

# Smart Valve Positioner 700 Series with HART Communication Protocol

Model AVP701/AVP702

## OVERVIEW

The Smart Valve Positioner 700 Series (model number: AVP7\_ \_) not only inherits the reliability of the core technology established by the 300 Series but has advanced control valve diagnostic techniques and the latest system integration technology.

The Smart Valve Positioner 700 Series provides numerous benefits for various stages in the life cycle of users' plants and contributes to the improvement of plant productivity.

## FEATURES

### 1. Improved valve diagnosis

Because the pressure sensor measures positioner output air pressure, the following valve diagnostic functions have been improved.

- Detection of abnormalities associated with valve closing, the actuator, and friction.
- Valve Signature (based on the relationship between the valve travel and pressure of the actuator)
- Positioner air circuit diagnosis

### 2. Easy adjustment and setup

The following can be easily adjusted or set up using the local user interface (LUI), which consists of an LCD and operation buttons. Since the operation buttons are isolated from the positioner, the positioner can be used in an explosive atmosphere.

- Auto-setup (auto-adjustment)
- Zero/span adjustment
- Supply bypass switching
- Control parameter configuration

### 3. Single model for multiple specifications

The model AVP702 settings can be changed without any replacement of changing of parts. A single model can be modified to suit any application without any parts change.

- Flow characteristic: Linear, EQ%, Quick opening or user customized characteristics
- Actuator type: Double or single acting actuator



### 4. Easy maintenance

Because the electric circuits are completely separated from the pneumatic circuit, maintenance work on the pneumatic circuit at the work site is easy.

In addition, the pilot component has an auto/manual switch. Thus, even if there is no electrical signal, a valve operation check can be conducted.

(However, in the case of a double-acting actuator, the switch cannot be used.)

### 5. Valve travel output function

In the case of (4 to 20 mA DC) valve travel output models in the AVP701 series, valve operation can be monitored from the control room.

(Note that because a power supply circuit for travel output is required in addition to the input signal line, 4-wire instrumentation is needed.)

The wiring method differs depending on whether this device is used as a normal current-pneumatic positioner or as a positioner with a travel transmission function. When using this device as a normal current-pneumatic positioner, it is necessary only to connect the positioner to the host controller with an input signal cable (4 to 20 mA DC) as with previous models. Figures 1 and 2 show the wiring diagrams.

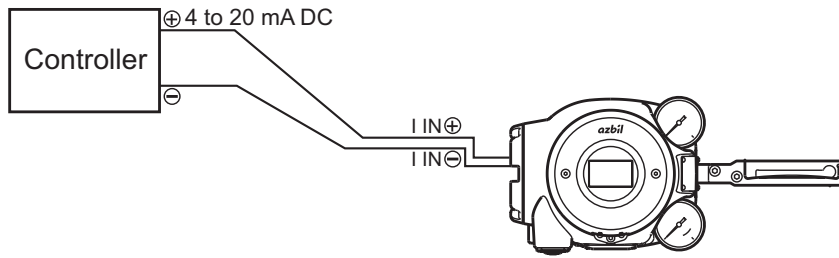


Figure 1. Normal current-pneumatic positioner (model AVP702)

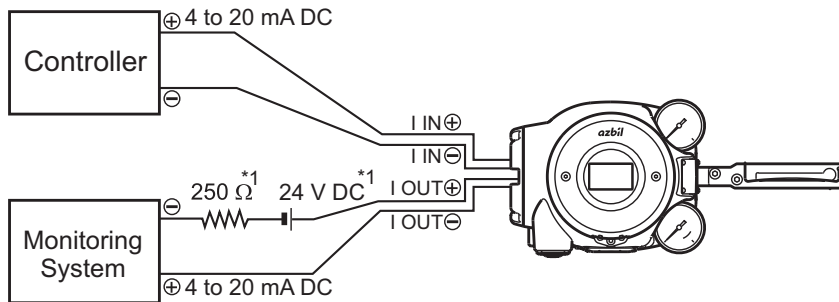


Figure 2. Positioner with travel transmission function (model AVP701)

\*1. For load resistance, refer to Figure 3.

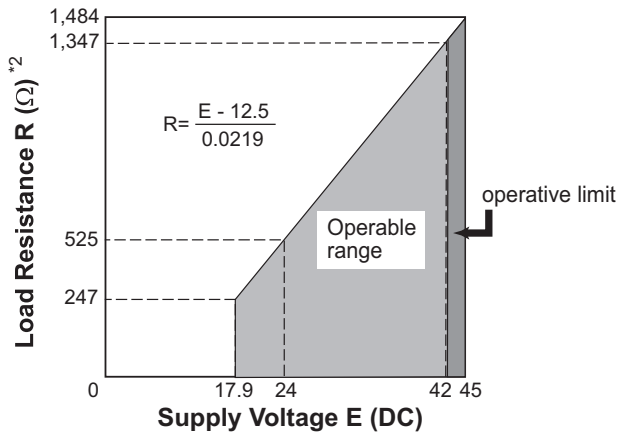


Figure 3. Supply voltage for travel transmission vs. load resistance characteristic

\*2. Load resistance = Resistance for Monitoring system + 250 W\*1 + Resistance of supply voltage\*1

**LIST OF FEATURES**

Item	Function
Desired input signal range	Any split-range value can be specified.
Forced fully open/closed	The control valve can be fully closed or opened securely when the desired percentage of input signal is reached.
Desired flow characteristics	The relationship between input signal and valve travel that is appropriate for the process can be defined by using a 21-point line graph.
Travel transmission (option)	Valve motion can be reliably monitored by transmitting the valve travel.

**FUNCTIONAL SPECIFICATIONS**

Item	Specification	
Applicable actuator	Pneumatic single and double acting, linear and rotary motion actuator	
Input signal	4 to 20 mA DC (Configurable to any required range for split range: minimum span 4 mA DC) Minimum driving current: 3.84 mA	
Output signal	4 to 20 mA DC (Travel transmission)	
Input resistance	475 Ω typically / 20 mA DC (Without the overvoltage protection) 600 Ω typically / 20 mA DC (With the overvoltage protection)	
Lightning protection	Peak value of voltage surge: 12 kV Peak value of current surge: 1000 A	
Flow characteristics	Linear, Equal percentage, Quick opening Custom user characteristics (21 points)	
Manual operation	Auto/Manual external switch or LUI (Local User Interface) (Not available double acting actuator)	
Supply air pressure	140 to 700 kPa	
Air consumption	for single acting actuator 3.2 L/min [N] or less: with steady supply air pressure of 140 kPa {1.4 kgf/cm <sup>2</sup> } and output of 50 % 4.0 L/min [N] or less: with steady supply air pressure of 280 kPa {2.8 kgf/cm <sup>2</sup> } and output of 50 % 4.8 L/min [N] or less: with steady supply air pressure of 500 kPa {5.0 kgf/cm <sup>2</sup> } and output of 50 %  for double acting actuator 8 L/min (N) or less: at air pressure of 400 kPa {4.0 kgf/cm <sup>2</sup> } and balanced output pressures at a steady 70 % of the supply air pressure	
Maximum air deliver flowrate	110 L/min (N) at 140 kPa {1.4 kgf/cm <sup>2</sup> }	
Air connections	Rc1/4 or 1/4NPT internal thread	
Electrical connections	G1/2, 1/2NPT or M20 × 1.5 internal thread	
Ambient temperature limits	−40 to +80 °C for general model TIIS Flameproof: −20 to +55 °C FM/FMC/IECEX/NEPSI/KOSHA/INMETRO Explosion protection: −30 to +75 °C FM Intrinsically safe (ic) and Nonincendive: −24 to +75 °C ATEX/IECEX Intrinsically safe: −40 to +60 °C LCD operating limit: 0 to +50 °C	
Ambient humidity limits	5 to 100 %RH	
Vibration characteristics	20 m/s <sup>2</sup> , 5 to 400 Hz (with standard mounting kit on Azbil Corporation's HA actuator)	
Color	Silver	
Material	Cast aluminum	
Weight	Without Pressure regulator with filter: 4.2 kg With Pressure regulator with filter: 4.9 kg	
Performance	Accuracy	±1.0% F.S. But: ±3.0 % FS if the feedback lever angle is outside the ±4° to ±20° range (see Table 1) There is an additional 0.5 % FS (input error) if 4 mA ≤ input signal span < 8 mA
	Travel transmission accuracy	±1.0 %F.S.*1
	Stroke coverage	14.3 to 100 mm Stroke (Feedback Lever Angle ±4° to ±20°)
Structure	TIIS Flameproof Ex d IIC T6 X  FM Explosionproof/Dust Ignition Protection Explosionproof (Division system): Class I, Division 1, Group B, C, D T6 • Factory sealed, conduit seal not required • Not including gasoline atmospheres Flameproof (Zone system): Class I, Zone 1, AEx d IIC T6 Gb Dust ignition protection (Division system): Class II, III, Division 1, Group E, F, G T6 Dust ignition protection (Zone system): Zone 21 AEx tb IIIC T85 °C Db Enclosure classification: IP66	

\*1. This applies only to positioners with travel transmission (model AVP701). In this case, a power supply circuit for travel transmission is required.

Item	Specification
Structure	<p>FM Intrinsically safe (ic) and Nonincendive</p> <p>Intrinsically safe (ic) (Zone system)            Class I, Zone 2, AEx ic IIC T4            Entity Parameters:            Positioner Circuit: <math>U_i=30\text{ V}</math>, <math>I_i=100\text{ mA}</math>, <math>P_i=1\text{ W}</math>, <math>C_i=24\text{ nF}</math>, <math>L_i=0.22\text{ mH}</math>            Transmitter Circuit (AVP701): <math>U_i=30\text{ V}</math>, <math>I_i=100\text{ mA}</math>, <math>P_i=1\text{ W}</math>, <math>C_i=20\text{ nF}</math>, <math>L_i=0.22\text{ mH}</math></p> <p>Nonincendive (Division system)            Class I, Division 2, Group A, B, C and D, T4            Nonincendive Field Wiring Parameters:            Positioner Circuit: <math>V_{\text{max}}=30\text{ V}</math>, <math>I_{\text{max}}=100\text{ mA}</math>, <math>C_i=24\text{ nF}</math>, <math>L_i=0.22\text{ mH}</math>            Transmitter Circuit (AVP701): <math>V_{\text{max}}=30\text{ V}</math>, <math>I_{\text{max}}=100\text{ mA}</math>, <math>C_i=20\text{ nF}</math>, <math>L_i=0.22\text{ mH}</math></p> <p>Suitable            Class II and Class III, Division 2, Group E, F and G, T4            Indoor/Outdoor Enclosure: NEMA Type 4X, IP66</p> <p>FMC Explosionproof/Dust Ignition Protection</p> <p>Explosionproof (Division system): Class I, Division 1, Group C, D T6</p> <ul style="list-style-type: none"> <li>• Factory sealed, conduit seal not required</li> <li>• Not including gasoline atmospheres</li> </ul> <p>Flameproof (Zone system): Class I, Zone 1, Ex d IIB T6</p> <ul style="list-style-type: none"> <li>• Seal all conduits within 450 mm (18 inches)</li> </ul> <p>Dust ignition protection (Division system): Class II, III, Division 1, Group E, F, G T6            Enclosure classification: IP66</p> <p>ATEX Intrinsically safe/Dust Ignition Protection</p> <p>Intrinsically safe: II 1 G Ex ia IIC T4 Ga            Dust ignition protection: II 1 D Ex ia IIIC T135°C Da            Enclosure classification: IP66            The barriers should be ATEX certified types and comply with the following conditions:            Input Signal Terminals (+/-IN):  <math>U_i=30\text{ V}</math>, <math>I_i=93\text{ mA}</math>, <math>P_i=0.9\text{ W}</math>, <math>C_i=4\text{ nF}</math>, <math>L_i=220\text{ }\mu\text{H}</math>            Output Signal Terminals (+/-OUT):            (AVP701) <math>U_i=30\text{ V}</math>, <math>I_i=93\text{ mA}</math>, <math>P_i=0.9\text{ W}</math>, <math>C_i=22\text{ nF}</math>, <math>L_i=220</math></p> <p>IECEX Flameproof/Dust Ignition Protection</p> <p>Flameproof: Ex d IIC T6 Gb            Dust ignition protection: Ex tb IIIC T85 °C Db            Enclosure classification: IP66            Please use IECEX Ex d IIC-approved products as the cable gland for connecting it to the electrical connection port.            However, please use IP66-approved products when using it in an environment that requires IP66.</p> <p>IECEX Intrinsically safe/Dust Ignition Protection</p> <p>Intrinsically safe: Ex ia IIC T4 Ga            Dust ignition protection: Ex ia IIIC T135°C Da            Enclosure classification: IP66            The barriers should be IECEX certified types and comply with the following conditions:            Input Signal Terminals (+/-IN):  <math>U_i=30\text{ V}</math>, <math>I_i=93\text{ mA}</math>, <math>P_i=0.9\text{ W}</math>, <math>C_i=4\text{ nF}</math>, <math>L_i=220\text{ }\mu\text{H}</math>            Output Signal Terminals (+/-OUT):            (AVP701) <math>U_i=30\text{ V}</math>, <math>I_i=93\text{ mA}</math>, <math>P_i=0.9\text{ W}</math>, <math>C_i=22\text{ nF}</math>, <math>L_i=220\text{ }\mu\text{H}</math></p> <p>NEPSI Flameproof / Dust Ignition Protection</p> <p>Flameproof: Ex d IIC T6 Gb            Dust ignition protection: Ex tD A21 IP66 T85 °C            Enclosure classification: IP66            Please use Ex d IIC or Ex tD A21-approved products as the cable gland to be connected to the electrical connection port.            Please use IP66-approved products in an environment that requires IP66.</p> <p>KOSHA Flameproof</p> <p>Ex d IIC T6            Please use Ex d IIC-approved products as the cable gland to be connected to the electrical connection port.</p>

Item	Specification
Structure	INMETRO Flameproof/Dust Ignition Protection Flameproof: Ex d IIC T6 Gb Dust ignition protection: Ex tb IIIC T85 °C Db Enclosure classification: IP66 Please use INMETRO or IECEx Ex d IIC and Ex td IIIC-approved products as the cable gland to be connected to the electrical connection port. Please use IP66-approved products in an environment that requires IP66.
CE conformity	Electromagnetic compatibility EN61326-1: 2013 (CE Marking) The device is intended for use in industrial locations defined in CE marking directive (EN 61326-1).

Note: Depending on the inner diameter and length of the air pipe, automatic setup might not be sufficient to realize the optimum operation. In such a case, please specify the relevant parameters.

### Conditions of supply air (JIS C1805-1 (2001))

Item	Specification
Particles	Maximum diameter 3 μmm
Oil mist	Less than 1 ppm at mass
Humidity of the air supply	The dew point should be at least 10°C lower than the temperature of this device.

To meet the above specifications for instrument air, install the air purification devices listed below properly in the specified installation location.

### Examples of air purification devices

Installation	Air purification device	SMC corporation	CKD corporation
Compressor outlet or main line	Line filter	AFF series	AF series
	Mist separator	AM series	
Terminal device	Mist separator	AM150 or AM250 series	M3000S type

Table 1. Standard travel range and accuracy

Actuator	Travel (mm)	Accuracy [% F.S.]
PSA1, 2	14.3, 20, 25	1.0
PSA3, 4	20, 38	1.0
HA1	6, 8, 10	3.0
	14.3, 25	1.0
HA2	10	3.0
	14.3, 25, 38	1.0
HA3	14.3	3.0
	25, 38, 50	1.0
HA4	14.3	3.0
	25, 38, 50, 75	1.0
VA5	25, 37.5, 50, 75, 100	1.0
VA6	14.3	3.0
PSA6, 7	25, 37.5, 50, 75, 100	1.0
HK1 PSK1	10	3.0
	19	1.0
DAP560, 1000 1000X	14.3	3.0
	25~100	1.0
DAP1500, 1500X	14.3, 25	3.0
	38~100	1.0

## Safety precautions

The purpose of the safety precautions listed here is to ensure the user uses the product safely and correctly, to prevent harm to the user and other people and damage to property. Make sure to obey the safety precautions. Many different symbols are used in this manual. Their appearances and meanings are as described below. Thoroughly understand the explanation before starting to read the main text.



**WARNING** Wrong handling may cause the death or severe injury of the user.



**CAUTION** Wrong handling may cause a minor injury to the user or damage to equipment.

## Sample symbols

	• This symbol indicates "warnings" and "cautions" that you must pay attention to when handling the device.
	• This symbol indicates "prohibited" actions that must not be taken.
	• This symbol indicates "instructions" for the action that must be taken.

## Precautions for safe work

<b>WARNING</b>	
	• Do not perform wiring with wet hands or while the device is energized. This may lead to electric shock. Turn the power off before starting the work and work with dry hands or use gloves.
	• Follow the work procedure defined in the explosion protection guidelines when performing the power distribution work in an explosion-proof area.
	• For devices equipped with the pressure-resistant, explosion-proof specifications, do not open the cover during operation (while the power is on).

<b>CAUTION</b>	
	• Do not get on the installed device or use it as a step stool. This is dangerous because the device may tip over.
	• Do not touch the device during operation without reason. This is dangerous because the surface may be hot or cold depending on the usage environment.
	• Be careful not to touch the edge of the cover or the screw threads of the main unit when opening the cover of the terminal box. You may be injured by these parts.
	• Use a DC power supply with overload protection. Overload may cause smoke or fire.
	• If a tool or other item touches the glass part of the display, it may break, leading to an injury. • Be careful. Wear safety glasses during work.
	• This product is heavy. Be careful where you step and wear safety shoes during work.
	• Do not touch the feedback lever or other moving part while the device is operating. You may be injured by getting your hand or other body part caught in them.

<b>CAUTION</b>	
	• Properly use the power supply based on the specifications. Inputting a different power supply may damage the device.
	• Use gloves and other protective equipment during work in a hot, cold, or other severe environment.
	• Do not move the device close to a magnet or magnetic driver. The control valve may operate.
	• Apply the correct supply air pressure in accordance with the specification of the device. The overpressure may cause abnormal actions of the control valve or damage to the pressure gauge.

## Precautions for installation

<b>CAUTION</b>	
	• Be careful not to get injured by sharp parts such as the edge of the main unit or actuator or screw threads during mounting. • The type of mounting plate, mounting method, and mounting procedure differ depending on the actuator model to be mounted in the device.
	• If the device is not properly mounted, not only will the device not be able to operate at its true performance but it may be damaged or fail. Pay attention to the following points. <ul style="list-style-type: none"> <li>• The mounting plate and its accessories differ depending on the specifications (actuator model). Be sure to use the appropriate mounting plate and accessories for the actuator to be mounted.</li> <li>• When installing the control valve, ensure as much surrounding space as possible and put the device in the correct orientation taking maintainability (such as piping, wiring, and adjustment) into consideration.</li> <li>• Deliver the device to the installation location in the packaged state if possible.</li> <li>• Do not apply excessive force to the feedback lever during mounting.</li> <li>• Do not bend the feedback pin.</li> <li>• Securely tighten bolts.</li> </ul>

## MODEL SELECTION

### Basic model number

AVP701	Analog signal (4 to 20 mA DC) with Travel Transmission and HART communication Protocol	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
AVP702	Analog signal (4 to 20 mA DC) with HART communication Protocol									
(1) Structure	Water-proof	X								
	TIIS Flameproof (Electrical connection G1/2 only) with cable gland *1	E								
	FM Explosionproof/Dust ignition protection (Electrical connection G1/2 is not available.)	F								
	FM Intrinsically safe (ic) and Nonincendive	V								
	FMC Explosionproof/Dust ignition protection (Electrical connection G1/2 is not available.)	A								
	ATEX Intrinsically safe/Dust Ignition Protection	L								
	IECEX Flameproof/Dust ignition protection (Electrical connection G1/2 is not available.)	D								
	IECEX Intrinsically safe/Dust Ignition Protection	T								
	NEPSI Flameproof/Dust ignition protection (Electrical connection G1/2 is not available.)	N								
	KOSHA Flameproof (Electrical connection G1/2 is not available.)	K								
	INMETRO Flameproof/Dust ignition protection (Electrical connection G1/2 is not available.)	B								
	(2) Connection	Electrical connection   Air piping connection   Mounting thread   Pressure gauge thread								
G1/2   Rc1/4   M8   Rc1/8		G								
1/2NPT   1/4NPT   M8   Rc1/8		N								
M20×1.5   1/4NPT   M8   Rc1/8		M								
(3) Finish	Standard (Baked acrylic)			S						
	Corrosion proof (Baked urethane)			B						
(4) (5) Display	Display with push button				D	X				
(6) Diagnostic	Advanced Diag (with four pressure sensors)						A			
(7) Overvoltage protection	None							X		
	Overvoltage protection (Input impedance +125)							V		
(8) (9) Option	None								X	X
	Explosion-proof universal elbow (SUS304 G1/2) (1)								A	A
	Explosion-proof universal elbow (SUS304 G1/2) (2)								A	C
	Model KZ03 pressure regulator with filter (Mounted on Positioner)*2								M	1
	Model KZ03 pressure regulator with filter (with bracket for separated mount)								M	2
	Model KZ03 pressure regulator with filter (with bracket for separated mount onto horizontal-installed actuator)								M	3
	Extension lever (In case of without mounting bracket)								M	L
	Seal tape prohibited								M	J
	Mounting bracket material SUS316*3								M	6
	Mounting bracket (PSA,1,2,PSK1)								Y	S
	Mounting bracket (New model PSA3, 4 (produced after 2000), VA1 to 3(produced after May. '83))								Y	Q
	Mounting bracket (PSA6, VA4 to 6(produced after May. '83))								Y	L
	Mounting bracket (PSA7)								Y	8
	Mounting bracket (HA1)								Y	A
	Mounting bracket (HA2, HL2)								Y	T
	Mounting bracket (HA3, HL3)								Y	C
	Mounting bracket (HA4, HL4)								Y	N
	Mounting Bracket (VR1)								Y	V
	Mounting Bracket (VR2, 3)								Y	R
	Mounting Bracket (VR3H)								Y	6
	Mounting Bracket (RSA1)								Y	F
	Mounting Bracket (RSA2)								Y	U
	Mounting Bracket (old model PSA3, 4 (those produced before 1999))								Y	Y
	Mounting Bracket (VA1 to 3 (produced before Apr. '83, former model Motion Connector), 800-1, 2, 3)*4								Y	W
	Mounting Bracket (VA4,5(produced before Apr. '83, former model Motion Connector), 800-4, 5)*4								Y	J
	Mounting Bracket (VP5,6)								Y	1
Mounting Bracket (VP7)								Y	7	
Mounting bracket (DAP560, 1000, 1000X (stroke: 100mm max.))								Y	4	
Mounting bracket (DAP1500, 1500X (stroke: 100mm max.))								Y	5	

\*1. One set of TIIS Flameproof cable gland shall be attached for model AVP702. Two sets are for model AVP701.

\*2. Select the code "M1" only when the direction of drain of the pressure regulator with filter on the control valve is downward(ground).

\*3. Material of mounting bracket when you don't select code "M6" is SUS304.

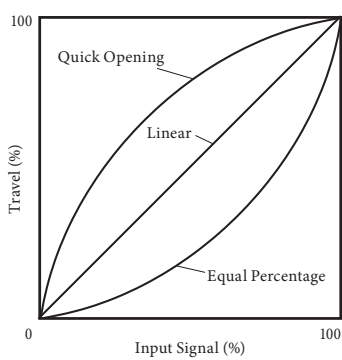
\*4. Consult with sales representative in case of no mounting hole on the side of valve yoke.



**Individual specifications**

Device TAG No. (8 characters)	Be sure to configure the data.
Long TAG No. (max 32 characters)	Configure the data if necessary.
Input range	4 to 20 mA DC Note: Minimum span 4mA
Input characterization*1	L: Linear EQ%: Equal percentage QO: Quick opening USER: User-defined
Positioner action*2	D: Direct for single acting actuator R: Reverse for single acting actuator W: For double acting actuator
Supply pressure classification	1: 140≤Ps≤150 kPa 2: 150<Ps≤300 kPa 3: 300<Ps≤400 kPa 4: 400<Ps≤450 kPa 5: 450<Ps≤700 kPa
Unit of pressure gauge	A: kPa B: kgf/cm <sup>2</sup> C: MPa D: bar E: psi
Valve closed position	DOWN, UP
Actuator type	L: Linear R90: Rotary 90° R60: Rotary 60° RS90: Rotary sub 90° RS60: Rotary sub 60°
Travel transmitter fail safe direction (Model AVP701 only)	DOWN, UP The setting of failure output direction cannot be changed after delivery.
LCD facing upwards	X: No optional parts A: LCD cover and Pressure gages jointed to elbows B: LCD cover C: Pressure gages jointed to elbows

\*1. Refer to following when selecting the input/ output characteristics.



**Figure 4. Input characterization**

**Selection of input characterization**

The flow characteristic of a control valve is set by selecting the valve plug characteristic, and the input-output characteristics of the positioner must be specified as linear. However, if the valve plug flow characteristic, which depends on the control valve's shape and structure, does not meet requirements, you can correct the overall flow characteristic of the control valve by specifying "equal percentage" or "quick opening" for the input-output characteristics of the positioner, as shown in Table 2.

**Table 2. Control valve flow characteristics correction by the positioner**

Characteristic of valve plug	Input characterization of positioner	Overall flow characteristic of control valve
Linear	Quick opening	Quick opening
Linear	EQ%	EQ%
EQ%	Quick opening	Linear

*Note: If the valve plug characteristic is "quick opening," the overall flow characteristic of the control valve cannot be linear even if "equal percentage" is set for the positioner's input-output characteristics. (This is because when the valve plug characteristic is "quick opening," the control valve works as an ON/OFF valve and it is difficult to correct its characteristics by changing the setting of the positioner.)*

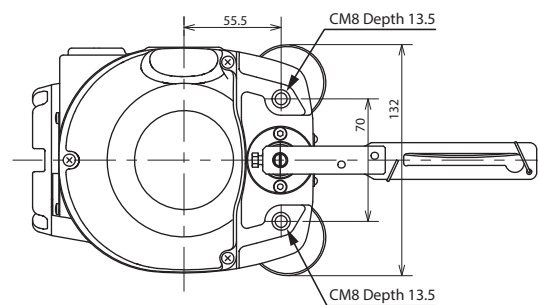
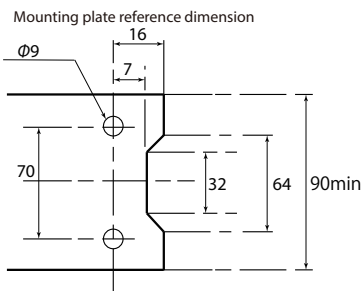
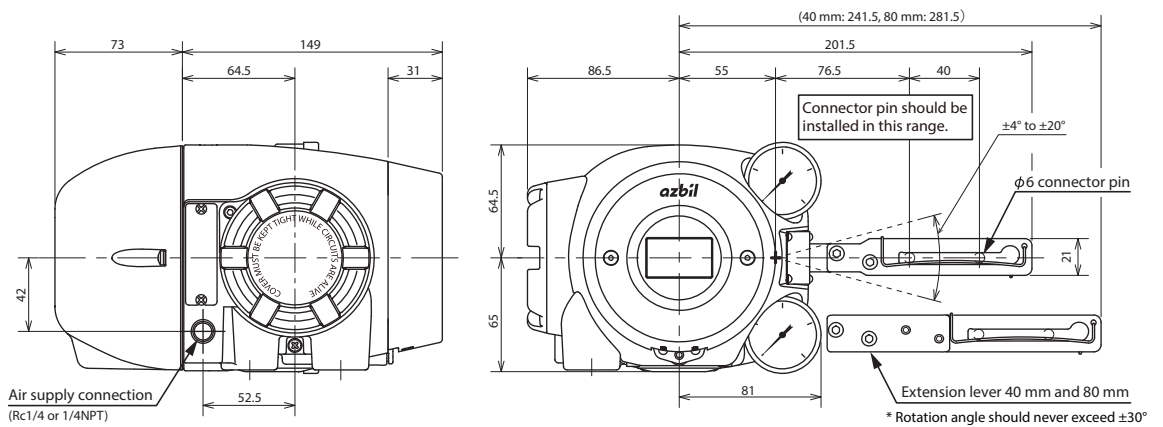
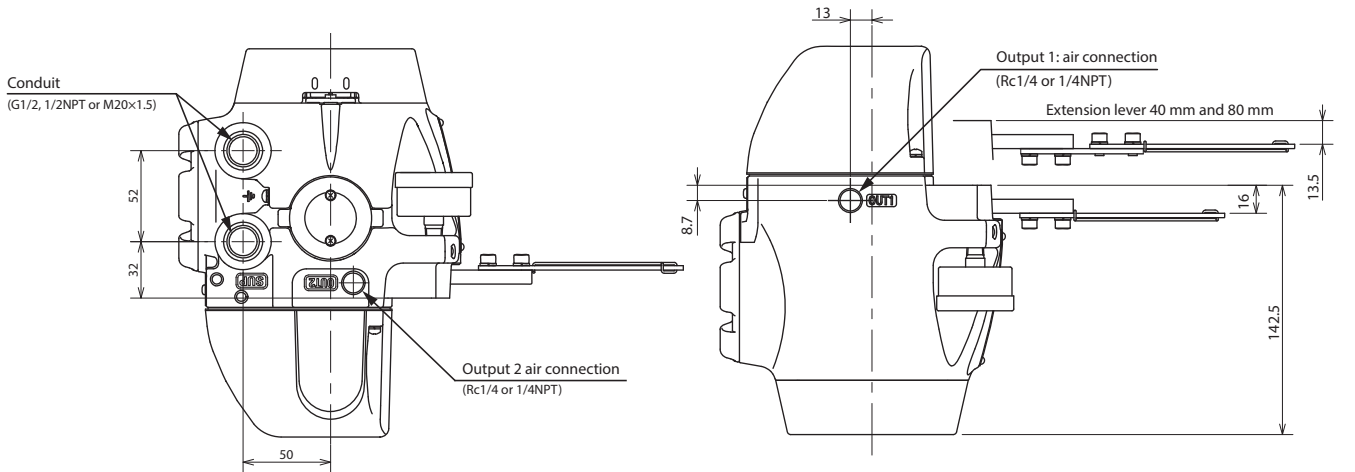
\*2. When the power is shut off, select D (Direct for single acting actuator) to make the output air pressure of this device zero, and R (Reverse for single acting actuator) to make the output at the maximum air pressure (supply air pressure). Positioner action differs from actuator and control valve action, so be careful in selecting the positioner's action.



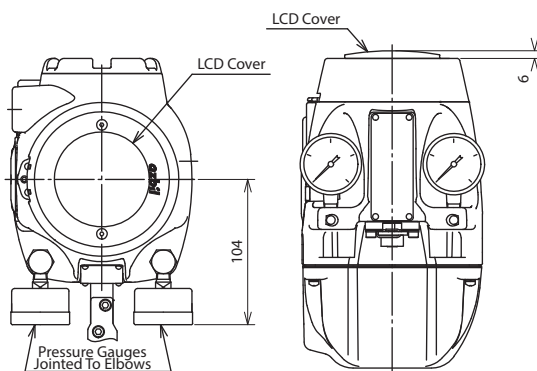
# DIMENSIONS

For single acting actuator without KZ03 regulator

[Unit: mm]



LCD Facing Upwards

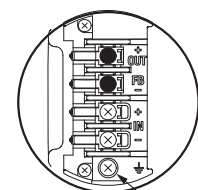
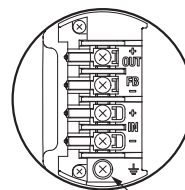


## Terminal

Screw size: M4

AVP701

AVP702

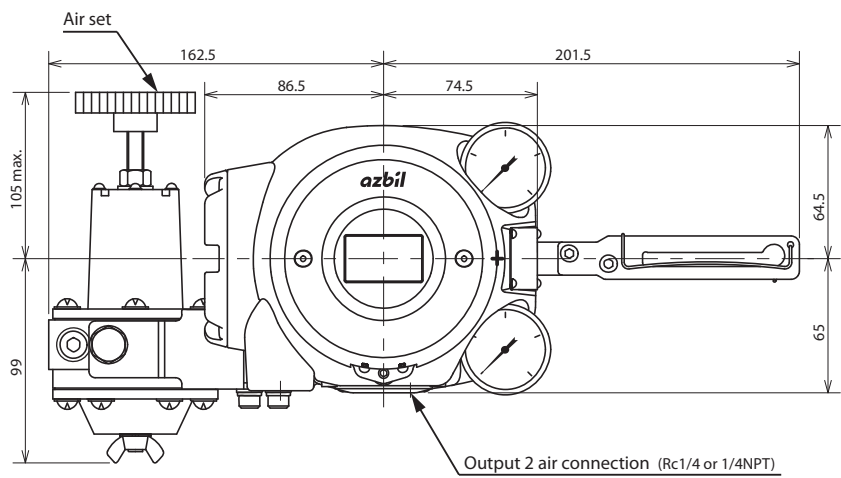
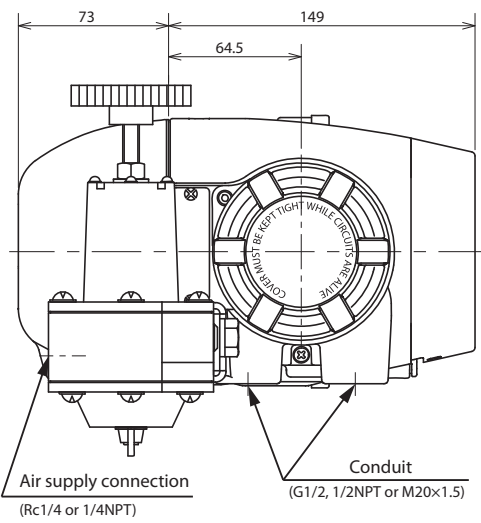
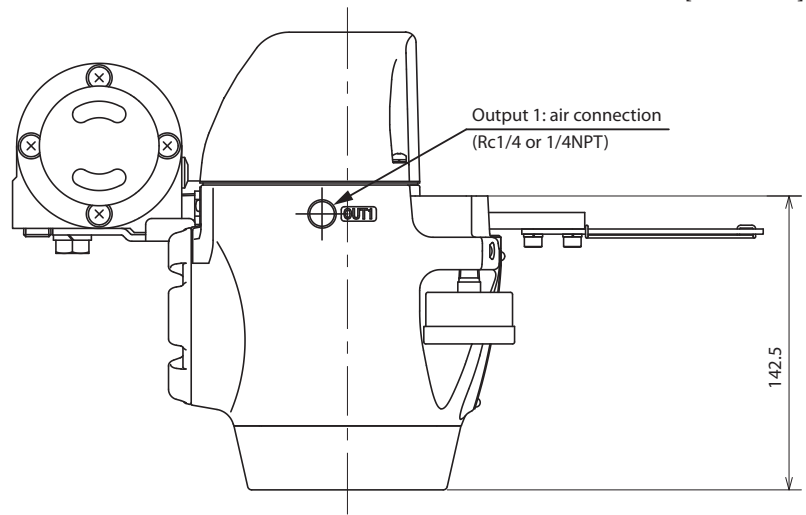


Ground terminal

Ground terminal

For single acting actuator with KZ03 regulator

[Unit: mm]

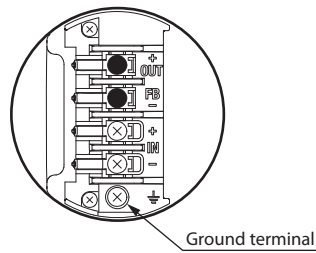
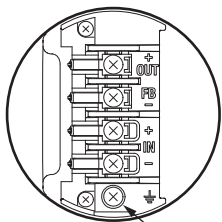


Terminal

Screw size: M4

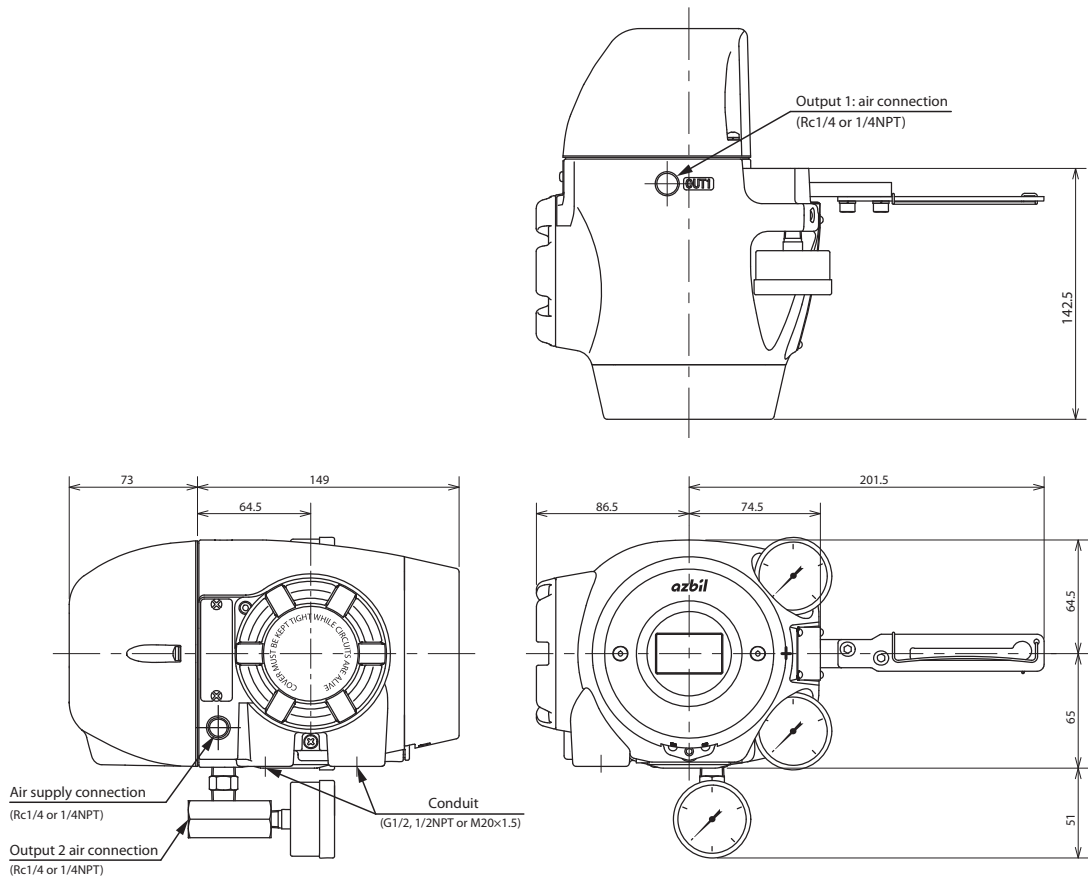
AVP701

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For double acting actuator without KZ03 regulator

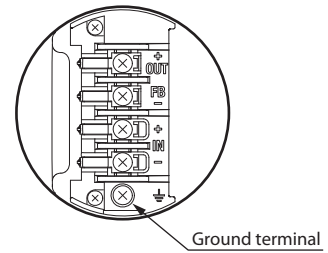
[Unit: mm]



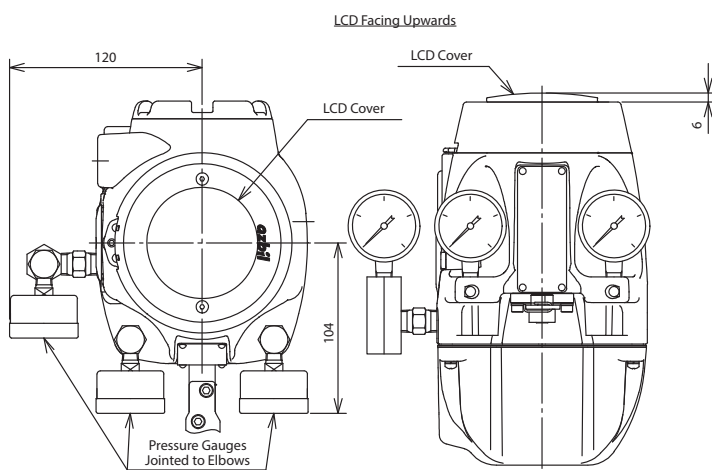
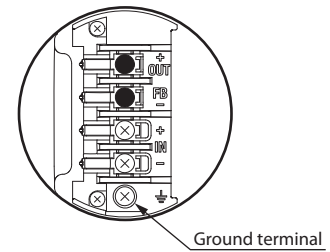
**Terminal**

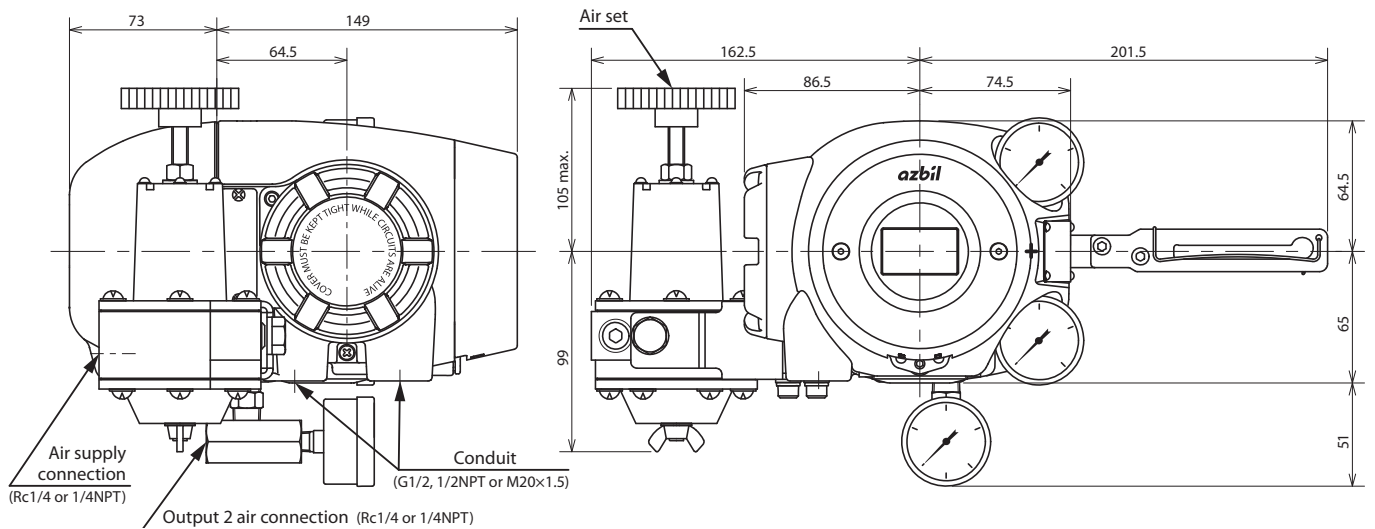
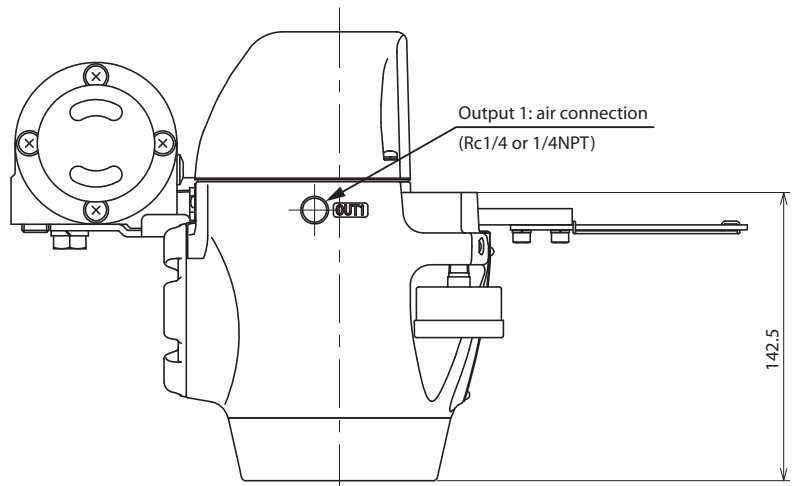
Screw size: M4

AVP701



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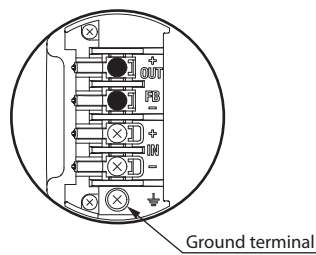
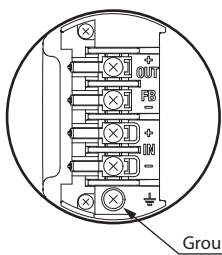


**Terminal**

Screw size: M4

AVP701

AVP702



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