



# Operation Manual

PRODUCT NAME

Low Profile 2/3-Port Solenoid Valve

MODEL / Series / Product Number

SX90/090 Series

**SMC Corporation**

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# 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: Manipulating industrial robots -Safety.

etc.



## 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

### **1. The compatibility of the product is the responsibility of the person who designs the equipment or decides its specifications.**

Since the product specified here is used under various operating conditions, its compatibility with specific equipment must be decided by the person who designs the equipment or decides its specifications based on necessary analysis and test results.

The expected performance and safety assurance of the equipment will be the responsibility of the person who has determined its compatibility with the product.

This person should also continuously review all specifications of the product referring to its latest catalog information, with a view to giving due consideration to any possibility of equipment failure when configuring the equipment.

### **2. Only personnel with appropriate training should operate machinery and equipment.**

The product specified here may become unsafe if handled incorrectly.

The assembly, operation and maintenance of machines or equipment including our products must be performed by an operator who is appropriately trained and experienced.

### **3. Do not service or attempt to remove product and machinery/equipment until safety is confirmed.**

1. The inspection and maintenance of machinery/equipment should only be performed after measures to prevent falling or runaway of the driven objects have been confirmed.

2. When the product is to be removed, confirm that the safety measures as mentioned above are implemented and the power from any appropriate source is cut, and read and understand the specific product precautions of all relevant products carefully.

3. Before machinery/equipment is restarted, take measures to prevent unexpected operation and malfunction.

### **4. Contact SMC beforehand and take special consideration of safety measures if the product is to be used in any of the following conditions.**

1. Conditions and environments outside of the given specifications, or use outdoors or in a place exposed to direct sunlight.

2. Installation on equipment in conjunction with atomic energy, railways, air navigation, space, shipping, vehicles, military, medical treatment, combustion and recreation, or equipment in contact with food and beverages, emergency stop circuits, clutch and brake circuits in press applications, safety equipment or other applications unsuitable for the standard specifications described in the product catalog.

3. An application which could have negative effects on people, property, or animals requiring special safety analysis.

4. Use in an interlock circuit, which requires the provision of double interlock for possible failure by using a mechanical protective function, and periodical checks to confirm proper operation.



# Safety Instructions

## **Caution**

### **The product is provided for use in manufacturing industries.**

The product herein described is basically provided for peaceful use in manufacturing industries.

If considering using the product in other industries, consult SMC beforehand and exchange specifications or a contract if necessary.

If anything is unclear, contact your nearest sales branch.

## **Limited warranty and Disclaimer/Compliance Requirements**

The product used is subject to the following “Limited warranty and Disclaimer” and “Compliance Requirements”.

Read and accept them before using the product.

### **Limited warranty and Disclaimer**

1. The warranty period of the product is 1 year in service or 1.5 years after the product is delivered, whichever is first.\*2)

Also, the product may have specified durability, running distance or replacement parts. Please consult your nearest sales branch.

2. For any failure or damage reported within the warranty period which is clearly our responsibility, a replacement product or necessary parts will be provided.

This limited warranty applies only to our product independently, and not to any other damage incurred due to the failure of the product.

3. Prior to using SMC products, please read and understand the warranty terms and disclaimers noted in the specified catalog for the particular products.

\*2) Vacuum pads are excluded from this 1 year warranty.

A vacuum pad is a consumable part, so it is warranted for a year after it is delivered.

Also, even within the warranty period, the wear of a product due to the use of the vacuum pad or failure due to the deterioration of rubber material are not covered by the limited warranty.

### **Compliance Requirements**

1. The use of SMC products with production equipment for the manufacture of weapons of mass destruction(WMD) or any other weapon is strictly prohibited.

2. The exports of SMC products or technology from one country to another are governed by the relevant security laws and regulation of the countries involved in the transaction. Prior to the shipment of a SMC product to another country, assure that all local rules governing that export are known and followed.

## **Caution**

### **SMC products are not intended for use as instruments for legal metrology.**

Measurement instruments that SMC manufactures or sells have not been qualified by type approval tests relevant to the metrology (measurement) laws of each country.

Therefore, SMC products cannot be used for business or certification ordained by the metrology (measurement) laws of each country.



# 2/3-Port Solenoid Valves Precautions 1

Be sure to read this before handling products.

## Design/Selection

### ⚠ Warning

#### 1. Confirm the specifications.

Products represented in this catalog are designed only for use in compressed air systems (including vacuum).

Do not operate at pressures, temperatures, etc., beyond the range of specifications, as this can cause damage or malfunction. (Refer to the specifications.)

Please contact SMC when using a fluid other than compressed air (including vacuum).

We do not guarantee against any damage if the product is used outside of the specification range.

#### 2. Actuator drive

When an actuator, such as a cylinder, is to be driven using a valve, take appropriate measures (such as the installation of a cover or the restricting of access to the product) to prevent potential danger caused by actuator operation.

#### 3. Holding pressure (including vacuum)

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

#### 4. Not suitable for use as an emergency shut-off valve, etc.

The valves listed in this catalog are not designed for safety applications such as an emergency shutoff valve. If the valves are used in such applications, additional safety measures should be adopted.

#### 5. Release of residual pressure

For maintenance and inspection purposes install a system for releasing residual pressure.

#### 6. Ventilation

Provide ventilation when using a 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.

#### 7. Do not disassemble the product or make any modifications, including additional machining.

Doing so may cause human injury and/or an accident.

#### 8. Resumption after a long period of holding time

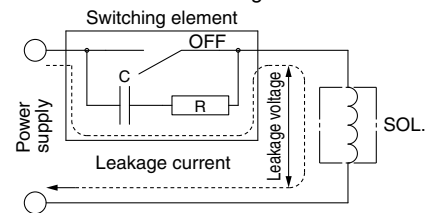
When resuming operation after a long period of holding time, there are cases in which, regardless of whether the product is in an ON or OFF state, there is a delay in the initial response time due to adhesion. Conducting several cycles of running-in operation will solve this problem. Please consider implementing this before resumption.

### ⚠ Caution

#### 1. Leakage voltage

Take note that the leakage voltage will increase when a resistor is used in parallel with a switching element or when a C-R circuit (surge voltage suppressor) is used for protecting a switching device because of the leakage voltage passing through the C-R circuit. The suppressor residual leakage voltage should be as follows.

Keep it at 2% or less of the rated voltage.



#### 2. Valves with a power-saving circuit (PWM circuit built-in type)

Valves with a power-saving circuit (PWM circuit built-in type) perform the high-speed switching operation with the PWM control circuit inside the valve after the rated power has been applied for several tens of ms to reduce the power consumption. The problems shown below may occur in this type of valve due to the switch or drive circuit system by the PWM control. Be sure to check the operation with the customer's machine sufficiently when selecting the product.

1) The valve does not turn ON.

1. If the PWM circuit built-in type valve is driven by a mechanical relay, etc., and chattering occurs during the several tens of ms necessary for the valve to reach its rated voltage, the valve may not turn ON correctly.

2. If a filter, etc., is connected between the power supply and the PWM circuit built-in type valve, the current necessary to drive the valve lowers due to the effects of the filter, and then the valve may not turn ON correctly.

2) The valve does not turn OFF.

If the PWM circuit built-in type valve is driven by the photo coupler, the photo coupler cannot turn OFF and the valve is kept in an ON state. Therefore, take great care when using the photo coupler built-in SSR (solid state relay) or drive circuit.

#### 3. Surge voltage suppressor

1) If an overvoltage or overcurrent is received from an external peripheral device, the surge voltage protection element inside the valve is overloaded, causing the element to break. In the worst case, the breakage causes the electric circuit to enter short-circuit status. If energizing continues while in this state, a large current flows. This may cause secondary damage to the output circuit, external peripheral device, or valve, and may also cause a fire. So, take appropriate protective measures, such as the installation of an overcurrent protection circuit in the power supply or a drive circuit to maintain a sufficient level of safety.

2) If a surge protection circuit contains nonstandard diodes, such as Zener diodes or varistor, a residual voltage that is in proportion to the protective circuit and the rated voltage will remain. Therefore, take into consideration the surge voltage protection of the controller.

In the case of diodes, the residual voltage is approximately 1 V.



# 2/3-Port Solenoid Valves Precautions 2

Be sure to read this before handling products.

## Design/Selection

### ⚠ Caution

#### 4. Surge voltage intrusion

Applicable series (non-polar type solenoid valves)  
With non-polar type solenoid valves, at times of sudden interruption of the loading power supply, such as emergency shutdown, surge voltage intrusion may be generated from loading equipment with a large capacity (power consumption), and a solenoid valve in a de-energized state may switch over (see Figure 1).

When installing a breaker circuit for the loading power supply, consider using a solenoid valve with polarity (with polarity protection diode), or install a surge absorption diode between the loading equipment COM line and the output equipment COM line (see Figure 2).

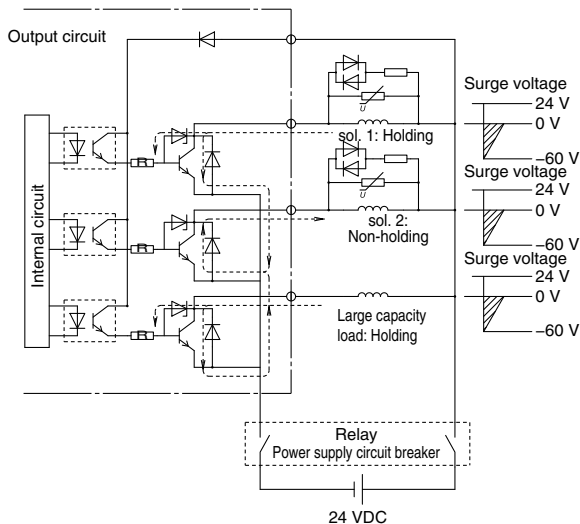


Figure 1. Surge intrusion circuit example (NPN outlet example)

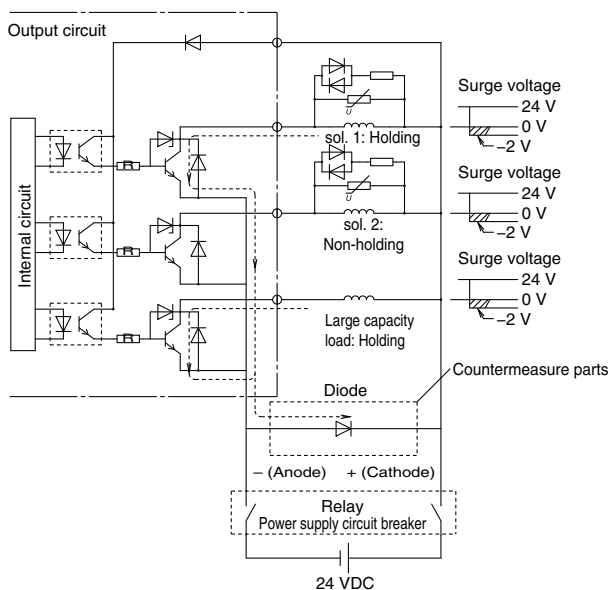


Figure 2. Surge intrusion countermeasure example (NPN outlet example)

### ⚠ Caution

#### 5. Operation in low temperature conditions

Take appropriate measures to avoid the freezing of drainage, moisture, etc., in low temperatures.

#### 6. Mounting orientation

The mounting orientation is universal.

#### 7. Initial lubrication of main valve

The main valve is already applied initial lubricant (Grease).

## Mounting

### ⚠ Warning

#### 1. Operation manual

Install the products and operate them only after reading the operation manual carefully and understanding its contents. Also, keep the manual where it can be referred to as necessary.

#### 2. Ensure sufficient space for maintenance activities.

When installing the products, allow access for maintenance and inspection.

#### 3. Tighten threads with the proper tightening torque.

When installing the products, follow the listed torque specifications.

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

Check mounting conditions when air and power supplies are connected. Initial function and leakage tests should be performed after installation.

#### 5. Painting and coating

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

Please consult with SMC before applying paint to resinous parts, as this may have an adverse effect due to the solvent in the paint.

## Piping

### ⚠ Caution

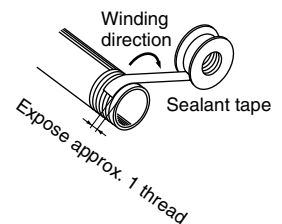
#### 1. Refer to the Fittings and Tubing Precautions (pages 52 to 56) for handling One-touch fittings.

#### 2. 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.

#### 3. Winding of sealant tape

When screwing piping or fittings into ports, ensure that chips from the pipe threads or sealing material do not enter the piping. Also, if sealant tape is used, leave 1 thread ridge exposed at the end of the threads.





# 2/3-Port Solenoid Valves

## Precautions 3

Be sure to read this before handling products.

### Wiring

#### Warning

1. The solenoid valve is an electrical product. For safety, install an appropriate fuse and circuit breaker before use.

#### Caution

##### 1. Polarity

When connecting power to a solenoid valve with a DC specification and a light or surge voltage suppressor, check for polarity.

If there is polarity, take note of the following.

##### Without diode to protect polarity:

If a mistake is made regarding the polarity, damage may occur to the diode in the valve, the switching element in the control device, power supply equipment, etc.

##### With diode to protect polarity:

If the polarity connection is wrong, the valve will not operate.

##### 2. Applied voltage

When electric power is connected to a solenoid valve, be careful to apply the proper voltage. Improper voltage may cause malfunction or coil damage.

##### 3. Check the connections.

Check if the connections are correct after completing all wiring.

##### 4. External force applied to the lead wire

If an excessive force is applied to the lead wire, this may cause faulty wiring. Take appropriate measures so that a force of 10 N or more is not applied to the lead wire.

### Air Supply

#### Warning

##### 1. Type of fluids

Please consult with SMC when using the product in applications other than compressed air.

##### 2. When there is a large amount of drainage

Compressed air containing a large amount of drainage can cause the malfunction of pneumatic equipment. An air dryer or water separator should be installed upstream from filters.

##### 3. Drain flushing

If condensation in the drain bowl is not emptied on a regular basis, the bowl will overflow. This may cause the malfunction of pneumatic equipment.

If the drain bowl is difficult to check and remove, the installation of a drain bowl with an auto drain option is recommended.

For compressed air quality, refer to the SMC Best Pneumatics No. 6 catalog.

##### 4. Use clean air

Do not use compressed air that contains chemicals, synthetic oils that include organic solvents, salt, corrosive gases, etc., as it can cause damage or malfunction.

### Air Supply

#### Caution

1. When extremely dry air is used as the fluid, degradation of the lubrication properties inside the equipment may occur, resulting in reduced reliability (or reduced service life) of the equipment. Please consult with SMC.

##### 2. Install an air filter.

Install an air filter upstream near the valve. Select an air filter with a filtration size of 5  $\mu\text{m}$  or smaller.

##### 3. 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 the 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.

##### 4. If an excessive amount of carbon powder is present, install a mist separator on the upstream side of the valve.

If excessive carbon dust is generated by the compressor, it may adhere to the inside of a valve and cause it to malfunction. For compressed air quality, refer to the SMC Best Pneumatics No. 6 catalog.

### Operating Environment

#### Warning

1. Do not use in an atmosphere containing corrosive gases, chemicals, sea water, water, water steam, or where there is direct contact with any of these.
2. Do not use in an environment where flammable gas or explosive gas exists. Usage may cause a fire or explosion. The products do not have an explosion proof construction.
3. Do not use in a place subject to heavy vibration and/or shock.
4. The valve should not be exposed to prolonged sunlight. Use a protective cover. Note that the valve is not for outdoor use.
5. Remove any sources of excessive heat.
6. If it is used in an environment where there is possible contact with oil, weld spatter, etc., exercise preventive measures.
7. When the solenoid valve is mounted in a control panel or it's energized for a long period of time, make sure the ambient temperature is within the specifications of the valve.



# 2/3-Port Solenoid Valves Precautions 4

Be sure to read this before handling products.

## Operating Environment

### Caution

#### 1. Temperature of ambient environment

Use the valve within the range of the ambient temperature specification of each valve. In addition, pay attention when using the valve in environments where the temperature changes drastically.

#### 2. Humidity of ambient environment

- When using the valve in environments with low humidity, take measures to prevent static.
- If the humidity rises, take measures to prevent the adhesion of water droplets on the valve.

## Maintenance

### Warning

#### 1. Perform maintenance and inspection according to the procedures indicated in the operation manual.

If handled improperly, human injury and/or malfunction or damage of machinery and equipment may occur.

#### 2. Removal of equipment, and supply/exhaust of compressed air

Before components are removed, first confirm that measures are in place to prevent workpieces from dropping, run-away equipment, etc. Then, cut off the supply air and electric power, and exhaust all air pressure from the system using the residual pressure release function.

For the 3-position closed center or double check valve types, exhaust the residual pressure between the valve and the cylinder.

When the equipment is operated after remounting or replacement, first confirm that measures are in place to prevent the lurching of actuators, etc. Then, confirm that the equipment is operating normally.

In particular, when a 2-position double solenoid valve is used, releasing residual pressure rapidly may cause the spool valve to malfunction, depending on the piping conditions, or the connected actuator to operate.

#### 3. Low-frequency operation

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

#### 4. Manual override

When a manual override is operated, connected equipment will be actuated.

Operate only after safety is confirmed.

#### 5. If the volume of air leakage increases or the valve does not operate normally, do not use the valve.

Perform periodic maintenance on the valve to confirm the operating condition and check for any air leakage.

### Caution

#### 1. Drain flushing

Remove drainage from the air filters regularly.

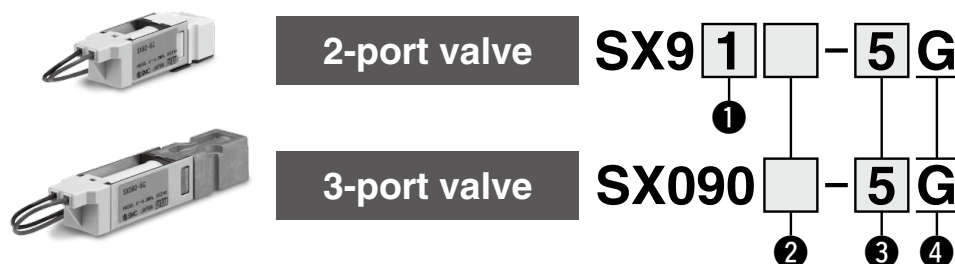


# Low Profile 2/3-Port Solenoid Valve

# SX90/090 Series



## How to Order



### 1 Type of actuation

1	Normally closed
2	Universal

### 2 Power-saving circuit

Nil	Without power-saving circuit
Y1	With power-saving circuit

### 3 Rated voltage

5	24 VDC
6	12 VDC

### 4 Electrical entry

G	Grommet (Lead wire length: 300 mm)
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## Specifications

Model		SX91		SX92		SX090			
Valve specifications	Valve construction	2-port direct operated poppet valve		2-port direct operated poppet valve		3-port direct operated poppet valve			
	Type of actuation	Normally closed		Universal		Universal			
	Fluid <sup>*1</sup>			Air, Nitrogen					
	Operating pressure range [MPa]			-100 kPa to 0.2					
	Proof pressure [MPa]			0.6					
	Ambient and fluid temperatures [°C] <sup>*2</sup>			0 to 50					
	C [dm <sup>3</sup> /(s·bar)]	0.25		0.12		0.5			
	Cv	0.07		0.032		0.14			
	b	0.25		0.25		0.3			
	Flow rate [L/min (ANR)] at 0.2 MPa <sup>*4</sup>	45		22		90			
	Response time [msec] <sup>*3</sup>	ON, OFF: 10 or less				ON, OFF: 15 or less			
	Impact/Vibration resistance [m/s <sup>2</sup> ]			150/30					
Mounting orientation			Unrestricted						
Enclosure			IP40						
Weight [g]	10				20				
Electric specifications	Inrush <sup>*2</sup>	Rated voltage/Power consumption		12 VDC/4 W	24 VDC/4 W	12 VDC/4 W	24 VDC/4 W	12 VDC/6 W	24 VDC/6 W
		Holding <sup>*2</sup>		5 VDC (Rated 42%)/0.7 W	10 VDC (Rated 42%)/0.7 W	5 VDC (Rated 42%)/0.7 W	10 VDC (Rated 42%)/0.7 W	4.2 VDC (Rated 35%)/0.8 W	8.4 VDC (Rated 35%)/0.8 W
	Allowable voltage fluctuation <sup>*5</sup>		±10% of rated voltage (0 to +10%)						
	Type of coil insulation		Class B						

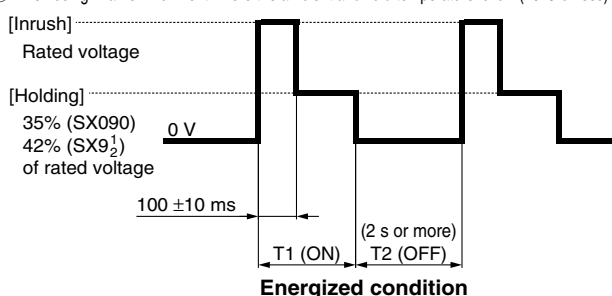
\*1 For use with fluids other than air or nitrogen, please contact your SMC sales representative.

\*2 Please make sure the coil surface temperature does not exceed 80°C. As a guide, please refer to [Inrush], [Holding], and [T2 (OFF)] in the figure below. Please check each application as the surface temperature is application dependent.

\*3 2-port (SX91/92): Based on dynamic performance test, JIS B 8373.  
(Coil temperature: 20°C, at rated voltage)  
3-port (SX090): Based on dynamic performance test, JIS B 8419.  
(Coil temperature: 20°C, at rated voltage)

Use of the product under the conditions and environment below may cause delay in the response (switching) of the valve during start-up.

- ① The first operation after a long period of inactivity
- ② When using at low supply pressure (0.1 MPa or less)
- ③ When using in an environment where the ambient and fluid temperature is low (10°C or less)



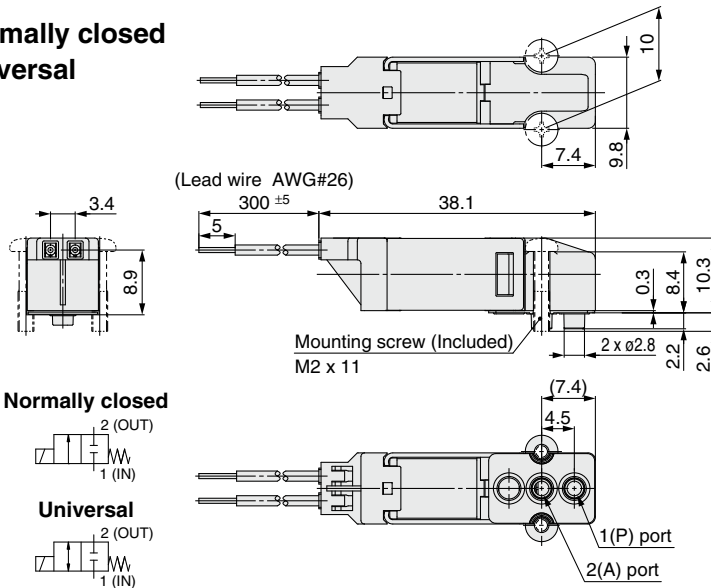
\*4 The flow rate is measured when the pressure difference is 0.2 MPa. Please refer to the graph below for the relationship between the flow rate and pressure difference.

\*5 For the solenoid valve with power-saving circuit, the allowable voltage fluctuation is between 0 and +10%.

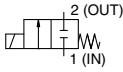
## Dimensions

### 2-port

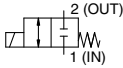
**SX91/Normally closed**  
**SX92/Universal**



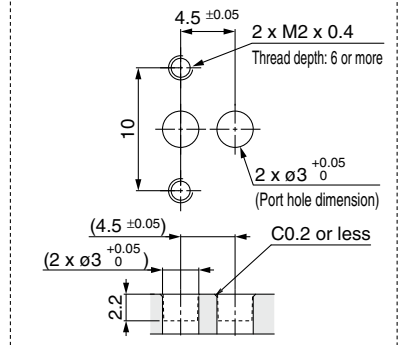
**Normally closed**



**Universal**

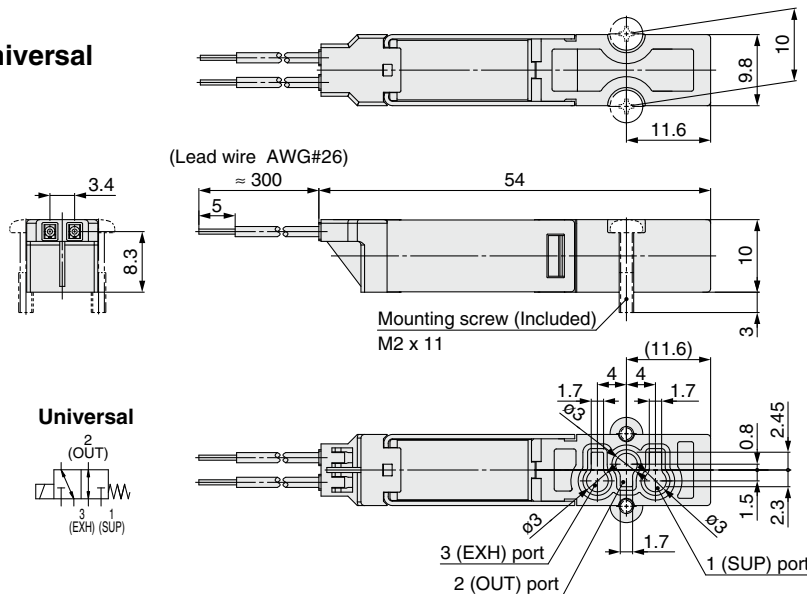


#### Base hole dimension

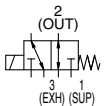


### 3-port

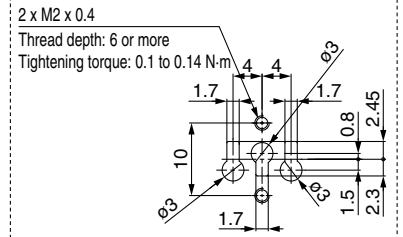
**SX090/Universal**



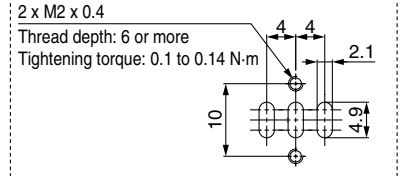
**Universal**



#### Base hole dimension ①



#### Base hole dimension ②



## ⚠ Specific Product Precautions

Be sure to read this before handling the products.  
Refer to the back cover for safety instructions.

### Continuous Energization

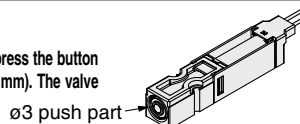
#### ⚠ Caution

- For the solenoid valve without power-saving circuit, continuous energization is not allowed at the start-up voltage (rated voltage) as there is a risk of damaging the coil. For continuous energization with the holding voltage, please make sure the coil surface temperature does not exceed 80°C.
- Coil temperature may get high due to ambient temperature or energizing duration. Do not touch the valve by hand directly. When there is such a dangerous case to be touched by hands directly, install a protective cover.
- When using the solenoid valves on a manifold, note that the temperature rise will be larger if three or more adjacent valves are energized together. Please ensure that the coil surface temperature does not exceed 80°C in the actual operating conditions.

### Manual Override

#### ⚠ Caution

- To operate the manual override to the ON position, press the button fully in the direction of the arrow (approximately 0.5 mm). The valve will be turned OFF when the button is released. (For 3-port valve)



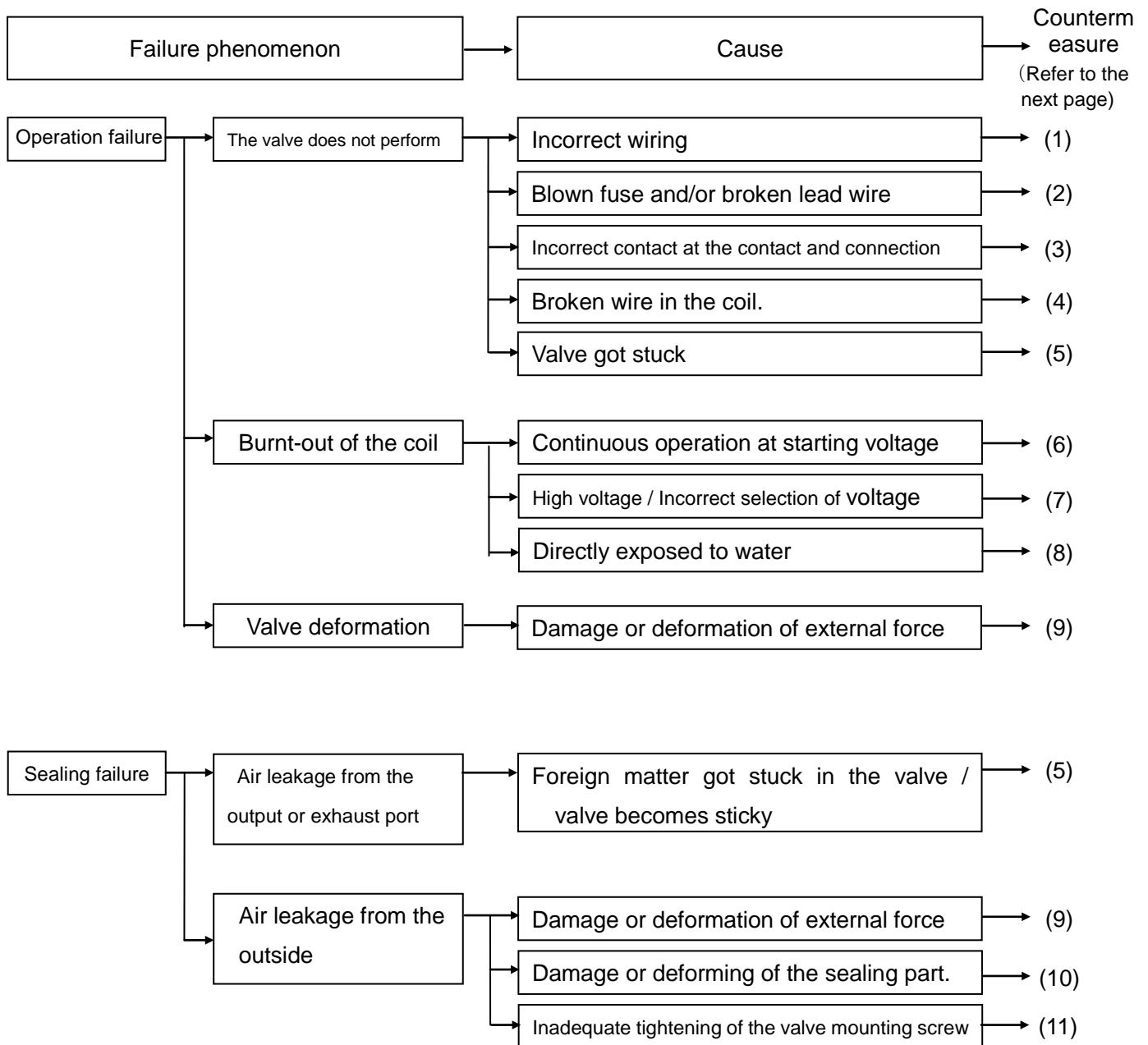
### Valve Mounting

#### ⚠ Caution

- Confirm that the gasket is correctly mounted on the body interface and then tighten the screws to the specified torque. (Fasten equally so that the valve will not tilt.) The specified torque is from 0.10 to 0.14 N·m, please apply a torque setting depending on the base condition and operating environment.
- Please do not apply force to the coil and frame when installing the piping and valves. If they receive 10 N or more of force, a malfunction may occur.
- Do not pull the lead wire with excessive force. Applying 10 N or more of load may result in broken wire or contact failure.

## Troubleshooting

Check and take corrective action following the troubleshooting below.



## Countermeasure

No.	Countermeasures
(1)	Connect wires correctly.
(2)	Replace the part with broken wire. Not to pull the valve lead wire too tightly.
(3)	Replace the parts or connect wires correctly.
(4)	Replace the valve.
(5)	Remove foreign matter in the piping by air blow and replace the valve. Clean the air supply.
(6)	Replace the valve. When the product does not have power saving board, do not continuously energize the product at starting voltage (rated voltage). Keep the voltage condition specified in the catalogue.
(7)	Check the voltage and replace the valve.
(8)	Replace the valve. Protect the valve to prevent it from being exposed to water.
(9)	Replace the valve. Please do not apply force to the coil and frame when installing the piping and valves.
(10)	Replace the valve. Make sure that the supply voltage does not exceed the maximum specification pressure in the catalogue. Check for air leaks from the fitting and piping.
(11)	In case of air leakage from the interface, stop air supply and check the mounting condition of the gasket. Tighten the mounting screw with appropriate torque.

If the countermeasures above are not effective, there may be a problem with the valve. In that case, stop using the valve immediately.

※When the product fails to operate correctly, return the valve without any modification.

Revision history
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## SMC Corporation

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