Instruction Manual

TIME DELTA-C
ULTRASONIC FLOWMETER

TYPE: FSV (Flow transmitter)
FLS, FSG, FSD (Detector)
FLY (Signal cable)

Fuji Electric Co., Ltd.

INF-TN1FSVGd-E

Introduction

We thank you very much for purchasing Fuji Electric's ultrasonic flow meter.
The instruction manual concerns the installation, operation, checkup and maintenance of the Flow transmitter (FSV), Detector (FLS/FSG/FSD) and Signal cable (FLY) of ultrasonic flow meter. Read it carefully before operation.

- First read this instruction manual carefully until an adequate understanding is acquired, and then proceed to installation, operation and maintenance of the flow meter. Improper handling may result in an accident or a failure.
- The specifications of this flow meter are subject to change without prior notice for improvement of the product.
- Do not attempt to modify the flow meter without permission. Fuji will not bear any responsibility for a trouble caused by such a modification. If it becomes necessary to modify the flow meter, contact our office in advance.
- This instruction manual should always be kept on hand by the operator.
- After reading the manual, be sure to store it at a place easier to access.
- This instruction manual should be delivered to the end user.
- If the instruction manual has been lost, request another one (with charge) to our local business office.

Manufacturer:	Fuji Electric Co., Ltd.
Type:	Described in the nameplate put on the main body
Date of manufacture:	Described in the nameplate put on the main body
Product nationality:	Japan

Issued in June, 2007
Rev. 1st edition March, 2008
Rev. 2nd edition Septmber, 2010
Rev. 3rd edition April, 2011
Rev. 4th edition March, 2012

SAFETY PRECAUTIONS

Before using this product, read the following safety precautions and use the product correctly.

The following items are important for safe operation and must be fully observed.
These safety precautions are ranked in 2 levels; "DANGER" and "CAUTION".

Warning/Symbol	Meaning
DANGER	Incorrect handling of the device may result in death or serious injury.
CAUTION	Incorrect handling may lead to a risk of medium or light injury, or to a risk of physical damage.

The items noted under "⚠ CAUTION" may also result in serious trouble depending on circumstances.
All the items must be fully observed.

Caution on mounting and piping

DANGER

- This unit is not explosion-proof type. Do not use it in a place with explosive gases. Otherwise, it may result in serious accidents such as explosion, fire, etc.

CAUTION

- The unit should be installed in a place conforming to the installation requirements noted in this instruction manual. Otherwise, it may cause electric shocks, fire or malfunction of the unit.
- Install the flow meter according to the following steps to prevent it from damage, and to avoid error or malfunction.
- During installation, make sure that the inside of the unit is free from cable chips and other foreign objects. Otherwise, it may cause fire, failure or malfunction.
- The items under "Caution on Installation" noted in the manual must be fully observed. Careless installation may result in trouble or malfunction of the unit.

Cautions in wiring

CAUTION

- When performing wiring termination to prevent output trouble caused by moisture, dew condensation or water leak, follow “Section 3.4. Flow transmitter wiring” described in this manual.
- Before performing the wiring work, be sure to turn OFF the main power. Otherwise, it may cause electric shock.
- Do not perform wiring work outdoors in rainy days to prevent insulation deterioration and dew condensation. Otherwise, it may result in trouble, malfunction, etc.
- Be sure to connect a power source of correct rating. Use of power source out of rating may cause fire.
- The unit must be grounded as specified. Otherwise, it may cause electric shocks, malfunction, etc.
- The signal cable and analog output signal cable should be wired as far away as possible from high-voltage lines to prevent entry of noise signals as it will cause malfunction of the unit.
- To prevent malfunction of the unit, the analog output signal cable and power cable should be wired using separate conduits.

Caution on maintenance and inspection

⚠ CAUTION

- The unit should be inspected every day to always obtain good results of measurements.
- When measuring the insulation resistance between the power/output terminal and the case, follow “Section 6.2.3. How to measure the insulation resistance” described in this manual.
- If the fuse is blown, detect and eliminate the cause, and then replace the fuse with a spare. If there are no spares, replace the fuse with the one specified in this manual (that must be aquired separately). Use of a fuse other than specified or its short-circuit may cause an electric shock or fire. The fuse should be replaced according to “Section 6.3. How to replace the fuse” described in this manual.

CAUTION ON INSTALLATION LOCATION

⚠ CAUTION

(1) A place that provides enough space for periodic inspection and wiring work.
(2) A place not exposed to direct sunshine nor inclement weather.
(3) A place free from excessive vibration, dust, dirt and moisture.
(4) A place not subjected to radiated heat from a heating furnace, etc.
(5) A place not subjected to corrosive atmosphere.
(6) A place not to be submerged.
(7) A place remote from electrical devices (motor, transformer, etc.) which generate electromagnetic induction noise, electrostatic noise, etc.
(8) A place not subjected to excessive fluid pulsation such as pump discharge side.
(9) A place that provides enough place for the length of the straight pipe.
(10) A place where ambient temperature and humidity are -20 to +50°C and 95% RH or less for flow transmitter (FSV), -20 to +60°C and 95% RH or less for detector (FSG) and -20 to +60°C and 90% RH or less for detector (FLS/FSD).

Contents

1. PRODUCT OUTLINE

1.1. Checking delivered items

After opening the package, check if all following parts are present.
Note that the delivered parts vary according to the model type.

Flow transmitter (FSV)
- Flow transmitter main unit ····· 1 set
- Waterproof gland (Built into the main unit) ····· 1 set
- Wall mount frame (Built into the main unit)····· 1 set
- Panel mounting bracket (option)
  (U bolt, support fixture, butterfly nut 2 pieces,
  spring washer 2 pieces, plain washer 2 pieces)····· 1 set

Detector (FLSS12, FLSS22)
- Frame····· 1 piece
- Sensor unit × 2 ····· 1 set
- Stainless steel belt (FLSS12: 2 pieces, FLSS22: 4 pieces)····· 1 set
- Optional Acoustic coupler····· 1 piece

Detector (FSGS31, 32)
- Small size detector····· 1 set
- Chain × 2····· 1 set
- Silicone rubber or optional acoustic coupler

Detector (FSGS41)
- Middle size detector × 2 ····· 1 set
- Wire rope × 2 ····· 1 set
- Mounting spring × 2····· 1 set
- Silicone rubber or optional acoustic coupler

Detector (FSGS50, 51)
- Large size detector × 2 ····· 1 set
- Wire rope × 2 ····· 1 set
- Mounting spring × 2 ····· 1 set
- Silicone rubber or optional acoustic coupler
- Detector mounting set····· 1 set

Detector (FSD22)
- Small diameter detector ····· 1 set
- Stainless steel belt ····· 1 set
- Silicone rubber·····1 piece

Detector (FSD32)
- High temperature detector ····· 1 set
- Stainless steel belt ····· 1 set
- Silicone grease for high temperature ·····1 piece

Signal cable (for FLS) (FLY3: length specified) × 2 ····· 1 set
Signal cable (for FSG) (FLY8: length specified) × 2····· 1 set
Signal cable (for FSD) (FLY9: length specified) × 2····· 1 set
Communication cable (for RS-232C)····· 1 set
CD-ROM (Instruction manual and loader software)···1 piece

Out of delivery
- Power cable
- Output signal cable
- RS-485 communication cable

Flow transmitter (FSV)
FSV···S (IP66) FSV···H (IP67)

Pipe mounting bracket (option)

Detector (FSGS31, 32)
Small size detector

Chain

Detector (FSGS50, 51)
Large size detector

Wire rope

Mounting spring

Detector mounting set

Signal cable (FLY3)

Signal cable (FLY8)

Signal cable (FLY9)

Detector (FLSS12, FLSS22)

Stainless steel belt

Communication cable (RS-232C)

Detector (FSGS41)
Middle size detector

Wire rope

Mounting spring

Detector (FLD22, 32)
Small diameter detector

High temperature detector

Stainless steel belt

Acoustic coupler
Silicone rubber

Silicone-free grease

Silicone grease for high temperature

Silicone grease

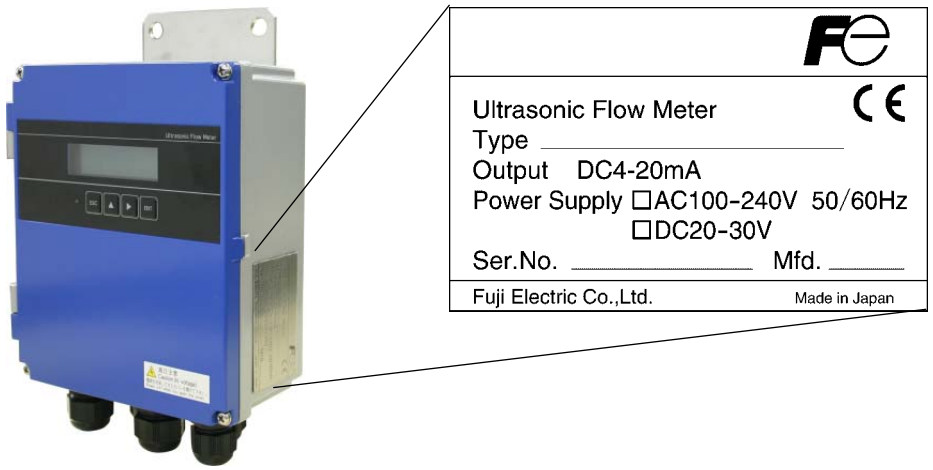
1.2. Check on type and specifications

The type and specifications of product are indicated on the specifications plate mounted on the flow transmitter and detector frame.
Check that they represent the type you ordered, referring to the following code symbols.

<Flow transmitter (FSV)>

1	2	3	4	5	6	7	8	-	9	10	11	12	13	-	14	Contents
F	S	V			Y		1	-						-		
			S													<Type> Standard (Japanese)
			E													Standard (English)
				Y												<Communication> Without
				A												RS-232C + DI (for cable only)
				B												RS-485 + DI
					Y											<Application> Single-path
						1										<Power supply> 100 to 240V AC, 50/60Hz
						4										20 to 30V DC
							1									Modification No. (8th digit)
									S							<Case structure> IP66
									H							IP67
										Y						<Wiring connection port> G1/2 and G3/8 (female screw) with water-proof connection
										A						Union (for plica) with gland [G1/2 female screw] (when "H" is specified at 9th digit)
											Y					<Used in combination with the explosion-proof detector> Without
												Y				<Parameter setting> Without
												A				With setting
												B				With setting and tag plate
												C				Tag plate
													A			<Mounting method> Pipe mounting (if the 9th digit is S)
													B			Wall mounting
													C			Pipe mounting (if the 9th digit is H)

Flow transmitter : FSV···S (IP66)



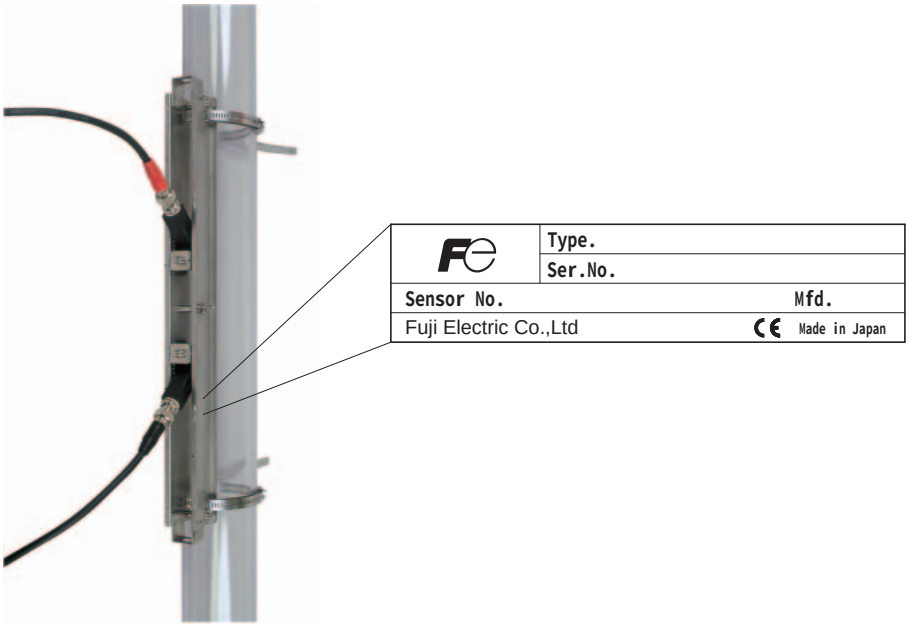
Flow transmitter : FSV···H (IP67)

<Detector (FLS)>

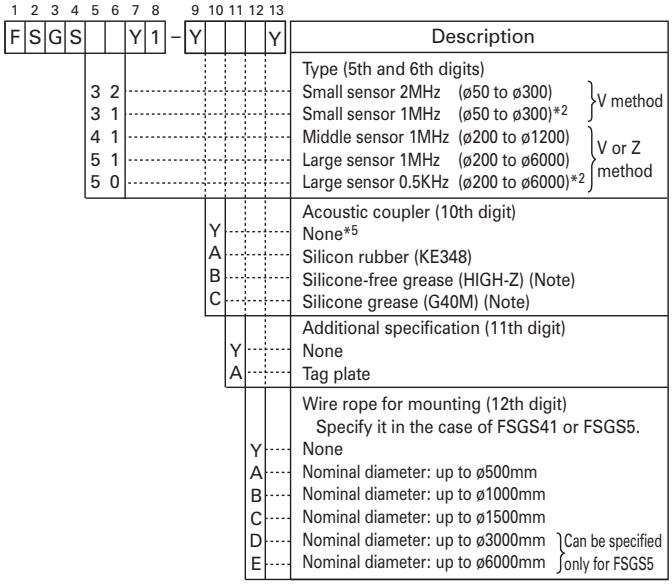
1	2	3	4	5	6	7	8		9	10	Contents	
F	L	S	S				3	-				
			S								Specification (4th digit) Standard	
				1	2						Type (5th to 6th digit) Small diameter detector 2 MHz (Φ25 to Φ100mm)	V method
				2	2						Small size detector 2 MHz (Φ50 to Φ225mm)	
						Y					Acoustic coupler (7th digit) (Note) Without	
						A					Silicone rubber	
						B					Silicone-free grease	
							3				Modification No. (8th digit)	
									Y		Fluid temperature range (9th digit) -20 to +100°C	
									A		0 to +120°C	
										Y	Optional specifications (10th digit) Without	
										B	Tag plate	

Note) Select silicone rubber (A) for the acoustic coupler in ordinary cases. Silicone rubber is supplied in a tube (100g). If two or more instruments are ordered, you can select a tube of silicone rubber for every 5 units. Select silicone-free grease (B) if the instrument is to be used in an environment where generation of silicone is not desirable such as semiconductor manufacturing facilities. The grease, which is soluble in water, should not be used in an environment where water may be splashed onto it or condensation may occur on the surface of the piping. Since it does not harden, periodic maintenance (cleaning and refilling of approximately once every 6 months in room temperature) is required.

FLSS12, 22



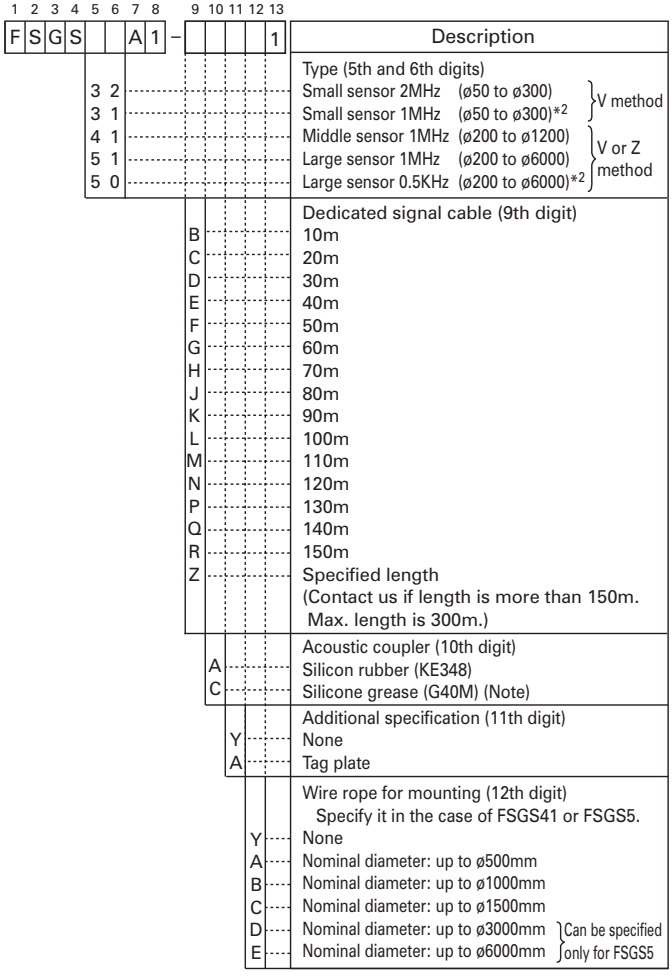
<Detector (FSG), common type>



1 2 3 4 5 6 7 8	9 10 11 12 13	Description
F S G S	Y	
		Type (5th and 6th digits)
3 2		Small sensor 2MHz (ø50 to ø300) } V method
3 1		Small sensor 1MHz (ø50 to ø300)*2 } V method
4 1		Middle sensor 1MHz (ø200 to ø1200) } V or Z method
5 1		Large sensor 1MHz (ø200 to ø6000) } V or Z method
5 0		Large sensor 0.5KHz (ø200 to ø6000)*2 } V or Z method
		Acoustic coupler (10th digit)
	Y	None*5
	A	Silicon rubber (KE348)
	B	Silicone-free grease (HIGH-Z) (Note)
	C	Silicone grease (G40M) (Note)
		Additional specification (11th digit)
	Y	None
	A	Tag plate
		Wire rope for mounting (12th digit) Specify it in the case of FSGS41 or FSGS5.
	Y	None
	A	Nominal diameter: up to ø500mm
	B	Nominal diameter: up to ø1000mm
	C	Nominal diameter: up to ø1500mm
	D	Nominal diameter: up to ø3000mm } Can be specified only for FSGS5
	E	Nominal diameter: up to ø6000mm } Can be specified only for FSGS5

*2: For aging pipes, cast iron pipes or mortar-lined pipes that interrupts the propagation of ultrasonic signals, select FSGS31 or FSGS50.
*3: Procure type FLY for the signal cable.
*5: Silicone rubber (KE-348W) is provided as a standard accessory to fill the wiring mold. (It can also be used as an acoustic coupler.)
If an additional acoustic coupler is required, select one among A, B and C.

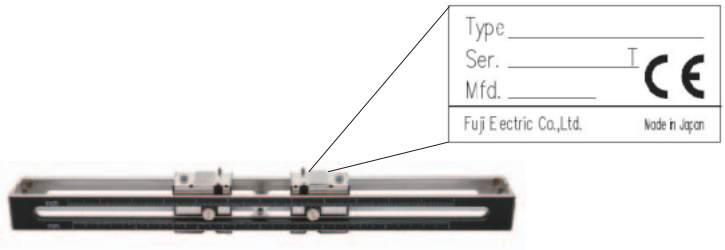
<Detector (FSG), submersible type>



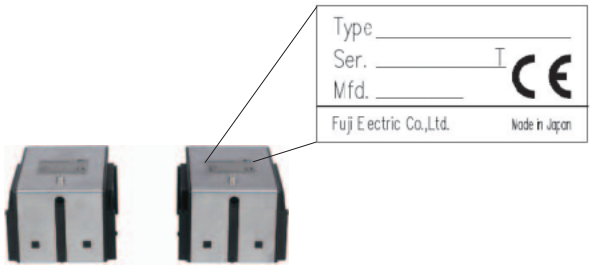
1 2 3 4 5 6 7 8	9 10 11 12 13	Description
F S G S	1	
		Type (5th and 6th digits)
3 2		Small sensor 2MHz (ø50 to ø300) } V method
3 1		Small sensor 1MHz (ø50 to ø300)*2 } V method
4 1		Middle sensor 1MHz (ø200 to ø1200) } V or Z method
5 1		Large sensor 1MHz (ø200 to ø6000) } V or Z method
5 0		Large sensor 0.5KHz (ø200 to ø6000)*2 } V or Z method
		Dedicated signal cable (9th digit)
	B	10m
	C	20m
	D	30m
	E	40m
	F	50m
	G	60m
	H	70m
	J	80m
	K	90m
	L	100m
	M	110m
	N	120m
	P	130m
	Q	140m
	R	150m
	Z	Specified length (Contact us if length is more than 150m. Max. length is 300m.)
		Acoustic coupler (10th digit)
	A	Silicon rubber (KE348)
	C	Silicone grease (G40M) (Note)
		Additional specification (11th digit)
	Y	None
	A	Tag plate
		Wire rope for mounting (12th digit) Specify it in the case of FSGS41 or FSGS5.
	Y	None
	A	Nominal diameter: up to ø500mm
	B	Nominal diameter: up to ø1000mm
	C	Nominal diameter: up to ø1500mm
	D	Nominal diameter: up to ø3000mm } Can be specified only for FSGS5
	E	Nominal diameter: up to ø6000mm } Can be specified only for FSGS5

*2: For aging pipes, cast iron pipes or mortar-lined pipes that interrupts the propagation of ultrasonic signals, select FSGS31 or FSGS50.

FSGS3, (FSGS4)



FSGS5

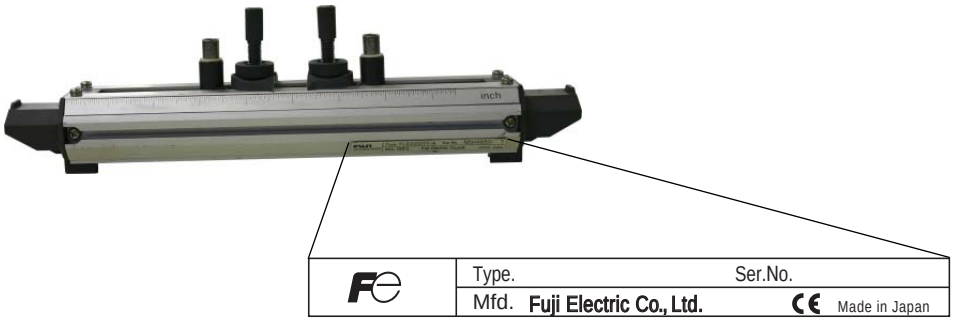


<Detector (FSD)>

1	2	3	4	5	6	7	8	Description
F	S	D	2	2	0	S	1	Small diameter sensor (ø13 to ø100) V method
F	S	D	3	2	0	Y	1	High-temperature sensor *1 (ø50 to ø400) V or Z method

*1: For turbid fluid or old pipe, cast iron pipe, mortar lining pipe or others through which the ultrasonic signal could not be transmitted easily, use an optional guide rail for high temperature (TK4J5917C3), and carry out mounting by Z method.
Applicable diameter range
V method: ø50 to ø250 Z method: ø150 to ø400

Note: As standard acoustic coupler, silicone rubber (KE-348W) is provided for small diameter sensor, or grease for high temperature (KS62M) for high-temperature sensor.



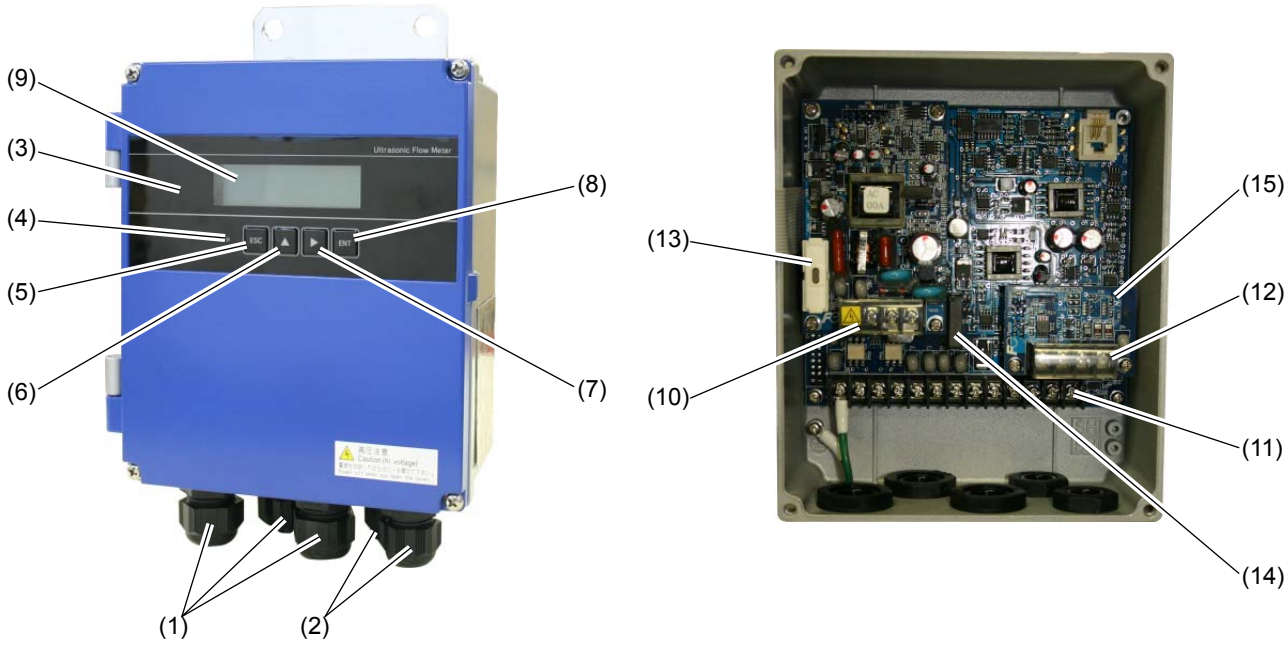
<Signal cable (FLY)>

1	2	3	4	5	6	7	8	Contents
F	L	Y					1	Type (4th digit)
			3					For FLS (Max.60m) Provided with one-side waterproof BNC connector (Interlock waterproof type)
			8					For FSG (Max. 150m)
			9					For FSD Provided with one-side BNC connecton (Non-waterproof type)
								Cable length (5th to 7th digit)
				0	0	5		5m
				0	1	0		10m
				0	1	5		15m
				0	2	0		20m
				0	3	0		30m
					·			Note) 20 to 150m is treated in the unit of 10m.
					·			
				1	5	0		150m
				Z	Z	Z		Others (Please contact us.)

Note) Must be procured unless the sensor is a submersible type.

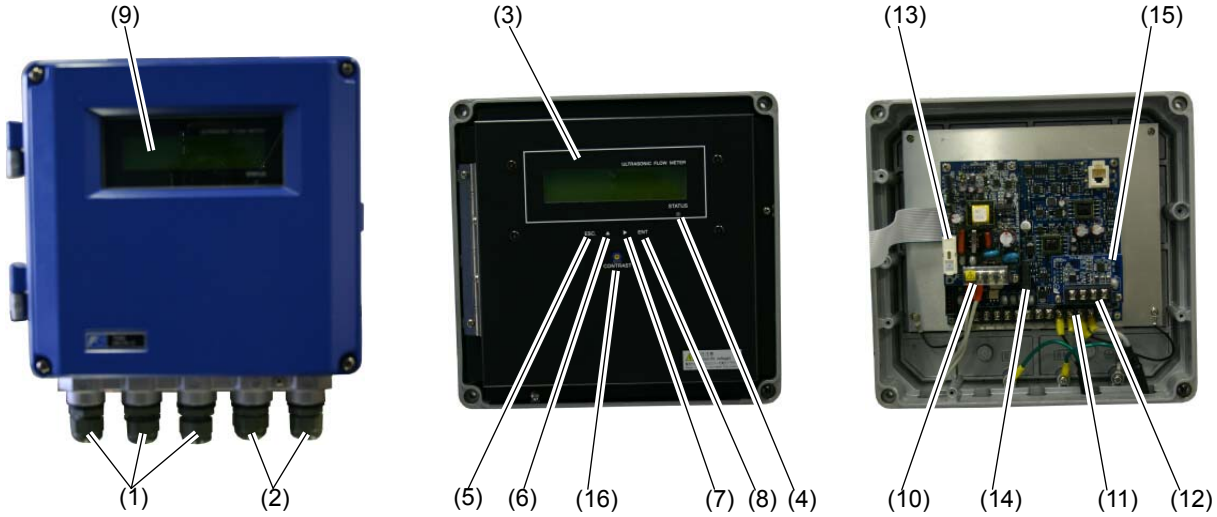
1.3. NAME AND FUNCTION OF EACH PART

1.3.1. Flow transmitter : FSV···S (IP66)



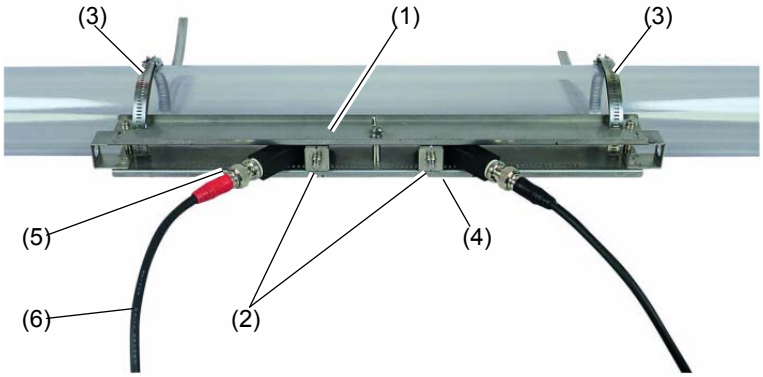
No.	Name	Key	Description
(1)	Wiring connection port, large		Wiring connection port for power cable and output cable.
(2)	Wiring connection port, small		Wiring connection port for signal cable only.
(3)	Indication and setting unit		Indicates and sets the flow rate, etc.
(4)	Received wave diagnostic indication (LED)		Indicates whether received wave is normal (green) or abnormal (red).
(5)	Escape key	ESC	Returns to the next-higher menu level or cancels the set status.
(6)	UP key	△	Selects items, numeric values and symbols.
(7)	Shift key	▷	Moves the cursor and selects decimal place.
(8)	Entry key	ENT	Enters a selection or registers a setting.
(9)	LCD display		Indicates the flow rate or setting.
(10)	Power terminal		Connects the power cable.
(11)	Input/output terminal		Connects signal cable, analog output or DO output cable.
(12)	Communication board terminal		Connects communication cable. (A communication board is optional)
(13)	Fuse holder		Fuse holder
(14)	Relay		Relay contact for DO3 output
(15)	Communication board		Mounted if communication is optionally designated.

1.3.2. Flow transmitter : FSV···H (IP67)



No.	Name	Key	Description
(1)	Wiring connection port, large		Wiring connection port for power cable and output cable.
(2)	Wiring connection port, small		Wiring connection port for signal cable only.
(3)	Indication and setting unit		Indicates and sets the flow rate, etc.
(4)	Received wave diagnostic indication (LED)		Indicates whether received wave is normal (green) or abnormal (red).
(5)	Escape key	ESC	Returns to the next-higher menu level or cancels the set status.
(6)	UP key	△	Selects items, numeric values and symbols.
(7)	Shift key	▷	Moves the cursor and selects decimal place.
(8)	Entry key	ENT	Enters a selection or registers a setting.
(9)	LCD display		Indicates the flow rate or setting.
(10)	Power terminal		Connects the power cable.
(11)	Input/output terminal		Connects signal cable, analog output or DO output cable.
(12)	Communication board terminal		Connects communication cable. (A communication board is optional)
(13)	Fuse holder		Fuse holder
(14)	Relay		Relay contact for DO3 output
(15)	Communication board		Mounted if communication is optionally designated.

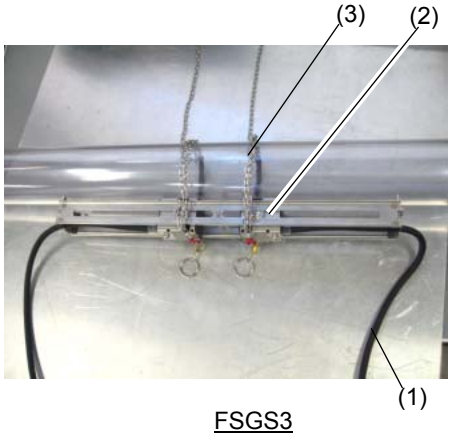
1.3.3. Small diameter/small size detector (FLS)



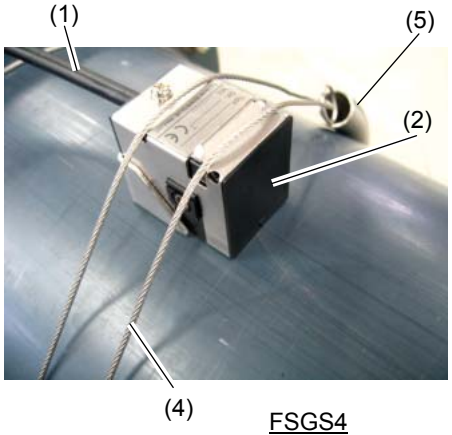
FLSS12, 22

No.	Name	Description
(1)	Frame for small size	Fastens the sensor unit on pipe.
(2)	Sensor unit	Sends and receives an ultrasonic wave.
(3)	Stainless steel belt	Fastens the frame on pipe.
(4)	Scale	Reads the sensor mounting spacing.
(5)	Fastening hole	Makes a position and fastens the sensor units.
(6)	Signal cable	Transmits send/receive signals.

1.3.4. Small/middle size detector (FSG)



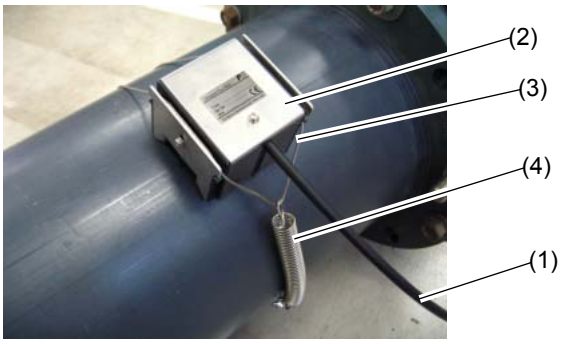
FSGS3



FSGS4

No.	Name	Description
(1)	Signal cable	Transmits send/receive signals.
(2)	Detector	Sends and receives an ultrasonic wave.
(3)	Chain	Fastens the detector on pipe.
(4)	Wire rope	Fastens the detector on pipe.
(5)	Mounting spring	Removes the play of wire rope.

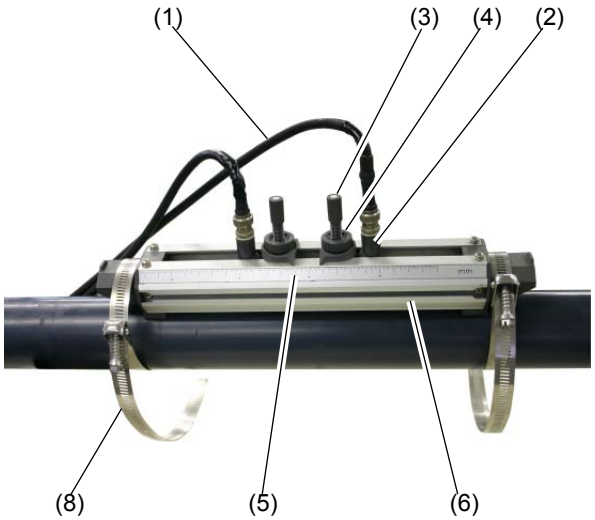
1.3.5. Large size detector (FSG)



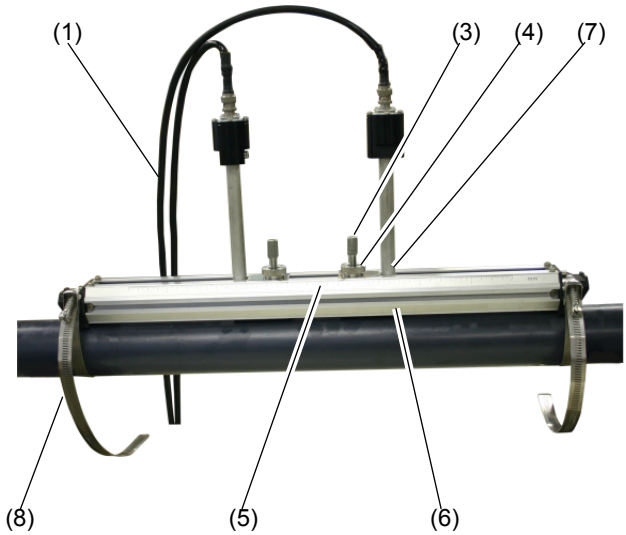
FSGS5

No.	Name	Description
(1)	Signal cable	Transmits send/receive signals.
(2)	Detector	Sends and receives an ultrasonic wave.
(3)	Wire rope	Fastens the detector on pipe.
(4)	Mounting spring	Removes the play of wire rope.

1.3.6. Small diameter/High temperature detector (FSD)



FSD22



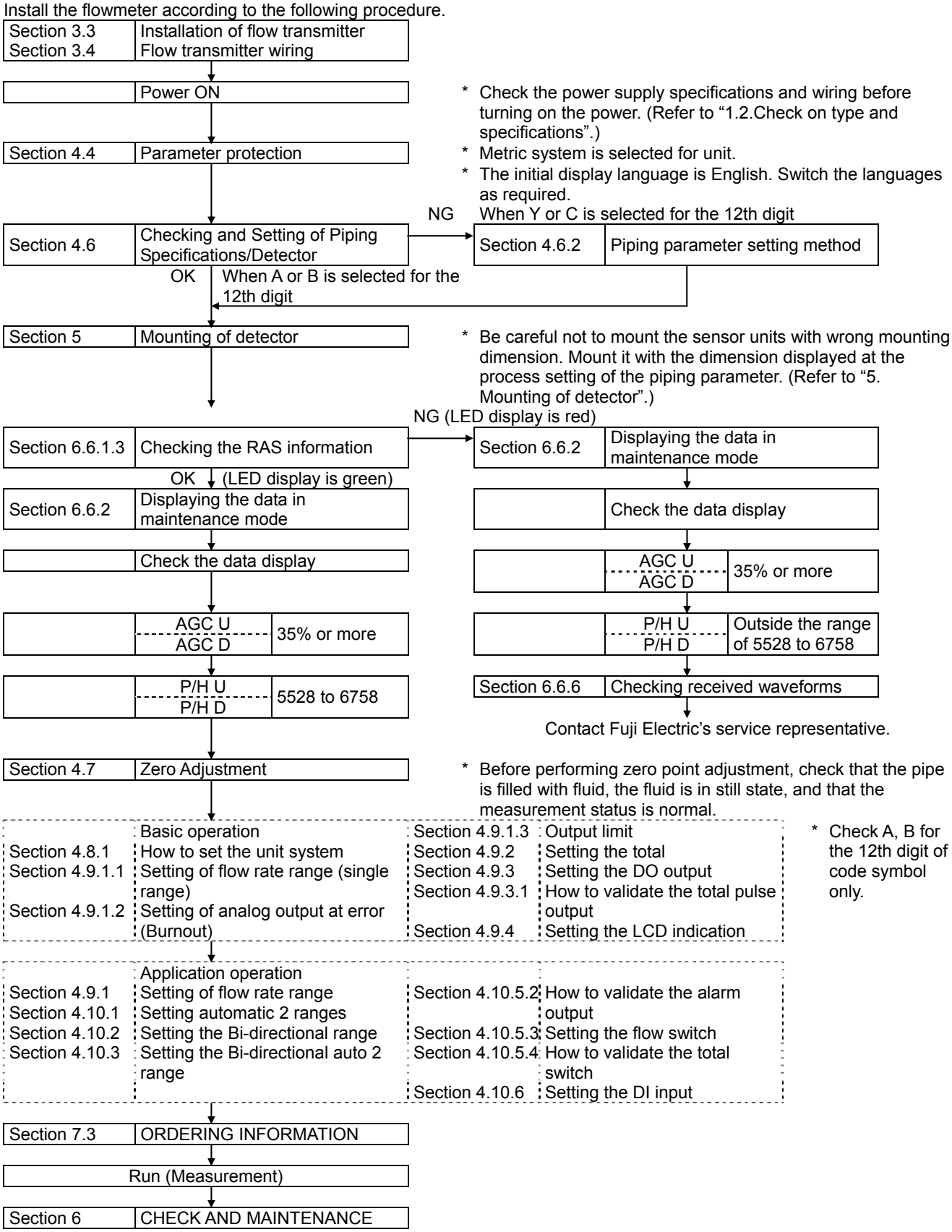
FSD32

No.	Name	Description
(1)	Signal cable	Transmits the send/receive signals.
(2)	Sensor unit	Sends and receives an ultrasonic wave.
(3)	Element holder	Attaches the sensor unit firmly to the pipe.
(4)	Lock nut	Fixes the sensor unit mounting position.
(5)	Scale	Reads the spacing between the sensor units.
(6)	Frame	Fastens the sensor unit on pipe.
(7)	High temperature detector	Sends and receives an ultrasonic wave.
(8)	Stainless steel belt	Fastens the sensor frame on pipe.

2. INSTALLATION AND BEFORE START OF OPERATION OF THE FLOW TRANSMITTER

2.1. Outline of installation procedure

Install the flowmeter according to the following procedure.



Note) Set the parameter protection to OFF before you change settings or perform zero adjustment.

3. INSTALLATION

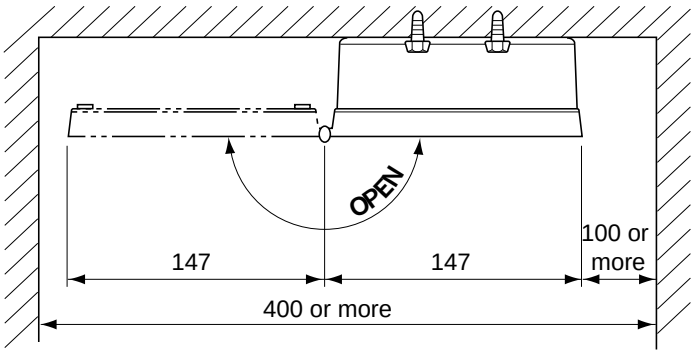
Select an installation location that satisfies the following conditions for ease of maintenance and inspection, service life of the instrument, and assurance of reliability all considered.

⚠ CAUTION

(1) A place where ambient temperature and humidity are -20 to +55°C and 95% RH or less for flow transmitter (FSV), -20 to +60°C and 95% RH or less for detector (FSG) and -20 to +60°C and 90% RH or less for detector (FLS/FSD).
(2) A place not exposed to direct sunshine nor inclement weather.
(3) Space for periodic inspection and wiring work is available.
(4) A place not subjected to radiated heat from a heating furnace, etc.
(5) A place not subjected to corrosive atmosphere.
(6) A place not to be submerged.
(7) A place free from excessive vibration, dust, dirt and moisture.

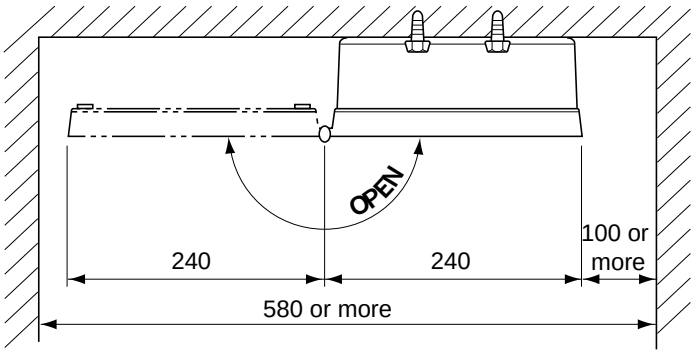
3.1. Installation location of flow transmitter

Secure at least 100 mm of space between the flow transmitter and nearby wall. Also secure a space of opening the front cover in case of maintenance.
Allow space for cable wiring under the case.



Unit:mm

Fig. 3.1 Top view of mounting (Flow transmitter : FSV···S (IP66))

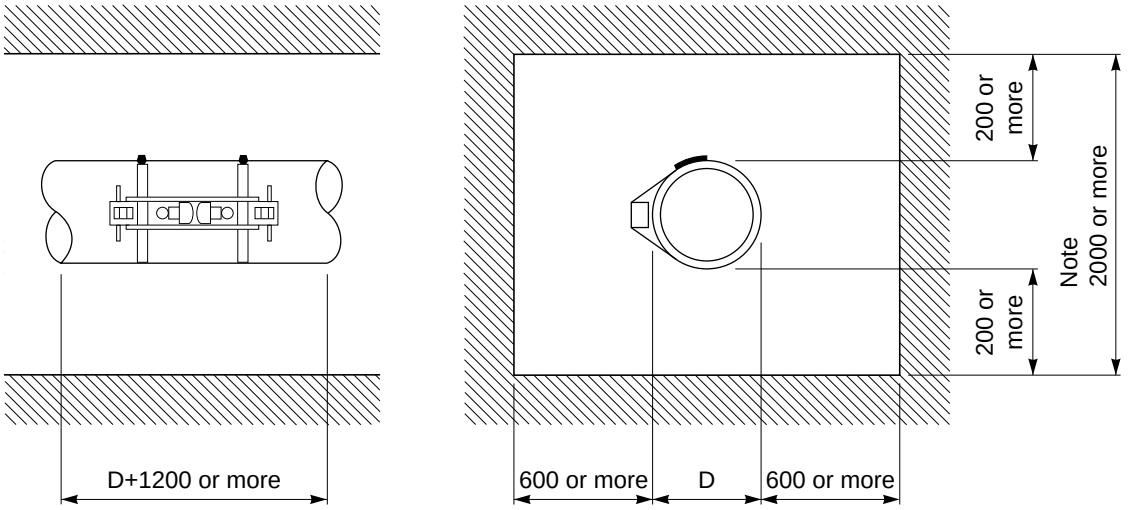


Unit:mm

Fig. 3.2 Top view of mounting (Flow transmitter : FSV···H (IP67))

3.2. Installation location of detector

The measuring accuracy is considerably affected by the detector mounting place, including physical setup of pipe to measuring a flow rate. Select a location which meets the condition in section 3.2.1. (Length of straight pipe). Also, reserve enough space for installation and maintenance referring to the following diagram.



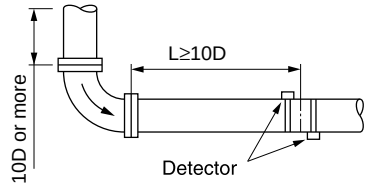
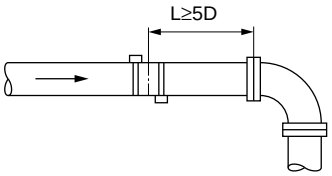
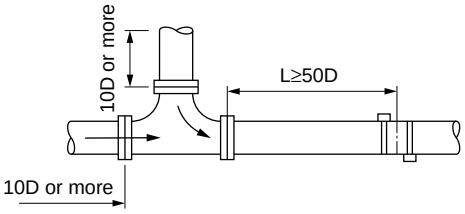
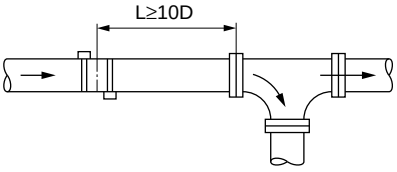
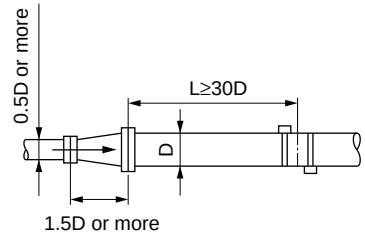
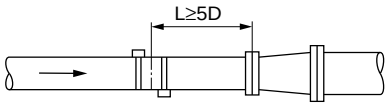
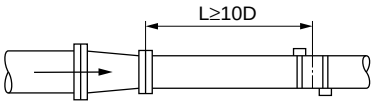
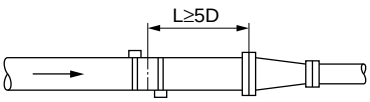
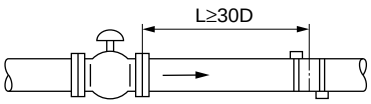
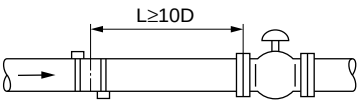
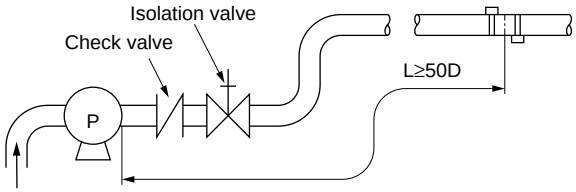
D : Pipe diameter
Unit : mm

Adequate space for the installation location of detector

3.2.1. Length of straight pipe

The length of upstream and downstream straight pipe of the ultrasonic detector should be long enough to ensure accurate measurements.

(D is nominal diameter for a pipe)

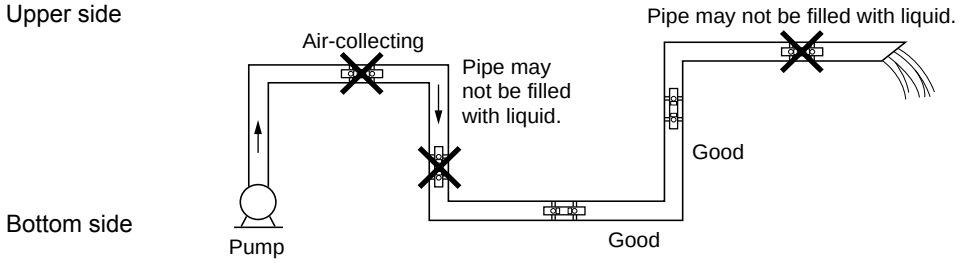
Type	Length of upstream straight pipe	Length of downstream straight pipe
90° vending		
Tee		
Extension pipe		
Contraction pipe		
Individual valves	 When adjusting flow rate by the valve on the upstream side	 When adjusting flow rate by the valve on the downstream side
Pump		

Note) Source: Japan Electric Measuring Instruments Manufacturers' Association (JEMIS-032)

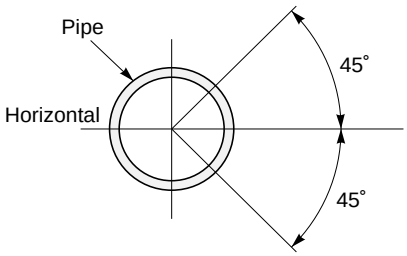
3.2.2. Mounting position

The detector can be installed vertical, horizontal or at any position provided that attention is paid to the following things.

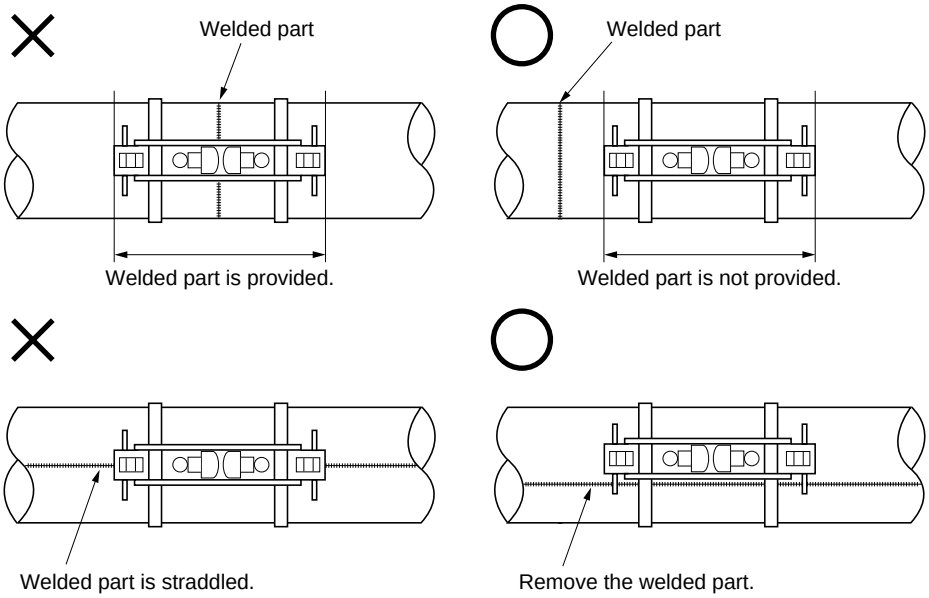
(1) The piping must completely be filled with fluid when it flows.



(2) Where a horizontal pipe is used, install the sensor within ±45° from the horizontal plane. Otherwise, the measurement could be impossible if bubbles stay in the upper part of piping or if deposits are accumulated in the lower part of piping. In case of vertical piping, the detector may be mounted at any position on its periphery provided that the flow is upward.



(3) Avoid installing the sensor on a deformed portion of pipe or welded portion of pipe, or on flange.

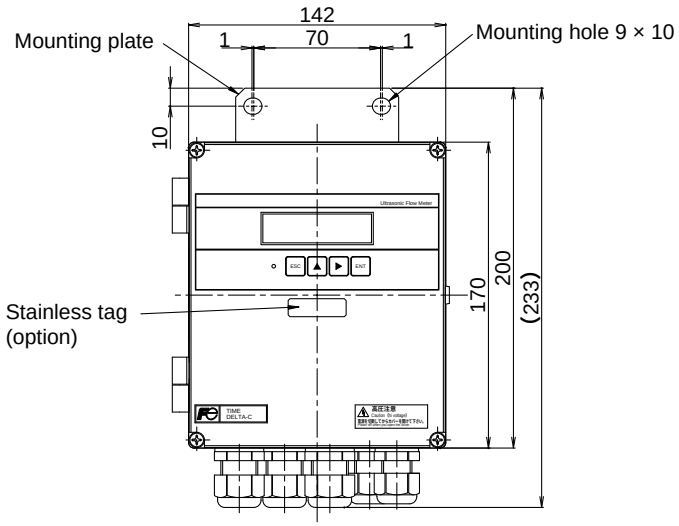


3.3. Installation of flow transmitter

The flow transmitter may be mounted on a wall or 2B pipe stand (option).

3.3.1. Wall mounting (Flow transmitter : FSV···S (IP66))

For wall mounting, use two M8 bolts.
Drill holes according to the mounting hole dimensions shown below, and fasten the flow transmitter using the M8 bolts.



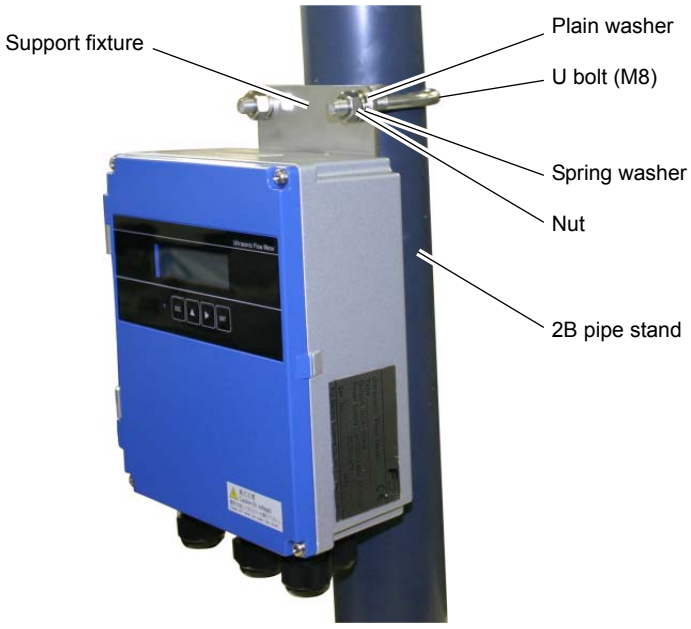
Norminal	Standard tightening torque
M8	12.5 [N·m]

3.3.2. 2B pipe stand mounting (Flow transmitter : FSV···S (IP66))

⚠ CAUTION

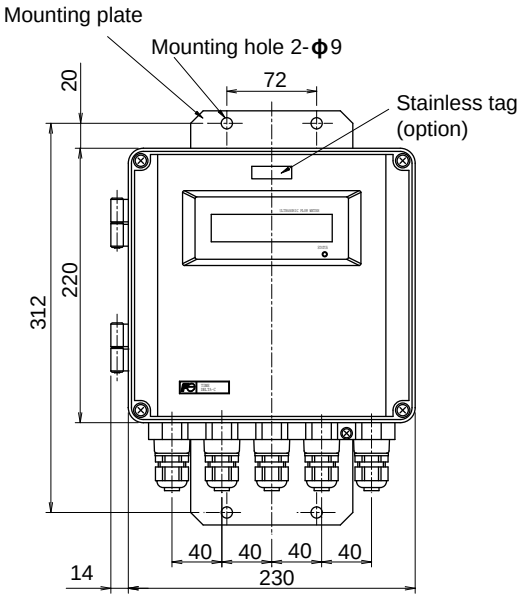
When mounting on 2B pipe, be sure to use a complete set of fixtures (U bolt, support fixture, plain washer, spring washer, nut) furnished if optionally designated. Tighten the nut by hand. If any support fixture is not used or if the assembly is excessively tightened by tool, the wall mounting fixture may be deformed.

Mount the instrument on 2B pipe stand as illustrated below.



3.3.3. Wall mounting (Flow transmitter : FSV···H (IP67))

For wall mounting, use four M8 bolts.
Drill holes according to the mounting hole dimensions shown below, and fasten the flow transmitter using the M8 bolts.



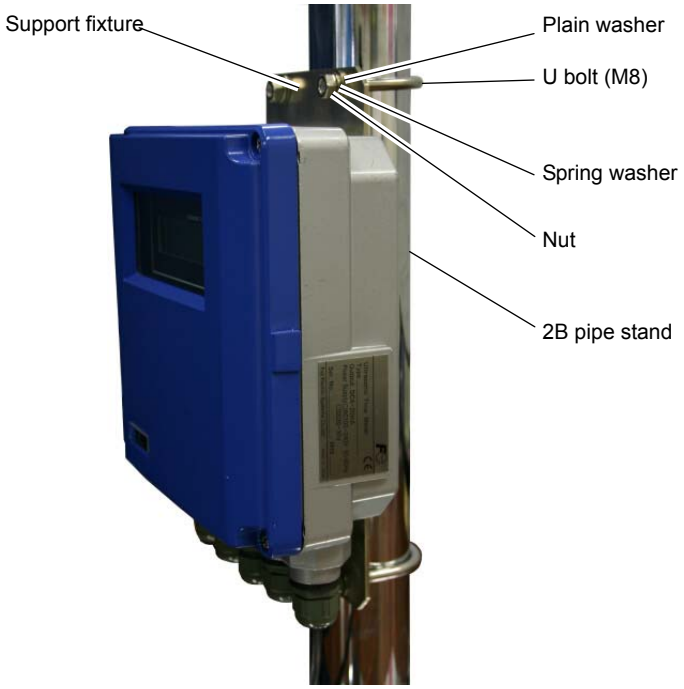
Norminal	Standard tightening torque
M8	12.5 [N·m]

3.3.4. 2B pipe stand mounting (Flow transmitter : FSV···H (IP67))

⚠ CAUTION

When mounting on 2B pipe, be sure to use a complete set of fixtures (U bolt, support fixture, plain washer, spring washer, nut) furnished if optionally designated. Tighten the nut by hand. If any support fixture is not used or if the assembly is excessively tightened by tool, the wall mounting fixture may be deformed.

Mount the instrument on 2B pipe stand as illustrated below.



3.4. Flow transmitter wiring

3.4.1. Cautions in wiring

⚠ CAUTION

(1) Use a special coaxial cable (FLY3, FLY8 or FLY9) as a signal cable between the detector (FLS/FSG/FSD) and flow transmitter (FSV). Do not provide a junction or splice of the signal cable midway.
(2) The signal cable between the detector or flow transmitter should be run in metallic conduits. Upstream and downstream signal cables may be put in the same conduit but, to avoid interference, do not put the power cable together.
(3) For output signal, use a shielded cable, where possible.
(4) To avoid noise interference, do not put the cables together with heavy duty line or the like into the same duct.
(5) If a ground wire is included in the power cable, connect it to ground as it is.
(6) A power switch is not provided on the instrument and must be mounted separately.
(7) Seal unused wiring ports by furnished caps.

3.4.2. Applicable wires

Use the following cables.

- Power cable : 3-wire or 2-wire cabtyre cable
  Nominal sectional area 0.75mm^2 or more
  Outside diameter Φ11mm
- Output signal cable : 2-wire or multi-wire cabtyre cable as required
  Outside diameter Φ11mm
- Detector-flow transmitter cable : Signal cable by type designation
  In case of detector FLS : Heat-resisting high-frequency coaxial cable having 50Ω of characteristics impedance.
  With one-side waterproof BNC connector
  Outside diameter Φ5mm
  In case of detector FSG : In case of FLW: High-frequency coaxial double shield cable with characteristic impedance of 50Ω
  Outside diameter Φ7.3mm
  In case of detector FSD : In case of FLW: High-frequency coaxial double shield cable with characteristic impedance of 50Ω
  With one-side Non-waterproof BNC connector
  Outside diameter Φ7.3mm

3.4.3. Treatment of wiring port

The casing of the flow transmitter is IP66 and IP67. However, if installed in a humid place, the wiring ports must be made airtight to avoid ingress of moisture, condensation, etc. Be sure to use the waterproof glands furnished with the instrument in order to ensure the waterproof means. A gland, which is not ready to be used, should be sealed by supplied cover.

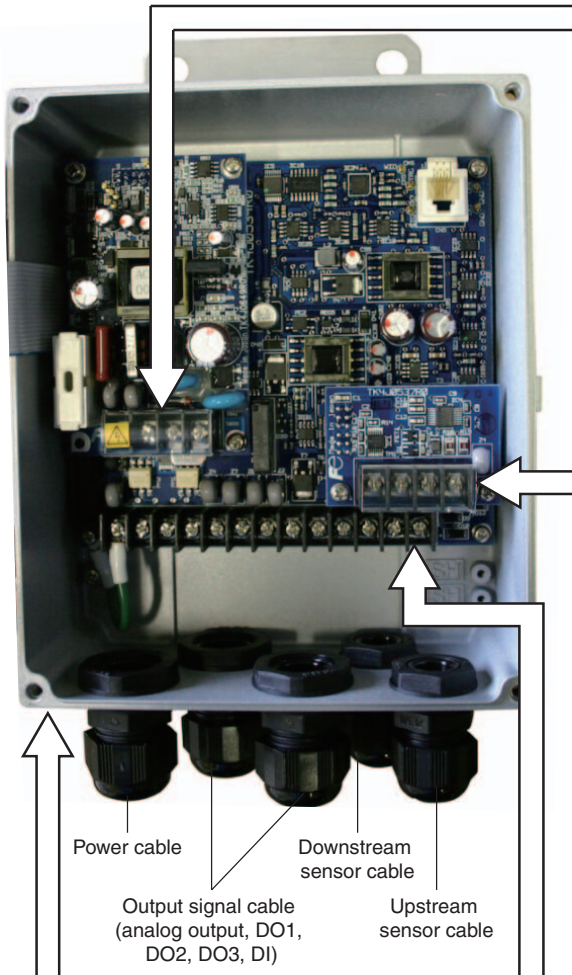
⚠ CAUTION

Do not install the instrument where there is a risk of flooding.

3.4.4. Wiring to each terminal

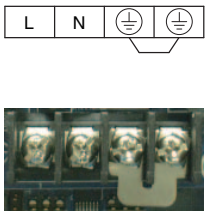
3.4.4.1. Flow transmitter : FSV···S (IP66)

Carry out wiring to each terminal according to the following figure.

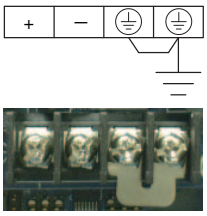


Power supply board terminal block

AC power supply
100 to 120V AC
or 200 to 240V AC
50/60Hz

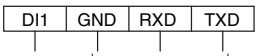


DC power supply
20 to 30V DC



Communication board terminal block (option)

RS-232C and DI



RS-232C

Status input
Non-voltage contact input

Note)

RS-485 and DI

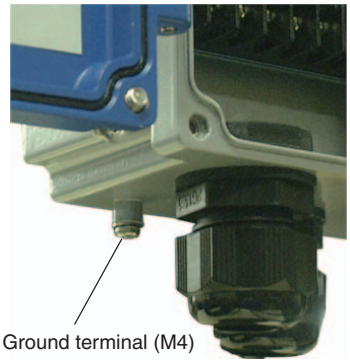
RS-485

Status input
Non-voltage contact input

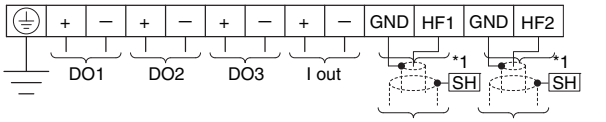
Note1) When you use optional PC communication loader cable, connect the cable of which terminal cap is black to GND, yellow to RXD and red to TXD.

Note2) Communication board identification
: Three-digit code at the upper right of the communication board
RS-232C ····2□□
RS-485 ·····1□□

External ground terminal

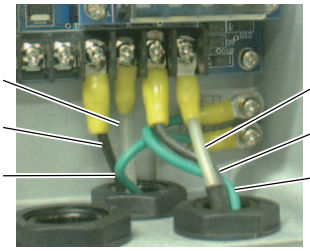


Main board terminal block



To upstream sensor

To downstream sensor



To upstream sensor

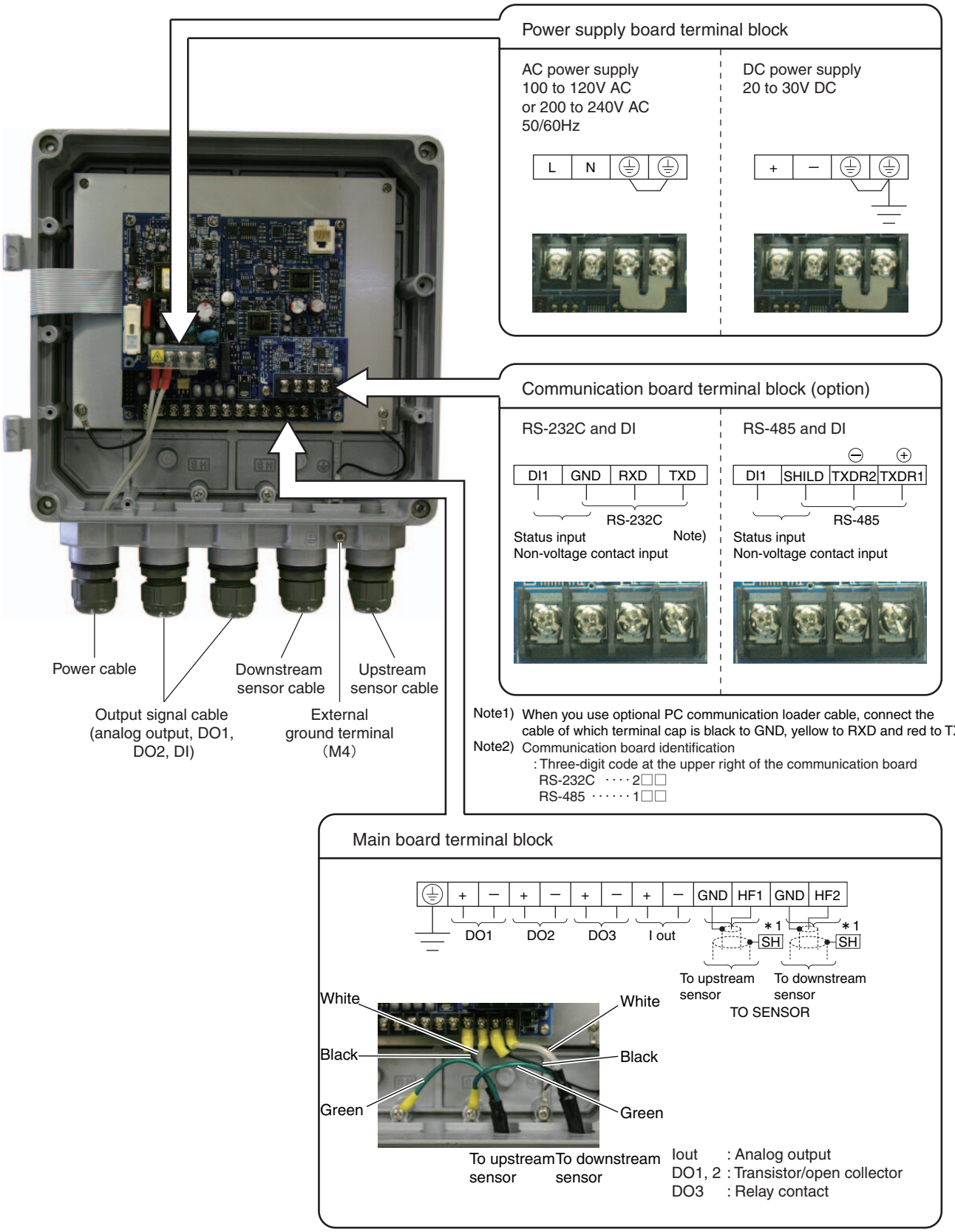
To downstream sensor

Iout : Analog output
DO1, 2 : Transistor/open collector
DO3 : Relay contact

Note 1) All screws are M3 on the terminal block. Use crimp-style terminals for M3 and whose outer diameter is Φ5.8 or smaller.
Note 2) Be sure to connect ground terminal to external ground terminal. (Class D grounding)
Note 3) For output signal, use multiple core cable as required.
Note 4) Differential signal line of RS-485 consists of two pins.
⊕ means TXD+／RXD+, and ⊖ means TXD-／RXD-.

3.4.4.2. Flow transmitter : FSV···H (IP67)

Carry out wiring to each terminal according to the following figure.



Note1) When you use optional PC communication loader cable, connect the cable of which terminal cap is black to GND, yellow to RXD and red to TXD.

Note2) Communication board identification
: Three-digit code at the upper right of the communication board
RS-232C ····2□□
RS-485 ·····1□□

Note 1) All screws are M3 on the terminal block. Use crimp-style terminals for M3 and whose outer diameter is Φ5.8 or smaller.

Note 2) Be sure to connect ground terminal to external ground terminal. (Class D grounding)

Note 3) For output signal, use multiple core cable as required.

Note 4) Differential signal line of RS-485 consists of two pins.
⊕ means TXD+／RXD+, and ⊖ means TXD-／RXD-.

4. Parameter

4.1. Description of display/setting unit

Display unit and setting unit are as shown below.

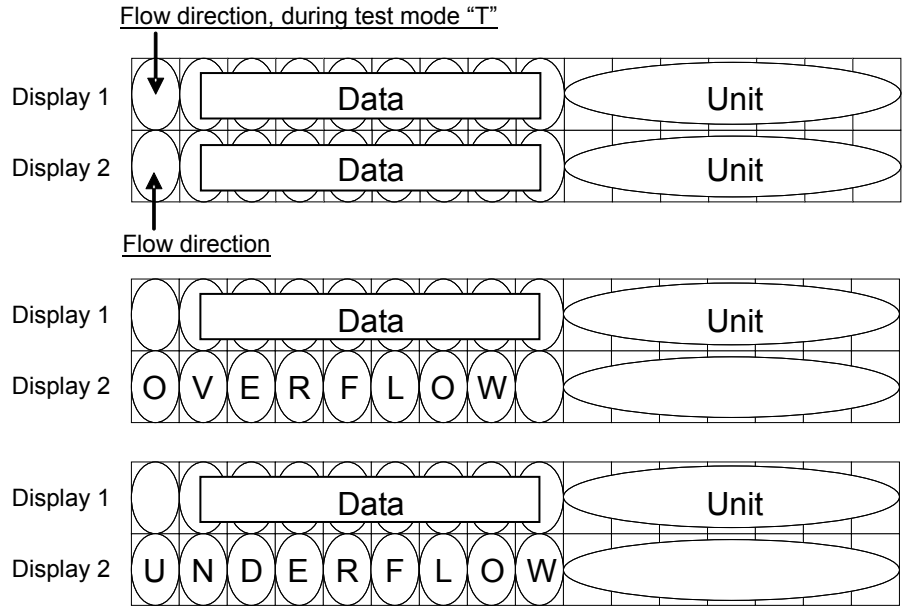
4.1.1. Flow transmitter : FSV···S (IP66) display/setting unit

4.1.2. Flow transmitter : FSV···H (IP67) display/setting unit

4.1.3. Description of display/setting unit

○ LCD display: Displays the measurement and setting (indication in 16 digits, 2 line).
"Measurement display"

Up to 8 digits including the decimal point are displayed in the data field. When the displayed digits exceed, "<" is displayed at the first digit. When the range exceeds maximum or is below minimum setting, "OVERFLOW" or "UNDERFLOW" is displayed blinking on the Display 2.



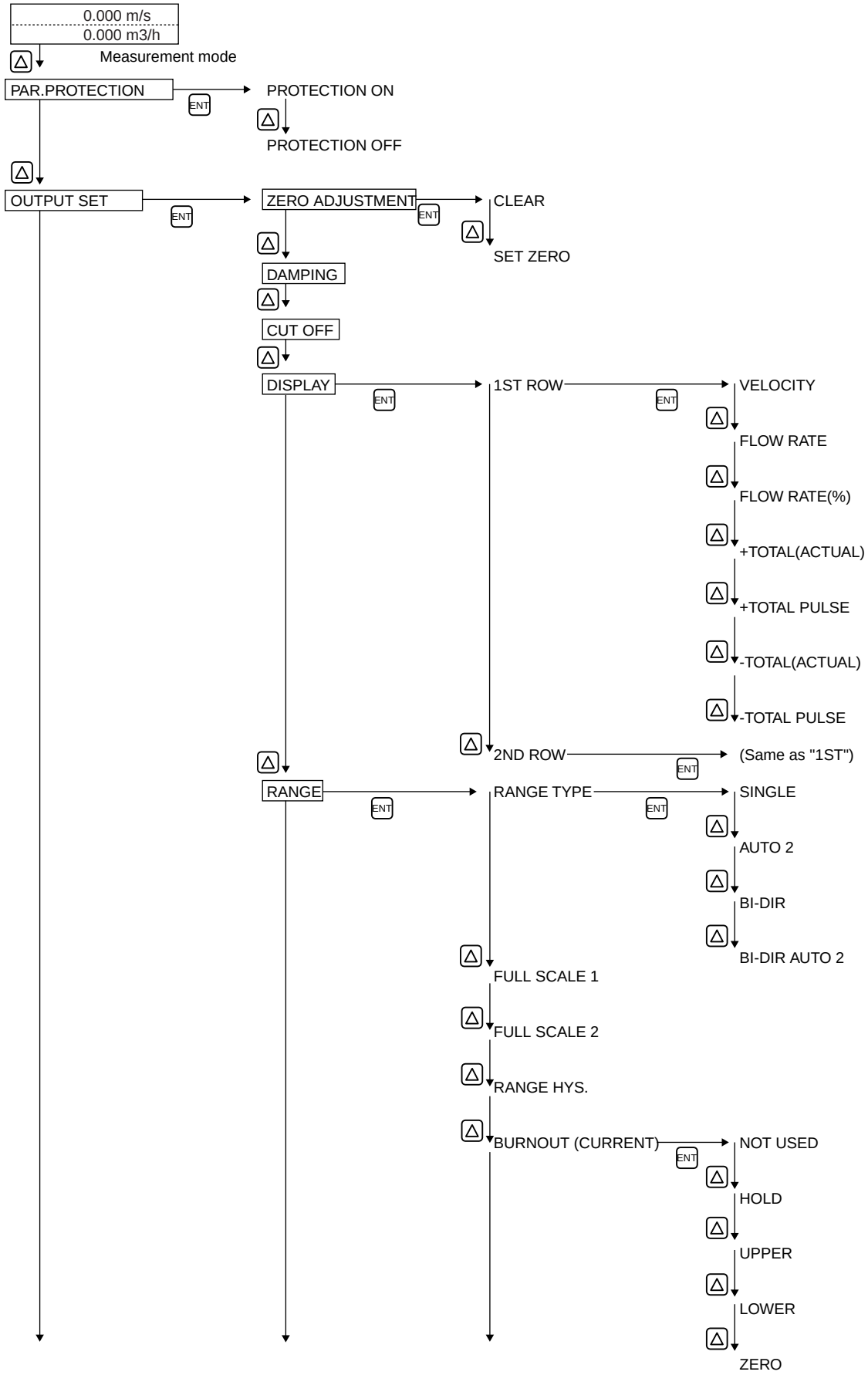
○ LED display: Indicates whether the received wave is normal or not.
(Green) : Received wave is normal.
(Red) : Received wave is abnormal.

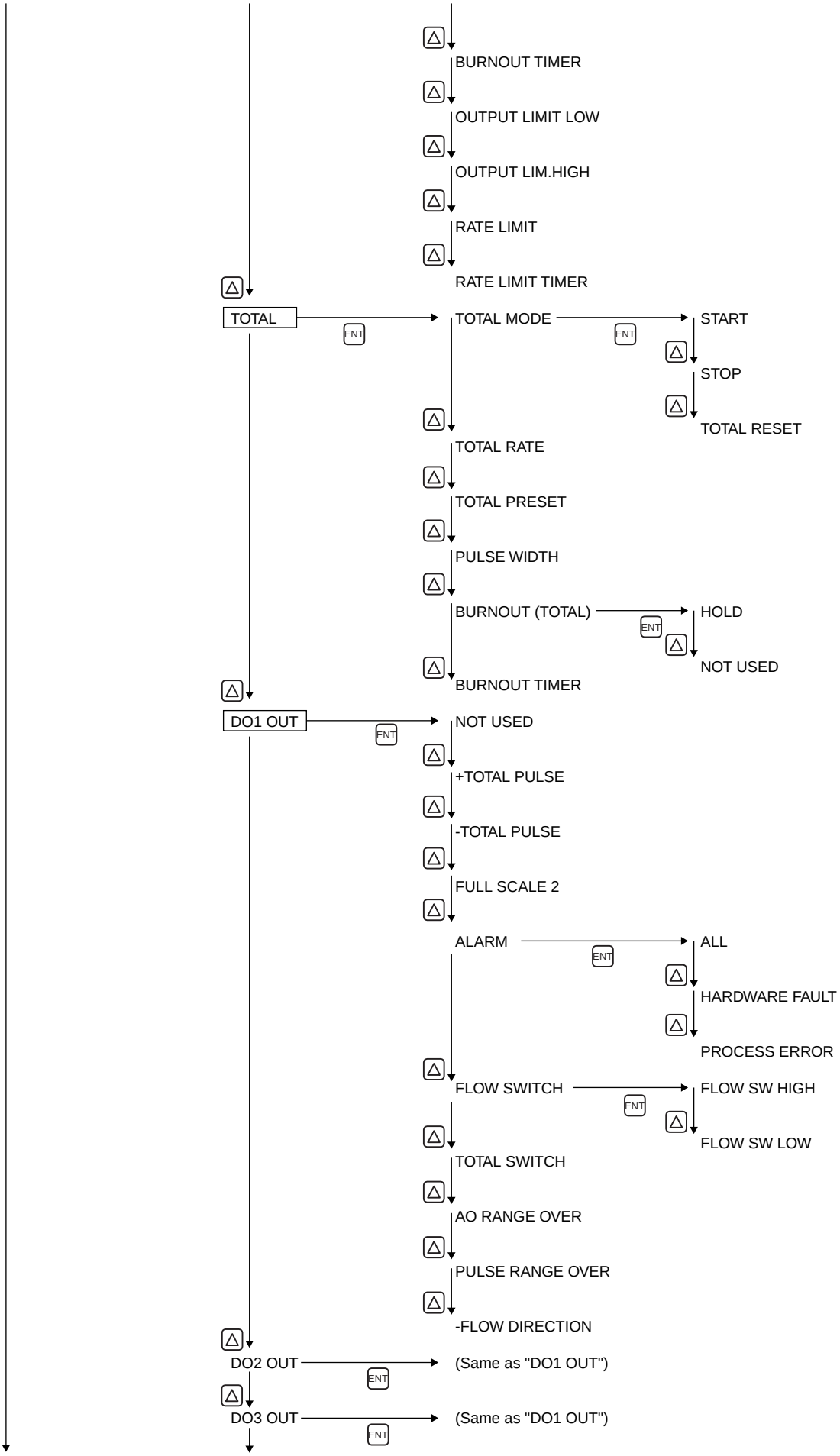
Set the parameter by setting switches.

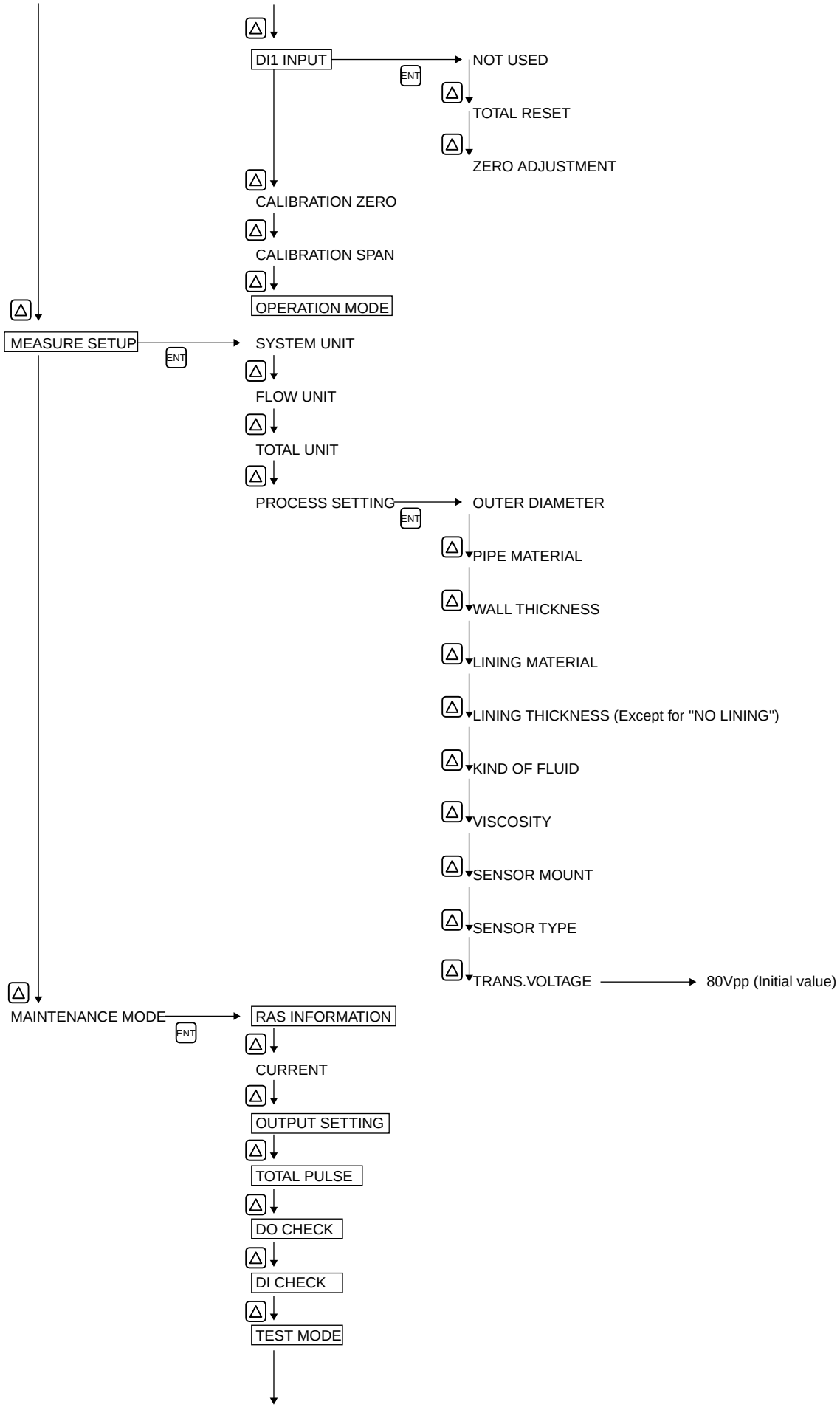
ESC	ESCAPE key	: Return to the next-higher menu level or cancels the set status.
△	UP key	: Selects items, numeric values and symbols.
▷	SHIFT key	: Moves the cursor and selects decimal place.
ENT	ENTRY key	: Enters a selection or registers a setting.

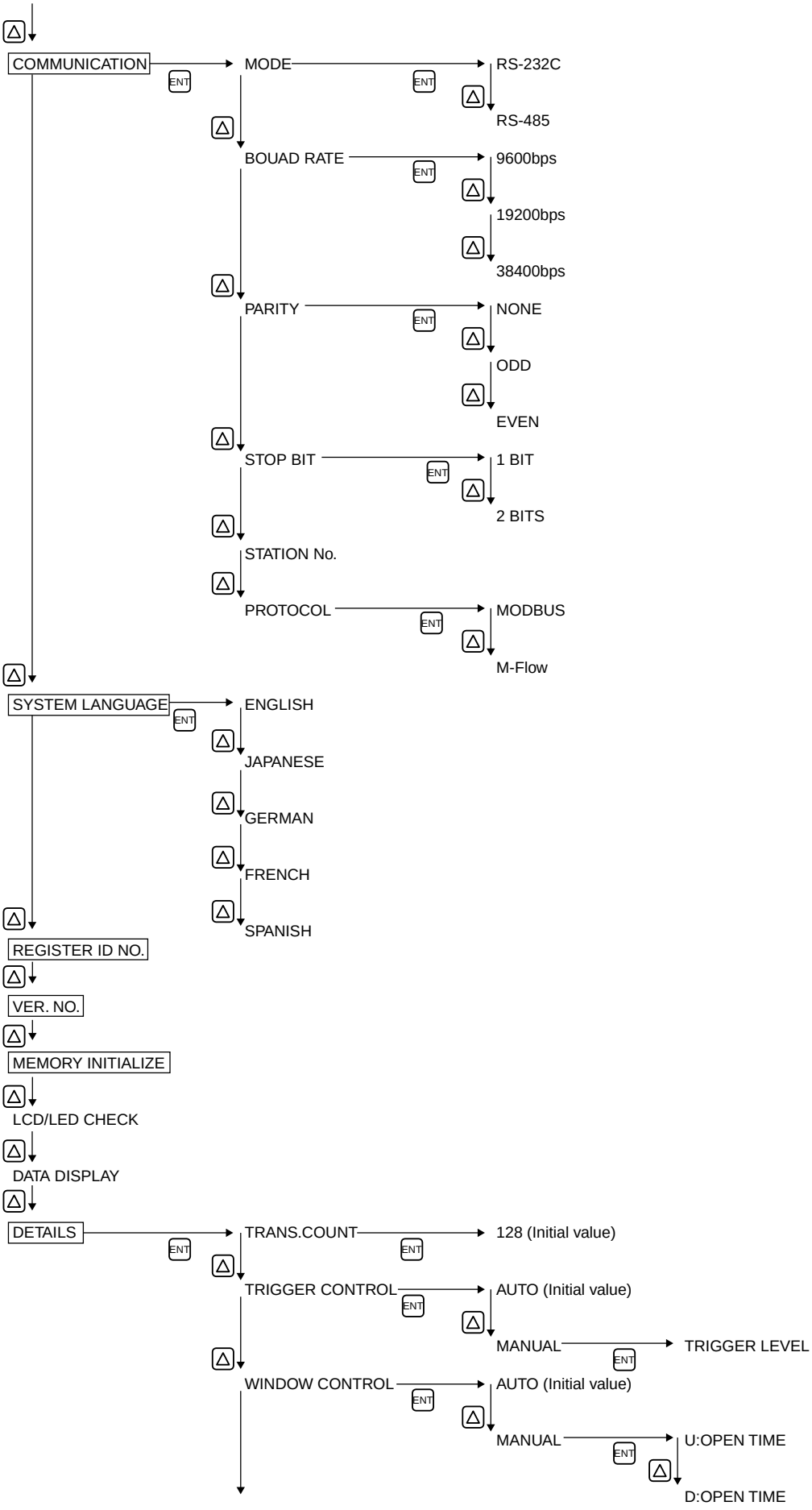
Note) For changing the parameter, enter the changed value, and press this key to confirm that it is registered.

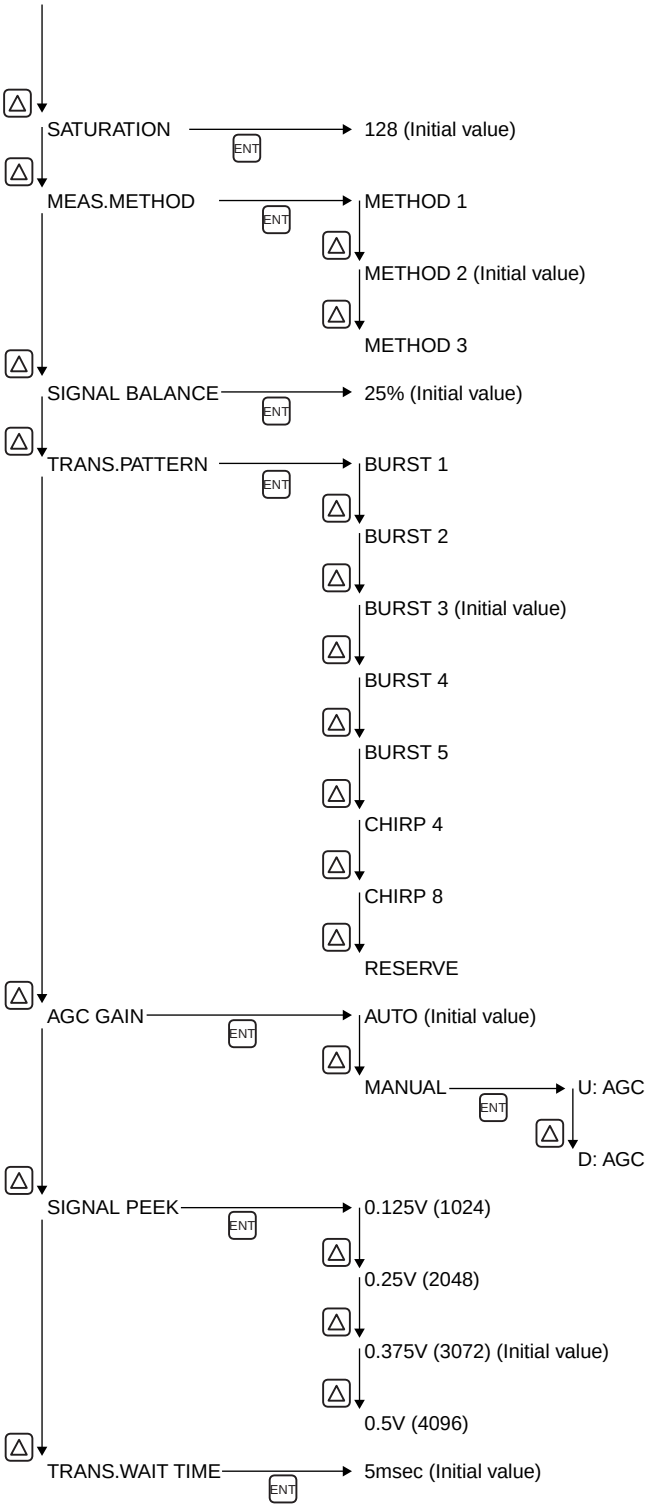
4.2. Composition of key operation




BURNOUT TIMER
OUTPUT LIMIT LOW
OUTPUT LIM.HIGH
RATE LIMIT
RATE LIMIT TIMER
TOTAL
ENT
TOTAL MODE
ENT
START
STOP
TOTAL RESET
TOTAL RATE
TOTAL PRESET
PULSE WIDTH
BURNOUT (TOTAL)
ENT
HOLD
NOT USED
BURNOUT TIMER
DO1 OUT
ENT
NOT USED
+TOTAL PULSE
-TOTAL PULSE
FULL SCALE 2
ALARM
ENT
ALL
HARDWARE FAULT
PROCESS ERROR
FLOW SWITCH
ENT
FLOW SW HIGH
FLOW SW LOW
TOTAL SWITCH
AO RANGE OVER
PULSE RANGE OVER
-FLOW DIRECTION
DO2 OUT
ENT
(Same as "DO1 OUT")
DO3 OUT
ENT
(Same as "DO1 OUT")


DI1 INPUT
ENT
NOT USED
TOTAL RESET
ZERO ADJUSTMENT
CALIBRATION ZERO
CALIBRATION SPAN
OPERATION MODE
MEASURE SETUP
ENT
SYSTEM UNIT
FLOW UNIT
TOTAL UNIT
PROCESS SETTING
ENT
OUTER DIAMETER
PIPE MATERIAL
WALL THICKNESS
LINING MATERIAL
LINING THICKNESS (Except for "NO LINING")
KIND OF FLUID
VISCOSITY
SENSOR MOUNT
SENSOR TYPE
TRANS.VOLTAGE
80Vpp (Initial value)
MAINTENANCE MODE
ENT
RAS INFORMATION
CURRENT
OUTPUT SETTING
TOTAL PULSE
DO CHECK
DI CHECK
TEST MODE


COMMUNICATION
ENT
MODE
ENT
RS-232C
RS-485
BOUAD RATE
ENT
9600bps
19200bps
38400bps
PARITY
ENT
NONE
ODD
EVEN
STOP BIT
ENT
1 BIT
2 BITS
STATION No.
PROTOCOL
ENT
MODBUS
M-Flow
SYSTEM LANGUAGE
ENT
ENGLISH
JAPANESE
GERMAN
FRENCH
SPANISH
REGISTER ID NO.
VER. NO.
MEMORY INITIALIZE
LCD/LED CHECK
DATA DISPLAY
DETAILS
ENT
TRANS.COUNT
ENT
128 (Initial value)
TRIGGER CONTROL
ENT
AUTO (Initial value)
MANUAL
ENT
TRIGGER LEVEL
WINDOW CONTROL
ENT
AUTO (Initial value)
MANUAL
ENT
U:OPEN TIME
D:OPEN TIME


SATURATION
ENT
128 (Initial value)
MEAS.METHOD
ENT
METHOD 1
METHOD 2 (Initial value)
METHOD 3
SIGNAL BALANCE
ENT
25% (Initial value)
TRANS.PATTERN
ENT
BURST 1
BURST 2
BURST 3 (Initial value)
BURST 4
BURST 5
CHIRP 4
CHIRP 8
RESERVE
AGC GAIN
ENT
AUTO (Initial value)
MANUAL
ENT
U: AGC
D: AGC
SIGNAL PEEK
ENT
0.125V (1024)
0.25V (2048)
0.375V (3072) (Initial value)
0.5V (4096)
TRANS.WAIT TIME
ENT
5msec (Initial value)

4.3. Parameter initial value list

Factory-set value is shown below. (When parameter setting is not provided.)

	Setting unit			Setting range	Initial value	Setting value
1	Parameter protection			No. of menu: 2	PROTECTION ON	PROTECTION ON, PROTECTION OFF
2	ID No			0000 to 9999	0000	ID No. is invalid when 0000 is selected.
3	Language			No. of menu: 5	English *1	English, Japanese, German, French and Spanish
4	Measuring condition	System unit		No. of menu: 2	Metric	Metric or inch
5		Flow unit		No. of menu: 18	m^3/h	L/s, L/min, L/h, L/d, kL/d, ML/d, m^3/s, m^3/min, m^3/h, m^3/d, km^3/d, Mm^3/d, BBL/s, BBL/min, BBL/h, BBL/d, kBBL/d, MBBL/d
6		Total unit		No. of menu: 8	m^3	mL, L, m^3, km^3, Mm^3, mBBL, BBL, kBBL
7		Outer diameter		6.00 to 6200.00mm	60.00mm	[mm, in]
8		Pipe material		No. of menu: 13 Sound velocity: 1000 to 3700m/s	PVC pipe	Carbon steel, stainless steel, PVC, Copper, Cast iron, Aluminum, FRP, Ductile iron, PEEK, PVDF, Acrylic, and PP Pipe sound velocity (Sound velocity: [m/s, ft/s])
9		Wall thickness		0.10 to 100.00mm	4.00mm	[mm, in]
10		Lining material		No. of menu: 8 Sound velocity: 1000 to 3700m/s	No lining	No lining, Tar epoxy, Mortar, Rubber, Teflon, Pyrex glass, PVC Lining S.V. (Sound velocity: [m/s, ft/s])
11		Lining thickness		0.01 to 100.00mm	–	[mm, in]
12		Kind of fluid		No. of menu: 18 Sound velocity: 300 to 2500m/s	Water	Seawater, dist. water, ammonia, alcohol, benzene, bromide, ethanol, glycol, kerosene, milk, methanol, toluol, lube oil, fuel oil, petrol and refrigerant R410 Fluid S.V. (Sound velocity: [m/s, ft/s])
13		Dynamic viscosity coefficient		0.001 to 999.999 $\times 10^{-6} m^2/s$	1.0038 $\times 10^{-6} m^2/s$	[$\times 10^{-6} m^2/s$, ft^2/s]
14		Sensor mounting method		No. of menu: 2	V method	V method, Z method
15		Sensor type		No. of menu: 10	FLS_12	FLS_12, FLS_22,FLW11/FSG_31, FLW12/FSG_32, FLW41/FSG_41, FLW50/FSG_50, FLW51/FSG_51, FLD12, FLD22, FLD32
16		Transmission voltage		No. of menu: 4	80Vpp	20Vpp, 40Vpp, 80Vpp, 160Vpp
17	Output condition	Zero adjustment		No. of menu: 2	Clear (unadjusted)	Clear, adjustment (Clear has been factory-set.)
18		Damping		0.0 to 100.0sec	5.0sec	sec
19		Low flow cut		0 to 5m/s in terms of flow velocity	$0.150 m^3/h$	[(5) unit]
20		Display	Content of display 1st line	No. of menu: 7	Flow velocity (m/s)	Flow velocity, Flow rate, Flow rate (%), +Total (Actual), +Total pulse, -Total (Actual) and -Total pulse
21			Decimal point position of display 1st line		****.***	□□□□□□□□ (Fill in the specified digit)
22			Content of display 2nd line	No. of menu: 7	Flow rate (m/s)	Flow velocity, Flow rate, Flow rate (%), +Total (Actual), +Total pulse, -Total (Actual) and -Total pulse
23			Decimal point position of display 2nd line		****.***	□□□□□□□□ (Fill in the specified digit)
24		Analog output	Range type	No. of menu: 4	Single range	Single range, Auto 2 range, Bi-dir range and Bi-dir Auto 2 range
25			Full scale 1	0, ±0.3 to ±32m/s in terms of flow velocity	$15.000 m^3/h$	[(5) unit]
26			Full scale 2	0, ±0.3 to ±32m/s in terms of flow velocity	$0.000 m^3/h$	[(5) unit]
27			Hysteresis	0.00 to 20.00	10.00%	%
28			Burnout (current)	No. of menu: 5	Hold	Not used, Hold, Lower, Upper and Zero
29			Burnout timer	0 to 900sec	10sec	sec
30			Output limit low	-20 to 0%	-20%	%
31			Output limit high	100 to 120%	120%	%
32			Rate limit	0 to 5m/s in terms of flow velocity	$0.000 m^3/h$	[(5) unit]
33			Rate limit timer	0 to 900sec	0sec	sec
34		Total output	Total mode	No. of menu: 3	Stop	Start, Stop and Reset
35			Pulse value	0.000000 to 99999999	$0 m^3$	[(6) unit]
36			Total preset	0.000000 to 99999999	$0 m^3$	[(6) unit]
37			Pulse width	No. of menu: 5	50.0msec	5.0msec, 10.0msec, 50.0msec, 100.0msec, 200.0msec
38			Burnout (total)	No. of menu: 2	Hold	Not used, hold
39			Burnout timer	0 to 900sec	10sec	sec

	Setting unit		Setting range	Initial value	Setting value
40	Output condition	DO1 output type	No. of output content menu: 10 No. of alarm menu: 3 Flow switch range 0 to 32m/s in terms of flow velocity Total switch range 0.000000 to 99999999	Not used	☐Not used ☐+Total pulse ☐-Total pulse ☐Range full scale 2 ☐Alarm [All, Device error, Process error] ☐Flow rate switch ☐Flow SW high [[(5) unit]] ☐Flow SW low [[(5) unit]] ☐Total switch [[(6) unit]] ☐Range over ☐Pulse range over ☐–Flow direction
41		DO1 Output operation	No. of menu: 2	Active ON	Active ON, Active OFF
42		DO2 Output type	No. of output content menu: 10 No. of alarm menu: 3 Flow switch range 0 to 32m/s in terms of flow velocity Total switch range 0.000000 to 99999999	Not used	☐Not used ☐+Total pulse ☐-Total pulse ☐Range full scale 2 ☐Alarm [All, Device error, Process error] ☐Flow rate switch ☐Flow SW high [[(5) unit]] ☐Flow SW low [[(5) unit]] ☐Total switch [[(6) unit]] ☐Range over ☐Pulse range over ☐–Flow direction
43		DO2 Output operation	No. of menu: 2	Active ON	Active ON, Active OFF
44		DO3 Output type	No. of output content menu: 10 No. of alarm menu: 3 Flow switch range 0 to 32m/s in terms of flow velocity Total switch range 0.000000 to 99999999	Not used	☐Not used ☐+Total pulse ☐-Total pulse ☐Range full scale 2 ☐Alarm [All, Device error, Process error] ☐Flow rate switch ☐Flow SW high [[(5) unit]] ☐Flow SW low [[(5) unit]] ☐Total switch [[(6) unit]] ☐Range over ☐Pulse range over ☐–Flow direction
45		DO3 Output operation	No. of menu: 2	Active ON	Active ON, Active OFF
46		DI1 Input type	No. of input content menu: 3	Not used	☐Not used ☐Total reset ☐Zero adjustment
47		DI1 Input operation	No. of menu: 2	Active ON	Active ON, Active OFF
48		Zero calibration	-5 to 5m/s in terms of flow velocity	0.000m^3/h	[(5) unit]
49		Span calibration	-200.00 to 200.00%	100.00%	%
50		Operation mode	No. of menu: 2	Standard	Standard, High speed
51	Communication	Communication mode	No. of menu: 2	RS-232C	RS-232C, RS-485
52		Baud rate	No. of menu: 3	9600bps	9600bps, 19200bps, 38400bps
53		Parity	No. of menu: 3	Odd	None, Odd, Even
54		Stop bit	No. of menu: 2	1 bit	1 bit, 2 bits
55		Station No.	1 to 31	1	(In case of RS-485)
56		Communication protocol	No. of menu: 2	MODBUS	MODBUS, M-Flow

*1) English is set when 4th digit of the type is “E”.

FSV [S] : Japanese

FSV [E] : English

4.4. Parameter protection

4.4.1. Protection ON/OFF

Description
- Parameters can be protected so that the flow meter settings will not carelessly be changed.
- Parameters can be protected by setting the "ID No." (Note) in the maintenance mode.
  Note) 4 digits are factory set at "0000". (Refer to Section 4.11.8.)

Setting range: PROTECTION ON : Parameter cannot be changed.
PROTECTION OFF: Parameter can be changed.
* 1 hour after “PROTECTION OFF” is set, “PROTECTION ON” is automatically set.
* Protection is set after turning power on.

For actual keying, refer to the typical operation indicated below.

Operation (example)	Change the protection from ON to OFF (suppose ID No. is "2234").	
Key operation	Description	Display
△ ▼	Press the △ key in the measurement mode once to indicate “PAR. PROTECTION”.	PAR.PROTECT PROTECTION ON
ENT ▼	Press the ENT key once to blink the 2nd line.	PAR.PROTECT PROTECTION ON
△ ▼	Press the △ key once to display "PROTECTION OFF".	PAR.PROTECT PROTECTION OFF
ENT ▼ ▼ ▼ ▼	Press the ENT key once to display “PAR.PROTECTION”.	PAR.PROTECT ** COMPLETE ** ↓ INPUT ID NO. ****
ENT ▼ ▼	Press the ENT key once to indicate "0000" and blink the cursor. Note) If ID No. is "0000" (as factory set), press the ENT key to release the protection.	INPUT ID NO. 0000
△ ▷ ▼	Enter ID No. “2234” by the △ key or the ▷ key.	INPUT ID NO. 2234
ENT	Press the ENT key once. * If ID No. does not coincide, "INPUT ERROR!" appears, and the input screen is resumed. ——— Protection canceled. ———	INPUT ID NO. ** COMPLETE ** ↓ PAR.PROTECT PROTECTION OFF

* If you do not change parameter settings or perform zero adjustment, the setting of parameter protection turns ON automatically one hour later after you turned OFF the parameter protection.

Note) About the parameter setting change
When you change parameters of converter in current use which analog output or alarm has been set, if you change items which affect to the output, the output may change suddenly after display of "**COMPLETE**" and may generate alarm. If, especially, the output signal is being used for control, disable the signal lock on the system side before you change parameters.

4.5. Display language

4.5.1. How to select the language

Description
- Indication language (English, Japanese, German, French, Spanish) is selectable.

Setting contents
English (default setting), Japanese, German, French, Spanish

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Select English for the display language.	
Key operation	Description	Display
△	Press the △ key for 4 times to display “MAINTENANCE MODE”.	MAINTENANCE MODE
▼ ENT	Press the ENT key once to display “RAS INFORMATION”.	RAS INFORMATION 0000000000000000
▼ △	Press the △ key for 8 times to display “SYSTEM LANGUAGE”.	SYSTEM LANGUAGE JAPANESE
▼ ENT	Press the ENT key once to blink on the 2nd line.	SYSTEM LANGUAGE JAPANESE
▼ △	Press the △ key for 4 times to display “ENGLISH”.	SYSTEM LANGUAGE ENGLISH
▼ ENT	Press the ENT key once to register.	SYSTEM LANGUAGE ** COMPLETE **
▼ ▼ ▼ ▼	——— English has been registered. ———	↓ SYSTEM LANGUAGE ENGLISH
ESC △	Press the ESC key or the △ key to display the measurement mode.	0.000 m/s 0.000 m3/h

Operation (example)	Select Japanese for the display language.	
Key operation	Description	Display
△	Press the △ key for 4 times to display “MAINTENANCE MODE”.	MAINTENANCE MODE
▼ ENT	Press the ENT key once to display “RAS INFORMATION”.	RAS INFORMAITION 0000000000000000
▼ △	Press the △ key for 8 times to display “SYSTEM LANGUAGE”.	SYSTEM LANGUAGE ENGLISH
▼ ENT	Press the ENT key once to blink on the 2nd line.	SYSTEM LANGUAGE ENGLISH
▼ △	Press the △ key for 4 times to display “JAPANESE”.	SYSTEM LANGUAGE JAPANESE
▼ ENT	Press the ENT key once to register.	SYSTEM LANGUAGE ** ﾄｳﾛｸ **
▼ ▼ ▼ ▼	——— Japanese has been registered. ———	↓ ｹﾞﾝｺﾞ (LANGUAGE) ﾆﾎﾝｺﾞ (JAPANESE)
ESC △	Press the ESC key or the △ key to display the measurement mode.	0.000 m/s 0.000 m3/h

4.6. Checking and Setting of Piping Specifications/Detector

4.6.1. Checking piping parameter

Key operation	Description	Display
		0.000 m/s 0.000 m3/h
△	Press the △ key for 3 times to display “MEASURE SETUP”.	MEASURE SETUP
▼		
ENT	Press the ENT key once to display “SYSTEM UNIT”.	SYSTEM UNIT ENGLISH
▼		
△	Press the △ key for 3 times to display “PROCESS SETTING”.	PROCESS SETTING S= 31(93mm)
▼		
ENT	Press the ENT key once to display “OUTER DIAMETER”.	OUTER DIAMETER 60.00 mm
▼		
△	Press the △ key once to display “PIPE MATERIAL”.	PIPE MATERIAL PVC
▼		
△	Press the △ key once to display “WALL THICKNESS”.	WALL THICKNESS 4.00 mm
▼		
△	Press the △ key once to display “LINING MATERIAL”.	LINING MATERIAL NO LINING
▼		
△	Press the △ key once to display “KIND OF FLUID”.	KIND OF FLUID WATER
▼		
△	Press the △ key once to display “VISCOSITY”.	VISCOSITY 1.003800 E-6m2/s
▼		
△	Press the △ key once to display “SENSOR MOUNT”.	SENSOR MOUNT V METHOD
▼		
△	Press the △ key once to display “SENSOR TYPE”.	SENSOR TYPE FLS_12
▼		
△	Press the △ key once to display “TRANS. VOLTAGE”.	TRANS. VOLTAGE 80 Vpp
▼		
ESC △	Press the ESC key twice, and press the △ key twice to return to the measurement mode.	0.000 m/s 0.000 m3/h

4.6.2. Piping parameter setting method

Description
- Set the parameters of piping and fluid to be measured to determine the sensor mounting spacing.
- The mounting dimension of the sensor is automatically calculated. Refer to “5.1.1. Mounting of detector”.

⚠ CAUTION

Be sure to set the following parameters before mounting the sensor on the pipe. Mount the sensor to match the sensor mounting length.
- Unless the sensor units are spaced accurately, the measurement error will be excessive.
- Also, the received wave may be abnormal.

Setting items

1.	Pipe outer diameter	: 6.00 to 6200.00 [mm] (factory set at 60.00 [mm]).
2.	Piping material	: CARBON STEEL, STAINLESS STEEL, PVC (factory set), COPPER, CAST IRON, ALUMINIUM, FRP, DUCTILE IRON, PEEK, PVDF, ACRYLIC, PP, Others (Sound velocity: 1000 to 3700[m/s])
3.	Wall thickness	: 0.10 to 100.00 [mm] (factory set at 4.00 [mm]).
4.	Lining material	: NO LINING (factory set), TAR EPOXY, MORTAR, RUBBER, TEFLON, PYREX GLASS, PVC, Others (Sound velocity: 1000 to 3700[m/s])
5.	Lining thickness	: 0.10 to 100.00 [mm]
6.	Measuring fluid	: WATER, SEAWATER, DIST.WATER, AMMONIA, ALCOHOL, BENZENE, ETHANOL, GLYCOL, KEROSENE, MILK, METHANOL, TOLUOL, LUBE OIL, FUEL OIL, PETROL, REFRIGERANT R410, Others (Sound velocity: 300 to 2500[m/s])
7.	Dynamic viscosity coefficient	: 0.0010 to 999.999 × 10^{-6} [m^2/s] (factory set at 1.0038 x 10^{-6} [m^2/s])
8.	Detector mounting method	: V method (factory set), Z method
9.	Detector type	: FLS_12 (factory set), FLS_22, FLW11/FSG_31, FLW12/FSG_32, FLW41/FSG_41, FLW50/FSG_50, FLW51/FSG_51, FLD12, FLD22 and FLD32 **Note) If the sensor type is FSD, make a setting by regarding FLS as FSD.**
10.	Transmission voltage	: 20Vpp, 40Vpp, 80Vpp (factory set), 160Vpp Normally, select “80Vpp” for the transmission voltage.

For concrete keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

(1) Setting method when sensor type is “FLS_12” or “FLS_22”.

Operation (example)	Carry out setting for measuring the flow rate of water flowing through PVC pipe (for tap water) using FLS_12 detector.	
Key operation	Description	Display
		0.000 m/s 0.000 m3/h
△ ▼	Press the △ key for 3 times to display “MEASURE SETUP”.	MEASURE SETUP
ENT ▼	Press the ENT key once to display “SYSTEM UNIT”.	SYSTEM UNIT METRIC
△ ▼	Press the △ key for 3 times to display “PROCESS SETTING”.	PROCESS SETTING S= 16 (48mm)
ENT ▼	Press the ENT key once to display “OUTER DIAMETER”.	OUTER DIAMETER 60.00 mm
ENT ▼	Press the ENT key once to blink the cursor.	OUTER DIAMETER 0160.00 mm
		0160.00 mm
		0160.00 mm
		0110.00 mm
		0110.00 mm
△ ▷ ▼	Move the cursor by the ▷ key, and change the numeric value by △ the key. Operated to compose "114" because, from Piping data in Section 7.5., the outer diameter of polyvinyl chloride pipe (tap water size) is 114 mm.	OUTER DIAMETER 114.00 mm

ENT ▼ ▼ ▼ ▼	Press the ENT key once to register the outer diameter. ——— Outer diameter has been registered. ———	OUTER DIAMETER ** COMPLETE ** ↓ OUTER DIAMETER 114.00 mm
△ ▼	Press the △ key once to display “PIPE MATERIAL”. Because PVC (factory set) is already registered, go to the next step. Note) If the pipe is made of another material, press ENT key, and select a corresponding menu by the △ key.	PIPE MATERIAL PVC
△ ▼	Press the △ key once to display “WALL THICKNESS”.	WALL THICKNESS 4.00 mm
ENT ▼	Press the ENT key once to blink the cursor.	WALL THICKNESS 004.00 mm 004.00 mm
△ ▷ ▼	Move the cursor by the ▷ key, and change the numeric value by the △ key. Operated to compose "7" because, from Piping data in Section 7.5., the wall thickness of polyvinyl chloride pipe (tap water size) is 7.0mm.	WALL THICKNESS 007.00 mm
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register the wall thickness. ——— Wall thickness has been registered. ———	WALL THICKNESS ** COMPLETE ** ↓ WALL THICKNESS 7.00 mm
△ ▼	Press the △ key once to display “LINING MATERIAL”. "NO LINING" (factory set) is already registered. Because there is no lining, go to the next step. Note) If lining is provided, press the ENT key and △ key to select the material or enter the sound velocity. Further, go to "LINING THICKNESS", and input a lining thickness. Nothing is indicated in case of "NO LINING".	LINING MATERIAL NO LINING
△ ▼	Press the △ key once to display "KIND OF FLUID". Because, also, "WATER" (factory set) is already registered, go to the next step. Note) If fluid to be measured is other than water, press the ENT key, and select the menu or enter the sound velocity.	KIND OF FLUID WATER
△ ▼	Press the △ key once to display "VISCOSITY". Input the kinematic viscosity of the fluid to be measured. Because the kinematic viscosity 1.0038E^{-6} [m^2/s] of water at 20°C is already registered, go to the next step. In case of fluid other than water, input the kinematic viscosity at a measurement status of fluid to be measured referring to data in Section 7.5., etc.	VISCOSITY 1.0038 E-6m2/s
ESC ▼	Press the ESC key once to display “PROCESS SETTING”. “S=31” is indicated on the 2nd line. After mounting the frames on piping, insert into it 2 sensor units spaced at 31 divisions.	PROCESS SETTING S= 31 (93mm)
ESC △	Press the ESC key once and the △ key twice to return to the measurement mode.	0.000 m3/h 0.000 m3

(2) Setting method when sensor type is “FLW11/FSG_31”, “FLW12/FSG_32”, “FLW41/FSG_41”, “FLW50/FSG_50”, “FLW51/FSG_51”, “FLD12”, “FLD22” or “FLD32”
If the sensor type is “FSD12”, “FSD22”, or “FSD32”, make a setting by regarding FLS as FSD.

Operation (example)	Carry out setting for measuring the flow rate of water flowing through PVC pipe (for tap water) having 100 mm of nominal diameter, using FLS_12 detector. * Settings of piping and fluid to be measured are omitted, since it is same as “(1) Setting method when sensor type is “FLS_12” or “FLS_22””.	
Key operation	Description	Display
△ ▼	Press the △ key for 3 times to display “MEASURE SETUP”.	MEASURE SETUP
ENT ▼	Press the ENT key once to display “SYSTEM UNIT”.	SYSTEM UNIT METRIC
△ ▼	Press the △ key for 3 times to display “PROCESS SETTING”.	PROCESS SETTING S= 31 (93mm)
ENT ▼	Press the ENT key once to display “OUTER DIAMETER”.	OUTER DIAMETER 114.00 mm
△ ▼	Press the △ key for 7 times to blink the cursor.	SENSOR TYPE FLS_12
ENT ▼	Press the ENT key once to blink the cursor.	SENSOR TYPE FLS_12
△ ▼	Press the △ key for 3 times to display “FLW12/FSG_32” on the 2nd line.	SENSOR TYPE FLW12/FSG_32
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register “FLW12/FSG_32”. ——— “FLW12/FSG_32” has been registered. ———	SENSOR TYPE ** COMPLETE ** ↓ SENSOR TYPE FLW12/FSG_32
ESC ▼	Press the ESC key once to display “PROCESS SETTING”. “S=76.30mm” is displayed on the 2nd line. Align the sensor mounting spacing to 76.3mm, and attach the sensor to the pipe.	PROCESS SETTING S= 76.30mm
ESC △	Press the ESC key once and the △ key twice to return to the measurement mode.	0.000 m3/h 0.000 m3

4.7. Zero Adjustment

Description
● Zero point is calibrated.

Settable range:
CLEAR : Clears the zero point calibration value to "0".
Used in case the flow cannot be stopped when calibrating the zero point.
Note 1) Where possible, stop the flow and carry out "SET ZERO" stated below.
Otherwise, an error may occur in the zero point.
SET ZERO : A point where "SET ZERO" is carried out is regarded as zero, how condition used in case the flow cannot be stopped when calibrating the zero point.
Note 2) The flow must completely be stopped.
Otherwise, the flowing status is regarded as zero, thereby causing an error.

It takes ten seconds to several tens of seconds to complete adjustment, depending on pipe diameter.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Completely fill the piping, close the upstream and downstream valves, and proceed to zero point calibration.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key twice to display “ZERO ADJUSTMENT” and blink the cursor.	ZERO ADJUSTMENT CLEAR
△ ▼	Press the △ key once, and select “SET ZERO”.	ZERO ADJUSTMENT SET ZERO
ENT ▼ ▼ ▼ ▼	Press the ENT key once to carry out “SET ZERO”. * Be sure to completely stop the flow beforehand. ——— Zero adjustment has been completed. ———	ZERO ADJUSTMENT ** COMPLETE ** ↓ ZERO ADJUSTMENT SET ZERO
ESC △	Press the ESC key once, and the △ key for 3 times to enter the measurement mode.	0.000 m/s 0.000 m3/h

4.8. Setting of unit

4.8.1. How to set the unit system

Description
- Measurement unit can be selected from metric or inch system.
- Metric system (factory set)

  Length ····· mm
  Flow velocity ····· m/s
  Flow rate ····· L/s, L/min, L/h, L/d, kL/d, ML/d, m^3/s, m^3/min, m^3/h, m^3/d, km^3/d, Mm^3/d, BBL/s, BBL/min, BBL/h, BBL/d, kBBL/d, MBBL/d
  Total unit ····· mL, L, m^3, km^3, Mm^3, mBBL, BBL, kBBL
  Kinematic viscosity coefficient ····· $E^{-6}m^2/s$

  <Note> When setting, stop status should be set at total mode. (See Section 4.9.2.)

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Change the unit system from inch system to metric system.	
Key operation	Description	Display
△	Press the △ key for 3 times to display “MEASURE SETUP”.	MEASURE SETUP
▼		
ENT	Press the ENT key once to display “SYSTEM UNIT”.	SYSTEM UNIT INCH
▼		
ENT	Press the ENT key once to blink the cursor.	SYSTEM UNIT INCH
▼		
△	Press the △ key once to display “METRIC”.	SYSTEM UNIT METRIC
▼		
ENT	Press the ENT key once to register.	SYSTEM UNIT ** COMPLETE **
▼		↓
▼	——— METRIC has been registered. ———	SYSTEM UNIT METRIC
▼		
ESC △	Press the ESC key once and △ key twice to return to the measurement mode.	0.000 % 0.000 m3/h

4.8.2. How to set the flow rate unit

Description
- Select the unit of flow rate.
- Metric system

  Flow rate ····· L/s, L/min, L/h, L/d, kL/d, ML/d, m^3/s, m^3/min, m^3/h (factory set), m^3/d, km^3/d, Mm^3/d, BBL/s, BBL/min, BBL/h, BBL/d, kBBL/d, MBBL/d

<Note> First, set the unit system (metric) according to Section 4.8.1.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set a flow rate unit to “L/min”.	
Key operation	Description	Display
△ ▼	Press the △ key for 3 times to display “MEASURE SETUP”.	MEASURE SETUP
ENT ▼	Press the ENT key once to display “SYSTEM UNIT”.	SYSTEM UNIT METRIC
△ ▼	Press the △ key once to display “FLOW UNIT”.	FLOW UNIT m3/h
ENT ▼	Press the ENT key once to blink the cursor.	FLOW UNIT m3/h
△ ▼	Press the △ key several times to display “L/min”.	FLOW UNIT L/min
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register. ——— “L/min” has been registered. ———	FLOW UNIT ** COMPLETE ** ↓ FLOW UNIT L/min
ESC △	Press the ESC key once and the △ key twice to return to the measurement mode.	0.000 m/s 0.000 L/min

4.8.3. How to set the total unit

Description
- Select the unit of total volume.
- Metric system
  Total unit ····· mL, L, m^3 (factory set), km^3, Mm^3, mBBL, BBL, kBBL

<Note> First, set the unit system (metric) according to Section 4.8.1.
When setting, stop status should be set at total mode. (See Section 4.9.2.)

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set a flow rate unit to “L”.	
Key operation	Description	Display
△ ▼	Press the △ key for 3 times to display “MEASURE SETUP”.	MEASURE SETUP
ENT ▼	Press the ENT key once to display “SYSTEM UNIT”.	SYSTEM UNIT METRIC
△ ▼	Press the △ key once to display “TOTAL UNIT”.	TOTAL UNIT m3
ENT ▼	Press the ENT key once to blink the cursor.	TOTAL UNIT m3
△ ▼	Press the △ key twice to display “L”.	TOTAL UNIT L
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register. ——— “L” has been registered. ———	TOTAL UNIT ** COMPLETE ** ↓ TOTAL UNIT L
ESC △	Press the ESC key once and the △ key twice to return to the measurement mode.	0.000 L 0.000 L/min

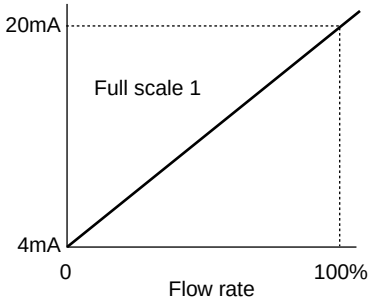
4.9. Output Setting

4.9.1. Setting of flow rate range

4.9.1.1. Setting of flow rate range (single range)

Description
- The range (full scale) of flow rate to be measured is set.
  * The analog output (4-20mA) corresponds to the range setting.
- Settable range: 0.3 to 32 [m/s] in terms of flow velocity in piping
  * The piping parameters and FLOW UNIT must be set beforehand.
  * If a value beyond the settable range is inputted, "INPUT ERROR" appears and then last setting is resumed.
  * If "piping parameters" or "FLOW UNIT" has been changed after setting the range, recommence the range setting.

<Note> The flow rate unit is as selected by "FLOW UNIT" in the "MEASURE SETUP" mode. (Refer to Section 4.8.2.)



・ Setting range of the full scale frow rate

<Note> • Converted flow rate in the Table 1 is the calculation results obtained by using the internal diameters of pipes in the left columns. Perform calculation using the actual internal diameters for accuracy.
• Simple formula for calculation of flow verocity

Flow velocity range: 0.3 ～ 32 [m/s] <Table1>

Int. dia. of pipes [mm]	Flow rate unit	
	[m^3/h]	[L/min]
25	0.530 to 56.5	8.84 to 942
50	2.12 to 226	35.3 to 3770
80	5.43 to 579	90.5 to 9651
100	8.48 to 905	141 to 15080
150	19.1 to 2036	318 to 33929
200	33.9 to 3619	565 to 60319
300	76.3 to 8143	1272 to 135717

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set 60m3/h to range type, SINGLE/FULL SCALE1. * Set the piping parameters and "FLOW UNIT" beforehand.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key to enter the “ZERO ADJUSTMENT” mode.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 4 times to display “RANGE”.	RANGE
ENT ▼	Press the ENT key once to display “RANGE TYPE”. Because SINGLE (factory set) is already registered, go to the next step.	RANGE TYPE SINGLE
△ ▼	Press the △ key once to display “FULL SCALE1”.	FULL SCALE1 15.000 m3/h
ENT ▼	Press the ENT key once to blink the cursor.	FULL SCALE1 00015.000 m3/h
△ ▷ ▼ ▼ ▼ ▼ ▼ ▼ ▼ ▼	Move the cursor by the ▷ key, and change the numeric value by the △ key. Change the full scale to “60”. Note) To change the decimal point position, align the cursor with a place to change to and press the △ key likewise.	00015.000 m3/h 00065.000 m3/h 00065.000 m3/h FULL SCALE1 000060.0 m3/h
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register. ——— FULL SCALE1 has been registered. ———	FULL SCALE1 ** COMPLETE ** ↓ FULL SCALE1 60.000 m3/h
ESC △	Press the ESC key for 3 times and then press the △ key for 3 times to enter the measurement mode.	0.000 m/s 0.000 m3/h

4.9.1.2. Setting of analog output at error (Burnout)

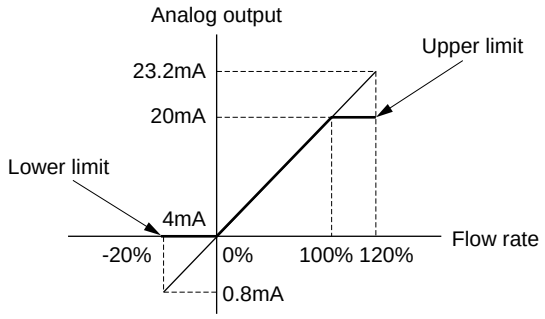
Description
- Determine how to set the analog output when received wave error, etc. due to device error, accidental drain of piping or entry of bubbles.
- Settable range
  (1) Analog output (4-20mA) at error
  HOLD (factory set): Outputs a current value preceding the error.
  UPPER : Sets analog output to upper of the output limit (over scale).
  LOWER : Sets analog output to lower of the output limit (under scale).
  ZERO : Outputs 4mA.
  (2) BURNOUT TIMER (time from error detection to BURNOUT processing) 0 to 900 seconds (factory set at 10 sec).
  * Perform BURNOUT processing as shown below.
  1. LCD display····· Measured value operates with analog output.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set “UPPER” to BURNOUT. Set “20sec” to BURNOUT TIMER. * Set the piping parameters and "FLOW UNIT" beforehand.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 4 times to display “RANGE”.	RANGE
ENT ▼	Press the ENT key once to display “RANGE TYPE”.	RANGE TYPE SINGLE
△ ▼	Press the △ key for 4 times to display “BURNOUT” (CURRENT).	BURNOUT (CURRENT) HOLD
ENT ▼	Press the ENT key once to blink on the 2nd line.	BURNOUT (CURRENT) HOLD
△ ▼	Press the △ key once to display “UPPER”.	BURNOUT (CURRENT) UPPER
ENT ▼	Press the ENT key once to register.	BURNOUT (CURRENT) ** COMPLETE ** ↓
▼ ▼ ▼	——— UPPER has been registered. ———	BURNOUT (CURRENT) UPPER
△ ▼	Press the △ key once to display “BURNOUT TIMER”.	BURNOUT TIMER 10 sec
ENT ▼	Press the ENT key once to blink the cursor.	BURNOUT TIMER 010 sec
▷ ▼	Press the ▷ key once to align the cursor to “1”.	BURNOUT TIMER 010 sec
△ ▼	Press the △ key once to set “2”.	BURNOUT TIMER 020 sec
ENT ▼	Press the ENT key once to register.	BURNOUT TIMER ** COMPLETE ** ↓
▼ ▼ ▼	——— BURNOUT TIMER has been registered. ———	BURNOUT TIMER 20 sec
ESC △	Press the ESC key twice and then press the △ key for 3 times to enter the measurement mode.	0.000 % 0.000 m3/h

4.9.1.3. Output limit

Description
- Upper and lower limits can be set within the range of analog output 0.8mA to 23.2mA (-20% to 120%).
- Settable range
  (1) Output lower limit: -20% to 0% (0.8mA to 4mA)
  (2) Output upper limit: 100% to 120% (20mA to 23.2mA)



For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set “-10% (2.4mA)” to lower limit, and “110% (21.6mA)” to upper limit. * Set the piping parameters and "FLOW UNIT" beforehand.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 4 times to display “RANGE”.	RANGE
ENT ▼	Press the ENT key once to display “RANGE TYPE”.	RANGE TYPE SINGLE
△ ▼	Press the △ key for 6 times to display “OUTPUT LIMIT LOW”.	OUTPUT LIMIT LOW -20 %
ENT ▼	Press the ENT key once to blink the cursor.	OUTPUT LIMIT LOW -20 %
▷ ▼	Press the ▷ key once to align the cursor to “2”.	OUTPUT LIMIT LOW -20 %
△ ▼	Press the △ key several times to set “1”.	OUTPUT LIMIT LOW -10 %
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register. ——— OUTPUT LIMIT LOW has been registered. ———	OUTPUT LIMIT LOW ** COMPLETE ** ↓ OUTPUT LIMIT LOW -10 %
△ ▼	Press the △ key once to display “OUTPUT LIM. HIGH”.	OUTPUT LIM. HIGH 120 %
ENT ▼	Press the ENT key once to blink the cursor.	OUTPUT LIM. HIGH 120 %
▷ ▼	Press the ▷ key once to align the cursor to “2”.	OUTPUT LIM. HIGH 120 %
△ ▼	Press the △ key several times to set “1”.	OUTPUT LIM. HIGH 110 %
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register. ——— OUTPUT LIM. HIGH has been registered. ———	OUTPUT LIM. HIGH ** COMPLETE ** ↓ OUTPUT LIM. HIGH 110 %
ESC △	Press the ESC key twice and then press the △ key for 3 times to enter the measurement mode.	0.000 % 0.000 m3/h

4.9.2. Setting the total

4.9.2.1. Setting the total pulse (pulse value, pulse width)

Description

- Set to totalize a process variable (flow rate) by total meter, etc. according to total pulse output.
- Pulse value: Total amount (volume) per pulse.
  A pulse is outputted when the total volume has attained an amount set by the pulse value, and adds to the total pulse count (in case of total pulse indication). Settable range: 0.000001 to 99999999
  * Set the total unit before setting the pulse value. (See Section 4.8.3.)
- Pulse width: Width of total pulse output.
  Select a pulse width according to a corresponding total meter out of menus. Settable range: 5ms, 10ms, 50ms, 100ms, 200ms
  Note) If the output is through DO2 (relay contact), select 50ms or longer. (See Section 4.9.3.)
- Restrictions in the setup
  Output of total pulses involves the following restrictions depending on the DO output port (DO1, DO2, DO3).

DO output port	Frequency range of pulse output (at full scale flow rate)	Pulse width
DO1, DO2: Transistor, open collector	100 pulse/sec	5ms, 10ms, 50ms, 100ms, 200ms
DO3: Relay contact	1 pulse/sec	50ms, 100ms, 200ms

The maximum output frequency is also restricted by the setup of the pulse width. Therefore, set the pulse width and pulse value so that both of condition 1 and condition 2 indicated below are satisfied. Correct results may not occur, if any setup that does not satisfy both of condition 1 and condition 2 is made.

Condition 1:

$$\frac{\text{FULL SCALE}^{\text{Note1)}}\ [\text{m}^3/\text{s}]}{\text{TOTAL RATE}\ [\text{m}^3]} \leq \begin{matrix} 100[\text{Hz}] \ \text{(In case of DO1, DO2)} \\ 1[\text{Hz}] \ \text{(In case of DO3)} \end{matrix}$$

Condition 2:

$$\frac{\text{FULL SCALE}^{\text{Note1)}}\ [\text{m}^3/\text{s}]}{\text{TOTAL RATE}\ [\text{m}^3]} \leq \frac{1000}{2 \times \text{PULSE WIDTH}\ [\text{ms}]}$$

Note 1) The range of FULL SCALE1 or FULL SCALE2, whichever is larger, is the object in the case of automatic 2-range setup, forward and reverse range setup or forward and reverse automatic 2-range setup.

Note 2) The output frequency on the output ports is limited when the flow rate exceeds the set range. Therefore, if such a setup that the maximum frequency per range occurs at the time of 100% flow rate, there is possibility that the total pulse output will be incapable of following when the flow rate exceeds 100%, and accurate total value cannot be obtained if over-range continues for a long time. If there are cases where the flow rate exceeds 100%, modify the set range and pulse value so that the maximum frequency will not exceed the restricted level.

Example of calculation

Calculate the range that permits setup of the total value under the range and pulse width indicated below.
When the range and the pulse width are as follows.
FLOW SPAN -1: 36[m^3/h] (=0.01[m^3/s]), Pulse width:50[ms]
i) In case of DO1/DO2 output
Condition 1

$$\text{TOTAL RATE} \geq \frac{\text{FULL SCALE}\ [\text{m}^3/\text{s}]}{100[\text{Hz}]} = \frac{0.01\ [\text{m}^3/\text{s}]}{100\ [\text{Hz}]}$$

$$= \underline{0.0001\ [\text{m}^3]} = \underline{0.1\ [\text{L}]}$$

As above:

$$\underline{0.1\ [\text{L}] \leq \text{TOTAL RATE}} \quad \cdots\cdots \text{A}$$

Condition 2

$$\text{TOTAL RATE} \geq \text{FULL SCALE}\ [\text{m}^3/\text{s}] \times \frac{2 \times \text{PULSE WIDTH}\ [\text{ms}]}{1000} = 0.01\ [\text{m}^3/\text{s}] \times \frac{2 \times 50\ [\text{ms}]}{1000}$$

$$= \underline{0.001\ [\text{m}^3]} = \underline{1\ [\text{L}]} \quad \cdots\cdots \text{B}$$

The settable range of the total value that satisfies both of condition 1 and condition 2 is as follows from results of calculation A and B.

$$\underline{1\ [\text{L}] \leq \text{TOTAL RATE}}$$

ii) In case of DO3 output
Condition 1

$$\text{TOTAL RATE} \geq \frac{\text{FULL SCALE}\ [\text{m}^3/\text{s}]}{1\ [\text{Hz}]} = \frac{0.01\ [\text{m}^3/\text{s}]}{1\ [\text{Hz}]}$$

$$= \underline{0.01\ [\text{m}^3]} = \underline{10\ [\text{L}]} \quad \cdots\cdots \text{C}$$

Condition 2 is same as that of the case of DO1 output indicated above.
Therefore, the settable range of the total value is as follows from results of calculation B and C.

$$\underline{10\ [\text{L}] \leq \text{PULSE VALUE} \leq 864\ [\text{m}^3]}$$

Note) When the total setting value is “0”, total pulse is not output.
Note) When setting, stop status is set at the total mode.

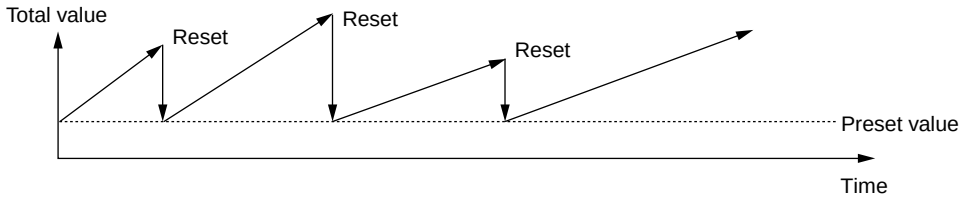
For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set total value to 0.1m³/pulse, and pulse width to 100ms. * Set the total value beforehand.	
Key operation	Description	Display
△	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
▼ ENT	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
▼ △	Press the △ key for 5 times to display “TOTAL”.	TOTAL
▼ ENT	Press the ENT key once to display “TOTAL MODE”.	TOTAL MODE STOP
▼ △	Press the △ key once to display “TOTAL RATE”.	TOTAL RATE 0 m3
▼ ENT	Press the ENT key once to display the cursor.	TOTAL RATE 00000000 m3
▼ ▷	Press the ▷ key for 7 times to move the cursor.	TOTAL RATE 0000000 0 m3
▼ △	Press the △ key several times to display decimal point.	TOTAL RATE 0000000.0 m3
▼ ▷	Press the ▷ key once to move the cursor.	TOTAL RATE 0000000.0 m3
▼ △	Press the △ key once to display “1”.	TOTAL RATE 0000000.1 m3
▼ ENT	Press the ENT key once to register.	TOTAL RATE ** COMPLETE ** ↓
▼ ▼ ▼ ▼	——— TOTAL RATE has been registered. ———	TOTAL RATE 0.1 m3
△	Press the △ key twice to display “PULSE WIDTH”.	PULSE WIDTH 50.0 msec
▼ ENT	Press the ENT key once to blink the cursor.	PULSE WIDTH 50.0 msec
▼ △	Press the △ key twice, and select “100.0msec”.	PULSE WIDTH 100.0 msec
▼ ENT	Press the ENT key once to register.	PULSE WIDTH ** COMPLETE ** ↓
▼ ▼ ▼ ▼	——— PULSE WIDTH has been registered. ———	PULSE WIDTH 100.0 msec
△	Press the △ key for 3 times to display “TOTAL MODE”.	TOTAL MODE STOP
▼ ENT	Press the ENT key once to blink the cursor.	TOTAL MODE STOP
▼ △	Press the △ key once, and select “TOTAL PRESET”.	TOTAL MODE TOTAL PRESET
▼ ENT	Press the ENT key once to register.	TOTAL MODE ** COMPLETE ** ↓
▼ ▼ ▼ ▼	——— TOTAL MODE has been registered. ———	TOTAL MODE TOTAL PRESET
ESC △	Press the ESC key twice and then press the △ key for 3 times to enter the measurement mode.	0.000 % 0.000 m3/h

4.9.2.2. Setting the preset value

Description

- Preset value: Value which appears on the total counter when the total value has been reset.
  Settable range:0 to 99999999
  <Note> A resetting action simultaneously resets both forward total memory and reverse total memory.
  Set the total unit beforehand in the MEASURE SETUP mode. (Refer to 4.8.3.)
  When setting, stop status is set at the total mode.



For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set the preset value to 100m^3. * Set the total unit beforehand.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 5 times to display “TOTAL”.	TOTAL
ENT ▼	Press the ENT key once to display “TOTAL MODE”.	TOTAL MODE STOP
△ ▼	Press the △ key twice to display “TOTAL PRESET”.	TOTAL PRESET 0 m3
ENT ▼	Press the ENT key once to display the cursor.	TOTAL PRESET 00000000 m3
▷ ▼	Press the ▷ key for 6 times to move the cursor. * Note that, it cannot be entered on the first digit (leftmost).	TOTAL PRESET 00000000 m3
△ ▼	Press the △ key once to display “1”.	TOTAL PRESET 00000100 m3
ENT ▼	Press the ENT key once to register.	TOTAL PRESET ** COMPLETE ** ↓
▼ ▼ ▼	——— “TOTAL PRESET” has been registered. ———	TOTAL PRESET 100 m3
△ ▼	Press the △ key for 4 times to display “TOTAL MODE”.	TOTAL MODE STOP
ENT ▼	Press the ENT key once to blink the cursor.	TOTAL MODE STOP
△ ▼	Press the △ key once, and select “TOTAL PRESET”.	TOTAL MODE TOTAL PRESET
ENT ▼	Press the ENT key once to register.	TOTAL MODE ** COMPLETE ** ↓
▼ ▼ ▼	——— “TOTAL MODE” has been registered. ———	TOTAL MODE TOTAL PRESET
ESC △	Press the ESC key twice and then press the △ key for 3 times to enter the measurement mode.	0.000 % 0.000 m3/h

4.9.2.3. TOTAL mode (total reset, start, stop)

Description
- The total is started, stopped or reset.
- Settable range: START, STOP, TOTAL RESET
  START : Starts totalizing. Totalizes continuously from the stopped status.
  STOP : Stops totalizing. Setting cannot be changed when it is not stopped.
  RESET : Resets the total memory to the preset value, and starts totalizing.
  <Note> A resetting action simultaneously resets both forward total memory and reverse total memory.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Reset the total value (preset value 0m^3), and restart a total.	
Key operation	Description	Display
		0.00 m3/h + 127.26 m3
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 5 times to display “TOTAL”.	TOTAL
ENT ▼	Press the ENT key once to display “TOTAL MODE”.	TOTAL MODE START
ENT ▼	Press the ENT key once to blink the cursor.	TOTAL MODE START
△ ▼	Press the △ key twice to display “TOTAL RESET”.	TOTAL MODE TOTAL PRESET
ENT ▼	Press the ENT key twice to execute “TOTAL RESET”.	TOTAL MODE ** COMPLETE ** ↓
▼ ▼ ▼	——— The total operation is started. ———	TOTAL MODE TOTAL PRESET
ESC △	Press the ESC key twice and then press the △ key for 3 times to enter the measurement mode.	0.00 m3/h 0.00 m3

4.9.2.4. Determining how to dispose of total at error (BURNOUT)

Description
BURNOUT (TOTAL)
- Determines how to dispose of the total when the measurement status is abnormal on account of an empty pipe interior or bubbles mixed in fluid (common to total indication and total pulse output).
- Settable range:
  HOLD : Stops the total (as factory set).
  NOT USED: Continues the total according to a flow rate marked immediately before the error occurrence.

BURNOUT TIMER
- Sets the time from error occurrence to error processing.
- Settable range: 0 to 900sec (factory set: 10sec)
  The total continues until the burnout timer is actuated.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Change the processing from "BURNOUT" to "HOLD", and change the burnout timer setting from 10 seconds to 15 seconds.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 5 times to display “TOTAL”.	TOTAL
ENT ▼	Press the ENT key once to display “TOTAL MODE”.	TOTAL MODE START
△ ▼ ▼ ▼ ▼	Press the △ key for 4 times to display “BURNOUT(TOTAL)”. Because HOLD (factory set) is already registered, go to the next step. Note) For setting “NOT USED”, press the //ENT key, and the /// key to select “NOT USED”.	BURNOUT(TOTAL) HOLD
△ ▼	Press the △ key once to display “BURNOUT TIMER”.	BURNOUT TIMER 10sec
ENT ▼	Press the ENT key once to blink the cursor.	BURNOUT TIMER 010sec
▷ ▼	Press the ▷ key twice to move the cursor.	BURNOUT TIMER 010sec
△ ▼	Press the △ key for 5 times to set “5”.	BURNOUT TIMER 015sec
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register. ——— BURNOUT TIMER has been registered. ———	BURNOUT TIMER ** COMPLETE ** ↓ BURNOUT TIMER 15sec
ESC △	Press the ESC key twice and then press the △ key for 3 times to enter the measurement mode.	0.00 m3/h + 0.00 m3

4.9.3. Setting the DO output

Description
- Selects the output of total pulses and statuses (of alarm, flow switch, total switch, etc.).

- Settable range (common to DO1, DO2 and DO3)

NOT USED	: Does not use the contact output.
+TOTAL PULSE	: Outputs the forward total pulses.
-TOTAL PULSE	: Outputs total pulse in reverse direction.
FULL SCALE 2	: Selects a contact output as FULL SCALE 2 measurement status. (forward automatic 2 ranges, forward and reverse range, forward/reverse automatic 2 ranges)
ALARM	
ALL	: Selects a contact output at HARDWARE FAULT or PROCESS ERROR status.
HARDWARE FAULT	: Selects a contact output when circuit error such as memory occurred and received signal error.
PROCESS ERROR	: Selects a contact output when no waves are received, or waves are unstable.
FLOW SWITCH	
FLOW SW HIGH	: Selects a contact output when flow rate is above the setting.
FLOW SW LOW	: Selects a contact output when flow rate is below the setting.
TOTAL SWITCH	: Selects a contact output when total value exceeds the setting.
AO RANGE OVER	: Selects a contact output when the lower and upper limits of range are above the setting.
PULSE RANGE OVER	: Selects a contact output when the total pulse output exceeds the maximum output frequency.
-FLOW DIRECTION	: Selects a contact output when the flow is in reverse direction.
CONTACT ACTION	
ACTIVE ON	: Normally off (DO1/DO2) or normal open (DO3).
ACTIVE OFF	: Normally on (DO1/DO2) or normal close (DO3).

⚠ CAUTION

- If the contact action is set to “ACTIVE OFF”, DO output is provided when the power is turned on.
- Check if DO output can be modified before setting.

<Note> DO output specifications

DO1/DO2 : Open collector, Contact capacity 30V DC, 0.1A
When total pulse output is selected (Note: See 4.9.2.1)
100 pulses/s or less (at full scale flow rate)
Pulse width: 5, 10, 50, 100 or 200ms.

DO3 : Relay contact, Contact capacity 220V AC/30V DC, 1A
Service life 200,000 times (under rated load), Can be replaced if provided with a socket. (See 6.4. How to replace the relay)
When total pulse output is selected (Note: See 4.9.2.1)
1 pulse/s or less (at full scale flow rate)
Pulse width: 50, 100 or 200ms.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

4.9.3.1. How to validate the total pulse output

Description
- Validates the total pulse output for DO1 OUT, DO2 OUT and/or DO3 OUT.
  +TOTAL PULSE: Outputs flow rate total pulse in forward direction.
  -TOTAL PULSE : Reverse flow rate total pulse output.
  Note) Referring to Section 4.9.2.1., set the pulse value, pulse width, etc.

For concrete keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set the DO1 output to “+ TOTAL PULSE”. Also, set the contact to “ACTIVE ON”.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 6 times to display “DO1 OUT”.	DO1 OUT NOT USED
	* Press the △ key again to display “DO2 OUT”.	
	* Press the △ key once again to display “DO3 OUT”.	
ENT ▼	Press the ENT key once to display the cursor.	DO1 OUT NOT USED

△ ▼	Press the △ key once to display “+TOTAL PULSE” on the 2nd line. Press the △ key again to select “-TOTAL PULSE”.	DO1 OUT +TOTAL PULSE
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register “+TOTAL PULSE”. ——— “+TOTAL PULSE” has been registered. ———	DO1 OUT ** COMPLETE ** ↓ STATUS OUT CONTACT ACTION
ENT ▼	Press the ENT key once to display “CONTACT ACTION”.	CONTACT ACTION ACTIVE ON
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register “ACTIVE ON” (normally off). * To select normally on, press the △ key. ——— “ACTIVE ON” has been registered. ———	CONTACT ACTION ** COMPLETE ** ↓ STATUS OUT CONTACT ACTION
ESC △	Press the ESC key twice and then press the △ key for 3 times to enter the measurement mode.	0.000 % 0.000 m3/h

4.9.4. Setting the LCD indication

Description
- Flow velocity indication
  Selectable flow velocity units: m/s (if SYSTEM UNIT was set to METRIC) (See 4.8.1)
  <Note> The decimal point position is fixed. (Decimal point 3 digits)
- Flow rate indication
  Selectable flow rate indications: Actual value reading, % reading.
  <Note> The indication unit is as selected by FLOW UNIT. (See 4.8.2.)
- Total indication
  Selectable total indications: Actual total value reading (forward/reverse flow), total pulse count (forward/reverse flow).
  <Note> The indication unit is as selected by TOTAL UNIT. (See 4.9.4.)
- How to validate the indication
  Set the DISPLAY setting mode to 1st ROW (for indication on 1st line) or 2nd ROW (for indication on 2nd line), and further select indication contents.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Display the 1st line of LCD indication in percentages (%).	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 3 times to display “DISPLAY”.	DISPLAY DISPLAY 1
ENT ▼	Press the ENT key once to blink the cursor.	DISPLAY DISPLAY 1
ENT ▼	Press the ENT key again, and select “1ST LOW”.	1ST LOW VELOCITY
△ ▼	Press the △ key twice to display “FLOW RATE(%)”.	1ST LOW FLOW RATE(%)
ENT ▼	Press the ENT key once, and select and fix “FLOW RATE(%)” to display “1:DECIMAL POINT”.	1:DECIMAL POINT ****.***
▷ ▼	Press the ▷ key once to shift the decimal point position to next place.	1:DECIMAL POINT *****.**
ENT ▼	Press the ENT key once to register.	1:DECIMAL POINT ** COMPLETE ** ↓
▼ ▼ ▼	——— FLOW RATE(%) indication has been set. ———	1:DECIMAL POINT *****.**
ESC △	Press the ESC key twice and then press the △ key for 3 times to enter the measurement mode.	0.00 % 0.000 m3/h

4.9.5. Setting the damping

Description
- Used for attenuating the variation of measured value.
  A time constant is set (response time of about 63%).

  Settable range: 0.0 to 100.0sec in 0.1 sec steps

Note) In case you set to 0 sec, response time become as below.
- System cycle 0.2sec
- Dead time 0.2sec or less, time constant 0.1sec

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Change the damping from 5 to 20 sec.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key once to display “DAMPING”.	DAMPING 5.0 sec
ENT ▼	Press the ENT key once to blink the cursor.	DAMPING 005.0 sec
		005.0 sec
		025.0 sec
		025.0 sec
△ ▷ ▼	Set “20” by the △ key and the ▷ key.	DAMPING 020.0 sec
ENT ▼	Press the ENT key once to register.	DAMPING ** COMPLETE ** ↓
▼ ▼ ▼	——— DAMPING has been registered. ———	DAMPING 20 sec
ESC △	Press the ESC key once and then press the △ key for 3 times to enter the measurement mode.	0.000 m/s 0.000 m3/h

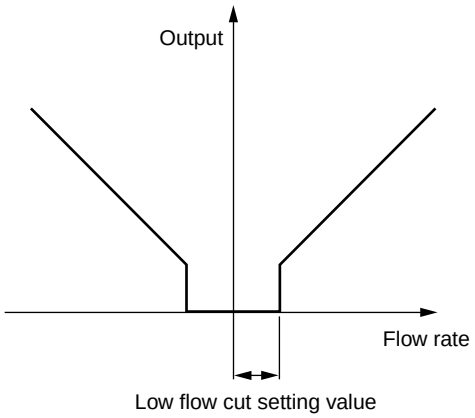
4.9.6. Setting the low flow rate cutting

Description
- The output can be cut when the flow rate is too small.
- Effective for indication, analog output (4-20mA) and total operation.

Settable range: 0 to 5 [m/s] in terms of flow velocity.
(Factory set: 0.150 [m^3/h])

Note 1) As required, set the low flow rate cut because the flow meter may read a flow rate when the fluid in the piping is moving on account of convection, etc. even if the valves are closed.
Note 2) The flow rate unit is as selected by "FLOW UNIT" in "MEASURE SETUP". (See 4.8.2.)

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

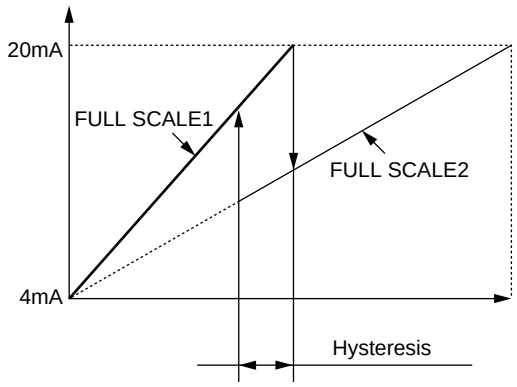


Operation (example)	Set the low flow rate cut point to 0.5 [m^3/h].	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key twice to display “CUT OFF”.	CUT OFF 0.150 m3/h
ENT ▼	Press the ENT key once to blink the cursor.	CUT OFF 0000.150 m3/h
		0000.150 m3/h
		0000.550 m3/h
		0000.550 m3/h
△ ▷ ▼	Set “0.5” by the △ key and the ▷ key.	CUT OFF 0000.500 m3/h
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register. ——— CUT OFF has been registered. ———	CUT OFF ** COMPLETE ** ↓ CUT OFF 0.500 m3/h
ESC △	Press the ESC key once and then press the △ key for 3 times to enter the measurement mode.	0.000 m/s 0.000 m3/h

4.10. Application operation of parameter

4.10.1. Setting automatic 2 ranges

Description
- The function carries out a measurement while changing over the range according to the flow rate.
- The current output changes with the action range as illustrated on the right.
- The hysteresis can be set to between 0 and 20% of the smaller range.
- Upon setting DO1, DO2 or DO3 to "FULL SCALE 2", a contact outputs "FULL SCALE 2" action. Select “ACTIVE ON” or “ACTIVE OFF” separately. (See 4.10.5.)
- Settable range: 0.3 to 32 [m/s] in terms of flow velocity in piping for any of FULL SCALE1 and FULL SCALE2.
  * Preset PIPE PARAMETER and FLOW UNIT.
  * If a value beyond the settable range is inputted, "INPUT ERROR" appears and then last setting is resumed.
  * If "FLOW UNIT" has been changed after setting the range, redo the range setting.
  * When FULL SCALE2 is not used (in the case of single range), set “0” to FULL SCALE2.



<Note> The flow rate unit is as selected by "FLOW UNIT". Before setting range, set the "FLOW UNIT". (See 4.8.2.)

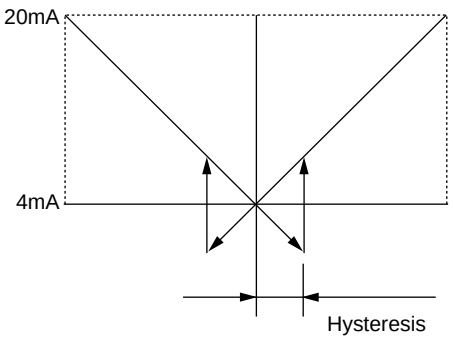
For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set “AUTO 2” to “RANGE TYPE”, 10[m^3/h] to “FULL SCALE1”, and 60[m^3/h] to “FULL SCALE2”. Set “RANGE HYS.” to 7%. * Preset “PIPE PARAMETER” and “FLOW UNIT”.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 4 times to display “RANGE”.	RANGE
ENT ▼	Press the ENT key twice to blink the cursor.	RANGE TYPE SINGLE
△ ▼	Press the △ key once, and select “AUTO 2”.	RANGE TYPE AUTO 2
ENT ▼	Press the ENT key once to display “RANGE TYPE”.	RANGE TYPE AUTO 2
△ ▼	Press the △ key once to display “FULL SCALE1”.	FULL SCALE1 20.0000 m3/h
ENT ▼	Press the ENT key once to blink the cursor on the 2nd line.	FULL SCALE1 0020.0000 m3/h
▷ ▼	Press the ▷ key several times to align the cursor to “2”.	FULL SCALE1 0020.0000 m3/h
△ ▼	Press the △ key several times to change to “1”.	FULL SCALE1 0010.0000 m3/h
	Note) To change the decimal point position, align the cursor with a place to change to, and press the △ key.	
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register. ——— FULL SCALE1 has been registered. ———	FULL SCALE1 ** COMPLETE ** ↓ FULL SCALE1 10.0000 m3/h
△ ▼	Press the △ key once to display “FULL SCALE2”.	FULL SCALE2 0.0000 m3/h

ENT	Press the ENT key once to blink the cursor.	FULL SCALE2 0000.0000 m3/h
▼ ▷	Press the ▷ key twice to move the cursor.	FULL SCALE2 0000.0000 m3/h
▼ △	Press the △ key for 6 times to set “6”.	FULL SCALE2 0060.0000 m3/h
▼ ENT	Press the ENT key once to register.	FULL SCALE2 ** COMPLETE ** ↓
▼ ▼ ▼ ▼	——— FULL SCALE2 has been registered. ———	FULL SCALE2 60.0000 m3/h
△	Press the △ key once to display “RANGE HYS.”.	RANGE HYS. 5.00 %
▼ ENT	Press the ENT key once to blink the cursor.	RANGE HYS. 05.00 %
▼ ▷	Press the ▷ key once to move the cursor.	RANGE HYS. 05.00 %
▼ △	Press the △ key twice to set “7”.	RANGE HYS. 07.00 %
▼ ENT	Press the ENT key once to register.	RANGE HYS. ** COMPLETE ** ↓
▼ ▼ ▼ ▼	——— RANGE HYS. has been registered. ———	RANGE HYS. 7.00 %
ESC △	Press the ESC key twice and then press the △ key for 3 times to enter the measurement mode.	0.000 % 0.000 m3/h

4.10.2. Setting the Bi-directional range

Description
- The function measures the flow rate of either forward or reverse flow while changing over the range corresponding to the flow direction.
- The current output changes with the action range as illustrated on the right.
- The hysteresis can be set to between 0 and 20% of the action range.
- Upon setting DO1, DO2 or DO3 to "FULL SCALE2", a contact outputs "FULL SCALE2" action.
  Select “ACTIVE ON” or “ACTIVE OFF” separately. (See 4.10.5.)
- Settable range: ±0.3 to 32[m/s] in terms of flow velocity in piping for any of FULL SCALE1 and FULL SCALE2.
  * Preset PIPE PARAMETER and FLOW UNIT.
  * If a value beyond the settable range is inputted, "INPUT ERROR" appears and then last setting is resumed.
  * If "FLOW UNIT" has been changed after setting the range, redo the range setting.
  * When FULL SCALE2 is not used (in the case of single range), set “0” to FULL SCALE2.



<Note> The flow rate unit is as selected by "FLOW UNIT" in “MEASURE SETUP” mode. Before setting range, set the "FLOW UNIT". (See 4.8.2.)

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

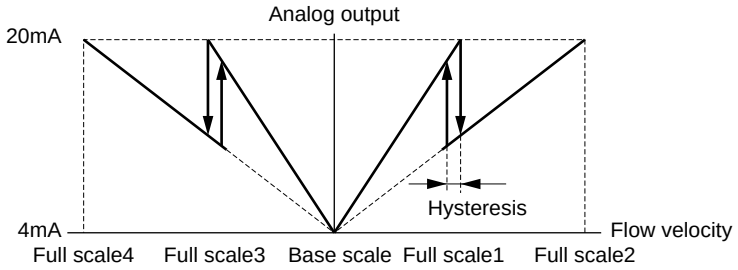
Operation (example)	Set “BI-DIR” to “RANGE TYPE”, 20[m3/h] to “FULL SCALE1”, and -10[m3/h] to “FULL SCALE2”. Set “RANGE HYS.” to 7%. * Preset “PIPE PARAMETER” and “FLOW UNIT”.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 4 times to display “RANGE”.	RANGE
ENT ▼	Press the ENT key twice to blink the cursor.	RANGE SINGLE
△ ▼	Press the △ key twice, and select “BI-DIR”.	RANGE TYPE BI-DIR
ENT ▼	Press the ENT key for 4 times to display “RANGE TYPE”.	RANGE TYPE BI-DIR
△ ▼	Press the △ key once to display “FULL SCALE1”.	FULL SCALE1 50.0000 m3/h
ENT ▼	Press the ENT key once to blink the cursor.	FULL SCALE1 0050.0000 m3/h
▷ ▼	Press the ▷ key several times to align the cursor to “5”.	FULL SCALE1 0050.0000 m3/h
△ ▼	Press the △ key several times to set “2”.	FULL SCALE1 0020.0000 m3/h
▼	Note) To change the decimal point position, align the cursor with a place to change to, and press the △ key.	
ENT ▼	Press the ENT key once to register.	FULL SCALE1 ** COMPLETE ** ↓
▼ ▼ ▼	——— FULL SCALE1 has been registered. ———	FULL SCALE1 20.0000 m3/h
△ ▼	Press the △ key once to display “FULL SCALE2”.	FULL SCALE2 0.0000 m3/h
ENT ▼	Press the ENT key once to register.	FULL SCALE2 0000.0000 m3/h
△ ▼	Press the △ key several times to display “-” on the 1st line.	FULL SCALE2 -000.0000 m3/h

▷ ▼	Press the ▷ key twice to move the cursor.	FULL SCALE2 -000.0000 m3/h
△ ▼	Press the △ key once to set “1”.	FULL SCALE2 -010.0000 m3/h
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register. ——— FULL SCALE2 has been registered. ———	FULL SCALE2 ** COMPLETE ** ↓ FULL SCALE2 -10.0000 m3/h
△ ▼	Press the △ key once to display “RANGE HYS.”.	RANGE HYS. 5.00 %
ENT ▼	Press the ENT key once to blink the cursor.	RANGE HYS. 05.00 %
▷ ▼	Press the ▷ key once to move the cursor.	RANGE HYS. 05.00 %
△ ▼	Press the △ key twice to set “7”.	RANGE HYS. 07.00 %
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register. ——— RANGE HYS. has been registered. ———	RANGE HYS. ** COMPLETE ** ↓ RANGE HYS. 7.00 %
ESC △	Press the ESC key twice and then press the △ key for 3 times to enter the measurement mode.	0.000 % 0.000 m3/h

4.10.3. Setting the Bi-directional auto 2 range

Description

- The function measures the flow rate of either forward or reverse flow while changing over the range corresponding to the flow direction.
- The current output changes with the action range as illustrated on the right.
- The hysteresis can be set to between 0 and 20% of either range of FULL SCALE1 or FULL SCALE2 and FULL SCALE3 or FULL SCALE4 whichever the span is smaller.
- Upon setting DO1, DO2 or DO3 to "FULL SCALE2", a contact outputs "FULL SCALE2" action.
  Select “ACTIVE ON” or “ACTIVE OFF” separately.
  (See 4.10.5.)



- Settable range: ±0.3 to 32[m/s] in terms of flow velocity in piping for any of FULL SCALE1 and FULL SCALE2.
  When FULL SCALE1 and FULL SCALE2 are set, FULL SCALE3 and FULL SCALE4 are automatically set.
  FULL SCALE1 and FULL SCALE3, FULL SCALE2 and FULL SCALE4 are related as follows.
  |FULL SCALE1| = |FULL SCALE3|
  |FULL SCALE2| = |FULL SCALE4|
  * Preset PIPE PARAMETER and FLOW UNIT.
  * If a value beyond the settable range is inputted, "INPUT ERROR" appears and then last setting is resumed.
  * If "FLOW UNIT" has been changed after setting the range, redo the range setting.
  * When FULL SCALE2 is not used (in the case of single range), set “0” to FULL SCALE2.

  <Note> The flow rate unit is as selected by "FLOW UNIT" in “MEASURE SETUP” mode. Before setting range, set the "FLOW UNIT". (See 4.8.2.)

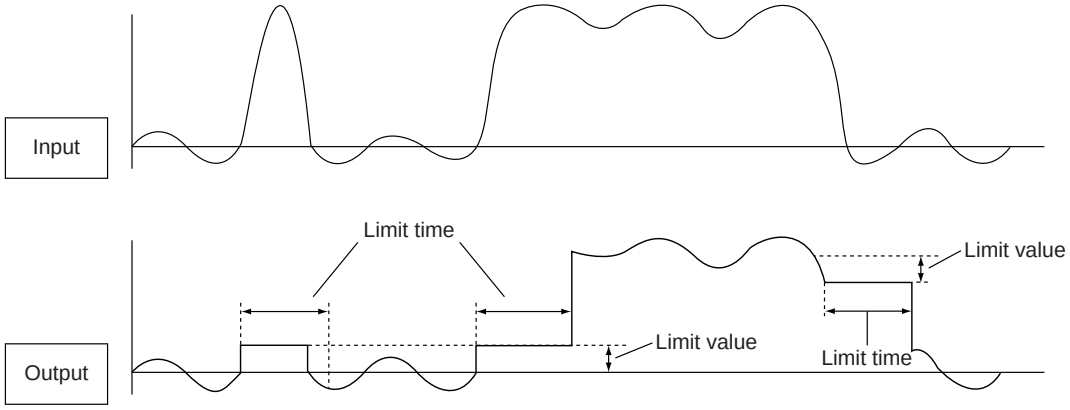
For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set “BI-DIR AUTO 2” to “RANGE TYPE”, 10[m^3/h] to “FULL SCALE1”, and 60[m^3/h] to “FULL SCALE2”. Set “RANGE HYS.” to 7%. * Preset “PIPE PARAMETER” and “FLOW UNIT”.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 4 times to display “RANGE”.	RANGE
ENT ▼	Press the ENT key twice to blink the cursor.	RANGE TYPE SINGLE
△ ▼	Press the △ key for 3 times, and select “BI-DIR AUTO 2”.	RANGE TYPE BI-DIR AUTO 2
ENT ▼	Press the ENT key once to display “RANGE TYPE”.	RANGE TYPE BI-DIR AUTO 2
△ ▼	Press the △ key once to display “FULL SCALE1”.	FULL SCALE1 20.0000 m3/h
ENT ▼	Press the ENT key once to blink the cursor on the 2nd line.	FULL SCALE1 0020.0000 m3/h
▷ ▼	Press the ▷ key several times to align the cursor to “2”.	FULL SCALE1 0020.0000 m3/h
△ ▼	Press the △ key several times to set “1”.	FULL SCALE1 0010.0000 m3/h
▼	Note) To change the decimal point position, align the cursor with a place to change to, and press the △ key.	
ENT ▼	Press the ENT key once to register.	FULL SCALE1 ** COMPLETE ** ↓
▼ ▼ ▼	——— FULL SCALE1 has been registered. ———	FULL SCALE1 10.0000 m3/h

△ ▼	Press the △ key once to display “FULL SCALE2”.	FULL SCALE2 0.0000 m3/h
ENT ▼	Press the ENT key once to blink the cursor.	FULL SCALE2 0000.0000 m3/h
▷ ▼	Press the ▷ key twice to move the cursor.	FULL SCALE2 000.0000 m3/h
△ ▼	Press the △ key for 6 times to set “6”.	FULL SCALE2 0060.0000 m3/h
ENT ▼	Press the ENT key once to register.	FULL SCALE2 ** COMPLETE **
▼ ▼ ▼	——— FLOW SPAN2 has been registered. ———	↓ FULL SCALE2 60.0000 m3/h
△ ▼	Press the △ key once to display “RANGE HYS.”.	RANGE HYS. 5.00 %
ENT ▼	Press the ENT key once to blink the cursor.	RANGE HYS. 05.00 %
▷ ▼	Press the ENT key once to move the cursor.	RANGE HYS. 05.00 %
△ ▼	Press the △ key twice to set “7”.	RANGE HYS. 07.00 %
ENT ▼	Press the ENT key once to register.	RANGE HYS. ** COMPLETE **
▼ ▼ ▼	——— RANGE HYS. has been registered. ———	↓ RANGE HYS. 7.00 %
ESC △	Press the ESC key twice and then press the △ key for 3 times to enter the measurement mode.	0.000 % 0.000 m3/h

4.10.4. Rate limit

Description
- Spike noise input such as slurry fluid can be cut and output.
- Settable range
  (1) RATE LIMIT 0 to 5 [m/s] in terms of flow velocity. Absolute value is input (Factory set: 0[m^3/h])
  (2) RATE TIMER Enter in the range of 0 to 900 sec. (Factory set: 0sec)



(Note 1) When input exceeding a limit value continues more than limit time, it is output as a true signal.
(Note 2) When the limit time is set to 0sec, this function does not operate.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set 5m^3/h to RATE LIMIT, and 10sec to RATE LIMIT TIMER. * Preset “PIPE PARAMETER” and “FLOW UNIT”.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 4 times to display “RANGE”.	RANGE
ENT ▼	Press the ENT key once to display “RANGE TYPE”.	RANGE TYPE SINGLE
△ ▼	Press the △ key for 8 times to display “RATE LIMIT”.	RATE LIMIT 0.000 m3/h
ENT ▼	Press the ENT key once to blink the cursor.	RATE LIMIT 00000.000 m3/h
▷ ▼	Press the ▷ key for 4 times to align the cursor.	RATE LIMIT 00000.000 m3/h
△ ▼	Press the △ key several times to set “5”.	RATE LIMIT 00005.000 m3/h
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register. ——— RATE LIMIT has been registered. ———	RATE LIMIT ** COMPLETE ** ↓ RATE LIMIT 5.000 m3/h
△ ▼	Press the △ key once to display “RATE LIMIT TIMER”.	RATE LIMIT TIMER 0 sec
ENT ▼	Press the ENT key once to blink the cursor.	RATE LIMIT TIMER 000 sec
▷ ▼	Press the ▷ key once to align the cursor.	RATE LIMIT TIMER 000 sec
△ ▼	Press the △ key several times to set “1”.	RATE LIMIT TIMER 010 sec

ENT ▼ ▼ ▼ ▼	Press the ENT key once to register. ——— RATE LIMIT TIMER has been registered. ———	RATE LIMIT TIMER ** COMPLETE ** ↓ RATE LIMIT TIMER 10 sec
ESC △	Press the ESC key twice and then press the △ key for 3 times to enter the measurement mode.	0.000 % 0.000 m3/h

4.10.5. Setting the DO output

4.10.5.1. How to validate outputting the FULL SCALE 2

Description
- Select a contact output as DO1, DO2 and/or DO3 at FULL SCALE2 measurement status.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set the DO1 output to “FULL SCALE2”. Also, set the contact to “ACTIVE ON”.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 6 times to display “DO1 OUT”.	DO1 OUT NOT USED
	* Press the △ key again to display “DO2 OUT”.	
	* Press the △ key once again to display “DO3 OUT”.	
ENT ▼	Press the ENT key once to blink the cursor.	DO1 OUT NOT USED
△ ▼	Press the △ key for 3 times to display “FULL SCALE2” on the 2nd line.	DO1 OUT FULL SCALE2
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register “FULL SCALE2”. ——— “FULL SCALE2” has been registered. ———	DO1 OUT ** COMPLETE ** ↓ STATUS OUT CONTACT ACTION
ENT ▼	Press the ENT key once to display “CONTACT ACTION”.	CONTACT ACTION ACTIVE ON
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register “ACTIVE ON”(normally off). * To select normally on, press the △ key. ——— ACTIVE ON has been registered. ———	CONTACT ACTION ** COMPLETE ** ↓ STATUS OUT CONTACT ACTION
ESC △	Press the ESC key twice and then press the △ key for 3 times to enter the measurement mode.	0.000 % 0.000 m3/h

4.10.5.2. How to validate the alarm output

Description
- Select a contact output as DO1 and/or DO2 when received wave or E^2PROM is abnormal.
- Settable range
  ALL : Select a contact output when hardware and received wave (nothing, unstable) are abnormal.
  HARDWARE FAULT : Select a contact output when circuit is abnormal.
  PROCESS ERROR : Select a contact output when received wave is abnormal.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

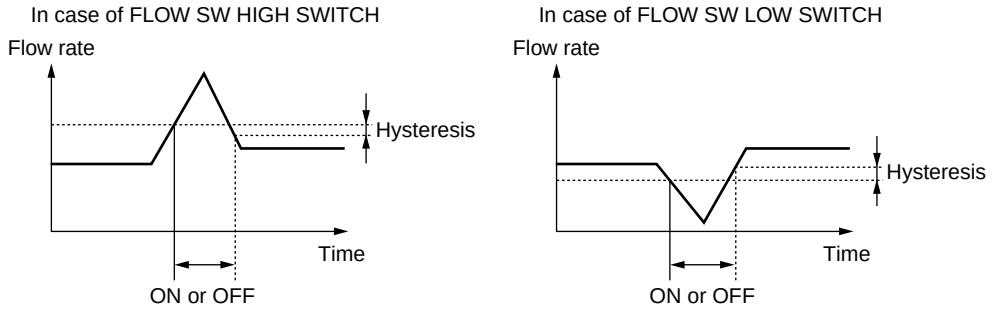
Operation (example)	Set the DO1 output to “PROCESS ERROR”. Also, set the contact to “ACTIVE ON”.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 6 times to display “DO1 OUT”.	DO1 OUT NOT USED
	* Press the △ key again to display “DO2 OUT”.	
	* Press the △ key once again to display “DO3 OUT”.	
ENT ▼	Press the ENT key once to blink the cursor.	DO1 OUT NOT USED
△ ▼	Press the △ key for 4 times to display “ALARM” on the 2nd line.	DO1 OUT ALARM
ENT ▼	Press the ENT key once to display the ALARM select panel.	ALARM ALL
△ ▼	Press the △ key twice to display “PROCESS ERROR”.	ALARM PROCESS ERROR
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register. ——— “PROCESS ERROR” has been registered. ———	ALARM ** COMPLETE ** ↓ STATUS OUT CONTACT ACTION
ENT ▼	Press the ENT key once to display “CONTACT ACTION”.	CONTACT ACTION ACTIVE ON
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register “ACTIVE ON”(normally off). * To select normally on, press the △ key. ——— “ACTIVE ON” has been registered. ———	CONTACT ACTION ** COMPLETE ** ↓ STATUS OUT CONTACT ACTION
ESC △	Press the ESC key twice and then press the △ key for 3 times to enter the measurement mode.	0.000 m/s 0.000 m3/h

Burnout timer
The time between error occurrence and contact output can be changed by a setting of the burnout timer. Make a setting according to the section “4.9.1.2 Setting of analog output at error (Burnout)”.
Note) If “Process error” or “All” is issued, the burnout timer is enabled. If “Device error” is issued, the burnout timer is disabled.

4.10.5.3. Setting the flow switch

Description

- Select a contact output as DO1, DO2 and/or DO3 when the flow rate has exceeded a setting.



- Settable range
  Flow rate : 0 to 32m/s in terms of flow velocity.
  Action : FLOW SW HIGH or FLOW SW LOW
  Contact action: ACTIVE ON : DO1/DO2: Normally off DO3: Normally open
  ACTIVE OFF: DO1/DO2: Normally on DO3: Normally close
  Note) The hysteresis value set in Section 4.9.1 "Setting of flow rate range" is applied to the action range.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set the DO1 output to "FLOW SW HIGH", and upper limit flow rate to 12 [m^3/h]. Also, set the contact to "ACTIVE ON".	
Key operation	Description	Display
△ ▼	Press the △ key twice to display "OUTPUT SETTING".	OUTPUT SETTING
ENT ▼	Press the ENT key once to display "ZERO ADJUSTMENT".	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 6 times to display "DO1 OUT".	DO1 OUT NOT USED
	* Press the △ key again to display "DO2 OUT".	
	* Press the △ key once again to display "DO3 OUT".	
ENT ▼	Press the ENT key once to blink the cursor.	DO1 OUT NOT USED
△ ▼	Press the △ key for 5 times to display "FLOW SWITCH" on the 2nd line.	DO1 OUT FLOW SWITCH
ENT ▼	Press the ENT key once to display the flow rate setting screen of "FLOW SW HIGH".	FLOW SW HIGH 10.0000 m3/h
	* Press the △ key once to display the flow rate setting screen of "FLOW SW LOW".	
ENT ▼	Press the ENT key once to blink the cursor.	FLOW SW HIGH 0010.0000 m3/h
▷ ▼	Press the ▷ key for 3 times to move the cursor.	FLOW SW HIGH 0010.0000 m3/h
△ ▼	Press the △ key twice to set "2".	FLOW SW HIGH 0012.0000 m3/h
ENT ▼	Press the ENT key once to register.	FLOW SW HIGH ** COMPLETE ** ↓
▼	——— "FLOW SW HIGH" has been registered. ———	STATUS OUT CONTACT ACTION
ENT ▼	Press the ENT key once to display "CONTACT ACTION".	CONTACT ACTION ACTIVE ON

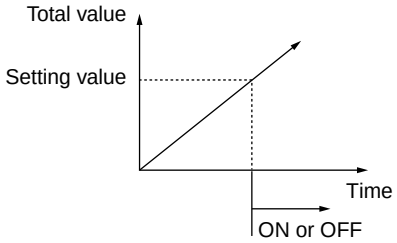
ENT ▼ ▼ ▼ ▼ ESC △	Press the ENT key once to register “ACTIVE ON”(normally off). * To select normally on, press the △ key. ——— “ACTIVE ON” has been registered. ——— Press the ESC key twice and then press the △ key for 3 times to enter the measurement mode.	CONTACT ACTION ** COMPLETE ** ↓ STATUS OUT CONTACT ACTION 0.000 % 0.000 m3/h

4.10.5.4. How to validate the total switch

Description

- Select a contact output as DO1, DO2 and/or DO3 when the total value exceeds a setting.
  Settable range: 0.000001 to 99999999
  Contact action:
  ACTIVE ON : DO1/DO2: Normally off DO3: Normally open
  ACTIVE OFF: DO1/DO2: Normally on DO3: Normally close
  Note) Different values can be assigned to DO1, DO2 and DO3.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)



Operation (example)	Set the DO1 output to “TOTAL SWITCH”, and change the setting value from 10000[m^3] to 100[m^3]. Also, set the contact to “ACTIVE ON”.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 6 times to display “DO1 OUT”. * Press the △ key again to display “DO2 OUT”. * Press the △ key once again to display “DO3 OUT”.	DO1 OUT NOT USED
ENT ▼	Press the ENT key once to blink the cursor.	DO1 OUT NOT USED
△ ▼	Press the △ key for 6 times to display “TOTAL SWITCH” on the 2nd line.	DO1 OUT TOTAL SWITCH
ENT ▼	Press the ENT key once to display the setting screen of “TOTAL SWITCH”.	TOTAL SWITCH 10000 m3
ENT ▼	Press the ENT key once to blink the cursor.	TOTAL SWITCH 00010000 m3
▷ ▼	Press the ▷ key for 3 times to move the cursor.	TOTAL SWITCH 00010000 m3
△ ▼	Press the △ key for 10 times to set “0”.	TOTAL SWITCH 00000000 m3
▷ ▼	Press the ▷ key twice to move the cursor.	TOTAL SWITCH 00000000 m3
△ ▼	Press the △ key once to set “1”.	TOTAL SWITCH 00000100 m3
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register. ——— “TOTAL SWITCH” has been registered. ———	TOTAL SWITCH ** COMPLETE ** ↓ STATUS OUT CONTACT ACTION
ENT ▼	Press the ENT key once to display “CONTACT ACTION”.	CONTACT ACTION ACTIVE ON
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register “ACTIVE ON”(normally off). * To select normally on, press the △ key. ——— “ACTIVE ON” has been registered. ———	CONTACT ACTION ** COMPLETE ** ↓ STATUS OUT CONTACT ACTION
ESC △	Press the ESC key twice and then press the △ key for 3 times to enter the measurement mode.	0.000 % 0.000 m3/h

4.10.5.5. How to validate the range over output and pulse range over output

Description
- AO RANGE OVER : Select a contact output as DO1, DO2 and/or DO3 when the upper limit and lower limit output are above the setting.
- PULSE RANGE OVER: Select a contact output as DO1, DO2 and/or DO3 when the total pulse output exceeds the maximum output frequency value.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set the DO1 output to “AO RANGE OVER”. Also, set the contact to “ACTIVE ON”.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 6 times to display “DO1 OUT”.	DO1 OUT NOT USED
	* Press the △ key again to display “DO2 OUT”.	
	* Press the △ key once again to display “DO3 OUT”.	
ENT ▼	Press the ENT key once to blink the cursor.	DO1 OUT NOT USED
△ ▼	Press the △ key for 7 times to display “AO RANGE OVER” on the 2nd line.	DO1 OUT AO RANGE OVER
	* Press the △ key again to display “PULSE RANGE OVER”.	
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register “RANGE OVER”. ——— “RANGE OVER” has been registered. ———	DO1 OUT ** COMPLETE ** ↓ STATUS OUT CONTACT ACTION
ENT ▼	Press the ENT key once to display “CONTACT ACTION”.	CONTACT ACTION ACTIVE ON
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register “ACTIVE ON”(normally off). * To select normally on, press the △ key. ——— “ACTIVE ON” has been registered. ———	CONTACT ACTION ** COMPLETE ** ↓ STATUS OUT CONTACT ACTION
ESC △	Press the ESC key twice and then press the △ key for 3 times to enter the measurement mode.	0.000 % 0.000 m3/h

4.10.5.6. How to validate the output at the minus direction action

Description
- Select a contact output as DO1, DO2 and/or DO3 when the flow is in reverse direction.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set the DO1 output to "-:FLOW DIRECTION". Also, set the contact to "ACTIVE ON".	
Key operation	Description	Display
△ ▼	Press the △ key twice to display "OUTPUT SETTING".	OUTPUT SETTING
ENT ▼	Press the ENT key once to display "ZERO ADJUSTMENT".	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 6 times to display "DO1 OUT".	DO1 OUT NOT USED
	* Press the △ key again to display "DO2 OUT".	
	* Press the △ key once again to display "DO3 OUT".	
ENT ▼	Press the ENT key once to blink the cursor.	DO1 OUT NOT USED
△ ▼	Press the △ key for 9 times to display "-:FLOW DIRECTION" on the 2nd line.	DO1 OUT -:FLOW DIRECTION
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register "-:FLOW DIRECTION". ——— "-:FLOW DIRECTION" has been registered. ———	DO1 OUT ** COMPLETE ** ↓ STATUS OUT CONTACT ACTION
ENT ▼	Press the ENT key once to display "CONTACT ACTION".	CONTACT ACTION ACTIVE ON
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register "ACTIVE ON"(normally off). * To select normally on, press the △ key. ——— "ACTIVE ON" has been registered. ———	CONTACT ACTION ** COMPLETE ** ↓ STATUS OUT CONTACT ACTION
ESC △	Press the ESC key twice and then press the △ key for 3 times to enter the measurement mode.	0.000 % 0.000 m3/h

4.10.6. Setting the DI input

Description
- Zero adjustment or total preset can be performed by no-voltage contact input signal.
  Note 1) To use the DI input, communication board (option) is required.
- Settable range
  NOT USED : Contact input is not used.
  TOTAL RESET : Total value becomes the preset value.
  ZERO ADJUSTMENT : Zero adjustment can be performed.

  CONTACT ACTION
  ACTIVE ON : Normally off. Activated when a contact is closed.
  ACTIVE OFF : Normally on. Activated when a contact is open.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

4.10.6.1. Invalidating the DI input

Description
- Select not to use the contact input of the DI1 INPUT.

For concrete keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Change the DI1 setting from “ZERO ADJUSTMENT” to “NOT USED”.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 9 times to display “NOT USED” on the 2nd line.	DI1 INPUT ZERO ADJUSTMENT
ENT ▼	Press the ENT key once to blink the cursor.	DI1 INPUT ZERO ADJUSTMENT
△ ▼	Press the △ key once to display “NOT USED” on the 2nd line.	DI1 INPUT NOT USED
ENT ▼	Press the ENT key once to register “NOT USED”.	DI1 INPUT ** COMPLETE **
▼ ▼ ▼	——— “NOT USED” has been registered. ———	↓ DI1 INPUT NOT USED
ESC △	Press the ESC key once and then press the △ key for 3 times to enter the measurement mode.	0.000 % 0.000 m3/h

4.10.6.2. How to validate the total preset with the external contact.

Description
- The total value becomes the preset value by closing or opening the contact.
- The contact should be closed or open for about 1 second.
- When total presetting, “TOTAL PRESET” is indicated on the 2nd line of the LCD display (for about 4 seconds).
- Related setting items: 4.9.2.2. Setting the preset value”, “4.9.2.3. TOTAL mode”
  Note 1) This function is valid when the LCD display is measurement screen. When the display is setting screen, it becomes invalid.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set the DO1 output to “TOTAL RESET”.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 9 times to display “NOT USED” on the 2nd line.	DI1 INPUT NOT USED
ENT ▼	Press the ENT key once to blink the cursor.	DI1 INPUT NOT USED
△ ▼	Press the △ key for once to display “TOTAL RESET” on the 2nd line.	DI1 INPUT TOTAL RESET
ENT ▼	Press the ENT key once to register “TOTAL RESET”.	DI1 INPUT ** COMPLETE **
▼ ▼ ▼	——— “TOTAL RESET” has been registered. ———	↓ DI1 INPUT TOTAL RESET
ESC △	Press the ESC key once and then press the △ key for 3 times to enter the measurement mode.	0.000 % 0.000 m3/h

4.10.6.3. How to validate the zero adjustment with the external contact.

Description
- The zero adjustment can be performed by closing or opening the contact.
- The contact should be closed or open for about 1 second.
- During zero adjustment, “ZERO ADJUSTMENT” is indicated on the 2nd line of the LCD display (for about 4 seconds).
- Related setting items: “4.7. Zero Adjustment”

  Note 1) This function is valid when the LCD display is measurement screen. When the display is setting screen, it becomes invalid.
  Note 2) Even if the measuring fluid is supplied, zero adjustment is carried out by the contact input. Be sure to bring it to the still water status (upstream/downstream valves closed) before the contact input.

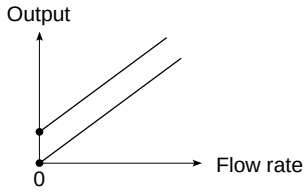
For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set the DI1 output to “ZERO ADJUSTMENT”.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key 9 times to display “DI1 INPUT”.	DI1 INPUT NOT USED
ENT ▼	Press the ENT key once to blink the cursor.	DI1 INPUT NOT USED
△ ▼	Press the △ key for 2 times to display “ZERO ADJUSTMENT” on the 2nd line.	DI1 INPUT ZERO ADJUSTMENT
ENT ▼	Press the ENT key once to register “ZERO ADJUSTMENT”.	DI1 INPUT ** COMPLETE ** ↓
▼ ▼ ▼	——— “ZERO ADJUSTMENT” has been registered. ———	DI1 INPUT ZERO ADJUSTMENT
ESC △	Press the ESC key once and then press the △ key for 3 times to enter the measurement mode.	0.000 % 0.000 m3/h

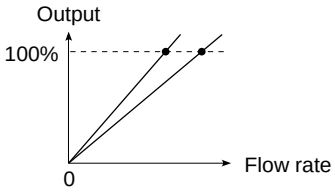
4.10.7. How to compensate the measurement value

Description

- Measurement value can be calibrated arbitrarily.
  Zero point and span adjustment can be made.
  Settable range
  (1) Zero point: -5 to +5 [m/s] in terms of flow velocity in piping.
  (2) Span : ±200%



Zero adjustment movement



Span movement

The output value (reading, analog output and total output) is computed by the following expression.

$$\text{Output} = \frac{\text{Measurement value} \times [\text{Span set value \%}]}{100} + \text{Zero point}$$

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Compensate the zero point to 0.5m³/h, and the span by +1%.	
Key operation	Description	Display
△	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
▼		
ENT	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
▼		
△	Press the △ key for 10 times to display “CALIBRATION ZERO”.	CALIBRATION ZERO 0.000 m3/h
▼		
ENT	Press the ENT key once to blink the cursor.	CALIBRATION ZERO 00000.000 m3/h
▼		
▷	Press the ▷ key for 6 times to move the cursor.	CALIBRATION ZERO 00000.000 m3/h
▼		
△	Press the △ key for 5 times to set “5”.	CALIBRATION ZERO 00000.500 m3/h
▼		
ENT	Press the ENT key once to register.	CALIBRATION ZERO ** COMPLETE **
▼		↓
▼	——— “CALIBRATION ZERO” has been registered. ———	CALIBRATION ZERO 0.500 m3/h
▼		
△	Press the △ key once to display “CALIBRATION SPAN”.	CALIBRATION SPAN 100.0 %
▼		
ENT	Press the ENT key once to blink the cursor.	CALIBRATION SPAN 100.0 %
▼		
▷	Press the ▷ key twice to move the cursor.	CALIBRATION SPAN 100.0 %
▼		
△	Press the △ key once to set “1”.	CALIBRATION SPAN 101.0 %
▼		
ENT	Press the ENT key once to register.	CALIBRATION SPAN ** COMPLETE **
▼		↓
▼	——— “CALIBRATION SPAN” has been registered. ———	CALIBRATION SPAN 101.0 %
▼		
ESC △	Press the ESC key once and then press the △ key for 3 times to enter the measurement mode.	0.000 % 0.000 m3/h

4.10.8. Setting of the operation mode

Description
- Used to switch computation cycle and output cycle.
- Settable range
  NORMAL : Standard mode (factory-set value), computation/output cycle is approximately 0.5 seconds.
  HIGH SPEED: High speed response mode, computation/output cycle is approximately 0.2 seconds.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

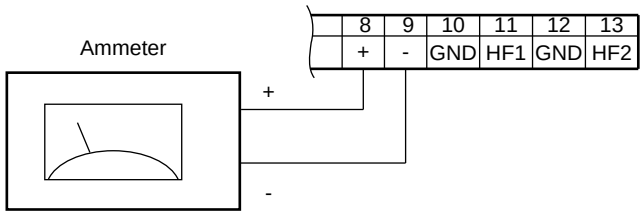
Operation (example)	Switch the operation mode to the high speed response mode.	
Key operation	Description	Display
△ ▼	Press the △ key twice to display “OUTPUT SETTING”.	OUTPUT SETTING
ENT ▼	Press the ENT key once to display “ZERO ADJUSTMENT”.	ZERO ADJUSTMENT SET ZERO
△ ▼	Press the △ key for 12 times to display “OPERATION MODE”.	OPERATION MODE NORMAL
ENT ▼	Press the ENT key once to blink the cursor.	OPERATION MODE NORMAL
△ ▼	Press the △ key for 6 times to move the cursor.	OPERATION MODE HIGH SPEED
ENT ▼	Press the ENT key once to register.	OPERATION MODE ** COMPLETE ** ↓
▼ ▼ ▼	——— “OPERATION MODE” has been registered. ———	OPERATION MODE HIGH SPEED
ESC △	Press the ESC key once and then press the △ key for 3 times to enter the measurement mode.	0.000 % 0.000 m3/h

Reference
The difference between standard mode and high speed mode
High speed mode is unfit for the measurement when foreign objects or air bubbles are contained.
Standard mode is about 10 times more resistant to entry of foreign objects or air bubbles than high speed mode.

4.11. MAINTENANCE MODE

4.11.1. How to calibrate the analog output

Description
- The calibration is performed so as to obtain 4mA and 20mA when the analog signal (4-20mA DC) output is 0% and 100%, respectively.
- Connect an ammeter to Iout terminals as shown below. In the CURRENT CALIBRATION mode, select 4mA or 20mA, and operate the △ key (UP) or the ▷ key (Down).



For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Adjust the 4mA and 20mA analog outputs.	
Key operation	Description	Display
△ ▼	Press the △ key for 4 times to display “MAINTENANCE MODE”.	MAINTENANCE MODE
ENT ▼	Press the ENT key once to display “RAS INFORMATION”.	RAS INFORMATION 0000000000000000
△ ▼	Press the △ key once to display “CURRENT”.	CURRENT CARIBRATION
ENT ▼	Press the ENT key twice to enter the calibration mode of 4mA output.	CARIBRATION 4 mA
	Adjust the output to 4mA by the △ (UP) and the ▷ (down) key, while observing the output of calibration devices such as an ammeter.	
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register the adjustment result. ——— 4mA adjustment result has been registered. ———	CARIBRATION ** COMPLETE ** ↓ CARIBRATION 4 mA
△ ▼	Press the △ key once, and select 20mA.	CARIBRATION 20mA
ENT ▼	Press the ENT key twice to enter the calibration mode of 20mA output.	CARIBRATION 20mA
	Adjust the output to 20mA by the △ (UP) and the ▷ (down) key.	
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register the adjustment result. ——— 20mA adjustment result has been completed. ———	CARIBRATION ** COMPLETE ** ↓ CARIBRATION 20mA
ESC △	Press the ESC key twice and then press the △ key once to enter the measurement mode.	0.000 % 0.000 m3/h

4.11.2. How to set the constant current output

Description
- Generates a fixed value output of analog signal.
  Application example: The operation of a connected receiver is checked by generating a fixed value output of analog signal.
- n the constant current setting mode (OUTPUT SETTING), set the constant current output value.
  Settable range: -20%(0.8mA) to +120%(23.2mA)

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set the constant current output of 50% (12mA).	
Key operation	Description	Display
△	Press the △ key for 4 times to display “MAINTENANCE MODE”.	MAINTENANCE MODE
▼		
ENT	Press the ENT key once to display “RAS INFORMATION”.	RAS INFORMATION 0000000000000000
▼		
△	Press the △ key twice to display “OUTPUT SETTING”.	CURRENT OUTPUT SETTING
▼		
ENT	Press the ENT key once to display the setting screen.	OUTPUT SETTING 0 %
▼		
ENT	Press the ENT key once to blink the cursor.	OUTPUT SETTING +000 %
▼	Note) Start constant current output.	
▷ △	Enter “5” by the ▷ and the △ key.	OUTPUT SETTING +050 %
▼		
ENT	Press the ENT key once to output 12mA.	OUTPUT SETTING ** COMPLETE **
▼		↓
▼	——— Outputting 12mA. ———	OUTPUT SETTING 50 %
▼		
ESC	Press the ESC key once to stop constant current output.	CURRENT OUTPUT SETTING
▼	Note) Current output is in the measurement status.	
ESC △	Press the ESC key once and then press the △ key once to enter the measurement mode.	0.000 % 0.000 m3/h

4.11.3. How to check the action of total pulses

Description
- Checks the action of total pulse output.

The output action can be checked upon designating the number of pulses to be outputted per second.
Settable range: 1 to 100 pulses/s (DO1/DO2 only)
Note 1) The output pulse width is as selected currently. (See 4.9.2.1.)
Set the frequency taking the pulse width into account referring to the following expression.
The number of setting pulses ≤ 1000/(Pulse width[ms] × 2)
Example: If the pulse width is set at 50ms, select 10 pulses/s or less.
Note 2) DO1/DO2 (transistor open collector) and DO3 (relay contact) operate simultaneously.
Before checking the action, confirm whether proceeding to an action is permitted.
Note 3) DO3 (relay contact) always operates at the rate of 1 pulse/sec regardless of setting.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Perform pulse output of 5 pulses/s.	
Key operation	Description	Display
△ ▼	Press the △ key for 4 times to display “MAINTENANCE MODE”.	MAINTENANCE MODE
ENT ▼	Press the ENT key once to display “RAS INFORMATION”.	RAS INFORMATION 0000000000000000
△ ▼	Press the △ key for 3 times to display “TOTAL PULSE”.	TOTAL PULSE 1 PULSE/s
ENT ▼	Press the ENT key once to blink the cursor. Note) Start simulated pulse output.	TOTAL PULSE 001 PULSE/s
▷ ▼	Press the ▷ key twice to move the cursor.	TOTAL PULSE 001 PULSE/s
△ ▼	Press the △ key for 4 times to set “5”.	TOTAL PULSE 005 PULSE/s
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register. ——— 5 PULSE/s has been registered. ——— 5 PULSE/s simulated pulse is output.	TOTAL PULSE ** COMPLETE ** ↓ TOTAL PULSE 005 PULSE/s
ESC ▼	After checking the output, press the ESC key once to stop simulated pulse output.	TOTAL PULSE 005 PULSE/s
ESC △	Press the ESC key once and then press the △ key once to enter the measurement mode.	0.000 % 0.000 m3/h

4.11.4. How to check the status output

Description
- Check the status output.
  Setting content ON: Close the contact.
  OFF: Open the contact.

⚠ CAUTION

- This operation sets DO1, DO2 and DO3 the same contact action.
- Before operation, check whether DO output testing is permitted.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Check the contact action.	
Key operation	Description	Display
△	Press the △ key for 4 times to display “MAINTENANCE MODE”.	MAINTENANCE MODE
▼		
ENT	Press the ENT key once to display “RAS INFORMATION”.	RAS INFORMATION 000000000000000
▼		
△	Press the △ key for 4 times to display “STATUS”.	DO CHECK OFF
▼		
ENT	Press the ENT key once to blink the cursor.	DO CHECK OFF
▼	Note) Contact output is displayed at this time. “OFF” is given at right.	
△	Press the △ key once, and select “ON”.	DO CHECK ON
▼		
ENT	Press the ENT key once to register “ON”.	DO CHECK ** COMPLETE **
▼		↓
▼	——— “ON” has been registered. ———	DO CHECK ON
▼	* Check the contact output “ON”.	
△	Press the △ key once, and select “OFF”.	DO CHECK OFF
▼		
ENT	Press the ENT key once to register “OFF”.	DO CHECK ** COMPLETE **
▼		↓
▼	——— “OFF” has been registered. ———	DO CHECK OFF
▼	* Check the contact output “OFF”.	
ESC	Press the ESC key once to stop the cursor from blinking.	DO CHECK OFF
▼	* It returns to contact output at the normal measurement status.	
ESC △	Press the ESC key once and then press the △ key once to enter the measurement mode.	0.000 % 0.000 m3/h

4.11.5. How to check the DI input

Description
- Check the DI input.
  This is a function for checking the contact status on the LCD display by closing or opening the contact.
  Check method ON: Close the contact.
  OFF: Open the contact.
  Note 1) To check the DI input, the communication board (option) is required.

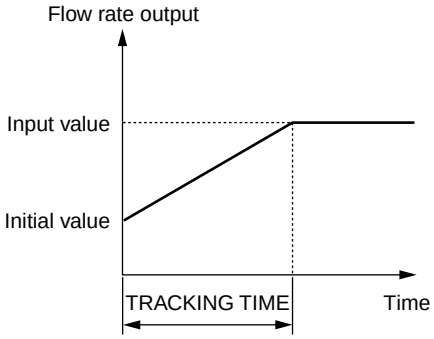
For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Check the contact action.	
Key operation	Description	Display
△	Press the △ key for 4 times to display “MAINTENANCE MODE”.	MAINTENANCE MODE
▼		
ENT	Press the ENT key once to display “RAS INFORMATION”.	RAS INFORMATION 0000000000000000
▼		
△	Press the △ key for 5 times to display “DI CHECK”.	DI CHECK
▼		
ENT	Press the ENT key once to blink the cursor.	DI CHECK OFF
▼		
▼	Close the contact.	DI CHECK
▼	* Check the contact input “ON”.	ON
▼		
▼	Open the contact.	DI CHECK
▼	* Check the contact input “ON”.	OFF
▼		↓
ESC	Press the ESC key once to stop the cursor from blinking.	DI CHECK
▼	* It returns to contact output at the normal measurement status.	
ESC △	Press the ESC key once and then press the △ key once to enter the measurement mode.	0.000 %s 0.000 m3/h

4.11.6. How to validate the test mode (simulated flow rate output)

Description

- Checks different outputs (LCD indication, analog output, DO output) upon simulating flow rate outputs.
  With the output at the actuated time as an initial value, the output changes up to the input value (simulated flow rate target value) in a selected TRACKING TIME, and at the input value, the output value becomes constant.
  So long as the test mode is valid, "T" blinks on the left end of the 1st line of LCD on the measurement mode screen.



Setting content

TEST MODE	: Enables or disables the test mode.
INPUT DATA	: Simulated flow rate target (percentage of MV full scale).
TRACKING TIME	: Time required to attain the simulated flow rate target (above input value).

Settable range

TEST MODE validation	: SETTING (valid), NOT USED (invalid)
INPUT DATA	: ±120%
TRACKING TIME	: 0 to 999 seconds

* For setting TRACKING TIME, 0sec is set to the damping (See 4.9.5).

⚠ CAUTION

- By performing the operation, the output of analog outputs, DO1, DO2, and DO3, varies depending on the setting. Check beforehand whether each output can be changed or not.
- Be sure to resume "NOT USED" after the end of test.
  Otherwise, the input value output status will be held until power is turned off.
- If “START/RESET” is selected as TOTAL MODE, the total value also changes. Select “STOP” to prevent the total value change.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Set the simulated flow rate target to 100%, and the tracking time to 100 [s].	
Key operation	Description	Display
△ ▼	Press the △ key for 4 times to display “MAINTENANCE MODE”.	MAINTENANCE MODE
ENT ▼	Press the ENT key once to display “RAS INFORMATION”.	RAS INFORMATION 0000000000000000
△ ▼	Press the △ key for 6 times to display “TEST MODE”.	TEST MODE NOT USED
ENT ▼	Press the ENT key once to blink the cursor.	TEST MODE NOT USED
△ ▼	Press the △ key once, and select “SETTING”.	TEST MODE SETTING
ENT ▼	Press the ENT key once to register “SETTING”.	INPUT DATA 0 %
ENT ▼	Press the ENT key once to blink the cursor on the 2nd line.	INPUT DATA +000 %
▷ △ ▼	Enter “100” by the ▷ and the △ key.	INPUT DATA +100 %
ENT ▼	Press the ENT key once to register.	INPUT DATA ** COMPLETE **
▼ ▼ ▼	——— “INPUT DATA” has been registered. ———	↓ INPUT DATA 100 %
△ ▼	Press the △ key once to display “TRACKING TIME”.	TRACKING TIME 0 sec
ENT ▼	Press the ENT key once to blink the cursor on the 2nd line.	TRACKING TIME 000 sec

△ ▼ ENT ▼ ▼ ▼ ▼ ESC △	Press the △ key once to set “100”. Press the ENT key once to register. ——— “TRACKING TIME” has been registered. ——— * Simulating flow rate output is started. Display the measurement mode by the ESC key and the △ key. "T" blinks on the left end of 1st line of LCD, and the output changes. In 100 seconds (at which tracking time is set), the output becomes stable at 10 [m^3/h] (simulated flow rate target). (In case of full scale 10 [m^3/h]) Note) Be sure to return the TEST MODE to "NOT USED" after checking the output.	TRACKING TIME 100 sec TRACKING TIME ** COMPLETE ** ↓ TRACKING TIME 100 s T 0.00 % 0.000 m3/h ↓ T 100.00 % 10.000 m3/h

4.11.7. How to validate a serial transmission (RS-232C/RS-485)

Description
- Validates a transmission before using the transmission function.

Setting content
Transmission type, transmission rate, parity, stop bits and slave No.

Settable range

Transmission type	: RS-232C (factory set) or RS-485.
Transmission rate (BAUD RATE)	: 2400 BPS, 4800 BPS, 9600 BPS (factory set) or 19200 BPS, 38400BPS.
Parity	: NONE, EVEN (factory set), ODD
Stop bits	: 1 BIT (factory set), 2 BITS
Station No.	: 1 to 31 (factory set: 1)
Communication protocol	: MODBUS RTU mode (factory set) or M-Flow (Fuji Electric's M-Flow [Type: FLR] protocol)

Note) For the transmission specifications, refer to the separate instruction manual "Ultrasonic Flowmeter Communication functions" (INF-TN5A0177).

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Select the RS-485, and set the baud rate to 9600 BPS, the parity to "NONE", the stop bits to "1 BIT", and the slave No. to "5".	
Key operation	Description	Display
△ ▼	Press the △ key for 4 times to display "MAINTENANCE MODE".	MAINTENANCE MODE
ENT ▼	Press the ENT key once to display "RAS INFORMATION".	RAS INFORMATION 0000000000000000
△ ▼	Press the △ key for 7 times to display "COMMUNICATION".	COMMUNICATION
ENT ▼	Press the ENT key once to select, and press it once again to blink on the 2nd line.	MODE RS-232C
△ ▼	Press the △ key once to display "RS-485".	MODE RS-485
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register. ——— RS-485 has been registered. ———	MODE ** COMPLETE ** ↓ MODE RS-485
△ ▼	Press the △ key once to display "BAUD RATE". Because "9600 BPS" is set, go to the next step. To select other baud rate, press the ENT key, and select by the △ key, and register by the ENT key.	BAUD RATE 9600BPS
△ ▼	Press the △ key once to display "PARITY".	PARITY ODD
ENT ▼	Press the ENT key once to blink on the 2nd line.	PARITY ODD
△ ▼	Press the △ key once to display "NONE".	PARITY NONE
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register. ——— "NONE" has been registered. ———	PARITY ** COMPLETE ** ↓ PARITY ODD
△ ▼	Press the △ key once to display "STOP BIT". Because "1 BIT" is set, go to the next step. To select "2 BITS", press the ENT key, and select by the △ key, and register by the ENT key.	STOP BIT 1 BIT
△ ▼	Press the △ key once to display "STATION No.".	STATION NO. 01

ENT ▼ △ ▷ ▼ ENT ▼ ▼ ▼ ▼ △ ▼ ESC △	Press the ENT key once to blink the cursor. Set “5” by the △ and the ▷ key. Press the ENT key once to register. ——— SLAVE No. has been registered. ——— Press the △ key once to display “PROTOCOL”. Because “MODBUS” is set, setting is completed. To select other protocol, press the ENT key, and select a protocol by the △ key, and register it by the ENT key. Display the measurement mode by the ESC key and the △ key.	SLAVE NO. 01 SLAVE NO. 05 SLAVE NO. ** COMPLETE ** ↓ SLAVE NO. 05 PROTOCOL MODBUS 0.000 m/s 0.000 m3/h

4.11.8. How to set the ID No.

Description
- Set the ID No. for parameters (Section 4.4.1).
  If ID No. is set, the number must be inputted before canceling the protection.
- To validate the protection, set the protection to "ON". (See Section 4.4.1.)

ID No. settable range: 0000 to 9999 (4-digit number)

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)
If you forget the ID number you set, contact us.

Operation (example)	Set “1106” as the ID No.	
Key operation	Description	Display
△ ▼	Press the △ key for 4 times to display “MAINTENANCE MODE”.	MAINTENANCE MODE
ENT ▼	Press the ENT key once to display “RAS INFORMATION”.	RAS INFORMATION 0000000000000000
△ ▼	Press the △ key for 9 times to display “REGISTER ID NO.”.	REGISTER ID NO.
ENT ▼	Press the ENT key twice to blink on the 2nd line.	REGISTER ID NO. 0000
△ ▷ ▼	Set “1106” by the △ and the ▷ key.	REGISTER ID NO. 1106
ENT ▼ ▼ ▼ ▼	Press the ENT key once to register. ——— ID NO. has been registered. ———	REGISTER ID NO. ** COMPLETE ** ↓ REGISTER ID NO. ****
ESC △	Display the measurement mode by the ESC key and the △ key. Note) To validate the protection, set the protection to "PROTECT ON". (See Section 4.4.1.)	0.000 % 0.000 m3/h

4.11.9. How to confirm the software version

Description
- Indicates the software version.

For actual keying, refer to the typical operation indicated below.

Operation (example)	Check the software version.	
Key operation	Description	Display
△ ▼	Press the △ key for 4 times to display “MAINTENANCE MODE”.	MAINTENANCE MODE
ENT ▼	Press the ENT key once to display “RAS INFORMATION”.	RAS INFORMATION 0000000000000000
△ ▼	Press the △ key for 10 times to display “VER. NO.”.	* VER. NO. FSV1SYS00A 01
ESC △	After checking, display the measurement mode by the ESC key or the △ key.	0.000 % 0.000 m3/h

* The indicated version number is display example.

4.11.10. Initializing setting parameters

Description
- Initializes the setting parameters saved in the memory.
- Initializes those other than the zero adjusted values or analog output calibration value.

Initialize code: 0100 (4-digit number)

⚠ CAUTION

- This parameter is intended for our service personnel.
- Do not attempt to initialize the setting parameters. Otherwise measurement is disabled.
  When the parameter is initialized, display language is set to English.
  To switch the display language, refer to “4.5. Display language”.

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

Operation (example)	Initializes the setting parameters.	
Key operation	Description	Display
△ ▼	Press the △ key for 4 times to display “MAINTENANCE MODE”.	MAINTENANCE MODE
ENT ▼	Press the ENT key once to display “RAS INFORMATION”.	RAS INFORMATION 0000000000000000
△ ▼	Press the △ key for 11 times to display “MEMORY INITIAL”.	MEMORY INITIAL
ENT ▼	Press the ENT key twice to blink on the 2nd line.	MEMORY INITIAL 0000
▷ △ ▼	Set “0100” by the ▷ and the △ key.	MEMORY INITIAL 0100
ENT ▼	Press the ENT key once to register.	MEMORY INITIAL ** COMPLETE ** ↓
▼	— Flow transmitter is reset, and the measurement mode is displayed. —	0.000 m/s 0.000 m3/h

4.11.11. How to set the detailed setting

Description
- The data required for time difference measurement can be set as follows.

⚠ CAUTION

- This parameter is intended for our service personnel.
- Do not change the setting by yourself. Otherwise measurement may be disabled.
- Make the detailed setting only when a problem should arise in flow rate measurement with factory default settings, and instructed to do so by a trained factory representative. Setting need not be made in other cases.

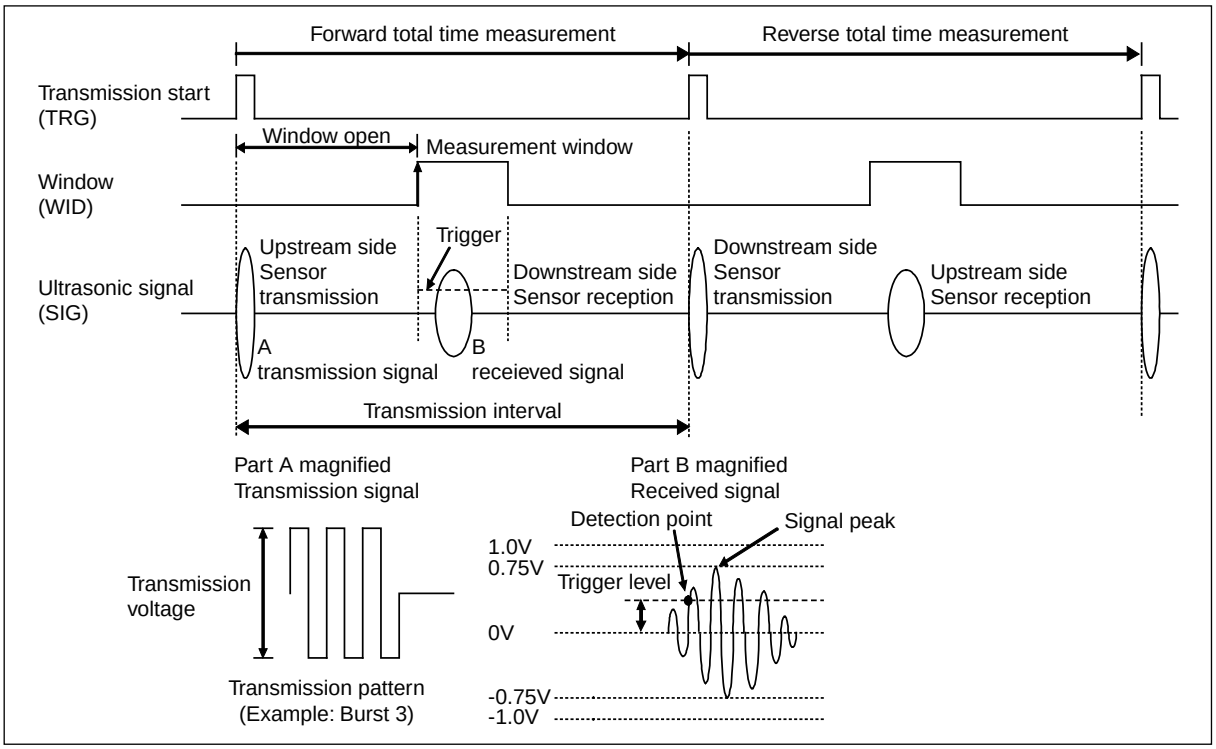
- Setting items

Item	Input method	Function, range or menu
Transmission count	Select	The number of transmission of ultrasonic signals per flow rate signal output[*1]. (Factory-set value: 128) When standard mode is selected for the operation mode: • 8, 16, 32, 64, 128, 256 When high speed response mode is selected for the operation mode: • 4, 8, 16, 32, 64, 128
Trigger control	Select Numeric value	Control method setting of the trigger level (detection point) of ultrasonic signals. (Factory-set value: AUTO) • AUTO • MANUAL Select the detection point according to the rate against the peak of receiving wave regarded as 100%. • Trigger level: 10% to 90%.
Window control	Select Numeric value Numeric value	Setting of control method of measurement window that takes in signals (Factory-set value: AUTO) • AUTO • MANUAL Set the time of starting taking in signals (period from the start of transmission until the startup of window signals) • U: open time: 1μs to 16383μs • D: open time: 1μs to 16383μs Note) U: forward direction, D: reverse direction In case of MANUAL, set U and D.
Saturation (level)	Numeric value	The number of times that the amplitude of received signals fluctuates and exceeds ±1.0V (saturation) per 1 flow rate signal output. Used as the threshold value for judging the error status of signals. A signal error occurs if the specified number of times is exceeded. (Factory-set value: 128) Refer to diagram *1) in the next page. • 0 to 256
Measurement method	Select	Setting of measurement method for measuring transit time. (Factory-set value: method 2) • Method 1: Strong against interference • Method 2: Controls triggers on the plus side of the direction of voltage of received signals. • Method 3: Controls triggers on the minus side of the direction of voltage of received signals.
Signal balance	Numeric value	Setting of threshold value used for judging the existence of transit time. A signal error occurs if the specified value is exceeded. (Factory-set value: 25%) • 0% to 100% Note) Set to 50% or higher for Method 1.
Transmission pattern	Select	Setting of transmission pattern of ultrasonic signals (Factory-set value: Burst 3) • Select from BURST 1, BURST 2, BURST 3, BURST 4, BURST 5, CHIRP 4 and CHIRP 8.
AGC gain	Select Numeric value Numeric value	Setting of control method of signal AGC gain (Factory-set value: AUTO) Signal peak is controlled to be kept at $1.5V_{PP}$. • AUTO • MANUAL Make the setting so that the signal peak in both forward and reverse directions is kept at $1.5V_{PP}$. • Forward gain: 1.00% to 99.00% • Reverse gain: 1.00% to 99.00%
Signal peak	Select	Setting of signal peak threshold value per 1 flow rate signal output *1). Used as the threshold value for judging the error status of signals. A signal error occurs if the value becomes lower than the specified value. (Factory-set value: 3072) • 0.5V(4096) : Equivalent to $0.5V_{0P}$ • 0.375V(3072) : Equivalent to $0.375V_{0P}$ • 0.25V(2048) : Equivalent to $0.25V_{0P}$ • 0.125V(1024) : Equivalent to $0.125V_{0P}$
Transmission wait time	Numeric value	Transmission interval of ultrasonic signals. (Factory-set value: 5msec) • 1msec to 30msec

For actual keying, refer to the typical operation indicated below. Set the protection to OFF beforehand. (See Section 4.4.1.)

*1) Forward-direction signals are taken in with forward total time measurement, while reverse-direction signals are taken in with reverse total time measurement. They are conducted alternately for the transmission count. Forward and reverse signal data is added for the transmission count and averaged. The result is 1 output of signal in forward/reverse direction.

[Outline drawing of signal processing]



Note) Make the setting, following the description in “6.6.6. Checking received waveforms”.

Operation (example)	Set measurement method to “METHOD 1”.	
Key operation	Description	Display
△ ▼	Press the △ key for 4 times to display “MAINTENANCE MODE”.	MAINTENANCE MODE
ENT ▼	Press the ENT key once to display “RAS INFORMATION”.	RAS INFORMATION 0000000000000000
△ ▼	Press the △ key for 14 times to display “DETAILS”.	DETAILS
ENT ▼	Press the ENT key once to display “TRANS.COUNT”.	TRANS.COUNT 128
△ ▼	Press the △ key for 4 times to display “MEAS.METHOD”.	MEAS.METHOD METHOD:2
ENT ▼	Press the ENT key once to select, and press it once again to blink on the 2nd line.	MEAS.METHOD METHOD:2
△ ▼	Press the △ key twice to display “METHOD 1”.	MEAS.METHOD METHOD:1
ENT ▼	Press the ENT key once to register.	MEAS.METHOD ** COMPLETE ** ↓
▼ ▼ ▼	——— “METHOD 1” has been registered. ———	MEAS.METHOD METHOD:1
ESC △	Press the ESC key twice and then press the △ key once to enter the measurement mode.	0.000 m/s 0.000 m3/h

5. Mounting of detector

5.1. Detector mounting procedure

Mount the sensor on the pipe, and perform the following steps in order before making measurement.

Reference section	Work item	: Outline steps
5.2	Selection of mounting position	: A place that provides enough space for the length of the straight pipe.
5.3	Selection of mounting method	: Check the V/Z method, pipe size, and detector.
5.4	Preparation of mounting surface	: Perform preprocessing of the detector mounting pipe surface.
5.5	How to determine the mounting position	: In mounting by the Z method, prepare the paper gauge, and wrap it around the pipe, and put a mark on the sensor mounting position.
5.6	Selection of acoustic couplant	: Select silicone compound or silicone-free grease for each application.
5.7	Cable end treatment	: When cutting the cable, perform the end treatment.

FLSS12, 22

5.8.1	Frame mounting method	: Fastens the frame on pipe by the stainless belt.
5.8.2	Detector mounting method	: Apply acoustic couplant to the detector oscillation surface, and mount it on the frame to connect the sensor cable.

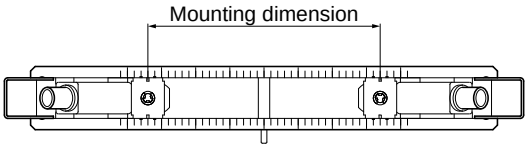
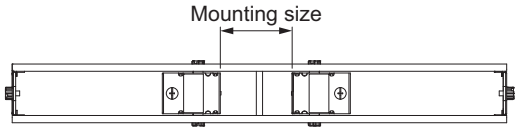
FSGS31 FSGS32	FSGS41	FSGS50 FSGS51	FSD22	FSD32	
5.9.1	5.9.1	5.10	(5.11)	(5.12)	Connection of sensor cable: Connect the sensor cable to the sensor.
5.9.2	—	—	—	—	Assembly procedure of the sensor: Assemble the detector which is connected to the sensor cable.
5.9.3.1	5.9.3.2	0	5.11	5.12	Mounting method on the pipe: Apply acoustic couplant to the detector oscillation surface, and connect the sensor cable.

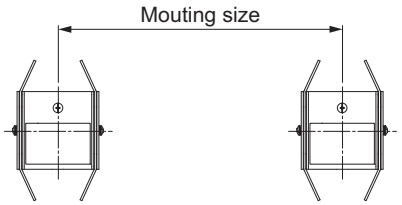
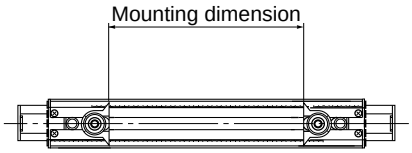
5.1.1. Mounting of detector

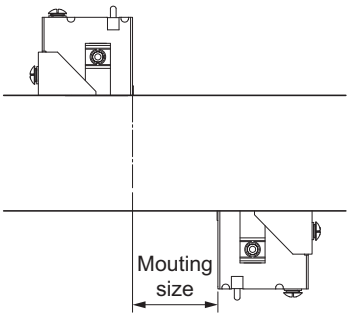
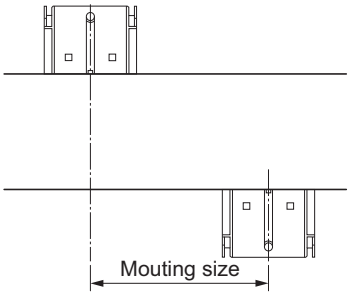
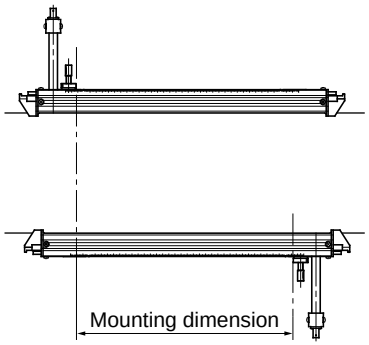
For sensor spacing, select either method in advance.

- Calculate from flow transmitter
  Turn ON the flow transmitter.
  Enter the piping information, etc described in Section 4.6.2, and display it.
  Display example: PROCESS SETTING S=16 (48mm)
  During wiring work, be sure to turn the power off.
- Calculate from our website.
  Address http://www.fic-net.jp/eng/products/flowmeter/top.html
- Calculate from the CD attached to the equipment.

5.1.2. Image figure of mounting dimension

Type	FLSS12, 22	FSGS31, 32
Mounting method	V method	V method
Mounting dimension		

Type	FSGS50, 51	FSD22, 32
Mounting method	V method	V method
Mounting dimension		

Type	FSGS41	FSGS50, 51	FSD32
Mounting method	Z method	Z method	Z method
Mounting dimension			

5.2. Selection of mounting position

Detector mounting location, i.e., the conditions of the pipe subjected to flow rate measurement exert a great influence on measurement accuracy. So select a location meeting the conditions listed below.

(1) Straight piping greater than 10D must exist on the upstream side and greater than 5D on the downstream side.
(2) Elements (pump, valve, etc) on the upstream side must be greater than 30D away to prevent disturbances.
(3) The piping must be filled with fluid free from air bubbles and foreign objects.
(4) Make sure that a maintenance space is provided around the piping where the sensor is mounted. (See Fig. 5-1.)
Note) A space should be provided so that maintenance work can be made with workers standing on both sides of the piping.

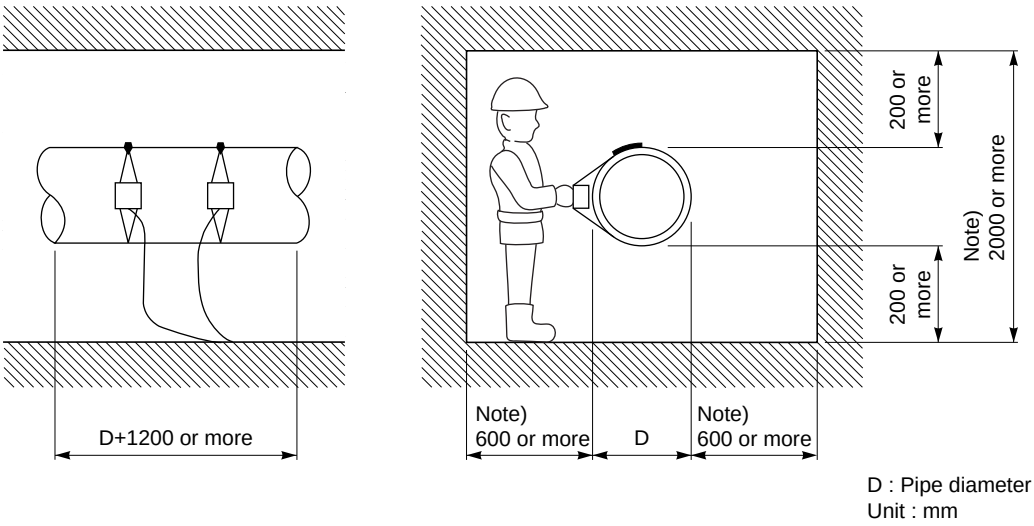
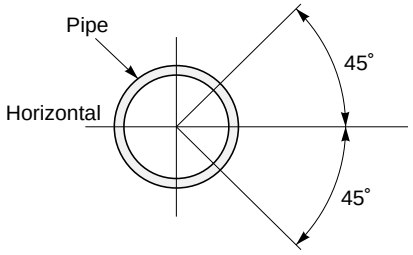


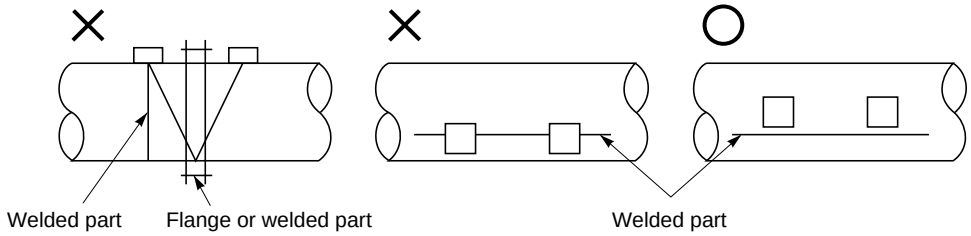
Fig. 5-1 Necessary space for the detector mounting position

⚠ CAUTION

(1) Mount the detector within ± 45° from the center plane in the case of horizontal pipe run.
For a vertical pipe, the detector can be mounted at any position on the outer circumference.



(2) Avoid installing the sensor on a deformed portion of pipe or welded portion of pipe, or on flange.



5.3. Selection of mounting method

There are 2 methods for mounting the detector; V method and Z method. (See Fig. 5-2.)

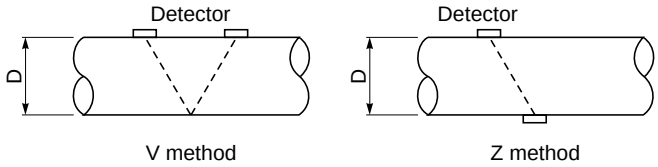


Fig. 5-2 Mounting method

The Z method should be used in the following cases.

- Where a V mounting space is not available.
- When measuring fluid of high turbidity such as sewage.
- When the pipe has a mortar lining.
- Piping is old and presumed to have a deposit of a thick layer of scales inside the piping.

Selection standard

The Z method for large size sensor is recommended for outer diameter 300mm or more.

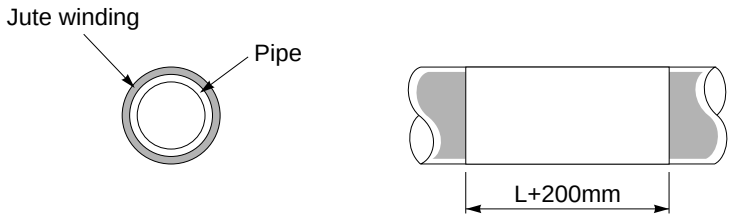
Type	Fluid temperature [°C]	Mounting method	Inner diameter of piping ø (mm) 13 25 50 100 200 250 300 400 1000 3000 6000
FLSE12□2-Y	-20 to 100	V	25 P 100
FLSE12□2-A	0 to 120		50 M 100
FLSE22□2-Y	-20 to 100	V	50 P, M 225
FLSE22□2-A	0 to 120		50 P, M 150
FSGS32 Note) FSGS31	-40 to 80	V	50 Px, P, M 300
FSGS41		V	200 Px, P, M 600
		Z	200 Px, P, M 1200
FSGS51 Note) FSGS50		V	200 Px, P, M 3000
		Z	200 Px, P, M 6000
FSD22	-40 to 100	V	13 Px, P, M 100
FSD32	-40 to 200	V	50 Px, P, M 250
		Z	150 Px, P, M 400

Classification of piping materials
- Px : PP, PVDF
- P : Plastic (PVC, etc.)
- M : Msetallic piping (steel pipe, copper pipe, aluminum, etc.)

Note: If ultrasonic waves cannot pass through the piping because the piping material category is Px or the turbidity of the fluid is high, it is recommended to use FSGS31, 41, or 50 types.

5.4. Processing of mounting surface

Using thinner and sand-paper, remove the pitches, rust and uneven surface of the detector mounting piping over the entire mounting area of (L) + 200mm wide. (Fig. 5-3)
Note) When the piping exterior is wrapped with jute, remove the jute and then perform the above treatment.

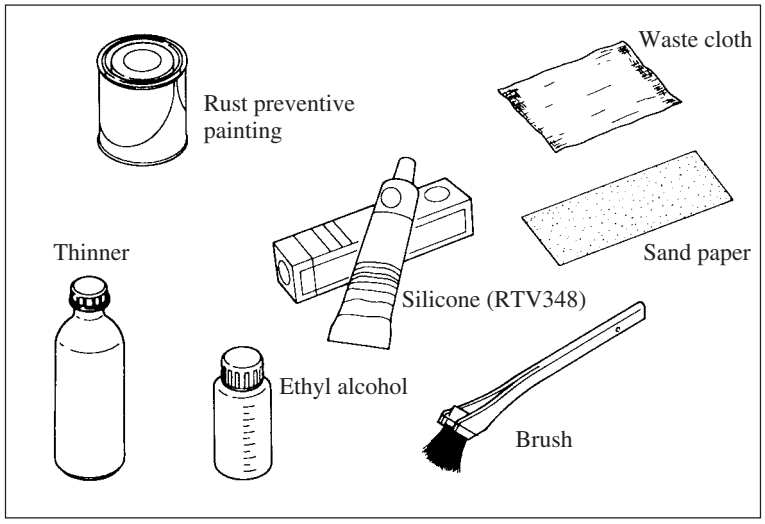


Length of frame

Type	L
FLSS1	228mm
FLSS2	348mm
FSGS3	410mm
FLW1	510mm
FSD2	320mm
FSD3	530mm

Fig. 5-3

Large size sensor (FSGS5) is attached to the following accessories.
Use for surface treatment of pipes.

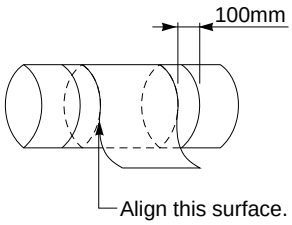


Name	Quantity	Application
• Rust preventive painting	1	Applied to detector or related parts for rust prevention.
• Ethyl alcohol	1 bottle	Used for surface treatment of pipes and degreasing of transmitting surface.
• Sand paper	1 pc	Used for removing rust from pipe surface or used for making surface smooth.
• Brush	1	
• Waste cloth	1 sheet	
• Thinner	1 can	Used for remove pitch from piping surface.
• Silicone	1 tube	Used for mounting sensor or for molding sensor terminal block.

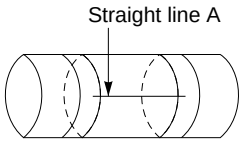
5.5. How to determine the mounting position

When the mounting is Z method, or the sensor is large, carry out the following to determine the mounting position beforehand.
Gauge paper is necessary for this work. (Refer to “7.4. How to make gauge paper”.)

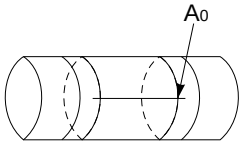
(1) Match the edge of gauge paper with the line at about 100mm from one end of the pipe portion treated for detector mounting, and wind the gauge paper so that the line marked on the paper is parallel with the pipe axis (fix with tape not to allow deviation). At this time, the edge of gauge paper should be aligned.



(2) Extending the line marked on the gauge paper, mark straight line A on the pipe.

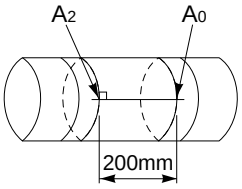


(3) Mark a line along on edge of the gauge paper. Assume the intersection of the line and the straight line A is A_0.



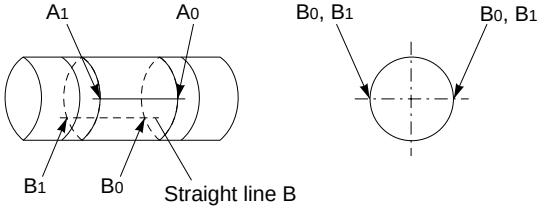
V method / Z method

Example) When L = 200mm



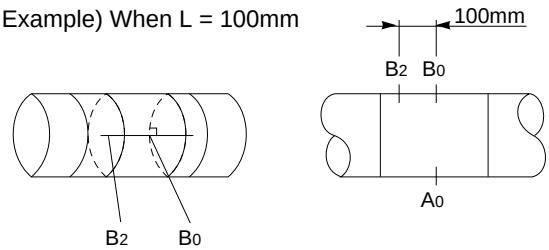
(4) Remove the gauge paper and measure the mounting dimension from A_0.
Then, draw a line which crosses the straight line A (determine the position A_2).

A_0 and A_2 become the mounting positions.



(4) Measure the circumference of the pipe from the point A_0, and mark a line (straight line B) between the point B_0 and B1 obtained at 1/2 of the circumference.

Example) When L = 100mm

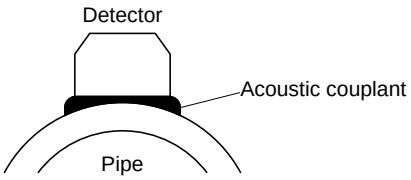


(5) Mark the points B_0 and peel off the gauge paper. Measure the mounting dimension from B_0 to determine B_2 position. At this position, make a line orthogonal to the straight line B.

A_0 and B_2 become the mounting positions.

5.6. Selection of acoustic couplant

Acoustic couplant is a media that eliminates a gap between the detector and the pipe.



There are 4 types of acoustic couplant. Select a suitable one referring to the following table.

Type	Silicone compound (KE-348W)	Silicone-free grease (HIGH Z)	Silicone grease (G40M)	High temperature grease (KS62M)
Fluid temperature	-40 to +150°C	0 to +60°C	-30 to +150°C	-30 to +250°C
Teflon tube	×	○	○	○

Note1) Before coating the acoustic couplant, eliminate material such as rust, water drops, dust, oil/ grease or other foreign matters from the pipe surface using the thinner, sand paper, etc.

Note2) Curing time of silicone rubber (KE-348W)

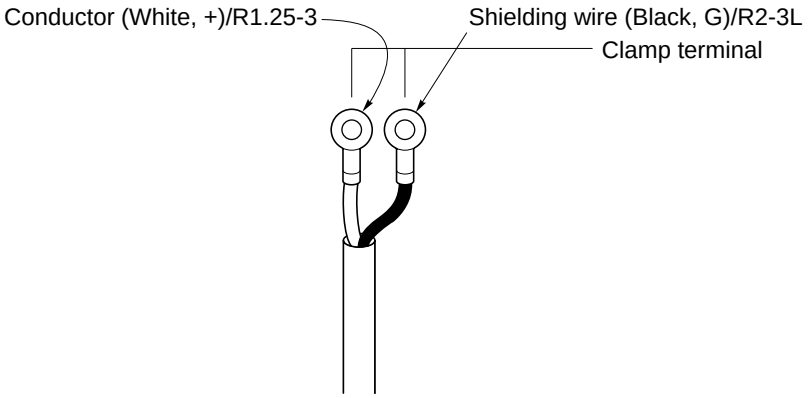
Thickness	20℃,60%RH
1mm	12h
2mm	24h
3mm	48h

· If the environmental temperature and humidity rise, the curing time of silicone rubber becomes shorter.
· Curing time of surface is between 1 to 60 minutes.
· It takes about three days to obtain sufficient adhesive strength.

5.7. Cable end treatment

5.7.1. Cable end treatment for FLS

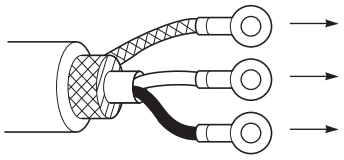
The end of coaxial cable is treated at the factory prior to delivery.
If the cable needs to be cut before use, the conductor and the shielding wires should be treated using clamp terminals.



Note) When cutting the coaxial cable, make sure that the upstream side and the downstream side are the same in length.

5.7.2. Cable end treatment for FSG, FSD

The end of coaxial cable is treated at the factory prior to delivery.
If the cable needs to be cut before use, the conductor, the shielding wires, and the external shielding wire should be treated using clamp terminals.



Kind of clamp terminal

Name	Flow transmitter side (for M3 screw)	Detector side (for M4 screw)
External shielding wire (green)	R1.25-3	R1.25-4
Conductor (White, +)	R1.25-3	R1.25-4
Shielding wire (Black, G)	R2-3L	R2-4

Note) When cutting the coaxial cable, make sure that the upstream side and the downstream side are the same in length.

5.8. Mounting small-diameter and small size detector (FLSS12, FLSS22)

5.8.1. Frame mounting method

⚠ CAUTION

Be careful not to cut your hand with the stainless steel belt when mounting the frame.

(1) Pass the stainless steel belt through 2 belt holes on the frame as shown in Fig. 5-4.

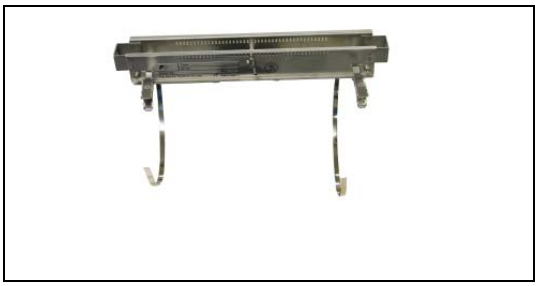


Fig. 5-4

(2) As shown in Fig. 5-5, apply the frame on the pipe section subjected to a surface treatment.

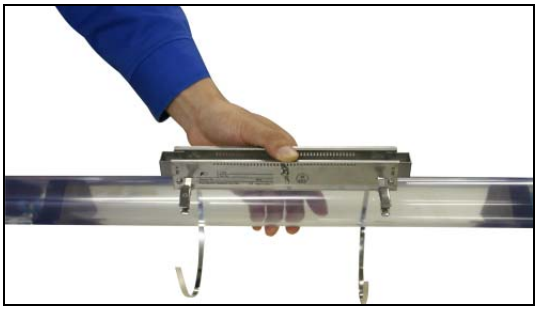


Fig. 5-5

(3) Turn the stainless steel belt around the pipe as shown in Fig. 5-6, and insert the lever.

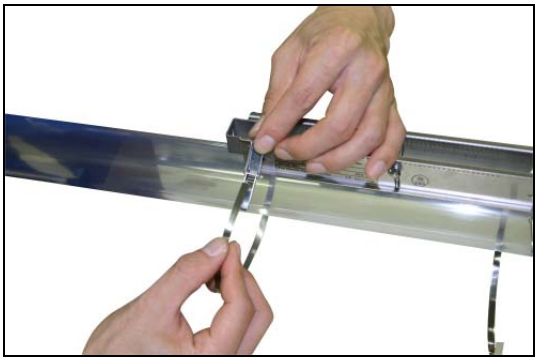


Fig. 5-6

(4) Adjust the frame so as to be in parallel with the pipe, and check whether the frame is securely tightened while pulling down the lever. Adjust the frame at the bending position A.

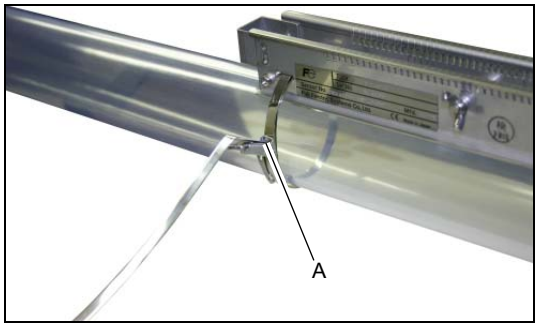


Fig. 5-7

(5) When the stainless steel belt is long, cut it as shown in Fig. 5-8.

Fig. 5-8

(6) Fit the lever window securely on the dowel. When the frame is not securely tightened, move the lever upward using blade-edge screwdriver, etc, and readjust the frame at the bending position in (4).

Fig. 5-9

Note) The stainless steel belt can be used repeatedly.

5.8.2. Mounting of sensor unit

(1) Mount both sensor units spaced at the SPACING value [S= * *] (number of graduations on frame) indicated after setting the piping parameters.

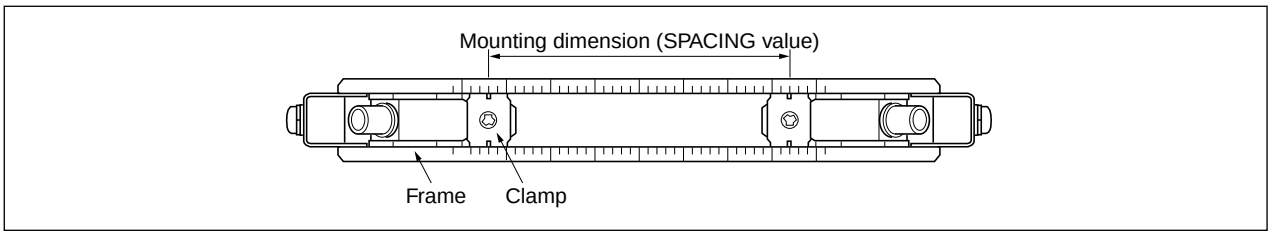


Fig. 5-10

(2) Before mounting the sensor unit into the frame, sufficiently apply acoustic coupler (or silicone-free grease*) over the entire transmission surface of the sensor unit, taking care not to introduce bubbles. (Fig. 5-11)

*) When using silicone-free grease, pay attention to the fluid temperature range. The fluid temperature range is shown below.
- Silicone compound : -40 to +150°C
- Silicone-free grease : 0 to +60°C

When using silicone-free grease, reapply it on the transmission surface of the sensor unit approximately once every 6 months. (Silicone rubber need not be reapplied.)

Fig. 5-11

(3) Then insert the sensor unit into the frame, align the slit provided on the pressing fixture of the sensor unit with graduations located on the frame top surface (see Fig. 5-12), and press the sensor unit until the fixture claws are engaged with the frame side square holes. Mount both sensor units so as to be roughly symmetrical with respect to the frame. (Refer to Fig. 5-13)

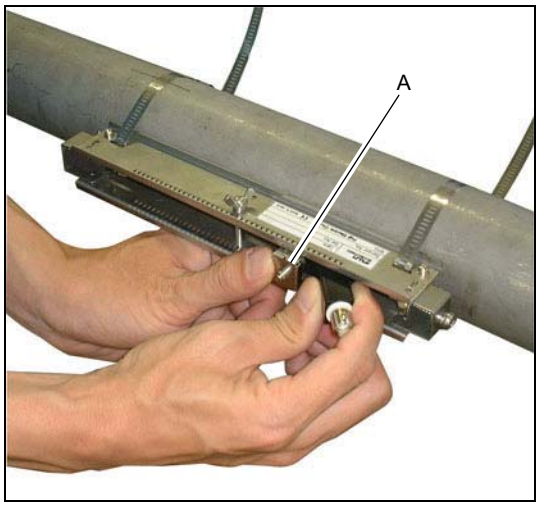
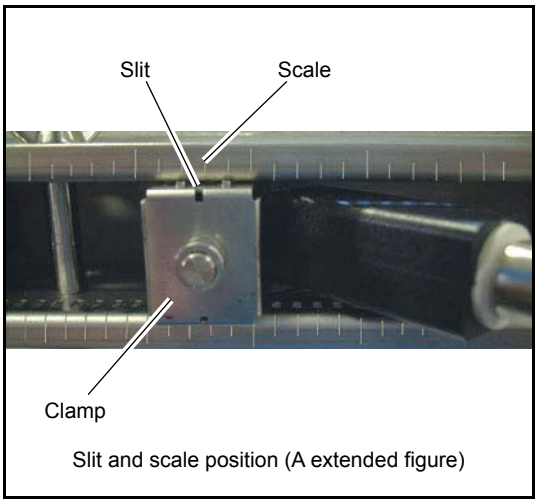


Fig. 5-12



Slit and scale position (A extended figure)

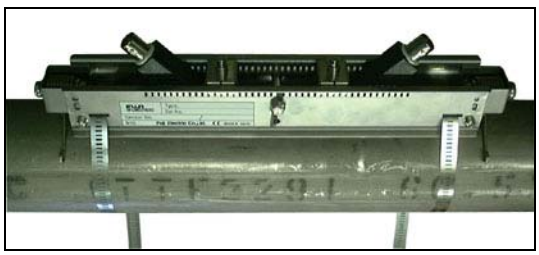


Fig. 5-13

⚠ CAUTION

Mount the sensor units so that their BNC connectors will face outward (Fig. 5-14a). If at least one is mounted opposite, the measurement is impossible (Fig. 5-14b, c). The pressing fixture claws must completely be engaged with square holes provided on sides of the frame. Otherwise, the sensor and pipe will not correctly get in contact with each other, whereby the measurement will be impossible.

Mount the BNC connectors of sensor units so as to face outward.

Fig. 5-14a

Do not mount the BNC connectors of sensor units in the same direction.

Fig. 5-14b

Do not mount the BNC connectors of sensor units so as to face inward.

Fig. 5-14c

Fig. 5-14

(4) Engage the signal line with BNC connectors of the sensor units. At this time, do not mistake the upstream and downstream sides for each other. Engage the red BNC connector upstream, and the black BNC connector downstream (see Fig. 5-15).

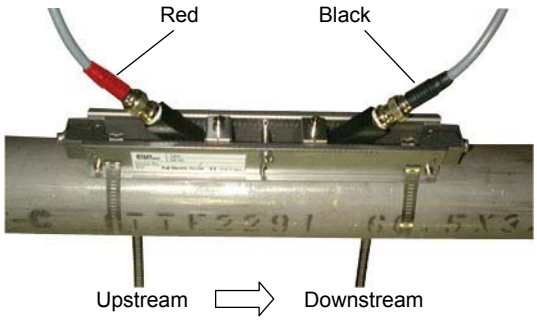


Fig. 5-15

5.9. Mounting small-diameter and middle size sensor (FSGS31, 32, 41)

5.9.1. Connection of sensor cable

⚠ CAUTION

When engaging or disengaging the cover, be sure to wear protective gloves. Otherwise, you may cut a hand.

(1) Remove the detector cover with a Phillips-head screwdriver.

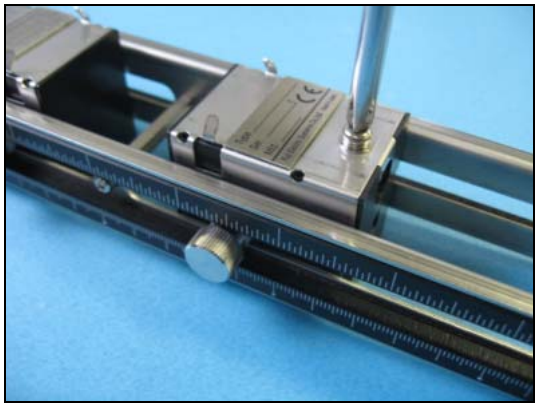


Fig. 5-16

(2) Remove the internal cable clamp.

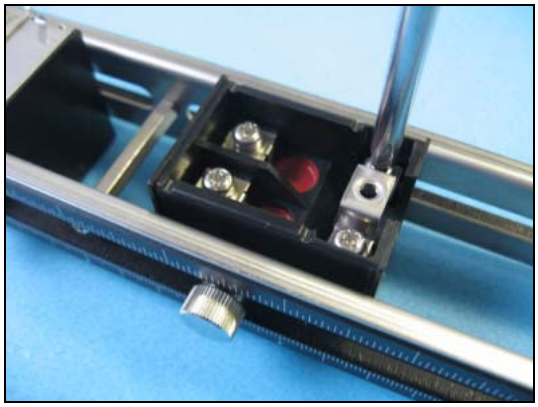


Fig. 5-17

(3) Remove the terminal (+/–) screws and place the signal cable.

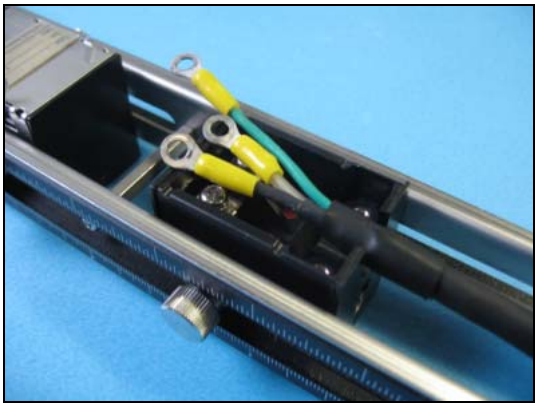


Fig. 5-18

(4) Attach the screw to the one side of the cable clamp. Do not tighten a screw too tight.
(Appropriate tightening torque: 80 to 120 [N·cm])

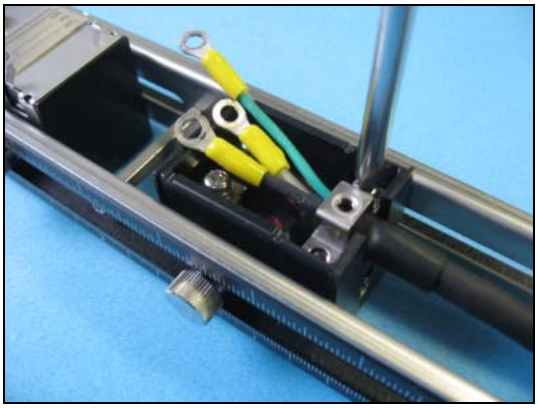


Fig. 5-19

(5) Connect signal cable.
Note: Connect the cable to the terminal (black to G terminal, white to + terminal).
Do not tighten a screw too tight.
(Appropriate tightening torque: 80 to 120 [N·cm])

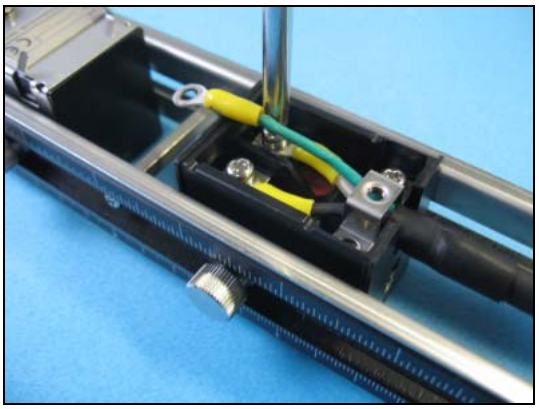


Fig. 5-20

(6) Attach the screws to the one side of the cable clamp and tighten them while fastening the ground wire (green) with them.
Do not tighten a screw too tight.
(Appropriate tightening torque: 80 to 120 [N·cm])

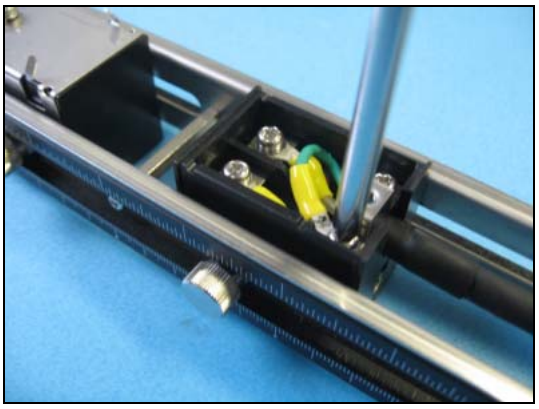


Fig. 5-21

(7) Arrange the wiring. Fill the whole terminal area with provided acoustic coupler and dry the surface.
Note: Apply the silicone filler while pressing it against the terminal area in order to prevent bubbles from entering, otherwise insufficient insulation may result.

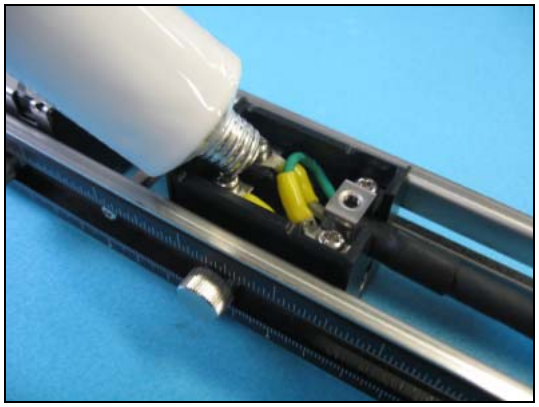


Fig. 5-22

(8) After the acoustic coupler surface dries, attach the cover and screws.

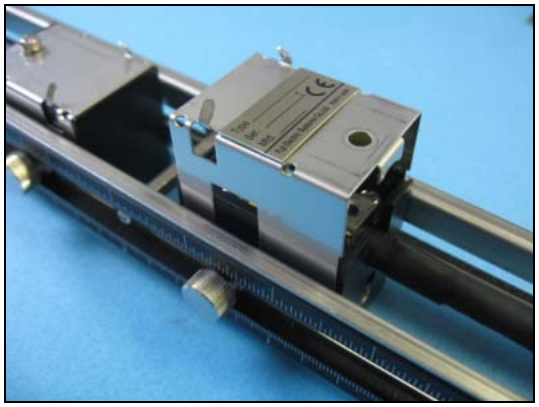


Fig. 5-23

5.9.2. Assembly procedure of the detector

If you order a small detector (FSGS31 or 32) with a cable (submersible type) whose length is 10 m or more, a sensor and frame will be delivered separately.
Assemble them following the procedure below before installing the detector to the piping.

⚠ CAUTION

Avoid applying bending or tensile stress to the base of the signal cable, otherwise the cable may be damaged.

(1) Remove the sensor fixing screw.

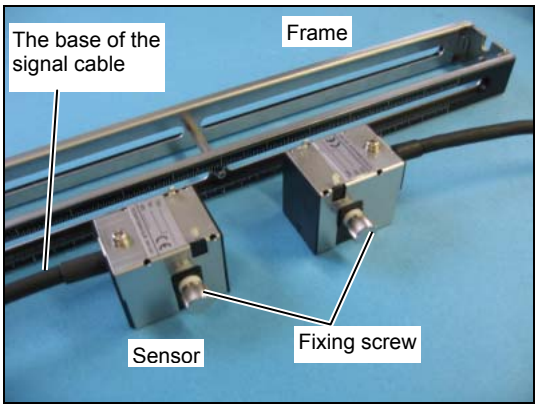


Fig. 5-24

(2) Loosen the screws on the center of the frame.

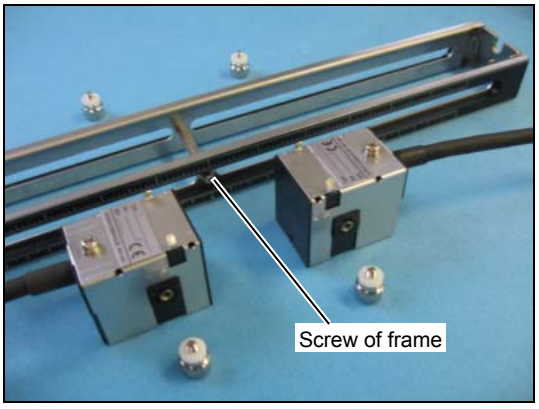


Fig. 5-25

(3) Open the frame to insert the sensor and tighten the screws on the frame.
Check that the sensor is inserted in the frame.

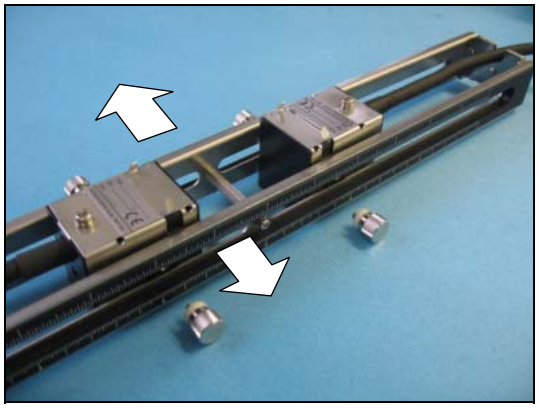


Fig. 5-26

(4) Attach the fastening screws for the sensor to complete the assembly.

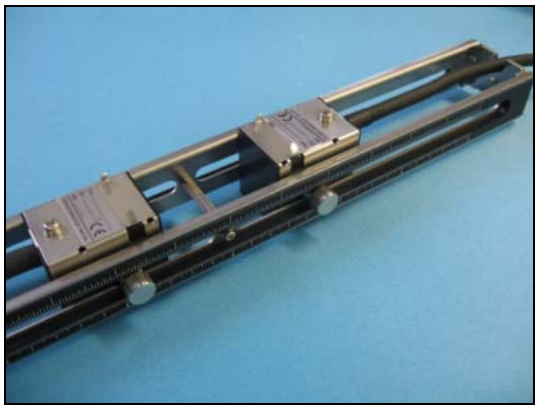


Fig. 5-27

5.9.3. Mounting method on the pipe

The small type detector is mounted on pipe with a diameter of Φ50 to 300mm for measurements.
The middle type detector is mounted on pipe with a diameter of Φ200 to 1200mm (Z method) for measurements.

5.9.3.1. In case of small type detector (FSGS3)

Mounting the detector using the following procedure.
For mounting, prepare a scale or a slide calipers.

(1) Loosen the fixing screw (4 places), slide the detector so as to match the mounting dimension, place a scale on the mounting dimension reference surface and adjust the dimension, then tighten the fixing screw.

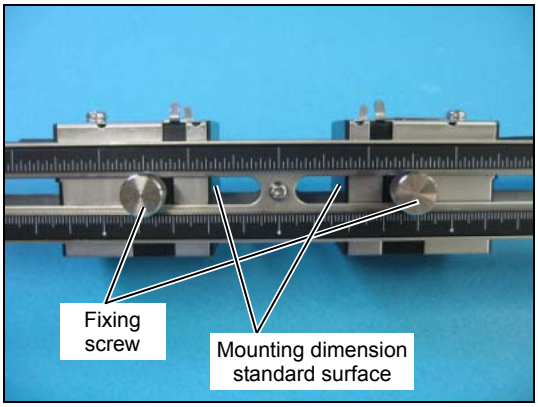


Fig. 5-28

(2) Spread acoustic coupler over the whole transmitting side of the detector. Care should be taken to prevent entry of air bubbles.
Clean the surface of the pipe, then mount the detector.

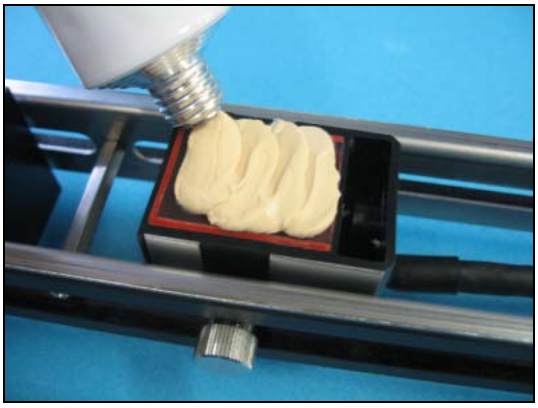


Fig. 5-29

(3) Pull the frame end and fix it in that condition.

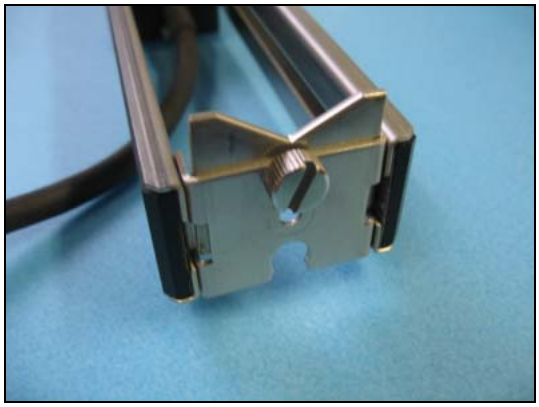


Fig. 5-30

(4) Press the detector against the piping and put the 1st ring of the chain on the hook.

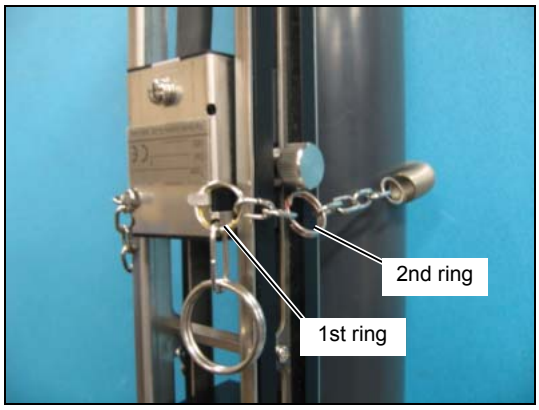


Fig. 5-31

(5) Attach the other chain to the other hook of detector, and secure it loosely.

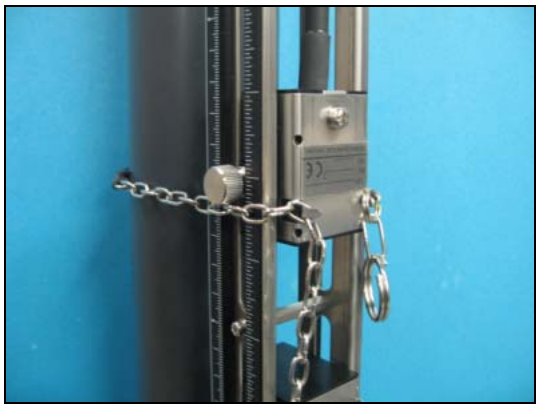


Fig. 5-32

(6) Loosen the screws on the frame end and attach the detector to the piping tightly.

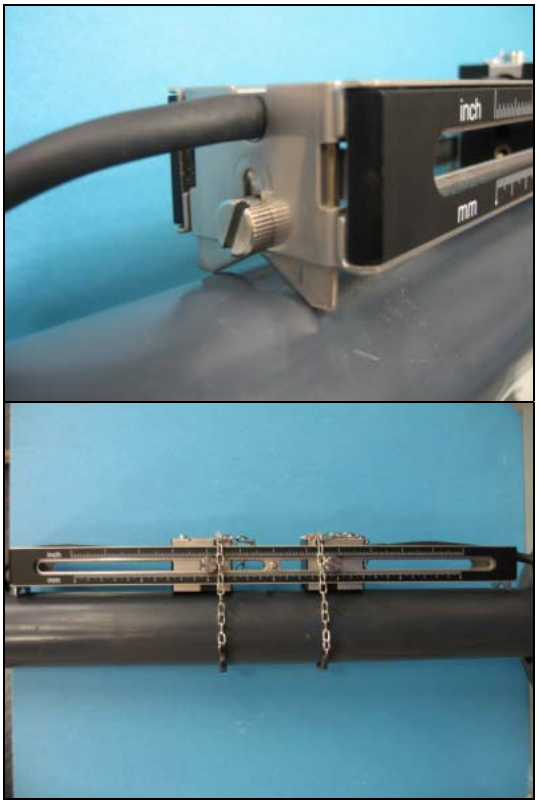


Fig. 5-33

(7) Pull the 2nd ring and attach it to the hook. Use the same procedure for the other sensor.

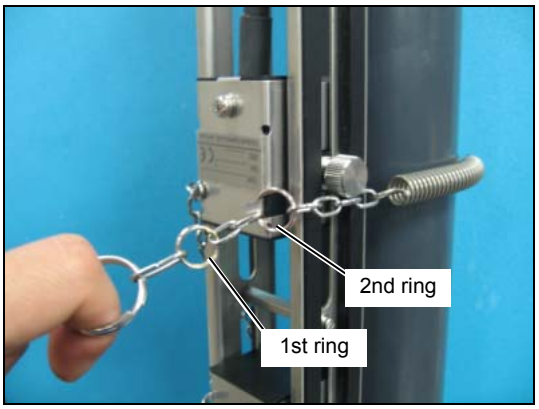


Fig. 5-34

(8) Press the sensor firmly against the pipe. Ensure that the sensor makes a close contact with the pipe.
Note: Adjust the sensor so that it faces the center of the piping, otherwise measurement may not be performed.

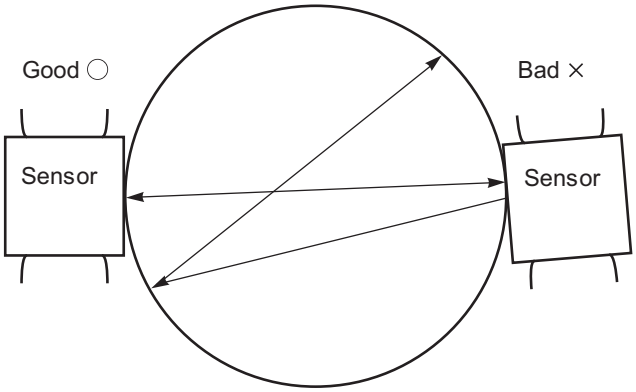


Fig. 5-35

5.9.3.2. In case of middle type detector (FSGS4)

Mounting the detector using the following procedure.

(1) Provide wire rope for the upstream and the downstream detectors.
Make sure that the length of the wire rope is longer than the circumference of the pipe.

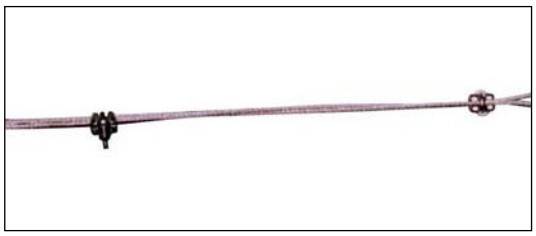


Fig. 5-36

(2) Lay the wire rope around the pipe at the position of the upstream detector. Then hook the mounting spring into the wire rope.

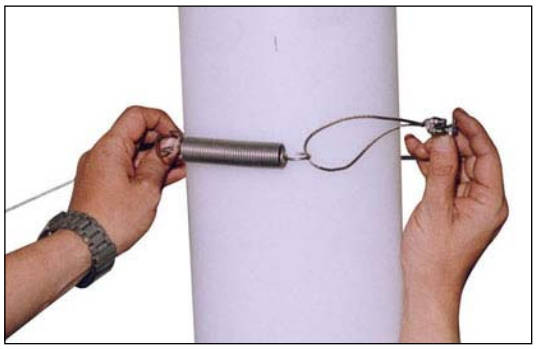


Fig. 5-37

(3) Loosen the guide frame fixing screw and slide the guide frame until its edge and transmitting surface touch the surface of pipe.

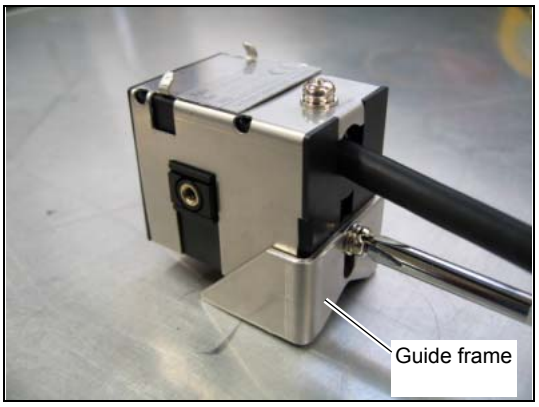


Fig. 5-38

(4) Spread acoustic coupler over the whole transmitting side of the detector. Care should be taken to prevent entry of air bubbles.

Fig. 5-39

(5) Clean the surface of the pipe, then mount the detector.

Fig. 5-40

(6) Press the detector against the pipe. Align the center of the detector with the intersection of the marking line. Make sure that the matching mark on the detector is aligned with the marking line.

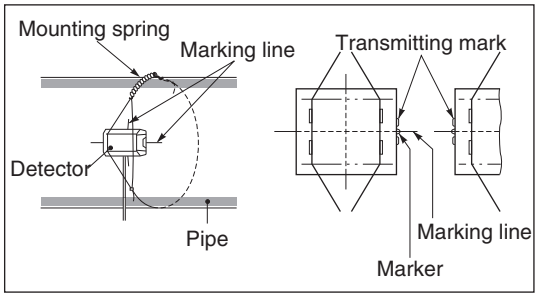


Fig. 5-41

(7) Make sure that the center mark on the detector is aligned with the marking line. Then, connect the coaxial cable to the transmitter.
Note: Do not pull the coaxial cable.
If it is pulled, the detector is shifted which results in incorrect measurements due to poor contact with the pipe.

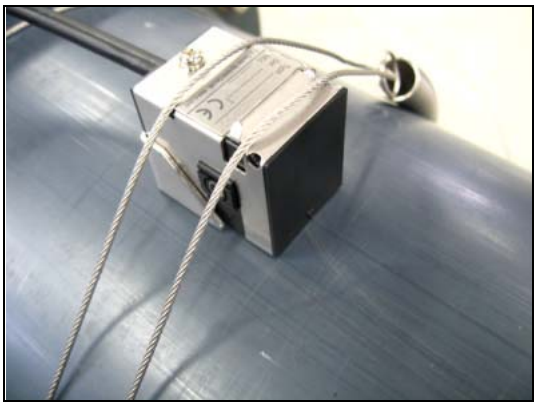


Fig. 5-42

(8) After mounting the upstream sensor, mount the downstream sensor in the same mounting dimensions.

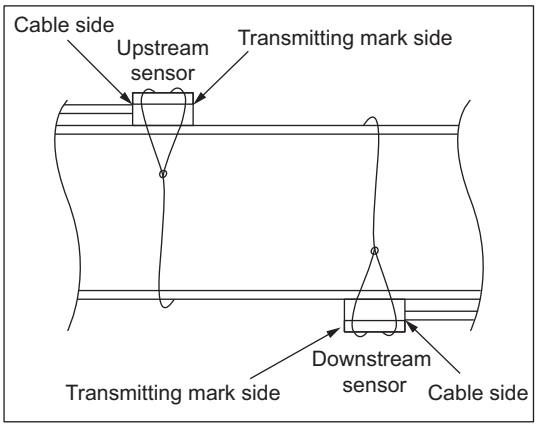


Fig. 5-43

5.10. Mounting large size detector (FSGS50, FSGS51)

5.10.1. Connection of sensor cable

⚠ CAUTION

When engaging or disengaging the cover, be sure to wear protective gloves. Otherwise, you may cut a hand.

(1) Remove the M4 screws on the detector cover.
Remove the cover while opening it.

Fig. 5-44

(2) Confirm the mounting position on the pipe.
- Align the transmitting direction marks so that they are facing with each other.

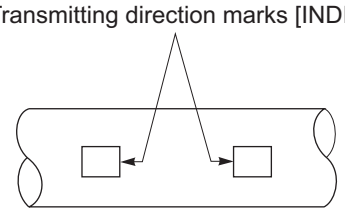


Fig. 5-45

(3) Remove the two M4 screws to remove the cable clamp.
Put the cable and fix the signal cable with the cable clamp (one side only).
Note: Connect the signal cable to the terminal (black to G terminal, white to + terminal).
Note: Connect to the M4 crimp terminal side
(Appropriate tightening torque: 80 to 120 [N·cm])

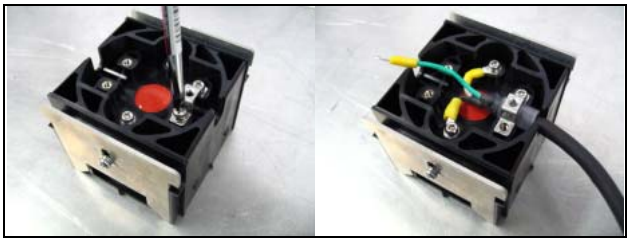


Fig. 5-46

(4) Attach the screws to the one side of the cable clamp and tighten them while fastening the ground wire (green) with them.
(Appropriate tightening torque: 80 to 120 [N·cm])

Fig. 5-47

(5) Remove foreign matters from the terminals, and mold them while terminal block with silicone filler.
- Cut off the tip of the silicone filler tube. Apply silicone to the terminal block while pressing the head of the tube against the bottom of terminals.
At this time, care should be taken to prevent entry of air bubbles.
Put the cover on the sensor.

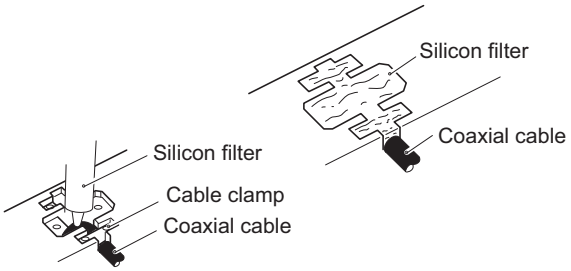
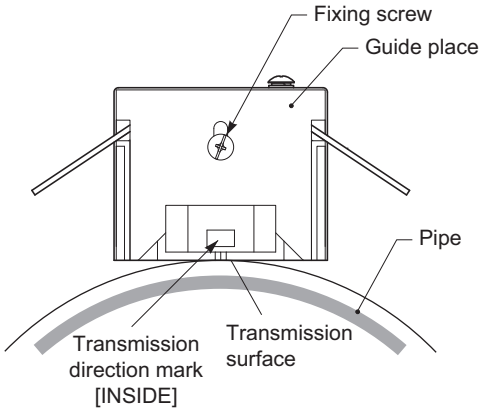


Fig. 5-48

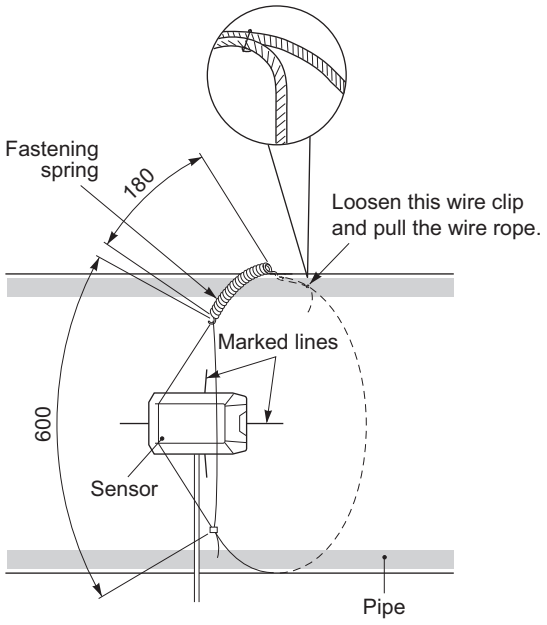
5.10.2. Mounting method on the pipe

(1) Adjustment of guide plate height
Place the sensor on the pipe surface in parallel with the pipe axis.



Loosen the guide plate fixing screw and slide the guide plate until its edge and transmitting surface touch the surface of pipe.
Tighten the retaining screw.

(2) Setting of wire rope length
Place the sensor on the marked lines and fit the wire rope and fastening spring.



Loosen the wire clip and pull the wire rope until the overall length of fastening spring approximates 180mm. Then tighten the wire clip. (The fastening spring has a free length of 110mm.)
Remove the sensor with the wire rope fixed in place.

(3) Mounting of sensor

- Clean the sensor transmitting surface and pipe mounting surface.
- Spread acoustic coupler over the whole transmitting surface of the sensor.
- The thickness of acoustic coupler should be about 3mm.

- Spread the wire rope near the marked lines in the left-right direction, bring the sensor in close contact and fit the wire rope.

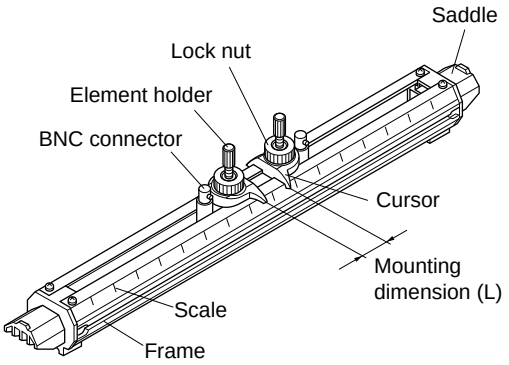
- Make sure that the matching mark on the sensor is aligned with the marking line. In addition, make the transmitting direction marks of sensors face each other.

- Make sure the matching mark of sensor is aligned with the marked line and connect the signal cable to the flow transmitter.

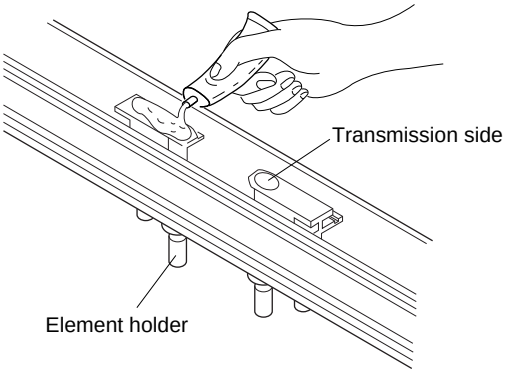
Note: Do not pull the signal cable. Otherwise, the sensor will be activated to disturb measurement.

5.11. Mounting small diameter detector (FSD22)

(1) Loosen the lock nut and slide the sensor so as to meet the mounting dimension (the first decimal place at the displayed mounting dimension is rounded) and then tighten the nut.

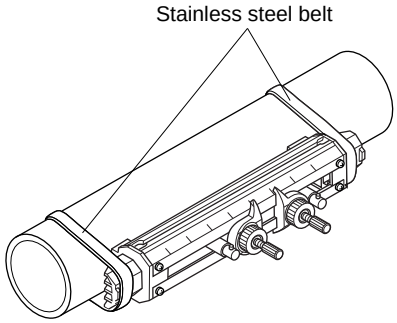


(2) Apply the acoustic coupler on the transmitting surface of sensor wile spreading it evenly.

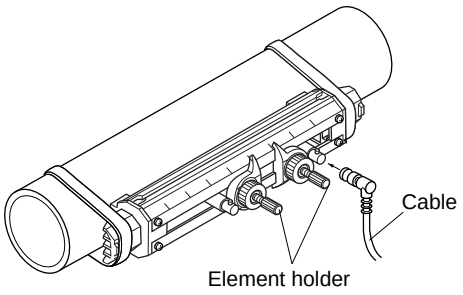


Turn the element holder counterclockwise to return the sensor.
Clean the surface of the pipe and mount the sensor on the pipe.

(3) Mount the sensor saddles on the pipe with stainless belt.
Wrap the stainless belt around the pipe previously for easy mounting.



(4) Make sure that the sensor is mounted in parallel with the piping and that the mounting position is correct. Then, turn the element holder clockwise until the sensor is firmly fitted to the piping.



Stop turning the element holder where the transmitting surface contacts the surface of pipe, and thus the element holder will not rotate. Do not turn it excessively.

5.12. Mounting high temperature detector (FSD32)

The high temperature sensor is mounted on pipe with a diameter of Φ50 to 250 (V method) or Φ150 to 400 (Z method) for measurements.

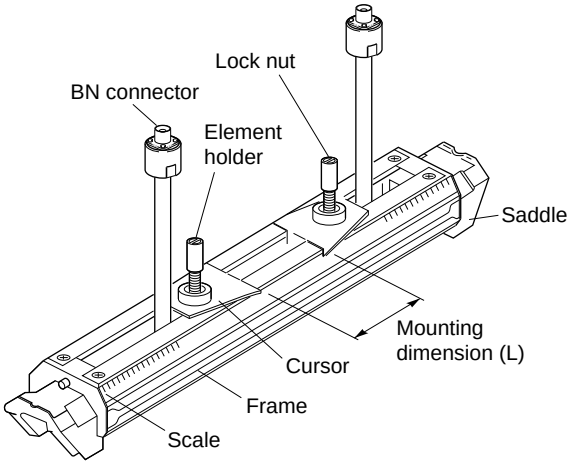
5.12.1. Mounting of detector (in case of V method)

Mounting the detector using the following procedure.

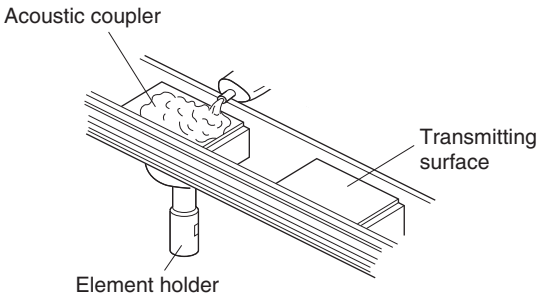
⚠ CAUTION

Do not perform mounting when the temperature of pipe is high. Otherwise, you may suffer a burn.

(1) By loosening lock nuts, slide the sensor to fit the mounting size displayed on the converter. Tighten the lock nuts.

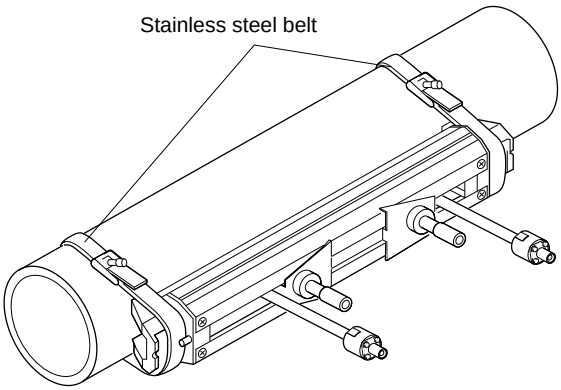


(2) Spread acoustic coupler over the whole transmitting surface of the sensor.

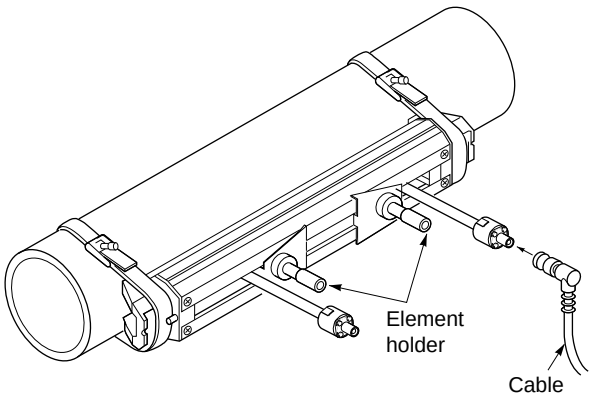


Turn the element holder counterclockwise to return the sensor.
Clean the surface of the pipe and mount the sensor on the pipe.

(3) Mount the sensor saddles on the pipe with stainless belt.



(4) Make sure that the sensor is mounted in parallel with the piping and that the mounting position is correct. Then, turn the element holder clockwise until the sensor is firmly fitted to the piping.

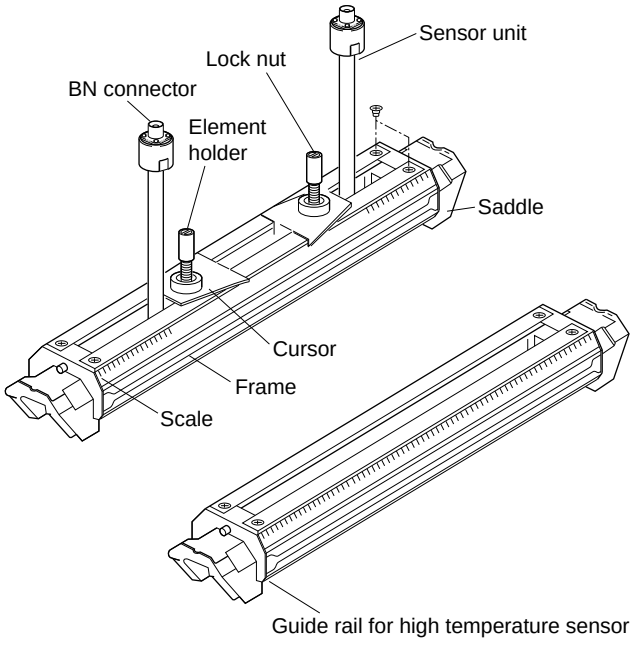


Stop turning the element holder where the transmitting surface contacts the surface of pipe, and thus the element holder will not rotate. Do not turn it excessively.

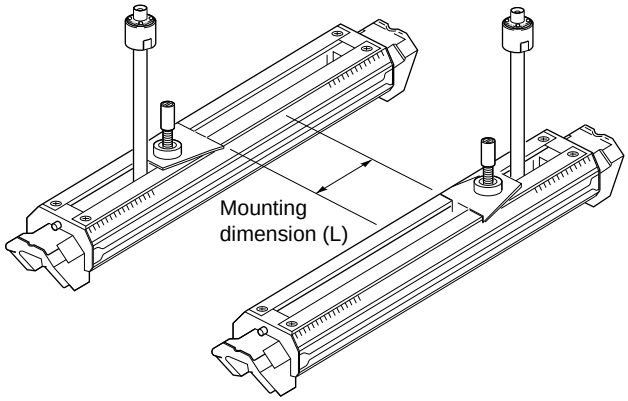
5.12.2. Mounting of detector (in case of Z method)

Mounting the detector using the following procedure.

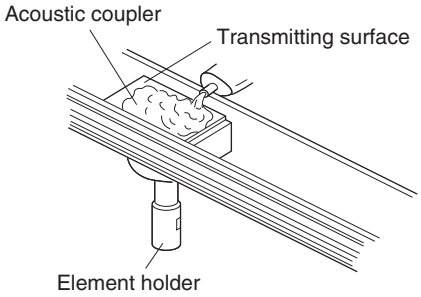
(1) Remove saddle set screws at 4 locations, and remove a saddle and a sensor unit out of the frame.
Also, remove a saddle on the guide rail for high temperature sensor (option).



(2) Mount the removed sensor unit on the guide rail for high temperature sensor.
Fasten the sensor unit with mounting dimension (L).

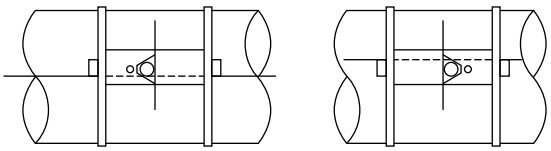


(3) Spread acoustic coupler over the whole transmitting surface of the sensor.



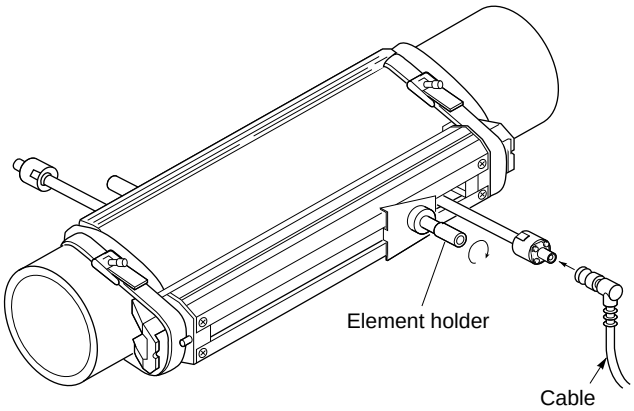
Turn the element holder counterclockwise to return the sensor.
After cleaning the surface of the pipe, the sensor should be mounted.

(4) Mount each sensor individually on the marking line.



Front view	Back view
Upper side of the marking line	Bottom side of the marking line

(5) Make sure that the sensor is mounted in parallel with the piping and that the mounting position is correct.
Then, turn the element holder clockwise until the sensor is firmly fitted to the piping.
Stop turning the element holder where the transmitting surface contacts the surface of pipe, and thus the element holder will not rotate.
Do not turn it excessively.



6. CHECK AND MAINTENANCE

6.1. Daily Check

Visually check the following items.

- Whether flow transmitter cover screws are loose. ⇒ Tighten.
- Whether cable glands are loose. ⇒ Tighten.
- Whether detector mounting band is loose. ⇒ Stretch.
- Whether received wave is abnormal (LED lit red). ⇒ Check whether piping is filled or not. Remove bubbles or foreign matters, if mixed in measurement pipe. Also check if detector mounting and wiring are set up properly.

6.2. Periodic Inspection

6.2.1. Checking zero point

Stop the fluid flow, fill the measurement pipe fully, and check the zero point.

6.2.2. Reapplying grease

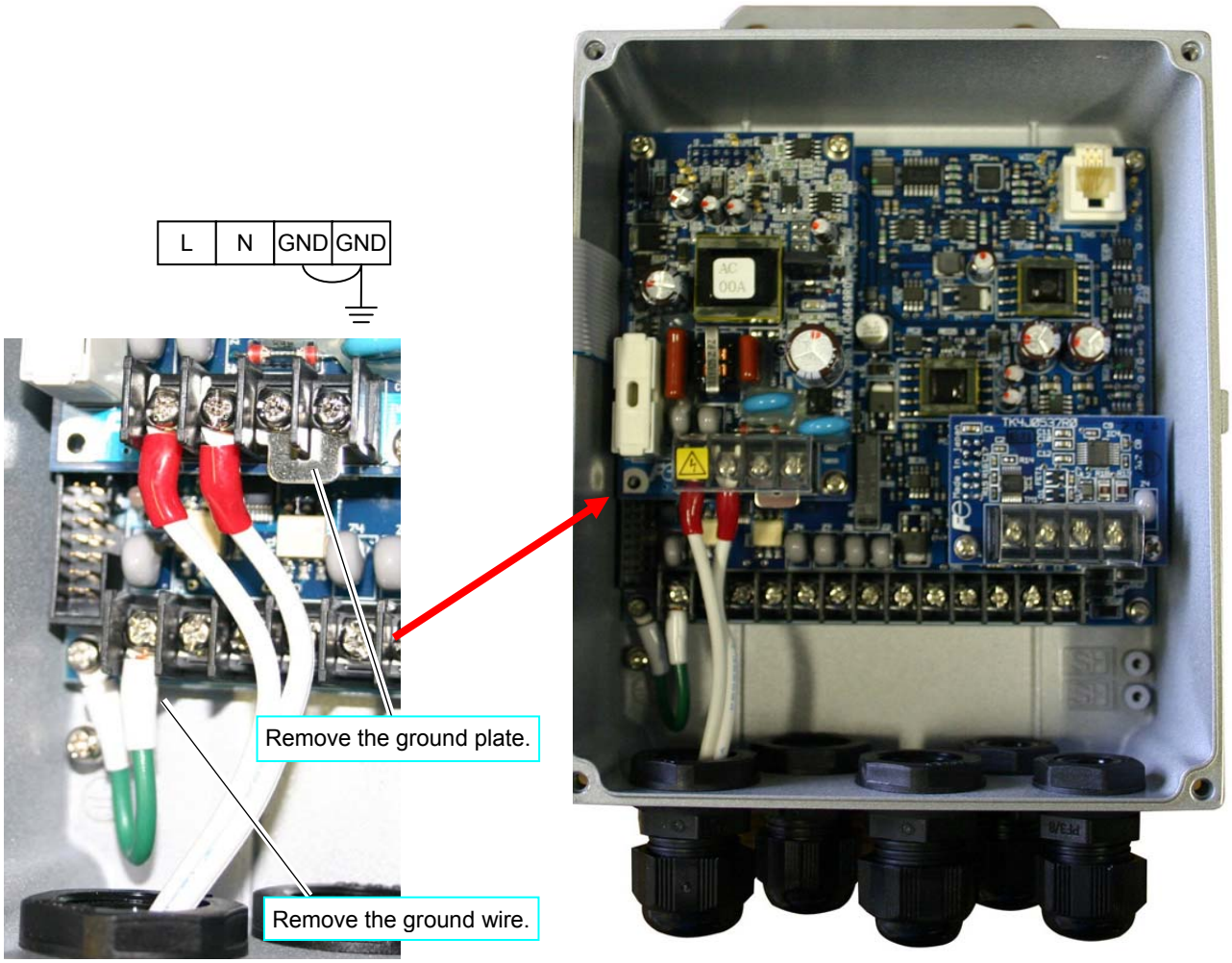
When using grease for the acoustic couplant, reapply it on the transmission surface of the sensor unit approximately once every 6 months.
Note) Silicone rubber need not be reapplied.

6.2.3. How to measure the insulation resistance

6.2.3.1. Flow transmitter : FSV···S (IP66)

⚠ CAUTION

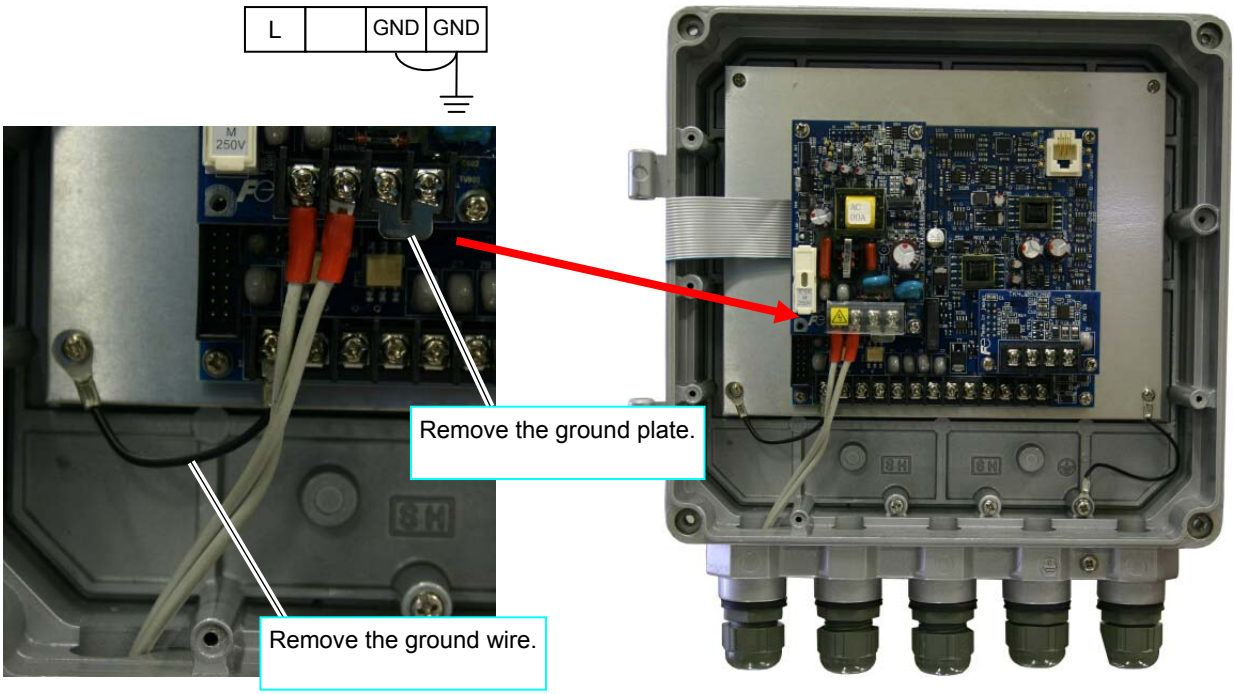
Turn off power before opening the flow transmitter cover.
The power terminals (N,L) and the output terminals (Iout, DO1, DO2, DO3) are provided with an arrester as standard.
To measure the insulation resistance between the power terminal and the grounding terminal, and between each output terminal and the grounding terminal, remove the earth plate of the power terminal block and the ground wire of the output terminal as shown by the following figure.
If the communication board (option) is provided, remove it before measuring.
The insulation resistance performance of the equipment is 100 MΩ/500 V DC.
Be sure to return the earth plates and ground wire in position after the measurement is completed.



6.2.3.2. Flow transmitter : FSV···H (IP67)

⚠ CAUTION

Turn off power before opening the flow transmitter cover.
The power terminals (N,L) and the output terminals (Iout, DO1, DO2, DO3) are provided with an arrester as standard.
To measure the insulation resistance between the power terminal and the grounding terminal, and between each output terminal and the grounding terminal, remove the earth plate of the power terminal block and the ground wire of the output terminal as shown by the following figure.
If the communication board (option) is provided, remove it before measuring.
The insulation resistance performance of the equipment is 100 MΩ/500 V DC.
Be sure to return the earth plates and ground wire in position after the measurement is completed.



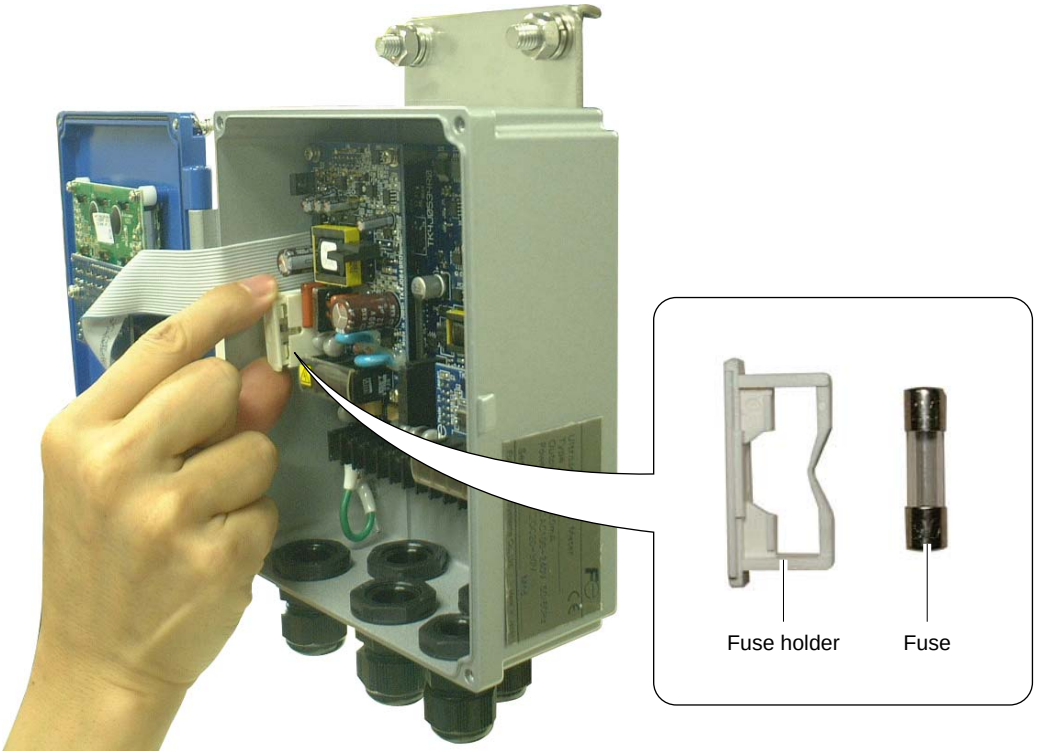
6.3. How to replace the fuse

⚠ CAUTION

- Be sure to turn off the power before replacing the fuse.
  Fuse specifications
  (1) AC power supply (100V and 200V): 5.2mm (diameter) × 20mm (long), 250V, 0.5A.
  As represented by Fuji Terminal Industry Co., Ltd. FGMB: 250V, 0.5A.
  (2) DC power supply: 5.2mm (diameter) × 20mm (long), 250V, 1A.
  As represented by Fuji Terminal Industry Co., Ltd. FGMB: 250V, 1A.

6.3.1. Flow transmitter : FSV···S (IP66)

(1) Opening the cover after turning off power.
Loosen 4 screws from the flow transmitter front, and open the cover.
(2) Replace the fuse.
Detach the fuse holder from the power supply board, and replace the fuse. Then, return the fuse holder in place.
(3) Closing the cover.
Close the cover, and tighten 4 screws.

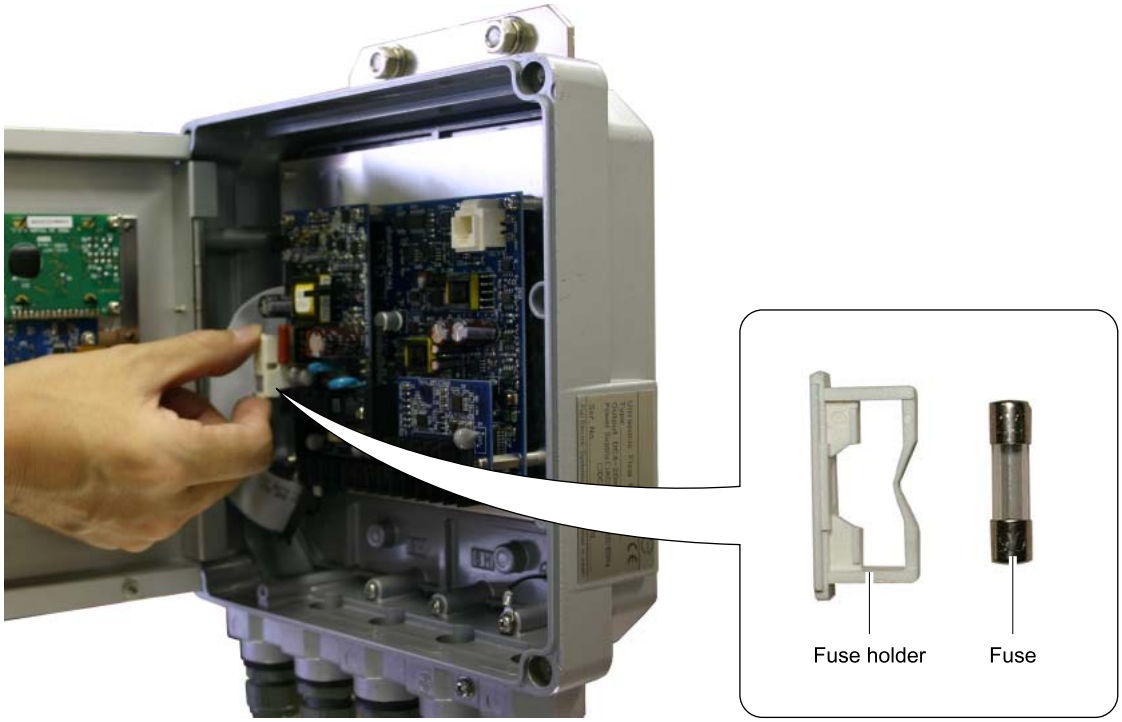


⚠ CAUTION

- Turn on power only after closing the cover.

6.3.2. Flow transmitter : FSV···H (IP67)

(1) Opening the cover after turning off power.
Loosen 4 screws from the flow transmitter front, and open the cover.
(2) Loosen 2 screws from the setting section of the display unit, and open the cover.
(3) Replace the fuse.
Detach the fuse holder from the power supply board, and replace the fuse. Then, return the fuse holder in place.
(4) Close the setting section of the display unit, and tighten 2 screws.
(5) Closing the cover.
Close the cover, and tighten 4 screws.



⚠ CAUTION

- Turn on power only after closing the cover.

6.4. How to replace the relay

DO3 is a relay contact, whose service life is 200,000 times (under rated load).
Replace it before the end of its life estimating the number of contact operations.
Card relay type: RB104-DY (manufactured by Fuji Electric)

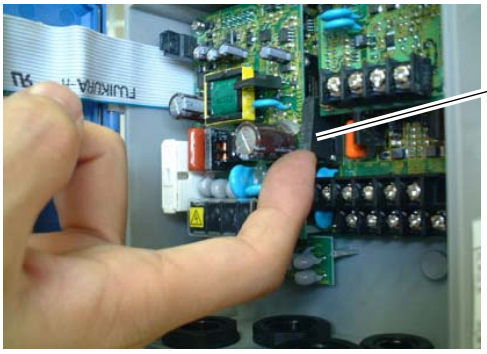
6.4.1. Flow transmitter : FSV···S (IP66)

[How to replace]
(1) Open the cover after turning off power.
(2) As shown by the following photo, pull out the card relay from socket.
(3) Set a new card relay into the socket. Push it enough to engage the card relay claws.
(4) Close the cover and turn on the power.
(5) Set the maintenance mode to "STATUS OUTPUT", and check the relay “ON” and “OFF” actions.

⚠ CAUTION

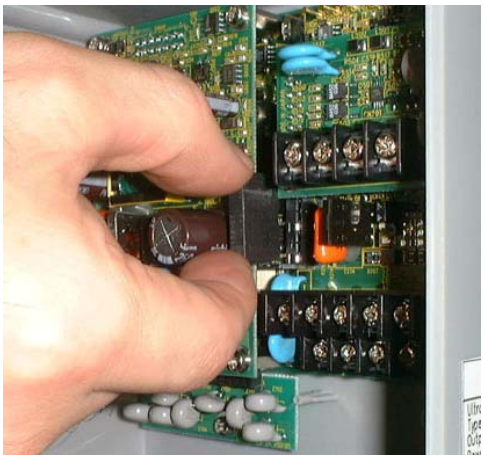
- Be sure to turn off the power before opening the cover. The unit containts high voltage.

Relay removing procedures



Push up the card relay bottom.

Push the card relay top from socket.



Pull out the card relay from socket.

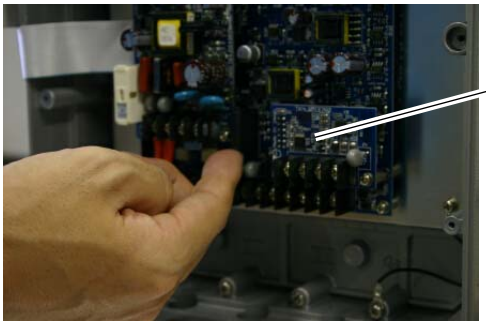
6.4.2. Flow transmitter : FSV···H (IP67)

[How to replace]
(1) Open the cover after turning off power.
(2) Loosen 2 screws from the setting section of the display unit, and open the cover.
(3) As shown by the following photo, pull out the card relay from socket.
(4) Set a new card relay into the socket. Push it enough to engage the card relay claws.
(5) Close the setting section of the display unit, and tighten 2 screws.
(6) Close the cover and turn on the power.
(7) Set the maintenance mode to "STATUS OUTPUT", and check the relay “ON” and “OFF” actions.

⚠ CAUTION

- Be sure to turn off the power before opening the cover. The unit containts high voltage.

Relay removing procedures



Push up the card relay bottom.

Push the card relay top from socket.

Pull out the card relay from socket.

6.5. How to replace the LCD

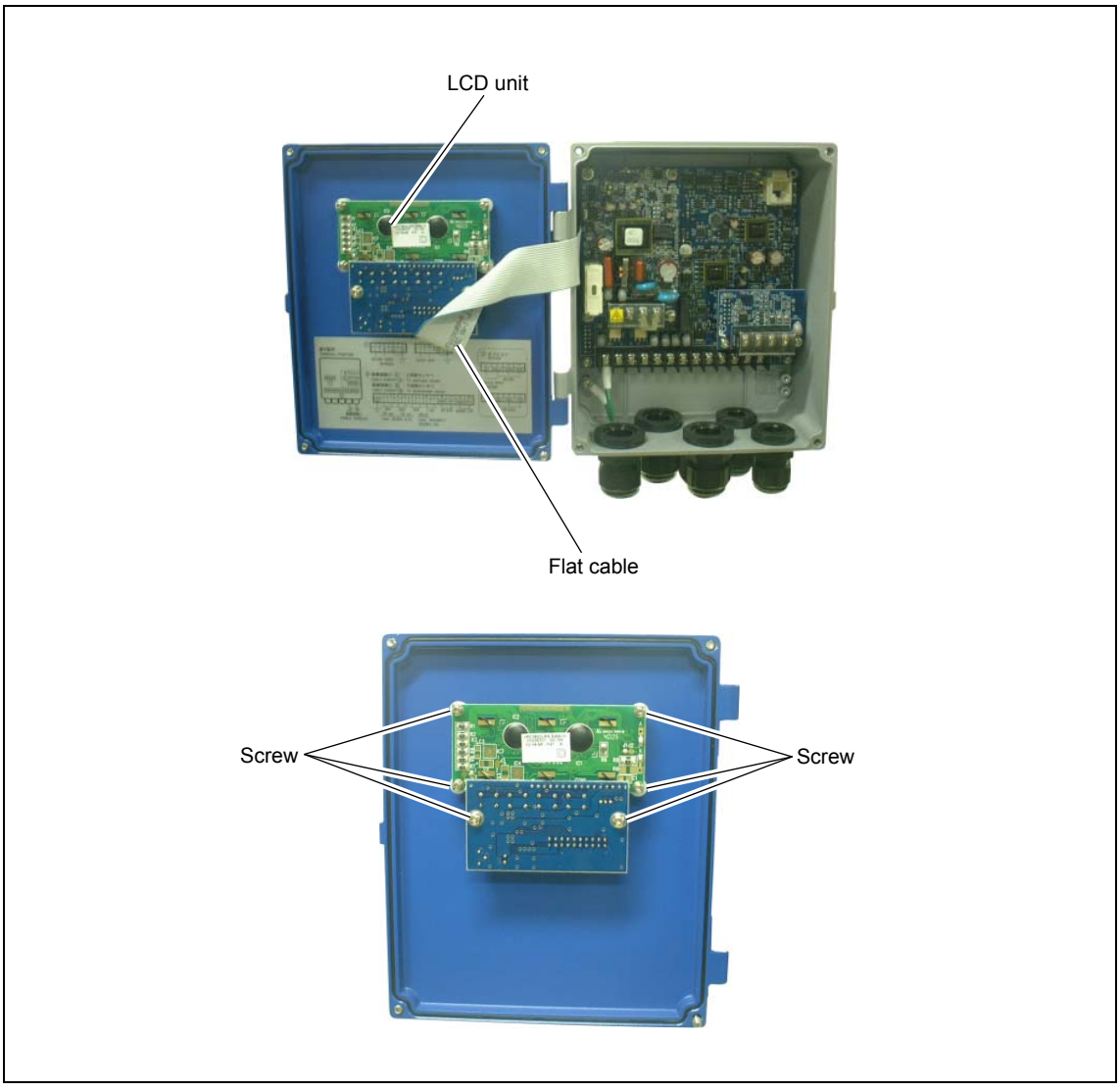
The nominal service life of the LCD is 7 years. The contrast gradually deteriorates with time.
Replace it about 5 years after starting its use.

6.5.1. Flow transmitter : FSV···S (IP66)

[How to replace]
(1) Open the cover after turning OFF power.
(2) Remove the flat cable connector.
(3) Loosen 6 screws from the LCD unit.
(4) Mount a new LCD unit (see parts list), inserting the operation keys and LED properly into the cover holes. Take care not to allow interference by the cover.
(5) Connect the flat cable connector. (Insert it securely all the way.)
(6) Close the cover and turn on the power.
(7) Check that the LCD display and key operation are functioning correctly.

⚠ CAUTION

- Be sure to turn off the power before opening the cover. The unit containts high voltage.



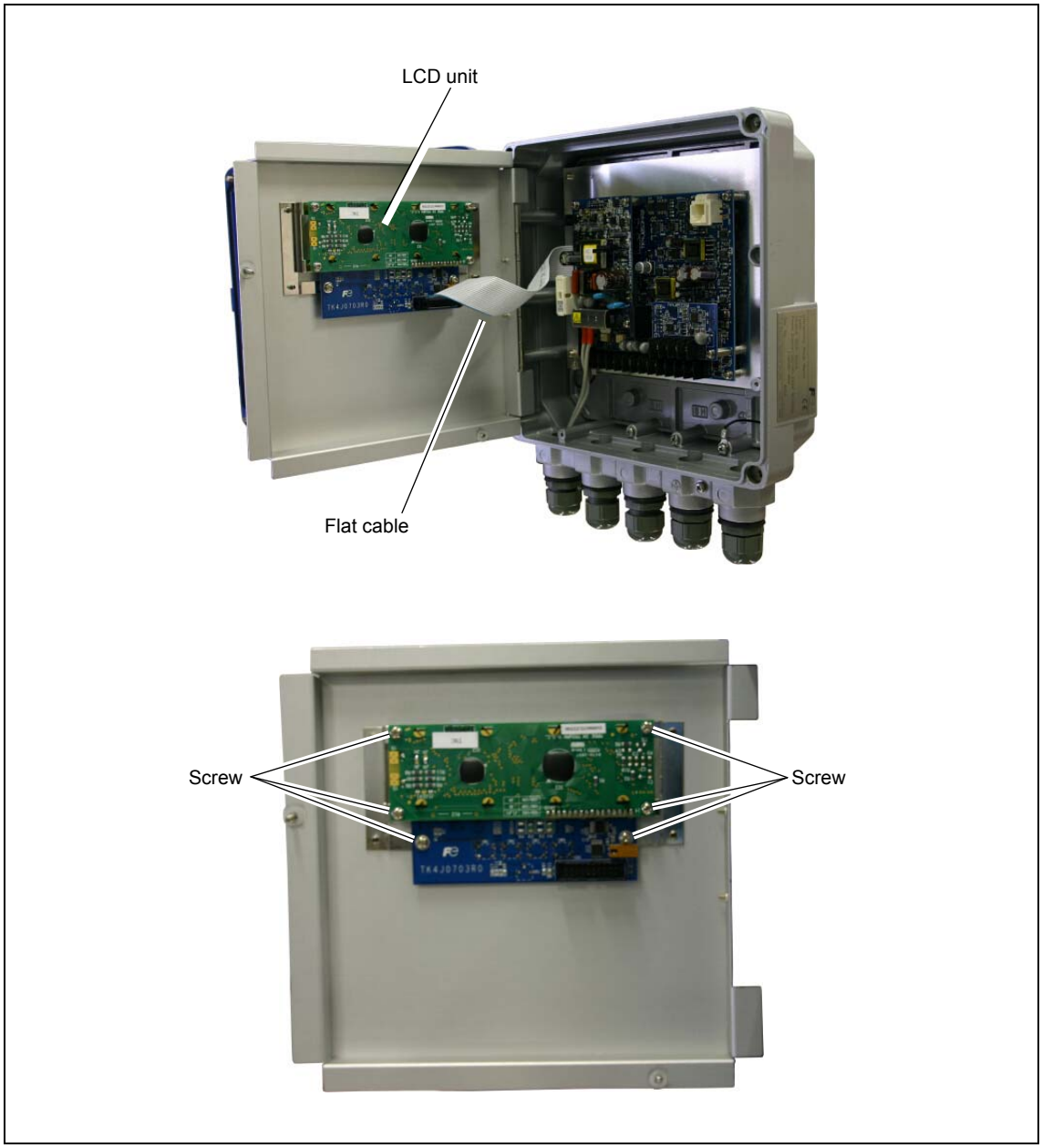
6.5.2. Flow transmitter : FSV···H (IP67)

[How to replace]

(1) Open the cover after turning OFF power.
(2) Loosen 2 screws from the setting section of the display unit, and open the cover.
(3) Remove the flat cable connector.
(4) Loosen 6 screws from the LCD unit.
(5) Mount a new LCD unit (see parts list), inserting the operation keys and LED properly into the cover holes. Take care not to allow interference by the cover.
(6) Connect the flat cable connector. (Insert it securely all the way.)
(7) Close the setting section of the display unit, and tighten 2 screws.
(8) Close the cover and turn on the power.
(9) Check that the LCD display and key operation are functioning correctly.

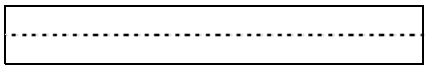
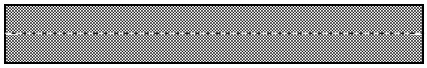
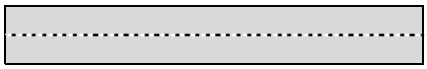
⚠ CAUTION

- Be sure to turn off the power before opening the cover. The unit containts high voltage.



6.6. ERROR AND REMEDY

6.6.1. Display error

State	Probable cause
 Nothing is displayed.	● Power supply is not turned on. ● Low power supply voltage ● Fuse is blown out. ● LCD error ⇒ Refer to “6.6.7. Remedying a hardware fault”. ● Reverse polarity of DC power supply
 Upper side appears black.	● Low power supply voltage ● Reverse polarity of DC power supply ● LCD error ⇒ Refer to “6.6.7. Remedying a hardware fault”.
 Irrational display	● Hardware error ⇒ Refer to “6.6.7. Remedying a hardware fault”.
 Pale display	● Ambient temperature is low (-20°C or lower) ⇒ Increase temperature. ● LCD has reached the end of its service life. ⇒ Replace the LCD.
 Entire display is blackish.	● Ambient temperature is high (50°C or higher) ⇒ Decrease temperature.
LCD characters are skipped. LED does not come on	● Refer to “6.6.1.1. Checking the LCD/LED” for LCD/LED. The dots on the LCD are missing or the LED does not come on. ⇒ Refer to “6.6.7. Remedying a hardware fault”.
LED is displayed in red.	● Received wave is abnormal. ⇒ Refer to “6.6.1.2. Checking the LED lit in red”.

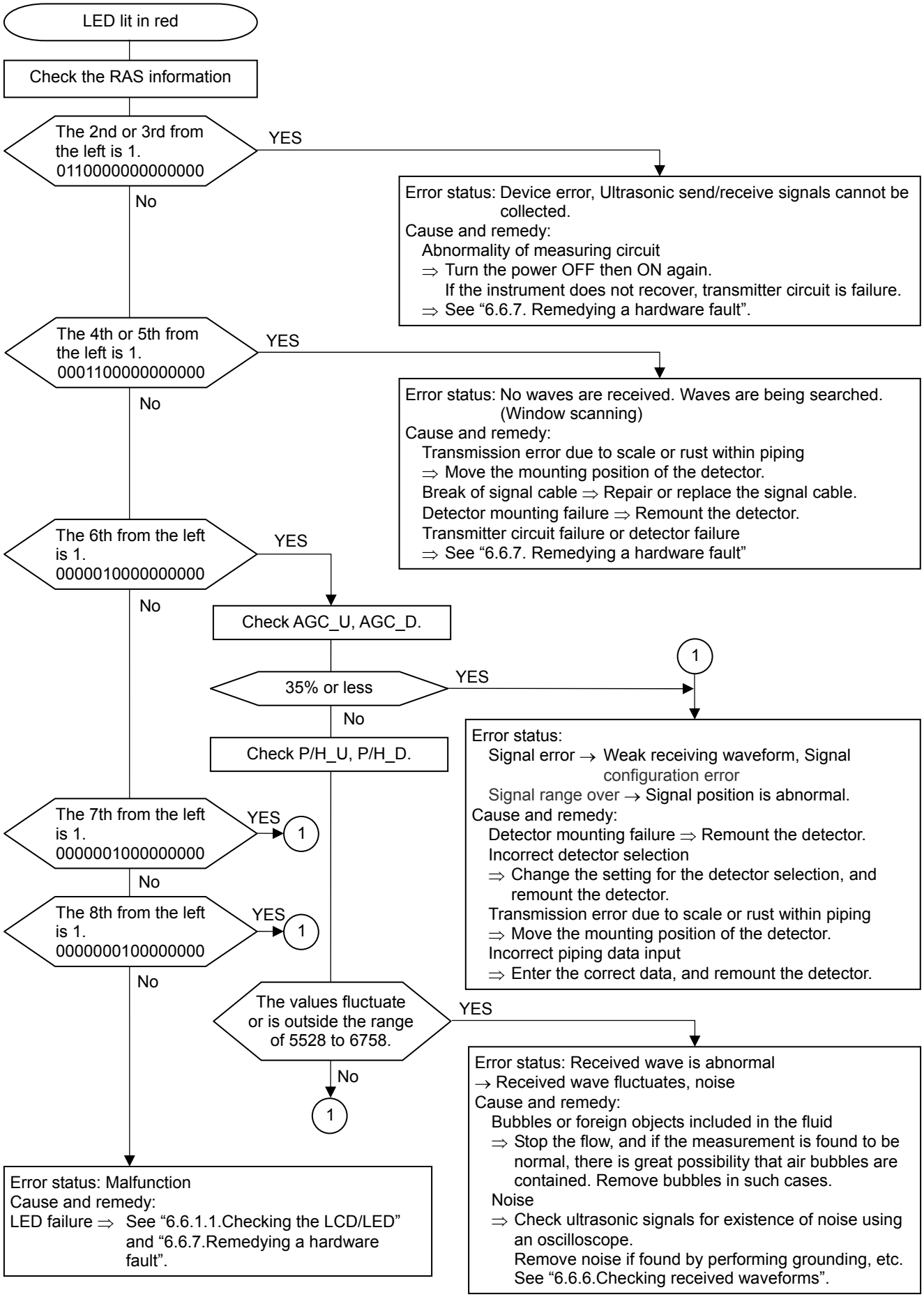
6.6.1.1. Checking the LCD/LED

Follow the procedure shown below to check possible display errors.

Key operation	Description	Display
△ ▼	Press the △ key for 4 times to display “MAINTENANCE MODE”.	MAINTENANCE MODE
ENT ▼	Press the ENT key once to display “RAS INFORMATION”.	RAS INFORMATION 0000000000000000
△ ▼	Press the △ key for 12 times to display “LCD/LED CHECK”.	LCD/LED CHECK
ENT ▼	Press the ENT key once.	● ← Lit in red
▷ ▼	Every time the ▷ key is pressed, the display is switched in the order shown below. LCD: OFF completely LED: Lit in green LCD: Darkened LED: Lit in red If dots on the LCD are missing or the LED does not come on, the LCD/LED may have failed.	● ← Lit in green
ESC △	Obtain a measurement-mode display using the ESC and the △ keys.	0.000 m/s 0.000 m3/h

6.6.1.2. Checking the LED lit in red

Check the LED lit in red, following the procedure shown below.



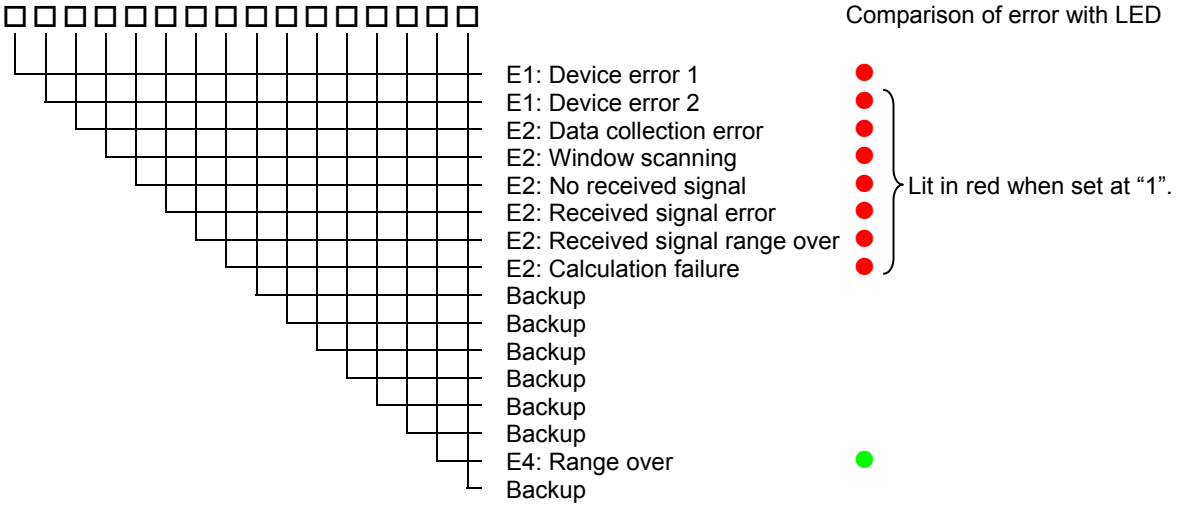
6.6.1.3. Checking the RAS information

When the red LED lights up, check the error contents according to the RAS information.

Key operation	Description	Display
△ ▼ ENT	Press the key for 4 times to display “MAINTENANCE MODE”. Press the key once to display “RAS INFORMATION”.	MAINTENANCE MODE RAS INFORMATION 0000000000000000

If the display is abnormal, 1 is set.
Move the cursor to 1 by the △ key, and press the ENT key to display the status contents. Pressing the ENT key again displays the troubleshooting.

Configuration of the RAS information



RAS information	Status	Troubleshooting
E1: Device error 1	Backup memory failure	See “6.6.7. Remedying a hardware fault”.
E1: Device error 2	Abnormality of measuring circuit	Turn the power off then on again. If the instrument does not recover properly, refer to “6.6.7. Remedying a hardware fault”.
E2: Data collection error	Ultrasonic send/receive signals cannot be collected.	
E2: Window scanning	The ultrasonic receiving signal waveform is being detected.	Move the mounting position of the detector, and remount the detector.
E2: No received signal	No ultrasonic receiving signal waveform	Repair or replace the signal cable. Transmitter circuit failure or detector failure ⇒ See “6.6.7. Remedying a hardware fault”.
E2: Received signal error	The status of received waveform is poor.	Check the air bubbles or foreign objects. Check the receive sensitivity. ⇒ Move the mounting position of the detector, and remount the detector.
E2: Received signal range over	Receiving signal waveform is outside the appropriate range.	Check the piping data. Check the detector mounting dimensions.
E2: Calculation failure	The value of detected measurement data is abnormal.	Check the piping data. Check the receive sensitivity. ⇒ Move the mounting position of the detector, and remount the detector.
E4: Range over	Analog output and total output exceed the range.	Check the range data and the totalize setting.

Correspondence between DO output and Alarm
“All” : Alarm is issued at occurrence of E1 or E2. [Burnout timer is enabled]
“Device error” : Alarm is issued at occurrence of E1 or E2. [Burnout timer is disabled]
“Process error” : Alarm is issued at occurrence of E2. [Burnout timer is enabled]
Burnout timer is to set a time between error occurrence and contact output.

6.6.2. Displaying the data in maintenance mode

Follow the procedure shown below to check possible display errors.

Key operation	Description	Display
△ ▼	Press the △ key for 4 times to display “MAINTENANCE MODE”.	MAINTENANCE MODE
ENT ▼	Press the ENT key once to display “RAS INFORMATION”.	RAS INFORMATION 0000000000000000
△ ▼	Press the △ key for 13 times to display “DATA DISPLAY”.	DATA DISPLAY
ENT ▼	Press the ENT key. ● Displays the transit time and the window value calculated from the piping setting.	T0 C: 89 usec WinC: 80 usec
△ ▼	Press the △ key once. ● Displays the measurement value of transit time, T1 (forward time), and T2 (reverse time) from the piping setting.	T1: 0.000 usec T2: 0.000 usec
△ ▼	Press the △ key once. ● Displays the measurement value of average transit time, T0, and transit time difference, DT.	T0: 0.000 usec DT: 0.00 nsec
△ ▼	Press the △ key once. ● Displays the calculated value of pass time of the substances other than fluid, Ta, and angle of incidence of the fluid, θ.	Ta: 0.0000 usec θf: 0.000°
△ ▼	Press the △ key once. ● Displays the calculation value of sound velocity in fluid, Cf, and Reynolds number, Re.	Cf: 0.0 m/s Re: 0
△ ▼	Press the △ key once. ● Displays correction coefficient of flow velocity distribution, K, and flow velocity, V.	K: 1.3333 V: 0.000 m/s
△ ▼	Press the △ key once. ● Displays the intensity of received signals. The larger the value, the larger the intensity of received signals. Normal measurement values fall in 35% or more. If the display appears as 0%, no signals are being received. Ultrasonic waves may not be transmitted because of insufficient water volume or rust of piping.	AGC U: 0.00 % AGC D: 0.00 %
△ ▼	Press the △ key once. ● Displays the peak value of received signal waveform. Normal values stably fall within the range from 5528 to 6758. If the value fluctuates significantly, objects that constitute barriers against ultrasonic wave transmission such as air bubbles or foreign matter may be contained in the fluid. Stop the flow and check if normal value is resumed. If so, there is a possibility that air bubbles are contained.	P/H U: 6143 P/H D: 6143
△ ▼	Press the △ key once. ● Displays the detection level value of received signal waveform.	TRG U: 25.00% TRG D: 25.00%
ESC △	Press the ESC key or the △ key to display the measurement mode.	

6.6.3. Keying is abnormal

Status	Probable cause
No response is made to key input.	● Hard failure ⇒ Refer to “6.6.7. Remedying a hardware fault”.
Certain key is not responded. Action is not as defined.	

6.6.4. Error in measured value

<table>
<tr><th>Status</th><th>Probable cause</th><th>Troubleshooting</th></tr>
<tr><td rowspan="2">The reading appears with “-” (minus).</td><td>● Connection between main unit and sensor units (upstream, downstream) are inverted.</td><td>→ Connect properly.</td></tr>
<tr><td>● Flow of fluid is reversed.</td><td></td></tr>
<tr><td rowspan="3">Measured value fluctuates though flow rate is constant.</td><td>● Straight pipe length is inadequate.</td><td>→ Move the sensor to the place where the length of 10D can be assured on upstream side and 5D on downstream side.</td></tr>
<tr><td>● Pump, valve or others which disturb the flow are located nearby.</td><td>→ Mount the instrument with a clearance of 30D or more.</td></tr>
<tr><td>● Pulsation exists in flow.</td><td>→ Set the damping to increase the response time.</td></tr>
<tr><td>Measured value remains the same though flow rate is changing. (LED lit in red)</td><td colspan="2">Measured value is held because ultrasonic wave cannot be propagated into a pipe.

1. Incomplete installation

● Error in piping specifications
● Sensor is mounted on welding.
● Error in sensor mounting dimensions
● Error in acoustic coupler at the time of mounting the sensor
● Error in connection of the sensor cable.
→ Upon checking, remove the sensor, apply acoustic coupler, and slightly off position the sensor.

Sensor mounting is poor
● Mounting dimension
● The sensor is coming off the pipe.
→ ● Mount the sensor in parallel with pipe, allowing correct sensor unit spacing.
● Mount the sensor properly so that it is kept in close contact with the pipe.

2. Problem on pipe or fluid

○ Pipe not filled with fluid
→ Locate a place which is completely filled on the same piping line, and shift the sensor there.
● Attach the sensor to the lowest place on the pipeline.

○ Bubbles present in the fluid

Bubbles are introduced if reading is normal when flow is stopped.
→ Eliminate ingress of bubbles.
● Raise the level of the pump well.
● Check the shaft seal of the pump.
● Retighten the flange of negative pressure pipe.
● Arrange so that fluid doesn’t fall into the pump well.

If mounted immediately downstream a valve, a cavitation causes the same phenomenon as when bubbles are introduced.
Move the sensor to the location where air bubbles have not entered.
● Inlet side of the pump
● Upstream side of the valve

(Continued on next page.)</td></tr>
</table>

Status	Probable cause	Troubleshooting
(Continued from the previous page.)	○ High turbidity Turbidity is higher than those of sewage and return sludge. →	
	○ Pipe is old and scale is attached on inside. →	
	○ Lining is thick. Because of mortar lining or the like, thickness is tens mm or more. →	● Move sensor to a place of smaller diameter on the same pipeline. ● Move the sensor to other places or to different piping.
	○ Lining is peeled. There is a gap between the lining and the pipe. →	
	○ Sensor is mounted on bend pipe or tapered pipe. →	Mount the sensor on straight pipe.
	3. Effect of external noise →	● Reduce the length of main unit sensor cable to a minimum. ● Ground the main unit and piping.
	● There is a radio broadcasting station nearby. ● Measurement conducted near a passage of vehicles or electric cars.	
	4. Hard failure →	Refer to “6.6.7. Remedying a hardware fault”.
Measured value not zero when fluid stops flowing.	● Fluid forms a convection inside the pipe. →	Normal
	● Zero point adjustment →	● Readjust the zero point after fluid has completely stopped flowing.
	● Pipe is not completely filled or is empty when water is at a standstill (LED lit red). →	Normal
Error in measured value	● Input piping specifications differ from the actual ones. →	A difference of 1% in inner diameter causes an error of about 3%. ● Input the correct specifications.
	● Scales exist on wall of old pipe. →	● Input scale as lining.
	● Insufficient linear pipe length (10D or more for upstream and 50D or more for downstream) →	Find another mounting place (upstream of disturbing objects).
		No disturbing objects in flow within 30D upstream without pump, valve, combined pipe, etc. → ● Mount the sensor at different angles with respect to the cross section of pipe to fine the location where mean value is obtainable. The mount the sensor at that location.
	● Pipe is not filled with fluid or sludge is deposited in the pipe. →	Occurs particularly where sectional area is small. ● Move sensor to a vertical pipe.

6.6.5. Error in analog output

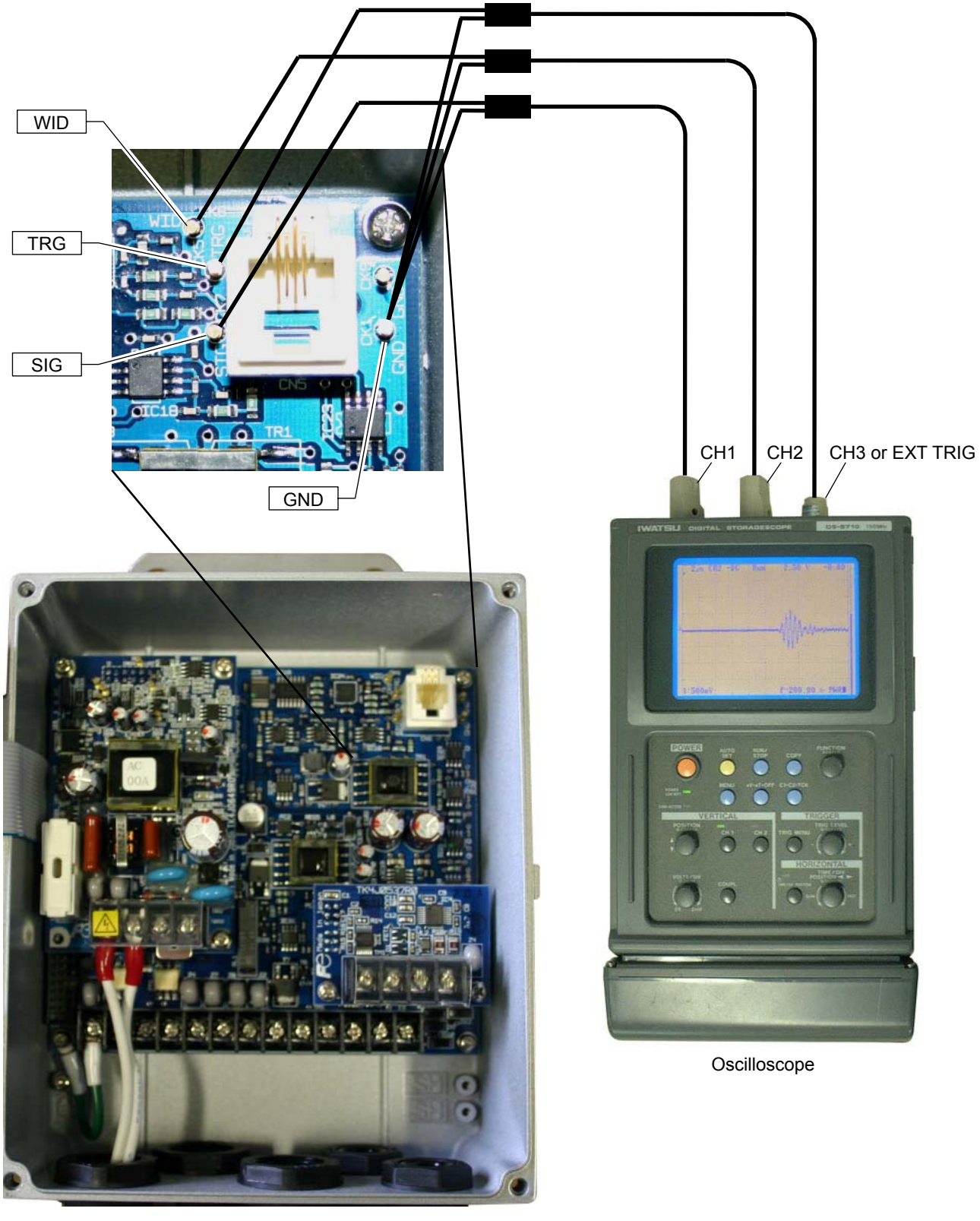
Status	Probable cause	Troubleshooting
Current output is not matched.	Range setting is wrong.	⟶ ● Set the range correctly.
Not 4mA when measurement value is 0.	Analog output is misadjusted.	⟶ ● Perform analog output calibration.
Output is 0mA.	Break of wiring	
Output rises beyond 20mA.	“OVER FLOW” appears on the LCD.	⟶ Range over ● Recommence setting of range data of analog output.
The output becomes lower than 4mA.	“UNDER FLOW” appears on the LCD.	⟶ Back flow ● Set upper/lower stream properly.
Indication is changed but analog output remains the same.	The output load is 1 kΩ or more.	⟶ ● It must be less than 1 kΩ.
Indication does not agree with analog output.	Analog output is misadjusted.	⟶ ● Perform analog output calibration.
Analog output doesn’t change even after it has been adjusted.	Hard failure	⟶ ● Contact manufacture or service.

6.6.6. Checking received waveforms

The unit has high-voltage part. Be sure to ask our service personnel for the steps described below.

6.6.6.1. How to connect the oscilloscope

Open the cover, and connect an oscilloscope to the check pin on the printed board according to the following figure.
The unit has high-voltage components. Do not touch the parts other than those specified below.

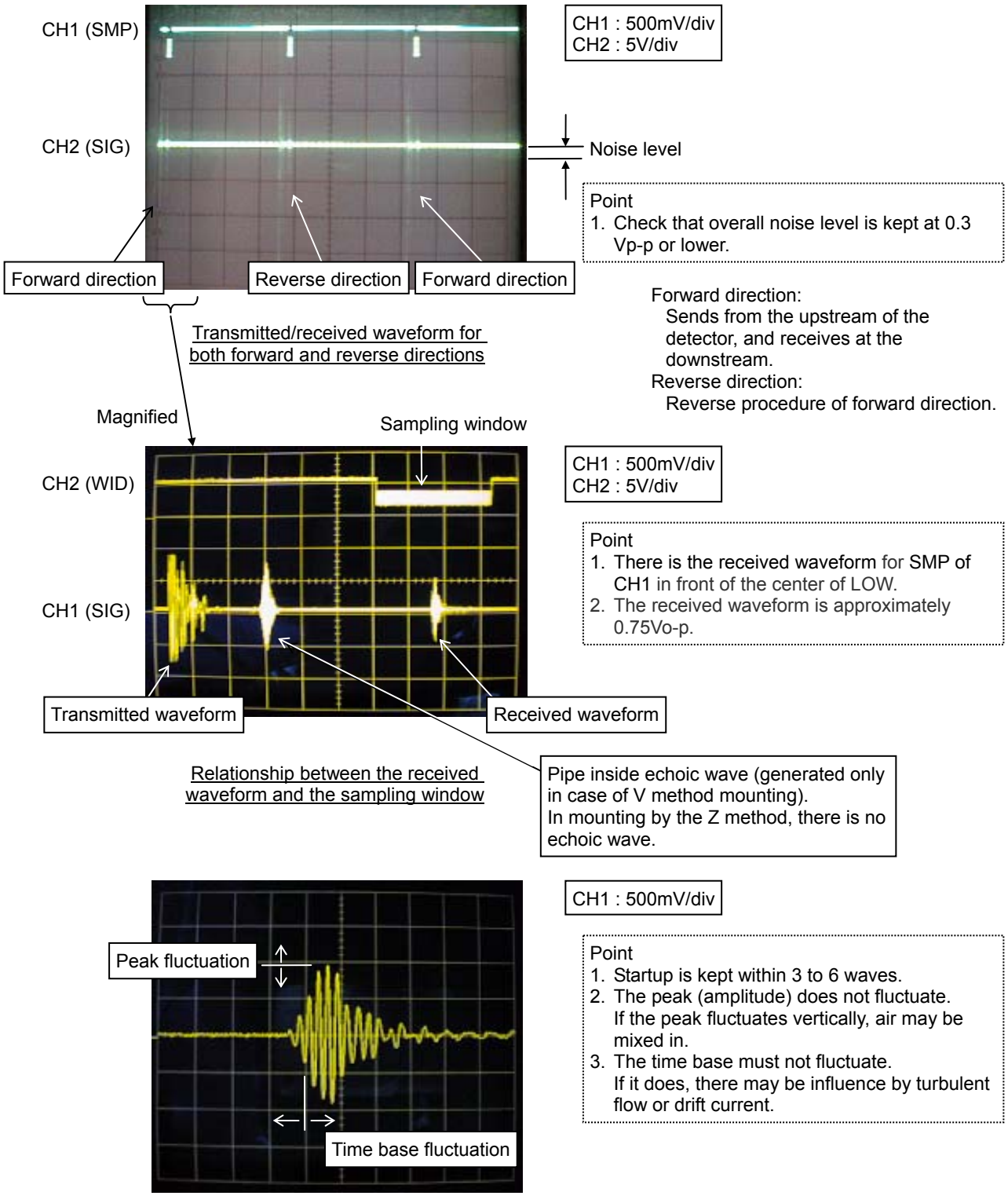


Oscilloscope

6.6.6.2. Checking sending/receiving

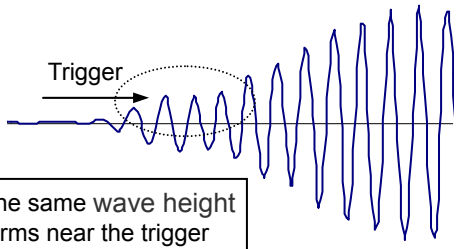
Monitor the waveform, and check the status of received waveform.

a) Normal status

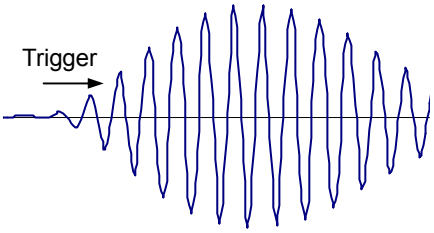


The received waveform controls the peak to be approximately 1.5Vp-p.

Startup of signals is not good



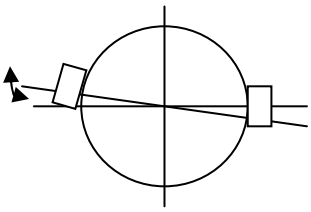
The same wave height forms near the trigger level.



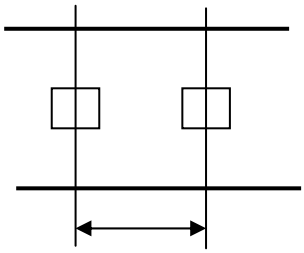
Startup of signals is not good
There is not large difference among triggering waveform.

Cause of the poor startup signals

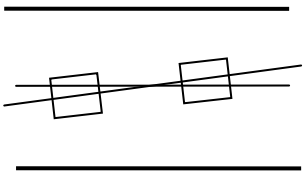
(1) Incorrect detector mounting, dimensions (sensor mounting dimension, outer diameter, etc) and detector mounting angle



Displacement from the center of the pipe.
(in case of Z method)



Displacement of the mounting dimension

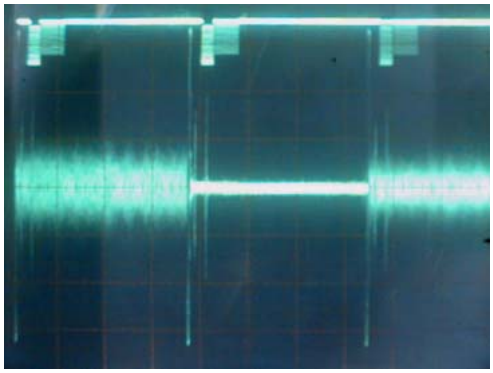


Displacement from the pipe axis.

⇒ Mount the detector properly.

(2) Interference from acoustic wave (It is likely to happen when the outer diameter is set longer than the actual length.)
⇒ Make a setting of the acoustic wave of the fluid type to be 20 to 50m/s lower, and remount the detector again.
Note) 1400m/s is set for water.

b) Noise on the one side

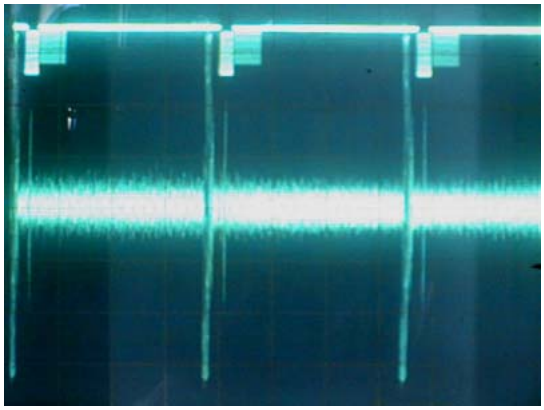


CH1 : 500mV/div
CH2 : 5V/div

Waveform with noise on the one side

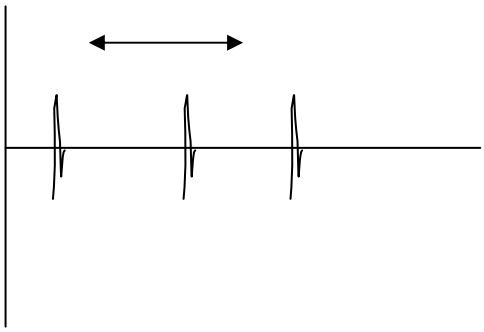
<Cause>	<Check>
Dedicated cable on the one side is abnormal.	Measure the insulation resistance.
Polarity of connected terminals is inverted.	Check the connection
Sensor on the one side is abnormal.	Peel off the detector and check the sensitivity
Detector bonding surface is peeling.	Peel off the detector and temporarily place it by grease, etc.
Dedicated cable is disconnecting.	Check the continuity.
Poor contact.	

c) There is white noise all around.



Waveform with the overall noise

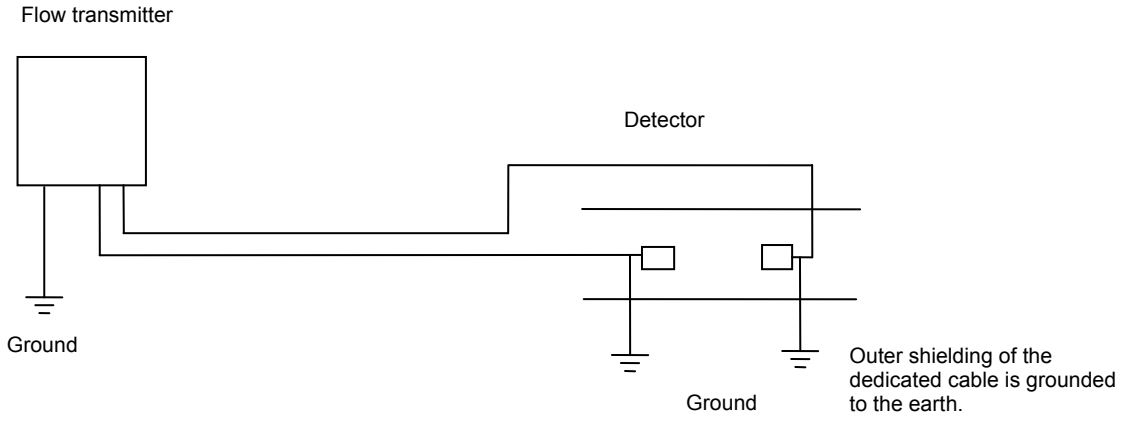
d) Pulsed noise is observed.



Waveform with pulsed noise on the signal line

Measurement can be performed if the noise level is smaller than the received waveform level ($0.75V_{0\text{-}p}$).

<Cause>	<Check>
Noise is placed on the power line.	Check the power line using an oscilloscope, and install a noise-suppression transformer.
Noise is placed on the grounding line (panel earth, etc).	Check the power line using an oscilloscope, and remove the ground wire.
Dedicated cable is picking the inductive noise.	Move the flow transmitter near the detector and perform confirmation. Keep the dedicated cable apart from the power cable.
The distance between the detector and the flow transmitter is long, and dedicated cable length is long.	Perform grounding according to the figure below.
Insufficient sensitivity Signal power (AGC_U, AGC_D) 35% or less	Change the detector. FLS_ _2, FSD_22, FSG_32→FSG_31 FSG_51→FSG_50



6.6.7. Remedying a hardware fault

If the hardware is found faulty as a result of Section 6.6.1 to Section 6.6.6 above, provide specific details to Fuji Electric.

7. Appendix

7.1. Specifications

Operational specifications

System configuration:
Single-path system of a flow transmitter (Model FSV) and a detector (Model FLS/FSG/FSD)

Applicable fluid: Homogenous liquid where the ultrasonic signal can be transmitted
Bubble quantity: 0 to 12vol% (for pipe size 50A, water, velocity 1m/s)
Fluid turbidity: 10000mg/L max.
Type of flow: Fully-developed turbulent or laminar flow in a full-filled pipe

Flow velocity range:
0 to ±0.3 ... ±32m/s

Power supply: 100 to 240V AC +10%/-15%, 50/60Hz; or 20 to 30V DC

Signal cable (between detector and converter):
Coaxial cable (5m standard, 300m (60m for popular detector (FLS)) max.)
Heat resistance: 80°C

Installation environment:
Non-explosive area without direct sunlight, corrosive gas and heat radiation.

Ambient temperature:
Flow transmitter: -20 to +55°C
Detector: -20 to +60°C
-20 to +80°C
(for FLSE□2□2-A only)

Ambient humidity:
95%RH max.

Grounding: Class D (100 Ω)

Arrester: Provided as standard at output and power supply

Applicable piping and fluid temperature:

Detector		Pipe size (inner diameter)	Applicable pipe material	Mounting method	Fluid temperature range (Note 3)
Popular type	FLSE12	ø25 to ø100 mm	Plastic (PVC, etc.) (Note 1)	V method	9th digit in code symbol Y... -20 to +100°C A... 0 to +120°C (Note 4) Heat shock resistance 150°C, 30min
		ø50 to ø100 mm	Metal pipe (SS, steel pipe, copper pipe, aluminum pipe, etc.) (Note 2)		
	FLSE22	ø50 to ø225 mm	Plastic (PVC, etc.) (Note 1) Metal pipe (SS, steel pipe, copper pipe, aluminum pipe, etc.) (Note 2)		
Common type	FSD22	ø13 to ø100 mm	Plastic (PVC, etc.) (Note 1) Metal pipe (SS, steel pipe, copper pipe, aluminum pipe, etc.) (Note 2)	V method	-40 to 100°C
	FSGS3	ø50 to ø300 mm		V or Z method	-40 to 80°C
	FSGS41	ø200 to ø1200 mm			
	FSGS5	ø200 to ø6000 mm			
	FSD32	ø50 to ø400 mm			-40 to 200°C

Note 1: If the pipe material is PP or PVDF, select FSGS31, FSGS41 or FSGS5. Note that the wall thickness is 15mm or less for PP, and 9mm or less for PVDF.

Note 2: For cast iron pipe, lining pipe, old steel pipe or others through which the ultrasonic signal could not be transmitted easily, select FSGS31,FSGS41 or FSGS50.
Lining material: Tar epoxy, mortar, rubber, etc.
* In case the lining is not glued to a pipe, the measurement may be impossible.
Straight pipe length: Typically 10D for upstream and 5D for dowstream.
(D: Pipe inner diameter)
Refer to conditions on straight pipe for details (Japan Electric Measuring Instruments Manufacturers' Association Standard JEMIS-032).

Note 3: If silicone-free grease is used as acoustic coupler, the fluid temperature range is 0 to 60°C regardless of the detector.

Note 4: When the 9th digit in the code symbol is "A", the applicable piping diameter is up to 150mm.

Performance specifications

Rated accuracy:

Detector		Pipe size (diameter)	Applicable pipe material	Flow velocity	Accuracy
Popular type	FLSE12	ø25 to ø50 mm	Plastic	2 to 32m/s	±2.0% of rate
				0 to 2m/s	±0.04m/s
		ø50 to ø100 mm		2 to 32m/s	±1.0% of rate
				0 to 2m/s	±0.02m/s
		ø50 to ø100 mm	Metal pipe	2 to 32m/s	±2.0% of rate
				0 to 2m/s	±0.04m/s
	FLSE22	ø50 to ø225 mm	Plastic	2 to 32m/s	±1.0% of rate
				0 to 2m/s	±0.02m/s
		ø50 to ø225 mm	Metal pipe	2 to 32m/s	±2.0% of rate
				0 to 2m/s	±0.04m/s
Common type	FSD22	ø13 to ø50 mm	Plastic, metal pipe	2 to 32m/s	±1.5% to ±2.5% of rate
				0 to 2m/s	±0.03 to ±0.05m/s
		ø50 to ø100 mm		2 to 32m/s	±1.5% of rate
				0 to 2m/s	±0.03m/s
	FSGS32 FSD32 FSGS51	ø50 to below ø300		2 to 32m/s	±1.0% of rate
				0 to 2m/s	±0.02m/s
		ø300 to ø6000 mm		0.75 to 32m/s	±1.0% of rate
				0 to 0.75m/s	±0.0075m/s
	FSGS31 FSGS41 FSGS50	ø50 to below ø300		2 to 32m/s	±1.5% of rate
				0 to 2m/s	±0.03m/s
		ø300 to ø6000 mm		0.75 to 32m/s	±1.5% of rate
				0 to 0.75m/s	±0.0113m/s

Response time: 0.5s (standard mode)
0.2s as selected (quick response mode)

Power consumption:
15VA max. (AC power supply)
6W max. (DC power supply)

Functional specifications

Analog signal: 4 to 20mA DC (1 point)
Load resistance: 1 kΩ max.

Digital output: Forward total, reverse total, alarm, acting range, flow switch, total switch assignable arbitrarily
(1) Mechanical relay contact (isolated, socket provided, arrester incorporated)
- Output: 1 point
- Normal: Open/Close selectable
- Contact capacity: 240V AC, 30V DC, 1A
- Output frequency: 1P/s max. (pulse width: 50, 100, 200ms)

(2) Transistor contact (isolated, open collector, arrester incorporated)
- Outputs: 2 points
- Normal: ON/OFF selectable
- Contact capacity: 30V DC, 0.1A
- Output frequency: 1000P/s max. (pulse width: 5, 10, 50, 100, 200ms)

Digital input: 1 point (no-voltage contact) (option)/
Set zero, Preset total assignable

Serial communication (option):
RS-232C equivalent or RS-485, isolated, arrester incorporated
Connectable quantity: 1 unit (RS-232C)/up to 31 units (RS-485: MODBUS)
Baud rate: 9600, 19200, 38400bps
Parity: None/Odd/Even selectable
Stop bits: 1 or 2 bits selectable

Cable length: 15m max. (RS-232C)/1km max. (RS-485)
Data: Flow velocity, flow rate, forward total, reverse total, status, etc.

Display device: 2-color LED (Normal: green, Extraordinary: red)
LCD with 2 lines of 16 characters and back light

Indication language:
Japanese (Katakana)/English/French/German/Spanish (changeable)

Flow velocity/flow rate indication:
Instantaneous flow velocity, instantaneous flow rate indication (minus indication for reverse flow)
Numerals: 8 digits (decimal point is counted as 1 digit)
Unit: Metric/Inch system selectable

	Metric system	Inch system
Velocity	m/s	ft/s
Flow rate	L/s, L/min, L/h, L/d, kL/d, ML/d, m^3/s, m^3/min, m^3/d, km^3/d, Mm^3/d, BBL/s, BBL/min, BBL/h, BBL/d, kBBL/d, MBBL/d	gal/s, gal/min, gal/h, gal/d, kgal/d, Mgal/d, ft^3/s, ft^3/min, ft^3/d, Kft^3/d, Mft^3/d, BBL/s, BBL/min, BBL/h, BBL/d, kBBL/d, MBBL/d

Note: The "gal" means USgal.

Total indication: Forward or reverse total value indication (negative indication for reverse direction)
Numerals: 8 digits (decimal point is counted as 1 digit)
Unit: Metric/Inch system selectable

	Metric system	Inch system
Total	mL, L, m^3, km^3, Mm^3, mBBL, BBL, KBBL	gal, kgal, ft^3, kft^3, Mft^3, mBBL, BBL, kBBL, ACRE-ft

Configuration: Fully configurable from the 4-key pad (ESC, △, ▷, ENT)

Zero adjustment: Set zero/Clear available

External zero adjustment:
Set zero available upon digital input setting

Damping: 0 to 100s (every 0.1s) for analog output and flow velocity/flow rate indication

Low flow rate cutoff:
0 to 5m/s in terms of flow velocity

Alarm: Digital output available for Hardware fault or Process fault

Burnout: Analog output: Hold/Overscale/Underscale/Zero selectable
Flow rate total: Hold/Count selectable
Burnout timer: 0 to 100s (every 1s)

Bi-directional range:
Forward and reverse ranges configurable independently.
Hysteresis: 0 to 10% of working range
Working range applicable to digital output

Auto-2 range: 2 forward ranges configurable independently
Hysteresis: 0 to 10% of working range
Working range applicable to digital output

Flow switch: Lower limit, upper limit configurable independently
Digital output available for status at actuated point

Total switch: Forward total switching point configurable
Digital output available when actuated

External total preset:
Preset total settable upon contact input setting

Physical specifications

Type of enclosure:
Flow transmitter: FSV···S: IP66
FSV···H: IP67 (With large LCD)
Detector:
FLS (popular type):
IP65 (When waterproot BNC connector is provided)
FSG (common type):
IP67 (Silicone compound is filled on the terminal part when wiring)
FSG (submersible type):
IP68 (submersible in water for 5 days)
FSD (small diameter and high temperature type): IP52

Mounting method:
Flow transmitter: Mounted on wall or by 2B pipe
Detector: Clamped on pipe surface

Acoustic coupler:
Silicone rubber, silicone grease or silicone-free grease
Note: The acoustic coupler is a medium that eliminates a gap between detector and pipe

Type of acoustic coupler:

Type	Silicone rubber (KE-348W)	Silicone grease (G40M)	Silicone-free grease (HIGH Z)	Grease for high temperature (KS62M)
Fluid temperature	-40 to +150℃	-30 to +150℃	0 to +60℃	-30 to +250℃
Teflon piping	×	○	○	○

In case of Teflon piping, use grease.
Procure silicone grease (G40M), if necessary, as an optional accessory.

Material: Flow transmitter: Aluminum alloy
Detector:

Detector	Sensor housing	Sensor cover	Guide rail
FLSE1	PBT	–	SUS304
FLSE2	PBT	–	SUS304
FSD22	PBT	–	Aluminum alloy + plastic
FSGS3	PBT	SUS304	SUS304 + plastic
FSGS41 FSGS5	PBT	SUS304	–
FSD32	SUS304	–	SUS304 + aluminum alloy

Signal cable: FLY3 (applicable detector: FLS)
- Structure: Heat-resisting high-frequency coaxial cable (3D2V)
- Sheath: Flame-resisting PVC
- Outer diameter: ø5mm
- Termination: M3 amp terminal (flow transmitter side) and BNC connector (sensor side)

FLY8, FLY9 (applicable detector: FSG, FSD)
- Structure: High frequency coaxial cable (double shield)
- Sheath: Black flame-resisting PVC
- Outer diameter: ø7.3mm
- Termination: M3 amp terminal (flow transmitter side) and M4 amp terminal (FLY8).Note, however, that the detecter side of FSD22 and FSD32 is provided with BNC connector (FLY9).
- Mass: Approx. 90g/m

Dimensions:
Flow transmitter FSV···S (IP66):
H170×W142×D70mm
Flow transmitter FSV···H (IP67):
H277×W244×D95mm
Detector: H50×W228×D34mm (FLSE1)
H50×W348×D34mm (FLSE2)
H90×W320×D53mm (FSD22)
H46×W410×D50mm (FSGS3)
H46×W54×D37mm (FSGS41)
H67×W78×D84mm (FSGS5)
H205×W530×D52mm (FSD32)

Mass:
Flow transmitter (indoor type): 1.5kg
Flow transmitter (outdoor type): 4.5kg
Detector: 0.3kg (FLSE1)
0.4kg (FLSE2)
0.6kg (FSD22)
0.6kg (FSGS3)
0.3kg (FSGS4)
1.2kg (FSGS5)
1.6kg (FSD32)

■PC Loader software

Provided as standard
- Compatible model is PC/AT compatible instrument.
- Operation is undefined for PC98 series (NEC).
- Main functions: Software for Main unit parameter setting/change on PC
- OS: Windows 2000/XP or Windows7 (Home Premium, Professional)
- Memory requirement: 125MB min.
- Disk unit: CD-ROM drive compatible with Windows 2000/XP or Windows7 (Home Premium, Professional)
- Hard disk capacity: Minimum vacant capacity of 52MB or more

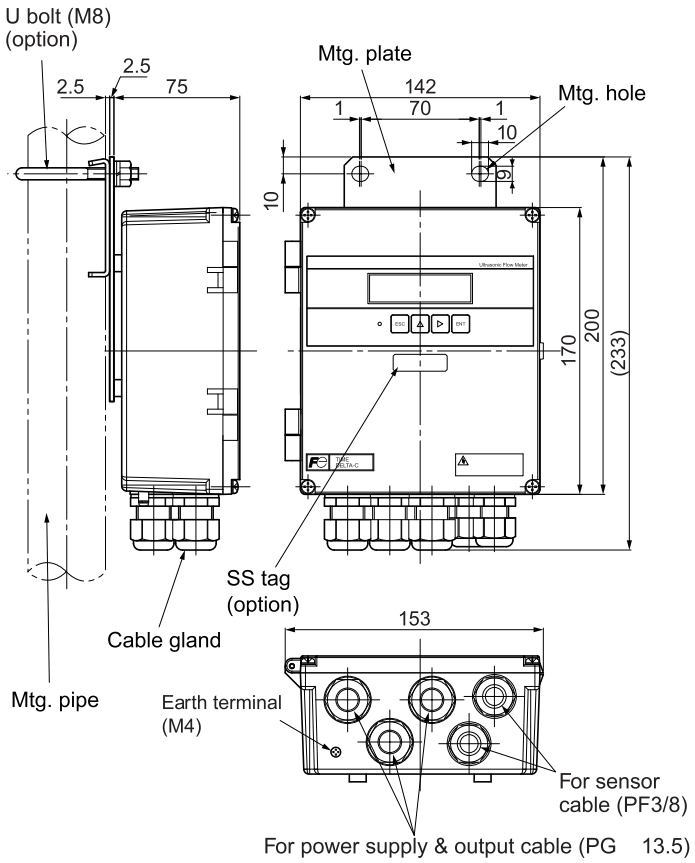
Note: Optional communication board (specified at the 5th digit of code symbols) and loader cable (Model ZZP∗TK4J1236) are additionally necessary for RS232C serial communication.

Note: USB-RS232C converter
For PC that does not support RS-232C serial interface, a converter is necessary for connecting the PC and main unit.
USB-RS232C converter should be combined with the above loader cable.
<Recommendation>
USB-CVRS9 (manufactured by Sanwa Supply)

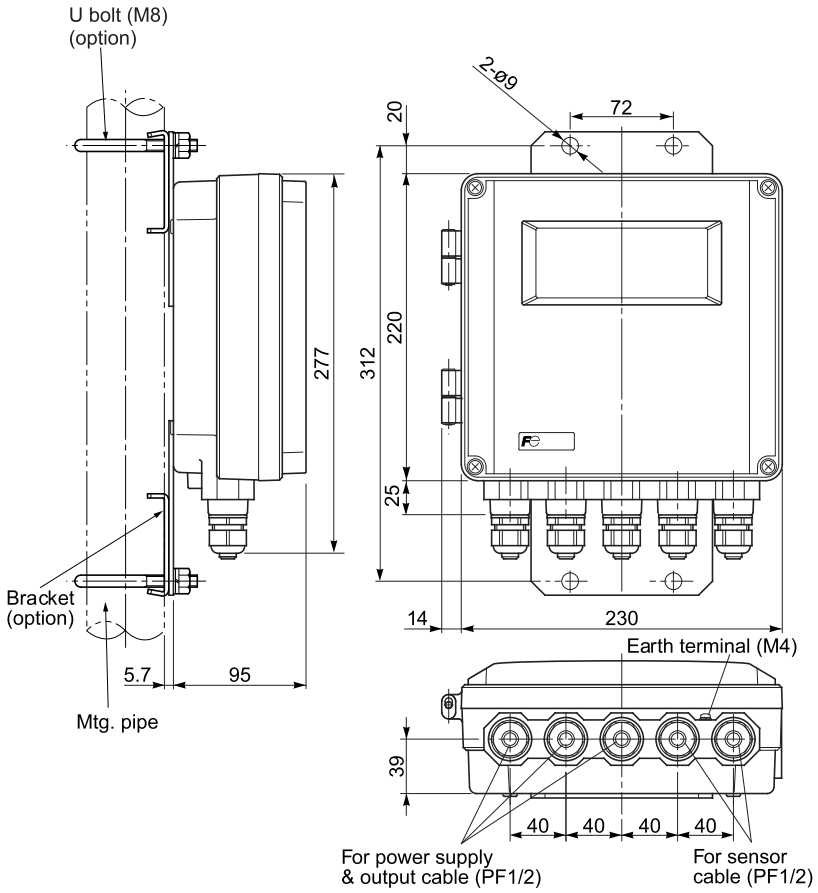
7.2. OUTLINE DIAGRAM

Flow transmitter (Type: FSV□□Y□1-S)

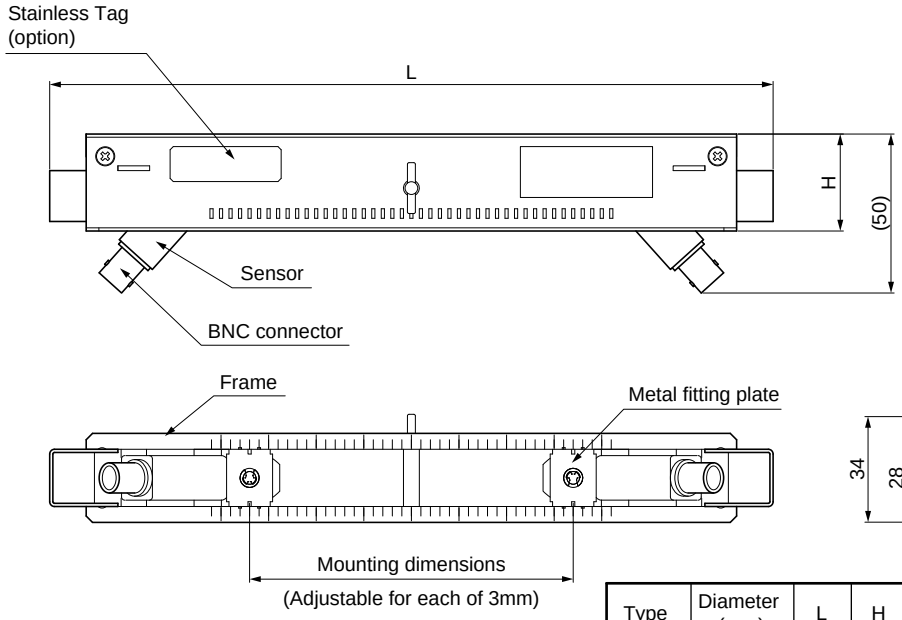
Unit : mm



Flow transmitter (Type: FSV□□Y□1-H)

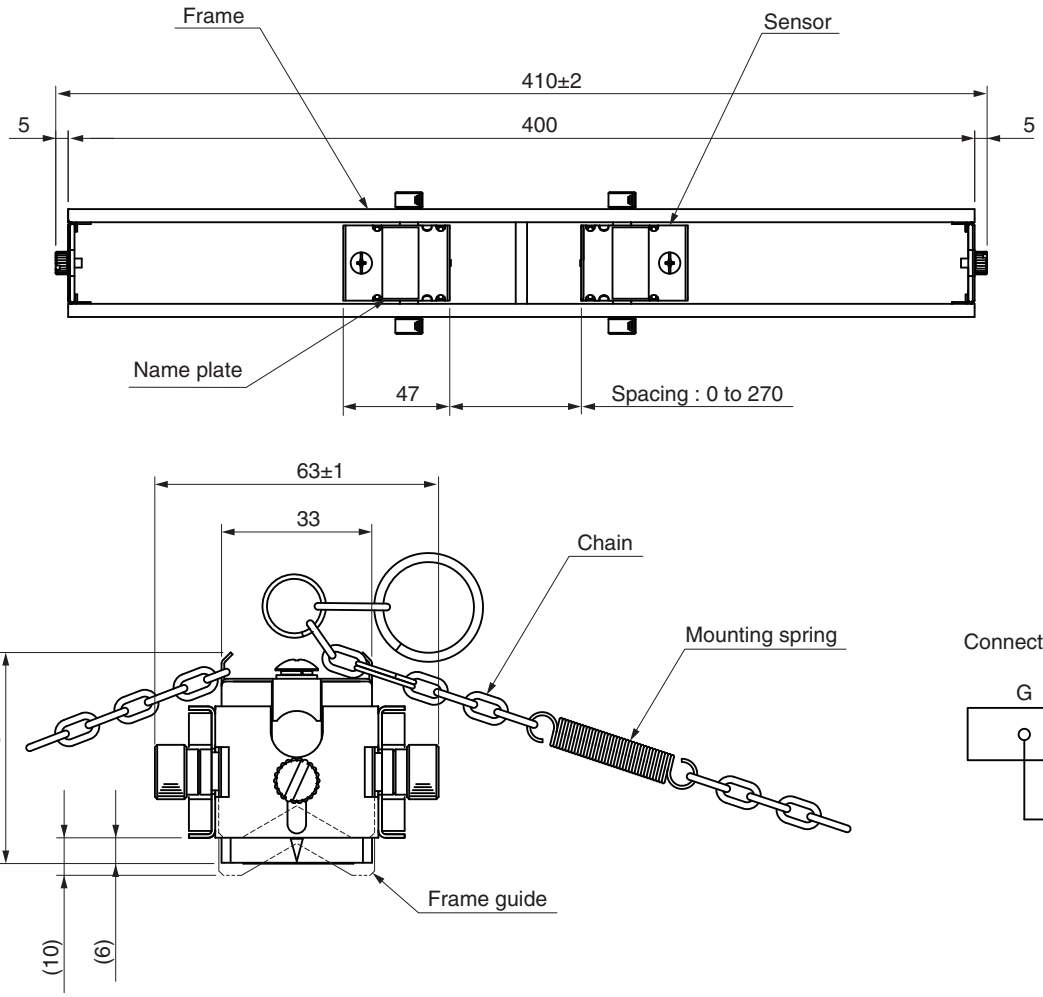


Detector (Type: FLSS□2)

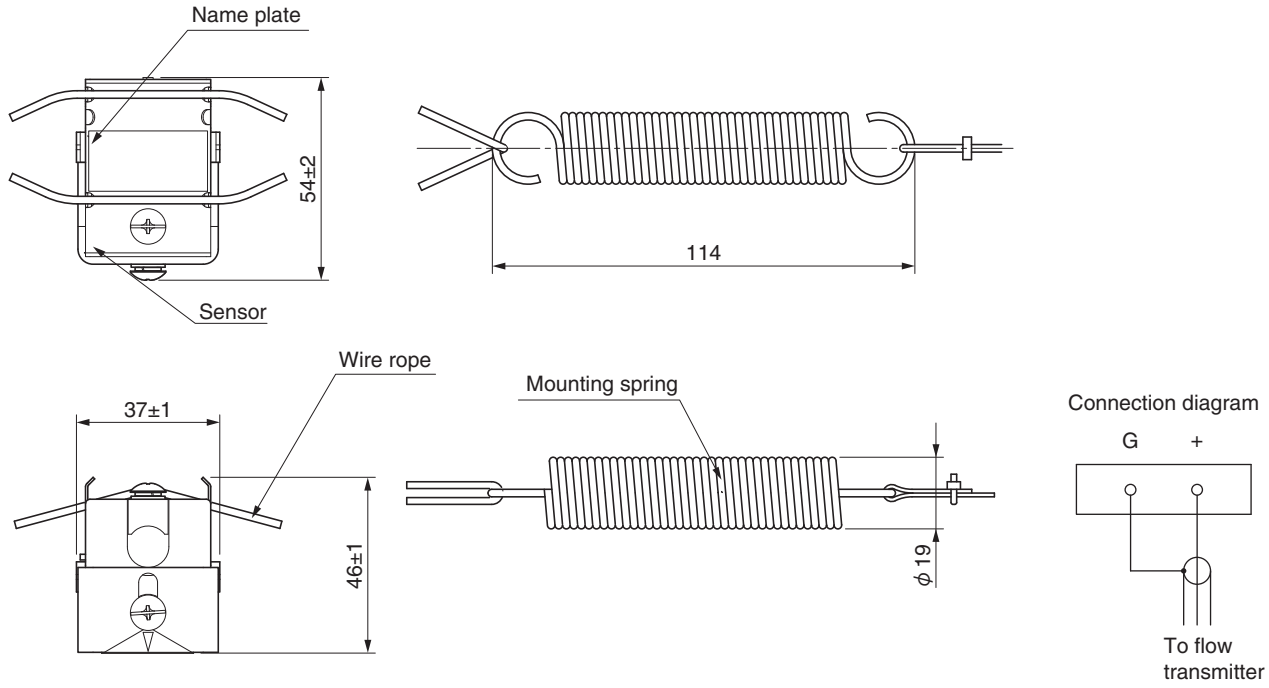


Type	Diameter (mm)	L	H	Mounting dimensions	Weight: Approx.(kg)
FLSS12	25 to 100	228	31	21 to 120	0.3
FLSS22	50 to 225	348	30	21 to 240	0.4

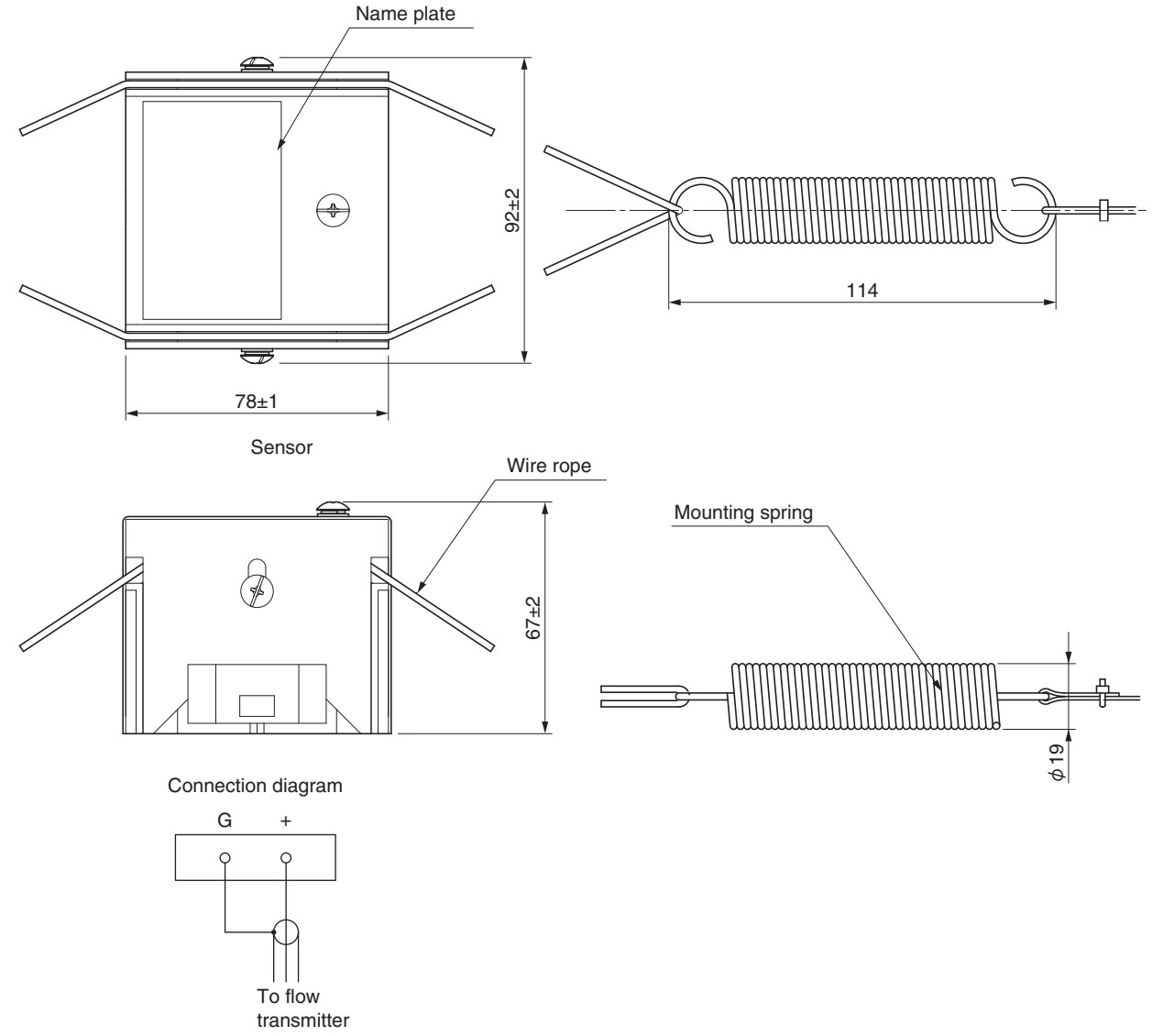
Detector (Type: FSGS3)



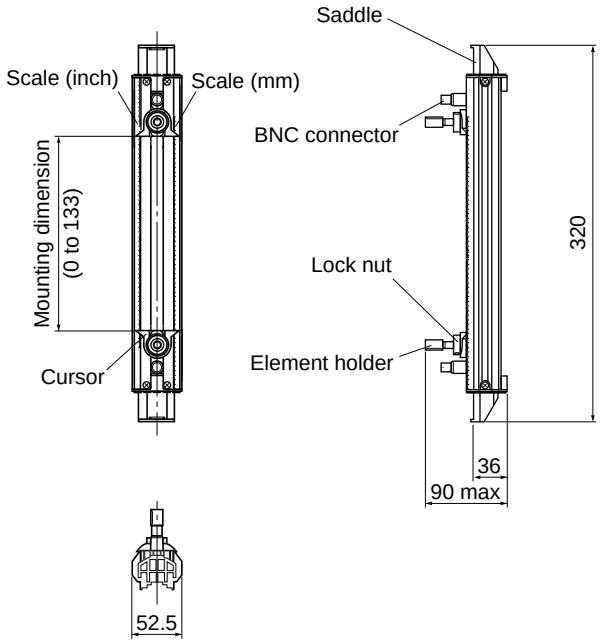
Detector (Type: FSGS4)



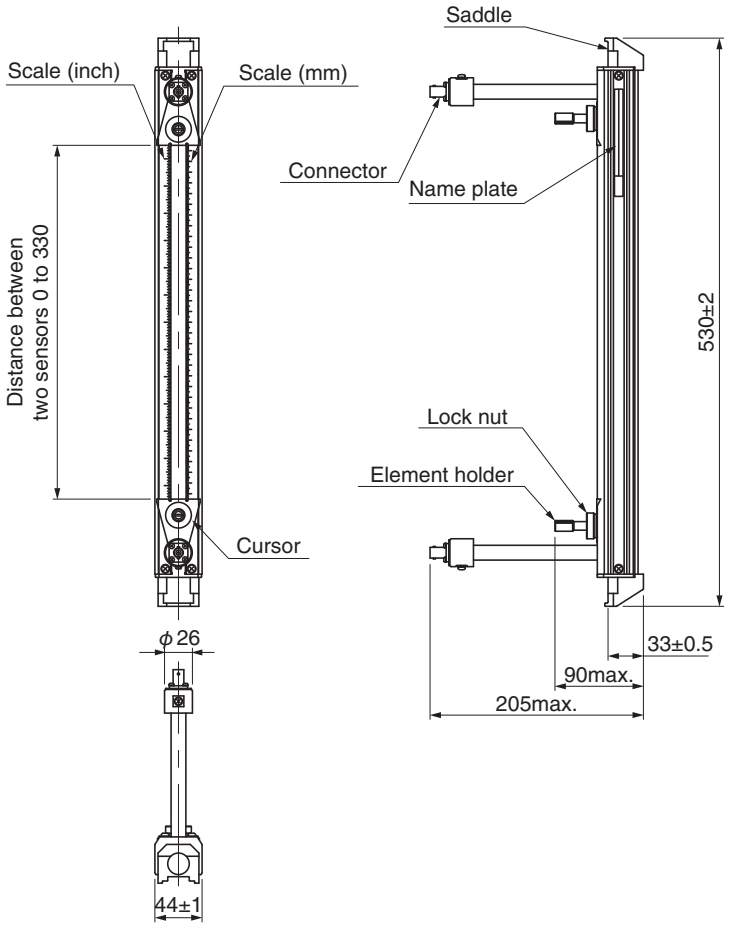
Detector (Type: FSGS5)



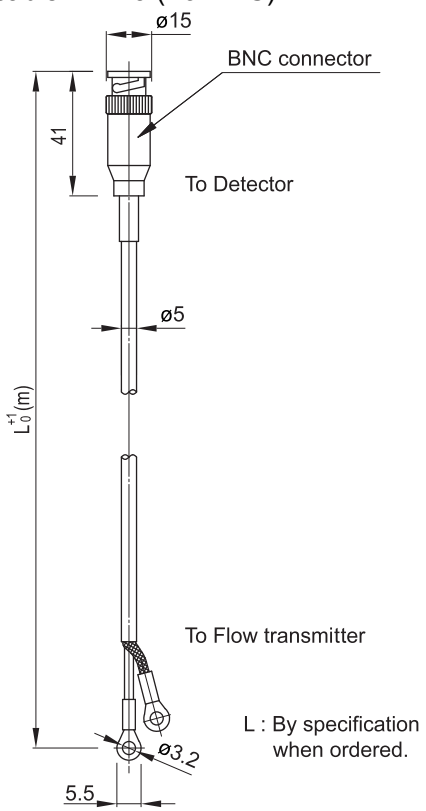
Detector (Type: FSD22)



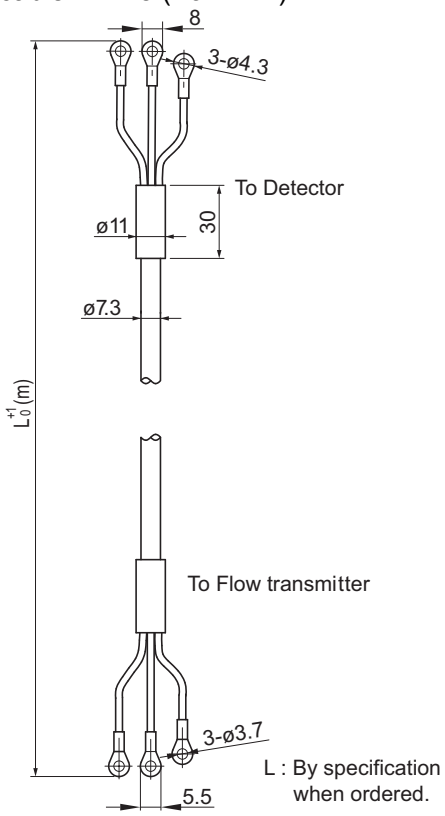
Detector (Type: FSD32)



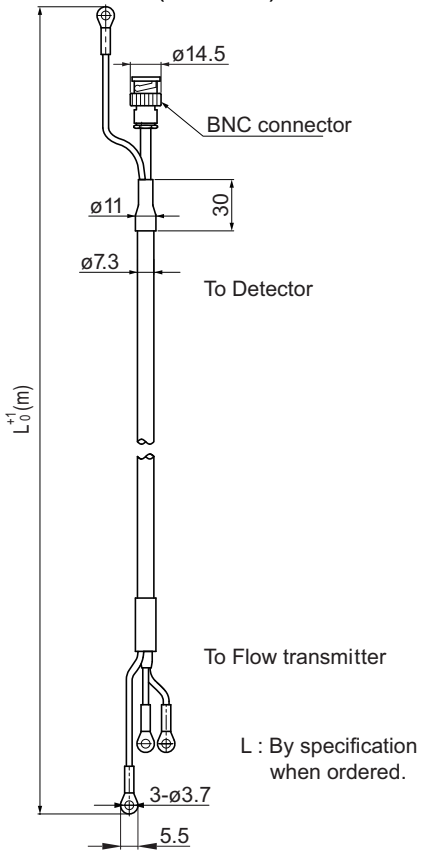
Single cable : FLY3 (For FLS)



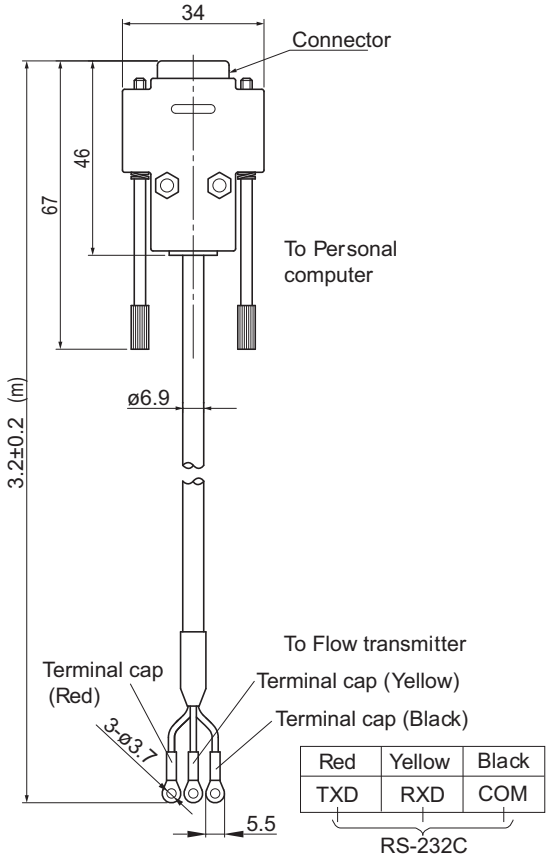
Single cable : FLY8 (For FLW)



Single cable : FLY9 (For FLD)



Loader cable : ZZP*TK4J1236



7.3. ORDERING INFORMATION

1. Type of detector
2. Type of flow transmitter
3. Type of signal cable
4. Tag No. (When tag plate is specified)
5. Parameter setting list (When parameter setting is specified)

Company name: _____ Branch: _____

Name of the contact person: _____ TEL: _____

Measuring fluid: _____

Parameter setting list

Setting items			Initial value	Setting value	Setting items			Initial value	Setting value
ID No			0000		Output condition	Total output	Total mode	Stop	
Language			English				Pulse value	0m^3	
Measurement condition	System unit		Metric				Total preset	0m^3	
	Flow unit		m^3/h				Pulse width	50.0msec	
	Total unit		m^3				Burnout (total)	Hold	
	Outer diameter		60.00mm				Burnout timer	10sec	
	Pipe material		PVC			DO1 Output type (Note1)		Not used	
	Wall thickness		4.00mm			DO1 Output operation		Active ON	
	Lining material		No lining			DO2 Output type		Not used	
	Lining thickness		-			DO2 Output operation		Active ON	
	Kind of fluid		Water			DO3 Output type		Not used	
	Viscosity		1.0038×10^{-6}m^2/s			DO3 Output operation		Active ON	
	Sensor mount		V method			DI1 Input type		Not used	
	Sensor type		FLS_12			DI1 Input operation		Active ON	
	Transmit. voltage		80Vpp			Operation mode		Standard	
Output condition	Damping		5.0sec		Communication	Communication mode		RS-232C	
	Cut off		0.150m^3/h			Baud rate		9600bps	
	Display	Content of 1st line	Velocity (m/s)			Parity		Odd	
		Decimal point position of 1st line	****.***			Stop bit		1 bit	
		Content of 2nd line	Flow Rate (m^3/h)			Station No.		1	
		Decimal point position of 2nd line	****.***						
	Analog output	Range type	SINGLE						
		Full scale 1	15.000m^3/h						
		Full scale 2	0.000m^3/h						
		Hysteresis	10.00%						
		Burnout (current)	HOLD						
		Burnout timer	10sec						
		Output limit low	-20%						
		Output limit high	120%						
		Rate limit	0.000m^3/h						
		Rate limit timer	0sec						

Note 1) When total pulse output has been selected for DO1, DO2 or DO3 specify total pulse value and total pulse width so that conditions 1 and 2 shown below are satisfies.

Condition 1:

$$\frac{\text{Full scale*1 [m}^3\text{/s]}}{\text{Pulse value [m}^3\text{]}} \leq \begin{matrix} 100\text{[Hz]} & \text{(In case of DO1, DO2)} \\ 1\text{[Hz]} & \text{(In case of DO3)} \end{matrix}$$

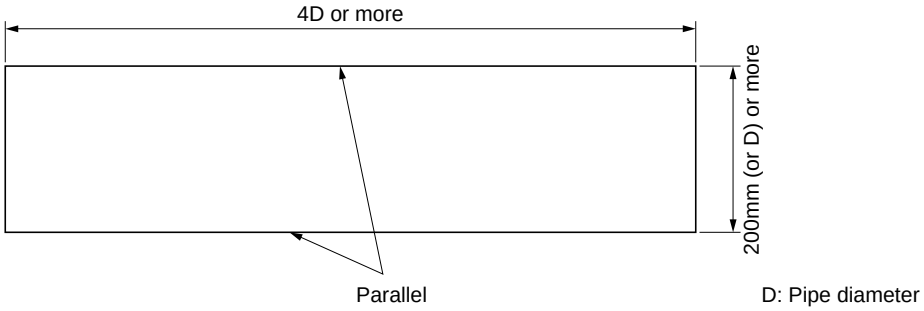
Condition 2:

$$\frac{\text{Full scale*1 [m}^3\text{/s]}}{\text{Pulse value [m}^3\text{]}} \leq \frac{100}{2 \times \text{Pulse width [ms]}}$$

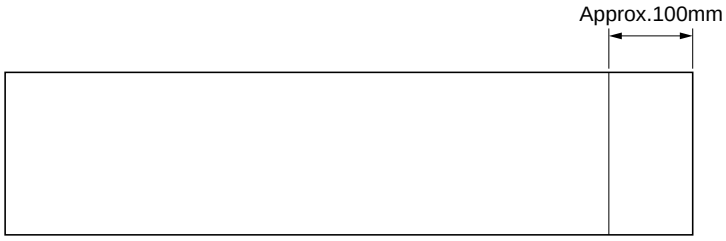
*1) The range of FULL SCALE 1 or FULL SCALE 2, whichever is larger, is the object in case of automatic 2-range, forward and reverse range, forward and reverse automatic 2-range.

7.4. How to make gauge paper

(1) Provide a sheet of paper (or vinyl) having the length of 4D and width of 200 mm (D if possible) or longer, with long sides parallel to each other.



(2) Draw a line that intersects with the long sides at right angles at a place about 100 mm from one end.



7.5. Piping data

Stainless steel pipe for pipe arrangement (JIS G3459-2004)

Nominal diameter		Outer diameter mm	Thickness						
			Schedule 5S	Schedule 10S	Schedule 20S	Schedule 40	Schedule 80	Schedule 120	Schedule 160
A	B		Thickness mm	Thickness mm	Thickness mm	Thickness mm	Thickness mm	Thickness mm	Thickness mm
15	1/2	21.7	1.65	2.1	2.5	2.8	3.7	-	4.7
20	3/4	27.2	1.65	2.1	2.5	2.9	3.9	-	5.5
25	1	34.0	1.65	2.8	3.0	3.4	4.5	-	6.4
32	1 1/4	42.7	1.65	2.8	3.0	3.6	4.9	-	6.4
40	1 1/2	48.6	1.65	2.8	3.0	3.7	5.1	-	7.1
50	2	60.5	1.65	2.8	3.5	3.9	5.5	-	8.7
65	2 1/2	76.3	2.1	3.0	3.5	5.2	7.0	-	9.5
80	3	89.1	2.1	3.0	4.0	5.5	7.6	-	11.1
90	3 1/2	101.6	2.1	3.0	4.0	5.7	8.1	-	12.7
100	4	114.3	2.1	3.0	4.0	6.0	8.6	11.1	13.5
125	5	139.8	2.8	3.4	5.0	6.6	9.5	12.7	15.9
150	6	165.2	2.8	3.4	5.0	7.1	11.0	14.3	18.2
200	8	216.3	2.8	4.0	6.5	8.2	12.7	18.2	23.0
250	10	267.4	3.4	4.0	6.5	9.3	15.1	21.4	28.6
300	12	318.5	4.0	4.5	6.5	10.3	17.4	25.4	33.3
350	14	355.6	-	-	-	11.1	19.0	27.8	35.7
400	16	406.4	-	-	-	12.7	21.4	30.9	40.5
450	18	457.2	-	-	-	14.3	23.8	34.9	45.2
500	20	508.0	-	-	-	15.1	26.2	38.1	50.0
550	22	558.8	-	-	-	15.9	28.6	41.3	54.0
600	24	609.6	-	-	-	17.5	34.0	46.0	59.5
650	26	660.4	-	-	-	18.9	34.0	49.1	64.2

Polyethylene pipe for city water (JIS K6762-2004)

Nominal diameter (mm)	Outer diameter (mm)	1st type (Soft pipe)		2nd type (Hard pipe)	
		Thickness (mm)	Weight (kg/m)	Thickness (mm)	Weight (kg/m)
13	21.5	3.5	0.184	2.5	0.143
20	27.0	4.0	0.269	3.0	0.217
25	34.0	5.0	0.423	3.5	0.322
30	42.0	5.5	0.595	4.0	0.458
40	48.0	6.5	0.788	4.5	0.590
50	60.0	8.0	1.210	5.0	0.829

Galvanized steel pipe for city water SGPW (JIS G3442-2004)

How to call pipe		Outer diameter (mm)	Thickness (mm)
(A)	(B)		
15	1/2	21.7	2.8
20	3/4	27.2	2.8
25	1	34.0	3.2
32	1 1/4	42.7	3.5
40	1 1/2	48.6	3.5
50	2	60.5	3.8
65	2 1/2	76.3	4.2
80	3	89.1	4.2
90	3 1/2	101.6	4.2
100	4	114.3	4.5
125	5	139.8	4.5
150	6	165.2	5.0
200	8	216.3	5.8
250	10	267.4	6.6
300	12	318.5	6.9

Asbestos cement pipe for city water (JIS A5301-1971)

Nominal diameter (mm)	1st type		2nd type		3rd type		4th type	
	Thickness of connected part (mm)	Outer diameter of connected part (mm)	Thickness of connected part (mm)	Outer diameter of connected part (mm)	Thickness of connected part (mm)	Outer diameter of connected part (mm)	Thickness of connected part (mm)	Outer diameter of connected part (mm)
50	10	70	-	-	-	-	-	-
75	10	95	-	-	-	-	-	-
100	12	124	10	120	9	118	-	-
125	14	153	11	147	9.5	144	-	-
150	16	182	12	174	10	170	-	-
200	21	242	15	230	13	226	11	222
250	23	296	19	288	15.5	281	12	274
300	26	352	22	344	18	336	14	328
350	30	410	25	400	20.5	391	16	382
400	35	470	29	458	23	446	18	436
450	39	528	32	514	26	502	20	490
500	43	586	35	570	28.5	557	22	544
600	52	704	42	684	34	668	26	652
700	-	-	49	798	39	778	30	760
800	-	-	56	912	44	888	34	868
900	-	-	-	-	49	998	38	976
1000	-	-	-	-	54	1108	42	1084
1100	-	-	-	-	59	1218	46	1192
1200	-	-	-	-	65	1330	50	1300
1300	-	-	-	-	73	1496	57	1464
1500	-	-	-	-	81	1662	63	1626

Polyethylene pipe for general use (JIS K6761-2004)

Nominal diameter	Outer diameter (mm)	1st type (Soft pipe)	2nd type (Hard pipe)
		Thickness (mm)	Thickness (mm)
13	21.5	2.7	2.4
20	27.0	3.0	2.4
25	34.0	3.0	2.6
30	42.0	3.5	2.8
40	48.0	3.5	3.0
50	60.0	4.0	3.5
65	76.0	5.0	4.0
75	89.0	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
250	267	-	9.0
300	318	-	10.0

Hi vinyl chloride pipe (city water pipe size)

Nominal diameter	Outer diameter	Pipe thickness
13	18.0	2.5
20	26.0	3.0
25	32.0	3.5
30	38.0	3.5
40	48.0	4.0
50	60.0	4.5
75	89.0	5.8
100	114.0	7.0
125	140.0	7.5
150	165.0	8.5

Hi vinyl chloride pipe (conduit size)

Nominal diameter of pipe	Outer diameter	Pipe thickness
28	34.0	3.0
35	42.0	3.5
41	48.0	3.5
52	60.0	4.0
65	76.0	4.5
78	89.0	5.5

Vertical type cast iron pipe (JIS G5521)

Nominal diameter D	Pipe thickness T		Actual outer diameter D1
	Normal pressure pipe	Low pressure pipe	
75	9.0	-	93.0
100	9.0	-	118.0
150	9.5	9.0	169.0
200	10.0	9.4	220.0
250	10.8	9.8	271.6
300	11.4	10.2	322.8
350	12.0	10.6	374.0
400	12.8	11.0	425.6
450	13.4	11.5	476.8
500	14.0	12.0	528.0
600	15.4	13.0	630.8
700	16.5	13.8	733.0
800	18.0	14.8	836.0
900	19.5	15.5	939.0
1000	22.0	-	1041.0
1100	23.5	-	1144.0
1200	25.0	-	1246.0
1350	27.5	-	1400.0
1500	30.0	-	1554.0

Hard vinyl chloride pipe (JIS K6741-2004)

Type / Nominal (mm)	VP		VU	
	Outer diameter	Thickness	Outer diameter	Thickness
13	18	2.2	-	-
16	22	2.7	-	-
20	26	2.7	-	-
25	32	3.1	-	-
30	38	3.1	-	-
40	48	3.6	48	1.8
50	60	4.1	60	1.8
65	76	4.1	76	2.2
75	89	5.5	89	2.7
100	114	6.6	114	3.1
125	140	7.0	140	4.1
150	165	8.9	165	5.1
200	216	10.3	216	6.5
250	267	12.7	267	7.8
300	318	15.1	318	9.2
350	-	-	370	10.5
400	-	-	420	11.8
450	-	-	470	13.2
500	-	-	520	14.6
600	-	-	630	17.8
700	-	-	732	21.0
800	-	-	-	-

Coated steel pipe for city water PTPW (JIS G3443-1968)

Nominal diameter (A)	Outer diameter (mm)	Thickness (mm)
80	89.1	4.2
100	114.3	4.5
125	139.8	4.5
150	165.2	5.0
200	216.3	5.8
250	267.4	6.6
300	318.5	6.9
350	355.6	6.0
400	406.4	6.0
450	457.2	6.0
500	508.0	6.0
600	609.6	6.0
700	711.2	6.0
800	812.8	7.1
900	914.4	7.9
1000	1016.0	8.7
1100	1117.6	10.3
1200	1219.2	11.1
1350	1371.6	11.9
1500	1524.0	12.7

Carbon steel pipe for pipe arrangement (JIS G3452-2004)

How to call pipe		Outer diameter (mm)	Thickness (mm)
(A)	(B)		
15	1/2	21.7	2.8
20	3/4	27.2	2.8
25	1	34.0	3.2
32	1 1/4	42.7	3.5
40	1 1/2	48.6	3.5
50	2	60.5	3.8
65	2 1/2	76.3	4.2
80	3	89.1	4.2
90	3 1/2	101.6	4.2
100	4	114.3	4.5
125	5	139.8	4.5
150	6	165.2	5.0
175	7	190.7	5.3
200	8	216.3	5.8
225	9	241.8	6.2
250	10	267.4	6.6
300	12	318.5	6.9
350	14	355.6	7.9
400	16	406.4	7.9
450	18	457.2	7.9
500	20	508.0	7.9

Coated steel pipe for city water STW (JIS G3443-2007)

Nominal diameter (A)	Outer diameter (mm)	Symbol for type				Symbol for type			
		STW 30	STW 38	STW 41		STW 290	STW 370	STW 400	
				Nominal thickness				Nominal thickness	
				A	B			A	B
		Thickness (mm)	Thickness (mm)	Thickness (mm)	Thickness (mm)	Thickness (mm)	Thickness (mm)	Thickness (mm)	Thickness (mm)
80	89.1	4.2	4.5	-	-	4.2	4.5	-	-
100	114.3	4.5	4.9	-	-	4.5	4.9	-	-
125	139.8	4.5	5.1	-	-	4.5	5.1	-	-
150	165.2	5.0	5.5	-	-	5.0	5.5	-	-
200	216.3	5.8	6.4	-	-	5.8	6.4	-	-
250	267.4	6.6	6.4	-	-	6.6	6.4	-	-
300	318.5	6.9	6.4	-	-	6.9	6.4	-	-
350	355.6	-	-	6.0	-	-	-	6.0	-
400	406.4	-	-	6.0	-	-	-	6.0	-
450	457.2	-	-	6.0	-	-	-	6.0	-
500	508.0	-	-	6.0	-	-	-	6.0	-
600	609.6	-	-	6.0	-	-	-	6.0	-
700	711.2	-	-	7.0	6.0	-	-	7.0	6.0
800	812.8	-	-	8.0	7.0	-	-	8.0	7.0
900	914.4	-	-	8.0	7.0	-	-	8.0	7.0
1000	1016.0	-	-	9.0	8.0	-	-	9.0	8.0
1100	1117.6	-	-	10.0	8.0	-	-	10.0	8.0
1200	1219.2	-	-	11.0	9.0	-	-	11.0	9.0
1350	1371.6	-	-	12.0	10.0	-	-	12.0	10.0
1500	1524.0	-	-	14.0	11.0	-	-	14.0	11.0
1600	1625.6	-	-	15.0	12.0	-	-	15.0	12.0
1650	1676.4	-	-	15.0	12.0	-	-	15.0	12.0
1800	1828.8	-	-	16.0	13.0	-	-	16.0	13.0
1900	1930.4	-	-	17.0	14.0	-	-	17.0	14.0
2000	2032.0	-	-	18.0	15.0	-	-	18.0	15.0
2100	2133.6	-	-	19.0	16.0	-	-	19.0	16.0
2200	2235.2	-	-	20.0	16.0	-	-	20.0	16.0
2300	2336.8	-	-	21.0	17.0	-	-	21.0	17.0
2400	2438.4	-	-	22.0	18.0	-	-	22.0	18.0
2500	2540.0	-	-	23.0	18.0	-	-	23.0	18.0
2600	2641.6	-	-	24.0	19.0	-	-	24.0	19.0
2700	2743.2	-	-	25.0	20.0	-	-	25.0	20.0
2800	2844.8	-	-	26.0	21.0	-	-	26.0	21.0
2900	2946.4	-	-	27.0	21.0	-	-	27.0	21.0
3000	3048.0	-	-	29.0	22.0	-	-	29.0	22.0

Centrifugal nodular graphite cast iron pipe for city water (A type) (JWWA G-105 1971)

Nominal diameter	Pipe thickness			Actual outer diameter
D	T			D_1
	1st type pipe	2nd type pipe	3rd type pipe	
75	7.5	-	6.0	93.0
100	7.5	-	6.0	118.0
150	7.5	-	6.0	169.0
200	7.5	-	6.0	220.0
250	7.5	-	6.0	271.6
300	7.5	-	6.5	332.8
350	7.5	-	6.5	374.0
400	8.5	7.5	7.0	425.6
450	9.0	8.0	7.5	476.8
500	9.5	8.5	7.0	528.0

Centrifugal nodular graphite cast iron pipe for city water (K type) (JWWA G-105 1971)

Nominal diameter	Pipe thickness			Actual outer diameter
D	1st type pipe	2nd type pipe	3rd type pipe	D_1
400	8.5	7.5	7.0	425.6
450	9.0	8.0	7.5	476.8
500	9.5	8.5	8.0	528.0
600	11.0	10.0	9.0	630.8
700	12.0	11.0	10.0	733.0
800	13.5	12.0	11.0	836.0
900	15.0	13.0	12.0	939.0
1000	16.5	14.5	13.0	1041.0
1100	18.0	15.5	14.0	1144.0
1200	19.5	17.0	15.0	1246.0
1350	21.5	18.5	16.5	1400.0
1500	23.5	20.5	18.0	1554.0

Arc welded large-diameter stainless steel pipe for pipe arrangement (JIS G3468-2004)

Nominal diameter		Outer diameter (mm)	Nominal thickness			
			Schedule 5S	Schedule 10S	Schedule 20S	Schedule 40S
A	B		Thickness mm	Thickness mm	Thickness mm	Thickness mm
150	6	165.2	2.8	3.4	5.0	7.1
200	8	216.3	2.8	4.0	6.5	8.2
250	10	267.4	3.4	4.0	6.5	9.3
300	12	318.5	4.0	4.5	6.5	10.3
350	14	355.6	4.0	5.0	8.0	11.1
400	16	406.4	4.5	5.0	8.0	12.7
450	18	457.2	4.5	5.0	8.0	14.3
500	20	508.0	5.0	5.5	9.5	15.1
550	22	558.8	5.0	5.5	9.5	15.9
600	24	609.6	5.5	6.5	9.5	17.5
650	26	660.4	5.5	8.0	12.7	-
700	28	711.2	5.5	8.0	12.7	-
750	30	762.0	6.5	8.0	12.7	-
800	32	812.8	-	8.0	12.7	-
850	34	863.6	-	8.0	12.7	-
900	36	914.1	-	8.0	12.7	-
1000	40	1016.0	-	9.5	14.3	-

Ductile iron specials (JIS G5527-1998)

Nominal diameter (mm)	Pipe thickness (mm)
75	8.5
100	8.5
150	9.0
200	11.0
250	12.0
300	12.5
350	13.0
400	14.0
450	14.5
500	15.0
600	16.0
700	17.0
800	18.0
900	19.0
1000	20.0
1100	21.0
1200	22.0
1350	24.0
1500	26.0
1600	27.5
1650	28.0
1800	30.0
2000	32.0
2100	33.0
2200	34.0
2400	36.0

Dimensions of centrifugal sand mold cast iron pipe (JIS G5522)

Nominal diameter D	Pipe thickness (T)			Actual outer diameter D_1
	High pressure pipe	Normal pressure pipe	Low pressure pipe	
75	9.0	7.5	-	93.0
100	9.0	7.5	-	118.0
125	9.0	7.8	-	143.0
150	9.5	8.0	7.5	169.0
200	10.0	8.8	8.0	220.0
250	10.8	9.5	8.4	271.6
300	11.4	10.0	9.0	322.8
350	12.0	10.8	9.4	374.0
400	12.8	11.5	10.0	425.6
450	13.4	12.0	10.4	476.8
500	14.0	12.8	11.0	528.0
600	-	14.2	11.8	630.8
700	-	15.5	12.8	733.0
800	-	16.8	13.8	836.0
900	-	18.2	14.8	939.0

Dimensions of centrifugal sand mold cast iron pipe (JIS G5523 1977)

Nominal diameter (mm)	Pipe thickness (T)		Actual outer diameter D_1
	High pressure pipe	Normal pressure pipe	
75	9.0	7.5	93.0
100	9.0	7.5	118.0
125	9.0	7.8	143.0
150	9.5	8.0	169.0
200	10.0	8.8	220.0
250	10.8	9.5	271.6
300	11.4	10.0	322.8

Cast iron pipe for waste water (JIS G5525-1975)

Nominal diameter	Pipe thickness	Actual internal diameter	Actual outer diameter
	T	D_1	D_2
50	6.0	50	62
65	6.0	65	77
75	6.0	75	87
100	6.0	100	112
125	6.0	125	137
150	6.0	150	162
200	7.0	200	214

Hard vinyl chloride pipe for city water (JIS K6742-1975)

Nominal diameter	Outer diameter	Thickness
13	18	2.5
16	22	
20	26	3.0
25	32	3.5
30	38	3.5
40	48	4.0
50	60	4.5
75	89	5.9
100	114	7.1
150	165	9.6

Arc welded carbon steel pipe STPY (JIS G3457-2005)

Unit: kg/m

Nominal diameter		Thickness (mm) / Outer diameter (mm)	6.0	6.4	7.1	7.9	8.7	9.5	10.3	11.1	11.9	12.7	13.1	15.1	15.9
(A)	(B)														
350	14	355.6	51.7	55.1	61.0	67.7									
400	16	406.4	59.2	63.1	69.9	77.6									
450	18	457.2	66.8	71.1	78.8	87.5									
500	20	508.0	74.3	79.2	87.7	97.4	107	117							
550	22	558.8	81.8	87.2	96.6	107	118	129	139	150	160	171			
600	24	609.6	89.3	95.2	105	117	129	141	152	164	175	187			
650	26	660.4	96.8	103	114	127	140	152	165	178	190	203			
700	28	711.2	104	111	123	137	151	164	178	192	205	219			
750	30	762.0		119	132	147	162	176	191	206	220	235			
800	32	812.8		127	141	157	173	188	204	219	235	251	258	297	312
850	34	863.6				167	183	200	217	233	250	266	275	315	332
900	36	914.4				177	194	212	230	247	265	282	291	335	352
1000	40	1016.0				196	216	236	255	275	295	314	324	373	392
1100	44	1117.6						260	281	303	324	346	357	411	432
1200	48	1219.2						283	307	331	354	378	390	448	472
1350	54	1371.6									399	426	439	505	532
1500	60	1524.0									444	473	488	562	591
1600	64	1625.6											521	600	631
1800	72	1828.8											587	675	711
2000	80	2032.0												751	791

Stainless steel sanitary pipe (JIS G3447-2004)

Nominal	Outer diameter (mm)	Thickness (mm)	Internal diameter (mm)
1.0S	25.4	1.2	23.0
1.25S	31.8	1.2	29.4
1.5S	38.1	1.2	35.7
2.0S	50.8	1.5	47.8
2.5S	63.5	2.0	59.5
3.0S	76.3	2.0	72.3
3.5S	89.1	2.0	85.1
4.0S	101.6	2.0	97.6
4.5S	114.3	3.0	108.3
5.5S	139.8	3.0	133.8
6.5S	165.2	3.0	159.2

PVDF-HP

	SDR33 S16　PN10	SDR21 S10　PN16	SDR17 S8　PN20
Outer diameter (mm)	Thickness (mm)	Thickness (mm)	Thickness (mm)
16		1.5	1.5
20		1.9	1.9
25		1.9	1.9
32		2.4	2.4
40		2.4	2.4
50		3.0	3.0
63	2.5	3.0	
75	2.5	3.6	
90	2.8	4.3	
110	3.4	5.3	
125	3.9	6.0	
140	4.3	6.7	
160	4.9	7.7	
180	5.5	8.6	
200	6.2	9.6	
225	6.9	10.8	
250	7.7	11.9	
280	8.6	13.4	
315	9.7	15.0	
355	10.8		
400	12.2		
450	13.7		

Heat-resistant hard vinyl chloride pipe PVC-C
(JIS G6776-2004)

Nominal diameter	Outer diameter (mm)	Thickness (mm)	Weight (kg/m)
13	18.0	2.5	0.180
16	22.0	3.0	0.265
20	26.0	3.0	0.321
25	32.0	3.5	0.464
30	38.0	3.5	0.561
40	48.0	4.0	0.818
50	60.0	4.5	1.161

Polyethylene pipe for city water service
(Japan Polyethylene Pipes Association for Water Service standard PTC K 03:2006)

Nominal diameter	Outer diameter (mm)	Thickness (mm)	Inner diameter (mm)	Weight (kg/m)
50	63.0	5.8	50.7	1.074
75	90.0	8.2	72.6	2.174
100	125.0	11.4	100.8	4.196
150	180.0	16.4	145.3	8.671
200	250.0	22.7	201.9	16.688

(a) Velocity of sound subject to change f temperature of water (0 to 100°C)

T °C	V m/s	T °C	V m/s	T °C	V m/s	T °C	V m/s
0	1402.74						
1	1407.71	26	1499.64	51	1543.93	76	1555.40
2	1412.57	27	1502.20	52	1544.95	77	1555.31
3	1417.32	28	1504.68	53	1545.92	78	1555.18
4	1421.98	29	1507.10	54	1546.83	79	1555.02
5	1426.50	30	1509.44	55	1547.70	80	1554.81
6	1430.92	31	1511.71	56	1548.51	81	1554.57
7	1435.24	32	1513.91	57	1549.28	82	1554.30
8	1439.46	33	1516.05	58	1550.00	83	1553.98
9	1443.58	34	1518.12	59	1550.68	84	1553.63
10	1447.59	35	1520.12	60	1551.30	85	1553.25
11	1451.51	36	1522.06	61	1551.88	86	1552.82
12	1455.34	37	1523.93	62	1552.42	87	1552.37
13	1459.07	38	1525.74	63	1552.91	88	1551.88
14	1462.70	39	1527.49	64	1553.35	89	1551.35
15	1466.25	40	1529.18	65	1553.76	90	1550.79
16	1469.70	41	1530.80	66	1554.11	91	1550.20
17	1473.07	42	1532.37	67	1554.43	92	1549.58
18	1476.35	43	1533.88	68	1554.70	93	1548.92
19	1479.55	44	1535.33	69	1554.93	94	1548.23
20	1482.66	45	1536.72	70	1555.12	95	1547.50
21	1485.69	46	1538.06	71	1555.27	96	1546.75
22	1488.63	47	1539.34	72	1555.37	97	1545.96
23	1491.50	48	1540.57	73	1555.44	98	1545.14
24	1494.29	49	1541.74	74	1555.47	99	1544.29
25	1497.00	50	1542.87	75	1555.45	100	1543.41

Note) T: Temperature, V: Velocity

(b) Sound velocity and density of various liquids

Name of liquid	T °C	ρ g/cm^3	V m/s
Acetone	20	0.7905	1190
Aniline	20	1.0216	1659
Alcohol	20	0.7893	1168
Ether	20	0.7135	1006
Ethylene glycol	20	1.1131	1666
n-octane	20	0.7021	1192
o-xylol	20	0.871	1360
Chloroform	20	1.4870	1001
Chlorobenzene	20	1.1042	1289
Glycerin	20	1.2613	1923
Acetic acid	20	1.0495	1159
Methyl acetate	20	0.928	1181
Ethyl acetate	20	0.900	1164
Cyclohexane	20	0.779	1284
Dioxane	20	1.033	1389
Heavy water	20	1.1053	1388
Carbon tetrachloride	20	1.5942	938
Mercury	20	13.5955	1451
Nitrobenzene	20	1.207	1473
Carbon bisulfide	20	1.2634	1158
Chloroform	20	2.8904	931
n-propyl alcohol	20	0.8045	1225
n-pentane	20	0.6260	1032
n-hexane	20	0.654	1083
Light oil	25	0.81	1324
Transformer oil	32.5	0.859	1425
Spindle oil	32	0.905	1342
Petroleum	34	0.825	1295
Gasoline	34	0.803	1250
Water	13.5	1.	1460
Sea water (salinity: 3.5%)	16	1.	1510

Note) T: Temperature, ρ: Density, V: Velocity

(c) Sound velocity of pipe material

Material	V m/s
Iron	3230
Steel	3206
Ductile cast iron	3000
Cast iron	2460
Stainless steel	3206
Copper	2260
Lead	2170
Aluminium	3080
Brass	2050
Hi vinyl chloride	2640
Acrylic	2644
FRP	2505
Mortar	2500
Tar epoxy	2505
Polyethylene	1900
Teflon	1240

Note) V: Velocity

(d) Kinematic viscosity coefficient of various liquids

Name of liquid	T °C	ρ g/cm^3	V m/s	v (×10^{-6}m^2/s)
Acetone	20	0.7905	1190	0.407
Aniline	20	1.0216	1659	1.762
Ether	20	0.7135	1006	0.336
Ethylene glycol	20	1.1131	1666	21.112
Chloroform	20	1.4870	1001	0.383
Glycerin	20	1.2613	1923	11.885
Acetic acid	20	1.0495	1159	1.162
Methyl acetate	20	0.928	1181	0.411
Ethyl acetate	20	0.900	1164	0.499
Heavy water	20	1.1053	1388	1.129
Carbon tetrachloride	20	1.5942	938	0.608
Mercury	20	13.5955	1451	0.114
Nitrobenzene	20	1.207	1473	1.665
Carbon bisulfide	20	1.2634	1158	0.290
n-pentane	20	0.6260	1032	0.366
n-hexane	20	0.654	1083	0.489
Spindle oil	32	0.905	1324	15.7
Gasoline	34	0.803	1250	0.4 to 0.5
Water	13.5	1.	1460	1.004 (20°C)

Note) T: Temperature, ρ: Density, V: Velocity, v: Kinematic viscosity coefficient

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