



OPERATION MANUAL

PRODUCT NAME: Soft Start-up Valve

MODEL : AV2000

AV3000

AV4000

AV5000

- Read this operation manual carefully to understand before installation and operation.
- Pay extra attention on the clause concerning the safety.
- Keep this operation manual available whenever necessary.

SMC CORPORATION

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CONTACT ADDRESS: SMC CORPORATION


**AKIHABARAUDX 15F, 4-14-1, SOTOKANDA, CHIYODA-KU, TOKYO
101-0021, JAPAN
TEL: 03-5207-8271**

1. PRECAUTIONS FOR SAFETY

These safety instructions are intended to prevent a hazardous situation and/or equipment damage. These instructions indicate the level of potential hazard by a label of "**Caution**", "**Warning**" or "**Danger**". To ensure safety, be sure to observe ISO 4414 Note 1), JIS B 8370 Note 2) and other safety practices.

 **Caution:** Operator error could result in injury or equipment damage.

 **Warning:** Operator error could result in serious injury or loss of life.

 **Danger:** In extreme conditions, there is a possible result of serious injury or loss of life.

Note 1) ISO 4414 : Pneumatic fluid power – Recommendations for the application of equipment to transmission and control systems.

Note 2) JIS B 8370 : General Rules for Pneumatic Equipment.

Warning

1. The compatibility of pneumatic equipment is the responsibility of the person who designs the pneumatic system or decides its specifications.

Since the products specified here are used in various operating conditions, their compatibility for the specific pneumatic system must be based on specifications or after analysis and/or tests to meet your specific requirements.

2. Only trained personnel should operate pneumatically operated machinery and equipment.

Compressed air can be dangerous if an operator is unfamiliar with it. Assembly, handling or repair of pneumatic systems should be performed by trained and experienced operators.

3. Do not service machinery/equipment or attempt to remove components until safety is confirmed.

1. Inspection and maintenance of machinery/equipment should only be performed after confirmation of safe locked-out control positions.
2. When equipment is to be removed, confirm the safety process as mentioned above. Cut the supply pressure for this equipment and exhaust all residual compressed air in the system.
3. Before machinery/equipment is restarted, take measures to prevent shooting-out of cylinder piston rod, etc. (Bleed air into the system gradually to create back pressure.)

4. Contact SMC if the product is to be used in any of the following conditions:

1. Conditions and environments beyond the given specifications, or if product is used outdoors.
2. Installation on equipment in conjunction with atomic energy, railway, air navigation, vehicles, medical equipment, food and beverages, recreation equipment, emergency stop circuits, press applications, or safety equipment.
3. An application which has the possibility of having negative effects on people, property, or animals, requiring special safety analysis.

Design

⚠ Warning

1. Actuator drive

When a component such as a solenoid valve or actuator is to be driven using this product, take appropriate measures to prevent potential danger caused by actuator operation.

2. Holding of pressure

Since the products are subject to air leakage (allowed), they cannot be used for applications such as holding pressure in a pressure vessel.

3. Maintenance space

The installation should allow sufficient space for maintenance activities.

Selection

⚠ Warning

1. Confirm the specifications.

The products presented in this catalog are 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 specifications.)

Contact SMC when using a fluid other than compressed air.

2. Extended periods of continuous energization

Contact SMC if valves will be continuously energized for extended periods of time.

3. Operation of closed center solenoid valves

When closed center solenoid valves are used, or when used on an actuator with a load factor of 50% or more, jumping (lurching) cannot be prevented even if this product is used.

4. Using a regulator on the secondary side

When mounting a regulator on the secondary side (A port side), use a residual pressure relief regulator (AR2550 to 4050) or a check type regulator (AR2560 to 6060).

With a standard regulator (AR1000 to 6000), the secondary side pressure may not be released when this valve is exhausted.

5. Operation of secondary side solenoid valves

To operate solenoid valves mounted on this product's secondary side (A port side), first confirm that the secondary side's pressure (P) has increased to become equal to the primary side's pressure (P).

6. Operation

The residual pressure release function of this product is for emergency use only; therefore, avoid operation in the same manner as ordinary 3 port valves.

7. Using a lubricator

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

8. Operation for air blowing

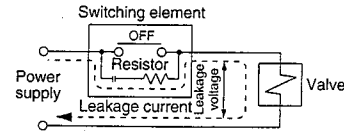
This product cannot be operated for air blowing due to the mechanism that switches the main valve to be fully open after the secondary side's pressure increases to approximately 1/2 of the primary side.

Selection

⚠ Caution

1. Leakage voltage

Particularly when using a C-R element (surge voltage suppressor) for protection of the switching element, take note that leakage voltage will increase due to leakage current flowing through the C-R element, etc.



AC coil is 20% or less of rated voltage.

DC coil is 3% or less of rated voltage.

2. Low temperature operation

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

Mounting

⚠ Warning

1. If air leakage increases or equipment does not operate properly, stop operation.

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

2. Instruction manual

Mount and operate the product after reading the manual carefully and understanding its contents. Also keep the manual where it can be referred to as necessary.

3. Painting and coating

Warnings or specifications printed or pasted on the product should not be erased, removed or covered up.

Furthermore, contact SMC before painting resin parts, as this may cause adverse effects depending on the solvent.

Adjustment

⚠ Caution

1. To perform the initial speed adjustment of a secondary side actuator, supply air from this valve's primary side and turn ON the pilot valve. Then, rotate the needle counter clockwise from the fully closed condition.

Piping

⚠ Caution

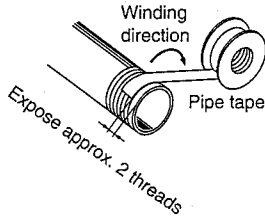
1. Preparation before piping

Before piping is connected, it should be thoroughly blown out with air (flushing) or washed to remove chips, cutting oil and other debris from inside the pipe.

2. Wrapping of pipe tape

When connecting pipes and fittings, etc., be sure that chips from the pipe threads and sealing material do not get inside the valve.

Further, when pipe tape is used, leave 1.5 to 2 thread ridges exposed at the end of the threads.



3. Tighten threads with the proper tightening torque.

When screwing fittings into valves, tighten with the torques given below.

Tightening torque for piping

Connection 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

4. Connection of piping to products

When connecting piping to a product, refer to its instruction manual to avoid mistakes regarding the supply port, etc.

5. F.R.L. module combination

When connecting to a modular F.R.L. combination (AC2000 to 6000), select one of the spacers, which are included. (Refer to page 6 for details.) However, modular combination with AC4000-06 is not possible.

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

6. Primary 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 composite effective area of the primary side's (P port side's) piping or equipment should be equal to or larger than the values below.

Model	Composite effective area mm ²
AV2000	5
AV3000	22
AV4000	35
AV5000	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.

Indicator Light/Surge Voltage Suppressor

⚠ Caution

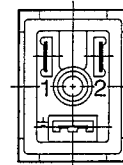
Voltage	AC and 100VDC	24VDC or less
Electrical circuit	<p>Terminal no. 1 (+) With indicator light Terminal no. 2 (-)</p>	<p>Terminal no. 1 + (-) With indicator light Terminal no. 2 - (+) Note) There is no polarity (+ or -).</p>

Electrical Connection

⚠ Caution

The internal connection of the DIN terminal is as shown below, therefore, connect to the power supply side as shown.

DIN terminal



Terminal	1	2
DIN terminal	+	-

Lubrication

⚠ Caution

- The valve has been lubricated for life at the factory, and does not require any further lubrication.
- In the event that it is lubricated, use Class 1 turbine oil (without additives), ISO VG32. However, once lubrication is applied it must be continued, as the original lubricant may be eliminated leading to malfunction. Contact SMC regarding Class 2 turbine oil (with additives), ISO VG32.

Air Supply

Warning

1. Use clean air.

Do not use compressed air which contains chemicals, synthetic oils containing organic solvents, salts or corrosive gases, etc., as this can cause damage or malfunction.

Caution

1. Install air filters.

Install air filters close to valves at their upstream side. A filtration degree of 5µm or less should be selected.

2. Install an after-cooler, air dryer or water separator, etc.

Air that includes excessive drainage may cause malfunction of valves and other pneumatic equipment. To prevent this, install an after-cooler, air dryer or water separator, etc.

Operating Environment

Warning

1. Do not use valves in atmospheres of corrosive gases, chemicals, salt water, water or steam, or where there is direct contact with any of these.
2. Do not use in an explosive atmosphere.
3. Do not use in locations subject to vibration or impact.
4. A protective cover, etc., should be used to shield valves from direct sunlight.
5. Shield valves from radiated heat generated by nearby heat sources.
6. Employ suitable protective measures in locations where there is contact with water droplets, oil or welding spatter, etc.
7. In a dusty environment or when valve switching noise is intrusive, take measures for the prevention of dust entry and for noise reduction, such as mounting a silencer on the R port.

Maintenance

Warning

1. Perform maintenance procedures as shown in the instruction manual.

If handled improperly, malfunction or damage of machinery or equipment may occur.

2. Equipment removal and supply/exhaust of compressed air

When equipment is removed, first confirm that measures are in place to prevent dropping of work pieces and run-away of equipment, etc. Then cut the supply pressure and power, and exhaust all compressed air from the system using its residual pressure release function.

3. Low frequency operation

Valves should be switched at least once every 30 days to prevent malfunction. (Use caution regarding the air supply.)

4. Manual override operation

When the manual override is operated, connected equipment will be actuated. Confirm safety before operating.

Caution

1. Drainage removal

Remove drainage from air filters regularly. (Refer to specifications.)

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

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

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

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

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

Q : Air flow rate [ℓ/min (ANR)]

S : Effective area (mm²)

P1: Upstream pressure [MPa]

P2: Downstream pressure [MPa]

t : Air temperature

Note) Formulas above apply to compressed air only. Use conventional formulas for water and steam.

2. CHARACTERISTICS

·Start-up valve for low-speed air supply to gradually raise initial pressure in an air system and for quick exhaust by cutting off air supply.

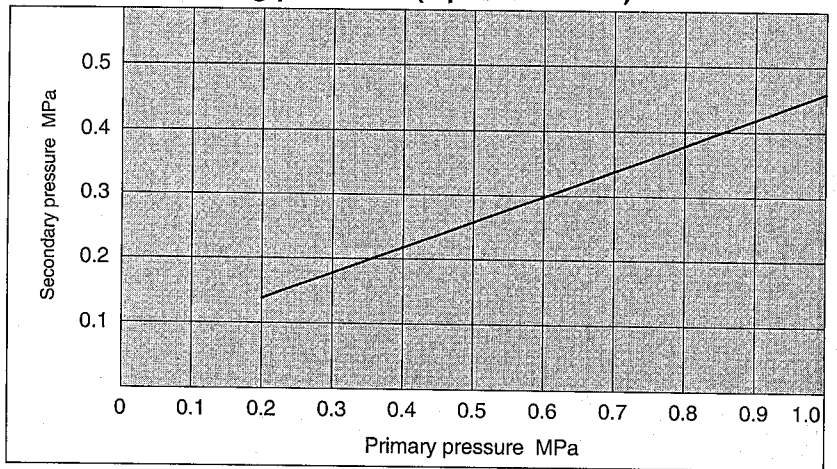
3. SPECIFICATIONS

MODEL		AV2000	AV3000	AV4000	AV5000	
Port size		1/4	3/8	1/2	3/4	1
Proof pressure		1.5MPa				
Operating pressure range		0.2 to 1MPa				
Pressure gauge port size		1/8				
Ambient and fluid temperature		0~60°C (SHOULD BE NO FREEZING)				
Effective area(mm ²)	1(P)→2(A)	20	37	61	113	122
	2(A)→3(R)	24	49	76	132	141
Weight (kg)		0.27	0.48	0.74	1.60	1.54
Electrical specifications	Rated coil voltage		100, 200, 110, to 120, 220VAC (50/60Hz), 12, 24VDC			
	Allowable voltage fluctuation		-15% to +10% of rated voltage			
	Coil insulation type		Equivalent to B type(130°C)			
	Apparent power AC (current consumption)	Inrush	5.6VA(50Hz), 5.0VA(60Hz)			
		Energized	3.4VA(2.1W)/50Hz, 2.3VA(1.5W)/60Hz			
	Current consumption DC		1.8W			
	Electrical entry		Grommet, type D DIN terminal, Type Y DIN terminal			
Optional specification		Indicator light/Surge voltage suppressor				
Pilot valve manual override		Non-locking push type(flush type), Locking type(tool required), Locking type(lever type)				

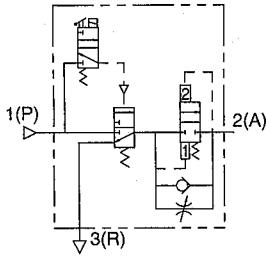
Note1) Use dry air when operating at a low temperature.

Note2) The grommet type can have a surge voltage suppressor(direct coupling type lead wire),
But without indicator light.

Piston B switching pressure (Open→Closed)

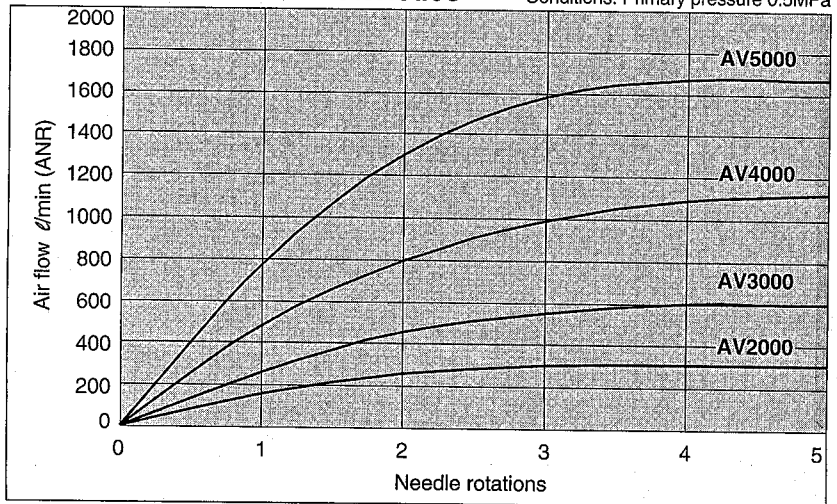


Symbol

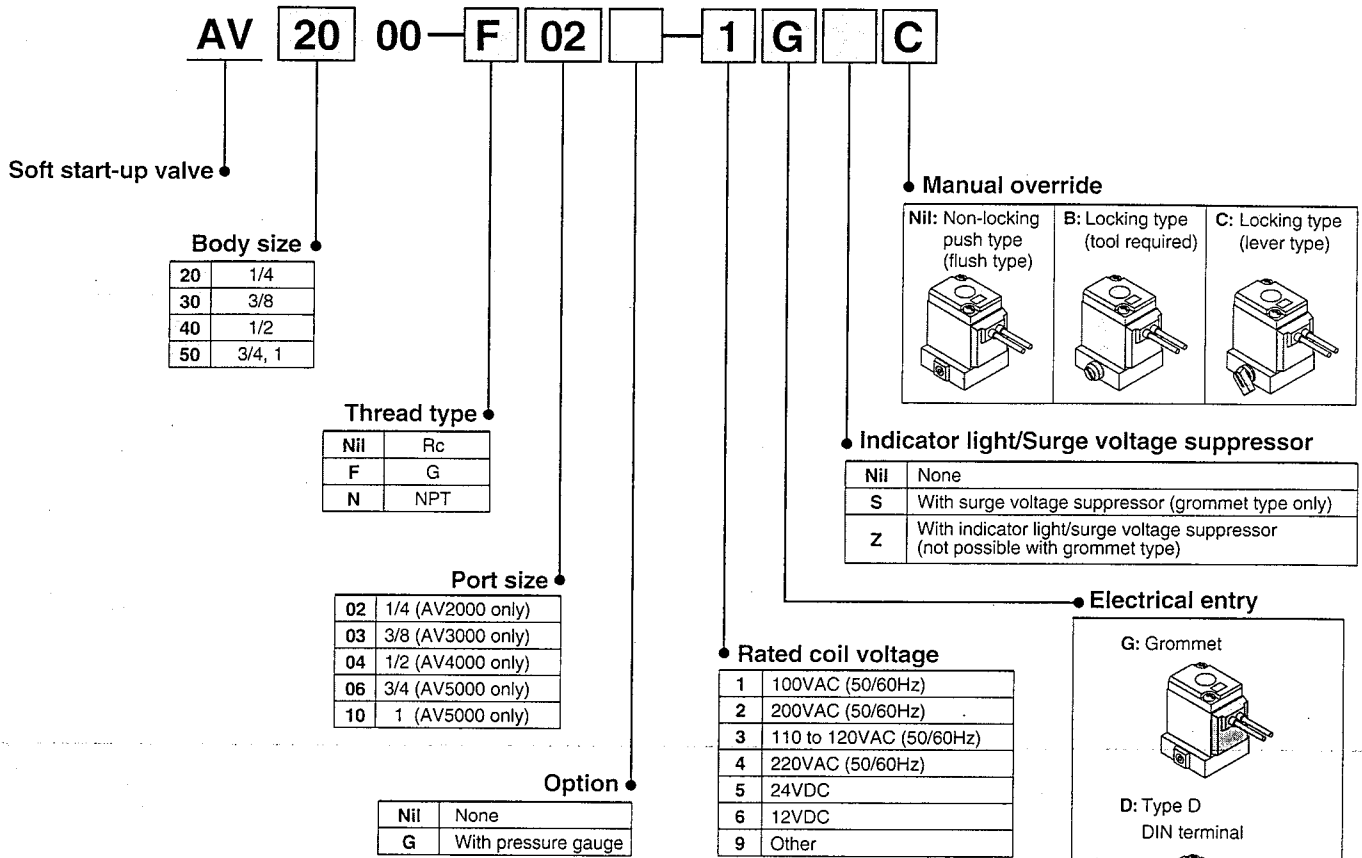


Needle valve flow characteristics

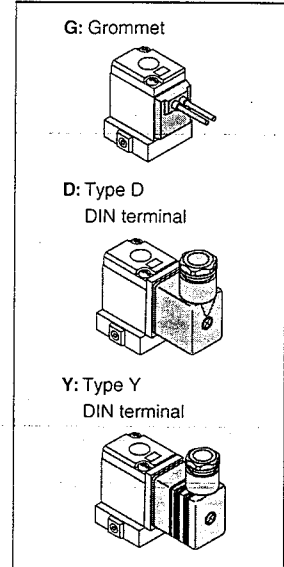
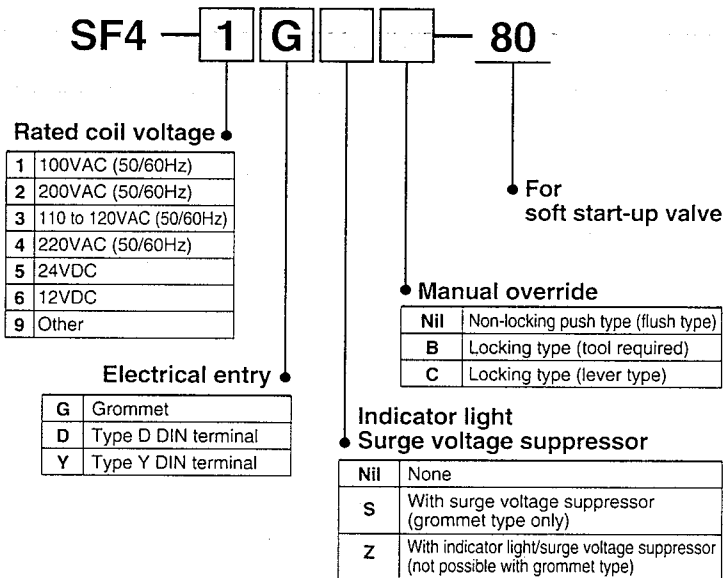
Conditions: Primary pressure 0.5MPa



4. HOW TO ORDER



How to Order Pilot Valve Assemblies



Note) The grommet type can have a surge voltage suppressor (direct coupling type lead wire), but without indicator light.



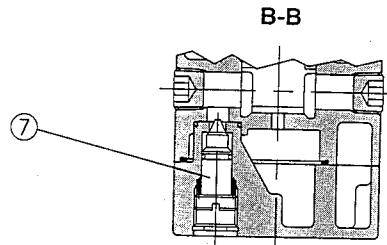
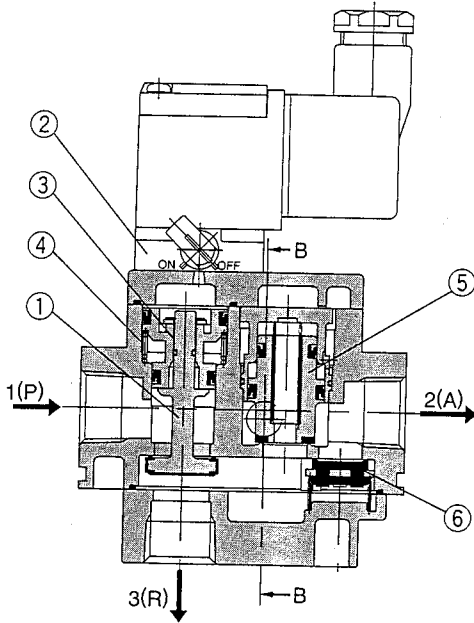
BAUART
GEPRÜFT
TYPE
APPROVED

TÜV approved product
(Conforms to standards necessary to satisfy EC directives.)

Series AV has received approval from TÜV Rheinland, an EC Notified Body (EC authorization number 0197), for conformity to DIN VDE0580: 1994 Standards.

Consult SMC for details when ordering TÜV approved products because of restrictions regarding product model, voltage specification, and electrical entry, etc.

5. CONSTRUCTION

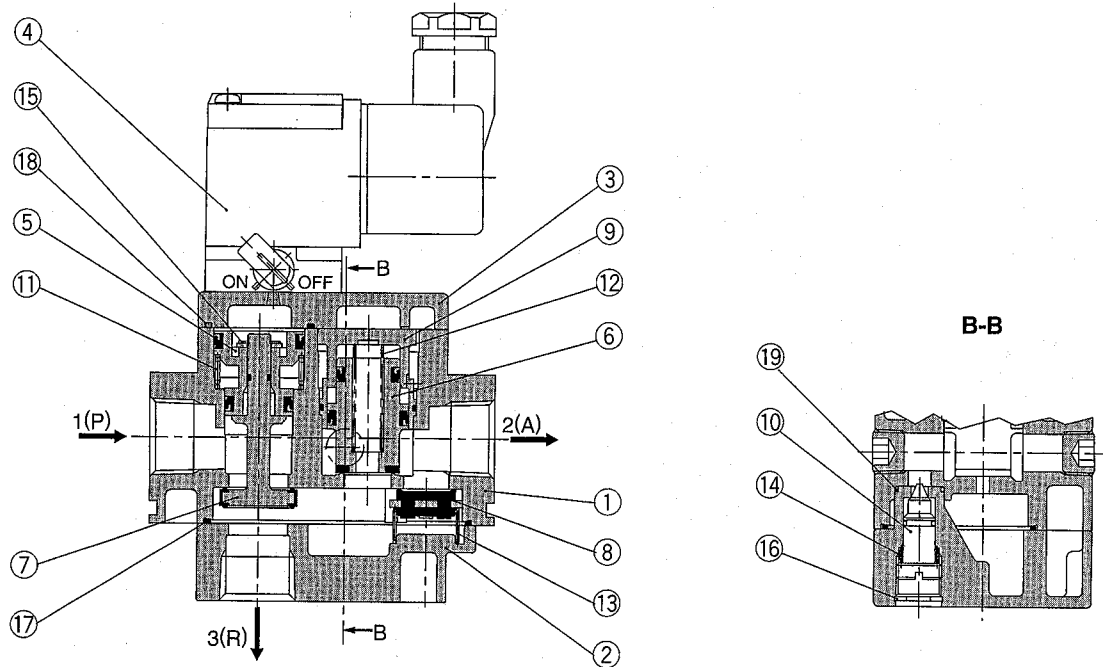


Working condition	Pilot valve	Pressure conditions	Working description	Pressure time chart (meter-out control) example	Cylinder drive circuit (meter-out control) example
Low speed supply	ON	$1/2 PP > PA$	When pilot valve ② is turned ON by energization or manual override, the pilot air pushes piston A ③ and main valve ① downward and opens main valve ① while R port closes simultaneously. The air from P port moves to needle valve ⑦, where its flow is adjusted, and flows to A port. The meter-in control of needle valve ⑦ slowly moves the cylinder from ① to ②.	<p>Initial operation return stroke</p>	
High speed supply		$1/2 PP \leq PA$	When $1/2 PP \leq PA$ after the cylinder reaches ②, piston B ⑤ fully opens and PA increases rapidly as shown from ③ to ④ and becomes the same pressure as PP.		
Normal operation		$1/2 PP = \text{approx. } PA$	Since piston B ⑤ holds the fully open condition, during normal operation the cylinder's speed will be controlled by the usual meter-out control.		
Quick exhaust	OFF	—	When pilot valve ② is turned OFF, spring ④ pushes piston A ③ and main valve ① upward and opens R port while shutting off the air supply from P port. The pressure difference generated at this time opens check valve ⑥ and the residual pressure on the A port side is quickly exhausted from R port.		

6. Failure and countermeasure

Power supply of pilot valve	Phenomenon	Cause	Countermeasure
OFF	Air leaks from R port.	<ol style="list-style-type: none"> 1.The inclusion of foreign body onto sheet side of the main valve. 2.Damage on rubber lining of the main valve. 3.Damage of valve spring. 4.Damage of stopper ring of piston A fixed part. 	<ol style="list-style-type: none"> 1.Please wash the sheet side of the main valve. 2.Please exchange the main valve assembly. 3.Please exchange the valve spring. 4.Please exchange stopper ring.
	The residual pressure is not exhausted.	<ol style="list-style-type: none"> 1.The manual of the pilot valve is in the status of turning on. 2.Failure of pilot valve. 3.Damage of valve spring. 4.Damage of stopper ring of piston A fixed part. 	<ol style="list-style-type: none"> 1.Please turn off the manual. 2.Please exchange the pilot valve assembly. 3.Please exchange the valve spring. 4.Please exchange stopper ring.
ON	The main valve is not turned on. (There is no leakage from R port)	<ol style="list-style-type: none"> 1. Decrease in operating pressure. 2.Failure of pilot valve. 	<ol style="list-style-type: none"> 1.Please use the operating pressure within the range of 0.2-1MPa. 2.Please exchange the pilot valve assembly.
	The main valve is not turned on. (There is a large amount of leakage from R port)	<ol style="list-style-type: none"> 1.Decrease in operating pressure. 2.Air supply ability shortage on supply side (P or 1 port side) (A synthetic stress area is a small) 	<ol style="list-style-type: none"> 1.Please use the operating pressure within the range of 0.2-1MPa. 2.Please review piping and the equipment on the first side referring to ⑥ of the piping notes.
	It is an air leakage (small amount) from R port.	<ol style="list-style-type: none"> 1. The inclusion of foreign body onto sheet surface of main valve. 2. Damage on rubber lining of main valve. 	<ol style="list-style-type: none"> 1,Please wash the sheet side of the main valve. 2.Please exchange the main valve assembly.
	The modulating flow by the switching operation ON/OFF by the needle cannot be done. (Air leaks to A port even if the needle is all closes.)	<ol style="list-style-type: none"> 1. Damage in check valve spring. 2.The inclusion of foreign body on sheet side of check valve. 3. Damage of check valve. 4,Damage of piston spring. 5.The inclusion of foreign body onto sheet side of piston B. 6.Damage on rubber lining of piston B. 	<ol style="list-style-type: none"> 1,Please exchange the check valve spring. 2.Please wash the sheet side of check valve. 3.Please exchange check valve. 4.Please exchange the piston spring. 5.Please wash the sheet side of piston B. 6.Please exchange piston B assembly.
	Piston B does not change.	<ol style="list-style-type: none"> 1.There is external Leak from connected piping and the equipment on the second side (A port). 2. The inclusion of foreign body to sliding area of piston B. 3. Shrinkage of piston guide. 	<ol style="list-style-type: none"> 1Please stop Leak after investigating piping and the equipment on secondary side. 2.The foreign body must be removed after decomposition, and grease must be applied more. Moreover, please exchange piston B assembly if necessary. 3.Please exchange the piston guide.

7. PARTS LIST



Parts list

No.	Description	Material
1	Body	ADC
2	Cap	ADC
3	Cover	ADC

Replacement parts

No.	Description	Material	Part no.			
			AV2000	AV3000	AV4000	AV5000
4	Pilot valve assembly	—	SF4-□-80*			
5	Piston A assembly	POM, NBR	P424204A	P424304A	P424404A	P424504A
6	Piston B assembly	Brass, NBR (HNBR)	P424205A	P424305A	P424405A	P424505A
7	Main valve assembly	Brass, NBR (HNBR)	P424206A	P424306A	P424406A	P424506A
8	Check valve	Brass, NBR (HNBR)	P424207	P424307	P424407	P424507
9	Piston guide assembly	POM, NBR	P424208A	P424308A	P424408A	P424508A
10	Needle assembly	Brass, NBR	P424209A	P424309A	P424409A	P424509A
11	Valve spring	Steel wire	P424211	P424311	P424411	P424511
12	Piston spring	Stainless steel	P424212	P424312	P424412	P424512
13	Check spring	Stainless steel	P424213	P424313	P424413	P424513
14	Needle spring	Steel wire	P424214	P424314	P424414	—
15	C type snap ring for shaft	Tool steel	G-5	STW-5	STW-8	STW-10
16	C type snap ring for hole	Tool steel	0-9	0-10	RTW-12	RTW-15
17	Seal	NBR	P424210	P424310	P424410	P424510
18	Seal	NBR	P424218	P424315	P424415	P424514
19	O-ring	NBR	10 x 8 x 1	11 x 9 x 1	12.5 x 9.5 x 1.5	16.5 x 12.5 x 2

* Refer to page 1 for pilot valve assembly part number designations.

8. DISASSEMBLY

2-M3 Tightening torque for the mounting screw of the pilot valve 30N-cm

