SOAK OPERATION INSTRUCTIONS. NOT A MENU SELECTION - USED TO ENTER RAMP/SOAK OPERATION and DISPLAY MODE		B
rSEn	2	Ramp/Soak Enable	0 = Off (Single Set Point Control) 1 = On (Ramp/Soak Control)	0 = Off	C
Unit	3	Time Units	1 = 1 to 9999 seconds 2 = 0.1 to 999.9 minutes 3 = 0.01 to 99.99 hours	1 = seconds	
StbY	4	Standby Set Point	Sensor Range	J,K,E,T,N T/C = 0°F R,S T/C = 50°F RTD = 0°F	
Int 1	5	Interval 1 Time Span	0 = Program End 1 to 9999 seconds 0.1 to 999.9 minutes 0.00 to 99.99 hours	1 second	
SP 1	6	Set Point 1	Sensor Range	See MENU 4	
Int2	7	Interval 2 Time Span	See MENU 5	1 second	
SP 2	8	Set Point 2	Sensor Range	See MENU 4	
Int3	9	Interval 3 Time Span	See MENU 5	1 second	
SP 3	10	Set Point 3	Sensor Range	See MENU 4	
Int4	11	Interval 4 Time Span	See MENU 5	1 second	
SP 4	12	Set Point 4	Sensor Range	See MENU 4	
Int5	13	Interval 5 Time Span	See MENU 5	1 second	
SP 5	14	Set Point 5	Sensor Range	See MENU 4	
Int6	15	Interval 6 Time Span	See MENU 5	1 second	
SP 6	16	Set Point 6	Sensor Range	See MENU 4	
Int7	17	Interval 7 Time Span	See MENU 5	1 second	
SP 7	18	Set Point 7	Sensor Range	See MENU 4	
Int8	19	Interval 8 Time Span	See MENU 5	1 second	
SP 8	20	Set Point 8	Sensor Range	See MENU 4	
Int9	21	Interval 9 Time Span	See MENU 5	1 second	
SP 9	22	Set Point 9	Sensor Range	See MENU 4	
Int10	23	Interval 10 Time Span	See MENU 5	1 second	
SP10	24	Set Point 10	Sensor Range	See MENU 4	
Int11	25	Interval 11 Time Span	See MENU 5	1 second	
SP 11	26	Set Point 11	Sensor Range	See MENU 4	
Int 12	27	Interval 12 Time Span	See MENU 5	1 second	
SP 12	28	Set Point 12	Sensor Range	See MENU 4	

PAGE 4: RAMP/SOAK PROGRAM SET UP rSPG					
CUE	MENU	SELECTION	AVAILABLE SETTINGS	FACTORY SETTING	SEC.
in 13	29	Interval 13 Time Span	See MENU 5	1 second	C
SP 13	30	Set Point 13	Sensor Range	See MENU 4	
in 14	31	Interval 14 Time Span	See MENU 5	1 second	
SP 14	32	Set Point 14	Sensor Range	See MENU 4	
in 15	33	Interval 15 Time Span	See MENU 5	1 second	
SP 15	34	Set Point 15	Sensor Range	See MENU 4	
in 16	35	Interval 16 Time Span	See MENU 5	1 second	
SP 16	36	Set Point 16	Sensor Range	See MENU 4	
cont	37	Continuous Operation	0 = Off 1 = On	0 = Off	
Frm	38	Loop from the end of Interval A	A = 1 to 16	1	
to	39	to the beginning of Interval B	B = 1 to 16	1	
no.	40	C number of times	C = 0 to 9999	0 = No Looping	
SbEt	41	Standby Events	0 = Event OFF 1 = Event ON	0 = Event OFF	
i1 E	42	Interval 1 Events	See MENU 41		
i2 E	43	Interval 2 Events			
i3 E	44	Interval 3 Events			
i4 E	45	Interval 4 Events			
i5 E	46	Interval 5 Events			
i6 E	47	Interval 6 Events			
i7 E	48	Interval 7 Events			
i8 E	49	Interval 8 Events			
i9 E	50	Interval 9 Events			
i10E	51	Interval 10 Events			
i11E	52	Interval 11 Events			
i12E	53	Interval 12 Events			
i13E	54	Interval 13 Events			
i14E	55	Interval 14 Events			
i15E	56	Interval 15 Events			
i16E	57	Interval 16 Events			
GSdb	58	Guaranteed Soak Differential	0.00 to 99.99% of input sensor range	.50%	
rSrO	59	Ramp/Soak Remote Operation	0 = No Remote Operation 1 = RUN and HOLD 2 = RUN and STANDBY	0 = No Remote Operation	

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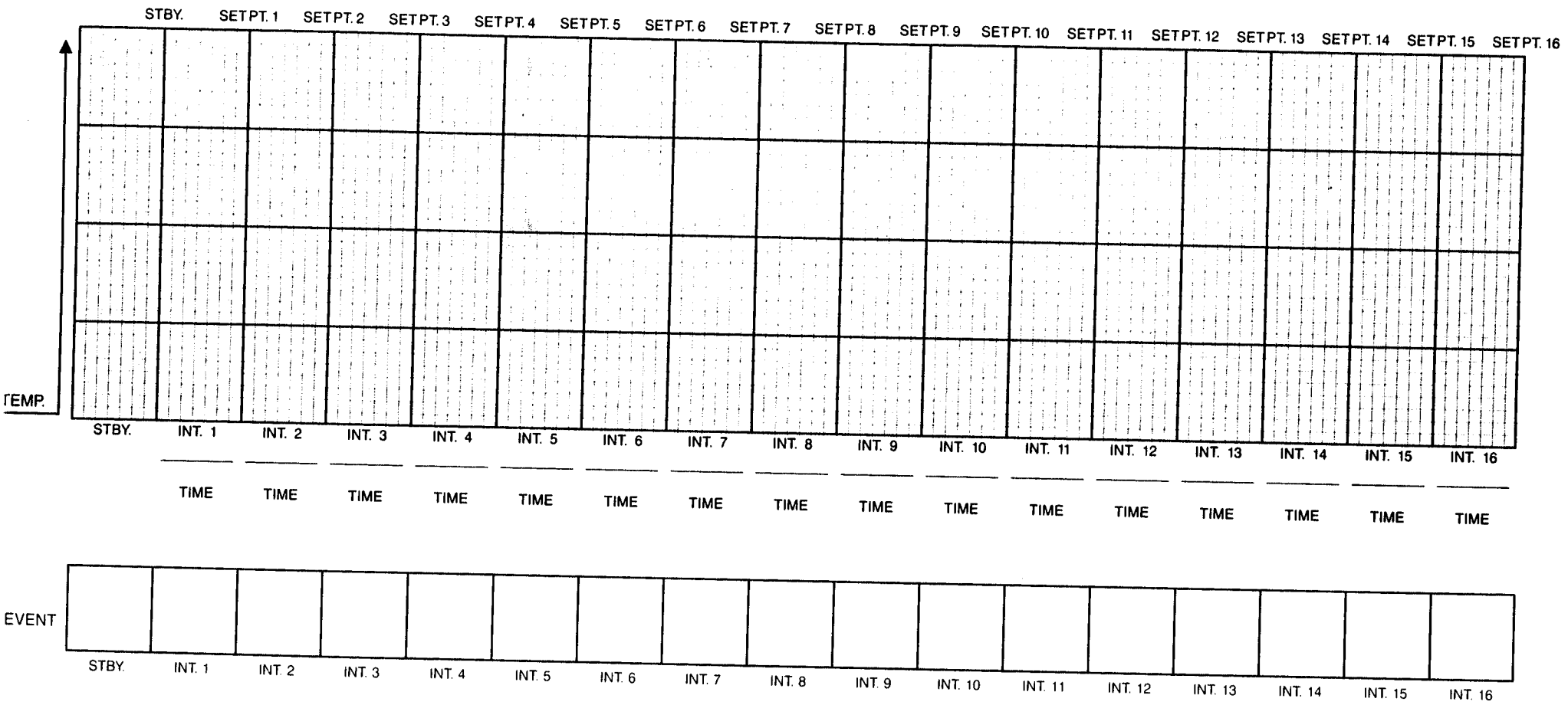
2002 *PLUS!* Ramp/Soak Profile Graph

You may order this form under part number below, or reproduce this page on your copier.



LOOP:

Loop from end of Interval _____

to beginning of Interval _____

How many times? _____

Part No. 0037-75126

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2002 *PLUS!* Programming Worksheet

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PAGE 4: Ramp/Soak Program

CUE	MENU	SELECTION	YOUR SETTINGS:		
			Date:	Date:	Date:
rSEn	2	Ramp/Soak Enable			
un it	3	Time Units			
StbY	4	Standby Set Point			
int 1	5	Interval 1 Time Span			
SP 1	6	Set Point 1			
int2	7	Interval 2 Time Span			
SP 2	8	Set Point 2			
int3	9	Interval 3 Time Span			
SP 3	10	Set Point 3			
int4	11	Interval 4 Time Span			
SP 4	12	Set Point 4			
intS	13	Interval 5 Time Span			
SP S	14	Set Point 5			
int6	15	Interval 6 Time Span			
SP 6	16	Set Point 6			
int7	17	Interval 7 Time Span			
SP 7	18	Set Point 7			
int8	19	Interval 8 Time Span			
SP 8	20	Set Point 8			
int9	21	Interval 9 Time Span			
SP 9	22	Set Point 9			
in 10	23	Interval 10 Time Span			
SP 10	24	Set Point 10			
in 11	25	Interval 11 Time Span			
SP 11	26	Set Point 11			
in 12	27	Interval 12 Time Span			
SP 12	28	Set Point 12			
in 13	29	Interval 13 Time Span			
SP 13	30	Set Point 13			
in 14	31	Interval 14 Time Span			
SP 14	32	Set Point 14			
in 15	33	Interval 15 Time Span			
SP 15	34	Set Point 15			
in 16	35	Interval 16 Time Span			
SP 16	36	Set Point 16			
cont	37	Continuous Operation			
Fro	38	Loop from the end of Interval A			
to	39	to the beginning of Interval B			
no.	40	C number of times			
SbEt	41	Standby Events			
i1 E	42	Interval 1 Events			
i2 E	43	Interval 2 Events			
i3 E	44	Interval 3 Events			
i4 E	45	Interval 4 Events			
i5 E	46	Interval 5 Events			
i6 E	47	Interval 6 Events			
i7 E	48	Interval 7 Events			
i8 E	49	Interval 8 Events			
i9 E	50	Interval 9 Events			
i10E	51	Interval 10 Events			
i11E	52	Interval 11 Events			
i12E	53	Interval 12 Events			
i13E	54	Interval 13 Events			
i14E	55	Interval 14 Events			
i15E	56	Interval 15 Events			
i16E	57	Interval 16 Events			
GSdb	58	Guaranteed Soak Differential			
rSrO	59	Ramp/Soak Remote Operation			

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