



ORIGINAL INSTRUCTIONS

Instruction Manual
Soft Start-up Valve
Series AV2000~5000-A



Refer to Declaration of
Conformity for relevant
Directives



The intended use of this product is to protect machine mechanism against sudden movement during start up.

1 Safety Instructions

These safety instructions are intended to prevent hazardous situations and/or equipment damage. These instructions indicate the level of potential hazard with the labels of “Caution,” “Warning” or “Danger.” They are all important notes for safety and must be followed in addition to International Standards (ISO/IEC)¹⁾, and other safety regulations.

- ¹⁾ ISO 4414: Pneumatic fluid power - General rules relating to systems.
ISO 4413: Hydraulic fluid power - General rules relating to systems.
IEC 60204-1: Safety of machinery - Electrical equipment of machines. (Part 1: General requirements)
ISO 10218-1: Manipulating industrial robots - Safety. etc.

- Refer to product catalogues, Operation Manual and Handling Precautions for SMC Products for additional information.
- Keep this manual in a safe place for future reference.

	Caution	Caution indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
	Warning	Warning indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
	Danger	Danger indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.

Warning

- Always ensure compliance with relevant safety laws and standards.**
- All work must be carried out in a safe manner by a qualified person in compliance with applicable national regulations.

Warning

- When using a solenoid valve or actuator on the outlet side of this product, implement appropriate measures to prevent potential danger caused by actuator operation.
- This product may experience air leakage (within tolerance), therefore this valve is not suitable for holding pressure in a pressure vessel for a long period of time.
- This valve is not to be used as emergency shutoff valve. Using the valve in such applications, take a separate measure to ensure safe use.
- Provide ventilation when using the valve in a confined area, such as in a closed control panel. For example, install a ventilation opening, etc. in order to prevent pressure from increasing inside of the confined area and to release the heat generated by the valve.
- The circuit designer shall ensure external cables have strain relief and correct protective bonding in accordance with the requirements of EN 60204-1
- The circuit designer shall ensure correct insulation monitoring in accordance with the requirements of EN60204-1.

2 Specifications

2.1 Mechanical Specification

Model			AV2000-A	AV3000-A	AV4000-A	AV5000-A	
Port Size	1(P), 2(A)		1/4	3/8	1/2	3/4	1
	3(R)		1/4	3/8	1/2	3/4	
Pressure Gauge Port Size			1/8				
Fluid			Air				
Ambient/Fluid Temperature			0-50°C ^{Note 1)}				
Proof Pressure [MPa]			1.5				
Operating Pressure Range [MPa]			0.2-1.0				
Max. operating frequency			5 cycles/min not exceeding 100 cycles/day				
Min. operating frequency			Once every 30 days				
Min. air quality			5 μm filtration				
IP rating			IP65 (DIN terminal only)				
Weight [kg]			0.43	0.45	0.80	1.30	1.25
Flow characteristics	1(P)→2(A)	C(dm³/s·bar)	9.2	13.1	19.2	34.8	41.3
		b	0.36	0.27	0.32	0.66	0.34
		Cv	2.4	3.1	5.1	12.6	13.7
	2(A)→3(R)	C(dm³/s·bar)	8.8	9.2	10.1	23.7	
		b	0.46	0.48	0.55	0.67	
		Cv	2.5	2.6	3.2	9.2	
	^{Note 2)}		1000 m/s ² (11ms)				
	^{Note 3)}		50 m/s ² (0.35mm)				

Note 1) Please use dry air when operating at a low temperature to avoid freezing
Note 2) Two axes (horizontal and vertical) and two directions were tested and no malfunction of the valve occurred (pulse shape: sine shape), 3 times for each condition (pilot valve ON and OFF, test sample mounted with bracket)
Note 3) No malfunction occurred in a sweep cycle test between 10 to 150 Hz at vibration sweep 0.35mm. The test was performed in the two axes and two directions, 7 min per cycle (20 cycles) 20 times for each condition (pilot valve ON and OFF)

2.2 Electrical Specification

Electrical Entry		Grommet	DIN Terminal
Coil Rated	DC	24 , 12	
Voltage [V]	AC 50/60 Hz	100 , 200 , 110[115] , 220[230] ^{Note1)}	
Power Consumption [W]	DC	0.35 (with light: 0.4)	0.35(with light: 0.45)
Allowable	24V	±10% of rated voltage	

DC				
	AC	12V	±10% of rated voltage	
		100V	±10% of rated voltage	
		110V ^{Note1)}	±10% of rated voltage	
		[115V]	[-15% to +5% of rated voltage]	
		200V	±10% of rated voltage	
		220V ^{Note1)}	±10% of rated voltage	
		[230V]	[-15% to +5% of rated voltage]	
Apparent Power [VA]	AC	100V	0.78 (with light: 0.81)	0.78(with light: 0.87)
		110V	0.86 (with light: 0.89)	0.86(with light: 0.97)
		[115V]	[0.94 (with light: 0.97)]	[0.94(with light: 1.07)]
		200V	1.18 (with light: 1.22)	1.15(with light: 1.30)
		220V	1.30 (with light: 1.34)	1.27(with light: 1.46)
		[230V]	[1.42 (with light: 1.46)]	[1.39(with light: 1.60)]
Surge Voltage Suppressor		Refer to Specific Product Precautions 3.7		
Indicator light		LED	LED (neon bulb for AC)	

Note 1) The 110VAC and 115VAC are interchangeable. The 220V AC and 230V AC are interchangeable as well.
Note 2) Valve state is not defined if electrical input is outside of specification

2.3 Working Principle

Initial Operation Return Stroke

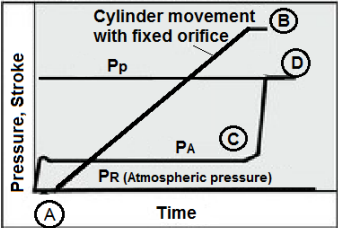


Figure 1

PA – outlet pressure
PP – inlet pressure
PR – atmospheric pressure

2 Specifications - continued

2.3.1 Low speed supply – Pilot valve ON

Operation

When the pilot valve is energised, the spool is pushed down by pilot air and closes the main valve, closing the flow passage to port 3 (R). In this case, force pushing the valve up is larger or equal to force pushing the spool down. Therefore, the flow path from the valve to Port A is also kept closed.

When the pilot valve turns on, the piston is pushed down by pilot air, and the flow passage from the needle to Port A opens. The air pressure whose flow rate is adjusted by the needle flows to Port A.

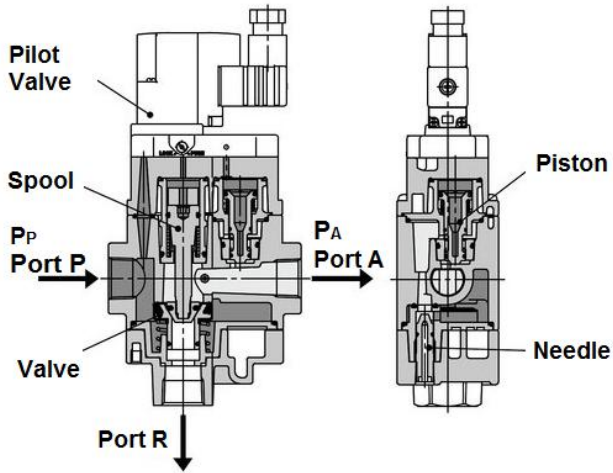
Cylinder actuation

The meter-in control of the needle slowly moves cylinder From A to B (Figure 1).

Pressure

Ps > PA

Ps – pressure for switching to rapid air supply



2.3.2 High speed supply – Solenoid valve ON

Operation

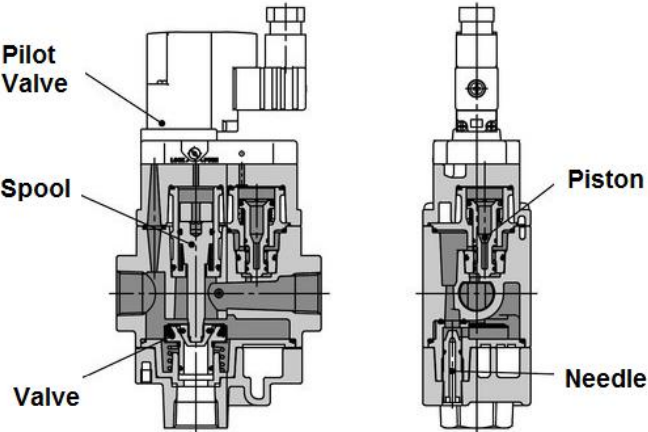
-When the outlet side is filled with the air supply from the needle, PA increases. When PA reaches a certain pressure level, force pushing the valve up is smaller than force pushing the spool down. The valve is pushed down, opening the flow passage and is supplied to Port A rapidly.

Cylinder actuation -When Ps<PA after the cylinder reaches B (Figure 1), the main valve fully opens and PA increases rapidly as shown from C to D (Figure 1) and becomes the same pressure as PP.

Ps – pressure for switching to rapid air supply
PA – outlet pressure

Pressure

Ps ≤ PA



2.3.3 Normal operation – Pilot valve ON

Operation

- The valve holds the fully open condition.

2 Specifications - continued

Cylinder actuation

- The cylinder operation is controlled by a meter-out circuit on the cylinder side.

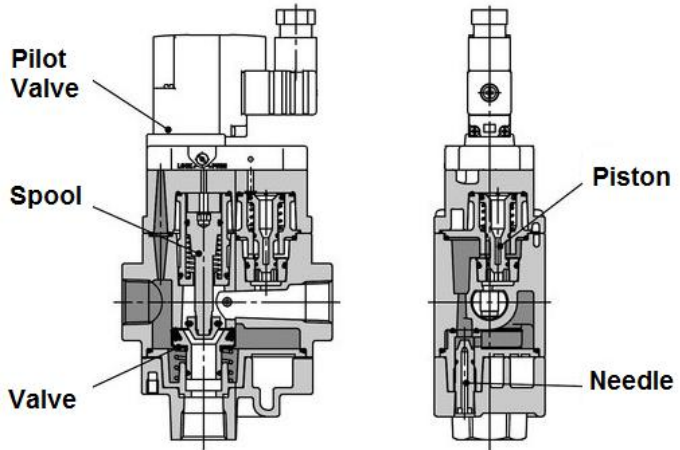
PP=PA

2.3.4 Quick exhaust – Pilot valve OFF

Operation

When the pilot valve is turned off, the pilot air of the spool is exhausted from the pilot valve. The spool and the valve are returned upward due to spring. This opens the flow pressure to port R exhausting the air pressure on Port A.

The pilot air of the piston is also exhausted from the pilot valve and the piston is returned upward due to the spring, closing the flow passage from the needle.



Caution

Special products might have specifications different from those shown in this section. Contact SMC for specific drawings.

3 Installation

3.1 Installation

Warning

- Do not install the product unless the safety instructions have been read and understood.**
- Stop operation if air leakage increases or the equipment does not operate properly.**

After mounting or maintenance, etc., connect the compressed air and power supply, then perform appropriate function and leakage tests to ensure that the unit is mounted properly.

• Operation manual/Instruction manual

Mount and operate the product after reading the manual carefully and understanding its contents. Keep the manual in a place where it can be referred to as necessary.

• Painting and coating

Warnings or specifications printed or labelled on a product should not be erased, removed or covered up. Please contact SMC before painting the resin parts, as this may cause adverse effects depending on the solvent.

• Maintenance space

Allow the sufficient space for maintenance and inspection.

Warning

• Confirm the specifications.

The product presented in this document is designed only for use in compressed air systems. Do not operate at pressures or temperatures, etc., beyond the range of specifications, as this can cause damage or malfunction (refer to the specifications). Please contact SMC if using for any fluid other than compressed air.

• Operation of closed centre solenoid valves

Even if this product is used for closed center solenoid valves or actuator with a load factor of 50% or more, lurching (quick extension) cannot be prevented.

• Using a regulator on the outlet side

When mounting a regulator on the outlet side (A port side), use a residual pressure relief regulator (AR25K to 40K) or check type

3 Installation - continued

regulator. With a standard regulator (AR10 to 60), the outlet side pressure may not be released when this valve is exhausted.

• Operation of solenoid valves on the outlet side

To operate solenoid valves mounted on this product's outlet side (A port side), make sure that the outlet side's pressure (P_A) has increased to the pressure equal to the inlet side (P_P).

• Operation

The residual pressure release function of this product is for emergency use only. Avoid using this valve in the same manner as ordinary 3 port valves.

• Using a lubricator

If mounting a lubricator, mount it on the inlet side (P port side) of this product. If mounted on the outlet side (A port side), back flow of oil will occur and may spurt out of the valve's R port.

• Operation for air blowing

This product cannot be operated for air blowing due to the mechanism that switches the main valve to be fully open after the outlet side's pressure increases to approximately 1/2 of the inlet side.

Warning

• Solenoid valve for 200, 220VAC

The AC solenoid valves with grommet have a built-in rectifier circuit in the pilot section to operate the DC coil.

With 200V and 220 VAC pilot valves, this built-in rectifier generates heat when energised. The surface may become hot depending on the energised condition. To prevent burns, do not touch the solenoid valve.

3.2 Environment

Warning

- Do not use in an environment where corrosive gases, chemicals, sea water or steam are present.
- Do not use in an explosive atmosphere.
- Do not expose to direct sunlight. Use a suitable protective cover.
- Do not install in a location subject to vibration or impact in excess of the product's specifications.
- Do not mount in a location exposed to radiant heat that would result

in temperatures in excess of the product's specifications

- Take suitable protective measures if water, oil or welding spatter is likely to adhere to the valve.
- Take measures to ensure air quality, such as by installing an aftercooler, air dryer, or water separator. Compressed air that contains a large amount of drainage can cause a malfunction of pneumatic equipment such as valves. Therefore, take appropriate measures to ensure air quality, such as by providing an aftercooler, air dryer, or water separator.
- Take suitable measures to prevent dust or noise if operating in an environment generating dust or intrusive valve switching noise, by providing a silencer in the R port.

Caution

• Low temperature operation

Although the valve can be operated at temperature as low as 0°C, measures should be taken to avoid solidifying or freezing drainage and moisture.

3.3 Piping

Caution

- Before connecting piping make sure to clean up chips, cutting oil, dust etc.
- When installing piping or fittings, ensure sealant material does not enter inside the port. When using seal tape, leave 1.5-2 thread ridges exposed on the end of the pipe/fitting.

- Refer to the instruction manual/operation manual during installation and make sure to connect to the correct supply port, etc.

• F.R.L module combination

When connecting to a modular F.R.L. unit (AC20 to 60), select one of the spacers, included amongst the accessories. However, modular combinations with AC40-06 are not possible.

3 Installation - continued

Furthermore, connect soft start-up valves to the outlet side of the F.R.L. combination.

• Inlet side piping conditions

The nominal size of the piping material's or equipment's bore should be equal to or larger than the soft start-up valve's port size. The combined sonic conductance of the inlet side's (P port side's) piping or equipment should be equal to or larger than the values below.

Model	Combined sonic conductance [dm ³ /(s·bar)]
AV2000-A	5
AV3000-A	22
AV4000-A	35
AV5000-A	50

When the piping is restricted or the supply pressure is insufficient, the main valve will not switch and air leakage may occur from the R port.

- Tighten fittings to the specified tightening torque.

Connecting threads	Proper tightening torque (N·m)
Rc 1/4	12 to 14
Rc 3/8	22 to 24
Rc 1/2	28 to 30
Rc 3/4	28 to 30
Rc 1	36 to 38

3.4 Lubrication

Caution

- The valve has been lubricated for life at the factory, and does not require any further lubrication.
- If a lubricant is used in the system, refer to catalogue for details. Once lubricant is utilized within the system, since the original lubricant applied within the product during manufacturing will be washed away, please continue to supply lubrication to the system. Without continued lubrication, malfunctions could occur. If turbine oil is used, refer to the corresponding Material Safety Data Sheet (MSDS).

- Lubrication amount

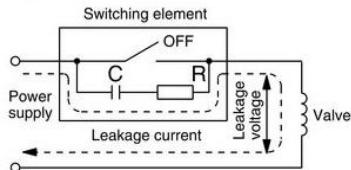
If a lubricant is applied excessively, it may accumulate inside the pilot

valve, causing malfunction or delayed response. Avoid using large amount of lubricant. If it is not avoidable, use an external pilot type, whereby supply air to the external pilot port contains no oil. This prevents accumulation of oil inside the pilot valve.

3.5 Wiring

Caution

- When electric power is connected to a solenoid valve, make sure to apply correct voltage. Incorrect voltage may cause malfunction or coil damage.
- Check the connections. Check if the connections are correct after completing all wiring.
- External force applied to lead wire An excessive force to the lead wire may cause wire breakage. Take appropriate measures to avoid applying a force of 30 N or more to the lead wire.
- Voltage leakage Particularly when using a C-R element (surge voltage suppressor) to protect the switching element, take note that leakage current will flow through the C-R element, increasing leakage voltage.



AC coil is 8% or less of rated voltage.
DC coil is 3% or less of rated voltage.

3.6 Air supply

Caution

- Install air filters close to the valve on the upstream side.
- Implement countermeasures by installing after-cooler or air dryer, or water separator, etc.

3 Installation - continued

The compressed air containing a large amount of moisture may result in a malfunction of the valve and other pneumatic equipment. Install an after-cooler, air dryer or water separator or otherwise take an appropriate measure.

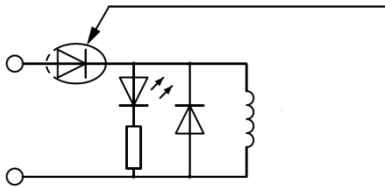
3.7 Surge voltage suppressor

Caution

3.7.1 DC power supply

3.7.1.1 Grommet – standard type (with polarity)

- With light/surge voltage suppressor (□Z)



NOTE1: Connect correctly the lead wires to + (positive) and - (negative) indications on the connector.

NOTE2: Solenoids, whose lead wires have been pre-wired: positive side (+) is red and negative side (-) is black.

3.7.1.2 DIN Terminal

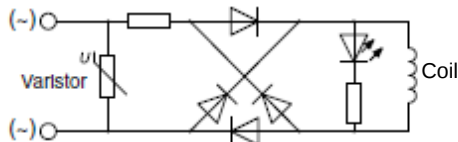
With light/surge voltage suppressor (DZ)

DIN terminal has no polarity.

3.7.2 AC power supply

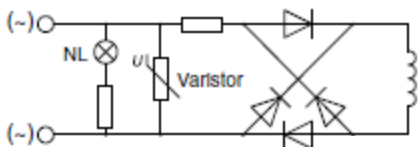
3.7.2.1 Grommet

- With light (GZ)



3.7.2.2 DIN Terminal

With light (DZ) and (YZ)



NOTE1: Surge voltage suppressor of varistor has residual voltage corresponding to the protective element and rated voltage; therefore, protect the controller side from the surge voltage. The residual voltage of the diode is approximately 1V.

3.8 How to use DIN terminal

3.8.1 Construction

Type “Y”

Y type DIN connector is a DIN connector that confirms to the DIN pitch 8-mm standard.

Type “D”

D type DIN connector with 9.4 mm pitch between terminals is not interchangeable with Y type connector.

- To distinguish between “Y” and “D” type DIN connector, “Y” has “N” listed at the end of voltage symbol. For connector parts without lights, “N” is not indicated. Refer to the name plate to distinguish.
- “Y” Dimensions are the same as “D” type DIN connector.
- When exchanging the pilot valve assembly only, “V115K-□D-X400” is interchangeable with “V115K-□Y-X400”. Do not replace “V111K-□G-X400” with “V115-□D/□Y-X400” (DIN terminal), and vice versa.

3.8.2 Connection

- Loosen the holding screw and pull the connector out of the solenoid valve terminal block.

3 Installation - continued

- After removing the holding screw, insert a flat head screwdriver, etc. into the notch on the bottom of the terminal block and pry it open, separating the terminal block and the housing.
- Loosen the screw (slotted screws) on the terminal block. Insert the lead cores wires into the terminals according to the connection method, and secure the wires by re-tightening the terminal screw.
- Secure the cord by tightening the gland nut.

Caution

When making connections, take note that using other than the supported size (ø3.5 to ø7) heavy duty cord will not meet IP65 (enclosure) standards. Ensure to tighten the gland nut and holding screw within their specified torque ranges.

3.8.3 Changing the entry direction

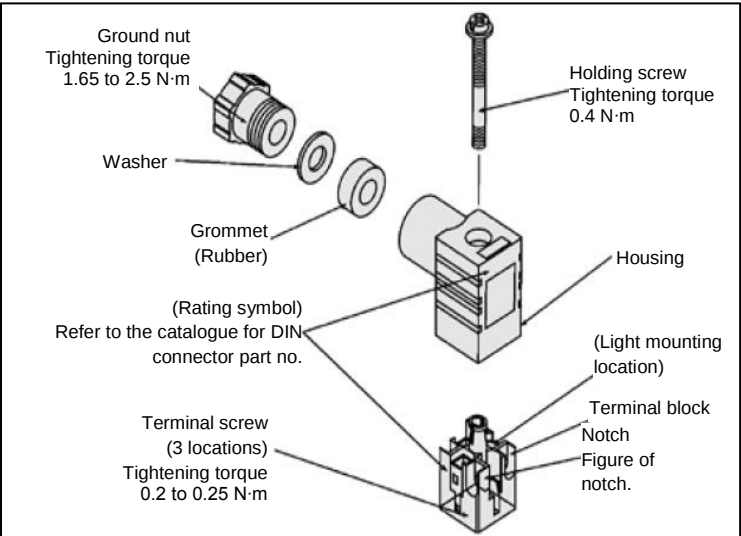
After separating the terminal block and housing, the cord entry can be changed by attaching the housing in the desired direction (4 directions at 90° intervals).

*When equipped with light, handle carefully to avoid damage to the light with the lead wires in the cable.

NOTE: Plug in and pull out the connector vertically without tilting to one side.

3.8.4 Compatible cable

Cable O.D.: ø3.5 to ø7
(Reference) 0.5mm², 2-core or 3-core, equivalent to JIS C 3306

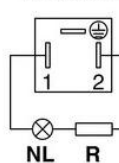


3.8.5 DIN Connector part numbers

Type	Option	Rated Voltage	Rated Symbol	Part number
“D” Type	Without light	-	-	SY100-61-1
	With light	24 VDC	24 V	SY100-61-3-05
		12 VDC	12 V	SY100-61-3-06
		100 VAC	100 V	SY100-61-2-01
		200 VAC	200 V	SY100-61-2-02
		110 VAC	110 V	SY100-61-2-03
“Y” Type	Without light	-	-	SY100-61-2-04
	With light	24VDC	24 VN	SY100-82-1
		12VCD	12 VN	SY100-82-3-05
		100VAC	100 VN	SY100-82-3-06
		200VAC	200 VN	SY100-82-2-01
		110VAC(115VAC)	110 VN	SY100-82-2-02
		220VAC(230VAC)	220 VN	SY100-82-2-03
				SY100-82-2-04

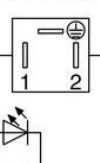
3.8.6 Circuit Diagram with light

AC circuit



NL: Neon light
R: Resistor

DC circuit

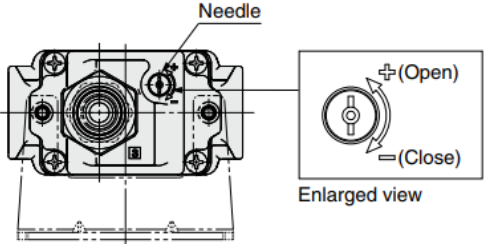


LED: Light emitting diode
R: Resistor

4 Settings

4.1 Initial speed adjustment

To perform the initial speed adjustment of the outlet side actuator, supply air from this valve's inlet side and turn ON the pilot valve. Then, rotate the needle counterclockwise from the fully closed position.



4.2 How to Find the Flow Rate (At air temperature of 20°C)

Choke flow: $(P_2+0.1)/(P_1+0.1) \leq 0.5$

$$Q = 120 \cdot S \cdot (P_1 + 0.1) \cdot \sqrt{\frac{293}{273 + t}}$$

Subsonic flow, when: $(P_2 + 0.1)/(P_1 + 0.1) > 0.5$

$$Q = 240 \cdot S \cdot \sqrt{(P_1 - P_2)(P_2 + 0.1)} \cdot \sqrt{\frac{293}{273 + t}}$$

Q: Air flow rate [L/min (ANR)]

S: Effective area [mm²]

P₁: Inlet pressure [MPa]

P₂: Outlet pressure [MPa]

t: Air temperature [°C]

NOTE: The above formulas above are applied to pneumatics only

4.3 Manual override

Warning

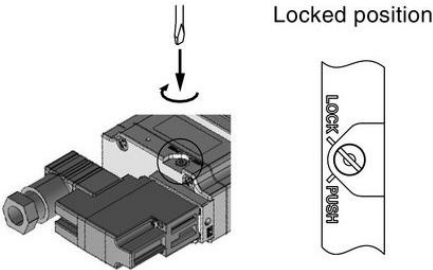
Since connected equipment will operate when the manual override is activated, confirm that conditions are safe prior to activation.

4.3.1 Push-turn locking slotted type [Type B]

While pressing, turn in the direction of the arrow.

If it is not turned, it can be operated in the same way as the non-locking

type.



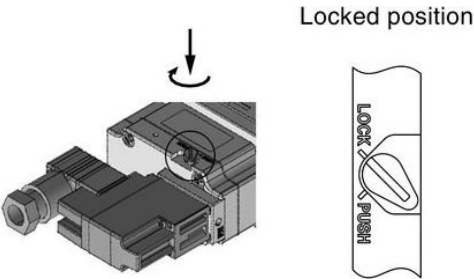
Caution

When operating the locking type D with a screw driver, turn it gently using a watchmakers screw driver [Torque: Less than 0.1N•m]

4.3.2 Push-turn locking lever type [Type C]

While pressing, turn in the direction of the arrow.

If it is not turned, it can be operated in the same way as the non-locking type.



Caution

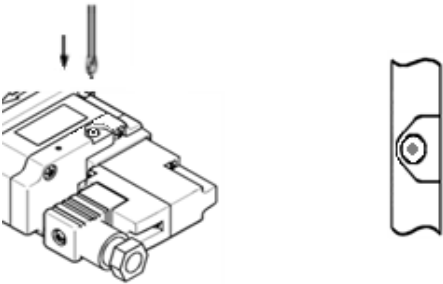
When locking the manual override on the push-turn locking type (B, C), make sure to push it down before turning. Turning without first pushing

4 Settings - continued

it down can cause damage to the manual override and failures such as air leakage, etc.

4.3.3 Non-Locking push type (AV-A-X2004)

Press the blue button to override solenoid valve.



5 How to Order

Refer to catalogue and drawings for “How to Order”

6 Outline Dimensions (mm)

Refer to catalogue for outline dimensions.

7 Maintenance

- Not following proper maintenance procedures could cause the product to malfunction and lead to equipment damage.
- If handled improperly, compressed air can be dangerous.
- Maintenance of pneumatic systems should be performed only by qualified personnel.
- Before performing maintenance, turn off the power supply and be sure to cut off the supply pressure. Confirm that the air is released to atmosphere.
- After installation and maintenance, apply operating pressure and power to the equipment and perform appropriate functional and leakage tests to make sure the equipment is installed correctly.
- If any electrical connections are disturbed during maintenance, ensure they are reconnected correctly and safety checks are carried out as required to ensure continued compliance with applicable

national regulations.

- Do not make any modification to the product.
- Do not disassemble the product, unless required by installation or maintenance instructions.
- **Removal of equipment, and supply/exhaust of compressed air**
Before equipment removal, ensure that measures are in place to prevent falling or run-away of the driven objects. Then, cut off the air supply, electric power and exhaust air pressure from the system using the residual pressure release function.
- If handled improperly, damage or malfunction of machinery or equipment may occur.
- **Low frequency operation:**
Valves should be operated at least once every 30 days to prevent malfunction (use caution regarding the air supply)

Caution

- **Drain flushing**
Remove drained fluid from air filters periodically.

8 Limitations of Use

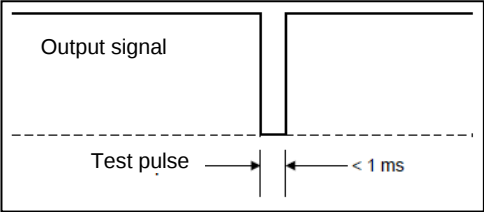
8.1 Limited warranty and Disclaimer/Compliance Requirements

Refer to Handling Precautions for SMC Products.

8.2 Safety relays

Warning

If a safe output from a safety relay or PLC is used to operate this valve, ensure that any output test pulse duration is shorter than 1 ms to avoid the valve solenoid responding.



8 Limitations of Use - continued

Warning

Soft start function is not to be used as a safety function.

8.3 failure modes

The system designer should determine the effect of the possible failure states on the system

Energy source status	Single
Air supply present, electricity cut	Spool returns to the off position by spring force
Air supply cut before electricity cut	Spool returns to the off position by spring force
Air supply cut after electricity cut	Spool returns to the off position by spring force

9 Contacts

Refer to Declaration of Conformity or www.smcworld.com for contacts.

SMC Corporation

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