# Integrated Display Type Digital Flow Sensor For Gas
# FM-200 SERIES


Related Information
■ General terms and conditions..... F-3
■ Selection guide ..... P.699~
■ Glossary of terms..... P.1569~
■ General precautions ..... P.1571~


panasonic.net/id/pidsx/global

CE

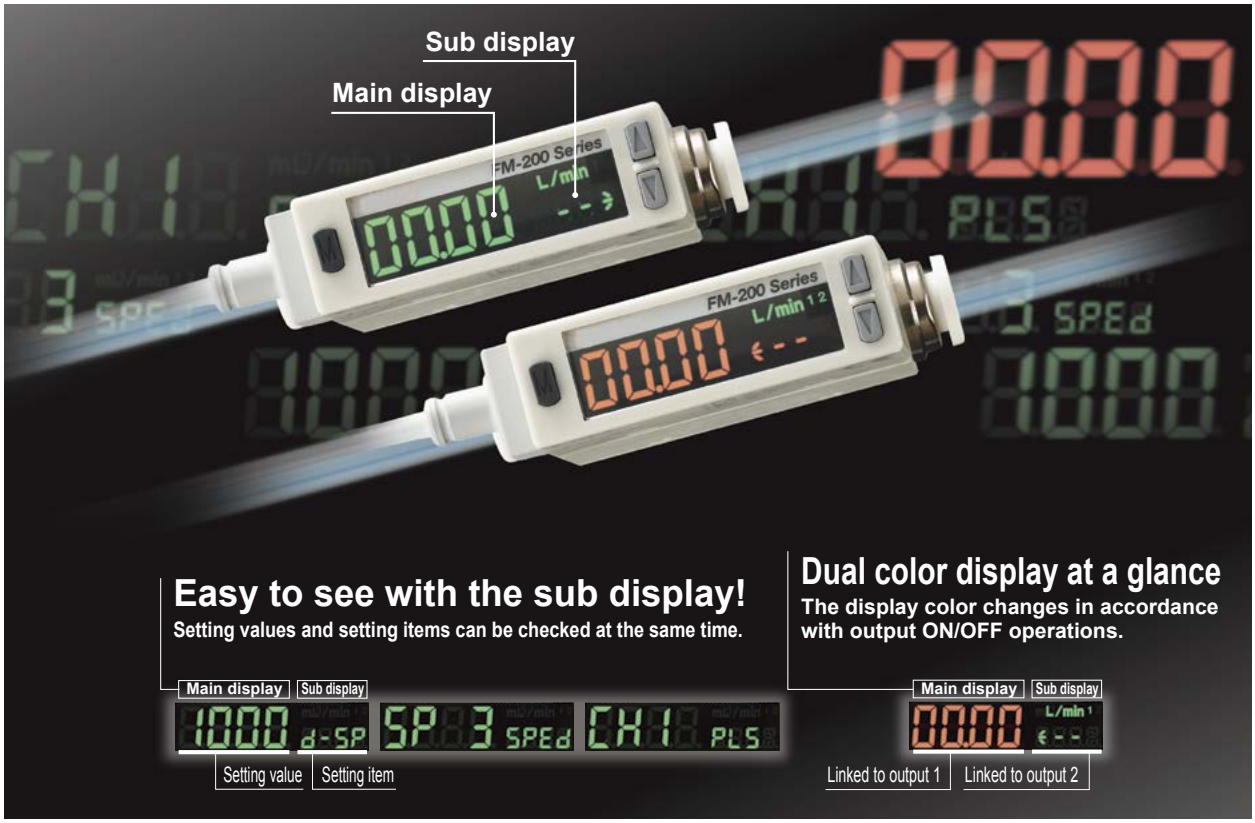
LCD 123 Digital

With analog output

## Dual color with sub display at a glance

### Easy-to-see dual color with sub display!

The setting conditions are displayed on the sub display, making it much easier to keep track of operations.
In addition, the digital display which switches between 2 colors lets you check the status of sensor operation at a glance.





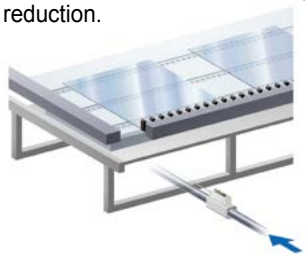
FIBER SENSORS
LASER SENSORS
PHOTOELECTRIC SENSORS
MICRO PHOTOELECTRIC SENSORS
AREA SENSORS
SAFETY LIGHT CURTAINS / SAFETY COMPONENTS
PRESSURE / FLOW SENSORS
INDUCTIVE PROXIMITY SENSORS
PARTICULAR USE SENSORS
SENSOR OPTIONS
SIMPLE WIRE-SAVING UNITS
WIRE-SAVING SYSTEMS
MEASUREMENT SENSORS
STATIC CONTROL DEVICES
LASER MARKERS
PLC
HUMAN MACHINE INTERFACES
ENERGY MANAGEMENT SOLUTIONS
FA COMPONENTS
MACHINE VISION SYSTEMS
UV CURING SYSTEMS

Selection Guide
Pressure/ Digital Display
Pressure/ Head-separated
Flow
FM-200

## APPLICATIONS

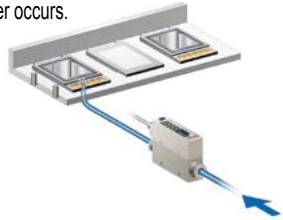
### Controlling purge gas and air blowing

By controlling purge gas and air blowing, performance and quality of the products can be maintained, while contributing to cost reduction.



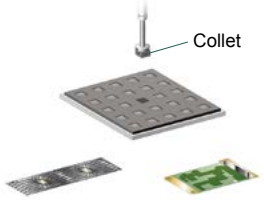
### Checking seating

Flow sensors can be used for stable detection of transparent objects which were difficult to detect using photoelectric sensors. The nozzle can be extended for detection even in places where oil spatter occurs.



### Checking suction

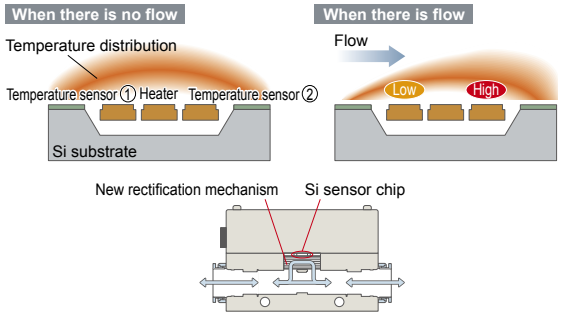
Detection of objects is possible even on conveyors with low suction pressures where air is flowing constantly (such as collet conveyors and network conveyors).




## High precision of ±3 % F.S.

A new rectification mechanism and Micro Electro Mechanical System (MEMS) technology allow the sensor to be mounted on a Si sensor chip (3 × 3.5 mm 0.118 × 0.138 in). This provides an extremely small heat capacity, high precision of ±3 % F.S. and high-speed response. The two temperature sensors on each side of the heater detect the heat distribution to make bidirectional detection possible.

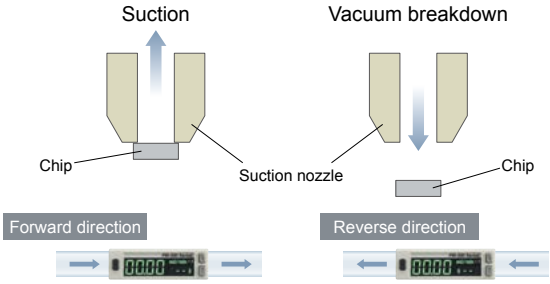
**Principle of Si sensor chip**




## One sensor for both intake and exhaust

A single sensor can detect flows bidirectionally. In addition, it can be set to detect flows in either the forward or reverse direction only, making it suitable for a variety of applications.


**For example, using a single sensor to check chip suction**




## No straight pipes needed

The rectification method used by the new mechanism makes straight pipes unnecessary at both the intake and exhaust sides.

## Flexible installation direction

Other than the ability to carry out bidirectional detection, there are no limitations on the installation direction, making the installation very flexible.

## Connection

Quick connection is possible with a cover-attached connector.

## Equipped with a wide variety of functions for greater ease of use

- **Integrated value reset function**
  During integrated mode, external input allows reset of the integrated value.
- **Analog voltage output**
  1 to 5 V analog voltage output is incorporated.
- **Key lock function**
  Key operation can be disabled to prevent mis-operation.
- **Rattle prevention function (Response time setting)**
  The response time can be set to one of seven steps from 50 ms to approximately 1,500 ms. This prevents rattling from rapid changes in flow or from noise.
- **Display rate setting**
  The display update period for the digital display can be changed to 250 ms, 500 ms or 1,000 ms in order to eliminate display flickering.
- **ECO mode**
  After approx. one minute of no operation, sensor will be switched to ECO mode.
  Backlight will be turned off to reduce power consumption.

## Suitable for cost and quality control! Integrated output mode incorporated

The **FM-200** series can control and manage flows in a wide variety of output modes such as integrated output mode, depending on the required application.

## INTEGRATED FLOW RATE DISPLAY

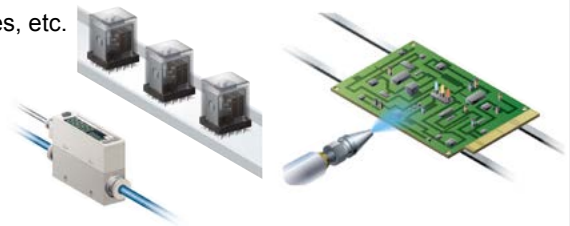

Integrated flow rate can be displayed with 7 digits

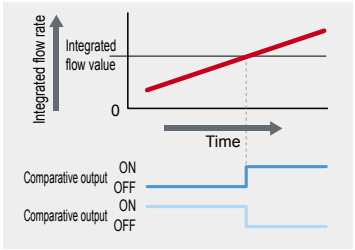
- **Integrated output mode**

### Quality control

When the volume of flow of the gas being measured reaches the set integrated value, output switches to ON or OFF.

- Controls $N_2$ charging volumes for electronic components
- Controls air blowing volumes, etc.





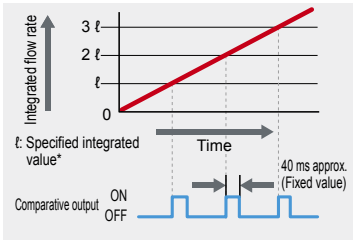

- **Integrated pulse output mode**

### Cost management

The pulse output is generated once at every specified integrated value*.
This lets you know the amount of air consumed per unit of time easily.

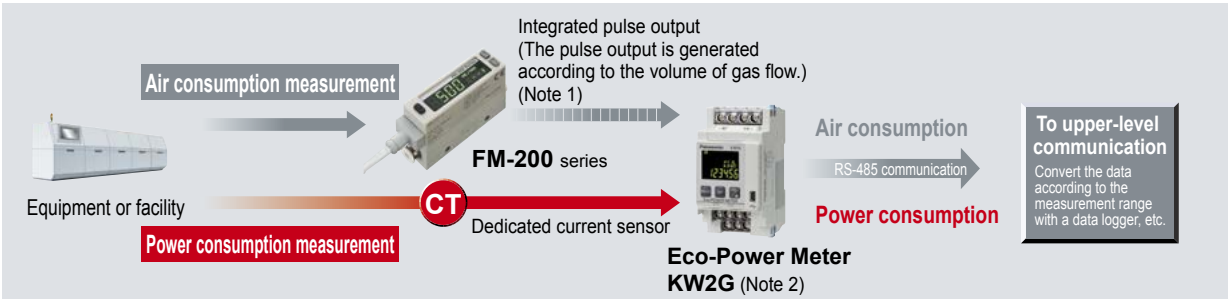
- Controls $N_2$ purge volumes in reflow furnaces
- Controls overall volumes of air consumed by equipment, etc.

* Integrated values are specified by range and can vary. For details, refer to "**SPECIFICATIONS**" (p.773).




### Energy-saving and environmental-friendly

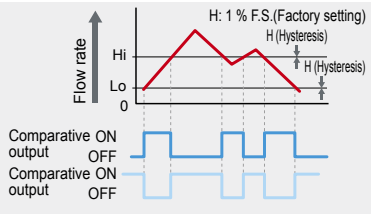
The pulse output from the flow sensor can be inputted to the pulse counter of an Eco-Power Meter so that air consumption and power consumption can both be measured simultaneously.



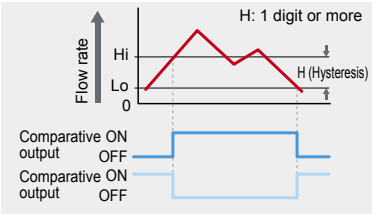

Notes: 1) Displayed value data is not outputted.
2) Refer to p.1372 for the Eco-Power Meter **KW2G** (**AKW2010GB**).

## INSTANT FLOW RATE DISPLAY (FACTORY SETTING)

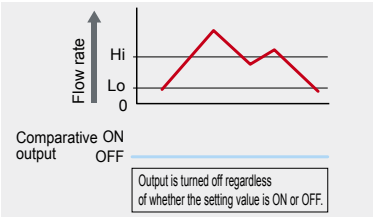

- **Window comparator mode**
  This mode is used for setting comparative output to ON or OFF at flow rates within the setting range.




- **Hysteresis mode**
  This mode is used for setting comparative output hysteresis to the desired level and for carrying out ON/OFF control.




- **Output OFF mode**
  Comparative output is forcibly maintained at OFF regardless of the setting value.



## ORDER GUIDE

| Type | Appearance | Applicable fluid | Flow rate range | Model No. | Port size | Comparative output |
|---|---|---|---|---|---|---|
| Resin body |  | Clean air (Note)<br>Compressed air (Note)<br>Nitrogen gas | 500 mℓ/min. | **FM-252-4** | ø4 ø0.157 push-in | NPN Open-collector transistor |
| | | | | **FM-252-4-P** | | PNP Open-collector transistor |
| | | | 1,000 mℓ/min. | **FM-213-4** | | NPN Open-collector transistor |
| | | | | **FM-213-4-P** | | PNP Open-collector transistor |
| | | | 5 ℓ/min. | **FM-253-4** | | NPN Open-collector transistor |
| | | | | **FM-253-4-P** | | PNP Open-collector transistor |
| | | | 10 ℓ/min. | **FM-214-4** | | NPN Open-collector transistor |
| | | | | **FM-214-4-P** | | PNP Open-collector transistor |
| |  | | 50 ℓ/min. | **FM-254-8** | ø8 ø0.315 push-in | NPN Open-collector transistor |
| | | | | **FM-254-8-P** | | PNP Open-collector transistor |
| | | | 100 ℓ/min. | **FM-215-8** | | NPN Open-collector transistor |
| | | | | **FM-215-8-P** | | PNP Open-collector transistor |
| Aluminum body |  | | 500 ℓ/min. | **FM-255-AR2** | Rc1/2 female thread | NPN Open-collector transistor |
| | | | | **FM-255-AR2-P** | | PNP Open-collector transistor |
| | | | | **FM-255-AG2-P** | G1/2 female thread | PNP Open-collector transistor |
| | | | 1,000 ℓ/min. | **FM-216-AR2** | Rc1/2 female thread | NPN Open-collector transistor |
| | | | | **FM-216-AR2-P** | | PNP Open-collector transistor |
| | | | | **FM-216-AG2-P** | G1/2 female thread | PNP Open-collector transistor |

Note: The clean air complies with JIS B 8392-1.1.1 to 5.6.2, and the compressed air complies with JIS B 8392-1.1.1 to 1.6.2.

### Accessory

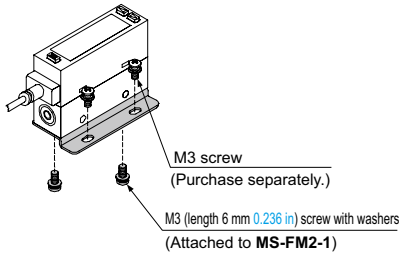
- **CN-F15-C1** (Connector attached cable 1 m 3.281 ft)

## OPTIONS

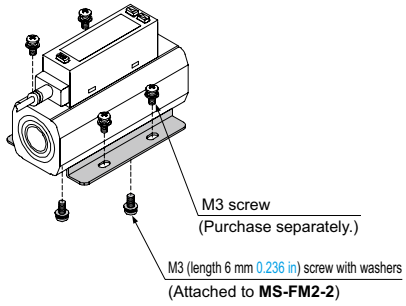
| Designation | Model No. | Description |
|---|---|---|
| Sensor mounting bracket | **MS-FM2-1** | Allows resin body type sensor to be installed on the flooring. |
| | **MS-FM2-2** | Allows aluminum body type sensor to be installed on the flooring. |

### Sensor mounting bracket

- **MS-FM2-1**




- **MS-FM2-2**




### Recommended vacuum filter

Manufactured by Nihon Pisco Co., Ltd.
VFU1-44-15P (Element length 15 mm 0.591 in)
VFU1-44-25P (Element length 25 mm 0.984 in)
VFE015B01 (Filter element for refill, length 15 mm 0.591 in)
VFE025B01 (Filter element for refill, length 25 mm 0.984 in)

Note: Contact the manufacturer for details of the recommended products.

# SPECIFICATIONS

## Individual specifications

| Item \ Model No. | | FM-252-4(-P) | FM-213-4(-P) | FM-253-4(-P) | FM-214-4(-P) | FM-254-8(-P) | FM-215-8(-P) |
|---|---|---|---|---|---|---|---|
| | | Resin body type | | | | | |
| Full scale flow rate (Note 1) | | 500 mℓ/min. | 1,000 mℓ/min. | 5 ℓ/min. | 10 ℓ/min. | 50 ℓ/min. | 100 ℓ/min. |
| Instant flow rate | Display range (Note 2) | –550 to +550 mℓ/min. | –1,100 to +1,100 mℓ/min. | –5.5 to +5.5 ℓ/min. | –11 to +11 ℓ/min. | –55 to +55 ℓ/min. | –110 to +110 ℓ/min. |
| | Setting and display resolution | 1 mℓ/min. | | 0.01 ℓ/min. | | 0.1 ℓ/min. | |
| Integrated flow rate | Display range (Note 2) | ±9999999 mℓ | | ±99999.99 ℓ | | ±999999.9 ℓ | |
| | Setting and display resolution | 1 mℓ | | 0.01 ℓ | | 0.1 ℓ | |
| Specified integrated value | | 5 mℓ | 10 mℓ | 0.05 ℓ | 0.1 ℓ | 0.5 ℓ | 1 ℓ |
| Port size | | ø4 ø0.157 push-in | | | | ø8 ø0.315 push-in | |
| Weight | | Net weight: 50 g approx., Gross weight: 115 g approx. | | | | Net weight: 70 g approx., Gross weight: 135 g approx. | |

| Item \ Model No. | | FM-255-AR2(-P) | FM-255-AG2-P | FM-216-AR2(-P) | FM-216-AG2-P |
|---|---|---|---|---|---|
| | | Aluminum body type | | | |
| Full scale flow rate (Note 1) | | 500 ℓ/min. | | 1,000 ℓ/min. | |
| Instant flow rate | Display range (Note 2) | –550 to +550 ℓ/min. | | –1,100 to +1,100 ℓ/min. | |
| | Setting and display resolution | 1 ℓ/min. | | | |
| Integrated flow rate | Display range (Note 2) | ±9999999 ℓ | | | |
| | Setting and display resolution | 1 ℓ | | | |
| Specified integrated value | | 5 ℓ | | 10 ℓ | |
| Port size | | Rc1/2 female thread | G1/2 female thread | Rc1/2 female thread | G1/2 female thread |
| Weight | | Net weight: 155 g approx., Gross weight: 220 g approx. | | | |

## Common specifications

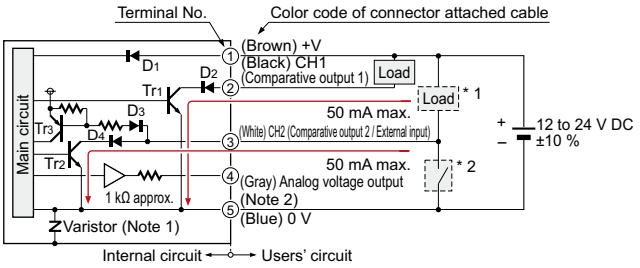
| Item \ Model No. | | NPN output type FM-2□ | PNP output type FM-2□-P |
|---|---|---|---|
| CE marking directive compliance | | EMC Directive, RoHS Directive | |
| Rated pressure range | | −0.09 to +0.7 MPa | |
| Pressure withstandability | | 1 MPa | |
| Applicable fluid | | Clean air (Note 3), compressed air (Note 3), nitrogen gas | |
| Supply voltage | | 12 to 24 V DC ±10 % Ripple P-P10 % or less | |
| Current consumption | | Normal mode: 60 mA or less, ECO mode: 40 mA or less | |
| Comparative outputs (Comparative output 1 / Comparative output 2) | | NPN open-collector transistor<br>• Maximum sink current: 50 mA or less<br>• Applied voltage: 26.4 V DC or less (between comparative output and 0 V)<br>• Residual voltage: 2.4 V or less (at 50 mA sink current) | PNP open-collector transistor<br>• Maximum source current: 50 mA or less<br>• Applied voltage: 26.4 V DC or less (between comparative output and +V)<br>• Residual voltage: 2.4 V or less (at 50 mA source current) |
| | Output modes | Output OFF mode, window comparator mode, hysteresis mode, integrated output mode, integrated pulse output mode | |
| | Short-circuit protection | Incorporated | |
| | Hysteresis | Window comparator mode: 1 to 8 % F.S. approx. (variable) (Factory settings: approx. 1 % F.S.), Hysteresis mode: Variable (minimum 1 digit) | |
| | Response time | 50 ms, 80 ms, 120 ms, 200 ms, 400 ms, 800 ms, 1,500 ms, selectable by key operation | |
| Analog voltage output | | Output voltage: 1 to 5 V, Output impedance: 1 kΩ approx. [For details, refer to "**Analog voltage output**" (p.774)] | |
| Repeatability | | Within ±1 % F.S. | |
| Accuracy assurance range (Note 4) | | Bi-direction : -100 to -3 % F.S., +3 to +100 % F.S., One-side direction : +3 to +100 % F.S. | |
| External input | | ON voltage: 0 to +0.4 V, OFF voltage: +5 V to +V, or open<br>Input time: 80 ms or more | ON voltage: +5 V to +V, OFF voltage: 0 to +0.6 V, or open<br>Input time: 80 ms or more |
| Linearity | | Within ±3 % F.S. (Ambient temperature +25 °C +77 °F, flow rate range 3 to 100 % F.S., atmospheric criteria on secondary side) | |
| Display | | 4 digits + 4 digits 2-color LCD display (Display refresh rate: 250 ms, 500 ms, 1,000 ms, selectable by key operation) | |
| Environmental resistance | Protection | IP40 (IEC) | |
| | Ambient temperature | 0 to +50 °C +32 to +122 °F (No dew condensation allowed), Storage: -10 to +60 °C +14 to +140 °F | |
| | Ambient humidity | 35 to 90 % RH, Storage: 35 to 90 % RH | |
| | Voltage withstandability | 1,000 V AC for one min. between all supply terminals connected together and enclosure (Excluding the aluminum body type) | |
| | Insulation resistance | 10 MΩ, or more, with 500 V DC megger between all supply terminals connected together and enclosure (Excluding the aluminum body type) | |
| | Vibration resistance | 10 to 150 Hz frequency, 0.75 mm 0.030 in double amplitude or 49 m/s$^2$ max. acceleration, in X, Y and Z directions for two hours each | |
| | Shock resistance | 100 m/s$^2$ acceleration (10 G approx.) in X, Y and Z directions three times each | |
| Temperature characteristics | | Within ±0.2 % F.S./°C (+25 °C +77 °F criteria, +15 to +35 °C +59 to +95 °F ambient temperature range) | |
| Pressure characteristics | | Within ±5 % F.S. (-0.09 to +0.7 MPa, +25 °C +77 °F, atmospheric criteria on secondary side) | |
| Enclosure earthing | | Floating (Note 5) | |
| Material | | Enclosure: ABS, Body: Polyamide (Aluminum body type: Aluminum), Switch: EPDM, Display: Acrylic, Mounting screw part (Resin body type): Brass<br>Current plate / Port filter: Stainless steel (used for the gas contact area), Sensor chip: Silicon, Gasket: Fluorine rubber | |
| Connecting method | | Connector | |
| Cable length | | Total length up to 10 m 32.808 ft is possible with 0.3 mm$^2$, or more, cable. | |
| Accessory | | **CN-F15-C1** (Connector attached cable 1 m 3.281 ft): 1 pc. | |

Notes: 1) Converted to volumetric flow at +20 °C +68 °F and 1 atmospheric pressure (101 kPa).
2) The display flow rate range is the case when setting to bi-direction at the flow direction setting. When the flow direction is set to one-side forward direction or one-side reverse direction, the negative side of the display flow rate range shows 10 % of the full-scale (F.S.).
3) The clean air complies with JIS B 8392-1.1.1 to 5.6.2, and the compressed air complies with JIS B 8392-1.1.1 to 1.6.2.
4) Take care that if fluid flows in the vicinity of zero-point which is out of the accuracy assurance range, the instant flow rate value may forcibly display "zero", or the integrated flow display value may not be counted up, or the integrated pulse output may not be outputted.
5) As a varistor (clamping voltage: approx. 40 V) is connected to the aluminum body type, do not apply voltage higher than the rated voltage of the sensor.

# I/O CIRCUIT AND WIRING DIAGRAMS

## FM-2□ — NPN output type

### I/O circuit diagram

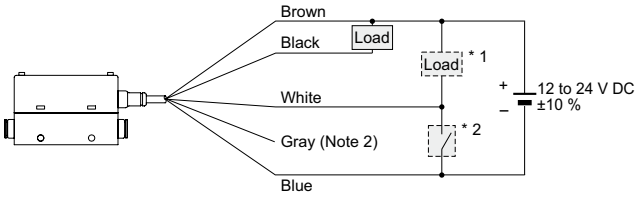



Notes: 1) As for the aluminum body type, varistor (clamping voltage approx. 40 V) is connected between the internal power circuit and the metal body to prevent breakdown of the sensor. Connect the metal body to +V of power supply or to frame ground (F.G.) of a device that is connected to 0 V. High potential and insulation resistance tests between the internal power circuit and the metal body must not be done.

2) Short-circuit protection is not incorporated into the analog voltage output. Do not connect the power supply or capacitive load directly to the analog voltage output.

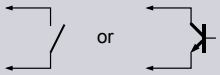
Symbols… $D_1$ to $D_4$ : Reverse supply polarity protection diode
$Tr_1$,$Tr_2$ : NPN output transistor
$Tr_3$ : PNP input transistor

### Wiring diagram




* 1: When using CH2 as a comparative output 2
* 2: When using CH2 as an external input

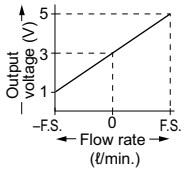
Non-voltage contact or NPN open-collector transistor



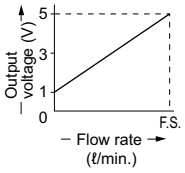

High (+5 V to +V, or Open): Invalid
Low (0 to +0.4 V): Valid

### Analog voltage output

**<Bi-direction detection>**

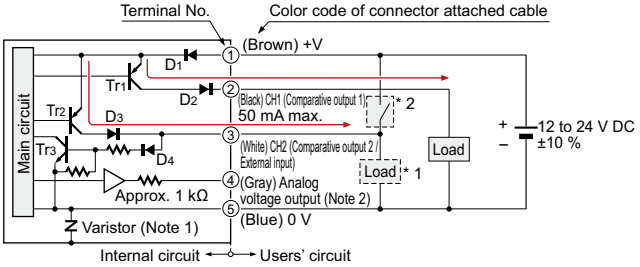



**<One-side detection>**




## FM-2□-P — PNP output type

### I/O circuit diagram

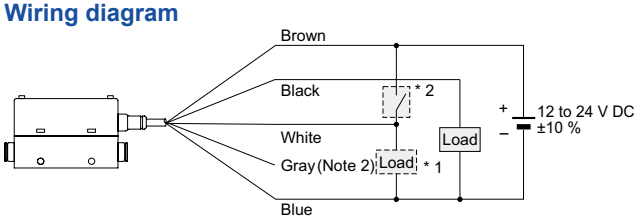



Notes: 1) As for the aluminum body type, varistor (clamping voltage approx. 40 V) is connected between the internal power circuit and the metal body to prevent breakdown of the sensor. Connect the metal body to +V of power supply or to frame ground (F.G.) of a device that is connected to 0 V. High potential and insulation resistance tests between the internal power circuit and the metal body must not be done.

2) Short-circuit protection is not incorporated into the analog voltage output. Do not connect the power supply or capacitive load directly to the analog voltage output.

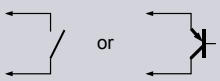
Symbols… $D_1$ to $D_4$ : Reverse supply polarity protection diode
$Tr_1$,$Tr_2$ : PNP output transistor
$Tr_3$ : NPN input transistor

### Wiring diagram




* 1: When using CH2 as a comparative output 2
* 2: When using CH2 as an external input

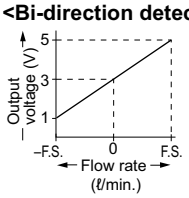
Non-voltage contact or PNP open-collector transistor



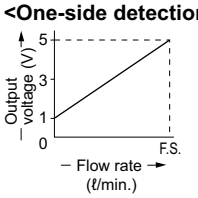

High (+5 V to +V): Valid
Low (0 to +0.6 V, or Open): Invalid

### Analog voltage output

**<Bi-direction detection>**

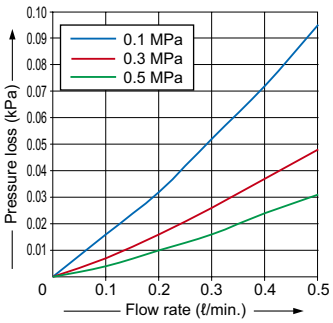



**<One-side detection>**

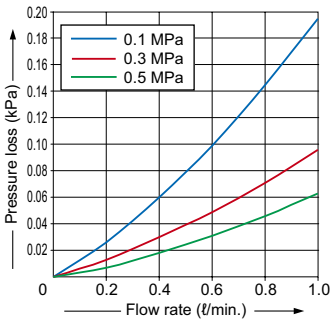


## PRESSURE LOSS CHARACTERISTICS (TYPICAL)

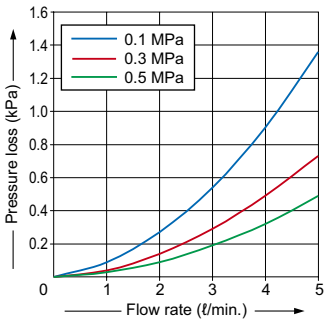
### FM-252-4(-P)



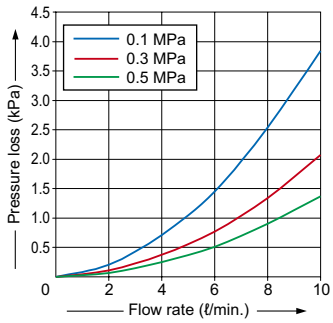

### FM-213-4(-P)



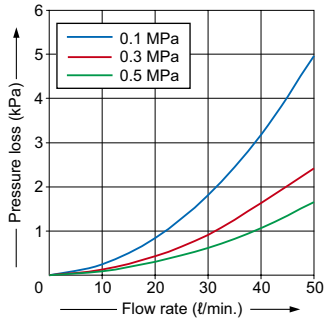

### FM-253-4(-P)



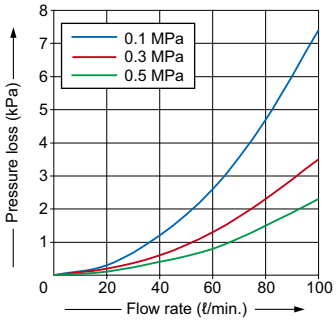

### FM-214-4(-P)



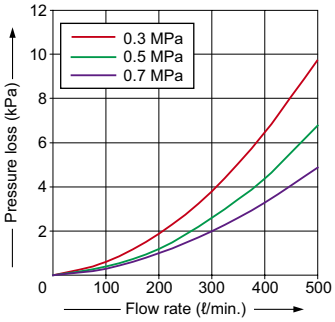

### FM-254-8(-P)



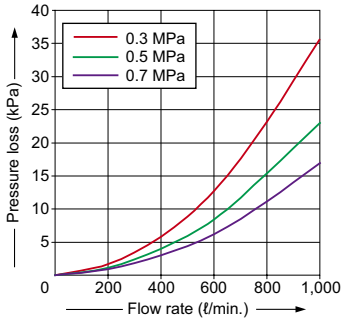

### FM-215-8(-P)




### FM-255-A□2(-P)




### FM-216-A□2(-P)

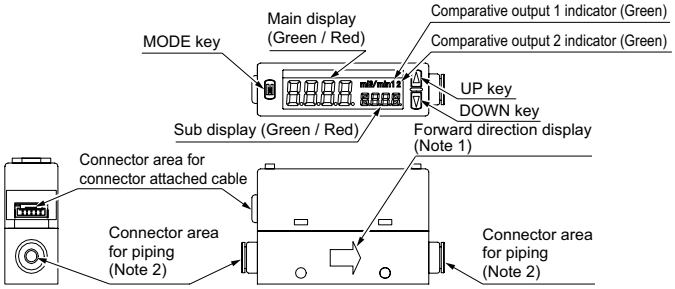



## PRECAUTIONS FOR PROPER USE

Refer to p.1571~ for general precautions.

- Never use this product as a sensing device for personnel protection.
- In case of using sensing devices for personnel protection, use products which meet laws and standards, such as OSHA, ANSI or IEC etc., for personnel protection applicable in each region or country.
- This product is for use in air and nitrogen only. Do not use the product for other fluids since the sensing accuracy cannot be guaranteed.
- Take care that if foreign materials are mixed in the sensing part, the product may break.

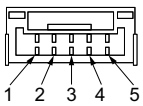
### Part description




Notes: 1) Direction of the arrow indicates the forward direction of flow rate when setting the flow direction to bi-direction or one-side forward direction. When setting the flow direction to one-side reverse direction, a direction opposite to the forward direction display will be the forward direction of the flow rate.
2) ø4 mm ø0.157 in push-in joint / ø8 mm ø0.315 in push-in joint is incorporated in **FM-2□-4(-P)** / **FM-2□-8(-P)**, respectively.
The push-in joint is not incorporated in the aluminum body type.

### Terminal arrangement diagram

**Terminal arrangement of the connectors of this product (sensor body)**




| Connector pin No. | Color code of the connector attached cable | Terminal |
|---|---|---|
| 1 | Brown | +V |
| 2 | Black | CH1 (comparative output 1) |
| 3 | White | CH2 (comparative output 2 / external input) |
| 4 | Gray | Analog voltage output |
| 5 | Blue | 0 V |

## PRECAUTIONS FOR PROPER USE

Refer to p.1571~ for general precautions.

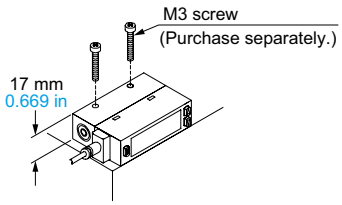
### Mounting

- This product can be installed facing up or down or to the left or right.

#### Horizontal mounting

- Use M3 screws, and the tightening torque should be 0.5 N·m.

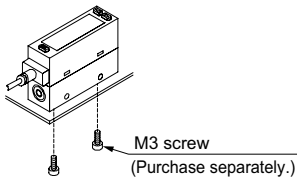
**<Resin body type>**



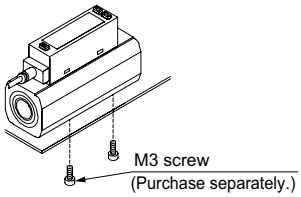

#### Vertical mounting

- Use M3 screws, and the tightening torque should be 0.5 N·m.

**<Resin body type>**




**<Aluminum body type>**

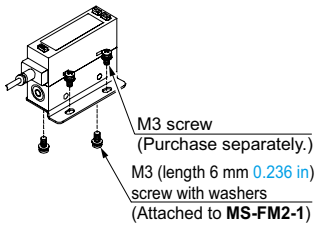



#### When using sensor mounting bracket

- When mounting the product on the sensor mounting bracket **MS-FM2-1** (optional) or **MS-FM2-2** (optional), use the M3 screws (length 6 mm 0.236 in) attached to the sensor mounting bracket. The tightening torque should be 0.5 N·m. Use M3 screws to mount the sensor mounting bracket on a sensing surface.

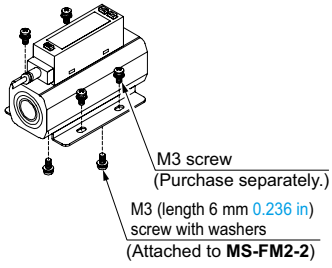
**<Resin body type>**

Use **MS-FM2-1**




**<Aluminum body type>**

Use **MS-FM2-2**

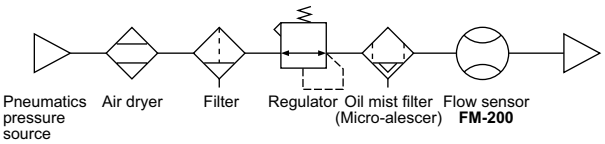



### Piping

- The following specified tube should be used to insert to the push-in joint type product.

| Material of tube | Tube diameter (mm in) | Allowable diameter |
|---|---|---|
| Polyamide | ø4 ø0.157, ø8 ø0.315 | Within ±0.1 mm ±0.004 in |
| Polyurethane | ø4 ø0.157 | Within ±0.1 mm ±0.004 in |
| | ø8 ø0.315 | Within +0.1 / -0.15 mm ±0.004 in / -0.006 in |

- Before using this product, make sure to check that the tube is firmly inserted.
- Install a filter, an air dryer and an oil mist filter (micro-alescer) onto the primary side (upstream) of this product since the compressed air from the compressor contains drain (water, oil oxide and foreign materials, etc.). Mesh (wire net) in this product is used to rectify the flow rate in the pipe. Always install a filter to the primary side of this product since this mesh is not a filter to remove foreign materials.




- When using a valve on the primary side of the product, only use an oil-prohibit specification valve. This product may malfunction or break if subject to splattering grease or oil, etc.
- When using this product for suction verification, etc., always install an air filter whose filtration property is 10 µm 0.394 mil or less onto the suction side to prevent suction of foreign materials and water. Furthermore, consider atmospheric dew point and ambient temperature of the product, use the product under the conditions that dew condensations will not be formed in the inside of pipe.
- In case of mounting commercial joint to the aluminum body type, apply a spanner on the metal part of this product and tighten by the tightening torque of 16 to 18 N·m. If excessive torque is applied, the commercial joint or the main body may break.
- When piping, take care that foreign materials such as sealing tape and adhesive must not enter into the inside of the pipe. If foreign materials are entered, the product may malfunction or break.
- Make sure to mount the joint when using the product with its secondary side (downstream) open to the air. If the joint is not mounted, the port filter of the product may fall off.

### Wiring

- Make sure that the power supply is OFF during wiring.
- Take care that wrong wiring will damage this product.
- Take care if applying voltage exceeding the rated range, or connecting to AC power supply, this product may break or burn.
- If power is supplied from a commercial switching regulator, ensure that the frame ground (F.G.) terminal of the power supply is connected to an actual ground.
- In case noise generating equipment (switching regulator, inverter motor, etc.) is used in the vicinity of this sensor, connect the frame ground (F.G.) terminal of the equipment to an actual ground.
- Do not run the wires together with high-voltage lines or power lines or put them in the same raceway. This can cause malfunction due to induction.
- Extension up to total 10 m 32.808 ft is possible with 0.3 mm$^2$, or more, cable.
- Make sure that stress by forcible bend or pulling is not applied directly to the sensor cable joint.

## PRECAUTIONS FOR PROPER USE

Refer to p.1571~ for general precautions.

### Others

- Do not use this product for commercial purposes since the product does not comply with International System of Units (SI).
- Do not apply pressure that exceed resistant-pressure.
- Do not use during the initial transient time (approx. 5 sec.) after the power supply is switched ON.
- The specifications may not be satisfied in a strong magnetic field.
- Accuracy of the display and the analog voltage output is influenced by self-heating by applying current other than the temperature characteristics. Standby time (5 min. or more after applying current) should be taken when using the product.
- These sensors are only for indoor use.
- Do not use this product in places having excessive vapor, dust, etc., or where it may come in contact with corrosive gas, etc.
- Take care that the product does not come in contact with water, oil, grease, or organic solvents such as thinner, etc., strong acid or alkaline.
- Do not drop the product or apply hard shock. This can cause product breakage.

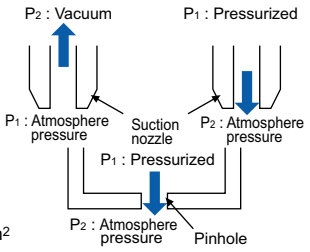
## FLOW SENSOR SELECTION

- If using a flow sensor for tasks such as checking suction and release from suction nozzles and sensing leaks, use the flow rate range setting table as a guide. The effective cross-section area of the nozzle (pinhole) and the difference in pressure inside and outside the nozzle can be used to calculate the flow rate.

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

● For $P_1 < 1.89 \times P_2$ (sub-acoustic velocity)
$Q=226.4 \times S \times \sqrt{P_2(P_1-P_2)}$

Q : Flow rate ℓ/min.
$P_1$ : Absolute pressure at primary side (MPa)
$P_2$ : Absolute pressure at secondary side (MPa)
S≥: Effective cross-section area of nozzle (pinhole) $mm^2$




### <Calculation example>

The flow rate calculation value for a nozzle diameter of ø0.1 to ø2.0 mm ø0.004 to ø0.079 in when $P_2$ is varied is shown in the table below.

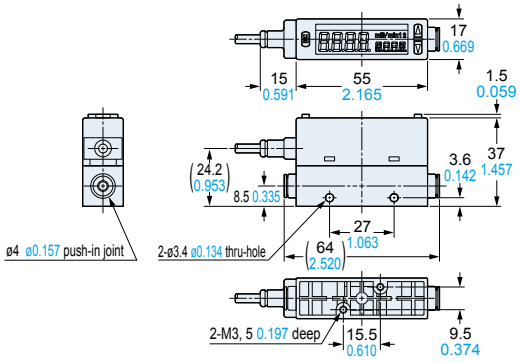
| | $P_1$(MPa) Absolute pressure | $P_1$(MPa) Gauge pressure | $P_2$(MPa) Absolute pressure | $P_2$(MPa) Gauge pressure | Acoustic velocity / Sub-acoustic velocity | Calculated flow rate value (ℓ/min) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | ø0.1 mm ø0.004 in | ø0.2 mm ø0.008 in | ø0.3 mm ø0.012 in | ø0.4mm ø0.016 in | ø0.5mm ø0.020 in | ø0.7 mm ø0.027 in | ø1.0 mm ø0.039 in | ø1.5 mm ø0.059 in | ø2.0 mm ø0.079 in |
| Suction | 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 | Sub-acoustic 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 | Sub-acoustic 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 | Sub-acoustic 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 | Sub-acoustic velocity | 0.054 | 0.215 | 0.483 | 0.859 | 1.343 | 2.631 | 5.370 | 12.083 | 21.480 |
| Blow (leakage detection) | 0.1113 | 0.01 | 0.1013 | 0 | Sub-acoustic 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 | Sub-acoustic 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 | Sub-acoustic 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 | Sub-acoustic 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 | Sub-acoustic 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 |

Notes: 1) In case of any leakage from tubes, etc., actual values will differ greatly from calculated values. When measuring flows, make sure that there is no leakage from any tubes.
2) In case of any points in the tubes which are narrower than the diameter of the suction nozzle, flow rate will be restricted and may turn out to be lower than the calculated values.
In addition, suction verification may not be possible in such cases.
3) The effective cross-section area is a guide only. If the nozzle is long and narrow, the effective cross-section area may be smaller than the area at the tip of the nozzle.
4) Response times are determined by the internal volume of the tube from the flow sensor to the suction nozzle (pinhole). If carrying out high-speed sensing, reduce the internal volume of the tube as much as possible such as by locating the flow sensor as close as possible to the suction nozzle.

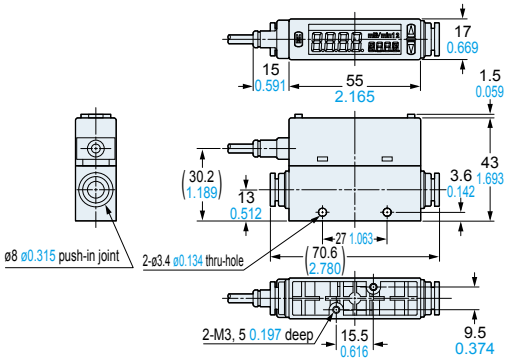
## DIMENSIONS (Unit:mm in)

The CAD data can be downloaded from our website.

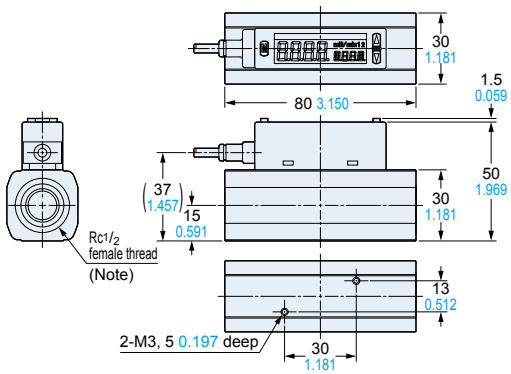
### FM-2□-4(-P) — Sensor




### FM-2□-8(-P) — Sensor

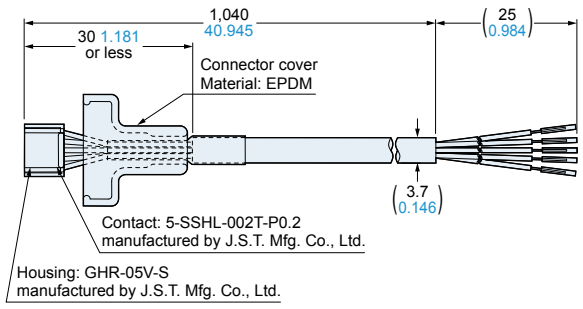



### FM-2□-A□(-P) — Sensor

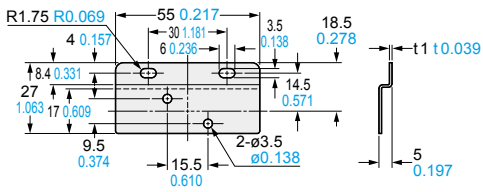



Note: **FM-2□-AG2-P** has G1/2 female thread.

### CN-F15-C1 — Connector attached cable (Accessory)

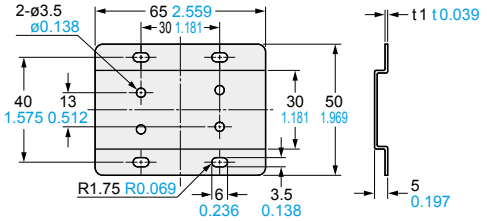



### MS-FM2-1 — Sensor mounting bracket (Optional)




Material: Cold rolled carbon steel (SPCC)(Nickel plated)
Two M3 (length 6 mm 0.236 in) screws with washers are attached.

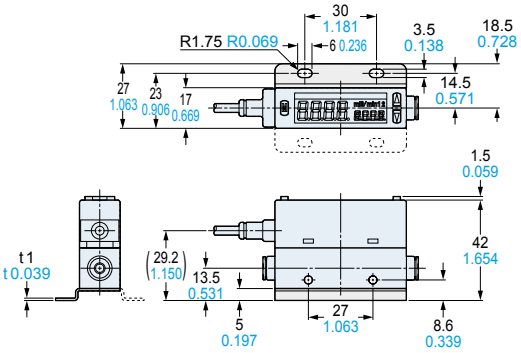
### MS-FM2-2 — Sensor mounting bracket (Optional)




Material: Cold rolled carbon steel (SPCC)(Nickel plated)
Two M3 (length 6 mm 0.236 in) screws with washers are attached.

### Assembly dimensions

Mounting drawing with **FM-252-4**




### Assembly dimensions

Mounting drawing with **FM-255-AR2**