Doc. No. DOC1092179

Operation Manual

PRODUCT NAME

Safety exhaust valve

MODEL / Series / Product Number

Series: (25A-)VPX400

SMC Corporation

Contents

Products compatible with safety standard ISO13849-1

Safety Instructions

These safety instructions are intended to let you use the product safely and correctly and to prevent hazardous situations and/or equipment damage. The following instructions indicate the level of potential hazard with the labels of **"Caution," "Warning," or "Danger**." As all of them are used to describe important matters concerning safety,
be sure to observe those safety instructions as well as the international standards (ISO/IEC), Japanese Industrial Standards (JIS)[*1)], and other safety regulations[*2)].

*1) ISO 4414: Pneumatic fluid power -- General rules and safety requirements for system and their components
ISO 4413: Hydraulic fluid power -- General rules and safety requirements for system and their components
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
JIS B 8370: Pneumatic fluid power - General rules and safety requirements for systems and their components
JIS B 8361: Hydraulic fluid power - General rules and safety requirements for systems and their components
JIS B 9960-1: Safety of machinery - Electrical equipment for machines (Part 1: General requirements)
JIS B 8433-1: Robots and robotic devices - Safety requirements for industrial robots - Part 1: Robots

*2) Industrial Safety and Health Act, etc.

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

Warning

(1) The compatibility of the product is the responsibility of the person who designs the system or decides its specifications.

Since the product specified here is used under various operating conditions, its compatibility with specific system must be decided by the person who designs the equipment or decides its specifications by conducting analyses and tests as necessary.
The expected performance and safety assurance of the system 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 system.

(2) Only personnel with sufficient knowledge and experience should operate our products.

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 with sufficient knowledge and experience.

(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, secure the safety of the system by cutting off the power from any appropriate source, and read and understand the specific product precautions of devices in use.
3. Before machinery/equipment is restarted, take measures to tackle unexpected operation and malfunction.

(4) SMC products cannot be used beyond their specifications. As SMC products are not developed, designed, or manufactured for use in conditions or environment other than those shown below, products used in such conditions or environment shall be out of the scope of the product warranty.

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 appliances, shipping, vehicles, military, equipment that affects lives, human body, or properties, combustion devices, entertainment equipment, emergency stop circuits[*3], clutch and brake circuits in press applications[*3], safety equipment[*3], or any other applications unsuitable for the standard specifications described in the product catalog and instruction manual.
3. When the product is used in an interlocking circuit. However, use of a product with double interlock against possible failure by means of, for example, a mechanical protective function is excluded. Inspect the product periodically to confirm proper operation.

*3) Except for machinery safety in factory automation applications.

Safety Instructions

⚠ Caution

SMC products are developed, designed, and manufactured as products for automatic control equipment and provided to manufacturing industries for peaceful use. Use of the product in other than manufacturing industries shall be out of the scope of the product warranty.
Products manufactured and sold by SMC cannot be used for business or certification ordained by the metrology (measurement) laws.
Units other than SI units cannot be used in Japan due to a new measurement law.

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 our product is 1 year in service or 1.5 years after the product is delivered, whichever comes earlier.[*4)]
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 for the particular products.

***4) 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

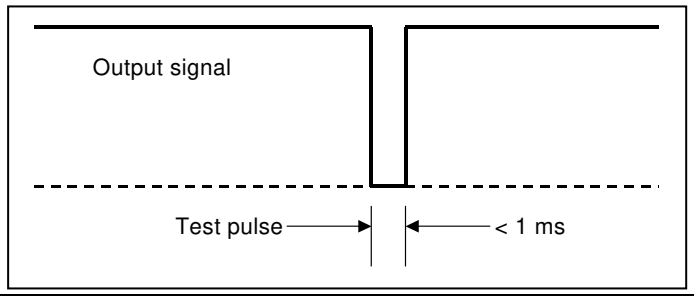
When exporting SMC products to overseas countries, be sure to observe the laws and regulations specified the Ministry of Economy, Trade and Industry (Foreign Exchange and Foreign Trade Law) and relevant procedures.

Safety Instructions

⚠ Warning

Restrictions on safety relay and safety control

When the safety output from a safety relay or safety control is used to operate this product, set the widths of all output test pulses to less than 1 ms so that the solenoid does not respond.



⚠ Caution

Use restrictions

This product is compliant with the CE/UKCA marking as a safety part defined in the Machinery Directive 2006/42/EC. For details, refer to the Declaration of Conformity of this product.

This product can be dedicatedly used for the safety function of a machine that supplies pressure or discharges air to the whole or part of pneumatics system on the assumption that the monitoring device takes complete control. This product functions as a safety part only when it is appropriately installed in a system that observes the corresponding safety standards.

For this reason, use the product within the specification range and applicable conditions.

To satisfy the required performance defined in the corresponding safety standards, prepare all of parts that are necessary for the safety system to fulfill its functions.

The user bears the responsibility for the specifications, design, implementation, verification, and maintenance of a safety system.

(25A-)VPX400 Series

3 port solenoid valve / Precautions 1

Be sure to read before handling.

Design/Selection

⚠ Warning

(1) Confirm the specifications.

This product is designed for use only in compressed air systems. Do not use this product under pressure or temperature out of the specified range because doing so causes damage and/or malfunction of the product.

SMC does not guarantee the product against any damage if it is used outside the specification range.

(2) Actuator drive

When an actuator, such as a cylinder, is to be driven using a safety exhaust valve (hereinafter referred to as "valve"), take appropriate measures (cover installation or approach prohibition) in advance to prevent potential danger from being posed by actuator operation.

(3) Pressure retention

Since the valves are subject to air leakage, they cannot be used for applications such as pressure retention in a pressure vessel.

(4) Ventilation

Provide ventilation when using a valve in a confined area, such as in a closed control panel. For example, provide a ventilation opening, etc. in order to prevent pressure from increasing inside the control panel due to discharged air and to release the heat generated by the valve.

(5) Prohibition of disassembly and modification

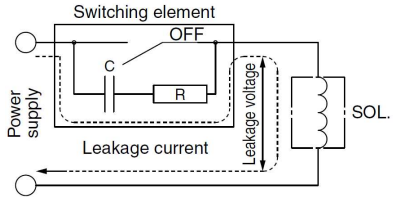
Do not disassemble the product or make any modifications, including additional machining.

Failure to follow this instruction may cause bodily injury and/or an accident.

⚠ Caution

(1) Leakage voltage

In particular, when a resistor and a switching element are used in parallel or a C-R device (surge voltage suppressor) is used for the protection of the switching device, note that the leakage voltage will increase because leakage current passes through the resistor or C-R device. Suppress the residual voltage leakage to 3% of the rated voltage or less.



(2) Surge voltage suppressor

1) A surge voltage suppressor built into the valve is intended to protect the output contacts so that the surge generated inside the valve will not adversely affect the output contacts. Therefore, if an overvoltage or overcurrent is received from an external peripheral device or the like, the surge voltage protection element inside the valve may be overloaded and broken. In the worst case, the electric circuit becomes short-circuited due to the breakage. If the energization continues in this condition, a large current may flow, which may cause secondary damage to the output circuit, peripheral device, or valve, and may also cause fire accident. Therefore, take appropriate protective measures, such as installation of an overcurrent protection circuit in the power unit or drive circuit, to maintain the sufficient safety.

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

(3) Mounting orientation

Mounting orientation is not specified.

(4) Initial lubricant applied to main valve

Initial lubricant has been applied to the main valve.

Mounting

⚠ Warning

(1) Operation Manual

Thoroughly read and understand the operation manual before installing and operating the product.

Keep the manual at hand so that it can be referred to anytime.

(2) Securing of maintenance space

Secure a space that allows access for maintenance.

(3) Tightening of screw and strict observation of screw tightening torque

When installing the product, tighten screws to the recommended torque.

(4) If air leakage increases or the equipment does not operate properly, do not use the product.

At the time of installation and maintenance, connect compressed air and power supplies to the equipment and perform appropriate functional and leakage inspections to make sure that the equipment is mounted properly.

(5) Do not erase or peel off warnings or specifications printed or labeled on the product and do not paint over characters.

Piping

⚠ Caution

(1) For the handling of one-touch fittings, refer to the Fittings and Tubing Precautions.

3 port solenoid valve / Precautions 2

Be sure to read before handling.

Wiring

⚠ Warning

(1) As a valve is an electric part, when using it, please install an appropriate fuse or circuit breaker for the purpose of safety.

⚠ Caution

(1) Applied voltage

When electric power is connected to the valve, do not apply a voltage outside of specification.

Failure to follow this instruction may burn out the coil or cause operation failure.

(2) Wiring check

After wiring, check whether the connections are correctly made.

(3) External force applied to the lead wire

Application of an excessive force to the lead wire may cause it to be broken. Make sure that a force at 30 N or greater is not applied to the lead wires. When specific product precautions have a relevant instruction, follow it.

Lubrication

⚠ Warning

The valve has been initially lubricated and does not require any further lubrication. Therefore, do not lubricate it with a lubricator or the like.

Air Supply

⚠ Warning

(1) Type of fluid

The applicable fluid is compressed air.

(2) When amount of condensate is large

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

(3) Draining control

If condensate in the air filter is not drained on a regular basis, it will overflow to the downstream side to cause the malfunction of pneumatic equipment. If draining control is difficult, installation of a filter with an auto drain option is recommended.

For detailed information regarding the quality of the compressed air described above, refer to SMC's "Compressed Air Cleaning Systems."

(4) Use clean air.

Do not use compressed air if it contains chemical, synthetic oil containing organic solvent, salt, or corrosive gases, etc., as it can cause damage or malfunction.

⚠ Caution

(5) If ultra dry air is used as fluid, the lubrication characteristics inside the equipment will deteriorate and this can affect the reliability (life) of the product. Therefore, when you intend to use ultra dry air, contact SMC beforehand.

(6) Install an air filter.

Install an air filter at immediate upstream of the valve.

Select an air filter with a filtration degree of 5 µm or finer.

(7) Take appropriate measures including installation of an aftercooler, air dryer, or water separator to ensure air quality.

Compressed air containing a large amount of condensate can cause malfunction of valves and other pneumatic equipment. Take appropriate measures including installation of an aftercooler, air dryer, or water separator to ensure air quality.

(8) If excessive carbon powder is observed, install a mist separator on the upstream side of the valve to remove it.

If carbon dust is excessively generated by the compressor, it may adhere to the inside of a valve and cause it to malfunction.

Refer to SMC's "Compressed Air Cleaning Systems" for further details on compressed air quality.

Operating Environment

⚠ Warning

(1) Do not use the product in an environment where corrosive gas, chemical, sea water, water, or steam is contained in the atmosphere or may attach.

(2) Products with IP65 enclosures are protected against dust and water. However, note that they cannot be used under water.

(3) Products compliant with IP65 satisfy the respective specifications once they are installed properly. Be sure to read the precautions for each product.

(4) Do not use the product in an environment where flammable gas or explosive gas exists. Failure to follow this instruction may cause a fire or explosion. The product does not have an explosion proof construction.

(5) Do not use the product in a place subject to vibration and/or shock.

(6) If the product is used in direct sunlight, a protective cover or the like should be used.
Note that the product is not for outdoor use.

(7) If there is a heat source around the product, shut off the radiant heat.

(8) If the product is used in an environment where oil, weld spatter, etc. may attach, take appropriate preventive measures.

(9) When the valve is installed in a control panel, take measures against heat radiation in order to keep the valve temperature within the specified range.

⚠ Caution

(1) Ambient environment temperature

Operate valves within the respective specification temperature ranges. However, do not use the valves in such an environment where the temperature greatly changes.

3 port solenoid valve / Precautions 3

Be sure to read before handling.

Operating Environment

⚠ Caution

(2) Ambient environment humidity

- When the valve is used in an environment with low humidity, take countermeasures against static electricity.
- When the valve is used in an environment with high humidity, take countermeasures against adhesion of water droplets on the valve.

Maintenance

⚠ Warning

(1) Maintenance should be performed according to the procedures provided in the operation manual (this document).

If the product is handled improperly, bodily injury or malfunction or damage of machinery or equipment may occur.

(2) Removal of equipment, and supply/exhaust of compressed air

Before removing equipment, first confirm that measures to prevent driven object from dropping, safe lock out, etc. are in place. Then, cut off the supply air and power supply, and bleed air pressure from the system using its residual pressure release function. When the equipment is started up after it is remounted or replaced, first confirm that measures to prevent lurching of actuators, etc. are in place. Then, confirm that the equipment is operating normally.

(3) Low frequency operation

Switching operation of valves should be performed at least once every week to prevent malfunction. (Pay attention to air supply.)

(4) If air leakage increases or the equipment does not operate properly, do not use the product.

⚠ Caution

(1) Discharging condensate

Discharge condensate from the air filters regularly.

(25A-)VPX400 Series
3 port solenoid valve / Specific Product Precautions 1

Be sure to read before handling.

Specifications

1. Valve specifications

Switching method	N.C. (Spring return(1))
Fluid	Air
Operating pressure range [MPa]	0.25 ~ 1.0
Withstand pressure [MPa](2)	1.5
Ambient temperature and fluid temperature [°C]	0 ~ 50 (No freezing)
Humidity range (During operation/storage)	35 ~ 85% RH (No condensation)
Manual operation	None
Pilot exhaust method	Individual exhaust
Flow characteristics	Refer to the Section 2 of "Specifications."
Response time [ms]	Refer to the Section 10.2 of "Specifications."
Maximum duty ratio [%]	100
Min. operating frequency	1 time/7 days
Max. operating frequency [Hz](3)	1
Lubrication	No
Impact resistance/vibration resistance [m/s²](4)	150/30
Enclosure (In accordance with IEC60529)	IP40 (pressure gauge type: E1/E2/E3/E4)
	IP65 (pressure gauge type: Nil/G/M/E)
Mounting orientation	Free
Operating environment	Indoors
Weight [kg](5)	A3 (AC30 connection size): 1.71
	A4 (AC40 connection size): 1.71
	A6 (AC60 connection size): 1.81
B_{10D} [cycle](6)	1,083,893
Mission time	Maximum 20 years or when the number of cycles = B_{10D}, whichever occurs first. (7)

Note

(1) The soft start-up valve is of the air return method.

(2) As the withstand pressure refers to a pressure range that does not cause breakage with danger, do not apply a pressure exceeding the maximum operating pressure range. Failure to follow this instruction may lead to a malfunction or air leakage.

(3) This occurs when the duty ratio is 50% and no load is applied.

(4) Impact resistance
- The product must not malfunction in an impact test that uses a drop tester.
- No malfunction when the test is performed once each in the axial/vertical directions of main valve and armature in energized and de-energized conditions.
- Vibration resistance 45 to 2000 Hz
  No malfunctioning in a single scanning
- No malfunction when the test is performed in the axial/vertical directions of main valve and armature in energized and de-energized conditions (the valve is in the initial state).

(5) The weight indicates the weight without M12 connector cable. Weight of M12 connector cable (for 2 pcs.) = 0.4 kg

(6) The B10D value is predicted based on the life test conducted in the SMC's test conditions.

(7) Refer to Section 10.5 of "Specifications" for details.

(8) This product is a pilot type solenoid valve with large flow rate. Note that if the operating pressure drops to 0.25 MPa or below because of pressure drop caused by an insufficient air supply capacity, the valve may not be appropriately switched.

(9) For the specifications of and precautions on various pressure gauges (G/M/E/E1/E2/E3/E4), refer to the catalog for this series or the operation manual. For other matters, refer to the catalog and operation manual for the series shown in the table below.

Pressure gauge symbol	G/M	E	E1/E2/E3/E4
Series	G46	AR-D	ISE35

2. Flow Characteristics

Series	Flow path	C [dm³ (/ s・bar)]	b
VPX406-A3	1 ⇒ 2	16.2	0.40
	2 ⇒ 3	25.0	0.20
VPX406-A4	1 ⇒ 2	20.0	0.30
	2 ⇒ 3	31.0	0.15
VPX406-A6	1 ⇒ 2	22.6	0.25
	2 ⇒ 3	35.8	0.10

3. Solenoid specifications (SOL.)

Coil rated voltage	DC[VDC]	24
Electrical wiring		M12 connector
Allowable voltage fluctuation		-8% to +10% of the rated voltage
Power consumption [W] (Solenoid power consumption x 2 pcs.)	At time of startup	0.45 x 2 pcs.
	At time of holding	0.2 x 2 pcs.
Surge voltage suppressor		Diode
LED	SOL.1/SOL.2	LED (Green)

4. Failure detection specifications (SEN.)

Pressure sensor	Sensor E	For detection of inconsistency with main valve(1)
	Sensor 2	For detection of 2-port output(1)
Rated voltage [VDC]		24
Electrical wiring		M12 connector
Allowable voltage fluctuation		±10% of rated voltage, and power supply ripple of 10% or less
Power consumption [W] (pressure sensor power consumption × 2 pcs.)		0.3 x 2 pcs.
Output type		PNP open collector output
Output mode		Hysteresis mode
Maximum load current [mA]		80
Internal voltage drop [V]		1 or less (load current: 80 mA)
LED	SEN./PWR.	LED (green)
	ERR.	LED (red)

Note

(1) Refer to Section 10 "Safety system" of "Specifications" for the details of the pressure sensors.

5. Digital pressure switch specifications (pressure gauge type: E1/E2/E3/E4)

Display/lowest configurable increment [MPa]	0.01
Rated voltage [VDC]	24
Allowable voltage fluctuation	±10% of rated voltage, and power supply ripple of 10% or less
Output type	NPN or PNP Open collector output
Repeatability	±1% F.S.
Display accuracy	±1% F.S. ±1 digit (At 25°C±3°C)
Electrical wiring	M12 connector

Note

(1) Refer to the ISE35 series catalog for the specifications of the digital pressure switches and others. Refer to the specific product precautions on ISE35 Series for how to handle them.

6. Pneumatic circuit diagram

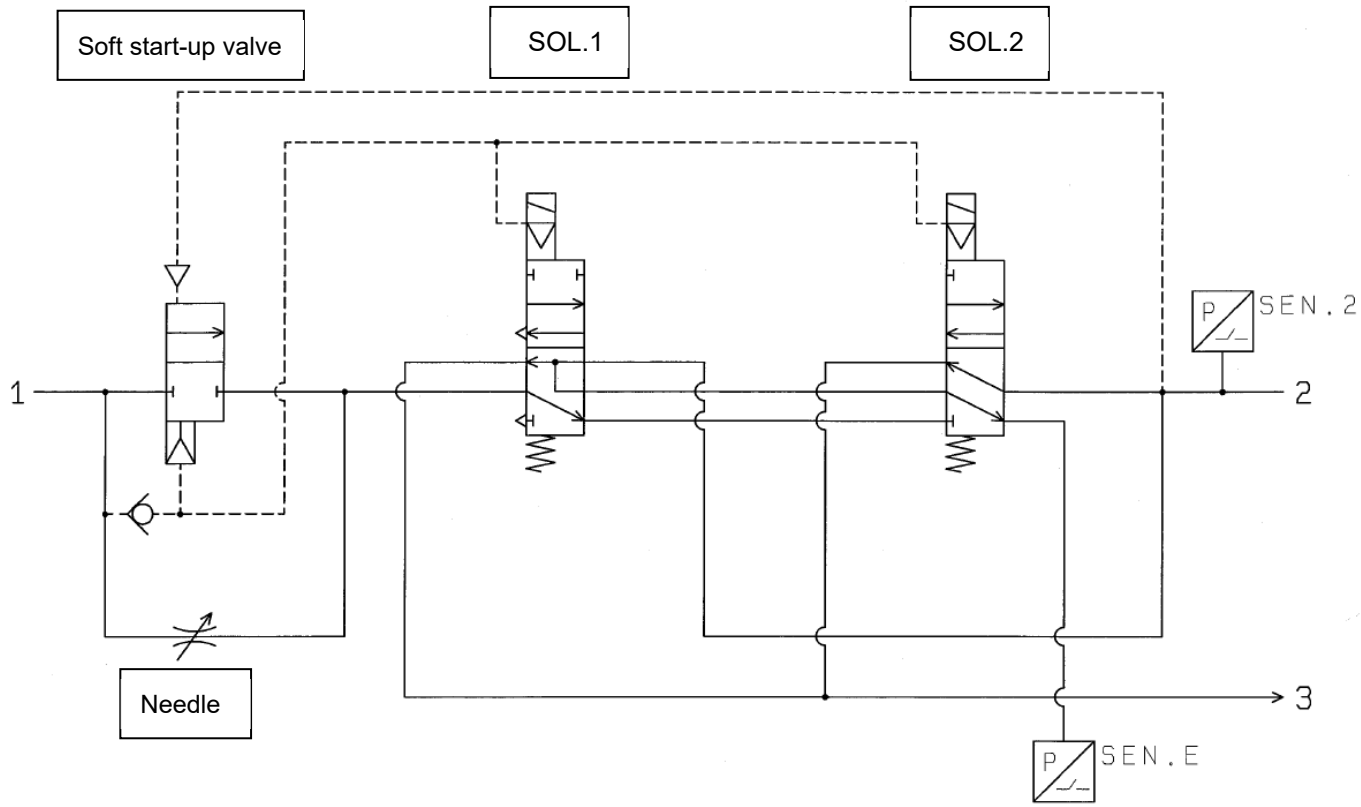


Fig. 1. Pneumatic circuit diagram (VPX400)

7. LEDs

LED		LED color	LED ON condition	LED OFF condition
SOL.1	LED for solenoid energization check	Green	SOL.1 energized	SOL.1 non-energized
SOL.2			SOL.2 energized	SOL.2 non-energized
SEN.PWR.	LED for sensor energization check		SEN.E and SEN.2 are simultaneously energized.	Either of SEN.E and SEN.2 or both are not energized.
ERR.	LED for main valve inconsistency check	Red	When SEN.E output is OFF (At time of failure)	When SEN.E output is ON (In normal state)

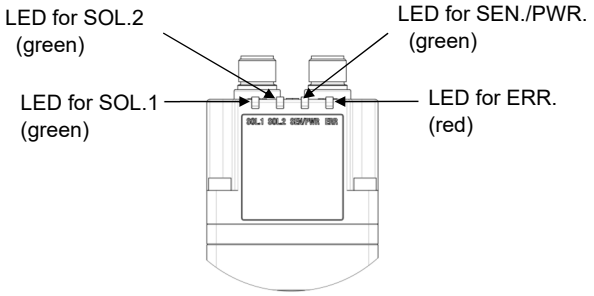


Fig. 2. Detail drawing of LEDs

8. Soft start-up valve specifications

In this product, the pressure is gradually increased by means of a needle to suppress abrupt action of the protected system (actuator), and once the switching pressure indicated in Fig. 3 is exceeded, the soft start-up valve is switched.
As the soft start-up valve is switched, fluid is supplied at the flow rate shown in Section 2 of "Specifications."
As it is possible to adjust the timing of switching of the soft start-up valve by means of needle opening, adjust the needle opening at the time of establishment of a system. (Fig. 4, Fig. 5)
(The needle at the time of shipment from factory is fully closed.)

⚠ Warning

The equipment may make an unexpected movement at the time of switching of the soft start-up valve. Therefore, pay attention to the valve.

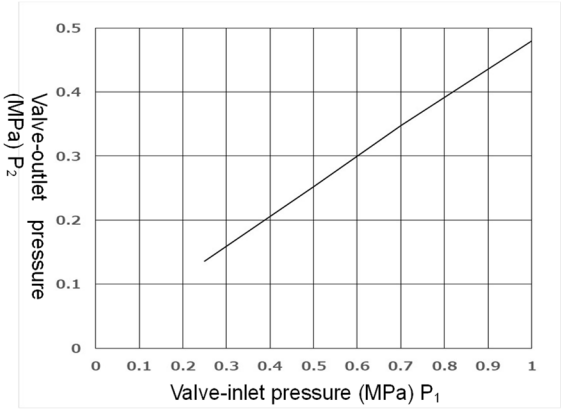


Fig. 3. Switching pressure (Close → Open) of soft start-up(SS) valve

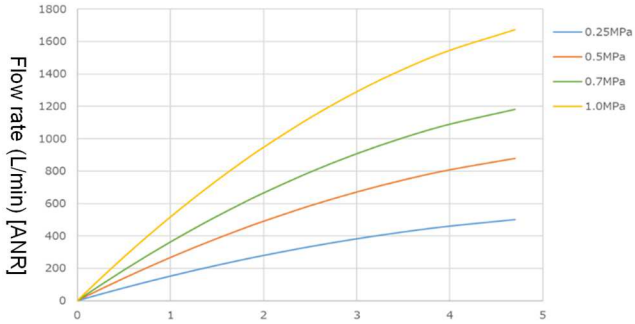


Fig. 4. Needle valve flow characteristics (Use this graph as a guide only)

Fig. 5. Valve front view

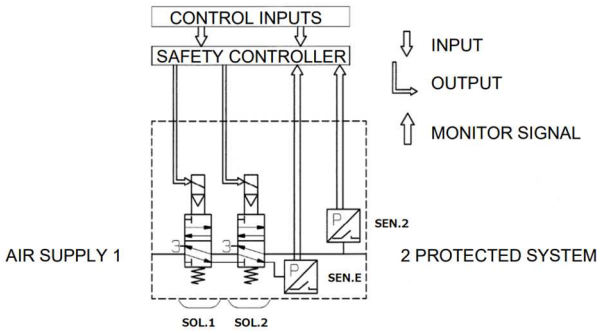
9. Safety specifications

- Safe exhaust (SDE): When this product is de-energized, the valves are returned to the OFF positions by the spring force. Protection against unexpected startup (PUS): When the valves are set to OFF, both valves will not be switched to the ON position by a single failure.
- This product is, when installed on an appropriate safety system, compliant with up to Category 4 of the safety standard.
- In this operation manual, "safety standard" refers to EN ISO 13849-1.
- From the viewpoint of the safety standard, the valve does not have a manual operation function.
- The soft start-up valve is not affected by the safety specifications.

10. Safety system

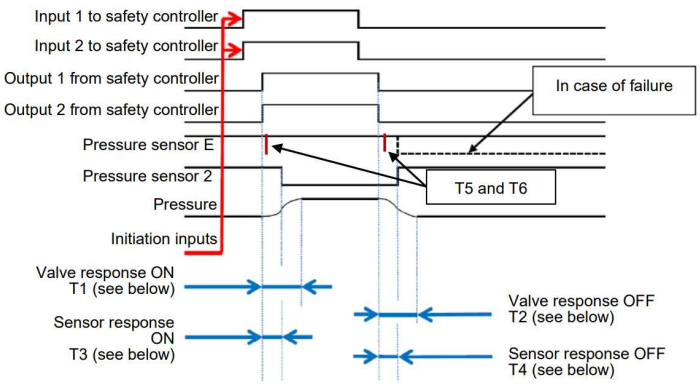
10.1 Safety system circuit diagram

A circuit diagram of a safety system that includes a valve is shown below.
The area enclosed by dotted lines represents a valve.



- Confirm that the safety level of the safety controller conforms to the required SIL or PL that was determined through the safety analysis of the control system. Configure a setting so that when the safety controller detects a valve failure, the safety controller displays a warning message and disables the machine operation.
- The pressure sensors (SEN.E/SEN.2) send monitoring signals that are used as a diagnosis means for checking the correct operation of the safety exhaust valve. As those signals are not safety outputs, do not use them as input signals to another safety device or to check the safety condition of the connected system. Wire the output signals from the pressure sensors (SEN.E/SEN.2) to the safety inputs of the safety controller and safety relay.

10.2 Timing chart and response times



Note

- When no pressure is applied, ON signal is output from the pressure sensors (SEN.E/SEN.2).
- The SEN.E sensor is installed to detect the valve condition.
- When one of the valves becomes abnormal, the ON signal stops.
- The dashed line in the chart indicates a case where the conditions of the valves are inconsistent (one of the valves has failed).
- When the valve is in the ON or OFF state, the ON signal from SEN.E sensor may instantaneously become OFF due to variation of the response time of the solenoid.
  As the SEN.E sensor turns OFF, the system may judge it as a failure. Refer to Section 10.3 of "Specifications" for details.
- The valve response time ON (T1) depends on the supply pressure and volume of the protected system and the operation of the soft start-up valve (refer to Section 8 of "Specifications"). The T1 time is irrelevant to the safety function.
- The valve response time OFF (T2) depends on the volume (V) and flow rate of the protected system. We define the period of time in which the pressure from the test volume connected to the downstream side port of the valve decreases from 0.63 MPa to 0.05 MPa in accordance with the change of control signals to the valve as response time.
- The OFF response time (T3) of the pressure sensor 2 depends on the setting of the soft start-up valve and the sensor threshold value.
- The ON response time (T4) of the pressure sensor 2 depends on the system volume and the sensor threshold value.
- The calculation formulas of T2 and T4 are shown below. Note that these formulas assume no failures.

[Normal exhaust time]
T2 calculation formula: T2 (ms) = 60 x Volume (L) + 800
T4 calculation formula: T4 (ms) = 50 x Volume (L) + 800

Caution

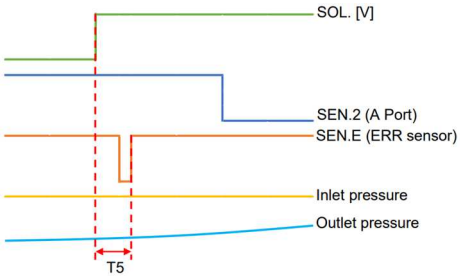
The response time is based on the test conducted under SMC conditions and not guaranteed. Always observe the conditions provided in Section 10.4.

- If only one channel is functioning due to a failure, the exhaust time of double valves becomes longer.
  The valve OFF response time (T2) and pressure sensor 2 ON response time (T4) in a failed condition are shown below.

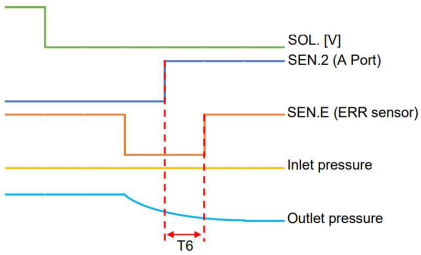
[Exhaust time at time of failure]
T2 calculation formula: T2 (ms) = 90 x Volume (L) + 800
T4 calculation formula: T4 (ms) = 80 x Volume (L) + 800

10.3 SEN.E signal characteristics

Maximum time since energization of T5 = SOL.1/SOL.2 to stabilization of SEN.E ON output (based on SOL. Output signal)



Maximum time since de-energization of T6 = SOL.1/SOL.2 to stabilization of SEN.E ON output (based on SEN.2 output signal)
The maximum detection times of T5 and T6 are shown below. If T5 or T6 exceeds the corresponding value in the table below, the valve could have failed. Refer to the failures and countermeasures provided in this operation manual.



T5[ms]	T6[ms]
500	500

10.4 Relationship of flow rate and response time to safety function
- The safety function is a function to discharge compressed air from the protection system so that the protection system does not fall into a hazardous state when the application is operating under the control of an appropriate safety system. The time it takes to discharge air and remove hazard is determined by the following factors.
- Valve flow rate
- Flow rate restriction of silencer installed on valve
- Volume of protection system
- Pneumatic pressure of protection system
- Flow rate restriction in protection system
- Calculate the air discharge time of the application system, and make sure that this time period suits the conditions of the whole safety system. For this purpose, select an appropriate silencer.
- Verify the performance of the system after its installation by means of a test, and make sure that the actual valve performance positively satisfies the safety function. Verify the system performance in all possible operation conditions of pressure, flow rate, and volume.

10.5 Mission time compliant with safety standard
The operational life of the product shall be limited to the mission time stated in Section 1 of "Specifications.". The user is expected to calculate an equivalent figure in time units from the B10D value based on the operating cycles of the application. In no circumstances can the mission time exceed 20 years. To achieve a mission time of 20 years, it is necessary to send the product to SMC for overhaul every 5 years. After the mission time has expired for the component, it shall be replaced with a new unit.

10.6 MTTFd compliant with safety standard
The B10D for the component given in section 1 “Specifications” is derived from product knowledge and based on specific life tests. The system integrator should use this data to determine MTTFd and the Performance Level (PL) of the system using the methods described in the Safety Standard.

10.7 Diagnosis range compliant with safety standard
The diagnosis range of this product is evaluated by means of FMEDA, and when the product is appropriately connected with the safety controller, 99% of the DC value of the safety function can be satisfied.

10.8 Common Cause Failure (CCF) compliant with safety standard
- This product satisfies "CCF score > 65" that is required of Cat. 4.
- The system builder bears the responsibility for CCF analysis.

Installation

1. Installation

⚠ Warning

Be sure to read through these safety precautions, understand them, and then install the product.
- When the product is considered to have been damaged during its transportation, do not install the product.
- Do not paint the product.
- Make sure that the connection of pipes and cables with the unit does not pose a risk of stumbling for system workers and maintenance workers.
- When making air supply connection and power supply connection, check the installation conditions. After installation, conduct the initial function inspection and leakage inspection.
- If air is discharged via the valve, protect the valve from the contaminant from the downstream system.

⚠ Caution

The valve is incorporated with a check valve so that even when the pressure drop occurs due to insufficiency of flow rate on the upstream side, the pilot valve operates stably. However, check the valve for the following three matters.

1) Note that when the pilot pressure drops due to narrowing of pipe, repetitive operation, or for other reason even when the pressure on the upstream side is within the operating pressure range, the valve may not operate normally.
2) Even when the pressure on the upstream side is shut off, there may be residual pressure in the pilot path. As there is residual pressure in the pilot path, even when no pressure is applied to the upstream side, the valve may operate once the solenoid is energized.
   To bleed the residual pressure from the pilot path, with the pressure on the upstream side shut off, repetitively energize and de-energize the solenoid valve several times.
3) In selection of a regulator or filter regulator, use the recommended AC size and select a product with sufficient flow rate characteristics.

- Do not leave the exhaust port of the valve in an unconnected state. Never block the valve exhaust port, but provide protection by using an appropriate silencer to prevent contaminant from entering the port.
  For silencers, refer to the catalog for this series.
  For how to install silencer, refer to "AN series/Specific product precautions/installation/when case is made of resin."
- This product is compatible with the air combination: AC-D Series. For the installation method and direction, observe the precautions for AC-D.
  This product cannot be lubricated for the purpose of its use. Note that combination of this product and a lubricator (AL) is prohibited.

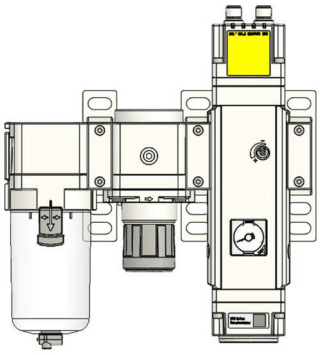


Fig. 6. Installed condition of AC-D Series

As this product is not equipped with connection threads, it is necessary to separately order spacers with bracket and piping adapters. For product numbers, refer to the VPX catalog. Refer to the specific product precautions on AC-D Series for how to handle spacer with bracket and piping adapter.

- Tighten the hexagon head bolts of the spacer with bracket to the corresponding tightening torque shown in the table below.

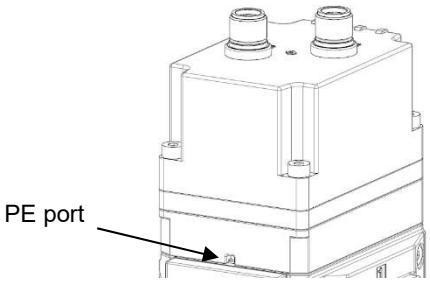
Hexagon head screw

Fig 7. Spacer with bracket

Fig 8. Piping adapter

Spacer with bracket	Applicable valve	Tightening torque (N·m)
Y300T-D	VPX406-A3	1.2±0.05
Y400T-D	VPX406-A4	1.2±0.05
Y600T-D	VPX406-A6	2.0±0.1

- For screwing-in of piping materials, refer to the specific product precautions on FRL Series.
- If the pilot EXH port (PE) port of the valve is extremely narrowed or blocked, the valve operation may become abnormal. Therefore, do not block the port.



2. Environment

⚠ Warning

- Do not install the product at a location subject to radiant heat.
- Do not install the product in a location with strong magnetic field.
- Do not use the product at a location where surge occurs. If the product is used at a location where surge occurs, malfunction or failure may occur. Take appropriate measures before using the product.
- When using a load that generates a surge voltage, take appropriate countermeasures against surge. If surge voltages are repeatedly applied, this may cause malfunction or failure.
- Do not install this product in other EMC environment than "Industrial" environment in accordance with the standard application range described in the .Declaration of Conformity.
- Products with IP65 enclosures are protected against dust and water. However, note that they cannot be used under water.
- This product can be used in temperatures as cold as 0°C, but take appropriate measures against solidification or freezing of condensate, moisture, etc.
- The highest altitude for use of this product is 2,000 m above sea level.

3. Air supply

⚠ Warning

- Do not install any device that obstructs the safety function between the valve and a protection system.

4. Noise

⚠ Caution

To protect workers from noise that temporarily occurs when the valve is de-energized, we recommend that you install a silencer or muffler on the valve.
When designing or testing an application system, make sure that the safety function can be positively maintained in consideration of the pressure drop in the silencer or device.

5. Electrical circuit and electric connection

5.1.1 Solenoid (SOL.1/SOL.2) electric circuit

- Fig. 9 shows a diagram of the solenoid electric circuit of this product. The solenoid circuit of this product has an energy-saving circuit. After the solenoid is energized, the energy-saving circuit functions when 62 ms have passed according to a timer circuit. Be careful about the allowable voltage fluctuation since a voltage drop of about 0.5 V occurs due to a transistor. For the power consumption and allowable voltage fluctuation, refer to the catalog.

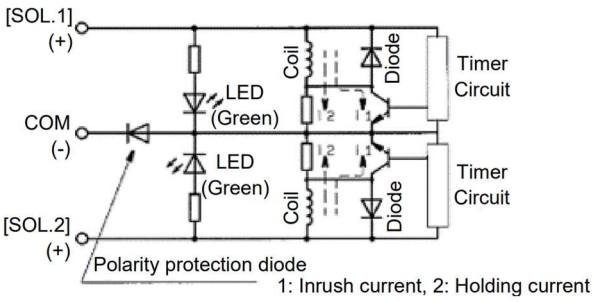


Fig. 9. Solenoid electric circuit diagram (negative common: NZ)

5.1.2 Pressure sensor (SEN.E/SEN.2) electric circuit

- Fig. 10 to Fig. 12 show diagrams of the pressure sensor electric circuits of this product. Be careful about the allowable voltage fluctuation since a voltage drop of about 1 V occurs due to a transistor. For the power consumption and allowable voltage fluctuation, refer to the catalog.

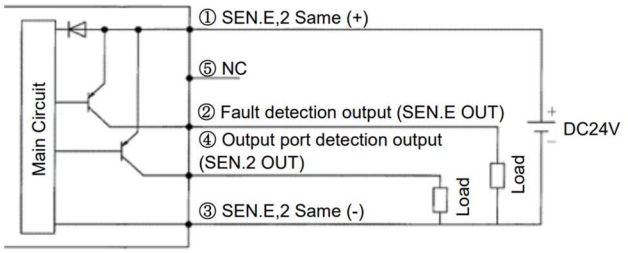


Fig. 10. Pressure sensor electric circuit diagram (double common: D)

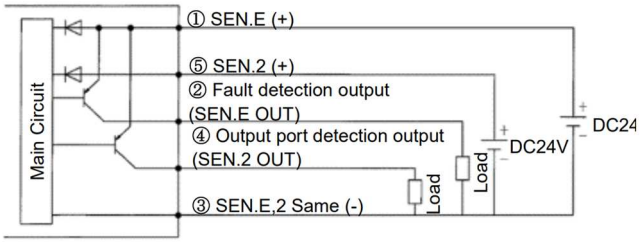


Fig. 11. Pressure sensor electric circuit diagram (negative common wiring type 1: N1)

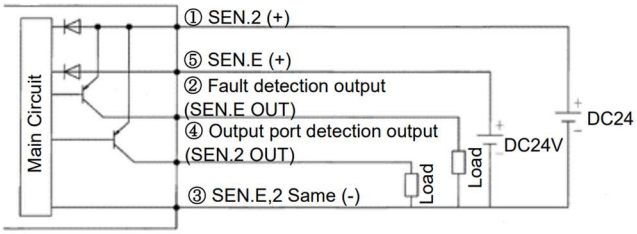


Fig. 12. Pressure sensor electric circuit diagram (negative common wiring type 2: N2)

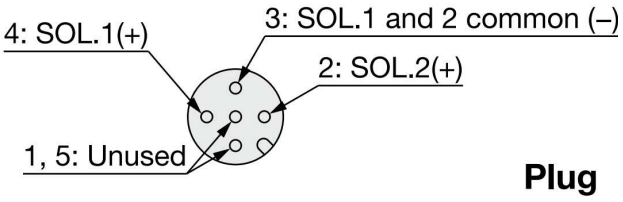
5.1.3 Digital pressure switch (pressure gauge type: E1/E2/E3/E4) electric circuits

- For electric circuit diagrams of the digital pressure switches of this product, refer to the ISE35 series catalog.

5.2 Electric connection
- When electric power supply is connected to the valve, make sure to apply an appropriate voltage. Inappropriate voltage may cause malfunction or coil breakage.
- After wiring of all wires has completed, check whether the connections are correct.

5.2.1 Valve wiring diagram
- **M12 connector for solenoid (for SOL.1/SOL.2) Pin arrangement (A cord, plug)**

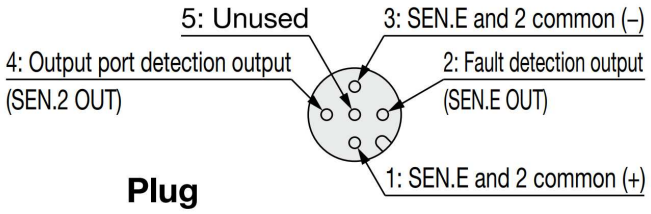
Negative common



Plug

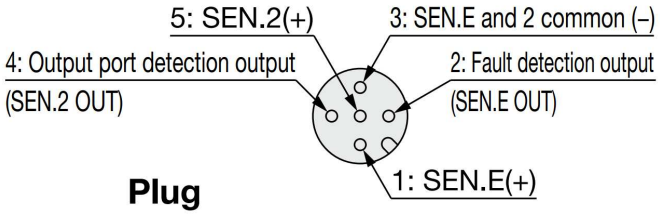
- **Connector pin assignment (A cord, plug) for pressure sensor (SEN.E/SEN.2)**

Double common



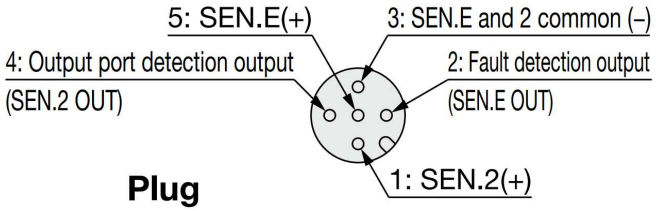
Plug

Negative common (Wiring type 1)



Plug

Negative common (Wiring type 2)



Plug

5.2.2 Cable with M12 connector

- **Specifications of cable with M12 connector for SOL.SEN. (A cord, socket)**

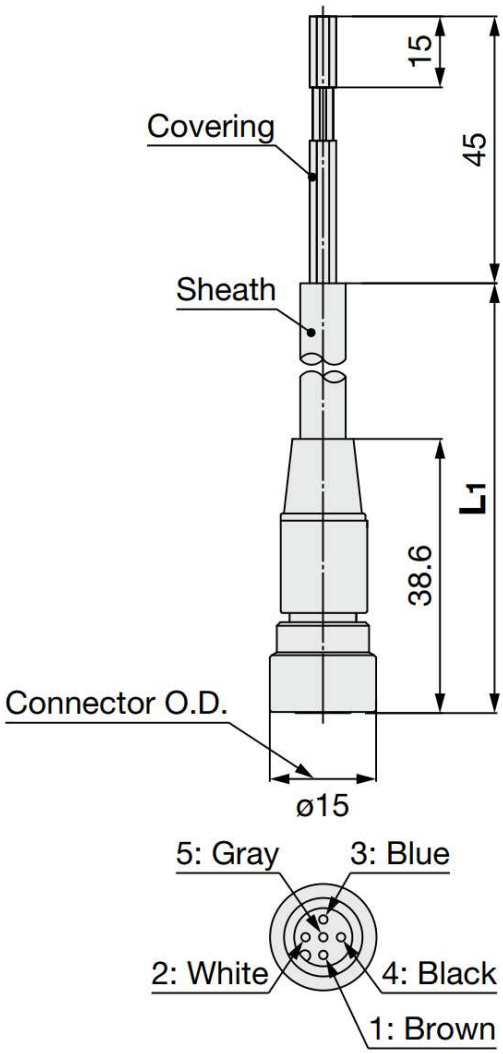
[Standard products]

Part no.	Lead wire length (L)
V100-200-5-10	1000 mm
V100-200-5-30	3000 mm
V100-200-5-50	5000 mm

[25A-]

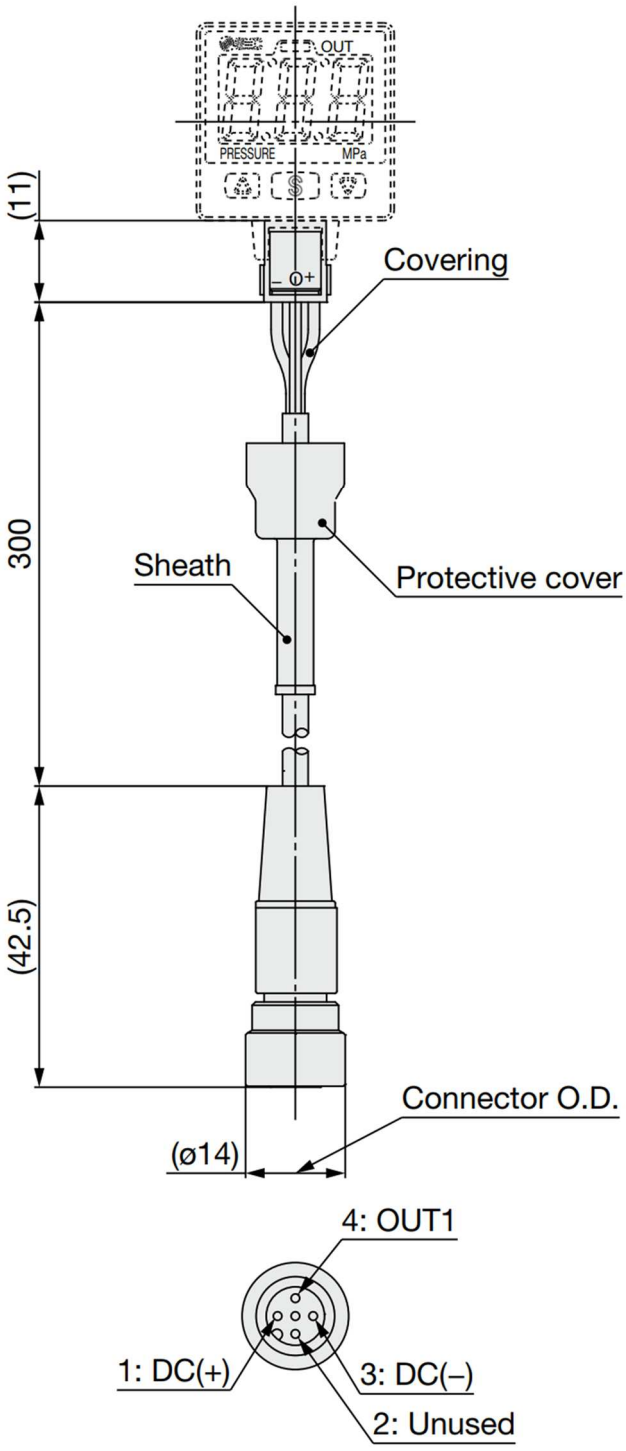
Part no.	Lead wire length (L)
V100-200-6-10	1000 mm
V100-200-6-30	3000 mm
V100-200-6-50	5000 mm

Sheath O.D.	ø6.5 mm
Cover diameter	ø1.8 mm
Conductor cross section	0.5 mm²



- **Specifications of cable with M12 connector (A cord, plug) for pressure switch (pressure gauge type: E1/E2/E3/E4)**

Sheath O.D.	ø3.4 mm
Cover diameter	ø1.16 mm
Conductor cross section	0.2 mm²



3 port solenoid valve / Specific Product Precautions 10

Be sure to read before handling.

Maintenance

1. Maintenance

Caution

- Failure to observe the procedures for maintenance may cause malfunction or breakage of device.
- If the product is handled inappropriately, compressed air may become dangerous. Only people who have sufficient knowledge and experience are allowed to conduct maintenance of the pneumatic system.
- Before conducting maintenance, turn off the power supply and stop the pressure supply. Confirm that the product is open to the atmosphere..
- After the installation and maintenance is finished, turn on the operating pressure and power supply to the device, and conduct appropriate function inspection and leakage inspection to confirm that the device is correctly installed.
- If electric connection is cut off during maintenance, confirm whether it is correctly reconnected, check the device and surrounding for safety, and continue observation of relevant domestic laws and regulations.
- Do not modify the product.
- Follow the installation or maintenance instruction, and do not disassemble the product unless disassembly is necessary.

2. Program setting method and actions to take in the event of detection of abnormality

- When using this product, confirm that every time the solenoid voltage is turned ON or OFF, the pressure sensors are put into the corresponding state in the table below.
  Set the program so that this monitoring test is automatically conducted by the safety controller.

Input signal (INPUT)		Pilot valve		Main valve		Pressure sensor			Diagnosis result
						SEN.E		SEN.2	
CH 1	CH 2	CH1	CH2	CH1	CH2	ERR LED	OUT PUT	OUT PUT	
0	0	OFF	OFF	OFF	OFF	OFF	ON	ON	Normal
		ON	OFF	ON	OFF	ON	OFF	ON	Failure -> Safe/detectable
		OFF	ON	OFF	ON	ON	OFF	ON	
		(ON)	(ON)	(ON)	(ON)	(OFF)	(ON)	(OFF)	Replacement
1	1	ON	ON	ON	ON	OFF	ON	OFF	Normal
		OFF	ON	OFF	ON	ON	OFF	ON	Failure -> Safe/detectable
		ON	OFF	ON	OFF	ON	OFF	ON	
		(OFF)	(OFF)	(OFF)	(OFF)	(OFF)	(ON)	(ON)	Replacement

- If the safety controller has detected a possibility of failure in one of two VPX channels, have the safety controller use the remaining channel in order to retain the safe condition.

Note) Each string in parentheses in the table indicates that failure to diagnose or two or more failures due to other factor (use beyond the specification range) are detected.
If the problem persists even after identifying the failure and taking the corresponding corrective action, replace the product.

Note) For details, refer to the timing chart and response time in Section 10.2 of "Specifications."

Warning

If the equipment is not operating, this product needs to go through the monitoring test at least once a week.

3. Diagnosis test

Warning

For the purpose of declaring Cat.4, conduct the following diagnosis tests once a day.
Set the program so that these diagnosis tests are automatically conducted by the safety controller.

Diagnosis test	Valve		Pressure sensor		LED ON				Diagnosis result	Safety function
	SOL.1	SOL.2	SEN.E Output	SEN.2 Output	SOL.1	SOL.2	SEN/ PWR	ERR		
A	OFF	OFF	ON	ON	OFF	OFF	ON (Green)	OFF	Normal	PUS SDE
B	ON	OFF	OFF	ON	ON (Green)	OFF	ON (Green)	ON (Red)	Failure	PUS SDE
C	OFF	ON	OFF	ON	OFF	ON (Green)	ON (Green)	ON (Red)	Failure	PUS SDE
D	ON	ON	ON	OFF	ON (Green)	ON (Green)	ON (Green)	OFF	Normal	SDE

- Pressure sensor E:
  When normally operating: SEN.E output is ON
  When failed: SEN.E output is OFF
- Pressure sensor 2:
  When no pressure is applied to 2 port: SEN.2 output is ON
  When pressure is applied to 2 port: SEN.2 output is OFF
- For the diagnosis to function correctly, the supply pressure must be at 0.25 MPa or higher. For details, refer to the timing chart and response time in Section 10.2 of "Specifications."

3 port solenoid valve / Specific Product Precautions 11

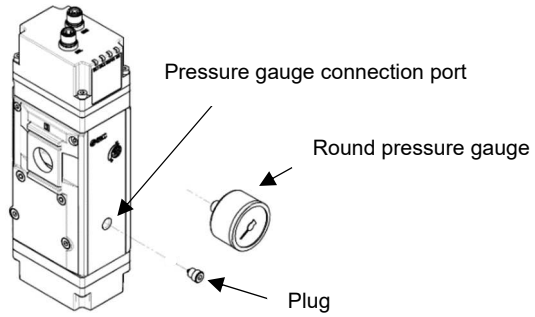
Be sure to read before handling.

4.Replacement

Warning

- As the solenoid is an indispensable part for the valve, do not make any change to the solenoid under any circumstances. If any change is made to the solenoid, the product will be out of the scope of SMC guarantee.
  Note that the parts in this product that can be replaced are plug, round pressure gauge, square embedded-type pressure gauge, digital pressure switch, and silencer, and other parts cannot be replaced.
- When conducting a replacement work, turn off all power supplies and confirm that the pressure at the valve has decreased to zero.

4.1 Replacing plug/round pressure gauge (Nil/G/M)



[Replacing plug (Nil)]

1) Remove the plug.
   (Tool to be used: hexagon wrench key (nominal size: 4)
2) Install the plug.
   (Tool to be used: hexagon wrench key (nominal size: 4)
3) Tightening torque: 0.6±0.05 N·m

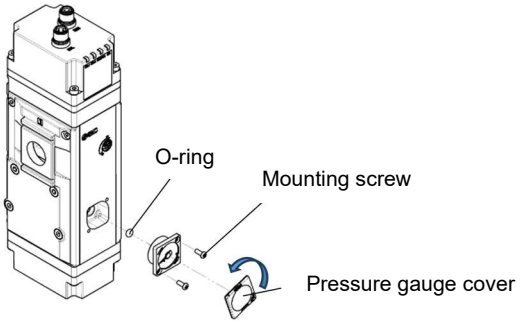
[Replacing round pressure gauge (G/M)]

1) Remove the round pressure gauge. (Tool to be used: wrench with size 14)
2) Mount the round pressure gauge.
   Confirm that a sealing material is attached on the round pressure gauge, and then mount the pressure gauge to the pressure gauge connection port of the valve.
   When using sealant tape, wind it by leaving 1.5 to 2 thread ridges exposed at the end of the threads.
   (Tool to be used: wrench with size 14)
3) Tightening torque: 3 to 5 N·m

Note1) Adjust the position of the round pressure gauge by tightening the thread. Adjustment in the loosening direction may cause air leakage.

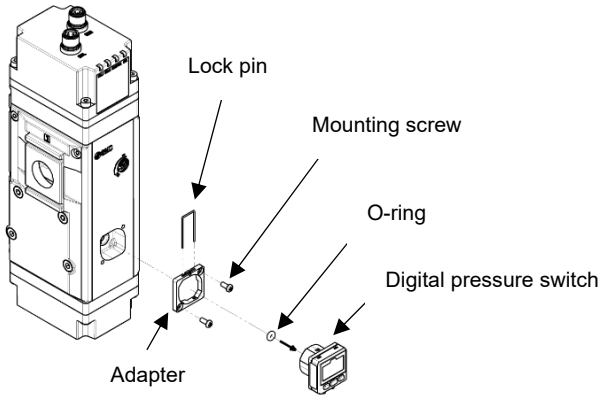
Note2) When you have selected a round pressure gauge, as no plug is fit in the pressure gauge connection port of the valve, install the bundled round pressure gauge by following the Steps 2) and 3) above.

4.2 Replacing square embedded-type pressure gauge (E)



1) Remove the pressure gauge cover.
   Turn the pressure gauge cover by 15 degrees in the arrow direction (counterclockwise) and then pull it out toward you.
2) Remove the pressure gauge.
   Remove the two mounting screws and remove the pressure gauge from the product.
   (Tool to be used: Phillips screwdriver)
3) Confirm that the O-ring is mounted on the replacing pressure gauge.
   When the O-ring is left in the valve, remove the O-ring from the valve and mount it to the pressure gauge.
   When installing the O-ring, confirm that it is free from deformation and foreign matter and correctly installed.
4) Mount the pressure gauge.
   Temporarily mount the pressure gauge to the valve with the mounting screws, and tighten the screws to the tightening torque 0.85±0.05 N·m to fix it.
   (Tool to be used: Phillips screwdriver)
5) Mount the pressure gauge cover.
   Set the pressure gauge cover with the arrow on it at its lower right corner. Mate the 2 fingers of the pressure gauge cover with the 2 finger slits of the pressure gauge, and rotate the pressure gauge cover 15 degrees to the opposite direction of the arrow (clockwise) to mount it.

4.3 Replacing digital pressure switch (E1, E2, E3, E4)



1) Pull the lock pin out from the adapter, and remove the digital pressure switch. (Tool to be used: flat blade screwdriver)
2) When replacing the adapter, remove the two mounting screws and remove the adapter from the valve. If you are not going to replace the adapter, perform replacement from Step 5).
   (Tool to be used: Phillips screwdriver)
3) Mount the replacing adapter on the product by using the mounting screws.
   Mount the adapter in the direction that does not allow the lock pin to fall.
   (Tool to be used: Phillips screwdriver)
4) Tightening torque: 0.85±0.05 N·m
5) Confirm that the supplied O-ring is correctly mounted on the digital pressure switch without deformation and foreign matter.
6) Assemble the digital pressure switch to the valve.
7) Insert the lock pin to the adapter. Insert it all the way to the back.
8) The pressure switch can be assembled even when it is rotated by 180 degrees.

4.4 Silencer

Warning

- If the silencer mounted on the valve is clogged, the safety function will be adversely affected. Therefore, keep the silencer clean and free from contamination during operation. If the nature of the application environment requires it, inspect the silencer once a month at least.
- For handling of the silencer, refer to the catalog for this series, operation manual, and specific product precautions on AN Series.

4.5 Replacement parts

Replacement parts	Applicable valve product No. (refer to the catalog for the part No.)			Plug/pressure gauge/ digital pressure switch product No.
	Pressure gauge type	Units on pressure gauge	Thread type	
Plug	Nil	Nil	Nil, F	AR24P-370AS-01
		Nil	N	AR24P-370AS-N01
Pressure gauge	G	Nil	Nil, F	G46-10-01
		Nil	N	G46-10-N01
		Z	N	G46-P10-N01-X30
	M	Nil	Nil, F	G46-10-01-L
			N	G46-10-N01-L
	E	Nil	Nil	GC3-10AS-D[Note 1)]
		Z	Nil	GC3-P10AS-D-X30[Note 1)]
Digital pressure switch	E1	Nil	Nil	ISE35-N-25-M(L)A-X534[Note 2)]
	E2	Nil	Nil	ISE35-R-25-M(L)A-X534[Note 2)]
	E3	Nil	Nil	ISE35-N-65-M(L)A-X534[Note 2)]
	E4	Nil	Nil	ISE35-R-65-M(L)A-X534[Note 2)]
	E1	Z	Nil	ISE35-N-25-P(L)A-X534[Note 2)]
	E2	Z	Nil	ISE35-R-25-P(L)A-X534[Note 2)]
	E3	Z	Nil	ISE35-N-65-P(L)A-X534[Note 2)]
	E4	Z	Nil	ISE35-R-65-P(L)A-X534[Note 2)]
	E1	ZA	Nil	ISE35-N-25-(L)A-X534[Note 2)]
	E2	ZA	Nil	ISE35-R-25-(L)A-X534[Note 2)]
	E3	ZA	Nil	ISE35-N-65-(L)A-X534[Note 2)]
	E4	ZA	Nil	ISE35-R-65-(L)A-X534[Note 2)]

Note 1) Supplied with O-ring (1 pc.) and mounting screws (2 pcs.).
Note 2) Supplied with lead wire with connector (300 mm, 1 pc.), adapter (1 pc.), lock pin (1 pc.), O-ring (1 pc.), and mounting screws (2 pcs.)
(L) indicates the absence/presence of lead wire. If you need a lead wire, select a model with "L."

Replacement parts	Product No.	Port size
Silencer	INA-25-100	G1

UL-certified parts

⚠ Caution

For the direct current power supply to be used when conformity to UL is necessary, use a UL1310 class 2 power unit.

The product is a UL-certified product only if it has a c UL us mark on its name plate.

About 25A-

- For handling of 25A- Series, refer to this operation manual and specific product precautions on 25A- Series.

Use restrictions

- Since the valves are affected by air leakage, they cannot be used for applications such as pressure retention in a system.

Troubleshooting

Symptom	Possible causes	Corrective action
The valve does not open.	The pilot valves (2 pcs.) are not energized.	- Confirm that the LEDs (SOL.1/SOL.2) of the pilot valve are lit. - Confirm that the voltage is within the specification range.
	The supply pressure is too low.	- Confirm that the supply pressure is within the specification range.
	The pilot valve or main valve has failed. [The valve does not open even when the pilot valves (2 pcs.) are energized and the supply pressure is within the specification range.]	- Replace the whole valve.
The valve does not close.	The pilot valves (2 pcs.) are energized.	- Confirm that the LEDs (SOL.1/SOL.2) of the pilot valve are not lit. - Confirm that the leakage voltage to the pilot valves (2 pcs.) is 3% of the rated voltage or less.
	The supply pressure is too high.	- Confirm that the supply pressure is within the specification range.
	The pilot valve or main valve has failed. [The valve does not close even when the pilot valve(s) (1 pc. or 2 pcs.) is(are) not energized and the supply pressure is within the specification range.]	- Replace the whole valve.
The pressure sensor does not operate as shown in the diagnosis test[Note 1] or monitoring test[Note 2].	The pressure sensor is not energized.	- Confirm that the LED (SEN.PWR.) of the pressure sensor is lit. - Confirm that the voltage is within the specification range.
	The supply pressure is out of the specification range.	- Confirm that the supply pressure is within the specification range.
	The pressure sensor has failed. [The pressure sensor does not operate as shown in the diagnosis test[Note 1] or monitoring test[Note 2] even when the pressure sensor is energized and the supply pressure is within the specification range.]	- Replace the whole valve.
Abnormal sound is generated in the valve, and the valve operation is unstable.	The supply flow rate is insufficient.	- Increase the supply pressure or flow rate.
	The operating frequency is too high.	- Confirm that the operation frequency is within the specification range.
	The supply pressure is out of the specification range.	- Confirm that the supply pressure is within the specification range.
	The valve has failed. [When abnormal sound is generated in the valve or the valve operation is unstable even when the supply flow rate is sufficient and the operating frequency and supply pressure are within the specification ranges.]	- Replace the whole valve.
Supply of protected system by valve is slow.	The supply flow rate in the protected system is insufficient.	- Increase the supply pressure or needle flow rate. - Decrease the volume of the protected system. - Increase the flow path in the protected system.
Exhaust from protected system by valve is slow.	The flow rate in the protected system is insufficient.	Change the flow rate in the protected system.
	A single channel in the valve is not functioning.	Refer to the troubleshooting for the case where the above valve does not close.
	The exhaust silencer is dirty or clogged.	Conduct inspection and replacement as necessary, and check the quality of compressed air and operating environment[Note 3].

Note1) Refer to Section 2 of "Maintenance" of this operation manual.

Note2) Refer to Section 3 of "Maintenance" of this operation manual.

Note3) Refer to the air supply and operating environment in (2) of "Common Precautions."

If the countermeasures above are not effective, there may be a problem with the valve.
In that case, stop using the valve immediately.
If any of the examples below are applicable, there may be an internal problem with the valve. In that case, stop using the valve immediately.

(1) The voltage used was not the rated voltage. (2) The product was directly exposed to water (3) Severe impact was applied.
(4) Foreign matter such as condensate or dust has entered the product (5) Other than the cases (1) to (4) above, any usage which falls into the precautions given in this operation manual. *If the product has failed, then please return the valve as it is.

Revision

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