

Fujikin® Flow Control System



FINE series PURE®

FCS® Pressure Series

Fujikin® Incorporated



Total Solution for Gas Supply System

Fujikin®'s **FCS**® (Flow Control System) series leads the way in flow control technology.

4th Manufacturers Awards,
Part Category Prize: Incentive Award

Developed to enhance stability and repeatability during etch and deposition, the most critical steps in semiconductor wafer manufacturing, the FCS® differs dramatically from conventional mass flow controllers (MFC) in its very theory of operation.

By developing the FCS® around non-conventional methods, highly accurate flow control is achieved – accuracy that is impossible to achieve with traditional pressure-based MFC's.

The FCS® overcomes unstable process variations such as pressure fluctuations (hunting) and crosstalk in gas supply systems and provides an unlimited amount of flow control stability.

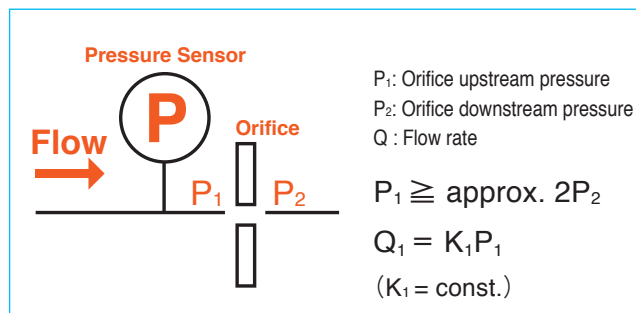
In addition, the high accuracy of the FCS® matches the state-of-the-art in semiconductor manufacturing and is therefore one of the FCS®'s most appealing features.

The FCS® promises the highest level of performance.



Operating Principle

The FCS® - unlike conventional mass flow controllers – controls flow by utilizing sonic or choked flow conditions.

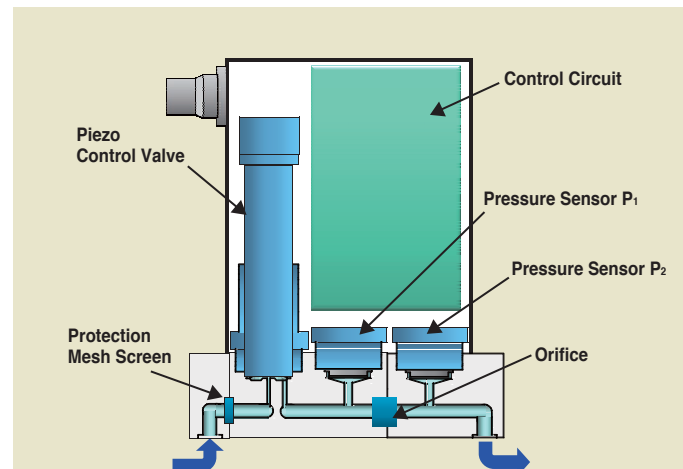


How does a pressure-based flow control system control flow?

If the absolute pressure upstream of an orifice (P_1) is at least double that of the pressure immediately downstream of the orifice (P_2), the flow rate (Q) of the gas through the orifice will equal the speed of sound (sonic flow).

Since the gas velocity through the orifice always remains at sonic velocity, the flow rate is proportional to P_1 only. This principle, known as critical expansion, is the principle under which the FCS® provides ultra-high flow control accuracy despite its amazingly simple design.

Internal Structure (for Part Number FCSP7000W)



Simple Structure

The FCS® features a simple internal structure with no dead space.

The FCS® has the following parts that come into contact with gas: a piezo control valve that allows quick response, high precision pressure sensors, and a special orifice. In addition, a control circuit with a high performance CPU is mounted for digital control of those parts.

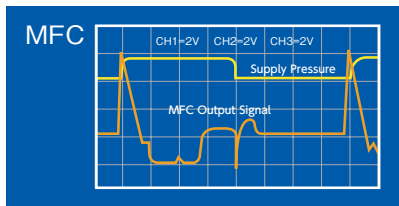
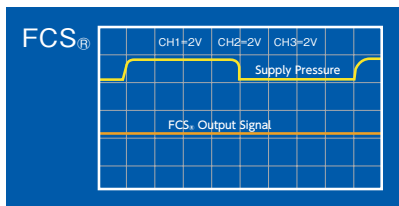
Features

1. Fluctuations in upstream pressure have no effect on control flow rate.
2. Quick response time of 0.5 sec. or less.
3. Can be mounted in any attitude or position.
4. Incorporates flow rate diagnosis function.
5. Not gas specific.
6. Complies with RoHS (Restriction of Hazardous Substances regulations).

(Because **Fujikin**® strives to develop and manufacture environmentally-friendly products, the FCS® complies with the RoHS.)

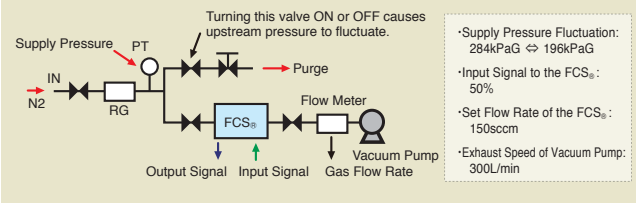
Superior Anti-Pressure Fluctuation Characteristics

Variations in upstream pressure can cause output of a Mass Flow Controller to fluctuate greatly. However, **Fujikin**’s FCS® is immune to such fluctuations and flow spikes.

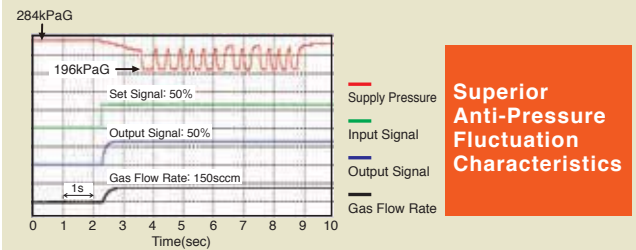


The advanced design eliminates the need for an upstream regulator (required with an MFC with a pressure of 0.8MPaG or less) and reduces the cost – as well as the size – of the gas system.

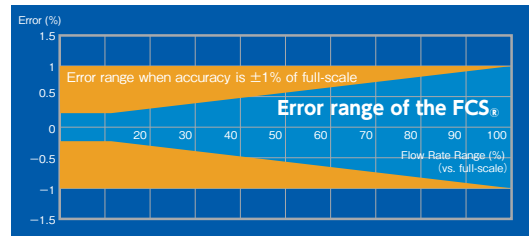
Test Flow Chart



FCS® Signal Monitor



Superior Accuracy



Accuracy: ±1% S.P. (set point)
Controls flow rate to within ±1% S.P. (set point) when the flow rate is 10% or more of the F.S. (full scale).

Accuracy: ±0.1% F.S. (full scale)
Controls flow rate to within ±0.1% F.S. (full scale) when the flow rate is 10% or less of the F.S. (full scale).

Pressure regulator not required on the gas supply line.

Gas line costs can be reduced!

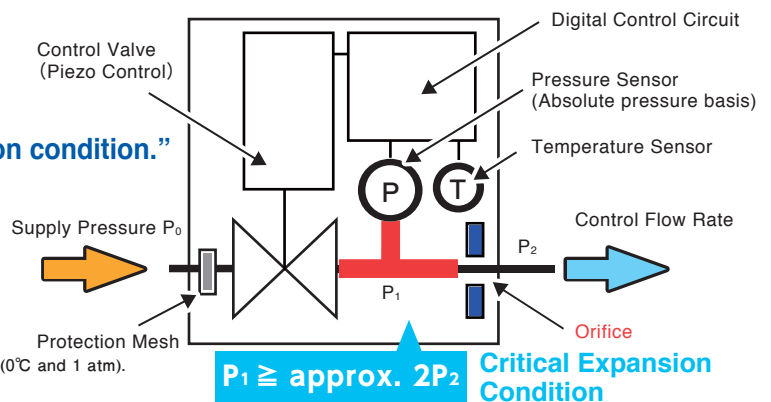
Structure

The FCS® is a pressure-based flow controller incorporating the principle of “Critical expansion condition.”

For example, when orifice downstream pressure P_2 is 10 torr or less

- $P_1 = 20\text{torr} \rightarrow$ Flow rate: 10sccm
- $P_1 = 200\text{torr} \rightarrow$ Flow rate: 100sccm
- $P_1 = 2000\text{torr} \rightarrow$ Flow rate: 1000sccm

* sccm: volumetric flow (cc/min) converted in terms of standard conditions (0°C and 1 atm).



FCSP7000

High Performance Standard Model

RoHS

Operating Principle

Critical Expansion Condition

$$[P_1 \text{ (Supply Pressure)} \geq \text{approx. } 2P_2 \text{ (Output Pressure)}, \\ Q=K_1P_1 \text{ (} K_1=\text{const.)}]$$

Quick Response

Within 0.5 seconds of flow rate response time
(Rising Response Time)

No Regulator Required

Since the flow rate is controlled by pressure, no regulator is required.

High Performance and High Reliability

Flow rate accuracy: $\pm 1\%$ S.P. (10 to 100%)

Seal Materials

Metal seal

I/O

Analog, DeviceNet™, RS-485



Specifications

Model	FCSP7000 / FCSP7000D		
Type	Standard Type	Low Pressure (AS) Type	Low Pressure (B) Type
Supply Pressure Range	250 to 898.7 kPaG	20 to 898.7 kPaG	50 to 898.7 kPaG
Flow Rate Accuracy	$\leq \pm 1\%$ S.P. (Setting Signal: 10 to 100%) $\leq \pm 0.1\%$ F.S. (Setting Signal: 1 to 10%)	$\leq \pm 1\%$ S.P. (Setting Signal: 30 to 100%) $\leq \pm 0.3\%$ F.S. (Setting Signal: 1 to 30%)	$\leq \pm 1\%$ S.P. (Setting Signal: 20 to 100%) $\leq \pm 0.2\%$ F.S. (Setting Signal: 1 to 20%)
Flow Rate Control Range (N ₂ gas conversion)	10SCCM – 10SLM	27SCCM – 1SLM	39SCCM – 2SLM
Response Time	Within 0.5 seconds reach to $\pm 2\%$ of setting value (starting characteristic)		
Downstream Pressure	$\leq P_1$		
Maximum Pressure	1MPaG (However, the pressure for guaranteed accuracy is 0.89 MPaG or less.)		
External Leakage	1×10^{-10} Pa·m ³ /sec or less		
Seat Leakage	2×10 ⁻⁵ Pa·m ³ /sec or less (at supply pressure of F2400 (F850B) or less) 5×10 ⁻⁴ Pa·m ³ /sec or less (at supply pressure of F3L (F1300B) or more)		
Temperature for Guaranteed Accuracy	0 to 50°C (Guaranteed Accuracy: 15 to 35°C *HT50: 15 to 50°C)		
Supply Voltage Power Consumption	Analog I/O specifications +15VDC: 120mA, -15VDC: 120mA	DeviceNet™ communication specifications +11 to +25VDC: 4.5VA(4.5W)	
I/O Signals	0 to 5VDC	DeviceNet™ (as per SEMI E54 and ODVA SEMI SIG Profile-compliant), RS-485	
Mounting Attitude	Can be installed in any attitude		
Material of Wetted Area	SUS316L Stainless Steel, Super Ferrite Alloy (Cr ₂ O ₃ treated), Ni-Co alloy		
Connections / Dimensions	1.125 Wseal (92mm), 1.5 Wseal (79.8mm), 1/4"UJR(124mm), 1.125 C-Seal (92mm)		

The latest catalog can be downloaded from <http://www.fujikin.co.jp/go/c75101e>.

FCSP7000W

Wide Range Model

RoHS

Operating Principle

This model controls the differential pressure within and partly outside the Critical Expansion Condition range.

[P_1 (Supply Pressure) \geq approx. $2P_2$ (Output Pressure),
 $Q=K_1P_1$ ($K_1=\text{const.}$)] range

Quick Response

Within 0.5 seconds of flow rate response time
 (Rising Response Time)

No Regulator Required

Since the flow rate is controlled by pressure, no regulator is required.

High Performance and High Reliability

Flow rate accuracy: $\pm 1\%$ S.P. (10 to 100%)

Seal Materials

Metal seal

I/O

Analog, DeviceNet™, RS-485



Specifications

Model	FCSP7000W / FCSP7000DW		
Type	Standard Type	Low Pressure (AS) Type	Low Pressure (B) Type
Supply Pressure Range	250 to 898.7 kPaG	20 to 898.7 kPaG	50 to 898.7 kPaG
Flow Rate Accuracy	$\leq \pm 1\%$ S.P. (Setting Signal: 10 to 100%) $\leq \pm 0.1\%$ F.S. (Setting Signal: 1 to 10% [For controlling differential pressure: 4 to 10%])	$\leq \pm 1\%$ S.P. (Setting Signal: 30 to 100%) $\leq \pm 0.3\%$ F.S. (Setting Signal: 1 to 30% [For controlling differential pressure: 10 to 30%])	$\leq \pm 1\%$ S.P. (Setting Signal: 20 to 100%) $\leq \pm 0.2\%$ F.S. (Setting Signal: 1 to 20% [For controlling differential pressure: 8 to 20%])
Flow Rate Control Range (N ₂ gas conversion)	20SCCM to 10SLM	27SCCM to 1SLM	39SCCM to 2SLM
Response Time	Within 0.5 seconds reach to $\pm 2\%$ of setting value (starting characteristic)		
Downstream Pressure	$\leq P_1$		
Maximum Pressure	1MPaG (However, the pressure for guaranteed accuracy is 0.89 MPaG or less.)		
External Leakage	1×10^{-10} Pa·m ³ /sec or less		
Seat Leakage	2 $\times 10^{-5}$ Pa·m ³ /sec or less (at supply pressure of F2400(F850B) or less) 5 $\times 10^{-4}$ Pa·m ³ /sec or less (at supply pressure of F3L(F1300B) or more)		
Temperature for Guaranteed Accuracy	0 to 50°C (Guaranteed Accuracy: 15 to 35°C *HT50: 15 to 50°C)		
Supply Voltage Power Consumption	Analog I/O specifications +15VDC: 120mA, -15VDC: 120mA	DeviceNet™ communication specifications +11 to +25VDC: 4.5VA(4.5W)	
I/O Signals	0 to 5VDC	DeviceNet™ (as per SEMI E54 and ODVA SEMI SIG Profile-compliant), RS-485	
Mounting Attitude	Can be installed in any attitude		
Material of Wetted Area	SUS316L Stainless Steel, Super Ferrite Alloy (Cr ₂ O ₃ treated), Ni-Co alloy		
Connections / Dimensions	1.125 Wseal (92mm), 1.5 Wseal (79.8mm), 1/4"UJR(124mm), 1.125 C-Seal (92mm)		

The latest catalog can be downloaded from <http://www.fujikin.co.jp/go/c75101e>.

FCSP8000

Dynamic Range Model

Incorporating two orifices
(one for large flow rate and one for small flow rate), this
single FCS® can cover two flow rate ranges.

RoHS

Operating Principle

Critical Expansion Condition

$[P_1 \text{ (Supply Pressure)} \geq \text{approx. } 2P_2 \text{ (Output Pressure)},$
 $Q=K_1P_1 \text{ (} K_1=\text{const.)}]$

Quick Response

Within 0.5 seconds of flow rate response time
(Rising Response Time)

No Regulator Required

Since the flow rate is controlled by pressure, no regulator
is required.

High Performance and High Reliability

Flow rate accuracy: $\pm 1\%$ S.P. (10 to 100%)

Seal Materials

Metal seal

I/O

DeviceNet™



Specifications

Model	FCSP8000 / FCSP8000D		
Type	Standard Type	Low Pressure (AS) Type	Low Pressure (B) Type
Supply Pressure Range	250 to 898.7 kPaG	20 to 898.7 kPaG	50 to 898.7 kPaG
Flow Rate Accuracy	$\leq \pm 1\%$ S.P. (Setting Signal: 10 to 100%) $\leq \pm 0.1\%$ F.S. (Setting Signal: 1 to 10%)	$\leq \pm 1\%$ S.P. (Setting Signal: 30 to 100%) $\leq \pm 0.3\%$ F.S. (Setting Signal: 1 to 30%)	$\leq \pm 1\%$ S.P. (Setting Signal: 20 to 100%) $\leq \pm 0.2\%$ F.S. (Setting Signal: 1 to 20%)
Flow Rate Control Range (N ₂ gas conversion)	10SCCM – 2.4SLM		
Response Time	Within 0.5 seconds reach to $\pm 2\%$ of setting value (starting characteristic)		
Downstream Pressure	$\leq P_1$		
Maximum Pressure	1MPaG (However, the pressure for guaranteed accuracy is 0.89 MPaG or less.)		
External Leakage	1×10^{-10} Pa·m ³ /sec or less		
Seat Leakage	2×10^{-5} Pa·m ³ /sec or less (at supply pressure of 0.89 MPaG)		
Temperature for Guaranteed Accuracy	0 to 50°C (Guaranteed Accuracy: 15 to 35°C *HT50: 15 to 50°C)		
Supply Voltage Power Consumption	+11 to +25VDC: 4.5VA (4.5W)		
I/O Signals	DeviceNet™ (as per SEMI E54 and ODVA SEMI SIG Profile-compliant)		
Mounting Attitude	Can be installed in any attitude		
Material of Wetted Area	SUS316L Stainless Steel, Super Ferrite Alloy (Cr ₂ O ₃ treated), Ni-Co alloy		
Connections / Dimensions	1.125Wseal (92mm), 1.125C-Seal (92mm)		

The latest catalog can be downloaded from <http://www.fujikin.co.jp/go/c75101e>.

Auto Pressure Controller

UPC Series

The Ultimate Pressure Controller

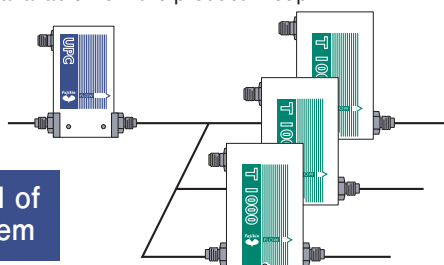
RoHS

Operating Principle

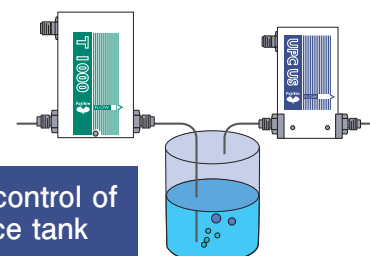
The UPC Series controllers keep the pressure constant using a built-in pressure sensor.

Application

- ▶ Any pressure can be set using an electrical signal.
- ▶ Connecting a UPC Series controller to the upstream side of a mass flow controller makes extremely stable flow control possible.
- ▶ When two or more mass flow controllers are connected in one line and a rapid change in gas flow rate occurs on one of them, the other mass flow controllers may sometimes be affected. This can be prevented by using a UPC series controller (downstream type).
- ▶ The UPCUS (upstream type of pressure controller) keeps constant the internal pressure of the liquid source tank of an MOCVD system, for example, to improve the vaporization stability in amount of a liquid source.
- ▶ Can be used as a controller for cooling wafer rear surfaces.
- ▶ High temperature type (for max. 150°C and max. 250°C) and with a flow monitor type are also available from the product lineup.



Pressure control of gas supply system



Internal pressure control of MO material source tank

Part number designation

UPC Analog I/O Downstream pressure controller - **4J2C** Face-to-face dimension: 124mm Piping height: 12.7mm - **C150** Full scale pressure range: 150kPa abs. **L** Control valve Cv value: 0.0055

Specifications

Model	UPC (Downstream pressure controller)	UPCUS (Upstream pressure controller)
Pressure Range	F.S.13.3kPa abs. (100torr)	F.S. 150/300/500kPa abs.
Control Pressure Range	1 to 100%	1 to 100% ※1
Control Valve Cv Value	—	L Type: 0.0055 / M Type: 0.011 / H Type: 0.03
Pressure Adjusting Accuracy (After auto zeroing)	1 to 40%: ±0.2%F.S. 40 to 100%: ±0.5%S.P.	F.S.150kPa abs. [1 to 40%: ±0.2%F.S., 40 to 100%: ±0.5%S.P.] F.S.300/500kPa abs. [1 to 20%: ±0.1%F.S., 20 to 100%: ±0.5%S.P.]
Supply Pressure Range	0 to 200kPaG	to 897.3kPaG
Maximum Pressure	200kPaG	1MPaG
External Leakage	1.0×10 ⁻¹⁰ Pa·m ³ /sec.	
Permissible Operating Temperature Range	0 to 50°C (Guaranteed Accuracy: 15 to 35°C) ※2	
Supply Voltage	Analog: ±15VDC (Power Consumption +15V 120mA, -15V 120mA) DeviceNet™: +11 to +25VDC, 4.0W	
Pressure Setting/Output Signal	0-10VDC/0-10VDC	0-5VDC/0-5VDC
Material of Wetted Area	SUS316L, Ni-Co Alloy	SUS316L, Ni-Co Alloy, FS9
Connections / Dimensions	1.5 Wseal (79.8mm), 1/4"UJR(124mm)	1.5 Wseal (79.8mm), 1/4"UJR(106mm, 124mm), 1.125 Wseal (92mm)

Note 1) Pressure control range of the UPCUS will change based on the flow conditions. For details, please contact us.

Note 2) The accuracy guaranteed temperature range of 15 to 50°C can be supported by the HT50 type as option.

The latest catalog can be downloaded from <http://www.fujikin.co.jp/go/c75101e>.

Part No. Designation

FCSP7000

FCSP 7002 D W - HT50 - 4WS3 - F10 A - A1 - BK

FLOW CONTROL SYSTEM	① Series P: PRESSURE CONTROLLER ② 7010 F10-F2400 10 SCCM-2.4SLM F3L-F10L 3 SLM-10 SLM	③ Communication None: Analog communication D : DeviceNet™ communication RS : RS-485 communication	④ Control Range None: Standard W : Wide range	⑤ Guaranteed Accuracy None: 15 to 35°C HT50: 15 to 50°C	⑥ Fitting type, face-to-face dimension or seal pitch 4 J 1: 1/4UR, face-to-face dimension: 106 mm, piping height: 25 mm 4 J 2: 1/4UR, face-to-face dimension: 124 mm, piping height: 25 mm 4 P 1: 1/4UPG, face-to-face dimension: 95 mm, piping height: 25 mm 4 P 2: 1/4UPG, face-to-face dimension: 115 mm, piping height: 25 mm 4WS1: 1.5Wseal, seal pitch: 79.8 mm 4WS3: 1.5Wseal, seal pitch: 52 mm 4WS4: 1.5Wseal, seal pitch: 79.8 mm 4CC2: 1.125C-Seal, seal pitch: 92 mm 4CW2: 1.125Wseal, seal pitch: 92 mm Note: Some fitting shapes may not support the DeviceNet™	⑦ Full scale F10: 10SCCM F1L: 1SLM (For details, see Table 1.)	⑧ Pressure condition (for minimum supply pressure) None: Standard Type (250 kPaG) A: Low Pressure (AS) Type (20 kPaG) B: Low Pressure (B) Type (50 kPaG)	⑨ Functions and option A0: Not equipped with flow rate self-diagnosis function A1: Performs flow rate self-diagnosis independently. A2: Performs flow rate self-diagnosis after auto zeroing.	⑩ Surface treatment None: UP treated B K: BK treated P S: PS treated
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Table 1 Full-scale flow rate range table

(N2 gas and unit: SCCM, SLM)

Standard Type			Low Pressure (AS) Type		Low Pressure (B) Type	
F10	F160	F1L	F27A	F300A	F39B	F375B
F20	F200	F1300	F37A	F500A	F50B	F850B
F30	F210	F1600	F50A	F680A	F64B	F1LB
F40	F260	F2L	F65A	F1LA	F83B	
F43	F300	F2400	F100A	F2300A	F100B	
F50	F400	F3L	F115A		F122B	
F65	F450	F5L	F133A		F145B	
F80	F500	F7L	F160A		F180B	
F100	F600	F10L	F200A		F200B	
F110	F850		F285A		F250B	
F130						

FCSP8000

FCSP 8102 D-4CW2-F1L A F100 A

FLOW CONTROL SYSTEM	① Series P: PRESSURE CONTROLLER	③ Communication D: DeviceNet™ communication	⑤ Full scale pressure range (for large flow rate side) F10: 10SCCM F1L: 1SLM(For details, see Tables 2-1 to 2-3.)	⑥ Supply pressure None: Standard Type A: AS Type B: B Type
	② 8102 F10-F2400 10SCCM-2.4SLM	④ Fitting type, face-to-face dimension or seal pitch 4CC2: 1.125C-Seal, seal pitch: 92 mm 4CW2: 1.125Wseal, seal pitch: 92 mm	⑦ Full scale pressure range (for small flow rate side) F10: 10SCCM F1L: 1SLM(For details, see Tables 2-1 to 2-3.)	⑧ Supply pressure None: Standard Type A: AS Type B: B Type

Table 2-1 Flow rate range table (Maximum outlet pressure: 50torr)

No.	Flow rate range type	Flow rate range (N2 Gas) (SCCM)
1	F300, F20	300 - 1
2	F1L, F50	1000 - 3
3	F2L, F100	2000 - 6
4	F50B, F6B	50 - 1
5	F200B, F28B	200 - 4
6	F500B, F64B	500 - 10
7	F1LB, F122B	1000 - 20

Table 2-2 Flow rate range table (Maximum outlet pressure: 100torr)

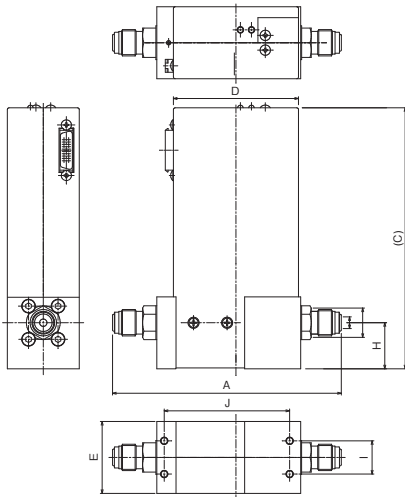
No.	Flow rate range type	Flow rate range (N2 Gas) (SCCM)
1	F100, F10	100 - 1
2	F500, F50	500 - 5
3	F1L, F100	1000 - 10
4	F2L, F200	2000 - 20
5	F50B, F13B	50 - 3.5
6	F100B, F28B	100 - 7
7	F200B, F50B	200 - 14
8	F500B, F125B	500 - 35
9	F1LB, F250B	1000 - 70

Table 2-3 Flow rate range table (Maximum outlet pressure: 150torr)

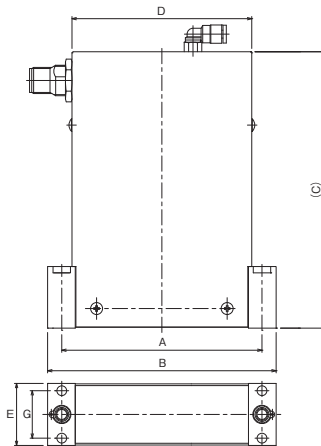
No.	Flow rate range type	Flow rate range (N2 Gas) (SCCM)
1	F100, F20	100 - 3
2	F200, F30	200 - 6
3	F500, F80	500 - 15
4	F1L, F160	1000 - 30
5	F2L, F300	2000 - 60
6	F50B, F20B	50 - 7.5
7	F100B, F39B	100 - 15
8	F200B, F83B	200 - 30
9	F300B, F122B	300 - 45
10	F500B, F180B	500 - 75
11	F1LB, F375B	1000 - 150

Dimensions

Connection: UJR Type



Connection: Wseal Type



UJR Type

(Unit: mm)

	A	C	D	E	H	I	J
P7000(WR)	124	141.5	67.8	39	12.7	25	68
UPC	106/124	128	70.5	28.1	12.7	18	—

IGS 1.5 Wseal Type

(Unit: mm)

	A	B	C	D	E	G
P7000(WR)	79.8	93	141.5	67.8	39	30
UPC	79.8	93	128	70.5	39	30

IGS 1.125 Wseal Type

(Unit: mm)

	A	B	C	D	E	G
P7000/P8000	92	105	127	82.6	28.5	21.8
UPC	92	105	128	70.5	28.5	21.8

Accessories

Signal Checkers (one complete set)

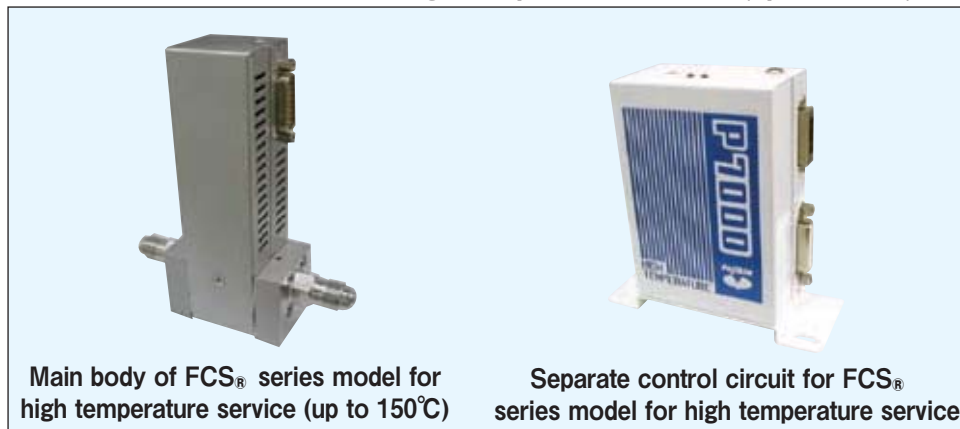


Special Power Supply + Branch Adaptor

Signal Checkers (Main Body)

Related Products

The FCS_® series models for high temperature service (up to 150°C)



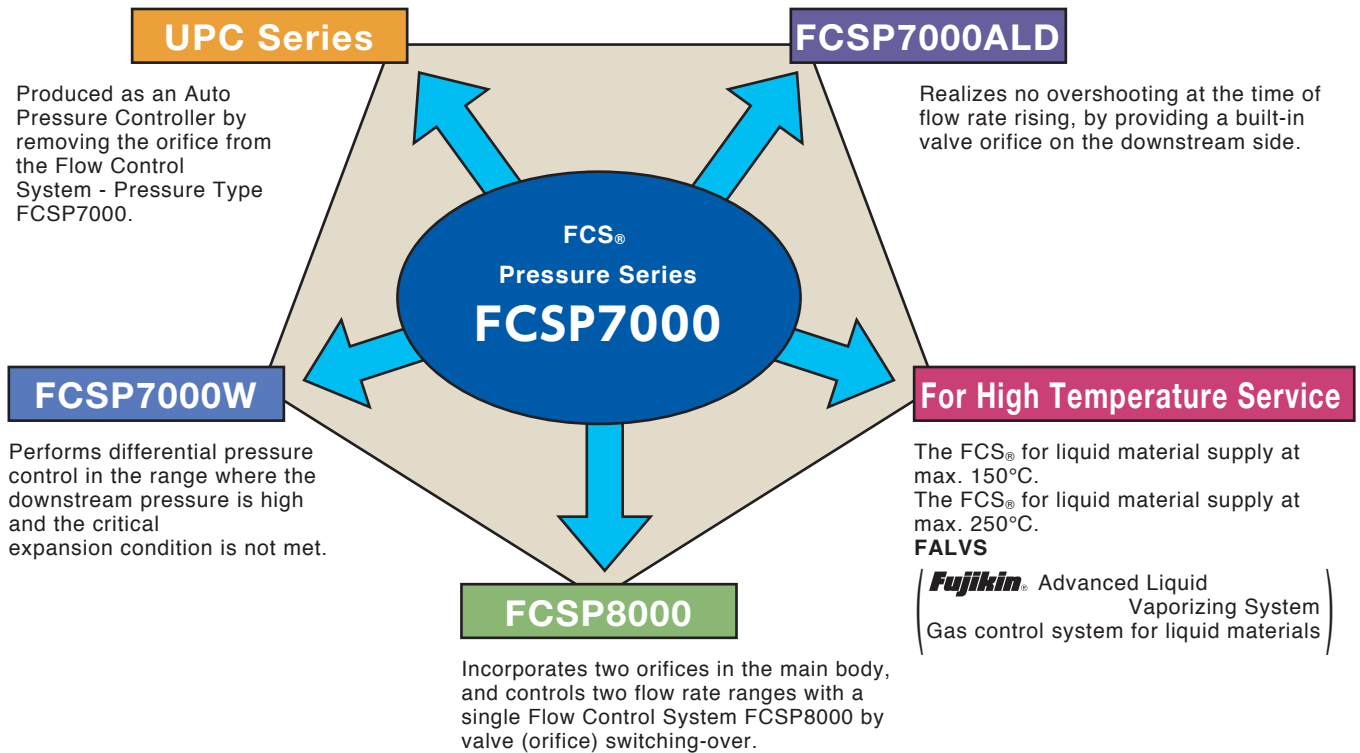
Main body of FCS_® series model for high temperature service (up to 150°C)

Separate control circuit for FCS_® series model for high temperature service

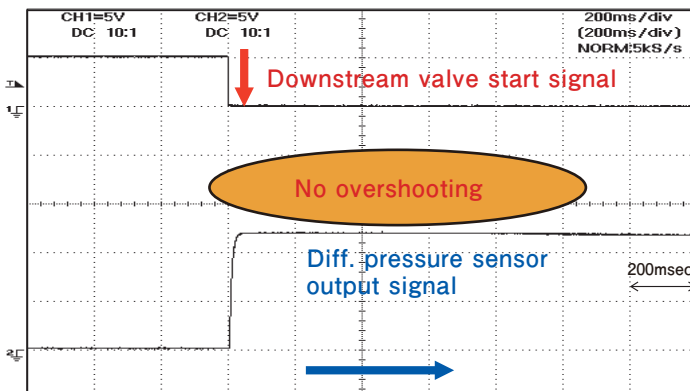
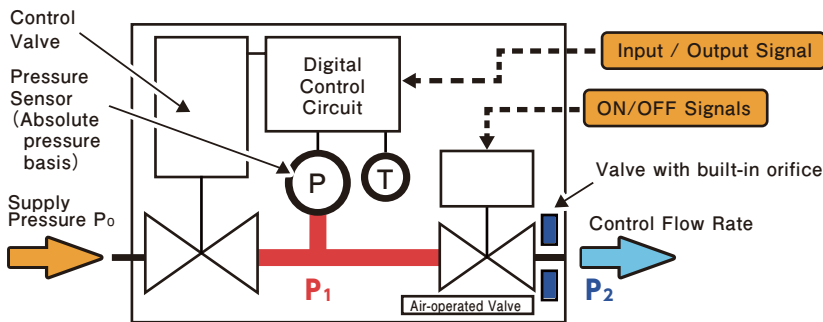


FFMS
(Fujikin_® Flow Measurement System)

Devices Derived from FCSP7000



■ FCSP7000ALD (FCS[®] for measures against transient response fluctuations)



■ For High Temperature Service

FALVS (**Fujikin**® Advanced Liquid Vaporizing System, Vapor Control System for Liquid Materials)

The Shared Prize and Special Prize for Manufacturing received 2011

Vaporization Section

- Controls liquid material supply with the upstream orifice of the vaporization section and a pneumatic valve.
- Generates vapor pressure appropriate to the heating temperature of the vaporization section.
- Composed of three chambers for sufficient heating of gas and prevention of liquid flow into the FCS®.

The FCS® for High Temperature Service

- No change in flow rate due to change in supply pressure – high accuracy and quick response. → Easy temperature control of vaporizer (to ensure temperature setting between min. supply pressure and max. allowable pressure of pressure sensor)

The FALVS is used to vaporize liquid material and precisely control the vapor flow rate.

Body of the FALVS

Vaporization section: composed of three chambers

Gas → The FCS® for high temperature service → Controlled Gas

Orifice Gasket Orifice

Liquid

Separate Control Circuit for the FALVS

The FCS® for High Temperature Service at 250°C (max.)

Body of the FCS® for High Temperature Service at 250°C (max.)

Separate Control Circuit of the FCS® for High Temperature Service

The Manufacturers Awards 2010, Part Category Prize: Machinery Component Award received

Fujikin®



Fujikin® Carp® Group

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The Year 2005
The 1st Monozukuri (manufacturing)
Nippon Grand Awards
: Excellence Prize