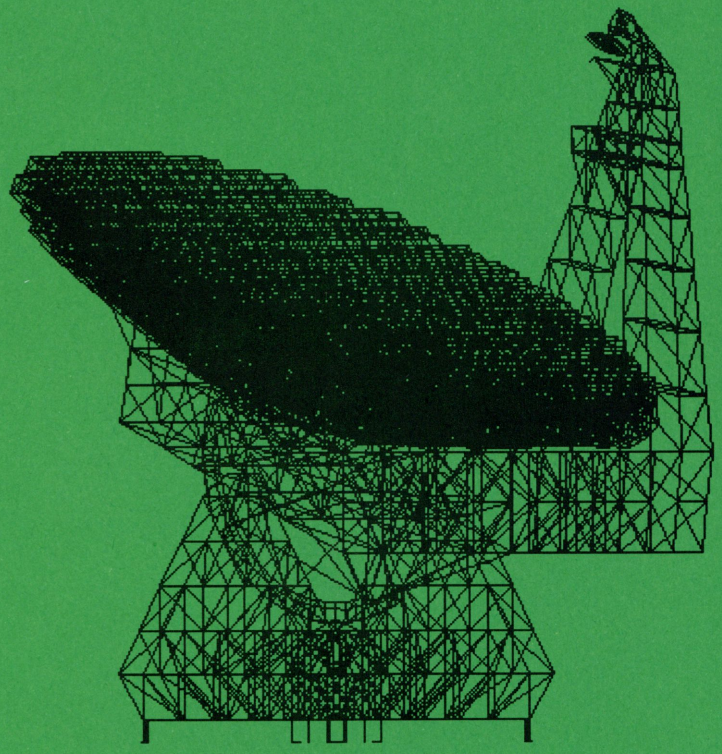
Green Bank Telescope Project

GBT Technical Report No. 1

PID HVAC Controller

Roger D. Norrod
October 1998



National Radio Astronomy Observatory
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NATIONAL RADIO ASTRONOMY OBSERVATORY
GREEN BANK, WEST VIRGINIA

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PIC HVAC CONTROLLER

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1.0 Introduction

For best operation, the temperature of radio astronomy instrumentation, (particularly analog RF or microwave components), must be kept highly stable. Critical systems are often insulated or contain active temperature control to control the magnitude and timescale of temperature variations. However, when equipment is located in heated and air-conditioned rooms, commercial HVAC systems often induce small (several degrees centigrade) but significant temperature fluctuations of a cyclic nature. Anticipating this possibility, soon after the new wing of the Jansky Lab was accepted, a temperature logger was placed in various equipment rooms on the second floor. The resulting measurements showed variations in air temperature of several degrees centigrade over periods as short as ten minutes. Figure 1 shows a typical measurement in room 206, the GBT Equipment Room. Following installation of GBT Electronics systems in this room, it was confirmed that changes in detected total power correlated with the room air temperature were easily detectable. It is likely that correlated phase changes would also occur which would be a problem for VLBI experiments.

As a result, a project was initiated to improve the control characteristics of the HVAC systems in the GBT Equipment room. A concept was developed and tried initially in room 204, the VLBI Tape room, which was then empty. The concept involves bypass of the standard HVAC controllers, and installation of a PID (proportional-integrating-differential) controller. The operation of the new controller proved satisfactory in room 204, and it was then installed in the GBT Equipment room. It should be noted that the HVAC systems delivered with the building are entirely satisfactory for rooms containing people and computer systems, and appear to meet the building contract specifications.

This report describes the design, installation, operation, and maintenance of the new HVAC control system.

2.0 System Descriptions

This section describes the theory of operation of the original and modified HVAC systems in the equipment rooms located on the second floor of the new Jansky wing.

2.1 Operation of Original HVAC Systems

Each room contains two independent air-handler units manufactured by Compu-Aire, Inc. of Whittier, CA. Each unit consists of a blower, heat exchangers for heated and chilled water, solenoid actuated water valves in series with each heat exchanger, temperature and humidity sensors, a humidifier unit, and a microprocessor based controller. The air-handlers sit on a raised floor which also serves as a pressurized air plenum. The direction of air flow is into the top of the air-handlers, by the temperature and humidity sensors, through the heat exchangers, and out the bottom of the units into the air plenum. The air then flows up through electronics racks sitting on the raised

floor or through floor vents and then flows back to the top of the air-handlers. The controller (a Compu-Aire "System 2000") attempts to maintain the return air temperature and humidity within a set range by controlling the flow of chilled and heated water through the heat exchangers. If low humidity is sensed, the controller activates the humidifier to add water vapor to the air. It also will sound alarms if temperature or humidity limits are exceeded, and will shut the unit down if air stops flowing. A front control panel displays the measured temperature and humidity and provides user control for the set points and alarm values. Hot water at approximately 140°F and cold water at approximately 40°F are supplied to all air handlers by a distribution piping system from the building mechanical room.

The water valve actuators are manufactured by Siebe Environmental Controls, Inc., Loves Park, IL. Two different types of actuators are used. The hot water actuator is a two position valve powered by a 24VAC control voltage. When 24VAC is applied to the actuator, the valve is opened and hot water flows. When power is removed, the valve closes and hot water flow stops. The hot water valve actuator unit is a self-contained hydraulic actuator with an internal motor and pump. The cold water valve actuator is similar, but incorporates a control transducer producing a proportional actuator controlled by a DC voltage between 6 and 9 VDC. When 6VDC is applied, the valve is closed and no cold water flows; when 9VDC is applied, the valve is open and full flow of cold water occurs. The cold water actuator also requires 24VAC for its internal hydraulic motor, and if not present the valve is closed. Manufacturer's data sheets for the Siebe actuators and valves are included in Appendix A. During testing of the PID controller with the Siebe valves, it was discovered that the proportional valves have significant hysteresis, and it was necessary to change the control voltage scale to 5-9VDC from the manufacturer's stated 6-9VDC in order to ensure the valve completely closes.

2.2 Modification of HVAC Systems

Drawing D35201W001, Sheet 1 (Appendix B) gives instructions for wiring modifications required in the HVAC system. Control wires between both water valves and the Compu-Aire internal controller are cut and connected to an added Elco connector, J1. A four wire cable connects J1 to the NRAO PID controller chassis. A mating "patchback" connector for J1 is provided in each air handler which may be used in place of the PID cable; this returns control to the Compu-Aire controller and may be useful in case the PID controller fails.

Drawing D35201W001, Sheet 2 is a wiring diagram for the PID Controller chassis. The heart of this chassis is A1, a PID process controller Model CN76122-485, manufactured by Omega Engineering, Inc., Stamford, CT. A manual for the CN76122 controller is reproduced in Appendix C. The CN76122 is a flexible controller that accepts a variety of sensor inputs and provides two linkable control outputs. In our application, a platinum RTD temperature sensor is connected to the CN76122 sensor inputs (pins 1,2, 3). The control outputs are configured as 0-5V pulse-width modulated signals; Output A (pins 8,7) is used to control the cold water valves in both air handler units; Output B (pins 10,9) is used to control the hot water valves. An alarm contact closure output

(pins 4,5) is connected through a front-panel switch S2 to a Mallory audio alarm. The CN76122 may be remotely programmed via a RS-485 serial port (pins 11,12) but this feature is not currently used; configuration programming is accomplished via the front panel. Table 1 lists the CN76122 programmed values for this application.

In order to interface to the Siebe hot water valves, the CN76122 PWM Output B is connected to the control ports of solid-state relays K1 and K2. The load side of these relays are connected in series with the hot water valve actuator 24VAC power, supplied by the air handlers. Output B is programmed to a 60 second cycle time.

In order to interface to the Siebe cold water valve proportional control point, the CN76122 PWM Output A must be converted to a DC voltage, offset, and scaled to the 5-9VDC range. This function is performed by A3, a PWM/Vo Converter circuit built by NRAO. This card is described below.

Drawing D35201W001, Sheet 3 is the schematic for the PWM/Vo Converter. Op-amp U1 serves as a current-voltage converter and a low-pass filter. The two 1.50 MΩ resistors supply a constant 5μA current to the U1 summing junction. The PWM Output A signal from the CN76122, configured to a 1 second cycle time, is connected to the circuit card pins 6,7. Therefore, 0 or 4μA flows into the U1 summing junction through the series 1.00MΩ and 250KΩ resistors, as the PWM input switches between 0V and 5V. The RC feedback network around U1 filters and scales the input currents to -5 to -9VDC, proportional to the fraction of its cycle time the Output A signal is ON. Amplifiers U2 and U3 invert the negative output of U1 and provide sufficient drive current for the Siebe cold water valves (approximately 15mA).

3.0 Installation

Installation of the PID Controller consists of the following steps:

1. Select a location for the PID chassis and the temperature sensor. Mount both and connect the sensor to the PID chassis J3 Sensor connector.

2. Modify the Compu-Aire air handlers per D35201W001. Connect the added J1 connector in each handler to the PID chassis J1 and J2 connectors.

3. Ensure that the CN76122 input is configured for "RTD Input", per the Omega Operator's Manual (Appendix C), page 3. Ensure that the CN76122 outputs are configured for "5Vdc Type Output", per the Omega Operator's Manual, pages 3 and 4. Note that for this configuration process the CN76122 can be snapped from its case by grasping and pulling the front bezel; it is not necessary to remove the case from the chassis.

4. Turn on power to the PID chassis and program the CN76122 controller per Table 1, following directions in the Omega Operator's Manual (Appendix C), pages 9-16. Note that the configuration parameters are stored in non-volatile memory, so once programmed, reprogramming should not be required unless the CN76122 is replaced.

4.0 Operation

In the GBT Equipment Room, the PID Controller chassis is located in the LAN Rack (RNG3-Unit 5). Figure 2 shows typical performance measured near the control sensor, as well as several other locations in the room, after installation of the PID controller. Figure 3 shows response of the PID system to a step in setpoint.

4.1 Monitoring the PID Controller Operation

Refer to the CN76122 Operator's Manual (Appendix C), page 7 for a diagram of the front panel display. As configured per Table 1, the upper digital display shows the sensed temperature in Fahrenheit. The "Set Point 1 Lamp" indicates the PWM output for SP1, used to control the cold water valves. For example, if the controller is calling for 50% cold water, the SP1 lamp will be on ½ second, off ½ second. The "Set Point 2 Lamp" indicates the PWM output for SP2, used to control the hot water valves. For example, if the controller is calling for 50% hot water, the SP2 lamp will be on 30 seconds, and off 30 seconds. The lower digital display indicates the output of the controller in percent. An "o" will appear in the right hand side of the lower display indicating percent output for Output A (cold water). An "o" with a line over it indicates the percent output for Output B (hot water). The lower display will alternate between the two values about once a second. This display set is termed the HOME display position in the Omega manual.

4.2 Changing the Setpoint Temperature

From the HOME display, pressing the Index key causes the lower display to change to "SP1" and the upper display shows the current temperature set point in Fahrenheit. (This is the "Primary Menu" described in the Omega Operator's Manual, page 8.) The arrow keys may be used to change the temperature set point. The Enter key must be pressed to activate any change. Pressing the index key a second time causes the lower display to change to "SP2". The upper display should then show 1.0; do not change this value. Pressing Index a third time causes the HOME display to return.

In the GBT Equipment Room, the PID controller temperature sensor is located in the pressured air plenum directly underneath the Analog Filter Rack (RNG3-Unit 4). Currently, the setpoint temperature is 60.0 °F. Typically, the controller calls for 20% cold water and 0% hot water to maintain this setpoint. These percentages will vary with equipment loads and outside temperature.

4.3 Monitoring the Air Handler Operation

After installation of the PID controller, the Compu-Aire controllers in the air handlers no longer have control of the water valves. However, they do not realize this and so their front panel displays may falsely indicate HEATING or COOLING or an alarm condition. These indications should be ignored, or the air handler setpoints, deadbands, and alarm windows should be changed to prevent false indications.

The PID Controller does not sense humidity so makes no attempt to maintain a certain humidity level. However, the Compu-Aire system continues to sense humidity and will use the humidifier to add water vapor if the sensed humidity drops below the humidity setpoint minus the humidity deadband value.

4.4 Reverting to Operation by the Compu-Aire Controllers

Should the PID Controller fail, it is a simple task to revert to control by the Compu-Aire controllers. Turn off the air handlers at their front panel. Open the air handlers' left cover panel. Locate the added Elco 20-pin connector near the water valves. Disconnect the cable going to the PID Controller and connect the provided patchback connector. Close the door, turn the air handlers on, and check the parameter settings using the air handler front panel interface. Adjust if necessary.

5.0 Troubleshooting

- If the PID controller appears to lose control, e.g. the room temperature rises and the CN76122 indicates it is calling for 100% cooling, check that the building system is providing chilled and heated water properly to the air handlers. The most common problem to date has been shutdown of the building chillers. This frequently occurs following a power outage.

- To troubleshoot the system, it may prove useful to temporarily place the CN76122 in Manual control mode. This allows explicit setting of the control outputs anywhere between 0-100% from the front panel. Refer to the Omega Operator's Manual (Appendix C), page 13.

- Should a problem occur with hot water valve control, refer to D35201W001, Sheet 2. When the hot water control Output B (SP2) is ON (5 VDC), K1 and K2 should be "closed", and the voltage across the load side should measure 1 to 2 VAC. When Output B is OFF (0 VDC), the voltage across the load side should measure 28VAC. If these values are not seen, check the connections to the relevant air handler. If necessary to further isolate a problem, disconnect the cable to the air handler and use an external voltage source and dummy load in series with the solid-state relays to check for their proper operation.

- To check proper operation of the PWM/Vo circuit card, use a DVM or oscilloscope and refer to the wiring diagram D35201W001, Sheet 3. When control Output A (SP1) is 0%, the CN76122 PWM should be stable at 0 VDC. Output pin 6 of U1 should be -5 VDC. The outputs of U2 and U3 should measure +5 VDC. When control Output A is 50%, the CN76122 PWM should cycle between 0 and 5 VDC with cycle time 1 second and 50% duty cycle. The output of U1 should be -7 VDC; ripple should be less than 50mV. When control Output A is 100%, the CN76122 PWM output should be stable at 5 VDC, and the output of U1 should be -9 VDC. It will take several seconds for the output of U1 to reach a stable value following a PWM percentage change. Errors in the U1, U2, or U3 output values less than 200 mV are insignificant.

- A list of CN76122 diagnostic error messages is given in the Omega Operator's Manual (Appendix C), pages 17-18.

Table 1

OMEGA PID CONTROLLER
Parameters

Primary Menu

SP1	60.0
SP2	1.0

Secure Menu (Δ Enter 5sec)

SECr	4
InP	P385
Unit	F
dPT	0.0
InPT	2.0
SenC	OFF
SCAL	-328
SCAH	1607
SPL	50
SPH	80
SP1o	OutA
S1Ot	F+
	1.10
SISt	dir
SI0L	0
SI0H	100
SILt	O On
S2t	dE
S2Ot	CY
S25t	rE
S2OL	0
S2OH	100
S2LP	O On
AL	OFF
ADDR	32
bAUd	19.2
nAt	OFF
cflt	1

Secondary Menu (Λ Enter)

Auto	On
tune	Pid
Pb1	6
Pb2	10
rES	3.0
rtE	0.25
PID2	On
ArUP	On
ArtE	OFF
PEA	69
UAL	42
S1Ot	F+
CY2	60
PctO	On
Prog	OFF
StAt	OFF
lrt	0.00
1St	0.00
PEnd	Hold
InPC	0.0
	Filt 4
LPbr	OFF
LOrE	LOC
CFSP	73.0
Addr	32

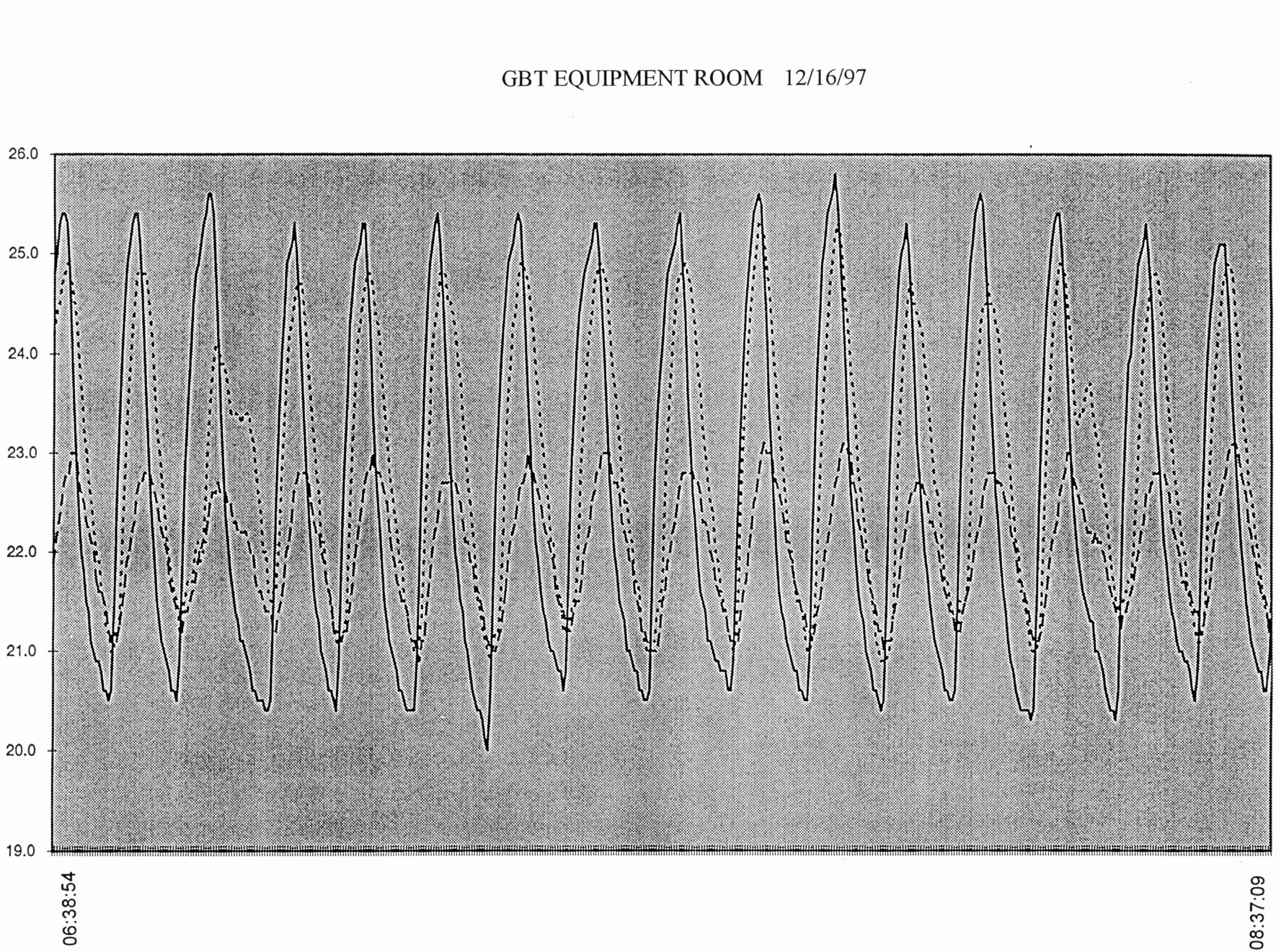


Figure 1

Temperature Measurements in the GBT Equipment Room with Compu-aire Controllers. Solid line is the plenum temperature. Dashed lines are at two other room locations.

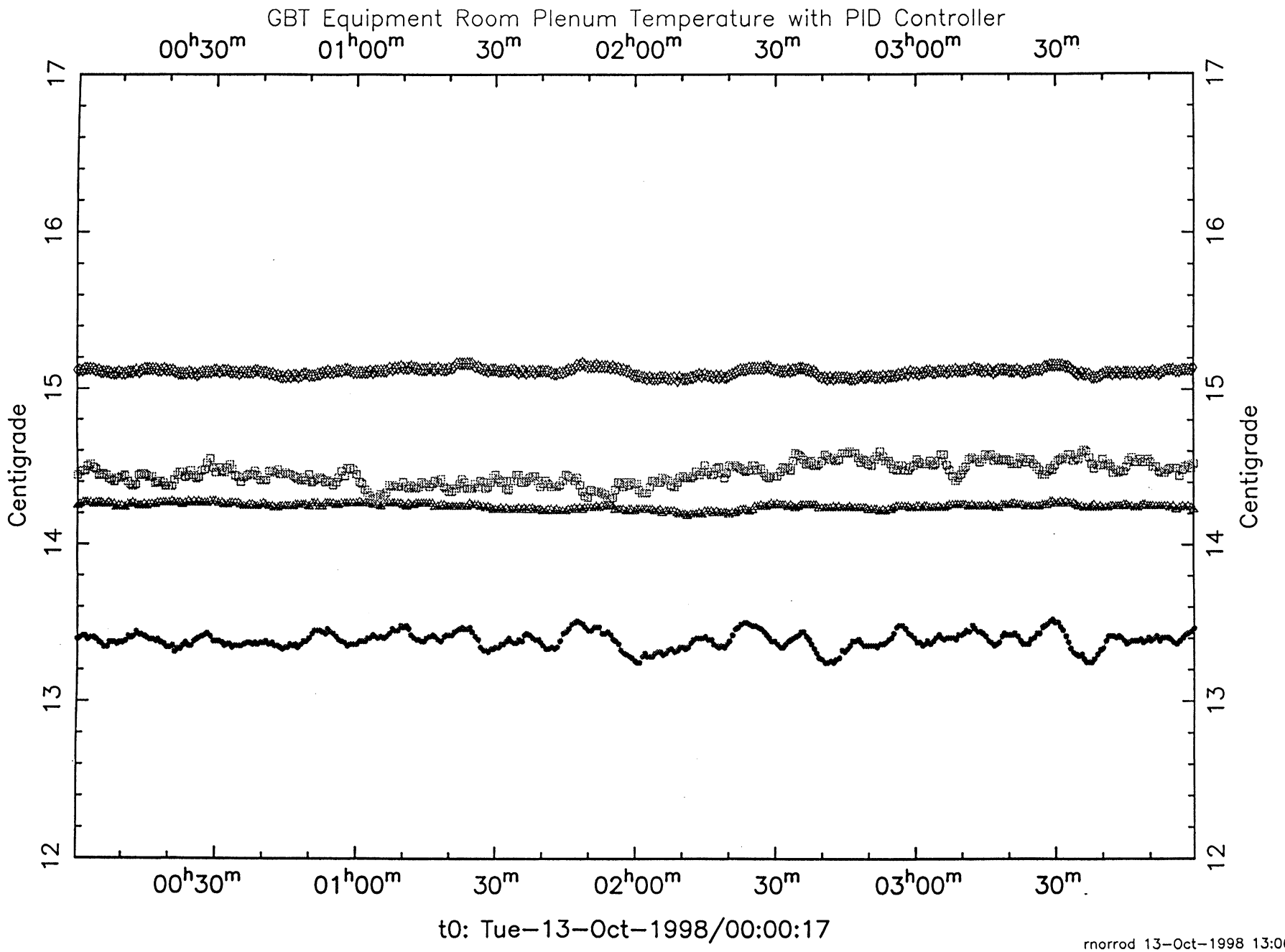


Figure 2
TYPICAL TEMPERATURE STABILITY
Lower trace is the plenum temperature. Other traces are from sensors at various places in the room. PID Controller is operating.

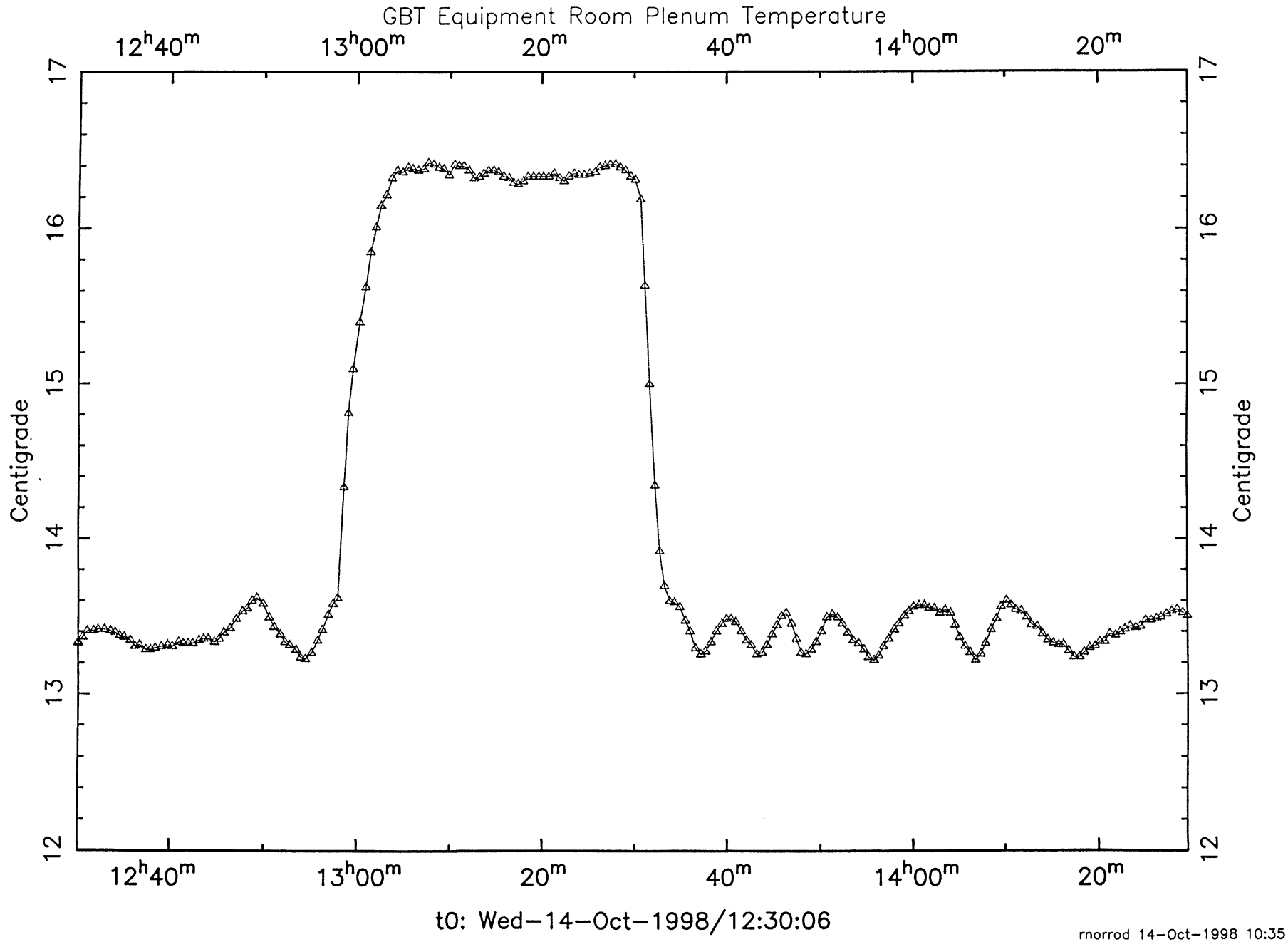


Figure 3
PID Controller response to a 3 °C step in set point.

DATE: 10-14-98 BOM A35201B006 PID HVAC CONTROLLER

PARENT BOM	TYPE	DESCRIPTION	PART NUMBER	MANUFACTURER	QTY REQD
B006	ASSY	HVAC CONTROL BOX	D35201M029	NRAO	1
B006	CAP	0.1 UF CERAMIC			6
B006	CAP	10 UF TANTALUM			1
B006	CAP	1 UF CERAMIC			2
B006	CONN	5 PIN BULKHEAD	126-5S	AMPHENOL	1
B006	CONN	BNC BULKHEAD	31-4803	AMPHENOL	1
B006	CONN	22 PIN EDGECARD	9144	CINCH	1
B006	CONN	ELCO PANEL,20P,PROTECTED		ELCO	2
B006	CONN	ELCO,CABLE,20P,EXPOSED		ELCO	2
B006	CONN	ELCO,PANEL,20P,EXPOSED		ELCO	2
B006	CONN	ELCO,CABLE,20P,PROTECTED		ELCO	2
B006	DWG	WIRING DIAGRAM	D35201W001	NRAO	1
B006	IC	OP AMP	ADOP07	ANALOG DEV	3
B006	MISC	SWITCH, AC SPST			1
B006	MISC	SWITCH, DC, SPST			1
B006	MISC	FUSEHOLDER	HKP	BUSSMAN	3
B006	MISC	BUZZER ALARM	PF-27N36W	MALLORY	1
B006	MISC	PROCESS CONTROLLER	CN76122-485	OMEGA	1
B006	MISC	TEMPERATURE SENSOR	RTD-805	OMEGA	1
B006	MISC	SOLID-STATE RELAY	SSR240DC45	OMEGA	2
B006	MISC	POWER SUPPLY, 15V DUAL	HAD15-0.4-A	POWER ONE	1
B006	MISC	AC PANEL SOCKET	6100-3100	SCHURTER	1
B006	RES	RESISTOR, 1%, 1.50MEG			2
B006	RES	RESISTOR, 1%, 1.00MEG			2
B006	RES	RESISTOR, 1%, 250K			1
B006	RES	RESISTOR, 1%, 100K			4

Appendix A
Manufacturer Data Sheets

MA-5200 Series
MA-5300 Series

SIEBE ENVIRONMENTAL CONTROLS

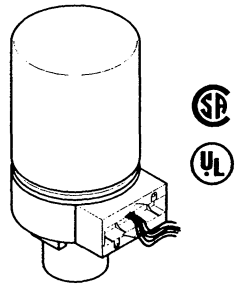
Hot Water ! MA-5213-0-0-3

1354 Clifford Avenue
P.O. Box 2940
Loves Park, IL U.S.A. 61132-2940

Two-Position Actuators General Instructions

Application

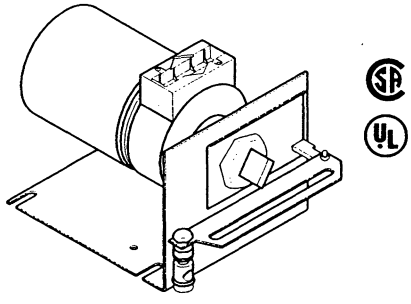
The MA-5200 series and MA-5300 series actuators are used for two-position control of valves and dampers which require a return to the normal position upon power interruption.



MA-521X Series Valve Actuator

Features

- Two-position actuators controlled by an SPST controller
- Spring return
- 24 Vac, 120 Vac, and 240 Vac models are available
- Optional built-in, adjustable, SPDT auxiliary switch
- Available in damper models or base models that require damper or valve linkage
- Die cast lower housing with 1/2" conduit opening and painted steel upper housing
- Hydraulic actuator with oil-immersed motor and pump



MA-533X Series Damper Actuator

Applicable Literature

- Siebe Environmental Controls Cross-Reference Guide, F-23638
- Siebe Environmental Controls Reference Manual, F-21683
- Environmental Controls Application Manual, F-21335
- Engineering Bulletin EN-110, Damper Actuator Sizing, F-15260
- General Instructions Sheet, F-19069, for Valve Linkages AV-600 and AV-601
- Material Safety Data Sheet MSDS-3, (Until Feb. 1989)
- Material Safety Data Sheet MSDS-12 (Currently)

SPECIFICATIONS

Actuator Inputs

Control Circuit: Two-wire, SPST.
Power Input: Refer to Table-1 and Table-2.
Connections: Color-coded 4' (1.2 m) leads.

Actuator Outputs

Electrical:

Auxiliary Switch (MA-5XXX-500), 10 Amps, 120/240 Vdc adjustable SPDT, factory set to close the N.O. contact at the retracted end of stroke.

Mechanical:

Stroke,

Damper Approximately 2" (51 mm) from fully retracted to fully extended (includes AM-601 linkage).

Valve Approximately 9/16" (14.3 mm) from fully retracted to fully extended.

Nominal Damper Area, Actuator Sizing should be done in accordance with damper manufacturer's specifications. If this information is not available, the following general guidelines can be used:

Nominal damper rating is 11.1 $ft.^2$ (1.0 m^2) for parallel and 14.3 $ft.^2$ (1.3 m^2) for opposed blade standard dampers (not low leakage) with 2,000 fpm (10.2 m/s) velocity at 1 in. H_2O (0.25 kPa) static pressure. For damper ratings under other operating conditions, refer to **Engineering Bulletin EN-110 (Damper Actuator Sizing), F-15260.**

Environment

Ambient Temperature Limits:

Shipping & Storage, -40 to 140° F (-40 to 60° C).

Operating,

Damper 0 to 140° F (-18 to 60° C).

Valve Refer to Table-3.

Humidity: 5 to 95% RH, non-condensing.
Location: NEMA Type 1.

Table-1 Model Chart for Damper Actuators.

Part Number	Actuator Power Input					Timing in Seconds @ 72° F (22° C)		Torque Rating lb.-in. (N-m)
	AC Voltage +10/ -15%	Hz		VA	Watts	To Extend (No Load Stroke)	Retract on Power Loss	
MA-5330	120	50	60	18	10	60	15	20 (2.3)
MA-5333	24							

Table-2 Model Chart for Valve Actuators. Also for Damper Actuators with Field Assembled Damper Linkages.

Part Number	Actuator Power Input				10 Amps Aux Switch	Timing in Seconds @ 72° F (22° C)		Required Linkage**	
	AC Voltage +10/-15%	Hz		VA	Watts	To Extend (No Load Stroke)	Retract on Power Loss	Damper	Valve
MA-5210	120	50	60	18	10	No	60	15	AM-601	AV-600 AV-601*
MA-5210-500						Yes				
MA-5211	240					No				
MA-5211-500						Yes				
MA-5213	24					No				
MA-5213-500						Yes				

*May be required for steam and hot water. Refer to Table-3.

**Damper models are provided with factory-installed damper linkages. Only base models require separately-ordered linkages.

Table-3 Restrictions on Maximum Ambient Temperature for Valve Actuators.

Maximum Temperature of Media in the Valve Body (Check Rating of the Valve) °F (°C)	Maximum Ambient Temperature of MA-521X Series	
	AV-600 (Only) °F (°C)	AV-600 and AV-601 °F (°C)
366 (186)	90 (32)	90 (32)
340 (171)	100 (38)	100 (38)
281 (138)	115 (46)	140 (46) *
181 (83)	140 (60) *	140 (60) *
80 (26)	140 (60) *	140 (60) *

* Maximum ambient temperature of the actuator must never exceed 140° F (60° C).

ACCESSORIES

Common

11-1612 1/2" conduit bushing

Damper Linkages

AM-111 Crank arm for 5/16" (8 mm) diameter damper shaft
AM-112 Crank arm for 3/8" (10 mm) diameter damper shaft
AM-113 Crank arm for 1/2" (13 mm) diameter damper shaft
AM-115 Crank arm for 7/16" (11 mm) diameter damper shaft
AM-122 Linkage connector straight type
AM-123 Damper clip
AM-125 5/16" diameter x 20" (8 x 508 mm) damper rod
AM-125-048 5/16" diameter x 48" (8 x 1219 mm) damper rod
AM-132 Ball joint connector
AM-161-3 Damper linkage kit
AM-601 Device includes mounting bracket, damper linkage with spring, and AM-122 straight connector. Required to modify (MA-521X series) valve actuators into 2" (51 mm) stroke damper actuators.
AM-602 Spacer

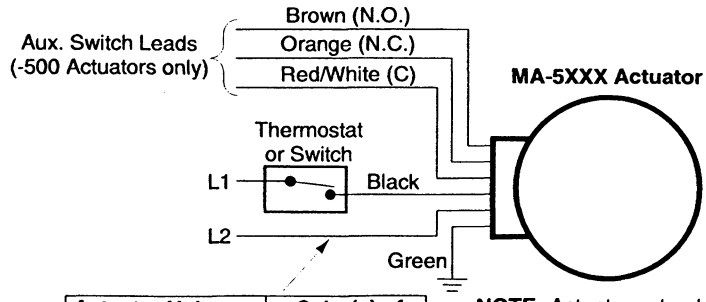
Valve Linkages

AV-600 Valve linkage
AV-601 Valve linkage extension for hot water and steam applications; use with AV-600

TOOLS (factory-available)

TOOL-12 Wrench for adjustment of auxiliary switch
TOOL-19 Spring compression tool for AV-600
TOOL-37 1-5/8" (41 mm) open-ended wrench

TYPICAL APPLICATIONS (wiring diagrams)



Actuator Voltage Vac	Color(s) of L2 Lead
24	Black/Blue
120	White
240	White/Black

NOTE: Actuator extends when contacts are closed and retracts when contacts are open

3/4 A

Figure-1 Typical Wiring for MA-5XXX Series Actuators.

INSTALLATION

Inspection

Inspect the package for damage. If damaged, notify the appropriate carrier immediately. If undamaged, open the package and inspect the device for obvious damage. Return damaged products.

Requirements

- Job wiring diagrams.
- Tools (not provided):
  - Digital Volt-ohm Meter (DVM).
  - Appropriate drill and drill bit for mounting screws.
  - Appropriate screw drivers and wrenches.
  - TOOL-12, Wrench for adjustment of auxiliary switch.
  - TOOL-19, Spring compression tool for AV-600.
  - TOOL-37, 1-5/8" (41 mm) open-ended wrench.
- Training: Installer must be a qualified, experienced technician.

▼ ***WARNING***

- Disconnect the power supply (line power) before installation to prevent equipment damage.
- Make all connections in accordance with the wiring diagram and in accordance with national and local electrical codes. *Use copper conductors only.*

▼ ***CAUTION***

- Do not exceed the ratings of the device(s).
- Do not apply power to the unit unless the damper linkage and/or the valve assembly have been installed.
- Avoid locations where excessive moisture, corrosive fumes, or vibration is present.
- Do not install insulation on any part of the actuator.

Mounting

▼ *CAUTION*

Do not twist or exert any force on the actuator housing during installation. Either turn the base by hand or, if necessary, use a 1-5/8" (41 mm) open-ended wrench (TOOL-37) on the flats provided on the actuator base or the valve body mounting nut. Refer to Figure-2.

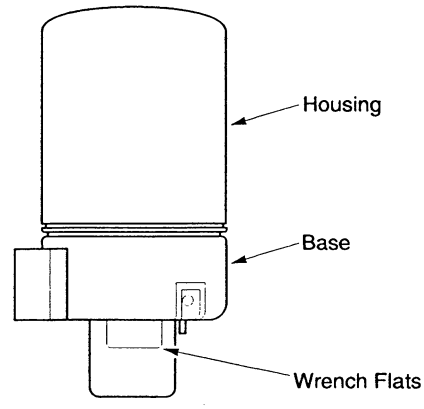


Figure-2 Housing and Base Location.

Dampers

The actuator is not position sensitive. It can be mounted in any position in an NEMA Type 1 location.

Valves

Allow 3" (76 mm) of clearance above the actuator valve assembly for the removal and reattachment of the actuator to the installed valve.

1. Install all two-way valves so that they close against the flow. An arrow on the valve body or tag indicates proper flow direction.
2. Always install three-way mixing valves with two inlets and one outlet.
3. Always install three-way diverting valves with one inlet and two outlets.

▼ *CAUTION*

For steam applications only, mount the actuator above the valve body at 45° from vertical.

4. Actuators can be mounted in any upright position above the centerline of the valve body.

Wiring Requirements

Power Leads

The low voltage (24 Vac) power leads may be connected to a Class 2 circuit if routed separately from Class 1 circuit wiring. The line voltage (120 and 240 Vac) leads must be connected to a Class 1 circuit. Refer to Figure-7.

Refer to Table-4 for the maximum length of run for the power leads, for the given wire size(s). To determine the allowable maximum power lead run when wiring multiple actuators, divide the maximum run shown in Table-4 by the number of actuators on the run. Refer to Figure-3 for further details.

Table-4 Power Wiring Data.

Actuator Voltage Vac	Actuator Model Number	Power Lead Colors	Wire Size GA	Maximum Wire Run ft. (m)
120	**MA-5210**	Black & White	14	3,500 (1,067)
	MA-5210-500			
240	**MA-5211**	Black & White/Black	14	6,000 (1,829)
	MA-5211-500			
24	**MA-5213**	Black & Black/Blue	14 12	300 (91.5) 480 (146.3)
	MA-5213-500			
120	**MA-5330**	Black & White	14	3,500 (1,067)
	MA-5330-500			
24	**MA-5333**	Black & Black/Blue	14 12	300 (91.5) 480 (146.3)
	MA-5333-500			

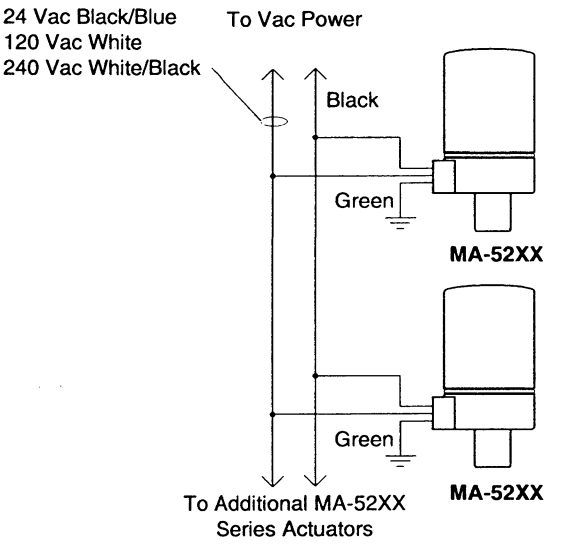


Figure-3 Wiring of Multiple MA-52XX Series Actuators to Single Power Source.

Auxiliary Switch Leads

The low voltage (24 Vac) auxiliary switch leads may be connected to a Class 2 circuit.

The line voltage (120 Vac and 240 Vac) auxiliary switch leads must be connected to a Class 1 circuit and routed separately from any Class 2 circuit wiring. Refer to Figure-7.

Wiring Connections

General

Make connections as required. Refer to the following sections:

- Wire Lead Connections (No Conduit)
- Install 3/8" reduced (thin wall) flexible conduit onto either side of actuator
- Install 3/8" reduced (thin wall) flexible conduit directly onto actuator
- Install conduit box onto actuator

Wire Lead Connections (No Conduit)

Make connections as required. Refer to Figure-1 for a wiring diagram of a typical application. Refer to Figure-4 for a view of the actuator.

NOTE

The cover plate and screw supplied with the actuator are not required with this method.

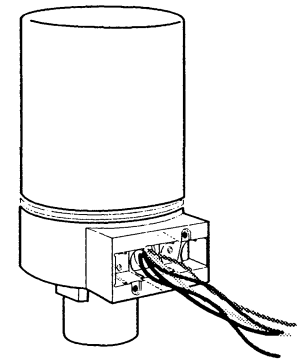


Figure-4 Connection of Wire Leads (No Conduit).

Install 3/8" reduced (thin wall) flexible conduit onto one or both sides of actuator.

Flexible conduit may be installed onto one or both sides of the actuator (refer to Figure-6 and Figure-7). Install each conduit as follows:

1. Determine the side of the actuator to which the flexible conduit is to be attached.
2. Remove the knockout (e.g., with channel lock pliers) on the selected side of the actuator. Refer to Figure-5.
3. Make the required connections. Refer to Figure-1 for a wiring diagram of a typical application.

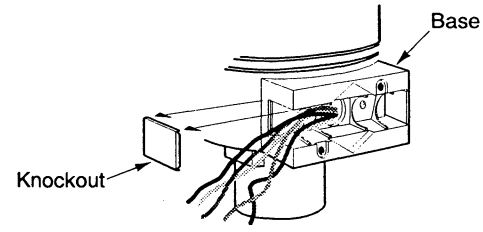


Figure-5 Removal of Knockout on Actuator Base.

4. Slip the conduit onto the base, over the ribs. Refer to Figure-6 and Figure-7.
5. If flexible conduit is to be installed on both sides of the actuator, repeat the preceding steps to install the second conduit.

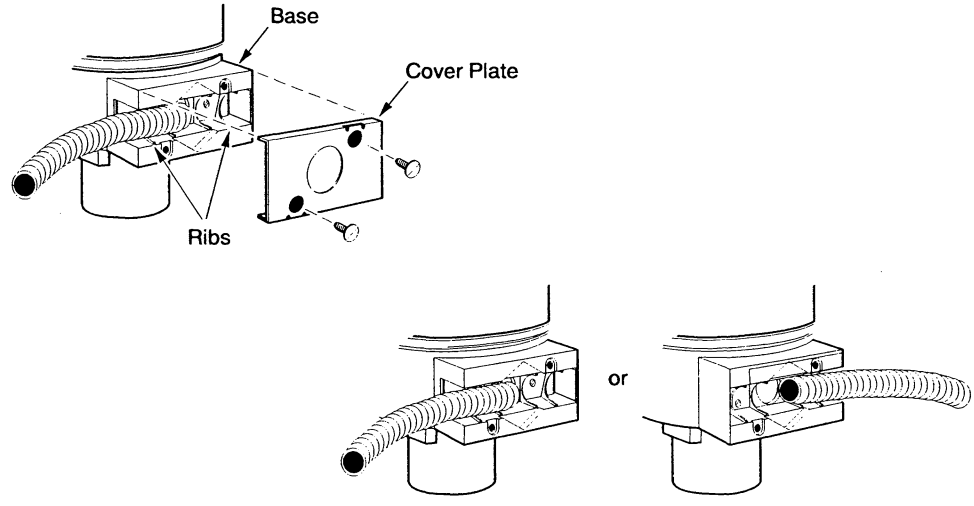


Figure-6 Flexible Conduit Installation to Either Side of Actuator.

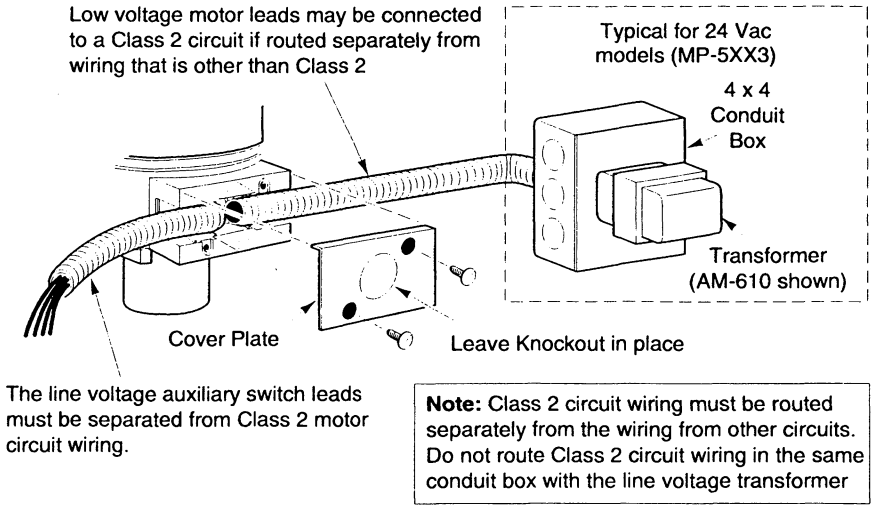


Figure-7 MA-5200 and MA-5300 Series Wiring with Separation for Class 2 and Line Voltage Circuits.

6. Install the cover plate with two screws. The cover plate and two screws are supplied with the actuator.

Install 3/8" reduced (thin wall) flexible conduit directly onto actuator.

1. Remove the knockout from the cover plate supplied with the actuator. Refer to Figure-8.

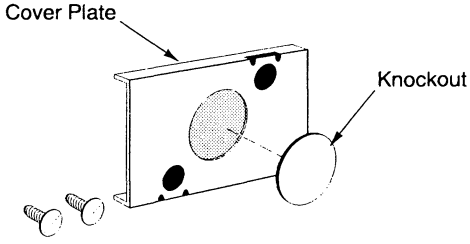


Figure-8 Cover Plate Knockout Removal.

2. Slip the leads through a standard 1/2" conduit bushing (not supplied) and the knockout hole in the cover plate. Refer to Figure-9 and Figure-10.

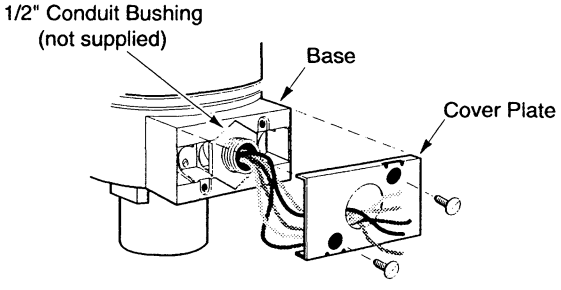


Figure-9 Conduit Bushing and Cover Plate Installation.

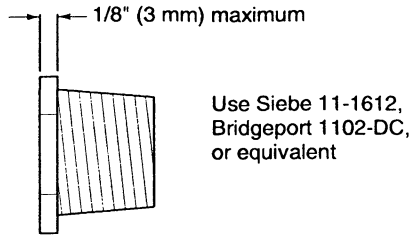


Figure-10 1/2" Conduit Bushing.

3. Nest the conduit bushing in the base.
4. Install the cover plate, using the two screws provided.
5. Make the required connections. Refer to Figure-1 for a wiring diagram of a typical application.
6. Attach the flexible conduit to the conduit bushing, as required.

Install conduit box onto actuator.

1. Remove the knockout from the cover plate supplied with the actuator. Refer to Figure-8.
2. Slip the leads through a standard 1/2" conduit bushing (not supplied) and the knockout hole in the cover plate. Refer to Figure-9 and Figure-10.
3. Nest the conduit bushing in the base.
4. Install the cover plate, using the two screws provided.
5. Attach the conduit box to the threaded adaptor.
6. Make the required connections. Refer to Figure-1 for a wiring diagram of a typical application.
7. Install the rigid conduit, the flexible conduit, etc. to the conduit box as required. Refer to Figure-11.

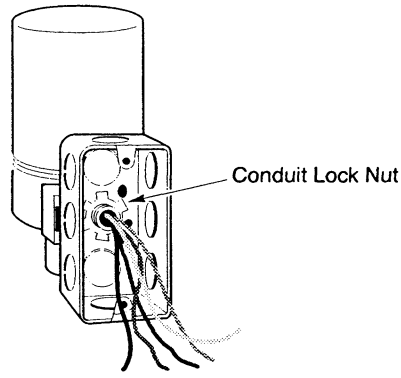


Figure-11 Attachment of Conduit Box to Threaded Adaptor.

NOTE

As shown in Figure-9, the hole in the cover plate of the actuator conduit housing is sized to accept both British standard M20 (20 mm) conduit connectors and 20 mm-to-PG16 adaptors for use with DIN PG16 connectors. (Follow the steps for installing the conduit box to the actuator.)

Linkage Assembly

Damper

NOTE

Each actuator in the MA-5X3X series is provided with a factory-installed damper linkage. No separately-ordered linkage is required.

▼ ***CAUTION***

Do not twist or exert any force on the actuator housing during installation. Either turn the base by hand or, if necessary, use a 1-5/8" (41 mm) open-ended wrench (TOOL-37) on the flats provided on the actuator base, or on the valve body mounting nut. (Refer to Figure-2.)

1. Determine the best mounting position for the actuator as follows:
   a. Determine, from the system requirements, if the damper should spring-return to the open position (refer to Figure-12) or closed position (refer to Figure-13) whenever power is lost to the actuator. An actuator is normally linked so as to retract (spring-return) to the damper's fully open position (heat position).

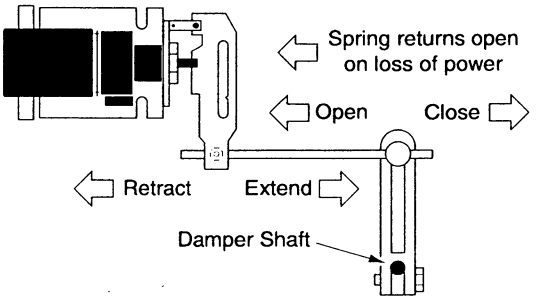


Figure-12 Dampers Open When Actuator Retracts (Spring-Returns Open on Power Loss).

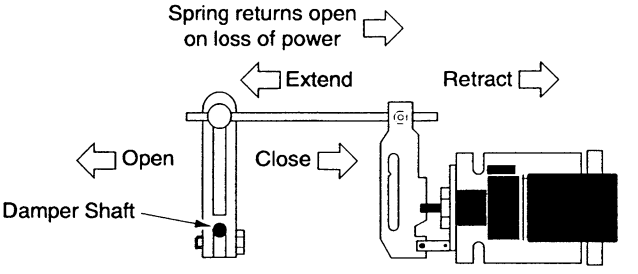
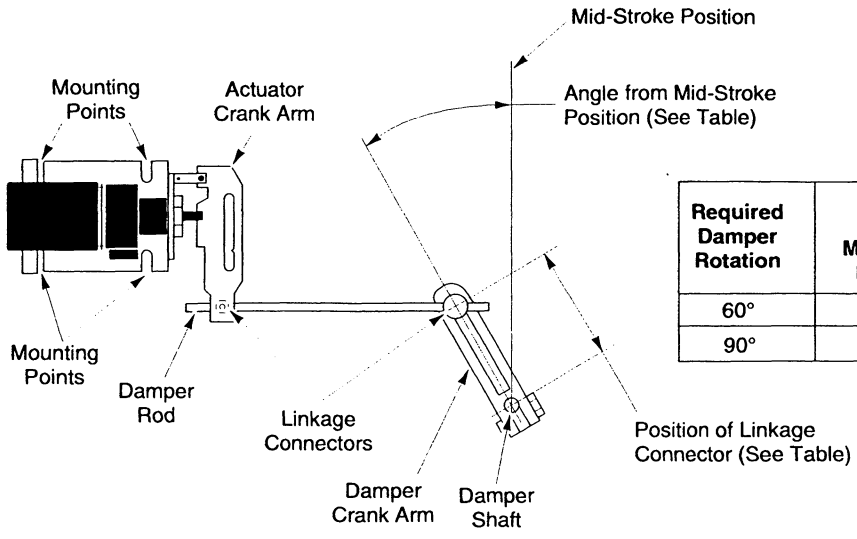


Figure-13 Dampers Open When Actuator Extends (Spring-Returns Closed on Power Loss).

   b. Be sure to allow adequate working space around the actuator mounting location to mount the actuator, link it to the damper, and wire it into the system (refer to Figure-20).
   c. If possible, select a mounting position such that, at mid-stroke, the actuator crank arm and the damper crank arm on the drive shaft are each at a 90° angle to the damper rod (Refer to Figure-14). This is the recommended mounting position. It may be necessary to swivel the actuator linkage to arrive at this mounting location.



Required Damper Rotation	Angle from Mid-Stroke Position	Position of Linkage Connector
60°	30°	2" (50 mm)
90°	45°	1-1/2" (38 mm)

Figure-14 Recommended Actuator/Damper Mounting.

d. Consider the damper rod length when positioning the actuator in relation to the damper. A damper rod that is too long is not rigid enough to provide good control, while a damper rod that is too short makes adjustment difficult.

2. Position the actuator on the duct and mark the location of the mounting holes, using the actuator mounting bracket as a template (refer to Figure-20).
3. Drill or punch the mounting holes in the duct for the appropriate 1/4" (6 mm) diameter screws or bolts. The actuator must be mounted firmly enough to prevent excessive actuator movement under normal damper loading. If there is excessive actuator movement, the damper may not fully open or close.
4. Mount a ball joint connector in the slot on the damper crank arm. To achieve 90° of damper rotation, position the connector 1-1/2" (38 mm) from the centerline of the shaft hole on the crank arm. For 60° of damper rotation, position the connector 2" (50 mm) from the shaft hole centerline. Typically, 60° to 70° of rotation (maximum is 90°) is sufficient to permit almost maximum air flow through the dampers. (Refer to Figure-14).
5. Rotate the damper to its open position. Install and secure the damper crank arm (with ball joint connector) to the damper shaft, positioning the crank arm as follows (Refer to Figure-14):
   a. To achieve 60° of damper rotation, position the crank arm so that it is pointed towards the actuator at 30° from its mid-stroke position.
   b. To achieve 90° of damper rotation, position the crank arm so that it is pointed towards the actuator at 45° from its mid-stroke position.
6. Install the damper rod by sliding one end through the ball joint connector mounted on the damper crank arm, and the other end through the straight connector on the actuator crank arm. Tighten the nut on the actuator crank arm's straight connector. Cut off any excess length of damper rod.
7. For normally open dampers, tighten the nut on the ball joint connector on the damper crank arm. To ensure that the damper closes completely, make adjustments so that the actuator is 1/16" (1.6 mm) from the extended end of stroke when the damper closes. Verify and, if necessary, make final adjustments during system checkout.
8. For normally closed dampers, rotate the damper crank arm until the damper is closed. While holding the damper closed, tighten the nut on the ball joint connector on the damper crank arm. To ensure that the damper closes completely, make adjustments so that the actuator is 1/16" (1.6 mm) from the retracted end of stroke when the damper closes.

Final adjustment of the actuator and damper must be performed when the system is powered and functioning. Refer to the CHECKOUT section to ensure that the damper is linked correctly.

Valve

For valve assembly details refer to **AV-600 and AV-601 General Instructions, F-19069.** Refer to Figure-21 for external dimensions of the valve actuator.

Adjustments

Auxiliary Switch (MA-5XXX-500)

The switching point is adjustable over the entire actuator stroke and is pre-set at the factory to close the N.C. contacts at the retracted end of stroke. Turning the switch adjustment screw CW (using TOOL-12), adjusts the make (or break) point closer to the extended end of stroke. (Refer to Figure-15).

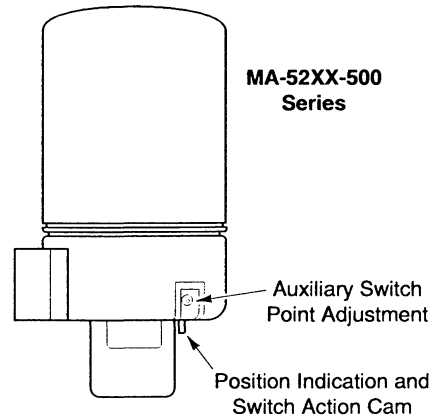


Figure-15 Auxiliary Switch Actuation Point Adjustment and Position Indication for MA-5XXX-500 Series.

CHECKOUT

After the entire system has been installed and the actuator has been powered up, perform the following checks for proper system operation.

▼ ***CAUTION***

Never power the actuator without a spring return linkage attached.

Positioning with Controller

If the sensed media is within the controller's setpoint range, the actuator can be positioned by adjusting the controller setpoint up and down. Check for correct operation of the actuator (valve or damper) while the actuator is being stroked.

Go, No-Go Test

1. Apply power to the actuator. The actuator motor should run and the actuator shaft should extend.
2. Remove power from the actuator. The actuator motor should stop running and the actuator shaft should spring-return to the retracted position.

THEORY OF OPERATION

Refer to Figure-16. The permanently sealed, oil-filled case contains a movable hydraulic piston assembly and an electric pump for the hydraulic system. The pump generates a fluid pressure which is transmitted to the top of the piston, creating a hydraulic force which drives the piston downward. Opposing the hydraulic force is the spring of the valve or damper linkage. When the hydraulic force becomes great enough to overcome the opposing spring force, the piston translates downward, extending the output shaft. The electric pump is powered by the input supply voltage and runs whenever the voltage is applied. When power is removed from the pump, it stops running, decreasing the hydraulic force above the piston. This allows the spring force to overcome the hydraulic force, pushing the piston upward and retracting the output shaft. The oil above the piston is allowed to flow backward through the pump by means of a check valve.

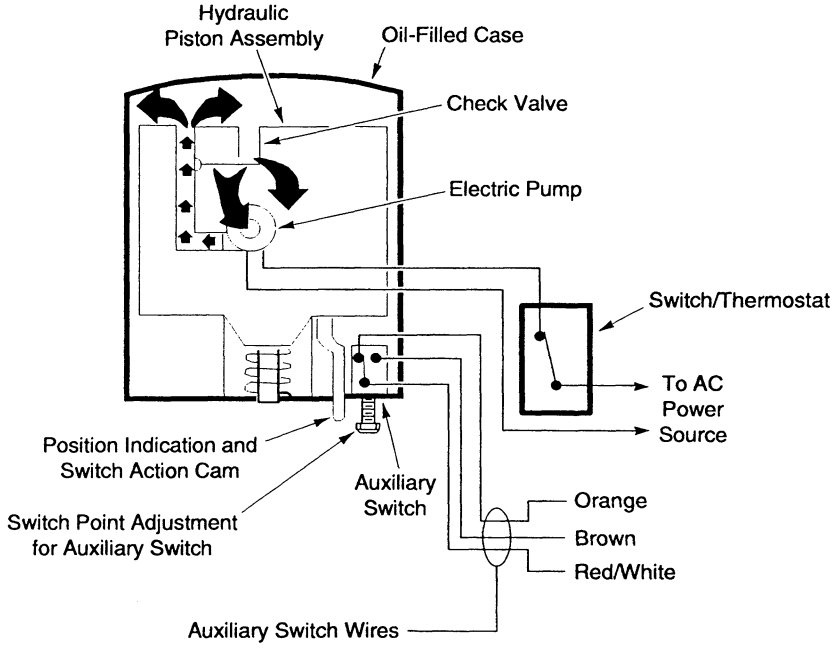


Figure-16 MA-5XXX Series Actuators.

REPLACEMENT PARTS

The installation of replacement actuators, in place of the obsolete series of MA-5XXX actuators (refer to Figure-17), may require additional items. These replacement items are required for the following reasons:

1. The AM-601 damper linkage is used to convert base actuators to damper actuators when damper models are not available.
2. The AM-602 spacer is used when current actuators are installed on old linkages (refer to Figure-18 and Figure-19).
3. The AE-249 transformer (208 Vac to 120 Vac) is used when replacing 208 Vac actuators (MA-5XX2) with 120 Vac actuators (MA-5XX0).

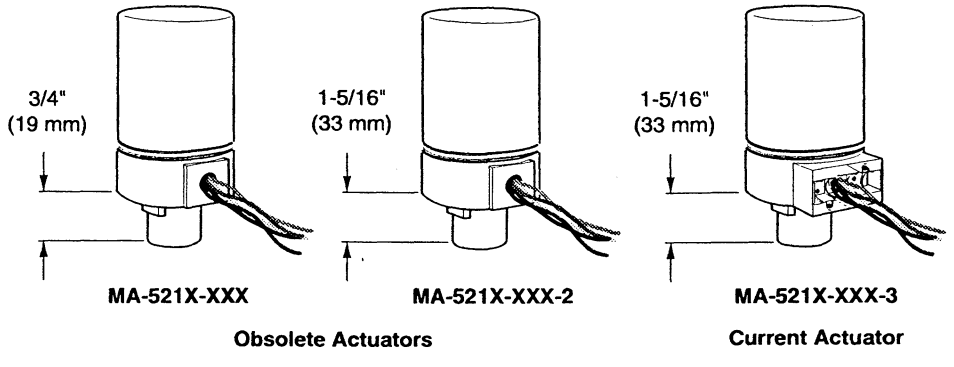


Figure-17 Current and Obsolete Actuators.

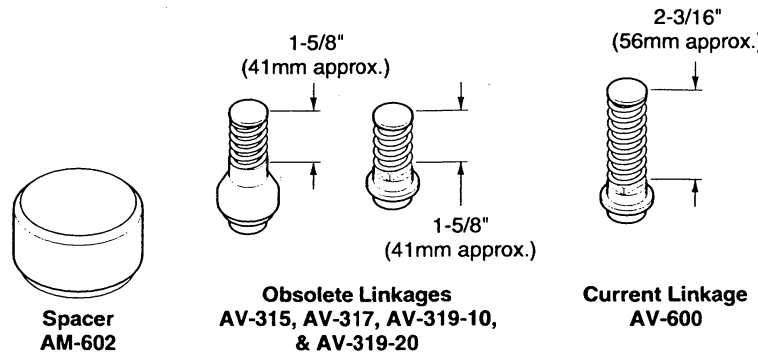


Figure-18 Current and Obsolete Valve Linkages.

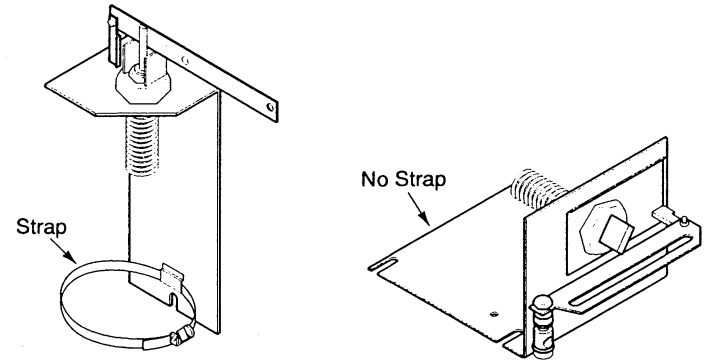


Figure-19 Current and Obsolete Damper Linkages.

MAINTENANCE

The actuator is sealed in oil and requires no maintenance.

Regular maintenance of the total system is recommended to assure sustained, optimum performance.

TROUBLESHOOTING

Use the following steps to locate malfunctions:

1. Check the actuator by applying the proper supply voltage.
2. The motor should run when power is applied. If it does not run, the actuator is inoperative and should be replaced.
3. While the motor is running, the actuator should extend. If it does not extend, check the mechanical linkage for any damage or misadjustment which could prevent the actuator from extending. If the mechanical linkage is inoperative, adjust the linkage or replace the damaged components, as applicable. If the mechanical linkage moves correctly and freely, the problem lies in the actuator and it must be replaced.
4. If applying power directly to the actuator results in correct operation of the actuator, the actuator and linkage are functional, and the problem lies in the wiring or thermostat. Repair or replace the wiring or thermostat, as applicable.

FIELD REPAIR

None. Replace an inoperative actuator with a functional unit.

DIMENSIONAL DATA

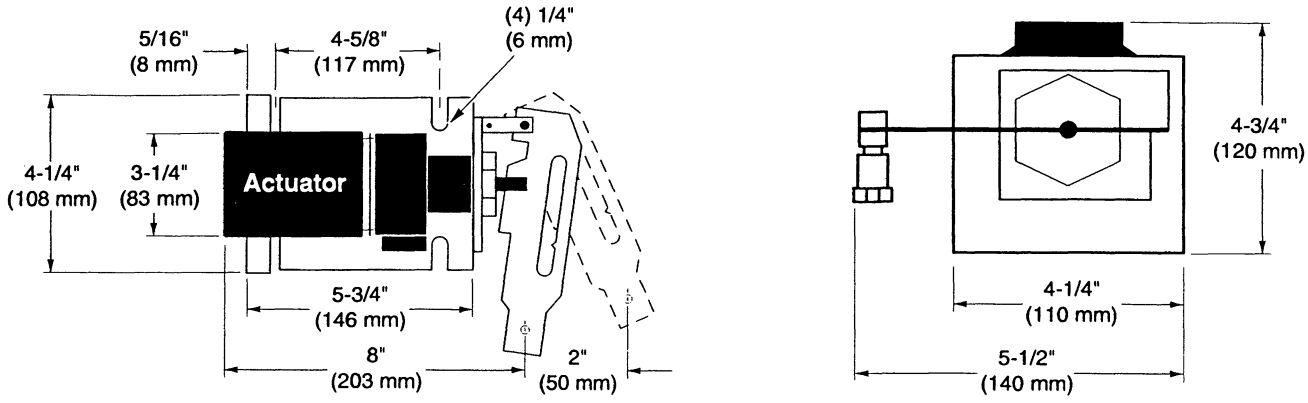


Figure-20 Damper Linkage Assembly Dimensions.

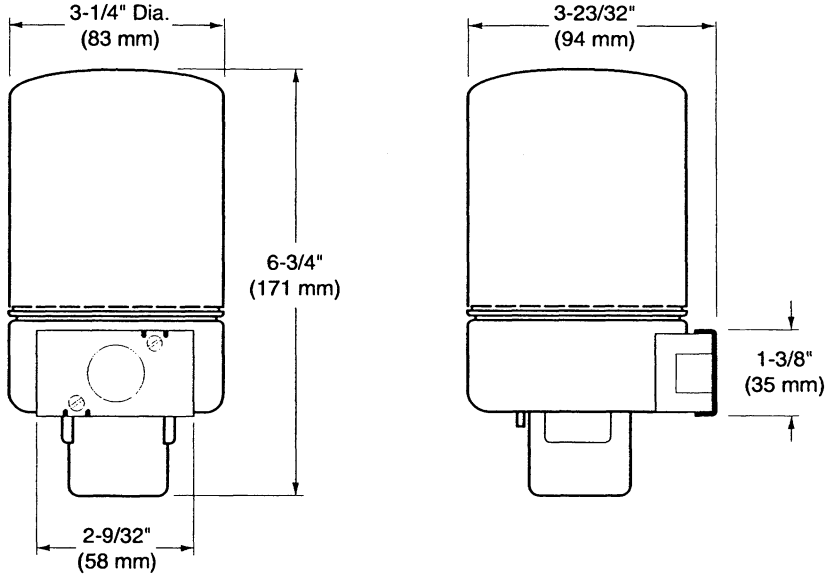


Figure-21 Actuator Dimensions.

MP-52XX-0-0-3 Series

chilled water valve :
MP 5213-0-0-3

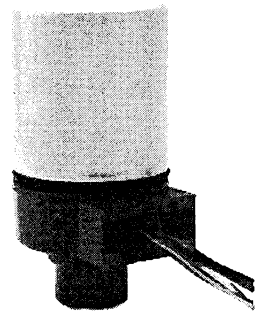
SIEBE ENVIRONMENTAL CONTROLS

1354 Clifford Avenue
P.O. Box 2940
Loves Park, IL U.S.A. 61132-2940

Electric/Electronic Actuator General Instructions

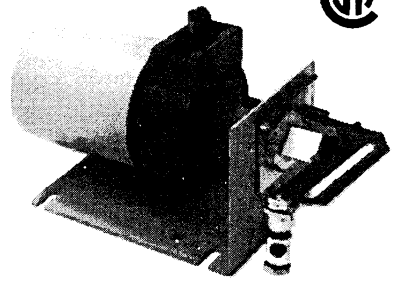
Application

For electronic proportional control of dampers, valves, or program switches which require the return to normal position upon power interruption. MP-52XX series are compatible with 2 to 15 Vdc (System 8000) input signals.



Features

- Proportional actuators controlled by variable Vdc input signal.
- Spring return.
- Fixed 3 Vdc operating span.
- Non-adjustable start point and non-positive positioning. Typically one actuator is controlled from one Vdc output signal.
- 10,000Ω or greater input impedance.
- 24 Vac, 120 Vac, and 240 Vac models.
- -500 models have adjustable SPDT auxiliary switch.
- Available in damper models or base models that require damper or valve linkage.
- Die cast lower housing and painted steel upper housing.
- Hydraulic actuator with oil-immersed motor, transducer, and pump.



Applicable Literature

- Environmental Controls Cross-Reference Guide F-23638
- Environmental Controls Reference Manual F-21683
- Environmental Controls Application Manual F-21335

SPECIFICATIONS

Actuator Inputs

Compatible with: 2 to 15 Vdc from System 8000 controllers.
Operating Span, Approximately 3 Vdc fixed.
Start Point, Approximately 6 Vdc fixed.
Impedance, 10,000Ω or greater.
Power Input: SeeTable-1 and Table-2.
Connections: Color-coded 4' (1.2 m) leads.

Actuator Outputs

Electrical:
Internal Power Supply, 20 Vdc, 25 mA.
Auxiliary Switch (MP-52XX-500), 10 Amps, 120/240 Vdc adjustable SPDT, factory set to close the N.O. contact and open the N.C. contact at retracted end of stroke.
Position Signals, Internal feedback circuitry provides positive positioning of the damper in relation to the controller signal.
Mechanical:
Stroke,
Damper Approximately 2" (51 mm) over a nominal 6 Vdc (fully retracted) to 9 Vdc (fully extended) input range (includes AM-601 linkage).
Valve Approximately 9/16" (14.3 mm) over a nominal 6 Vdc (fully retracted) to 9 Vdc (fully extended) input range.
Nominal Damper Area, Nominal damper rating is 1.06 ft^2 for parallel and 1.33 ft^2 for opposed blade standard dampers (not low leakage) with 2000 fpm (10.2 m/s) velocity at 1 inch H_2O (0.25 kPa) static pressure. For damper ratings under other operating conditions, refer to EN-110.
Power Outputs: SeeTable-1 and Table-2.

Environment

Ambient Temperature Limits:
Shipping & Handling, -40 to 140°F (-40 to 60°C).
Operating, -20 to 140°F (-29 to 60°C).
Damper -20 to 140°F (-29 to 60°C).
Valve See Table-3.
Humidity: 5 to 95% RH, non-condensing.
Location: NEMA Type 1, indoor only.

Table-1 Model Chart for Damper Actuators.

Part Number	Actuator Power Input				10 Amps* Aux Switch	Timing in Seconds @ 72°F (22°C)			Torque Rating lb. - in. (N-m)
	Voltage +10/ -15%	Hz		VA	Watts		No Load Stroke		Retract on Power Loss	
							To Extend	To Retract		
MP-5230	120	50	60	18	10	No	60	40	15	1.86 (0.21)
MP-5230-500						Yes				
MP-5233	240					No				
MP-5233-500						Yes				

*Common of switch is in series with AC power supply to the motor. Therefore, the switch must be wired to control the same voltage as the actuator itself.

Table-2 Model Chart for Valve Actuators.
Also for Damper Actuators with Field Assembled Damper Linkages.

Part Number	Actuator Power Input					10 Amps* Aux Switch	Timing in Seconds @ 72°F (22°C)			Required Linkage	
	Voltage +10/ -15%	Hz		VA	Watts		No Load Stroke		Retract on Power Loss	Damper	Valve
							To Extend	To Retract			
MP-5210	120	50	60	18	10	No	60	40	15	AM-601	AV-600 AV-601**
MP-5210-500						Yes					
MP-5211	240					No					
MP-5211-500						Yes					
MP-5213	24					No					
MP-5213-500						Yes					

*Common of switch is in series with AC power supply to the motor. Therefore, the switch must be wired to control the same voltage as the actuator itself.
**May be required for steam and hot water. See Table-3.

Table-3 Restrictions on Maximum Ambient Temperature for Valve Actuators.

Maximum Temperature of Media in the Valve Body (Check Rating of the Valve)	Maximum Ambient Temperature of MP-52XX Series	
	AV-600	AV-600 and AV-601
366°F (180°C)	90°F (32°C)	90°F (32°C)
340°F (171°C)	100°F (38°C)	100°F (38°C)
281°F (138°C)	115°F (46°C)	140°F (46°C)
181°F (83°C)	140°F (60°C)	140°F (60°C)
80°F (26°C)	140°F (60°C)	140°F (60°C)

ACCESSORIES

Common

AD-8969-612	Capacitor kit (Included with each actuator)

Damper Only

AD-553	Sequencing adaptor
AE-249	Transformer
AM-111	Crank arm for 5/16" diameter damper shaft
AM-112	Crank arm for 3/8" diameter damper shaft
AM-113	Crank arm for 1/2" diameter damper shaft
AM-115	Crank arm for 7/16" diameter damper shaft
AM-122	Linkage connector straight type
AM-123	Damper clip
AM-125	5/16" diameter x 20" damper rod
AM-125-048	5/16" diameter x 48" damper rod
AM-132	Ball joint connector
AM-161-3	Damper linkage kit
AM-601	Device includes mounting bracket, damper linkage with spring, and AM-122 straight connector. Required to modify (MP-521X series) valve actuators into 2" (51 mm) stroke damper actuators.
AM-602	Spacer

Valve Only

AV-600	Valve linkage
AV-601	Valve linkage extension for hot water and steam applications; use with AV-600

TOOLS (factory available)

TOOL-12	Wrench for adjustment of auxiliary switch
TOOL-19	Spring compression tool for AV-600
TOOL-37	1-5/8" open-end wrench
TOOL-202	Manual positioner

TYPICAL APPLICATIONS (wiring diagrams)

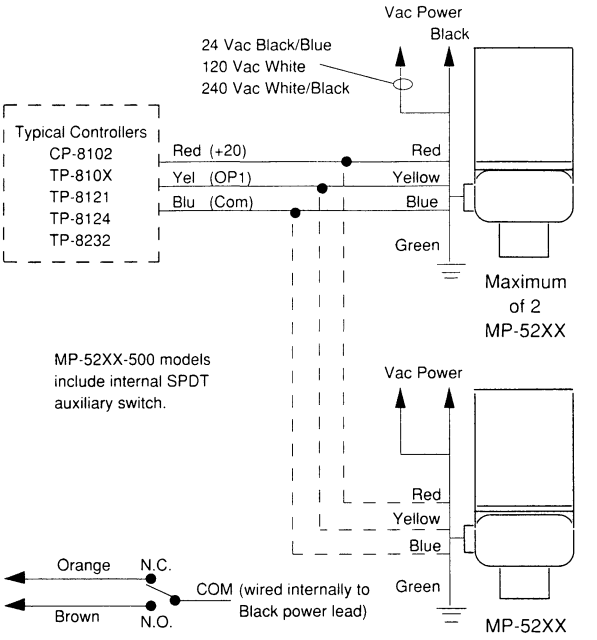


Figure-1 Typical Control Wiring for Up to Two MP-52XX Series Actuators to Controllers Requiring External 20 Vdc Power Supply.

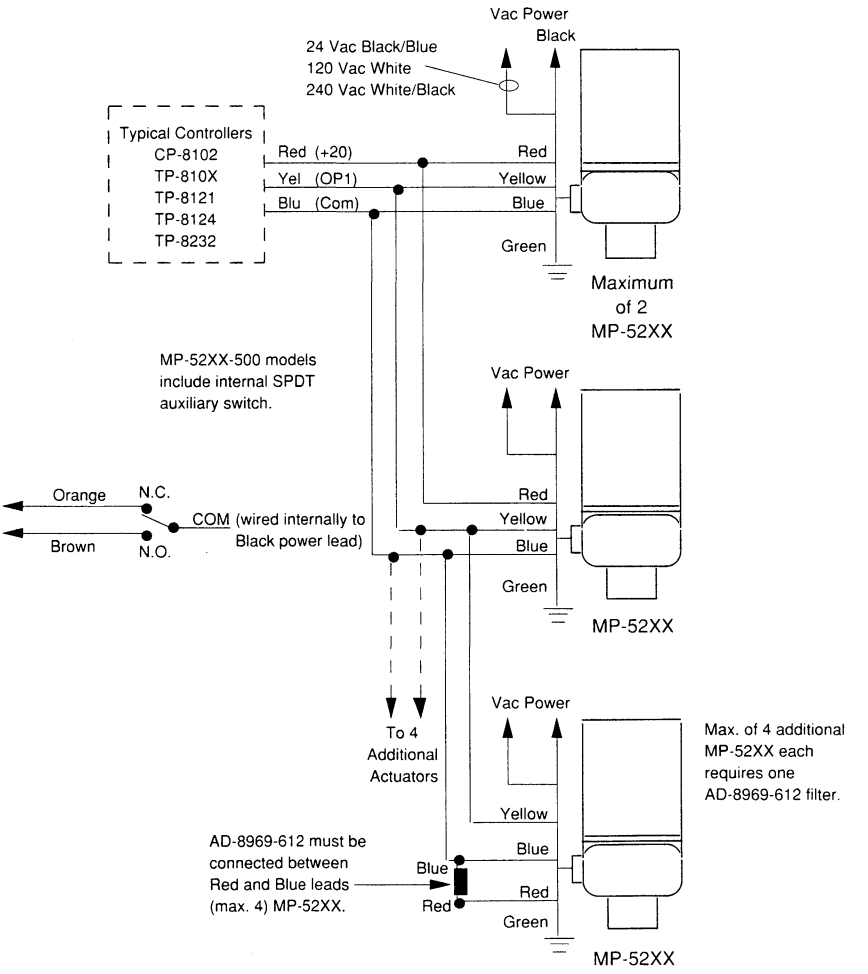


Figure-2 Typical Control Wiring for More Than Two MP-52XX Series Actuators to Controller Requiring External 20 Vdc Power Supply.

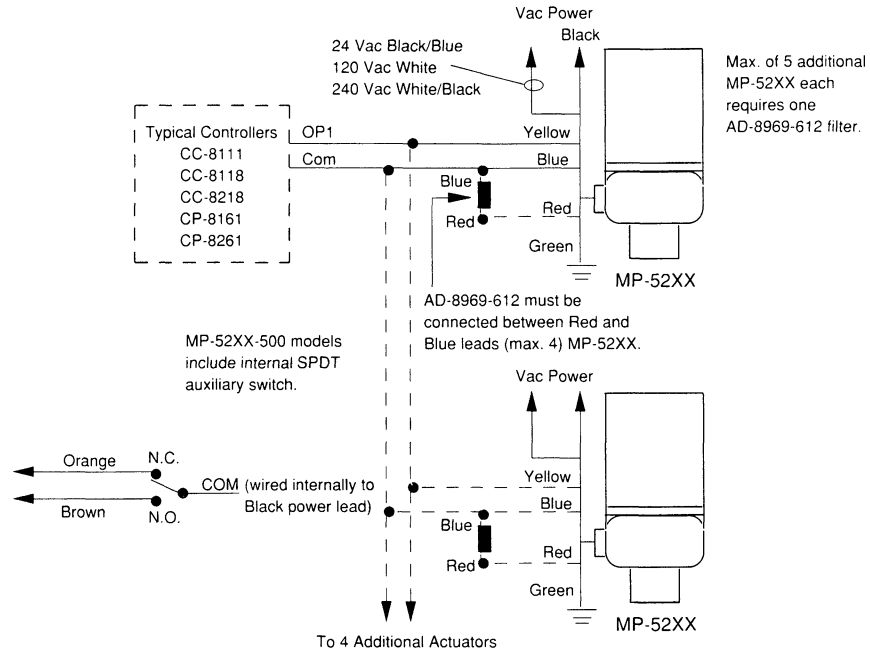


Figure-3 Typical Control Wiring for Up to Six MP-52XX Series Actuators to Controllers Having Internal 20 Vdc Power Supply.

INSTALLATION

Inspection

Inspect the package for damage. If damaged, notify the appropriate carrier immediately. If undamaged, open the package and inspect the device for obvious damage. Return damaged products.

Requirements

- Job wiring diagrams
- Tools (not provided):

  Digital Volt-ohm Meter (DVM)

  Appropriate drill and drill bit for mounting screws

  Appropriate screw drivers and wrenches
- Training: Installer must be a qualified, experienced technician

▼***CAUTION***

- Disconnect the power supply (line power) before installation to prevent equipment damage.
- Do not power unit unless damper linkage and/or valve assembly have been installed.
- Make all connections in accordance with the wiring diagram and in accordance with national and local electrical codes. *Use copper conductors only.*
- Do not exceed ratings of the device(s).
- Avoid locations where excessive moisture, corrosive fumes, or vibration is present.

Mounting

Dampers

The actuator is not position sensitive. It can be mounted in any direction.

Valve

Allow 3" (76 mm) above the actuator valve assembly for removal and reattachment of actuator to installed valve.

▼*CAUTION*

Do not twist or exert any force on actuator housing during installation. Either turn the base by hand or, if necessary, use 1-5/8" (41mm) open-ended wrench (TOOL-37) on flats provided on the actuator base or the valve body mounting nut. See Figure-4.

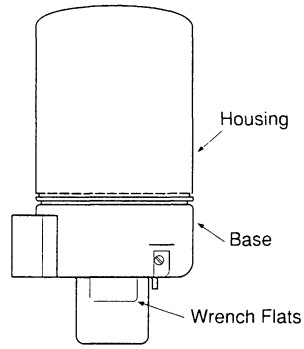


Figure-4 Housing and Base Location.

1. Install all two-way valves so that they close against the flow. An arrow on the valve body or tag indicates proper flow direction.
2. Always install three-way mixing valves with two inlets and one outlet.
3. Always install three-way diverting valves with one inlet and two outlets.
4. Actuators can be mounted in any upright position above the centerline of the valve body. For steam applications only, mount the actuator above the valve body at 45° from vertical.

Wiring Requirements

Control Leads (colors of leads) (See Table-4)

▼*CAUTION*

- Use three-conductor twisted shielded wire when it becomes necessary to install the control leads in the same conduit with power wiring or when RFI/EMI generating devices are near.
- Do not connect shield or conduit to earth ground.

Table-4 Control Wiring Data.

Wire Size (GA)	Maximum Wire Run in ft. (m)
18	1000 (304.8)
16	2250 (685.8)
14	4000 (1219.1)

Power Leads

Low voltage actuators installed to NEC (National Electrical Code) codes may use Class II wiring.

Wire line voltage (120 and 240 Vac) to NEC codes. See Table-5 for maximum length of run for given wire size(s). To determine the allowable maximum power lead run for multiple actuator wiring, divide the maximum run shown in Table-5 by the number of actuators on the run.

Table-5 Power Wiring Data.

Actuator Voltage (Vac)	Actuator Model Number	Power Lead Colors	Wire Size (GA)	Maximum Wire Run in ft. (m)
120	**MP-52X0**	Black & White	14	3500 (1067)
	MP-52X0-500			
240	**MP-52X1**	Black & Wht/Blk		6000 (1829)
	MP-52X1-500			
24	**MP-52X3**	Black & Blk/Blu		300 (91.5)
	MP-52X3-500			
24	**MP-52X3**	Black & Blk/Blu	12	480 (146.3)
	MP-52X3-500			

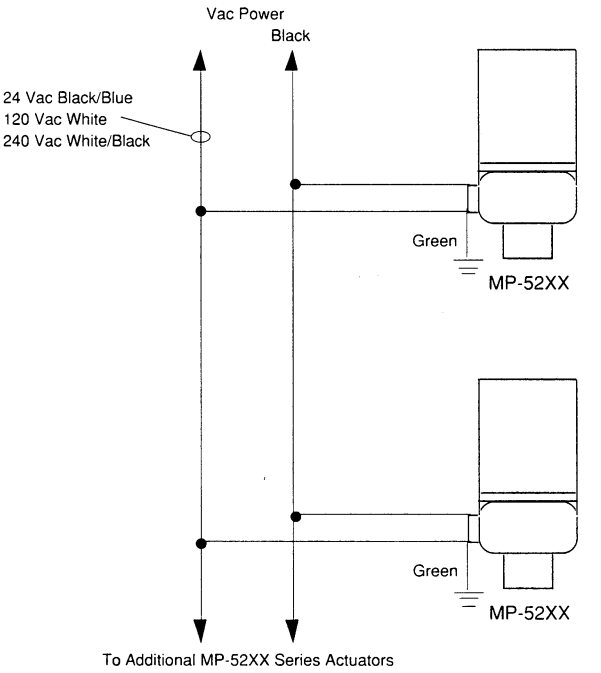


Figure-5 Wiring of Multiple MP-52XX Series Actuators to Single Power Source.

Wire Lead Connections (No Conduit)

Make connections as required. See Figure-6.

NOTE

Cover plate and screw supplied with actuator are not required with this method.

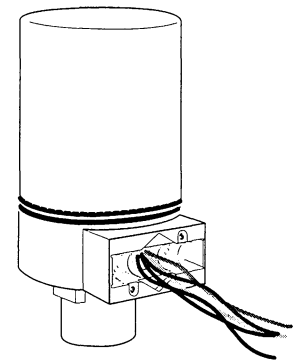


Figure-6 Wire Leads Connection (No Conduit).

Install 3/8" reduced flexible (thin wall) conduit to either side of actuator.

1. Determine the side of the actuator the flexible connector is to be attached.
2. Remove the knockout (e.g., with channel lock pliers) on selected side. See Figure-7.
3. Make required connections.

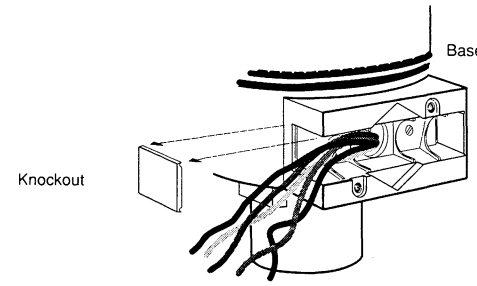


Figure-7 Removal of Knockout on Actuator Base.

4. Slip conduit on the base over shoulder. See Figure-8.

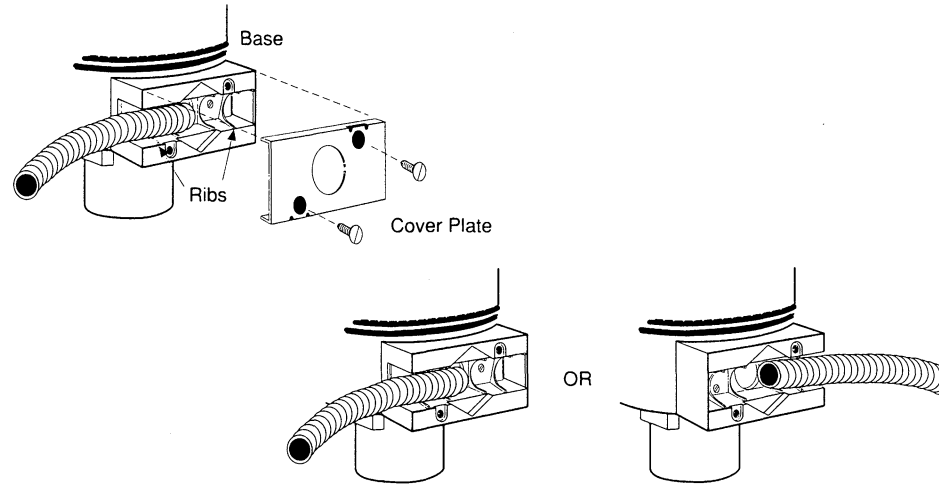


Figure-8 Flexible Conduit Installation to Either Side of Actuator.

5. Install cover plate with two screws. Cover plate and two (2) screws are supplied with actuator.

Install 3/8" reduced flexible (thin wall) conduit directly to actuator.

1. Remove knockout from cover plate supplied with actuator. See Figure-9.

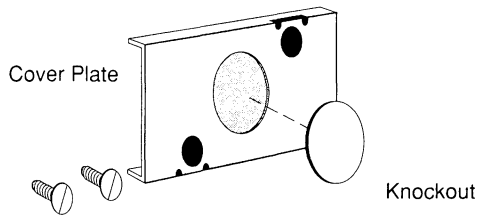


Figure-9 Cover Plate Knockout Removal.

2. Slip leads through standard 1/2" conduit bushing (not supplied) and knockout hole in cover plate. See Figure-10.

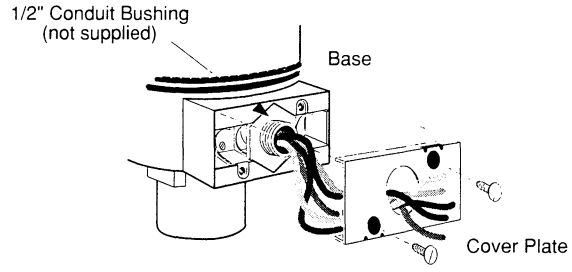


Figure-10 Conduit Bushing and Cover Plate Installation.

3. Nest conduit bushing in base.
4. Install cover plate using the two (2) screws provided.
5. Attach flexible conduit as required to conduit bushing.

Install conduit box to actuator.

1. Remove knockout from cover plate supplied with actuator. See Figure-9.
2. Slip leads through standard 1/2" conduit bushing (not supplied) and knockout hole in cover plate. See Figure-10.
3. Nest conduit bushing in base.
4. Install cover plate using the two (2) screws provided.
5. Attach conduit box to threaded adaptor. Install rigid conduit, flexible conduit, etc. to conduit box as required. See Figure-11.

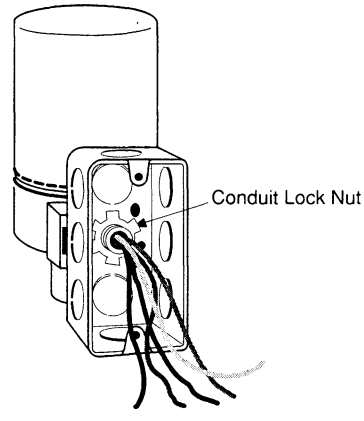


Figure-11 Attachment of Conduit Box to Threaded Adaptor.

NOTE

As shown in Figure-9, the hole in the cover plate of the actuator conduit housing is sized to accept both British standard M20 (20 mm) conduit connectors and 20 mm to PG16 adaptors for use with DIN PG16 connectors. (Follow steps for installing conduit box to actuator.)

Linkage Assembly

Damper

Allow adequate working space for mounting, connecting actuator to damper and wiring of the system.

▼ *CAUTION*

Do not twist or exert any force on actuator housing during installation. Either turn the base by hand or, if necessary, use 1-5/8" (41 mm) open-ended wrench (TOOL-37) on flats provided on the actuator base or the valve body mounting nut. (See Figure-4)

1. Determine from the system requirements if the damper should spring return open (Figure-12) or spring return close (Figure-13) on a power loss to the actuator. Normally the dampers are linked to the full open (heat) position when the actuator is retracted (spring return position on a power loss).

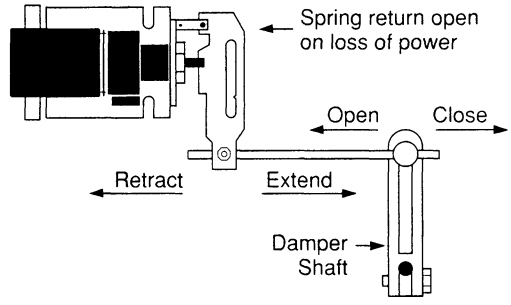


Figure-12 Damper Open When Actuator Retracts (Spring Returns Open on Power Loss).

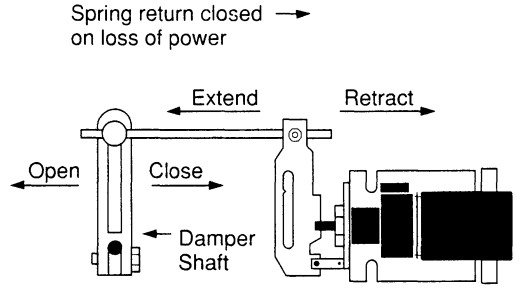


Figure-13 Dampers Open When Actuator Extends (Spring Returns Closed on Power Loss).

2. Allow adequate working space to wire and link actuator into the system.
3. The best position for the actuator mounting is with the actuator crank arm and the damper crank arm on the drive shaft at a 90° angle to the damper rod at mid-stroke. It may be necessary to swivel the actuator linkage to arrive at the best mounting location.

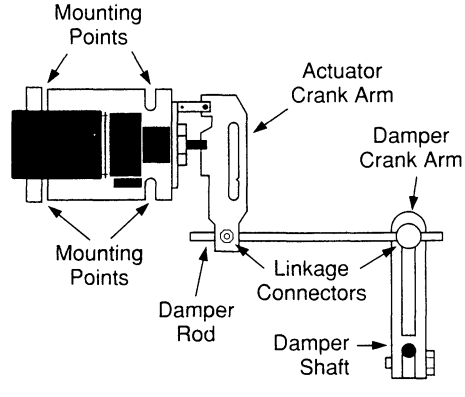


Figure-14 Actuator/Damper Mounting.

4. Position the actuator to the duct and mark the location of the mounting holes using the actuator mounting bracket as a template. Relationship of the actuator to the damper should allow for a convenient damper rod length. A damper rod that is too long (not rigid enough) does not provide for good control. A damper rod that is too short makes it difficult to adjust.
5. Drill or punch the mounting holes in the duct for the appropriate 1/4" (6 mm) diameter screws or bolts. The actuator must be mounted firmly enough to prevent excessive actuator movement under normal damper loading. If these is excessive actuator movement, the damper may not fully open or fully close.
6. Mount a ball joint connector in the slot on the damper crank arm. Position the connector, from the centerline of the shaft hole on the crank arm, 1-1/3" (38 mm) for 90° damper rotation of 2" (50 mm) for 60° damper rotation. Typically, 60 to 70° rotation (maximum of 90°) permits almost maximum air flow through dampers.
7. Rotate the damper to its normal open position. Install and secure the damper crank arm (with ball joint connector) to the damper shaft positioning:
   a. 30° from mid-stroke of the damper crank arm for 60° damper rotation and pointing toward the actuator.
   b. 45° from mid-stroke of the damper crank arm for 90° damper rotation and pointing toward the actuator.
8. Install the damper rod by sliding through the damper crank arm ball joint connector and the actuator crank arm straight connector. Tighten the nut on the actuator crank arm straight connector. Cut off excessive damper rod length.
9. For normally open dampers, tighten the nut on the ball joint connector on the damper crank arm. When the damper is closed the actuator should be 1/16" (1.6 mm) from the extended end of stroke to ensure close-off of the damper. Verify and make final adjustments during system checkout.
10. For normally closed dampers, push the damper crank arm until the damper is closed. Tighten the nut on the ball joint connector on the damper crank arm while holding the damper closed. When the damper is closed the actuator should be 1/16" (1.6 mm) from the retracted end of stroke to ensure close-off of the damper.

Final adjustment of actuator/damper must be performed when the system is powered and functioning. Refer to CHECKOUT section to ensure the damper is linked correctly.

Valve

For Valve assembly details refer Valve Linkage General Instruction sheet for AV-600/AV-601, F-19069.

Adjustments

Auxiliary Switch (MP-52XX-500)

The switching point is adjustable over the entire actuator stroke and is factory set to close the N.C. contact at the retracted end. Use of TOOL-12 to turn the switch adjustment screw CW will adjust the make (break) point closer to the extended end of stroke. See Figure-15.

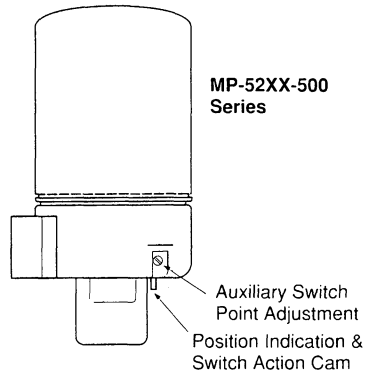


Figure-15 Auxiliary Switch Point Adjustment and Position Indication for MP-52XX Series.

CHECKOUT

After the entire system has been installed and the actuator has been powered up, the following checks can be made for proper system operation.

▼ ***CAUTION***

Never power the actuator without a spring return linkage attached.

Positioning with Controller

If the sensed media is within the controller's setpoint range, the actuator can be positioned by adjusting the controller setpoint up and down. Check for correct operation of the actuator (valve or damper) while the actuator is being stroked.

Go, No Go Test

1. The actuator should be powered.
2. Disconnect the control leads from the controller.
3. To make the actuator shaft extend fully, short the red lead to the yellow lead.
4. To make the actuator shaft retract fully, short the blue lead to the yellow lead.
5. Check for proper operation of the valve or damper as the actuator is operated.
6. Reconnect the control wiring.

Manual Positioning

1. The actuator should be powered.
2. Disconnect the control leads from the controller.
3. Attach the leads from the calibration box to the same color leads on the actuator.
4. The actuator can be manually positioned by turning the knob of calibration box; turning knob in the clockwise direction will make the shaft of the actuator retract and in the counterclockwise direction will make shaft of the actuator extend.
5. Check for proper operation of the valve or damper as the actuator is operated.
6. Reconnect the control wiring.

THEORY OF OPERATION

The permanently sealed oil-filled case (1 in Figure-16) contains a movable hydraulic piston (3) and a motor/electric pump (8) for the hydraulic system. The pump generates a fluid pressure which is transmitted to the top of the piston. Opposing the hydraulic force is the spring (6) of the damper or valve linkage. The electric pump/motor (8) is powered by the input supply voltage (9) and runs continuously. A regulated Vdc power supply (4) is powered by a transformer winding from the electric pump/motor (8). The control signal 2 to 15 Vdc) input (10) positions the transducer flapper (7) for proportional positioning of the shaft (5).

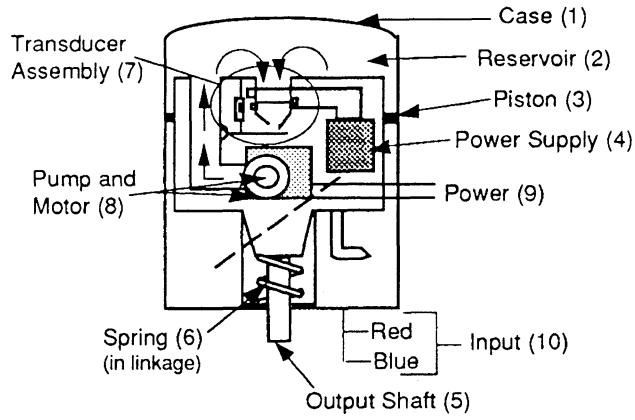


Figure-16 MP-52XX Series Actuators.

REPLACEMENT PARTS

Replacement of obsolete series of MP-52XX actuators can require items in addition to the replacement actuator. Table-6 shown below provides a cross reference of obsoleted actuators to current actuators and lists what additional items that may be required. The replacement items are required for the following reasons:

1. AM-601 damper is linkage is used to convert base actuators to damper actuators when damper models are no longer available.
2. AM-602 spacer is used when current actuators are installed on old linkages (see Figure-17 and Figure-18).
3. AE-249 transformer (208 Vac to 120 Vac) is used when replacing 208 Vac actuators.
4. Resistors are required when the current actuators are controlled by the obsolete TP-5XXX or CP-51XX controllers. Engineering bulletin EN-111 in section C1.1 provides details on resistor and wiring information.

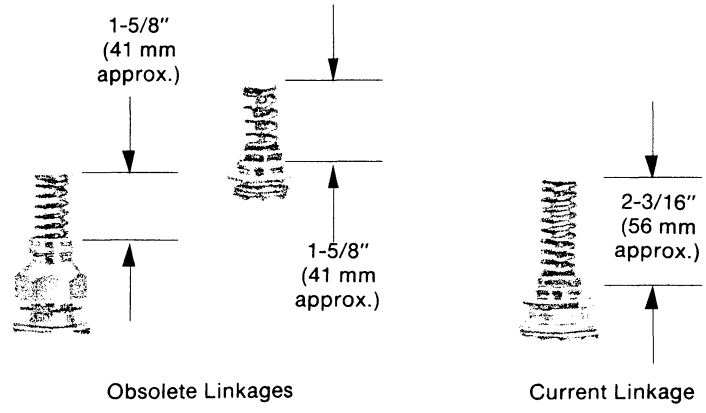


Figure-17 Current or Obsolete Valve Linkage.

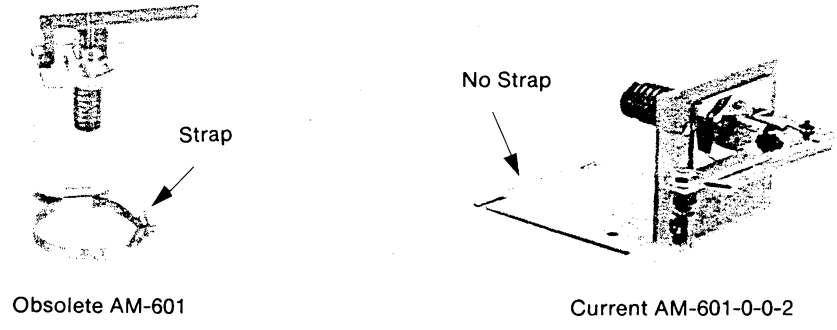


Figure-18 Current or Obsolete Damper Linkage.

Table-6 Cross Reference of Obsolete Series of MP-52XX Actuators.

Actuator Being Replaced	Replacement Actuator	Other Replacement Items Required			
		AM-601-0-0-2 Current Damper Linkage	AM-602 Spacer	AE-249 #	Resistor *
MP-5210	MP-5210-0-0-3	No	Yes	No	Yes
MP-5210-0-0-1	MP-5210-0-0-3	No	Yes	No	Yes
MP-5210-0-0-2	MP-5210-0-0-3	No	No	No	No
MP-5210-500	MP-5210-500-0-3	No	Yes	No	Yes
MP-5210-500-0-1	MP-5210-500-0-3	No	Yes	No	No
MP-5210-500-0-2	MP-5210-500-0-3	No	No	No	No
MP-5211	MP-5211-0-0-3	No	Yes	No	Yes
MP-5211-0-0-1	MP-5211-0-0-3	No	Yes	No	No
MP-5211-0-0-2	MP-5211-0-0-3	No	No	No	No
MP-5211-500	MP-5211-500-0-3	No	Yes	No	Yes
MP-5211-500-0-1	MP-5211-500-0-3	No	Yes	No	No
MP-5211-500-0-2	MP-5211-500-0-3	No	No	No	No
MP-5212	MP-5210-0-0-3	No	Yes	Yes	Yes
MP-5212-0-0-1	MP-5210-0-0-3	No	Yes	Yes	No
MP-5212-0-0-2	MP-5210-0-0-3	No	No	Yes	No
MP-5212-500	MP-5210-500-0-3	No	Yes	Yes	Yes
MP-5212-500-0-1	MP-5210-500-0-3	No	Yes	Yes	No
MP-5212-500-0-2	MP-5210-500-0-3	No	No	Yes	No
MP-5213	MP-5213-0-0-3	No	Yes	No	Yes
MP-5213-0-0-1	MP-5213-0-0-3	No	Yes	No	No
MP-5213-0-0-2	MP-5213-0-0-3	No	No	No	No
MP-5213-500	MP-5213-500-0-3	No	Yes	No	Yes
MP-5213-500-0-1	MP-5213-500-0-3	No	Yes	No	No
MP-5213-500-0-2	MP-5213-500-0-3	No	No	No	No
MP-5220	MP-5230-0-0-1	No	No	No	Yes
MP-5220-0-0-1	MP-5230-0-0-1	No	No	No	No
MP-5220-500	MP-5230-500-0-1	No	No	No	Yes
MP-5220-500-0-1	MP-5230-500-0-1	No	No	No	No
MP-5221	MP-5211-0-0-3	Yes	No	No	No
MP-5221-0-0-1	MP-5211-0-0-3	Yes	No	No	No
MP-5221-500	MP-5211-500-0-3	Yes	No	No	Yes
MP-5221-500-0-1	MP-5211-500-0-3	Yes	No	No	No
MP-5222	MP-5230-0-0-1	No	No	Yes	Yes
MP-5222-0-0-1	MP-5230-0-0-1	No	No	Yes	No
MP-5222-500	MP-5320-500-0-1	No	No	Yes	Yes
MP-5222-500-0-1	MP-5230-500-0-1	No	No	Yes	No
MP-5223	MP-5233-0-0-1	No	No	No	Yes
MP-5223-0-0-1	MP-5233-0-0-1	No	No	No	No
MP-5223-500	MP-5230-500-0-1	No	No	No	Yes
MP-5223-500-0-1	MP-5233-500-0-1	No	No	No	No
MP-5230	MP-5230-0-0-1	No	No	No	No
MP-5230-500	MP-5230-500-0-1	No	No	No	No
MP-5231	MP-5211-0-0-3	Yes	No	No	No
MP-5231-500	MP-5230-0-0-1	Yes	No	No	No
MP-5232	MP-5230-0-0-1	No	No	Yes	No
MP-5232-500	MP-5230-500-0-1	No	No	Yes	No
MP-5233	MP-5233-0-0-1	No	No	No	No
MP-5233-500	MP-5233-500-0-1	No	No	No	No

*See Engineering Bulletin EN-111 section C1.1 for resistor value and wiring information.

#AE-249 is 208 Vac to 120 Vac Transformer.

MAINTENANCE

The actuator is sealed in oil and requires no maintenance.

Regular maintenance of the total system is recommended to assure sustained optimum performance.

Use the following steps to locate malfunctions:

1. Check the controller and determine that it is operating to manufacturer's specifications.
2. The MP-5XXX series actuator should run continually. If it does not run check the supply voltage and the actuator wiring.
3. Verify actuator operation using the checkout procedure. If actuator does not function, then replace.

FIELD REPAIR

None. Replace with a functional actuator.

DIMENSIONAL DATA

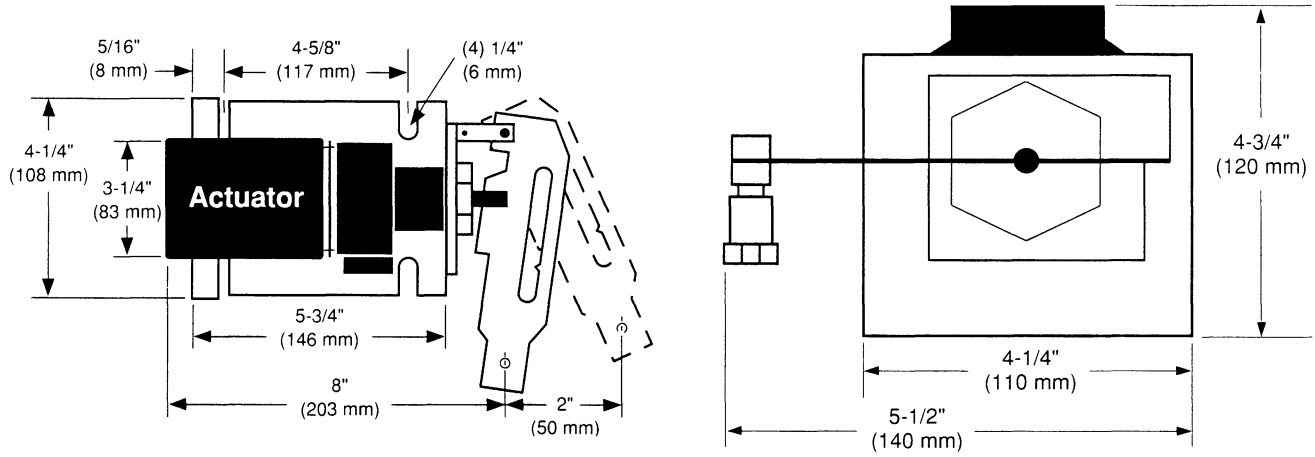


Figure-19 Damper Linkage Assembly Dimensions.

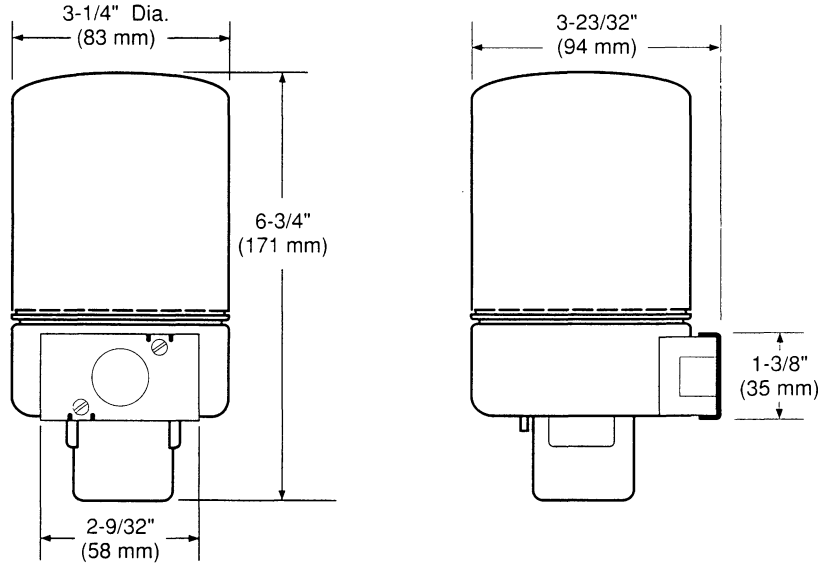


Figure-20 Actuator Dimensions.

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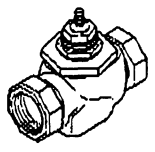
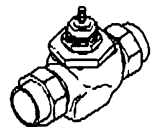
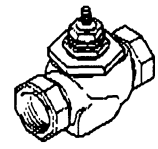
Specifications may change as design improvements are introduced.

2-Way Valves, Screwed (1/2 to 2 in.) and Union Sweat (1/2 to 2 in.) with Hydraulic Actuators

TABLE 1. Select Valve Body including P Code (Valve Size, Cv Rating, Port Code) or select Valve Assembly with correct Input Signal (refer to Table 3 also) less Actuator Code (XXX) including the P Code (Size, Cv Rating, Port Code). (Refer to Pages 698 to 703 for Valve Sizing.)

		Application			
		Chilled or Hot Water 281°F Max. 35 psig Steam		Hot Water 340°F Max. 100 psig Steam	Hot Water 400°F Max. 150 psig Steam
		Screwed NPT	Union Sweat	Screwed NPT	
					
Size		1/2 to 2 in.	1/2 to 2 in. I.D.	1/2 to 2 in.	1/2 to 2 in.
Normally Open Valves	Valve Body	VB-7213-0-4-P	VB-7214-0-4-P	VB-7253-0-4-P	VB-7215-0-4-P
	Valve Assembly 2 to 15 Vdc Input, 4 to 20 mA	VS-7213-XXX-4-P	VS-7214-XXX-4-P	—	—
	Two-Position SPST Valve Assembly	VA-7213-2XX-4-P	VA-7214-2XX-4-P	VA-7253-2XX-4-P	VA-7215-2XX-4-P
Normally Closed Valves	Valve Body	VB-7223-0-4-P	VB-7224-0-4-P	VB-7253-0-4-P	VB-7235-0-4-P
	Valve Assembly, 2 to 15 Vdc Input, 4 to 20 mA	VS-7223-XXX-4-P	VS-7224-XXX-4-P	—	—
	Two-Position SPST Valve Assembly	VA-7223-2XX-4-P	VA-7224-2XX-4-P	VA-7253-2XX-4-P	VA-7235-2XX-4-P
Flow Type		Equal % (Refer to page 696)		Modified Linear (Refer to page 696)	
Material	Body	Bronze	Bronze	Bronze	Bronze
	Seat	Bronze	Bronze	Stainless Steel	Stainless Steel
	Stem	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
	Plug	Brass	Brass	Stainless Steel	Stainless Steel
	Packing	Spring loaded TFE	Spring loaded TFE	Spring loaded TFE	Spring loaded TFE
	Disc	Composition	Composition	Teflon	None
ANSI Pressure Class (psig)		250 (up to 400 psig below 150°F, see page 695)			
Maximum Inlet Pressure Steam psig (kPa)		35 (241)		100 (690)	150 (1034)
Allowable Control Media Temp [a]		20 to 281°F (-7 to 138°C)	20 to 281°F (-7 to 138°C)	20 to 340°F (-7 to 171°C)	20 to 400°F (-7 to 205°C)
Allowable Differential Pressure for Water psig (kPa)		35 psi (241) Max. for normal life (Refer to page 698 for cavitation limits)		35 (241)	35 (241)
Allowable Differential Pressure for Steam		20 psi (138 kPa)	20 psi (138 kPa)	35 psi (241 kPa)	50 psi (345 kPa)

NOTE: These charts are color coded as shown below to assist valve selection. Note it is possible to select either a valve assembly or component parts (actuator, valve linkage, valve body).

1. **Valve Assembly:** VS-7223-211-4-8
2. **Valve Body:** VB-7223-0-4-8
   Actuator: MP-5210
   Linkage: AV-7600

- Valve Body Data less P Code (Size, Cv Rating, Port Code) or Valve Assembly less Actuator Code (XXX) and less P Code (Size, Cv Rating, Port Code)
- P Code (Size, Cv Rating, Port Code)
- Actuator or Actuator Code (XXX) for Valve Assemblies
- Valve Linkage

TO SELECT A PORT CODE (P).

P Code	Valve Size in.	Cv			
-1 [b]	1/2	0.4	0.4	0.4	0.4
-2 [b]		1.3	1.3	1.3	1.3
-3 [b]		2.2	2.2	2.2	2.2
-4		4.4	4.4	4.4	4.4
-5 [b]	3/4	5.5	5.5	5.5	5.5
-6		7.5	7.5	7.5	7.5
-7 [b]	1	10	10	10	10
-8		14	14	12	12
-9	1-1/4	20	20	20	20
-10	1-1/2	28	28	28	28
-11	2	40	40	40	40

[a] CAUTION: Freeze protection required for fluid temperatures below 32°F (0°C). Avoid ice formation on stems. Do not use Hydraulic Actuators with fluid temperatures below 40°F (4°C).

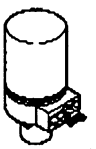
[b] Factory assemblies are not available for two-position applications using reduced port valve bodies.

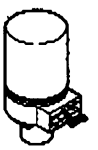
To: Roger
From: Mark

Please note that the VB-4204 + VB-4314 have changed to VB-7204 + VB-7314.
If you need any further information Please call.
Thank you.

2-Way Valves, Screwed (1/2 to 2 in.) and Union Sweat (1/2 to 2 in.) with Hydraulic Actuators

TABLE 2. Select Actuator Type or Actuator Code (XXX) series with correct Input Signal having sufficient close-off for the application. If selecting Component Parts, select Valve Linkage.





Input Signal					Two-Position SPST Floating SPDT	Electronic Vdc 4 to 20 mA 135 Ohm Slidewire
Valve Linkage — C, 1/2 to 1-1/4 in. Valve					AV-7500	AV-7500[a]
Actuator Code (XXX)					2XX	2XX
Actuator					MA-521X-XXX MF-5X1X	MP-5X1X MPR-561X MPR-571X
N.P.	Factory Available Valve Assembly	Valve Body	P Code	Size In.	CLOSE-OFF PRESSURE RATING (psi)[b]	
N.O.	VA-7213-2XX-4-P VS-7213-XXX-4-P	VB-7213-0-4-P VB-7214-0-4-P VB-7253-0-4-P VB-7273-0-4-P	-1-2-3-4	1/2	130	130
			-5-6	3/4	80	80
			-7-8	1	50	40
			-9	1-1/4	35	25
			-10	1-1/2	25	15
			-11	2	15	6
N.C.	VA-7223-2XX-4-P VS-7223-XXX-4-P	VB-7223-0-4-P VB-7224-0-4-P VB-7263-0-4-P VB-7283-0-4-P	-1-2-3-4	1/2	200	130
			-5-6	3/4	130	80
			-7-8	1	60	40
			-9	1-1/4	35	25
			-10	1-1/2	20	15
			-11	2	10	6

[a] MF-5X1X, MP-541X, MPR-5XXX use AV-7500 and AV-601.

[b] Close-off rated with pressure at inlet (port A). Close-off ratings for normally open valves are with indicated supply air pressure applied to actuator. Close-off ratings for normally closed valves are within 1 psi or less applied to actuator (for kPa multiply C_v by 6.89).

TABLE 3. Factory Assemblies, select exact Actuator Code (XXX). Any MA-52XX, MF-5X1X, MP-5XXX, MPR-5X1X can be assembled to 1/2 to 1-1/4 in. valve bodies with the close-off pressure ratings listed in Table 2. Select below listed Hydraulic Actuators or Actuator Codes (XXX) for factory available assemblies. For applications that factory assemblies are not available, select actuator, linkage, valve body and field assemble.

Input Signal	Wiring Figure No.[a]	Voltage Vac 50/60 Hz	VA	Aux. Switch	Actuator Part No.	Actuator Code (XXX) for Factory Available Assembly	
						VA-72X3	VS-72X3
Two-Position SPST	Figure 2 on page 705	24	18	No	MA-5213	201	
		120			MA-5210	211	
		240			MA-5211	221	
2 to 15 Vdc. System 8000, stroke occurs 6 to 9 Vdc approx., non-positive positioning	Figure 11 on page 708	24			MP-5213		201
		120			MP-5210		211
		240			MP-5211		221
2 to 15 Vdc, System 8000, start 6 Vdc factory set, adjustable 2 to 12 Vdc, 3 Vdc span, positive positioning	Figure 11 on page 708	24			MP-5413		247[b]
		120			MP-5410		244[b]
		240			MP-5411		245[b]
4 to 20 mA	Figure 18 on page 715	24	18		MPR-5613		267[b]
		120			MPR-5610		264[b]
		240			MPR-5611		265[b]
Floating SPDT	Figure 19 on page 715	24	21		MF-5413	221[b]	
					MF-5513	223[b]	

[a] Refer to the Valve/Actuator Wiring Diagrams in this section.

[b] Includes AV-601.

2-Way Valves, Screwed (1/2 to 2 in.) and Union Sweat (1/2 to 2 in.) with Hydraulic Actuators

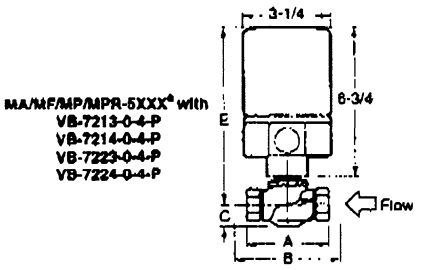
TABLE 4. Dimensions in Inches (Millimeters).

Valve Body					Actuator Series MA/MF/MP/ MPR-5XXX[a]
Part Number	Size in.	A	B[b]	C	E
VB-7213-0-4-P VB-7214-0-4-P	1/2	3 (76)	4-3/16 (106)	1-1/16 (27)	6-11/16 (170)
	3/4	3-5/8 (92)	5-7/16 (138)	1-1/16 (27)	6-11/16 (170)
	1	4-5/8 (117)	6-5/8 (168)	1-1/8 (29)	8-9/16 (217)
	1-1/4		6-13/16 (173)	1-3/8 (35)	8-9/16 (217)
	1-1/2	5-3/8 (137)	8-5/16 (211)	1-1/2 (38)	8-5/8 (219)
	2	6-1/8 (156)	9-3/16 (233)	1-9/16 (40)	8-7/8 (225)
VB-7253-0-4-P VB-7273-0-4-P	1/2	3 (76)	4-3/16 (106)	1-3/16 (30)	6-11/16 (170)
	3/4	3-5/8 (92)	5-7/16 (138)	1-3/16 (30)	6-11/16 (170)
	1	4-5/8 (117)	6-5/8 (168)	1-1/8 (29)	8-9/16 (217)
	1-1/4		6-13/16 (173)	1-3/8 (35)	8-9/16 (217)
	1-1/2	5-3/8 (137)	8-5/16 (211)	1-1/2 (38)	8-5/8 (219)
	2	6-1/8 (156)	9-3/16 (233)	1-9/16 (40)	8-7/8 (225)
VB-7223-0-4-P VB-7224-0-4-P VB-7263-0-4-P VB-7283-0-4-P	1/2	3 (76)	4-3/16 (106)	1-1/4 (32)	6-11/16 (170)
	3/4	3-5/8 (92)	5-7/16 (138)	1-1/4 (32)	6-11/16 (170)
	1	4-5/8 (117)	6-5/8 (168)	1-3/4 (44)	7-15/16 (202)
	1-1/4		6-13/16 (173)	1-3/4 (44)	8-3/16 (208)
	1-1/2	5-3/8 (137)	8-5/16 (211)	1-13/16 (46)	8-5/16 (211)
	2	6-1/8 (156)	9-3/16 (233)	2-1/16 (52)	8-3/8 (213)

[a] Add 2-3/32 in. (53 mm) to the "E" dimension for a valve assembly using an AV-601 linkage extension.

[b] Use B dimension for VB-7214 and VB-7224 valve bodies.

NOTE: Allow 3 inches clearance above actuator for removal. Mount MA/MF/MP/MPR-5XXX actuators above the valve body at 45° from vertical on steam applications.



[a] AV-601 linkage extension (not shown) required for hot water applications for MF-5XXX, MP-54XX, MPR-5XXX, MP-55XX.

TABLE 5. Restrictions on Maximum Ambient Temperature for Valve Actuators.

Temperatures °F (°C)				
Actuator Code (XXX)		20X, 21X, 22X		24X, 26X
Actuator Series		MA-521X-XXX MP-521X-XXX	MA-521X-XXX MP-521X-XXX w/AV-601 Linkage Extension	MPR-561X, MPR-571X, MP-541X, MF-5X1X, MP-551X w/ AV-601 Linkage Extension
Maximum Ambient		140 (60)	140 (60)	140 (60)
Max. Allowable Fluid		181 (83)	281 (138)	140 (60)
VB-7213-0-4-P VB-7214-0-4-P VB-7223-0-4-P VB-7224-0-4-P	Maximum Fluid	281 (138)		281 (138)
	Max. Allow. Ambient	115 (46)	140 (46)	103 (39)
VB-7253-0-4-P	Maximum Fluid	340 (171)	340 (171)	340 (171)
VB-7263-0-4-P	Max. Allow. Ambient	100 (38)	100 (38)	93 (34)
VB-7273-0-4-P	Maximum Fluid	366 (180)	366 (180)	366 (186)
VB-7283-0-4-P	Max. Allow. Ambient	90 (32)	90 (32)	88 (31)

CAUTION: Avoid condensation which can facilitate corrosion. With 40°F (4°C) water, the maximum allowable ambient dew point temperature is 68°F (20°C). Piping insulation must not stop drainage at actuator mounting nut. Do not use Hydraulic Actuators with fluid temperatures below 40°F (4°C).

1/16 DIN Auto-Tune Controller Universal Input

Very High Performance in a Very Small Package

5 YEAR WARRANTY | MADE IN USA | UL

KMTSS-125G-6 Thermocouple Sold Separately, $24.

Shown Larger than Actual Size

- Dual 4-Digit Display
- Auto-Tune PID, PID or On-Off Control
- Thermocouple Input with 1° or 0.1° Resolution
- RTD Input with 1° or 0.1° Resolution
- Scalable Voltage and Current Inputs
- °F, °C or Engineering Unit Display
- Password Protection
- Front Panel Programming
- Relay, dc Pulse, ac SSR, Voltage or Current Output(s)

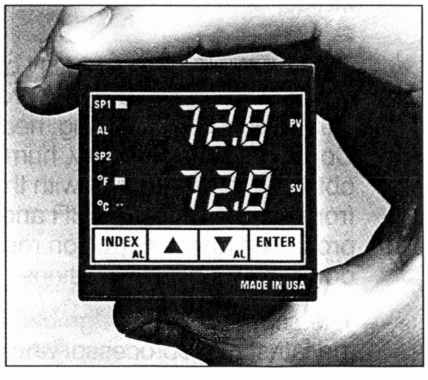
Optional Features:

- 4 Stage Setpoint
- Analog Process or RS-485 Digital Output
- Tracking/Non-Tracking Alarms

Additional Features:

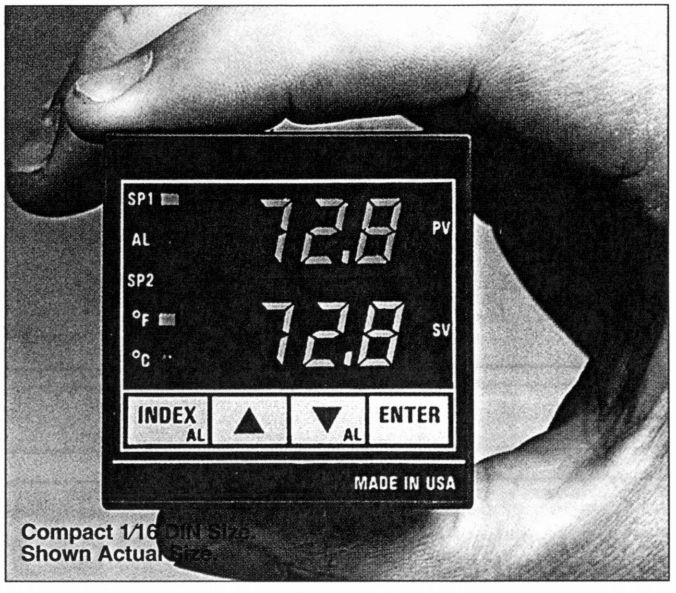
- Loop Break Protection
- Min/Max Indication
- Auto/Manual Operation
- Percent Output Indication
- Single Segment Ramp and Soak

Compact, 1/16 DIN Size, with NEMA 2, 3R and 12 Rated Front Panel

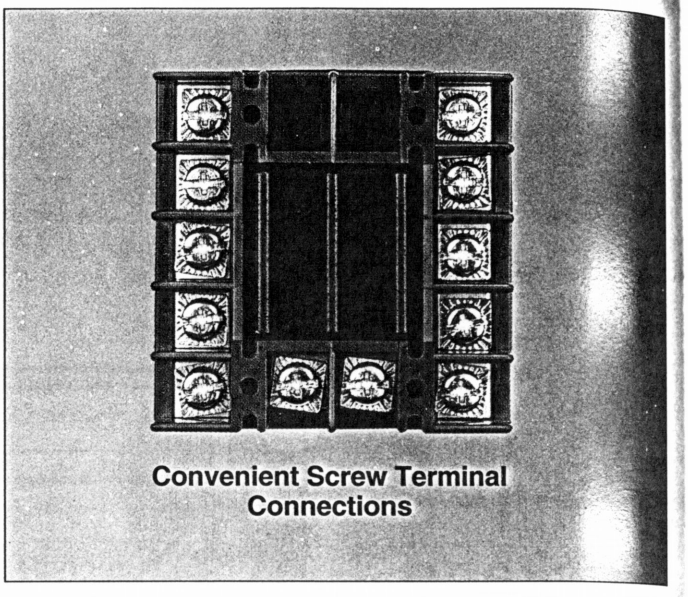


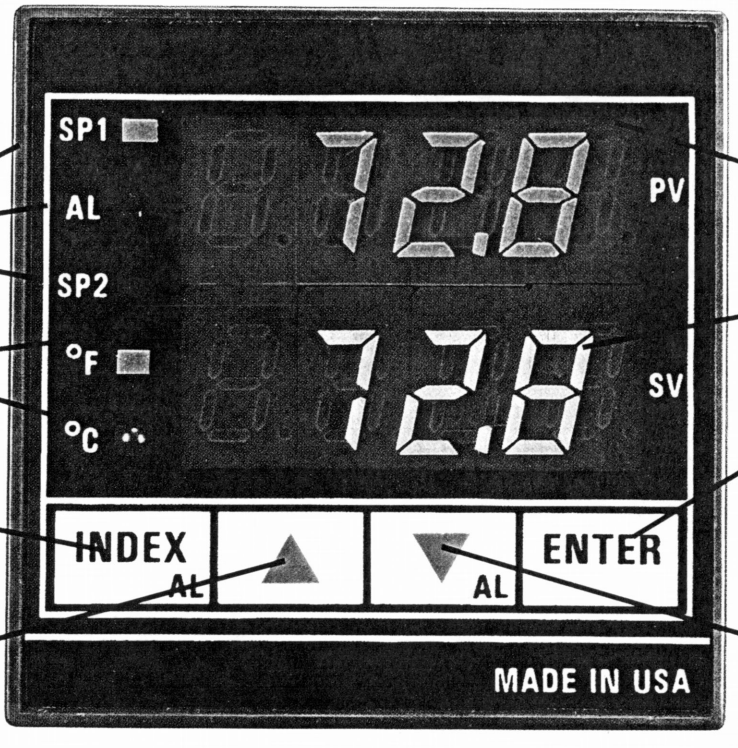
Single Output
$189

Dual Output
$199



Compact 1/16 DIN Size.
Shown Actual Size.


Convenient Screw Terminal Connections



Status LEDs indicate status of setpoint and alarm outputs.

°F/°C engineering units. Both indicators are off for non-temperature inputs.

INDEX key advances menu for programming. Also used with decrement key to reset an alarm programmed for manual reset.

Increment key raises value or turns "on" menu item chosen. Also used with ENTER key to display secondary and secure menus.

Upper display continuously indicates process value or value of menu item selected.

Lower display continuously indicates set value or menu item selected.

ENTER key enters new settings or commands into memory. Also used with the increment key to display other menus.

Decrement key lowers value or turns "off" menu item chosen. Also used with INDEX key to reset an alarm programmed for manual reset.

The new CN76000 1/16 DIN controllers provide economical temperature or process control for a wide variety of heating, cooling, heat/cool or other processes. Control of pressure, flow, humidity, motion or pH can be obtained in conjunction with the proper transmitters. The front panel is NEMA 2, 3R and 12 rated for waterproof protection and is corrosion resistant; it may be washed down in sanitary applications.

The sophisticated design of the CN76000 incorporates the latest microprocessor and surface mount technology, to provide an unprecedented number of standard features in an economical 1/16 DIN package. All control functions are programmed from the front panel, while input types are DIP switch selectable. Multiple tuning modes allow the operator to select from three standard tuning pre-sets, manual or auto-tuning.

Standard features include self-diagnosis with fault indication. Non-volatile memory retains all process parameters when power is off, without battery backup. The optional alarm provides a full array of configurable alarm actions. The alarm action may be defeated on startup, or until the process value exceeds the alarm setpoint. A selectable power interrupt feature allows the alarm to reset on powerup if the alarm condition no longer exists.

Additional standard features include min/max storage and display, auto/manual control, percent output indication, ramp and soak operation, four user-selectable security levels with password protection and jumper selected 5 Vdc pulse output to drive external solid state relays. Optional features include RS-485 communications, process recorder output or four-stage setpoint.

Input Types and Ranges (Field Selectable)

	Input Type	Range	Resolution	Range	Resolution
J	Iron-Constantan	-100 to 1600°F -100.0 to 990.0°F	1°F 0.1°F	-73 to 871°C -73.0 to 871.0°C	1°C 0.1°C
K	CHROMEGA®-ALOMEGA®	-200 to 2500°F -190.0 to 990.0°F	1°F 0.1°F	-129 to 1371°C -129.0 to 990.0°C	1°C 0.1°C
E	CHROMEGA-Constantan	-100 to 1800°F -100.0 to 990.0°F	1°F 0.1°F	-73 to 982°C -73.0 to 990.0°C	1°C 0.1°C
T	Copper-Constantan	-350 to 750°F -190.0 to 750.0°F	1°F 0.1°F	-212 to 398°C -212.0 to 398.0°C	1°C 0.1°C
N	OMEGALLOY® Nicrosil-Nisil	-100 to 2372°F -100.0 to 990.0°F	1°F 0.1°F	-73 to 1300°C -73.0 to 990.0°C	1°C 0.1°C
R	Pt/13%Rh-Pt	0 to 3200°F	1°F	-17 to 1760°C	1°C
S	Pt/10%Rh-Pt	0 to 3200°F	1°F	-17 to 1760°C	1°C
B	Pt/6%Rh-Pt/30%Rh	75 to 3308°F	1°F	24 to 1820°C	1°C
C	W/5%Re-W/26%Re	0 to 4208°F	1°F	-17 to 2320°C	1°C
RTD	100Ω Pt 0.00385 curve	-328 to 1607°F -190.0 to 990.0°F	1°F 0.1°F	-200 to 875°C -190.0 to 875.0°C	1°C 0.1°C
RTD	100Ω Pt 0.00392 curve	-328 to 1607°F -190.0 to 990.0°F	1°F 0.1°F	-200 to 875°C -190.0 to 875.0°C	1°C 0.1°C
RTD	120Ω Ni	-112 to 608°F -112.0 to 608.0°F	1°F 0.1°F	-80 to 320°C -80.0 to 320.0°C	1°C 0.1°C
Process Current		0 to 20 mA, 4 to 20 mA†			
Process Voltage		0 to 5 Vdc, 1 to 5 Vdc†			

† Voltage and current inputs are fully scalable for zero and span. Maximum setting range is -1999 to +9999 counts.

Ordering Information

To Order *(Specify Model Number)*

Single Output Models

Model No.	Price	Output
CN76(*)30	$189	Relay/dc Pulse††
CN76(*)20	189	dc Pulse/ac SSR††
CN76(*)50	189	0 to 20 mA
CN76(*)60	189	0 to 10 Vdc

** Specify 0 for std unit, 1 for alarm unit, for alarms, add $6 to price.*

††These outputs are logic jumper selectable between relay and dc pulse, or between dc pulse and ac SSR.

Ordering Example:** CN76030-485, CN76000 controller with single relay/dc pulse output and optional RS-485 communications. $189 + 50 = **$239.

Each unit supplied with mounting bracket and complete operator's manual.

To Order *(Specify Model Number)*

Dual Output Models

Model No.	Price	Output 1	Output 2
CN76(*)33	$199	Relay/ dc Pulse††	Relay/ dc Pulse††
CN76(*)22	199	dc Pulse/ ac SSR††	dc Pulse/ ac SSR††
CN76(*)53	199	0 to 20 mA	Relay/dc Pulse††
CN76(*)63	199	0 to 10 Vdc	Relay/dc Pulse††

** Specify 0 for std unit, 1 for alarm unit, for alarms, add $6 to price.*

††These outputs are logic jumper selectable between relay and dc pulse, or between dc pulse and ac SSR.

***Ordering Example:** CN76133-485, CN76000 controller with dual relay/dc pulse outputs, alarms and optional RS-485 communications. $199 + 50 = **$249**.*

Options

Ordering Suffix	Add'l. Price	Description
-PV	39	Scalable Recorder Output, 0-10 Vdc
-4SP	39	Four Stage Remote Setpoint
-485	50	RS-485 Communications

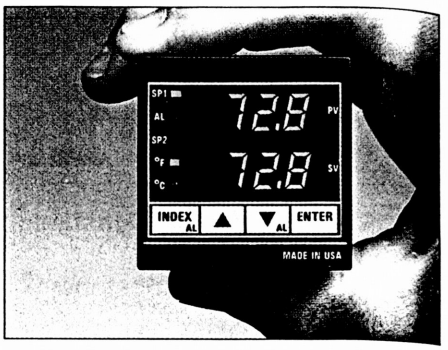
Note: only one option may be installed in a unit.

IN STOCK FOR FAST OFF-THE-SHELF DELIVERY!

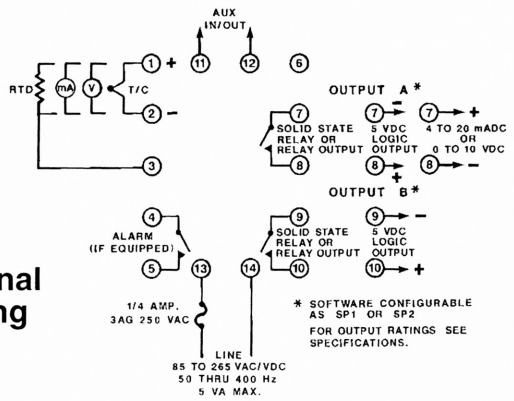
Accessories

Model No.	Price	Description
1821-101	$8	Noise suppression kit for mechanical relay models driving ac contactors or solenoids

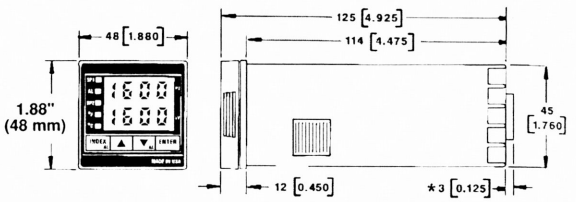
1/16 DIN Auto-Tune Controller
CN76000 Series



External Wiring



Dimensions

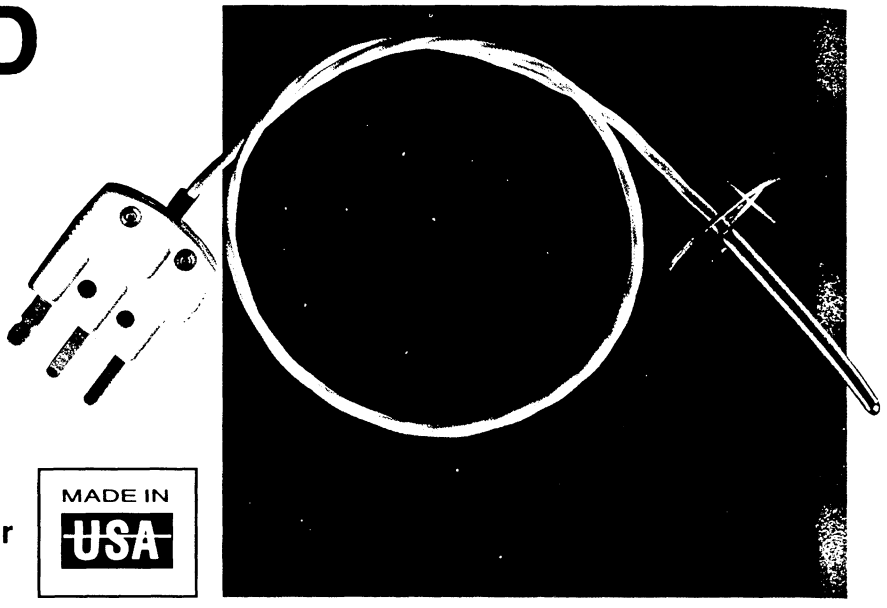


PANEL CUTOUT FOR ALL MODELS IS 1.775" X 1.775" (45 X 45 MM).
ALLOW FOR 0.5" (13 MM) CLEARANCE AT REAR OF INSTRUMENT.
* PRESENT FOR ALL OUTPUTS OTHER THAN RELAY.

Specifications:

Inputs: thermocouple, RTD, voltage or current; see input chart for ranges
Resolution: see range chart; voltage and current input models are fully field scalable to engineering units with up to 2 decimal places
Accuracy: ±0.25% span ±1 digit
Input Impedance: 3 MΩ min, thermocouple; 200 µA, RTD current; 249 Ω, current; 5 kΩ, voltage
Sensor Break Protection: de-energizes control outputs to protect system
Loop Break Protection: error message is initiated on shorted sensor or open heater circuit; break time adjustable from off to 99 min.
Loop Break Alarm: on alarm relay equipped units, unit can be programmed to alarm on loop break
Setpoint Range: selectable
Displays: dual 4-digit, 7 segment LED, 0.3" (7.6 mm) high; process variable in red, setpoint in green
Control Action: reverse (heat) or direct (cool) action; selectable for single or dual setpoint models
Control Modes: time proportioning and proportional control modes; selectable pre-set tune, auto-tune or manual PID, P, PI or PD with reset anti-windup
Proportional Band: 6 to 5000°F or equivalent °C units; 6 to 9990 for voltage/current inputs
Integral Time: 0.1 to 99.9 minutes, or off
Derivative Time: 0.01 to 99.99 minutes or off
Cycle Time: 2 to 80 sec.
Approach Rate: off to 99.99 min.
On-Off Control: adjustable on-off differential 2° to full scale in 1° steps, 2 counts to full scale in 1 count steps (voltage/current inputs)
Ramp and Soak: one ramp time and soak time each adjustable from 0 to 100 hours; end procedure can be set for HOLD or OFF
Power: 85 to 265 Vdc or Vac, 50-400 Hz
Power Consumption: 5 VA max.
Line Voltage Stability: ±0.05% over supply voltage range
Temperature Stability: 2.3µV/°F (4µV/°C) typical, 4.5µV/°F (8µV/°C) max.
Common Mode Rejection: 140 dB minimum at 60 Hz
Normal Mode Rejection: 65 dB typical, 60 dB at 60 Hz
Isolation: relay and SSR outputs are isolated; current, voltage and logic outputs must not share common grounds with the input
Memory: non-volatile; no batteries required
Mechanical Relay Output: SPST (form A), 3 A @ 250 Vac, resistive; 1.5 A @ 250 Vac, inductive; 250 VA pilot duty rating, 2 A @ 125 Vac or 1 A @ 250 Vac, 1/8 HP @ 125 Vac or 250 Vac
Solid State Relay Output: 3.5 A up to 240 Vac at 77°F (25°C); derates to 1.25 A @ 131°F (55°C)
Voltage Output: non-isolated; 0 to 10 Vdc, 500Ω min.
Current Output: non-isolated; 0 to 20 mA, 600Ω max.; zero and span adjustable
dc Pulse Output: non-isolated; 5 Vdc @ 25 mA
Operating Ambient: -4 to 130°F (-10 to 55°C); 0 to 90% RH up to 40°C, non-condensing; 10 to 50% at 55°C, non-condensing
Storage Ambient: -40 to 175°F (-40 to 80°C)
Alarms: Two alarms operate the same relay. 3.0 A resistive 250 Vac; Form A contact (SPST); Field programmable for absolute (non-tracking) or deviation (tracking); can be set anywhere within the scaling of the controller; selectable inhibit and power interrupt; automatic/manual reset
Process Signal Output (optional): linearized, non-isolated 0 to 10 Vdc @ 5 mA; user selectable scale positioning of zero and full scale; scaling span is 50 to 11,998 counts
Four Stage Setpoint (optional): up to 4 setpoints may be selected through two sets of external contacts. Each setpoint has its own set of PID values
RS485 Communications (optional): unit with RS-485 compatible communications
Dimensions: 1.88"H x 1.88"W x 4.925"D (48 x 48 x 125 mm); 4.54" (115.3 mm) depth behind panel
Panel Cutout: 1.775" (45 mm) square; 1/16 DIN
Weight: 8 oz (227 g)
Front Panel Ratings: NEMA 2, 3R and 12; dust and splash resistant

Precision RTD Probes
For Laboratory Applications
RTD-800 Series

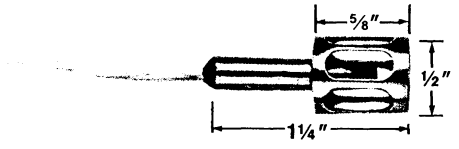
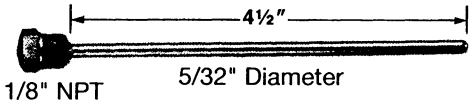
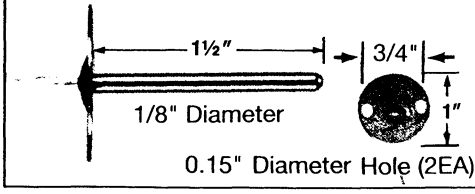


- 100Ω Pt RTD Sensor
- 3′ Teflon® Coated Lead Wires
- Subminiature MTP Series Connector

MADE IN USA

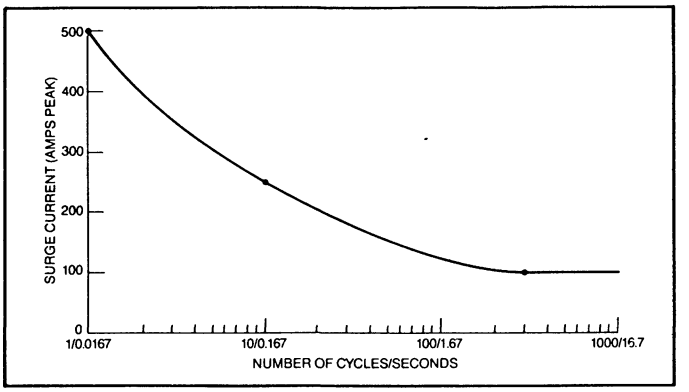
In-Stock for Fast Delivery

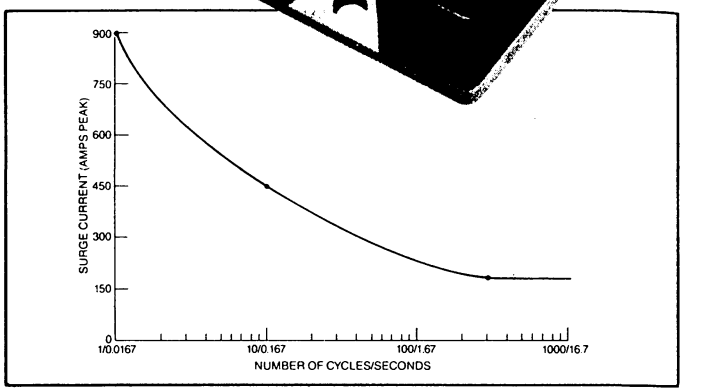
To Order (Specify Model Number)

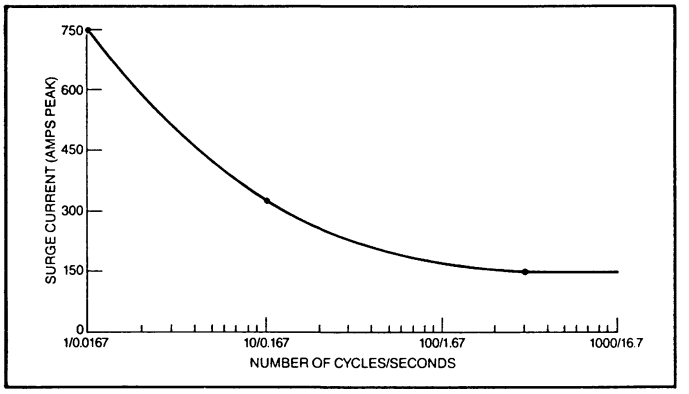
Configuration	Model No.	Description	Temp. Range	Applications	Price
	RTD-805	RTD element mounted in open-end stainless steel housing with Teflon insulated leads. Designed for air temperature measurement and monitoring of gas streams. 3′ lead wires. RTD-806 features economical plastic housing.	−200 to 230°C	Gas and Air	$86
	RTD-806				81
	RTD-809	Encapsulated sensor in stainless steel housing with Teflon insulated leads. Surface temperature measurement design, ideal for heat loss or compressor efficiency measurement. 3′ lead wires.	−200 to 230°C	Surface	83
	RTD-810	Closed-end stainless steel tube with Teflon insulated leads. Rugged design is ideally suited for fluid measurement. Also for use in a wide variety of pressurized systems applications. 3′ lead wires	−200 to 750°C	Gas and Liquid	79
	RTD-830	Encapsulated sensor in screw-mounted Aluminum housing with Teflon insulated leads. Sensor design provides low cost, fast response, and is designed for easy mounting on flat surfaces. 3′ lead wires.	−200 to 230°C	Flat Surface	64
	RTD-850	Stainless steel housing with ¼″ hex head and #8-32 NC-2A threaded body. RTD sensor encapsulated in housing with Teflon insulated leads. Designed for applications requiring vibration & shock resistance. 3′ lead wires.	−200 to 230°C	Surface	64
	RTD-860	Closed-end stainless steel tube with sensor mounted in tip. Stainless steel mounting plate with two (2) mounting holes welded to tube. Teflon insulated 3′ lead wires.	−200 to 230°C	Gas and Air	83

Solid State Relays

MADE IN USA







To Order (Specify Model Number)			
Model No.	**Price**	**Description**	**Nominal Rating**
SSR240AC10	$27	ac Control Signal (280 Vac line)	10A
SSR240AC25	37		25A
SSR240AC45	50		45A
SSR240AC75	96		75A
SSR240AC90	114		90A
SSR240DC10	$21	dc Control Signal (280 Vac line)	10A
SSR240DC25	26		25A
SSR240DC45	47		45A
SSR240DC75	91		75A
SSR240DC90	118		90A
SSR440AC50	$108	ac Control Signal (440 Vac line)	50A
SSR440AC75	118		75A
SSR440AC90	137		90A
SSR440DC50	$91	dc Control Signal (440 Vac line)	45A
SSR440DC75	109		75A
SSR440DC90	137		90A
FHS-1	$13	Finned Heat Sink	2°C/W
FHS-2	17		1.2°C/W
FHS-6	21		0.7°C/W

Shunt Resistors

To Order (Specify Model Number)		
Model No.	**Price**	**Value**
SSRR20-12	$6	2000 ohms, 12 watts
SSRR20-50	9	2000 ohms, 50 watts
SSRR15-12	6	1500 ohms, 12 watts
SSRR15-50	9	1500 ohms, 50 watts

Fuses

Model No.	Price	Capacity
KAX-10	$10	10 A ac
KAX-25	10	25 A ac
KAX-45	43	45 A ac
KAX-70	41	70 A ac
KAX-90	46	90 A ac
KBH-50	35	50 A ac
KBH-70	41	70 A ac
KBH-90	46	90 A ac

Fuse Blocks

Model No.	Price	Compatible Fuse
FB-1	$7	KAX-10, KAX-25
FB-2	12	KAX-10, KAX-25
FB-3	16	KAX-10, KAX-25
BS101	46	KAX-45, KAX-75, KAX-90, KBH (all models)

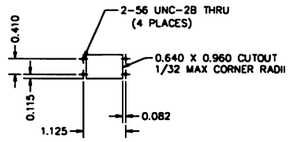
Shunt Resistor Guide for Controllers with Triac or SSR Outputs

Controller Model No.	Page No.	Model No. Resistor, 120 Vac	Model No. Resistor, 240 Vac
4000/4000A with option T	P-79	SSRR20-12	SSRR20-50
4200/4200A with option T	P-79	SSRR20-12	SSRR20-50
CN6070/6070A with option T	P-39	SSRR20-12	SSRR20-50
CN2000, CN2010, CN2040	P-27	SSRR20-12	SSRR20-50
CN5000 Series (with 1.5 or 15 amp SSR)	P-74	SSRR15-12	SSRR15-50
CN5050 with 1 amp SSR	P-44	SSRR15-12	SSRR15-50
CN9131A, 9231, or 9231A	P-23	SSRR12-12	SSRR15-50

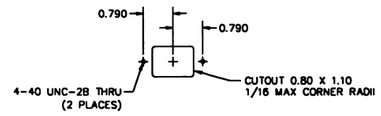
Appendix B
Drawings

DATE: 10-14-98 BOM A35201B006 PID HVAC CONTROLLER

PARENT BOM	TYPE	DESCRIPTION	PART NUMBER	MANUFACTURER	QTY REQD
B006	ASSY	HVAC CONTROL BOX	D35201M029	NRAO	1
B006	CAP	0.1 UF CERAMIC			6
B006	CAP	10 UF TANTALUM			1
B006	CAP	1 UF CERAMIC			2
B006	CONN	5 PIN BULKHEAD	126-5S	AMPHENOL	1
B006	CONN	BNC BULKHEAD	31-4803	AMPHENOL	1
B006	CONN	22 PIN EDGECARD	9144	CINCH	1
B006	CONN	ELCO PANEL,20P,PROTECTED		ELCO	2
B006	CONN	ELCO,CABLE,20P,EXPOSED		ELCO	2
B006	CONN	ELCO,PANEL,20P,EXPOSED		ELCO	2
B006	CONN	ELCO,CABLE,20P,PROTECTED		ELCO	2
B006	DWG	WIRING DIAGRAM	D35201W001	NRAO	1
B006	IC	OP AMP	ADOP07	ANALOG DEV	3
B006	MISC	SWITCH, AC SPST			1
B006	MISC	SWITCH, DC, SPST			1
B006	MISC	FUSEHOLDER	HKP	BUSSMAN	3
B006	MISC	BUZZER ALARM	PF-27N36W	MALLORY	1
B006	MISC	PROCESS CONTROLLER	CN76122-485	OMEGA	1
B006	MISC	TEMPERATURE SENSOR	RTD-805	OMEGA	1
B006	MISC	SOLID-STATE RELAY	SSR240DC45	OMEGA	2
B006	MISC	POWER SUPPLY, 15V DUAL	HAD15-0.4-A	POWER ONE	1
B006	MISC	AC PANEL SOCKET	6100-3100	SCHURTER	1
B006	RES	RESISTOR, 1%, 1.50MEG			2
B006	RES	RESISTOR, 1%, 1.00MEG			2
B006	RES	RESISTOR, 1%, 250K			1
B006	RES	RESISTOR, 1%, 100K			4

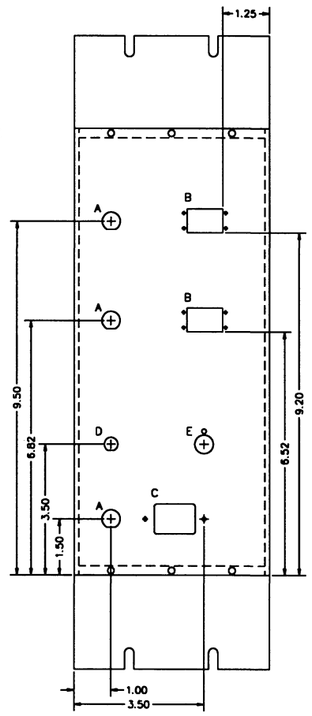


DETAIL
ELCO 20 PIN
CHASSIS MOUNT

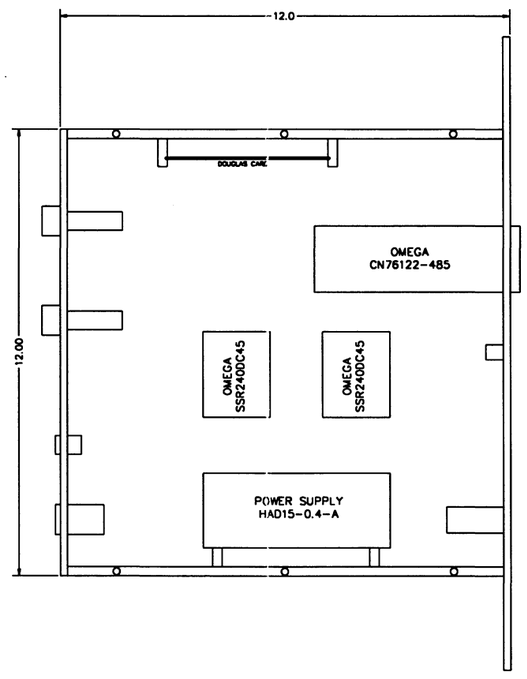


DETAIL
EAC 309 AC POWER SOCKET
CHASSIS MOUNT

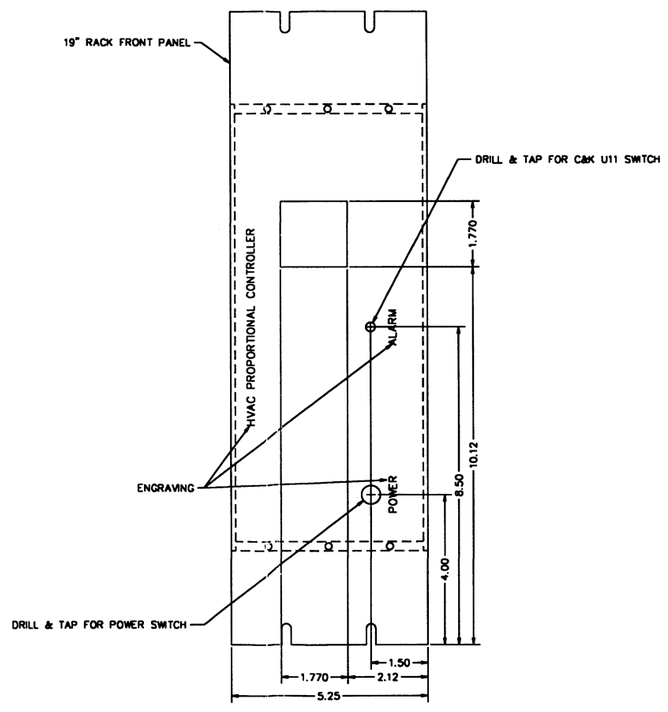
A - FUSEHOLDER .47 X .50 D-HOLE
B - ELCO 20 PIN CONNECTOR
C - AC POWER SOCKET
D - ISOLATED BNC .35 X .38 D-HOLE
E - AMPHENOL 126-5S CONNECTOR



REAR PANEL



TOP VIEW



FRONT PANEL
PAINT FRONT PANEL GBT GREY

NOTE: TOP - PERFORATED ALUMINUM
FRONT PANEL, REAR PANEL, BOTTOM PANEL - 3/16 THK ALUMINUM
SIDE PANELS - 1/4 THK ALUMINUM

NATIONAL RADIO ASTRONOMY OBSERVATORY
P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944

PROJECT/TITLE	GBT EQUIPMENT ROOM HVAC CONTROL BOX			
DESIGNED	R. NORROD	DRAWN	R. NORROD	CHECKED	DATE 4/23/98
SCALE	1 = 2	MATERIAL	AS NOTED	FINISH	CHROMATE	DRAWING NO. D35240M029
FILE	ARCHIVE\GBTELEC\35240\M029	SHEET	1 OF 1	REVISION	-

TOLERANCES UNLESS OTHERWISE SPECIFIED
ANGULAR ±0°30'
FRACTIONAL ±1/64
2 PLACE DECIMAL ±.01
3 PLACE DECIMAL ±.005
DIMENSIONS ARE IN INCHES

REVISIONS					
REVISION	MADE BY	DESCRIPTION	ZONE	DATE	APPROVED
A	R. TAGGART	MISCELLANEOUS CHANGES TO SHEET 2 & 3	ALL	08/05/98	
B	R. TAGGART	MISCELLANEOUS CHANGES TO SHEET 2	ALL	10/14/98	

COMPUAIR
HVAC UNIT
TYP RM 204,206

INTERNAL CONTROLLER

0XX 60X 2XX 4XX 6XX 0XX 60X

CUT EXISTING WIRES AT DASHED LINES AND RE-ROUTE TO CONNECTOR J1 AS SHOWN

18 AWG HWV LO OUT	60X	L	L
18 AWG HWV HI OUT	0XX	K	K
18 AWG CW RTN OUT	6XX	E	E
18 AWG CW CTRL OUT	4XX	D	D
18 AWG CW 20V OUT	2XX	F	F
18 AWG 24V LO OUT	60X	X	X
18 AWG 24V HI OUT	0XX	W	W
18 AWG CW 24V HI IN	0XX	M	M
18 AWG CW 24V LO IN	60X	N	N
18 AWG CW 20V IN	2XX	C	C
18 AWG CW CTRL IN	4XX	A	A
18 AWG CW RTN IN	6XX	B	B
HWV HI IN	0XX	P	P
HWV LO IN	60X	R	R

CHILLED WATER VALVE
SIEBE MP5213-0-0-3
CWV
0XX
60X
2XX
4XX
6XX
5XX NO CHANGE TO GND

HOT WATER VALVE
SIEBE MA5213-0-0-3
HWV
0XX
60X
5XX NO CHANGE TO GND

J1
ELCO CABLE
20 PROTECTED
PINS

P1
ELCO CABLE
20 EXPOSED
PINS

L K E D F X W M N C A B P R

ELCO CABLE
20 EXPOSED
PINS

ALL WIRES 18 AWG

PATCHBACK CONNECTOR PROVIDED TO REPLACE P1 & CABLE TO OMEGA CONTROLLER. RETURNS UNIT TO INTERNAL CONTROL.

SHIELDED TWISTED PAIR 22 AWG PLENUM CABLE
BELDEN 88723 OR EQUIVALENT

SHIELDED TWISTED PAIR 18 AWG PLENUM CABLE
BELDEN 88760 OR EQUIVALENT

CABLE LENGTH
AS REQUIRED

A B X R

P2
ELCO CABLE
20 PROTECTED
PINS

TO EXTERNAL PID CONTROLLER CHASSIS (SEE SHEET 2)

NATIONAL RADIO ASTRONOMY OBSERVATORY P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944					TOLERANCES UNLESS OTHERWISE SPECIFIED ANGULAR ± 0°30' FRACTIONAL ± 1/64 2 PLACE DECIMAL ± .01 3 PLACE DECIMAL ± .005 DIMENSIONS ARE IN INCHES
PROJECT/TITLE: GBT EQUIPMENT ROOM HVAC CONTROLLER					
DESIGNED: R. NORROD	DRAWN: R. TAGGART	CHECKED:		DATE: 06/25/98	
SCALE: --	MATERIAL: --	FINISH: --		DRAWING NO.: D35201W001	
FILE: ARCHIVE\GBTELEC\35201\W001-1	SHEET: 1 OF 3	REVISION: B			

J1, J2 — ELCO 20P PANEL MOUNT, EXPOSED
J3 — AMPHENOL 126-5S

J1
UNIT 1

CWV CTRL (+) A
CWV CTRL (-) B
M
N
P
HWV CTRL - L R
W
24V IN - L X
SHIELDS J

90X 22 AWG
91X 22 AWG
6XX 16 AWG
7XX 16 AWG

K1
SSR
F1, 3A
OMEGA
SSR240DC45

J2
UNIT 2

CWV CTRL (+) A
CWV CTRL (-) B
M
N
P
HWV CTRL - L R
W
24V IN - L X
SHIELDS J

90X 22 AWG
91X 22 AWG
6XX 16 AWG
7XX 16 AWG

K2
SSR
F2, 3A
OMEGA
SSR240DC45

A3
NRAO
PWM/Vo CONVERTER
(SEE SHEET 3)

M 11 9
+ + Vo -

PWM IN + -
15V IN + - C
6 7 14 12 22

CARD EDGE
CONNECTOR

OMEGA
RTD-805

+
-
GROUND

BNC
95X 22 AWG
94X 22 AWG

J3
SENSOR
A 96X 22 AWG
B 97X 22 AWG
H 98X 22 AWG

A1
OMEGA
CN76122-485
-PV

1 2 3
11 12
8 7
92X 22 AWG
93X 22 AWG

120VAC H
120VAC L
GND 5XX

S1
1/2 A
F3
0XX
9XX
13
14
4 5

10 9
6XX 22 AWG
7XX 22 AWG

MALLORY
PF-27N36W

0XX
S2
22 AWG
ALARM

16 AWG
16 AWG

A2
15V
COM

+
-
2XX 22 AWG
4XX 22 AWG
0XX 22 AWG

15V SUPPLY
HAD15-0.4-A

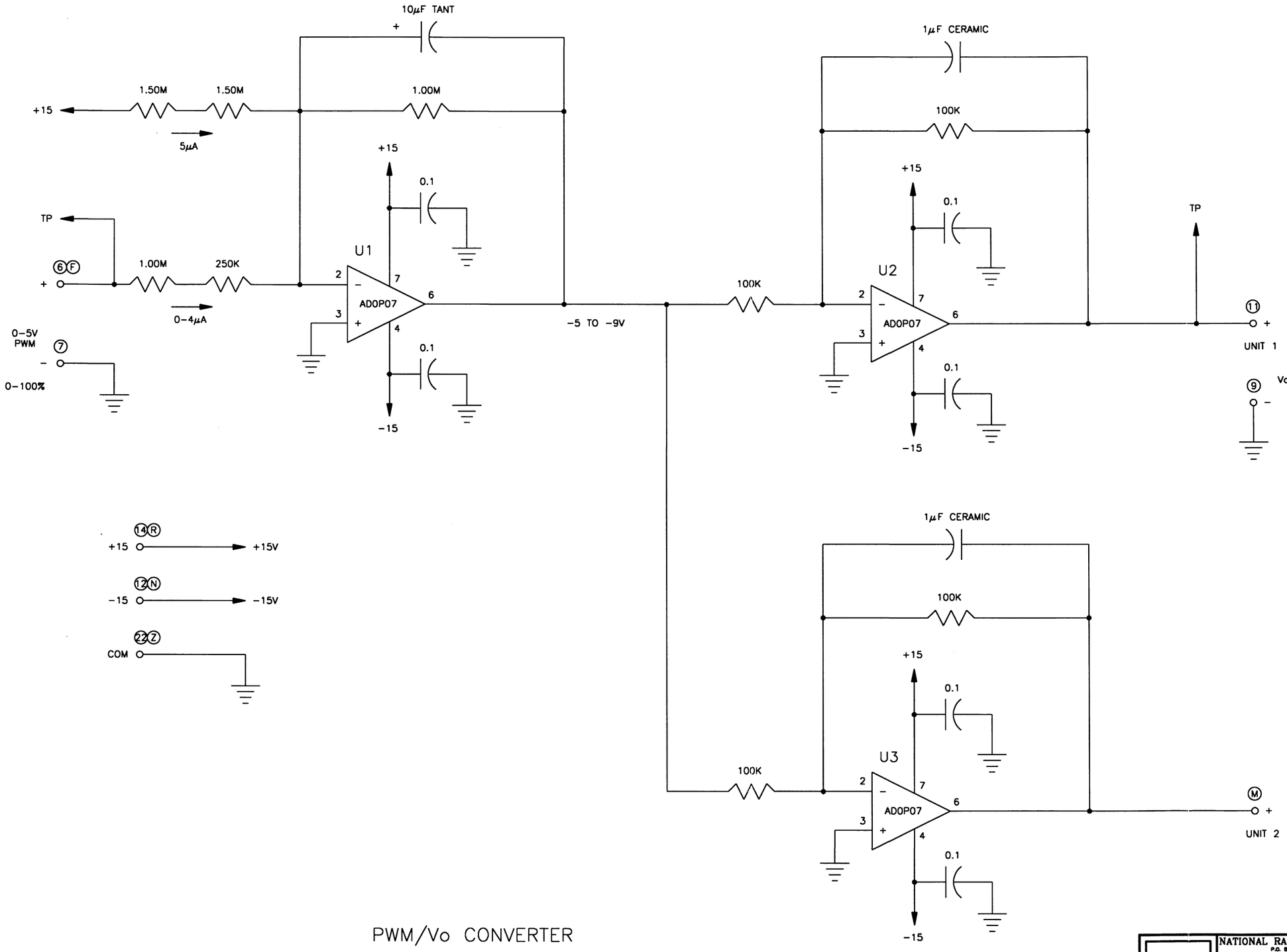
PID CONTROLLER
CHASSIS

NATIONAL RADIO ASTRONOMY OBSERVATORY
P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944

PROJECT/TITLE: GBT
EQUIPMENT ROOM HVAC CONTROLLER

DESIGNED: R. NORROD | DRAWN: R. TAGGART | CHECKED:
SCALE: -- | MATERIAL: -- | FINISH: --
FILE: ARCHIVE\GBTELEC\35201\W001-2 | SHEET: 2 OF 3 | REVISION: B
DATE: 06/25/98
DRAWING NO.: D35201W001

TOLERANCES UNLESS OTHERWISE SPECIFIED
ANGULAR ±0°30'
FRACTIONAL ±1/64
2 PLACE DECIMAL ±.01
3 PLACE DECIMAL ±.005
DIMENSIONS ARE IN INCHES



PWM/Vo CONVERTER

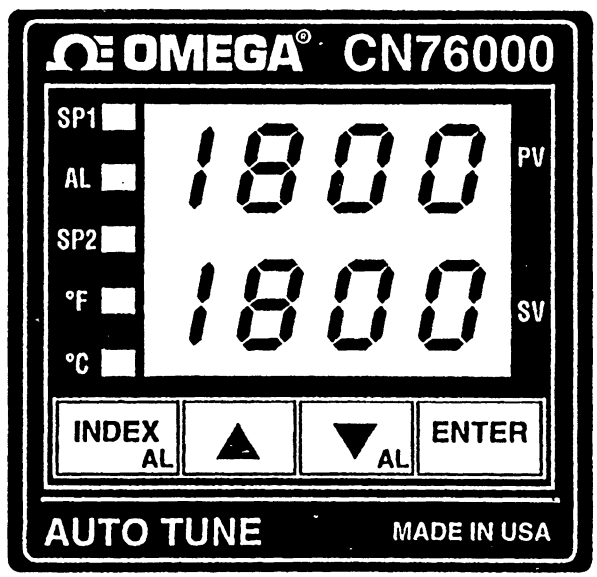
NATIONAL RADIO ASTRONOMY OBSERVATORY, P.O. BOX 2, GREEN BANK, WEST VIRGINIA, 24944			TOLERANCES UNLESS OTHERWISE SPECIFIED: ANGULAR ±0°30'; FRACTIONAL ±1/64; 2 PLACE DECIMAL ±.01; 3 PLACE DECIMAL ±.005; DIMENSIONS ARE IN INCHES
PROJECT/TITLE: GBT EQUIPMENT ROOM HVAC CONTROLLER			
DESIGNED: R. NORROD	DRAWN: R. TAGGART	CHECKED:	DATE: 06/25/98
SCALE: --	MATERIAL: --	FINISH: --	DRAWING NO.: D35201W001
FILE: ARCHIVE\GBTELEC\35201\W001-3	SHEET: 3 OF 3	REVISION: B	

Appendix C
Omega Operator's Manual

12/97

CN76000

Microprocessor-Based Temperature/Process Controller



OMEGA®
An OMEGA Technologies Company

Operator's Manual
M1303/0493

MADE IN USA

WARRANTY

OMEGA warrants this unit to be free of defects in materials and workmanship and to give satisfactory service for a period of **13 months** from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal **one (1) 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.

We are glad to offer suggestions on the use of our various products. Nevertheless OMEGA only warrants that the parts manufactured by it will be as specified and free of defects.

OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED.

LIMITATION OF LIABILITY: The remedies of buyer set forth herein are exclusive and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

Every precaution for accuracy has been taken in the preparation of this manual, however, OMEGA ENGINEERING, INC. neither assumes responsibility for any omissions or errors that may appear nor assumes liability for any damages that result from the use of the products in accordance with the information contained in the manual.

RETURN REQUESTS / INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA ENGINEERING Customer Service Department. Call toll free in the USA and Canada: 1-800-622-2378, FAX: 203-359-7811; International: 203-359-1660, FAX: 203-359-7807.

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 DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence. Please have the following information available BEFORE contacting OMEGA:

1. P.O. number under which the product was PURCHASED,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems you are having with the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. That way our customers get the latest in technology and engineering.

OMEGA is a registered trademark of OMEGA ENGINEERING, INC.

Table of Contents

GETTING STARTED

1. Install the instrument as described on page 2.
2. Make sure that the Input DIP switch is set correctly for the input you wish to use. Instructions are on page 3. Factory defaults are set for thermocouple input.
3. Identify the model number to verify output type. If necessary, change the output jumper. Refer to the instructions on page 3.
4. Wire your instrument following the drawings on pages 4 and 5.
5. Make any programming changes necessary in the Secure and Secondary Menus. DO NOT make changes to the Configuration Menu unless specifically instructed. If you need to back up in a menu, press the INDEX and DOWN ARROW keys together.
6. To quickly return to the HOME position, press the **UP ARROW** and **ENTER** keys together, and then the **INDEX** and **DOWN ARROW** keys.

HOW TO USE THIS BOOK

Because of the number of features available in this instrument, information is included that may not apply to your specific instrument. Options, for example, are included in this book, but may not be included in your instrument. To increase clarity the following conventions are used:

Optional features or functions are shown in this book in *Roman type*. The Option code (from the configuration menu) is listed after the menu item in parenthesis. If you do not have an option installed, you may skip any items listed in *Roman type*.

Options are referred to by the configuration code(s) and not the ordering code(s). Use the following cross reference (ordering code = configuration code):

- PV	**=**	**936**	**Process variable output 0 to 10 Vdc.**
- 4SP	**=**	**948**	**Four Stage Set Point selectable via contact closures at the rear of the control.**
- 485	**=**	**992**	**RS-485 Serial Communication.**

UNPACKING

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

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

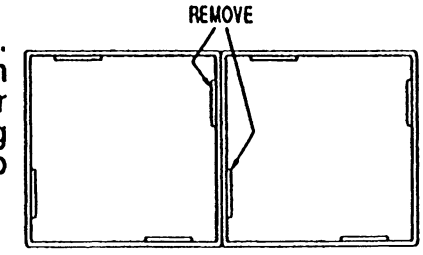
NOTE

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

INSTALLATION

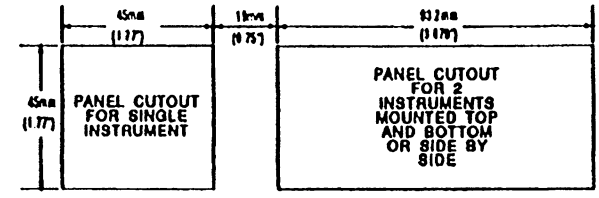
Mount the instrument in a location that will not be subject to excessive temperature, shock, or vibration. All models are designed for mounting in an enclosed panel.

Select the position desired for the instrument on the panel. If more than one instrument is required, only two units can be mounted closely together, either one above the other or side by side. When mounted together, the mounting collar will require modification by removing the inside tab from each collar.



Prepare the panel by cutting and deburring the required opening.

From the front of the panel, slide the housing through the cut out. The housing gasket should be against the housing flange before installing.

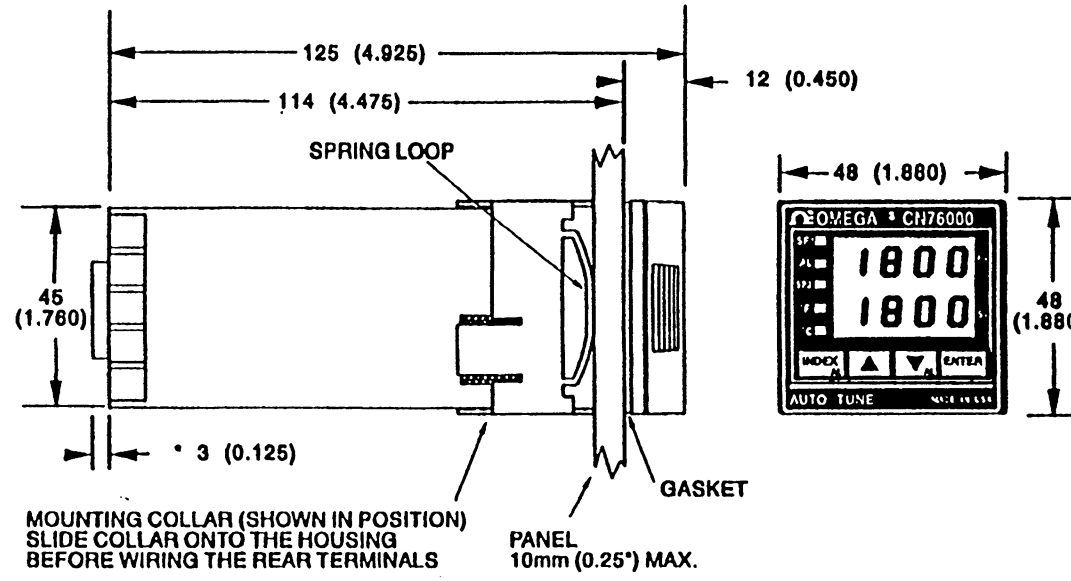


ALL TOLERANCES ARE
-0.00 +0.25mm (-0.000 +0.010)

From the rear of the panel slide the mounting collar over the housing. Hold the housing with one hand and using the other hand, push the collar evenly against the panel until the spring loops are slightly compressed. The ratchets will hold the mounting collar and housing in place.

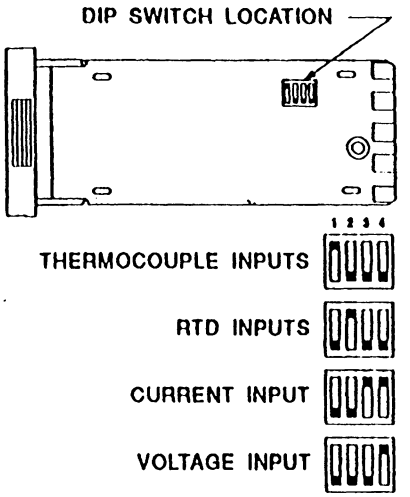
DIMENSIONS

(ALL DIMENSIONS IN MM WITH INCHES IN PARENTHESIS)



PANEL CUTOUT FOR ALL MODELS 45 MM X 45 MM (1.775" X 1.775")
ALLOW FOR 13 MM (0.5") CLEARANCE AT THE REAR OF INSTRUMENT.
* PRESENT FOR ALL OUTPUTS EXCEPT RELAY.

INPUT SELECTION



To change the input type, remove the instrument from its housing. Grasp the front bezel sides and pull forward to release it from the housing lock. Locate the dip switch on the right pcb. Determine the input type desired and change the dip switch setting as shown to the right.

NOTE : Factory default is set for thermocouple inputs.

After changing input selection with the DIP switches, be sure to change the InP menu item (page 9) in the Secure Menu.

NOTE: InP menu item factory default is set for type "J" thermocouple, Iron/Constantan

Scaling for thermocouple and RTD inputs is fixed for each range type. See page 8 for scale ends.

Scaling for current and voltage inputs is field adjustable by using SCAL and SCAH in the Secure menu. Program SCAL to the low end value of your transmitter. Program SCAH to the high end value of your transmitter. If the span of your transmitter is less than 100 units (referred to as 'counts' in these instructions), multiply the transmitter span by 10 and change the decimal point position in menu item dP.

For example, if you have a differential pressure transmitter with a range of -0.25 to +0.25 inches of water. SCAL would be programmed to -250, SCAH to +250, and dP to 0.000.

VERIFY MODEL NUMBER ON THE INSTRUMENT TO DETERMINE OUTPUT TYPE PRE-SET FROM FACTORY.

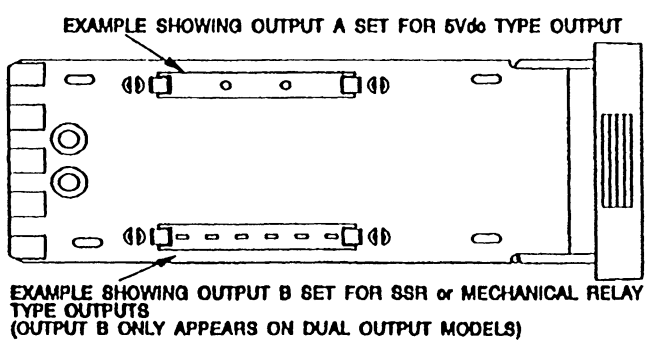
OUTPUT TYPE JUMPER SELECTION

Instruments with **SSR** or **MECHANICAL RELAY** type outputs can be changed to and from a **5 Vdc** output in the field.

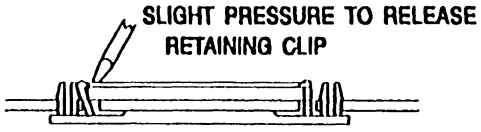
CAUTION: Damage to the instrument may result from an incorrectly installed jumper strip. Follow the instructions carefully.

1. Remove the instrument from its housing. Grasp the front bezel sides and pull forward to release it from the housing lock.

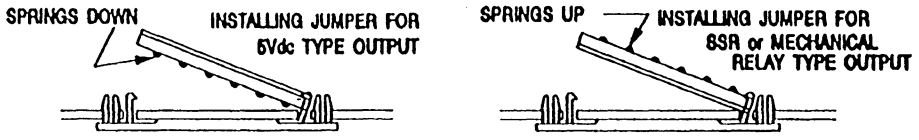
2. Locate the desired logic jumper strip on the left printed circuit board. The **OUTPUT A** jumper strip is always located near the top edge.



To remove the logic jumper strip, carefully insert a small flat blade screwdriver between the retaining clip and the jumper at one end of the jumper strip. Apply slight pressure to move the clip away from the jumper end until it is released, then lift it up and out of the clip.



To re-install the jumper strip, hold it with the spring contacts in the desired position. Face springs **up** for **SSR** or **MECHANICAL RELAY** outputs, or face springs **down** for **5 Vdc** outputs. Insert one end of the jumper strip under the retaining clip and press the other end down until the remaining clip engages the jumper.



To avoid any damage, recheck the jumper installation and the housing rear terminal panel output wiring.

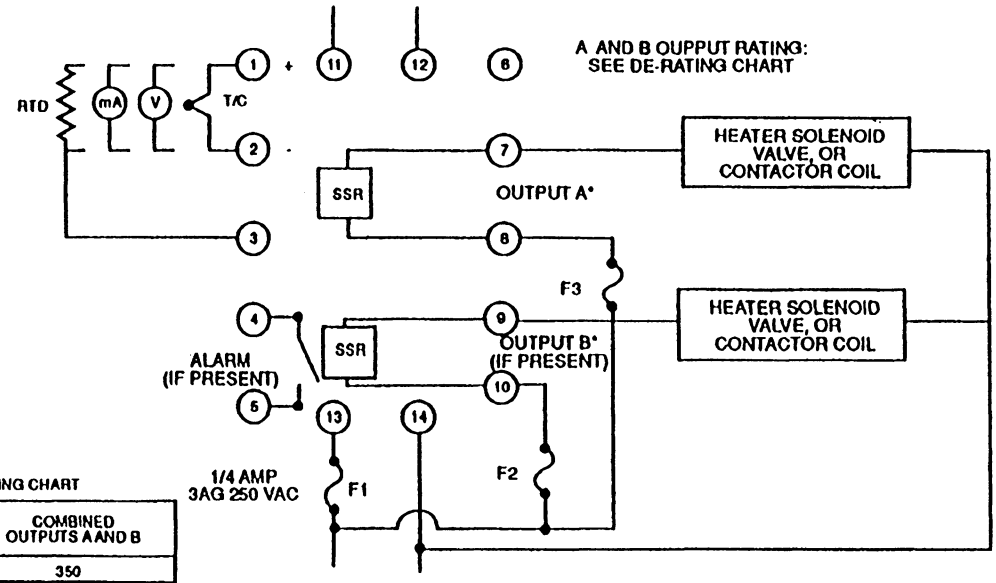
Replace the instrument into its housing.

INPUT WIRING

Do not run thermocouple or other input wiring in the same conduit as power leads. Use only the type of thermocouple or RTD probe for which the control has been programmed. See the "Secure Menu" for input selection.

For thermocouple input always use extension leads of the same type designated for your thermocouple.

AC SOLID STATE RELAY OUTPUT WIRING



DERATING CHART

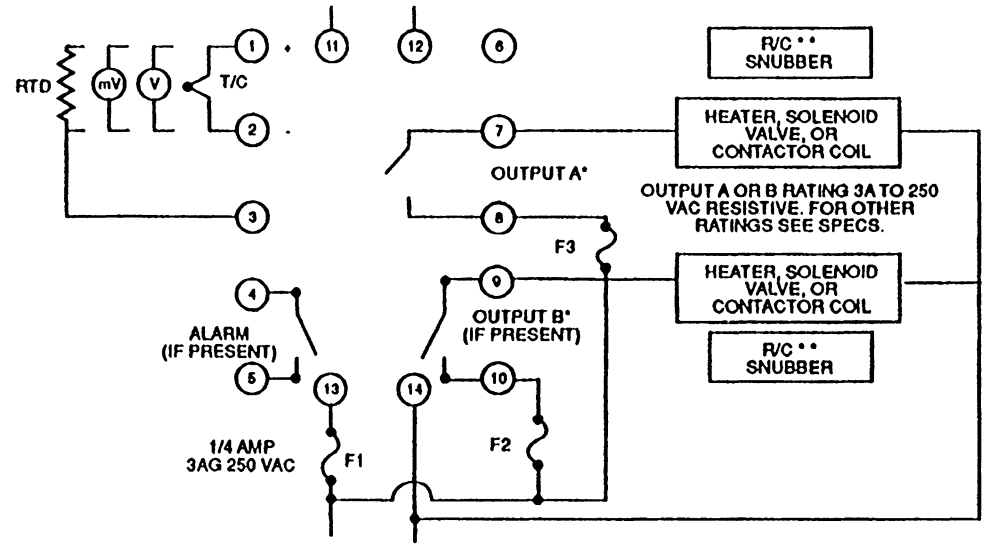
°C	°F	COMBINED OUTPUTS A AND B
25	77	350
35	95	275
45	113	200
55	131	125

LINE 85 TO 265VDC/VAC
50 THRU 400 Hz
5 VA MAX.

* SOFTWARE CONFIGURABLE
AS SP1 OR SP2

F2 AND F3 TYPE AGC OR 3AG 4A MAX LOW LAG FUSE RECOMMENDED

MECHANICAL RELAY OUTPUT WIRING



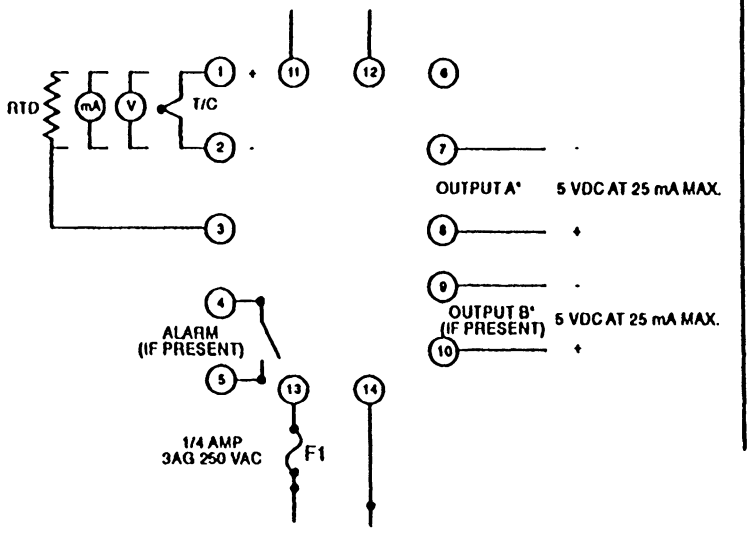
LINE 85 TO 265VDC/VAC
50 THRU 400 Hz
5 VA MAX.

* SOFTWARE CONFIGURABLE
AS SP1 OR SP2

F2 AND F3 TYPE MDA OR 3AB 3.5A MEDIUM LAG FUSE RECOMMENDED

** R/C SNUBBER (OMEGA PART NO 1821 -1101) RECOMMENDED
FOR SOLENOID OR CONTACTOR LOADS

5 VDC OUTPUT WIRING

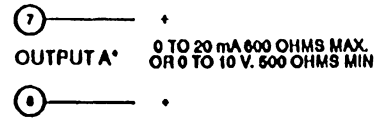


LINE 85 TO 265VDC/VAC
50 THRU 400 Hz
5 VA MAX.

* SOFTWARE CONFIGURABLE AS SP1 OR SP2

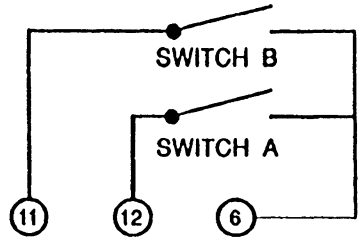
CAUTION; OUTPUT MUST NOT SHARE A COMMON GROUND WITH INPUT

CURRENT OR VOLTAGE OUTPUT

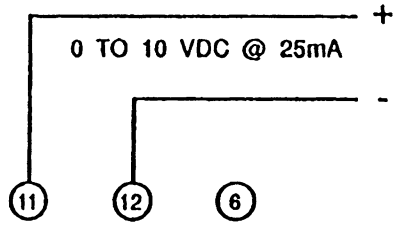


OPTIONS

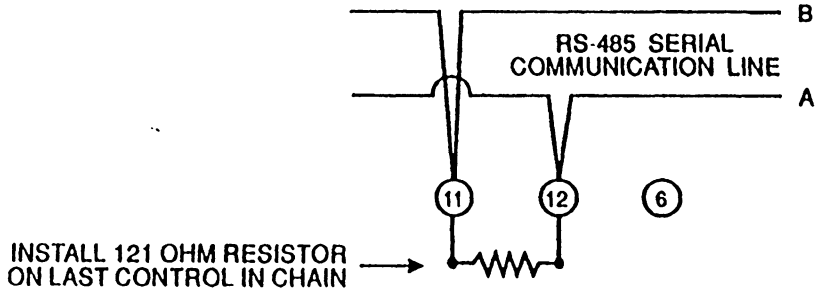
-4SP



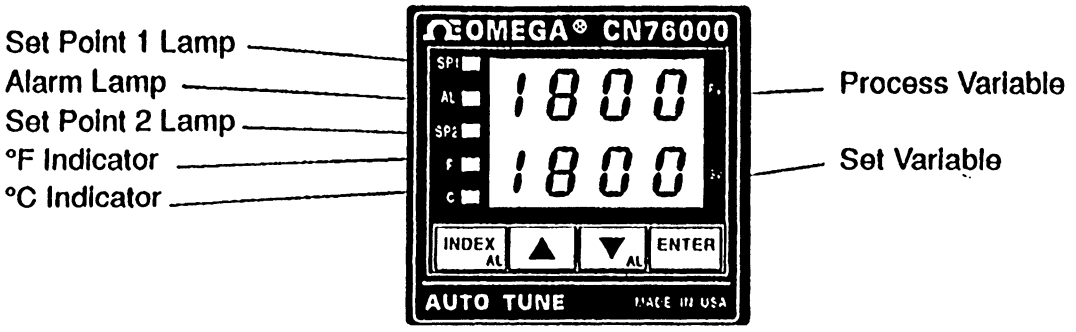
-PV



-485



FRONT PANEL KEY FUNCTIONS



1. **INDEX:** Pressing the INDEX key advances the display to the next menu item. May also be used in conjunction with other keys as noted below.
2. **UP ARROW:** Increments a value, changes a menu item, or selects the item to ON in the upper display.
3. **DOWN ARROW:** Decrements a value, changes a menu item, or selects the item to OFF in the upper display.
4. **ENTER:** Pressing ENTER stores the value or the item changed. If not pressed, the previously stored value or item will be retained.
5. **UP ARROW & ENTER:** Pressing these keys simultaneously brings up the **Secondary menu** starting at the auto/manual selection. Pressing these keys for 5 seconds will bring up the **Secure menu.**
6. **INDEX & DOWN ARROW:** Pressing these keys simultaneously will allow backing up one menu item, or if at the first menu item they will cause the display to return to the **Primary menu.**
7. **INDEX & ENTER:** Pressing these keys simultaneously and holding them for 5 seconds allows recovery from the various error messages. The following menu items will be reset:

   LPbr: Loop break
   SEnC: Sensor rate of change
   ALIH: Alarm inhibit
   OPEn InP: Open input error message
   bAd InP: Bad input error message
   ArEA: Area error message
   CHEC CAL: Check calibration error message

Correct the problems associated with the above conditions first before using these reset keys. More than one error could be present. Caution is advised since several items are reset at one time.

While in the **Primary or Secondary menu,** if no key is pressed for a period of 30 seconds, the display will return to the HOME position displaying the PV and SV values. The time is increased to 1 minute when in the **Secure menu.**

NOTE: To move to the **Primary menu** quickly from any other menu, press the **UP ARROW & ENTER** keys followed by pressing the **INDEX & DOWN ARROW** keys.

METHOD FOR SET UP OF A HEAT / COOL CONTROL WITH SELF TUNE

Determine if the process is predominantly heating or cooling. An extruder, for example, is predominantly cooling when running product. An environmental chamber can be either heating or cooling. (For explanation of menu items see pages 12 & 13.)

If the process is predominantly cooling, set S1St to dir and S2St to rE. If the process is predominantly heating, set S1St to rE and S2St to dir. Redirect SP1 to output A or B as

required by the hardware (see SP1o). Set S2t to dE. Set SP2 for zero (no overlap of bands, no deadband). Set Pb2 to a desired value (default is 12° F). Set tunE to SELF, Strt to YES, and LErn to End.

Start the process and wait for it to come to stability. Occasionally check that the Self Tune has completed the learning process by INDEXing to Strt In the secondary menu. If the YES value has changed to no, then the process has been learned. Once learning is complete, you may adjust SP2 to either overlap the SP1 band (SP2 value less than zero), or add some separation between them (deadband — SP2 greater than zero) if required to optimize control.

SECURITY LEVEL SELECTION

Four levels of security are provided in the CN76000 menu system. The display shows the current security level. The level determines which menus are locked preventing changes in menu item in those menus. To change security levels, change the password value using the **UP & DOWN ARROW** keys and pressing the **ENTER** key. Refer to the password table below for the correct value to enter for the security level desired. The **SECr** menu item security level may be viewed or changed at any time regardless of the present security level. The password values shown in the table cannot be altered, so retain a copy of this page for future reference. This will be the only reference made to password values in this instruction book.

PASSWORD TABLE

SECURITY LEVEL MENU	SECURITY	DISPLAYED VALUE WHEN VIEWED	PASSWORD VALUE TO ENTER
Primary	Locked	1	1110
Secondary	Locked		
Secure	Locked		
Primary	Unlocked	2	1101
Secondary	Locked		
Secure	Locked		
Primary	Unlocked	3	1011
Secondary	Unlocked		
Secure	Locked		
Primary	Unlocked	4	111
Secondary	Unlocked		
Secure	Unlocked		

MENU SELECTIONS

PRIMARY MENU

Press **INDEX** to scan the Lower Display. Press **UP ARROW** or **DOWN ARROW** to change the value in the upper display.

In the following, the symbol "#" will be used before a letter in a menu item to indicate the set point value to be viewed and/or modified. (Applies to Option 948 only.)

#SP1 *(948) or*
Set Point 1, Main Control Point.

Set Point 2, if equipped.

SECURE MENU

Hold **UP ARROW** & **ENTER** for 5 Seconds to display the Secure menu. Press **INDEX** to change the lower display. Press **UP ARROW** or **DOWN ARROW** to change the value in the upper display. Press **ENTER** to store the value.

Selections

SECr Security Code: See the Security Level Selection and the Password Table in this manual, in order to enter the correct password.

InP Input Type: Select one of the following. The Inputs are based on four different groups; Thermocouples, RTDs, Current, and Voltage. If changing from one of these groups, the DIP switch on the A/D circuit board will have to be changed to match that particular group. Refer to the Input wiring section for the proper switch settings.

- **J-IC** Type "J" Thermocouple, Iron/Constantan (NIST)
- **CA** Type "K" Thermocouple CHROMEGA®/ALOMEGAŠ
- **E-** Type "E" Thermocouple CHROMEGA/Constantan
- **t-** Type "T" Thermocouple Copper/Constantan
- **L-** Type "L" Thermocouple Iron/Constantan (DIN)
- **n-** Type "N" Thermocouple Nicrosil/Nisil
- **r-13** Type "R" Thermocouple Pt 13%Rh/Pt
- **S-10** Type "S" Thermocouple Pt 10%Rh/Pt
- **b-** Type "B" Thermocouple Pt 6%Rh/Pt 30%Rh
- **C-** Type "C" Thermocouple W 5%Re/W 26%Re
- **P392** 100 ohm Platinum (NIST 0.00392 Ω/Ω/°C)
- **n120** 120 ohm Nickel (NIST 0.006 Ω/Ω/°C)
- **P385** 100 ohm Platinum (DIN 0.00385 Ω/Ω/°C)
- **Curr** DC Current Input 0.0 to 20.0 or 4.0 to 20.0 milliamperes.
- **VoLt** DC Voltage Input 0.0 to 5.0 or 1.0 to 5.0 volts.
- **----** For Access to Calibration and FACt dFLt.

OSUP Zero Suppression: Select **On** or **OFF**. Only with Current and Voltage Input types.

- **OFF** The Input range will start at 0 (zero) Input.
- **On** The Input range will start at 4.00 mA or 1.00 V.

Unit F, C or None

- **F** °F descriptor is On and temperature Inputs will be displayed in actual degrees Fahrenheit.
- **C** °C descriptor is On and temperature Inputs will be displayed in actual degrees Celsius.
- **nonE** °F and °C descriptors will be Off. This is only available with Current and Voltage Inputs.

dPt Decimal Point Positioning: Select **0**, **0.0**, **0.00**, or **0.000**. On temperature type Inputs this will only effect the Process Value, SP1, SP2, ALLo, ALHI, and InPC. For Current and Voltage Inputs all Menu Items related to the Input will be affected.

- **0** No decimal Point is selected. This is available for all Input types.
- **0.0** One decimal place is available for Type J, K, E, T, L, RTDs, Current and Voltage Inputs.
- **0.00** Two decimal places is only available for Current and Voltage Inputs.
- **0.000** Three decimal places is only available for Current and Voltage Inputs.

InPt Input Fault Timer: Select **OFF**, **0.1** to **540.0** minutes. Whenever an input is out of range, shorted, or open the timer will start. When the time has elapsed, the controller will revert to a safe condition (Outputs Off, Flashing Displays). If OFF is selected, the Input Fault Timer will not be recognized (time = Infinite).

SECURE MENU (cont'd)

SEnC Sensor Rate of Change: Select **OFF, 1** to **4000** °F, °C, or counts per 1 second period. This value is usually set to be slightly greater than the fastest process response expected during a 1 second period, but measured for at least 2 seconds. If the process is faster than this setting, the SEnC bAd error message will appear. The outputs will then be turned off. This function can be used to detect a runaway condition, or speed up detection of an open thermocouple. Use the **INDEX** & **ENTER** keys to reset.

SCAL Scale Low: Select **100** to **9999** counts below **SCAH**. The total span between **SCAL** and **SCAH** must be within 11998 counts. Maximum setting range is -1999 to +9999 counts. For Current and Voltage Inputs, this will set the low range end. Value fixed for Thermocouples and RTD ranges.

SCAH Scale High: Select **100** to **9999** counts above **SCAL**. The total span between **SCAL** and **SCAH** must be within 11998 counts. Maximum setting range is -1999 to +9999 counts. For Current and Voltage Inputs, this will set the high range end. Value fixed for Thermocouples and RTD ranges.

SPL Set Point Low: Select from **SCAL** value to **SPH** value. This will set the minimum SP1,SP2, ALLo, ALHi, SP1d, and SP2d values that can be entered. If any of the values are less than the SPL value, a check message will appear and the value will not be accepted.

SPH Set Point High: Select from **SCAH** value to **SPL** value. This will set the maximum SP1, SP2, ALLo, ALHi, SP1d, and SP2d values that can be entered. If any of the values are greater than the SPH value, a check message will appear and the value will not be accepted.

SP1o Set Point 1 Output Terminal Assignment: Select **OutA** or **Outb.**
NOTE: Reassigning the output terminals does not change the Hardware type assigned to those terminals. For single set point models, SP1o is locked to OUT A.
- **OutA** Set Point 1 output will be directed to terminals 7 & 8 and Set Point 2 output to terminals 9 & 10.
- **Outb** Set Point 1 output will be directed to terminals 9 & 10 and Set Point 2 output to terminals 7 & 8.

S#Ot Set Point Output Type: Select **CY, OnOF, PUL,** or **Ft.** Fixed for Current and Voltage, the Hardware Configuration has selected this.
- **CY** Cycle Rate, Adjustable Time Proportioning.
  - **CY#** Cycle Rate Time: Select **2** to **80** seconds.
- **OnOF** On/Off Output.
  - **SP#d** Set Point Differential in 1 degree or count steps from 2 degrees or counts to full scale, but limited by SPL and SPH.
- **PUL** Pulse Time Proportioning.
  - **PUL#** Pulse Width Value: Select **1** to **7.**
- **Ft** Fast Time Proportioning: Fixed at 1 second Time Base.
- **Volt** Proportional Voltage, 0 to10 V.
- **Curr** Proportional Current, 0 to 20 mA.

S#St Set Point State: Select **dIr** or **rE.**
- **dIr** Direct Action. As the input increases the output will increase. Most commonly used in cooling processes.
- **rE** Reverse Action. As the input increases the output will decrease. Most commonly used in heating processes.

S#OL Set Point Output Low Limit: Select **0** to **90%** but less than **S#OH.** This item limits the lowest output value. This is useful for adding a bias to the process when needed. When a current or voltage output is used, the standard output value is 0 to 20mA or 0 to 10V. If 4 to 20 mA or 2 to 10 V is required, the S#OL value should be set for 20% to raise the lowest output.

S#OH Set Point Output High Limit: Select **10** to **102%** but greater than **S#OL.** This item allows setting the maximum output limit. This is useful with processes that are over powered.

SECURE MENU (cont'd)

S#LP Set Point Lamp: Select **O on** or **OoFF**.
O on Lamp ON when Output is ON.
OoFF Lamp OFF when Output is ON.

S2t Set Point 2 type: Select Abs or dE.
AbS Absolute SP2. SP2 is independent of SP1, and may be set anywhere between the limits of SPL and SPH.
dE Deviation SP2. SP2 is set as a deviation from SP1, and allows SP2 to retain its relationship with SP1 when SP1 is changed (tracking SP2).

ALARM TYPE AND ACTION (if present)

CAUTION: In any critical application where failure could cause expensive product loss or endanger personal safety, a redundant limit controller is recommended.

When setting an alarm value for an absolute alarm (ALt = AbS), simply set the alarm to the value at which the alarm is to occur.

When setting the alarm value for a deviation alarm (ALt = dE), set the alarm to the value equal to the difference in value between the desired alarm and Set Point 1. For example if a low alarm is required to be 5 degrees below SP1, then set ALLo to -5. If a high alarm is required 20 degrees above SP1, then set ALHI to +20. If SP1 is changed, the alarm will continue to hold the same relationship as originally set.

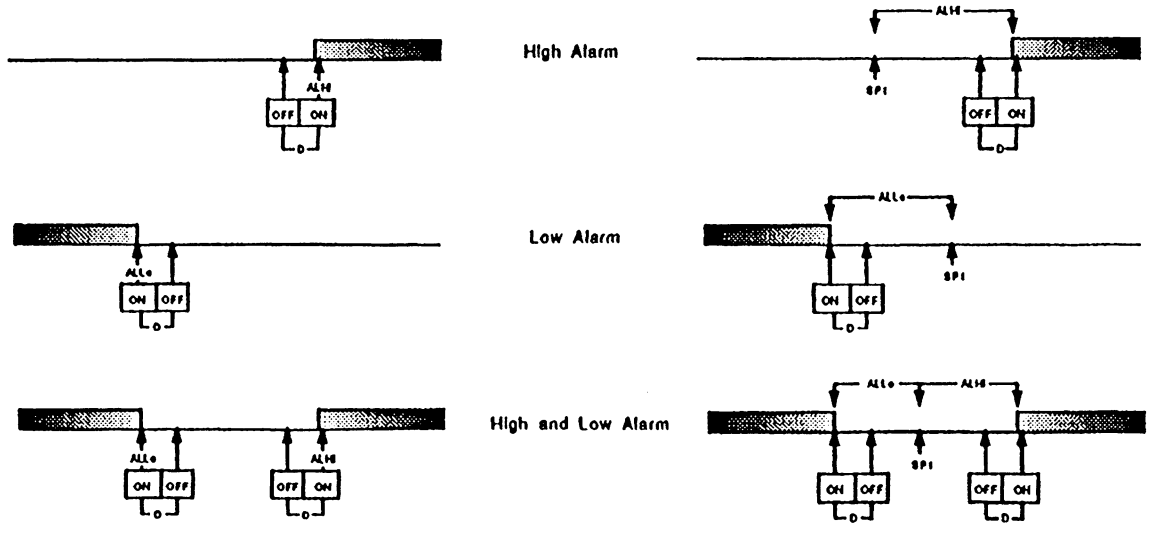
The following diagram shows the action and reset functions for both absolute and deviation alarms.

When "Alarm Power Interrupt" ALPI is programmed ON and "Alarm Reset" is programmed for Hold, the alarm will automatically reset upon a power failure and subsequent restoration if no alarm condition is present.

If "Alarm Inhibit" ALIH is selected ON, an alarm condition is suspended upon power up until the process value passes through the alarm set point once. Alarm inhibit can be restored as if a power up took place by pressing together the **INDEX** and **ENTER** keys for 5 seconds.

WARNING: Resetting a high alarm inhibit will not allow an alarm to occur if the Process Value does not first drop below the high alarm setting. Do not use the Alarm Inhibit feature if a hazard is created by this action. Be sure to test all combinations of high and low alarm inhibit actions before placing control into operation.

ABSOLUTE ALARMS **DEVIATION ALARMS**



SECURE MENU (cont'd)

The following Secure menu items appear only if the instrument has the alarm option.

Alarms: Select **OFF, Lo, HI,** or **HILo.**
- **OFF** Alarms are turned OFF. No Alarm menu items appear in the Secondary and Secure menus.
- **Lo** Low Alarm Only. ALLo appears in the Secondary Menu.
- **HI** High Alarm Only. ALHi appears in the Secondary Menu.
- **HILo** High and Low Alarms. Both share the same Alarm Relay output.

Alarm Type: Select **AbS** or **dE**
- **AbS** Absolute Alarm that may be set anywhere within the values of SPL and SPH and is independent of SP1.
- **dE** Deviation Alarm that may be set as an offset from SP1. As SP1 is changed the Alarm Point will track with SP1.

ALrE Alarm Reset: Select **OnOF** or **Hold.**
- **OnOF** Automatic Reset.
- **Hold** Manual Reset. Acknowledge by simultaneously pressing the **INDEX & DOWN ARROW** keys for 5 seconds.

ALPI Alarm Power Interrupt: Select **On** or **OFF.** This resets an alarm on power on if no alarm is present.
- **On** Alarm Power Interrupt is ON. Alarms will reset at power on.
- **OFF** Alarm Power Interrupt is OFF. Alarms will not reset.

ALIH Alarm Inhibit: Select **On** or **OFF.**
- **On** Alarm Inhibit is ON. Alarm action is suspended at power up or after reset until the process value first enters a non-alarm condition.
- **OFF** Alarm Inhibit is OFF. Alarm action is not suspended.

ALSt Alarm Output State: Select **CLOS** or **OPEn.**
- **CLOS** Closes Contacts at Alarm Set Point.
- **OPEn** Opens Contacts at Alarm Set Point.

ALLP Alarm Lamp: Select **O on** or **OoFF.**
- **O on** Alarm Lamp is ON when alarm contact is closed.
- **OoFF** Alarm Lamp is OFF when alarm contact is closed.

ALbr Alarm Loop Break: Select **On** or **OFF.**
- **On** Loop Break Condition will cause an Alarm Condition.
- **OFF** Loop Break will not affect the Alarm Condition.

The following Secure menu items apply only to Options. They may not appear in your instrument.

SPSA *Set Point Select Action (948): Select* ***rE*** *or* ***Int.***
- ***rE*** *Remote (external) selection of active set point value.*
- ***Int*** *Internal selective of active set point value.*

Addr *Control Address (992): Set from 1 to FF. This number (hexadecimal, base 16) must match the address number used by the host computer.*

bAUd *Communications baud rate (992): Select 300, 1200, 2400, 4800, 9600, 19.2, 28.8, or 57.6. This number must match the baud rate used by the host computer. The data format is 8 bits, 1 stop bit, No parity.*

No Activity Timer (992): Select OFF to 99. If a number is set, the control will expect access by the host computer. If no access is detected within that time, the control will indicate an error, ***CHEC LorE*** *and go to the set point indicated by* ***CFLt.***

CFLt *Communication Fault Mode (992): Select 1 or 2. 1 = On Communication fault, use local Se Point. 2 = On Communications fault, use* ***CFSP.***

SECONDARY MENU

Hold **UP ARROW & ENTER** to display the Secondary menu. Press **INDEX** to scan the Lower Display. Press **UP ARROW** or **DOWN ARROW** to change the value in the upper display. Press **ENTER** to store the value.

Selections

Auto Auto/Manual Control: Select On or OFF.
- **On** Automatic Control
- **OFF** Manual Control is enabled. The lower display in the HOME position will display the output in percent for SP1 or SP2, and is adjustable for each from 0.0 to 100 percent. SP1 appears first with a flashing "o" on the right hand corner of the lower display to represent percent. Press INDEX to display SP2 output. A flashing "ō" will appear on the right hand corner of the lower display to represent percent. When Manual is enabled, the present control outputs are held (bumpless transfer) and displayed. The output for SP1 or SP2 can then be manually adjusted while displayed by pressing the **UP** or **DOWN Arrow** key to change the value, and then the **ENTER** key. The Upper display will normally indicate the Process Value. Since Manual will override most fault messages the upper display could indicate a fault message. Refer to the Diagnostic Error Message Section for further explanation.

ALLo Alarm Low: The Low Alarm point is usually set below the Main Set Point.

ALHI Alarm High: The High Alarm Point is usually set above the Main Set Point.

SP *Active set point (948): Select **1SP1**, **2SP1**, **3SP1**, or **4SP1**. Allows setting of the multiple stages of SP1, and SP1 tuning constants.*

#SP1 *Set Point Value # (948): Select desired value.*

#tun *(948) or*
tunE Tuning Choice: Select **SELF, PId, SLO, nor,** or **FASt.**
- **SELF** The Controller will evaluate the Process and select the PID values to maintain good control. Active for SP1 only.
  - **Strt** Select **YES** or **no**
    - **YES** Start Learning the Process. After the process has been learned the menu item will revert to **no.**
    - **no** Learning will stay in present mode.
  - **LErn** Select **Cont** or **End**
    - **Cont** Continuously adjust the PID values to maintain the best control. The Process is being monitored at all times by collecting and analyzing the data to adjust the PID values. (adaptive control).
    - **End** The Process data is collected once and then the PID values are saved, tuning is stopped.
  - **dFAC** Damping factor, Select **OFF, 1** to **7.** Sets the ratio of Rate to Reset for the SELF tunE mode. 7 = most Rate. Factory set to 3. For a fast response process the value should be lowered (less Rate). For a slower process the value should be increased (more Rate).
- **PId** Manually adjust the PID values. PID control consists of three basic parameters, Proportional Band (Gain), Reset Time (Integral), and Rate Time (Derivative).
  - ***#Pb1*** *(948) or*
  - **Pb1** Proportional Band (Bandwidth). Select **6** to **5000 °F, 3** to **2778 °C,** or **6** to **9999** counts.
  - **Pb2** Proportional Band (Bandwidth). Select **6** to **5000 °F, 3** to **2778 °C,** or **6** to **9999** counts. *(Appears after **#rtE** when Option 948 is selected.)*
  - ***#rES*** *(948) or*
  - **rES** Automatic Reset Time. Select **OFF, 0.1** to **99.9** minutes. Select **OFF** to switch to **OFS.**
  - ***#OFS*** *(948) or*
  - **OFS** Manual Offset Correction Select **OFF, 0.1** to **99.9%.** Select **OFF** to switch to **rES.**
  - ***#rtE*** *(948) or*
  - **rtE** Rate Time. Select **OFF, 0.01** to **99.99** minutes, Derivative.

SLO PID values are preset for a slow response process.
nor PID values are preset for a normal response process.
FASt PID values are preset for a fast response process.

PId2 Linkage of PID parameters between SP1 and SP2: Select **On** or **OFF**.
On Links SP2 to SP1 *or #SP1* rEs and rtE terms for heat/cool applications.
OFF Sp2 functions without rEs and rtE.

ArUP Anti- Reset Wind-up Feature: Select **On** or **OFF**.
On When ArUP is **On** the accumulated Reset Offset value will be cleared to 0% when the process input is not within the Proportional Band.
OFF When ArUP is **OFF**, the accumulated Reset Offset Value is retained in memory when the process input is not within the Proportional Band.

ArtE Approach Rate Time: Select **OFF, 0.01** to **99.99** minutes. The function defines the amount of Rate applied when the input is outside of the Proportional Band. The ArtE time and the rtE time are independent and have no effect on each other. To increase damping effect and reduce overshoot set the approach rate time for a value greater than the natural rise time of the process (natural rise time = process value time to set point).

PEA The Peak feature will remember the highest input the instrument has had since the last reset or Power On. At Power On it is reset to the present input. To manually reset the value, PEA must be in the lower display and then press the **ENTER** key. This will cause PEA to be reset to the present input value.

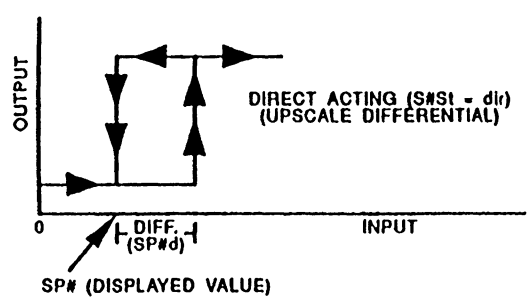
UAL The Valley feature will remember the lowest input the instrument has had since the last reset or Power On. At Power On it is reset to the present input, and may have to be manually reset. To manually reset the value, VAL must be in the lower display and then press the **ENTER** key. This will cause UAL to be reset to the present input value.

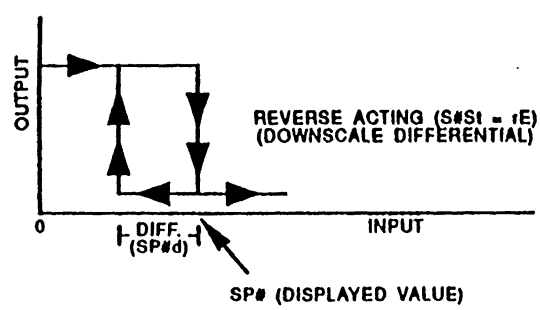
In the following the symbol "#" will be used following letters to refer to either a number "1" or number "2". The "1" will relate to SP1 functions, the "2" for SP2. If your control is not equipped with a second set point, no SP2 functions will appear. The appearance of **CY#, SP#d,** or **PUL#** is dependent upon the output type selected in the Secure Menu item S#Ot. If time proportioning (cycle time) was selected, then CY# is adjustable. If On - Off was selected, then SP#d is adjustable. If pulsed time proportioning was selected then PUL# is adjustable. If none of the above are selected the menu indexes directly to S#Ot.

CY# Cycle Rate: Select **2** to **80** sec. Time Proportioning Control is adjustable in 2 sec. steps. For best contact life, a time should be selected as long as possible without causing the process to wander.

SP#d Set Point On-Off Differential. Select **1** to **1999** deg. or counts. When adjusting SP#d keep in mind that SPL and SPH have to be considered to avoid a CHEC error message.

SECONDARY MENU (cont'd)





PUL# Pulsed Time Proportioning Output: Select **1** to **7**. 1 = Linear and 7 = most non-linear. Changes output linearity for use in cooling applications or for an extremely fast response processes. At the center of the proportional band, a pulse value of 1 provides an output of one second on and one second off (50% output). A pulse value of 2 provides an output of one second on and two seconds off (33% output). Output at center of band equals one second on, $2^{(\text{pulse value}-1)}$ seconds off.

S#Ot Set Point Output Type. FT, Curr, or Volt.
- **Ft** refers to Fast Time Proportioning, for Solid State Relay or 5V Logic Outputs. Timing is fixed at 1 sec.
- **Curr** refers to Proportional Current Output of 0 to 20 mA.
- **Volt** refers to Proportional Voltage Output of 0 to 10 V.

Both Curr & Volt are selected by the Hardware Configuration Code and cannot be changed.

PctO Percent Output Feature: Select **On** or **OFF**.
- **On** When selected **On**, the HOME lower display will indicate the output of the controller in percent. An "o" will appear in the right hand side of the lower display to indicate percent output for SP1. An "ō" will appear on the right hand corner of the lower display to represent percent output for SP2. The display will alternate between these values.
- **OFF** Percent Output display is disabled.

Prog Ramp/Soak Feature: Select **On** or **OFF**

StAt Status Display in the HOME Position when Prog (above) is On: Select **On** or **OFF**. When selected **OFF**, the HOME display will alternately indicate the normal HOME and the Ramp/Soak partial status in the Lower Display. The partial status display sequences with the set value showing the ramp (S1rA) or soak (S1So) segment being processed at that moment. It will also show the Program output status if at Hold or OoFF.
When selected **On**, the HOME Display will alternately indicate the normal HOME and the Ramp/Soak full status in both the upper and lower displays. The full status display sequences with the set value; Program run, Hold, or OoFF; and with the time remaining for the ramp S1rA or the soak S1So segments.

1rt Ramp Time in Hours & Minutes: Select **0.00** to **99.59** (HH.MM).

1St Soak Time in Hours & Minutes: Select **0.00** to **99.59** (HH.MM).

PEnd End of Soak action: Select **Hold** or **OoFF**.
- **Hold** Stay at the Present Set Pt.
- **OoFF** Turn Off SP1 and SP2 Outputs at the End of the Soak.

InPC Input Correction: Select **±500 °F (±260 °C)** or **±1000** counts. This feature allows the input value to be changed to agree with an external reference or to compensate for sensor error. When setting values having one or more decimal points, the lowest negative value allowed is -199.9, -19.99, or -1.999. **Note:** InPC is reset to zero when the input type is changed, or when decimal position is changed in T/C or RTD ranges. Changing decimal position in current or voltage ranges will not reset InPC.

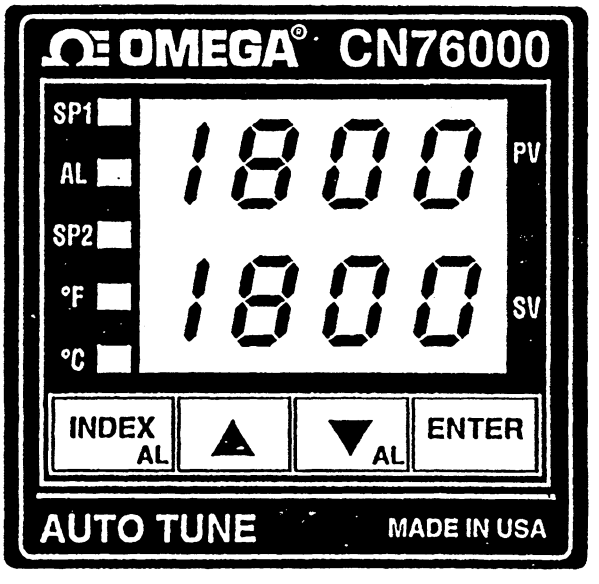
FILt Digital Filter: Select **OFF**, **1** to **99**. In some cases the time constant of the sensor, or noise could cause the display to jump enough to be unreadable. A setting of 2 is usually sufficient to provide enough filtering for most cases, (2 represents approximately a 1 second time constant). When the 0.1 degree resolution is selected this should be increased to 4. If this value is set too high, controllability will suffer.

SECONDARY MENU (cont'd)

12/97

CN76000

Microprocessor-Based Temperature/Process Controller



OMEGA®
An OMEGA Technologies Company

Operator's Manual
M1303/0493

WARRANTY

OMEGA warrants this unit to be free of defects in materials and workmanship and to give satisfactory service for a period of **13 months** from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal **one (1) 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.

We are glad to offer suggestions on the use of our various products. Nevertheless OMEGA only warrants that the parts manufactured by it will be as specified and free of defects.

OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED.

LIMITATION OF LIABILITY: The remedies of buyer set forth herein are exclusive and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

Every precaution for accuracy has been taken in the preparation of this manual, however, OMEGA ENGINEERING, INC. neither assumes responsibility for any omissions or errors that may appear nor assumes liability for any damages that result from the use of the products in accordance with the information contained in the manual.

RETURN REQUESTS / INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA ENGINEERING Customer Service Department. Call toll free in the USA and Canada: 1-800-622-2378, FAX: 203-359-7811; International: 203-359-1660, FAX: 203-359-7807.

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 DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence. Please have the following information available BEFORE contacting OMEGA:

1. P.O. number under which the product was PURCHASED,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems you are having with the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. That way our customers get the latest in technology and engineering.

OMEGA is a registered trademark of OMEGA ENGINEERING, INC.

Table of Contents

GETTING STARTED

1. Install the instrument as described on page 2.
2. Make sure that the input DIP switch is set correctly for the input you wish to use. Instructions are on page 3. Factory defaults are set for thermocouple input.
3. Identify the model number to verify output type. If necessary, change the output jumper. Refer to the instructions on page 3.
4. Wire your instrument following the drawings on pages 4 and 5.
5. Make any programming changes necessary in the Secure and Secondary Menus. DO NOT make changes to the Configuration Menu unless specifically instructed. If you need to back up in a menu, press the INDEX and DOWN ARROW keys together.
6. To quickly return to the HOME position, press the **UP ARROW** and **ENTER** keys together, and then the **INDEX** and **DOWN ARROW** keys.

HOW TO USE THIS BOOK

Because of the number of features available in this instrument, information is included that may not apply to your specific instrument. Options, for example, are included in this book, but may not be included in your instrument. To increase clarity the following conventions are used:

Optional features or functions are shown in this book in *Roman type*. The Option code (from the configuration menu) is listed after the menu item in parenthesis. If you do not have an option installed, you may skip any items listed in *Roman type*.

Options are referred to by the configuration code(s) and not the ordering code(s). Use the following cross reference (ordering code = configuration code):

- PV	**=**	**936**	**Process variable output 0 to 10 Vdc.**
- 4SP	**=**	**948**	**Four Stage Set Point selectable via contact closures at the rear of the control.**
- 485	**=**	**992**	**RS-485 Serial Communication.**

UNPACKING

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

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

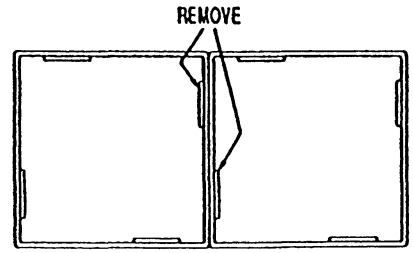
NOTE

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

INSTALLATION

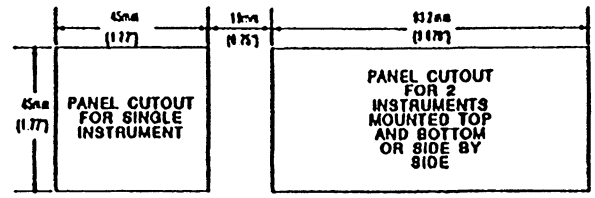
Mount the instrument in a location that will not be subject to excessive temperature, shock, or vibration. All models are designed for mounting in an enclosed panel.

Select the position desired for the instrument on the panel. If more than one instrument is required, only two units can be mounted closely together, either one above the other or side by side. When mounted together, the mounting collar will require modification by removing the inside tab from each collar.



Prepare the panel by cutting and deburring the required opening.

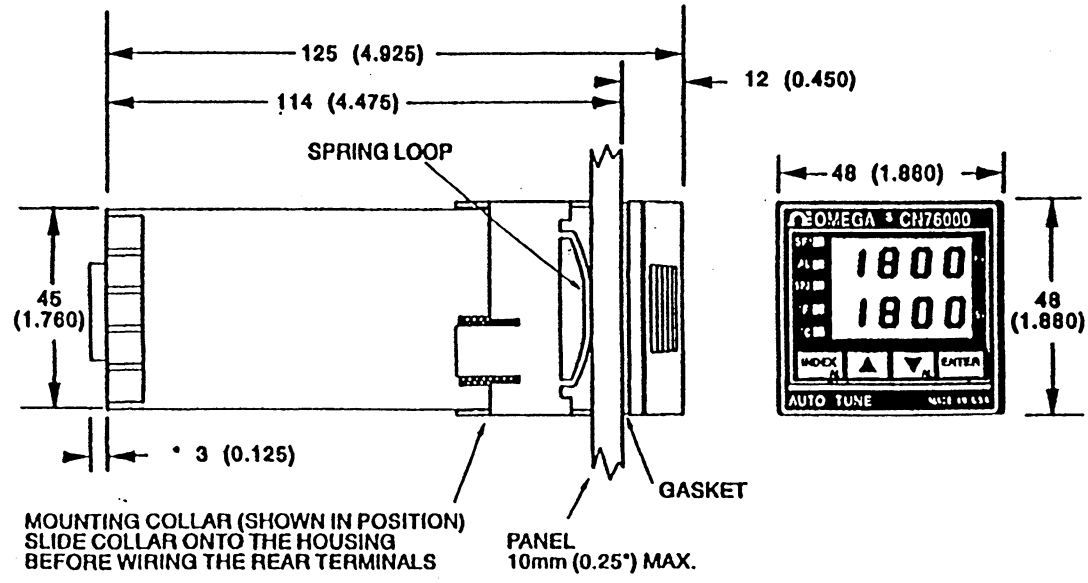
From the front of the panel, slide the housing through the cut out. The housing gasket should be against the housing flange before installing.



From the rear of the panel slide the mounting collar over the housing. Hold the housing with one hand and using the other hand, push the collar evenly against the panel until the spring loops are slightly compressed. The ratchets will hold the mounting collar and housing in place.

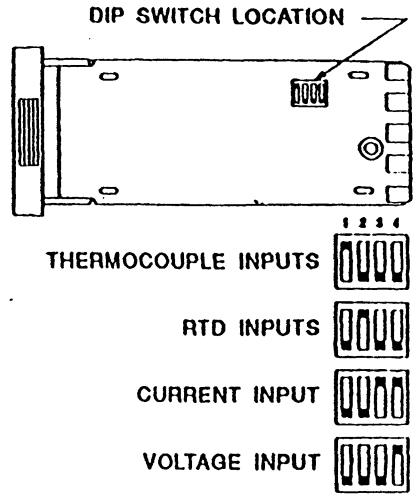
DIMENSIONS

(ALL DIMENSIONS IN MM WITH INCHES IN PARENTHESIS)



PANEL CUTOUT FOR ALL MODELS 45 MM X 45 MM (1.775" X 1.775")
ALLOW FOR 13 MM (0.5") CLEARANCE AT THE REAR OF INSTRUMENT.
* PRESENT FOR ALL OUTPUTS EXCEPT RELAY.

INPUT SELECTION



To change the input type, remove the instrument from its housing. Grasp the front bezel sides and pull forward to release it from the housing lock. Locate the dip switch on the right pcb. Determine the input type desired and change the dip switch setting as shown to the right.

NOTE : Factory default is set for thermocouple inputs.

After changing input selection with the DIP switches, be sure to change the InP menu item (page 9) in the Secure Menu.

NOTE: InP menu item factory default is set for type "J" thermocouple, Iron/Constantan

Scaling for thermocouple and RTD inputs is fixed for each range type. See page 8 for scale ends.

Scaling for current and voltage inputs is field adjustable by using SCAL and SCAH in the Secure menu. Program SCAL to the low end value of your transmitter. Program SCAH to the high end value of your transmitter. If the span of your transmitter is less than 100 units (referred to as 'counts' in these instructions), multiply the transmitter span by 10 and change the decimal point position in menu item dP.

For example, if you have a differential pressure transmitter with a range of -0.25 to +0.25 inches of water. SCAL would be programmed to -250, SCAH to +250, and dP to 0.000.

VERIFY MODEL NUMBER ON THE INSTRUMENT TO DETERMINE OUTPUT TYPE PRE-SET FROM FACTORY.

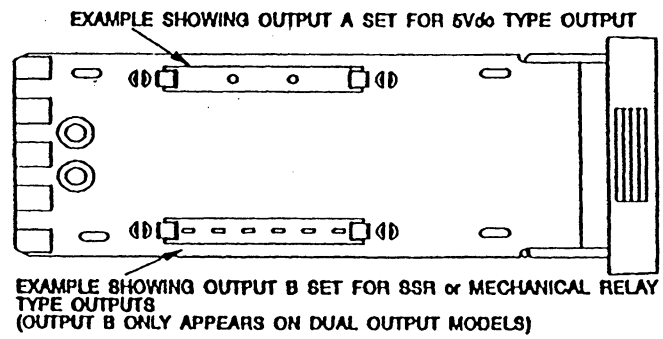
OUTPUT TYPE JUMPER SELECTION

Instruments with **SSR** or **MECHANICAL RELAY** type outputs can be changed to and from a **5 Vdc** output in the field.

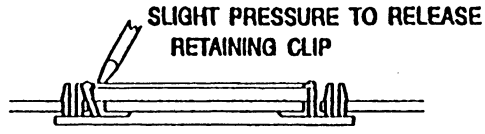
CAUTION: Damage to the instrument may result from an incorrectly installed jumper strip. Follow the instructions carefully.

1. Remove the instrument from its housing. Grasp the front bezel sides and pull forward to release it from the housing lock.

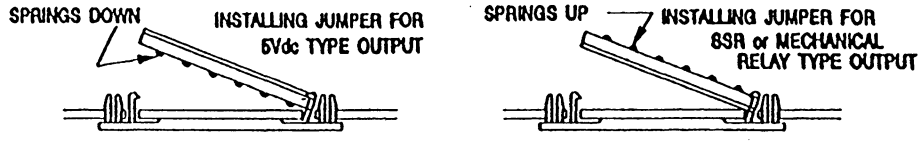
2. Locate the desired logic jumper strip on the left printed circuit board. The **OUTPUT A** jumper strip is always located near the top edge.



To remove the logic jumper strip, carefully insert a small flat blade screwdriver between the retaining clip and the jumper at one end of the jumper strip. Apply slight pressure to move the clip away from the jumper end until it is released, then lift it up and out of the clip.



To re-install the jumper strip, hold it with the spring contacts in the desired position. Face springs **up** for **SSR** or **MECHANICAL RELAY** outputs, or face springs **down** for **5 Vdc** outputs. Insert one end of the jumper strip under the retaining clip and press the other end down until the remaining clip engages the jumper.



To avoid any damage, recheck the jumper installation and the housing rear terminal panel output wiring.

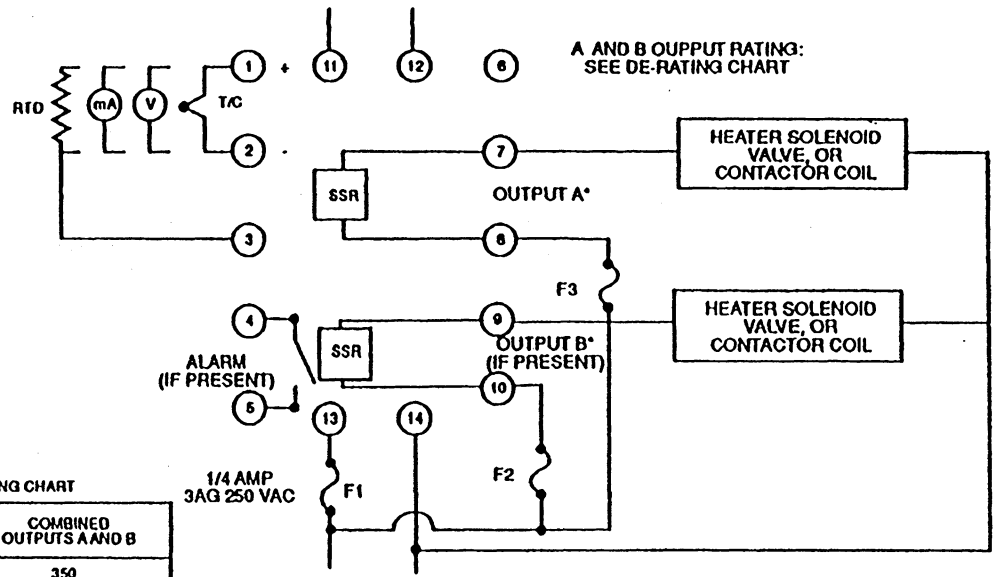
Replace the instrument into its housing.

INPUT WIRING

Do not run thermocouple or other input wiring in the same conduit as power leads. Use only the type of thermocouple or RTD probe for which the control has been programmed. See the "Secure Menu" for input selection.

<u>For thermocouple input always use extension leads of the same type designated for your thermocouple.</u>

AC SOLID STATE RELAY OUTPUT WIRING

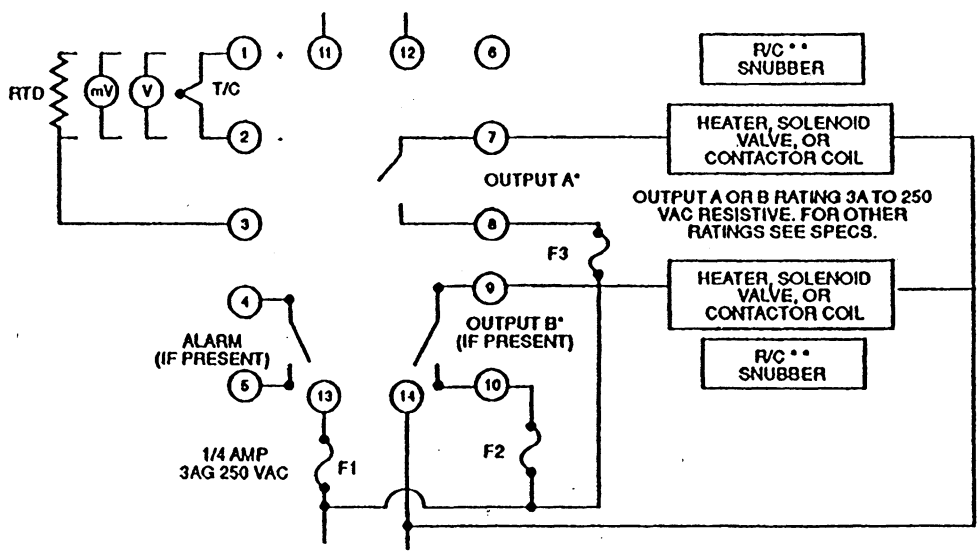


DERATING CHART

°C	°F	COMBINED OUTPUTS A AND B
25	77	350
35	95	275
45	113	200
65	131	125

F2 AND F3 TYPE AGC OR 3AG 4A MAX LOW LAG FUSE RECOMMENDED

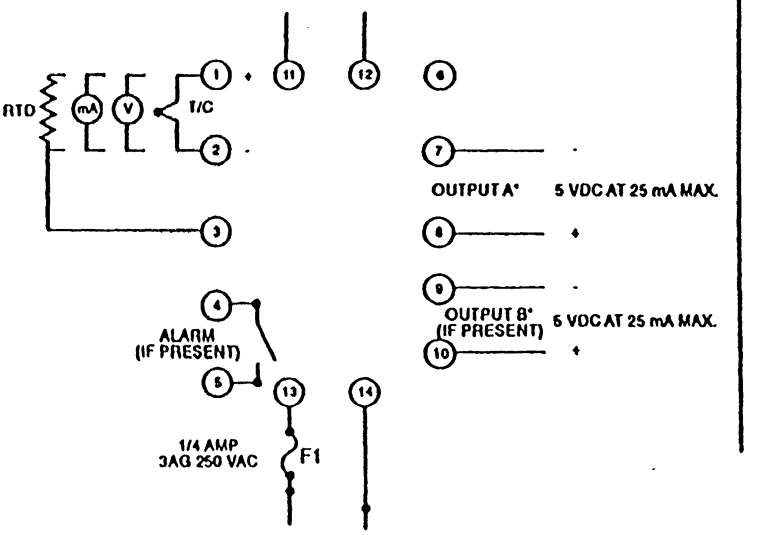
MECHANICAL RELAY OUTPUT WIRING



F2 AND F3 TYPE MDA OR 3AB 3.5A MEDIUM LAG FUSE RECOMMENDED

** R/C SNUBBER (OMEGA PART NO 1821 -1101) RECOMMENDED FOR SOLENOID OR CONTACTOR LOADS

5 VDC OUTPUT WIRING

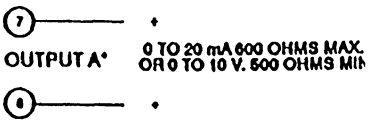


LINE 85 TO 265VDC/VAC
50 THRU 400 Hz
5 VA MAX.

* SOFTWARE CONFIGURABLE AS SP1 OR SP2

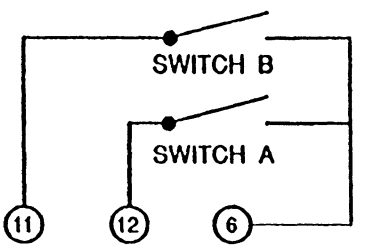
CAUTION: OUTPUT MUST NOT SHARE A COMMON GROUND WITH INPUT

CURRENT OR VOLTAG OUTPUT

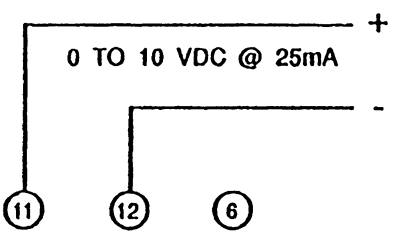


OPTIONS

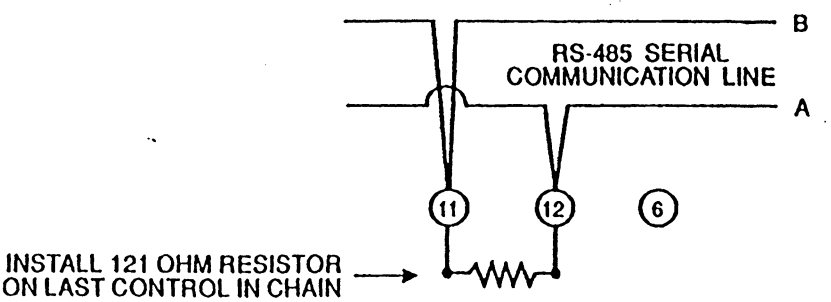
-4SP



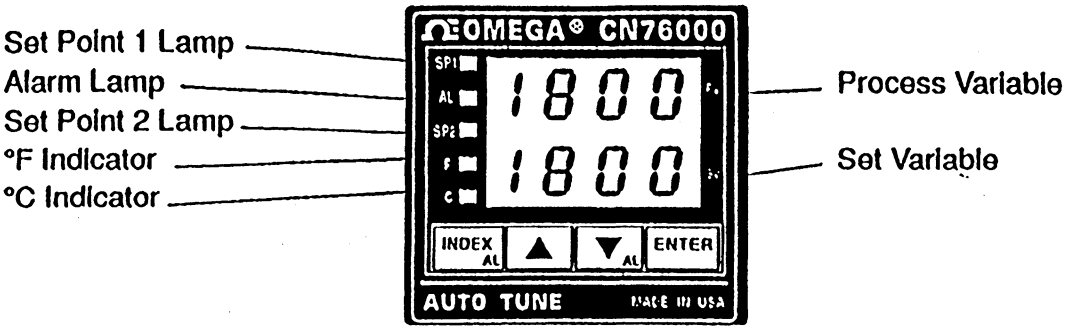
-PV



-485



FRONT PANEL KEY FUNCTIONS



1. **INDEX:** Pressing the INDEX key advances the display to the next menu item. May also be used in conjunction with other keys as noted below.
2. **UP ARROW:** Increments a value, changes a menu item, or selects the item to ON in the upper display.
3. **DOWN ARROW:** Decrements a value, changes a menu item, or selects the item to OFF in the upper display.
4. **ENTER:** Pressing ENTER stores the value or the item changed. If not pressed, the previously stored value or item will be retained.
5. **UP ARROW & ENTER:** Pressing these keys simultaneously brings up the **Secondary menu** starting at the auto/manual selection. Pressing these keys for 5 seconds will bring up the **Secure menu.**
6. **INDEX & DOWN ARROW:** Pressing these keys simultaneously will allow backing up one menu item, or if at the first menu item they will cause the display to return to the **Primary menu.**
7. **INDEX & ENTER:** Pressing these keys simultaneously and holding them for 5 seconds allows recovery from the various error messages. The following menu items will be reset:

   LPbr: Loop break
   SEnC: Sensor rate of change
   ALIH: Alarm Inhibit
   OPEn InP: Open Input error message
   bAd InP: Bad input error message
   ArEA: Area error message
   CHEC CAL: Check calibration error message

Correct the problems associated with the above conditions first before using these reset keys. More than one error could be present. Caution is advised since several items are reset at one time.

While in the **Primary or Secondary menu,** if no key is pressed for a period of 30 seconds, the display will return to the HOME position displaying the PV and SV values. The time is increased to 1 minute when in the **Secure menu.**

NOTE: To move to the **Primary menu** quickly from any other menu, press the **UP ARROW & ENTER** keys followed by pressing the **INDEX & DOWN ARROW** keys.

METHOD FOR SET UP OF A HEAT / COOL CONTROL WITH SELF TUNE

Determine if the process is predominantly heating or cooling. An extruder, for example, is predominantly cooling when running product. An environmental chamber can be either heating or cooling. (For explanation of menu items see pages 12 & 13.)

If the process is predominantly cooling, set S1St to dir and S2St to rE. If the process is predominantly heating, set S1St to rE and S2St to dir. Redirect SP1 to output A or B as

required by the hardware (see SP1o). Set S2t to dE. Set SP2 for zero (no overlap of bands, no deadband). Set Pb2 to a desired value (default is 12° F). Set tunE to SELF, Strt to YES, and LErn to End.

Start the process and wait for it to come to stability. Occasionally check that the Self Tune has completed the learning process by INDEXing to Strt in the secondary menu. If the YES value has changed to no, then the process has been learned. Once learning is complete, you may adjust SP2 to either overlap the SP1 band (SP2 value less than zero), or add some separation between them (deadband — SP2 greater than zero) if required to optimize control.

SECURITY LEVEL SELECTION

Four levels of security are provided in the CN76000 menu system. The display shows the current security level. The level determines which menus are locked preventing changes in menu item in those menus. To change security levels, change the password value using the **UP & DOWN ARROW** keys and pressing the **ENTER** key. Refer to the password table below for the correct value to enter for the security level desired. The **SECr** menu item security level may be viewed or changed at any time regardless of the present security level. The password values shown in the table cannot be altered, so retain a copy of this page for future reference. This will be the only reference made to password values in this instruction book.

PASSWORD TABLE

SECURITY LEVEL MENU	SECURITY	DISPLAYED VALUE WHEN VIEWED	PASSWORD VALUE TO ENTER
Primary	Locked	1	1110
Secondary	Locked		
Secure	Locked		
Primary	Unlocked	2	1101
Secondary	Locked		
Secure	Locked		
Primary	Unlocked	3	1011
Secondary	Unlocked		
Secure	Locked		
Primary	Unlocked	4	111
Secondary	Unlocked		
Secure	Unlocked		

MENU SELECTIONS

PRIMARY MENU

Press **INDEX** to scan the Lower Display. Press **UP ARROW** or **DOWN ARROW** to change the value in the upper display.

In the following, the symbol "#" will be used before a letter in a menu item to indicate the set point value to be viewed and/or modified. (Applies to Option 948 only.)

#SP1 *(948) or*
Set Point 1, Main Control Point.

Set Point 2, if equipped.

LPbr Loop Break Protection: Select **OFF, 1** to **9999** seconds. If, during operation, the output is minimum (0%) or maximum (100%), and the input moves less than 5°F (3°C) or 5 counts over the time set for LPbr, the **LOOP bAd** message will appear. This condition can also be routed to an Alarm Condition if alarms are present and turned On (see ALbr in the secure menu). The loop break error can be reset by pressing the **ENTER** key when at the LPbr menu item. The **INDEX & ENTER** keys may also be used.

Process Output Low (936): Select -450°F, -260°C, or -1999 counts to 50 degrees or counts less than ***POH.***

Process Output High (936): Select from 50 degrees or counts greater than ***POL*** *to +9990°F, +5530°C, or 9990 counts. A voltage output is scalable from 0 to 10 VDC that represents the Process Variable. To properly scale the output, the values for* ***POL*** *and* ***POH*** *must be calculated. The simplest example is an output of 0 to 10 VDC from 0 to 200°. In this example* ***POL****=0 and* ***POH****=200. To Calculate POL and POH for other ranges use the following:*
K *= (Highest desired temperature - Lowest desired temperature) /*
(Maximum desired voltage - Minimum desired voltage)
POH *= ((10 - Maximum desired voltage) * K) + Highest desired temperature*
POL *= ((Minimum desired voltage - 0) * K) - Lowest desired temperature*

LOrE *Local / Remote Status (992): Select LOC or rE. When LOC is selected, the host computer is advised not to send remote commands. When rE is selected, CFLt=2, and nAt is set > 0, if the control is not accessed by the host computer in the time set in nAt, the control will revert to the CFSP.*

CFSP *Communications Fail Set Point (992): Set to desired value.*

Addr *Control Address (992): Set from 1 to FF. This number (hexadecimal, base 16) must match the address number used by the host computer. Viewed only in this menu.*

DIAGNOSTIC ERROR MESSAGES

DISPLAY	MEANING	SP1, SP2, and ALARM OUTPUTS	ACTION REQUIRED
UFL or **OFL**	Underflow or Overflow: Process value has exceeded input range ends set by **SCAL** or **SCAH**.	Set point outputs active Alarms active	Input signals may normally go above or below range ends. If not, check input and correct.
bAd InP **OPEn InP**	**UFL** or **OFL** will sequence to display one of these messages if the **InPt** is set for a time value. For RTD, CURRENT, or VOLTAGE inputs; input error has occurred. For THERMOCOUPLE inputs thermocouple is open.	Set point outputs inactive Alarms active	To reset, use the **INDEX & ENTER** keys. When **InPt** (input fault timer) has been set for a time, the outputs will be turned off after the set time. Setting the time to OFF causes the outputs to remain active; however, **UFL** or **OFL** will still be displayed. Correct or replace sensor. To reset use the **INDEX & ENTER** keys.
LOOP bAd	The sensor may be defective, heater fuse open, heater open or the final power output device is bad.	Set point outputs inactive Alarms active	Correct or replace sensor, or any element in the control loop that may have failed. To reset use the **INDEX & ENTER** keys, or press the **ENTER** key while in the **LPBr** menu item.
SEnC bAd	Sensor rate of change exceeded the programmed limits set for **SEnC**.	Set point outputs inactive Alarms active	Check the cause. The value setting may be too slow for the process, or the sensor is intermittent. To reset use the **INDEX & ENTER** keys.
#### ArEA	Area appears if the controller's ambient temperature nears specification ends, -5°C (+23°F) or +50°C (+122°F).	Set point outputs active Alarms active	Correct the ambient temperature conditions. Ventilate the area of the cabinet or check for clogged air filters.
(blank) ArEA	Area appears if the controller's ambient temperature exceeds specification ends, -10°C (+14°F) or +55°C (+131°F).	Set point outputs inactive Alarms active	Correct the ambient temperature conditions. Ventilate the area of the cabinet or check for clogged air filters. To reset use the **INDEX & ENTER** keys.
CHEC CAL	Check calibration appears as an alternating message if the instrument calibration nears tolerance edges.	Set point outputs active Alarms active	
	Check calibration appears as a flashing message if the instrument calibration exceeds specification.	Set point outputs inactive Alarms active	Remove the instrument for service and / or recalibration. To reset use the **INDEX & ENTER** keys.

DISPLAY	MEANING	SP1, SP2 AND ALARM OUTPUTS	ACTION REQUIRED
No displays lighted	Both displays are blank. Instrument may not be getting power, or the supply voltage is too low.	Set points inactive Alarms inactive	Check that the power supply is on, or that the external fuses are good.
FAIL tESt	Fail test appears upon power up if the internal diagnostics detect a failure. This message may occur during operation if a failure is detected. Displays flash.	Set points inactive Alarms inactive	Press the **INDEX** key to display the following messages: **FACt dFLt**: Memory may be corrupted. Press the **ENTER** key and the **DOWN ARROW** key to start the factory default proceedure. Re-check controller programming. **bAd A-d**: The A/D board is bad, return to factory. **rEt FACt**: Can not recover from error, return to factory for service.
CHEC SCAL or **CHEC SCAH**	The difference between scale low and scale high is programmed for more than 11,998 or less than 100 counts during programming of the voltage or current ranges.	Set points inactive Alarms inactive	Program parameter within the allowed count range.
CHEC SP1, ***CHEC SP1***, **CHEC SP1d**, **CHEC SP2**, **CHEC SP2d**, **CHEC ALLo**, **CHEC ALHI**, or ***CHEC CFSP***	One or more of these messages will appear upon power up if any of these set points or differentials are set outside of the **SPL** or **SPH** values, or the range ends (**SCAL** or **SCAH**).	Set points inactive Alarms inactive	Check that each of the set points are within **SPL**, **SPH** range, or reprogram SPL and / or SPH values to be at or beyond the set points values found in error. Do not exceed the range ends (**SCAL** or **SCAH**).
CHEC SPL or **CHEC SPH**	This message appears at power up if **SPL** or **SPH** values are programmed above or below the range ends (**SCAL** or **SCAH**). This message also appears if one or more set points are set above or below **SPL** or **SPH** during normal programming.	Set points inactive Alarms inactive	Correct the **SPL** or **SPH** values by programming new values. **CAUTION:** When the **CHEC** message appears, the value entered is rejected. The old value for that menu item is retained.
CHEC POL or ***CHEC POH***	This message appears if the POL or POH values are incorrectly programmed.	Set points active Alarms active	Correct the POL or POH by programming new values.

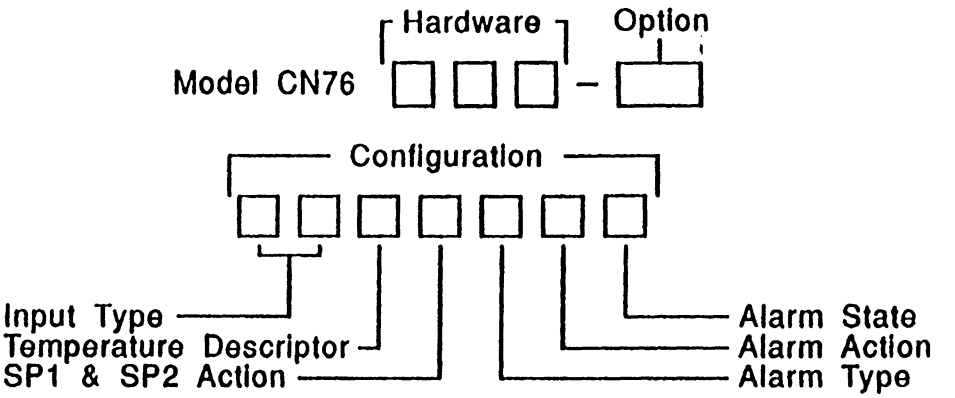
CONFIGURATION MENU

DO NOT ENTER THE CONFIGURATION MENU UNLESS YOU HAVE BEEN INSTRUCTED TO BY ANOTHER PART OF THESE INSTRUCTIONS. INCORRECT ENTRY OF DATA IN THE CONFIGURATION MENU MAY PREVENT YOUR CONTROL FROM OPERATING PROPERLY.

If re-configuration is required, follow the instructions below.

The Configuration Menu is used to quickly configure the Instrument. The configuration for your particular model is shown on the Model / Serial label located on the top of the instrument housing. A label found inside on the right printed circuit board only shows the hardware configuration and options.

The numbers shown are defined as follows:



The Hardware configuration code **must not** be changed as it defines the hardware for the specific instrument. All other configuration may be altered if necessary. It is important that the codes be correctly entered in order for the instrument to function properly. If an invalid code number is entered for a particular configuration item, it will not be accepted and the old configuration code will be retained.

To re-configure:

1. At power up, simultaneously press and hold the **INDEX** & **ENTER** keys while the lamp test or self test is displayed. Hold the keys down until **Hrd1** appears. A dash appears in the upper display.
2. Press the **INDEX** key to advance through the menu items. Pressing the **INDEX** & **DOWN** keys simultaneously will back up to a menu item. Stop at the menu item you wish to change.
3. Press the **UP** or **DOWN** key to select the desired Configuration Code from the following chart.
4. Press **ENTER** to retain the Configuration Code.
5. Press **INDEX** to advance.
6. If you do not want to retain the re-configuration, this is your last chance to return to the old configuration. Press **ENTER** at **AcPt no** to exit and retain the old configuration.

CONFIGURATION CHART

Do not change **Hrd1, Hrd2** or **Hrd3** to codes different from those on the controller labels. Codes in boldface type indicate factory defaults. See **FACt dFLt.**

DISPLAY	MENU ITEM	CONFIGURATION CODE
Hrd1	Alarm Hardware	0 = NO 1 = YES
Hrd2	Output A Hardware	1 = SSR/5 Vdc 2 = 5 Vdc/SSR 3 = RELAY/5 Vdc 4 = 5 Vdc/RELAY 5 = CURRENT 6 = VOLTAGE
Hrd3	Output B Hardware	0 = NONE 1 = SSR/5 Vdc 2 = 5 Vdc/SSR 3 = RELAY/5 Vdc 4 = 5 Vdc/RELAY
OPt1	Option Hardware	936 = Process Output 948 = 4-Stage Set Point 992 = Serial Communications If number flashes, option is NOT selected. Press ENTER to select (number will not flash).
CnF1	Input Type	**01 = J 1°** 02 = J 0.1° 03 = K 1° 04 = K 0.1° 05 = E 1° 06 = E 0.1° 07 = T 1° 08 = T 0.1° 09 = L 1° 10 = L 0.1° 11 = N 1° 12 = N 0.1° 13 = R 1° 14 = S 1° 15 = B 1° 16 = C 1° 17 = RTD 1° (DIN) 18 = RTD 0.1° (DIN) 19 = RTD 1° (NIST) 20 = RTD 0.1° (NIST) 21 = RTD 1° NI 22 = RTD 0.1° NI 23 = 0 to 20 mA 24 = 4 to 20 mA 25 = 0 to 5 Vdc 26 = 1 to 5 Vdc
CnF2	Temperature Descriptor	0 = No Descriptor 1 = °F 2 = °C
CnF3	SP1 and SP2 Action	**0 = SP1 = Output A, reverse action** (Single Set Point Models) 1 = SP1 = Output A, direct action (Single Set Point Models) **2 = SP1 = Output A, reverse act.; SP2 = Output B, direct act.** 3 = SP1 = Output B, reverse act.; SP2 = Output A, direct act. 4 = SP1 = Output A, direct act; SP2 = Output B, reverse act. 5 = SP1 = Output B, direct act.; SP2 = Output A, reverse act. 6 = SP1 = Output A, reverse act.; SP2 = Output B, reverse act. 7 = SP1 = Output B, reverse act.; SP2 = Output A, reverse act. 8 = SP1 = Output A, direct act.; SP2 = Output B, direct act. 9 = SP1 = Output B, direct act.; SP2 = Output A, direct act.
CnF4	Alarm Type	0 = No Alarm **1 = Absolute High Alarm** 2 = Deviation High Alarm 3 = Absolute Low Alarm 4 = Deviation Low Alarm 5 = Absolute High - Low Alarms 6 = Deviation High - Low Alarms
CnF5	Alarm Action	0 = No Alarm **1 = On - Off** 2 = Manual Reset with Power Interrupt 3 = Manual Reset without Power Interrupt 4 = On - Off with Inhibit 5 = Manual Reset with Inhibit
CnF6	Alarm State	0 = No Alarm **1 = Close at SP, LED flashing** 2 = Open at SP, LED flashing 3 = Close at SP, LED off 4 = Open at SP, LED off

CONFIGURATION CHART (cont'd)

DISPLAY	MENU ITEM	CONFIGURATION CODE
CnF6	Alarm State	0 = No Alarm **1 = Close at SP, LED flashing** 2 = Open at SP, LED flashing 3 = Close at SP, LED off 4 = Open at SP, LED off
AcPt	Accept Configuration	no = Retain old Configuration. Press ENTER to exit. YES = Accept Configuration. Press ENTER to exit.
Id ##		Factory Identification. Not for customer use.
FACt dFLt		Factory default. Defaults Configuration to factory codes shown in boldface type in the chart above.  **Warning:** The Hardware Configuration will be cleared and must be re-entered using the Hardware Configuration code found on the Model / Serial label located on the top of the instrument housing. The configuration menu cannot be exited until valid Hardware codes are entered. If factory default is desired, simultaneously press the **ENTER & DOWN ARROW** keys.

SPECIFICATIONS

Selectable Inputs: Thermocouple, RTD, current or voltage.
Input Impedance:
Thermocouple = 3 megohms minimum. RTD current = 200 uA.
Current = 249 ohms. Voltage = 5000 ohms.
Sensor Break Protection: De-energizes control outputs to protect system.
Loop Break Protection: Error message is initiated upon shorted sensor or open heater circuit. Break time is adjustable from OFF to 9999 seconds.
Loop Break Alarm: If equipped with an Alarm relay, the Alarm may be programmed to operate upon a loop break.
Set Point Range: Selectable.
Displays: Two 4 digit, 7 segment 0.3" high LEDs. Process Variable red, Set Variable green.
Control Action: Reverse (usually heating), Direct (usually cooling) selectable for single or dual set point models.
Proportional Band: 6 to 5000 °F or equivalent °C for temperature inputs. 6 to 9990 counts for current or voltage inputs.
Reset Time (Integral): Off or 0.1 to 99.9 minutes.
Rate Time (Derivative): Off or 0.01 to 99.99 minutes.
Cycle Rate: 2 to 80 seconds,
Approach Rate: Off to 99.99 minutes.
On - Off Differential: Adjustable 2 °F to full scale in 1° steps (equivalent °C), or 2 counts to full scale in 1 count steps for current and voltage inputs.
Alarm On - Off Differential: 2 °F or equivalent in °C, or 2 counts.
Scaling for Current or Voltage Inputs: Adjustable for a maximum negative to positive

span value of -1999 to +9999 counts (total span of 11,998 counts). Independent settings for low scale (SCAL) and high scale (SCAH) range ends.

Ramp / Soak: One ramp time and soak time, each adjustable from 0 to 100 hours. End procedure can be set for HOLD or OFF.

Accuracy: ±0.25% of span, ±1 least significant digit.

Resolution: 1 degree, 0.1 degree, or 1 count.

Line Voltage Stability: ±0.05% over the supply voltage range.

Temperature Stability: 4µV/°C (2.3 µV/°F) typical, 8 µV/°C (4.5 µV°F) maximum.

Common Mode Rejection: 140 dB minimum at 60 Hz.

Normal Mode Rejection: 65 dB typical, 60 dB at 60 Hz.

Isolation: Relay and SSR outputs are isolated. Current, voltage, and 5 Vdc outputs must not share common grounds with the input.

Supply Voltage: 85 to 265 Vdc or Vac, 50 through 400 Hz. This applies to the instrument power only.

Power Consumption: 3 VA nominal, 5VA maximum.

Operating Temperature: -10 to +55 °C (+14 to 131 °F).

Storage Temperature: -40 to +80 °C (-40 to 176 °F).

Humidity Conditions: 0 to 90% up to 40 °C non-condensing 10 to 50% at 55 °C non-condensing.

Memory Backup: Non-volatile memory. No batteries required.

Control Output Ratings:

1. SSR, 3.5 A @ 250 Vac at 25 °C. Derates to 1.25 A @ 55 °C.
2. Mechanical Relay, Form A contact (SPST), 3 A @ 250 Vac resistive, 1.5 A @ 250 Vac inductive, Pilot duty rating = 250 VA, 2 A @ 125 Vac or 1 A @ 250 Vac. 1/8 HP @ 125 Vac or 250 Vac.
3. Alarm Relay, Form A contact (SPST). Same rating as control relay (2) above.
4. Current (non-isolated), 0 to 20 mA across 600 ohms maximum.
5. Voltage (non-isolated), 0 to 10 Vdc across 500 ohms minimum.
6. 5 Vdc (non-isolated), 5 Vdc @ 25 mA.

Panel Cutout: 45 mm x 45 mm (1.775" x 1.775").

Depth Behind Mounting Surface: 115.3 mm (4.54").

Weight: 227 g (8 oz).

Dimensions: See diagram, Page 2.

Agency Approvals: UL and CSA pending.

Front Panel Rating (non-hazardous locations): Meets NEMA 2, 3R, and 12 ratings.

Input Ranges

Input Type	RANGE	RESOLUTION	RANGE	RESOLUTION
J Iron-Constantan	-100 to 1600°F -100.0 to 990.0°F*	1°F 0.1°F	-73 to 871°C -73.0 to 871.0°C	1°C 0.1°C
K CHROMEGA-ALOMEGA	-200 to 2500°F -190.0 to 990.0°F*	1°F 0.1°F	-129 to 1371°C -129.0 to 990.0°C*	1°C 0.1°C
E CHROMEGA-Constantan	-100 to 1800°F -100.0 to 990.0°F*	1°F 0.1°F	-73 to 982°C -73.0 to 982.0°C	1°C 0.1°C
T Copper-Constantan	-350 to 750°F -190.0 to 750.0°F*	1°F 0.1°F	-212 to 398°C -190.0 to 398.0°C*	1°C 0.1°C
N OMEGALLOY® Nicrosil-Nisil	-100 to 2372°F -100.0 to 990.0°F*	1°F 0.1°F	-73 to 1300°C -73.0 to 990.0°C*	1°C 0.1°C
R Pt 13% Rh-Pt	0 to 3200°F	1°F	-17 to 1760°C	1°C
S Pt 10% Rh-Pt	0 to 3200°F	1°F	-17 to 1760°C	1°C
B Pt 30% Rh-Pt 6% Rh	75 to 3308°F	1°F	-24 to 1820°C	1°C
C W 5% Re-W 26% Re	0 to 4208°F	1°F	-17 to 2320°C	1°C
RTD, 100 Ohm Platinum 0.00385 DIN curve	-328 to 1607°F -190.0 to 990.0°F*	1°F 0.1°F	-200 to 875°C -190.0 to 875.0°C*	1°C 0.1°C
RTD, 100 Ohm Platinum 0.00392 NIST curve	-328 to 1607°F -190.0 to 990.0°F*	1°F 0.1°F	-200 to 875°C -190.0 to 875.0°C*	1°C 0.1°C
RTD, 120 Ohm Nickel	-112 to 608°F -112.0 to 608.0°F	1°F 0.1°F	-80 to 320°C -80.0 to 320.0°C	1°C 0.1°C
Current: 0 to 20 mA, 4 to 20 mA	Programmable	Programmable	Programmable	Programmable
Voltage: 0 to 5 Vdc, 1 to 5Vdc	Programmable	Programmable	Programmable	Programmable

* DISPLAY WILL REVERT TO 1° RANGE IF THE RANGE LIMITS FOR 0.1° RANGE ARE EXCEEDED.