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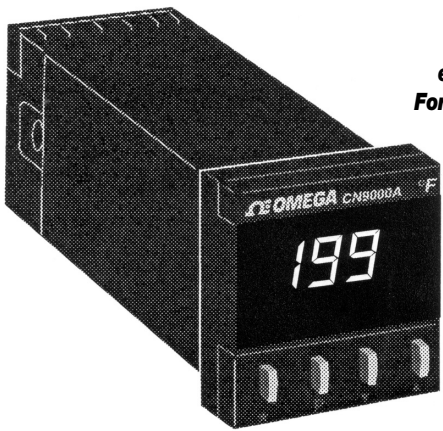

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C9000A SERIES

Autotune Temperature Controller

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SECTION 1 INTRODUCTION

1.1 GENERAL DESCRIPTION

The OMEGA® CN9000A Series Miniature Autotune Microprocessor Controllers are designed for accurate, precise temperature control. They feature high accuracy and reliability, as well as sophisticated PID or Autotune PID with approach control (PDPI) for optimal control during start-up and steady-state operation.

The CN9000A controllers feature models with user selectable inputs from nine thermocouple types or 2-wire RTD, or models with 3-wire RTD input. These units are °C/°F switchable, offer a 0.1° resolution up to 200°, and the second setpoint and output are standard. The controller can also be programmed to accept linear voltage signals up to 20 mV.

The CN9000A features advanced PDPI control, which enables the unit to suppress overshoot, and allows the process warm-up to be tuned independently from the steadystate operating conditions. For other processes, a user may select PiD (Proportional-Integral-Derivative), PD (Proportional-Derivative). Proportional, or On/Off control.

The CN9000A controllers are well suited to a broad range of applications, and are easy to install and operate. For most applications, the user need only select the desired input type by using the front pushbuttons. The CN9000A is ‘pre-set’ for control parameters which are suitable for most applications. These pre-set (or default) parameters can be changed by the operator at any time, in order to fine-tune the controller to an individual process.

The controller can easily be used in the Autotune Mode, allowing the microprocessor to attempt to calculate the optimum PID parameters.

Selection of all operational controls is made through the three keys on the front panel of the CN9000A, with the display prompting the user for each step. After the parameters have been set, they can be 'locked-in' by removing the jumper located under the front bezel. The user may select the control mode and parameters, the display resolution (1° or 0.1°) and the units (°C/°F). The user may also utilize the ranging feature of the instrument, which limits the range in which a setpoint may be chosen, or lock-out an operator from changing the setpoint.

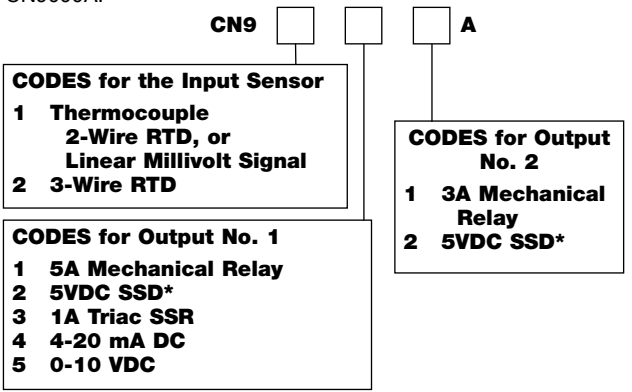
The second setpoint (or output) of the CN9000A may have proportional or on/off control. The second setpoint is set as a deviation from the primary setpoint. Cycle time, proportional band and on/off deadband are all set independently of the primary setpoint (SP1).

The CN9000A display has a large 3½ digit green LED readout, with auxiliary indicators for output 1 and output 2, and three LEDs to indicate deviation from setpoint. The microprocessor, in addition to automatic processing of key calculations, holds the data in non-volatile memory-with the ability to retain data for up to 10 years with no power.

1.2 AVAILABLE MODELS

Refer to Figure 1-1 and Table 1-1 for the CN9000A model number information.

Refer to Figure 1-2 and Table 1-2 for the plug-in replacement output board and socket model number information for the CN9000A.



*SSD output is a Solid State Driver (5 Volt DC Pulse) designed to be used with a DC controlled solid state relay such as OMEGA's model number SSR240DC45 relay.

Figure 1-1. CN9000A Model Number Information

TABLE 1-1
CN9000A MODEL NUMBER DETAILS

MODEL	INPUT	OUTPUT 1	OUTPUT 2
CN9111A	Thermocouple 2-Wire RTD Linear Millivolt Signal	Relay	Relay
CN9112A		Relay	5VDC SSD*
CN9121A		5VDC SSD*	Relay
CN9122A		5VDC SSD*	5VDC SSD*
CN9131A		1 A Triac	Relay
CN9141A		4-20 mA	Relay
CN9151A		0-10 VDC	Relay
CN9211A	3-Wire RTD	Relay	Relay
CN9212A		Relay	5VDC SSD*
CN9221A		5VDC SSD*	Relay
CN9222A		5VDC SSD*	5VDC SSD*
CN9231A		1 A Triac	Relay
CN9241A		4-20 mA	Relay
CN9251A		0-10 VDC	Relay
For 230 VAC, add "-230VAC" at the end of the part number.			

**SSD output is a Solid State Driver (5 Volt DC Pulse) designed to be used with a DC controlled solid state relay.*

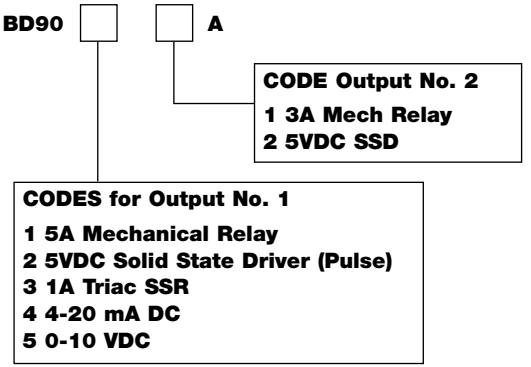


Figure 1-2. CN9000A Series Replacement Output Board Numbering Information

TABLE 1-2
CN9000A REPLACEMENT OUTPUT BOARD DETAILS

MODEL	OUTPUT 1	OUTPUT 2
BD9011A	Relay	Relay
BD9021A	5VDC SSD	Relay
BD9012A	Relay	5VDC SSD
BD9022A	5VDC SSD	5VDC SSD
BD9031A*	1 Amp Triac SSR	Relay
BD9041A*†	4-20 mA DC	Relay
BD9051A*†	0-10 VDC	Relay

**Requires that BD9021A is already installed in the controller.*
†For 230 VAC models, add "-230VAC" to the part number

SECTION 2 INSTALLATION

2.1 UNPACKING

Remove the Packing List and verify that you have received all equipment. If there are any questions about the shipment, please call the OMEGA Customer Service Department at 1-800-622-2378 or (203) 359-1660.

Upon receipt of shipment, inspect the container and equipment for any signs of damage. Note any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE

The carrier will not honor any claims unless all shipping material is saved for their examination. After examining and removing contents, save packing material in the event reshipment is necessary.

2.2 CAUTIONS AND MOUNTING INSTRUCTIONS

READ THESE CAUTIONS BEFORE YOU INSTALL, OPERATE, OR SERVICE YOUR CN9000A

CAUTION

For safe use apply good engineering practices applicable to all products of this type.

INSTALLATION CAUTIONS

1. Install in a grounded metal enclosure, prevent live parts from being touched and ground sensor sheaths to avoid possible shock hazard.
2. Wire according to the information in this manual and conform with the appropriate standards and regulations.

ALARM CAUTION

Output number 2 should not be used as an alarm in a safety circuit where damage or personal injury may be caused by equipment failure. A separate unit should be used, instead.

CONFIGURATION CAUTION

The controller functions are user selectable. It is therefore the user's responsibility to ensure that the controller configuration corresponds to the factory's requirements and is safe. Remove the parameter lock jumper to restrict tampering after configuration.

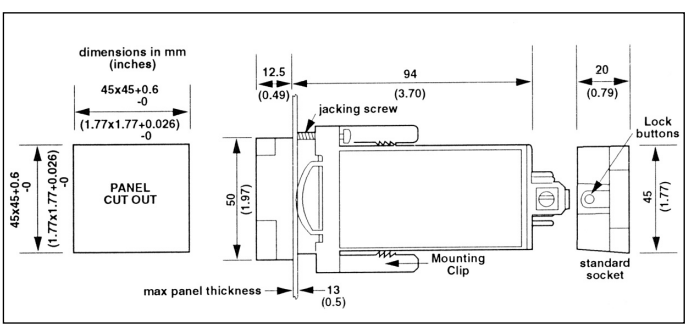
MOUNTING INSTRUCTIONS

The CN9000A is mounted in a panel through a 1.772" (45 mm) square $^{1}/_{16}$ DIN 43700 cutout using the speciai mounting clip provided (refer to Figure 2-1).

To install the CN9000A, remove the rear socket by pressing the lock buttons. Slide the controller into the panel cutout from the front. Slide the mounting clip back onto the controller from the rear. Press to home position until the clip holds the unit firmly in place. If necessary, the mounting can be further tightened using the jacking screws. Plug the rear socket back into place on the controller.

To remove the controller from the panel, pull the legs of the mounting clips away from the controller case to release the ratchet.

The minimum spacing for mounting several controllers is shown in Figure 2-2.



**To unplug socket, press in lock buttons and pull apart*

Figure 2-1. Controller Mounting and Panel Cutout Dimensions

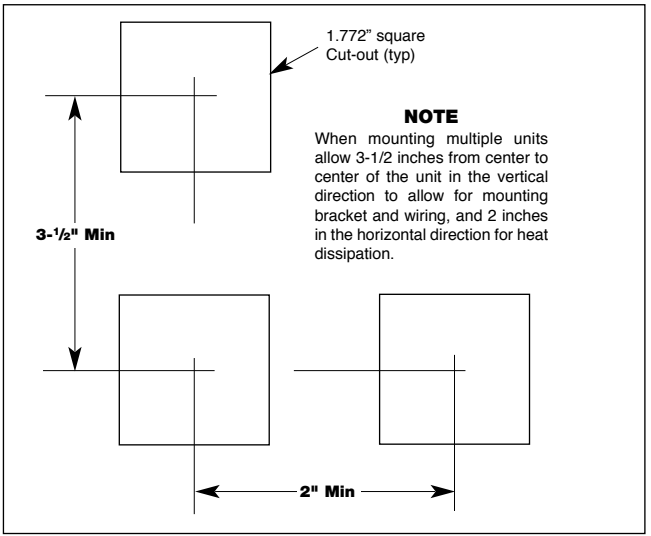


Figure 2-2. Mounting Multiple Units

2.3 WIRING

The CN9000A operates on either 115VAC ±15%, 50/60 Hz (std) or 230VAC ±15%, 50/60 Hz (selectable by changing internal jumpers-discussed in Section 7). The CN9000A outputs feature either the standard mechanical relay or the optional non-isolated 5VDC Solid State Driver pulse output (designed for operating an external DC SSR such as an OMEGA SSR240DC45). Three other optional outputs are available using a plug-in replacement combination socket. These outputs are a 1A Triac SSR, 0 to 10VDC, or a 4 to 20 mA DC output. They are described in Table 1-2.

Figure 2-3 shows the rear view of the controller and designates which signals connect to the terminals. The chart directly following Figure 2-3 details the actual connections.

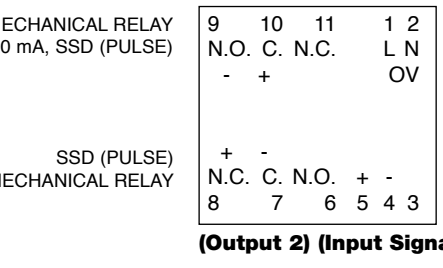


Figure 2-3. CN9000A, Rear View, Signal Connection Designations

TERMINAL DESIGNATIONS AND SIGNAL CONNECTIONS

1 AC Power, 115 VAC 50/60 Hz (230 VAC, optional)
2 AC Power, Neutral

---

3 RTD (black, if 3-wire RTD) (For T/C, do not use terminal.)
4 Thermocouple (-); or RTD (black if 3-wire RTD); or Neg. Voltage
5 Thermocouple (+); or RTD (red, if 3-wire RTD); or Pos. Voltage

---

6 Output 2 (SP2) Mechanical Relay Normally Open (N.O.)
7 Output 2 (SP2) Mechanical Relay Common (C.) or 5V Pulse (-)
8 Output 2 (SP2) Mechanical Relay Normally Closed (N.C.); or 5V Pulse (+)

---

9 Output 1 (SP1) Mech Relay N.O.; 1 A SSR N.O.; 5V Pulse (-); 0-10V (-); or 4-20 mA (-)
10 Output 1 (SP1) Mech Relay C.; 1A SSR C; 5V Pulse (+); 0-10 V (+); or 4-20 mA (+)
11 Output 1 (SP1) Mech Relay N.C.; or 1A SSR N.C.

CAUTION

Check side label on controller for supply voltage before wiring.

Your choice of thermocouple types J, K, T, E, R, S, N, B, J DIN, and the Pt100 2-wire RTD inputs are selectable via the keys on the CN91XXA version of the controller. The CN92XXA controller is configured to accept a 3-wire RTD input only. Figure 2-4 shows how to wire any of these sensor inputs to the controller.

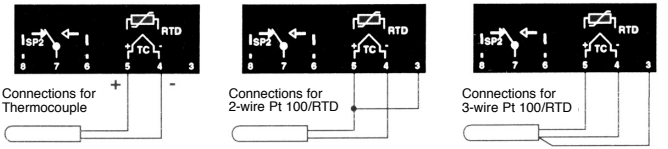


Figure 2-4. Thermocouple and RTD Input Wiring

2.4 TYPICAL WIRING DIAGRAMS

Figures 2-5 and 2-6 illustrate typical wiring of the CN9000A Controllers. (Standard controllers operate on 115VAC 50/60Hz. 230VAC operation is optional.)

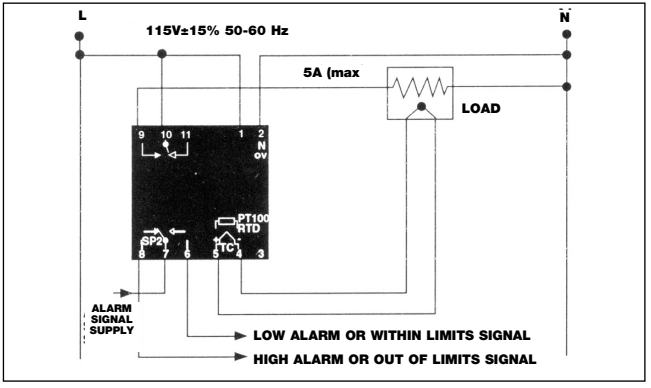


Figure 2-5. Wiring Heater with Alarms (Two Mechanical Relays-Model CN9111A)

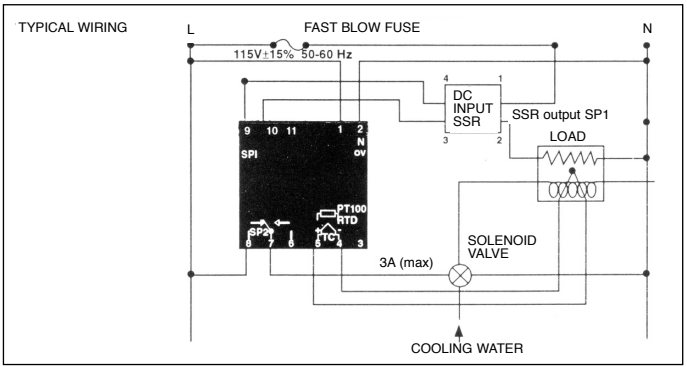


Figure 2-6. Heating and Cooling CN9121A [One DC Solid State Relay Driver for Heating (SP1), 3A Mechanical Relay for Cooling (SP2)]

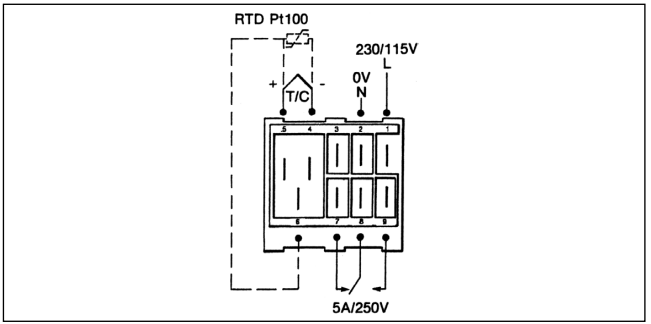


Figure 2-7. Wiring of single output controller CN9110A, CN9210A

NOTE

The CN9000A Series has been designed to be as immune as possible to electrical interference. However, electrical noise suppression may be required in some applications, particularly if the output of the controller is firing a contactor or coil. A noise suppression kit is available for use with 115VAC, OMEGA part no. 1821-101 (consists of an RC network or metal oxide varistor (MOV)).

SECTION 3 OPERATION

3.1 GENERAL CONSIDERATIONS

The CN9000A is pre-set for control parameters that are suitable for many applications. The CN9000A can be operated with the default (pre-set) settings, or the default settings can be overridden by more appropriate control modes and parameters and/or enabling of the second setpoint, by programming the CN9000A through the front panel keys. Refer to Table 3-1, Controls and Indicators and Table 3-4, Standard Functions .0 through .25.

The CN9000A allows the user to use autotune rather than the default settings. In the autotune mode, the controller will attempt to select the optimum PID settings.

3.2 CONTROLS AND INDICATORS

Figure 3-1 and Table 3-1 illustrate the controls and indicators of the CN9000A Series Controller.

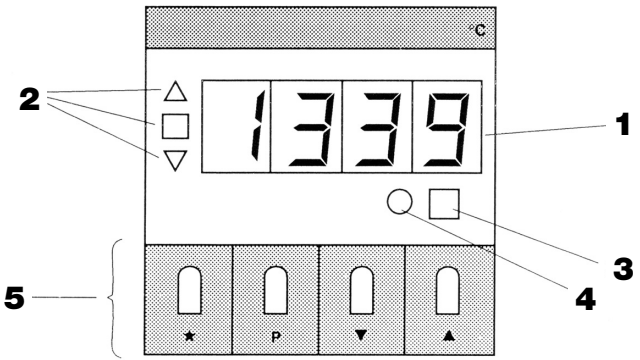


Figure 3-1. CN9000A Front Panel-Controls and Indicators

TABLE 3-1
CONTROLS AND INDICATORS

ITEM	CONTROL/INDICATOR	FUNCTION
1	LED Display	The four-digit display normally shows process temperature to 1°C or 1°F resolution (for example, 197°F). However, if the CN9000A is set for a tenth degree resolution (up to 200°), the display shows the temperatures in 0.1°C or 0.1°F increments (for example, 197.3°F). The display also shows the setpoint value (flashing) and the Function and Option numbers when in the Set-Up Mode. Functions are the available controller facilities (e.g., Derivative); Options are the available values for each Function (e.g., Derivative value-50 seconds). When in the Set-Up Mode, remember that the Function numbers are on the RIGHT and the Option numbers are on the LEFT of the floating decimal point.
2	Deviation Indicators	These three LEDs display the difference between set point and process temperatures in five steps, each one representing 2% of full scale value. Flashing ▲>3% above setpoint Steady ▲1%-3% above setpoint Steady ■±1% about setpoint Steady ▼1%-3% below setpoint Flashing ▼>3% below setpoint The error indicator can also be used in high resolution (±1% steps) or low resolution (±4% steps).

TABLE 3-1 (Cont'd)

ITEM	CONTROL/INDICATOR	FUNCTION	
		All three Error Indicator LEDs are on when unit is in Manual or Park Mode.	
3	SP1 Output Indicator	This LED is illuminated (green) when the SP1 output is ON.	
4	SP2 Output Indicator	This LED is illuminated (red) when the SP2 output is ON or OFF, depending on mode of operation. Refer to Function .31 in Table 3-6 for more details.	
5	Control Keys	★	When pressed, displays the SP1 temperature.
		★▲	Pressed simultaneously increases the SP1 temperature value.
		★▼	Pressed simultaneously decreases the SP1 temperature value.
		P	Selects Set-Up Mode (entry into the Function and Option commands -refer to Table 3-4). Display flashes, normal temperature control is maintained.
		▲or▼	When in the Set-Up Mode, increments the Function and Option numbers up or down.
		★	When in Set-Up Mode, changes the sub mode from Functions to Options and vice-versa.

NOTE: The Parameter lock jumper is located under the lower front bezel (discussed in Section 3.13).

3.3 DEFAULT (PRE-SET) SETTINGS

For ease of use in normal applications, the CN9000A has been pre-set with factory or Default settings (or Parameters). Section 3.5 discusses how to change these Default settings.

These pre-set Parameters enable the instrument to operate in the PID Control Mode, with a single set point and slow cycle relay output. This configuration should give good results where the heater is adequately rated and the control sensor is located reasonably close to it.

Default Settings (for SP1 only) are:

Proportional Time (Cycle Rate) = 20 seconds

Proportional Band (Gain) = 2.5% of Default full scale

Derivative Time (Rate) = 25 seconds

Integral Time (Reset) = 350 seconds

To use the controller with the Default settings requires only that the correct Option number of the sensor. selected from Table 3-3, Sensor Default Setpoint Range Table, be keyed into the instrument. Also, check that the instrument is set to either °C or °F, as required. (Refer to Function .22 in Table 3-4).
Also check that the desired control temperature is within the Setpoint Default range. Refer to Section 3.4.2.

3.4 GETTING STARTED

3.4.1 Selecting Sensor and Adjusting Setpoint

To operate unit:

Apply power. All LED segments will be briefly illuminated during the self-check routine, then the display will request sensor selection (from Table 3-3), i.e., the desired Option number for Function .16, and will not respond to any further instructions until this selection is made.

Refer to Table 3-2 for getting started with the commonly needed Default settings of the control parameters. Changing from the Default values will be covered in subsequent sections.

To operate with Autotune Settings, refer to Section 5.1 or Appendix B.

TABLE 3-2
OPERATION WITH DEFAULT SETTINGS

STEP	ACTION	DISPLAY
1 Install Unit. Power on. Check that display reads:	*Note: digits shown bold are flashing	☐ **0.** 1 6
NOTE If the display does not read 0.16 with the zero flashing, then the unit has already been programmed with a sensor type. Refer to Table 3-4 and step through to Function .16 and set proper sensor type. Note other functions may have to be changed as well.		
2 To key in the selected sensor type Example: OPTION 2. K-Type thermocouple (page 31, FN .16): Check that the display reads:	Press ▲ Twice	☐ **2.** 1 6
3 To store the selected thermocouple type into memory: The display now reads the sensor temperature, ex: ambient = 70°F.	Press P once	☐ ☐ 7 0
4 To key in the setpoint value: to increase the setpoint: to decrease the setpoint: (It should be noted that the digit rollover rate increases as arrow keys are held.) ex: selected setpoint = 250°F.	Press ★ and hold Press ▲ Press ▼	☐ ☐ ☐ 0 ☐ 2 5 0
When the keys in (4) above are released the unit will operate as a normal temperature controller. The square LED, is illuminated, showing the SP1 output is energized. To view the setpoint temperature:	Press ★	
To re-adjust the setpoint value at any time:	Repeat Step 4	

When the Default settings are not suitable for your application, the CN9000A can be tuned for optimum performance by the adjustment of control Parameters. Section 5 will provide the guidance needed to establish the appropriate settings.

Alternatively, the Autotune Option can be used to enable the controllers microprocessor to attempt to calculate the optimum PID Parameters. If you wish to use the Autotune Option, go to Section 5.1.2 and run Autotune AT.

3.4.2 Changing the Allowable Setpoint Default Range (Function .24)

The Default Range will limit the setpoint values. However, should a particular application require the use of additional controller features, for example: second setpoint output or tenth degree resolution, refer to Section 3.5, Parameter Adjustments. The instrument will indicate process temperatures over the full linearized range shown in Table 3-4, Function .16. The Default setpoint full scale (automatically selected by choice of sensor) may be altered to any value within the linearized band (Table 3-4, Function .16) by using the following procedure to adjust Function .24. (Refer to Section 3.5 for more details on adjusting Functions).

Steps 1 through 6 are used to change the upper limit of the setpoint range. Steps 7 through 10 are used to change the actual setpoint and check the value.

CAUTION

Ensure that the setpoint range maximum is compatible with safety requirements.

1. Press the P button (use blunt tool since the P key is a recessed button). The display shows "0.**0**" with the right most digit (function number) flashing.

2. Press ▲ 24 times (or until the CN9000A displays "- -**24**" with "**24**" flashing).

3. Press ★ to display the maximum allowable setpoint (for example, "**400**" with "**400**" flashing).

4. Press and hold in ★ Repeatedly press ▲ to increase value (while pressing ★) Repeatedly press ▼ to decrease value (while pressing ★).

5. Release ★ (and stop pressing ▲ or ▼ button).

6. Press the P button. The temperature is now displayed. The upper limit of the allowable setpoint has now been changed. The new allowable setpoint range can be checked by repeating Steps 1, 2, 3.

Steps 1-6 are repeated in Section 3.5.1.3 for your convenience.

7. **To change the setpoint** to the desired value, press ★ and hold in.

8. Press ▲ or ▼ to change the setpoint to the new value.

9. Release the ★ button. The temperature is now displayed.

10 Press the ★ button to check the setpoint value.

NOTE

If an attempt is made to set the setpoint outside of the setpoint range, the setpoint will be at the end of the range.

TABLE 3-3
SENSOR DEFAULT SETPOINT RANGE TABLE

Fn .16 Option	Type		Min/Max °C	Min/Max °F
1	J	Iron-Constantan	0-400	32-800
2	K	CHROMEGA®ALOMEGA®	0-400	32-800
3	N	Nicrosil-Nisil	0-400	32-800
4	R	Pt-13% Rh/Pt	0-1600	32-1999
5	S	Pt-10% Rh1Pt	0-1600	32-1999
6	T	Copper-Constantan	0-250	32-500
7	E	CHROMEGA®-Constantan	0-500	32-1000
8	J DIN	Iron-Constantan	0-400	32-800
9	Pt100	100 Ω Pt RTD(α=0.00385)	0-200	32-400
10	B	Pt-30% Rh/Pt-6% Rh	0-1600	32-1999

Note: If the Default setpoint range maximum is not suitable, it can be increased or decreased to any desired value within the linearized band

3.5 PARAMETER ADJUSTMENTS (STANDARD FUNCTIONS)

To change the CN9000A's Default Parameters to new parameter settings, refer to this section and Section 3.6. All adjustable parameters are held in memory.

There are two classes of Functions. Functions .0 through .25 are STANDARD FUNCTIONS that are used more often and are easily accessible to the user. Functions .26 through .50 are known as ADVANCED FUNCTIONS. They are not designed to be changed in the normal operation and should not be accessed except during setup by qualified personnel.

NOTES

Because the selection of tenth degree resolution (Function .18 Option 1), °C/°F selection (Function .22), and setpoint range adjustments influence the values of other settings and can have a fundamental effect on control characteristics, it is important that, when required, they should be made during initial set-up to avoid the need for re-tuning.

If the temperature units scale (°C or °F) is changed, it is essential to change the upper bezel to correspond to the units selected (supplied with controller).

If you are having difficulty in adjusting the Options, refer to Section 3.13, Parameter Lock, since the unit may be in the locked mode.

Normal control is maintained with existing settings during programming.

3.5.1 Keying in Standard Functions

You need to know the Option code and Function number to set up the CN9000A. For example, Option 0/Function .5 is SP1 Proportional Band of 2.5%.

Appendix A lists all the Function numbers and their names in a short concise list.

Table 3-4 describes the Option details for Standard Functions .0- .25.

Table 3-6 describes the Option details for Advanced Functions .26 - .50.

3.5.1.1 Example of Programming Functions. 0, .1,.2,.3,-.23

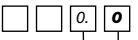
STEP	ACTION	DISPLAY

The following steps apply only to Functions .0,-.23. Section 3.6 covers more examples.

1 Ensure that the jumper behind the lower front bezel is in the Parameter Setting Position (refer to Section 3.13). Note Functions .1, .2, .3 are not protected by the Parameter Lock Jumper.

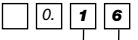
2 To convert the main display from a temperature read-out to the Function/Option Mode:

Press P
Option 0
Function .0
(flashing)



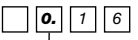
3 To change from Function .0 to Function .16 (for example)†:

Press and Hold ▲ until you see 0.16 Function (flashing)



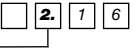
4 To change flashing Function digit to Option digit:

Press ★
Option (flashing)



5 To change from Option 0 to Option 2 (for example)††:

Press ▲ 2 times
Option (flashing)



6 To go to another Function:

Press ★ and repeat steps 3-5 as necessary

7 When finished selecting the Functions and Options (exiting Program Mode), the process temperature is displayed. Control begins with the new instructions now entered into memory.

Press P

†If using ▲ button, the Function number changes in the following sequence: ":0, .1, .2,.... .25" and back to ".0". If using ▼ button, and the display shows ".0" in Function place, the display changes to ".13" and then ".12, .11, ..., .0".
††If using ▲ button, the Option number goes as high as 100. If using ▼ button, the Option number goes down to 0.

3.5.1.2 Example of Programming Functions .19 & .2 (SP2)

NOTE

When using SP2 as a tracking second setpoint (deviation from first setpoint): Function .19, Options 1, 2, 3, or 7 will enable the second setpoint and Function .2 is to be used to set the differential value between the first and second setpoint.

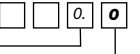
STEP	ACTION	DISPLAY

The following steps apply to Function .2. Function .19 must be set up before setting Function .2.

1 Ensure that the jumper behind the lower front bezel is in the Parameter Setting position (the jumper should be on the two right-most pins). Refer to Section 3.13 if necessary.

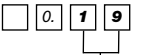
2 To convert the main display from a temperature read-out to the Function/Option Mode:

Press P
Option 0
Function .0
(flashing)



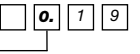
3 To change from Function .0 to Function .19:

Press ▲
until you see 0.19
Function (flashing)



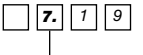
4 To display Option:

Press ★
Option (flashing)



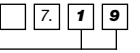
5 To change Option value (refer to Table 3-4); for example, 7:

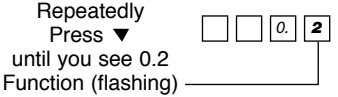
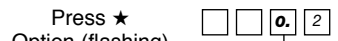
Press ▲ to increase (or ▼ to decrease depending on Option value)
Flashing



6 To change to Function:

Press ★ Function
(flashing)



STEP		ACTION	DISPLAY
7	To change from Function .19 to Function .2:	Repeatedly Press ▼ until you see 0.2 Function (flashing)	
8	To change to Option Mode:	Press ★ Option (flashing)	
9	To change from Option number; can go down to -128° can go up to +127°, since you selected option 7 in Function .19. See the chart in Function .2 to see the range allowed. (For example, set to 100°).	Press ▲ to increase value	
10	To exit program mode (and lock in parameters just set up). Process temperature is displayed.	Press P	

3.5.1.3 Example of Programming Functions .24 and Special Case of Function .2

The following steps apply to Function .24 and Function .2 when using SP2 as a full scale alarm or non-tracking second setpoint (Function .19, Option 4 or 5).

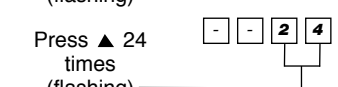
1 Ensure that the jumper behind the lower front bezel is in the Parameter Setting position (the jumper should be on the two right-most pins). Refer to Section 3.13 if necessary.

2 To convert the main display from a temperature read-out to the Function/Option Mode:

Press P
Option
Function
(flashing)

3 To change from Function .0 to Function .24:

Press ▲ 24 times
(flashing)



STEP		ACTION	DISPLAY
4	To display maximum allowable setpoint:	Press ★	[ ] [4.] [0] [0]
5	To increase or decrease the setpoint:	Press and hold in ★ and simultaneously press ▲ to increase or ▼ to decrease value	[ ] [5.] [0] [0]
6	To stop changing the setpoint:	Release fingers	
7	To get back to process temp (exit Function/Option Program Mode). The upper limit of the allowable setpoint is now changed.	Press P	[T] [E] [M] [P]

3.5.1.4 Details of Standard Functions .0-.25

NOTES

Initial Configuration:
Function .16 must be selected first followed by settings in Functions .17-.24 if required, then exit from Programming Mode before making further selections. (Press P)
If 20 seconds is not a suitable Proportional Cycle Time for the process, the correct value for Function .4 can be preselected before Autotune (AT).

Protected Functions:
All Functions (except user settings Functions .1, .2 and .3) may be locked into memory after setting to prevent tampering. Put small jumper socket beneath lower bezel to left pair of pins (Section 3.13).

Locating Standard Functions:
Function .0 is the Function starting point. From there, you can go up or down.

1. Press to ▲ increase.
2. Press ▼ to decrease: display jumps directly to Function .13 to access the higher Functions. Press and hold to scroll through to Function .0.
3. Refer to Section 3.12 for ADVANCED FUNCTIONS.

TABLE 3-4
STANDARD FUNCTIONS .0 THROUGH.25

NOTE: For each Function, the "0" Option is the default setting!

FUNCTION

.0 OPERATING MODES (Autotune/Auto-manual)

This allows Autotune to be selected; either AT (Autotune at start-up) or PT (Push to Tune at setpoint). Park Mode (Option 3) allows first output to be put on standby (turned off) while leaving the second output activated for alarm or cooling, as described in Section 3.9. Manual control of the heating output (Option 4-100) can also be selected, and is explained in Section 3.8. This is the function that the unit starts with when the Parameter (P) key is first pressed.

(Op#).(Fn#)	Parameter/Comment
0.0	Normal Operation
1.0	Start Autotune AT (Refer to Section 5.1)
2.0	Start Autotune PT (Refer to Section 5.1)
3.0	Park Mode (turns output 1 off)
4.0 to 100.0	Manual Heat % (Manual output adjustment)

.1 MANUAL RESET (NOT USED IN PID)

If the CN9000A is used in Proportional only (P) or Proportional-Derivative (PD) without Automatic Reset, the system is offset by digitally altering the value of the offset in ±1° steps, up to half of the proportional band or ±127°, whichever is smaller. Use if Function .8 (Integral Time) is not used. (Not protected by the Parameter Lock jumper.)

(Op#).(Fn#)	Parameter/Comment
XXX.1	Adjusting the offset: enter in the amount of the offset in ±1° steps (max to ±127° or one half of the proportional band)

TABLE 3-4 (Cont'd)

FUNCTION

.2 SETPOINT 2 ADJUST

If Function .19 (Setpoint 2 Operation Selection) is set to Option 1, 2, 3 or 7, deviation from setpoint 1 is in 1° steps, up to 127° (12.7° in tenth degree resolution). The second setpoint tracks the first setpoint. Therefore, if the first setpoint is changed, the second setpoint changes along with it. If Function .19 is set to Option 4 or 5, then the actual temperature is set for alarm, independent of the first setpoint (non-tracking).
(Not protected by the Parameter lock jumper). User must set up Function .19 first then Function .2 (Refer to Function .19).

Function .19 Parameter	Fn.19 Op. No.	Select Fn .2 Range	Comment
Deviation Alarm	1,2,3	0-127°	(tracking)
Full scale alarm	4,5	0-*	(non-tracking)
Cool strategy	7	±127°	(tracking)

**For full range, refer to Function .16 chart.*

.3 SETPOINT 1 LOCK

Allows the first setpoint to be "locked" to keep it from being changed inadvertently. (Not protected by Parameter Lock jumper).

(Op# .(Fn#)	Parameter/Comment
0.3	Unlocked
1.3	Locked

.4 CYCLE TIME/ON-OFF (OUTPUT 1)

Total length of time that the output will cycle on and off when the temperature is within the proportional band. This can also be set for ON/OFF Control. **Note that cycle times of less than 10 seconds are not recommended for use when SP1 is a mechanical relay.** Option 6 should only be used with Analog Outputs (4-20 mA DC or 0-10VDC).

TABLE 3-4 (Cont'd)

FUNCTION

.4 (Cont'd) CYCLE TIME/ON-OFF (OUTPUT 1)

(Op#).(Fn#)	Parameter/Comment
0.4	20 sec (Default setting)
*1.4	1 sec
*2.4	5 sec
3.4	10 sec
4.4	30 sec
5.4	60 sec
6.4	Analog Outputs (4-20 mA DC or 0-10VDC only)
7.4	ON/OFF
8.4	0.3 sec
*9.4	2 sec
*10.4	3 sec
*11.4	7 sec
12.4	14 sec
13.4	45 sec Operational
14.4	AT value
15.4	Latest calculated AT value

**not recommended with mechanical relay*

.5 PROPORTIONAL BAND/DEADBAND (OUTPUT 1)

This is the percent of the Span (allowable setpoint range) both below and above setpoint in which proportion action is active. Output is 100% at the bottom of the proportion band, 0% at the top, and proportional in between. If ON/OFF Control was selected (Function .4, Option 7), then this selection represents deadband (hysteresis), or the amount the temperature must fall after reaching setpoint before the relay returns to original state.

TABLE 3-4 (Cont'd)

FUNCTION

.5 (Cont'd) PROPORTIONAL BAND/DEADBAND (OUTPUT 1)

(Op#).(Fn#)	Parameter/Comment	
	SP1 Proportional band/Gain	SP1 Hysteresis in ON/OFF mode (Deadband)
0.5	2.5% x range	1.25% x span
1.5	0.5%	0.25%
2.5	1 %	0.5%
3.5	2%	1 %
4.5	3%	1.5%
5.5	5%	2.5%
6.5	10%	5%
7.5	20%	10%
8.5	1.5%	0.75%
9.5	4%	2%
10.5	6%	3%
11.5	7%	3.5%
12.5	8%	4%
13.5	14%	7%
14.5	100%	50%
*15.5	AT value	

**Note: You will not see 15.5 on the display. The actual AT value, in %, will appear at the left side of the display.*

.6 DERIVATIVE TIME/RATE (OUTPUT 1)

Refer to Section 5.6. Set to OUT (Option 1) if Proportional Only Control is desired.

(Op#).(Fn#)	Parameter/Comment
0.6	25 sec
1.6	OUT
2.6	5 sec
3.6	10 sec
4.6	50 sec
5.6	100 sec

(Option list continued on next page)

TABLE 3-4 (Cont'd)

FUNCTION

.6 (Cont'd) DERIVATIVE TIME/RATE (OUTPUT 1)

(Op#).(Fn#)	Parameter/Comment
6.6	200 s
7.6	1 sec
8.6	2 sec
9.6	3 sec
10.6	7 sec
11.6	15 sec
12.6	20 sec
13.6	35 sec
14.6	75 sec
*15.6	AT value

**Note: You will not see 15.6 on the display. The actual AT value, in seconds, will appear at the left side of the display.*

.7 DERIVATIVE APPROACH CONTROL (DAC) (OUTPUT 1)

Used to eliminate derivative action during system warm-up time. Refer to Section 5.7.

(Op#).(Fn#)	Parameter/Comment
0.7	1.5 x proportional band
1.7	0.5 x proportional band
2.7	1.0 x proportional band
3.7	2.0 x proportional band
4.7	2.5 x proportional band
5.7	3.0 x proportional band
6.7	4.0 x proportional band
*7.7	AT value

**Note: You will not see 7.7 on the display. The actual AT value in multiples of the proportional band will appear at the left side of the display.*

TABLE 3-4 (Cont'd)

FUNCTION

.8 INTEGRAL TIME (OUTPUT 1)

Also known as Automatic Reset. Refer to Section 5.5.

(Op#).(Fn#)	Parameter/Comment
0.8	5 min (300 sec)
1.8	OUT: Manual Reset (Function .1 used)
2.8	0.5 min (30 sec)
3.8	1 min (60 sec)
4.8	2 min (120 sec)
5.8	3 min (180 sec)
6.8	10 min (600 sec)
7.8	18 min (1080 sec)
8.8	0.2 min (12 sec)
9.8	7 min (420 sec)
10.8	13 min (780 sec)
11.8	25 min (1500 sec)
12.8	33 min (1980 sec)
13.8	43 min (2580 sec)
*14.8	AT value

**Note: You will not see 14.8 on the display. The actual AT value in minutes will appear at the left side of the display*

.9 SENSOR OFFSET (CALIBRATION)

Provides correction at one single temperature. Adjust in 1° steps (±127° max). Refer to Figure 6-1 for the Sensor Error Graph.

.10 CYCLE TIME/ON-OFF (OUTPUT 2)

Cycle time for second setpoint. Set similarly to first setpoint (Function .4). Note that SP2 must first be activated in Function .19. The preset Default setting for SP2 is ON/OFF.

(Op#).(Fn#)	Parameter/Comment
0.10	ON/OFF
*1.10	1 sec
*2.10	5 sec
3.10	10 sec

(Options continued on next page)

**not recommended with mechanical relay*

TABLE 3-4 (Cont'd)

FUNCTION

.10 (Cont'd) CYCLE TIME/ON-OFF (OUTPUT 2)

(Op#).(Fn#)	Parameter/Comment
4.10	20 sec
5.10	60 sec
6.10	Not Used
7.10	30 sec
*8.10	2 sec
*9.10	3 sec
*10.10	7 sec
11.10	14 sec
12.10	45 sec
Non-linear ranges for Cool Strategy:	
13.10	0.15-10 sec
14.10	0.15-20 sec
15.10	0.06-15 sec

**not recommended with mechanical relay*

.11 PROPORTIONAL BAND/DEADBAND (OUTPUT 2)

Set similarly to first setpoint Proportional Band (Function .5).

Op#).(Fn#)	SP2 Proportional Band/Gain	SP2 Hysteresis in ON/OFF mode (Deadband)
0.11	2.5% x range	1.25%
1.11	0.5% x range	0.25%
2.11	1% x range	0.5%
3.11	2% x range	1%
4.11	3% x range	1.5%
5.11	5% x range	2.5%
6.11	10% x range	5%
7.11	20% x range	10%
8.11	1.5% x range	0.75%
9.11	4% x range	2%
10.11	6% x range	3%
11.11	7% x range	3.5%
12.11	8% x range	4%
13.11	14% x range	7%
14.11	100% x range	50%

TABLE 3-4 (Cont'd)

FUNCTION

.12 LOOP BREAK ALARM TIME

Controller detects a break in the control loop caused by a sensor short or heater break. This is the amount of time the controller will wait for the control action to have an affect before an error message is given (EE3). Not recommended for control around ambient temperature. Option 14 is recommended for typical applications (two times integral time). Refer to Section 4.2.

(Op#).(Fn#)	Parameter/Comment
0.12	OUT
1.12	1 min
2.12	2 min
3.12	4 min
4.12	6 min
5.12	8 min
6.12	10 min
7.12	15 min
8.12	20 min
9.12	30 min
10.12	40 min
11.12	50 min
12.12	70 min
13.12	90 min
Recommended initial setting:	
14.12	2 x Operational Integral Time

.13 ACTIVATE ADVANCED FUNCTIONS .26-50

Press ★ for 5 seconds to access Advanced Functions .26-.50.

CAUTION

Advanced Functions to be selected at initial setup by qualified personnel **only.**

.14 NOT USED

TABLE 3-4 (Cont'd)

FUNCTION

.15 RESETTING FUNCTION'S .0 -.24 TO DEFAULT SETTINGS

Allows quick reset of all Functions to Default settings. Only Function .22 (°C/°F) and Function .9 (Sensor Offset) will not be reset. NOTE: 'Hidden' Function 15/Option 5 resets all functions, except Function .22.

(Op#).(Fn#)	Parameter/Comment
0.15	Normal
1.15	Reset (Functions .22 and .9 will not reset)
5.15	Resets all functions except Function .22

.16 INPUT SENSOR SELECT & RANGE TABLE

Selects thermocouple type or RTD. This is the first selection that must be made for the unit to be used. NOTE: If 3-wire RTD configuration is ordered, the Pt-100 (Option 9) must be selected. Option 0 causes the CN9000A to "lock up" (another Option must be selected to "bring the CN9000A back to life").

Op.Fn	Sensor Type	Default Range °C	Default Range °F	Linearized Range °C	Linearized Range °F
1.16	J	0 to 400	32 to 800	0 to 800	32 to 1470
2.16	K	0 to 400	32 to 800	0 to 1200	32 to 1999
3.16	N	0 to 400	32 to 800	0 to 1200	32 to 1999
4.16	R	0 to 1600	32 to 1999	0 to 1600	32 to 1999
5 16	S	0 to 1600	32 to 1999	0 to 1600	32 to 1999
6.16	T	0 to 250	32 to 500	-199 to 250	-199 to 480
7.16	E	0 to 500	32 to 1000	0 to 600	32 to 1110
8.16	J-DIN	0 l0 400	32 to 800	0 to 800	32 to 1470
9.16	Pt100	0 to 200	32 to 400	-199 to 400	-199 to 750
10.16	B	0 to 1600	32 to 1999	0 to 1800	32 to 1999

(Options cont'd on next page)

NOTE

Range adjustments (including Default) only limit setpoint values. Process temperatures will be displayed over the full linearized range.

TABLE 3-4 (Cont'd)

FUNCTION

.16 (Cont'd) INPUT SENSOR SELECT & RANGE TABLE

LINEAR PROCESS INPUTS (SEE SECTION 3.10)

(Op#).(Fn#)	Input	Display
11.16	0-20 mV	0-100
12.16	4-20 mV	0-100
13.16	0-20 mV	0-1000
14.16	4-20 mV	0-1000
15.16	0-20 mV	0-2000

.17 NEGATIVE TEMPERATURES

Must be enabled to allow negative temperatures to be measured (using either T thermocouple or RTD only).

(Op#).(Fn#)	Parameter/Comment
0.17	Disabled
1.17	Enabled

.18 DISPLAY RESOLUTION (1 OR 0.1 DEGREE)

Allows selection of 0.1° resolution over limited temperature range (-199.9 to + 199.9). Note: this affects other selections, such as setpoint. Settings in 1° increments become 0.1° when Option 1 is selected.

(Op#).(Fn#)	Parameter/Comment
0.18	Normal (1°)
1.18	High (tenth deg) Resolution (0.1°): -199.9° to + 199.9

.19 SETPOINT 2 OPERATION SELECTION

Allows for activation of second setpoint. Refer to Second Output Operation, Section 3.11. Note that in ON/OFF mode, SP2 can act as a deviation alarm from the first setpoint. It can be set as a high deviation, low deviation, or either high or low deviation (out of bounds).

TABLE 3-4 (Cont'd)

FUNCTION

.19 (Cont'd) SP2 OPERATING MODE

Make the proper selection here in Function .19 before adjusting SP2 in Function .2.

(Op#).(Fn#)	Parameter/Comment
0.19	OUT
1.19	Deviation alarm-High (Above SP1)
2.19	Deviation alarm-Low (Below SP1)
3.19	Deviation band alarm (Out of Limits)
4.19	Full scale alarm-High (Non-tracking)
5.19	Full scale alarm-Low (Non-tracking)
6.19	LBA-Loop Break Alarm
7.19	Cool strategy

.20 SENSOR BREAK PROTECTION (OUTPUT 1)

Allows for selection of upscale or downscale thermocouple break protection for first setpoint so that output will be in safest state if input is lost. Most heating applications require upscale protection.

(Op#).(Fn#)	Parameter/Comment
0.20	SP1 output OFF (upscale)
1.20	SP1 output ON (downscale)

.21 SENSOR BREAK PROTECTION (OUTPUT 2)

Allows for selection of upscale or downscale protection for second output.

(Op#).(Fn#)	Parameter/Comment
0.21	SP2 output OFF (upscale)
1.21	SP2 output ON (downscale)

TABLE 3-4 (Cont'd)

FUNCTION

.22 °C/°F SELECTION

Allows selection of °C or °F for display. Note that the correct bezel must be used.

(Op#).(Fn#)	Parameter/Comment
0.22	°C (not reset by Function .15)
1.22	°F (not reset by Function .15)

.23 SOFTWARE VERSION NUMBER

Read only-not changeable, factory set. Functions .28 and .30 are not operational with Software Version 3 or less.

.24 UPPER SETPOINT LIMIT (SPAN)

Allows changing of high end of allowable setpoint range, set in 1° increments. Refer to Section 3.4.2.

Refer to Function .16 for linearized range table. Select before Tuning.

.25 (Not Used)

NOTE: Functions .26 through .50 are the Advanced Functions and are discussed in Section 3.12 as well as Table 3-6.

3.6 EXAMPLES OF PARAMETER ADJUSTMENTS

The following two sections are examples of parameter adjustments for the CN9000A Controller.

3.6.1 Changing SP1 Proportioning Time (Function .4)

To change SP1 proportioning time from 20 seconds (Default setting) to 30 seconds, access Function .4 and change the Option number from 0 to 4. See the example that follows.

TABLE 3-4 (Cont'd)

STEP		ACTION	DISPLAY
1	To display OPTION/FUNCTION List: Ensure that jumper behind lower bezel is in 'unlocked' position.	Press P	[ ] [ ] [0.] [0]
2	To change the FUNCTION number to 4:	Press ▲ 4 times	[ ] [ ] [0.] [4]
3	Change to OPTION numbers:	Press ★	[ ] [ ] [0.] [4]
4	To change OPTION number 0 to OPTION number 4:	Press ▲ 4 times	[ ] [ ] [4.] [4]
5	To place in memory:	Press P	[T] [E] [M] [P]

3.6.2 Use of Manual Reset

P and PD mode. When the system has settled, if a discrepancy exists between Setpoint and Process Temperature, the 'offset' can be removed by the use of Manual Reset. For example, if the process temperature is 252°C and the setpoint is 250°C.

STEP		ACTION	DISPLAY
1	Process temperature is 252° To view the setpoint temperature:	 Press ★	[ ] [2] [5] [2] [ ] [2] [5] [0]
2	To correct 'offset' of -2°C.	Press P	[ ] [ ] [0.] [0]
3	Change to FUNCTION .1:	Press ▲	[ ] [ ] [0.] [1]
4	Change to OPTION numbers flashing:	Press ★	[ ] [ ] [0.] [1]
5	To key in the 'offset' temperature (-2°C):	Press ▼ twice	[-] [ ] [2.] [1]
6	To place in memory: The process temperature reading will settle from 252°C to 250°C.	Press P	[ ] [2] [5] [0]

3.7 NEGATIVE TEMPERATURE RANGING

The following sensor types can be used for negative temperatures. The negative value shown against each type is automatically set by the choice of sensor (Function .16) and requires enabling with Function .17, Option 1.

Type T:	-90°C, -130°F
Pt100:	-100°C, -148°F
Type N:	-50°C, -58°F non-linearized
Type K:	-50°C, -58°F non-linearized

3.8 MANUAL MODE (AUTO/MANUAL) (FUNCTION 0 OPTION 4-100)

Enables the heater power to be manually adjusted in the event of a sensor break, thus avoiding a plant shutdown at an inconvenient time. The duty cycle monitor (DCM) provides a guide to a suitable manual heat power setting. This Manual Mode function is Function .0, Options 4 through 100. All three of the Error Indication LEDs are on when unit is in Manual Mode. Display shows a flashing number that represents % output followed by an H (for % heat). Example: at 50%, Manual Mode display shows 50H with the 50 flashing.

3.9 PARK MODE

Temporarily switches off SP 1 output, the controller otherwise, remains fully operational. Normally used during startup, for example, to disable a fast load to adjust to setpoint and then start autotune or to cool from setpoint. The park mode function is Function .0, Option 3. All three of the error Indication LEDs are on when unit is in Park Mode.

3.10 LINEAR PROCESS INPUTS

Five linear inputs (Function .16, Options 11, 12, 13, 14, and 15) enable non-temperature process applications to be controlled. The input signal may be either 0-20 mV or 4-20 mV. Full scale display is provided for 100, 1000 and 2000 engineering units.

NOTE

By using a precision one (1) ohm resistor, a 4-20 mA DC or 0-20 mA DC input can be converted to 4-20 mV or 0-20 mV respectively.

3.11 SECOND OUTPUT OPERATION

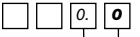
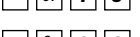
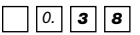
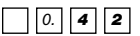
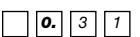
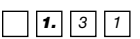
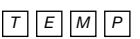
The following table shows operation of SP2 when Functions .30 and .31 are in the Default settings.

TABLE 3-5
SP2 OPERATION

Control Mode (Function .10)	Operating Mode (Function .19) Setting Compared to SP1	SP2 Relay is Energized	SP2 LED Is On	Typical Examples of Use
ON/OFF (Option 0)	High (Above SP1) Options 1 or 4	Below SP2 Setting	Above SP2 Setting	Alarm High
	Low (Below SP1) Options 2 or 5	Above SP2 Setting	Below SP2 Setting	Alarm Low
	Out of Limits (Above SP1) Option 3	Within Set Band Around SP1 Setting	Outside Set Band Around SP1 Setting	Deviation Alarm High & Low
Proportional (Options 1-7)	High (Above SP1) Options 1 or 7	Above SP2 Setting	Above SP2 Setting	SP2 Cooling
	Low (Below SP1) Option 2	Below SP2 Setting	Below SP2 Setting	SP1 Cooling SP2 Heating

3.12 DETAILS OF ADVANCED FUNCTIONS .26-.50

The following steps describe the sequence of keys one must press to change any of the Options related to Functions .26 through .50. Access is gained into these Advanced Functions via Function .13, as described below.

STEP		ACTION	DISPLAY
1	Ensure that the jumper behind the lower front bezel is on the two right-most pins		
2	To convert the display from temperature readout to Function/Option Mode:	Press P Option 0 Function 0 (flashing)	
3	Change to Function .13:	Press ▼	
4	To get to the Advanced Functions:	Press and hold ★ until .38 appears	
5	To change to another Function number:	Press ▲ to go up press ▼ to go down	
6	To select Option number:	Press ★ Option (flashing)	
7	To change Option number:	Press ▲ or ▼ as many times as required to get Option number that you want	
8	To exit Program Mode:	Press P	

**Bold type means digit is flashing*
†Temperature of sensor will be displayed

TABLE 3-6
ADVANCED FUNCTIONS.26 -.50

NOTE

These Advanced Functions, .26 through .50, are not required for day-to-day use. They should **not** be accessed except during set-up by qualified personnel.

FUNCTION

.26 HEATING OUTPUT LIMIT (OUTPUT 1)

Allows adjustment of maximum output to heater in percent. Example: if 50% (Option 10) is selected, then the output of the controller would never be allowed to be greater than 50%. This might be used with an oversized heater. Autotune can not be used with SP1 heat limit other than 100% (Option 0). Example: with 10 second cycle time 50% (Option 10) would never allow more than 5 sec on 5 sec off when controller calls for 100% output. Not applicable if SP1 is ON/OFF.

(Op#).(Fn#)	Parameter/Comment
0.26	100% x max output
1.26	95%
2.26	90%
3.26	85%
4.26	80%
5.26	75%
6.26	70%
7.26	65%
8.26	60%
9.26	55%
10.26	50%
11.26	45%
12.26	40%
13.26	30%
14.26	20%
15.26	10%

TABLE 3-6 (Cont'd)

FUNCTION

.27 COOLING OUTPUT LIMIT (OUTPUT 2)

Same as Function .26 but for cooling. Used when cooler is oversized. Sets the limit to the maximum cooling power % required.

(Op#).(Fn#)	Parameter/Comment
0.27	100% x max
1.27	80% output
2.27	60%
3.27	50%
4.27	40%
5.27	30%
6.27	20%
7.27	10%

.28 OUTPUT 1 DIRECT/REVERSE (HEAT/COOL)

Allows action of output to set to reverse acting for heating (standard) or direct acting.

WARNING

Inverting output may affect controller failsafe characteristics.

Selection should only be made by qualified personnel. Consult OMEGA if you are not sure of your application. This function is not available with Software Version 3. Refer to Function .23.

(Op#).(Fn#)	Parameter/Comment
0.28	Reverse Acting (Heating)
1.28	Direct Acting (Cooling)

.29 OUTPUT 1 LED OPERATION

Allows reversal of action of SP1 LED (e.g. change to on when logically off and off when logically on).

(Op#).(Fn#)	Parameter/Comment
0.29	ON when logically on (standard)
1.29	OFF when logically on (reversed)

TABLE 3-6 (Cont'd)

FUNCTION

.30 OUTPUT 2 DIRECT/REVERSE

Allows action of second output to be set to direct acting for cooling (standard) or reverse acting.

WARNING

Inverting output may affect controller failsafe characteristics.

Selection should only be made by qualified personnel. Consult OMEGA if you are not sure of your application. This function is not available with Software Version 3. Refer to Function .23.

(Op#).(Fn#)	Parameter/Comment
0.30	Direct Acting (cooling)
1.30	Reverse Acting (Heating)

.31 OUTPUT 2 LED OPERATION

Allows reversal of action of SP2 LED (e.g. change to on when logically off and off when logically on). Refer also to Function 19.

(Op#).(Fn#)	Parameter/Comment
0.31	ON when logically on (standard)
1.31	OFF when logically on (reversed)

.32 ERROR INDICATION RESOLUTION

Allows adjustment in the indication of the deviation from setpoint.

(Op#).(Fn#)	Parameter/Comment
0.32	Normal (2% range/segment)
1.32	High (1%)
2.32	Low (4%)

TABLE 3-6 (Cont'd)

FUNCTION

.33 TEMPERATURE DISPLAY SENSITIVITY

Allows faster or slower (damped) response to output signal.

(Op#).(Fn#)	Parameter/Comment
0.33	Normal
1.33	High
2.33	Low

.34 DERIVATIVE POLLING RATIO

Allows adjustment of the frequency at which the controller checks the derivative function. This should not have to be adjusted from the Default value (0.5 x Derivative Time) for most processes. Not applicable if SP1 derivative is not used.

(Op#).(Fn#)	Parameter/Comment
0.34	0.5 x derivative time
1.34	0.2
2.34	0.7
3.34	1.0

.35 SENSOR SPAN ADJUST (CALIBRATION)

Allows adjustment of slope span for calibration. Should not need to be used in normal conditions. Refer to Section 6.2.2.

1° steps (+15°/-16° max)

.36 LIMIT (LATCHING) CONTROL (OUTPUT 2)

Allows the second setpoint (SP2) to be used for limit (latching) alarm with manual reset. Relay will not reset itself until operator acknowledges when alarm condition no longer exists.

(Op#).(Fn#)	Parameter/Comment	
0.36	Normal	
1.36	Latch	(cont'd)

TABLE 3-6 (Cont'd)

FUNCTION

.36 (Cont'd) LIMIT (LATCHING) CONTROL (OUTPUT 2)

Only for: SP2 ON/OFF mode Function .19/Options 1 through 5. PRESS ▲▼ simultaneously to reset (in non-alarm condition).

.37 (Not used)

FUNCTIONS .38 -.49 ARE PERFORMANCE DIAGNOSTICS

.38 RESETS FUNCTIONS .39 TO.42

Display shows Function .38 (0.38) after getting to Function .13.

(Op#).(Fn#)	Parameter/Comment
0.38	Off
1.38	Start

FUNCTIONS .39 through .49 can only be READ.

To read, press ★

.39 READ TEMPERATURE VARIANCE

Reads the difference between the maximum and minimum temperatures (0.1° resolution). Press ★ to read.

.40 READ MAXIMUM TEMPERATURE

Read maximum temperature in °F or °C. Press ★ to read.

.41 READ MINIMUM TEMPERATURE

Reads minimum temperature in °F or °C. Press ★ to read.

.42 READ DUTY CYCLE MONITOR

Monitors power (SP1 % on time) in previous proportioning cycle. Average several readings for more accurate result. Refer to Section 4.3.2. Press ★ to read.

.43 READ AUTOTUNING OVERSHOOT 1

Measured in °C/°F, maximum 255°/Hi-Res 25.5°. Refer to Section 4.3.3. Press ★ to read.

.44 READ AUTOTUNING OVERSHOOT 2

Measured in °C/F°, maximum 255°/Hi-Res 25.5°. Press ★

.45 READ AUTOTUNING UNDERSHOOT

Measured in °C/°F, maximum 255°/Hi-Res 25.5°.

TABLE 3-6 (Cont'd)

FUNCTION

.46 READ QUARTER CYCLE TIME 1

Measured in seconds, minimum of 2 seconds, maximum of 1800 seconds (30 minutes).

.47 READ QUARTER CYCLE TIME 2

Measured in seconds, minimum of 2 seconds, maximum of 1800 seconds (30 minutes).

.48 READ QUARTER CYCLE TIME 3

Measured in seconds, minimum of 2 seconds, maximum of 1800 seconds (30 minutes).

.49 READ QUARTER CYCLE TIME 4

Measured in seconds, minimum of 2 seconds, maximum of 1800 seconds (30 minutes).

.50 (Not used) Press ▲ to go to Function .0.

3.13 PARAMETER LOCK

The chosen Parameters may be mechanically locked into memory by removing or altering the position of the jumper behind the lower front bezel (refer to Figure 3-2). Note that locked positions (2) and (3) are alternatives and that the jumper socket is in the "inactive" or locked position in (2). When the Parameter Lock has been applied, only the Set-Up adjustments listed below are possible (depress the P key):

1. Adjust Manual Reset (PD, P and ON/OFF modes only)-refer to Section 3.6.2 for key sequences.
2. Adjust the second setpoint (assuming Function .19, either Options 1, 2 or 3 have been selected).
3. Lock the main setpoint to prevent adjustment by the operator.

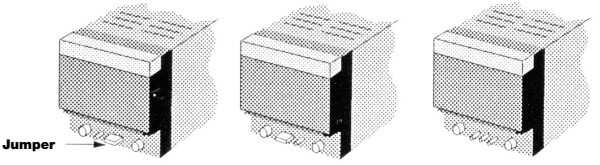


Figure 3-2. Parameter Lock Positions

SECTION 4 DIAGNOSTICS

4.1 FAULT INDICATION

Depending on the selection made at Functions .20 and .21, the SP1 and SP2 outputs are turned ON or OFF if sensor is open. The main temperature display, on a fault indication, is replaced by "EE" flashing, followed by a digit. This indicates that an error has been detected in the system. Action should be taken as follows:

ERROR CODE	APPLICATION PROBLEMS	ACTION	RESET
EE1	Sensor burnout	Check sensor	Self clearing
EE2	RTD/Pt 100 short	Check sensor	Self clearing
EE3	LBA Loop break	Check control loop	Latches: Reset
Autotune AT/PT tuning cycle problems			
Autotune run aborted: Previous values retained			
EE5	Outside time limit		Latches: Reset
EE6	Overshoot exceeds limit		Latches: Reset
EE7	Unable to run Autotune, SP1 in ON/OFF mode		Latches: Reset
Software problems			
EE8	Calibration data error	Replace CN9000A if it persists	See next page
EE9	System error	Replace CN9000A if it persists	See next page
H	Unit in Manual Mode	If Manual Mode not desired, check Function .0	Reset to 0.0 for normal operation

If EE8 or EE9 do not clear themselves, the following can be attempted. Disconnect power and make sure that the jumper is in the unlocked position (across center and right pins under the key pad). Then press P key and keep pressing it. Finally reconnect power for 10 seconds, and release P key. This will clear memory. All functions will go to default state and must be reprogrammed.

PRESS ▼ ▲ simultaneously to reset latched message.

If you have any other problems, contact the OMEGA Customer Service Department at 1-800-622-2378 or (203) 359-1660.

4.2 LOOP BREAK ALARM

The Loop Break Alarm (LBA) detects a control loop fault, and displays an error message (EE3). In addition the SP2 relay may be configured to act in the LBA state. Note that the SP1 output state is unaffected by LBA alarm condition.

The LBA operates if the controller fails to receive a correct response to the output within a limited time period. Specifically, the LBA state occurs when the SP1 output is at 0% or 100%, and is unresponsive within the LBA waiting time specified in Function .12. The controller is considered to be unresponsive if the process temperature fails to move a minimum of 50% of the proportional band (or hysteresis if SP1 is in the ON/OFF mode). Figure 4-1 shows the kinds of faults detected by the LBA.

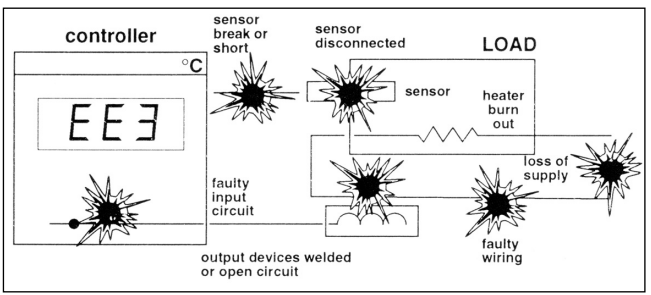


Figure 4-1. Typical faults detected by LBA

Selecting LBA-EE3 message only:

1. Step to Function .12-LBA time Option 0-LBA OUT, displayed.
2. PRESS ★ to change to option.
3. PRESS ▼ to select Option 14, the recommended initial setting (2 x the control band in use).
4. In the LBA alarm condition, EE3 is displayed alternating with process temperature. The alternating EE3 display latches until reset. To reset, Press ▼ ▲ simultaneously.

To configure Alarm relay SP2 to LBA:

Select Option 6 in Function .19 (Relay latches in alarm condition, to reset, Press ▼ ▲ simultaneously).

NOTE

Reset EE3/Relay before any other program changes.

4.3 OPERATIONAL DIAGNOSTICS

4.3.1 Diagnostics (Functions .38 -.49)

Used to assist with machine operation and troubleshooting.

Monitors and displays minimum and maximum temperatures, and variance (deviation) to 0.1°C/°F.

Displayed temperatures are measured values, independent of setpoint. This high sensitivity monitor may be affected by interference. (Use a snubber to minimize disturbance).

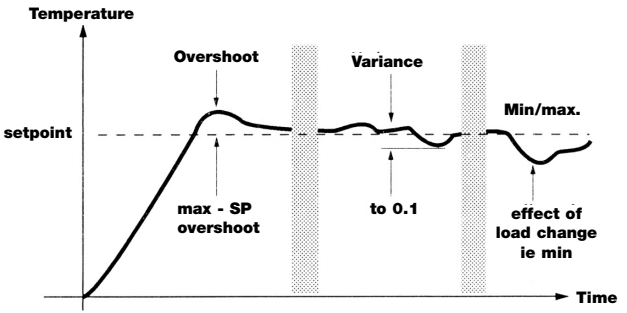


Figure 4-2. How to use Functions .38 -.41

4.3.2 Duty Cycle Monitor (DCM) (Function .42):

Monitors percentage of power used in the previous proportioning cycle. Average several readings for a more accurate result.

Power requirements outside the range 20%-80% may be difficult to control and autotune.

1	To start monitoring:	Select Function .38/Option 1
2	To return to normal operation:	Press P
3	To view readings:	Select Functions .39-.42
4	To stop monitor: (Readings are retained)	Select Function .38/Option 0
5	Reset Readings reset on next monitor start. Monitor and readings reset	Select Function .38/Option 1 or On de-powering

4.3.3 Autotune Tuning Data (Functions .43 -.49)

Functions .43 through .49 provide data on size and length of oscillations used by the controller in "learning the system" while autotuning. Refer to Figure 4-3. Also refer to Section 5.1, Autotune.

Function .43: OS1 (overshoot 1)
Function .44: OS2 (overshoot 2)
Function .45: US (undershoot)
Function .46: T1 (quarter cycle time 1)
Function .47: T2 (quarter cycle time 2)
Function .48: T3 (quarter cycle time 3)
Function .49: T4 (quarter cycle time 4)

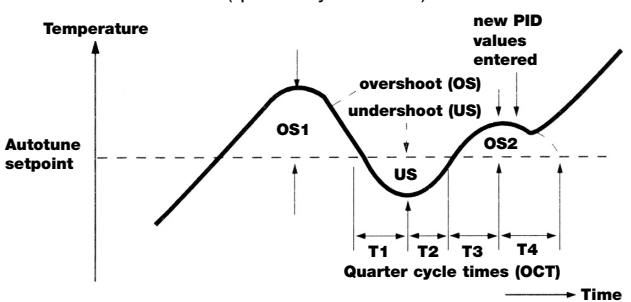


Figure 4-3. Autotune Tuning Data (Functions .43-.49)

SECTION 5 TUNING
5.1 AUTOTUNE

Two types of autotune are provided to ensure optimum control of a wide spread of applications.

Autotune AT: normal method, tunes during warm up (start up).

Autotune PT (push-to-tune): for difficult applications, fine tunes at setpoint.

5.1.1 Autotune AT

Start Autotune AT with the load cool. A short tuning cycle occurs at 75% setpoint during warm up. New PID values are automatically entered and the temperature rises to setpoint.

Autotuned Parameters	**Autotune Limits**
Entered automatically:	
Proportional Band/Gain	0.5%-20% range
Integral time/Reset	0.2-43.5 min
Derivative time/Rate	1.0-255 sec
DAC/Approach control	0.5-9.0 x gain
Proportional cycle time	0.8-81.9 sec

calculated but for safety reasons needs manual confirmation. Refer to Figure 5-1.

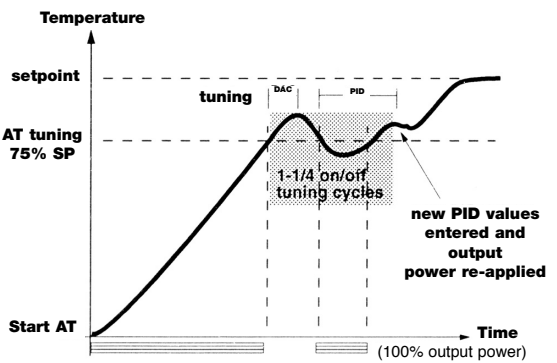


Figure 5-1. Autotune AT

5.1.2 Using Autotune AT

NOTE

Read the following before using the Autotune feature.

See Section 3.5 to change functions.

1. Functions .16-.24 should be selected first unless default values are used.
2. Adjust range if required (see Functions .16 and .24).
3. Select high (tenth degree) resolution (0.1°) (Function .18) or Negative Temperature Ranging (Function .17) if required.
4. Select required display units (°C/°F)-Function .22.
5. Proportional cycle time, factory set at 20 seconds, may be changed (Function .4 or .10), or by accepting the optimum time calculated after running AT.

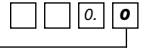
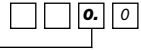
NOTE

For units with a mechanical relay (or a mechanical contactor in the system), do not attempt Autotune with a cycle time shorter than 20 sec.

6. For best results, use normal setpoint and load conditions.
7. Start with the cool load.

To Autotune:

8. Start Autotune process near ambient temperature, and follow these 4 steps.

STEP		ACTION	DISPLAY
1	To get into Program Mode:	Press P Function (flashing)	
2	To change to Option Mode: (leaving the Function as .0).	Press ★ Option (flashing)	

STEP	ACTION	DISPLAY
3 To change Option 0 to Option 1:	Press ▲ Option (flashing)	1. 0
4 To start Autotune process: "AT" display will alternate with process temperature display.	Press P	A T T E M P

NOTE

The Autotune algorithm can be tried on any process. However, it is designed to work best for heating processes when the setpoint is at least 100°F (50°C) above ambient. Other processes may need to be manually tuned for best results.

5.1.3 Using Autotune PT (Push-to-Tune) Function .0, Option 2

Used to fine tune difficult applications at setpoint. Useful if the setpoint or thermal conditions are substantially changed. During PT tuning some overshoot will occur. If this is unacceptable, temporarily lower the setpoint. PT tunes the parameters listed above except DAC. Proportional cycle time is recalculated but needs manual confirmation.

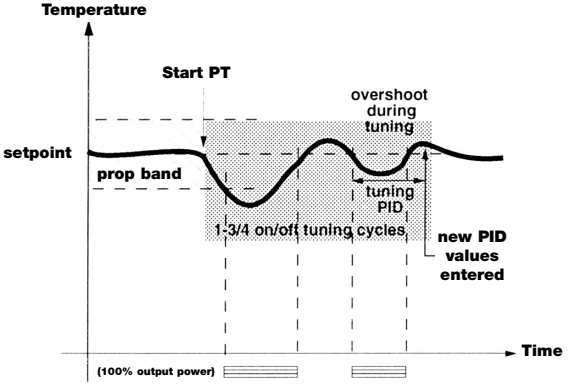
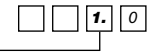
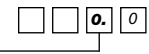
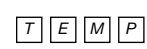


Figure 5-2. Autotune PT

5.1.4 To Abort Autotune

To abort Autotune, simply do the following:

	STEP	ACTION	DISPLAY
1	To get to Function Mode:	Press P Function (flashing)	
2	To get to Option Mode:	Press ★ Option (flashing)	
3	To change Option 1 to Option 0:	Press ▼ Option (flashing)	
4	To get back to process temperature:	Press P	

5.1.5 Over-riding Autotune Values

After AT/PT, any Autotuned parameter may be changed to an Option from the table. The original Autotuned value is retained in memory.

NOTE

Subsequent Autotune AT or PT replaces manual selections with new calculated values (except Cycle Time).

5.1.6 Autotune Hints

For Autotune error messages, see EE5 through EE7 in Section 4.1. Latched: Press ▲ ▼ simultaneously to reset.

AT/PT tunes most applications satisfactorily, but if tuning fails and error messages repeatedly occur, the application has unusual characteristics requiring manual tuning.

Tuning with setpoint near ambient temperature: Difficult both to control and Autotune. Use PT. If tuning fails, try using Function .5/Option 1. Otherwise increase setpoint or tune manually.

In high resolution mode (tenth degree, 0.1°):

Should error message EE6 occur during tuning, select normal resolution (Function .18/Option 0), then Autotune and reselect Hi-resolution mode.

5.1.7 Autotune Value Display

At the end of an Autotune cycle, the AT value is automatically entered and may be displayed in Functions:

Function .5	Prop band/Gain
Function .6	Derivative time/Rate
Function .7	DAC/Approach Control
Function .8	Integral time/Reset

For example to see the AT value for Function .5.

STEP		ACTION	DISPLAY
1	Get into Program Mode:	Press P Function (flashing)	□ □ 0. **0**
2	Change to Function .5:	Repeatedly Press ▲ Until you see Function (flashing)	□ □ 0. **5**
3	Change to Option Mode:	Press ★ Option (flashing)	□ □ **0.** 5
4	Change Option 0 to AT Option:	Press ▼	□ 2. 3. 5 †

†▲ on left side of the display being
■ lit means that you are seeing the
▼ AT value to the left of the function number.

5.1.8 Proportional Cycle Time

Autotune Cycle Time:

Autotune calculates the optimum value but for safety reasons does not automatically implement it. To see the calculated cycle time:

1 . Program for Function .4 Option 0, similar to the example in Section 5.1.7.

2. Press ▼ once. To the left of the .4 Function code the calculated cycle time will be displayed preceded by a "-". To accept this value, press P or ★.

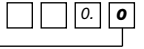
3. To see the operational cycle time, press ▲ once. The new AT operation cycle time will be displayed to the left of the .4 Function code.

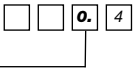
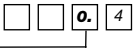
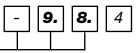
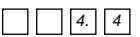
▲ will be shown to the left of the numeral displays
■ when the operational value is displayed.
▼

If the cycle time needed is shorter than the 20 second default setting (e.g., 1 sec is generally used for driving an SSR and 0.05 sec is used for linear outputs), the user should select the appropriate Option in Function .4. (Refer to Table 3-4). The cycle time setting will not be changed automatically, but may be replaced with the calculated AT value if preferred after the Autotune run.

Normal Procedure

Run Autotune AT. When finished (alternating AT display stops) display the AT calculated cycle time. If you want the displayed value, lock it in (value replaces the previous cycle time setting).

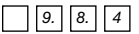
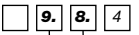
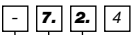
STEP	ACTION	DISPLAY
1 Ensure that the jumper behind the lower front bezel is in the Parameter Setting position.		
2 To convert the main display from temperature read-out to Function/Option Mode:	Press P Function (flashing)	

STEP		ACTION	DISPLAY
3	Change Function .0 to Function .4:	Press ▲ 4 times Option (20 seconds)	
4	To change to Option Mode:	Press ★ Option (flashing)	
5	Change Option 0 to AT Option: Calculated AT Value Indicates that the display shows AT value	Press ▼ Flashing	
6	If AT value is suitable, press P. (AT value now operational)	Press P	
7	If the AT value is not suitable, press ▲ to select suitable option for example: Option 4 (30 sec)	OR	

AT cycle time values in Function 4:

Two AT cycle time values are stored to enable the current operational value to be retained until a new value from a subsequent Autotune run is considered.

Example of two AT cycle time values after a subsequent Autotune run to follow:

STEP	ACTION	DISPLAY
8 Go through steps 2 through 5 once again. This time ▲ is on. 9.8 sec is accepted ■ from before. ▼		
9 To change to Option Mode:	Press ★ Flashing	
10 To display latest calculated AT value: For example, 7.2 seconds	Press ▲ (Flashing) shows that the display shows latest AT value	
11 Alternatively a. Press P to accept the latest calculated AT value -7.2 sec which replaces 9.8 sec as the operational AT value b. Press ▼ to display current operational AT value. Then Press P to retain 9.8 secs c. Press ▲ repeatedly to select Option from Table 3-4.		

5.2 MANUAL TUNING

5.2.1 The Simplified Method

If the pre-set PID Default values prove to be unsuitable for a particular application, the following method can be used to establish new settings which should be acceptable and which can be adjusted to give optimum control. Other methods may also be used-tuning is a trial and error process.

The first step is to control the system with the instrument in ON/OFF mode and use these results to calculate the new parameter values for SP1.

Check that all settings are in Default. If required, range adjustments should be made first (refer to Section 3.3).

Check that the Parameter Lock is in the Parameter Setting Position (refer to Figure 3-2 in Section 3.13) and proceed as follows:

1. Adjust Proportioning Time to ON/OFF. (This switches off all other control terms and sets Hysteresis to 1.25% of full scale.)
2. Enter setpoint temperature.
3. Turn ON and allow process to stabilize. Monitor process temperature, ideally using a chart recorder, or alternatively by taking readings from the display at regular intervals, as frequently as possible. The results should look similar to Figure 5-3.

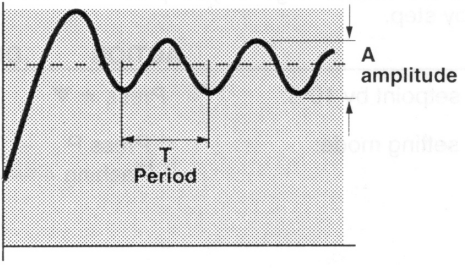


Figure 5-3. Simplified Tuning Method

4. Using the figures obtained for the oscillation period (T) seconds and amplitude (A) degrees (refer to Figure 5-3), the following parameter values can be calculated:

a. Proportional Time= $\frac{T}{20}$ If 10 seconds or less use the pulse output model.

b. Proportional Band % = $\frac{A \times 1.5 \times 100}{\text{full scale}}$ Set to next LARGER % setting.

c. Derivative (Rate) Time = $\frac{T}{20}$ Set to next SHORTER setting.

d. Integral (Reset) Time = T Set to next LONGER time setting.

NOTE

Approach control will be activated in DEFAULT setting=1.5 x prop. band. If the warm up characteristic is unacceptable, refer to Section 5.7.

5. Enter these new values and restart the process from cold.

The above settings can be further adjusted to give optimum performance. Sections 5.3 through 5.8 will provide guidance for tuning the individual control terms.

5.2.2 Alternative Tuning Method

If control is not satisfactory, the most likely cause is that the factory (default) settings are unsuitable for your application. To find the best settings for your process proceed as follows step by step.

	STEP	ACTION	DISPLAY
1	Lower setpoint by 10%:	Press ★▼	□□□□
2	Select setting mode:	Press P Flashing	□□ 0. **o**

STEP		ACTION	DISPLAY
3	Change to Function .4:	Press ▲ four times Flashing	0. **4**
4	Change to Option Mode:	Press ★ Flashing	**0.** 4
5	Change to Option 7:	Press ▲ seven times Flashing	**7.** 4
6	Return to Operating Mode	Press P	

CONTROL MAY NOW BE WORSE-TEMPERATURE WILL SWING ABOVE AND BELOW SETPOINT.

7 Observe this swing carefully and record the difference between the highest and the lowest reading (A =_____) and time in seconds between consecutive highest readings (T=_____)

8 Locate your sensor in the table below to obtain a sensor factor and use this with value for A to calculate size of "Proportioning Band" **(Function .5).**

Sensor Type	**Pt100 RTD**	**THERMOCOUPLE TYPES**			
		T	**J, K, N, Fe Const.**	**E**	**R, S, and B**
Sensor Factor	4	5	8	10	32

$$\frac{Ax3}{\text{Sensor Factor}}\ \%$$

Use calculated % value for "Programming Band" width to select option number in Function .5 table below. When between fixed values choose next larger option.

STEP

Fixed Values	0.5%	1%	2%	2.5%	3%	5%	10%	20%	*
Option No.	1	2	3	0	4	5	6	7	

**For other fixed values, refer to Table 3-4.*

9 Using value for T (time interval between consecutive highest readings) calculate new value for "Proportioning Time" (Function .4).

$\frac{T}{20}$ = seconds

Use calculated value to select option number in **Function .4** table below. When between fixed values choose next shorter option.

	SECONDS								
Fixed Values	1	5	10	20	30	60	0.05	On/Off	*
Option No.	1	2	3	4	0	5	6	7	

**For other fixed values, refer to Table 3-4.*

NOTE

If options 1, 2 or 3 are selected, it is recommended that you use one of the CN9000A models that provides an SSD output for SP1. Option 6 is only used for analog output only (4-20 mA DC or 0-10 VDC output)

10 Using same value for T calculate "Derivative Time" (Function .6).

$\frac{T}{10}$ = seconds

Use calculated value to select option number in **Function .6** table below. When between fixed values choose next shorter option.

	SECONDS							
Fixed Values	Out	5	10	25	50	100	200	*
Option No.	1	2	3	0	4	5	6	

**For other fixed values, refer to Table 3-4.*

STEP

11 Using the same value of T, select option number in **Function .8** "Integral Time" table below.

	SECONDS								
Fixed Values	**Out**	**30**	**60**	**120**	**180**	**300**	**600**	**1080**	*
Option No.	1	2	3	4	5	0	6	7	

**For other fixed values, refer to Table 3-4.*

Now enter in new option numbers for Functions 4, 5, 6. and 8. P key is used to enter and exit from setting mode. Option numbers are on the left of the decimal point. Function numbers are on the right side of the decimal point. Flashing digits can be raised or lowered using ▲ or ▼ keys. Use ★ key to transfer adjustment from Function to Option column or vice versa.

If this procedure fails to produce good results, repeat observations, calculations, and check controller setting.

5.3 PROPORTIONING TIME

The Proportional Time setting determines the cycle rate of the output device. In the interest of long contact life, this should be the slowest (longest setting) possible if mechanical relay output is being used. Otherwise there is no disadvantage in using faster settings. Refer to Figure 5-4.

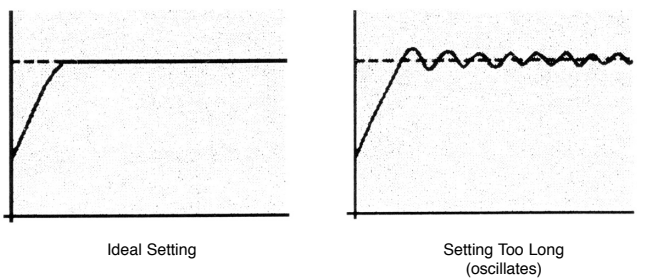


Figure 5-4. Proportioning Time

5.4 PROPORTIONAL BAND

In time proportioning control, the proportional band is employed to smooth out the oscillating characteristic typical of ON/OFF control.

A feature of proportional control is that the system may run at a slightly different temperature to the set point (Offset), and have a slower reaction to disturbances. Refer to Figure 5-5.

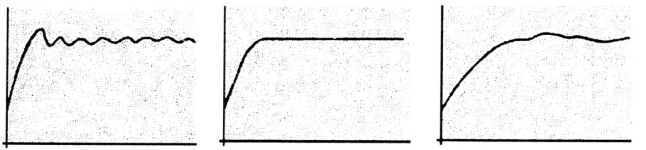


Figure 5-5. Proportional Band

5.5 INTEGRAL (RESET) TIME

The purpose of the integral time is to automatically correct for offset errors caused by the introduction of Proportional control. If incorrectly set, this can cause instability or increase warm up time.

If the Integral Time (constant) is too long, the process will take a long time to return the temperature to the set point. Conversely, if the Integral Time is too short, the process temperature oscillates because the integral action outruns the process. Refer to Figure 5-6.

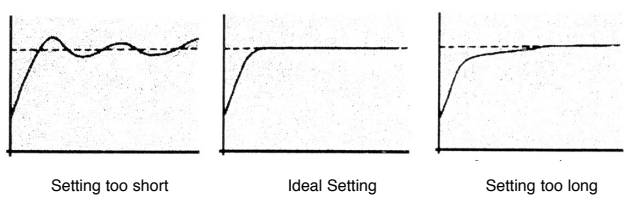


Figure 5-6. Integral (Reset) Time

5.6 DERIVATIVE (RATE) TIME

Derivative enables the controller to shift the proportional band up or down in an amount proportional to the rate of temperature change to help the system compensate for rapidly changing temperature.

The derivative term is added to Proportional Control action to speed up response to disturbances and to suppress overshoot. Refer to Figure 5-7. In applications where these two requirements would need different settings, the use of Derivative Approach Control for adjusting warm-up characteristics allows the Derivative setting to be biased in favor of disturuance behavior.

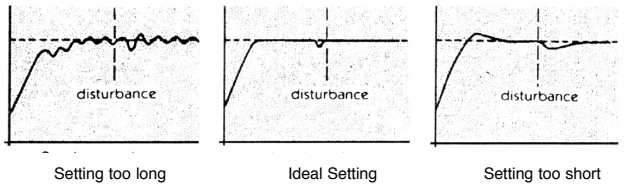


Figure 5-7. Derivative (Rate) Time

5.7 DERIVATIVE APPROACH CONTROL

This feature allows the warm-up characteristics to be tuned separately from normal running conditions and is particularly useful for applications where the sensor is some distance from the heater. The setting determines where the derivative action starts with respect to set point. The smaller the setting, the closer to setpoint. Refer to Figure 5-8.

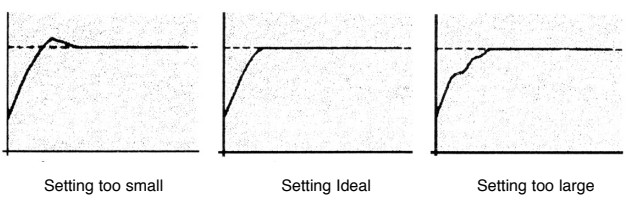


Figure 5-8. Derivative Approach Control

Where a given application cannot be tuned to give acceptable results over the required range of process temperatures and conditions, it is possible that better results may be obtained with Proportional, Derivative and Approach Control terms only.

5.8 HEATING AND COOLING

5.8.1 General Considerations

Ideal settings for these systems are very dependent on the application; and are often best determined by experiment.

The following general points may prove useful for initial consideration:

1. A common characteristic is that there is a considerable difference between the system response to the input of heating and of cooling energy.
2. In general, both channels can be set independently using the tuning guidelines for settings for Proportioning Time and Proportioning Band, and where it is known that one channel has a dominating and rapid effect on system temperature, the employment of narrow hysteresis ON/OFF settings for this may give excellent results.
3. Where both setpoints are required to be set close together (small deadband), wide proportioning or hysteresis band settings will overlap allowing simultaneous operation of outputs, which may give the best overall control.

5.8.2 Cool Strategy for Heat-Cool Applications

Cool strategy: A change in load causes integral to move the linked heat and cool prop bands. Refer to Figure 5-9.

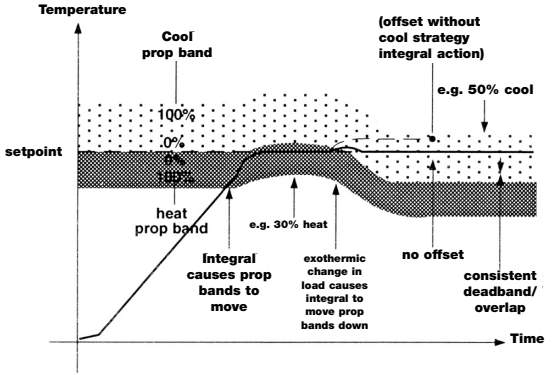


Figure 5-9. Cool Strategy

1. Integral causes linked prop bands to move up.
2. Stabilizes eg. 30% heat.
3. Exothermic load change causes integral to move prop bands down minimizing and disturbance.
4. Minimum offset achieved (4a = offset without cool strategy integral action).
5. Stabilizes eg. 50% cool.
6. Consistent dead band/overlap throughout.

5.8.3 Setting Up Routine for Heat-Cool Control

STEP	ACTION	PARAMETER
1	**Run Autotune AT:** with cooling disabled (Function .19 Option 0). Set normal operating temp. Accept AT proportional cycle time	Function .4 Option 15

NOTE

SP1 cycle time must be compatible with switching devices used (SP2 cool output is OFF)

STEP	ACTION	PARAMETER
2	**When temperature stable at setpoint:**	
	* Select cool strategy	Function .19/
	* Select cool prop band option value	Option 7
	from table nearest to Heat prop band value (view Function .5)	Function .11
	* Select cool cycle time option value nearest to Heat cycle time value (view Function .4)	Function .10
	* Adjust SP2 overlap/deadband to 0° (zero) (Factory set 5°)	Function .2
3	**Thermal conditions:** Run with normal background/exothermic thermal conditions, good results should be achieved and provide the basis for fine tuning.	
4	**Further adjustments:** Eg. water cooling. Should oscillation occur try (in order):	
	* Double cool prop band value and	Function .11
	double integral time value	Function .8
	* Halve cool cycle time	Function .10
	* Introduce cool overlap by setting negative value in Function .2 start with a small negative number	Function .2 (negative)
5	**Non-linear cooling**	
	For water cooling above 100°C where flash to steam requires a non-linear output. Select non-linear ranges in cool cycle time.	Function .10/ Options 13-15
6	**Fine tuning**	
	If overshoot (into cool) or undershoot (into heat) occurs, slowly make the following adjustments, observing the results:	Function .2 (negative)
	* Increase cool overlap	Function .27/
	* Apply SP2 cool limit, progressively	Option 1, 2..
	Also if needed: SP1 heat limit	Function .26/ Option 1,2...

SECTION 6 CALIBRATION

6.1 DISPLAY OFFSET

The CN9000A is not designed to allow field calibration.

A one point "Display Offset" can be programmed from the front of the unit using Function .9 sensor Error Correction (Display Bias). This function should not be used in normal operation.

Display Bias can be used to correct for small errors in calibration of a particular thermocouple or the CN9000A. It should never be used as a fudge factor to account for temperature gradients in a system.

Note that this is not a true calibration since the entire curve is shifted, and although the unit can be recalibrated at one point, the reading can be off at another temperature since the temperature curve is not exactly linear. Therefore, the Display Bias should be attempted as close to the desired setpoint temperature possible.

6.2 RECALIBRATING TO A REMOTE STANDARD

To enable the CN9000A calibration to match an external meter datalogger etc. (i.e. "Reference" reading).

6.2.1 Sensor Correction (Function .9)

Provides correction at one single temperature.

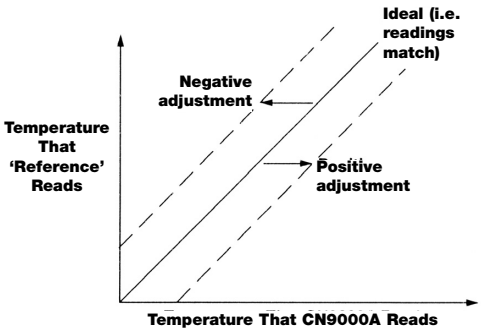


Figure 6-1. Sensor Error Graph

NOTE

Error polarity applies to CN9000A correction

EXAMPLE	READS
CN9000A	404°
Ext. Meter	400°
Error	+4

Set (-4) correction at Function .9.

6.2.2 Sensor Span Adjust (Function .35)

Steps for providing correction where two temperatures require differing amounts of adjustment.

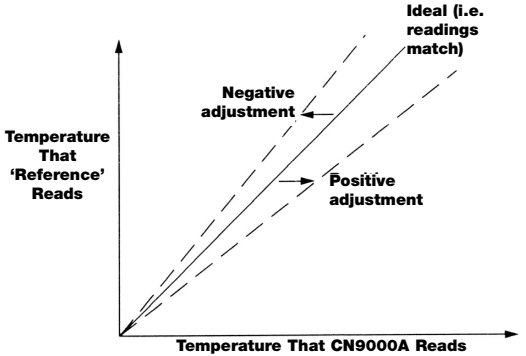


Figure 6-2. Sensor Span Graph

1. Choose a temperature near the bottom of the normal operating range and one near the top.
2. Run at the lower temperature T1 &, note the error E1 between CN9000A and "Reference" reading.
3. Repeat at upper temperature T2 and note error E2.

Example	T1 reads	T2 reads
CN9000A	60°	200°
"Reference"	58°	205°
Error	E1=+2	E2=-5°

4. Calculate, span adjustment for Function .35

Formula: Function .35 = $\frac{\text{E2-E1}}{\text{T2-T1}}$ x span (as Function .24)

Example: Function .35 = $\frac{(-5°)-(+2°)}{200°-60°}$ x 250° (Function .24 span)

Function .35 $\frac{-7}{140}$ x 250 = -12°

Set (-12°) in Function .35°

5. A span error entered in Function .35 immediately changes the reading. Allow time to stabilize at T2. If an error exists correct with Function .9. Then check at T1. If an error exists check readings and calculations, repeat if necessary.

NOTES

SECTION 7 INTERNAL JUMPER CHANGES FOR 115/230 VAC AND 2-WIRE/3-WIRE RTD CONVERSIONS

Input power conversion requires changes on the Main PC Board (PCB). RTD 2-wire to 3-wire conversions also requires jumper changes on the Main PCB. THESE MODIFICATIONS SHOULD BE MADE ONLY BY A QUALIFIED TECHNICIAN.

Voltage conversion (from 115VAC to 230VAC or vice versa) IS allowed in the following models:

CN9111/CN9111A	CN9211/CN9211A	BD9011/BD9011A
CN9112/CN9112A	CN9212/CN9212A	BD9012/BD9012A
CN9121/CN9121A	CN9221/CN9221A	BD9021/BD9021A
CN9122/CN9122A	CN9222/CN9222A	BD9022/BD9022A
CN9131/CN9131A	CN9231/CN9231A	

Voltage conversion IS NOT allowed in the following models under any circumstances. Doing so, will result in permanent damage to the controller.

CN9141/CN9141A	CN9241/CN9241A
CN9141-230V/CN9141A-230V	CN9241-230V/CN9241A-230V
CN9151/CN9151A	CN9251/CN9251A
CN9151-230V/CN9151A-230V	CN9251-230V/CN9251A-230V
BD9041/BD9041A	
BD9041-230V/BD9041A-230V	
BD9051/BD9051A	
BD9051-230V/BD9051A-230V	

7.1 TO REMOVE MAIN PC BOARD

Remove the controller from the panel (if installed). The Main PC Board (PCB) must next be removed before any modifications can be made. Refer to Figure 7-1 and proceed as follows:

1. Remove the rear socket on the controller.
2. Separate the output module from the controller body by gently prying both slots in the rim of the cover with a screwdriver. Cover rim will bow out to release module tabs.

3. Gently slide the output module from the housing. Next remove the Main PCB from the controller. This can be done by carefully taping module cover on table top (as shown below) to release the PC board. **Do not use pliers on protruding board cladding.** Carefully pull out the board to avoid damaging components.

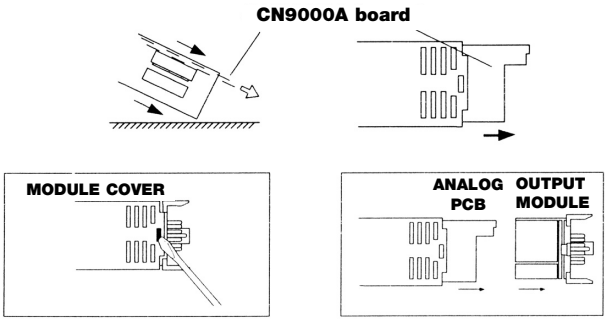


Figure 7.1. Removing the Main PC Board

7.2 115/230VAC VOLTAGE CONVERSION

Remove the Main PC Board from the controller using the steps described in Section 7.1. Lay the PCB on the workbench with transformer side down.

To convert the controller from 115 VAC to 230 VAC, refer to Figure 7-2 and proceed as follows:

1. Remove jumpers LK5 and LK3.
2. Install 1 jumper across the sockets marked "LK4"

To convert from 230 VAC to 115 VAC. refer to Figure 7-2 and proceed as follows:

1. Remove jumper LK4.
2. Install 1 jumper across LK3 and one across LK5 (19 AWG or 22 SWG).

7.3 2-WIRE/3-WIRE RTD CONVERSION

Use of a 3-wire RTD reduces measurement error when the sensor is more than 30 feet (10 meters) from the controller. Note that conversion to a 3-wire RTD inhibits subsequent selection and use of thermocouples.

To convert from an input of a 2-wire RTD sensor to a 3-wire RTD, refer to Figure 7-2 and proceed as follows:

1. Cut PC Board cladding where marked with an `X' (Fig 7-2).
2. Solder a wire jumper across LK2 and LK1.

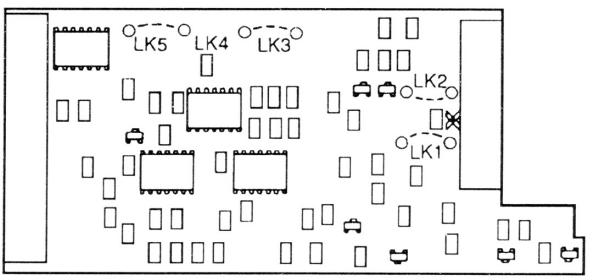


Figure 7-2. Voltage and 2-Wire/3-Wire RTD Conversions

7.4 INSTALLING THE TRIAC, 4-20mA AND 0-10VDC OUTPUTS OPTIONS

To install a module with a 1A Triac SSR, 4-20mA DC or 0-10VDC output will require a controller that has a 5VDC SSD (DC Pulse) on the first output-; namely the OMEGA model CN9121A, CN9122A, CN9221A or CN9222A controllers.

The BD9031A, BD9041A, or BD9051A socket can then be plugged on the back of the unit in place of the standard socket used for wiring. Refer to Figure 8-1 for dimensions.

Hardware required to make units is as follows:

CN9121A + BD9031A makes a CN9131A
CN9121A + BD9041A makes a CN9141A
CN9121A + BD9051A makes a CN9151A
CN9221A + BD9031A makes a CN9231A
CN9221A + BD9041A makes a CN9241A
CN9221A + BD9051A makes a CN9251A

NOTE

230VAC units use different modules for BD9041A or BD9051A

SECTION 8 SPECIFICATIONS

POWER; Dual 115/230V ±15% 50/60 Hz 5 VA, Factory set, jumper changeable

OUTPUT MODULES

RELAY ON OUTPUT 1: SPDT relay, rated 5A resistive at 250V continuous use†

RELAY ON OUTPUT 2: SPDT relay, rated 3A resistive at 250V continuous use†

NOTES

Dual relays are the standard output modules (CN9111A). The relay ratings shown are conservative. Although the Output 1 relay is capable of handling a current of 10A and the Output 2 relay a current of 5A, the life of the relays will be considerably reduced if the controller is used continuously (24 hours/day) at or near 10A (Output 1) or 5A (Output 2).

†Using the controller in an elevated ambient temperature, or with a slightly inductive load, also derates the relays. In those situations, the rating of Output 1 is 5A and Output 2 is 3A.

OPTIONAL OUTPUTS

5VDC SSD: Non-isolated 5 VDC pulses 25 mA for driving an external DC controlled solid state relay

1A TRIAC: 1A/264V 100 VA max, SPST

4-20 mA: Isolated, 500 Ω maximum

0-10 VDC: Isolated, 20 mA maximum

ACCURACY & RANGES CALIBRATION

ACCURACY: ±0.25% of range ±1°C (±0.5°C in Hi-res) plus linearity tolerance

CONTROL STABILITY: Typically ±0.15% of full scale, dependent on application

TEMPERATURE INPUT RANGE: T/C Input-Table 8-1 Millivolt Input-Table 8-2

LINEARITY TOLERANCE: T/C Input-Table 8-1 Millivolt Input-Table 8-2

TABLE 8-1
TEMPERATURE DISPLAY-LINEARITY AND DEFAULT SETTINGS

SENSOR TYPE	LINEARIZED RANGE*	LINEARITY TOLERANCE ±	DEFAULT SETPOINT ADJ*
J	0 to 800°C	1°C	400°C
K	0 to 1200°C	1°C	400°C
N	0 to 1200°C	1°C	400°C
R	0 to 300°C	5°C	1600°C
	300 to 1600°C	2°C	
S	0 to 300°C	5°C	1600°C
	300 to 1600°C	2°C	
T	-200 to 250°C	2°C	250°C
E	0 to 600°C	1°C	500°C
B	300 to 1800°C	6°C	1600°C
J DIN	0 to 800°C	1°C	400°C
Pt100 RTD	-200 to 250°C	0.25°C	200°C
	250 to 400°C	0.5°C	

**Maximum display in °F is 1999 for all thermocouple types*

TABLE 8-2
LINEAR PROCESS INPUT DISPLAY RANGES

RANGE	LINEAR INPUT	DISPLAY	LINEARITY TOLERANCE*
1	0-20 mV	0-100	±1.5%
2	4-20 mV	0-100	±1.5%
3	0-20 mV	0-1000	±1.5%
4	4-20 mV	0-1000	±1.5%
5	0-20 mV	0-2000	±1.5%

**Minimum impedance: 100 k ohms*

Linear Process input ranges are selectable in Function .16.

SAMPLING TIME:	3 samples per second. Re-zero of CJC and auto calibrate every 5 seconds
TEMPERATURE COEFFICIENT:	<150ppm/°C of max. linearized range (typical)
REFERENCE CONDITIONS:	22°C ±2°C, 115/230 V ±15% after 30 minutes settling time
SENSORS INPUT TYPES:	Thermocouple: J, K, E, R, S, N, B, J DIN: RTDs: 2-wire Pt-100, 3-wire Pt100 0 to 20 mV, 4 to 20 mV, user selectable
EXTERNAL RESISTANCE (TC):	100 ohms maximum
COLD JUNCTION COMPENSATION:	0.05°/°C (20:1)
BURNOUT PROTECTION:	Fault display, upscale (downscale is key selectable)
COMMONMODE REJECTION:	140 dB, 240 V, 50/60 Hz
NORMAL MODE NOISE REJECTION:	60 dB, 50 Hz

GENERAL

WEIGHT:	13.4 oz (380 g)
AMBIENT TEMPERATURE:	5° to 49°C (40° to 120°F)
NOISE IMMUNITY:	Excellent. Normal control restored within a short time after major power disturbance and "brown outs".
DATA RETENTION:	10 years with instrument unpowered
SAFETY STANDARDS:	Designed in accordance with: UL 873 Industrial Temperature Controllers, CSA C22.2/24-1981, VDE 0411 Class 1; Moldings in flame retardant polycarbonate
DEGREE OF PROTECTION:	Designed in accordance with: IEC 529:1976 BS 5490:1977; Bezel assembly IP-54 "Protected against splashing water and dust"; Case inside panel IP-30 "Protected against >2.5 mm dia. objects"
PANEL CUTOUT:	$^{1}/_{16}$ DIN or 1,772" square (45 mm square). DIN 43700
DIMENSIONS WITHOUT POWER SOCKET:	1.89" x 1.89" x 0.5" (48 x 48 x 13 mm) bezel; 4.4" (115 mm) depth behind panel. See Figure 2-1 for complete diagram with dimensions. (See Figure 8-1 for dimensions with power socket)

DIMENSIONS WITH POWER SOCKET: See Figure 8-1 below.

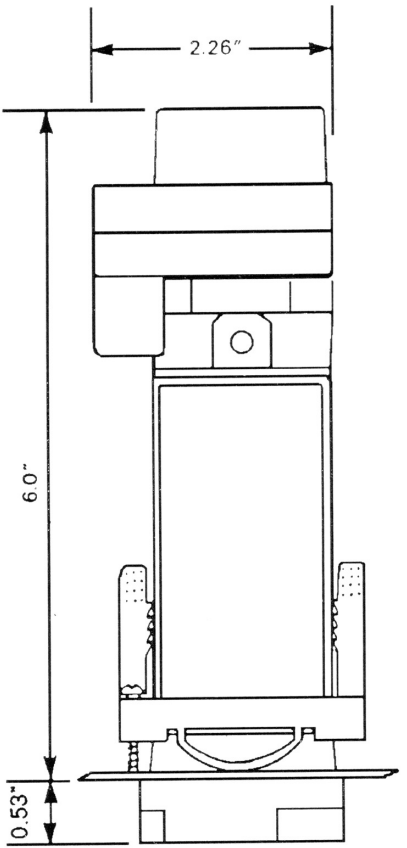


Figure 8-1. Dimensions with the Power Socket

APPENDIX A
FUNCTION QUICK REFERENCE GUIDE

STANDARD FUNCTIONS (.0 -.25)

OPERATOR ADJUSTMENTS

.0 Operating Modes (Autotune/Auto-manual)
.1 Manual Reset
.2 Setpoint 2 Adjust
.3 Setpoint 1 Lock

TUNING

.4 Cycle Time/On-off (Output 1)
.5 Proportional Band/Deadband (Output 1)
.6 Derivative Time/Rate (Output 1)
.7 Derivative Approach Control (Output 1)
.8 Integral Time (Output 1)
.9 Sensor Offset (Calibration)
.10 Cycle Time/On-off (Output 2)
.11 Proportional Band/Deadband (Output 2)
.12 Loop Break Alarm Time

SPECIAL SETUP FUNCTIONS

.13 Activate Advanced Functions .26 -.50
.14 (Not Used)
.15 Resetting Functions .0 - .24 to Default Settings

INITIAL CONFIGURATION

.16 Input Sensor Select and Range Table
.17 Negative Temperatures
.18 Display Resolution (1 or 0.1 Degree)
.19 Setpoint 2 Operation Selection
.20 Sensor Break Protection (Output 1)
.21 Sensor Break Protection (Output 2)
.22 °C/°F Selection
.23 Software Version Number
.24 Upper Setpoint Limit (Span)
.25 (Not Used)

APPENDIX A (Cont'd)
FUNCTION QUICK REFERENCE GUIDE

ADVANCED FUNCTIONS (.26 -.50)

INITIAL CONFIGURATION

.26 Heating Output Limit (Output 1)
.27 Cooling Output Limit (Output 2)
.28 Output 1 Direct/Reverse (Heat/Cool)
.29 Output 1 LED Operation
.30 Output 2 Direct/Reverse
.31 Output 2 LED Operation
.32 Error Indication Resolution
.33 Temperature Display Sensitivity
.34 Derivative Polling Ratio
.35 Sensor Span Adjust (Calibration)
.36 Limit (Latching) Control (Output 2)
.37 (Not Used)

DIAGNOSTICS

.38 Resets Functions .39 to .42
.39 Read Temperature Variance
.40 Read Maximum Temperature
.41 Read Minimum Temperature
.42 Read Duty Cycle Monitor
.43 Read Autotuning Overshoot 1
.44 Read Autotuning Overshoot 2
.45 Read Autotuning Undershoot
.46 Read Quarter Cycle Time 1
.47 Quarter Cycle Time 2
.48 Quarter Cycle Time 3
.49 Quarter Cycle Time 4
.50 (Not Used)

APPENDIX B
QUICK STARTUP

Sample case - Type K thermocouple input, autotuned to 147°C:

STEP	ACTION	DISPLAY
1 Mount controller in panel. Attach T/C & power leads in accordance with the diagram on back of controller. Note use 115 VAC or 240 VAC depending on which power level is required for the controller you ordered. Controller goes through self check routine. All segments light up momentarily.		1 8 8 8
2 Set the T/C type if no sensor has been selected previously the controller will display Function .16, option zero. The zero will flash.	Flashing	0. 1 6

NOTE

If the display does not read 0.16 with the zero flashing, then the unit has already been programmed with a sensor type. Refer to Section 3.7 and step through to Function .16 and set proper sensor type. Note other functions may have to be changed as well.

Set, e.g., T/C Type K sensor (Option 2, see page 31)	Press ▲, twice	2. 1 6
3 Enter T/C type in memory display now reads sensor temperature, e.g., 23°C	Press P, once	2 3
4 Read setpoint temperature For example 0°C.	Press ★	0

APPENDIX B (cont'd)
QUICK STARTUP

	STEP	ACTION	DISPLAY
5	Change setpoint temperature. Hold ★ button while pressing "up arrow" (▲) to increase setpoint, or alternately "down arrow" (▼) to decrease (Note that the digits will change while arrows are held, slowly at first, then more quickly).	Press ★, hold Press ▲, ▼	
	For example, the setpoint is set for 147°		1 4 7
6	Enter setpoint in memory and display process temperature, e.g., 25°C.	Press ★ Release ▲ or ▼	2 5
7	Change controller parameters by accessing Functions. For example, Function .0 (flashing) and Option 0 are displayed.	Press P Flashing	0. 0
8	To change Option 0 to Option 1 (for autotuning). Enable change of option.	Press ★ Flashing	0. 0
9	Increase Option 0 to Option 1 to enable autotuning.	Press ▲ once	1. 0
10	Start autotuning. Display will alternately flash "AT" and the process temp until Autotuning is finished. Unit will then read actual process temperature.	Press P	A T 2 6

NOTES

WARRANTY

OMEGA warrants this unit to be free of defects in materials and workmanship and to give satisfactory service for a period of **37 months** from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal three **(3) year product warranty** to cover handling and shipping time. This ensures that our customers receive maximum coverage on each product. If the unit should malfunction, it must be returned to the factory for evaluation. Our Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective it will be repaired or replaced at no charge. However, this WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear or which are damaged by misuse are not warranted. These include contact points, fuses, and triacs.

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BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, YOU MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OUR CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAY'S). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

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FOR **NON-WARRANTY** REPAIRS OR **CALIBRATION,** consult OMEGA for current repair/calibration charges. Have the following information available BEFORE contacting OMEGA:

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2. Model and serial number of product, and
3. Repair instructions and/or specific problems you are having with the product.

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