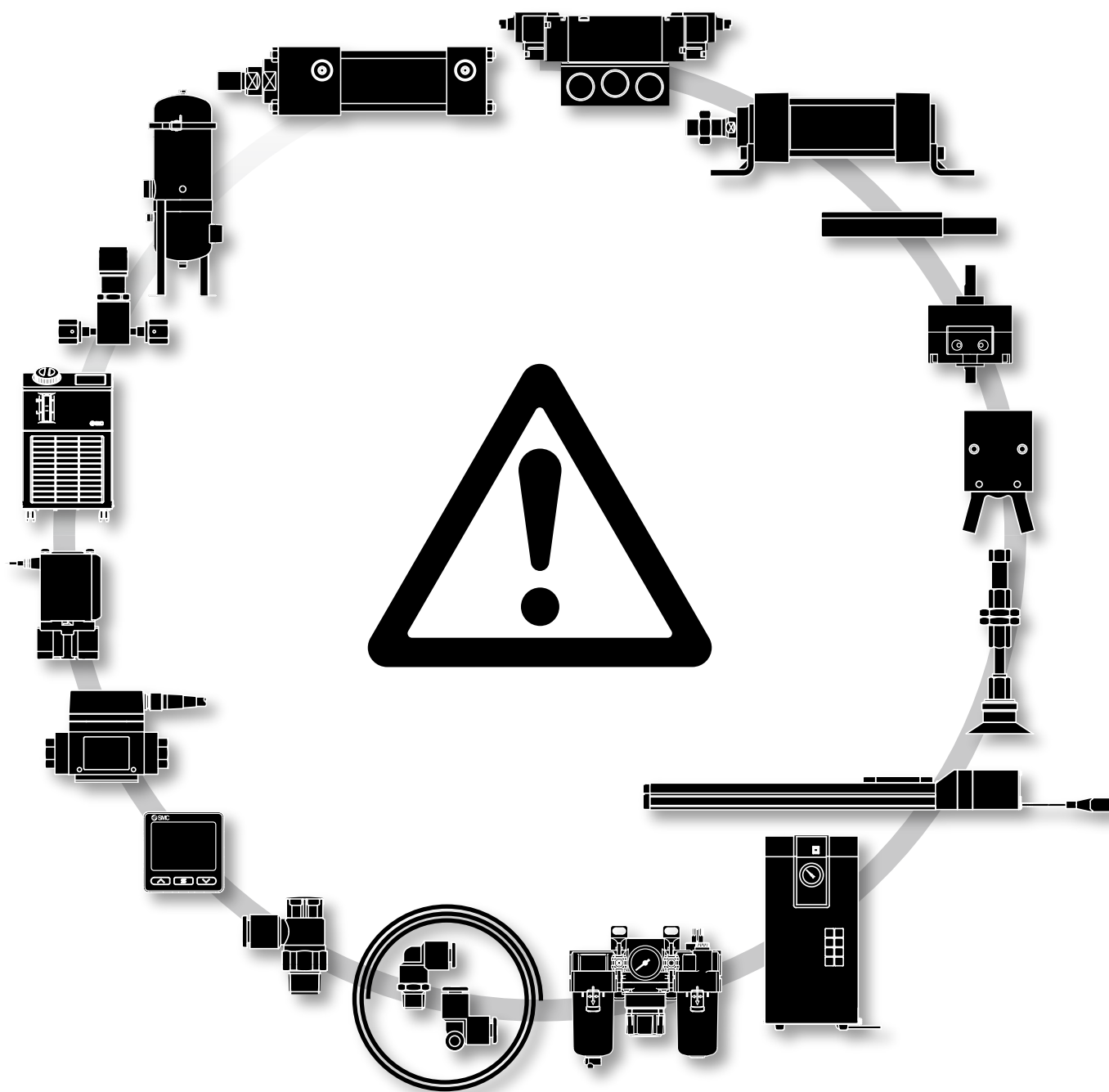


Handling Precautions for SMC Products



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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.

 **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.

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

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.

Caution

1. 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 regulations 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.

Safety Instructions

Be sure to read the “Handling Precautions for SMC Products” (M-E03-3) and “Operation Manual” before use.

Temperature Control Equipment

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), and other safety regulations.

-  **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 installation, operation, and maintenance of the product must be performed by an operator who is appropriately trained and experienced and who has a thorough understanding of the precautions in the operation manual and maintenance materials.

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

1. Use of the product under conditions and environments outside of the specifications described in the catalog or operation manual.
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.

Caution

1. 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.

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 regulations 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.

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. Period

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

2. Scope

For any failure reported within the warranty period which is clearly our responsibility, replacement parts will be provided. In that case, removed parts shall become the property of SMC.
This guarantee applies only to our product independently, and not to any other damage incurred due to the failure of the product.

3. Content

The following situations are out of scope of this warranty.

1. The product was incorrectly installed or connected with other equipment.
2. The product was modified or altered in construction.
3. The failure was a secondary failure of the product caused by the failure of equipment connected to the product.
4. The failure was caused by a natural disaster such as an earthquake, typhoon, or flood, or by an accident or fire.
5. The failure was caused by operation different from that shown in the Operation Manual or outside of the specifications.
6. The checks and maintenance specified (daily checks and regular checks) were not performed.
7. The failure was caused by the use of circulating fluid or facility water other than those specified.
8. The failure occurred naturally over time (such as discoloration of a painted or plated face).
9. The failure does not affect the functioning of the product (such as new sounds, noises and vibrations).
10. The failure was due to the “Installation Environment” specified in the Operation Manual.

4. Disclaimer

1. Expenses for daily and regular checks
2. Expenses for repairs performed by other companies
3. Expenses for transfer, installation and removal of the product
4. Expenses for replacement of parts other than those in this product, or for the supply of liquids
5. Inconvenience and loss due to product failure (such as telephone bills, compensation for workplace closure, and commercial losses)

For warranted repair, please contact the supplier you purchased this product from.

Safety Instructions

Be sure to read the “Handling Precautions for SMC Products” (M-E03-3) and “Operation Manual” before use.

Process Gas Equipment

⚠ 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)*1), Japan Industrial Standards (JIS)*2) and other safety regulations*3).

⚠ Caution:

Operator error could result in injury or equipment damage.

⚠ Warning:

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

⚠ Danger :

In extreme conditions, there is a possibility of serious injury or loss of life.

- *1) ISO 4414: Pneumatic fluid power -- General rules relating to systems.
- *2) JIS B 8370: General rules for pneumatic equipment.
- *3) High Pressure Gas Safety Act, Labor Safety and Sanitation Law etc.

⚠ 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 fluid and specific equipment must be decided by the person who designs the equipment or decided 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 thoroughly 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 install and operate machinery and equipment.

The product specified here may become unsafe if handled incorrectly.
The assembly, installation operation maintenance of the given 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 outdoors (use in a place protected from adverse environmental).

2. Installation on equipment in conjunction with atomic energy, railways, air navigation, space, shipping, vehicles, military, medical treatment, combustion, or 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.

⚠ Caution

1. 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 after the product is delivered to customer from SMC.

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 the products, please read and understand the warranty terms and disclaimers noted in the specified catalog for the particular products.

Compliance Requirements

1. When the product is exported, strictly follow the laws required by the Ministry of Economy, Trade and Industry (Foreign Exchange and Foreign Trade Control Law).

2. The products printed in the catalog are USA manufactured products of AP Tech. As such, they fall within the United States Export Administration Regulations (EAR) regarding re-exports.
It is the exporter’s responsibility to assure that these regulations are followed when the products are exported.

⚠ Safety Instructions

Be sure to read “Handling Precautions for SMC Products” (M-E03-3) before using.

Ⓐ

Metso Valve Controller

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.

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

Warning

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

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

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

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

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

Scope of Warranty: Warranty shall be granted for non-conformity of the Company's product (“Product”) to the relevant specifications. Any such non-conformity resulting from wear of expendable parts resulting from the Customer's normal use thereof, or from the Customer's inappropriate, insufficient or inexperienced maintenance or from the Customer's inappropriate storage, installation, use, operation or the like, or from the Customer's modification or the like are excluded from warranty.

Period of Warranty: One (1) year from the commencement of use by the Customer or one year and half (1.5) from the delivery of the Product; whichever expires earlier.

Claiming Procedures: If the Customer determines that the Product is non-conforming, the Customer shall immediately notify the Company. If the notice does not arrive at the Company within two (2) weeks from the date of expiration of the relevant warranty period, the Customer's rights to warranty is forfeited. Even in the case where the notice arrives within the period prescribed above, liability for any damage arising from any delay of the notice shall be borne by the Customer.

Remedies: If any non-conformity is actually found in the Product as a result of an inspection made by the Company, the Company shall, upon consultation, repair or replace the Product. The Company will not accept any other claims (such as monetary compensation).

Related Expenses: Where the Product is eligible for warranty, shipment expenses therefor shall be borne by the Company. Regardless of whether or not the Product is eligible for warranty, expenses for removal and installation incurred in relation to replacement of the Product shall be borne by the Customer.

Limitation of Liability: Even if any legal liability in whichever form other than the warranties set forth above arises in respect of the Company, the Company's scope of liability shall be limited as follows:

- The Company shall be held liable only to the extent that the relevant liability is caused by its act or omission due to its negligence.
- The Company's liability shall not exceed the amount of direct damages incurred by the Customer in respect of the Product, and the Company shall not be held liable for any indirect, contingent, consequential or punitive damage.
- The Company's liability shall not exceed the amount of the sales price of the Product.
- The Company shall not be held liable for any damage caused to the nuclear energy, space or aviation business, for any damage due to any force majeure events including war, terrorist activities or natural disasters, or for compliance with safety regulations or environmental regulations that is beyond the scope of business of the Company.

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 regulations 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.

Safety Instructions

Be sure to read the “Handling Precautions for SMC Products” (M-E03-3) and “Operation Manual” before use.



3/4/5-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. Intermediate stops

- Rubber seal: Use a closed center type valve.
- Metal seal: For the exhaust center type valve, use in combination with either a double check spacer or a double check block.
- For the 3-position closed center or double check valve types, it is difficult to make the piston stop at the required position accurately due to the compressibility of air. Furthermore, since valves and cylinders are not guaranteed for zero air leakage, it may not be possible to hold a stopped position for an extended period of time. However, as the metal seal closed center type valve leaks more air than the rubber seal and double check type valves, the intermediate stopping time will be shorter.

4. Effects of back pressure when using a manifold

Use caution when valves are used on a manifold because actuators may malfunction due to back pressure.

Especially when using a 3-position exhaust center valve, a double check valve, or a single acting cylinder, take appropriate measures to prevent malfunction by using it with an individual EXH spacer assembly, a back pressure check valve, or an individual exhaust manifold.

Also, since the SQ1000 4-position dual 3-port valve is a 4-port valve specification (R1 and R2 are common), one back pressure check valve can be installed. As a result, back pressure from valves in other stations can be prevented, but back pressure inside this valve cannot be prevented.

5. 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.

6. Not suitable for use as an emergency shutoff 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.

7. Release of residual pressure

For maintenance and inspection purposes install a system for releasing residual pressure. Especially in the case of the 3-position closed center valve or double check valve types, ensure that the residual pressure between the valve and the cylinder is released.

8. Operation in a vacuum condition

When a valve is used for switching a vacuum, take measures to install a suction filter or similar to prevent external dust or other foreign matter from entering inside the valve.

In addition, at the time of vacuum adsorption, be sure to supply a constant supply of vacuum. Failure to do so may result in foreign matter sticking to the adsorption pad or air leakage, causing the workpiece to drop.

9. Regarding vacuum switch valves and vacuum release valves

If a non-vacuum valve is installed in the middle of a piping system that contains a vacuum, the vacuum condition will not be maintained. Use a valve designed for use under vacuum conditions.

10. Double solenoid type

When using the double solenoid type for the first time, actuators may travel in an unexpected direction depending on the switching position of the valve. Implement measures to prevent any danger from occurring when operating the actuator.

11. 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.

12. Extended periods of continuous energization

- 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
- Direct operated: A continuous duty type valve such as the VK series or the VT series

If conflicting instructions are given in the "Specific Product Precautions" or on the "How to Order Valves" page, give them priority.

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

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

14. 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.



3/4/5-Port Solenoid Valves Precautions 2

Be sure to read this before handling products.

Design/Selection

Warning

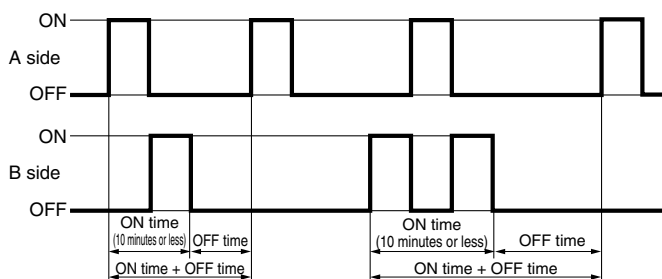
Latching Type [VQ/SQ series double (latching) type]

The latching solenoid is equipped with a self-holding mechanism which permits the movable iron core in the solenoid to hold the set position or reset position during momentary energization (20 ms or longer), so there is no need for continuous energization. Depending on conditions, continuous energization may cause a rise in the coil temperatures, resulting in a malfunction.

<Special precautions to be taken with the latching type>

- 1) Do not continuously energize the latching type.

When it is necessary to energize it continuously, keep the energized period to 10 minutes or less, and then leave a de-energized period (on both the A side and B side) lasting longer than the energized period, before operating it again. The duty ratio should be 50% or less.



- Maximum ON time is 10 minutes.

- Duty ratio $\leq 50\%$ $\left(\text{Duty ratio} = \frac{\text{ON time}}{\text{ON time} + \text{OFF time}} \right)$

Example: When energization lasts for five minutes, it should be followed by five or more minutes of de-energization. Because the latching type has only one solenoid, both the A side and B side should be off for five minutes or more.

However, a minimum energization time of 20 ms is recommended.

[Ambient temperature]

The product should be installed in an environment with an ambient temperature of -10° to 50°C . Especially in environments with poor heat dissipation, such as in a panel, the heat of the coil can cause the ambient temperature to rise, so please exercise caution.

- 2) Use a circuit in which the set and reset signals will not be energized at the same time.
- 3) The minimum energization time for self-holding is 20 ms.
- 4) Even when there is no problem with normal operations and locations, please consult with SMC before using in locations with a vibration of 30 m/s^2 or more or a strong magnetic field.
- 5) Even though this valve is set to the reset position at the time of shipment (passage: A $\rightarrow$ R), it may switch to the set position during transportation or due to impact when mounting valves, etc. Therefore, check the initial position with the power supply or by performing a manual override prior to use.

Latching	Passage	Indicator light	Single	Passage	Indicator light
A-C ON (set)	P $\rightarrow$ A	Orange	A-C ON	P $\rightarrow$ A	Orange
B-C ON (reset)	A $\rightarrow$ R	Green	OFF	A $\rightarrow$ R	—

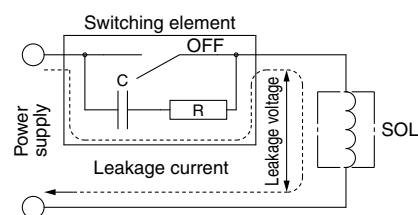
Caution

1. Precautions for 2-position double solenoid valves

If a double solenoid valve is operated with momentary energization, it should be energized for at least 0.1 seconds. However, depending on the piping conditions, the cylinder may malfunction even when the double solenoid valve is energized for 0.1 seconds or longer. In this case, energize the double solenoid valve until the cylinder is exhausted completely.

2. 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.



DC coil

- SV, SY, SYJ, SX, SZ, SJ, VV061 (V060), VQ (V100), VQC (V100), SQ (V100), VQZ, VF, VFR, VFS, VP7, VS7, VP300, VP500, VP700, VT307, VG342 } 3% or less of the rated voltage
- VQD, VZ, VZS, VK, VT317, VT325 } 2% or less of the rated voltage
- VT301, VT315, VP31□5, VP4□50, VP4□70 } 5% or less of the rated voltage

AC coil

- VK, VFR, VFS, VP7, VS7, VT317 } 20% or less of the rated voltage
- VZ, VZS, VT307, VG342, VT301, VT315, VT325, VP31□5, VT4□50, VP4□70 } 15% or less of the rated voltage
- SY, SYJ, VQZ, VF, VP300, VP500, VP700, VQ (V100) } 8% or less of the rated voltage

3. 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.



3/4/5-Port Solenoid Valves Precautions 3

Be sure to read this before handling products.

Design/Selection

⚠ Caution

- 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.

Applicable solenoid valve series with power-saving circuit

- SY (High pressure type), VF, VP
- VQ100, VQD1000, S070

4. Solenoid valve drive for AC with a solid state output (SSR, TRIAC output, etc.)

- 1) Current leakage

When using a snubber circuit (C-R element) for surge protection of the output, a very small amount of electrical current will continue to flow even during the OFF state.

This results in the valve not returning. In a situation where the tolerance is exceeded, as in the above case, take measures to install a bleeder resistor.

- 2) Minimum allowable load amount (Min. load current)

When the consumption current of a valve is less than the output's minimum allowable load volume or the margin is small, the output may not switch normally. Please contact SMC.

- 3) Solenoid valve with full wave rectifier circuit

When the solenoid valve built-in full wave rectifier circuit with AC specifications is used, a return failure of the solenoid valve may occur depending on the kind of triac output circuit. Carefully check this point when selecting a SSR or sequencer.

For details, contact the SSR or sequencer manufacturer.

5. Surge voltage suppressor

- 1) The surge voltage suppressor built into the valve is intended to protect the output contacts so that the surge generated inside valve does not adversely affect the output contacts. Therefore, 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.

6. Surge voltage intrusion

Applicable series (non-polar type solenoid valves)

VQ100 and 3/4/5-port solenoid valves VQ(C), VQZ, VQD (2 W type) series

SY100, V100, and 3/4/5-port solenoid valves SY, SYJ, SX, SZ, SV, SJ, VF, VP series

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).

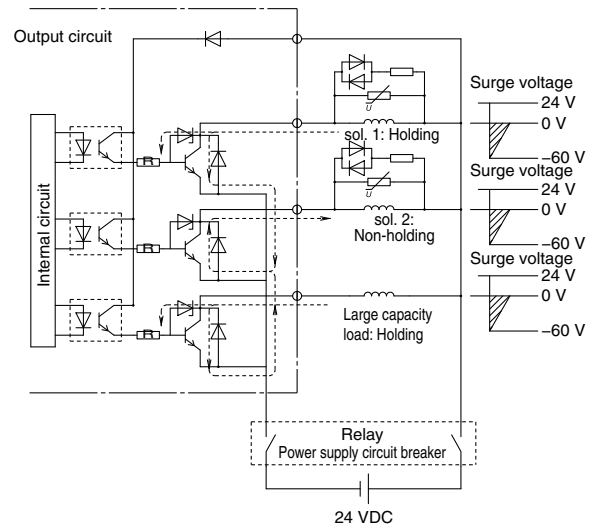


Figure 1. Surge intrusion circuit example (NPN outlet example)

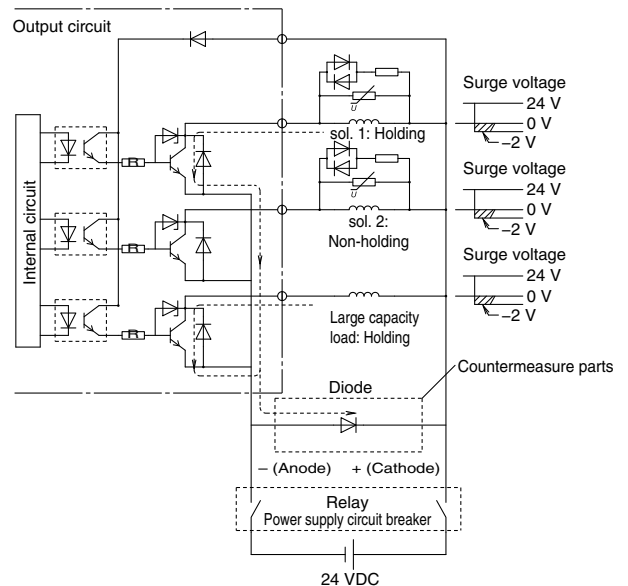


Figure 2. Surge intrusion countermeasure example (NPN outlet example)



3/4/5-Port Solenoid Valves

Precautions 4

Be sure to read this before handling products.

Design/Selection

⚠ Caution

7. Operation in low temperature conditions

It is possible to operate a valve in extreme temperatures, as low as -10°C . Take appropriate measures to avoid the freezing of drainage, moisture, etc., in low temperatures.

8. Operation for air blowing

When using a solenoid valve for air blowing, use an external pilot type.

Use caution because the pressure drop caused by the air blowing can have an effect on the internal pilot type valve when internal pilot type valves and external pilot type valves are used on the same manifold.

Additionally, when compressed air within the pressure range of the established specifications is supplied to the external pilot type valve's port, and a double solenoid valve is used for air blowing, the solenoids should be energized when air is being blown.

9. Mounting orientation

Rubber seal: Refer to the specifications of each series.

Please consult with SMC for models not indicated in the specification column.

Metal seal: The mounting orientation of a single solenoid is universal. No specific orientation is necessary. When installing a double solenoid or a 3-position configuration, mount the valve so that the spool valve is horizontal.

10. Initial lubrication of main valve

The following initial lubricant has already been applied to the main valve.

- Rubber seal, spool valve: Grease

Please consult with SMC, as there are some standard valve products that use fluorine grease for food processing equipment (NSF H-1).

- Metal seal, spool valve: Turbine oil

Turbine oil is applied to the spool valve of the metal seal type. Therefore, turbine oil may seep out when a new product is delivered or while the valve is in storage.

11. For the pilot EXH (PE) port

If the solenoid valve and the manifold's pilot EXH (PE) port is restricted extremely or blocked, abnormal operation of the solenoid valve may occur.

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

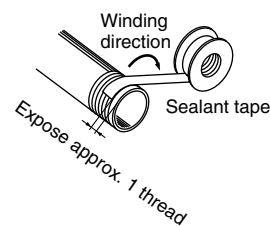
1. Refer to the Fittings and Tubing Precautions (pages 52 to 56) for handling One-touch fittings.

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.



4. Closed center and double check valve types

For the closed center or double check valve types, check the piping to prevent air leakage from the piping between the valve and the cylinder.

5. Connection of piping and fittings

When screwing piping or fittings into the valve, tighten them as follows.

- 1) When using SMC's M3, M5, M6, or 10-32UNF fittings, follow the procedures below to tighten them.

• Connection thread: M3

First, tighten by hand, then use a suitable wrench to tighten the hexagonal portion of the body an additional 1/4 turn. The reference value for the tightening torque is 0.4 to 0.5 N·m.

• Connection thread: M5 and 10-32UNF

First, tighten by hand, then use a suitable wrench to tighten the hexagonal portion of the body an additional 1/6 to 1/4 turn. The reference value for the tightening torque is 1 to 1.5 N·m.

• M6

First, tighten by hand, then use a suitable wrench to tighten the hexagonal portion of the body an additional 1/6 to 1/4 turn.

* Excessive tightening may damage the thread portion or deform the gasket and cause air leakage. Insufficient tightening may loosen the threads or cause air leakage.

• When using a fitting other than an SMC fitting, follow the instructions given by the fitting manufacturer.

- 2) For a fitting with sealant R or NPT, first, tighten it by hand, then use a suitable wrench to tighten the hexagonal portion of the body an additional two or three turns. For the tightening torque, refer to the table below.

Connection thread size (R, NPT)	Proper tightening torque (N·m)
1/8	3 to 5
1/4	8 to 12
3/8	15 to 20
1/2	20 to 25
3/4	28 to 30
1	36 to 38
1 1/4	40 to 42
1 1/2	48 to 50
2	48 to 50



3/4/5-Port Solenoid Valves

Precautions 5

Be sure to read this before handling products.

Piping

⚠ Caution

- 3) If the fitting is tightened with excessive torque, a large amount of sealant will seep out. Remove the excess sealant.
- 4) Insufficient tightening may cause seal failure or loosen the threads.
- 5) For reuse
 - (1) Normally, fittings with a sealant can be reused up to 2 to 3 times.
 - (2) To prevent air leakage through the sealant, remove any loose sealant stuck to the fitting by blowing air over the threaded portion.
 - (3) If the sealant no longer provides effective sealing, wind sealing tape over the sealant before reusing. Do not use any form of sealant other than the tape type of sealant.
 - (4) Once the fitting has been tightened, backing it out to its original position often causes the sealant to become defective. Air leakage will occur.

6. Uni thread fittings

- 1) First, tighten the threaded portion by hand, then use a suitable wrench to tighten the hexagonal portion of the body further at wrench tightening angle shown below. For the reference value for the tightening torque, refer to the table below.

Connection Female Thread: Rc, NPT, NPTF

Uni thread size	Wrench tightening angle after tightened by hand (deg)	Tightening torque (N·m)
1/8	30 to 60	3 to 5
1/4	30 to 60	8 to 12
3/8	15 to 45	14 to 16
1/2	15 to 30	20 to 22

Connection Female Thread: G

Uni thread size	Wrench tightening angle after tightened by hand (deg)	Tightening torque (N·m)
1/8	30 to 45	3 to 4
1/4	15 to 30	4 to 5
3/8	15 to 30	8 to 9
1/2	15 to 30	14 to 15

- 2) The gasket can be reused up to 6 to 10 times. It can be replaced easily when it has sustained damage. A broken gasket can be removed by holding it and then turning it in the same direction as loosening the thread. If the gasket is difficult to remove, cut it with nippers, etc. In such a case, use caution not to scratch the seat face because the seat face of the fitting's 45° gasket is the sealing face.

7. Piping to products

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

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 30 N or more is not applied to the lead wire.

When instructions are given in the Specific Product Precautions, follow these specifications.



3/4/5-Port Solenoid Valves

Precautions 6

Be sure to read this before handling products.

Lubrication

Warning

1. Lubrication

[Rubber seal]

- 1) All valves except those listed below have been lubricated for life by the manufacturer and therefore do not require lubrication while in service.

Valves requiring lubrication

VP4□50, VP4□70, VP31□5, VPA4□50, VPA4□70, VPA31□5

- 2) If a lubricant is used in the system, use class 1 turbine oil (no additives), ISO VG32. For details about lubricant manufacturers' brands, refer to the SMC website. Additionally, please contact SMC for details about class 2 turbine oil (with additives) ISO VG32.
Once lubricant is utilized within the system, since the original lubricant applied within the product during manufacturing will be washed away, please continue to supply lubrication to the system. Without continued lubrication, malfunctions could occur.
If turbine oil is used, refer to the Safety Data Sheet (SDS) of the oil.

[Metal seal]

- 1) These valves can be used without lubrication.
- 2) If a lubricant is used in the system, use class 1 turbine oil (no additives), ISO VG32. For details about lubricant manufacturers' brands, refer to the SMC website. Additionally, please contact SMC for details about class 2 turbine oil (with additives) ISO VG32.

2. Lubrication amount

If the lubrication amount is excessive, the oil may accumulate inside the pilot valve, causing malfunction or response delay. So, do not apply a large amount of oil. When a large amount of oil needs to be applied, use an external pilot type to put the supply air on the pilot valve side in the non-lube state. This prevents the accumulation of oil inside the pilot valve.

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.

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 µm 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.



3/4/5-Port Solenoid Valves

Precautions 7

Be sure to read this before handling products.

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. Products with IP65 and IP67 enclosures (based on IEC60529) are protected against dust and water. However, these products cannot be used in water.
3. Products compliant with IP65 and IP67 satisfy the product specifications when mounted properly. Be sure to read the precautions for each product.
4. 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.
5. Do not use in a place subject to heavy vibration and/or shock.
6. The valve should not be exposed to prolonged sunlight. Use a protective cover. Note that the valve is not for outdoor use.
7. Remove any sources of excessive heat.
8. If it is used in an environment where there is possible contact with oil, weld spatter, etc., exercise preventive measures.
9. 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.

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.

2. **Lubrication**

In the case of rubber seals, once lubrication has been started, it must be continued.

Use class 1 turbine oil (with no additives), VG32. If other lubricant oil is used, it may cause a malfunction. Please contact SMC for information on the suggested class 2 turbine oil (with additives), VG32.

3. **Manual override operation**

When switching a double solenoid valve via the manual override operation, instantaneous operation may cause the malfunction of the cylinder. It is recommended that the manual override be held until the cylinder reaches the stroke end position.



Actuators 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 made by pneumatic equipment (including vacuum).

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

2. Confirm the applicable specification range.

The cylinder specifications listed in the catalog apply to standard strokes, including intermediate strokes. Please consult with SMC for specifications on long strokes. There are also some made-to-order products (-XB□/-XC□) for which product specifications do not apply.

3. There is a danger of sudden action by cylinders if the sliding parts of machinery are twisted, etc., or changes in forces occur.

In such cases, human injury may occur, e.g. by hands or feet getting caught in the machinery, or damage to the machinery itself may occur. Therefore, the machine should be designed to operate smoothly and to avoid such dangers.

4. If there is a chance that the product will pose a hazard to humans, install a protective cover.

If the moving portion of the product will pose a hazard to humans or will damage machinery or equipment, provide a construction that prevents direct contact with those areas.

5. Be certain that the secured portions will not loosen.

Be certain to adopt a reliable connecting method if the cylinder is used very frequently or if it is used in a location that is exposed to a large amount of vibration.

6. There may be cases in which a speed-reduction circuit or a shock absorber is required.

If the driven object moves at high speeds or is heavy, it will be unfeasible for only the cylinder's cushion to absorb the shock. Therefore, provide a speed-reduction circuit to reduce the cylinder's speed before the thrust is applied to the cushion or an external shock absorber to dampen the shock. If these countermeasures are taken, make sure to take the rigidity of the mechanical equipment into consideration.

7. Consider the possibility of a power source related malfunction.

For equipment that relies on power sources such as compressed air, electricity, or hydraulic pressure, adopt a countermeasure to prevent the equipment from causing a hazard to humans or damage to the equipment in the event of a malfunction.

8. Design the circuitry to prevent the sudden lurching of driven objects.

When a cylinder is driven by an exhaust center type directional control valve or when starting up after residual pressure is exhausted from the circuit, etc., the piston and its driven object will lurch at a high speed if pressure is applied to one side of the cylinder because of the absence of air pressure inside the cylinder. Therefore, select equipment and design circuits to prevent sudden lurching because there is a danger of human injury and/or damage to equipment when this occurs.

9. Consider the action of the cylinder in the event of an emergency stop.

Devise a safe system so that if a person engages the emergency stop or if a safety device is tripped during a system malfunction, such as a power outage, the movement of the cylinder will not cause a hazard to humans or damage the equipment.

10. Avoid synchronized operation using cylinders only.

Even if multiple pneumatic cylinders are initially set to the same speed, their speeds may vary due to changes in operating conditions. Therefore, avoid designs where a single load is moved by synchronizing multiple cylinder operations.

11. Consider the action of the cylinder when restarting after an emergency stop.

Devise a safe design so that the restarting of the cylinder will not pose a hazard to humans or damage the equipment. Install manually controlled equipment for safety when the actuator has to be reset to the starting position.

12. Intermediate stops

When an intermediate stopped position is performed with a 3-position closed center type/double check valve type directional control valve, it is difficult to achieve accurate and precise stopped positions due to the compressibility of air.

Furthermore, since valves and cylinders are not guaranteed for zero air leakage, it may not be possible to hold a stopped position for an extended period of time. Please contact SMC in case it is necessary to hold a stopped position for an extended period of time.

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

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

14. Refer to the Auto Switches Precautions for using with an auto switch.

15. When a cylinder is used in a clamping, suspending, or lifting mechanism

There is a danger of workpieces dropping if there is a decrease of thrust due to a drop in circuit pressure caused by a power outage, etc. Therefore, safety equipment should be installed to prevent damage to machinery and/or human injury.



Actuators Precautions 2

Be sure to read this before handling products.

Design/Selection

⚠ Caution

1. Use the product within the limits of the maximum usable stroke.

The piston rod will be damaged if operated beyond the maximum stroke. Refer to the Cylinder Model Selection Procedure for the maximum usable stroke.

2. Operate the cylinder component parts within a range such that collision damage will not occur at the stroke end.

For applications where a piston with inertial force strikes a cover and stops at the stroke end, follow the cylinder model selection procedure (the front matter), or select while taking into account the allowable kinetic energy indicated in each model's specifications.

3. Use a speed controller to adjust the cylinder drive speed, gradually increasing from a low speed to the desired speed setting.

4. Provide intermediate supports for long stroke cylinders.

Provide intermediate supports for cylinders with long strokes to prevent rod damage due to the sagging of the rod, deflection of the tube, vibration, external loads, etc.

In addition, thoroughly examine the possibility of buckling and establish safety measures, such as constructing a guide outside of the product, etc.

5. If pressure is applied to the external cylinder parts, there is a possibility that air will get inside the cylinder from the rod seal section. (Example: inside a chamber, etc.)

6. Resumption after a long stop.

When resuming operation after a long stop, there are cases in which the starting pressure rises or there is a delay in the piston starting time due to adhesion.

Conducting several cycles of running-in operation will solve this problem. Please consider implementing this before resumption.

Mounting

⚠ Warning

1. Operation manual

Install the product and operate it only after reading the operation manual carefully and understanding its contents. Also, keep the manual in a location 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. Do not place a magnetic object near the product.

The auto switch is a magnetic sensing type. If a magnetic object is placed close to it, the actuator could operate suddenly, which could pose a hazard to humans or damage the machinery and equipment.

5. Do not perform additional machining on the product.

Performing additional machining on the product can result in insufficient strength and cause damage to the product. This can lead to possible human injury or damage to the surrounding equipment.

Mounting

⚠ Warning

6. Do not enlarge the fixed throttle by modifying the pipe connectors.

If the hole diameter is enlarged, the product's rotation speed will increase, causing the shock force to increase and damage the product. As a result, it could pose a hazard to humans or damage the machinery and equipment.

⚠ Caution

1. Be certain to align the rod axis with the load and direction of movement when connecting.

When not properly aligned, the rod and tube may be twisted, and damage may be caused due to wear on certain areas, such as the inner tube surface, bushings, rod surface, or seals.

For off-center loads, we recommend using in combination with a floating joint, etc., for effective deviation absorption. Confirm the allowable eccentricity and rotating angle before selecting for use.

2. When an external guide is used, connect the rod end and the load in such a way that there is no interference at any point within the stroke.

3. Do not scratch or gouge the sliding parts of the cylinder tube, piston rod, etc., by striking or grasping them with other objects.

Cylinder bores are manufactured to precise tolerances, so even a slight deformation may cause a malfunction. Also, scratches, gouges, etc., on the piston rod may lead to damaged seals or cause air leakage.

4. Prevent the seizure of rotating parts.

Prevent the seizure of rotating parts (pins, etc.) by applying grease.

5. Do not use until you can confirm that equipment can operate properly.

Confirm correct mounting by performing function and leak tests properly after compressed air and power are connected following mounting or repair.

6. Cantilever fastening

If a cylinder is actuated at a high speed when mounted with one side fastened and one side free (basic type, flange type, direct mount type), the bending moment may act on the cylinder due to vibration at the stroke end, causing damage to the cylinder. In such cases, install a mounting bracket to suppress the vibration of the cylinder body, or reduce piston speed until the cylinder body does not vibrate at the stroke end.

Also, use a mounting bracket when moving the cylinder body or mounting a long stroke cylinder horizontally with one-sided fastening.

7. Be very careful when handling the product.

Depending on the handling method, there is a risk that the corners of the product will injure your hands, fingers, etc.



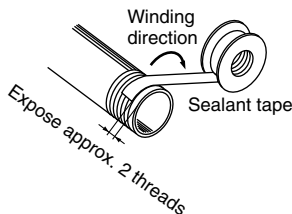
Actuators Precautions 3

Be sure to read this before handling products.

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 1.5 to 2 thread ridges exposed at the end of the threads.



Cushion

⚠ Caution

1. **Readjust using the cushion needle.**
Adjust the cushion needle on the cover when the product is put into service, based upon factors such as the size of the load and the operating speed. When the cushion needle is turned clockwise, the restriction becomes smaller and the cushion's effectiveness is increased. Tighten the lock nut securely after adjustment is performed.
2. **Do not operate with the cushion needle in a fully closed condition.**
This could tear the seal.

Lubrication

⚠ Warning

1. **Lubricating lube type cylinders**
Install a lubricator in the circuit, and use class 1 turbine oil (with no additives) ISO VG32. Do not use machine oil or spindle oil. If turbine oil is used, refer to the Safety Data Sheet (SDS) of the oil.
2. **Lubricating non-lube type cylinders**
These cylinders have been lubricated for life at the factory and can be used without any further lubrication. However, in the event that it is additionally lubricated, be sure to use class 1 turbine oil (with no additives) ISO VG32. Do not use machine oil or spindle oil. Stopping lubrication later on may lead to a malfunction because the new lubricant will displace the original lubricant. Therefore, lubrication must be continued once it has been started.
If turbine oil is used, refer to the corresponding Safety Data Sheet (SDS).

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 and allow the condensation to enter the compressed air lines. This causes 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.

⚠ 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 µm 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. **Ensure that the fluid and ambient temperatures are within the specified range.**
If the fluid temperature is 5°C or less, the moisture in the circuit could freeze, causing damage to the seals or equipment malfunction. Therefore, take appropriate measures to prevent freezing.
For compressed air quality, refer to the SMC Best Pneumatics No. 6 catalog.
5. **Precautionary measures against condensation**
Moisture condensation can occur inside pneumatic systems due to a drop in temperatures caused by the piping or operating conditions. This can degrade or wash away grease, resulting in a shortened service life or a malfunction.
For details, refer to the catalog "Precautionary measures against condensation in a pneumatic system" (CAT.P-E01-11).



Actuators Precautions 4

Be sure to read this before handling products.

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.**

Long machined parts made by machining plated carbon steel (end threads of piston rods, double-sided chamfer portions, tie rod threads, etc.) are not plated. Consider a made-to-order product (-XC6/-XC7) when using in an environment where rusting or corrosion will be a problem. Refer to each construction drawing for information on the materials of rotary actuators.

2. **Do not expose the product to direct sunlight for an extended period of time.**
3. **Do not use in a place subject to heavy vibration and/or shock.**
4. **Do not mount the product in locations where it is exposed to radiant heat.**
5. **Do not use in dusty locations or where water, oil, etc., splash on the equipment.**
Use the heavy duty scraper type (-XC4) in situations where there is a lot of dust. Use a water-resistant cylinder when there is splashing or spraying of a liquid.
6. **When using auto switches, do not operate in an environment with strong magnetic fields.**
7. **If a shock absorber is attached to an actuator, read the Specific Product Precautions for the shock absorber.**
8. **A decrease in the base oil of grease may be accelerated by the properties of the compressed air used in pneumatic equipment, the external environment, operating conditions, etc., and the resulting drop in lubricating performance may have an effect on the equipment's service life.**

Caution

1. **Internal lubricant or the base oil of grease may seep out of the cylinder depending on the operating conditions (an ambient temperature of 40°C or more, pressure retention, low-frequency actuation, etc.). Take great care when a clean environment is required.**

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. **Maintenance work**

If handled improperly, compressed air can be dangerous. Assembly, handling, repair, and element replacement of pneumatic systems should be performed by a knowledgeable and experienced person.

3. **Drain flushing**

Remove drainage from air filters regularly.

4. **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 pressure and electric power, and exhaust all compressed air from the system using the residual pressure release function.

When machinery is restarted, proceed with caution after confirming that appropriate measures are in place to prevent sudden movement.



Actuators Precautions 5

Be sure to read this before handling products.

For Air-hydro Type

Please read this page along with the Actuators Precautions.

Design/Selection

⚠ Warning

1. **Do not use an air-hydro cylinder near flames or in equipment or machinery that exceeds an ambient temperature of 60°C.**

There is a danger of causing a fire because the air-hydro cylinder uses a flammable hydraulic fluid.

Refer to the Safety Data Sheet (SDS) of the hydraulic fluid when supplying the fluid.

2. **Do not use the product in a clean room.**

⚠ Caution

1. **Select an air-hydro cylinder in combination with an air-hydro unit.**

Since the smooth operation of an air-hydro cylinder depends on its combination with an air-hydro unit, carefully select an appropriate air-hydro unit.

2. **Set the load of the air-hydro cylinder to be 50% or less of the theoretical force.**

For an air-hydro cylinder to obtain a level of constant speed and stopping accuracy similar to a hydraulic cylinder, it is necessary to keep the load at 50% or less of the theoretical output.

3. **Do not use in an environment, equipment, or machine that is not compatible with oil mist.**

Air-hydro cylinders generate oil mist during operation which may affect the environment.

4. **Be certain to install an exhaust cleaner on the directional control valve of the air-hydro cylinder.**

A very small amount of hydraulic fluid is discharged from the exhaust port of the air-hydro cylinder's directional control valve, which may contaminate the surrounding area.

5. **Install an air-hydro cylinder in locations where it can be serviced easily.**

Since the air-hydro cylinder requires maintenance, such as the refilling of hydraulic fluid and bleeding of air, ensure sufficient space for these activities.

Piping

⚠ Warning

1. **For air-hydro cylinder piping, use self-aligning fittings.**

Do not use One-touch fittings in the piping for an air-hydro cylinder because oil leakage may occur.

2. **For air-hydro cylinder piping, use hard nylon tubing or copper piping.**

As in the case of hydraulic circuits, surge pressures greater than the operating pressure may occur in an air-hydro cylinder's piping, making it necessary to use safer piping materials.

Lubrication

⚠ Warning

1. **Completely discharge the compressed air in the system before filling the air-hydro unit with hydraulic oil.**

Before supplying hydraulic fluid to the air-hydro unit, first confirm that safety measures are implemented to prevent the dropping of objects, the releasing of clamped objects, etc. Then, shut off the air supply and the equipment's electric power, and exhaust the compressed air in the system.

If the air-hydro unit's supply port is opened with compressed air still remaining in the system, there is a danger of hydraulic fluid being blown out.

Refer to the Safety Data Sheet (SDS) of the hydraulic fluid when supplying the fluid.

2. **Use petroleum hydraulic fluid which can be used as turbine oil.**

If non-flammable hydraulic fluid is used, it may cause problems.

The operating temperature range suitable for ISO VG32 is from 15 to 35°C. If a higher operating temperature range is required, select ISO VG46 (suitable for 25 to 45°C).

- * Refer to the SMC website for details about each manufacturer's brand name of class 1 turbine oil (no additives) ISO VG32. Additionally, please contact SMC for details about class 2 turbine oil (with additives) ISO VG32.

Maintenance

⚠ Caution

1. **Bleed air from the air-hydro cylinder on a regular basis.**

Since air may accumulate inside an air-hydro cylinder, bleed air from it, for example, before starting work. Bleed air from the bleeder valve provided on the air-hydro cylinder or the piping.

2. **Confirm the oil level of the air-hydro system on a regular basis.**

Since a very small amount of hydraulic fluid is discharged from the air-hydro cylinder and air-hydro unit circuit, the fluid will gradually decrease. Therefore, check the fluid regularly and refill as necessary.

The oil level can be checked with the level gauge in the air-hydro converter.



Auto Switches Precautions 1

Be sure to read this before handling products.

Design/Selection

There are many different kinds of cylinders, or actuators, including cylinders, air grippers, rotary actuators, and electrical actuators/cylinders.

Warning

1. Confirm the specifications.

If the product is used with excess load applied or beyond the specification range, this may cause the product to break or malfunction. We do not guarantee against any damage if the product is used outside of the specification range.

2. Use caution when using in an interlock circuit.

When an auto switch is used for an interlock signal requiring high reliability, devise a double interlock system to avoid problems by providing a mechanical protection function, or by using another switch (sensor) together with the auto switch. Also, perform periodic maintenance and confirm proper operation.

3. Do not attempt to disassemble, modify (including exchanging the printed circuit boards), or repair the product.

Doing so can result in injury or accident.

Caution

1. Pay attention to the length of time that a switch is ON at an intermediate stroke position.

When an auto switch is placed at an intermediate position of the stroke and a load is driven at the time the piston passes, the auto switch will operate, but the operating time will be short if the speed is too fast. As a result, the load may not operate completely. The maximum detectable piston speed is:

$$V \text{ (mm/s)} = \frac{\text{Auto switch operating range (mm)}}{\text{Time load applied (ms)}} \times 1000$$

In cases of high piston speed, the use of an auto switch (D-F5NT, F7NT, G5NT, M5NT, M5PT) with a built-in OFF delay timer (≈ 200 ms) makes it possible to extend the load operating time.

Please consult with SMC for information on other models.

2. Take precautions when multiple cylinders/actuators are used close together.

When multiple auto switch cylinders/actuators are used in close proximity, magnetic field interference may cause the auto switches to malfunction. Maintain a minimum cylinder separation of 40 mm. (When the allowable interval is specified for each cylinder series, use the indicated value.)

The auto switches may malfunction due to the interference from the magnetic fields.

Use of a magnetic screen plate (MU-S025) or commercially available magnetic screen tape can reduce the interference of magnetic forces.

3. Ensure sufficient clearance for maintenance activities.

When designing an application, be certain to allow sufficient clearance for maintenance and inspection.

Caution

4. Do not mount the cylinder or actuator with the auto switch on a footing.

If work personnel gets on or puts their foot on the footing accidentally, an excessive load is applied to the cylinder or actuator, causing the cylinder or actuator to break.

5. Design the circuit to prevent backflow in the event of short-circuit problems or when forced operation is performed to check the operation.

If backflow occurs, this may cause the switch to malfunction or break.

6. When multiple auto switches are required

"n" indicates the number of auto switches which can be physically mounted on a cylinder/actuator. Detection intervals depend on the auto switch mounting structure and set position, therefore some required intervals and set positions may not be available.

7. Limitations on detectable position

There are positions and surfaces (bottom surface of the foot bracket, etc.) where the auto switch cannot be mounted due to physical interference depending on the cylinder or actuator mounting status or mounting bracket. Select an appropriate auto switch setting position where the auto switch does not interfere with the cylinder or actuator mounting bracket (trunnion or reinforcing ring) after checking it sufficiently.



Auto Switches Precautions 2

Be sure to read this before handling products.

Mounting/Adjustment

Caution

1. Do not drop or bump.

Do not drop, bump, or apply excessive impact (300 m/s² or more for reed auto switches, 1000 m/s² or more for solid state auto switches) while handling the auto switch. It may cause the auto switch to break or malfunction.

2. Observe the proper tightening torque for mounting an auto switch.

When an auto switch is tightened beyond the range of tightening torque, auto switch mounting screws, auto switch mounting brackets, or the auto switch itself may be damaged. On the other hand, tightening below the range of tightening torque may allow the auto switch to slip out of position.

3. Do not carry a cylinder or actuator by the auto switch lead wires.

This may cause the disconnection of the lead wire or the internal element to break.

4. Do not use screws other than the set screws installed on the auto switch body to secure the auto switch.

If other screws are used, the auto switch may be damaged.

5. Mount an auto switch at the center of the operating range.

In the case of a 2-color indicator auto switch, mount it at the center of the green LED illuminating range. Adjust the mounting position of the auto switch so that the piston stops at the center of the operating range. (The mounting position shown in the catalog indicates the optimum position at stroke end.)

If mounted at the end of the operating range (around the borderline of ON and OFF), operation may be unstable depending on the operating environment. Also, there are some cylinders or actuators with specific setting methods for auto switches. If so, mount it in accordance with the indicated method.

Even if 2-color indicator solid state auto switches are secured within the proper operating range (the green light lights up), the operation may become unstable depending on the installation environment or magnetic field disturbance.

(Magnetic body, external magnetic field, installation near cylinders or actuators with built-in magnets, temperature change, other factors causing magnetic force fluctuation during operation, etc.)

6. Check the actual actuation status and adjust the auto switch mounting position.

According to the installation environment, the cylinder or actuator may not operate even at its proper mounting position. Even when setting at the middle of the stroke, check the actuation status and make adjustments accordingly.

7. Be very careful when handling the auto switch mounting band, as it has a thin structure.

Wiring

Caution

1. Confirm proper insulation of wiring.

If there is any improper insulation (mixed contact with other circuits, grounding faults, improper insulation between terminals, etc.) in the wiring, an over-current may flow in, causing the auto switch to break.

2. Wire separately from power lines or high-voltage lines, avoiding parallel wiring or wiring in the same conduit with these lines.

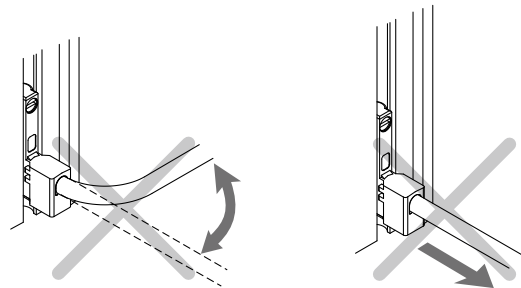
If an inrush current is generated, the noise may cause the auto switch to malfunction.

3. Avoid repeatedly bending or stretching lead wires.

Broken lead wires will result from repeatedly applying bending stress or stretching force to the lead wires.

Stress and tensile force applied to the connection between the lead wire and the auto switch increases the possibility of disconnection.

Keep the lead wire from moving, especially in the area where it connects with the auto switch.



4. Be certain to connect the load before power is applied.

<2-wire type>

If the power is turned ON when an auto switch is not connected to a load, the auto switch will be instantly damaged because of excess current (short circuit).

The same goes for when the 2-wire brown lead wire (+, output) is directly connected to the (+) power supply terminal.

5. Perform wiring only after shutting down the power.

If wiring is performed with the power turned ON, this may cause electric shock, malfunction, or damage to the auto switch.



Auto Switches Precautions 3

Be sure to read this before handling products.

Operating Environment

⚠ Warning

1. Never use in an atmosphere containing explosive gases.

Auto switches are not designed to prevent explosion. This may cause an explosion hazard.
Please contact SMC concerning ATEX compliant products.

⚠ Caution

1. Do not use in an area where a magnetic field is generated.

Auto switches will malfunction or magnets inside cylinders/actuators will become demagnetized. (Please consult with SMC to see if a magnetic field resistant auto switch can be used.)

2. Do not use in an environment where the auto switch will be continually exposed to water.

Although auto switches satisfy IEC Standard IP67 construction, with the exception of some models (D-A3□, A44□, G39□, K39□, RNK, RPK), do not use auto switches in applications where they will be continually exposed to water splash or spray. This may cause improper insulation or malfunction.

3. Do not use in an environment with oil or chemicals.

If auto switches are used in an environment containing coolant, cleaning solvent, various oils, or chemicals, even for a short period of time, this may adversely affect the auto switches, resulting in improper insulation, malfunction due to the swelling of potting resin, or hardening of the lead wires.

4. Do not use in an environment with temperature cycles.

If temperature cycles other than normal temperature changes are applied, this may adversely affect the insides of the auto switches.

5. Avoid the accumulation of iron waste or close contact with magnetic substances.

If too many iron particles, such as cutting chips or spatters, accumulate around a cylinder or actuator with auto switches, or if a magnetic substance (attracted by a magnet) is put close to a cylinder or actuator with auto switches, the magnetic force inside the cylinder or actuator may weaken, causing the auto switch to malfunction.

6. Please contact SMC concerning water resistance, elasticity of lead wires, usage at welding sites, etc.

7. Do not use in direct sunlight.

8. Do not mount the product in locations where it is exposed to radiant heat.

9. Take appropriate measures against lightning surges on the equipment side, as the auto switches do not have any lightning surge resistance specified in the CE marking.

Maintenance

⚠ Warning

1. Removal of equipment, and supply/exhaust of compressed air

Before any machinery or equipment is removed, first ensure that the appropriate measures are in place to prevent workpieces from dropping, run-away equipment, etc. Then, cut off the electric power and reduce the pressure in the system to zero. Only then should you proceed with the removal of any machinery or equipment.

When machinery is restarted, proceed with caution after confirming that appropriate measures are in place to prevent sudden movement.

2. Do not touch a terminal during energizing.

Touching a terminal during energizing may cause electric shock, malfunction, or auto switch breakage.

⚠ Caution

1. Perform the following maintenance and inspection periodically in order to prevent possible danger due to unexpected auto switch malfunction.

1) Secure and tighten auto switch mounting screws.

If screws become loose or the mounting position is dislocated, retighten them after readjusting the mounting position.

2) Confirm that there is no damage to the lead wires.

To prevent faulty insulation, replace auto switches or repair lead wires if damage is discovered.

3) Confirm the detection setting position.

• Red light on 1-color indicator auto switch

Confirm that the set position stops at the center of the operating range (red indication area).

• Confirm the green light and position of the 2-color indicator auto switch.

Confirm that the set position stops at the center of the appropriate operating range (green indication area). If stopped with the red LED lit, the operation may become unstable due to effects of the equipment environment or external disturbance. So, set the mounting position at the center of the appropriate operating range again.

Some cylinders or actuators indicate a specific setting procedure for the auto switch. If so, set the mounting position according to the specific setting procedure.

2. Do not use solvents, such as benzene, thinner, etc., to clean the product.

They could damage the surface of the body and erase the markings on the body. For heavy stains, use a cloth lightly dampened with diluted neutral detergent, then wipe up any residue with a dry cloth.



Solid State Auto Switches Precautions

Be sure to read this before handling products.

Design/Selection

Caution

1. Keep wiring as short as possible.

Be sure to use a wire length of 100 m or less.

When a long wire is required, we recommend attaching ferrite cores to both ends of the cable to prevent excess noise. A contact protection box is not necessary for solid state auto switches due to the nature of this product's construction.

2. Do not use a load that generates surge voltage.

If driving a load, such as a relay, that generates a surge voltage, use a built-in surge-absorbing element type device.

3. Pay attention to the internal voltage drop of the auto switch.

Generally, the internal voltage drop of the solid state auto switch is larger than that of the reed auto switch. When the auto switches ("n" pcs.) are connected in series, the voltage drop is multiplied by "n". In this case, even if the auto switches operate correctly, the loads may not operate. Additionally, note that the 12 VDC relay does not apply to the auto switch.

4. Pay attention to leakage current.

<2-wire type>

Current (leakage current) flows to the load to operate the internal circuit when in the OFF state.

Operating current of load (OFF condition) > Leakage current

If the criteria given in the above formula are not met, it will not reset correctly (stays ON). Use a 3-wire auto switch if this specification can not be satisfied.

Moreover, leakage current flow to the load will be "n" times larger when "n" auto switches are connected in parallel.

5. Output operation of the solid state auto switch is not stable for 50 [ms] after being powered ON.

In the output operation immediately after being powered ON or when using an AND connection operation, the input device (PLC, relay, etc.) may judge the ON position as OFF output or the OFF position as ON output. So, please set the equipment so that the input judgement signal is disabled for 50 [ms] immediately after being powered ON or when using an AND connection. When using SMC's AHC System (Auto Hand Changing System) MA Series, please also adjust this setting.

Wiring

Caution

1. Do not allow the short-circuit of loads.

All models of D-J51, and PNP output type auto switches do not have built-in short-circuit protection circuits.

Handle carefully as the auto switch may be damaged.

Wiring

Caution

2. Avoid incorrect wiring.

1) If connections are reversed on a 2-wire type auto switch, the auto switch will not be damaged if protected by a protection circuit, but the auto switch will remain in an ON state. However, it is still necessary to avoid reversed connections, since the auto switch could be damaged by a load short-circuit in this condition.

2) If connections are reversed (power supply line + and power supply line -) on a 3-wire type auto switch, the auto switch will be protected by a protection circuit. However, if the power supply line (+) is connected to the blue wire and the power supply line (-) is connected to the black wire, the auto switch will be damaged.

3. Do not disconnect the cable between the sensor and amplifier of the heat resistant 2-color indicator solid state auto switch.

Even when the sensor and amplifier are connected again, a contact resistance is produced, causing the auto switch to malfunction. Additionally, the sensor and amplifier are paired and they do not operate correctly in different combinations.

Operating Environment

Caution

1. Do not use in an area where surges are generated.

If there is an equipment unit (electromagnetic lifter, high-frequency induction furnace, motor, radio, etc.) that generates large surges or electromagnetic waves around cylinders or actuators with solid state auto switches, this may cause the circuit element inside the auto switch to break.

2. The AC magnetic field resistant solid state auto switch has no immunity against DC magnetic fields.

So it is not suitable for use in applications where welding takes place using a DC inverter/rectified source. If using in conjunction with a DC welding application, use it at a distance from the conductor, as with ordinary switches.

Approximate required distance from conductor to prevent malfunction (10,000 A: 30 cm or more)

Additionally, as for the effects of magnetization and demagnetization, in areas exceeding 10,000 A, detection performance may occasionally become unstable due to the demagnetization of the detection magnet (weakening of magnetic field) or the magnetization (temporary magnetization) of materials around the cylinders and actuators.

If green and red indicators are not lit or if multi-point operation occurs, contact SMC.



Reed Auto Switches Precautions

Be sure to read this before handling products.

Design/Selection

⚠ Caution

1. Keep wiring as short as possible.

As the length of the wiring to a load gets longer, the rush current when switching ON becomes greater, and this may shorten the product's life. (The switch will stay ON all the time.)

- 1) For an auto switch without contact protection circuit, use a contact protection box when the wire length is 5 m or longer.
- 2) Even if an auto switch has a built-in contact protection circuit, when the wiring is more than 30 m long, it is not able to adequately absorb the rush current and its life may be reduced. It is again necessary to connect a contact protection box in order to extend its life. Please consult with SMC in this case.

2. Do not use a load that generates surge voltage.

If a surge voltage is generated, the discharge occurs at the point of contact, possibly resulting in the shortening of the product's life.

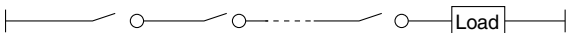
If driving a load, such as a relay, that generates a surge voltage, use an auto switch with a built-in contact protection circuit or use a contact protection box.

3. Pay attention to the internal voltage drop of the auto switch.

- 1) Auto switch with an indicator light (Exceptions: D-A56, A76H, A96, A96V, C76, E76A, Z76)

- If auto switches are connected in series as shown below, take note that there will be a large voltage drop because of internal resistance in the light emitting diodes. (Refer to the internal voltage drop in the auto switch specifications.) [The voltage drop will be "n" times larger when "n" auto switches are connected.]

Even if the auto switch operates normally, the load may not operate.



- In the same way, when operating under a specified voltage, even if the auto switch operates normally, the load may not operate. Therefore, the formula below should be satisfied after confirming the minimum operating voltage of the load.

$$\text{Supply voltage} - \text{Internal voltage drop of auto switch} > \text{Minimum operating voltage of load}$$

- 2) If the internal resistance of a light emitting diode causes a problem, select an auto switch without an indicator light (D-A6□, A80, A80H, A90, A90V, C80, R80, 90, 90A, E80A, Z80).

Wiring

⚠ Caution

1. Do not allow the short-circuit of loads.

If the power is turned ON with a load in a short-circuited condition, the auto switch will be instantly damaged because of excess current flow into the switch.

2. Avoid incorrect wiring.

A 24 VDC auto switch with indicator light has polarity. The brown lead wire, or terminal No. 1, is (+), and the blue lead wire, or terminal No. 2, is (–).

[For D-97, (+) is on the non-display side, and (–) is on the black line side.]

- 1) If connections are reversed, the auto switch will operate, but the light emitting diode will not light up.

Also, take note that a current greater than that specified will damage a light emitting diode and it will no longer operate.

Applicable models:

D-A73, A73H, A73C, A93, A93V, A53, A54, B53, B54, C73, C73C, E73A, Z73

D-R73, R73C, 97, 93A, A33, A34, A33A, A34A, A44, A44A

- 2) When using a 2-color indicator type auto switch (D-A79W, A59W, and B59W), the auto switch will constantly remain ON if the connections are reversed.

Operating Environment

⚠ Caution

1. Do not use in an environment where there is excessive impact shock.

When excessive impact (300 m/s² or more) is applied to a reed auto switch during operation, the contact point will malfunction and generate or cut off the signal momentarily (1 ms or less). If further excessive impact is applied, the reed auto switch may break. Depending on the environment, a solid state auto switch may be required. Please consult with SMC for details.

Handling Precautions

⚠ Caution

1. The protective cover supplied with the product (D-A9□, A9□V, Z7□, or Z80) when it is shipped from the factory is intended to absorb the impact generated by handling and prevent the auto switch holding screw from falling out. Do not remove this cover until immediately before installing the auto switch on the cylinder or actuator.

Prior to Use

Auto Switches Common Specifications 1

Refer to the Auto Switch Precautions on pages 15 to 19 before using auto switches.

Auto Switches Common Specifications

Type	Reed auto switch	Solid state auto switch
Leakage current	None	3-wire: 100 μ A or less, 2-wire: 0.8 mA or less
Operating time	1.2 ms	1 ms or less *3
Impact resistance	300 m/s ²	1000 m/s ² *4
Insulation resistance	50 M Ω or more (500 VDC measured via megohmmeter) (Between lead wire and case)	
Withstand voltage	1500 VAC for 1 minute *1 (Between lead wire and case)	1000 VAC for 1 minute (Between lead wire and case)
Ambient temperature	-10 to 60°C	
Enclosure	IEC60529 Standard IP67 *2	

- *1 Electrical entry: Connector type (A73C/A80C/C73C/C80C): 1000 VAC/min.
(Between lead wire and case)
- *2 The terminal conduit type (D-A3/A3□A/A3□C/G39/G39A/G39C/K39/K39A/K39C), DIN terminal type (D-A44/A44A/A44C), and heat-resistant auto switch (D-F7NJ) are IEC60529 Standard IP63 compliant.
The trimmer type amplifier section (D-R□K) is compliant with IP40.
- *3 Excludes solid state auto switches with a timer (D-M5□T/G5NT/F7NT/F5NT types) and the magnetic field resistant 2-color indicator solid state auto switch (D-P3DW□/P4DW)
The operating time for the D-J51 is 2 ms or less and is 40 ms or less for the D-P3DW□/P4DW.
- *4 980 m/s² for the trimmer type sensor section, 98 m/s² for the amplifier section

Lead Wire

Lead wire length indication

(Example)

D-M9BW L

Auto switch
model

Lead wire length

Symbol	Length	Tolerance	Connector specifications	Solid state	Reed
Nil	0.5 m	±15 mm		●	●
M	1 m	±30 mm		●*2	●*2
L	3 m	±90 mm		●	●
Z	5 m	±150 mm		●	●*3
N *1	None	—		●	●
SAPC	0.5 m	±15 mm	M8-3 pin	○	—
MAPC	1 m	±30 mm	Plug connector	○	—
SBPC	0.5 m	±15 mm	M8-4 pin	○	—
MBPC	1 m	±30 mm	Plug connector	○	—
SDPC	0.5 m	±15 mm	M12-4 pin A code (Normal key) Plug connector	○	—
MDPC	1 m	±30 mm		○	—
LDPC	3 m	±90 mm		○	—

●: Standard ○: Produced upon receipt of order (Standard)

- *1 Applicable to the connector type (D-□□C) only
- *2 Applicable to the D-M9□(V), D-M9□W(V), D-M9□A(V), and D-A93 only
- *3 Applicable to the D-B53/B54, D-C73(C)/C80C, D-A93(V), D-A73(C)/A80C, D-A53/A54, D-Z73, and D-90/97/90A/93A only
- *4 For reed auto switches M8 and M12 type with connector, please contact SMC.
- *5 The standard lead wire length of the trimmer auto switch is 3 m.
- *6 The standard lead wire length of the solid state auto switch with a timer (with the exception of the D-P3DW and D-M9□A(V)□), water-resistant 2-color indicator solid state auto switch, wide range detection auto switch, heat-resistant 2-color indicator solid state auto switch, and strong magnetic field resistant 2-color indicator solid state auto switch is 3 m or 5 m. (Product with a lead wire length of 0.5 m is not available.)

Lead wires with a connector indication

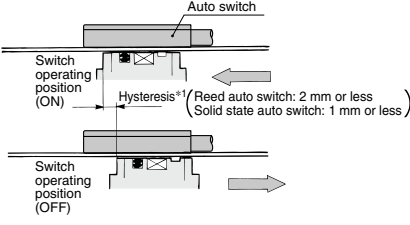
Part No. of Lead Wires with Connectors
(Applicable only for connector type)

Model	Lead wire length
D-LC05	0.5 m
D-LC30	3 m
D-LC50	5 m

Prior to Use

Auto Switches Common Specifications 2

Refer to the Auto Switch Precautions on pages 15 to 19 before using auto switches.

Term	Meaning
Hysteresis	 A deviation amount between the ON position and OFF position caused by auto switch characteristics (difference in sensitivity between ON and OFF). When the switch is turned ON once and the switch (or piston) is moved in the opposite direction, a symptom occurs that causes the switch's OFF position to deviate to a position where it is further returned from the ON position. This deviation amount is called "hysteresis." *1 Hysteresis may fluctuate due to the operating environment. Please contact SMC if hysteresis causes an operational problem.
Most sensitive position	A position (sensor layout position) where the sensitivity on the detection surface of the auto switch enclosure is highest. When the center of the magnet is aligned with this position, it is basically at the center of the operating range and stable operation can be obtained.
Programmable Logic Controller (PLC)	One of the elements that makes up the sequence control. The PLC is designed so that it can receive signals, such as the auto switch output signal, and output them to other devices in order to perform the electrical control according to the preset program.
Operating temperature range	A temperature range in which the auto switch can be used. If significant temperature change or freezing occurs even within this temperature range, it may cause the auto switch to malfunction.
Operating voltage	A voltage at which the auto switch can be used. The operating voltage is indicated using generally used voltages (24 VDC, 100 VAC, etc.). For the 2-wire type, the operating voltage has the same meaning as the power supply voltage or load voltage.
Operating current range	A range of the current value that can be flowed to the output of the auto switch. If the operating current is lower than this range, the auto switch may not operate correctly. Conversely, if the operating current is higher than this range, the auto switch may break.
Current consumption	This current value is necessary for the 3-wire type auto switch to operate the circuit through the power cable. For the 2-wire type, as the current consumption is a part of the load current, it is not defined.
Insulation resistance	A resistance between the electric circuit and enclosure. Unless otherwise specified, 50 MΩ (Min) is used for auto switches.
Magnetic field resistant auto switch	An auto switch with protection against the effects of external (welding) magnetic fields generated in the spot welding process, etc. The solid state auto switch is able to function as it detects the frequency of the applied magnetic field. If an external magnetic field (AC) is applied, the last signal is retained and the product remains unaffected by the external magnetic field. This system can be used with cylinders with normal magnetic force. The reed auto switch features a built-in magnetic field shielded sensor with low sensitivity that reduces the effects of external magnetic fields (DC or AC magnetic fields). Therefore, a dedicated cylinder with a strong built-in magnet needs to be selected, and the operable range (conditions) need to be considered.
Impact resistance value	A minimum acceleration that may cause the auto switch to malfunction or break when the standard impact is applied.
Water-resistant auto switch	In contrast with the general (general purpose) product, structural measures have been taken in order to provide this model with long-term water resistance.
Withstand voltage	A tolerated dose of voltage that can be applied to the portion between the electrical circuit and enclosure. The withstand voltage shows the strength level of the product against the voltage. If a voltage exceeding the withstand voltage is applied, it may cause the product to break. (The voltage described here is different from the power supply voltage necessary to operate the product.)
Proper mounting position	A dimension that shows the mounting position when the position is detected at the stroke end of the cylinder. When this position is set, the maximum sensitivity position is aligned with the center of the magnet. However, make the necessary adjustments to the actual machine by considering the characteristic differences of the actual setting. When an adjustment allowance is needed for the detection before the stroke, set a value with an adjustment allowance added to the proper mounting position.
Applicable load	A device that is assumed as a target load of the auto switch.
Operating time	A period of time until the auto switch output becomes stable after the magnetic force to operate the auto switch has been received.
Operating range	An auto switch operating range in response to the cylinder piston movement (ON length in response to the stroke). The operating range is determined by the magnetic force of the magnet (range in which the magnetic force acts) and switch sensitivity. So, the operating range may vary as these conditions can change according to the ambient environment, etc. The operating range in the standard status (normal temperature, single cylinder, magnetic force, sensitivity, etc.) is described in the catalog.

Prior to Use

Auto Switches Common Specifications 3

Refer to the Auto Switch Precautions on pages 15 to 19 before using auto switches.

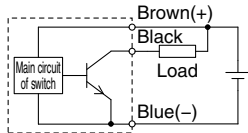
Term	Meaning																																
Minimum stroke for auto switch mounting	A minimum stroke value of the auto switch that can be mounted on the cylinder. The minimum stroke is determined by the specification limit (auto switch operation, position setting ability, etc.) and physical limit (mechanical interference associated with the auto switch mounting). Note that the catalog shows the value assuming that the position detection is performed at the stroke end and that this value does not consider the adjustment allowance. When an adjustment allowance is needed, such as for detection before the stroke, set the value so that this adjustment allowance is added to the minimum stroke.																																
Internal voltage drop	A voltage that is applied to the portion between the COM and signal line when the auto switch is ON. As only the value of the power supply voltage subtracted by the internal voltage drop is applied to the input side of the PLC, a detection fault (incorrect input) may occur if this value is lower than the minimum operating voltage. So, take great care when selecting a device.																																
2-color indicator	As the end part of the auto switch operating range (boundary between ON and OFF) is an area that is susceptible to external disturbances or stroke changes during cylinder operation, this function is intended to quickly and properly make the setting at the center of the operating range where stable operation can be obtained by changing the operation indication color of the auto switch.																																
Load	A device that is connected to the output of the auto switch in order to do any work is called a "load." For example, the load may be a relay, PLC, etc. To check the operation of the auto switch, a device equivalent to a load (such as a resistor, etc.) must be connected.																																
Load current	A current that flows to the load when the ON-OFF output is ON.																																
Enclosure	A class of protection against the entry of water or solids for electrical machinery and apparatus as specified in the IEC60529 Standard. IP— • Second characteristic numeral • First characteristic numeral ● First Characteristic: Degree of protection against solid foreign objects <table border="1"> <tr><td>0</td><td>Non-protected</td></tr> <tr><td>1</td><td>Protected against solid foreign objects of 50 mm ø and greater</td></tr> <tr><td>2</td><td>Protected against solid foreign objects of 12 mm ø and greater</td></tr> <tr><td>3</td><td>Protected against solid foreign objects of 2.5 mm ø and greater</td></tr> <tr><td>4</td><td>Protected against solid foreign objects of 1.0 mm ø and greater</td></tr> <tr><td>5</td><td>Dust-protected</td></tr> <tr><td>6</td><td>Dust-tight</td></tr> </table> ● Second Characteristic: Degree of protection against water <table border="1"> <tr><td>0</td><td>Non-protected</td></tr> <tr><td>1</td><td>Protected against vertically falling water drops</td></tr> <tr><td>2</td><td>Protected against vertically falling water drops when enclosure is tilted 15°</td></tr> <tr><td>3</td><td>Protected against rainfall when enclosure is tilted up to 60°</td></tr> <tr><td>4</td><td>Protected against splashing water</td></tr> <tr><td>5</td><td>Protected against water jets</td></tr> <tr><td>6</td><td>Protected against powerful water jets</td></tr> <tr><td>7</td><td>Protected against the effects of temporary immersion in water</td></tr> <tr><td>8</td><td>Protected against the effects of continuous immersion in water</td></tr> </table> Example) In the case of products stipulated as IP65, we can know the degree of protection is dust-tight and water jetproof on the grounds that the first characteristic numeral is 6 and the second characteristic numeral is 5. Therefore, we can assume it will not be adversely affected by direct water jets from any direction.	0	Non-protected	1	Protected against solid foreign objects of 50 mm ø and greater	2	Protected against solid foreign objects of 12 mm ø and greater	3	Protected against solid foreign objects of 2.5 mm ø and greater	4	Protected against solid foreign objects of 1.0 mm ø and greater	5	Dust-protected	6	Dust-tight	0	Non-protected	1	Protected against vertically falling water drops	2	Protected against vertically falling water drops when enclosure is tilted 15°	3	Protected against rainfall when enclosure is tilted up to 60°	4	Protected against splashing water	5	Protected against water jets	6	Protected against powerful water jets	7	Protected against the effects of temporary immersion in water	8	Protected against the effects of continuous immersion in water
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5	Protected against water jets																																
6	Protected against powerful water jets																																
7	Protected against the effects of temporary immersion in water																																
8	Protected against the effects of continuous immersion in water																																
Solid state auto switch	A switch that uses an MR element to detect magnetic fields and possesses an internal judgement circuit that is able to output an ON/OFF signal like a transistor regardless of mechanical contact or non-contact (such as when there is no point of contact).																																
Leak current	A current that flows to operate the internal circuit when the ON-OFF output is OFF. In particular, if the leak current exceeds the detection current in the 2-wire type auto switch or PLC, it may cause a reset failure. So, take great care when selecting a device.																																
Reed auto switch	A switch that uses a reed switch to detect magnetic fields and output an ON/OFF signal when there is mechanical contact or non-contact (when there is a point of contact, such as with a relay or limit switch).																																
Induction load	A load that has a coil. The connection target of the auto switch is a relay.																																
Recommended lead wire bending radius	A minimum bending radius (reference value) of the lead wire when the lead wire is secured and constructed (oscillation or rotation is not considered). (As the temperature and current value conforms to the auto switch specifications, this lead wire bending radius differs from the value disclosed by the electric wire manufacturer.)																																
Electrical entry	A structure in which the lead wire of the auto switch is taken out in the horizontal direction when the cylinder is laid out horizontally (cylinder rod is horizontal) is called an "in-line entry." A structure in which the lead wire is taken out in a direction perpendicular to the cylinder axis center is called a "perpendicular entry."																																

Prior to Use

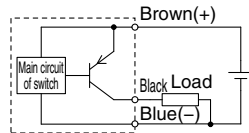
Auto Switches/Internal Circuits

Solid State Auto Switches

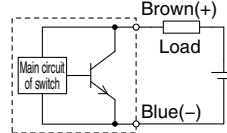
Solid state 3-wire, NPN



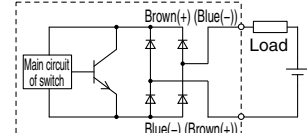
Solid state 3-wire, PNP



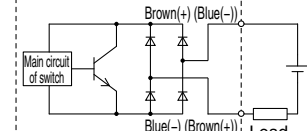
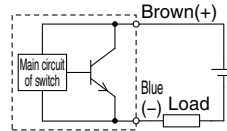
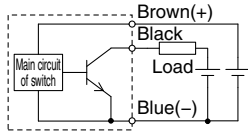
Solid state 2-wire



Solid state 2-wire, Non-polar type



(Power supply for switch and load are separate)



Reed Auto Switches

No.	①	②	③	④
Circuit diagram	2-wire (Reed switch)	2-wire (Reed switch)	2-wire (Reed switch)	2-wire (Reed switch)
No.	⑤	⑥	⑦	
Circuit diagram	3-wire (Reed switch, NPN)	2-wire (Reed switch)	2-wire (Reed switch)	

Contact Protection Box/CD-P11, CD-P12

<Applicable switch models>

D-A7/A8, D-A7□H/A80H, D-A73C, A80C, D-C7/C8, D-C73C/C80C, D-E7□A, E80A, D-Z7/Z8, D-9/9□A, D-A9/A9□V, D-A79W

The auto switches above do not have a built-in contact protection circuit.

A contact protection box is not required for solid state auto switches due to their construction.

1. Where the operation load is an inductive load

2. Where the wiring length to the load is 5 m or more

3. Where the load voltage is 100/200 VAC

Use a contact protection box with the switch for any of the above cases.

The contact life may be shortened (due to permanent energizing conditions).

D-A72(H) must be used with the contact protection box regardless of load types and lead wire length since it is greatly affected by loads.

(Where the load voltage is 110 VAC)

When the load voltage is increased by more than 10% of the rating of the applicable auto switches (Exceptions: D-A73C/A80C/C73C/C80C/90/97/A79W) above, use a contact protection box (CD-P11) to reduce the upper limit of the load current by 10% so that it can be set within the range of the load current range, 110 VAC.

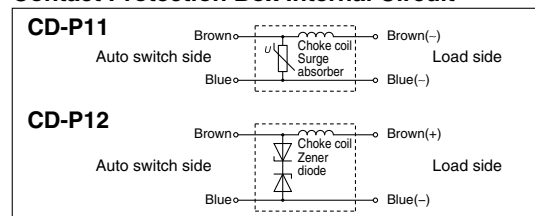
Even for the built-in contact protection circuit type (D-A34[A][C], D-A44[A][C], D-A54/A64, D-A59W, D-B59W), use the contact protection box when the wiring length to the load is very long (30 m or more) and when a PLC (Programmable Logic Controller) with a large inrush current is used.

Contact Protection Box Specifications

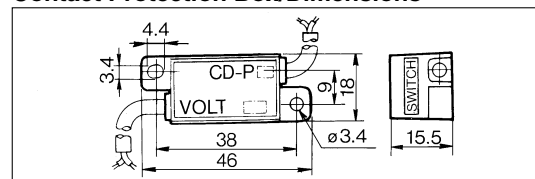
Part no.	CD-P11	CD-P12
Load voltage	100 VAC or less	200 VAC 24 VDC
Max. load current	25 mA	12.5 mA 50 mA

* Lead wire length — Auto switch connection side 0.5 m
Load connection side 0.5 m

Contact Protection Box Internal Circuit

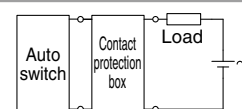


Contact Protection Box/Dimensions



Contact Protection Box Connection

To connect a switch unit to a contact protection box, connect the lead wire from the side of the contact protection box marked SWITCH to the lead wire coming out of the switch unit. Keep the switch as close as possible to the contact protection box, with a lead wire length of no more than 1 meter.

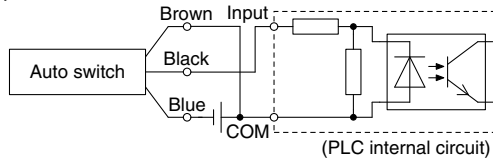


Prior to Use

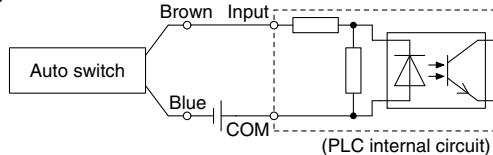
Auto Switch Connections and Examples

Sink Input Specifications

3-wire, NPN

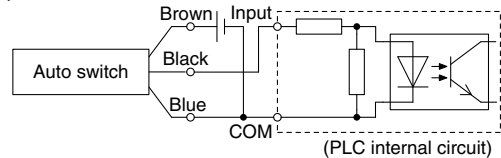


2-wire

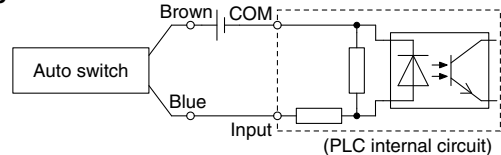


Source Input Specifications

3-wire, PNP



2-wire



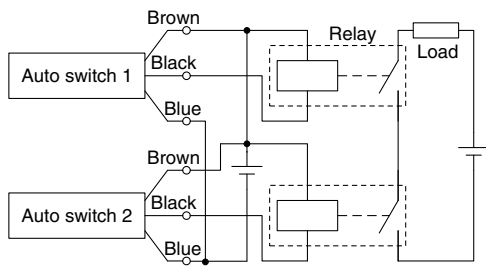
Connect according to the applicable PLC input specifications, as the connection method will vary depending on the PLC input specifications.

Examples of AND (Series) and OR (Parallel) Connections

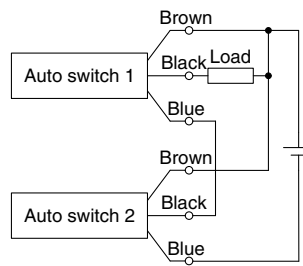
* When using solid state auto switches, ensure the application is set up so the signals for the first 50 ms are invalid. Depending on the operating environment, the product may not operate properly.

3-wire AND connection for NPN output

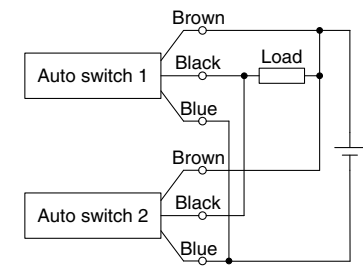
(Using relays)



(Performed with auto switches only)

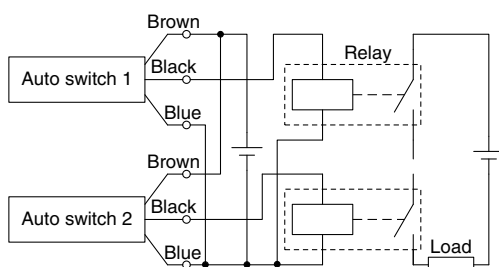


3-wire OR connection for NPN output

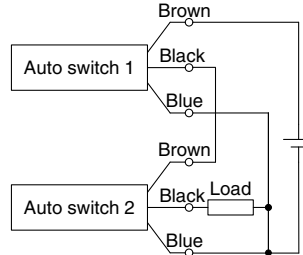


3-wire AND connection for PNP output

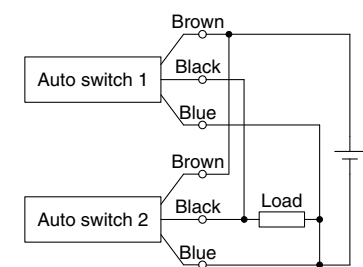
(Using relays)



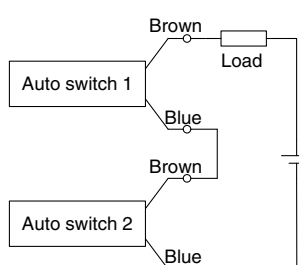
(Performed with auto switches only)



3-wire OR connection for PNP output



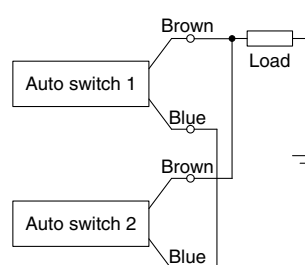
2-wire AND connection



When two auto switches are connected in series, a load may malfunction because the load voltage will decline when in the ON state. The indicator lights will light up when both of the auto switches are in the ON state. Auto switches with a load voltage less than 20 V cannot be used.

Example) Load voltage at ON
Power supply voltage: 24 VDC
Internal voltage drop: 4 V
Load voltage at ON = Power supply voltage –
Internal voltage drop x 2 pcs.
= 24 V x 4 V x 2 pcs.
= 16 V

2-wire OR connection



Example) Load voltage at OFF
Leakage current: 1 mA
Load impedance: 3 kΩ
Load voltage at OFF = Leakage current x 2 pcs. x
Load impedance
= 1 mA x 2 pcs. X 3 kΩ
= 6 V

(Solid state)
When two auto switches are connected in parallel, malfunction may occur because the load voltage will increase when in the OFF state.

(Reed)
Because there is no current leakage, the load voltage will not increase when turned OFF. However, depending on the number of auto switches in the ON state, the indicator lights may sometimes grow dim or not light up, due to the dispersion and reduction of the current flowing to the auto switches.



Rotary Actuators 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. If the operation involves load fluctuations, ascending/descending movements, or changes in frictional resistance, make sure to provide safety measures.

Operating speed will increase, and bodily injury or damage to the machinery itself may occur.

3. If there is a chance that the product will pose a hazard to humans, install a protective cover.

If the moving portion of the product will pose a hazard to humans or will damage machinery or equipment, provide a construction that prevents direct contact with those areas.

4. Be certain that the secured portions will not loosen.

Be certain to adopt a reliable connecting method if the rotary actuator is used very frequently or if it is used in a location that is exposed to a large amount of vibration.

5. There may be cases in which a speed-reduction circuit or a shock absorber is required.

If the driven object moves at high speeds or is heavy, it will be unfeasible for only the rotary actuator's cushion to absorb the shock. Therefore, provide a speed-reduction circuit to reduce the rotary actuator's speed before the thrust is applied to the cushion, or an external shock absorber to dampen the shock. If these countermeasures are taken, make sure to take the rigidity of the machinery and equipment into consideration.

6. Consider the possibility of a reduction in the circuit air pressure caused by a power failure.

When an actuator is used as a clamping mechanism, there is a danger of a workpiece dropping if there is a decrease in clamping force due to a drop in circuit pressure caused by a power failure. Therefore, safety equipment should be installed to prevent damage to machinery/equipment and bodily injury.

7. Consider the possibility of power source related malfunctions.

For machinery and equipment that rely on power sources such as compressed air, electricity, or hydraulic pressure, adopt a countermeasure to prevent the equipment from causing a hazard to humans or damage to the machinery and equipment in the event of a malfunction.

8. If a speed controller is provided in the exhaust restrictor, implement a safety design taking the residual pressure into consideration.

If air pressure is applied to the air supply side without residual pressure in the exhaust side, the rotary actuator will operate at an abnormally high speed, which could pose a hazard to humans or damage the machinery and equipment.

9. Consider the behavior of the rotary actuator in the event of an emergency stop.

Devise a safe system so that if a person engages the emergency stop, or if a safety device is tripped during a system malfunction, such as a power failure, the movement of the rotary actuator will not cause a hazard to humans or damage the equipment.

10. Consider the action of the rotary actuator when restarting after an emergency stop.

Devise a safe design so that the restarting of the rotary actuator will not pose a hazard to humans or damage the equipment. Install manually controlled equipment for safety when the actuator has to be reset to the starting position.

11. Do not use the product as a shock absorber.

If abnormal pressure or an air leakage occurs, the rotary actuator's speed reduction capability could become severely affected, which could pose a hazard to humans or damage the machinery and equipment.

12. Select a speed within the product's allowable energy value.

If the product's kinetic energy of the load exceeds the allowable value, it could damage the product (damage to the shaft, gear, etc.), cause a hazard to humans, or damage the machinery and equipment.

13. Provide a shock absorber if the kinetic energy that is applied to the product exceeds the allowable value.

If the product's kinetic energy exceeds the allowable value, it could damage the product (damage to the shaft, gear, etc.), cause a hazard to humans, or damage the machinery and equipment.

14. Do not stop or hold the product at midpoint by keeping air pressure in the product. (Air balancers, etc.)

For a product lacking an external stopping mechanism, if the directional control valve is closed to keep the air pressure in the product in an attempt to stop the product at midpoint, it might not be possible to maintain that stopped position due to an air leakage. As a result, it could pose a hazard to humans or cause damage to machinery and equipment.

15. Give consideration to the decline in strength caused by changes in the shaft shape.

Some shaft types, such as simple specials, may have shapes and dimensions that result in decreased strength when compared with standard models. Consider this carefully when using.

16. Do not use two or more rotary actuators with the aim of synchronized movement.

One of the actuators may bear the entire load of the operation, making synchronized movement impossible, and possibly leading to the deformation of the equipment.

17. Do not use in a location where adverse effects could result from the oozing of lubricant to the exterior.

The lubricant coating the interior of the product may leak to the outside of the product from the areas where the product connects to the rotary shaft, body cover, etc.

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

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

19. Refer to the Auto Switches Precautions (pages 15 to 19) for using with an auto switch.



Rotary Actuators Precautions 2

Be sure to read this before handling products.

Design/Selection

⚠ Caution

1. Do not use below the speed adjustment range specified for the product.

If the product is used below the specified speed adjustment range, it could cause the product to stick, slip, or the movement to stop.

2. Do not apply an external torque to the product that exceeds the rated output.

If an external force that exceeds the product's rated output is applied to the product, it could damage the product.

3. The holding torque of the rotating end of the double piston type

If the internal piston of a double piston product comes in contact with the angle adjustment screw or the cover and stops, the holding torque at the rotating end is one half of the actual output.

4. If it is necessary to provide repeatability of the rotation angle, directly stop the load externally.

Even with a product that is equipped with an angle adjuster, there are times in which the initial rotation angle could change.

5. Do not use under hydraulic pressure.

The product will be damaged if it is used by applying hydraulic pressure.

6. There is a possibility of backlash being generated when stopping the double piston type in the middle with a valve of the closed center type.

7. For the vane type product, if it is necessary to ensure a rotation angle, make sure to use a minimum pressure of 0.3 MPa.

8. Do not use the made-to-order -XC30 at low speeds.

Although fluorine grease is used, it is not designed for low-speed applications.

For information on fluorine grease, refer to the Safety Data Sheet (SDS).

9. Do not use in places where there are many temperature fluctuations. When using in lower temperature applications, use caution so that frost does not occur inside the cylinder or the piston rod.

Operation may be unstable.

10. Adjust the speed control in the environment in which it will be used in.

Speed adjustments may deviate if the environment changes.

Mounting

⚠ Warning

1. Operation manual

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

Mounting

⚠ Warning

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. Before adjusting the angle by supplying air pressure, take appropriate measures to prevent the equipment from rotating unnecessarily.

When an adjustment is performed under air pressure, the equipment could rotate and fall during the adjustment depending on the mounted placement of the equipment. As a result, it could pose a hazard to humans or damage the machinery and equipment.

5. Do not loosen the angle adjustment screw beyond the allowable adjustment range.

The angle adjustment screw could fall out if it is loosened beyond its allowable adjustment range and cause a hazard to humans or damage to machinery and equipment.

6. Do not place a magnetic object near the product.

The auto switch is a magnetic sensing type product. If a magnetic object is placed close to it, the rotary actuator could operate suddenly, which could pose a hazard to humans or damage the machinery and equipment.

7. Do not perform additional machining to the product.

Additional machining to the product can result in insufficient strength and cause damage to the product. This can lead to possible human injury or damage to the surrounding equipment.

8. Do not enlarge the fixed throttle by modifying the pipe connectors.

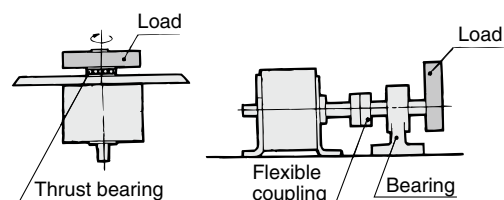
If the hole diameter is enlarged, the product's rotation speed will increase, causing the shock force to increase and damage the product. As a result, it could pose a hazard to humans or damage the machinery and equipment.

9. If shaft couplings are used, use ones with angular freedom.

If shaft couplings that lack angular freedom are used, they could twist due to eccentricity, leading to equipment malfunction or product damage. As a result, it could pose a hazard to humans or damage the machinery and equipment.

10. Do not apply to the shaft a load that exceeds the values given in the catalog.

If a load that exceeds the allowable value is applied to the product, it could lead to equipment malfunction, a hazard to humans, or damage to the machinery and equipment. Provided that a dynamic load is not generated, a load that is within the allowable radial/thrust load can be applied. However, applications in which the load is applied directly to the shaft should be avoided whenever possible. The methods such as those described below are recommended to prevent the load from being applied directly to the shaft in order to ensure a proper operating condition.





Rotary Actuators Precautions 3

Be sure to read this before handling products.

Mounting

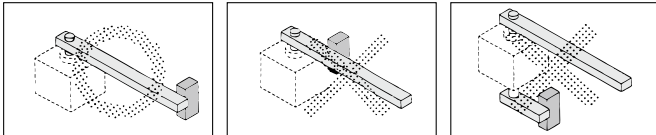
Warning

11. Place an external stopper in a position that is away from the rotating shaft.

If the stopper is placed near the rotating shaft, the torque that is generated by the product itself will cause the reaction force which is directed to the stopper to be redirected and applied to the rotating shaft. This will lead to the breakage of the rotating shaft and bearing. As a result, it could pose a hazard to humans or damage the machinery and equipment.

Precautions when Using External Stoppers

- Be sure to install external stoppers in the proper places. Installation in the wrong place can result in equipment breakage, which could damage other equipment or cause human injury.

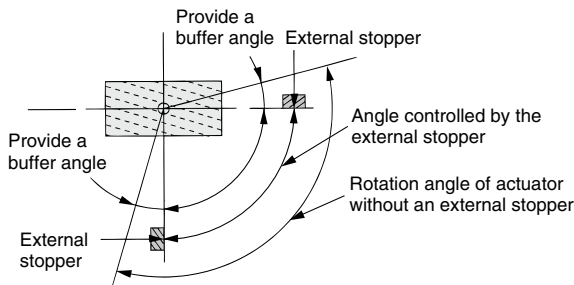


Install the stopper at a sufficient distance from the rotating shaft.

The external stopper becomes a fulcrum, resulting in the load's inertia force being applied to the shaft as a bending moment.

If an external stopper is installed on the shaft side which is opposite of the load, the inertia force generated by the load is applied directly to the shaft.

- Install external stoppers within the range of the rotating shaft angle. Installing an external stopper at the maximum rotation angle may result in the inability to fully absorb the kinetic energy generated, and damage to equipment may occur. When using external stoppers at rotation angles of 90°, 180°, or 270°, use products with rotation angles of 100°, 190°, or 280° respectively.



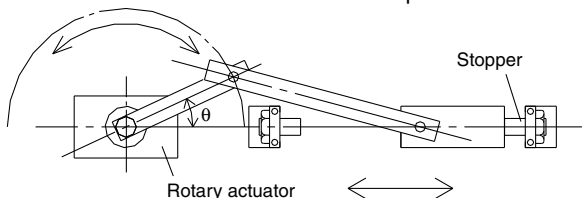
Backlash of the Single Rack Pinion Type CRA1 Series

There is a backlash of within 1° at the rotation end of the CRA1 series. It is necessary to decide the position of the external stopper when precise rotation is required.

Precautions when Converting Rotational Motion to Linear Motion

When using a link mechanism, etc., to convert rotational motion to linear motion and to determine the operation end using the stopper on the linear motion end (see below), a small value for θ at the operation end may result in the torque of the rotary actuator. This may cause an excessive radial load to act on the output axle, and equipment breakage may occur.

Install a stopper on the rotational motion side, or increase the value of θ at the operation end, to make sure the load generated does not exceed the allowable value for the product.



12. Do not use springs, etc., to add force in the rotational movement direction.

When rotational force from an external spring, etc., acts and generates negative pressure on the product's interior, breakage of the internal seal or the acceleration of abrasion may occur.

Caution

1. Observe the specified torque to secure the block of the angle adjustment unit.

If it is secured with a torque that is lower than the specified torque, the block could become loosened during use, causing the angle to exceed the set angle.

2. Do not use organic solvent to wipe the area of the name plate that shows the model.

It will erase what is indicated on the name plate.

3. Do not hit the rotating shaft when securing the body or hit the body when securing the rotating shaft.

These actions could cause the shaft to bend or damage the bearing. When a load must be coupled to the rotating shaft, secure the rotating shaft.

4. Do not place your foot directly on the shaft or on the equipment that is coupled to the shaft.

Placing one's weight directly onto the rotating shaft could cause the rotating shaft or the bearing to become damaged.

5. If a product is equipped with an angle adjustment function, use it within the specified adjustment range.

If the product is used outside the specified adjustment range, it could lead to equipment malfunction or product damage. Refer to the product specifications for details on the adjustment range of the products.

6. A product with an angle adjustment screw is temporarily secured at an arbitrary position near the rotation end. Before using the product, readjust it to the desired angle and tighten the screw firmly.

Piping

Caution

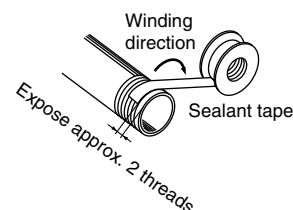
1. Refer to the Fittings and Tubing Precautions (pages 52 to 56) for handling One-touch fittings.

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 1.5 to 2 thread ridges exposed at the end of the threads.





Rotary Actuators Precautions 4

Be sure to read this before handling products.

Speed and Cushion Adjustment

Warning

1. To make a speed adjustment, gradually adjust starting from the low speed end.

If the speed adjustment is performed from the high speed end, it could damage the product. As a result, it could pose a hazard to humans or damage the machinery and equipment.

2. The cushion valve is not adjusted at the time of shipment. Therefore, an adjustment must be made in accordance with the operating speed and the moment of inertia of the load.

The absorption of kinetic energy by the bumper is regulated by the adjustment of the valve. An improper adjustment could lead to damage of the equipment and the product. As a result, it could pose a hazard to humans or damage the machinery and equipment.

3. Do not operate with the cushion valve in a fully closed condition.

This could tear the seal, which could pose a hazard to humans or damage the machinery and equipment.

4. Do not apply an excessive force to loosen the cushion valve.

The valve itself is provided with a pull stop. However, the pull stop could be damaged if the valve is loosened through the application of excessive force. As a result, it could pose a hazard to humans or damage the machinery and equipment.

5. For products with shock absorbers, when the shock absorber stops motion before reaching the stroke end using a stopper mechanism with the objective of shortening takt time, be sure the shock absorber is stopped in a position where it has adequately absorbed the kinetic energy.

Failure to do so may result in damage to equipment.

6. Note that a product with an air cushion or a shock absorber is not designed to achieve shock-less, smooth stop operation and constant deceleration of a load. The product absorbs the kinetic energy of a load to prevent its damage.

Lubrication

Warning

1. This product should be used without lubrication. If it is lubricated, it could lead to sticking or slipping.

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 and allow the condensation to enter the compressed air lines. This causes 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.

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 µm 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 rotary actuators. Therefore, take appropriate measures to ensure air quality, such as by providing an aftercooler, air dryer, or water separator.

4. Ensure that the fluid and ambient temperatures are within the specified range.

If the fluid temperature is 5°C or less, the moisture in the circuit could freeze, causing damage to the seals or equipment malfunction. Therefore, take appropriate measures to prevent freezing.

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



Rotary Actuators

Precautions 5

Be sure to read this before handling products.

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.**

Refer to the construction drawing for information on the materials of rotary actuators.

2. **Do not expose the product to direct sunlight for an extended period of time.**
3. **Do not use in a place subject to heavy vibration and/or shock.**
4. **Do not mount the product in locations where it is exposed to radiant heat.**
5. **Do not use in dusty locations or where water, oil, etc., splash on the equipment.**

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. **Maintenance work**

If handled improperly, compressed air can be dangerous. Assembly, handling, repair, and element replacement of pneumatic systems should be performed by a knowledgeable and experienced person.

3. **Drain flushing**

Remove drainage from air filters regularly.

4. **Removal of equipment, and supply/exhaust of compressed air**

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

When machinery is restarted, proceed with caution after confirming that appropriate measures are in place to prevent sudden movement.

Caution

1. **For lubrication, use the designated grease for each specific product.**

The use of a non-designated lubricant could damage the seals.



Rotary Actuators Precautions 6

Be sure to read this before handling products.

For Air-hydro Type

Please read this page along with the Rotary Actuators Precautions.

Design

⚠ Warning

1. **Do not use the product near flames, or in equipment or machinery that exceeds an ambient temperature of 60°C.**

There is a danger of fire because the air-hydro type uses a flammable hydraulic fluid.

Refer to the Safety Data Sheet (SDS) of the hydraulic fluid when supplying the fluid.

2. **Do not use the product in a clean room.**

⚠ Caution

1. **Do not use in an environment, equipment, or machine that is not compatible with oil mist.**

The air-hydro type generates an oil mist during operation which may affect the environment.

2. **Be certain to install an exhaust cleaner on the directional control valve of the air-hydro type.**

A very small amount of hydraulic fluid is discharged from the exhaust port of a directional control valve, which may contaminate the surrounding area.

3. **Install the air-hydro type in a location where it can be serviced easily.**

Since the air-hydro type requires maintenance, such as the refilling of hydraulic fluid and bleeding of air, ensure sufficient space for these activities.

Selection

⚠ Caution

1. **Select an air-hydro type in combination with an air-hydro unit.**

Since good operation of an air-hydro type depends on its combination with an air-hydro unit, carefully select an appropriate air-hydro unit.

Piping

⚠ Warning

1. **For air-hydro type piping, use self-aligning fittings.**

Do not use One-touch fittings in the piping for an air-hydro type because oil leakage may occur.

2. **For air-hydro type piping, use hard nylon tubing or copper piping.**

As in the case of hydraulic circuits, surge pressures greater than the operating pressure may occur in air-hydro type piping, making it necessary to use safer piping materials.

Lubrication

⚠ Warning

1. **Completely discharge the compressed air in the system before filling the air-hydro unit with hydraulic oil.**

Before supplying hydraulic fluid to the air-hydro unit, first confirm that safety measures are implemented to prevent the dropping of objects, the release of clamped objects, etc. Then, shut off the air supply and the equipment's electric power, and exhaust the compressed air in the system.

If the air-hydro unit's supply port is opened with compressed air still remaining in the system, there is a danger of hydraulic fluid being blown out.

Refer to the Safety Data Sheet (SDS) of the hydraulic fluid when supplying the fluid.

2. **Use petroleum hydraulic fluid which can be used as turbine oil.**

If non-flammable hydraulic fluid is used, it may cause problems.

Suitable viscosity is in the range of approximately 40 to 100 mm²/s in operating temperature.

The suitable operating temperature for ISO VG32 is between 15 to 35°C. If a higher operating temperature range is required, select ISO VG46 (suitable for 25 to 45°C).

- * Refer to the SMC website for details about each manufacturer's brand name of class 1 turbine oil (no additives) ISO VG32. Additionally, please contact SMC for details about class 2 turbine oil (with additives) ISO VG32.

Maintenance

⚠ Caution

1. **Bleed air from the air-hydro type on a regular basis.**

Since air may accumulate inside the air-hydro type, bleed air from it, for example, before starting work. Bleed air from the bleeder valve provided on the air-hydro type or the piping.

2. **Confirm the oil level of the air-hydro system on a regular basis.**

Since a very small amount of hydraulic fluid is discharged from the air-hydro type and the air-hydro unit circuit, the fluid will gradually decrease. Therefore, check the fluid regularly and refill as necessary.

The oil level can be checked with the level gauge in the air-hydro converter.



Air Grippers 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).

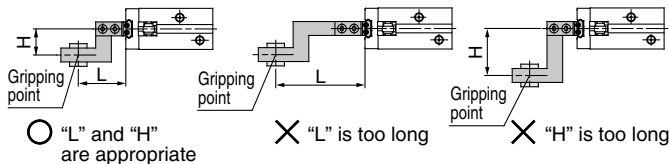
We do not guarantee against any damages if the product is used outside of the specification range.

2. Take safety measures (e.g. mounting protective covers) when workpieces pose a danger of fingers being caught in a gripper, etc.

3. If circuit pressure drops due to a power failure, trouble with the air supply, etc., there is a danger of workpieces dropping because of reduced gripping force. Implement drop prevention measures to avoid human injury and equipment damage.

4. Keep the gripping point within the specified range of the gripping distance.

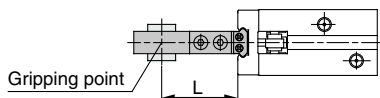
When the gripping point distance becomes too large, the gripper attachment applies an excessively large load to the gripper sliding section. This causes adverse effects on the service life. Refer to the graph of the specified range of the gripping distance for each series.



5. Attachments should be designed to be as light and short as possible.

1) A long or heavy attachment increases the inertia force to open or close the fingers. Therefore, it may cause unsteady movement of fingers and have an adverse effect on the product's life.

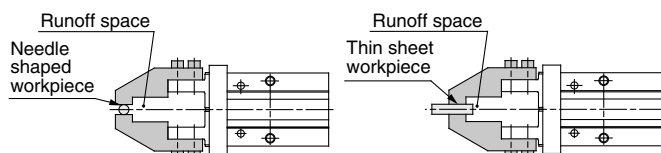
2) Even if the gripping point remains within the range limit, make the attachment as light and short as possible.



3) Select a larger size gripper or use two or more grippers together for handling a long and/or large workpiece.

6. Provide a runoff space in the attachment when using with a small or thin workpiece.

If a runoff space is not provided within the finger part, gripping becomes unsteady, and it may lead to gripping failure or slippage.



7. Select a model whose gripping force is compatible with the workpiece mass.

Incorrect selection may lead to the dropping of a workpiece, etc. Refer to the model selection criteria of each series for the effective gripping force and the workpiece mass.

8. Do not use in applications where excessive external force or impact force may be applied to the gripper.

Excessive external force or impact force may cause a malfunction. Please consult with SMC regarding any other applications.

9. Select a model with a sufficient working finger opening/closing width.

<In case of insufficient width>

1) Gripping becomes unsteady due to variations in opening/closing width or workpiece diameter.

2) When using an auto switch, the detection may not be reliable. Refer to the Auto Switch Hysteresis section and set the stroke to include the hysteresis length for a reliable switch function.

When using the water-resistant 2-color indicator auto switch, the gripper stroke may be limited by the setting of the indicator color during detection.

10. Please consult with SMC regarding a single acting, spring force only grip type.

This can cause unstable gripping in some cases or return malfunction due to faulty operation, etc.

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

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

12. Refer to the Auto Switches Precautions (pages 15 to 19) if using with an auto switch.

Mounting

⚠ Warning

1. Operation manual

Install the product and operate it only after reading the operation manual carefully and understanding its contents. Also, keep the manual in a location 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. Do not scratch or dent the air gripper by dropping or bumping it when mounting.

Even a slight deformation can cause inaccuracy or malfunction.

5. Tighten the screw within the specified torque range when mounting the attachment.

Tightening with higher torque than the specified range may cause malfunction, while tightening with lower torque may cause the gripping position to move out of place or the dropping of a workpiece.



Air Grippers Precautions 2

Be sure to read this before handling products.

Mounting

⚠ Caution

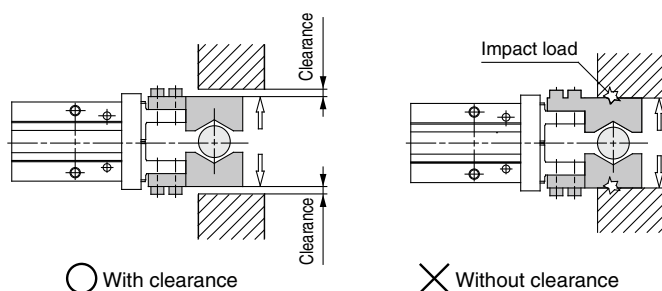
1. Avoid twisting the gripper when mounting an attachment.

Any damage to the gripper may cause malfunction and reduce accuracy.

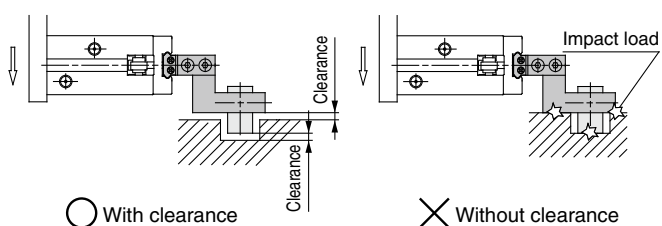
2. Avoid applying an external force to fingers.

Fingers may be damaged by a continual lateral or impact load. Provide clearance to prevent the workpiece or the attachment from striking against any object at the stroke end.

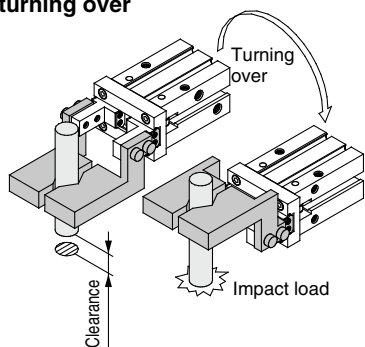
1) Stroke end when fingers are open



2) Stroke end when gripper is moving

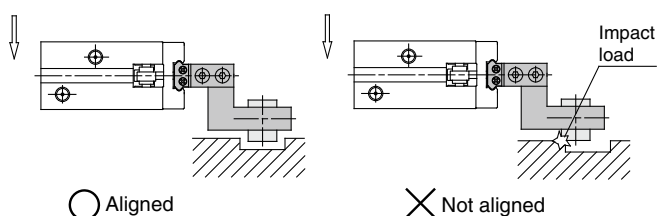


3) When turning over



3. Adjust the gripping point so that an excessive force will not be applied to the fingers when inserting a workpiece.

Confirm that the gripper can operate without receiving any shock by testing it in manual operation mode or by low speed operation.



4. Control the opening/closing speed with the speed controller to avoid excessive high-speed operation.

If the finger opening/closing speed is greater than necessary, impact forces on the fingers and other parts will increase. This can cause a loss of repeatability when gripping a workpiece and have an adverse effect on the life of the unit.

Finger Opening/Closing Speed Adjustment Example of Using SMC's Speed Controller

Double acting	- The speed can be adjusted with the built-in speed controller in the following series: MHC2-10D to 25D, MHK2-12D to 25D, and MHKL2-12D to 25D. Use the table below as a guide for adjusting the speed. - Series other than those previously mentioned For a cylinder with an inner diameter of $\phi 6$ or $\phi 10$, connect 2 speed controllers in a meter-in state or 1 dual speed controller. If the cylinder has a bore size of $\phi 16$ or larger, connect 2 speed controllers in a meter-out state.
Single acting	Connect 1 speed controller in a meter-in state or 1 dual speed controller. External gripping ——— Connect to closing port. Internal gripping ——— Connect to opening port.

Applicable speed controllers

Air gripper mounted type ——— AS1200-M3/M5
AS2200-01, etc.

Piping type ——— AS1000 series
AS1002F, AS2052F, etc.

Guide to Built-in Needle Adjustment

Model	Number of needle rotations from fully closed state *1
MHC2-10	1/4 to 1/2
MHC2-16	1/2 to 1
MHC2-20	1 to 1 1/2
MHC2-25	1 1/2 to 2
MHK2-12D	3/4 to 1
MHK2-16D	1 to 1 1/4
MHK2-20D	1 1/2 to 1 3/4
MHK2-25D	1 3/4 to 2
MHKL2-12D	1 to 1 1/4
MHKL2-16D	1 1/4 to 1 1/2
MHKL2-20D	1 3/4 to 2
MHKL2-25D	2 to 2 1/4

*1 Needle is tightened until it strikes the end lightly.

When an angular gripper is used, depending on the length of the attachment, it might be necessary to adjust the open/close movement to a slower speed. This will prevent the base of the fingers from being exposed to shocks that are created by inertial force.



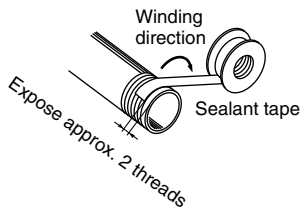
Air Grippers Precautions 3

Be sure to read this before handling products.

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 1.5 to 2 thread ridges exposed at the end of the threads.



Lubrication

⚠ Caution

1. The non-lube type air gripper is lubricated at the factory and can be used without any further lubrication.
With the exception of the M*HR series, when lubrication is applied, use class 1 turbine oil (without additives) ISO VG32. Furthermore, once lubrication is applied, it must be continued. If lubrication is later stopped, malfunction can occur due to loss of the original lubricant. Refer to the Safety Data Sheet (SDS) of the hydraulic fluid when supplying the fluid.

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 and allow the condensation to enter the compressed air lines. This causes 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.

⚠ 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 µm 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 air grippers. Therefore, take appropriate measures to ensure air quality, such as by providing an aftercooler, air dryer, or water separator.
4. Ensure that the fluid and ambient temperatures are within the specified range.
If the fluid temperature is 5°C or less, the moisture in the circuit could freeze, causing damage to the seals or equipment malfunction. Therefore, take appropriate measures to prevent freezing.
For compressed air quality, refer to the SMC Best Pneumatics No. 6 catalog.



Air Grippers Precautions 4

Be sure to read this before handling products.

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.**
Refer to each construction drawing for information on the materials of air grippers.
- 2. Do not expose the product to direct sunlight for an extended period of time.**
- 3. Do not use in a place subject to heavy vibration and/or shock.**
- 4. Do not mount the product in locations where it is exposed to radiant heat.**
- 5. Do not use in dusty locations or where water, oil, etc., splash on the equipment.**

Caution

- 1. Use caution in regards to the corrosion resistance of the finger guide section.**
Martensitic stainless steel is used for the finger guide. But, please note that its corrosion resistance is inferior to that of austenitic stainless steel.
Especially in an environment where water drops adhere due to condensation, etc., rust might be generated. Refer to Specific Product Precautions.

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. Maintenance work**
If handled improperly, compressed air can be dangerous. Assembly, handling, repair, and element replacement of pneumatic systems should be performed by a knowledgeable and experienced person.
- 3. Drain flushing**
Remove drainage from air filters regularly.
- 4. 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 pressure and electric power, and exhaust all compressed air from the system using the residual pressure release function.
When machinery is restarted, proceed with caution after confirming that appropriate measures are in place to prevent sudden movement.
- 5. Do not allow people to enter or place objects in the carrying path of the air gripper.**
This may cause human injury and/or an accident.
- 6. Do not put hands, etc., in between the air gripper fingers or attachments.**
This may cause human injury and/or an accident.
- 7. When removing the air gripper, first confirm that no workpieces are being held and then release the compressed air before removing the air gripper.**
If a workpiece is still being held, there is a danger of it being dropped.

Caution

- 1. The dust cover is a consumable part. Replace it as necessary.**
Fine particles, cutting oil, etc., may cause the main body to malfunction.



Vacuum Equipment 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. Safe designs should be developed, which account for the possibility of accidents resulting from a drop in vacuum pressure due to power failure, trouble with the air supply, etc.

If vacuum pressure drops and there is a loss of vacuum pad adsorption force, workpieces being carried may fall, causing human injury or damage to machinery. Sufficient safety measures should be implemented, such as drop prevention, to avoid any accidents.

3. Follow vacuum specifications for vacuum switching valves and vacuum release valves.

If non-vacuum equipment is installed in a vacuum piping, vacuum leakage will occur. Therefore, select only equipment for vacuum specifications.

4. Select an ejector which has a suitable suction flow rate.

<When there is vacuum leakage from the workpiece or the piping>

If the ejector's suction flow rate is too low, the adsorption will be poor.

<When piping is long or the diameter is large>

The adsorption response time will delay due to the increased volume of the piping.

Select an ejector with a suitable suction flow rate by referring to the technical data.

5. If the suction flow rate is too high, setting of vacuum switch will become difficult.

Setting the vacuum switch when adsorbing a small (few millimeter) workpiece will sometimes become difficult, if the selected ejector has a high suction flow rate and there is a small pressure difference when adsorbing and releasing the workpiece.

6. When two or more pads are piped to one ejector, if one pad releases its workpiece, the other pads will also release.

When one pad releases its workpiece, there is a drop in vacuum pressure which causes the other pad to release its workpiece as well.

7. When separating the pad from the workpiece, break the vacuum and confirm that the pressure is atmospheric pressure.

Do not separate them forcibly while vacuum pressure exists between them. This may cause cracking, tearing, or distortion of the pad, or cause the pad to come off the adapter.

8. Do not apply a lateral load (force), such as rotation or sliding force of the workpiece, to the adsorption surface of the pad during the adsorption of a workpiece.

This may cause deformation, cracking, tearing, or distortion of the pad, or cause the pad to come off the adapter.

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

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

When disassembling or assembling the product for the purpose of replacing parts, etc., be certain to follow the operation manual or catalogs.

10. Vacuum holding using check valves

SMC can issue no guarantees regarding the maintenance of workpiece adsorption when using check valves. Take separate safety measures to prevent workpieces from dropping in the case of an electrical power outage, etc.

Please consult with SMC when using check valves as a means of preventing interference caused by the exhaust from nearby ejectors.

11. Air leakage from main valve

SMC does not guarantee zero air leaks from the main valve used for the vacuum ejector/vacuum pump system. If air leakage is a problem, please contact SMC.

12. Vacuum pads are not guaranteed for zero air leakage (vacuum holding).

Caution

1. Mounting the suction filter

Because the suction of vacuum equipment acts not only on workpieces but also on dust or water droplets in the surrounding atmosphere, steps must be taken to prevent their penetration into the equipment's interior. Even when using equipment equipped with filters, if there is a considerable amount of dust in the environment, use a separately ordered large-size filter as well.

If there is a possibility of water droplets being sucked in by the vacuum, use a drain separator for vacuum.

2. The maximum vacuum pressure of the vacuum ejector is affected by the atmospheric pressure of the operating environment.

As atmospheric pressure changes based on altitude, climate, etc., the actual maximum vacuum pressure may not reach the value listed in the specifications.

3. For information on related items, such as directional control equipment and actuators, refer to the caution sections in each respective catalog.

4. Do not use the product in an environment that exposes it to vibration. If the product is used in such an environment, we can offer a lock nut type product to prevent it from loosening. Please contact SMC for the part number.

5. Foreign matter may get inside the pad.

Although SMC gives full attention to prevent foreign matter from getting inside the product during pad molding, it is difficult to remove foreign matter from the molded product completely. Therefore, products with imperceptible, fine foreign matter are determined as acceptable and shipped to customers.



Vacuum Equipment Precautions 2

Be sure to read this before handling products.

Design/Selection

⚠ Caution

6. There is a possibility of crystallized white powder or exuded liquid forming on the rubber surface.

The crystallized powder is called bloom, and the exuded liquid is called bleed. Bloom and bleed do not affect product operation. This phenomenon is caused by rubber compounding agents, such as a vulcanizing agent, antioxidants, oxidation inhibitors, softeners, parting agents, etc., and differs depending on the rubber material. As this phenomenon is influenced by changes in the environment (temperature differences, light (fluorescent light), humidity, etc.), the occurrence time cannot be estimated.

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. Be sure to secure the product in place when mounting the pad.

Not securing it firmly into place may cause problems.

5. Use caution when implementing rotating transfer with a pad or when using workpieces and pads with a deviation in the center of the suction position.

Screw looseness due to rotation and pad rotation may cause problems. Apply a screw lock agent as necessary.

6. Avoid operation in a rotational direction by using the ball joint pad mechanism.

Wear may cause problems.

7. A buffer is used to decrease the load applied to the pad (horizontal lifting).

A malfunction may occur when the buffer is used for inclined or vertical lifting.

8. After the stroke, make sure that the buffer returns to the initial state before starting the next process.

Malfunctions may occur.

9. When pushing a pad to a workpiece, make sure not to apply an impact or a large force.

This will lead to premature deformation, cracking, or wearing of the pad. When pushing a pad onto a workpiece, operate within the deformable range of the pad skirt.

10. Do not obstruct the exhaust port of the ejector.

If the exhaust port is obstructed when mounted, a vacuum will not be generated. Also, do not obstruct the exhaust port with the goal of removing the workpiece. It may cause damage to the equipment.

Piping

⚠ Caution

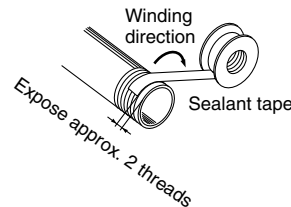
1. Refer to the Fittings and Tubing Precautions (pages 52 to 56) for handling One-touch fittings.

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 1.5 to 2 thread ridges exposed at the end of the threads.



4. Use piping with adequate conductance.

Select equipment and piping for the vacuum side which has adequate conductance so that the ejector's maximum suction flow rate can be accommodated by the piping.

Also, make sure that there are no unnecessary restrictions, leaks, etc., along the course of the piping. Furthermore, the air supply should be designed while taking into consideration the ejector's maximum air consumption and the air consumption of other pneumatic circuits.

5. Avoid disorganized piping.

Piping which is direct and of the shortest possible length should be used for both the vacuum and supply sides. Disorganized piping should be avoided. Unnecessary length increases the piping volume, and thus increases the response time.

6. Use piping with large conductance on the exhaust side of the ejector.

If the exhaust piping is restrictive, there will be a decline in the ejector's performance.

7. Be certain that there are no crushed areas in the piping due to damage or bending.

Vacuum Release Flow Adjusting Needle

⚠ Warning

1. The pressure and flow rate of the vacuum release air to be output varies depending on the supply pressure, needle opening, and difference between the vacuum ejector system and the vacuum pump system. Conduct appropriate adjustments with the adjusting needle mounted on the actual machine while checking the effects on the workpiece.

2. To adjust the flow rate, turn the adjusting needle to the right (clockwise) to decrease the flow rate, and turn it to the left (counter-clockwise) to increase the flow rate.



Vacuum Equipment Precautions 3

Be sure to read this before handling products.

Air Supply

⚠ Warning

1. Type of fluids

Be sure to use compressed air for the fluid. Please consult with SMC when using the product in applications other than compressed air.

Additionally, use purified compressed air, from which the water contents, oil contents, and drains have been removed completely.

2. Control of supply air

Compressed air containing a large amount of water content, oil content, drain, etc., may cause the pneumatic equipment to malfunction. So, install an air filter, air dryer, or a mist separator. (A system with a quality grade of No. C, D, or higher in the air preparation equipment model selection guide of Best Pneumatics No. 6 is recommended.)

Additionally, when applying oil to compressed air that is used for directional control equipment or actuators, install piping separately so that air is supplied to the vacuum equipment before the oil is applied.

If oil flows into the vacuum ejector/vacuum pump system, the silencer, nozzle, or filter may be clogged, causing reduced performance.

3. Drain flushing

If drain in the air filter or mist separator is not removed, the drain flows from the outlet, causing the pneumatic equipment to malfunction.

If drain flushing is deemed difficult, it is recommended to use a product with an auto drain option. For details about 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 contents, corrosive gases, etc. This may cause the product to break or malfunction.

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 a place subject to heavy vibration and/or shock.
3. 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.
4. The product should not be exposed to prolonged sunlight. Use a protective cover.
5. Remove any sources of excessive heat.
6. In locations where there is contact with spatter from water, oil, solder, etc., take suitable protective measures.
7. In cases where the vacuum unit is surrounded by other equipment, etc., or the unit is energized for an extended time, take measures to exhaust excess heat so that the temperature remains within the specifications.

Operating Environment

⚠ Caution

1. Under certain conditions, the exhaust of the vacuum ejector may generate intermittent noises, and vacuum pressure may be uneven.

Using the ejector under these conditions will not result in decreased performance, but if the intermittent noise becomes a nuisance, or there is an adverse effect on the operation of the vacuum pressure switch, try lowering or raising the supply pressure of the vacuum ejector to find a supply pressure level at which the intermittent noise ceases.

Maintenance

⚠ Warning

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

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

2. Maintenance work

If handled improperly, compressed air can be dangerous. Assembly, handling, repair, and element replacement of pneumatic systems should be performed by a knowledgeable and experienced person.

3. Drain flushing

Remove drainage regularly from the water separator, air filters, drain separator for vacuum, etc.

4. 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 pressure and electric power, and exhaust all compressed air from the system using the residual pressure release function.

When machinery is restarted 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.

5. Perform maintenance of suction filters and silencers periodically.

The performance of an ejector will deteriorate due to clogged filters and silencers. High-flow filters should be used, especially in dusty locations.

6. Leakage or clogging of the air pressure circuit, wear, cracks, or deterioration of the pad, or buffer sliding failure (wear, galling, or other failure of the sliding parts) may lead to problems. Make sure to perform periodic maintenance and inspection.

7. When adsorbing a deformed or spherical workpiece, it is necessary to push the pad against it.

Even if the workpiece can be adsorbed in the initial operation, deformation, cracks, or wear of the pad may occur prematurely, causing problems. Make sure to perform periodic maintenance and inspection.



Electric Actuators Precautions 1

Be sure to read this before handling products.

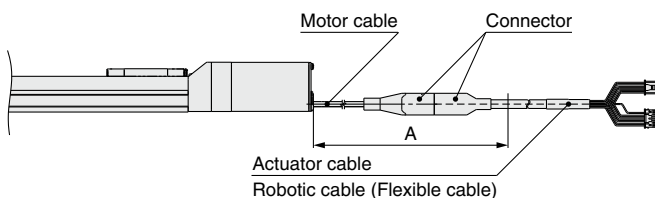
Wiring/Cables

⚠ Warning

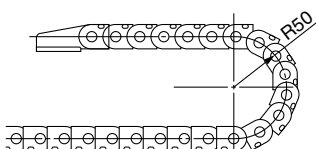
- Adjustment, installation, inspection, or wiring changes should be conducted after the power supply to this product has been turned off.**
Electrical shock, malfunction, or damage can result.
- Never disassemble the cable. Use only the specified cables.**
- Never connect or disconnect the cable or connector with the power on.**

⚠ Caution

- Wiring should be done correctly.**
For each terminal, voltages other than those stipulated in the operation manual should not be applied.
- Connect the connector securely.**
Check for correct connector wiring and polarity.
- Handling noise**
If the noise is at the same wavelength as the signal lines, it will lead to malfunction. As a countermeasure, separate the high and low electrical lines, shorten the length of wiring, etc.
- Do not connect power or high-voltage cables in the same wiring path as the unit.**
The product can malfunction due to noise and surge voltage interference in the signal line from power and high-voltage cables. Separate the wiring of the controller and its peripheral device from that of power and high-voltage cables.
- Be careful that cables are not caught by actuator movement.**
- Operate with cables such that they are not easily moved.**
Avoid bending cables at sharp angles where they enter the product.
- Avoid twisting, folding, rotating, or applying external force to the cable.**
Electric shock, wire breakage, contact failure, or a loss of product control may occur.
- Do not move cables connected to the actuator.**
The motor and lock cables are not robotic cables and can be broken when moved. Therefore, secure the cables and the connectors (part "A" in the figure below) in place during set up.



- Select a "robotic cable (flexible cable)" when repeated bending of the actuator cable is required. Also, do not put cables into a flexible moving tube with a radius smaller than the specified value (50 mm or longer).**
Electric shock, wire breakage, contact failure, or a loss of product control may occur if "standard cables" are used for repeated bending.



⚠ Caution

- Confirm wiring insulation.**
Insulation failure (interference with other circuits, poor insulation between terminals, etc.) could introduce excessive voltage or current to the controller or its peripheral devices, causing damage to them.
- The speed and force may change depending on the cable length, load, and mounting conditions.**
Furthermore, if the cable length exceeds 5 m, then it will decrease by up to 10% for every additional 5 m. (At 15 m: Reduced by up to 20%)
- When checking the conductivity of the cable, be careful not to deform the connector's mating hole and terminals.**
Inserting a non-compatible connector, tool, cylinder-shaped object, etc., into the connector's mating hole can cause the mating hole or terminals to become deformed, which may cause contact failure or disconnection.
- Refrain from plugging in and unplugging the connector frequently.**
Doing so may result in contact failure or disconnection.

[Transportation]

⚠ Caution

- Do not carry or swing the product by the cable.**

Design/Selection

⚠ Warning

- Be sure to read the operation manual (this manual and the one for the controller: LEC series).**
Handling or usage/operation other than that specified in the operation manual may lead to breakage or operation failure of the product.
Any damage attributed to use beyond the specifications is not covered by the warranty.
- There is a possibility of dangerous sudden action by the product if the sliding parts of the machinery are twisted due to external forces, etc.**
In such cases, human injury may occur, such as by hands or feet getting caught in the machinery, or damage to the machinery itself may occur. Design the machinery so as to avoid such dangers.
- A protective cover is recommended to minimize the risk of personal injury.**
If a driven object and the moving parts of the product are in close proximity, personal injury may occur. Design the system to avoid contact with the human body.
- Securely tighten all stationary parts and connected parts so that they will not become loose.**
When the product operates with high frequency or is installed where there is a lot of vibration, ensure that all parts remain secure.
- Consider a possible loss of power source.**
Take measures to prevent injury and equipment damage in the event of a power source failure.
- Consider emergency stops.**
Design so that human injury and/or damage to machinery and equipment will not be caused when machinery is stopped by a safety device under abnormal conditions, such as a power outage or a manual emergency stop.



Electric Actuators Precautions 2

Be sure to read this before handling products.

Design/Selection

⚠ Warning

7. Consider the whole system.

Design the system so that human injury or equipment damage will not occur upon the restart of operation of the whole system.

8. Never disassemble the product or make any modifications, including additional machining.

Doing so may cause human injury and/or an accident. It may also cause the deterioration of the product's performance.

9. Do not use the stop signals, the "EMG" of the controller and the stop switch on the teaching box, as the emergency stop of the system.

The stop signals, "EMG" of the controller and the stop switch on the teaching box, are for decelerating and stopping the actuator. Design the system with an emergency stop circuit which applies to the relevant safety standards separately.

10. When using the product vertically for applications, it is necessary to install a built-in safety device.

The table may fall due to the weight of a workpiece. The safety device should not interfere with the normal operation of the machine.

⚠ Caution

1. Operate within the limits of the maximum usable stroke.

The product will be damaged if it is used with a stroke which exceeds the maximum stroke. Refer to the specifications of the product.

2. When the product repeatedly cycles with partial strokes, operate it at a full stroke at least once a day or every 1000 strokes.

Otherwise, lubrication may run out.

3. Do not use the product in applications where excessive external force or impact force is applied to it.

The product can be damaged. The components, including the motor, are manufactured to precise tolerances. Even a slight deformation may cause a malfunction or seizure.

4. During operation (positioning operation or pushing operation), it cannot be returned to the origin position.

5. Refer to the Auto Switches Precautions (pages 15 to 19) if an auto switch is to be built in and used.

6. Step motor (servo/24 VDC) and servo motor (24 VDC) specifications with the following model number are not compliant with UL Standards: "Controller/Driver type: Without controller/driver (Nil)."

Individual actuators are not certified as UL Standards compliant products.

7. When UL Standards compliance is required, the electric actuator and controller/driver should be used with a UL1310 class 2 power supply.

8. Do not exceed the product specifications even if a work load is supported by external guides.

Although the actuator moment is reduced by external guides, the required transport ability (the relationship between the speed and the work load) is not reduced.

Mounting

⚠ Warning

1. Keep the manual in a safe place for future reference.

The product should be mounted and operated only after thoroughly reading the operation manual and understanding its contents.

2. Observe the tightening torque for screws.

Tighten the screws to the recommended torque for mounting the product.

3. Do not make any alterations to this product.

Alterations made to this product may lead to a loss of durability or damage to the product, which can lead to human injury or damage to other equipment and machinery.

Mounting

⚠ Warning

4. When connecting, make sure the rod axis and the load, and the direction of the movement match.

Failure to do so may cause complications with the lead screw, such as wear or damage.

5. When an external guide is used, connect the moving parts of the actuator and the load in such a way that there is no interference at any point within the stroke.

Do not scratch or dent the sliding parts of the product tube, piston rod, etc., by striking or grasping them with other objects. The components are manufactured to precise tolerances. Even a slight deformation may cause a malfunction or seizure.

6. Prevent the seizure of rotating parts (pins, etc.) by applying grease.

7. Do not use the product until you confirm that the equipment can operate properly.

After mounting or repair, connect the power supply to the product and perform appropriate functional inspections to check it is mounted properly.

8. When one side is fixed

When an actuator is operated at a high speed with one end fixed and the other free (basic, flange, or direct mount types), a bending moment may act on the actuator due to the vibration generated at the stroke end, which can damage the actuator. In such a case, install a mounting bracket to suppress the vibration of the actuator body, or reduce the speed so that the actuator does not vibrate. Also, use a mounting bracket when moving the actuator body or when a long stroke actuator is mounted horizontally and fixed at one end.

9. Do not apply strong impact or an excessive moment while mounting the product or a workpiece.

If an external force over the allowable moment is applied, it may cause play in the guide or an increase in the sliding resistance.

10. Maintenance space

Reserve sufficient space for maintenance.

Handling

⚠ Warning

1. Do not touch the motor during operation.

The surface temperature of the motor can increase to approx. 80°C due to operating conditions. The temperature may also increase due to energization. As it may cause burns, do not touch the motor when in operation.

2. If abnormal heating, smoking, fire, etc., occurs in the product, immediately shut off the power supply.

3. Stop operation at once if there are abnormal noises or vibrations.

Abnormal noises or vibrations may mean that the product is not properly mounted, and if allowed to continue in this state, damage to the equipment may occur.

4. Never touch the rotating parts of the motor while in operation.

5. Before installing, adjusting, inspecting, or performing maintenance on the product, controller, and related equipment, be sure to shut off the power supply. Then, lock it so that no one other than the person working can turn the power on, or implement measures such as a safety plug.

6. In the case of an actuator that has a servo motor (24 VDC), the motor phase detection step is conducted by inputting the servo's on signal just after the controller power is turned on. The motor phase detection step moves the table/rod the distance of the one screw-lead as the maximum.

(The motor rotates in the reverse direction if the table/rod hits an obstacle such as the end stop damper.) Take the motor phase detection step into consideration when installing and operating this actuator.



Electric Actuators Precautions 3

Be sure to read this before handling products.

Handling

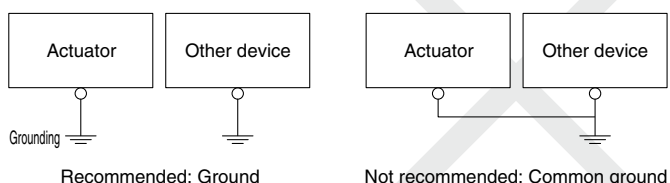
⚠ Caution

1. **Keep the controller and the actuator combined as delivered for use.**
The actuator's parameters are set at the time of shipment. If it is combined with a different set of parameters, failure can result.
2. **Conduct the following inspection before operation.**
 - a) Confirm that the power supply line and each signal line is not damaged.
 - b) Confirm that the power supply line and each signal line is not loosened.
 - c) Confirm that the electric actuator/cylinder/controller/driver is not mounted loosely.
 - d) Confirm that the electric actuator/cylinder/controller/driver is operating correctly.
 - e) Confirm the function of the emergency stop of the whole system.
3. **If several persons are to be working conjointly, determine the procedure, signs, measures against abnormality, and restarting measures in advance. Then, have someone else, supervise the work.**
4. **The product may operate at a speed different from the set speed depending on the load and resistance.**
When selecting a product, check the catalog for instructions regarding selection and specifications.
5. **Do not apply a load, impact, or resistance in addition to the transferred load during the return to origin.**
If the product is made to return to origin by pushing force, a displacement of the origin position may occur.
6. **Do not remove the name plate.**
7. **Operation tests should be done at a low speed. Start operation by predefined speed after confirming there are no problems.**
8. **Do not apply forces of impact, collision, or resistance to the moving parts of an actuator in operation.**
Doing so will cause a decrease in product life, damage to the product, etc.

[Grounding]

⚠ Warning

1. **Be certain to ground the actuator.**
2. **Dedicated grounding should be used.**
Grounding should be to a D-class ground. (Ground resistance of 100 Ω or less.)
3. **Grounding should be performed near the actuator to shorten the grounding distance.**
4. **The cross-sectional area of this wire shall be a minimum of 2 mm².**
5. **Avoid common grounding with other devices.**



[Unpackaging]

⚠ Caution

1. **Check that the received product is as ordered.**
If a product different from the one ordered is installed, injury or damage can result.

Operating Environment

⚠ Warning

1. **Avoid use in the following environments.**
 - a. Areas with large amounts of dust or cutting chips that could enter the product
 - b. Areas where the ambient temperature exceeds the specified range (Refer to the specifications.)
 - c. Areas where the ambient humidity exceeds the specified range (Refer to the specifications.)
 - d. Areas with corrosive gas, flammable gas, sea water, water, or steam that could adhere to the product
 - e. Areas where strong magnetic or electric fields are generated
 - f. Areas where direct vibration or impact shock is applied to the product
 - g. Areas where there are large amounts of dust or there is exposure to water/oil droplets

Operating Environment

⚠ Warning

- h. Areas that are exposed to direct sunlight (ultraviolet rays)
 - i. Areas at altitudes of over 1000 m
Heat radiation performance and withstand voltage may decline as a result. For details, consult with SMC.
2. **Do not use in an environment where the product is directly exposed to liquid, such as cutting oils.**
If cutting oil, coolant, or oil mist adheres to the product, failure or increased sliding resistance can result.
 3. **Install a protective cover when the product is used in an environment directly exposed to foreign matters, such as dust, cutting chips, and spatter.**
Looseness or increased sliding resistance can result.
 4. **Shade the product from direct sunlight.**
 5. **In locations near heat sources, block them off.**
When there is a heat source surrounding the product, the radiated heat from the heat source can increase the temperature of the product beyond the operating temperature range. Protect it with a cover, etc.
 6. **Levels of the base oil of grease may decrease due to the external environment and operating conditions, causing a decline in lubrication performance and a shortened life of the product.**

[Storage]

⚠ Warning

1. **Do not store the product in a place in direct contact with rain or water drops or where it is exposed to harmful gas or liquid.**
2. **Store in an area that is shaded from direct sunlight and has a temperature and humidity within the specified range (–10°C to 60°C and 35 to 85% no condensation or freezing).**
3. **Do not apply vibration or impact to the product during storage.**

Maintenance

⚠ Warning

1. **Do not disassemble or repair the product.**
Fire or electric shock can result. Contact SMC if the disassembly of the product is required for maintenance.
2. **Before modifying or checking the wiring, the voltage should be checked with a tester 5 minutes after the power supply has been turned off.**
Failure to do so may result in electrical shock.

⚠ Caution

1. **Perform maintenance and inspection according to the procedures indicated in the operation manual.**
Improper handling can cause an injury, damage, or the malfunction of equipment and machinery.
2. **Removal of equipment**
Before equipment is removed, first confirm that measures are in place to prevent the dropping or runaway of driven objects, etc. Proceed only after cutting off the electric power. When starting up again, proceed with caution after confirming that conditions are safe.
3. **Be sure to cut the power to the controller and disconnect the electric actuator cable before moving the electric actuator slider manually by hand.**
If the slider is moved with the electric actuator and controller still connected, the induced voltage of the motor will go to the controller, making it difficult to move the electric actuator smoothly. Moreover, frequently moving the electric actuator slider may result in controller damage or malfunction due to the induced voltage.

[Lubrication]

⚠ Caution

1. **The product has been lubricated for life by the manufacturer and does not require any further lubrication.**
When lubrication is applied, special grease must be used. Please read the maintenance manual of each actuator.



Electric Actuators

Precautions 4

Be sure to read this before handling products.

Actuator with Lock

Warning

1. **Do not use the lock as a safety brake or as a control that requires a locking force.**

The lock used for the product with lock is designed to prevent the dropping of workpieces.

2. **For vertical mounting, use the product with lock.**

If the product is not equipped with a lock, the product will move and drop the workpiece when the power is removed. Please ensure that your safe equipment designs include measures to prevent the falling of workpieces.

3. **“Drop prevention” is a safety precaution that prevents a workpiece from dropping due to its weight when the product operation is stopped and the power supply is turned off.**

4. **Do not apply an impact load or strong vibration while the lock is activated.**

If an external impact load or strong vibration is applied to the product, the lock will lose its holding force and damage to the sliding parts of the lock or a reduced service life may result. The same adverse effects may also occur when the lock slips due to a force exceeding the holding force, as this accelerates the wear of the lock.

5. **Do not apply liquid, oil, or grease to the lock or the area surrounding it.**

When liquid, oil, or grease are adhered to the sliding parts of the lock, its holding force will reduce significantly. Any changes in lock sliding performance and condition may cause a lock release malfunction.

6. **Take measures against drops and check that safety is assured before the mounting, adjustment, and inspection of the product.**

If the lock is released with the product mounted vertically, a workpiece can drop due to its weight.

7. **When the actuator is operated manually (when the SVRE output signal is off), supply 24 VDC to the [BK RLS] terminal of the power supply connector.**

If the product is operated without releasing the lock, the wearing of the lock sliding surface will be accelerated, causing a reduction in the holding force and the life of the locking mechanism.

8. **Do not supply 24 VDC power supply continuously to the [BK RLS (Lock release)] terminal.**

Stop supplying 24 VDC power supply to the [BK RLS (Lock release) terminal during normal operation. If power is supplied to the [BK RLS] terminal continuously, the lock will be released, and workpieces may be dropped when the stop signal (EMG) is received.

9. **The actuator may be unable to unlock when the sliding part for locking reaches its life due to the rotation sliding of the shoe during operation. When the lock mechanism reaches its life, please contact SMC sales office for the replacement parts.**

The sliding part for locking may make noise during operation, but this is normal.



Electric Actuators Precautions 5

Be sure to read this before handling products.

Controller (Including Driver) and Peripheral Devices

Design/Selection

⚠ Warning

- 1. Be sure to apply the specified voltage.**
Otherwise, malfunction or breakage may occur. If the applied voltage is lower than the specified voltage, it is possible that the load will not be able to be moved due to an internal voltage drop of the controller. Please check the operating voltage before use.
- 2. Do not operate the product beyond the specifications.**
Otherwise, a fire, malfunction, or actuator damage may result. Please check the specifications before use.
- 3. Install an emergency stop circuit.**
Please install an emergency stop outside of the enclosure so that the system operation can be stopped immediately and the power supply can be intercepted.
- 4. In order to prevent any damage caused by the breakdown or malfunction of the controller and its peripheral devices, a backup system should be established in advance by giving a multiple-layered structure or a fail-safe design to the equipment, etc.**
- 5. If a danger of human injury is expected due to abnormal heat generation, smoking, ignition, etc., of the controller and its peripheral devices, cut off the power supply of the product and the system immediately.**

⚠ Caution

- 1. Use an actuator with the lock option if the actuator will not be mounted horizontally for use.**
Burnout of the internal parts of the controller may occur. If the actuator is not equipped with a lock, it will move and drop the workpiece when the power and servo are turned OFF.

Handling

⚠ Warning

- 1. Do not touch the inside of the controller and its peripheral devices.**
Doing so may cause an electric shock or damage to the controller.
- 2. Do not perform the operation or setting of the product with wet hands.**
Doing so may cause an electric shock.
- 3. Products with damage or those missing any components should not be used.**
An electric shock, fire, or injury may result.
- 4. Use only the specified combination between the electric actuator and controller.**
Failure to do so may cause damage to the actuator or the controller.
- 5. Be careful not to be hit by workpieces while the actuator is moving.**
It may cause an injury.
- 6. Do not connect the power supply or power on the product before confirming the area to which the workpiece moves is safe.**
The movement of the workpiece may cause an accident.
- 7. Do not touch the product when it is energized and for some time after power has been disconnected, as it is very hot.**
Doing so may lead to a burn due to the high temperature.

Handling

⚠ Warning

- 8. Before installation, wiring, and maintenance, the voltage should be checked with a tester 5 minutes after the power supply has been turned off.**
Otherwise, an electric shock, fire, or injury may result.
- 9. Static electricity may cause malfunction or break the controller. Do not touch the controller while power is supplied.**
When touching the controller for maintenance, take sufficient measures to eliminate static electricity.
- 10. Do not use the product in an area where dust, powder dust, water, chemicals, or oil is in the air.**
It will cause failure or malfunction.
- 11. Do not use the product in an area where a magnetic field is generated.**
It will cause failure or malfunction.
- 12. Do not install the product in an environment containing flammable gas, explosive gas, or corrosive gas.**
It could lead to fire, explosion, or corrosion.
- 13. Radiant heat from strong heat sources, such as a furnace, direct sunlight, etc., should not be applied to the product.**
It will cause failure of the controller or its peripheral devices.
- 14. Do not use the product in an environment subject to a temperature cycle.**
It will cause failure of the controller or its peripheral devices.
- 15. Do not use the product in a place where surges are generated.**
When there are units that generate a large amount of surge around the product (e.g. solenoid type lifters, high-frequency induction furnaces, motors, etc.), this may cause deterioration or damage to the product's internal circuit. Avoid sources of surge generation and crossed lines.
- 16. Do not install the product in an environment under the effect of vibrations and impacts.**
It will cause failure or malfunction.
- 17. When a surge-generating load, such as a relay or solenoid valve, is driven directly, use a product that incorporates a surge absorption element.**
- 18. The power supplies should be separated between the controller power and the I/O signal power, and both power supplies must not be of the "inrush-current limited" type.**
If the power supply is of the "inrush-current limited" type, a voltage drop may occur during the acceleration or deceleration of the actuator.



Electric Actuators Precautions 6

Be sure to read this before handling products.

Controller (Including Driver) and Peripheral Devices

Installation

⚠ Warning

1. **Install the controller and its peripheral devices on a fire-proof material.**
Direct installation on or near a flammable material may cause a fire.
2. **Do not install the product in a place subject to vibrations and impacts.**
It will cause failure or malfunction.
3. **Do not mount the controller and its peripheral devices together with a large-sized electromagnetic contactor or no-fuse breaker, which generate vibration, on the same panel. Mount them on different panels, or keep the controller and its peripheral devices away from such a vibration source.**
4. **Install the controller and its peripheral devices on a flat surface.**
If the mounting surface is distorted or uneven, an unacceptable force may be added to the housing, etc., causing problems.
5. **Take measures to ensure that the operating temperatures of the controller and its peripheral devices are within the range of the specifications. Also, the controller should be installed with spaces between its sides and the other structures or components.**
Failure to do so may cause the malfunction of the controller and its peripheral devices or a fire.

Power Supply

⚠ Caution

1. **Use a power supply that has low noise between lines and between the power and ground.**
In cases where noise is high, an isolation transformer should be used.
2. **To prevent lightning surges, appropriate measures should be taken. Ground the surge absorber for lightning separately from the grounding of the controller and its peripheral devices.**

Grounding

⚠ Warning

1. **Be sure to carry out grounding in order to ensure the noise tolerance.**
2. **Dedicated grounding should be used.**
Grounding should be to a D-class ground. (Ground resistance of 100 Ω or less)
3. **Grounding should be performed near the controller and its peripheral devices to shorten the grounding distance.**
4. **In the unlikely event that a malfunction is caused by the ground, please disconnect it.**

Wiring

⚠ Warning

1. **Do not apply any excessive force to cables, such as repeated bending, tensioning, or placing a heavy object on the cables.**
It may cause an electric shock, fire, or the breaking of a wire.
2. **Connect wires and cables correctly.**
Incorrect wiring could break the controller or its peripheral devices depending on the seriousness.
3. **Do not connect wires while power is being supplied.**
It may cause the controller to break or its peripheral devices could be damaged, causing a malfunction.
4. **Do not carry the product by holding its cables.**
It may cause an injury or damage to the product.
5. **Do not connect power or high-voltage cables in the same wiring path as the unit.**
The product can malfunction due to noise and surge voltage interference in the signal line from the power and high-voltage cables.
Separate the wiring of the controller and its peripheral devices from that of the power and high-voltage cables.
6. **Confirm wiring insulation.**
Insulation failure (interference with other circuits, poor insulation between terminals, etc.) could introduce excessive voltage or current to the controller or its peripheral devices and damage them.

Maintenance

⚠ Warning

1. **Perform a maintenance and inspection periodically.**
Confirm wiring and screws are not loose.
Loose screws or wires may cause unintentional malfunction.
2. **Conduct an appropriate functional inspection after completing the maintenance and inspection.**
At times where the equipment or machinery does not operate properly, conduct an emergency stop of the system. Otherwise, an unexpected malfunction may occur and it will become impossible to ensure safety. Conduct a test of the emergency stop in order to confirm the safety of the equipment.
3. **Do not disassemble, modify, or repair the controller and its peripheral devices.**
4. **Do not put anything conductive or flammable inside of the controller.**
It may cause a fire.
5. **Do not conduct an insulation resistance test or withstand voltage test on this product.**
6. **Ensure sufficient space for maintenance activities.**
Design the system allowing the required space for maintenance and inspection.



Air Preparation Equipment 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. To select equipment, thoroughly confirm the purpose, specification requirements, and the operating conditions, such as pressure, flow rate, temperature, environment, and power supply. Then, make a selection based on the latest catalog, making sure not to exceed the specification ranges. If something is not clear, please contact SMC before making a selection.

3. Provide a design that prevents high temperature compressed air from flowing into the outlet side of cooling equipment.

If the flow of the cooling water in a water-cooled aftercooler is stopped, or if the fan motor of an air-cooled aftercooler is stopped, the hot compressed air will flow to the outlet side of the cooling equipment, causing the equipment on the outlet side to break or malfunction.

4. Provide a design in which interruptions in the supply of compressed air are taken into consideration.

There are cases in which compressed air cannot flow due to the freezing of a refrigeration air dryer or the malfunction of a heatless dryer in the switching valve.

5. Do not use this product for caisson shielding, breathing, medical use, medicine that is injected by humans, or for blowing air on food products.

The air preparation equipment has been designed exclusively for industrial compressed air, and it should not be used for any other purpose. If the product needs to be used under such conditions unavoidably, make sure to take appropriate safety measures and contact SMC beforehand.

6. Do not use this product on board a vehicle or a vessel.

This product must not be installed and used on board a conveyance, such as a vehicle or a vessel, since it may become damaged due to vibrations. If the product needs to be used under such conditions unavoidably, please contact SMC beforehand.

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

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

Caution

1. Design a layout in which the leakage of cooling water and the dripping of condensation are taken into consideration.

With a water-cooled aftercooler that uses cooling water, water leakage may occur due to freezing. Depending on the operating conditions, a refrigerated air dryer and its downstream pipes may drip water due to condensation formed by supercooling. Please attach a thermal insulator, etc.

Caution

2. Provide a design that prevents back pressure and backflow.

The generation of back pressure and backflow could lead to equipment damage. Take appropriate safety measures and follow proper installation procedures.

3. Do not introduce an air flow that is greater than the rated flow rate.

If the rated flow rate is exceeded even momentarily, it could cause insufficient moisture elimination, drainage or oil splash on the outlet side, or lead to equipment damage.

4. Do not use with low air pressure (blower).

The air preparation equipment, which operates at a specific minimum operating pressure in accordance with the equipment to be used, is designed to be used exclusively with compressed air. Using it below the minimum operating pressure could lower its performance or cause a malfunction. If the product needs to be used under such conditions unavoidably, please contact SMC beforehand.

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.

Caution

1. Confirm the installation position.

Because the installation position differs by model, refer to the catalog or the operation manual for confirmation. If the equipment is installed slanted, it could lead to improper drainage, causing the auto drain to malfunction or damage to the equipment.

2. Provide ventilation space.

Unless the necessary ventilation space for each piece of equipment is provided, the air-cooled aftercooler or the refrigerated air dryer's cooling performance could decline or the equipment could stall.

Piping

Warning

1. Hold the female thread side and tighten to the recommended torque when screwing in the piping material.

Insufficient tightening torque may cause loosening or defective sealing. Excessive tightening torque may damage the thread, etc. If it is tightened without holding the female thread side, excessive force will be directly applied to the piping bracket, resulting in a product failure.

Recommended Torque

Unit: N·m

Connection thread	1/8	1/4	3/8	1/2	3/4	1	1 1/2	2
Torque	7 to 9	12 to 14	22 to 24	28 to 30	28 to 30	36 to 38	48 to 50	48 to 50

* After tightening by hand, use a tightening tool to tighten an additional 1/6 turn.



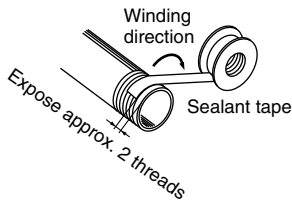
Air Preparation Equipment Precautions 2

Be sure to read this before handling products.

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 1.5 to 2 thread ridges exposed at the end of the threads.



4. **Take measures to prevent drainage from accumulating in the piping.**
Design the piping so that a drain relief is provided at the bottom of a riser pipe, or a slight taper is provided along the flow to prevent drainage from accumulating.
5. **Confirm the IN and OUT sides.**
When connecting the piping, do not mistake the IN side for the OUT side or vice versa.

Wiring

⚠ Warning

1. **Mounting a dedicated breaker**
To operate air preparation equipment that uses electricity (such as an air-cooled aftercooler or air dryer), install a leakage breaker with an appropriate leakage sensitivity and load capacity on the power supply side to prevent electric shocks or motor damage. Refer to the breaker specifications in the catalog or in the operation manual.
2. **Confirm the power supply voltage.**
Operating the equipment with a voltage that is out of specification could lead to a fire or a malfunction. Confirm the power supply and the voltage before wiring. The voltage fluctuation must be within $\pm 10\%$ of the specified value.
3. **Handle the wires carefully.**
To prevent fire or electric shocks, do not bend, twist, or pull on the power supply cords or wires.
4. **Wire with an appropriate size terminal.**
When connecting a power supply cord to equipment with a terminal box, use a terminal applicable to the terminal box. If an incorrect terminal size is used, it may cause a fire.
5. **Have the wiring done by a qualified professional.**
Only a qualified professional should perform wiring, such as mounting the breaker, wiring the breaker to other equipment, or connecting to the terminal block.

Wiring

⚠ Caution

1. **Installing ground**
To operate air preparation equipment that uses electricity (such as an air-cooled aftercooler or air dryer), provide a ground connection to prevent earth leakage. Do not connect the ground wire to a water pipe or a gas pipe due to the risk of explosion.
2. **Confirm the color of the wires and terminal numbers before wiring.**
Before connecting the wires, confirm the color of the wires and terminal numbers in the operation manual or on the electrical wiring diagram name plate. Improper wiring could cause the electrical parts to become damaged, malfunction, or operate improperly.
3. **Precautions for connecting a 3-phase power supply**
Make sure to correctly connect the R, S, and T terminals to equipment that uses a 3-phase power supply. If the terminals are connected improperly, the fan of the air-cooled aftercooler will rotate in reverse, and the refrigerated air dryer will not operate because the reverse phase relay will trip. In such cases, interchange two of the three power supply wires (except IDF370B).

Air Supply

⚠ Warning

1. **Type of fluids**
Please consult with SMC when using the product in applications other than compressed air.

⚠ Caution

1. **Do not use compressed air that contains chemicals, organic solvents, or corrosive gases.**
Do not use compressed air that contains chemicals, organic solvents, salt, or corrosive gases, as it can cause damage or malfunction.



Air Preparation Equipment Precautions 3

Be sure to read this before handling products.

Operating Environment

⚠ Warning

- 1. Do not operate under the conditions listed below due to a risk of malfunction.**
 - 1) In locations containing corrosive gases, organic solvents, and chemical solutions, or in locations in which these elements are likely to adhere to the equipment
 - 2) In locations in which sea water, water, or water steam could come in contact with the equipment
 - 3) In locations that are exposed to direct sunlight (Shield the equipment from sunlight to prevent its resin material from ultraviolet ray degradation or overheating.)
 - 4) In locations that have a heat source and poor ventilation (Shield the equipment from heat sources to protect it from softening degradation due to radiated heat.)
 - 5) In locations that are exposed to shocks and vibrations
 - 6) In locations with high humidity or large amounts of dust (Please contact SMC beforehand.)
- 2. Do not operate this equipment outdoors.**

All air preparation equipment is generally designed for indoor use. Exposing the equipment to rain could lead to electrical shock, equipment damage, or malfunction. If the equipment needs to be used under such conditions unavoidably, please contact SMC beforehand.
- 3. Adhere to the specified fluid temperature and ambient temperature ranges.**

The fluid temperature and the ambient temperature are established according to the equipment. Using the equipment outside of its specification range could cause it to be damaged, malfunction, or operate improperly.

Maintenance

⚠ Warning

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

If handled improperly, malfunction or damage of machinery and equipment may occur.
- 2. Maintenance work**

If handled improperly, compressed air can be dangerous. Assembly, handling, repair, and element replacement of pneumatic systems should be performed by a knowledgeable and experienced person.
- 3. 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 pressure and electric power, and exhaust all compressed air from the system using the residual pressure release function.

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.
- 4. If an abnormal condition occurs, turn off the power supply and stop the flow of compressed air.**

If an abnormal condition occurs, such as smoke, foul smell, or noise, immediately turn off the power supply, stop the flow of compressed air, and set the pressure of the compressed air to zero because there is a possible risk of electrical shock or fire.
- 5. Do not place your hands or foreign matter inside the unit.**

When operating air preparation equipment (such as an air-cooled aftercooler or air dryer) to which power is supplied, do not place your hands or foreign matter inside the unit, as there is a danger of electrical shock, burns, or injury. If the equipment must be used under such conditions due to unavoidable circumstances, turn off the power supply of the equipment, and confirm that it has stopped.

Maintenance

⚠ Warning

- 6. For inspection, disengage the breaker or pull out the power supply plug.**

To prevent electrical shock, burns, or injury during inspection, disengage the breaker or disconnect the power supply plug before inspecting the equipment.
- 7. Do not touch high-temperature areas.**

Do not touch the aftercooler (through which high-temperature compressed air flows), the refrigeration unit of the refrigerated air dryer, or refrigerant piping because each generates high heat and poses a risk of burns.
- 8. Set the pressure of the compressed air to zero before an inspection.**

Before disassembling the equipment on the compressed air side to inspect the auto drain or replace the filter element, confirm that the pressure is set to zero.
- 9. The adjustment of the safety valve and periodical voluntary inspection of class-2 pressure vessels is required by the Ordinance on Safety of Boilers and Pressure Vessels. Conduct the inspection according to the mentioned ordinance.**

⚠ Caution

- 1. Do not place a heavy object on top of equipment or use it as a step stool.**

Failure to observe this precaution could cause the equipment to become deformed or damaged, and a loss of balance could cause a fall or injury.
- 2. Discharge the drainage on a regular basis.**

If drain remains accumulated in the equipment or in the piping, it could cause the equipment to operate improperly, or the drain could splash to the outlet side, leading to unforeseen accidents. Therefore, check the drainage volume and the operation of the auto drain on a daily basis.
- 3. Additional tightening of the screws for the wire connection terminals**

Depending on the operating conditions, the screws for the wire connection terminals could loosen, leading to overheating or a fire. As a preventive measure, tighten the screws on a regular basis.
- 4. Use sufficient care in the disposal of refrigeration type air dryers.**

Some refrigerated air dryers use a refrigerant that destroys the ozone layer. Please consult with a professional contractor when collecting a refrigerant or disposing of such equipment.
- 5. Turn off the power supply at the source if the equipment will not be used for long periods of time.**

To prevent accidents, turn off the power supply at the source if the equipment will not be used for long periods of time.
- 6. Keep the Class-2 Pressure Vessel Certificate in a safe place.**

Large refrigerated air dryers (IDF190D and larger), large AFF and AMD (AFF220A, AMD900/1000), and air tanks comply with class-2 pressure vessel requirements. A Class-2 Pressure Vessel Certificate will be sent to you in 2 to 4 weeks after the product is shipped. Keep this certificate in a safe place.



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

2. The standard bowl for the air filter, filter regulator, and lubricator, as well as the sight dome for the lubricator are made of polycarbonate. Do not use in an environment where they are exposed to or come in contact with organic solvents, chemicals, cutting oil, synthetic oil, alkali, or thread lock solutions.

Effects of atmosphere of organic solvents and chemicals, and where these elements are likely to adhere to the equipment
Chemical data for substances causing degradation (Reference)

Type	Chemical name	Application examples	Material	
			Polycarbonate	Nylon
Acid	Hydrochloric acid	Acid washing liquid for metals	△	×
	Sulfuric acid, Phosphoric acid			
	Chromic acid			
Alkaline	Sodium hydroxide (Caustic soda)	Degreasing of metals Industrial salts Water-soluble cutting oil	×	○
	Potash			
	Calcium hydroxide (Slack lime)			
	Ammonia water			
	Carbonate of soda			
Inorganic salts	Sodium sulfide	—	×	△
	Potassium nitrate			
	Sulfate of soda			
Chlorine solvents	Carbon tetrachloride	Cleansing liquid for metals Printing ink Dilution	×	△
	Chloroform			
	Ethylene chloride			
	Methylene chloride			
Aromatic series	Benzene	Coatings Dry cleaning	×	△
	Toluene			
Ketone	Acetone	Photographic film Dry cleaning Textile industries	×	×
	Methyl ethyl ketone			
	Cyclohexane			
Alcohol	Ethyl alcohol	Antifreeze Adhesives	△	×
	IPA			
Oil	Gasoline	—	×	○
	Kerosene			
Ester	Phthalic acid dimethyl	Synthetic oil Anti-rust additives	×	○
	Phthalic acid diethyl			
	Acetic acid			
Ether	Methyl ether	Brake oil additives	×	○
	Ethyl ether			
Amino	Methyl amino	Cutting oil Brake oil additives Rubber accelerator	×	×
	—			
Other	Thread-lock fluid	—	×	△
	Seawater			
	Leak tester			

○: Essentially safe △: Some effects may occur ×: Effects will occur

When the above factors are present, or there is some doubt, use a metal bowl for safety.

3. Do not use in such a way as to frequently fill or release the pressure from the standard bowls, such as the air filter, filter regulator, lubricator, etc. Damage to the bowl may occur. A metal bowl is recommended in these cases.

4. Please consult with SMC if the intended application calls for absolutely zero leakage, due to special atmospheric requirements, or if the use of a fluid other than air is required.

5. The mineral grease used on internal sliding parts and seals may come in contact with outlet side components. Please consult with SMC if this is not desirable.

Please contact SMC if the Safety Data Sheet (SDS) of the grease is required.

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

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

Caution

1. Select a model that is suitable for the desired air cleanliness by referring to the SMC Best Pneumatics No. 6 catalog.

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.

Caution

1. To avoid reversed connections of the air inlet/outlet, make connections after confirming the "IN/OUT" marks or arrows that indicate the direction of air flow. Reversed connections can cause a malfunction.

2. Components with a bowl, e.g., an air filter, filter regulator, or lubricator, must be installed vertically with the bowl facing downward so that faulty drain discharge and dripping can be checked.

3. Ensure sufficient top, bottom, and front clearance for maintenance and operation of each component. Refer to the dimensions section for the minimum clearance of each component.



F.R.L. Units Precautions 2

Be sure to read this before handling products.

Piping

⚠ Warning

1. To screw piping material into a component, tighten with the recommended tightening torque while holding the female thread side.

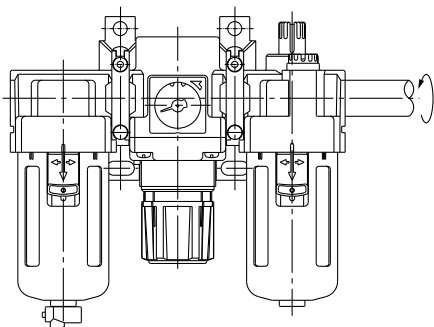
If the tightening torque is insufficient, looseness or seal failure may occur. On the other hand, excess tightening torque can cause damage to the threads. Furthermore, tightening without holding the female thread side can cause damage due to the excess force that is applied directly to the piping bracket.

Recommended Tightening Torque

Unit: N·m

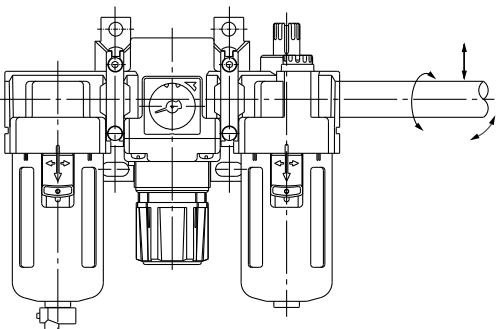
Connection thread	M5	1/8	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2
Torque	1 to 1.5 ^{*1}	7 to 9	12 to 14	22 to 24	28 to 30	28 to 30	36 to 38	40 to 42	48 to 50	48 to 50

*1 After tightening by hand, use a tightening tool to tighten an additional 1/6 to 1/4 turn.



2. Avoid excessive torsional moment or bending moment other than those caused by the equipment's own weight, as this can cause damage.

Support external piping separately.



3. Piping materials without flexibility, such as steel tube piping, are prone to be affected by excess moment loads and vibrations from the piping side. Use flexible tubing in between to avoid such effects.

⚠ Caution

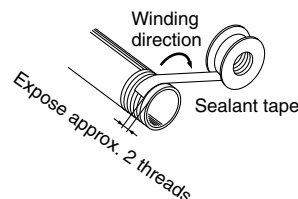
1. Preparation before piping

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

⚠ Caution

2. 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 1.5 to 2 thread ridges exposed at the end of the threads.



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

Air Supply

⚠ Warning

1. Type of fluids

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

2. 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 filters, regulators, and lubricators. Therefore, take appropriate measures to ensure air quality, such as by providing an aftercooler, air dryer, or water separator.

3. Drain flushing

If condensation in the drain bowl is not emptied on a regular basis, the bowl will overflow and allow the condensation to enter the compressed air lines. This causes 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 Air Preparation Equipment Selection Guide (Best Pneumatics No. 6).

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.

When synthetic oil is used for the compressor oil, depending on the type of synthetic oil used or on the conditions of use, there may be adverse effects on the resin of the pneumatic equipment or on the seals if the oil is flowed out to the outlet side. The mounting of a main line filter is recommended in such cases.



F.R.L. Units Precautions 3

Be sure to read this before handling products.

Air Supply

Caution

1. Ensure that the fluid and ambient temperatures are within the specified range.

When using at low temperatures, drain or moisture could solidify or freeze, causing damage to the seals or equipment malfunction. If the fluid temperature is less than 5°C, the moisture in the circuit could freeze, causing damage to the seals or equipment malfunction. Therefore, take appropriate measures to prevent freezing.

For compressed air quality, refer to the Air Preparation Equipment Selection Guide (Best Pneumatics No. 6).

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.

Refer to each construction drawing for information on the materials of F.R.L. units.

- 2. Do not expose the product to direct sunlight for an extended period of time.**
- 3. Do not use in a place subject to heavy vibration and/or shock.**
- 4. Do not mount the product in locations where it is exposed to radiant heat.**

Maintenance

Warning

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

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

2. Maintenance work

If handled improperly, compressed air can be dangerous. Assembly, handling, repair, and element replacement of pneumatic systems should be performed by a knowledgeable and experienced person.

3. Drain flushing

Remove drainage from air filters regularly.

4. 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 pressure and electric power, and exhaust all compressed air from the system using the residual pressure release function.

When machinery is restarted, proceed with caution after confirming that appropriate measures are in place to prevent sudden movement.

5. Perform periodical inspections to detect any cracks, scratches, or other deterioration of the transparent resin bowl of the air filter, filter regulator, and lubricator or the sight dome of the lubricator.

Replace with a new bowl, sight dome, or metal bowl when any kind of deterioration is found. Otherwise, damage may occur.

6. Perform periodical inspections to detect dirt on the transparent resin bowl of the air filter, filter regulator, and lubricator or the sight dome of the lubricator.

When you find dirt on any of the above devices, clean with a mild household cleanser. Do not use other cleaning agents, as damage may occur.

Caution

1. Perform periodical inspections of the filter element and replace it as necessary. Check the element whenever the outlet pressure drops below normal or air does not flow smoothly during operation.



F.R.L. Units Precautions 4

Be sure to read this before handling products.

Regulator/Filter Regulator Design/Selection

⚠ Warning

1. Attach a safety device if damage or malfunction of equipment and devices on the outlet side may result from the output pressure exceeding the set pressure.
2. Residual pressure release (outlet pressure release) is not complete by releasing the inlet pressure. To release residual pressure, select a model with a back-flow mechanism. Using a model without a back-flow mechanism may cause unstable residual pressure release (i.e., residual pressure may or may not be released) depending on the operating conditions.
3. Please contact SMC if air will not be consumed in the system for long periods of time or if the outlet side will be used with a sealed circuit and a balanced circuit, since this may cause the set pressure of the outlet side to fluctuate.
4. Set the outlet pressure range for the regulator at 85% or less of the inlet pressure. If set above 85%, the outlet pressure will be easily affected by fluctuations in the flow rate and inlet pressure, and will become unstable.
5. Since a safety margin is calculated into the maximum regulating pressure value of the set pressure range appearing in the catalog's specification table, the set pressure may exceed the range.
6. Please contact SMC when a circuit requires the use of a regulator having relief sensitivity with high precision and setting accuracy.

⚠ Caution

1. Air consumption is 0.1 L/min. (ANR) or less under standard operation specifications. Please consult with SMC if this value is not allowable.

Mounting

⚠ Caution

1. When adjusting the pressure, unlock the knob first, and relock it after the pressure is set.

Adjustment

⚠ Warning

1. Set the regulator while confirming the displayed values of the inlet and outlet pressure gauges. Turning the knob excessively can cause damage to the internal parts.
2. Do not use a tool on the pressure regulator knob, as this can cause damage. It must be operated by hand.

Regulator/Filter Regulator Adjustment

⚠ Caution

1. Check the inlet pressure before setting.
2. The pressure gauge included with products for 0.02 to 0.2 MPa setting is for up to 0.4 MPa only. Do not apply pressure exceeding 0.4 MPa. It can damage the pressure gauge.
3. To set the pressure using the knob, turn the knob in the direction that increases pressure and lock the knob after the pressure is set. If this is done in the direction that decreases pressure, the pressure may drop from the original set pressure. Turning the knob clockwise increases the outlet pressure, and turning it counterclockwise reduces the pressure.

Lubricator Design/Selection

⚠ Warning

1. Select a lubricator with a fixed throttle when the lubricator is used in high-frequency operations, such as in a press machine.
When selecting a model, it is necessary to select the passage area of the fixed throttle, so please consult with SMC.
2. Lubrication cannot be properly performed if the operating flow rate is too low. Select an appropriately sized lubricator by referring to the minimum dripping flow rate provided in the catalog.
3. Mount a pressure relief 3-port valve on the inlet side, and avoid the use of a lubricator that causes backflow, as this may cause damage to the internal parts.
4. Use a check valve (AKM series) to prevent the backflow of lubricant when the piping is branched at the inlet side.

Piping

⚠ Caution

1. Avoid riser piping and branch lines on the outlet side to prevent inferior lubrication.

Maintenance

⚠ Warning

1. Use class 1 turbine oil (without additives) ISO VG32. Using other lubricant can cause damage to devices or result in malfunction.
2. For the AL10, 20 type, supply the lubricant after releasing the inlet pressure, since the lubricant cannot be applied under pressurized conditions.

⚠ Caution

1. Check the usage rate once a day. If the lubricant is not normally consumed, problems may occur to the lubricated objects.



F.R.L. Units Precautions 5

Be sure to read this before handling products.

Mist Separator/Micro Mist Separator

Design/Selection

⚠ Caution

1. Design the system so that a mist separator and a micro mist separator are installed where a pulsation is not likely to be generated. The pressure difference between the internal and external pressure inside the element should be kept within 0.1 MPa, since exceeding this value can cause damage.

Maintenance

⚠ Warning

1. To prevent damage to the filter element, replace it every 2 years or when the pressure drop becomes 0.1 MPa, whichever comes first.
2. Release the accumulated condensation inside air filter bowls periodically and before the accumulation reaches the maximum capacity. If accumulated condensation flows out to the outlet side, it can cause a malfunction.

Air Filter

Maintenance

⚠ Warning

1. To prevent damage to the element, replace the element every 2 years or when the pressure drop becomes 0.1 MPa, whichever comes first.
2. Release the accumulated condensation inside air filter bowls periodically and before the accumulation reaches the maximum capacity. If accumulated condensation flows out to the outlet side, it can cause a malfunction.

Air Combination

Design/Selection

⚠ Caution

1. When using a 2-unit combination, such as the AC□0A, AC□0B, or AC□0D, secure the top and bottom of the bracket. For a 3-unit, securing the bottom side of the bracket is recommended.
2. The bracket position varies depending on the attachment (T-spacer or pressure switch) mounting.
3. The standard mounting position for a bracket is on the OUT side of each component (the AF, AR, AL, AW, and AFM). For the standard mounting position dimensions for brackets for mounting attachments, refer to Best Pneumatics No. 6.
4. A bracket cannot be mounted on both sides of a T-spacer or a pressure switch.
5. Please contact SMC if you wish to change the bracket mounting position.

Mounting

When using a hexagon socket head cap screw to wall mount an air combination, we recommend using a ballpoint screwdriver.

Float Type Auto Drain

Design/Selection

⚠ Warning

1. Use an auto drain under the following conditions to avoid malfunction.

<N.O. type>

- Operating compressor: 0.75 kW (100 L/min. (ANR)) or more
When using 2 or more auto drains, multiply the above value by the number of auto drains to find the minimum capacity of the required compressors.
Selecting a model with a minimum or larger required capacity is recommended. For example, when using 2 auto drains, a compressor capacity of at least 1.5 kW (200 L/min. (ANR)) is required.
- Operating pressure: 0.1 MPa or more

<N.C. type>

- Operating pressure for AD17/27: 0.1 MPa or more
Operating pressure for AD37/47: 0.15 MPa or more

Piping

⚠ Caution

1. Float type auto drain

Drain piping should be performed under the following conditions to avoid malfunction.

<N.O. type>

- Use piping whose I.D. is ø6.5 or larger, and whose length is 5 m or less. Avoid riser piping.

<N.C. type>

- AD17/27: Use piping with an I.D. of ø2.5 or larger.
AD37/47: Use piping with an I.D. of ø4 or larger.
Length is 5 m or less. Avoid riser piping.

Maintenance

⚠ Caution

1. Turn the knob counterclockwise to release the drainage manually. Avoid applying excessive torque to the knob, such as by using a tool, as this can damage the auto drain.

After releasing the condensation, turn the knob clockwise until it stops.

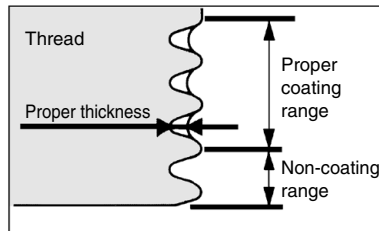
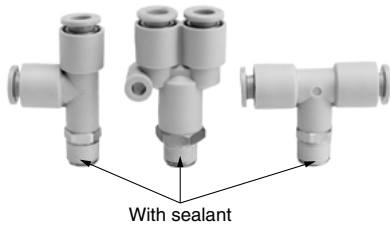
2. Air leakage or other performance malfunctions can occur if premature clogging of the element or pressure drop causes the pressure inside the bowl to deviate from the specified pressure range parameters.

Check the pressure whenever such an irregularity occurs.

For Pneumatic Piping/Fittings & Tubing Prior to Use

Fittings with Sealant

Seal material (fluororesin) is coated on the thread part to the proper thickness and within the proper coating range, which reduces piping work, such as coating the seal on the thread.



Female Thread Conditions Applicable to Face Seals

1. Surface roughness of bearing surface: Rz 25 or less
2. Chamfer dimension: $\phi D1$, Seal bearing surface diameter: $\phi D2$ (Refer to the table below.)
3. Female thread inclination angle: 1° or less
4. Counterbore diameter when the female thread is counterbored: $\phi D3$
 - Models with hexagonal flats: Body width across flats x 1.1 or more
 - Models other than hexagon (Hexagon socket head male connector, etc.): Body dimensions + 0.2 mm or more
- * The width across flats and the body dimensions differ depending on the model even when the same thread size is used. Refer to the dimensions in the catalog.
5. If oil content or sealant is sticking to the female thread, this may cause damage to the product. Remove it before piping.

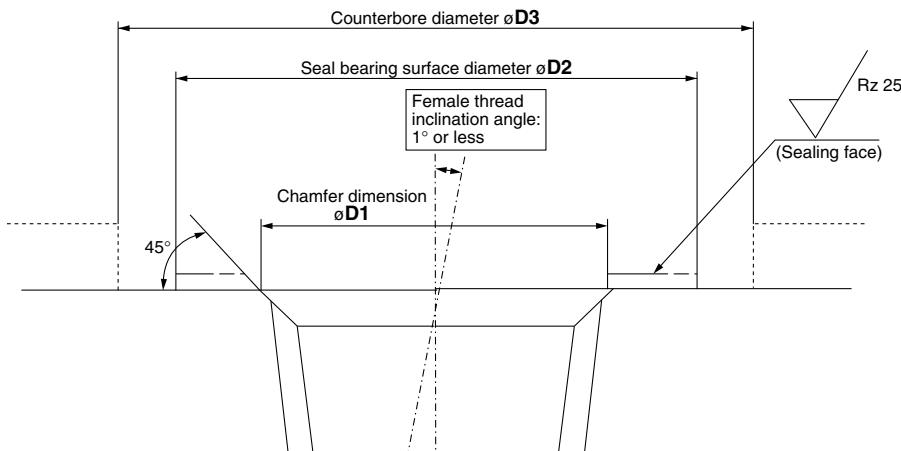


Table 1

Connection thread size	Chamfer dimension $\phi D1$ [mm]	Seal bearing surface diameter $\phi D2$ [mm]
R1/8	10.2 to 10.4	12 or more
R1/4	13.6 to 13.8	17 or more
R3/8	17.1 to 17.3	21 or more
R1/2	21.4 to 21.6	27 or more
NPT1/16	8.2 to 8.4	11.11 or more
NPT1/8	10.5 to 10.7	12.7 or more
NPT1/4	14.1 to 14.3	17.46 or more
NPT3/8	17.4 to 17.6	22 or more
NPT1/2	21.7 to 21.9	28.7 or more
G1/8	10.2 to 10.6	12 or more
G1/4	13.6 to 14.0	17 or more
G3/8	17.1 to 17.5	21 or more
G1/2	21.4 to 21.8	27 or more

Precautions

For products that do not satisfy the female thread conditions shown above and piping with a piping pitch narrower than the product dimension, use the current sealant type.

* The rubber parts of the face seal cannot be replaced.

* An air blow may cause the rubber parts of the face seal to fall off, and they cannot be remounted. Please refrain from performing an air blow.



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

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

3. Check if PTFE can be used in the application.

PTFE powder (Polytetrafluoroethylene resin) is included in the sealant. Confirm that the use of it will not cause any adverse effect on the system.

4. When operating at a high temperature, the fittings and tubing will also become very hot.

Touching the product may result in burns, so be sure to take safety measures before coming into direct contact with the product.

Caution

1. Keep the connection part of fittings and tubing from rotating or oscillating movement. Use rotary One-touch fittings (KS or KX series) in these cases.

The fittings may be damaged if they are used in the above manner.

2. The tubing bending radius in the vicinity of the fitting should be at least the minimum bending radius of the tubing.

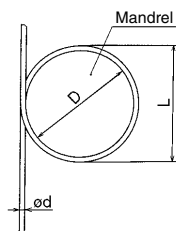
If the bending radius is less than the minimum value, fittings may be damaged, and tubing may crack or be crushed. The minimum bending radius of the FR soft nylon tubing (TRS series), FR double layer tubing (TRB series), antistatic soft nylon tubing (TAS series), polyolefin tubing (TPH series), and soft polyolefin tubing (TPS series) is measured as following in accordance with JIS B 8381.

The tubing deformation ratio at the minimum bending radius is obtained through the following formula, based on tubing diameter and mandrel diameter by winding the same radius mandrel tube.

$$\eta = \left(1 - \frac{L - D}{2d}\right) \times 100$$

Here, η : Deformation ratio [%]
 d : Tubing diameter [mm]
 L : Measured length [mm]
 D : Mandrel diameter [mm]
 (Twice against the minimum bending radius)
 Test temperature: 20 ±5°C
 Relative humidity: 65 ±5%

Tube deformation ratio at the minimum bending radius



3. Do not use fluids other than those listed on the specifications.

Applicable fluids are air and water. Please consult with SMC if using other fluids.

Design / Selection

Caution

4. When used with liquid fluid, the fittings or tubing may be damaged depending on the surge pressure.

5. Depending on the storage or operating environment and the period of storage or use, the surface of the brass (C3604) may blacken. If the discoloration of the brass is a problem, we recommend selecting electroless nickel-plated brass instead.

Example) KQ2H06-01 NS

Mounting / Piping

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. Maintenance space

Allow sufficient space for maintenance and inspection.

3. Adhere to the thread tightening method.

Refer to the "Connection Thread Tightening Method" when mounting the product.

4. There may be cases in which the tubing detaches from the fitting and thrashes around uncontrollably due to tubing degradation or fitting breakage.

To prevent the situation from becoming uncontrollable, fit the tubing with a protective cover or secure it in place.

Caution

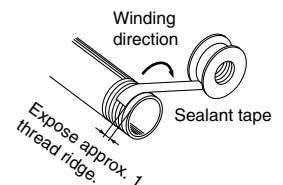
1. Preparation before piping

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

2. Winding of sealant tape

When screwing together pipes, fittings, etc., be certain that chips from the pipe threads and sealant do not get inside the pipe.

Also, if sealant tape is used, leave approx. 1 thread ridge exposed at the end of the threads.



3. Check the model, type, and size before installation. Also, confirm that there are no scratches, gouges, or cracks on the product.

4. When connecting the tubing, take pressure and possible changes to the tubing length into account, and allow a sufficient margin.

Failure to do so may result in fitting breakage or the detachment of the tubing. Refer to the recommended piping conditions.

5. Do not apply unnecessary forces, such as twisting, pulling, moment loads, vibration, impact, etc., on fittings or tubing.

This will cause damage to fittings and will crush, burst, or release tubing.



Fittings & Tubing Precautions 2

Be sure to read this before handling products.

Mounting / Piping

⚠ Caution

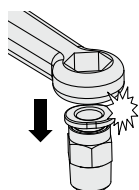
6. Tubing, with the exception of coiled tubing, requires stationary installation. Do not use standard tubing (non-coiled) in applications where tubing is required to travel inside the flexible protection tube. Tubing that travels may sustain abrasion, extension, or severance due to tensile force. The removal of tubing from the fitting may also occur. Use caution prior to use in an application.

7. To install the fitting, screw the fitting into the hexagonal face of the body, and tighten with a suitable wrench.

Affix the wrench at the base of the thread. If the size of the hexagonal face and wrench do not match, or tightening takes place near the tube side, it may cause the collapse or deformation of the hexagonal face, or damage to the equipment. After installing, confirm that there is no damage to the fitting, etc.

8. Interference in oval type release buttons

The following models cannot be used if a box wrench or socket wrench is used.



KQ2 Series

Model	Applicable tubing	Connection thread	Part number
Male connector	ø3.2	M3 x 0.5	KQ2H23-M3G1
	ø3.2	M5 x 0.8	KQ2H23-M5□1
	ø4	M3 x 0.5	KQ2H04-M3G1
	ø4	M5 x 0.8	KQ2H04-M5□1
	ø4	M6 x 1.0	KQ2H04-M6□1
	ø6	M5 x 0.8	KQ2H06-M5□1
	ø6	M6 x 1.0	KQ2H06-M6□1
	ø6	R1/8	KQ2H06-01□S1
	ø1/8	10-32UNF	KQ2H01-32□1
	ø5/32	10-32UNF	KQ2H03-32□1
	ø3/16	10-32UNF	KQ2H05-32□1
	ø5/32	NPT1/16	KQ2H03-33□S1
	ø1/8	M5 x 0.8	KQ2H01-M5□1
	ø3/16	M5 x 0.8	KQ2H05-M5□1
	ø3/16	R1/8	KQ2H05-01□S1
Female connector	ø4	M3 x 0.5	KQ2F04-M3□1
	ø4	M5 x 0.8	KQ2F04-M5□1
	ø6	M5 x 0.8	KQ2F06-M5□1
	ø1/8	10-32UNF	KQ2F01-32□1
	ø5/32	10-32UNF	KQ2F03-32□1
	ø1/8	M3 x 0.5	KQ2F23-M3□1
	ø1/8	M5 x 0.8	KQ2F23-M5□1

□: A (Brass), N (Brass + Electroless nickel plating)

KQ2-G Stainless Steel Series

Model	Applicable tubing	Connection thread	Part number
Male connector	ø4	M5 x 0.8	KQ2H04-M5G1
	ø6	M5 x 0.8	KQ2H06-M5G1
	ø6	R1/8	KQ2H06-01GS1

Air Supply

⚠ Warning

1. Type of fluids

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

Regarding products for general fluids, please contact SMC concerning applicable fluids.

Air Supply

⚠ Warning

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 and allow the condensation to enter the compressed air lines. This causes 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 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.

⚠ Caution

1. Install an air filter.

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

2. Install an aftercooler, air dryer, water separator, etc.

Compressed air containing a large amount of drainage can cause the malfunction of pneumatic equipment. Therefore, take appropriate measures to ensure air quality, such as by providing an aftercooler, air dryer, or water separator.

3. Ensure that the fluid and ambient temperatures are within the specified range.

If the fluid temperature is 5°C or less, the moisture in the circuit could freeze, causing damage to the seals or equipment malfunction. Therefore, take appropriate measures to prevent freezing.

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

Operating Environment

⚠ Warning

1. Do not use in an atmosphere where corrosive gases, chemicals, sea water, water, or water steam are present. Do not use in cases where there is direct contact with any of the above.

Refer to each construction drawing for information on the materials of fittings and tubing.

2. Do not expose the product to direct sunlight for an extended period of time.

3. Do not use in a place subject to heavy vibration and/or impact.

4. Do not mount the product in locations where it is exposed to radiant heat.

5. Do not use ordinary fittings and tubing in locations where static electricity would be problematic.

This may result in system failure or other problems. In such places, the use of antistatic fittings (KA series) and antistatic tubing (TA series) is recommended.



Fittings & Tubing Precautions 3

Be sure to read this before handling products.

Operating Environment

⚠ Warning

6. Do not use ordinary fittings and tubing in locations where spatter is generated.

Spattering may result in a fire hazard. In such places, the use of flame resistant fittings (KR/KRM series) and flame resistant tubing (TRS/TRB/TRBU/RTU series) is recommended.

7. Do not use in an environment where the product is directly exposed to cutting oil, lubricant, coolant oil, etc.

Please contact SMC if using in an environment exposed to cutting oil, lubricant, coolant oil, etc.

8. Take caution when nylon tubing and soft nylon tubing are used in a clean room.

The antioxidant on the surface of the tubing may come off, thereby lowering the cleanliness level.

9. Do not use in environments where foreign matter may stick to the product or get mixed in the product's interior.

This may cause leakage or the disconnection of the tubing.

Maintenance

⚠ Warning

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

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

2. Maintenance work

If handled improperly, compressed air can be dangerous. The assembly, handling, repair, and element replacement of pneumatic systems should be performed by a knowledgeable and experienced person.

3. Drain flushing

Remove drainage from air filters regularly.

4. 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 pressure and electric power, and exhaust all compressed air from the system using the residual pressure release function.

When the equipment is restarted, proceed with caution after confirming that appropriate measures are in place to prevent sudden movement.

⚠ Caution

1. Be certain to wear safety glasses at all times during periodical inspections.

2. Replace fittings or tubing having the following problems.

- 1) Cracks, gouges, wearing, corrosion
- 2) Air leakage
- 3) Twists or crushing of tubing
- 4) Hardening, deterioration, softening of tubing

3. When replacing tubes or fittings, do not try to mend or repair and then reuse them.

One-touch Fittings

Mounting / Piping

⚠ Caution

1. Installation and removal of tubing for One-touch fittings

1) Installation of tubing

- (1) Cut the tubing perpendicularly, being careful not to damage the outside surface. Use an SMC tube cutter TK-1, 2, 3, 5, or 6. Do not cut the tubing with pliers, nippers, scissors, etc., otherwise the tubing will be deformed and problems may result.
- (2) The outside diameter of the polyurethane tubing swells when internal pressure is applied to it. Therefore, it may be impossible to re-insert the tubing into the One-touch fitting. Check the tubing outside diameter, and when the accuracy of the outside diameter is +0.07 mm or larger for $\phi 2$, +0.15 mm or larger for other sizes, re-insert it into the One-touch fitting without cutting the tubing. When the tubing is re-inserted into the One-touch fitting, confirm that the tubing goes through the release button smoothly.
- (3) Grasp the tubing, and slowly push it straight (0 to 5°) into the One-touch fitting until it comes to a stop.
- (4) Pull the tubing back gently to make sure it has a positive seal. Insufficient installation may cause air to leak or the tubing to release.

As a guide for checking if the tubing is pulled out or not, refer to the following table.

Tubing size	Tensile force of tubing [N]
$\phi 2$, 3.2, 1/8"	5
$\phi 4$, 5/32", 3/16"	8
$\phi 6$, 1/4"	12
$\phi 8$, 5/16"	20
$\phi 10$, 3/8"	30
$\phi 12$, 1/2"	35
$\phi 16$	50

2) Removal of tubing

- (1) Push the release button flange evenly and sufficiently to release the tube. Do not push in the tubing before pressing the release button.
- (2) Pull out the tubing while keeping the release button depressed. If the release button is not held down sufficiently, the tubing cannot be withdrawn.
- (3) To reuse the tubing, remove the previously lodged portion of the tubing. If the lodged portion is left on without being removed, it may result in air leakage and make the removal of the tubing difficult.

2. Connecting products with metal rods

Products with metal rods (KC series, previous KQ series, KN series, KM series, etc.) cannot be connected to KQ2 series One-touch fittings. If connected, the metal rod cannot be retained by the chuck of the One-touch fitting, and products with metal rods may project during pressurization, causing serious personal injury or accident.

Even when products with metal rods can be connected to other One-touch fittings, do not use any tube, resin plug, or reducer after connection. This may cause releasing.

For details about One-touch fittings that can connect to products with metal rods, contact SMC.



Fittings & Tubing Precautions 4

Be sure to read this before handling products.

Connection Thread Tightening Method

1. Connection thread: M3

First, tighten by hand, then use a suitable wrench to tighten the hexagonal portion of the body an additional 1/4 turn. The reference value for the tightening torque is 0.4 to 0.5 N·m.

2. Connection thread: M5 and 10-32UNF

First, tighten by hand, then use a suitable wrench to tighten the hexagonal portion of the body an additional 1/6 to 1/4 turn. The reference value for the tightening torque is 1 to 1.5 N·m.

3. Connection thread: M6

First, tighten by hand, then use a suitable wrench to tighten the hexagonal portion of the body an additional 1/6 to 1/4 turn.

* Excessive tightening may damage the thread portion or deform the gasket and cause air leakage. Insufficient tightening may loosen the threads or cause air leakage.

4. Fittings with sealant: R, NPT

1) First, tighten the fitting by hand, then use a suitable wrench to tighten the hexagonal portion of the body a further two or three turns.

To find the appropriate tightening torque, see the table below.

Connection thread size (R, NPT)	Tightening torque [N·m]
1/16, 1/8	3 to 5
1/4	8 to 12
3/8	15 to 20
1/2	20 to 25

2) If the fitting is tightened with excessive torque, a large amount of sealant will seep out. Remove the excess sealant.

3) Insufficient tightening may cause seal failure or loosen the threads.

4) For reuse

(1) Normally, fittings with a sealant can be reused up to 2 to 3 times.

(2) To prevent air leakage through the sealant, remove any loose sealant stuck to the fitting by blowing air over the threaded portion.

(3) If the sealant no longer provides effective sealing, wind sealant tape over the sealant before reusing. Do not use any form other than the tape type of sealant.

(4) Once the fitting has been tightened, backing it out to its original position often causes the sealant to become defective. Air leakage will occur.

5. Face seal fittings: R, NPT, G

1) Tighten fittings with sealant using the proper tightening torques in the table below.

Connection thread size (R, NPT, G)	Proper tightening torque [N·m]
1/16, 1/8	3 to 5
1/4	8 to 12
3/8	15 to 20
1/2	20 to 25

2) Insufficient tightening may cause seal failure or loosen the threads.

3) For reuse

(1) Normally, fittings with a sealant can be reused up to 6 to 10 times.

(2) The seal ring cannot be replaced.

6. Uni thread fittings

1) First, tighten the threaded portion by hand, then use a suitable wrench to tighten the hexagonal portion of the body further at the appropriate wrench tightening angle shown below. For the reference value for the tightening torque, refer to the table below.

Connection Female Thread: Rc, NPT, NPTF

Uni thread size	Wrench tightening angle after hand-tightening [deg]	Tightening torque [N·m]
1/8	30 to 60	3 to 5
1/4	30 to 60	8 to 12
3/8	15 to 45	14 to 16
1/2	15 to 30	20 to 22

Connection Female Thread: G

Uni thread size	Wrench tightening angle after hand-tightening [deg]	Tightening torque [N·m]
1/8	30 to 45	3 to 4
1/4	15 to 30	4 to 5
3/8	15 to 30	8 to 9
1/2	15 to 30	14 to 15

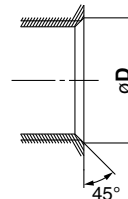
2) The gasket can be reused up to 6 to 10 times. It can be replaced easily when it has sustained damage. A broken gasket can be removed by holding it and then turning it in the same direction as loosening the thread. If the gasket is difficult to remove, cut it with nippers, etc. In such a case, use caution not to scratch the seat face because the seat face of the fitting's 45° gasket is the sealing face.

Chamfer Dimensions for Female Threads

Caution

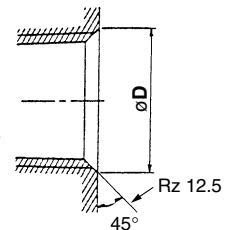
1. Chamfer dimensions for female connection threads M3, M5, 10-32UNF

In compliance with ISO 16030 Standards (air pressure fluid dynamics – connection – ports and stud ends), the chamfer dimensions shown below are recommended. By chamfering as shown in the following table, machining of threads is easier and effective for burr prevention.



Connection thread size	Chamfer dimension øD (Recommended value) [mm]
M3	3.1 to 3.4
M5	5.1 to 5.4
10-32UNF	5.0 to 5.3

2. Chamfer dimensions of R and NPT threads with sealant, and Uni threads



Connection thread size	Chamfer dimension øD (Recommended value)		
	G	Rc	NPT, NPTF
1/16	—	—	8.2 to 8.4
1/8	10.2 to 10.6	10.2 to 10.4	10.5 to 10.7
1/4	13.6 to 14.0	13.6 to 13.8	14.1 to 14.3
3/8	17.1 to 17.5	17.1 to 17.3	17.4 to 17.6
1/2	21.4 to 21.8	21.4 to 21.6	21.7 to 21.9

* For Uni threads, Rz 12.5 is necessary for sealing at the chamfered part.



Fittings & Tubing Precautions 5

Be sure to read this before handling products.

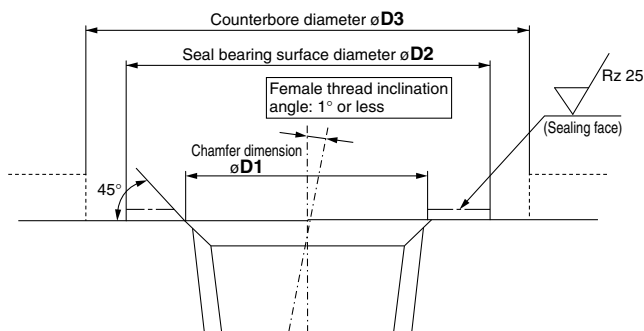
Chamfer Dimensions for Female Threads

⚠ Caution

3. Chamfer dimensions for female threads of face seal fittings (R, NPT, G)

- 1) Surface roughness of bearing surface: Rz 25 or less
- 2) Chamfer dimension: $\phi D1$, Seal bearing surface diameter: $\phi D2$
(Refer to the table below.)
- 3) Female thread inclination angle: 1° or less
- 4) Counterbore diameter when the female thread is counterbored: $\phi D3$
 - Models with hexagonal flats: Body width across flats x 1.1 or more
 - Models other than hexagon (Hexagon socket head male connector, etc.): Body dimensions + 0.2 mm or more
 - * The width across flats and the body dimensions differ depending on the model even when the same thread size is used. Refer to the dimensions in the catalog.
- 5) If oil content or sealant is sticking to the female thread, this may cause damage to the product. Remove it before piping.

Connection thread size	Chamfer dimension $\phi D1$ [mm]	Seal bearing surface diameter $\phi D2$ [mm]
R1/8	10.2 to 10.4	12 or more
R1/4	13.6 to 13.8	17 or more
R3/8	17.1 to 17.3	21 or more
R1/2	21.4 to 21.6	27 or more
NPT1/16	8.2 to 8.4	11.11 or more
NPT1/8	10.5 to 10.7	12.7 or more
NPT1/4	14.1 to 14.3	17.46 or more
NPT3/8	17.4 to 17.6	22 or more
NPT1/2	21.7 to 21.9	28.7 or more
G1/8	10.2 to 10.6	12 or more
G1/4	13.6 to 14.0	17 or more
G3/8	17.1 to 17.5	21 or more
G1/2	21.4 to 21.8	27 or more



Recommended Piping Conditions

1. When connecting piping to the One-touch fitting, use a pipe length with sufficient margin, in accordance with the piping conditions shown in Fig. 1.

Also, when using a tying band, etc., to bind the piping together, make sure that external force does not come to bear on the fitting. (See Fig. 2.)

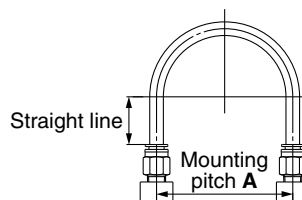


Fig. 1 Recommended piping

Unit: [mm]

Tubing size	Mounting pitch A			Straight line length
	Nylon tubing	Soft nylon tubing	Polyurethane tubing	
$\phi 2$	—	—	13 or more	10 or more
$\phi 3.2, 1/8"$	44 or more	35 or more	25 or more	16 or more
$\phi 4, 5/32"$	56 or more	44 or more	26 or more	20 or more
$\phi 3/16"$	67 or more	52 or more	38 or more	24 or more
$\phi 6$	84 or more	66 or more	39 or more	30 or more
$\phi 1/4"$	89 or more	70 or more	57 or more	32 or more
$\phi 8, 5/16"$	112 or more	88 or more	52 or more	40 or more
$\phi 10$	140 or more	110 or more	69 or more	50 or more
$\phi 3/8"$	134 or more	105 or more	69 or more	48 or more
$\phi 12$	168 or more	132 or more	88 or more	60 or more
$\phi 1/2"$	178 or more	140 or more	93 or more	64 or more
$\phi 16$	224 or more	176 or more	114 or more	80 or more

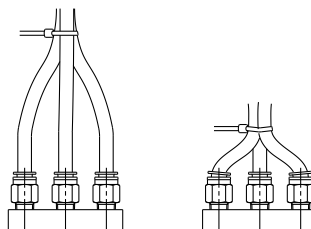


Fig. 2 When using a tying band to bind the piping together

Tubing Design / Selection

⚠ Caution

1. When using tubing from a manufacturer other than SMC, be careful of the tolerance of the tubing O.D. and tubing material.

- 1) Nylon tubing Within ± 0.1 mm
- 2) Soft nylon tubing Within ± 0.1 mm
- 3) Polyurethane tubing Within $+0.15$ mm, Within -0.2 mm

Do not use tubing which does not satisfy the specified tubing O.D. accuracy, or tubing with an I.D., material, hardness, or surface roughness that differs from SMC's tubing. Please consult SMC if anything is unclear. It may cause difficulty in connecting the tubing, leakage, disconnection of the tubing, or fitting damage.

When used with tubing other than those from SMC, due to their properties, the products listed below are not subject to warranty.

KQG2, KQB2, KFG2, KF, $\phi 2M$

2. When using fittings other than those from SMC, be certain to confirm that the operating conditions are such that no problems will arise.



Flow Control Equipment 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. Products mentioned in this catalog are not designed for use as stop valves with zero air leakage.

A certain amount of leakage is allowed in the products' specifications. Tightening the needle to reduce leakage to zero may result in equipment damage.

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

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

4. The flow rate characteristics for each product are representative values.

The flow rate characteristics are characteristics of each individual product. Actual values may differ depending on the piping, circuitry, pressure conditions, etc. Also, depending on product specifications, there may be variations in the zero needle rotations position of the flow rate characteristics.

5. Sonic conductance (C) and critical pressure ratio (b) values for products are representative values.

For controlled flow direction values the needle is fully open. For free flow direction values the needle is fully closed.

6. Check if PTFE can be used in the application.

PTFE powder (Polytetrafluoroethylene resin) is included in the seal material of the male thread type piping taper thread. Confirm that the use of it will not cause any adverse effects on the system. Please contact SMC if the Safety Data Sheet (SDS) is required.

7. Speed controllers are designed to control the speed of the actuator.

When it is used for adjusting the flow rate of the air blow, use a restrictor without a check valve function (X214 or X21).

Mounting

⚠ Warning

1. Operation manual

Install the product and operate it 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.

Mounting

⚠ Warning

4. Screw the R screw into the Rc thread and the NPT screw into the NPT thread.

5. Confirm that the lock nut is tightened.

A loose lock nut may cause speed changes in the actuator.

6. Check the degree of rotation of the needle valve.

Products mentioned in this catalog are retainer types, so the needle is not removed completely. Over rotation will cause damage.

7. Do not use tools, such as pliers, to rotate the knob.

This can cause the idle rotation of the knob or damage.

8. Confirm the air flow direction.

Mounting backwards is dangerous because the speed adjustment needle will not work, and the actuator may lurch suddenly.

9. Adjust the needle by opening the needle slowly after having closed it completely.

Loose needle valves may cause unexpected sudden actuator extension. When a needle valve is turned clockwise, it is closed and cylinder speed decreases. When a needle valve is turned counterclockwise, it is open and cylinder speed increases.

10. Do not apply excessive force or shock to the body or fittings with an impact tool.

This can cause damage or air leakage.

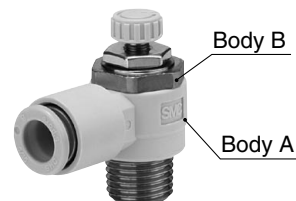
11. Refer to the Fittings and Tubing Precautions (pages 52 to 56) for handling One-touch fittings.

12. Tubing O.D. $\varnothing 2$

Tubing other than that from SMC cannot be used because it may result in the inability to connect the tube, air leakage after connecting the tube, or disconnection of the tube.

13. To install/remove flow control equipment, use an appropriate wrench to tighten/loosen the supplied nut on body B as close to the thread as possible.

Do not apply torque at other points, as the product may be damaged. Rotate body A manually for positioning after installation.



14. Do not use body A and universal type fittings for applications involving continuous rotation.

Body A and the fitting section may be damaged.



Flow Control Equipment Precautions 2

Be sure to read this before handling products.

Mounting

⚠ Caution

1. Tightening the threaded portion of the connection thread M3, M5, 10-32 UNF

1) M3

First, tighten it by hand, then give it an additional 1/4 turn with a wrench. The reference value for the tightening torque is 0.4 to 0.5 N·m.

* AS12□1F-M3-02 should be given an approx. 1/6 turn after tightening by hand (reference value: 0.4 to 0.5 N·m).

2) M5 and 10-32UNF

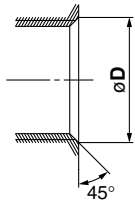
First, tighten it by hand, then give it an additional 1/6 turn to 1/4 turn with a wrench. The reference value for the tightening torque is 1 to 1.5 N·m.

* Excessive tightening may damage the thread portion or deform the gasket and cause air leakage.

If the screw is too shallowly screwed in, it may come loose or air may leak.

2. Chamfered female thread size of the connection thread M3, M5, 10-32UNF

In compliance with ISO16030 Standards (air pressure fluid dynamics – connection – ports and stud ends), the chamfered thread sizes shown below are recommended.



Female thread size	Chamfer dimension ØD (Recommended value)
M3	3.1 to 3.4
M5	5.1 to 5.4
10-32UNF	5.0 to 5.3

3. The proper tightening torques for hexagon lock nuts are shown in the table below. For standard installation, turn 15 to 30° using a tool, after fastening by hand.

Pay attention not to over tighten the product. Check the dimensions for each product for the width across flats.

Body size	Proper tightening torque (N·m)	Lock nut width across flats
M3	0.07	5 *1
M5	0.3 *2	7 *1
1/8	1 *3	10 *4
1/4	1.2 *3	12 *5
3/8	2	14
1/2	6	17

*1 4.5 for AS12□1F-M3-02, AS12□1F-M5-02, and AS1200-M3

*2 0.07 N·m for AS12□1F-M5-02, AS1□□1FM, AS12□0M, and ASD230FM

*3 2 N·m for AS22□1FE-01 and AS22□1FE-02

*4 9 for AS2001F-□-3 and 12 for AS22□1FE-01

*5 14 for AS22□1FE-02

UNI Thread Type

Mounting

⚠ Caution

1. First, tighten the threaded portion by hand, then use a suitable wrench to tighten the hexagonal portion of the body further at the appropriate wrench tightening angle shown below. As a reference value for the tightening torque, refer to the table below.

Connection Female Thread: Rc, NPT, NPTF

Nominal size of UNI thread	Approx. wrench tightening angle after tightened by hand deg	Proper tightening torque (N·m)
1/8	30 to 60	3 to 5
1/4	30 to 60	8 to 12
3/8	15 to 45	14 to 16
1/2	15 to 30	20 to 22

Connection Female Thread: G

Nominal size of UNI thread	Approx. wrench tightening angle after tightened by hand deg	Proper tightening torque (N·m)
1/8	30 to 45	3 to 4
1/4	15 to 30	4 to 5
3/8	15 to 30	8 to 9
1/2	15 to 30	14 to 15

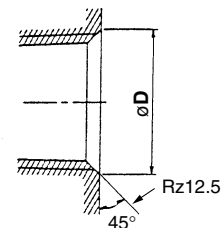
2. The gasket can be reused up to 6 to 10 times. It can be replaced easily when it has sustained damage. A broken gasket can be removed by holding it and then turning it in the same direction as loosening the thread. If the gasket is difficult to remove, cut it with nippers, etc. In such a case, use caution not to scratch the seat face because the seat face of the fitting's 45° gasket is the sealing face.

3. Please consult with SMC if using for fluids other than air.

4. Other precautions on handling, etc., are the same as those for One-touch fittings.

Chamfered area for female threads (Recommended value)

By chamfering as shown in the following table, machining of threads is easier and effective for burr prevention.



Nominal thread size	Chamfer dimension ØD (Recommended value)					
	G		Rc		NPT, NPTF	
	min	max	min	max	min	max
1/16	—	—	—	—	8.2	8.4
1/8	10.2	10.6	10.2	10.4	10.5	10.7
1/4	13.6	14.0	13.6	13.8	14.1	14.3
3/8	17.1	17.5	17.1	17.3	17.4	17.6
1/2	21.4	21.8	21.4	21.6	21.7	21.9



Flow Control Equipment Precautions 3

Be sure to read this before handling products.

With Sealant Type

Piping

⚠ Caution

1. First, tighten the fitting by hand, then use a suitable wrench to tighten the hexagonal portion of the body a further two or three turns. For the reference value for the tightening torque, refer to the table below. Check the dimensions of each product for the width across flats.

Connection thread size (R, NPT)	[Reference value] Tightening torque N·m
1/8	3 to 5
1/4	8 to 12
3/8	15 to 20
1/2	20 to 25

2. If the fitting is tightened with excessive torque, a large amount of sealant will seep out. Remove the excess sealant.
3. Insufficient tightening may loosen the threads or cause air leakage.
4. For reuse
 - 1) Normally, fittings with a sealant can be reused up to 2 to 3 times.
 - 2) To prevent air leakage through the sealant, remove any loose sealant stuck to the fitting by blowing air over the threaded portion.
 - 3) If the sealant no longer provides effective sealing, wind sealant tape over the sealant before reusing. Do not use any form other than the tape type of sealant.
5. Once the fitting has been tightened, backing it out to its original position often causes the sealant to become defective. Air leakage will occur.

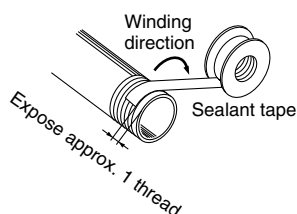
Piping

⚠ 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.



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 and allow the condensation to enter the compressed air lines. This causes 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 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.

⚠ Caution

1. Install an air filter.

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

2. 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 flow control equipment. Therefore, take appropriate measures to ensure air quality, such as by providing an aftercooler, air dryer, or water separator.

3. Ensure that the fluid and ambient temperatures are within the specified range.

If the fluid temperature is 5°C or less, the moisture in the circuit could freeze, causing damage to the seals or leading to equipment malfunction. Therefore, take appropriate measures to prevent freezing.

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



Flow Control Equipment Precautions 4

Be sure to read this before handling products.

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.**

Refer to each construction drawing for information on the materials of flow control equipment.

2. **Do not expose the product to direct sunlight for an extended period of time.**
3. **Do not use in a place subject to heavy vibration and/or shock.**
4. **Do not mount the product in locations where it is exposed to radiant heat.**
5. **Using a flat head screwdriver adjustable type tamper proof speed controller in locations where vibrations or impacts occur could lead to the loosening of the needle. So, please use a hexagon lock nut adjustable type speed controller.**

For reference, SMC has conducted vibration tests in 25G for 200 operations, and we have confirmed no loosening of the needle.

Maintenance

Warning

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

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

2. **Maintenance work**

If handled improperly, compressed air can be dangerous. Assembly, handling, repair, and element replacement of pneumatic systems should be performed by a knowledgeable and experienced person.

3. **Drain flushing**

Remove drainage from air filters regularly.

4. **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 pressure and electric power, and exhaust all compressed air from the system using the residual pressure release function.

When machinery is restarted, proceed with caution after confirming that appropriate measures are in place to prevent sudden movement.



Pressure Switches/Flow Switches

Precautions 1

Be sure to read this before handling products.

Refer to the Operation Manual on the SMC website for further precautions.

Warning

1. Check the product specifications before use.

If the product is used outside of the specifications, it may cause malfunction, failure, or damage to the product, leading to an electric shock, explosion, or fire.

2. Do not modify the product.

Do not disassemble, modify (including changing the printed circuit board), or repair the product. An injury or failure can result.

3. The product should be mounted correctly.

If the product is not mounted correctly, malfunction, failure, or damage may occur.

For the handling of fittings (including One-touch fittings), refer to the Precautions for Fittings and Tubing.

Refer to the operation manual for details on the 3 points below.

- Use the appropriate tool.
- Tighten with the required torque.
- If the mounting direction is specified, mount the product in accordance with the specified direction.

4. Perform regular maintenance and confirm normal operation.

If maintenance is not performed, malfunction or failure may occur.

Turn off the power supply and stop the fluid supply before performing maintenance.

Otherwise, injury may occur.

After maintenance is complete, perform appropriate functional inspections and leak tests.

Safety cannot be assured in the case of unexpected malfunction.

Cut off the power supply and stop supplying fluid if the equipment does not function properly or there is a leakage of fluid.

5. Do not apply vibration, impact, or loads.

If vibration, impact, or loads are applied, malfunction, failure, or damage may occur.

In particular, never mount a product in a location that will be used as a foothold.

6. Do not expose the product to direct sunlight.

If the product is exposed to direct sunlight, malfunction, failure, or damage may occur.

If the product is exposed to direct sunlight, provide a suitable protective cover.

7. Do not use the product in an environment where the product may be corroded.

If the product is used in a corrosive environment, malfunction, failure, or damage may occur.

Check the product materials before use.

8. Do not use products other than ATEX compliant products in an environment where the product is exposed to explosive or flammable gas or dust.

ATEX (explosion proof) compliant products should be used in an environment which is correspondent to ATEX compliance.

If products other than ATEX compliant products are used in an explosive or flammable environment, an explosion or fire may occur.

9. Ensure that the product is used within the enclosure specifications.

If the product is used outside of the specifications, malfunction or failure may occur.

Use the product in accordance with the protection level with reference to the IEC60529 Standard.

10. Use the product within the operating temperature, humidity, and fluid temperature range.

Do not use the product outside of these specifications.

Even when the product is used within the specifications, do not use in a location where there are rapid temperature changes, in a location where there are heating/cooling cycles, or in a location where there is freezing or condensation.

Doing so may result in malfunction or failure.

If the product is to be used in environments with low temperatures, protection against freezing is necessary.

11. Do not use fluids other than the applicable fluids.

If fluids other than the applicable fluids are used, malfunction, failure, or breakage may occur.

12. Do not use for flammable or poisonous fluids.

If flammable or poisonous fluids are used, an explosion or fire may occur.

13. Do not let foreign matter or condensate get inside the piping of the product.

If foreign matter or condensate enters the product, malfunction, failure, or damage may occur.

Mount an appropriate filter on the fluid inlet side (IN side).

14. Use the product within the specified operating pressure range.

If the product is used outside of the rated pressure range, malfunction may occur.

15. Do not apply pressure which exceeds the proof pressure.

If pressure exceeding the proof pressure is applied, malfunction, failure, or damage may occur.

16. Ensure that the product is used within the power supply specifications.

If the product is used outside of the specifications, malfunction or failure may occur, leading to an electric shock or fire.

17. Ensure that the FG terminal is connected to ground when using a commercially available switch-mode power supply.

When a switch-mode power supply is connected to the product, switching noise will be superimposed and the product will no longer meet specifications.

This can be prevented by inserting a noise filter, such as a line noise filter or ferrite core, between the switch-mode power supply and the product, or by using a series power supply instead of a switch-mode power supply.

18. Do not use a load exceeding the maximum load voltage or current.

If the product is used outside of the specifications, it may cause malfunction or damage, leading to a reduction in the life of the product.

19. Wire the product correctly.

Incorrect wiring could cause malfunction or failure, leading to an electric shock or fire.



Pressure Switches/Flow Switches

Precautions 2

Be sure to read this before handling products.

Refer to the Operation Manual on the SMC website for further precautions.

Warning

20. Avoid repeatedly bending, stretching, or applying load to the cable.

Applying repeated bending, tensile stress, or load to the cable can damage the wire.

The recommended bend radius of the cable is 6 times the outside diameter of the sheath, or 33 times the outside diameter of the insulation material, whichever is larger.

21. Do not perform wiring while the power is ON.

Touching the terminal or connector while the power is ON may cause an electric shock.

Performing wiring while the power is ON may result in malfunction or failure.

22. Use appropriate countermeasures against surges when using a load which generates a surge voltage.

If surge voltages are repeatedly applied, this may cause malfunction or failure.

23. Do not use in an area where surges are generated.

If the product is used in an environment where surges are generated (solenoid lifter, high frequency induction furnace, motor, etc.), malfunction or failure may occur.

Take appropriate measures before using the product.

24. Route the wires of the product separately from power or high-voltage cables.

If the wires of the product are routed with power or high-voltage cables, malfunction or failure may occur due to noise.

25. Confirm proper insulation of the wiring.

If there is insulation failure (short circuits, faulty ground connection, improper insulation between terminals, etc.), malfunction or failure may occur.

26. Do not use the product in a place where static electricity is a problem.

It may result in system failure or malfunction.

27. If the product to be returned is contaminated or is possibly contaminated with substances that are harmful to humans, for safety reasons, please contact SMC beforehand and then employ a specialist cleaning company to decontaminate the product. After the decontamination prescribed above has been carried out, submit a Product Return Request Sheet or the Detoxification/Decontamination Certificate to SMC and await SMC's approval and further instructions before attempting to return the item.

Please refer to the International Chemical Safety Cards (ICSC) for a list of harmful substances.

If you have any further questions, please don't hesitate to contact your SMC sales representative.

Caution

1. Slight scratches or dirt on the display or the product body will not cause any problems. Please continue to use the product.

2. Ensure sufficient space for installation and maintenance.

3. Install the product while taking into consideration the internal voltage drop. (Electrical type only)

Confirm that the equation below is satisfied after checking the operating voltage of the load.

Power supply voltage - Product internal voltage drop > Minimum operating voltage

Even if the product operates normally, if the operating voltage is not satisfied, the load may not operate.

4. Pay attention to the write limit of the input data. (Electrical type only)

The input data (the set value, etc.) is written into the memory, so if the power supply is cut, the data will not be lost. However, there is a limit to the number of write operations.

Refer to the operation manual for the write limit.

5. Do not use solvents, such as benzene, thinner, etc., to clean the product.

They could damage the surface of the body and erase the markings on the body.

Use a soft cloth to remove stains. For heavy stains, use a cloth lightly dampened with diluted neutral detergent, then wipe up any residue with a dry cloth.



2-Port Solenoid Valves for Fluid Control

Precautions 1

Be sure to read this before handling products.

For detailed precautions on each series, refer to the main text.

Design

Warning

1. Cannot be used as an emergency shutoff valve, etc.

The valves presented in this catalog are not designed for safety applications such as an emergency shutoff valve. If the valves are used in this type of system, other reliable safety assurance measures should also be adopted.

2. Extended periods of continuous energization

The solenoid coil will generate heat when continuously energized. Avoid using in a tightly shut container. Install the valve in a well-ventilated area. Furthermore, do not touch it while it is being energized or right after it has been energized.

3. This solenoid valve cannot be used for explosion proof applications.

4. Ensure sufficient space for maintenance activities.

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

5. Closed liquid circuit

In a closed circuit, when liquid is static, pressure could rise due to changes in temperature. This pressure rise could cause malfunction and damage to components such as valves. To prevent this, install a relief valve in the system.

6. Actuator drive

When an actuator, such as a cylinder, is to be driven using a valve, take appropriate measures to prevent potential danger caused by actuator operation.

7. Pressure (including vacuum) holding

It is not usable for an application such as holding the pressure (including vacuum) inside of a pressure vessel because air leakage is entailed in valves.

8. When the conduit type is used as an equivalent to an IP65 enclosure, install a wiring conduit, etc.

9. When an impact, such as water hammer, etc., caused by rapid pressure fluctuation is applied, the solenoid valve may be damaged.

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

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

Selection

Warning

1. Confirm the specifications.

Give careful consideration to the operating conditions, such as the application, fluid, and environment, and use within the specified operating ranges indicated in the catalog.

2. Fluid

1) Type of fluids

Before using a fluid, confirm whether it is compatible with the materials from each model by referring to the fluids listed in the catalog. Use a fluid with a dynamic viscosity of 50 mm²/s or less. If there is anything you are unsure of, please contact SMC.

Selection

Warning

2) Flammable oil, gas, etc.

Do not use the product with combustion-supporting or flammable fluids.

3) Corrosive fluids

Corrosive fluids or seawater cannot be used. If water is to be used as the fluid, use clear water equivalent to tap water. When using underground water, if the water is to be treated, be sure to check the disinfectant or corrosion treatment's compatibility with the product before use.

4) When a brass body is used, depending on the water quality, corrosion and internal leakage may occur. If such abnormalities occur, exchange the product for a stainless steel body.

5) Use an oil-free specification if the entrance of oil particles into the passage will cause problems.

6) Applicable fluids on the list may not be used depending on the operating conditions. Give adequate confirmation, and then determine a model. Keep in mind that the compatibility list refers to common use applications.

3. Fluid quality

The use of a fluid that contains foreign matter can cause problems, such as malfunction and seal failure by promoting the wear of the valve seat and armature, by sticking to the sliding parts of the armature, etc. Install a suitable filter (strainer) immediately upstream from the valve. As a general rule, use 80 to 100 mesh.

When used to supply water to boilers, substances such as calcium and magnesium, which generate hard scale and sludge, are included. Since scale and sludge can cause the valve to malfunction, install water softening equipment and a filter (strainer) directly upstream from the valve to remove these substances.

4. Air quality

1) 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.

2) Install air filters.

Install air filters upstream near the valves. A filtration size of 5 μm or less should be selected.

3) Install an aftercooler, air dryer, etc.

Compressed air that contains excessive drainage may cause the malfunction of valves and other pneumatic equipment. To prevent this, install an aftercooler, air dryer, etc.

4) If excessive carbon powder is generated, eliminate it by installing mist separators on the upstream side of valves.

If excessive carbon powder is generated by the compressor, it may adhere to the inside of the valves and cause malfunction.

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

5. Ambient environment

Use within the operable ambient temperature range. Confirm the compatibility between the product's composition materials and the ambient atmosphere. Be certain that the fluid used does not touch the external surface of the product.

6. Countermeasures against static electricity

Take measures to prevent static electricity, since some fluids can cause static electricity.

7. For the low particle generation specification, please consult with SMC separately.



2-Port Solenoid Valves for Fluid Control

Precautions 2

Be sure to read this before handling products.

For detailed precautions on each series, refer to the main text.

Selection

⚠ Warning

8. Low temperature operation

1. The valve can be used in an ambient temperature of between -10 to -20°C . However, take measures to prevent the freezing or solidification of impurities, etc.
2. When using valves for water applications in cold climates, take appropriate countermeasures to prevent the water from freezing in tubing after cutting the water supply from the pump, by draining the water, etc. When warming by a heater, etc., be careful not to expose the coil portion to the heater. The installation of a dryer, retaining the heat of the body, etc., is recommended to prevent a freezing condition in which the dew point temperature is high and the ambient temperature is low, or the high flow is running.

Mounting

⚠ Warning

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

After mounting is completed, confirm that it has been done correctly by performing a suitable function test.

2. Do not apply external force to the coil section.

When tightening is performed, apply a wrench or other tool to the outside of the piping connection ports.

3. Mount a valve with its coil position upwards, not downwards.

When mounting a valve with its coil positioned downwards, foreign objects in the fluid will adhere to the iron core, leading to a malfunction. Especially for strict leakage control, such as with vacuum applications and non-leak specifications, the coil must be positioned upwards.

4. Do not warm the coil assembly with a heat insulator, etc.

Use tape, heaters, etc., for freeze prevention on the piping and body only. This can cause the coil to burn out.

5. Secure with brackets, except in the case of steel piping and copper fittings.

6. Avoid sources of vibration, or adjust the arm from the body to the minimum length so that resonance will not occur.

7. Painting and coating

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

Piping

⚠ Caution

1. Refer to the Fittings and Tubing Precautions 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. Install piping so that it does not apply pulling, pressing, bending, or other forces on the valve body.

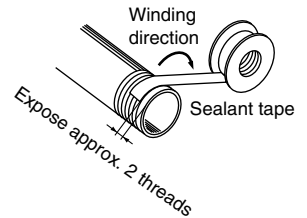
Piping

⚠ Caution

3. Winding of sealant tape

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

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



4. Avoid connecting ground lines to piping, as this may cause the electric corrosion of the system.

5. Tighten threads with the proper tightening torque.

When attaching fittings to valves, tighten with the proper tightening torque shown below.

Tightening Torque for Piping

Connection thread	Proper tightening torque (N·m)	Connection thread	Proper tightening torque (N·m)
Rc 1/8	7 to 9	Rc 1 1/4	40 to 42
Rc 1/4	12 to 14	Rc 1 1/2	48 to 50
Rc 3/8	22 to 24	Rc 2	48 to 50
Rc 1/2	28 to 30	Rc 2 1/2	48 to 50
Rc 3/4	28 to 30	Rc 3	48 to 50
Rc 1	36 to 38		

6. Connection of piping to products

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

7. Steam generated in a boiler contains a large amount of drainage. Be sure to operate it with a drain trap installed.

8. In applications such as vacuum and non-leak specifications, be sure to use caution to prevent contamination by foreign matter and air leakage of the fittings.

Operating Environment

⚠ Warning

Do not use the product in such locations as those described below.

1. Locations with atmospheres where water vapor is present or locations where corrosive fluids (chemicals), sea water, or water may come into contact with the product

Implement appropriate protective measures if water will be applied to the product for long periods of time, even for products which have IP65 or IP67 enclosures. Such water may enter through microscopic gaps in the product's external surfaces, resulting in fire damage or short-circuiting of the solenoid valve coils. If installing the product in close proximity to equipment, such as machine tools, processing machines, etc., which uses large amounts of liquids or oils, be sure to confirm that liquid dispersal or spatter from the peripheral equipment does not come into contact with the product.

2. Locations with explosive atmospheres

3. Locations subject to vibration or impact

4. Locations where radiated heat will be received from nearby heat sources



2-Port Solenoid Valves for Fluid Control

Precautions 3

Be sure to read this before handling products.

For detailed precautions on each series, refer to the main text.

Operating Environment

Warning

5. Locations that are outdoors (Excludes outdoor specification valves)

Although using an indoor specification product outdoors voids its product warranty, if outdoor use proves unavoidable, be sure to implement the protective measures mentioned below.

- 1) Install a protective cover, etc., to protect the product from direct sunlight.
- 2) Encase the product in an enclosure to protect it from rain and wind.
 - * If only a roof-type cover is provided for the product, it will not be sufficiently protected from side winds or rain splashing up from the ground, which will result in water adhering to and entering the product. In addition, when the product is encased in an enclosure, be sure to implement proper ventilation measures to prevent overheating due to long-term energizing of the product.
- 3) Be sure to confirm that the location is not one in which condensation is easily generated. If the product is used in an environment with large temperature changes, etc., condensation may be generated and water may adhere to the external surface of the product. Be sure to implement protective measures against condensation, such as ambient temperature control, in such locations where condensation is easily generated.

6. Locations where freezing may occur within piping lines

(When the fluid is liquid)

If the product is to be used in cold regions or in winter, be sure to implement measures to prevent the freezing of fluids.

If the fluid is likely to freeze, implement measures such as draining the water in the piping when the equipment is OFF, or installing a heater or insulation in the piping.

If warming the solenoid valve, be sure to avoid the coil portion as it will result in poor heat dissipation.

(When the fluid is air)

With large flow rates, drain may be generated due to adiabatic expansion, resulting in freezing.

Be sure to periodically drain the product or conduct drain removal using an air dryer.

Maintenance

Warning

1. Removal of product

The valve will reach a high temperature when used with high temperature fluids. Confirm that the valve temperature has dropped sufficiently before performing work. If touched inadvertently, there is a danger of being burned.

1. Shut off the fluid supply and release the fluid pressure in the system.
2. Shut off the power supply.
3. Dismount the product.

2. Low frequency operation

Switch valves at least once every 30 days to prevent malfunction. Also, in order to use them under the optimum state, conduct a regular inspection biannually.

Caution

1. Filters and strainers

1. Be careful regarding clogging of filters and strainers.
2. Replace filter elements after one year of use, or earlier if the pressure drop reaches 0.1 MPa.
3. Clean strainers when the pressure drop reaches 0.1 MPa.

2. Lubrication

When using after lubricating, do not forget to lubricate continuously.

3. Storage

In case of long term storage after use with heated water, thoroughly remove all moisture to prevent rust, the deterioration of rubber materials, etc.

4. Exhaust the drainage from air filters periodically.

Precautions

Warning

1. Valves will reach high temperatures when used with high temperature fluids. Use caution, as there is a danger of being burned if a valve is touched directly.
2. For pilot type 2-port solenoid valves, when the valve is closed, sudden pressure resulting from the startup of the fluid supply source (pump, compressor, etc.) may cause the valve to open momentarily and leakage to occur, so please exercise caution.
3. When problems are caused by a water hammer, install water hammer relief equipment (accumulator, etc.), or use an SMC water hammer relief valve (VXR series). Please consult with SMC for details.
4. Make sure when using pilot type 2-port solenoid valves that the flow direction is from 1 (IN) to 2 (OUT). The valve is designed based on a flow direction of 1 (IN) to 2 (OUT) and harnesses the fluid pressure of port 1 (IN) when the valve opens or closes. If reverse pressure (2 (OUT) to 1 (IN)) is applied, it may lead to a reduced service life or cause premature damage to parts, due to chattering or pulses from the main valve (diaphragm, piston, etc.). If there is a possibility that reverse pressure will be applied, take countermeasures by installing a check valve, etc., on the downstream side. When installing the check valve, allow ample space between the valve and the check valve. If it is placed near the valve, it may cause chattering and pulses in the main valve.

Applicable models

- Pilot type 2-port solenoid valve
VXD, VXED, VXZ, VXEZ, VXS, VXP, and VXR series

Return of Product

Warning

If the product to be returned is contaminated or is possibly contaminated with substances that are harmful to humans, for safety reasons, please contact SMC beforehand and then employ a specialist cleaning company to decontaminate the product. After the decontamination prescribed above has been carried out, submit a Product Return Request Sheet or the Detoxification/Decontamination Certificate to SMC and await SMC's approval and further instructions before attempting to return the item. Please refer to the International Chemical Safety Cards (ICSC) for a list of harmful substances. If you have any further questions, please don't hesitate to contact your SMC sales representative.



Temperature Control Equipment Precautions 1

Be sure to read this before handling products.

For detailed precautions on each series, refer to the main text.

Selection

Warning

1. Confirm the specifications.

Fully understand the applications, environment, fluids, and other operating conditions. Use this product within the specified range shown in the catalog. Using outside the specified range can cause injury, damage, or malfunction. When in doubt, please contact SMC beforehand.

2. Secure the performance margin.

When you consider the product's cooling/heating performance or flow rate characteristics, allowances must be made because heat loss from the piping, pressure drops, etc., may occur.

Operating Environment/Storage Environment

Warning

1. Observe the ambient temperature range.

The operating ambient temperature range must be within the specification range shown in the catalog.

Use caution because using beyond the range will lead to damage, breakage, or malfunction.

2. Avoid using and storing in the following environments because it will lead to malfunction.

1. In locations where water, water steam, salt water, and oil may splash on the product
2. In locations where a large amount of particles are airborne
3. In locations with an atmosphere of corrosive or explosive gases, solvents, or chemicals
(This product is not explosion proof.)
4. In locations which receive direct sunlight or radiated heat
(Protect from direct sunlight to avoid the resin from deteriorating by ultraviolet rays or increasing the temperature.)
5. In locations where temperature substantially changes
6. In locations where there is a heat source nearby and the ventilation is poor
(Insulate the heat source or ventilate well to avoid damages caused by the heat or temperature increase, such as softening.)
7. In locations where condensation occurs
8. In locations where strong magnetic noise occurs
(In locations where strong electric fields, strong magnetic fields, and surge voltage occur)
9. In locations where static electricity occurs, or conditions which make the product discharge static electricity
10. In locations where high frequency occurs
11. In locations where damage is likely to occur due to lightning
12. In locations where impacts or vibrations occur
13. In conditions where a massive force strong enough to deform the product is applied or the weight from a heavy object is applied
14. In locations more than 1000 m in altitude (Excluding: storage, transportation)

Fluid

Warning

1. Type of fluids

1. The operating fluids must be used within the specified range shown in the catalog.
Please consult with SMC when using the product with other fluids.
2. Depending on the combination, foreign matter, chemical leakage, and catalysts may change the piping material and operating fluid qualities.
3. When solid foreign objects may be mixed with a fluid, install a filter to remove them.

2. Use clear water (including for diluting ethylene glycol aqueous solution) which meets the water quality standards mentioned below.

Facility Water Quality Standard

The Japan Refrigeration and Air Conditioning Industry Association

JRA GL-02-1994 "Cooling water system – Circulation type – Circulating water"

	Item	Unit	Standard value	Influence	
				Corrosion	Scale generation
Standard item	pH (at 25°C)	—	6.0 to 8.0	○	○
	Electric conductivity (25°C)	[μS/cm]	100*1 to 300*1	○	○
	Chloride ion (Cl ⁻)	[mg/L]	50 or less	○	
	Sulfuric acid ion (SO ₄ ²⁻)	[mg/L]	50 or less	○	
	Acid consumption amount (at pH4.8)		50 or less		○
	Total hardness	[mg/L]	70 or less		○
	Calcium hardness (CaCO ₃)	[mg/L]	50 or less		○
Reference item	Ionic state silica (SiO ₂)	[mg/L]	30 or less		○
	Iron (Fe)	[mg/L]	0.3 or less	○	○
	Copper (Cu)	[mg/L]	0.1 or less	○	
	Sulfide ion (S ₂ ⁻)	[mg/L]	Should not be detected.	○	
	Ammonium ion (NH ₄ ⁺)	[mg/L]	0.1 or less	○	
	Residual chlorine (Cl)	[mg/L]	0.3 or less	○	
	Free carbon (CO ₂)	[mg/L]	4.0 or less	○	

*1 In the case of [MΩ·cm], it will be 0.003 to 0.01.

○: Factors that have an effect on corrosion or scale generation.

• Even if the water quality standards are met, complete prevention of corrosion is not guaranteed.

Transportation/Transfer/Movement

Warning

1. Product transfer should be performed by a knowledgeable and experienced person.

In particular, transferring heavy objects is dangerous.

Use adequate caution to prevent products from falling and dropping accidents from occurring.

2. Avoid transportation in the following environments because it will lead to breakage.

1. In conditions where strong shock and vibrations occur
2. In operating and storage environments other than those specified

3. Caution when transferring a heavy object

This product is heavy. Use adequate caution to avoid injury when picking up and setting down the product, and falling and dropping accidents.

4. Before moving this product, remove operating fluid and facility water from the inside of the product.



Temperature Control Equipment Precautions 2

Be sure to read this before handling products.

For detailed precautions on each series, refer to the main text.

Mounting/Installation

Warning

1. **Installation should be performed by a knowledgeable and experienced person.**

In particular, the installation of heavy objects is dangerous. This product is heavy. Use adequate caution to prevent products from falling and dropping accidents from occurring.

Caution

1. **Provide space for ventilation and maintenance.**

Provide enough space for the ventilation requirement of each piece of equipment. Otherwise, a cooling malfunction or operation stoppage may occur. Also, provide enough space for maintenance and inspection.

2. **Confirm the mounting orientation.**

Mount and install horizontally.

Piping

Warning

1. **For this product and future equipment, the design of the piping system should be performed by a knowledgeable and experienced person.**

2. **Work performed on the piping should be done by a knowledgeable and experienced person.**

If work performed on the piping is done by a less knowledgeable and inexperienced person, it will likely lead to operating fluid leakage, etc.

3. **Thoroughly read the operation manual.**

Read the operation manual completely before piping. Also, keep the manual where it can be referred to as necessary.

4. **Tighten threads with the proper tightening torque.**

When installing fittings, etc., follow the given torque levels below.

Tightening Torque for Piping

Connection thread	Proper tightening torque (N·m)
M5	1.5 to 2
Rc 1/8	7 to 9
Rc 1/4	12 to 14
Rc 3/8	22 to 24
Rc 1/2	28 to 30
Rc 3/4	28 to 30
Rc 1	36 to 38
Rc 1 1/4	40 to 42
Rc 1 1/2	48 to 50
Rc 2	48 to 50

5. **Check for fluid leakage.**

Confirm that the hose or tubing is not pulled out and that there is no leakage in the fitted parts.

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. **Use caution regarding the flowing direction of the fluid.**

When installing piping to a product, do not mistake the flow direction of the supply port, etc. Check the "IN" and "OUT" indications or other labels and the operation manual before connection.

4. **Winding of sealant tape**

When installing piping or fittings into a port, ensure that sealant material does not enter the port internally. When using sealant tape, leave 1.5 to 2 threads exposed on the end of the pipe/fitting.

5. **Take countermeasures against condensation.**

Depending on the operating conditions, condensation may occur in the piping. In such a case, take countermeasures such as installing insulation material, etc.



Temperature Control Equipment Precautions 3

Be sure to read this before handling products.

For detailed precautions on each series, refer to the main text.

Electrical Wiring

⚠ Warning

1. Electrical wiring should be performed by a knowledgeable and experienced person.

Power supply and wiring works should be implemented in accordance with the electric facilities technical standards and provisions and conducted correctly.

2. Mounting a dedicated circuit breaker

As a countermeasure against current leakage, install a ground fault circuit interrupter (GFCI) in the main power supply.

3. Check the power supply.

If this product is used with voltages other than those specified, it will likely lead to a fire or an electrical shock. Before wiring, confirm the voltage, volume, and frequency.

Confirm that the voltage fluctuation is within $\pm 10\%$ of the specified value.

4. Grounding

Be certain to ground (frame ground) with class D grounding (grounding resistance of 100 Ω or less).

This product can be grounded with the PE line of the power supply cable.

Also, do not use together with equipment that generates strong electrical magnetic noise or high-frequency noise.

5. Wiring cable should be handled with care.

Do not bend, twist, or stretch the cord or cable.

6. Wire with an applicable size cable and terminal.

In the event of attaching a power supply cable, use a cable and terminal size which is suitable for the electrical current of each product.

Forcibly mounting with an unsuitable size cable will likely result in a fire.

7. Avoid wiring the signal line and power line in parallel.

Since there may be a possibility of malfunction from noise, avoid parallel wiring between the temperature sensor line, communication line, signal line of the alarm line, etc., and the power line and high voltage line. Also, do not place them in the same wiring tube.

Facility Water Supply

(Water-cooled refrigeration)

⚠ Warning

1. Be certain to supply facility water.

1. Danger of no water operation, low water flow rate operation
Do not operate under conditions where there is no facility water or where there is very little flow rate of water flowing. In this kind of operation, facility water temperatures may become extremely high. There is a danger of the material of the hose softening and bursting when the piping supplying the facility water is connected with the hose.

2. Actions to be taken when an emergency stop occurs due to high temperatures

In case a stop occurs due to extremely high temperatures resulting from a decrease in the facility water flow rate, do not immediately flow facility water. There is a danger of the material of the hose softening and bursting when the piping supplying the facility water is connected with the hose.

First, let it cool down naturally by removing the cause of the flow rate reduction. Secondly, confirm that there is no leakage again.

⚠ Caution

1. Facility water quality

1. Use facility water within the specified range.

When using a fluid other than facility water, please consult with SMC.

2. When it is likely that foreign matter may enter the fluid, install a filter (20 mesh or equivalent).

Facility Water Quality Standard

The Japan Refrigeration and Air Conditioning Industry Association

JRA GL-02-1994 "Cooling water system – Circulation type – Circulating water"

	Item	Unit	Standard value	Influence	
				Corrosion	Scale generation
Standard item	pH (at 25°C)	—	6.5 to 8.2	○	○
	Electric conductivity (25°C)	[μ S/cm]	100 ^{*1} to 800 ^{*1}	○	○
	Chloride ion (Cl ⁻)	[mg/L]	200 or less	○	
	Sulfuric acid ion (SO ₄ ²⁻)	[mg/L]	200 or less	○	
	Acid consumption amount (at pH4.8)	[mg/L]	100 or less		○
	Total hardness	[mg/L]	200 or less		○
	Calcium hardness (CaCO ₃)	[mg/L]	150 or less		○
Reference item	Ionic state silica (SiO ₂)	[mg/L]	50 or less		○
	Iron (Fe)	[mg/L]	1.0 or less	○	○
	Copper (Cu)	[mg/L]	0.3 or less	○	
	Sulfide ion (S ₂ ⁻)	[mg/L]	Should not be detected.	○	
	Ammonium ion (NH ₄ ⁺)	[mg/L]	1.0 or less	○	
	Residual chlorine (Cl)	[mg/L]	0.3 or less	○	
	Free carbon (CO ₂)	[mg/L]	4.0 or less	○	

*1 In the case of [$\text{M}\Omega\cdot\text{cm}$], it will be 0.00125 to 0.01.

• ○: Factors that have an effect on corrosion or scale generation.

• Even if the water quality standards are met, complete prevention of corrosion is not guaranteed.



Temperature Control Equipment Precautions 4

Be sure to read this before handling products.

For detailed precautions on each series, refer to the main text.

Operation

Warning

1. Handle and operate only after the safety of this product and the rest of the system is confirmed.

This product and incidental equipment should be operated by a knowledgeable and experienced person.

2. Before operation, confirm the safety of mounting, installation, piping, and electric wiring conditions.

1. Confirm that the mounting and installation conditions are safe.
2. Confirm that the circulating fluid is filled and that the fluid level is within the display range.
3. Confirm whether the valve is open or closed and that the hose and resin tube are not twisted.
It is dangerous when the valve in the piping is closed because circulating fluid and the facility water will not flow and fluid pressure will increase.
4. Confirm the flow direction of the fluid.
Be certain that the flow direction of the fluid (Inlet/Outlet direction) is connected correctly.
5. Confirm that the electrical wiring condition is safe.
Incorrect wiring will lead to malfunction or breakage of the product. Confirm that there are no errors in wiring before operation.
6. When using the product with a 3-phase power supply, confirm the connection.
If the phase order is incorrect, the pump, etc. will run in reverse, or the phase-reversal relay will activate and the product will not operate.
In this case, after cutting off the main power supply, reverse 2 of the 3 wires and connect them in the correct phase order.

3. Do not remove the external panel during energization or operation.

If removed, there is a danger of electrical shock, burn, frostbite, or injury from rotating objects.

4. Avoid operating with a low flow rate.

Avoid operating with a low flow rate because the temperature control may become unstable or it may shorten the service life of the pump.

5. Confirm the safety of the product during operation.

During operation, if an emergency is detected, stop this product immediately and turn off the power supply breaker.

6. When not used for long periods of time, confirm the safety once again prior to beginning its operation.

Maintenance

Warning

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

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

2. Maintenance work

Improper handling of compressed air is dangerous. Therefore, in addition to observing the product specifications, the replacement of elements and other maintenance activities should be performed by personnel having sufficient knowledge and experience pertaining to pneumatic equipment.

3. Pre-maintenance inspection

Before removing this product, cut off the electric power, and be certain to shut off the supply pressure and exhaust the compressed air in the system. Proceed only after confirming that all pressure has been released to the atmosphere.

4. Post-maintenance inspection

After installation or repair, reconnect compressed air and electricity and conduct appropriate inspections to confirm proper operation. If there is an audible air leakage, or if the equipment does not operate properly, stop operation and confirm that the equipment is installed correctly.

5. Modification prohibited

Do not modify or reconstruct the unit.

6. Stopping for long periods of time

When not using for long periods of time, remove the fluid (circulating fluid, facility water) and cut off the main power supply.

7. Removal of product

Take the stop/inspection measures and confirm that there is no danger before the product is removed.
In the event of removing the product, discharge the used fluid and clean the inside of the piping.
When a dangerous fluid or polluted fluid is left inside, it is likely that the polluted area will become enlarged or an accident will occur.

8. Disposal of product

When the product is disposed, it must be in compliance with the ordinance or rules of the local municipality.
Ask for help from a professional industrial waste disposal company.
In particular, in the case of a refrigerated type product, entrust a company to collect the refrigerant, etc.
In such a case, the customer may be requested to submit a certificate showing the type of operating fluid and whether any quantity is left. These procedures are the responsibility of the customer.

9. Preparation of a backup product

In order to keep the downtime of a system to a minimum, prepare a backup product when necessary.



Process Gas Equipment Common Precautions 1

Be sure to read this before handling products.

Design

Warning

1. Confirm the specifications.

The compatibility of the product with specific equipment must be decided by the person who designs the equipment or decided 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.

Selection

Warning

1. Confirm the specifications.

When selecting a product, confirm the operating conditions, such as type of gas, operating pressure (inlet and outlet), flow rate, operating temperature, etc., and use within the operating range specified in the catalog. The product may not be suitable for use with certain gases and applications/environments. Check the compatibility of the product materials and the process gas.

Design the equipment and select a product with full understanding of the characteristics of gas to be used.

2. Follow the regulations and laws defined by the country or local government, and organization standards.

Reference: High Pressure Gas Safety Act, Labor Safety and Sanitation Law, etc.

Mounting

Warning

1. Operation manual

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

Caution

1. Flush the piping thoroughly with inert gas before installing the product.

Remove any dust or scales thoroughly, as they could cause the malfunction or failure of the product. Do not flush with a gas other than inert gas, as this could cause dangerous situations.

2. Do not touch the fitting or the wetted parts of the product by hand. Do not apply grease or oil to the product.

3. Unpack the hermetically-sealed package in a clean environment (with the exception of the AK series).

Products intended for high purity processes are double packed inside a clean room. Make sure to unpack the sealed inner bag inside a clean room or clean environment.

4. Ensure sufficient space for maintenance activities.

Ensure sufficient space for maintenance and inspection.

Mounting

Caution

5. Connect face seal fittings.

Use same size face seal fittings (metal gasket sealing type) for mating connections.

Place the gasket at the end of the fitting and tighten the female nut by hand, and then tighten the nut an additional 1/8 turn using a torque wrench. For gasket material, use either stainless or nickel.

6. Connect tube welds.

Follow the industry standards (refer to SEMI F78) when welding the piping. Make sure the valve is in the open position when supplying purge gas. If welding the inlet side, supply purge gas from the outlet side of the product, and if welding the outlet side, supply purge gas from the inlet side of the product.

7. Connect compression fittings.

Tighten the nut an additional 1-1/4 turn after hand tightening once the tube has been inserted into the fitting. Please use stainless steel material for piping. After installation, perform a leak test.

8. Connect pipe thread fittings.

Thread fitting or piping into the body and tighten it at the recommended torque. When holding the product, hold its body section.

Apply PTFE tape or sealant on the thread of the piping, fitting, etc. When using sealant other than PTFE, it will be difficult to fully remove the sealant and this could cause the malfunction or failure of the product.

9. After installation, perform a leak test.

Perform a leak test, such as a helium leak test, pressure decay test, bubble leak test, etc., appropriate for the application. It is recommended to perform a helium leak test on all face seal connections and tube welds as per the industry standards (refer to SEMI F1).

Storage and Operating Environment

Warning

1. Do not use in an area containing chemicals, sea water, or water, or where there is direct contact with any of these.

2. Do not use in a place subject to heavy vibration and/or shock.

3. Keep ambient temperature and use gas within the specified operating temperature. Remove any sources of excessive heat.

4. Do not keep the product in storage in an area where any dust or water may enter. Also, keep in dry conditions where there is no contact with humidity.



Process Gas Equipment Common Precautions 2

Be sure to read this before handling products.

Maintenance

Warning

1. Perform routine maintenance.

Performing routine maintenance, by taking into consideration the operating conditions of the equipment, is the customer's responsibility. It is recommended to perform routine maintenance for the following:

External leakage, internal leakage (across the seat leakage), performance, etc.

2. Shut down the system before removing the product for repair or replacement.

Follow the proper procedures to shut off the process gas supply, and vent the system.

3. Purge hazardous gases from the system before removing the product.

4. Do not disassemble products under warranty.

The warranty may be voided if the product is disassembled.

Operation

Warning

1. Do not put heavy objects on the product. Do not use the product as scaffold.

2. Do not use the product in conditions that do not meet the product specifications.

Product Returns

When returning a product to SMC, make sure to properly purge to remove all hazardous materials and return the product in accordance with SMC's specified procedures. For details, please contact SMC.

Export

Warning

These products fall within the United States Export Administration Regulations (EAR) regarding sale, export, and re-export. It is the exporter's responsibility to assure that these regulations are followed when the products are exported. The Export Control Classification Number (ECCN) related to the products is as follows.

Regulations (including ECCN) are subject to change with the amendment of laws.

The latest information regarding these regulations should be checked by the customer.

Reference: Bureau of Industry and Security (USA)
<http://www.bis.doc.gov/>

1) 2B350.g.1 <Applicable conditions>

(1) Product name: Diaphragm valve

(2) Body material: Ni-Cr-Mo alloy

(3) Connection size: 1/2 inch or more to less than 1 inch *1

*1 Refer to 2B999.g for connections 3/8" inch or smaller

2) 2B350.g.2 <Applicable conditions>

(1) Product name: Diaphragm valve

(2) Body material: Ni-Cr-Mo alloy

(3) Connection size: 1 inch or more to less than 4 inches

3) 2B999.g <Applicable conditions>

(1) Product name: Regulator, Back pressure regulator, Diaphragm valve, Check valve, Vacuum generator module (integrated with valve and check valve)

(2) Body material: 316 SS, 316L SS, 316L SS secondary remelt, Ni-Cr-Mo alloy regardless of connection size

4) EAR99 <Applicable conditions>

(1) Regulator and Back pressure regulator with brass bodies

(2) Vacuum generator, Flow switch, Other options (Pressure gauge, LOTO)



Industrial Filters Precautions 1

Be sure to read this before handling products.

For detailed precautions on each series, refer to the main text.

Model Selection/Range of Operating Conditions

Do not select a model exceeding specification ranges and carefully consider the purpose of use, required specifications, and operating conditions, such as fluid, pressure, flow rate, temperature, and environment. Mishandling may lead to an unexpected accident.

Warning

1. Operating pressure

Do not use the product beyond the operating pressure range. Do not use in locations where peak pressure exceeds the operating pressure range due to water hammer, surge pressure, etc.

2. Operating temperature

Do not use the product beyond the operating temperature range. Do not use at temperatures at or above the boiling point of the fluid.

3. Fluid

- Do not use fluids which cause the corrosion or swelling of the material used for each part of the filter.
- There are models which cannot be used for gases depending on the construction of the filter container. Be sure to confirm the compatibility by referring to the catalog and operation manual.

Also, be sure to confirm when using with gases because it may not be possible to use the standard product, as depending on the internal capacity and operating pressure of the filter container, the laws and regulations of class-2 pressure vessels may apply.

- Do not use the product for corrosive fluids.
- Do not use any fluid which will cause the seal, O-ring, or element to swell or deteriorate. The fluid may deteriorate these parts, causing leakage.
- When using with liquids that contain flammable ingredients, implement safety measures, such as fire prevention and leakage detection sensors, and measures against static.
- Do not use the industrial filter outdoors.

4. Operating environment

- Do not use in operating conditions or environments where changes in color or deterioration of material due to corrosion may occur.
- Do not use this product in a place where shock or vibrations occur.

Caution

1. Pressure drop (ΔP)

- Use the product with a flow which has an initial pressure drop of 20 kPa or less.

Design and Installation

Caution

[Design]

1. Design the system with operating conditions, including operating pressure, operating temperature, operating fluid, and operating environment appropriate for safe operation.
2. Use the product with a circuit that has minimal fluctuations to the filter caused by pressure or flow. (Ex.: circulating circuit, etc.)
3. Prevent back pressure and backflow from occurring.
The element may be damaged by back pressure or backflow.
4. Prevent the propagation of an excess moment load and vibration from the piping side.
5. Provide adequate space for maintenance and inspection before installing and piping the product.
6. When using outside of Japan, the laws and regulations concerning the pressure vessel and fluid established by each country and region may be applied. Confirm in advance to determine whether the product can be used.

[Mounting]

1. For free standing type filters, firmly secure the bottom to the ground using foundation bolts.
2. For piping support type filters, secure to a panel using a bracket.
3. It is recommended that the filter is attached vertically to the upper cover portion and lower portion of the case for maintainability purposes, such as air releasing and element replacement.

[Piping]

1. Connect the valves or fittings suited to the operating conditions by checking the size of each connection port.

During connection work, make sure that powder from the piping screws or seal material does not get into the interior of the piping. Prior to operating, flush the piping line and check for abnormalities, such as fluid leakage.

2. Firmly secure the piping to the mounting frame using a saddle, etc., to avoid vibration or force caused by weight.

3. During element replacement, it is necessary to release fluid from the vessel.

Be sure to connect the pipes so that fluid can be released without issue.

4. Make sure that air releasing is conducted.

If the pump is located in a high position, idling sometimes occurs during re-start. Take measures such as releasing the air from a high position, etc.



Industrial Filters

Precautions 2

Be sure to read this before handling products.

For detailed precautions on each series, refer to the main text.

Operation

Warning

1. Never loosen the tightened parts (V-band, tension bolt) under pressurized conditions.

Caution

1. Releasing the air

When applying pressure for starting a pump, be sure to release the air by opening the air release valve (air vent) on the top.

2. When operating

When applying pressure for starting a pump, confirm that each of the connecting parts are completely sealed. If any abnormality is found, such as fluid leakage, stop the product immediately and locate the possible cause of the failure.

Resume operation after taking appropriate measures to stop the fluid leakage by replacing the O-rings or seals, or retightening the fittings.

Maintenance

Warning

1. Failure to follow proper procedures will likely cause fluid leakage or the removal of the cover, which may lead to an unexpected accident. Follow the procedure indicated in the operation manual.
2. Make sure that the line is stopped and the pressure is atmospheric pressure (gauge pressure: zero) before starting maintenance and inspection.
3. Depending on the fluid, there may be effects on the human body. Check the SDS of the fluid, and take all necessary precautions.

Caution

1. Timing of element replacement

- When the time has come to replace the element, replace it with a new element immediately.
“Timing of element replacement”
- When the pressure drop has reached 0.1 MPa

2. Element replacement

- Carry out element replacement based on the procedure indicated in the operation manual. Mishandling could lead to malfunction or damage the machinery and equipment.
- Before replacing the elements, be sure to wear protective gloves and safety glasses.
There is a possibility of being injured by the captured foreign matter. There is also a possibility of being injured by hand slippage caused by the adhesion of fluid.
- After the elements are replaced, correctly perform the attachment and assembly of each part of the filter in the predetermined positions according to the operation manual.

3. Cleaning each component

During element replacement, in order for firm sealing to take place, clean the sealing surface of the O-ring and seal, and/or remove the paint which is left on the tightened parts or the thread parts.

4. Replacing O-rings and seals

Replace any deteriorated or expanded O-rings and seals.
Also, replace the seal after it has been used for one year or when fluid leakage occurs.

5. Temperature

When operating at high temperatures (40°C to 80°C), there is a danger of burns.

Confirm that the surface temperature of the filter and other operating parts are 40°C or less, to eliminate the risk of burns.



Hydraulic Cylinders Precautions 1

Be sure to read this before handling products.

Design

Warning

1. There is a possibility of dangerous sudden action by cylinders if sliding parts of machinery are twisted due to external forces, etc.

In such cases, human injury may occur, e.g. by hands or feet getting caught in the machinery, or damage to the machinery itself may occur. Therefore, the machine should be designed to operate smoothly and to avoid such dangers.

2. A protective cover is recommended to minimize the risk of personal injury.

If a stationary object and the moving parts of a cylinder are in close proximity, personal injury may occur. Design the structure to avoid contact with the human body.

3. Securely tighten all stationary parts and connected parts so that they will not become loose.

Especially when a cylinder operates with high frequency or is installed where there is a lot of vibration, ensure that all parts remain secure.

4. There are cases in which a deceleration circuit or shock absorber may be required.

When a driven object is operated at a high speed or the load is heavy, a cylinder's cushion will most likely not be sufficient to absorb the impact. Install a deceleration circuit to reduce the speed before cushioning, or install an external shock absorber to relieve the impact.

In this case, the rigidity of the machinery should also be examined.

5. Consider a possible drop in operating pressure due to a power outage.

When a cylinder is used as a clamping mechanism, there is a danger of workpieces dropping if there is a decrease in clamping force due to a drop in circuit pressure caused by a power outage. Therefore, safety equipment should be installed to prevent human injury or damage to machinery. Suspension mechanisms and lifting devices also require drop prevention measures.

6. Consider a possible loss of power source.

Measures should be taken to protect against human injury or equipment damage in the event that there is a loss of power to equipment controlled by air pressure, electricity, or hydraulics.

7. Design the circuitry to prevent the sudden lurching of driven objects.

When hydraulic pressure in a cylinder is zero, the driven object will lurch at a high speed if pressure is applied to one side of the piston. Therefore, equipment should be selected and circuits designed to prevent sudden lurching because there is a danger of human injury and/or damage to equipment when this occurs.

8. Consider emergency stops.

Design the system so that bodily injury and/or damage to machinery and equipment will not occur when machinery is stopped by a manual emergency stop or a safety device triggered by abnormal conditions.

9. Consider the action when operation is restarted after an emergency or abnormal stop.

Design machinery so that bodily injury or equipment damage will not occur upon the restart of operation.

When the cylinder has to be reset at the starting position, install manual safety equipment.

Selection

Warning

1. Confirm the specifications.

The products featured in this catalog are designed strictly for use in industrial oil hydraulic system applications. If the products are used in conditions that are outside the range of pressure and temperature specifications, damage and/or malfunction may occur. Do not use in these conditions. (Refer to the specifications.)

Please consult with SMC if a fluid other than hydraulic fluid is to be used.

2. Intermediate stops

Since hydraulic cylinders are not guaranteed for zero oil leakage, it may not be possible to hold a stopped position for an extended period of time.

3. Take surge pressure into consideration.

Use cylinders which can withstand the surge pressures (maximum allowable pressure) generated in hydraulic systems. (Refer to specifications.)

Inside cylinders, pressure may be generated that is higher than the set pressure for the relief valve, e.g. internal pressure due to load inertia or surge pressure when switching valves. Consider these factors and determine the operating pressure so that the pressure generated inside the cylinders will be within the maximum allowable pressure.

Pressure terminology used in this catalog is defined as follows:

Nominal pressure	Pressure assigned to a cylinder for convenient identification. It is not necessarily the same as the operating pressure which guarantees performance under specified conditions.
Maximum allowable pressure	The maximum allowable value for the pressure that is generated inside cylinders (such as surge pressure).
Proof pressure	Test pressure that the cylinder must be able to withstand without lowering system performance when returning to the nominal pressure.
Minimum operating pressure	Minimum pressure at which a horizontally installed cylinder operates with no-load.

4. Take into account compatibility with hydraulic fluids.

Hydraulic fluid	Compatibility
Standard mineral hydraulic fluid	○
W/O hydraulic fluid	○
O/W hydraulic fluid	○
Water-glycol hydraulic fluid	*1
Phosphate hydraulic fluid	×

*1 Please consult with SMC.

Caution

1. Use the product within the limits of the maximum usable stroke.

The piston rod will be damaged if operated beyond the maximum stroke. Refer to the Hydraulic Cylinder Stroke Selection (Best Pneumatics No. 11) for maximum strokes.



Hydraulic Cylinders Precautions 2

Be sure to read this before handling products.

Selection

Caution

2. Operate the piston within a range such that collision damage will not occur at the stroke end.

Operate within a range such that damage will not occur when a piston having inertial force stops by striking the cover at the stroke end.

- (1) Take load factors and piston speed (Best Pneumatics No. 11) into consideration and determine the operability by referring to the chart under "Selection standards."
- (2) When using a cylinder with no cushion, the speed when the piston strikes the cover should be reduced to 50 mm/sec or lower (a level at which no metallic sound is generated), or a stopper should be installed on the outside.

3. Use a flow control valve to adjust the hydraulic cylinder drive speed, gradually increasing from a low speed to the desired speed setting.

4. Provide intermediate supports for long stroke cylinders.

Provide intermediate supports for cylinders with long strokes to prevent piston rod damage due to sagging of the piston rod, deflection of the tube, vibration, or external loads.

Mounting

Caution

1. Be certain to align the axis center of the piston with the load and direction of movement when connecting.

When not properly aligned, twisting of the piston rod and tubing may occur, and damage may be caused due to wear on certain areas, such as the inner tube surface, bushings, piston rod surface, and seals.

2. When an external guide is used, connect the piston rod end and the load in such a way that there is no interference at any point within the stroke.

3. Do not scratch or gouge the sliding parts of the cylinder tube by striking or grasping them with other objects.

Cylinder bores are manufactured to precise tolerances so that even a slight deformation may cause faulty operation.

4. Do not use until you confirm that the equipment can operate properly.

Following mounting, repairs, or conversions, confirm that the product is mounted correctly by conducting suitable function and leakage tests after piping and power connections have been made.

5. Operation manual

The product should be mounted and operated after the operation manual is thoroughly read and its contents are understood.

Keep the operation manual where it can be referred to as necessary.

Piping

Caution

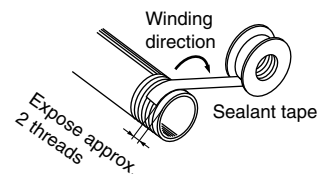
1. Preparation before piping

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

2. Winding of sealant tape

When screwing together pipes and fittings, be certain that chips from the pipe threads and sealing material do not get inside the piping.

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



3. Set up so that air cannot accumulate inside the piping.

Cushion

Caution

1. Readjust using the cushion needle.

Cushion needles are adjusted at the time of shipment. When the cylinder is put into service, the cushion needles should be readjusted based on factors such as the size of the load and the operating speed. When the cushion needles are turned clockwise, restriction of the air flow becomes greater and thus the cushioning effect also increases.

2. Do not operate with the cushion needle in a fully closed condition.

This will contribute to the generation of surge pressure, and the cylinder or equipment can be damaged.

3. Do not overly loosen the cushion needle.

This may cause oil to flow out. (As a guideline, loosen the needle 2 turns or less from the fully closed position.)

Air Release

Caution

1. Operate after opening the air release valve and completely releasing any internal air.

Residual air can cause malfunction.

2. When adjusting the air release, do not excessively loosen the plug.

Use caution, since excessively loosening the plug may cause it to fly out or fluid to blow out, posing a danger of human injury.



Hydraulic Cylinders Precautions 3

Be sure to read this before handling products.

Hydraulic Fluid

Warning

1. Use clean fluid.

Do not use deteriorated fluid or fluid containing foreign matter, moisture, or corrosive additives, as this can cause the malfunction, damage, or corrosion of parts.

Caution

1. Install hydraulic fluid filters.

Provide your hydraulic system with hydraulic fluid filters with a filtration size of 10 µm or smaller.
Refer to SMC's hydraulic filter specifications.

2. Use the product within the specified range of fluid and ambient temperatures.

Take measures to prevent freezing, as moisture in hydraulic fluid will freeze at 0°C or below, and this may cause damage to seals or lead to malfunction.

3. Use hydraulic fluid with a viscosity grade equivalent to ISO VG32 or VG46.

Operating Environment

Warning

1. Do not use in an environment where there is a danger of corrosion.

Refer to each construction drawing for information on the materials of cylinders.

2. Install a protective cover if the product is to be used in a dusty environment or where it will be exposed to chips and spatter.

When water droplets or coolant are spattering, use a water-resistant hydraulic cylinder.

Maintenance

Warning

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

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

2. Removal of equipment

Before machinery is removed, first ensure that there are measures in place to prevent the fall or sudden, erratic movement of driven objects and equipment. Then, cut off the air supply and electric power, and reduce the pressure in the system to zero.

When machinery is restarted, proceed with caution after confirming that appropriate measures are in place to prevent sudden movement.

Caution

1. Perform periodic maintenance on filters installed in a hydraulic system in order to keep the oil clean.

If the oil used in hydraulic cylinders contains foreign matter, parts, such as the piston seals and rod seals, will be damaged.



Hydraulic Filters/Precautions 1

Be sure to read this before handling products.

Operation

Warning

1. Never loosen the tightened parts (Bolt, Clamp ring.) under pressurized conditions.

Caution

1. When operating

When applying pressure for starting a pump, confirm that each connecting parts are completely sealed. If any abnormality is found, such as fluid leakage, stop the product immediately and locate the possible cause of the failure.

Resume operation after taking appropriate measures to stop the fluid leakage by replacing the O-rings or seals, or additionally tightening the fittings.

Maintenance

Warning

1. Failure to observe the procedure will likely cause fluid leakage or removal of a cover, which may lead to an unexpected accident. Follow the procedure in the operation manual.
2. Make sure that the line is stopped and the pressure is atmospheric pressure (gauge pressure: zero) before starting maintenance and inspection.
3. Depending on the fluid, it may affect the human body. Check the MSDS of the fluid, and take the necessary measures.

Caution

1. Timing of element replacement

- When the time has come to replace the element, replace it with a new element immediately.

Confirm the element replacement period by the differential pressure indicator or the differential pressure indication switch.

2. Element replacement work

- Carry out element replacement work based on the procedure in the operation manual. Mishandling could lead to malfunction or damage the machinery and equipment.
- Before replacing the elements, be sure to wear protective gloves, safety glasses.

There is a possibility of being injured by the captured foreign matter. There is also a possibility of being injured by slippage of your hands caused by the adhesion of fluid.

- After the elements are replaced, correctly perform the attachment and assembly of each part of the filter in the predetermined positions according to the Operation Manual.

3. Cleaning each component

During element replacement, in order for firm sealing to take place, clean the sealing surface of the O-ring and seal, and/or remove the paint which is left on the tightened parts or the thread parts.

4. Replacing O-rings and seals

Replace the deteriorated or expanded O-ring or seal.

Also, replace the seal after it has been used for one year or when fluid leakage occurs.

5. Temperature

When operating at high temperatures (40°C to 80°C), there is danger of burns.

Confirm that the surface temperature of the filter or the parts for operation are 40°C or less, to prevent a burn from occurring.



Hydraulic Filters/Precautions 2

Be sure to read this before handling products.

Model Selection/Range of Operating Conditions

Do not select a model exceeding specification ranges and carefully consider the purpose of use, required specifications and operating conditions such as fluid, pressure, flow rate, temperature and environment. Mishandling may lead to an unexpected accident.

Warning

1. Operating pressure

Do not use the product beyond the operating pressure range.
Do not use in locations where peak pressure exceeds the operating pressure range due to water hammer, surge pressure, etc.

2. Operating temperature

Do not use the product beyond the operating temperature range. Do not use at temperatures at or above the boiling point of the fluid.

3. Fluid

- Do not use fluids other than those indicated in the drawings and catalog.
- Do not use fluids which cause corrosion or swelling of the material used for each part of the filter.
- Never use the product with gases.
- Do not use any fluid which will cause the seal, O-ring or element to swell or deteriorate. The fluid may deteriorate these causing leakage.

4. Operating environment

- Do not use in operating conditions or environments where changes in color or deterioration of material due to corrosion occur.
- Do not use this product in a place where shock or vibrations occur.
- Do not use the hydraulic filter outdoors.

Caution

1. Rated flow rate

- Do not use flow rates beyond the rated flow rate indicated in the drawings and catalog.

Design and Installation

Caution

[Design]

1. Design the system with operating conditions, including operating pressure, operating temperature, operating fluid, and operating environment appropriate for safe operation.
2. Use the product with a circuit having lesser fluctuation to the filter caused by pressure or flow. If the occurrence of water hammering and surge pressure, etc. can be considered, take the necessary measures, such as installing an accumulator.
3. Prevent back pressure and backflow from occurring.
The element may be damaged by back pressure and backflow.
4. Prevent the propagation of an excess moment load and vibration from the piping side.
5. If a relief function of the hydraulic filter which controls the pressure is not used in the hydraulic circuit, design a circuit safe for the customer's system.
6. Provide sufficient space for maintenance.

[Piping]

1. Connect it with IN and OUT ports in proper location.
It does not work with the connection reversed.
2. Connect the valves or fittings suited to the operating conditions by checking the size of each connection port.
During connection work, make sure that powder from the piping screws or seal material does not get into the interior of the piping. Prior to operating, flush the piping line and check for abnormalities, such as fluid leakage.
3. Firmly fix the piping to the mounting frame using a saddle, etc., to avoid vibration or force caused by the weight.
4. During element replacement, it is necessary to release fluid from the vessel.
Be sure to connect the pipe so that fluid releasing work can be absolutely performed.
5. Make sure that air releasing work can be absolutely performed.
If the pump is in a high position, idling sometimes occurs during re-start. Take measures such as releasing the air in a high position, etc.

[Low temperature operation]

The hydraulic fluid used becomes high viscosity when the temperature is low during the winter, etc., and the differential pressure indicator or the switch may activate. If this occurs, wait until the oil temperature rises by a warm-up operation, and confirm if the differential pressure indicator and switch can be reset, then start the operation. (20 °C or more is the guide.) In the case of the differential pressure indication switch, design the system in combination with the temperature sensor, so that the output signal is not accepted until the oil temperature reaches the set value or more.

Information on Symbol Revision

Piping and electrical graphic symbol standards were revised.

Piping graphic symbol standards: JISB0125-1: 2007/ISO1219: 2006

Electrical graphic symbol standards: JISC0617: 2011/IEC60617

Therefore, the graphic symbols in the catalogs were also revised.

1. About the graphic symbols stated in catalogs

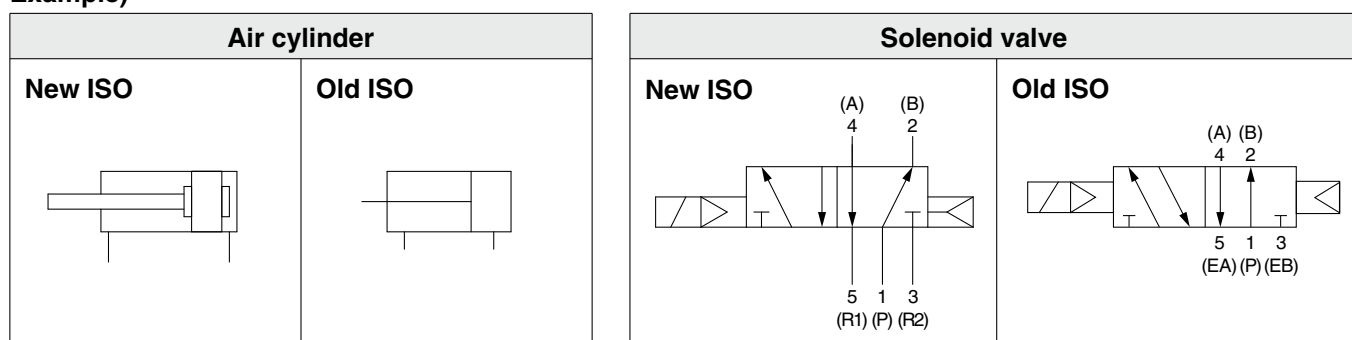
Please be aware that the old graphic symbols are still included in some catalogs.

Electronic catalogs on the SMC website will be revised one by one.

For further information, please refer to the SMC website (<http://www.smcworld.com>).

A few contrasting examples between the new and old symbols can be found below.

Example)



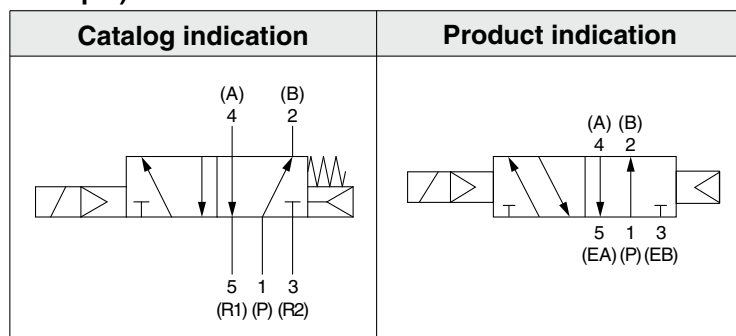
2. About port indication

The port symbol was changed from an alphabetic indication to a numeric indication.

Please be aware that the indication stated in the catalog may differ from that on the actual product.

An indication example can be found below.

Example)



G Thread of SMC Products

1. The thread shape (root diameter, thread diameter, pitch, etc.) and gauge diameter of the G thread complies with the thread standards defined in JIS B0202 (ISO228-1).

2. The products with the ISO1179-1 (hydraulic/pneumatic G thread) or ISO16030 (pneumatic G thread) indications comply with the thread shape and gauge diameter standards of JIS B0202 (ISO228-1), and relevant effective thread depth, seat surface range, surface roughness, and squareness standards.

3. As for ISO1179-1 (hydraulic/pneumatic G thread), original pressure tightness (withstand pressure) values are specified for each SMC product. These pressure tightness (withstand pressure) values are not guaranteed to comply with those defined in ISO 1179-1, ISO1179-2, ISO1179-3, and ISO1179-4.

4. As for ISO16030 (pneumatic G thread), original pressure tightness (withstand pressure) values are specified for each SMC product. These pressure tightness (withstand pressure) values are not guaranteed to comply with those defined in ISO16030.

Return of Product

Warning

If the product to be returned is contaminated or is possibly contaminated with substances that are harmful to humans, for safety reasons, please contact SMC beforehand and then employ a specialist cleaning company to decontaminate the product. After the decontamination prescribed above has been carried out, submit a Product Return Request Sheet or the Detoxification/Decontamination Certificate to SMC and await SMC's approval and further instructions before attempting to return the item.

Please refer to the International Chemical Safety Cards (ICSC) for a list of harmful substances. If you have any further questions, please don't hesitate to contact your SMC sales representative.

Revision History		
Edition B	* Handling precautions for equipment other than pneumatic equipment (models shown below) has been added. 2-Port Solenoid Valves for Fluid Control - Temperature Control Equipment - Hydraulic Cylinders - Electric Actuators/Cylinders * Number of pages has increased from 52 to 76.	MV
Edition C	* Process Gas Equipment was added. * "Information on Symbol Revision/G Thread of SMC Products" was added.	RW
Edition D	* Industrial Filters was added. * Number of pages has increased from 76 to 80.	VR