



ORIGINAL INSTRUCTIONS

Instruction Manual

5 Port Solenoid Valve, Rubber Seal  
Series VFR2000/3000/4000/5000/6000



The intended use of this valve is to control the movement of an actuator.

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<sup>1)</sup>, and other safety regulations.

- <sup>1)</sup> 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: Robots and robotic devices - Safety requirements for industrial robots - Part 1: Robots.

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

<b>Caution</b>	Caution indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
<b>Warning</b>	Warning indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
<b>Danger</b>	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.
- If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

**Caution**

- The product is provided for use in manufacturing industries only. Do not use in residential premises.

2 Specifications

2.1 Valve specifications

Fluid		Air
Operating pressure range [MPa]	For internal pilot	2 position single / 3 position 0.2 to 0.9
	For external pilot	2 position double 0.1 to 0.9
External pilot operating pressure range [MPa]	2 position single/3 position <sup>Note 1)</sup>	0.2 to 0.9
	2 position double	0.1 to 0.9
Ambient and fluid temperature [°C]		-10 to 50 (no freezing)
Flow characteristics		Refer to catalogue
Response time [ms]		Refer to catalogue
Duty cycle		Contact SMC
Min. operating frequency		1 cycle / 30 days

2 Specification - continued

Max. operating frequency [Hz]		Refer to catalogue
Manual override	Pilot valve	VFR2000/3000/4000/5000 Non-locking push type (Flush/Extended), Locking type (Tool required/Lever)
		VFR6000 Non-locking push type
Main valve	VFR3000/4000/5000/6000	Direct manual override
Lubrication		Not required
Impact/Vibration resistance [m/s <sup>2</sup> ] <sup>Note 2)</sup>		300/50
Enclosure		Refer to Table 2.
Mounting orientation		Unrestricted
Weight		Refer to catalogue

Table 1.

Note 1) External pilot pressure range [MPa] for  
VFR4000: 0.5 x Operating pressure + 0.1 to 0.9  
VFR5000: 0.3 x Operating pressure + 0.1 to 0.9

Note 2) Impact resistance: No malfunction occurred when it was tested with a drop tester in the axial direction and at right angles to the main valve and armature; in both energized and de-energized states and for every time in each condition. (Values quoted are for a new valve).

Vibration resistance: No malfunction occurred in a one-sweep test between 45 and 2000 Hz. Tests are performed at both energized and de-energized states in the axial direction and at right angles to the main valve and armature. (Values quoted are for a new valve).

2.1.1 Enclosure

Electrical entry		F	D	Y	
Enclosure (Equivalent based on JIS C 0920)	With light / surge voltage suppression	VFR2000	50	50	50
		VFR3#1#	50	50	-
		VFR3#4#	50	50	50
		VFR4#1#	50	50	-
		VFR4#4#	50	50	50
		VFR5000	50	54	-
	VFR6000	50	50	-	

	Without light / surge voltage suppression	F	D	Y
	VFR2000	54	54	54
	VFR3#1#	52	54	-
	VFR3#4#	52	54	54
	VFR4#1#	52	54	-
	VFR4#4#	52	54	54
	VFR5000	52	54	-
	VFR6000	52	54	-

Table 2.

2.2 Solenoid specifications

Pilot valve	SF4-###-##-#-Q	
Coil rated voltage	DC [VDC]	12, 24
AC [VAC] (50/60 Hz)		100, 110 to 120, 200, 220, 240
Electrical entry	Plug-in	Conduit terminal
	Non plug-in	DIN terminal
Coil insulation class (Based on JIS C 4003)	Class B or equivalent	
Allowable voltage fluctuation	-15 to 10% of rated voltage	
Apparent power [VA]	Inrush	5.6 (50 Hz), 5.0 (60 Hz)
	Holding	3.4 (50 Hz), 2.3 (60 Hz)
Power consumption [W]	1.8 (2.04 with light/surge voltage suppressor)	
Surge voltage suppressor	Varistor	
Indicator light	DC	LED
	AC	Neon light

Table 3.

2.3 Manifold specifications

2.3.1 VFR2000 series

Base model	Plug-in type VV5FR2-01#-Q		Non plug-in type VV5FR2-10-Q
Wiring	Terminal block	Multi-connector, D-sub connector	DIN terminal
Porting specifications	A, B port	Side / Bottom	
Port size	P, EA, EB	1/4	
	A, B	1/8, 1/4, C6, C8	
Stations	2 to 15	2 to 8	2 to 15
Applicable valve model	VFR2#00-#F-Q		VFR2#10-#D-Q

Table 4.

2 Specification - continued

2.3.2 VFR3000 series

Base model	Plug-in type VV5FR3-01#-Q		Non plug-in type VV5FR3-10-Q	Non plug-in type VV5FR3-40-Q
Wiring	Terminal block	Multi-connector, D-sub connector	DIN terminal	
Porting specifications	A, B port	Side / Bottom		
Port size	P, EA, EB	1/2		
	A, B	1/4, 3/8, C8, C10		
Stations	2 to 10	2 to 8	2 to 10	
Applicable valve model	VFR3#0#-#F-Q		VFR3#1#-#D-Q	VFR3#4#-#D-Q

Table 5.

2.3.3 VFR4000 series

Base model	Plug-in type VV5FR4-01#-Q		Non plug-in type VV5FR4-10-Q	Non plug-in type VV5FR4-40-Q
Wiring	Terminal block	Multi-connector, D-sub connector	DIN terminal	
Porting specifications	A, B port	Side / Bottom		
Port size	P, EA, EB	1/2		
	A, B	3/8, 1/2		
Stations	2 to 10	2 to 8	2 to 10	
Applicable valve model	VFR4#0#-#F-Q		VFR4#1#-#D-Q	VFR4#4#-#D-Q

Table 6.

2.3.4 VFR5000 series

Base model	Plug-in type VV5FR5-01#-Q		Non plug-in type VV5FR5-10-Q
Wiring	Terminal block	Multi-connector, D-sub connector	DIN terminal
Porting specifications	A, B port	Side / Bottom	
Port size	P, EA, EB	3/4	
	A, B	1/2, 3/4	
Stations	2 to 10	2 to 8	2 to 10
Applicable valve model	VFR5#0#-#F-Q		VFR5#1#-#D-Q

Table 7.

2.4 Pneumatic symbol

Refer to catalogue for pneumatic symbol.

2.5 Indicator light

Refer to catalogue for indicator light locations.

2.6 Special products

**Warning**

Special products (-X) 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.

3.2 Environment

**Warning**

- Do not use in an environment where corrosive gases, chemicals, salt 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.
- Products compliant with IP50, IP52 and IP54 have limited protection against dust.
- Products compliant with IP52 are protected against water drips and products compliant with IP54 are protected water splashes. However, these products cannot be used in water.
- Products compliant with IP50, IP52 and IP54 enclosures satisfy the specifications by mounting each product properly. Be sure to read the Specific Product Precautions for each product.

3 Installation - continued

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 thread exposed on the end of the pipe/fitting.
- Tighten fittings to the specified tightening torque.

Series	Port	Thread	Tightening torque [N·m]
VFR2000	Pilot exhaust, External pilot	M5	1 to 1.5
	1(P), 2(B), 3(EB), 4(A), 5(EA)	1/8	3 to 5
VFR3000	Pilot exhaust, External pilot	1/4	8 to 12
	1(P), 2(B), 3(EB), 4(A), 5(EA)	1/8	3 to 5
VFR4000	Pilot exhaust, External pilot	1/4	8 to 12
	1(P), 2(B), 3(EB), 4(A), 5(EA)	3/8	15 to 20
VFR5000	Pilot exhaust, External pilot	1/2	20 to 25
	1(P), 2(B), 3(EB), 4(A), 5(EA)	1/8	3 to 5
VFR6000	Pilot exhaust	3/8	15 to 20
	1(P), 2(B), 3(EB), 4(A), 5(EA)	1/2	20 to 25
		3/4	28 to 30
		1	36 to 38

Table 8.

3.4 Lubrication

**Caution**

- SMC products have been lubricated for life at manufacture, and do not require lubrication in service.
- If a lubricant is used in the system, refer to catalogue for details.

3.5 Air supply

**Warning**

- Use clean air. If the compressed air supply includes chemicals, synthetic materials (including organic solvents), salinity, corrosive gas etc., it can lead to damage or malfunction.

**Caution**

- Install an air filter upstream of the valve. Select an air filter with a filtration size of 5 µm or smaller.

3.6 Manual override

**Warning**

- Regardless of an electric signal for the valve, the manual override is used for switching the main valve. Since connected equipment will operate when the manual override is activated, confirm that conditions are safe prior to activation.
- Locked manual overrides might prevent the valve responding to being electrically de-energized or cause unexpected movement in the equipment.
- Refer to the catalogue for pilot manual override location.
- To operate the non-locking manual override, push the manual override until it stops.
- To operate the locking manual override, use a tool (not required for lever type) to turn the manual override 90° in the "1" direction, the valve will turn on and lock. To cancel the ON state, turn it 90° in the display "0" direction and check that it is in the OFF state.

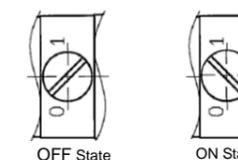


Figure 1. Locking manual override (Tool required type shown)

### 3 Installation - continued

#### 3.6.1 Main valve direct manual override

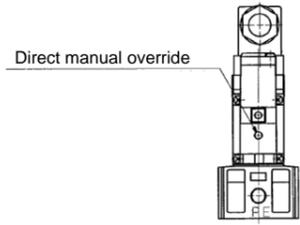


Figure 2. VFR3000 Direct manual override location

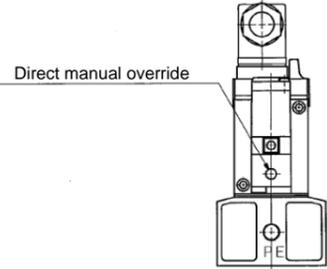


Figure 3. VFR4000 Direct manual override location

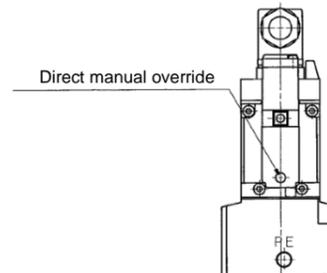


Figure 4. VFR5000 Direct manual override location

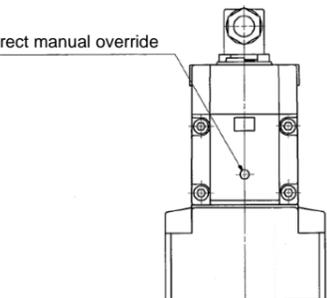


Figure 5. VFR6000 Direct manual override location

#### 3.7 Mounting

##### Caution

- Ensure gaskets are in good condition, not deformed and are dust and debris free.
- When mounting valves ensure gaskets are present, aligned and securely in place and tighten the mounting screws to the recommended tightening torque.

### 3 Installation - continued

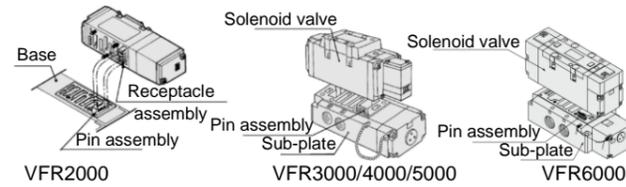


Figure 6. Mounting valve to base (Plug-in type)

Model	Mounting screw	Tightening torque [N·m]
VFR2000	M3 (3 pcs.)	0.9
VFR3000	M3 (3 pcs.)	1.1
VFR4000	M4 (4 pcs.)	1.4
VFR5000	M5 (4 pcs.)	2.8
VFR6000	M8 (4 pcs.)	16

Table 9.

- Refer to catalogue for more guidance on mounting valves.

#### 3.8 Electrical circuits

##### Caution

Surge suppression should be specified by using the appropriate part number. If a valve type without suppression (Type 'Nil') is used, suppression must be provided by the host controller as close as possible to the valve.

#### 3.8.1 VFR2#00, VFR3#(0/1)0, VFR4#(0/1)0, VFR5#(0/1)0, VFR6#(0/1)0

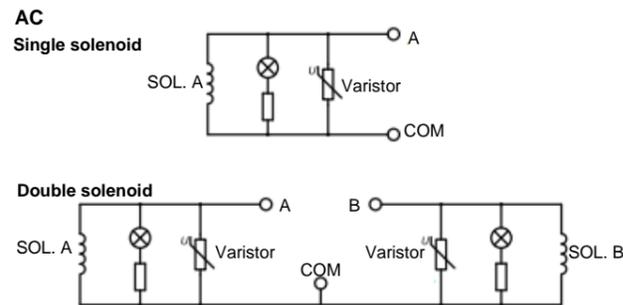


Figure 7. AC Circuit Diagrams (VFR2#00, VFR3#(0/1)0, VFR4#(0/1)0, VFR5#(0/1)0, VFR6#(0/1)0)

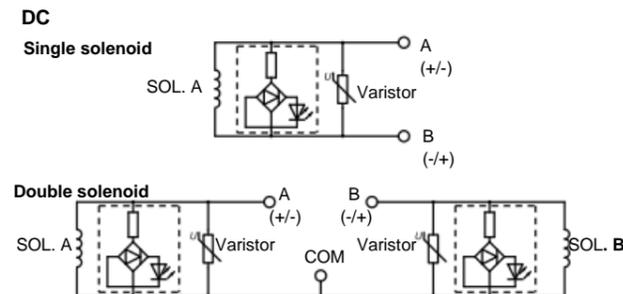


Figure 8. DC Circuit Diagrams (VFR2#00, VFR3#(0/1)0, VFR4#(0/1)0, VFR5#(0/1)0, VFR6#(0/1)0)

### 3 Installation - continued

#### 3.8.2 VFR2#10, VFR3#40, VFR4#40

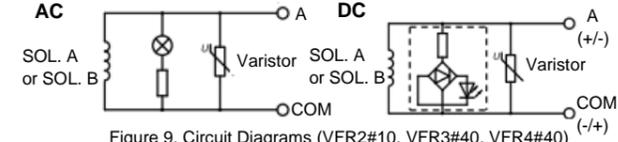


Figure 9. Circuit Diagrams (VFR2#10, VFR3#40, VFR4#40)

#### 3.9 Electrical connectors

##### 3.9.1 DIN terminal

##### Caution

- To change direction of the DIN connector/cable entry: Unscrew retaining screw, pull off outer cover, rotate connector block through 180°. Replace cover and tighten screw.

##### 3.9.1.1 VFR2000 Series, VFR3#40, VFR4#40

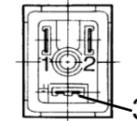
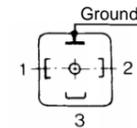


Figure 10. Internal wiring of DIN terminal

1	(-)(+) (no polarity)
2	(+)(-) (no polarity)
3	Ground

- In the case of DIN terminal block and terminal block, there is no polarity of positive [+] and negative [-]. Connect no. 1 and no. 2 terminals with corresponding power side.
- Applicable heavy-duty cord:
  - Type D VFR2000: O.D. ø6 mm to ø8 mm
  - Type D VFR3000/4000: O.D. ø4.5 mm to ø7 mm
  - Type Y: O.D. ø4.5 mm to ø7 mm

##### 3.9.1.2 VFR3#10, VFR4#10, VFR5000 series, VFR6000 series



1	SOL. A side
2	SOL. B side
3	COM
	Ground

Figure 11. Internal wiring of DIN terminal

- Can be used as either "+COM" or "-COM".
- Applicable cable Cross section of the wire: 0.5 to 1.5 mm<sup>2</sup> Cable O.D.: ø8 to ø10
- Refer to catalogue for applicable crimp terminal.
- Proper tightening torque: Connector set screw 0.5 to 0.6 N·m  
Terminal screw 0.5 to 0.6 N·m
- Incorrect connection of "COM terminal" (DIN terminal no. 3) can cause damage on power source circuit.

##### 3.9.2 Plug-in type (conduit terminal)

##### Caution

##### 3.9.2.1 VFR2000/3000/4000

- Removing junction cover (1) allows access to plug-in terminal block (2).

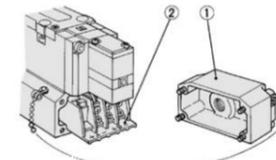


Figure 12. Plug-in (conduit terminal) electrical connection (VFR2000/3000/4000)

### 3 Installation - continued

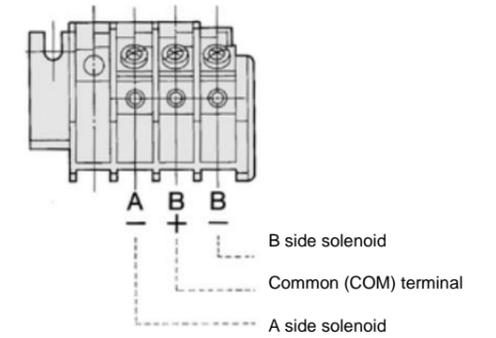


Figure 13. Plug-in contact terminal (VFR2000/3000/4000)

- Although "A-", "B+" and "B-" marks are indicated on the terminal block, this can be used as either "+COM" or "-COM".
- Applicable terminal:
  - VFR2000, VFR3000: 1.25-3, 1.25-3S, 1.25Y-3N, 1.25Y-3S
  - VFR4000: 1.25-3.5M, 1.25Y-3L, 1.25Y-3M

##### 3.9.2.2 VFR5000

- Remove junction cover for sub-plate (1), depress levers (3) of terminal block assembly (2), pull out terminal block assembly

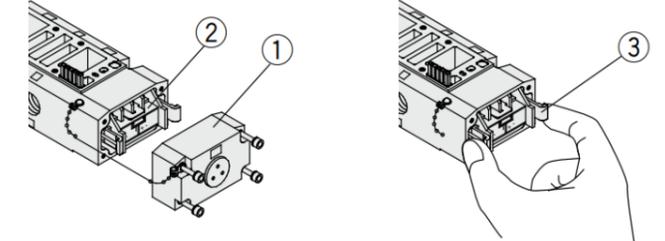


Figure 14. Plug-in (conduit terminal) electrical connection (VFR5000)

- Terminal block assembly is marked as below. Connect it to power supply side.

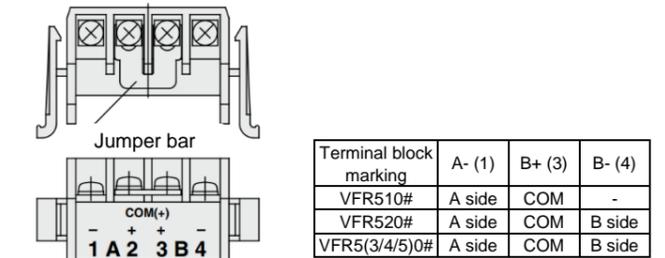


Figure 15. Plug-in contact terminal (VFR5000)

- Terminal block assembly can be used as "+" and "-" common regardless of markings. Do not remove jumper bar because it is used for common connection.
- Applicable terminal: 1.25-4, 1.25-4M

##### 3.9.2.3 VFR6000

- Removing junction cover (1) allows access to plug-in terminal block (2).

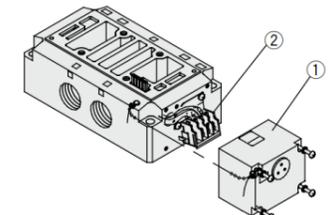
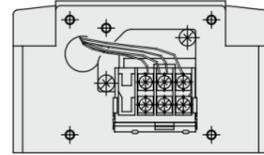


Figure 16. Plug-in (conduit terminal) electrical connection (VFR6000)

### 3 Installation - continued

- Terminal block assembly is wired as shown in Figure 14. Connect it to each power supply side.



Terminal block marking	Left	Centre	Right
VFR610#	A side	COM	-
VFR620#	A side	COM	B side
VFR6(3/4/5)0#	A side	COM	B side

Figure 17. Plug-in contact terminal (VFR6000)

- Can be used as either "+COM" or "-COM".
- Applicable terminal: 1.25-4, 1.25-4M

#### 3.9.3 Plug-in manifold wiring (terminal block, circular connector, D-sub connector)

##### Caution

Refer to catalogue for how to wire plug-in manifold.

#### 3.10 Residual voltage

##### Caution

- If a varistor voltage suppressor is used, the suppressor arrests the back EMF voltage from the coil to a level in proportion to the rated voltage.
- Ensure the transient voltage is within the specification of the host controller.
- Contact SMC for the varistor residual voltage.
- Valve response time is dependent on surge suppression method selected.

#### 3.11 Countermeasure for surge voltage

##### Caution

- At times of sudden interruption of the power supply, the energy stored in a large inductive device may cause non-polar type valves in a de-energised state to switch.
- When installing a breaker circuit to isolate the power, consider a valve with polarity (with polarity protection diode), or install a surge absorption diode across the output of the breaker.

#### 3.12 Extended period of continuous energization

##### Warning

- If a valve will be continuously energized for an extended period of time, the temperature of the valve will increase due to the heat generated by the coil assembly. This will likely adversely affect the performance of the valve and any nearby peripheral equipment. Therefore, if the valve is to be energized for periods of longer than 30 minutes at a time or if during the hours of operation the energized period per day is longer than the de-energized period, we advise using a valve with specifications listed below.
- Pilot operated: A 0.4 W or lower valve, such as the SY series, or a valve with a power-saving circuit

#### 3.13 Effect of back pressure when using a manifold

##### Warning

- Use caution when valves are used on a manifold, because an actuator may malfunction due to back-pressure.
- Special caution must be taken when using 3 position exhaust centre valve or when driving a single acting cylinder. To prevent a malfunction, implement counter measures such as using a single EXH spacer assembly or an individual exhaust manifold.

#### 3.14 Use as a 3 port valve

##### Caution

Refer to Specific Product Precautions in VFR series catalogue for how to use as a 3 port valve.

### 4 How to Order

Refer to catalogue for 'How to Order'.

### 5 Outline Dimensions

Refer to catalogue for outline dimensions.

### 6 Maintenance

#### 6.1 General maintenance

##### Caution

- 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.

#### 6.2 Mounting

##### Caution

- Refer to 3.7 Mounting for information on mounting valves to base.

#### 6.3 Maintainable parts

##### Caution

- Refer to catalogue for how to order manifold accessories, subplates, gaskets, mounting screws etc. Refer to catalogue for how to order and replace pilot valves assemblies. Recommended tightening torque for M3 pilot valve mounting screws is 0.6 N·m.

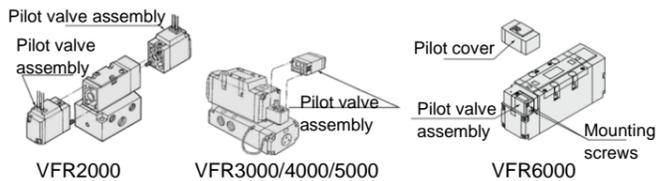


Figure 18. Pilot valve mounting

### 7 Limitations of Use

#### 7.1 Limited warranty and disclaimer/compliance requirements

Refer to Handling Precautions for SMC Products.

##### Warning

#### 7.2 Effect of energy loss on valve switching

	Single solenoid VFR2000/3000/4000	Single solenoid VFR5000/6000	Double solenoid	3 Position
Air supply present, electrical supply cut	Spool returns to the OFF position by air and spring force	Spool returns to OFF position by air force	Spool stops moving after electricity cut (Position cannot be defined)	Spool returns to the OFF position by spring force
Electrical supply present, air supply cut	Spool stops moving after air pressure cut (Position cannot be defined)	Spool stops moving after air pressure cut (Position cannot be defined)	Spool stops moving after air pressure cut (Position cannot be defined)	

Table 10.

Note) Applies to when the spool is at the end position and at an intermediate position.

### 7 Limitations of Use - continued

#### 7.3 Intermediate stopping

Refer to Handling Precautions for 3/4/5 port Solenoid Valves.

#### 7.4 Holding of pressure

Since valves are subject to air leakage, they cannot be used for applications such as holding pressure (including vacuum) in a system.

#### 7.5 Cannot be used as an emergency shut-off valve

This product is not designed for safety applications such as an emergency shut-off valve. If the valves are used in this type of system, other reliable safety assurance measures should be adopted.

##### Caution

#### 7.6 Leakage voltage

Ensure that any leakage voltage caused by the leakage current when the switching element is OFF causes  $\leq 3\%$  (for DC coils) or  $\leq 20\%$  (for AC coils) of the rated voltage across the valve.

#### 7.7 Low temperature operation

Unless otherwise indicated in the specifications for each valve, operation is possible to  $-10^{\circ}\text{C}$ , but appropriate measures should be taken to avoid solidification or freezing of drainage and moisture, etc.

#### 7.8 Momentary energization

If a double solenoid valve is operated with momentary energization, it should be energized for at least 0.1 second. However, depending on the secondary load conditions, it should be energized until the cylinder reaches the stroke end position, as there is a possibility of malfunction otherwise.

### 8 Product Disposal

This product shall not be disposed of as municipal waste. Check your local regulations and guidelines to dispose this product correctly, in order to reduce the impact on human health and the environment.

### 9 Contacts

Refer to [www.smcworld.com](https://www.smcworld.com) or [www.smc.eu](https://www.smc.eu) for your local distributor/importer.

## SMC Corporation

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