azbil

CM2-VRX100-2001

ULTRA Vortexor
Smart Ultrasonic Vortex Flowmeter

Model VRX10A

User's Manual

Azbil Corporation

Notice

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Conventions Used in This Manual

■ The safety precautions explained below aim to prevent injury to you and others, and to prevent property damage.

WARNING	**Warnings are indicated when mishandling this product may result in death or serious injury.**
CAUTION	**Cautions are indicated when mishandling this product may result in minor injury or property damage only.**

■ In describing the product, this manual uses the icons and conventions listed below.

Indicates that caution is required in handling.

The indicated action is prohibited.

Be sure to follow the indicated instructions.

Unpacking, Inspecting, and Storing the Product

Thank you for purchasing a Smart Ultrasonic Vortex Flowmeter. Using ultra-sonic waves to locate and measure the Karman vortex generated by a bluff body placed in the flow, the Smart Ultrasonic Vortex Flowmeter calculates the flow rate to be output/displayed. Before attempting to use this equipment, thoroughly read and understand the contents of thisguidebook to ensure proper usage.

● Unpacking

This equipment is a precision instrument. When unpacking, take care to avoid accidents or damage. Check the contents of the box against the list below as you unpack.

- Flowmeter
- Standard accessories

● Confirming the Specifications

Specifications are marked on the plate attached to the main unit. For full specifications, refer to Appendix A "Markings for Standard Specifications and Model Numbers for Equipment," and confirm that the specifications are correct. Particularly, confirm the following:

- Model Number
- Power Supply (POWER)
- Output
- Explosion-proof or not

● Contact Information

If you have any questions regarding these specifications, contact us at the address listed at the end of this manual. When contacting us, please keep handy for our reference the model number (MODEL NO.) and the product number (PRODUCT NO.).

● Notes for Storage

When storing the equipment as shipped, perform the following:

- Store the equipment indoors at room temperature and normal humidity in a location that is protected from vibration and shock.
- Maintain the original packing condition of the equipment.

When storing the equipment after use, perform the following:

(1) Screw on the main unit cover to moisture-proof the unit.

(2) Repack the equipment in accordance with the original packing condition.

(3) Store the equipment indoors at room temperature and normal humidity in an area protected from vibration and shock.

Organization of This User's Manual

This manual is organized as shown below.

Chapter 1. Measurement System Structure

Explains the structure of measurement systems used by this equipment, and the name and function of each component.

Chapter 2. Installation of the Equipment

Describes installation procedures for the equipment. Refer to this chapter when connecting this equipment to the piping.

Chapter 3. Electrical Wiring

Describes the electrical wiring for this equipment. Refer to this chapter when installing electrical wiring after installation of the piping has been completed.

Chapter 4. Operation

Explains procedures for setting the parameters when starting to use this equipment, and the operation for displaying information on the indicator. Refer to this chapter before attempting to operate this equipment.

Chapter 5. Troubleshooting

Describes troubleshooting procedures for this equipment. Refer to this chapter first in the event of a malfunction.

Contents

Chapter 1. Measurement System Structure

● **Chapter Outline**

This chapter introduces the measurement system used by this equipment, and the organization and structure of the equipment.

1 - 1 Measurement System

● The concept behind the measurement of flow when using this equipment

A vortexor inserted into a flow alternately generates a regular vortex ("Karman vortex") downstream. When specifying f for the Karman frequency, d for the width of the vortexor, and v for flow speed, the following relation is observable:

$f = St\ V/d$

As St represents a non-dimensional number called Strouhal, and is also a constant number, within the range of a certain Reynolds number, according to the shape of the vortexor, measuring frequency f tells us V, and V can tells us the volume rate of flow.

As shown in Figure 1-1, this flowmeter is equipped with two pairs of ultra-sonic wave sensors, each consisting of a transmitter and a receiver, down-stream from the vortexor. The transmitter constantly sends ultrasonic waves into the liquid. These ultrasonic waves pass through the liquid, and reach the receiver within a specific period of time. When a Karman vortex is generated in the opposite direction from this transmission as shown in Figure 1-1, transmission time to the receiver is increased. On the other hand, when the direction of the Karman vortex flow and the ultrasonic wave are the same, the transmission time is decreased. The transmission time changes in proportion to the frequency of the vortex. The flow rate can therefore be measured by identifying changes in the amount of time it takes an ultrasonic wave to reach the receiver.

As the ultrasonic wave sensors are affixed outside the pipeline of the flowmeter main unit, measurement without touching the measured flow is possible, and the sensor system is highly sensitive while remaining highly resistant to the influence of vibration.

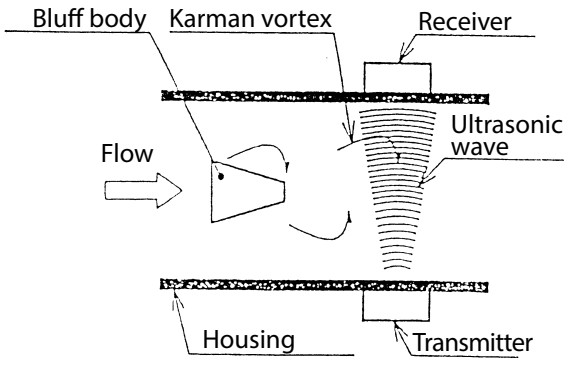


Figure 1-1. Measurement Principles

1 - 2 Structure and Component Functions

■ Structure of Main Unit

● Main components

This equipment features a 'one-piece' construction comprising both converter and a detector.The detector can either be configured as a wafer type (flange clamping type) or a flange type for connecting to the pipes.

● External view of the equipment

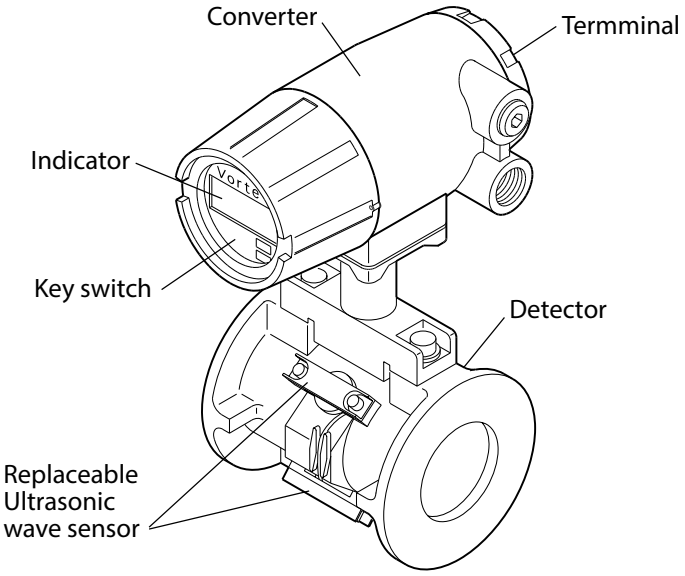


Figure 1-2. External View of the Ultrasonic Vortex Flowmeter

● Name and description of components

The table below describes the function of each component.

Name	Description
Converter	• Converts signals from the detector to analog or pulse output signals, then outputs or displays such signals
Detector	• Uses the ultrasonic wave sensor to detect the frequency of the Karman vortex according to flow speed, then transmits the data to the converter Contains a bluff body
Indicator	• Displays the instantaneous flow rate, reset integrated flow rate, total integrated flow rate, unit, alarm, and self-diagnostic status
Key Switch	• Allows changing of parameter settings for the converter. When using Vortexor in an explosion-proof area, changes to settings during operation not possible.
ReplaceableUltrasonic Wave Sensor	• Detects a Karman vortex generated in proportion to flow speed using four sensors (two pairs) which do not come into contact with the flow. The sensors are protected by an SUS 316 cover.

-MEMO-

Chapter 2. Installation of the Equipment

● **Chapter Outline**

How to connect this equipment to piping and complete installation procedures up to operation stage.

2 - 1 Installation Location

● Introduction

To facilitate daily maintenance and operation, and to ensure accuracy even during extended use, take the following into consideration when selecting an installation site.

● Installation location precautions

(1) The flowmeter may be installed at any angle; always confirm, however, that the pipe is completely filled with liquid.
Avoid installing the Transducer unit below the water surface, to protect against power shortage. Liquid builds up around the flowmeter during operation.

(2) When installing on vertical pipe, make the piping in such a way that ensures that measured liquid flows from bottom to top when the pipe is filled with liquid.

(3) Avoid any location subject to extreme fluctuations in temperature.

(4) Although the flowmeter possesses a good aseismatic structure, to maximize protection of the piping and joints, keep vibration and shocks under 9.8 m/s^2 by using supports.

(5) As the main unit is made of a stainless and aluminum alloy, avoid exposure to corrosive environments.

(6) As the water-resistant structure of this flowmeter is comparable to the JIS C0920 water-resistant structure (IEC IP66), it is not intended for submerged use.

(7) Install at a location with sufficient clearance to conduct inspections.

(8) Install at a location with sufficient clearance to enable installation of wiring and piping.

⚠ CAUTION

- **Measurement may not be possible in a two-phase flow consisting of gas and liquid or a flow that contains bubbles. Take care not to get liquids containing air bubbles in flows.**
- **If bubbles are trapped in the flowmeter, accurate measurement may not be possible. When installing the flowmeter, take care that bubbles are not trapped in the flowmeter.**
- **Do not subject the flow meter directly to water or other fluids. If installing in locations subject to water, the wiring connectors must be sealed thoroughly with glands, and the transducer cover must be closed tightly.**

2 - 2 Notes on Installing the Piping the Equipment

● Introduction

To ensure accuracy even during extended use, take the following into consideration when installing the piping and equipment.

● Pipework and installation precautions

(1) Match the flow direction of the fluid to the direction indicated (▶ mark) on the flowmeter.

(2) To ensure flow-rate measurement accuracy, install straight pipes of a length described in Table 2-1 on upstream and downstream sides of the flowmeter.

Table 2-1. Required Length of Straight Pipe

Upstream Piping	Straight Pipe Length for the upstream Side	Straight Pipe Length for the downstream side
One 90° bend	Diameter x to a factor of 23 or greater	Diameter x to a factor of 5 or greater
2 or more bends on the same plane	Diameter x to a factor of 25 or greater	
2 or more bends on a different plane	Diameter x to a factor of 40 or greater	
Ingot pipe	Diameter x to a factor of 15 or greater	
Expansion pipe	Diameter x to a factor of 27 or greater	
Gate valve	Diameter x to a factor of 15 or greater	

Table 2-2. Connection Pipe

Diameter	Internal Diameter of Flowmeter	Connection Pipe
25A to 50A	Comparable to schedule 40	Schedule 40 or greater
80A to 100A	Comparable to schedule 80	Schedule 80 or greater

(3) To ensure flow-rate measurement accuracy, make sure the gaskets between the flowmeter and the connection pipe remain outside the flow route.

(4) In the event that a pressure tap is required, to ensure the flow-rate measurement accuracy, install the tap at a distance, as measured from the edge of the downstream side of the flowmeter toward the lower stream, equal to at least twice the outlet diameter the diameter of the flowmeter. In the event that a temperature tap is required, install the tap at a distance from the pressure tap toward the lower stream equal to at least three times the outlet diameter the diameter.

(5) When making piping, ensure that the flowmeter and connection pipe are coaxial. Any gaps in the coaxial (gap in the center) will cause unstability and instrument errors. Use the center-aligning metal fittings and carry this out referring to page 2-11 included with the flowmeter, for installation.

(6) Large ripples, such as those caused by a bellows pump, may create variance. Use a damper to minimize such ripples.

(7) With lines which have globe valves and in which drift currents or rotating flows may occur, the flow meter should be positioned upstream of the valves.

(8) When installing a heat converter that significantly modifies liquid temperature, install it downstream of the flowmeter. In the event that it must be installed upstream, do so at an appropriate distance from the flowmeter.

(9) Cavitation lowers flow-rate measurement accuracy. To prevent cavitation, maintain the minimum pressure at the downstream line (located at a distance of 2-7 times the diameter of the flowmeter) at a pre

$Pd = 2.7 \times \Delta P + 1.3 \times P_0$

Pd : Downstream pressure (kPa, absolute pressure)
ΔP: Pressure loss (kPa)
P_0 : Vapor pressure of fluid at the temperature during measurement (kPa, absolute pressure)

The following formula calculates pressure loss.

$\Delta P = c \times \gamma$

ΔP: Pressure loss (kPa)
c : Pressure-loss coefficient (according to Figure 2-1)
γ : Fluid density (kg/m^3)

⚠ CAUTION

- **Ensure that the internal diameter of the connection pipe is equal to or greater than that of the flowmeter.**
- **Install gaskets between the flowmeter and the connection pipe and ensure that they are installed outside the flow route; otherwise, an instrument error will occur.This will cause errors.**
- **Pipe vibration should be minimized. The vibration frequency cannot be matched, and errors may occur.**
- **To prevent cavitation, allow sufficient back-pressure (pressure downstream of the flowmeter).**

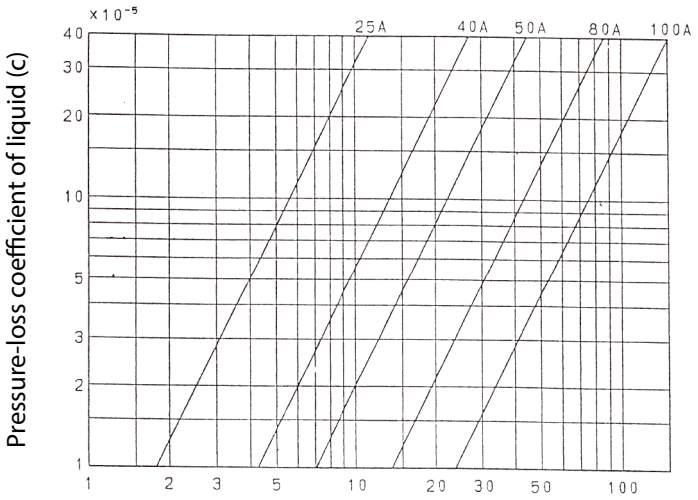


Figure 2-1. Pressure-Loss Coefficient

2 - 3 Caution Points Concerning Fluids Used

● Introduction

Please note the caution points described below in order to ensure consistent measurements over a long period of time.

● Fluid properties precautions

(1) The fluid temperature range is 20 to 160°C for general types, and 20 to 120°C for JIS explosion-proof types.

(2) The fluid pressures up to a maximum of 5MPa are possible, but the maximum value should match the rating of the flange actually being used.

(3) Fluid constituents adhering to the vortex generator may cause errors. Particular caution should be taken when using easily-precipitated fluids or fluids containing impurities.

● Precautions for fluids that cannot be used

The following fluids cannot be measured.

(1) Fluids that corrode SUS316L

(2) Steam, gases

(3) Fluids with viscosities exceeding 20 μ m^2/s (20mm^2/s)

2 - 4 Connect to Piping

■ Basic Installation

● Introduction

This device can be used with either wafer or flange-type connections. Refer to installation procedures to ensure proper installation of the equipment.

● Sample installation of a wafer detector

Figure 2-2 shows basic installation procedure of the wafer detector.

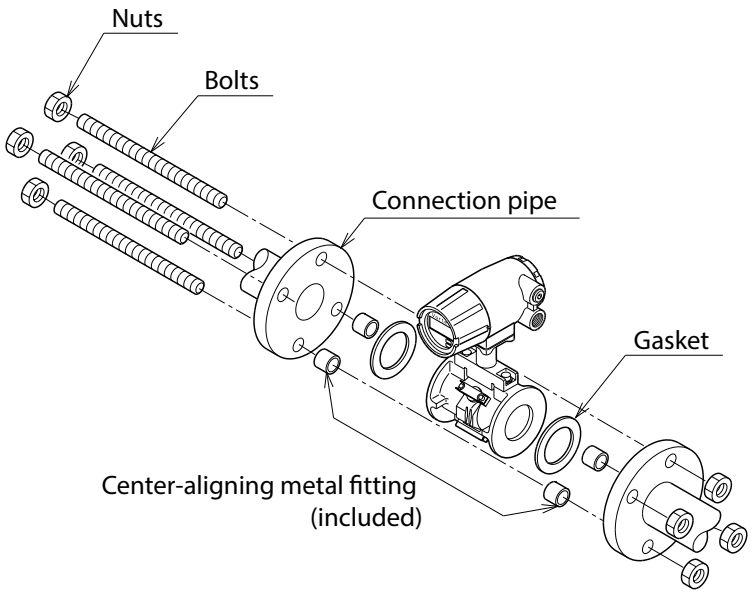


Figure 2-2. Installation Example

⚠ CAUTION

- **This instrument has a heavy construction. Use caution when handling or moving the Vortexor in order to prevent injuries.**

● **Torque**

CAUTION

- **Table 2-3 shows the allowable torque for each caliber. To prevent leakage from the piping, which can cause injuries, tighten the center-aligning metal fittings to the specified torque.**

Table 2-3. Torque

Nominal Diameter of Detector	Torque
25A	20 to 30N•m(200 to 300kgf•cm)
40A 50A 80A	30 to 50N•m(300 to 500kgf•cm)
100A	50 to 70N•m(500 to 700kgf•cm)

● **Configuration of flange at connection pipe**

As shown in Figure 2-3, use a flange that has considerable gasket-contact surface area.

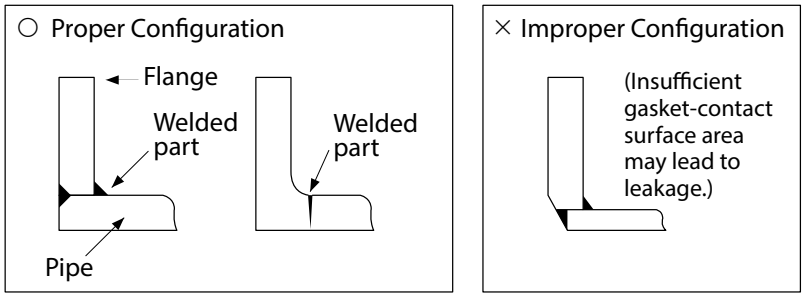


Figure 2-3. Flange Configuration

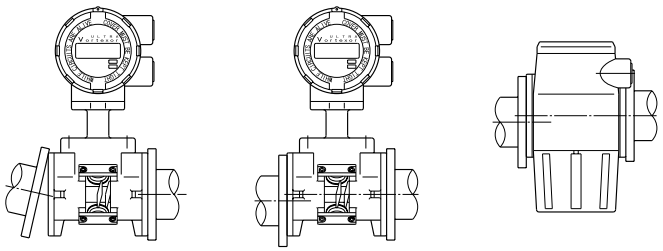
Handling Precautions

- Before installing the detector, flush to clean inside the pipe and remove any foreign matter from the flow route. Such substances cause irregular outputs.
- Match the direction indicated on the flowmeter to the flow direction. Measurements will not be possible.

● **Flange configuration**

⚠ WARNING

- **Before installation, confirm that the pipe is not installed at an angle and is properly aligned. Failure to do so may cause leakage, and result in injury.**



Pipe at an angle　　Misaligned　　Misaligned

Figure 2-4. Example of Improper Installation (1)

[!] Handling Precautions

- Do not force the Vortexor into a too-narrow space between pipe flanges, as the equipment may be damaged.

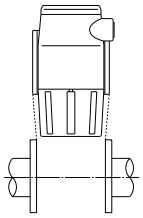


Figure 2-5. Example of Improper Installation (2)

⚠ CAUTION

- **Match the internal diameter of the connection pipe and the detector, and ensure that the gasket does not shift out of proper alignment, and penetrate the boundary of the piping.**

[!] Handling Precautions

- Tighten each bolt uniformly to the prescribed torque. If leakage does not stop after the bolts have been tightened, confirm that the center of piping is aligned, and cinch the bolts gradually. Ensure tightening torque is within the specified values; otherwise, the equipment may be damaged.

■ Required for Installation

● Introduction

The following are required for installation:

- Metal center-aligning fittings
- Through-bolts and nuts
- Gaskets

● Center-aligning fittings

Metal center-aligning fittings prevent misalignment between the connection pipes and the detector.

Pass the bolts through the center-aligning metal fittings. The detector must be positioned on or directly between the metal fittings.

The installation position of the metal fittings varies depending on the angle at which the detector is installed.

See Figure 2-6 and 2-7 for installation position.

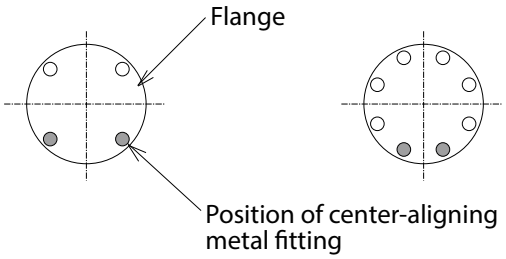


Figure 2-6. Horizontal Installation
(Attach two metal fittings -- one each to left and right flanges.)

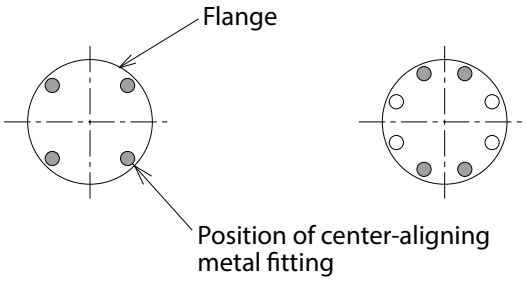


Figure 2-7. Vertical Installation
(Attach four metal fittings to the lower flange only.)

● Gasket

Handling Precautions

- If the internal diameter of the gasket is too small, flow speed distribution may be unbalanced and negatively impact accuracy.
- If the internal diameter of the gasket is too large, leakage may occur. If the measured flow includes solid substances, solids may accumulate between the gasket and flange, reducing accuracy.

Table 2-4. Recommended Internal Diameter of Full-Face Gasket (Unit mm)

Size \ Diameter of detector	25A	40A	50A	80A	100A
Internal Diameter	30 ±1	44 ±1	55 ±1	76 ±1	98 ±1

■ Connect to Horizontal Piping

⚠ CAUTION

- **Improper installation may cause leakage of the measured flow, damage the flanges, and result in injury.**

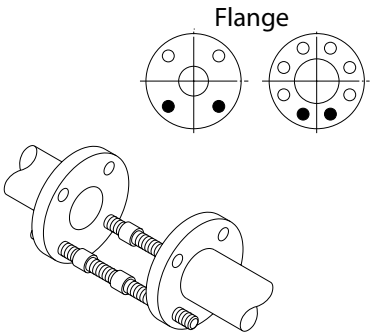
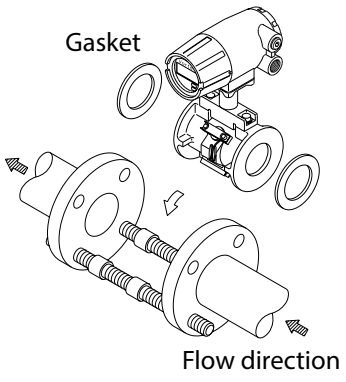
● Required for installation

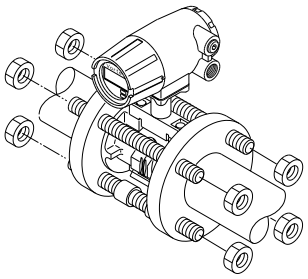
Prepare the following:

- Through-bolts and nuts
- Metal center-aligning fittings
- Gaskets

● Procedure

Install according to the following procedure.

Step	Description	Figure
1	Pass the bolts through the holes (shown in black in the Figure) at the flange. At this time, pass two center-aligning metal fittings through each bolt.	
2	• Match the direction of the flow to the direction indicated on the Vortexor. • Position the gasket and the detector between the flanges. • Place the detector on the metal center-aligning fittings.	

Step	Description	Figure
3	• Confirm that the center of the components are aligned. • Confirm that the gasket does not protrude into the flow route. • After confirming the above, pass the remaining bolts through the holes at the flanges, and tighten uniformly all bolts to the torque shown on page 2-7.	

■ Connection to Vertical Piping

⚠ CAUTION

- **Improper installation may cause leakage of the measured flow, damage the flanges, and result in injury.**

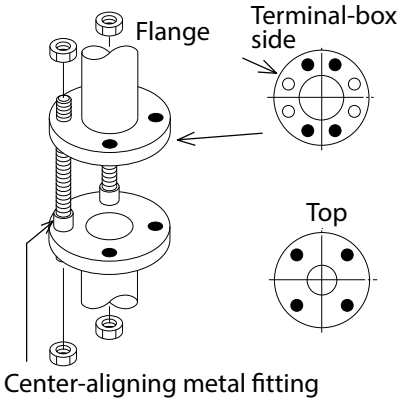
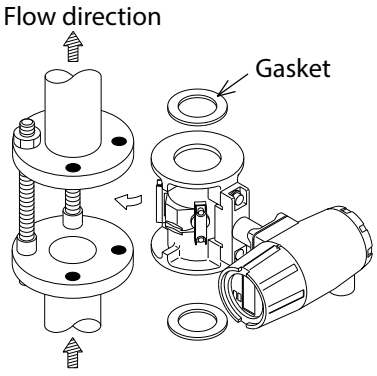
● Required for installation

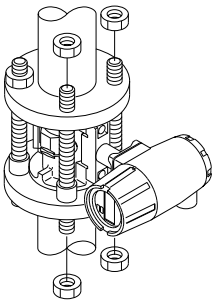
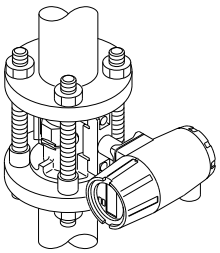
Prepare the following:

- Through-bolts and nuts
- Center-aligning metal fittings
- Gaskets

● Procedure

Perform installation according to the following procedure:

Step	Description	Figure
1	Pass the bolts through the two top holes, shown in black in the figure, of the flange, and tighten them partly with the nuts. At this time, pass the bolts one the center-aligning metal fittings through each bolt.	
2	• Match the direction of the flow to the direction indicated on the Vortexor. • Insert both the gasket and the detector between the flanges.	

Step	Description	Figure
3	Pass the bolts though the two remaining flange holes shown in black in the figure at Step 1 and 2, through the center-aligning metal fittings, and partially tighten.	
4	• Confirm that the center of the components are aligned. • Confirm that the gasket does not protrude into the flow route. • After confirming the above, pass the remaining bolts through the holes at the flanges, and tighten all bolts equally to the torque shown on page 2-7.	

■ Basic Installation Method

● Installation example for flange type

Figure 2-8 shows the basic installation method.

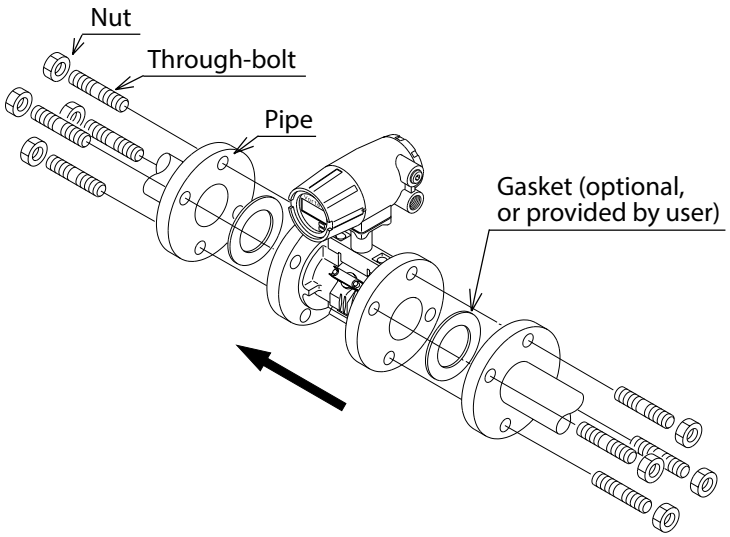


Figure 2-8. Installation example

CAUTION

- **Flange-type detector is heavy. Dropping on feet will result in injury or broken bones. Sufficient care must be taken.**

CAUTION

- **Table 2-5 shows the tightening torques for each bore diameter. Tighten to the prescribed torques to prevent fluid leakage from the pipe. Risk of injury.**

● Tightening torques

Table 2-5. Tightening torques

Bore diameter, flange rating		Units:N·m (kgf·cm)			
25 mm	JIS10K	21	to	31	(214 to 316)*
	JIS20K	21	to	32	(214 to 326)*
	JPI/ANSI150	11	to	17	(112 to 173)*
	JPI/ANSI300	22	to	34	(224 to 347)*
40 mm	JIS10K	22	to	32	(224 to 326)*
	JIS20K	22	to	34	(224 to 347)*
	JPI/ANSI150	13	to	18	(132 to 184)*
	JPI/ANSI300	36	to	57	(367 to 581)*
50 mm	JIS10K	24	to	34	(245 to 347)*
	JIS20K	19	to	31	(194 to 316)*
	JPI/ANSI150	23	to	32	(235 to 326)*
	JPI/ANSI300	20	to	32	(204 to 326)*
80 mm	JIS10K	20	to	31	(204 to 316)*
	JIS20K	37	to	61	(377 to 622)*
	JPI/ANSI150	26	to	35	(265 to 357)*
	JPI/ANSI300	37	to	57	(377 to 581)*
100 mm	JIS10K	22	to	33	(224 to 337)*
	JIS20K	41	to	66	(418 to 673)*
	JPI/ANSI150	21	to	31	(214 to 316)*
	JPI/ANSI300	43	to	66	(439 to 673)*

* Values in parentheses are for reference.

● Flange profile

A large flange should be used to maximize the contact area with the gasket as shown in Figure 2-9.

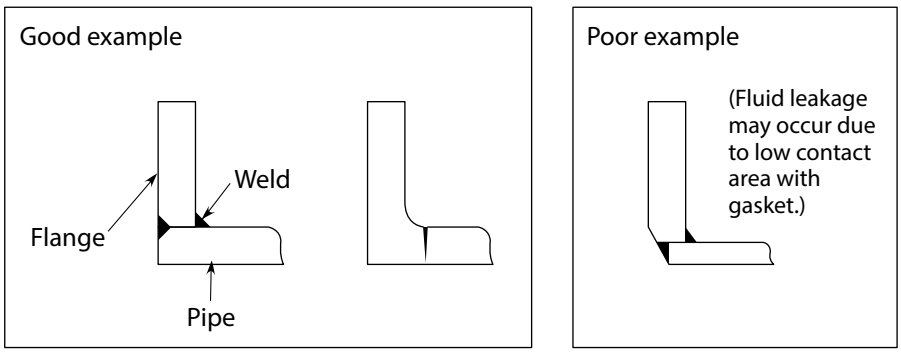


Figure 2-9. Flange profile

Handling Precautions

- Always flush the pipe to remove any debris from inside before installing the detector. Failure to do this will cause the output to drift. Insert a short length of pipe in place of the detector when flushing.
- Match the flow direction mark on the detector with the fluid flow direction. Failure to do this will prevent measurements.
- Do not force objects between the flange faces. This will result in damage to the device.

CAUTION

- **Match the internal diameters of the pipes and detector to ensure that the gaskets do not protrude inside the pipes.**

Handling Precautions

- When tightening bolts, tighten each bolt evenly. If fluid leakage does not stop after tightening, gradually tighten the bolts further. Take care to not to tighten the bolts over the prescribed torques. This will result in damage to the device.

■ Materials Required for Installation

● Introduction

The following materials are required for installing the Vortexor.

- Gaskets

● Gaskets

Joint sheet or PTFE is recommended for the gasket material. The gasket internal diameters should be as shown in Table 2-6.

[!] Handling Precautions

- If the gasket internal diameters are too small, the flow rate distribution will be disrupted, affecting accuracy.

Table 2-6. Recommended gasket internal diameters

Detector opening diameter (mm)	Internal diameter (mm)
25	30±1
40	44±1
50	55±1
80	76±1
100	98±1

2 - 5 Changing the Direction of the Converter / Indicator

When installation location of the flowmeter necessitates changing the direction of the converter and/or indicator, perform the following procedures.

The flowmeter must be connected to piping or placed on a stable work table.

■ Changing the Direction of the Converter Case

To turn the converter case through 180˚ in relation to the flow direction, perform the following procedure:

(1) If power is being supplied to the flowmeter, turn off the power.

(2) Remove the four bolts (5-inch) at the bottom of the converter.

(3) Lift the converter 2 to3 mm, and turn it through 180˚.
The ultrasonic-wave sensor cable (thin electric wire) resides between the flowmeter main unit and the converter case, and connects them. When rotating the converter, be careful not to sever the cable. Do not repeatedly turn the converter 180˚ in the same direction. Turn the case in the opposite direction every rotation to prevent the internal cable from being twisted and possibly severed.

(4) After setting the direction of the converter, place the converter on the flowmeter main unit, and completely tighten the four bolts (5-inch) at the bottom of the converter completely.
Since the JIS pressure-resistance explosion-proof model of the flowmeter has a pressure-resistant, explosion-proof structure, completely tighten the bolts.

⚠ WARNING

- **Since the flowmeter has a pressure-resistant explosion-proof structure, completely tighten the four bolts (5-inch) at the bottom of the converter after changing the direction of the converter, to maintain the explosion-proof structure.**
- **If the explosion-proof structure is not maintained due to insufficient tightening of the bolts, a fire or explosion may occur when the flow-meter is used in hazardous operating conditions.**

⚠ CAUTION

- **When changing the converter direction, be careful not to sever the ultrasonic wave sensor cable running between the flowmeter main unit. Turn the converter in the opposite direction every rotation to prevent the internal cable from being twisted and possibly severed.**

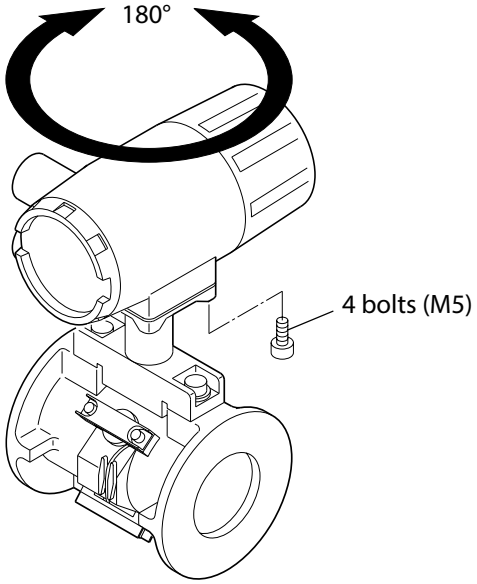


Figure 2-10. Changing the Direction of the Converter

■ Changing the Direction of the Indicator

To turn the direction of the indicator 90˚ as shown in Figure 2-11, perform the following procedure.

(1) If power is being supplied to the flowmeter, turn off the power.

(2) Remove the converter lid after loosening the set screws (with which it is affixed), as shown in Figure 2-12.
After loosening the set screws, turn the converter lid to remove it. Note that there is an O-ring in the connection area.

(3) Remove the LCD.
Remove the two screws affixing the LCD, and remove the LCD together with the outer-facade panels.

(4) Change the direction of the indicator.
After changing the direction of the indicator, insert the connector at the bottom of the board into the LCD receptacle.

(5) Fix the LCD into place.
Affix the LCD with the two screws (removed in Step (3) above).

(6) Attach the converter lid to the converter main unit. Remember to correctly position O-ring.

(7) After completely tightening the converter lid, tighten the set screws for the turn stopper.

⚠WARNING

- **Since the flowmeter has a pressure-resistant explosion-proof structure, completely tighten the converter lid after changing the direction of the indicator, to maintain the explosion-proof structure.**
- **If the explosion-proof structure is not maintained due to a failure to tighten the converter lid, a fire or explosion may occur when the flowmeter is used in dangerous operating conditions.**

⚠CAUTION

- **Do not forget to insert the O-ring between the converter main unit and the lid when tightening the converter lid.**
- **Without the O-ring, water-resistance may be negatively affected, and the converter circuit may be damaged due by liquid intrusion.**

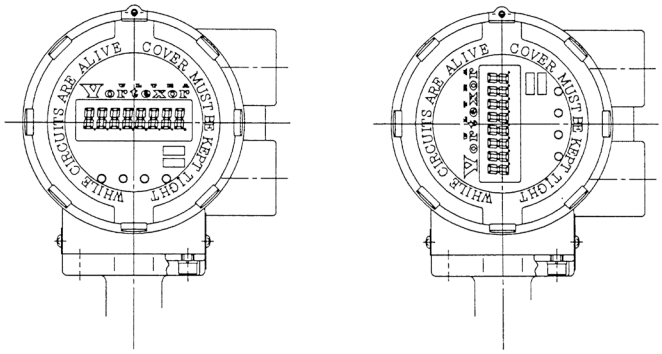


Figure 2-11. Direction of the Indicator

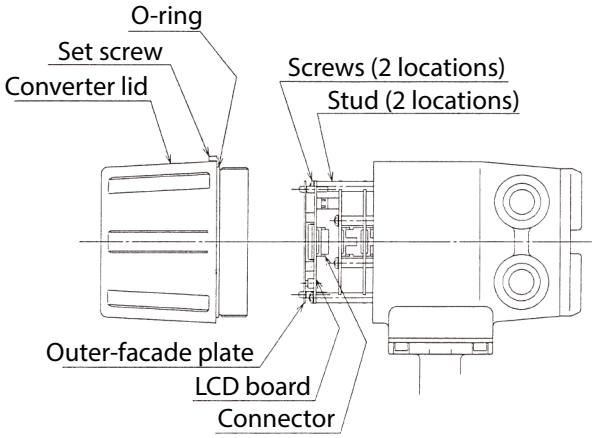


Figure 2-12. Changing the Direction of the Indicator

-MEMO-

Chapter 3. Electrical Wiring

● **Chapter Outline**

This chapter explains the electrical wiring for the power and output of the Vortexor.

3 - 1 Wiring Procedure

● Introduction

This section describes the method for wiring the flow meter. Please read this when wiring the power supply and outputs.

● Wiring instructions

(1) Follow Figure3-1(a). to wire external cables for the flowmeter, power supply, and external equipment.

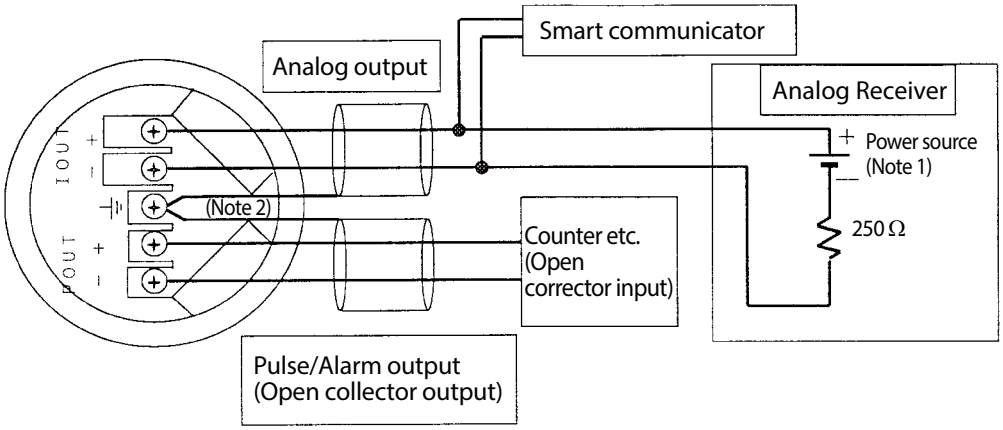


Figure 3-1. Figure3-1(a). Connection Diagram

Note 1: Supply power to the flowmeter

Note 2: When grounding the cable shield, use one-point grounding at the flowmeter side or at upstream equipment.

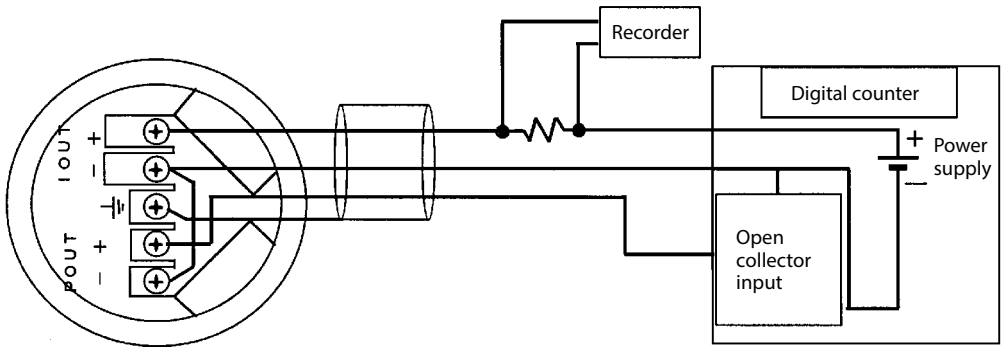


Figure 3-2. Figure3-1(b). Wiring diagram
(When using pulse/alarm outputs only)

(2) Analog output
The analog transmission loop of this flowmeter is created by establishing load resistance between the + line and - line of the analog output line. (The analog output line is also used as a power supply line for the flowmeter.)

(3) Pulse output / Alarm output
The pulse output/alarm output of this flowmeter is an open collector output. Connect a power source, using the current limit resistance, between the pulse/alarm output line and COM line to be used. Ensure the value of current limit resistance does not exceed the capacity of the pulse output.

(4) Remove the terminal cover at the amp case and the dust-proof plug at the wiring connection before attempting to install the wiring.

(5) To assure water-resistance, conduit tubes and ducts should be used for external wiring.

3 - 2 Wiring Precautions

(1) The cables used should be as follows.
Recommended cable: CVV-S or CEV-S

Flow meter output	Cores
None, or analog output only	2-core shielded
None, or analog output only + pulse output or alarm output	2-core shielded x2
Pulse or alarm output only	3-core shielded

* Ensure that the total of the circuit resistance and load resistance matches the value in Figure 2-2.
* It is recommended that cables are used with cross-sectional areas of at least 1.25mm^2.
* It is recommended that CEV-S cable with a cross-sectional area of at least 2mm^2 is used if the transmission distance exceeds 500m.

(2) In order to prevent noise intruding, the cables should be kept away from noise sources such as large-capacity motors, transformers and power plants, or from high-voltage and high-current sources.

(3) If using explosion-proof specifications, the pressure-resistant seal fittings included (or as optional specifications) must be used.

⚠ WARNING

- **The specified pressure-resistant seal fittings must be used at the cable inlets when using in hazardous atmospheres.**
- **Failure to use the specified pressure-resistant seal fittings, or use of unspecified fittings will not guarantee the explosion-proof construction, and there will be a danger of explosion in some cases.**

Chapter 4. Operation

● Chapter Outline

This chapter gives the procedure for specifying the parameters needed to start operating this device and explains what is displayed on the indicator.

4 - 1 Quick Start

● Introduction

This section gives the procedure for starting operation immediately after installation.

● Steps for quick start

Follow the steps below.

Step	Description
1	Turn on the power. Check that characters are displayed on the LCD.
2	Press the ▶ and ENT key switches simultaneously for 3 seconds or longer. "FUNC1" is displayed.
3	Press ENT and check the unit for instantaneous flow rate. Use ▲ or ▼ to make changes, if necessary.
4	Press ENT and check that "PASS" is displayed. Then, press ▲or ▼ to display "FUNC3."
5	Press ENT and check the maximum flow rate. Use ▲ or ▼ to make changes, if necessary. Use ▶ to select the next digit.
6	Press ENT and check that "PASS" is displayed.
7	Press ENT for 3 seconds or longer to return to measurement mode and start measurement.

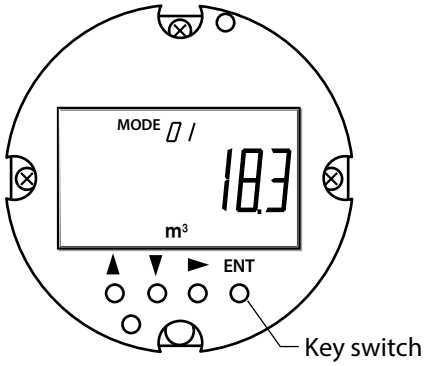


Figure 4-1. Indicator section

4 - 2 Converter Circuit Functions

● Introduction

This section gives a simple description of the structure of the converter circuit.

● Circuit structure

Figure 4-2 shows the circuit boards of the ultrasonic vortex flowmeter.

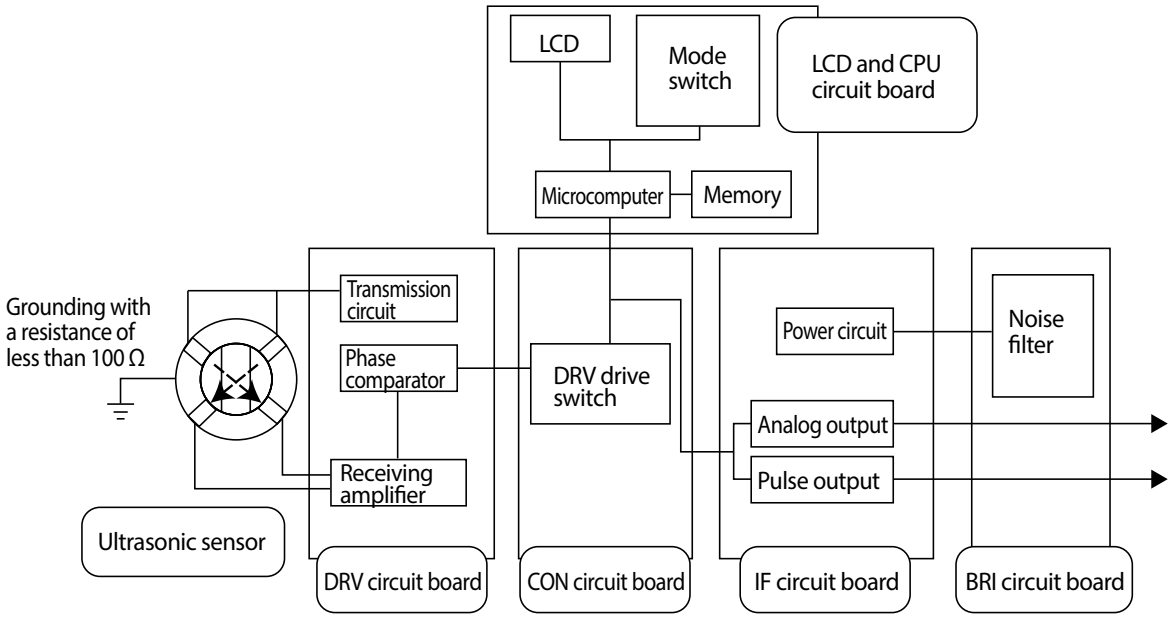


Figure 4-2. Converter circuit block diagram

(1) DRV circuit board
The DRV circuit board has transmitting and receiving circuits for the ultrasonic sensors and a circuit for processing the received vortex signals.

Since it is necessary to change internal constants depending on the pipe diameter, jumper pins JP4–6 should be set as shown in Table 4-1. (Note: The pins are set when this product is shipped from the factory.)

Table 4-1. Jumper pin settings depending on the pipe diameter

Pipe diameter	Jumper No.		
	JP4	JP5	JP6
25 mm	1–2 shorted	2–3 shorted	2–3 shorted
40/50/80 mm	2–3 shorted	1–2 shorted	1–2 shorted
100 mm	2–3 shorted	Open	Open

(2) CON circuit board
The CON circuit board is equipped with a switch for driving the DRV.

(3) IF circuit board
The IF circuit board has a power circuit, analog output circuit, and pulse output circuit.

(4) LCD and CPU circuit board
This circuit board is equipped with an LCD and a CPU.

(5) BRI circuit board
The BRI circuit board consists of a terminal block for connecting external cables and a noise filter circuit.

4-3 Indicator

● Introduction

This section describes the display function of the converter.

● Display function

The figure below shows the indicator section.

A magnetic switch is located at the position indicated by a circle in the figure below. The user can switch the display and operate this device by placing the magnet supplied with the product close to the switch.

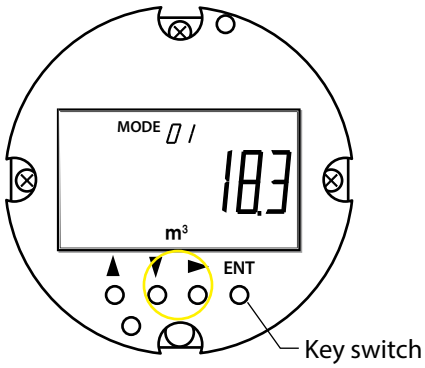


Figure 4-3. Indicator section (○: magnetic switch)

● Displayed information

The LCD of this flowmeter displays the total flow volume, instantaneous flow rate, total flow volume reset, and alarm No. in the case of something abnormal.

Figure 4-4 shows the items displayed on the LCD.

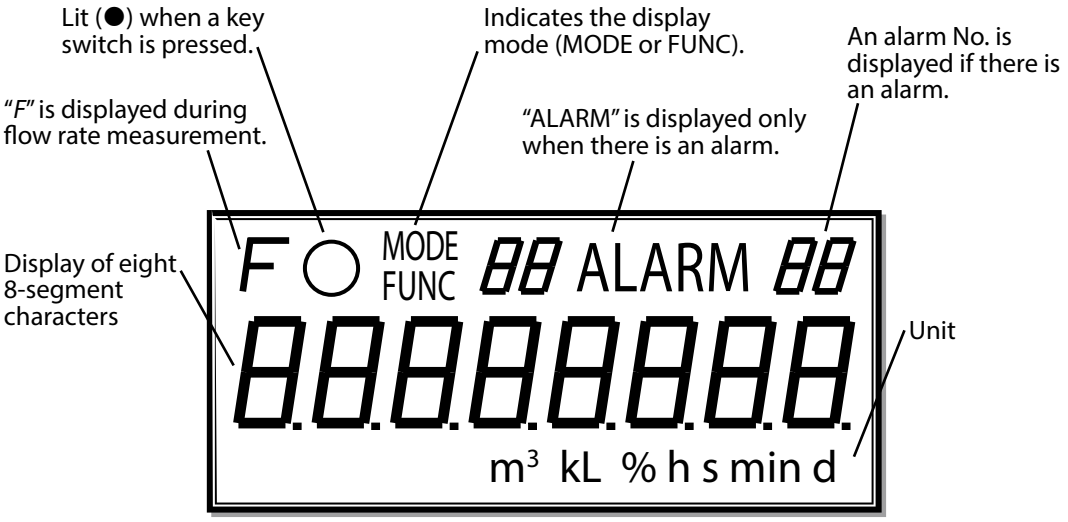
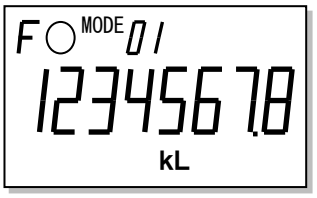
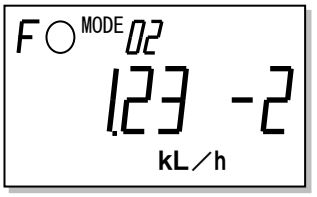
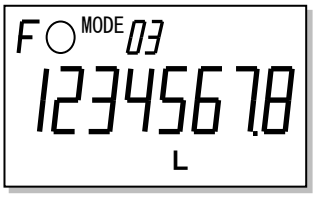
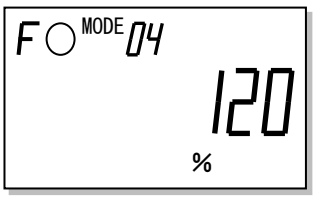


Figure 4-4. Items displayed on LCD

● Display mode

The items displayed during flow rate measurement vary depending on the mode No. Table 4-2 shows the displayed items for each mode.

Table 4-2. Items displayed during flow rate measurement

MODE	Item	Specifications	Display example
01	Name	Total flow volume	
	Display format and range	0.0–9999999.9	
	Unit	Select from m^3, kL, L	
	Number of decimal places	1 (not changeable)	
	Display update cycle	160 ms or less	
	Other	None	
02	Name	Instantaneous flow rate	
	Display format and range	Mantissa: 0.00–9.99 Exponent: 0 to ± 9 Note: "–" is displayed for a negative exponent, but "+" is not displayed.	
	Unit	Numerators (volume): m^3, kL, L Denominators (time): a combination of s, min, h, and d	
	Number of decimal places	Mantissa: 2 (not changeable) Exponent: No decimal point	
	Display update cycle	Approx. 1 s	
	Other	If the flow rate exceeds 200 % of the range (of the maximum flow rate), the value equivalent to 200 % blinks and continues to be displayed.	
03	Name	Reset counter	
	Display format and range	0.0–9999999.9	
	Unit	m^3, kL, L	
	Number of decimal places	1 (not changeable)	
	Display update cycle	160 ms or less	
	Other	The total flow volume can be reset to zero.	
04	Name	Flow rate range %	
	Display format and range	0–200	
	Unit	%	
	Number of decimal places	None	
	Display update cycle	Approx. 1 s	
	Other	If the flow rate exceeds 200 % of the range (of the maximum flow rate), "200 %" blinks and continues to be displayed.	

● Changing the display mode

When the flowmeter is turned on, the measured flow rate is displayed.

The displayed items (MODE No.) can be changed with the included magnet

using the procedure below.

(1) Place the magnet close to the magnetic switch that is located behind ▼ and ▶ on the indicator to change the mode No. and displayed items.

(2) The mode changes cyclically in the order: MODE 01 (total flow volume) → MODE 02 (instantaneous flow rate) → MODE 03 (reset counter) → MODE 04 (flow rate range %) → MODE 01, and so on.

(3) The instantaneous flow rate in MODE 02 is displayed in exponential notation, as a value with 2 decimal places and a 1-digit integer (a multiplier, as in the "x" of 10x).

(4) To reset the displayed total flow volume to zero in MODE 03 (reset counter), place the magnet close to the magnetic switch for 3 seconds or longer. The total flow volume will be displayed as "0." If the magnet is moved away from the switch before 3 seconds elapse, the total flow volume will not be reset and the device will enter MODE 04 (flow rate range %).

Figure 4-5 shows the process of switching between displays.

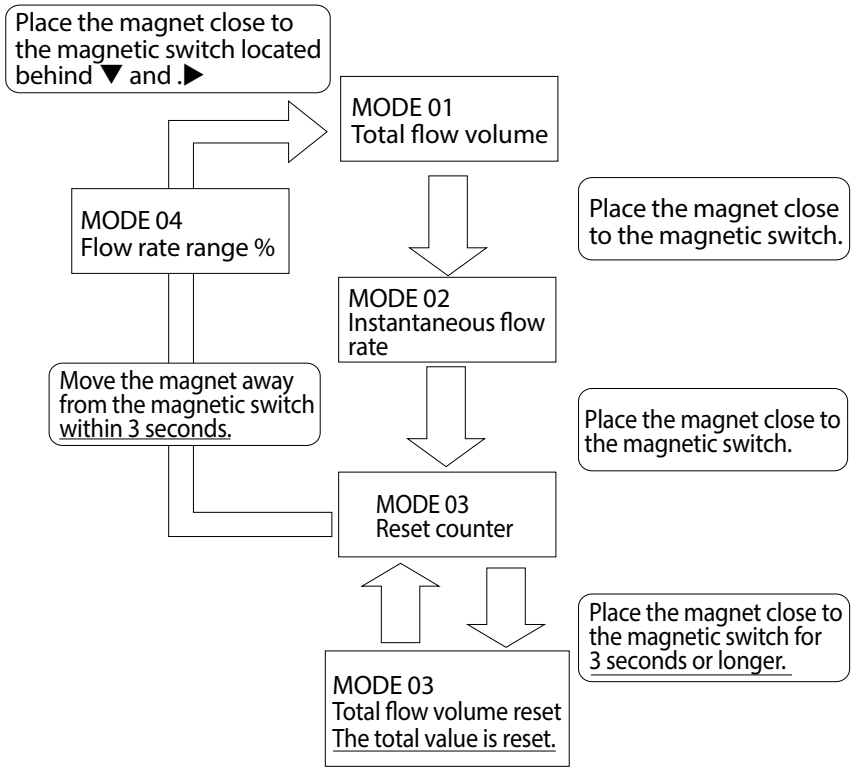


Figure 4-5. Switching between displays

● Alarm display

If a problem occurs with the flowmeter, "ALARM" and an alarm No. is displayed to indicate the type of abnormality. Table 4-3 shows the alarm numbers and the indicated problems.

Table 4-3. Alarm No. and problem

Alarm No.	Problem	Flow rate measurement
ALARM 01	Transmitter failure	Stops
ALARM 02	Failure of receiver 1	Continues
ALARM 03	Failure of receiver 2	(Same as above)
ALARM 04	Failure of both receivers	Stops
(Not used)	–	–
ALARM 06	Failure of F-RAM	Stops (this alarm is detected only during initialization)
ALARM 07	Failure of RAM	(Same as above)
ALARM 08	Failure of ROM	(Same as above)
ALARM 09	Abnormal total flow volume	(Same as above)

Handling Precautions

- Sensor errors may occur when a fluid containing bubbles enters the device, or even when the pipe is filled with fluid.
  If an alarm is displayed, remove the cause of the error immediately.
  (Take corrective actions, referring to chapter 5.)

CAUTION

- **If an alarm is displayed, take corrective actions for the error immediately.**
- **If operation continues when there is an error, incorrect measurement leading to problems in the plant may result.**

4 - 4 Specifying Parameters

● Introduction

This section describes how to input parameter settings to the converter.

● Indicator section

The figure below shows the indicator section. There are four key switches (▲, ▼, ▶, ENT) located below the LCD that are used to change the settings.

In addition, a magnetic switch is located in the position indicated by a circle.

When shifting from user setting mode to factory mode, use the magnetic switch along with the key switches.

The menu is designed so that the user will not accidentally switch to factory mode, which allows advanced settings for the flowmeter.

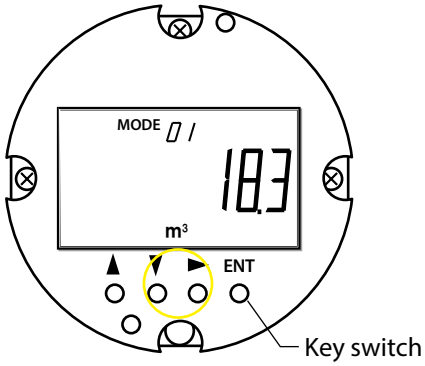


Figure 4-6. Indicator section (○: magnetic switch)

● **Flowchart of parameter settings**

Figure 4-7 shows a flowchart for parameter settings.

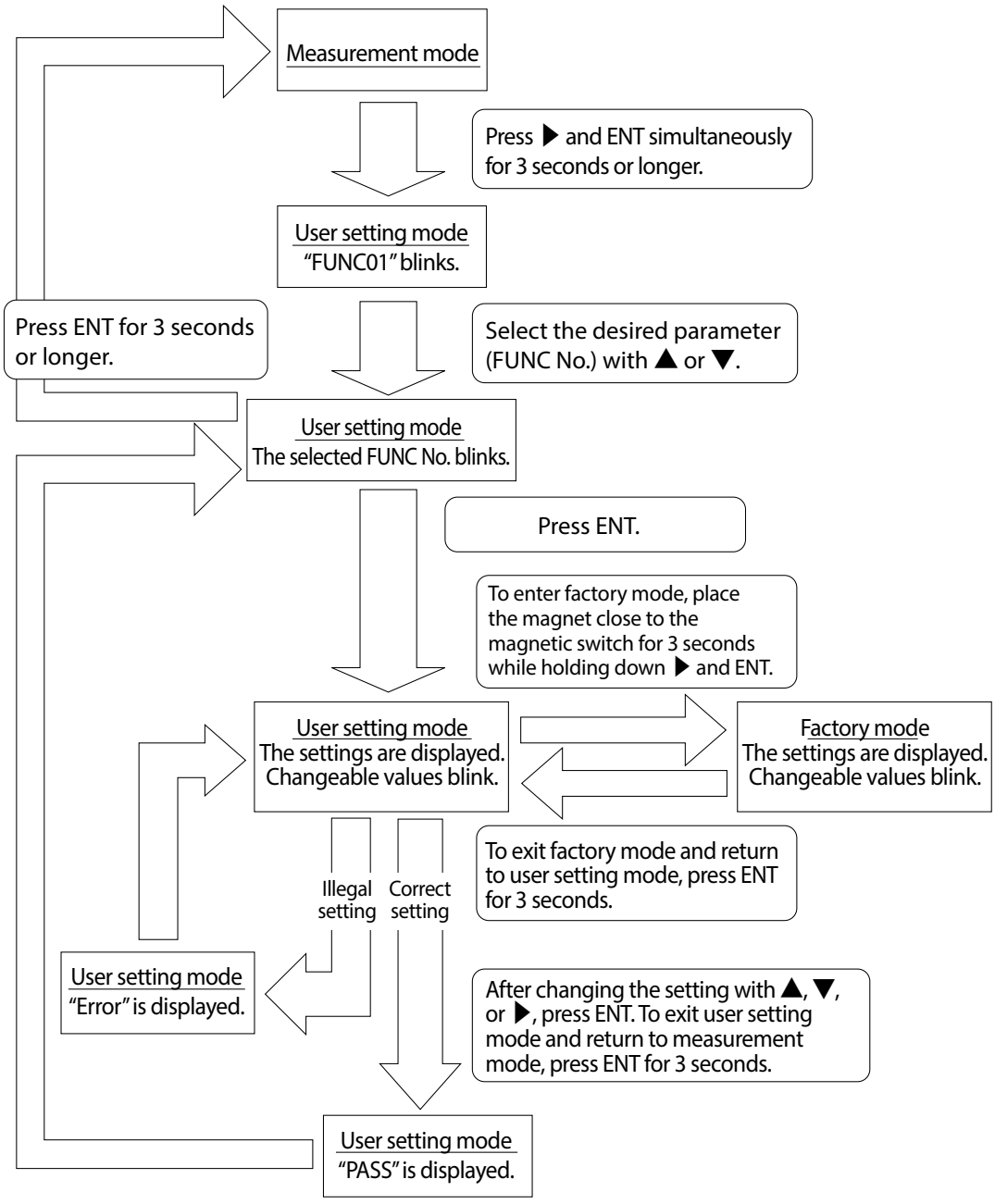


Figure 4-7. Procedure for specifying parameters

● User setting mode

User setting mode provides the basic operation menu of this device. Factory mode is available in addition to user setting mode. In factory mode, settings for dummy analog and pulse signal output, etc., can be specified.

1. Changing to user setting mode

The flowmeter is usually in measurement mode during operation. To shift from this mode to user setting mode in order to set various parameters, hold down the ▶ and ENT key switches simultaneously for 3 seconds or longer. "FUNC 1" blinks as shown in Figure 4-8.

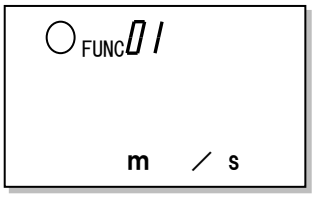
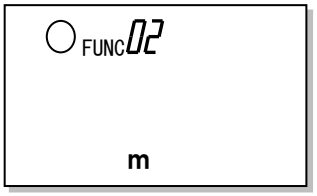
Figure 4-8. Display in user setting mode

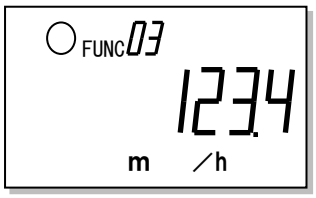
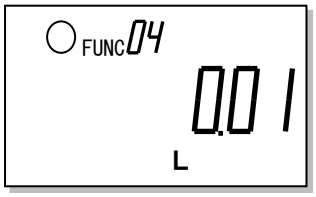
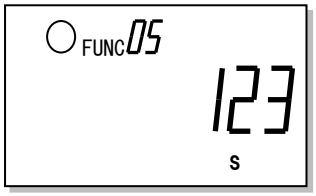
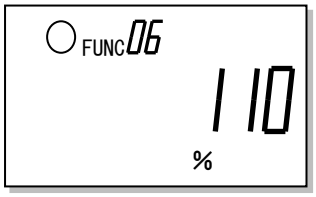
2. Selecting a parameter

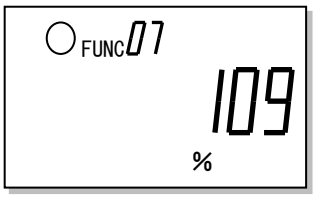
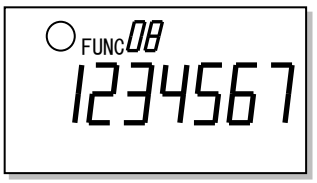
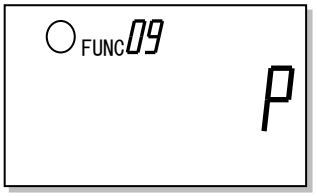
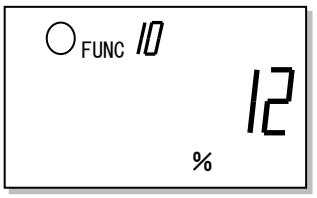
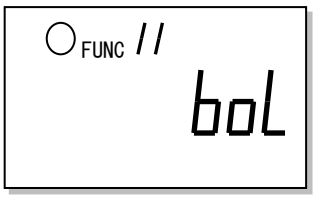
Select the FUNC No. corresponding to the parameter to be specified (changed) with ▲ and ▼.

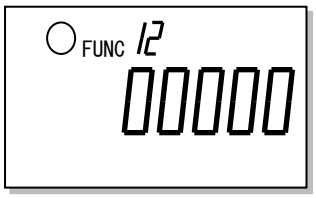
See Table 4-4 for FUNC numbers and changeable parameters.

Table 4-4. FUNC numbers and parameters in user setting mode

FUNC No.	Item	Specifications	Display example
01	Name	Instantaneous flow rate unit	
	Display format and range	Select the unit for instantaneous flow rate (MODE 02) display.	
	Unit	Numerators (volume): m3, kL, L Denominators (time): a combination of s, min, h, and d	
	Number of decimal places	None	
	Display update cycle	A changeable value blinks at 1 Hz. Display is updated at each setting operation.	
02	Name	Total flow volume unit	
	Display format and range	Select the unit of total flow volume (MODE 01) and total volume reset counter (MODE 03) display.	
	Unit	Select from m^3, kL, L	
	Number of decimal places	None	
	Display update cycle	A changeable value blinks at 1 Hz. Display is updated at each setting operation.	

FUNC No.	Item	Specifications	Display example
03	Name	Maximum flow rate (flow rate range)	
	Display format and range	Set a value within the range below according to the pipe diameter. Dia. 25 mm: 1.4–14 m^3/h 40 mm: 3.6–36 m^3/h 50 mm: 6.0–60 m^3/h 80 mm: 11.5–115 m^3/h 100 mm: 20.0–200 m^3/h	
	Unit	m^3/h (not changeable)	
	Number of decimal places	1 (not changeable)	
	Display update cycle	A changeable value blinks at 1 Hz. Display is updated at each setting operation.	
04	Name	Pulse output unit	
	Display format and range	Set the units from the options below according to the pipe diameter. Dia. 25 mm: 0.1 L, 1 L, 10 L, 100 L 40 mm: 0.1 L, 1 L, 10 L, 100 L 50 mm: 1 L, 10 L, 100 L, 1 m^3 80 mm: 1 L, 10 L, 100 L, 1 m^3 100 mm: 1 L, 10 L, 100 L, 1 m^3	
	Unit	Select from L (/p), m^3 (/p)	
	Number of decimal places	Changeable	
	Display update cycle	Option blinks at 1 Hz. Display is updated at each setting operation.	
05	Name	Damping time constant	
	Display format and range	001–199	
	Unit	s	
	Number of decimal places	None	
	Display update cycle	A changeable value blinks at 1 Hz. Display is updated at each setting operation.	
06	Name	Flow rate high limit alarm (= high limit alarm threshold)	
	Display format and range	001–110	
	Unit	%	
	Number of decimal places	None	
	Display update cycle	A changeable value blinks at 1 Hz. Display is updated at each setting operation.	

FUNC No.	Item	Specifications	Display example
07	Name	Flow rate low limit alarm (= low limit alarm threshold)	
	Display format and range	000–109	
	Unit	%	
	Number of decimal places	None	
	Display update cycle	A changeable value blinks at 1 Hz. Display is updated at each setting operation.	
08	Name	F-RAM update count (reference only)	
	Display format and range	0–9999999 (reference only)	
	Unit	None	
	Number of decimal places	No decimal point	
	Display update cycle	Option blinks at 1 Hz. Display is updated at each setting operation.	
09	Name	Open collector contact output function selection	
	Display format and range	Select from AL (alarm), F (unused), P (pulse output)	
	Unit	None	
	Number of decimal places	None	
	Display update cycle	Option blinks at 1 Hz. Display is updated at each setting operation.	
10	Name	Low flow cutoff	
	Display format and range	00–20	
	Unit	%	
	Number of decimal places	None	
	Display update cycle	A changeable value blinks at 1 Hz. Display is updated at each setting operation.	
11	Name	Burnout output (= output behavior in case of abnormality)	
	Display format and range	Select from boL (= burnout low; the minimum value is output), boH (= burnout high; the maximum value is output), HoLd (= output hold; the value immediately before the burnout occurs is retained)	
	Unit	None	
	Number of decimal places	None	
	Display update cycle	Option blinks at 1 Hz. Display is updated at each setting operation.	

FUNC No.	Item	Specifications	Display example
12	Name	Abnormality type (reference only)	
	Display format and range	The type of abnormality is displayed. The same information as ALARM 01–09. 000000–111111 (0: normal / 1: abnormal) 10^0 digit: Transmitter failure 10^1 digit: Failure of receiver 1 10^2 digit: Failure of receiver 2 10^3 digit: Failure of both receivers 10^4 digit: Failure of F-RAM 10^5 digit: Abnormal total flow volume	
	Unit	None	
	Number of decimal places	None	
	Display update cycle	Option blinks at 1 Hz. Display is updated at each setting operation.	

If an illegal setting is entered for a parameter, an error No. will be displayed on the LCD.

The table below describes the causes of the errors. Change the setting of the parameter and try again.

Table 4-5. Error identified in parameter relationship check

Error code	Description
Error 01	FUNC 03 (maximum flow rate) and FUNC 53 (pipe diameter) settings are inconsistent. The specifiable maximum flow rate is defined for each pipe diameter. A maximum flow rate that is not allowed for the diameter was entered. Change the maximum flow rate setting and try again.
Error 02	FUNC 04 (pulse output unit) and FUNC 54 (K factor) settings are inconsistent. The specifiable pulse output unit is determined by the pipe diameter based on the K factor. Change the pulse output unit and try again.
Error 03	FUNC 06 (flow rate high limit alarm) and FUNC 07 (flow rate low limit alarm) settings are inconsistent. Flow rate low limit alarm must be less than flow rate high limit alarm. Check the flow rate alarm settings.
Error 04	FUNC 51 (DA output zero point) and FUNC 52 (DA output span point) settings are inconsistent. The DA output zero point (analog output zero point) must be less than the DA output span point (analog output span point). Change the DA output zero point or span point and try again.

3. Changing settings

Use the procedure below to change the setting of the selected parameter (FUNC).

(1) Press the ENT key switch while the selected FUNC No. is blinking. The stored setting is displayed.

(2) The changeable value of the setting blinks.

For FUNC 01 and 02, pressing ▲ or ▼ changes the displayed units sequentially.

For FUNC 03, 05, 06, 07, and 10, press ▲ or ▼ to change the value of the blinking digit.

(Use ▲ to increase the value and ▼ to decrease it.)

Use ▶ to shift the blinking (changeable) digit.

For FUNC 04, pressing ▲ or ▼ displays specifiable values sequentially.

For FUNC 08, the number of times data was written to the F-RAM is displayed. (The value is for reference only and cannot be changed.)

For FUNC 09, pressing ▲ or ▼ displays available contact output settings sequentially. (“AL” indicates an alarm and “P” indicates pulse output.)

(3) After changing the settings, press ENT. If the new value is within the specifiable range, “PASS” is displayed, the value is written to the internal memory, and then the FUNC No. blinks again. If the new value is outside the specifiable range, “Error” is displayed and the display returns to step 2 (the stored setting is displayed and the changeable digit blinks) to wait for re-entry of the value.

4. Exiting user setting mode (completing configuration)

Press ENT for 3 seconds or longer while a FUNC No. is blinking. This device returns to measurement mode and starts measuring the flow rate.

● Factory mode

In factory mode, the user can adjust the range of analog signal output from this device, can output dummy analog and pulse signals, and can specify advanced settings, including the pipe diameter and K factor of this device. This mode is for those who are familiar with the handling of flowmeters.

⚠CAUTION

- **Be extremely careful when changing settings in factory mode.**
- **Incorrect settings will impair the measurement performance of the flowmeter.**
- **Also, be sure to take a note of the present settings before making a change. Otherwise, if there is a problem, it may not be possible to restore the state of operation before the change.**

1. Changing to factory mode

Factory mode is entered from user setting mode, so set user setting mode first.

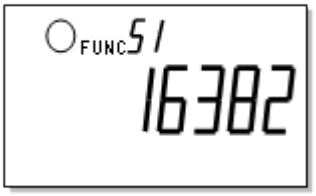
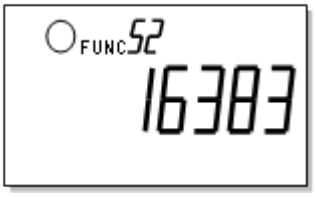
Then, place the magnet close to the magnetic switch while holding down ► and ENT.

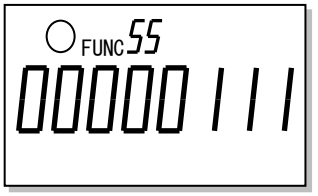
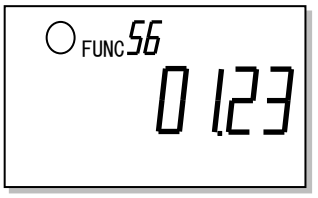
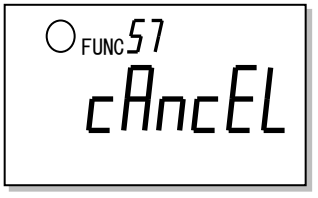
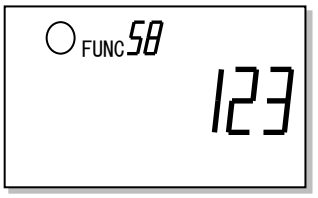
In factory mode, FUNC 51 and higher numbers are displayed.

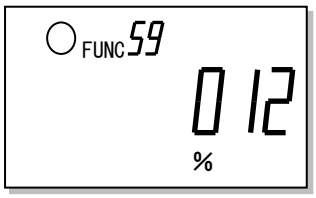
2. Selecting a parameter

Select the FUNC No. corresponding to the parameter to be specified (changed) with ▲ and ▼. See Table 4-6 for the FUNC numbers and parameters available in factory mode.

Table 4-6. FUNC numbers and parameters in factory mode

FUNC No.	Item	Specifications	Display example
51	Name	Analog output adjustment: zero point	
	Display format and range	00000–16382	
	Unit	None	
	Number of decimal places	None	
	Display update cycle	Input position blinks at 1 Hz. Display is updated at each setting operation.	
52	Name	Analog output adjustment: span point	
	Display format and range	00001–16383	
	Unit	None	
	Number of decimal places	None	
	Display update cycle	Input position blinks at 1 Hz. Display is updated at each setting operation.	

FUNC No.	Item	Specifications	Display example
53	Name	Pipe diameter Note: Normally this setting should not be changed.	
	Display format and range	Select from 25A, 40A, 50A, 80A, 100A ("A" = mm)	
	Unit	None	
	Number of decimal places	None	
	Display update cycle	Option blinks at 1 Hz. Display is updated at each setting operation.	
54	Name	K factor	
	Display format and range	Mantissa: 0.1000–0.9999 Exponent: 0–3 Note: Changing the K factor will change the flow rate. Use this setting only if you are familiar with the handling of flowmeters.	
	Unit	None	
	Number of decimal places	Mantissa: 4 (not changeable), exponent: none	
	Display update cycle	Input position blinks at 1 Hz. Display is updated at each setting operation.	
55	Name	Software switch Note: Do not change the setting.	
	Display format and range	Note: Do not change the setting.	
	Unit	None	
	Number of decimal places	None	
	Display update cycle	Input position blinks at 1 Hz. Display is updated at each setting operation.	
56	Name	Software version (reference only)	
	Display format and range	00.00–99.99	
	Unit	None	
	Number of decimal places	2 (not changeable)	
	Display update cycle	Option blinks at 1 Hz. Display is updated at each setting operation.	
57	Name	Total value reset to zero	
	Display format and range	Options: cAncEL, rESEt	
	Unit	None	
	Number of decimal places	None	
	Display update cycle	Option blinks at 1 Hz. Display is updated at each setting operation.	
58	Name	Pulse test output	
	Display format and range	Dummy pulse signal (000–500 Hz) can be output.	
	Unit	None	
	Number of decimal places	None	
	Display update cycle	Input position blinks at 1 Hz. Display is updated at each setting operation.	

FUNC No.	Item	Specifications	Display example
59	Name	Analog test output	
	Display format and range	Dummy analog signal (000–100 %) can be output.	
	Unit	%	
	Number of decimal places	None	
	Display update cycle	Input position blinks at 1 Hz. Display is updated at each setting operation.	

If an illegal setting is entered for a parameter, an error No. will be displayed on the LCD.

The table below describes the cause of errors. Change the setting of the parameter and try again.

Table 4-7. Error identified in parameter relationship check

Error code	Description
Error 01	FUNC 03 (maximum flow rate) and FUNC 53 (pipe diameter) settings are inconsistent. The specifiable maximum flow rate is defined for each diameter. A maximum flow rate that is not allowed for the diameter was entered. Change the maximum flow rate setting and try again.
Error 02	FUNC 04 (pulse output unit) and FUNC 54 (K factor) settings are inconsistent. The specifiable pulse output unit is determined by the pipe diameter based on the K factor. Change the pulse output unit and try again.
Error 03	FUNC 06 (flow rate high limit alarm) and FUNC 07 (flow rate low limit alarm) settings are inconsistent. Flow rate low limit alarm must be less than flow rate high limit alarm. Check the flow rate alarm settings.
Error 04	FUNC 51 (DA output zero point) and FUNC 52 (DA output span point) settings are inconsistent. The DA output zero point (analog output zero point) must be less than the DA output span point (analog output span point). Change the DA output zero point or span point.

3. Changing settings

Use the procedure below to change the setting of the selected parameter (FUNC).

(1) Press the ENT key switch while the selected FUNC No. is blinking. The stored setting is displayed.

(2) The changeable value of the setting blinks.
Use ▲ to increase the value and ▼ to decrease it. Use ▶ to shift the blinking (changeable) digit.

(3) When changing the setting is complete, press ENT. If the new value is within the specifiable range, "PASS" is displayed, the value is written to the internal memory, and then the FUNC No. blinks again. If the new value is outside the specifiable range, "Error" is displayed and the display returns to step 2 (the stored setting is displayed and the changeable digit blinks) to wait for re-entry of the value.

4. Exiting factory mode

Press ENT for 3 seconds or longer while a FUNC No. is blinking. This device returns to user setting mode.

Chapter 5. Troubleshooting

● Chapter Outline

This chapter explains troubleshooting procedures for dealing with malfunctions. The following points are described here.

- Corrective action for malfunctions
- Sensor replacement method
- Resale parts list

5 - 1 Measures for Malfunctions

● Introduction

This section describes the action to be taken if the flow meter malfunctions.

● Instructions

This equipment is adjusted for the surest usage upon shipment; however, if a malfunction occurs at startup or while operating the equipment, check the following.
If unsure of what needs to be done, contact our customer service network.

Table 5-1. Troubleshooting

Incident	Checkpoint	Countermeasures
No output (No output in the presence of a flow.)	• Is the wiring connected properly?	• Connect wiring correctly.
	• Is the power-supply voltage within the specified range?	• Adjust the power-supply so that it is within the specified range.
	• Is the load resistance correct?	• Adjust the load resistance so that it is within the specified range.
	• Is the piping filled with liquid?	• Modify piping or operating conditions so that the piping fills with liquid.
	• Is the flow rate within measurable range?	• Change the operating conditions.
	• Is sensor fault alarm given?	• If so, replace sensor.
Data is output even in absence of flow.	• Is the piping filled with liquid?	• Modify piping or operating conditions so that the piping fills with liquid.
	• Does the liquid inside the pipe churn due to considerable ripple pressure e.g., due to pumping?	• Control the conditions inside the pipe to eliminate waves. (Install a valve upstream of the flowmeter.)
	• Is the flowmeter installed on the T-pipe? (Effect of ripple pressure caused by T-pipe.)	• Install a valve closer to the junction of the flowmeter.
	• Are there any external noise sources e.g., motor line or electromagnetic wave generator?	• Isolate the flowmeter from noise sources. • Perform sufficient grounding. • Use a shield line.
Significant difference	• Is the power-supply voltage within the specified range?	• Adjust the power-supply so that it is within the specified range.
	• Is the load resistance correct?	• Adjust the load resistance so that it is within the specified range.
	• Are there any external noise sources e.g., motor line, electromagnetic wave generator?	• Isolate the flowmeter from noise sources. • Use a shield line.
	• Is there an element that is disturbing the flow (e.g., a valve that is upstream and the closest to the flowmeter)?	• Change the installation site of the flowmeter. (Confirm that the specified length of straight pipe is sufficient.)
	• Is cavitation occurring?	• Confirm there is sufficient line pressure to prevent cavitation.
	• Are there bubbles in the liquid?	• Prevent the occurrence of bubbles.
	• Is an object caught in the vortexor?	• Remove the object.
	• Is sensor fault alarm given?	• If so, replace sensor.

5 - 2 Error Messages and Corrective Action

● Introduction

This section describes the error messages given by the SFC self-diagnostic function, and includes methods for corrective action.

● Error messages

Details of status displays are described below.

Table 5-2. Alarms and countermeasures

Alarm No.	Problem	Countermeasure
ALARM01	Transmitter failure	
ALARM02	Failure of receiver 1	The reception level of receiver 1 (the sensor at the bottom right when viewed from the upstream side of the flowmeter) is low. There may be a problem with receiver 1, and/or receiver 1 and/or transmitter 1 may have come off of the measuring tube. Check also that the pipe of the flowmeter is filled with fluid. If this alarm occurs when the pipe is filled with fluid, the sensor or receiving circuit may have failed. In this case, the sensor should be replaced.
ALARM03	Failure of receiver 2	The reception level of receiver 2 (the sensor at the bottom left when viewed from the upstream side of the flowmeter) is low. There may be a problem with receiver 2, and/or receiver 2 and/or transmitter 2 may have come off of the measuring tube. Check also that the pipe of the flowmeter is filled with fluid. If this alarm occurs when the pipe is filled with fluid, the sensor or receiving circuit may have failed. In this case, the sensor should be replaced.
ALARM04	Failure of both receivers	The reception level of receivers 1 and 2 is low. There may be a problem with the receivers, and/or they and/or the transmitters may have come off of the measuring tube. Check also that the pipe of the flowmeter is filled with fluid. If this alarm occurs when the pipe is filled with fluid, the sensor or receiving circuit may have failed. In this case, the sensors should be replaced.
(Not used)	– – –	– – –
ALARM06	Failure of F-RAM	There is a problem with the F-RAM. Reset the flowmeter. (Place the magnet close to the magnetic switch for 3 seconds while holding down ▲ and ENT.)
ALARM07	Failure of RAM	The circuit board should be replaced. Please contact our service department.
ALARM08	Failure of ROM	The circuit board should be replaced. Please contact our service department.
ALARM09	Abnormal total flow volume	The circuit board should be replaced. Please contact our service department.

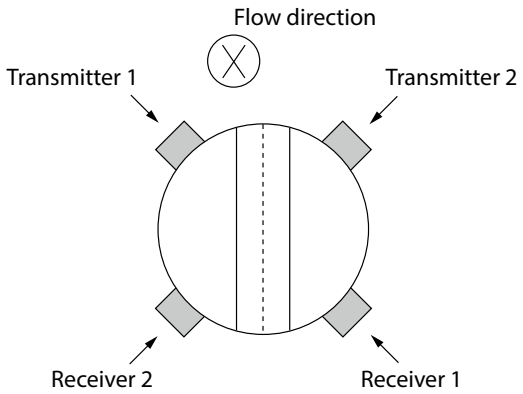


Figure 5-1. Sensor positions (viewed from the upstream end of the flowmeter)

5 - 3 Sensor Replacement Instructions

● **Introduction**

This section describes the procedure for replacing sensors when sensor faults occur.

⚠CAUTION

- **The sensor capillary lengths vary depending on the opening diameter. The correct replacement part must be used to match the relevant diameter.**

● **Replacement precautions**

⚠WARNING

- **Before replacing sensors, check that the detector unit is not hot or cold. There is a danger of injury or burns.**

⚠CAUTION

- **The output signal disappears while sensors are being replaced. Precautions must be taken such as operating manually to prevent effects on the control loop.**

● **Replacement procedure**

(1) Switch off the power.

(2) Unscrew the set screw.

(3) Remove the transducer case cover while rotating.
Note that there is an O-ring in the joint section.

(4) Unscrew the retaining screws (M3x4) on amplifier unit, and pull out the amplifier unit.
The retaining screws are designed not to fall out, so do not pull out with excessive force.

(5) Detach the cable and power cable connectors attached to the amplifier unit.
The sensor cable is fine wire, so take care not pull out with excessive force.

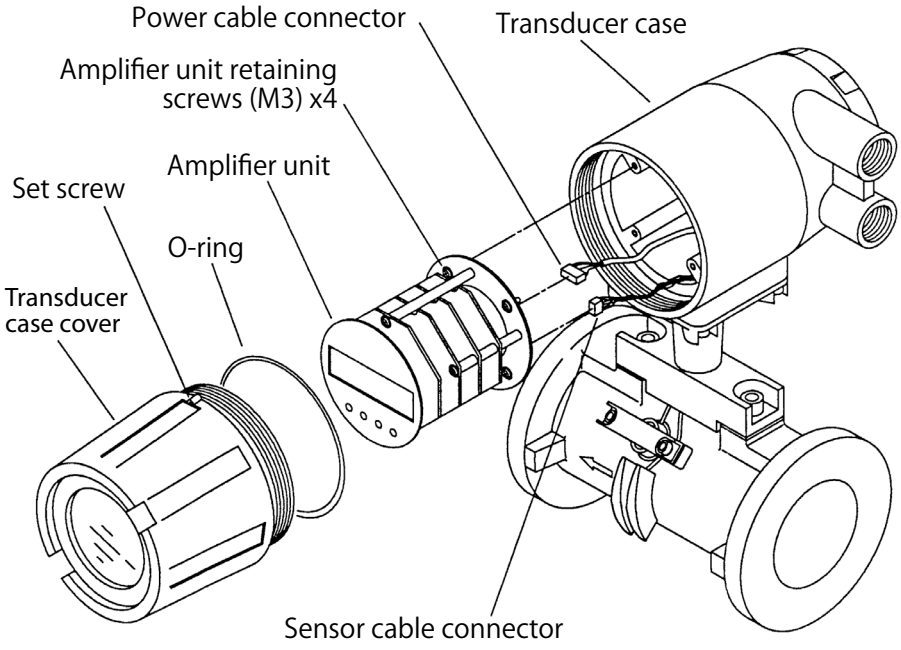


Figure 5-2. Structure of the converter

(6) Remove the bolts (M5x4) from the bottom of the transducer case.

(7) Remove the bolts (M4x2, 4 locations) securing the sensor unit holder from the housing.

(8) Remove the bolts (M8x2) securing the sensor unit to the housing.

(9) Remove the sensor unit from the housing.

(10) Wash the replacement sensor unit and housing holder attachment surface with organic solvent.
Take care not to scratch the holder underside and attachment surface, or leave debris adhering when washing.

(11) Fit the seal to the replacement sensor unit holder.

(12) Thinly apply silicone adhesive (DOWSIL: SE9185RTV) to the underside of the holder.
Take care that air bubbles are not introduced here.

(13) Thread the tube between the housing ribs, and attach the sensor unit to the housing.
If the tube does not align with the groove and the holder rises above attachment surface, arrange the tube first before continuing. (The replacement sensor unit tube is made to match the housing profile. If the profile does not match, however, it should be repaired.)
After attaching, seal the holder underside to the attachment face by pushing the holder firmly against the attachment face to eliminate air bubbles from between the holder underside and attachment face.

(14) Tighten the flat spring and retaining plate with the bolts (M4x2).
(Tightening torque: 12 - 18kgf.cm*)

(15) Refit the transducer case, amplifier unit, and transducer case cover in the reverse order in which they were removed.
Take care not to forget to fit O-rings, connect connectors, or tighten retaining screws, etc.

* Values enclosed by { and } are for reference.

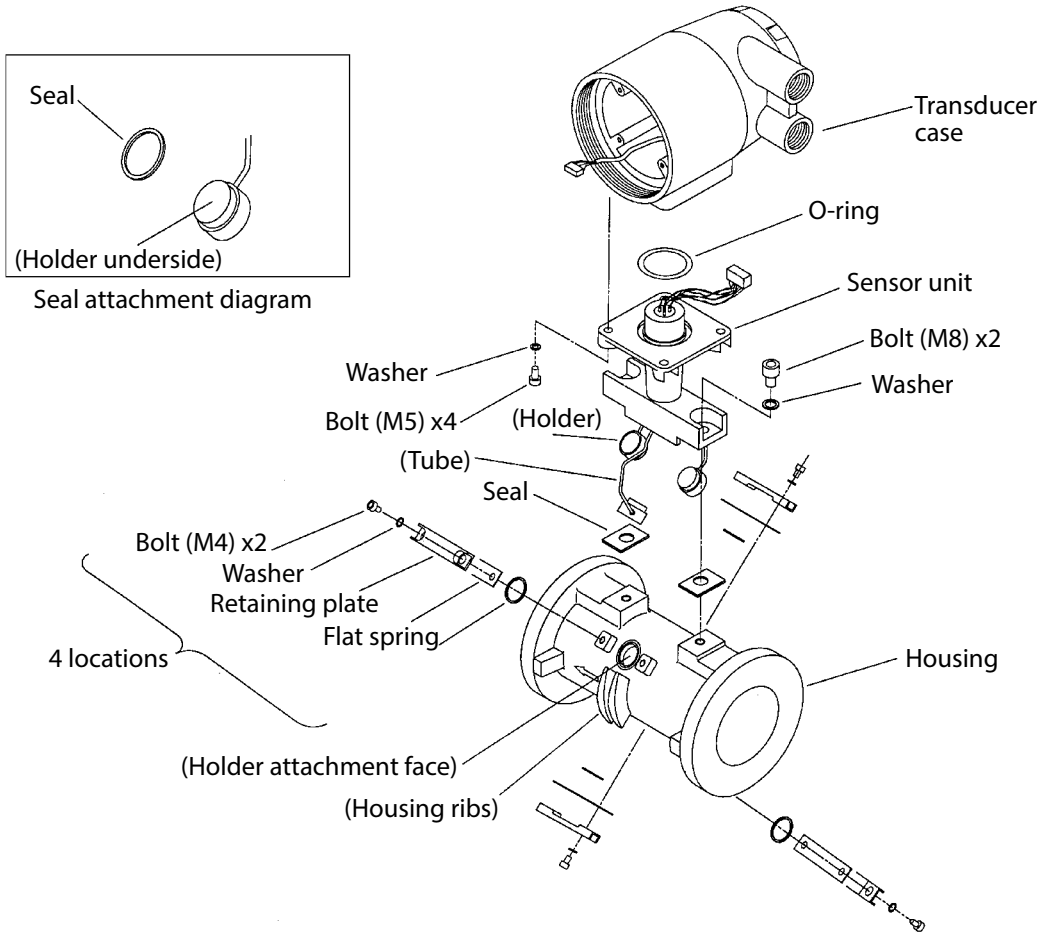


Figure 5-3. Structure of the detector

5 - 4 LCD Replacement Instructions

● **Introduction**

This section describes the procedure for replacing the LCD when it becomes life-expired after 5 years have elapsed.

● **Replacement procedure**

(1) Switch off the power.

(2) Unscrew the set screw.

(3) Remove the transducer case cover while rotating.
Note that there is an O-ring in the joint section.

(4) Remove the LCD mounting panel mounting screws (M3x2).

(5) Remove the LCD mounting panel together with the face panel.
(The LCD mounting panel is integral with the face panel.)

(6) Fit a new LCD panel, and secure with the screws.

(7) Attach the transducer case cover and tighten the set screw in the reverse order in which they were removed. (Do not forget to insert the O-ring.)

(8) Switch on the power.

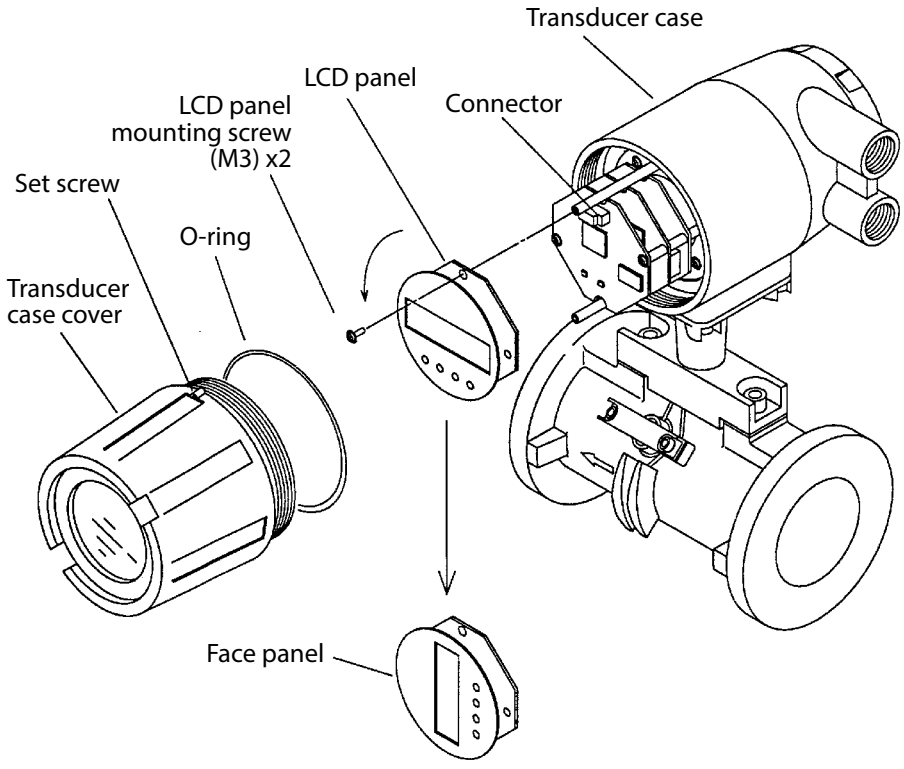


Figure 5-4.

5 - 5 Resale Parts List

● Introduction

This section includes exploded views of the ultrasonic vortex flow meter resale parts. Please mention the part numbers when ordering parts.

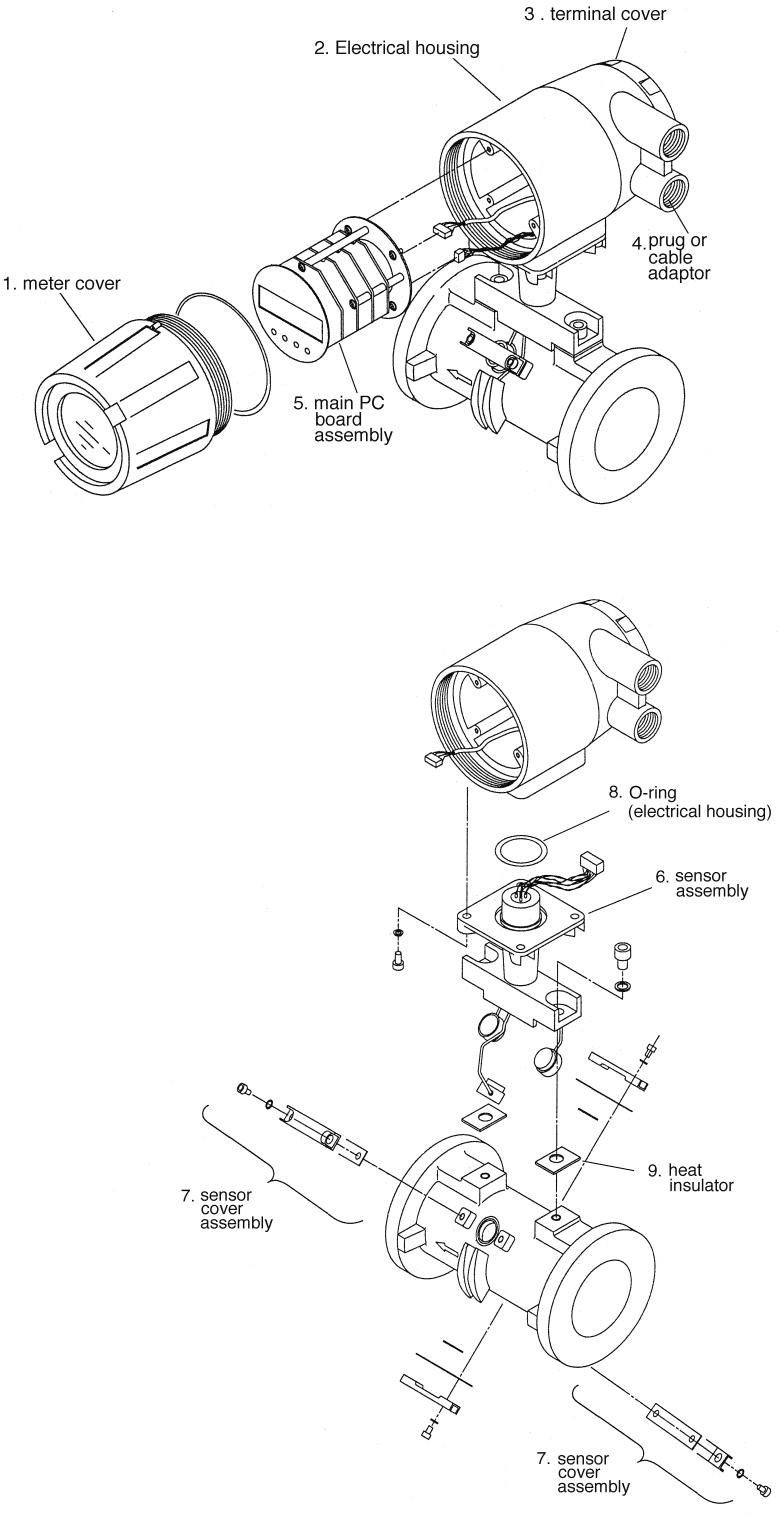


Figure 5-5. Parts

Table 5-3. Replacement Parts List

ULTRA Vortexor PARTS LIST

drawing No.	parts discription	finish	electrical conduit	parts number
1	meter cover(W/glass)	standard paint corrosion proof		80354353-101 80354353-103
1	meter cover(WO/glass)	standard paint corrosion proof		80354381-001 80354381-003
2	electrical housing	standard paint corrosion proof	G1/2 G1/2	80354351-001 80354351-003
3	terminal cover	standard paint corrosion proof		80277719-001 80277719-003
4	prug		G1/2	80277353-001
4	cable adaptpr		G1/2	80343903-003
5	main PC board assembly			8u-VRX000-001
6	sensor assembly(25A) sensor assembly(40A) sensor assembly(50A) sensor assembly(80A) sensor assembly(100A)			8u-VRX000-003 8u-VRX000-004 8u-VRX000-005 8u-VRX000-006 8u-VRX000-007
7	sensor cover assembly			8u-VRX000-008
8	O-ring(electrical housing)			8u-VRX000-010
9	heat insulator			8u-VRX000-011

Terms and Conditions

We would like to express our appreciation for your purchase and use of Azbil Corporation's products.

You are required to acknowledge and agree upon the following terms and conditions for your purchase of Azbil Corporation's products (system products, field instruments, control valves, and control products), unless otherwise stated in any separate document, including, without limitation, estimation sheets, written agreements, catalogs, specifications and instruction manuals.

1. Warranty period and warranty scope

   1.1 Warranty period

   Azbil Corporation's products shall be warranted for one (1) year from the date of your purchase of the said products or the delivery of the said products to a place designated by you.

   1.2 Warranty scope

   In the event that Azbil Corporation's product has any failure attributable to azbil during the aforementioned warranty period, Azbil Corporation shall, without charge, deliver a replacement for the said product to the place where you purchased, or repair the said product and deliver it to the aforementioned place. Notwithstanding the foregoing, any failure falling under one of the following shall not be covered under this warranty:

   (1) Failure caused by your improper use of azbil product (noncompliance with conditions, environment of use, precautions, etc. set forth in catalogs, specifications, instruction manuals, etc.);
   (2) Failure caused for other reasons than Azbil Corporation's product;
   (3) Failure caused by any modification or repair made by any person other than Azbil Corporation or Azbil Corporation's subcontractors;
   (4) Failure caused by your use of Azbil Corporation's product in a manner not conforming to the intended usage of that product;
   (5) Failure that the state-of-the-art at the time of Azbil Corporation's shipment did not allow Azbil Corporation to predict; or
   (6) Failure that arose from any reason not attributable to Azbil Corporation, including, without limitation, acts of God, disasters, and actions taken by a third party.

   Please note that the term "warranty" as used herein refers to equipment-only-warranty, and Azbil Corporation shall not be liable for any damages, including direct, indirect, special, incidental or consequential damages in connection with or arising out of Azbil Corporation's products.

2. Ascertainment of suitability

   You are required to ascertain the suitability of Azbil Corporation's product in case of your use of the same with your machinery, equipment, etc. (hereinafter referred to as "Equipment") on your own responsibility, taking the following matters into consideration:

   (1) Regulations and standards or laws that your Equipment is to comply with.
   (2) Examples of application described in any documents provided by Azbil Corporation are for your reference purpose only, and you are required to check the functions and safety of your Equipment prior to your use.
   (3) Measures to be taken to secure the required level of the reliability and safety of your Equipment in your use
   Although azbil is constantly making efforts to improve the quality and reliability of Azbil Corporation's products, there exists a possibility that parts and machinery may break down. You are required to provide your Equipment with safety design such as fool-proof design,*1 and fail-safe design*2 (anti-flame propagation design, etc.), whereby preventing any occurrence of physical injuries, fires, significant damage, and so forth. Furthermore, fault avoidance,*3 fault tolerance,*4 or the like should be incorporated so that the said Equipment can satisfy the level of reliability and safety required for your use.

   *1. A design that is safe even if the user makes an error.
   *2. A design that is safe even if the device fails.
   *3. Avoidance of device failure by using highly reliable components, etc.
   *4. The use of redundancy.

3. Precautions and restrictions on application

   3.1 Restrictions on application

   Please follow the table below for use in nuclear power or radiation-related equipment.

	Nuclear power quality*5 required	Nuclear power quality*5 not required
Within a radiation controlled area*6	Cannot be used (except for limit switches for nuclear power*7)	Cannot be used (except for limit switches for nuclear power*7)
Outside a radiation controlled area*6	Cannot be used (except for limit switches for nuclear power*7)	Can be used

   *5. Nuclear power quality: compliance with JEAG 4121 required
   *6. Radiation controlled area: an area governed by the requirements of article 3 of "Rules on the Prevention of Harm from Ionizing Radiation," article 2 2 4 of "Regulations on Installation and Operation of Nuclear Reactors for Practical Power Generation," article 4 of "Determining the Quantity, etc., of Radiation-Emitting Isotopes,"etc.
   *7. Limit switch for nuclear power: a limit switch designed, manufactured and sold according to IEEE 382 and JEAG 4121.

   Any Azbil Corporation's products shall not be used for/with medical equipment.

   The products are for industrial use. Do not allow general consumers to install or use any Azbil Corporation's product. However, azbil products can be incorporated into products used by general consumers. If you intend to use a product for that purpose, please contact one of our sales representatives.

   3.2 Precautions on application

   you are required to conduct a consultation with our sales representative and understand detail specifications, cautions for operation, and so forth by reference to catalogs, specifications, instruction manual, etc. in case that you intend to use azbil product for any purposes specified in (1) through (6) below. Moreover, you are required to provide your Equipment with fool-proof design, fail-safe design, anti-flame propagation design, fault avoidance, fault tolerance, and other kinds of protection/safety circuit design on your own responsibility to ensure reliability and safety, whereby preventing problems caused by failure or nonconformity.

(1) For use under such conditions or in such environments as not stated in technical documents, including catalogs, specification, and instruction manuals
(2) For use of specific purposes, such as:
    * Nuclear energy/radiation related facilities
      [When used outside a radiation controlled area and where nuclear power quality is not required]
      [When the limit switch for nuclear power is used]
    * Machinery or equipment for space/sea bottom
    * Transportation equipment
      [Railway, aircraft, vessels, vehicle equipment, etc.]
    * Antidisaster/crime-prevention equipment
    * Burning appliances
    * Electrothermal equipment
    * Amusement facilities
    * Facilities/applications associated directly with billing
(3) Supply systems such as electricity/gas/water supply systems, large-scale communication systems, and traffic/air traffic control systems requiring high reliability
(4) Facilities that are to comply with regulations of governmental/public agencies or specific industries
(5) Machinery or equipment that may affect human lives, human bodies or properties
(6) Other machinery or equipment equivalent to those set forth in items (1) to (5) above which require high reliability and safety

4. Precautions against long-term use

   Use of Azbil Corporation's products, including switches, which contain electronic components, over a prolonged period may degrade insulation or increase contact-resistance and may result in heat generation or any other similar problem causing such product or switch to develop safety hazards such as smoking, ignition, and electrification. Although acceleration of the above situation varies depending on the conditions or environment of use of the products, you are required not to use any Azbil Corporation's products for a period exceeding ten (10) years unless otherwise stated in specifications or instruction manuals.

5. Recommendation for renewal

   Mechanical components, such as relays and switches, used for Azbil Corporation's products will reach the end of their life due to wear by repetitious open/close operations.

   In addition, electronic components such as electrolytic capacitors will reach the end of their life due to aged deterioration based on the conditions or environment in which such electronic components are used. Although acceleration of the above situation varies depending on the conditions or environment of use, the number of open/close operations of relays, etc. as prescribed in specifications or instruction manuals, or depending on the design margin of your machine or equipment, you are required to renew any Azbil Corporation's products every 5 to 10 years unless otherwise specified in specifications or instruction manuals. System products, field instruments (sensors such as pressure/flow/level sensors, regulating valves, etc.) will reach the end of their life due to aged deterioration of parts. For those parts that will reach the end of their life due to aged deterioration, recommended replacement cycles are prescribed. You are required to replace parts based on such recommended replacement cycles.

6. Other precautions

   Prior to your use of Azbil Corporation's products, you are required to understand and comply with specifications (e.g., conditions and environment of use), precautions, warnings/cautions/notices as set forth in the technical documents prepared for individual Azbil Corporation's products, such as catalogs, specifications, and instruction manuals to ensure the quality, reliability, and safety of those products.

7. Changes to specifications

   Please note that the descriptions contained in any documents provided by azbil are subject to change without notice for improvement or for any other reason. For inquires or information on specifications as you may need to check, please contact our branch offices or sales offices, or your local sales agents.

8. Discontinuance of the supply of products/parts

   Please note that the production of any Azbil Corporation's product may be discontinued without notice. After manufacturing is discontinued, we may not be able to provide replacement products even within the warranty period.

   For repairable products, we will, in principle, undertake repairs for five (5) years after the discontinuance of those products. In some cases, however, we cannot undertake such repairs for reasons, such as the absence of repair parts. For system products, field instruments, we may not be able to undertake parts replacement for similar reasons.

9. Scope of services

   Prices of Azbil Corporation's products do not include any charges for services such as engineer dispatch service. Accordingly, a separate fee will be charged in any of the following cases:

   (1) Installation, adjustment, guidance, and attendance at a test run
   (2) Maintenance, inspection, adjustment, and repair
   (3) Technical guidance and technical education
   (4) Special test or special inspection of a product under the conditions specified by you

   Please note that we cannot provide any services as set forth above in a nuclear energy controlled area (radiation controlled area) or at a place where the level of exposure to radiation is equivalent to that in a nuclear energy controlled area.

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Specifications are subject to change without notice. (11)

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