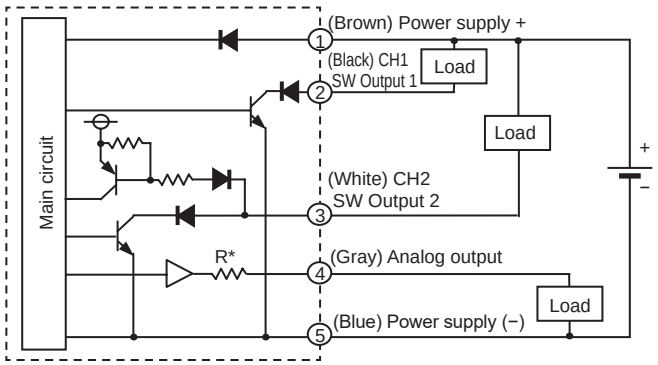
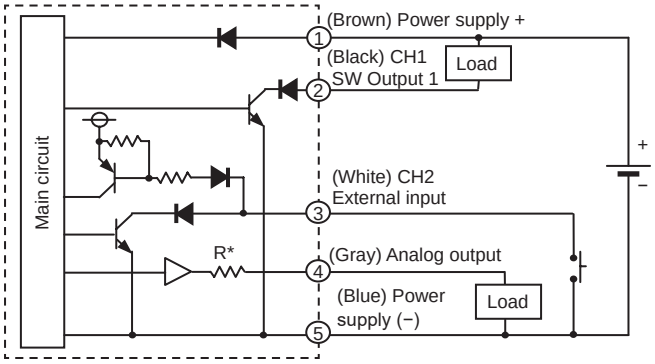
Example of internal circuit and load connection

●FSM3-L□□□□□B/F/□□ (LCD display NPN output)

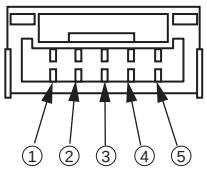
[CH2 is used as SW output]



[CH2 is used as external input]



* Analog output voltage output R: approx. 1 kΩ
Current output R: approx. 100 Ω

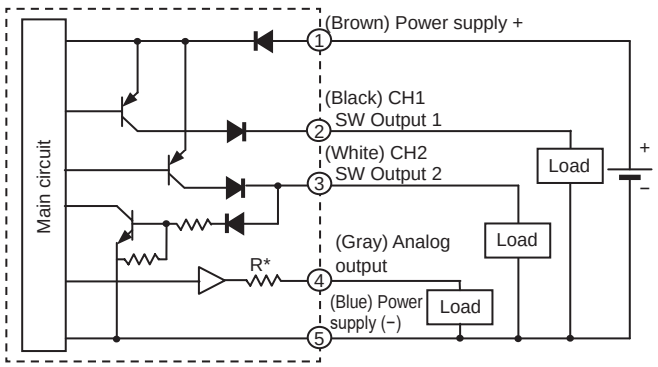


(FSM3 side)

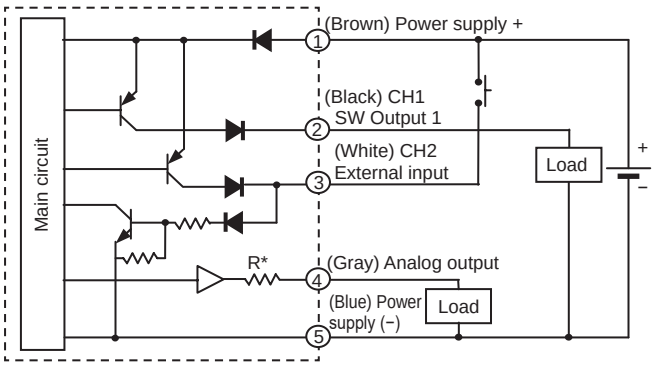
Terminal No.	Option lead wire color	Name
①	Brown	Power supply (+) (voltage output: 12 to 24 V, current output: 24 V)
②	Black	CH1 (switch output 1: max. 50 mA)
③	White	CH2 (switch output 2: max. 50 mA, or external input)
④	Gray	Analog output Voltage output: 1 to 5 V load impedance 50 kΩ or more Current output: 4 to 20 mA load impedance 300 Ω or less
⑤	Blue	Power supply − (GND)

●FSM3-L□□□□□D/H/□□ (LCD display PNP output)

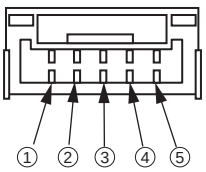
[CH2 is used as SW output]



[CH2 is used as external input]



* Analog output voltage output R: approx. 1 kΩ
Current output R: approx. 100 Ω

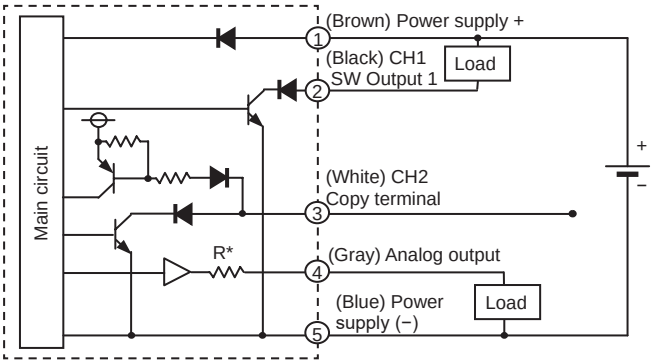


(FSM3 side)

Terminal No.	Option lead wire color	Name
①	Brown	Power supply (+) (voltage output: 12 to 24 V, current output: 24 V)
②	Black	CH1 (switch output 1: max. 50 mA)
③	White	CH2 (switch output 2: max. 50 mA, or external input)
④	Gray	Analog output Voltage output: 1 to 5 V load impedance 50 kΩ or more Current output: 4 to 20 mA load impedance 300 Ω or less
⑤	Blue	Power supply − (GND)

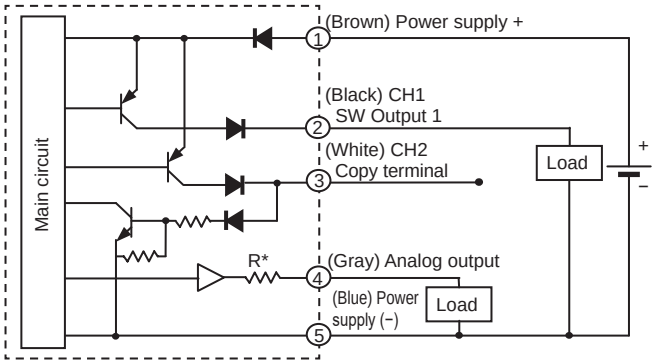
Example of internal circuit and load connection

●FSM3-L□□□□□A/E/□□
(LCD display, NPN output, with setting copy function)

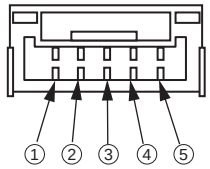


* Analog output voltage output R: approx. 1 kΩ
Current output R: approx. 100 Ω

●FSM3-L□□□□□C/G/□□
(LCD display, PNP output, with setting copy function)



* Analog output voltage output R: approx. 1 kΩ
Current output R: approx. 100 Ω

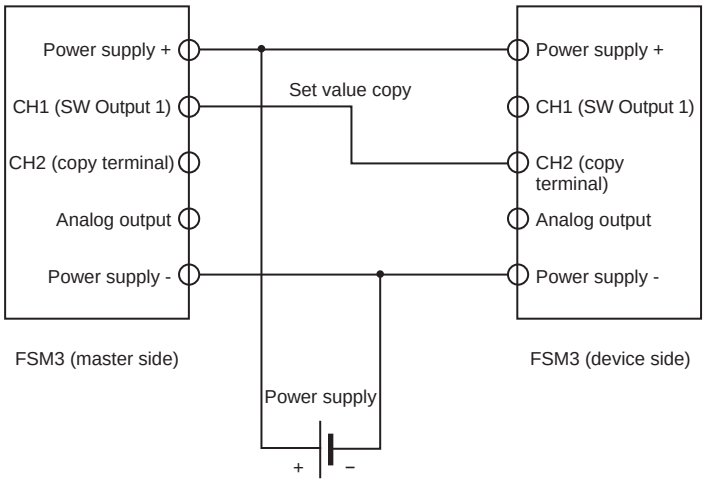


(FSM3 side)

Terminal No.	Option lead wire color	Name
①	Brown	Power supply (+) (voltage output: 12 to 24 V, current output: 24 V)
②	Black	CH1 (switch output 1: max. 50 mA)
③	White	CH2 (copy terminal)
④	Gray	Analog output Voltage output: 1 to 5 V load impedance 50 kΩ or more Current output: 4 to 20 mA load impedance 300 Ω or less
⑤	Blue	Power supply − (GND)

●FSM3-L□□□□□A/C/E/G/□□ (LCD display, with setting copy function)

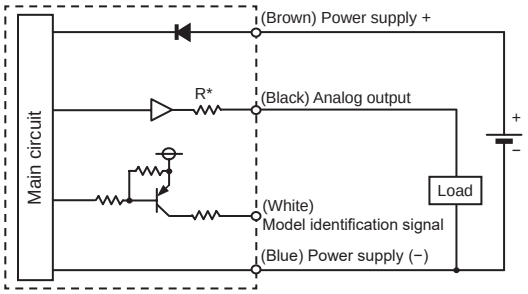
[When using setting copy function]



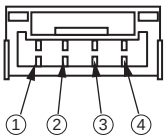
Connect CH1 (SW output 1) on the master side to CH2 (copy terminal) on the device side and power ON the sensor to use the setting copy function (F93). Please be sure to make this connection only when using the setting copy function. If copying is done while load is connected with the CH1, or switching is done while connected with the CH1 and CH2 as described in the load connection example above, there may be unexpected behavior on the equipment side or malfunctioning with the equipment and FSM3. Please be sure to never use it when it is connected to a copy terminal.

Example of internal circuit and load connection

●FSM3-B□□□□□J/K/□□ (bar display)



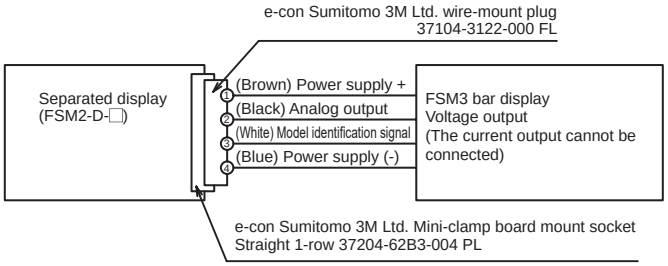
*Analog output voltage output R: approx. 1 kΩ
Analog output current output R: approx. 100 kΩ



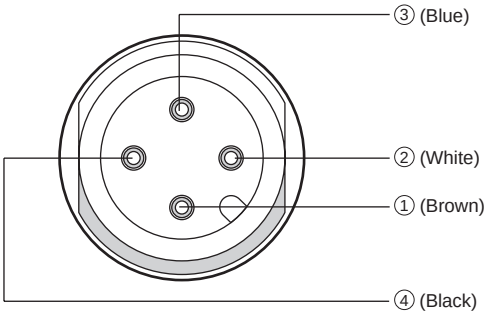
(FSM3 side)

Terminal No.	Option lead wire color	Name
①	Brown	Power supply (+) (voltage output: 12 to 24 V, current output: 24 V)
②	Black	Analog output Voltage output: 1-5 V Load impedance 50 kΩ and over Current output: 4 to 20 mA Load impedance 300 Ω or less
③	White	Model identification signal It will not connect during use with a single unit.
④	Blue	Power supply − (GND)

●Connecting the separated display and FSM3 bar display

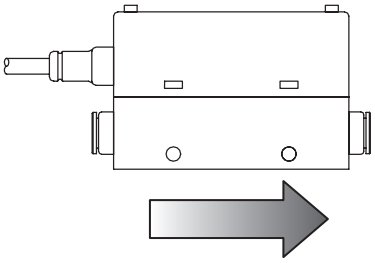
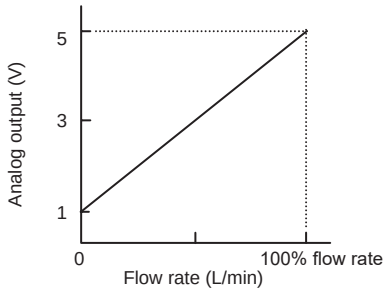
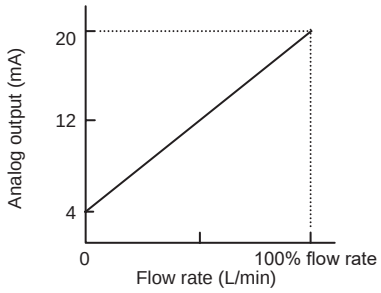
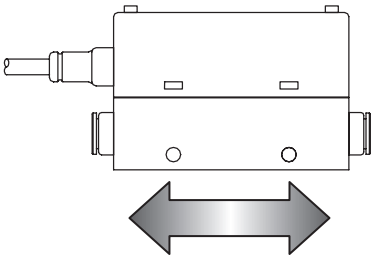
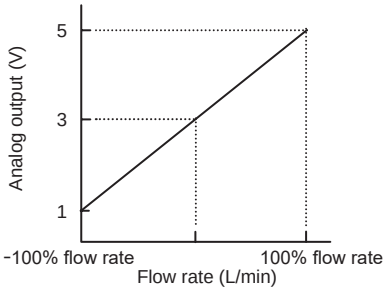
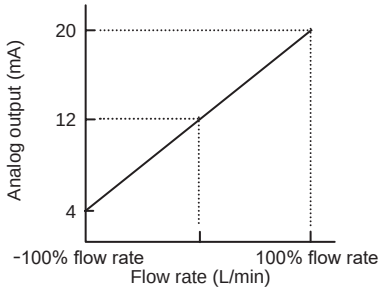


●FSM3-C□□□□□L□□ (IO-Link)



Terminal No.	Lead wire color	Name
①	Brown	Power supply + (18 to 30 V)
②	White	N.C.
③	Blue	Power supply − (GND)
④	Black	C/Q (IO-Link)

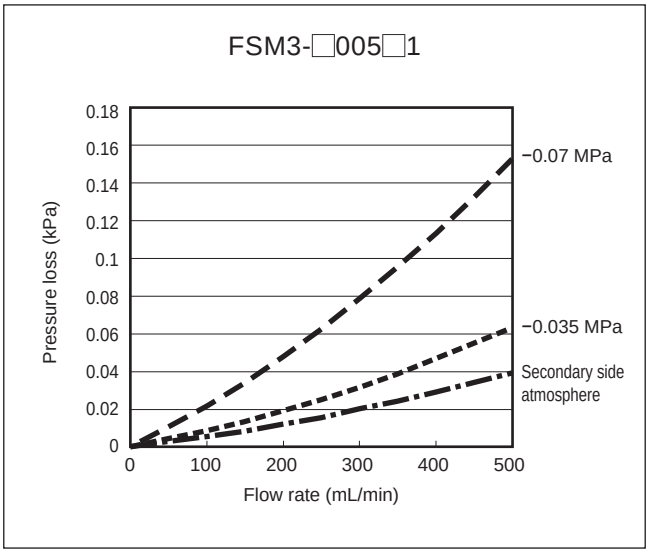
Analog output characteristics

Flow direction	Voltage output	Current output
[Uni-directional] 		
[Bi-directional] 		

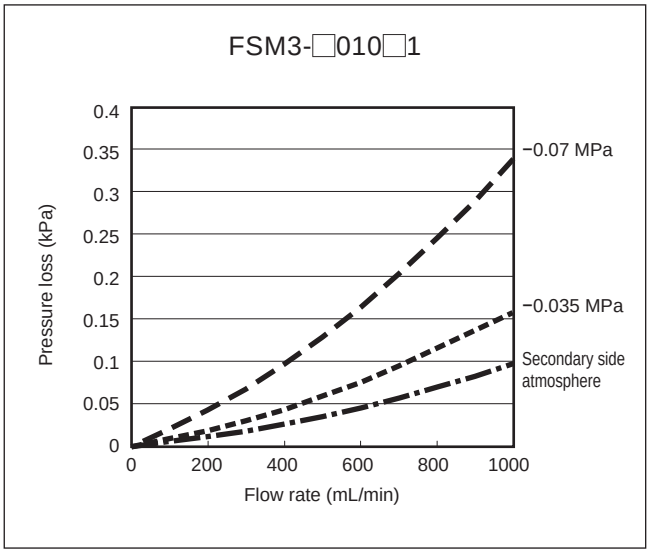
*1: The full scale of the uni-directional type is 0 to 100%, and full scale of the bi-directional type is −100% to 100%. With the display integrated bi-directional type, output can be switched to uni-directional with the button settings. The value after switching is a reference value. Refer to page 60 for details.
*2: Refer to page 2 for details of analog output when carbon dioxide is switched to.
*3: Analog output is available even outside the measurement flow rate range. Although the accuracy is not guaranteed, the lower and upper limits for uni-direction voltages can be output at about 0.6V and 5.4V, respectively. The lower and upper limits for current voltages can be output at about 2.4mA and 21.6mA, respectively. The bi-direction voltages can be output at about 0.8V and 5.2V, respectively, and the lower and upper limits for current voltages can be output at about 3.2mA and 20.8mA, respectively.

Pressure loss characteristics (resin body, air)

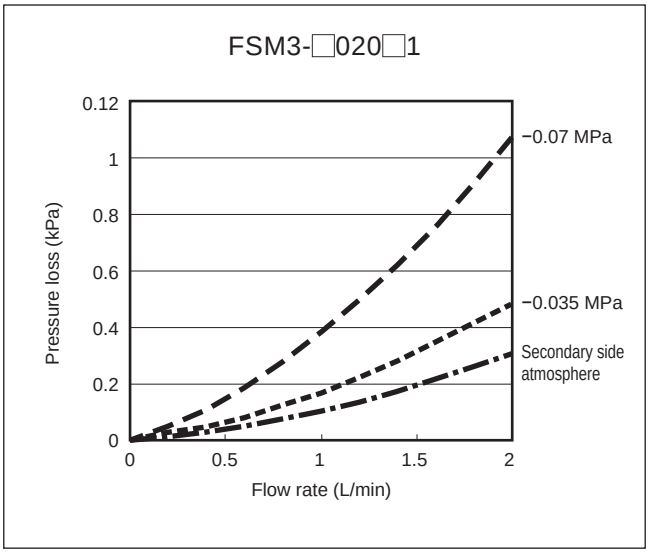
FSM3-□005□1



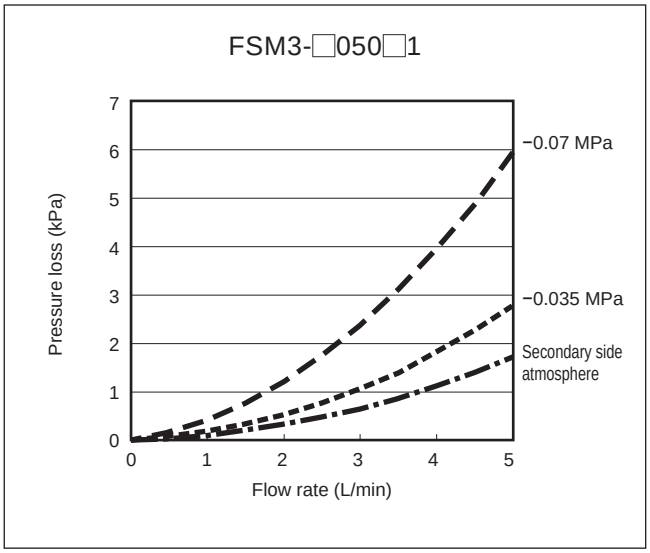
FSM3-□010□1



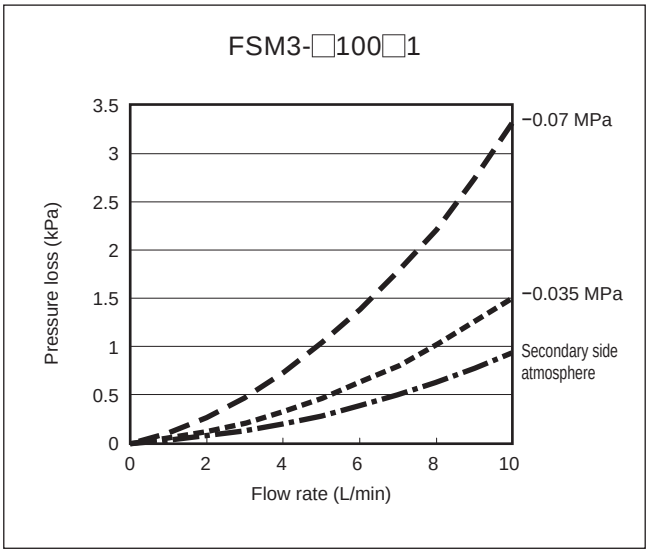
FSM3-□020□1



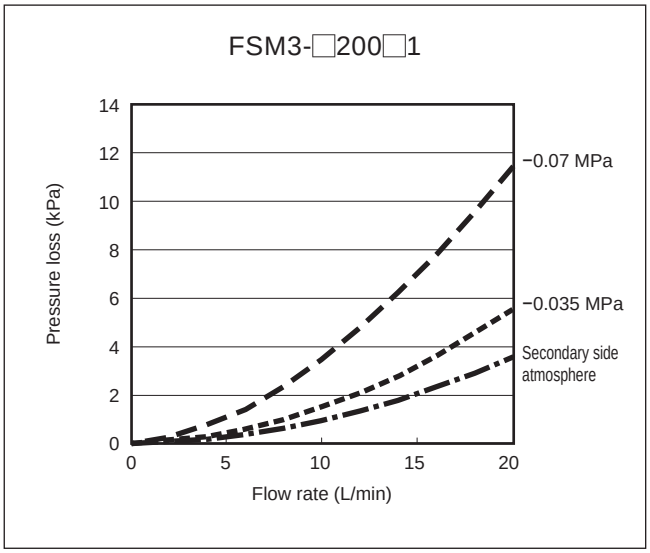
FSM3-□050□1



FSM3-□100□1



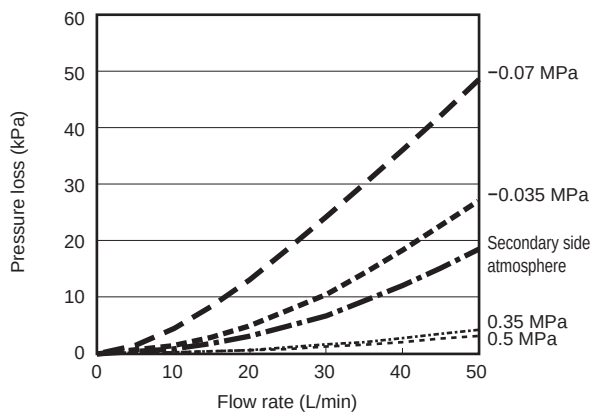
FSM3-□200□1



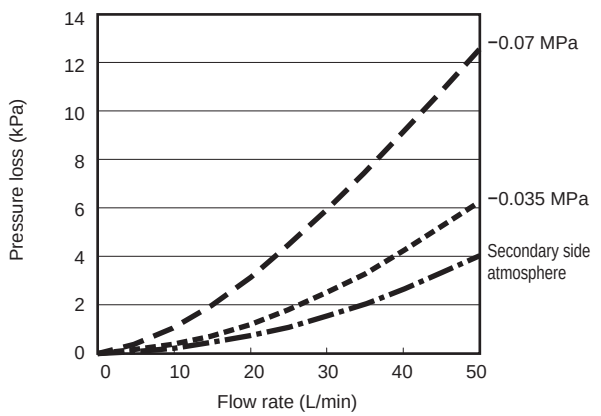
The graphs show data for air. For gases other than air, multiply by the following specific gravity as a guideline. Argon: 1.38, carbon dioxide: 1.53, argon 80% + carbon dioxide 20%: 1.41

Pressure loss characteristics (resin body, air)

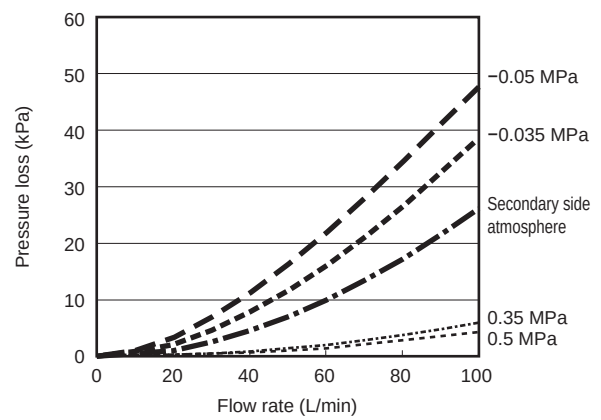
FSM3-□500□1 (small body)



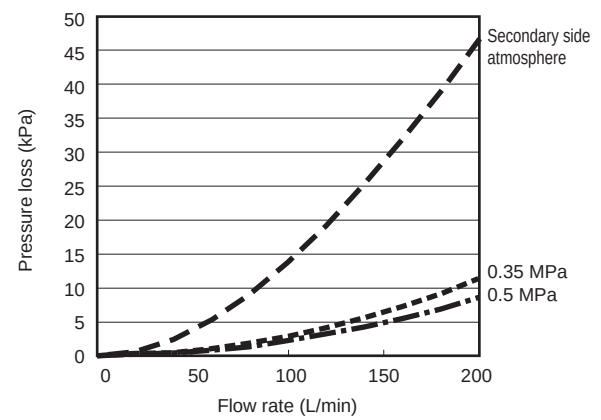
FSM3-□500□1 (medium body)



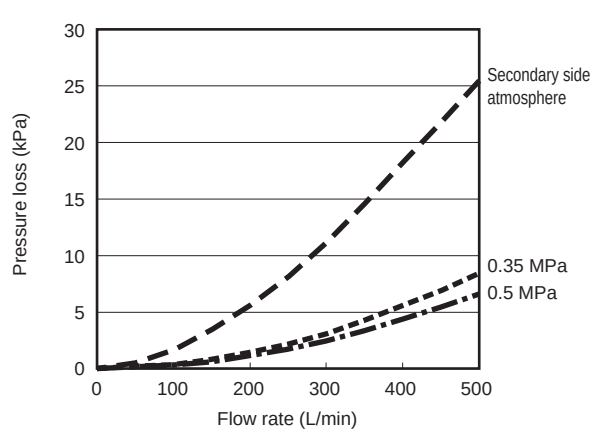
FSM3-□101□1



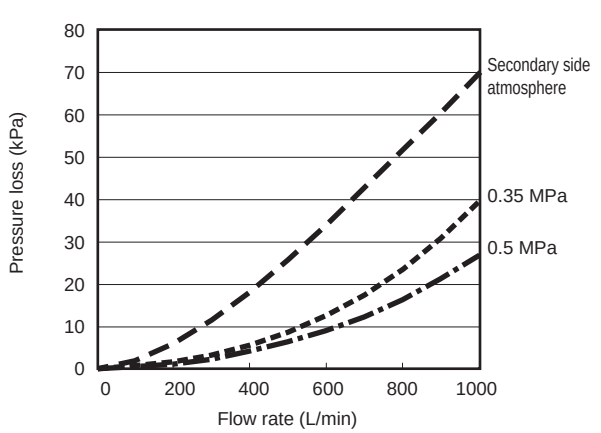
FSM3-□201□1



FSM3-□501□1



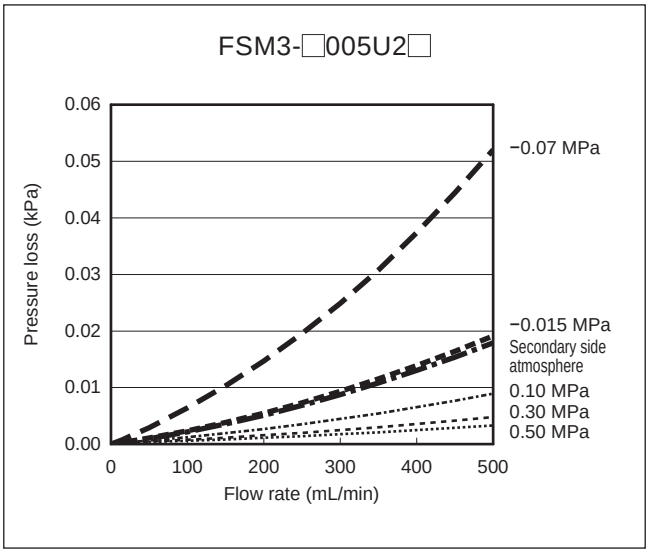
FSM3-□102□1



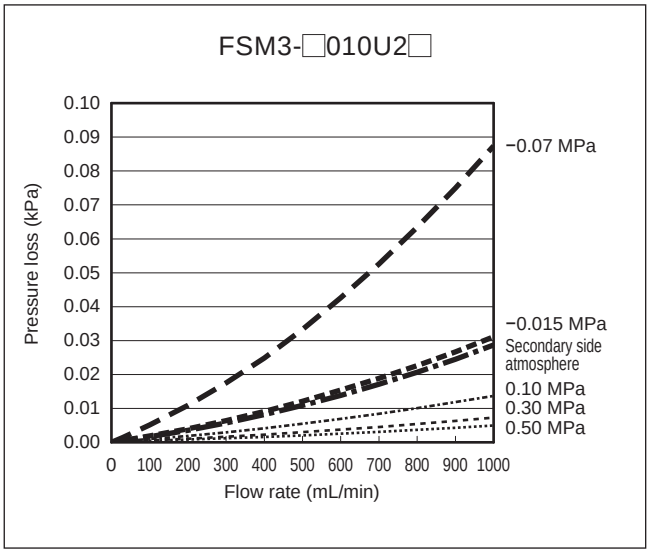
The graphs show data for air. For gases other than air, multiply by the following specific gravity as a guideline. Argon: 1.38, carbon dioxide: 1.53, argon 80% + carbon dioxide 20%: 1.41 (excluding 501 and 102)

Pressure loss characteristics (stainless steel body, air)

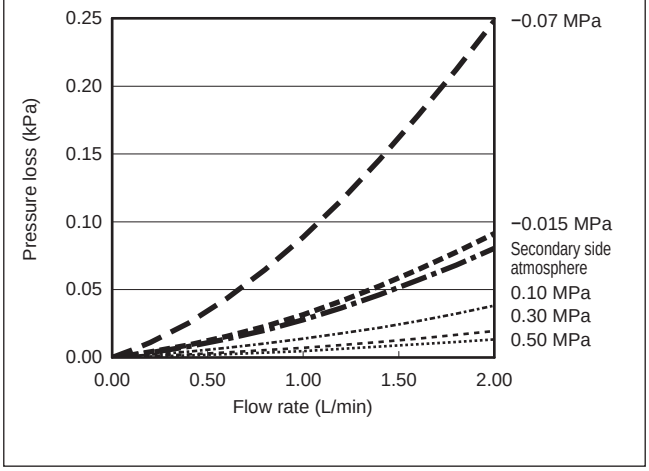
FSM3-□005U2□



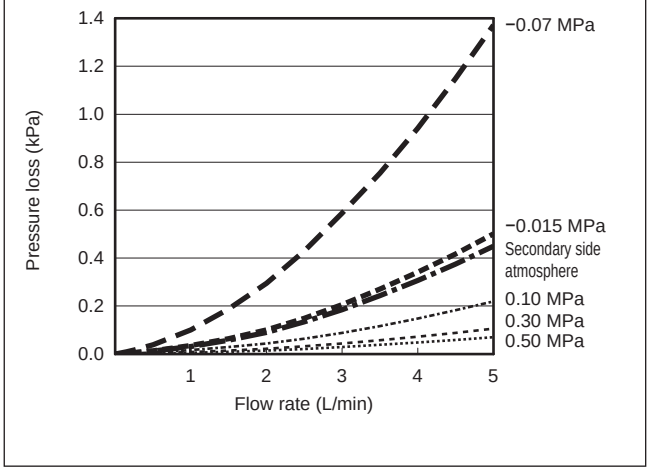
FSM3-□010U2□



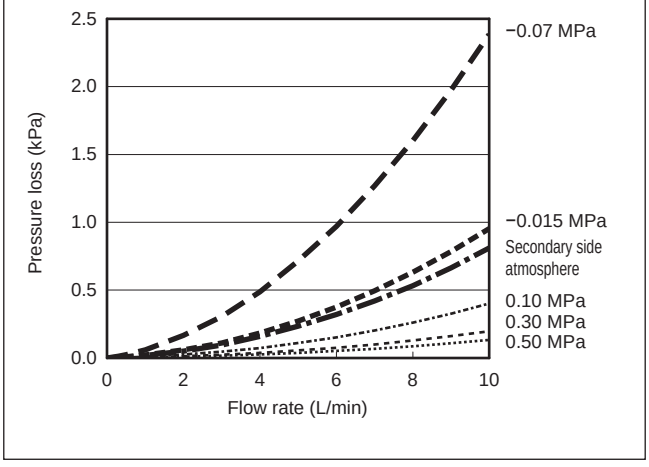
FSM3-□020U2□



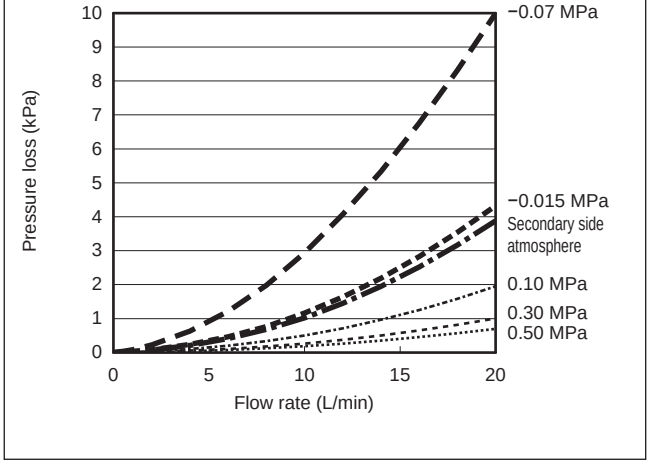
FSM3-□050U2□



FSM3-□100U2□



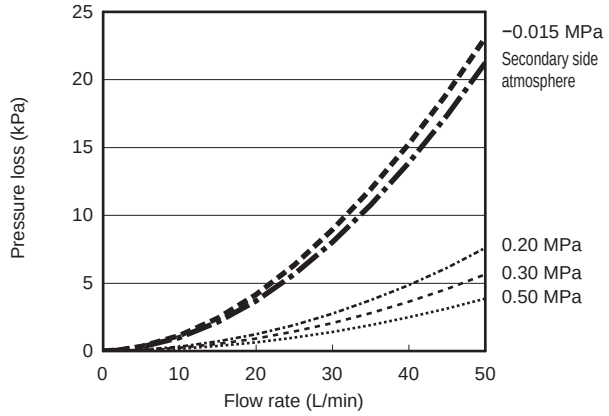
FSM3-□200U2□



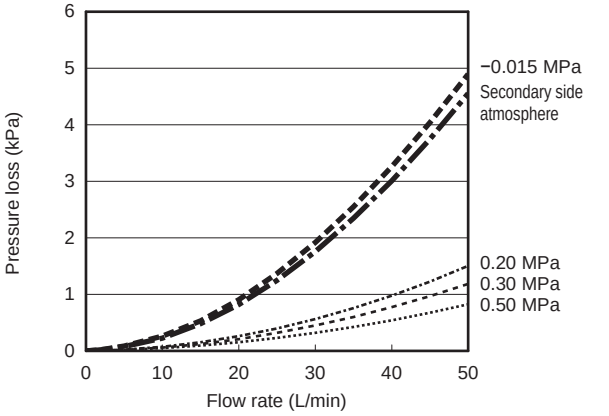
The graphs show data for air. For gases other than air, multiply by the following specific gravity as a guideline. Argon: 1.38, carbon dioxide: 1.53, argon 80% + carbon dioxide 20%: 1.41 (excluding 501 and 102)

Pressure loss characteristics (stainless steel body, air)

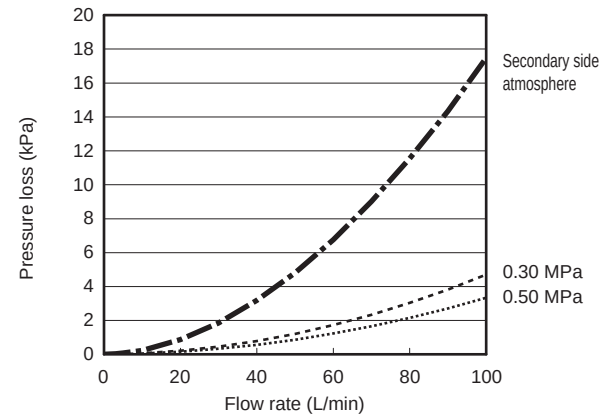
FSM3-□500U2□ (small body)



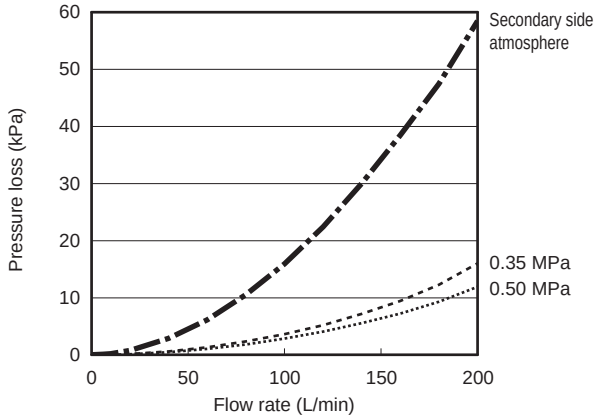
FSM3-□500U2□ (medium body)



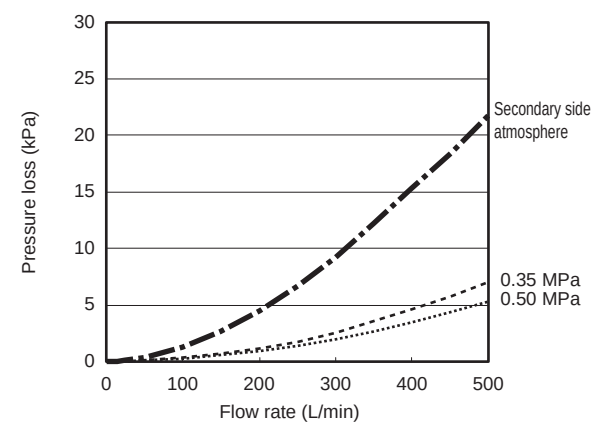
FSM3-□101U2□



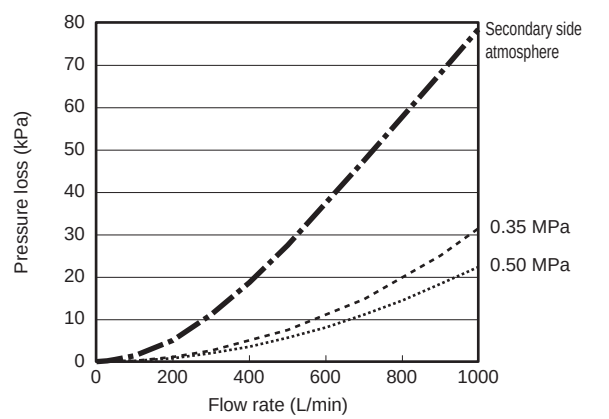
FSM3-□201U2□



FSM3-□501U2□



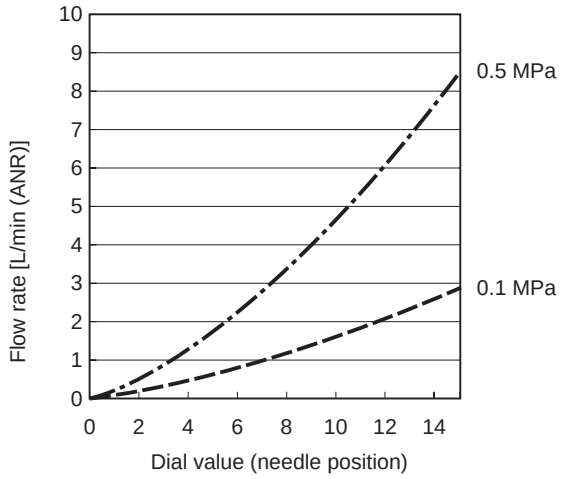
FSM3-□102U2□



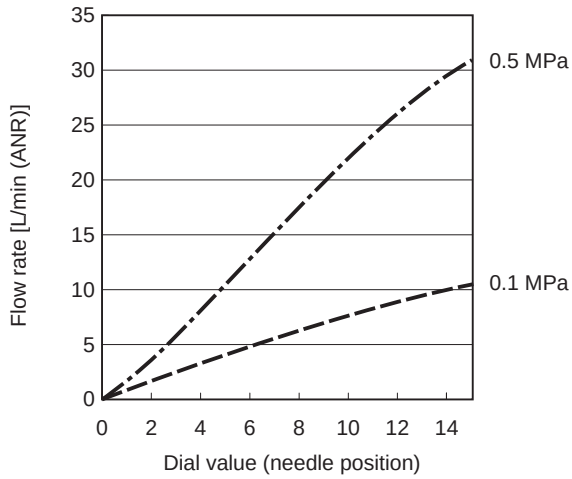
The graphs show data for air. For gases other than air, multiply by the following specific gravity as a guideline. Argon: 1.38, carbon dioxide: 1.53, argon 80% + carbon dioxide 20%: 1.41, oxygen: 1.11 (excluding flow rate ranges (full scale flow rates) 501 and 102)

Needle valve flow characteristics (resin body) (for air, nitrogen gas)

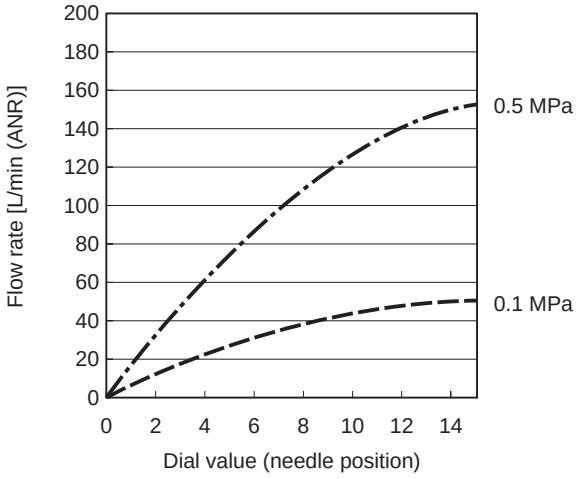
● FSM3-L005/010/020



● FSM3-L050/100



● FSM3-L200/500-H04/H06



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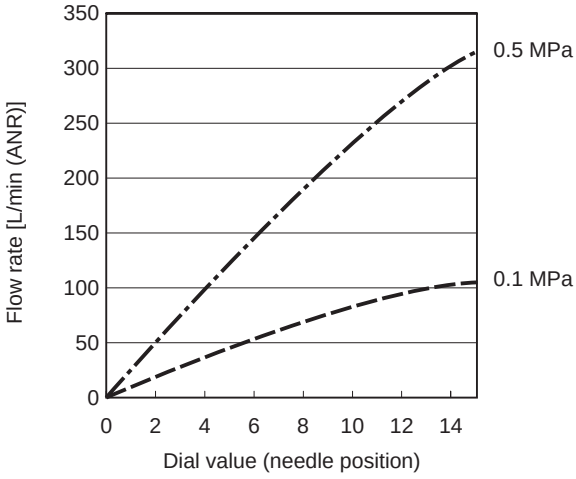
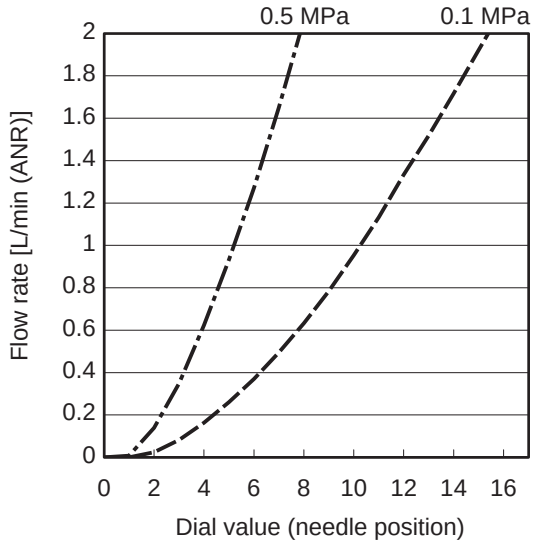
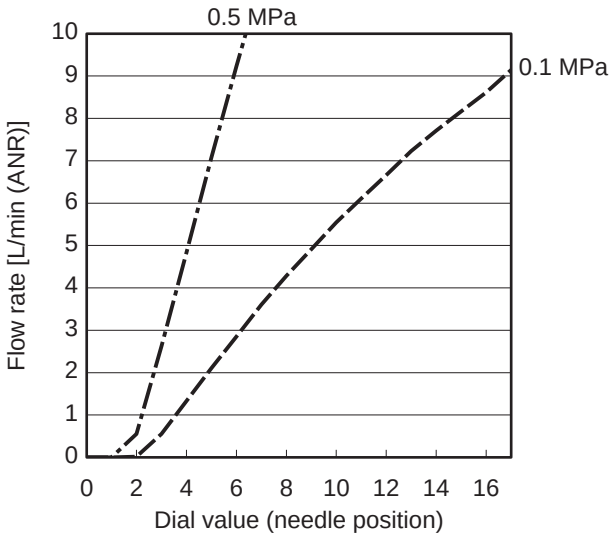


Needle valve flow characteristics (stainless steel body) (for air, nitrogen gas)

● FSM3-L005/010/020U2AA



● FSM3-L050/100U2AA



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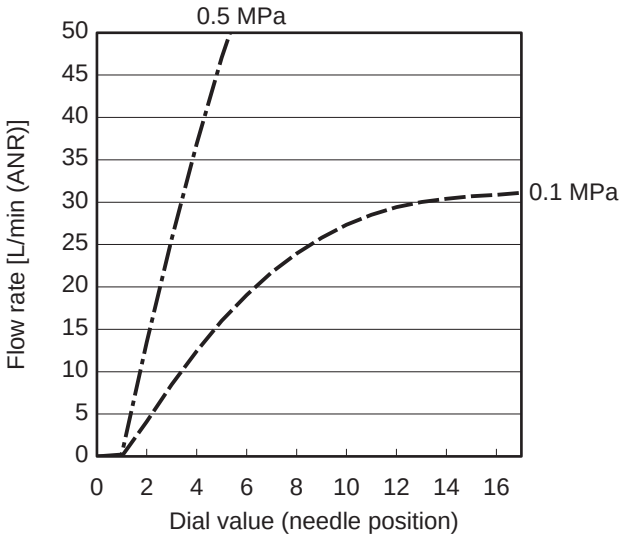

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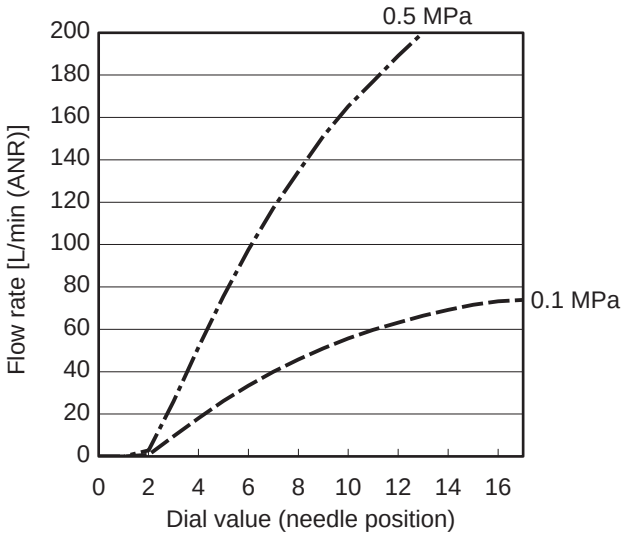
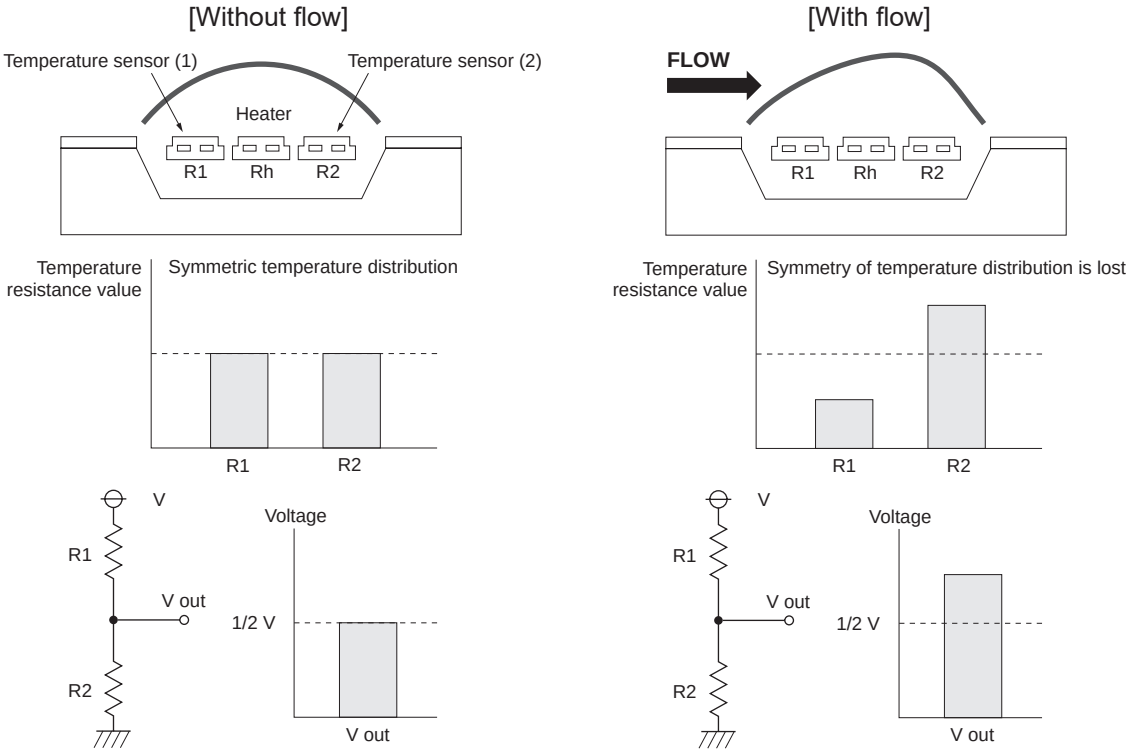


Measurement principle of FSM3 Series

The FSM3 Series incorporates a platinum sensor chip machined with silicon micro-machining. The sensor is thermally insulated from the silicon substrate. The heating capacity is extremely low, enabling high sensitivity with a high-speed response.
At the sensor, two temperature sensors are arranged with a heater in between. Platinum, which has a resistance that changes based on temperature, is used for the temperature sensor. When the heater is turned ON and heating occurs, the temperature distribution is symmetrical to the center of the heater if there is no flow. When flow is received, the symmetrical property of the temperature distribution is lost, temperature upstream from the heater drops, and temperature downstream rises. This temperature difference appears as the difference in temperature sensor resistance, and varies with the flow rate. When the flow is reversed, the temperature difference (difference in resistance) is inverted. By using this method, the bi-directional flow rate can be detected. This method is suitable for detecting a relatively small flow rate.



1 Flow rate sensor selection method

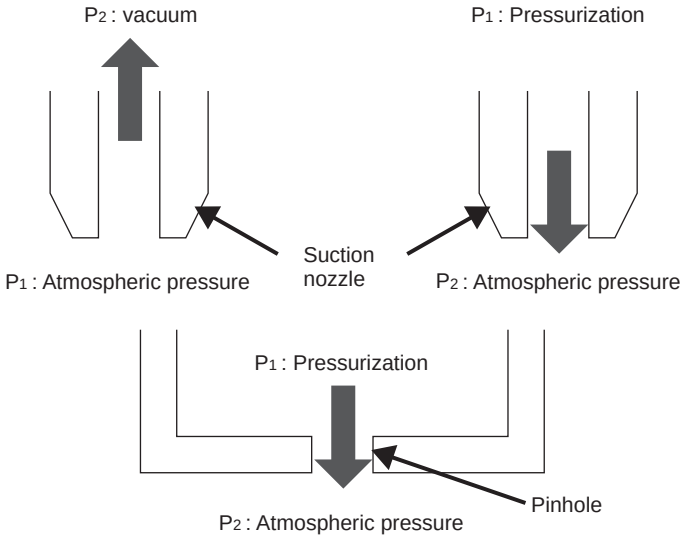
Use as a guide for selection of the flow rate range when using the flow rate sensor for suction/unload confirmation or leakage inspection, etc., with the suction nozzle.

The flow rate can be calculated using the effective cross-sectional area of nozzle (pinhole) and the pressure difference inside and outside of nozzle.

● For $P1 \geq 1.89P_2$ (acoustic velocity)
$Q = 113.2 \times S \times P_1$

● For $P1 < 1.89P_2$ (subsonic velocity)
$Q = 226.4 \times S \times \sqrt{P_2 (P1-P_2)}$

Q : Flow rate L/min
P_1 : Primary side absolute pressure MPa
P_2 : Secondary side absolute pressure MPa
S : Effective cross-sectional area of nozzle (pinhole) mm^2



● Example of calculation

The figure below shows the calculated value of flow rate when the nozzle diameter is ø0.1 to 2 and P2 is varied.

	P_1 (MPa) Absolute pressure	P_1 (MPa) Gauge pressure	P_2 (MPa) Absolute pressure	P_2 (MPa) Gauge pressure	Acoustic velocity/subsonic velocity	Calculated flow rate value (L/min)								
						ø0.1	ø0.2	ø0.3	ø0.4	ø0.5	ø0.7	ø1	ø1.5	ø2
Vacuum	0.1013	0	0.0313	−0.07	Acoustic velocity	0.090	0.360	0.810	1.440	2.250	4.411	9.002	20.254	36.007
	0.1013	0	0.0413	−0.06	Acoustic velocity	0.090	0.360	0.810	1.440	2.250	4.411	9.002	20.254	36.007
	0.1013	0	0.0513	−0.05	Acoustic velocity	0.090	0.360	0.810	1.440	2.250	4.411	9.002	20.254	36.007
	0.1013	0	0.0613	−0.04	Subsonic velocity	0.088	0.352	0.792	1.408	2.200	4.312	8.800	19.801	35.202
	0.1013	0	0.0713	−0.03	Subsonic velocity	0.082	0.329	0.740	1.315	2.055	4.028	8.220	18.494	32.878
	0.1013	0	0.0813	−0.02	Subsonic velocity	0.072	0.287	0.645	1.147	1.792	3.512	7.166	16.125	28.666
	0.1013	0	0.0913	−0.01	Subsonic velocity	0.054	0.215	0.483	0.859	1.343	2.631	5.370	12.083	21.480
Blow (leakage inspection)	0.1113	0.01	0.1013	0	Subsonic velocity	0.057	0.226	0.509	0.905	1.414	2.772	5.657	12.727	22.626
	0.1213	0.02	0.1013	0	Subsonic velocity	0.080	0.320	0.720	1.280	2.000	3.920	8.000	17.999	31.998
	0.1413	0.04	0.1013	0	Subsonic velocity	0.113	0.453	1.018	1.810	2.828	5.543	11.313	25.454	45.252
	0.1613	0.06	0.1013	0	Subsonic velocity	0.139	0.554	1.247	2.217	3.464	6.789	13.856	31.175	55.423
	0.1813	0.08	0.1013	0	Subsonic velocity	0.160	0.640	1.440	2.560	4.000	7.840	15.999	35.998	63.996
	0.2013	0.1	0.1013	0	Acoustic velocity	0.179	0.716	1.610	2.862	4.472	8.765	17.888	40.248	71.552
	0.3013	0.2	0.1013	0	Acoustic velocity	0.268	1.071	2.410	4.284	6.694	13.119	26.774	60.242	107.096
	0.4013	0.3	0.1013	0	Acoustic velocity	0.357	1.426	3.209	5.706	8.915	17.474	35.660	80.236	142.641
	0.5013	0.4	0.1013	0	Acoustic velocity	0.445	1.782	4.009	7.127	11.137	21.828	44.547	100.230	178.186
	0.6013	0.5	0.1013	0	Acoustic velocity	0.534	2.137	4.809	8.549	13.358	26.182	53.433	120.224	213.731

(CAUTION)
● When there is a leakage in the piping, etc., the actual flow rate becomes larger than the calculated value. When selecting the flow rate, consider the amount of leakage in the piping.
● When there is a portion narrower than the suction nozzle diameter in the middle of the piping, the flow rate may be reduced to lower than the calculated value.
In addition, suction confirmation, etc., may become impossible.
● The effective cross-sectional area is just a guideline. When the nozzle is long and thin, the effective cross-sectional area becomes smaller than the opening area.
● The response time is determined by the inner volume of the piping from the flow rate sensor to suction nozzle (pinhole). For high-speed detection, reduce the inner volume of the piping as much as possible by installing a flow rate sensor near the suction nozzle, etc.

Product weight

Resin body

[Unit: g]

Fitting		LCD display		Bar display	IO-Link
Model No.	Description	Without needle valve	With needle valve		
BH1	Push-in (for ø4 mm straight)	60	90	50	50
CH1	Push-in (for ø6 mm straight)	50	80	40	50
DH1	Push-in (for ø8 mm straight)	80	120	70	80
EH1	Push-in (for ø10 mm straight)	80	120	70	80
HH1	Push-in (for ø1/4" straight)	60	90	50	50
JH1	Push-in (for ø3/8" straight)	80	120	70	80
AA1	Rc1/8 Straight	60	90	50	50
BA1	Rc1/4 Straight	60	100	50	60
CA1	Rc1/2 Straight	120	–	110	120
AF1	G1/8 Straight	70	100	60	70
BF1	G1/4 Straight	85	125	75	85
CF1	G1/2 Straight	120	–	110	120
AB1	G1/8 Straight	60	90	50	60
BB1	G1/4 Straight	70	110	60	70
CB1	G1/2 Straight	140	–	130	140
AC1	NPT1/8 Straight	50	80	50	50
BC1	NPT1/4 Straight	60	100	50	60
CC1	NPT1/2 Straight	120	–	110	120
BH2	Push-in (for ø4 mm elbow)	70	100	60	60
CH2	Push-in (for ø6 mm elbow)	60	90	50	60
DH2	Push-in (for ø8 mm elbow)	100	140	90	90
EH2	Push-in (for ø10 mm elbow)	100	140	90	100
HH2	Push-in (for ø1/4" elbow)	70	100	60	60
JH2	Push-in (for ø3/8" elbow)	100	140	90	100
AA2	Rc1/8 Elbow	70	100	60	60
BA2	Rc1/4 Elbow	80	120	70	80
AF2	G1/8 Elbow	80	110	70	80
BF2	G1/4 Elbow	105	145	95	105
AB2	G1/8 Elbow	70	100	60	70
BB2	G1/4 Elbow	90	130	80	90
AC2	NPT1/8 Elbow	70	100	60	60
BC2	NPT1/4 Elbow	80	120	70	80

Stainless steel body

[Unit: g]

Fitting		LCD display		Bar display	IO-Link
Model No.	Description	Without needle valve	With needle valve		
AA1	Rc1/8 Straight	100	165	90	95
BA1	Rc1/4 Straight	115	200	105	110
CA1	Rc1/2 Straight	420	–	410	420
AF1	G1/8 Straight	155	220	145	150
BF1	G1/4 Straight	190	275	180	185
CF1	G1/2 Straight	420	–	410	420
AB1	G1/8 Straight	100	165	90	95
BB1	G1/4 Straight	110	195	100	105
CB1	G1/2 Straight	440	–	430	440
AC1	NPT 1/8 Straight	100	165	90	95
BC1	NPT 1/4 Straight	115	200	105	110
CC1	NPT 1/2 Straight	420	–	410	420
AD1	1/4" double barbed fitting (500 mL/min to 50 L/min)	155	220	145	150
BD1	1/4" double barbed fitting (50 L/min to 200 L/min)	190	275	180	190
AE1	1/4" JXR male fitting (500 mL/min to 50 L/min)	155	220	145	150
BE1	1/4" JXR male fitting (50 L/min to 200 L/min)	190	275	180	190