

INSTRUCTION MANUAL

SMALL SIZE FLOW SENSOR

RAPIFLOW®

FSM-V series

- Please read this instruction manual carefully before using this product, particularly the section describing safety.
- Retain this instruction manual with the product for further consultation whenever necessary.

For Safety Use

To use this product safely, basic knowledge of pneumatic equipment, including materials, piping, electrical system and mechanism, is required (ISO 4414 *1, JIS B 8370 *2).

We do not bear any responsibility for accidents caused by any person without such knowledge or arising from improper operation.

Our customers use this product for a very wide range of applications, and we cannot keep track of all of them. Depending on operating conditions, the product may fail to operate to maximum performance, or cause an accident. Thus, before placing an order, examine whether the product meets your application, requirements, and how to use it.

This product incorporates many functions and mechanisms to ensure safety. However, improper operation could result in an accident. To prevent such accidents, **read this operation manual carefully for proper operation.**

Observe the cautions on handling described in this manual, as well as the following instructions:



DANGER : Failure to pay attention to DANGER notices may cause a situation that results in a fatality or serious injury and that requires urgent addressing.



WARNING: Failure to pay attention to WARNING notices may result in a fatality or serious injury.



CAUTION : Failure to pay attention to WARNING notices may result in injury or damage to equipment or facilities.

*1) ISO 4414 : Pneumatic fluid power ... Recommendations for the application of equipment to transmission and control systems.

*2) JIS B 8370 : General rule for pneumatic systems

Design & Selection



DANGER :

Working fluid

- Do not use this product for flammable fluids.

Work environment

- Explosion-proof environment
Do not use this product in an atmosphere containing flammable gas. It does not have an explosion-proof structure, so flame or fires could occur.
- Applicable fluids
There is a risk of oxygen deficiency if nitrogen gas is used for the applicable fluid. Observe the following points when handling:
(1) Use this product in a well-ventilated place.
(2) Ventilate the area while using nitrogen gas.
(3) Regularly check nitrogen gas piping for leaks.

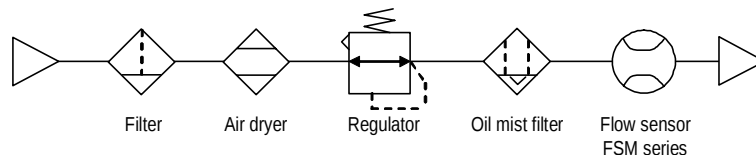


WARNING :

Working fluid

- This product is not to be used as a business meter.
This product does not conform to Measuring Laws, and thus cannot be used for commercial purposes. Use this sensor for industrial applications.
- Dry air or nitrogen can be used. Do not use other fluids or the precision cannot be guaranteed.
- Compressed air from the compressor contains drainage-water, oil oxide, foreign substances, etc. so install a filter, air dryer, and oil mist filter on the primary side (upper stream side) of the sensor. The sensor's meshing rectifies flow in the sensor. It does not filter out foreign substances, so provide a filter.

< Recommended air circuit >



Working environment

- Corrosive environment
Do not use this product in an environment containing corrosive gases such as sulphur dioxide.
- Ambient temperature & fluid temperature
Keep the fluid temperature within 0 to 50°C. Do not use this product where temperature suddenly changes, even if ambient temperature is within specifications. Otherwise, dew could form.
- Maximum working pressure and specified flow rate range
Applications exceeding the maximum working pressure and specified flow rate range may result in faults. Use this product only within the specified range.
- Drip-proof environment
The protective structure of this product is equivalent to IP40.
Do not install this product in a place where it is exposed to moisture, salt contents and dust or dirt, and subject to pressurization and decompression. This product cannot be used because there may arise a fault caused by dew condensation inside the main body in a place in which the temperature significantly changes and at a high humidity.



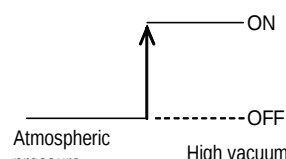
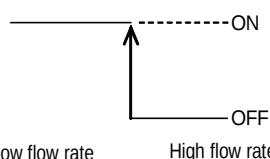
CAUTION :

Flow rate unit

- The flow rate of this product is measured with mass flow that is not influence of temperature and pressure.
The flow rate unit is "L /min". This is the indication of the mass flow converted to volumetric flow at 20 °C and 1 atmospheric pressure (101 kPa).

When this product is used for adsorption check or the like

- Select the flow range in consideration of working vacuum pressure and the diameter of the adsorption nozzle.
Refer to "6. Technical data (6.1 Theoretical calculation method of flow rate)".
- Be sure to install an air filter (filtration degree: 30 μm max.) in the upstream on the suction side to prevent foreign matter from being sucked.
- Use this product under the conditions that there arises no dew condensation inside the piping in consideration of the dew point of atmosphere and ambient temperature of this product.
- The response speed may be reduced due to the piping volume between the adsorption (vacuum) nozzle and this product. In this case, take proper measures; for example, reducing the piping volume.
- When this product is used for vacuum applications, such as air intake, do not bend the tube near or around the push-in joint part.
When stress is applied to the tube near or around the push-in joint, insert the insert ring into the tube, then insert it to the push-in joint before use.
- When the sensor for an adsorption check is switched to a flow sensor from a pressure sensor, theory of the sensor output (switch output) seems to be reversed. (refer to the following figure)
Keep in mind that the sequence program of PLC is required to change/modify.

	Pressure sensor	Flow sensor
Adsorption check	ON operation Pressure > set value 	ON operation Flow rate < set value 

When the source of the vacuum are not supplied at the time of power supply to the equipment, prevent such problem by correcting sequence program of PLC as the flow sensor will be in the state of "flow rate is 0", i.e. "the sensor output (switch output) is ON".

Installation, Piping, Wiring & Adjustment



DANGER : Wiring

- Set the power voltage and output at the specified voltage. Application of voltage exceeding the specified voltage could result in malfunctions, sensor damage, electrical shock, or fire. Do not use a load exceeding the output rating. Failure to observe this could result in output damage or fire.



WARNING : Wiring

- Check the wire color when wiring. Incorrect wiring connections could result in sensor damage, problems, and malfunctions, so check wire color the instruction manual before wiring.
- Check wiring insulation. Check that wires do not contact other circuits and that there are no ground faults or insulation faults across terminals. Overcurrent could flow in and damage the sensor.
- Use a DC stabilized power supply within the rating that is insulated from the AC power supply. A noninsulated power supply could result in electrical shock. If the power supply is not stabilized, the peak voltage could be exceeded, damaging the product or compromising accuracy.
- Stop the control device and machine devices and turn power OFF before wiring. Starting operation immediately after wiring could result in unpredictable operation and hazards. Do an energized test with control devices and machine devices stopped, and check switch data and unit settings before starting operation.
- Turn power OFF before wiring this product. Discharge static electricity from personnel or tools before and during work.
- For moving part, flexible cables should be used.
- Do not use a power voltage that exceeds specifications. The product could rupture or burn if voltage exceeding the working range is applied. If an AC power supply (100VAC) is applied.
- Install the product and wiring as far away as possible from sources of noise such as power distribution wires. Take separate measures against surge that enters the power wire.
- Do not short-circuit the load. Failure to observe this could result in rupture or burning.
- The power supply for metallic body type is a DC stabilized power supply completely isolated from the AC primary side. Connect either the +side or –side of power to the F.G. A variable resistor (voltage limit 40V) is connected between the internal power circuit and port installation section of this frame to prevent dielectrical breakdown of the sensor. Avoid withstand voltage and insulation resistance tests between the internal power supply of metallic body type and port installation section. If these tests are required, disconnect wiring of metallic body type. An excessive potential difference between the power supply of metallic body type and port installation section could burn internal parts.
After installing, connecting, and wiring the metallic body type, electrical welding of the device or frame, or 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. Do any work such as electrical wiring after removing this device and disconnecting all electric wires connected to the F.G.



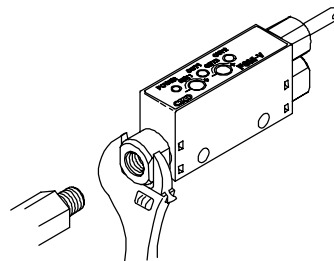
CAUTION :

Piping

- When installing the sensor on piping, use the following torque so that excessive screw-in torque or load torque is not applied to the connection port:

Set screw	Tightening torque (N·m)
M5	0.5 ~ 1.0

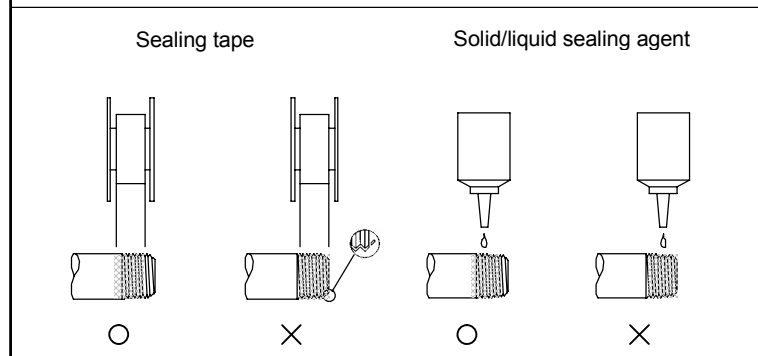
- Align the fluid direction and the direction shown on the body when piping.
- Clean out piping to remove foreign substances and swarf, etc., before piping. The rectifying unit or platinum sensor could be damaged if a large amount of foreign substances or swarf, etc., enters.
- Check that force is not applied to resin parts when piping.



- Check that sealing tape or adhesive does not get inside when piping.

When winding fluorine resin sealing tape around threads, wind sealing tape 1 to 2 times, leaving 2 to 3 threads open at the end of the screw. Press down on tape to stick it to threads.

When using liquid sealing agent, leave 1 to 2 threads open from the end, and avoid applying too much. Check that the sealing agent does not get on the device's threads.

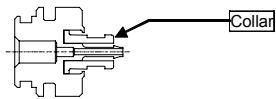


- Insert 4mm tubes into 2 Push-in joints for use. Tubes should be inserted firmly and before use tube should be checked that it is not come out. Cut the tube vertically.

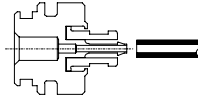


CAUTION :

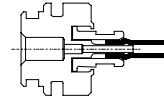
- Connect fiber tube as the following steps (to).



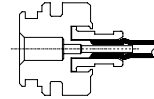
Collar is set in the most deep position.



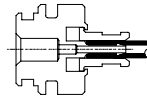
Cut the end of fiber tube at the right angle.



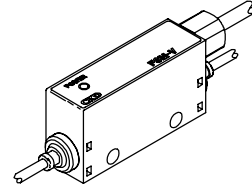
Connect while checking if fiber tube is properly inserted through the collar.



Insert air fiber until the end will reach wall.



Pull the collar in the front to lock.

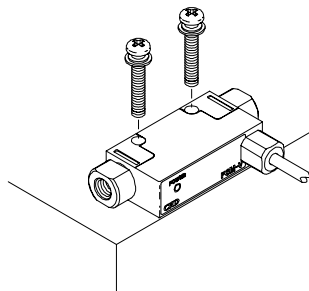




CAUTION :

Installation

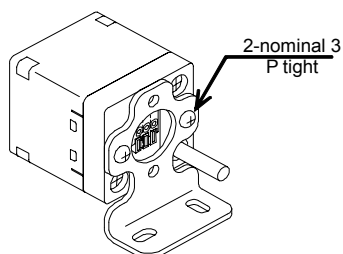
- For miniature flow sensor discrete
Using 2 through holes on the side ($\phi 3.2$), install the product.



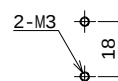
- Separate display unit

Separate mounting brackets/kits are available for installation of the separate display unit.

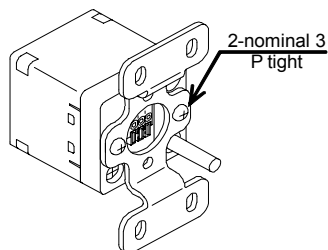
Bracket model no.: PPD3-KL-D : Single foot bracket (radial installation)



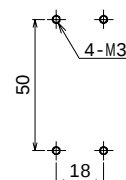
Mounting hole
machining dimensions



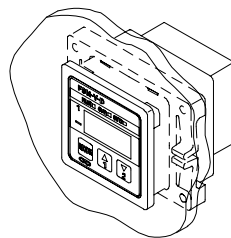
Bracket model no.: PPD3-KD-D : Both sides foot brackets (parallel)



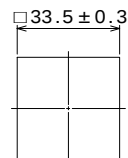
Mounting hole
machining dimensions



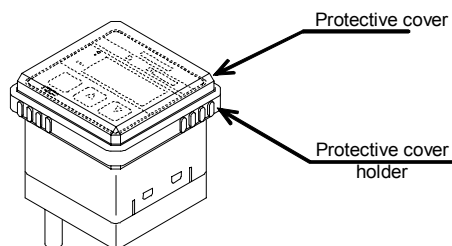
Bracket model no.: PPD3-KHS-D : Panel mount bracket set with panel cover



Mounting hole
machining dimensions



Bracket model no.: PPD3-KC : Operation protective cover

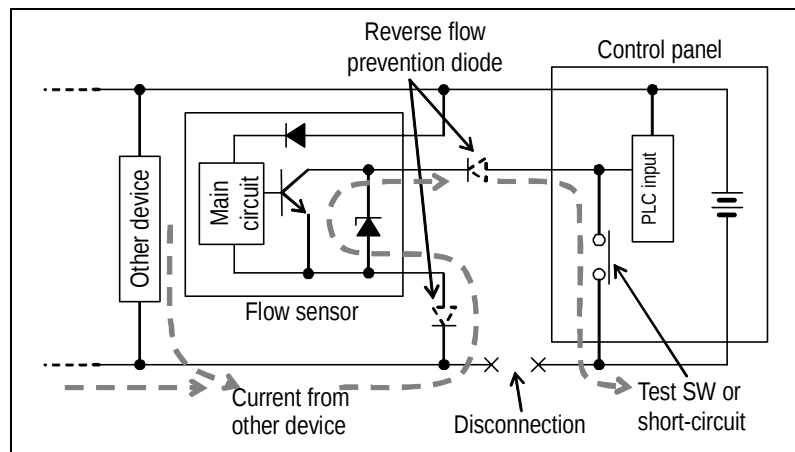


During use & Maintenance



CAUTION :

- The influence of self-generation of heat by energized other than the temperature characteristic also receives output accuracy. Please prepare standby time (5 minutes or more) at the time of use.
- If an error occurs during operation, immediately turn power OFF, stop use, and contact your dealer. Slight heating (40°C) of the display section is not a problem.
- Applications exceeding the maximum working pressure and specified flow rate range may result in faults. Use this product only within the specified range.
- This products self-diagnoses the internal circuit immediately after power is turned ON, so flow rate is not detected immediately. Set the control circuit so signals are ignored for 2 seconds after power is turned ON.
- When the output setting is changed, the control system device could operate unintentionally. Stop devices before changing settings.
- Inspect the sensor at least once a year and confirm that it is operates correctly.
- This product must not be disassembled.
The product could be damaged or performance compromised if this product is disassembled.
- This case is made of resin. Do not use solvent, alcohol, or detergent in cleaning, or resin could absorb it. Wipe off dirt with a rag soaked in a diluted neutral detergent solution and wrung out well.
- Pay attention to reverse currents caused by disconnected wires and wiring resistance. When other devices, including flow sensors, are connected to the same power supply as the flow sensor, and the output cable and power cable's minus side are short-circuited or the power supply's minus side is disconnected to check operation of the input device from the control panel, reverse current could flow to the flow sensor's output circuit and cause damage.



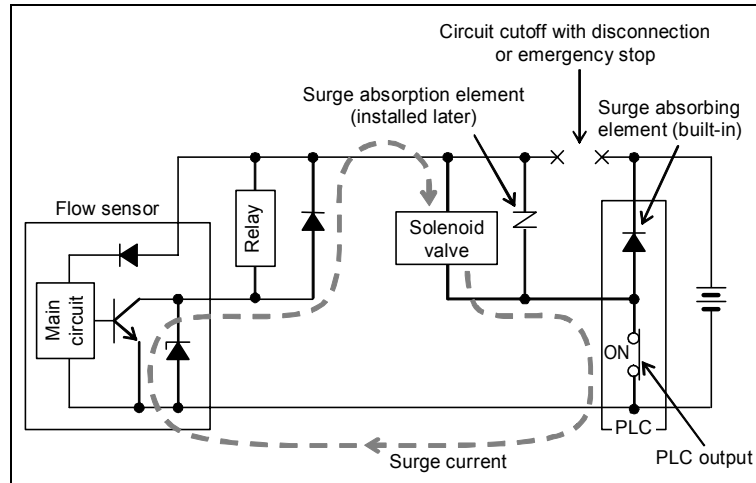
Take the following measures to prevent damage caused by reverse current:

- (1) Avoid centralizing current at the power cable, especially the minus side power cable, and use as thick wire as possible.
- (2) Limit the number of devices connected to the same power supply as the flow sensor.
- (3) Insert a diode in serial with the flow sensor's out put cable to prevent reversal of current.
- (4) Insert a diode serially with the flow sensor's power cable minus side to prevent reversal of current.

CAUTION :

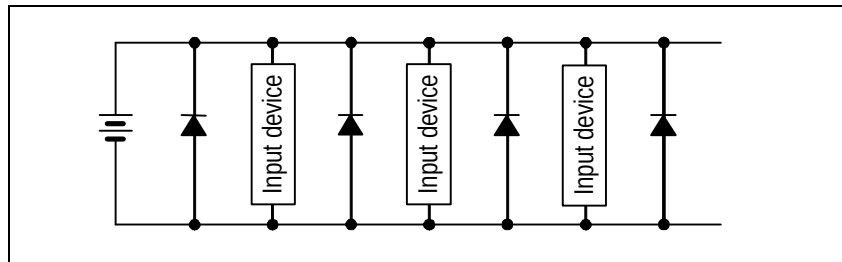
● Pay attention to leading of surge current

When flow 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 output circuit and cause damage depending on where the surge absorption element is installed.



Take the following measures to prevent damage from surge current that is led in:

- (1) Separate the power supply for the output system comprising the inductive load, such as the solenoid valve and relay, and the input system, such as the flow sensor.
- (2) If separate power supplies cannot be used, directly install a surge absorption element for all inductive loads. Remember that the surge absorption element connected to the PLC, etc., protects only that device.
- (3) Connect a surge absorption element to the following places on the power wiring as shown below as a measure against disconnections in unspecific areas.



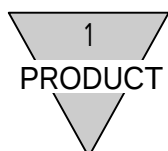
When the devices are connected to a connector, the output circuit could be damaged by the above phenomenon if the connector is disconnected while power is ON. Turn power OFF before connecting or disconnecting the connector.

- The analog output is carried out even when the flow exceed the flow range of the sensor, and the display becomes "Hi". Please note that it is beyond our accuracy guarantee range.

INDEX

FSM-V series SMALL SIZE FLOW SENSOR Manual No. SM-440361-A

1. PRODUCT	
1.1 Specification	11
1.2 External dimension	
1.2.1 Analog type/ Switch type	14
1.2.2 Separate display unit (only for analog type)	18
1.2.3 Bracket assembly drawing of separate display unit	19
2. CAUTION	21
3. OPERATION	
3.1 Switch type	22
3.2 Separate display unit	23
4. INSTALLATION	
4.1 Piping	26
4.2 Installation	28
4.3 Wiring	
4.3.1 FSM-V-A series (Analog type)	29
4.3.2 FSM-V-N series (Switch type : NPN output)	29
4.3.3 FSM-V-P series (Switch type : PNP output)	30
4.3.4 FSM-V-D series	31
4.3.5 Precautions for wiring	32
5. MAINTENANCE	
5.1 Trouble shooting	33
6. HOW TO ORDER	34
7. TECHNICAL DATA	
7.1 How to select flow sensor	35



1. Product

1.1 Specifications

Switch output type

Item		Switch Output Type	
		FSM-V-□ ^{*3} □ ^{H/V} 3-□-□ ^{*1 *2}	
Switch set flow rate range (L/min) (NOTE 1)	*1	R0005	-0.05 to +0.05
		R0010	-0.1 to +0.1
		R0050	-0.5 to +0.5
		R0100	-1 to +1
		R0500	-5 to +5
		R1000	-10 to -10
Connecting port diameter	*2	H2	φ1.8 air fiber joint
		H4	φ4 push-in joint
		HL4	φ4 push-in joint (Elbow)
		M5	M5
Operating conditions	Applicable fluid (NOTE 2)		Cleaned air (JIS B 8392-1.1.1 to 5.6.2) Compressed air (JIS B 8392-1.1.1 to 1.6.2) & N ₂ (nitrogen) gas
	Maximum operating pressure		0.2 MPa
	Minimum operating pressure		-0.1 MPa
	Allowable withstanding pressure		0.3 MPa
	Ambient temperature, humidity		0 to 50°C, 90% RH max. (No dew condensation allowed)
	Fluid temperature		0 to 50°C
Reproducibility (Precision of measurement in the partial different condition)		+/-2% F.S max.	
Response time (NOTE 3)		5 ms max. (When the sensor unit reaches 90% of the final ultimate output voltage)	
Display		Power supply indication (green) 2 switch outputs – The LED lights up in ON-state. (Yellow)	
Switch output	*3	N	2 points (NPN open collector output – Load current 50 mA – Voltage drop 2.4 V)
		P	2 points (PNP open collector output – Load current 50 mA – Voltage drop 2.4 V)
	Hysteresis		10% F.S max.
Power voltage		12 / 24 VDC (10.8 to 26.4 V)	
Current consumption		30 mA max.	
Lead wire		φ2.6, 4-core, 0.15 mm ² (3 m)	
Mounting direction		Vertically or horizontally	
Lead-in straight tube part		Not required	
Protective straight tube part		IEC Standard IP40	
Vibration resistance		10 to 150 Hz, dual amplitude 1.5 mm, 10G max., 2 hours each in X, Y & Z directions	
Mass		Approx. 8 g (Excluding the lead wire and joint)	

Note1: Converted to volumetric flow at 20°C and 1 atmospheric pressure (101kPa)

Note2: When using compressed air, use clean air complying with JIS B 8392-1:2003 class over 1.1.1 to 1.6.2. Compressed air from the compressor contains drainage (water, oxidized oil, foreign matter, etc.). Install a filter(filtration rating : 5μm), air dryer(minimum pressure dew point 10 or less) and oil mist filter(maximum oil concentration 0.1mg/m³) on the primary side of the product to maintain product function.

When using for purposes other than compressed air, use dry gas that does not contain corrosive elements such as chlorine, sulfur or acids, and clean gas that does not contain dust or oil mist.

Note3: The response time can be selected from 50ms to 1.5s.

Analog Output Type

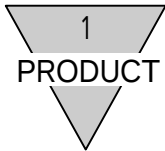
Analog Output Type				
Item	Analog Output Type			
	FSM-V-A ^{*1} / _V 3-□-□ ^{*2}			
Flow rate range (L/min) ^(NOTE 1)	*1	R0005	-0.05 to +0.05	
		R0010	-0.1 to +0.1	
		R0050	-0.5 to +0.5	
		R0100	-1 to +1	
		R0500	-5 to +5	
		R1000	-10 to -10	
Connecting port diameter	*2	H2	φ1.8 air fiber joint	
		H4	φ4 push-in joint	
		HL4	φ4 push-in joint (Elbow)	
		M5	M5	
Operating conditions	Applicable fluid ^(NOTE 2)	Cleaned air (JIS B 8392-1.1.1 to 5.6.2) Compressed air (JIS B 8392-1.1.1 to 1.6.2) & N ₂ (nitrogen) gas		
	Maximum operating pressure	0.2 MPa		
	Minimum operating pressure	-0.1 MPa		
	Allowable withstanding pressure	0.3 MPa		
	Ambient temperature and humidity	0 to 50°C, 90% RH max. (No dew condensation allowed)		
	Fluid temperature	0 to 50°C		
Accuracy	Linearity	+/-5% F.S max. (0.1 MPa, 25 °C – Flow range +/-100% F.S)		
	Pressure characteristics	+/-5% F.S max. (-0.09 to 0.2 MPa at 0.1 MPa standard)		
	Temperature characteristics	+/-2% F.S/°C max. (15 to 35 °C at 25°C standard)		
	Reproducibility (Precision of measurement in the partial different condition)	R0005, R0010, R0050, R0100	+/-1% F.S max.	
		R0500, R1000	+/-2% F.S max.	
Response time ^(NOTE 3)		5 ms max. (When the sensor unit reaches 90% of the final ultimate output voltage)		
Display		Power supply indication (Green)		
Analog output		1 output (1 to 5 V voltage output, connecting load impedance over 50 kΩ)		
Power supply voltage		12 / 24 VDC (10.8 to 26.4 V)		
Current consumption		30 mA max.		
Lead wire		φ2.6, 3-core, 0.15 mm ² (3 m)		
Mounting direction		Vertically or horizontally		
Lead-in straight tube part		Not required		
Protective straight tube part		IEC Standard IP40		
Vibration resistance		10 to 150 Hz, dual amplitude 1.5 mm, 10G max., 2 hours each in X, Y & Z directions		
Mass		Approx. 8 g (Excluding the lead wire and joint)		

Note1: Converted to volumetric flow at 20°C and 1 atmospheric pressure (101kPa)

Note2: When using compressed air, use clean air complying with JIS B 8392-1:2003 class over 1.1.1 to 1.6.2. Compressed air from the compressor contains drainage (water, oxidized oil, foreign matter, etc.). Install a filter(filtration rating : 5μm), air dryer(minimum pressure dew point 10 or less) and oil mist filter(maximum oil concentration 0.1mg/m³) on the primary side of the product to maintain product function.

When using for purposes other than compressed air, use dry gas that does not contain corrosive elements such as chlorine, sulfur or acids, and clean gas that does not contain dust or oil mist.

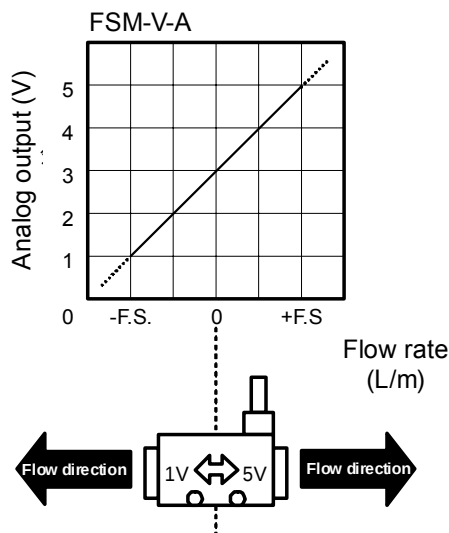
Note3: The response time can be selected from 50ms to 1.5s.



Separate Display Unit (Indicator)

Item	Separate Display Unit		
	*1 *2 FSM-V-D□-□		
Flow rate indication range	*2	R0005	-50.0 to +50.0 (mL/min)
		R0010	-100 to +100 (mL/min)
		R0050	-500 to +500 (mL/min)
		R0100	-1.00 to +1.00 (L/min)
		R0500	-5.00 to +5.00 (L/min)
		R1000	-10.0 to +10.0 (L/min)
Display	Flow rate indication (7-segment 3 digits, orange) running and switch output display (orange)		
Switch output	*1	N	2 outputs (NPN open collector output, load current 50 mA and voltage drop 2.4 V)
		P	2 outputs (PNP open collector output, load current 50 mA and voltage drop 2.4 V)
Switch output response time	Approx. 5 ms		
Analog output	1 output (1 to 5 V voltage output, connecting load impedance over 50 k Ω)		
Power voltage	12 / 24 VDC (10.8 to 26.4 V)		
Current consumption	50 mA max. (only display unit)		
Lead wire	ϕ 3.7, 5-core, 0.2 mm ² (1 m)		
Functions	Flow rate indication, flow rate indication peak hold, switch output and analog output		
Operating ambient temperature	0 to 50°C, 85% RH max. (No dew condensation allowed)		
Protective straight tube part	IEC Standard IP40		
Mass	Approx. 70 g (Including one-meter lead wire)		

● Analog out put



(Precautions)

- Output accuracy is affected by self exoergics caused by energizing other than temperature characteristics. When using, stand-by time (5 minutes and over after energizing) must be provided.
- If out of flow rate range, the output will reach up to max 9V.

(Note)

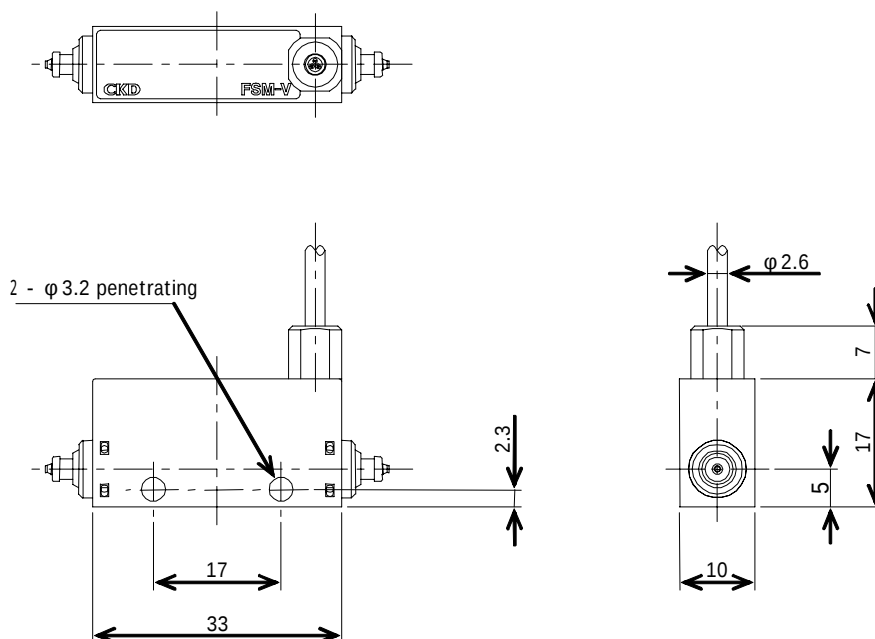
Analog output is so set that, with the border of 0 flow rate, direction of the flow can be identified between the value 「1~3V」 and 「3~5V」.

1.2 External dimension

1.2.1 Analog type/ Switch type

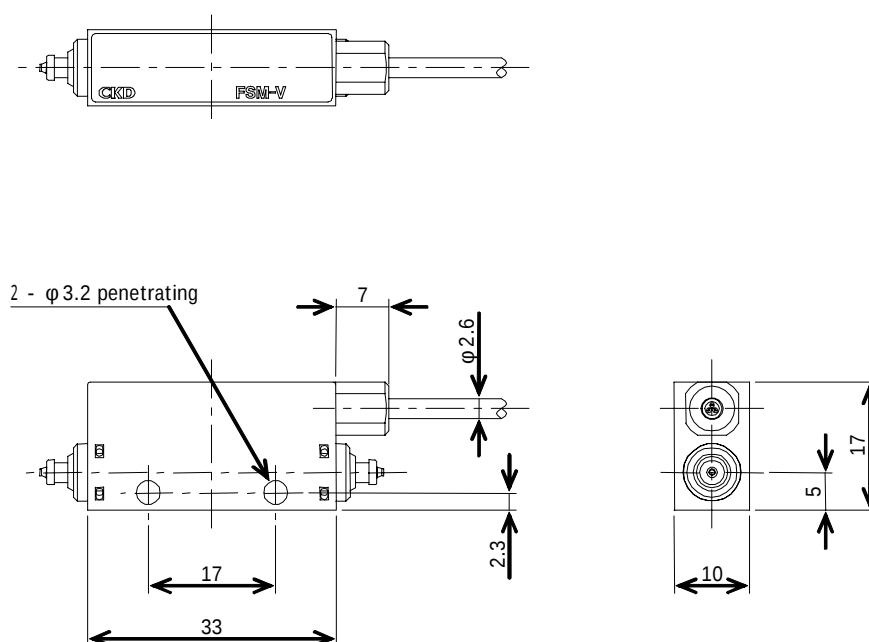
- FSM-V-□V3-□-H2

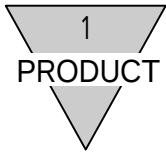
Radial lead wire and axial $\phi 1.8$ fiber tube



- FSM-V-□H3-□-H2

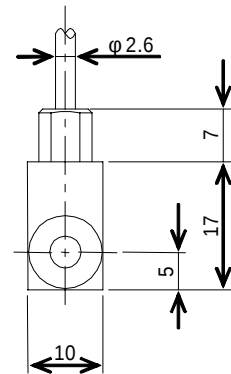
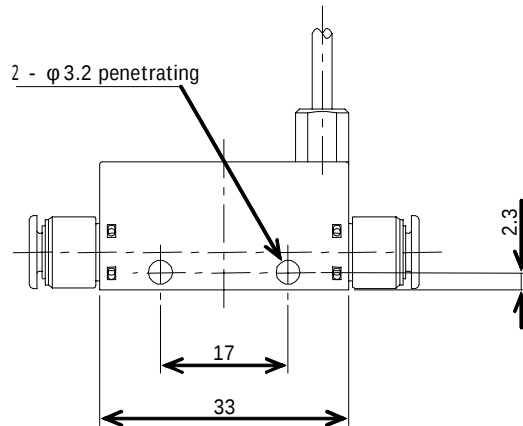
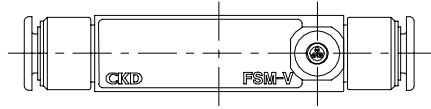
Axial lead wire and axial $\phi 1.8$ fiber tube





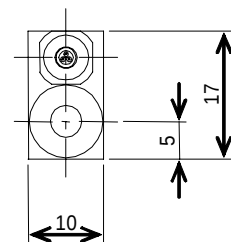
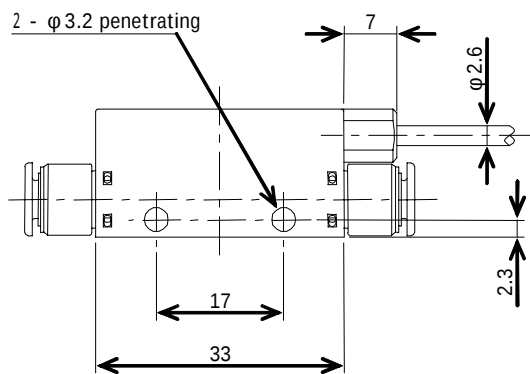
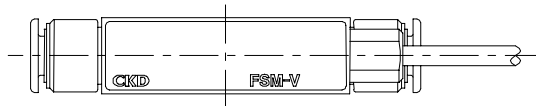
● FSM-V-□V3-□-H4

Radial lead wire and axial $\phi 4$ push in



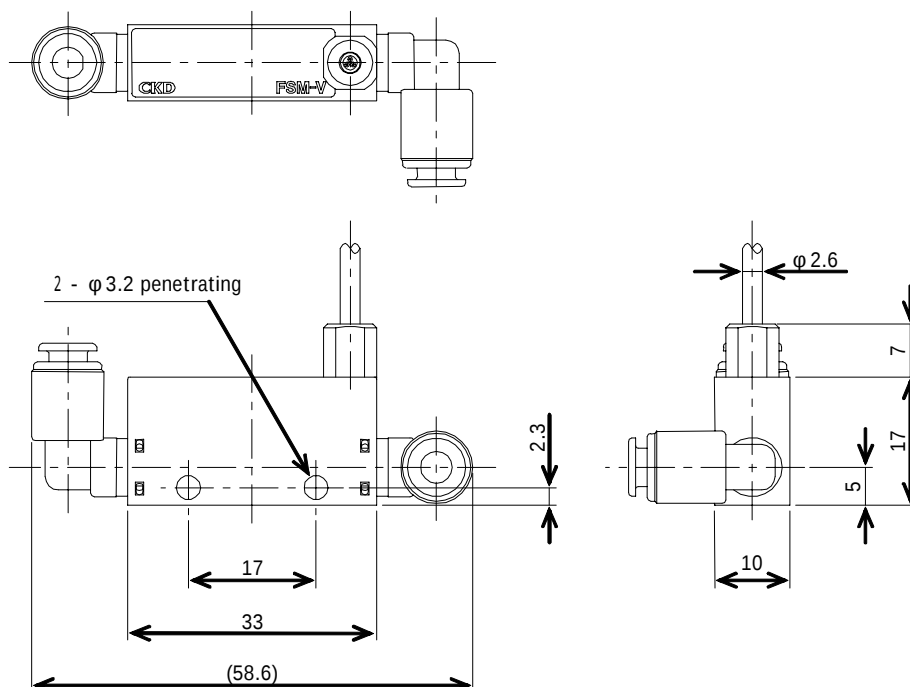
● FSM-V-□H3-□-H4

Axial lead wire and axial $\phi 4$ push in



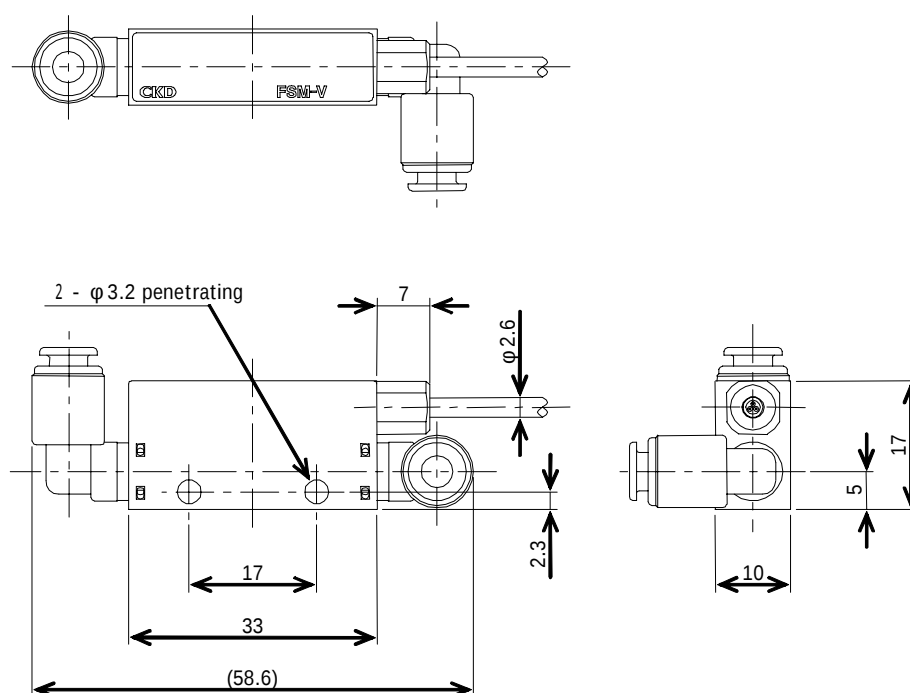
• FSM-V-☐V3-☐-HL4

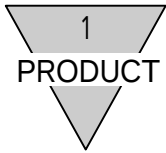
Radial lead wire and radial $\phi 4$ push in



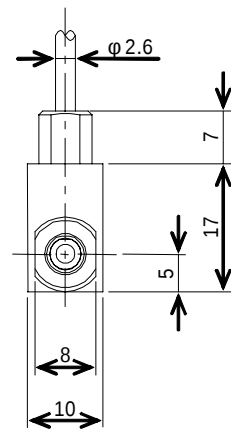
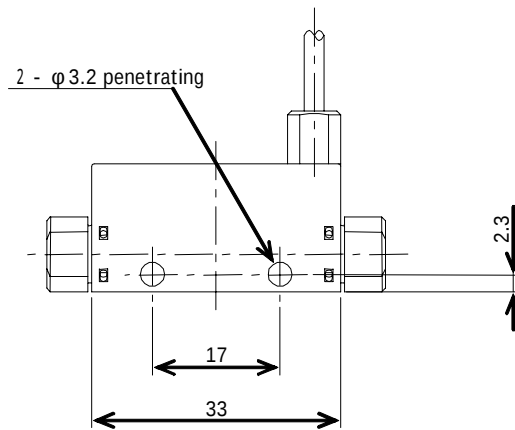
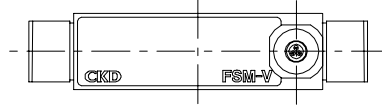
• FSM-V-☐H3-☐-HL4

Axial lead wire and radial $\phi 4$ push in

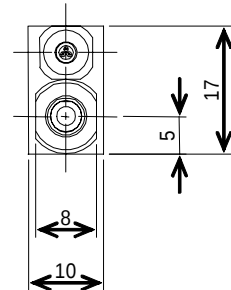
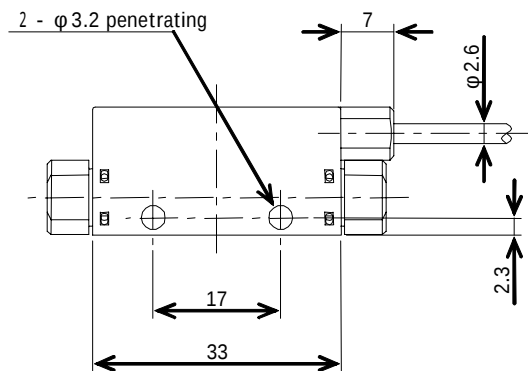
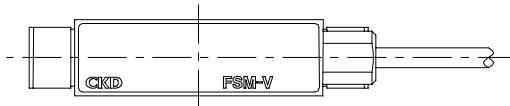




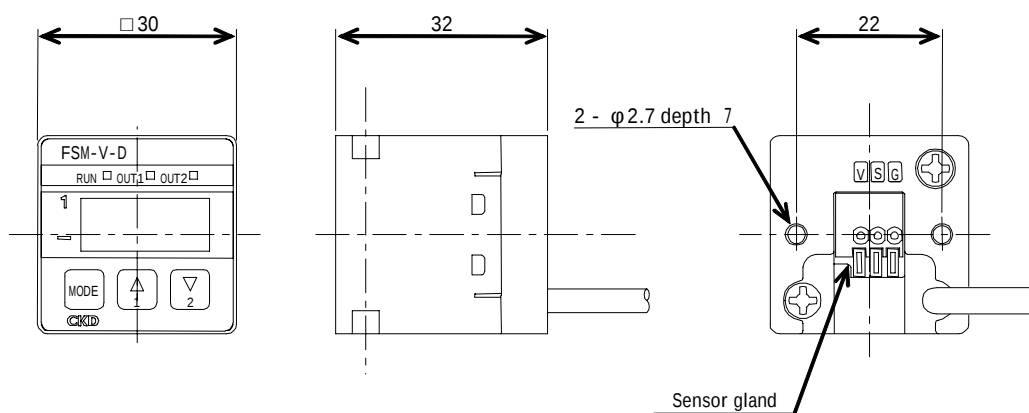
- FSM-V-V3--M5
Radial lead wire and port size M5



- FSM-V-H3--M5
Axial lead wire and port size M5

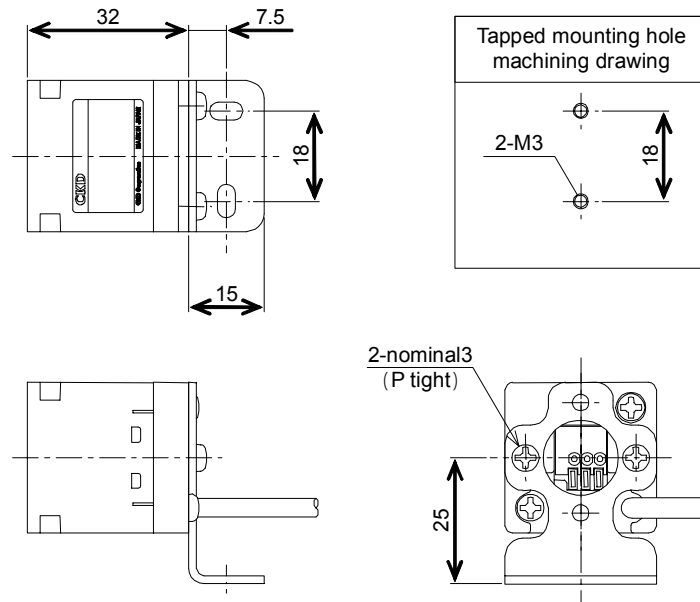


1.2.2 Separate display unit (only for analog type)



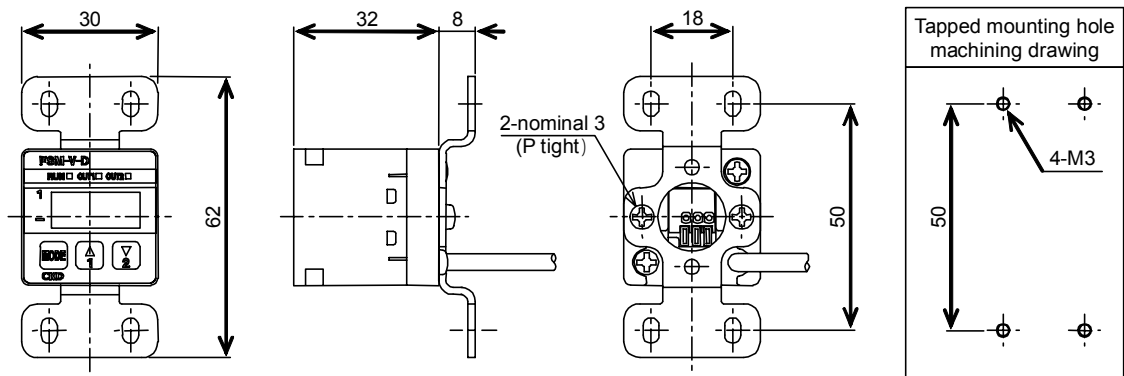
1.2.3 Bracket assembly drawing of separate display unit

PPD3-KL-D (L type bracket and 2 set screws)



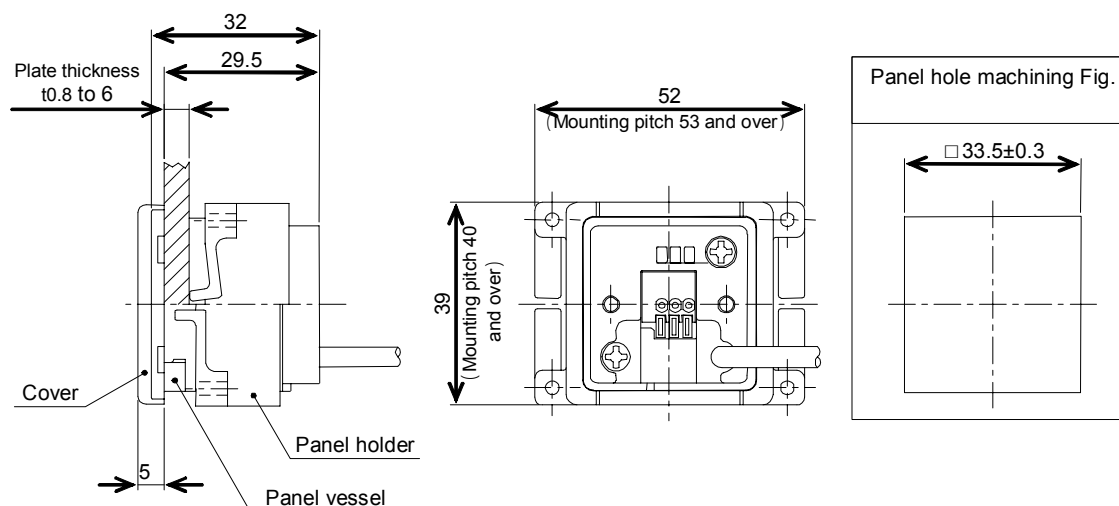
This bracket can be installed per 90 deg. increment against the switch body.
Determine the installation attitude according to the location

PPD3-KD-D (D type bracket and 2 setscrews)



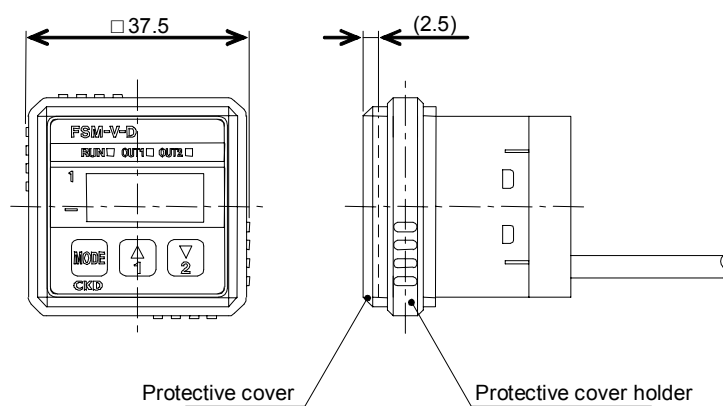
This bracket can be installed per 90 deg. increment.
Determine the installation attitude according to the location

PPD3-KHS-D : Panel vessel, holder, key and cover.

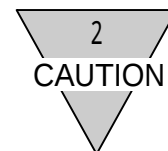


For panel holder, the installation attitude can be changed per 90 deg. increment.

PPD3-KC-D (Protective cover and its holder)



Note: A combination with PPD3-KHS-D is not available



2. Caution

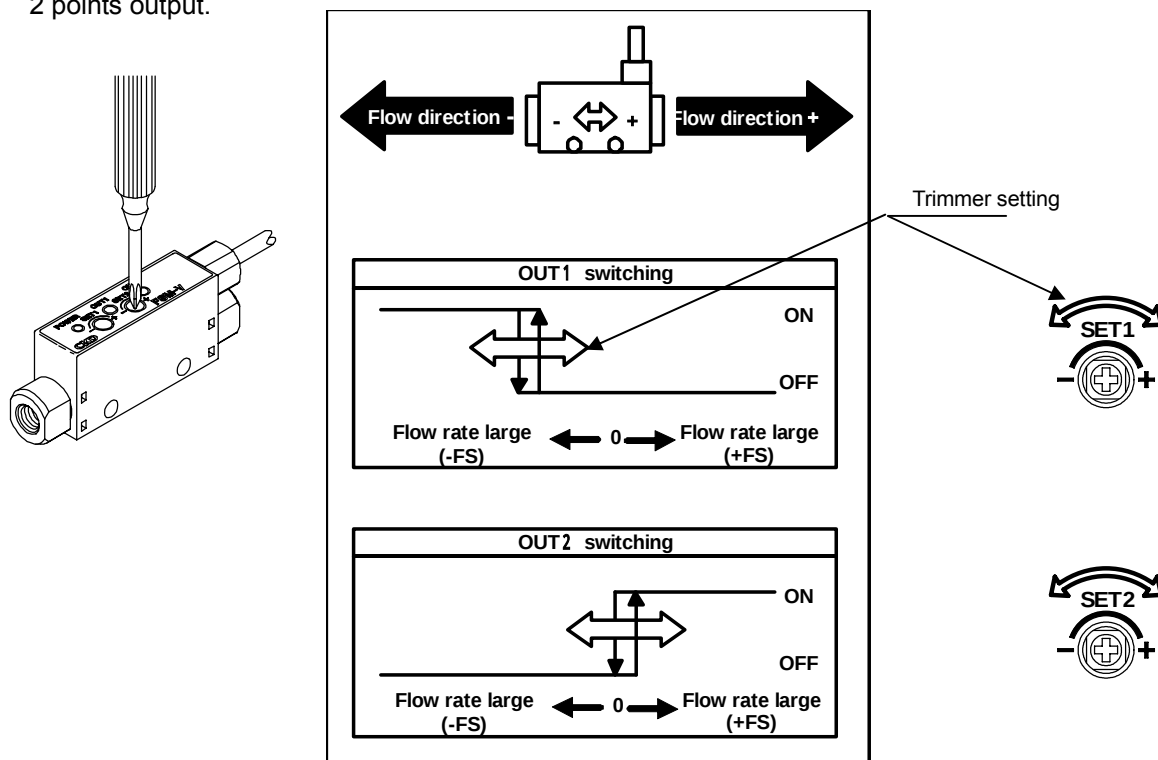
- This product is not to be used as a business meter.
This product does not conform to Measuring Laws, and thus cannot be used for commercial purposes. Use this sensor for industrial applications.
- Dry air or nitrogen can be used. Do not use other fluids or the precision cannot be guaranteed.
- Compressed air from the compressor contains drainage-water, oil oxide, foreign substances, etc. so install a filter, air dryer, and oil mist filter on the primary side (upper stream side) of the sensor. The sensor's meshing rectifies flow in the sensor. It does not filter out foreign substances, so provide a filter.
- Corrosive environment
Do not use this product in an environment containing corrosive gases such as sulphur dioxide.
- Ambient temperature & fluid temperature
Keep the fluid temperature within 0 to 50°C. Do not use this product where temperature suddenly changes, even if ambient temperature is within specifications. Otherwise, dew could form.
- Maximum working pressure and specified flow rate range
Applications exceeding the maximum working pressure and specified flow rate range may result in faults. Use this product only within the specified range.
- Drip-proof environment
The protective structure of this product is equivalent to IP40.
Do not install this product in a place where it is exposed to moisture, salt contents and dust or dirt, and subject to pressurization and decompression. This product cannot be used because there may arise a fault caused by dew condensation inside the main body in a place in which the temperature significantly changes and at a high humidity.

3. Operation

3.1 Switch output type

Switch setting method (switching and fluid flow direction)

Turn trimmer of SET1 and SET2 to set ON/OFF of two switch outputs (OUT1/OUT2). Care must be taken since different switching operations as shown right are applied to 2 points output.

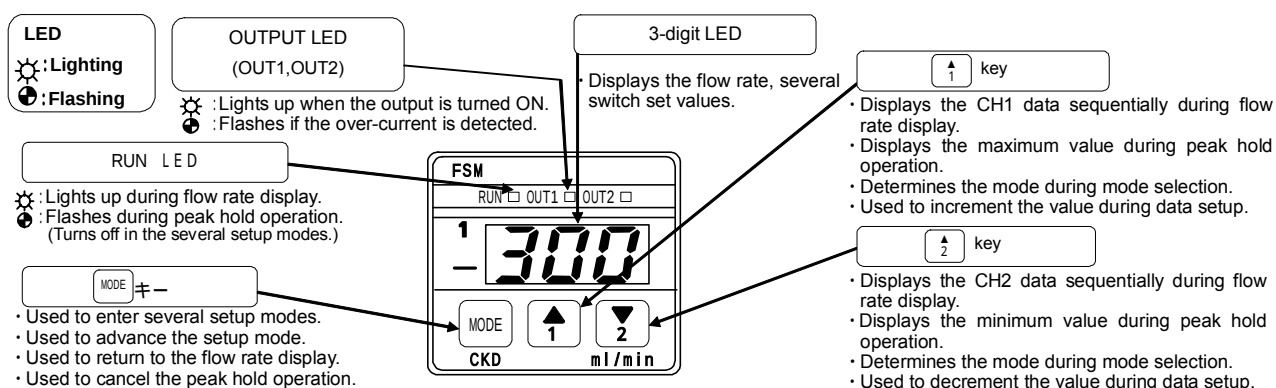


(Cautions) Hysteresis of switch output is fixing value (10%FS of loss).

Do not hold down the trimmer by a screwdriver strongly, or trimmer may be damaged.

3.2 Separate display unit

Name and functions of separate display unit



Switch output function

Either of the 2 outputs (CH1, CH2) can be selected from 5 operation patterns shown below.

Please select the operation pattern and set and input ON value and OFF value.

LED operation Waveform display	Operation waveform
Window operation 1 (ON operation within specified range) 	
Window operation 2 (ON operation beyond specified range) 	
Hysteresis operation 1 (Low-flow rate ON operation) 	
Hysteresis operation 2 (High-flow rate ON operation) 	
Operation stop 	

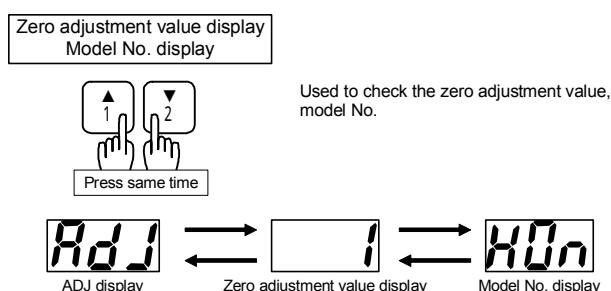
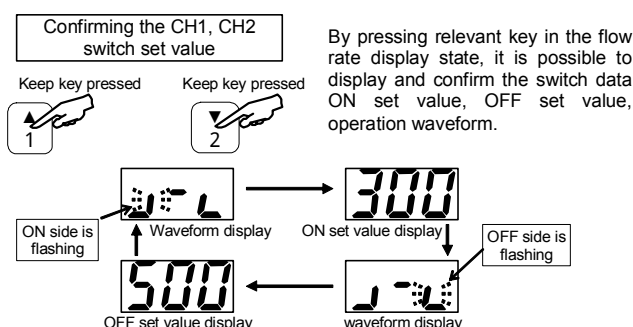
Note:

- In the window operation, an interval of 3% F.S. is put between two set values. A hysteresis of 1% F.S. is automatically added to each of ON and OFF side.
- In the hysteresis operation, an interval of 1% F.S. is put between two set values.
- There may be such case that the operation is unstable when the flow is not stable due to the pulsation of the media. For such case, please use this product after confirming that the switch operation is stable by keeping enough margins between the 2 set values.
- As the waveform pattern is determined, the large/small relationship between the ON and OFF set values is determined. The opposite relationship is not allowed. However, running of specified operation pattern takes precedence over others in this product. Therefore, when two set values are input, the large/small relationship between these values is judged automatically. Subsequently, the judgment is processed appropriately with the ON and OFF set values. That is, even though the ON and OFF set values are input in the reverse order, they are recognized as correct ON and OFF set values, and operation is always performed with the specified operation pattern.

Set example

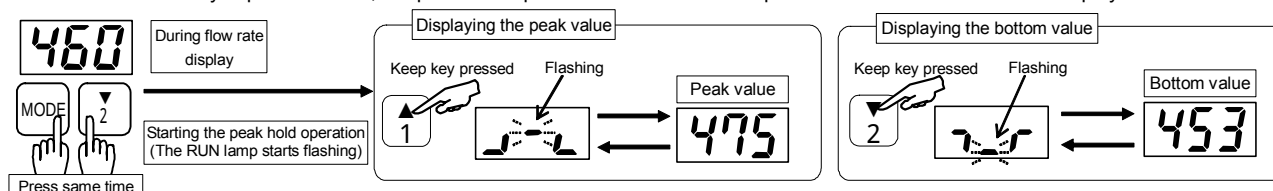
CH	Waveform	ON set value	OFF set value
1		200	350
2		300	250

Setpoint verification method



Peak hold function

In this operation mode, it is possible to check the maximum and minimum flow rate values within a certain period of time. Note that the peak hold operation does not affect the basic functions of this product, such as switch operation and flow rate display. When the "MODE" key is pressed once, the peak hold operation is canceled and operation returns to the flow rate display.



Switch output function

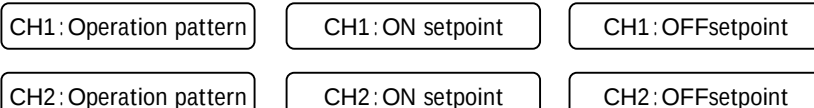
Refer to next page for the operation.

Having 2 pieces of switch output, 4 operation patterns and stop of operation can be set.

Setting the required operation pattern and two setpoints(ON and OFF setpoints) that defines operating points allows the switch function to start.

First determine operation pattern and ON and OFF setpoints to be used before setting work.

Select and set next data to operate a switch.



Forcible output function

Refer to next page for the operation.

Switch output ON forcibly, used for initial operation checking of wiring and input unit.

(Note) Use this test function for confirming wiring and action of input unit.

Avoid using this function instead of actual signals to run sequence program, while machinery and equipment are operated.

0 point adjustment function

Refer to next page for the operation.

Deviation of the display from 0 is corrected without flow.

(Note) Above setting and tests affect output signal and indicated value seriously.

Always stop machinery and equipment using this product, and, check that the safety is secured, even if malfunction/wrong display could be produced, then start the operation.

Handling during operation may produce an accident, malfunction and wrong display, causing a danger.

Return method

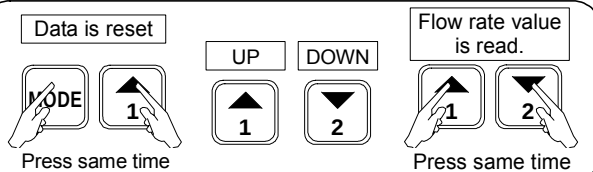
When you want to return to the flowing quantity display while operating it (state that exists in a set each mode), it turns off power once, then returns to the flowing quantity display when the power supply is turned on again.

Switch output function / forcible output function / 0 point adjustment operation

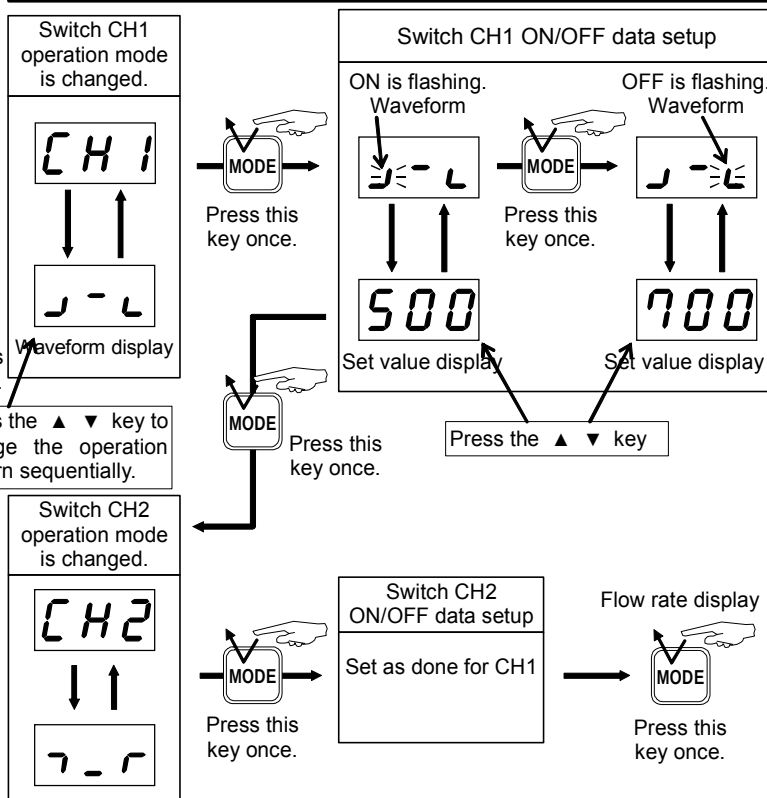
To ensure safety, operation returns to the flow rate display if no key operations are made for about 2 sec. or longer before setting the mode.

Basic key operations of setting value

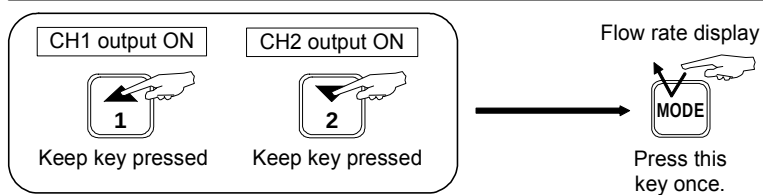
Use for "Switch data setup mode" "Selecting waveform mode" & "Zero adjustment mode".



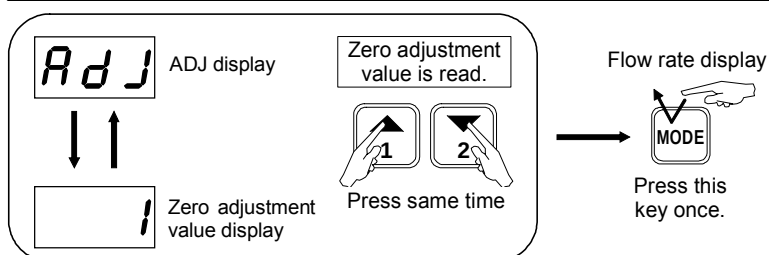
Switch data setup



Switch output forced ON mode



Zero adjustment mode



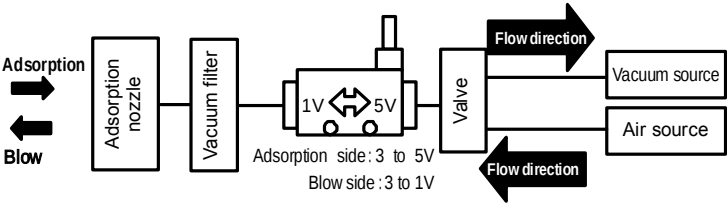
Caution Adjust 0 point in the state that a fluid never flows.

4. Installation

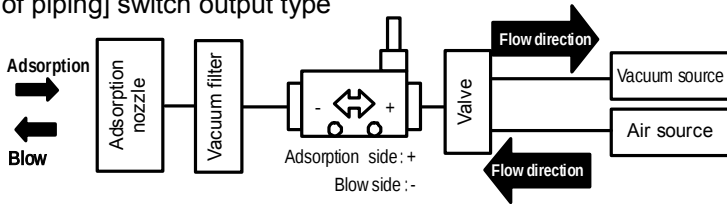
4.1 Piping

- The direction of arrow on the body must be checked, considering the flows direction and switching operation, then install and pipe the product.

[Example of piping] analog output type



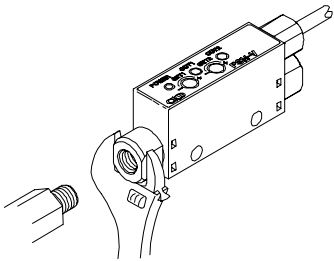
[Example of piping] switch output type



- When installing the sensor on piping, use the following torque so that excessive screw-in torque or load torque is not applied to the connection port:

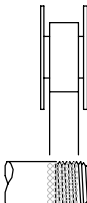
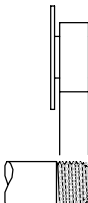
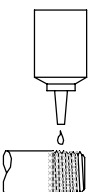
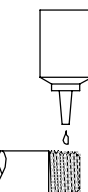
Set screw	Tightening torque (N·m)
M5	0.5 ~ 1.0

- Align the fluid direction and the direction shown on the body when piping.
- Clean out piping to remove foreign substances and swarf, etc., before piping. The rectifying unit or platinum sensor could be damaged if a large amount of foreign substances or swarf, etc., enters.
- Check that force is not applied to resin parts when piping.
- Check that sealing tape or adhesive does not get inside when piping.



When winding fluorine resin sealing tape around threads, wind sealing tape 1 to 2 times, leaving 2 to 3 threads open at the end of the screw. Press down on tape to stick it to threads.

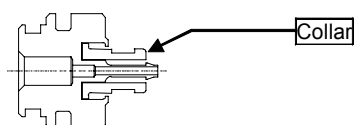
When using liquid sealing agent, leave 1 to 2 threads open from the end, and avoid applying too much. Check that the sealing agent does not get on the device's threads.

Sealing tape		Solid/liquid sealing agent	
			
○	×	○	×

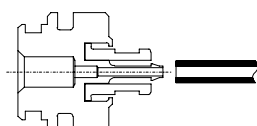
- Insert 4mm tubes into 2 Push-in joints for use. Tubes should be inserted firmly and before use tube should be checked that it is not come out. Cut the tube vertically.

4 INSTALLATION

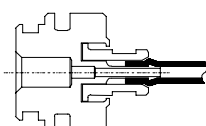
- Connect fiber tube as the following steps (to).



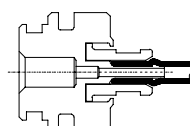
Collar is set in the most deep position.



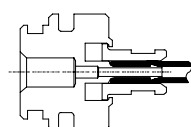
Cut the end of fiber tube at the right angle.



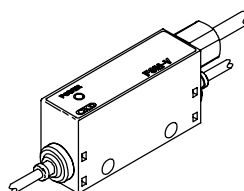
Connect while checking if fiber tube is properly inserted through the collar.



Insert air fiber until the end will reach wall.

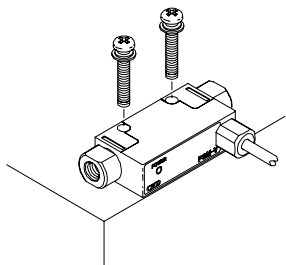


Pull the collar in the front to lock.



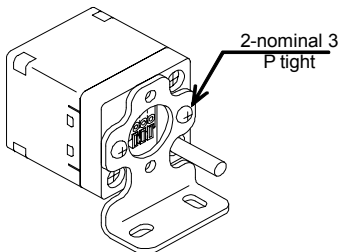
4.2 Installation

- For miniature flow sensor discrete
Using 2 through holes on the side (φ3.2), install the product.

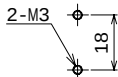


- Separate display unit
Separate mounting brackets/kits are available for installation of the separate display unit.

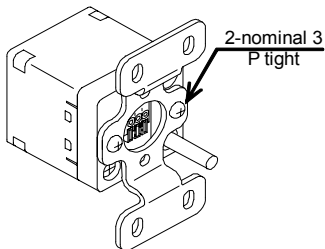
Bracket model no.: PPD3-KL-D : Single foot bracket (radial installation)



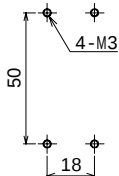
Mounting hole
machining dimensions



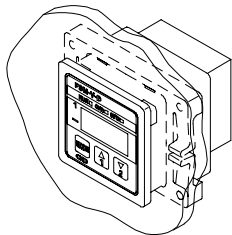
Bracket model no.: PPD3-KD-D : Both sides foot brackets (parallel)



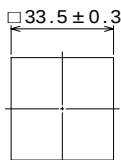
Mounting hole
machining dimensions



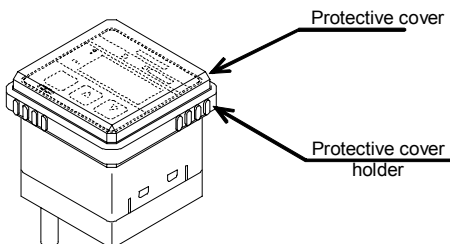
Bracket model no.: PPD3-KHS-D : Panel mount bracket set with panel cover



Mounting hole
machining dimensions



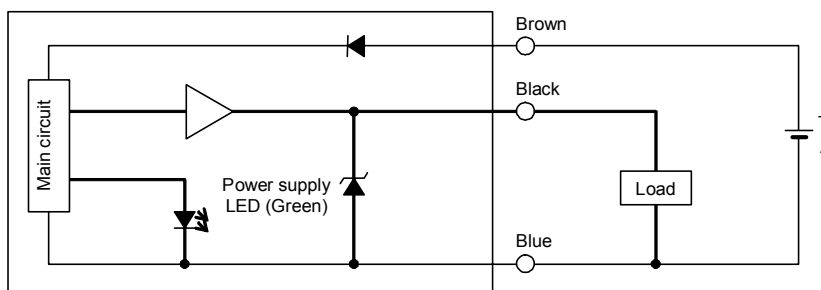
Bracket model no.: PPD3-KC : Operation protective cover



4.3 Wiring

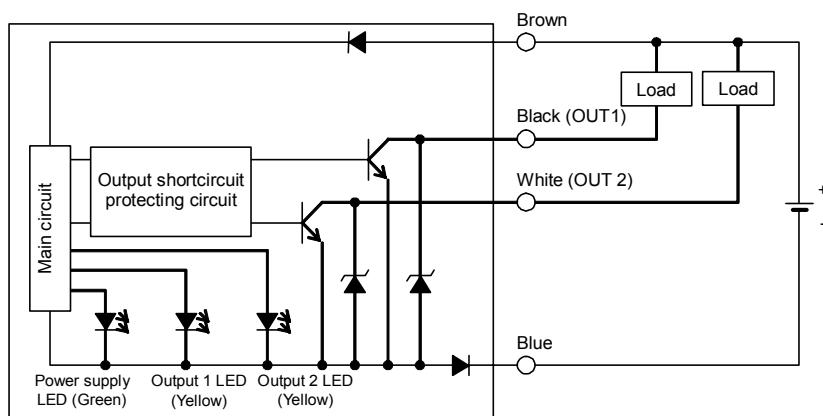
4.3.1 FSM-V-A Series (Analog output type)

Wire Color	Contents
Brown	Power supply 12 to 24 V DC
Blue	0V (GND)
Black	Analog output (1 to 5 V)



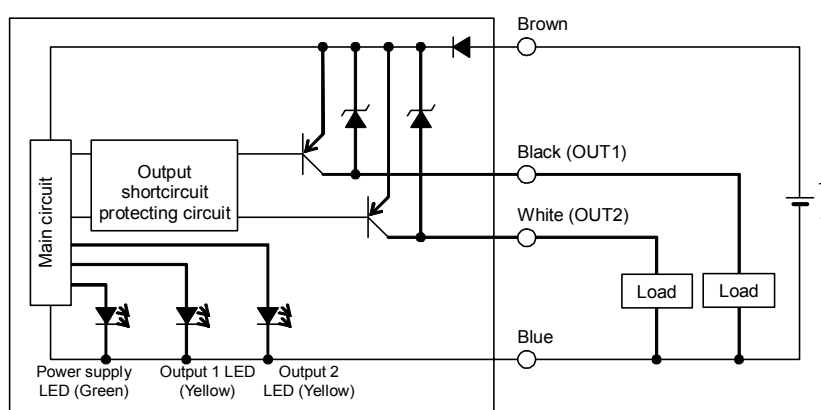
4.3.2 FSM-V-N Series (Switch output type: NPN transistor output)

Wire color	Contents
Brown	Power supply 12 to 24 VDC
Blue	0V (GND)
Black	OUT1
White	OUT2

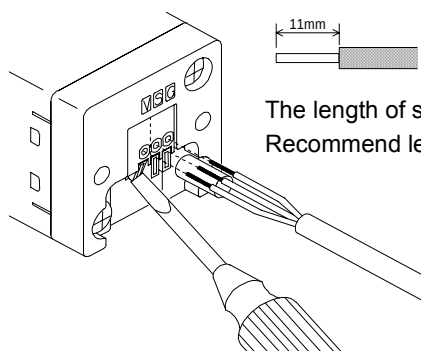


4.3.3 FSM-V-P Series (Switch output type: PNP transistor output)

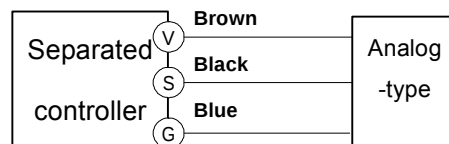
Wire color	Contents
Brwon	Power supply 12 to 24 VDC
Blue	0V (GND)
Black	OUT1
White	OUT2



4.3.4 FSM-V-D Sereies



The length of stripping-wire
Recommend length : 11mm



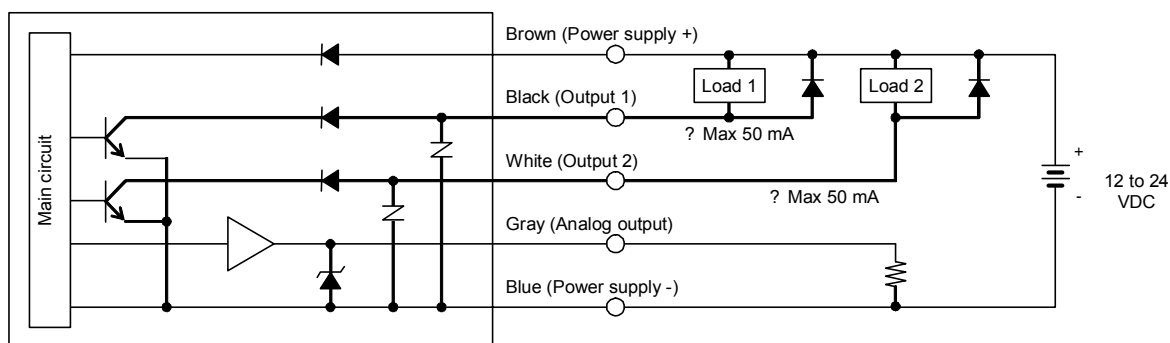
Electrical connection of sensor controller is made with terminal stand.
Insert the wire while yellow jaw is pushed.

- Refer to the spec. below if other wires than those for FSM-V are used.

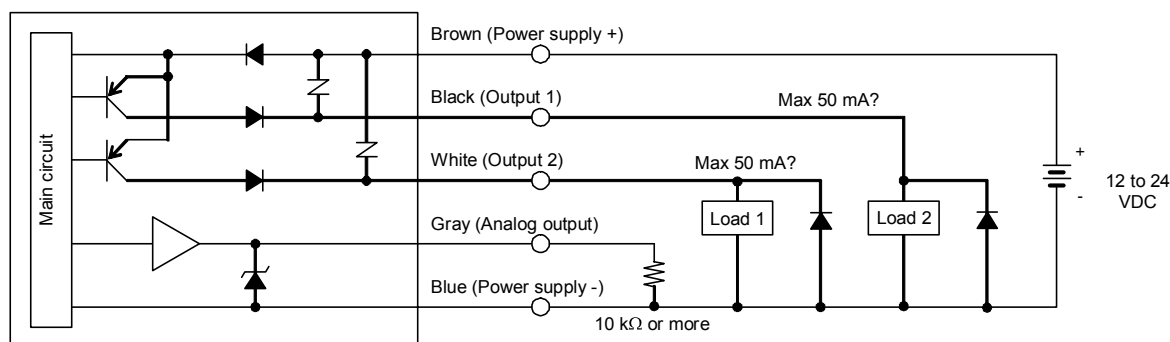
Single-wire	0.14 to 0.5mm ²
Twisted-wire	0.14 to 0.5mm ²
AWG	26 to 20

- Internal circuits and wiring

FSM-V-DN (Display unit part: NPN transistor output type)



FSM-DP (Display unit part: PNP transistor output type)



4.3.5 Precautions for wiring

- Check the wire color when piping. Incorrect wiring connections could result in sensor damage, problems, and malfunctions, so check wire color the instruction manual before wiring.
- Check wiring insulation.
Check that wires do not contact other circuits and that there are no ground faults or insulation faults across terminals. Overcurrent could flow in and damage the sensor.
- Use a DC stabilized power supply within the rating that is insulated from the AC power supply. A noninsulated power supply could result in electrical shock. If the power supply is not stabilized, the peak voltage could be exceeded, damaging the product or compromising accuracy.
- Stop the control device and machine devices and turn power OFF before wiring. Starting operation immediately after wiring could result in unpredictable operation and hazards. Do an energized test with control devices and machine devices stopped, and check switch data and unit settings before starting operation.
- Turn power OFF before wiring this product. Discharge static electricity from personnel or tools before and during work.
- For moving part, flexible cables should be used.
- Do not use a power voltage that exceeds specifications. The product could rupture or burn if voltage exceeding the working range is applied or if an AC power supply (100VAC) is applied.
- Install the product and wiring as far away as possible from sources of noise such as power distribution wires. Take separate measures against surge that enters the power wire.
- Do not short-circuit the load. Failure to observe this could result in rupture or burning.

The power supply for metallic body type is a DC stabilized power supply completely isolated from the AC primary side. Connect either the +side or –side of power to the F.G. A variable resistor (voltage limit 40V) is connected between the internal power circuit and port installation section of this frame to prevent dielectrical breakdown of the sensor. Avoid withstand voltage and insulation resistance tests between the internal power supply of metallic body type and port installation section. If these tests are required, disconnect wiring of metallic body type. An excessive potential difference between the power supply of metallic body type and port installation section could burn internal parts.

After installing, connecting, and wiring the metallic body type, electrical welding of the device of frame, or 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. Do any work such as electrical wiring after removing this device and disconnecting all electric wires connected to the F.G.

5. Maintenance

5.1 Trouble shooting

Trouble	Cause	Countermeasure
No flow display (No analog output)	Breakage of wire	Replace FSM-V. Recheck/repair external wiring.
	Wrong connection of power source	Connect the rated power source correctly.
	Malfunction caused by noise	Keep FSM-V main body and cable away from noise source.
	Output circuit is broken	Replace FSM-V.
	FSM-V is broken	Replace FSM-V.
Hi display (Analog output is 5V or higher)	Excessive flow rate	Select suitable flow range type.
	Sensor chip is broken	Replace FSM-V.
	Malfunction caused by noise	Keep FSM-V main body and cable away from the noise source.
Flow display remains 0 (Analog output remains 1V)	Flow path clogged by foreign matter	Remove foreign matter and install filter at primary side of FSM-V.
Flow display does not reach 0 (Analog output does not make 1V)	Leakage	Check and correct piping.
	Zero adjustment value is set incorrectly	Set the zero adjustment value again
	Foreign matter sticking to sensor chip	Replace FSM-V.
	Malfunction caused by noise	Keep FSM-V main body and cable away from the noise source.
Flow display is not stable (Analog output is not stable)	Pulsation of air	Reduce pulsation by installing tank, etc.
	Fault in power source (not enough voltage/capacity)	Supply rated voltage. Provide power source with enough capacity.
	Malfunction caused by noise	Keep FSM-V main body and cable away from noise source.
Switch output keeps OFF	Breakage of wire	Recheck/repair external wiring. Replace FSM-V.
	Load (input circuit) short-circuit.	Recheck/repair external wiring.
	Wrong setting of switch ON/OFF data	Check/modify the setting.
	Wrong selection of load (input circuit)	Check/change input circuit.
	Output circuit is broken	Replace FSM-V.
Switch output keeps ON	Wrong setting of switch ON/OFF data.	Check/modify the setting.
	Wrong selection of load (input circuit)	Check/change input circuit.
	Output circuit is broken.	Replace FSM-V.

6. How to order

● Sensor body

FSM — (V) — (A) (H) (3) — (R0005) — (H2)

Symbol	Content
Output type	
A	Analog output
N	Switch output (NPN)
P	Switch output (PNP)
Lead wire outlet direction	
H	Axial
V	Radial
Lead wire length	
3	3m
Flow rate range	
R0005	±0.05l/min
R0010	±0.1l/min
R0050	±0.5l/min
R0100	±1l/min
R0500	±5l/min
R1000	±10l/min
Joint type	
H2	Axial φ 1.8 fiber tube
H4	Axial φ 4 push in
HL4	Radial φ 4 push in
M5	Port size M5

● Separate indicator (analog output type only)

FSM — (V) — (D) (N) — (R0050)

Symbol	Content
Switch output type	
N	NPN output
P	PNP output
Flow rate range	
R0005	±0.05l/min
R0010	±0.1l/min
R0050	±0.5l/min
R0100	±1l/min
R0500	±5l/min
R1000	±10l/min

● Bracket for separate indicator

PPD3 — (KL-D)

Symbol	Content
Bracket kit	
KL-D	Single foot bracket (radial installation)
KD-D	Both sides foot bracket (parallel)
KHS	Panel mount bracket set cover attached
KC	Operation protective cover

7. Technical data

7.1. How to select flow sensor

The following information is for your reference for your sizing of flow sensor to be used for application like loading/unloading check with absorption nozzle, leak test etc.

Flow rate can be calculated from effective sectional area of nozzle (pin hole) and pressure difference between inside and outside of the nozzle.

- 1) $P1 \geq 1.89P2$ (sonic velocity)

$$Q = 11.32 \times S \times P1$$

- 2) $P1 < 1.89P2$ (subsonic velocity)

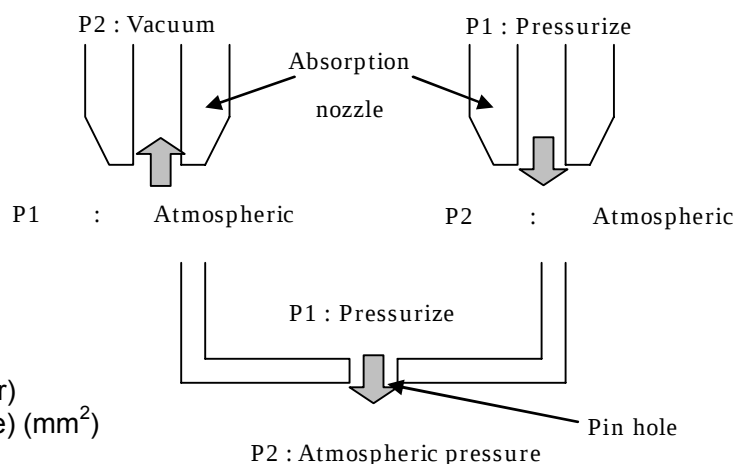
$$Q = 22.64 \times S \times \sqrt{P2 (P1 - P2)}$$

Q : Flow rate L/min.

P1: Absolute pressure at primary side (bar)

P2: Absolute pressure at secondary side (bar)

S: Effective sectional area of nozzle (pin hole) (mm²)



<Calculation example>

Flow calculated values (nozzle diameter $\phi 0.1$ - $\phi 2$ with varied P2) are shown in the table below.

	P1(bar) Absolute pressure	P1(bar) Gauge pressure	P2(bar) Absolute pressure	P2(bar) Gauge pressure	sonic/ subsonic velocity	Flow calculated values(L/min)								
						$\phi 0.1$	$\phi 0.2$	$\phi 0.3$	$\phi 0.4$	$\phi 0.5$	$\phi 0.7$	$\phi 1$	$\phi 1.5$	$\phi 2$
Absorb	1.013	0	0.313	-0.7	sonic velocity	0.090	0.360	0.810	1.440	2.250	4.411	9.002	20.254	36.007
	1.013	0	0.413	-0.6	sonic velocity	0.090	0.360	0.810	1.440	2.250	4.411	9.002	20.254	36.007
	1.013	0	0.513	-0.5	sonic velocity	0.090	0.360	0.810	1.440	2.250	4.411	9.002	20.254	36.007
	1.013	0	0.613	-0.4	subsonic velocity	0.088	0.352	0.792	1.408	2.200	4.312	8.800	17.249	35.202
	1.013	0	0.713	-0.3	subsonic velocity	0.082	0.329	0.740	1.315	2.055	4.028	8.220	16.110	32.878
	1.013	0	0.813	-0.2	subsonic velocity	0.072	0.287	0.645	1.147	1.792	3.512	7.166	14.046	28.666
	1.013	0	0.913	-0.1	subsonic velocity	0.054	0.215	0.483	0.859	1.343	2.631	5.370	10.525	21.480
Blow	1.113	0.1	1.013	0	subsonic velocity	0.057	0.226	0.509	0.905	1.414	2.772	5.657	11.087	22.626
	1.213	0.2	1.013	0	subsonic velocity	0.080	0.320	0.720	1.280	2.000	3.920	8.000	15.679	31.998
	1.413	0.4	1.013	0	subsonic velocity	0.113	0.453	1.018	1.810	2.828	5.543	11.313	22.174	45.252
	1.613	0.6	1.013	0	subsonic velocity	0.139	0.554	1.247	2.217	3.464	6.789	13.856	27.157	55.423
	1.813	0.8	1.013	0	subsonic velocity	0.160	0.640	1.440	2.560	4.000	7.840	15.999	31.358	63.996
	2.013	1	1.013	0	sonic velocity	0.179	0.716	1.610	2.862	4.472	8.765	17.888	40.248	71.552
	3.013	2	1.013	0	sonic velocity	0.268	1.071	2.410	4.284	6.694	13.119	26.774	60.242	107.096
	4.013	3	1.013	0	sonic velocity	0.357	1.426	3.209	5.706	8.915	17.474	35.660	80.236	142.641
	5.013	4	1.013	0	sonic velocity	0.445	1.782	4.009	7.127	11.137	21.828	44.547	100.230	178.186
	6.013	5	1.013	0	sonic velocity	0.534	2.137	4.809	8.549	13.358	26.182	53.433	120.224	213.731

(Note)

- There will be a larger flow than the calculated value when there is any leakage from piping etc. When selecting the flow range, the leakage from piping should be considered.
- There will be a smaller flow than the calculated value when there is any thinner part than nozzle diameter in the piping. And there may be such cases that absorption check is not possible.
- Effective sectional area will be smaller than nozzle opening area when nozzle is narrow and long. The response time depends on internal volume of piping between the flow sensor and the absorption nozzle (pin hole). When high speed detection is desired, it is recommended to minimize the internal volume of piping by installing the sensor next to the nozzle.