Doc No. KF25−004A

Portable Ultrasonic Flowmeter

UW-30P

Installation & Operation Manual

TOKYO KEIKI

Safety Precautions

This contains important safety information, so please read it carefully and be sure to follow the instructions.

This manual describes important information to prevent injury to users of our flowmeters and damage to property, and to ensure the safe and correct use of our products. Please read the manual after fully understanding the following information (indications, symbols).

Keep this manual in an easily accessible place so that you can refer to it quickly when necessary.

Display Explanation

The safety symbols used in this manual and on this product have the following meanings:

 **Danger**	This indicates that ignoring this warning and handling the product incorrectly may result in imminent danger **of death or serious injury.**
 **Warning**	This indicates that ignoring this warning and handling the product incorrectly may result in **death or serious injury.**
 **Caution**	Indicates that ignoring this symbol and mishandling the product may result in **injury to persons or damage to property only.**
	Indicates on the device that there are cautions or information regarding the handling of a function or feature. Please check the relevant item in this manual.
Note	This document provides information about the handling of a function or feature.
∼	Indicates Alternating current, ”AC”.
⎓	Indicates Direct current, ”DC”.

Introduction

Thank you for purchasing our ultrasonic flowmeter. This instruction manual provides detailed explanations of the portable ultrasonic flowmeter ” UW-30P ”, including safety precautions, specifications, structure, installation, operation, malfunctions and countermeasures, etc. Please fully understand this device and use it correctly.

Instructions For Use, etc.

Please observe the following points regarding this instruction manual.

⚠ Caution

1. Please read this instruction manual carefully.
   This instruction manual contains important information, so be sure to read it through to the end before operating this device.
2. Please keep this instruction manual in a safe place.
   This instruction manual is required when using this equipment. Please determine the person in charge of storing this instruction manual and the storage location so that it can be read at any time.
3. Please deliver this instruction manual to the person operating this device.
   Agents and other intermediaries involved in the sale of this equipment must ensure that this instruction manual is delivered to the people who will actually be using the equipment.
4. If you lose this instruction manual, please contact your nearest sales office and request a replacement. Please caution that there will be a fee for the replacement.
5. Please make sure the equipment nameplate is intact. The ratings are listed.
   If the equipment nameplate becomes dirty or peels off, please contact your nearest sales office to have a new one refilled. As with this instruction manual, there will be a fee for refilling the equipment nameplate.
6. Reproduction, transmission or copying of all or part of the contents of this document without permission is prohibited.

Instructions For Use, etc.

⚠ Caution

1. This instruction manual has been created based on the standard specifications of this equipment. If there are any descriptions in this manual that differ from the approved drawings you have, the descriptions in the approved drawings shall take precedence.
2. This manual describes the operation method, functions, and performance details of this equipment, but does not guarantee its suitability for your specific applications.
3. The contents of this document are subject to change without notice.
4. Every effort has been made to ensure the accuracy of the contents of this manual, but if you notice any suspicious points, errors, or omissions, please contact us or the distributor from whom you purchased the product.
5. Please caution that this manual may not be revised each time there are changes to specifications, structure, or parts used that do not affect the functionality or performance.

Prohibited Items And Precautions For Protecting The Equipment

To protect this device, please observe the following:

⚠ Caution

1. Do not subject the flowmeter or sensor to shock, such as dropping it.
2. Do not use the product outside the specified operating environment (ambient temperature, ambient humidity).
3. Do not use any power source other than that specified.
4. Do not use cables that are damaged or have their insulation removed.
5. There are high-voltage circuits inside the device, so never touch the terminals or inside the device while it is powered on.
6. Do not disassemble or modify the device. If the device is malfunctioning, please contact us.
7. This device and its accessories cannot be used in explosion-proof areas.
8. Please observe the following points when transporting the equipment.
   a) When transporting, please observe the specified temperature range.
   b) Please transport the product in the original packaging.
9. Please observe the following when storing the equipment.
   a) When storing, please observe the specified temperature range.
   b) Avoid placing in direct sunlight.
   c) Avoid exposing the device to vibrations or shocks.
   d) Avoid locations where corrosive gases are present.
   e) Avoid high humidity locations.

Handling Precautions

This device is a flow meter that uses ultrasonic waves. Please pay attention to the following points to ensure the product's performance and safe use.

⚠ Caution

1. If all of the following conditions are not met, measurements may not be performed correctly.
   a) Use this device within the specified power supply voltage, ambient temperature and humidity ranges.
   b) Use the product when the pipes are full of water.
   c) Make sure that the fluid being measured does not contain any air bubbles or foreign objects that could significantly impede the propagation of ultrasonic waves.
   d) When installing the sensor, select a location that satisfies the required straight pipe length.
   e) Do not subject this device to vibration or shock.
   f) Use this device in a location that is not affected by external noise.
2. If the device is unable to perform normal measurements, a warning will be displayed on the display. Please caution that while a warning is displayed, the value immediately prior to the warning may be displayed.
3. When changing the settings of this device, please read this manual carefully and set the values correctly. If the settings are incorrect, measurements may not be performed correctly.
4. Do not disassemble or modify this device under any circumstances, as this may result in electric shock, burns, or breakdowns.
5. Please use the battery and AC adapter specified by our company.
   Using any product other than that specified by our company may result in electric shock or breakdown.
6. When charging the battery, charge it in a temperature range of 0 ℃ to 45 ℃ .
7. The cigarette lighter cable is a part (optional) exclusive to this device. Do not use any other cable than that specified by our company. Doing so may result in electric shock, burns, or breakdown.
8. Turn off the power when performing maintenance or inspection.

Battery Warning

When handling the battery, be sure to observe the following warnings. Improper use of the battery may cause it to deform, leak, overheat, explode, or catch fire, or to emit irritating or corrosive gases.

⚠ Warning

1. Do not subject the product to strong shocks such as dropping it.
2. Do not short circuit
3. Do not disassemble or modify the product.
4. Do not connect the polarity incorrectly.
5. Charge the battery using the AC adapter specified by our company.
6. Do not throw into fire
7. Do not immerse in water or seawater and do not get wet.
8. Do not crush or puncture
9. If you notice any abnormality in the battery, stop using it immediately.
10. If you will not be using this device for a long period of time, remove it from the device and store it within the specified temperature range.

Installation Precautions

Please check the following precautions before installation.

Caution

1. Be careful not to get injured by burrs or sharp edges of the mounting brackets.
2. Be careful not to drop the magnet.
3. Do not use the lashing belt when it is tied or twisted.
4. Do not throw, drag or hit the lashing belt hard against any object.
5. When tightening the lashing belt, do not insert an object into the lever to use it as a lever or step on it with your foot.
6. Do not use lashing belts on sharp edges.
7. Do not use the following lashing belts:
   a) It is so fluffy and melted that the texture is no longer visible.
   b) There are scratches or other damage that are 10% of the width in the width direction and 20% of the thickness in the thickness direction.
   c) Items with even slight cut, fraying, or peeling of sewing threads in the stitching.

Wiring Precautions

Please check the following precautions before wiring.

Caution

1. Use within the rated range.
2. The surface temperature of the pipe is outside the specified temperature range of the cable, do not directly touch the pipe.
3. The sensor cable can be extended up to 160 m , but this may be limited by the measurement environment.

Caution On Firmware Updates

Please check the following precautions before updating the firmware.

⚠ Caution

1. Please update the firmware at your own risk. We also provide a paid firmware update service. For details, please contact your sales representative or our company.
2. If the power is cut off during a firmware update due to a power outage or accident, or if the firmware update fails due to incorrect operation or for any other reason, the device may no longer function properly. Please be careful when performing the update.
3. If the firmware update fails and the device no longer functions properly, we will repair it for a fee. Please contact your sales representative or our company.

For KC Marking

사 용 자 안 내 문

이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다.

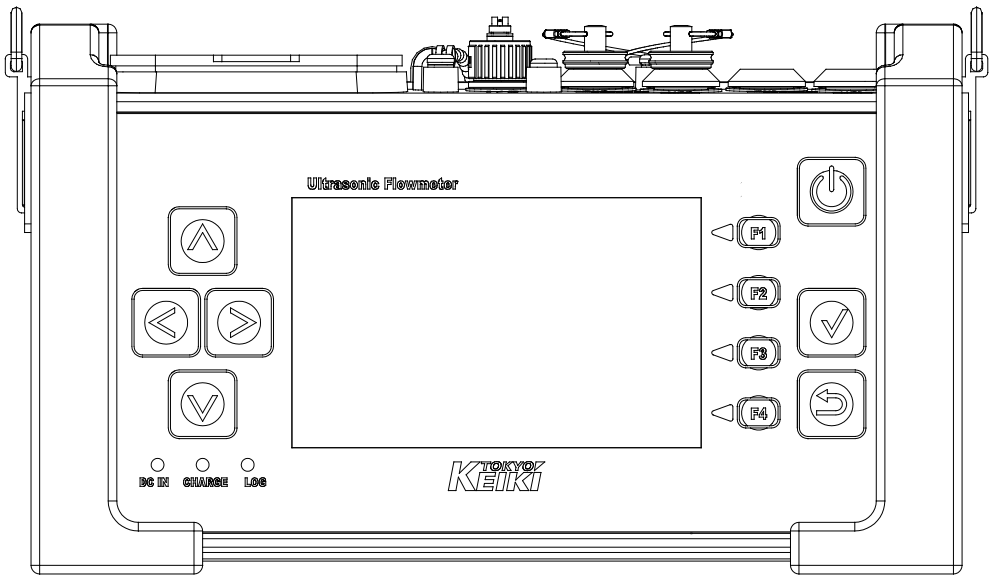
For information on KC mark compliance, please refer to the link below.
URL:http://www.rra.go.kr/selform/Tkc-UW-30P

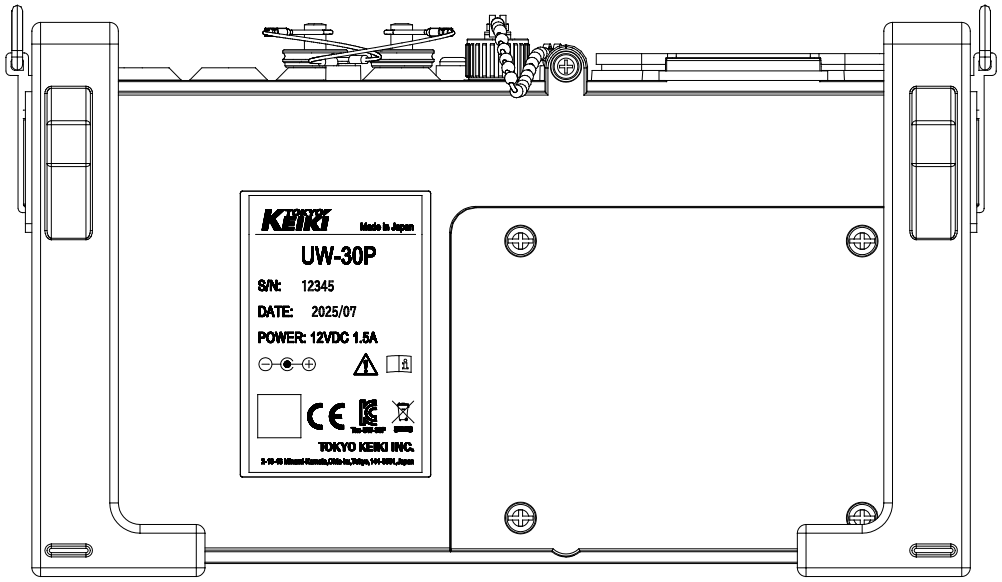
Disposal Of Equipment

Of this device, please follow local regulations.

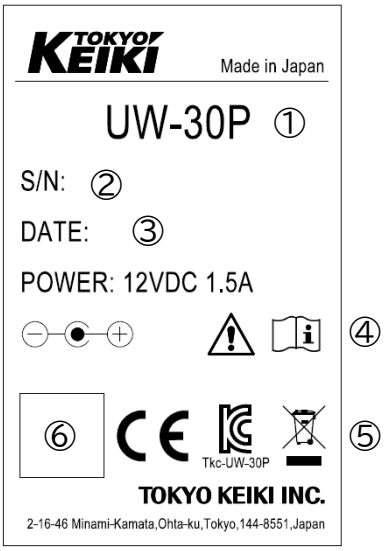
Please recycle batteries in accordance with the law and local regulations. If you have any questions, please contact our sales office and ask for assistance. This battery must be disposed of in a discharged state at the collection center. If the battery is not fully discharged, there is a risk of a short circuit. A short circuit can be prevented by insulating the terminals with tape.

Flow meter body





Production Label



①Model name
②Serial number
③Shipment date
④Read manual mark
⑤Certification mark
⑥QR code(Link to TOKYO KEIKI INC. HP)

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Chapter1 Composition

1.1 Equipment overview

The portable ultrasonic flowmeter "UW-30P" is a convenient device that can easily measure the flow rate of liquids without cutting the piping. It has the following features:

1. **Easy installation**
   The clamp-on method enables safe, non-contact measurements by simply attaching the sensor to the outside of the pipe.

2. **Versatile**
   It can be used for homogeneous liquids that transmit ultrasound, such as water, hot water, distilled water, and alcohol.

3. **Built-in battery**
   Battery power allows for long periods of continuous operation, and can be used even in locations where power is unavailable.

4. **Logging**
   The measured data can be saved in the internal memory of the main unit or on a USB memory stick and can be used for later analysis.

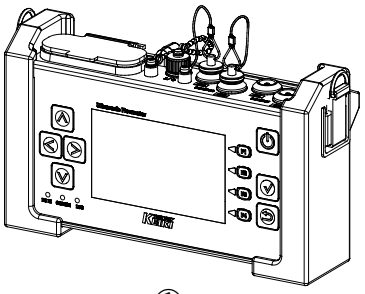
5. **Calorie measurement function**
   It has a function to calculate the amount of heat from heating and cooling equipment, which is useful for energy conservation management.

1.2 Product configuration

This device consists of the following main components:

1.2.1 Standard components

Number	Product name	Quantity	Remarks
①	Converter	1	
②	AC adapter	1	
③	Neck strap	1	Can be attached to ①
④	Thickness meter sensor	1	Sensor for measuring pipe thickness and fluid sound speed
⑤	Calibration test piece	1	Used for sensor calibration when measuring Thickness meter
⑥	I/O junction box	1	2 analog outputs, 2 resistance thermometer inputs
⑦	Sensor cable	2	3m, Operating temperature range: -20 ℃ to 65 ℃
⑧	Medium sensor	2	UP10BST
⑨	Z -method mounting fixture	1	Supports 20 to 50A
⑩	Medium sensor connection expansion mounting fixture	1	Used for 250 to 500A
⑪	Medium sensor mounting fixture	1	50 to 200A , 250A or more should be used in combination with ⑩
⑫	Extension chain	2	Use in combination with ⑩ and ⑪ for 250A or more
⑬	Grease	1	
⑭	Dry couplant (medium sensor)	10	For medium sensors
⑮	Carrying case	1	



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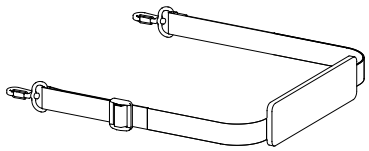

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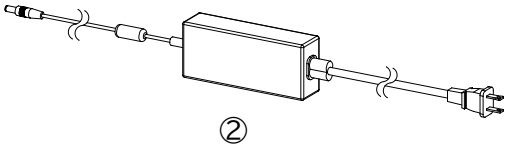

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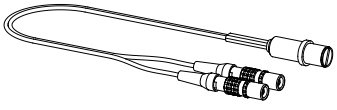

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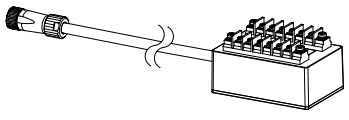

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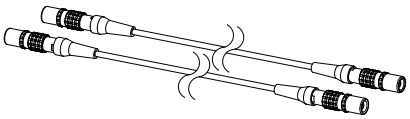

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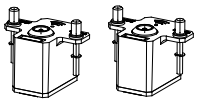

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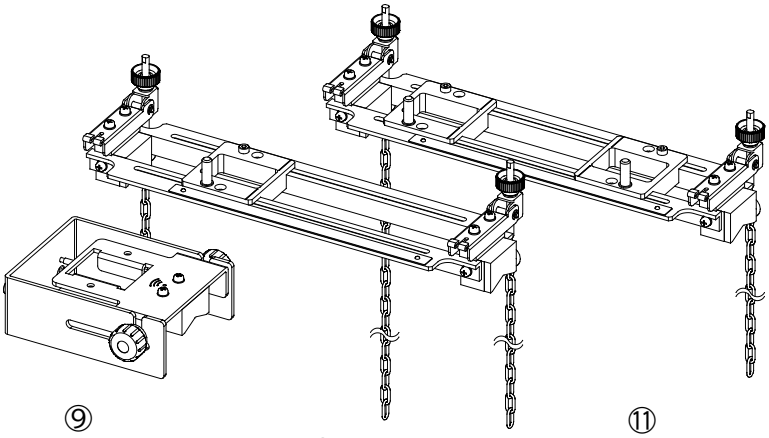

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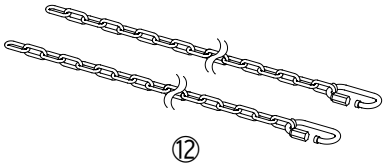

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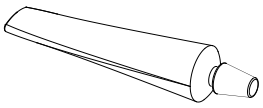

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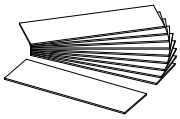

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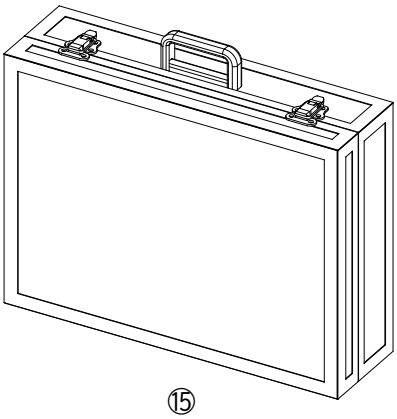

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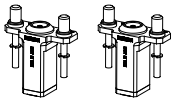
1.2.2 Optional items

Number	Product name	Quantity	Remarks
①	Small sensor	2	UP50BST, 13 to 50A
②	Dry couplant (small sensor)	10	For small sensors
③	Small sensor mounting fixture	1	Used for ①
④	Large sensor	2	UP04BST, 300 to 5,000A
⑤	Large sensor magnet mounting fixture	1	Used in combination with ④. Used with steel pipes that are magnetic.
⑥	Large sensor belt mounting fixture	1	Used in combination with ④. Supports 300 to 1200A.
⑦	For large sensors carrying case	1	Stores ④, ⑤, and ⑥
⑧	Sensor cable (3m)	2	3m, Operating temperature range: -20 ℃ to 65 ℃
⑨	Sensor cable (high temperature)	2	7m, Operating temperature range: -20 ℃ to 120 ℃
⑩	Extension sensor cable (7m)	2	7m, Operating temperature range: -20 ℃ to 65 ℃
⑪	Extension sensor cable (50m)	2	50m, Operating temperature range: -20 ℃ to 65 ℃
⑫	Cigarette lighter cable	1	For power supply from the cigarette lighter socket of a car
⑬	Resistance temperature detector (Pt100)	2	For heat measurement
⑭	Aluminum tape	1	⑬For fixing resistance temperature detector piping

Note
The extension sensor cable is an auxiliary cable for extending the length of the sensor cable. The extension sensor cable alone cannot be used to directly connect the sensor and converter.



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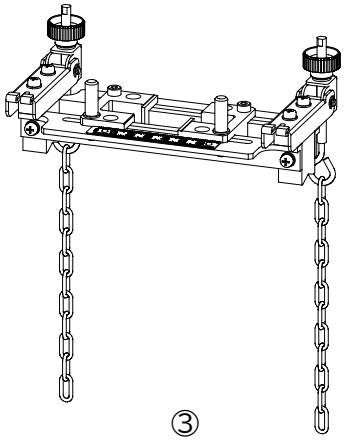

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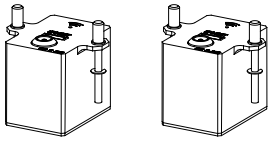

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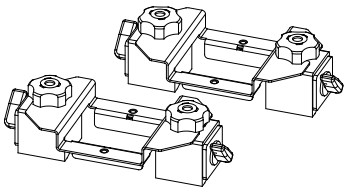

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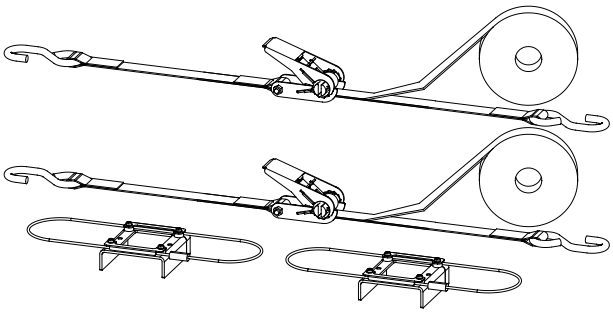

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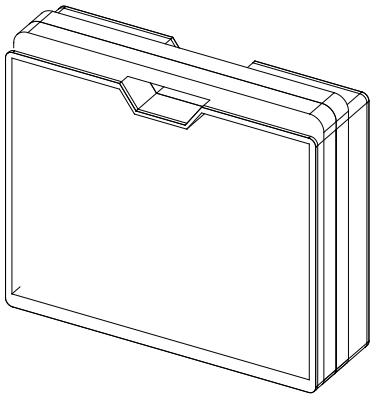

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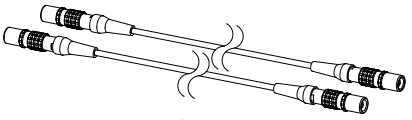

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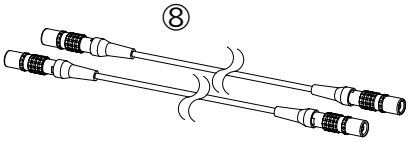

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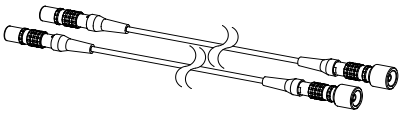

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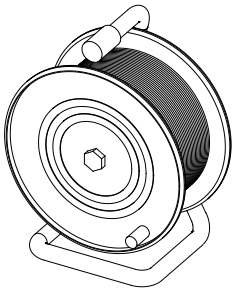

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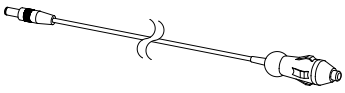

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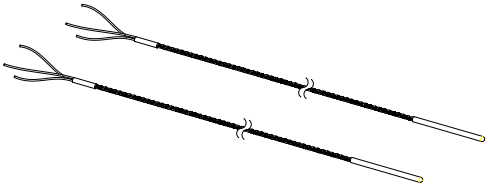

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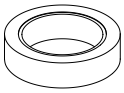

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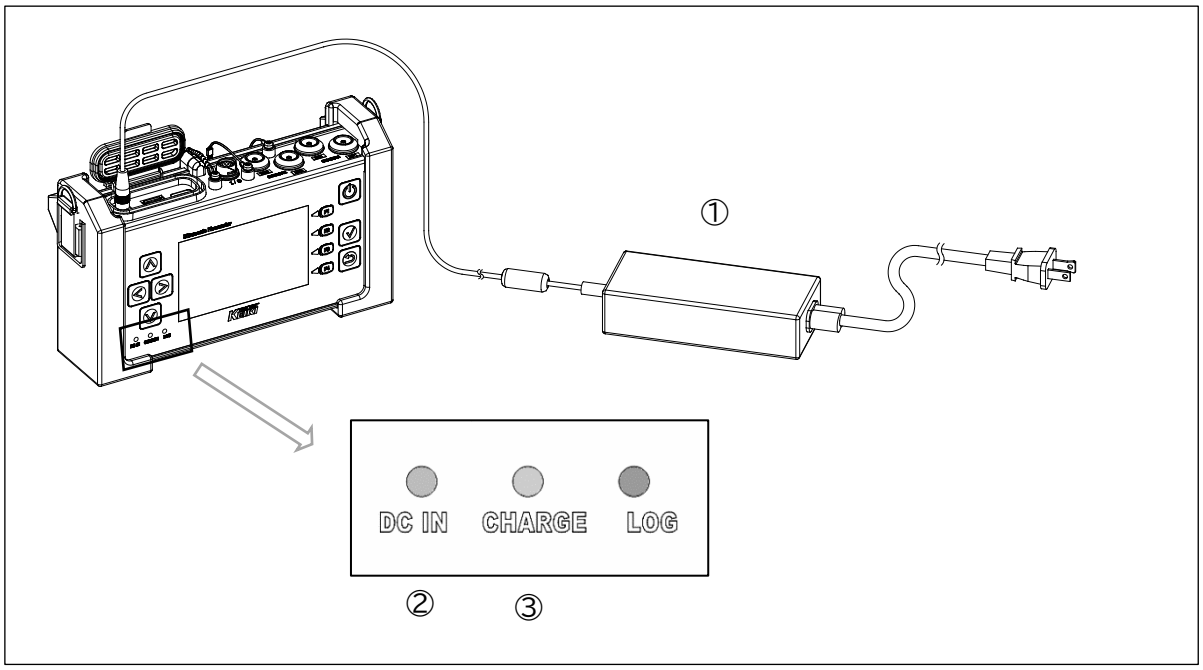
1.3 Set up

(1) Charging the battery

When using the converter for the first time, connect the included AC adapter and charge the battery.

1. The AC adapter is connected, the green ”DC IN” LED will light up.
2. When charging begins, the orange ”CHARGE” LED will light up.
3. Please check the lighting status of each LED.
4. When charging is complete, the orange ”CHARGE” LED will turn off.



Connection destination : ⓐ ☞ ”5.1.1 Connector layout”

① AC adapter
② DC IN (green) : Lights up when AC adapter is connected
③ CHARGE (orange) : Lights up when charging
Periodically blinking when there is a charging failure ☞ ”Battery warnings”
When charging at high temperature, flashes irregularly

Note
The battery charging operating temperature range is 0 ˚C to 45 ˚C. Charge within this range. Otherwise, it may cause a breakdown.

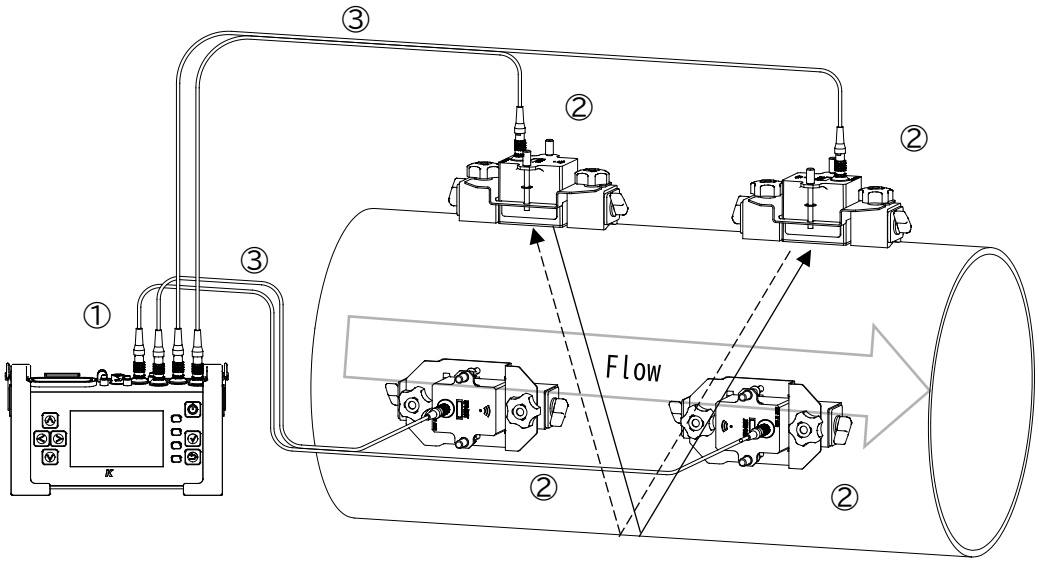
1.4 Example of ultrasonic flowmeter configuration

A typical example of equipment configuration is shown below.

1.4.1 Flow rate / mass measurement

It measures the volumetric flow rate of liquid flowing through a pipe. By multiplying the volumetric flow rate by the density of the fluid being measured, it is also possible to calculate and display the mass flow rate.

Normally, measurements are taken using a single line method with two sensors. However, if there is turbulence in the flow velocity distribution inside the pipe, the use of a two- line method is recommended. With the two- line method, the flow velocity is measured on each line and the average value is calculated, reducing the effects of turbulence in the flow velocity distribution.

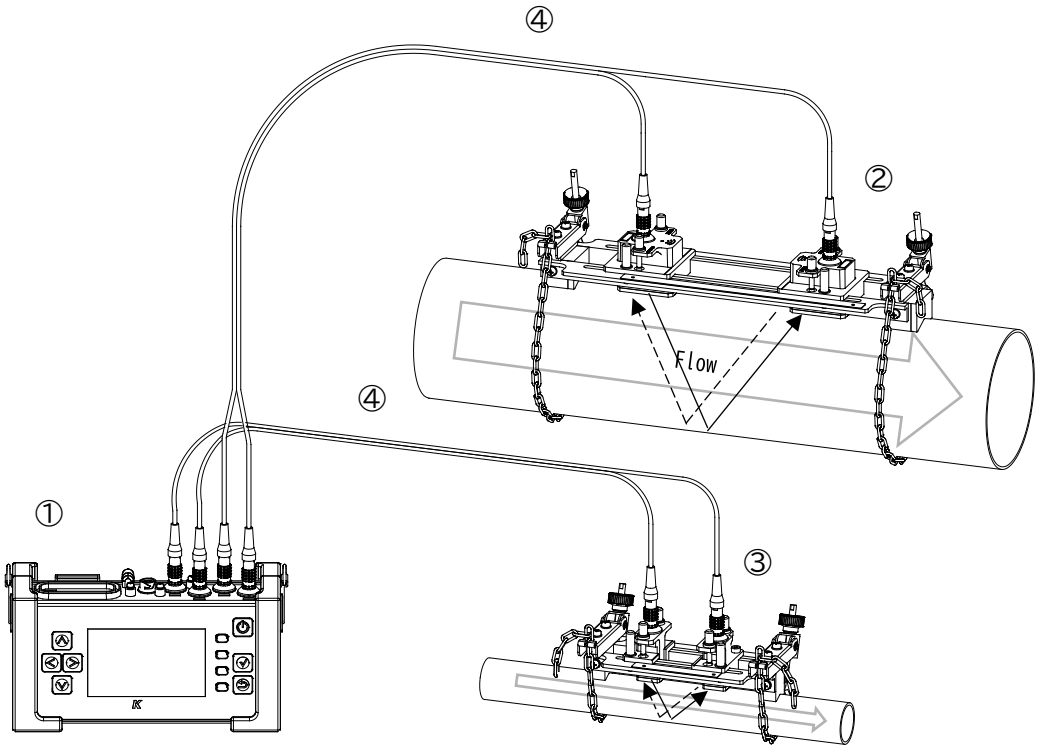


Flow / mass measurement configuration (1 or 2 lines)

① Converter
② Large sensor
③ Sensor cable

1.4.2 Simultaneous measurement of two pipes

By installing a sensor on each of two different pipes, two pipes can be measured simultaneously. This allows the flow rate at two locations to be measured in parallel, and analog output can be provided from two systems.



Flow rate / mass measurement configuration (two pipes at the same time)

① Converter
② Medium sensor
③ Small sensor
④ Sensor cable

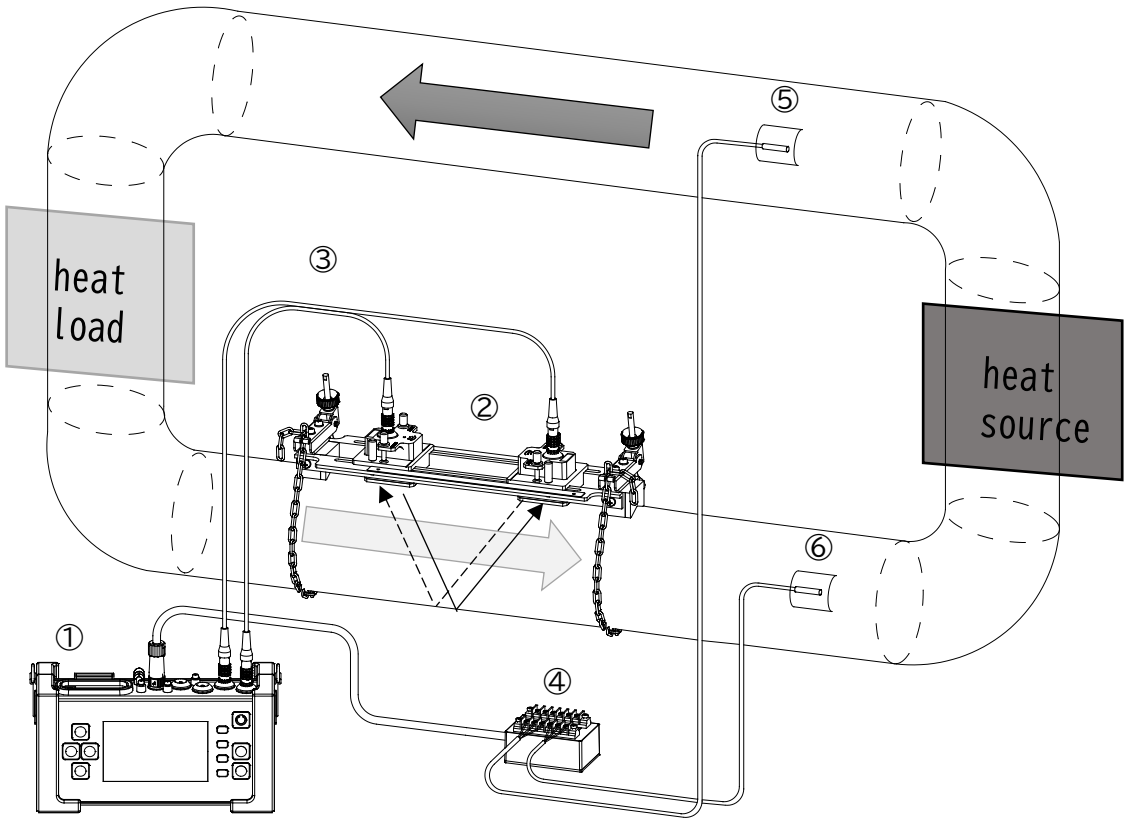
1.4.3 Example of heat measurement configuration

The converter, heat measurement can be performed. In heat measurement, the flow rate and temperature difference of the fluid are used to calculate the amount of energy consumed.

- **Flow measurement:** The flow velocity of a fluid is measured by utilizing the difference in the propagation time of ultrasonic waves.
- **Temperature measurement :** A resistance temperature detector (Pt100) is used to measure the temperature difference between the inlet and outlet of the fluid.
- **Calorie calculation :** Based on the flow rate and temperature difference, calculate the heat output using the following formula:

$$Q = m\ c\ \Delta T$$

Q	: Heat amount
m	: Mass flow rate of fluid (calculated from flow rate and density)
c	: Specific heat of the fluid
ΔT	: Temperature difference



Example of heat measurement configuration

① Converter
② Medium sensor
③ Sensor cable
④ I/O junction box
⑤ Pt100 (CH1, sending side)
⑥ Pt100 (CH2, return side)

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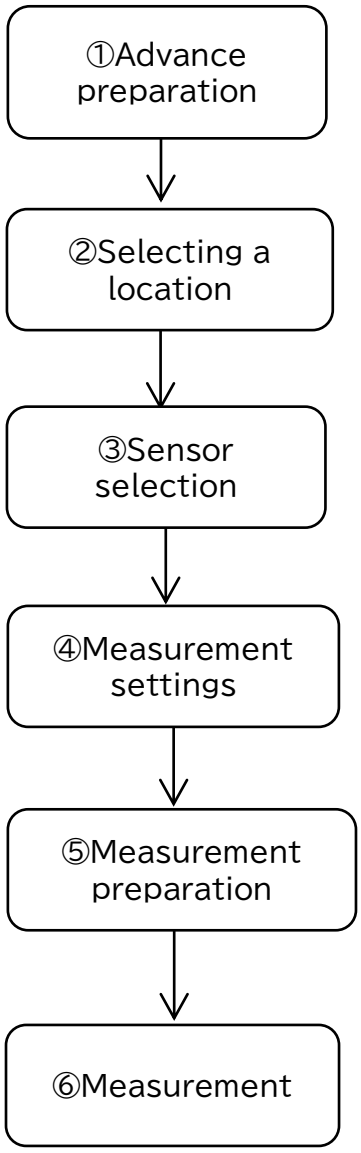
Chapter2 Measurement procedure

2.1 Measurement procedure

Briefly describes the basic steps to a typical flow measurement.



Before measuring, check the following information.
- Pipe information to be measured (diameter/pipe material/pipe thickness, etc.)
- Fluid (type of liquid/temperature)

Check the installation location conditions.
- Condition of the piping (must be full of water)

Select the sensor according to the pipe diameter.

Measurement settings are made on the converter.

Measurement preparation
- Check sensor holder spacing
- Install the sensor
- Check signal strength

2.2 Measurement procedure example

An example of the measurement process is shown below.

① Advance preparation

Before measurement, check the following information:

- Check the information of the pipe to be measured.
  - Outside diameter (or circumference) of the pipe
  - Thickness
  - Material
  - Lining and thickness
- Liquid type to be measured

② Selecting a location

Select the location to install the sensor. For details, refer to "4.1 Selecting the installation location".

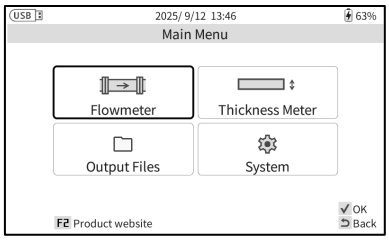
③ Sensor selection

Select a sensor according to the diameter of the pipe. For details, refer to "4.2 Sensor Selection" or the "Applicable Sensor Diameters" table in the "Main Menu" - "Help" of this unit.

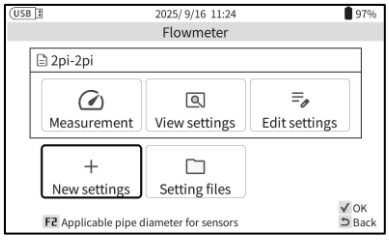
④ Measurement settings

Turn on the power of this unit, and from the main menu, go to "① Flowmeter" - "② New Settings" and then "③ Measurement Settings" to set up the settings. When you have finished setting up, "Save" the settings to a file.

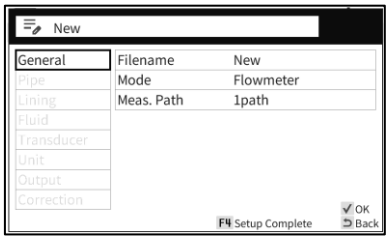
①Flowmeter



② New Settings



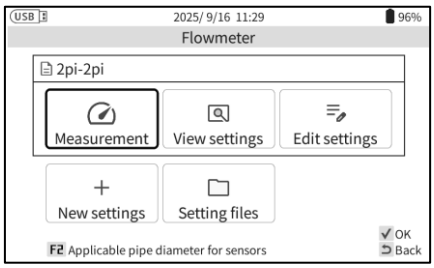
③Measurement settings



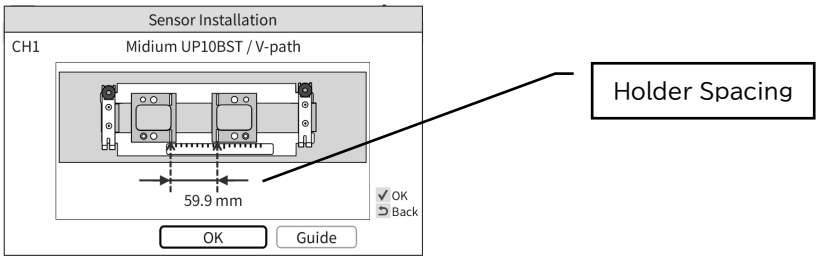
[Settings]
General: Mode, measurement line, etc.
Piping: Input pipe information
Lining: Input pipe information
Fluid: Select liquid type
Sensor: Select sensor
Measurement unit: Input unit
Output: Analog output setting
Correction: Damping setting, etc.

⑤ Measurement preparation

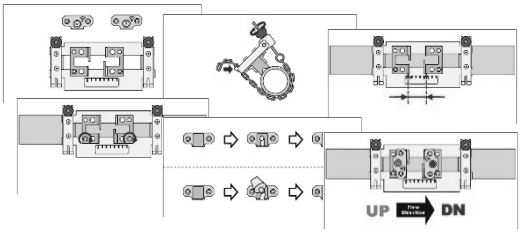
1. On the flow meter menu screen, select ”Measurement”.



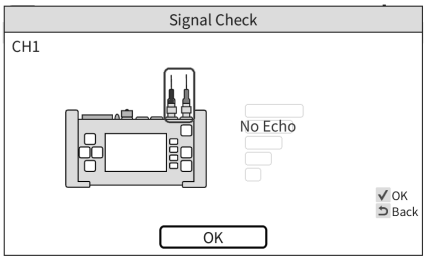
2. The ”Holder Spacing” is displayed on the sensor mounting surface. Follow the instructions on the screen to adjust the sensor holder spacing on the mounting fixture, and then install the mounting fixture on the piping.



3. Selecting ”Guide” will display the ”Installation Guide.” Please refer to this to install the fixture and sensor correctly.

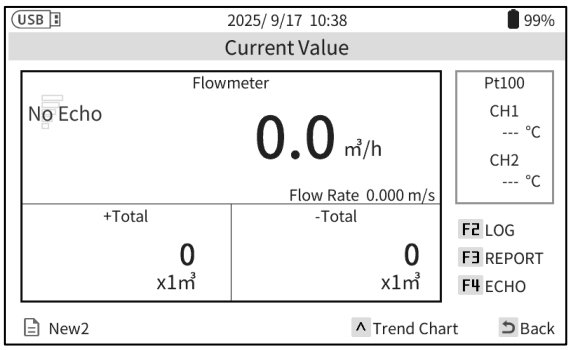


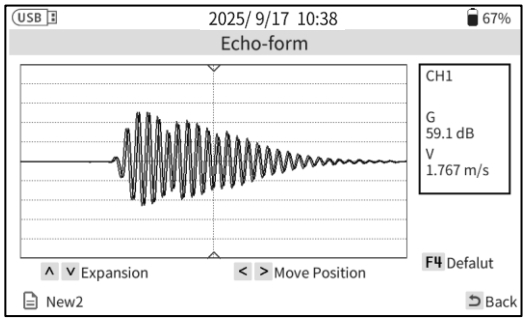
4. Then ”Signal Check” will be displayed. The signal strength will be displayed. If the signal strength is not sufficient, adjust the installation position.

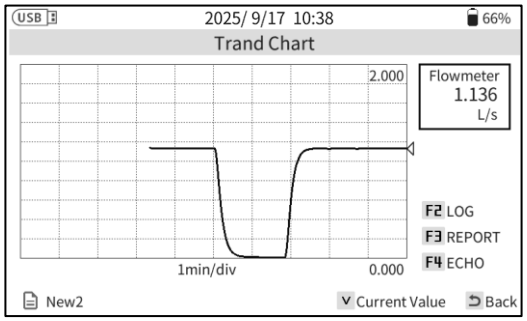


⑥ Start of measurement

When measurement starts, the instantaneous flow rate and totalized value are displayed. Temperature measurement is also possible by connecting a resistance temperature detector (Pt100). In addition, trend graphs and received waveforms can also be displayed. For details, please refer to the explanations in each chapter.



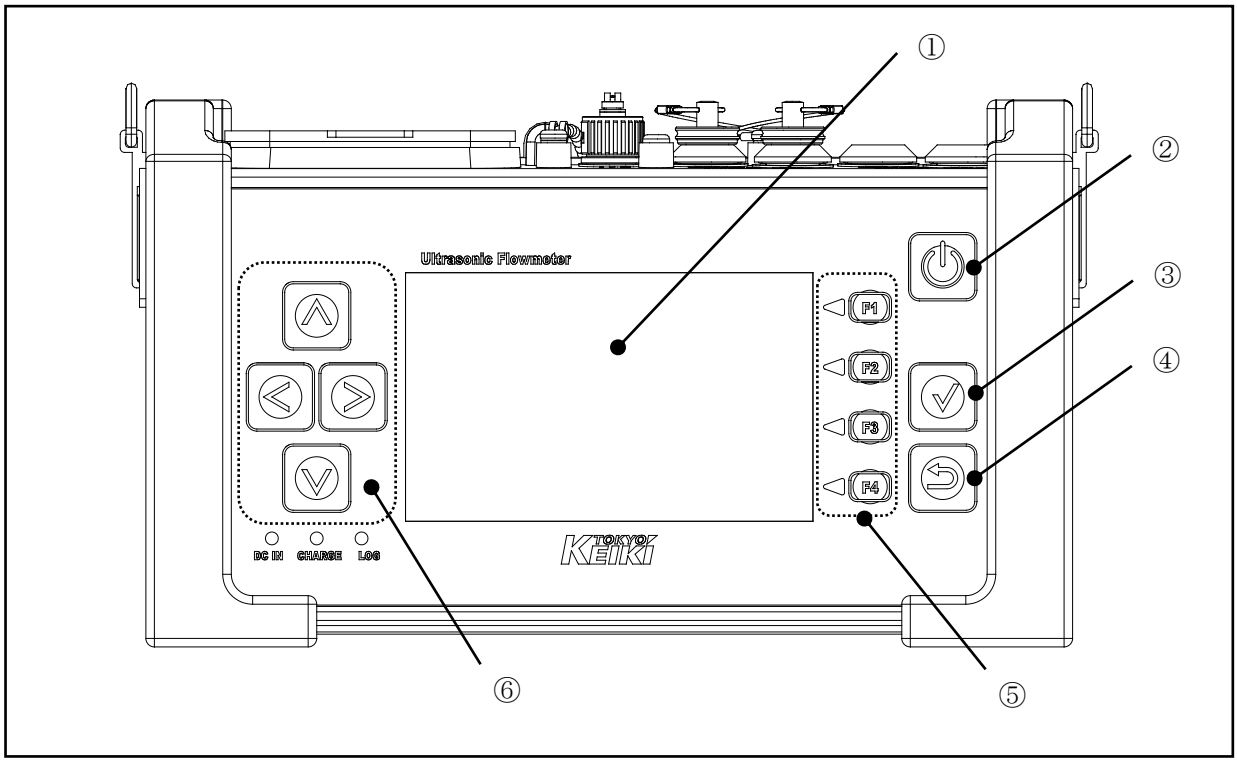




Chapter3 Settings / operation

3.1 Key layout

Various settings can be made using the keys on the key sheet on the front of the unit. The layout is shown below.

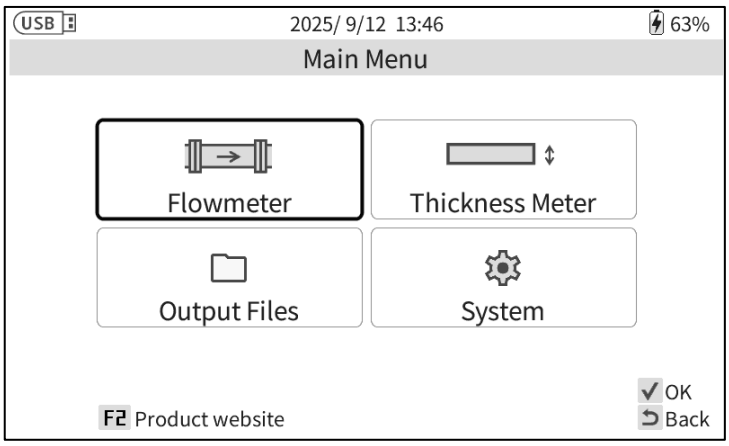


Number	Name	Explanation
①	Display screen	Displays measurement values, etc.
②	Power key	Turns the power on / off. Power on, press and hold the power key.
③	Confirm key	Confirm your selections etc.
④	Back key	Cancels the selected items and returns to the previous screen.
⑤	Function keys	Four keys, whose functions are displayed on the display screen.
⑥	Left/right/up/down keys	Moves the selection screen left/right/up/down.

3.2 Menu

3.2.1 Main Menu

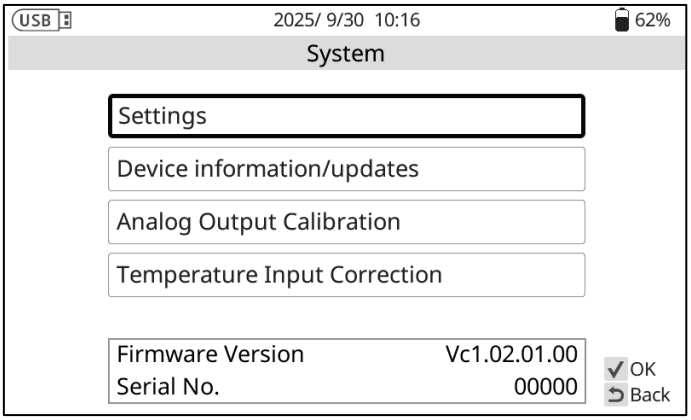
The main menu consists of ”Flowmeter”, ”Thickness Meter”, ”Output Files”, and ”System”. The main menu screen is shown below. The contents of each are as follows:



Name	Explanation
Flowmeter	Switch to flow meter mode. In this mode, flow rate measurement, massmeter measurement, and heat quantity measurement can be performed.
Thickness Meter	Switch to Thickness meter mode. Thickness and sound speed measurements can be performed.
Output Files	The log, screenshot, and report management screen will be displayed. On this screen, you can copy acquired data to a USB memory stick or delete unnecessary data remaining in the internal memory.
System	In the “System”, you can set the language, time, initialize internal data, update firmware, etc.

3.2.2 System Menu

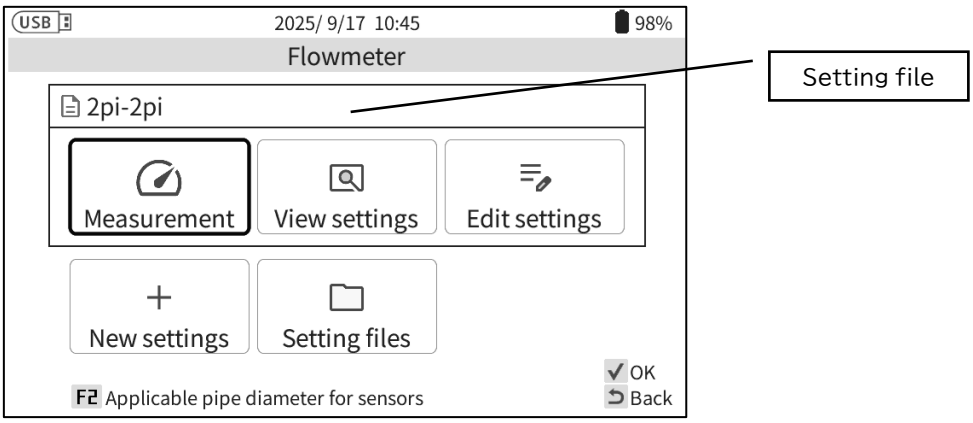
The “System” menu consists of ”Settings”, ”Device Information/Update”, ”Analog Output Calibration”, and ”Temperature Input Correction”. The “System” menu screen is shown below. The contents of each are as follows:



Name	Explanation
Settings	Go to device settings. You can initialize the date and time, language and units, display, and data.
Device information/updates	Go to device information. You can check the battery status, perform self-diagnosis, and update the firmware.
Analog Output Calibration	Proceed to analog output calibration. Calibration can be performed at 4mA and 20mA for each channel.
Temperature Input Compensation	Proceed to temperature input correction. Zero and span corrections can be performed for each channel.
Firmware Version	The current firmware version is displayed.
Serial No.	The serial number will be displayed.

3.2.3 Flow meter menu

The flowmeter menu consists of ”Measurement”, ”View settings”, ”Edit settings”, ”New settings” and ”Settings files”. The contents are shown below. The flowmeter menu screen is shown below. The contents of each are as follows:



Name	Explanation
Measurement	The measurement value display screen will appear.
View settings	This will take you to the settings confirmation screen, where you can check the contents of the currently selected settings file.
Edit settings	You will be taken to the settings editing screen. You can edit the currently selected configuration file. You can change the settings of the currently selected file and save it, and you can also change the file name to create a new configuration file.
New settings	Select this when creating a new configuration file.
Setting files	This will take you to the configuration file screen. You can see a list of the configuration files you have created so far. You can select a file from the list and configure the measurement. You can import and export configuration files using a USB memory stick.

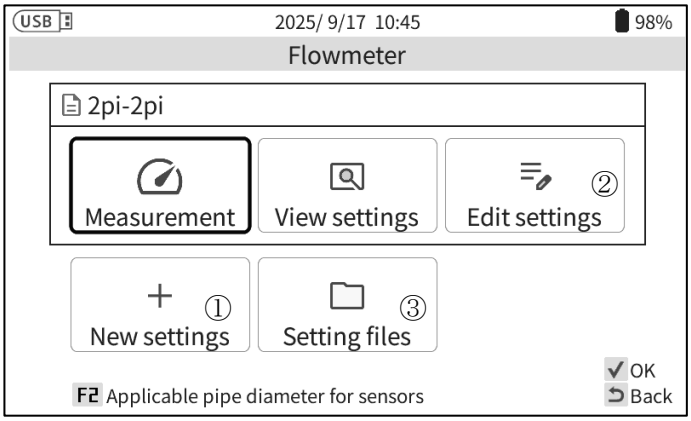
3.3 How to edit measurement settings

This section explains how to set up the flowmeter.

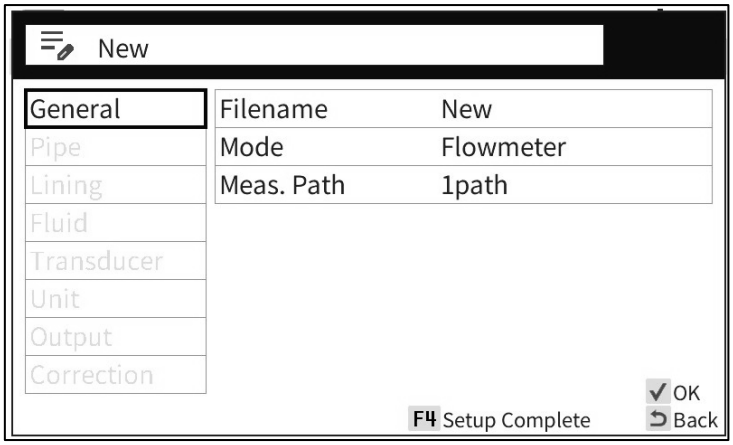
3.3.1 Start editing the settings

There are three ways to begin configuring your flow meter:

① From ” New settings ”
”New settings” to start a new configuration file.
② From ”Edit settings”
Select ”Edit settings” to edit the previous settings and start the setup.
③ ”Setting files” and load an existing file, then edit that file in ”Edit settings” to begin the configuration.



When you enter the ”Edit settings” screen, the following screen will be displayed. Configure each setting according to the ”Items” on the left. For details on the setting items, please refer to ”3.4 Measurement Settings”.

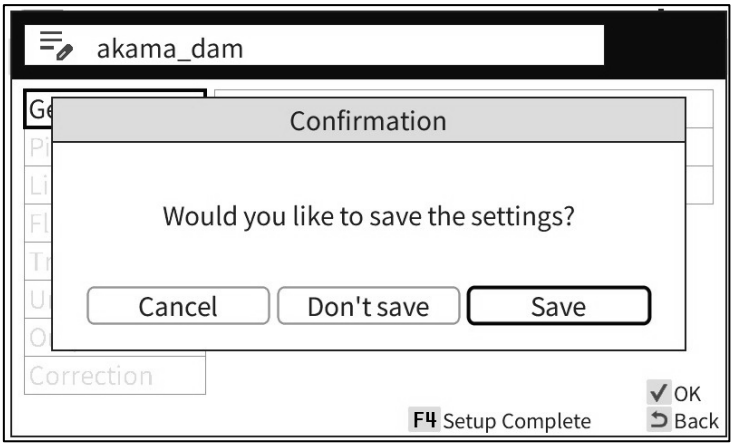


3.3.2 Finish editing the settings

When you have finished configuring the flowmeter, there are two ways to exit ”Edit settings”.

① From function key [F4]
[F4] on the right side of the screen to display the ”Confirmation” screen. Select ”Save” or ”Don’t save” to exit.

② From the ” BACK ” key
The ” BACK ” key multiple times to display the ”Confirmation” screen. Select ”Save” or ”Don’t save” to exit.

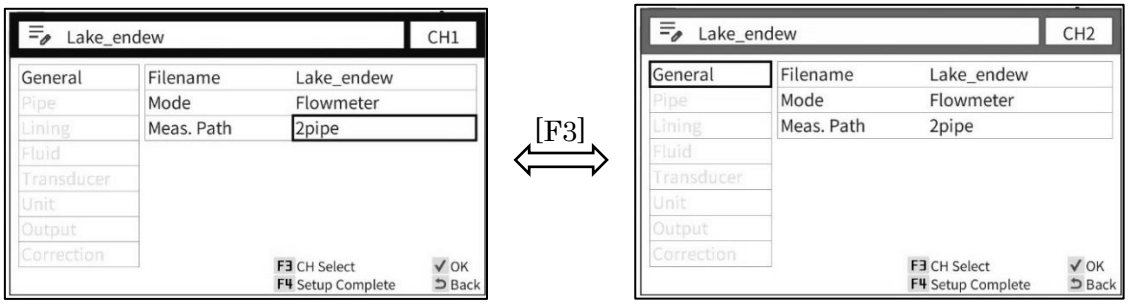


3.3.3 View settings

You can check the data you have set in ”View settings” The screen layout of ”View settings” is the same as ”Edit Settings.” On this screen, you can only check the settings. If you want to edit the settings, please use ”Edit settings”.

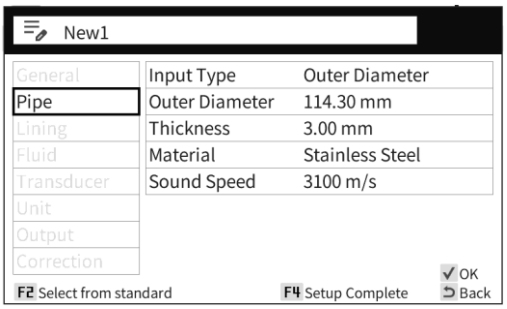
3.3.4 How to switch channels (CH)

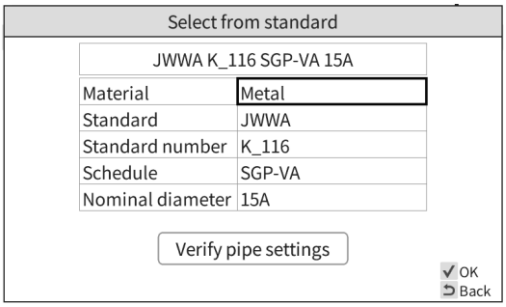
”2pipe” measurement, you need to set up the measurement for each channel. To do so, use the function key you can switch channels by pressing [F3]. Please set each channel separately.

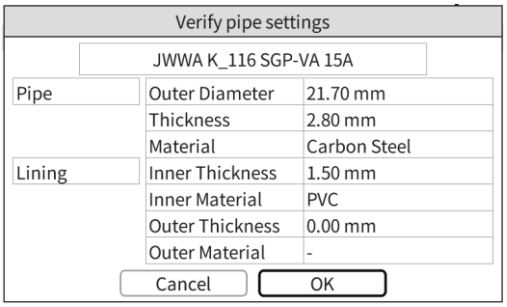


3.3.5 Select from standards

Pipe data can be set from piping standards. Press the function key [F2] when selecting Pipe or Lining. You will be taken to the standard selection menu.







Material	Standard	Standard number	Schedule	Nominal Diameter
Metal	JIS	G 5526	According to standards	According to standards
		G 3452		
		G 3442		
		G 3454		
		G 3459 / G 3468		
		G 3447		
		G 3448		
	JWWA	K 116		
		G 115		
	ASME	B36.10		
		B36.19		
Resin	JIS	K 6741		
		K 6742		
		K 6776		
		K 6761		
	JWWA	G 144		

3.4 Measurement settings

The setting items are listed below:

Item	Item	Input range	Initial value
General	Filename	20 characters	New
	Mode	Flowmeter / Massmeter / Heatmeter	Flowmeter
	Meas. Path	1path / 2path / 2pipe	1path
	Temp. Zero Cut	0.0 – 10.0 ℃	0.0 ℃ (When Heatmeter is selected)
Pipe	Input Type	Outer diameter / Circumference	Outer Diameter
	Outer Diameter	7.00 – 5500.00 mm	114.30 mm (When selecting Outer Diameter)
	Circumference	21.99 – 17278.76 mm	359.08 mm (When the Circumference is selected)
	Thickness	0.10 – 100.00	3.00 mm
	Material	User-defined / Carbon steel / Stainless steel/ Ductile iron / Cast iron / Copper / PVC / HD Polyethylene / FRP / ACRYLIC	Stainless steel
	Sound Speed	500 – 9000 m/s	3100 m/s
Lining	Thickness	0.00 – 100.00 mm	0.00 mm
	Material	User-defined / Epoxy / Mortar / Rubber/ PVC	User defined
	Sound Speed	500 – 9000 m/s	Depends on material
Fluid	Type	User defined / Water / Seawater / Ethylene glycol (50wt%) /Glycerin/Acetone/Toluene	Water
	Sound Speed	500 – 9000 m/s	1460 m/s
	KV Factor	0.01 – 9000.00 m/s	1.20 mm^2 / s
Transducer	Type	Large UP04BST / Medium UP10BST / Small UP50BST /Others	Medium UP10BST
	Others	Large UP04AST (UFP20) / Medium UP10AST (UFP20) /Small UP50AST (UFP20)	Large UP04AST (UFP20) (When Others are selected)
	Cable Length	3 – 160 m	3 m
	Sound Path	Z-path / V-path / W-path	V-path
	Couplant	Grease/Dry couplant	Grease
Unit	Flow Unit	Metric m^3/s / L/s / m^3/min / L/min / m^3/h / L/h / m^3/D / L/D / km^3/s / km^3/min / km^3/h / km^3/D / Mm^3/D Imperial ft^3/s / ft^3/min / ft^3/h / ft^3/D / Mft^3/D / bbl/s / bbl/min / bbl/h / bbl/D / Mbbl/D / gal/s / gal/min / gal/h / gal/D / Mgal/D / acf/s / acf/min / acf/h / acf/D / Macf/D	m^3/h (When Flowmeter is selected)
	Decimal Position	****** / *****.* / ****.** / ***.*** / **.**** / *.*****	*****.*
	Total Unit	Metric x0.01L / x0.1L / x1L / x10L / x100L / x1m^3 / x5m^3 / x10m^3 / x100m^3 Imperial ft^3 / kft^3 / Mft^3 / bbl / kbbl / Mbbl / gal / Mgal / acf / kacf / Macf	x1m^3 (When Flowmeter is selected)

	Mass rate unit	Metric kg/s / kg/min / kg/h / kg/D / t/s / t/min / t/h / t/D / kt/s / kt/min / kt/h / kt/D / Mt/D Imperial lb/s / lb/min / lb/h / lb/D / klb/s / klb/min / klb/h / klb/D / Mlb/s / Mlb/min / Mlb/h / Mlb/D / Glb/D	kg/h (When Massmeter is selected)
	Total unit	Metric x0.01kg / x0.1kg / x1kg / x10kg / x100kg / x1t / x10t / x100t Imperial x0.01lb / x0.1lb / x1lb / x10lb / x100lb / x1klb / x10klb / x100klb	x1kg (When Massmeter is selected)
	Energy unit	Metric W / kW / MW Imperial BTU/h / kBTU/h / MBTU/h	MW (when Heatmeter is selected)
	Total unit	Metric J / kJ / MJ / GJ Imperial BTU / MBTU	MJ (When Heatmeter is selected)
Output	Qmin	--- (Depending on the display format)	0.0
	Qmax	--- (Depending on the display format)	10000.0
	Analog output	OFF / ON	OFF
	Alarm operation	HOLD / 4mA output / 20mA output	HOLD (When "ON" is selected)
Correction	Output damping	1 – 120s	15s
	Low cut	--- -Depending on the display format	0.0
	Span correction	0.100 - 20.000	1.000
	Zero shift	--- (Depending on the display format)	0.0

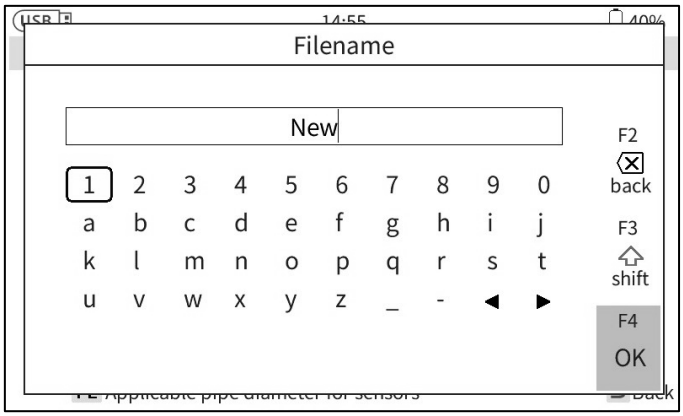
3.4.1 General

In "General", set the following items:

Item	Item	Input range	Initial value
General	Filename	20 characters	New
	Mode	Flowmeter / Massmeter / Heatmeter	Flowmeter
	Meas. Path	1path / 2path / 2pipe	1path
	Temp. Zero cut	0.0 – 10.0 ℃	0.0 ℃ (When Heatmeter is selected)

[Filename]

- File names can be set using alphabets (uppercase / lowercase), numbers, _, and -.
- The number of characters can be between 1 and 20.
- F2 is the "back" key and deletes a character.
- F3 is the "shift" key that switches between uppercase and lowercase.
- ◂ Use the ▸ to move the cursor position.

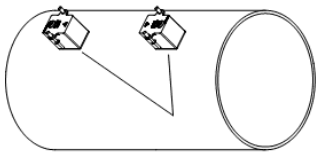
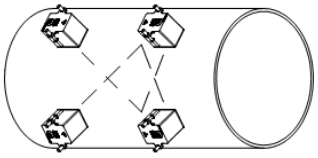
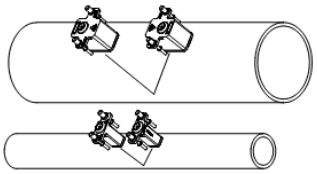


【Mode】

Choose from the following three types:

Item	Explanation
Flowmeter	Measures the volumetric flow rate of liquid flowing through a pipe.
Massmeter	The mass flow rate is calculated by multiplying the volumetric flow rate by the density of the fluid being measured and displayed.
Heatmeter	It measures energy consumption based on the flow rate and temperature difference in the pipes.

[Meas. Path]
Choose from the following three types:

Item	Explanation	
1path	This is the normal measurement method.	
2path	Two measurement lines and taking the average, the effects of disturbances in the flow velocity distribution are reduced.	
2pipe	By installing a sensor on each of two different pipes, two pipes can be measured simultaneously.	

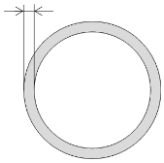
[Temp. Zero Cut]
This can be set when you select the Heatmeter.

Item	Explanation
Temp. Zero cut	Set this when in ”Heatmeter” mode. Set the sending temperature to CH1 of the temperature input, and the return temperature to CH2. If the absolute value of the difference between CH1 and CH2 is smaller than the set value, the temperature difference will be forcibly set to 0 ℃. The input range is 0.0 – 10.0 ℃.

3.4.2 Pipe

In "Pipe", set the following items.

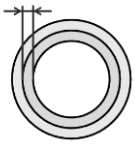
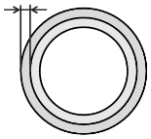
Item	Item	Input range	Initial value
Pipe	Input type	Outer diameter / Circumference	Outside diameter
	Outside diameter	7.00 – 5500.00 mm	114.30 mm (When selecting outer diameter)
	Circumference	21.99 – 17278.76 mm	359.08 mm (When the circumference is selected)
	Thickness	0.10 – 100.00	3.00 mm
	Material	User-defined / Carbon steel / Stainless steel/ Ductile iron / Cast iron / Copper / PVC / HD Polyethylene / FRP / ACRYLIC	Stainless steel
	Sound speed	500 – 9000 m/s	3100 m/s

Item	Explanation
Input type	Select the method for entering pipe information.  Outer diameter Circumference
Outer diameter	Enter the outer diameter of the pipe. (When selecting outer diameter)
Circumference	Enter the circumference of the pipe. (When selecting circumference)
Thickness	Enter the thickness of the pipe. 
Material	Select the pipe material. Set the sound speed of the pipe material by selecting the pipe material. If the pipe material is not available, set the desired sound speed by selecting "User defined." Material / Sound speed [m/s] User-defined: 500 - 9000 Carbon steel: 3200 Stainless steel: 3100 Ductile iron: 3000 Cast iron: 2500 Copper: 2270 PVC: 2280 HD Polyethylene: 2350 FRP: 2560 ACRYLIC: 2720
Sound speed	Displays the sound speed value selected for the material. It can be changed to any value. If you select the material again, the sound speed value will return to the preset value.

3.4.3 Lining

In ”Lining”, set the following items.

Item	Item	Input range	Initial value
Lining	Inner Thickness	0.00 – 100.00 mm	0.00 mm
	Outer Thickness	0.00 – 100.00 mm	0.00 mm
	Material	User-defined / Epoxy / Mortar /Rubber/ PVC	User defined
	Sound speed	500 – 9000 m/s	Depends on material

Item	Explanation
Inner Thickness	Enter the thickness of the lining. 
Outer Thickness	Enter the thickness of the lining. 
Material	Select the lining material. The sound speed of the lining material is set by selecting the material. If the lining material is not available, set the desired sound speed in ”User Defined”. Material / Sound speed [m/s]: User defined: 500 - 9000 Epoxy: 2000 mortar: 2500 Rubber: 1900 PVC: 2280
Sound speed	Displays the sound speed value selected for the material. Can be changed to any value.

3.4.4 Fluid

In ”Fluid”, set the following items.

Item	Item	Input range	Initial value
Fluid	Type	User-defined / Water / Seawater / Ethylene glycol (50wt%) /Glycerin/Acetone/Toluene	Water
	Sound speed	500 – 9000 m/s	1460 m/s
	KV Factor	0.01 – 9000.00 m/s	1.20 mm^2/s
	Density	100.0 - 9000.0 kg/m^3	1000.0 kg/m^3
	Specific heat	0.0 – 999999.0 J/kgK	4184.0 J/kgK

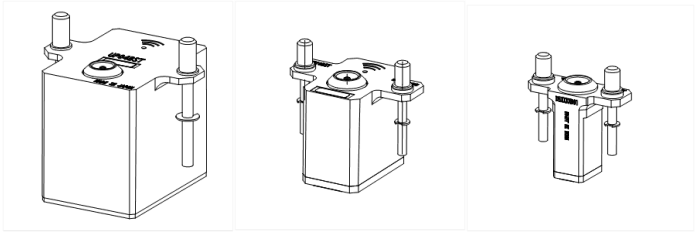
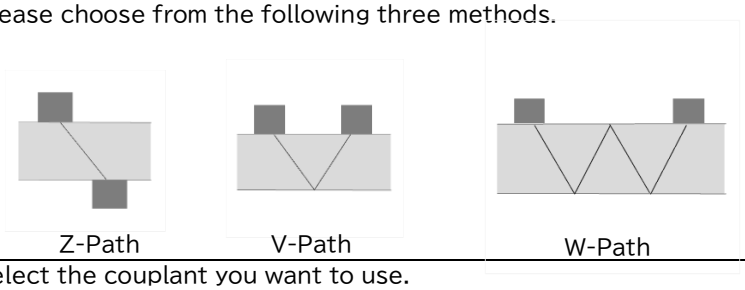
Item	Explanation
Type	Select the flued type. By selecting the flued type, the speed of sound and the kinematic viscosity coefficient for the liquid are set. If the flued type is not listed in the options, use ”User-defined” to manually set the speed of sound and the kinematic viscosity coefficient.
Sound speed	The speed of sound value for the selected fluid type is displayed. This value can be modified to any desired value if necessary
KV Factor	The kinematic viscosity coefficient for the selected fluid type is displayed. This value can also be adjusted to any desired setting as required.

Type	Sound Speed [m/s]	KV Factor [mm^2/s]
User-defined	500 - 9000	0.01 - 9000.00
Water	1460	1.20
Seawater	1510	1.00
Ethylene glycol (50wt%)	1691	4.13
Glycerin	1923	1188.50
Acetone	1190	0.41
Toluene	1420	0.59

3.4.5 Transducer

In "Transducer", set the following items.

Item	Item	Input range	Initial value
Transducer	Type	Large UP04BST / Medium UP10BST / Small UP50BST /Others	Medium UP10BST
	Others	Large UP04AST (UFP20) / Medium UP10AST (UFP20) /Small UP50AST (UFP20)	Large UP04AST (UFP20) (When Others are selected)
	Cable length	3 – 160 m	3 m
	Sound path	Z-path / V-path / W-path	V-path
	Couplant	Grease/Dry couplant	Grease

Item	Explanation
Type	Select the sensor to be used. Large UP04BST : Used for measuring large diameter pipes. Medium UP10BST : Standard sensor. Small UP50BST : Used for measuring small diameter pipes. Others : UFP-20 sensor can be selected.  Large UP04BST Medium UP10BST Small UP50BST
Cable length	Enter the sensor cable length. The standard cable length is 3m. If a 7m extension cable is connected, enter 10m .
Sound path	Please choose from the following three methods.  Z-Path V-Path W-Path
Couplant	Select the couplant you want to use. Grease: Ultrasonic waves are transmitted efficiently through the pipes. Dry couplant sheet: Allows for easy sensor installation. Note: Dry couplant seat is not available for large sensors.

Note
1. For UP10BST, if V method installation is not possible for small diameters such as less than 50A, please select Z method. 2. For UP04BST, select Z method for diameters over 2000A. 3. For UP04BST, the W method is up to 1000A.

3.4.6 Unit

In "Unit", set the following items:

Item	Item	Input range	Initial value
Unit	Flow unit	Metric m^3/s / L/s / m^3/min / L/min / m^3/h / L/h / m^3/D / L/D / km^3/s / km^3/min / km^3/h / km^3/D / Mm^3/D Imperial ft^3/s / ft^3/min / ft^3/h / ft^3/D / Mft^3/D / bbl/s / bbl/min / bbl/h / bbl/D / Mbbl/D / gal/s / gal/min / gal/h / gal/D / Mgal/D / acf/s / acf/min / acf/h / acf/D / Macf/D	m^3/h (When Flowmeter is selected)
	Decimal position	****** / *****.* / ****.** / ***.*** / **.**** / *.*****	*****.*
	Total unit	Metric x0.01L / x0.1L / x1L / x10L / x100L / $x1m^3$ / $x5m^3$ / $x10m^3$ / $x100m^3$ Imperial ft^3 / kft^3 / Mft^3 / bbl / kbbl / Mbbl / gal / Mgal / acf / kacf / Macf	$x1m^3$ (When Flowmeter is selected)
	Mass rate unit	Metric kg/s / kg/min / kg/h / kg/D / t/s / t/min/ t/h / t/D / kt/s / kt/min / kt/h / kt/D / Mt/D Imperial lb/s / lb/min / lb/h / lb/D / klb/s / klb/min / klb/h / klb/D / Mlb/s / Mlb/min / Mlb/h / Mlb/D / Glb/D	kg/h (When Massmeter is selected)
	Total unit	Metric x0.01kg / x0.1kg / x1kg / x10kg / x100kg / x1t / x10t / x100t Imperial x0.01lb / x0.1lb / x1lb / x10lb / x100lb / x1klb / x10klb / x100klb	x1kg (When Massmeter is selected)
	Energy unit	Metric W / kW / MW Imperial BTU/h / kBTU/h / MBTU/h	MW (when Heatmeter is selected)
	Total unit	Metric J / kJ / MJ / GJ Imperial BTU / MBTU	MJ (When Heatmeter is selected)

3.4.7 Output

In ”Output”, set the following items:

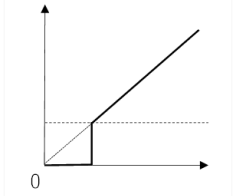
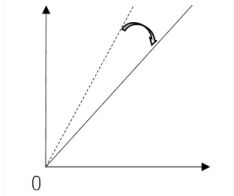
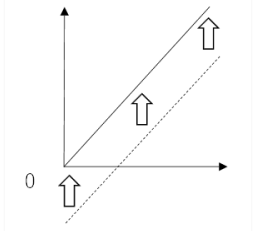
Item	Item	Input range	Initial value
Output	Qmin	---	0 ・Units are based on flow rate/mass/heat quantity ・The decimal part of the display format will be “number of digits - 1 ” digits, and the first digit will be 0 . In the case of display digit format + ***.***, it is 0. 00 0
	Qmax	---	10000 - Units are based on flow rate/mass/heat quantity ・The integer part of the display format shall be “number of digits + 1 ” digits, and the first digit shall be 1 . Example) Display digit format + ***.*** is 100. 00 0
	Analog output	OFF / ON	OFF
	Alarm operation	HOLD / 4mA output / 20mA output	HOLD (When ”ON” is selected)

Item	Explanation
Qmin	Set the minimum instantaneous value (instantaneous flow rate, instantaneous heat amount). This setting is assigned to the following functions: Analog output ・Trend function - Trend graph ・Report function - Trend graph
Qmax	Set the maximum instantaneous values (instantaneous flow rate, instantaneous heat amount). This setting is assigned to the following functions: Analog output ・Trend function - Trend graph ・Report function - Trend graph
Analog output	Sets whether or not analog output is enabled. ” 2pipe” is selected for the measurement line, analog output will be provided from each channel.
Alarm output	there is no signal received for 10 seconds or more, an alarm will be generated. Select the output when an alarm occurs from the following three items. HOLD / 4mA output / 20mA output

3.4.8 Correction

In ”Correction”, set the following items:

Item	Item	Input range	Initial value
Correction	Output damping	1 – 120s	15s
	Low cut	--- Depending on the display format	0.0
	Span correction	0.100 - 20.000	1.000
	Zero shift	--- (Depending on the display format)	0.0

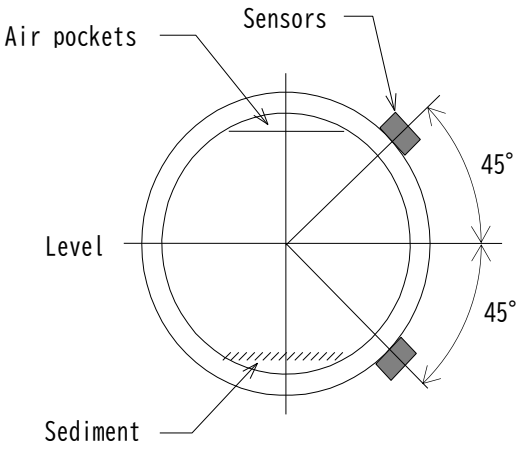
Item	Explanation
Output damping	90% of the step change. If the flow rate fluctuation is large, increasing the setting will increase the effect of suppressing the fluctuation.
Low cut	The absolute value of the flow rate is less than the low flow cut setting, the flow rate is forced to zero. 
Span correction	Corrects the inclination of the span line. 
Zero shift	Corrects the offset of the measurement value. 

Chapter4 Installation

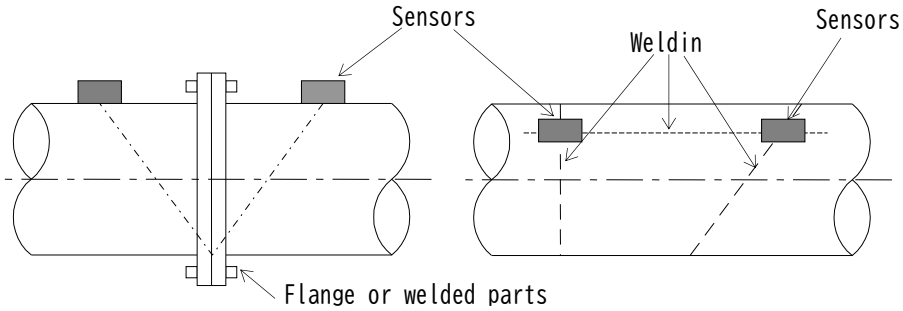
4.1 Selecting the sensor mounting location

When selecting an installation location, take the following conditions into consideration:

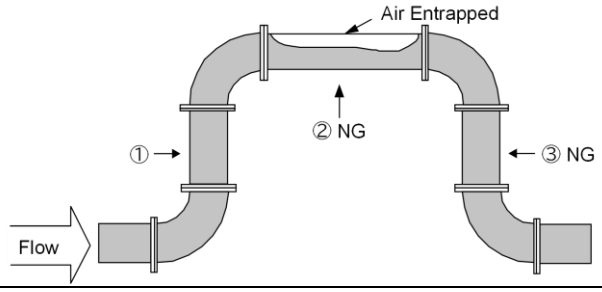
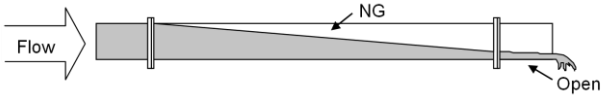
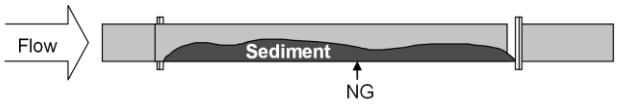
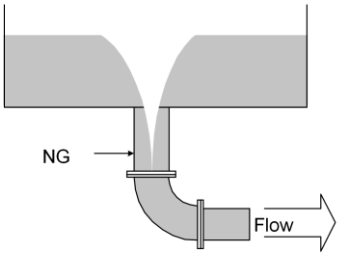
(1) No heat sources nearby and no direct sunlight.
(2) Free from dust and corrosive atmosphere.
(3) A place where maintenance and inspection can be easily performed.
(4) A location free from inductive interference from power equipment and its wiring.
(5) Where fluid remains filled even when flow has stopped.
(6) Select a piping location with minimal obstructions to the flow. The required straight pipe length must be secured for sensor installation. Please refer to "11.1 Piping requirements and required straight pipe length". Select a location that is free of air pockets or deposits. Also, avoid joints such as welds, and select a location where the outer surface of the pipe is as smooth as possible and where there is little corrosion on the inner surface of the pipe.



Sensor installation position

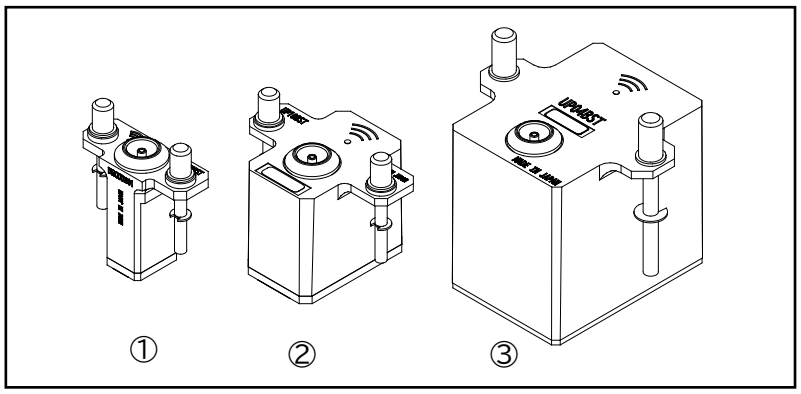


Positions where sensors cannot be attached

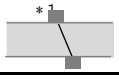
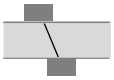
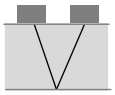
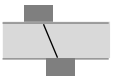
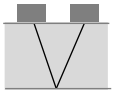
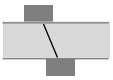
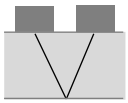
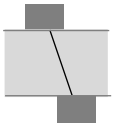
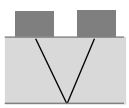
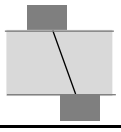
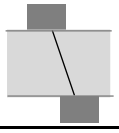
Phenomenon	Pipe condition	Remarks
Air Entrapped & Not full		For rising pipe, if the flowmeter is installed in positions ② or ③, air may accumulate and the pipe is not completely filled with liquid, which may result in measurement errors. Please install it in position ①.
Not full		If the downstream side of the flow meter installation location is open to the atmosphere, there is a risk of the pipe being half-full.
Sediment		Sediment accumulation at the flowmeter position may cause measurement errors.
Entrained air		Measurement may not be possible if there is entrained air at the flowmeter position.

4.2 Sensor selection

There are three types of sensors available, so please select the appropriate sensor according to the pipe diameter to be measured. The V method is recommended for sensor installation, as it is easy to install. However, in conditions where ultrasonic signals are difficult to transmit (e.g. old pipes, cast pipes, lined pipes), consider using the Z method.



① Small sensor UP50BST (5MHz)
② Medium sensor UP10BST (1MHz)
③ Large sensor UP04BST (400kHz)

Caliber range	Sensors	1st choice	2nd choice
13 to 50A 20 to 50A	Small (UP50BST)		*1 
	Medium (UP10BST)		
50 to 250A	Medium (UP10BST)		
300 to 500A	Medium (UP10BST)		
	Large (UP04BST)		
550 to 2000A	Large (UP04BST)		
～ 5000A	Large (UP04BST)		

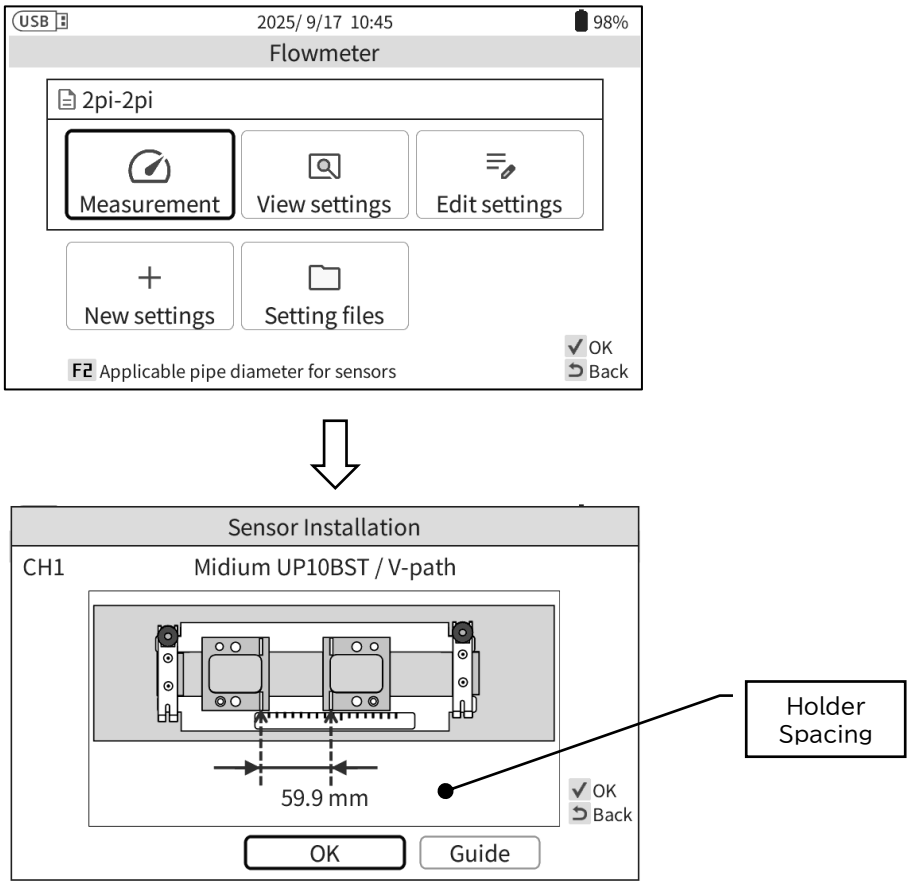
*1) A small mounting bracket must be purchased separately.

4.3 Check the sensor installation interval

After completing ”Measurement Settings”, install the sensor. For details on measurement settings, see ”3.4 Measurement Settings”.

The sensor mounting interval can be confirmed on the ”Measurement” - ”Sensor mounting” screen. This screen displays the ”**holder spacing” of the sensor according to the sensor, mounting method, and mounting tool used.**

The marking lines on the sensor holder of each mounting fixture indicate the position of the front of the sensor. However, for the Z mounting fixture exclusively for medium sensors, the sensor holder spacing is indicated in the same way as for the V method mounting, taking into consideration ease of mounting. For details, see ”4.4.4 Z Method Mounting Fixture for Medium sensors”.



4.4 How to install the fixture

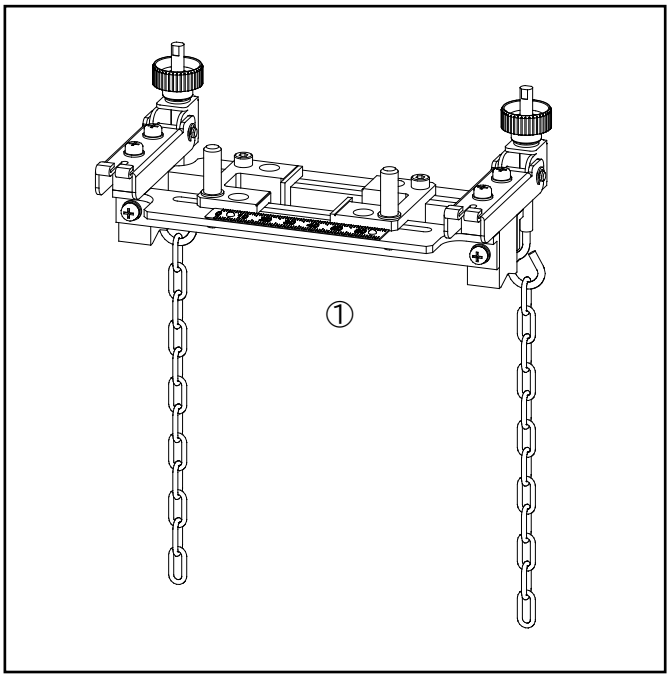
The installation method for each fixture is shown below.

4.4.1 Small sensor mounting fixture

This section explains how to install the small sensor mounting bracket. The small sensor mounting bracket is compatible with pipe sizes from 13 to 50A and can be installed.

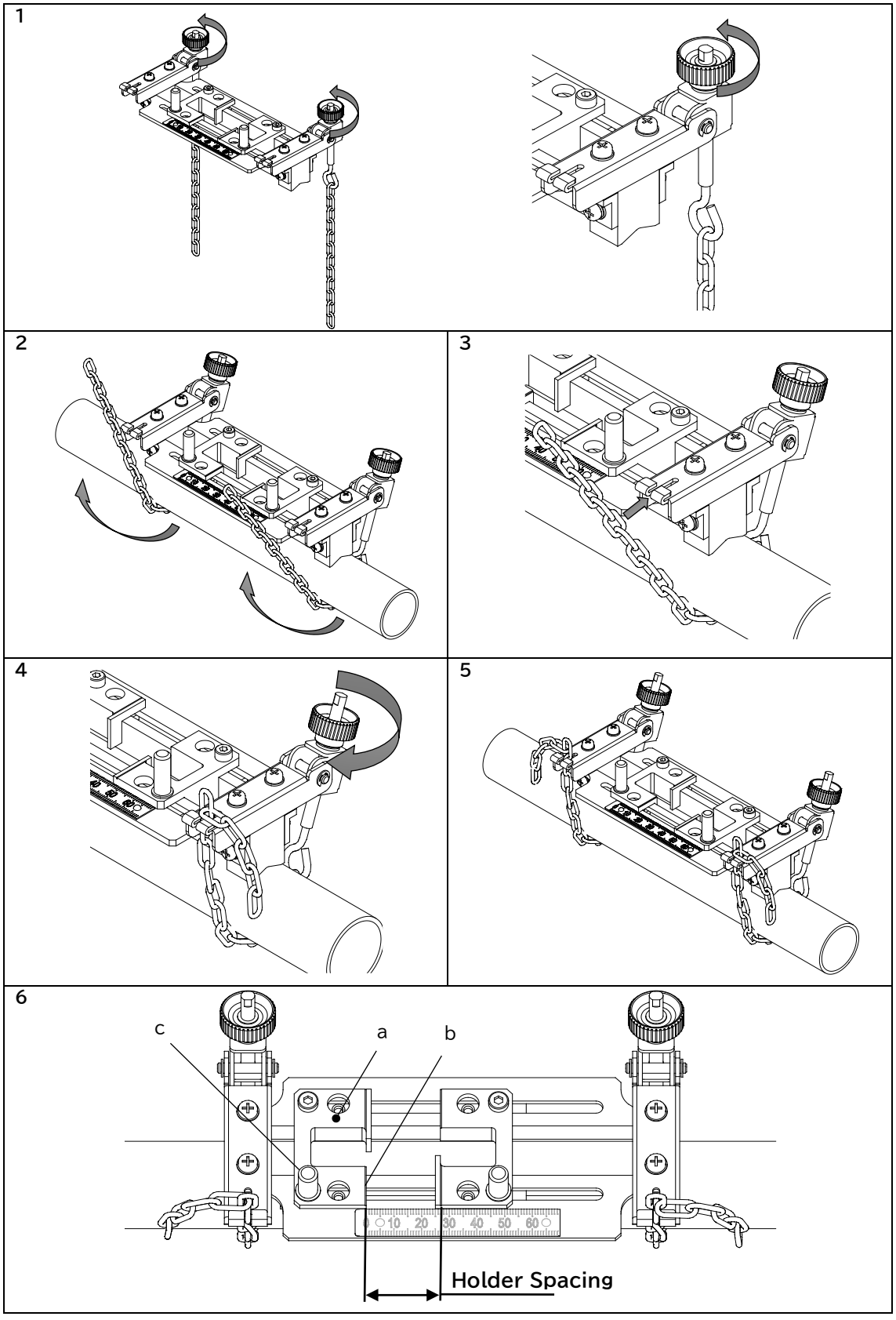
4.4.1.1 composition

The configuration is shown below.



① Small sensor mounting fixture

4.4.1.2 Installation procedure



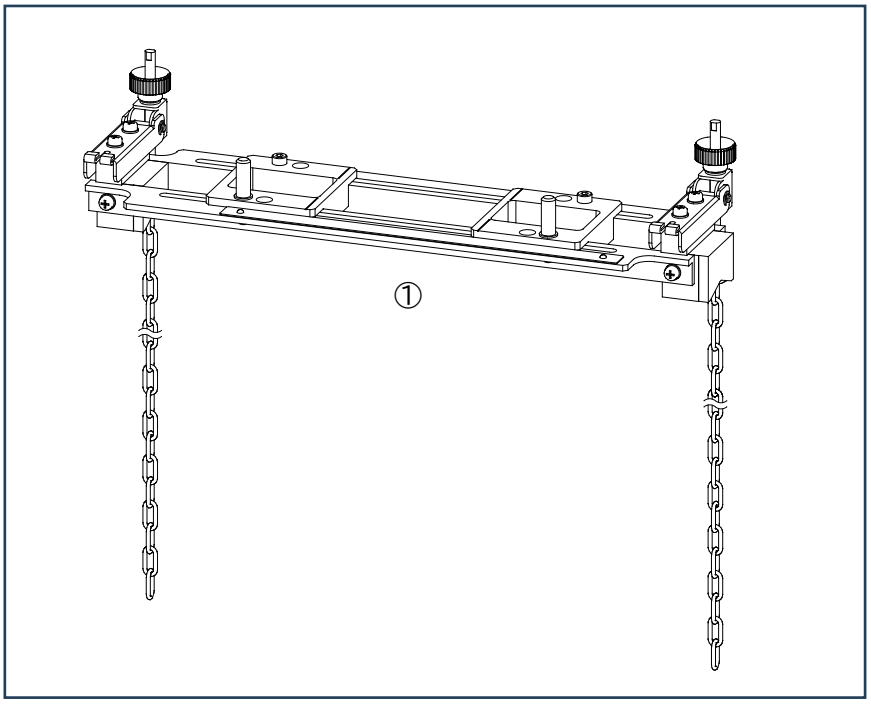
1. Loosen the knob as far as possible to ensure sufficient chain pull.
2. Place the fixture on the pipe and wrap the chain around the pipe without any slack.
3. Insert the chain into the groove of the mounting bracket and hook it securely.
4. With the chain secured in place, turn the knob to tighten the chain and secure the fitting to the pipe.
5. Secure the other chain in the same way.
6. Set the marking line (b) on the sensor holder (a) to the ”holder spacing” confirmed on the screen. Tighten the knob screw (c) to fix the sensor holder in place.

4.4.2 Medium sensor mounting bracket (50 to 200A)

This section explains how to install a medium sensor mounting fixture for pipe sizes of 50 to 200A.

4.4.2.1 composition

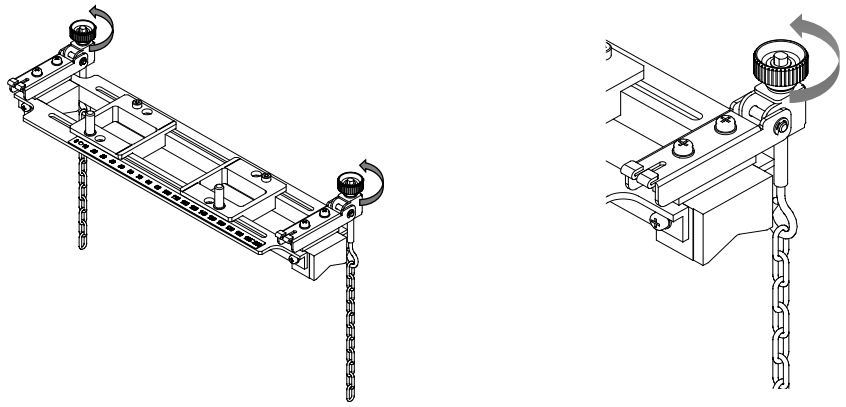
The configuration is shown below.



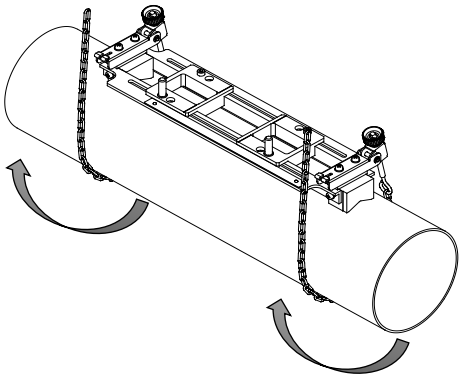
① Medium sensor mounting fixture

4.4.2.2 Installation procedure

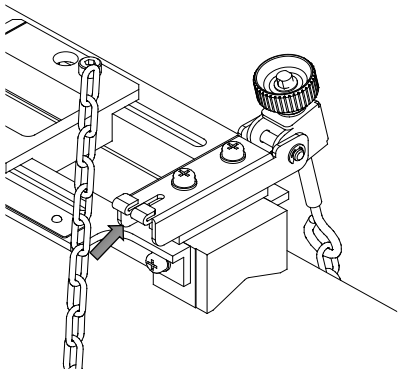
1



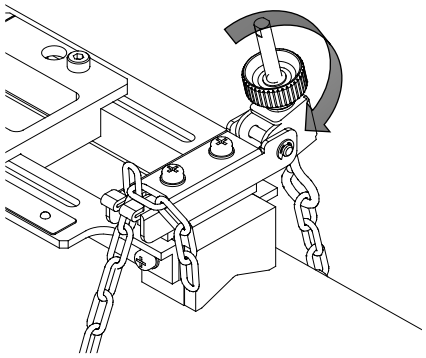
2



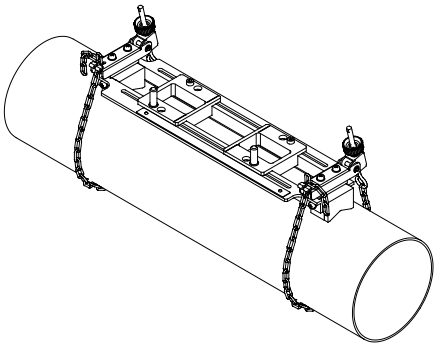
3



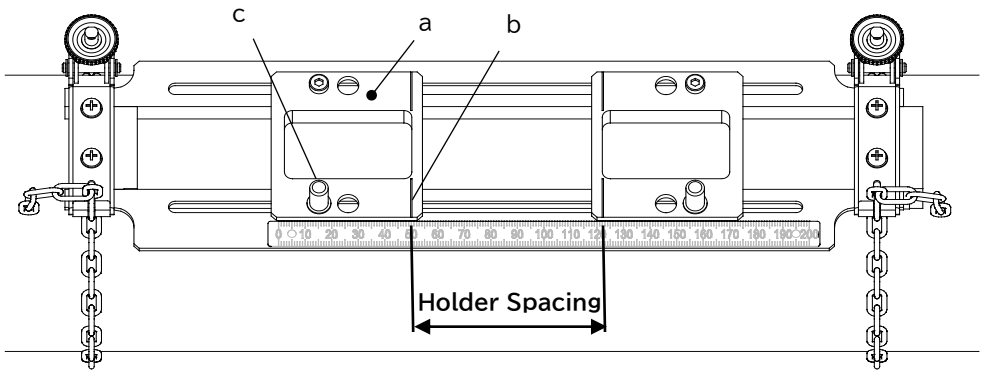
4



5



6



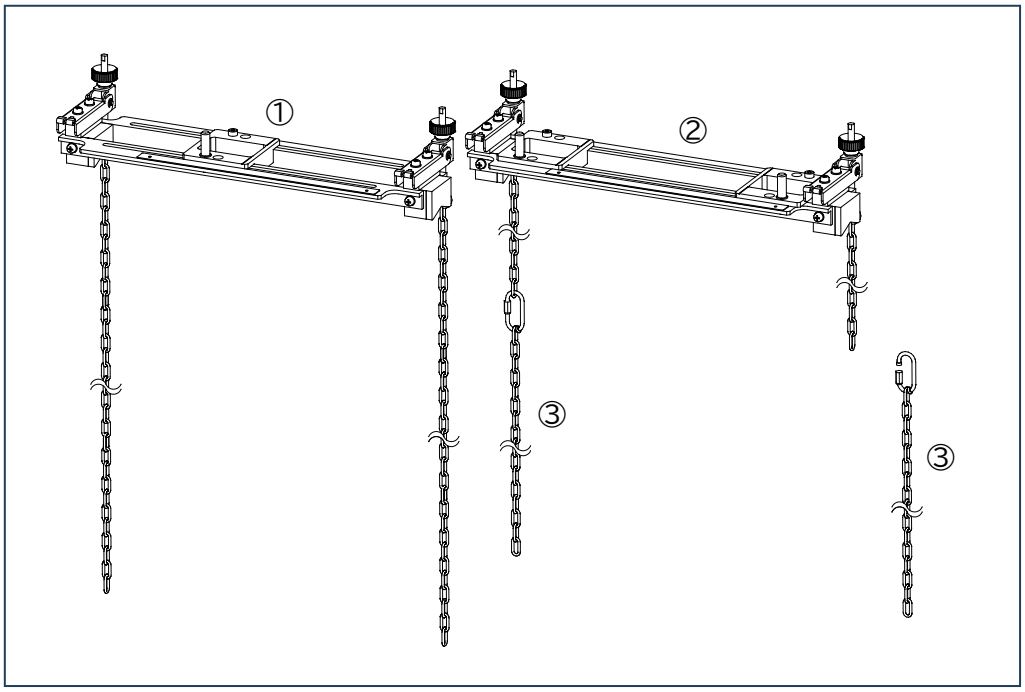
1. Loosen the knob as far as possible to ensure sufficient chain pull.
2. Place the fixture on the pipe and wrap the chain around the pipe without any slack.
3. Insert the chain into the groove of the mounting bracket and hook it securely.
4. With the chain secured in place, turn the knob to tighten the chain and secure the fitting to the pipe.
5. Secure the other chain in the same way.
6. Set the marking line (b) on the sensor holder (a) to the ”holder spacing” confirmed on the screen. Tighten the knob screw (c) to secure the sensor holder in place.

4.4.3 Medium sensor mounting bracket (250 to 500A)

This section explains how to install a medium sensor mounting fixture for pipe sizes of 250 to 500A.

4.4.3.1 composition

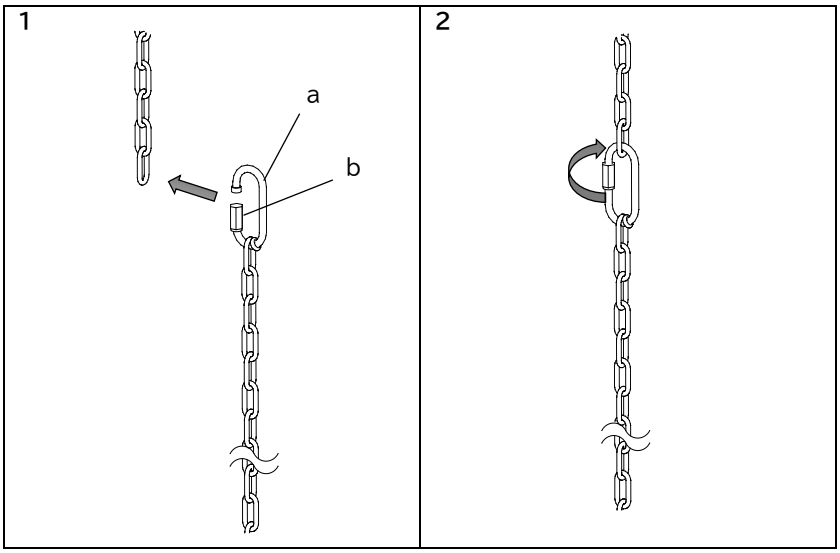
The configuration is shown below.



① Medium sensor connection expansion mounting fixture
② Medium sensor mounting fixture
③ Extension chain (x2)

4.4.3.2 Preparation

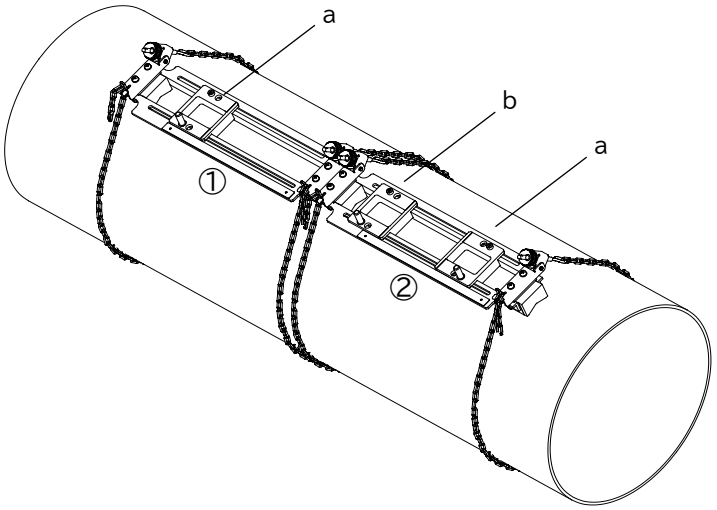
The chain for the medium sensor mounting bracket is compatible with pipe diameters up to 200A. For pipe diameters of 250A or more, please use the included extension chain to extend the chain length.



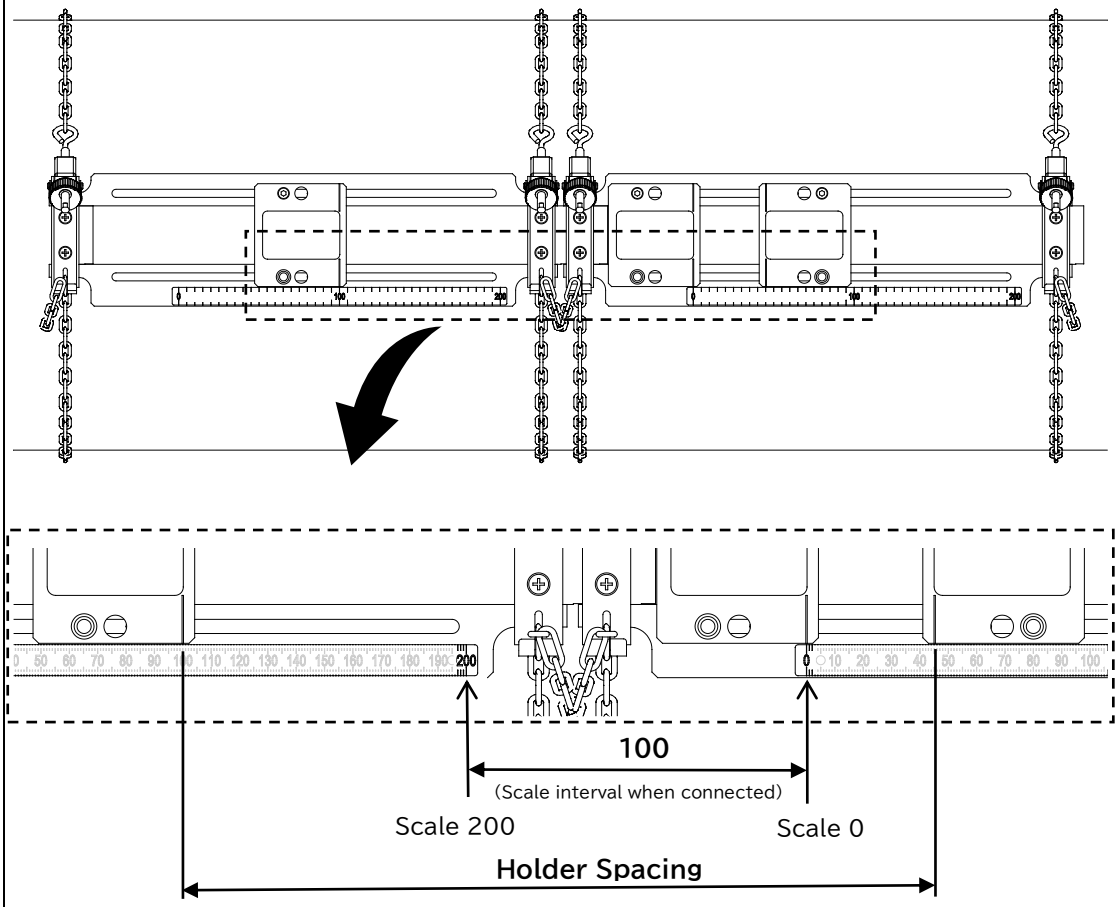
1. (b) of the ring catch (a) on the end of the extension chain and hook it onto the end of the chain on the attachment.
2. Tighten the ring catch nut securely to secure it in place.

4.4.3.3 Installation procedure

1



2

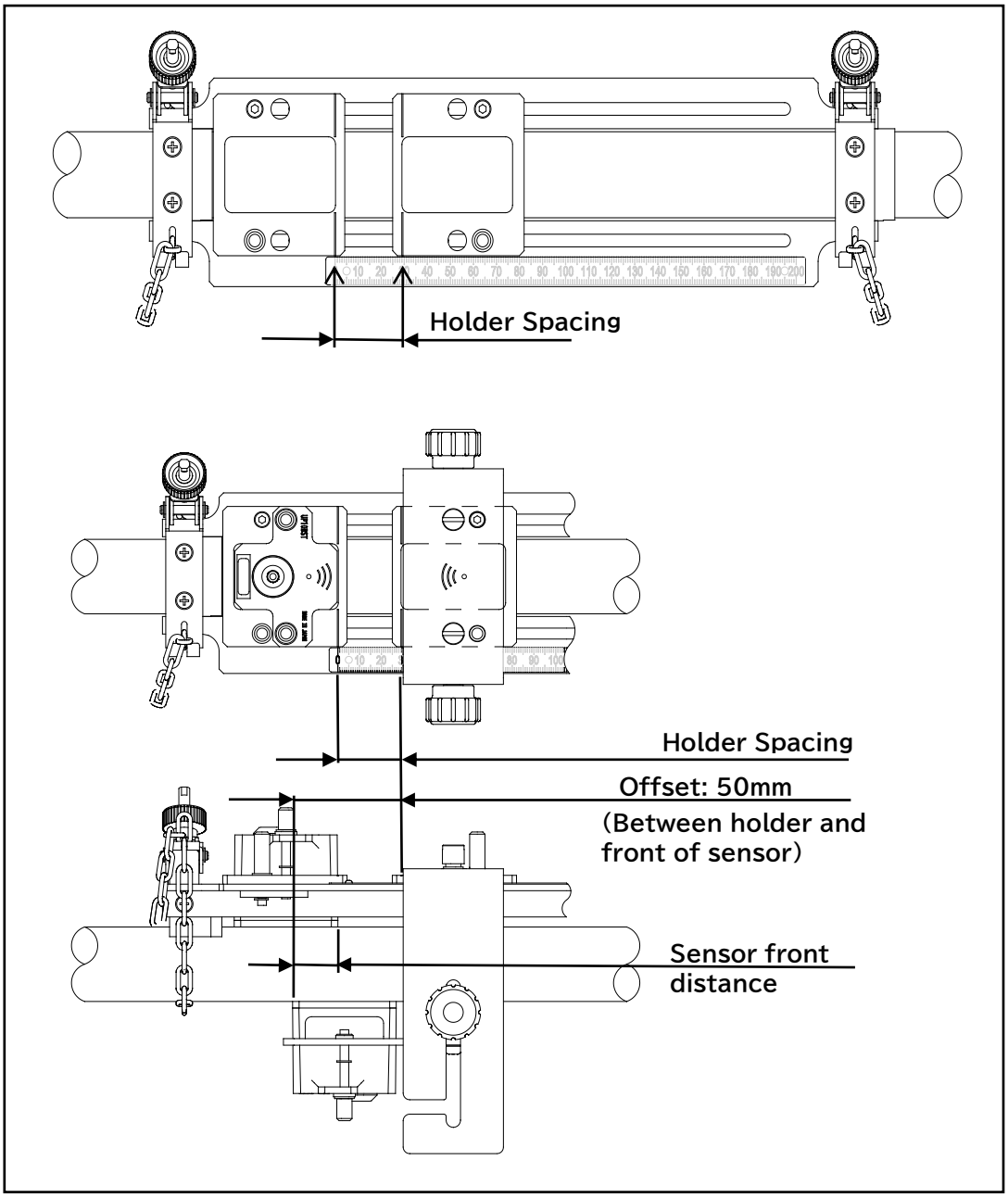


1. The medium sensor mounting fixture and the medium sensor connection extension mounting fixture are connected without any gaps and installed. In this installation, the sensor is attached using two points of the sensor holder (a). The sensor holder (b) is not used.
2. Set the marking line on the sensor holder to the ”Holder spacing” confirmed on the screen. Tighten the knob screw to fix the sensor holder in place.

4.4.4 Medium sensor Z method mounting fixture (20 to 50A)

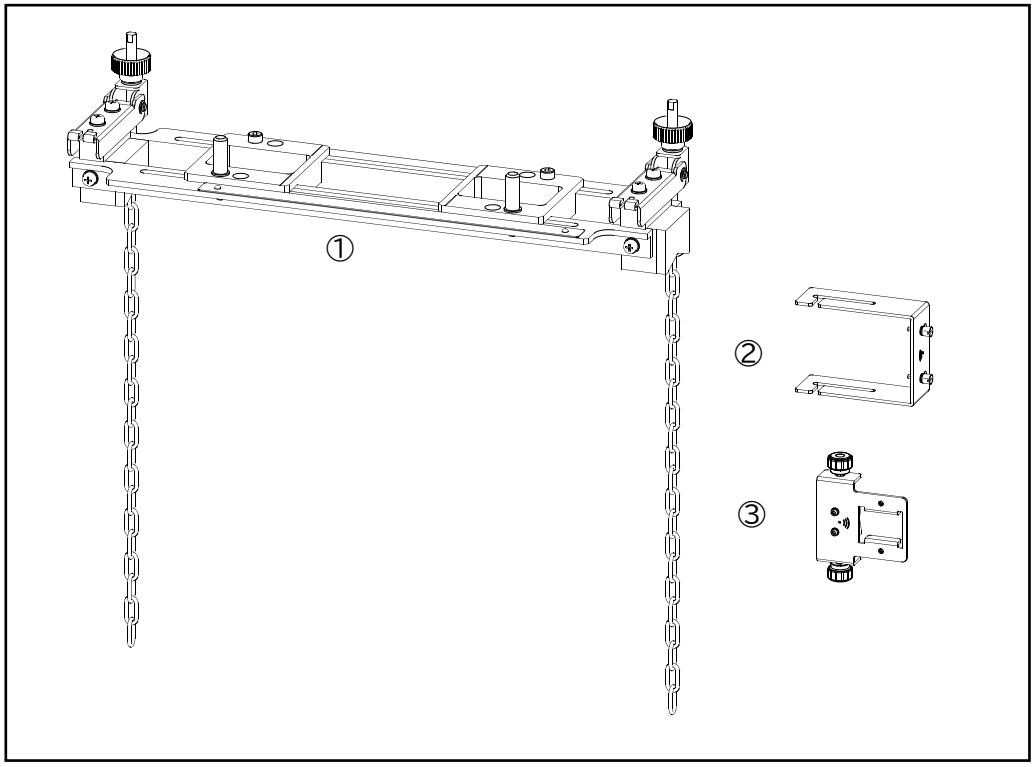
This section explains how to install the Z method mounting fixture for use with medium sensors on pipes with diameters of 20 to 50A.

When using this fixture, the sensor can be easily attached by setting the ”holder spacing” in the same way as when mounting using the V method. When mounting the sensor using the ”guide/base” of the Z method fixture, the distance between the holder’s marking line (b) and the front of the sensor is offset by 50 mm, but this can be avoided when mounting the sensor.



4.4.4.1 Composition

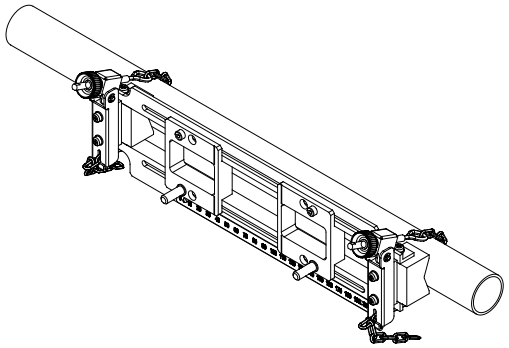
The configuration is shown below.



① Medium sensor mounting fixture
② Z- method mounting bracket_guide
③ Z -method mounting bracket - base

4.4.4.2 Installation procedure

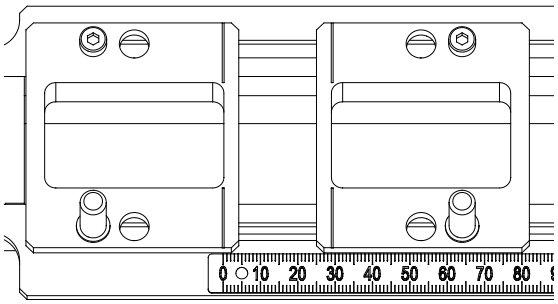
1

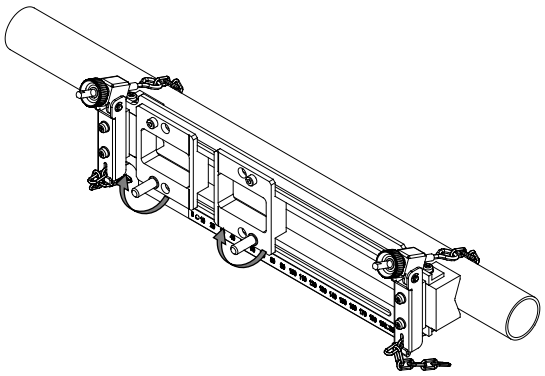


2

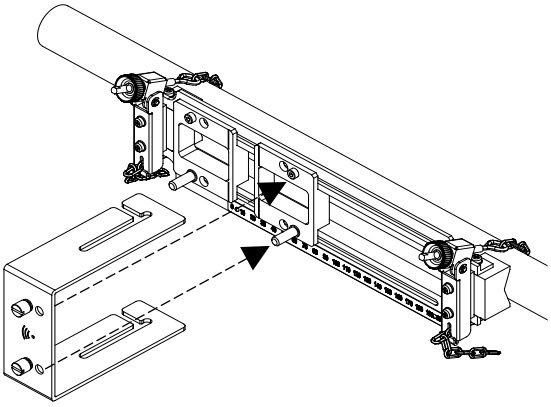
Holder Spacing check

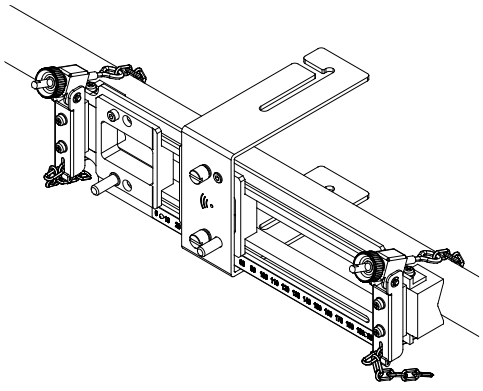
3



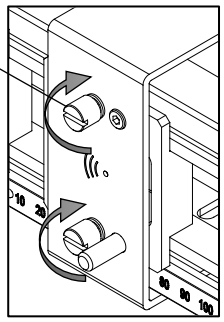


4

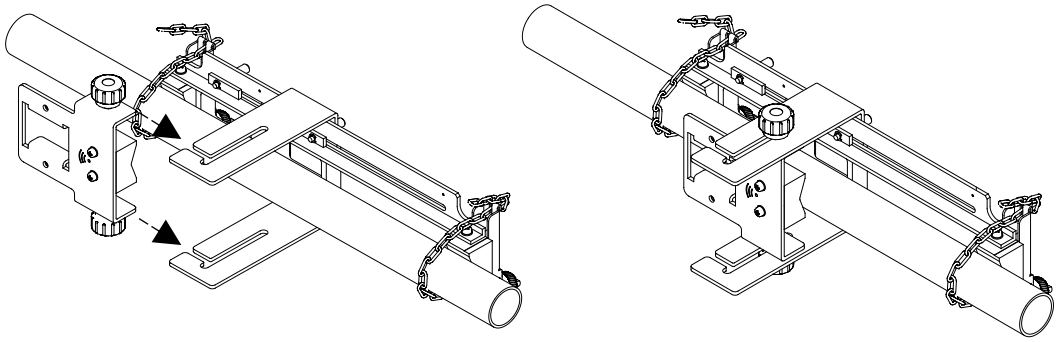




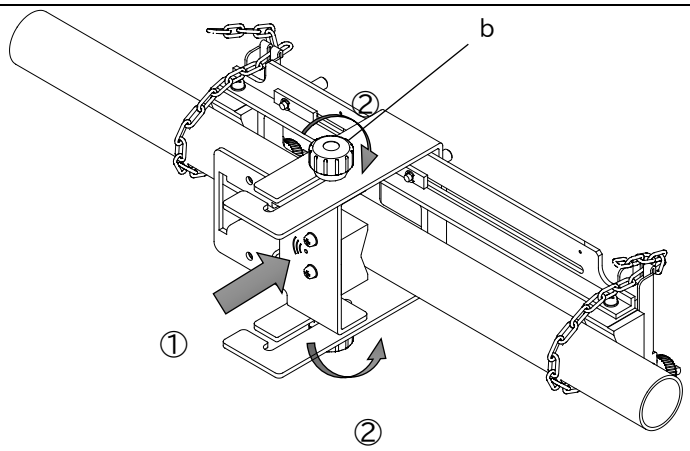
a



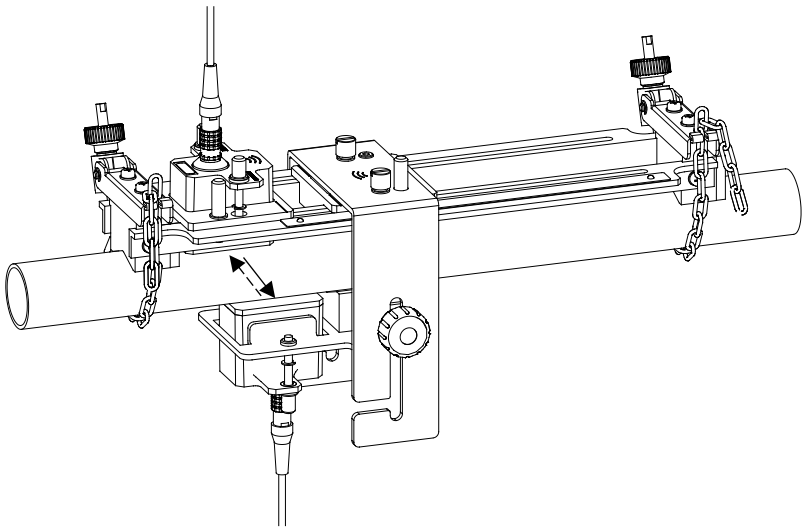
5



6



7



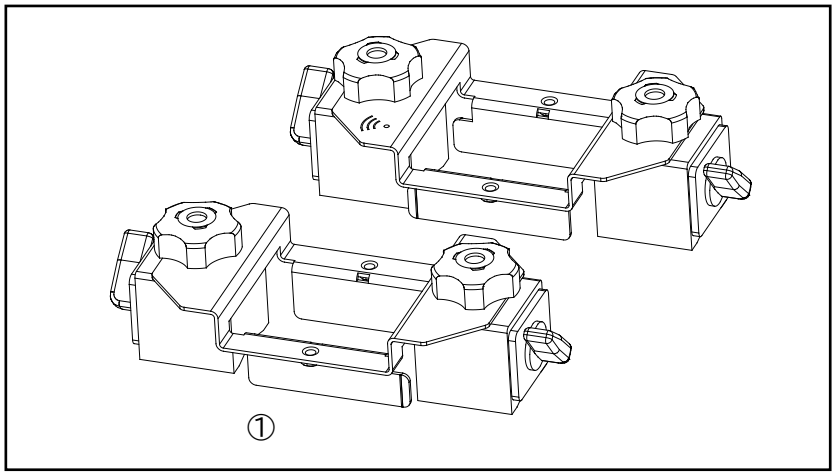
1. Attach the medium fitting to the piping.
2. Enter the piping conditions and check the ”Installation Interval”.
3. Set the sensor holder according to the ”Mounting interval”.
4. Set the Z- method mounting bracket guide on one side of the sensor holder and secure it to the sensor holder with the knob screw (a).
5. Insert the Z- method mounting bracket base into the guide groove.
6. With the base firmly pressed against the piping, turn the knob screw (b) on the base to secure the base to the guide.
7. Fix the sensor in the sensor holder while paying attention to the orientation of the sensor.

4.4.5 Large sensor magnet mounting bracket (300 to 5000A)

This section explains how to install a magnet fixture suitable for use with large sensors in steel pipes with diameters of 300 to 5000A.

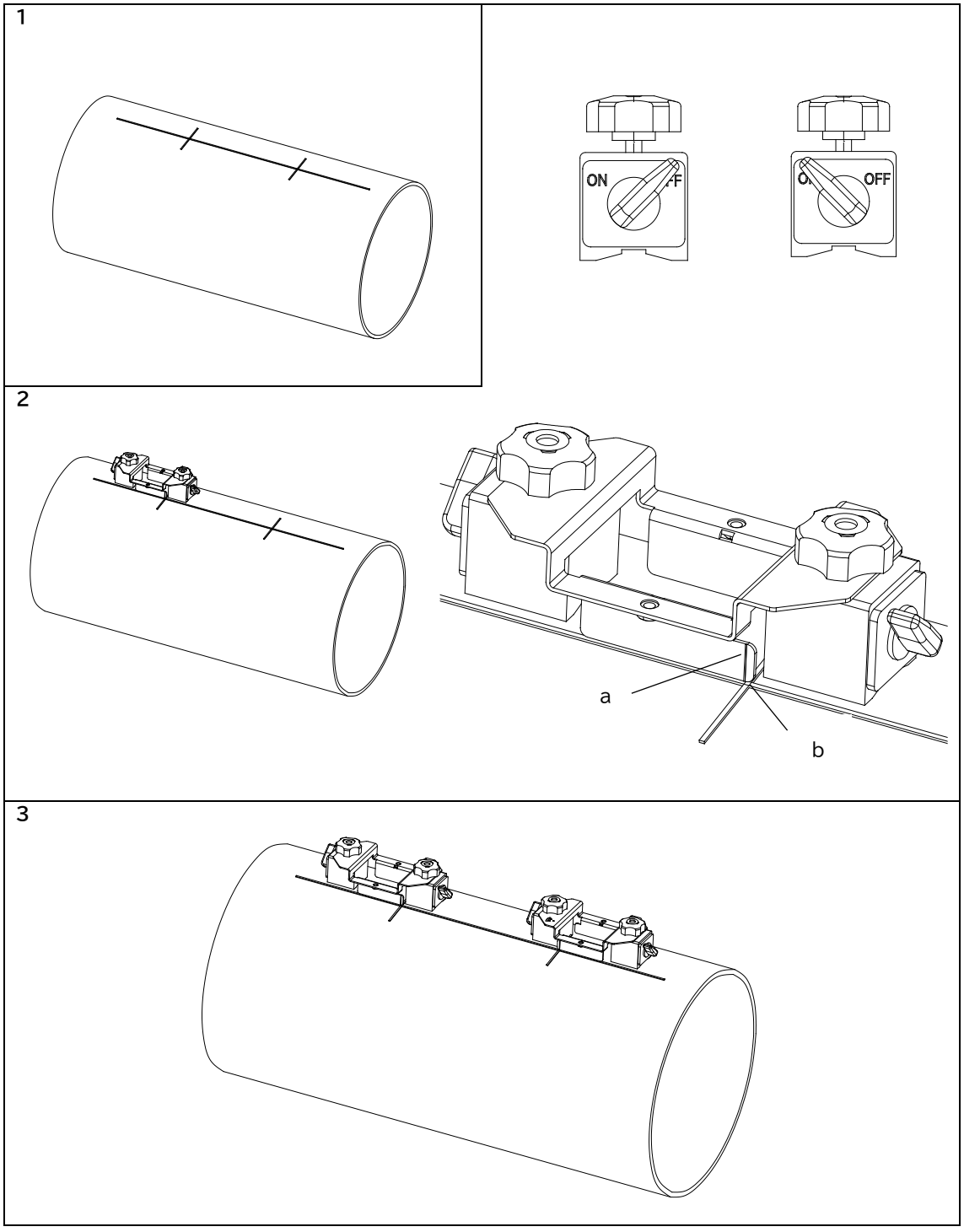
4.4.5.1 composition

The configuration is shown below.



① Large sensor magnet mounting bracket (x 2)

4.4.5.2 Installation



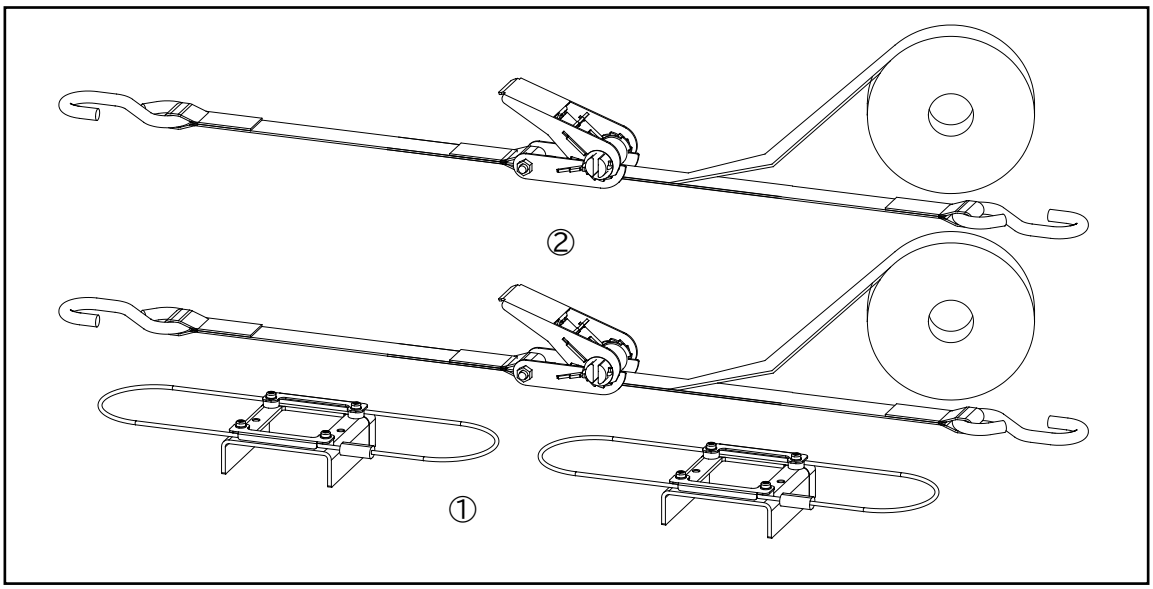
1. Mark the sensor installation interval on the pipe.
2. (a) on the side of the sensor holder and on the sensor holder plate with the marking line (b), and then secure the mounting fixture to the piping. The magnet is ON : energized, OFF : de-energized.
3. Secure the other mounting fixture in the same way.

4.4.6 Large sensor belt mounting fixture (300 to 1200A)

Explains how to install the belt mounting fixture for large sensors used in piping where magnets cannot be used, such as stainless steel or plastic pipes with a piping diameter of 300 to 1200A.

4.4.6.1 Composition

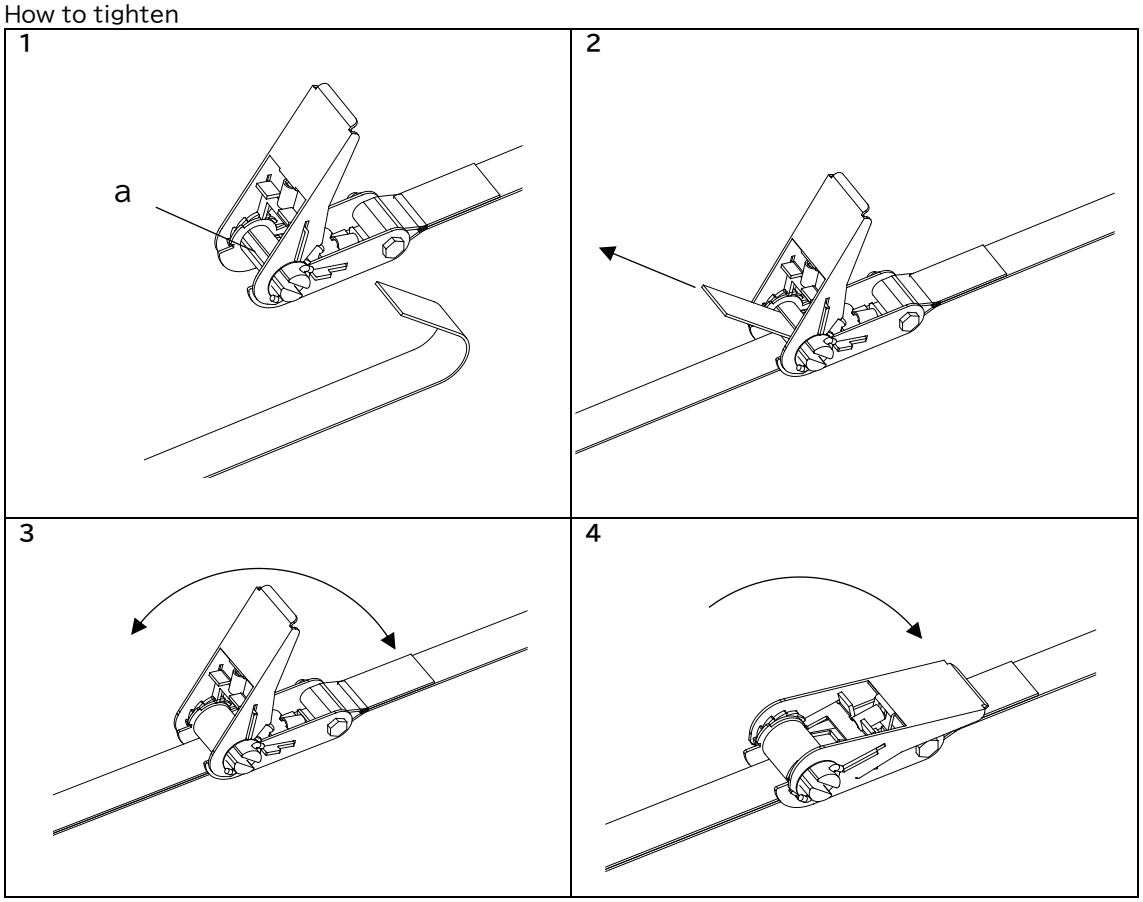
The configuration is shown below.



① Sensor holder (x2)
② Lashing belt (x2)

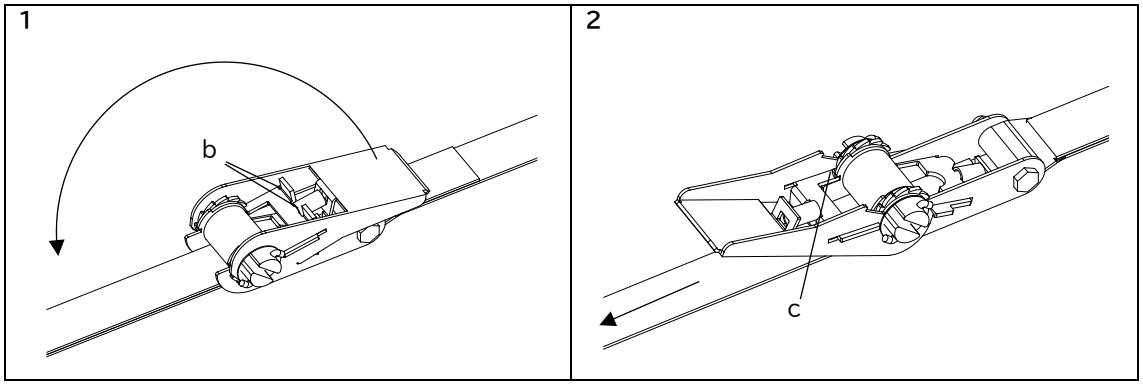
4.4.6.2 How to use the lashing belt

How to tighten



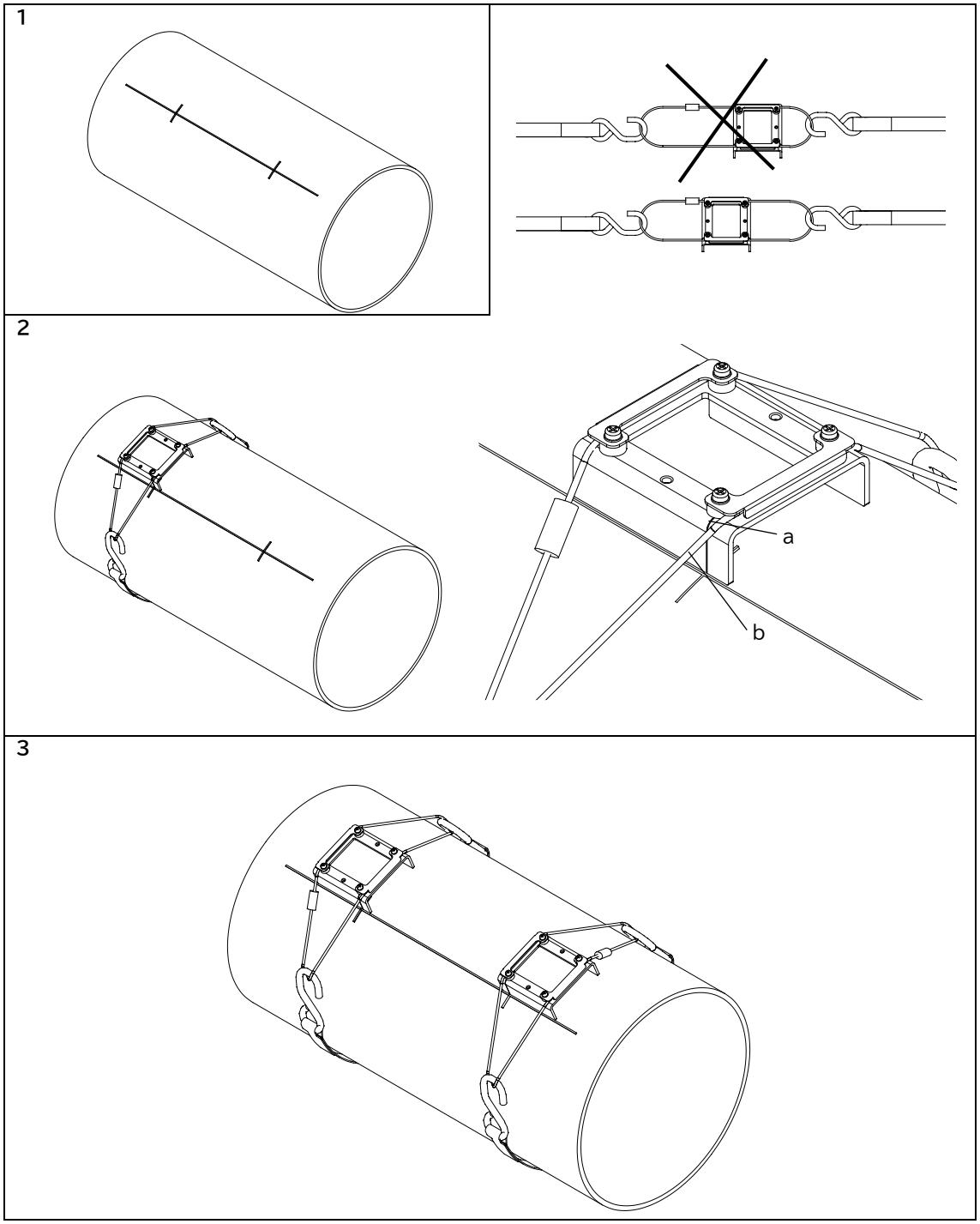
1. Pass the belt through the groove (a) on the take-up shaft.
2. Pull the belt tight so that there is no slack.
3. Operate the lever to tighten the belt.
4. Push down the lever.

How to loosen



1. While holding the release lever (b), open the operating lever 180 degrees.
2. With the operating lever hooked on the release stopper (c), pull the belt to release it.

4.4.6.3 Installation



1. Mark the sensor installation interval on the pipe.
2. Fix the sensor holder to the pipe with a lashing belt. Set the side of the sensor holder and the red line (a) on the sensor holder to the marking line (b), and fix the mounting fixture to the pipe. Set it so that the stainless steel wire is evenly wrapped around the sensor holder.
3. Secure the other mounting fixture in the same way.

4.5 Couplant application

A couplant is required between the sensor and the pipe to transmit ultrasonic waves from the sensor to the pipe. Two types of couplants are available: grease type and sheet type (dry couplant).

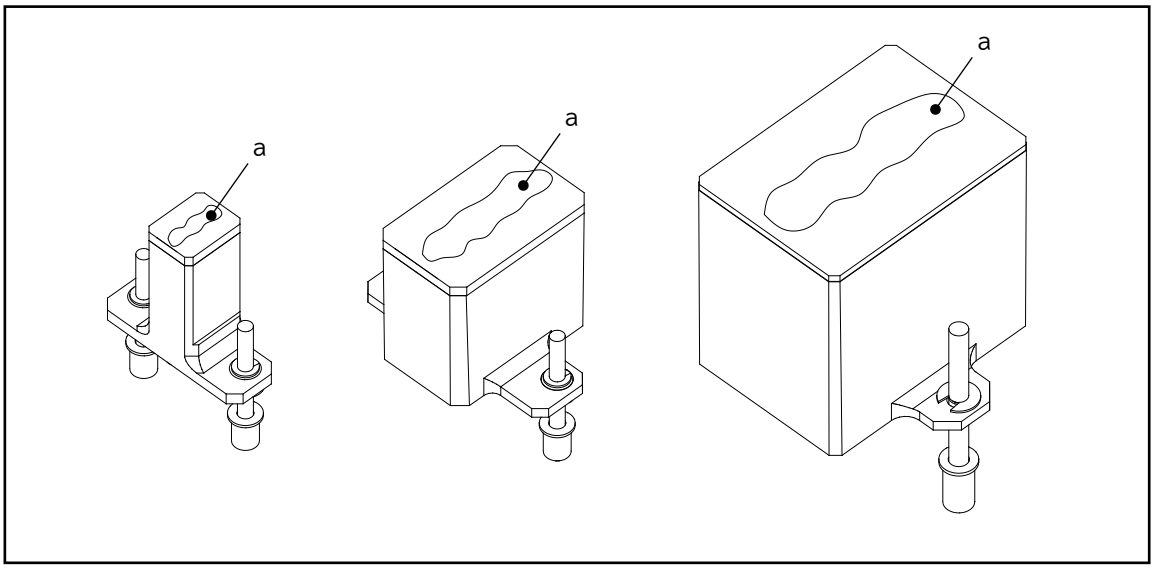
If the couplant is greased, ultrasonic waves will be transmitted efficiently through the pipe. We recommend using grease in situations where a decrease in sensitivity is expected (old pipes, liquids with high attenuation).

Dry couplants transmit ultrasonic waves through pipes without the need for grease, making sensor installation easy.

Please understand the characteristics of each and use them correctly.

4.5.1.1 Grease

Apply grease to the sensor's contact surface (a) with the pipe. Applying grease will allow ultrasonic waves to propagate more efficiently into the pipe.



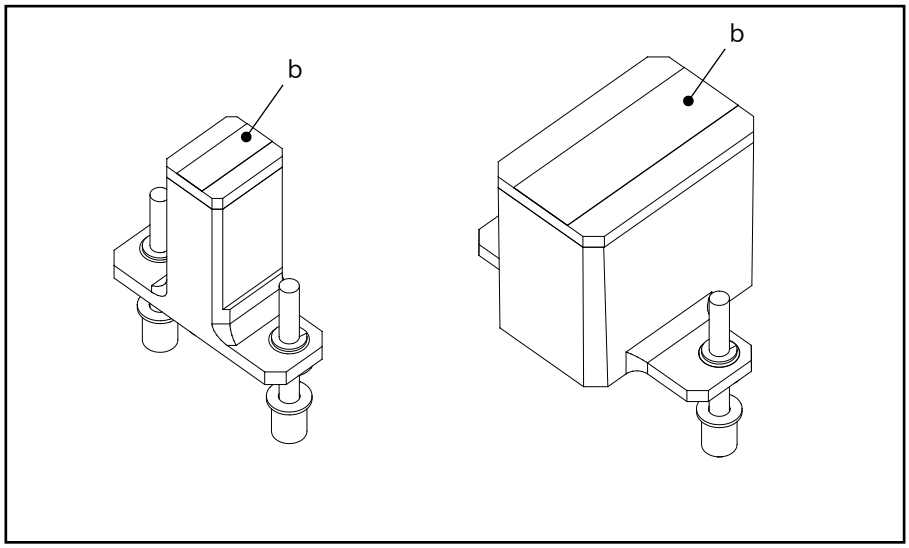
4.5.1.2 Dry couplant sheet

A dry couplant is attached to the contact surface of the sensor with the pipe. Ultrasonic waves are transmitted to the pipe without the need for grease. The sensor can be easily installed because there is no need to apply grease.

Dry couplant sheets are constructed with a weak adhesive layer on one side and a strong adhesive layer on the other.

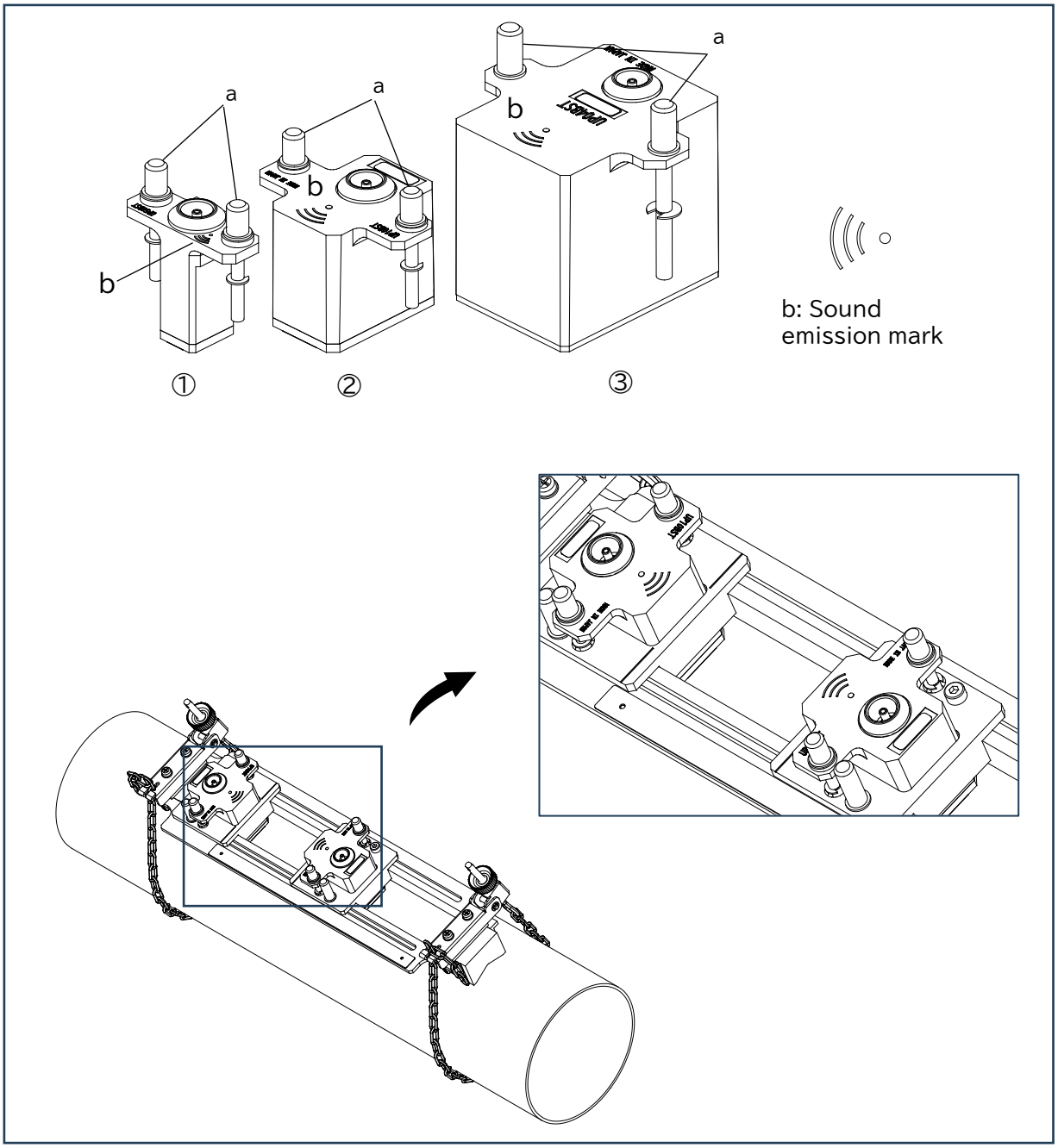
The strong adhesive layer should be on the sensor side and the weak adhesive layer on the pipe side. The procedure is as follows:

Peel off the protective film (brown) from the strong adhesive layer and attach it to the center of the sensor shown in the figure. Next, peel off the protective film (transparent) from the weak adhesive layer before use. If the adhesive layer on the pipe side becomes dirty, you can wash it with water and use it several times.



4.6 Sensor fixation

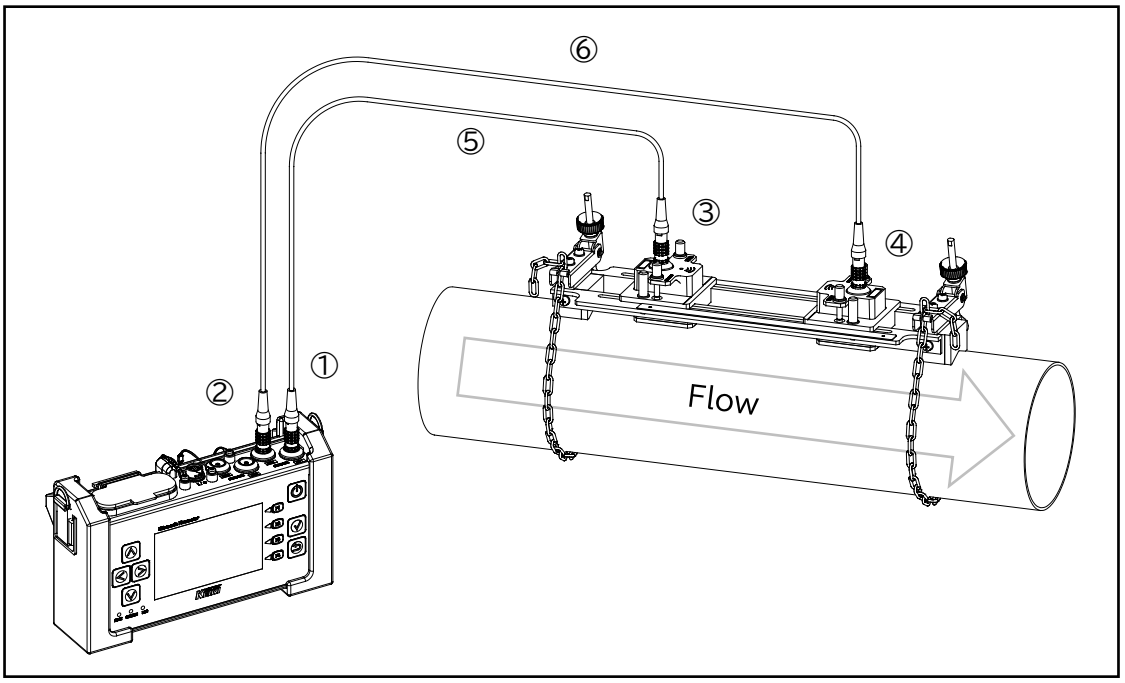
Is fixed to the mounting fixture with the thumbscrew (a). Set the sensor so that the acoustic emission mark (b) on the top of the sensor faces the sensor.



① Small sensor
② Medium sensor
③ Large sensor

4.7 Sensor cable connection

Connect the sensor and converter with the included sensor cable. The sensors are identified as upstream and downstream when they are installed. Connect the upstream sensor to the UP connector on the converter. Connect the downstream sensor to the DN connector on the converter. The connectors on the sensor cable and converter are color-coded, green for the upstream side and red for the downstream side.



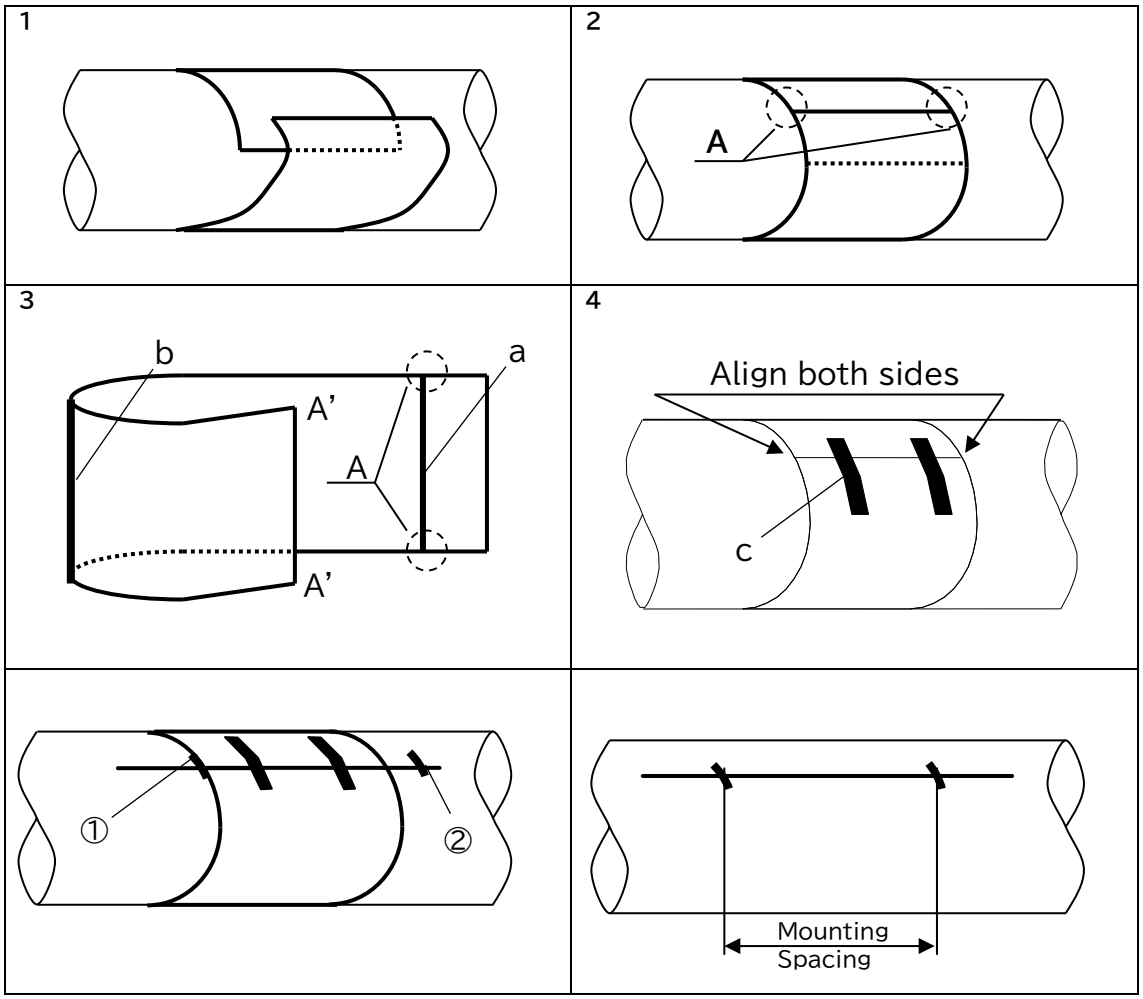
Connection destination: ⓓ , ⓔ (ⓕ , ⓖ for two lines) ☞ "5.1.1 Connector arrangement"

④ Connector: Sensor 1_UP (green)
⑤ Connector: Sensor 1_Down (red)
⑥ Sensor (upstream)
⑦ Sensor (downstream)
⑧ Sensor cable (green connector)
⑨ Sensor cable (red connector)

4.8 How to mark mounting intervals

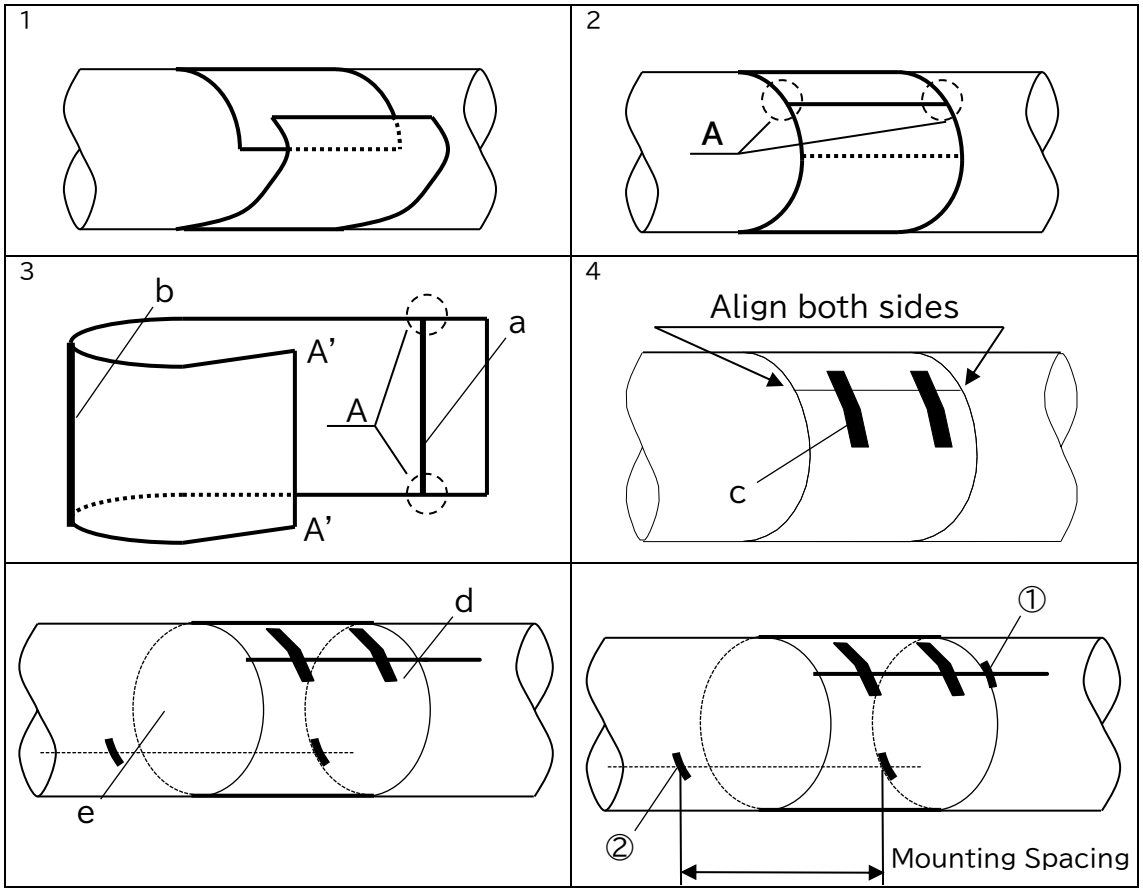
This section explains how to mark the sensor installation interval on pipes using a gauge sheet, which is mainly used when installing large sensors.

4.8.1 V method using a gauge sheet



1. Wrap the gauge sheet around the pipe, making sure it fits snugly.
2. Put a mark on the overlapping part (A) of the gauge sheet. The distance between these marks will be the circumference of the pipe.
3. And mark 1/2 of the pipe's circumference. Draw a line (a) at AA, and then draw a line (b) on the crease created by overlapping AA and A'-A'.
4. Wrap the gauge sheet around the pipe, making sure both sides are even, then secure it in place with adhesive tape (c).
5. Extend the overlapping parts of the gauge sheet outward from ① and ② and mark a line in the axial direction of the pipe. Next, mark the sensor installation interval lines. After marking, remove the gauge sheet.

4.8.2 Z method using a gauge sheet



1. Wrap the gauge sheet around the pipe, making sure it fits snugly.
2. Put a mark on the overlapping part (A) of the gauge sheet. The distance between these marks will be the circumference of the pipe.
3. And mark 1/2 of the pipe's circumference. Draw a line (a) at AA, and then draw a line (b) on the crease created by overlapping AA and A'-A'.
4. Wrap the gauge sheet around the pipe, making sure both sides are even, then secure it in place with adhesive tape (c).
5. Extend the fold lines on the gauge sheet from ① to the outside, and from ② on the other side, and mark a line in the axial direction of the pipe. Next, mark the sensor installation interval lines. After marking, remove the gauge sheet.

Chapter5 Wiring / connections

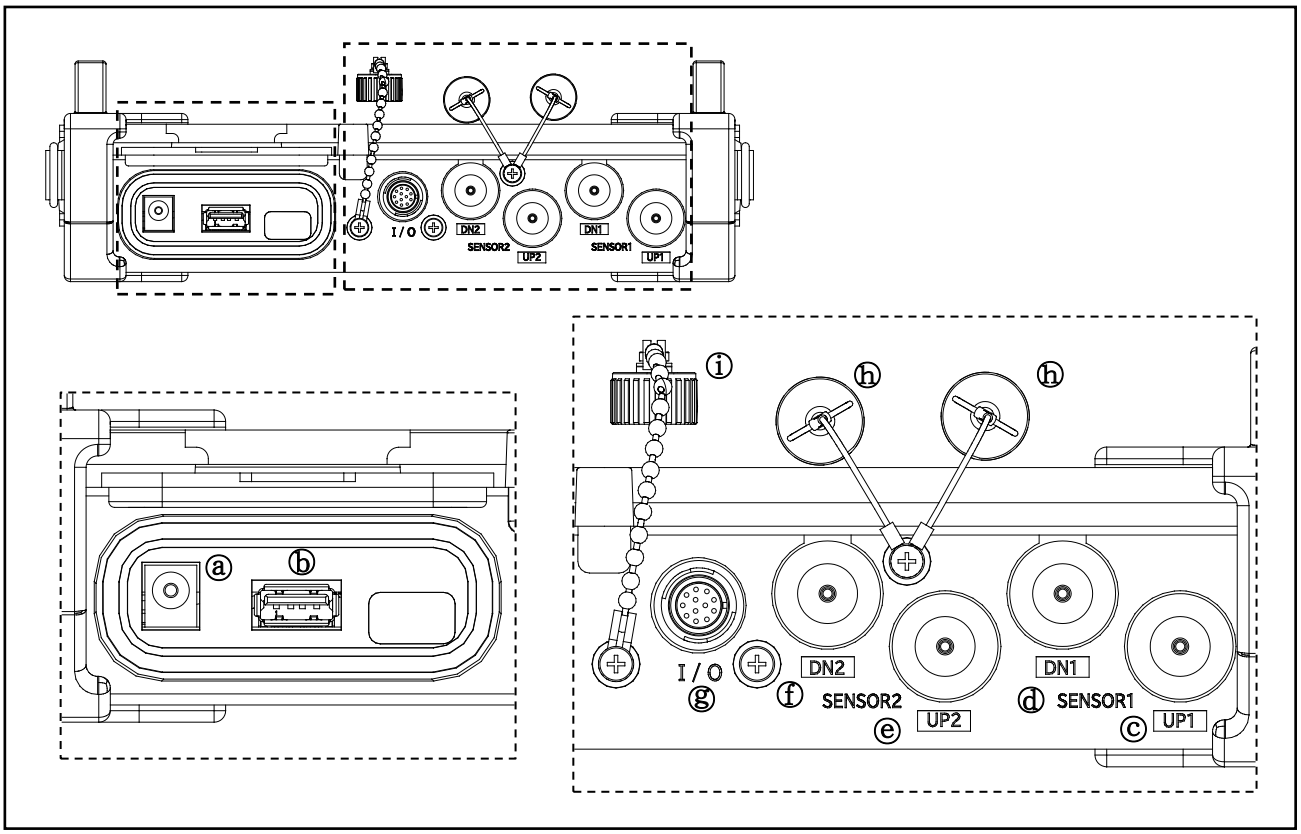
5.1 Wiring

When selecting the installation location for the flowmeter, take the following conditions into consideration:

a. Ambient temperature -10 ˚C to + 50 ˚C, with few heat sources nearby and no direct sunlight.
b. A location free of corrosive atmosphere.
c. A location that is free from inductive interference from power equipment and its wiring.
d. IP65 cannot be maintained under the following conditions:
- ·When an AC adapter or USB memory is connected
- ·When the C H1 sensor cable is not connected
- ·When the cap of an unused connector is removed

5.1.1 Connector layout

The connector arrangement on the top of the converter is shown below.

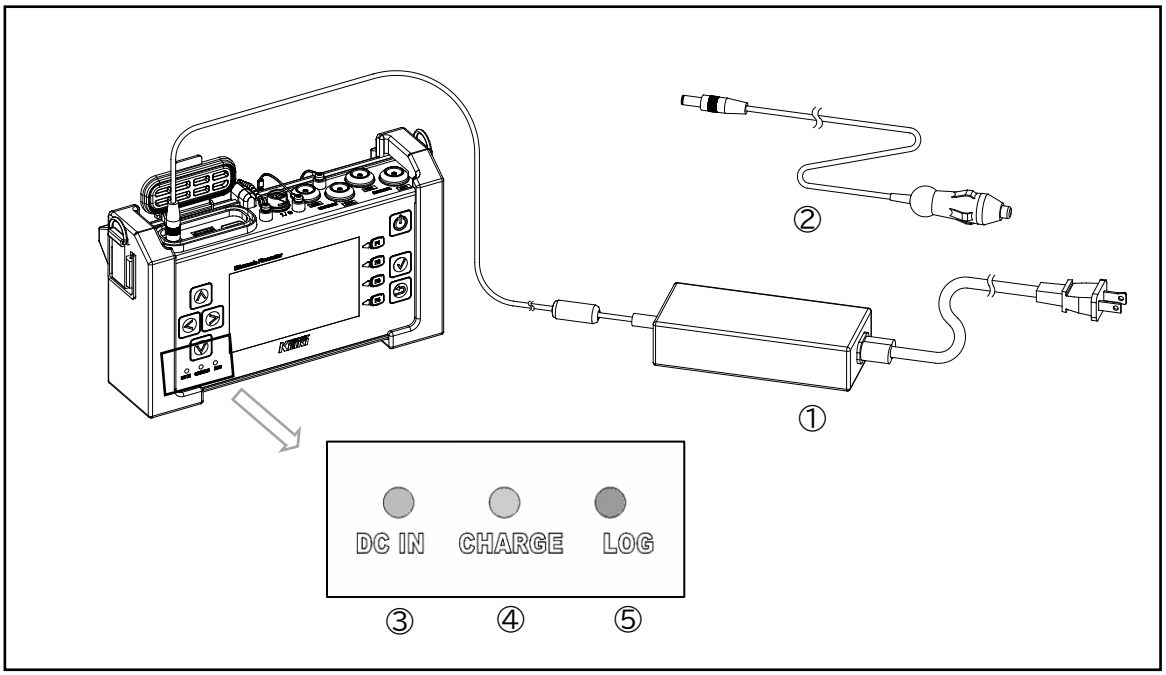


ⓐ DC connector (AC adapter)
ⓑ USB-A
ⓒ Sensor 1_UP1
ⓓ Sensor 1_Down1
ⓔ Sensor 2_UP2
ⓕ Sensor 2_Down2
ⓖ I/O connectors
ⓗ Connector protection cap (for sensor 2)
ⓘ Connector protection cap (for I/O)

5.1.2 Power supply

Use the included AC adapter. You can also power it from a car's cigarette lighter socket by using the optional cigarette lighter cable.

The "DC IN" LED will light up. While the battery is charging, the "CHARGE" LED will light up. If you will not be using the converter for more than a month, remove the battery from the flowmeter and store it in a cool place.



Connection destination : ⓐ ☞ "5.1.1 Connector layout"

① AC adapter
② Cigarette lighter cable (optional)
③ DC IN (green) : Lights up when AC adapter is connected
④ CHARGE (orange) : Lit when charging
Periodically blinking when there is a charging failure ☞ "Battery warnings"
When charging at high temperature, flashes irregularly
⑤ LOG (red) : Lights up during logging

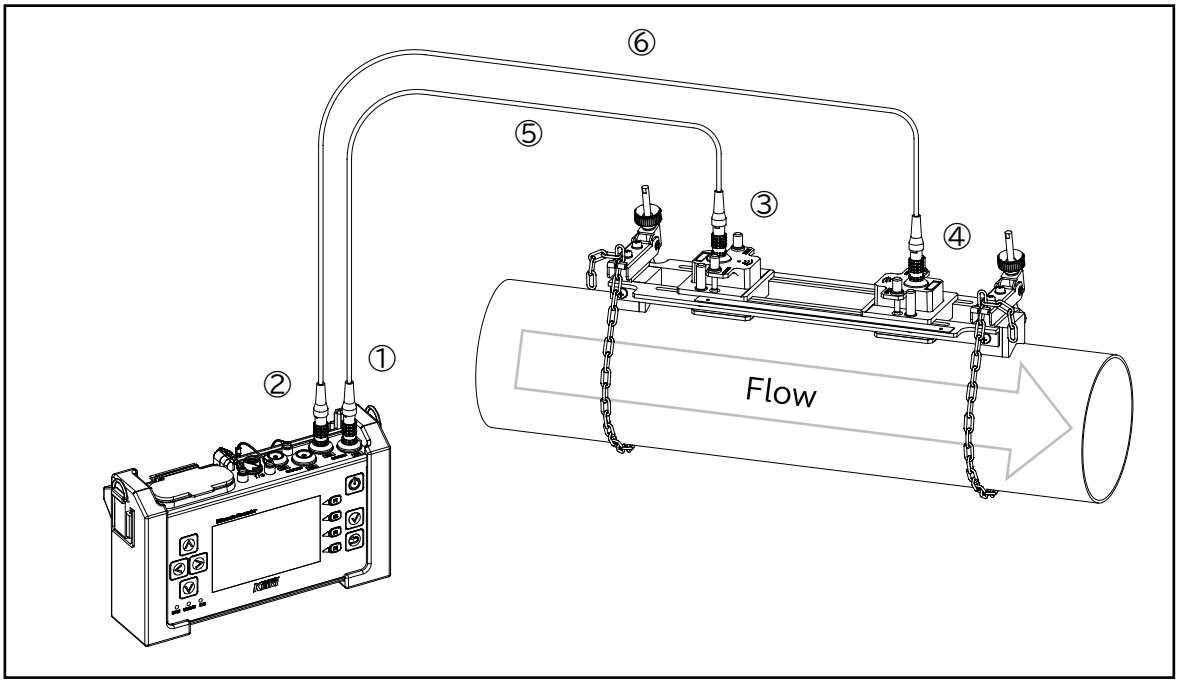
Note
The battery charging operating temperature range is 0 ˚C to 45 ˚C. Charge within this range. Otherwise, it may cause a breakdown.

5.1.3 Sensor (flow meter)

The sensor and converter are connected using the included sensor cable. When installing the sensor, it is necessary to identify upstream/downstream.

The upstream sensor to the UP connector of the converter, and connect the downstream sensor to the DN connector of the converter. Note that the connectors of the sensor cable and converter are color-coded: green for the upstream side and red for the downstream side.

The sensor cable can be extended by connecting an optional extension sensor cable (7m/50m). The sensor cable can be extended up to 160m. However, the extension sensor cable is only for extending the sensor cable length. The sensor and converter cannot be connected using only the extension sensor cable.

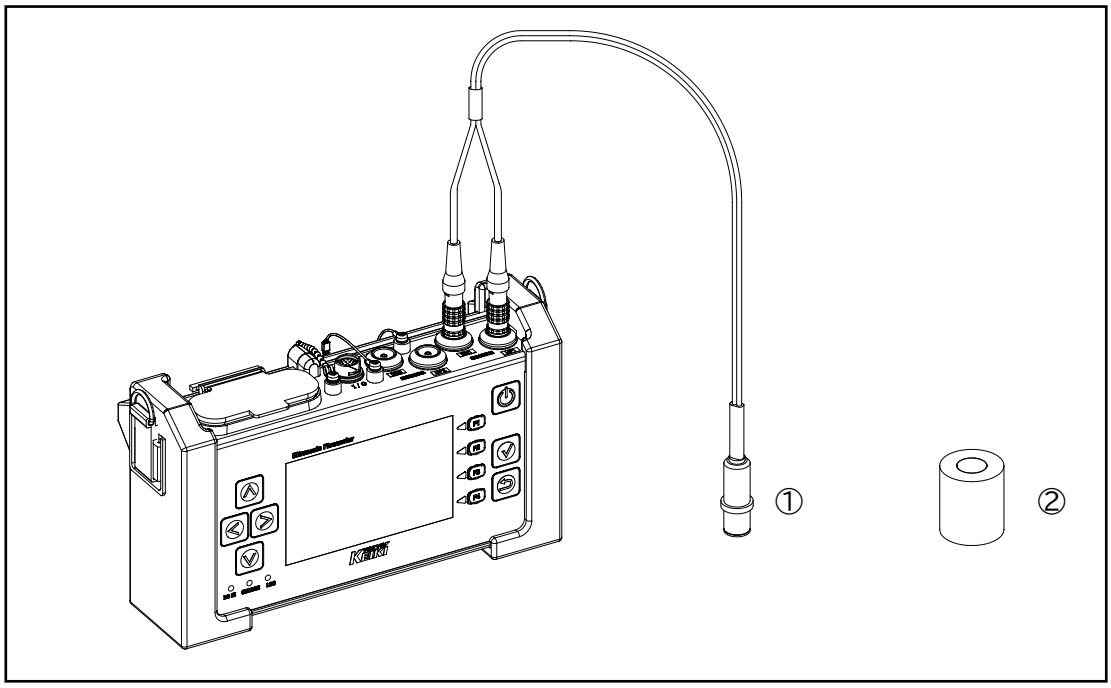


Connection destination : ⓒ, ⓓ (ⓔ , ⓕ for two lines) ☞ "5.1.1 Connector arrangement"

① Connector: Sensor 1_UP (green)
② Connector: Sensor 1_Down (red)
③ Sensor (upstream)
④ Sensor (downstream)
⑤ Sensor cable (green connector)
⑥ Sensor cable (red connector)

5.1.4 Thickness meter sensor

The thickness meter sensor to the UP1 and DN1 connectors of the converter. When connecting, match the color (green/red) of the cable of the thickness meter sensor with that of the converter.



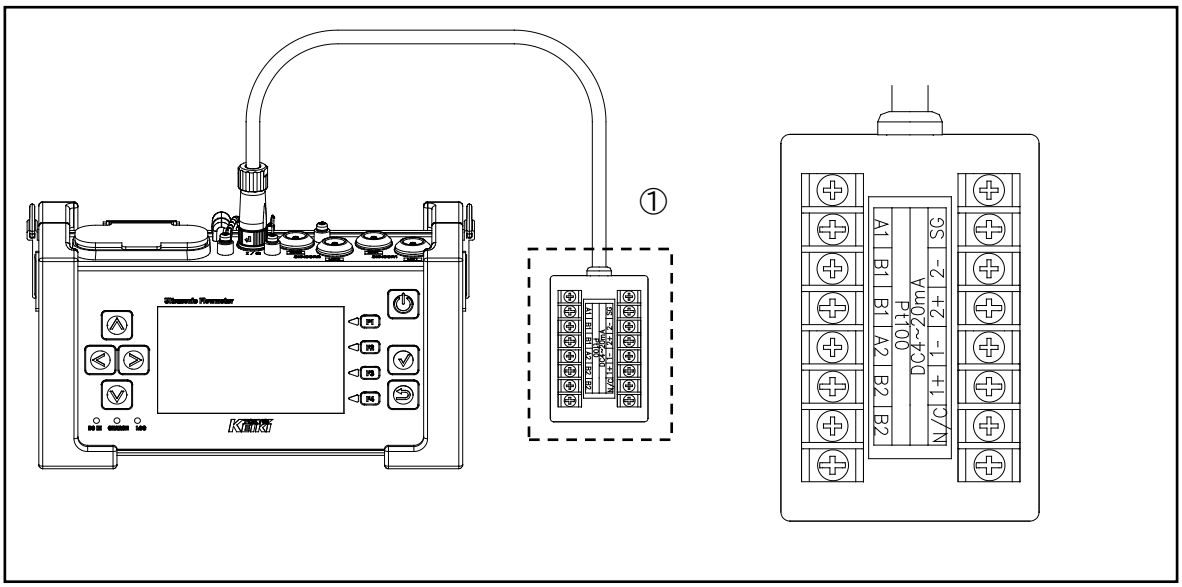
Connection destination : ⓒ, ⓓ ☞ "5.1.1 Connector layout"

① Thickness meter sensor

② Calibration test piece

5.1.5 Analog output / resistance thermometer (Pt100)

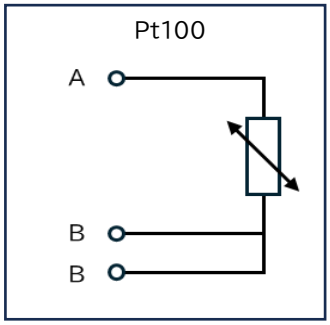
By connecting the I/O junction box to the converter, it is possible to connect analog output (2 outputs) and resistance thermometer (2 inputs). Temperature measurement is possible by using a resistance thermometer. In addition, when using it as a Heatmeter, set the sending temperature to CH1 of the temperature input and the return temperature to CH2 .



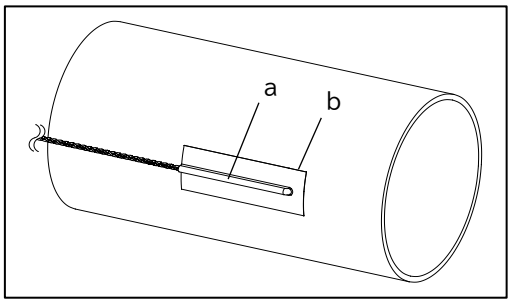
Connect to : ⓖ ☞ "5.1.1 Connector layout"

① I/O junction box

Terminal block	Symbol	Output contents
DC4 to 20mA (Analog output)	N/C	No connection
	1+	CH1 +
	1-	CH1 -
	2+	CH2 +
	2-	CH2 -
	SG	shield
Pt100 (Resistance temperature detector)	A1	CH1 A
	B1	CH1 B
	B1	CH1 B
	A2	CH2 A
	B2	CH2 B
	B2	CH2 B



When attaching the resistance thermometer, press the resistance thermometer (a) firmly against the pipe and attach it with the aluminum foil tape (b).

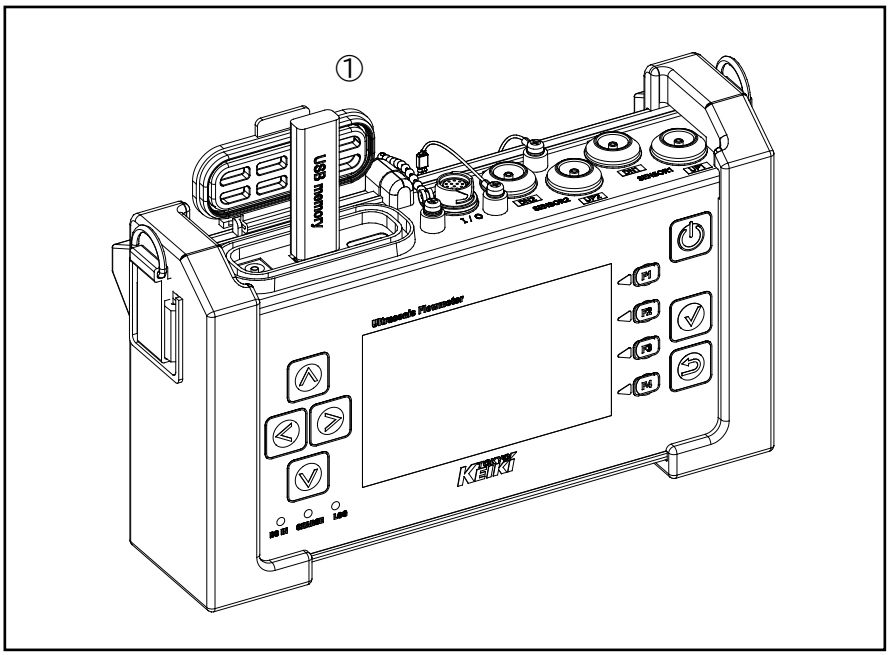


5.1.6 USB-A

USB memory to the converter, you can extract the log data stored in the converter. You can also read and write the site setting information.

The converter's USB standard is USB2.0. The file system of the USB memory supported is F AT32. Please connect the converter and USB memory one to one.

Function	Explanation
Saving log files	You can directly save the log file when connecting.
Transferring log files	You can copy files from the device's internal memory.
Save screen capture	You can save the captured screen as image data.
Saving a report	You can save the report.
Firmware Update	Firmware updates can be performed by storing the firmware on a USB memory stick.



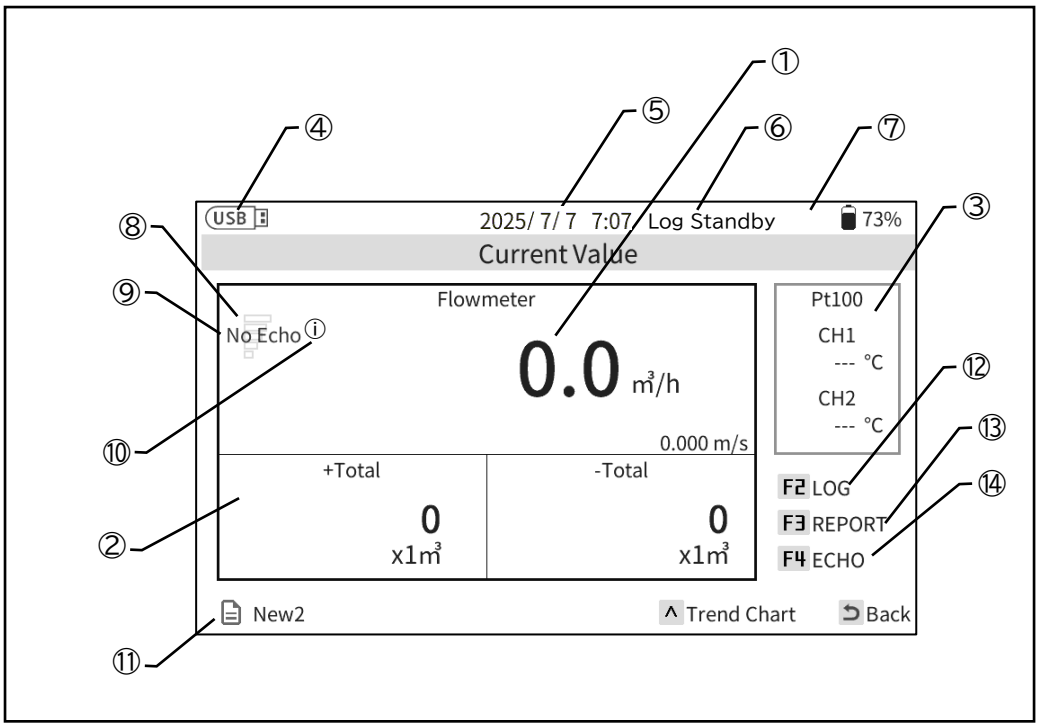
Connect to : ⓑ ☞ "5.1.1 Connector layout"

① USB memory

Chapter6 Measurement - flow meter

6.1 Measurement screen (current value)

The contents displayed on the measurement screen are as follows:



Number	Name	Explanation
①	Instantaneous value display area	Displays the instantaneous flow rate (or heat quantity). Below the instantaneous flow rate, the flow velocity is displayed.
②	Accumulated value display area	The total value in the forward flow direction is displayed on the left side, and the total value in the reverse flow direction is displayed on the right side. Totalization starts and ends in sync with the log. When the log starts, the previous total value is reset.
③	Temperature display area	Displays the temperature of the resistance thermometer (Pt100) connected to the I/O junction box.
④	USB port	A USB memory is recognized.
⑤	clock	Displays the time. For details on setting the time, see ”8.1.1 Date and time”.
⑥	Log display	Displays the log status. If logging is reserved, ”Log Standby” is displayed. If logging is in progress, ”Logging” is displayed.
⑦	Battery status	Displays the battery status.
⑧	Signal strength	The signal strength at the time of measurement is displayed in six levels.
⑨	Alarm	When there is no signal, No Echo is displayed.
⑩	Measurement obstacle detection	When the measurement obstruction detection function is activated, ⓘis displayed. It removes temporary disturbances in the measurement value caused by air bubbles, solid objects, external noise, etc. in the fluid, and suppresses sudden fluctuations in the flow rate value. If this function is activated during logging, an error code is output.
⑪	File name	Displays the name of the current configuration file.

⑫	Log function key	The function key [F2] to go to the ”Log Menu”.
⑬	Report function key	Use the function key [F3] to create a report on the USB memory. The report will output a trend graph of the last 10 minutes and the current settings in PDF format.
⑭	Waveform display function key	The function key [F4] to go to the ”Waveform display screen.”

6.2 Screen transitions

This section explains the screen transitions.

On the measurement screen, you can switch between the measurement screen and the trend graph screen using the up and down keys (△▽).

If the measurement line setting is ”2 measurement lines” or ”2 measurement points”, you can switch the channel display with the right key (▷).

On the measurement screen, functions are assigned to the function keys [F2][F3][F4].

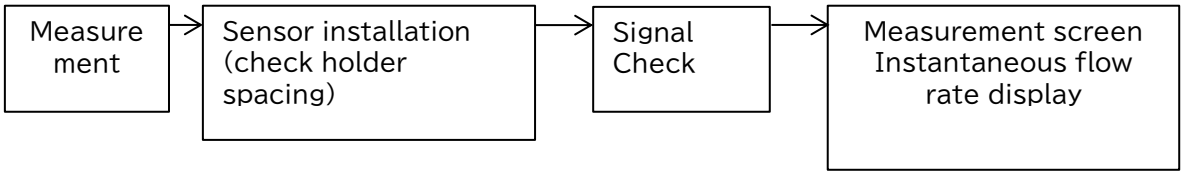
The function key [F2] to switch to the ”Log Menu”. In the ”Log Menu”, you can configure the log settings. For details on the log function, see ”8.23 Log function”.

Press the function key [F3] to ”Output report”. The report will be output in PDF format to a USB memory stick. For details on the report function, see ”8.16 Report function”.

The function key [F4] to switch to the ”Waveform Display Screen.” Here you can check the received waveform. For information on the waveform display function, see ”8.17 Waveform display”.

6.3 Start of measurement

The flow up to the start of measurement is shown below.



Name	Explanation
Sensor installation (Check the holder spacing)	Displays the sensor holder spacing of the fixture. Set the mounting holder to the holder spacing shown. [Guide] on the screen, installation procedures for the fixtures and sensors will be displayed.
Signal Check	Displays the ultrasonic signal strength in 6 bar levels. 5 : High 4 to 3 : Medium 2 to 1 : Low 0 : No reception (displays No Echo)
Measurement screen	The measurement value is displayed.

6.4 Flowmeter

Measures the flow rate of liquid flowing through pipes.

6.4.1 Display of measurement values

The measurement value consists of a number and a measurement unit. The measurement unit can be selected from the units used by the flow meter, massmeter, or heat meter. The mass / heat amount is calculated from the measured flow rate using various coefficients (density, specific heat capacity, etc.).

(1) Measurement values

Measurement values can be displayed in up to 6 digits (excluding the decimal point and sign). The maximum displayable measurement value is 999999. If the measurement value exceeds the maximum display value, "OVER" is displayed. The position of the decimal point can also be set arbitrarily. An example of the display of the decimal point position is shown below.

Display format	Initial value
****** / *****.* / ****.** / ***.*** / **.**** / *.*****	*****.*

(2) Units of measurement

Indicates the measurement units that can be set on this device.

Flowmeter		
Metric	Imperial	
m^3/s	ft^3/s	gal/s
L/s	ft^3/min	gal/min
m^3/min	ft^3/h	gal/h
L/min	ft^3/D	gal/D
m^3/h	Mft^3/D	Mgal/D
L/h	bbl/s	acf/s
m^3/D	bbl/min	acf/min
L/D	bbl/h	acf/h
km^3/s	bbl/D	acf/D
km^3/min	Mbbl/D	Macf/D
km^3/h		
km^3/D		
Mm^3/D		

Massmeter	
Metric	Imperial
kg/s	lb/s
kg/min	lb/min
kg/h	lb/h
kg/D	lb/D
t/s	klb/s
t/min	klb/min
t/h	klb/h
t/D	klb/D
kt/s	Mlb/s
kt/min	Mlb/min
kt/h	Mlb/h
kt/D	Mlb/D
Mt/D	Glb/D

Heatmeter	
Metric	Imperial
W	BTU/h
kW	kBTU/h
MW	MBTU/h

Here, " D " stands for 24 hours.

6.4.2 Display of integrated values

The total value consists of a numerical value and a measurement unit. The numerical value can be displayed up to 8 digits. The total unit can be selected from the units used by the flow meter / Massmeter / Heatmeter.

(1) Estimation screen

The display range is 0 to 99999999. The integrated value is an integer. If the integrated value exceeds 99999999, it will reset to 0 and start counting again.

(2) Totalization unit

Indicates the totalization units that can be set on this instrument.

Flowmeter	
Metric	Imperial
x0.01L	ft^3
x0.1L	kft^3
x1L	Mft^3
x10L	bbl
X100L	kbbl
$x1m^3$	Mbbl
$x5m^3$	gal
$x10m^3$	kgal
$x100m^3$	Mgal
	acf
	kacf
	Macf

Massmeter	
Metric	Imperial
x0.01kg	x0.01lb
x0.1kg	x0.1lb
x1kg	x1lb
x10kg	x10lb
x100kg	x100lb
x1t	x1klb
x10t	x10klb
x100t	x100klb

Heatmeter	
Metric	Imperial
J	BTU
kJ	MBTU
MJ	
GJ	

(3) Start and end of Totalization

You can start / stop integration in sync with the log. During integration, the ”Logging” icon is displayed at the top of the measurement screen, and the icon disappears when integration is stopped. When you start integration again, the previous integration value is cleared to 0.

6.4.3 1 line measurement

This is the basic flow measurement configuration. There is one measurement path.

(1) Set up the device according to ”3.4 Measurement settings”.

(2) For sensor installation, see ”4.3 Checking the sensor installation intervals”.

6.4.4 2 line measurement

This flow measurement configuration has two measurement paths to reduce the effect of disturbances in the flow velocity distribution at the measurement point.

(1) Set up the device according to ”3.4 Measurement settings”.

(2) For sensor installation, refer to ”4.3 Checking the sensor installation interval”. Install two sensors on the same circumference.

6.4.5 Simultaneous measurement of two pipes

This configuration measures flow rate at two measurement points. With this flow rate measurement, the flow rate at each measurement point is displayed simultaneously.

(1) To set up each measurement point, please set up the main unit according to ”3.4 Measurement settings”. You need to enter parameters for two points.

(2) For sensor installation, see ”4.3 Checking the sensor installation intervals”.

6.5 Massmeter

The flow rate of the liquid flowing through the pipe is measured, and the mass flow rate is calculated and displayed by multiplying it by the density of the fluid being measured.

6.5.1 1 line measurement

This is the basic mass measurement configuration. There is one measurement path.

(1) Set up the device according to ”3.4 Measurement settings”.

(2) For sensor installation, see ”4.3 Checking the sensor installation intervals”.

6.5.2 2 line measurement

This mass measurement configuration has two measurement paths to reduce the effect of disturbances in the flow velocity distribution at the measurement point.

(1) Set up the device according to ”3.4 Measurement settings”.

(2) For sensor installation, refer to ”4.3 Checking the sensor installation interval”. Install two sensors on the same circumference.

6.5.3 Simultaneous measurement of two pipes

This configuration measures flow rate at two measurement points. With this flow rate measurement, the mass at each measurement point can be displayed simultaneously.

(1) To set up each measurement point, please set up the main unit according to ”3.4 Measurement settings”.

(2) For sensor installation, see ”4.3 Checking the sensor installation intervals”.

6.6 Heatmeter

Measures the heat quantity of the liquid flowing through the pipes.

6.6.1 1 line measurement

This is the basic heat measurement configuration. There is one measurement path. The resistance thermometer is attached to the heat source and the heat load.

(1) Set up the device according to ”3.4 Measurement settings”.

(2) For sensor installation, see ”4.3 Checking the sensor installation interval”. For resistance thermometer installation, see ”5.1.5 Analog output / resistance thermometer (Pt100)”.

6.6.2 2 line Measurement

Two measurement paths to reduce the effect of disturbances in the flow velocity distribution at the measurement point. The resistance temperature detector is attached to the heat source and the heat load.

(1) Set up the device according to ”3.4 Measurement settings”.

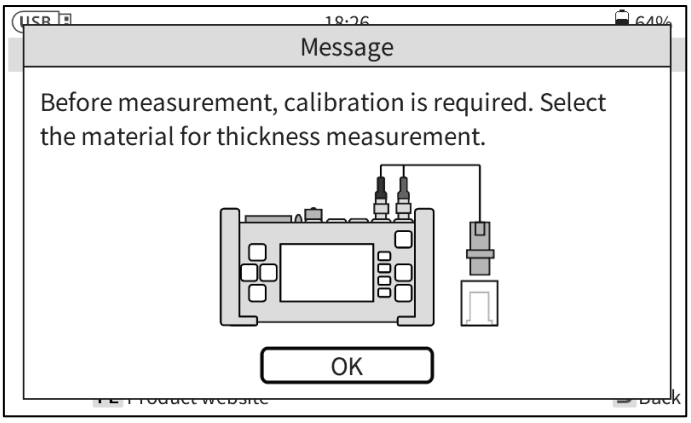
(2) For installing the sensors, see ”4.3 Checking the sensor installation interval”. Install two sensors on the same circumference. For installing the resistance thermometer, see ”5.1.5 Analog output / resistance thermometer (Pt100)”.

Chapter7 Measurement - Thickness meter

This instrument can measure the thickness of pipes. It can also measure the sound speed of liquids. Connect the thickness meter sensor to the SENSOR1 (CH1) sensor connector.

7.1 Thickness meter

Measures pipe thickness or the speed of sound in liquids.
Before measuring, a calibration confirmation screen will be displayed, so be sure to calibrate.



The thickness is calculated by multiplying the sound speed of the longitudinal wave by half the time it takes for the ultrasonic wave to propagate. The calculation formula is as follows:

(Thickness) = (Longitudinal wave speed) x (Round-trip propagation time) / 2

Note
1. The temperature of the test piece at 20 °C. If you perform calibration under other conditions, the accuracy of the thickness measurement may decrease.
2. Since the sound speed of the material being measured varies depending on the temperature, even if the material is the same, calibration is required for each thickness measurement.

7.2 Operation

Supports one-handed operation while holding the thickness meter sensor.

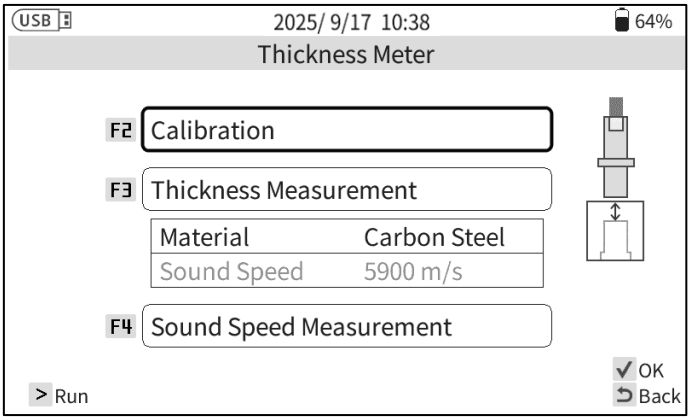
Left-handed actions: Use the left and right arrow keys to select a menu and the up arrow key to perform the selected action.

Right-hand operation: Shortcuts can be executed using function keys.

[F2] : Calibration

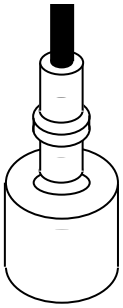
[F3] : Thickness measurement

[F4] : Sound speed measurement



7.2.1 proofreading

Place the thickness / sound speed transducer on top of the couplant coated test piece.

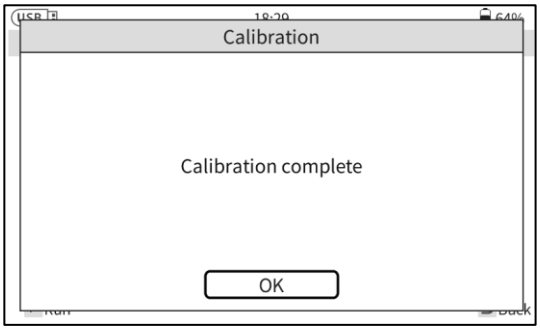


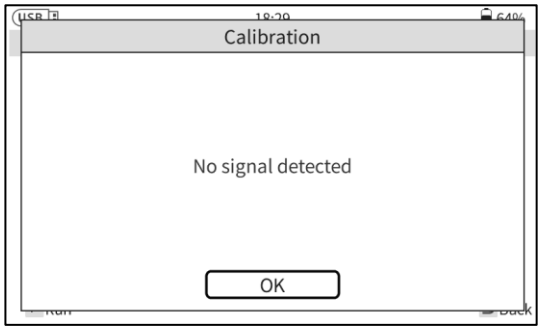
Thickness / sound speed measurement probe

Test Piece

Select calibrate on the thickness meter / sound speed screen.

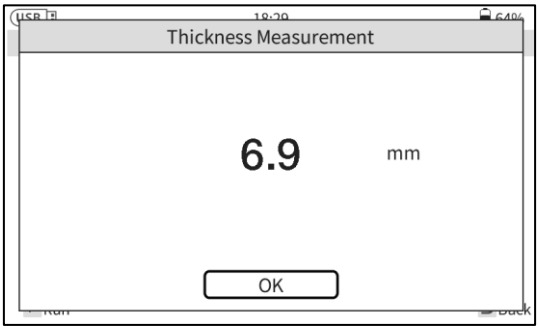
If the calibration is successful, the message ”Calibration complete” will be displayed. If the calibration fails, the message ”No signal detected” will be displayed. Please repeat the same procedure to calibrate again.





7.2.2 Thickness measurement

Before performing a thickness measurement, select the material to be measured.
If you define the material as user-defined, you can set any sound speed. The sound speed that can be entered ranges from 500 to 9000 m/s.



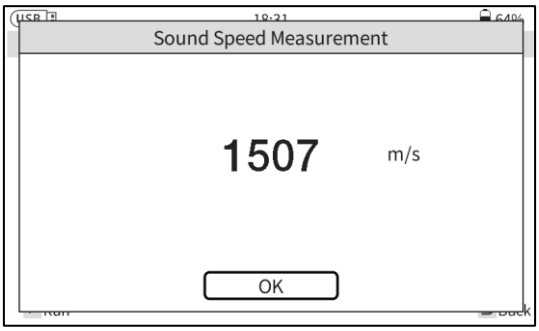
If measurement is not possible, the measurement value will be displayed as ” ---- ”.

User defined	Enter any value between 500 and 9000
Carbon steel	5900
stainless steel	5730
Ductile iron	5800
cast iron	4500
copper	5010
PVC	2280
FRP	2560
acrylic	2720

7.2.3 Sound speed measurement

To perform a sound speed measurement, prepare the fluid to be measured.
Insert the thickness meter / sound speed measurement transducer into the test piece, taking care not to trap air.

If measurement is not possible, the measurement value will be displayed as ” ---- ”.



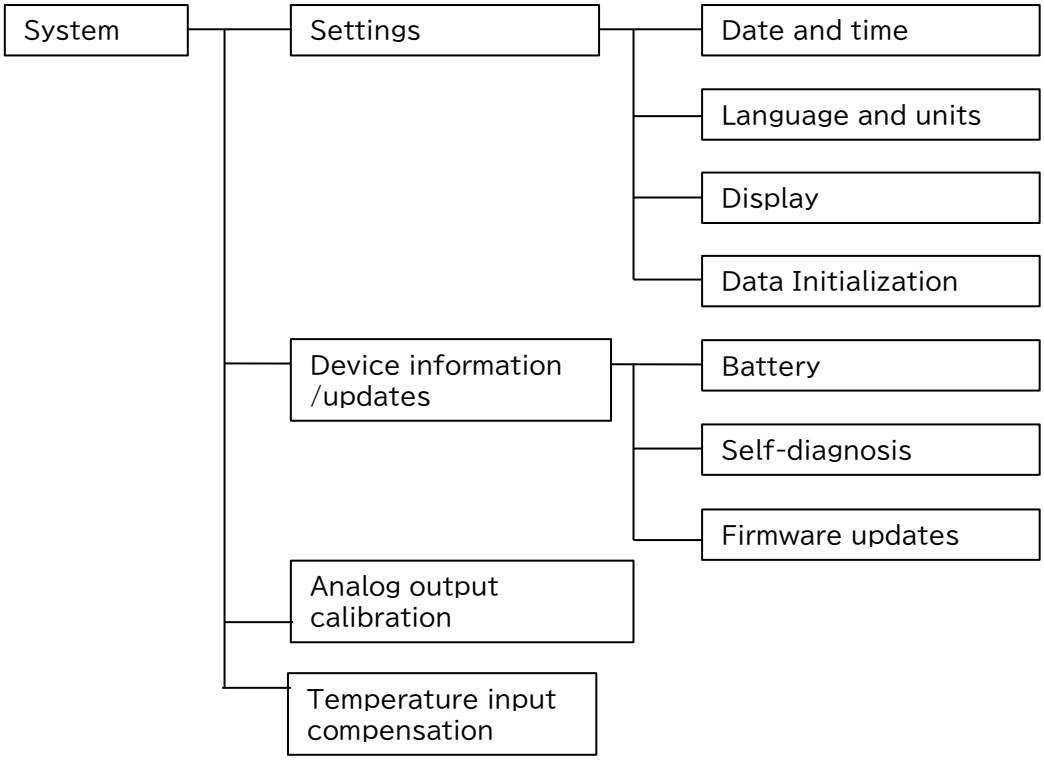
Chapter8 Function

This section describes the functions of this device.

8.1 System

You can check the firmware version and serial number in ”System”.

The ”System” tab has the following hierarchical structure:
Each tab is explained in detail in the topics.



8.1.1 Date and time

Set the date and time.

First, set the “year / month / day” order. Each letter corresponds to the following:

YY : Year
MM : month
DD : Day

The order of year / month / day can be selected from YY_MM_DD, MM_DD_YY, or DD_MM_YY, which will be reflected in the file names and time data of the ”Log Function” and ”Report Function”.

8.1.2 Languages and units

In the ”Languages / units” tab, set the following items.

Item	Item	Input range	Initial value
Languages and units	Language	English/日本語/Tiếng Việt/한국어/中文/Portugais /Türkçe	English
	Unit	Metric/Imperial	Metric

[Language]

Item	Explanation
English	The screen display will be in “English”.
日本語	The screen display will be in “Japanese”.
Tiếng Việt	The screen display will be in “Vietnamese”.
한국어	The screen display will be in “Korean”.
中文	The screen display will be in “Chinese”.
Portugais	The screen display will be in “Portuguese”.
Türkçe	The screen display will be in “Turkish”.

[System measurement units]

Item	Explanation
Metric	Set system units to ”Metric”. Use MKS units.
Imperial	Set system units to ”Imperial”. Use Imperial units.

8.1.3 Display

In the ”Display” tab, set the following items:

Item	Item	Input range	Initial value
Display	Brightness	0 – 100%	50%
	Power saving mode	OFF / 5min / 10min / 30min / 1hour	5min

[Brightness]

Item	Explanation
Brightness	Adjusts the brightness of the screen. Brightness is expressed as a percentage and has the following relationship: Increase brightness Decrease brightness 100% ⟺ 0% Change the brightness by pressing the function key [F1] and the up/down keys [△][▽] at the same time. Changing the brightness using the function keys and up/down keys can be done on any screen. Increase brightness : [F1]+[△] Decrease brightness: [F1]+[▽]
Power saving mode	Set the time to switch to power saving mode. When the set time has elapsed since the last ”key operation”, the display brightness will be reduced to 5% and the system will switch to power saving mode. Executing a key operation will return the system to normal mode from power saving mode.

8.1.4 Data initialization

The data set in this device will be initialized to the factory settings. The following items will be initialized:

[Items/files to be initialized]

- All settings in the ”Main Menu” - ”Flow Meter” tab
  - Contains configuration files.
- All settings in the ”Main Menu” - ”Thickness Meter” tab
- All log, capture, and report files in the ”Main Menu” - ”Output Files” tab
- All settings items in the ”Main Menu” - ”System” tab

Note: However, the date and time will not be initialized.

8.1.5 Device information_battery

You can check the battery status. You can check the following items.

Item	Explanation
Battery level	Displays the remaining battery power from 0 - 100%. You can also check the remaining battery power with the icon in the top right of the screen. When the battery is not connected, ”---” is displayed.
Maximum capacity	Displays the battery capacity as a percentage based on when the battery was new. Replacement recommendations are displayed at 61 - 70%. Shows exchange at 60% or less. When the battery is not connected, ”---” is displayed.
Situation	Displays the battery status. Display: Normal — Situation: Normal Display: Error — Situation: Breakdown Display: --- — Situation: Not connected
Detail	Depending on the battery condition, the following messages will be displayed. (1) The battery is normal. (2) The battery is broken. Please replace it. (3) The battery is not connected. (4) Your battery is deteriorating. We recommend replacing it. (5) [Warning] Your battery has deteriorated significantly. Please replace it.

8.1.6 Device information - Self-diagnosis

The CPU, memory, etc. on the board built into the device are operating normally. If it is normal, it will display ”OK”, if it is abnormal, it will display ”NG”, and if there is a communication abnormality between CPU1 and CPU2, it will display ”Unknown”.

8.1.7 Firmware updates

This device using a USB memory stick. Updating the firmware will keep it up to date.

For information on how to obtain the latest firmware, please contact your sales representative or our company. For information on how to update the firmware, please refer to the documentation that comes with the latest firmware.

[Update procedure]

1. Go to the main menu, ”System” - ”Device Information & Updates” - ”Firmware Update” tab.
2. The USB memory containing the firmware update into the unit.
3. Press the function key [F1].
4. The update will run and the device will automatically reboot when the update is complete.

8.1.8 Analog output calibration

The analog output is calibrated at the factory, so it is usually not necessary to calibrate it. If it is necessary to calibrate the analog output, please do so. The items are as follows:

Item	Input range	Initial value
Output Channel	CH1/CH2	CH1
Output mA	4mA/20mA	4mA
CH1 4mA calibration value	3.800 – 4.200mA	4.000mA
CH2 4mA calibration value	18.000 – 22.000mA	20.000mA
CH1 20mA calibration value	3.800 – 4.200mA	4.000mA
CH2 20mA calibration value	18.000 – 22.000mA	20.000mA

Item	Explanation
Output Channel	Select the channel (CH1/CH2) to perform calibration.
Output mA	Select the output to be calibrated (4mA/20mA).
CH1 4mA calibration value	Enter the ammeter measurement value when CH1_4mA is output.
CH2 4mA calibration value	Enter the ammeter measurement value when CH1_20mA is output.
CH1 20mA calibration value	Enter the ammeter measurement value when CH2_4mA is output.
CH2 20mA calibration value	Enter the ammeter measurement value when CH2_20mA is output.

Note
On this screen, the current set in ”Output mA” is always output to the CH selected in ”Output CH ”.

8.1.9 Temperature input compensation

Temperature input is calibrated at the factory, so there is usually no need to correct it. If temperature input correction is required, please do so. ”Temperature input correction” allows you to perform zero correction and span correction of the resistance thermometer connected to the terminal block of the I/O junction box. The items are shown below.

Item	Input range	Initial value
Pt100-CH1 zero correction	-10.0 ℃ – +10.0 ℃	0.0 ℃
Pt100-CH1 span correction	0.000 - 20.000	1.000
Pt100-CH2 zero correction	-10.0 ℃ – +10.0 ℃	0.0 ℃
Pt100-CH2 span correction	0.000 - 20.000	1.000
Temperature Damping	1s - 120s	20s

Item	Explanation
Pt100-CH1 zero correction	Enter the zero correction for Pt100-CH1.
Pt100-CH1 span correction	Enter the span correction for Pt100-CH1.
Pt100-CH2 zero correction	Enter the zero correction for Pt100-CH2.
Pt100-CH2 span correction	Enter the span correction for Pt100-CH2.
Temperature Damping	Enter the damping time.

8.2 No reception detection function

You can check the no echo status. When no echo is received, ”No Echo” is displayed on the measurement screen. In the 2 line measurement/ 2 point measurement, no echo is detected for each channel.

8.3 Obstacle detection

Detects solid objects such as air bubbles and dust contained in the measured fluid. If an obstacle is detected, ”ⓘ” is displayed on the measurement screen.

8.4 Flowmeter

This device can measure flow rate. Click ”Flow meter” to switch to the flow measurement function. You can measure flow rate by setting the measurement setting mode to flow meter.

8.5 Massmeter mode

This device can measure mass. By multiplying the mass by the density of the fluid being measured, the mass flow rate can be calculated and displayed.

8.6 Heatmeter mode

This device can measure heat quantity. You can switch to heat quantity measurement by setting the measurement setting mode to Heatmeter.

8.7 Thickness meters

This instrument can measure the thickness of pipes and also the speed of sound in liquids. For details, please refer to ”7 Measurement - Thickness meter”.

8.8 2 line measurement

This device can measure two lines. You can switch between these by setting the measurement line in the measurement settings to two lines.

8.9 2-point measurement

This device can perform two-point measurements. You can switch between these by setting the measurement line in the measurement settings to two points.

8.10 Temperature measurement

A resistance thermometer (Pt100) to this unit via and I/O junction box, two- point temperature measurement is possible. In addition, zero and span correction of the resistance thermometer can be performed. For wiring, see ”5.1.5 Analog output / resistance thermometer (Pt100)”, for screen display, see ”6.1 Measurement screen”, and for settings, see ”8.1.9 Temperature input correction”.

8.11 Analog output (4-20mA current output)

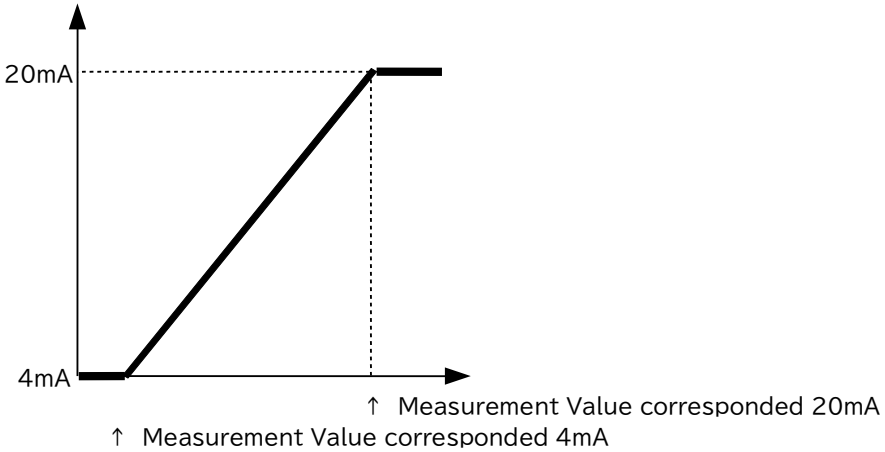
This device can output a current value that is converted from the measurement value to 4 to 20mA. The current output is non-insulated.

(1) Output channel

For 1path / 2path, select "OFF / ON". For 2pipe simultaneously, select "OFF / ON" for each channel.

(2) Output pattern

You can set the measurement value equivalent to 4mA and 20mA. The relationship between the measurement value and analog output is shown below.



(3) Output when an alarm occurs

You can choose from the following three output settings when an alarm goes off.

Item	Explanation
Hold	The final measurement value is output and displayed on the screen.
4mA	The minimum output setting is output. The minimum output setting is displayed on the screen.
20mA	The maximum output setting is output. The maximum output setting is displayed on the screen.

(4) Calibration

The analog output is calibrated at the factory, so it usually does not need to be calibrated. If the analog output needs to be calibrated, go to [System] - [Calibrate Analog Output] to calibrate it.

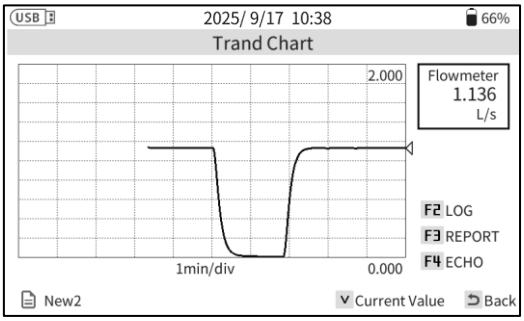
8.12 Trend graph function

The trend graph of the instantaneous flow rate or instantaneous heat quantity being measured is displayed on the screen. Pressing the up or down key on the measurement screen switches to the trend graph screen. Pressing the function key [F3] on the trend graph screen switches the channel.

Displays the current flow rate value and up to 10 minutes' worth of measurement values (600 points). If you change the "Measurement Settings", the graph will be reset.

Item	Explanation
Qmax	The maximum output value of the setting data is reflected. This setting can be changed in "Measurement Settings" - "Output" and "Maximum Value". It works in conjunction with the following functions: Analog output - Trend graph display - Trend graph ・Report function - Trend graph
Qmin	The minimum output value of the setting data is reflected. This setting can be changed in "Measurement Settings" - "Output" and "Maximum Value". It works in conjunction with the following functions: Analog output - Trend graph display - Trend graph ・Report function - Trend graph
Flow units	The flow rate unit of the setting data is reflected.

An example of a trend graph is shown below.



8.13 Reporting

Trend graphs of instantaneous flow rate or instantaneous heat quantity being measured and their setting data are output as a PDF report.

Pressing the function key [F3] on the measurement screen or trend graph screen will output a report to the USB memory if one is inserted, or to the device if one is not inserted. The report will include device information, setting data, trend graphs, and results.

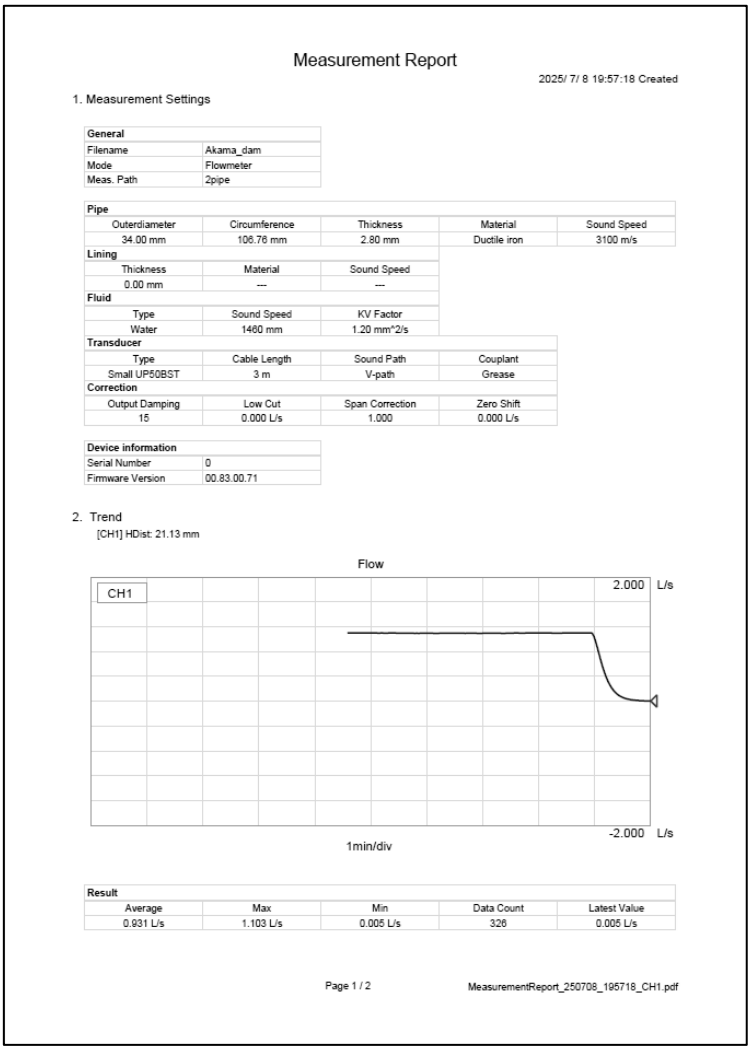
The PDF file name will be saved as MeasurementReport_YYMMDD_hhmmss.pdf.

MeasurementReport YYMMDD hhmmss.pdf

Start time (e.g. hh hour mm minute ss second)

Start date (e.g. YY year MM month DD day)

Below is an example of the report output:



Measurement Report

2025/ 7/ 8 19:57:18 Created

1. Measurement Settings

General	
Filename	Akama_dam
Mode	Flowmeter
Meas. Path	2pipe

Pipe				
Outerdiameter	Circumference	Thickness	Material	Sound Speed
34.00 mm	106.76 mm	2.80 mm	Ductile iron	3100 m/s

Lining		
Thickness	Material	Sound Speed
0.00 mm	---	---

Fluid		
Type	Sound Speed	KV Factor
Water	1460 mm	1.20 mm^2/s

Transducer			
Type	Cable Length	Sound Path	Couplant
Small UP50BST	3 m	V-path	Grease

Correction			
Output Damping	Low Cut	Span Correction	Zero Shift
15	0.000 L/s	1.000	0.000 L/s

Device information	
Serial Number	0
Firmware Version	00.83.00.71

2. Trend

[CH1] HDist: 21.13 mm

Flow

CH1

2.000 L/s

-2.000 L/s

1min/div

Result				
Average	Max	Min	Data Count	Latest Value
0.931 L/s	1.103 L/s	0.005 L/s	326	0.005 L/s

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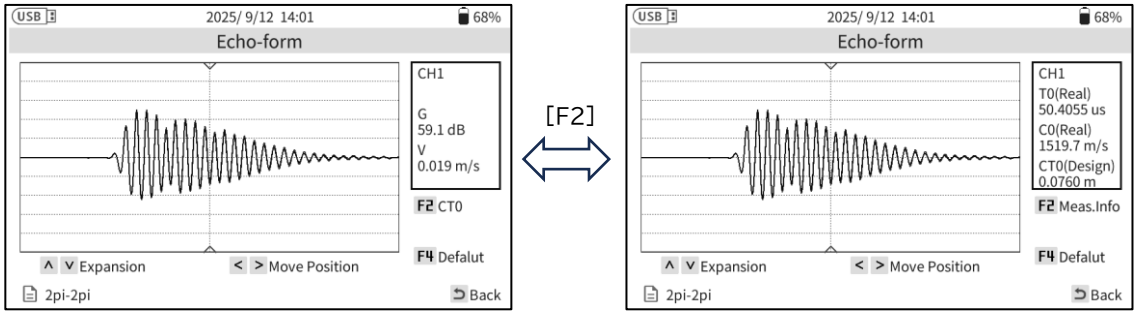
MeasurementReport_250708_195718_CH1.pdf

8.14 Waveform display

On the measurement screen, press function key [F4] to check the received waveform. An example of the received waveform is shown below. On the received waveform screen, you can move with the left and right keys, adjust the time span with the up and down keys, switch channels with function key [F3], and return to the initial position with function key [F4].

The red line shows the received waveform from UP to Down, and the blue line shows the received waveform from Down to UP.

You can check the values of T0(Real), C0(Real), and CT0(Design) by pressing function key [F2] on the Echo-form.



8.15 Display language switching

Select the ”System” - ”Settings” - ”Languages and Units” tab to switch. The default setting is English.

8.16 Easy setup (installation guide)

Select the ”Flow Meter” - ”Measurement” tab to display the sensor installation screen. Select ”Guide” to display a diagram of the installation method for the mounting brackets and the sensor.

8.17 Output damping

90% of the step change. If the flow rate fluctuation is large, increasing the filter setting value will increase the suppression effect against the fluctuation. The initial value and setting range of output damping are shown below.

Initial value	Minimum	Maximum
15	1	120

8.18 Low flow cut

Set the low flow cutoff for the measured value. If the measured value is equal to or less than the set value, it can be forced to zero. The initial value and setting range of the low flow cutoff are shown below. The input range depends on the display digit setting. The unit will be the unit set in the instantaneous flow rate / mass / heat unit.

Initial value	Minimum	Maximum
0.0	0.000 00	999999

8.19 Span correction

Span correction can be set in the Span correction field for each configuration file. The measurement value is corrected by multiplying it by a coefficient. The initial value and setting range of span correction are shown below.

Initial value	Minimum	Maximum
1.000	0.000	20.000

The correction value is calculated using the following formula:

(Value after correction) = (Span correction) x (Value before correction) + (Zero correction)

8.20 Zero correction

You can correct the offset of the measurement value for each setting file by using the zero correction in the correction field. The initial value and setting range of the zero correction value are shown below. The input range depends on the display digit setting. The unit will be the unit set in the instantaneous flow rate / mass / heat unit.

Initial value	Minimum	Maximum
0.0	-99999 9	999999

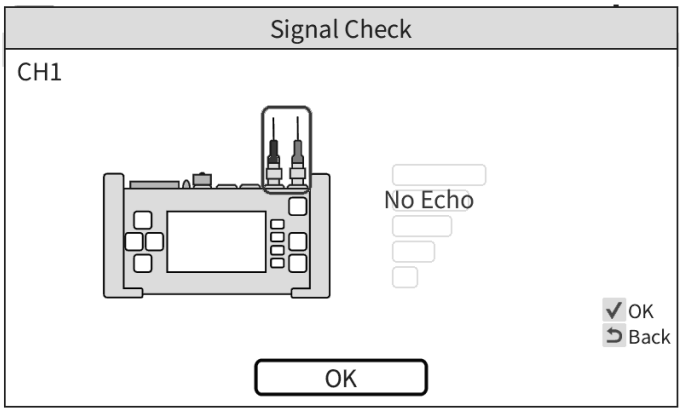
8.21 Temperature damping

90% of the step change. If the temperature fluctuation is large, increasing the filter setting will increase the effect of suppressing the fluctuation. The initial value and setting range of temperature damping are shown below.

Initial value	Minimum	Maximum
20	1	120

8.22 Response diagnosis/sensitivity display

Before starting measurement, you can check the ultrasonic signal. The signal strength is displayed in six levels as shown below. If the signal strength is low, change the installation position. Measurements cannot be made if ” No Echo ” is displayed. An example display is shown below.



Signal check	Displays the ultrasonic signal strength in 6 bar levels. 5 : High 4 to 3 : Medium 2 to 1 : Low 0 : No reception (displays No Echo)

8.23 Log function

The measured data can be saved in the internal memory of the unit or in a USB memory. The settings and operation method are shown below.

8.23.1 Log management

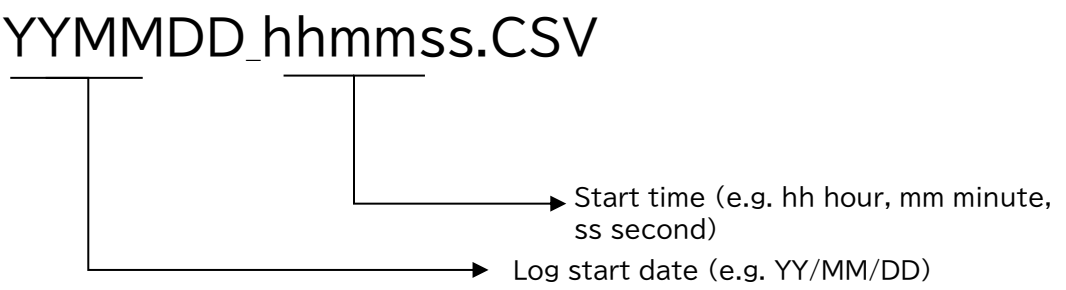
(1) Check the log area

You can check the saved data and used capacity from ”Main Menu” - ”Log File”. Up to 30 log files can be created. Also, if the log area usage rate reaches 99.5%, you will not be able to create a new log file. If you have used up to the maximum, delete the log files to free up some space in the log area.

99.5% during logging, the data will be saved and logging will end.

(2) Log files

The log file name is automatically created as ”Log start date _ start time.CSV”. The rules for the log file name are as follows:



1. Delete the log files

You can delete a file by placing the cursor on the file you want to delete and pressing the function key [F3].

2. Copy the log file

Insert a USB memory and check that the USB memory icon is displayed. If the USB memory recognition icon is not displayed, you cannot copy the log file to the USB memory.

In Log Management, move the cursor to the log file you want to copy and press the function key [F2] to copy it to the USB memory. The log file will be saved in the following format.

Year / Month / Day order	The name of the file to be created
YY-MM-DD	YYMMDD_hhmmss.CSV
MM-DD-YY	MMDDYY_hhmmss.CSV
DD-MM-YY	DDMMYY_hhmmss.CSV

8.23.2 Log settings

Press function key [F2] on the measurement screen to go to the log menu, where you can configure the log settings.

(1) Select a log item

You can select the items to save in the log file. The fewer the items selected, the longer the logging time. The selectable items are as follows:

Item	Explanation
Flow rate	It is recorded in the set flow rate units.
Flow velocity	The units are recorded in m/s.
Addition	The data is recorded in the cumulative unit you set.
Temperature	CH1 and CH2 are recorded.
Mass	This can only be selected when a Massmeter is set. The mass is recorded in the set mass unit.
Amount of heat	This can only be selected when a Heatmeter is set. It will be recorded in the set calorie unit.

(2) Setting the log interval

Set the log interval. The initial value and setting range of the log interval are shown below. If the log interval is made shorter, the time that can be logged will be reduced.

Initial value	Minimum	Maximum
00:00:30	00:00:01	99:59:59

Below are some examples of maximum logging times:

Mode	Measurement method	Log interval	Maximum logging time
Flow meter	1 line	1 minute	1200 hours (50 days)
Heatmeter	2 piping simultaneously	1 minute	300 hours (12.5 days)

(3) Save destination

You can select the destination to save the log file to either the ”Main Unit” or ”USB Memory”. If the USB memory is not inserted, the log file cannot be saved even if the destination is set to USB memory.

The internal storage can store up to 200,000 points. Up to 30 log files can be saved. The log file is saved to a USB memory, the number of log files is limited by the storage capacity of the USB memory. Also, there is no limit to the number of log files.

Note
The maximum number of points that can be saved on the device is 200,000, but this varies depending on the number of log items selected.

8.23.3 Start of log

You can choose between ”Start Now” and ”Schedule”. If you select ”Start Now”, it will switch to ”Log Standby” and when logging starts, ”Logging” will be displayed. If you select ”Schedule”, you can set the start and end times of logging.

You can set the start and end times for logging from the ”Schedule” tab.
When the log time is set correctly, the screen will show ”Log Standby”. When logging starts, it will switch to ”Logging”.

Note
1. On the ”Log Menu” tab, pressing the function key [F2] displays the maximum logging time calculated from the free log space. This is calculated based on the settings at the time the function key [F2] is pressed. If you change the settings, the remaining time will also change. Please use the maximum logging time as a guide only. 2. ”99-99-99” as the end time date, logging will continue until the log free space is exhausted. There is no need to enter a time.

8.23.4 Stopping the log

To stop logging, press the function key [F2] on the measurement screen to end logging. Or, press back on the measurement screen to exit the measurement screen to end logging. If it is synchronized with accumulation, accumulation will also end.

The status codes recorded in the log file are shown below.

Status code	Explanation
0	Measurement is performed normally.
1	Detects no reception state
2	Detect Obstacles
3	Err Code 1 and 2 occur simultaneously
4 (Calorie time measurement)	Temperature measurement on the sending side cannot be performed correctly
5 (Calorie time measurement)	Cannot measure temperature properly on the return side

The log file contents when measuring flow rate are shown below. Only the measurement values selected in the log item selection will be saved.

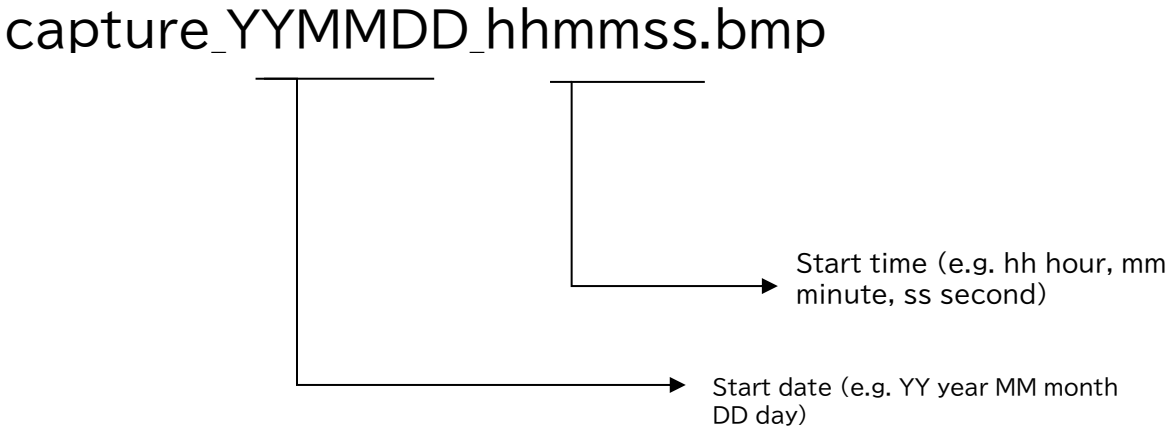
Measurements							
Date (YY-MM-DD) Time	Status code CH1	Flow rate [m3/h]	Flow velocity [m/s]	+ Accumulation [x1 m3]	- Accumulation [x1 m3]	Pt100 - CH1 [deg C]	Pt100 - CH2 [deg C]

When two measurement points are set, the values of CH1 and CH2 are recorded separately.
When two measurement lines are set, the error codes for CH1 and CH2 and the average measurement values for the measurement lines are recorded.

8.24 Screen capture function

The screen can be captured and saved as image data. If a USB memory stick is inserted, the report will be output to the USB memory stick; if not, the report will be output inside the device. On the screen you want to save, press the function key [F1] and the arrow key "◁" simultaneously to save. The LOG LED will light up while saving, and a message will appear when saving is complete.

The screen capture file name will be saved as capture_YYMMDD_hhmmss.bmp.



Chapter9 Maintenance and inspection

9.1 Maintenance and inspection of the main unit and sensors

(1) Wipe off any dirt on the main unit and sensor with a soft, dry cloth. Do not use chemicals such as thinner.
(2) Always inspect and clean the equipment nameplate so that it is legible. If the equipment nameplate becomes dirty or peeled off, contact our sales office.
(3) Do not subject the main body or sensor to impacts.
(4) The sensor is designed to be able to measure even in rainy weather, but please avoid environments where it is exposed to wind and rain for long periods of time as much as possible, and wipe off any moisture immediately after use. Note that the sensor will not be waterproof if the connector is not connected correctly.
(5) Even if the sensor becomes defective, there will be no visible difference except in extreme cases. If you suspect a defect, please contact our sales office. Deterioration of characteristics can be confirmed by observing the ultrasonic wave received and comparing it with normal conditions.
(6) The main unit is designed to allow basic measurements even in the rain, but please avoid environments where it is exposed to the elements for long periods of time, and wipe off any moisture immediately after use. Note that the waterproof performance will not be achieved if the connectors are not connected correctly, if the battery cover or the rubber cover for the USB section is not attached correctly, or if the screws are loose. Also, it cannot be used underwater.

9.2 Limited life parts

Please contact our sales office when parts need replacing.

(1) LCD

An LCD reaches the end of its lifespan, visibility is affected, such as the screen becoming dark. By avoiding direct sunlight and strong ultraviolet rays and keeping the LCD in a room temperature, low humidity environment, the burden on the LCD can be reduced.
The LCD brightness, see ”8.1.3 Display”.

(2) Coin battery (lithium battery for clock backup)

The backup battery is used as a clock backup and has a lifespan of approximately 5 years at room temperature. If the battery runs out, the date and time will be initialized when the power is turned off.
If the remaining battery power is low, a message will be displayed at startup prompting you to replace the backup battery.

(3) Battery

The performance of rechargeable batteries will deteriorate over time. As this deterioration progresses, symptoms such as the operating time of the battery becoming extremely short even when fully charged will appear. If the battery is significantly deteriorated, replace it with a new one. You can check the battery status in ”System” - ”Device Info & Updates” - ”Battery”.
If you will not be using the battery for more than a month, remove it from the device and store it in a cool, low-humidity place.

The battery can be charged and discharged approximately 800 times (at an average ambient temperature of 25°C).

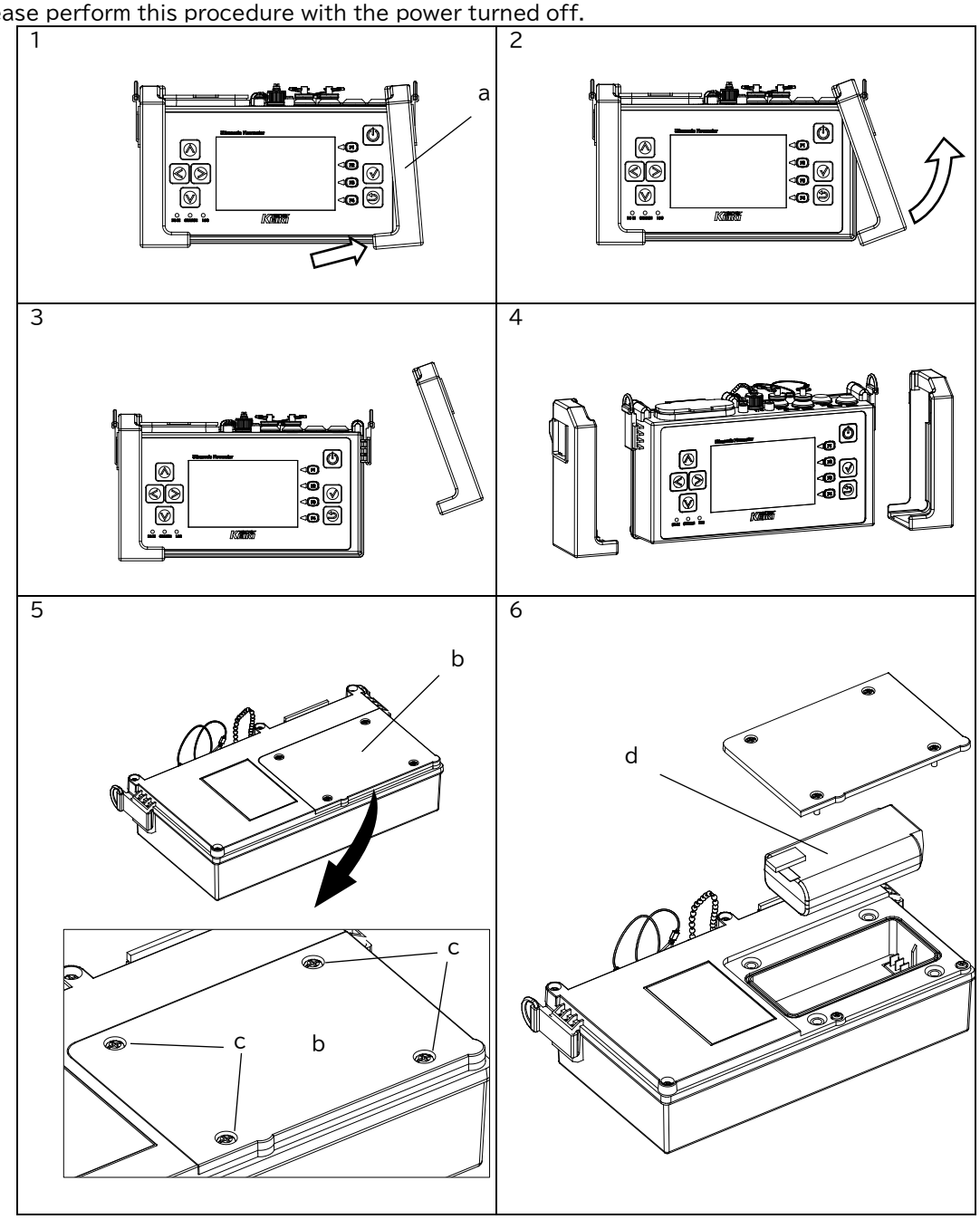
※This may vary depending on the usage environment.

(4) O-rings, packing

If the O-rings or gaskets are damaged or deteriorated, waterproof performance will not be achieved.

9.3 Removing the battery

Please perform this procedure with the power turned off.



1. Remove the protective cover (a). The protective cover is designed to hook onto the protrusions on the top of the main case. Remove it from the bottom of the case.
2. Use the top of the protective cover as a pivot point to remove it towards the outside of the case.
3. Remove the protective cover, being careful of the strap retaining ring.
4. Remove the protective cover on the other side in the same way.
5. There is a battery cover (b) on the back of the main unit case. The battery cover is secured in place with four screws (c). Remove the cover using a Phillips head screwdriver.
6. The battery (d) can be removed.

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Chapter10 Specification

10.1 General specifications

Measurement	Measurement fluid	Homogeneous liquid through which ultrasonic waves propagate (Tap water, sewage, industrial water, river water, seawater, pure water, oil, etc.)
	Measurement range	Flow velocity equivalent to -30 to + 30m/s
	Measurement method	Ultrasonic pulse propagation time difference method
Piping	Caliber	13A to 5000A
	Kinds	Pipes made of materials that transmit ultrasonic waves stably, such as steel pipes, SUS pipes, cast iron pipes, ductile iron pipes, and PVC pipes Note: Depending on the material and condition of the piping, it may not be possible to meet the applicable diameter.
	Turbidity	10000mg/L (degrees) or less Note : Do not contain air bubbles.
	Lining	None, or tar epoxy, mortar, etc. Note : The lining must be in close contact with the original pipe.
	Straight pipe length	According to JEMIS 032-2019

Sensors	Applicable caliber	Fluid temperature (The storage temperature range is also the same)
Small : UP50BST	13A to 50A	-20 ℃ to 120 ℃
Medium : UP10BST	20A to 500A (*1)	-20 ℃ to 120 ℃
Large : UP04BST	300A to 5000A	-20 ℃ to 80 ℃
	(*1) 20 to 40A can only be attached with Z-method brackets. Note : Depending on the material or condition of the piping or the fluid being measured, the applicable diameter may not be met. There may be cases where this is the case.	

Measurement accuracy	Flow velocity 1m/s or more	Flow velocity: less than 1m/s
13 (*1) to 90A	±2%	±0.02m/s
20 to 50A (Medium sensor Z method)	±2 to ±5%	±0.02 to ±0.05m/s
100 to 250A	±1.5%	±0.015m/s
300 to 5000A	±1%	±0.01m/s
	(*1) Due to proofreading. Note 1) Accuracy measured during testing using our equipment. Note 2) It is necessary for the flow to be fully developed within a full pipe. Note 3) The accuracy at the time of calibration is as follows. 100 to 250A : ±0.75% or ±0.0075m/s (flow velocity less than 1m/s) 300 to 5000A : ±0.5% or ±0.005m/s (flow velocity less than 1m/s)	

Repeatability	Flow velocity 1m/s or more	Flow velocity: less than 1m/s
13 to 90A	±1%	±0.01m/s
100 to 250A	±0.75%	±0.0075m/s
300 to 5000A	±0.5%	±0.005m/s

Others	Sensor protection structure	IP65 / IP68 (JIS C 0920, IEC 60529) Note 1) The operating temperature range when using IP68 is 0 ℃ to 40 ℃.
	Sensor cable	Standard accessories Sensor cable (3m) Cable length: 3m Temperature range: -20 ℃ to 65 ℃ (PE sheath) option Sensor cable (high temperature) Cable length: 7m Temperature range: -20 ℃ to 120 ℃ (FEP sheath) Extension sensor cable (7m) Cable length: 7m Temperature range: -20 ℃ to 65 ℃ (PE sheath) Extension sensor cable (50m) Cable length: 50 m Temperature range: -20 ℃ to 65 ℃ (PE sheath) Note 1) An extension cable alone cannot connect the converter and sensor; be sure to use it together with the sensor cable. Note 2) The cable can be extended up to 160m , but this may be limited by the measurement environment.
	Resistance temperature detector (option)	Pt100 3- wire JIS A class (JIS C 1604, IEC 60751) Used when measuring heat quantity. The accuracy of heat quantity measurement is a combination of the accuracy of flow rate measurement and the accuracy of temperature measurement. The temperature measurement accuracy of the converter is ±(0.2 ℃ + 0.1%) (main unit ambient temperature 25 ℃). For the accuracy of the resistance thermometer, refer to JIS C 1604 or IEC 60751. Accuracy in environments with a lot of external noise is ±0.5 ℃.

10.2 Specifications

Power supply	DC12V 1.5A
Maximum power consumption	17W (at maximum load)
Continuous operation time	12 hours (1 line, log period 30s, LCD brightness 5 %)
Battery	DC7.2V 3.35Ah Li-Ion Battery Standard operating time: 12 hours (When neither analog output nor USB memory is connected) Quick charging time: Approximately 4 hours Note : The temperature range for charging the battery is 0 ℃ to 45 ℃ . Charging is not possible outside this range.
Operating temperature range	-10 ℃ to 50 ℃
Storage temperature range	-10 ℃ to 50 ℃
Operating humidity range	20 % to 90 % RH However, non-condensing
Body protection structure	IP65 (JIS C 0920, IEC 60529) Note 1) When the connector and protective cap are mated Note 2) It is not waterproof when the AC adapter or USB memory is connected.
Main unit case Material	Resin (Polycarbonate ABS)
Size	211(W) x 50 (D) x 112 (H) , not including protrusions
Mass	Approx. 0.9 kg (including battery)
European Compliance (CE marking)	EMC Directive 2014/30/EU Harmonised Standard / EN IEC 61326-1:2021 -Separation into group / Group I -Division into classes / Class A -Location intended for use / In industrial locations RoHS Directive 2011/65/EU + (EU) /2015/863 Harmonised Standard / EN IEC 63000:2018 LVD Directive 2014/35/EU Harmonised Standard / EN61010-1:2010/A1:2019 [Condition] The length of sensor cable is 10m (3m + 7m (option)). No cigarette lighter cable (option).
Korean Standard (KC marking)	KS C 9811:2019 KS C 9610-6-2:2019 KS C 9610-3-2:2023 KS C 9610-3-3:2023 [Condition] The length of sensor cable is 10m (3m + 7m (option)). No High-Temp transducer cable (option) No cigarette lighter cable (option).

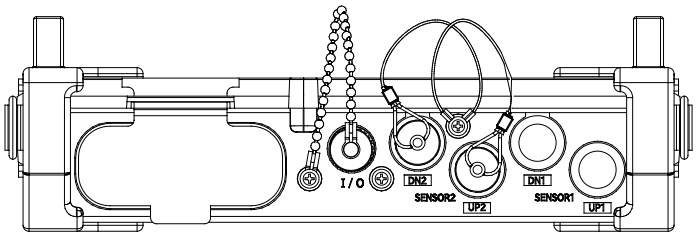
Display	Display method	LCD (480 x 800 WVGA), with backlight	
	Display content	Measurement data such as measurement units, various operation displays, and instantaneous flow rate	
	Number of digits displayed	Instantaneous flow rate	Maximum 6 digits (excluding sign and decimal point)
		Instantaneous flow velocity	1 digit for the sign, 2 digits for the integer, and 3 digits for the decimal
		Accumulated Flow	8 digits
		Temperature	1 digit for the sign , 3 digits for the integer, 1 digit for the decimal
	Unit	Flow units ・m^3/s , m^3/min , m^3/h , m^3/D , km^3/s , km^3/min , km^3/h , km^3/D , Mm^3/D , L/s , L/min , L/h , L/D Mass units ・kg/s , kg/min , kg/h , kg/D , t/s , t/min , t/h , t/D , kt/s , kt/min , kt/h , kt/D , Mt/D Heat unit ・W , kW , MW	
		Accumulation unit ・x1m^3 , x5m^3 , x10m^3 , x100m^3 , x0.01L , x0.1L , x1L , x10L , x100L ・x1kg , x10kg , x100kg , x0.1kg , x0.01kg , x1t , x10t , x100t J , kJ , MJ , GJ	
	Display update cycle	Approximately 1 second	
USB connection	Standard / Optional	Standard	
	Response details	The converter's USB standard is USB 2.0. The supported file system for USB memory is FAT32. Please connect the converter and USB memory one to one.	
Logging	Standard / Optional	Standard	
	Output	2,000,000 measurement data points can be stored in the internal memory of the main unit. It can be stored directly on a USB memory stick. Log contents: Measurement date and time, error (operating status), instantaneous flow rate, forward flow cumulative flow rate and reverse flow cumulative flow rate, instantaneous flow velocity, instantaneous mass, instantaneous heat quantity, temperature	
	Output format	The data will be saved in CSV format on the USB memory.	
Temperature input	Standard / Optional	Standard	
	Input	Temperature can be measured by connecting a resistance temperature detector (optional) via the I/O junction box. Number of inputs: 2	
Analog output	Standard / Optional	Standard	
	Output	Output contents: Instantaneous flow rate or heat flow rate Number of outputs: 2 Note) When measuring two pipes simultaneously, the instantaneous flow rate of each measurement line is output.	
	Output format	Output format: 4 - 20mA Maximum allowable load resistance: 550 Ω	

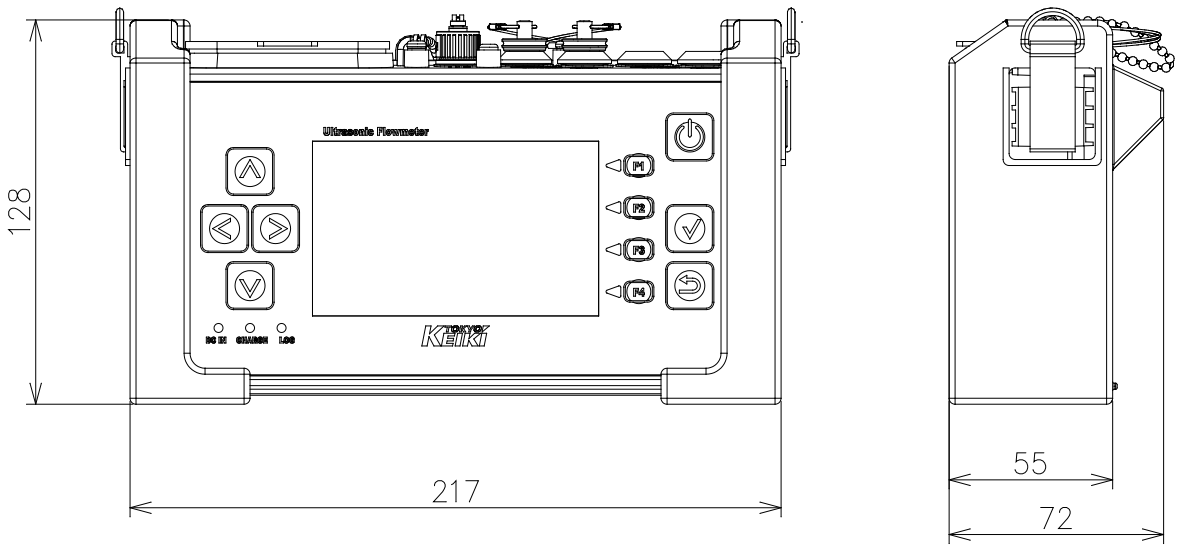
Function	Easy set up	Step-by-step instructions to help you complete basic setup. Installation Guide.
	Thickness meter function	It has thickness meter function. Use a thickness meter / sound speed measurement transducer and test piece. Measurement range: 1 mm to 100 mm (for steel plates) Sound speed setting range: 500m/s to 9999m/s Accuracy: ± 0.1mm or ± 1.5%, whichever is greater (for steel plate materials)
	Fluid sound speed measurement function	It has a fluid sound speed measurement function. Use a thickness meter / sound speed measurement probe and a sound speed measurement cell (also used as a test piece). Measurement range: 500m/s to 3000m/s Accuracy: ± 5 % (in water)
	2 line measurements and simultaneous measurement of two pipes	2 line measurements: By connecting an additional sensor (optional), two measurement lines can be measured. Simultaneous measurement of two pipes: By connecting an additional sensor (optional), two pipes can be measured simultaneously.
	Waveform display	It is possible to display the ultrasonic reception waveform.
	Display language	You can choose from several languages.
	Low flow cut	Any flow rate below the specified instantaneous flow rate will be replaced with 0. Note: This is used when you want to avoid the flow rate becoming a value other than 0 due to turbulence when the flow is stopped.
	No reception processing	15 consecutive seconds or more and measurement is not possible, - "No Echo" will be displayed on the LCD. ・The analog output will transition to the state set in "Output at alarm". "Output at alarm" can be set to HOLD, 4mA, or 20mA.
	Measurement obstacle detection	When a large number of air bubbles or other measurement obstacles are detected in the fluid, ・Displayed on ⓘthe LCD . - Suppresses fluctuations in flow rate values.
	Zero correction	The zero point can be corrected by the specified instantaneous flow rate.
	Span correction	The inclination of the span line can be corrected.
	Self-diagnosis	This device performs self-diagnosis to check for any malfunctions.
	Output damping	Suppresses fluctuations in measurement output.
	Data retention	Even when the power is turned off, the following is maintained by a backup battery. ・Clock operation Note 1) The life of the backup battery is approximately 5 years at room temperature with the power turned off. Note 2) There is no charging function for the backup battery.
	Mass flow measurement	Mass flow rate can be displayed by entering density.
	Temperature input correction during calorific value measurement, etc.	When measuring heat quantity, zero point correction and span correction are possible for the temperature input. In addition, a low cut can be set for the temperature difference between the sending side temperature and the returning side temperature.
	Trend graph function	A trend graph of the instantaneous flow rate or instantaneous heat quantity being measured is displayed on the screen.
	Reporting	Trend graphs of instantaneous flow rate or instantaneous heat quantity being measured and their setting data are output as a PDF report to a USB memory stick.

10.3 Accessory specifications

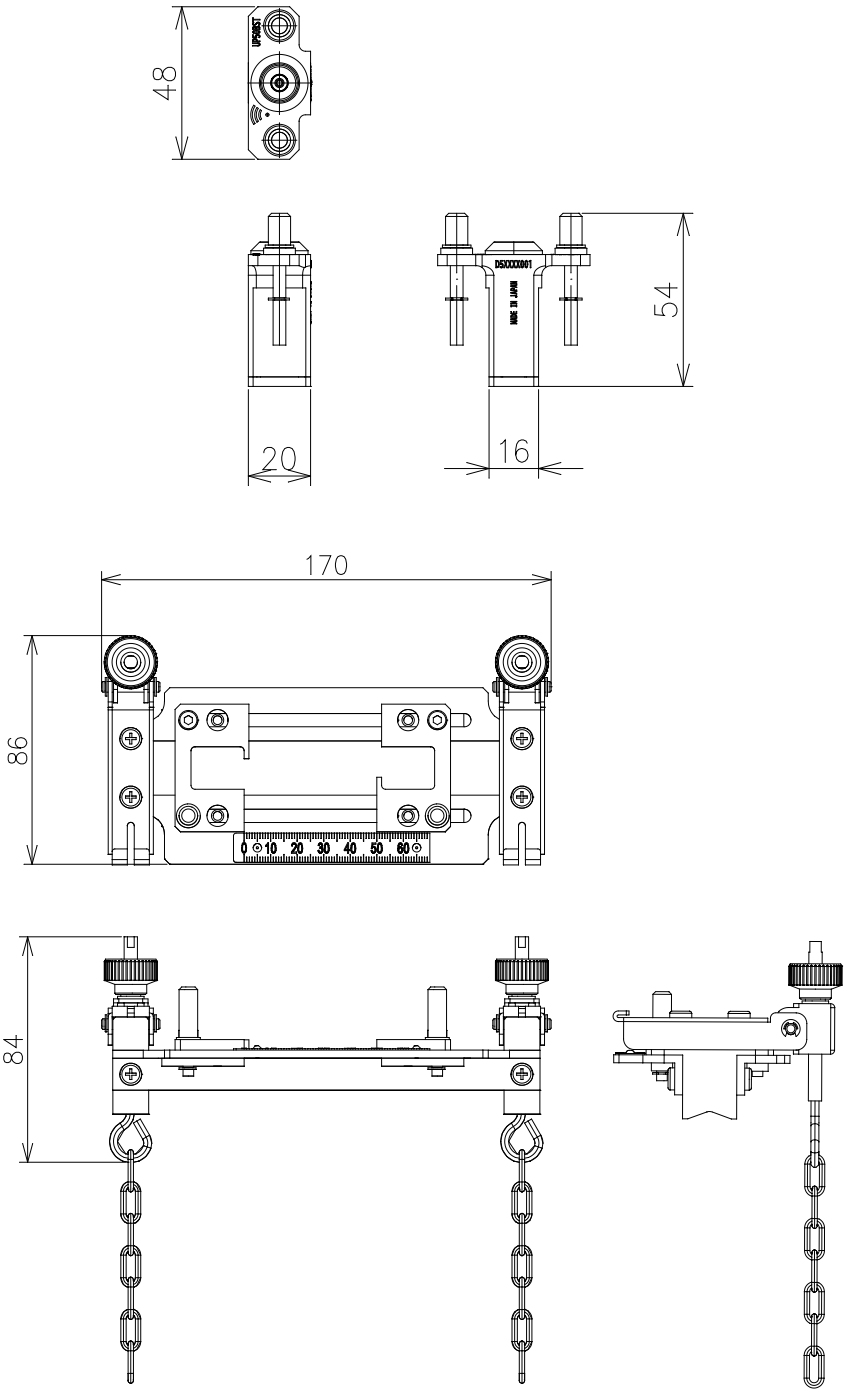
AC adapter	AC adapter exclusively for this device.	
	Standard / Optional	Standard
	Others	Input: AC90V to AC264V 47Hz -63Hz 1.5A(AC90V) Output: DC12V 5A (max) Operating temperature range: 0 ℃ to 40 ° C Storage temperature range: -20 ℃ to 80 ℃ Operating humidity range: 20% RH to 80% RH (non-condensing)
Car adapter	This is a car adapter specifically for this device.	
	Standard / Optional	Option
	Others	Input: DC12V Output: DC12V Built-in input fuse
Thickness meter sensor	TH5010L Note: Test piece is included.	
	Standard / Optional	Standard
	Others	Operating temperature range: -10 ℃ to 50 ℃ (same as storage temperature range) Protection structure: IP65 (JIS C 0920, IEC 60529) Cable length: 0.7m
I/O junction box	Two analog outputs and two resistance thermometers can be connected.	
	Standard / Optional	Standard
	Others	Material: ABS Operating temperature range: -10 ℃ to 50 ℃ (same as storage temperature range) Cable length: 0.5m
Resistance temperature detector	Pt100 3- wire JIS A class (JIS C 1604, IEC 60751) Attaches to piping with a clamp-on.	
	Standard / Optional	Option
	Others	Operating temperature range: -20 ℃ to 120 ℃ (same as storage temperature range) Cable length: 5m
Dry couplant (medium)	Dry couplant sheet for medium sensors.	
	Standard / Optional	Standard
	Others	Material: Acrylic Operating temperature range: 0 ℃ to 40 ℃ (same as storage temperature range)
Dry couplant (small)	Dry couplant sheet for small sensors.	
	Standard / Optional	Option
	Others	Material: Acrylic Operating temperature range: 0 ℃ to 40 ℃ (same as storage temperature range)

10.4 External dimensions
(1) Flow meter body

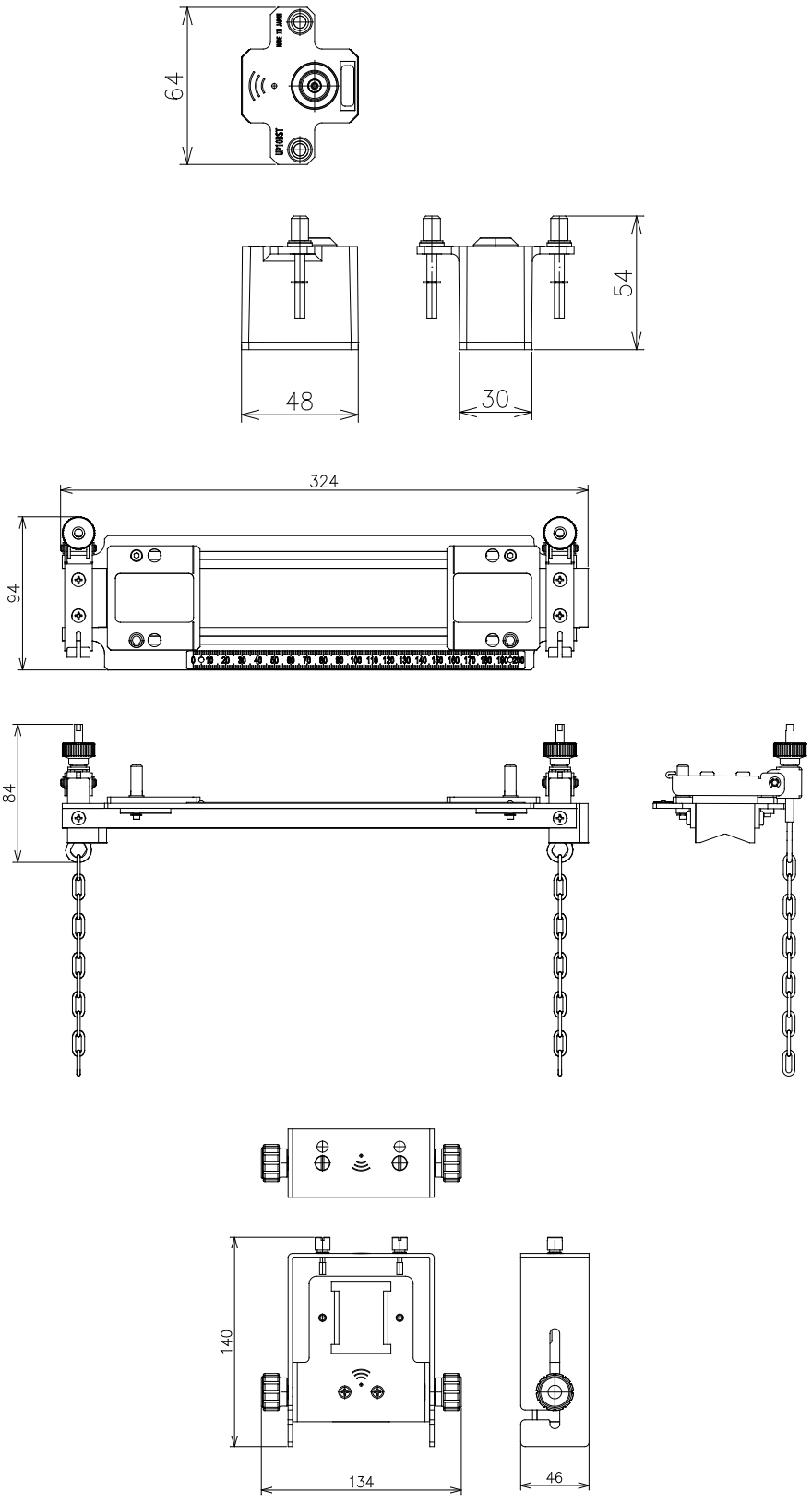


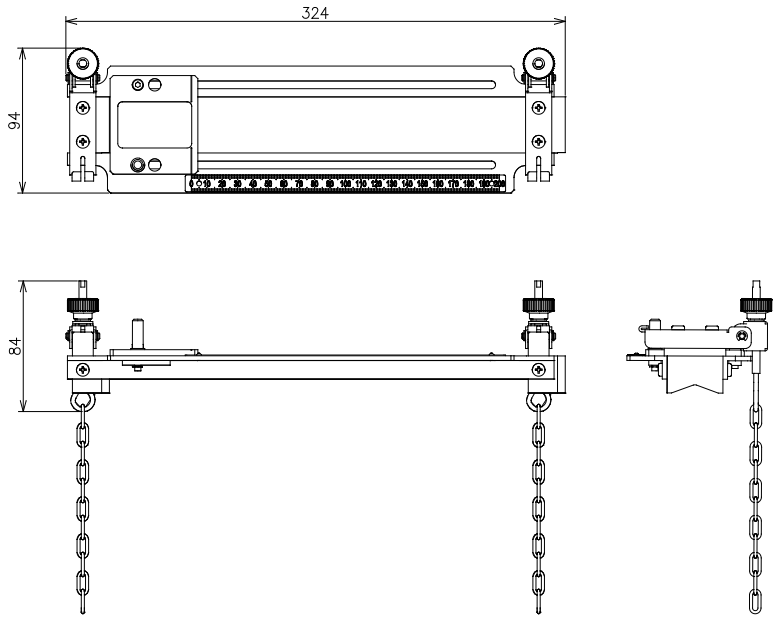


(2) Small sensor set

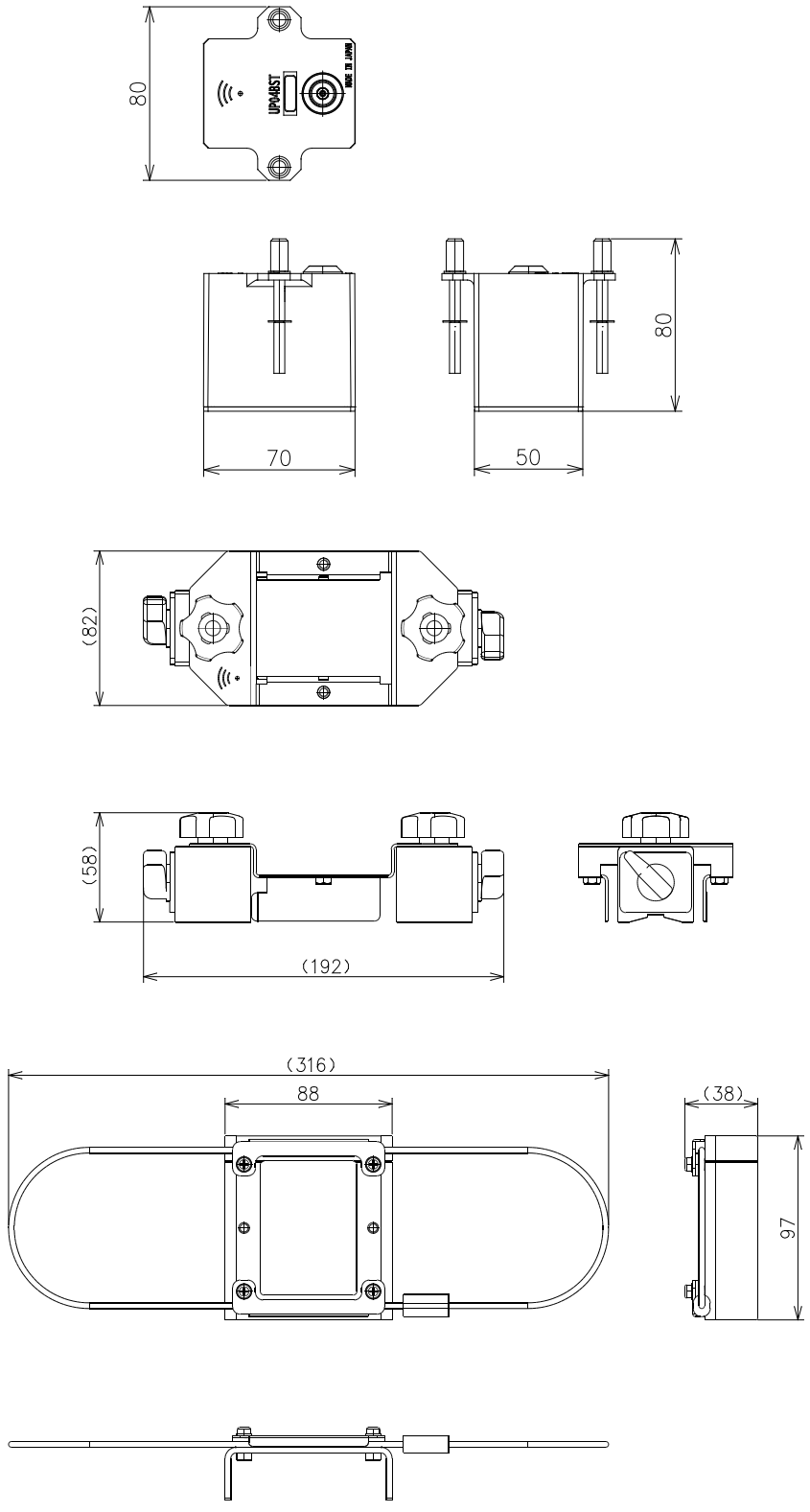


(3) Medium sensor set




324
94
84

(4) Large sensor set



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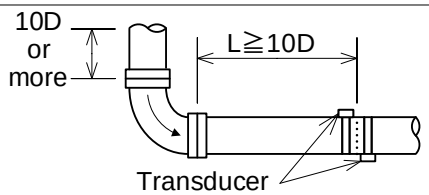
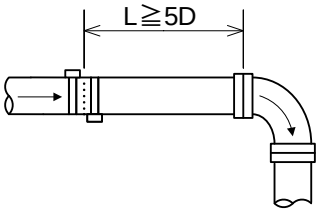
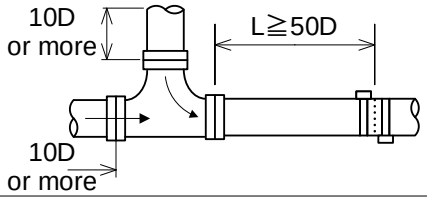
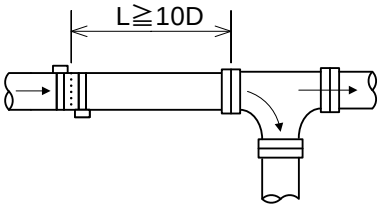
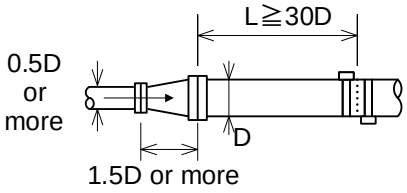
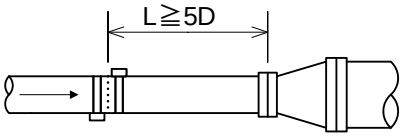
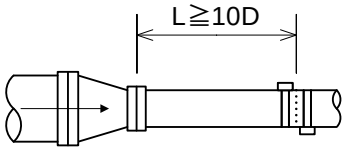
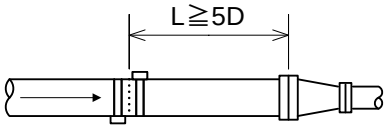
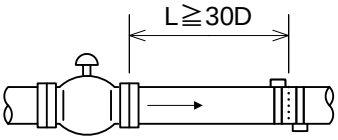
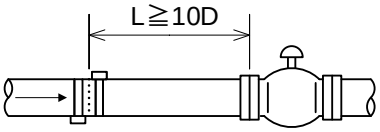
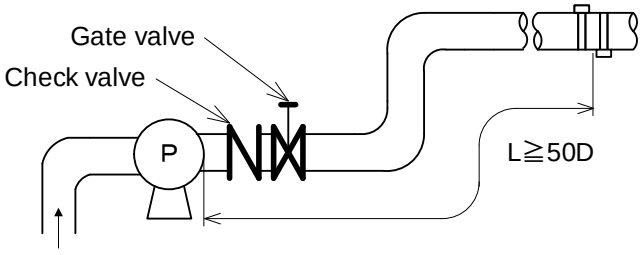
Chapter11 Appendix

11.1 Piping requirements and required straight pipe length

JEMIS 032-2019 is shown below.

[Refer to JEMIS 032-2019.]

Section	Upstream straight pipe length	Downstream straight pipe length
90°bend		
T		
Expanding pipe		
Contracting pipe		
Various valves	 When flow volume is adjusted at the upstream valve.	 When flow volume is adjusted at the downstream valve.
Pump		

[D: pipe diameter]

11.2 Sound speed and dynamic viscosity

The sound speed and dynamic viscosity coefficient of materials used for piping, etc. are shown below. Note that the values are representative values.

(1) Pipe

Kinds	Material name	Sound speed (longitudinal wave) [m/s] (*1)	Sound speed (transverse wave) [m/s]
Metal	Copper	5010	2270
	Inconel	5720	3020
	Ductile iron	5800	3000
	Cast iron	4500	2500
	Monel	6020	2720
	Nickel	5630	2960
	Carbon steel	5900	3200
	Stainless steel	5730	3100
	Tantalum	4100	2900
	Titanium	6070	3110
Plastic	Polycarbonate	2300	
	Vinyl chloride	2280	
	PTFE	1390	
	Acrylic	2720	
	FRP	2560	
	High density polyethylene	2350	

(*1) Sound speed used in Thickness Meters / sound speed measurement probes.

(2) Lining

Kinds	Material name	Sound speed (longitudinal wave) [m/s]	Sound speed (transverse wave) [m/s]
Lining	Epoxy	3 000	2000
	Mortar	4500	2500
	Rubber		1900
	Vinyl chloride	2280	

(3) Fluid

Kinds	Substance name	Composition formula	Density [kg/m^3]	Speed of sound [m/s]	Dynamic viscosity [mm^2/s]
Alcohol	Butanol	C4H10O	810	1268(20 ℃)	3.239(25 ℃)
	Ethanol	C2H5OH	790	1127(30 ℃)	1.39(25 ℃)
	Ethylene glycol	>99.5%	1110	1689(20 ℃)	17.208(25 ℃)
	Ethylene glycol (25wt %)			1599(15 ℃)	
	Ethylene glycol (25wt %)			1603(25 ℃)	
	Ethylene glycol (25wt %)			1609(40 ℃)	
	Ethylene glycol (50wt %)		1066	1691(15 ℃)	4.13(15 ℃)
	Ethylene glycol (50wt %)			1683(25 ℃)	
	Ethylene glycol (50wt %)			1670(40 ℃)	
	Methanol	CH3OH	800	1090(30 ℃)	0.695(25 ℃)
Oil	Diesel oil			1250	
	Gasoline	C8H18	717	1250	0.574(25 ℃)
	Glycerin	C3H8O3	1261.3	1923	1188.5(25 ℃)
	Kerosene (US)		810	1320	1.5(25 ℃)
	Kerosene (UK)			1428(20 ℃)	
	Motor oil	SAE 20	870	1740	5.6 to 9.3 (100 ° C)
	Motor oil	SAE 30	880	1700	190(25 ℃)
	Baby oil			1416(23 ℃)	
	Mineral Oil (Heavy)		843	1460	140(15 ℃)
	Mineral oil (light)		825	1440	3(25 ℃)
	Phenyl Silicone		1100	1370	
	Silicone (1000cSt)		972	990	1000
	Silicone (100cSt)		968	980	100
	Silicone (10cSt)		940	968	10
	Silicone (1cSt)		818	960	1
	Olive oil			1449(23 ℃)	100(25 ℃)
	Lubricating oil	Mobil		1417(20 ℃)	31.5(40 ℃)
Solvent	Acetone		790.5	1190	0.41(25 ℃)
	Benzene	C6H6	880	1310(25 ℃)	0.711(25 ℃)
	Chlorobenzene	C6H5Cl	1110	1300(22 ℃)	0.722(25 ℃)
	Toluene			1420	
Water	Water		1000	1460(13.5 ℃)	1.2
	Sea water		1023.1	1510	1(25 ℃)

11.3 Sound speed (water)

Water temperature [°C]	Speed of sound [m/s]	Water temperature [°C]	Speed of sound [m/s]	Water temperature [°C]	Speed of sound [m/s]
0	1402.74	34	1518.12	68	1554.70
1	1407.72	35	1520.12	69	1554.93
2	1412.58	36	1522.06	70	1555.12
3	1417.33	37	1523.93	71	1555.27
4	1421.97	38	1525.74	72	1555.38
5	1426.50	39	1527.49	73	1555.44
6	1430.93	40	1529.18	74	1555.47
7	1435.25	41	1530.81	75	1555.46
8	1439.46	42	1532.37	76	1555.40
9	1443.58	43	1533.88	77	1555.31
10	1447.60	44	1535.33	78	1555.19
11	1451.52	45	1536.73	79	1555.02
12	1455.34	46	1538.06	80	1554.82
13	1459.07	47	1539.35	81	1554.57
14	1462.71	48	1540.57	82	1554.30
15	1466.25	49	1541.75	83	1553.98
16	1469.71	50	1542.87	84	1553.63
17	1473.08	51	1543.94	85	1553.25
18	1476.36	52	1544.95	86	1552.83
19	1479.55	53	1545.92	87	1552.37
20	1482.66	54	1546.84	88	1551.88
21	1485.69	55	1547.70	89	1551.35
22	1488.64	56	1548.52	90	1550.79
23	1491.50	57	1549.29	91	1550.20
24	1494.29	58	1550.01	92	1549.58
25	1497.00	59	1550.68	93	1548.92
26	1499.64	60	1551.31	94	1548.23
27	1502.20	61	1551.89	95	1547.50
28	1504.69	62	1552.42	96	1546.75
29	1507.10	63	1552.91	97	1545.96
30	1509.44	64	1553.36	98	1545.14
31	1511.72	65	1553.76	99	1544.29
32	1513.92	66	1554.12	100	1543.41
33	1516.05	67	1554.43		

11.4 Piping table

11.4.1 JIS standard

(1) Cast iron pipes

Name			Ductile iron pipes				Water works type cast iron		Straight pipe	
JIS number			JIS G 5526-2014				JIS G 5521-1977 *1)		JIS G 5522-1977 *1)	
Material			FCD				FC		FC	
Type			D1	D2	D3	D4	Normal pressure	Low pressure	Normal pressure	Low pressure
Nominal diameter	Outside diameter	Lining thickness								
75	93	4	7.5		6		9		7.5	
100	118	4	7.5		6		9		7.5	
150	169	4	7.5		6		9.5	9	8	7.5
200	220	4	7.5		6		10	9.4	8.8	8
250	271.6	4	7.5		6		10.8	9.8	9.5	8.4
300	322.8	6	7.5		6.5		11.4	10.2	10	9
350	374	6	7.5		6.5		12	10.6	10.8	9.4
400	425.6	6	8.5	7.5	7		12.8	11	11.5	10
450	476.8	6	9	8	7.5		13.4	11.5	12	10.4
500	528	6	9.5	8.5	8		14	12	12.8	11
600	630.8	6	11	10	9	8.5	15.4	13	14.2	11.8
700	733	8	12	11	10	9	16.5	13.8	15.5	12.8
800	836	8	13.5	12	11	10	18	14.8	16.8	13.8
900	939	8	15	13	12	11	19.5	15.5	18.2	14.8
1000	1041	10	16.5	14.5	13	12	22			
1100	1144	10	18	15.5	14	13	23.5			
1200	1246	10	19.5	17	15	13.5	25			
1350	1400	12	21.5	18.5	16.5	15	27.5			
1500	1554	12	23.5	20.5	18	16.5	30			
1600	1650	15	25	22	19	17.5				
1650	1701	15	25.5	22.5	19.5	18				
1800	1848	15	28	24	21	19.5				
2000	2061	15	30.5	26.5	23.5	21				
2100	2164	15	32	28	24.5	22				
2200	2280	15	33.5	29	25.5	23				
2400	2458	15	36.5	31.5	27.5	25				
2600	2684	15	39.5	34	29.5	27				

*1) "JIS G 5521-1977" and "JIS G 5522-1977" are both obsolete standards. (For reference only)

(2) Carbon steel pipes

Name		For piping Carbon steel pipe	For water supply Galvanized steel pipe	Coated steel pipes for water transportation				Carbon steel pipes for pressure piping					
JIS number		JIS G 3452 -2019	JIS G 3442 -2015	JIS G 3443-2014				JIS G 3454-2017					
Material		SGP	SGPW	STW				STPG					
Type				STW 290	STW 370	STW 400A	STW 400B	Sch 10	Sch 20	Sch 30	Sch 40	Sch 60	Sch 80
Nominal diameter	Outside diameter												
15	21.7	2.8	2.8								2.8	3.2	3.7
20	27.2	2.8	2.8								2.9	3.4	3.9
25	34	3.2	3.2								3.4	3.9	4.5
32	42.7	3.5	3.5								3.6	4.5	4.9
40	48.6	3.5	3.5								3.7	4.5	5.1
50	60.5	3.8	3.8						3.2		3.9	4.9	5.5
65	76.3	4.2	4.2						4.5		5.2	6	7
80	89.1	4.2	4.2	4.2	4.5				4.5		5.5	6.6	7.6
90	101.6	4.2	4.2						4.5		5.7	7	8.1
100	114.3	4.5	4.5	4.5	4.9				4.9		6	7.1	8.6
125	139.8	4.5	4.5	4.5	5.1				5.1		6.6	8.1	9.5
150	165.2	5	5	5	5.5				5.5		7.1	9.3	11
175	190.7	53											
200	216.3	5.8	5.8	5.8	6.4				6.4	7	8.2	10.3	12.7
225	241.8	6.2											
250	267.4	6.6	6.6	6.6	6.4				6.4	7.8	9.3	12.7	15.1
300	318.5	6.9	6.9	6.9	6.4				6.4	8.4	10.3	14.3	17.4
350	355.6	7.9	7.9			6		6.4	7.9	9.5	11.1	15.1	19
400	406.4	7.9	7.9			6		6.4	7.9	9.5	12.7	16.7	21.4
450	457.2	7.9	7.9			6		6.4	7.9	11.1	14.3	19	23.8
500	508	7.9	7.9			6		6.4	9.5	12.7	15.1	20.6	26.2
550	558.8							6.4	9.5	12.7	15.9		
600	609.6					6		6.4	9.5	14.3			
650	660.4							7.9	12.7				
700	711.2					7	6						
800	812.8					8	7						
900	914.4					8	7						
1000	1016					9	8						
1100	1117.6					10	8						
1200	1219.2					11	9						
1350	1371.6					12	10						
1500	1524					14	11						
1600	1625.6					15	12						
1650	1676.4					15	12						
1800	1828.8					16	13						
1900	1930.4					17	14						
2000	2032					18	15						
2100	2133.6					19	16						
2200	2235.2					20	16						
2300	2336.8					21	17						
2400	2438.4					22	18						
2500	2540					23	18						
2600	2641.6					24	19						
2700	2743.2					25	20						
2800	2844.8					26	21						
2900	2946.4					27	21						
3000	3048					29	22						

(3) Stainless steel pipes

Name		Stainless steel pipes for piping Large diameter welded stainless steel pipes for piping						
JIS number		JIS G 3459-2016/ JIS G 3468-2016						
Material		SUS***TP, SUS***HTP, SUS***LTP, SUS***HTP						
Type		Sch 5	Sch 10	Sch 20	Sch 40	Sch 80	Sch 120	Sch 160
Nominal diameter	Outside diameter							
15	21.7	1.65	2.1	2.5	2.8	3.7		4.7
20	27.2	1.65	2.1	2.5	2.9	3.9		5.5
25	34	1.65	2.8	3	3.4	4.5		6.4
32	42.7	1.65	2.8	3	3.6	4.9		6.4
40	48.6	1.65	2.8	3	3.7	5.1		7.1
50	60.5	1.65	2.8	3.5	3.9	5.5		8.7
65	76.3	2.1	3	3.5	5.2	7		9.5
80	89.1	2.1	3	4	5.5	7.6		11.1
90	101.6	2.1	3	4	5.7	8.1		12.7
100	114.3	2.1	3	4	6	8.6	11.1	13.5
125	139.8	2.8	3.4	5	6.6	9.5	12.7	15.9
150	165.2	2.8	3.4	5	7.1	11	14.3	18.2
200	216.3	2.8	4	6.5	8.2	12.7	18.2	23
250	267.4	3.4	4	6.5	9.3	15.1	21.4	28.6
300	318.5	4	4.5	6.5	10.3	17.4	25.4	33.3
350	355.6	4	5	8	11.1	19	27.8	35.7
400	406.4	4.5	5	8	12.7	21.4	30.9	40.5
450	457.2	4.5	5	8	14.3	23.8	34.9	45.2
500	508	5	5.5	9.5	15.1	26.2	38.1	50
550	558.8	5	5.5	9.5	15.9	28.6	41.3	54
600	609.6	5.5	6.5	9.5	17.5	31	46	59.5
650	660.4	5.5	8	12.7	18.9	34	49.1	64.2
700	711.2	5.5	8	12.7				
750	762	6.5	8	12.7				
800	812.8		8	12.7				
850	863.6		8	12.7				
900	914.4		8	12.7				
1000	1016		9.5	14.3				

Name	Stainless steel pipes for general piping	
JIS number	JIS G 3448-2016	
Material	SUS***TPD	
name	Outside diameter	Pipe Thickness
13Su	15.88	0.8
20Su	22.22	1
25Su	28.58	1
30Su	34	1.2
40Su	42.7	1.2
50Su	48.6	1.2
60Su	60.5	1.5
75Su	76.3	1.5
80Su	89.1	2
100Su	114.3	2
125Su	139.8	2
150Su	165.2	3
200Su	216.3	3
250Su	267.4	3
300Su	318.5	3

Name	Stainless steel sanitary pipes*	
JIS number	JIS G 3447-2015	
Material	SUS***TBS, SUS***LTBS	
Call (S) Reference	Outside diameter	Pipe Thickness
1S	25.4	1.2
1.25S	31.8	1.2
1.5S	38.1	1.2
2S	50.8	1.5
2.5S	63.5	2
3S	76.3	2
3.5S	89.1	2
4S	101.6	2
4.5S	114.3	3
5.5S	139.8	3
6.5S	165.2	3

* Stainless steel sanitary pipes (JIS G 3447) do not have nominal size. Only the outer diameter and thickness are standardized. The nominal size (S) of the fitting is shown for reference when connecting to IDF/ISO standard ferrule fittings.

(4) Polyvinyl chloride pipes and polyethylene pipes

Name		Hard polyvinyl chloride pipe		
JIS number		JIS K 6741-2016		
Material		PVC-U		
Type		VP/HIVP	VM	VU
Nominal diameter	Outside diameter	Pipe Thickness	Pipe Thickness	Pipe Thickness
13	18	2.2		
16	22	2.7		
20	26	2.7		
25	32	3.1		
30	38	3.1		
40	48	3.6		1.8
50	60	4.1		1.8
65	76	4.1		2.2
75	89	5.5		2.7
100	114	6.6		3.1
125	140	7		4.1
150	165	8.9		5.1
200	216	10.3		6.5
250	267	12.7		7.8
300	318	15.1		9.2
350	370		14.3	10.5
400	420		16.2	11.8
450	470		18.1	13.2
500	520		20	14.6
600	630			17.8

Name	Hard polyvinyl chloride water pipe	
JIS number	JIS K 6742-2016	
Material	PVC-U	
Type		VP/HIVP
Nominal diameter	Outside diameter	Pipe Thickness
13	18	2.5
16	22	3
20	26	3
25	32	3.5
30	38	3.5
40	48	4
50	60	4.5
65	76	4.5
75	89	5.9
100	114	7.1
125	140	7.5
150	165	9.6

Name	Heat-resistant rigid polyvinyl chloride pipe	
JIS number	JIS K 6776-2016	
Material	PVC-C	
Type		HT
Nominal diameter	Outside diameter	Pipe Thickness
13	18	2.5
16	22	3
20	26	3
25	32	3.5
30	38	3.5
40	48	4
50	60	4.5

(5) Polyethylene pipe

Name		General-purpose polyethylene pipe			
JIS number		JIS K 6761-2017			
Material		PE80, PE100			
Type		3 types of pipes SDR11	3 types of pipes SDR13.6	3 types of pipes SDR17	3 types of pipes SDR21
Nominal diameter	Outside diameter				
25	25	2.3			
32	32	3			
40	40	3.7			
50	50	4.6			
63	63	5.8			
75	75	6.8	5.6	4.5	3.6
90	90	8.2	6.7	5.4	4.3
110	110	10	8.1	6.6	5.32
125	125	11.4	9.2	7.4	6
160	160	14.6	11.8	9.5	7.7
180	180	16.4	13.3	10.7	8.6
250	250	22.7	18.4	14.8	11.9
315	315	28.6	23.2	18.7	15
355	355	32.2	26.1	21.1	16.9
400	400	36.3	29.4	23.7	19.1
450	450	40.9	33.1	26.7	21.5
500	500	45.4	36.8	29.7	23.9
560	560	50.8	41.2	33.2	26.7
630	630	57.2	46.3	37.4	30
710	710		52.2	42.1	33.9
800	800		58.8	47.4	38.1

11.4.2 JWWA Standards

Name	PVC-lined steel pipes for water supply			
Standard number	JWWA K 116-2025			
Material	Carbon steel			
Type	SGP-VA、SGP-VB			SGP-VD
Nominal diameter	Outside diameter	Pipe Thickness	Lining (inner surface)	Lining (Outer)
15	21.7	2.8	1.5	1.5
20	27.2	2.8	1.5	1.5
25	34	3.2	1.5	1.2
32	42.7	3.5	1.5	1.2
40	48.6	3.5	1.5	1.2
50	60.5	3.8	1.5	1.2
65	76.3	4.2	1.5	1.2
80	89.1	4.2	2	1.2
100	114.3	4.5	2	1.5
125	139.8	4.5	2	1.5
150	165.2	5	2.5	1.5

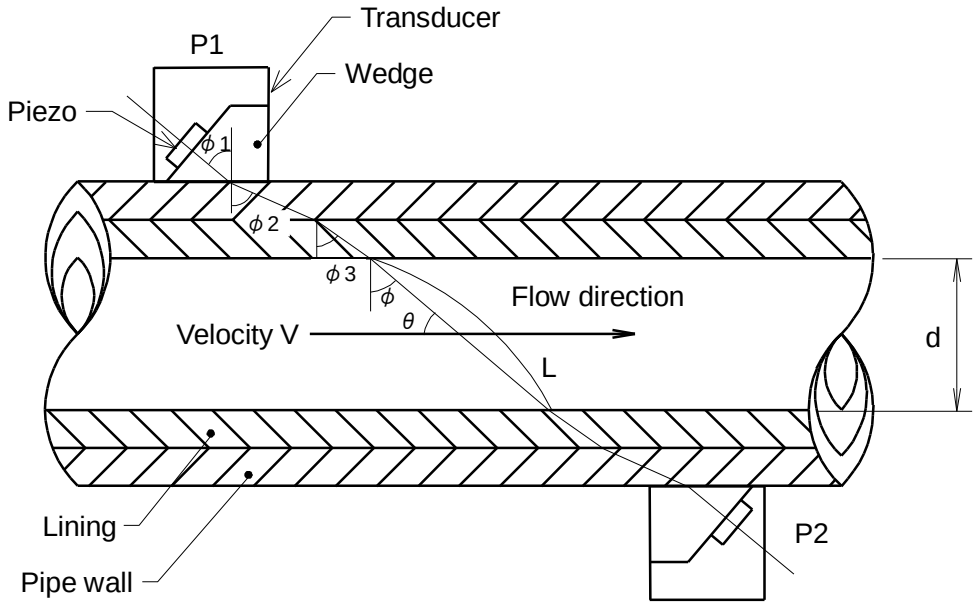
Name	Stainless steel pipes for water supply	
Standard number	JWWA G 115-2012	
Material	SSP-SUS***	
Nominal diameter	Outside diameter	Pipe Thickness
13	15.88	0.8
20	22.22	1
25	28.58	1
30	34	1.2
40	42.7	1.2
50	48.6	1.2

Name	High-density polyethylene pipes for water distribution	
Standard number	JWWA K 144-2017	
Material	PE	
Nominal diameter	Outside diameter	Pipe Thickness
50	63	5.8
75	90	8.2
100	125	11.4
150	180	16.4

11.4.3 ASME standard (overseas standard)

Name		Welded and seamless wrought steel pipe				Stainless steel pipe			
Standard number		ASME B36.10				ASME B36.19			
Material		Carbon steel				Stainless steel			
Type		Sch 5	Sch 10	Sch 20	Sch 40	Sch 5	Sch 10	Sch 40	Sch 80
Nominal diameter	Outside diameter								
1/2B	21.3	1.65	2.11		2.77	1.65	2.11	2.77	3.74
3/4B	26.7	1.65	2.11		2.87	1.65	2.11	2.87	3.92
1B	33.4	1.65	2.77		3.37	1.65	2.77	3.37	4.55
1 1/4B	42.2	1.65	2.77		3.55	1.65	2.77	3.55	4.86
1 1/2B	48.3	1.65	2.77		3.68	1.65	2.77	3.68	5.08
2B	60.3	1.65	2.77		3.91	1.65	2.77	3.91	5.54
2 1/2B	73	2.1	3.04		5.15	2.1	3.04	5.15	7.01
3B	88.9	2.1	3.04		5.48	2.1	3.04	5.48	7.62
3 1/2B	101.6	2.1	3.04		5.74	2.1	3.04	5.74	8.08
4B	114.3	2.1	3.04		6.02	2.1	3.04	6.02	8.56
5B	141.3	2.77	3.4		6.55	2.77	3.4	6.55	9.53
6B	168.2	2.77	3.4		7.11	2.77	3.4	7.11	10.98
8B	219.1	2.77	3.75	6.35	8.17	2.77	3.75	8.17	12.7
10B	273.1	3.4	4.2	6.35	9.27	3.41	4.2	9.28	12.7
12B	323.9	3.96	4.57	6.35	10.3	3.97	4.58	9.53	12.7
14B	355.6	3.96	6.35	7.92	11.1	3.97	4.78		
16B	406.4	4.19	6.35	7.92	12.7	4.19	4.78		
18B	457.2	4.19	6.35	7.92	14.3	4.19	4.78		
20B	508	4.78	6.35	9.53	15.1	4.78	5.54		
22B	558.8	4.78	6.35	9.53	-	4.78	5.54		

11.5 Measurement principle of ultrasonic flowmeter



Ultrasonic pulse propagation

A “Transducer” consists of piezo-electric device for transmitting and receiving ultrasonic pulse and a plastic wedge. Transducers P1 and P2 have the same structure and characteristics.

When an ultrasonic pulse is transmitted from the piezo-electric device r of transducer P1, the pulse is propagated through the wedge and strikes the boundary with the pipe wall at angle $\phi 1$. The wave is then refracted and propagated through the pipe wall at angle $\phi 2$.

The pulse then passes through the lining at refraction angle $\phi 3$ and through the fluid at refraction angle ϕ.

When the sound speed is defined as C1 in the wedge, C2 in the pipe wall, C3 in the lining, and C in the fluid, the following formula can be deduced from the law of refraction.

$$\frac{\sin\phi 1}{C1} = \frac{\sin\phi 2}{C2} = \frac{\sin\phi 3}{C3} = \frac{\sin\phi}{C} \qquad (1)$$

The ultrasonic pulse propagated through the fluid reverses the previous path (fluid→lining→ pipe wall) and is received by transducer P2. The received pulse is then converted into an electronic pulse.

The following formula can be written when the propagation time of an ultrasonic pulse from P1 to P2 (in other words the positive direction of the fluid) is defined as td.

$$td = \frac{d}{\sin\theta \cdot (C + V \cdot \cos\theta)} + \tau \quad (2)$$

Conversely, the following formula can be written when the propagation time of an ultrasonic pulse from P2 to P1 (in other words the reverse direction of the fluid) is defined as tu.

$$tu = \frac{d}{\sin\theta \cdot (C - V \cdot \cos\theta)} + \tau \quad (3)$$

In these formulas d is the internal diameter of the pipe, θ is the angle between the ultrasonic pulse advance and the flow direction, and τ is the fixed delay time (sum of time required for the pulse to travel through the wedge, pipe wall, and lining and the electronic delay time of the flowmeter).

Since the velocity of sound in water C is much larger than flow rate V, the following assumption can be made: $C^2 > V^2 \cos^2\theta$
Therefore, when the propagation time difference $\Delta t = tu - td$ is calculated, the following formula can be deduced from formulas (2) and (3).

$$\Delta t = tu - td = \frac{2 \cdot (d/\sin\theta) \cdot V \cdot \cos\theta}{C^2} \quad (4)$$

If the propagation time in still water is defined as to, formula (5) can be deduced from formulas (2) and (3).

$$to = \frac{tu + td}{2} = \frac{d/\sin\theta}{C} + \tau \quad (5)$$

The following is then obtained by substituting formula (4) into the above formula.

$$\Delta t = \frac{2 \cdot (to - \tau)^2 \cdot V \cdot \cos\theta}{d/\sin\theta} \quad (6)$$

Finally, the following is obtained by solving for V in formula (6).

$$V = \frac{d/\sin\theta}{2 \cdot (to - \tau)^2 \cdot \cos\theta} \cdot \Delta t = \frac{d}{2 \cdot \sin\theta \cdot \cos\theta \cdot (to - \tau)^2} \cdot \Delta t \quad (7)$$

Since the flow velocity V obtained by the ultrasonic flowmeter is an average velocity through the diameter between the transducers, the actual average velocity $\overline{V}$ is different. The ratio between these 2 velocities is expressed using flow volume correction coefficient k, as shown below.

$$\text{Flow volume correction coefficient}\,(k) = \frac{\text{Average flow velocity obtained by ultrasonic flow meter}(V)}{\text{Actual average flow velocity}(\overline{V})} \quad (8)$$

Next, flow volume q can be expressed as shown in formula (9) when the cross-sectional area of the pipe is defined as A.

$$q = A \cdot \overline{V} = A \cdot \frac{V}{k} = \frac{1}{k} \cdot \frac{\pi \cdot d^2}{4} \cdot \frac{d}{2 \cdot \sin\theta \cdot \cos\theta \cdot (to - \tau)^2} \cdot \Delta t$$
$$= \underbrace{\left[\frac{1}{k} \cdot \left\{ \frac{\pi \cdot d^2}{4} \cdot \frac{d}{2 \cdot \sin\theta \cdot \cos\theta} \right\} \right]}_{\text{Scale factor}} \cdot \frac{\Delta t}{(to - \tau)^2} \quad (9)$$

Therefore, if the scale factor in formula (9) is calculated beforehand, flow volume q can be calculated from the actual measurement values of formulas (4) and (5). In other words, formula (9) shows that the affects of changes in the velocity of sound in water can be eliminated by measuring Δt and to.

Next, the flow volume correction coefficient k, expressing the relationship between the measurement velocity V and the actual average velocity $\overline{V}$ as shown by formula (8), changes depending on the Reynolds Number. Therefore, with this ultrasonic flowmeter, the velocity V obtained from formula (7) using the ultrasonic flowmeter is further used to obtain a temporary average velocity $\overline{V}$ using formula (10). The Reynolds Number Re expressed in formula (11) is then calculated using this temporary value.

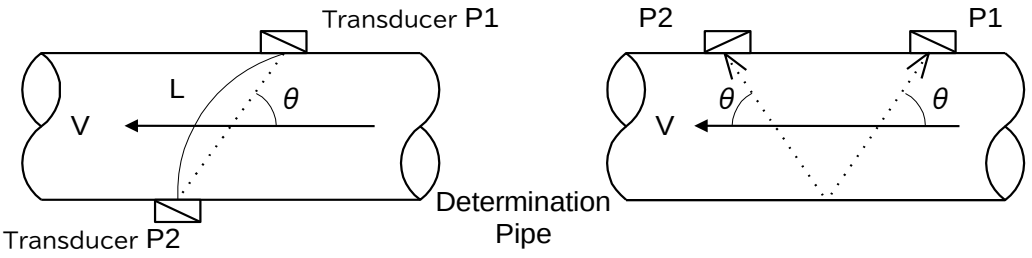
$$\overline{V} \fallingdotseq V \quad (10)$$

$$Re = \frac{d \cdot \overline{V}}{\nu} \quad (\nu; \text{Kinematic viscosity}) \quad (11)$$

Finally, the Reynolds Number Re calculated using formula (11) is used to calculate a flow volume correction coefficient k, correlated to the flow velocity, from the formula of G.E. Birger.

11.6 Z method (transmission method) and V method (reflection method)

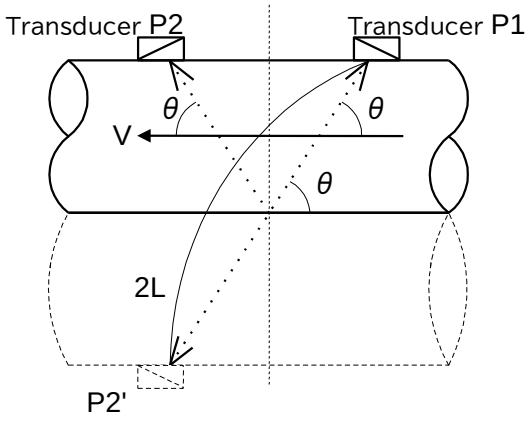
In ultrasonic flowmeters, there are two measurement methods, the Z method (transmission method) and the V method (reflection method), depending on the ultrasonic propagation path shown below. For convenience in explaining the measurement principle, we have used the Z method, but here we will explain the V method. The V method has the advantage that it is easy to obtain stable measurement values even when the fluid flow direction has a flow component perpendicular to the pipe axis, that is, even when the flow is a swirling flow. However, there are problems such as greater ultrasonic attenuation because the ultrasonic propagation path is about twice that of the Z method.



Z method (transmission method) determination

V method (reflection method) determination

As can be seen below, the calculation formula for the V method is the same as the formula for the Z method, which was calculated by assuming that the inner diameter is doubled and the flow velocity does not change. Therefore, apart from some slight changes, such as changing d to 2d and the scale factor to 1/2, the formula can be used to calculate the result as a whole.



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Chapter12 Questions and answers

12.1 Measurement method

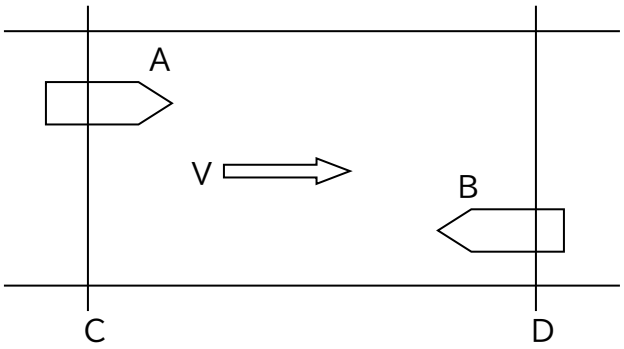
(1) What is ultrasound?
It is a sound with a high frequency that cannot be heard by the human ear (generally considered to be above 20 kHz).

(2) What frequency of sound is used in ultrasonic flow meters?
Typically, frequencies from several hundred kHz to several MHz are used.

(3) Why do you use such high frequencies?
Normal sounds (audible sounds) were used, they would get mixed up with surrounding sounds.

(4) Is it harmful to the human body?
No. Ultrasound is also used in the medical field.

(5) How can flow rate be measured using ultrasound?



When there is no water flowing in a river like the one shown above, if boat A and boat B are traveling at exactly the same speed, the time tA for A to reach D and the time tB for B to reach C are the same. what happens if water is flowing from C to D at a flow velocity V, Boat A, riding the flow of the water, will reach its destination faster than boat B, which is going against the flow. In other words, tB will take longer to travel against the flow, and tA will arrive sooner by going with the flow. The principle is extremely simple. Flow velocity is measured by utilizing the fact that the difference in the arrival times of these two boats (time lag) is roughly proportional to the flow velocity. This relationship can be expressed by the following equation.

$$tB - tA = \Delta t$$

Δt in the above formula is the time difference. By measuring Δt , the flow velocity V can be calculated, and then the flow rate can be calculated by multiplying it by the cross-sectional area of the circular pipe or the cross-sectional area of the open channel. In this case, the measured flow velocity V must be corrected to the average flow velocity using a flow correction coefficient.

(6) Is the time difference method the only method for measuring flow rate using ultrasound?

Three types of measurement methods in practical use:
①Frequency difference method ②Time difference method ③Doppler method
① and ② are primarily used to measure relatively clean water. This is because fluctuations in the ultrasonic propagation level (sensitivity of ultrasonic transmission and reception) can be a problem (dirty water has greater attenuation). Measurement method ③ detects the shift (change) in the ultrasonic frequency , so fluctuations in the ultrasonic propagation level are not a big issue and it is suitable for measuring dirty water such as sewage.

(7) Does the speed of sound change with water temperature?

Yes, it does. Ultrasonic flow meters are designed to reduce the effects of changes in sound speed caused by changes in water temperature.

12.2 Measurement fluid

(1) Measurement fluid

In principle, any liquid that allows stable propagation of sound waves can be measured. However, liquids that contain a large amount of air bubbles or foreign matter may result in missing readings or may be impossible to measure. Also, it is not possible to make generalized statements about high-temperature, high-pressure liquids (such as oil), so please consult with our sales office.

(2) Can you measure raw water?

It can measure not only purified water, but also river water and raw water.

(3) In the case of raw water, what is the effect of turbidity?

This can be broadly divided into two issues.
1) Will changes in turbidity cause measurement errors?
②Will the high turbidity cause the ultrasound to be attenuated and make it impossible to measure?
① , if the ultrasonic wave penetrates sufficiently, usually there will be no error due to changes in turbidity.
② , the attenuation of ultrasonic waves is related to the grain size of the mud, but it is true that the signal is attenuated when the turbidity is extremely high. Our company specifies that the turbidity should be up to 10,000 degrees for a pipe diameter of 1m (note: 1,000 degrees is 1g of refined white clay in 1 liter of water).
Although 5,000 degrees is a considerable amount of turbidity, it is said that turbidity in rivers rarely exceeds 1,000 degrees, so it is not a problem in practical use.

(4) What happens to the measurement if air gets into the tube?

・Compared to water, air hardly transmits ultrasonic waves. Therefore, if the pump continuously sucks in air, air bubbles will continuously pass through the ultrasonic wave propagation path, which may cause the measurement value to fluctuate or be missing.
Please note that if the depth from the water surface at the intake point to the top of the pipe is insufficient, air may be sucked in, resulting in missing readings or making measurements impossible.
・If air accumulates on the top of the pipe, it will not interfere with the measurement, but it will indicate a flow rate that is higher than the actual flow rate. (Note: If the sensor is installed vertically on a horizontal pipe, measurement will not be possible if there is an air layer in the pipe.) Therefore, if there is a possibility that air may accumulate, install an air vent in front of the measurement position.

(5) Can sewage be measured?

There are no problems with turbidity in the inflow sewage or discharge water. However, since air bubbles are likely to occur in areas such as downfalls and immediately after the pump discharge port, it is necessary to pay attention to the piping conditions at the measurement location.

(6) Can measurements be made when solid objects or debris are present?

If the solid object is small, the ultrasonic waves have a certain beam width (irradiation width), so stable measurement is possible. If the debris is large enough to block the ultrasonic waves, the received waves disappear and it can be clearly distinguished from normal measurement values, so the device has a function to determine not to use it as input data. This is a function called obstacle detection, and whether or not normal measurement can be performed depends on the frequency of obstacle detection occurrences. However, if a large number of solid objects or debris is continuously mixed in, measurements will be missing or measurement will be impossible.

12.3 About the measuring tube

(1) What types of pipes can be measured?

We have a proven track record of measuring steel pipes, SUS pipes, cast iron pipes, ductile cast iron pipes, and plastic pipes.

- Measurements have been performed on RC steel pipes, but ultrasonic waves do not propagate easily through these pipes, so they are not particularly suitable.
- Asbestos pipes are rarely measurable, but are practically impossible to measure.
- Hume pipes are practically impossible to measure.
- Ultrasonic waves may not propagate easily through PVC-lined steel pipes. Please refer to (3) below.
- Ultrasonic waves may not propagate easily through SGP pipes.

(2) What is the pipe diameter that can be measured?

The diameters range from 13A to 5000A.

(3) Is there any problem with the lining?

There is no effect from the lining of ordinary pipes, whose inside is lined with mortar, epoxy, etc. If the outside of the pipe is wrapped in jute, etc., remove the jute only at the part where the sensor is to be installed and then install the sensor.

In PVC-lined steel pipes, an air gap may exist between the steel pipe and the PVC lining. In such cases, measurement is not possible, but it may be possible to deal with the problem by changing the sensor installation position, etc.

(4) What happens if the lining on the inside of the pipe peels off?

I have heard that the lining on the inside of the pipe is generally tightly attached, and because water pressure is applied during use, there are almost no cases of peeling. Even if peeling does occur, it is not a problem as long as it is not exactly at the sensor position. Although it is difficult to say for sure, even in the worst-case scenario of the sensor falling off, it may be possible to deal with the problem by changing the sensor installation position, etc.

(5) What about the effect of rust or rust bumps on the inside of the pipe?

A small amount of rust here and there in cast iron pipes will not have an effect. However, if rust occurs over the entire surface, it will cause errors and missing readings. For example, if 1mm rust bumps occur over the entire inner surface of a ϕ1,000mm pipe, it will cause an error of about 0.7 %.

12.4 Installation location

(1) How much straight pipe section (straight pipe length) is required?

Ultrasonic flowmeters require a well-developed flow velocity distribution. However, according to JEMIS 032-2019 , the required straight pipe length for ultrasonic flowmeters is generally 10D or more upstream of the sensor and 5D or more downstream to guarantee accuracy (D is the pipe diameter) . For details on straight pipe length, please refer to "11. 1 Piping requirements and required straight pipe length".

(2) How far away can the flow meter body be from the sensor?

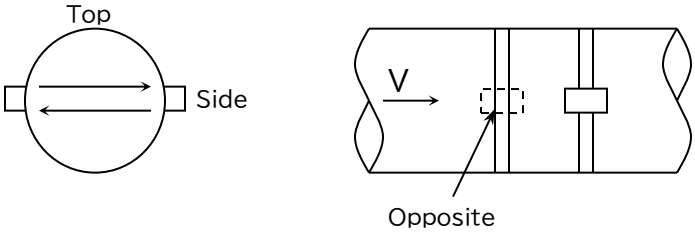
160 m long by using an extension cable. However, when the cable is extended, it becomes more susceptible to external noise and electrical attenuation of the signal.

(3) What are the Z method and V method measurement methods?

It is the abbreviation of the sensor installation method. The Z method is also called the "through-beam method". It is applied to pipes with a large amount of ultrasonic attenuation. It is also used for pipes where the sensor cannot be installed using the V method.
The V method is a method of receiving ultrasonic waves by reflecting them off the inner wall of a pipe, and is also called the "reflection method." In general, it is easier to install a sensor than the Z method. This method was devised as a measurement method that is not affected by the radial flow velocity component (V method effect) when the flow direction is not parallel to the pipe axis. The applicable diameter of the V method varies depending on the pipe material, but is generally ϕ2,000mm or less. For details, please refer to "11. 6 Z method (transmission method) and V method (reflection method)".

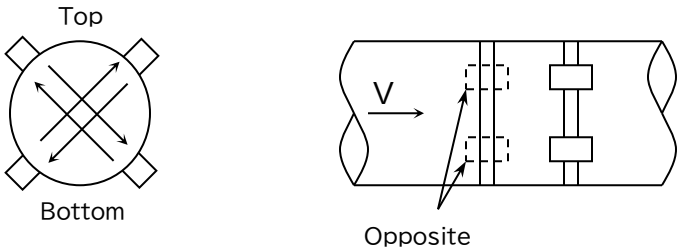
(4) What are the one- line and two- line measurement methods?

The standard measurement method is single line measurement with two sensors attached (the diagram below is an example of Z method measurement with two sensors attached horizontally on the pipe).



Sensor installation example (1 line, Z method)

Two- line measurement method, two sets of sensors (four sensors) are installed as shown in the figure below. While the one- line measurement method measures the flow velocity on one line (diameter axis), this two- line measurement method measures the flow velocity on two lines (diameter axis) and takes the average of these measured flow velocity values, which reduces the effects of disturbances in the flow velocity distribution.



Sensor installation example (2 lines, Z method)

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Chapter13 Troubleshooting

13.1 Equipment edition

Symptoms	Cause	Treatment
The power won't turn on.	The power key is not pressed correctly.	Press and hold the power key (for 3 seconds or more).
	The AC adapter is not connected.	Please check the AC adapter connection.
	The battery is not charged. (If operating on battery)	Please charge the battery.
	The battery is not inserted correctly.	Please check the battery insertion.
LCD display is dim	The LCD brightness is not adjusted properly.	Adjust the LCD brightness.
LCD brightness cannot be adjusted	The LCD is deteriorating.	The LCD needs to be replaced. Please contact our sales department.
The LCD display goes blank	The power saving mode is set.	Press any key to return the LCD display to normal. In power saving mode, the LCD display will turn off if no key is pressed for a certain period of time.
Key operation is not possible	There is a possibility of equipment failure.	Please contact our sales office.
The date and time are reset when the power is turned off.	The backup battery is dead.	The backup battery needs replacing. Please contact our sales office.
Battery won't charge	The charging temperature is outside the specified range. There is a possibility of equipment failure.	Please check the status at "System" - "Device Information" - "Device Information/Updates" - "Battery". Please contact our sales office.
No echo is displayed	No reception	Change the sensor mounting position.
ⓘ is displayed	It eliminates measurement disturbances caused by air bubbles and solids in the fluid, external noise, etc.	If this message appears frequently, check that the measured fluid does not contain air bubbles or solid objects.

13.2 Measurement

Symptoms	Cause	Treatment
Ultrasound detection is unstable or not possible.	Air bubbles or foreign matter are present.	Eliminate these factors.
	Air bubbles are mixed in due to cavitation.	Places where there is a pressure difference in the pipeline (near a valve, etc.). If bubbles caused by cavitation have an effect, please move sufficiently away from the place where they are generated and perform the measurement at a position where the bubbles have disappeared.
	The unit is affected by external noise.	Ultrasonic flowmeters generally receive weak electrical signals of a few mV, so they may be affected by strong opening and closing noises such as surges and kicks. If you suspect that external noise may be affecting the system, check the wiring and grounding of each cable (especially the sensor cable). In the case of metal piping, it may be effective to electrically insulate the metal parts of small and medium sensors from the piping. However, the noise from the inverter may be very strong and may be impossible to deal with. If the sensor cable is extended, it becomes more susceptible to external noise.
There are some pipes that cannot be measured.	There is rust or scale on the inside of the pipes.	Try moving the flowmeter installation location to find a measurement position where the received signal can be obtained (for example, a position with less rust). If you are using the V method, changing to the Z method will improve reception strength. Also, change a small sensor to a medium sensor, or a medium sensor to a large sensor. Changing to a sensor will also improve reception strength. Old SGP pipes (white gas pipes) may have rust on the inside of the pipe.
	It is attached to a PVC-lined steel pipe.	There may be an air gap between the steel pipe and the PVC lining, making it impossible to measure. Try moving the flowmeter installation position to find a measurement position where the received wave can be obtained (a position with less air gap).
	The ultrasonic waves are attenuated significantly.	Asbestos pipes and FRPM pipes are known to significantly attenuate sound waves due to the pipe materials. Please try the Z method installation.
There are some fluids that cannot be measured.	There is a large amount of air bubbles or foreign matter mixed in.	Please measure at a location with few air bubbles. If the air bubbles are caused by a drop in the upstream, reduce the drop. If there is an air layer in the piping, install an air bleed valve before the measurement location.
The required measurement accuracy cannot be achieved.	The flow velocity distribution is disturbed.	Install in a position that satisfies the straight pipe length requirements.
	The cross-sectional area of the flowing water has changed due to rust, scale, and non-full water.	Install in a location that is free of rust and scale.

	It is affected by the seams of the piping.	Install at an angle to avoid seams.
	The piping specifications are incorrect.	Please enter the correct piping information.
	The sensor is not installed correctly.	When installing the sensor, make sure it is parallel to the pipe.
Even though there is no fluid, there is no echo.	The ultrasonic waves transmitted through the pipe wall are received.	This may be avoided by changing the sensor mounting method.
Measure when no echo is received.	Is set. For example, if 20mA is set to 1000m3/h, it will output 1000m3 /h. The cumulative value is also counted.	Please review the analog output burnout setting.

Document No. KF25-004A
Portable Ultrasonic Flowmeter UW-30P
Installation & Operation Manual
August 2025 1st Edition
September 2025 2nd Edition

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