172-65091M-00 (VFM Vortex Flowmeter Transmitter) 17 September 2001

ISO 9001/ ISO 14001

Manufacturer

TLV CO., LTD.

Kakogawa, Japan

is approved by LRQA LTD. to ISO 9001/14001

TLV®

Instruction Manual

Vortex Flowmeter Transmitter

VFM

Contents

Introduction

Thank you for purchasing the TLV vortex flowmeter transmitter.

This product has been thoroughly inspected before being shipped from the factory. When the product is delivered, before doing anything else, check the specifications and external appearance to make sure nothing is out of the ordinary. Also be sure to read this manual carefully before use and follow the instructions to be sure of using the product properly.

If detailed instructions for special order specifications or options not contained in this manual are required, please contact TLV for full details.

This instruction manual is intended for use with the model(s) listed on the front cover. It is necessary not only for installation, but for subsequent maintenance, disassembly/reassembly and troubleshooting. Please keep it in a safe place for future reference.

Safety Considerations

- Read this section carefully before use and be sure to follow the instructions.
- Installation, inspection, maintenance, repairs, disassembly, adjustment and valve opening/closing should be carried out only by trained maintenance personnel.
- The precautions listed in this manual are designed to ensure safety and prevent equipment damage and personal injury. For situations that may occur as a result of erroneous handling, three different types of cautionary items are used to indicate the degree of urgency and the scale of potential damage and danger: DANGER, WARNING and CAUTION.
- The three types of cautionary items above are very important for safety: be sure to observe all of them as they relate to installation, use, maintenance and repair. Furthermore, TLV accepts no responsibility for any accidents or damage occurring as a result of failure to observe these precautions.

Symbols

	**Indicates a DANGER, WARNING or CAUTION item.**
	Indicates an urgent situation which poses a threat of death or serious injury
	Indicates that there is a potential threat of death or serious injury
	Indicates that there is a possibility of injury or equipment / product damage

	**DO NOT use this product outside the recommended operating pressure, temperature and other specification ranges.** Improper use may result in such hazards as damage to the product or malfunctions that may lead to serious accidents. Local regulations may restrict the use of this product to below the conditions quoted.
	Use hoisting equipment for heavy objects (weighing approximately 20 kg or more). Failure to do so may result in back strain or other injury if the object should fall.
	Take measures to prevent people from coming into direct contact with product outlets. Failure to do so may result in burns or other injury from the discharge of fluids.
	When disassembling or removing the product, wait until the internal pressure equals atmospheric pressure and the surface of the product has cooled to room temperature. Disassembling or removing the product when it is hot or under pressure may lead to discharge of fluids, causing burns, other injuries or damage.

Safety considerations are continued on the next page.

⚠ CAUTION	**Be sure to use only the recommended components when repairing the product, and NEVER attempt to modify the product in any way.** Failure to observe these precautions may result in damage to the product and burns or other injury due to malfunction or the discharge of fluids.
	Do not use excessive force when connecting threaded pipes to the product. Over-tightening may cause breakage leading to fluid discharge, which may cause burns or other injury.
	Use only under conditions in which no freeze-up will occur. Freezing may damage the product, leading to fluid discharge, which may cause burns or other injury.
	Use only under conditions in which no water hammer will occur. The impact of water hammer may damage the product, leading to fluid discharge, which may cause burns or other injury.
	Make sure the power supply is OFF before carrying out work on the wiring or inspections involving disassembly. If such work is carried out with the power on, there is a danger that equipment may malfunction or electric shock may occur, leading to injury or other accidents.
	Make sure that wiring work requiring a special license is carried out only by qualified personnel. If carried out by unqualified personnel, overheating or short circuits leading to injury, fires, damage or other accidents may occur.

Handling Precautions

1. Verifying the Specifications

1) When the unit is received, it should be thoroughly inspected for any signs of damage incurred during transit.
2) The model and specifications are shown on the nameplate of the flowmeter. Check to confirm that these are the specifications that were ordered.

2. Transporting the Product

1) If at all possible, transport the product to the installation site in the original packaging in which it was shipped from TLV.
2) During transport, avoid subjecting the product to strong impacts or shocks and make sure that the product does not become exposed to rain.

3. Storing the Product

1) If at all possible, store the product in the original packaging in which it was shipped from TLV.
2) Select a location for storage that meets the conditions set forth below.
   - A location in which it will not be exposed to rain or water
   - A location in which it is subjected to minimal vibration or impacts
   - A location that undergoes only slight fluctuations in temperature and humidity (approximately 25°C and 65%)
3) When storing a flowmeter that has previously been placed into service, thoroughly purge the interior to ensure that none of the metered fluid remains pooled inside or adhering to the interior walls. Furthermore, measures should be taken for protecting the electrical wiring connections from exposure to moisture.

<Caution> Without exception, any modification made to the product will result in loss of warranty coverage.

Operating Conditions

In order to ensure the high precision and maintain the long service life of this flowmeter, it must be used only within the rated capacity, pressure and temperature conditions. The rated conditions are listed on the nameplate, which is located on the flowmeter's transducer. Please read the nameplate carefully before operating the product.

General Description

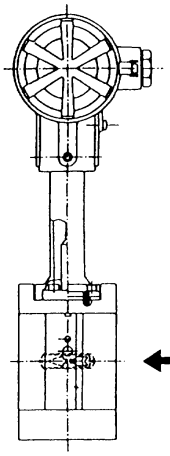
The VFM flowmeter employs a piezoelectric sensor. Von Karman vortices proportional to the rate of flow form and shed alternately downstream and on either side of the triangular bluff body (vortex shedder) that is place perpendicularly to the stream of flow.

These von Karman vortices are detected by the piezoelectric sensor, allowing the flow rate to be measured.

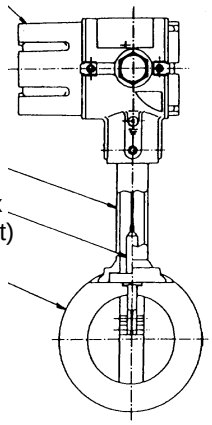
<Features>

1) High precision metering over a wide flow measurement range.
2) The piezoelectric sensor's isolation from direct contact with the metered fluid and the simple construction with no moving parts lead to superior durability.
3) No age-induced deterioration of accuracy even with extended use.
4) A wide temperature and pressure range. Suitable for use with most fluids, including liquids, gases and steam.
5) An energy-saving design with only a small pressure loss across the meter.

Components and their Functions

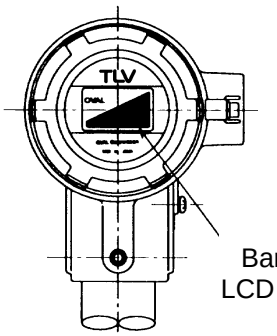


Direction of Flow



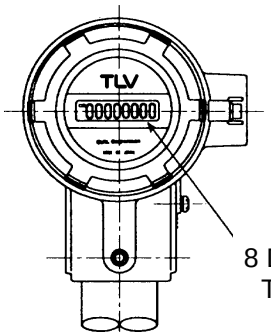
5) Transducer (with Indicator), (with Totalizer)

Indicator



Bar Graph LCD Indicator

Totalizer



8 Digit LCD Totalizer

1) Meter Body
This contains a sensor pipe and a bluff body (triangular element). The stream of measured fluid strikes the triangular bluff body and von Karman vortices are shed.

2) Sensor (Vortex Sensing Element)
The vortex sensor has an integrated piezoelectric element.
All parts that come into contact with the measured medium are made of stainless steel for superior durability. (Parts are identical for nominal diameters 40 mm and greater.)

3) Pipe Stand
This connects the meter body and the transducer. It serves the function of protecting the sensor and radiates excess heat.

4) Transducer
This converts the electrical charge change generated by the sensor into a flow rate output signal.
The interior contains an input board, an amplifier board and an output board.
There are two types of transducers; pulse type output and analog type output .

5) Transducer (w. Indicator), Transducer (w. Totalizer)
It is possible to modify the angle of the transducer unit in increments of 90° around the axis of the sensor pipe.
It is also possible to rotate the angle of the indicator within the transducer in increments of 90°.

Piping Instructions

CAUTION

Use only under conditions in which no water hammer will occur. The impact of water hammer may damage the product, leading to fluid discharge, which may cause burns or other injury.

For general precautions, please see JIS Z 8766, “Methods for Measuring Flow Rate using a Vortex Flowmeter”

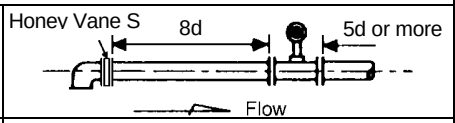
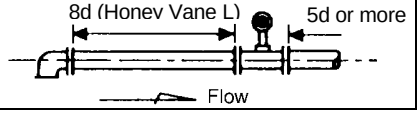
1. Standard Piping Conditions

As a general rule, it is required that the flow profile of the fluid medium at the inlet of an inferential flowmeter be as uniform and stable as possible to ensure accurate measurement by the flowmeter. In order to achieve this, it is necessary that flow-conditioning measures be taken at the time of flowmeter installation.

Downstream: Secure a straight run of piping of a length of 5d (5 pipe diameters) or greater downstream of the flowmeter.

Upstream: Take measures as follows:

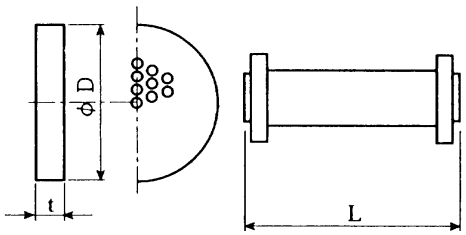
1) Using flow conditioners supplied by TLV
(applicable for piping with nominal diameters 25 mm or greater) d = nominal diameter

No.			Remarks
1	Honey Vane S		Honey vane S and 8d straight piping; refer to dimensions shown below
2	Honey Vane L		Honey vane L alone; refer to dimensions shown below

Honey Vane Dimensions

Units: mm

Size (mm)	ϕD*	Honey Vane S	Honey Vane L
		t	L
25	74	3.5	200
32	85	4.6	256
40	89	5.4	320
50	104	6.9	400
80	134	10.2	640
100	159	13.3	800
150	220	19.6	1200
200	270	26	1600
250	333	32.3	2000
300	378	38.7	2400



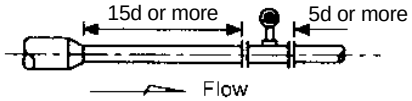
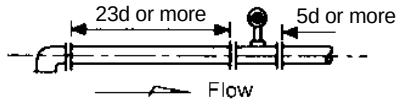
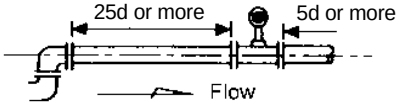
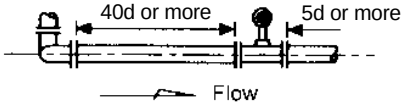
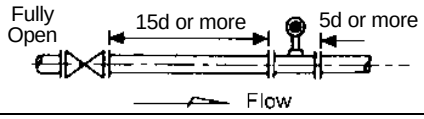
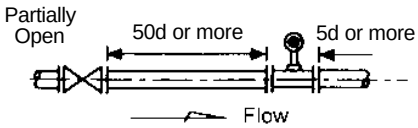
Honey Vane S Honey Vane L

* Dimensions for JIS10K

2) No flow conditioners are used

Use a straight run of Schedule 40 pipe that is of the same diameter as the internal diameter of the flowmeter.

(Length of Straight Pipe Based on ISO-5167) d = nominal diameter

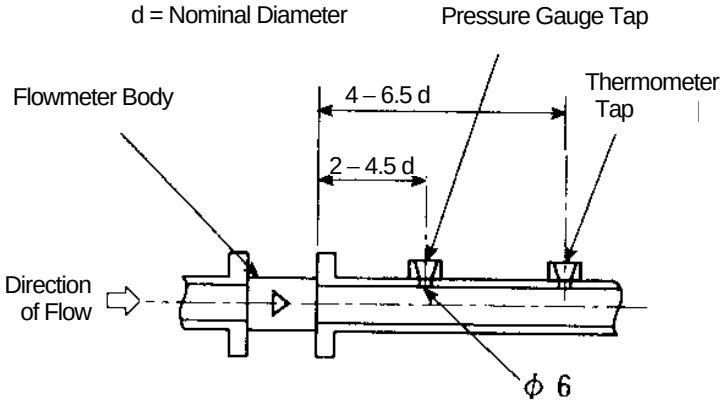
No.			Remarks
1	Reducer		When there is a concentric reducer upstream of the meter
2	Elbow		When there is an elbow upstream of the meter
			When there are two elbows horizontally upstream of the meter
			When there are two elbows vertically upstream of the meter
3	Fully open shutoff valve		When there is a fully open shutoff valve upstream of the meter
4	Partly open shutoff valve		When there is a partly open shutoff valve, sudden constriction or other factor that greatly disturbs the flow upstream of the meter

2. Pipe Standard Specification

Use piping of nominal wall thickness Schedule 40 for the piping upstream and downstream of the flowmeter.

3. Pressure Gauge Tap and Thermometer Tap

When a pressure gauge tap and/or a thermometer tap are required, locate them downstream of the meter, as shown in the figure below.



4. Pulsating Influences

Performance may be adversely affected if there is a large amount of pulsating pressure from compressors and/or root blowers being used as air blowers. Use the formula below to reduce the pulsating pressure as much as possible.

$N < 2.25 \rho v^2$ (mm H_2O)

N = pulsating pressure (mm H_2O)
ρ = density (kg/m^3)
V = minimum velocity (m/s)

If the pulsating pressure is excessive ($N \geq 2.25 \rho v^2$), corrective measures such as the following are required:

1) Move the source of the pulsations to the downstream side of the meter.
   Alternatively, put as much distance as possible between it and the flowmeter.
2) Install a pulsation dampener such as a chamber.
3) Close the valves before and after the flowmeter when there is no flow.
   (This is to prevent false non-zero readings under zero-flow conditions.)

5. Prevention of Cavitation (With Liquids)

To prevent the occurrence of cavitation when using liquid mediums, ensure a line pressure of at least the value calculated using the formula below.

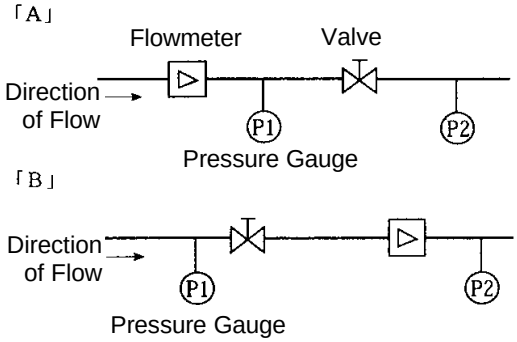
$P \geq 2.60\Delta P + 1.25P_O$ (MPa abs)

ΔP = pressure loss (MPa) $\approx 2.4 \cdot \rho/2g \cdot V^2 \times 10^{-4}$
P_O = vapor pressure of the liquid (MPa abs)
ρ = density (kg/m^3)
V = flow velocity (m/s)
g = acceleration due to gravity (9.8m/s^2)

6. Prevention of Excessive Flow Rates

To ensure long service life for the flowmeter, excessive instantaneous flow rates should be held under 1.6 times the flow meter's maximum flow rate.

When measuring steam using the method shown in the examples, special care is necessary, as excessive instantaneous flow rates often occur.



Examples of Flow Rates Momentarily Exceeding the Flowmeter's Maximum Flow Rate

When measuring steam when piping pressure P1>P2, if the valve is opened suddenly the flow rate is dependent on the resistance (principally the degree of valve opening in the case of A, and flowmeter resistance in the case of B) in the pipeline. The resulting flow rate is the computed using the capacity of the downstream pipeline and the consumption. However, when the pressure differential across the valve is large, the velocity of the fluid can easily reach the velocity of sound, resulting in an excessive instantaneous flow rate. (This example often occurs at equipment start-up.)

7. Prevention of Mixed Phase Flow

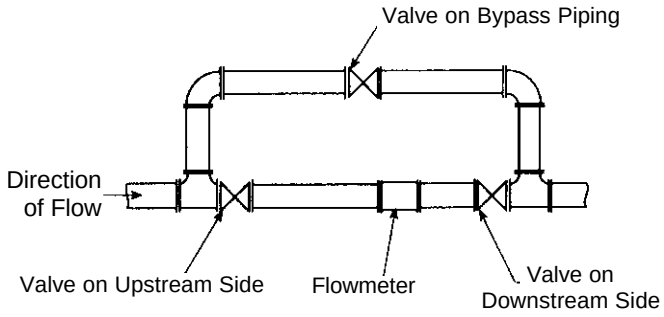
This flowmeter is designed to measure both gas and liquids. However, accurate measurement cannot be obtained when gases and liquids are mixed together (i.e. gas-liquid mixed phase flow).

8. Ensure that the Piping is Full of Liquid

When measuring liquids, make sure that the pipes are completely flooded with liquid. If the piping is not completely flooded, avoid installing in locations where air pockets are likely to occur.

9. Bypass Lines

The installation of bypass lines can facilitate maintenance and inspections. When installing a bypass line, use upstream and downstream valves of a type that does not disturb the flow profile, such as ball valves (full bore type).



Installation Procedure

CAUTION **Use hoisting equipment for heavy objects (weighing approximately 20 kg or more). Failure to do so may result in back strain or other injury if the object should fall.**

CAUTION **Take measures to prevent people from coming into direct contact with product outlets. Failure to do so may result in burns or other injury from the discharge of fluids.**

CAUTION **DO NOT use this product outside the recommended operating pressure, temperature and other specification ranges. Improper use may result in such hazards as damage to the product or malfunctions which may lead to serious accidents. Local regulations may restrict the use of this product to below the conditions quoted.**

CAUTION **Do not use excessive force when connecting threaded pipes to the product. Over-tightening may cause breakage leading to fluid discharge, which may cause burns or other injury.**

Installation, inspection, maintenance, repairs, disassembly, and adjustment should be done only by trained maintenance personnel.

1. Installation Location

Install the flowmeter in a location that has an ambient temperature range of -40°C to +80°C (for explosionproof models and transducers with indicators or totalizers: -20°C to +60°C).

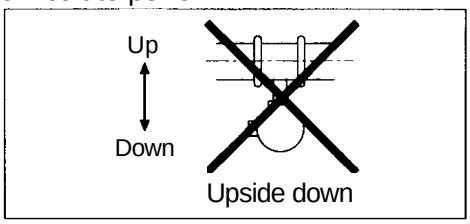
Also avoid installation in the following types of locations:

1) Areas in which maintenance and inspection operations would be difficult to perform.
2) Areas that are subject to severe fluctuations in temperature and heavy vibration.
3) Areas that present a danger of submersion in water.
4) Areas with corrosive gas atmospheres.
5) Areas for which the product's intrinsic safety rating is not suitable.

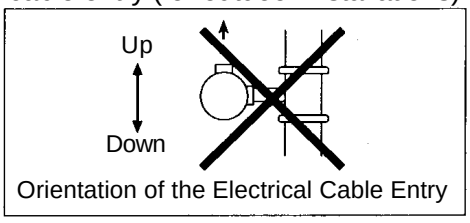
2. Installation Orientation

This flowmeter may be installed in either horizontal or vertical piping.
However, the installation orientations shown in the figures below should be avoided.

1) Maintenance and inspections are difficult to perform



2) Rainwater can infiltrate through the electrical cable entry (for outdoor installations)

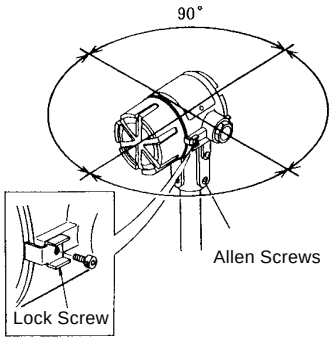


3. Modifying the Orientation of the Transducer Mounting

As shown in the figure on the right, the orientation of the transducer can be changed in increments of 90°.

Changing the orientation requires the use of an Allen wrench (JIS B 4648) with a 4mm diameter.

Make sure to first disconnect the sensor lead wiring before loosening the 4 Allen screws to rotate the transducer.



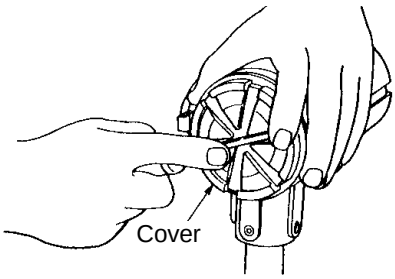
⚠ **<CAUTION> Damage to the sensor may result if the transducer is rotated while the sensor lead wires are still connected.**

Procedure

Please see “Exploded View and Part Names”, p. 29.

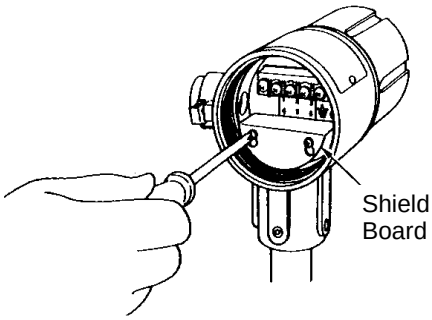
1) Turn OFF the power.

2) Remove the cover from the terminal box side. (See figure at right)



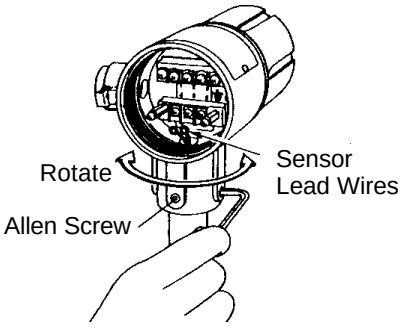
⚠ **<CAUTION> For explosionproof models, disconnect the lock screw before removing the cover.**

3) Remove the shield board. (See figure at right)



4) Disconnect the sensor lead wires from the terminal block.

5) Loosen the 4 Allen screws on the neck of the transducer. (See figure at right)



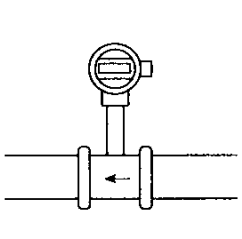
6) Rotate the transducer, being careful to avoid applying excessive force on the sensor lead wires.

7) After rotating the transducer, put the unit back together in the reverse order in which it was taken apart.

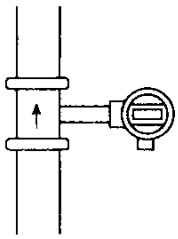
4. Modifying the Angle of the Indicator and Totalizer Displays

For units with an integral display (either the indicator or the totalizer), it is possible to rotate the built-in display unit in the transducer a full 360°, in increments of 90°.

By changing the angle of the built-in display unit, it is possible to place the display of the indicator or totalizer in an orientation that allows it to be read easily, even on vertical piping installations.



<Horizontal Piping>

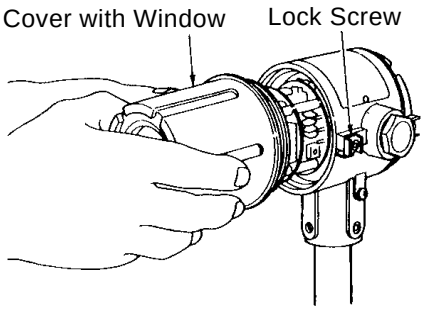


<Vertical Piping>

*** Modifying the Angle of the Display ***

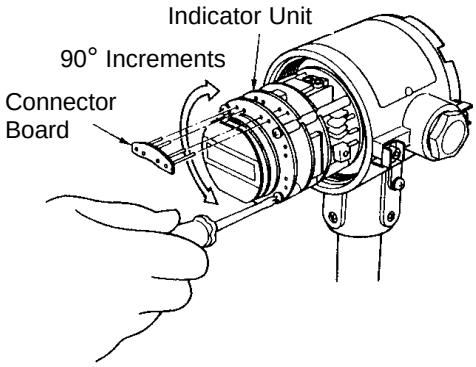
Please see “Connecting the Built-in Display”, p. 28 and “Exploded View and Part Names”, p. 29.

⚠ **<CAUTION> For explosionproof models, an Allen wrench (JIS B 4648) with a diameter of 3mm is required to disconnect the lock screw before the angle of the display can be changed.**



1) For explosionproof models, disconnect the lock screw from the cover with the window. (See figure at right.)

2) Remove the cover with the window. (See figure at right.)



3) Pull the attached connector board out from the display unit. (See figure at right.)

4) The display unit is removed by loosening the 4 screws that hold the unit in place. (See figure at right.)

5) After setting the display unit to the desired angle (being an increment of 90°), fix it in place again using the 4 set screws.

6) Reinsert the connector board into the display unit.

⚠ **<CAUTION> Securely insert it as far as it will go.**

7) Reattach the cover with the window to its former position.

8) For explosionproof models, make sure to reconnect the lock screw.

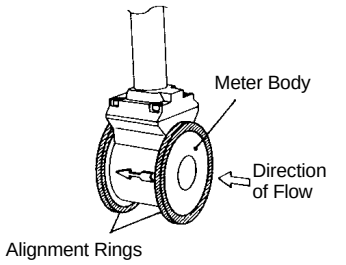
5. Installation

Follow the instructions below to install the flowmeter body.

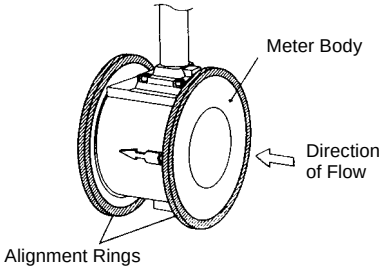
Flangeless

1) Begin by inserting the alignment rings into the outer peripheries of both end faces of the meter body.
Note that alignment rings are not necessary for ANSI 150 and JPI 150 nominal diameters of 25 mm.

(For nominal diameters 15 mm to 25 mm)



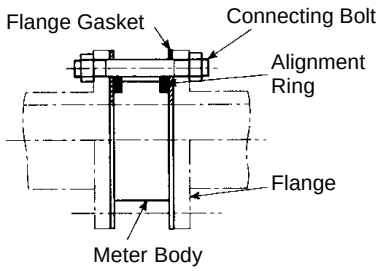
(For nominal diameters 40 mm to 150 mm)



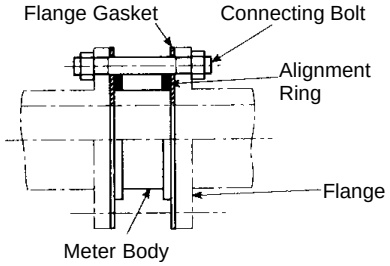
2) Next, install flange gaskets on both faces and then sandwich the flowmeter body between the flanges of the pipeline.

⚠ **<CAUTION> Exercise care not to allow the flange gaskets to protrude into the interior of the flowmeter body (into the pipeline), as this would have an adverse effect on meter accuracy.**

(For nominal diameters 15 mm to 25 mm)

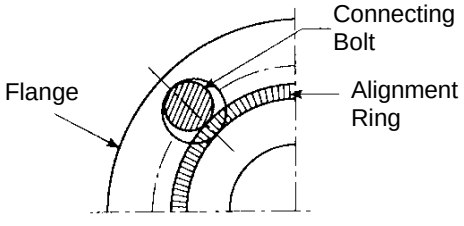


(For nominal diameters 40 mm to 150 mm)



3) Lastly, place the specified connecting bolts through the slots and tighten to secure the flowmeter into the pipeline. The outer diameters (inside edges) of the bolts will come into contact with the alignment ring and the inner wall of the bolt holes on the flange, effectively forcing the meter body into alignment with the pipeline.

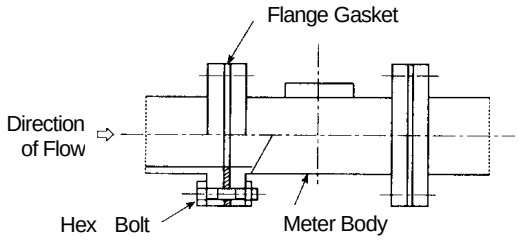
⚠ **<CAUTION> If an alignment ring is not used, the resulting misalignment of the flowmeter and the pipeline will have an adverse effect on meter accuracy. To prevent this, be sure to insert an alignment ring before tightening the connecting bolts.**



Flanged

1) Align the outer diameter of the flanges on the flowmeter body with the outer diameter of the flanges on the pipeline and tighten the hex bolts.

2) For the flange gaskets, wherever possible use those included.

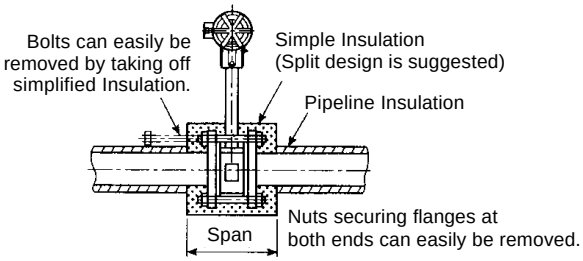


⚠ **<CAUTION> Do not use flange gaskets of an inner diameter that is smaller than the inner diameter of the flowmeter body. If the flange gaskets protrude into the interior of the flowmeter body (into the pipeline), it will have an adverse effect on meter accuracy. Check to make sure that the gaskets do not protrude.**

6. Insulation Work Instructions

When measuring steam, be sure to insulate the flowmeter.

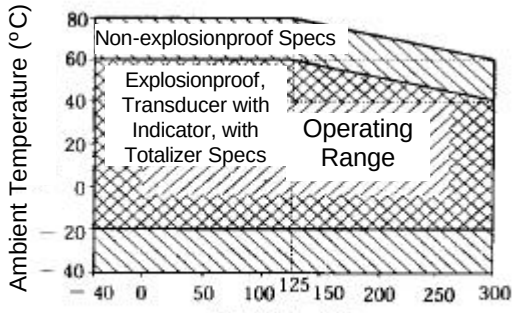
It is recommended, however, that simplified insulation (without mortar finish) be used on the area in which the flowmeter is installed, in order to facilitate maintenance and inspections.



7. Ambient Temperature

The figure on the right shows the correlation between the temperature of the measured fluid and the ambient temperature. Make sure that the ambient temperature does not exceed the rated value. Where there is a possibility of an excessive ambient temperature, consider preventative measures such as those below.

- Avoid exposure to direct sunlight.
- Distance the product from high-temperature piping or instrumentation. Alternatively, install a thermal shielding panel.
- Insulate the transducer (in cases of low temperatures).



Acceptable Ambient Temperature Range

Wiring Connection Instructions

CAUTION

Make sure the power supply is OFF before carrying out work on the wiring or inspections involving disassembly. If such work is carried out with the power on, there is a danger that equipment may malfunction or electric shock may occur, leading to injury or other accidents.

CAUTION

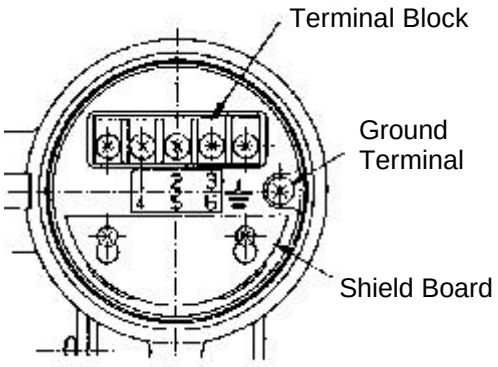
Make sure that wiring work requiring a special license is carried out only by qualified personnel. If carried out by unqualified personnel, overheating or short circuits leading to injury, fires, damage or other accidents may occur.

1. Wiring Connection Specifications

Item	Description
Electrical Cable Entry	G1/2 (PF1/2) internal threads
Transmission Length	Distance from transducer to receiving instrument: maximum 1 km
Field Wiring	-Distance from transducer to receiving instrument: minimum 1.25mm^2, shielded 2-conductor cable -Finished outer diameter: Non-explosionproof: ϕ13.5 mm or less Flameproof: ϕ8.5 mm to ϕ11 mm
Connection Terminal Block	Allen screws M3.5
Explosionproof Construction	To ensure conformity with factory electrical facility explosionproof guidelines: - Ground the transducer. - Use the supplied pressure-tight gland seal lead-in hardware.

2. Description of the Transducer Connection Terminal Block

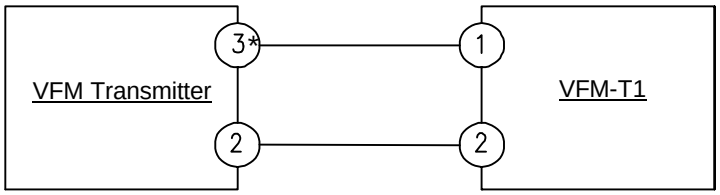
Categorization of Output Specifications		Terminal No.
Pulse Type	Scaled Pulse	(1) : + (2) : –
	Unscaled Pulse	(3) : + (2) : –
Analog Type		(1) : + (2) : –



Field Connection Terminal Block

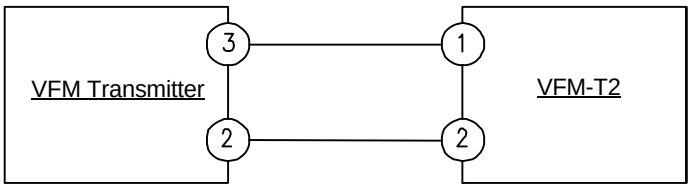
<CAUTION> The 2 pulse type signals, scaled pulse and unscaled pulse, cannot be used at the same time.

Connecting VFM and VFM-T1

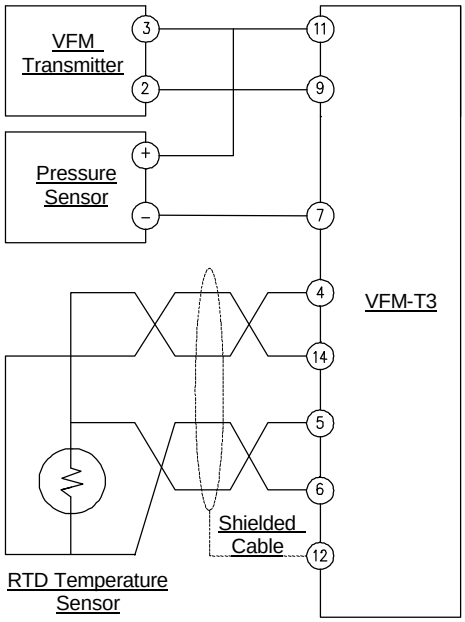


* NOTE: For transmitters with nominal diameters 15 mm and 25 mm, change (3) to (1).

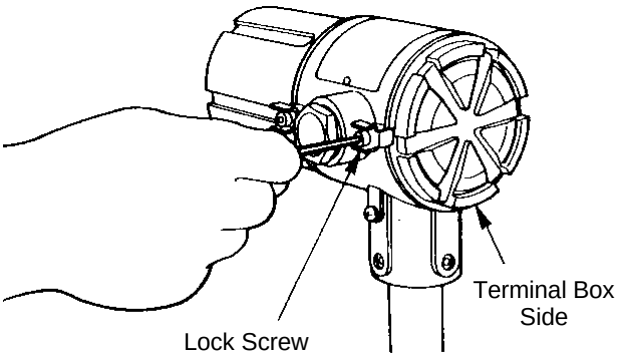
Connecting VFM and VFM-T2

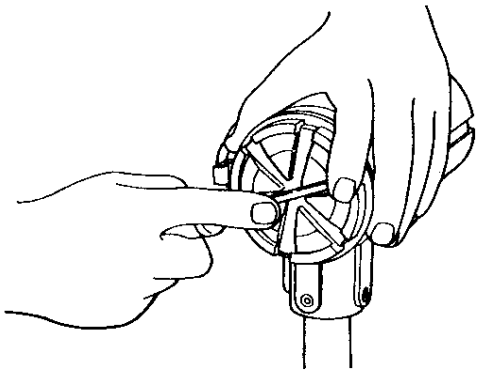


Connecting VFM and VFM-T3



3. Detaching the Terminal Box





1) Use an Allen wrench to remove the lock screw from the terminal box side cover.

2) Using a wrench as shown in the figure above, turn the terminal box side cover to remove it and reveal the connection terminal block.

4. Precautionary Items for Wiring Connections

1) For explosionproof models, use the pressure-tight gland seal lead-in hardware below. (Included with explosionproof models.)

*** Required Part for Explosionproof Certification**

Name: Explosionproof Type Cable Gland Seal Union
Model: KXY-16
Manufacturer: Kokusan Hanbai Co., Ltd.
Remarks: Specify the cable outer diameter at the time of order.

<CAUTION> A selection of rubber packings, of inner diameters f9, 10 and 11mm, are included with the lead-in hardware mentioned above. Select the appropriate one for use according to the outer diameter of the cable used.

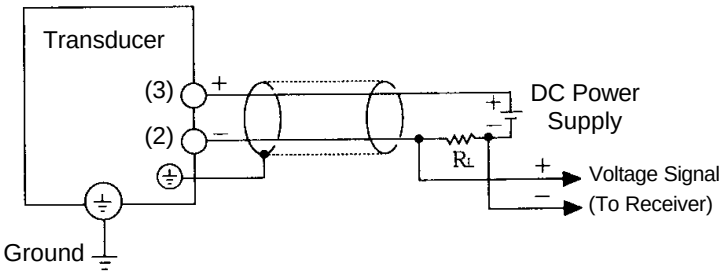
2) Use crimp-style terminals compatible with M3.5 for the cable terminal ends.
3) The ground terminal of the transducer must be connected without fail.
4) Keep in mind that rainwater must be kept from getting into the interior of the electrical cable entry.
5) To prevent damage to the lead from problems due to induction, make sure to keep a distance between the wiring and any high voltage line, vibrating lines or instruments with a strong magnetic field.
6) In areas where there is a danger of lightening strikes, install a lightening arrester.

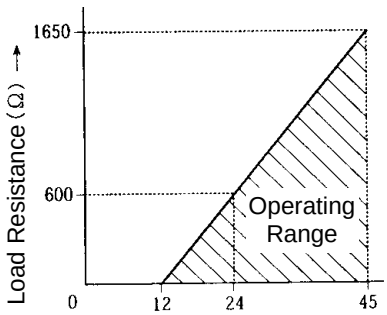
5. Coupling the Transducer and the Receiver

The flowmeter's output signal is via 2-wire transmission system. This means that direct current is supplied to the flowmeter and an output signal of either a pulse or analog electrical output signal is transmitted along the same electrical wire.

TLV's specialized receiver may be directly coupled to the transducer. If other manufacturer's receivers are used for voltage signal input, however, a load resistor must first be connected. As the level of the voltage signal varies depending on the size of the load resistance, determine the desired resistance value by referring to the receiver's specifications and the acceptable load resistor range graph.

- Voltage Signal Receiver Input





<Load Resistance Range>

Output Signal	Voltage Signal (V)	
Pulse Type	ON	OFF
	$20mA \times \frac{1}{1000} \times R_L\Omega$	$4mA \times \frac{1}{1000} \times R_L\Omega$
Analog Type	At 0	At Fs
	$4mA \times \frac{1}{1000} \times R_L\Omega$	$20mA \times \frac{1}{1000} \times R_L\Omega$

<Example> As shown above, if supply voltage = 24V DC and load resistance $R_L = 250\Omega$, then a voltage signal of 1 – 5V DC is generated.

Operating Instructions

CAUTION

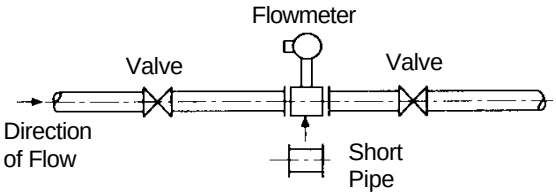
DO NOT use this product outside the recommended operating pressure, temperature and other specification ranges. Improper use may result in such hazards as damage to the product or malfunctions which may lead to serious accidents. Local regulations may restrict the use of this product to below the conditions quoted.

CAUTION

Use only under conditions in which no water hammer will occur. The impact of water hammer may damage the product, leading to fluid discharge, which may cause burns or other injury.

1. Flushing the Piping Assembly

In instances where scale and sludge can be expected to be present, such as in newly installed piping, thoroughly flush out the piping before operation. Additionally, in order to avoid adverse affects to the flowmeter, use a bypass line when flushing the piping. If there is no bypass line, install a short section of piping for use in place of the flowmeter during the flushing operation.



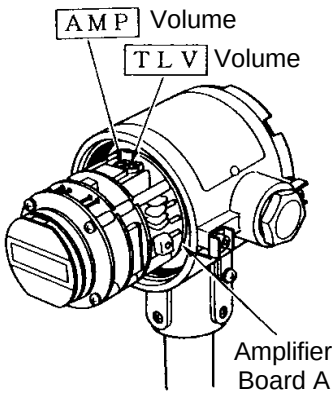
2. Operating Procedure

1) Discharge Condensate (When Measuring Steam)
   To prevent the occurrence of water hammer, discharge all the condensate from inside the piping.
2) Check the Condition of Flowmeter Installation
   To ensure safety, check factors such as the tightness of the connecting bolts and the condition of the gaskets. Also confirm the direction of flow.
3) Check for Leakage
   First check to make sure that the flowmeter is full of fluid, and then make sure there is no leakage.
4) Power ON
   After checking the wiring connections, turn the power ON. Make sure that the receiver doesn't give a false non-zero reading when there is no flow.
5) Start Up the Line to Be Measured
   Start up the pump or open the valve to begin the gradual flow of fluid.

   ⚠ **<CAUTION> In order to avoid adverse effects on the instrumentation, take care not to increase the flow rate suddenly.**
6) Check the Operation
   Check the flow rate indication for abnormalities. Make sure that the fluid conditions (e.g. pressure, temperature) and flow rate are within the flowmeter specifications.

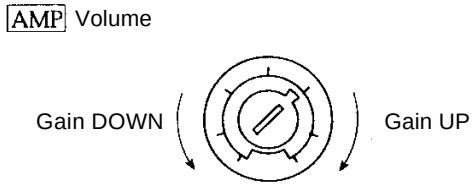
Adjusting the Flowmeter Sensitivity

At the time the flowmeter is shipped from the factory, the flow rate sensitivity is adjusted to achieve the specified flow rate range. When the sensor has been replaced or if there is a false non-zero reading under zero-flow conditions due to noise caused by pipe vibration, re-adjust the sensitivity.



1. Amplifier Gain

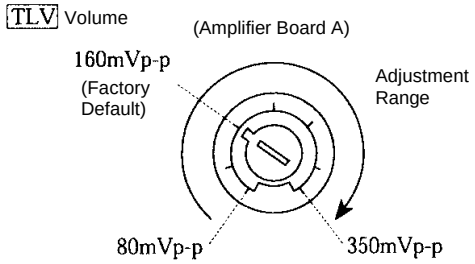
Amplifier gain (amplification factor) is adjusted in relation to the sensor being used. Accordingly, it does not change over time. The amplifier gain is adjusted using the [AMP] volume on amplifier board A. Observe the vortex waveform after amplification using an oscilloscope and adjust the gain until the peak of the vortex waveform at minimum flow is approximately 100mVp-p.



Sensitivity Volume	Vortex Waveform After Amplification
Amplifier Board A: [AMP]	Amplifier Board: [VTX] (+) to [OV] (–)

2. Trigger Level

The flow rate sensitivity can be decreased by increasing the trigger level (pulse generation sensitivity). Increasing the trigger level can offer a solution in cases where there is a great deal of noise from pipe vibration or pulsation or where there is a false non-zero reading under zero-flow conditions. The trigger level is adjusted using the [TLV] volume on amplifier board A. When the peak of the vortex waveform after amplification becomes greater than the set trigger level, it is converted into a pulse. In this manner, the flow rate sensitivity is decreased by increasing the trigger level to suppress influences such as that of noise under zero-flow conditions. When the product is shipped from the factory, the trigger level is set at 160mVp-p.



Trigger Level Volume
Amplifier Board A: [TLV]

1) When the trigger level has been increased, the resulting decrease in flow rate sensitivity will be proportional to the increase in trigger level (proportional sensitivity).

   <Example> If a trigger level of 160mVp-p is changed to 350mVp-p, the sensitivity becomes 160/350 ≈ 1/2.2 (proportional sensitivity).

2) The minimum flow rate (lower limit for flow rate measurement) after the sensitivity has been changed is approximately $\sqrt{1/\text{Proportional Sensitivity}}$ times that of the normal minimum flow rate.

   <Example> If a trigger level of 160mVp-p is changed to 350mVp-p, the minimum flow rate becomes approximately $\sqrt{1/(160/350)} = \sqrt{350/160} \approx 1.48$ times what it was previously.

Setting the Scaled Pulse Units (For pulse type)

CAUTION

When disassembling or removing the product, wait until the internal pressure equals atmospheric pressure and the surface of the product has cooled to room temperature. Disassembling or removing the product when it is hot or under pressure may lead to discharge of fluids, causing burns, other injuries or damage.

For the pulse type, it is possible to choose either unscaled pulse or scaled pulse. The applicable pulse units for each product are listed on the nameplate, which is located on the flowmeter's transducer.

Unscaled Pulse Units	Nameplate: "METER FACTOR"
Scaled Pulse Units	Nameplate: "FACTORED PULSE"

Set the scaled pulse units using the pulse board meter coefficient setting switches SW1 to SW4 and the divider switch [DIV].

Find the scaled pulse units using the formula below.

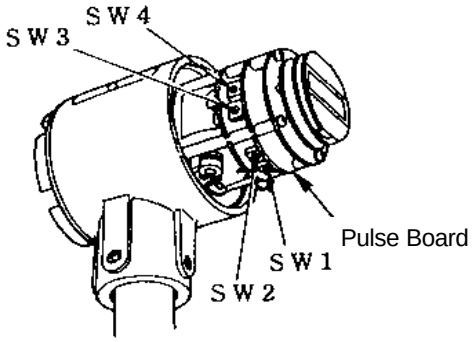
$$\text{Scaled pulse units} = \frac{\text{"meter coefficient"}}{\text{"meter coefficient setting switch set value"} \times \text{"dividing value"}} \times 10^4$$

1. Meter Coefficient Setting Switch

The meter coefficient setting switch sets the meter coefficient to 4 significant digits.

<Example> If the meter coefficient is Mf = 0.06021 ℓ/P, the set each of the meter coefficient switches SW1, SW2, SW3 and SW4, using a slotted screwdriver.

Meter Coefficient Setting Switch	Set Value
SW1	6
SW2	0
SW3	2
SW4	1



In cases such as the standard fixed conversion output for gases and the mass fixed conversion output for steam, the volume meter coefficient (ℓ/P) is converted as a function of the conversion coefficient and density into the converted meter coefficient, and is set to the value of 4 significant digits.

<Example> For the mass fixed conversion output when the meter coefficient is:

Mf = 0.06021 (ℓ/P)

and the fluid density is:

ρ = 1.638 kg/m^3 (g/ℓ)

then the converted meter coefficient would be:

Mf = 0.06021 ℓ/P x 1.638 ℓ/P

= 0.09862 (g/P)

In this manner, the meter coefficient switch is set as shown on the right.

Meter Coefficient Setting Switch	Set Value
SW1	9
SW2	8
SW3	6
SW4	2

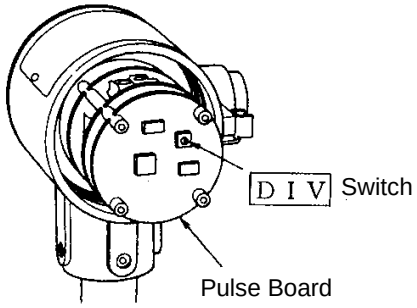
2. Divider Switch

The dividing value is determined using the formula below.

$$\text{Dividing value} = \frac{\text{“meter coefficient”}}{\text{“meter coefficient setting switch set value” × “scaled pulse units”}} \times 10^4$$

Set the divider switch [DIV] in the pulse board to the dividing value determined.

Dividing Value	Switch [DIV] Setting
0.1	4
0.01	5
0.001	6
0.0001	7



<Example> When Mf = 0.06021 ℓ/P and the scaled pulse units = 100 ℓ/P, for the dividing value and the divider switch [DIV]:

$$\text{Dividing Value } \frac{0.06021(\ell / P)}{6021 \times 100\ (\ell / P)} \times 10^4$$

$$= 0.001 = 1/1000$$

Therefore, the divider switch [DIV] is set to "6".

<Example> For fixed conversion, if the meter coefficient Mf = 0.09862 g/P and the scaled pulse units = 1 kg/P, for the dividing value and the divider switch [DIV]:

$$\text{Dividing Value } \frac{0.09862\ (g / P)}{9862 \times 1000\ (g / P)} \times 10^4$$

$$= 0.0001 = 1/10000$$

Therefore, the divider switch [DIV] is set to "7".

Adjusting the Analog Output Zero Point and Full Scale

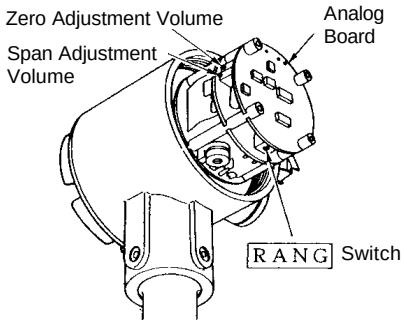
(For analog type)

CAUTION

When disassembling or removing the product, wait until the internal pressure equals atmospheric pressure and the surface of the product has cooled to room temperature. Disassembling or removing the product when it is hot or under pressure may lead to discharge of fluids, causing burns, other injuries or damage.

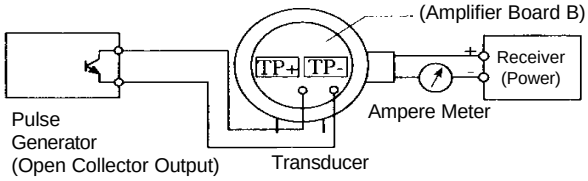
Analog output (4 – 20mA) zero point adjustment and full scale adjustment are carried out using the analog board [RANG] switch, the zero adjustment volume and the span adjustment volume.

1) A standard signal pulse generator (open collector output) and an ampere meter to measure the output signal are required for full scale adjustment.
2) Perform the adjustment under zero-flow conditions.



1. Connection Method

Connect the pulse generator output to the [TP+] and [TP-] check pins on amplifier board B. Connect it in series with the output line from the ampere meter. Measurement of the current output is also possible by connecting the ampere meter to the ⊕ ⊖ check pins on the analog board.



2. Calculation of Full Scale Frequency

Calculate the unscaled pulse frequency corresponding to the full scale flow rate using the formula below.

Full Scale Frequency (Hz)

$$= \frac{\text{full scale flow rate (flow unit/h)}}{\text{meter coefficient (flow unit/P)}} \times \frac{1}{3600}$$

<Example> When the meter coefficient is Mf = 0.06021 L/P and full scale = 200m^3/h:

$$\text{Full Scale Frequency} = \frac{200000\ (\ell / h)}{0.06021\ (\ell / P)} \times \frac{1}{3600}$$

In cases such as the standard fixed conversion output for gases and the mass fixed conversion output for steam, the volume meter coefficient (ℓ/P) is converted as a function of the conversion coefficient and density into the converted meter coefficient, and the full scale frequency is calculated using the converted meter coefficient.

⚠ <CAUTION> Use the same measurement units for the full scale flow rate and the meter coefficient. In addition, note that the full scale frequency at the time the product is shipped from the factory is shown on the nameplate as "ANALOG F.S.".

<Example> When the meter coefficient is Mf = 0.06021 ℓ/P, the density ρ = 1.638kg/m^3(g/ℓ) and full scale is 400 kg/h, then

Converted Meter Coefficient Mf
= 0.06021(ℓ/P) × 1.638(g/ℓ)
= 0.09862(g/P).

Full scale frequency

$$= \frac{400000(g / h)}{0.09862(g / P)} \times \frac{1}{3600}$$

= 1126.7 Hz.

3. Setting the [RANG] Switch

Set the [RANG] switch on the analog board according to the full scale frequency determined in the preceding step.

The [RANG] switch setting standards are as shown in the table to the right.

Full Scale Frequency	[RANG] Switch
4.00 – 7.99	8
8.00 – 15.99	9
16.00 – 19.99	A
20.00 – 39.99	0
40.00 – 79.99	1
80.00 – 159.99	2
160.0 – 319.99	3
320.0 – 639.99	4
640.0 – 1279	5
1280 – 2559	6
2560 – 5119	7

4. Adjusting the Zero Point

Under conditions of no input from the pulse generator, adjust the output current to 4mA using the zero point adjustment volume.

5. Adjusting the Full Scale

Generate a full scale frequency pulse using the pulse generator and adjust the output current to 20mA using the span adjustment volume. (Note: The zero point and the span adjustments can be carried out independently; they do not interfere with each other.) Also, to improve accuracy, the measurement of other points within the waveform (ie. 25%, 50% and 75%) is suggested. The relationship between the input pulse and the output is as shown in the table below.

Input Frequency	0%	25%	50%	75%	100%
Output Current (mA)	4	8	12	16	20

(CAUTION) The input frequency is shown as a 100% ratio of the full scale frequency.

Maintenance Instructions

CAUTION **Take measures to prevent people from coming into direct contact with product outlets. Failure to do so may result in burns or other injury from the discharge of fluids.**

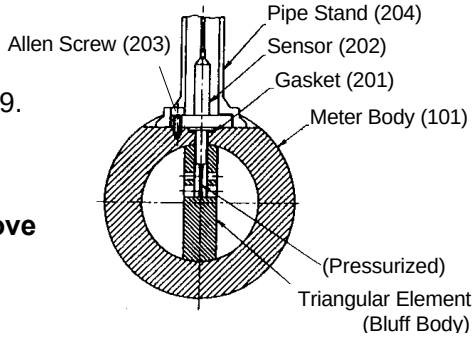
CAUTION **DO NOT use this product outside the recommended operating pressure, temperature and other specification ranges. Improper use may result in such hazards as damage to the product or malfunctions which may lead to serious accidents. Local regulations may restrict the use of this product to below the conditions quoted.**

CAUTION **When disassembling or removing the product, wait until the internal pressure equals atmospheric pressure and the surface of the product has cooled to room temperature. Disassembling or removing the product when it is hot or under pressure may lead to discharge of fluids, causing burns, other injuries or damage.**

Installation, inspection, maintenance, repairs, disassembly, and adjustment should be done only by trained maintenance personnel.

⚠ **<CAUTION> As the sensor is pressurized, be sure to stop the flow and discharge any pressure from the line before removing it. Furthermore, to ensure safety, it is recommended that a leakage check be performed whenever the sensor has been replaced.**

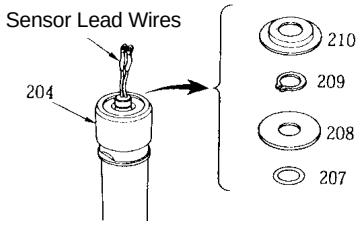
1. Replacing the Sensor

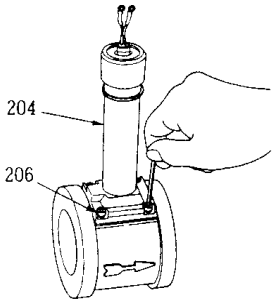


● Removing the Sensor

Please see “Exploded View and Part Names”, p. 29.

1) Turn OFF the power.
2) Remove the cover from the terminal box side.
   <CAUTION> For explosionproof models, remove the lock screw before removing the cover.
3) Remove the field wiring cable.
4) Remove the shield board.
5) Remove the sensor lead wires.
6) Loosen the Allen screws and lift the transducer housing up and out.
7) Remove the stopper (210) and the C-shaped shaft retaining ring (209).
8) Remove the O-ring retainer (208) and the O-ring (207).
9) Remove the Allen screws (206) and then remove the pipe stand (204).
10) Remove the Allen screw (203).
    <CAUTION> Loosen the screws gradually and uniformly. As this is a pressurized part, check to make sure that there is no pressure remaining in the interior.
11) Remove the sensor (202) from the meter body (101).

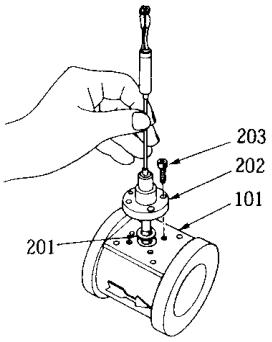




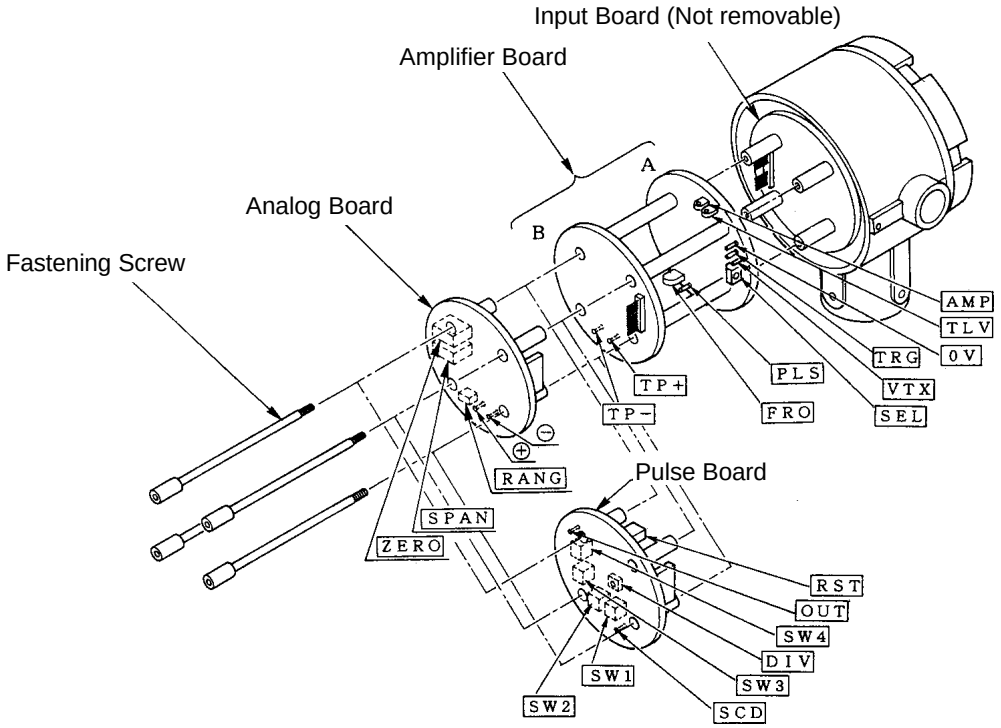
● **Reattaching the Sensor**

Please see “Exploded View and Part Names”, p, 29.
When reattaching the sensor, follow the steps taken to remove it in reverse order, giving special care to the following points:

1) Do not drop the sensor or subject it to strong forces.
2) When reattaching the sensor, make sure the gasket (201) is in place.
3) Align the sensor’s positioning pin with the pin hole in the meter body and gently insert the sensor.
4) When attaching the sensor with the Allen screws (203), tighten in a uniform manner, being careful to avoid uneven tightening.
   <CAUTION> Tighten bolts in increments of 30° and in a cross-wise pattern.

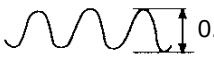
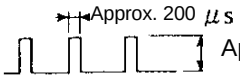


2. Inspecting the Transducer



Explanation of Test Pins

1) Amplifier Board A

Name	Test Pin	Description
Vortex Waveform After Amplification	+ · · · [VTX] − · · · [0 V]	Waveform  0.1Vp-p or greater
Vortex Synchronized Pulse (Before the low frequency cut-off filter)	+ · · · [TRG] − · · · [0 V]	 Approx. 5.5Vp-p
Vortex Synchronized Pulse (After the low frequency cut-off filter)	+ · · · [PLS] − · · · [0 V]	 Approx. 200 μs Approx. 5.5Vp-p

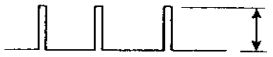
2) Amplifier Board B

Name	Test Pin	Description
Simulator Pulse Input Terminal	+ · · · [TP +] – · · · [TP -]	Input from frequency generator (open collector pulse output)

3) Analog Board (For analog type)

Name	Test Pin	Description
Output Current Measurement Terminal	+ · · · ⊕ – · · · ⊖	4 – 20mA current output

4) Pulse Board (For pulse type)

Name	Test Pin	Description
Scaled Pulse (Before dividing)	+ · · · [SCD] – · · · Amplifier Board B's [TP -]	 Approx. 5Vp-p
Scaled Pulse (After dividing)	+ · · · [OUT] – · · · Amplifier Board B's [TP -]	 Approx. 5Vp-p

Amplifier Board Settings

Fluid	Size (mm)	Amp. Properties Selection	Low Frequency Cut-off Setting	
		[SEL] Switch	[FRQ] Scale Setting	Target Frequency
Gas or Steam	15	0*	10.0	37**
	25	1	10.0	37
	40	2	9.0	21
	50	3	8.5	17
	80	4	7.0	10
	100	5	5.5	7.3
	150	3	3.5	5.5
	200	7	3.0	5.1
	250	7	3.0	5.1
	300	7	3.0	5.1
Liquid	15	8*	11.0	6.9**
	25	9	9.5	4.4
	40	A	9.0	3.8
	50	B	8.0	2.5
	80	C	7.0	1.9
	100	D	6.5	1.6
	150	E	6.0	1.5
	200	F	5.0	1.2
	250	F	4.0	1.0
	300	F	1.0	0.81

* For nominal diameter 15 mm, the [SEL] switch setting is responsible for automatic 1/2 dividing.

** For low frequency cut-off of nominal diameter 15 mm, this is the frequency after the vortex frequency has been divided in half.

Explanation of Switches and Volume

1) Amplifier Board A

Name	Symbol	Description
Amplifier Amplification Factor Adjustment Volume	[AMP]	The amplifier's amplification factor is adjusted in relation to the sensor being used. Therefore, as a rule, it will not change unless the sensor is replaced. (See "Adjusting the Flowmeter Sensitivity", p. 18.)
Trigger Level Setting Volume	[TLV]	Set the trigger level (pulse generation sensitivity) to between 80 and 350mVp-p. When the product is shipped from the factory, the trigger level is set at 160mVp-p. (See "Adjusting the Flowmeter Sensitivity", p.18.)
Fluid and Nominal Diameter Setting Switch	[SEL]	This switch allows selection of amplification properties with respect to the measured fluid and nominal diameter of the meter. Set this in accordance with the flowmeter specifications. (See "Amplifier Board Settings", p. 25.)
Low Frequency Cut-off Setting Volume	[FRQ]	Signals of a frequency lower than the frequency set by this volume will be cut out. This is set with respect to the measured fluid and the nominal diameter of the meter. (See "Amplifier Board Settings", p. 25.)

2) Analog Board (For analog type)

Analog Full Scale Adjustment Volume	[SPAN]	This volume is used to adjust the analog output (4 – 20mA) full scale (20mA). At the time that the product is shipped from the factory, the frequency is adjusted to that indicated on the nameplate. (See "Adjusting the Analog Output Zero Point and Full Scale", p. 21.)
Analog Zero Point Adjustment Volume	[ZERO]	This volume is used to adjust the analog output (4 – 20mA) zero point adjustment (4mA). At the time that the product is shipped from the factory, this is adjusted to 4mA.(See "Adjusting the Analog Output Zero Point and Full Scale", p. 21.)
Divider Switch	[RANG]	This switch is used to set the adjustment frequency range of the full scale adjustment volume for full scale frequency. This is determined by the full scale frequency. (See "Adjusting the Analog Output Zero Point and Full Scale", p. 21.)

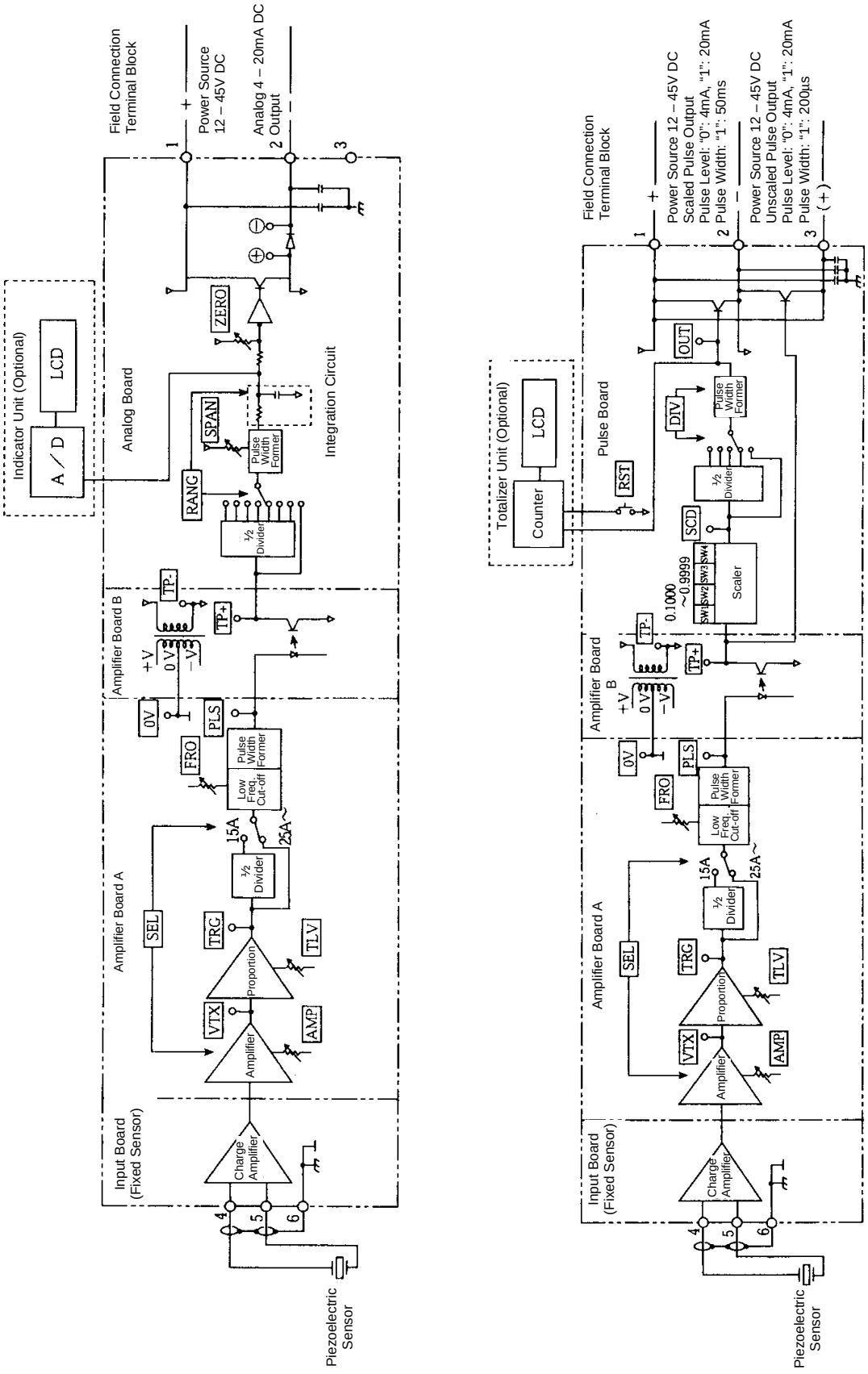
3) Pulse Board (For pulse type)

Meter Coefficient Setting Switch	[SW1] to [SW4]	These are for setting the 4 significant digits of the meter coefficient. At the time that the product is shipped from the factory, the meter coefficient is set as indicated on the nameplate. (See "Setting the Scaled Pulse Units", p. 20.)
Divider Switch	[DIV]	The dividing value is set with respect to the scaled pulse units. At the time that the product is shipped from the factory, the scaled pulse units are set as indicated on the nameplate. (See "Setting the Scaled Pulse Units", p. 20.)
Totalizer Reset Switch	[RST]	This is used to reset (totalized count "0") the totalized count of the totalizer. This is not used when there is no totalizer installed. (See "Setting the Scaled Pulse Units", p. 20.)

4) Indicator Unit

Flow Rate Indicator Display Adjustment Volume	[R10]	This volume is used to adjust the flow rate indicator display (bar graph). As this is pre-adjusted before shipment from the factory, do not touch the volume knob.

Transducer Block Diagrams

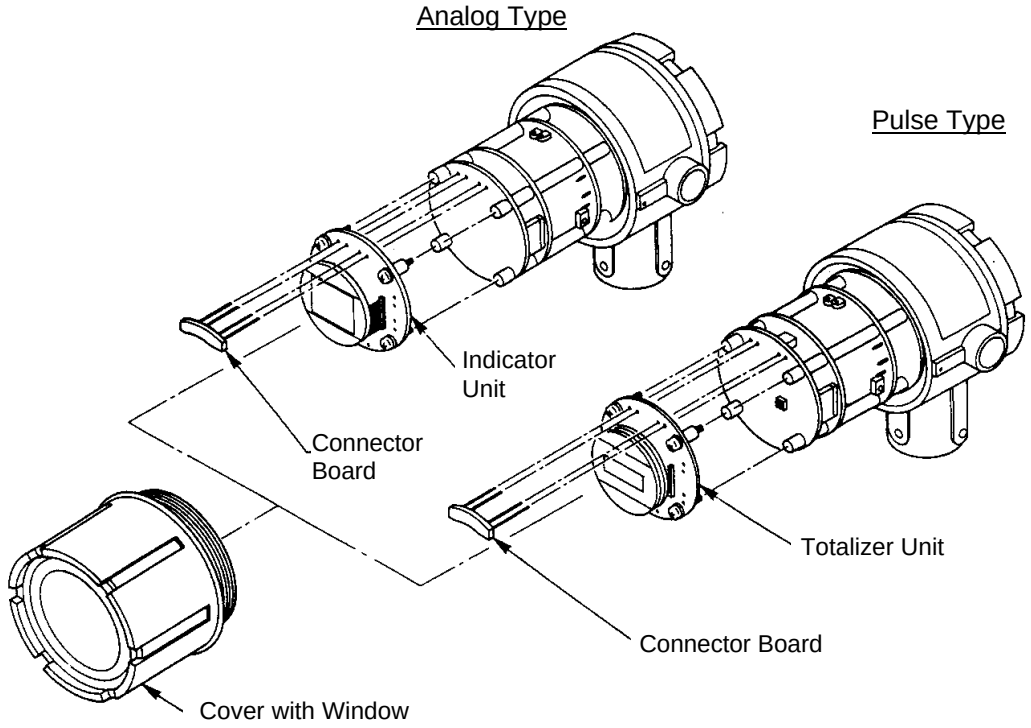


3. Mounting the Display Unit

Connecting the Built-in Display Unit

An optional built-in indicator is available for analog types, and an optional built-in totalizer is available for pulse types. Adding an indicator unit or a totalizer unit to the product in its present state is extremely simple, requiring only connection.

⚠ **<CAUTION> When adding the display unit, the cover on the product must be replaced with a cover that has a window slot.**



Power Outage Back-up Battery (only for pulse type)

⚠ **<CAUTION> It is not possible to replace only the battery. The entire totalizer unit must be replaced.**

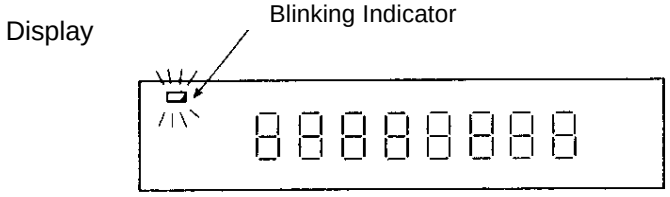
In the event that the external power supply becomes cut off (power outage), the totalizer's count is maintained by an internal battery.

The battery life for continuous back-up use (during a power outage) is approximately 7 years. The storage life of the battery requires that it be replaced after 10 years.

Replace the totalizer unit when a period of 10 years has elapsed since the date of manufacture indicated on the unit.

When the remaining battery life becomes low, a battery-shaped warning indicator begins flashing in the upper left-hand corner of the display.

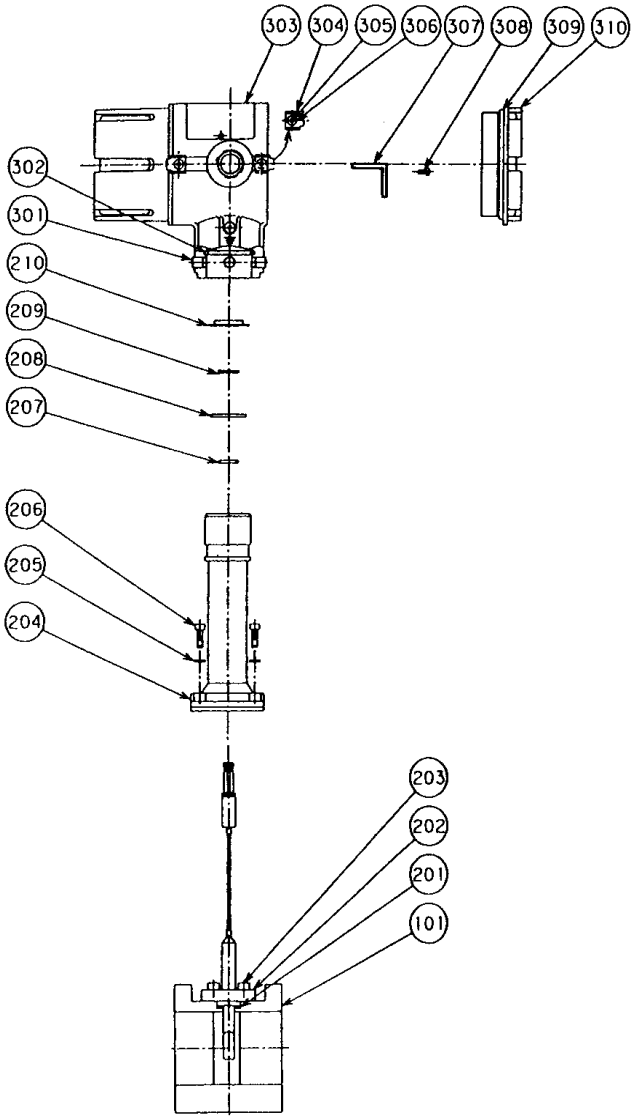
Replace the totalizer unit immediately when the indicator beings blinking.



Exploded View and Part Names

CAUTION

When disassembling or removing the product, wait until the internal pressure equals atmospheric pressure and the surface of the product has cooled to room temperature. Disassembling or removing the product when it is hot or under pressure may lead to discharge of fluids, causing burns, other injuries or damage.



No.	Name	Qty.	Remarks	No.	Name	Qty.	Remarks
101	Meter Body	1		301	Allen Screws C	4	M8 x 10
201	Gasket A	1	ø17.5 x 2mm	302	O-Ring B	1	JASO-2033
202	Sensor	1		303	Transducer Case	1	
203	Allen Screws A	4	M5 x 13	304	Lock Screw	2	For explosion-proof specs only
204	Pipe Stand	1		305	Allen Screws D	2	M4 x 6
205	Spring Washer A	4	ø4mm	306	Spring Washer B	2	ø4mm
206	Allen Screws B	1	M4 x 12	307	Shield Board	1	
207	O-Ring A	1	P10A	308	Phillips Pan Screws	2	M3 x 6
208	O-Ring Retainer	1		309	O-Ring C	2	AS568-233
209	C-shaped Shaft Retaining Ring	1	ø10mm	310	Terminal Box Side Cover	1	
210	Stopper	1					

Standard Specifications

CAUTION

DO NOT use this product outside the recommended operating pressure, temperature and other specification ranges. Improper use may result in such hazards as damage to the product or malfunctions which may lead to serious accidents. Local regulations may restrict the use of this product to below the conditions quoted.

CAUTION

Do not use excessive force when connecting threaded pipes to the product. Over-tightening may cause breakage leading to fluid discharge, which may cause burns or other injury.

1. Sensor Specifications

Item		Description		
Body Type		Flangeless	Flanged (RF is standard)	
Size (mm)		15, 25, 40, 50, 80, 100, 150	50, 80, 100, 150	200, 250, 300
Material	Meter Body	SUS316 or SCS14A	SCS14A	SUS316 (Flange is SFVC2A)
	Bluff Body (Triangular Element)	SUS316 or SCS14A		
	Pipe Stand	SUS304 or SCS13A		
Maximum Operating Pressure		Depends on flange rating (body design pressure: 5 MPaG)		
Accuracy		Depends on specified operating conditions 1) within ± 1% of the indicated reading* 2) within ± 1% of the full scale (* for analog output, ± 0.1% of full scale is added)		
Repeatability		within ± 0.2%		
Installation Orientation		No restrictions with regard to accuracy (however, ease of maintenance and protecting the electrical cable entry from moisture should be taken into consideration)		
Flange Pressure Rating		JIS 10, 16, 20, 30K ANSI Class 150, 300 JPI 150, 300		
Standard Connecting Pipe		Nominal wall thickness Schedule 40		
Operating Temperature Range		-40 to 300°C (however, nominal diameter 200 mm and greater is 0 to 300°C)		
Suitable Fluids		Steam, liquid and gas		
Coating / Color		Nominal diameter 15 – 150 mm: unfinished Nominal diameter 200 – 300 mm: diallyl phthalate resin finish / Munsell 7.5G7/2.5		

Flange Ratings (Pressure – Temperature)

Nominal Diameter 15 mm to 150 mm (material: SUS316, SCS14A) Units: MPaG

	JIS10K	JIS10K	JIS10K	JIS10K	ANSI150	ANSI150
220°C or less	1.18	1.96	2.45	4.51	1.21	3.20
220 – 300°C	0.98	1.77	2.26	4.22	1.02	2.91

Nominal Diameter 200 mm to 300 mm (flange material: SFVC) Units: MPaG

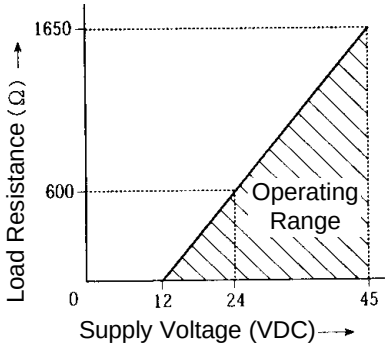
	JIS10K	JIS16K	JIS20K	JIS30K	ANSI150	ANSI300
220°C or less	1.18	2.45	3.04	4.51	1.32	4.31
220 – 300°C	0.98	2.26	2.84	4.22	1.02	3.87

2. Transducer Specifications

Item	Description		
Category	Standard	With Indicator	With Totalizer
Mounting	Integrated in flowmeter unit		
Water Resistance	JIS C 0920, jet-proof (IP65)		
Explosion Class (option) (Integrated in flowmeter unit)	Exd II B + H_2T4		Exd II B + H_2T4/ Exia II B + H_2T4
Ambient Temperature*	-40 to +80°C (explosionproof construction: –20 to +60°C)	-20 to +60°C	
Ambient Humidity	5 to 100% RH without dew condensation		
Case Material	Aluminum alloy		
Case Coating / Color	Baked melamine Munsell 7.5G7/2.5 (cover: Munsell 10G5/5.5)		
Output Signal	Current signal, 2-wire system (serves also as power line) 1) Pulse Type: Unscaled pulse or Scaled pulse Pulse level: "0": 4mA "1": 20mA Pulse width: Unscaled: 200µs Scaled: 50ms 2) Analog Type: 4 to 20mA DC at 0 to full scale Time constant: 2.5s (FS ≥ 20Hz) or 10s (FS < 20Hz)	Analog Type: 4 to 20mA DC at 0 to full scale Time constant: 2.5s (FS ≥ 20Hz)or 10s (FS < 20Hz)	Pulse Type: Unscaled pulse or Scaled pulse Pulse level: "0": 4mA "1": 20mA Pulse width: Unscaled: 200µs Scaled: 50ms
Integrated Indicator (Optional)	—	Display: Full scale % in LCD bar graph with 40 divisions. Indicator Full Scale: Identical to full scale of analog output.	• Display: 8-digit LCD flow rate totalizing counter. • Units for totalizing: identical to those for scaled pulse. The totalized count can be reset by means of a built-in switch. • Built-in totalized count back-up battery for power outages. (Battery life: 7 years with low-battery alert feature)
Power Supply	12 to 45V DC (see figures on next page for load resistance range curve)		
Electrical Cable Entry	G1/2 internal threads The flameproof construction transducer is furnished with one of the following types of field lead wire lead-in methods: 1) Conduit seal 2) Cable gland seal (special lead-in hardware included)		
Field Wiring	Transducer to receiving instrument: minimum 1.25 mm^2, 2-conductor shielded cable Finished cable outer diameter: non-explosionproof ϕ13.5 mm or less, flameproof ϕ8.5 mm to ϕ11 mm		
Transmission Length	Transducer to receiving instrument: maximum 1 km		

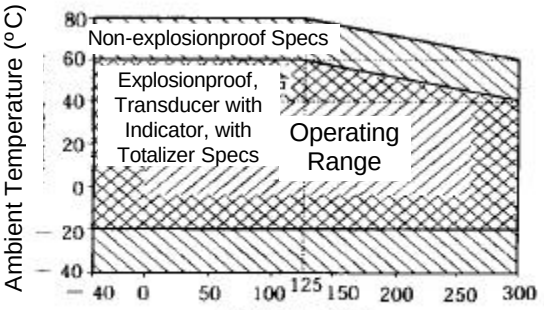
* See note on next page.

Acceptable Load Resistance Range



Ambient Temperature Range

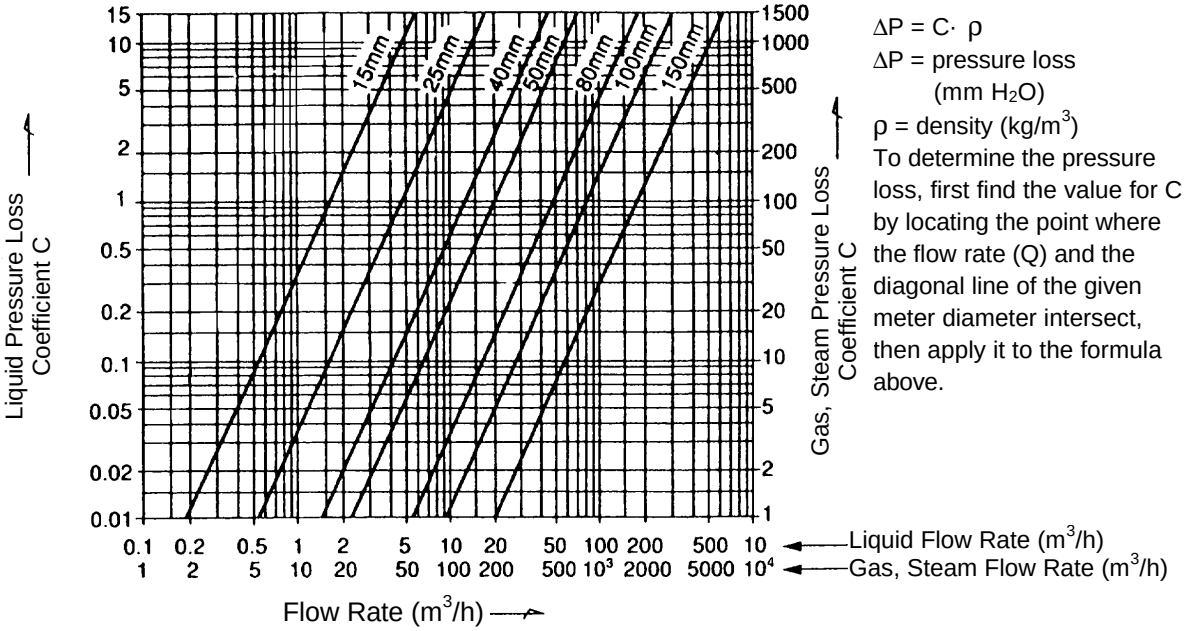
*Note: If the temperature of the fluid exceeds 125°C,reduce the acceptable operation ambient temperature range in accordance with the figure below.



Acceptable Ambient Temperature Range

3. Pressure Loss

- Nominal Diameter 15 – 150 mm



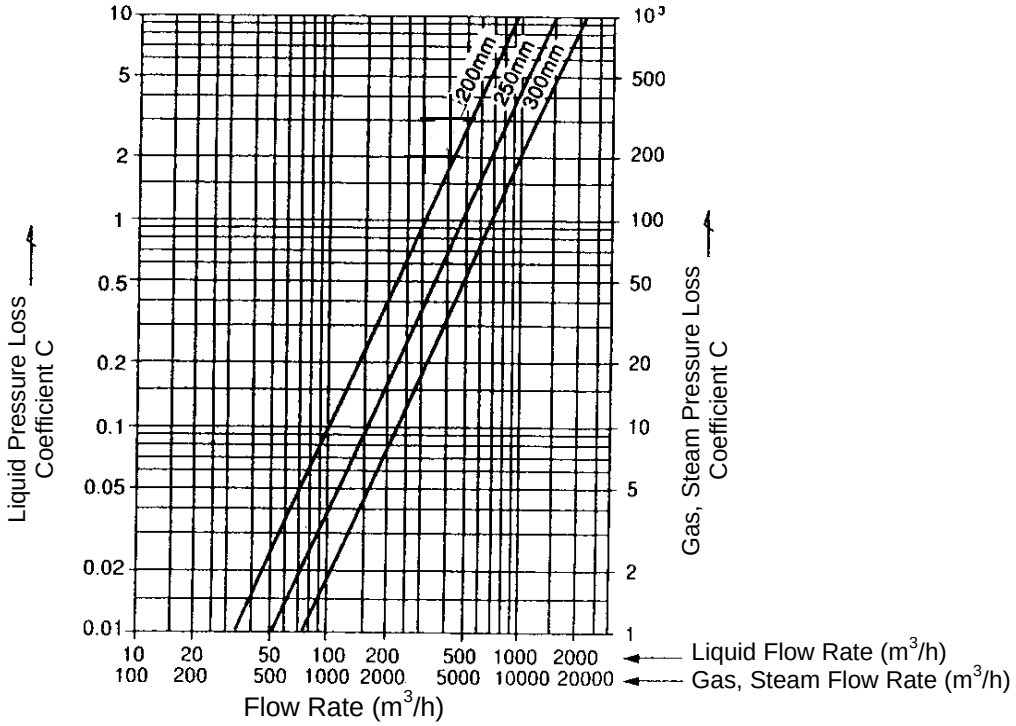
$\Delta P = C \cdot \rho$

ΔP = pressure loss (mm H_2O)

ρ = density (kg/m^3)

To determine the pressure loss, first find the value for C by locating the point where the flow rate (Q) and the diagonal line of the given meter diameter intersect, then apply it to the formula above.

- Nominal Diameter 200, 250, 300 mm



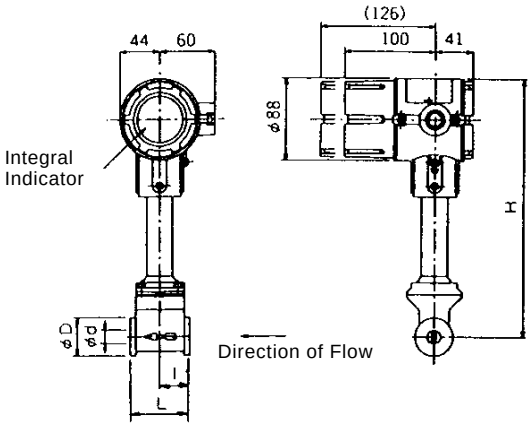
Exterior Dimensions

1. Flangeless

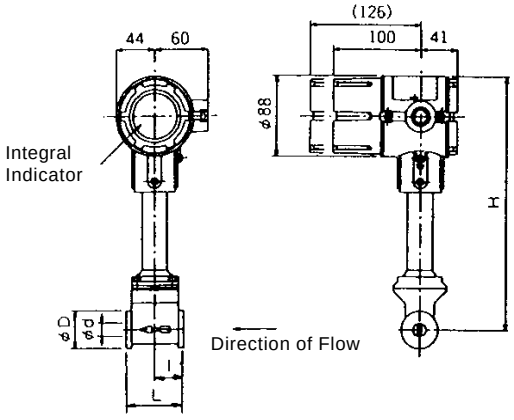
[Units: mm]

NOTE: Values enclosed by ( ) represent units with built-in indicators.

- Nominal Diameters 15, 25 mm



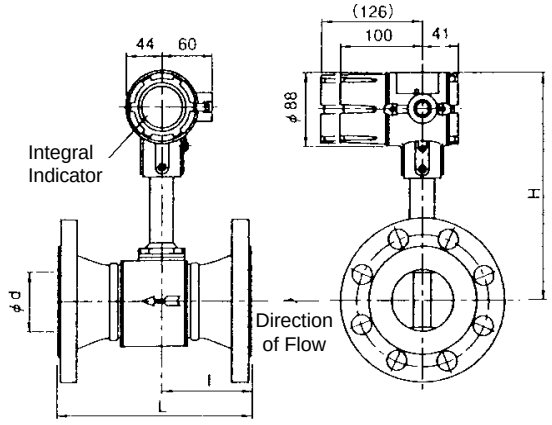
- Nominal Diameters 40 – 150 mm



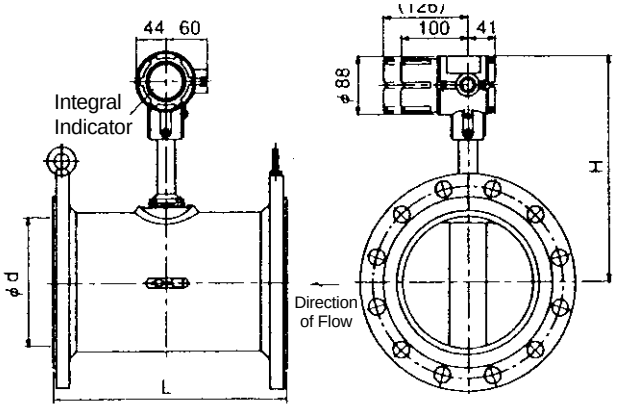
Size mm (in)	L	l	ϕd (Interior Diameter of Body)	ϕD	H	Approximate Weight (kg)		
						Without Integrated Indicator	With Integrated Indicator	Separate Type with Terminal Box
15 (1/2")	65	32.5	14.5	40	277	2.6	2.9	2.4
25 (1")	65	32.5	26.6	67	277	3.2	3.5	3.0
40 (1-1/2")	80	40	37.6	81	262	3.9	4.2	3.7
50 (2")	80	40	48.5	91	266	4.0	4.3	3.8
80 (3")	100	40	72.4	126	282	6.8	7.1	6.6
100 (4")	125	48	95.2	156.2	302	10.5	10.8	10.3
150 (6")	165	54	140.3	214.9	332	20.4	20.7	20.2

2. Flanged

- Nominal Diameters 50 – 150 mm



- Nominal Diameters 200 – 300 mm



Size		L	I	φd (Interior Diameter of Body)	H	Approximate Weight (kg)		
						Without Integrated Indicator	With Integrated Indicator	Separate Type with Terminal Box
Mm	(in)							
50	(2”)	173	86.5	48.5	266	9.2	9.5	9.2
80	(3”)	219	99.5	72.4	282	15.2	15.5	15.5
100	(4”)	250	110.5	95.2	302	21.2	21.5	21.9
150	(6”)	322	132.5	140.3	332	43.7	44.0	45.2
200	(8”)	350	–	199.9	347	38.3	39.1	38.8
250	(10”)	450	–	248.8	369	68.8	69.1	68.8
300	(12”)	500	–	297.9	391	88.8	89.1	88.8

<CAUTION> These dimensions and weights are for JIS 10K.

Product Warranty

1. Warranty Period
   One year following product delivery.
2. Warranty Coverage
   TLV CO., LTD. warrants this product to the original purchaser to be free from defective materials and workmanship. Under this warranty, the product will be repaired or replaced at our option, without charge for parts or labor.
3. This product warranty will not apply to cosmetic defects, nor to any product whose exterior has been damaged or defaced; nor does it apply in the following cases:
   - Malfunctions due to improper installation, use, handling, etc., by other than TLV CO., LTD. authorized service representatives.
   - Malfunctions due to dirt, scale, rust, etc.
   - Malfunctions due to improper disassembly and reassembly, or inadequate inspection and maintenance by other TLV CO., LTD. authorized service representatives.
   - Malfunctions due to disasters or forces of nature.
   - Accidents or malfunctions due to any other cause beyond the control of TLV CO., LTD.

Under no circumstances will TLV CO., LTD. be liable for consequential economic loss damage or consequential damage to property.

* * * * * * *

For Service or Technical Assistance:
Contact your TLV representative or your regional TLV office.

Manufacturer

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