Flow Sensor Product Variations

Applicable fluids

For air
Thermal type (MEMS)

Dry air, nitrogen, argon, CO_2

(Air quality grade is JIS B 8392.1-1. 1.2 to 1.6.2, ISO 8573.1-1. 1.2 to 1.6.2)

For air
Thermal type (Thermistor)

Air, nitrogen

For water
Karman vortex

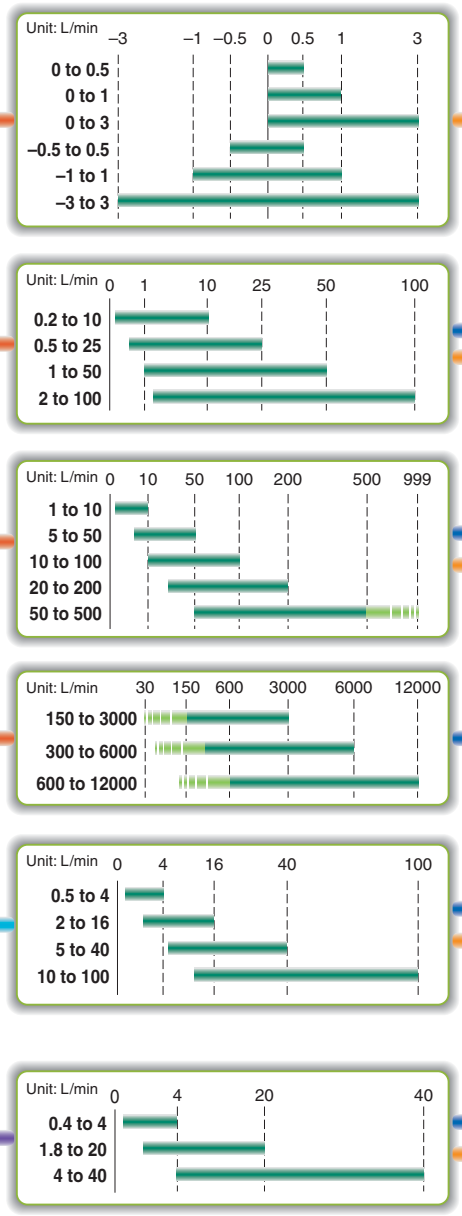
Water
Mixture of water (50%) and ethylene glycol (50%)

For deionized water, chemicals
Karman vortex

Deionized water
Fluids that does not corrode or osmose the wetted parts
(with viscosity 3 mPa·s [3 cP] or less)

Flow range

Standard: Made to order:



Product type

Integrated type

Output type: Switch output, Analog output, Digital display

- Sensor/Display self-contained
- Numerically displays the setting and measurement values.

Sensor

Output type

- Sensor only product
- Can be connected to a separate monitor.

Monitor

Output type

- Sensor type display
- Numerical control can be placed in a distant location.

Corresponding model

	For air	For water	For deionized water, chemicals
Integrated type	Front matter 25 • Series PFM7 • Series PF2A7 • Series PF2A7□□H	Front matter 26 • Series PF2W7 • Series PF3W7	• Series PF3W7
Sensor	Front matter 27 • Series PFM5 • Series PFMV5 • Series PF2A5	Front matter 28 • Series PF2W5 • Series PF3W5	Front matter 28 • Series PF2D5 • Series PF3W5
Monitor	Front matter 27 [For 1 ch] • Series PFM3 • Series PFMV3 • Series PF2A3 [For 4 ch] • Series PF2A2	Front matter 28 [For 1 ch] • Series PF2W3 • Series PF3W3 [For 4 ch] • Series PF2W2	Front matter 28 [For 1 ch] • Series PF2D3 [For 4 ch] • Series PF2D2

Note) The PF2A7 and PF2A7□□H series are compatible with made to order specifications.

General Performance Table

Model Selection Table

Self-contained Type

Model	PFM7	PF2A7	PF2W7	PF3W	PF3W (PVC piping type)
					
Fluid	Dry air, N_2, Ar, CO_2	Air, N_2	Water	Water, ethylene glycol aqueous solution	Water, deionized water, chemicals
Calibration method	Push-button calibration				
Rated flow range	0.2 to 10 L/min 0.5 to 25 L/min 1 to 50 L/min 2 to 100 L/min	1 to 10 L/min 5 to 50 L/min 10 to 100 L/min 20 to 200 L/min 50 to 500 L/min 150 to 3000 L/min 300 to 6000 L/min 600 to 12000 L/min	0.5 to 4 L/min 2 to 16 L/min 5 to 40 L/min 10 to 100 L/min	0.5 to 4 L/min 2 to 16 L/min 5 to 40 L/min 10 to 100 L/min	10 to 100 L/min
Power supply voltage	24 VDC±10%	12 to 24 VDC Ripple ± 10%			
Temperature characteristics (based on 25°C)	±2% F.S. (15 to 35°C) ±5% F.S. (0 to 50°C)	±3% F.S. (15 to 35°C) ±5% F.S. (0 to 50°C) ±2% F.S. (PF2A7□□H: 0 to 50°C)	±5% F.S. (0 to 50°C)		
Repeatability	±1% F.S. or less (Fluid: Dry air) Analog output: ±3% F.S. or less	±1% F.S. (PF2A7□0, PF2A7□□H) ±2% F.S. (PF2A7□1)	±3% F.S. or less	±2% F.S. or less	
Hysteresis	Hysteresis mode: Variable Window comparator mode: Variable	Hysteresis mode: Variable Window comparator mode: Fixed (3 digits*) * Digit is min. calibration unit.		Variable	
Output	NPN/PNP open collector Accumulated pulse output Analog voltage output Analog current output	NPN/PNP open collector Accumulated pulse output		NPN/PNP open collector Accumulated pulse output Analog voltage output Analog current output	
Display	2-color display	1-color display		3-color display	
Enclosure	IP40	IP65			
Note	Flow adjustment valve integrable Panel mounting possible DIN rail mountable Selectable flow rate display unit Responses time setting function→All renewed Secret code setting function Power-saving mode Accumulated flow display function	Selectable flow rate display unit Accumulated flow display function		3-color/2-screen display Integrated temperature sensor Secret code setting function Power-saving mode Accumulated flow display function	
Page	**P.213**	**P.285**	**P.285**	**P.329**	

General Performance Table

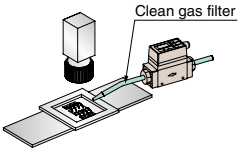
Model Selection Table

Self-contained Type

	Sensor unit	Monitor unit	Sensor unit	Monitor unit	Sensor unit	Monitor unit		Sensor unit	Monitor unit		Sensor unit	Monitor unit		Sensor unit	Monitor unit	
Model	**PFM5**	**PFM3**	**PFMV5**	**PFMV3**	**PF2A5**	**PF2A3**	**PF2A2**	**PF2W5**	**PF2W3**	**PF2W2**	**PF3W5**	**PF3W3**		**PF2D5**	**PF2D3**	**PF2D2**
Fluid	Dry air, N_2, Ar, CO_2		Dry air, N_2		Air, N_2			Water			Water, ethylene glycol aqueous solution		Water, deionized water, chemicals	Deionized water, Fluids that dose not corrode or osmose SuperIFPA.		
Sensor input amount		1 input		1 input		1 input	4 inputs		1 input	4 inputs		1 input			1 input	4 inputs
Calibration method		Power supply voltage		Power supply voltage		Power supply voltage			Push-button calibration			Push-button calibration			Push-button calibration	
Rated flow range	0.2 to 10 L/min 0.5 to 25 L/min 1 to 50 L/min 2 to 100 L/min		0 to 0.5 L/min 0 to 1 L/min 0 to 3 L/min	−0.5 to 0.5 L/min −1 to 1 L/min −3 to 3 L/min	1 to 10 L/min 5 to 50 L/min 10 to 100 L/min 20 to 200 L/min 50 to 500 L/min			0.5 to 4 L/min 2 to 16L/min 5 to 40L/min 10 to 100L/min			0.5 to 4 L/min 2 to 16 L/min 5 to 40 L/min 10 to 100 L/min		10 to 100 L/min	0.4 to 4 L/min 1.8 to 20 L/min 4 to 40 L/min		
Power supply voltage	24 VDC±10%		24 VDC±10%		12 to 24 VDC Ripple ±10%			12 to 24 VDC Ripple ±10%			12 to 24 VDC Ripple ±10%			12 to 24 VDC Ripple ±10%		
Temperature characteristics (25°C reference)	±2% F.S. (15 to 35°C) ±5% F.S. (0 to 50°C)	±0.5% F.S. (0 to 50°C)	±2% F.S. (15 to 35°C) ±5% F.S. (0 to 50°C)	±0.5% F.S. (0 to 50°C)	±2% F.S. (15 to 35°C) ±3% F.S. (0 to 50°C)	±1% F.S. (15 to 35°C) ±2% F.S. (0 to 50°C)	±2% F.S. (0 to 50°C)	±5% F.S. (0 to 50°C)	±1% F.S. (15 to 35°C) ±2% F.S. (0 to 50°C)	±2% F.S. (0 to 50°C)	±5% F.S. (0 to 50°C)	±0.5% F.S. (0 to 50°C)	±5% F.S. (0 to 50°C)	±5% F.S. (0 to 50°C)	±1% F.S. (15 to 35°C) ±2% F.S. (0 to 50°C)	±2% F.S. (0 to 50°C)
Repeatability	±0.1% F.S. or less (Fluid: Dry air) Analog output: ±5% F.S. or less	±0.1% F.S. or less (Fluid: Dry air) Analog output: ±5% F.S. or less	±0.1% F.S. or less (Fluid: Dry air) Analog output: ±5% F.S. or less	±0.1% F.S. or less (Fluid: Dry air) Analog output: ±5% F.S. or less	±1% F.S. (Connected with PF2A3□) ±2% F.S. (Connected with PF2A2□)	±0.1% F.S. or less	±3% F.S. or less	±3% F.S. or less	±3% F.S. or less ±1% F.S. or less (PF2A33□)	±3% F.S. or less	±2% F.S.	±0.5% F.S.	±2% F.S.	±1% F.S. or less	±0.5% F.S. or less	±3% F.S. or less
Hysteresis		Hysteresis mode: Variable Window comparator mode: Variable		Hysteresis mode: Variable Window comparator mode: Variable		Hysteresis mode: Variable Window comparator mode: Fixed (3 digits*) * Digit is min. calibration unit.			Hysteresis mode: Variable Window comparator mode: Fixed (3 digits*) * Digit is min. calibration unit.			Variable			Hysteresis mode: Variable Window comparator mode: Fixed (3 digits*) * Digit is min. calibration unit.	
Output	Analog voltage output Analog current output	NPN/PNP open collector Accumulated pulse output Analog voltage output Analog current output	Analog voltage output Analog current output	NPN/PNP open collector Analog voltage output Analog current output	Analog voltage output Analog current output	NPN/PNP open collector Accumulated pulse output		Analog voltage output Analog current output	NPN/PNP open collector Accumulated pulse output		Analog voltage output Analog current output	NPN/PNP open collector Analog voltage output Analog current output	Analog voltage output Analog current output	Analog voltage output Analog current output	NPN/PNP open collector Accumulated pulse output	
Display		2-color display		2-color display		1-color display	1-color display		1-color display	1-color display		3-color display			1-color display	1-color display
Enclosure	IP40		IP40		IP65	IP40	Front only: IP65 The rest: IP40	IP65	IP40	Front only: IP65 The rest: IP40	IP65	Front only: IP65 The rest: IP40	IP65	IP65	IP40	Front only: IP65 The rest: IP40
Note	Flow adjustment valve integrable Panel mounting possible Manifold mountable DIN rail mountable	Panel mounting possible Selectable flow rate display unit Secret code setting function Power-saving mode Accumulated flow display function	Manifold mountable	Panel mounting possible Selectable flow rate display unit Secret code setting function Power-saving mode Auto shift function	Connectable with 4 ch monitor	Selectable flow rate display unit Accumulated flow display function		Connectable with 4 ch monitor	Selectable flow rate display unit Accumulated flow display function		Temperature sensor and flow adjustment valve integrable Flow indicator	3-step setting Copy function 3-color/ 2-screen display	Flow indicator	Connectable with 4 ch monitor	Selectable flow rate display unit Accumulated flow display function	
Page	**P.213**		**P.261**		**P.285**			**P.285**			**P.329**			**P.361**		

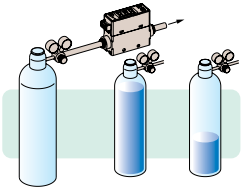
Application Examples

Flow control of N_2 gas to prevent detection camera shimmering and lead frame oxidation

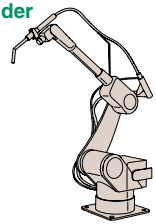


Set the clean gas filter on the outlet side piping of the flow switch.

Accumulated indication shows the operating flow rate or residual amount (of N_2 etc.) in a gas cylinder.

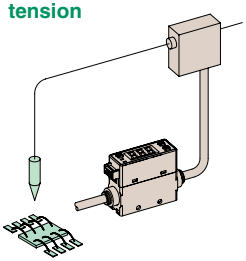


Welder

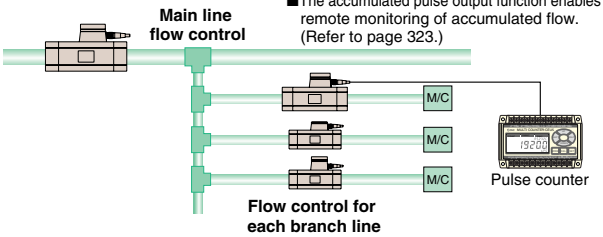


Models compatible with argon (Ar) and carbon dioxide (CO_2) mixed gas are available. Refer to page 256 for details.

Control of metal wire tension

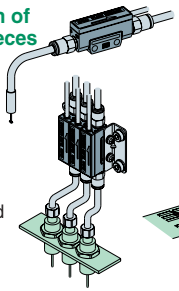


Makes it possible to monitor the air flow from the main line to each branch line.

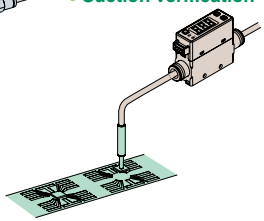


Suction verification of very small work pieces

- Suction of small components can be checked.
- Highly applicable to small nozzles
- Nozzle clogging and crushing detectable.
- Sensors can be mounted as a manifold.
- Sensors can be mounted near pads.

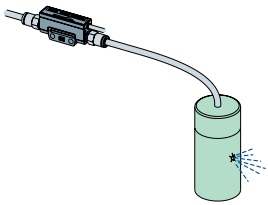


Suction verification



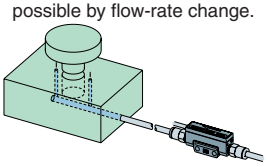
Easy leak test

- Easily detects pin halls on molded parts.

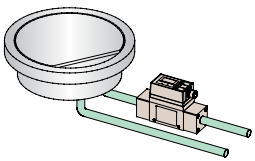


Easy placement verification

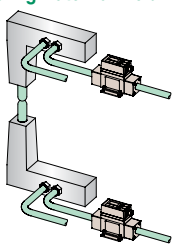
•Placement verification is possible by flow-rate change.



Flow control of cooling water for wafer temperature control and high frequency power supply



Flow control of pressurized cooling water for welding gun



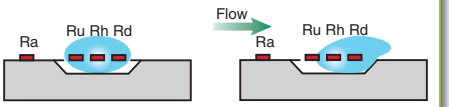
Flow Sensor Principle

Thermal type (MEMS)

This MEMS sensor chip consists of upstream temperature measuring sensor (Ru) and downstream temperature measuring sensor (Rd), which are placed symmetrically from the center of a platinum thin film coated heater (Rh) mounted on a membrane, and an ambient temperature sensor (Ra) for measuring gas temperature.

The principle is shown as the diagram below, the difference in resistance between Ru and Rd is proportional to the flow velocity, so measurement and analysis of the resistance can show the flow direction and velocity of the gas.

Ra is used to compensate the gas and/or ambient temperature.



(a) The gas is static. (b) The gas flows from the left side.

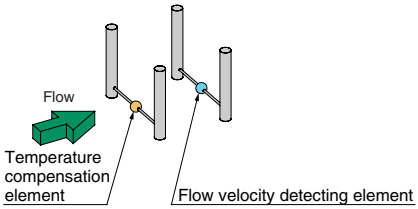
This flow switch uses L/min as the flow rate indicator unit. The mass flow is converted and displayed under the conditions of 0°C and 101.3 kPa and 20°C and 101.3 kPa.

For air

Applicable fluid: Air, nitrogen, argon, carbon dioxide
Air quality grade is
JIS B 8392.1-1. 1.2 to 1.6.2 , ISO 8573.1-1. 1.2 to 1.6.2

Thermal type (Thermistor)

A heated thermistor is installed in the passage, and fluid absorbs heat from the thermistor as it is introduced to the passage. The thermistor's resistance value increases as it loses heat. Since the resistance value increase ratio has a uniform relationship to the flow velocity, the flow velocity can be detected by measuring the resistance value. To further compensate the fluid and ambient temperature, the temperature sensor is also built into the switch to allow stable measurement within the operating temperature range.



This flow switch uses L/min as the flow rate indicator unit. The mass flow is converted and displayed under the conditions of 0°C and 101.3 kPa and 20°C and 101.3 kPa.

For air

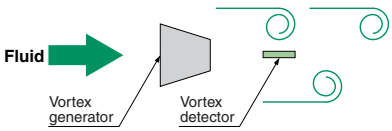
Applicable fluid: Air, nitrogen

Karman vortex

When an elongated object (vortex generator) is placed in the flow, reciprocal vortexes are generated on the downstream side. These vortexes are stable under certain conditions, and their frequency is proportional to the flow velocity, resulting the following formula.

$$f = k \times v$$

f: Frequency of vortex v: Flow velocity k: Proportional constant (determined by the vortex generator's dimensions and shape).
Therefore, the flow rate can be measured by detecting this frequency.



For water

Applicable fluid: Water
Mixture of water (50%) and ethylene glycol (50%)

For water, deionized water, chemicals

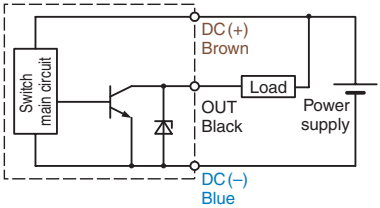
Applicable fluid: Deionized water
Ultrapure water
Fluids that dose not corrode piping materials.

Output Type

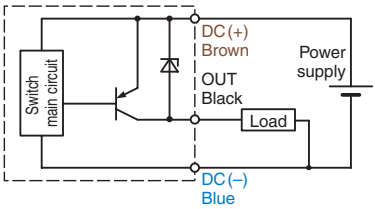
Switch output (ON/OFF output)

• The switch is activated when the set threshold value is exceeded.

NPN output type



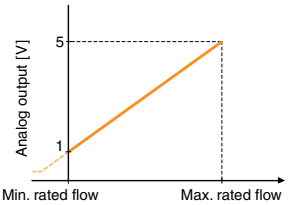
PNP output type



Analog output

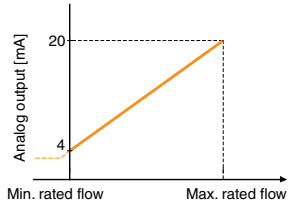
• Outputs voltage and current proportional to pressure.

Voltage output (1 to 5 VDC) type



Current output (4 to 20 mA DC) type

Effective for long distance transmission (10 m or more).



Wiring Specifications

Wiring

M8/M12 connector

• The main body wiring part connector specification for the PF2□7□ and PF2A5□/PF2W5□ series is M12. The PF3W7□ series connector specification is M8.

• The provided cable with connector terminal is half-stripped.

Terminal block

• The PF2□3□ series has a terminal block in the bottom which is connected to the sensor unit of the PF2□5□ series and control component such as PLC.

Dedicated cable

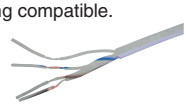
• The PFM, PFMV, PF2□2□, and PF2D series are wired with the dedicated cable or the dedicated cable with connector.

Cable end option

Standard

Half-stripped

Half-stripped cables are used except for the PF2□3□ series, which is wired onto terminal blocks, and the PF2D5□ series, which is pre-solder wiring compatible.

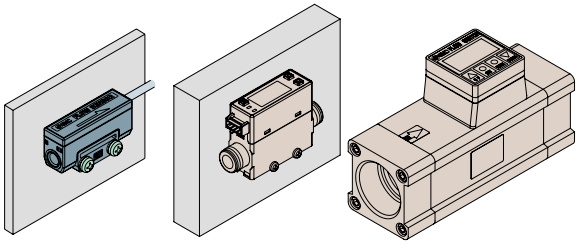


Made to Order

• We can provide the cable with a connector from the shown manufacturers. (Tyco Electronics Japan G.K., Molex Japan Co., Ltd., J.S.T. Mfg. Co., Ltd., HIROSE ELECTRIC CO., LTD., Sumitomo 3M Limited, etc.)

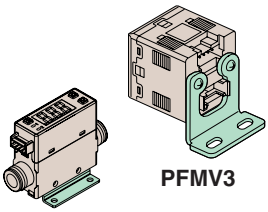
Type of Mounting

Direct mount



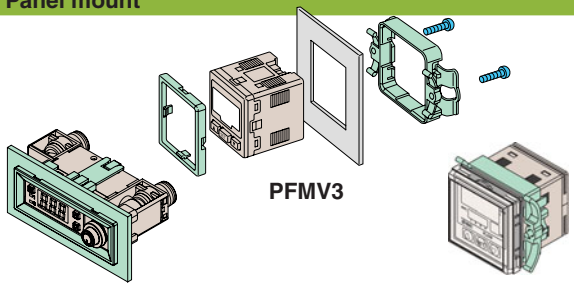
PFMV5 PFM7 PF2A7H

Bracket



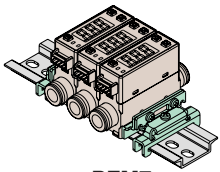
PFM7 PFMV3

Panel mount



PFM7□S PFMV3 PF2W200

DIN rail

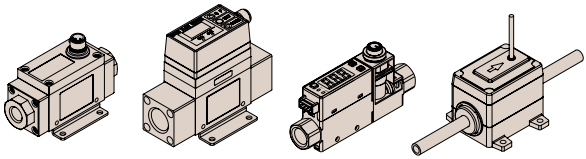


PFM7

Piping Specifications

Fittings

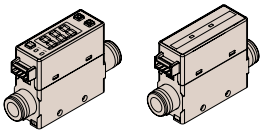
Steel tube piping compatible with PT thread (R thread/Rc thread), NPT thread, PF thread (G thread) and M thread.
The PF2D5□ series for chemicals compatible with fluoropolymer fittings (LQ1).



PF2A5 PF2W7 PFM7 PF2D5

One-touch fittings

Straight types available in mm and inch diameter.



PFM7 PFM5

Adaptable to Different Environments

Clean room — Made to Order

Application
- To prevent particles from entering a clean room.

Details
- After inspection, blowing with a high purity air (Cleanliness class: ISO class 5) is performed inside of a clean environment.
- Packaging consists of an antistatic protection bag, which is double packaged before being shipped.
- Grease-free for the wetted parts' seals.

Copper-free — Made to Order

Application
- Suitable in environments where copper ions are not permitted. For example, CRT manufacturing or front-end semiconductor manufacturing process equipment.

Details
- Application of material which does not include copper in wetted parts (or electroless nickel plating treatment).

Grease-free — Made to Order

Application
- Suitable in environments where oils are not permitted. For example, in a nitrogen or oxygen supply line.

Details
- No grease is used in the product assembly. (Grease-free)

Silicon-free — Made to Order

Application
- Suitable in environments where siloxane, the gas emitted from silicon, is not permitted.

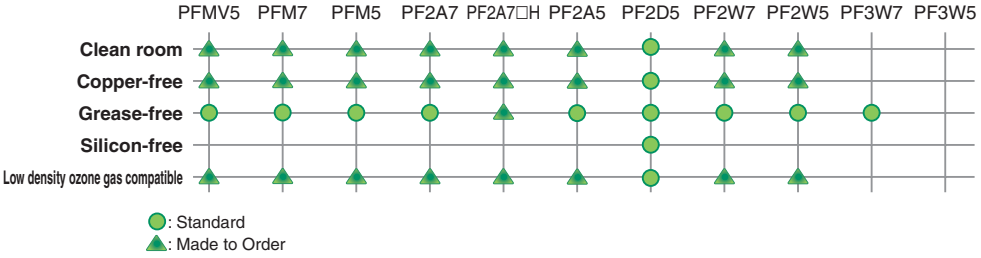
Details
- Any components which contain silicon are not used.
- Since the MEMS sensor with a silicon film cannot be used, it is not applicable to the PFM series.

Low density ozone gas compatible — Made to Order

Application
- Suitable in environments where low density ozone gas is generated.

Details
- FKM is used for the seals.
- Sensor parts and resin materials are the same as those used for standard products.

Applicability chart



Functions

Auto shift function

Summary

- Function to output for relative change amount referring the instantaneous flow when external signal is input as a base.

Application

- The solution of the flow rate fluctuation due to supply pressure fluctuation or nozzle diameter change during suction verification.

Response time setting function

Summary

- Function to select the response time for the switch output.

Application

- Can be prevented the output chattering in such a case when the fluid pulsation should not be detected as an abnormal flow rate.

Auto preset function

Summary

- Function to calculate the rough set value automatically for suction verification.

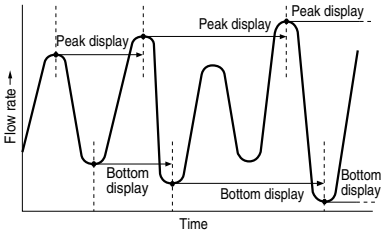
Application

- To easily setup the suction verification.

Peak/Bottom hold function

Summary

- Function to detect and display the fluctuating flow rate peak (maximum value) and bottom (minimum value).



Application

- For confirming the maximum or minimum flow rate being measured.

Keylock function

Summary

- Function to prevent the changing of settings other than those for normal key operations.

Application

- For preventing a malfunction due to unauthorised changes in setup.

Accumulating function

Summary

- Function to confirm a total flow rate in a certain period.

Application

- For confirming the consumption flow rate.

Accumulated pulse output function

Summary

- Function to provide pulse output every time the flow rate reaches a certain value.

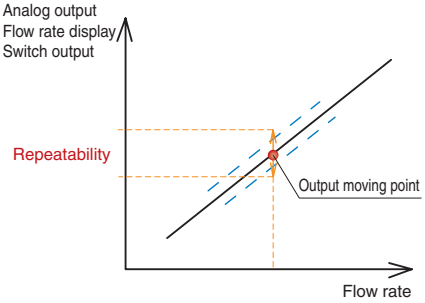
Details

- For monitoring the flow rate by remote control.

Accuracy

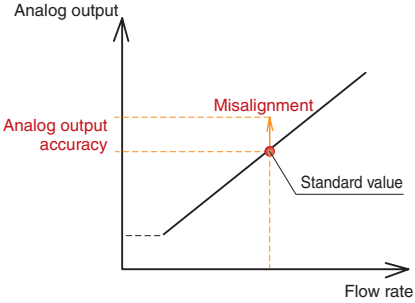
Repeatability

This graph shows the repeatability of an analog output, flow display and a switch (ON-OFF) output's moving point. The flow rate is increased or decreased under normal temperature (25°C).



Analog output accuracy

This graph shows the difference between the analog output voltage (current) standard value versus the flow rate, at a normal temperature (25°C).



Glossary of Terms

UL/CSA standards

UL and CSA standards have been applied in North America (U.S.A. and Canada) symbolizing safety of electrical products, and are defined to mainly prevent danger from an electrical shock or fire, resulting from trouble with the electrical products. The power supply of the flow switch is 24 VDC, which does not meet the voltage requirement for the electrical shock category. However, measures against a fire hazard have been taken.
Some flow switches are **UL/CSA** certified. (Use the UL approved products for DC power supply combinations. Refer to each product's operation manuals for details.)

CE marking

CE marked products or equipment that are imported to countries that are EU members must conform to the EC directives. SMC products are subject to either or both the low power voltage directive (regarding electrical safety) and the EMC directive (regarding noise conformity).
The operating voltage of the flow switches is 24 VDC, therefore it is not subjected to the low voltage directive (50 to 1000 VAC or 75 to 1500 VDC).
The flow switches undergo EMC testing by a third party and bears the **CE marking** (self-declaration).
Since the product is a component which is ultimately integrated into the user's equipment machine or facility, the user must confirm that the product conforms to the EC directive.

Enclosure

The **enclosure** is rated according to the IP (International Protection) standards (IEC 60529) which defines protection against dust or water.

IP40: Is not protected against the water intrusion, even though a wire exceeding 1.0 mm in diameter can not enter.

IP65: Powdered dust cannot enter the enclosure and the enclosure is not affected by water sprayed from all directions.

IP67: Powdered dust cannot enter the enclosure, as well as water, even though the enclosure is immersed in water with a specified pressure and time.