Gas Mass Flow Measurement and Control

Microflow

What is Mass Flow?

- Differential pressure, Orifice, Venturi tube

Volume

- Ultrasonic

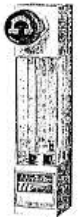
Volume

Volume

- Vortex

- Mechanical Variable area
  Purge meter, Rotary meter
  Turbine meter

Volume



Volume

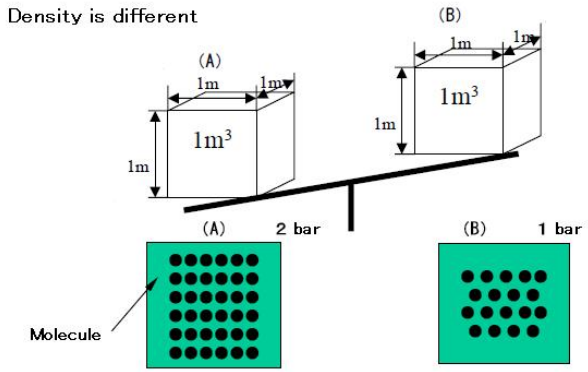
- Thermal transfer!

Mass Flow

Why Mass Flow?

Gases will experience density compression or expansion under the influence of:

- Temperature
- Pressure



PV=nRT

V=(nR)T/P

Volume = Temperature (K) / Pressure

1℃=273.16K

Units for measuring mass flow take into account the temperature and pressure:

→NLM (Normal Liter per Minute): Volume at 0 degree C , 1 atm.

→ SLM (Standard Liter per Minute): Volume at customer standard temperature at 1atm.

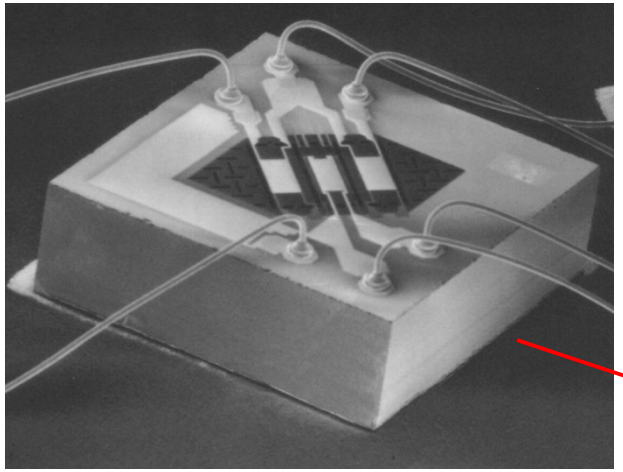
Azbil Yamatake SLM is 20 degree C, 1atm.

Many Gas supplier SLM are 50 degree C, 1atm.

Many users SLM are 0 degree C, 1atm.

What is Microflow ?

Technology Principle

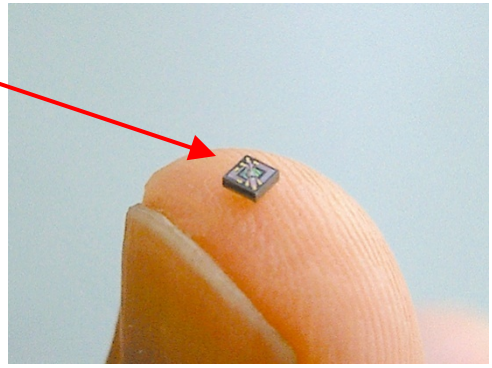


<u>One Single Semiconductor Chip:</u>

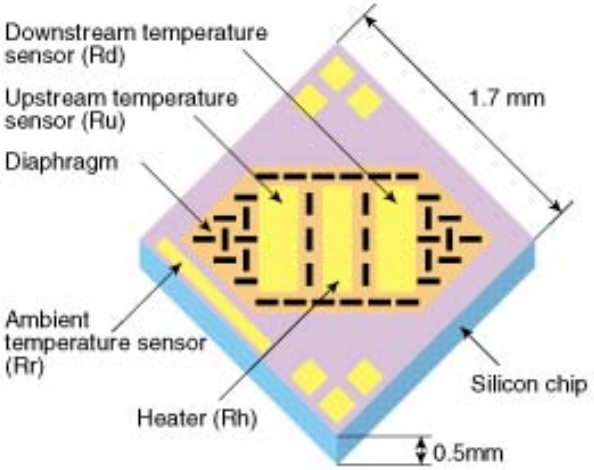
- 1.7 square mm size at 0.5mm thickness
- MEMS structure (Micro Electrical Mechanical System)

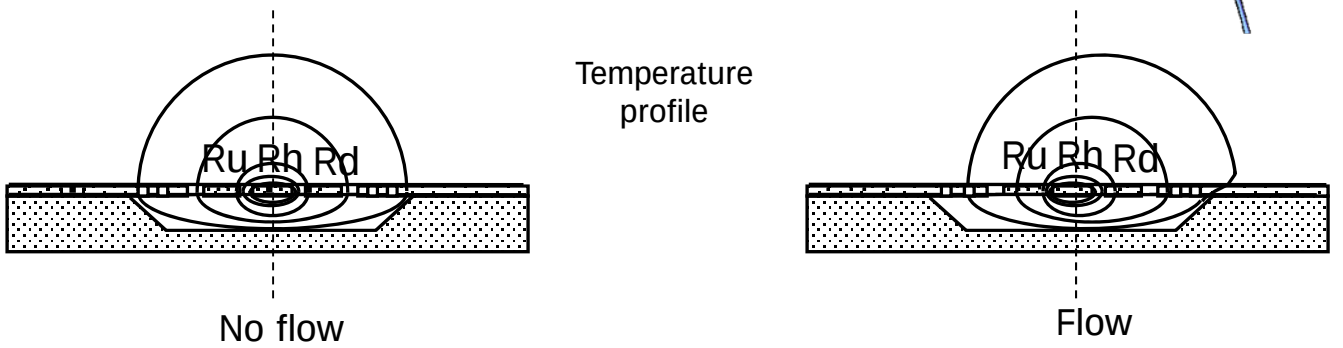
<u>Integrated into this single structure are:</u>

- Flow sensor
- Temperature Compensation
- Pressure Compensation



What is MEMS?





How is Microflow applied?

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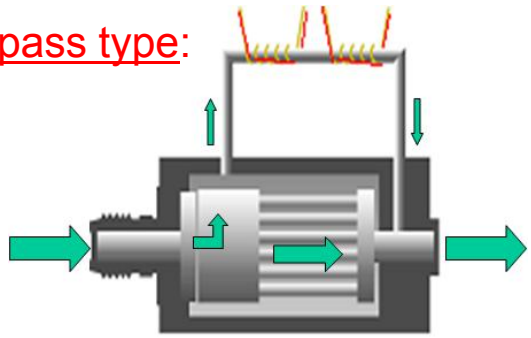
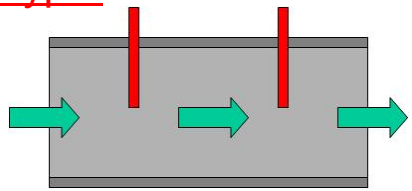
Traditional application

Bypass type:



- Slow reponse time: 4 to 10 sec
- Accuracy: reduces over time
- Bypass: easily blocked
- Pressure drop: min 49kPa

Insertion type:

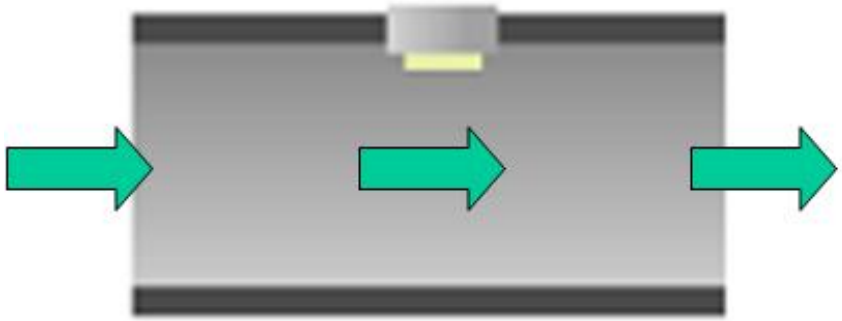


- Power consumption high
- Response time: 4 to 10 sec

versus

Direct IC Thermal sensor:

Yamatake Azbil's Microflow:



- Chip reponse time: **0.002 sec**
- Product response time: **0.002 to 0.1 sec**
- Pressure drop: **min. 1-10kPa**

Rice

Microflow Product Line-up

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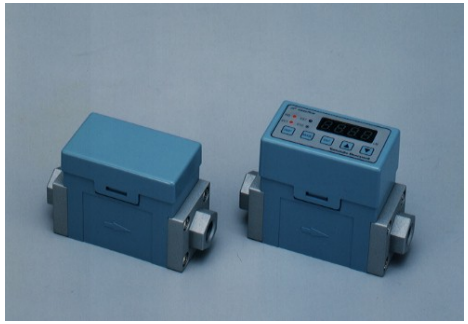
Model	Product	Features	Accuracy	Pipe size	Flow range	Air	N2	Ar	O2	CO2	LNG	Propane	Butane	H2	He	Acetylen
Mass flow Controller CMQ		Quick response（500ms） High Accuracy Digital control Multi-function	1%FS	1/4~1/2 UNF Rc Swageloc VCR	0~200ccm ～ 0~1000LM	○	○	○	○	○	○	○	○	○	○	○
Panel Mount Mass flow Controller MPC		Panel mount Worldwide's smallest Worldwide's lightest	2%FS	1/8 Rc	0~500ccm ～ 0~20LM	○	○	○	×	○	×	×	×	×	×	×
Mass Flow Meter CMS		Wide range ability High Accuracy Multi function	3%RD	1/4~1/2 UNF Rc Swageloc VCR	0~500ccm ～ 0~2000LM	○	○	○	○	○	○	○	○	○	○	○
Compact Mass Flow Meter CME		Embedded equipment Reasonable price	5%RD	1/4 Rc	0~500ccm ～ 0~50LM	○	○	○	○	○	○	×	×	×	×	×
Gas Flow Monitor CMG		Low pressure loss High reliability Fuel/Air ratio monitoring	4%RD	20~50A Rc	0~4m3/h ～ 0~150m3/h	○	○	×	×	×	○	○	○	×	×	×
Vortex Flow Meter MVF		Wide range ability 100:1（Accuracy guaranteed） Mass flow measurement	2%RD at Volume flow	50~150A Wafer	0~1700m3/h ～ 0~15000m3/h	○	○	○	○	○	○	○	○	×	×	×
Compressed Air/Nitrogen Mass flow Meter MCF		Low cost Aluminium bodo 50:1（Accuracy guaranteed） Compressor energy monitor	3%FS	1/4B 1/2B 1B 1 1/2B 2B	0~160m3/h ～ 0~1600m3/h	○	○	×	×	×	×	×	×	×	×	×
Air Mass Flow Sensor MCS100		Ultra wuick response (5ms) Ultra compact and light	5%FS	1/8 M5	0~500ccm -500~500ccm 0~3LM -3~3LM	○	○	○	×	×	×	×	×	×	×	×
Air Mass Flow Sensor MCS200		Ultra quick response (5ms) Ultra compact and light	3%FS 5%FS	manifold	0~500ccm 0~1LM 0~3LM -500~500ccm -6L~6LM	○	○	○	×	×	×	×	×	×	×	×

Microflow:
Sensors/Meters

CMS Gas Mass Flowmeters

- CMS series gas mass flowmeters do not require temperature/pressure compensation.
- The Yamatake-designed thermal mass flow sensor gives the CMS high accuracy of ±3% RD, wide measurement range of 100:1 and low pressure loss of 1kPa max. (excluding the CMS500/1500).
- Instantaneous/integrated flow-rate indication/output are standard features, supporting easy energy management.
- Wide lineup of measurement ranges: 0.5, 2, 5, 20, 50, 200, 500, 1500L/min (standard)



CMG Gas Flow Monitors

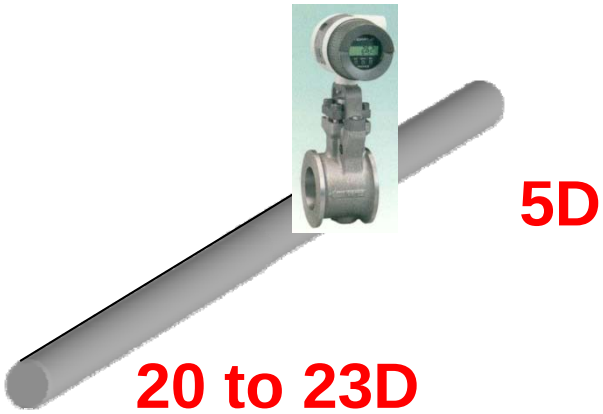
- The **CMG** series consists of low pressure-loss mass flowmeters suitable for low-pressure fuel gas measurement, perfect for energy management for each piece of equipment.
- Lineup of measurement ranges: 4, 10, 30, 80, 150m^3/h (normal)
- Instantaneous/integrated flow-rate indication/output are standard features, supporting easy energy management.
- 24Vdc, 100Vac and 200Vac models
- Low pressure loss of 200Pa

MVF Micro Flow Vortex Gas Flowmeter

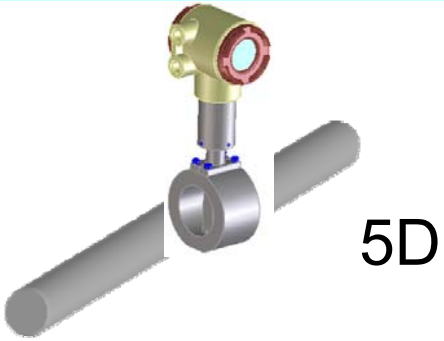
- The vortex frequency is detected by the flow sensor, enabling a low flow range measurement (from 0.3m/s).
- The integrated temperature/pressure compensator (ambient temperature sensor on the flow sensor chip and built-in gauge-pressure sensor), dramatically reduces total instrumentation cost.
- Suitable for low-pressure measurement, MVF offers air flow measurement for air-fuel ratio control and air-ratio management, which have been costly to do with traditional technologies.
- Port sizes and measurement ranges (at 0.5MPa)
  - 50A: 14 to 1,388m3/h (normal)
  - 80A: 31 to 3,064m3/h (normal)
  - 100A: 48 to 4,718m3/h (normal)
  - 150A: 102 to 10,153m3/h (normal)

MVF: Reduced Space Requirement

Conventional vortex



MVF Thermal Vortex

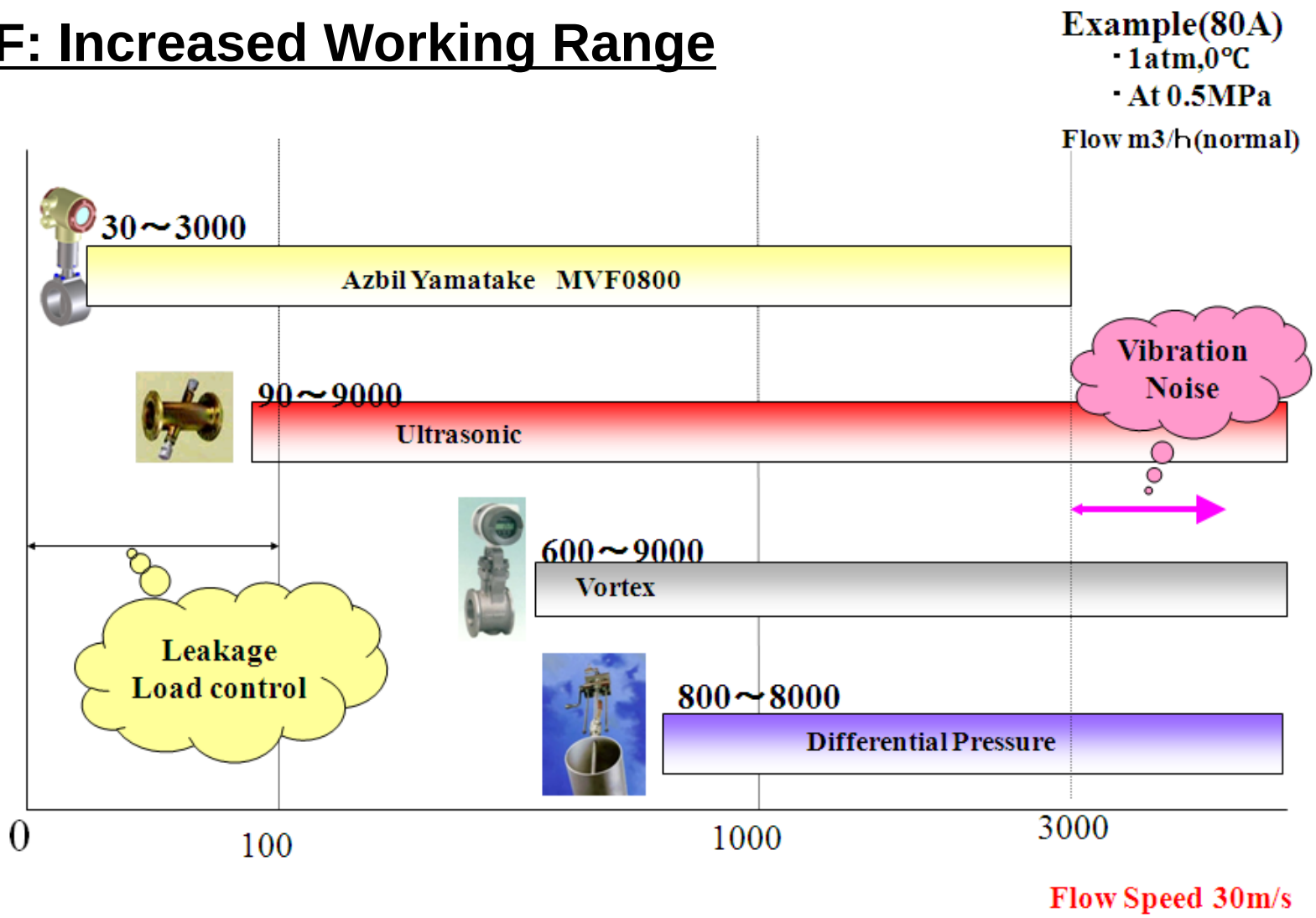


Required straight pipe length dramatically shortened:

- Upstream: **10D**
- Downstream: **5D**

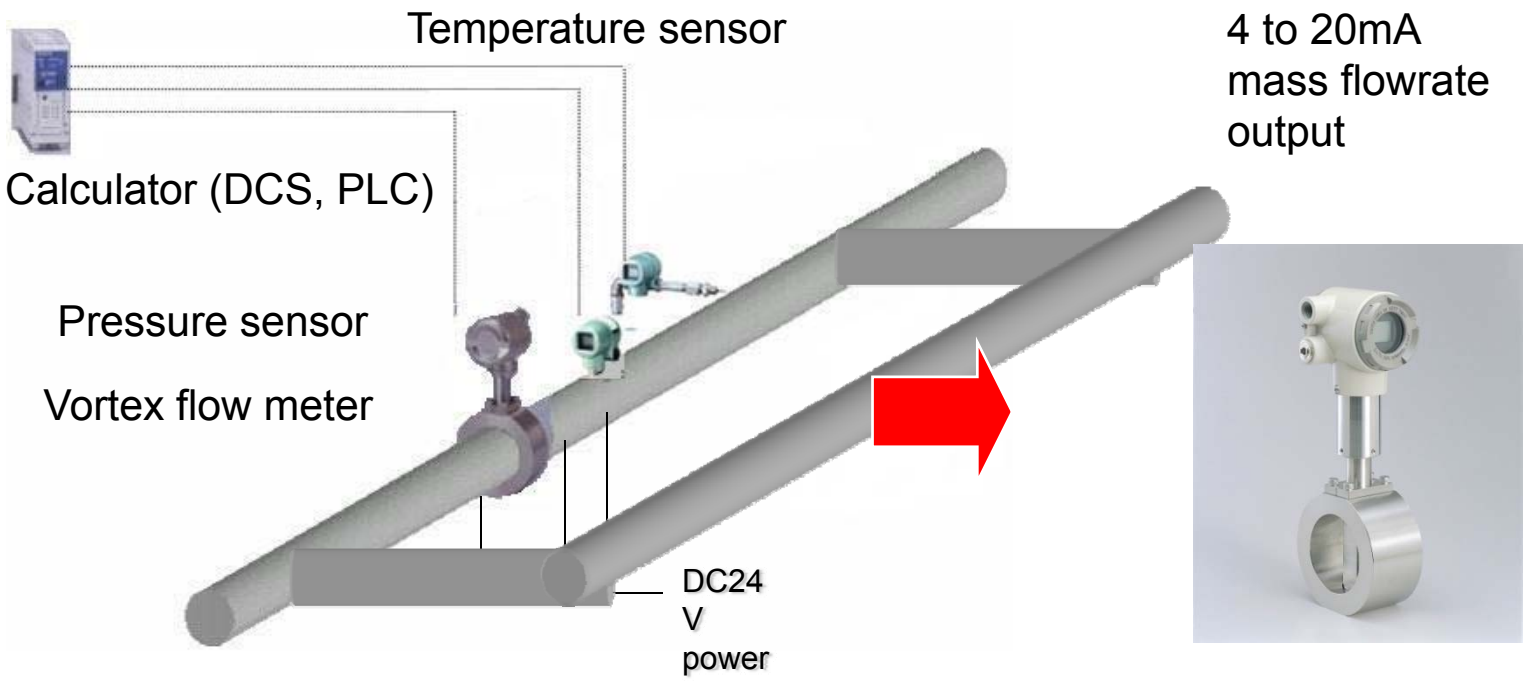
(D = pipe diameter)

MVF: Increased Working Range



MVF: Reduced Instrumentation Load

4 to 20mA mass flowrate output



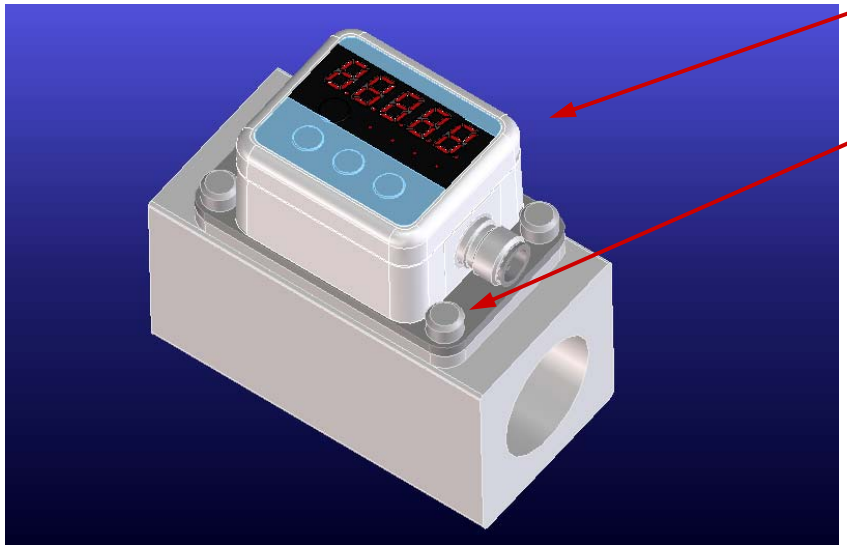
volume Flow sensor **Mass Flow Sensor**

MCF Flowmeter for compressed air

- Specifically designed for compressed air and nitrogen applications MCF offers a wide measuring range ratio of 50:1
- Detection of consumption and leakage offer improved maintenance ability
- Installation near the workplace allow for accurate cost visualization and reduction
- Product Outline:
  - ❑Diameters：8/15/25/40/50A
  - ❑Ranges：200/500/3000/6000/12000L/min
  - ❑Fluids： Air and Nitrogen
  - ❑Accuracy ：±3%FS / Response time： 0.5s maximum
  - ❑Pressure drop ： approx. 5kPa at 0.5MPa max flow
  - ❑Power supply ：DC24V / Out put ：4-20mA and pulse
  - ❑Protection ：IP65
  - ❑Option ： Data logging

Microflow Sensors/Meters

Structure Overview

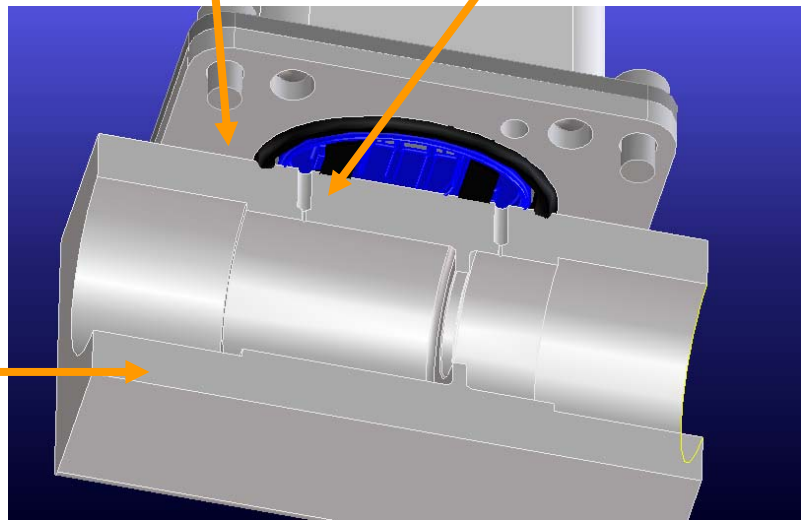


- Advanced maintenance ability

Display unit and Sensor unit can easily be disassembled for maintenance exchange by 4 bolts

Bypass structure

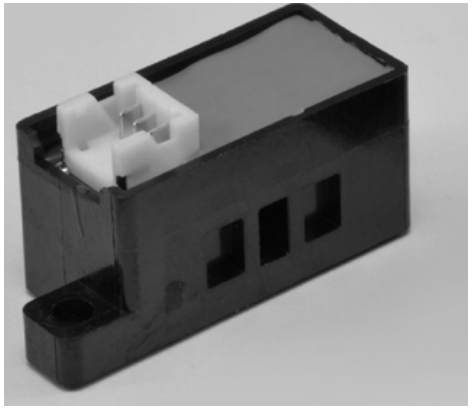
Orifice



Main stream
(Aluminum extrusion)

MCS Miniature Flow Sensor

- Specifically as compact, fast response lightweight air mass flow sensor for applications in physics, medical and industry.
- No need for temperature and pressure compensation
- Product Outline:
  - ❑Fast response time：5msec max
  - ❑Lightweight: 9 grams
  - ❑Fluids： Air and Nitrogen (standard)
  - ❑Accuracy ：±5%FS
  - ❑Power supply：12~24VDC (MCS100) 5VDC (MCS200)
  - ❑Output: 1-5VDC
  - ❑Connections：M5 (MCS100) or manifold (MCS200)



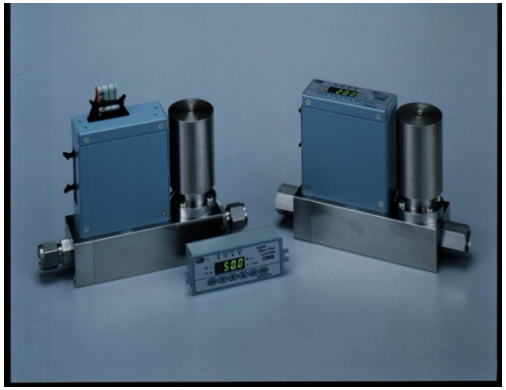
MCS200

MCS100

Microflow: Controllers

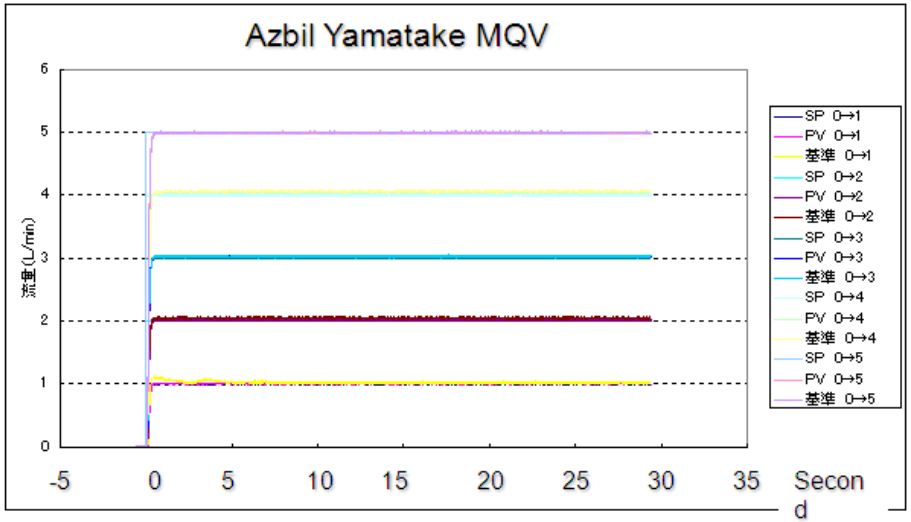
MQV Mass Flow Controllers

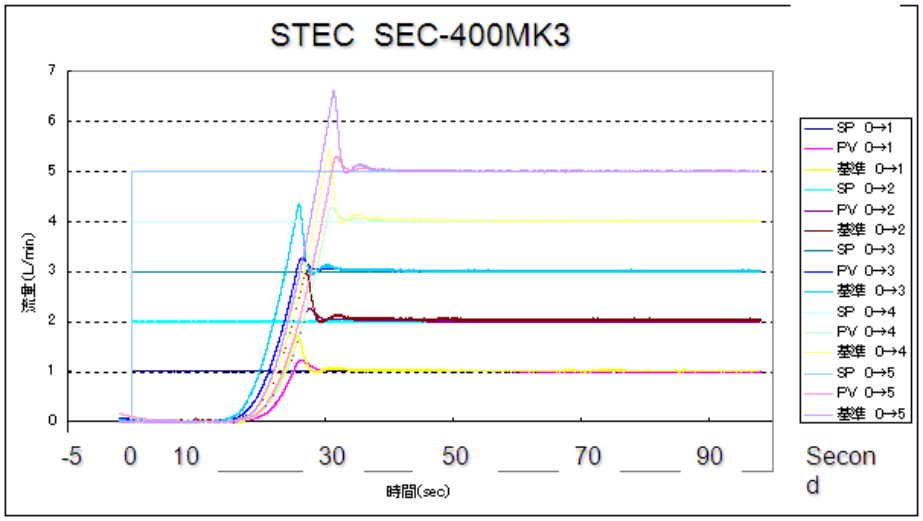
- MQV series flow controllers have integrated proportional solenoid valves. Their high-speed control and low pressure-differential operation are suitable for burner air-fuel ratio control (glass forming, etc.) and gas injection flow control for vacuum evaporation.
- Lineup of measurement/control ranges 0.2, 0.5, 2, 5, 20, 50, 200, 500L/min
- Wide control range of 1 to 100% FS
- High-speed, 300ms control (700ms for 200/500L models)
- Low pressure-differential operation of 0.98 to 294kPa (150 to 294kPa for conventional models)



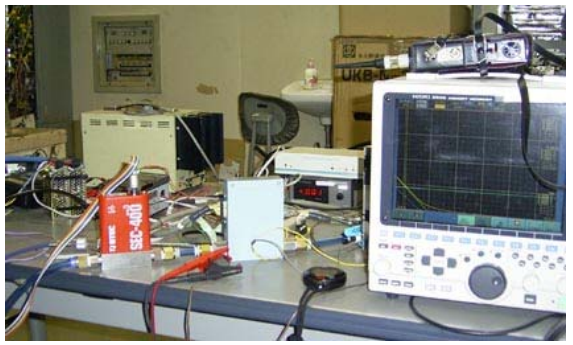
Microflow Controllers

MQV control result

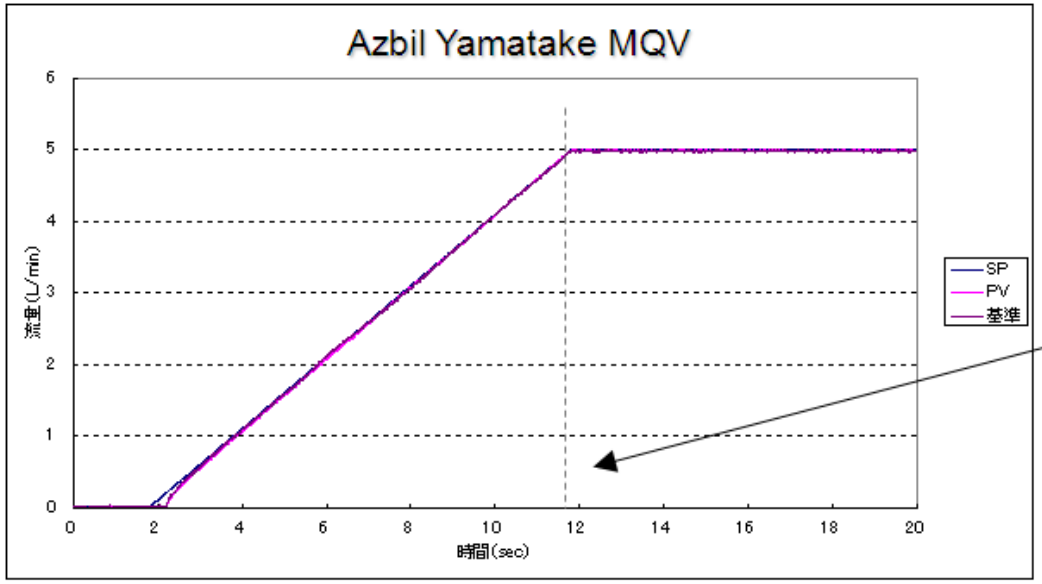




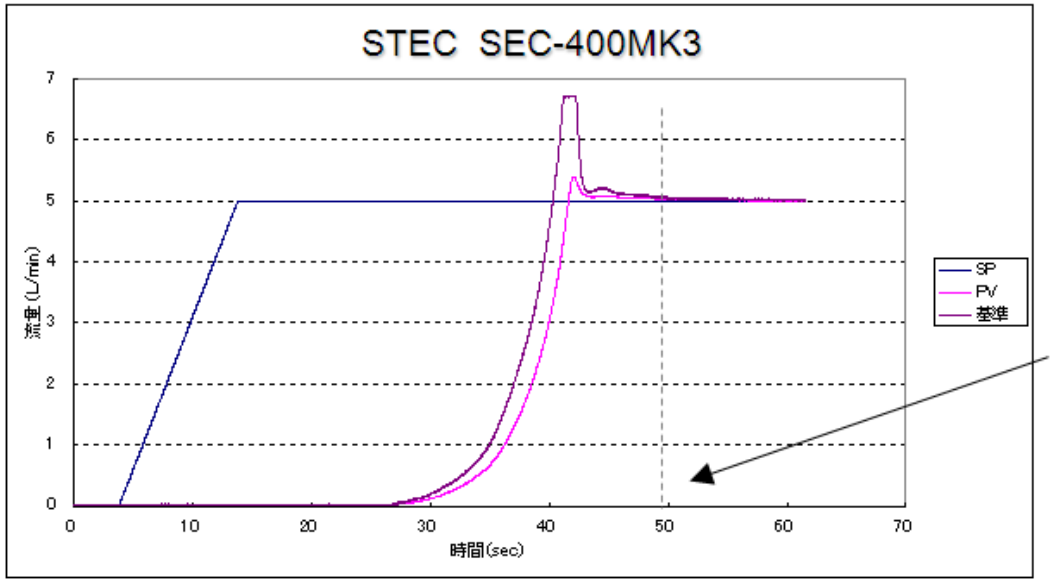
Pressure sensor : SPS300
SP voltage set : YEW 7651
Redorder : Hioki memory hi recorder
Fluid : Hydrogen
Temperature : 23℃



Microflow Controllers



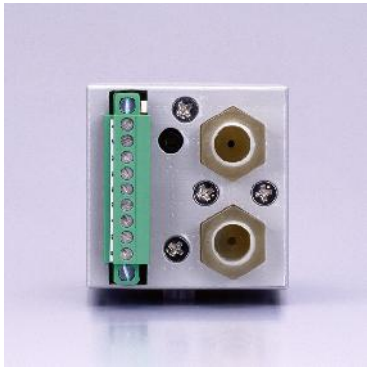
12 Second



50 Second

MPC Panel-Mounted Mass Flow Controller

- Control flow ranges of 0.5, 2, 5 and 20L/min
- Smallest and light mass flow controller:
  48 × 48mm, depth 73.7mm, weight 300g
- Easy operation and visible digital indication
- High-speed control (control to flow in 1sec)
- No dedicated power supply or indication unit required
- Variety of functions:
  - Flow-rate integration, flow-rate alarm output, multiple setpoints, gas type selection, slow start, OK flow-rate indication/output, automatic shutoff, analog I/O (optional), RS-485 communications (optional), etc.

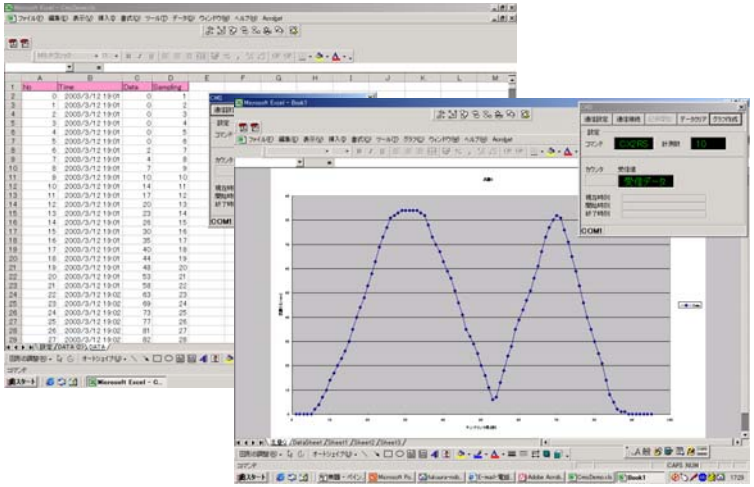


- Electrical wiring terminals and pipe connections are on the back for easy mounting.
- Connectors shorten the replacement work time.
- PC connection port is standard. Parameter setup and control data acquisition are easy on a PC using Smart Loader software.

PC Tools

For **CMS** mass flowmeters:

Instantaneous flow data acquisition and trend monitoring are possible by simply connecting the dedicated cable (sold separately).
PC software (Excel macro) is provided for free.



For **MQV** and **MPC** mass flow controllers:

Instantaneous flow data acquisition and trend monitoring are possible with PC software (sold separately) and dedicated cable (included with software).