2104 Chromalox®

Temperature Controller

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Technical Manual
0037-75276

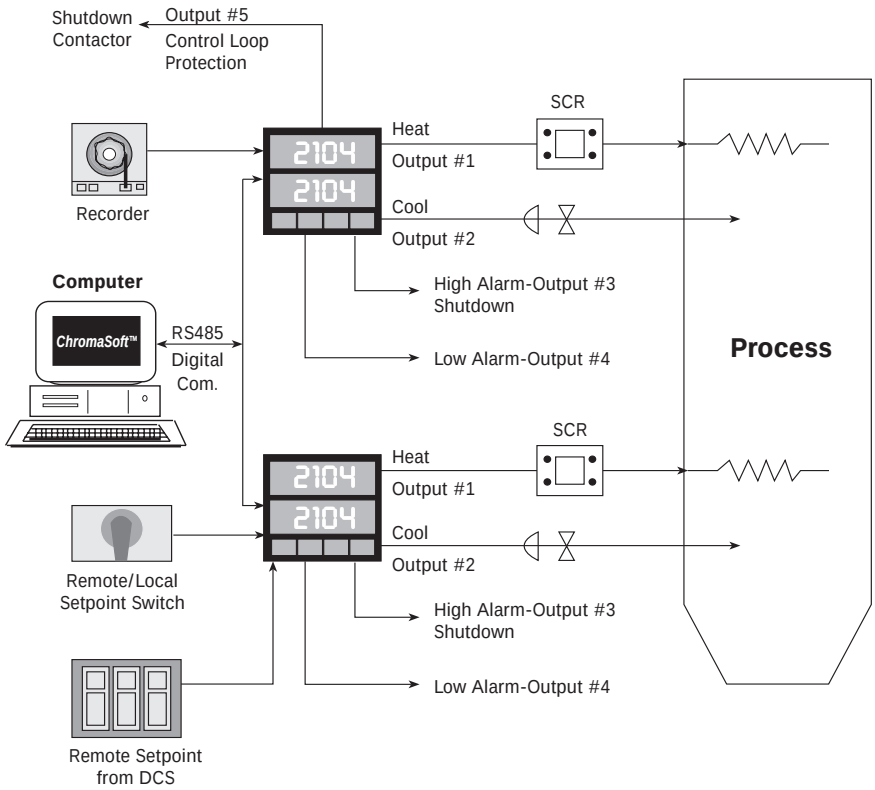
Sections

Illustrations

Illustrations

The Chromalox 2104 1/4 DIN temperature and process controller is a low-cost, high-performance, single-loop controller that can be used for temperature, flow, pressure and level control applications. With universal sensor inputs and front panel operator setup, one 2104 controller can be easily field configured for a wide variety of applications, and simply reconfigured as application needs change. This makes it an exceptional choice for OEMs with multiple control needs, manufacturing facilities, testing facilities and testing applications.

Figure 1.1
Typical Application



Model Identification

Before installation, please identify your controller model number. The model number is written on the tag on the side of the housing.

Figure 1.2 Model Identification

Model	Temperature Controller
2104	Microprocessor-based 1/4 DIN Temperature Controller. Universal Sensor Input accepts Thermocouple, RTD, Current or Voltage Inputs. PID, ON/OFF with Fuzzy Logic Control Capability. One Digital Input and Analog Remote Set Point.

Code	Outputs #1—Single Output Control
RO	Output #1 Single Output Control Relay/SSR Drive (jumper selectable) Relay—N.O. Form A Contact, 1A at 120 or 230 Vac SSR Drive—24Vdc at 40mA
TO	Triac—1 Amp at 120 or 230 Vac
AO	Analog—4-20mA or 1-5 Vdc, non-isolated
	Outputs #1 & #2 - Heat/Cool Control
RR	Relay/Relay
TT	Triac/Triac
AA	Analog/Analog
SS	SSR Drive/SSR Drive
AR	Analog/Relay
AT	Analog/Triac
SR	SSR Drive/Relay
ST	SSR Drive/Triac

Code	Outputs #3 & #4 (Alarm/Event Outputs)
0	None
1	Dual Relay—Two (2) Form A contacts, 1A at 120 or 230 Vac with shared common terminal

Code	Isolated Digital Communications, Output #5 (Alarm/Event Output), and Analog Output Option
0	None
1	RS-422/485 Digital Communications and Output #5
2	RS-232 Digital Communications and Output #5
3	Analog Output Option
4	RS-422/485 Digital Communications, Output #5 and Analog Output Option
5	RS-232 Digital Communications, Output #5 and Analog Output Option

Code	Power Supply
0	100 - 240 Vac or Vdc
1	12-24 Vdc or Vac

2104-	RO	1	1	0	Typical Model Number

Inspection and Unpacking

On receipt of your 2104 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.

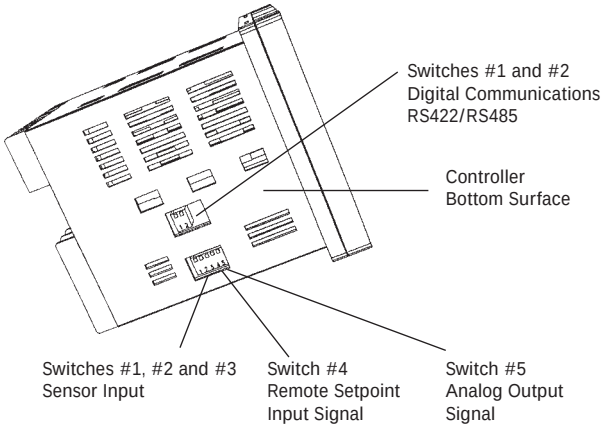
If the controller will not be immediately installed and placed into operation, it should be stored in a cool, dry environment in its original protective packaging until time for installation and operation. Temperature extremes and excessive moisture can damage the instrument.

Switch Settings

The 2104 has up to seven (7) hardware switches located on the bottom of the controller. The switches are accessible through cutouts in the controller housing and do not require that you remove the controller from its housing to access the switches.

Figure 2.1 identifies the switches. Instructions for switch settings are given in the corresponding sections of the manual.

Figure 2.1
Sensor Selection
Dip Switch
Settings



Sensor Selection Switches

Sensor selection requires that you:

1. Set the sensor switches for the correct sensor type.
2. Program the input sensor type in sensor selection setup on the inPt Page (see page 36).

It is much easier to set the sensor input switches before you mount and wire the controller.

To set the sensor switches:

1. Locate the sensor switches—#1, #2 and #3—on the bottom of the controller, as shown in Figure 2.1 on the previous page.
2. Place the switches in the appropriate Up or Down position for your input type:

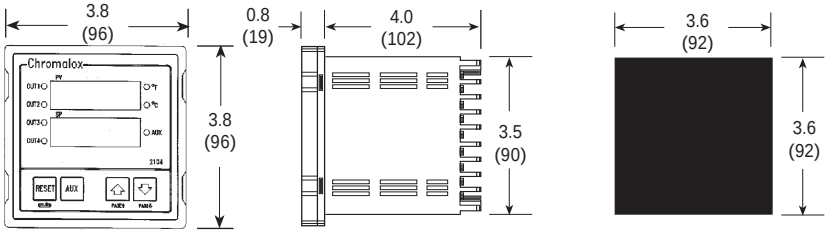
	Switch #		
Input Type	**1**	**2**	**3**
T/C	Up	Up	Up
RTD	Down	Up	Up
4-20mA	Up	Down	Down
1-5 Vdc	Up	Up	Down

Mounting

Figure 2.2, on the following page, shows the mounting dimensions for the controller:

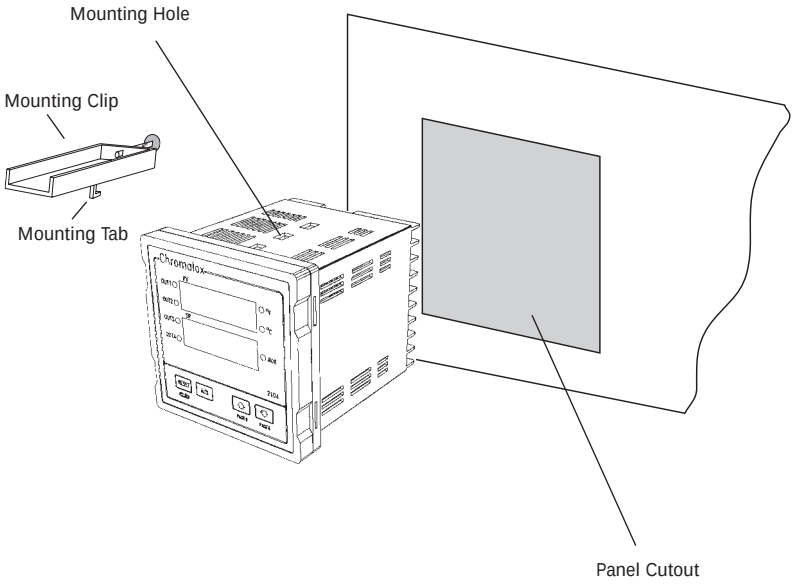
1. Cut out the square “panel cutout” mounting hole and install the unit as shown in Figure 2.3.
2. Place the controller through the square panel cutout and replace the mounting clip.
3. Tighten the mounting clip screw (do not over- tighten) to secure the controller firmly against the mounting surface.

Figure 2.2 Mounting Dimensions



Measurements are shown in inches. Millimeters are shown in parentheses.

Figure 2.3 Mounting Diagram



Wiring Instructions

Good Wiring Practices

1. When planning the system wiring, separate 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).

2. Locate all sources of electrical noise in your system, and separate these sources from the control systems—motors, contacts, solenoids, etc. Electrical noise can affect the function of any control system. When driving a contactor coil or other inductive load, an appropriately rated AC snubber circuit is recommended (Chromalox Part. No. 0149-01305), as described on page 11, “Relay Output Wiring.”

3. For sensor wiring practices, see Sensor Wiring Notes, next page.

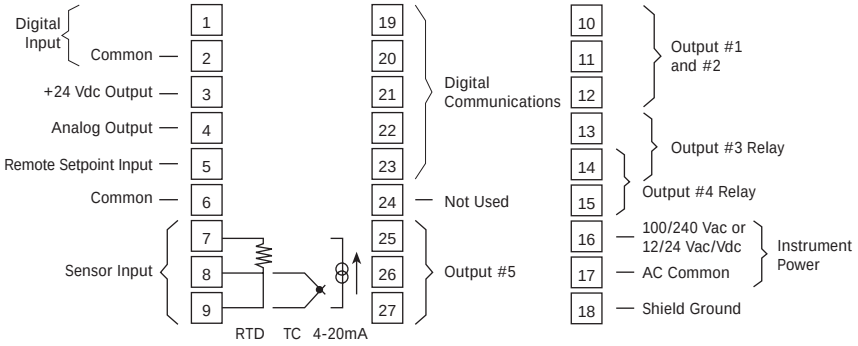
4. Additional information on good wiring practices is available from IEEE, 345 East 47th St., NY, NY 10017. Request IEEE Standard No. 518-1982.

Make all electrical wiring connections to 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 shows the wiring terminations. All wires will be connected to the terminals on the back of the instrument case. Specific wiring instructions for different input and output types are given in this section.

Figure 2.4 Wiring Terminal Identification



Sensor Input Wiring

Sensor Input Wiring Notes:

- Sensor leads (thermocouple and RTD) should not be run together in the same conduit as power wiring.
- Twisted pair, shielded wire is recommended for sensor connections.
- False process readings can occur if the sensor wire is exposed to electrical noise.
- Ungrounded thermocouples are recommended.
- If thermocouple extension wire is required, it must be the same type as the thermocouple (i.e., if a Type K thermocouple is used, then Type K extension wire must be used).
- Thermocouple wires should connect directly to the controller terminals. Do not use copper crimp terminals or solder terminals to make connections.
- If shielded thermocouple wire is used, the shield must be grounded at one end only, preferably at the shield ground terminal on the controller, as shown in Figure 2.5.
- Three wire RTDs are recommended for greatest accuracy.
- Standard shielded copper wire is recommended for RTD extensions.

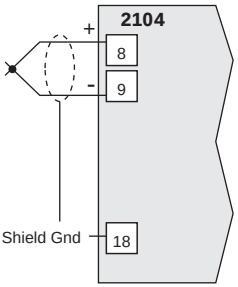
Thermocouple Inputs

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

T/C Type	Material	Polarity (+)	Polarity (-)
B	Plat, 30% Rhodium/ Plat, 6% Rhodium	Gray	Red
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

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

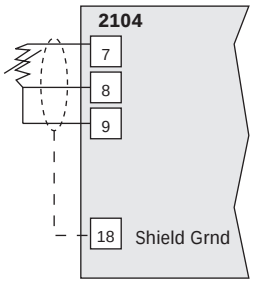
Figure 2.5
Thermocouple
Connections



3-Wire RTD Inputs

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 and same length of wire for optimum leadwire compensation. Chromalox recommends 3-wire RTDs for greatest accuracy, and standard shielded copper wire for RTD extensions. Make 3-wire RTD connections to terminals 7, 8 and 9 as shown in Figure 2.6 on the following page.

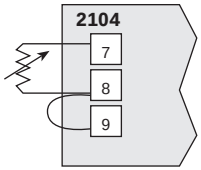
Figure 2.6
3-Wire RTD
Connections



2-Wire RTD Inputs

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 measurement. It is also necessary to jumper terminals 8 and 9 on the instrument to complete a 2-wire hookup.

Figure 2.7
2-Wire
Connections



Current/Voltage Inputs

Figure 2.8
Current
Input Wiring
(Self-powered)

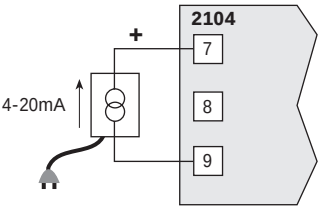
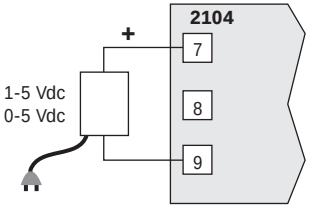
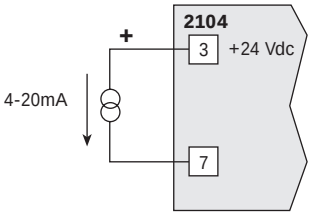


Figure 2.9
Voltage
Input Wiring
(Self-powered)



The 2104 has a +24 Vdc power supply which can be used to power a 4-20mA transmitter.

Figure 2.10
Current
Input Wiring
(Loop-powered
by controller)



Digital Input Connections

The digital input can be used in a number of ways:

- to control ramp/soak operations
- to switch between two setpoints, PID parameters, or Auto/Manual control
- to reset an alarm
- to disable the control output.

Setup for the digital input is shown on the CtrL setup page. An external switch, pushbutton or dry contact can be connected to this input. Use isolated switches only. Do not tie the Digital Input terminals to ground.

Figure 2.11
Digital Input
Connections
External Switch

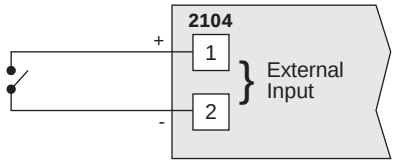
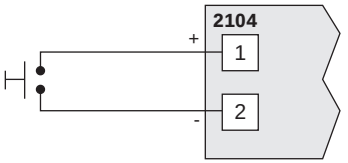


Figure 2.12
Momentary
Contact
Pushbutton for
Ramp/Soak



Output Wiring

The 2104 is supplied with either:

- 1 Control Output for Single Output Control (#1)
- 2 Control Outputs for Heat/Cool Control (#1 and #2)

The output wiring varies depending on the control type and applications. The wiring instructions are presented separately for each of these two controller types/applications.

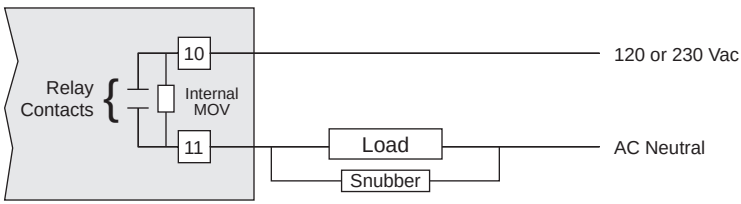
☛ Warning
Incorrect output wiring may cause system/process damage.

Single Output Control Wiring

Relay Output

Output Code "RO" on the 2104 (2104 - RO***) gives you the option of SSR Drive or Relay control for output #1. When shipped from the factory, the relay output is active.

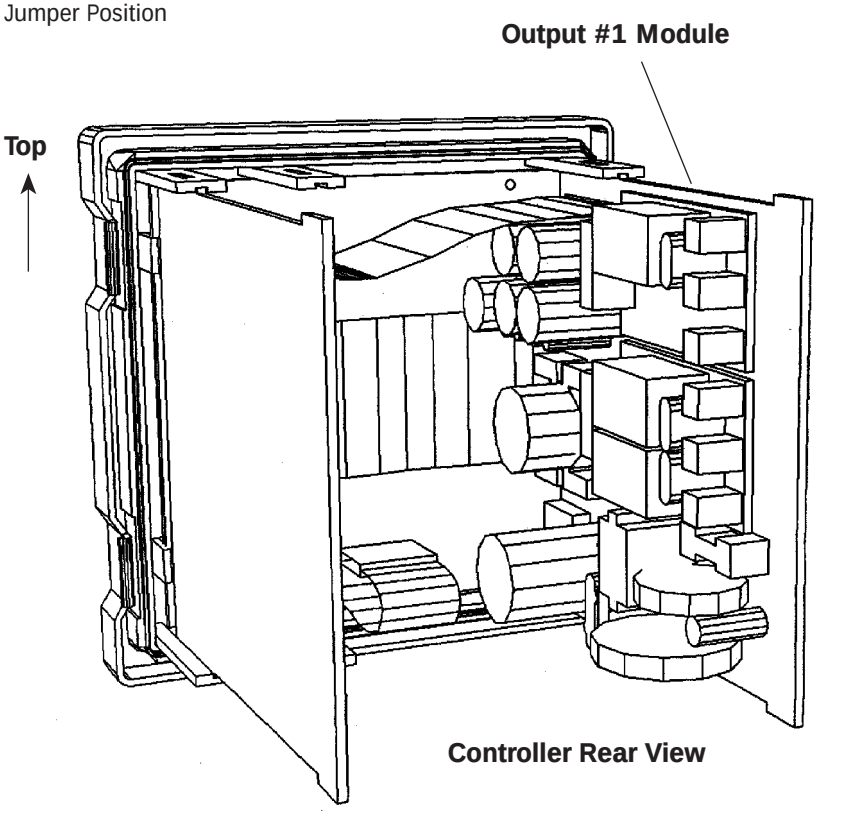
Figure 2.13
Relay Output Connections

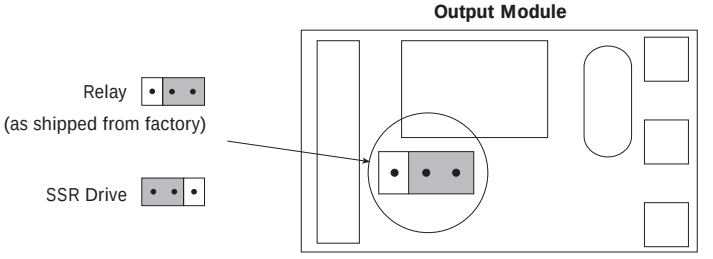


SSR Drive Output

For SSR drive output applications, you must move an internal jumper on the Output #1 module to select SSR drive output. Remove the controller from its housing, and locate the output module as shown in Figure 2.14 on the following page. Reposition the jumper to select SSR Drive output.

Figure 2.14
SSR Drive Output
Jumper Position



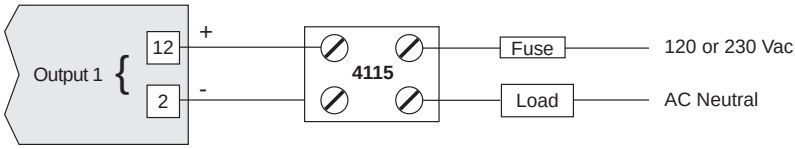


Solid State Relay Drive Connections

The solid state relay 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.

Note: Negative lead connects to Terminal #2.

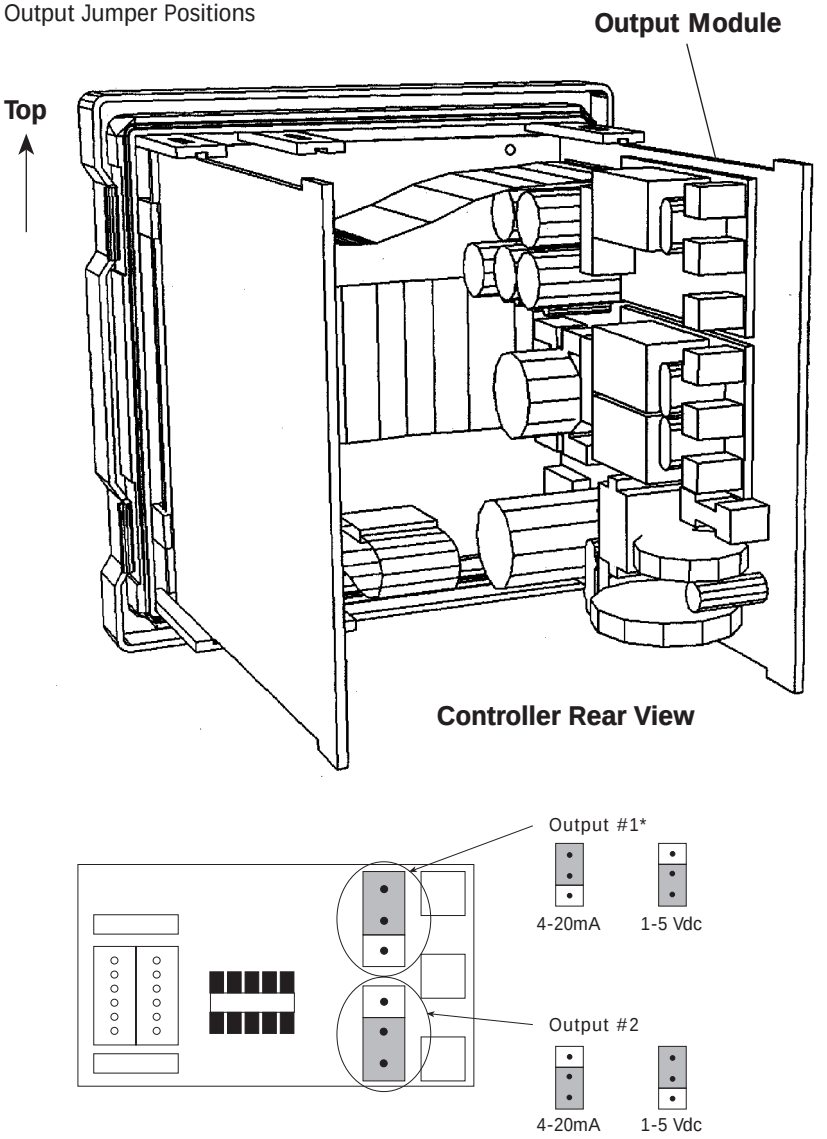
Figure 2.15
Solid State Relay Drive Output Connections



Current/Voltage Output

Controllers with output codes “AO,” “AA,” “AR” and “AT” give you the option of 4-20mA or 1-5 Vdc output. When shipped from the factory, these control outputs are configured for 4-20mA output. For 1-5 Vdc output, you must access the internal output board and move the jumper(s) to the 1-5 Vdc position, as shown in Figure 2.16 on the following page.

Figure 2.16
Current/Voltage
Output Jumper Positions



*All controllers with Analog Output (output codes AR, AT) for output #1 use same 4-20mA/1-5 Vdc jumper positions as shown here.

Figure 2.17
Triac Output Connections

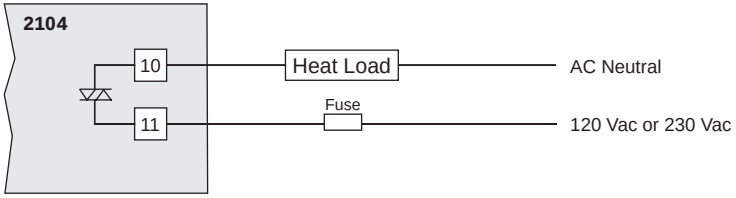


Figure 2.18
4-20mA Analog Output Connections

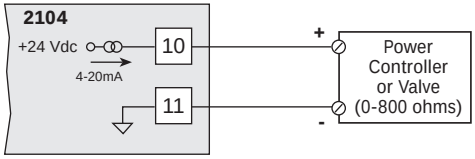
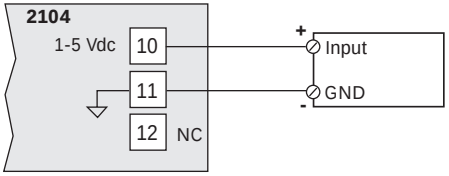


Figure 2.19
1-5 Vdc Output Connections



Heat/Cool Control Output Wiring

Figure 2.20
Dual Relay Output Wiring

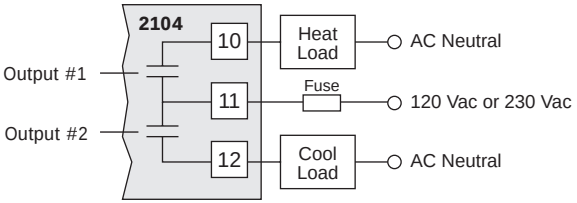


Figure 2.21
Dual Triac Output Wiring

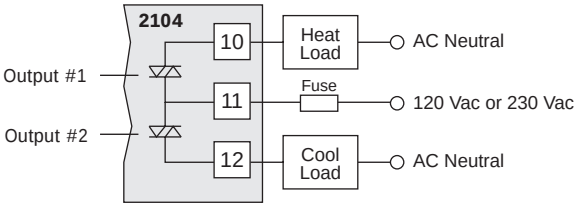


Figure 2.22
Dual Analog Output Wiring

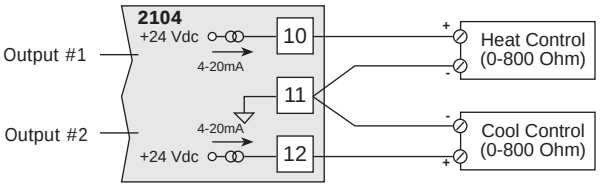
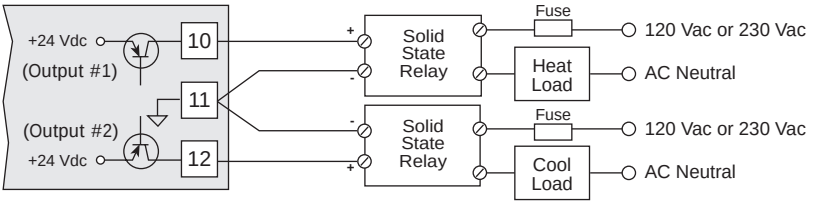
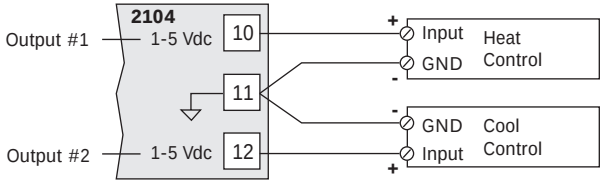


Figure 2.23
Dual SSR Drive Output Wiring



Heat/Cool Control Output Wiring
(continued)

Figure 2.24
Dual 1-5 Vdc Output Wiring*



*Note: See page 14 for Analog/Voltage jumper positions.

Figure 2.25
Dual Output SSR/Relay Wiring

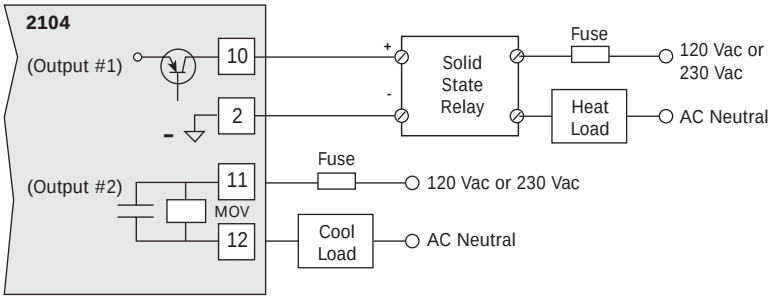
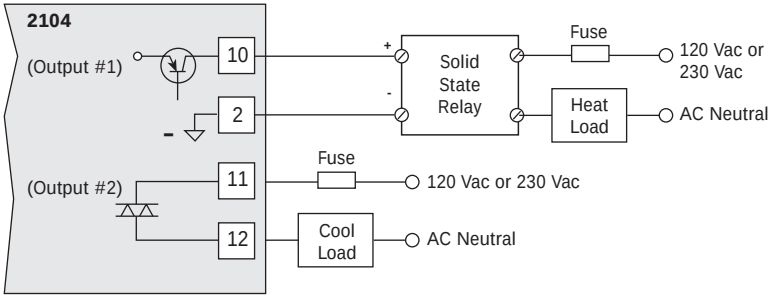


Figure 2.26
Dual Output SSR/Triac Wiring



Heat/Cool Control Output Wiring
(continued)

Figure 2.27
Dual Output Analog/Relay Wiring

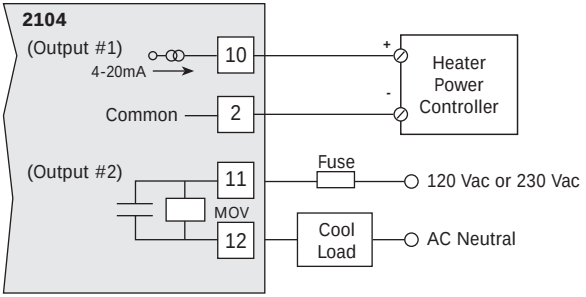
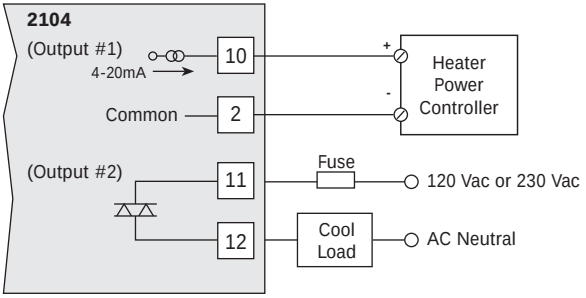


Figure 2.28
Dual Output Analog/Triac Wiring



Instrument Power Wiring

Make 120 Vac or 230 Vac instrument power connections to terminals 16-18 as shown in Figure 2.29.

Figure 2.29
100-240 Vac Instrument Power Connections (2104-****0)

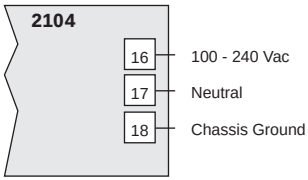
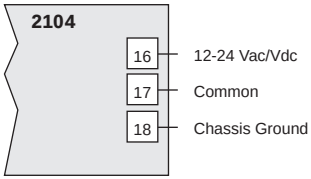


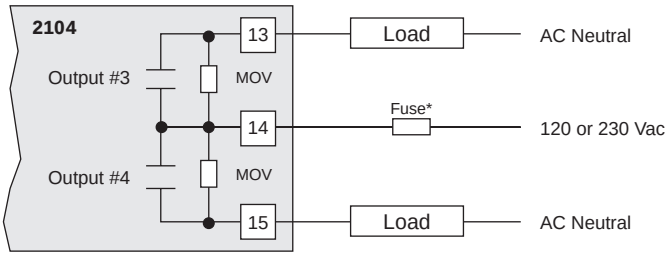
Figure 2.30
12-24 Vac/Vdc Instrument Power Connections (2104-****1)



Alarm/Events Outputs #3 & #4

The two independent alarm (Output #3 or #4) relay outputs are connected as shown in Figure 2.31.

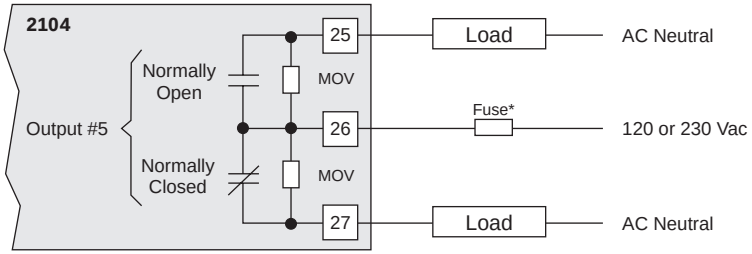
Figure 2.31
Alarm/Event Outputs #3 and #4



* Fuse should be sized for the combined current of Output #3 and #4.

Alarm/Event Output #5 The Form C Relay Output is connected as shown in Figure 2.32.

Figure 2.32
Alarm/Event
Output #5



* Fuse should be sized for the current of Output #5.

Section Contents

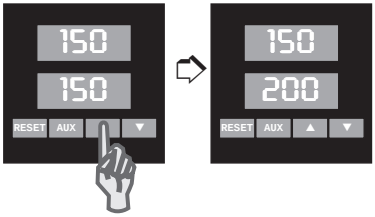
Pushbuttons and Indications

Control programming is easily accomplished with the front panel pushbuttons. The displays provide a constant overview of the process. Figure 3.1, on the next page, summarizes the functions of the pushbuttons and displays.

Normal Display Mode

At powerup, and when the controller is not being programmed, the upper display shows the Process Value and the lower display shows the setpoint.

The setpoint can be changed in the Normal Display Mode using the ▲ and ▼ pushbuttons, if the Security Level allows setpoint changes (see page 26 for Security Levels).



Use ▲ and ▼ to change setpoint in Normal Display Mode.

Figure 3.1
Front Panel
Identification

- Process Variable Display in Normal Display Mode
- Alphanumeric Menu display in Setup Mode

LEDs indicate Control Output #1 or #2 ON

LEDs indicate Alarm or Event Output ON

LEDs indicate °F or °C selected for Process Variable

LED indicates an Auxiliary function is active

Active Setpoint Display

RESET

Pushbutton
- Reset Latching Alarm
- Hold for more than 3 seconds to enter or exit Setup Mode
- Scrolls through MENUs in Setup Mode

AUX

Programmable Pushbutton
- PID1/PID2 Toggle Switch
- Auxiliary Setpoint Enable
- Remote Setpoint Enable
- Output Disable
- Ramp/Soak Operations
- Auto/Manual Selector

- In Normal Display Mode, pushbuttons adjust Setpoint.
- In Setup Mode, pushbuttons increase/decrease MENU values.
- Ramp to Setpoint, press once to determine target setpoint.
- For Ramp/Soak Operation:

Start

Hold

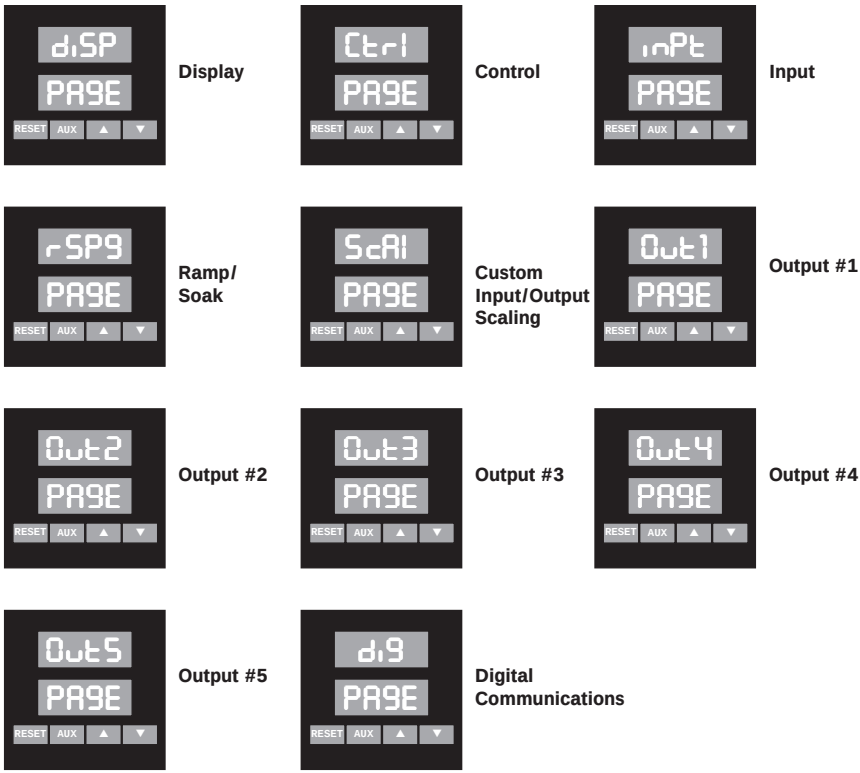
Press together to Stop

PAGE/MENU Setup

All control parameters, selections and calibration procedures for the 2104 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.

This organization allows you to go directly to the parameter to be adjusted, without stepping through a long series of unrelated entries. Figure 3.2 illustrates the 2104 PAGE/MENU setup structure. Only pages that apply to your unit will be displayed (i.e. if you do not have Digital Communications option, this page will not appear).

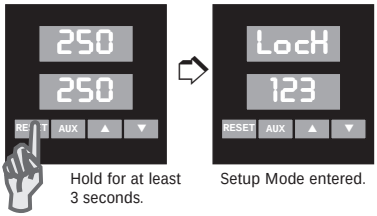
Figure 3.2
PAGE/MENU Setup Structure



Accessing a MENU is accomplished by entering the Setup Mode, then selecting a PAGE and MENU.

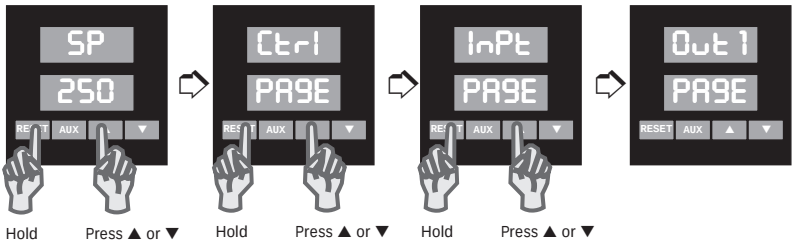
To enter Setup Mode:

Hold down the RESET pushbutton for longer than 3 seconds.



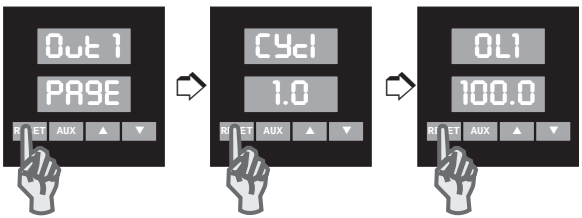
To select a PAGE:

Press and hold the Reset pushbutton, while pressing the ▲ or ▼ Pushbutton. The upper display will increment (or decrement) through the PAGEs, and PAGE will be displayed in the lower display.



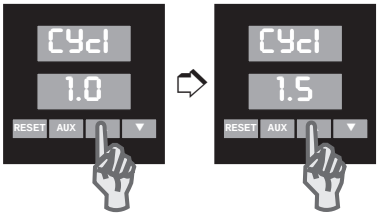
To select a MENU:

After reaching the correct PAGE, press RESET to move through the MENUs. The alpha cue for the MENU will appear on the upper display, and the current value will appear in the lower display.



To change a MENU value:

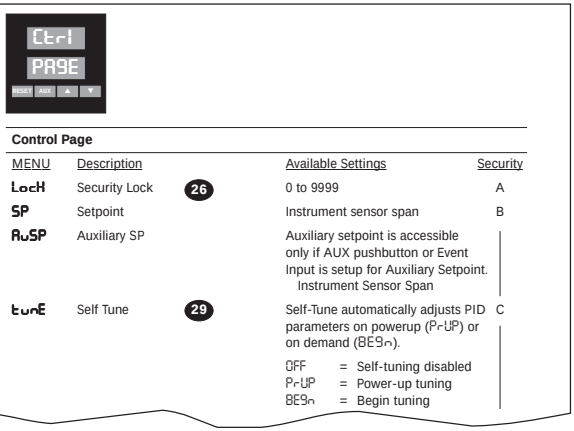
After the MENU is selected and displayed, use the ▲ and ▼ pushbuttons to change the value. For large adjustments (for example, 100 to 200), hold the pushbutton pressed and the display will change more quickly.



To return to Operating Mode:

Press and hold RESET for more than 3 seconds. The controller will automatically return to operating mode after 10 minutes of no pushbutton activity.

Figure 3.3
Sample of
PAGE/MENU
Table



Control Page

MENU	Description		Available Settings	Security
LocK	Security Lock	26	0 to 9999	A
SP	Setpoint		Instrument sensor span	B
AuSP	Auxiliary SP		Auxiliary setpoint is accessible only if AUX pushbutton or Event Input is setup for Auxiliary Setpoint. Instrument Sensor Span	
tunE	Self Tune	29	Self-Tune automatically adjusts PID parameters on powerup (PrUP) or on demand (BEGn).	C
			OFF = Self-tuning disabled PrUP = Power-up tuning BEGn = Begin tuning	

Security Levels

Every parameter or selection in the 2104 controller's setup PAGEs has an identifying MENU. Each MENU is assigned one of four Security Levels, A-D. In each level you may *view* certain MENUs , and *adjust* certain MENUs. This allows you to set the Security level that is appropriate for your operating environment, prohibiting unauthorized access to or accidental changing of control parameters.

Figure 3.4
Security Levels and PAGE/MENU Contents

Level	Code	Description
A	---	Display Page and Security Lock
B	123	Setpoint and Auxiliary Setpoint
C	458	Settings for: Control Input Ramp/Soak Digital Communications
D	736	Calibration Security Codes

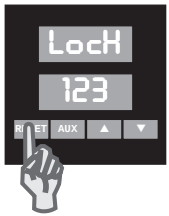
Entering the Security Code

The Security Code is entered on the Control PAGE CtrL , at the MENU LocK. This code determines which MENUs may be viewed and adjusted.

The controller is set at Security Level A (view only, no adjustments) when you receive it from Chromalox.

To access and enter the Security Code:

1. Press and hold RESET for more than 3 seconds to enter Setup Mode. Security Lock is the first menu that will appear.



Security Codes

Figure 3.5 lists the Security Codes for each of the four Security Levels, along with the levels that may be viewed and adjusted.

Figure 3.5
Security Codes & 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

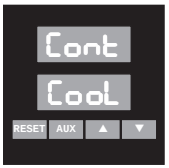
If a number other than one of the three codes listed above is entered at LocH on the CtrI PAGE, adjustment of all parameters is locked out. An additional security number can be added using the menu for User Selectable Security Code (CtrI PAGE, menu CodE).

Control Operation

The 2104 Controller is capable of single output and heat/cool PID control. The selection for single or heat/cool control is made in the Controller Type menu (Ctrl PAGE, Cont) with PID settings also in the Control Page. Additionally, the 2104 features ramp to setpoint and ramp/soak capabilities.

Control Algorithms

PID is the standard control algorithm of the 2104. ON/OFF control action is selected by setting the proportional band (Ctrl PAGE, Pb1 or Pb2) to zero. Two sets of PID and ON/OFF control parameters are located in the Control Page for increased flexibility. Additionally, a Fuzzy Logic algorithm can be used to help prevent overshoot at power-up or during upsets.

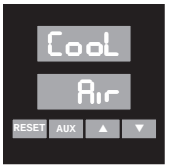


Standard Single Output Control

In standard single output control (Ctrl PAGE, Cont = HEAt or CooL) the Sensor Input is used to measure the process variable and Output #1 is used to control the process. PID1 parameters (Ctrl PAGE, db1, Ar1, rAt1) are used to determine the response of the control loop.

Heat/Cool Control

In heat/cool control (Ctrl PAGE, Cont = HtCL) Outputs #1 and #2 are used to control the process. Output #1 acts as the Heat output and Output #2 acts as the Cool output. PID1 parameters (Ctrl PAGE, Pb1, Ar1, rAt1) are used to determine the response of the Heat output and PID2 parameters (Ctrl PAGE, Pb2, Ar2, rAt2) are used for the cool output.



One way to automatically set the PID2 parameters is via the cooling medium parameters. These are setup at menu CooL on the Ctrl PAGE.

Cooling Medium parameters automatically establish the optimum PID2 cooling parameters, based on the cooling medium used/selected. If air, oil or water cooling medium is selected, and PID1 parameters change (during self-tune OR Manually), PID2 parameters will also be adjusted. If "Pid2" is selected (PAGE Ctrl, CooL = Pid2, no cooling medium specified), the PID2 parameters will change only if changed in Menus Pb2, Ar2 and rAt2.

Control Operation (continued)

Self-Tuning

The 2104 tuning algorithm establishes PID constants (Pb1, Ar1, rAt1) that will bring the process to setpoint as quickly as possible with little overshoot. Tuning can be performed at powerup (Ctrl PAGE, tunE = PrUP) or can be initiated immediately (Ctrl PAGE, tunE = BEGn). When tuning, the 2104 will flash "tunE" in the lower display.

If the process variable is not at least 50°F (28°C) away from setpoint, the 2104 will turn off the control output until the process temperature is 50°F from setpoint. If the 50°F temperature difference is not reached within 30 minutes, "tErr" will be displayed, indicating that tuning was not successful (tuning error). Press RESET to clear "tErr". After successfully tuning, tuning is turned OFF in the tuning menu (tunE).

Heat/Cool Self-Tuning

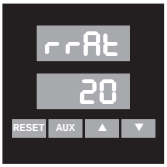
For heat/cool control applications, when the cooling medium is specified (PAGE Ctrl, CooL = Air, H2O, Oil), both heat (PID1) and cool (PID2) parameters are computed during a heat tune (tuning is invoked while the process temperature is at least 50°F below setpoint). If no cooling medium is specified (PAGE Ctrl, CooL = Pid2) the PID2 parameters (Pb2, Ar2, rAt2) will not change during a self-tune.

A cool tune (tuning is invoked while the process temperature is at least 50°F above setpoint) will compute PID parameters for cooling only. One way to initiate a cool tune is to first heat tune, then lower the setpoint by 50°F (28°C) and initiate self-tuning for cooling (Ctrl PAGE, tunE = BEGn). A cool tune will change PID2 settings if Heat/Cool control is selected for the control type (Ctrl PAGE, Cont HtCL).

Control Operation (continued)

Fuzzy Logic Overshoot Protection

Fuzzy Logic Overshoot Protection (Ctrl PAGE, FL) works to minimize the overshoot that accompanies standard PID control. The 2104 actively learns the characteristics of the load and adjusts the PID control algorithm to reduce overshoot. Overshoot Protection, when combined with PID constants established by the 2104 tuning algorithm, produces a response that brings the process to setpoint with a minimum of overshoot. Fuzzy Logic overshoot protection is not possible with ON/OFF type control. It is recommended that Fuzzy Logic is always enabled.



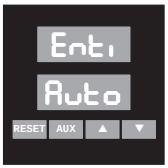
Ramp to Setpoint

(ctrl PAGE, rrAt = 1 to 9999 degrees/hour or OFF)

The Ramp to Setpoint feature allows the control setpoint to be ramped to the final value at powerup or during operation when the setpoint is adjusted. At powerup, the setpoint is ramped from the current measured process temperature to the control setpoint. During operation, the setpoint is ramped from the current value to the new value. When enabled, Ramp to Setpoint will begin in any of the following situations:

- Powerup
- Change of setpoint from front panel
- Change of setpoint from digital communications
- Digital Input or Aux Key used to change between the local and auxiliary setpoints
- Digital Input or Aux Key used to change between the local and remote setpoints
- Remote Setpoint is active and the remote device changes the setpoint faster than the programmed ramp rate

Control Operation (continued)



Manual Operation

Manual operation allows the controller output command to be controlled from the front panel Keyboard. On initial powerup, the controller enters Automatic control mode (closed loop). When Manual Mode is entered, the output command appears in the lower display. The output command can be adjusted using the up and down arrow keys. The manual mode can be entered by using the Aux Key or the Digital Input (Ctrl PASE, Ent1 or Auto). Manual Operation is not possible when ramp/soak is enabled. In the heat/cool control mode, only the currently active control output can be adjusted.

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 automatic mode. When returning to automatic control, the output is forced to be the last manual mode output command.

If automatic reset is enabled (Ctrl PASE, Ar = non-zero value) the integral value slowly changes the output value until it reaches the correct automatic (PID) output value. If automatic reset is not enabled, the output is ramped from the last manual output command to the current automatic output command at a rate determined by the disintergration time menu (Ctrl PASE, Auto).

Section Contents

This section contains detailed information for the following controller setup pages:

- dISP: Display
- Ctrl: Control
- inPt: Input
- ScAL: Custom Scaling
- Out1: Output #1
- Out2: Output #2

Setup PAGEs specific to certain functions are located in the section of this manual that addresses that function specifically.

Section	Page	Topic	Setup PAGE
5	41	Ramp/Soak	rSPG
6	47	Alarms and Events	Out3, Out4, Out5
8	67	Remote Setpoint Input and Analog Output Option	Ctrl, inPt, ScAL
9	71	Digital Communications	d.9

More Info.

Throughout the following Setup PAGEs you will find these symbols 40 . This indicates a section of this User's Manual where more specific information on a parameter/application/feature can be found.

The Display Page is for status only.
None of the settings can be changed.

Display Page

MENU	Description	Displays	Security
Proc	Process Variable	Sensor Span	A
A SP	Active Setpoint	Sensor Span	
Out1	Output #1 Command	0.0 to 100.0%	
Out2	Output #2 Command	0.0 to 100.0%	
rSP	Remote Setpoint Input	Sensor Span	
rS	Ramp/Soak Status	OFF = Program not running run = Program running Hold = Program in hold Stby = Program in standby SS = Guaranteed soak	
int	Ramp/Soak Interval Number	0 - 16	
LEFt	Ramp/Soak Time Left in Interval	0.0 to 999.9 hr/min/sec	
LooP	Ramp/Soak Loops Remaining	0 - 9999	
AIr	Alarm Output Status	NonE = No alarms A3 = Alarm Output #3 A4 = Alarm Output #4 A43 = Alarm Outputs #4 and #3 A5 = Alarm Output #5 A53 = Alarm Outputs #5 and #3 A54 = Alarm Outputs #5 and #4 A543 = Alarms 5, 4 and 3	
Ent	Event Output Status	NonE = All off E3 = Event Output #3 E4 = Event Output #4 E43 = Event Outputs #4 and #3 E5 = Event Output #5 E53 = Event Outputs #5 and #3 E54 = Event Outputs #5 and #4 E543 = Events 5, 4 and 3	

Control Page

MENU	Description		Available Settings	Security
LocK	Security Lock	26	0 to 9999	A
SP	Setpoint		Instrument sensor span	B
AuSP	Auxiliary SP		Auxiliary setpoint is accessible only if AUX pushbutton or Event Input is set up for Auxiliary Setpoint. Instrument Sensor Span	
tunE	Self-Tune	29	Self-Tune automatically adjusts PID parameters on powerup (PrUP) or on demand (BEGn). OFF = Self-tuning disabled PrUP = Power-up tuning BEGn = Begin tuning	C
PID1 (Pb1 - db1) applies to Output #1 in heat/cool mode. For single output control, PID1 (Pb1-db1) can be switched with PID2 (Pb2 - db2) settings *via* AUX pushbutton or Digital Input.				
Pb1	Proportional Band 1		0°F to sensor range 0°F displays as onoF to indicate ON/OFF control	C
Ar1	Automatic Reset 1		0.00 to 99.99 repeats/minute	
rAt1	Rate 1		0 to 500 seconds	
db1	Dead Band 1		db1 is not used unless Pb1 is set to zero. 1 to 100°F 0.01 to 6.25% span for analog inputs	
PID2 (Pb2 - db2) applies to Output #2 in heat/cool mode. For single output control, can be used for Output #1, if switched *via* AUX pushbutton or Digital Input.				
Pb2	Proportional Band 2		0°F to sensor range 0°F displays as onoF to indicate ON/OFF control	
Ar2	Automatic Reset 2		0.00 to 99.99 repeats/minute	
rAt2	Rate 2		0 to 500 seconds	
db2	Dead Band 2		db2 is not used unless Pb2 is set to zero. 1 to 100°F 0.01 to 6.25% span for analog inputs	

Control Page (continued)

MENU	Description		Available Settings	Security
OFSt	Manual Reset		-99.9 to 99.9	C
FL	Fuzzy Logic	29	OFF = Disabled On = Enabled	
Orng	Open Sensor Output Command		In the event of an open sensor, control output will automatically adjust to % output preset. For Heat Only or Cool Only control, adjustable 0.0 to 100.0%. For Heat/Cool Control, adjustable: -100.0 to 100.0%: -100.0 to -0.1 for cooling 0.1 to 100.0 for heating	
LooP	Control Loop Protection Timer	55	OFF, 0.1 to 999.9 minutes	
Auto	Auto/Manual Disintegration Timer		0 to 100 seconds	
rrAt	Ramp Rate		OFF 1 to 9999 degrees/hour	
Cont	Controller Type	28	Controller type can be used as heat/cool (HtCL) only if controller is equipped with Output#1 (Heat) and Output #2 (Cool). HEAt = Reverse Acting Single Output Controller CooL = Direct Acting Single Output Controller HtCl = Heat/Cool Controller	
CooL	Cooling Medium	28	Pid2 = Uses PID2 settings for cooling Air = Air Cooling Oil = Oil Cooling H2O = Water Cooling	
rSP	Remote Setpoint Enable		OFF On	
Ent1	Event/Digital Input Function	59	nonE = Disabled Pid2 = PID2 enable AuSP = Auxiliary SP enable rSP = Remote SP enable Outd = Output disable rS = Ramp/Soak Auto = Auto/Manual AlR = Alarm Reset	

Control Page (continued)

MENU	Description		Available Settings	Security
Au	Auxiliary Pushbutton Function	60	nonE = Disabled Pid2 = PID2 enable AuSP = Auxiliary SP enable rSP = Remote SP enable Outd = Output disable Auto = Auto/Manual	C
Aout	Analog Output Assignment	70	nonE = Disabled Proc = Process Variable ASP = Active Setpoint Out1 = Control Output 1 Out2 = Control Output 2	
rSEn	Ramp/Soak	41	Ramp/Soak "On" enables the Ramp/Soak Setup Page (rSPG) OFF On	
CodE	User Selected Security Code	26	Allows you to establish your own user-defined security code. 0-122 = Level A 123-457 = Level B 458-735 = Level C 736-999 = Level D	D

Input Page

MENU	Description		Available Settings	Security
SEnS	Sensor Type	4	Sensor Type selected here must agree with dip switch settings. J = J Thermocouple K = K Thermocouple T = T Thermocouple E = E Thermocouple R = R Thermocouple S = S Thermocouple B = B Thermocouple rtd = 100Ω Pt RTD (α = .00385) 4-20 = 4 to 20mA 0-5 = 0 to 5 Vdc 1-5 = 1 to 5 Vdc rtdt = 100 Ω Pt RTD (0.1° resolution)	C
unit	Display Units		none = no units °F = Degrees Fahrenheit °C = Degrees Celsius	
CoFF	Display/Calibration Offset	82	Display/Calibration Offset offsets temperature process reading. -100°F to 100°F	
Setpoint Limits prevent setpoints from being adjusted above or below these pre-established limits.				
SPLL	Setpoint Low Limit		Instrument Sensor Span	
SPUL	Setpoint Upper Limit		Instrument Sensor Span	
CALS	Sensor Calibration		inLo inHi done	D
CALr	Remote Setpoint Calibration		inLo inHi done	
AoO	Analog Output Zero Calibration		0 to 4095	
AoS	Analog Output Span Calibration		0 to 4095	
rECc	Factory Calibration Recovery		rdY = Ready --- = Wait done = Finished	
Digital Filtering menu (FILT) can be used to stabilize a fluctuating 0.1° resolution process variable display. To stabilize the display, increase the menu value (adjustable from 1 to 60 seconds).				
FiLt	**Digital Filter**		**0 to 60 seconds**	
hPrc	**High (max.) Process Input**		**Instrument Sensor Span**	
LPrc	**Low (min.) Process Input**		**Instrument Sensor Span**	
hiA	**High (max.) Ambient Temp.**		**Instrument Sensor Span**	
LoA	**Low (min.) Ambient Temp.**		**Instrument Sensor Span**	

This PAGE appears only when Analog Input is selected, Remote SP is enabled, or Analog Output is enabled on CtrL PAGE.

Custom Scaling Page

MENU	Description		Available Settings	Security
dP	Analog Input Decimal Pts.	9	0 = none 1 = 123.4 2 = 12.34 3 = 1.234	C
AinL	Analog Input Low	9	-500 to 5000	
AinH	Analog Input High	9	-500 to 5000	
AotL	Analog Output Low	70	-500 to 5000	
AotH	Analog Output High	70	-500 to 5000	
rSPL	Remote SP Input Low	67	-500 to 5000	
rSPH	Remote SP Input High	67	-500 to 5000	

Output #1 Page

MENU	Description	Available Settings	Security
Cyc1	Output #1 Cycle Time	0.0 to 60.0 seconds 0.0 = Voltage/Current algorithm	C
OL1	Output #1 Limit	0.0 to 100.0%	
HoFF	Heat Offset	0°F to PB1 setting	

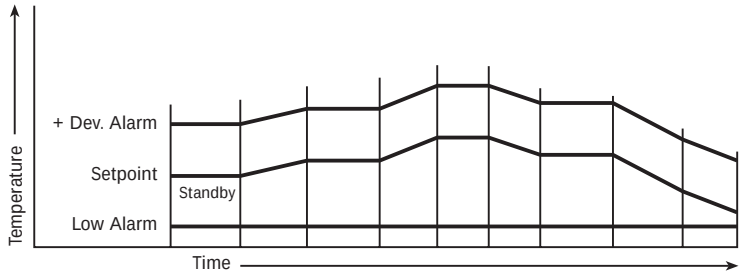
This PAGE is visible only if setup for heat/cool control on CtrL PAGE.

Output #2 Page

MENU	Description	Available Settings	Security
Cyc2	Output #2 Cycle Time	0.0 to 60.0 seconds 0.0 = Voltage/Current algorithm	C
OL2	Output #2 Limit	0.0 to 100.0%	
CoFF	Heat Offset	0°F to Pb2 setting	

The 2104 controller features a Ramp/Soak Program. The program consists of 16 intervals plus a standby interval. The time span and setpoint for each interval are individually adjustable. These intervals make up a Ramp/Soak Profile. An example of a typical 8-interval Ramp/Soak program is shown below.

Figure 5.1
Ramp/Soak Profile

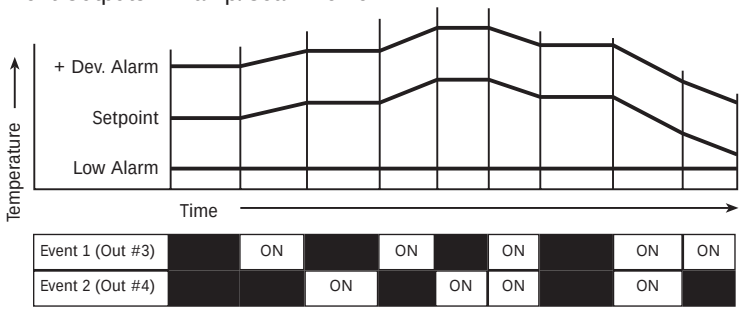


Event Outputs

Event Outputs may be configured to turn ON or OFF during each of the intervals. Event outputs are merely timed outputs that are either ON or OFF during an entire interval.

Examples of event outputs might be annunciation of a soak interval, an indicator light or addition of a product to the process. Outputs #3, #4 and #5 (if your controller was purchased with these options) may be setup as event outputs. For Outputs #3, #4 or #5 to be used as Events, the output must be set up as an Event on its setup page (i.e. Out3). For example, for Output #3 to turn on during interval 2, set menu 2E (interval 2 event) to E3 (Output #3 on). See page 43 for details.

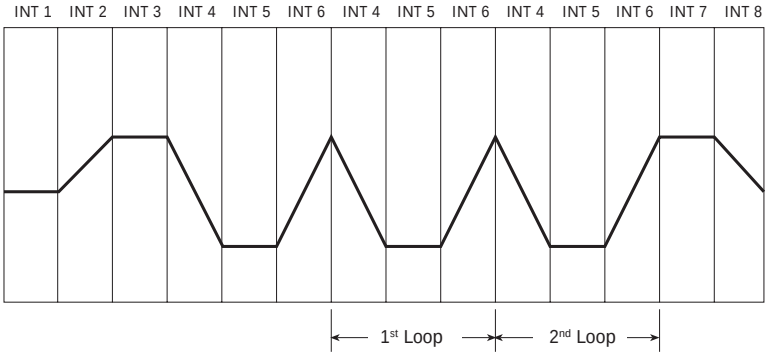
Figure 5.2
Event Outputs in Ramp/Soak Profile



Looping Intervals

Looping means that intervals within a Program may be repeated 1 to 9999 times. If a loop is inserted in the program shown in Figure 5.1, so that intervals 4, 5 and 6 will be repeated 2 times in addition to the single Program run of these intervals, the final profile would look Figure 5.3.

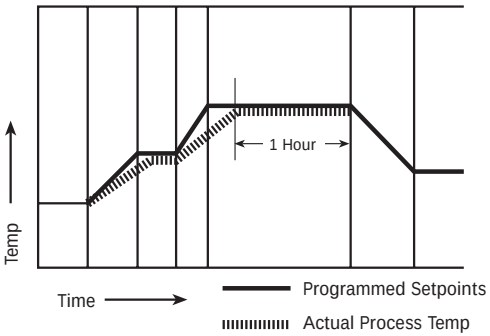
Figure 5.3
Looping Intervals



Guaranteed Soak

This Ramp/Soak feature of the 2104, when enabled, assures that the "soaking" time in a "soak" interval does not begin until the process reaches setpoint or is within the guaranteed soak differential band. A soak interval has the same setpoint at the beginning and end of the interval.

Figure 5.4
Guaranteed Soak



Guaranteed Soak is enabled on the rSP9 PAGE by setting the differential band to a value greater than 0. It is adjustable from 1°F to the sensor span.

This setup PAGE appears only if Ramp/Soak control is turned on. The Ramp/Soak Enable parameter is the next to the last menu on CtrL PAGE, Menu Cont.

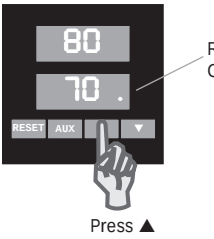
Ramp/Soak Page

MENU	Description	Available Settings	Security
unit	Time Units	SEc = seconds (1 to 9999) Min = minutes (0.1 to 999.9) hr = hours (0.01 to 99.99)	C
StbY	Standby Setpoint	Instrument Sensor Span	
int1	Interval 1 Time	see Time Units Menu (above)	
SP1	Setpoint 1 • •Intervals 2-15 •Time and Setpoint	Instrument Sensor Span	
in16	Interval 16 Time	see Time Units Menu (above)	
SP16	Setpoint 16	Instrument Sensor Span	
Cont	Continuous Program	OFF On	
Fro	Loop from the end of interval (42)	1 to 16	
to	To the beginning of interval	1 to 16	
no	Number of times	0 to 9999	
SbEt	Standby Events (41)	OFF = All off E3 = Event Output 3 On E4 = Event Output 4 On E43 = Event Outputs 4 & 3 On E5 = Event Output 5 On E53 = Event Outputs 5 & 3 On E54 = Event Outputs 5 & 4 On E543 = Event Outputs 5, 4, 3 On	
i1 E	Interval 1 Events (41)	OFF = All off E3 = Event Output 3 On E4 = Event Output 4 On E43 = Event Outputs 4 & 3 On E5 = Event Output 5 On E53 = Event Outputs 5 & 3 On E54 = Event Outputs 5 & 4 On E543 = Event Outputs 5, 4, 3 On	
i16E	Interval 16 Event (41)	same as above	
GSdb	Guaranteed Soak differential (42)	OFF, 1°F to sensor range	

Control Operation

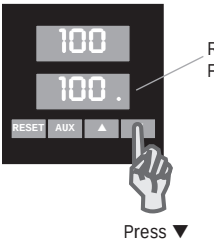
In order to use the Ramp/Soak program, it must be enabled on the Ctrl Page, rSEn = On. Control of ramp/soak operation (Start, Stop and Hold) can be accomplished via the front panel. In the Setup mode, first return to the Normal Display Mode by holding the reset button for 3 seconds. Pressing the up arrow key Starts the program, pressing the down arrow key Holds the program, and pressing both together Stops the program.

To Start Ramp/Soak Program:



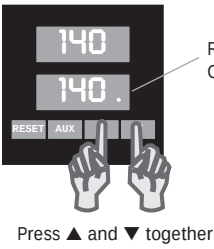
▲ Starts the Ramp/Soak program or if the program is on Hold, continues the program

To Hold Ramp/Soak Program:



▼ (Hold) Stops the program in progress and "holds" the program until the ▲ (Start) button is pressed.

To Stop Ramp/Soak Program:



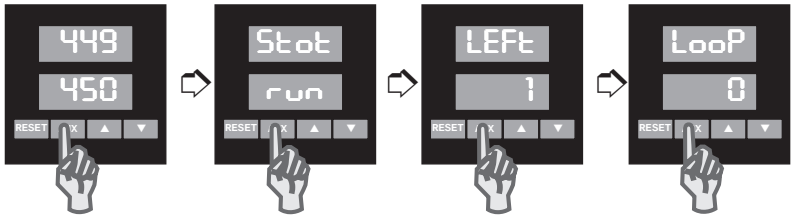
▼ and ▲ together (Stop Pushbutton) return the Ramp/Soak program to the Standby setpoint.

Control Operation (continued)

Ramp/Soak (continued)

Alternately, the Digital Input or *Chromasoft*™ can be used to control program operation. The ramp/soak indicator LED (right-most decimal point in the lower display) is ON when a program is running, OFF in standby, and flashes in hold mode.

Note: If the Aux key function is set to none (CtrI PASE, Au = nonE), the current ramp/soak status will be displayed when the Aux key is pressed.



Status: Run # Intervals Left # Loops Left

The 2104 controller can provide up to three alarm outputs using Output #3, #4 and #5. These optional outputs are indicated by the following controller model numbers:

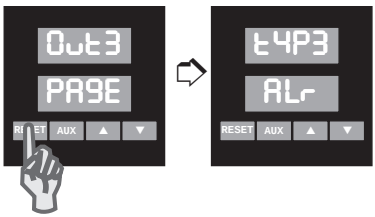
Optional Outputs	Model Number
Outputs #3 and #4	2104 - **1**
Output #5	2104 - ***1* ***2*
	2104 - ***4* ***5*

Each alarm is individually setup with a high and low setpoint on its own Page:

- OUt3 PAGE
- OUt4 PAGE
- OUt5 PAGE

Outputs #3, #4 and #5 can be individually setup as Alarms or Events, and can be individually disabled.

To function as an alarm, the output type must be specified as an alarm output, ALr, in the first menu, output type (t4P3, t4P4, t4P5). If the function is an Event, the output type must be specified as Ent. The Events then are enabled in the Ramp/Soak (rSP9) page, menus SbEt (Standby Event) through i16E.



Alarm Types

Each of the alarms can be set up for the following alarm types:

Hi	High Alarm—Absolute Temperature Alarm
Lo	Low Alarm—Absolute Temperature Alarm
HiLo	High/Low Alarm—Absolute Temperature Alarm
PdE	+Deviation Alarm—Setpoint Tracking Alarm
-dE	-Deviation Alarm—Setpoint Tracking Alarm
dE	±Deviation Alarm—Setpoint Tracking Alarm
LooP	Control Loop Protection Alarm—System Alarm

(see page 53 for detailed information)

The Absolute Temperature Alarms are set to a specific value; i.e. if the High Alarm is set for 100°F, the alarm will turn on at 100°F. The Deviation Alarms, or Setpoint Tracking Alarms, track the process setpoint. If the Alarm = 5°F and the setpoint is 70°F, the Alarm will energize at 75°F.

Alarm Inhibit

When enabled, the Alarm Inhibit feature prevents false alarms during initial powerup. For example, the low alarm will not be set until after the process temperature has initially reached setpoint. Alarm Inhibit is adjustable for each alarm output.

Alarm Wiring

Wiring instructions for Outputs #3, #4 and #5 are given on pages 19-20.

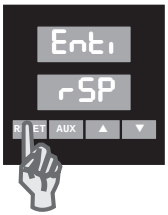
Alarm Relay Action

Output Relays #3, #4 and #5 can be set to be normally energized or de-energized, latching or non-latching. A normally de-energized relay is in its non-energized state when not in alarm. For example, Outputs #3 and #4 are normally-open contacts. When setup as normally de-energized, the relays will be open when not in alarm, and closed when in alarm.

A non-latching relay will not stay in alarm if the alarm condition goes away. A latching relay will not go out of alarm until the alarm condition no longer exists and RESET is pressed.

Alarm Operation

Latching alarms can be reset by pressing the RESET pushbutton on the controller front panel. The alarm cannot be reset until the process is out of the alarm condition. The Digital Input can be setup to function as a remote alarm reset button (see pages 59-63).



This setup PAGE appears only if the controller is equipped with Outputs #3 and #4.

Output #3 Page

MENU	Description		Available Settings			Security
tYP3	Output #3 Type	47	OFF	=	Disabled	C
			AIr	=	Alarm Output	
			Ent	=	Event Output (Setup Event Output parameters on Ramp/Soak Page)	
AIr3	Alarm #3 Type	48	nonE	=	Disabled (off)	
			Hi	=	High Alarm	
			Lo	=	Low Alarm	
			HiLo	=	High-Low Alarm	
			PdE	=	Plus Deviation Alarm	
			-dE	=	Minus Deviation Alarm	
			dE	=	Plus/Minus Deviation Alarm	
			LooP	=	Control Loop Protection Alarm	
rLY3	Alarm #3 Relay Action	49	ndE	=	Normally de-energized non-latching	
			nE	=	Normally energized non-latching	
			ndEL	=	Normally de-energized latching	
			nEL	=	Normally energized latching	
Low Setpoint is used for low and -deviation setpoints						
ALo3	Alarm #3 Low Setpoint		Instrument Sensor Span			
High Setpoint is used for high and +deviation setpoints						
AHi3	Alarm #3 High Setpoint		Instrument Sensor Span			
db3	Output #3 Dead Band (Alarm Hysteresis)		0 to 100°F			
inh3	Alarm #3 Inhibit	48	OFF			
			On			

This setup PAGE appears only if the controller is equipped with Outputs #3 and #4.

Output #4 Page

MENU	Description		Available Settings			Security
tYP4	Output #4 Type	47	OFF AIr Ent	= = =	Disabled Alarm Output Event Output (Setup Event Output parameters on Ramp/Soak Page)	C
AIr4	Alarm #4 Type	48	nonE Hi Lo HiLo PdE -dE dE LooP	= = = = = = = =	Disabled (off) High Alarm Low Alarm High-Low Alarm Plus Deviation Alarm Minus Deviation Alarm Plus/Minus Deviation Alarm Control Loop Protection Alarm	
rLY4	Alarm #4 Relay Action	49	ndE nE ndEL nEL	= = = =	Normally de-energized non-latching Normally energized non-latching Normally de-energized latching Normally energized latching	
Low Setpoint is used for low and -deviation setpoints						
ALo4	Alarm #4 Low Setpoint		Instrument Sensor Span			
High Setpoint is used for high and +deviation setpoints						
AHi4	Alarm #4 High Setpoint		Instrument Sensor Span			
db4	Output #4 Dead Band (Alarm Hysteresis)		0 to 100°F			
inh4	Alarm #4 Inhibit	48	OFF On			

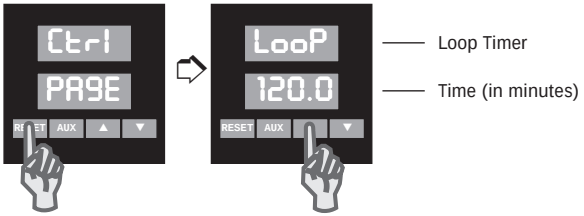
This setup PAGE appears only if the controller is equipped with Output #5.

Output #5 Page

MENU	Description	Available Settings	Security
tYPS	Output #5 Type (47)	OFF = Disabled AIr = Alarm Output Ent = Event Output (Setup Event Output parameters on Ramp/Soak Page)	C
AIr5	Alarm #5 Type (48)	nonE = Disabled (off) Hi = High Alarm Lo = Low Alarm HiLo = High-Low Alarm PdE = Plus Deviation Alarm -dE = Minus Deviation Alarm dE = Plus/Minus Deviation Alarm LooP = Control Loop Protection Alarm	
rLY5	Alarm #5 Relay Action (49)	ndE = Normally de-energized non-latching nE = Normally energized non-latching ndEL = Normally de-energized latching nEL = Normally energized latching	
Low Setpoint is used for low and -deviation setpoints			
ALo5	Alarm #5 Low Setpoint	Instrument Sensor Span	
High Setpoint is used for high and +deviation setpoints			
AHi5	Alarm #5 High Setpoint	Instrument Sensor Span	
db5	Output #5 Dead Band (Alarm Hysteresis)	0 to 100°F	
inh5	Alarm #5 Inhibit (48)	OFF On	

Control Loop Protection Alarm (CLP)

Control Loop Protection (CLP) monitors the controller's process variable input and load output to detect and respond to conditions indicating a failure in the control loop (Sensor, Controller Output, Load or Process flow). CLP is selected by setting the LooP Timer on the Ctrl PAGE menu to a value from 0.1 to 999.0 minutes (0.0 disables CLP).



The timer setting should be chosen according to the response time of the system. The minimum time seting should be 0.25% of span divided by the normal load response rate to full ON or full OFF condition (whichever is slower).

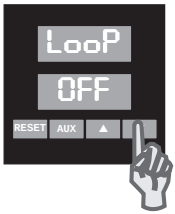
$$\text{Minimum Timer Setting} = \frac{\text{Span x .0025}}{\text{Slowest Response Rate (Heat or Cool)}}$$

Response Rate = Process Response (in degrees/minute) when 100% ON or 100% OFF

Example: For a controller with type J T/C (span -100°F to 1400°F), 0.25% of span is 3.75°F. If the heating response is 2°F/min., and the cooling response is 1°F/min., the minimum Loop Timer setting would be 3.8 minutes. To prevent false alarms, it is recommended that you start by doubling the setting to 7.6 minutes.

The CLP Alarm sequence begins when the control output reaches 0.0% or 100.0% (process variable outside of the proportional band). The controller then measures the time for the process variable to respond (increase or decrease the process variable) and compares the measured time to the Loop Timer value.

Control Loop Protection Alarm (continued)
If the control loop does not respond with a change in the process variable of 0.25% of span (3.75°F for a J thermocouple) within the programmed loop time, a Loop Error will result and the control output will turn off. The error will be indicated by the lower display flashing LooP and Loop Alarm Output (Output #3, #4, or #5 as selected on the menu) will be activated. The Loop Alarm is cleared by pressing RESET.



Press RESET
to clear Loop Alarm

Warning

The CLP is not a substitute for safety shutdown devices such as flow switches or overtemperature monitors. The CLP Alarm responds to specific conditions that may provide early warning of system loop failures or aid in troubleshooting failures.

CLP Loop Alarm Conditions

The following table details conditions that activate a loop alarm, and gives the controller response to the condition.

Figure 6.1 CLP Loop Alarm Conditions

Probable Cause	Control Output Response	Display
Loss of process flow	Turns control output off	 Flashing

In a control application where the process is being heated at one point and measured at a point downstream, CLP Alarm could be used to detect a flow failure. If the process flow is interrupted and heat is no longer transferred to the sensor, the controller output will increase to 100%, the Loop alarm will start timing the load response and when the preset Loop Timer value is reached, the Loop Alarm will be activated and the control output will be turned off. The failure will be indicated by the lower display flashing LooP. Loop Alarm Output (Output #3, #4 or #5) will be activated if selected.

Probable Cause	Control Output Response	Display
Load Power is interrupted (blown fuse or tripped circuit breaker)	Turns control output off	 Flashing

If load power is interrupted by the circuit protection devices (user supplied fuse or circuit breaker), the Loop Alarm will be activated when the process variable goes outside of the proportional band for a time greater than the preset Loop Timer value. The control output will be turned off and the failure will be indicated by the lower display flashing LooP. Loop Alarm Output (Output #3, #4, or #5) will be activated If selected.

Probable Cause	Control Output Response	Display
Load fails (open circuit)	Turns control output off	 Flashing

If the load fails open, the Loop Alarm will be activated when the process variable goes outside of the proportional band for a time greater than the preset Loop Timer value. The control output will be turned off and the failure will be indicated by the lower display flashing LooP. Loop Alarm Output (Output #3, #4, or #5) will be activated if selected.

Probable Cause	Control Output Response	Display
Load fails (short circuit)	Turns control output Off	 Flashing

If the load fails shorted, power to the load will be interrupted by the circuit protection devices (user supplied fuse or circuit breaker). The Loop Alarm will be activated when the process variable goes outside of the proportional band for a time greater than the preset Loop Timer value. The control output will be turned off and the failure will be indicated by the lower display flashing LooP. Loop Alarm Output (Output #3, #4, or #5) will be activated if selected.

(continue on the next page)

Figure 6.1 CLP Loop Alarm Conditions (continued)

Probable Cause	Control Output Response	Display
Controller or remote power control output fails (open circuit)	Turns control output off	 Flashing

If the controller output or the remote power control device (SCR or contactor) fails open, the Loop Alarm will be activated when the process variable goes outside of the proportional band for a time greater than the preset Loop Timer value. The failure will be indicated by the lower display flashing LooP. Loop Alarm Output (Output #3, #4, or #5) will be activated if selected.

Probable Cause	Control Output Response	Display
Controller or remote power control output fails (short circuit)	None (load must be interconnected with alarm)	 Flashing

If the controller output or the remote power control device (SCR or contactor) fails shorted, the Loop Alarm will be activated when the process variable goes outside of the proportional band for a time greater than the preset Loop Timer value. The failure will be indicated by the lower display flashing LooP. Loop Alarm Output (Output #3, #4, or #5) will be activated. To protect the loop under this condition, the Loop Alarm Output (Output #3, #4 of #5) should be interconnected to remove power from the load.

Probable Cause	Control Output Response	Display
Sensor wiring reversed (thermocouple only)	Turns control output off	 Flashing

If the sensor wiring is reversed, the Loop Alarm will be activated when the process variable goes outside of the proportional band for a time greater than the preset Loop Timer value. The control output will be turned off and the failure will be indicated by the lower display flashing LooP. Loop Alarm Output (Output #3, #4, or #5) will be activated if selected.

Probable Cause	Control Output Response	Display
Sensor loses contact with process	Turns control output off	 Flashing

If the sensor loses contact with the process (sensor becomes dislodged or pulled loose), the Loop Alarm will be activated when the process variable goes outside of the proportional band for a time greater than the preset Loop Timer value. The failure will be indicated by the lower display flashing LooP. Loop Alarm Output (Output #3, #4, or #5) will be activated if selected.

Probable Cause	Control Output Response	Display
Sensor fails (open circuit)	Defaults to preset (0-100%)	 Flashing

If the sensing device fails open, the controller defaults to the preset output condition (0-100% OrnG setting selected on the Ctrl PAGE menu) and uses both displays to indicate OPEN SENS. The Loop alarm is not activated for this condition. Alarms selected as Low, High-Low, + Deviation or +/- Deviation will actuate if selected.

(continued on the next page)

Figure 6.1 CLP Loop Alarm Conditions (continued)

Probable Cause	Control Output Response	Display
Sensor fails (short circuit, RTD only)	Defaults to preset (0-100%)	 Flashing

If the RTD sensing device fails shorted, the controller defaults to the preset output condition (0-100% `OrnG` setting selected on the `CtrI PAGE` menu) and uses both displays to indicate `OPEN SENS`. The Loop alarm is not activated for this condition. Alarms selected as Low, High-Low, - Deviation or +/- Deviation will actuate if selected.

Probable Cause	Control Output Response	Display
Controller Self Diagnostic (signal conversion)	Defaults to preset (0-100%)	 Flashing

If a failure occurs in the signal conversion circuit of the controller, the controller defaults to the preset output condition (0-100% `OrnG` setting selected on the `CtrI PAGE` menu) and displays `Err4` on the lower display. Loop Alarm Output (Output #3, #4, or #5) will be activated if selected.

Probable Cause	Control Output Response	Display
Controller Self Diagnostic	Turns control output off	 Flashing

If a failure occurs in the control circuitry of the controller, the control output will be turned off and `Err3` will be displayed on the lower display. Loop Alarm Output (Output #3, #4, or #5) will be activated if selected.

The 2104 controller gives you two different options for actuation of any one of several field-selectable controller functions:

1. A Digital Input that is hardwired to terminals 1 and 2 of the controller.
2. The AUX pushbutton located on the controller front faceplate.

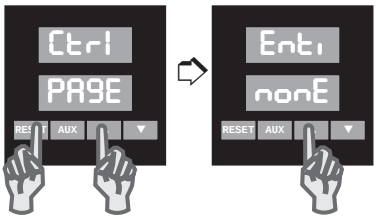
You may choose to use either the Digital Input or the AUX pushbutton, but you cannot use both.

Digital Input

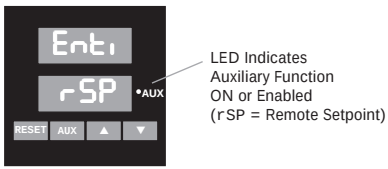
The Digital Input allows you to use a remote switch, pushbutton or contact to perform any one of seven possible functions:

- PID1/PID2 Switch
- Output Disable/Enable
- SP/AUX Setpoint Switch
- Ramp/Soak
- Local/Remote Setpoint Switch
- Alarm Reset
- Auto/Manual Control Switch

The external switching device is connected to the controller Digital Input at terminals 1 and 2 (see page 10 for wiring instructions). The Digital Input function is selected in the Ctrl PAGE programming.

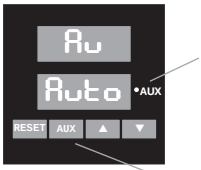


When the Digital Input is used, the AUX (Auxiliary) LED on the controller front panel is used for indication of the Digital Input function.



AUX Pushbutton

The AUX front panel pushbutton can be assigned to perform any one of six possible functions and the AUX LED is used for indication of that function. Like the Digital Input, its function is selected in the Ctrl PAGE programming. No wiring or hardware adjustments are required to use the AUX pushbutton as a function key.



LED Indicates
Auxiliary Function
ON or Enabled
(Auto = Auto/Manual Control)

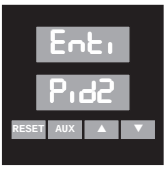
Programmable Pushbutton

- PID1/PID2 Toggle Switch
- SP/Auxiliary Setpoint Switch
- Local/Remote Setpoint Switch
- Output Disable/Enable
- Auto/Manual Selector

Remember:

- The Digital Input and AUX function pushbutton cannot be used at the same time.
- If the AUX pushbutton is set to nonE, it will display the Ramp/Soak Program Status when pressed. 45
- When the AUX function = nonE, the Digital Input can be used.

Digital Input



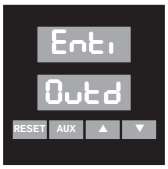
nonE = None
When disabled, the Digital Input has no effect on controller operation. If the AUX key is also disabled, the AUX light is used to indicate the output state (ON or OFF) of Output #5, if the controller has Output #5.

Pid2 = Enable
This function can be used in single output control applications only (Ctrl PASE, cont = HEAt or COOL). When this function is selected, the controller uses PID1 parameters (Ctrl PASE) when the Digital Input switch is open. The PID2 parameters will be used when the switch is closed. The AUX indicator is ON when PID2 parameters are selected and OFF when PID1 parameters are selected.

AuSP = Auxiliary Setpoint Enable
When this function is selected, the controller uses the Local Setpoint (Ctrl PASE, SP) when the Digital Input switch is open. The Auxiliary Setpoint (Ctrl PASE, AuSP) is used when the switch is closed. The AUX indicator is ON when the Auxiliary SP is selected and OFF when the Local Setpoint is selected. The setpoints are adjustable in the Operator Mode according to security. This function cannot be used when Ramp/Soak is enabled.

rSP = Remote SP Enable
When this function is selected, the controller uses the Local Setpoint (Ctrl PASE, SP) when the Digital Input switch is open. The Remote Setpoint is used when the switch is closed. Remote Setpoint must be enabled (Ctrl PASE, rSP = On) for this function to operate. The AUX indicator is ON when the Remote Setpoint is selected and OFF when the Local Setpoint is selected. This function cannot be used when Ramp/Soak is enabled.

Digital Input (continued)



Outd = Output Disable
When this function is selected, the control output(s) are enabled when the Digital Input switch is open, and disabled, when the switch is closed. The AUX indicator is ON, when the control output(s) are disabled and OFF, when enabled.

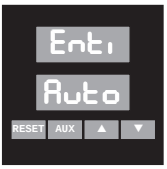
Note: Disabling the outputs allows all control parameters to be set up without starting the process.

This setting is NOT intended for process shutdown. An external disconnect should be used for process shutdown.

41 rS = Ramp/Soak
This function allows the Digital Input to act as a Start/Stop and Hold button for controlling Ramp/Soak operation:

- Ramp/Soak operation is started when the Digital Input switch is closed (100 milliseconds), then opened (momentary action) while in Standby Mode.
- In Run Mode, this action will skip to the next interval.
- Hold Mode is entered by closing the Digital Input switch for 2 seconds while the program is running.
- Momentarily closing (100 milliseconds) the input switch while in HOLD will continue the program.
- Closing the Digital Input Switch for 2 seconds while in Hold Mode will stop the program and return to Standby.

Digital Input (continued)



31

Auto = Auto/Manual Control
This function allows the Digital Input to act as an Auto/Manual Control selector. Manual operation is selected when the Digital Input switch is closed. Automatic operation is selected when the switch is open. The AUX light is ON in Manual, and OFF in Automatic Mode.

Alr = Alarm Reset
This function allows the Digital Input switch to be used as a remote Alarm Reset button for use with latching type alarms. The AUX light is used to indicate the state (ON or OFF) of Output #5, if the Output #5 option is installed in the controller.

AUX Key

The AUX Key can be setup for any of the functions listed below:

nonE = None
When disabled, the AUX Key has no effect on controller operation. AUX can be used to display the Ramp/Soak status, if Ramp/Soak is enabled. If the Digital Input is also disabled, the AUX light is used to indicate the state (ON or OFF) of Output #5, if installed.

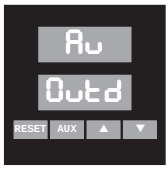
AUX Key
(continued)

Pid2 = PID2 Enabled
This function can be used in single output control applications only (Ctrl PAGE Cont = HEAt or COOL). When this function is selected, pressing the AUX Key will toggle between PID1 (Ctrl PAGE, menus Pb1, Ar1, rAt1) and PID2 (Ctrl PAGE, menus Pb2, Ar2, rAt2) parameters. If the power is interrupted, the last active PID parameters will be used when power is restored. The AUX indicator is ON when PID2 parameters are selected and OFF when PID1 parameters are selected.

AuSP = Auxiliary Setpoint Enable
When this function is selected, pressing the AUX Key will toggle between the Auxiliary and Local setpoints. If the power is interrupted, the last active setpoint will be used when power is restored. The AUX indicator is ON when the Auxiliary Setpoint is selected and OFF when the Local Setpoint is selected. The setpoints are adjustable in Operator Mode according to security. This function cannot be used when Ramp/Soak is enabled.

rSP = Remote Setpoint Enable
When this function is selected, pressing the AUX Key will toggle between the Remote and Local Setpoints. If the power is interrupted, the last active setpoint will be used when power is restored. Remote setpoint must be enabled (Ctrl PAGE, rSP = ON) for this function to operate. The AUX indicator is ON when the Remote Setpoint is selected and OFF when the Local Setpoint is selected. This function cannot be used when Ramp/Soak is enabled.

AUX Key
(continued)



Outd = Output Disable
When this function is selected, pressing the AUX Key will toggle between outputs enabled and outputs disabled. The AUX indicator is ON when the control output(s) are disabled and OFF when enabled.

Note: Disabling the outputs allows for all the parameters to be set without starting the process.

This setting is not intended for shutdown of the process. An external disconnect should be used.

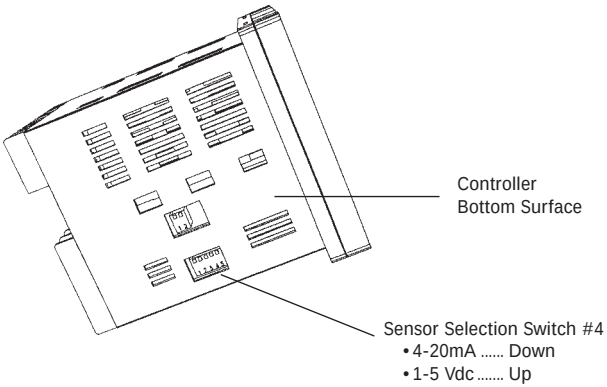
31 Auto = Auto/Manual
When this function is selected, pressing the AUX Key toggles between Manual and Automatic operation with Automatic as default at powerup. The AUX light is ON in Manual Mode, and OFF in Automatic Mode.

Remote Setpoint

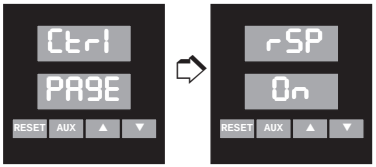
The Remote Setpoint standard feature allows an external device to control the setpoint of the controller. The Remote Setpoint input accepts either 4-20mA or 1-5 Vdc input signals, selectable by a switch on the bottom of the controller. The Digital Input or AUX pushbutton can be set up to switch between the Local Setpoint and the Remote Setpoint.

To Select the Remote Setpoint Input Signal
Locate switch #4 on the bottom of the controller, as shown in Figure 8.1. Place the switch in the desired position.

Figure 8.1
Remote
Setpoint
Input Signal



To Enable the Remote Setpoint
Go to MENU rSP on the Ctrl PAGE and select ON.



Note: The Digital Input or AUX pushbutton can be used to switch between Remote Setpoint and Local Setpoint (see page 57 for setup).

To Scale the Input Signal
Go to the ScAI PAGE, MENUs rSPL (remote setpoint low) and rSPH (remote setpoint high). Enter the sensor span low and high ranges. For example, for a 100 to 500°F range, 4mA would equal 100°F setpoint, and 20mA would equal 500°F setpoint.

This page appears only if Remote Setpoint and/or Analog Process Output are Enabled.

Custom Scaling Page

MENU	Description	Available Settings	Security
rSPL	Remote Setpoint-Low	Instrument Sensor Span	C
rSPH	Remote Setpoint-High	Instrument Sensor Span	C

Remote Setpoint Wiring

Figure 8.2
2-Wire 4-20mA Transmitter (Loop-Powered)

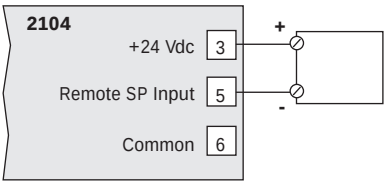


Figure 8.3
2-wire 4-20mA, 1-5 Vdc Transmitter (Self-Powered)

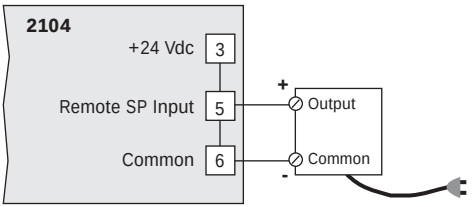
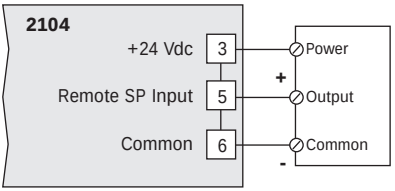


Figure 8.4
3-wire 4-20mA, 1-5 Vdc Transmitter



Analog Output Option

The Analog Output Option is provided on controllers with model number

- 2104 - ***3*
- 2104 - ***4*
- 2104 - ***5*

This option can be used to transmit any one of four process parameters:

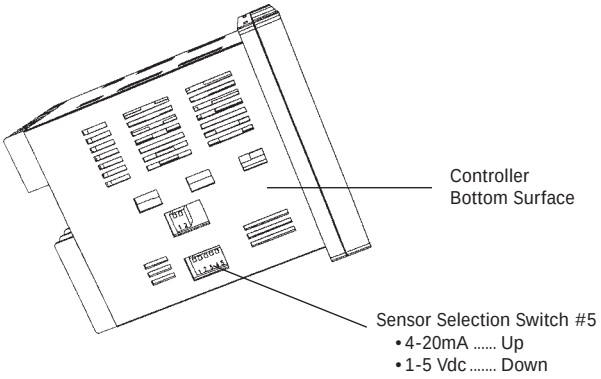
- Proc ..... Process Variable
- ASP ..... Active Setpoint
- Out1 ..... Output #1 Command (%ON)
- Out2 ..... Output #2 Command (%ON)

The variable can be transmitted to a remote recorder, computer or other device via a 4-20mA or 1-5 Vdc signal, selectable by a switch on the bottom of the controller.

To Select the Analog Process Output Signal

Locate switch #5 on the bottom of the controller, as shown in Figure 8.2. Place the switch in the desired position.

Figure 8.5
Analog Output Signal



To Enable the Analog Output Option:
Go to MENU AOUT on the CtrL PAGE and select one of the 4 parameters.

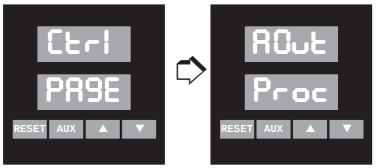
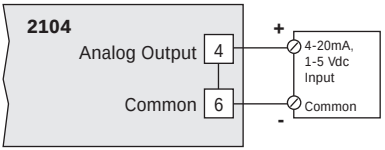


Figure 8.6
Process
Output Wiring



To Scale the Output Signal
When the Process Variable or Active Setpoint is selected for transmission, the output signal is scaled using the Analog Output scaling MENUs. Go to the ScAL PAGE, MENUs AOtl (analog output low) and AOtH (analog output high). Enter the output signal range to be sent to your recorder or computer (i.e., 100 = 4mA and 500°F = 20mA).

Custom Scaling Page

MENU	Description	Available Settings	Security
AOtL	Analog Process Output - Low	Instrument Sensor Span	C
AOtH	Analog Process Output - High	Instrument Sensor Span	C

When Output #1 or Output #2 are selected for transmission, the low end of span (4mA or 1 Vdc) represents 0.0% output, and the high end of span (20mA or 5 Vdc) represents 100.0% output.

The Digital Communications option is provided on the following controllers:

Model	Communications
2104 - ***2*	RS232
2104 - ***5*	RS232
2104 - ***1*	RS485/422
2104 - ***4*	RS485/422

The Digital Communications option gives the 2104 the ability to interface with computers using either Chromalox's Computer Interface mode or ASCII Line mode. These modes implement communications that can address up to 255 Chromalox controllers on an RS422A/RS485 multidrop line. The protocols for these two modes are described in the Digital Communications User's Manual (P/N 0037-75129) that is supplied with controllers containing the Digital Communication option.

ChromaSoft™

If a prepackaged software program is preferred for multidrop digital communication with up to 255 Chromalox controllers, Chromalox offers *ChromaSoft* remote operator interface software. *ChromaSoft* is DOS-based and communicates with the controllers via a serial interface port. Instructions for using *ChromaSoft* are given in the User's Manual provided with the software.

Hardware Setup

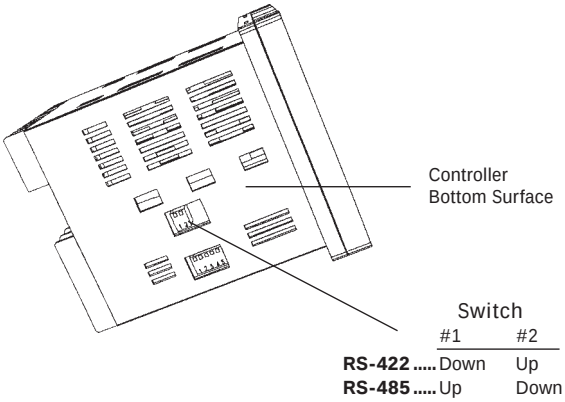
RS232 can be used to connect a computer or modem to a single 2104 controller. RS232 lines can be run over distances up to 50 feet.

RS422 and RS485 provide multidrop network communications where up to 255 controllers can communicate with a single computer at a distance of up to 4000 feet.

Hardware Setup (continued)

When shipped from the factory, the multidrop communications interface is set for RS422. If you are using RS485, two switches in the controller hardware must be positioned for the communications interface. Locate the switches on the bottom of the controller and position them as shown in Figure 9.1.

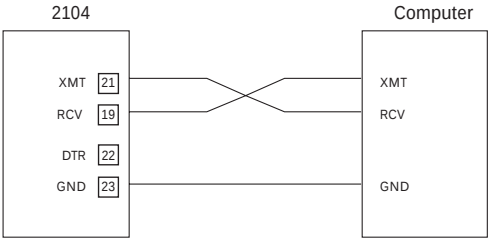
Figure 9.1
RS422/RS485
Communications
Switches



Digital Communications Wiring

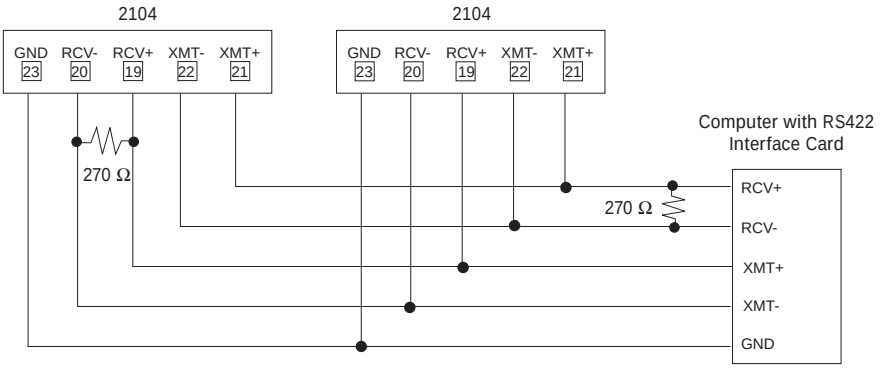
Wiring connections for the digital communications interface are made on terminals 9-13 using shielded serial interface cable.

Figure 9.2
RS232 Wiring
Connections



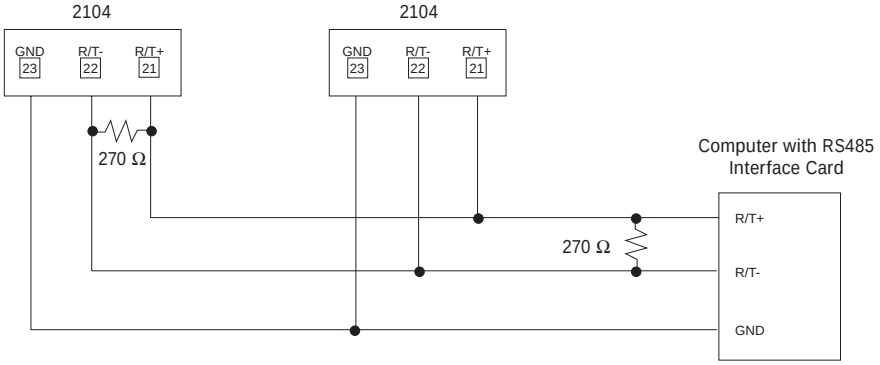
Note: The DTR output is always enabled when the 2104 power is on.

Figure 9.3
RS422A Wiring Connections (4-wire)



Note: 270 Ω resistors recommended across receive line on computer and last controller.

Figure 9.4
RS485 Wiring Connections (2-wire)



Note: 270 Ω resistors recommended across receive line on computer and last controller.

Digital Communications Programming and Setup

All programmed selections are made on the dig PAGE of the controller.

This setup PAGE appears only if the controller is equipped the digital Communications option.

Digital Communications Page: dig PAGE

MENU	Description	Available Settings	Security
digt	Mode Selection	OFF = Disabled CPiF = Computer Interface LinE = ASCII Line	C
bAud	Baud Rate	1200 2400 4800 9600 19.2K	
Addr	Address	1 to 255	

In this section you will find calibration instructions for calibrating:

- *Sensor Input*
- *Remote Setpoint Input*
- *Analog Output*

Instructions are also given for:

- *Factory Calibration Recovery*
- *Calibration Offset*

When is Calibration Required?

The 2104 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)

Important Calibration Notes

1. Disconnect load power when calibrating or disable the control output using the AUX pushbutton.
2. RTD 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.
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 menu LocK on the Ctrl PAGE.

Sensor Input Calibration

The sensor input of the 2104 can be calibrated using an appropriate sensor simulator and the Sensor Calibration menu on the Input Page.

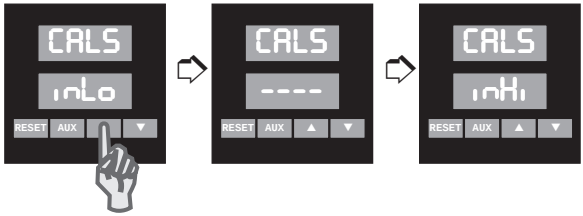
1. Connect the sensor simulator to the sensor input terminals.
2. Go to menu CALS. The lower display will show inLo, indicating that you should first calibrate the sensor low end.

Sensor Input Calibration (continued)

3. Adjust the simulator to output the low end of the selected sensor range. Sensor minimum ranges are:

Sensor	°F	°C
J T/C	-100	-73
K T/C	-300	-184
T	-350	-212
E	-100	-73
R	0	-18
S	0	-18
B	50	10
RTD	48.46Ω	
rtd (0.1°)	70.98Ω	
4-20mA	4mA	
0-5 Vdc	0 Vdc	
1-5 Vdc	1 Vdc	

4. Wait 30 seconds for the electronics to fully stabilize. Press ▲. Dashes will appear in the lower display while the controller calibrates the low end of span.

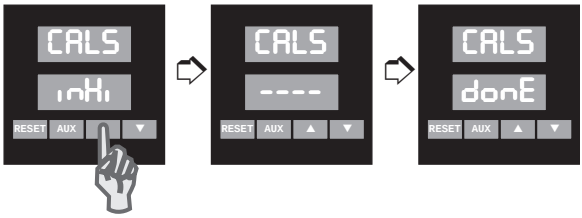


5. When the controller prompts inHi in the lower display, adjust the sensor simulator to output the high end of the currently selected sensor span. Sensor maximum ranges are:

Sensor	°F	°C
J T/C	1400	760
K T/C	2400	1316
T	750	399
E	1100	593
R	3200	1760
S	3200	1760
B	3300	1816
RTD	293.49Ω	
rtd (0.1°)	275.04Ω	
4-20mA	20mA	
0-5 Vdc	5 Vdc	
1-5 Vdc	5 Vdc	

Sensor Input Calibration (continued)

6. Wait 30 seconds for the electronics to stabilize. Press ▲. Dashes will appear in the lower display while the controller calibrates the high end of span. When finished, the controller will display donE.



7. Press RESET to exit calibration.

Remote Setpoint Input Calibration

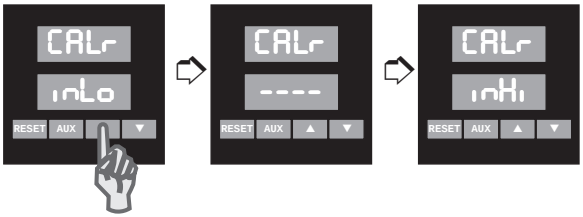
The Remote Setpoint Input is calibrated using an appropriate 4-20mA or 1-5 Vdc simulator. Calibration is performed in the menu CALr on the Input Page.

1. Connect the simulator to the remote setpoint input terminals.

2. Go to menu CALr. The lower display will show inLo, indicating that you should first calibrate the input low end (4mA or 1 Vdc).

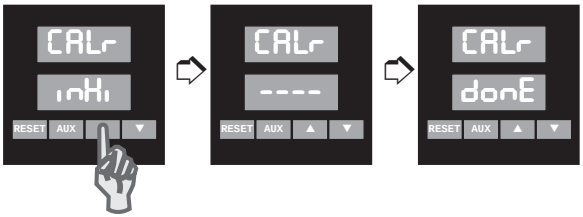
Remote Setpoint Input Calibration (continued)

3. Adjust the simulator to output the low end of the selected range. Wait 30 seconds for the electronics to fully stabilize. Press ▲. Dashes will appear in the lower display while the controller calibrates the low end of span.



4. When the controller prompts inHi in the lower display, adjust the simulator to output the high end of the currently selected input span (20mA or 5 Vdc).

5. Wait 30 seconds for the electronics to stabilize. Press ▲. Dashes will appear in the lower display while the controller calibrates the high end of span. When finished, the controller will display donE.



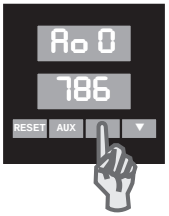
6. Press RESET to exit calibration.

Analog Output Option Calibration

The Analog Output signal is calibrated using an appropriate current or voltage meter. Calibration is performed in the two analog output calibration menus (Ao 0 and Ao 5) on the Input Page.

1. Connect the meter to the analog process output terminals. To calibrate the analog output, the output must be forced to the low end of span. If the setpoint is selected for transmission (Ctrl PASE, Aout = ASP) this can be done by adjusting the setpoint to the low end of span (i.e. J T/C = -100°F).

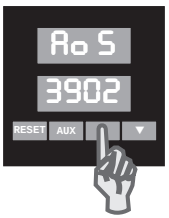
2. Go to menu Ao 0. Adjust the Analog Output (using ▲ and ▼) until the meter reads 4mA or 1.000 Vdc.



Note: The number displayed in the lower display page is for reference only.

3. Go to menu Ao 0 = ASP and adjust the setpoint to the high end of span (i.e., for J T/C = 1400°F).

4. Go to menu Ao 5. Adjust Analog Output (using ▲ and ▼) until the meter reads 20mA or 5.000 Vdc.

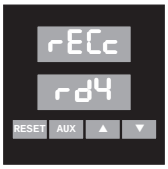


5. Press and hold RESET for 3 seconds to exit calibration mode.

Factory Calibration Recovery

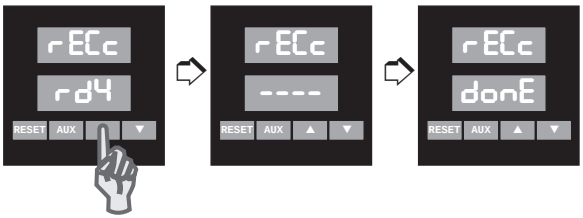
This option allows you to return the controller to its factory calibration settings in the event that it is severely out of calibration due to poor technique or unauthorized calibration. Although the factory calibration settings are recovered, this does not guarantee original calibration accuracy. The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

Factory Calibration Recovery is performed on the inPt PAGE, menu rECc.



To reestablish the factory calibration constants:

1. Disconnect load power.
2. Go to menu rECc and press ▲. The controller will automatically recalibrate.



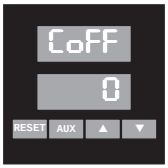
3. The lower display cycles from “----” to “donE”. Press RESET to exit the calibration mode.

Display Calibration Offset

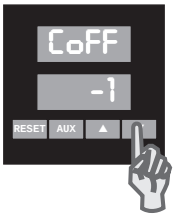
If an offset on the temperature reading is desired, the Display/Calibration Offset menu may be used. In some applications, this offset may be desired to match another instrument or an inferred temperature in another part of the system.

To establish the calibration offset:

1. Go to menu CoFF on the Input Page.



2. Use ▲ and ▼ to set the calibration offset, adjustable from -100 to 100°F.



Section 11
Specifications

Control Modes	
Automatic	On/Off Proportional (P) PID-Proportional with Integral and/or Derivative (PID, PI, PD) PID + Fuzzy Logic Heat/Cool (Dual PID)
Control Adjustments	
Control Setpoint	Sensor Range
Setpoint Limits	Sensor Range
Deadband	1 to 100°F
Proportional Band	Sensor Range
Manual Reset	-99.9 to 99.9
Automatic Reset	0.00 to 99.99 repeats per minute
Rate	0 to 500 seconds
Output Cycle Time	0.1 to 60.0 seconds
Output Limit	0.0 to 100.0%
Open Sensor & Out of Range	
Output Command	0.0 to 100.0%
Display Offset	-100 to 100°F
Heat/Cool Adjustments	
Output Offsets	0 to 100% of Proportional Band
Cooling Medium	Air, Water or Oil
Alarm Adjustments	
Setpoints	High and Low Settings for each Alarm Output
Alarm Types	Absolute: High, Low and High/Low Tracking: + Deviation, - Deviation and +/- Deviation
Relay Action	Latching or Non-Latching, Energized or De-Energized
Alarm Deadband	Adjustable, 0 to 100°F
Alarm Inhibit	On Power-Up, Enabled or Disabled
Control/Alarm Outputs	Total of five (5) Control/Alarm outputs possible
Relay	Relay—Form A contacts, 1.0 Amps at 120/230 Vac (resistive)
Solid State Relay Drive	24 Vdc nominal at 40mA
Triac	1 Amp continuous, 10 Amp in-rush, at 120 or 230 Vac
Current/Voltage	4 to 20mA into 0 to 800Ω, field changeable to 1-5 Vdc
Output #5 (Optional)	Relay—N.O. Form C contact, 5A at 120 or 2.5A at 230 Vac (resistive)
Sensor Input	Field selectable Thermocouple, RTD, Current or Voltage
Input Update Rate	2 Samples per Second

Input Specifications	Range °F	Range °C	Accuracy @ 77°F ambient
J T/C	-100 to 1400	-73 to 760	± 0.2% of sensor span
K T/C	-300 to 2400	-184 to 1316	± 0.2% of sensor span
T T/C	-350 to 750	-212 to 399	± 0.2% of sensor span for PV > -80°C ± 0.4% of sensor span for PV < -80°C
E T/C	-100 to 1100	-73 to 593	± 0.2% of sensor span
R T/C	0 to 3200	-18 to 1760	± 0.4% of sensor span
S T/C	0 to 3200	-18 to 1760	± 0.4% of sensor span
B T/C	50 to 3300	10 to 1816	± 0.4% of sensor span for PV > 538°C
100Ω Pt RTD (α = .00385)	-200 to 1000	-128 to 538	± 0.2% of sensor span
rtdt (0.1° res.)	-99.9 to 899.9	-73.3 to 432.1	± 0.2% of sensor span
4-20mA	-500 to 5000 (programmable)		± 0.2% of sensor span
0-5 Vdc	-500 to 5000 (programmable)		± 0.2% of sensor span
1-5 Vdc	-500 to 5000 (programmable)		± 0.2% of sensor span

Transmitter Power	
+24 Vdc Output	+24 Vdc ±20% at 50mA maximum
Ramp/Soak Programming	
Intervals	16 intervals
Loops	1 loop, 0-255 times or continuous
Event Outputs	Up to 3
Guaranteed Soak	
Differential	Off, 1°F to sensor span
Time Units	Seconds, Minutes, Hours (1 second to 99.99 hours/segment)
Readout Stability	
J, K, E Thermocouple	±1°F/10°F change in ambient temperature
T Thermocouple	±2°F/10°F change in ambient temperature for sensor temperature > -80°C ±5°F/10°F change in ambient temperature for sensor temperature < -80°C
R, S, B Thermocouple	±2°F/10°F change in ambient temperature
RTD	±0.5°F/10°F change in ambient temperature
4-20mA, 1-5Vdc	±0.05% of span / 10°F change in ambient temperature
Open Sensor and Out-of-Range Conditions	Programmable control action with display indicating condition "OPEN SENS"
Remote Setpoint Input	
Input Signal	4-20mA, 250Ω Input Impedance 1-5 Vdc, 110kΩ Input Impedance Voltage or Current Field Selectable via switch
Range	Programmable over selected Sensor Span
Accuracy	±0.3% of Sensor Span (initial accuracy) at 75°F ambient temperature and rated line voltage. field calibrate to ±0.2% of Sensor Span

Digital Input	Accepts dry-contact closure
Analog Output Option	
Assignable Functions	Process Variable Active Setpoint Output #1 Command Output #2 Command
Output Signal	4-20mA into 0-800Ω load 1-5 Vdc into 100KΩ or greater load Selectable via DIP switch
Range	Programmable over selected sensor span for retransmission of Process Variable and Active Setpoint, fixed to 0 to 100% for transmission of output commands
Accuracy	±0.2% of programmed span, ±1 LSD
Digital Communications (Optional)	
RS-232	Single-drop, isolated
RS-422/485	Multi-drop, isolated, field selectable by switch
Baud rates	1200, 2400, 4800, 9600, 19.2K
Protocols	ASCII Line, Computer Interface
Instrument Power	100 to 240 Vac, +10%, -15%; 12 to 24 Vac/Vdc, ±10%; 50 to 60 Hz
Operating Environment	32 to 150°F (0 to 65°C) ambient temperature, relative humidity less than 95%, non-condensing
Dimensions	
Overall	3.8 x 3.8 x 4.75 inches (96 x 96 x 121mm)
Depth Behind Projection	4.0 inches (102 mm)
Front Panel Projection	0.75 inches (19 mm)
Panel Cutout	3.6 x 3.6 inches (92 mm x 92 mm)
Case Material	High Impact, Black ABS Plastic
Front Panel	NEMA 4X Construction
Influence of Line Voltage Variation	±0.1% of Sensor Span/10% change in nominal line voltage
Noise Rejection	
Common Mode Noise	140dB at 60 Hz
Series Mode Noise	±0.1% of Sensor Span with 300mV peak to peak, 50 or 60Hz series mode noise
RFI	Typically less than 0.5% of Sensor Span at a distance of 1 meter (3.1 feet) from transmitter (4W, 464Mhz)

Sensor Leadwire Effect

J Thermocouple	+1°F for 1000 Ft. of 18 AWG extension wire
K Thermocouple	+5°F for 1000 Ft. of 18 AWG extension wire
E Thermocouple	+4°F for 1000 Ft. of 18 AWG extension wire
R Thermocouple	+3°F for 1000 Ft. of 18 AWG extension wire
S Thermocouple	+3°F for 1000 Ft. of 18 AWG extension wire
B Thermocouple	+6°F for 1000 Ft. of 18 AWG extension wire
T Thermocouple	+1°F (temperatures > -80°C) +2°F (temperatures < -80°C)
RTD, 4-20mA, 1-5 Vdc	±0.1% of Sensor Span/20Ω balanced leadwire resistance

The following Troubleshooting Guide gives simple solutions to common problems, and explains the 2104's Error Messages. 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.

Note: A specific List of Loop Alarms and probable causes are given on pages 55-57.

Troubleshooting Guide

Symptom	Probable Cause	Correction
Power applied, display does not light and controller does not function	1. No power applied	1. Check power wiring and fusing 2. Power down and repower up
Display reads OPEN SENS	1. Open sensor 2. Out of calibration	1. Check sensor wiring (page 7) 2. Check sensor type selected at InPt PAGE, SEnS 3. Recover Factory Calibration (page 81) 4. Attach sensor simulator and verify calibration (page 76) 5. Check "Control Loop Protection" Alarm
Process does not heat up	1. No power being applied to the load	1. Verify output wiring (page 11) 2. Verify that load is not open and output jumpers are properly installed 3. Check "control type" entered at Ctrl PAGE, Cont (Heat, Cool or Heat Cool) 4. Check "output limit" entered on Out1/Out2 PAGE, OL1/OL2
Erratic operation	1. Intermittent sensor connections 2. Controller failure (internal electronics)	1. Check sensor wiring or substitute sensor simulator 2. Power down and repower up 3. Contact factory

continued on next page

Troubleshooting Guide

Symptom	Probable Cause	Correction
Process not in control	1. Incorrect "control action" selected 2. Not tuned correctly	1. Check "control type" entered Ctrl PAGE, Cont 2. See Self-Tuning and PID settings, Ctrl PAGE
Instrument continually goes through power-up reset	1. Internal electronic failure 2. Drastic power line anomalies	1. Contact factory
Err3 displayed with PAGE in lower display	1. EEPROM failed redundancy check	1. Power down and back up to retest EEPROM 2. Set controller to Level D (736) Security Code. 3. Go to PAGE shown. Use RESET pushbutton to scroll through all menus. Readjust any settings that appear incorrect. After scrolling through all menus, error will clear.
Err4 displayed	1. A to D electronics failure	1. Power down and up to reset 2. Consult factory
tErr flashing on upper or lower display	1. Self-tune was enabled, but unable to successfully tune because: a. process could not get 50°F below setpoint (for heating) or 50° above setpoint (for cooling) in 30 minutes b. over a 10 hour period, the process has not changed enough to initiate turning c. process went in and out of sensor range during tune. d. 2104 is unable to calculate PID parameters	1. Press RESET to clear error. Previous PID parameters are retained 2. Consult factory
LooP error	See pages 55-57	1. Press RESET to clear error 2. Verify wiring and external devices

Warranty

Chromalox warrants only that the Products and parts manufactured by Chromalox, when shipped, and the work performed by Chromalox when performed, will meet all applicable specification and other specific product and work requirements (including those of performance), if any, and will be free from defects in material and workmanship under normal conditions of use. All claims for defective or nonconforming (both hereinafter called defective) Products, parts or work under this warranty must be made in writing immediately upon discovery, and in any event, within three (3) years from delivery, provided, however all claims for defective Products and parts must be made in writing no later than thirty-six (36) months after shipment by Chromalox. Defective and nonconforming items must be held by Chromalox's inspections and returned to the original f.o.b. point upon request. THE FOREGOING IS EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES WHATSOEVER, EXPRESSED, IMPLIED AND STATUTORY, INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

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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. It should appear on the exterior of the shipping carton and on the shipping documents. 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

Appendix 1
PAGE/MENU Tables

Setup Page	PAGE Name	PAGE Contents
dISP	Display	Allows you to monitor any of 11 real time variables in the lower digital display: process variable; setpoint; outputs; timers and alarm status. This is useful during troubleshooting or brief trending periods. Values on this page are for display only and cannot be changed on this PAGE.
Ctrl	Control	Security Lock Setpoints Self Tune PID1 and PID2 Control Parameters Manual Reset Fuzzy Logic Output Commands Control Loop Protection (CLP) Auto/Manual Disintegration Timer Ramp Rate Controller Type Cooling Medium Event/Digital Function Auxiliary Pushbutton Function Analog Output assignment Ramp/Soak User Selected Security Code
inPt	Input	Sensor Type Display Units Display/Calibration Offset Setpoint Low Limit Setpoint Upper Limit
ScAL	Custom Scaling	Analog Input Decimal Points Analog Input Low Analog Input High Analog Output High Remote Setpoint Input Low Remote Setpoint Input High
Out1	Output #1	Output #1 Cycle Time Output #1 Limit Heat Offset
Out2	Output #2	Output #2 Cycle Time Output #2 Limit Heat Offset

Security Levels

See pages 26-27 for details.

Security Levels and PAGE/MENU Contents

Level	Code	Description
A	---	Display Page and Security Lock
B	123	Setpoint and Auxiliary Setpoint
C	458	Settings for: Control Input Ramp/Soak Digital Communications
D	736	Calibration Security Codes

Security Codes

Security Codes

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

See pages 35-37 for details.

Control Page

Menu	Description	Available Settings	Factory Settings	Security
LocH	Security Lock	0 to 9999	458	A
SP	Setpoint	Instrument sensor span	Span Low	B
AuSP	Auxiliary SP	Instrument Sensor Span	Span Low	
tunE	Self Tune	OFF = Self tuning disabled PrUP = Powerup tuning BEGn = Begin tuning	OFF	C
Pb1	Proportional Band 1	0°F to sensor range	25°F	
Ar1	Automatic Reset 1	0.00 to 99.99 repeats/minute	0.10	
rAt1	Rate 1	0 to 500 seconds	10	
db1	Dead Band 1	1 to 100°F 0.01 to 6.25% span for analog inputs	5°F	
Pb2	Proportional Band 2	0°F to sensor range	25°F	
Ar2	Automatic Reset 2	0.00 to 99.99 repeats/minute	0.10	
rAt2	Rate 2	0 to 500 seconds	10	
db2	Dead Band 2	1 to 100°F 0.01 to 6.25% span for analog inputs	5°F	
OFSt	Manual Reset	-99.9 to 99.9	0.0	
FL	Fuzzy Logic	OFF = Disabled On = Enabled	On	
Orn9	Open Sensor Output Command	For Heat/Cool Control, adjustable: -100.0 to 100.0%: -100.0 to -0.1 for cooling 0.1 to 100.0 for heating	0.0%	
LooP	Control Loop Protection	OFF, 0.1 to 999.9 minutes	OFF	
Auto	Auto/Manual Disintegration Timer	0 to 100 seconds	10	
rrAt	Ramp Rate	OFF	OFF	

Control Page

See pages 35-37 for details.

Control Page (continued)

Menu	Description	Available Settings	Factory Settings	Security
Cont	Controller Type	HEAt = Reverse Acting Output Controller CooL = Direct Acting Single Output Controller HtCl = Heat/Cool Controller	HEAt	C
CooL	Cooling Medium	Pid2 = Uses PID2 settings for cooling Air = Air Cooling Oil = Oil Cooling H2O = Water Cooling	Pid2	
rSP	Remote Setpoint Enable	OFF On	OFF	
Ent1	Event/Digital Function	nonE = Disabled Pid2 = PID2 enable AuSP = Auxiliary SP enable rSP = Remote SP enable Outd = Output disable rS = Ramp/Soak Auto = Auto/Manual Air = Alarm Reset	nonE	
Au	Auxiliary Pushbutton Function	nonE = Disabled Pid2 = PID2 enable AuSP = Auxiliary SP enable rSP = Remote SP enable Outd = Output disable Auto = Auto/Manual	nonE	
Aout	Analog Output Assignment	nonE = Disabled Proc = Process Variable ASP = Active Setpoint Out1 = Control Output ! Out2 = Control Output 2	ASP	
rSEn	Ramp/Soak	OFF On	OFF	
CodE	User Selected Security Code	0-122 = Level A 123-457 = Level B 458-735 = Level C 736-999 = Level D	0	D

See pages 41-45 for details.

Ramp/Soak Page

MENU	Description	Available Settings	Factory Settings	Security
unit	Time Units	SEc = seconds (1 to 9999) Min = minutes (0.1 to 999.9) hr = hours (0.01 to 99.99)	SEc	C
StbY	Standby Setpoint	Instrument Sensor Span	Span Low	
int1	Interval 1 Time	see Time Units Menu (above)	0	
SP1	Setpoint 1 • •Intervals 2-15 •Time and Setpoint	Instrument Sensor Span	Span Low	
in16	Interval 16 Time	see Time Units Menu (above)	0	
SP16	Setpoint 16	Instrument Sensor Span	Span Low	
Cont	Continuous Program	OFF On	OFF	
Fro	Loop from the end of interval	1 to 16	1	
to	To the beginning of interval	1 to 16	1	
no	Number of times	0 to 9999	0	
SbEt	Standby Events	OFF = All off E3 = Event Output 3 On E4 = Event Output 4 On E43 = Event Outputs 4 & 3 On E5 = Event Output 5 On E53 = Event Outputs 5 & 3 On E54 = Event Outputs 5 & 4 On E543 = Event Outputs 5, 4, 3 On	OFF	
i1E	Interval 1 Events	OFF = All off E3 = Event Output 3 On E4 = Event Output 4 On E43 = Event Outputs 4 & 3 On E5 = Event Output 5 On E53 = Event Outputs 5 & 3 On E54 = Event Outputs 5 & 4 On E543 = Event Outputs 5, 4, 3 On	OFF	
i16E	Interval 16 Events	same as above	OFF	
GSdb	Guaranteed Soak differential	OFF, 1°F to sensor range	0°F	

Input Page

See page 38 for details.

Input Page

MENU	Description	Available Settings	Factory Settings	Security
SEnS	Sensor Type	Sensor Type selected here must agree with dip switch settings. J = J Thermocouple K = K Thermocouple T = T Thermocouple E = E Thermocouple R = R Thermocouple S = S Thermocouple B = B Thermocouple RTD = 100Ω Pt RTD (a = .00385) 4-20 = 4 to 20mA 0-5 = 0 to 5 Vdc 1-5 = 1 to 5 Vdc rtdt = 100Ω Pt RTD (0.1° resolution)	J	C
unit	Display Units	none = no units °F = Degrees Fahrenheit °C = Degrees Celsius	°F	
CoFF	Display/ Cal. Offset	-100°F to 100°F	0	
SPLL	Setpoint Low Limit	Instrument Sensor Span	Span Low	
SPUL	Setpoint Upper Limit	Instrument Sensor Span	Span High	
CALS	Sensor Calibration	InLo InHi donE	InLo	D
CALr	Remote Setopint Calibration	InLo InHi donE	InLo	
AoO	Analog Output Zero Calibration	O to 4095		
AoS	Analog Output Span Calibration	0 to 4095		
rECc	Factory Calibration Recovery	rdY = Ready --- = Wait donE = Finished		
FiLt	Digital Filter	0 to 60 seconds		
hPrc	High (max.) Process Input	Instrument Sensor Span		
LPrc	Low (min.) Process Input	Instrument Sensor Span		
hiA	High (max.) Ambient Temp.	Instrument Sensor Span		
LoA	Low (min.) Ambient Temp.	Instrument Sensor Span		

Custom Scaling Page

See page 39 for details.

Custom Scaling Page

MENU	Description	Available Settings	Factory Settings	Security
dP	Analog Input Decimal Pts.	0 = none 1 = 123.4 2 = 12.34 3 = 1.234	1	C
AinL	Analog Input Low	-500 to 5000	0.0	
AinH	Analog Input High	-500 to 5000	100.0	
AotL	Analog Output Low	-500 to 5000	Span Low	
AotH	Analog Output High	-500 to 5000	Span High	
rSPL	Remote SP Input Low	-500 to 5000	Span Low	
rSPH	Remote SP Input High	-500 to 5000	Span High	

Output #1 Page

See page 39 for details.

Output #1 Page

MENU	Description	Available Settings	Factory Settings	Security
Cyc1	Output #1 Cycle Time	0.0 to 60.0 seconds	1.0*	C
OL1	Output #1 Limit	0.0 to 100.0%	100.0%	
HoFF	Heat Offset	0°F to PB1 setting	0	

* For 2104-A (voltage or current output) cycle time must be set to 0.0.

Output # 2 Page

See page 39 for details.

Output #2 Page

MENU	Description	Available Settings	Factory Settings	Security
C4c2	Output #2	0.0 to 60.0 seconds 0.0 = Voltage/Current algorithm	1.0	C
OL2	Output #2 Limit	0.0 to 100.0%	100.0%	
HoFF	Heat Offset	0°F to PB1 setting	0	

Output # 3 Page

See page 50 for details.

Output #3 Page

MENU	Description	Available Settings	Factory Settings	Security
t4P3	Output #3 Type	OFF = Disabled Alr = Alarm Output Ent = Event Output (Setup Event Output parameters on Ramp/Soak Page)	OFF	C
Alr3	Alarm #3 Type	nonE = Disabled (off) Hi = High Alarm Lo = Low Alarm HiLo = High-Low Alarm PdE = Plus Deviation Alarm -dE = Minus Deviation Alarm dE = Plus/Minus Deviation Alarm LooP = Control Loop Protection Alarm	nonE	
rL33	Alarm #3 Relay Action	ndE = Normally de-energized non-latching nE = Normally energized non-latching ndEL = Normally de-energized latching nEL = Normally energized latching	ndE	

Output # 3 Page

See page 50 for details.

Output #3 Page (continued)

MENU	Description	Available Settings	Factory Settings	Security
AoL3	Alarm #3 Low Setpoint	Instrument Sensor Span	Span Low	C
AhI3	Alarm #3 High Setpoint	Instrument Sensor Span	Span High	
db3	Output #3 Dead Band (Alarm Hysteresis)	0 to 100°F	1°F	
inh3	Alarm #3 Inhibit	OFF On	OFF	

Output # 4 Page

See page 51 for details.

Output #4 Page

MENU	Description	Available Settings	Factory Settings	Security
t4P4	Output #4 Type	OFF = Disabled AIr = Alarm Output Ent = Event Output (Setup Event Output parameters on Ramp/Soak Page)	OFF	C
AIr4	Alarm #4 Type	nonE = Disabled (off) Hi = High Alarm Lo = Low Alarm HiLo = High-Low Alarm PdE = Plus Deviation Alarm -dE = Minus Deviation Alarm dE = Plus/Minus Deviation Alarm LooP = Control Loop Protection Alarm	nonE	

Output # 4 Page

See page 51 for details.

Output #4 Page (continued)

MENU	Description	Available Settings	Factory Settings	Security
rL44	Alarm #4 Relay Action	ndE = Normally de-energized non-latching nE = Normally energized non-latching ndEL = Normally de-energized latching nEL = Normally energized latching	ndE	C
Ao14	Alarm #4 Low Setpoint	Instrument Sensor Span	Span Low	
Ah14	Alarm #4 High Setpoint	Instrument Sensor Span	Span High	
db4	Output #4 Dead Band (Alarm Hysteresis)	0 to 100°F	1°F	
inh4	Alarm #4 Inhibit	OFF On	OFF	

Output # 5 Page

See page 52 for details.

Output #5 Page

MENU	Description	Available Settings	Factory Settings	Security
t4P5	Output #5 Type	OFF = Disabled Alr = Alarm Output Ent = Event Output (Setup Event Output parameters on Ramp/Soak Page)	OFF	C
Alr5	Alarm #5 Type	nonE = Disabled (off) Hi = High Alarm Lo = Low Alarm HiLo = High-Low Alarm PdE = Plus Deviation Alarm -dE = Minus Deviation Alarm dE = Plus/Minus Deviation Alarm LooP = Control Loop Protection Alarm	nonE	

Output # 5 Page

See page 52 for details.

Output #5 Page (continued)

MENU	Description	Available Settings	Factory Settings	Security
rL45	Alarm #5 Relay Action	ndE = Normally de-energized non-latching nE = Normally energized non-latching ndEL = Normally de-energized latching nEL = Normally energized latching	ndE	C
Ral 5	Alarm #5 Low Setpoint	Instrument Sensor Span	Span Low	
Rh15	Alarm #5 High Setpoint	Instrument Sensor Span	Span High	
db5	Output #5 Dead Band (Alarm Hysteresis)	0 to 100°F 0.00 to 6.25% for analog input	1°F	
inh5	Alarm #5 Inhibit	OFF On	OFF	

Digital Communications Page

See page 52 for details.

Digital Communications Page: d.9 PAGE

MENU	Description	Available Settings	Factory Settings	Security
d.9t	Mode Selection	OFF = Disabled CP.F = Computer Interface LinE = ASCII Line	CP.F	C
bAud	Baud Rate	1200 2400 4800 9600 19.2K	19.2K	
Addr	Address	1 to 255	1	

Display Page

The Display Page is for status only.
None of the settings can be changed.

See page 34 for details.

Display Page

MENU	Description	Displays	Security
Proc	Process Variable	Sensor Span	A
A SP	Active Setpoint	Sensor Span	
Out1	Output #1 Command	0.0 to 100.0%	
Out2	Output #2 Command	0.0 to 100.0%	
rSP	Remote Setpoint Input	Sensor Span	
rS	Ramp/Soak Status	OFF = Program not running run = Program running Hold = Program in hold StbY = Program in standby SS = Guaranteed soak	
int	Ramp/Soak Interval Number	0 - 16	
LEFt	Ramp/Soak Time Left in Interval	0.0 to 999.9 hr/min/sec	
LooP	Ramp/Soak Loops Remaining	0 - 9999	
AIr	Alarm Output Status	NonE = No alarms A3 = Alarm Output #3 A4 = Alarm Output #4 A43 = Alarm Outputs #4 and #3 A5 = Alarm Output #5 A53 = Alarm Outputs #5 and #3 A54 = Alarm Outputs #5 and #4 A543 = Alarms 5, 4 and 3	
Ent	Event Output Status	NonE = All off E3 = Event Output #3 E4 = Event Output #4 E43 = Event Outputs #4 and #3 E5 = Event Output #5 E53 = Event Outputs #5 and #3 E54 = Event Outputs #5 and #4 E543 = Events 5, 4 and 3	

Index

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