



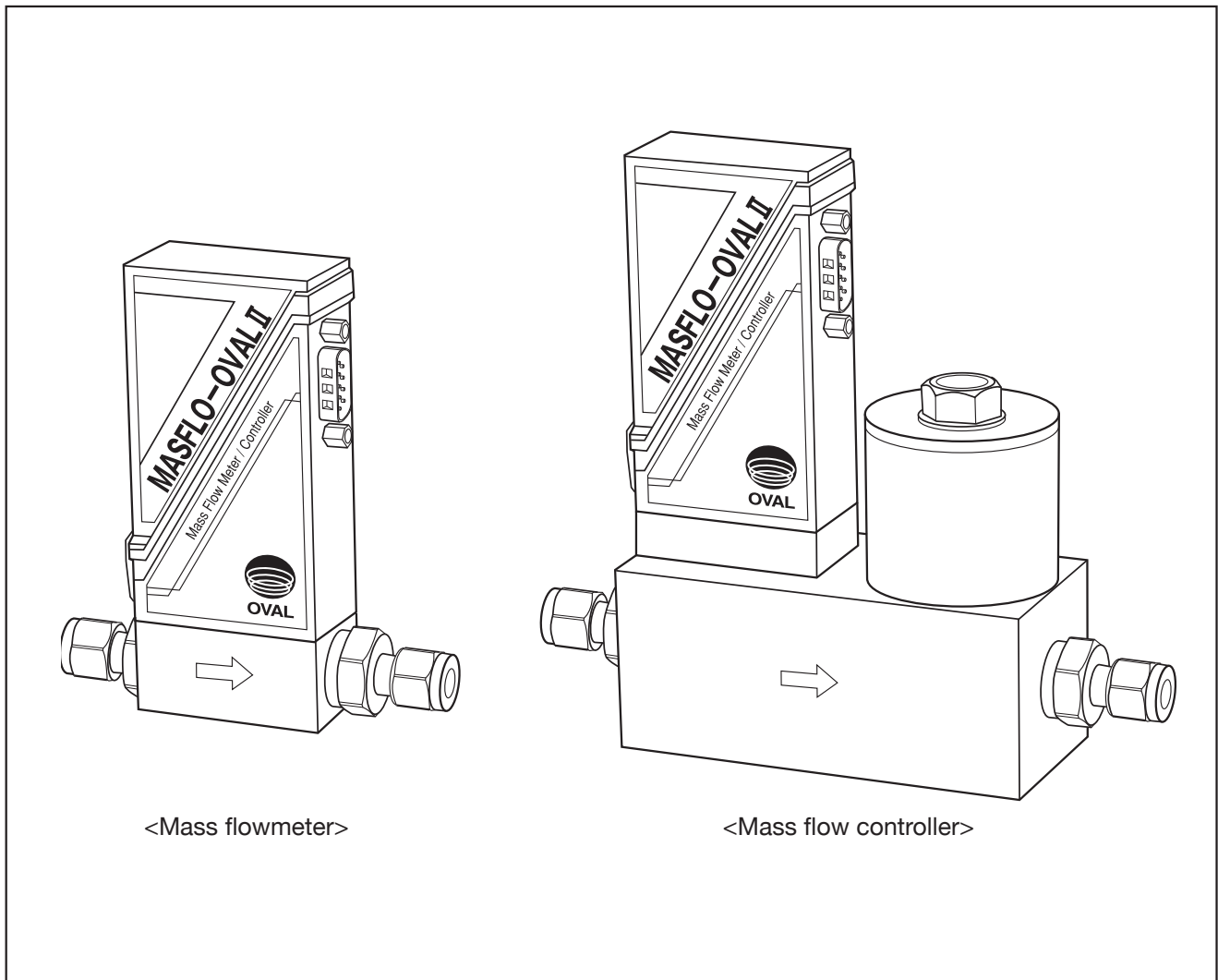
INSTRUCTIONS

Ins. No. L-513-4-E

Thermal mass flowmeter/controller

MASFLO-OVAL II

MODEL: FHA series (mass flowmeter)
FHB series (mass flow controller)



Every OVAL product is fabricated, tested, and inspected under stringent quality control before it leaves our factory.

To derive maximum benefit from the product, we recommend you to be well familiar with the information and instructions given in this manual before you place it in service and retain this manual at the field location for ready reference.

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The indications **NOTE**, **CAUTION**, and **WARNING** shown throughout this manual are to draw your attention to specific items:

➡ **NOTE**

Notes are separated from the general text to bring user's attention to important information.

⚠ CAUTION

Caution statements call attention to user about hazards or unsafe practices that could result in minor personal injury or property damage.

⚠ WARNING

Warning statements call attention to user about hazards or unsafe practices that could result in serious personal injury or death.

1. BEFORE YOU BEGIN

1.1 Confirming the specifications

- (1) When you receive this device, it should be carefully inspected for any indication of rough handling during transit.
- (2) Type and specifications are described on the name plate of flowmeter. Verify the specifications correspond to that of a product you ordered.
- (3) For specifications and handling of a control valve and readout unit etc. that is used with this device, refer to the instruction manual of the corresponding device.
- (4) In this section, instructions necessary for handling your system are described. Make yourself familiar with these instructions. If you have something to inquire, consult OVAL sales office or nearest representative.

1.2 Transportation considerations

- (1) To safeguard against damage during transit, it is suggested that this device be transported to the installation place in its original package of shipment from the factory.
- (2) During the transit, do not apply strong impact to the device or do not expose it to rainwater.

1.3 Storage considerations

This device that has been stored for extended periods of time from the date of shipment may possibly be involved in an unexpected accident. So if storage over extended periods of time is anticipated, bear in mind the following instructions;

- (1) Keep this device in its original package of shipment from the factory if circumstances permit.
- (2) Select a storage location which meets the following requirements;
 - Free from rain or water
 - Free from vibration and impact shocks
 - Place where temperature and humidity rarely change and normal temperature and normal humidity (about 25°C, 65%RH) can be kept
- (3) In case of storing this device which has once has been placed in service for any length of time, purge it with clean air or N₂ gas to ensure that no foreign object is adhered or left in the device, joints, etc.

⚠ CAUTION: Unauthorized modification will invalidate the specifications.

2. OPERATING CONDITIONS

This device needs to be used under specified conditions of fluid, flowrate range, pressure, and temperature to keep proper performance, flowrate control, and durability. These conditions are described on the name plate affixed to this device and in "Standard specifications" in this instruction manual. Be sure to verify them before operation.

The gas to be measured should be clean and dried gas that does not contain impure substances such as dust or mist.

(-20°C dew-point temperature at atmosphere pressure is a condition of dryness)

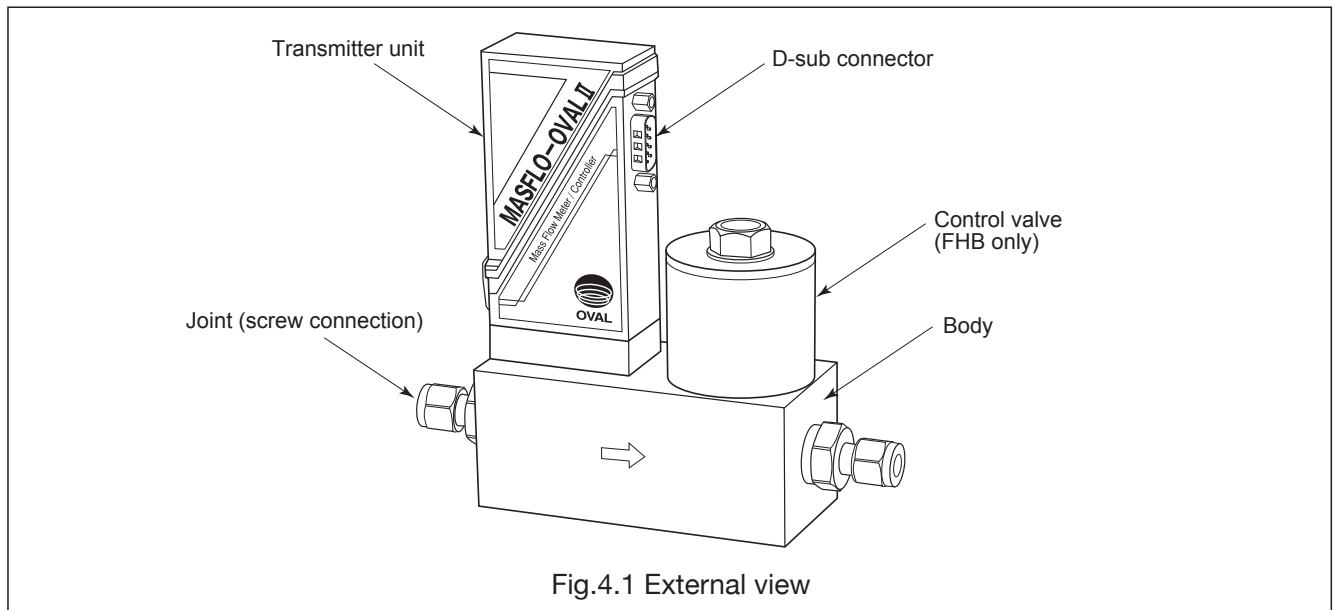
➡ NOTE: To change the operating conditions, consult OVAL sales office or nearest representative.

3. GENERAL

This device is non-explosionproof and indoor type mass flowmeter and mass flow controller. The mass flowmeter covers wide range of flowrate; 5mL/min (normal) to 500L/min (normal) and the mass flow controller covers wide range of flowrate; 7.5mL/min (normal) to 70L/min (normal).

4. PART NAMES AND FUNCTIONS

4.1 Part names

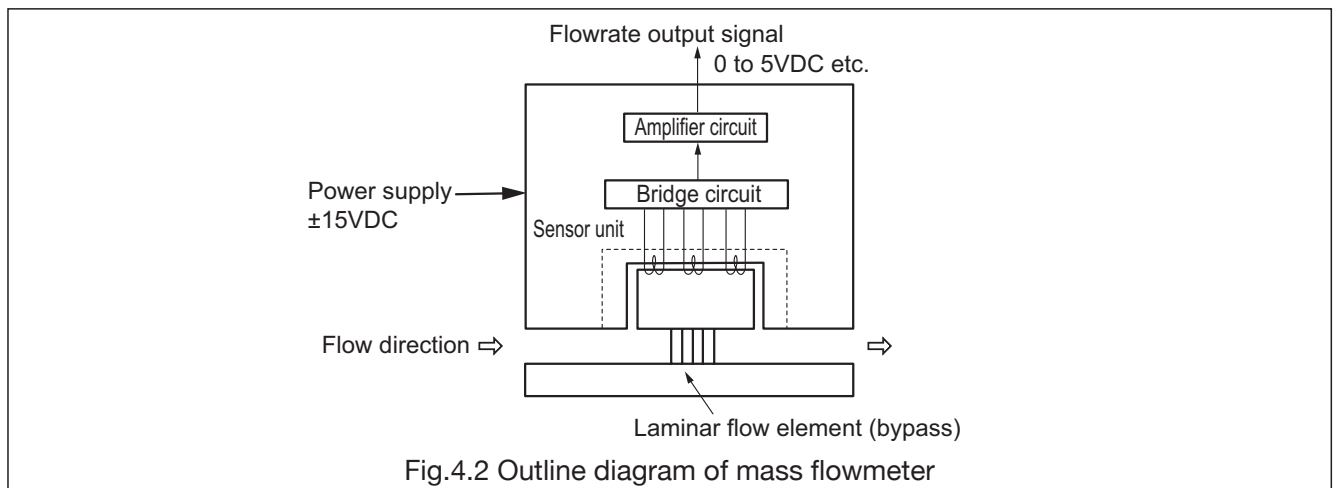


4.2 Measurement principle

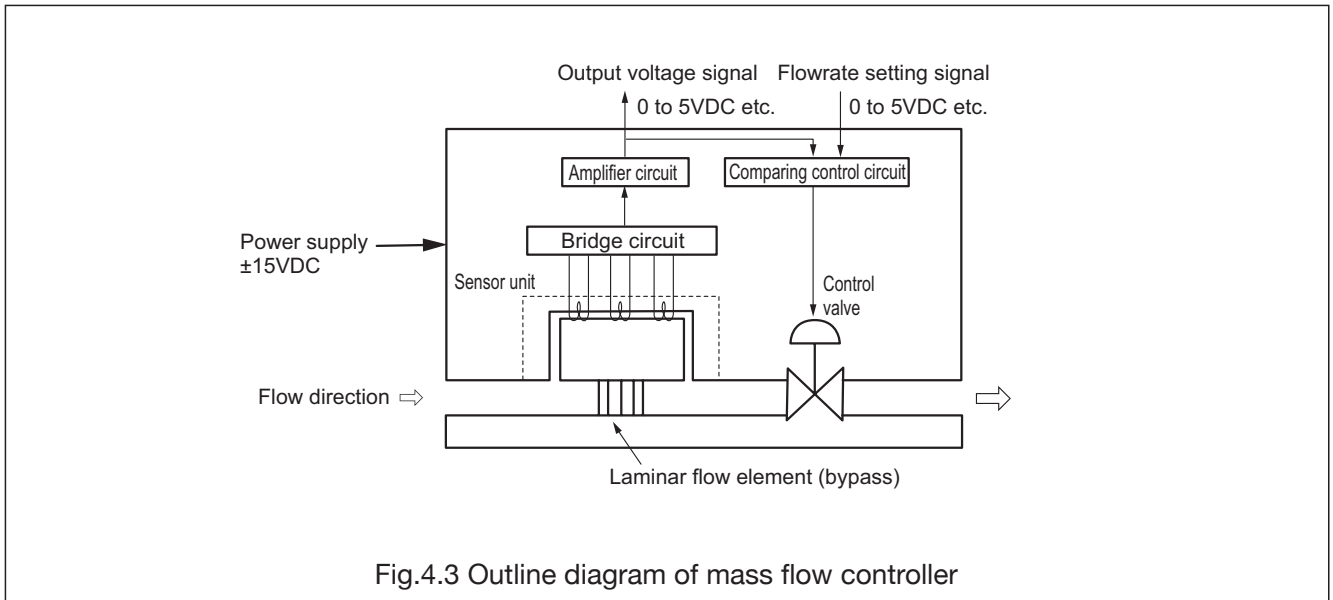
The gas introduced into the meter is divided into the sensor unit at a constant ratio by laminar flow element. Inside the sensor unit, a heater coil and temperature sensors loop around the capillary in the center and both ends, respectively. These temperature sensors make up two arms of bridge circuit (refer to Fig.4.2).

While the gas flowing through the sensors remains at rest, the heat quantity supplied by the heater coil is evenly transferred to the sensors on both sides and the balance of bridge circuit can be kept. However, once the gas begins to flow, a difference will be generated in the amount of heat transferred to the temperature sensors and an output proportional to the mass flowrate is obtained from the bridge circuit.

As the desired flowrate range can be obtained by changing the branch current ratio in the laminar flow element, it can support the desired specifications.



With the mass flow controller, a control valve is embedded in the mass flowmeter. With the signal processing circuit, a comparing control circuit embedded in addition to bridge circuit and amplifier circuit. By inputting your desired flowrate as a setting signal, the valve aperture is automatically controlled to achieve the desired flowrate.



5. INSTALLATION

5.1 Installation location

This device is for indoor use. As waterproof/dustproof construction is not adopted, be sure to avoid the installation in a place where the device will be exposed to rainwater. Install this device at a sufficiently ventilated place where the temperature rarely changes.

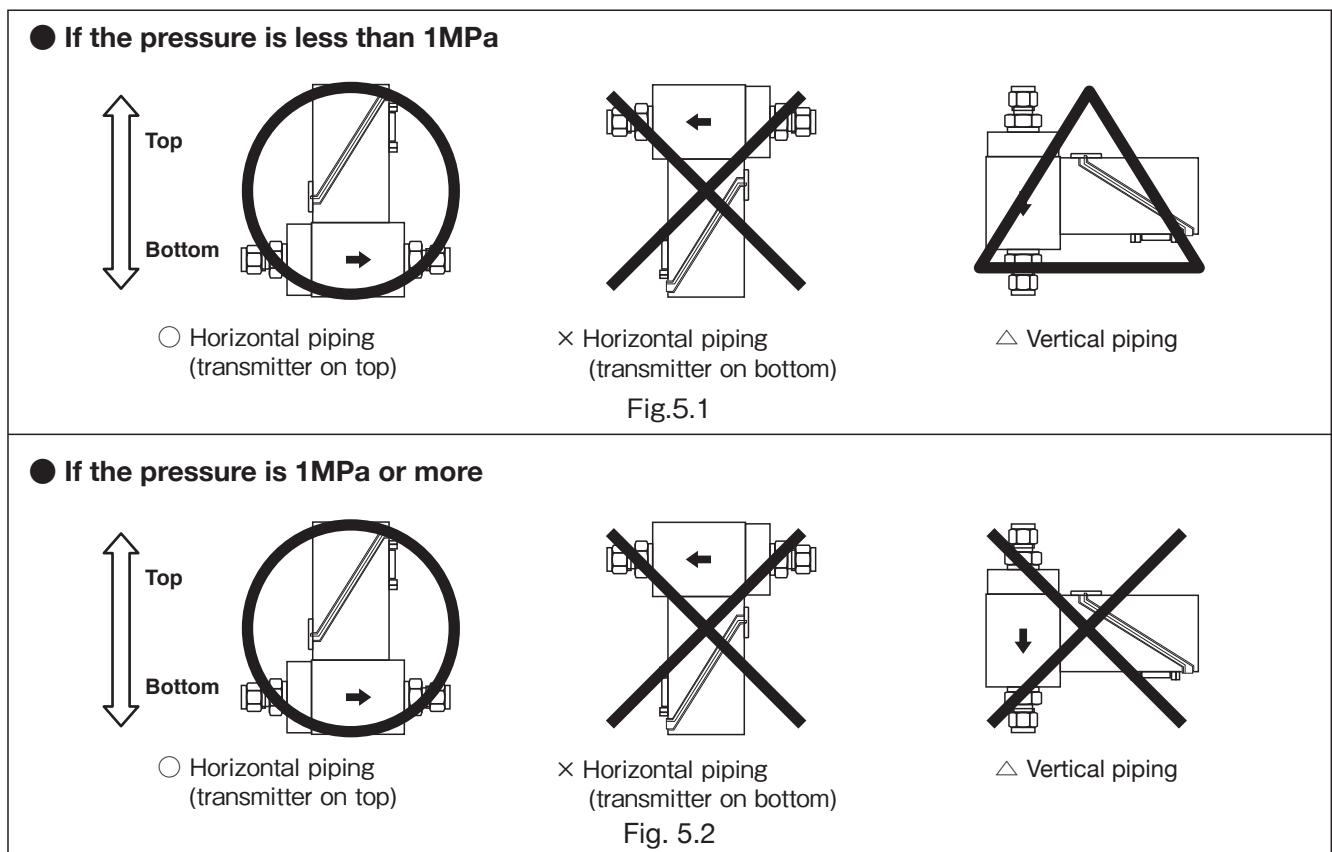
Avoid the installation at following places.

- (1) Place where vibration or shock is applied
- (2) Place where the temperature may exceed the range -10 to +70°C
- (3) Place where the temperature and humidity are high (relative humidity 90% or more)
- (4) Place that may be exposed to a substance that deteriorates the case of transmitter (material: ABS)
- (5) Place under corrosive gas atmosphere
- (6) Place near a source of electric noise or place where effects of such source are expected.

**⚠ CAUTION: As this device does not adopt the explosionproof structure, it cannot be installed in the explosionproof area.
If the explosionproof structure is necessary, use the explosionproof type (FHC, FHD series).**

5.2 Physical orientation

The performance of mass flowmeter/controller will be affected if it is installed on a vertical line. Therefore, installation on a horizontal line is recommended. In cases where pressure is 1MPa or more, the mass flowmeter/controller must be installed horizontally (Installation on vertical line is not allowed). As standard, the transmitter should be in upright position. Installation with the transmitter on the bottom is basically unavailable since it may cause clogging in sensor tube.



5.3 Meter body installation

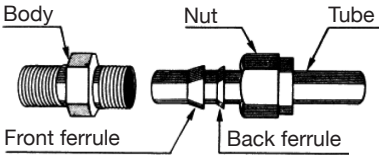
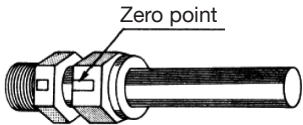
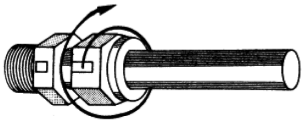
- (1) There are two attachment holes on the bottom surface of the body. Fix the device using these holes.
The screw size is M4 and the screw depth on the body is 5mm. For the dimensions, refer to the external view in section 11.
- (2) When installing, be sure to observe the physical orientation shown in the previous section. Do not mistake the inflow direction of gas.

5.4 Pipe connection

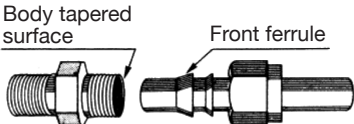
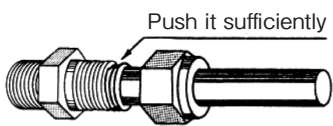
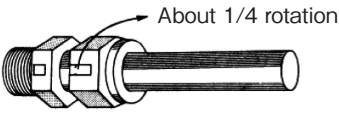
The standard pipe connection is bite-type fitting. The procedure of tightening bite-type connection is shown below.

For other connection types, refer to the standard connection method of each joint manufacturer.

(1) Tightening procedure

| | | |
|---|--|---|
| 1 |  <p>Fig.5.3</p> | <p>Tighten the body onto the meter body in advance. Verify that the joint is properly attached as shown in Fig.5.3 (pay attention to the direction of front ferrule and back ferrule).</p> |
| 2 |  <p>Fig.5.4</p> | <p>Insert the tube end sufficiently until it contacts the body. Next, tighten the nut manually until the tube stops moving. Put a counter mark on nut and body. This mark is referred to as zero point.</p> |
| 3 |  <p>Fig.5.5</p> | <p>Tighten the nut for the specified number of rotations from the zero point position using a spanner. After the tightening, verify that there is no leak.</p> <p><Specified number of rotations></p> <ul style="list-style-type: none"> - Tube diameter 1/8" : 3/4 rotation - Tube diameter other than 1/8" : 1•1/4 rotation |

(2) Re-tightening procedure after removal

| | | |
|---|--|--|
| 1 |  <p>Fig.5.6</p> | <p>Tighten the body onto the meter body in advance. Before attachment, verify there is no foreign object or flaw on the tapered surface of the body and the front ferrule.</p> |
| 2 |  <p>Fig.5.7</p> | <p>Insert the front ferrule until it contacts the tapered part of the body, and then tighten the nut securely by hand.</p> |
| 3 |  <p>Fig.5.8</p> | <p>Tighten the nut using a spanner. For the position after tightening, the zero point should be at the original position or the position after tightening the nut by 1/4 rotation. After the tightening, verify that there is no leak.</p> |

5.5 Precautions on installation

- ① Install the buffer tank with a capacity calculated by following formula.
(The capacity of upstream and downstream pipings can be treated as a capacity of buffer.)

$$V \geq \frac{0.15d^2}{\sqrt{\rho}} \quad V: \text{capacity (L)} \quad d: 7.6 \sqrt{Kv} \quad \rho: \text{density of gas (kg/Nm}^3\text{)}$$

- ② Do not directly install a pressure reducing valve at an inlet of the mass flowmeter/controller. Keep the pressure reducing valve at least 25D away from the mass flowmeter/controller. Capacity of the pressure reducing valve must be at least two times of control flowrate.
- ③ For the mass flow controller, the control valve is used and it is properly adjusted for each unit depending on the specifications. Ensure the system configuration so that the pressure on upstream side and downstream side does not exceed the specifications as much as possible.
- ④ 50 μ m filter is incorporated in a joint on gas inlet side to prevent the intrusion of dust, however, if it is used on a line where dust or mist is frequently generated, make consideration on system such as installation of approx. 5 μ m filter so that dust or mist can be removed at the previous stage. If dust or mist may be mixed due to backflow from downstream side, install approximately 5 μ m filter on downstream side too.
- ⑤ Install stop valves on both upstream and downstream of the mass flowmeter/controller. Use these stop valves to stop the flow.
- ⑥ The diameter of upstream and downstream piping should be the same as the connection diameter of the meter body as much as possible. Extreme difference in diameters may affect the performance. Ensure a straight pipe section of approximately 10D (D represents nominal diameter of piping) at the inlet.
- ⑦ Purge the piping before installing this device. For the measurement of strongly-reactive gas, such as silane-based gas, it is especially essential to purge the piping with inert gas before flowing the gas. Moreover, if the connection joint is to be disconnected and exposed to air, the piping must be purged sufficiently before disconnecting the piping connection.

⚠ CAUTION: To use this device, cleanliness of piping is necessary. Remove cutting fluid and dust after screw cutting completely (cleaning with solvent such as dichloromethane).

Make sure that there is no protrusion of sealing tape inside the piping.

- ⑧ Do not install the mass flowmeter/controller near a source of electric noise. Keep away from power sources and electric furnaces (induction heating furnaces), such as a motor, solenoid, and inverter, as much as possible since these equipments may generate noises.
Separate the device from the power supply series and grounding line of a device that consumes much electric power. Verify there is no commercial power supply line near the device.
- ⑨ This product may malfunction due to backflow of the fluid. If there is a risk of backflow, please take measures to prevent backflow such as installing a check valve.

6. PROCEDURE OF WIRE CONNECTION

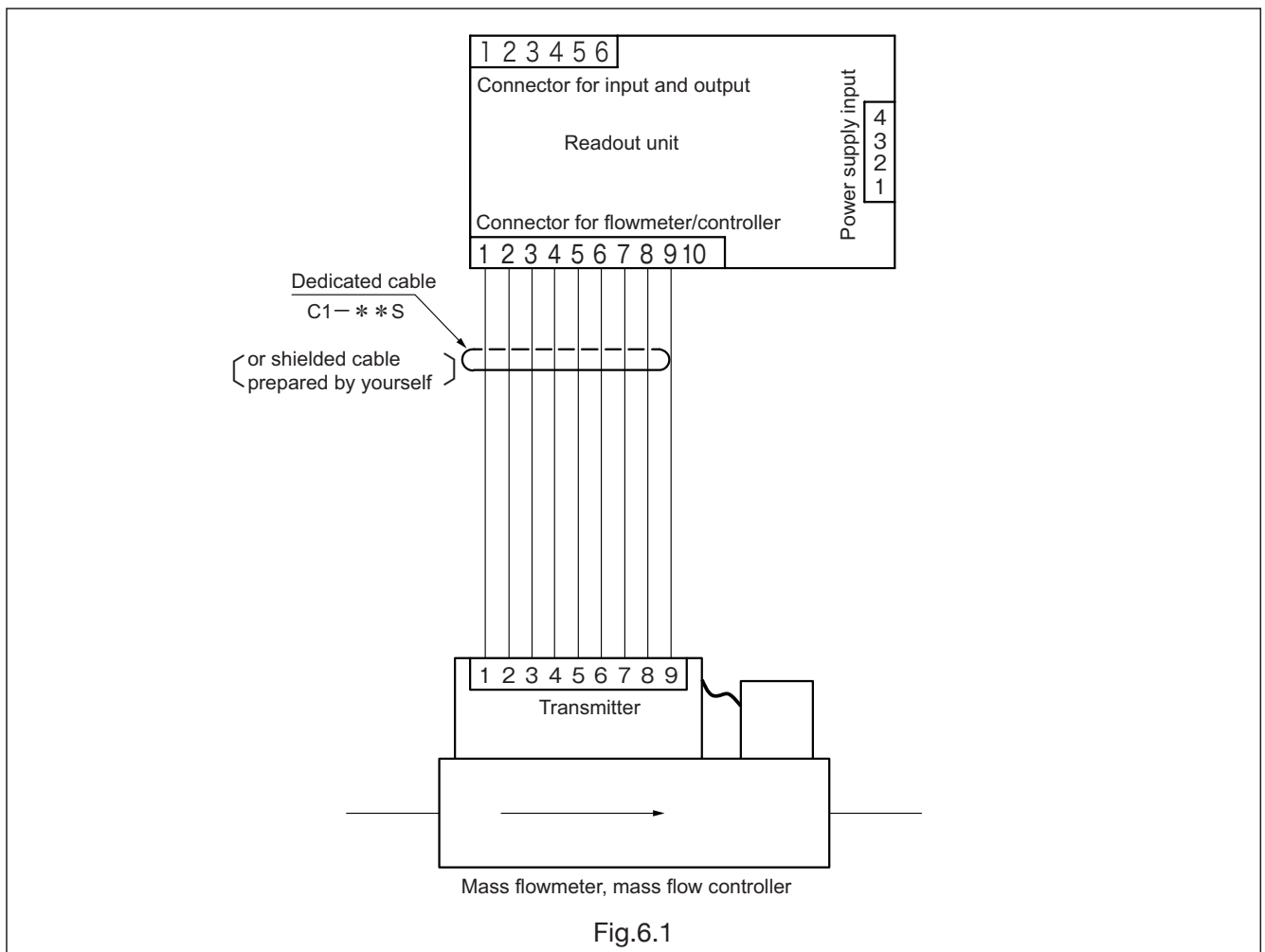
6.1 Specifications of wire connection

| Item | Description |
|--------------------------------|--|
| Electric wire connection port | D-sub connector (9-pin) |
| Standard transmission distance | Up to readout unit: max. 30m |
| Used cable | Dedicated cable (C1 cable with both-end connector) |

☞ NOTE: If 30m or more transmission distance up to readout unit is required, adopt the current output (4 to 20mA specification etc.). In this case, the transmission distance can be extended to up to 200m, however, the dedicated cable cannot be used.

Carry out the wire connection using the shielded cable whose core wire diameter is 1.25 to 2mm². (However, D-sub 9-pin connector and round connector on readout unit side do not support large core wire diameter. It is necessary to carry out the wiring using a junction terminal, etc. If the transmission distance is long and the dedicated cable cannot be used, proper consideration to the wiring is necessary.)

6.2 Connection wiring diagram



☞ NOTE: Use the dedicated cable (C1 cable) purchased at the time of order for the connection between the readout unit and the mass flowmeter/controller. Both ends are of connector connection. Secure the mass flowmeter/controller side with an accompanying connector fixing screw.

7. OPERATION

7.1 Confirmation before operation

Verify the following items before operation.

- ① Is the inflow direction of gas correct?
- ② Is the piping assembly purged sufficiently?
- ③ Are the measures against dust/mist of gas taken sufficiently?
- ④ Does the used gas correspond to the gas name shown on name plate?
- ⑤ Do the pressure conditions correspond to content shown on name plate?
- ⑥ Did you verify there is no problem in connected piping and electric connection?

7.2 Power supply and warm-up


Before turning ON the power supply, verify the leak is not generated from each connection joint. After the power supply is turned ON, carry out warm-up for approximately 30 minutes while the flow of gas is stopped. The device can be operated immediately after the power supply is turned ON, however, the accuracy is low (approximately $\pm 2\%$ FS in 2 minutes after the power supply is turned ON).

7.3 Confirming the zero

After warm-up period, verify the zero point with no gas running. If the reading value of readout unit is approximately 0.2 to 0.3%, the zero point is normal.

7.4 Startup

Verify there is no dust or mist in the piping assembly and the gas is sufficiently clean, and then run the gas and verify there is no error in flowrate measurement and flowrate control. Increase the supplied pressure gradually and avoid the sudden pressurization.

 NOTE: For the mass flow controller, open the stop valve first to start the operation. Also, when closing the stop valve, set "0" for the flowrate setting of the mass flow controller.

8. MAINTENANCE

8.1 Maintenance

Mass flowmeter and mass flow controller do not have mechanical moving part. They bring out stable performance for a long time if they are used under optimum conditions.

However, aging degradation or swelling due to component contained in the gas may be caused to the sealing parts made of rubber, such as O-ring and plunger. Consequently, to use the device safely for a long time, periodical detailed inspection at our factory is recommended. (Do not disassemble mass flowmeter and mass flow controller by yourself even for inspection because they are assembled precisely. If you disassemble the device, warranty will be invalid.

 **WARNING: Do not disassemble the device by yourself. If the maintenance is not carried out with dedicated inspection tools and by a worker with expertise, important performance related to safety may be lost.**

8.2 Troubleshooting

If problems arise while using the device, verify the device referring to the table below. If "Request the inspection" is indicated in Check item/measure, please consult OVAL sales office or nearest representative.

| Symptom | Cause | Check item/measure |
|--|--|---|
| There is no flowrate output | The power is not supplied | Check whether the voltage is properly output from $\pm 15\text{VDC}$ power supply of readout unit. |
| | Wire connection error | Check whether the wires are properly connected. |
| | Short-circuit of output | Check PC board for failure. |
| | Supply pressure or differential pressure is high | Check whether the supply pressure is within the specification range. |
| | Clogging or fixing of control valve | If the valve cannot be opened by specifying FS with flowrate setting signal to fully open the valve, request the inspection. |
| | Clogging of filter | Check the filter of inlet joint is not clogged. |
| | Infiltration of fluid, dew condensation, or liquefaction of gas | If the internal is wet when the joint is disconnected, request the inspection. |
| Output is generated when the flow is stopped | There is no error | When the stop valves upstream and downstream device are closed, and the flowrate indication is 0.2 to 0.3%, it is not an error. If the temperature is high, the output sometimes becomes high within the range of temperature characteristic, however, it is not an error. |
| | Pressure is too high or too low | Check the supply pressure is within the specification range. |
| | Effect of noise | Check whether there is a device that becomes noise source around the product. Turn OFF the power supply of device that may become noise source and verify the operation. |
| | Leak from control valve | Leak may be caused by contamination or defect of valve seal. Request the inspection. |
| The indication causes hunting | Supply pressure or differential pressure is high | Check the supply pressure is within the specification range. |
| | The reducing valve is directly connected | Check the position of reducing valve. Install it at a place at least 20D away from device. |
| | The reducing valve is oscillating | Check the operation of reducing valve and verify the pressure does not fluctuate. |
| | The position of mass flowmeter is too distant from control valve | Check the position and bring them closer as much as possible. |
| | Effect of noise | Check whether there is a device that becomes noise source around the product. Turn OFF the power supply of device that may become noise source and verify the operation. |
| | Failure of control valve | Possible failure in control valve. Request the inspection. |
| Excessive flowrate | Wrong operating condition | Check the specifications such as gas type and pressure are correct. |
| | Failure of output circuit | Check PC board for failure. |
| | Infiltration of fluid, dew condensation, or liquefaction of gas | If the internal is wet when the joint is disconnected, request the inspection. |
| The flowrate indication gradually decreases | Infiltration of fluid, dew condensation, or liquefaction of gas | If the internal is wet when the joint is disconnected, request the inspection. If the gas may be liquefied, decrease the supply pressure or heat up the gas. |
| The set flowrate is not obtained | Wrong operating condition | Check the specifications such as gas type and pressure are correct. |
| | Clogging | Check filter of inlet joint and internal of device are not clogged. If the internal of device may be clogged, request the inspection. |
| | Infiltration of fluid, dew condensation, or liquefaction of gas | If the internal is wet when the joint is disconnected, request the inspection. |
| | Failure of control valve | Possible failure in control valve. Request the inspection. |

9. EFFECT OF GAS TYPE

9.1 Conversion factor

As the mass flowmeter is affected by characteristics of gas in principle, every mass flowmeter is calibrated for type, pressure, temperature, and flowrate of gas one unit at a time. Consequently, any gases other than the gas specified at the time of order cannot be measured. However, the conversion factor is provided as a method for calibrating the effect of characteristics of gas, and it can be used to convert the flowrate when other types of gas is measured.

- ① The conversion factors of various gases are decided based on air set as 1.
- ② The conversion factor is a factor for convenience and it may not derive sufficient accuracy. The conversion by conversion factor is just a rough indication.
- ③ Use the following formula to convert the flowrate when different type of gas is used.

$$\text{Flowrate of used gas} = \text{flowrate reading} \times \frac{\text{conversion factor of used gas}}{\text{conversion factor of calibration gas}}$$

- ④ The accuracy of conversion factor (CF) is represented as shown below.

If $CF > 1$: $2 \times CF$ (%)

If $CF < 1$: $2 \div CF$ (%)

9.2 Conversion factor application example

<Example>

A mass flowmeter is calibrated for nitrogen with the full scale of 200NmL/min. When carbon dioxide is measured with this flowmeter, the flowrate reading was 80%. How much is the actual flowrate of carbon dioxide?

Referring to the section 9.1 ③, the flowrate of carbon dioxide is calculated with $CF=0.74$ of carbon dioxide and $CF=1.00$ of nitrogen as follows:

$$Q_{\text{CO}_2} = 80 \times \frac{0.74}{1.00} = 59.2$$

Consequently, 59.2% of full scale becomes the flowrate of carbon dioxide.

$$200 \times \frac{59.2}{100} = 118.4$$

∴ It follows that the flowrate of carbon dioxide is 118.4 NmL/min.

⚠ WARNING: When the density changes considerably, even if the conversion factor is similar value, it is possible that an extreme change in the branch current ratio of the laminar flow element or significant change in Kv value of the control valve causes a loss of ability to measure the specified flow range and control the flow properly.

➡ NOTE: If you want to measure a different type of gas, please consult OVAL sales office or nearest representative in advance.

9.3 Characteristics list of various gases

| No. | Name | Molecular formula | Density ρ_n [kg/Nm ³] | Specific heat under constant pressure Cp [kcal/kg·K] | Conversion factor @20°C, 1atm |
|-----|----------------------------|--------------------------------|--|--|-------------------------------|
| 1 | Acetylene (Ethyne) | C ₂ H ₂ | 1.172 | 0.438 | 0.61 |
| 2 | Air | Air | 1.293 | 0.241 | 1.00 |
| 3 | Allene (propadiene) | C ₃ H ₄ | 1.832 | 0.392 | 0.43 |
| 4 | Argon | Ar | 1.784 | 0.125 | 1.40 |
| 5 | Arsin | AsH ₃ | 3.524 | 0.133 | 0.66 |
| 6 | Butadiene (1.3-) | C ₄ H ₆ | 2.504 | 0.405 | 0.31 |
| 7 | Butene (1-) | C ₄ H ₈ | 2.581 | 0.415 | 0.29 |
| 8 | Butene (2-) (Cis) | C ₄ H ₈ | 2.503 | 0.387 | 0.32 |
| 9 | Butene (2-) (Trans) | C ₄ H ₈ | 2.503 | 0.421 | 0.30 |
| 10 | Carbonyl fluoride | COF ₂ | 2.983 | 0.194 | 0.54 |
| 11 | Carbon dioxide | CO ₂ | 1.977 | 0.213 | 0.74 |
| 12 | Carbon monoxide | CO | 1.25 | 0.249 | 1.00 |
| 13 | Cyclopropane | C ₃ H ₆ | 1.919 | 0.374 | 0.43 |
| 14 | Deuterium | D ₂ | 0.1798 | 1.73 | 1.00 |
| 15 | Dimethylpropane (2, 2-) | C ₅ H ₁₂ | 3.219 | 0.462 | 0.21 |
| 16 | Disilane | Si ₂ H ₆ | 2.857 | 0.352 | 0.31 |
| 17 | Ethylene (ethene) | C ₂ H ₄ | 1.261 | 0.414 | 0.60 |
| 18 | Ethyl acetylene (1-butyne) | C ₄ H ₆ | 2.413 | 0.401 | 0.32 |
| 19 | Helium | He | 0.1785 | 1.24 | 1.41 |
| 20 | Helium (3-) | 3He | 0.1346 | 1.606 | 1.44 |
| 21 | Hydrogen | H ₂ | 0.08991 | 3.44 | 1.01 |
| 22 | Isobutylene (Isobutene) | C ₄ H ₈ | 2.6 | 0.429 | 0.28 |
| 23 | Methane | CH ₄ | 0.7175 | 0.568 | 0.76 |
| 24 | Methyl bromide | CH ₃ Br | 4.35 | 0.118 | 0.61 |
| 25 | Neon | Ne | 0.9002 | 0.246 | 1.41 |
| 26 | Nitogen | N ₂ | 1.25 | 0.249 | 1.00 |
| 27 | Nitrous oxide | N ₂ O | 1.978 | 0.221 | 0.71 |
| 28 | Oxygen | O ₂ | 1.429 | 0.222 | 0.98 |
| 29 | Ozone | O ₃ | 2.154 | 0.207 | 0.70 |
| 30 | Tetrafluoroethylene | C ₂ F ₄ | 4.523 | 0.206 | 0.33 |
| 31 | Phosphorous pentafluoride | PF ₅ | 5.694 | 0.183 | 0.30 |
| 32 | Propylene (propane) | C ₃ H ₆ | 1.915 | 0.408 | 0.40 |
| 33 | Sulfur hexafluoride | SF ₆ | 6.626 | 0.175 | 0.27 |
| 34 | Xenon | Xe | 5.899 | 0.0382 | 1.38 |
| 35 | Propane | C ₃ H ₈ | 2.012 | 0.456 | 0.34 |
| 36 | Ethane | C ₂ H ₆ | 1.355 | 0.468 | 0.49 |

➡ NOTE: This table shows the typical characteristics of various gases and does not guarantee that all gases shown in this table can be measured.

10. SPECIFICATIONS

10.1 General specifications

| Item | Description | |
|-----------------------------|--|--|
| Turndown | 1:50 (mass flowmeter) | |
| Control range | 2 to 100% (mass flow controller) | |
| Operating temperature range | - 10 to + 70°C (no dew condensation) | |
| Maximum operating pressure | mass flowmeter FHA series | 39.2 MPa |
| | mass flow controller FHB series | 19.6 MPa |
| Accuracy | ± 1% FS (in case of calibration with actual gas) ... including linearity | |
| Reproducibility | ± 0.2% FS | |
| Response | Mass flowmeter FHA series | 1 to 3 seconds (time constant) |
| | Mass flow controller FHB series | 1 to 2 seconds (within ± 2% or setting value) |
| Temperature effect | 0.1% FS/°C | |
| Pressure effect | 0.1% RD/0.1MPa (N ₂), 0.01% RD/0.1MPa (H ₂) | |
| Zero stability | Long-term error: maximum 1%/year, temperature drift: 0.05%/°C | |
| Material | Body | SUS316 |
| | Seal | Fluoro-rubber (FKM): standard, Chloroprene rubber (CR), etc. |
| Output signal | 0 to 5VDC (standard), 1 to 5VDC, 0 to 20mADC, 4 to 20mADC | |
| Load resistance | Minimum: 2kΩ at 5V output Maximum : 375Ω at 20mA output | |
| Setting input | 0 to 5VDC (standard), 1 to 5VDC, 0 to 20mADC, 4 to 20mADC | |
| Power supply | ± 15VDC | |
| Consumption current | Mass flowmeter FHA series | 30mA at +15VDC and 30mA at -15VDC |
| | Mass flow controller FHB series | 250mA at +15VDC and 30mA at -15VDC |
| Pipe connection | Double ferrule joint type connection (standard), metal gasket surface seal joint etc. | |
| Electrical connection | D-sub connector 9-pin | |
| Construction | Non-explosionproof, indoor type | |
| Installation | Horizontal installation recommended, horizontal installation only for 1MPa or more | |
| Orientation effect | (Compared to horizontal installation) when installed vertically: Maximum 0.1% FS at 0.1MPa (N ₂ as typical example) | |
| Warm-up time | Optimum accuracy: 30 minutes or more, ±2% FS: 2 minutes or more | |

➡ NOTE: The used materials may vary depending on specifications.

10.2 Flowrate, maximum operating pressure, connection specifications

● Mass flowmeter FHA series

| Flow range NL/min (air) | Maximum operating pressure/Model code | | | | External diameter of connected tube |
|---------------------------|---------------------------------------|--------|---------|---------|-------------------------------------|
| | 0.99MPa | 9.8MPa | 19.6MPa | 39.2MPa | |
| Minimum 0.0001 to 0.005 | FHA00S | FHA10S | FHA20S | FHA30S | 1/8" (standard), 1/4", 6mm |
| Maximum 0.00015 to 0.0075 | | | | | |
| Minimum 0.00015 to 0.0075 | FHA01S | FHA11S | FHA21S | FHA31S | 1/8", 1/4" (standard), 3/8", 6mm |
| Maximum 0.3 to 15 | | | | | |
| Minimum 0.3 to 15 | — | FHA12S | FHA22S | FHA32S | 1/4" (standard), 3/8", 6mm |
| Maximum 2 to 100 | | | | | |
| Minimum 2 to 100 | — | FHA13S | FHA23S | FHA33S | 1/2" (standard), 12mm |
| Maximum 10 to 500 | | | | | |

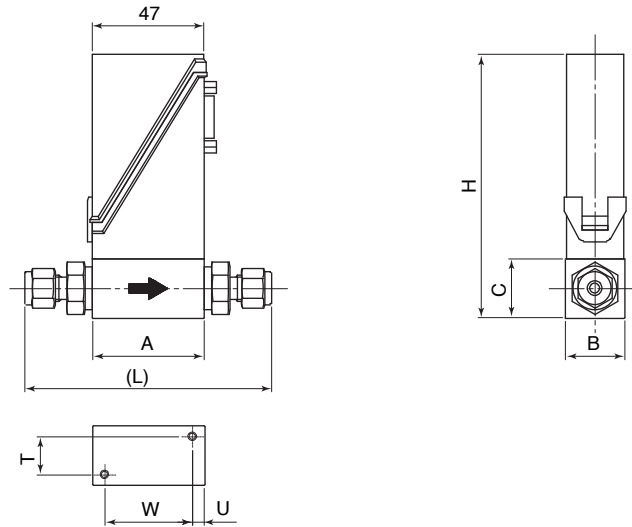
● Mass flow controller FHB series

| Flow range NL/min (air) | Maximum operating pressure/Model code | | Kv value | External diameter of connected tube |
|---------------------------|---------------------------------------|---------|---|-------------------------------------|
| | 9.8MPa | 19.6MPa | | |
| Minimum 0.00015 to 0.0075 | FHB11S | FHB21S | 1.1×10 ⁻⁵ to 6.6×10 ⁻² | 1/8", 1/4" (standard), 3/8", 6mm |
| Maximum 0.3 to 15 | | | | |
| Minimum 0.3 to 15 | FHB12S | — | | 1/4" (standard), 3/8", 6mm |
| Maximum 1.4 to 70 | | | | |

➡ NOTE: *FHB12S can support up to 100NL/min in case of hydrogen and helium.

11. EXTERNAL DIMENSION DIAGRAM

● Mass flowmeter FHA series

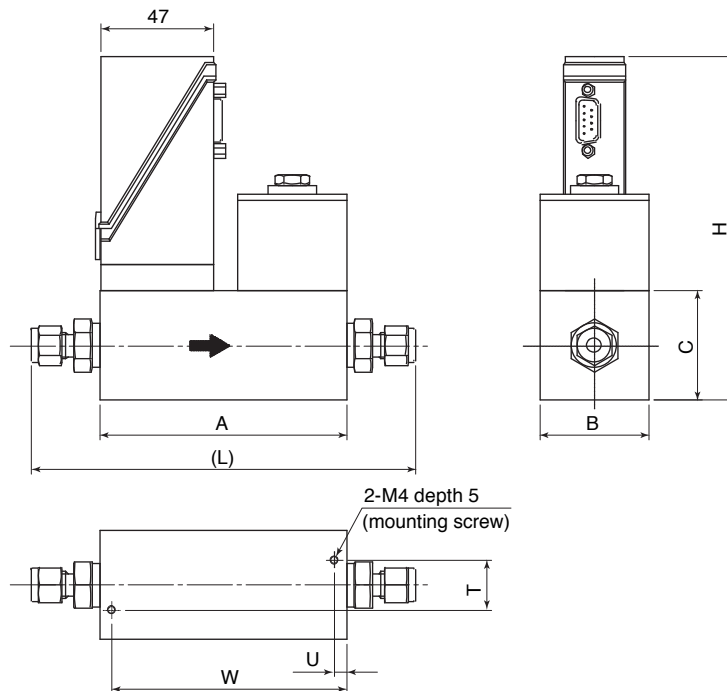


Unit: mm

| Model | A | B | C | H | (L) | T | U | W | Body internal thread | Weight (kg) |
|------------|-----|-----|-----|-----|-----|----|---|----|-------------------------|-------------|
| FHA□0S | 47 | 25 | 25 | 111 | 98 | 16 | 5 | 37 | IN : G1/4 OUT : G1/8 | 0.3 |
| FHA□1S | | | | | 103 | | | | | |
| FHA12S | 72 | 46 | 46 | 132 | 129 | 21 | 5 | 47 | G1/4 | 1.2 |
| FHA22S/32S | 91 | 65 | 65 | 151 | 148 | 23 | 5 | 50 | | 2.9 |
| FHA13S | 108 | 66 | 66 | 152 | 176 | 28 | 5 | 75 | G1/2 | 3.1 |
| FHA23S/33S | 135 | 101 | 101 | 187 | 202 | 40 | 5 | 75 | | 9.1 |

➡ NOTE: L is the referential dimension when a screw joint of standard size is used.

● Mass flow controller FHB series

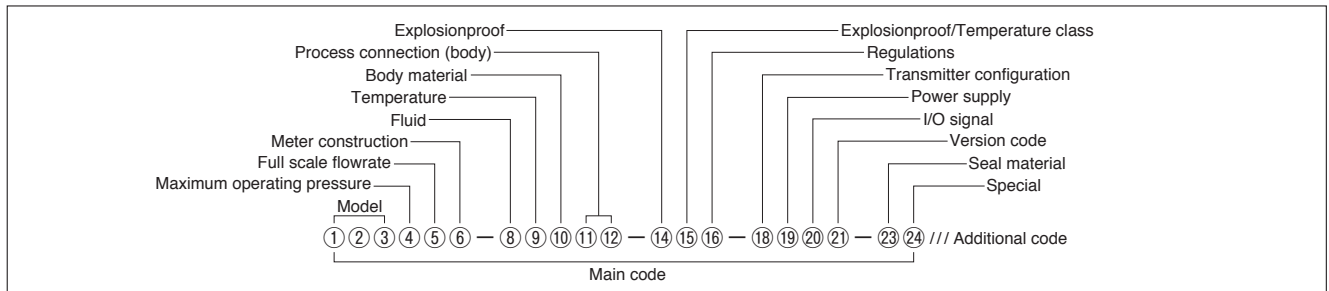


Unit: mm

| Model | A | B | C | H | (L) | T | U | W | Body internal thread | Weight (kg) |
|------------|-----|----|----|-----|-----|----|---|----|----------------------|-------------|
| FHB11S/21S | 102 | 45 | 45 | 142 | 159 | 21 | 5 | 92 | G1/4 | 2.0 |
| FHB12S | 117 | 46 | 46 | 143 | 174 | 21 | 5 | 92 | | 2.1 |

➡ NOTE: L is the referential dimension when a screw joint of standard size is used.

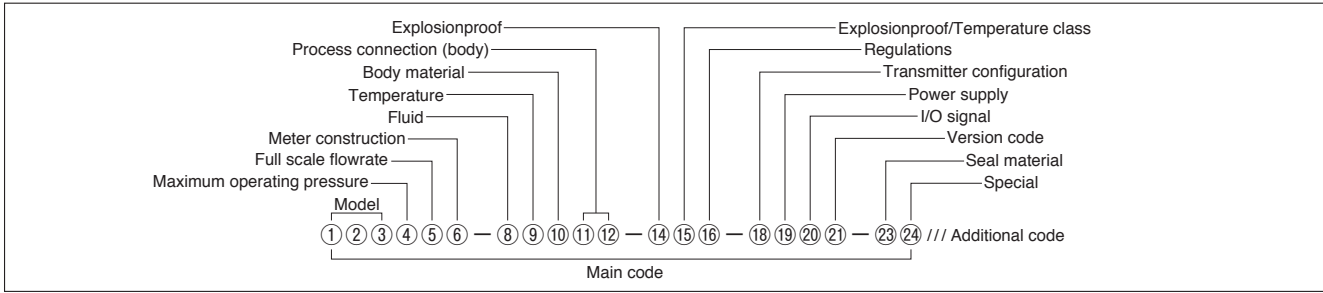
12. PRODUCT CODE EXPLANATION



●Main code

| ① | ② | ③ | Model | Combination | | | | | |
|---|--|-----------------------------------|---|--|---------|---------|--------|---------|---------|
| | | | | FHB | | FHA | | | |
| | | | | 9.8MPa | 19.6MPa | 0.99MPa | 9.8MPa | 19.6MPa | 39.2MPa |
| F | H | A | Mass flowmeter (Non-explosionproof) | | | ○ | ○ | ○ | ○ |
| F | H | B | Mass flow controller (Non-explosionproof) | | | ○ | ○ | ○ | ○ |
| ④ | Maximum operating pressure ※ 1 | | | | | | | | |
| 0 | 0.99MPa | | | | | | | | |
| 1 | 9.80MPa | | | | | | | | |
| 2 | 19.6MPa | | | | | | | | |
| 3 | 39.2MPa | | | | | | | | |
| ⑤ | Full scale flowrate | | | | | | | | |
| 0 | 7.5 mL/min (normal) at Air | | | | | ○ | ○ | ○ | ○ |
| 1 | 15 L/min (normal) at Air | | | ○ | ○ | ○ | ○ | ○ | ○ |
| 2 | 100 L/min (normal) at Air | | | △ | | | ○ | ○ | ○ |
| 3 | 500 L/min (normal) at Air | | | | | | ○ | ○ | ○ |
| ⑥ | Meter construction | | | △: Other than H2 and He, maximum is 70NL/min . | | | | | |
| S | Standard | | Welded joint is "special" | | | | | | |
| Z | Special | | | | | | | | |
| ⑦ | — | | | | | | | | |
| ⑧ | Fluid | | | | | | | | |
| G | Gas | | | | | | | | |
| ⑨ | Temperature | | | | | | | | |
| 0 | Standard | | | | | | | | |
| ⑩ | Body material | | | | | | | | |
| C | SUS316 | | | | | | | | |
| ⑪ | ⑫ | Process connection (body) | | | | | | | |
| T | G | Parallel female thread (Standard) | | | | | | | |
| Z | 9 | Special | | | | | | | |
| ⑬ | — | | | | | | | | |
| ⑭ | Explosionproof | | | | | | | | |
| 0 | Non-explosionproof | | | | | | | | |
| ⑮ | Explosionproof/Temperature class | | | | | | | | |
| 0 | Non-explosionproof | | | | | | | | |
| ⑯ | Regulations | | | | | | | | |
| 0 | Standard | | | | | | | | |
| J | High Pressure Gas Safety Act (Completion inspection) | | ※ w/Material test certificate | | | | | | |
| F | w/Material test certificate | | | | | | | | |
| ⑰ | — | | | | | | | | |
| ⑱ | Transmitter configuration | | | | | | | | |
| 1 | Integrally mounted | | | | | | | | |
| ⑲ | Power supply | | | | | | | | |
| M | ±15VDC | | | | | | | | |
| ⑳ | I/O signal | | | | | | | | |
| A | Analog signal | | | | | | | | |
| ㉑ | Version code | | | | | | | | |
| A | Version code: A | | | | | | | | |
| ㉒ | — | | | | | | | | |
| ㉓ | Seal material | | | | | | | | |
| 1 | Fluoro-rubber (FKM) | Viton | | | | | | | |
| 2 | Chloroprene rubber (CR) | Neoprene | | | | | | | |
| 3 | Perfluoroelastomer (FFKM) | Kalrez | | | | | | | |
| 4 | Combination of several | | | | | | | | |
| 5 | Special | | | | | | | | |
| ㉔ | Special | | | | | | | | |
| N | Non (Standard) | | | | | | | | |
| Z | Special | | | | | | | | |

※ 1 : Maximum operating pressure could become lower depending on the requirement of applicable Japan law.



●Additional code

| Double ferrule bite type joint ※Must choose | | | |
|--|---|---|---|
| S | W | 1 | Tube outer diameter: 1/8" |
| S | W | 2 | Tube outer diameter: 1/4" |
| S | W | 3 | Tube outer diameter: 3/8" |
| S | W | 4 | Tube outer diameter: 1/2" |
| S | W | 5 | Tube outer diameter: 3/4" |
| S | W | 6 | Tube outer diameter: 6mm |
| S | W | 7 | Tube outer diameter: 8mm Special size |
| S | W | 8 | Tube outer diameter: 10mm Special size |
| S | W | 9 | Tube outer diameter: 12mm |
| Pressure-proof cable led-in clasp ※Must choose | | | |
| J | F | 0 | Non |
| Dedicated cable ※Must choose | | | |
| C | 0 | S | No C1 cable (Non-explosionproof). Choose "No" when special length is required |
| C | 1 | S | C1-03S Both ends connector |
| C | 2 | S | C1-05S Both ends connector |
| C | 3 | S | C1-10S Both ends connector |
| C | 4 | S | C1-15S Both ends connector |
| C | 5 | S | C1-20S Both ends connector |
| C | 6 | S | C1-30S Both ends connector |
| C | 1 | Z | C1-03Z Receiver side loose end |
| C | 2 | Z | C1-05Z Receiver side loose end |
| C | 3 | Z | C1-10Z Receiver side loose end |
| C | 4 | Z | C1-15Z Receiver side loose end |
| C | 5 | Z | C1-20Z Receiver side loose end |
| C | 6 | Z | C1-30Z Receiver side loose end |
| Category of High Pressure Gas ※Must choose | | | |
| H | P | 0 | Other than High Pressure Gas |
| H | P | 1 | Toxic gas and flammable gas Threaded joint inapplicable |
| H | P | 2 | Toxic gas Threaded joint inapplicable |
| H | P | 3 | Flammable gas |
| H | P | 4 | Other than toxic or flammable gas |
| Accuracy ※Must choose | | | |
| F | 1 | 0 | ±1.00% FS |
| Special test (instrumental error) ※Must choose | | | |
| A | 0 | 3 | Calibration test Measured fluid: other than hydrogen, helium |
| A | 0 | 4 | Calibration test (hydrogen, helium) |
| A | 9 | 9 | Designated calibration test method Addition of a test fluid, etc. |
| Connector position ※Must choose | | | |
| F | L | 2 | Right side of D-sub connector Flow direction: left to right |
| Cleansing | | | |
| T | W | 0 | Oil free and Water free treatment |

※1: Need not choose the item when required to implement in Japan law and regulation. Only for items other than the legal requirement, customer can choose as special requirement.

| Document | | | |
|--------------|---|---|--|
| D | S | J | SPEC. & DWG (Approval Drawing) (Japanese) |
| D | S | E | SPEC. & DWG (Approval Drawing) (English) |
| D | R | 0 | Re-submission of SPEC. & DWG |
| D | C | J | Final DWG (Japanese) |
| D | C | E | Final DWG (English) |
| D | P | J | Strength Calculation sheet (Japanese) |
| D | P | E | Strength Calculation sheet (English) Unavailable for the Japan law compliant |
| S | E | J | Inspection Certificate (Calibration report) (Japanese) |
| S | E | E | Inspection Certificate (Calibration report) (English) |
| S | T | J | Pressure test report (Japanese) |
| S | T | E | Pressure test report (English) |
| S | A | J | Airtight test report (Japanese) |
| S | A | E | Airtight test report (English) |
| D | D | J | Dimensional check record (Japanese) |
| D | D | E | Dimensional check record (English) |
| S | P | J | Penetrant test report (Japanese) Welded part of pressure resistant vessel ※1 |
| S | P | E | Penetrant test report (English) Welded part of pressure resistant vessel ※1 |
| D | Y | J | WPS/PQR (Japanese) |
| D | Y | E | WPS/PQR (English) |
| D | 9 | J | Photo (Japanese) |
| D | 9 | E | Photo (English) |
| D | T | J | Inspection procedure (Japanese) |
| D | T | E | Inspection procedure (English) |
| C | A | J | Traceability certificate: A set Only available in Japanese |
| C | B | J | Traceability certificate: B set Only available in Japanese |
| C | C | J | Traceability certificate: C set Only available in Japanese |
| C | D | J | Traceability certificate: D set Only available in Japanese |
| Witness Test | | | |
| V | 1 | 0 | Required |

13. FORMER PRODUCT CODE EXPLANATION

The new product code has been implemented since April 2017.
Therefore, the product code explanation of the old product code will not be updated after April 2017.
Consult OVAL sales office or nearest representative if you wish to order with the old product code for reasons such as type approval.

| Item | Product Code | | | | | | | | | | | | | | | | | | | | Description | | | | | | | |
|--|----------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|-------------|---|---|---|-----|--|--|---------|
| | ① | ② | ③ | ④ | ⑤ | ⑥ | - | ⑦ | ⑧ | ⑨ | ⑩ | ⑪ | - | ⑫ | ⑬ | ⑭ | - | ⑮ | ⑯ | ⑰ | | ⑱ | - | ⑳ | ㉑ | | | |
| Model | F | H | A | | | | | | | | | | | | | | | | | | | | | | | Mass flowmeter (non-explosionproof) | | |
| | F | H | B | | | | | | | | | | | | | | | | | | | | | | | | Mass flow controller (non-explosionproof) | |
| Capacity | Maximum operating pressure | 0 | | | | | | | | | | | | | | | | | | | | | | | | 0.99MPa | | |
| | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 9.80MPa | |
| | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | 19.6MPa |
| | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | 39.2MPa |
| | Full scale flowrate | 0 | | | | | | | | | | | | | | | | | | | | | | | | | 7.5mL/min (normal) @Air | |
| | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 15L/min (normal) @Air | |
| | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | 100L/min (normal) @Air | |
| | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | 500L/min (normal) @Air | |
| Meter construction | S | - | | | | | | | | | | | | | | | | | | | | | | | | Standard | | |
| | Z | - | | | | | | | | | | | | | | | | | | | | | | | | Special | | |
| Fluid | | | | | | | G | | | | | | | | | | | | | | | | | | | Gas | | |
| Temperature | | | | | | | | 0 | | | | | | | | | | | | | | | | | | Standard | | |
| Body material | | | | | | | | | C | | | | | | | | | | | | | | | | | SUS316 | | |
| | | | | | | | | | Z | | | | | | | | | | | | | | | | | Other | | |
| Process connection (body) | | | | | | | | | T | G | - | | | | | | | | | | | | | | | Parallel female thread (standard) | | |
| | | | | | | | | | Z | 9 | - | | | | | | | | | | | | | | | Other | | |
| Explosionproof/Temperature class | | | | | | | | | | | | | 0 | 0 | | | | | | | | | | | | Non-explosionproof | | |
| Regulations | | | | | | | | | | | | | | | | | | | | | | | | | | 0 - | None | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | J - | High Pressure Gas Safety Act (completion inspection) | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | F - | With material test report | |
| Power, transmitter configuration, etc. | | | | | | | | | | | | | | | | | | | | | | | | | 1 M | Power: ±15VDC, Transmitter: integrally mounted | | |
| I/O signal | | | | | | | | | | | | | | | | | | | | | | | | | A | Analog signal | | |
| Version | | | | | | | | | | | | | | | | | | | | | | | | | A - | Version A | | |
| Sealing material | | | | | | | | | | | | | | | | | | | | | | | | | 1 | Fluoro-rubber (FKM) | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | 2 | Chloroprene rubber (CR) | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | 3 | Perfluoroelastomer (FFKM) | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | 4 | Combination of several | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | 5 | Other than above | | |
| Customer specific specifications | | | | | | | | | | | | | | | | | | | | | | | | | N | None (standard) | | |

All specifications are subject to change without notice for improvement.

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