Operating Instructions

Actuators & Positioners
Models AV3/AV4

Characterizable Pneumatic Positioners

Power and productivity
for a better world™

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CAUTION notices apply to hazards or unsafe practices which could result in property damage.

NOTES highlight procedures and contain information which assist the operator in understanding the information contained in this manual.

WARNING

POSSIBLE PROCESS UPSETS. Maintenance must be performed only by qualified personnel and only after securing equipment controlled by this product. Adjusting or removing this product while it is in the system may upset the process being controlled. Some process upsets may cause injury or damage.

NOTICE

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Read First

WARNING

INSTRUCTION MANUALS
Do not install, maintain or operate this equipment without reading, understanding and following the proper factory-supplied instructions and manuals, otherwise injury or damage may result.

RETURN OF EQUIPMENT
All equipment being returned to the factory for repair must be free of any hazardous materials (acids, alkalis, solvents, etc.). A Material Safety Data Sheet (MSDS) for all process liquids must accompany returned equipment. Contact the factory for authorization prior to returning equipment.

Read these instructions before starting installation; save these instructions for future reference.

Contacting the Factory . . .

Should assistance be required with any of the company's products, contact the following:

Telephone:

24-Hour Call Center
1-800-HELP-365

E-Mail:

ins.techsupport@us.abb.com

SECTION 1 - INTRODUCTION

INTRODUCTION

This section covers the following topics:

- Type AV3/4 description.
- Type AV3/4 application.
- Features of positioners.
- Instruction content.
- How to use this instruction book.
- Type AV3/4 nomenclature.
- Type AV3/4 specification.
- Position transmitter specification.
- Agency approvals.
- Accessories.
- Mounting kits.

NOTE: Appendix B provides a quick start guide for the Type AV positioner. It is intended for control engineers having experience in the use and application of pneumatic positioners. The quick start guide highlights the major points of installation and calibration. Detailed installation and calibration information is contained in Section 3 and 4.

INTENDED USER

The information in this publication is a guide for technical personnel responsible for installation, calibration, operation, maintenance and repair of the Type AV3/4 positioner.

TYPE AV3/4 POSITIONER DESCRIPTION

The Type AV3 and Type AV4 positioners are electro-pneumatic control devices that satisfy a wide range of applications. They provide fast, sensitive and accurate positioning of pneumatic single or double acting actuators.

The Type AV3 positioner accepts a four to 20 milliamp current that is applied to an I/P (current to pneumatic) converter (located inside the housing) to generate an internal signal pressure. The Type AV4 positioner responds to a solid state (DDC) or contact closure input to generate a similar internal signal pressure.

If a loss of signal occurs, both Type AV3 and AV4 positioners retain their position just prior to the signal loss (referred to as ***fail in place***).

A mechanical connection from the actuator (i.e., cylinder, valve, etc.) to the position feedback cam in the positioner establishes actual position. Three characterized segments on the cam provide application flexibility by establishing various relationships between the input signal and the actuator position. The characterized curves on the cam provide:

- Square root relationship.
- Linear relationship.
- Square characteristic.

Using zero, span and gain adjustments and the cam, the actuator can respond with characteristics specific to an application.

An optional manifold assembly provides an integral shutoff and equalizing valve that can be used to isolate the positioner from an actuator, allowing manual override without removing the positioner from the process. The manifold also provides gage ports and disposable filter cartridges that insure fast servicing and minimum downtime.

The Type AV3 positioner can be equipped with either an optional potentiometric or a four to 20 milliamp position transmitter. The Type AV4 positioner comes standard with a four to 20 milliamp position transmitter.

TYPE AV3/4 POSITIONER APPLICATION

The ABB Type AV3 and Type AV4 Characterizable Pneumatic Positioners control the position of a pneumatic actuator in a linear or nonlinear relation to a current or pulse input signal.

TYPE AV3/4 POSITIONER FEATURES

- ***Troublefree Operation***. Proven pilot valve, that is quickly removable, provides less downtime, lower maintenance costs, increased reliability and extended performance.

- ***Compact Rugged Design***. Die cast aluminum housing, beam, spring arm, follower arm and 303 stainless steel pilot valve provide long life and maximum environmental protection. The compact housing increases mounting flexibility.

- ***Characterizable Output***. Large positioning cam can be shaped to provide desired relationship between the input signal and the actuator position.

- ***Accurate Calibration***. Independent zero and span adjustments eliminate interaction and provide fast and accurate calibration.

- ***Simplified Reverse Operation***. Action can be changed in the field by changing cams and reversing 01 and 02 connections. The reverse-acting cam is conveniently located on the inside of the front cover.

- ***Highly Visible Position Status Indicator***. A fluorescent orange position indicator is visible through a polycarbonate window, providing fast indication of actuator position.

- ***Vent Design Allows Natural Gas Operation***. Vent pipe arrangement permits operation using natural gas.

- ***Split Range Service***. Split range capability allows sequencing of multiple actuators using a single control signal.

- ***Adjustable Gain***. Two levels of gain are possible by simply changing the hinge springs supplied with the positioner.

- ***Adaptable Usage***. The positioner can control both single and double-acting, linear and rotary type actuators.

- ***High Capacity***. More than 0.65 cubic meters per minute (23 standard cubic feet per minute) can be supplied or exhausted from the positioner at 483 kilopascals (70 pounds per square inch) supply pressure. See Figure 1-1 in ***SPECIFICATIONS***.

- ***Continuously Adjustable Span and Zero for Each Stroke Level***. Capable of 100 percent stroke for 50 percent signal span or 50 percent stroke for 100 percent signal span.

- ***Low Air Consumption***. Enhanced pilot valve design and manufacturing technique allows the Type AV positioner maximum performance with minimum air consumption. See Figure 1-2 in the ***SPECIFICATIONS*** section.

- ***Adjustable Speed Control without Additional Hardware***. Speed of actuator can be reduced to desired speed using the pilot valve stroke adjustment screws.

INSTRUCTION CONTENT

This document includes the following sections:

Introduction Provides a description of this instruction book; its sections and uses, along with a brief description of the Type AV3 and Type AV4 positioners. This section also provides product nomenclature (Table 1-2), specifications (Tables 1-3, 1-4, 1-5), instructions on how to use this document, agency approvals (Table 1-6) and positioner accessories (Table 1-7). Table 1-8 lists retrofit mounting kits, Table 1-9 lists available speed control orifices, and Table 1-10 lists

the available pressure gages. Table 1-11 lists pressure regulators and Table 1-12 lists supply air filters available from ABB.

Description and Operation Describes the functional operation of the positioners.

Installation Provides information about installing a Type AV positioner.

Calibration Provides calibration and adjustment procedures.

Operating Procedures Presents information and procedures for various applications suitable for Type AV positioners.

Troubleshooting Provides a table containing errors, causes, and corrective action for Type AV positioners.

Maintenance Includes maintenance information and procedures on Type AV positioners.

Repair/Replacement Provides step-by-step instructions for removing and replacing components of Type AV positioners.

Support Services Provides recommended and replacement parts lists. Illustrations of both positioners provide part numbers for all major components.

Appendix A Provides calibration information about the four to 20 milliamp position transmitter and potentiometric position transmitter.

Appendix B Contains quick start information for control engineers who are knowledgeable about positioners and the overall process in which the positioner is to be used.

Appendix C Details cam shaping information.

HOW TO USE THIS INSTRUCTION BOOK

For safety and operating reasons, read and completely understand this product instruction book before installing or completing any tasks or procedures associated with operation.

The section arrangement of this instruction book is sequential. After initial start-up and calibration, store this manual in a safe place for future reference.

REFERENCE DOCUMENTS

Table 1-1. Reference Documents

Number	Document Title
ANSI/NFPA 70	National Electrical Code
CEC	Canadian Electrical Code
D-APE-AV1234	Characterizable Positioners, Type AV1, AV2, AV3, AV4 (Specification)
CSA C22.1	Process Control Equipment
PN25039	Characterizable Pneumatic Positioner, Type AV1 and AV2 (Instruction book)
ANSI/ISA-7.0.01-1996	Quality Standards for Instrument Air (Instrument Society of America)
ISA S75.13-1989	Method of Evaluating the Performance of Positioners with Analog Input Signals and Pneumatic Output (Instrument Society of America)
P-P88-001	Installing a Type AV Positioner in a Hazardous Location (Product Application Guide)

TYPE AV3/4 POSITIONER NOMENCLATURE

Table 1-2. Type AV3/4 Nomenclature

Position	3	4	5	6	7	8	
Type AV	_	_	_	_	_	_	**Characterizable Positioners**
							Type
	3						Characterizable 4 to 20 mA Input Positioner (fail in place upon loss of signal)
	4						Characterizable Pulse Input Positioner (fail in place upon loss of signal)
							Input Signal
		3					4 to 20 mA (Type AV3)
		4					Contact closure/open collector DDC (Type AV4)
							Stroke/Rotary Motion (cam selection)
			1				12.7 - 50.8 mm (0.5 - 2.0 in.) or 45° rotary motion
			2				25.4 - 101.6 mm (1.0 - 4.0 in.) or 90° rotary motion
							Manifold (includes filters)
				0			None
				1			Manifold with equalizing valve
				2			Manifold with equalizing valve inoperable [2]
				3			Gage block (gage port only)
							Position Transmitter[1]
					0		None (Type AV3 and Type AV4)
					1		Potentiometric resistive output (Type AV3 only)
					2		4 to 20 mA Output (Type AV3 only)
							Drive Shaft
						0	Standard with drive arm
						1	½-inch square end

NOTE:
1. When ordering Type AV44, position 7 must be 0. The 4 to 20 mA output position transmitter is not an option, it is a standard feature of Type AV44 positioner. The position transmitter options are only valid for Type AV33 positioners
2. No longer available as of October 2003..

SPECIFICATIONS

Table 1-3 provides performance specifications of the Type AV3 and Type AV4 positioners. Tables 1-4 and 1-5 provide performance specifications for the position transmitters.

Table 1-3. Type AV 3/4 Positioner Specifications

<table>
<tr><th>Property</th><th>Characteristic/Value</th></tr>
<tr><td>Input Range
Type AV3
Type AV4</td><td>
4 to 20 mA DC (30 VDC maximum)
Computer DDC (direct digital control), solid state or contact closure input.

Units have 50% range suppression and/or zero elevation capability.

Minimum pulse width test data taken at 20°C (68°F) and factory preset fine speed adjustment. Operation at other fine speed adjustment settings will require different minimum pulse widths. Operation at colder temperatures may require longer minimum pulse widths.
<table>
<tr><th colspan="2">Minimum Pulse Width</th></tr>
<tr><th>Coarse Speed Adjustment Position</th><th>Msecs</th></tr>
<tr><td>4</td><td>40</td></tr>
<tr><td>3</td><td>20</td></tr>
<tr><td>2</td><td>15</td></tr>
<tr><td>1</td><td>12.5</td></tr>
</table>
</td></tr>
<tr><td>Voltage Supply (Type AV4 only)
Minimum
Nominal
Maximum</td><td>
16 VDC
24 VDC
34 VDC
NOTE: Maximum 50 mA current draw.</td></tr>
<tr><td>Input Impedance[1]</td><td><1.66 kΩ at 4 mA
<0.57 kΩ at 12 mA
<0.35 kΩ at 20 mA</td></tr>
<tr><td>Standard Stroke Range (cam selection)
Type AV__1 positioner
Type AV__2 positioner</td><td>
12.7 to 50.8 mm (0.5 to 2.0 in.) linear, rotary input 45°
25.4 to 101.6 mm (1.0 to 4.0 in.) linear, rotary input 90°
NOTE: It is recommended that the 90° cam be used wherever possible (Type AV__2___ positioner).</td></tr>
<tr><td>Gain</td><td>Two adjustment levels by changing gain hinge spring.</td></tr>
<tr><td>Accuracy[1,2]</td><td>0.70% of span typical; <0.90% of span maximum</td></tr>
<tr><td>Resolution</td><td><0.30% of span maximum</td></tr>
<tr><td>Hysteresis[1,2]</td><td>0.35% of span typical; <0.60% of span maximum</td></tr>
<tr><td>Repeatability[1,2]</td><td>0.40% of span typical; <0.60% of span maximum</td></tr>
</table>

Table 1-3. Type AV 3/4 Positioner Specifications (continued)

Property	Characteristic/Value
Dead Band[2]	<0.30% of span maximum
Linearity[1,2]	0.60% of span typical; <0.80% of span maximum
Supply Pressure	172 to 1,034 kPa (25 to 150 psig)
Supply Pressure[2] Effect Single-acting Double-acting	 0.05%/6.9 kPa for ±69 kPa change 0.05%/1.0 psi for ±10 psi change 0.05%/6.9 kPa for ±35 kPa change 0.05%/1.0 psi for ±5 psi change
Capacity (max. capacity, exhausting to atmosphere)	See Figure 1-1.
Air Consumption	See Figure 1-2.
Positioner Weight Type AV3 Type AV4	 2.27 kg (5 lbs) 2.35 kg (5 lbs 3 oz)
Temperature Limits[3] Operating Storage	 -20° to 60°C (-4° to 140°F)[4] -20° to 80°C (-4° to 176°F)
Temperature Effect Type AV3 Type AV4	 <0.18% per °C (<0.09% per °F) <0.03% per °C (<0.015% per °F)
Vibration Effect[2]	Less than 2.0% error for: 5 to 15 Hz at peak to peak constant displacement of 4 mm (0.16 in.) 15 to 120 Hz at accelerations to 2 Gs
RFI Effect Type AV3 Type AV4	 ±1.5% maximum at 10 V per meter field strength, 20 to 540 MHz ±1.5% maximum at 10 V per meter field strength, 20 to 450 MHz
Pneumatic Connections	¼-NPT on supply, signal, and output connections ⅛-NPT on pressure gages
Materials of Construction Enclosure Pilot Valve	 Aluminum, and <0.5% magnesium 303 Stainless Steel
Enclosure Classification	NEMA 3R classification when vent hole is protected from rain using rain elbow (½-14 NPT street elbow, see Figure 3-1). Corrosion resistant to NEMA 4X test requirements (NEMA 250).

NOTES:
1. Not applicable to the Type AV4.
2. Tested according to ISA-S75.13-1989.
3. Operation below specification (not recommended) will increase stroke time.
4. For operation below 4.4×C (40×F,)dew point of the supply air must be -7.7×C (18×F) lower than the lowest expected operating temperature.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

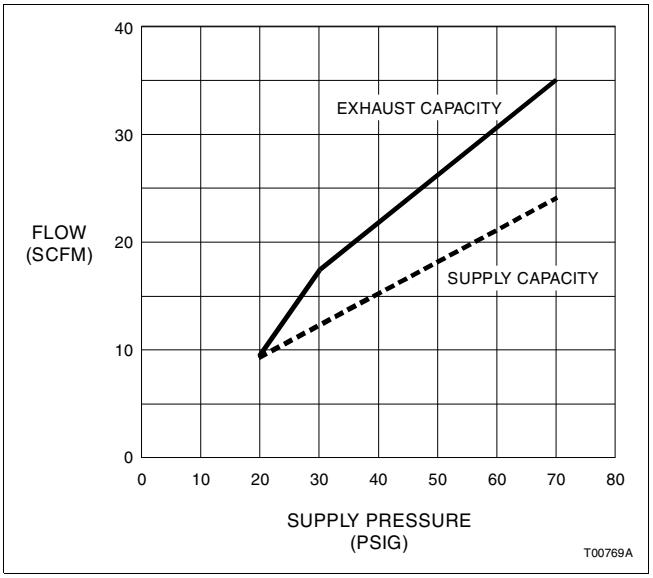


Figure 1-1. Capacity Data of Type AV3/4 Positioners (Exhaust to Atmosphere)

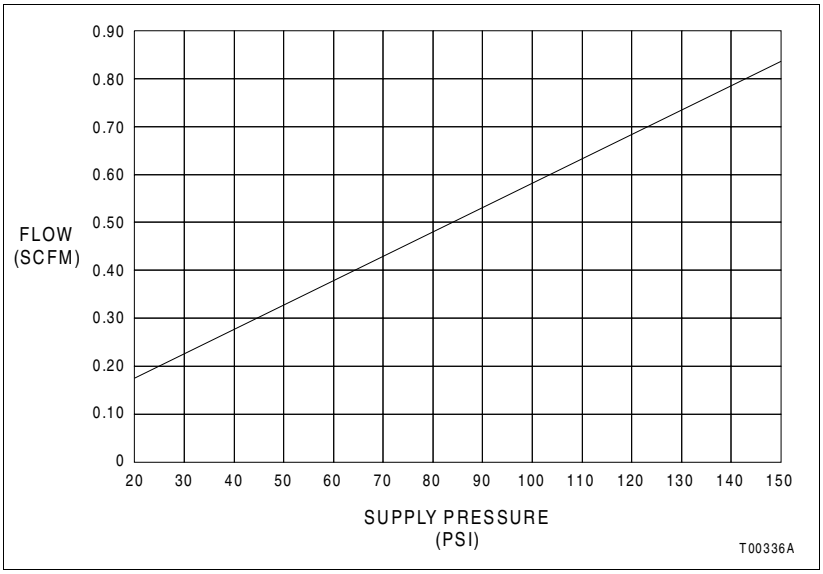


Figure 1-2. Air Consumption Data of Type AV3/4 Positioners

Table 1-4. Optional Potentiometric Position Transmitter Specifications (Type AV33__1_ Only)

Property	Characteristic/Value
Total Resistance	2,000 Ω ±20%
Power Rating	1 W up to 70°C (158°F) 0 W at or above 125°C (257°F)
Wiper Rate of Change	9.9 Ω nominal per degree of cam rotation
Temperature Effect	0.05% (500 ppm) per °C 0.03% (278 ppm) per °F maximum
Maximum Voltage	35 VDC or 30 VAC across the potentiometer ends

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

Table 1-5. 4 to 20 mA Position Transmitter Specifications (Type AV33__2_ and AV44__0_)

Property	Characteristic/Value
Supply Voltage	16 to 34 VDC
Output Signal	4 to 20 mA
Output Loading	500 Ω at 24 VDC 1000 Ω at 34 VDC
Accuracy	0.6% of span maximum
Hysteresis	0.5% of span maximum
Repeatability	0.4% of span maximum
Ambient Temperature Effect	0.063% per °C 0.035% per °F
EMI/RFI Effect	1.5% maximum at 10 volts per meter field strength, 20 to 450 MHz

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

Table 1-6. Agency Approvals

Nomenclature	Approval/Certification
AV3/4[1, 2]	FM and CSA approval and certifications in the following categories: Nonincendive for Class I, Division 2, Groups A, B, C, D. Intrinsically safe for Class I, Division 1, Groups A, B, C, D, when used with an approved intrinsic safety barrier.

NOTES:

1. Approvals and certifications pending. The position transmitters of Type AV3/4___1/2__ positioners are CSA certified and FM approved in the categories listed.

2. Hazardous location approvals for use in flammable atmospheres are for ambient conditions of -25° to 40°C (-13° to 104°F), 86 to 106 kPa (12.5 to 15.7 psi) with a maximum oxygen concentration of 21%.

ACCESSORIES

Table 1-7. Positioner Accessories[1]

Accessories	Description
Mounting Kits	Dependent on valve stem size. For ABB rotary actuator retrofit kits, refer to Table 1-8.
Speed Control Orifices	Regulate time constant of positioner and final control device. Orifices are installed directly into positioner output ports (refer to Table 1-9). Speed adjustment can also be controlled by using the internal stroke adjustment screws (refer to ***GAIN AND SPEED ADJUSTMENTS*** in Section 4).
Pressure Gages	For reading signal supply and output pressures, refer to Table 1-10.
Blank Cam	Used to characterize the positioner if the standard cams (square, linear, square root) will not produce the desired relationship. Blank cam must be profiled (part number 5400277_1).
Regulator	Refer to Table 1-11.
Air Filters	ABB recommends installing an air filter in the supply air line to prevent particles from entering the positioner, which can lead to malfunction. Refer to Table 1-12 for filter part numbers.

NOTE:
1. For recommended spare parts and additional spare parts, refer to Section 9.

Table 1-8. Rotary Actuators Retrofitting Mounting Kits

Retrofit Mounting Kit	Drive Nomenclature	Kit Number
AP positioner to AV positioner	UP10, UP20 UP3, UP4 UP5, UP6	5400309_1 258493_1 258494_1
	AC0404 AC0608	258527_1 258528_1
	AC0816 AC1016	258529_1 258530_2
Pilot valve positioners to AV positioners	AC0404 AC0608	258527_1 258528_1
	AC0816 AC1016	258529_1 258530_1

Table 1-9. Optional Speed Control Orifices[1]

Orifice Size		Orifice Part Number
mm	in.	
1.02	0.04	5327327_1
Blank	Drill to suit	5327327_2

NOTE:
1. Speed control can also be obtained by internal positioner adjustment, refer to ***GAIN AND SPEED ADJUSTMENTS*** in Section 4.

Table 1-10. Pressure Gages

Range		Legend	Part Number
kPa	psi		
0 - 200	0 - 30	Instrument	5326605_4
0 - 1000	0 - 160	Supply[1]	5326605_5
0 - 1000	0 - 160	Output	5326605_6

NOTE:
1. The optional manifold provides gage ports, one for instrument (internal input signal) and two output gages. A supply gage can be installed in the supply line (piping by customer).

Table 1-11. Supply Air Regulators with Gages

Part Number	Max. Outlet Pressure (psi)	Max. Inlet Pressure (psi)	Inlet/Outlet Connections
1951029_5	125	250	¼-NPT

Table 1-12. Supply Air Filters[1]

Part Number	Max. Inlet Pressure (psi)	Maximum Temperature		Inlet/Outlet Connection Size
		°C	°F	
5328563_2	250	52	125	1/4-NPT

NOTE:
1. In-line coalescing filter for removal of solid and liquid contaminants in compressed air. Filter comes with universal mounting bracket and grade 6 filter that is 99.97% efficient at 0.3 micron. Part number 5328563_2 has a zinc bowl.

SECTION 2 - DESCRIPTION AND OPERATION

INTRODUCTION

This section describes and explains the functional and physical operation of Type AV3 and AV4 positioners. Figure 2-1 diagrams operating principles of the positioners. Figure 2-2 shows the placement of a Type AV positioner in a typical system.

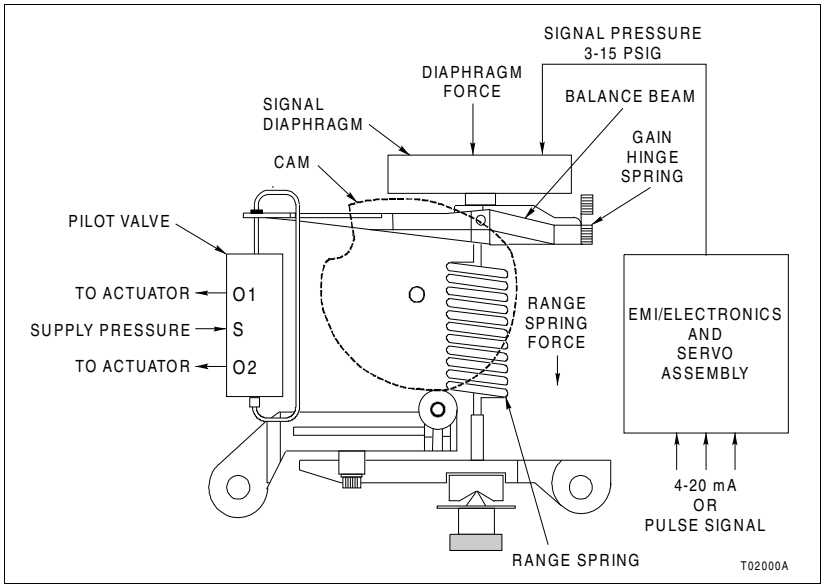


Figure 2-1. Type AV3/4 Positioner Operation Diagram

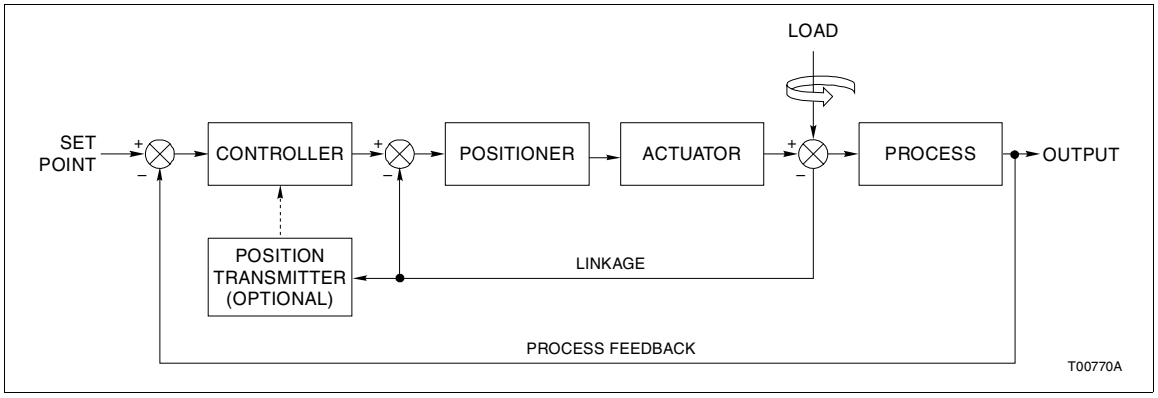


Figure 2-2. Block Diagram of a Typical Control System Utilizing a Positioner

FUNCTIONAL OPERATION

Type AV positioners operate by balancing opposing forces. Figure 2-1 shows a diagram of the Type AV positioner. A balance beam, hinged at one end and connected to the pilot valve at the other, is acted upon by two forces:

- The upward force of the signal diaphragm assembly.
- The downward force from the range spring.

The internal input signal pressure determines the diaphragm force. The Type AV3/4 positioner internally generates the input signal pressure; the AV3 uses a current to pneumatic converter, the AV4 uses a voltage pulse to pneumatic converter. The converter in both cases consists of a servo and EMI/electronics assembly. The assembly contains electronic circuitry. Applying an input signal (four to 20 milliamp or voltage pulse) to the converter produces an input signal pressure to the signal diaphragm.

The range spring force is a function of the shape and position of the cam. The cam is coupled to the cam shaft, the cam shaft is connected through linkage (or coupling) to the actuator. Therefore, range spring tension is a function of the actuator position.

A change in input signal (a pulse or some value between four and 20 milliamp), changes the force exerted by the signal diaphragm, moving the balance beam, in turn moving the pilot valve. The pilot valve supplies and/or exhausts air to the actuator which ultimately changes the position of the actuator. The change in actuator position is fed back to the positioning cam. The positioning cam moves, changing the tension of the range spring until a balanced condition exists once again.

The positioner is normally located in a control loop (Fig. 2-2) between the controller and the actuator.

Actuator position is fed back to the positioner for comparison with the position commanded by input control signal (current value or voltage pulse). For linear motion actuators, the feedback mechanism consists of:

- Drive rod which follows the motion of the actuator.
- Adjustable-length, swivel-ended connecting link which transmits the motion of the drive rod to an adjustable drive arm on the positioner.
- Camshaft and cam which are rotated through an angle by the arm.

A function of the cam is to permit characterization of actuator position versus input signal.

SECTION 3 - INSTALLATION

INTRODUCTION

Several applications are possible using a Type AV positioner. The steps for installing a Type AV positioner are as follows:

- Unpack and inspect the equipment.
- Mount the positioner.
- Connect tubing to the positioner.
- Connect wiring to the positioner.

CAUTION	**Certain installation methods will not stroke the actuator or cylinder to a fail-safe condition if the controller fails to send a signal. ABB strongly recommends that, for increased safety, an installation method be selected that will provide a fail-safe mode upon loss of controller signal.**

The outlined steps are covered in sequence in this section. After installation is complete, refer to Section 4 for calibration information.

NOTES:

1. For application in a hazardous location, refer to ABB document P-P88-001, ***Installing a Type AV Positioner in a Hazardous Location***.

2. Appendix B provides a quick start guide for the Type AV positioner. It is intended for control engineers having extensive experience in the use and application of pneumatic positioners. The quick start guide highlights the major points of installation and calibration. Detailed installation and calibration information is contained in Section 3 and Section 4.

UNPACKING AND INSPECTION

1. Check for obvious damage to the shipping carton.

2. Open carton and remove all loose packing.

3. Carefully remove positioner from carton and inspect for any physical damage which may have occurred during shipping.

4. Remove the 2 cover screws and positioner cover and examine the interior for any loose components such as nuts, screws, springs, etc. Check data on nameplate to be certain the positioner type which was ordered for the application was received.

5. If positioner is suitable for the application and appears undamaged, replace cover and proceed with installation instructions.

ENCLOSURE CLASSIFICATION

The Type AV3 and Type AV4 positioners conform to NEMA 3R when a ½-14 NPT street elbow (Fig. 3-1) is installed into the vent hole on the housing. The elbow prevents water or other liquid from entering the enclosure. The position of the elbow is related to the mounting plane of the positioner in its service location. The elbow must be positioned to face downward. The enclosure also meets corrosion resistance requirements for NEMA 4X classification (NEMA 250).

MOUNTING CONSIDERATIONS

Choose a location for the positioner based on the following factors:

1. ***Access to the internal positioner housing*** - the mounting location should provide enough room to remove the cover in order to perform calibration and repair and replacement procedures inside the positioner. Refer to Figure 3-1 for positioner dimensions.

2. ***Allow room for linkage to the actuator*** - the mounting position should be such that a practical linkage arrangement can be made between the positioner and the actuator for full range travel.

MOUNTING TYPE AV3 AND AV4 POSITIONERS

The Type AV positioner can be used with double-acting or single-acting actuators. Mounting and external dimensions are shown in Figure 3-1. Figure 3-2 shows a typical mounting arrangement using a mounting kit (part number 5327321__). Refer to Figure 9-2 for an exploded view and complete parts list of kit. If using the positioner with a rotary actuator, the positioner can be directly connected to the actuator, as shown in Figure 3-3.

> **NOTE:** If the actuator is equipped with a Type AV positioner as ordered, verify that all the connections are secure and make any adjustments as required.

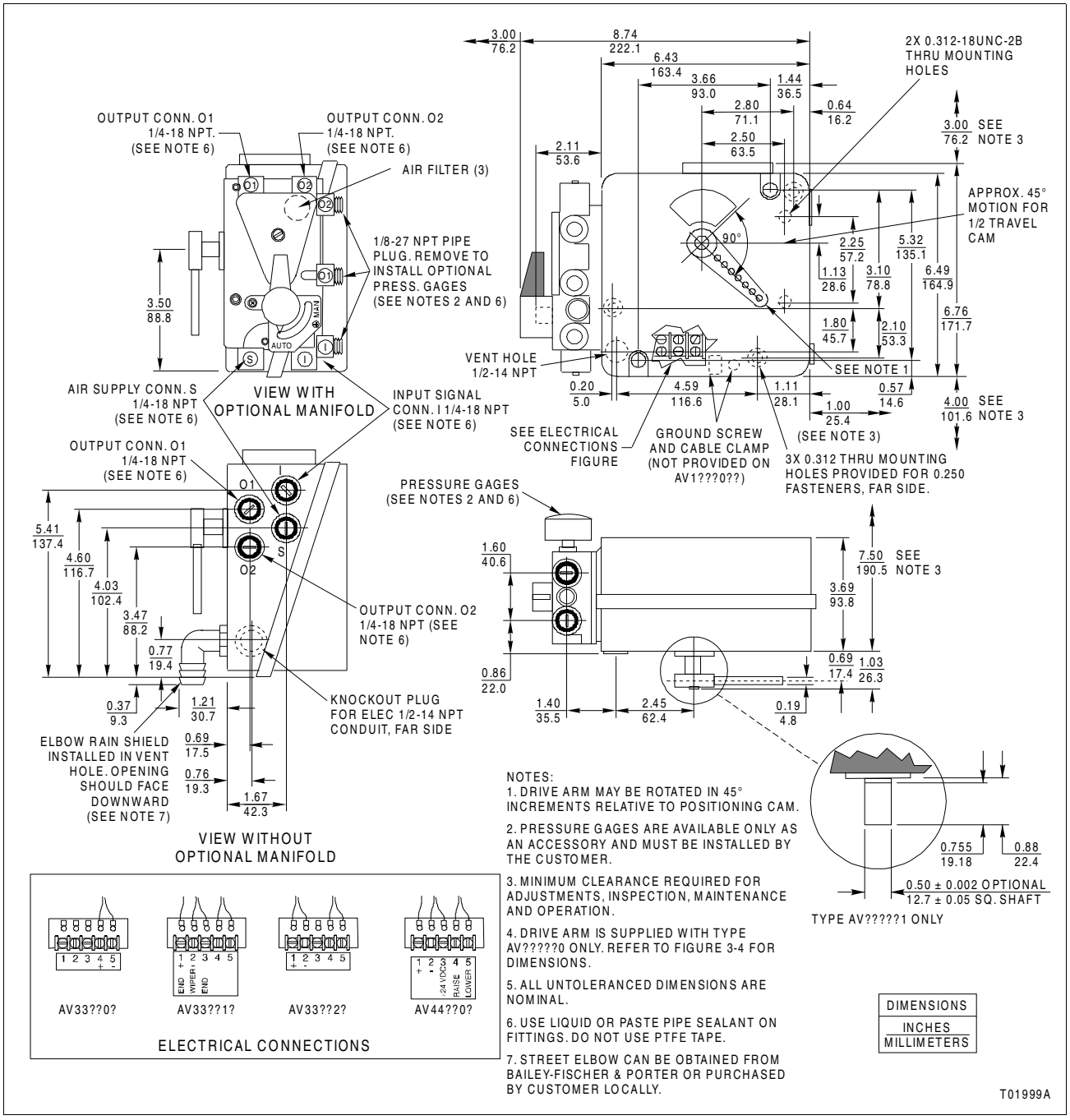


Figure 3-1. External and Mounting Dimensions for the Type AV Positioner

Due to the wide range of applications that the Type AV positioner is suited for, we can only provide general information about mounting. Use the following procedure to mount the positioner.

1. Set the actuator at the zero position. Connect the adjustable linkage to the drive arm. The drive arm holes correspond to stroke

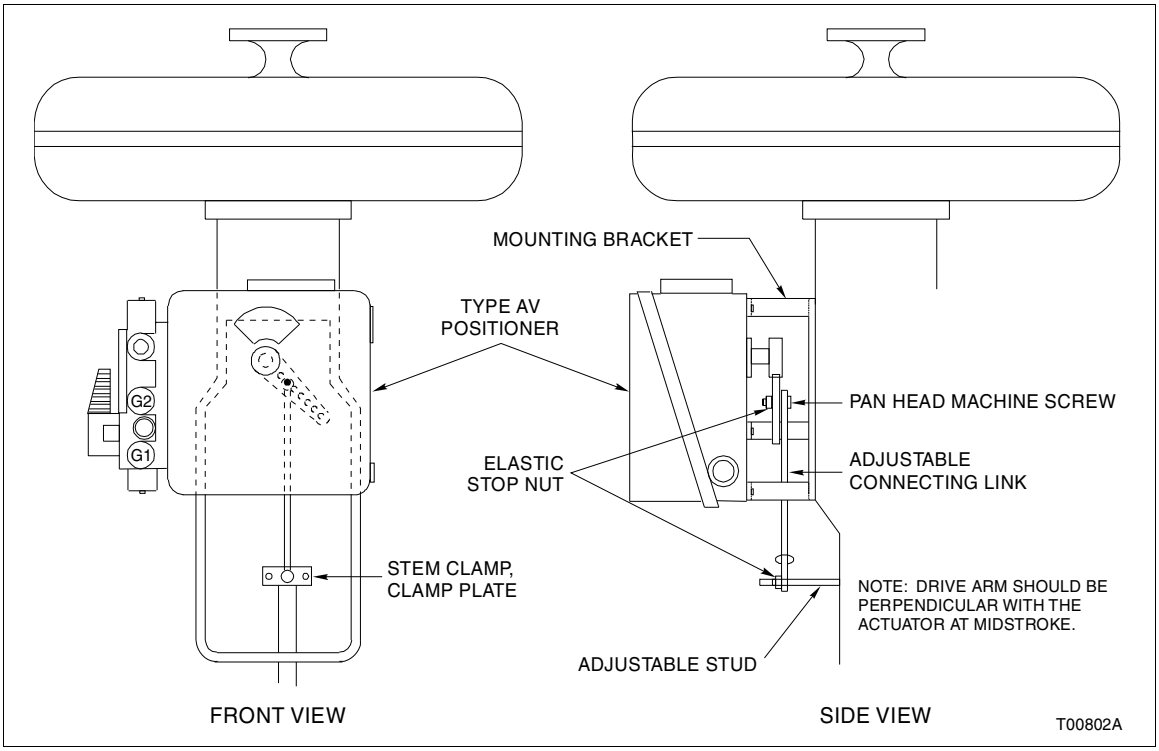


Figure 3-2. Typical Positioner Mounting Using Linkage

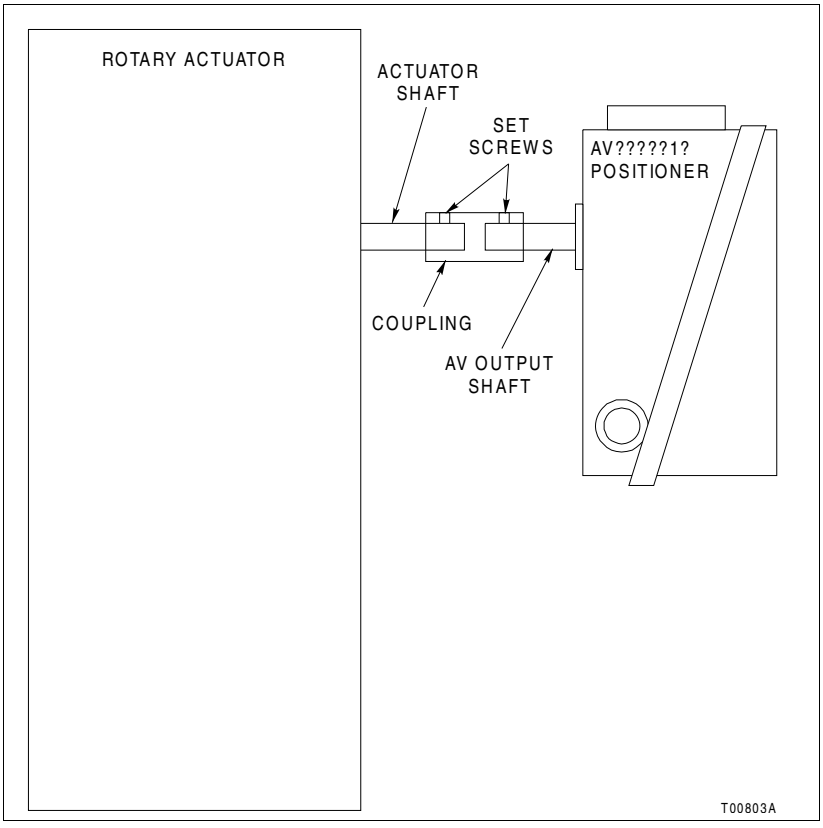


Figure 3-3. Typical Positioner Mounting Using Direct Coupling

WARNING	**Before mounting or installing positioner, check nameplate data to make certain positioner is suitable for application desired. DO NOT AT ANY TIME EXCEED THE RATINGS LISTED ON THE NAMEPLATE.**

length of the actuator. Refer to Figure 3-4 for the stroke length for each drive arm hole.

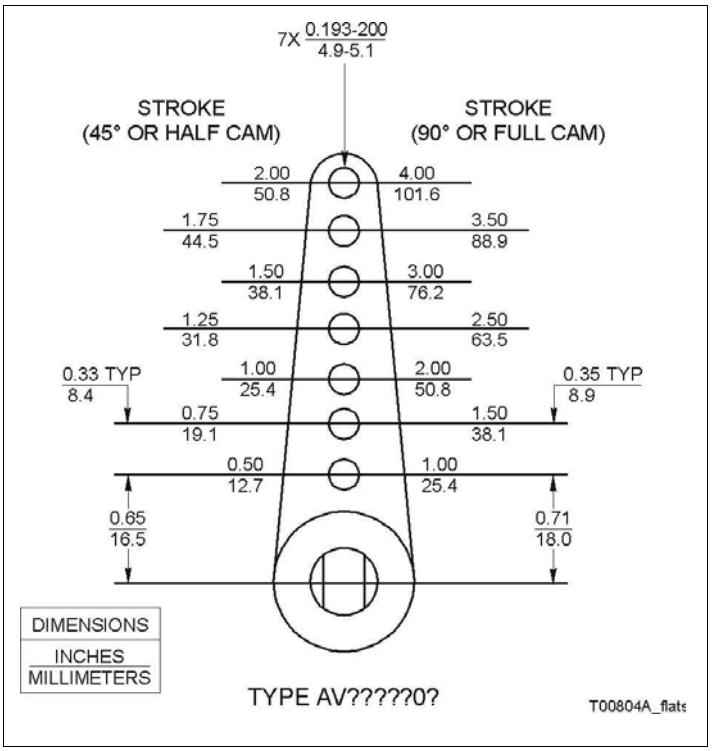


Figure 3-4. Drive Arm Connections

2. Install the cam (black, direct-acting; or red, reverse-acting) that will provide the required direction of rotation.

A forward-acting (black) positioning cam with segments A, B and C (Fig. 3-5) and a reverse-acting cam (stored on the inside of the positioner cover has ***red*** radial lines and arcs) are furnished with each positioner. Cam A is for a square root function, cam B is for linear motion and cam C is a square function (Table 3-1). The B cam is in place when the positioner is shipped from the factory. The cams may be shaped to conform to special applications. Refer to Appendix C for information about cam shaping.

NOTE: If application is reverse-acting, the reverse-acting cam (red radial lines) must be installed and ports 01 and 02 connections must be reversed.

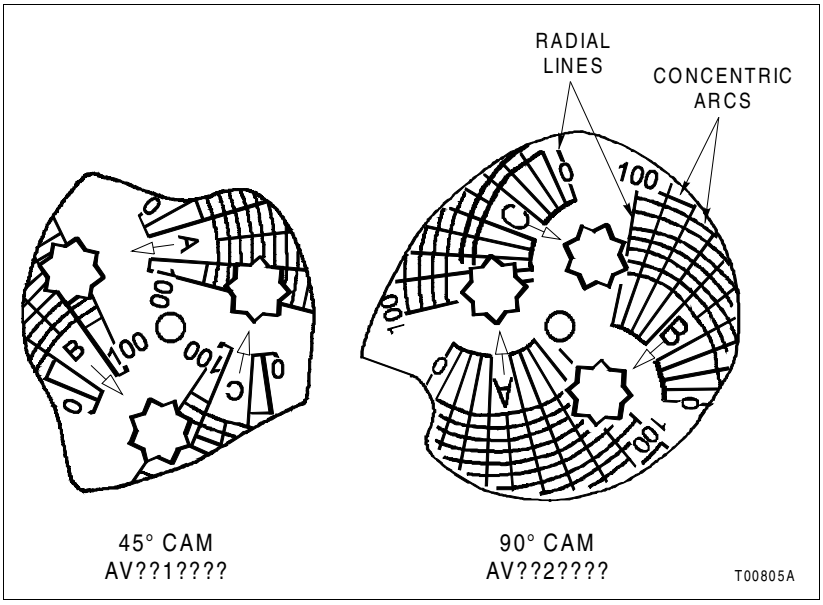


Figure 3-5. Positioning Cam

Table 3-1. Positioner Cam Characteristics

Positioning Cam Any Stroke	Piston or Valve Position (P) vs Control Signal (I)	Figure Number
A	Square Root ($I = \sqrt{P}$)	C-1
B	Linear ($I = P$)	C-2
C	Square ($I = P^2$)	C-3

The cam, camshaft and drive arm rotate as an assembly. Cam motion is 90 degrees (AV__2___) or 45 degrees (AV__1___) depending on positioner type specified by nomenclature.

Each cam shape (A, B or C) has its own eight-point center hole for mounting on the camshaft (Fig. 3-5). Place the drive arm in any of eight 45-degree positions with respect to the cam. This provides flexibility in arrangement so that the midpoint of the cam will correspond to the mid stroke of the actuator.

3. Adjust the connecting linkage so that the zero radial line on the cam intersects the center of the cam roller (Fig. 3-6).

4. Lock all linkage components in place.

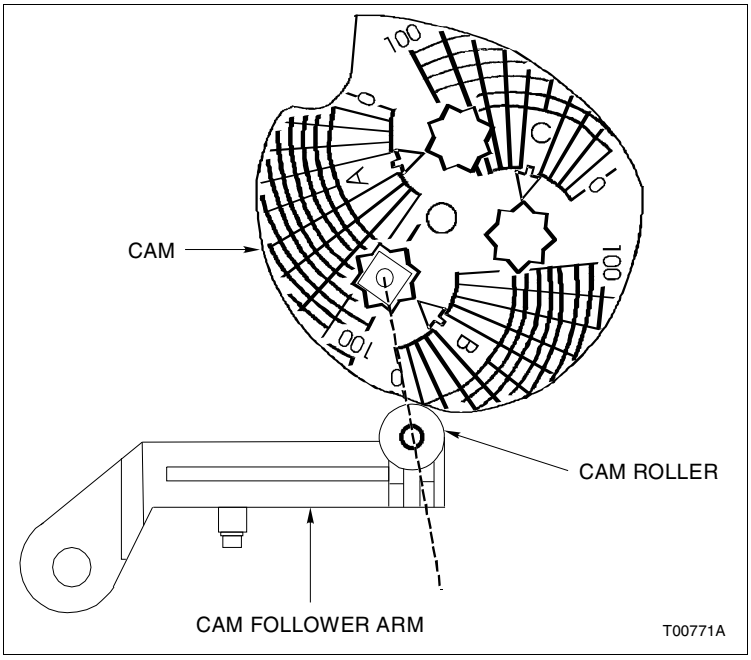


Figure 3-6. Cam Roller Alignment

CONNECTING TUBING TO TYPE AV POSITIONER

Type AV positioners are available with (Type AV___1__ and AV___2__) or without (AV___0__) manifolds. The following outlines supply air information and describes the piping connections.Supply Pressure

WARNING	**Type AV positioners are suitable for a maximum supply pressure of 1034 kilopascal (150 pounds per square inch gage). Do not exceed maximum recommended actuator operating pressure.**

Supply pressure range is 172 to 1,034 kilopascals (25 to 150 pounds per square inch gage).

NOTE: Minimum supply pressure should be 34.4 kilopascals (5 pounds per square inch gage) above operating pressure required by actuator.

Filtering Supply Air

An outside filter is recommended for Type AV positioners for primary filtration of the supply air. ABB provides supply air filters as accessories, refer to Table 1-12 for part numbers.

NOTE: Primary supply air filters are recommended for positioners with a manifold (AV____1__ and AV___2__) or without a manifold (AV___0__).

Positioners equipped with manifolds have three secondary filters as part of the unit. If the filters become clogged, they can be cleaned (by removing and reverse flushing with air or liquid) or replaced by kit number 258487_1. Refer to Section 8 for manifold filter replacement procedures.

Recommended Supply Air Quality

For long-term, trouble free operation, it is recommended that the supply air be of instrument quality and conform to the ANSI/ ISA-7.0.01-1996 standard that includes the following:

- The pressure dew point as measured at the dryer outlet shall be at least 10°C (18°F) below the minimum temperature to which any part of the instrument air system is exposed. The pressure dew point shall not exceed 4°C (39°F) at line pressure.
- The oil content should be as close to zero as possible and, under no circumstances, shall it exceed one (1) ppm w/w or v/v.
- Instrument air should be free of corrosive contaminants and hazardous gases, which could be drawn into the instrument air supply.

In addition, the particle size in the supply line should not be greater that 3.0 microns.

Tubing Connections

1. Connect the required supply air to connection S. Refer to Figure 3-7.

NOTES:
1. Maximum torque for ¼-inch NPT fittings is 13.6 Nm (10 ft-lbs).

2. Make sure port I is plugged (not used).

2. Connect the output ports 01 and 02 as required to provide the desired direction of rotation. Figure 3-8 shows single-acting tubing examples and Figure 3-9 shows a double-acting tubing example.

NOTE: The tubing arrangements shown in Figures 3-8 and 3-9 are general examples and may not reflect exactly the arrangement required for the application.

3. The ⅛-inch NPT permanent instrument gages can be installed into the gage ports for calibration requirements.

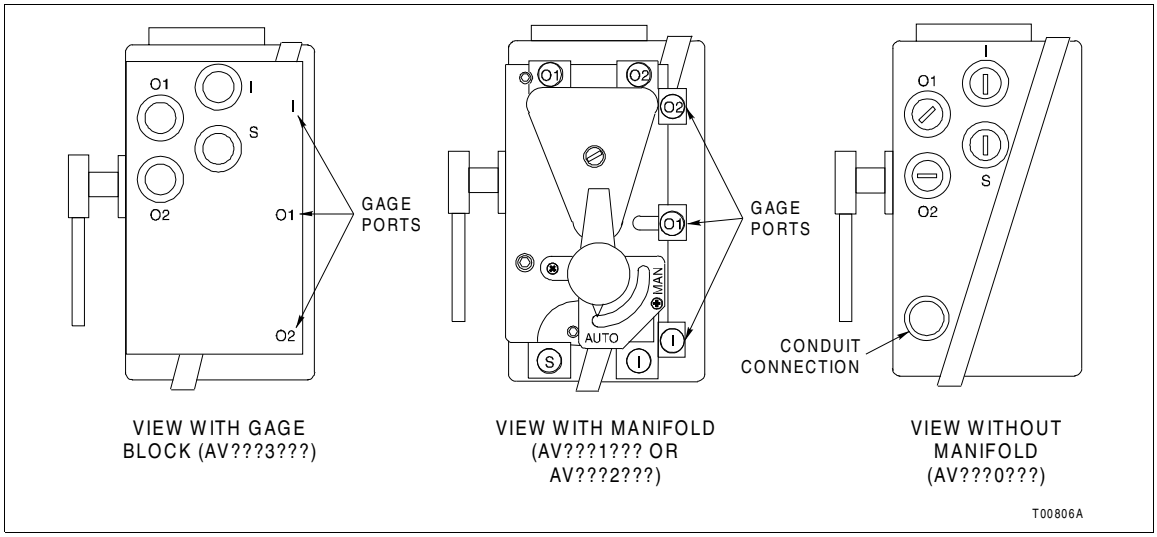


Figure 3-7. Type AV Positioner Port Locations

WIRING TYPE AV POSITIONER

1. Connect the signal wiring using ½-inch NPT conduit. Figure 3-7 shows the location of the conduit connection. See Figure 3-10 which shows the wiring diagram. This diagram is also shown on the inside of the front cover of the positioner.

   a. ***Type AV33 positioner*** - Connect the 4 to 20 mA position demand signal wires to terminals TB1-4 (+) and TB1-5 (-) of the terminal block (Fig. 3-10).

   If equipped with optional 4 to 20-milliamp position transmitter, terminals TB1-1 (+) and TB1-2 (-) provide customer access to the 4 to 20-milliamp feedback signal. If equipped with optional potentiometric position transmitter, three leads are available for customer use at terminals TB1-1, TB1-2 and TB1-3. Refer to Appendix A for detailed information about position transmitters.

   b. ***Type AV44 positione***r - Connect DDC pulse or contact closure (raise/lower) input signal wires to terminals TB1-4 and TB1-5. Connect the (+) 24 VDC to terminal TB1-3 and the position transmitter feedback connection to terminals TB1-1 (+) and TB1-2 (-) (Fig. 3-10).

   NOTE: Route the wiring inside the positioner so it does not become entangled with moving parts. A cable clamp (Fig. 3-1 or 4-1) is provided inside the positioner so entanglement can be avoided.

2. If using a twisted shielded pair for signal wiring, ground one end of the shielded pair at the source. Trim the other end of the pair, located inside the enclosure, so that bare wires are not exposed.

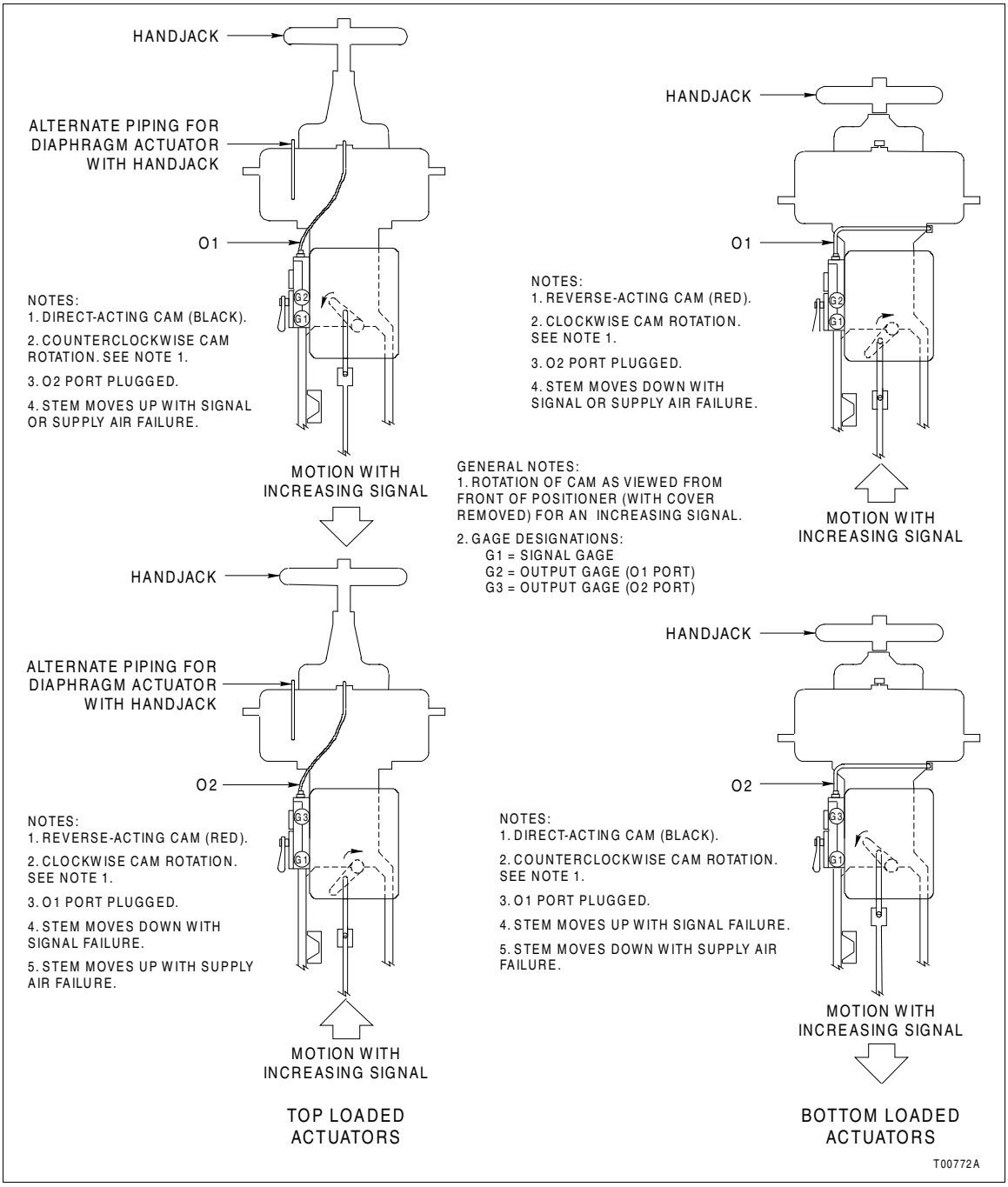


Figure 3-8. Tubing Examples of Single-Acting Actuators

3. Grounding positioners should be done in accordance with local electrical codes (in U.S, National Electrical Code, ANSI/ NFPA 70. In Canada, Canadian Electrical Code, CSA c22.1). A

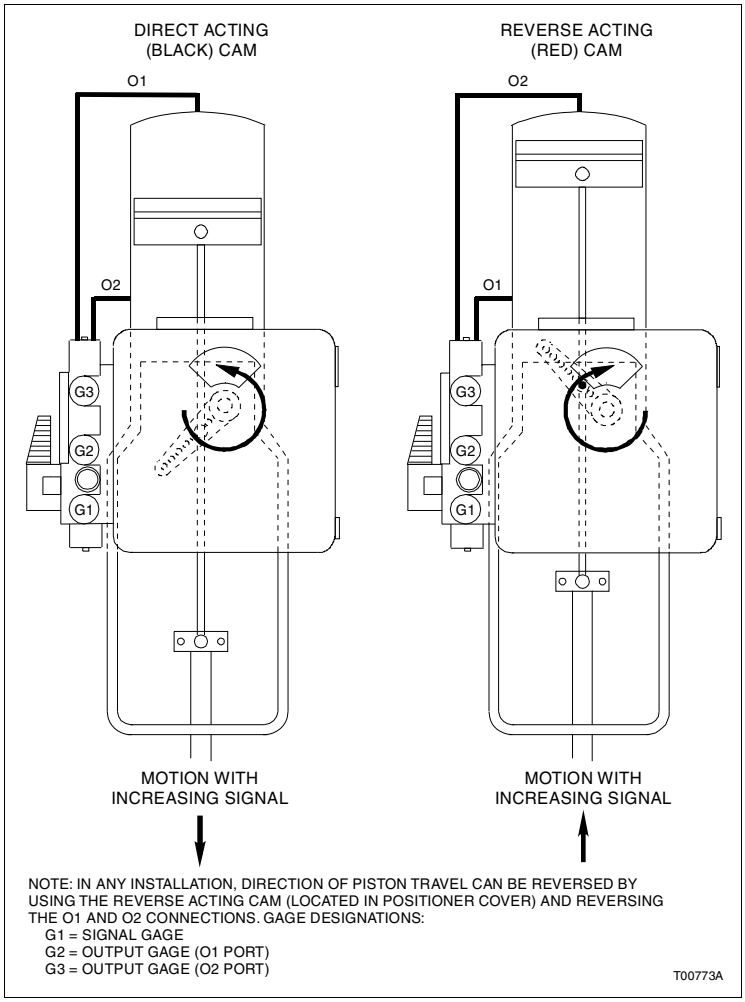


Figure 3-9. Tubing Example of a Double-Acting Actuator

	TB1 CONNECTIONS				
NOMENCLATURE	1	2	3	4	5
AV23?????				+	–
Av33?????				+	–
AV44?????	+	–	+24	RAISE	LOWER
AV????1??					
AV????2??	+	–			

T00807A

Figure 3-10. Type AV Positioner Wiring Connections

grounding screw is provided inside the AV enclosure for grounding, denoted by ⏚.

NOTE: The grounding screw located inside the AV enclosure is a safety ground and should not be used to ground the shielded pair.

SECTION 4 - CALIBRATION

INTRODUCTION

This section contains the following information:

- General calibration.
- Gain adjustment.
- Speed control.
- Troubleshooting calibration.

NOTES:

1. All procedures in this section assume direct-acting operation.

2. The troubleshooting calibration procedures in this section are not required for normal operation. The procedure is used only when operating difficulties occur. The corrective action column of Table 6-1 will prompt when to use the troubleshooting calibration.

3. Calibration can also involve cam shaping to achieve the required control characteristics. Refer to Appendix C for detailed information about the cam.

GENERAL CALIBRATION

A coarse calibration is performed during installation (Section 3), that normally consists of adjusting the linkage between the positioner and actuator so that the positioning cam rotates through its full range for full actuator travel. The general calibration procedure involves fine adjustments to the zero and span such that the input signal will cause the desired travel.

AV3 Calibration

Calibration consists of applying four milliamps to set the zero position, and applying 20 milliamps to set the span. These adjustments are made with the supply air applied to the positioner.

The Type AV3 positioner has position transmitter options that are available for feedback purposes. Refer to Appendix A for more information about the position transmitter options.

ZERO ADJUSTMENT (AV3)

Setting the zero requires the alignment of the zero percent radial line of the cam with the center of the cam roller. Use the following steps to adjust the zero.

1. Apply a 4 mA input signal to the positioner. The actuator should be in the closed position.

2. Loosen the zero adjustment set screw (Fig. 4-1) with a 3⁄32-inch Allen wrench.

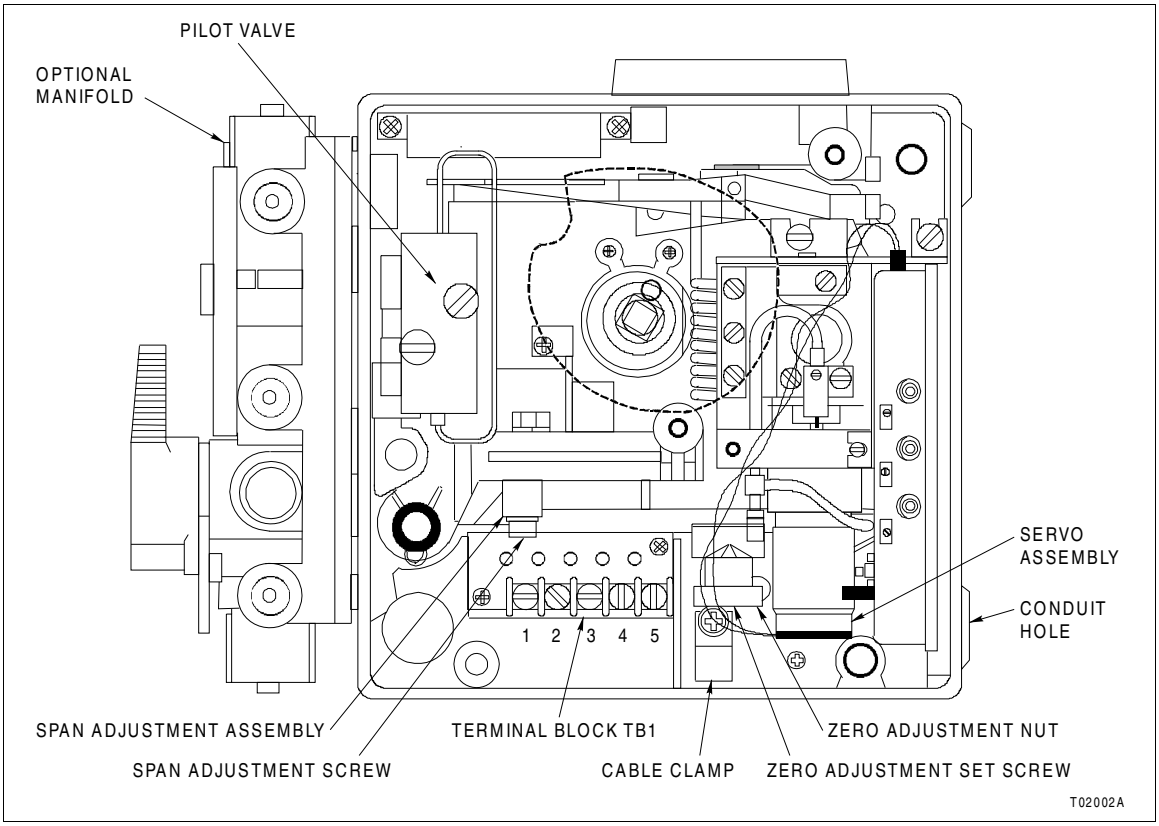


Figure 4-1. Type AV Calibration Adjustment Locations

3. Turn the zero adjustment nut (clockwise moves actuator down range) appropriately until the 0% radial line on the cam intersects with the center of the cam roller (Fig. 4-2).

> **NOTE:** This adjustment may be biased, i.e. turning the zero nut slightly counterclockwise to make sure a valve or damper is firmly seated at the minimum input signal.

4. Tighten the zero adjustment set screw.

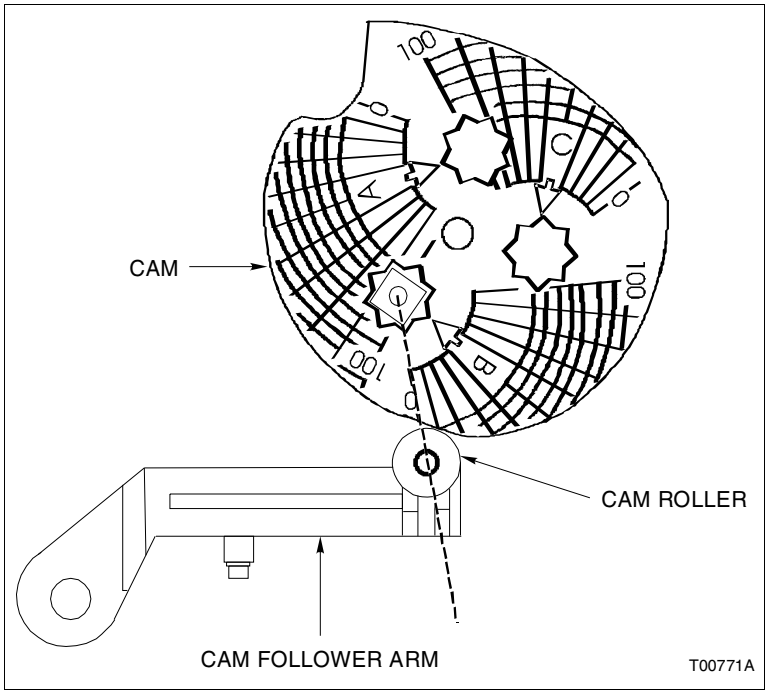


Figure 4-2. Cam Roller Alignment

SPAN ADJUSTMENT (AV3)

Setting the span normally requires the alignment of the 100 percent radial line of the cam with the center of the cam roller. Use the following steps to adjust the span.

1. Apply 20 mA to the positioner. The actuator should move to its full open position.

2. Loosen the span adjustment screw (Fig. 4-1) using a 5/32-inch Allen wrench.

3. Slide the span adjustment assembly (Fig. 4-1) in the appropriate direction until the actuator moves to align the 100% radial line with the center of the cam roller (toward pilot valve increases span of actuator).

4. Tighten the span adjustment screw.

AV4 Calibration

The Type AV4 positioner uses voltage pulses from a controller to produce a proportional internal signal of 20 to 103 kilopascals (three to 15 pounds per square inch). Pulses to either the ***raise*** or ***lower*** terminal moves the actuator and subsequently the positioner cam shaft. When the pulse is removed the positioner holds its position just prior to the end of the pulse. The positioner does

not move until another pulse is provided to either the ***raise*** or ***lower*** terminals.

Calibrating a Type AV4 positioner consists of the following adjustments:

- Zero.
- Span.
- Motor speed adjustment.

The Type AV4 positioner has a four to 20 milliamp position transmitter that provides feedback to the controller. The feedback signal is proportional to the position of the cam. Refer to Appendix A for more information about the position transmitters.

ZERO ADJUSTMENT (AV4)

Setting the zero requires the alignment of the zero percent radial line of the cam with the center of the cam roller. Use the following steps to adjust the zero.

1. Pulse the ***lower*** (TB1-5) terminal of the positioner in order to arrive at the minimum internal signal of 20.0, ±1.4 kPa (3.0, ±0.2 psi). The internal signal pressure may be measured at port I.

2. Loosen the zero adjustment set screw (Fig. 4-1) using 3⁄32-inch Allen wrench.

3. Turn the zero adjustment nut (clockwise moves actuator down range) appropriately until the actuator moves so that the 0% radial line on the cam intersects with the center of the cam roller (Fig. 4-2).

   NOTE: This adjustment may be biased, i.e. turning the zero nut slightly counterclockwise to make sure a valve or damper is firmly seated at the minimum input signal.

4. Tighten the zero adjustment set screw.

SPAN ADJUSTMENT (AV4)

Setting the span requires the alignment of the 100 percent radial line of the cam with the center of the cam roller. Use the following steps to adjust the span.

1. Pulse the ***raise*** (TB1-4) terminal until the actuator reaches the maximum position.

2. Loosen the span adjustment screw with a 5⁄32-inch Allen wrench.

3. Slide the span adjustment assembly in the appropriate direction in order to align the 100% radial line with the center of the cam roller (toward pilot valve increases span of actuator).

4. Tighten the span adjustment screw.

SERVO MOTOR SPEED ADJUSTMENT (AV4)

The speed of the pulse to pneumatic (P/P) converter can be adjusted with the coarse and fine speed adjustments located on the EMI/electronics housing enclosure (Fig. 4-3). Speed in this case is defined as the time it takes the P/P converter to make a full scale 20.4 to 103.0 kilopascals (three to 15 pounds per square inch gage) or 103.0 to 20.4 kilopascals (15 to three pounds per square inch gage) signal change.

Ideally, the speed of the converter should match the stroking speed of the actuator. A converter speed faster than the actuator can cause actuator overshoot. However, actuator stroking speed is typically not precisely known and is affected by temperature and load variations. Therefore, in applications that are not critical, the P/P converter should be set to a speed somewhat slower than the actuator speed.

Servo motor speed has coarse and fine adjustment provisions. Coarse adjustment is made using a four position switch. Fine adjustment is made using a 20-turn potentiometer. Table 4-1 lists the switch positions, factory set speed and speed range for each switch position.

Table 4-1. Servo Motor Speed Adjustment (Coarse and Fine)

Coarse Adjustment Switch Position	Factory Set Speed (seconds)	Fine Adjustment Speed Range (seconds)
4	26.0	21.0 to 42.0
3	13.5	12.0 to 22.0
2	8.0	7.0 to 13.0
1	5.0	4.5 to 8.0

In applications where stroke speed is critical use the following procedure to match actuator stroke speed with the servo motor speed.

1. Set the COARSE adjustment to 1 (Fig. 4-3).

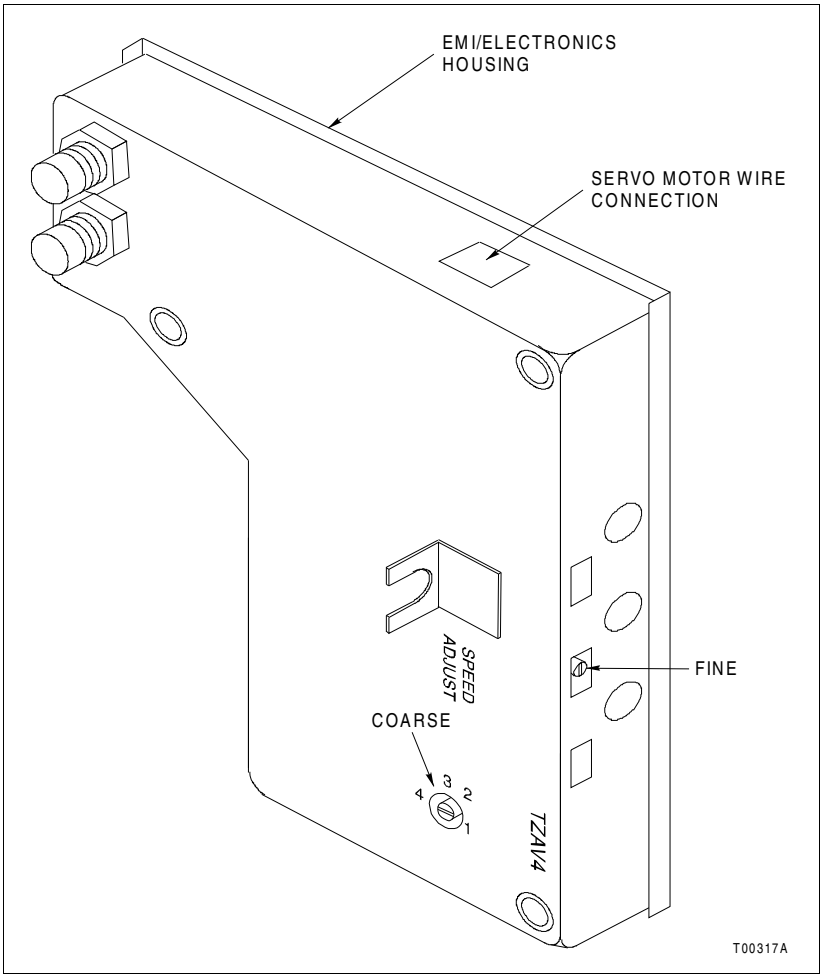


Figure 4-3. Type AV4 Positioner Motor Speed Adjustments

2. Set the FINE adjustment to the fastest speed (fully clockwise) (Fig. 4-3).

> **NOTE:** The fine adjustment potentiometer does not have an end stop. At the end of travel a clutch within the potentiometer slips to indicate that you have reached the end.

3. Apply pulse inputs until the actuator reaches 0%.

4. Using a stopwatch measure the time it takes the actuator to reach 100% by applying a constant increase signal.

5. Having obtained an actuator speed value in Step 4, use Table 4-1 to determine the coarse speed adjustment setting which encompasses the actuator speed.

6. Turn the FINE adjustment potentiometer counterclockwise (Fig. 4-3) by an estimated number of turns to achieve a motor speed that equals the speed of the actuator measured in Step 4.

7. Check the speed adjustment by repeating Steps 3 and 4. Adjust using Step 6 if necessary.

CALIBRATION FOR PARTICULAR APPLICATION (AV3 ONLY)

The following positioner adjustments may be used to tailor the operation of the actuator to meet application requirements.

Zero Adjustment

The positioner zero adjustment can be used to set initial tension on the range spring so that the actuator will not begin to move from its minimum position until it receives an input signal between four milliamps and 12 milliamps (Fig. 4-4). This application of suppression is useful when two or more actuators are to be operated in sequence; where the actuator is equipped with a minimum stop; or where the characteristics of the device that the actuator is moving must be matched with the characteristics of another regulated device.

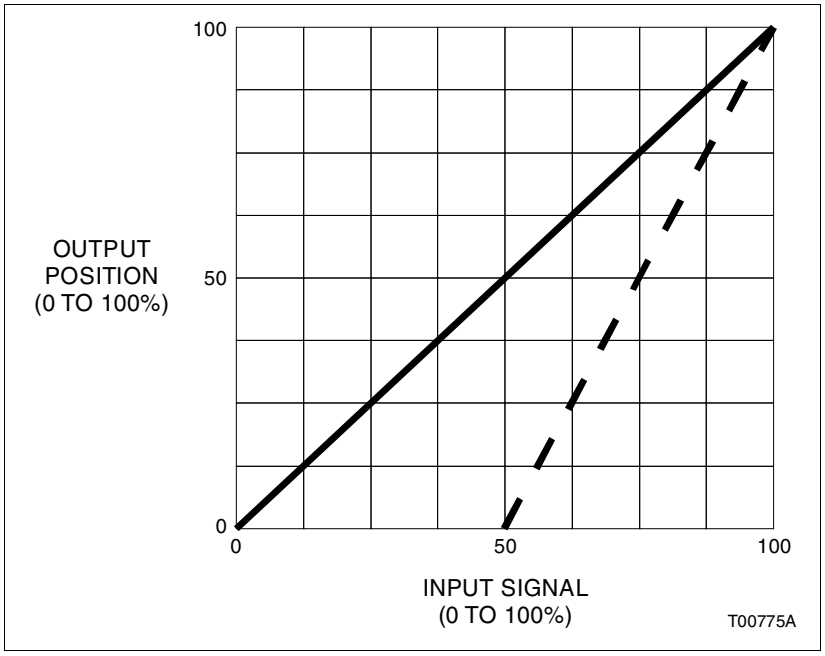


Figure 4-4. Zero Adjustment Graph

Span Adjustment

The span adjustment affords a variation of actuator motion for a given span of input signal. For example, the span may be adjusted to allow full actuator travel to occur with a signal change as small as 50 percent of its full span (Fig. 4-5). At the other extreme, the span adjustment can be set to produce as little as 50 percent of the travel capability of the actuator over the full input signal pressure span.

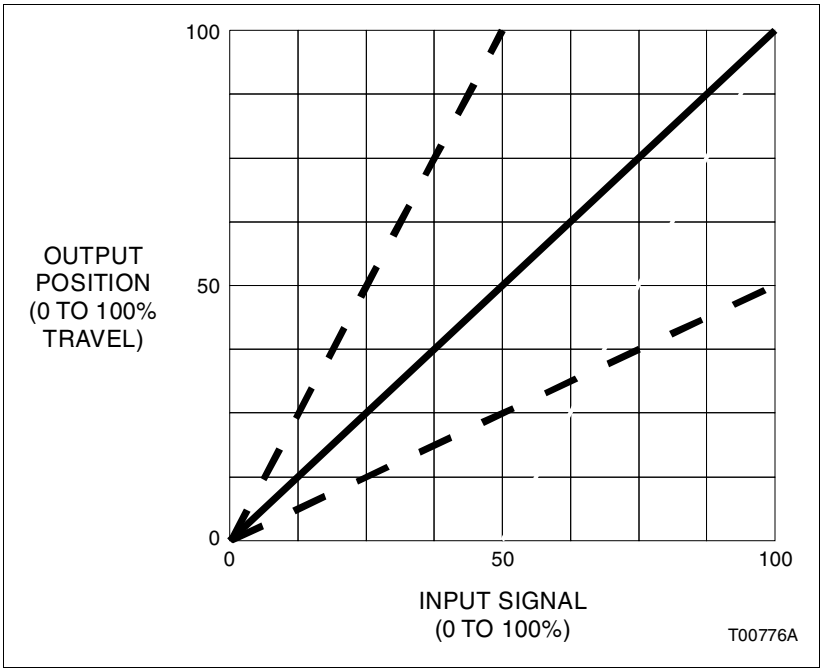


Figure 4-5. Span Adjustment Graph

This flexibility in span adjustment is useful when the device being regulated is oversized, since the adjustment allows operation of the actuator or cylinder through its useful motion for desired full change in control signal pressure. It also is useful in matching the signal versus position characteristics of the actuator or cylinder with the characteristics of related power devices in the same control system.

GAIN AND SPEED ADJUSTMENTS

Gain and speed adjustment information applies to both the Type AV3 and Type AV4 positioners. This is the gain of the overall positioner. The factory installed gain hinge spring (0.010 inch) suits most applications. This adjustment is not a mandatory part of calibration.

Gain Adjustment

Gain adjustment on the Type AV positioners is accomplished by changing the gain hinge spring (item 7, Figures 9-3 through 9-6) connecting the beam assembly to the positioner housing. Provided with each positioner are two different gain hinge springs. If actuator oscillation occurs, the overall positioner gain may be too high. Positioner gain is related to the thickness of the gain hinge spring. Gain decreases as the thickness of the gain hinge spring increases. Refer to Table 4-2 for hinge information.

For information on changing the gain hinge spring, refer to ***GAIN HINGE SPRING*** in Section 8.

Table 4-2. Gain Hinge Spring Characteristics

Part Number	Thickness		Gain
	mm	in.	
5400264_1[2]	0.25	0.010	High
5400264_2	0.76	0.030	Medium

NOTES:
1. To distinguish hinge type, the thickness is printed on the hinge (i.e., 0.010, or 0.030).
2. Comes installed from the factory.

Speed Adjustment

Normally speed adjustment is not required when calibrating a positioner. Type AV positioners come from the factory adjusted for maximum operating speed. However the speed of operation can be reduced in two ways. Speed control orifices can be used to slow positioner operation or a speed adjustment can be made internal to the positioner to change operating speed.

When the system involves only a single actuator, a high positioning speed is usually an advantage. However, in a complex control system, it is generally desirable to operate all power devices at the same speed in order to avoid interaction between units and consequently undesirable process conditions.

ORIFICE SPEED CONTROL

If it is necessary to reduce the speed of operation, 1.02-millimeter (0.040-inch) speed control orifices (part number 5327327_1) are available as an option from ABB. These orifices are installed directly into the output ports (01 and 02) of the positioner and have ¼-NPT ports for connecting tubing from the actuator. If these orifices are too small (causing the actuator to respond too slowly) they may be drilled out to obtain desired speed control. Blank orifices (part number 5327327_2) are also available.

SPEED CONTROL BY PILOT VALVE STROKE ADJUSTMENT

If it is necessary to reduce the speed of operation, a pilot valve stroke adjustment can reduce the speed and does not require additional hardware. This adjustment limits the pilot valve stroke.

The pilot valve stroke is measured by the movement (displacement) of the pilot valve stem. Figure 4-6 shows the maximum stroke length which is also the maximum speed of operation and

is how the positioner comes from the factory. Use the following procedure to reduce the speed of operation.

CAUTION	**Never adjust the pilot valve for a stroke greater than the 0.030 in either direction. A greater stroke will reduce the positioner's performance.**

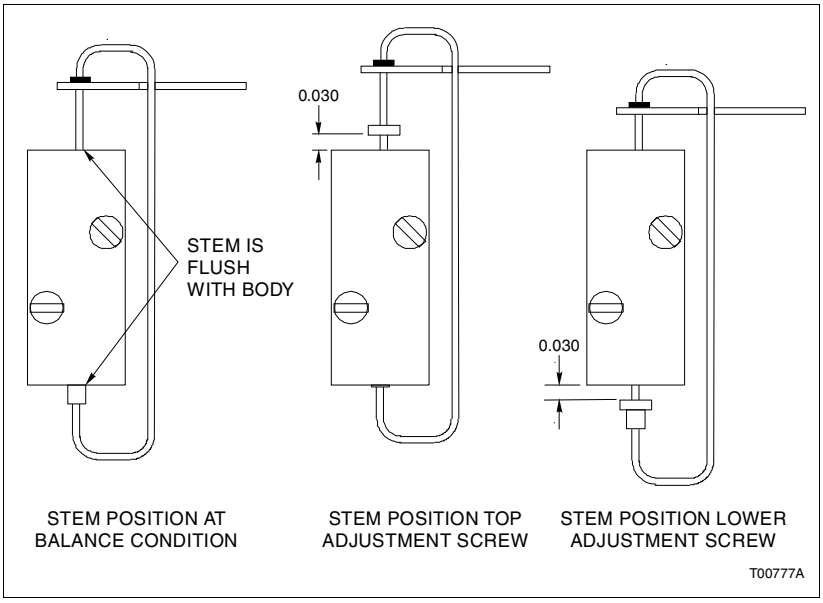


Figure 4-6. Pilot Valve Measurement for Maximum Speed

1. To reduce the stroke speed, use a 3⁄32-inch Allen wrench. Turn the top adjustment screw clockwise ⅛ of a turn to reduce stroke time (Fig. 4-7). ABB suggests ⅛-turn increments. Take note of the number of turns. In total, do not exceed one full turn (clockwise) from the factory setting (Fig. 4-6). This adjustment controls the amount of air going to port 01.

2. Use a 3⁄32-inch Allen wrench (the wrench must be at least 5-inches long). Turn the lower adjustment screw clockwise the same amount as the top to insure speed of operation is the same in both directions. Be careful when accessing the lower adjustment screw. Insert the Allen wrench up through the bottom of the range spring (Fig. 4-7). This adjustment controls the amount of air going to port 02.

> **NOTE:** A single-acting application only requires one pilot valve screw adjustment depending on the port connection. The top adjustment screw affects the 01 port. The bottom adjustment screw affects the 02 port.

3. Test for satisfactory stroke time and adjust as required.

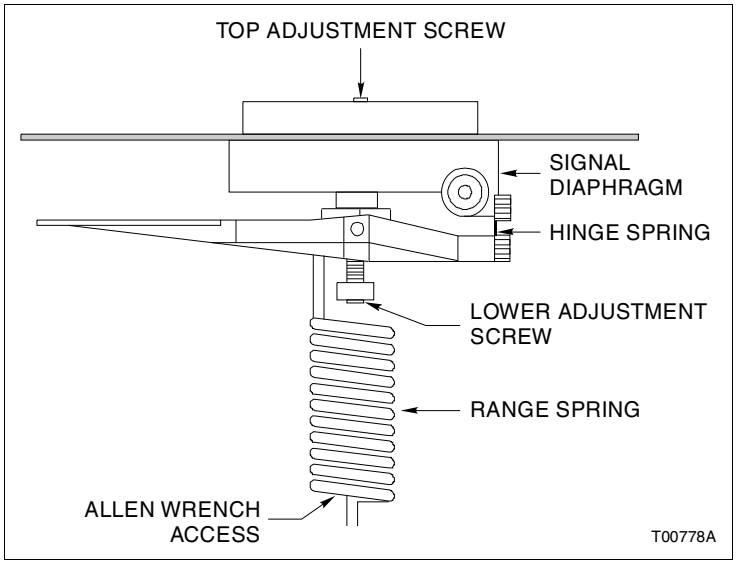


Figure 4-7. Speed Adjustment Screw Locations

TROUBLESHOOTING CALIBRATION ADJUSTMENTS

The servo assemblies of the Type AV3/4 positioners come from the factory completely calibrated. ***Use the following procedures only when operating difficulties occur***. The corrective action column of Table 6-1 will prompt you to use the troubleshooting calibration.

Servo Assembly Adjustments (Type AV3 Positioner)

The purpose of this procedure is to adjust the servo so that the four to 20-milliamp input signal will produce a 20.7 to 103-kilopascals (three to 15 pounds per square inch gage) signal. Use the following procedure to adjust the servo assembly.

Instruments Required:

Digital voltmeter
0 to 30 psig instrument gage
Small screwdriver
Current source

WARNING	**Type AV positioners are suitable for a maximum supply pressure of 1034 kPa (150 psig). Do not exceed maximum recommended final control element operating pressure.**

1. If the positioner is mounted on an actuator and it is not desirable to have the actuator move during calibration, remove the air lines from 01 and 02 ports. Plug the ports. If bench calibrating, plug 01 and 02 ports to prevent excess air flow during calibration (Fig. 3-7).

2. Connect a customer supplied 0 to 207 kPa (0 to 30 psig) instrument gage to the I port. The gage allows you to monitor the pneumatic signal output.

3. Make supply air connections (172 to 1,034 kPa (25 to 150 psig)) to the S port. The minimum supply pressure should be 34 kPa (5 psig) above the operating requirements of the actuator.

4. Turn on the supply air to the positioner.

5. Check the zero and span of the servo assembly as follows:

   a. Connect a current source to terminals TB1-4 (+) and TB1-5 (-) on the terminal block (Fig. 3-1).

   b. Apply 4 mA and observe the pressure at the I port. The pressure value should be 20.7, ±1.7 kPa (3.00, ±0.25 psig). If the pressure equals this value, go to Step 5c. If the pressure does not equal this value, go to Step 6.

   c. Apply 20 mA and observe the pressure at the I port. The pressure value should be 103.0, ±1.7 kPa (15.00, ±0.25 psig). If the pressure equals this value, proceed to Step 7. If the pressure does not equal this value, proceed to Step 6.

6. Adjust the zero and span of the servo as follows:

   a. a. Disconnect the servo motor wires from the EMI/electronics housing (Fig. 4-8).

   b. Set the input current to 4 mA and record the setpoint voltage across P2 and P3 (Fig. 4-8).

   c. Set the input current to 20 mA and record the setpoint voltage across P2 and P3.

   d. Apply a reference pressure to the transducer of the EMI/electronics housing (Fig. 4-8). Do not exceed 138 kPa (20 psig). Adjust the reference pressure to 20.3, ±1.7 kPa (3.00, ±0.25 psig). Connect the digital voltmeter across P1 and P3 (feedback voltage) and turn the ZERO potentiometer (Fig. 4-8) until you match within 8 mV of the setpoint voltage recorded across P2 and P3 in Step 6b.

   e. Adjust the reference pressure to 103, ±1.7 kPa (15, ±0.25 psig). Connect the digital voltmeter across P1 and P3 and turn the SPAN potentiometer until you match within 8 mV of the setpoint voltage value recorded across P2 and P3 in Step 6c.

   f. Repeat Steps d and e until the comparisons are stable.

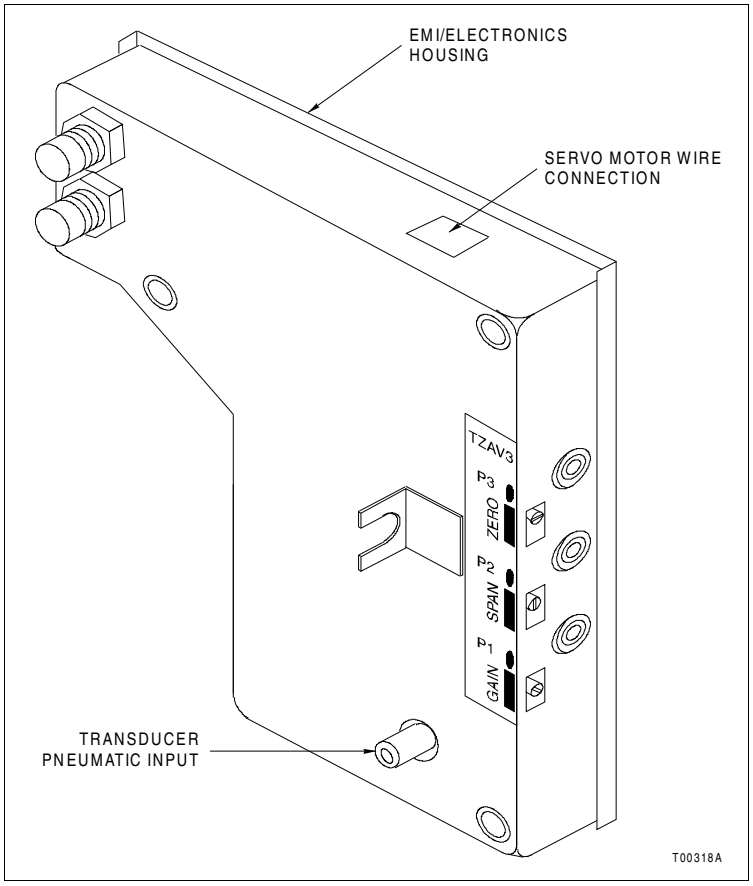


Figure 4-8. Type AV3 Positioner EMI/Electronics Housing

7. Adjust the servo gain as follows:

   a. Apply 20 mA and observe the pressure at port I. Increase the gain by adjusting the GAIN potentiometer (clockwise), until oscillation occurs (Fig. 4-8).

   b. Decrease the gain by adjusting the GAIN potentiometer (counterclockwise) until oscillation stops (Fig. 4-8). Then decrease gain another half turn.

   NOTE: If, during operation any oscillation or overshoot of the servo assembly occurs, the gain may be decreased further.

   c. After adjusting the gain, Return to Step 5.

   NOTE: This gain adjustment applies only to the servo assembly. It is not used to adjust the gain of the overall positioner. Refer to ***Gain Adjustment*** for information detailing overall positioner gain.

Servo Adjustments (Type AV4 Positioner)

The Type AV4 positioner servo comes from the factory completely calibrated. The adjustments shown in the following procedures should only be performed when required. Section 6 outlines the criterion for the adjustments.

The purpose of this procedure is to adjust the servo so that it produces a 20.7 to 103 kilopascals (three to 15 pounds per square inch gage) pneumatic signal when pulsing the input. Use the following procedure to perform the check.

1. If electrical connections have not been made, refer to ***WIRING TYPE AV POSITIONER*** in Section 3.

WARNING	**Type AV positioners are suitable for a maximum supply pressure of 1034 kPa (150 psig). Do not exceed maximum recommended final control element operating pressure.**

1. Connect supply air (172 to 1034 kPa (25 to 150 psig)) to the S port on the manifold (if equipped) or positioner. The minimum supply pressure must be 34.4 kPa (5.0 psig) above the operating requirements of the actuator.

2. Apply the supply air to the positioner.

3. Connect a calibrated pressure gage (or some other accurate pressure measuring device) to the I port. This allows you to monitor the signal pressure during calibration.

4. Adjust the internal pressure to the minimum value (13.8 to 17.0 kPa (2.0 to 2.5 psig)). Do so by closing the ***lower*** contact until the pressure stops decreasing.

   a. If 13.8 to 17.0 kPa (2.0 to 2.5 psig) pressure is obtained, proceed to Step 6.

   b. If the desired pressure is not obtained, proceed to Step 5.

5. Loosen and back off the minimum locknut. With the ***lower*** contact closed, rotate the minimum stop screw (clockwise to increase) until a pressure of 13.8 to 17.0 kPa (2.0 to 2.5 psig) is obtained. Verify that the hub screw is still in contact with the tip of the minimum stop screw (Fig. 4-9). Tighten the minimum locknut and check the pressure.

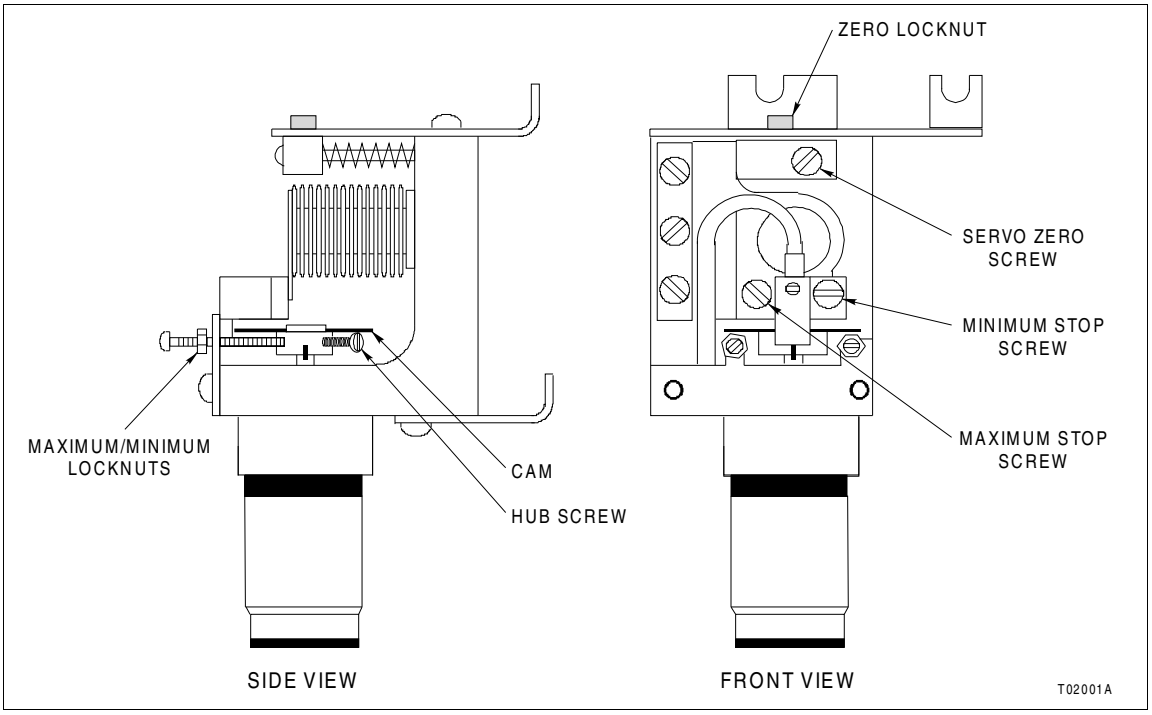


Figure 4-9. Servo Adjustments (AV4)

6. Adjust the internal signal pressure to the maximum value 107 to 110 kPa (15.5 to 16.0 psig). Do so by closing the ***raise*** contact until the pressure stops increasing.

a. If 107 to 110 kPa (15.5 to 16.0 psig) pressure is obtained, calibration is complete.

b. If 107 to 110 kPa (15.5 to 16.0 psig) pressure is not obtained, proceed to Step 7.

7. Loosen and back off the maximum stop screw locknut. With the ***raise*** contact closed, rotate the maximum stop screw (clockwise to decrease) until the pressure is between 107 to 110 kPa (15.5 and 16.0 psig). Verify that the hub screw is in contact with the tip of the maximum stop screw (Fig. 4-9). Tighten the maximum locknut and check the pressure.

8. If unable to obtain the correct pressures in Steps 5 or 7, close the contact for the problem direction, loosen the zero locknut screw. With the appropriate stop screw positioned at mid-stroke, rotate the servo zero screw (Fig. 4-9) to give the desired pressure. Tighten the zero lockscrew. Repeat Steps 4 through 7.

SECTION 5 - OPERATING PROCEDURES

INTRODUCTION

This section details the equalizing valve of the optional manifold.

NOTE: The following procedure applies when the positioner is equipped with a manifold assembly.

EQUALIZING AND AIR SUPPLY SHUTOFF VALVE

The equalizing valve supplied with the manifold assembly, allows the actuator to be manually or automatically operated. By turning the valve handle to MAN, supply pressure to the positioner is cut off and 01 and 02 are tied together, allowing manual repositioning of the actuator.

NOTE: It is important to understand that the equalizing valve is not a bypass vale. Be aware that if the actuator is not secured before transferring the valve handle of the manifold, the actuator will move.

WARNING	**Moving the equalizing valve to MAN or to AUTO will cause the actuator to move if it is not locked. If unaware of the movement, personal injury can occur.**

Transfer from Automatic to Manual Operation

1. Manually lock the actuator or final control element.

2. If equipped with a manifold and equalizing valve, push in the valve handle and turn it to the MAN position.

3. If not equipped with a manifold and equalizing valve, turn off the supply air.

NOTE: If there are not means of locking the actuator or final control element, it will move in the direction of the process or mechanical load when the supply air is turned off.

Transfer from Manual to Automatic Operation

1. Valve handle should be in the MAN position.

2. If manual operator does not lock the actuator is position:

   a. The actuator must be positioned from prior knowledge of the position versus signal or the actuator may ***jump*** when transferred to automatic.

   b. Push the valve handle in and turn to AUTO position.

3. If the manual operator locks the actuator is position:

   a. Depress valve handle and turn to AUTO position. Actuator will oppose manual operator if drive position and input signal do not correspond.

   b. Manually operate the actuator until the load on manual operator decreases. If output pressure gages are installed on the position, gage reading should equalize.

   NOTE: If in Step 3 it is desired that the drive stay in its initial position, the input signal must be adjusted to correspond with drive position as indicated by the load on manual operator, output pressure gages, or prior knowledge of position versus input signal.

SECTION 6 - TROUBLESHOOTING

INTRODUCTION

This section provides the operator with information about the Type AV positioner when operating difficulties are encountered. A table listing errors, probable causes, and corrective actions allows the operator to troubleshoot a problem pertaining to the positioner.

WARNING

Make certain the positioner is disconnected from the supply pressure source and the signal source or is removed from service before attempting any repair or replacement procedures. Failure to do so could cause unexpected movement of the actuator and bodily injury could result.

If a problem occurs and is traced to the positioner, check supply pressure, input and output connections, and mechanical adjustments before removing from service.

Table 6-1. Positioner Errors

Error	Probable Cause	Corrective Action
Oscillation of actuator	Gain too high.	Change gain hinge spring to greater thickness. Refer to ***GAIN HINGE SPRING*** in Section 8.
	Drive arm not securely attached to actuator.	Tighten or correct linkage as necessary.
	Servo assembly unstable - gain too high.	Adjust servo gain. Refer to ***TROUBLESHOOTING CALIBRATION ADJUSTMENTS*** in Section 4.
	Pneumatic signal leak.	Check for leaks in connectors or fittings.
	Pilot valve stuck.	Remove pilot valve and clean or replace. Refer to ***PILOT VALVE BODY*** in Section 8.
Actuator at one end of stroke and does not respond to input change	Air lines in wrong ports.	Check air line connections. Refer to Figures 3-8 and 3-9.
	Incorrect cam installed for application.	Determine application (reverse or direct-acting) and check for correct cam. Refer to Figures 3-8 and 3-9.

Table 6-1. Positioner Errors (continued)

Error	Probable Cause	Corrective Action
Actuator at one end of stroke and does not respond to input change *(continued)*	Pneumatic signal leak.	Check signal at I port. If pressure is between 20 to 103 kPa (3 to 15 psig) and does respond to input signal change then problem exists elsewhere. If pressure not between 20 to 103 kPa (3 to 15 psig) or does not respond to input change, then check for leaks inside positioner and check servo calibration (refer to ***TROUBLESHOOTING CALIBRATION ADJUSTMENTS*** in Section 4).
	Mechanical calibration shift (zero or span shift).	Recalibrate the mechanical zero and span. Refer to ***GENERAL CALIBRATION*** in Section 4.
	Servo not functioning.	Check servo calibration. Refer to ***TROUBLESHOOTING CALIBRATION ADJUSTMENTS*** in Section 4.
Excessive air consumption (exhaust loud)	Leakage at the joint of the manifold assembly (if equipped).	Remove manifold and check the O-rings. Refer to ***MANIFOLD*** in Section 8.
	Pilot valve leaking.	Remove pilot valve body and check O-rings. Refer to ***PILOT VALVE BODY*** in Section 8.
	Tubing disconnected.	Check connection at pressure regulator and servo.
Slow response	Pilot valve blocked.	Remove and clean. Refer to ***PILOT VALVE BODY*** in Section 8.
Full range cannot be obtained with mechanical zero and span adjustment	Signal diaphragm leaking.	Replace diaphragm. Refer to ***DIAPHRAGM ASSEMBLY*** in Section 8.
	Servo out of calibration or not functioning.	Calibrate servo. Refer to ***TROUBLESHOOTING CALIBRATION ADJUSTMENTS*** in Section 4.
Unable to match setpoint and feedback voltages in troubleshooting calibration adjustments in Section 4	Motor control circuit board is faulty.	Replace the motor control circuit board, refer to ***SERVO ASSEMBLY AND ELECTRONICS CIRCUIT BOARD*** in Section 8.
Servo output pressure not 20 to 103 kPa (3 to 15 psig) after troubleshooting calibration adjustments	Servo is defective.	Replace servo. Refer to ***SERVO ASSEMBLY AND ELECTRONICS CIRCUIT BOARD*** in Section 8.

SECTION 7 - MAINTENANCE

INTRODUCTION

Procedures for maintenance are covered in this section. By following these procedures and time frames, reliable and troublefree operation is greatly increased.

ROUTINE SERVICE

WARNING

Permit only qualified personnel to maintain the system. Maintenance personnel must secure the system prior to starting maintenance procedures. Altering or removing components may affect safe operation of the device.

Use solvents only in well-ventilated areas. Avoid prolonged or repeated breathing of vapors. Avoid prolonged or repeated contact with skin. Solvents can cause nausea, dizziness and skin irritation. In some cases, overexposure to solvents has caused nerve and brain damage. Solvents are flammable-do not use near extreme heat or open flame.

1. Annually, check all air connections for leakage while the positioner is under pressure. Use a soapsuds solution to check for leaks.

2. Annually, check the signal diaphragm for leaks using a soapsuds solution.

3. Maintain a clean air supply (free of dirt, oil, or moisture) to ensure satisfactory operation of positioner. If recommended filter is installed in supply line (refer to ***Filtering Supply Air*** in Section 3), annually clean or replace the filter.

4. Annually clean pilot valve and stem with a low residue solvent. Refer to ***PILOT VALVE BODY*** in Section 8.

5. If Type AV positioner is equipped with a manifold assembly (AV___1/2__). Annually replace filters (refer to ***MANIFOLD*** in Section 8).

6. Annually check adjustments and calibration of positioner and actuator. Refer to ***GENERAL CALIBRATION*** in Section 4.

7. Annually, verify that the coupling between the positioner and the actuator is tight.

SECTION 8 - REPAIR/REPLACEMENT PROCEDURES

INTRODUCTION

This section provides the operator with procedures which detail removal and replacement of positioner components.

WARNING	**Make certain the positioner is disconnected from the supply pressure source and the signal source or is removed from service before attempting any repair or replacement procedures. Failure to do so could cause unexpected movement of the actuator and bodily injury could result.**

MANIFOLD FILTERS

Tools Required Screw driver

1. Transfer the positioner from automatic to manual operation (refer to Section 5).

WARNING	**Moving the equalizing valve to MAN or to AUTO will cause the actuator to move if it is not locked. If unaware of the movement, personal injury can occur.**

2. After allowing the pressure to bleed off, remove the cover screw securing the filter cover (Fig. 8-1) and set the cover screw and cover aside.

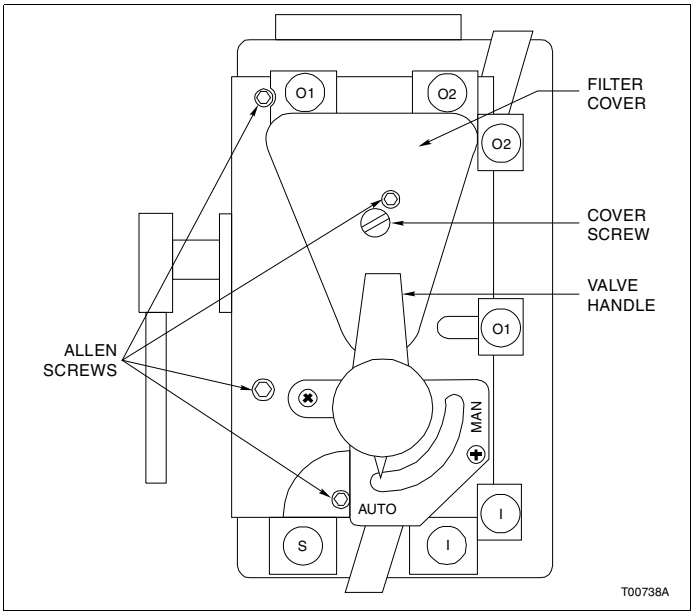


Figure 8-1. Type AV Positioner with Manifold

3. Clean or replace the filters.

   a. To clean the filters, soak them in a low residue solvent. After soaking, spray the filters thoroughly using compressed air until they are free of particles and solvent.

   b. Insert the clean or new filters (kit number 258487_1) into the filter wells.

4. Replace and lubricate the 3 O-rings (Fig. 8-2) using the lubricant supplied in the kit.

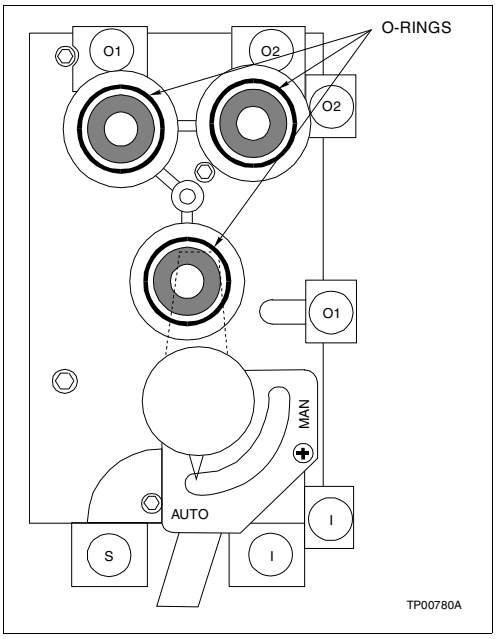


Figure 8-2. Manifold without Filter Cover

5. Clean and place the cover over the filters and replace the cover screw. Torque the cover screw to 2 Nm (18 in-lbs).

6. Transfer positioner back to automatic operation (refer to Section 5).

MANIFOLD

Tools Required: Screw driver
5⁄32-inch Allen wrench

1. Secure (lock) the actuator and remove supply air.

2. If equipped with equalizing valve, push in on the valve handle and move it to the MAN position (Fig. 8-1).

3. Remove four Allen screws securing the manifold (Fig. 8-1).

4. Lift the manifold off the positioner.

5. Before replacing the manifold, make sure there are no deposits on the bosses of the positioner or on the back of the manifold. If there is, remove the deposits.

6. Replace the O-rings or clean them if they are in good condition (Fig. 8-3).

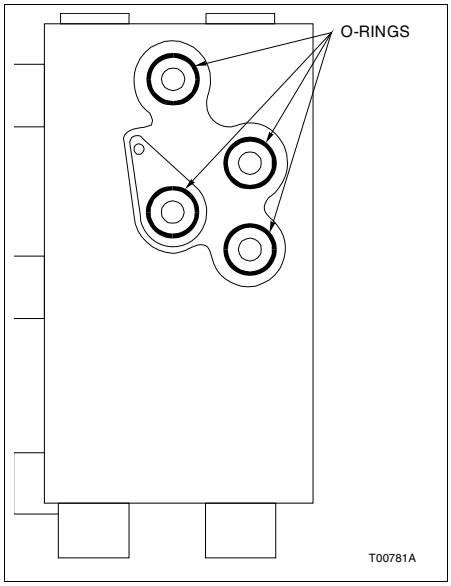


Figure 8-3. Manifold (Rear View) Showing O-Rings

7. Clean O-ring grooves and apply Dow Corning® No. 4 or equivalent lubricant to the O-rings.

8. Place the manifold in place on the positioner so it properly seats on the bosses.

9. Insert the Allen screws and torque them to 3.5 Nm (31 in-lbs).

NOTE: Not all Allen screws are the same length.

10. To replace the filters and filter cover refer to ***MANIFOLD FILTERS.***

GAIN HINGE SPRING

(Item numbers reference Figures 9-1 through 9-6.)

Tools required

Flat-tip screwdriver
9/64-inch Allen wrench

1. Transfer the positioner from automatic to manual operation (refer to Section 5).

2. Remove positioner cover by removing two cover screws.

3. Remove plug (item 29) from positioner housing. (Access to the hinge screws is provided through this opening.)

4. Remove four gain hinge spring screws (item 42) while holding the beam assembly steady (item 6).

5. Remove gain hinge spring.

6. Insert new hinge spring.

NOTE: When installing the hinge spring, be sure it properly seats (flush) between the steps. If the hinge spring hangs up, remove and rotate hinge 90°. Recheck for proper seating.

7. Insert and torque hinge screws to 2.6, ±0.2 Nm (23, ±2 in-lbs) while holding the beam assembly steady (item 6).

8. Transfer the positioner back to automatic operation (refer to Section 5).

9. Perform the procedure outlined in ***PILOT VALVE STROKE ADJUSTMENT***.

PILOT VALVE BODY

(Item numbers reference Figure 9-1 through 9-6.)

Tool required

Flat-tip screwdriver

1. Transfer the positioner from automatic to manual operation (refer to Section 5).

2. Remove positioner cover by removing two cover screws.

3. Carefully, unhook ends of valve clip (item 5). Remove clip from valve body. Remove valve stem (item 3) from lower end of valve body.

4. Remove two pilot valve screws (item 52) securing valve body and lift valve body off housing.

5. Replace O-rings. Clean O-ring grooves and apply Dow Corning No. 4 or equivalent lubricant to the O-rings.

6. Set (replacement or clean) valve body in place.

7. Secure valve body by replacing and tightening pilot valve screws to 2.6, ±0.2 Nm (23, ±2 in-lbs).

8. Make certain valve stem is clean (refer to Section 7). Install valve stem.

9. Install valve clip.

10. Transfer the positioner back to automatic operation (refer to Section 5).

11. Perform the procedure outlined in ***PILOT VALVE STROKE ADJUSTMENT***.

SERVO ASSEMBLY AND ELECTRONICS CIRCUIT BOARD

This procedure details the steps necessary to remove the servo assembly (part number 6639300__) and the electronics circuit board (AV3, part number 6639917_1 or AV4, part number 6639473_1) from the EMI/electronics housing. Use this procedure if you are replacing either or both items. (Item numbers reference Figures 9-1 through 9-6 depending on positioner type.)

Tools Required

Flat-tip screwdriver
Philips screwdriver
Pliers

1. Transfer the positioner from automatic to manual operation (refer to Section 5).

2. Remove positioner cover by removing two cover screws.

3. Remove the two (AV3) or three (AV4) wires that connect the servo and EMI/electronics housing assembly to terminal block (item 59).

4. Remove the indicator (item 19) and cam (item 13) by removing the screw securing the indicator. Remove the cam nut and washer (Figures 9-1 through 9-6). Set the cam and related items aside.

5. Loosen the three screws (two Phillips head and one socket head) that secure the servo assembly to the positioner housing (Fig. 8-4) and partially remove the servo. If replacing only the motor control board, go to Step 10.

6. Remove the tubing (coming from the regulator) from the bottom of the rear tee connector on the servo assembly (Fig. 8-4).

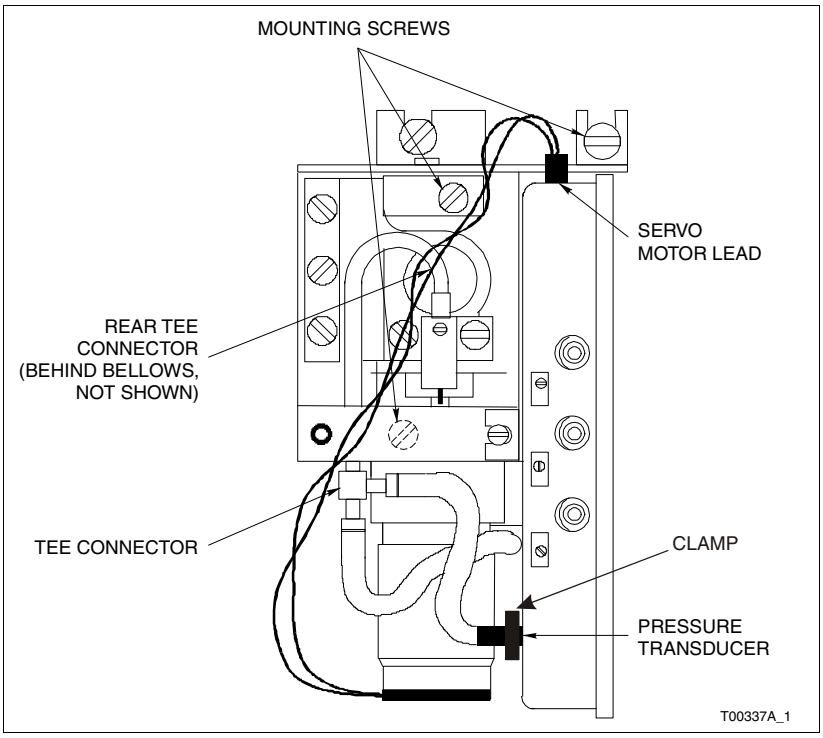


Figure 8-4. Servo and EMI/Electronics Assembly

NOTE: When removing tubing from barb fittings do not reconnect the same tubing to fittings until you have clipped and discarded the end of the tubing that was connected to the fitting. This is required because the fittings often tear loose particles of the tubing. This can cause blockage in the air lines.

7. Remove the servo motor lead connector from the EMI/electronics board.

8. Remove the three screws securing the EMI/electronics housing to the servo assembly.

NOTE: When replacing, do not over tighten the screws that secure the EMI/electronics to the servo assembly. Tighten these screws just until they become tight or snug.

9. If replacing the servo assembly, reverse the preceding steps. If replacing the electronics circuit board, perform Steps 10 through 12.

10. Remove the two nuts and one screw (item 68, Figures 9-1 through 9-6) securing the EMI/electronics housing cover. Remove the cover from the housing.

11. Carefully remove the circuit board from the housing. Determine which type of electronics circuit board you are replacing (AV3 or AV4) and perform the appropriate lettered step:

a. ***AV3:*** Use a thin-bladed screwdriver to carefully pry the ***black*** wire connector from P1 and the ***red*** wire connector from P2 of the electronics circuit board.

b. ***AV4****:* Use a thin-bladed screwdriver to carefully pry the ***black*** wire connector from P1 (lower), the ***red*** wire connector from P2 (+ 24) and the white wire connector from P3 (raise) of the electronics circuit board.

12. To replace the circuit board and servo assembly, reverse the preceding steps.

13. Transfer the positioner back to automatic operation (refer to Section 5).

CAM

(Item numbers reference Figures 9-1 through 9-6.)

Tools required

Flat-tip Screwdriver
Adjustable Wrench
Pliers

1. Transfer the positioner from automatic to manual operation (refer to Section 5).

2. Remove positioner cover, by removing two cover screws.

3. Remove indicator screw (item 51) and indicator (item 19).

4. Hold and stop the cam shaft from rotating if it is not secured by linkage or coupling. Using the adjustable wrench, remove cam nut (item 30) and washer (item 55).

5. Lift cam from cam shaft.

6. To replace cam, determine which cam mounting hole (A, B or C) is appropriate for application, and set cam on shaft. Make certain star-shaped hole engages squarely on shaft.

7. Replace cam washer and nut and tighten.

8. Set indicator on cam shaft and insert and tighten screw.

9. Transfer the positioner back to automatic operation (refer to Section 5).

DIAPHRAGM ASSEMBLY

(Item numbers reference Figures 9-1 through 9-6).

Removing

Tools required 7/64-inch Allen wrench
Adjustable wrench

1. Transfer the positioner from automatic to manual operation (refer to Section 5).

2. Using an Allen wrench, remove four diaphragm cover screws (item 45) and remove diaphragm cover.

3. Remove diaphragm support screw (item 53) and washer (item 54).

NOTE: When removing diaphragm support screw, do not allow the diaphragm support (item 23) to rotate.

NOTE: Item 53 is replaced by SEM screw NBMHA13006A as of November 23, 2009/Serial Number 3K620000029936 & Item 54 is no longer used.

4. Remove diaphragm support (item 23).

5. Carefully remove large diaphragm (item 73) from assembly.

6. Remove diaphragm spacer (item 22).

7. Remove diaphragm ring (item 24).

8. Carefully remove small diaphragm.

Replacing

1. Place the small diaphragm (item 20) in diaphragm housing with the concave side facing up. Check for correct alignment of tabs relative to the diaphragm housing.

2. Place diaphragm ring (item 24) over small diaphragm (item 20). Make sure the alignment pins on the diaphragm ring properly engages the other mating parts.

3. Set in place diaphragm spacer (item 22).

4. Place large diaphragm (item 73) in place with the convex side up. Check for correct alignment of tabs relative to the diaphragm housing.

5. Place diaphragm support (item 23) on large diaphragm.

6. Replace washer (item 54) and screw (item 53). Torque screw to 0.35 Nm (50 in-oz) while securing the diaphragm support (item 23) so it does not rotate.

NOTE: Item 53 is replaced by SEM screw NBMHA13006A as of November 23, 2009/Serial Number 3K620000029936 & Item 54 is no longer used.

7. Inspect the diaphragm assembly for distortion. If distortion occurs repeat this procedure from the start.

8. Replace diaphragm cover (item 25) and screws (item 45). Make certain diaphragm cover is properly seated. Torque cover screws to 0.9 Nm (8 in-lbs).

9. Transfer the positioner back to automatic operation (refer to Section 5).

10. Apply input signal pressure and check for leaks around the diaphragm assembly using soapsuds solution.

11. Perform the procedure outlined in ***PILOT VALVE STROKE ADJUSTMENT***.

PILOT VALVE STROKE ADJUSTMENT

The purpose of this adjustment is to keep the valve stem in the proper operating range. This procedure should be used in conjunction with the following procedures:

GAIN HINGE SPRING
PILOT VALVE BODY
DIAPHRAGM ASSEMBLY

NOTE: For internal speed adjustment refer to ***GAIN AND SPEED ADJUSTMENTS*** in Section 4.

When the valve stem is in the balance position, as shown in Figure 8-6, the stem is flush with both ends of the valve body. There are two adjustment screws to adjust. Use the following procedure to check and adjust the travel of the valve stem.

Tools required Two Allen wrenches (a normal size 3⁄32-inch and a long 3⁄32-inch wrench being at least 5 inches in length)

1. With the positioner cam at approximately 50%, manually lock the actuator in position by:

a. Using manual override if available.

- or -

b. If manual override is not available, disconnect (and secure) the linkage and plug ports 01 and 02.

2. Apply supply pressure.

3. Apply the maximum input signal to the positioner (20 mA for Type AV3 positioner or a voltage pulse to the ***raise*** terminal for Type AV4 positioner).

4. Using the 3⁄32-inch Allen wrench, adjust the top adjustment screw (Fig. 8-5) appropriately until the measurement matches the value shown in Figure 8-6. Figure 8-6 also shows the way the measurement is taken.

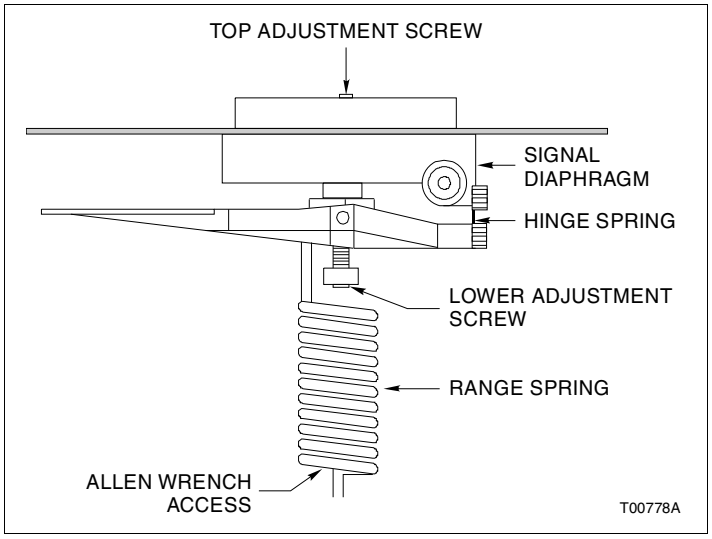


Figure 8-5. Stroke Adjustment Screw Locations

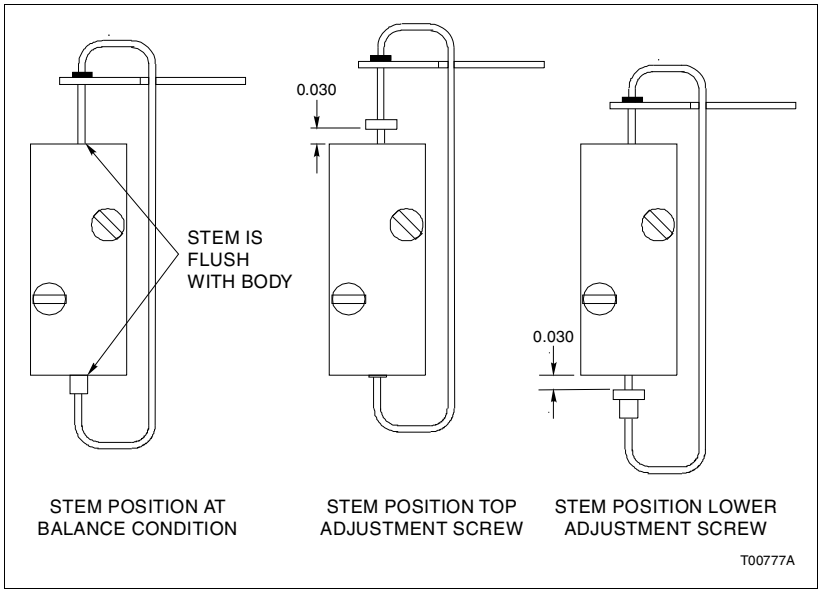


Figure 8-6. Pilot Valve Measurement for Maximum Speed

5. Apply the minimum input span to the positioner (4 mA for Type AV3 positioner or a voltage pulse to the ***lower*** terminal for Type AV4 positioner).

6. Use the long (at least 5 inch) 3⁄32-inch Allen wrench to adjust the lower stroke adjustment screw (Fig. 8-5). Adjust the screw until the measurement matches the value shown in Figure 8-6

SECTION 9 - SUPPORT SERVICES

INTRODUCTION

This section provides the following items:

Recommended spare parts — This is a list of the parts that should be kept on hand so that if malfunctions occur, replacements are quickly accessible.

Additional spare parts — This is a list of parts that can be ordered for replacement.

Positioner illustrations — These illustrations point out all major components of the Type AV3 and Type AV4 positioners. A parts list is included along with part numbers.

RECOMMENDED SPARE PARTS

ABB suggests that the following items be kept on hand in case replacement is necessary. To order, call your nearest ABB sales representative; supply the kit numbers or if the items are not of a kit, supply the part numbers.

NOTE: This is not a complete list of available parts; refer also to ***ADDITIONAL SPARE PARTS KITS*** located in this section and ***ACCESSORIES*** in Section 1.

Table 9-1. Pilot Valve Assembly Kit No. 258488_1

Item	Part Number	Quantity	Description
3	5400259_1	1	Valve stem
4	5400260_1	1	Valve body
5	5400261_1	1	Valve clip
35	1951398_12	3	O-ring
-	19984_1	1	O-ring lubricant

Table 9-2. AV Diaphragm Assembly Kit No. 258486_1 [2]

Item	Part Number	Quantity	Description
20	5400288_2	1	Small diaphragm
22	5400292_1	1	Diaphragm spacer
23	5400293_1	1	Diaphragm support
23[1]	5400293_2	1	Diaphragm support
24	5400294_1	1	Diaphragm ring
73	5400288_1	1	Large diaphragm
73[1]	5400288_3	1	Large diaphragm

NOTE:

1. Discard items for Type AV3/4 positioners.
2. Kit contains SEM screw NBMMA13006A as of November 2009/Serial Number 3K620000029936.

Table 9-3. Filter Replacements Kit No. 258487_1

(Positioners equipped with optional manifold)

Part Number	Quantity	Description
5400057_1	3	Filters
5311428_1	3	O-rings
19984_1	1	O-ring lubricant

Table 9-4. Shutoff Valve Kit No. 258270_1

(Positioners equipped with optional manifold)

Part Number	Quantity	Description
5400060_1	1	Shutoff valve

Table 9-5. Cam

Part Number	Quantity	Description
5400289_1	1	Forward-acting half rise cam, 45° rotation
5400289_2	1	Reverse-acting half rise cam, 45° rotation
5400281_1	1	Forward-acting full rise cam, 90° rotation
5400281_2	1	Reverse-acting full rise cam, 90° rotation

ADDITIONAL SPARE PARTS KITS

Table 9-6. Manifold Assembly Kit No. 258491_1

Replaces 5400282_1 or 5400282_2

(For replacement or field addition, Type AV___1/2__)

Item	Part Number	Quantity	Description
17	5400282_1	1	Manifold assembly
64	5311428_207	4	Manifold 0-rings
65	NTJHA09030	4	Manifold washers
66	NBAHA16020	4	Manifold screws
67	NBAHA16024	2	Manifold screws
-	19984_1	1	O-ring lubricant
-	5400066_1	1	Valve plate[1]

NOTE:
1. Used to make equalizing valve handle inoperable for AV___2__) applications. Discard for AV___1__) applications.

Table 9-7. Gain Hinge Springs Kit No. 258485_1

Item	Part Number	Quantity	Description
7	5400264_1	1	Hinge spring
7	5400264_2	1	Hinge spring

Table 9-8. Servo Assemblies

Part Number	Description	Quantity	Application
6639300_1	Servo assembly	1	AV3
6639300_2	Servo assembly	1	AV4

Table 9-9. Electronics Board Assemblies

Part Number	Description	Quantity	Application
6639917_1	I/P receiver assembly	1	AV3
6639473_1	I/P receiver assembly	1	AV4

Table 9-10. Potentiometric Position Transmitter

Part Number	Quantity	Description
6639540_1	1	Potentiometer assembly

Table 9-11. Cover Assembly Kit No. 258545_1
(Replaces 5400258_1)

Part Number	Quantity	Description
5400254_1	1	Cover
5400255_1	1	Window
5400256_1	1	Gasket
5400257_1	1	Cover
5400257_2	1	Cover insert
1964033_1	1	Styleplate

Table 9-12. Cam Follower Arm Kit No. 258544_1
(Replaces 5400306_1)

Part Number	Quantity	Description
258544_1	1	Cam follower arm assembly

Table 9-13. Type AV3 Positioner Parts List for Figures 9-1, 9-2 and 9-3

Item	Part No.	Description	Item	Part No.	Description
1	5400253_2	Housing	51	NIDHA13005	Indicator screw
2	5400258_1	Cover assembly	52	NIDHA15012	Pilot valve screw (2 req.)
3	5400259_1	Valve stem	53	NBMHA13006	Diaphragm support screw [2]
4	5400260_1	Valve body	54	NTCHA07000	Diaphagm support scr. washer [2]
5	5400261_1	Valve clip	55	NTCHA12000	Cam washer
6	5400263_1	Beam assembly	56	NTJHAO9030	Span adjustment washer
7	5400264_1,2	Hinge	57	Fm. MP432-889	Label, indicator
8	5400306_1	Cam follower arm assembly	58	NDPAC13005	Thread forming screw [1]
9	5400271_1	Spring arm	59	6639559_1	Termination assembly
10	5400272_1	Pivot	60	NIDAC09004	Machine screw pan hd. slotted
11	5400273_1	Eyebolt	61	1963353_101	Label, universal, CSA
12	5400275_1	Nut retainer	62	1963318_	Nameplate, universal
13	See Table 9-1	Cam	63	See Table 9-1	Drive arm
14	See Table 9-1	Cam shaft	64	5311428_207	Manifold O-ring [1]
15	5400279_1	Zero adjustment nut	65	NTJHA09030	Manifold washer [1]
16	5400280_1	Range spring	66	NBAHA16020	Manifold screw [1]
17	See Table 9-1	Manifold assembly	67	NBAHA16024	Manifold screw [1]
18	5400283_1	Signal connector assembly	68	NBZAC13014	Machine screw pan hd. slotted
19	5400286_1	Indicator	69	197675_2	Washer, cup
20	5400288_2	Small diaphragm	70	6639914_1 [4]	EMI enclosure assembly
21	See Table 9-1	Potentiometer assembly	71	193197_1	Span adjustment bearing
22	5400292_1	Diaphragm spacer	72	1943187_1	Cable clip
23	5400293_1	Diaphragm support	73	5400288_1	Large diaphragm
24	5400294_1	Diaphragm ring	74	1951569_8	Plug
25	5400295_1	Diaphragm cover	75	1951655_1	Brass fitting (2 req.)
26	5400296_1	Exhaust mesh	76	6639300_1	Servo assembly
27	193243_1	Large position trans. gear [1]	77	NTJBC07030	Lock washer
28	1951652_1	Barb fitting	78	5400297_1	Regulator bracket
29	1945803_1	Plug button	79	1951745_1	Regulator assembly
30	197120_28	Cam nut	80	NHRAC13005	Threaded forming screw
31	19734_45	Washers [1]	82	NDPAC15004	Pan head screw
32	197777_50	Retaining ring, cam (2 req.)	83	R9025-0046	Tubing (14.188 in.)
33	197164_18	Retaining ring, span	84	R9025-0093	Tubing nylon (9.625 in.)
34	197227_1	Special hex head sem. screw [1]	85	5325032_3	Orifice
35	1951398_12	O-ring (3 req.)	86	1990015_2	Label, terminal block
36	197843_1	Fastener, push-on, removable	88	5400302_1	Signal connection bracket
37	1945750_1	Pull plug (3 req.)	89	1951757_1	Ground spring [3]
38	5400072_1	Knife base	90	1951747_1	Tee, barbed, nylon (2 req.)
39	5400073_1	Knife edge	91	6639479_1	4-20 mA pos. Xmitter assy.[1]
40	NBZHA21014	Cover screw	92	NDPAC13012	Threaded forming screw [1]
41	NBZHA21040	Cover screw	93	NBABC13005	Hex. soc. head cap screw
42	NBAHA15006	Hinge screw (4 req.)	95	5400268_1	Bracket, pot mounting [1]
43	NPSHA05000	Hairpin clip (2 req.)	96	193242_1	Small position Xmitter gear [1]
44	NTBTF13150	PTFE washer (2 req.)	98	1951755_1	Bumper grommet (3 req.)
45	NBAHA13006	Diaphragm cover screw (4 req.)	99	1951755_2	Bumper grommet (2 req.)
46	197865_2	Stroke adjustment screw	100	NTMHA13000	Lock washer
47	197865_1	Stroke adjustment screw	101	6639817_2	Label, position transmitter [1]
48	NKJHA16004	Zero adjustment set screw	103	5400317_1	Gear adapter [1]
49	NBAHA16020	Span adjustment screw	104	NKJHA13004	Socket head cup pt set screw
50	1951041_1	Soc. head pipe plug	105	197860_1	Cable strap

NOTE:

1. See Table 9-1 for quantity.
2. Items 53 & 54 are replaced by SEM screw NBMHA13006A as of November 23, 2009/Serial Number 3K620000029936.
3. Item 89 is no longer used.
4. Refer to Table 9-9.

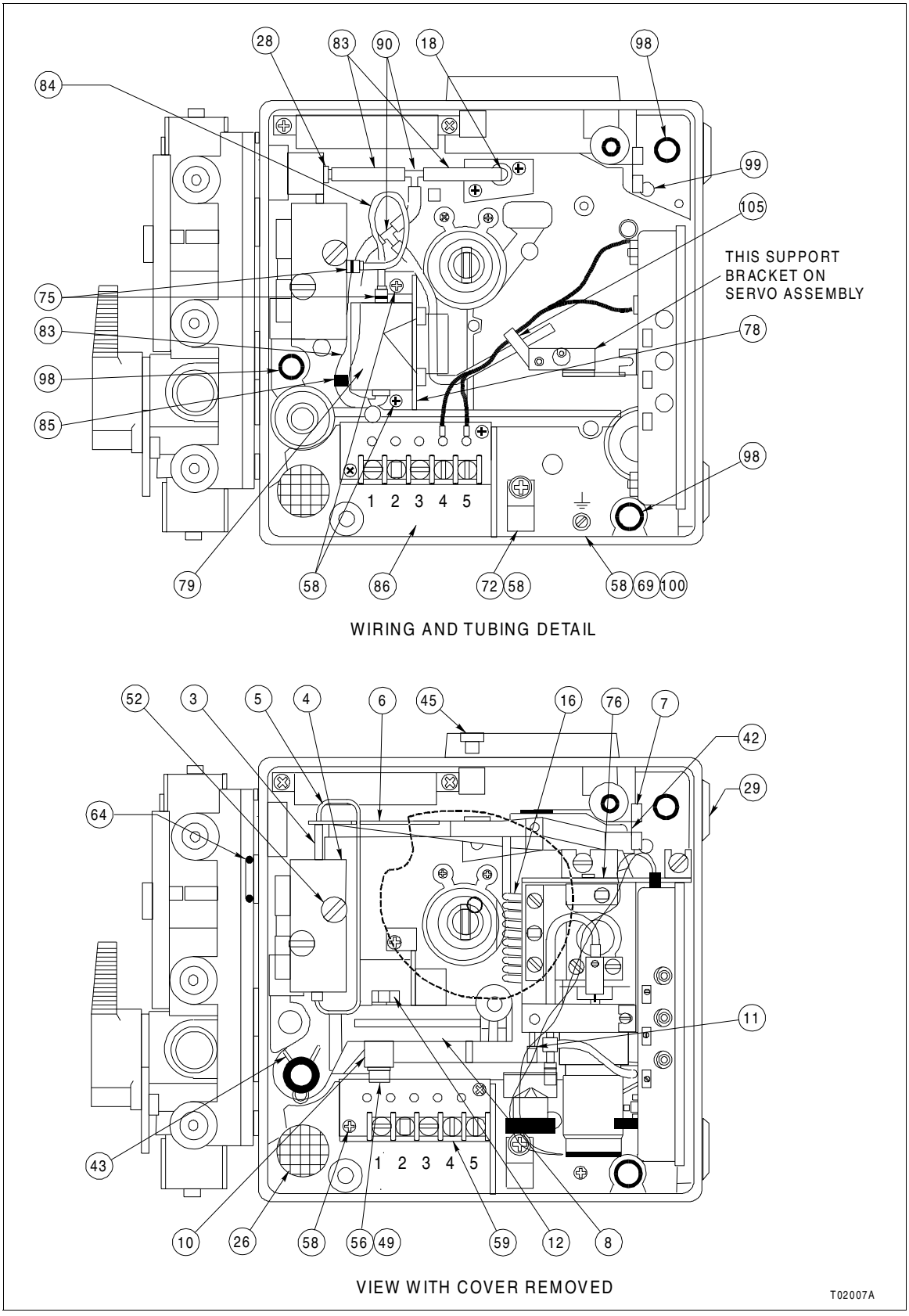


Figure 9-1. Type AV3 Positioner (Interior, Wiring, and Tubing Details)

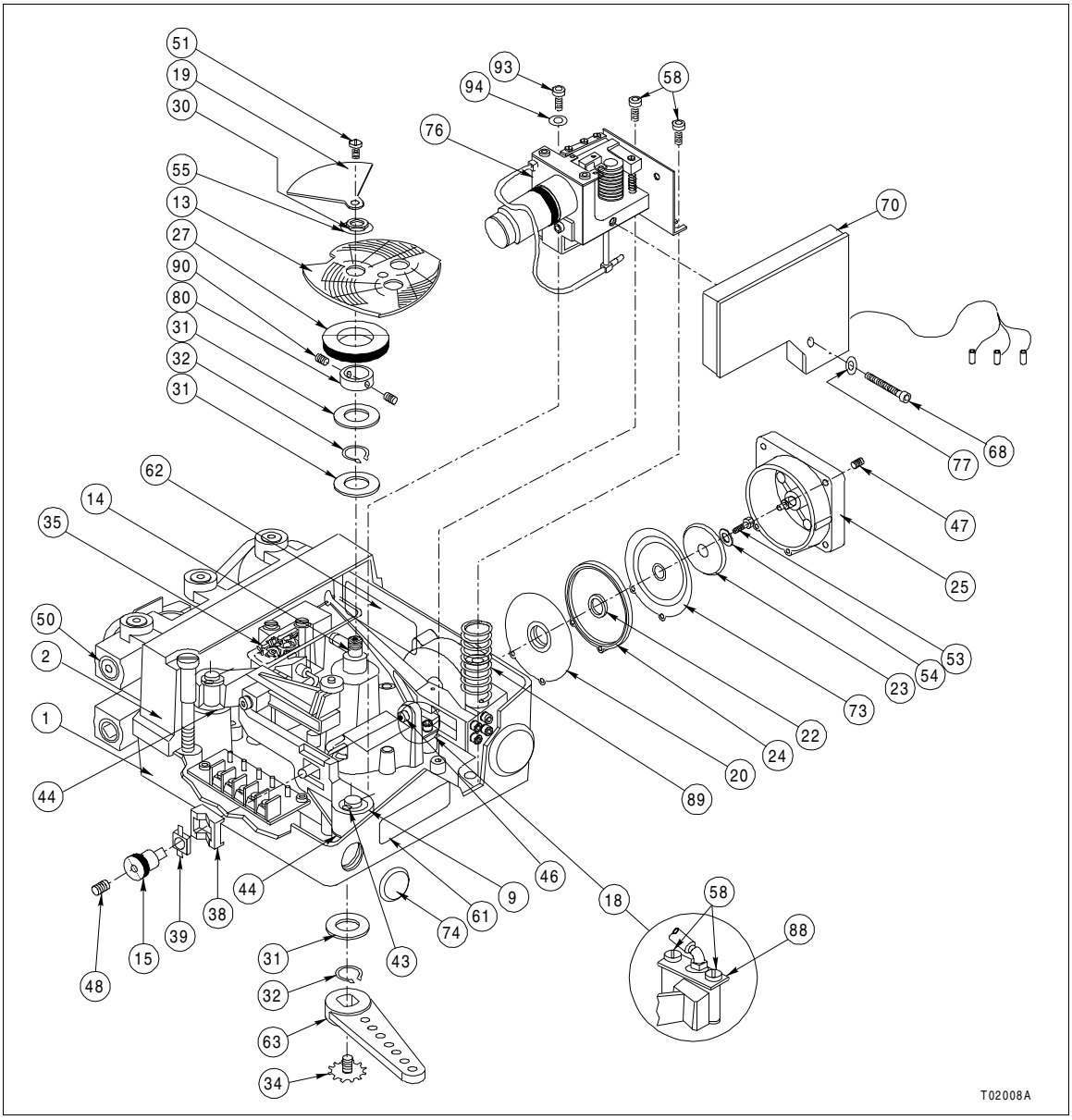


Figure 9-2. Type AV3 Positioner (Exploded View)

Table 9-14. Type AV3 Reference Table for Cam and Manifold

Type	Item						
	13	17	64, 65	66, 67	58	91, 101	31
AV331___	5400289_1,2[1]				11 req.		2 req.
AV332___	5400281_1,2[2]				11 req.		2 req.
AV33_0__		Omit	Omit	Omit			
AV33_1__		5400282_1	4 req.	2 req.			
AV33_2__		5400282_2	4 req.	2 req.			

NOTES:
1. 5400289_1 or 5400281_1 direct-acting (black) cam is shipped installed on the positioner.
2. 5400289_2 or 5400281_2 reverse-acting (red) cam is shipped installed inside the front cover.

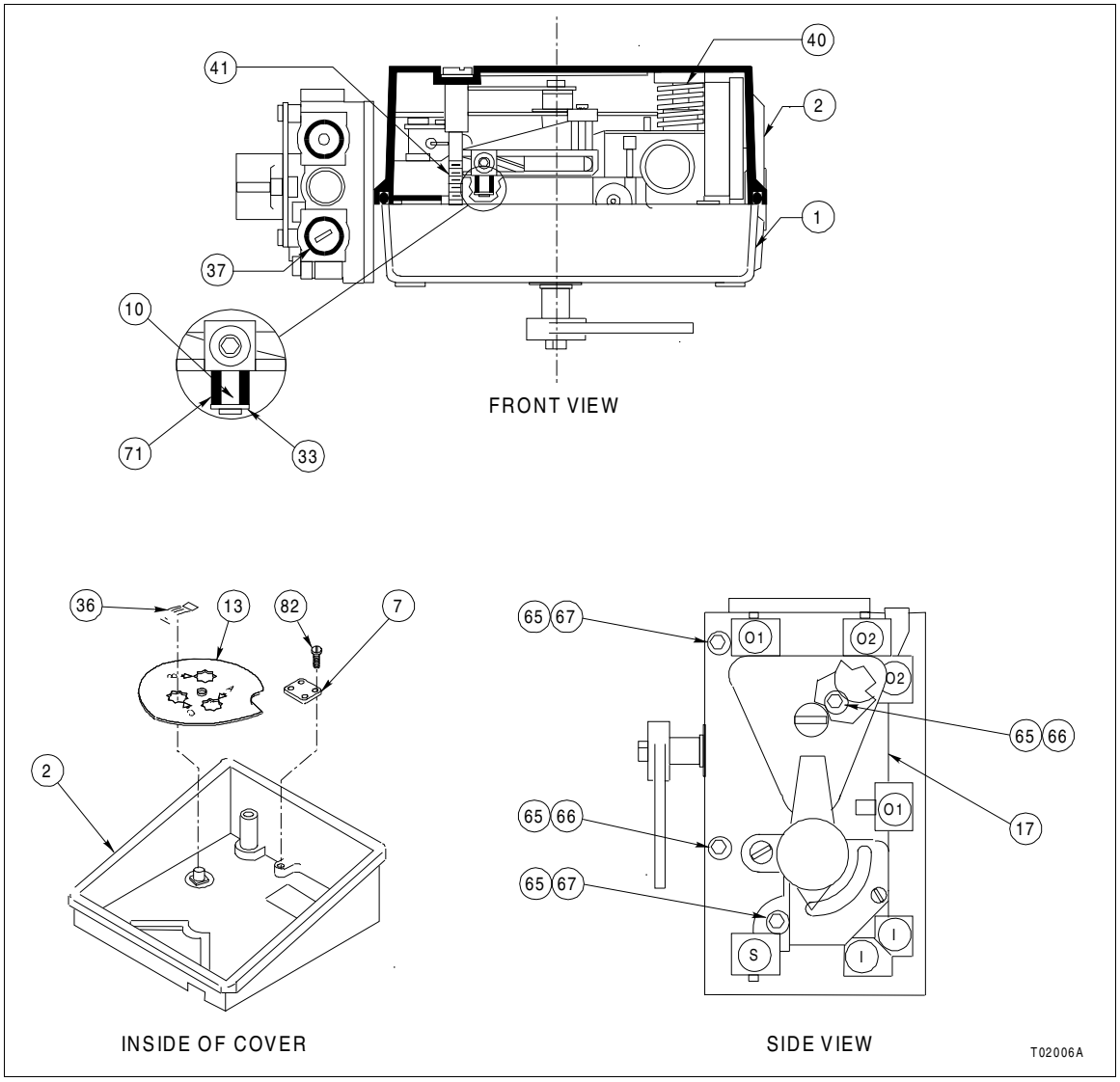


Figure 9-3. Type AV3 Positioner (Front, Side and Inside of Cover)

Table 9-15. Type AV3 Reference Table for Output and Drive Shaft

Type	Item								
	21	14	34	27, 95, 96, 103	92, 104	58	91, 101	63	31
AV33__0_	Omit			Omit	Omit		Omit		3 req.+1
AV33__1_	6639540_2			1 req.	2 req.		Omit		3 req.+1
AV33__2_	6639540_1			1 req.	2 req.	13 req.+2	1 req.		
AV331__0		5400287_1	1 req.					5327445_2	
AV332__0		5400287_1	1 req.					5327445_1	
AV33___1		5400278_1	Omit					Omit	

NOTES:
1. 5400289_1 or 5400281_1 direct-acting (black) cam is shipped installed on the positioner.
2. 5400289_2 or 5400281_2 reverse-acting (red) cam is shipped installed inside the front cover.

Table 9-16. Type AV4 Positioner Parts List for Figures 9-4, 9-5, and 9-6

Item	Part No.	Description	Item	Part No.	Description
1	5400253_2	Housing	50	1951041_1	Soc. head pipe plug
2	5400258_1	Cover assembly	51	NIDHA13005	Indicator screw
3	5400259_1	Valve stem	52	NIDHA15012	Pilot valve screw (2 req.)
4	5400260_1	Valve body	53	NBMHA13006	Diaphragm support screw [2]
5	5400261_1	Valve clip	54	NTCHA07000	Diaphragm support scr. washer [2]
6	5400263_1	Beam assembly	55	NTCHA12000	Cam washer
7	5400264_1,2	Hinge	56	NTJHAO9030	Span adjustment washer
8	5400306_1	Cam follower arm assembly	57	Fm. MP432-889	Label, indicator
9	5400271_1	Spring arm	58	NDPAC13005	Thread forming screw (15 req.)
10	5400272_1	Pivot	59	6639559_1	Termination assembly
11	5400273_1	Eyebolt	60	NTAACO5000	Flat washer
12	5400275_1	Nut retainer	61	1963353_101	Label, universal, CSA
13	See Table 9-2	Cam	62	1963318_	Nameplate, universal
14	See Table 9-2	Cam shaft	63	See Table 9-2	Drive arm[1]
15	5400279_1	Zero adjustment nut	64	5311428_207	Manifold O-ring[1]
16	5400280_1	Range spring	65	NTJHA09030	Manifold washers[1]
17	See Table 9-2	Manifold assembly	66	NBAHA16020	Manifold screw[1]
18	5400283_1	Signal connector assembly	67	NBAHA16024	Manifold screw[1]
19	5400286_1	Indicator	69	197675_2	Washer, cup
20	5400288_2	Small diaphragm	70	6639914_2 [4]	EMI enclosure assembly
21	6639540_1	Potentiometer assembly	71	193197_1	Span adjustment bearing
22	5400292_1	Diaphragm spacer	72	1943187_1	Cable clip
23	5400293_1	Diaphragm support	73	5400288_1	Large diaphragm
24	5400294_1	Diaphragm ring	74	1951569_8	Plug
25	5400295_1	Diaphragm cover	75	1951655_1	Brass fitting (2 req.)
26	5400296_1	Exhaust mesh	76	6639300_2	Servo assembly
27	193243_1	Large position trans. gear	77	NTJBC07030	Lock washer
28	1951652_1	Barb fitting	78	5400297_1	Regulator bracket
29	1945803_1	Plug button	79	1951745_1	Regulator assembly
30	197120_28	Cam nut	80	5400317_1	Lock washer
31	19734_45	Washer (3 req.)	81	5325032_3	Orifice
32	197777_50	Retaining ring, cam	82	NDPAC15004	Pan head screw
33	197164_18	Retaining ring, span	83	1951747_1	T-fitting
34	197227_1	Special hex head sem. screw [1]	84	R9025-0093	Tubing nylon (9.188 in.)
35	1951398_12	O-ring (3 req.)	85	R9025-0046	Tubing (14.188 in.)
36	197843_1	Fastener, push-on, removable	86	1990015_2	Label, terminal block
37	1945750_1	Pull plug (3 req.)	88	5400302_1	Signal connection bracket
38	5400072_1	Knife base	89	1951757_1 [3]	Ground spring
39	5400073_1	Knife edge	90	1978707_1	Set screw brass tip
40	NBZHA21014	Cover screw	91	6639479_1	4-20 mA pos. Xmitter assembly
41	NBZHA21040	Cover screw	92	NDPAC13012	Threaded forming screw (2 req.)
42	NBAHA15006	Hinge screw (4 req.)	93	NBABC13005	Hex. soc. head cap screw
43	NPSHA05000	Hairpin clip (2 req.)	95	5400268_1	Bracket, pot mounting
44	NTBTF13150	PTFE washer (2 req.)	96	193242_1	Small position Xmitter gear
45	NBAHA13006	Diaphragm cover screw (4 req.)	97	NDPAC09004	Threaded forming screw (2 req.)
46	197865_2	Stroke adjustment screw	98	1951755_1	Bumper grommet (3 req.)
47	197865_1	Stroke adjustment screw	99	1951755_2	Bumper grommet (2 req.)
48	NKJHA16004	Zero adjustment set screw	100	NTMHA13000	Lock washer
49	NBAHA16020	Span adjustment screw	101	197860_1	Cable strap

NOTE:
1. See Table 9-2 for quantity.
2. Items 53 & 54 are replaced by SEM screw NBMHA13006A as of November 23, 2009/Serial Number 3K620000029936.
3. Item 89 is no longer used.
4. Refer to Table 9-9.

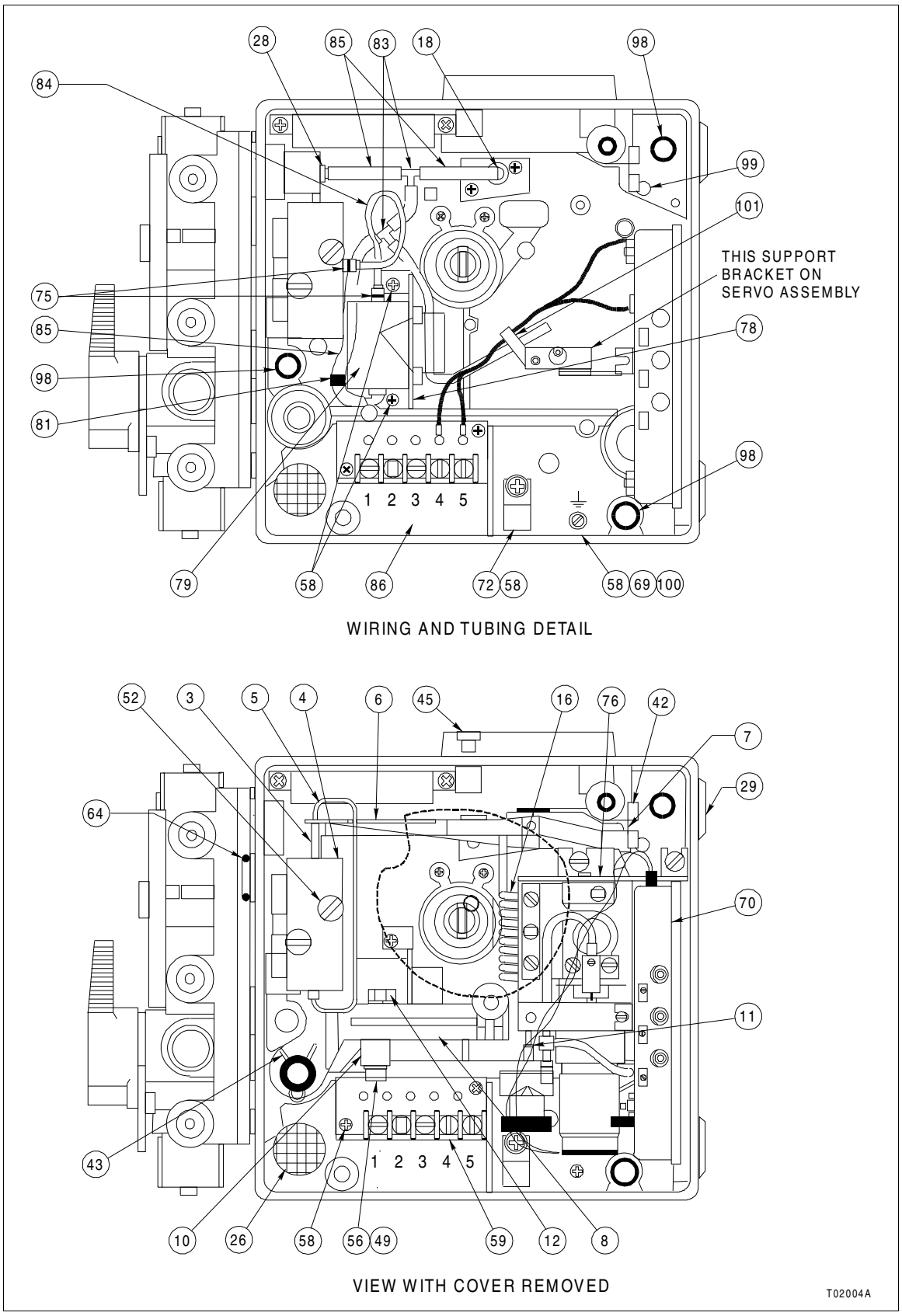


Figure 9-4. Type AV4 Positioner (Interior, Wiring, and Tubing Details)

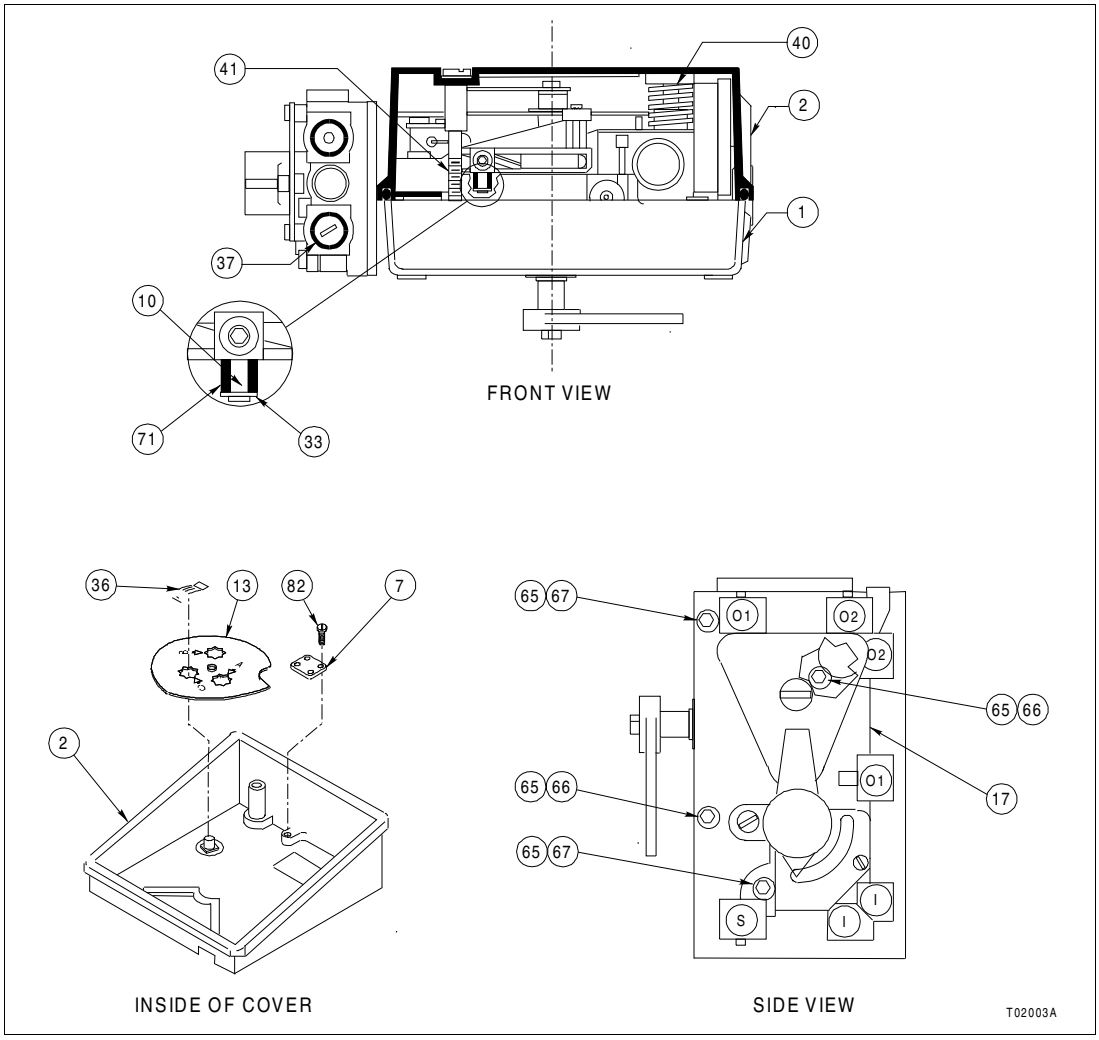


Figure 9-5. Type AV4 Positioner (Front, Side and Inside of Cover)

Table 9-17. Type AV4 Reference Table

Type	Item						
	13	17	64,65	66, 67	14	34, 36	63
AV441	5400289_1,2[1]						
AV442	5400281_1,2[2]						
AV44_0__		Omit	Omit	Omit			
AV44_1__		5400282_1	4 req.	2 req.			
AV44_2__		5400282_2	4 req.	2 req.			
AV44___0					5400287_1	1 req.	
AV44___1					5400278_1	Omit	
AV441__0							5327445_2
AV442__0							5327445_1
AV442__1							Omit

NOTES:
1. 5400289_1 or 5400281_1 direct-acting (black) cam is shipped installed on the positioner.
2. 5400289_2 or 5400281_2 reverse-acting (red) cam is shipped installed inside the front cover.

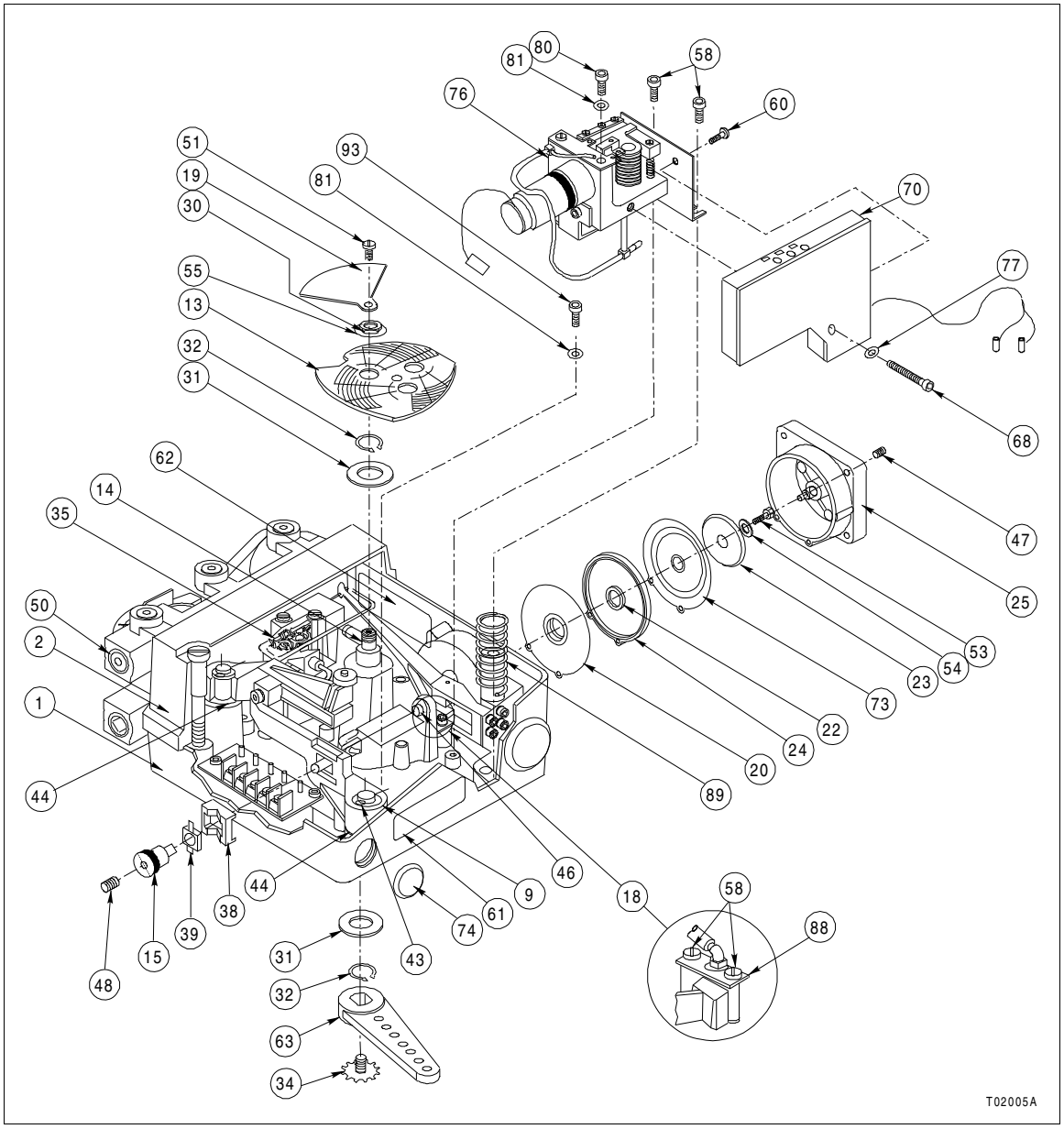


Figure 9-6. Type AV4 Positioner (Exploded View)

Table 9-18. Positioner Mounting Kit Number 5327321_12[1]

Valve Stem Diameter: 0.375 to 0.750 inches Part

Item	Part Number	Description	Item	Part Number	Description
1	5400266_1	Positioner mounting bracket	13	5311690_1	Adjustable stud, 2.69 in.
2	.250-20x.750	Socket head screw (3 req.)	14	5311690_2	Adjustable stud, 3.43 in.
3	.250	Reg. spg. lock washer (3 req.)	21	.375	Med. sprg. lock washer (3 req.)
5	.312-18x.625	Hex soc. head cap screw (2 req.)	22	.375-24	Hex jam nut
6	.312	Reg. spring lock washer (2 req.)	23	5311687_2	Stem clamp, 0.375 - 0.750 in. diameter
7	R6440-005	Type 347 stainless steel wire, 0.030 diameter 6-in. length	25	5211691_1	Clamp plate, 0.375 - 0.750 in. diameter
10	5312449_4	Connecting link, 12-in. length (cut to size)	27	.375-16x1.50	Hex soc. head cap screw (2 req.)
11	.190-32x.875	Pan head machine screw (2 req.)	28	.375-16	Hex jam nut (2 req.)
12	197120_5	Elastic stop nut, (2 req.)	29	.125 dia.x.750	Type 1 groove pin

NOTES:

1. Positioner mounting kits for direct or reverse-acting diaphragm actuators and single or double-acting piston actuators with linear (reciprocating) motion.

2. If it is necessary to mount the positioner on a yoke without mounting bosses, order mounting bracket assembly, part number 5313138_1. Minimum yoke diameter is 2.25 inches. This mounting bracket assembly is not included in the positioner mounting kits.

Table 9-19. Positioner Mounting Kit Number 5327321_13[1]

Valve Stem Diameter: 0.750 to 1.00 inches

Item	Part Number	Description	Item	Part Number	Description
1	5400266_1	Positioner mounting bracket.	12	197120_5	Elastic stop nut, (2 req.)
2	.250-20x.750	Socket head screw (3 req.)	14	5311690_2	Adj. stud, 3.43 in.
3	.250	Reg. spg. lock washer (3 req.)	21	.375	Med. sprg. lock washer (3 req.)
5	.312-18x.625	Hex soc. head cap screw (2 req.)	22	.375-24	Hex jam nut
6	.312	Reg. spring lock washer (2 req.)	24	5312483_1	Stem clamp, 0.750 - 1.00 in. diameter
7	R6440-0005	Type 347 stainless steel wire, 0.030 diameter. 6-in. length	26	5312471_1	Clamp Plate, 0.750 - 1.00 in. diameter
10	5312449_4	Connecting link, 12-in. length (cut to size)	27	.375-16x1.50	Hex soc. head cap screw (2 req.)
11	.190-32x.875	Pan head mach. screw (2 req.)	29	.125 dia.x.750	Type 1 groove pin

NOTES:

1. Positioner mounting kits for direct or reverse-acting diaphragm actuators and single or double-acting piston actuators with linear (reciprocating) motion.

2. If it is necessary to mount the positioner on a yoke without mounting bosses, order mounting bracket assembly, part number 5313138_1. Minimum yoke diameter is 2.25 inches. This mounting bracket assembly is not included in the positioner mounting kits.

Table 9-20. Positioner Mounting Kit Number 5327321_14[1]

(for use on Fisher actuators) Valve Stem Diameter: 0.750 to 1.00 inches

Item	Part Number	Description	Item	Part Number	Description
1	5400266_1	Positioner mounting bracket	22	.375-24	Hex jam nut
2	.250-20x.750	Socket head screw (3 req.)	10	5312449_4	Connecting link, 12-in. length (cut to size)
3	.250	Reg. spg. lock washer (3 req.)	11	.190-32x.875	Pan head mach. screw (2 req.)
5	.312-18x.625	Hex soc. head cap screw (2 req.)	12	197120_5	Elastic stop nut, (2 req.)
6	.312	Spring lock washer (2 req.)	15	5319500_11	Drive stud, 2.69-in.
7	R6440-005	Type 347 stainless steel wire, 0.030 diameter 6-in. length	16	5319500_1	Drive stud, 3.43-in.
17	5328155_1	Stud bracket	23	5311687_2	Stem clamp, 0.375 - 0.750 in. diameter
18	.312-18x.500	Hex head cop screw (2 req.)	25	5211691_1	Clamp plate, 0.375 - 0.750 in. diameter
19	1218-00	Shkproof lock washer (2 req.)	27	.375-16x1.50	Hex soc. head cap screw (2 req.)
20	5319524_1	Star lock washer	28	.375-16	Hex jam nut (2 req.)
21	.375	Med. sprg. lock washer (3 req.)	29	.125 dia.x.750	Type 1 groove pin

NOTES:

1. Positioner mounting kits for direct or reverse-acting diaphragm actuators and single or double-acting piston actuators with linear (recip-rocating) motion.
2. If it is necessary to mount the positioner on a yoke without mounting bosses, order mounting bracket assembly, part number 5313138_1. Minimum yoke diameter is 2.25 inches. This mounting bracket assembly is not included in the positioner mounting kits.

Table 9-21. Rotary Actuators Retrofitting Mounting Kits

Retrofit Mounting Kit	Drive Nomenclature	Kit Number
AP positioner to AV positioner	UP10, UP20 UP30, UP40 UP50, UP60	5400309_1 258493_1 258494_1
	AC0404 AC0608	258527_1 258528_1
	AC0816 AC1016	258529_1 258530_2
ABB part number pilot valve positioners to AV positioners	AC0404 AC0608	258527_1 258528_1
	AC0816 AC1016	258529_1 258530_1

APPENDIX A - POSITION TRANSMITTERS

INTRODUCTION

This appendix provides operation and calibration information for ABB position transmitter options. Refer to Table 1-4 (potentiometric position transmitter) or 1-5 (four to 20 milliamp position transmitter) for position transmitter performance specifications. A position transmitter provides additional control features to Type AV positioners.

Position transmitters sense the position of positioner cam shaft. Two variations exist:

- Potentiometric option (AV____1_).
- Four to 20 mA option (AV____2_).

DESCRIPTION AND OPERATION

Potentiometric Position Transmitter

This is available as an option for the Type AV3 positioner (order through nomenclature). The potentiometric option is not available for the Type AV4 positioner.

The potentiometric position transmitter option (AV33__1_) uses a high durability plastic film potentiometer. Gears connect the potentiometer to the positioner cam shaft. The position of the potentiometer shaft indicates the position of the actuator.

The relationship between the potentiometer and the cam shaft results in one degree of rotation of the cam shaft corresponding to approximately 9.9 ohms of resistive change at the potentiometer wiper. Three leads from the potentiometer are for customer use and are available at terminals TB1-1, TB1-2, and TB1-3.

Four to 20 mA Position Transmitter

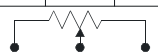
The four to 20 milliamp position transmitter option also uses a high durability plastic film potentiometer and electronic circuitry. Gears connect the potentiometer shaft to the positioner cam shaft. The resistive change of the potentiometer outputs to a bridge circuit, producing a proportional voltage. EMI/RFI protected circuitry converts the bridge voltage to a four to 20 milliamp current signal. Terminals TB1-1 (+) and TB1-2 (-) of the Type AV positioner provide customer access to the four to 20 milliamp control signal. Jumper position determines direct or reverse-acting operation. Test jacks are available for in line current monitoring.

CALIBRATION

The following text details the calibration procedures of the position transmitter options. There are two procedures for calibration; one for the potentiometric option (AV____1_) and another for the four to 20 milliamp option (AV____2_).

Calibrating the Potentiometric Position Transmitter

The following text provides a calibration example using the potentiometric position transmitter. This example can be used as a guide for other applications. Final calibration of the potentiometric position transmitter option depends on the application. Field connections to the potentiometer are shown on a label located inside the positioner cover, and is shown in Figure A-1.

	TB1 CONNECTIONS				
NOMENCLATURE	1	2	3	4	5
AV23?????				+	–
Av33?????				+	–
AV44?????	+	–	+24	RAISE	LOWER
AV????1??					
AV????2??	+	–			

T00807A

Figure A-1. Terminal Block Connections TB1-1 through TB1-5

The nomenclature and terminal connections of Figure A-1 are described as follows:

AV23 The positive (+) and negative (-) connections at position TB1-4 and TB1-5 refer to the four to 20 milliamp signal to the I/P converter.

AV33 The positive (+) and negative (-) connections at position TB1-4 and TB1-5 refer to the four to 20 milliamp signal to the servo assembly.

AV44 The positive (+) and negative (-) connections at position TB1-1 and TB1-2 refer to the output signal from the four to 20 milliamp position transmitter. The connections at TB1-3, TB1-4 and TB1-5 go to the servo assembly.

AV____1_ Depicts the connections for the potentiometric position transmitter option (not available on Type AV44 positioners).

AV____2_ The positive (+) and negative (-) connections at position TB1-1 and TB1-2 refer to the output signal from the four to 20 milliamp position transmitter.

Direct-acting cam rotation of 0 to 100 percent produces increasing resistance between terminal block TB1-1 and TB1-2. Reverse-acting cam rotation of 0 to 100 percent produces decreasing resistance between TB1-1 and TB1-2.

The resistive change of the potentiometer is approximately 9.9 ohms (nominal) per degree of cam rotation, with a total resistance of 2000 ohms (nominal).

Application of the potentiometric option must consider the possibility of end resistance wrap-around.

POTENTIOMETRIC APPLICATION EXAMPLE

A customer has a Type AV positioner with a 90 degree, direct-acting cam, potentiometric position transmitter, along with a 24 VDC supply. The customer wishes to output a five-VDC signal when the Type AV positioner output is 80 percent.

1. Determine the angular rotation of 80% of 90 degrees:

   0.80 x 90 degrees = 72 degrees

The 72 degrees of cam rotation is 80% of 90 degrees.

2. Determine the resistive change of the potentiometer through 72 degrees of rotation. For every degree of rotation the resistive change is 9.9 ohms (nominally):

   72 degrees x 9.9 ohms = 712.8 ohms

The change of resistance for this rotation is 712.8 ohms, and appears between TB1-1 and TB1-2.

3. To guard against wrap-around, the minimum resistance at the potentiometer wiper at 0% cam rotation is set to 200 ohms. Therefore, the resistance between TB1-1 and TB1-2 should vary between 200 and 912.8 (712.8 + 200 = 912.8) ohms for a cam rotation of 0 to 80%.

4. Determine the required current in the potentiometer that develops 5 volts at the wiper at 80%:

   5 VDC ÷ 912.8 ohms = 5.48 mA

5. Determine the nominal voltage to produce 5.48 mA across the potentiometer:

   5.48 mA x 2000 ohms = 10.96 VDC

6. Determine the dropping resistor value which reduces the supply voltage to 10.96 VDC:

$$\frac{24\ VDC - 10.96\ VDC}{5.48\ mA} = 2380\Omega$$

Connect a 2380 ohm variable resistor in series with the power supply. A variable resistor is required to account for the 20-percent tolerance of the potentiometer. Figure A-2 is a schematic diagram of this application example.

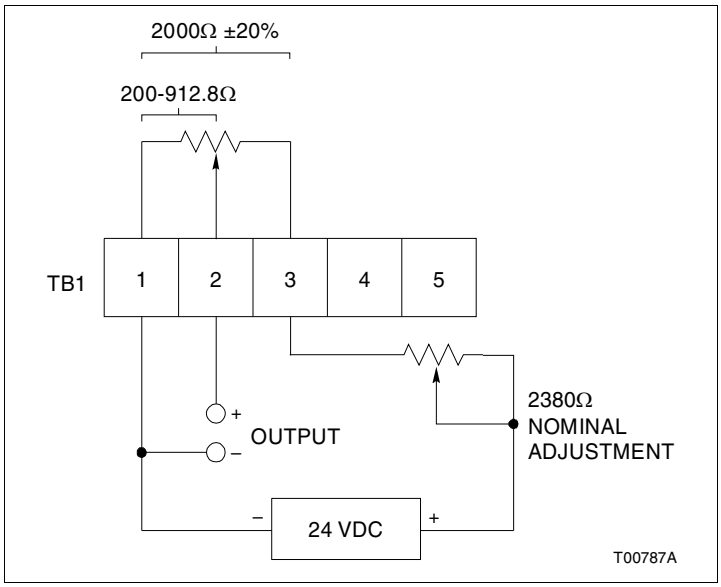


Figure A-2. Schematic for Potentiometric Position Transmitter Example

CALIBRATE THE POTENTIOMETRIC APPLICATION EXAMPLE

T he calibrating information that follows is based on the application put forth in ***Potentiometric Application Example*.**

1. Move the actuator to the 0% output position.

2. Remove the field wiring from TB1-1, TB1-2 and TB1-3. Using an ohmmeter, measure the resistance between TB1-1 and TB1-2. If the reading is 200, ±20 ohms, remove the ohmmeter and proceed to Step 3. Otherwise continue with Step 2.

WARNING	**The pneumatic supply pressure must be turned off before removing the positioning cam. The final control element will go to one end of the stroke and can cause a process upset. Some process upsets may cause damage to equipment and endanger personnel.**

a. Remove the cam by removing the screw, flag, nut, and washer (Fig. A-3).

b. Loosen the set screw on the hub of the small gear using a 1/16-inch Allen wrench (Fig. A-3).

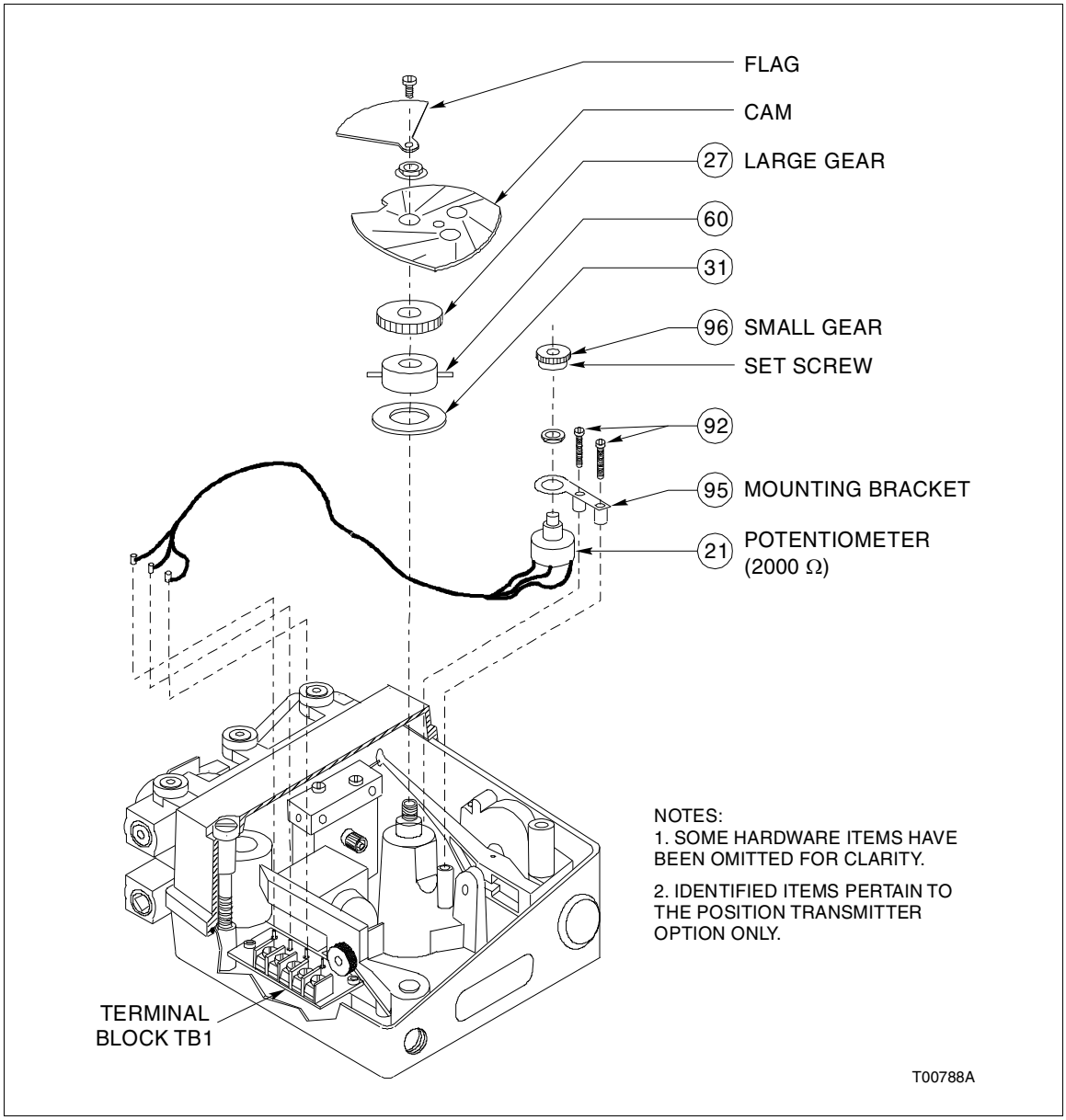


Figure A-3. Potentiometric Position Transmitter Assembly (Exploded View)

c. Use a screwdriver to adjust the shaft on the potentiometer until the ohmmeter reads 200, ±20 ohms. While adjusting the resistance, hold the gears and cam shaft stationary so rotation does not occur. Only the potentiometer shaft should move while adjusting the resistance.

d. Tighten the set screw on the small gear hub.

NOTE: If the mesh between the large and small gears is not tight, adjust the position of the potentiometer mounting bracket (Fig. A-3) so that backlash is eliminated.

e. Remove the ohmmeter from TB1-1 and TB1-2. Install the cam, screw, flag, nut, and washer (Fig. A-3).

3. Connect the field wiring to the terminal block. Connect a DC voltmeter between TB1-1 (-) and TB1-2 (+).

4. Move the actuator to the 80% position. Adjust the resistor in series with the 24 VDC supply until the voltmeter reads 5 VDC.

5. Move the actuator to the 0% position to verify that the voltmeter reads less than 5 VDC.

6. Move the actuator to the 100% position to verify that the voltmeter reads greater than 5 VDC.

7. Potentiometric calibration complete.

Calibrating the Four to 20 mA Position Transmitter

Labels located inside the positioner cover show the location of jumpers, test points, calibration pots, and field connection terminals for the position transmitter (Fig. A-1 and A-4).

1. Remove the FOR/REV jumpers, and place the CAL/OPER jumpers in the calibrate (CAL) position (Fig. A-4).

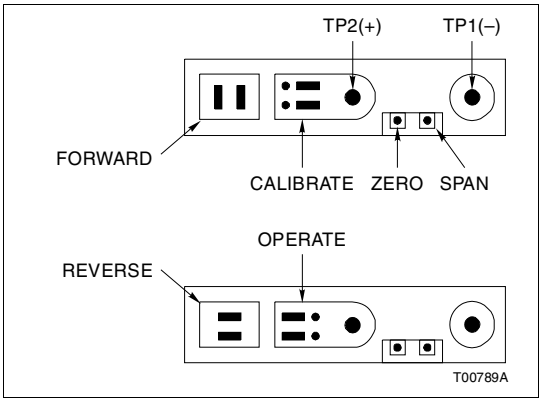


Figure A-4. Location of Calibration Features for 4 to 20 mA Position Transmitter

2. Move the actuator to the 50% output position.

3. Insert ohmmeter leads into test jacks TP1 and TP2. If the resistance value is between 940 and 1060 ohms, remove the ohmmeter leads and proceed to Step 4. Otherwise continue with Step 3.

WARNING	**The pneumatic supply pressure must be turned off before removing the positioning cam. The final control element will go to one end of the stroke and can cause a process upset. Some process upsets may cause damage to equipment and endanger personnel.**

a. Remove the cam, by removing the screw, flag, nut, and washer (Fig. A-5).

b. Loosen the set screw on the hub of the small gear using a 1/16-inch Allen wrench (Fig. A-5).

c. Use a screwdriver to adjust the shaft on the potentiometer until the ohmmeter reads 1000, ±10 ohms. While adjusting the resistance, hold the gears and cam shaft stationary so rotation does not occur. Only the potentiometer shaft should move while adjusting the resistance.

NOTE: If the mesh between the large and small gears is not tight, adjust the position of the potentiometer mounting bracket (Fig. A-5) so that backlash is eliminated.

d. Tighten the set screw on the small gear hub.

e. Remove the ohmmeter from TB1-1 and TB1-2. Install the cam, screw, flag, nut, and washer (Fig. A-5).

4. Place the CAL/OPER jumpers into the operate (OPER) position (Fig. A-4). If a direct-acting cam is being used, place the FOR/REV jumpers in the FOR position. For a reverse action cam, place these jumpers in the REV position (Fig. A-4).

5. Move the actuator to the 0% position. Insert ammeter leads into TP2(+) and TP1(-). If the position of the cam limits access to TP1, connect the (-) lead of the meter to TB1-2 on the terminal block.

6. Adjust the ZERO potentiometer to 4.00 mA. See Figure A-4 for the location of the zero potentiometer.

7. Move the actuator to the 100% position. Adjust the SPAN potentiometer to 20.00 mA. See Figure A-4 for the location of the SPAN potentiometer.

8. Repeat Steps 6 and 7 until the indicated current readings are obtained.

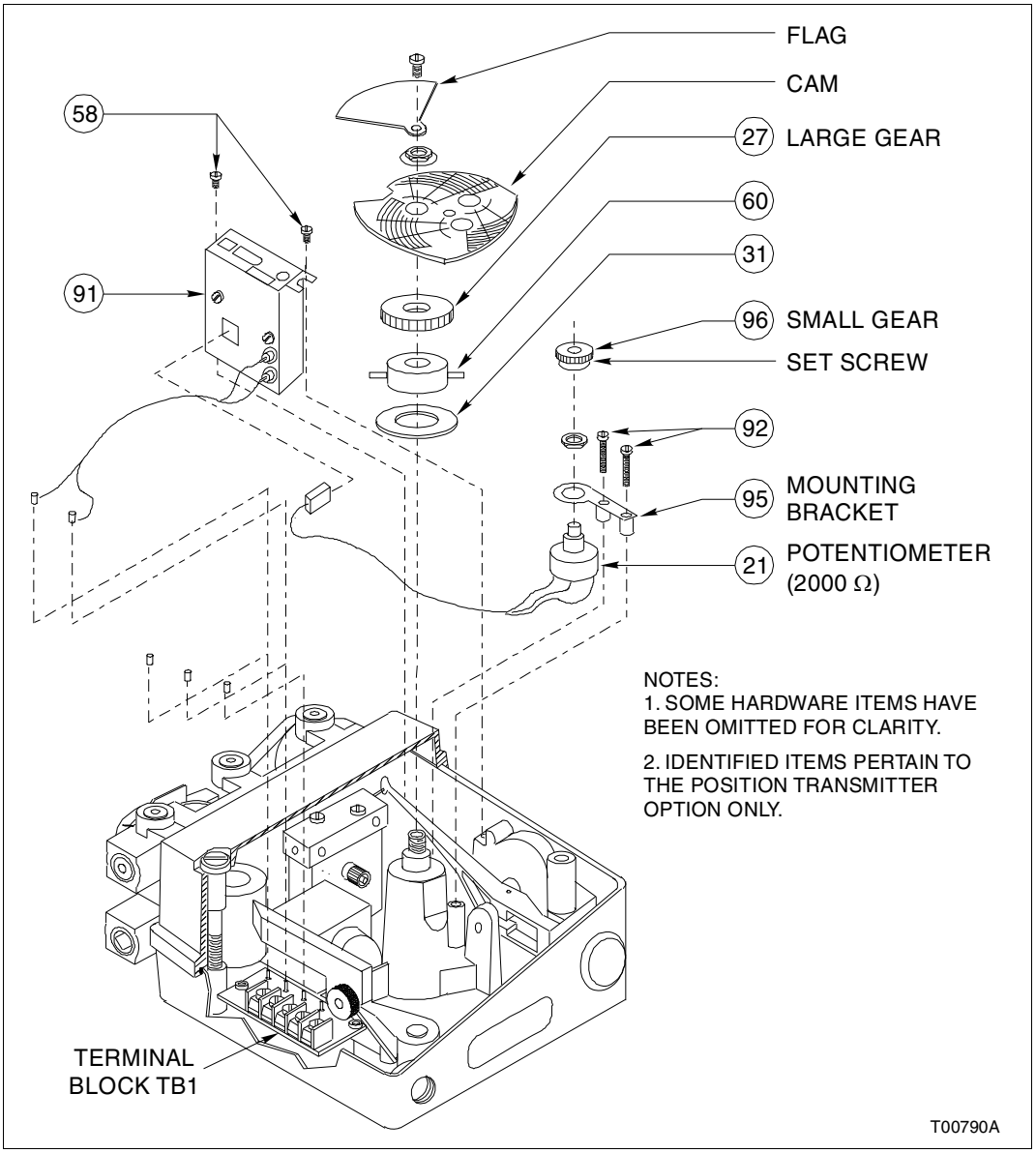


Figure A-5. 4 to 20 mA Position Transmitter Assembly (Exploded View)

Table A-1. 4 to 20 mA Position Transmitter Kit 258670_1

Item	Part Number	Quantity	Description
21	6639540_1	1	Potentiometer assembly
27	193243_1	1	Large position transmitter gear
31	19734_45	1	Washer
58	NDPAC13005	2	Threaded forming screws
60	5400317_1	1	Gear adapter
91	6639479_1	1	4-20 mA position transmitter assembly
92	NDPAC13012	2	Threaded forming screws
95	5400268_1	1	Potentiometer mounting bracket
96	193242_1	1	Small position transmitter gear

APPENDIX B - QUICK START

INTRODUCTION

This section is intended for control engineers with in-depth knowledge of positioners and positioner applications. This quick start only highlights the primary tasks involved in installation and operation. Section 1 through 5, in the main body of this instruction book address installation and operation in more detail.

PRODUCT IDENTIFICATION (NOMENCLATURE)

Table B-1. Type AV3/4 Nomenclature

Position	3	4	5	6	7	8	
Type AV	_	_	_	_	_	_	**Characterizable Positioners**
							Type
	3						Characterizable 4 to 20 mA Input Positioner (fail in place upon loss of signal)
	4						Characterizable Pulse Input Positioner (fail in place upon loss of signal)
							Input Signal
		3					4 to 20 mA (Type AV3)
		4					Contact closure/open collector DDC (Type AV4)
							Stroke/Rotary Motion (cam selection)
			1				12.7 - 50.8 mm (0.5 - 2.0 in.) or 45° rotary motion
			2				25.4 - 101.6 mm (1.0 - 4.0 in.) or 90° rotary motion
							Manifold (includes filters)
				0			None
				1			Manifold with equalizing valve
				2			Manifold without equalizing valve [2]
				3			Gage Block (gage ports only)
							Position Transmitter[1]
					0		None (Type AV3 and Type AV4)
					1		Potentiometric resistive output (Type AV3 only)
					2		4 to 20 mA Output (Type AV3 only)
							Drive Shaft
						0	Standard with drive arm
						1	½-inch square end
						2	0.342-in. square end for older DeZurik actuators
						3	0.250 in. across flats (UP1 and UP2 after August, 1995)
						4	0.375 in. square for DeZurik PowerRac® actuators
						5	0.156 in. across flats for NAMUR rotary actuators

NOTE:
1. When ordering Type AV44, position 7 must be 0. The 4 to 20 mA output position transmitter is not an option, it is a standard feature of Type AV44 positioner. The position transmitter options are only valid for Type AV33 positioners.
2. No longer available as of October, 2003.

MOUNTING THE POSITIONER

Install the positioner as required on the actuator. Figures B-1 and B-2 show typical mounting arrangements.

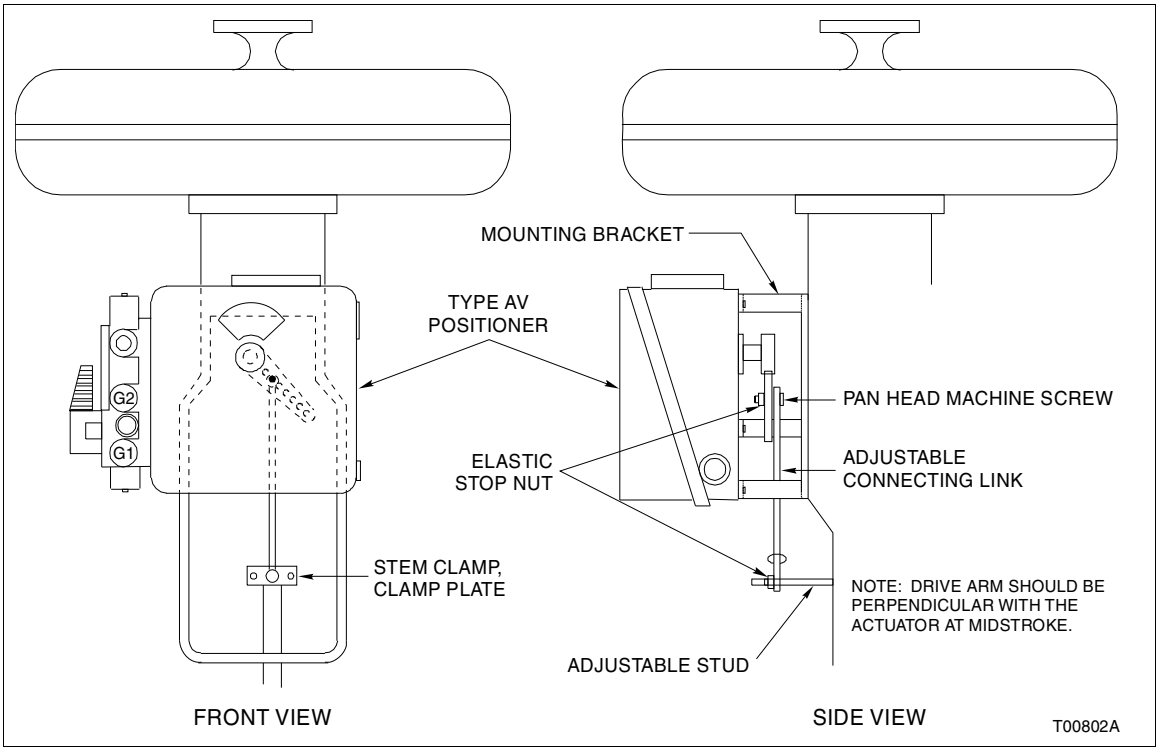


Figure B-1. Typical Positioner Mounting Using Linkage

NOTE: If your actuator is equipped with a Type AV positioner as ordered, verify that all the connections are secure and make any adjustments as required.

Use the following procedure for mounting guidelines.

1. Set the actuator at the 0 position. Connect the adjustable linkage to the drive arm. The drive arm holes correspond to stroke length of the actuator. Refer to Figure B-3 for the stroke length for each drive arm hole.

2. Install the cam (black, direct-acting; or red, reverse-acting) that will provide the required direction of rotation.

NOTE: Cams have three mounting holes: A, square root; B, linear; C, square. Each mounting hole is star shaped so the cam can be rotated in 45° increments to suit the application.

3. With the actuator in the closed position, adjust the connecting linkage so that the zero radial line on the cam intersects the center of the cam roller (Fig. B-4).

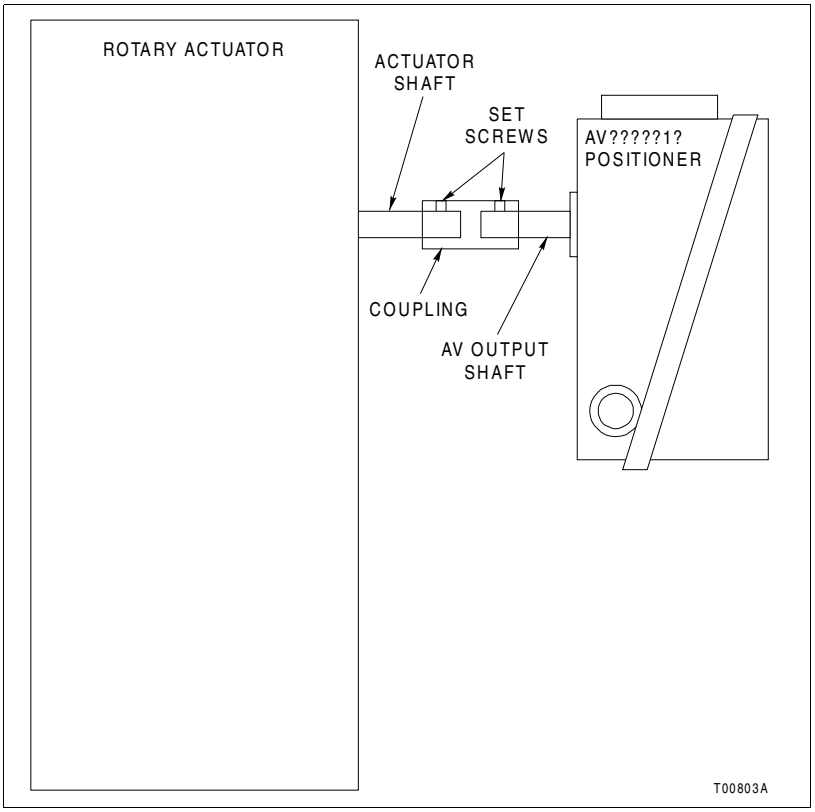


Figure B-2. Typical Positioner Mounting Using Driect Coupling

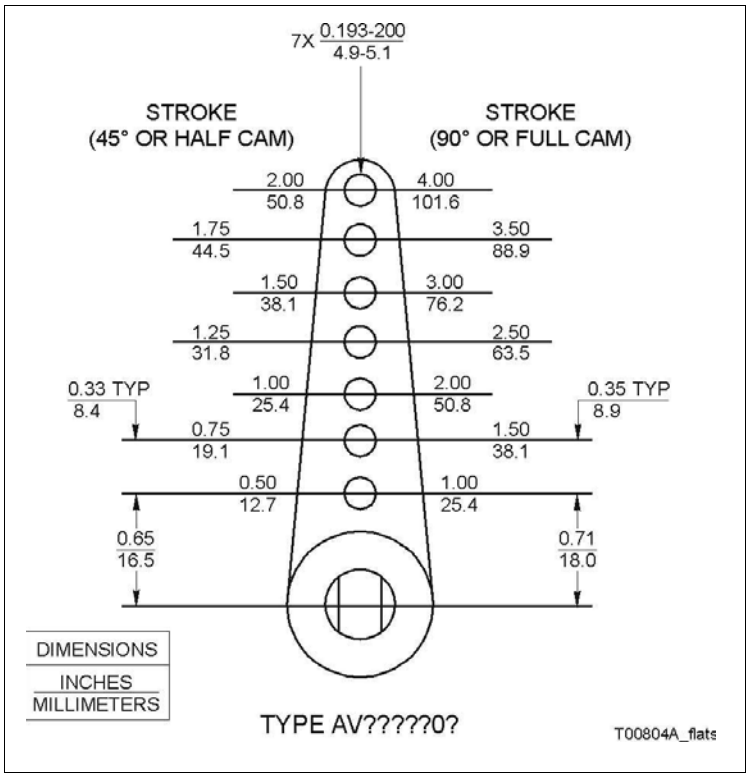


Figure B-3. Drive Arm Connections

4. Lock all linkage components in place.

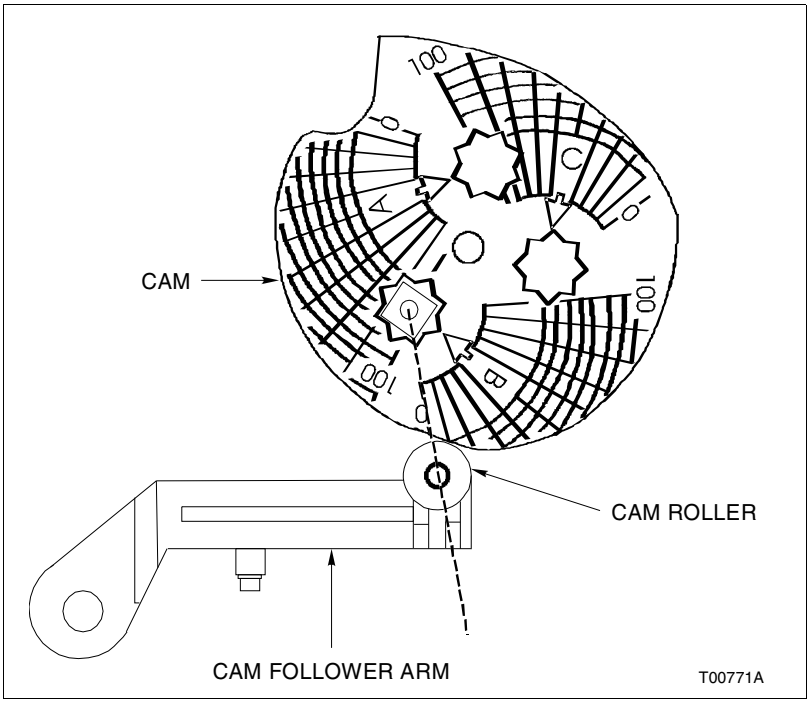


Figure B-4. Cam Roller Alignmment

EXTERNAL TUBING CONNECTIONS

1. Connect the required supply air to connection (Fig. B-5).

   NOTE: Maximum torque for ¼-NPT fittings is 13.6 Nm (10 ft-lbs).

2. Connect the output ports 01 and 02 as required to provide the desired direction of rotation. Figure B-6 shows a single-acting tubing example and B-7 shows a double-acting tubing examples.

   NOTE: The piping arrangements shown in Figures B-6 and B-7 are general examples and may not reflect exactly the arrangement required for your application.

3. Install ⅛-inch NPT permanent instrument gages to the gage ports if desired or for calibration requirements.

EXTERNAL WIRING CONNECTIONS

Connect the signal wiring using ½-inch NPT conduit. Figure B-5 shows the location of the conduit connection. Refer to Figure B-8

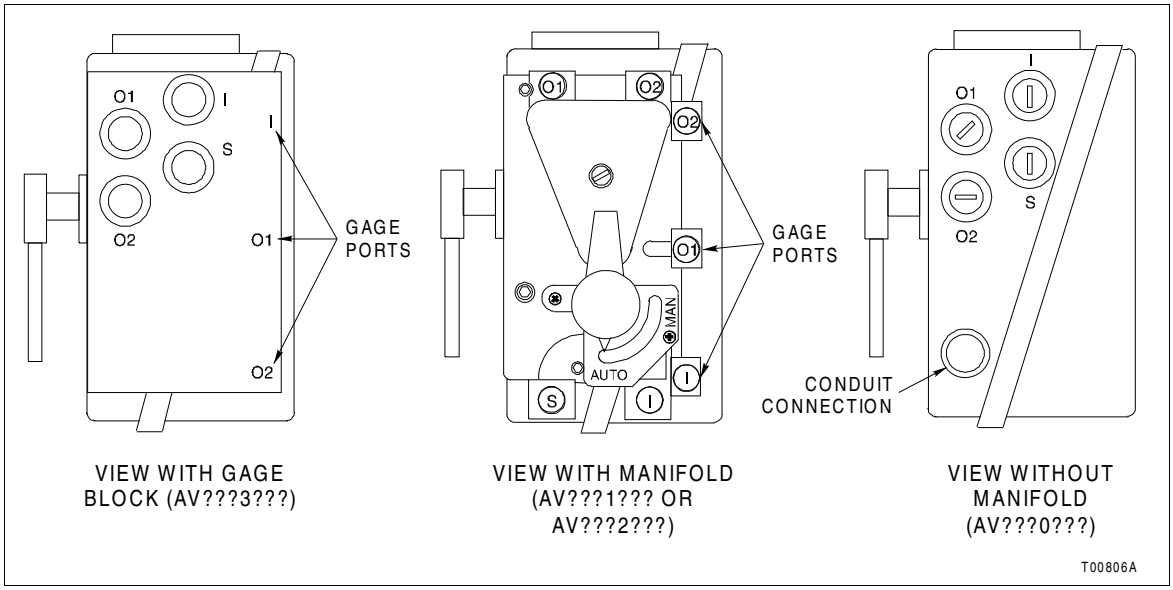


Figure B-5. Type AV Positioner Port Locations

which shows the wiring diagram. This diagram is also shown on the inside of the front cover of the positioner.

1. ***Type AV33 positioner***: connect the 4 to 20 mA position demand signal wires to terminals TB1-4 (+) and TB1-5 (-) to the terminal block (Fig. B-8).

If equipped with the optional 4 to 20 mA position transmitter, terminals TB1-1 (+) and TB1-2 (-) provide customer access to the 4 to 20 mA feedback signal. If equipped with the optional potentiometric position transmitter, three leads are available for customer use at terminals TB1-1, TB1-2, and TB1-3. For detailed information about position transmitters, refer to Appendix A.

2. ***Type AV44 positioner***: Connect DDC pulse or contact closure (raise/lower) input signal wires to terminals TB1-4 and TB1-5. Connect the (+) 24 VDC to terminal TB1-3 and the position transmitter feed back connection to terminals TB1-1 (+) and TB1-2 (-) (Fig. B-8).

> **NOTE:** Route the wiring inside the positioner so it does not become entangled with moving parts. A cable clip (Fig. B-9) is provided inside the positioner so entanglement can be avoided.

CALIBRATION

Table B-2 presents calibration procedures for Type AV3 and Type AV4 positioners in table format. Table B-3 pertains to Type AV4 and is a required part of calibration.

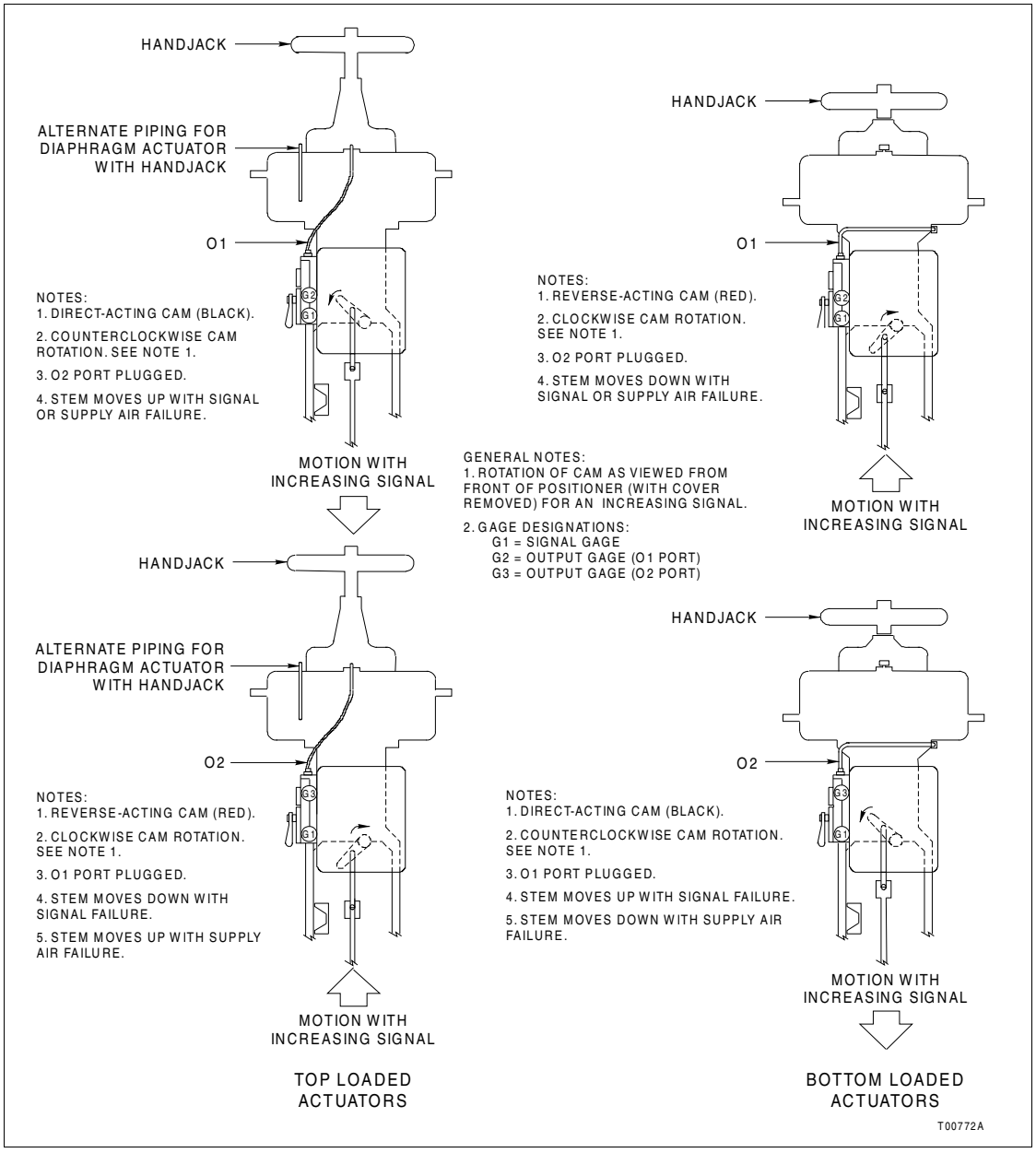


Figure B-6. Tubing Examples of Single-Acting Actuators

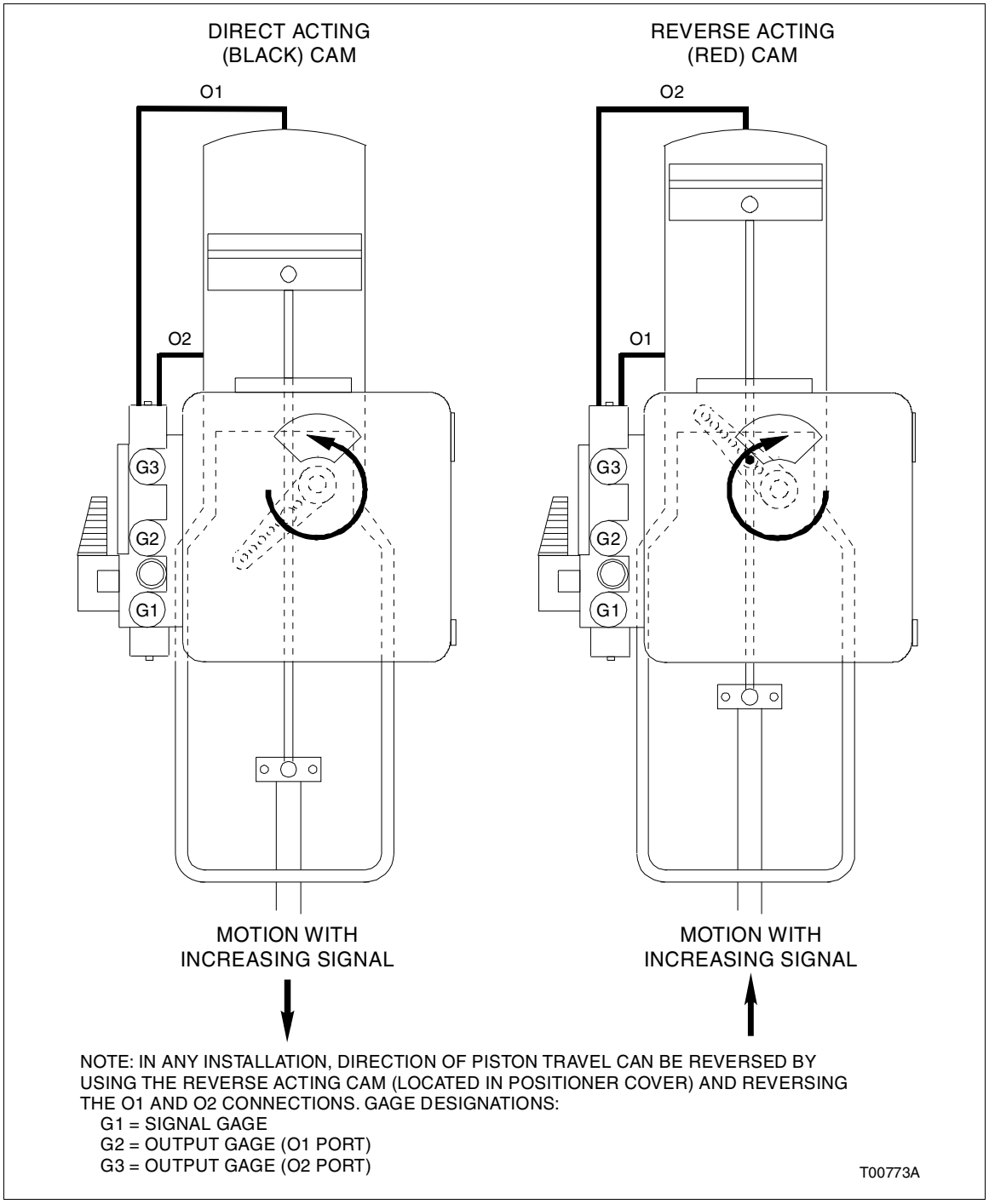


Figure B-7. Tubing Example of a Double-Acting Actuator

	TB1 CONNECTIONS				
NOMENCLATURE	1	2	3	4	5
AV23?????				+	–
Av33?????				+	–
AV44?????	+	–	+24	RAISE	LOWER
AV????1??					
AV????2??	+	–			

T00807A

Figure B-8. Type AV Wiring Connections

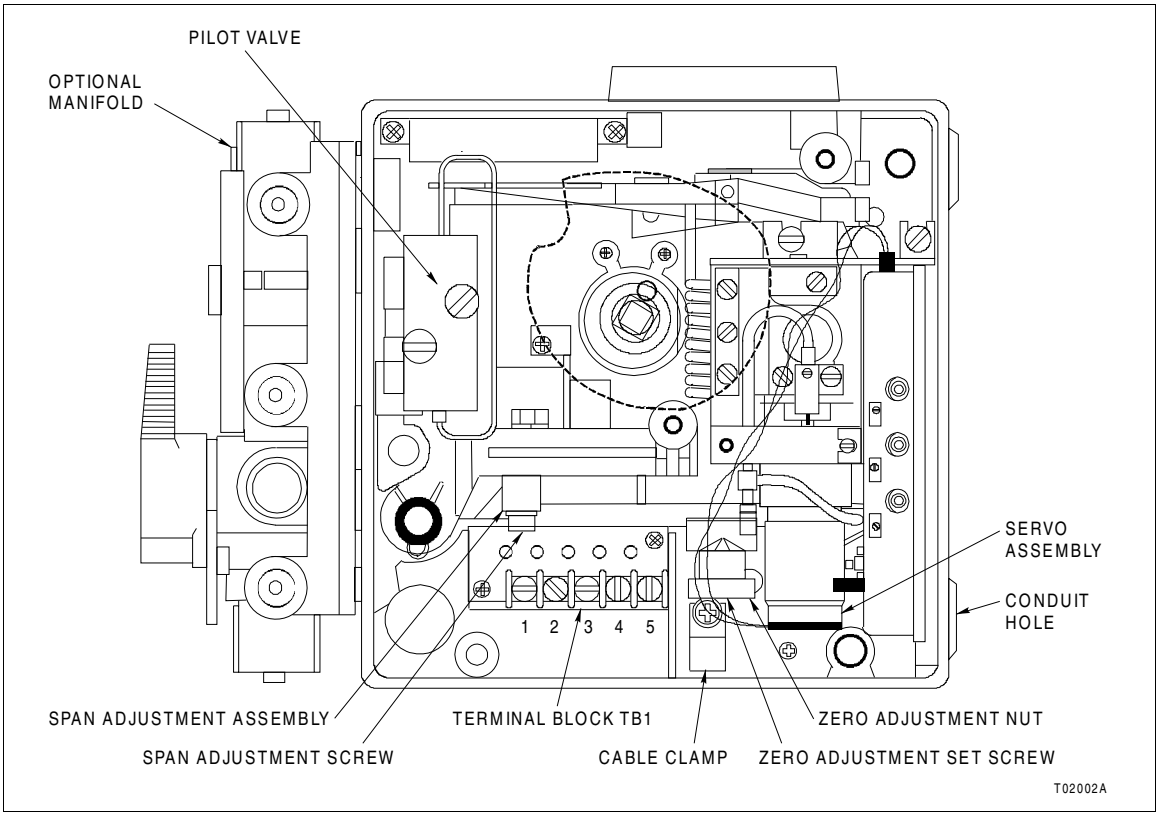


Figure B-9. Type AV Calibration Adjustment Locations

Table B-2. Calibration Procedures

AV3 Calibration Adjustment	Procedure	AV4 Calibration Adjustment	Procedure
Zero	1. Turn on supply air. Apply a 4 mA input signal to the positioner. The actuator should be in the closed position.	Zero	1. Turn on supply air. Pulse the positioner in order to arrive at the minimum (closed) position.
	2. Loosen the zero adjustment setscrew (Fig. B-9) using a 3/32-inch Allen wrench.		2. Loosen the zero adjustment setscrew (Fig. B-9) using a 3/32-inch Allen wrench.
	3. Turn the zero adjustment nut (clockwise to increase) until the 0 radial line on the cam intersects with the center of the cam roller (Fig. B-4).		3. Turn the zero adjustment nut (clockwise to increase) until the radial line on the cam intersects with the center of the cam roller (Fig. B-4).
	4. Tighten the zero adjustment setscrew.		4. Tighten the zero adjustment setscrew.
Span	1. Apply 20 mA to the positioner. The actuator should be in its full open position.	Span	1. Pulse the Raise (TB1-4) terminal until the actuator is in the full open position.
	2. Loosen the span adjustment screw (Fig. B-9) using a 3/32-inch Allen wrench.		2. Loosen the span adjustment screw (Fig. B-9) using a 3/32 -inch Allen wrench.
	3. Slide the span adjustment assembly in the (Fig. B-9) appropriate direction (toward cam to increase) in order to align the 100% radial line with the center of the cam roller.		3. Slide the span adjustment assembly in the (Fig. B-9) appropriate direction (toward cam to increase) in order to align the 100% radial line with the center of the cam roller.
	4. Tighten the span adjustment screw.		4. Tighten the span adjustment screw. Refer to Table B-3 for motor speed adjustment information.

Table B-3. Motor Speed Adjustment (AV4 Only)

AV4 Calibration	
Adjustment	**Procedure**
Motor Speed	1. Set the coarse adjustment potentiometer, located on the EMI/electronics housing, to position 1.
	2. Set the fine adjustment to the fastest speed (fully clockwise) (Fig. B-10).
	3. Apply pulse inputs until the actuator reaches 0%.
	4. Using a stopwatch measure the time it takes the actuator to reach 100% by applying a constant increase signal.
	5. Having obtained an actuator speed value in Step 4, use Table B-4 to determine the coarse speed adjustment setting which encompasses the actuator speed.
	6. AV4 calibration is complete.

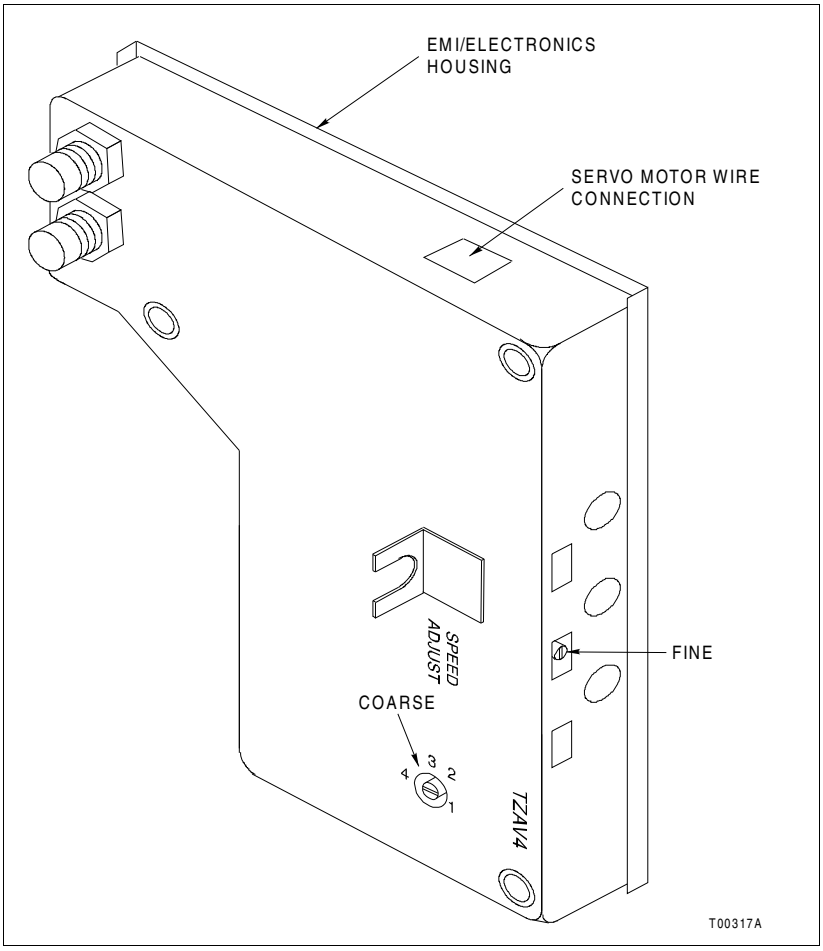


Figure B-10. Type AV4 Positioner Motor Speed Adjustment

Table B-4. Servo Motor Speed Adjustment (Coarse and Fine)

Coarse Adjustment Switch Position	Factory Set Speed (seconds)	Fine Adjustment Speed Range (seconds)
4	26.0	21.0 to 42.0
3	13.5	12.0 to 22.0
2	8.0	7.0 to 13.0
1	5.0	4.5 to 8.0

APPENDIX C - CAM CHARACTERIZATION

INTRODUCTION

This section provides cam shaping information. Cam shaping is the process of changing the shape of the cam by cutting or forming so the control signal produces the desired control characteristic. The standard cam normally does not require shaping.

CAM CHARACTERIZATION

Selecting or shaping these cams allows you to obtain a piston (or valve) position versus control signal characteristic that will produce a desired controlled medium versus control signal characteristic. An example is a desired flow rate of air, water, or steam through a valve for each control signal pressure applied to the positioner.

The control characteristics for which the cams are shaped are listed in Table 3-1 and are shown in Figures C-1, C-2, and C-3. The figures show a family of curves for each cam whose boundaries are established by a span adjustment. Table C-1 lists control signal pressures of specific Type AV3 positioners which corresponds to the signal span percent values in Figures C-1, C-2 and C-3. Table C-1 shows the relationship between input current to output for the servo assembly.

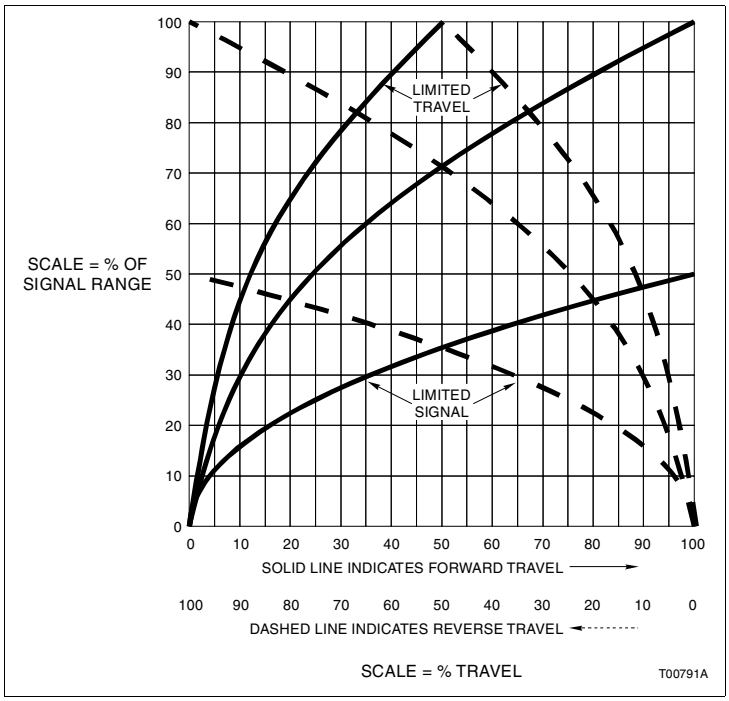


Figure C-1. Cam A, Square Root Relationship

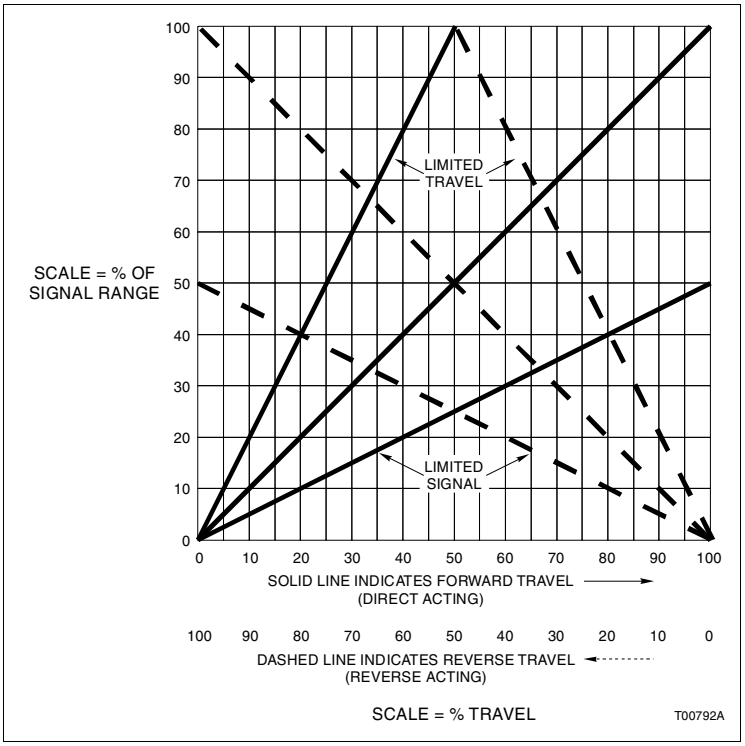


Figure C-2. Cam B, Linear Relationship

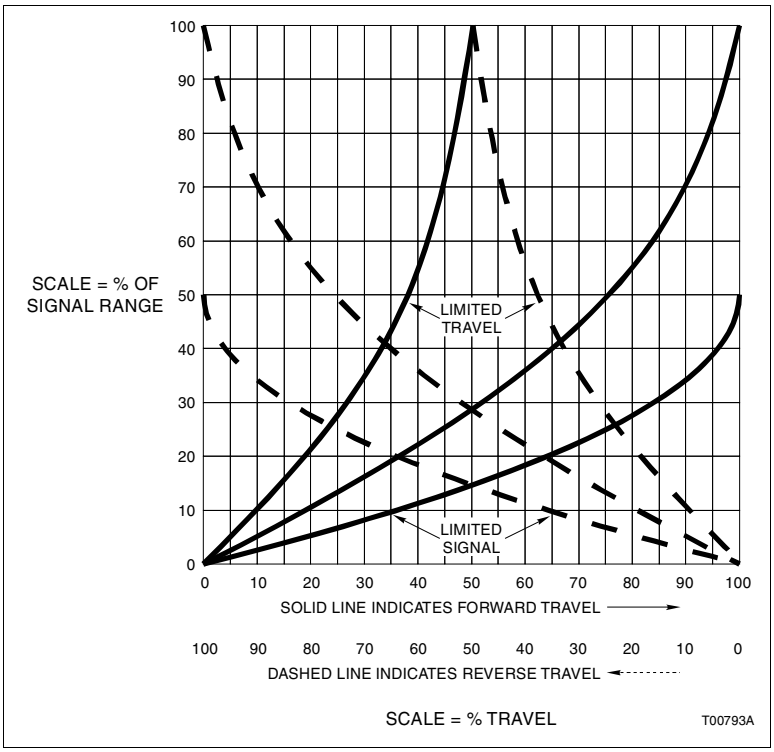


Figure C-3. Cam C, Square Relationship

Table C-1. Relationship of Input to Output for I/P Converter (AV3)

% of Control Signal	I/P Converter		% of Control Signal	I/P Converter	
	Input (mA)	Output (psig)		Input (mA)	Output (psig)
0	4.0	3.0	60	13.6	10.2
10	5.6	4.2	70	15.2	11.4
20	7.2	5.4	80	16.8	12.6
30	8.8	6.6	90	18.4	13.8
40	10.4	7.8	100	20.0	15.0
50	12.0	9.0			

CAM SELECTION

In a system involving only a single actuator or cylinder, the B cam is probably satisfactory and should be tried first. However, one of the other cams may provide a more stable control over a wide range of operation within a given proportional band gain adjustment on the controller. Where the actuator or cylinder is part of a complex control system, the three standard cams A, B and C provide a choice of control characteristics. The cam, in conjunction with a span adjustment, are likely to meet the control characteristic required for your system.

Steps in selecting a standard cam for a particular application are:

1. With the B (linear) cam in place, determine and plot the actual controlled medium versus piston (or valve) position characteristic by manually adjusting valve position and measuring the controlled medium (Fig. C-4).

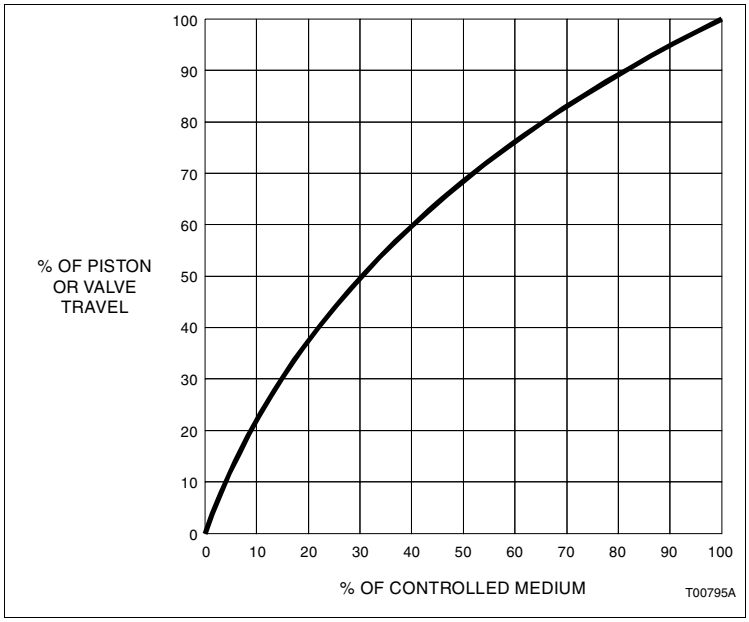


Figure C-4. Regulated Device Characteristics

2. Plot the exact control medium versus control signal characteristic given or desired for the application. This is usually a linear function (Fig. C-5).

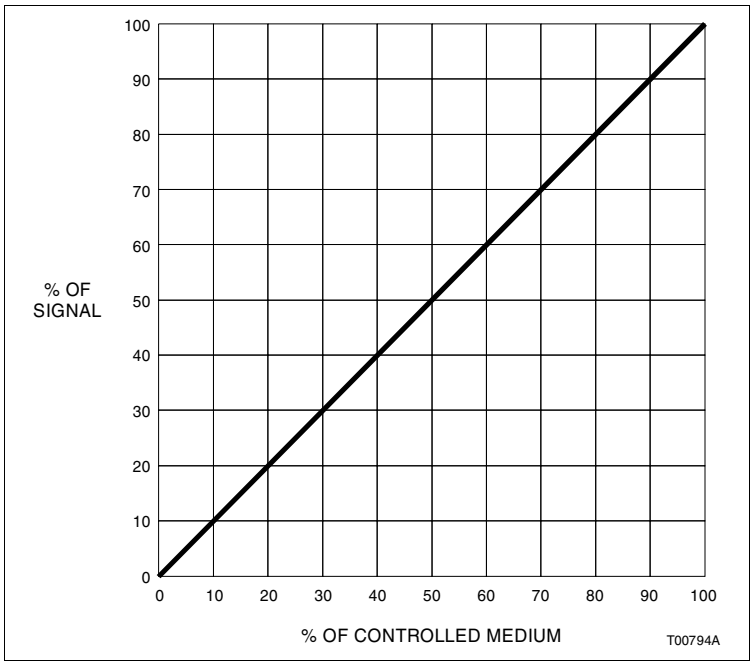


Figure C-5. Desired Control

NOTES:

1. If angularity is introduced into the drive linkage, replot the controlled medium versus piston travel curves. In all cases, avoid overstroking the final control device.

2. In terms of the Type AV4 positioner, the percent of control signal input is related to the pulse duration; where 100 percent signal corresponds to the time required for full scale position change.

3. Using values determined in Steps 1 and 2, plot a curve for the exact control signal versus piston (or valve) characteristic that will produce the results of Figure C-7 from a cylinder or actuator which performs as in Figure C-4. In the examples shown, the required curve is a mirror image of the Step 1 curve taken about the Step 2 curve (Fig. C-7).

4. Compare the curve plotted in Step 3 with the cam curves shown in Figures C-1, C-2 and C-3. Select a standard cam shape (in this case a C cam) whose characteristic most closely matches the control signal versus piston (or valve) characteristic plotted in Step 3.

5. If necessary, adjust positioner zero and span as outlined under ***Zero Adjustment*** and ***Span Adjustment*** in Section 4 to make the control signal pressure versus piston (or valve) characteristic conform better to the curve plotted in Step 3.

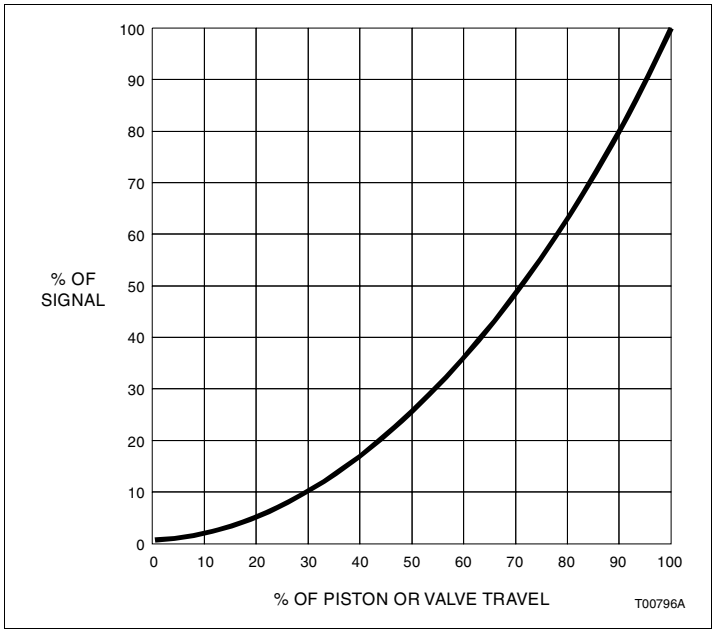


Figure C-6. Cam Characteristics

6. If the required characteristic cannot be obtained using the above procedure, or if more exact characteristics are required, alter the shape of a standard A, B, or C cam or cut a new cam from a blank cam as outlined under ***CAM SHAPING METHOD***.

CAM SHAPING METHOD

To assist in the alteration process, a graph is imprinted on each cam. This graph consists of radial lines and concentric arcs. The first and last radial lines mark the angles at which zero and 100 percent of cam rotation occur for control purposes; the radial lines in between are equal intervals of rotation. These lines are indexes of percentage of piston (or valve) travel.

The concentric arcs on the cam correspond to actual control signal pressure values shown in Table C-1 for the particular positioner being used. Together, the radial lines and concentric arcs form a polar diagram on which a new cam shape (and characteristic) can be plotted.

> **NOTE:** Before cutting any cam, make sure that shaping will involve removal of cam material and not build up of cam material. For example if the characteristic plotted lies between the A and B cams (Figs. C-1 and C-2), cut the A away.

1. Use the cam selected in Step 4 under ***CAM SELECTION***. Also have available a graph of control signal versus actuator travel for the characteristic desired. (Such a graph may be derived from the cam characteristic curve developed in Step 3 of ***CAM SELECTION***). Simply replace the percent values on the vertical axis with the corresponding actual signal from Table C-1 for the positioner being used.

2. Refer to Figure ***Transferring Data from the Graph to the Cam***C-7 for the method of transferring data from the graph to the cam. For each radial line on the cam (representing a percent piston or valve travel), find the value of signal on the graph which corresponds to that percent piston or valve travel. Proceed along the radial line to the concentric arc which represents the signal pressure for the radial lines percentage piston or valve travel. Mark the cam at that point.

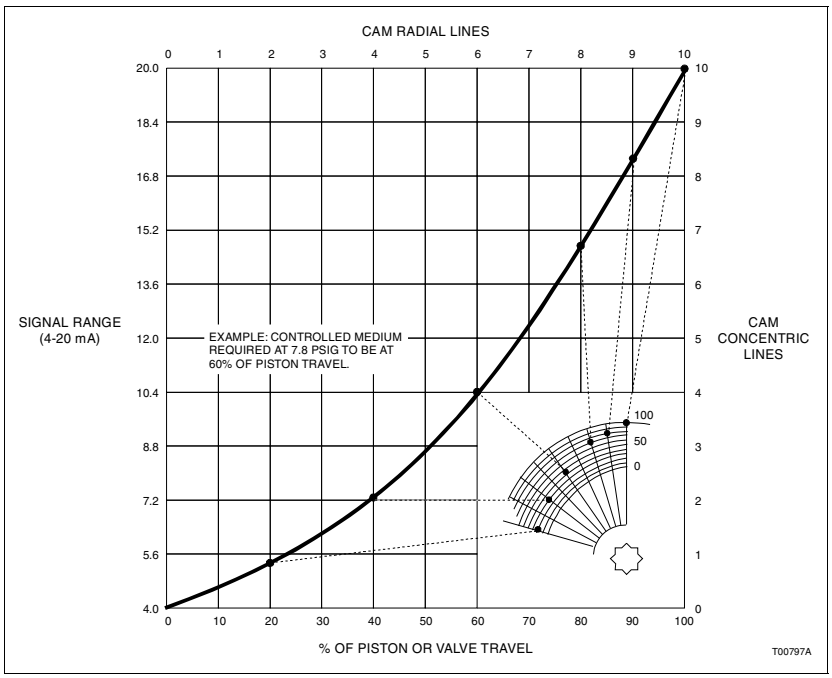


Figure C-7. Transferring Data from the Graph to the Cam

Continue in this manner until all the radial lines are marked with a signal pressure point. (Example: in Figure C-7, the graph calls for a signal of 10.4 milliamps at 60 percent travel position. On the 60 percent travel radial line of the cam, a mark is placed at concentric line 4, representing that pressure.)

3. Draw a line through the points located in Step 2. This will be the desired cam shape.

> **NOTE:** If a cam shape has too steep a rise, the cam follower may become locked. A cam with too steep a rise may be replaced with a cam with a gentler rise if sufficient angularity is introduced into the drive linkage of the actuator or cylinder. Optional blank cam (part number 5400277_1) is available from ABB if alteration of the standard cam is not desired.

Index

Index (continued)

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