Safety Precautions

Be sure to read this section before use.

When designing and manufacturing a device using CKD products, the manufacturer is obligated to check that device safety mechanism, pneumatic control circuit, or water control circuit and the system operated by electrical control that controls the devices is secured.
It is important to select, use, handle and maintain the product appropriately to ensure that the CKD product is used safely.
Observe warnings and precautions to ensure device safety.
Check that device safety is ensured, and manufacture a safe device.

WARNING

1 This product is designed and manufactured as a general industrial machine part.
It must be handled by an operator having sufficient knowledge and experience.

2 Use this product in accordance with specifications.

This product must be used within its stated specifications. In addition, never modify or additionally machine this product.
This product is intended for use in general industrial machinery equipment or parts. It is not intended for use outdoors (except for products with outdoor specifications) or for use under the following conditions or environments.
(Note that this product can be used when CKD is consulted prior to its usage and the customer consents to CKD product specifications. The customer should provide safety measures to avoid danger in the event of problems.)

❶ Use for applications requiring safety, including nuclear energy, railways, aircraft, marine vessels, vehicles, medical devices, devices or applications in contact with beverages or foodstuffs, amusement devices, emergency cutoff circuits, press machines, brake circuits, or safety devices or applications.
❷ Use for applications where life or assets could be significantly affected, and special safety measures are required.

3 Observe organization standards and regulations, etc., related to the safety of device design and control, etc.

ISO4414, JIS B 8370 (Pneumatics fluid power - General rules and safety requirements for systems and their components)
JFPS2008 (Principles for pneumatic cylinder selection and use)
Including the High Pressure Gas Safety Act, Industrial Safety and Health Act, other safety rules, organization standards and regulations, etc.

4 Do not handle, pipe, or remove devices before confirming safety.

❶ Inspect and service the machine and devices after confirming safety of all systems related to this product.
❷ Note that there may be hot or charged sections even after operation is stopped.
❸ When inspecting or servicing the device, turn OFF the energy source (air supply or water supply), and turn OFF power to the facility.Discharge any compressed air from the system, and pay attention to possible water leakage and leakage of electricity.
❹ When starting or restarting a machine or device that incorporates pneumatic components, make sure that the system safety, such as pop-out prevention measures, is secured.

5 Observe warnings and cautions in the following pages to prevent accidents.

■ The precautions are ranked as "DANGER", "WARNING" and "CAUTION" in this section.

DANGER: When a dangerous situation may occur if handling is mistaken leading to fatal or serious injuries, and when there is a high degree of emergency to a warning.

WARNING: If handled incorrectly, a dangerous situation may occur, resulting in death or serious injury.

CAUTION: When a dangerous situation may occur if handling is mistaken leading to minor injuries or physical damage.

Note that some items described as "CAUTION" may lead to serious results depending on the situation.
Every item provides important information and must be observed.

Warranty

1 Warranty period

The product specified herein is warranted for one (1) year from the date of delivery to the location specified by the customer.

2 Warranty coverage

If the product specified herein fails for reasons attributable to CKD within the warranty period specified above, CKD will promptly provide a replacement for the faulty product or a part thereof or repair the faulty product at one of CKD's facilities free of charge.
However, following failures are excluded from this warranty:

1) Failure caused by handling or use of the product under conditions and in environments not conforming to those stated in the catalog, the Specifications, or the Instruction Manual.
2) Failure caused by use of the product exceeding its durability (cycles, distance, time, etc.) or caused by consumable parts.
3) Failure not caused by the product.
4) Failure caused by use not intended for the product.
5) Failure caused by modifications/alterations or repairs not carried out by CKD.
6) Failure caused by reasons unforeseen at the level of technology available at the time of delivery.
7) Failure caused by acts of nature and disasters beyond control of CKD.

The warranty stated herein covers only the delivered product itself. Any loss or damage induced by failure of the delivered product is excluded from this warranty.
Note: For details on the durability and consumable parts, contact your nearest CKD sales office.

3 Compatibility check

The customer is responsible for confirming the compatibility of CKD products with the customer's systems, machines and equipment.

Pneumatic components: Warnings and Cautions

Be sure to read this section before use.

Product-specific cautions: Compact flow rate sensor FSM3 Series

Design/selection

Working fluids

DANGER

■ Never use with flammable fluids

WARNING

■ This product cannot be used as a billing meter. Do not use this product for commercial transactions as it is not compliant with the Measurement Act. Intended applications include industrial sensors.

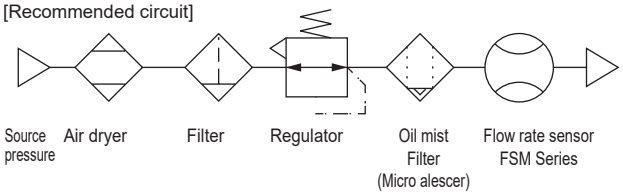
■ Do not use fluids which are not applicable.

■ Use dry gas which does not contain corrosive elements such as chlorine, sulfur or acids, and which is clean and does not contain dust or oil mist.

■ Depending on the fluid, retaining the fluid for long periods could adversely affect the performance. Do not seal the fluid in the pipe for long periods of time.

■ When using compressed air, use clean air that complies with JISB8392-1 Class 1.1.1 to 1.6.2. Since compressed air from the compressor contains drainage (water, oxidized oil, foreign matter, etc.), attach a filter, an air dryer and an oil mist filter (microalescer) to the primary side (upstream) of the sensor. The sensor's mesh rectifies flow in the pipe. It does not filter out foreign matter, so provide a filter.

[Recommended circuit]



■ Working pressure/flow rate range

Applications exceeding the max. working pressure and specified flow rate range may result in faults. If energized in a vacuum state of −0.09 MPa or less, the sensor's heat dissipation will suffer, leading to degradation of the sensor.

■ When using a valve on the primary side of this product, use only an oil-prohibited specification valve. This sensor could malfunction or fail if exposed to splattering grease, oil, etc. As friction powder may be generated depending on the valve, mount a filter to prevent the powder from entering the sensor.

■ The sensor for oxygen gas is a custom model. To prevent ignition accidents, treat the inside of the flow paths on oxygen models in accordance with oil free specifications. Do not allow oxygen gas to flow again when it has been used on fluids other than oxygen to flow even once.

■ When using liquefied gas such as carbon dioxide, always vaporize it first. Failure may result if liquefied gas enters the product.

Working environment

DANGER

■ Flammable environment

Refer to "ATEX Compliance" on page 26 for safety precautions.

WARNING

■ Corrosive environment

Do not use this product in an atmosphere containing corrosive gases such as sulfur dioxide.

■ Ambient/fluid temperatures

Use at ambient/fluid temperatures within the specified range of 0 to 50°C. Even if the temperature is within the specified range, do not use this product if the ambient temperature and fluid temperature could suddenly change and cause dew to condense.

■ Degree of protection

The degree of protection of this product is equivalent to IP65. This product employs a dust-proof, waterproof structure that provides reliability during maintenance and cleaning, during which it may be exposed to water splashing. Note that this product cannot be used in environments where it will be constantly exposed to water, or in water or where water or oil may radiate violently. Also refer to the precautions regarding the "explosion-proof structure and protective structure" on page 26 for design and selection.

Flow rate unit

⚠ CAUTION

■ This product's flow rate is measured at a mass flow rate unaffected by temperature or pressure. The unit is L/min, but this is the display when the mass flow rate is converted to volumetric flow rate at 20°C 1 atmosphere (101 kPa) relative humidity 65%RH.(For gases other than air: 20°C, 1 barometric pressure (101 kPa), relative humidity 0%RH)

Overflow

⚠ CAUTION

■ With each series, the sensor can handle an overflow double the measured range. If dynamic pressure is applied near the maximum working pressure (when a pressure difference exceeding the max. working pressure is applied between primary and secondary sides), the sensor may operate abnormally. If dynamic pressure is applied, such as when a workpiece is filled for leakage inspection, provide a bypass circuit or restrictor so that dynamic pressure is not applied to the sensor.

Use for suction confirmation, etc.

⚠ CAUTION

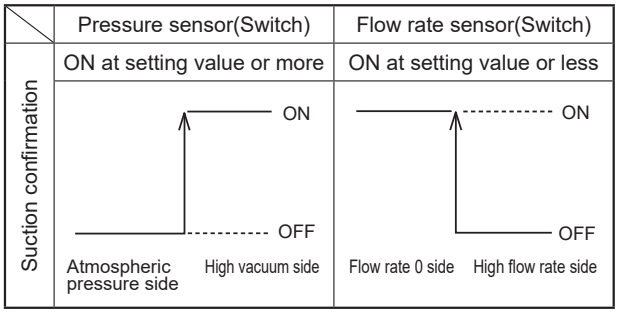
■ Mount an air filter upstream from suction in compliance with the working status to prevent the entry of foreign matter.

■ Consider the atmospheric dew point and the product's ambient temperature, and use the product under conditions in which dew does not condense in pipes.

■ Select the flow rate range based on the operating vacuum pressure and suction nozzle.

■ Response speed may be delayed by the piping volume between the suction nozzle and this product. In this case, take countermeasures to reduce piping capacity.

■ When the suction confirmation sensor is switched from a pressure sensor (switch) to a flow rate sensor (switch), sensor output (switch output) logic will be reversed. Refer to the drawing below. Note that the PLC sequence program must be changed or revised. If source pressure or vacuum source is not supplied when device power is turned ON, "flow rate 0" = "sensor output (switch output) ON" status is set at the flow rate sensor (switch). Check that this is not a problem with the PLC sequence program, etc.



Other

⚠ CAUTION

■ The flow path is not completely free of dust generation. A final clean filter should be used in circuits where dust generation could be a problem.

■ If the actual flow rate is fluctuating, the measured flow rate value will also fluctuate. Either increase the FSM3 display cycle or response time, or average the analog output on the device. In particular, note that control valves such as solenoid valves can be easily generated when used near a circuit or pump that opens and closes quickly and frequently.

■ Measuring the pulsating flow rate may cause errors in the measured flow rate. Restrict the flow rate with the fixed orifice and needle valve, etc., and use it in a laminar flow state (normal flow that does not include irregular fluctuations).

■ The flow rate measured with the gas type switching function is a reference value calculated inside the product based on the converted value. Accuracy other than the air mode is a guideline.

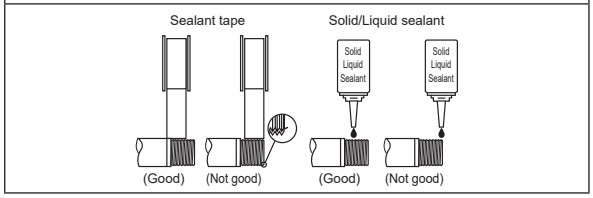
Mounting/Installation/During adjustment

Piping

⚠ CAUTION

- Always attach the pipes before starting wiring.
- Align the fluid flow direction to the direction indicated on the body when connecting the pipes.
- Do not install the regulator/solenoid valve, etc., immediately before this product. Generated drift may cause errors. Provide a straight pipe with approx. 10 times the bore size when necessary.
- Before installing the piping, clean out the pipes using an air blower to remove all foreign matter and cutting chips from the pipes. The rectifier or sensor chip could be damaged if a large amount of foreign matter, cutting chips, etc., enters.
- Check that sealing tape or adhesive does not get inside during piping.
  * When using for clean-room specifications, make sure that the sealant material matches the system being used.

When winding fluoro resin sealing tape around threads, wind sealing tape once or twice, leaving two to three threads open at the end of the screw. Press tape with your fingernail tip to stick it onto threads. When using liquid sealant, leave one to two threads open from the end, and avoid applying too much. Check that the sealant does not get on device threads.



- Refer to the torque on the right so that excessive screw-in torque or load torque is not applied to the connection port.

[Reference value]

Port thread	Tightening torque N·m
Rc1/8 (G1/8)	**3 to 5**
Rc1/4	**6 to 8**
Rc1/2	**16 to 18**

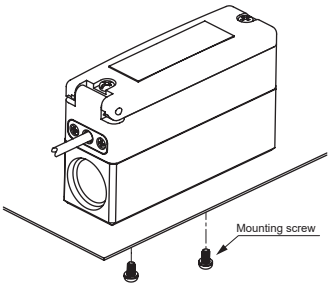
- When using a push-in fitting, accurately insert the tube and confirm that it does not become dislocated even when pulled. Cut the tube at a right angle with a dedicated cutter before use.
- Connect a fitting even when using with the OUT side opened. The port filter could come off.
- Make sure that the leakage detection solution does not enter the inside of this product when inspecting the pipe for leaks.
- Do not rotate fittings while fluid pressure is still applied to this product. The sealant parts could seize or wear, possibly resulting in external leakage.

Mounting

⚠ CAUTION

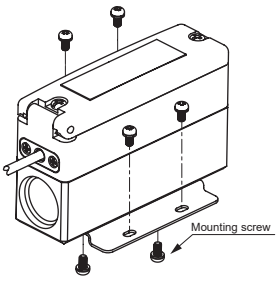
- The LCD display type flow rate meter uses a liquid crystal display. This may be difficult to read depending on the angle.
- Do not install multiple product bodies in close contact. The generation of heat on each part could cause the product's temperature to rise, hastening changes in characteristics or deterioration of the resin material. When using the products in a row, set intervals of distance of 10 mm and over.
- Although the mounting is "unrestricted in vertical/horizontal direction", the flow rate may vary depending on difference in the mounting orientation or piping conditions.

Vertical mounting (use of female thread on bottom surface)



Tighten the mounting screw with a tightening torque of 0.5 N·m.

Bracket mounting (use of dedicated bracket)



Discrete bracket model No.: FSM3-J

Tighten the mounting screw with a tightening torque of 0.5 N·m.

Wiring

⚠ DANGER

- Use power supply voltage and output within the specified voltage. If voltage exceeding the specified voltage is applied, the sensor could malfunction or be damaged, or electrical shock or fire could occur. Do not use any load that exceeds the rated output. Otherwise, output may result in damage or fire.
- Stop the controls and machine devices and turn power OFF before wiring. Starting operation suddenly could cause unpredictable and dangerous operation. Conduct an energized test with controls and machine devices stopped, and set target switch data.Be sure to discharge any accumulated electrostatic charge among personnel, tools, or equipment before and during work. Connect and wire bending resistant material, such as robot wire material for movable sections.

⚠ WARNING

- Install the product and wiring as far away as possible from sources of noise such as power distribution wires. Provide separate countermeasures for surge applied to the power cable. The display or output could fluctuate.
- Do not short-circuit the load. Failure to observe this could result in rupture or burning.
- The output impedance of the analog output section is approx. 1 kΩ. If the impedance of the connecting load is small, output error increases. Check error with the impedance of the connecting load before using. (The analog/current output type is excluded.)

Example of calculation

(FSM3-voltage output impedance: Ro=1kΩ
Load internal impedance: Rx = 1 MΩ

$$\text{Output value} = \left(1 - \frac{Ro}{Ro+Rx}\right) \times 100\%$$

$$= \left(1 - \frac{1\ k\Omega}{1\ k\Omega+1M\Omega}\right) \times 100\%$$

Output value error ⇨approx. 0.1%

- Check wiring insulation.
  Check that wires do not come into contact with other circuits, that no ground faults occur, and that the insulator between terminals is not defective. Overcurrent could flow in and damage the sensor.
- Check line color when wiring. As incorrect wiring could result in sensor damage and malfunctions, check wire color against the instruction manual before wiring.
- Use a DC stabilized power supply within the specified rating, insulated from the AC power supply. A non-isolated power supply could result in electrical shock. If power is not stabilized, the peak value could be exceeded. This could damage the product or impair accuracy.
- The power supply is a DC stabilized power supply completely isolated from the AC primary side. Connect either the + side or - side of the power to the FG. Between the internal power circuit and metal body, a varistor (limit voltage approx. 40 V) is connected to prevent dielectric breakdown of the sensor. Do not perform withstand voltage or insulation resistance test between the internal power supply circuit and metal test. Disconnect wiring first if this testing is required. An excessive potential difference between power and metal body will burn internal parts. An excessive potential difference between the power supply and product housing will burn internal parts. After installing, connecting and wiring the unit, electrical welding of the device/ frame, short-circuit accidents, etc., could cause welding current, excessively high voltage caused by welding, or surge voltage, etc., to run through the wiring, ground wire, or fluid path connected between the above devices, damaging wires or devices. Conduct any work such as electrical welding after removing this device and disconnecting all electric wires connected to the F.G.
- Do not use this product at levels exceeding the power supply voltage. If voltage exceeding this range or AC power is applied, the controller could rupture or burn.
- Check that stress (10 N and over) is not directly applied to lead wire leadouts.

During adjustment

⚠ CAUTION

- If switches are operated when fluid is not stable, such as pulsating, operation may be unstable. In this case, provide sufficient margin between the two setting values and avoid setting switches in an unstable area. Confirm that switch operation is stable before use.

Usage/Maintenance

⚠ WARNING

■ CE-compliance working conditions

This product is CE-marked, indicating conformity with the EMC Directives. The standard for the immunity for industrial environments applied to this product is EN61000-6-2; the following requirements must be satisfied in order to conform to this standard:

Conditions

- The evaluation of this product is performed by using a lead wire that has a power supply line and a signal line paired to assess the product's performance.
- This product is not equipped with surge protection. Implement surge protection measures on the system side.

■ Do not disassemble or modify this product. Doing so could result in faults.

■ Output accuracy is affected by temperature characteristics and heat generated when energized. Provide a standby time (5 minutes or more) after turning the power ON for use.

■ This product does not use flow rate control for five seconds after power is turned ON to complete self-diagnostics. Provide a control circuit/program that ignores signals for at approximately 5 seconds after power is turned ON.

⚠ CAUTION

■ If a problem occurs during operation, immediately turn the power OFF, stop use, and contact your dealer.

■ This product uses a micro-sensor chip, and must be installed where it will not be subject to dropping, impact or vibration. Handle this product as a precision component during installation and transportation.

■ Keep this product's flow rate within the rated flow range.

■ Use this product within the working pressure.

■ If the output setting value is changed, control system devices could operate unintentionally. Stop devices before changing settings.

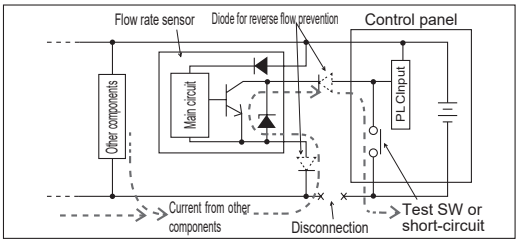
■ Analog output continues even if the flow rate range is exceeded. With the LCD display, "Hi" or "Lo" will be displayed. With the bar display, the bar display will blink. Note that this is outside the guaranteed precision.

■ The accuracy may vary from the initial status depending on the working environment or working conditions. It is recommended to check the operation of the product periodically.

■ The sensor chip will degrade when used for long periods and cause the detected flow rate to fluctuate. Periodically inspect the sensor chip.

■ Replace the working gas in the flow paths before changing the gas type.

■ Pay attention to reverse currents caused by disconnected wires and wiring resistance. If other devices, including a flow rate sensor, are connected to the same power supply as the flow rate sensor, and the switch output wire and power cable negative (-) side are short-circuited to check the operation of the control panel input unit, or if the power cable negative (-) side is disconnected, reverse current could flow to the flow rate sensor's switch output circuit and cause damage.



■ Take the following measures to prevent damage caused by reverse current:

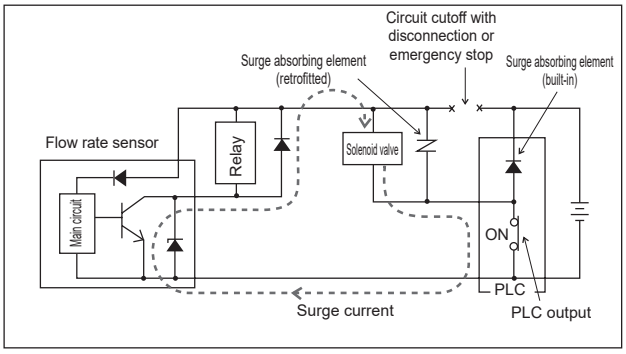
①Avoid centralizing current at the power cable, especially the minus side power cable, and use as thick a cable as possible.

②Limit the number of devices connected to the same power source as the flow rate sensor.

③Insert a diode parallel to the flow rate sensor's output line to prevent reverse current.

④Insert a diode parallel to the flow rate sensor power wire's negative (-) side to prevent reverse current.

■ Pay attention to surge current flow-around. When flow rate sensor power is shared with an inductive load that generates surges, such as a solenoid valve or relay, if the circuit is cut off while the inductive load is functioning, surge current could enter the switch output circuit and cause damage depending on where the surge absorbing element is installed.

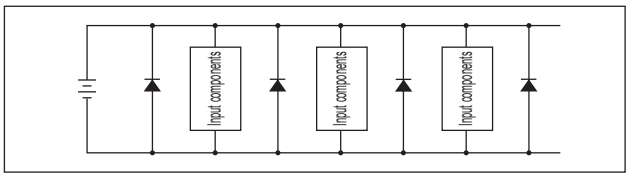


Take the measures below to prevent damage from sneak surge current.

①Separate the power supply for output including the inductive load, such as the solenoid valve and relay, and input, such as the flow rate sensor.

②If a separate power supply cannot be used, directly install a surge absorption element for all inductive loads. Consider that the surge absorption element connected to the PLC, etc., protects only the individual device.

③Connect a surge absorption element to places on the power wiring shown in the figure below, as a measure against disconnections in unspecified areas.



When the devices are connected to a connector, the output circuit could be damaged by the above phenomenon if the connector is disconnected while the power is ON. Turn power OFF before connecting or disconnecting the connector.

■ When using the LCD display type, do not press down on the display section. This may lead to failure.

■ The case is made of resin. Do not use solvent, alcohol or detergent in cleaning, since the resin could absorb it. There is a risk of affecting the resin. Wipe off dirt with a rag soaked in a diluted neutral detergent solution and wrung out well.

■ The explosion-proof and protective structures function with the protective cover (transparent cover) correctly attached. Regularly confirm that the cover bolt (M3) for fixing the protective cover is tightened to the following torque. Also, when opening and closing the protective cover, make sure that there is no floating or displacement of the protective cover and that there is no adhered foreign matter, etc., on the seal surface. Tighten and fix with the following torque.
Cover bolt tightening torque: 0.6N·m ±10%

ATEX Compliance

■ The following are supported.
II3 G Ex ec II C T6 Gc 0°C ≦ Ta ≦ 50°C

■ Working conditions
1) There is a risk of static discharge. Attach to grounded metal and wipe with a wet cloth.
2) Use in a clean environment with a contamination level of 2 or more.
3) The cable retaining parts of this product do not have sufficient retaining functions. When using this product, be sure to provide the cable with an additional retainer function in order to ensure that tension is not transmitted to the end.
4) The protective cover of this product can be opened and closed, but it has explosion-proof construction only when the protective cover is closed and the cover bolts are tightened with the specified torque. Cover bolt tightening torque: 0.6N·m±10%

■ Fluid temperature rating
The temperature of the fluid measured for explosion-proof specifications is 50°C.

■ ATEX Directive 2014/34/EU
EN standards for explosive atomosheres
EN IEC 60079-0:2018
EN IEC 60079-7:2015/A1:2018

⚠WARNING

■ Do not remove or insert cables while energized in an explosive atmosphere.
■ Do not loosen the cover bolt while the unit is energized in an explosive atmosphere. Do not open the protective cover.
■ Do not disassemble or modify the product.

⚠CAUTION

■ The separated display (FSM2-D) does not conform to the ATEX standard.
When using the separated display (FSM2-D) in combination, install outside the explosive atmosphere.