Doc No. KF08-002L

Portable
Ultrasonic Flowmeter

UFP-20

Installation & Operation Manual

TOKYO KEIKI INC.

Ultrasonic Flowmeter
Safety Precautions

The following safety precautions contain important information pertaining to the safe use of the Ultrasonic Flowmeter. Read this text carefully and follow the directions given herein at all times.
In order to prevent injury and/or damage resulting from inappropriate use, carefully follow the instructions given in this Operation Manual when operating the equipment, and observe the caution markings and messages below. Read the instructions in the Operation Manual carefully and make sure to fully understand its contents before attempting to operate the Ultrasonic Flowmeter.
For quick reference, store this Operation Manual in a designated location with easy access (preferably near the equipment).

1. Caution Messages
Refer to the table below for definitions of caution messages on the equipment and in this manual.

Danger	Indicates that incorrect usage can result directly in death or serious injury to the operator.
Warning	Indicates that incorrect usage may result in death or serious injury to the operator.
Caution	Indicates that incorrect usage may result in injury to the operator or damage to the equipment.

2. Warning label
The following warning label is attached to the equipment.

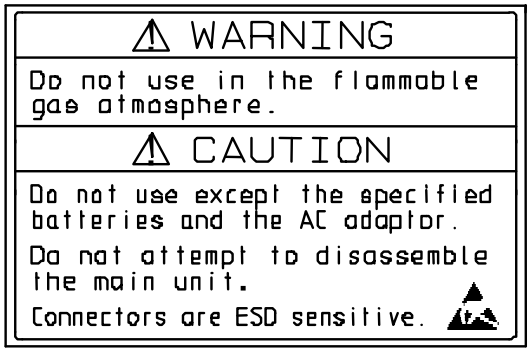

Fig. 1-1 Warning label

The attachment of warning label is as follows.

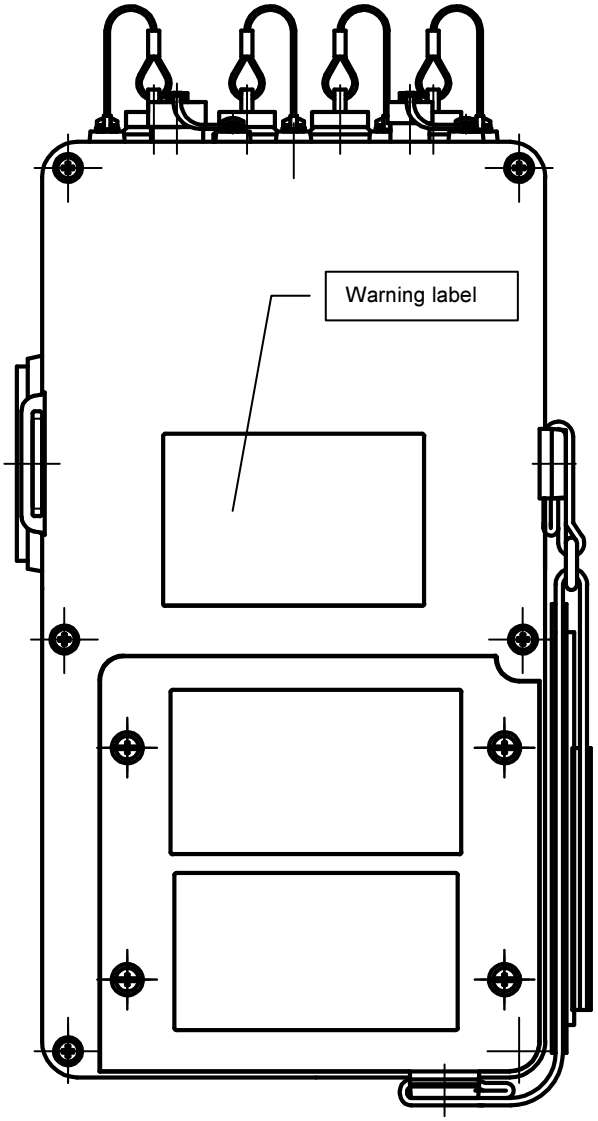

Fig. 1-2 Rear view of main unit

Usage Precautions

This instrument is used to measure flow quantities by means of ultrasound. For safe usage and optimum performance of the flowmeter, always operate the instrument according to the usage precautions below.

1. Failure to comply with one or more of the following conditions may result in poor measurement performance or incorrect measurement values.
   - Use an appropriate power supply rated for the voltage range designated in the specifications.
   - Use the equipment within the predetermined ambient temperature and humidity range.
   - Fill pipes entirely with water.
   - Be sure bubbles or particles that might interfere with ultrasonic waves are absent during measurement.
   - Position the transducer in accordance with the required straight pipe length.
   - Do not subject the transducer to vibration or mechanical shock.
   - Place the flowmeter unit, transducer and cable in a location without noise interference.

2. In case of measurement failure, alarm indications are displayed on the LCD. During measurement failure, the flowmeter may display the flow value preceding the alarm.

3. Be sure to use the instructions in the Manual when changing settings on the main flowmeter unit. Incorrect settings will result in poor performance or incorrect measurement values.

4. Do not modify or disassemble the unit. Such actions may result in electrical shock or equipment damage.

5. Do not use any battery or AC adaptor except the specified one by manufacturer. In case of such unmatched combination may result in electrical shock or equipment damage.

6. To comply with CE certification, do not operate the unit with the charger plugged in.

7. If this Operation Manual is lost, contact the nearest representatives.

Introduction

Thank you for purchasing our Ultrasonic Flowmeter.
This Manual includes detailed explanations regarding safety cautions, structure, set up, operation, troubleshooting, and maintenance of the Ultrasonic Flowmeter.
Read this manual carefully before operation to ensure an adequate understanding of the equipment.

Proper use of the Operation Manual

The following points must be observed:

1. Carefully read the Manual. The contents of this Manual are very important and should be read completely.
2. Store the Manual in a safe location. The Manual is essential for appropriate operation of the equipment. Store the manual in a safe and accessible location. The storage location and person in charge should be determined after careful consideration.
3. Ensure that the Manual is supplied to the operator of the equipment. The representative or dealer of this equipment must provide this Manual to the user who will actually operate the equipment.
4. The Manual must be replaced if lost or damaged. If the Manual is lost, contact the representative. A new manual is available for purchase.
5. Ensure that the warning label is properly attached. If the warning label is illegible or has come off, contact the manufacturer to purchase a new label.

Precautions regarding the Manual

This Manual was written in accordance with the standard specifications of the original instrument.
In case of discrepancies between written specifications and approved drawings, the drawings should be given precedence.

Restrictions and precautions necessary to maintain the equipment

The following items must be observed in order to maintain the equipment.

1. Do not drop or bump the unit and the transducer.
2. Do not use the unit in environmental conditions (ambient temperature, ambient humidity) other than those prescribed in this manual.
3. Do not use the unit with a power supply other than the one prescribed in this manual.
4. Do not use damaged or worn-out cables (power cables, coaxial cables, signal cables).
5. Under no circumstances attempt to modify or disassemble the instrument. Contact the manufacturer in the event of a malfunction.
6. Do not use the unit and/or accessories in restricted hazardous areas.
7. Paying attention is required when touch the connectors. The excessive static electricity might cause a defective operation and the breakdown
8. In EU area, do not dispose this unit as household waste, please contact with the nearest representatives.

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3. Other

Here you can see concerned with Maintenance, Specification or Measuring Principle.

1. Installation

Chapter 1

INDEX

1.1 Configuration

(1) Components

This Ultrasonic Flowmeter consists of the following primary components. Figure 1.1-1 to 1.1-4 shows the interrelationship among the different parts.

Table 1.1-1 Primary components

No.	Name	Q'ty	Details	Photo
1	Main unit	1pc	Ultrasonic flowmeter Main unit	
2	Battery	1pc	Ni-MH battery	
3	AC adaptor	1pc	AC adaptor for main unit	
4	Couplant	1pc	Silicone grease for acoustic couplant	
5	Protection cover	1pc	Protection cover for main unit	
6	Transducer cable	1pc	Connection cable for transducer and main unit Temperature range: -20 to 65 degree C Length : 7 m	

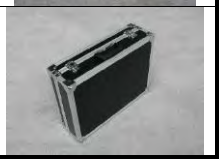
7	Medium transducers and mounting fixture	1set	Ultrasonic transmitter-receiver sensors (to be used in combination with cables) Metal fixtures used to attach transducers onto pipe. Upper photo : transducer 2nd photo : mounting fixture 1 3rd photo : mounting fixture 2 4th photo : Z-path method adaptor (Applicable diameter DN20mm~40mm)	   
8	Carrying case	1pc	Carrying case for primary components	

Table 1.1-2 Transducer Options (Option)

No.	Name	Q'ty	Details	Photo
1	Transducer cable	1pc	Connection cable for transducer and main unit Temperature range : -20 to 65 degree C Length : 7 m	
2-1	Small transducers and mounting fixture	1set	Ultrasonic transmitter-receiver sensors (to be used in combination with cables) Metal fixtures used to attach transducers onto pipe. Upper photo : transducer Below photo : mounting fixture	 
2-2	Medium transducers and mounting fixture	1set	Ultrasonic transmitter-receiver sensors (to be used in combination with cables) Metal fixtures used to attach transducers onto pipe. Upper photo : transducer 2nd photo : mounting fixture 1 3rd photo : mounting fixture 2 4th photo : Z-path method adaptor (Applicable diameter DN20mm~40mm)	   
2-3	Large transducers and mounting fixture	1set	Ultrasonic transmitter-receiver sensors (to be used in combination with cables) Metal fixtures used to attach transducers onto pipe. Upper photo : transducer Mid photo : belt type mounting fixture Below photo : magnet type mounting fixture	  

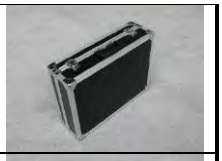
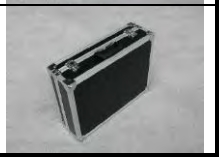
3	Carrying case for small/medium transducer	1pc	Carrying case for small/medium Transducer Kit	
4	Carrying case for large transducer	1pc	Carrying case for large Transducer Kit	

Table 1.1-3 Temperature Options (Option)

No.	Name	Q'ty	Details	Photo
1	Temperature sensor	1pair	Temperature sensor Pt-100 (2pcs) Length : 5 m	
2	Temperature junction box	1pc	Junction box for connection of 4pcs temperature sensor	
3	Metal tape for temperature sensor	1pc	Metal tape for temperature sensor attachment.	

Table 1.1-4 Accessories (Option)

No.	Name	Q'ty	Details	Photo
1	High-Temp transducer cable	1pc	High temperature connection cable for transducer and main unit Temperature range : -20 to 120 degree C Length : 7 m	
2	Extension cables	1pc	50m of Extra connection cable between the transducers and main unit Temperature range : -20 to 65 degree C Length : 50 m	
3	Analog output cable	1pc	Cable for analog output Length : 3 m	

4	Thickness gauge	1pc	Sensor thickness & sound speed measurement Length : 0.7 m	
5	Test piece	1pc	Calibration test piece for above sensor (No.4)	
6	Cigarette lighter cable	1pc	Cable for cigarette lighter port of automobile to supply power to flowmeter Length : 3 m	

(2) Example of flowmeter or massmeter basic system

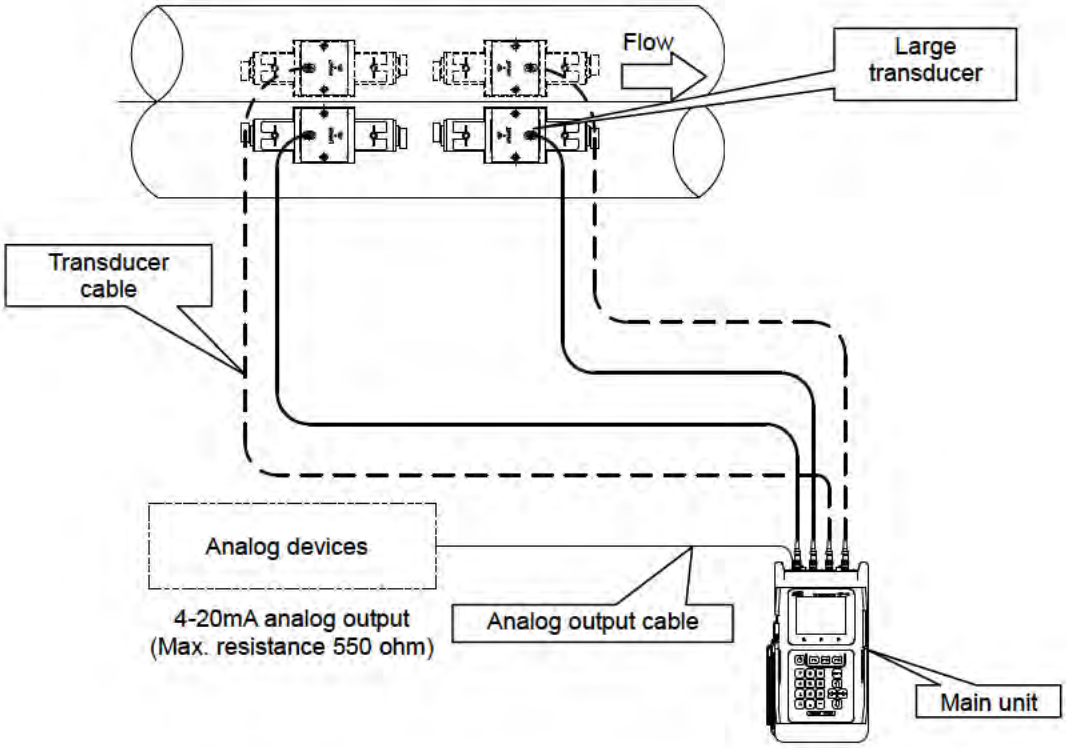


Fig. 1.1-1 Exp. basic system (1 path and 2 path)

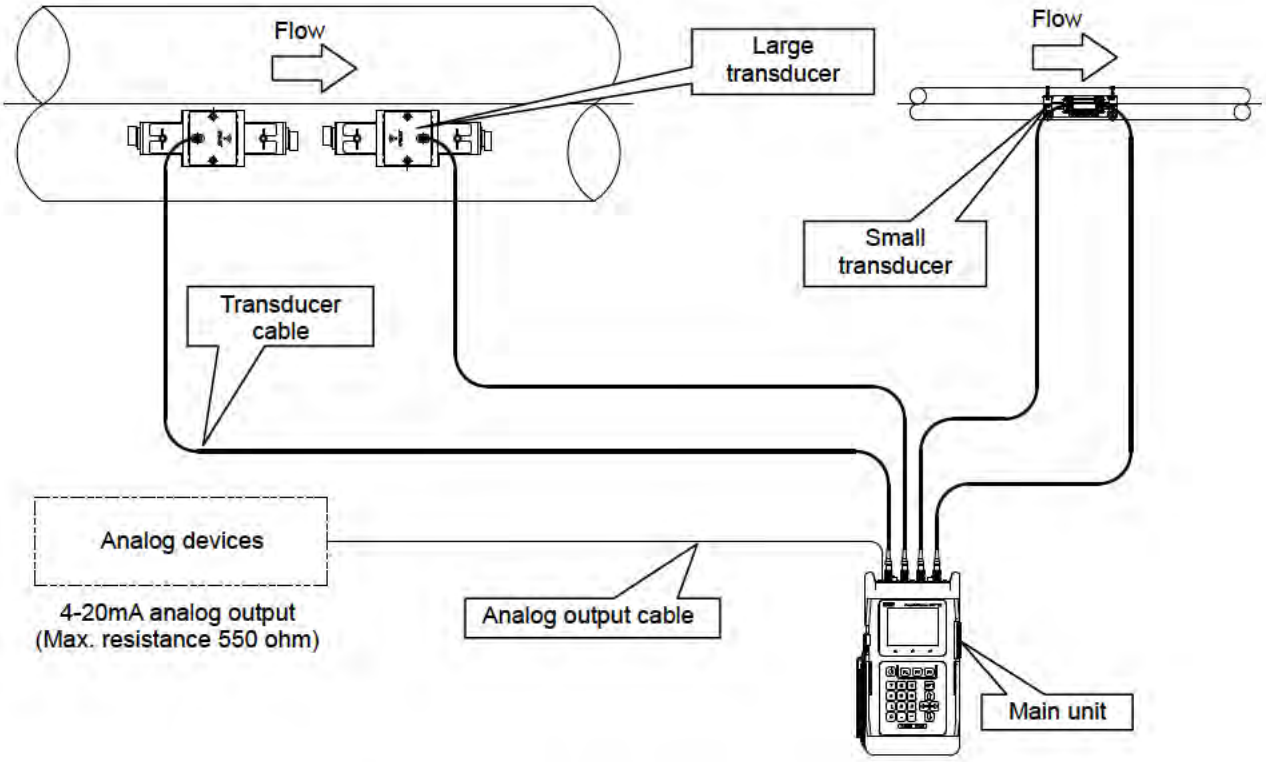


Fig. 1.1-2 Exp. basic system (2 pipes)

(3) Example of heatmeter basic system

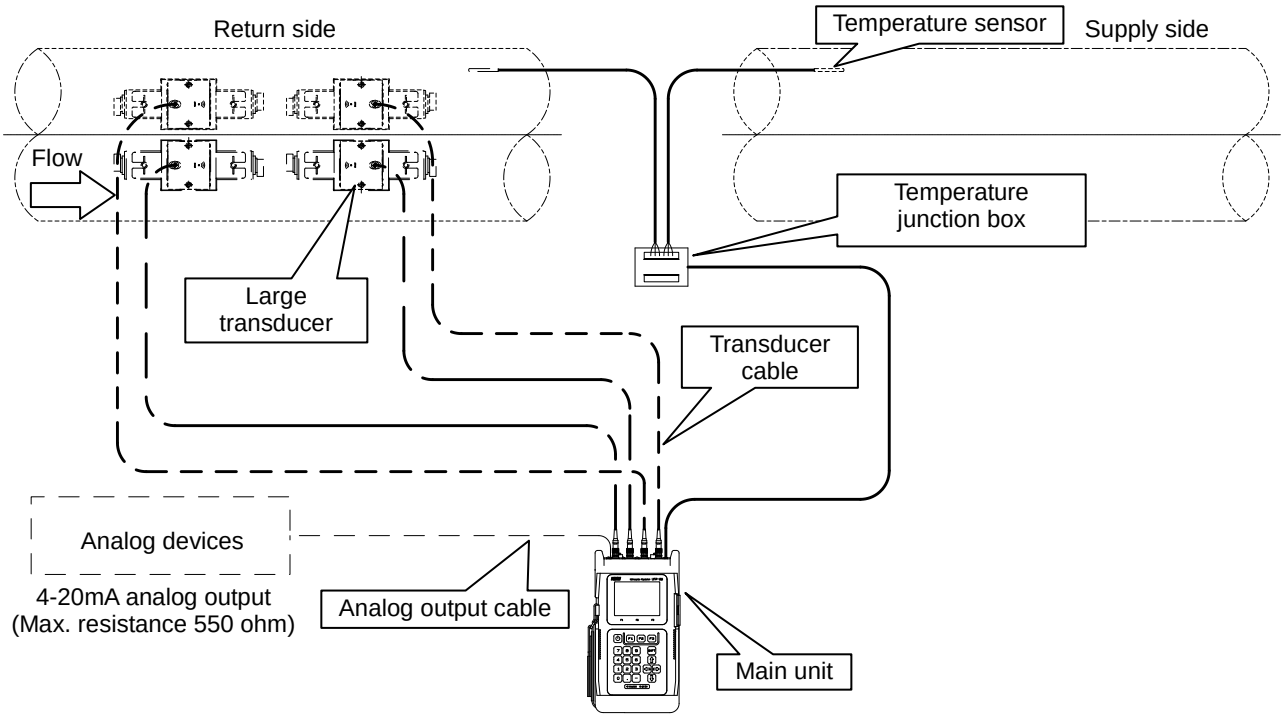


Fig. 1.1-3 Exp. heatmeter basic system (1 path and 2 path)

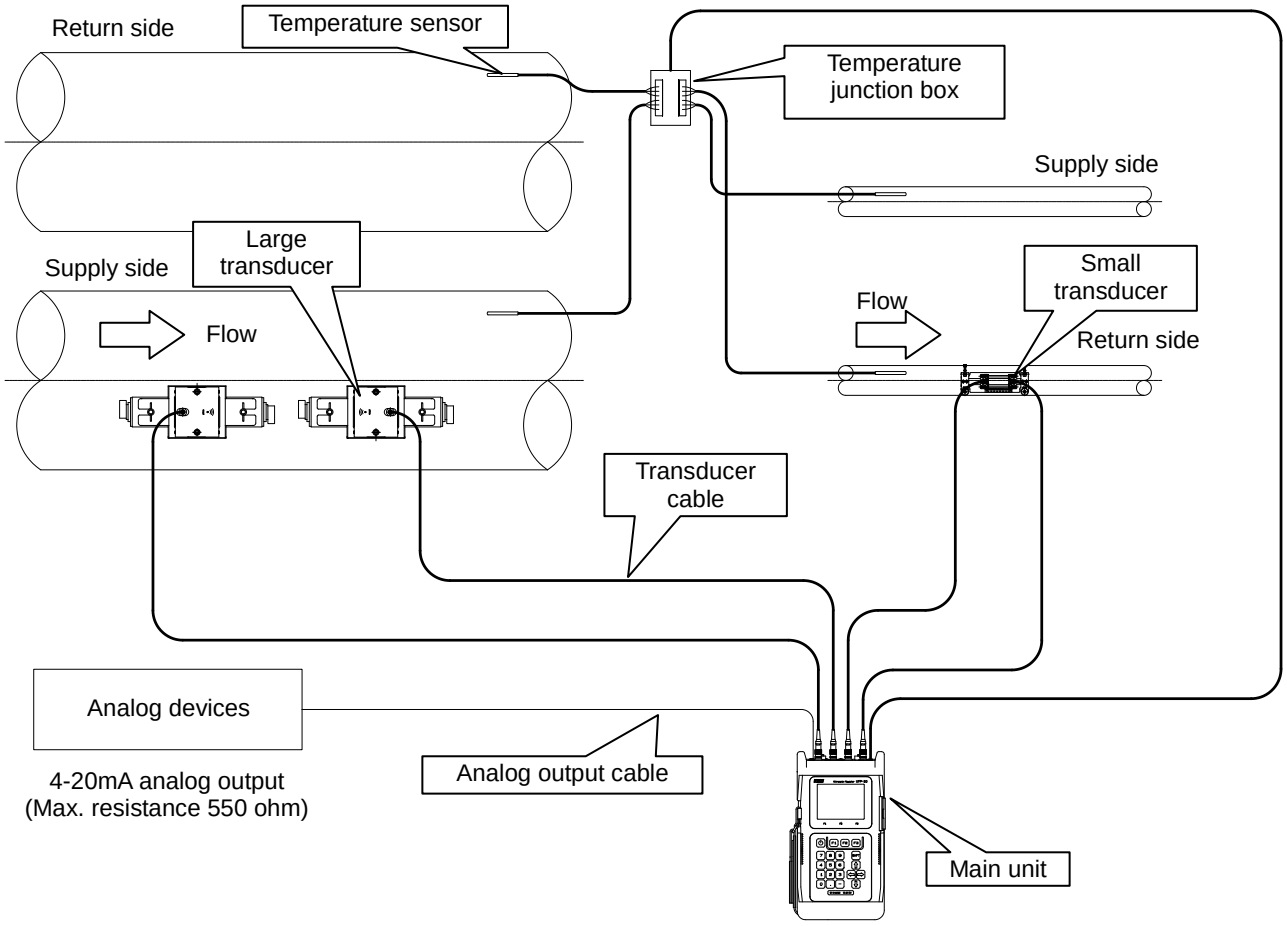


Fig. 1.1-4 Exp. heatmeter basic system (2 pipes)

1. 2 Installation and connections

When setting up the Ultrasonic Flowmeter, carefully consider the conditions stated below.

1. 2. 1 Overview for setup procedure

(1) Procedure for first start-up

The basic steps in starting up the flowmeter system are outlined below.

Table 1.2.1-1 Setup items for first start-up

No.	Step	Procedure	Reference Chapter
1	Battery connection	Please open battery cover and set battery. (Screw driver will be required.)	1.2.3 (1)~(3)
2	Battery charge	Battery must be charged prior to use.	1.2.3 (4)
3	Time setting	Please adjust time stamp in your local area.	1.2.3 (7)
4	Localizing setting	Please select your language and system unit from system setting. This procedure requires first once only.	1.2.3 (9)

Note: Battery will be delivered as disconnected.

(2) Procedure for measurement

The basic steps in setting up the flowmeter system are outlined below.

Table 1.2.1-2 Procedure for measurement

No.	Step	Procedure	Reference Chapter
1	Mode selection (if any)	Select from Heatmeter, Flowmeter or Massmeter.	1.2.3 (8)
2	Path & channel selection (if any)	Selection of path & channel Q'ty.	1.2.3 (8)
3	Selection of transducer setup position	Select the best position for measurement.	1.2.5
4	Installation Wizard (Parameter input)	Input required parameters.	1.2.6 ~ 1.2.8
5	Transducer distance confirmation	Check transducer distance on the display.	1.2.9 (1) ~ (5)
6	Transducer installation	Clamp transducers onto the pipe.	
7	Temperature sensor installation (in case of energy measurement)	Attach RTD onto the pipe.	1.2.9 (5)
8	Logging (if any)	Set log function parameters. (interval, start and stop time)	2.2.5 (4)

1.2.2 Connection ports & display indication of the main unit

(1) Setup location

Consider the following conditions when selecting a setup location for the main unit.

a. Place the main unit in a location with an ambient temperature range of -10 to +50 degree C. Do not place the unit near a heating element and avoid exposure to direct sunlight.

b. Do not place the unit in an area with a corrosive atmosphere.

c. Do not place the unit in a location where interference through electrical devices and power lines could occur.

d. Please be noted that IP65 can not kept following conditions

- with AC adaptor connection
- with USB memory connection
- without connector cover on the connector

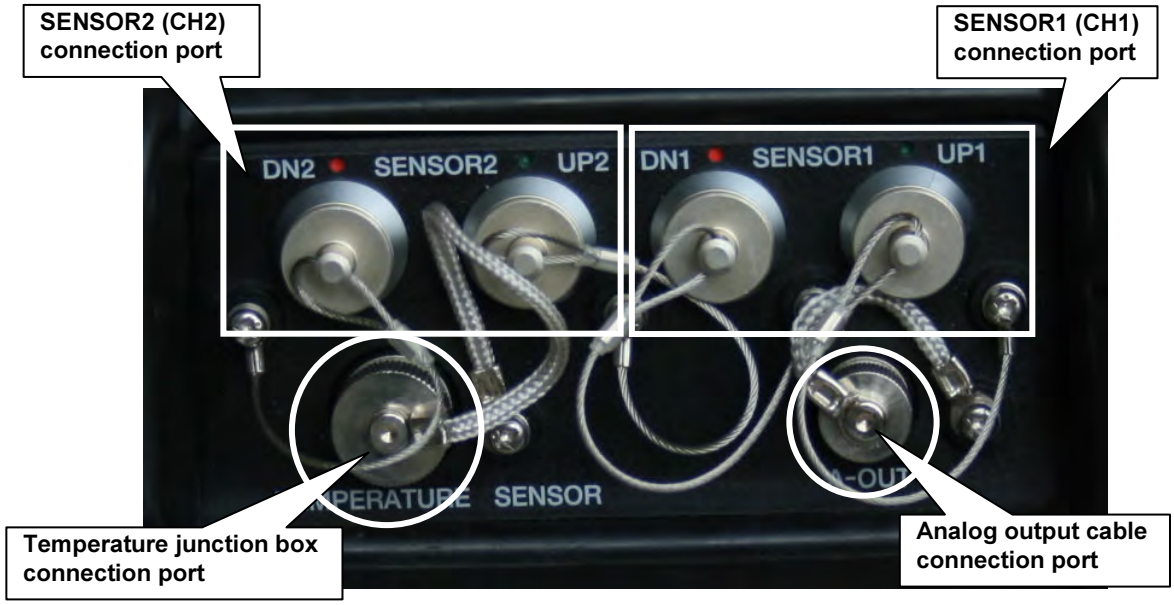


Fig. 1.2.2-1 Sensor connection port

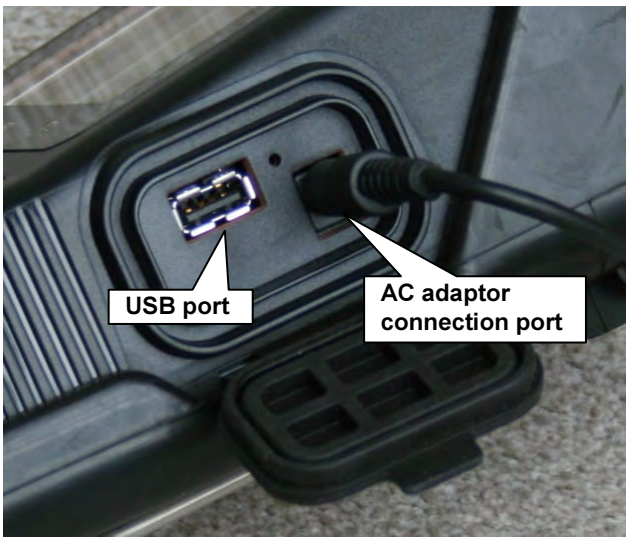


Fig.1.2.2-2 USB & AC adaptor connection port

(2) LCD indication & key panel assignment

All icons and key arrangements are as follows. For detail, please refer to Table1 on next page.

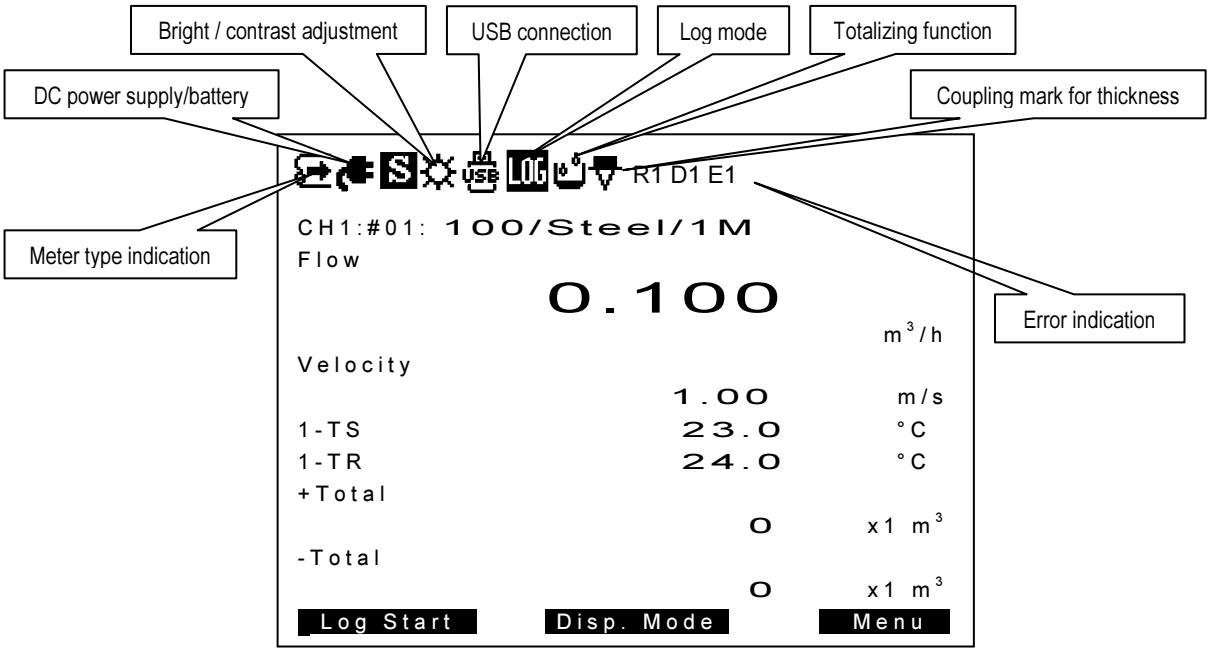


Fig.1.2.2-3 Display indication of the main unit

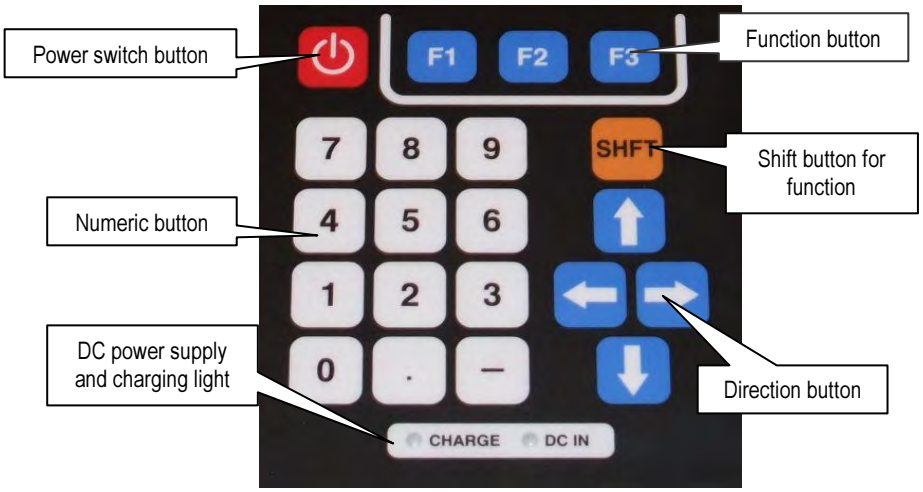


Fig. 1.2.2-4.Key panel

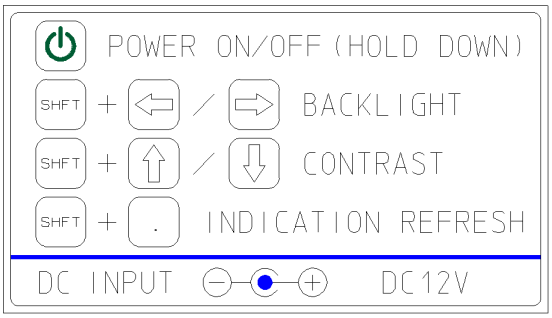


Fig. 1.2.2-5 Backlight/Contrast adjustment

Table 1.2.2-1 Connection terminals, indications and key functions

Specification or settings may limit the functions.

Please be careful of the polarization of each line.

Name	Connection	Icon on display	Instruction
SENSOR1 UP, DN	LEMO		Connection to primary path transducers or thickness gauge. Connect upstream transducers to "UP" side. Connect to downstream transducers to "DN" side.
SENSOR2 UP, DN (*1)	LEMO		Connection to secondary path transducers Connect upstream transducers to "UP" side. Connect to downstream transducers to "DN" side. This connection requires in case of 2 path measurement.
Power-IN/ battery			AC power supply
			The icon indicates remain level of battery. This icon means full charged.
			The icon indicates remain level of battery. Charging is recommended.
			The icon indicates remain level of battery. Battery charge required if battery icon indicated as left. Within 20min power might be off. (*2)
USB port	USB		The icon indicates capable USB memory
Temperature port	12 Core		4 temperature input can be achieved with temperature junction box.
Analog output	2 Core		Analog output
Power button			Power control key
Function button			F1 ~ F3 key will be assigned variable functional key
Shift button			Shift Key for 2nd menu
Contrast adjustment			With shift button and direction key Contrast-Bright control can be adjustable.
Direction button			Selection of direction
Numeric button			Use numeric when input data
Meter type			Flowmeter mode
			Massmeter mode
			Heatmeter mode
Totalizing			Totalizing function activated
Logging			Logging function appointed
			Blinking during logging function activated
			Not available any logging area
Error		R * / D * / E*	R : No Receiving echo warning D : Disturbance error warning E : Parameter error
Thickness / sound speed measurement			Enough echo receiving during thickness / sound speed measurement
			No receiving echo during thickness / sound speed measurement

(*1) 2 path / 2 channel measurement system is an option.

(*2) Remain time until power off depends on component or measurement status.

1.2.3 Procedure for start up

(1) Remove the protection cover

Prior to set battery, first protection cover must be taken out. Please follow bellow steps.

1. Open hook and loop fastener.

2. Pull hand strap out from sleeve.

3. Pull the protection cover off form down side.

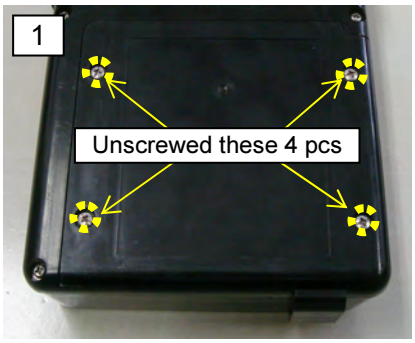
4. Pick up the main unit.

5. Take out the main unit from the protection cover.

Fig. 1.2.3-1 Remove the protection cover

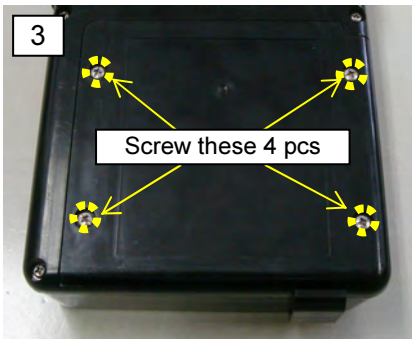
(2) Battery connection

Open the cover of the battery and connect the battery cable.



1. Loose 4pcs of screw by +screw driver.

2. Connect cable with care on polarization.



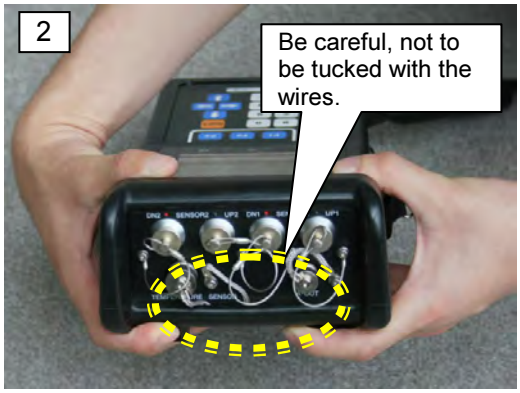
3. Fix. 4pcs of screw again.

Fig. 1.2.3-2 Battery connection

(3) Restore the protection cover

After connection of the battery, let the cover attach the main unit again. Please follow below steps.

1. Insert top side of the main unit to the protection cover.



2. Pay attention any connector cables not to tuck between the main unit and the protection cover.

3. Pull strap out to outside of the protection cover.

4. After set downside of the main unit into the protection cover insert the strap into sleeve.

5. Pull strap then close hook and loop fastener.

6. Completed.

Fig. 1.2.3-3 Restore the protection cover

(4) Battery Charge

Open side cover, then connect AC adaptor.
Please be noted that battery charging will not start during the main unit runs.

Fig. 1.2.3-4 Battery charge

You can check GREEN LED when DC power supplied, also RED LED when charging started.
Charging will be completed when RED LED turns off.

Please be noted following points

- Main unit can not be charged during power on. Please turn off the power for battery charging.
- Proper battery icon with remain level will be indicated on the display after a few minutes.
- In case of NOT used more than 1 month, battery must be disconnected from main unit and keep cool location.
- To comply with CE certification, do not operate the unit with the charger plugged in.

Caution

- The battery is designed and specified for main unit. Do not use any other battery except the specified one by manufacturer. It may result in injury to the operator or damage to the equipment.
- Please charge the battery under proper ambient temperature. (0 ~ 40 degree C)

(5) Turn on the main unit

Push power key about 3 seconds, then automatically self-check diagnostic will activate. After self check you can see, message as right for basic setting check.

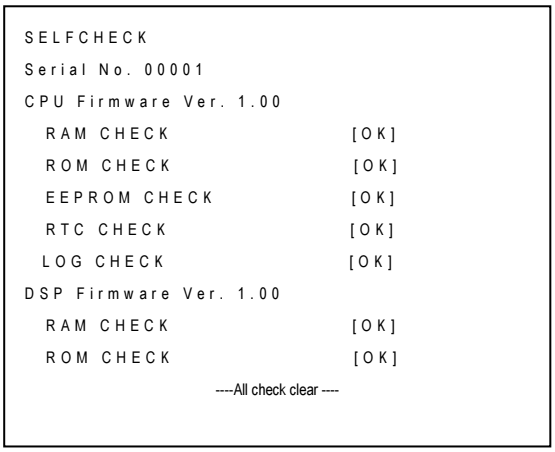


Fig. 1.2.3-5 Message of self check

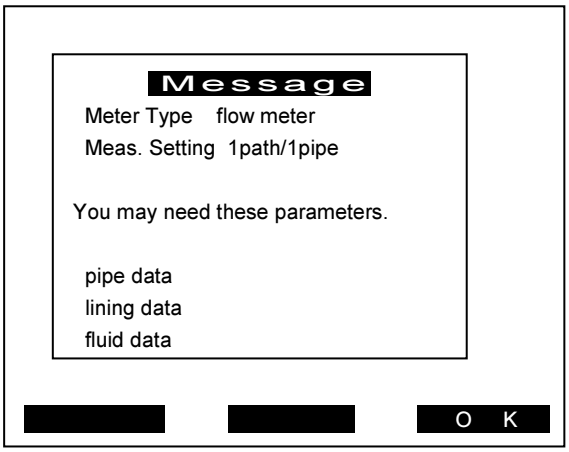


Fig. 1.2.3-6 Basic setting message

(6) Turn off the main unit

Push power key about 5 seconds, then you can select turn off power or resume as below.

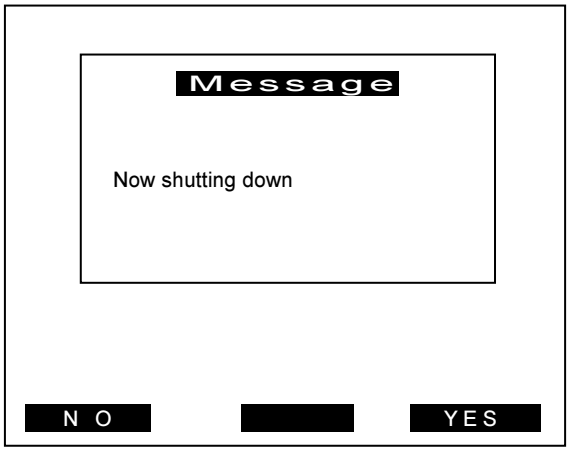


Fig. 1.2.3-7 Shutdown message

(7) Time setting

Under “System setting” directory, you can find date-time setting as below.

Table 1.2.3-1 The items of time setting

Items	Selection
Date	Input YY-MM-DD format (default) by numeric button
Time	Input HH:MM:SS format by numeric button
Date Format	Select from following options for your local area by up/down button. “YY/MM/DD”, “MM/DD/YY” or “DD/MM/YY”.

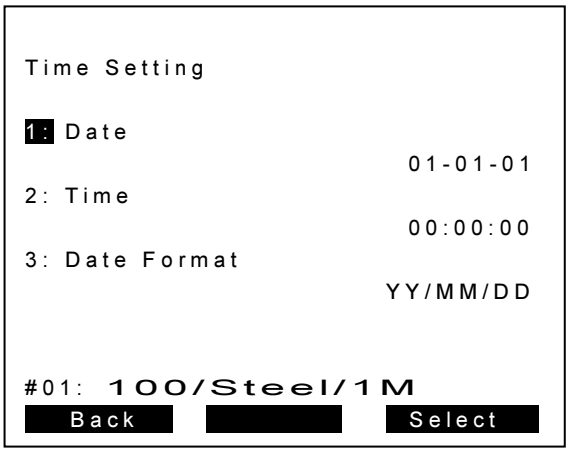


Fig. 1.2.3-8 Time setting

(8) Meter type selection and path application setting

Under “System setting” directory, you can select meter type and path setting.

Table 1.2.3-2 The items of meter type and path setting

Items	Selection
Meter Type	Select from following options for your application by up/down button. “flow meter”, “mass meter” or “heat meter”.
Meas. Setting	Select from following options for your application by up/down button. “1Path/1Pipe”, “2Path/1Pipe” or “1Path/2Pipe”.

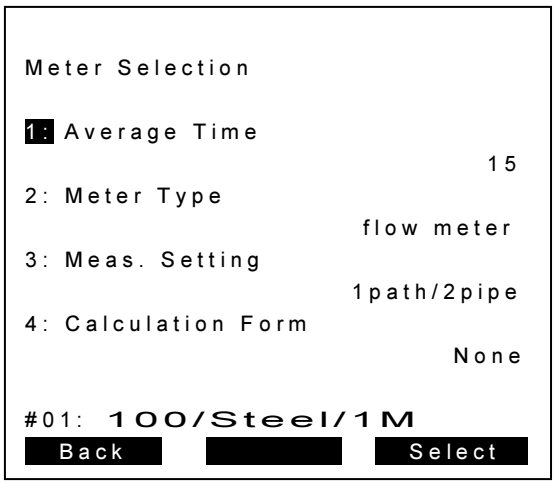


Fig. 1.2.3-9 Meter selection menu

(9) Unit and Language setting

Under “System setting” directory, you can select Metric or English unit system here.

Table 1.2.3-3 The items of local setting

Items	Selection
Unit Select	Select from following options for your local area by up/down button. “Metric” or “English”
Language	Select from following options for your local area by up/down button. “English”, “Japanese”, “Italian”, “Turkish”, “Deutsch”, “Frances”, “Spanish”, “Portuguese” or “Russian”

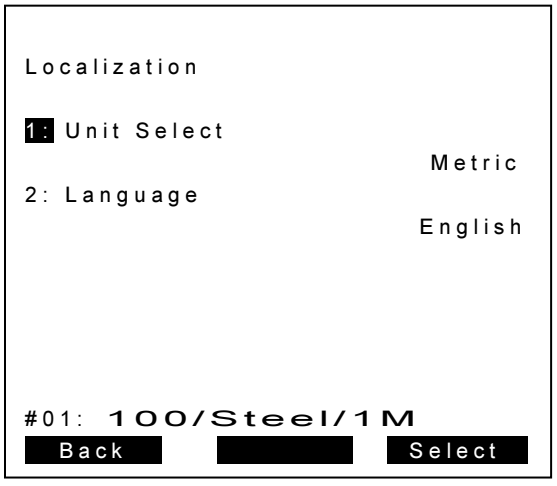


Fig. 1.2.3-10 Localization menu

1.2.4 Connection detail of main unit ports

(1) Open connector

[Transducer Connection Port]

Connector must be pulled with lid as photo on the left.

In case of tight, you can pull the wire instead. But normally we will not recommend this procedure.

[Temperature Junction Box Connection Port]

Loose thread lid, then open.

[Analog output Port]

Loose thread lid, then open.

Fig. 1.2.4-1 Open connector

(2) 2path or 2-channel connection for transducers

2pair of transducers should be connected onto proper port as below photo.

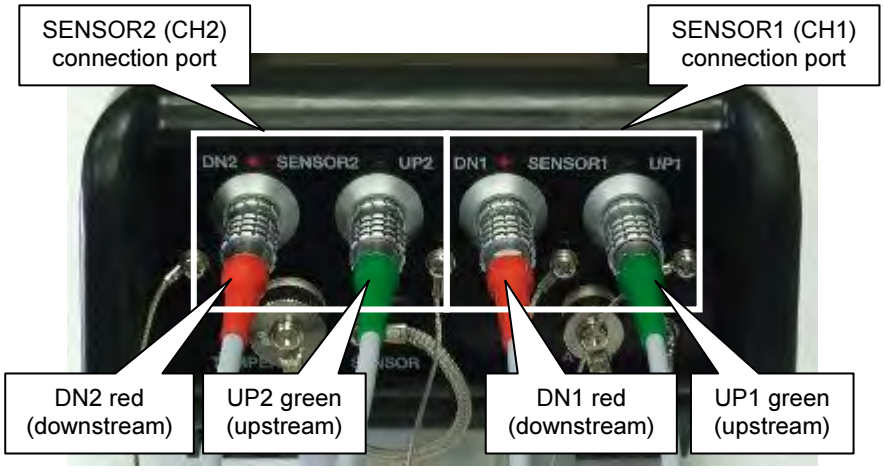


Fig. 1.2.4-2 Connection for transducers

(3) Connection of extended cable

50 m extended cable can be connected with standard cable mixed as below.

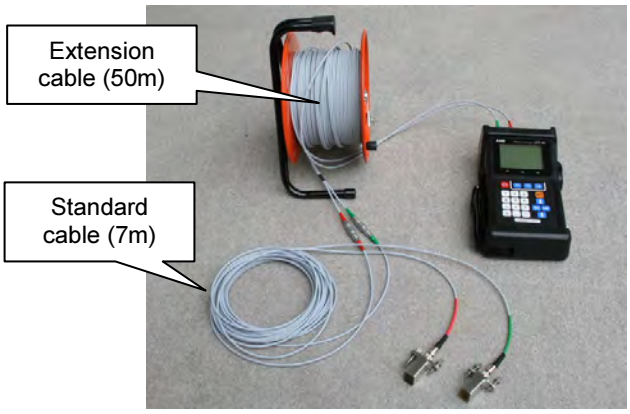


Fig. 1.2.4-3 Connection of extended cable

(4) Temperature sensor connection

Up to 4 pcs of temperature sensor can be through “temperature junction box” as below.
Each temperature sensor should be connected proper port.

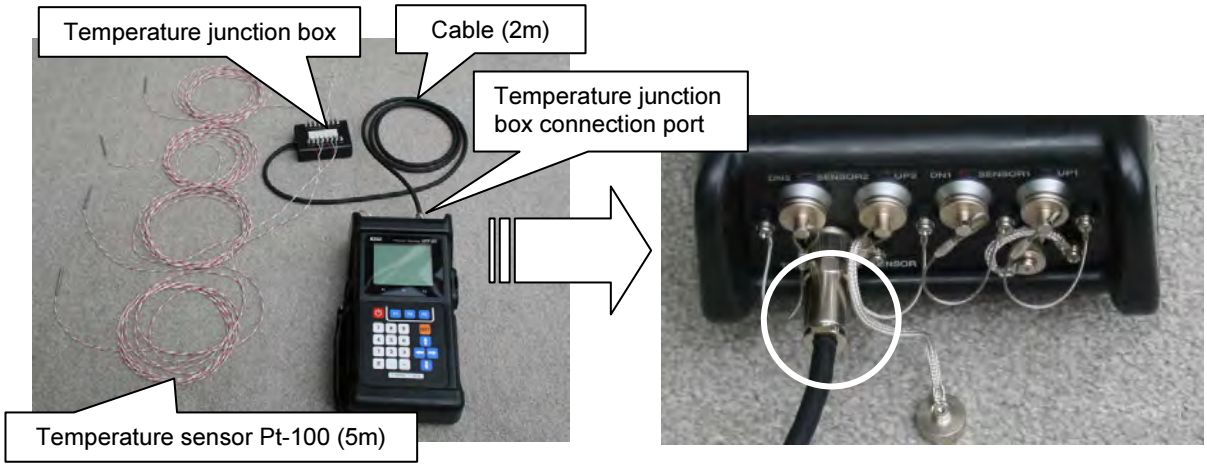


Fig. 1.2.4-4 Temperature sensor connection

(5) Attachment of Pt-100 temperature sensor (RTD)

For reviewing whole heatmeter system sample with temperature sensors, please refer to Fig.1.1-3 (p.1-8) and Fig.1.1-4 (p.1-9).

5-a. Connection of RTD sensor

RTD will be connected through “Temperature junction box”. The each name label of connection port is as Fig.1.2.4-5 and Fig.1.2.4-6.

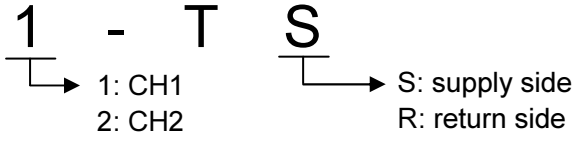


Fig 1.2.4-5 Marks of temperature junction box

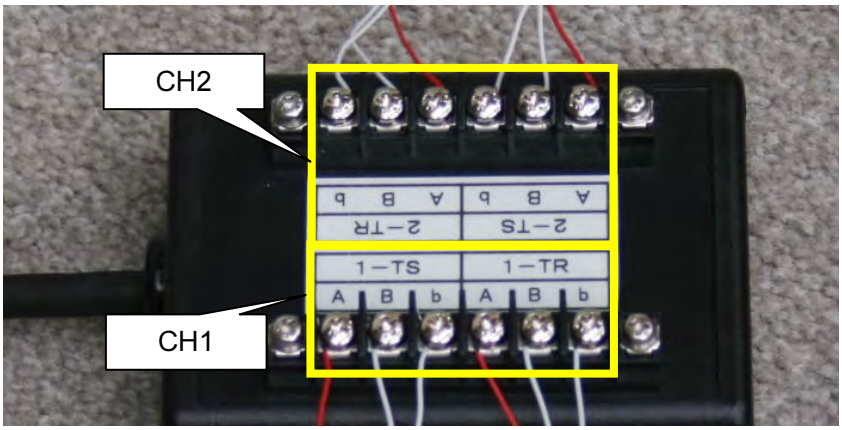
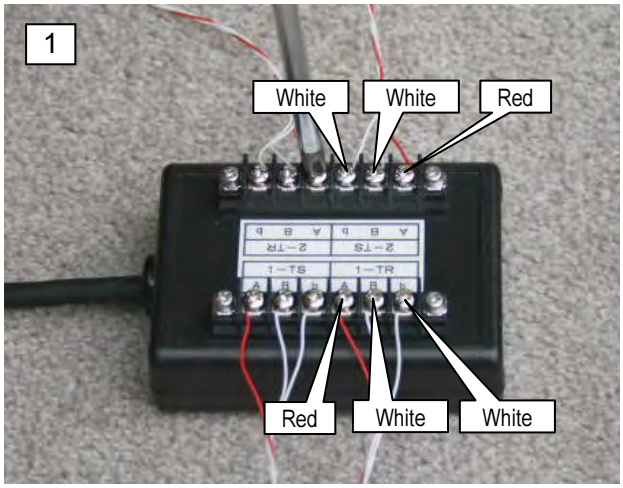


Fig. 1.2.4-6 Temperature junction box connector

5-b. Connection of RTD, Temperature junction box and the main unit

Each wire of RTD should be connected and tightened by fine screw driver.
Then connect the junction box with connection port of the main unit.
RTD should be 3 wire type. The color of each wire is Red, White and White.
This color will adopt with A, B and b. Those white wires (B or b) are common.



1. RTD connection

2. Main unit side connection

3. System configuration

Fig. 1.2.4-7 Connection of RTD, Temperature junction box and the main unit

5-c. Attachment of RTD onto the pipe

RTD will be attached by metal adhesive tape to be well touched onto the pipe as Fig.1.2.4-8.

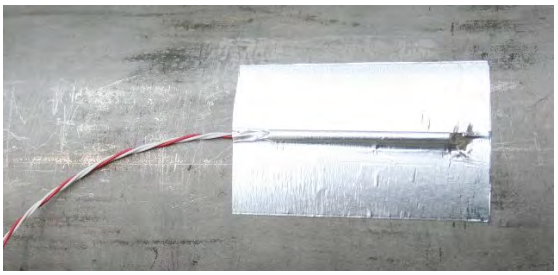


Fig. 1.2.4-8 Attachment of RTD

(6) Thickness / sound speed measurement sensor connection

Sensor should be connected to SENSOR 1 (DN1/UP1) port of transducer's port.

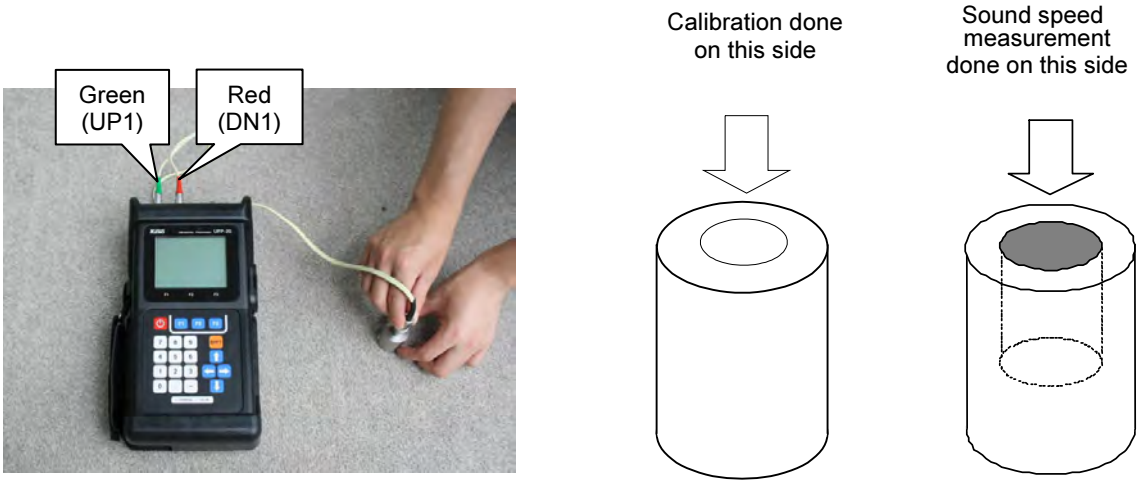


Fig. 1.2.4-9 Thickness and sound speed measurement

(7) Analog output cable connection

1 analog signal can be output. To use analog output, connect analog output cable to analog output connector as below photo.

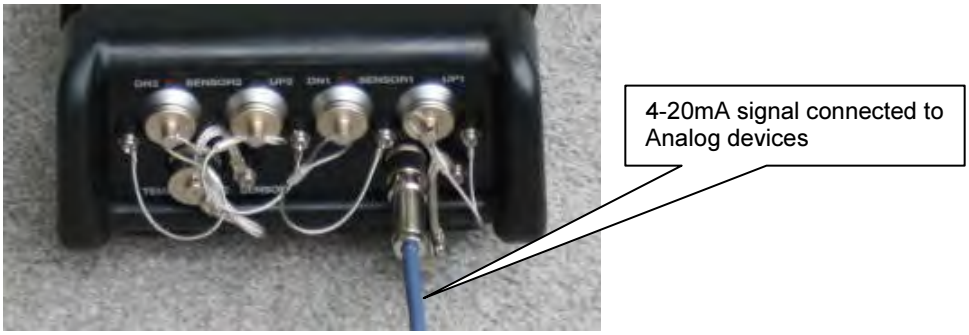


Fig. 1.2.4-10 Connection of analog output cable

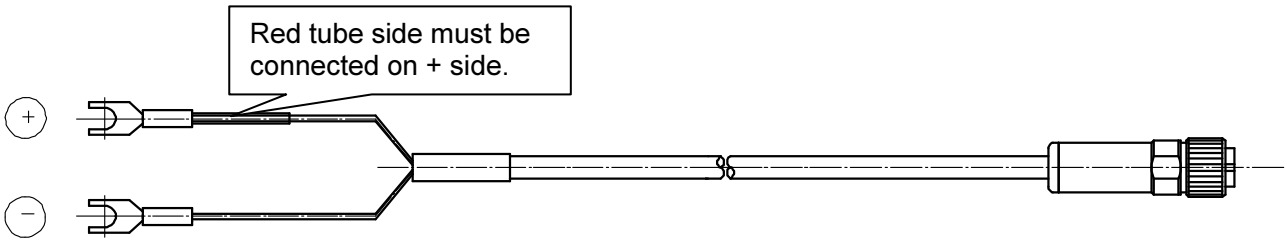


Fig. 1.2.4-11 Analog output cable

(8) Cigarette lighter cable connection

The cigarette lighter port of the automobile can supply power to the flowmeter by using the cigarette lighter cable of the option. Figure 1.2.4-12 shows the connection diagram of this cable.

Fig. 1.2.4-12 Connection of cigarette lighter cable

Caution

- The cigarette lighter cable of the option is designed and specified for main unit. Do not use any other cigarette lighter cable except the specified one by manufacturer. It may result in injury to the operator or damage to the equipment.

1.2.5 Selection of transducer setup position

(1) Setup position

As a rule, compliance with the conditions given below when positioning the transducers assures top performance of the flowmeter and keeps measurement aberrations due to flow quantity fluctuation at an absolute minimum.

a. Install transducers in a position that is filled with fluid, even after flow has stopped.
b. Fully developed and rotationally symmetrical flow profile will be required for ideal condition of measurement. In general, refer to the information in **3.4.1 General condition for straight pipe length**, regarding minimum required straight pipe lengths for the upstream and downstream side when selecting a position.
c. Select a position with minimum flow-obstruction. Contact the manufacturer if circumstances require positioning of a pump, valves, pipes with gradual width increment, merger pipe, etc. either at the upstream or downstream side.
d. Consider the possibility of sedimentation at the bottom of the pipe and the presence of an air pocket at the top of the pipe (Fig. 1.2.5-1). In addition, avoid flanges and welding areas and select a smooth portion of the pipe to install the transducers.

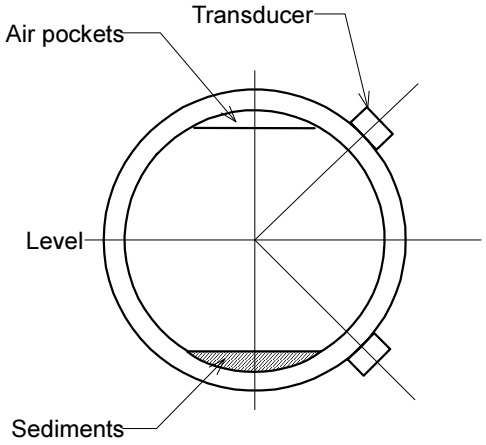


Fig. 1.2.5-1 Transducer positioning

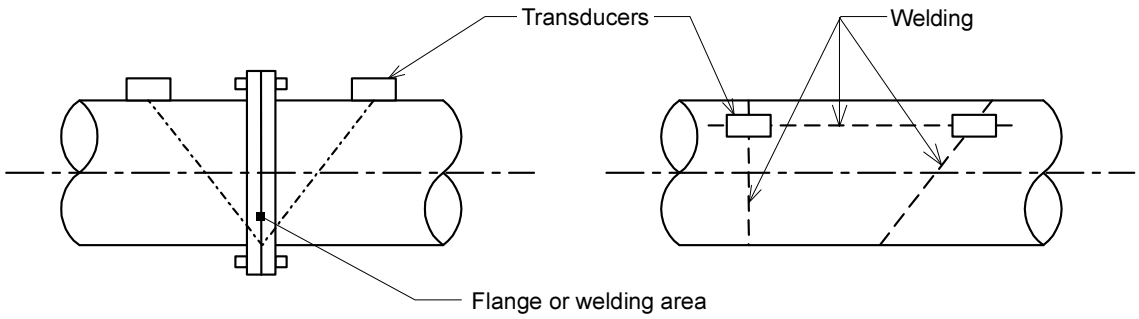
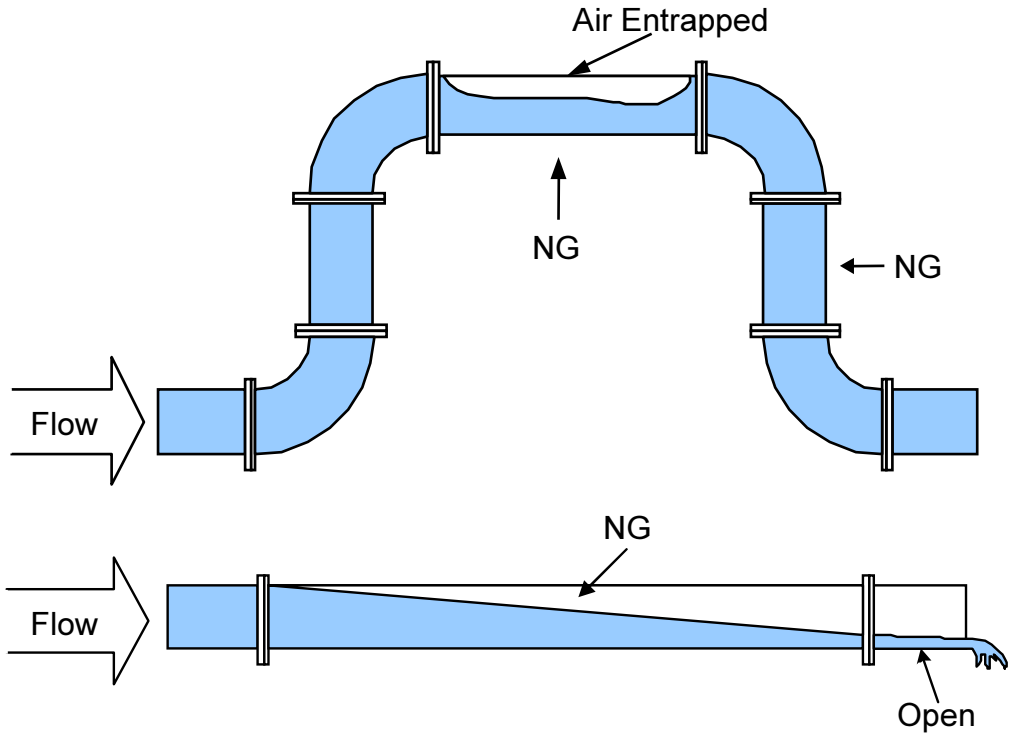


Fig. 1.2.5-2 Unsuitable transducer positions

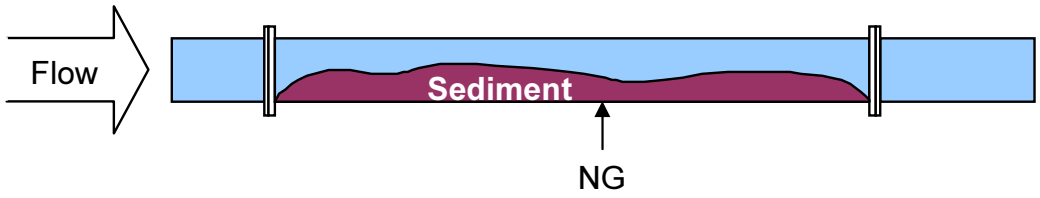
a. Pipe should always be filled with water

Measurements cannot be made accurately if pipe is not completely filled with water.



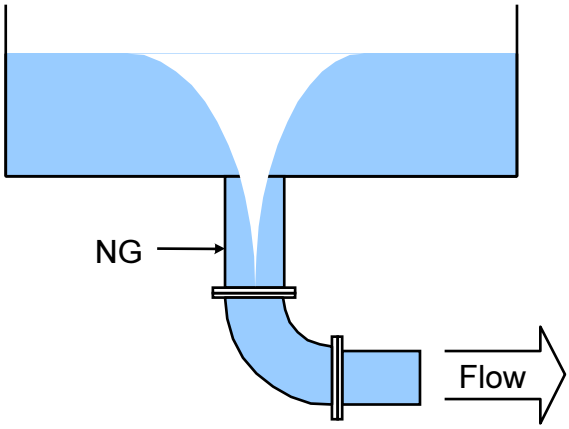
b. Sediment

Sediment accumulation at the transducer position may cause measurement errors.
Countermeasures include installation of closing flange, etc.



c. Entrained air

Measurement may not be possible if there is entrained air at the transducer position.



1.2.6 Input parameters for flowmeter

(1) Flow of installation wizard

Installation wizard archives easy parameters input of all required parameters through dialog type menu.

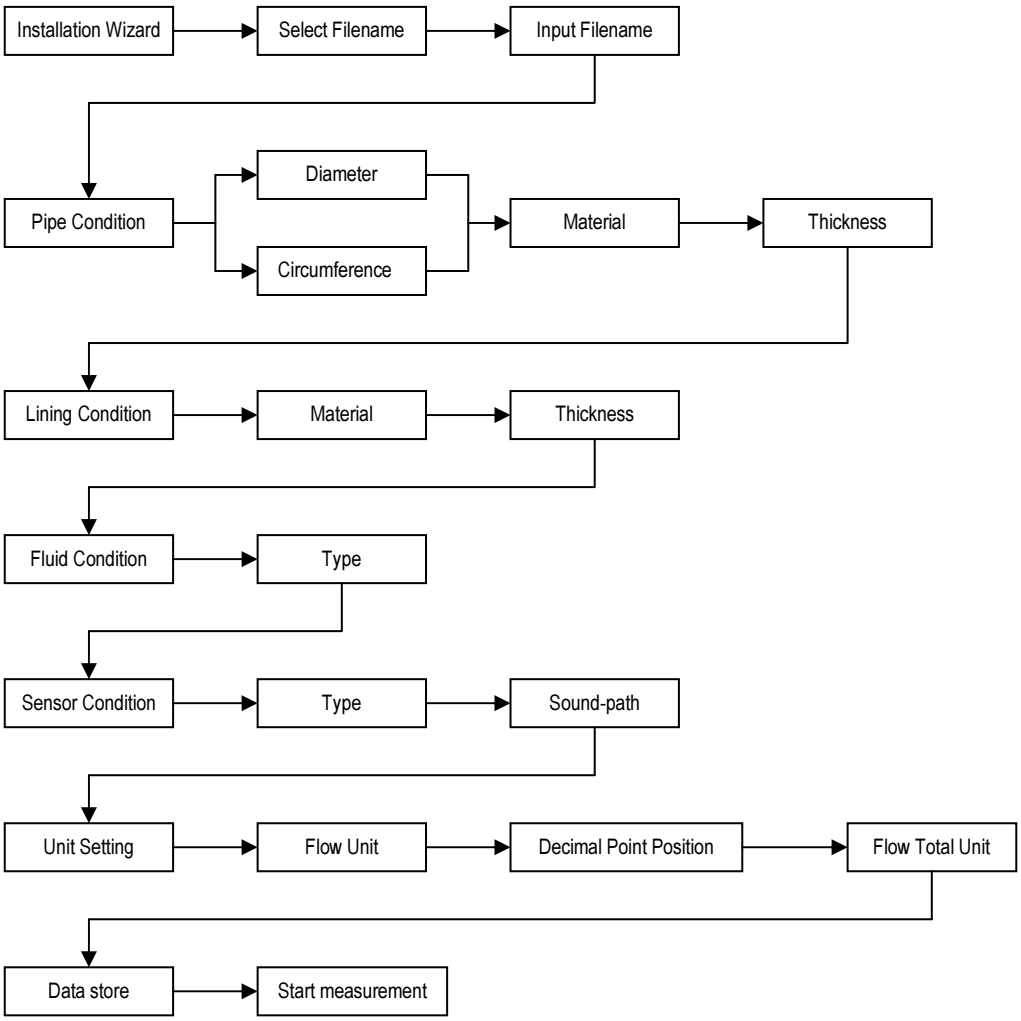


Fig. 1.2.6-1 Flow of installation wizard

(2) Installation wizard for flowmeter with 1path/1pipe or 2path/1pipe

This portable unit can be selectable from “flow meter”, “mass meter” and “heat meter”.
Also “1path / 1pipe (1 location)”, “2path / 1pipe (1 location)” and “1path / 2 pipe (2 locations)” can be selected on each meter mode.
Here you can see easy-setup procedure (Installation Wizard) for meter type with “1path / 1pipe (1 location)”, “2path / 1pipe (1 location)” for “flow meter”.
If you would like to change each value independently through the advanced setup menu (3:<Advanced Setting>), please refer to the Chapter 2.

Required parameters

Before started, please confirm following value for input.

- Diameter or the circumference of the pipe
- Thickness of the pipe
- Material of the pipe
- Thickness of the lining (if any)
- Material of the lining (if any)
- Fluid type

Table 1.2.6-1 Sample of item parameters

Meas. Setting	1path/1pipe or 1path/2pipe
Filename	100/Steel/1M
Pipe Diameter	114.30 mm
Pipe Thickness	4.50 mm
Pipe Material	Carbon Steel
Lining	None
Fluid Type	Water
Sensor Type	UP10AST
Flow Unit	m^3/h
Flow Total Unit	m^3

Note1: Check “Meter Type” set as “flow meter” on the following directory.
Menu – 7: System – 2: Measuring Setting – 2: Meter Type ; flow meter

Note2: Check “Path” set as “1path/1pipe” or “2path/1pipe” on the following directory.
Menu – 7: System – 2: Measuring Setting – 2: Path ; x path / 1 pipe

1. Select “Installation Wizard” on the basic menu

Select “1:Installation Wizard” by direction or numeric button.
Then push “Select” key (F3 button).

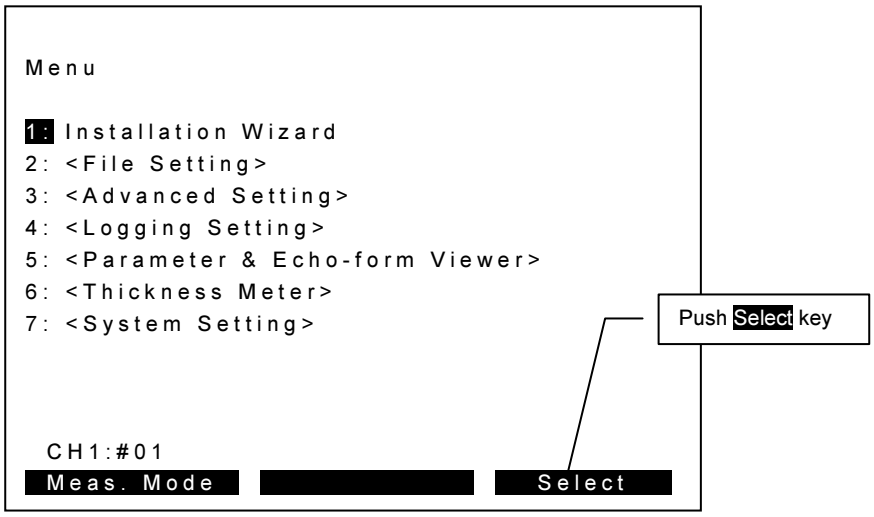


Fig. 1.2.6-2 Basic menu

2. Select file position as “#No.”

Please select Not-Used area by direction button, then push “Enter” key (F3 button).

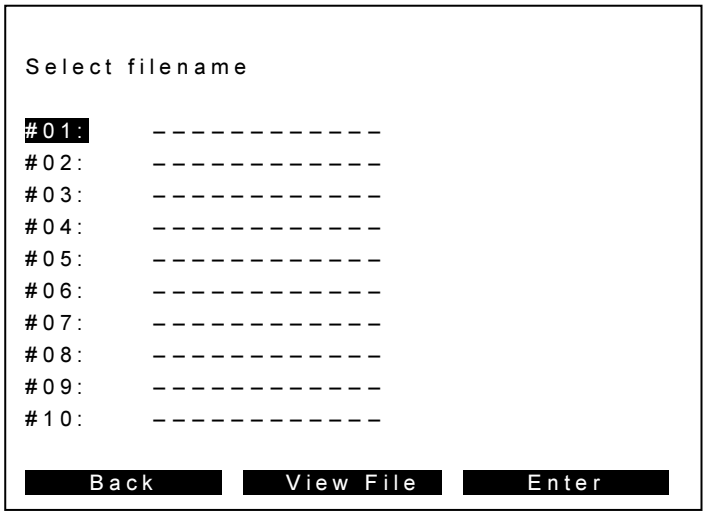


Fig. 1.2.6-3 File selection menu

Not-used area indicated as “--------” and you can not select this position. To remove site setting file, please refer to Chapter 2.
When you select used area, you can see following indication.

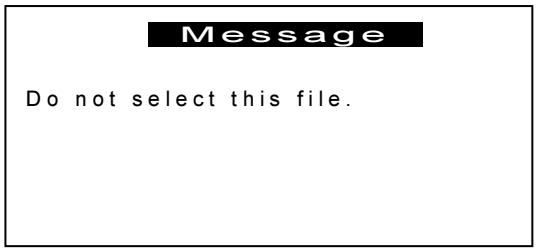


Fig.1.2.6-4 Message of selection not used area

3. File name input

Please input file name by direction button.
Here for example, let's input as "100/Steel/1M".

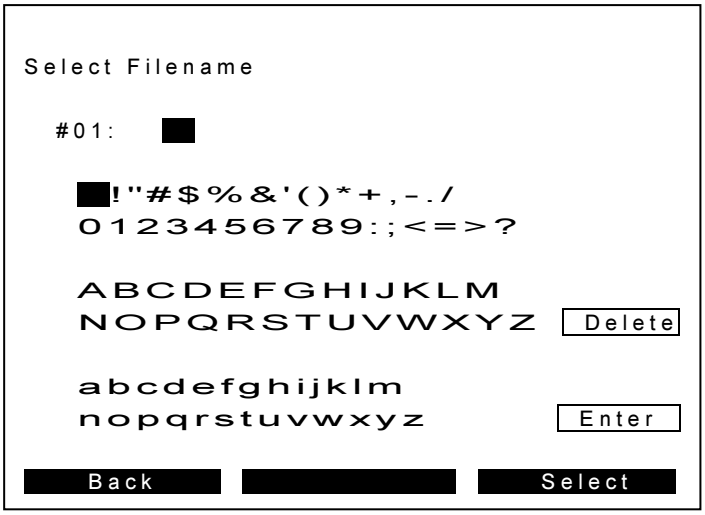


Fig. 1.2.6-5 File name input menu

Move cursor to "1" (for example) by direction button. and push "Select" key (F3 button) to select character.
You can see that "1" would set first position as below.

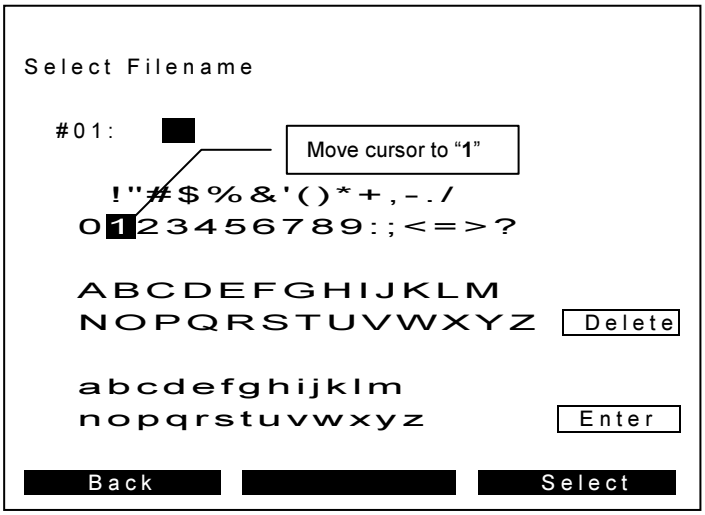


Fig. 1.2.6-6 Word selection menu

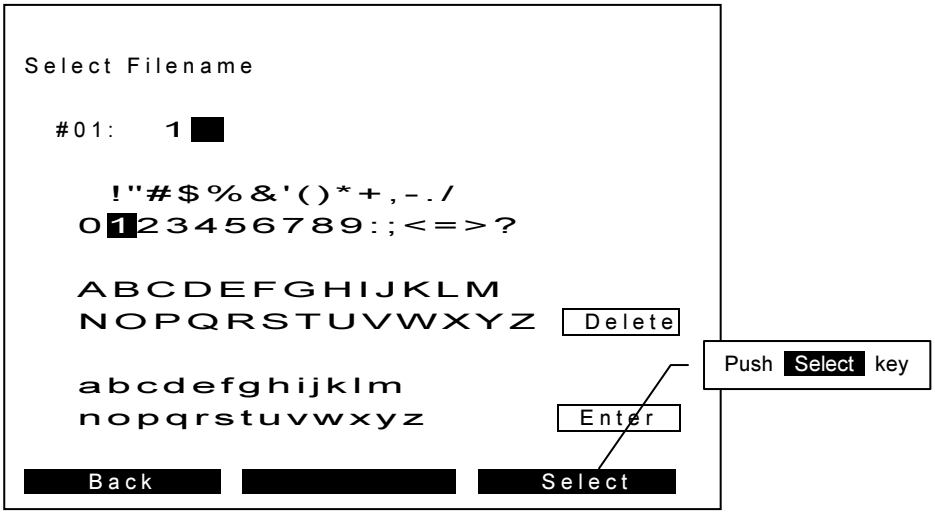


Fig. 1.2.6-7

4. Delete the character (if any)

If you would like to delete the character, you can move cursor onto "Delete", then push "Select" key (F3 button).

Otherwise pushing [SHFT] button to show "Delete" key up at F3 column, then push the F3 to remove the selected character.

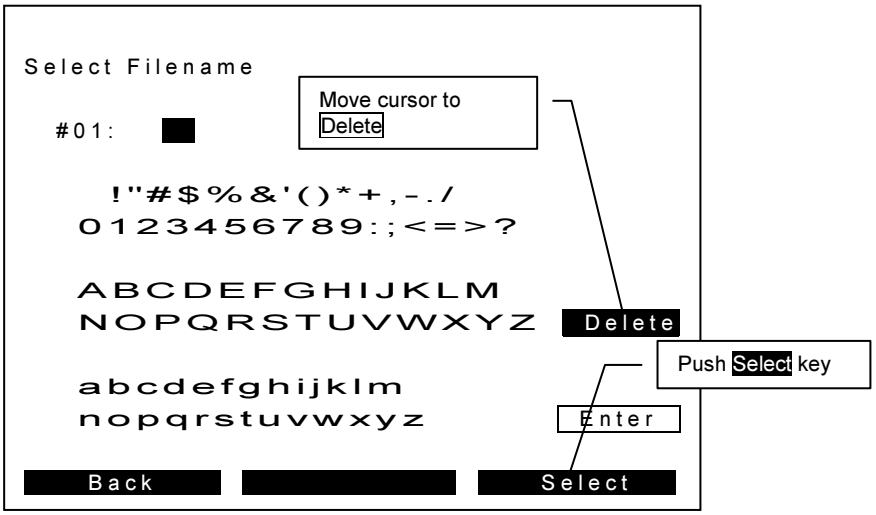


Fig. 1.2.6-8 Delete a character

5. Finalizing file name

By repeating procedure of 1-4, you can input “100/Carbon Steel/1M” as follows.
After finalizing the file name, proceed next menu by move cursor “Enter” and push “Select” key (F3 button), otherwise [SHFT] + F3 button makes the same step taken.

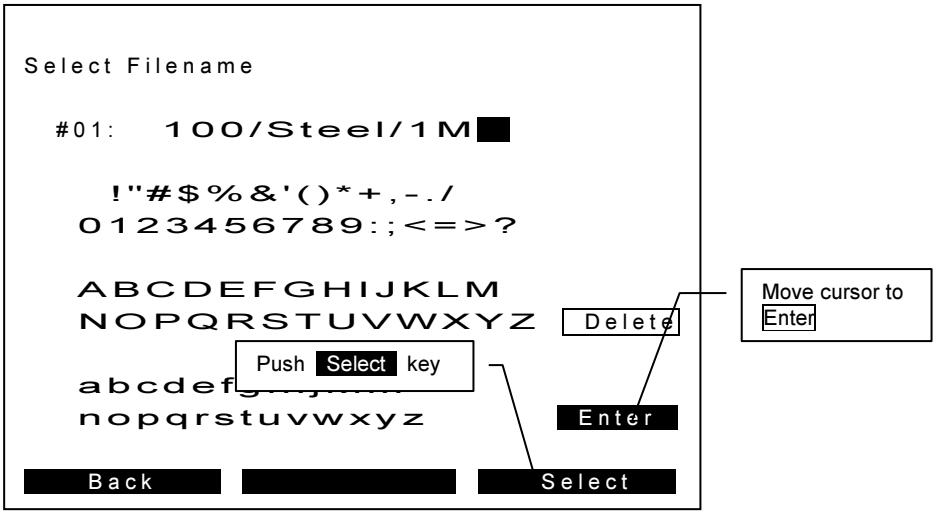


Fig. 1.2.6-9 File name finalize

6. Pipe size settings

Input pipe diameter by diameter itself or circumference of pipe. You can select which way you want by direction or numeric button. Here for example, select “1: Diameter” by push “Select” key (F3 button).

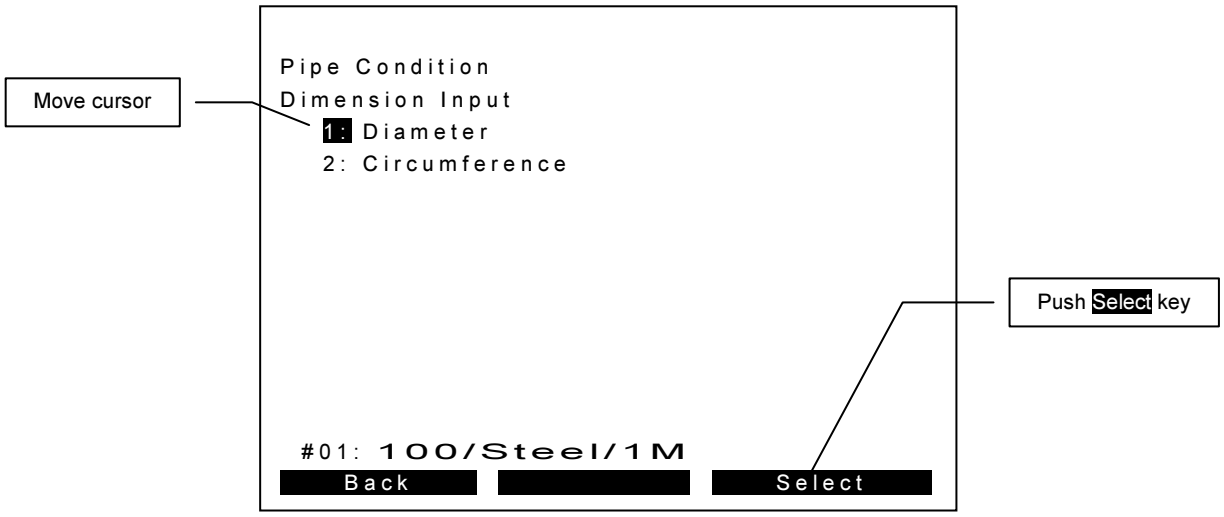


Fig. 1.2.6-10 Selection menu by diameter

Input diameter by numeric button directly. Here for example, input 114.30mm as right. Then push "Enter" key (F3 button) to proceed to next step.

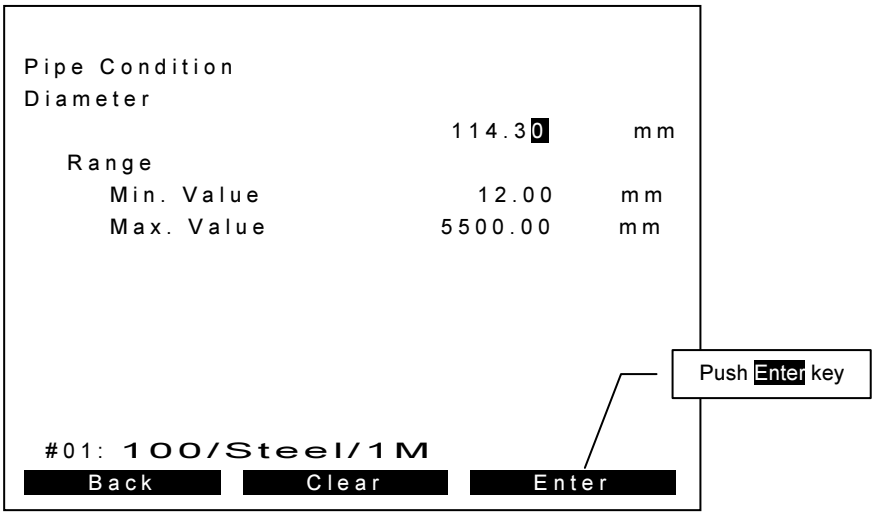


Fig. 1.2.6-11 Input menu

7. Pipe material

Select material of the pipe from default choices or User Defined by direction or numeric button. Here for example, select "1: Carbon Steel", then push "Select" key (F3 button) to proceed next step.

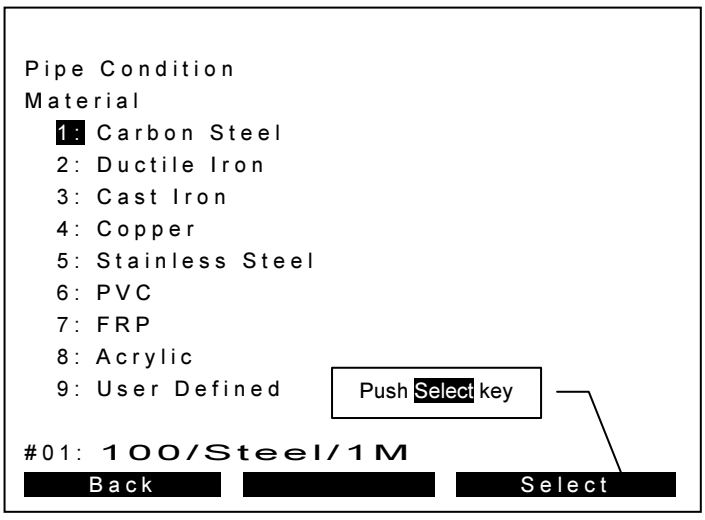


Fig. 1.2.6-12 Pipe material selection menu

Following sound speed is defined as default listed material.

Table 1.2.6-2 Selectable items of pipe material

Material	Sound speed [m/s]
Carbon Steel	3200
Ductile Iron	3000
Cast-Iron	2500
Copper	2270
Stainless Steel	3100
PVC (Poly Vinyl Chloride)	2280
FRP	2560
Acrylic	2720

After you select material, you will see predefined sound speed, normally just proceed to next. If you would like to select any un-listed materials, please select "User Defined" then enter actual sound speed of the material at the next extra menu.

8. Thickness of pipe

Input pipe thickness by numeric button directly. Here for example, input “4.50mm”, then push “Enter” key (F3 button) to proceed to next step.

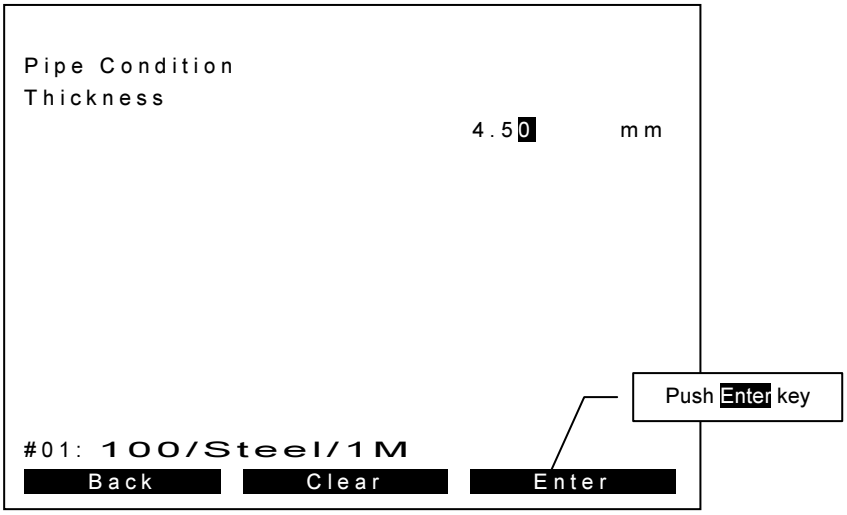


Fig. 1.2.6-13 Pipe thickness input menu

Note: Over ½ of pipe diameter is invalid value. (Max range: up to 100mm)

9. Lining material

Select material of the lining from default choices or User Defined by direction or numeric button. Here for example, select “2:Epoxy”, then push “Select” key (F3 button) to proceed next step.

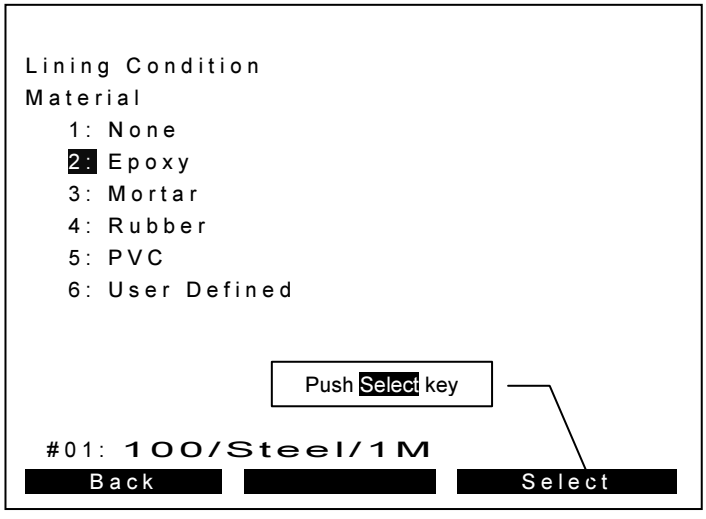


Fig. 1.2.6-14 Lining material selection menu

Following sound speed is defined as default listed material.

Table 1.2.6-3 Selectable items of lining material

Material	Sound speed [m/s]
Epoxy	2000
Mortar	2500
Rubber	1900
PVC (Poly Vinyl Chloride)	2280

After you select material, you will see predefined sound speed, normally just proceed to next. If you would like to select any un-listed materials, please select “User Defined” then enter actual sound speed of the material later at the next extra menu.

10. Thickness of lining

Input lining thickness by numeric button directly. Here for example, input “1.00mm”, then push “Enter” key (F3 button) to proceed to next step.

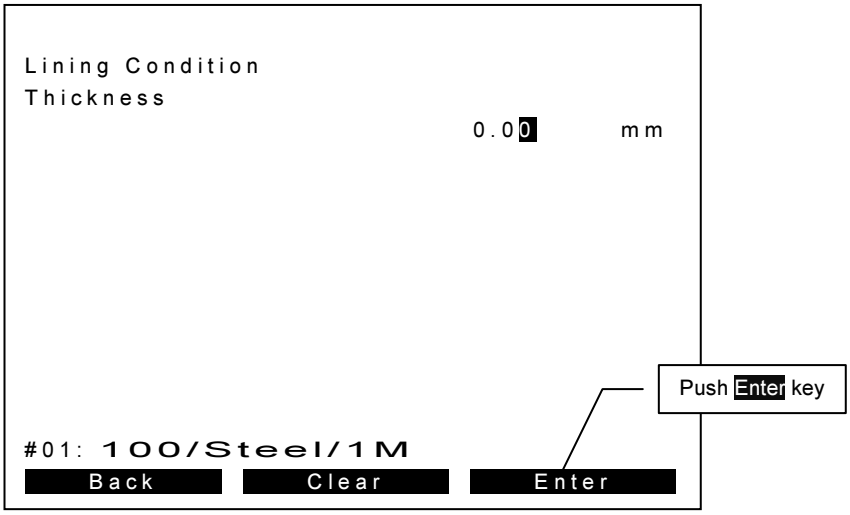


Fig. 1.2.6-15 Lining thickness input menu

Note: Over ½ of pipe diameter is invalid value. (Max range: up to 100mm)

11. Fluid Selection

Select fluid from default choices or User Defined by direction or numeric button.
Here for example, select “1:Water”, then push “Select” key (F3 button) to proceed next step.

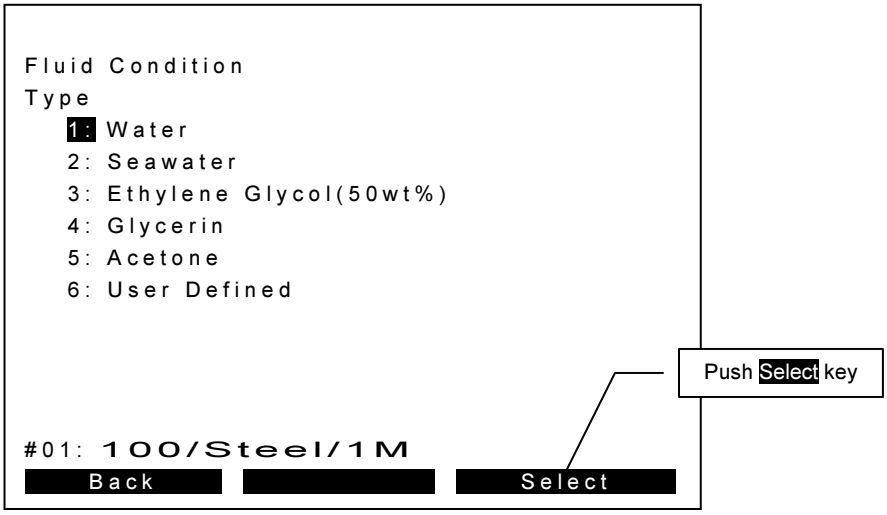


Fig. 1.2.6-16 Fluid type selection

After you select material, you will see predefined sound speed and viscosity, normally just proceed to next. If you would like to select any un-listed fluid, please select “User Defined” then enter actual sound speed of the fluid later at the next extra menu.

Table 1.2.6-4 Selectable items of fluid type

Fluid	Sound speed [m/s]	Viscosity [x10^{-6} m^2/s]
Water	1460	1.20
Sea Water	1510	1.00
Ethylene Glycol (50wt%)	1691	4.13
Glycerin	1923	1188.50
Acetone	1190	0.41

12. Transducer type

Select transducer type from default choices by direction or numeric button.
Here for example, select "2:UP10AST", then push "Select" key (F3 button) to proceed next step.

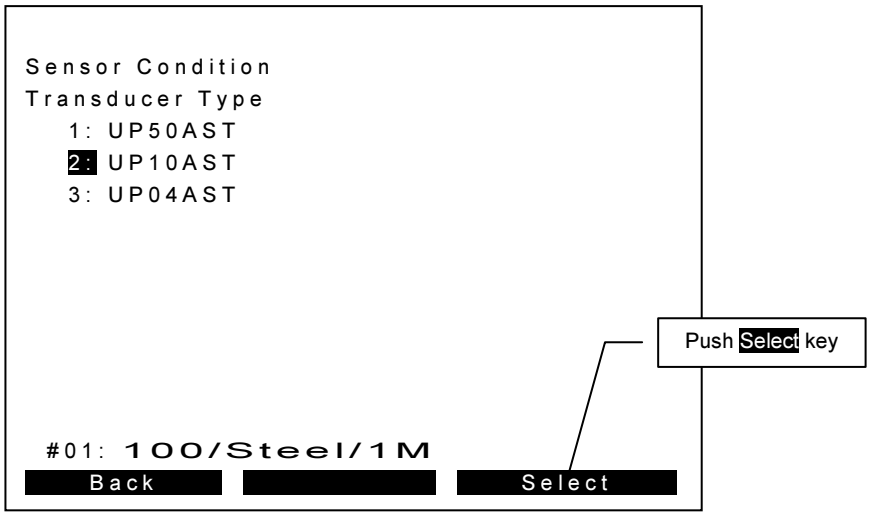


Fig. 1.2.6-17 Transducer type selection menu

13. Sound-path selection

Select sound-path method from default choices by direction or numeric button.
Here for example, select "2: V-path method", then push "Select" key (F3 button) to proceed next step.

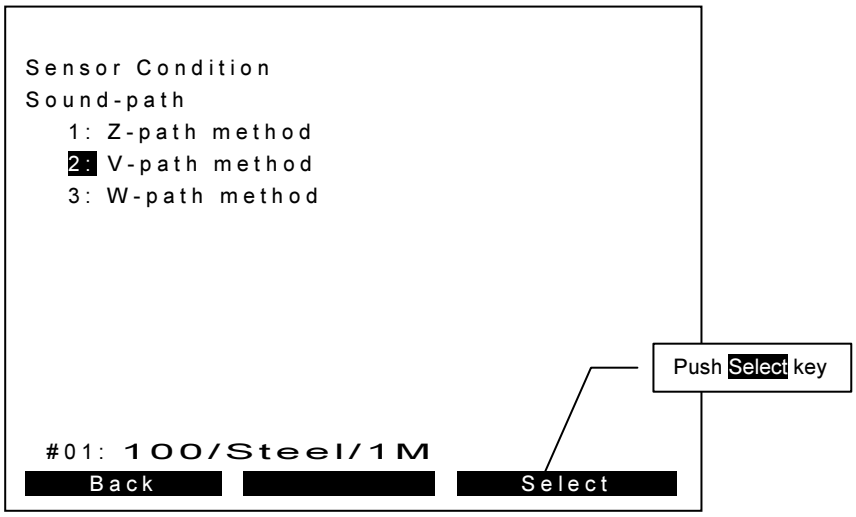


Fig.1.2.6-18 Sound-path selection menu

(a) Z-path method

This type of method is effective for application of measurement on the larger pipe or measurement for attenuating fluid against ultrasonic. Because of transducers distance is relatively shorter, so please select this method when V-path method installation is impossible.

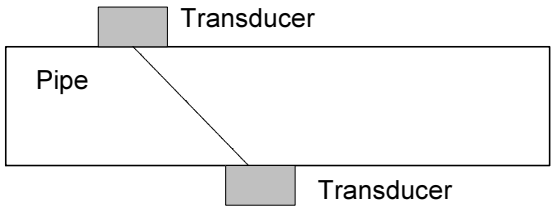


Fig. 1.2.6-19 Z-path method

(b) V-path method

This method is typical. Please select this method as primary.

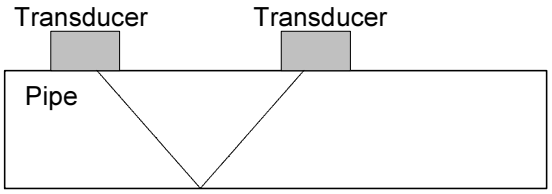


Fig. 1.2.6-20 V-path method

(c) W-path method

This method may be effective for smaller pipe measurement. Please select this method when you have any problems by V or Z-path method.

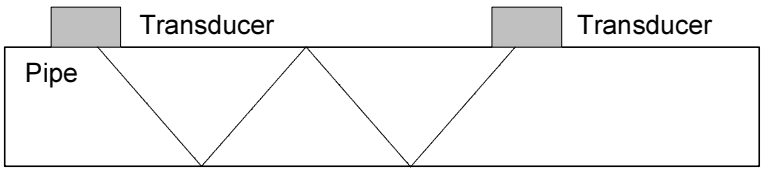


Fig. 1.2.6-21 W-path method

14. Flow rate unit setting

Select flow rate unit from default choices by direction or numeric button.
Here for example, select "3: m^3/h", then push "Select" key (F3 button) to proceed next step.

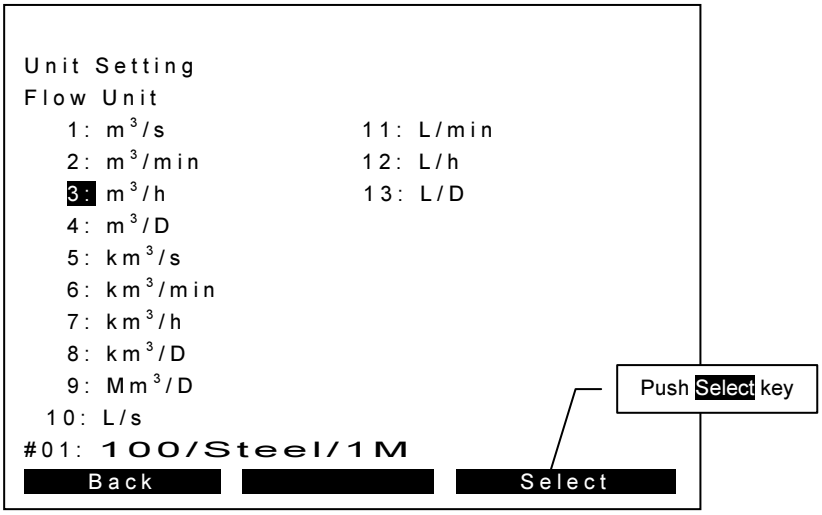


Fig. 1.2.6-22 Flow rate unit setting menu

15. Decimal point position

Select decimal point position from default choices by direction or numeric button.
Here for example, select "3: ***.***", then push "Select" key (F3 button) to proceed next step.

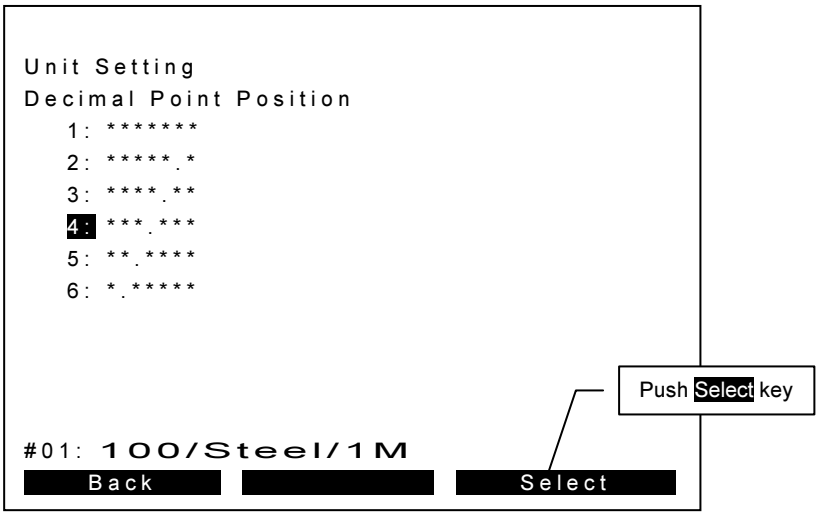


Fig. 1.2.6-23 Decimal point position setting menu

16. Totalizing unit setting

Select totalizing unit from default choices by direction or numeric button.
Here for example, select "1: x1m^3", then push "Select" key (F3 button) to proceed next step.

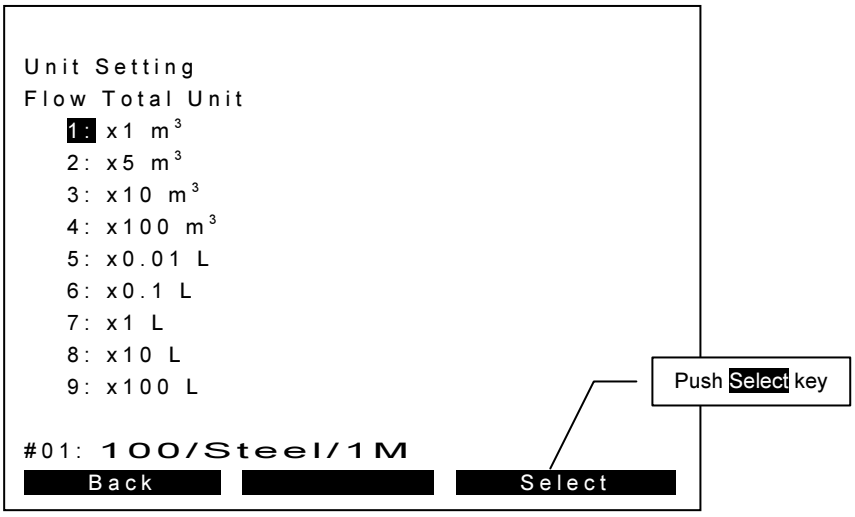


Fig.1.2.6-24 Totalizing unit setting menu

17. Store site data

Finalize wizard by store all data on this menu. Select "2: Yes" by direction or numeric button.
Then push "Select" key (F3 button) to proceed next step.

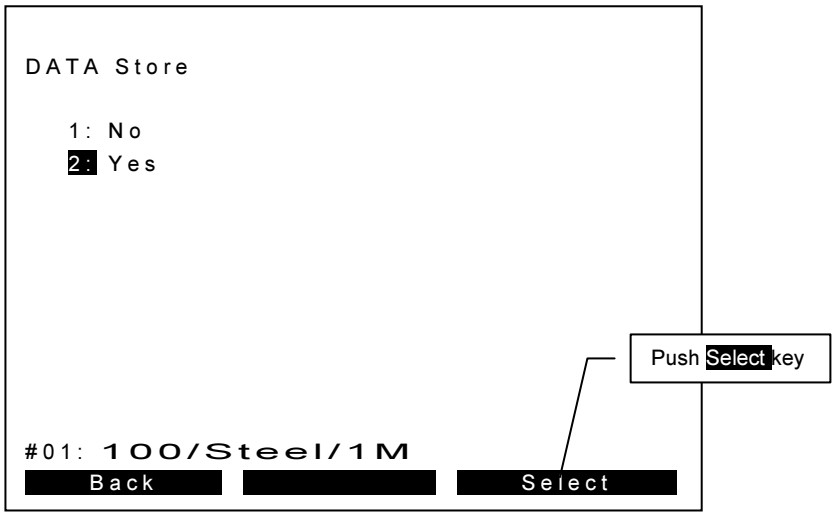


Fig. 1.2.6-25 Data storing menu

When select “2: Yes”, following message will be shown.

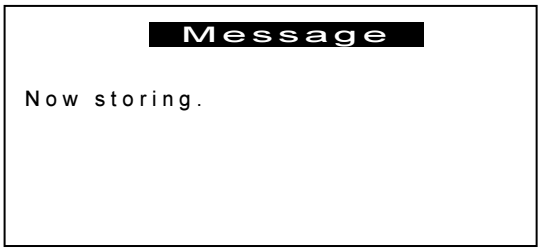


Fig. 1.2.6-26 Data storing

When select “1: No”, following message will be shown. Then again you select “Yes” (F1 button), site setting data will be discarded. Otherwise when you select “No” (F3 button), return to previous data storing menu.

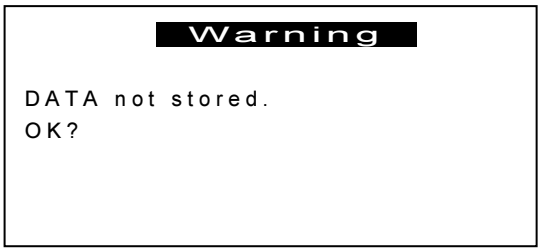


Fig. 1.2.6-27 Data discarding

After storing site setting data, following confirmation message shows up. Then push “Yes” (F3 button) to proceed next step. Otherwise when you select “No” (F1 button), return to initial basic menu.

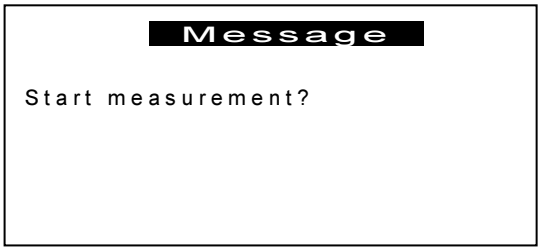


Fig. 1.2.6-28 Confirmation message to start measurement

18. Mounting transducers

The main unit calculates proper distance between transducers as following message. Then push "OK" (F3 button) to start measurement. Please set transducer mounting with indicated transducer distance in accordance with instruction on Chapter 1.2.9.
On this example, distance of transducers is 63.8 mm.

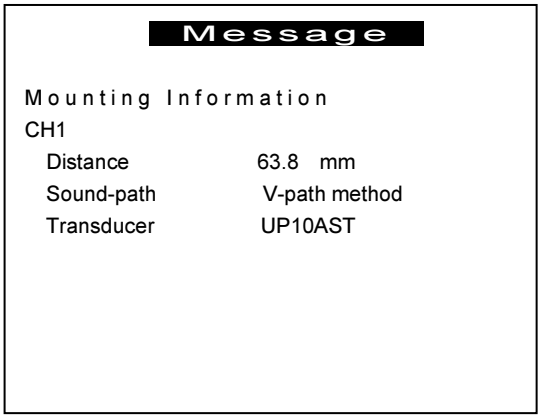


Fig. 1.2.6-29 Message of mounting information

19. Measurement start

Volumetric flowrate measurement starts as below.

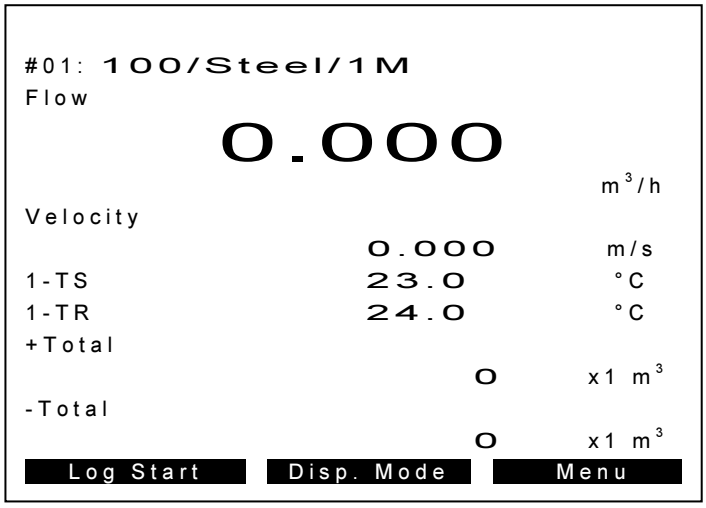


Fig. 1.2.6-30 Volumetric flowrate measurement display

(3) Installation wizard for flowmeter with 1path/2pipe (2-channel) setting

This portable unit can be selectable from “flow meter”, “mass meter” and “heat meter”.
Also “1path / 1pipe (1 location)”, “2path / 1pipe (1 location)” and “1path / 2 pipe (2 locations)” can be selected on each meter mode.
Here you can see easy-setup procedure for meter type with “1path / 1pipe (1 location)”, “2path / 1pipe (1 location)” for “flow meter”.
If you would like to change each value independently through the advanced setup menu, please refer to the Chapter 2.

1path/2pipe mode means 1 main unit measures 2 different pipes even site condition like pipe diameter is different.

Required parameters

Before started, please confirm following value for input.

- Diameter or the circumference of the 2 pipes
- Thickness of the 2 pipes
- Material of the 2 pipes
- Thickness of the lining (if any)
- Material of the lining (if any)
- Fluid type

Note1: Check “Meter Type” set as “flow meter” on the following directory.
Menu – 7: System – 2: Measuring Setting – 2: Meter Type ; flow meter

Note2: Check “Path” set as “1path/2pipe” on the following directory.
Menu – 7: System – 2: Measuring Setting – 2: Path ; 1 path / 2 pipe

1. Select installation wizard

Proceed all parameters input as same as 1pipe version.

2. Channel Selection

After input parameters, channel selection will be required as below.

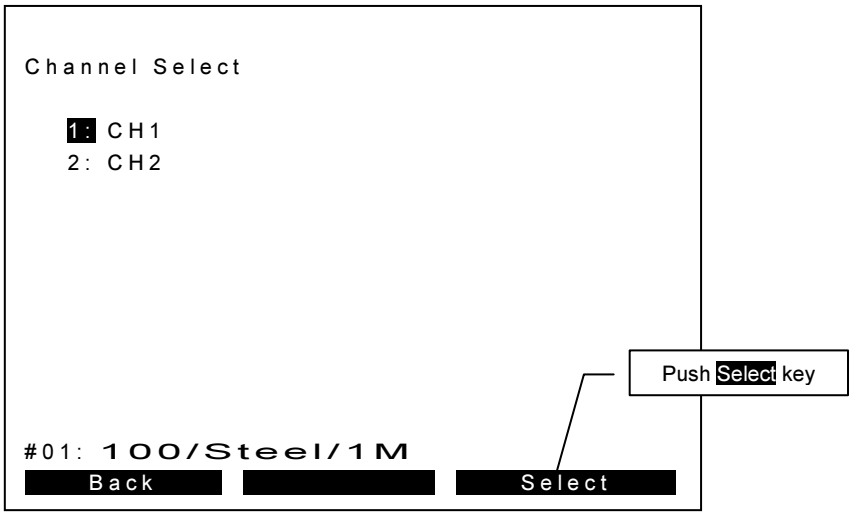


Fig. 1.2.6-31 Channel selection menu

3. Store site data

Finalize wizard by store all data on this menu. Select "2: Yes" by direction or numeric button. Then push "Select" to proceed next step.

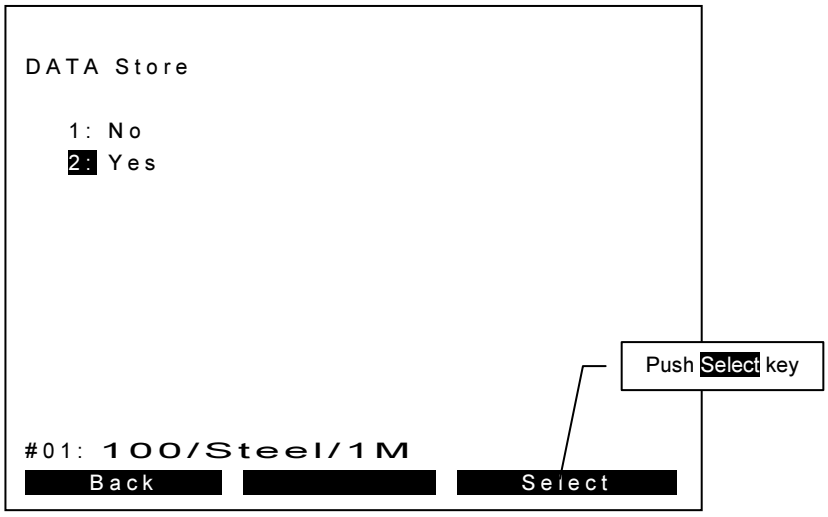


Fig. 1.2.6-32 Data storing menu

4. Data for Channel 2

Proceeded the menu, following message shows up for copying the site setting.

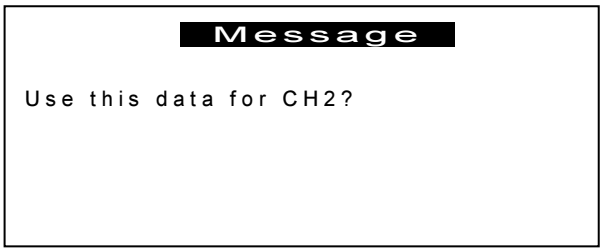


Fig. 1.2.6-33 Message of using same data for CH2

If you select "Yes" (F1 button), same site setting data will be used 2nd channel setting.
Otherwise when you select "No" (F1 button), return to first menu of wizard.
You need to make other site setting data through this wizard for 2nd channel.

Note: When you select "CH2" at first channel selection, only CH2 data is made through wizard process.
You will need to set "CH1" parameters independently.

1.2.7 Input parameters for massmeter

(1) Flow of installation wizard

Installation wizard archives easy parameters input of all required parameter through dialog type menu.

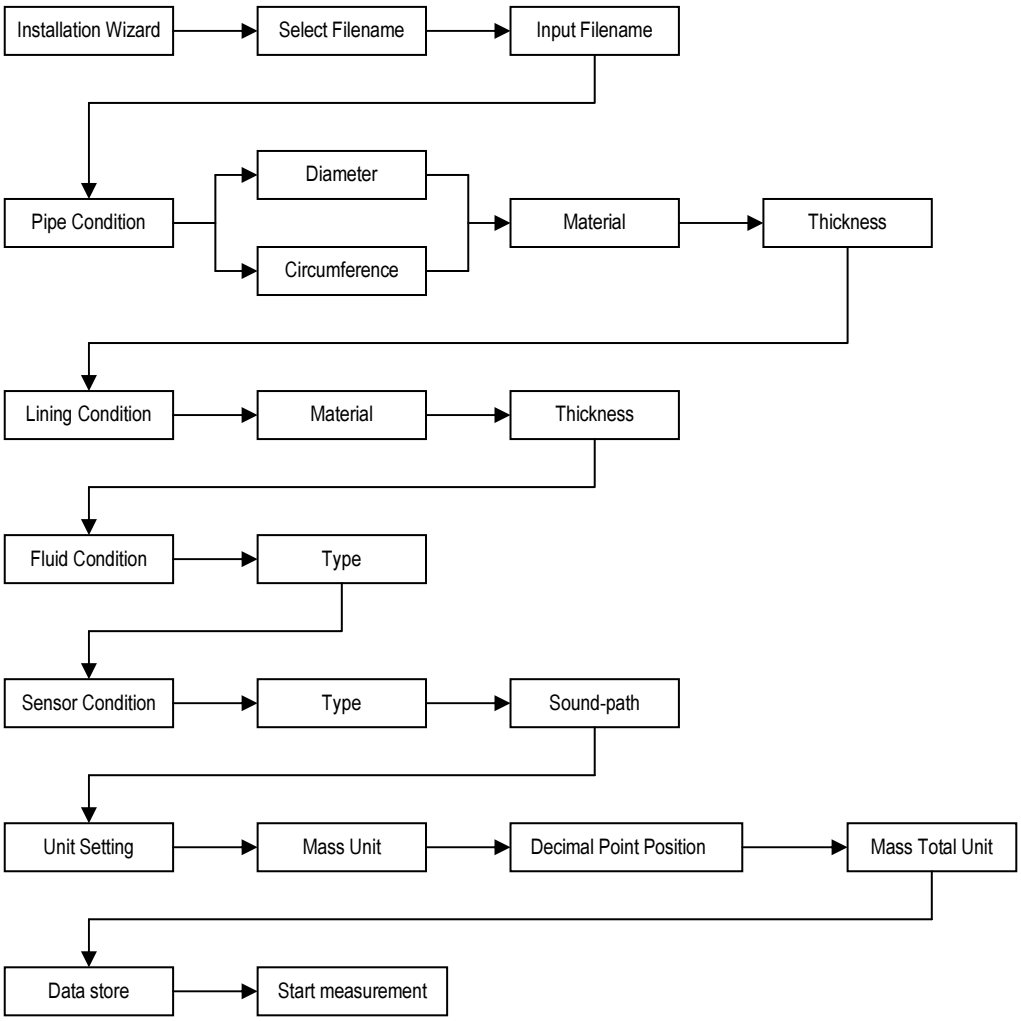


Fig. 1.2.7-1 Flow of installation wizard

(2) Installation wizard for massmeter with 1path/1pipe or 2path/1pipe

This portable unit can be selectable from “flow meter”, “mass meter” and “heat meter”.
Also “1path / 1pipe (1 location)”, “2path / 1pipe (1 location)” and “1path / 2 pipe (2 locations)” can be selected on each meter mode.
Here you can see easy-setup procedure (Installation Wizard) for meter type with “1path / 1pipe (1 location)”, “2path / 1pipe (1 location)” for “mass meter”.
If you would like to change each value independently through the advanced setup menu (3:<Advanced Setting>), please refer to the Chapter 2.

Required parameters

Before started, please confirm following value for input.

- Diameter or the circumference of the pipe
- Thickness of the pipe
- Material of the pipe
- Thickness of the lining (if any)
- Material of the lining (if any)
- Fluid type

Table 1.2.7-1 Sample of item parameters

Meas. Setting	1path/1pipe or 1path/2pipe
Filename	100/Steel/1M
Pipe Diameter	114.30 mm
Pipe Thickness	4.50 mm
Pipe Material	Carbon Steel
Lining	None
Fluid Type	Water
Sensor Type	UP10AST
Mass Unit	kg/h
Mass Total Unit	kg

Note1: Check “Meter Type” set as “mass meter” on the following directory.
Menu – 7: System – 2: Measuring Setting – 2: Meter Type ; mass meter

Note2: Check “Path” set as “1path/1pipe” or “2path/1pipe” on the following directory.
Menu – 7: System – 2: Measuring Setting – 2: Path ; x path / 1 pipe

1. Select “Installation Wizard” on the basic menu

Select “1:Installation Wizard” by direction or numeric button.
Then push “Select” key (F3 button).

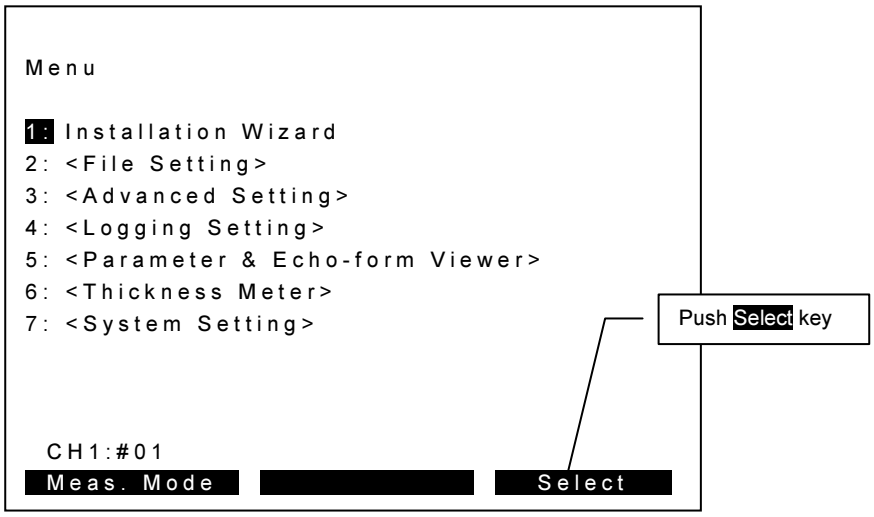


Fig. 1.2.7-2 Basic menu

2. Select file position as “#No.”

Please select Not-Used area by direction button, then push “Enter” key (F3 button).

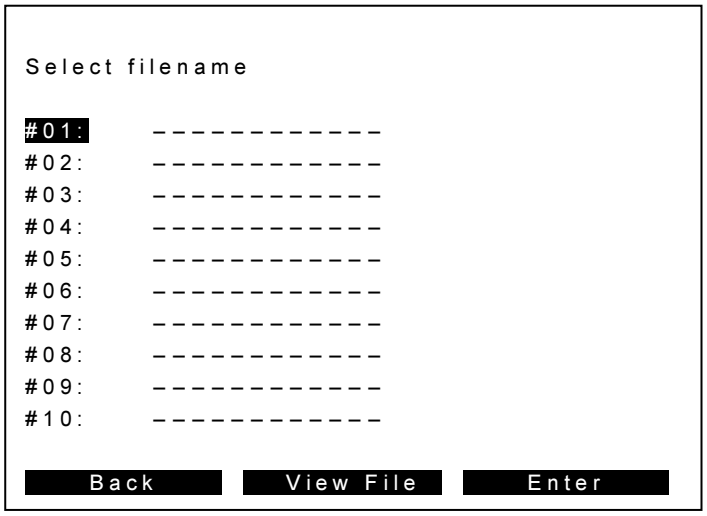


Fig. 1.2.7-3 File selection menu

Not-used area indicated as “--------” and you can not select this position. To remove site setting file, please refer to Chapter 2.
When you select used area, you can see following indication.

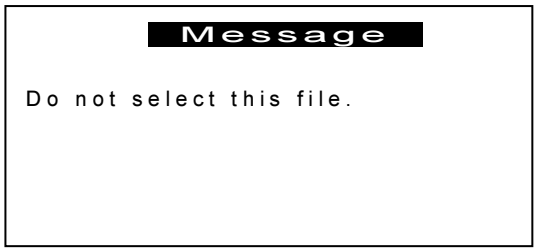


Fig.1.2.7-4 Message of selection not used area

3. File name input

Please input file name by direction button.
Here for example, let's input as "100/Steel/1M".

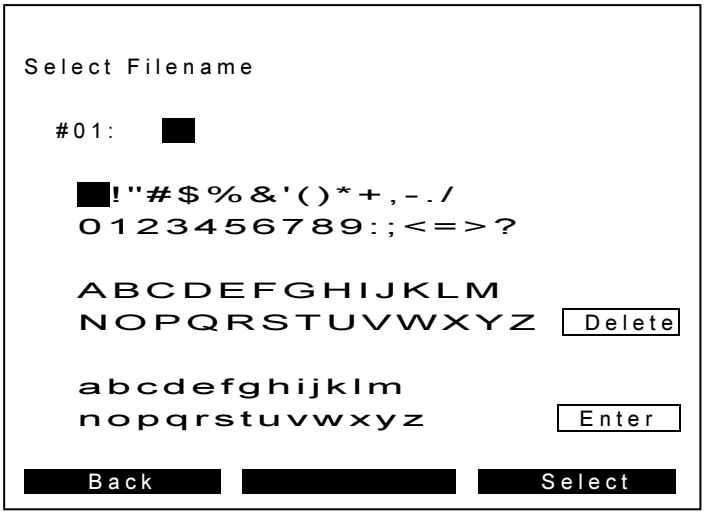


Fig. 1.2.7-5 File name input menu

Move cursor to "1" (for example) by direction button. and push "Select" (F3 button) to select character.
You can see that "1" would set first position as below.

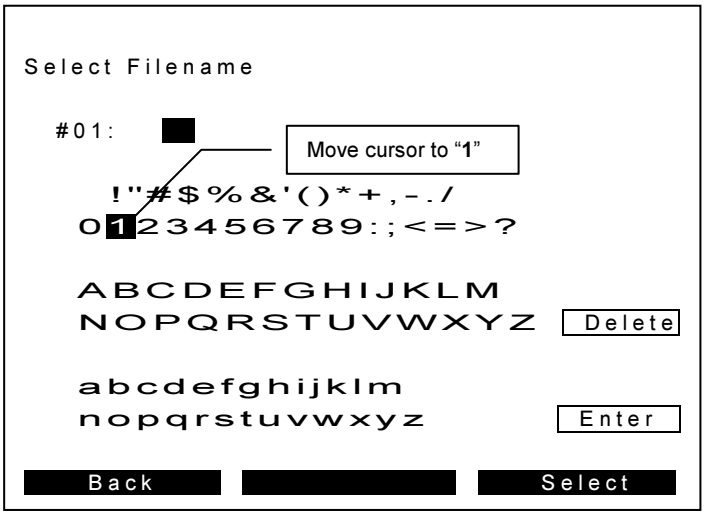


Fig. 1.2.7-6 Word selection menu

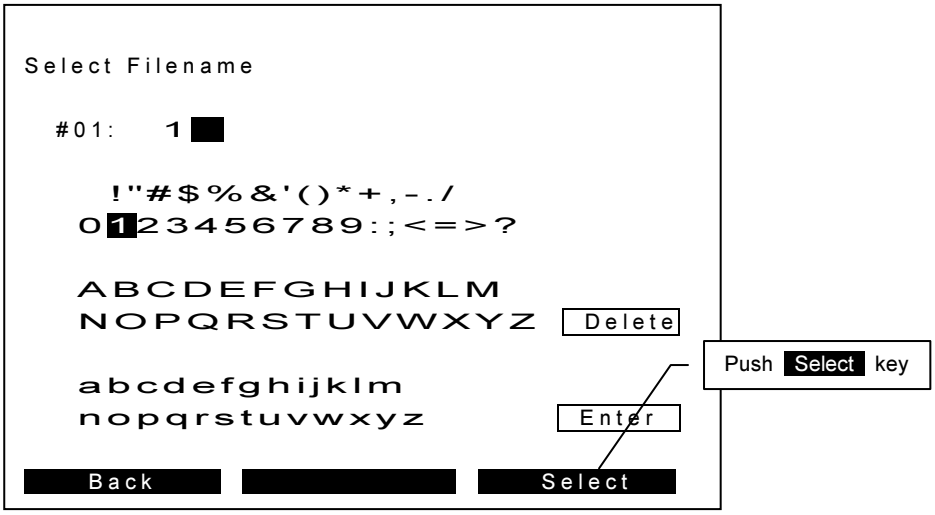


Fig. 1.2.7-7

4. Delete the character (if any)

If you would like to delete the character, you can move cursor onto "Delete", then push "Select" key (F3 button).

Otherwise pushing [SHFT] button to show "Delete" key up at F3 column, then push the F3 to remove the selected character.

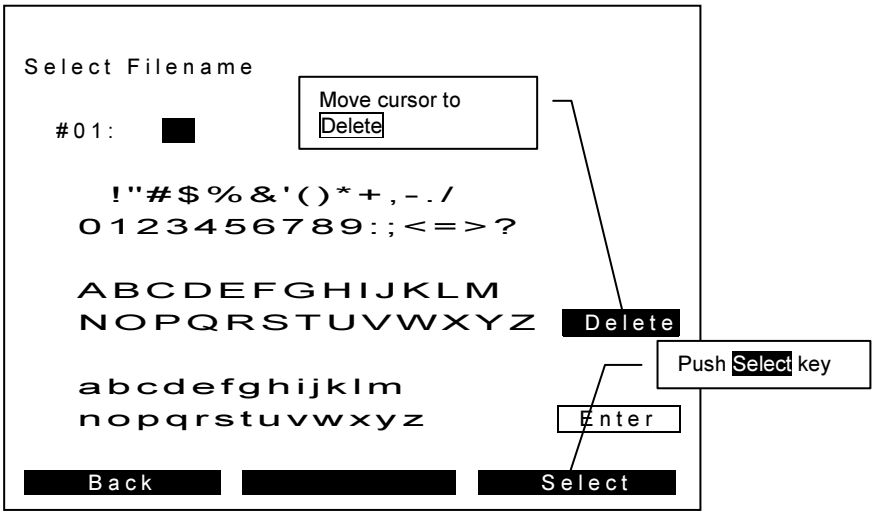


Fig. 1.2.7-8 Delete a character

5. Finalizing file name

By repeating procedure of 1-4, you can input “100/Carbon Steel/1M” as follows.
After finalizing the file name, proceed next menu by move cursor “Enter” and push "Select" key (F3 button), otherwise [SHFT] + F3 button makes the same step taken.

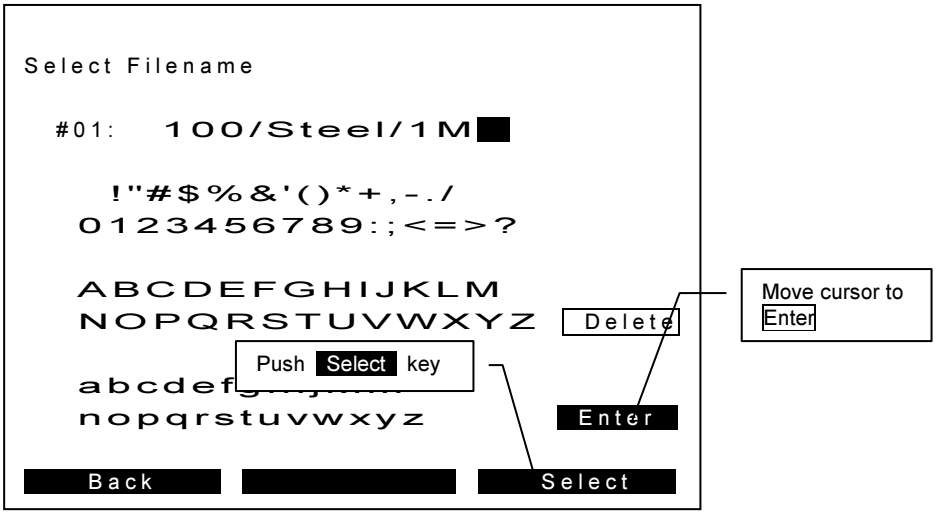


Fig. 1.2.7-9 File name finalize

6. Pipe size settings

Input pipe diameter by diameter itself or circumference of pipe. You can select which way you want by direction or numeric button. Here for example, select “1: Diameter” by push “Select” key (F3 button).

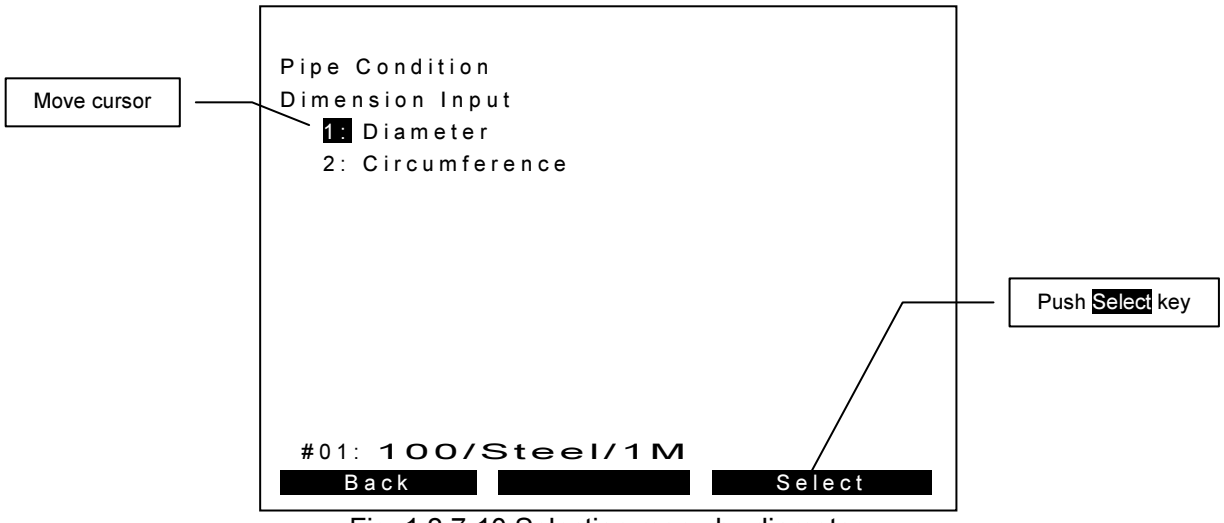


Fig. 1.2.7-10 Selection menu by diameter

Input diameter by numeric button directly. Here for example, input 114.30mm as right. Then push "Enter" key (F3 button) to proceed to next step.

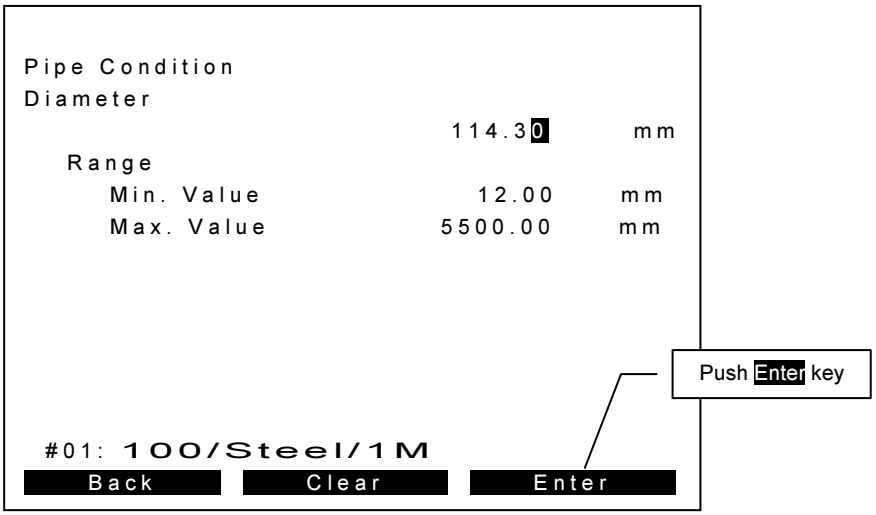


Fig. 1.2.7-11 Input menu

7. Pipe material

Select material of the pipe from default choices or User Defined by direction or numeric button. Here for example, select "1: Carbon Steel", then push "Select" key (F3 button) to proceed next step.

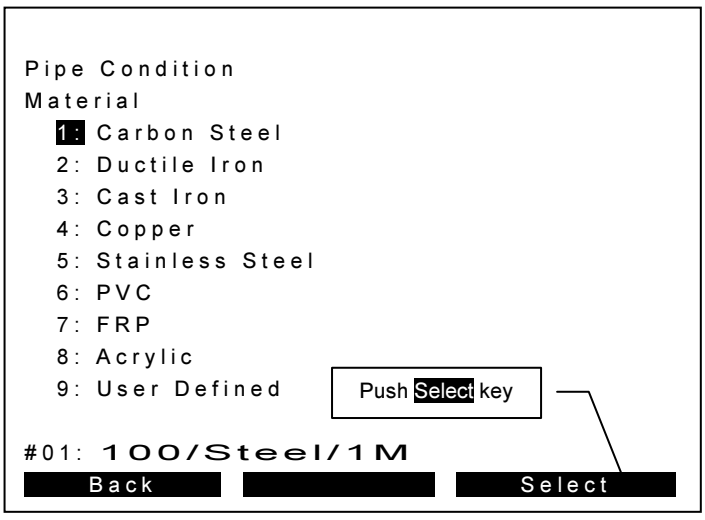


Fig. 1.2.7-12 Pipe material selection menu

Following sound speed is defined as default listed material.

Table 1.2.7-2 Selectable items of pipe material

Material	Sound speed [m/s]
Carbon Steel	3200
Ductile Iron	3000
Cast-Iron	2500
Copper	2270
Stainless Steel	3100
PVC (Poly Vinyl Chloride)	2280
FRP	2560
Acrylic	2720

After you select material, you will see predefined sound speed, normally just proceed to next. If you would like to select any un-listed materials, please select "User Defined" then enter actual sound speed of the material at the next extra menu.

8. Thickness of pipe

Input pipe thickness by numeric button directly. Here for example, input “4.50mm”, then push “Enter” key (F3 button) to proceed to next step.

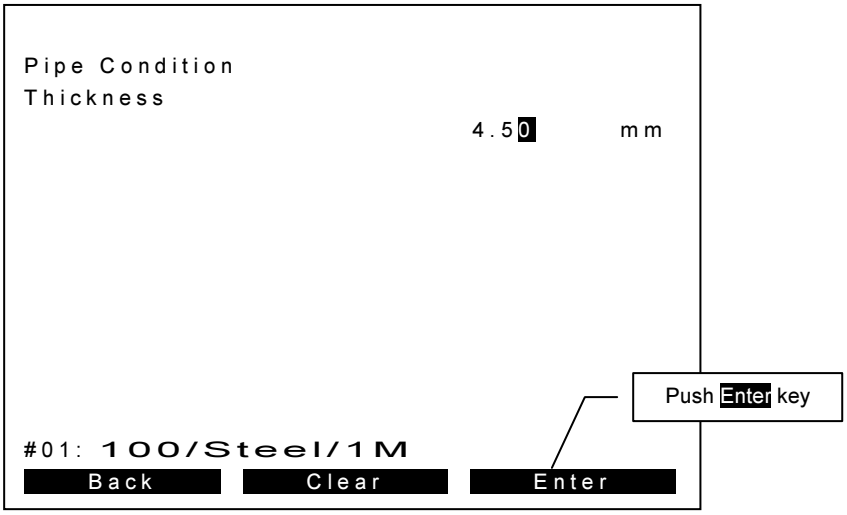


Fig. 1.2.7-13 Pipe thickness input menu

Note: Over ½ of pipe diameter is invalid value. (Max range: up to 100mm)

9. Lining material

Select material of the lining from default choices or User Defined by direction or numeric button. Here for example, select “2:Epoxy”, then push “Select” key (F3 button) to proceed next step.

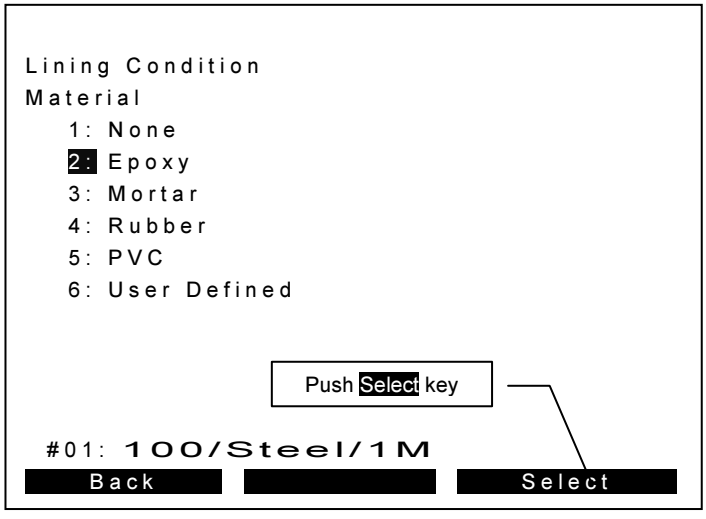


Fig. 1.2.7-14 Lining material selection menu

Following sound speed is defined as default listed material.

Table 1.2.7-3 Selectable items of lining material

Material	Sound speed [m/s]
Epoxy	2000
Mortar	2500
Rubber	1900
PVC (Poly Vinyl Chloride)	2280

After you select material, you will see predefined sound speed, normally just proceed to next. If you would like to select any un-listed materials, please select “User Defined” then enter actual sound speed of the material later at the next extra menu.

10. Thickness of lining

Input lining thickness by numeric button directly. Here for example, input “1.00mm”, then push “Enter” key (F3 button) to proceed to next step.

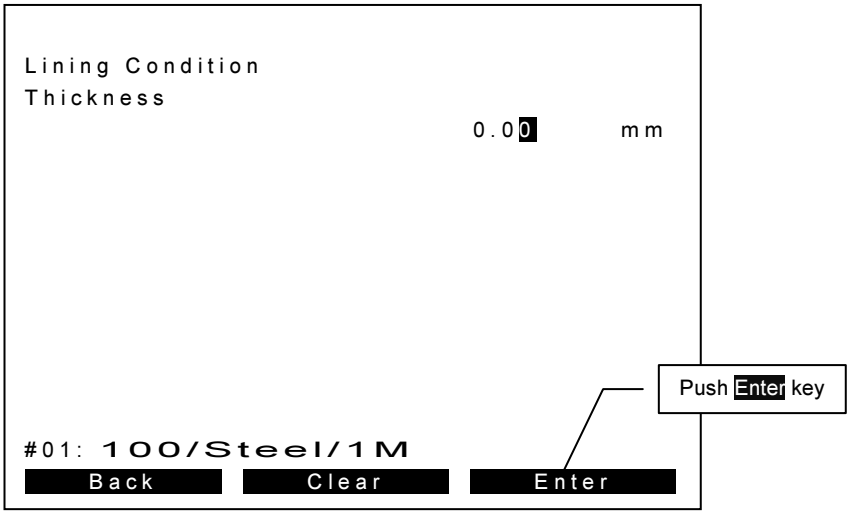


Fig. 1.2.7-15 Lining thickness input menu

Note: Over ½ of pipe diameter is invalid value. (Max range: up to 100mm)

11. Fluid Selection

Select fluid from default choices or User Defined by direction or numeric button.
Here for example, select “1:Water”, then push “Select” key (F3 button) to proceed next step.

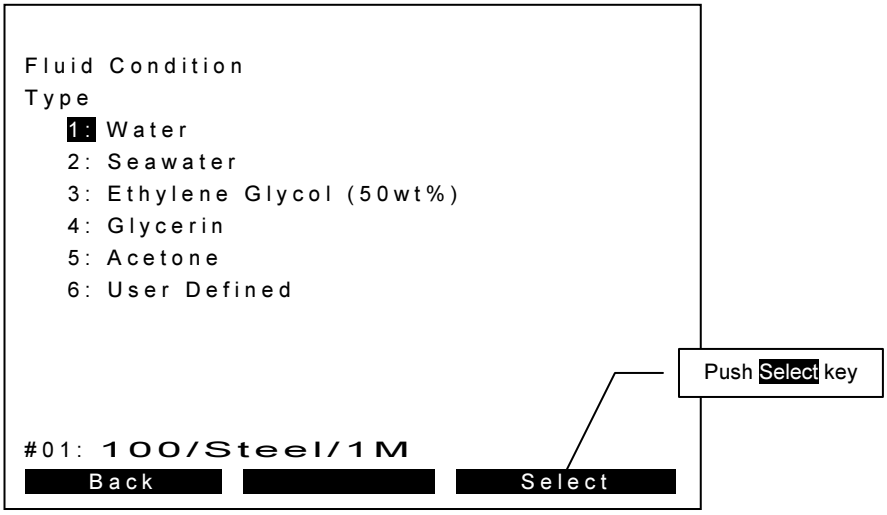


Fig. 1.2.7-16 Fluid type selection

After you select material, you will see predefined sound speed and viscosity, normally just proceed to next. If you would like to select any un-listed fluid, please select “User Defined” then enter actual sound speed of the fluid later at the next extra menu.

Table 1.2.7-4 Selectable items of fluid type

Fluid	Sound speed [m/s]	Viscosity [x10^{-6} m^2/s]	Density [kg/m^3]
Water	1460	1.20	1000.0
Sea Water	1510	1.00	1023.1
Ethylene Glycol (50wt%)	1691	4.13	1066.0
Glycerin	1923	1188.50	1261.3
Acetone	1190	0.41	790.5

12. Transducer type

Select transducer type from default choices by direction or numeric button.
Here for example, select "2:UP10AST", then push "Select" key (F3 button) to proceed next step.

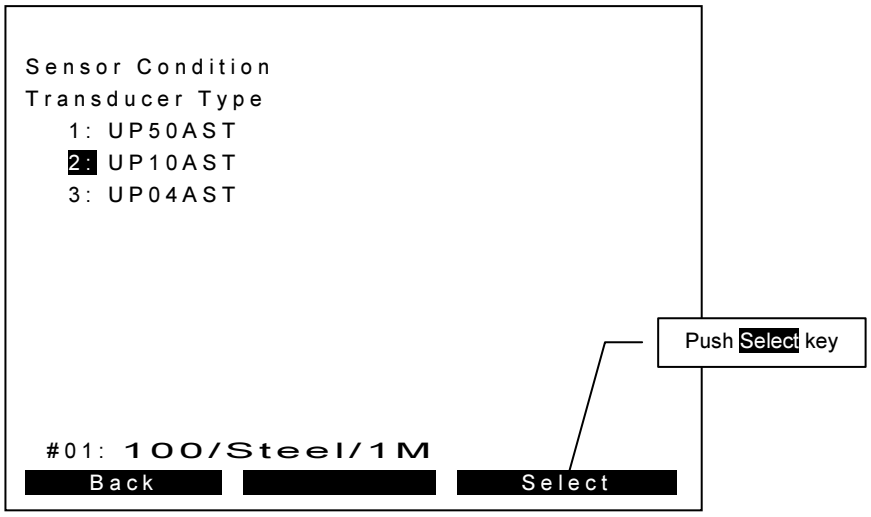


Fig. 1.2.7-17 Transducer type selection menu

13. Sound-path selection

Select sound-path method from default choices by direction or numeric button.
Here for example, select "2: V-path method", then push "Select" key (F3 button) to proceed next step.

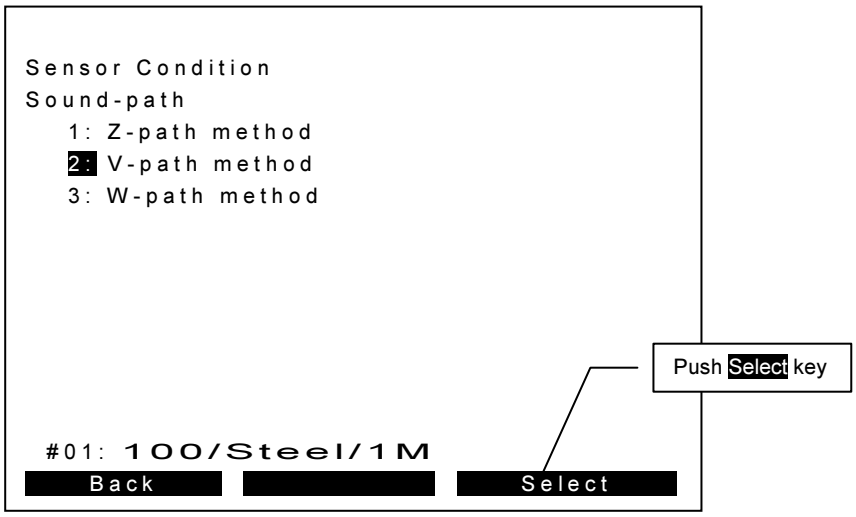


Fig.1.2.7-18 Sound-path selection menu

(a) Z-path method

This type of method is effective for application of measurement on the larger pipe or measurement for attenuating fluid against ultrasonic. Because of transducers distance is relatively shorter, so please select this method when V-path method installation is impossible.

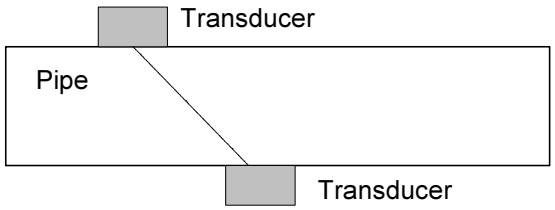


Fig. 1.2.7-19 Z-path method

(b) V-path method

This method is typical. Please select this method as primary.

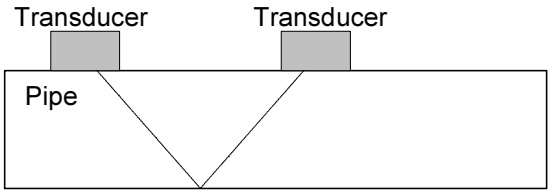


Fig. 1.2.7-20 V-path method

(c) W-path method

This method may be effective for smaller pipe measurement. Please select this method when you have any problems by V or Z-path method.

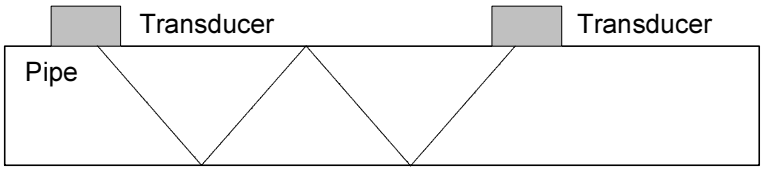


Fig. 1.2.7-21 W-path method

14. Mass unit setting

Select mass unit from default choices by direction or numeric button.
Here for example, select "3: kg/h", then push "Select" key (F3 button) to proceed next step.

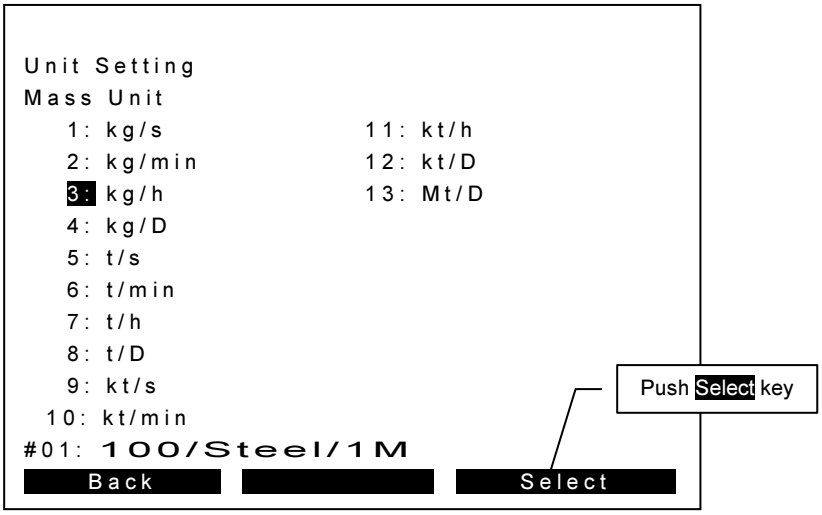


Fig. 1.2.7-22 Flow rate unit setting menu

15. Decimal point position

Select decimal point position from default choices by direction or numeric button.
Here for example, select "3: ***.***", then push "Select" key (F3 button) to proceed next step.

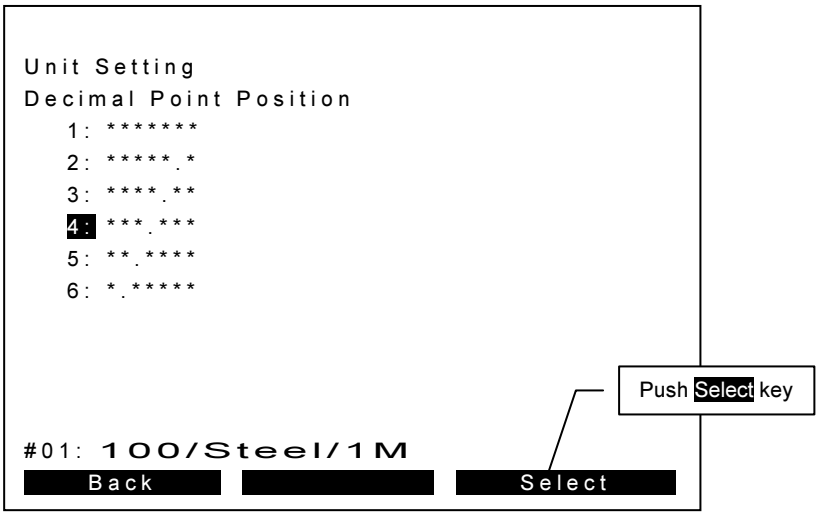


Fig. 1.2.7-23 Decimal point position setting menu

16. Totalizing unit setting

Select totalizing unit from default choices by direction or numeric button.
Here for example, select "1: x1 kg", then push "Select" key (F3 button) to proceed next step.

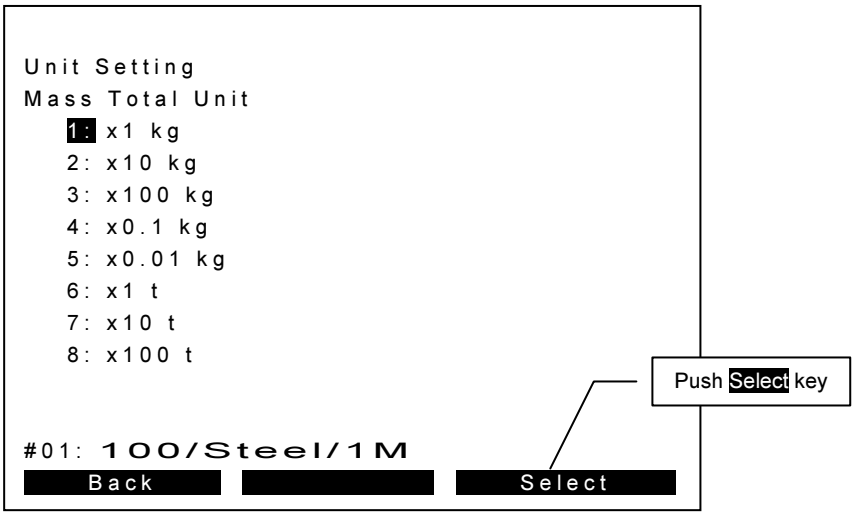


Fig.1.2.7-24 Totalizing unit setting menu

17. Store site data

Finalize wizard by store all data on this menu. Select "2: Yes" by direction or numeric button.
Then push "Select" key (F3 button) to proceed next step.

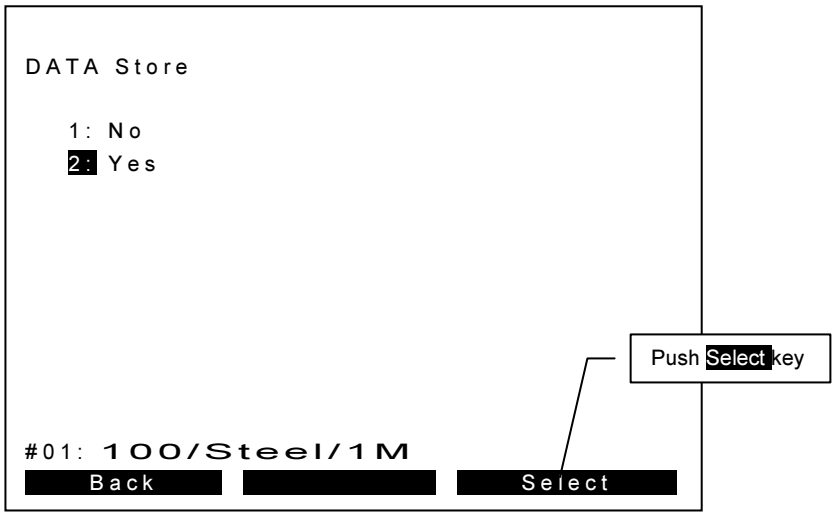


Fig. 1.2.7-25 Data storing menu

When select “2: Yes”, following message will be shown.

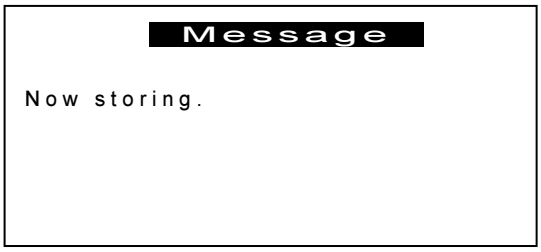


Fig. 1.2.7-26 Data storing

When select “1: No”, following message will be shown. Then again you select “Yes” (F1 button), site setting data will be discarded. Otherwise when you select “No” (F3 button), return to previous data storing menu.

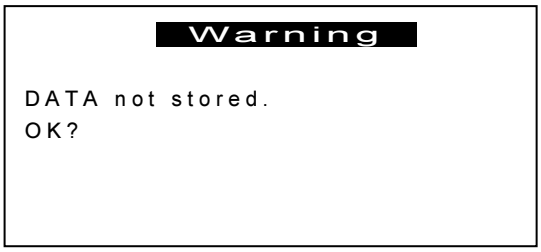


Fig. 1.2.7-27 Data discarding

After storing site setting data, following confirmation message shows up. Then push “Yes” (F3 button) to proceed next step. Otherwise when you select “No” (F1 button), return to initial basic menu.

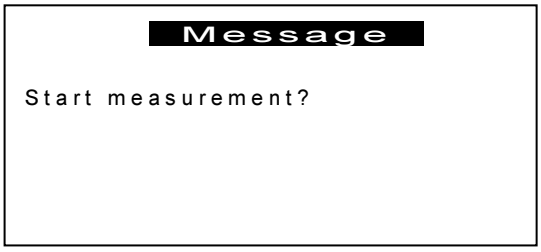


Fig. 1.2.7-28 Confirmation message to start measurement

18. Mounting transducers

The main unit calculates proper distance between transducers as following message. Then push "OK" (F3 button) to start measurement. Please set transducer mounting with indicated transducer distance in accordance with instruction on Chapter 1.2.9.
On this example, distance of transducers is 63.8 mm.

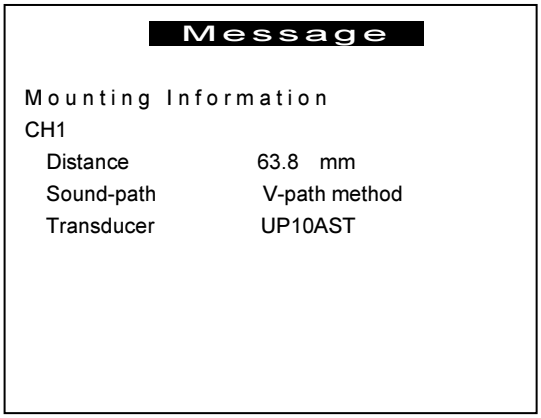


Fig. 1.2.7-29 Message of mounting information

19. Measurement start

Mass flowrate measurement starts as below.

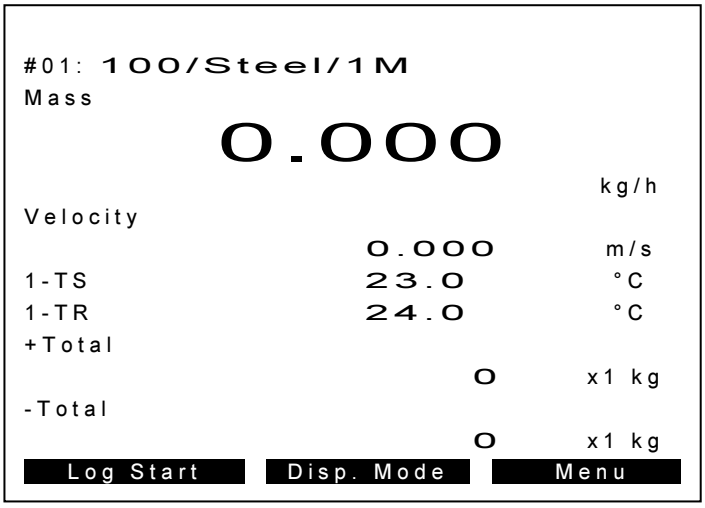


Fig. 1.2.7-30 Mass flowrate measurement display

(3) Installation wizard for massmeter with 1path/2pipe (2-channel) setting

This portable unit can be selectable from “flow meter”, “mass meter” and “heat meter”.
Also “1path / 1pipe (1 location)”, “2path / 1pipe (1 location)” and “1path / 2 pipe (2 locations)” can be selected on each meter mode.
Here you can see easy-setup procedure for meter type with “1path / 1pipe (1 location)”, “2path / 1pipe (1 location)” for “mass meter”.
If you would like to change each value independently through the advanced setup menu, please refer to the Chapter 2.

1path/2pipe mode means 1 main unit measures 2 different pipes even site condition like pipe diameter is different.

Required parameters

Before started, please confirm following value for input.

- Diameter or the circumference of the 2 pipes
- Thickness of the 2 pipes
- Material of the 2 pipes
- Thickness of the lining (if any)
- Material of the lining (if any)
- Fluid type

Note1: Check “Meter Type” set as “mass meter” on the following directory.
Menu – 7: System – 2: Measuring Setting – 2: Meter Type ; mass meter

Note2: Check “Path” set as “1path/2pipe” on the following directory.
Menu – 7: System – 2: Measuring Setting – 2: Path ; 1 path / 2 pipe

1. Select installation wizard

Proceed all parameters input as same as 1pipe version.

2. Channel Selection

After input parameters as menu 1-18, channel selection will be required as below.

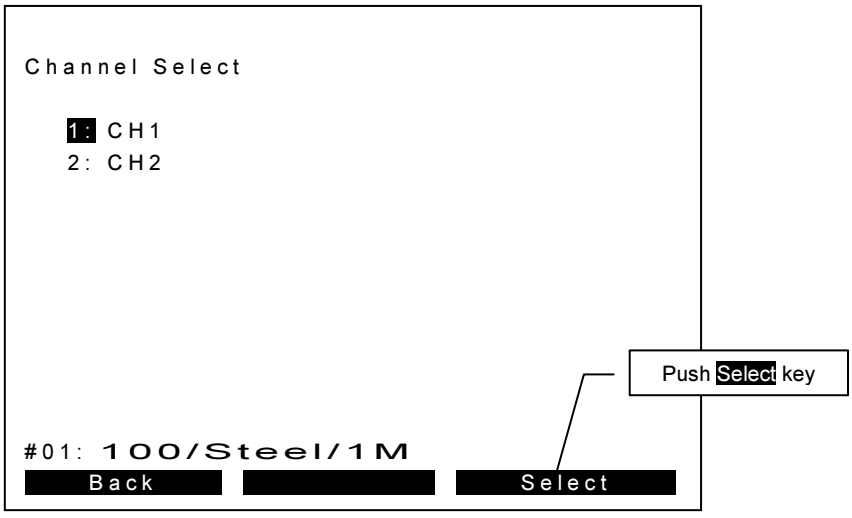


Fig. 1.2.7-31 Channel selection menu

3. Store site data

Finalize wizard by store all data on this menu. Select "2: Yes" by direction or numeric button. Then push "Select" key (F3 button) to proceed next step.

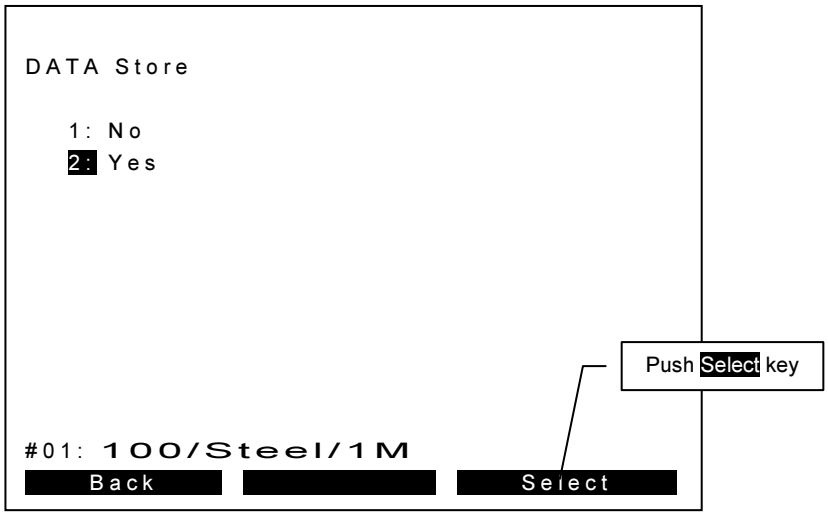


Fig. 1.2.7-32 Data storing menu

4. Data for Channel 2

Proceeded 2-4 menu, following message shows up for copying the site setting.

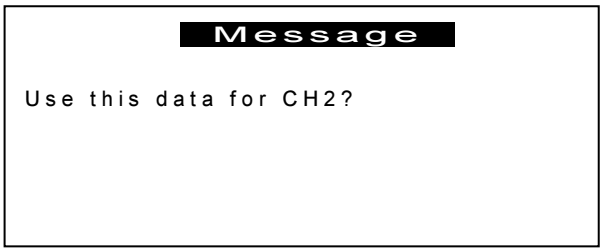


Fig. 1.2.7-33 Message of using same data for CH2

If you select "Yes" (F1 button), same site setting data will be used 2nd channel setting.
Otherwise when you select "No" (F1 button), return to first menu of wizard.
You need to make other site setting data through this wizard for 2nd channel.

Note: When you select "CH2" at first channel selection, only CH2 data is made through wizard process.
You will need to set "CH1" parameters independently.

1.2.8 Input parameters for heatmeter

(1) Flow of installation wizard

Installation wizard archives easy parameters input of all required parameter through dialog type menu.

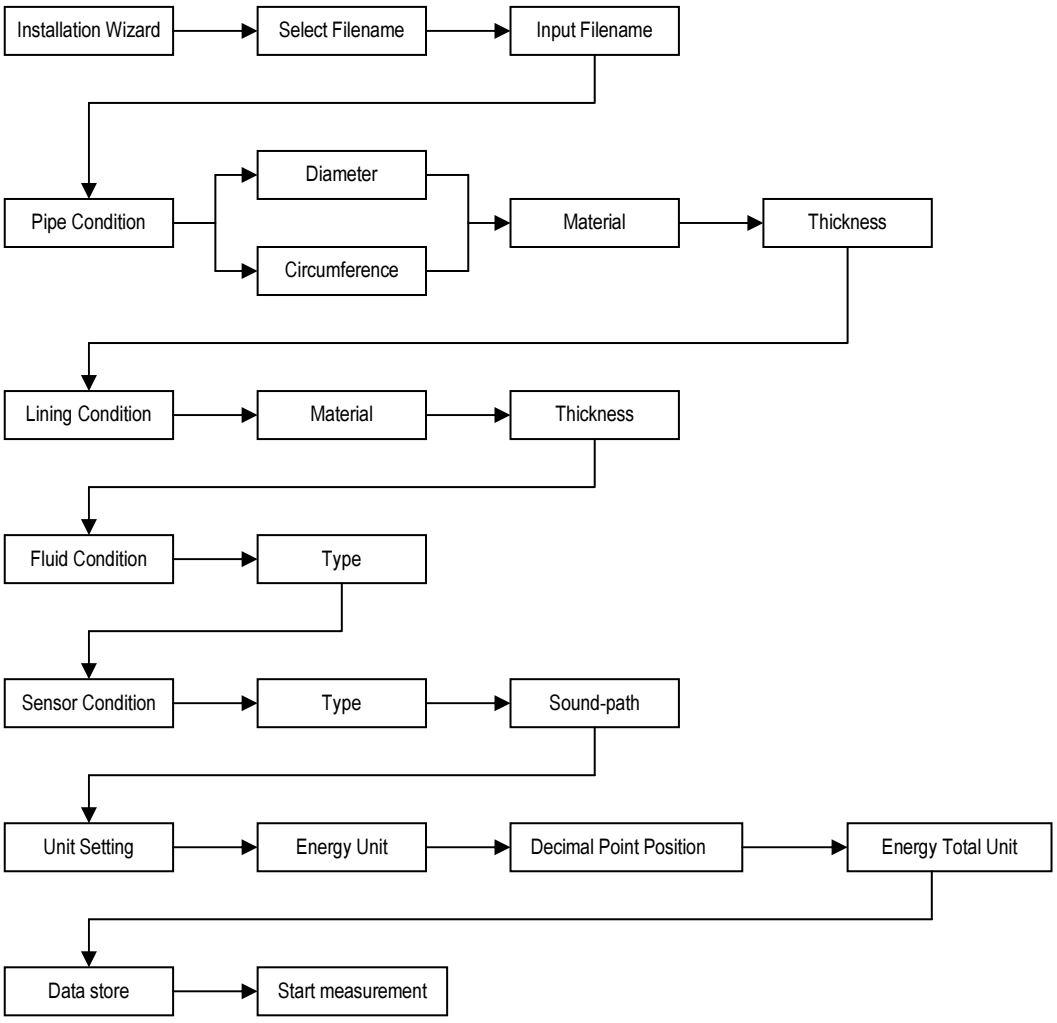


Fig. 1.2.8-1 Flow of installation wizard

(2) Installation wizard for heatmeter with 1path/1pipe or 2path/1pipe

This portable unit can be selectable from “flow meter”, “mass meter” and “heat meter”.
Also “1path / 1pipe (1 location)”, “2path / 1pipe (1 location)” and “1path / 2 pipe (2 locations)” can be selected on each meter mode.
Here you can see easy-setup procedure (Installation Wizard) for meter type with “1path / 1pipe (1 location)”, “2path / 1pipe (1 location)” for “heat meter”.
If you would like to change each value independently through the advanced setup menu (3:<Advanced Setting>), please refer to the Chapter 2.

Required parameters

Before started, please confirm following value for input.

- Diameter or the circumference of the pipe
- Thickness of the pipe
- Material of the pipe
- Thickness of the lining (if any)
- Material of the lining (if any)
- Fluid type

Table 1.2.8-1 Sample of item parameters

Meas. Setting	1path/1pipe or 1path/2pipe
Filename	100/Steel/1M
Pipe Diameter	114.30 mm
Pipe Thickness	4.50 mm
Pipe Material	Carbon Steel
Lining	None
Fluid Type	Water
Sensor Type	UP10AST
Mass Unit	W
Mass Total Unit	J

Note1: Check “Meter Type” set as “heat meter” on the following directory.
Menu – 7: System – 2: Measuring Setting – 2: Meter Type ; heat meter

Note2: Check “Path” set as “1path/1pipe” or “2path/1pipe” on the following directory.
Menu – 7: System – 2: Measuring Setting – 2: Path ; x path / 1 pipe

1. Select “Installation Wizard” on the basic menu

Select “1:Installation Wizard” by direction or numeric button.
Then push “Select” key (F3 button).

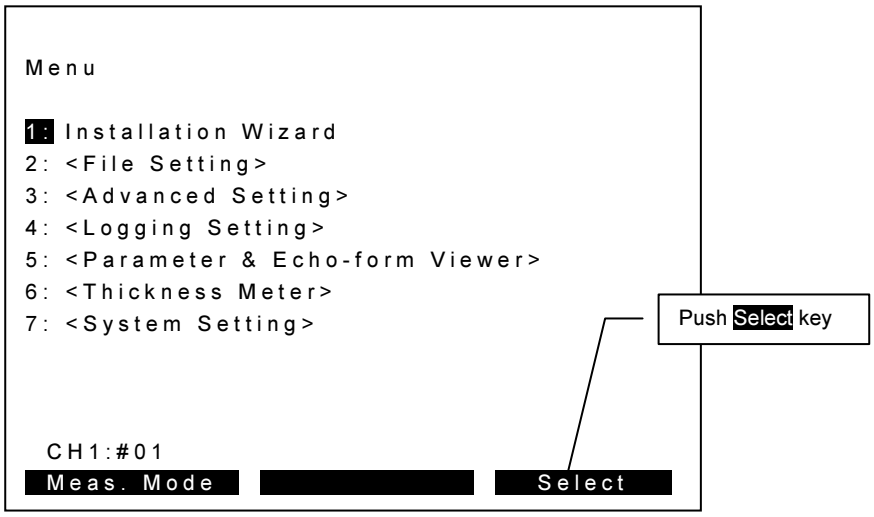


Fig. 1.2.8-2 Basic menu

2. Select file position as “#No.”

Please select Not-Used area by direction button, then push “Enter” key (F3 button).

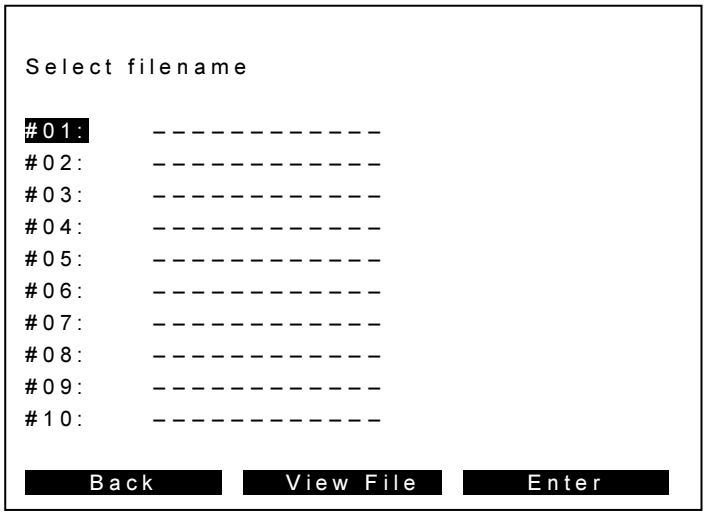


Fig. 1.2.8-3 File selection menu

Not-used area indicated as “--------” and you can not select this position. To remove site setting file, please refer to Chapter 2.
When you select used area, you can see following indication.

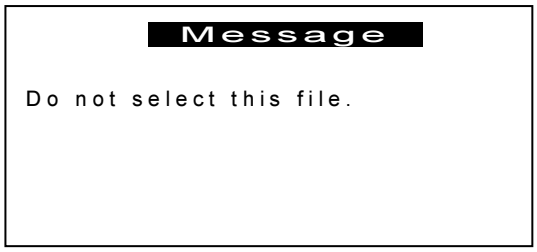


Fig.1.2.8-4 Message of selection not used area

3. File name input

Please input file name by direction button.
Here for example, let's input as "100/Steel/1M".

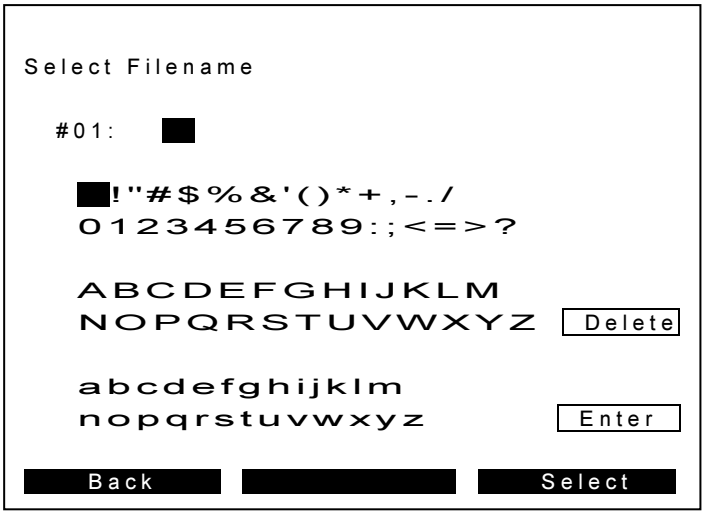


Fig. 1.2.8-5 File name input menu

Move cursor to "1" (for example) by direction button. and push "Select" key (F3 button) to select character.
You can see that "1" would set first position as below.

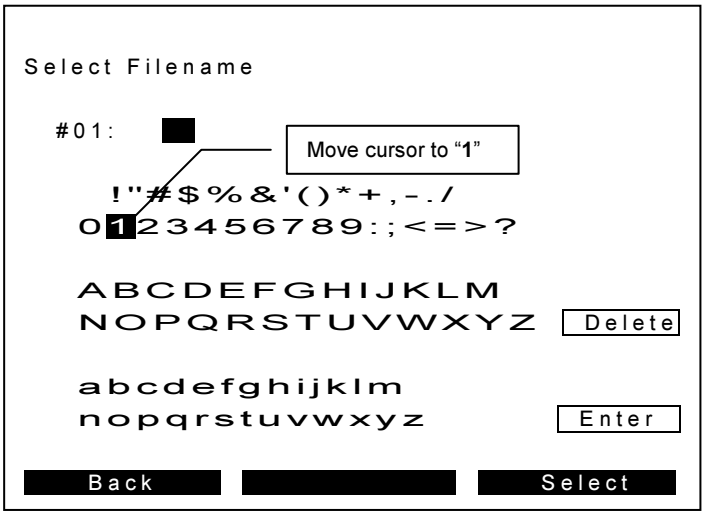


Fig. 1.2.8-6 Word selection menu

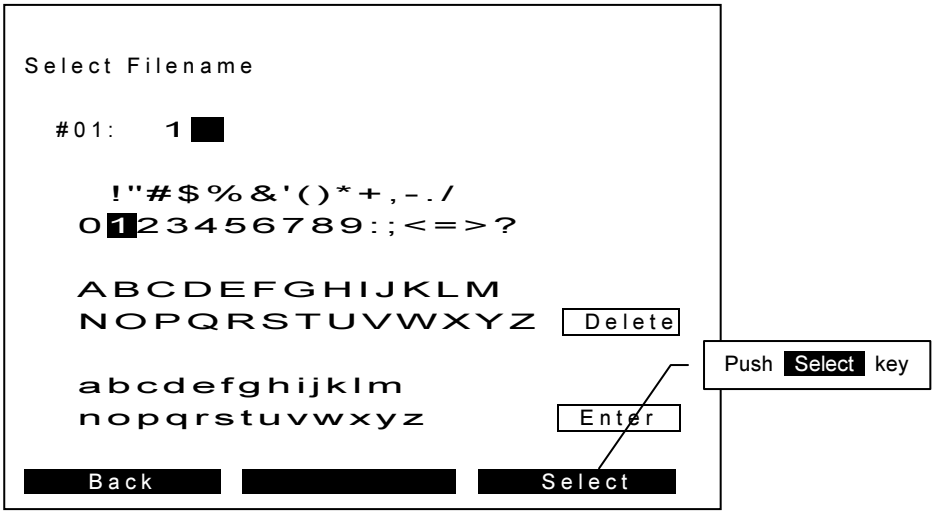


Fig. 1.2.8-7

4. Delete the character (if any)

If you would like to delete the character, you can move cursor onto "Delete", then push "Select" key (F3 button).

Otherwise pushing [SHFT] button to show "Delete" key up at F3 column, then push the F3 to remove the selected character.

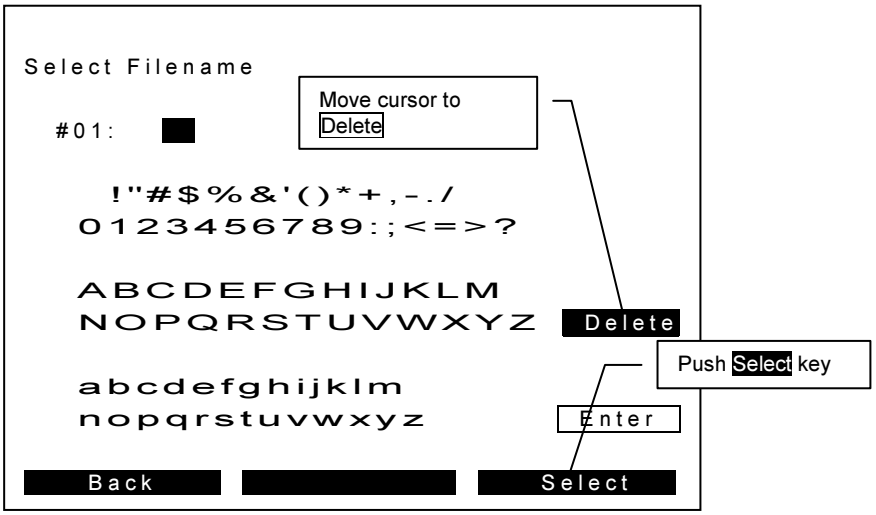


Fig. 1.2.8-8 Delete a character

5. Finalizing file name

By repeating procedure of 1-4, you can input “100/Carbon Steel/1M” as follows.
After finalizing the file name, proceed next menu by move cursor “Enter” and push “Select” key (F3 button), otherwise [SHFT] + F3 button makes the same step taken.

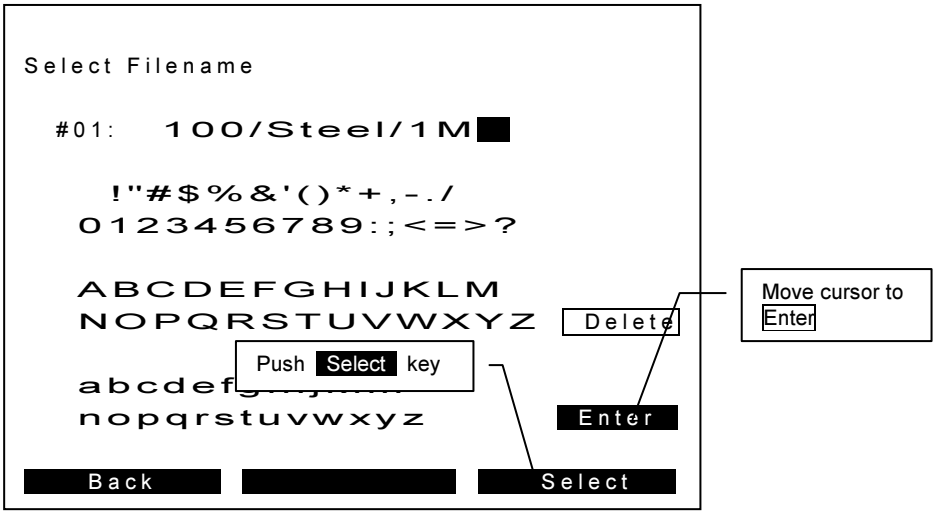


Fig. 1.2.8-9 File name finalize

6. Pipe size settings

Input pipe diameter by diameter itself or circumference of pipe. You can select which way you want by direction or numeric button. Here for example, select “1: Diameter” by push “Select” key (F3 button).

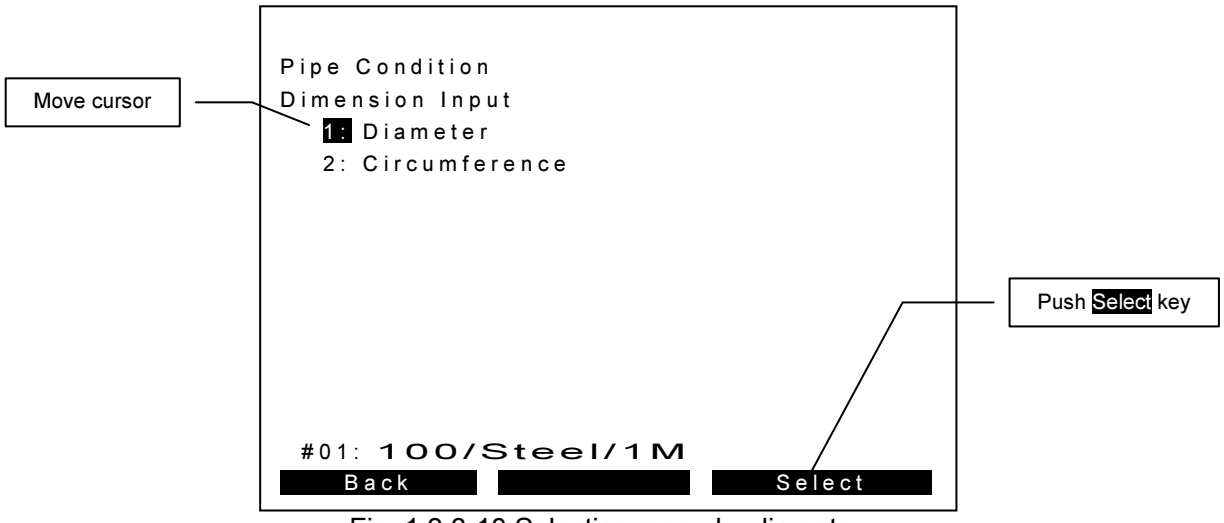


Fig. 1.2.8-10 Selection menu by diameter

Input diameter by numeric button directly. Here for example, input 114.30mm as right. Then push "Enter" key (F3 button) to proceed to next step.

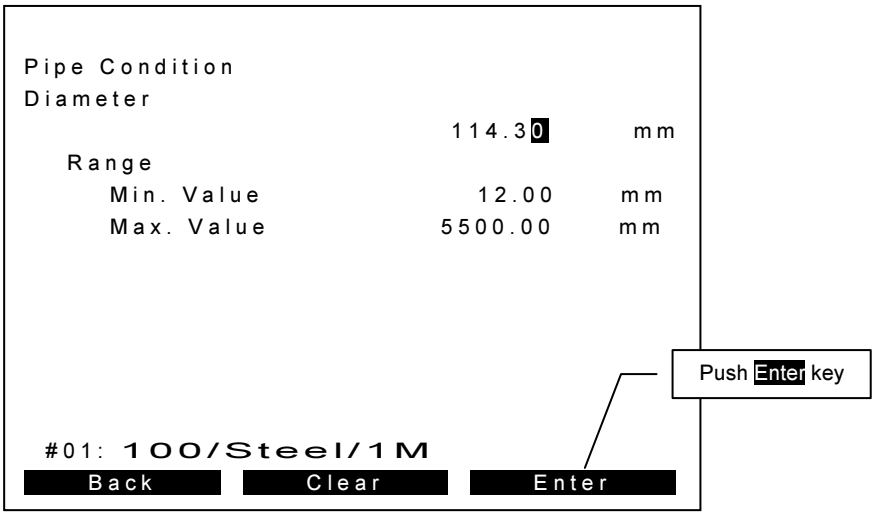


Fig. 1.2.8-11 Input menu

7. Pipe material

Select material of the pipe from default choices or User Defined by direction or numeric button. Here for example, select "1: Carbon Steel", then push "Select" key (F3 button) to proceed next step.

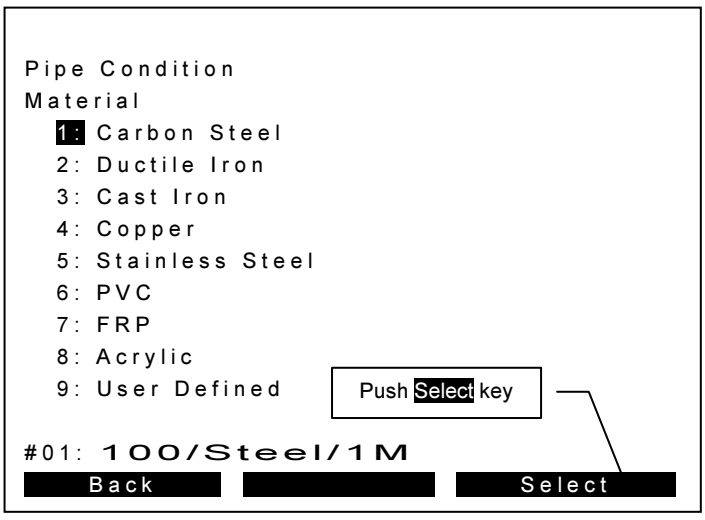


Fig. 1.2.8-12 Pipe material selection menu

Following sound speed is defined as default listed material.

Table 1.2.8-2 Selectable items of pipe material

Material	Sound speed [m/s]
Carbon Steel	3200
Ductile Iron	3000
Cast-Iron	2500
Copper	2270
Stainless Steel	3100
PVC (Poly Vinyl Chloride)	2280
FRP	2560
Acrylic	2720

After you select material, you will see predefined sound speed, normally just proceed to next. If you would like to select any un-listed materials, please select "User Defined" then enter actual sound speed of the material at the next extra menu.

8. Thickness of pipe

Input pipe thickness by numeric button directly. Here for example, input “4.50mm”, then push “Enter” key (F3 button) to proceed to next step.

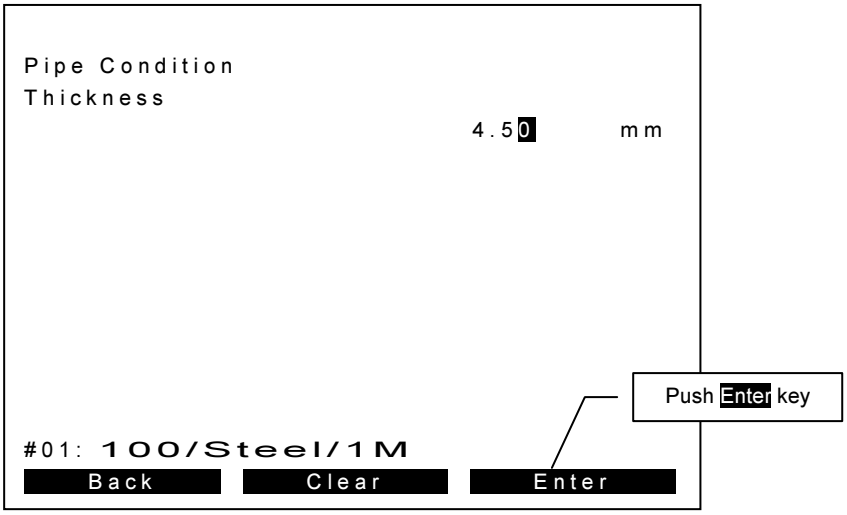


Fig. 1.2.8-13 Pipe thickness input menu

Note: Over ½ of pipe diameter is invalid value. (Max range: up to 100mm)

9. Lining material

Select material of the lining from default choices or User Defined by direction or numeric button. Here for example, select “2:Epoxy”, then push “Select” key (F3 button) to proceed next step.

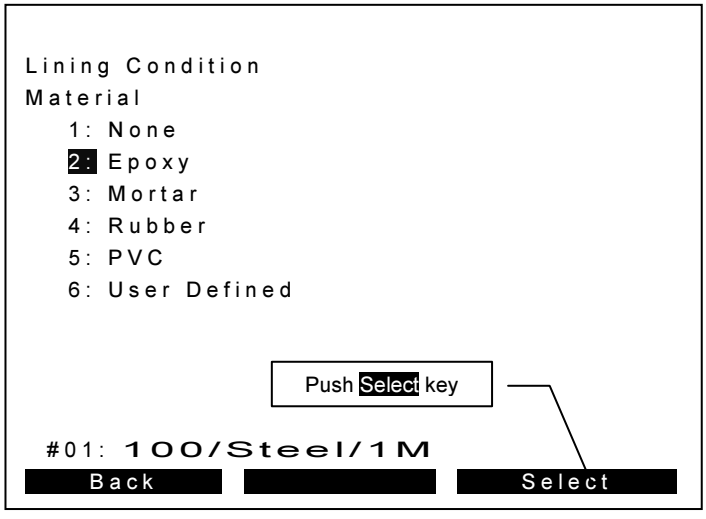


Fig. 1.2.8-14 Lining material selection menu

Following sound speed is defined as default listed material.

Table 1.2.8-3 Selectable items of lining material

Material	Sound speed [m/s]
Epoxy	2000
Mortar	2500
Rubber	1900
PVC (Poly Vinyl Chloride)	2280

After you select material, you will see predefined sound speed, normally just proceed to next. If you would like to select any un-listed materials, please select “User Defined” then enter actual sound speed of the material later at the next extra menu.

10. Thickness of lining

Input lining thickness by numeric button directly. Here for example, input “1.00mm”, then push “Enter” key (F3 button) to proceed to next step.

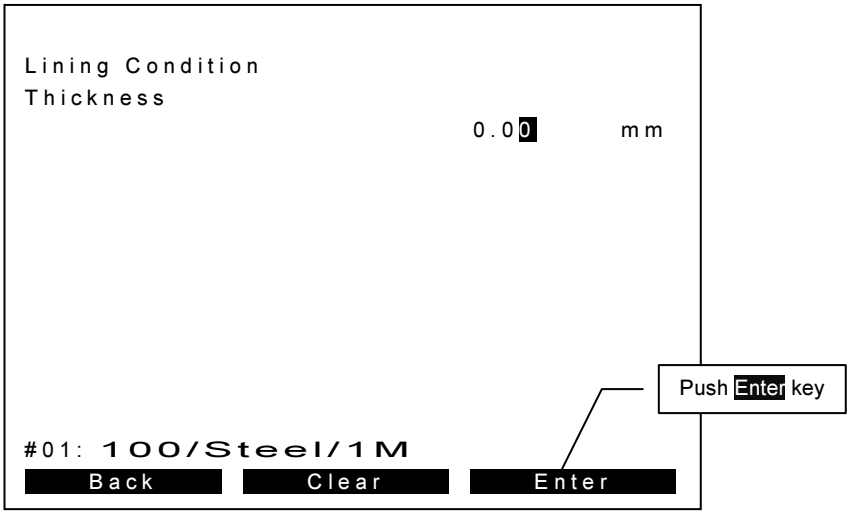


Fig. 1.2.8-15 Lining thickness input menu

Note: Over ½ of pipe diameter is invalid value. (Max range: up to 100mm)

11. Fluid Selection

Select fluid from default choices or User Defined by direction or numeric button.
Here for example, select “1:Water”, then push “Select” key (F3 button) to proceed next step.

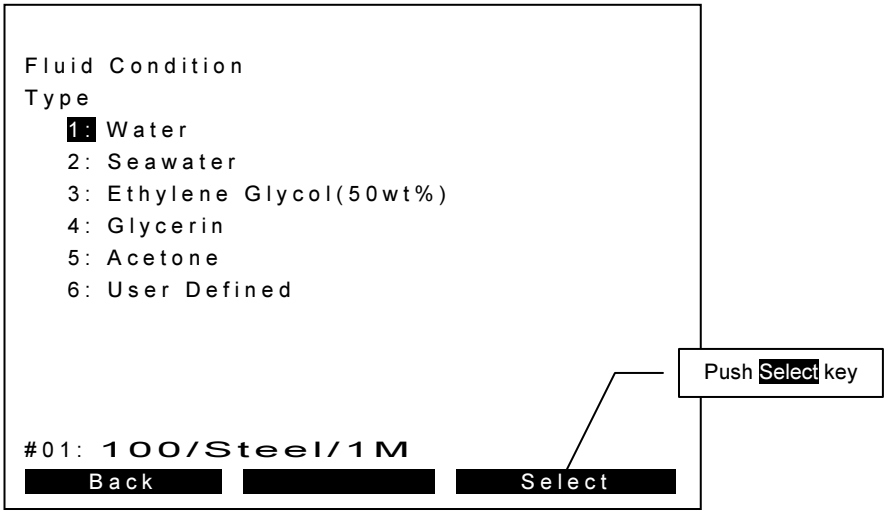


Fig. 1.2.8-16 Fluid type selection

After you select material, you will see predefined sound speed and viscosity, normally just proceed to next. If you would like to select any un-listed fluid, please select “User Defined” then enter actual sound speed of the fluid later at the next extra menu.

Table 1.2.8-4 Selectable items of fluid type

Fluid	Sound speed [m/s]	Viscosity [x10^{-6} m^2/s]	Density [kg/m^3]	Specific heat [J/kgK]
Water	1460	1.20	1000.0	4184.0
Sea Water	1510	1.00	1023.1	3930.0
Ethylene Glycol (50wt%)	1691	4.13	1066.0	3265.0
Glycerin	1923	1188.50	1261.3	580.0
Acetone	1190	0.41	790.5	516.0

12. Transducer type

Select transducer type from default choices by direction or numeric button.
Here for example, select "2:UP10AST", then push "Select" key (F3 button) to proceed next step.

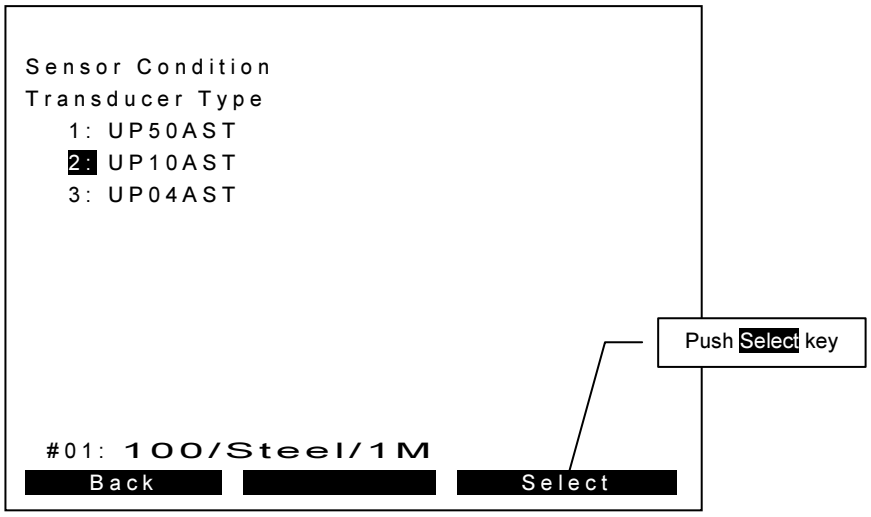


Fig. 1.2.8-17 Transducer type selection menu

13. Sound-path selection

Select sound-path method from default choices by direction or numeric button.
Here for example, select "2: V-path method", then push "Select" key (F3 button) to proceed next step.

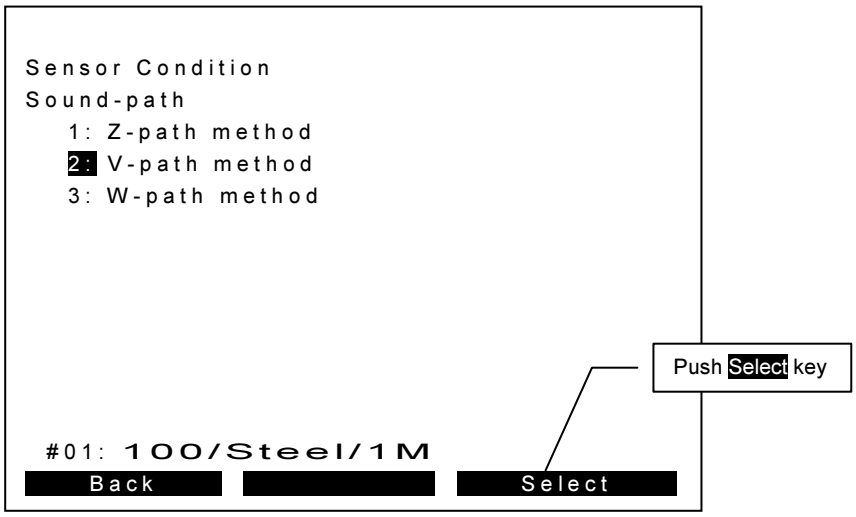


Fig.1.2.8-18 Sound-path selection menu

(a) Z-path method

This type of method is effective for application of measurement on the larger pipe or measurement for attenuating fluid against ultrasonic. Because of transducers distance is relatively shorter, so please select this method when V-path method installation is impossible.

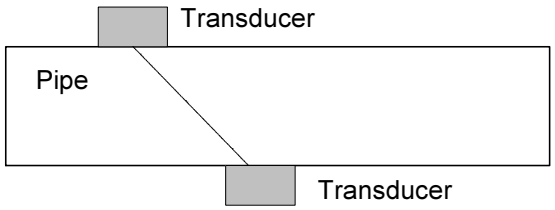


Fig. 1.2.8-19 Z-path method

(b) V-path method

This method is typical. Please select this method as primary.

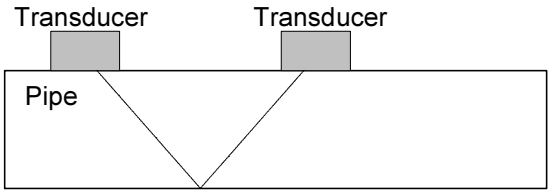


Fig. 1.2.8-20 V-path method

(c) W-path method

This method may be effective for smaller pipe measurement. Please select this method when you have any problems by V or Z-path method.

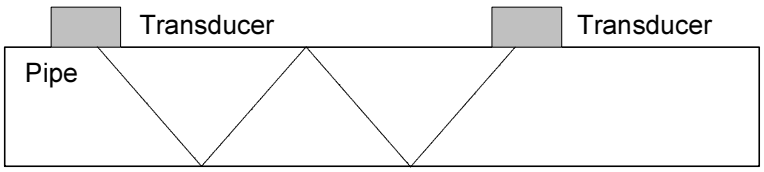


Fig. 1.2.8-21 W-path method

14. Energy unit setting

Select energy unit from default choices by direction or numeric button.
Here for example, select "3: W", then push "Select" key (F3 button) to proceed next step.

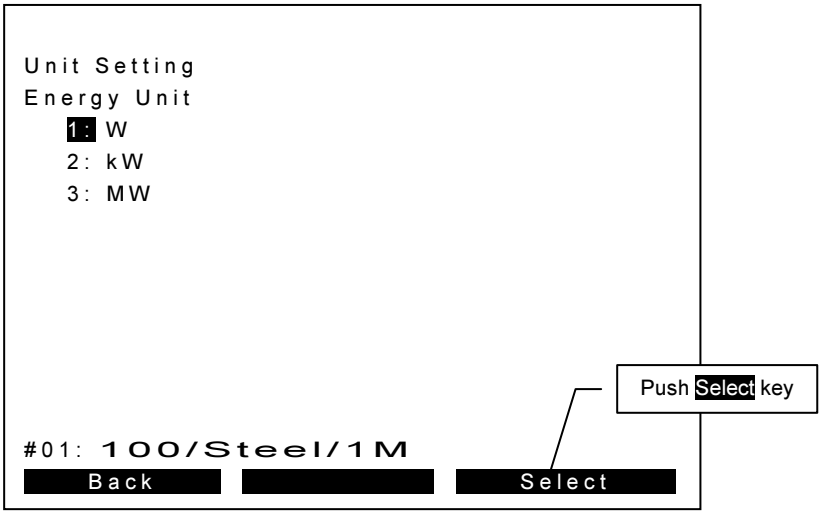


Fig. 1.2.8-22 Flow rate unit setting menu

15. Decimal point position

Select decimal point position from default choices by direction or numeric button.
Here for example, select "3: ***.***", then push "Select" key (F3 button) to proceed next step.

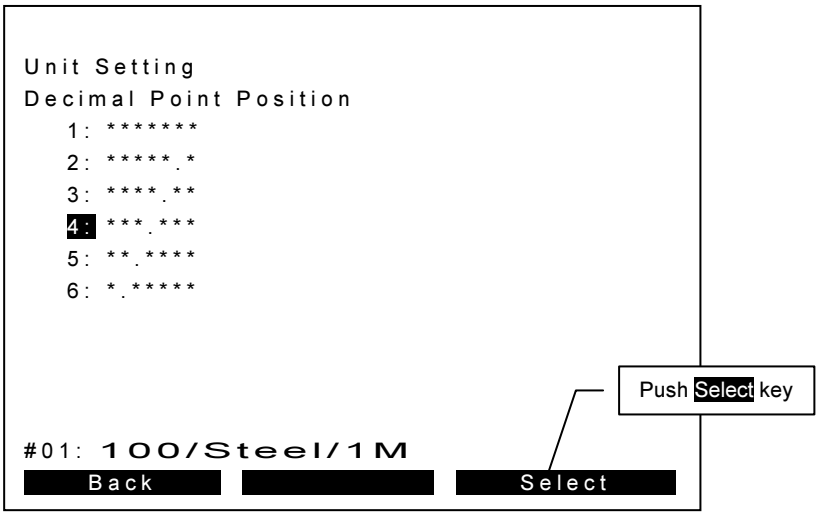


Fig. 1.2.8-23 Decimal point position setting menu

16. Totalizing unit setting

Select totalizing unit from default choices by direction or numeric button.
Here for example, select "1: J", then push "Select" key (F3 button) to proceed next step.

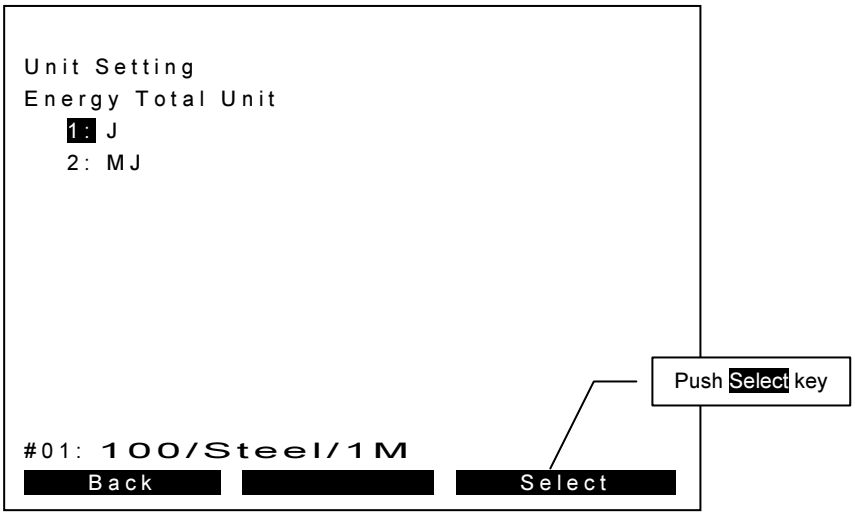


Fig.1.2.8-24 Totalizing unit setting menu

17. Store site data

Finalize wizard by store all data on this menu. Select "2: Yes" by direction or numeric button.
Then push "Select" key (F3 button) to proceed next step.

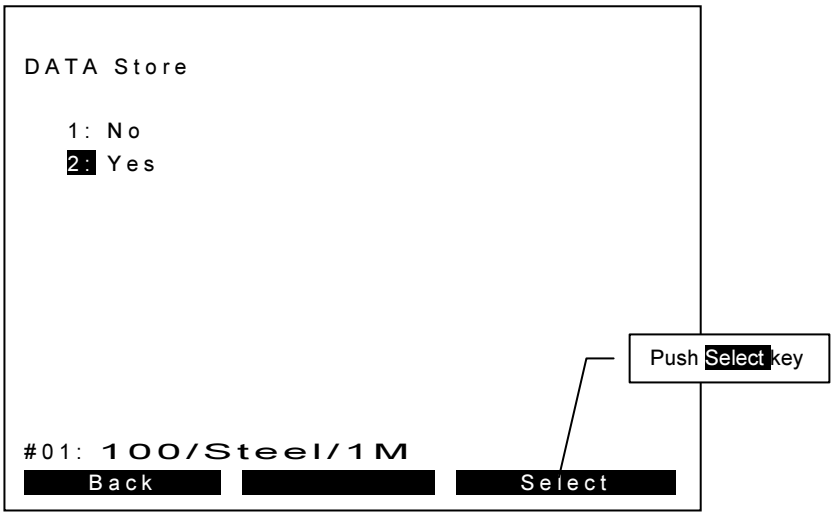


Fig. 1.2.8-25 Data storing menu

When select “2: Yes”, following message will be shown.

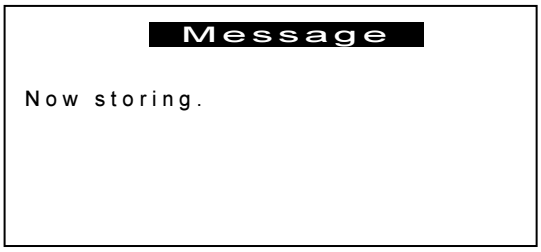


Fig. 1.2.8-26 Data storing

When select “1: No”, following message will be shown. Then again you select “Yes” (F1 button), site setting data will be discarded. Otherwise when you select “No” (F3 button), return to previous data storing menu.

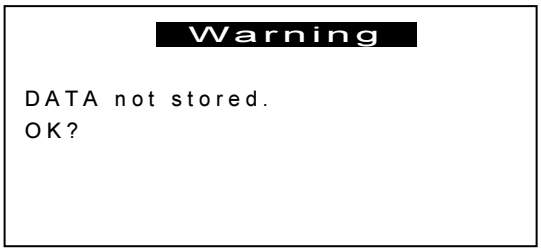


Fig. 1.2.8-27 Data discarding

After storing site setting data, following confirmation message shows up. Then push “Yes” (F3 button) to proceed next step. Otherwise when you select “No” (F1 button), return to initial basic menu.

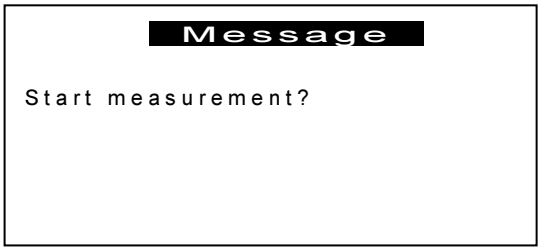


Fig. 1.2.8-28 Confirmation message to start measurement

18. Mounting transducers

The main unit calculates proper distance between transducers as following message. Then push "OK" (F3 button) to start measurement. Please set transducer mounting with indicated transducer distance in accordance with instruction on Chapter 1.2.9.
On this example, distance of transducers is 63.8 mm.

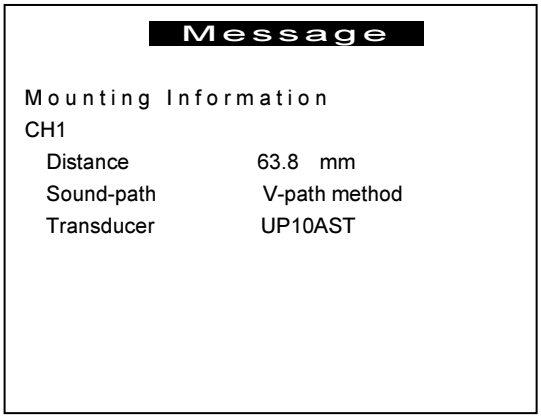


Fig. 1.2.8-29 Message of mounting information

19. Measurement start

Energy (Heat) flowrate measurement starts as below.

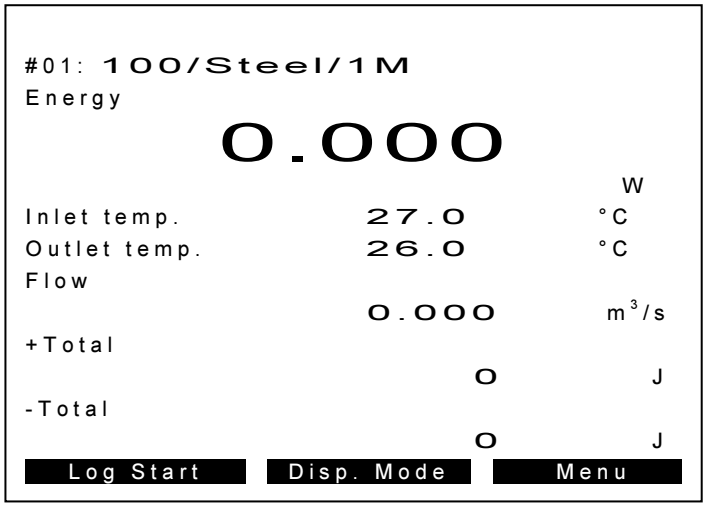


Fig. 1.2.8-30 Energy (Heat) flowrate measurement display

(3) Installation wizard for heatmeter with 1path/2pipe (2-channel) setting

This portable unit can be selectable from “flow meter”, “mass meter” and “heat meter”.
Also “1path / 1pipe (1 location)”, “2path / 1pipe (1 location)” and “1path / 2 pipe (2 locations)” can be selected on each meter mode.
Here you can see easy-setup procedure for meter type with “1path / 1pipe (1 location)”, “2path / 1pipe (1 location)” for “heat meter”.
If you would like to change each value independently through the advanced setup menu, please refer to the Chapter 2.

1path/2pipe mode means 1 main unit measures 2 different pipes even site condition like pipe diameter is different.

Required parameters

Before started, please confirm following value for input.

- Diameter or the circumference of the 2 pipes
- Thickness of the 2 pipes
- Material of the 2 pipes
- Thickness of the lining (if any)
- Material of the lining (if any)
- Fluid type

Note1: Check “Meter Type” set as “heat meter” on the following directory.
Menu – 7: System – 2: Measuring Setting – 2: Meter Type ; heat meter

Note2: Check “Path” set as “1path/2pipe” on the following directory.
Menu – 7: System – 2: Measuring Setting – 2: Path ; 1 path / 2 pipe

1. Select installation wizard

Proceed all parameters input as same as 1pipe version.

2. Channel Selection

After input parameters as menu 1-18, channel selection will be required as below.

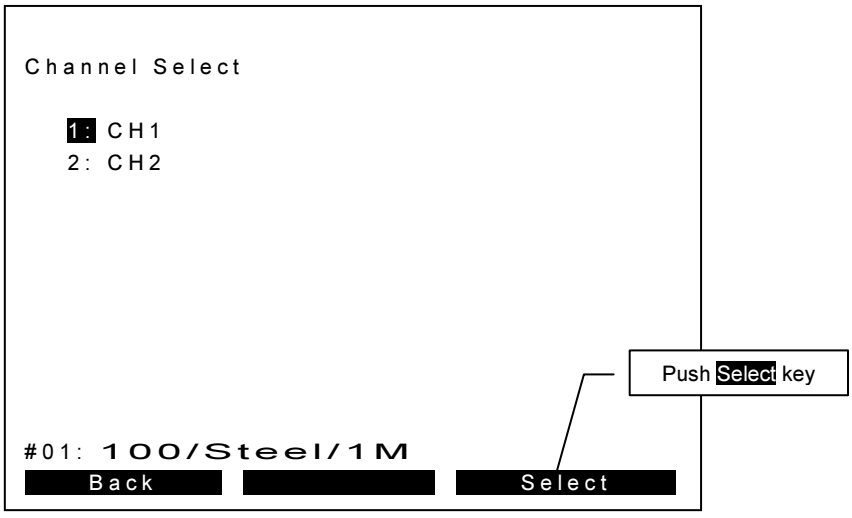


Fig. 1.2.8-31 Channel selection menu

3. Store site data

Finalize wizard by store all data on this menu. Select "2: Yes" by direction or numeric button. Then push "Select" key (F3 button) to proceed next step.

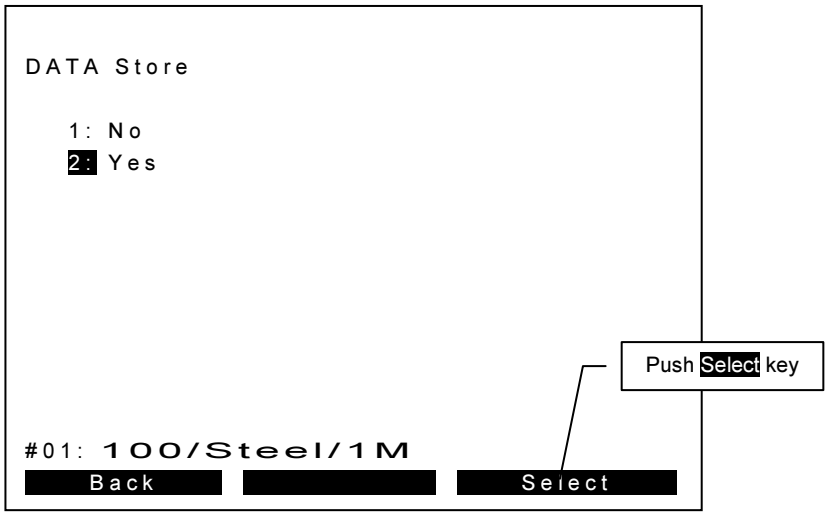


Fig. 1.2.8-32 Data storing menu

4. Data for Channel 2

Proceeded 2-4 menu, following message shows up for copying the site setting.

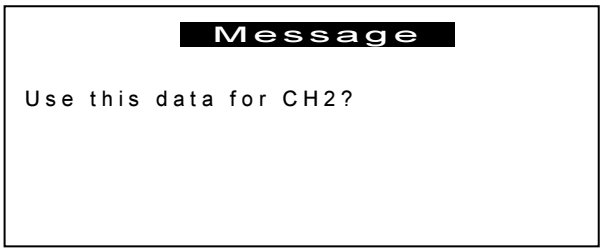


Fig. 1.2.8-33 Message of using same data for CH2

If you select "Yes" (F1 button), same site setting data will be used 2nd channel setting.
Otherwise when you select "No" (F1 button), return to first menu of wizard.
You need to make other site setting data through this wizard for 2nd channel.

Note: When you select "CH2" at first channel selection, only CH2 data is made through wizard process.
You will need to set "CH1" parameters independently.

1.2.9 Transducer installation

(1) Installation for small transducer

Note: The distance between transducers needs to be determined prior to transducer installation. Please refer to section 1.2.6 ~ 1.2.8 to determine this distance before proceeding with the steps described below for installation.

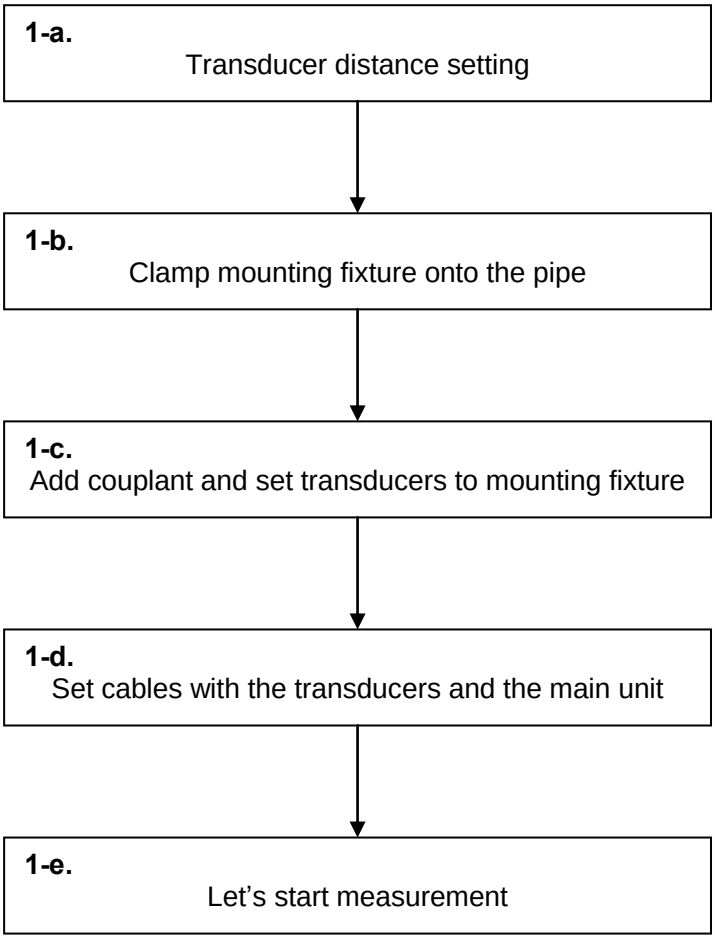


Fig. 1.2.9-1 Flow of small transducer installation

1-a. Transducer distance setting

Set distance between transducers on mounting fixture in accordance with the main unit calculation.

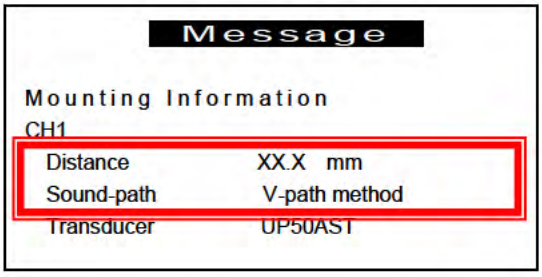


Fig. 1.2.9-2 Message of mounting information

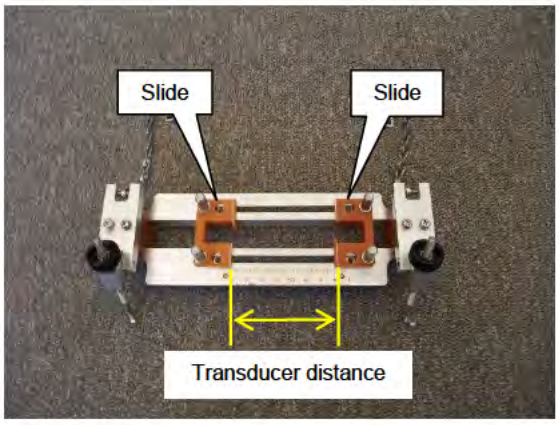
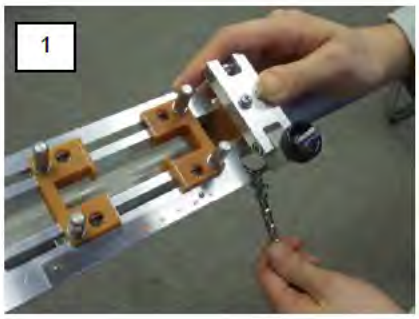


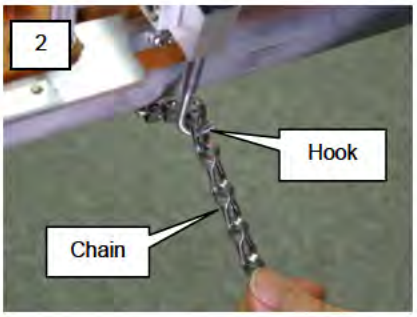
Fig. 1.2.9-3 Set transducer distance on fixture

1-b. Clamp mounting fixture onto the pipe

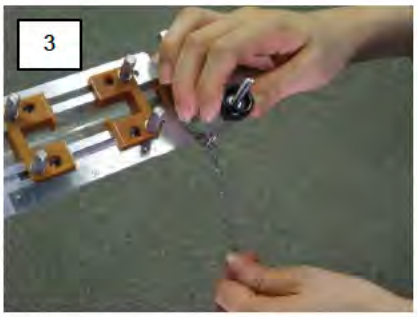
After fixing transducer distance, you can set mounting fixture on to the pipe. (see Fig. 1.2.9-4 bellow)



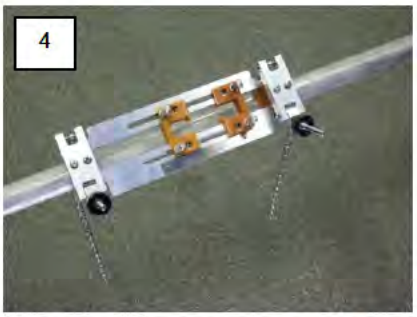
1. Roll chain around the pipe.



2. Hook the chain at appropriate length.



3. Tighten chain by knob.



4. Take same procedure on the other side, then complete.

Fig. 1.2.9-4 Set mounting fixture

1-c. Add couplant and set transducers to mounting fixture

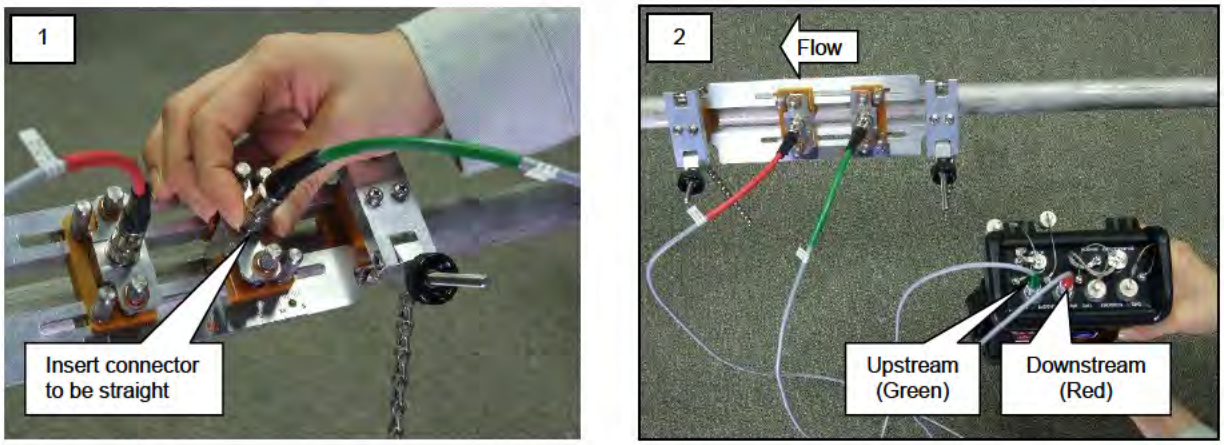
Add silicone grease as acoustic couplant onto surface of transducers.
Then set them into mounting fixture.

1. Add couplant onto surface of transducer as photo.
2. Set transducer to fixture.
3. Fix transducers by screw.

Fig. 1.2.9-5 Set the transducers into mounting fixture

1-d. Set cables with the transducers and the main unit

Connect cables with the transducers and the main unit.



1. Connect with the transducers
2. Connect with the main unit

Fig. 1.2.9-6 connect with the transducer cables

Note: Cable connectors should be inserted. Otherwise connection failure may be occurred.

1-e. Let's start measurement

Finished prepare to measurement. Push O K key as Fig.1.2.9-2 to start measurement (mounting information menu).

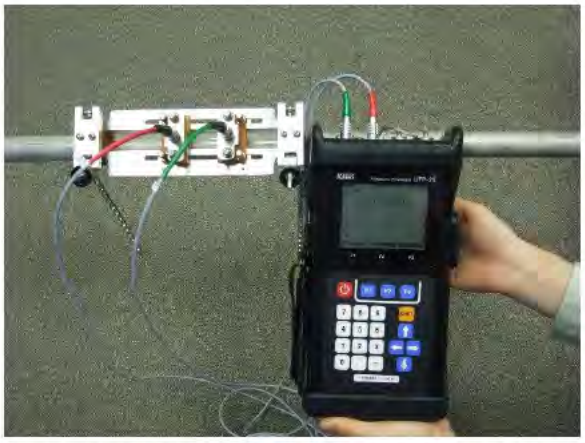


Fig. 1.2.9-7 Finished small size transducer setting

Caution

- Please pay attention to burr of chains, corner of mounting fixture etc, not to be injured.

(2) Installation for medium transducer (V-path method)

Note1: The distance between transducers needs to be determined prior to transducer installation. Please refer to section 1.2.6 ~ 1.2.8 to determine this distance before proceeding with the steps described below for installation.
Note2: In case of measurement below DN200mm pipe, please use the mounting fixture 1 for V-path method installation.
Over DN200mm pipe, mounting fixture 2 for extension will be required.
Note3: Please refer to 1.2.9 for installation of Z-path method adaptor.

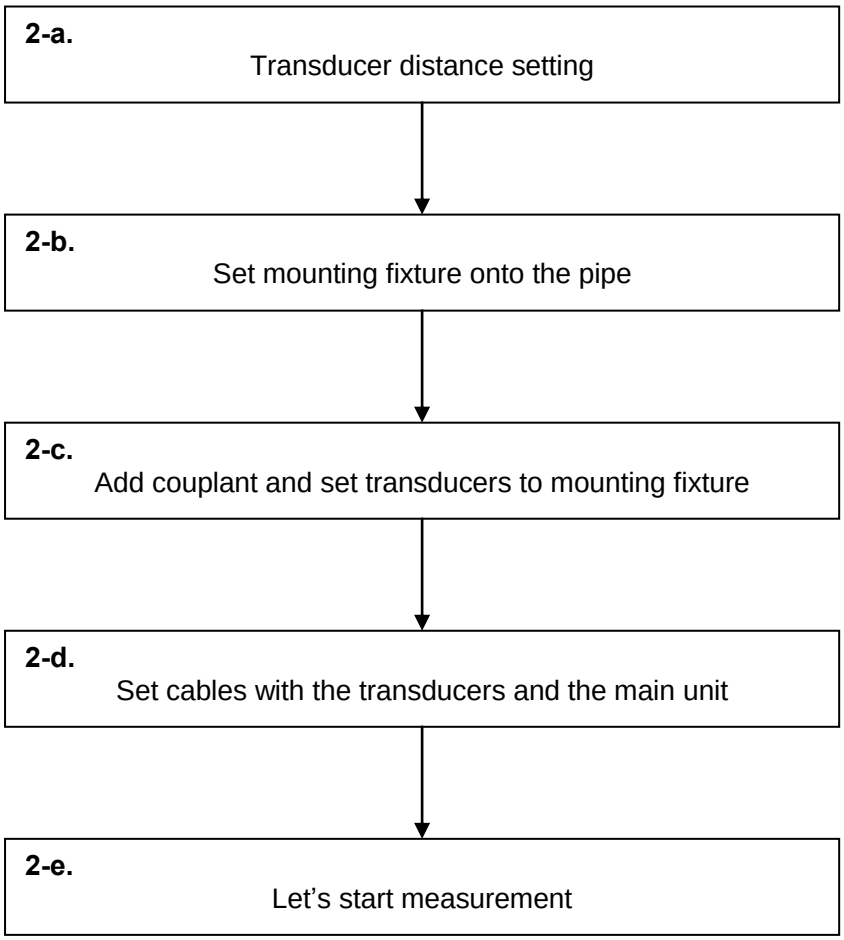


Fig. 1.2.9-8 Flow of medium transducer installation

2-a. Transducer distance setting

Set distance between transducers on mounting fixture in accordance with the main unit calculation.

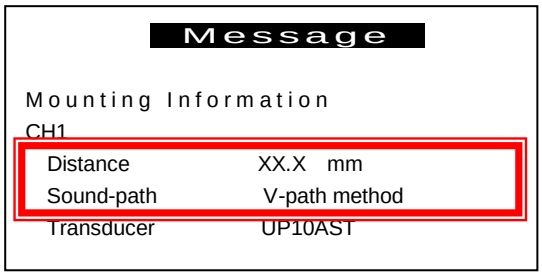


Fig. 1.2.9-9 Message of mounting information

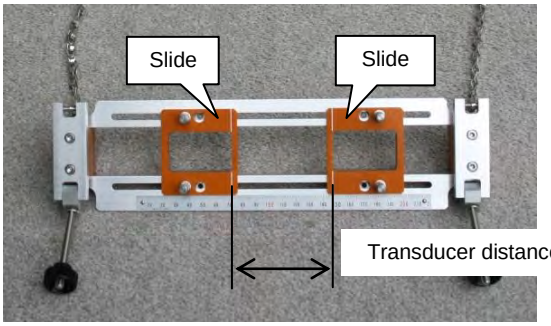


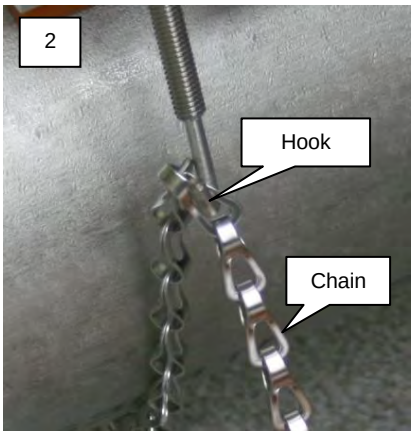
Fig. 1.2.9-10 Set transducer distance on fixture

2-b. Set mounting fixture onto the pipe

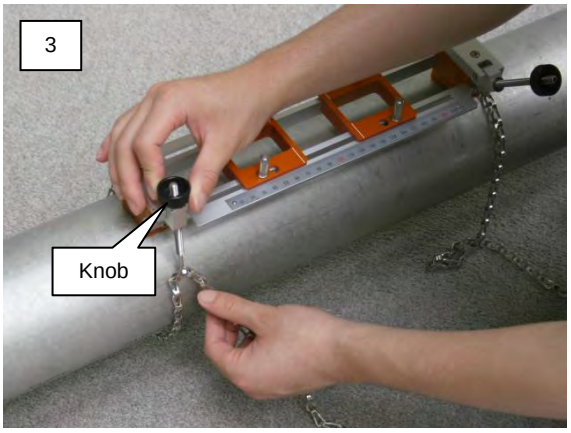
Wrap the mounting chain around the pipe and hook an end link with the hook knob arrangement.

Tighten the chain at the other end of the fixture.

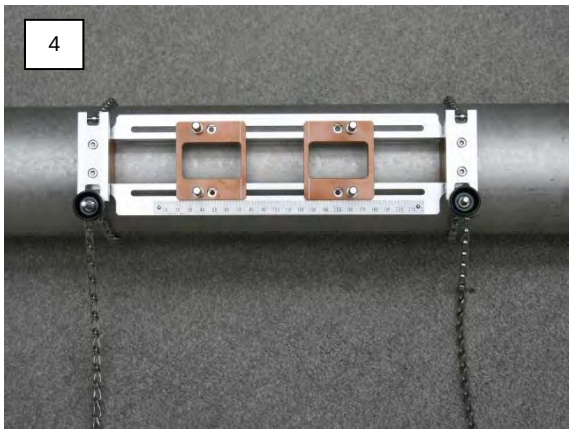
1. Roll chain around the pipe.



2.Hook the chain at appropriate length.



3. Tighten chain by knob.

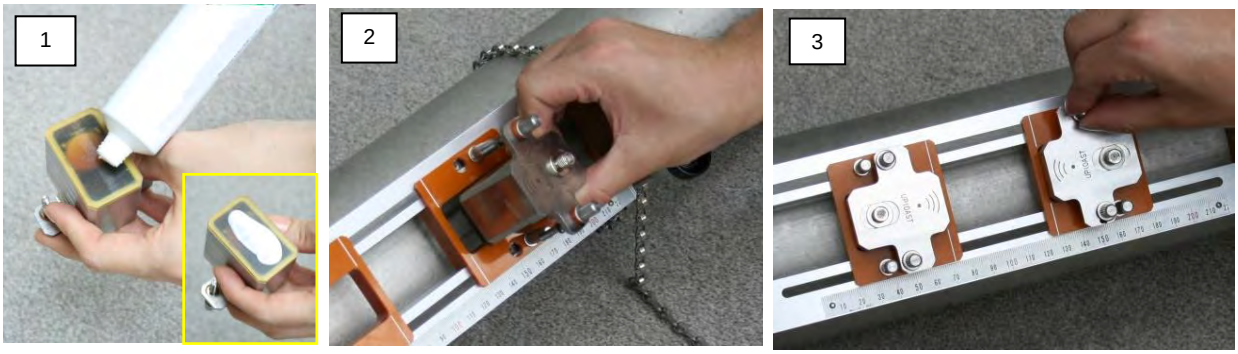


4.Take same procedure on the other side, then complete.

Fig. 1.2.9-11 Set mounting fixture

2-c. Add couplant and set transducers to mounting fixture

Add silicone grease as acoustic couplant onto surface of transducers.
Then set them into mounting fixture.

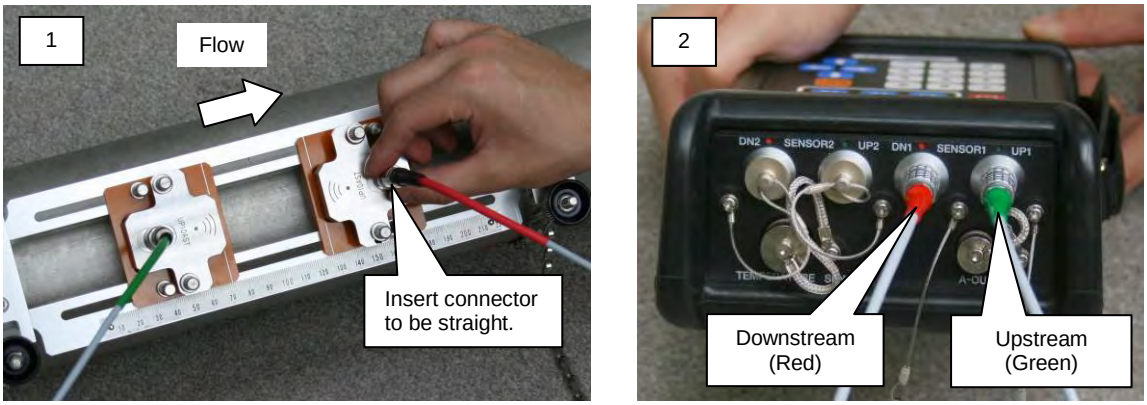


1. Add couplant onto surface of transducer as photo.
2. Set transducer to fixture.
3. Fix transducers by screw.

Fig. 1.2.9-12 Set the transducers into mounting fixture

2-d. Set cables with the transducers and the main unit

Connect cables with the transducers and the main unit.



1. Connect with the transducers.
2. Connect with the main unit.

Fig. 1.2.9-13 Connect with the transducer cables

2-e. Let's start measurement

Finished prepare to measurement. Push O K key as Fig.1.2.9-9 to start measurement (mounting information menu).

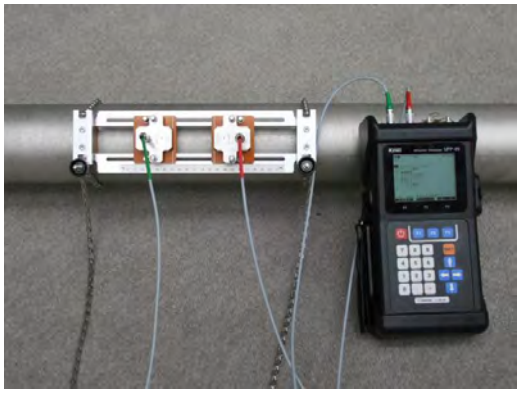


Fig. 1.2.9-14 Finished medium size transducer setting

2-f. Measurement for over DN200mm pipe

In case of measurement for over DN200mm, you need to use mounting fixture 1 and 2 for extension together as below Fig.1.2.9-16. Transducer installation procedure is the same as Fig.1.2.9-8 as below DN200mm installation way.

Note: In case of more than 200mm pipe, you may be required to combine with 2 mounting fixtures for mid size transducers as below. The distance of between fixtures is 100mm.

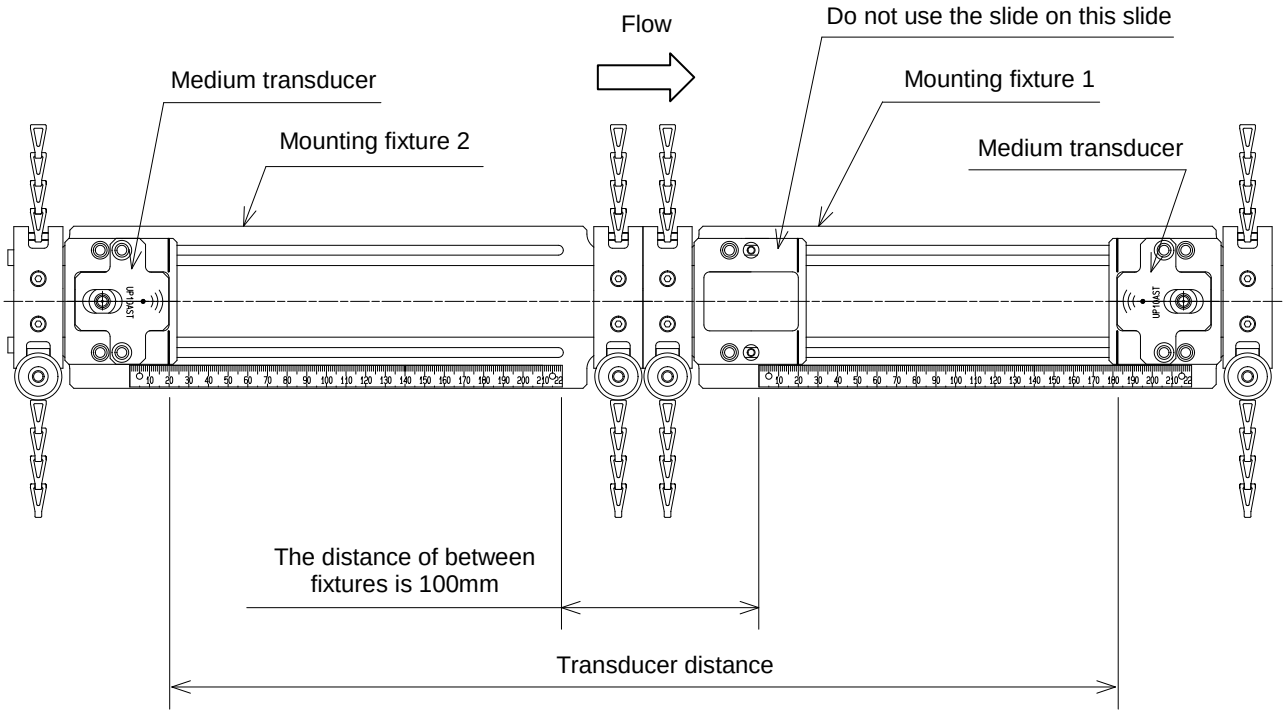


Fig. 1.2.9-15 Combine mounting fixture (over DN200mm)

When the transducer distance 245mm(DN300mm), if Up side slide sets at 200 mm point, Down side slide most be set at 125 mm point. The point of scale is just sample. Whenever transducer distance can be kept, scale point does not matter.

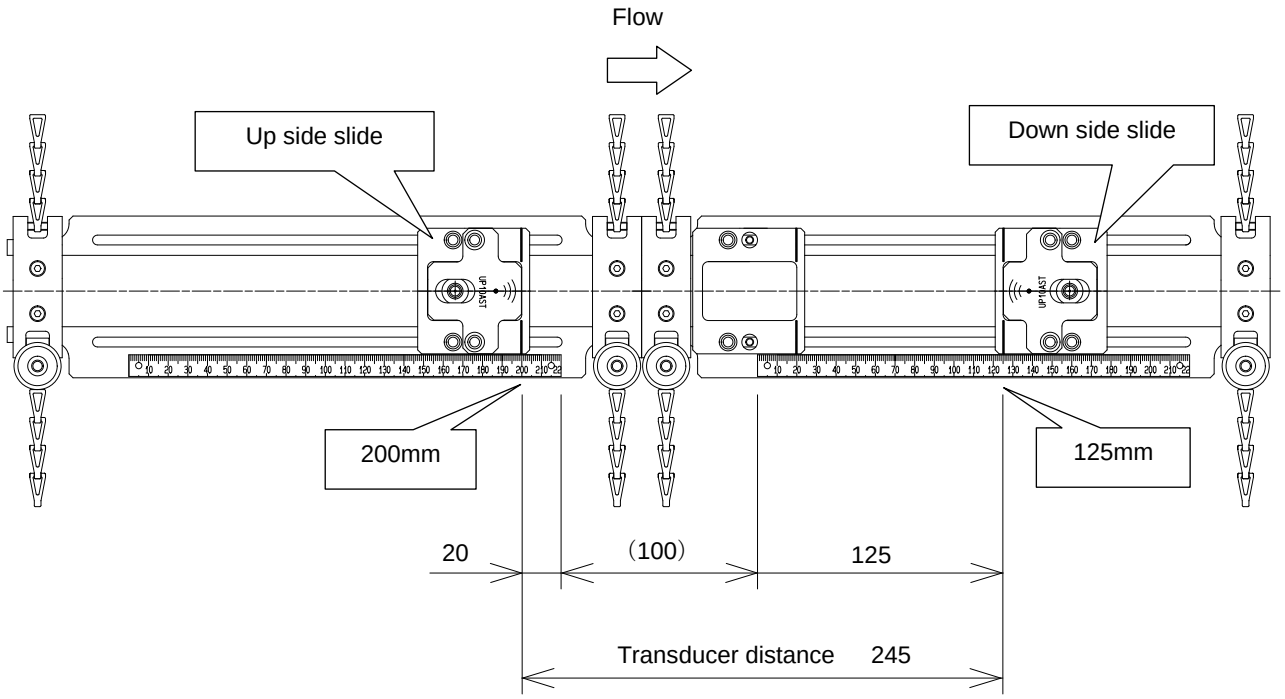


Fig. 1.2.9-16 Sample of combine mounting fixture (Transducer distance : 245mm)

Caution

・Please pay attention to burr of chains, corner of mounting fixtures etc, not to be injured.

(3) Installation for medium transducer (Z-path method)

Sample installation Fig.1.2.9-17 is example as transducer distance as “-14mm”. The Z-path method is single-traverse, the transducers are mounted diametrically opposite each other. Please refer to chapter “**1.2.5 Selection of transducer setup position** (p.1-26)” for recommendation place for transducer installation.

Note: Applicable pipe diameter for Z-path method installation by medium transducer is DN20mm ~ 40mm.

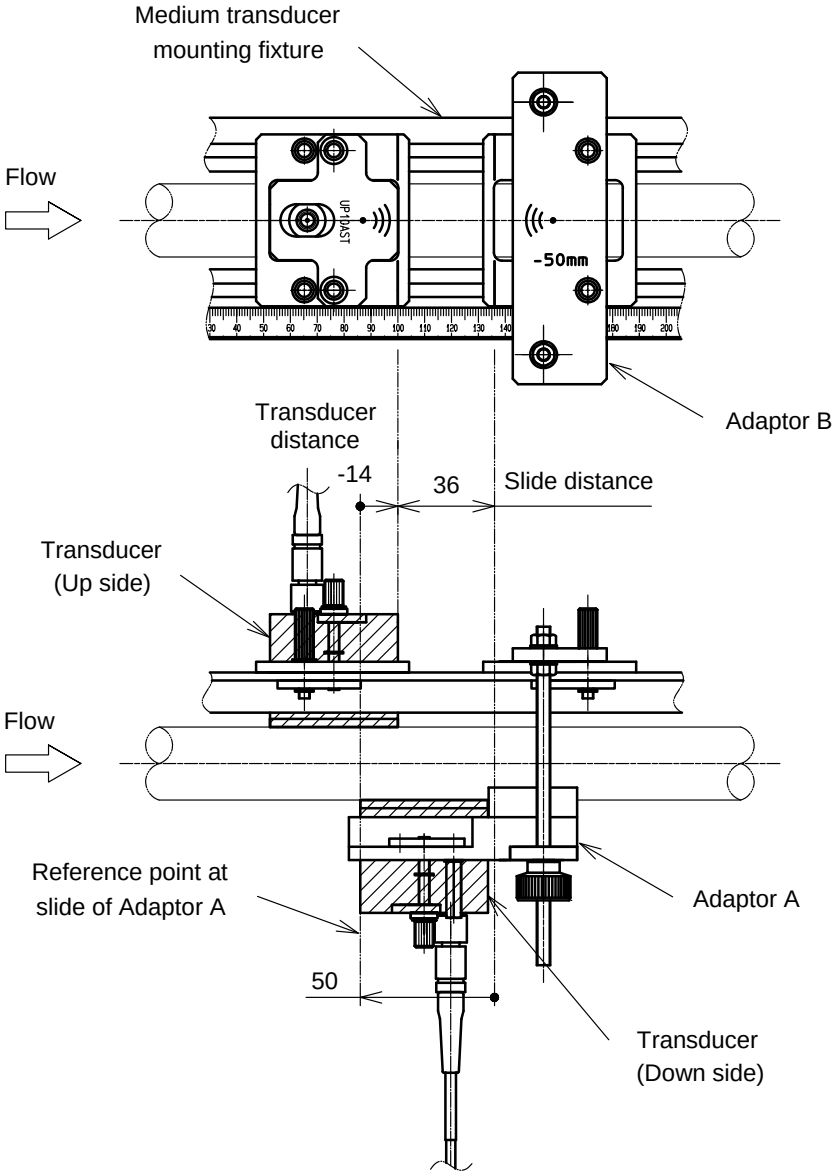


Fig. 1.2.9-17 Sample of Z-path method installation (Transducer distance : -14mm)

Note: The distance between transducers needs to be determined prior to transducer installation. Please refer to section 1.2.6 ~ 1.2.8 to determine this distance before proceeding with the steps described below for installation.

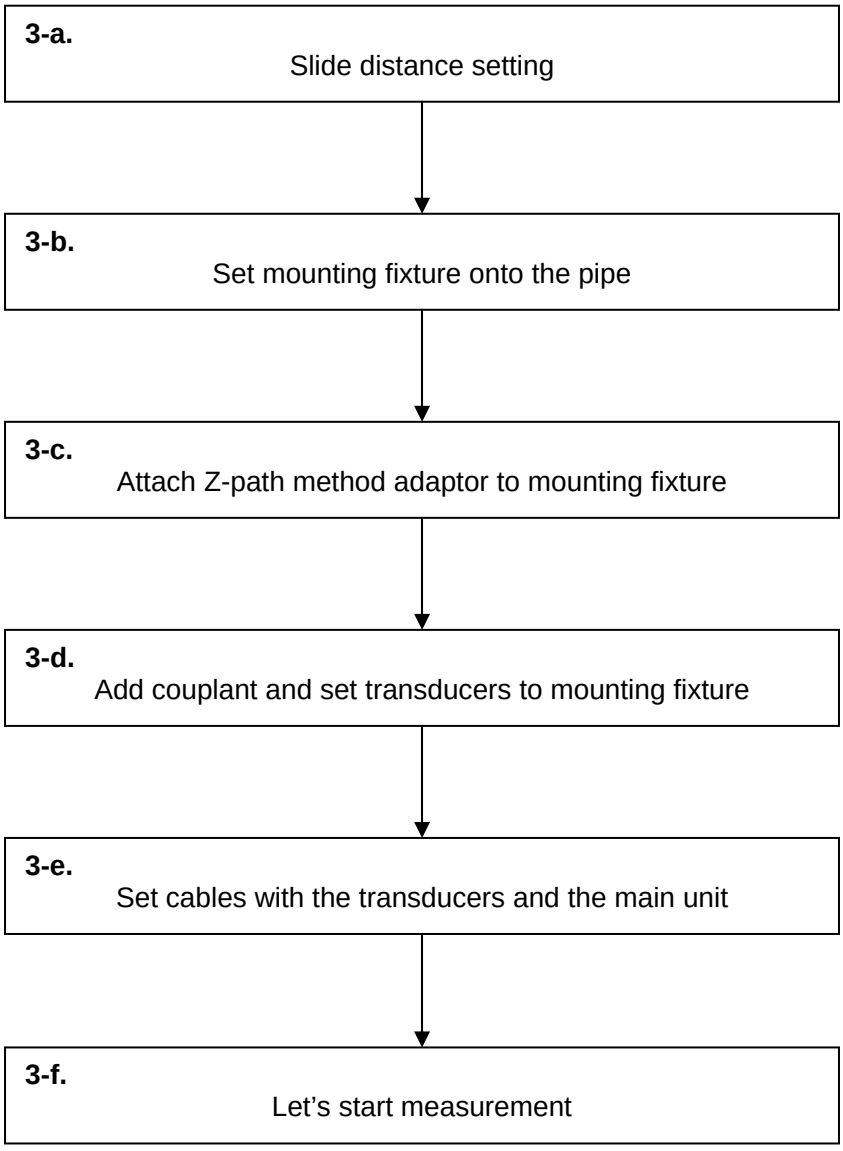


Fig. 1.2.9-18 Flow of medium transducer installation

3-a. Transducer distance setting

Set slide distance as indicated value which is calculated by main unit +50mm.
Please note that proper transducer distance is calculated by manually for Z-path method installation.

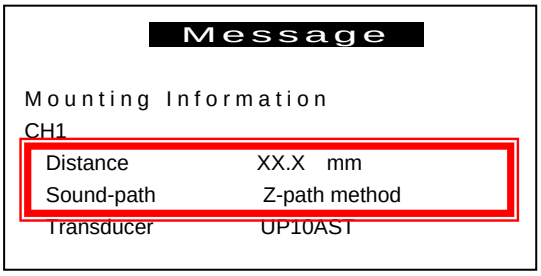


Fig. 1.2.9-19 Message of mounting information

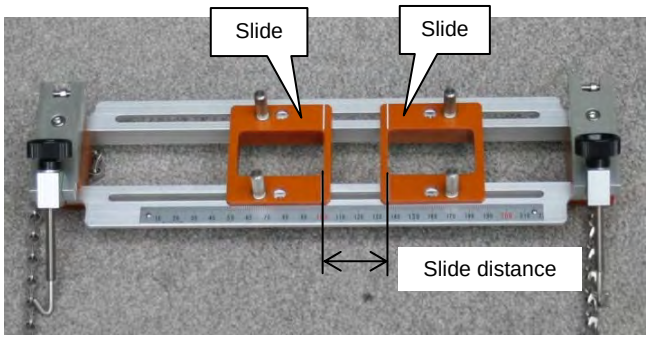


Fig. 1.2.9-20 Set slide distance on fixture

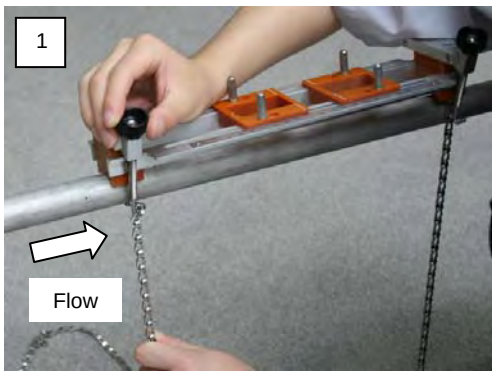
Note1: Slide distance = indicated distance + 50 mm

Note2: Transducer distance indicated on Fig.1.2.9-19 is different from set distance as Fig.1.2.9-20 in case of using Z-path method adaptor.

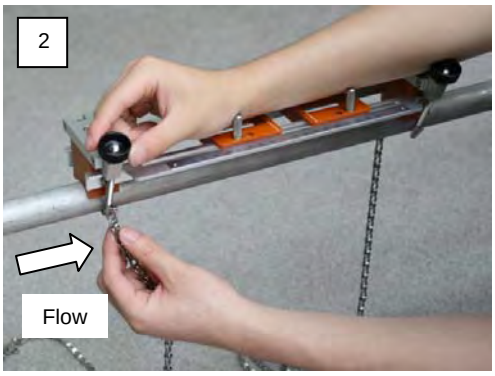
3-b. Set mounting fixture onto the pipe

Wrap the mounting chain around the pipe and hook an end link with the hook knob arrangement.

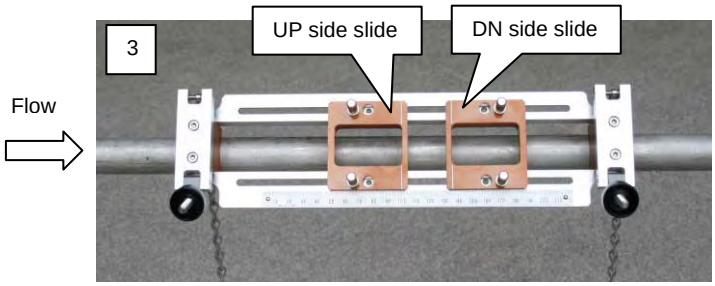
Tighten the chain at the other end of the fixture.



1. Wrap chain onto the pipe and hook at appropriate length.



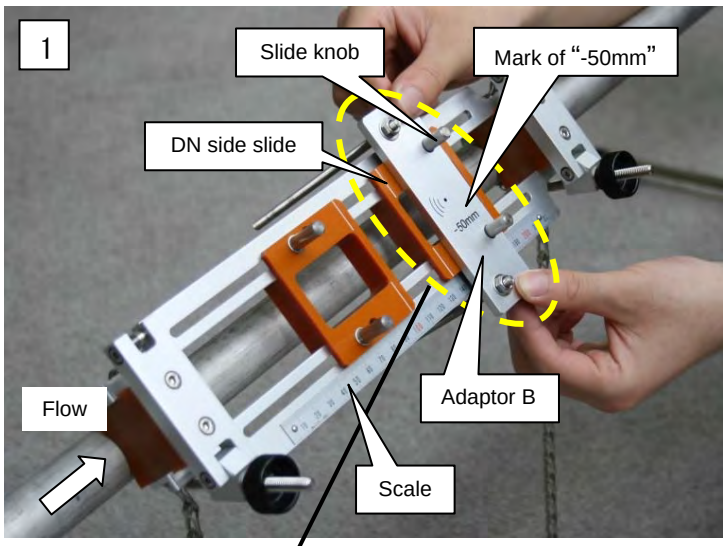
2. Tighten chain by knob.



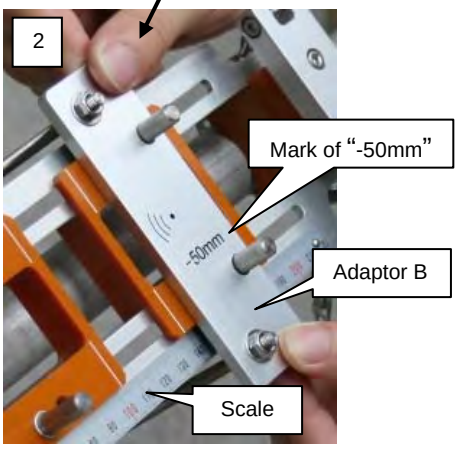
3. Tighten the other side either.
   Slide distance must be set prior to mounting.

Fig. 1.2.9-21 Set mounting fixture

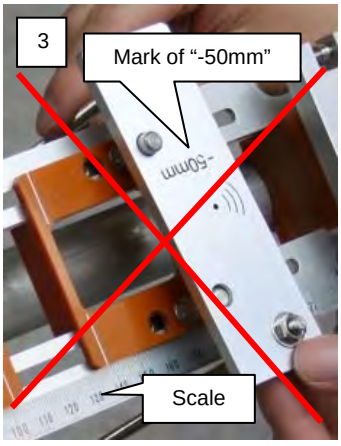
3-c. Attach Z-path method adaptor



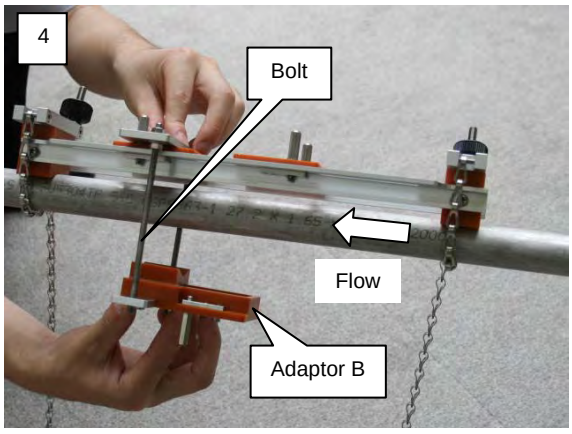
1.Set adaptor B onto the slide of down side. Slide knob will fix adaptor position.
Please install it on the direction of which the mark of “-50mm” comes to the scale side.



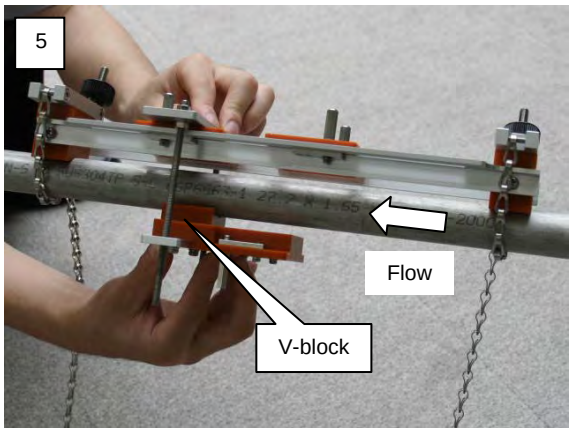
2. Adaptor B expansion



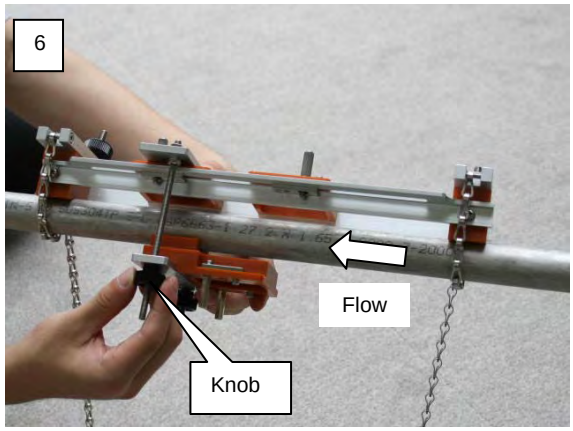
3. Wrong example
(opposite direction)



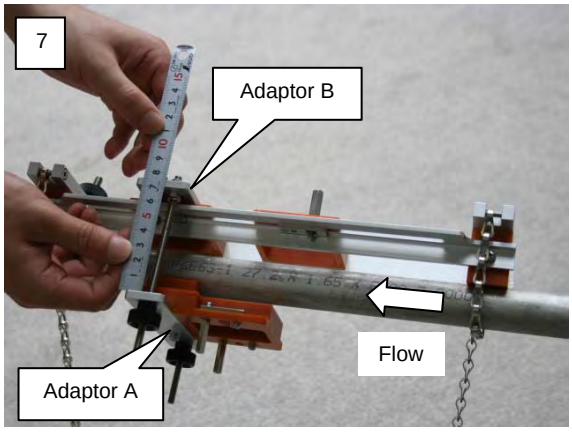
4. Attach adaptor A on the other side of the pipe.



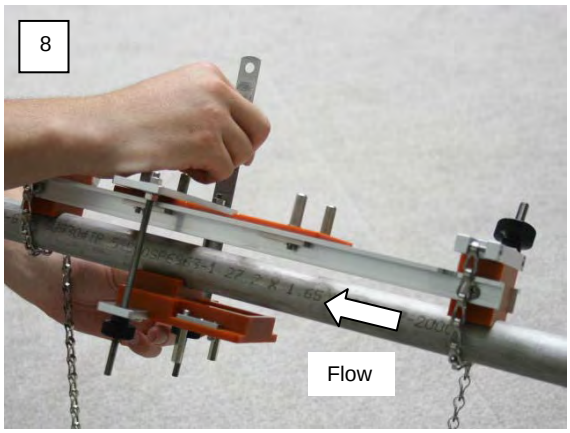
5. V-block part will fit pipe.



6. Fix adaptor A by attaching knob



7. After fix knob, please check each length as almost same.



8. We recommend each distance to be same for parallel installation.

Fig. 1.2.9-22 Attach Z-path method adaptor

When main unit calculates transducer distance as -14 mm. Slide distance will be 36 mm.
So if up side slide sets at 100 mm point, DN side slide most be set at 136 mm point. The point of scale is just sample. Whenever slide distance can be kept, scale point does not matter.

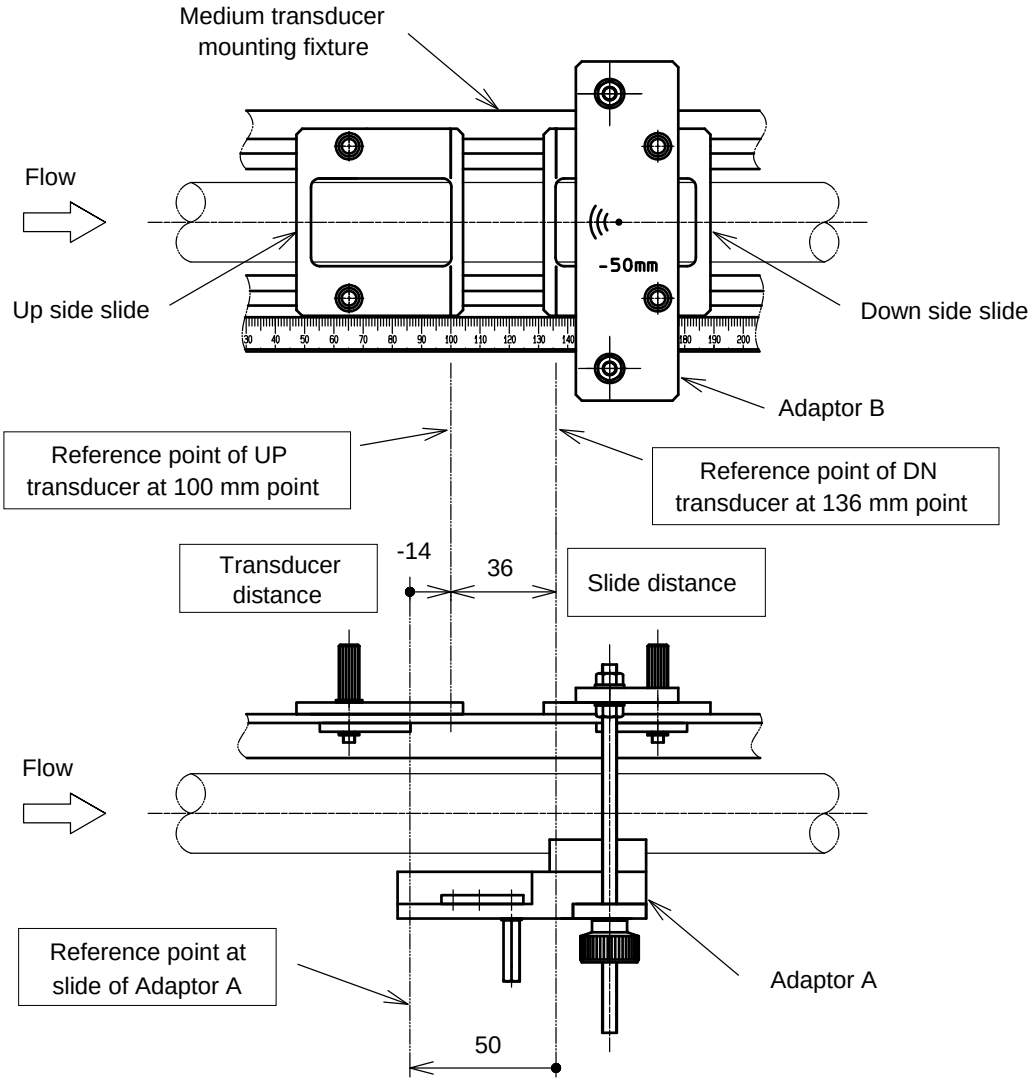
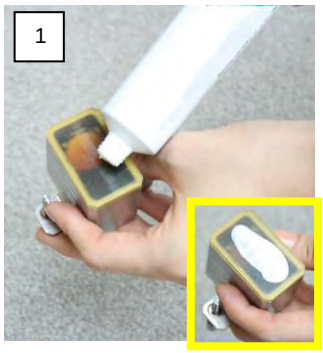


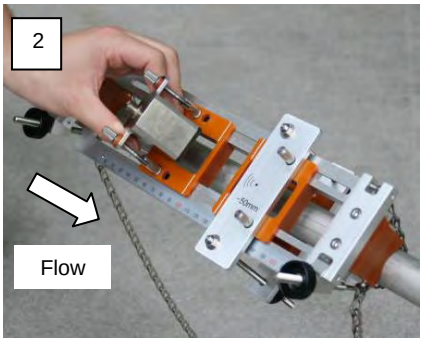
Fig. 1.2.9-23 Installation Sample of Z-path method (indicated value on main unit is -14 mm)

3-d. Add couplant and set transducers to mounting fixture

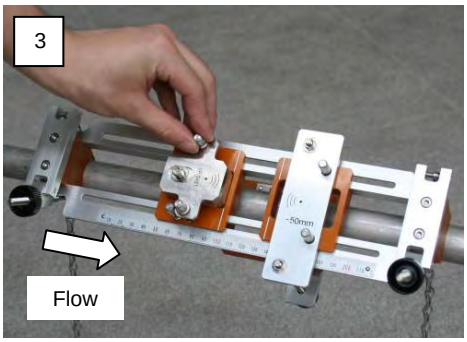
Add silicone grease as acoustic couplant onto surface of transducers.
Then set them into mounting fixture.
Insulating transducer and pipe may be effective to reduce noise.
Please keep the chain away from transducers.



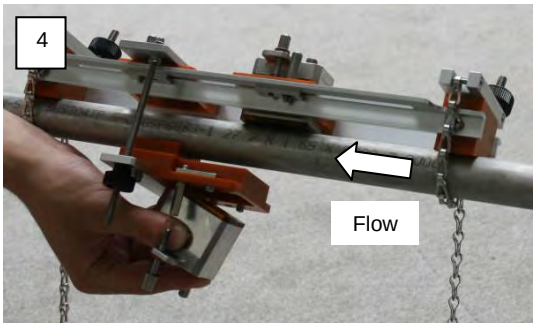
1. Add couplant onto surface of transducer as photo.



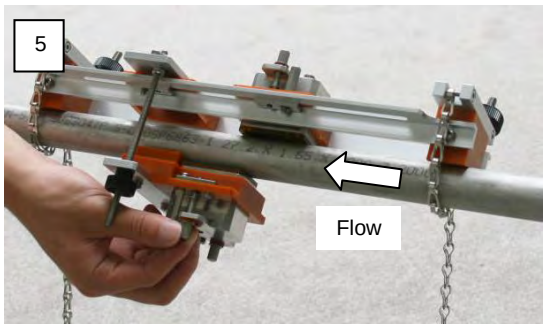
2. Set transducer(Up side) to fixture.



3. Fix transducer by screw.



4. Set transducer(Down side) to fixture.

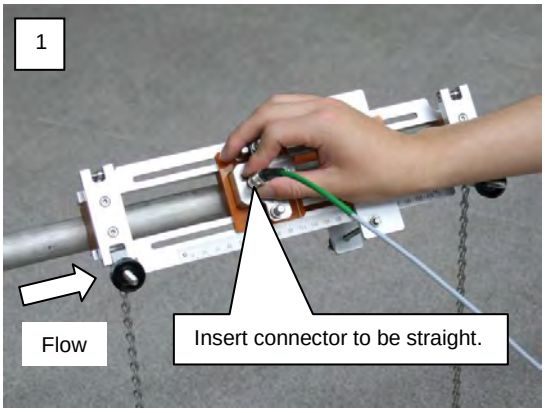


5. Fix transducer by screw.

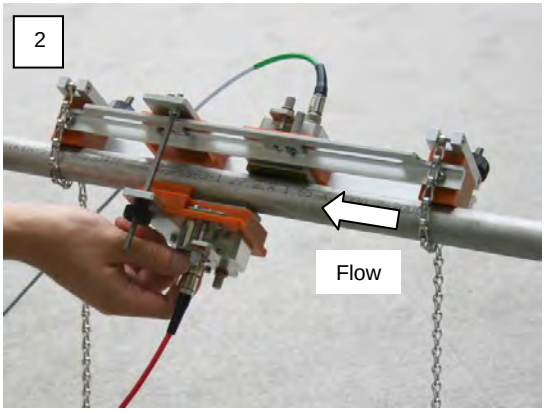
Fig. 1.2.9-24 Set the transducers into mounting fixture

3-e. Set cables with the transducers and the main unit

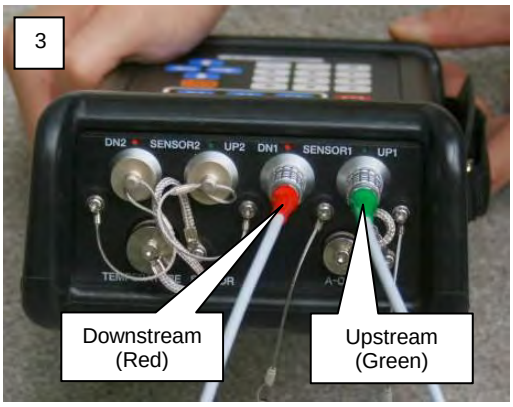
Connect cables with the transducers and the main unit.



1. Connect with the transducer (Up side).



2. Connect with the transducer (Down side).



3. Connect with the main unit.

Fig. 1.2.9-25 Connect with the transducer cables

3-f. Let's start measurement

Finished prepare to measurement. Push O K key as Fig.1.2.9-19 to start measurement (mounting information menu).

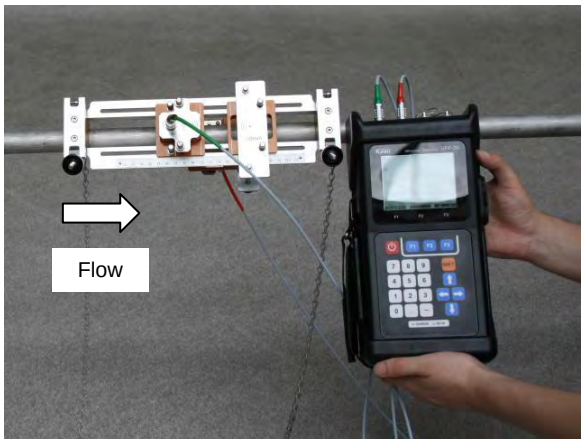


Fig. 1.2.9-26 Finished medium size transducer setting (Z-path method)

Caution

・Please pay attention to burr of chains, corner of mounting fixtures etc, not to be injured.

(4) Installation for large transducer (Greater than 300mm in diameter)

There are two transducer installation methods. One is the reflection method and the other is the transmission method. Generally, the reflection method is applied to small pipe (less than 500mm) while the transmission method is used for larger diameter pipes. However the method to be chosen may also depend on signal strength based on the pipe material and/or flow conditions.

Note: The distance between transducers needs to be determined prior to transducer installation. Please refer to section 1.2.6 ~ 1.2.8 to determine this distance before proceeding with the steps described below for installation.

(4A) V-path method (Reflection method)

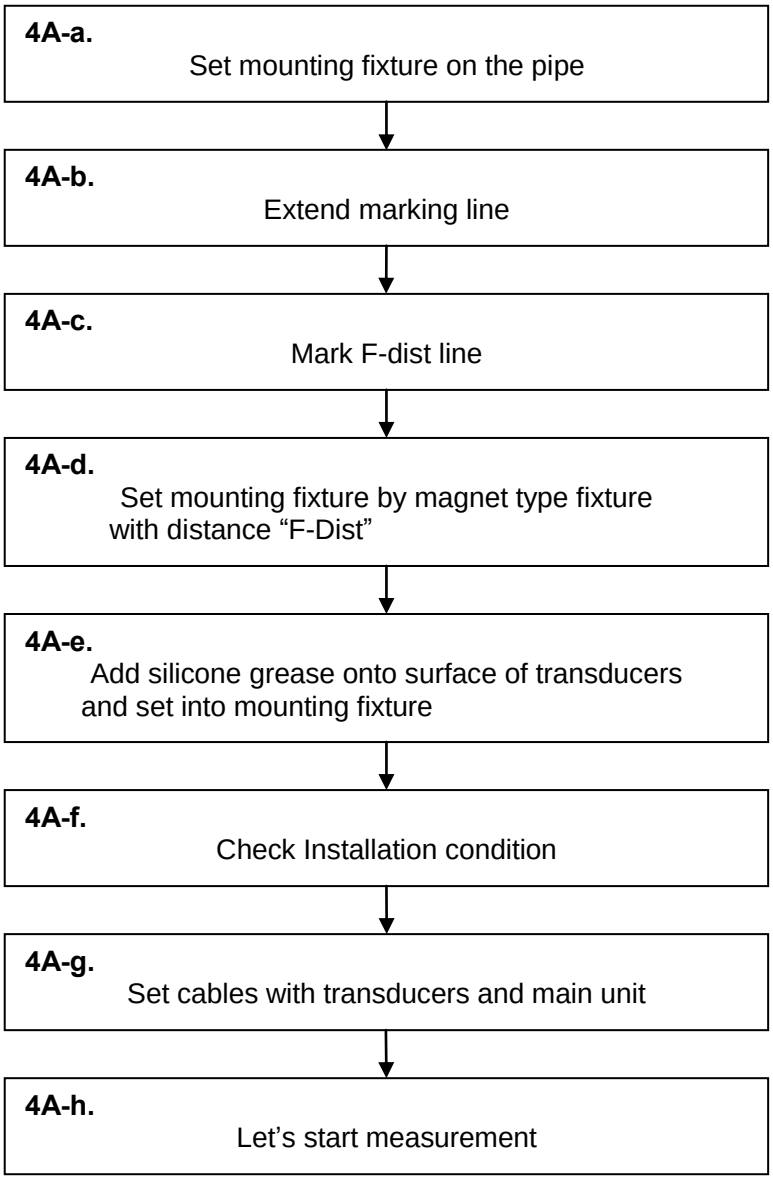


Fig 1.2.9-28 Flow of large transducer installation

4A-a. Set mounting fixture on the pipe

Set fixture as temporary where you intend to make the flow measurement as shown in Fig.1.2.9-29. When you see fixture settable horizontally against in longitudinal direction of pipe, if stable.

So you can mark the horizontal line on the pipe as Fig.1.2.9-30.

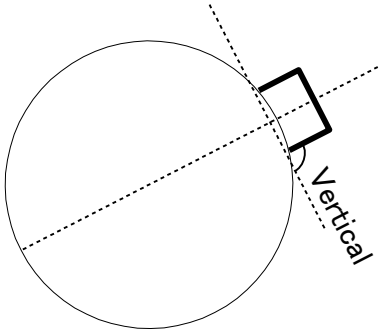


Fig. 1.2.9-29 Set fixture as temporary

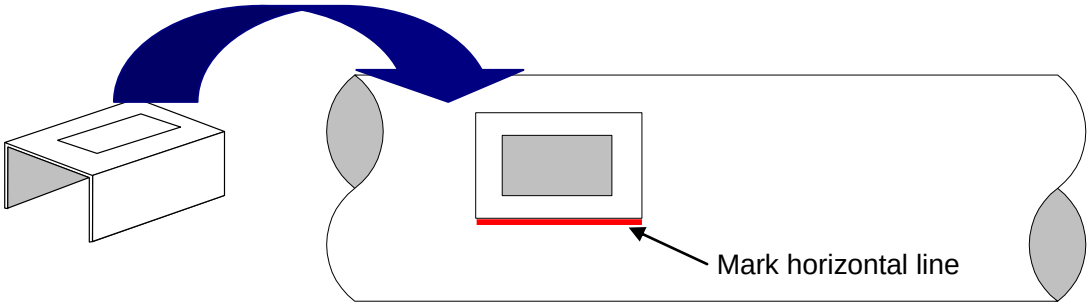


Fig. 1.2.9-30 Mark horizontal line

4A-b. Extend marking line

Using a pencil or marking pen, extend the marking line on the pipe by moving fixture or long scale.

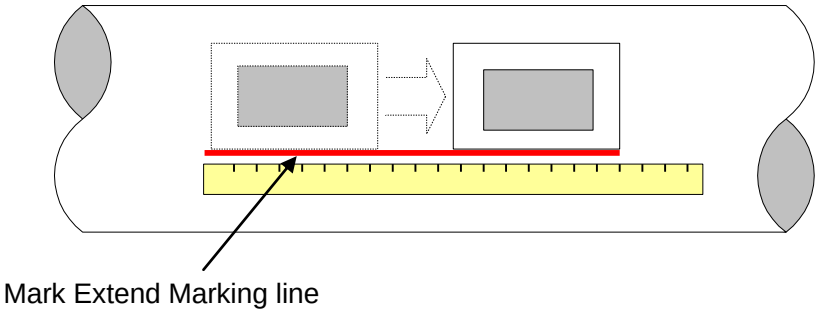


Fig. 1.2.9-31 Extend marking line

4A-c. Mark F-Dist line

You can mark F-Dist line, which means distance between transducers with scale.

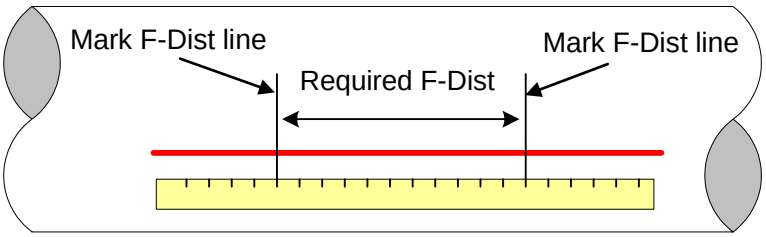


Fig. 1.2.9-32 Mark “F-Dist” line

4A-d. Set mounting fixture by magnet type fixture with distance “F-Dist”.

Rewrap the paper around the pipe at the intended flow measure point.
Position the Transducer-mounting holders by magnet fixture on the pipe and align in accordance with the lines marked F-dist, which is the distance between the opposing inside edges of the transducers.
Magnet will be switched on by turning rotary switch.

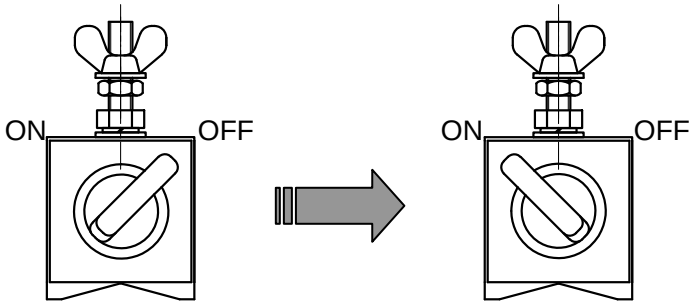


Fig. 1.2.9-33 Magnet switch

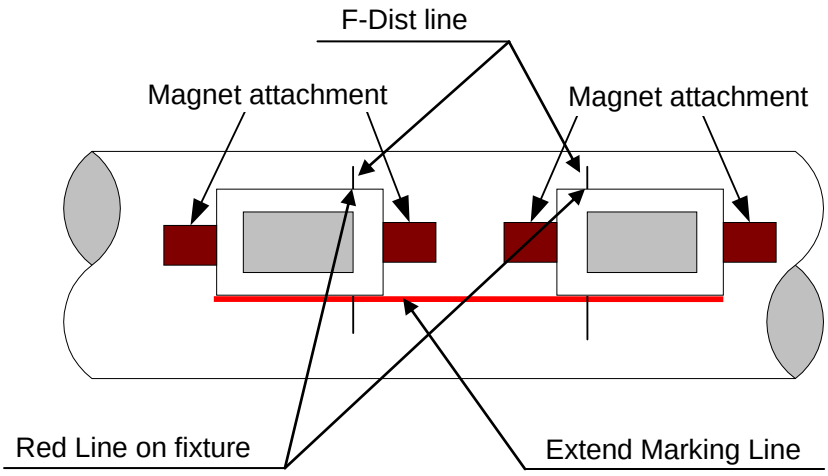
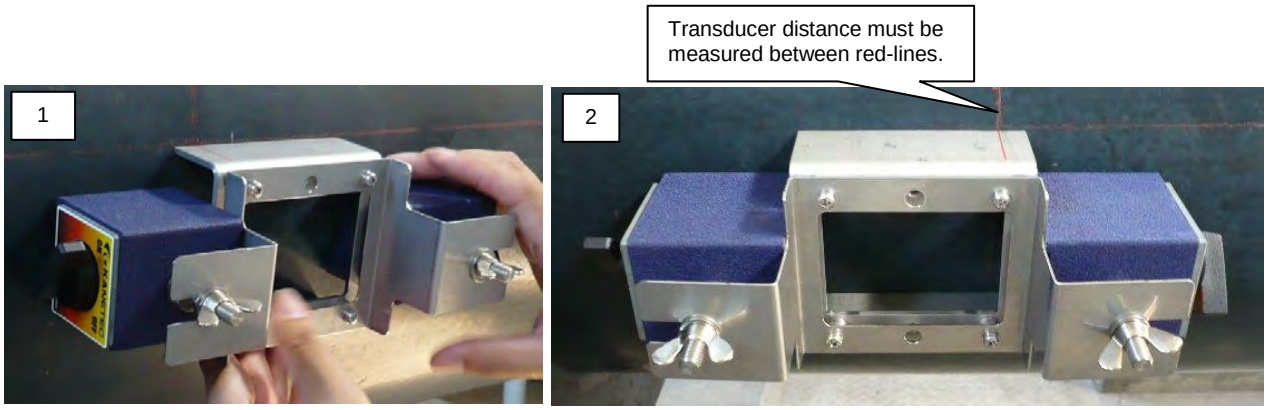


Fig. 1.2.9-34 Position of the mounting fixtures with the magnets



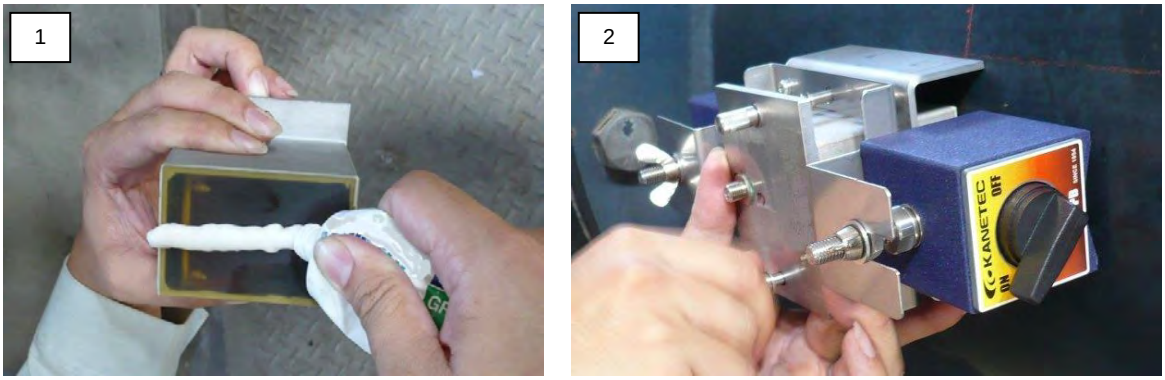
1. Attach fixture by magnet.

2. Check red line on the fixture of the side whether positions properly.

Fig. 1.2.9-35 Set the mounting fixture with the magnets

4A-e. Add silicone grease onto surface of transducers and set into mounting fixture.

Add silicone grease enough to avoid any air layer between pipe and transducer.
And set transducers into holder, and then tighten by screws.



1. Add couplant onto transducer surface.

2. Attach transducer with fixture by screw to be fit onto pipe.

Fig. 1.2.9-36 Set the transducer

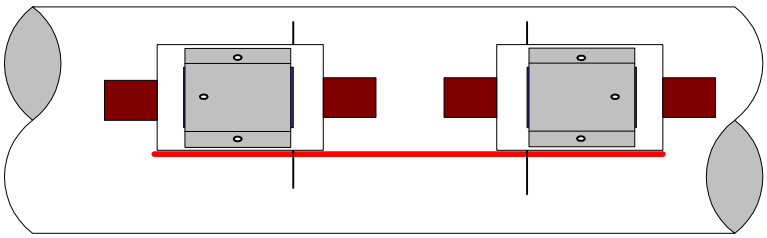
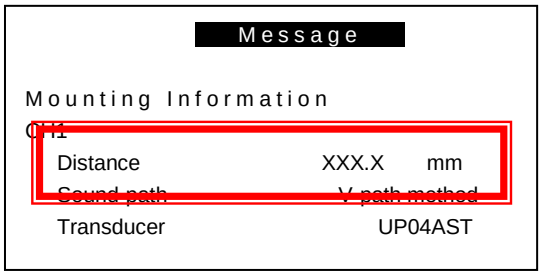


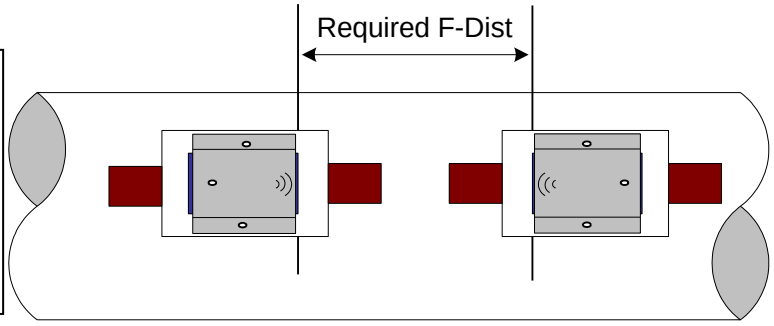
Fig. 1.2.9-37 The transducers installation completed

4A-f. Check installation condition

Position the transducer-mounting holders on the pipe and align in accordance with the lines marked on the pipe. Check the F-Dist and acoustic direction as final.



(1) Information of transducer distance which calculated by main unit
If English unit is selected, “inch” will be indicated.



(2) Required transducer distance = F-Dist

(3) Example of transducer installation

Fig. 1.2.9-38 Check installation condition

4A-g. Set cables with transducers and main unit

Connect transducer cable to receptacle of transducers.
Please be noted that cable connector must be insert receptacle straight, not to be obliquely.
Upstream side of cable must be connected to “UP” side, downstream side to “DN” side.

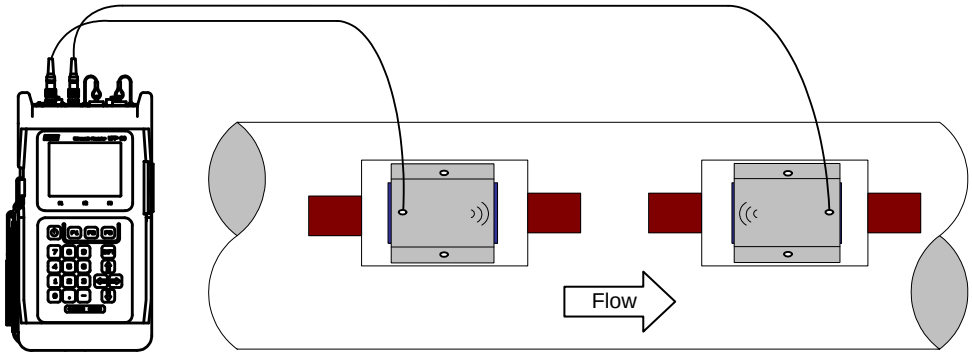
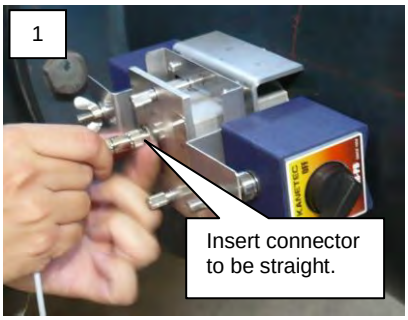
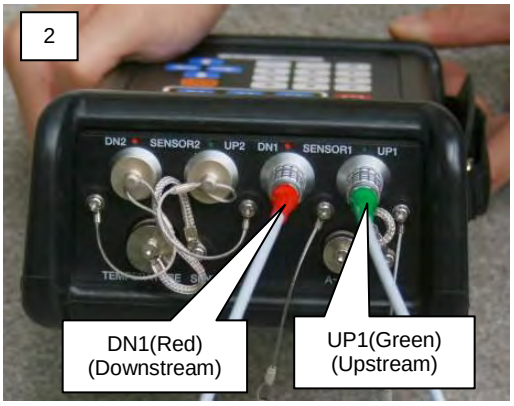


Fig. 1.2.9-39 Set the transducer cables





1. Connection to the transducer side　　2. Connection to the main unit side

Fig. 1.2.9-40 Connect the transducer cables

4A-h. Let's start measurement

Finished prepare to measurement. Push O K key as Fig.1.2.9-38 (1) to start measurement (mounting information menu).

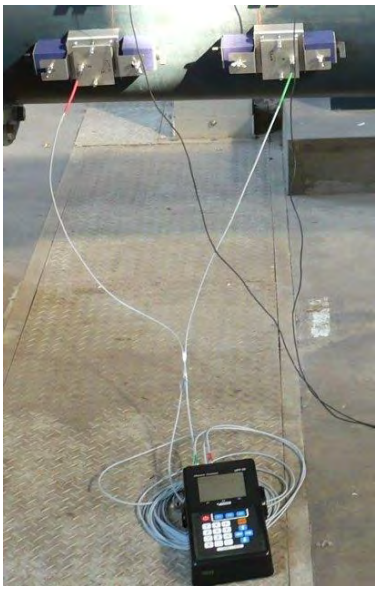


Fig. 1.2.9-41 Setup is completed

Caution

・Please pay attention to burr of chains, corner of mounting fixtures etc, not to be injured.
・Please be noted that it may contain popssibility to drop mouting fixture off.

(4B) V-path method (Reflection method) with Gauge Paper

In case of larger pipe, most of the case, over DN2000mm, you may be better to use gauge paper or similar gauge to set proper F-Dist position.

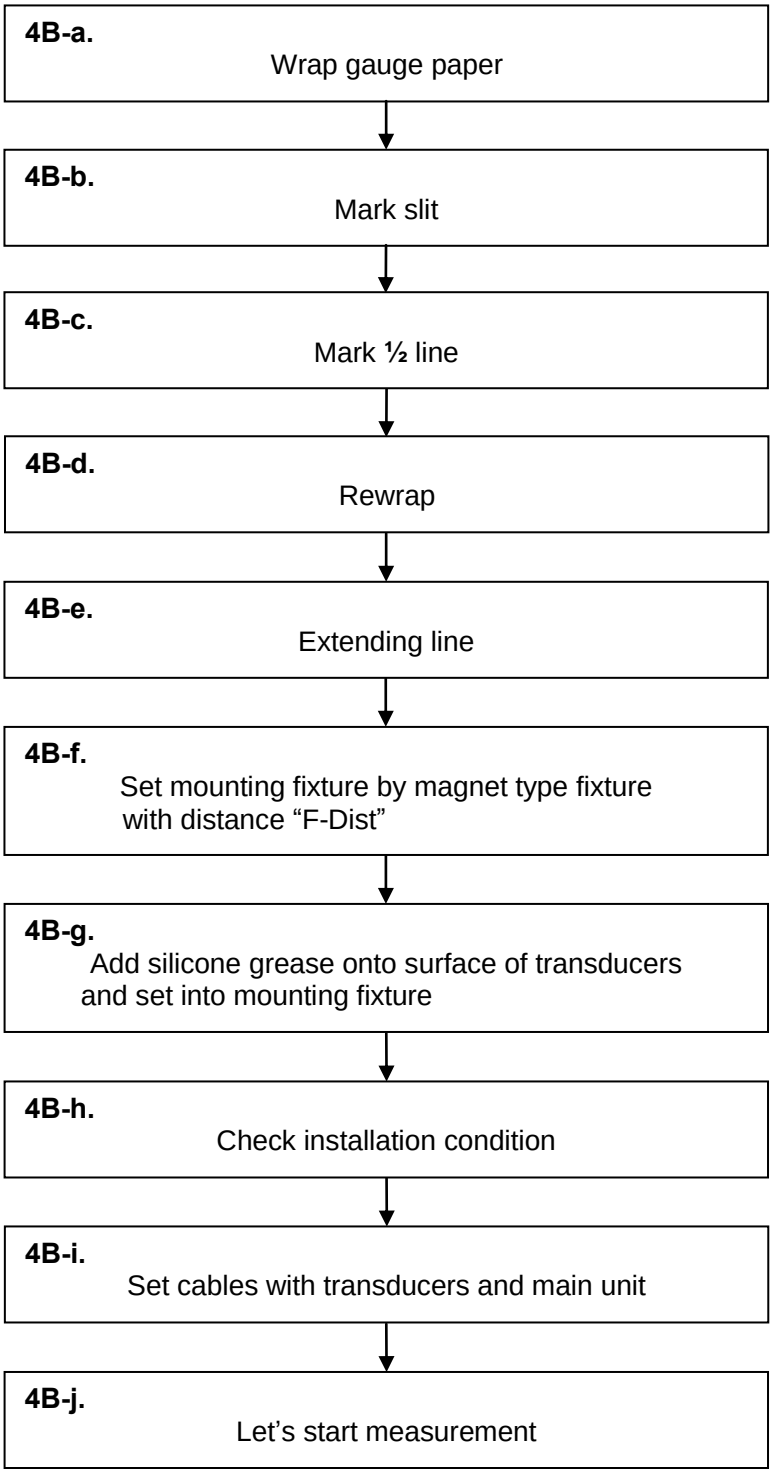


Fig. 1.2.9-42 Flow of large transducer with gauge paper

4B-a. Wrap gauge paper

Wrap gauge paper around the pipe where you intend to make the flow measurement as shown in Fig.1.2.9-43.
Make sure the paper is long enough to overlap and that the overlapping edge is square.
Gauge paper may be ordered and included in the standard installation kit.

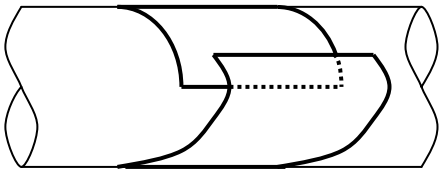


Fig. 1.2.9-43 Wrap gauge paper

4B-b. Mark slit

Mark the pipe on either side of the paper where it overlaps (points “A” in Fig. 1.2.9-44).

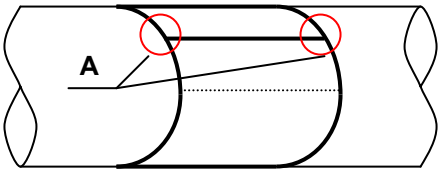


Fig. 1.2.9-44 Mark slit

4B-c. Mark ½ line

Remove the paper from the pipe. Fold the paper in half, aligning the mark with the square edge of the paper. Crease and mark along the fold. Alternately, you can measure half the distance between the mark and the squared end and draw a line. Measure and confirm the circumference of the pipe.

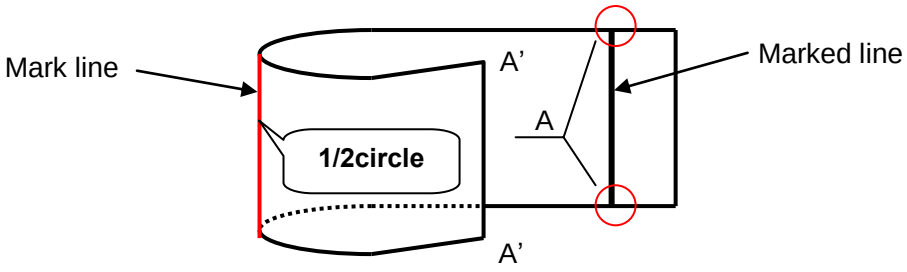


Fig. 1.2.9-45 Mark ½ line

4B-d. Rewrap

Rewrap the paper around the pipe at the intended flow measure point.

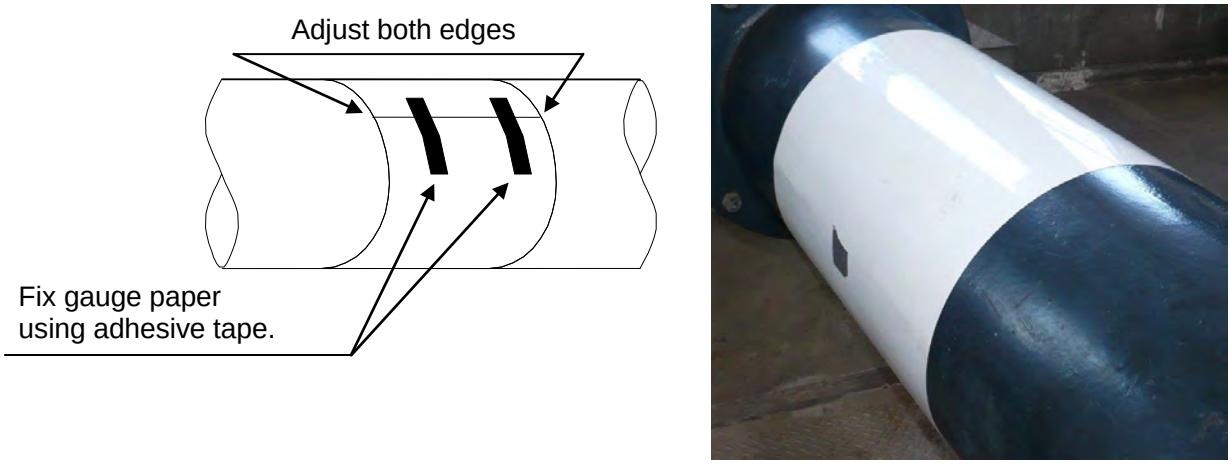


Fig. 1.2.9-46 Fix gauge paper

4B-e. Extending the line

Using a pencil or marking pen, extend the crease lines outward from each edge of the paper onto the pipe (at points (1), (2) in Fig. 1.2.9-47). With the outside edge of F-Dist which is to be positioned at one edge of the gauge paper, measure and mark off the F-Dist to the other transducer holder as shown in Fig. 1.2.9-47. After marking, remove the gauge paper.

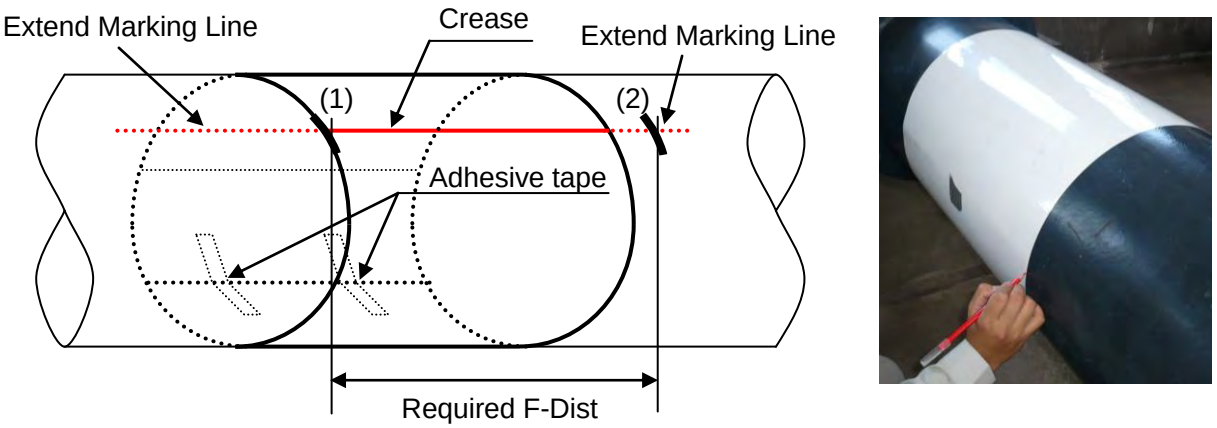


Fig. 1.2.9-47 Mark the extend lines

4B-f. Set mounting fixture by magnet type fixture with distance “F-Dist”.

Remove the paper around the pipe at the intended flow measure point.
Position the Transducer-mounting holders by magnet fixture on the pipe and align in accordance with the lines marked F-Dist, which is the distance between the opposing inside edges of the transducers.
Magnet will be switched on by turning rotary switch.

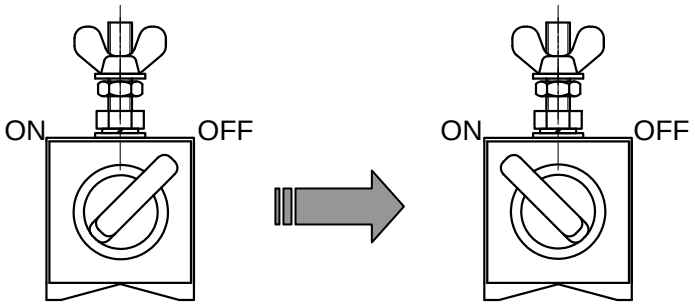


Fig. 1.2.9-48 Magnet switch

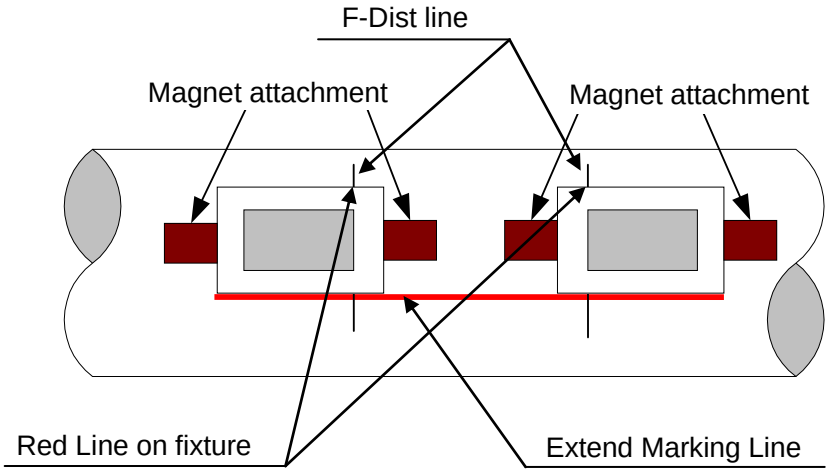
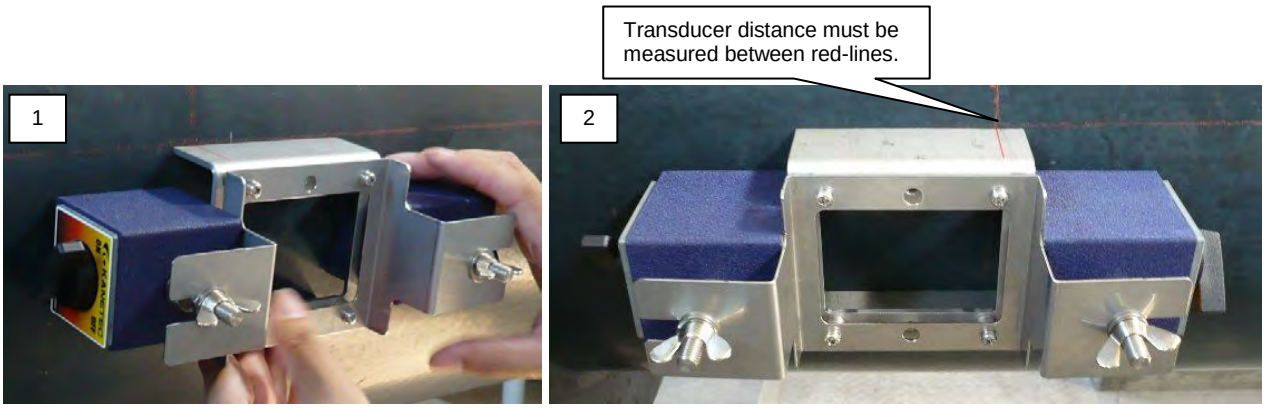


Fig. 1.2.9-49 Position of the mounting fixtures with the magnets



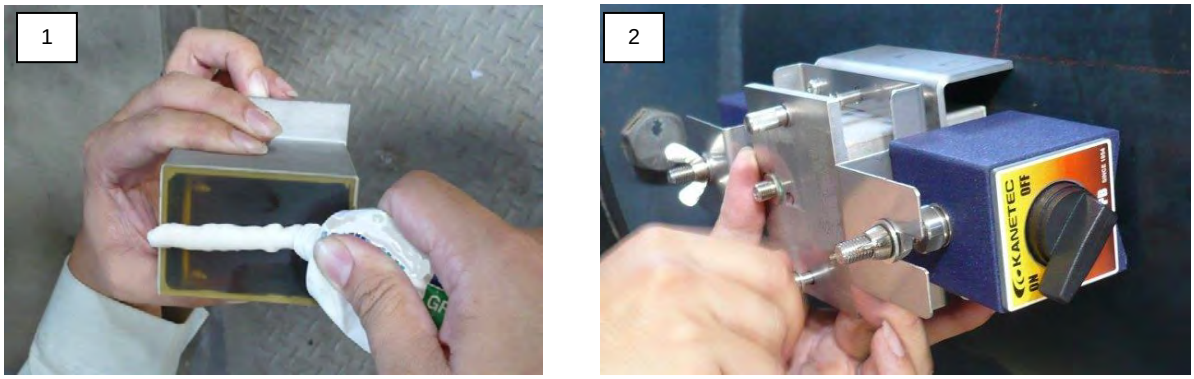
1. Attach fixture by magnet.

2. Check red line on the fixture of the side whether positions properly.

Fig. 1.2.9-50 Set the mounting fixture with the magnets

4B-g. Add silicone grease onto surface of transducers and set into mounting fixture.

Add silicone grease enough to avoid any air layer between pipe and transducer.
And set transducers into holder, then tighten by screws.



1. Add couplant onto transducer.

2. Attach transducer with fixture by screw to be fit onto pipe.

Fig. 1.2.9-51 Set the transducer

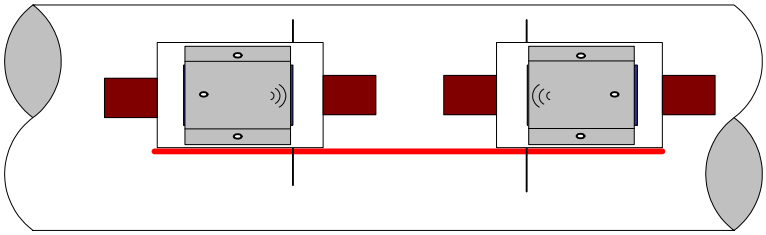
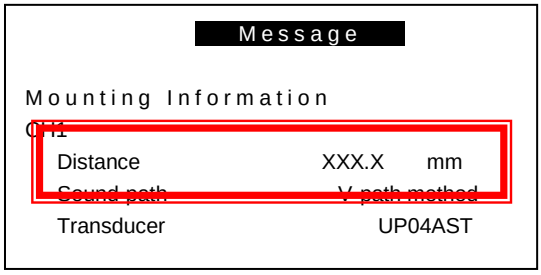


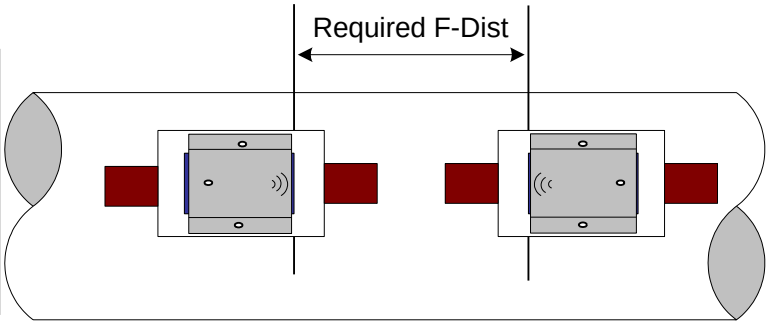
Fig. 1.2.9-52 The transducers installation completed

4B-h. Check installation condition

Position the transducer-mounting holders on the pipe and align in accordance with the lines marked on the pipe. Check the F-Dist and acoustic direction as final.



(1) Information of transducer distance which calculated by main unit
If English unit is selected, “inch” will be indicated.



(2) Required transducer distance = F-Dist

(3) Example of transducer installation

Fig. 1.2.9-53 Check installation condition

4B-i. Set cables with transducers and main unit

Connect transducer cable to receptacle of transducers.
Please be noted that cable connector must be insert receptacle straight, not to be obliquely.
Upstream side of cable must be connected to “UP” side, downstream side to “DN” side.

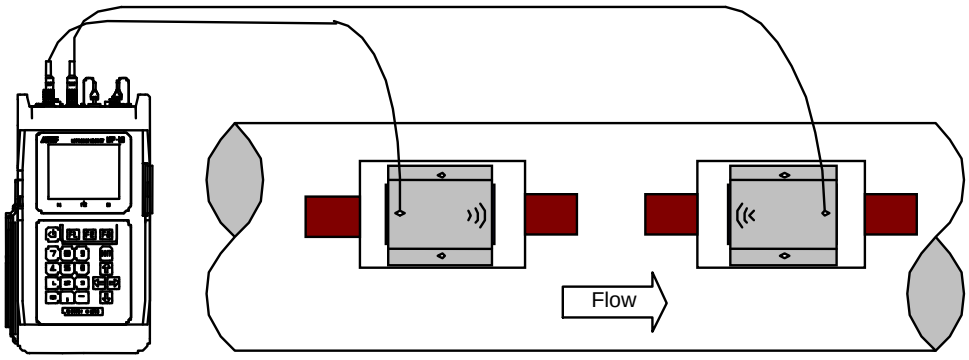
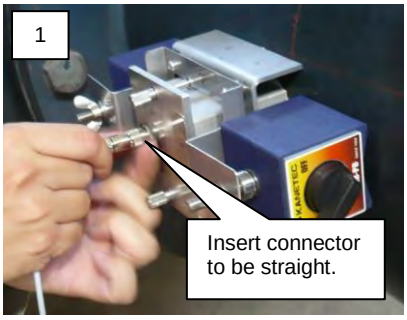
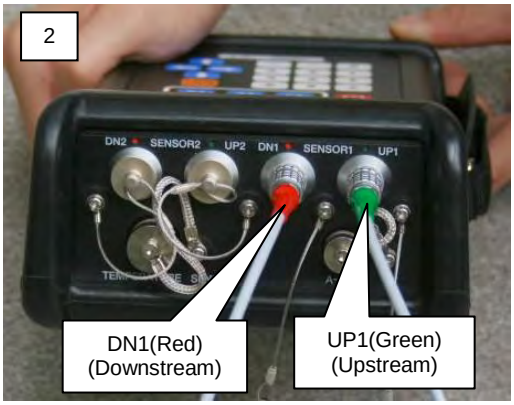


Fig. 1.2.9-54 Set the transducer cables



1. Connection to the transducer side



2. Connection to the main unit side

Fig. 1.2.9-55 Connect the transducer cables

4B-j. Let's start measurement

Finished prepare to measurement. Push O K key as Fig.1.2.9-53 (1) to start measurement (mounting information menu).

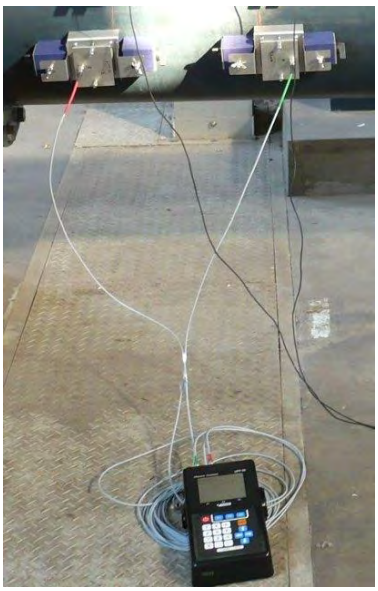


Fig. 1.2.9-56 Setup is completed

Caution

・Please pay attention to burr of chains, corner of mounting fixtures etc, not to be injured.
・Please be noted that it may contain popssibility to drop mouting fixture off.

(4C) Z-path method (Direct transmission method)

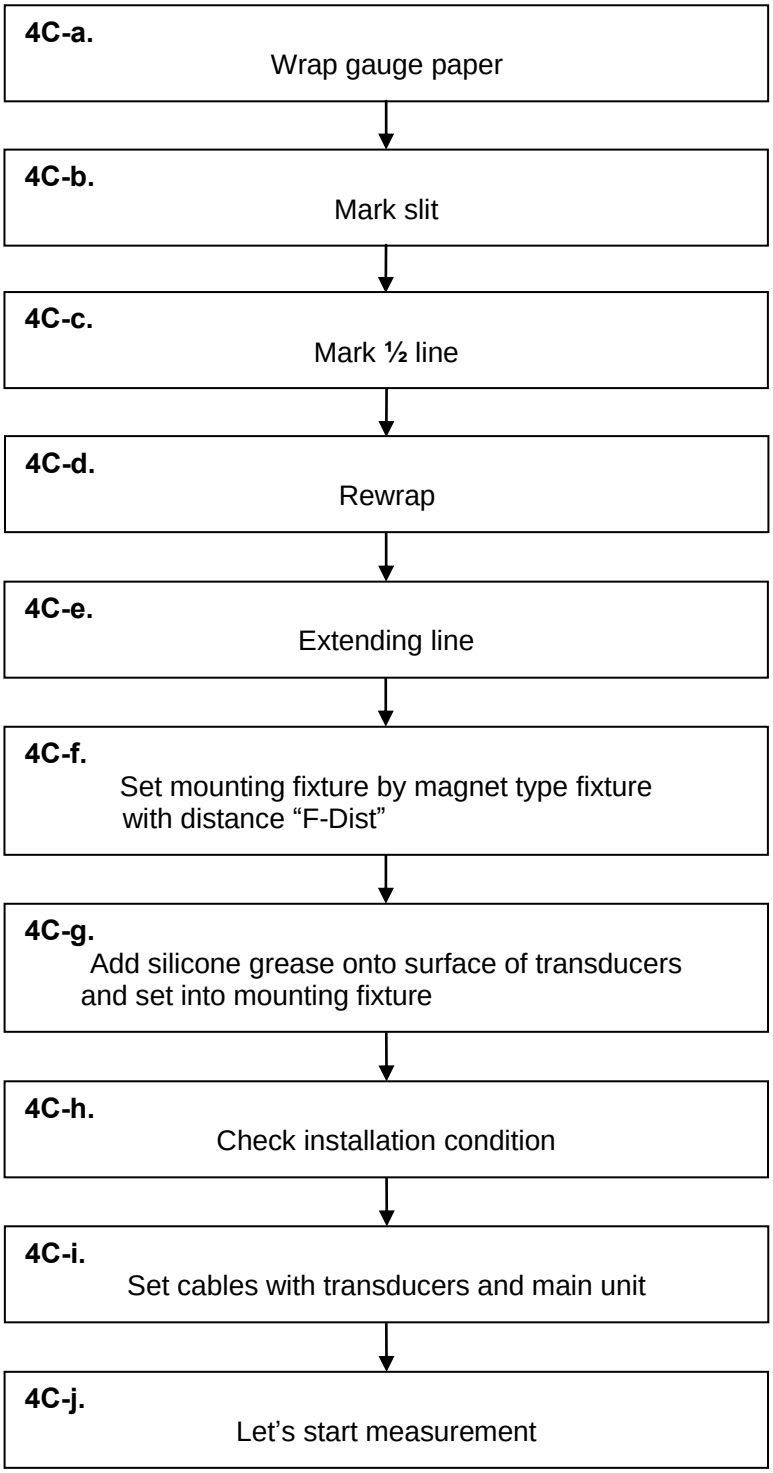


Fig. 1.2.9-57 Flow of large transducer with gauge paper

4C-a. Wrap gauge paper

Wrap gauge paper around the pipe where you intend to make the flow measurement as shown in Fig.1.2.9-58.
Make sure the paper is long enough to overlap and that the overlapping edge is square.
Gauge paper may be ordered and included in the standard installation kit.

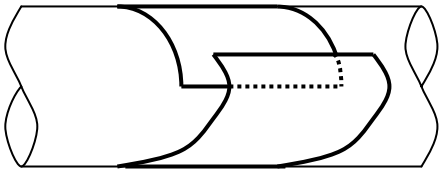


Fig. 1.2.9-58 Wrap gauge paper

4C-b. Mark slit

Mark the pipe on either side of the paper where it overlaps (points “A” in Fig. 1.2.9-59).

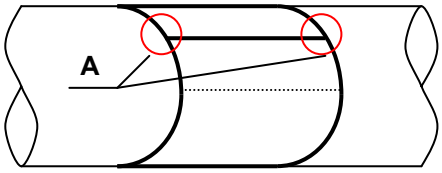


Fig. 1.2.9-59 Mark slit

4C-c. Mark ½ line

Remove the paper from the pipe. Fold the paper in half, aligning the mark with the square edge of the paper. Crease and mark along the fold. Alternately, you can measure half the distance between the mark and the squared end and draw a line. Measure and confirm the circumference of the pipe.

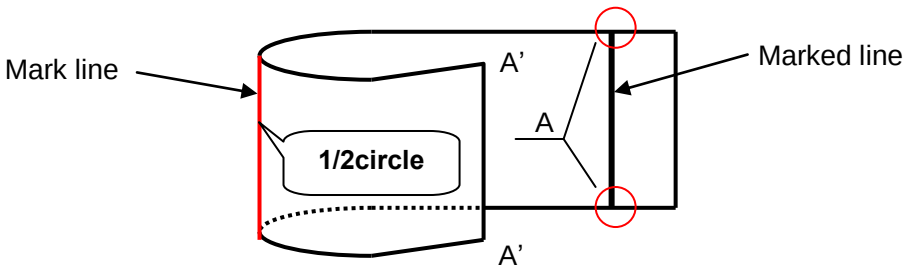


Fig. 1.2.9-60 Mark ½ line

4C-d. Rewrap

Rewrap the paper around the pipe at the intended flow measure point.

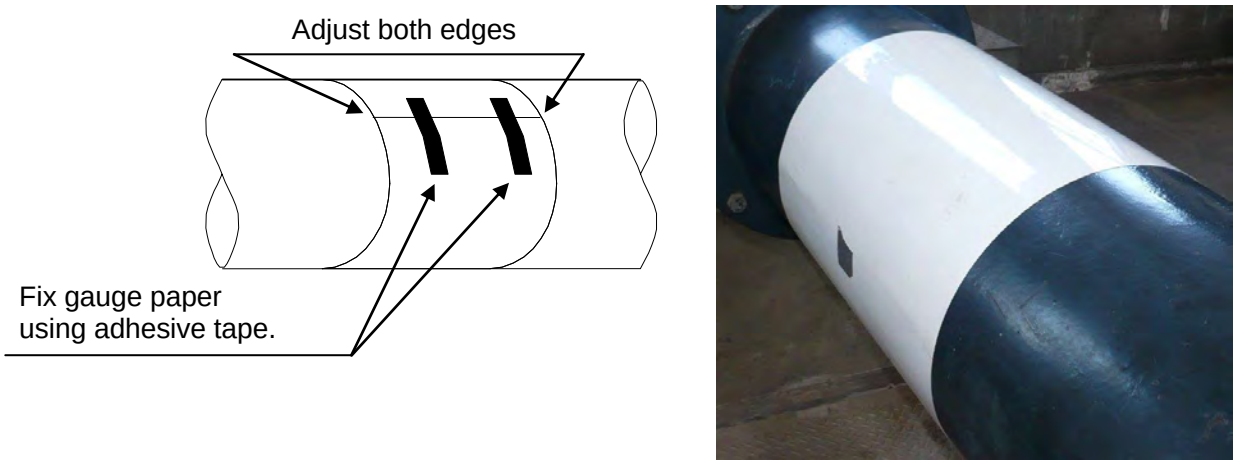


Fig. 1.2.9-61 Fix gauge paper

4C-e. Extend the line

Using a pencil or marking pen, mark the pipe at both edges of the paper at the overlap and at the crease by using a pencil or marking pen to extend the lines outward from the paper onto the pipe.

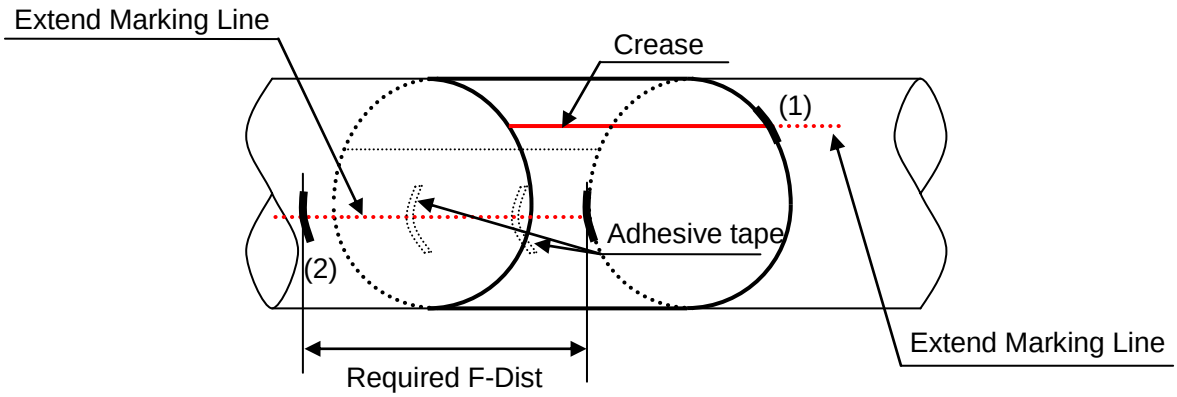


Fig. 1.2.9-62 Mark the extend lines

4C-f. Set mounting fixture by magnet type fixture with distance "F-Dist"

Remove the paper around the pipe at the intended flow measure point.
Position the Transducer-mounting holders on the pipe diametrically opposite each other by magnet fixture, one on the side at the crease mark and the other on the side at the overlap and align in accordance with the lines marked on the pipe. Mark the F-dist, which is the distance between the opposing inside edges of the transducers.
Magnet will be switched on by turning rotary switch.

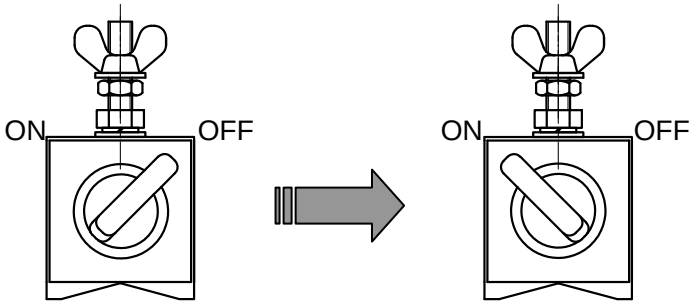


Fig. 1.2.9-63 Magnet switch

Note: Transducers should be positioned diametrically opposite the other.

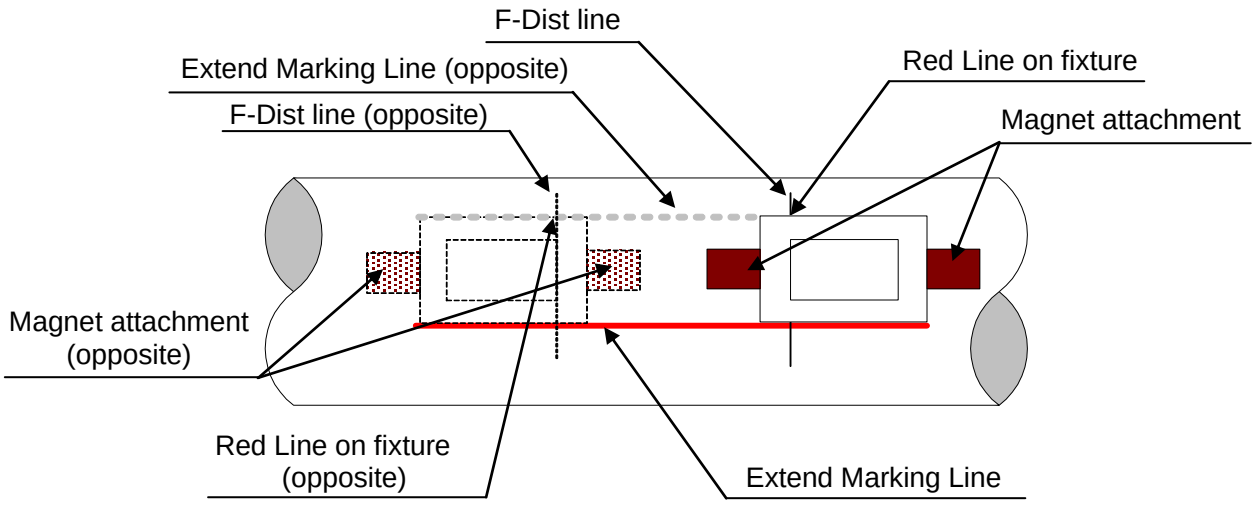


Fig. 1.2.9-64 Position of the mounting fixtures with the magnets

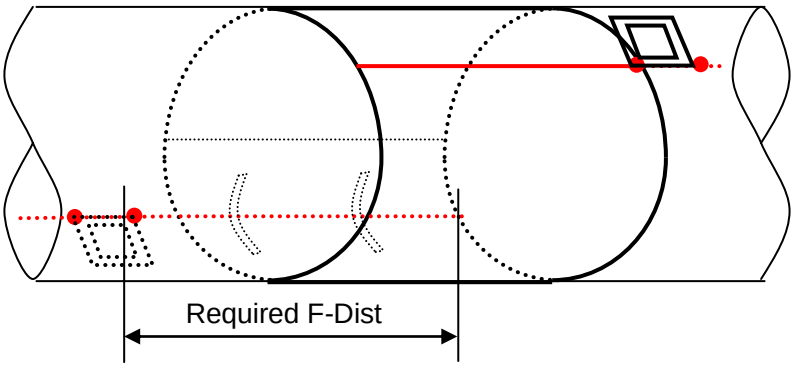
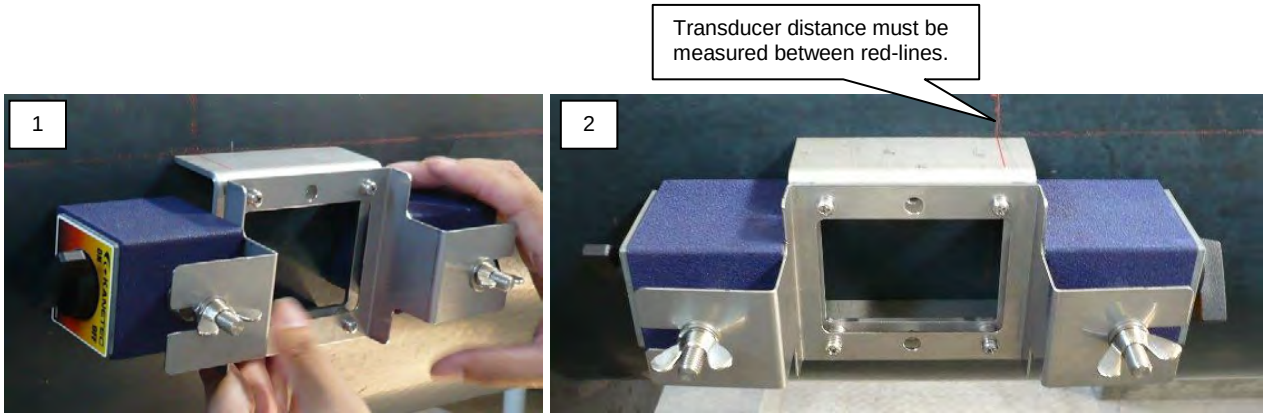


Fig. 1.2.9-65 Required F-Dist



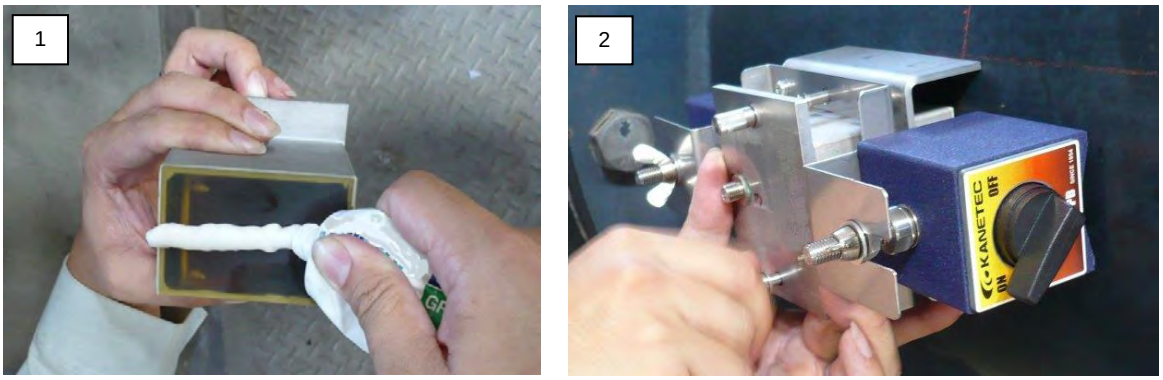
1. Attach fixture by magnet.

2. Check red line on the fixture of the side whether positions properly.

Fig. 1.2.9-66 Set the mounting fixture with the magnets

4C-g. Add silicone grease onto surface of transducers and set into mounting fixture.

Add silicone grease enough to avoid any air layer between pipe and transducer.
And set transducers into holder, then tighten by screws.



1. Add couplant onto transducer surface.

2. Attach transducer with fixture by screw to be fit onto pipe.

Fig. 1.2.9-67 Set the transducer

4C-h. Check installation condition

Position the transducer-mounting holders on the pipe and align in accordance with the lines marked on the pipe. Check the F-Dist and acoustic direction as final.

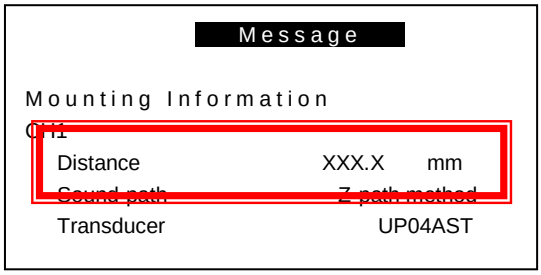


Fig. 1.2.9-68 Message of mounting information

4C-i. Set cables with transducers and main unit

Connect transducer cable to receptacle of transducers.
Please be noted that cable connector must be insert receptacle straight, not to be obliquely.
Upstream side of cable must be connected to “UP” side, downstream side to “DN” side.

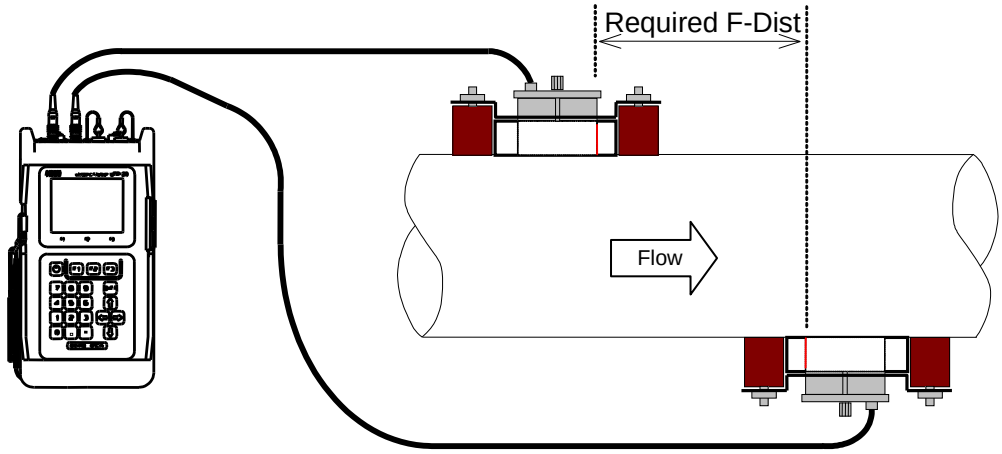
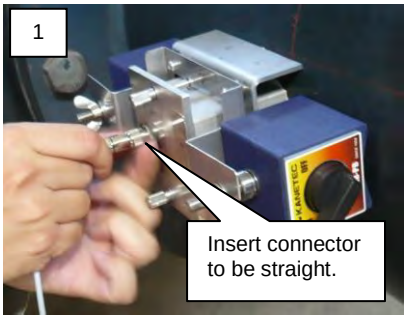
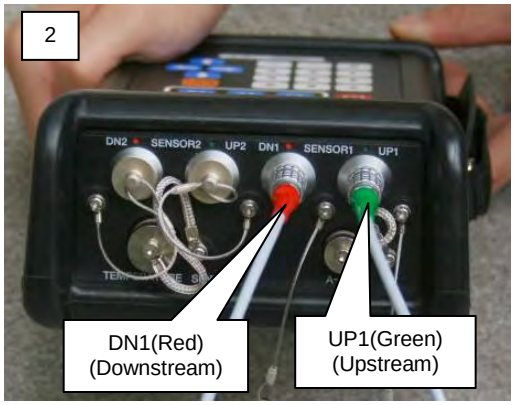


Fig. 1.2.9-69 Set the transducer cables





1. Connection to transducer side　　2. Connection to main unit side

Fig. 1.2.9-70 Connect the transducer cables

4C-j. Let’s start measurement

Finished prepare to measurement. Push O K key as Fig.1.2.9-68 to start measurement (mounting information menu).

Caution

・Please pay attention to burr of chains, corner of mounting fixtures etc, not to be injured.
・Please be noted that it may contain popssibility to drop mouting fixture off.

(4D) Non metal pipe Installation

In case of non-metallic pipe, you can use ratchet type tightener as option instead as Fig.1.2.9-71.

Please refer to (4A) V-path method (Reflection Method), (4B) V-path method (Reflection Method) with Gauge Paper or (4C) Z-path method (Direct Transmission Method) for installation procedure of mounting fixture.

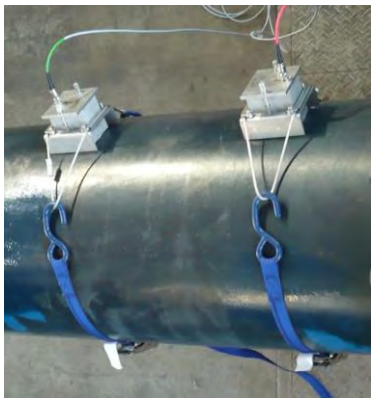
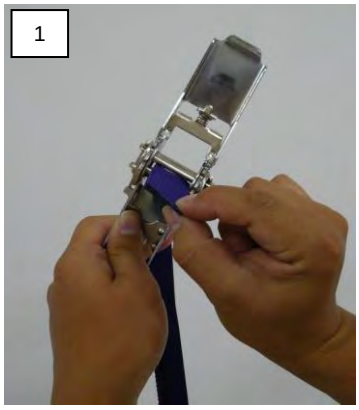


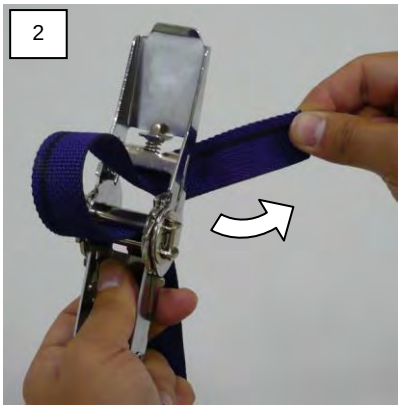
Fig. 1.2.9-71 Example of non metal pipe setup

4D-a. Instruction of ratchet

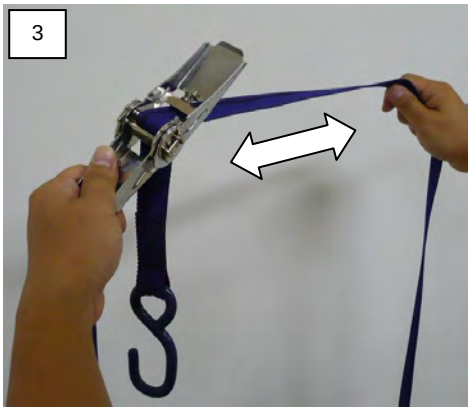
Please refer to following procedure to use ratchet tightener as Fig.1.2.9-70.



1. Insert belt.

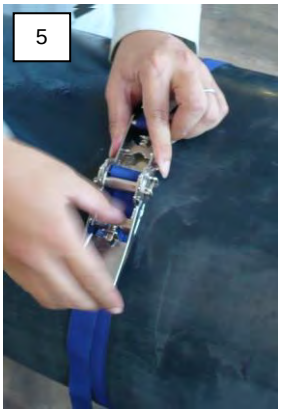


2. Return belt to outside.

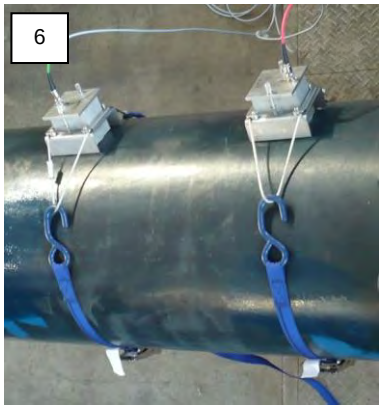


3. Adjust remain length to tighten.

4. Hooked on the wire.



5. The wire tighten by ratchet lever.



6. Completed.

Fig. 1.2.9-72 How to use ratchet tightener

Warning

- Do not use the belt as tied or twisted.
- Do not add any damage by hurling, dragging or bump hardly.
- Do not use the belt except above defined proper instructions.
- Do not use the belt to tighten the sharp-edged object.

Caution

- Please pay attention to burr of chains, corner of mounting fixtures etc, not to be injured.
- Do not use defected following belt.
  a. Fuzzed or molten
  b. damaged more than 10% for side axis or 20% for thickness axis.
  c. Any damages on sewn part.

(5) Multi-Path transducer installation

When 2 pairs of transducers are employed, the basic procedures for mounting transducers for single paths are also used in multi-path installations.

Gauge paper (if used) should be double folded to divide the circumference by 4.

Please refer to installation procedure of mounting fixture of each transducer.

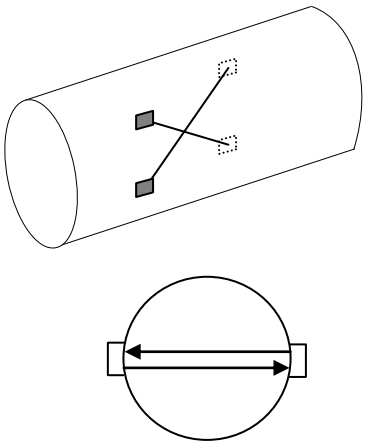


Fig. 1.2.9-73 2Z-path method

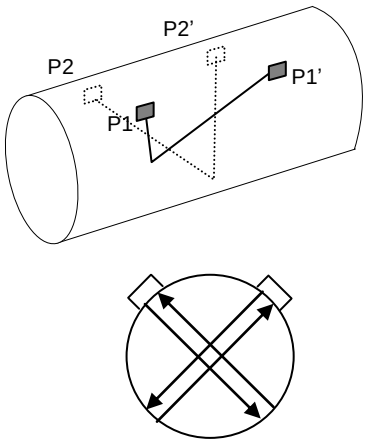


Fig. 1.2.9-74 2V-path method

2. Operation

Chapter 2

INDEX

2.1 Functions

This chapter summarizes the functions of the ultrasonic flowmeter. Please refer to Chapter 2.2 “Operation” for setting methods.

2.1.1 Flow display

Flow values are composed of numerical units.
Normally volumetric flow is the unit of measurement used, but measurement can be converted to mass flow if liquid density is set manually or default value. Besides specific heat coefficient will be requires for heatmeter.

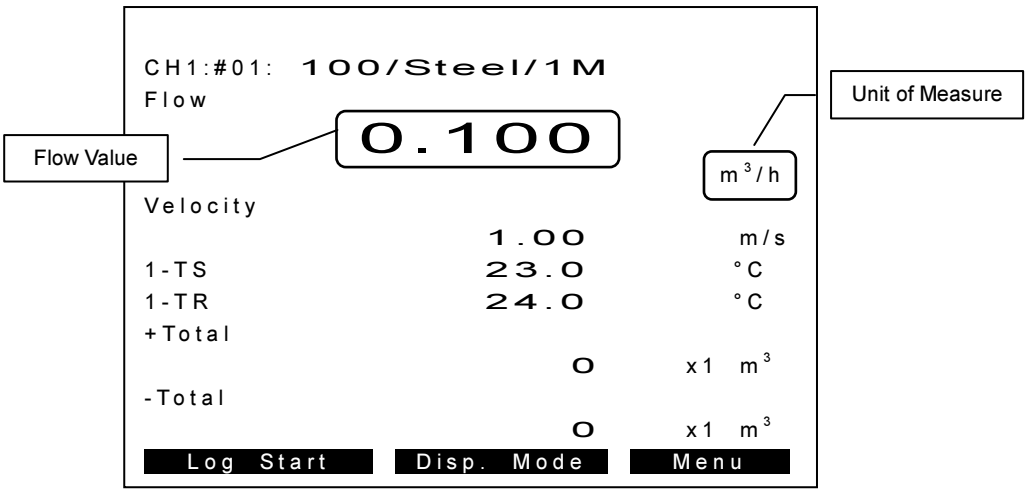


Fig. 2.1.1-1 Flow display

(1) Numerical section

The numerical portion of the display consists of a maximum 7 digits sequence, excluding alphanumeric but including decimal point although forward flow display consists of numbers and decimal point only, no symbols. (However the maximum measurable flow value is 999999.)
Flow display digits and decimal point position is determined by system setting as below.
If exceeded digits, “----------” will be displayed.

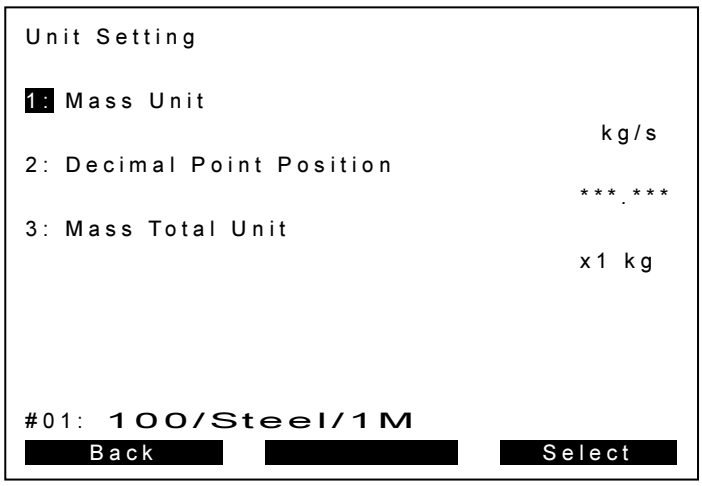


Fig. 2.1.1-2 Unit setting menu

Table 2.1.1-1 Decimal point position

Selectable items	Example
*.*****	1.23456
.**	12.3456
.	123.456
****.**	1234.56
*****.*	12345.6
*******	1234567

(2) Units of flow

Units of flow measurement can be selected from the following.

Table 2.1.1-2 Units of flow

[Unit for Instantaneous rate]

for Flowmeter			for Massmeter		for Heatmeter	
Metric	English		Metric	English	Metric	English
m^3/s	ft^3/s	gal/s	kg/s		W	BTU/h
m^3/min	ft^3/min	gal/min	kg/min		kW	kBTU/h
m^3/h	ft^3/h	gal/h	kg/h		MW	MBTU/h
m^3/D	ft^3/D	gal/D	kg/D			
km^3/s	Mft^3/D	Mgal/D	t/s			
km^3/min	bbl/s	acf/s	t/min			
km^3/h	bbl/min	acf/min	t/h			
km^3/D	bbl/h	acf/h	t/D			
Mm^3/D	bbl/D	acf/D	kt/s			
L/s	Mbbl/D	Macf/D	kt/min			
L/min			kt/h			
L/h			kt/D			
L/D			Mt/D			

For example, “D” would be expressed as “24H” and “m^3/s” would be expressed as “m^3/sec”.

2.1.2 Analog output (4-20 mA current output)

This function converts the flow measurement range setting into a 4 ~ 20mA current output.
One output channel and One output pattern are provided.

- The channel is not insulated which allows current output.

(1) Output source

Analog output source can be selectable from “None” or “CH1” on 1path or 2path mode.
And “None”, “CH1”, “CH2” on 2-channel mode.
When calculation mode is allowed, “CH1 + CH2” or “CH1 - CH2” will be available in accordance with setting.

(2) Output profiles

Measures any direction flow can be set as 0% ~ 100% range.
Graph of flow relative to output current is shown as below.

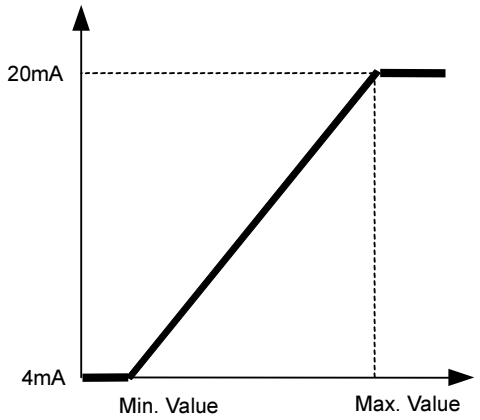


Fig. 2.1.2-1 Analog output pattern

(3) Output calibration

Output current is calibrated during product testing prior to shipment from factory and no recalibration at site is necessary. If recalibration becomes necessary for some reason however, the unit can be recalibrated according to the procedure described under Chapter 2.2.8 (3) 5 Analog output calibration.

2.1.3 Totalizing

Totalized value is composed of an alphanumeric sequence and unit of measurement.
The alphanumeric display is expressed with a maximum of 8 digits. If the unit of flow is set as volumetric flow, the selectable totalizing unit to be set will be in volumetric flow units.

If the unit of flow is set in mass flow units, the selectable totalized flow unit to be set will be in mass flow units. However when setting mass flow units, it is necessary to know the density of the liquid being measured.

(1) Totalized display

The alphanumeric sequence can be expressed up to 8 digits. Plus and minus independent display range is 0 to 99999999. When totalizing value exceeds 99999999, " * " mark will be indicated on the left side of the highest-order digit.

There are no decimal points in the totalized value display. For example, if the totalized value is 10 m^3 and totalized unit is set at x1m^3, "10 x1m^3" is displayed. But if the totalized unit is set at x100m^3, the display will be "0 x100m^3".

(2) Totalized units

Totalized units can be selected from the following.

Table 2.1.3-1 Totalized units

For Flowmeter	
Metric	English
x1 m^3	ft^3
x5 m^3	kft^3
x10 m^3	Mft^3
x100 m^3	bbl
x0.01 L	kbbl
x0.1 L	Mbbl
x1 L	gal
x10 L	kgal
x100 L	Mgal
	acf
	kacf
	Macf

For Massmeter	
Metric	English
x1 kg	
x10 kg	
x100 kg	
x0.1 kg	
x0.01 kg	
x1 t	
x10 t	
x100 t	

For Heatmeter	
Metric	English
J	BTU
MJ	MBTU

(3) Totalizing start and stop modes

Totalizing function will start and stop as logging function activated, if set synchronized.
The [START] command initiates totalizing from 0.
The [STOP] command ends totalizing.
During totalizing, an icon "  " at the upper left of the measurement screen and disappears when totalizing ends.

2.1.4 Confirmation of operational status

Operation of each function after data setting such as analog output, range fixing, and measurement path fixing and whether or not measurement is functioning properly can be checked.

(1) No receiving echo warning

Check whether fault is due to no received signal or equipment failure.

- A letter "**R**" with channel No. is displayed in the upper middle of the measurement screen when there is no received signal echo.

(2) Detection of disturbance

Momentary distortions in measurement values caused by bubbles or solids in the liquid are detected.

- When disturbance of flow are detected, a "**D**" with channel No. appears at the upper middle of the measurement screen.

(3) Parameter failure

Setting parameter failure caused by out of range or contradiction of values.

- When input parameters are not properly set, an "**E**" with channel No. appears at the upper middle of the measurement screen.

(4) Self-diagnostics

This function checks for equipment failure at start-up procedure.

2.1.5 Compensation

(1) Correction of measurement values

1. Zero shift (Zero point correction)

Addition and subtraction to compensate for offsets in measurement values can be performed.
Displayed digits and decimal point position is determined by systems setting.
Value units are determined by the units of flow.

2. Span correction

Measurement values can be corrected by an proportional coefficient.

3. Low Cut (flow volume cutoff)

When the measured flow value is less than the flow value setting, “0” flow can be imposed.
Displayed digits and decimal point position are determined by system setting.
Value unit is determined by the units of flow.

(2) Moving averaging function

Flow is expressed at the time it takes to achieve defined time average of measuring flow rate during stepped changes.
When flow measurement values fall into disarray, dampening can be enhanced by prolonging the averaging time. Specifically, the response to flow changes is dulled.

2.1.6 Other

(1) Data transfer

Logging data can be transferred through USB memory as CSV format onto any PC which has USB port. All logged data can be printed by commercial software like spreadsheet-type.
Logging data cannot be stored directly to USB memory.

For example,

Mode	Path / Channel	Log Interval	Storage-able hours
Flow meter	1path	1min	600 hours (25days)
Heat meter	2-channel	1hour	9000 hours (375days)

(2) Thickness / sound speed measurement function

With optional probe and test piece, thickness or sound speed can be measured.

(3) Echo waveform monitoring function

Except oscilloscope, receiving echo wave can be monitored on Check Mode.

2.2 Operation

This chapter provides information necessary for system operation, screen navigation, and operating instructions.

Caution

- Measurement values during operation may change when settings are changed.

2.2.1 Measurement display

(1) Flowmeter display

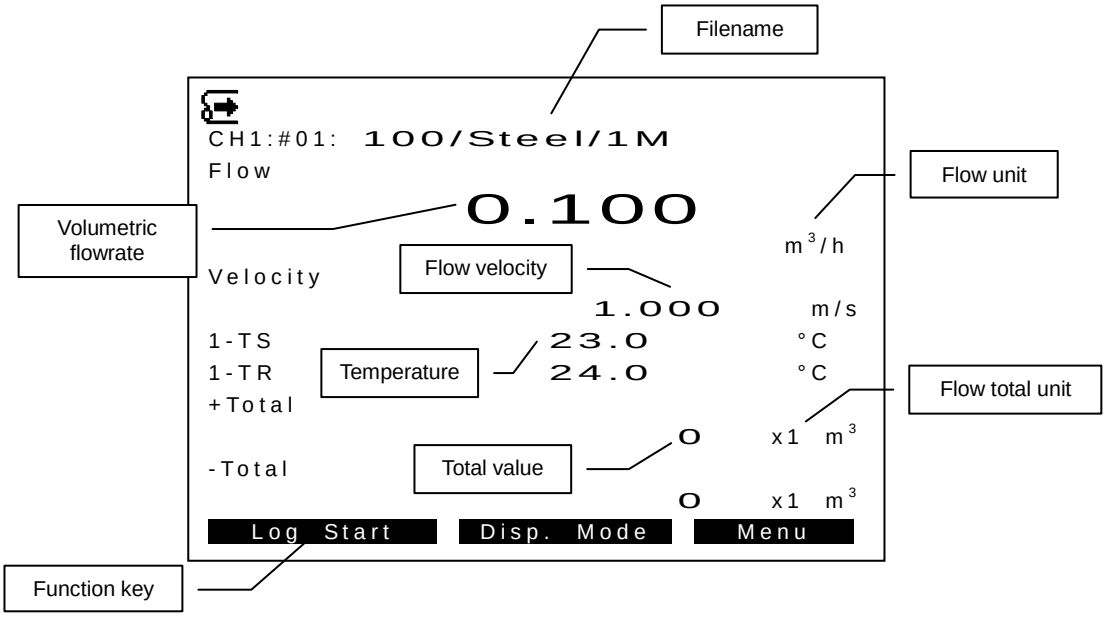


Fig. 2.2.1-1 Flowmeter display

Volumetric flowrate, flow velocity, temperature, forward and backward totalizing value are displayed in Fig.2.2.1-1.
Flow rate and totalizing unit can be selectable.

(2) Massmeter display

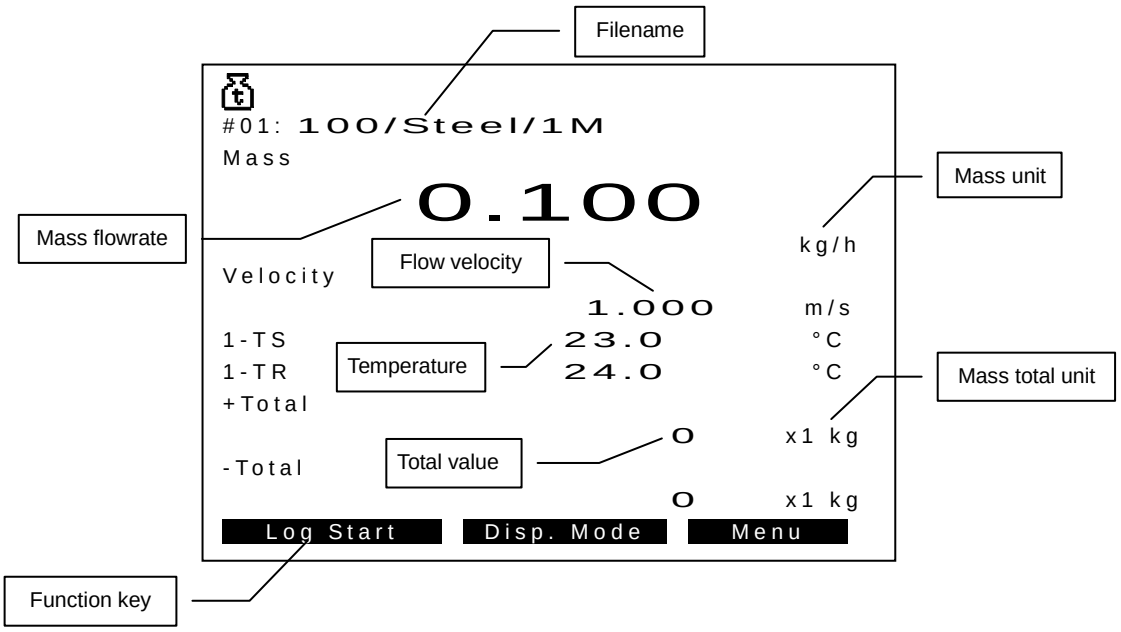


Fig. 2.2.1-2 Massmeter display

Mass flowrate, flow velocity, temperature, forward and backward totalizing value are displayed in Fig.2.2.1-2.
Flow rate and totalizing unit can be selectable.
Mass value will be calculated by setting density that is as fixed density.

(3) Heatmeter display

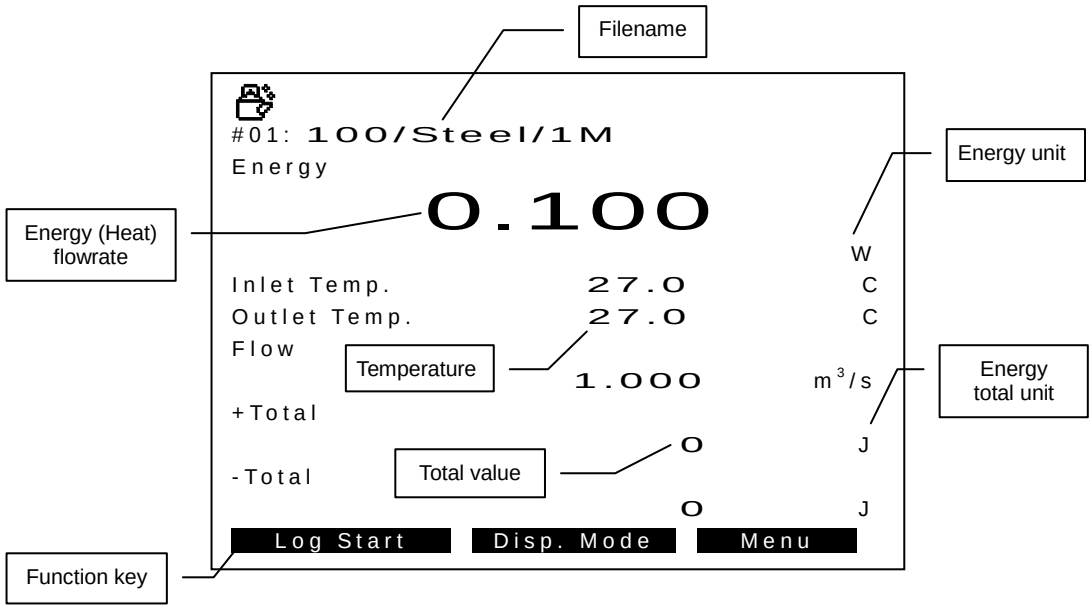


Fig.2.2.1-3 Heatmeter display

Energy (Heat) flowrate, flow velocity, inlet and outlet temperature and forward and backward totalizing value are displayed in Fig.2.2.1-3.
Flow rate and totalizing unit can be selectable.
Energy (Heat) value will be calculated by setting fixed density and specific heat coefficient.

(4) 2-channel display

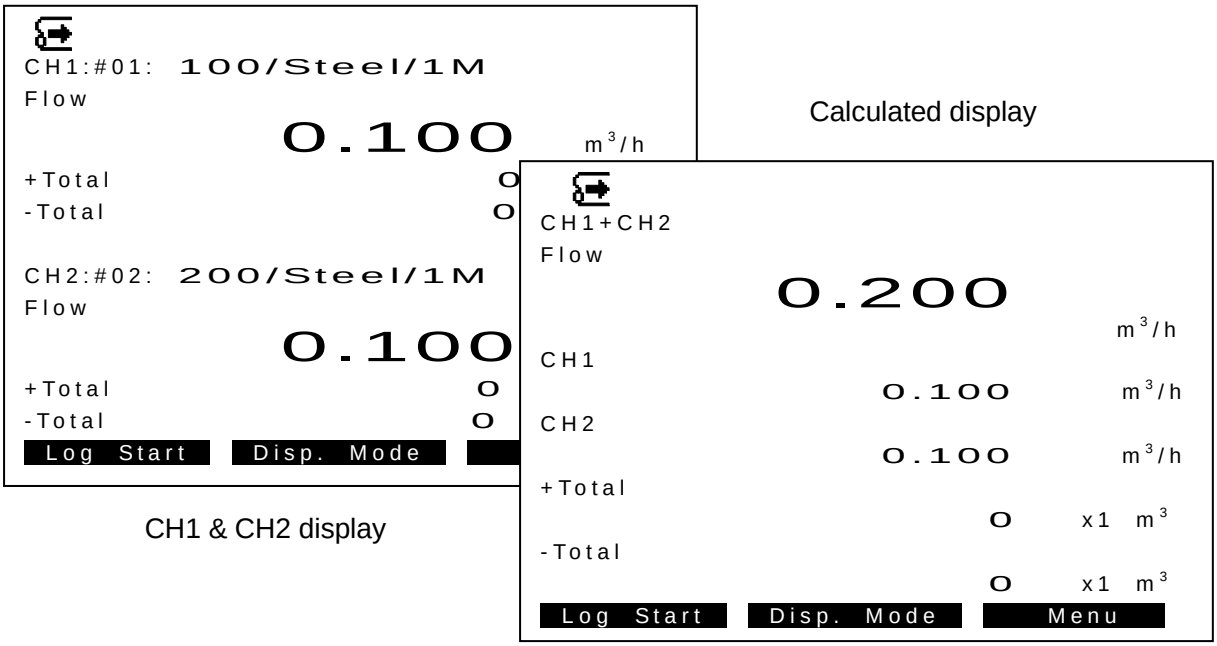


Fig.2.2.1-4 Disp. mode (2-channel system)

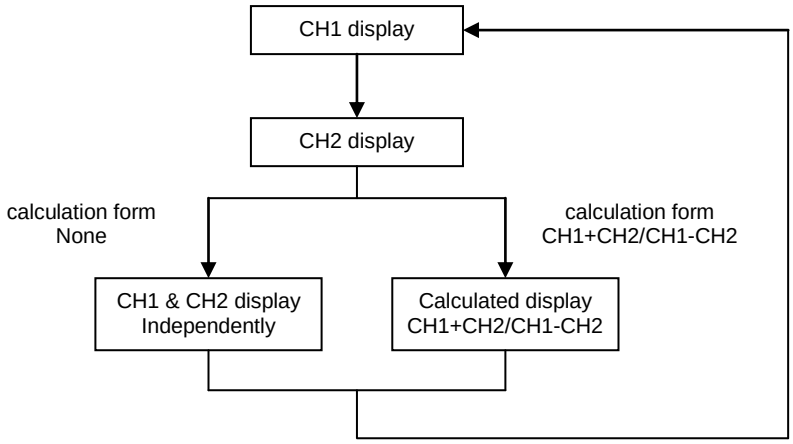


Fig.2.2.1-5 Changing Disp. Mode (2-channel system)

In case of 2-channel system, you can see 2 patterns of measurement result as above. 2-channel display is indicated both channel value at the same time.
Calculation display is indicated calculated value with independent value at the same time. Calculation method is defined at system directory.

2.2.2 Menu tree

Whole system tree is as follows,

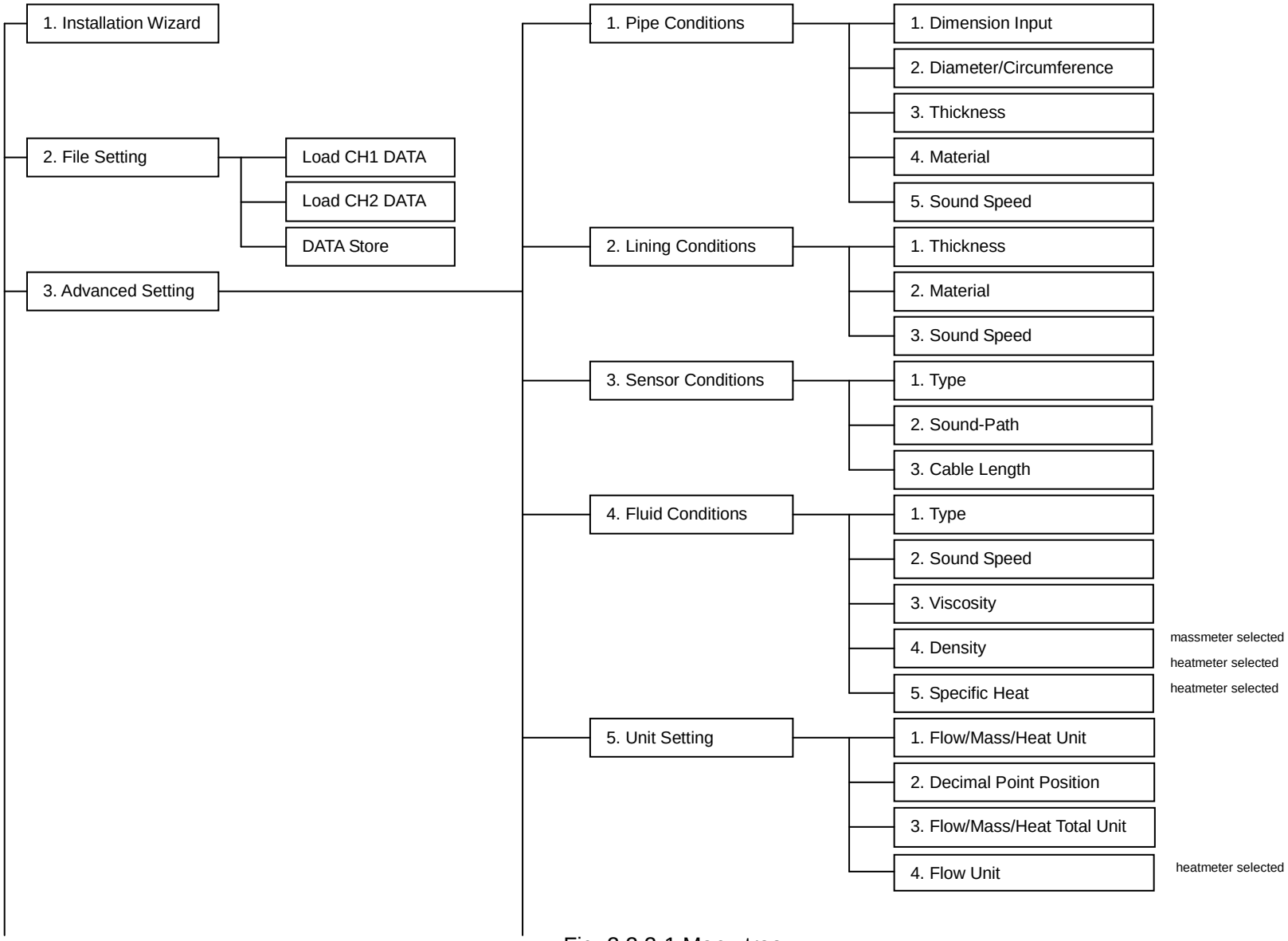


Fig. 2.2.2-1 Menu tree

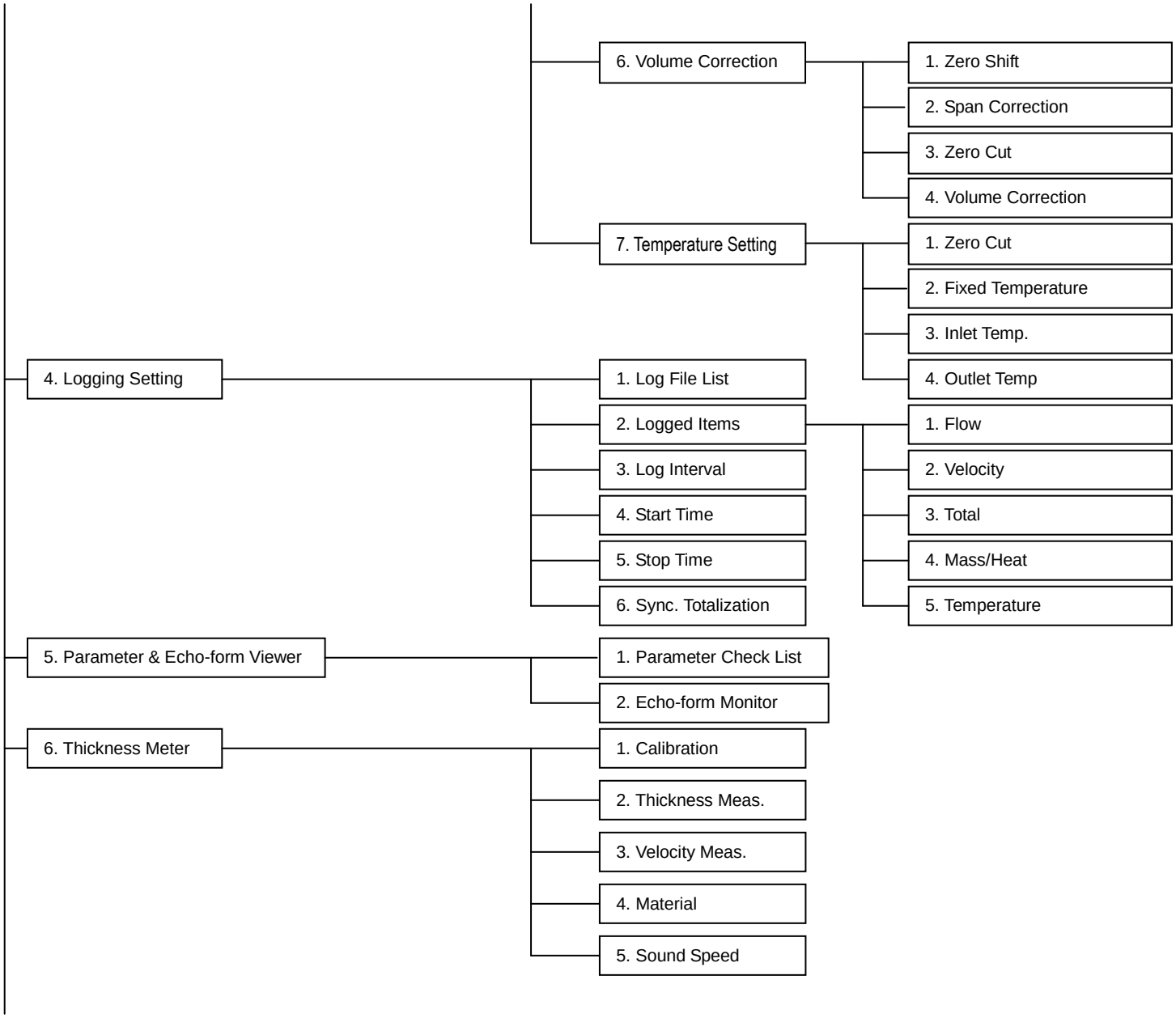


Fig. 2.2.2-1 Menu tree (cont.)

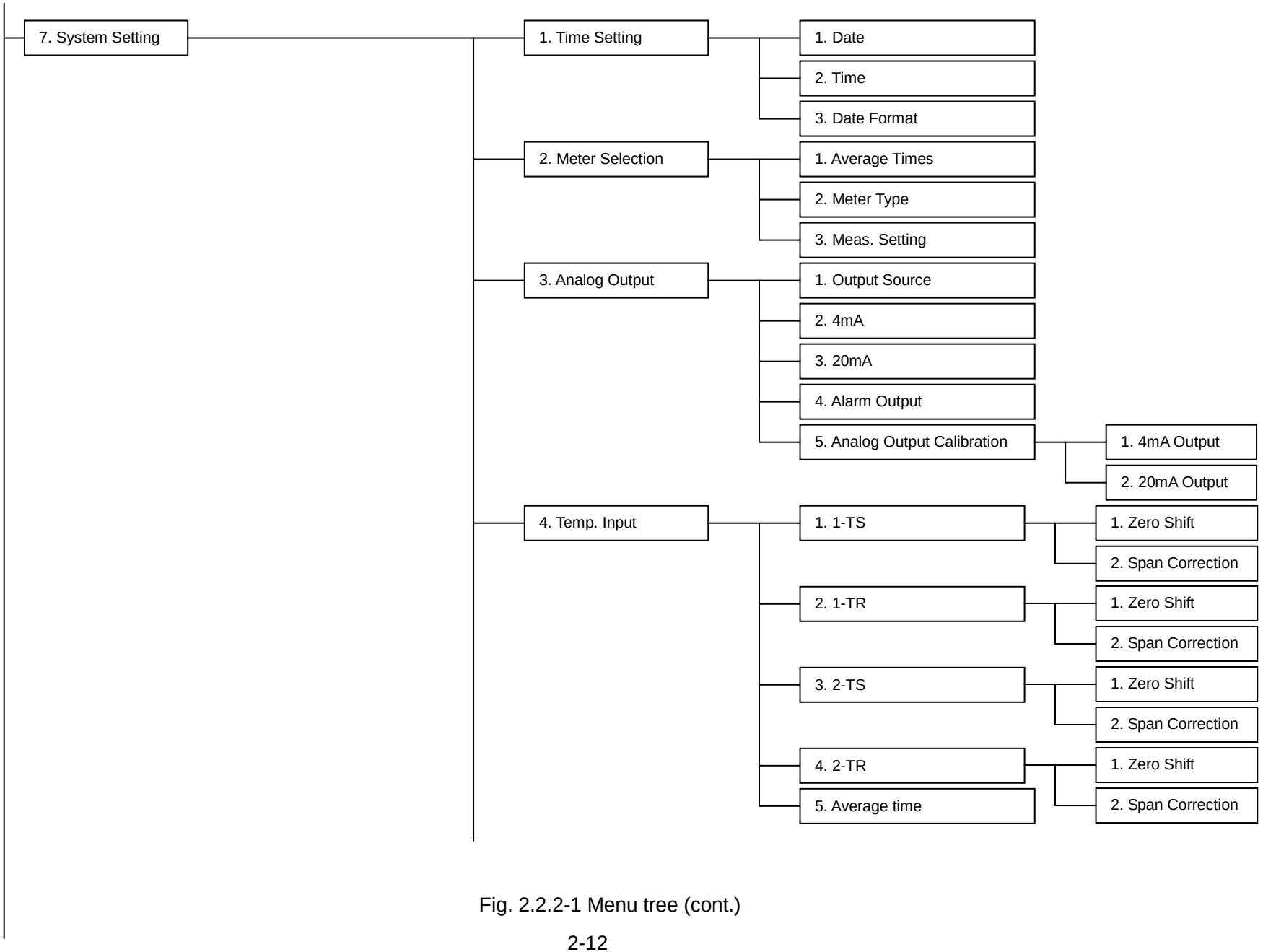


Fig. 2.2.2-1 Menu tree (cont.)

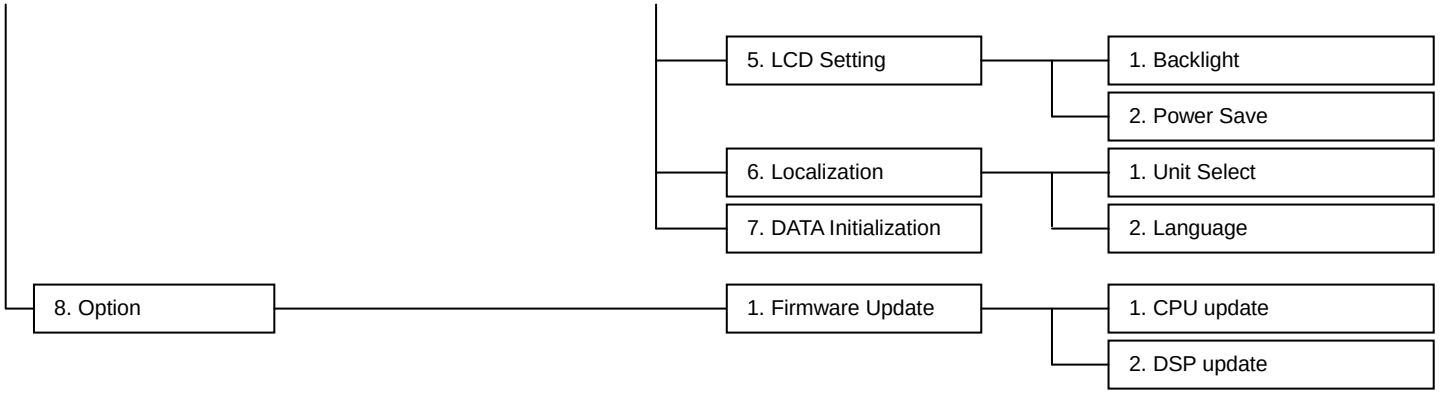


Fig. 2.2.2-1 Menu tree (cont.)

2.2.3 Basic operation

(1) Selectable items

Move cursor using direction or numeric key and push Select key (F3 button).

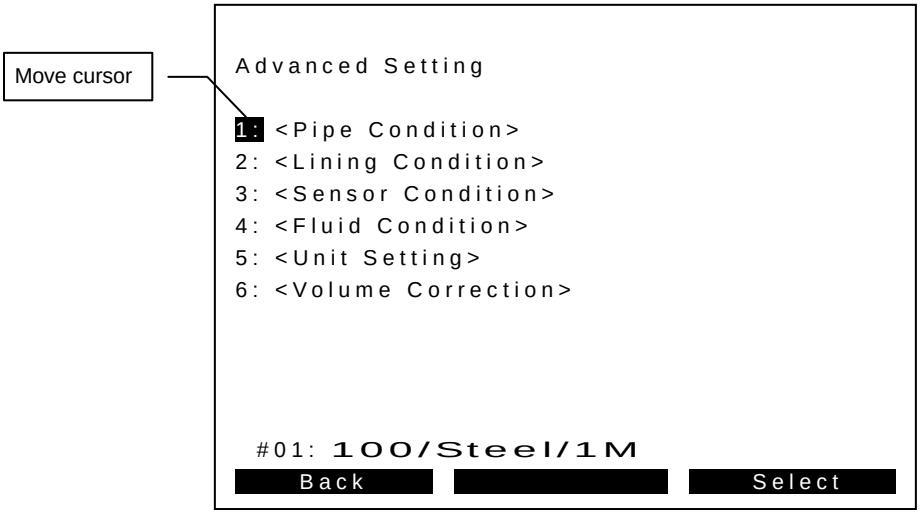


Fig. 2.2.3-1 Sample of selectable items

(2) Change item value (selectable item)

Select item using direction or numeric button.
Press Select key (F3 button) key and change item using direction button.

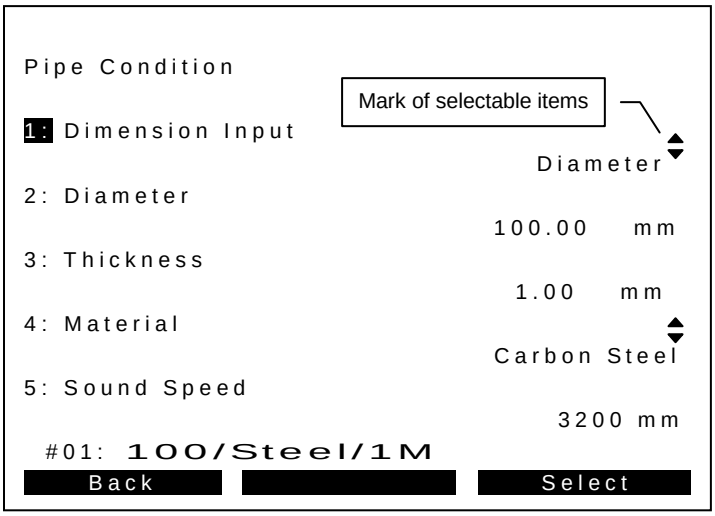


Fig. 2.2.3-2 Select selectable items

After change items, press Enter key (F3 button) to confirm the choice.
Cancel key (F1 button) can be canceled changed value.

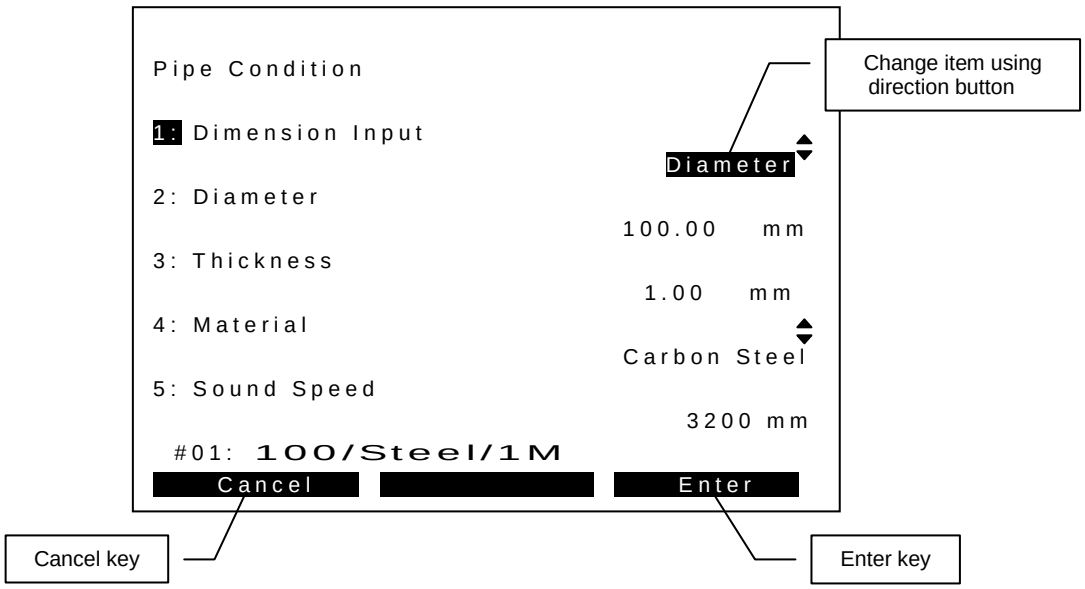


Fig. 2.2.3-3 Change selectable items

(3) Change item value (numerical input)

Select item using direction or numeric button.
Input item value using numeric button and press Enter key (F1 button) to confirm input value.
Cancel key (F1 button) can be canceled changed value.
Delete key (F2 button) can be deleted one character.

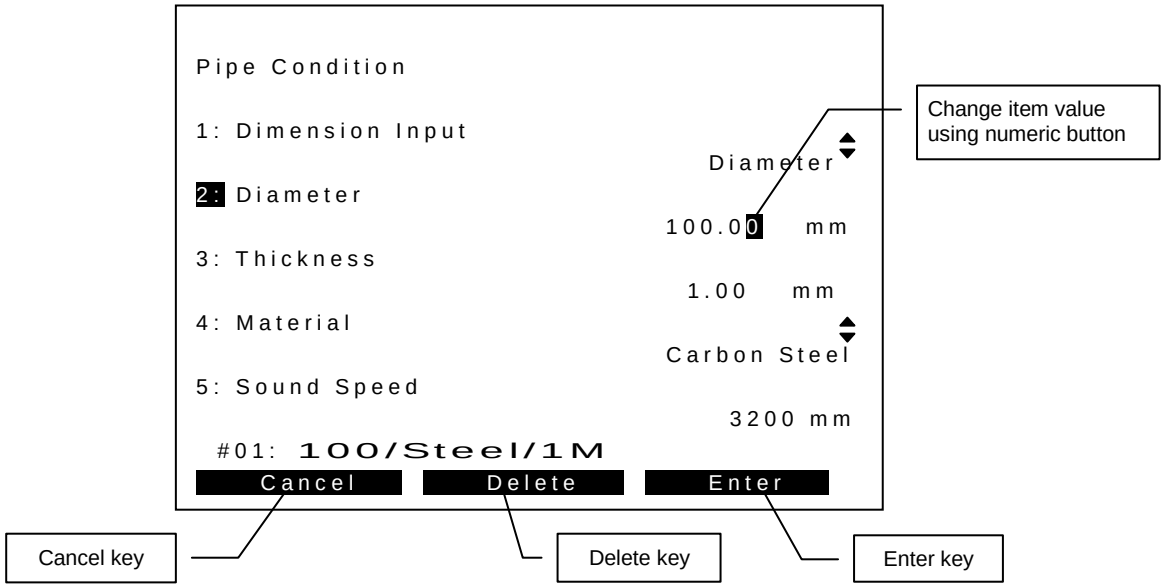


Fig. 2.2.3-4 Change numeric input value

2.2.4. Advanced setting operation

Changing site file and parameters through below advanced setting menu.

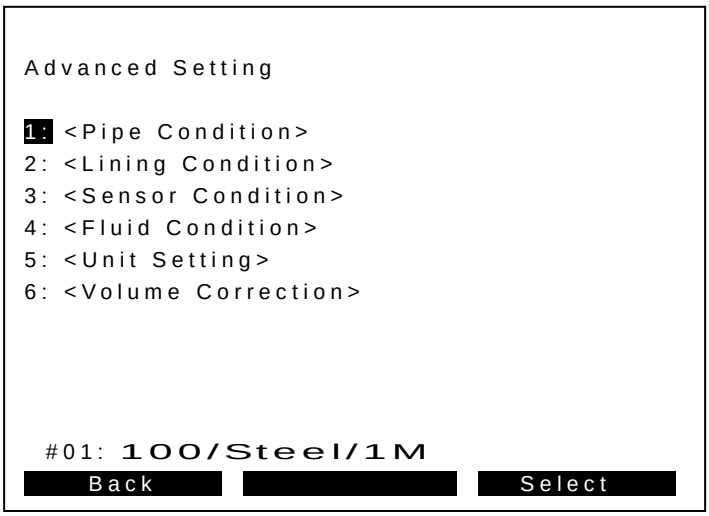


Fig. 2.2.4-1 Advanced setting menu

(1) Pipe condition

Change the pipe dimension, diameter, thickness, material and so on.

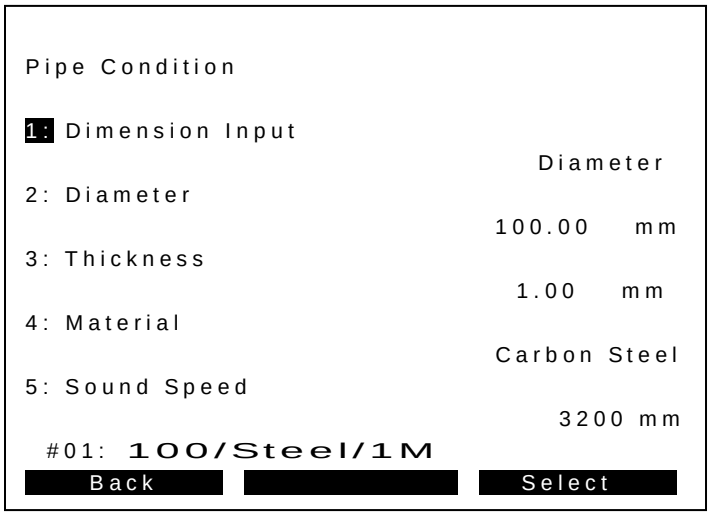


Fig. 2.2.4-2 Pipe condition menu

1. Dimension input

Select input method for pipe dimension.
Press Select key (F3 button) and select item using direction button.
Press Enter key (F3 button) to confirm the selected item.

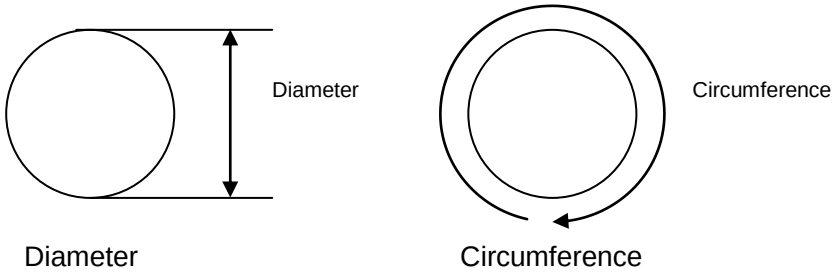


Fig. 2.2.4-3 Diameter & circumference

Table 2.2.4-1 Selectable items

Item name
Diameter
Circumference

2. Diameter (Circumference)

Press Select key (F3 button) and input diameter (circumference) value using numeric button.
Press Enter key (F3 button) to confirm the change value.

Table 2.2.4-2 Range of diameter (circumference)

Item name	Default [mm]	min. [mm]	max. [mm]
Diameter	100.00	12.00	5500.00
Circumference	314.15	37.70	172787.59

3. Thickness

Press Select key (F3 button) and input diameter (circumference) value using numeric button.
Press Enter key (F3 button) to confirm the change value.

Table 2.2.4-3 Range of thickness

Default [mm]	min. [mm]	max. [mm]
1.00	0.10	Diameters 1/2 (up to 100)

4. Material

Press Select key (F3 button) and select item using direction button.
Press Enter key (F3 button) to confirm the selected item.

Table 2.2.4-4 Selectable Items of pipe material

Material	Sound speed [m/s]	Material	Sound speed [m/s]
Carbon Steel	3200	PVC	2280
Ductile Iron	3000	FRP	2560
Cast Iron	2500	Acrylic	2720
Copper	2270	User Defined	Input any value between 500 to 9000
Stainless Steel	3100		

If you do not find materials, you can use “User Defined” items and input any value.

(2) Lining condition

Change the lining thickness, material and so on.

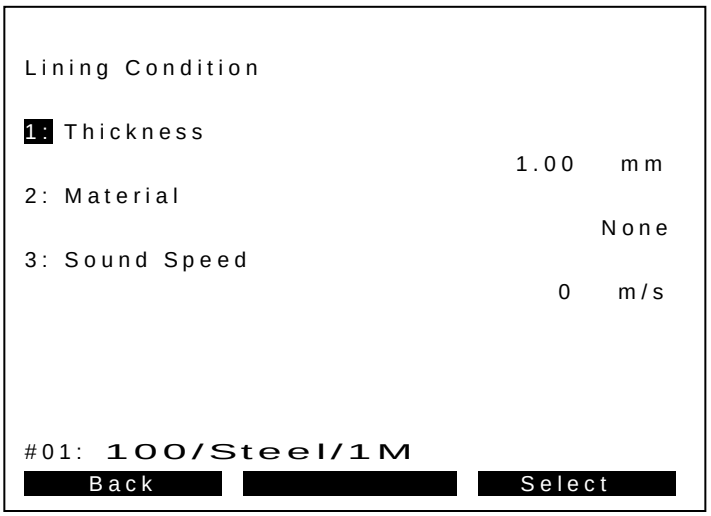


Fig. 2.2.4-4 Lining condition menu

1. Thickness

Press Select key (F3 button) and input lining thickness value using numeric button.
Press Enter key (F3 button) to confirm the change value.

Table 2.2.4-5 Range of thickness

Default [mm]	min. [mm]	max. [mm]
0.00	0.00	inner diameters 1/2 (up to 100)

2. Material

Press Select key (F3 button) and select item using direction button.
Press Enter key (F3 button) to confirm the selected item.
If you do not input lining data, you have to select “None” item. Initial condition is “None”.

Table 2.2.4-6 Selectable items of lining material

Material	Sound speed [m/s]
None	none
Epoxy	2000
Mortar	2500
Rubber	1900
PVC	2280
User Defined	Input any value between 500 to 9000

If you do not find materials, you can use “User Defined” items and input any value.

(3) Sensor condition

Change the transducer, sound-path and so on.

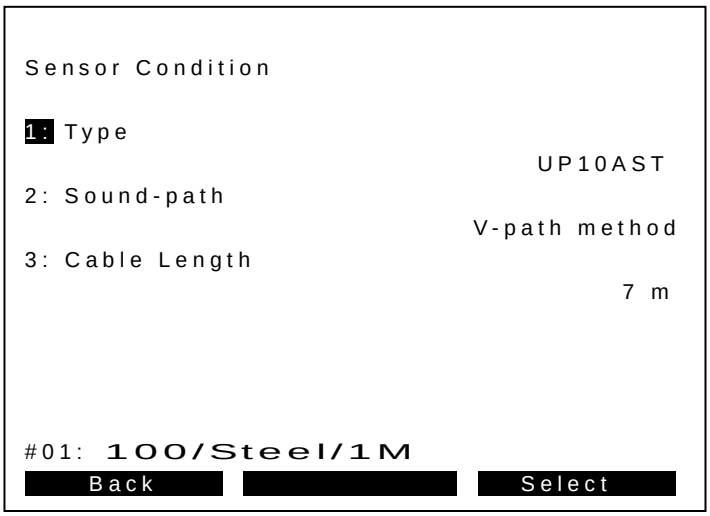


Fig. 2.2.4-5 Sensor condition menu

1. Type

Press Select key (F3 button) and select item using direction button.
Press Enter key (F3 button) to confirm the selected item.

Table 2.2.4-7 Transducer type

Transducer type	Recommended diameter	Fluid temperature
UP50AST	13A ~ 50A	-20 ~ 120 deg. C
UP10AST	65A ~ 500A (20A ~ 50A)	-20 ~ 120 deg. C
UP04AST	300A ~ 5000A	-20 ~ 80 deg. C
User Defined	none	none

Note: Do not select “User Defined” item.

2. Sound-path

Press Select key (F3 button) and select item using direction button.
Press Enter key (F3 button) to confirm the selected item.

Table 2.2.4-8 Selectable items of Sound-path

Sound-path
Z-path method (Fig. 2.2.4-6)
V-path method (Fig. 2.2.4-7)
W-path method (Fig. 2.2.4-8)

Note1: Please select Z-path method with UP10AST, when it is applied for smaller pipe diameter as less than DN50mm.
Note2: When it is applied exceeding DN3500mm pipe diameter with UP04AST, please select Z-path method.
Note3: Do not use W-path method with UP04AST.

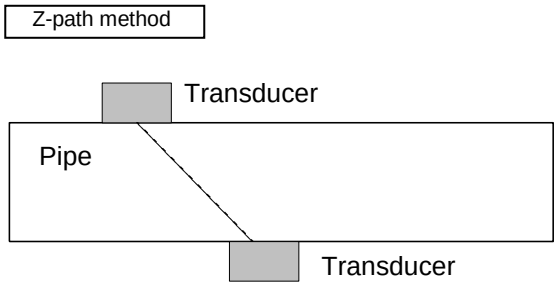


Fig. 2.2.4-6 Z-path method

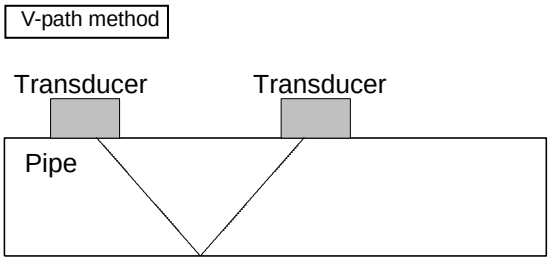


Fig. 2.2.4-7 V-path method

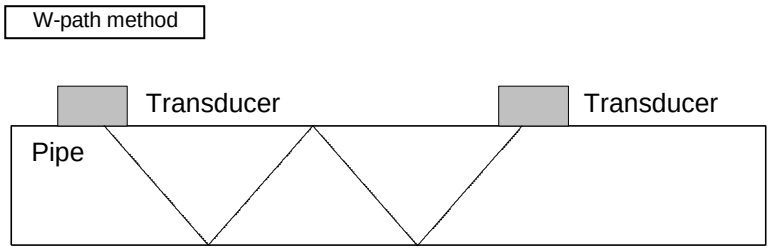


Fig. 2.2.4-8 W-path method

3. Cable length

Press Select key (F3 button) and select item using direction button.
Press Enter key (F3 button) to confirm the selected item.

Table 2.2.4-9 Selectable items of cable length

Selectable Items
7 m
7 + 50 m
7 + 100 m
7 + 150 m

(4) Fluid condition

Change fluid type, sound speed viscosity and so on.

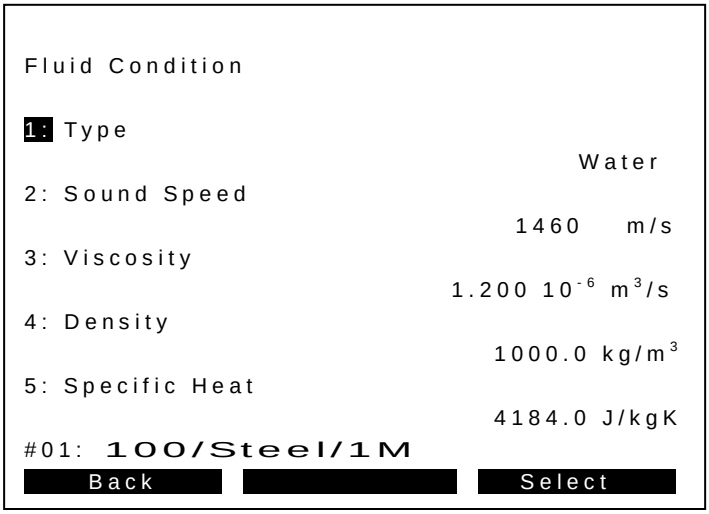


Fig. 2.2.4-9 Fluid condition menu

1. Type

Press Select key (F3 button) and select item using direction button.
Press Enter key (F3 button) to confirm the selected item.

Table 2.2.4-10 Fluid type

Fluid type	Sound speed [m/s]	Viscosity [x10^{-6}m^2/s]	Density [m^3/kg] (*1)	Specific heat [J/kgK] (*2)
Water	1460	1.20	1000.0	4184.0
Seawater	1510	1.00	1023.0	3930.0
Ethylene Glycol (50wt%)	1691	4.13	1066.0	3265.0
Glycerin	1923	1188.55	1261.3	580.0
Acetone	1190	0.407	790.5	516.0
User Defined	Input any value between 500 to 9000	Input any value between 0.01 to 9000	Input any value between 100 to 9000	Input any value between 0.0 to 999999.0

If you do not find fluid type, you can use “User Defined” item.

Note:
(*1) When meter type item is selected mass meter or energy meter, it have to input density.
(*2) When meter type item is selected energy meter, it have to input specific heat.

(5) Unit setting

Change flow unit, total unit and so on. When meter type is selected heat meter, it is shown “4:Flow Unit” in the menu.

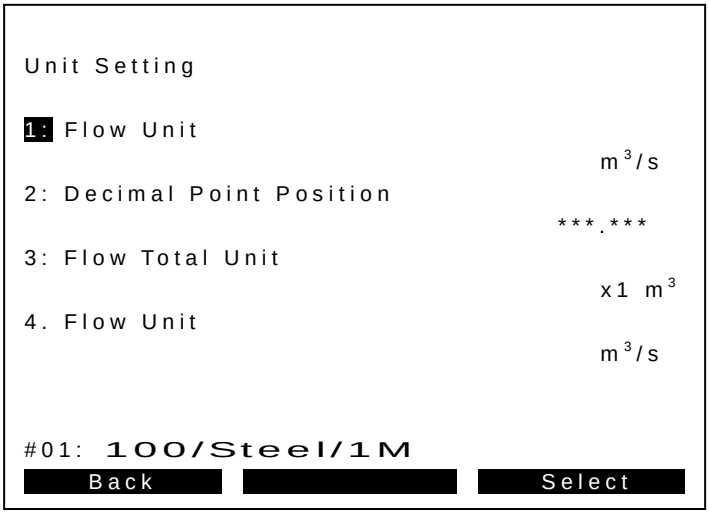


Fig. 2.2.4-10 Unit setting menu

1. Flow unit

Press Select key (F3 button) and select item using direction button.
Press Enter key (F3 button) to confirm the selected item.

Table 2.2.4-11 Flow / mass / energy unit

for Flowmeter			for Massmeter		for Heatmeter	
Metric	English		Metric	English	Metric	English
m^3/s	ft^3/s	gal/s	kg/s		W	BTU/h
m^3/min	ft^3/min	gal/min	kg/min		kW	kBTU/h
m^3/h	ft^3/h	gal/h	kg/h		MW	MBTU/h
m^3/D	ft^3/D	gal/D	kg/D			
km^3/s	Mft^3/D	Mgal/D	t/s			
km^3/min	bbl/s	acf/s	t/min			
km^3/h	bbl/min	acf/min	t/h			
km^3/D	bbl/h	acf/h	t/D			
Mm^3/D	bbl/D	acf/D	kt/s			
L/s	Mbbl/D	Macf/D	kt/min			
L/min			kt/h			
L/h			kt/D			
L/D			Mt/D			

2. Decimal point position

Change decimal point position.
Press Select key (F3 button) and select item using direction button.
Press Enter key (F3 button) to confirm the selected item.

Table 2.2.4-12 Selectable items of decimal point position

Selectable items	Example
*.*****	1.23456
.**	12.3456
.	123.456
****.**	1234.56
*****.*	12345.6
*******	1234567

3. Totalizing unit

Change flow total unit.
Press Select key (F3 button) and select item using direction button.
Press Enter key (F3 button) to confirm the selected item.

Table 2.2.4-13 Total unit

For Flowmeter	
Metric	English
x1 m^3	ft^3
x5 m^3	kft^3
x10 m^3	Mft^3
x100 m^3	bbl
x0.01 L	kbbl
x0.1 L	Mbbl
x1 L	gal
x10 L	kgal
x100 L	Mgal
	acf
	kacf
	Macf

For Massmeter	
Metric	English
x1 kg	
x10 kg	
x100 kg	
x0.1 kg	
x0.01 kg	
x1 t	
x10 t	
x100 t	

For Heatmeter	
Metric	English
J	BTU
MJ	MBTU

4. Flow unit (selected heatmeter)

When meter type is selected heat meter, it is changed flow unit. Selectable items of flow unit are shown Table 2.2.4-11.

(6) Volume correction

Change zero shift, span correction and so on.

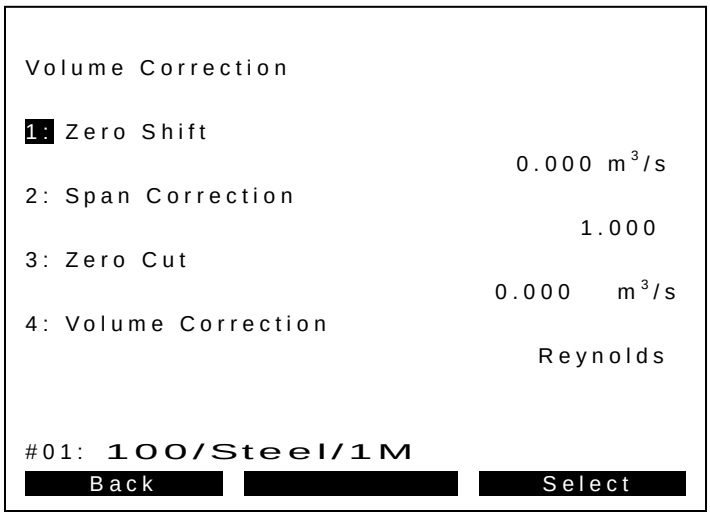


Fig. 2.2.4-11 Volume correction menu

1. Zero shift

Change zero shift value. Unit is defined by flow/mass/energy unit.

Table 2.2.4-15 Range of zero shift

Default	min.	max.
0.000	-99999.0	999999.0

2. Span correction

Change span correction value.

Table 2.2.4-16 Range of span correction

Default	min.	max.
1.000	0.000	20.000

The correction value is calculated below equation,

$$q = a \times v + b$$

where, "***q***" is correction value, "***a***" is span correction, "***v***" is without correction value and "***b***" is zero shift.

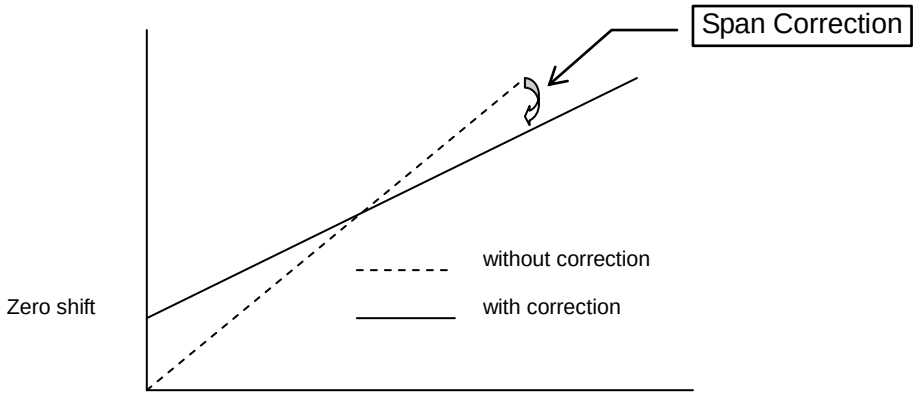


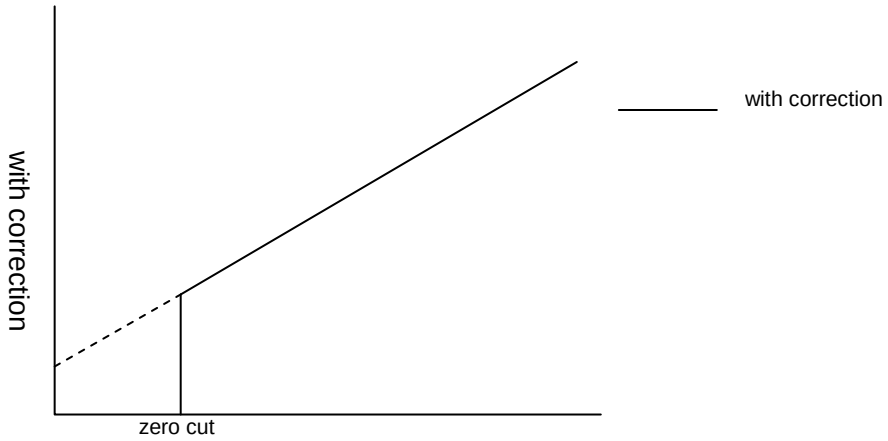
Fig. 2.2.4-12 Zero shift & span correction

3. Zero cut

Change zero cut value. Unit is defined by flow/mass/energy unit.

Table 2.2.4-17 Range of zero cut

Default	min.	max.
0.000	0.000	9999999.0



without correction

Fig. 2.2.4-13 Zero cut

4. Volume correction

Change volume correction methods.

Table 2.2.4-18 Volume correction

Selectable items
Reynolds
None

Note: Usually it is selected Reynolds method.

2.2.5 Logging setting

The setting procedure of Logging function is as Fig.2.2.5-1.

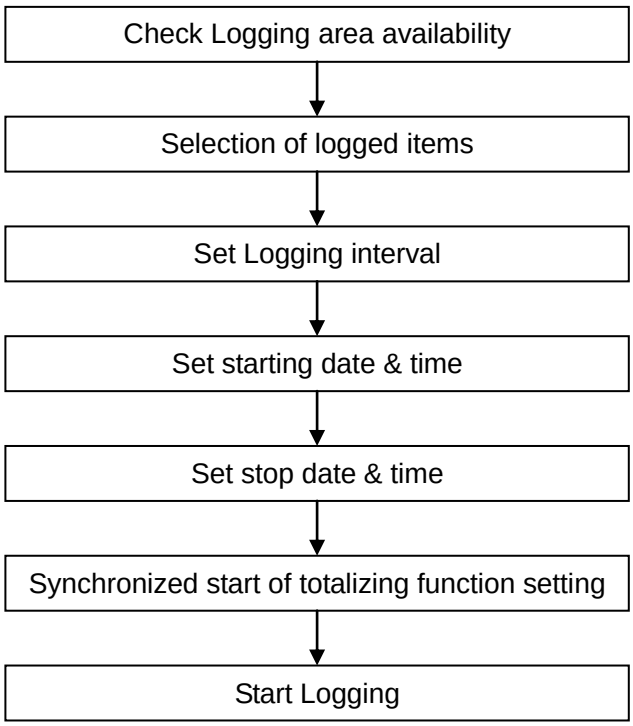


Fig. 2.2.5-1 Flow of logging setting

(1) Logging area

The logging file can be made up to 20 files. When logging area is used 100% even less than 20 files, any additional files will not be made, also warning icon "[illegible]" will be indicated on the upper side of LCD. In such case, enough files must be deleted for free area before Logging setting. When logging area become 100% during logging, logging function will be stopped. Even if logging function is stopped, the logging data until it stops will be stored correctly.

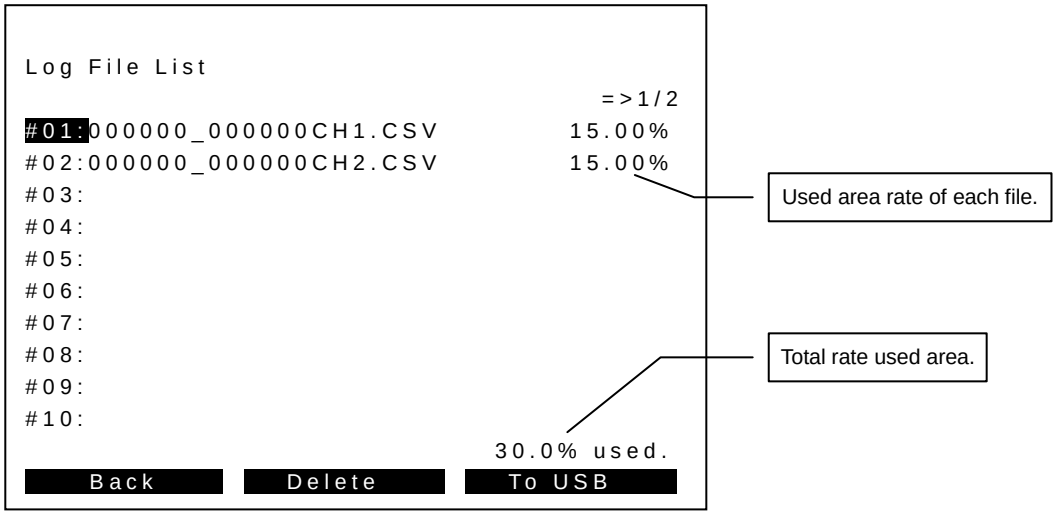
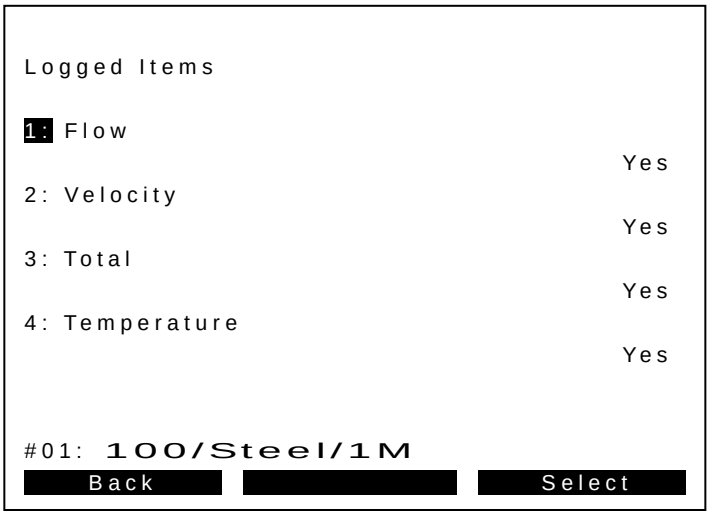


Fig. 2.2.5-2 Log file list menu

Note: For 2-channel measurement, 2 log files will be required at once.
When total files over 19, Logging function for 2-channel is not available.

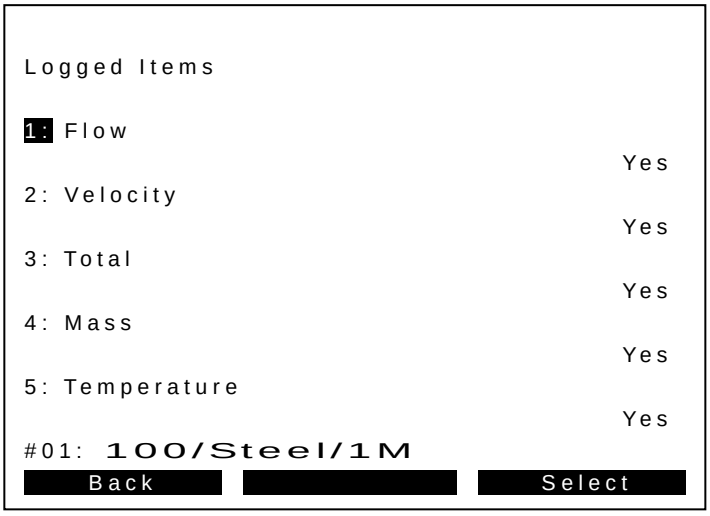
(2) Logged items

Select logged items to save logging files.



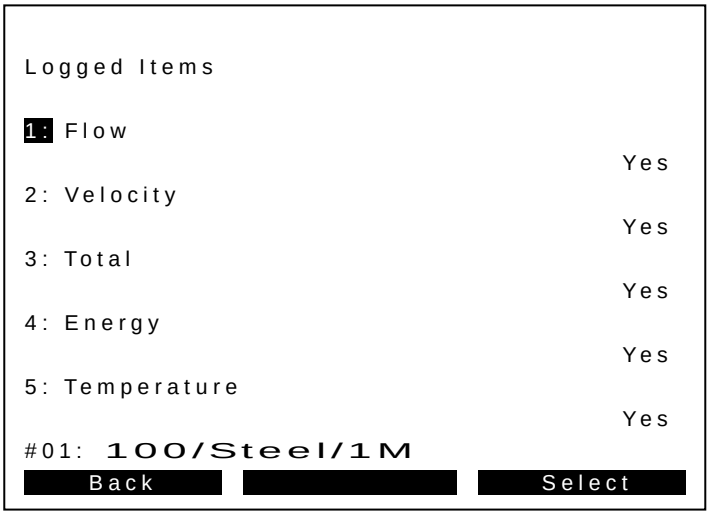
Logged Items (flowmeter)
1) Volumetric flowrate
2) Velocity
3) Totalizing value
4) Temperature

Fig. 2.2.5-3 Logged items menu (selected flowmeter)



Logged Items (massmeter)
1) Volumetric flowrate
2) Velocity
3) Totalizing value
4) Mass flow rate
5) Temperature

Fig. 2.2.5-4 Logged items menu (selected massmeter)



Logged Items (heatmeter)
1) Volumetric flowrate
2) Velocity
3) Totalizing value
4) Energy flow rate
5) Temperature

Fig. 2.2.5-5 Logged items (selected heatmeter)

(3) Set log interval

Minimum logging interval is every 5sec. Maximum is every 99h59min59sec.

Table 2.2.5-1 Range of interval

Default	min.	max.
00:00:30	00:00:05	99:59:59

(4) Set logging time

Set start date & time and stop date & time for Logging. After both schedule set as correctly, "LOG" icon will appear on the upper side of LCD.

Note1: Max. available Logging schedule will be informed before set Stop date & time. Please set shorter schedule than informed one. Please be aware that this is only a rough guide.
Note2: By inputting "99-99-99" at Stop date section, it can be logged max. time.

(5) Sync. totalizing

Synchronized totalizing and logging. This item is set "**Yes**", Logging and totalizing at the same time.

(6) Start logging

After all setting done, back to measuring mode as Fig.2.2.5-4.
When scheduled time comes, Logging will start with blinking "LOG" icon.
In case of set sync. totalization as "**Yes**", totalizing will start at the same time.

Note: Logging will not start until back to measuring display.
Please wait on the measuring display until Logging starting.

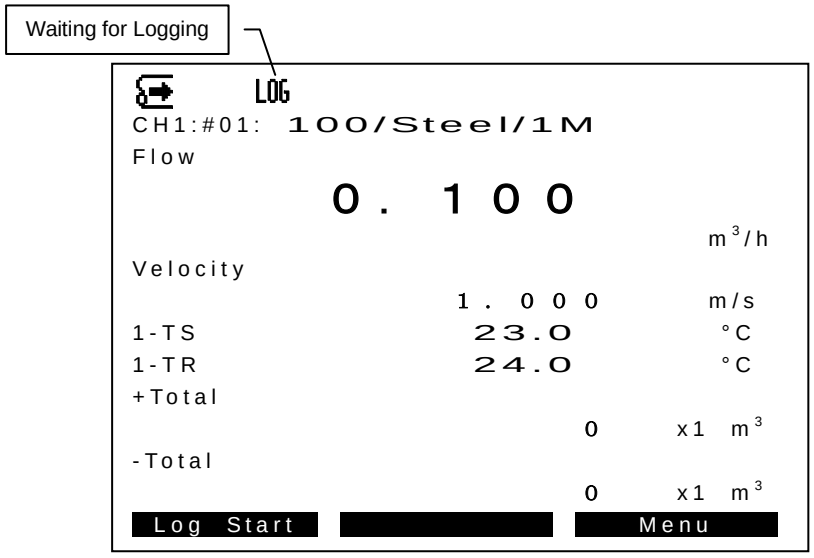


Fig. 2.2.5-6 Waiting for Logging

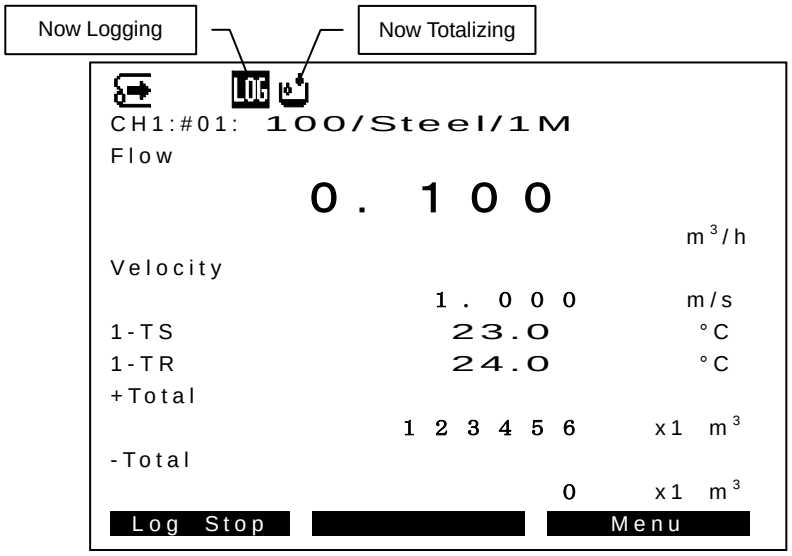


Fig. 2.2.5-7 Logging & Totalizing Start

(7) Stop logging function

To stop the logging, push Log Stop key (F1 button). In case of set sync. totalization as "**Yes**" , totalizing function will stop at the same time.

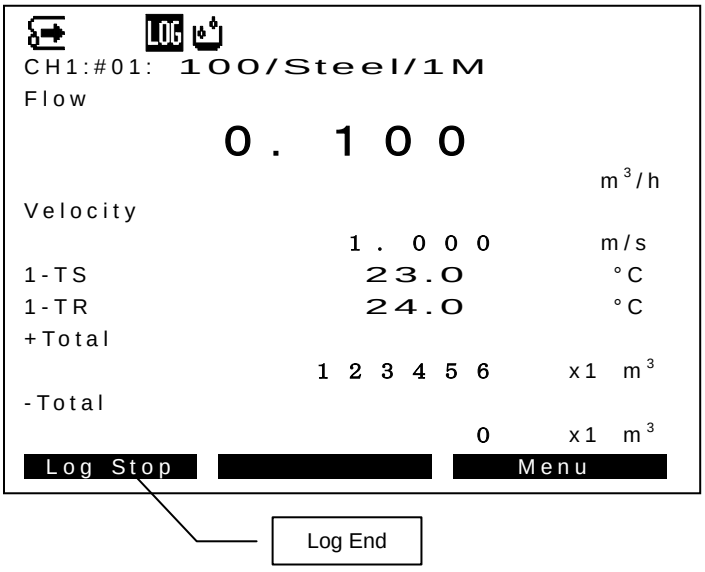


Fig. 2.2.5-8 Stop at measuring display

(8) Log file list

The logging filename is defined automatically.

YYMMDD_HHMMSSCH No.csv where, “YYMMDD” is start date and “HHMMSS” is start time and “CH No.” is channel number.

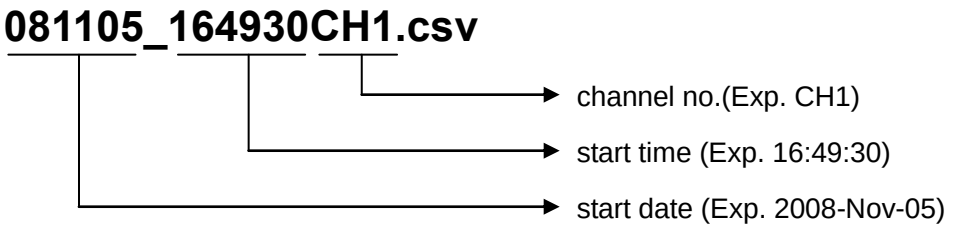


Fig. 2.2.5-9 Logging filename

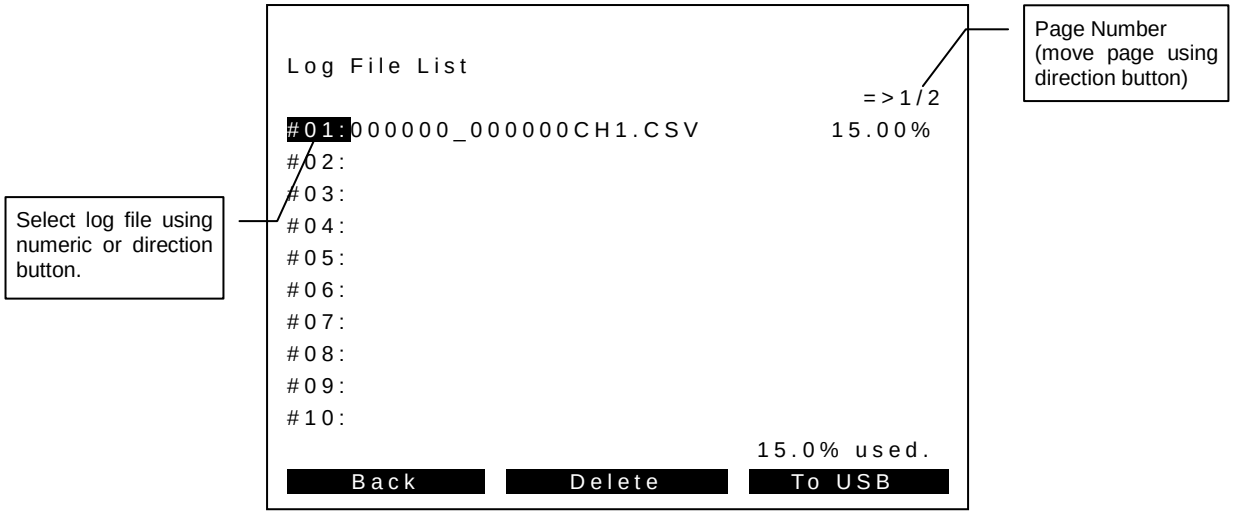


Fig. 2.2.5-10 Log file list menu

1. Delete logging file

Pushing Delete key (F2 button) will make logging files deleted.

2. Copy logging file to USB memory

Pushing To USB key (F3 button) will make logging file copied to USB memory.

Pushing left and right direction button will change page number.

When insert USB memory, “USB” icon will be indicated on the LCD. Until main unit recognize USB memory with “USB” icon, copy menu will not be shown up and copy function can not be done also accordingly. Log file will be transferred to directory named “LOGYYMMDD_DIR” which is made at the same time of transfer in the USB memory. The logged file cannot be transferred during logging function activated.

If the same file name has existed already in inserted USB memory, the file name will be changed into “YYMMDD_HHMMSSCHx_counting Number.” like “20080704_1335CH1_1” by adding “_1”. This suffix number will count up by every time of copying.

Table 2.2.5-2 Logging folder

Date Format	Folder	Exp.(2008-Jan.-31)
YY-MM-DD	LOGYYMMDD_DIR	LOG080131_DIR
MM-DD-YY	LOGMMDDYY_DIR	LOG013108_DIR
DD-MM-YY	LOGDDMMYY_DIR	LOG310108_DIR

3. Logging file

Sample of logging file is shown below.

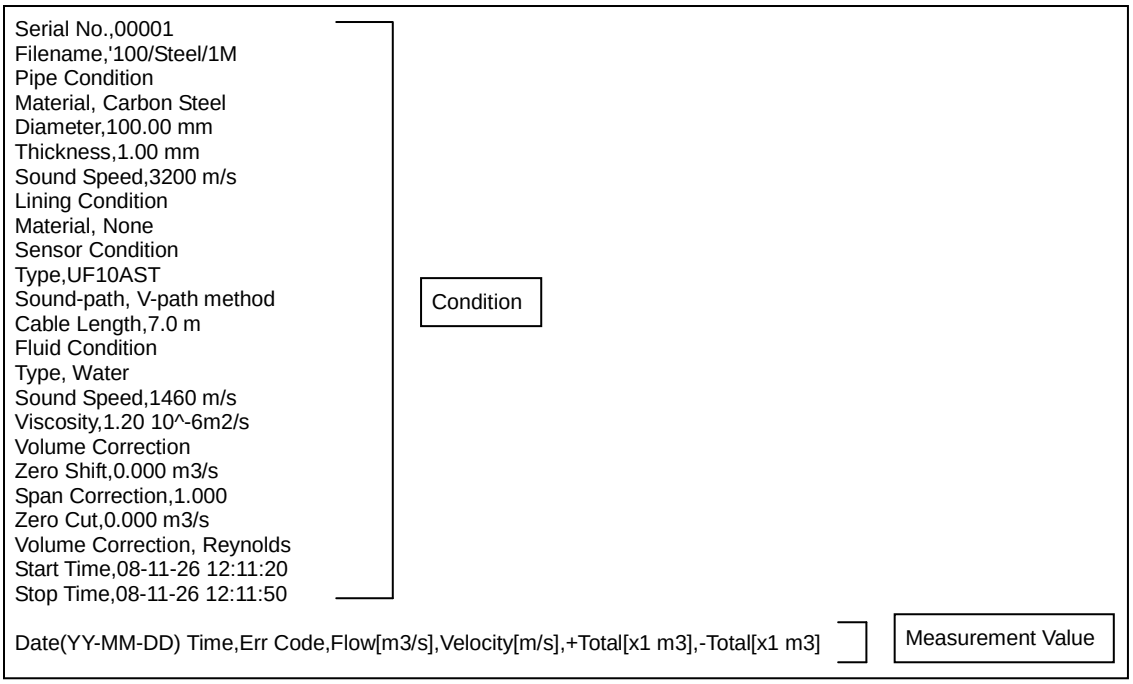


Fig. 2.2.5-11 Logging file

Table 2.2.5-3 Warning List

Mark (Err. Code)	Remarks
R	No receiving echo warning
D	Detection of disturbance
Ts (for heatmeter)	No temperature input (supply side)
Tr (for heatmeter)	No temperature input (return side)
E	Parameter setting failure

2.2.6. Parameter & Echo-Form Viewer

(1) Parameter check list

Check the input parameters.

a) Flow/mass/heat unit, flow/mass/heat total unit and decimal point position.
b) Pipe diameter (circumference), thickness, material and sound speed
c) Lining thickness, lining material and sound speed
d) Transducer type, Sound-Path and cable length
e) Fluid type, sound speed, viscosity, density and specific heat
f) Output source, 4mA setting, 20mA setting and alarm output type
g) Zero shift, span correction, zero cut and volume correction
h) Log interval, start & stop time and synchronizing totalizing select
i) Logged items
j) CT0, C0 (Real) and CT0 (Design)

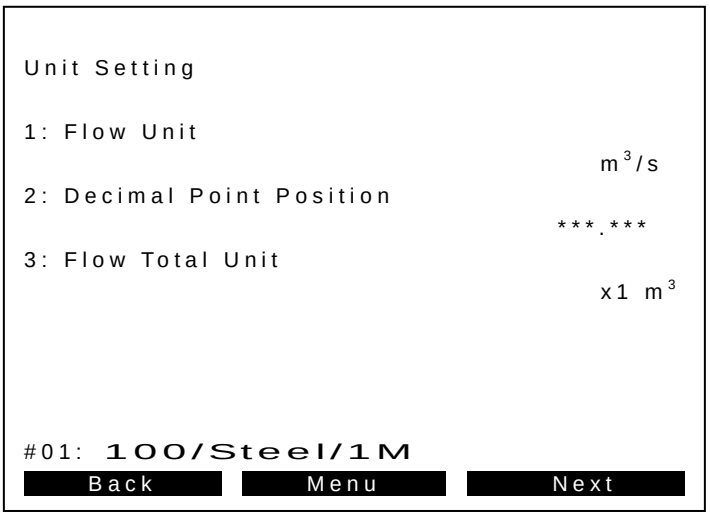


Fig. 2.2.6-1 Check Item menu

Table 2.2.6-1 Key operation

Operation	Remarks
Back (F1 button)	Back to pre. page
Menu (F2 button)	Back to main menu
Next (F3 button)	Go to next page

When Meas. Setting item is selected 1path/2pipe, the meter has two parameters. Press Change CH NO key (F2 button), you can check another channel parameters. Selected channel is displayed reversal as Fig. 2.2.6-2 (selected CH1).

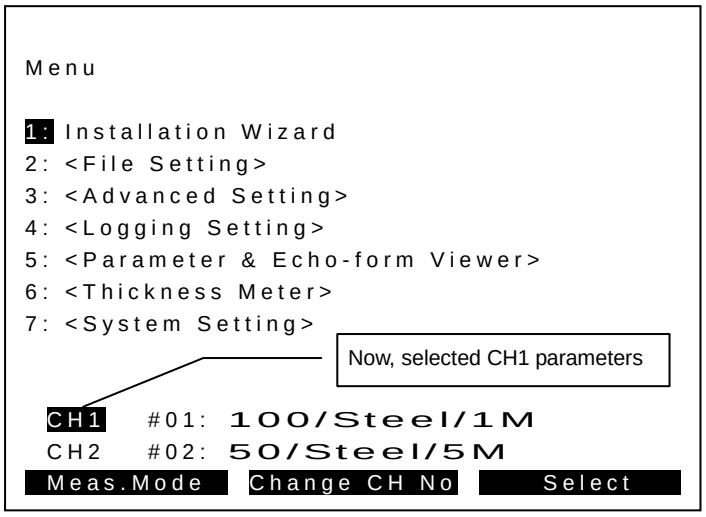
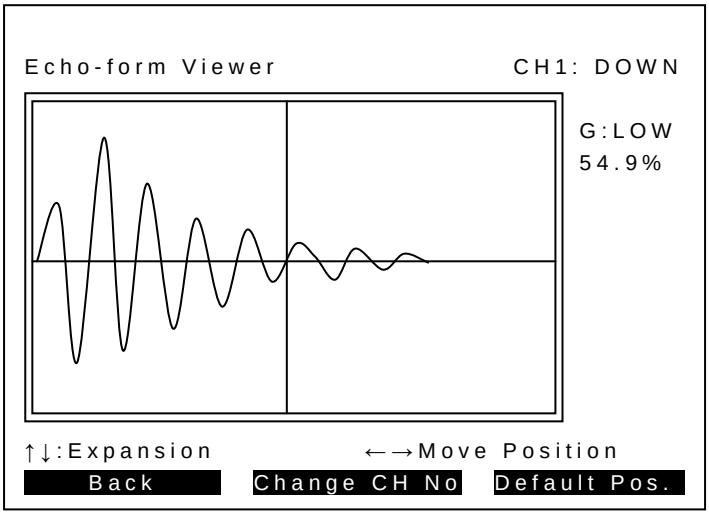


Fig. 2.2.6-2 Selected CH1 parameters

(2) Echo-waveform Viewer

You can see actual receiving echo-form here. Fig. 2.6-3 shows example of echo-waveform.



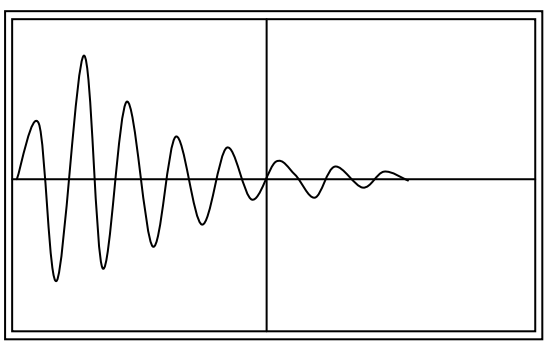
As left example, "G:LOW 54.9%" means sensitivity of receiving ultrasonic echo as amplified 54.9% by low gain mode.
UFP-20 has 2 modes for amplification of high and low. Normally gain mode runs by low mode. When receiving echo will be weaker, it will turn to high mode to get enough signal strength.
In case of "G:LOW ≧80.0%"(=Low gain mode ≧80%) or "G:HIGH **.*%" (=High gain mode), signal strength of receiving echo might not be enough for stable measurement. Please refer to the chapter 3.6.2 Measurement.
This classification might not cover all cases.

Fig. 2.6-3 Example of echo-waveform

Up and down direction buttons can expand horizontal axis from the center of display which is cross point at horizontal and vertical line. When you expand the echo wave by up direction button, the wave goes left side.
You may need to move the wave position to right side by right direction button.

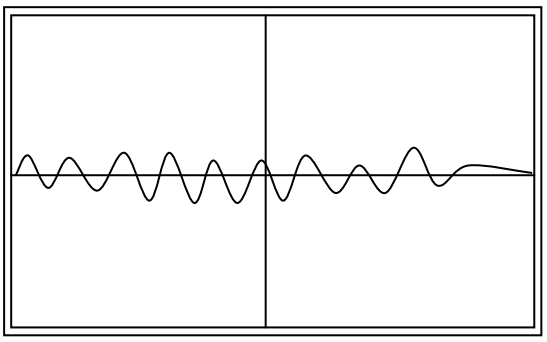
Table 2.2.6-2 Key operation

Operation	Remarks
Up direction button	Expand waveform
Down direction button	Back to main menu
Right direction button	Move to right side
Left direction button	Move to left side
Change CH No (F2) key	Change waveform (upstream/downstream/CH1/CH2)
Default Pos. (F3) key	Move to default position and waveform



(1)Good waveform

Typical “Good” waveform.
You can expect accurate flow measurement.



(2)Bad waveform

Typical “Bad” waveform.
It can not be expected accurate measurement or No-echo-wave is received.

Fig. 2.6-4 Examples of echo-waveform

2.2.7 Thickness meter

Be sure to calibrate before measuring thickness.
Sensor should be connected to SENSOR 1 (DN1/UP1) port of transducer's port.

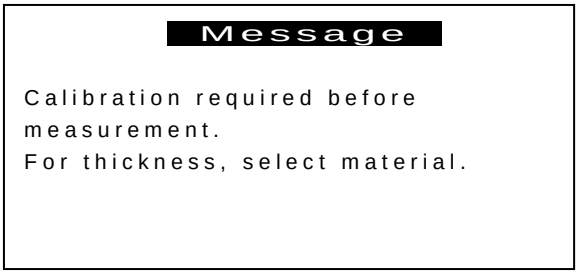


Fig. 2.2.7-1 Message of calibration

The time required for sound waves to propagate a thickness is measured and multiplied by the sound speed (longitudinal wave) as shown blow:

thickness = sound speed (longitudinal wave) x round-trip propagation / 2

Accordingly, if the input sound speed (longitudinal wave) is incorrect, the thickness measurement will not be correct even if the propagation time is measured correctly.
The sound speed varies according to the temperature, even with the same material. Therefore, it is important to input the sound speed at the measurement temperature.

Note: Similarly, the test piece temperature must be 20 degree C during calibration.
Calibration at higher temperatures reduces the precision of the thickness measurement.

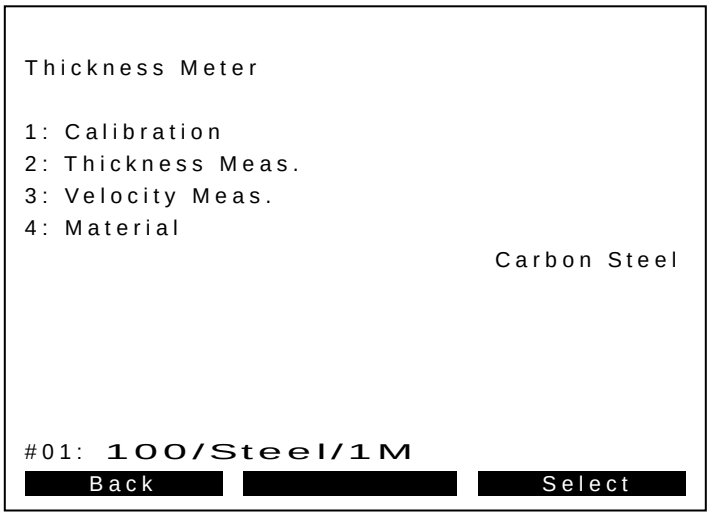


Fig. 2.2.7-2 Thickness meter menu

Before starting thickness measurement, please select Material which is the target pipe material.

(1) Calibration

Calibration of thickness meter.

Required equipment for calibration is as follows:

1) Main unit
2) Thickness / Sound speed transducer: TH5010L
3) Test piece
4) Acoustic coupling medium

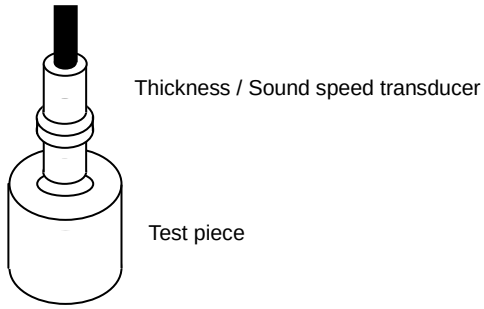


Fig. 2.2.7-3 Calibration

As above drawing, put thickness probe onto test piece with enough acoustic couplant.
Then enter calibration mode.
You will see following message, if calibration successes. Otherwise in case of “NG”, please try again by same procedure.

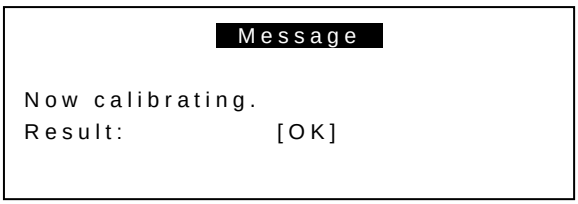


Fig. 2.2.7-4 Message of calibration succeeded

(2) Thickness measurement

Before starting thickness measurement, please select Material which is the target pipe material. Measures pipe thickness by attached transducer onto the target material.

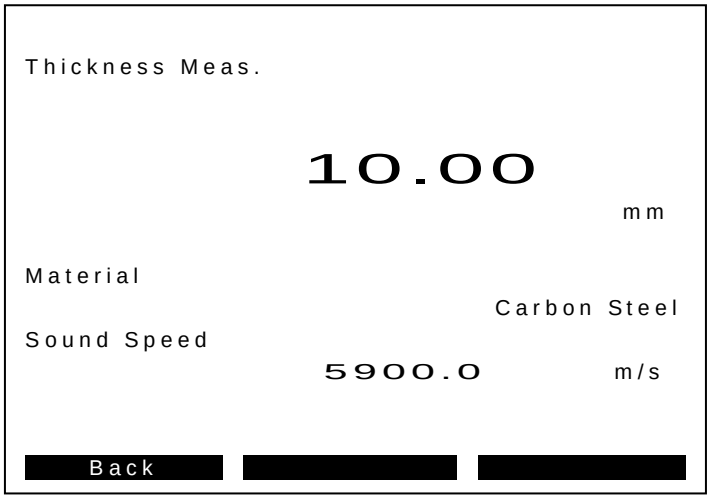


Fig. 2.2.7-5 Thickness measurement mode

(3) Velocity measurement

Required equipment for calibration is as follows:

1) Main unit
2) Thickness / Sound speed transducer: TH5010L
3) Test piece
4) Same fluid

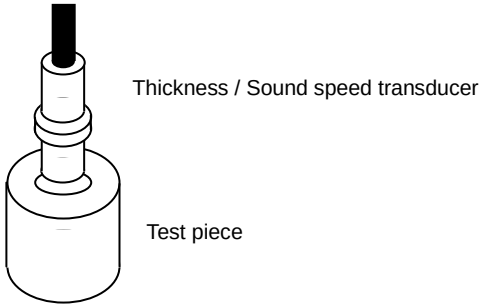


Fig. 2.2.7-6 Apparatus of velocity measurement

Note: Put target fluid into test piece cup, and then put transducer onto fluid surface. Please be noted that any air layer must be avoided between transducer and liquid surface.

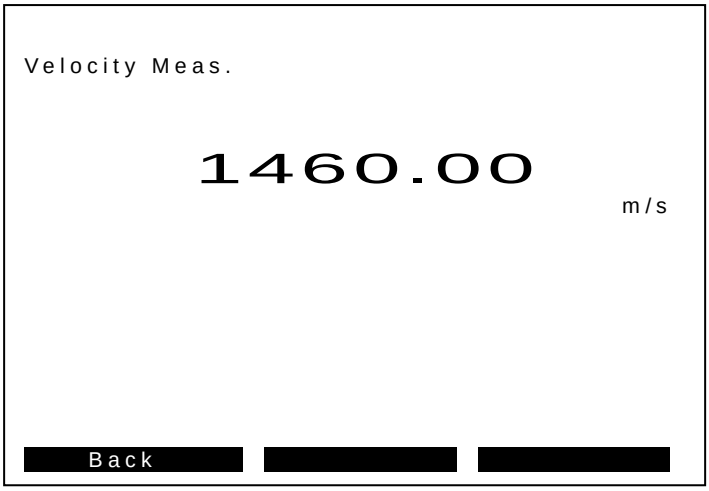


Fig. 2.2.7-7 Velocity measurement mode

(4) Material selection

Please select a material, which is the target pipe material.

Table 2.2.7-1 Selectable materials

Selectable materials	Sound speed [m/s]
Carbon Steel	5900
Ductile Iron	5800
Cast-iron	4500
Copper	5010
Stainless Steel	5730
PVC (Poly Vinyl Chloride)	2280
FRP	2560
Acrylic	2720
User Defined	Input any value between 500 to 9000

If you would like to another parameter, you can use “User Defined” item and input any value.

2.2.8 System setting

On this directory, you can set time, meter selection or system conditions.
Select by direction or numeric button, then push Select key (F3 button) to enter.

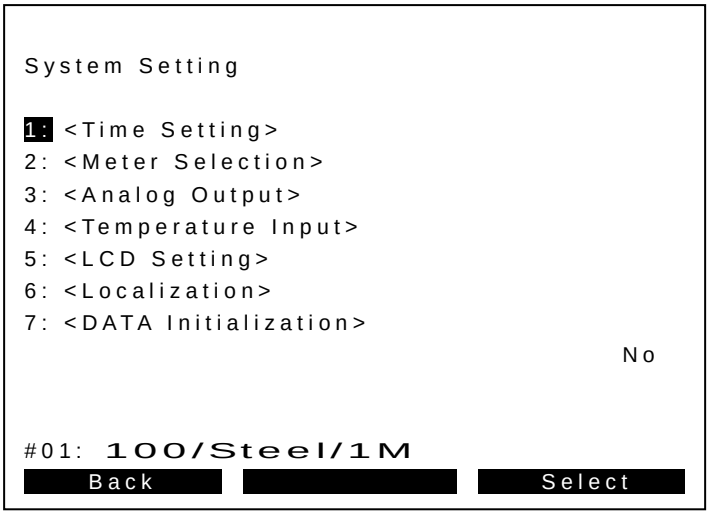


Fig. 2.2.8-1 System setting menu

(1) Time setting

You can set Date, Time and Date format.

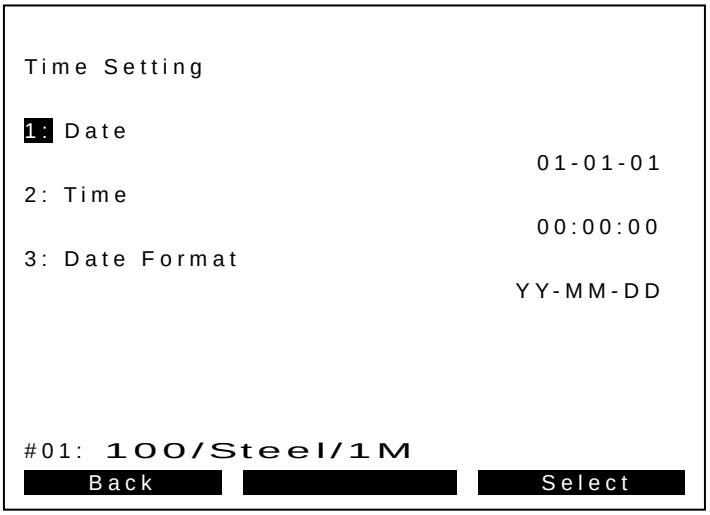


Fig. 2.2.8-2 Time setting menu

1. Date

Select by direction or numeric button "1: Date", then push Select key (F3 button) to enter.
You will see factory setting date, please update in accordance with your local area.
Default date format is YY-MM-DD.

2. Time

Select by direction or numeric button "2: Time", then push Select key (F3 button) to enter.
You will see factory setting time, please update in accordance with your local area.

3. Date format

You can change format from following listed pattern.

Table 2.2.8-1 Date format items

Selectable item	Order
YY-MM-DD	Year - Month - Day
MM-DD-YY	Month - Day - Year
DD-MM-YY	Day - Month - Year

When you change this item, order of logging data and logging folder also will be changed accordingly.

(2) Meter selection

You can set averaging time, meter type, measurement setting (number of path or channel) or calculation form.

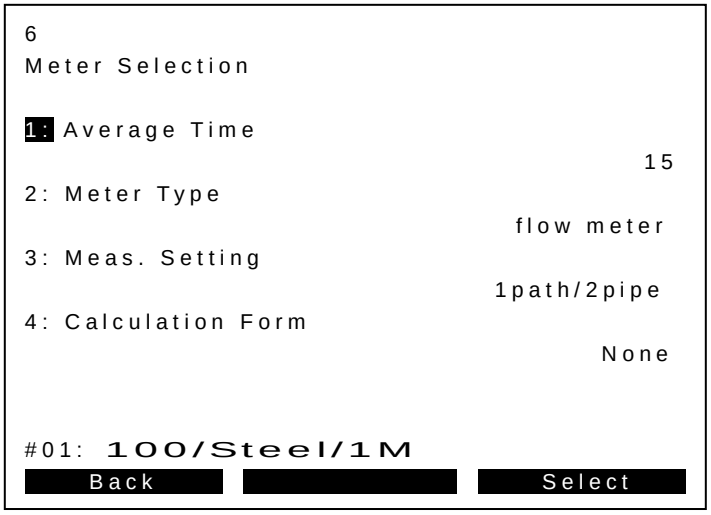


Fig. 2.2.8-3 Meter selection menu

1. Average times

Moving averaging time by measurement time.

Table 2.2.8-2 Range of average time

Default	min. [times]	max. [times]
15	1	120

2. Meter type

You can select which type of meter you intend to use from following options.
Select by direction or numeric button, then push Enter key (F3 button) to define.

Table 2.2.8-3 Selectable items for meter type

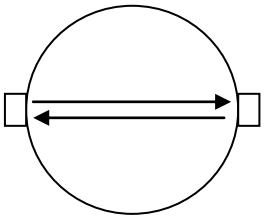
Selectable meter type
flow meter
mass meter
heat meter

3. Meas. setting

You can select which type of measurement way from following options.

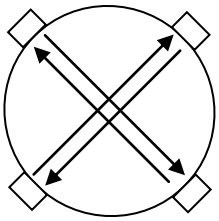
Table 2.2.8-4 Selectable items for meas. setting

Selectable type	Remarks
1path / 1pipe	By 1 pair of transducers for 1 pipe
2path / 1pipe	By 2 pair of transducers for 1 pipe
1path / 2pipe	By 2 pair of transducers for 2 pipe



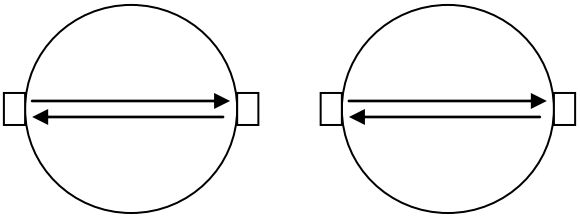
1path/1pipe

Fig. 2.2.8-4 Exp. 1path / 1pipe



2path/1pipe

Fig. 2.2.8-5 Exp. 2path / 1pipe



1path/2pipe

Fig. 2.2.8-6 Exp. 1path / 2pipe

4. Calculation form (selected 1path / 2pipe)

You can select calculation form between CH1 and CH2.

Table 2.2.8-5 Selectable items for calculation form

Selectable type	Remarks
None	None
CH1 + CH2	Indicate calculated value CH1 measured value plus CH2 measured value
CH1 - CH2	Indicate calculated value CH1 measured value minus CH2 measured value

(3) Analog output

Here you can set parameters related analog output.

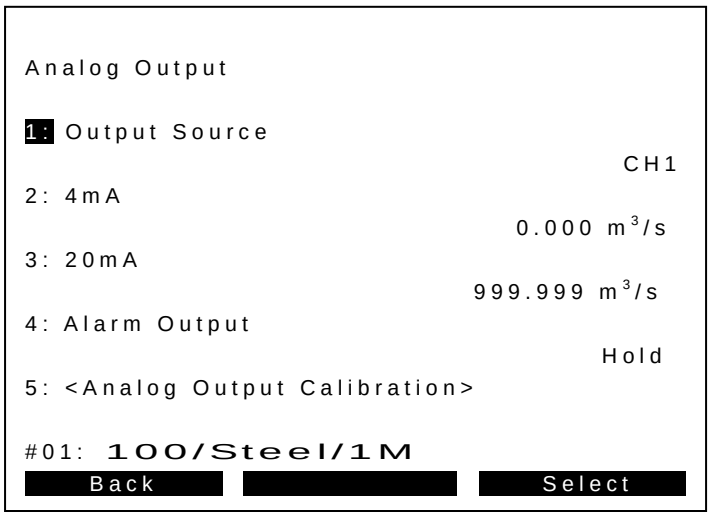


Fig. 2.2.8-7 Analog output menu

1. Output source selection

Select output channel. Default is None. You can select CH2 in case of 2-channel measurement mode.

Table 2.2.8-6 Selectable items for output source

Meas. Setting	Selectable output channel
1path / 1pipe	None
	CH1
2path / 1pipe	None
	CH1
1path / 2pipe	None
	CH1
	CH2

2. 4 mA

Set value equivalent to 4 mA with unit, which is the same as flow/mass/energy unit.

Table 2.2.8-7 Range of 4mA output

Default	min.	max.
0	-99999.0	999999.0

3. 20 mA

Set value equivalent to 20 mA with unit, which is the same as flow/mass/energy unit.

Table 2.2.8-8 Range of 20mA output

Default	min.	max.
0	-99999.0	999999.0

4. Alarm output

Following setting can be selected in case of alarming (R / D warning).

Table 2.2.8-9 Selectable items for alarm output

Alarm output	Remarks
Hold	Hold measured value
4 mA	Keep output 4mA
20 mA	Keep output 20mA

5. Analog output calibration

Here you can calibrate analog output on loop.

[Required item] Calibrated ampere meter

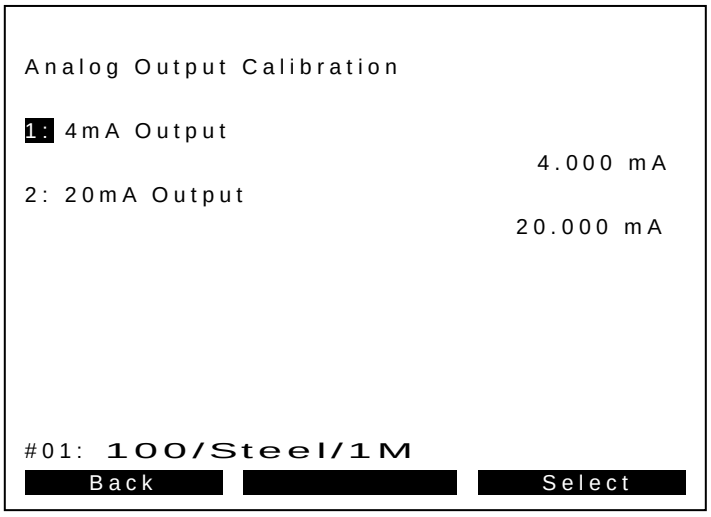


Fig. 2.2.8-8 Analog output calibration menu

a. Calibration on 4mA

When push Select key (F3 button), the main unit output 4mA on a mandatory basis.
Input indicated mA value on the ampere meter.

b. Calibration on 20mA

When push Select key (F3 button), the main unit output 20mA on a mandatory basis.
Input indicated mA value on the ampere meter.

(4) Temperature input

Here you can set compensation factor for temperature sensor.

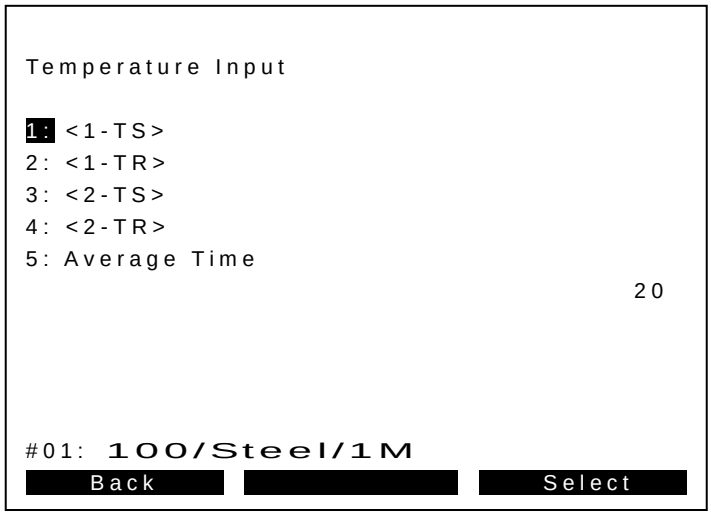


Fig. 2.2.8-9 Temperature input menu

1. Temperature sensor correction

After selecting each temperature sensor name connected to proper connector on temperature junction box, you can set zero shift and span correction of each temperature sensor.

2. Temperature sensor average time

You can select average time for temperature measurement.

Table 2.2.8-10 Range of average time

Default	min.	max.
20	1	120

(5) LCD setting

Here you can LCD system setting.

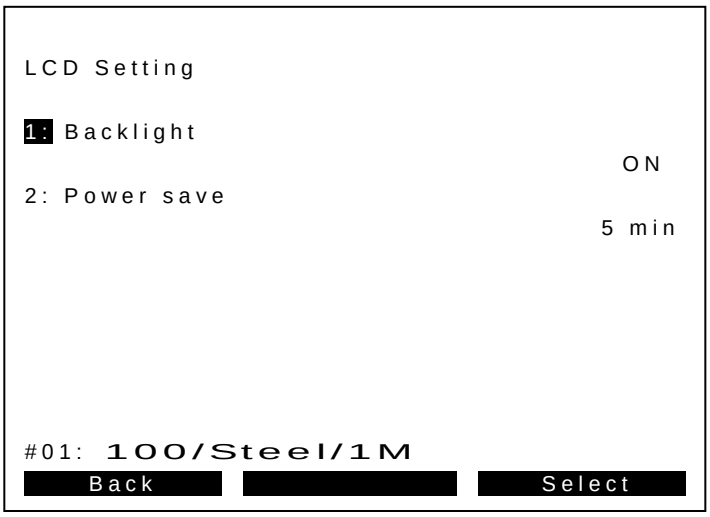


Fig. 2.2.8-10 LCD setting menu

1. Backlight setting

Select backlight ON or OFF. Default is ON. In spite of any settings of power save, backlight will be turn off automatically after 1 min from no any keys input. But whenever input any keys, backlight will be recover to turn on.

To save battery life, please turn off backlight here.

2. Power save setting

After setting time passed without any keys input, LCD power will be off automatically.

You can set time until LCD turned off.

Table 2.2.8-11 Selectable items for power save

Selectable items
OFF
5 min
10 min
30 min
1 hour

(6) Localization

You can select unit system and language.

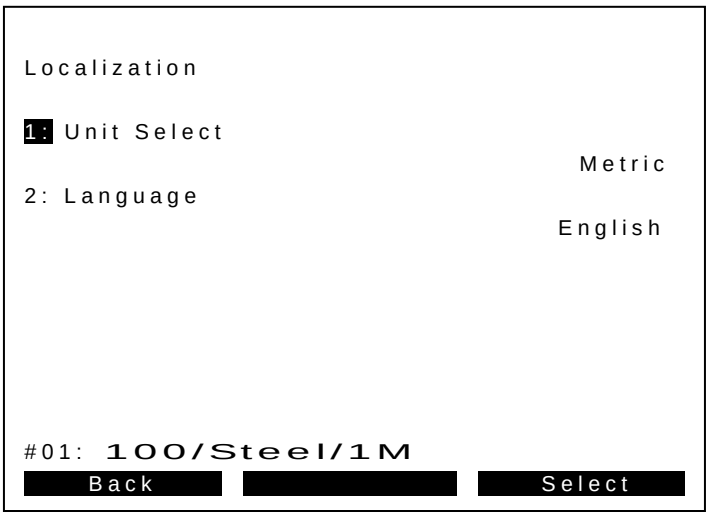


Fig. 2.2.8-11 Localization menu

1. Unit selection

Selectable unit system is as follows.

Table 2.2.8-12 Selectable item of system unit

Selectable Items
Metric
English

2. Language selection

Selectable language is as follows.

Table 2.2.8-13 Selectable item of language

Selectable Items
English
Japanese
Italian
Russian
French
German
Portuguese
Turkish
Spanish

(7) DATA initialization

You can initialize all site data here.

Date, time, localization mode or Logging data will be retained even after initialization.

2.2.9 File setting

Here you can store defined parameters or load stored parameters. Up to 10 files can be stored.

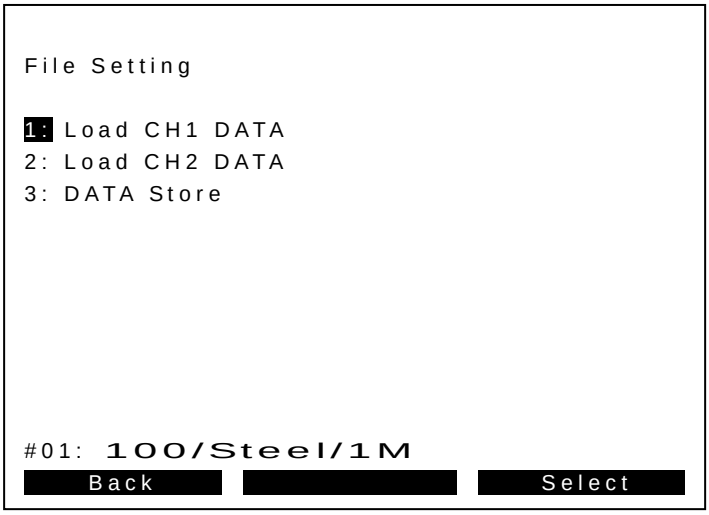


Fig. 2.2.9-1 File setting menu

(1) Load DATA

You can load input parameters. Select the file by arrow key, push Enter key (F3 button) to load parameters.

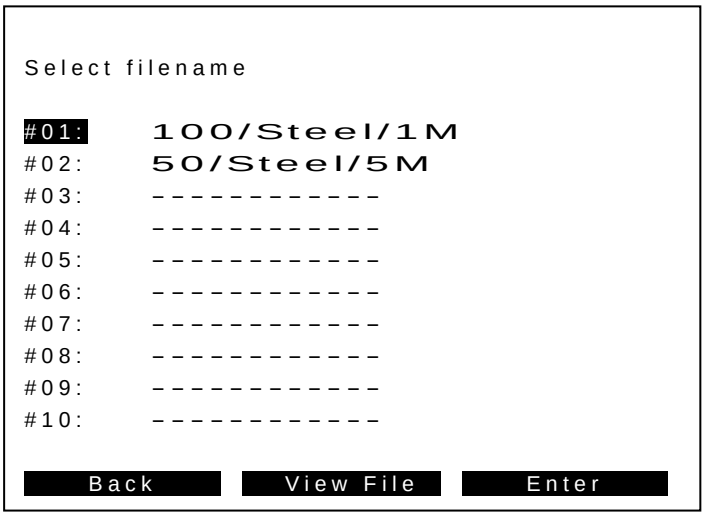


Fig. 2.2.9-2 File selection menu

By View File key (F2 button), you can review input parameters before up loading.
Indication sample is as Fig. 2.2.9-3. After checking view file menu, you can load input parameters.

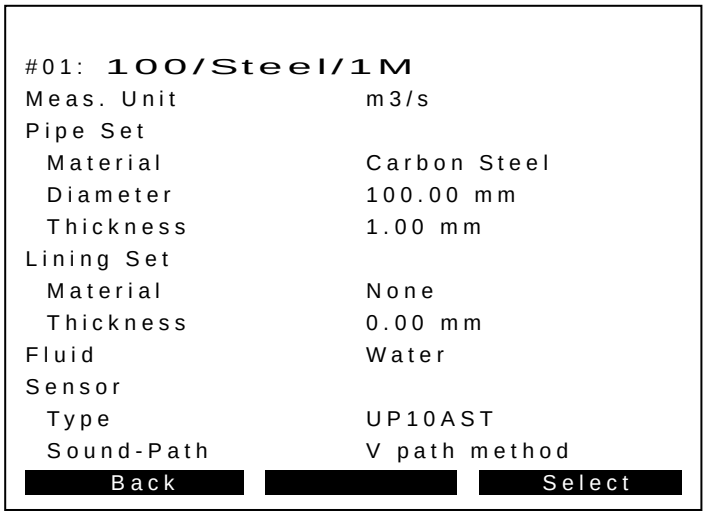


Fig. 2.2.9-3 View file menu

(2) Store DATA

You can store parameters. Please select empty area shown as "----------". For input may of filename definition, please refer to 1.2.6 (2) 3 File name input (p.1-31).

(3) Delete DATA

Here you can delete parameter file.

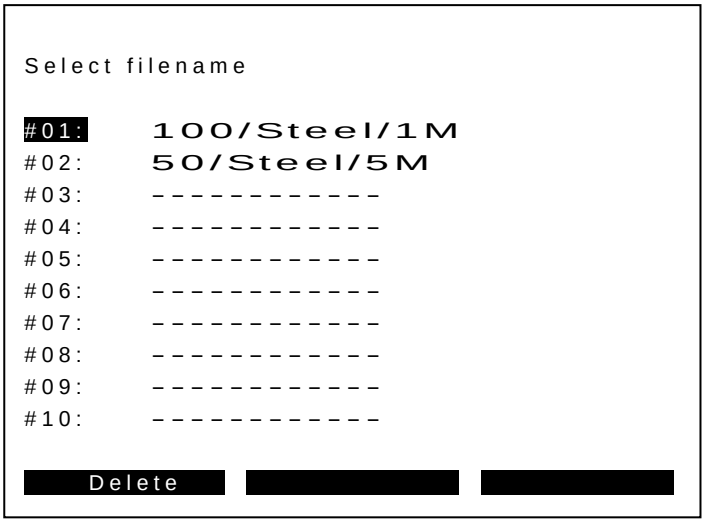


Fig. 2.2.9-4 Delete file

To delete file, push [SHFT] button then Delete key (F1 button). When you can delete the file, the file is never recovered.

2.2.10 Firmware Updating

Caution

Please confirm following notices prior to update firmware of main unit.

1. Firmware updating must be done under self-responsibility. We can offer update in our factory onerously, if you demand. In such case, please contact with your nearest dealership.
2. It could be possible to turn to be malfunctioned, updating failure or stop process due to power loss or mis-operations. The caution is demanded for firmware updating by user.
3. Factory reset will be required when firmware updating fails.

UFP-20 has capability to update its firmware through USB memory. It could be possible to keep the latest version of function by updating firmware. Please contact with the nearest dealership if you intend to update your UFP-20's firmware. The detail procedure will be provided with the latest firmware at that time.

3. Other

Chapter 3

INDEX

3.1 Maintenance and Inspections

Preventative maintenance and periodic inspection is important to ensure long life and proper functioning of the ultrasonic flowmeter.

3.1.1 Transducer and Main unit maintenance and inspection

Although maintenance of transducers or main unit is generally not required, be aware of the following items.

(1) Cleaning

Do not use any chemical liquids like thinner to clean up flowmeter systems. Please use dry-soft cloth for cleaning up the main unit or other items.

(2) Warning labels

Inspect and clean the warning labels to ensure readability. Contact representative in your area of the manufacturer when warning labels have dirtied or peeled off.

(3) Avoid subjecting transducers to shocks or impacts.

Do not subject transducers to impact from hard objects, dropping, or other handle harshly in any other manner.

(4) Transducers are designed considering to measure outside during the rain. But, please be noted that avoiding the environment such as exposed to wind and rain for a long time would be highly appreciated. Please wipe moisture off promptly after used in wet atmosphere.

In the following cases, the waterproof performance will not be retained. The connector is not correctly connected. You can not use it in water (non-submergible).

(5) Although the transducers may be deteriorated in performance, outward will not be changed. If you may doubt its performance, please contact the nearest representative. To compare ultrasonic signals, deterioration will be identified.

(6) Transducers are designed considering to measure outside during the rain. But, please be noted that avoiding the environment such as exposed to wind and rain for a long time would be highly appreciated. Please wipe moisture off promptly after used in wet atmosphere.

In the following cases, the waterproof performance will not be retained. The connector is not correctly connected. Rubber cover of the battery and USB (main unit right side) is not correctly obtained. The screw is loose. You can not use it in water (non-submergible).

3.1.2 Life of components

Certain components of the main unit have operational life expectancies. Periodic check of these components is recommended. Please contact the nearest representative in your area when any component replacement is required.

(1) LCD

The contrast of the LCD may darken when this life is exceeded. (Contrast is adjustable. Please refer to Chapter "**1.2.2 (2) LCD indication & key panel assignment** (p.1-12)".) Generally LCD life may be shortened if it is exposed to direct sunlight, high temperature or high humidity.

(2) Lithium battery (for logging and date-time backup)

The lithium battery which is used for date-time and logged file backup, requires replacement approximately every 5 years.

When battery is fully-discharged, logged file will be deleted, date-time back to default if power is off.

In case of battery discharged, warning message comes up at start-up self-check.

(3) Battery
The performance of a rechargeable battery will deteriorated accordingly. When battery will be deteriorated spontaneously, the operation time may be extremely short though it is full charged. Please exchange the battery when deterioration of its performance is remarkable shorter.
In case of “Not Use for more than 1 month”, we recommend making to the full charge, then detach it from main unit. Please hold it under low humidity and cool.

(4) Periodic checks for packing or O-ring items are recommended to insure IP class conformance.

Warning

- When performing maintenance or inspections, shut down the main unit and cut the power. If these measures are not taken electrical shocks may occur.
- Do not use any battery or AC adaptor except the specified one by manufacturer. In case of such unmatched combination may result in electrical shock or equipment damage.

3.2 General Specifications

3.2.1 Overall Specifications

Measurement	Applicable Fluid	Homogeneous and sonically conductive fluids (water, waste water, industrial water sea water, pure water, oil, ethylene glycol-water solution etc)
	Range	Converted to flow velocity: -30 m/s ~ +30 m/s
	Method	Ultrasonic pulse transit time difference method
Pipe & Flow Condition	Diameter	DN13mm ~ DN 5000mm
	Material	Materials which allow stable transit of ultrasonic waves such as steel, SUS, castings, ductile casting, PVC, FRPM, etc. (Note: Applicable diameters may vary with material.)
	Turbidity	10000 mg/L or less Note) The air bubble must not be contained.
	Lining	None, tar epoxy, mortar, etc. Note) The lining must be stucked to the pipe.
	Flow Condition	Fully developed and rotationally symmetrical flow profile required.

Transducer	Applicable diameter	Applicable Temperature
Small Transducer	DN 13 ~ 50 mm	-20 ~ 120 °C
Midium Transducer	DN 65 ~ 500 mm (DN 20 ~ 50 mm) (*1)	-20 ~ 120 °C
Large Transducer	DN 300 ~ 5000 mm	-20 ~ 80 °C
	Note) Applicable diameters may vary with material or fluid.	
Measurement Accuracy	Velocity ≥ 1 m/s	Velocity < 1 m/s
DN 13 (*2) ~ 90 mm (DN 20 ~ 50 mm) (*1)	±2.0 % (±2.0 ~ ±5.0 %) (*1)	±0.02 m/s (±0.02 ~ ±0.05 m/s) (*1)
DN 100 ~ 250 mm	±1.5 %	±0.015 m/s
DN 300 ~ 5000 mm	±1.0 %	±0.01 m/s
	(*1) Medium transducer is recommended for measurement of DN20 ~ 50mm which attenuates sonically like Zinc-coated-pipe. (*2) Site calibration required. Note) Calibrated accuracy DN 100 ~ 250 mm : ±0.75 % or ±0.0075 m/s (Velocity < 1 m/s) DN 300 ~ 5000 mm : ±0.5 % or ±0.005 m/s (Velocity < 1 m/s)	
Repeatability	Velocity ≥ 1m/s	Velocity < 1m/s
DN 13 ~ 90 mm	±1.0 %	±0.01 m/s
DN 100 ~ 250 mm	±0.75 %	±0.0075 m/s
DN 300 ~ 5000 mm	±0.5 %	±0.005 m/s

Other	Protection degree	IP65 (IEC 60529)
	Cable length	7 m Note1) PE sheath (up to +65 °C) and FEP sheath (up to +120 °C) is available. Note2) Extension cable（PE sheath）is available. MAX. 150m can be extended. But it is limited by the measurement environment.
	RTD (Pt100) (option)	IEC 60751 / JIS-A-Class (3-wires) (The total accuracy for heatmeter measurement is synthesized from each flow rate and temperature accuracy. Temperature measurement accuracy of converter is ±(0.2 °C + 0.1 %) (Ambient temperature of main body : 25 °C). Please refer to JIS C 1604-1997 or IEC 60751 for the accuracy of Pt100.)

3.2.2 Main Unit specifications

Power Supply	DC 10 ~ 30 V	
	Battery	DC 6.0 V 4.0 Ah Ni-MH Standard operation time : 8hours (When analog output and USB memory are not connected.) Rapid charging time : 4hours Note) The range of the temperature of the battery that can be charged is Approx. 0 ~ 50 °C. It is not possible to charge it outside this range.
	AC adaptor	Output : DC 12 V 5 A Input : AC 90 ~ 264 V 47 - 63 Hz 1.5 A(AC 90 V)
Power Consumption	Approx. 5 W (DC 24 V supply, Main unit operates) Approx. 20 W (DC 24 V supply, Battery is charged) Approx. 5 W (DC 12 V supply, Main unit operates) Approx. 20 W (DC 12 V supply, Battery is charged) Note) When the power supply of main unit is turned off with the AC adaptor connected, the battery is charged.	
Operating Temperature	-10 ~ 50 °C (for AC adaptor : 0 ~ 40 °C)	
Storage Temperature	-10 ~ 50 °C (for AC adaptor : -20 ~ 85 °C)	
Operating Humidity	20 ~ 90 %RH (non-condensation)	
Protection Degree	IP65 (IEC 60529) Note) It is non-waterproof while connected with the AC adaptor or USB memory.	
Material	Polycarbonate/ABS	
Dimension	135（W）x 250（L）x 68（H）	
Mass	Approx. 1.4kg (including battery)	
European Compliance (CE marking)	EMC Directive 2014/30/EU Harmonized Standard / EN61326-1:2013 -Separation into group / Group I -Division into classes / Class A -Location intended for use / In industrial locations RoHS Directive 2011/65/EU Harmonized Standard / EN 50581:2012 [Condition] AC Adaptor is only used to recharge the battery. The length of sensor cable is 7m.	

Display	Method	LCD（320 x 240 Dot Matrix） / high-intensity Backlight equipped	
	Content	• Instantaneous flow rate, warnings and totalizing status • Forward/Backward flow totalized value	
	Digits	Flow rate	Max. 6 digits (including Sign section)
		Flow velocity	Max. 6 digits Sign section ; 1 digit Integer section ; 2 digits Decimal fraction ; 3 digits
		Flow Totalizing	Max. 8 digits
		Temp.	Max. 5 digits Sign section ; 1 digit Integer section ; 3 digits Decimal fraction ; 1 digit
	Unit	Flow rate 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 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 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 W,kW,MW,BTU/h,kBTU/h,MBTU/h	
		Totalize units x1 m^3,x5 m^3,x10 m^3,x100 m^3 x0.01 L,x0.1 L,x1 L,x10 L,X100 L ft^3,kft^3,Mft^3,bbl,kbbl,Mbbl,gal,kgal,Mgal,acf,kacf,Macf x1 kg,x10 kg,x100 kg,x0.1 kg,x0.01 kg,x1 t,x10 t,x100 t J,MJ,BTU,MBTU	
	Updating cycle	Approx. 1sec	

Logging Function	St'd/option	Standard
	Output	Approx. 165,000 points Date, time, Instantaneous flow rate (volumetric, mass or heat), + Total, -Total, Flow velocity, Temperature, Error code (Selectable) Internal logged data transferred through USB memory as CSV format
	Output format	CSV
Temperature Input	St'd/option	Option / Junction Box Required
	Input	4pcs of Pt100 (Max.) (For Energy measurement, they can be connected main unit through junction box.)
Analog Output	St'd/option	Standard
	Output	1 port; Instantaneous flow rate Energy, Mass (calculated by fixed density setting), Calculation flow rate, mass or energy (path1 + path2 or path1 - path2)
	Output format	4-20 mA Allowable load resistance 550 ohm Max.

Function	Installation Wizard	Installation Wizard for EASY interface
	Thickness gauge	Thickness meter function included (Range; 1 ~ 100mm / Accuracy; +/-0.1mm or +/-1.5%R.D. which is larger in case of steel)
	Sound speed measurement	Sound speed measurement function included (Range; 500 ~ 3000 m/s / Accuracy; +/-5 %, in case of water)
	Multi-path measurement	2 path: - Flow meter main unit is equipped with connector for transducer cable as standard. - Transducer, fixture, extension cable for each path required. 2-channel: - Flow meter main unit is equipped with connector for transducer cable as standard. - Transducer, fixture, extension cable for each path required.
	Receiving echo-monitoring	Receiving echo-monitoring function included as standard
	Multi-Language available	Multi-Language available (English, French, German, Italian, Japanese, Portuguese, Russian, Spanish, Turkish)
	Metric / English	Metric / English (inch, gallon or barrel) units available
	Low flow cut	Cuts (zeros) flows when flow falls below prescribed instantaneous flow rate. Used in order to avoid output of flow values other than 0 when measurement value during still flow becomes disordered
	No Echo receiving warning	If measurement cannot be made when no echo is received continuously over the setting time (determined transition time), status is changed to - Display “R” on LCD. - Selected analog output type Selectable analog output transition status as follows. 0% (4mA), hold, 100% (20mA)
	Disturbance detection	Check whether processing values are measured properly or not and if determined to be disturbed conditions then measuring values are eliminated. - Display “D” on the display
	Zero shift	Zero point can be independently compensated (shifted) for forward and backward flow rate.
	Span compensation	Slope of span line can be independently compensated for forward and backward flow rate.
	Self-diagnostics	Self-diagnostics runs at start-up.
	Moving Average time	Rapid flow rate changes would be smoother by this filter.
	Basic data display	Following internal data can be referenced. - Flow Unit and Flow Total Unit - Pipe Diameter, Thickness, Material and Material Sound Speed - Lining Thickness, Lining Material and Lining Material Sound Speed - Transducer Type, Sound-Path and Cable length - Fluid type, Fluid Sound Speed and Fluid Viscosity - 4mA setting and 20mA setting - Zero Shift, Span Correction, Zero Cut and Volume Correction - Log Interval, Start & Stop time, Synchronizing Totalization select and Logged Items - Sound speed

	Data Retention	Site conditions, Logged data and Data-Time are retained in memory with lithium battery even if power failure. Note1) Backup battery is non-rechargeable. Note2) 5-year life at room temperature. Note3) Site conditions are stored in the nonvolatile memory.
	Mass Indication	Mass flow rate is calculated by fixed density input.
	Temperature Compensation (for heat meter)	Temperature input can be calibrated by Zero offset and Span correction in case of Heatmeter selected. Low cut function effects on the differential of both send and return side temperature.

3.2.3 Accessories

Thickness/ sound speed meter sensor	TH5010L Note) Test piece is attached.	
	St'd/option	Standard
	Note	Operating temperature range : -10 ~ 50 °C (Storage temperature range is same.) Protection Degree : IP65 (IEC 60529) Cable length : 0.7 m
Temperature Detector (RTD)	Pt100 IEC 60751 / JIS-A-Class (3-wires)	
	St'd/option	Option
	Note	Operating temperature range : -20 ~ 120 °C Storage temperature range : -20 ~ 120 °C Cable length : 5 m
Temperature Junction box	CB21 Connected box to connect Pt100 with main unit. Connection port : 4	
	St'd/option	Option
	Note	Protection Degree : IP20 (IEC 60529) Material : ABS Operating temperature range : -10 ~ 50 °C Storage temperature range : -10 ~ 50 °C Cable length : 2 m

3.2.4 Dimensions

(1) Main Unit

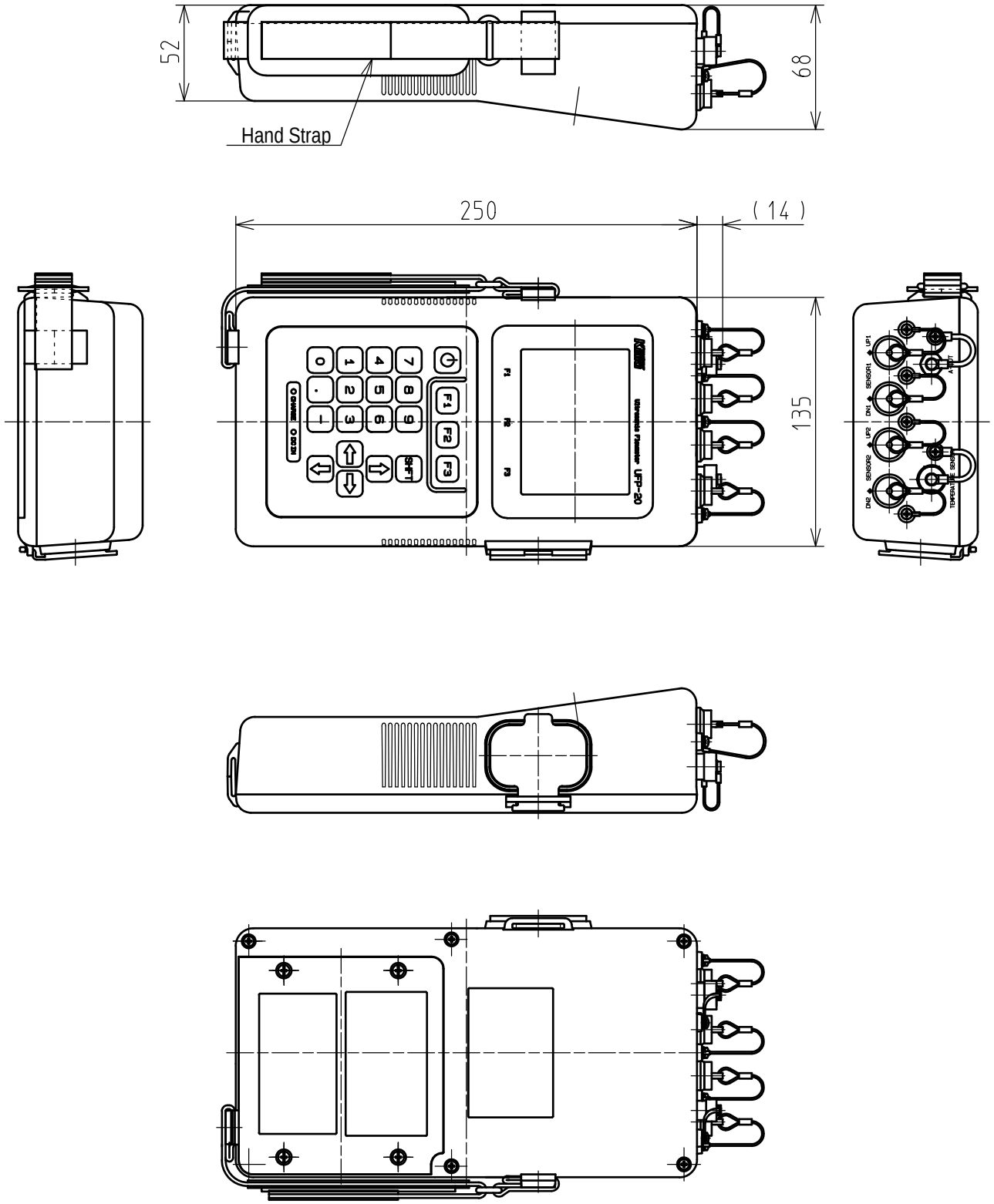


Fig.3.2.4-1 Main Unit

(2) Small Transducer Kit

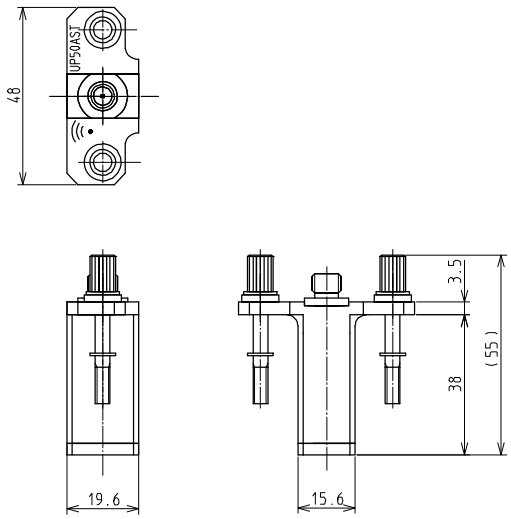


Fig. 3.2.4-2 Small transducer

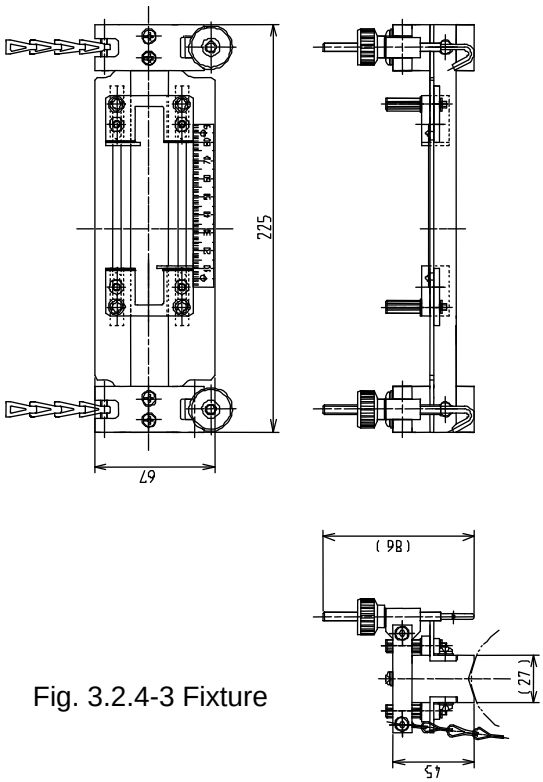


Fig. 3.2.4-3 Fixture

(3) Medium Transducer Kit

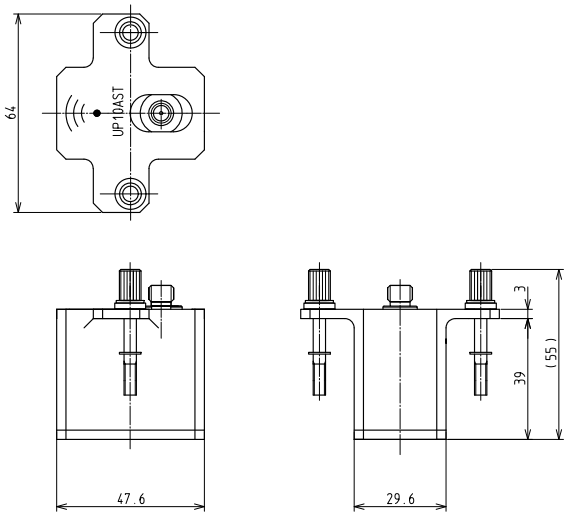


Fig. 3.2.4-4 Medium transducer

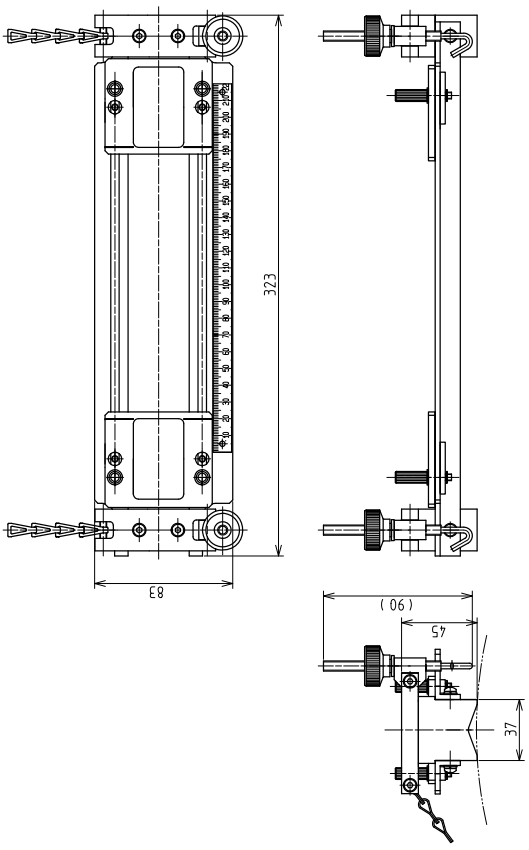


Fig. 3.2.4-5 Fixture 1

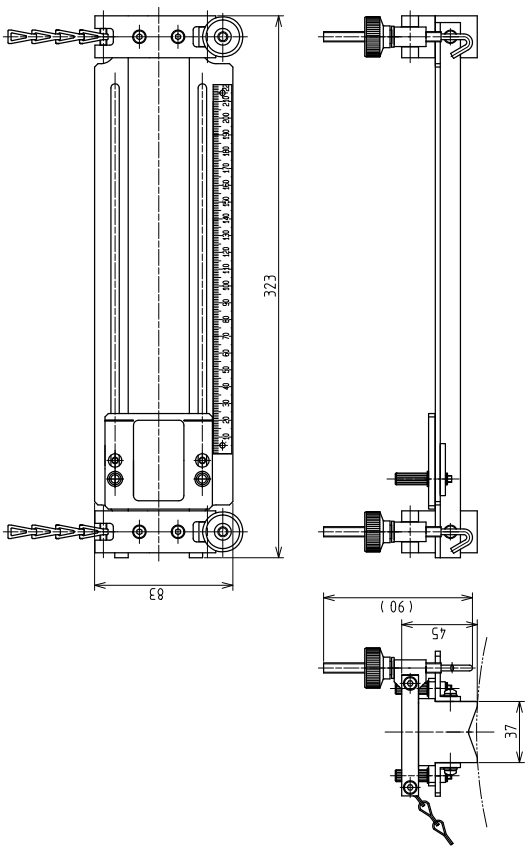
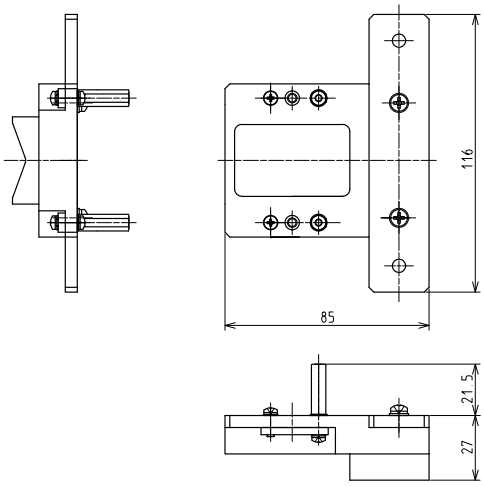
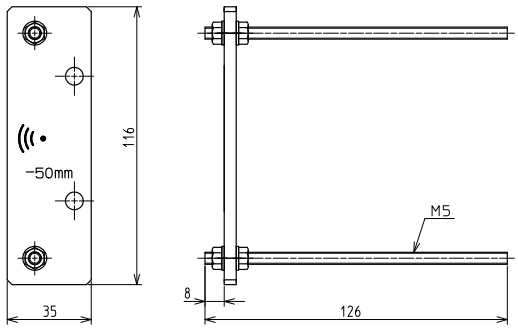


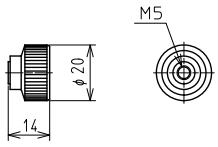
Fig. 3.2.4-6 Fixture 2



(1) Adaptor A



(2) Adaptor B



(3) Knob

Fig. 3.2.4-7 Z-path method adaptor

(4) Large Transducer Kit

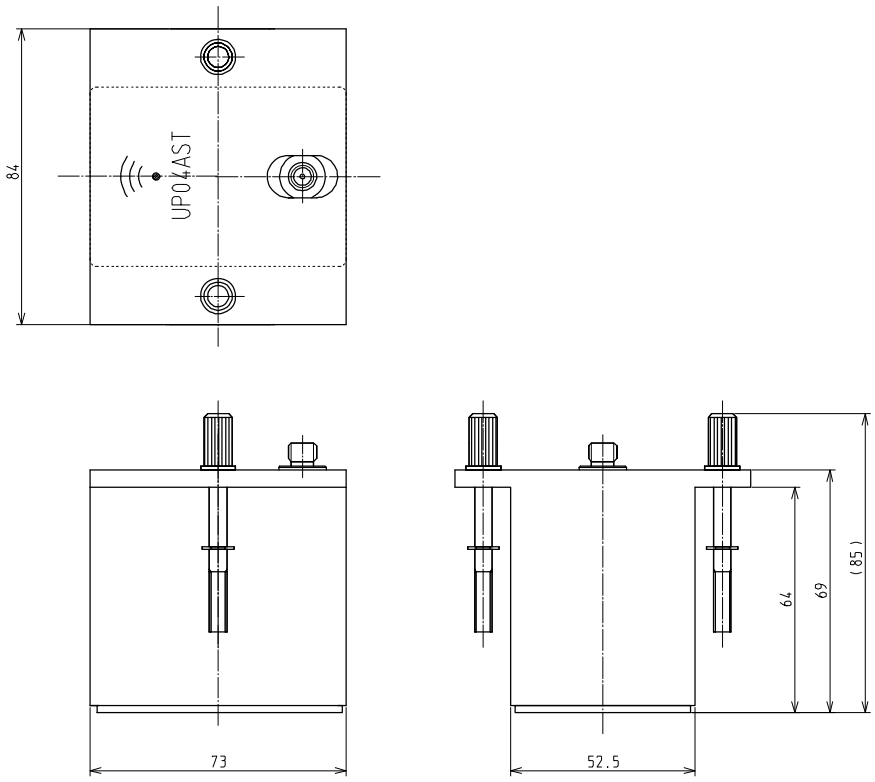


Fig. 3.2.4-8 Large transducer

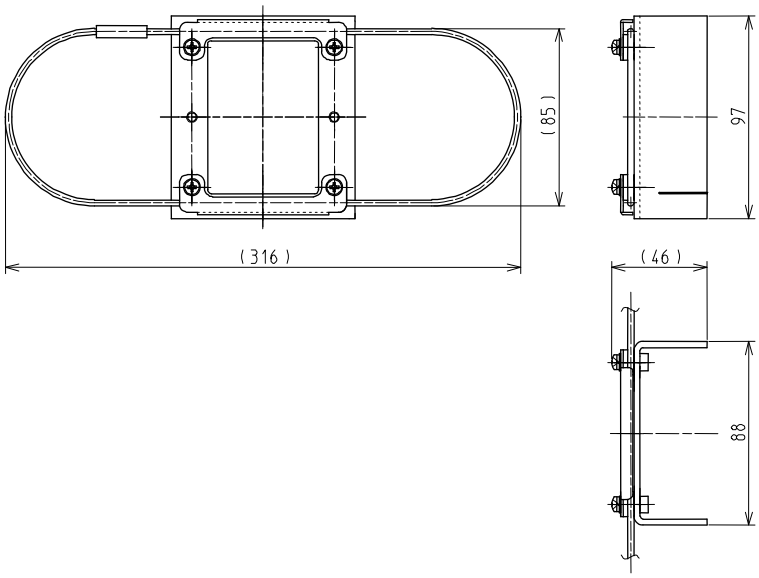


Fig. 3.2.4-9 Fixture 1

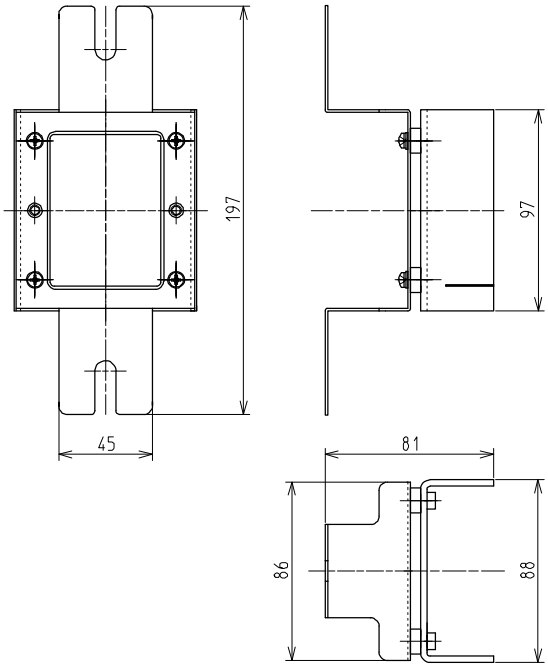


Fig. 3.2.4-10 Fixture 2

3.3 Principles of the Ultrasonic Flowmeter

3.3.1 Measurement principles

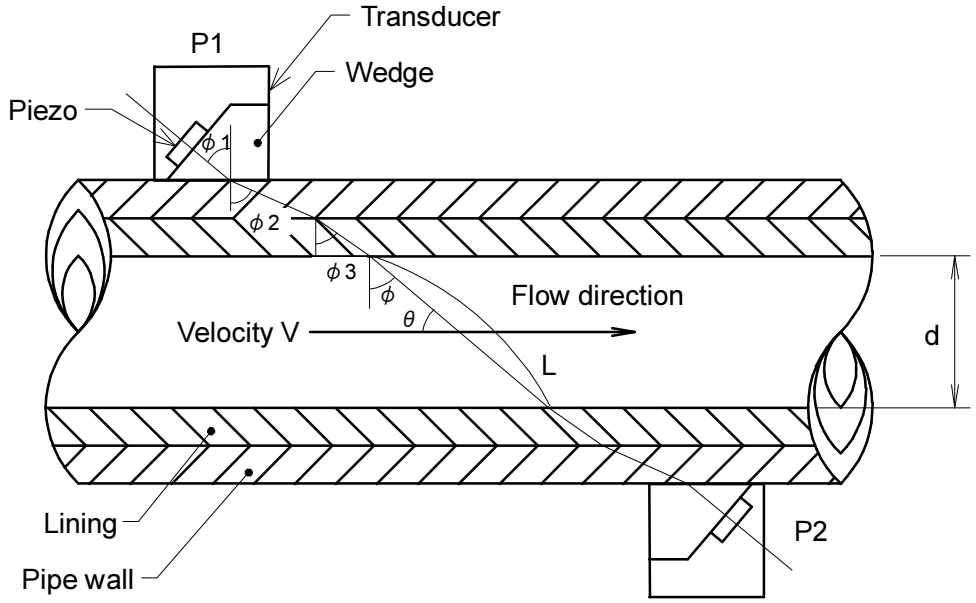


Fig. 3.3.1-1 Ultrasonic pulse Propagation

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 Δt = 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.

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

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.

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

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

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.

3.3.2 Z-path (transmission) and V-path (reflection) methods

With ultrasonic flowmeters, depending on the propagation route of the ultrasonic waves, the measurement methods can be divided into Z-path method (the transmission method) and V-path method (the reflection method) as shown in Fig. 3.3.2-1. Since the above explanation of measurement principles used the transmission method, the reflection method will be explained here. An advantage of the reflection method is the ability to consistently obtain correct measurement values even when some flowing components move perpendicular to the flow direction. These situations include circling flow, etc. However, since the propagation route of the ultrasonic waves is approximately twice the length of the route with the transmission method, larger propagation loss occurs.

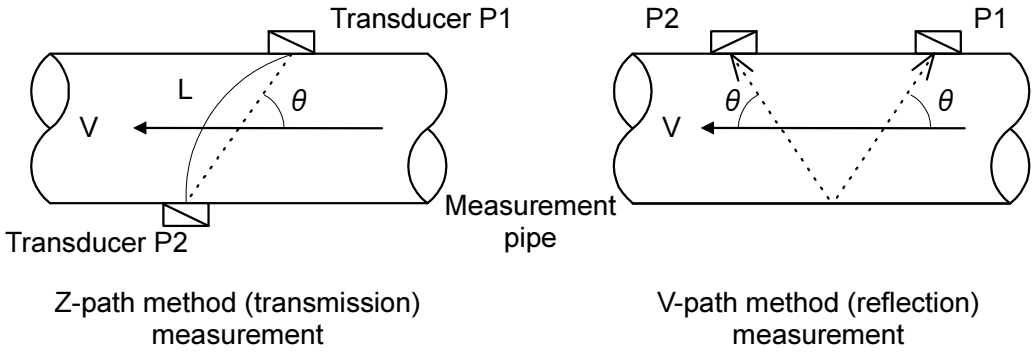


Fig. 3.3.2-1 Measurement Methods

With the reflection method, although the internal diameter is doubled, as shown in the figure below, the flow rate is the same and the calculation formulas of the transmission method are applicable. Therefore, d is changed to 2d and the scale factor is cut in half. Aside from such small changes, the same formulas are generally used.

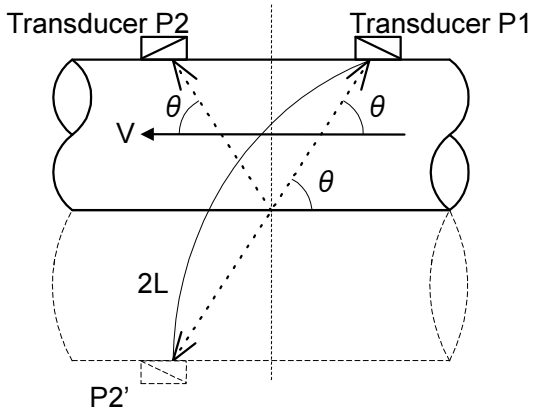


Fig. 3.3.2-2 Explanatory Diagram for Reflection Method

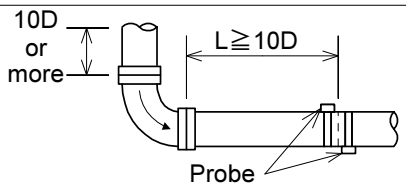
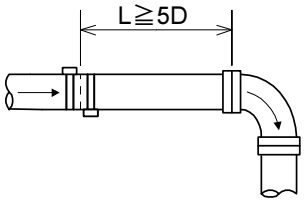
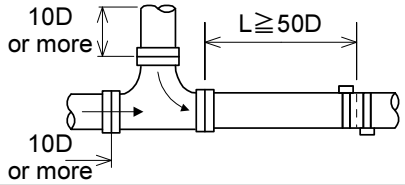
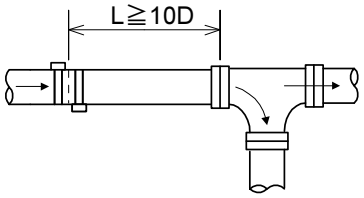
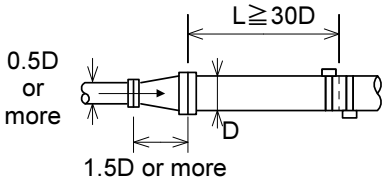
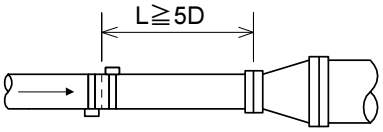
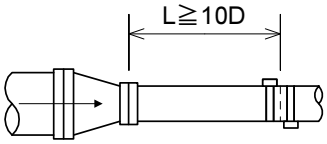
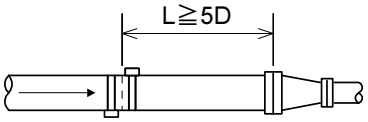
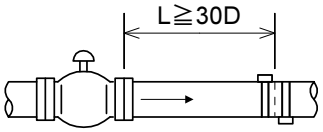
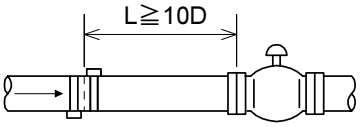
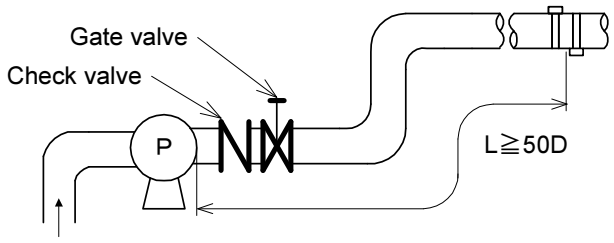
3.4 Appendix

3.4.1 General condition for straight pipe length

According to JEMIS032-1987, generally required straight pipe length for ultrasonic flowmeter is defined as below.

Longer straight pipe length might be better to be choosen for ideal condition of measurement.

Table 3.4.1-1 [Refer to JEMIS 032-1987.]

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]

3.4.2 Sound Velocity & Kinematic Viscosity reference list

Main unit uses follwing value for internal setting parameter, but those values are considered as nomial.

(1) Pipe

Table 3.4.2-1

Material type	Material Name	Velocity Longitudinal wave [m/s] (*1)	Velocity Shear 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	5730	3200
	Stainless Steel	5790	3100
	Tantalum	4100	2900
	Titanium	6070	3110
Plastic	Polycarbonate	2300	
	Poly Vinyl Chloride	2280	
	PTFE	1390	
	Acrylic	2720	
	FRP	2560	

(*1) This value uses for thisckness measurement.

(2) Lining

Table 3.4.2-2

Material type	Material Name	Velocity Longitudinal wave [m/s]	Velocity Shear wave [m/s]
Lining	Epoxy	3000	2000
	Mortar	4500	2500
	Rubber		1900
	Poly Vinyl Chloride	2280	

(3) Fluid

Table 3.4.2-3

Material type	Material Name	Composition Formula	Density [g/cm^3]	Velocity Longitudinal wave [m/s]	Viscosity [×10^{-6}m^2/s]
Alcohol	Butanol		0.81	1268(20°C)	3.239(25°C)
	Ethanol	C_2H_5OH	0.79	1127(30°C)	1.39(25°C)
	Ethylene Glycol	>99.5%	1.11	1689(20°C)	17.208(25°C)
	Ethylene Glycol solution (50wt%)		1.066	1691(15°C)	4.13(15°C)
				1683(25°C)	
				1670(40°C)	
	Ethylene Glycol solution (25wt%)			1599(15°C)	
				1603(25°C)	
				1609(40°C)	
	Methanol	CH_3OH	0.8	1090(30°C)	0.695(25°C)
Oil	Diesel Oil			1250	
	Gasoline	C_8H_{18}	0.717	1250	0.574(25°C)
	Glycerin	$C_3H_8O_3$	1.26	1920	757.1(25°C)
	Gravity Fuel Oil AA		0.99	1490	
	Kerosene		0.81	1320	1.5(25°C)
	Motor Oil	SAE 20	0.87	1740	5.6 ~ 9.3(100°C)
	Motor Oil	SAE 30	0.88	1700	190(25°C)
	Baby Oil			1416(23°C)	
	Mineral-Heavy		0.843	1460	140(15°C)
	Mineral-Light		0.825	1440	3(25°C)
	Phenylated Silicone		1.1	1370	
	Silicone 1000 cSt		0.972	990	1000
	Silicone 100 cSt		0.968	980	100
	Silicone 10 cSt		0.94	968	10
	Silicone 1 cSt		0.818	960	1
	Olive Oil			1449(23°C)	100(25°C)
	Lubricant	Mobil		1417(20°C)	31.5(40°C)
	Paraffin Oil			1428(20°C)	
Solvent	Acetone		0.791	1158	0.399(25°C)
	Benzene	C_6H_6	0.88	1310(25°C)	0.711(25°C)
	Chloro Benzene	C_6H_5Cl	1.11	1300(22°C)	0.722(25°C)
	Toluene			1420	
Water	Water		1	1460(13.5°C)	1.2
	Sea Water		1.0231	1510	1 (25°C)

3.4.3 Sound velocity (water)

Table 3.4.3-1

Water Temperature [°C]	Sound Velocity [m/s]	Water Temperature [°C]	Sound Velocity [m/s]	Water Temperature [°C]	Sound Velocity [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		

3.4.4 Pipe Chart

(1) Cast iron

Table 3.4.4-1

Name			Water Works Type Cast Iron		Straight Pipe		Ductile Iron Pipe							
JIS Number			JIS G5521-1977		JIS G5522-1977		JIS G5526-1989							
Material			FC		FC									
Type			Normal Pressure	Low Pressure	Normal Pressure	Low Pressure	D1	D1.5	D2	D2.5	D3	D3.5	D4	D4.5
Nominal Diameter	Outer Diameter	Lining Thickness												
75	93	4	9		7.5		7.5				6			
100	118	4	9		7.5		7.5				6			
150	169	4	9.5	9	8	7.5	7.5				6			
200	220	4	10	9.4	8.8	8	7.5				6			
250	271.6	4	10.8	9.8	9.5	8.4	7.5				6			
300	322.8	6	11.4	10.2	10	9	7.5				6.5			
350	374	6	12	10.6	10.8	9.4	7.5				6.5			
400	425.6	6	12.8	11	11.5	10	8.5		7.5		7			
450	476.8	6	13.4	11.5	12	10.4	9		8		7.5			
500	528	6	14	12	12.8	11	9.5		8.5		8			
600	630.8	6	15.4	13	14.2	11.8	11		10		9		8.5	
700	733	8	16.5	13.8	15.5	12.8	12		11		10		9	
800	836	8	18	14.8	16.8	13.8	13.5		12		11		10	
900	939	8	19.5	15.5	18.2	14.8	15		13		12		11	
1000	1041	10	22				16.5		14.5		13		12	
1100	1144	10	23.5				18		15.5		14		13	
1200	1246	10	25				19.5		17		15		13.5	
1350	1400	12	27.5				21.5		18.5		16.5		15	
1500	1554	12	30				23.5		20.5		18		16.5	
1600	1650	15					25	23.5	22	20.5	19	18	17.5	16
1650	1701	15					25.5	24	22.5	21	19.5	18.5	18	16.5
1800	1848	15					28	26	24	22.5	21	20	19.5	18
2000	2061	15					30.5	28.5	26.5	25	23.5	22	21	19.5
2100	2164	15					32	30	28	26	24.5	23	22	20.5
2200	2280	15					33.5	31	29	27	25.5	24	23	21.5
2400	2458	15					36.5	34	31.5	29.5	27.5	26	25	23
2600	2684	15					39.5	36.5	34	31.5	29.5	28	27	25

(2) Steel

Table 3.4.4-2

Name		Tubing Type Carbon Steel	Water Works Typ Zinc	Water Circulation Type TOFUKUSO Steel Pipe				Pressure Line Type Carbon Steel Pipe				Tubing Type Stainless Steel Pipe			
JIS Number		JIS G3452-1988	JIS G3442-1988	JIS G3443-1987				JIS G3454-1988				JIS G34T9-1988			
Material		STP	SGP-W	STW				STPG				SUS***TP, SUS***HTP, SUS***LTP, SUS***HTP			
Type				STW290	STW370	STW400A	STW400B	Schedule 10	Schedule 20	Schedule 30	Schedule 40	Schedule 5	Schedule 10	Schedule 20	Schedule 40
Nominal Dia.	Outer Dia.														
15	21.7	2.8	2.8								2.8	1.65	2.1	2.5	2.8
20	27.2	2.8	2.8								2.9	1.65	2.1	2.5	2.9
25	34	3.2	3.2								3.4	1.65	2.8	3	3.4
32	42.7	3.5	3.5								3.6	1.65	2.8	3	3.6
40	48.6	3.5	3.5								3.7	1.65	2.8	3	3.7
50	60.5	3.8	3.8						3.2		3.9	1.65	2.8	3.5	3.9
65	76.3	4.2	4.2						4.5		5.2	2.1	3	3.5	5.2
80	89.1	4.2	4.2	4.2	4.5				4.5		5.5	2.1	3	4	5.5
90	101.6	4.2	4.2						4.5		5.7	2.1	3	4	5.7
100	114.3	4.5	4.5	4.5	4.9				4.9		6	2.1	3	4	6
125	139.8	4.5	4.5	4.5	5.1				5.1		6.6	2.8	3.4	5	6.6
150	165.2	5	5	5	5.5				5.5		7.1	2.8	3.4	5	7.1
175	190.7	5.3													
200	216.3	5.8	5.8	5.8	6.4				6.4	7	8.2	2.8	4	6.5	8.2
225	241.8	6.2													
250	267.4	6.6	6.6	6.6	6.4				6.4	7.8	9.3	3.4	4	6.5	9.3
300	318.5	6.9	6.9	6.9	6.4				6.4	8.4	10.3	4	4.5	6.5	10.3
350	355.6	7.9				6		6.4	7.9	9.5	11.1				11.1
400	406.4	7.9				6		6.4	7.9	9.5	12.7				12.7
450	457.2	7.9				6		6.4	7.9	11.1	14.3				14.3
500	508	7.9				6		6.4	9.5	12.7	15.1				15.1
550	558.8							6.4	9.5	12.7	15.9				15.9
600	609.6					6		6.4	9.5	14.3					17.5
650	660.4							7.9	12.7						18.9
700	711.2					7	6								
750	762														
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) FRPM Pipe, Vinyl Pipe, Polyethylene Pipe

Table 3.4.4-3

Name	FRPM Pipe	
JIS Number	JIS A5350	
Material	FRPM	
Type		
Nominal Dia.	Outer Dia.	Pipe Thickness
150		
200		
250		
300		
400		
450		
500		
600	624	12
700	728	14
800	832	16
900	936	18
1000	1040	20
1100	1144	22
1200	1248	24
1350	1404	27
1500	1560	30
1650	1716	33
1800	1872	36
2000	2080	40
2200	2288	44
2400	2496	48
2600	2704	52
2800	2912	56
3000	3120	60

Name	Vinyl Pipe		
JIS Number	JIS K 6741-1984		
Material	Poly Vinyl Chloride		
Type		VP	VU
Nominal Dia.	Outer Dia.	Pipe Thickness	Pipe Thickness
13	18	2.5	
16	22	3.0	
20	26	3.0	
25	32	3.5	
30	38	3.5	
40	48	4	2
50	60	4.5	2
65	76	4.5	2.5
75	89	5.9	3
100	114	7.1	3.5
125	140	7.5	4.5
150	165	9.6	5.5
200	216	11	7
250	267	13.6	8.4
300	318	16.2	9.9
350	370		11.2
400	420		12.6
450	470		14.1
500	520		15.6
600	630		19.2
700	732		22.6
800	835		25.8

Note) Pipe Thickness is median of tolerance in the specification.

Name	Polyethylene Pipe		
JIS Number	JIS K 6761-1995		
Material	Polyethylene		
Type		Class 1	Class 2
Nominal Dia.	Outer Dia.	Pipe Thickness	Pipe Thickness
13	21.5	2.7	2.4
20	27	3.0	2.4
25	34	3.0	2.6
30	42	3.5	2.8
40	48	3.5	3.0
50	60	4.0	3.5
65	76	5.0	4.0
75	89	5.5	5.0
100	114	6.0	5.5
125	140	6.5	6.5
150	165	7.0	7.0
200	216	8.0	8.0
250	267	9.0	9.0
300	318	10.0	10.0

3.5 FAQ
3.5.1 Measurement method

1.1 What is ultrasonic?

Ultrasonic refers to acoustic waves or vibrations of a frequency beyond the range of human hearing (generally above 20,000 Hz).

1.2 At what frequencies do ultrasonic flowmeters operate?

The frequency generally utilized is several 100 kHz up to several MHz.

1.3 Why are such high frequencies used?

Frequencies in the normal range (i.e. in the audible range) are apt to mix with and become lost in the ambient noise.

1.4 Is ultrasonic harmful to humans or animals?

No. Ultrasonic is used in the medical field in place of X-rays.

1.5 How does ultrasonic measure flow?

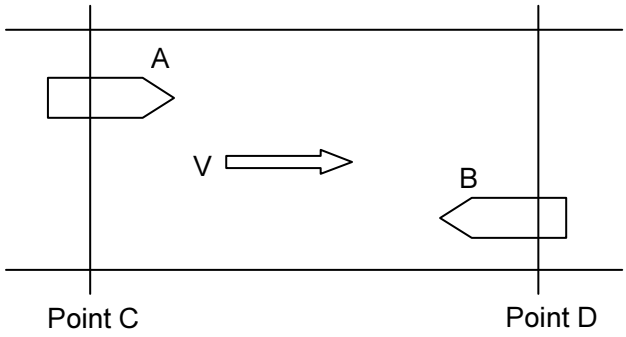


Fig. 3.5.1-1

Let us illustrate this by an example of two boats, “A” and “B”, positioned at two points on a river as shown in Fig. 9. If boats “A” and “B” approach each other at exactly the same speed, the time, “***tA***”, it takes for boat “A” to arrive at point “D” and the time, “***tB***”, it takes for boat “B” to arrive at point “C” will be the same.

Now what would happen if the river is flowing at velocity “V” in the direction of the arrow as shown? What happens is that boat “A” which is proceeding downstream will arrive at point “D” faster than boat “B” which is traveling upstream. In other words, time “***tB***” is longer in comparison to time “***tA***” which reflects the additional time involved in opposing the flow, and thus time, “***tA***” for boat “A” which is traveling downstream to arrive at point “D” will be faster. This time difference is proportional to the magnitude of the velocity of the flow and this principle is utilized to measure flow velocities. This can be expressed by the formula:

$$tB - tA = \Delta t$$

where Δt is the time difference.

As flow velocity "***V***" can be determined by measuring ***Δt***, you can calculate the volume of flow through a pipe or open channel by multiplying ***Δt*** by the cross sectional area of the pipe or open channel. In such calculations, it is necessary to employ a flow volume compensation coefficient with the measured flow velocity "***V***" in order to obtain average flow velocity.

1.6 Is the time difference method the only method used in ultrasonic flow measurement?

Presently there are three measurement methods in practical use.

(1) Frequency difference method
(2) Time difference method
(3) Doppler method

Methods (1) and (2) are mainly used for measurement of relatively clean water. This is because fluctuations in propagation level of ultrasonic signals (i.e. sensitivity of ultrasonic transmissions and reception) become problematic with dirty water which reduces signal strength.

Measurement method (3) involves detection of frequency shifts (changes) in acoustic signals. As changes in signal propagation level is not directly a factor, this method is suitable for measurement of dirty water such as sewage.

1.7 Does sound speed vary with water temperature?

Yes. It is thus important to devise means to overcome the affect of acoustic velocity changes caused by changes in water temperature.

3.5.2 Measured fluids

2.1 Measured fluids

In principle, any liquid, which allows stable propagation of ultrasonic pulse, can be measured. However in liquids where large amounts of air bubbles or solid particles are present, problems such as mis-measurements or non-measurable conditions may occur. As high temperature and high pressure liquids (oil, etc.) cannot be described categorically, consult Manufacturer when measuring such liquids.

2.2 Can raw water be measured?

River water and raw water can be measured in addition to clean water.

2.3 In the case of raw water, how does turbidity affect measurement?

Two separate questions arise with regard to this.

(1) Do changes in turbidity produce measurement error?

(2) Does high turbidity attenuate acoustic signals creating non-measurable conditions?

Regarding (1), if the penetration of acoustic signals is adequate, changes in turbidity does not normally cause errors.

Regarding (2), although related to attenuation of acoustic signals by solid particles in the liquid, exceedingly high levels of turbidity does cause reduction in signal. Manufacturer specifies turbidity levels up to 10,000 in the case of a pipe diameter of 1m. (Note: turbidity of 1g of refined Kaolin clay in 1 litter of water is 1,000.)

Turbidity of 5,000 is quite severe, but as turbidity of river water rarely exceeds 1,000, there should be no problem for all practical purposes.

2.4 How is measurement affected if air enters the pipe?

(1) Compared to water, air is a very difficult medium for the transmission of acoustic signals. Therefore when pumps continuously draw air into the piping, air bubbles will pass through the acoustic signal transverse path resulting in measurement swings or mis-measurements.

(2) Also in cases where the depth of the tap from the water surface to the top of the pipe at the intake location is insufficient, air will be sucked into the pipe and may cause mis-measurements or create non-measurable conditions.

(3) If air accumulates at the upper part of the pipe, although flow measurement can be carried out, the flow indicated will be larger than the actual flow. (Note: If the transducers are located vertically on the pipe, measurement cannot be done if there is a layer of air in the pipe.) Thus, in cases where there may be accumulation of air in pipes, air bleed valves should be installed fore and aft of the measurement position.

2.5 Can waste water be measured?

From the standpoint of turbidity, there are no problems with measuring waste water inflows or discharges. However pipe conditions in selecting measurement location should be carefully considered as air bubbles are apt to be generated when there are drops or when measuring locations are directly aft of pump discharge outlets.

2.6 Can measurements be made if solid particles or debris are present in the fluid?

The beam width (radiating width) of acoustic waves are sufficient to enable stable measurement in the presence of small-sized solid particles in the fluid. In the case of large size debris which can obstruct acoustic signals, the flowmeter has a discrimination function which can differentiate such conditions from normal measurement values and ignore such data input. However when there is continuous flow of fluid containing large volume of solid particles and debris, problems such as mis-measurements or non-measurable conditions are apt to occur.

3.5.3 Pipes

3.1 What kind of pipe material enables ultrasonic measurement?

We have had numerous experiences with measurements through steel, stainless steel, cast iron, ductile iron, and resins.

(1) Although we have measured through RC steel pipes, transmission of acoustic signals is difficult and this type of pipe material is not conducive to ultrasonic measurement.

(2) Measurement through pipes of asbestos material is possible on rare occasions, but for all practical purposes, measurement is not possible with this material.

(3) Hume pipes cannot be measured with sensors mounted on the outside of the pipe. Special measurement methods incorporating sensors on the inside of the pipe are employed for this type of application.

(4) The ultrasonic might not be propagated easily with PVC lining steel pipe. Refer to 3.3.

(5) The ultrasonic might not be propagated easily into the Zinc-coated-pipe.

3.2 What are the minimum and maximum measurable pipe sizes?

Measurable diameters are from DN13mm to DN5000mm.

3.3 Is pipe lining a problem?

Mortar, epoxy and other common linings on the inside of pipes do not affect measurement. In cases where the outsides of pipes are wound with jute or similar material, remove this material at the location where the transducers are to be positioned.

Regarding to PVC lining steel pipe, this type of pipe may contain air layer between metal part and PVC lining partially due to its manufacturing way.

In such case, it could be find better point for ultrasonic on the same circumferences or another part.

3.4 Are there problems with lining detachment from the pipe interior?

Centrifugal force is generally used to bond linings to the interior of pipes and during operation and the pressure of the water also acts on the lining, so problems with lining detachments are few. Should such problem occur however, as long as the sensors are not positioned directly at that point, there should be no adverse affect on measurements. Even if a slight separation of lining occurs at the point of measurement but not a complete detachment from the pipe wall, water would fill the space between the lining and the wall, and any deviations may be corrected for by readjusting the sensitivity of the system. Although not a sure method, a system readjustment or change in transducer position may enable measurement even in the case of lining separation.

3.5 How does rust or rust scale on the pipe interior affect measurement?

Rust spots in some places in cast iron pipes do not affect measurement. However extensive rust on entire surfaces may cause errors or mis-measurements. For example, a 1mm accumulation of rust scale on the entire interior surface of the pipe of DN1000mm will result in a measurement error of approx. 0.7%.

3.5.4 Installation location

4.1 What straight length of pipe is necessary?

Ultrasonic flowmeter requires “fully developed and rotationally symmetrical flow profile” as pre-condition. But According to JEMIS032-1987, generally required straight pipe length for ultrasonic flowmeter is defined as more than 10D (“D” being the upstream pipe diameter) upstream, and more than 5D downstream in order to ensure measurement accuracy.
Longer straight pipe length might be better to be choosen for ideal condition of measurement.
Please reference Chapter 3.4.2 “General condition for straight pipe length”.

4.2 What is the affect on measurement if it rains?

The standard system with flow transducers are of weatherproof construction IP65 conforming to IEC60529.

4.3 How far apart can the flowmeter unit and transducers be placed?

Coaxial cable is used to connect the main unit to the transducers. Coaxial cable length is limited to 157m with extension cable. However installation should also take into consideration external noise interference.

4.4 What are “Z” and “V” -path methods of measurement?

These refer to transducer placements. The Z-path method (transmission or single-traverse) is where the transducers are mounted diametrically opposite each other and the ultrasonic signal is transmitted directly from one transducer to the other across the pipe. This method is used when the pipe is of adequate diameter or for pipes where acoustic signals are greatly reduced.

With the V-path method (reflection or double traverse) transducers are mounted on the same side of the pipe and the ultrasonic signal is bounced from one transducer to the other off the opposite

pipe wall. This method is devised to measure flows that are not linear with the pipe axis and which are not affected by radial flow velocity components. The applicable diameters for the V-path method depends on pipe material but is generally less than DN2000mm.

See Chapter 3.3.2 for more detail on the through Z-path method and V-path method.

4.5 What are single path and dual path methods of measurement?

Single path is the standard method of measurement. With the Z-path method, transducers are mounted opposite side of the pipe as shown in Fig. 3.5.4-1.

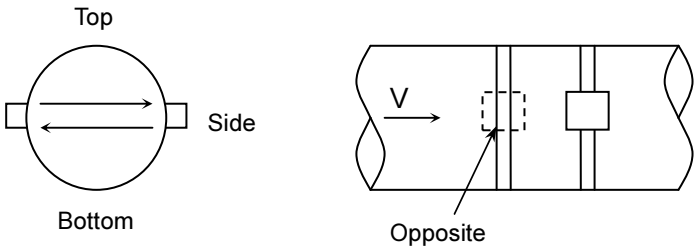


Fig. 3.5.4-1

With dual path measurement, two pairs of transducers (4 pcs) are mounted on the pipe as shown in Fig. 3.5.4-2. Compared to single path measurement of flow velocity along 1 path (diametrical axis), the dual path method measures flow velocity along 2 paths (diametrical axis) as shown in Fig. 3.5.4-2. The values of the two flow velocity measurements obtained are averaged to lessen the affect of distortions in flow velocity distribution over the pipe cross section providing more stable measurements.

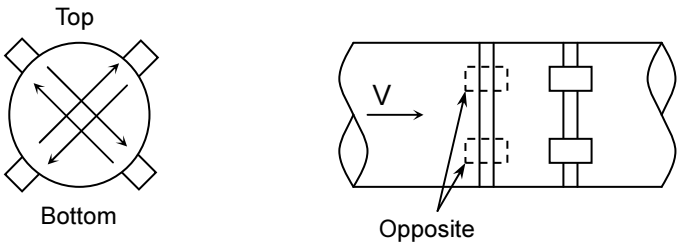


Fig. 3.5.4-2

3.6 Troubleshooting

3.6.1 Main unit and components

In the event of problems, please review this section to identify causes and suggested remedies.
If the steps shown in this section cannot solve a problem, contact with the nearest representative.

• Unit does not startup when the system is powered up.

Q; Was the power supply key correctly operated?
A; Power supply enters long of the power supply key (3 seconds or more).

Q; Are the battery or AC adaptor correctly connected?
A; Check whether connection of the cables is properly.

Q; Is the battery charged? (At the battery operation)
A; Charge battery prior to use.

• LCD display is dim.

Q; Was contrast adjusted?
A; See Chapter "**1.2.2 (2) LCD indication & key panel assignment** (p.1-12)".

Q; Has the specification life been exceeded?
A; It is necessary to exchange LCD. Contact our sales office.
When direct sunshine and strong ultraviolet rays are avoided in the environment of normal temperature and low humidity, the load to LCD can be decreased.

• LCD display disappears.

Q; Is the power saving set?
A; LCD display disappears if there is no key operation during the fixed time when the power saving is set.
LCD display returns if an arbitrary key is pushed. See Chapter "**2.2.8 System setting (5) LCD setting** (p.2-44)".

Q; Did excessive static electricity hang?
A; LCD display returns if [SHFT] + [.] is pushed.

• No any keys available.

Q; Is Shift mode activated?
A; If "  " icon is displayed in the upper part of LCD, [SHFT] is effective.
Push and release [SHFT].

• Logged data disappears when power is shut down.

Q; Is backup battery dead? (Does alarm message appear at start-up self-check?)
A; It is necessary to exchange the backup battery. Contact with the nearest representative.
Copy it onto USB memory before main unit turns off power when there is already log file.

• Date and time are initialized when turning off power.

Q; When starting, was the message of the backup battery exchange displayed?
A; It is necessary to exchange the backup battery. Contact the nearest representative.

• Flow values do not vary.

Q; Does “R1/R2” marks appear?
A; There is no echo receiving.
The receiving signal of enough strength is not obtained.
See Chapter “**3.6.2 Measurement** (p.3-31)”.

Q; Does “D1/D2” marks appear?
A; The obstacle has been detected.
The receiving signal is unstable. Or, the appearance of the flow has changed rapidly.
If frequency of occurrence is high, see Chapter “**3.6.2 Measurement** (p.3-31)”.

Q; Does “E1/E2” marks appear?
A; The setting is improper. Therefore, a correct measurement preparation cannot be done.
Confirm the setting. Especially, confirm the coverage of the sensor.
See Chapter “**2.2.4 Advanced setting operation (3) Sensor condition** (p.2-19)”.

For example : DN 500 mm, UP50AST, V-path method --- improper
DN 1000 mm, UP10AST, V-path method --- improper
DN 5000 mm, UP04AST, V-path method --- improper

• USB memory is not recognized.

A part of USB memory cannot be recognized. Pull out and put into USB memory. Check other makers’ USB memory.
It doesn’t correspond to the card reader.

• Battery is not charged.

The temperature range of the battery that can be charged is Approx.0 ~ 50°C. The charge stops automatically outside this range. See Chapter “**1.2.3 Procedure for start up (4) Battery Charge** (p.1-17)”.

3.6.2 Measurement

The following is a description of some general problems and remedies relating to measurement.
If the steps shown in this section cannot solve a problem, contact with the nearest representative.

(1) Pipes which cannot be measured

• Asbestos

If the pipe surface is sufficiently wet, measurements can be made in some cases, but generally it is difficult with this pipe material.

• FRPM

Ultrasonic may be attenuated through composite material. Hence generally it is difficult to measure with this pipe material.

• Scale and rust

Pronounced scaling and rust inside of pipes causes attenuation and diffusion of acoustic signals and the drop in transmission and receiving sensitivity sometimes makes measurement impossible. Especially zinc coated pipe may be typical pipe conductive to scale and rust inside pipe.
In such cases, a better measurement location (for example an area where there is little rust) might be found by shifting sensor positions which should improve signal reception.
So, it would be better to improve signal strength by following option.

- V-path method to Z-path method
- Small transducer to medium transducer
- Medium transducer to large transducer

Care should be exercised when doing this, however as a narrower flow cross sectional area may output results which are not true flow values.

• PVC lining steel pipe

This type of pipe may contain air layer between metal part and PVC lining partially due to its manufacturing way.
In such case, it could be find better point for ultrasonic on the same circumferences or another part.
Also it would be better to improve signal strength by following option.

- V-path method to Z-path method
- Small transducer to medium transducer
- Medium transducer to large transducer

In this case, you may have same failure as chap. (5). Please refer to it.

(2) Fluids which cannot be measured

• The presence of continuous and large amounts of bubbles in the fluid will greatly attenuate the acoustic signal, cause missed measurements, or make measurement impossible.
Even ultrasonic flowmeters employing the Doppler method which works better under such entrained bubble conditions compared to transit-time flowmeters also encounter missed measurements or are unable to make measurements when there is a continuous and large amount of bubbles contained in the fluid being measured.

- Select measurement location where fluid contains few bubbles.
- If the cause of bubbles is a drop in level upstream, lessen the drop.
- When there is a layer of air in the pipe, install an air bleed valve forward of the measurement location.

(3) Given measurement accuracy cannot be obtained

• Incorrect site condition

Check pipe specification.

• Insufficient straight pipe length

Required straight pipe length may vary according to changes in pipe conditions forward and backward of the measurement position (merged or separating flows, presence of valve, etc.). Refer to Chapter "**1.2.5 Selection of transducer setup position** (p.1-26)".

• Inside pipe condition

Cause may also be attributable to changes in fluid cross sectional area due to pipe rust, scale and partially filled pipe conditions. Refer to Chapter "**1.2.5 Selection of transducer setup position** (p.1-26)".

• Seam part of pipe

It may cause seam part to make un-expected reflection of ultrasonic. Select no-seam part for transducer installation. Please refer to Chapter "**1.2.5 Selection of transducer setup position** (p.1-26)".

(4) Measurement values are unstable

• Entrained bubbles or solid particles in the fluid

It may cause fluctuation or spikes in measurements or create non-measurable conditions. Please eliminate the sources of these problems.

• Cavitation occurs.

Cavitation sometimes occurs when butterfly valves are used.
When there is cavitation from entrained air, select a measurement position sufficiently distanced from such locations and where the bubble problem ceases to exist.

• External noise

Electrical signals received by ultrasonic flowmeters generally are very weak - in the order of a few mV's - and as such ultrasonic flowmeters are susceptible to power surges and noises. When there is the possibility of external noise interference on ultrasonic flowmeter measurement, check the layout of each cable. In the case of noise intrusion (especially on sensor cables) from an AC power source, installation of a shielded transformer, etc., is effective. However the high magnitude of noise interference from inverters sometimes invalidates such countermeasures.
In case of metal pipe application, small or medium transducer must be insulated from the pipe electrically. Some of the stronger noise like coming from invertors may not be avoidable. Using extension cable is also conductive to get noise influence.

(5) Echo is received, but no fluid inside.

• Ultrasonic transmits through the pipe wall surface

In case of some of the conditions which related with pipe material, pipe diameter or transducer installation method, the ultrasonic may transmit on the pipe wall surface.
When the location of surface echo is very near-by proper echo point, main unit may not be able to clarify between proper echo and surface echo. Therefore, it might not be able to be judged no echo receiving.
When the transducer installation method is changed, it could be possible to avoid this.
A similar phenomenon might be shown in PVC lining steel pipe which may contain air layer between metal and lining, even if there is a fluid. Refer to "**(1) Pipes which cannot be measured** (p.3-31)".

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