

Flow Switches

Series *PF2*□, *IF*□

Digital Flow Switch

Digital Flow Switch for Air: *Series PF2A* Refer to page 16-11-7.

Digital Flow Switch for Water: *Series PF2W* Refer to page 16-11-17.

Digital Flow Switch for Deionized Water and Chemicals: *Series PF2D* Refer to page 16-11-37.

Mechanical Flow Switch

Diaphragm Style Flow Switch: *Series IFW*

Model	Flow rate measuring range (ℓ/min)	Contacts	Port size (Rc, NPT, G)	Page
IFW510	1 to 10	1ab	3/8, 1/2, 3/4	16-12-1
IFW520	10 to 20			
IFW550	20 to 50			

Paddle Style Flow Switch: *Series IF3*□

Model	Flow rate measuring range (ℓ/min)	Contacts	Port size (Rc, NPT, G)	Page
1F3 □0	14 to 60	1ab	3/4	16-12-6
1F3 □1	20 to 150		1	
1F3 □3	36 to 2600		1	

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Data



Flow Switches Precautions 1

Be sure to read before handling.

Design and Selection

Warning

- 1. Make sure to use a switch by the specified voltage.**
Use of a switch outside the range of the specified voltage can cause not only malfunction and damage of the switch, but also electrocution and fire.
- 2. Never use such a load, which exceeds the maximum allowable load.**
It may result in a damage to a switch.
- 3. Since the type of fluid varies depending on the product, make sure to verify the specifications.**
Never use flammable gases or fluids, since the switch is not explosion proof construction. It may result in a fire.

[For air]

- 4. Make sure to use a switch within the specified flow rate for measurement and the maximum operating pressure.**
Operating beyond the specified flow rate and operating pressure can damage the switch.
If using a switch by exceeding the maximum operating pressure, switch is damaged.

[For water]

- 5. Make sure to use a switch within the specified flow rate for measurement and the maximum operating pressure.**
Operating beyond the specified flow rate and operating pressure can damage the switch.
Damage to the switch may occur if the switch is subject to higher pressure than its designed limit.
Avoid especially the application of pressure above specifications through a water hammer.
<Countermeasure examples>
 - a) Use a device such as a water hammer relief valve to slow the valve's closing speed.
 - b) Absorb an impact pressure by using a rubber material piping such as a rubber hose and an accumulator.
 - c) Keep the piping length as short as possible.

Mounting

Warning

- 1. Mount a switch by observing the proper tightening torque.**

When a switch is tightened beyond the specified tightening torque, a switch may be damaged. On the other hand, tightening below the specified tightening torque may cause the installation screws to come loose during operation.

Thread	Proper tightening torque (N·m)
1/8	7 to 9
1/4	12 to 14
3/8	22 to 24
1/2	28 to 30
3/4	28 to 30
1	36 to 38

- 2. Apply a wrench only to the metal part of the piping when installing the flow switch in the system piping.**

Do not apply a wrench to the plastic part of the main housing of the switch.

- 3. Monitor the flow direction of the fluid.**

Install a switch in the direction as indicated on the body.

- 4. Remove solid foreign objects, etc. inside piping by air blow before connecting a switch with piping.**

- 5. Do not drop or bump.**

Do not drop, bump, or apply excessive impacts (490 m/s²) while handling. Although the external body of the switch (switch case) may not be damaged, the inside of the switch could be damaged and cause a malfunction.

- 6. Hold the body of a switch when handling.**

The tensile strength of the cord is 49 N. Applying a greater pulling force on it can cause a malfunction. When handling, hold the body of the switch—do not dangle it from the cord.

- 7. Do not use until you can verify that equipment can operate properly.**

Verify whether it is mounted correctly by running fluids or applying the electricity in order to conduct suitable function and leakage tests when mounting for the first time or after system repair or modification was made.

[For air]

- 8. Ever mount a switch in a place that will be used as a scaffold during piping.**

If an excessive weight is applied on a switch, switch may be damaged.

- 9. Be sure to allow straight pipe length that is minimum 8 times the port size upstream and downstream of the switch piping.**

Do not suddenly narrow the pipe size because doing so will disturb the flow speed distribution in the pipe, making it impossible to obtain the correct measurements.

[For water]

- 10. Never install a switch in such a place, where switch is used as a foothold in the piping.**

Damage may occur if an excessive load is applied to the switch. Especially when the switch supports the piping, do not apply a load of 15 N·m or more to the metal parts of the switch.



Flow Switches Precautions 2

Be sure to read before handling.

Wiring

Warning

- 1. Verify the color and terminal number when wiring.**
Incorrect wiring can cause a switch to be damaged and may result in a malfunction. Verify the color of wiring and the terminal number in the instruction manual when wiring.
- 2. Avoid repeatedly bending or stretching the lead wire.**
Repeatedly applying bending stress or stretching force to the lead wire will cause it to break.
- 3. Confirm proper insulation of wiring.**
Make sure that there is no wiring insulation (contact with other circuits, ground fault, improper insulation between terminals, etc.). Overcurrent is flown and may result in a damage.

Operating Environment

Warning

- 1. Never use in an environment, where explosive gases are used.**
The switches do not have an explosion-proof rating. Never use in an environment, where explosive gases are used, as this may cause a serious explosion.
- 2. Mount a switch in such locations, where no vibration or shock (less than 98 m/s²) is affected.**

[For air]

- 3. Use the switch within the specified fluid and ambient temperature range.**
Fluid and ambient temperatures are 0° to 50°C. Take measures to prevent freezing fluid when below 5°C, since this may cause damage to a switch and lead to a malfunction. The installation of an air dryer is recommended for eliminating condensate and moisture.
Never use a switch in an environment, where temperature changes drastically even within the allowable ambient temperature range.

Maintenance

Warning

- 1. Perform periodical inspections to ensure proper operation of the switch.**
Unexpected malfunctions and wrong operations may not secure the safety.
- 2. Use caution when using a switch for an interlock circuit.**
When a pressure switch is used for an interlock circuit, devise a multiple interlock system to prevent trouble or malfunctioning. Verify the operation of the switch and interlock function on a regular basis.
- 3. Do not disassemble or modify the main body.**

Fluid

Warning

- 1. Check regulators and the flow adjustment valves before introducing the fluid.**
If pressure or flow rate beyond the specified range are applied to the switch, the sensor unit may be damaged.

[For air]

- 2. Fluids for measurement for this digital flow switch are nitrogen and air.**
Please note that accuracy cannot be guaranteed when other fluids are used.
- 3. Never use flammable fluids.**
- 4. Install a filter or mist separator on the upstream side when there is a possibility of condensate and foreign matter being mixed in with the fluid.**
The rectifying device built into the switch will be clogged up and accurate measurement will no longer be possible.

[For water]

- 5. Never use flammable fluids.**
- 6. Install a filter in the inlet side when it is likely for solid foreign objects to get mixed with fluids.**

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Digital Flow Switch For Deionized Water and Chemicals Series PF2D



Series PF2D

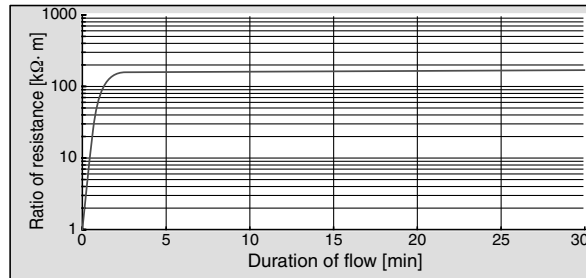
Body and sensor New PFA Tube Super PFA

Three types of flow range

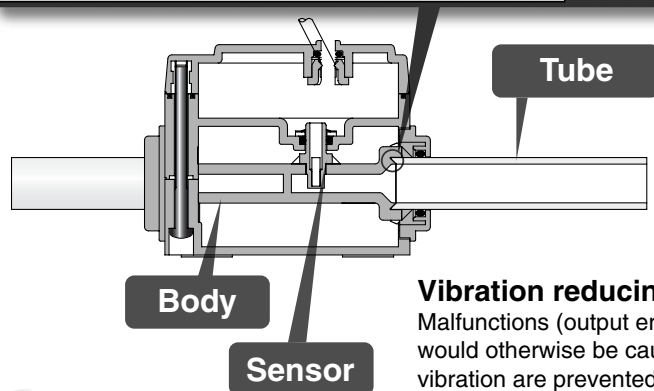
- 0.4 to 4 μmin (PF2D504)
- 1.8 to 20 μmin (PF2D520)
- 4.0 to 40 μmin (PF2D540)

Swept flow characteristics
Tapered side seal minimizes dead volume
to reduce accumulation of liquid pool.

Swept Flow Characteristics (Reference)



Fill the flow path with sulfuric acid and leave it for 30 minutes. After disposing the sulfuric acid, flush the flow path out with deionized water and measure the resistance rate of the fluid that is discharged from the downstream side. A quick recovery time indicates little liquid pool.



Vibration reducing seals
Malfunctions (output errors) that would otherwise be caused by vibration are prevented.

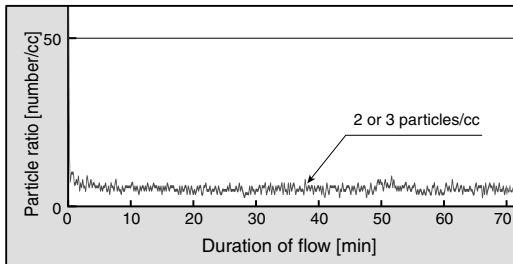
4 types of outputs available
With button operation, 4 types of output specification combinations are available.

	1	2	3	4
Output 1	Switch output	Switch output	Accumulated pulse output	Accumulated pulse output
Output 2	Switch output	Accumulated pulse output	Switch output	Accumulated pulse output

Dust generation of 3 particles/cc or less
(Average number)

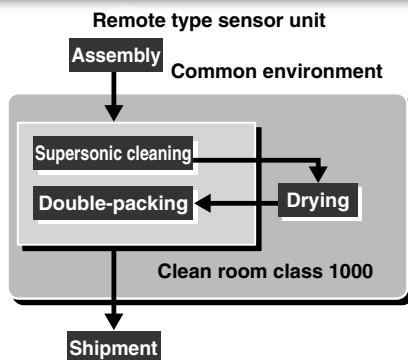
Karman vortex eliminates moving parts and allows low dust generation.

Particle Characteristics (Reference)



The data was obtained by performing an actual 10 minutes' supersonic cleaning using an average 16 M Ω -cm of deionized water at class 10000 clean room (1 μmin flow rate). The diameter of the measured particles ranges from 0.1 to 0.5 μm . The flow rate used during measuring is 100 cc/min.

Processing chart for Series PF2D



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Data

Digital Flow Switch For Deionized Water and Chemicals Series *PF2D*

How to Order



Remote type
Sensor unit

PF2D5 **20** — **13** — **1**

Flow rate range

04	0.4 to 4 ℓ/min
20	1.8 to 20 ℓ/min
40	4 to 40 ℓ/min

Port size (inch)

11	3/8	PF2D504
13	1/2	PF2D520
19	3/4	PF2D540

Output specifications

1	Output for display unit Note 1) + analog output (1 to 5 V)
2	Output for display unit Note 1) + analog output (4 to 20 mA)

Note 1) Output for the display units of PF2D 300/301

Specifications for Sensor Unit

Model		PF2D504	PF2D520	PF2D540
Measured fluid		Liquid not to corrode nor erode deionized water and/or Teflon®. Viscosity: 3 mPa·s (3 cP) or less		
Detection style		Karman vortex		
Flow rate measuring range		0.4 to 4 ℓ/min	1.8 to 20 ℓ/min Note 1)	4 to 40 ℓ/min
Operating pressure range Note 2)		0 to 1 MPa		0 to 0.6 MPa
Proof pressure Note 3)		1.5 MPa		0.9 MPa
Operating fluid temperature		0 to 90°C		
Linearity Note 4)		±2.5%F.S. or less (at 25°C water)		
Repeatability		±1%F.S. or less (at 25°C water)		
Temperature characteristics		±5%F.S. or less (0 to 50°C)		
Output specifications	Pulse output	Pulse output, N channel, open drain, output for display unit PF2D300/301 (Specifications: Maximum load current of 10 mA; Maximum applied voltage of 30 V)		
	Analog output	Voltage output Note 5) 1 to 5 V within the flow rate range Linearity: ±2% F.S. or less, Allowable load resistance: 100 kΩ or more		
Current output Note 6) 4 to 20 mA within the flow rate range Linearity: ±2% F.S. or less, Allowable load resistance: 30 0Ω or less with 12 VDC, 600 Ω or less with 24 VDC				
Power supply voltage		12 to 24 VDC (Ripple ±10% or less)		
Current consumption		20 mA or less (Without load)		
Environmental resistance	Enclosure	IP65		
	Operating temperature range	Operating: 0 to 50°C, Stored: -25 to 85°C in stock (No freezing or condensation)		
	Voltage resistance	1000 VAC for 1 min between external terminals and case		
	Insulation resistance	50 MΩ or more (500 VDC) between external terminals and case		
	Vibration resistance	4.9 m/s ²		
	Impact resistance	490 m/s ² to X, Y, Z directions 3 times for each		
	Noise resistance	1000 Vp-p, Pulse width: 1 μs, Standing: 1 ns		
Weight		140 g (Without lead wire)	225 g (Without lead wire)	
Port size		3/8 inch tube	1/2 inch tube	3/4 inch tube
Wetted material		Body: New PFA, Sensor: New PFA, Tube: Super PFA		

Note 1) 1.6 to 20 ℓ/min (0.1 MPa) with viscosity of 1 mPa·s (1 cP) or less

Note 2) The operating pressure range drops according to the fluid temperature. See attached graph.

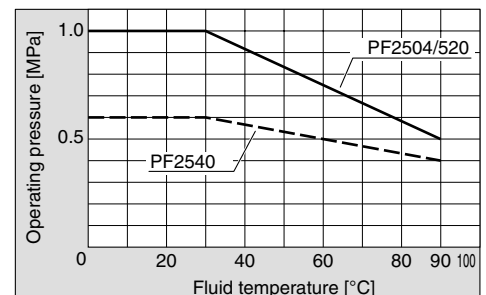
Note 3) 1.5 times of the maximum operating pressure and varying with fluid temperature.

Note 4) The system accuracy when combined with PF2D300□.

Note 5) When the voltage output is selected.

Note 6) When the current output is selected.

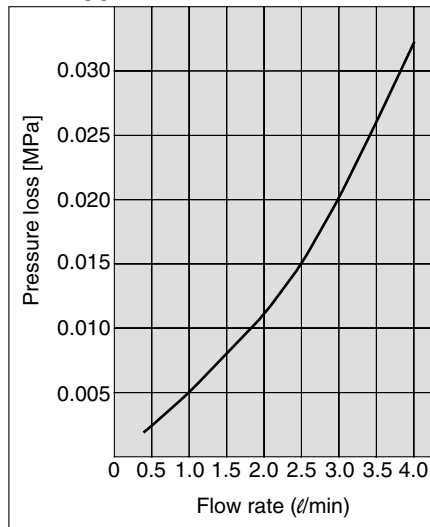
Note 7) The sensor unit is conformed to CE mark.



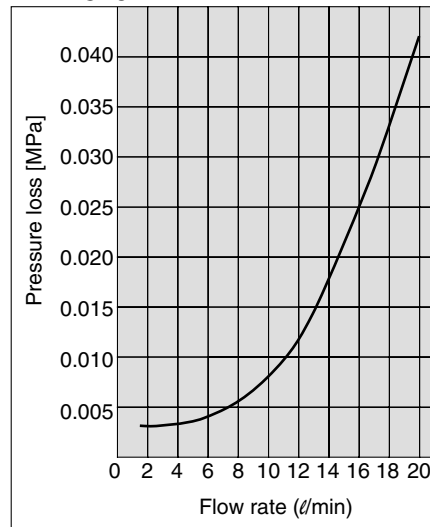
Series PF2D

Flow Characteristics (Pressure characteristics)

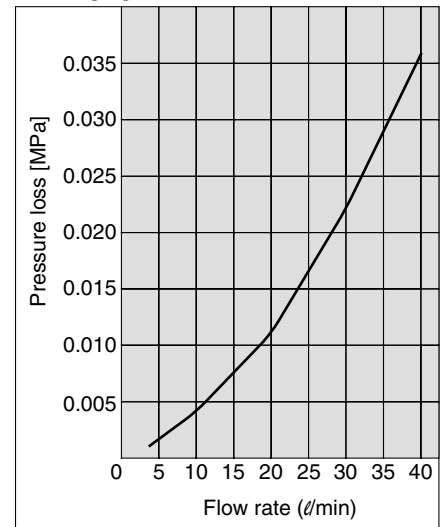
PF2D504



PF2D520

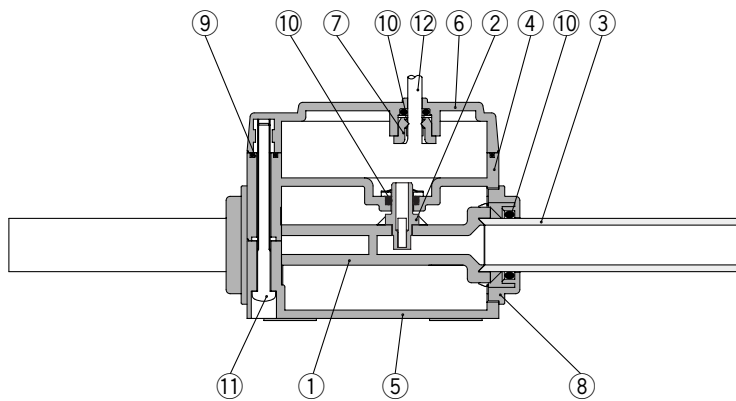


PF2D540



Construction

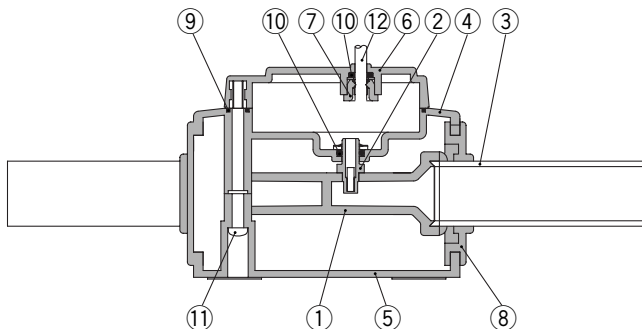
PF2D504/520



Component Parts

No.	Description	Material
①	Body	New PFA
②	Sensor	New PFA
③	Tube	Super PFA
④	Housing A	PPS
⑤	Housing B	PPS
⑥	Housing C	PPS
⑦	Bushing	POM
⑧	Cap	PPS
⑨	Gasket	FKM
⑩	O-ring	FKM
⑪	Thread	Stainless steel 304
⑫	Lead wire	PVC

PF2D540

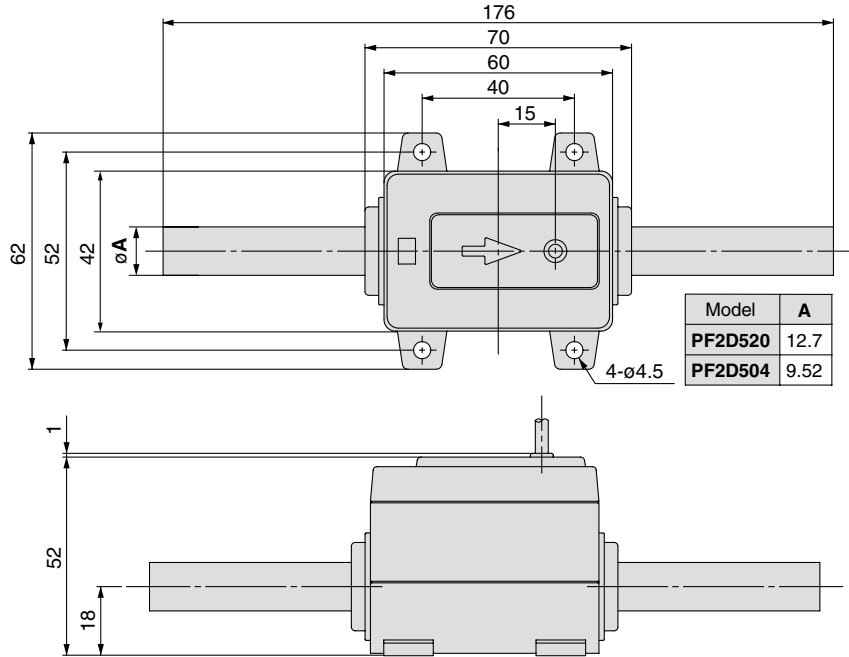


Digital Flow Switch Series PF2D

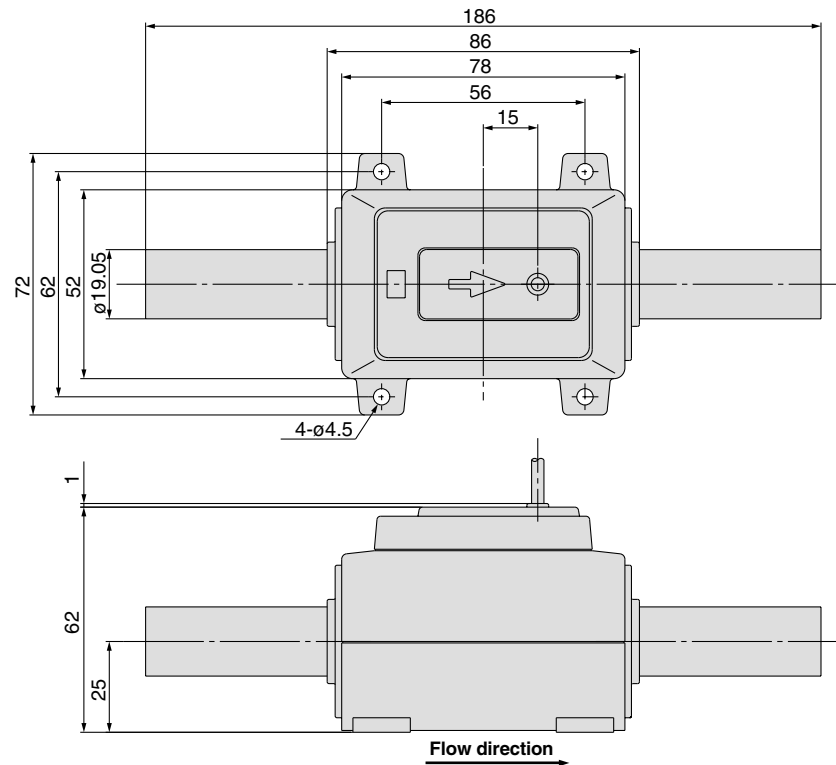
For Deionized Water and Chemicals

Dimensions: Separate Type Sensor Unit

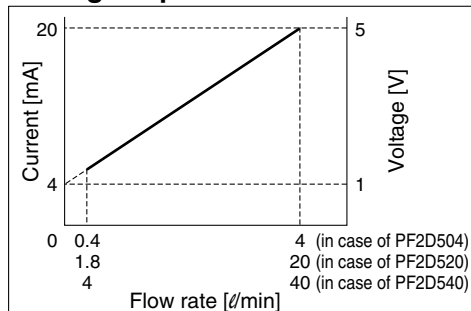
PF2D504-11/520-13



PF2D540-19

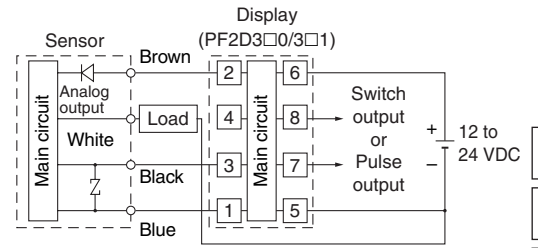


Analog Output

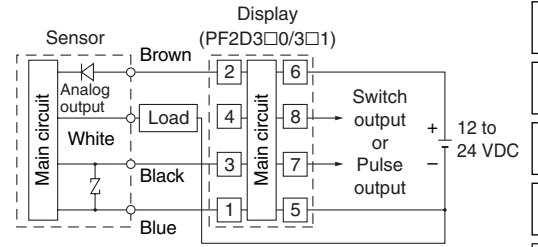


Internal circuit and wiring example

① to ⑧ are terminal numbers.

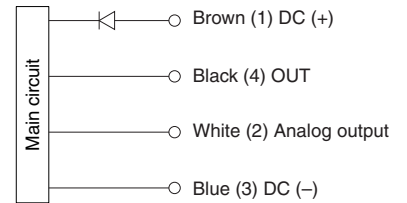


PF2D5□□-□-1



PF2D5□□-□-2

Wiring



* Use this sensor by connecting to SMC remote type display unit Series

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Data

Functions/PF2D

Refer to the operation manual how to set and to operate.

Flow rate measurement selection

Real-time flow rate and accumulated flow rate can be selected.
Up to 999999 of flow rate value can be accumulated.

Unit switching

Display	Real-time flow rate	Accumulated flow
U_1	ℓ/min	ℓ
U_2	GPM	gal (US)

GPM = gal (US)/min

Note) Fixed SI unit (ℓ/min, ℓ, m³ or m³ x 10) will be set for the type without the unit switching function.

Flow rate measuring unit confirmation

This function allows to confirm the accumulated flow rate when real-time flow rate is selected and to confirm the real-time flow rate when accumulated flow rate is selected.

Error correction

LED display	Contents	Solution
E-1	A current of more than 80 mA is flowing to OUT1	Check the load and wiring for OUT1
E-4	The setting data has changed for whatever reasons.	Perform the RESET operation, and reset all data again.
- - - -	The flow rate is over the flow rate measurement range.	Reduce the flow rate until it is within the flow rate range, using an adjustment valve.

Key lock

This function prevents incorrect operations such as changing the set value accidentally.

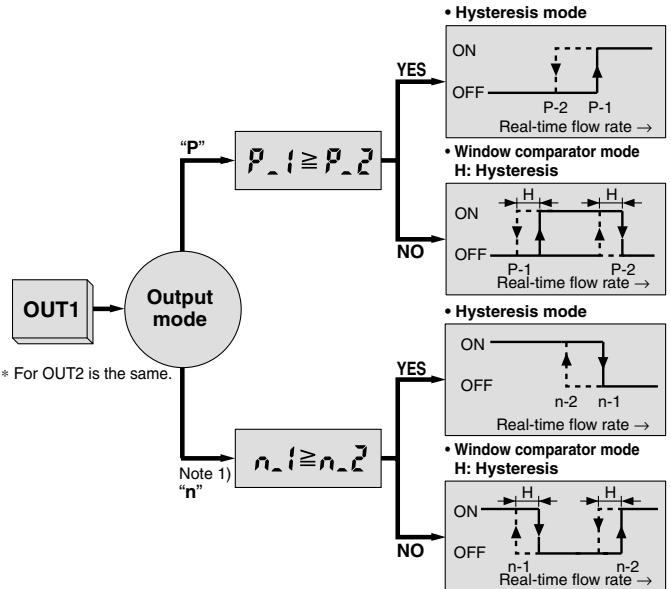
Accumulation clearance

This is to clear the accumulated value.

Output types

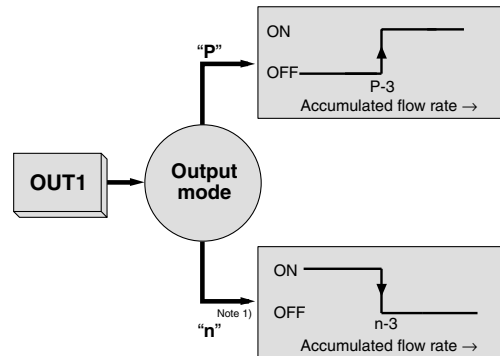
Real-time switch output, accumulated switch output, or accumulated pulse output can be selected as an output type.

Real-time switch output (αU 1.0)



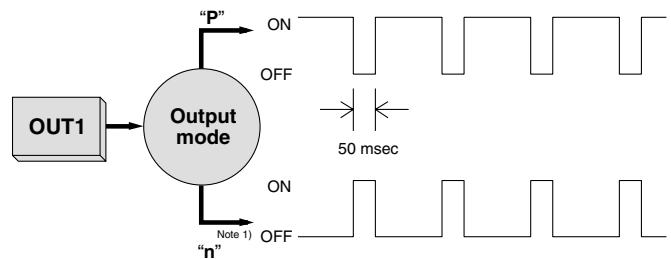
Note 1) Output mode is set to inverted output at the factory before shipment.

Accumulated switch output (αU 1.1)



Note 1) Output mode is set to inverted output at the factory before shipment.

Accumulated pulse output (αU 1.2)



Note 1) Refer to the specifications of display unit for the flow rate value per pulse.

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Applicable Fluid

Compatibility check list: Materials of digital flow switch for deionized water and chemicals and fluid

Chemical	Compatibility
Acetone	○
Ammonium hydroxide	○
Isobutyl alcohol	X
Isopropyl alcohol	○
Hydrochloric acid	○
Ozone	X
Hydrogen peroxide Concentration 50% or less 50°C or less	○
Ethyl acetate	○
Butyl acetate	○
Nitric acid (Except fuming nitric acid) Concentration 10% or less	○
Deionized water	○
Sodium hydroxide	X
Ultra deionized water	○
Toluene	○
Hydrofluoric acid Concentration 50% or less	○
Sulfuric acid (Except fuming sulfuric acid) Concentration 20% or less	○
Phosphoric acid Concentration 30% or less	○

Note 1) The material and fluid compatibility check list provides reference values as a guide only.

Note 2) Please consult with SMC for made to order specifications such as: Teflon coated threads to prevent rust/corrosion when in contact with strong acid or alkali.

- Compatibility is indicated for fluid temperatures at 100°C or less.
- Please consult with SMC regarding fluids other than the above.
- Please consult with SMC regarding operating conditions.
- The product is not explosion proof. Please be sure to take measures to guard it from explosive gas when using explosive fluid.

Table symbols ○ : Can be used
○ : Can be used under certain conditions
X : Cannot be used



Specific Product Precautions 1

Be sure to read before handling.

Design and Selection

⚠ Warning

1. Operate the switch only within the specified voltage.

Use of the switch outside the range of the specified voltage can cause not only malfunction and damage of the switch but also electrocution and fire.

2. Do not exceed the maximum allowable load specification.

A load exceeding the maximum load specification can cause damage to the switch.

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

Although surge protection is installed in the circuit at the output side of the switch, damage may still occur if a surge is applied repeatedly. When a surge generating a load such as a relay or solenoid is directly driven, use a type of switch with a built-in surge absorbing element.

4. Be sure to verify the applicable fluid.

The switch does not have an explosion proof rating. To prevent possible fire hazard, do not use with flammable gases or fluids.

5. Monitor the internal voltage drop of the switch.

When operating below a specified voltage, it is possible that the load may be ineffective even though the pressure switch function is normal. Therefore, the formula below should be satisfied after confirming the minimum operating voltage of the load.

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

6. Use the switch within the specified flow rate measurement and operating pressure.

Operating beyond the specified flow rate and operating pressure can damage the switch. Avoid especially the application of pressure above specifications through a water hammer.

<Examples of pressure reduction measures>

- a) Use a device such as a water hammer relief valve to slow the valve's closing speed.
- b) Absorb impact pressure by using an accumulator or elastic piping material such as a rubber hose.
- c) Keep the piping length as short as possible.

7. Design the system so that the fluid always fills the detection passage.

Especially for vertical mounting, introduce the fluid from the bottom to the top.

8. Operate at a flow rate within the flow rate measurement range.

If operated outside of the flow rate measurement range, the Karman vortex will not be generated and normal measurement will not be possible.

9. Never use flammable fluids and/or penetrable fluids.

These can cause fire, explosion or corrosion.

* Refer to MSDA (material safety data sheet) when using chemicals.

Design and Selection

⚠ Caution

1. Data of the flow switch will be stored even after the power is turned off.

Input data will be stored in EEPROM so that the data will not be lost after the flow switch is turned off. (Data can be rewritten for up to one million times, and data will be stored for up to 20 years.)

Mounting

⚠ Warning

1. Monitor the flow direction of the fluid.

Install and connect piping so that fluid flows in the direction of the arrow indicated on the body.

2. Remove dirt and dust from inside the piping using an air blower before connecting piping to the switch.

3. Do not drop or bump.

Do not drop, bump, or apply excessive impacts (490 m/s²) while handling. Although the external body of the switch (switch case) may not be damaged, the inside of the switch could be damaged and cause a malfunction.

4. Hold the body of the switch when handling.

The tensile strength of the cord is 49 N. Applying a greater pulling force on it can cause a malfunction. When handling, hold the body of the switch—do not dangle it from the cord.

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

Following mounting, repair, or retrofit, verify correct mounting by conducting suitable function and leakage tests after piping and power connections have been made.

6. Never mount a switch in a place that will be used as a scaffold during piping.

7. Be sure to allow straight pipe length that is minimum 8 times the port size upstream and downstream of the switch piping.

When abruptly reducing the size of piping or when there is a restriction such as a valve on the inlet side, the pressure distribution in the piping changes and makes accurate measurement impossible. Therefore, flow restriction measures such as these should be implemented on the outlet side of the switch.

When used with the outlet side open, be careful of the cavitation that is prone to occur.

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Specific Product Precautions 2

Be sure to read before handling.

Wiring

Warning

- 1. Verify the color and terminal number when wiring.**
Incorrect wiring can cause the switch to be damaged and malfunction. Verify the color and the terminal number in the instruction manual when wiring.
- 2. Avoid repeatedly bending or stretching the lead wire.**
Repeatedly applying bending stress or stretching force to the lead wire will cause it to break.
- 3. Confirm proper insulation of wiring.**
Make sure that there is no faulty wiring insulation (contact with other circuits, ground fault, improper insulation between terminals, etc.). Damage may occur due to excess current flow into a switch.
- 4. Do not wire in conjunction with power lines or high voltage lines.**
Wire separately from power lines and high voltage lines, avoiding wiring in the same conduit with these lines. Control circuits including switches may malfunction due to noise from these other lines.
- 5. Do not allow loads to short circuit.**
Although switches indicate excess current error if loads are short circuited, all incorrect wiring connections such as power supply polarity cannot be protected. Take precautions to avoid incorrect wiring.

Usage

Warning

- 1. When using a switch for high temperature fluid, the switch itself also becomes hot due to the high temperature fluid. Avoid touching the switch directly as this may cause a burn.**

Operating Environment

Warning

- 1. Never use in the presence of explosive gases.**
The switches do not have an explosion proof rating. Never use in the presence of an explosive gas as this may cause a serious explosion.
- 2. Mount switches in locations where there is no vibration greater than 98 m/s², or no impact greater than 490 m/s².**
- 3. Do not use in an area where surges are generated.**
When there are units that generate a large amount of surge in the area around pressure switches, (e.g., solenoid type lifters, high frequency induction furnaces, motors, etc.) this may cause deterioration or damage to the switches' internal circuitry. Avoid sources of surge generation and crossed lines.
- 4. Switches are not equipped with surge protection against lightning.**
Flow switches are CE compliant; however, they are not equipped with surge protection against lightning. Lightning surge protection measures should be applied directly to system components as necessary.
- 5. Avoid using switches in an environment where the likelihood of splashing or spraying of liquids exists.**
Switches are dustproof and splashproof; however, avoid using in an environment where the likelihood of heavy splashing or spraying of water and/or oil exist. Since the display unit of the remote type switches featured here is not dust or splash proof, the use in an environment where water and/or oil splashing or spraying exists must be avoided.

Maintenance

Warning

- 1. Perform periodical inspections to ensure proper operation of the switch.**
Unexpected malfunctions may cause possible danger.
- 2. Take precautions when using the switch for an interlock circuit.**
When a pressure switch is used for an interlock circuit, devise a multiple interlock system to prevent trouble or malfunctioning. Verify the operation of the switch and interlock function on a regular basis.
- 3. Do not disassemble or perform any conversion work on flow switches.**
- 4. Check the following during regular maintenance to avoid damage and loss because of chemicals.**
 - a) Do not touch the remaining chemicals in piping and/or digital flow switch.
 - b) Verify the names and characteristics of using chemicals and treat them accordingly.



Series PF2D

Specific Product Precautions 3

Be sure to read before handling.

Measured Fluid

Warning

1. Check regulators and flow adjustment valves before introducing the fluid.

If pressure or flow rate beyond the specified range are applied to the switch, the sensor unit may be damaged.

2. Be sure to take preventive measures not to expose the switch to inflammable and/or explosive gases when using inflammable fluid.

3. Place the filter on the upstream side when extraneous material can be infected.

Accurate measurement cannot be fulfilled when extraneous material is adherent to the vortex generator and the vortex detector of the switch.

Others

Warning

1. Since switch output remains OFF while a message is displayed after the power is turned on, start measurement after a value is displayed.

2. Perform settings after stopping control systems.

When the switch's initial setting and flow rate setting are performed, output maintains the condition prior to the settings. Output turns OFF when the switch's initial setting and flow rate setting are performed.

Set Flow Rate Range and Rated Flow Rate Range

Caution



Set the flow rate within the rated flow rate measuring range.

The set flow rate range is the range of flow rate that is possible in setting at the controller side.

The flow rate measuring range is the range that satisfies the specifications (accuracy, linearity etc.) on the sensor.

Although it is possible to set a value outside the flow rate measuring range, the specifications will not be guaranteed.

Sensor	Flow range					
	0.4 ℓ/min	1.8 ℓ/min	4 ℓ/min	10 ℓ/min	20 ℓ/min	40 ℓ/min
PF2D504	0.4 ℓ/min		4 ℓ/min			
	0.25 ℓ/min		4.5 ℓ/min			
PF2D520	1.8 ℓ/min		20 ℓ/min			
	1.3 ℓ/min		21 ℓ/min			
PF2D540	4 ℓ/min		40 ℓ/min			
	2.5 ℓ/min		45 ℓ/min			

 Rated flow rate range of sensor
 Set flow rate range of sensor

ZSE□
ISE□

PSE

ZSE3

PS

ZSE1
SE2

ZSP

ISA2

IS□

ZSM

PF2□

IF□

Data