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**Instruction Manual**

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**ULTRASONIC FLOWMETER  
FOR AIR**

TYPE: FWD

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## ○ Preface/Request

Thank you very much for purchasing the Ultrasonic Flow Meter for Air FWD this time. Please be sure to read this Instruction Manual to use this product correctly and safely and to prevent failures.

### Request

Please arrange for operators who actually use this product to know the context of this Instruction Manual surely. This Instruction Manual becomes necessary for performing maintenance, too. Please keep the Manual in a safe place until this product is disposed of.

## ○ Outline of product

This flow meter is the ultrasonic flow meter for air capable of measuring the flow of air at pressure from the atmospheric pressure to less than 1 MPa. The flow meter is installed to pipes by screwing its taper pipe threads to the pipes or by being tightened between pipe flanges.

- Screw connection type (Taper pipe threads) applied models: FWD025, FWD032
- Wafer connection type (Installation between pipe flanges and by tightening with bolts) applied models : FWD040, FWD050, FWD065, FWD080
- Flange connection type (JIS 10K flange): FWD100, FWD150, FWD200

○ **Important notice**

To ensure the safe use of this flow meter and to prevent a failure or an unexpected situation, instructions to which attention must be paid are indicated with the following symbols.

**Structure of warning indications**

 <b>Danger</b>	Incorrect handling by failure to follow instructions with this sign may lead to imminent danger of death or serious injury.
 <b>Warning</b>	Incorrect handling by failure to follow instructions with this sign may lead to death or serious injury.
 <b>Note</b>	Incorrect handling by failure to follow instructions with this sign may lead to injury, properties loss (product damage, etc.), pecuniary loss, and/or punishment according to a penal regulation for violation of laws and ordinances.
	 This symbol indicates that improper operation may results in an accident.
	 This symbol indicates prohibited acts.
	 This symbol indicates matters you should observe without fail.

○ **For safe and proper use**

**Precautions for use**

 <b>Danger</b>	<ul style="list-style-type: none"> <li> 1. Do not use for applications that require safety, such as nuclear, railroad, aircraft, vehicle, playground equipment, etc.</li> <li> 2. Do not modify the product.</li> <li> 3. Do not use the product for foods, drinks, medical chemicals, etc., because it is not of sanitary specifications.</li> <li> 4. Do not use the product in the atmosphere of an inflammable gas, etc., because it is not of explosion-proof specifications.</li> </ul>
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**Working environment and applicable fluid**

 <b>Note</b>	<ul style="list-style-type: none"> <li> 1. Do not apply any fluid other than air (compressed air used in factories) to this flow meter. (The meter can be applied for nitrogen by factory setting before shipment from our factory.)</li> <li> 2. Observe the temperature and humidity ranges (-10 to +60°C and 90%RH or lower) and pressure range (the atmospheric pressure to less than 1 MPa) in use.</li> <li> 3. Avoid usage in an ambient containing a corrosive gas (chlorine, hydrogen sulfide, etc.) and/or for an application to a fluid containing a corrosive gas.</li> <li> 4. This flow meter is not of a perfect waterproof structure (IP64). Do not install it at a place that may be submerged in water.</li> <li> 5. Install the flow meter as far away from an electric noise source as possible. If it is installed near the electric noise source, ground the shield of the external connection cable.</li> <li>6. The installation of a sunshade is recommended if the flow meter is exposed to direct sunlight.</li> </ul>
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**Notes for operations**

 <b>Note</b>	<ul style="list-style-type: none"> <li>1. This flow meter is not a specified measuring instrument defined in Japanese measurement law. The product is not able to be used for billing transactions or certification.</li> <li> 2. When opening a valve to start fluid flow, open the valve not all at once but gradually. Opening of the valve all at once may cause a failure of the flow meter if a pressure difference is occurring between the upstream side and downstream side of the valve.</li> </ul>
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## Storage

 <b>Note</b>	<ul style="list-style-type: none"><li>⊘ 1. Store the flow meter at a place away from fire and not exposed to direct sunlight.</li><li>⊘ 2. Do not place any combustible material, inflammable substance and heating body in the periphery of the flow meter.</li><li>ⓘ 3. Store this flow meter at a place which ambient temperature is -20 to +70°C and where no dew condensation occurs.</li></ul>
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## Piping

 <b>Warning</b>	<ul style="list-style-type: none"><li>⊘ 1. Do not ride on this flow meter using it as a foothold.</li><li>⊘ 2. Do not hold the display section of this flow meter.</li></ul>
 <b>Note</b>	<ul style="list-style-type: none"><li>1. In the case that a flow-regulating valve, etc., that may cause turbulence of the flow is installed, its location must be on the downstream side of the flow meter.</li><li>2. In the case of new piping, install the product after sufficient cleaning of the pipe(s).</li><li>3. Vertical piping is recommended when mist, dust, etc. are contained in a large amount. In horizontal piping, install the flow meter in such a way that the display section faces upward.</li><li>4. Do not install the product in locations where strong compressive force, tensile force, or load may be applied after its installation.</li><li>5. Arrange piping so that the flow direction conforms to the direction of arrow indicated on the flow meter's body.</li><li>6. Do not drop it or do not make it bumped. Do not apply excessive impact, either.</li><li>7. When rotating the display section, do not apply a force in a direction other than the rotating direction.</li><li>ⓘ 8. Keep hands off the ultrasonic sensors.</li></ul>

## Wiring

 <b>Danger</b>	<ul style="list-style-type: none"><li>ⓘ 1. When performing wiring work, follow the instructions in this Manual.</li><li>ⓘ 2. Use the product within the rating. ⊘ Do not use the product on a voltage exceeding permissible load.</li></ul>
 <b>Note</b>	<ul style="list-style-type: none"><li>1. Do not place the product's external connection cable together with or near to power supply line(s) or power line(s), etc.</li><li>2. Electrical isolation of a remote counter (a receiver) from others is recommended.</li><li>3. Do not apply an excessive tensile force to the external connection cable.</li><li>4. Ensure that the cable tip is not soaked in water during wiring work, etc..</li><li>ⓘ 5. When connecting the power supply wire of the external connection cable to an external power supply, be careful not to short-circuit it. Use an external power supply having a short-circuit protecting function.</li><li>ⓘ 6. Be sure to perform the wiring work in a state that power supply from the external power supply is interrupted.</li><li>⊘ 7. Do not perform operation and the wiring work with wet hands.</li></ul>

## Disassembling and inspection

 <b>Note</b>	<ul style="list-style-type: none"><li>⊘ 1. Do not disassemble this flow meter.</li><li>2. Presence of fluid flow makes a pilot lamp light up in a normal state. In the case of no indication of the pilot lamp, contact our branch or sales office nearby.</li><li>3. If mist and dust is contained in a large amount, disconnect the flow meter periodically to check for the presence of dirt etc., and remove it as necessary.</li><li>ⓘ Be careful not to touch the ultrasonic sensors during inspection.</li></ul>
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## Disposal

 <b>Warning</b>	<ul style="list-style-type: none"><li>ⓘ 1. A lithium ion battery is incorporated in this flow meter. NEVER dispose of this flow meter through general disposal routes. [Built-in battery type]</li><li>ⓘ 2. NEVER throw this flow meter into a fire. Otherwise, it may catch a fire or explode. [Built-in battery type]</li></ul>
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# 1. Introduction

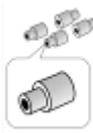
## 1-1. Confirmation of package contents

Upon delivery of the product, confirm that the following items are contained in the package:

Name	Quantity	Remark
Ultrasonic flow meter	1	
Centering collars	4	See P.6, P7 about usage. Accessory of the wafer connection type
M4 hexagonal wrench	1	
Flange gasket	2	Accessory of the wafer connection type
Instruction Manual (This document)	1	
Bolt set (Bolts/nuts/plain washes)	1 set	The bolts/nuts/plain washers are put into a bag in a set of required quantities Accessory of the wafer connection type
External connection cable (external power supply type)	1	5 m or 20 m (Option)



FLOW METER



CENTERING COLLARS



HEXAGONAL WRENCH



FLANGE GASKETS  
(WAFER CONNECTION TYPE)



INSTRUCTION MANUAL

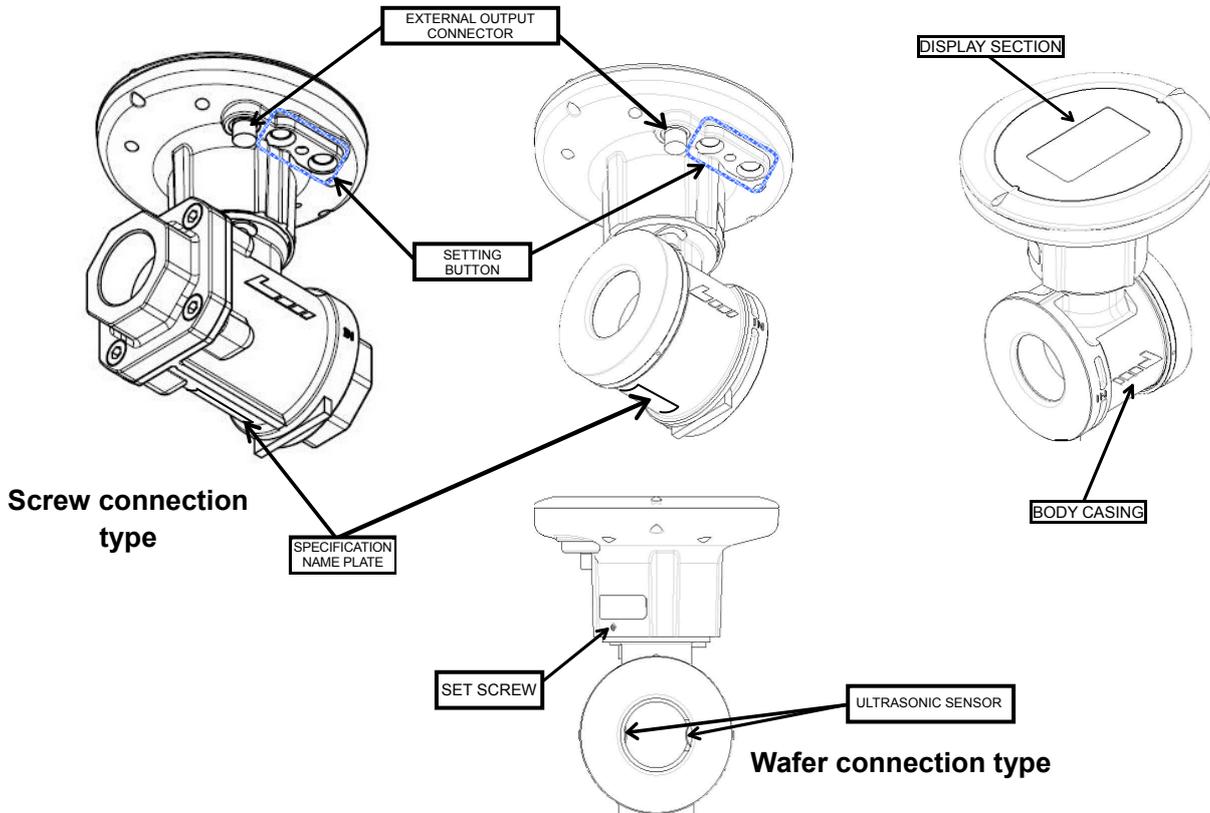


BOLT SET  
(WAFER CONNECTION TYPE)



EXTERNAL CONNECTION CABLE

## 1-2. Name of each part



## 2. Installation procedures

It is recommended that setting operation (P.8 onward) and change of the direction of the display section (P.7) are carried out before installation.

- 1) Mate the forward flow direction of a fluid to the arrow of the body.
- 2) For this flow meter, the straight pipe lengths as shown in Fig. 2-1 are recommended.

Condition	Upstream side	Downstream side
90°elbow / full open of full-bore valve	<p>Screw connection type: 20D or longer Wafer connection type and flange connection type: 10D or longer</p>	<p>5D or longer</p>
Confluence	<p>20D or longer</p>	<p>10D or longer</p>
Enlarged pipe	<p>20D or longer</p>	<p>5D or longer</p>
Reduced pipe	<p>10D or longer</p>	<p>10D or longer</p>

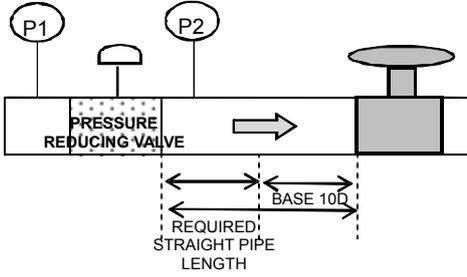
Fig. 2-1 Recommended straight pipe length L (D: Nominal diameter)

- 3) When the flow meter is installed near a pressure reducing valve or a flow adjustment valve, strictly observe "required straight pipe length L" as shown in the following Fig. 2-2, because ultrasonic noise may be generated inside the pipe.  
**Especially, note that when the flow meter is installed at the downstream of the pressure reducing valve etc., there are many constraints. (If conditions are not satisfied, there is a possibility that flow cannot be measured.)**

$$\text{Required straight pipe length } L \text{ (mm)} = 10D + \text{Differential pressure (kPa)} \times D \times \frac{\text{Maximum working flow speed (m/s)}}{20 \text{ (m/s)}} \times (0.8)^{\text{Number of elbows}}$$

When the flow meter is installed at the downstream of the pressure reducing valve

Without elbow

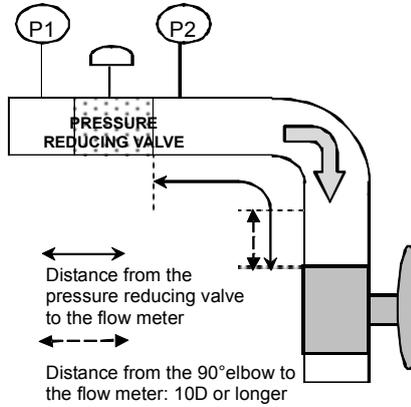


(Example of calculation)

Ex. 1: Nominal diameter 50mm, Flow velocity 10m/s, Without elbow  
When P1 is 25 kPa and P2 is 5 kPa  
 $500 + (25-5) \times 50 \times 10 / 20 = 1000 \text{ mm (20D)}$

Ex. 2: Nominal diameter 50mm, Flow velocity 10m/s, Without elbow  
When P1 is 160 kPa and P2 is 10 kPa  
 $500 + (160-10) \times 50 \times 10 / 20 = 4250 \text{ mm (85D)}$

With elbow  
(The ultrasonic noise is attenuated by an elbow. When plural numbers of elbows exists, required length becomes shorter.)



(Example of calculation)

Ex. 1: Nominal diameter 50mm, Flow velocity 10m/s, With "one" elbow  
When P1 is 160 kPa and P2 is 10 kPa  
 $500 + (160 - 10) \times 50 \times 10 / 20 \times 0.8 = 3500 \text{ mm (70D)}$

When the flow meter is installed at the upstream of the pressure reducing valve

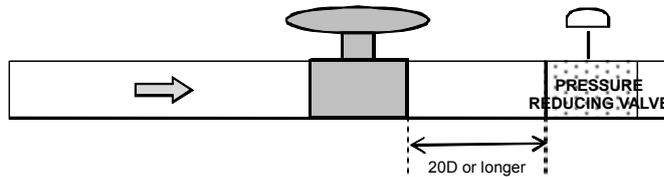


Fig. 2-2 Recommended straight pipe portion length 2 (D: Nominal diameter)  
(When the meter is installed near the pressure reducing valve or a flow adjustment valve)

- Install the wafer connection type flow meter so that the central axis of the flow meter is aligned to that of pipes to be connected. To reduce the displacement of the central axes of the flow meter and the pipes, it is recommended that the centering collars provided as accessory be used. As shown in Fig. 2-3, insert the centering collars provided as accessory into the holes of flange gaskets and flanges. By fitting the flow meter to the centering collars, the central axis of the flow meter can be aligned to that of the pipe. If it is difficult to install the centering collars at both upstream and downstream sides due to the misalignment etc. of pipes, install the collars only at the upstream side.

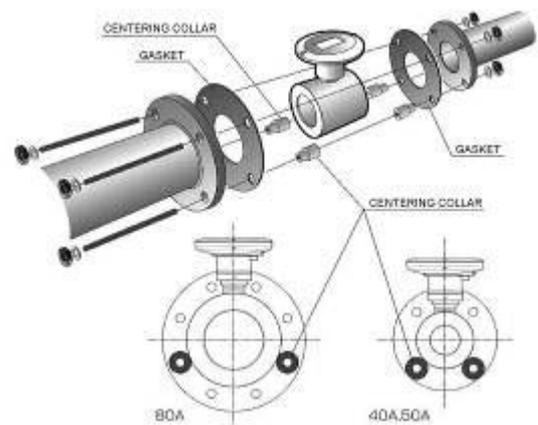


Fig. 2-3 Example of attaching the centering collars

- 5) Install the flange type flow meter so that the central axis of the flow meter is aligned to that of a pipe. To reduce the displacement of the central axes of the flow meter and the pipe, it is recommended that the centering collars provided as accessory be used. As shown in Fig. 2-4, insert the centering collars provided as accessory into the holes of flange packings and flanges when installing the upstream side.

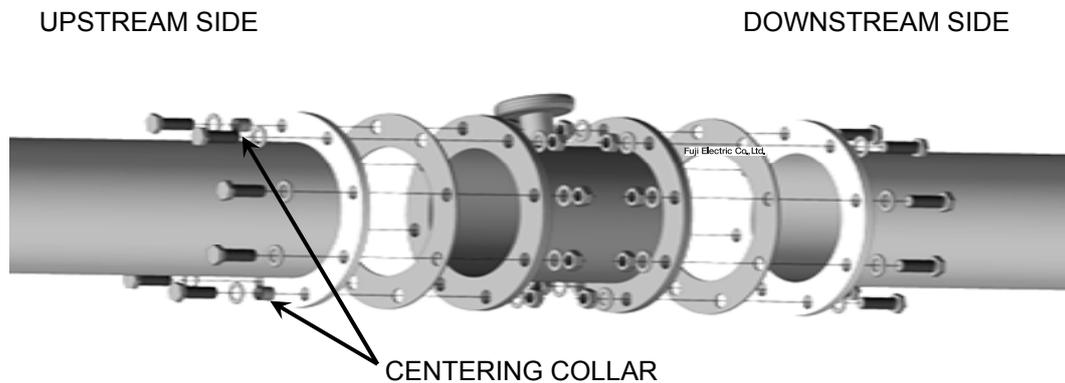


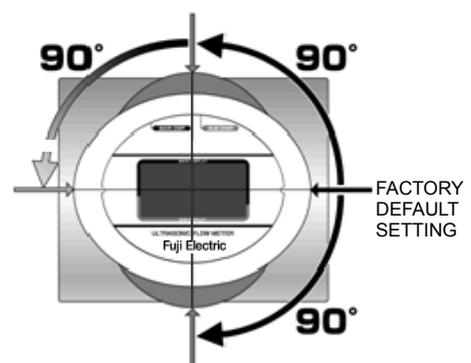
Fig. 2-4 Example of attaching centering collars

- 6) This flow meter can be installed both indoors and outdoors and on a horizontal pipe and a vertical pipe. Install the flow meter in a portion of the straight pipe. When a large amount of mist, dust, etc. are contained inside a pipe, the vertical piping is recommended. When installing the flow meter horizontally on a similar piping, install it in such a way that the display section faces upward. This flow meter is not of a perfect waterproof structure (IP64). Do not install it at a place that may be submerged in water. The installation of a sunshade is recommended if the flow meter is exposed to direct sunlight. When the flow meter is installed at such a place splashed with rainwater, install it at a position where the display section does not face downward.
- 7) For the screw connection type flow meter, fix it by screwing its taper pipe threads to pipes within the following torque range.

FWD025: 36 to 38 Nm FWD032: 47 to 49 Nm
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- 8) For the wafer connection type and frange connection type flow meter, take care so that the flange gaskets may not stick out inside a pipe.
- 9) The direction of the display section can be rotated. It is recommended to change the direction before installation. To change the direction of the display section, temporarily loosen a set screw on the neck part of the display section with the M4 hexagonal wrench provided as accessory, and then rotate the display section. Do not fail to fix the display section by tightening the set screw at a desired position.

The display section can be rotated by 90° clockwise and 180° counterclockwise from the setup at the factory.



- When rotating the display section, do not apply a force in a direction other than the rotating direction.
- 10) At the time of piping, keep hands off inside the body and the ultrasonic sensors (See P4) in particular.
- ⊘ Do not hold the display section of this flow meter.

### 3. Setting of flow meter

It is recommended that the setting of the flow meter be carried out before installation.

For this flow meter, 16 or 13 items shown in Table 3-1 and Table 3-2 can be set. On delivery from factory, the “factory default settings” in Table 3-1 or Table 3-2 are arranged, so that the flow meter can be used as it is. Change the setting as necessary so as to make them suit to your working conditions.

**See “4. Description of operation of display section” on the next item about button operations and setting methods.**

Table 3-1 Various setting items and details in setting mode (for 25 ~ 80 mm dia.)

Setting item indication	Corresponding setting item	Setting detail and range	Detail of factory default setting
F1	Indication/output	Forward flow, forward/reverse flow	Forward flow
F2	Analog output Full scale flow-rate	0 to 9999 [Nm <sup>3</sup> /h]	25mm : 300 32mm : 600 40mm : 700 50mm : 1200 65mm : 2000 80mm : 2500
F3	Contact output changeover	Pulse output, alarm output	Pulse output
F4	Output pulse unit	10 <sup>Note1)</sup> , 100, 1000 [NL/P]	100
F5	Alarm output contact state	Normal open, normal close	Normal open
F6	Alarm output lower limit flow-rate	-9999 to 9999 [Nm <sup>3</sup> /h]	0000
F7	Alarm output upper limit flow-rate	-9999 to 9999 [Nm <sup>3</sup> /h]	9999
F8	Alarm judgment value hysteresis width	0 to 9999 [Nm <sup>3</sup> /h]	0000
F9	Moving average time	1, 2, 4, 8, 16 [times]	4
F10	NORMAL conversion	With (ON), Without (OFF)	With
F11	Selection of test mode time	3, 60, no limit [min]	3
F12	(Maintenance setting)	-	-
F13	(Maintenance setting)	-	-
F14	Current output changeover	Instantaneous flow-rate, pressure, temperature	Instantaneous flow-rate
F15	Atmospheric pressure of Working environment	000.0 to 1099.9 <sup>Note2)</sup> [kPa]	101.3
F16	With or without averaging of pressure values	With (10 times), Without (once)	With

Note1) When the NORMAL conversion is set to With (ON) in F10, 10[NL/P] cannot be set in setting of F4 (Output pulse unit).

Note2) In F15 (**Atmospheric pressure of working environment**), 101.3 kPa (standard atmospheric pressure) is set as factory default setting. The flow meter can be used without changing the factory default setting except when it is used at a high altitude place etc.

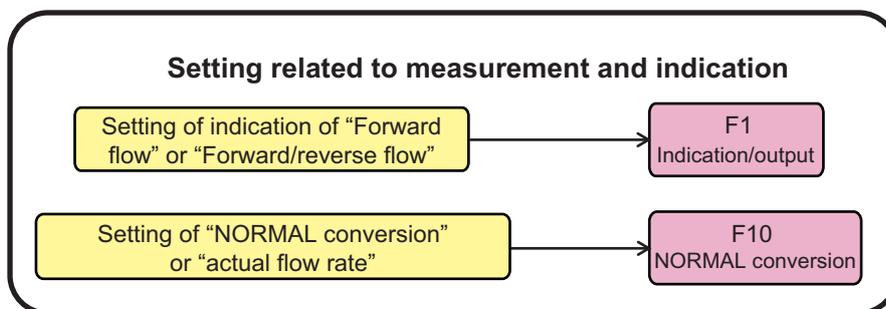
Table 3-2 Various setting items and details in setting mode (for 100 ~ 200 mm dia.)

Setting item indication	Corresponding setting item	Setting detail and range	Detail of factory default setting
F1	Indication/output	Forward flow, forward/reverse flow	Forward flow
F2	Analog output Full scale flow-rate	0 to 99999 [Nm <sup>3</sup> /h]	100mm : 5000 150mm : 10000 200mm : 20000
F3	Contact output changeover	Pulse output, alarm output	Pulse output
F4	Output pulse unit	10, 1, 0.1 [Nm <sup>3</sup> /p]	1
F5	Alarm output contact state	Normal open, normal close	Normal open
F6	Alarm output lower limit flow-rate	-99999 to 99999 [Nm <sup>3</sup> /h]	00000
F7	Alarm output upper limit flow-rate	-99999 to 99999 [Nm <sup>3</sup> /h]	99999
F8	Alarm judgment value hysteresis width	0 to 9999 [Nm <sup>3</sup> /h]	0000
F9	Moving average time	1, 2, 4, 8, 16 [times]	4
F10	NORMAL conversion	With (ON), Without (OFF)	With
F11	With or without averaging of pressure values	With (10 times), Without (once)	With
F12	Selection of test mode time	3, 60, no limit [min]	3
F13	Current output changeover	Instantaneous flow-rate, pressure, temperature	Instantaneous flow-rate

Note) When 0.1[Nm<sup>3</sup>/p] is selected in F4 Output pulse unit setting, note that right output will not be appeared more than 3600 Nm<sup>3</sup>/h.

Setting items include the one related to fluid to be applied, the ones related to measurement and indication, and the ones related to outputs.

1) Setting of items related to measurement and indication



a) Setting of indication of “Forward flow” or “Forward/reverse flow” [F1]

Indication of a main display is set.

When the “Forward flow” is selected, forward accumulated flow volume (total) or accumulated flow volume (trip) can selectively be indicated on the main display by button operation.

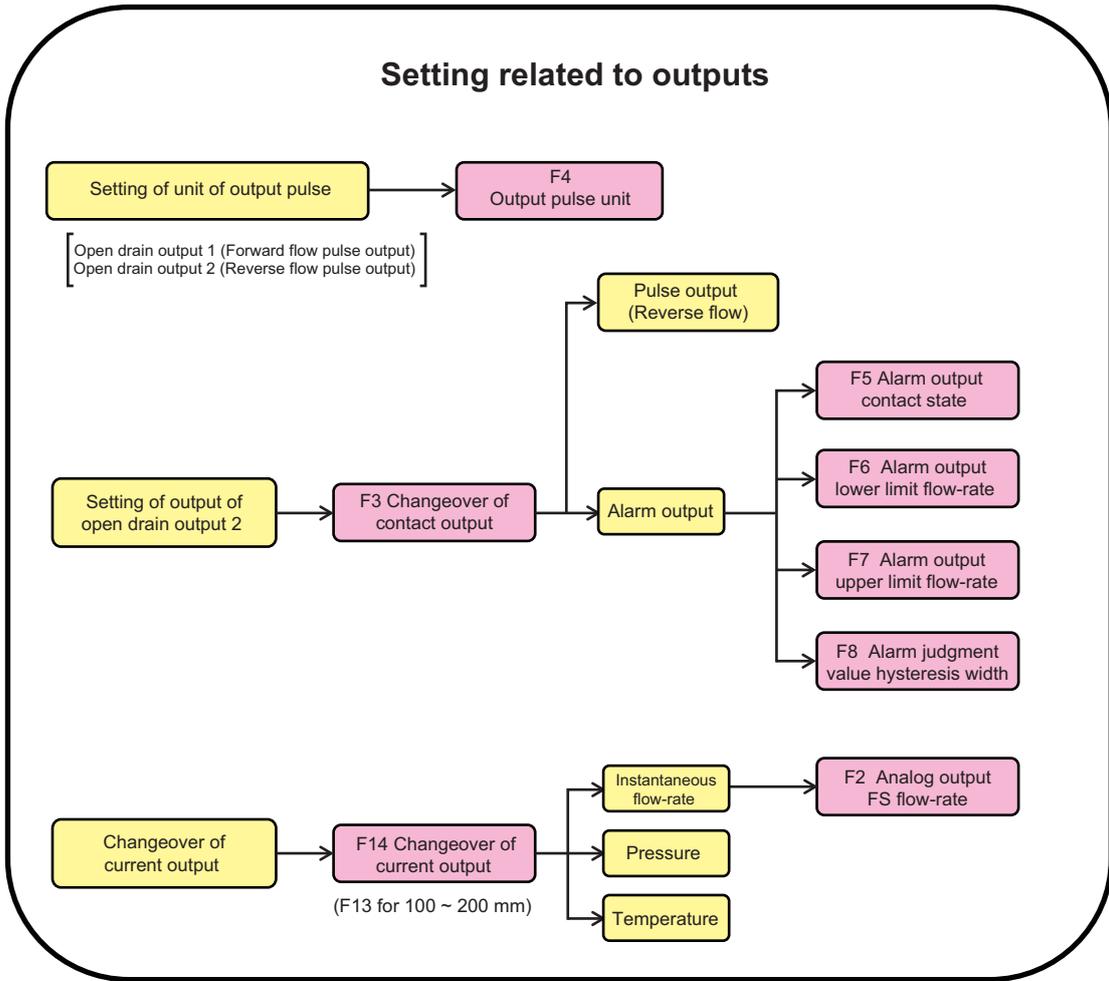
When the “Forward/reverse flow” is selected, forward accumulated flow volume (total) or reverse accumulated flow volume (total) can selectively be indicated on the main display by button operation.

When the analog output (4-20 mA) is selected for the flow-rate output, the electric current value of the zero flow-rate output becomes 12 mA.

b) Setting of NORMAL conversion [F10]

“With(ON)/Without(OFF)” of the NORMAL conversion is set. When the NORMAL conversion “With(ON)” is selected, all of accumulated volume indication, instantaneous flow-rate indication and an output signal correspond to flow in NORMAL.

2) Setting of items related to outputs (For External power supply type)



It is recommended that the setting of the flow meter be carried out before installation.

- a) Changeover of current output [F14 for 25 ~ 80 mm dia.] [F13 for 100 ~ 200 mm dia.]  
 One of three output forms of instantaneous flow-rate, pressure and temperature can be selected for the current output so as to suit your usage.  
 When the instantaneous flow-rate is selected, electric current corresponding to the setting of the maximum flow-rate value of the analog output is outputted.  
 When the pressure is selected, 4 mA is outputted at the atmospheric pressure, and 20 mA is outputted at 1 MPa.  
 When the temperature is selected, 4 mA is outputted at -10°C, and 20 mA is outputted at +60°C.
- b) Setting of the maximum flow-rate value of the analog current output (Analog output FS flow-rate) [F2]  
 When the analog output is used by setting to the instantaneous flow-rate, it is recommended that full scale flow-rate (FS flow-rate) of the analog current output be set with a value corresponding to maximum flow-rate used.  
 It is recommended that a numerical value having a margin be set as a set value of the FS flow-rate.  
 (Setting example of the FS flow-rate: A set value at the time of nominal diameter 50mm, NORMAL conversion "With(ON)", room temperature (30°C), pressure 0.7 MPa, flow speed 10m/s: 600 Nm<sup>3</sup>/h)

As a reference, Table 3-3 shows a NORMAL flow-rate conversion value [Conversion example].

Table 3-3 NORMAL flow-rate conversion value (Nm<sup>3</sup>/h) [Conversion example]

	Pressure (MPa)	0 (Atmospheric pressure)		0.5		0.7		0.98	
	Temperature (°C)	0	30	0	30	0	30	0	30
FWD025	0.6(m <sup>3</sup> /h)	0.6	0.5	3.6	3.2	4.7	4.3	6.4	5.8
	35(m <sup>3</sup> /h)	35	32	210	190	280	250	370	330
FWD032	1.1(m <sup>3</sup> /h)	1.1	1.0	6.5	5.9	8.7	7.8	12	11
	65(m <sup>3</sup> /h)	65	59	390	350	510	460	690	630
FWD040	1.3(m <sup>3</sup> /h)	1.3	1.2	7.7	7.0	10	9.3	14	13
	80(m <sup>3</sup> /h)	80	72	470	430	630	570	850	770
FWD050	2.5(m <sup>3</sup> /h)	2.5	2.3	15	13	20	18	27	24
	150(m <sup>3</sup> /h)	150	135	890	800	1180	1070	1600	1440
FWD065	4(m <sup>3</sup> /h)	4.0	3.6	24	21	32	29	43	39
	240(m <sup>3</sup> /h)	240	220	1420	1280	1900	1710	2560	2310
FWD080	5(m <sup>3</sup> /h)	5.0	4.5	30	27	40	36	53	48
	300(m <sup>3</sup> /h)	300	270	1780	1600	2370	2140	3200	2880
FWD100	10(m <sup>3</sup> /h)	10	9	59	53	79	71	110	96
	500(m <sup>3</sup> /h)	500	450	2970	2670	3950	3560	5340	4810
FWD150	24(m <sup>3</sup> /h)	24	22	140	130	190	170	260	230
	1200(m <sup>3</sup> /h)	1200	1080	7120	6420	9490	8550	12810	11540
FWD200	40(m <sup>3</sup> /h)	40	36	240	210	320	290	430	390
	2000(m <sup>3</sup> /h)	2000	1800	11870	10700	15820	14250	21340	19230

c) Setting of output pulse unit [F4]

When a pulse output of the open drain output 1 (forward pulse output) is used, set the output pulse unit in advance so as to suit your working conditions. The output pulse unit set here is reflected in the open drain output 2 (reverse flow pulse output), too.

d) Setting of contact output [F3]

One of two output formats of pulse output (reverse flow), flow-rate upper/lower limit alarm output. Can be selected for the open drain output 2 so as to suit your use.

When the pulse output (reverse flow) is selected, set the output pulse unit. However, when the output pulse unit is set in advance for the use of the open drain output 1 (forward flow pulse output), it is not necessary to set it here.

For the flow-rate upper/lower limit alarm output, an alarm can be outputted or stopped with a desired flow-rate value.

When this function is selected, set the alarm output contact state, the alarm output lower limit flow-rate and alarm output upper limit flow-rate, and the alarm judgment value hysteresis width.

#### 4. Description of operation of display section

Perspective view of back surface

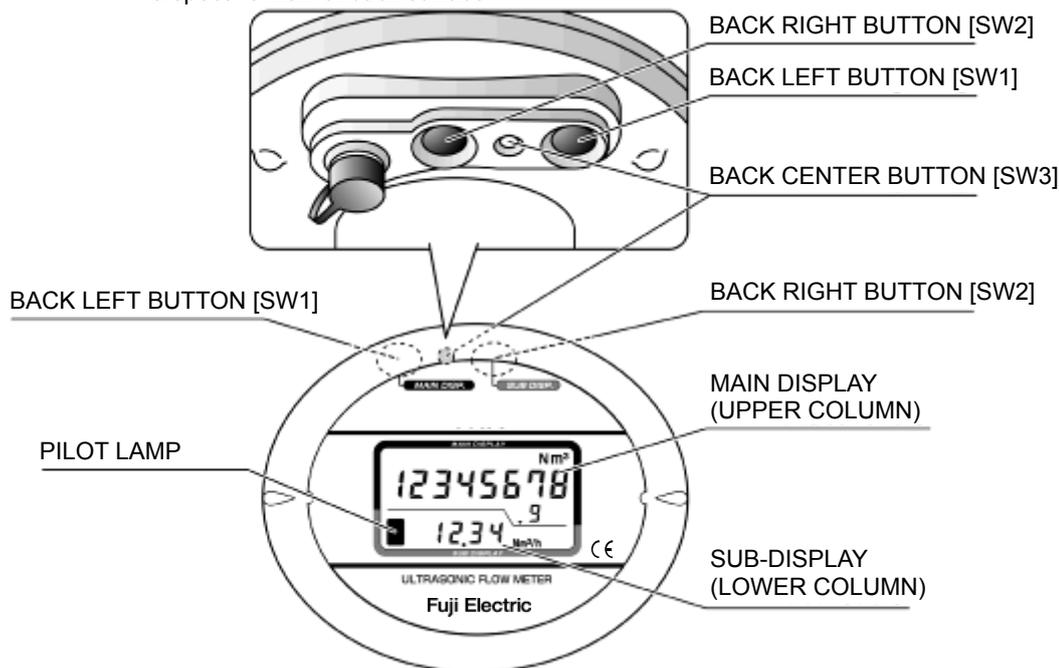


Fig. 4-1 Description of each operation part and display section

##### A. Description of operations

- 1) Usually is the measurement mode, and the main display (upper column) shows accumulated flow volume, and the sub-display (lower column) shows instantaneous flow-rate.
- 2) Various individual setting items can be set at a local site by the three button switches provided on the back of the display section.
- 3) See Fig. 4-1 about the arrangement of “SW1”, “SW2” and “SW3.”
- 4) By performing button operations in Table 4-1, the flow meter can be shifted to various modes as shown in Fig. 4-2.

Table 4-1 How to operate buttons in measurement mode, setting mode, and test mode

Button position and name		Measurement mode	Various setting modes		Test mode
Button position	Name		Local setting indication	Setting of details	
Back left	SW1	Forward accumulated flow volume (total) / accumulated flow volume (trip) - Changeover of instantaneous flow-rate (L/min)	Changeover to the next setting item	Changeover of setting details, Movement of blinking digit	/
		Forward accumulated flow volume (total) / reverse accumulated flow volume (total) - Changeover of instantaneous flow- late (L/min)			
Back right	SW2	Instantaneous flow-late (m <sup>3</sup> /h) / Pressure / temperature - Changeover of maintenance indication <sup>2)</sup>	Changeover to the previous setting item	Change of a numerical value at a blinking portion	Releasing the test mode
		Changeover to test mode			
Back center	SW3	Changeover to setting mode	Changeover to measurement mode		/
/	SW1+SW2 <sup>1)</sup>	Resetting of trip accumulation to zero <sup>3)</sup>	Changeover of local setting indication and setting of details		/

Note 1) “SW1+SW2” indicates that two switches are pressed simultaneously.

Note 2) Indication cannot be changeover when the main display shows the instantaneous flow-rate [L/min].

Note 3) Accumulated flow volume (trip) is reset to zero in the following cases:

- When SW1+SW2 are pressed during the indication of accumulated flow volume (trip)
- If power supply is interrupted by a power failure [External power supply type]

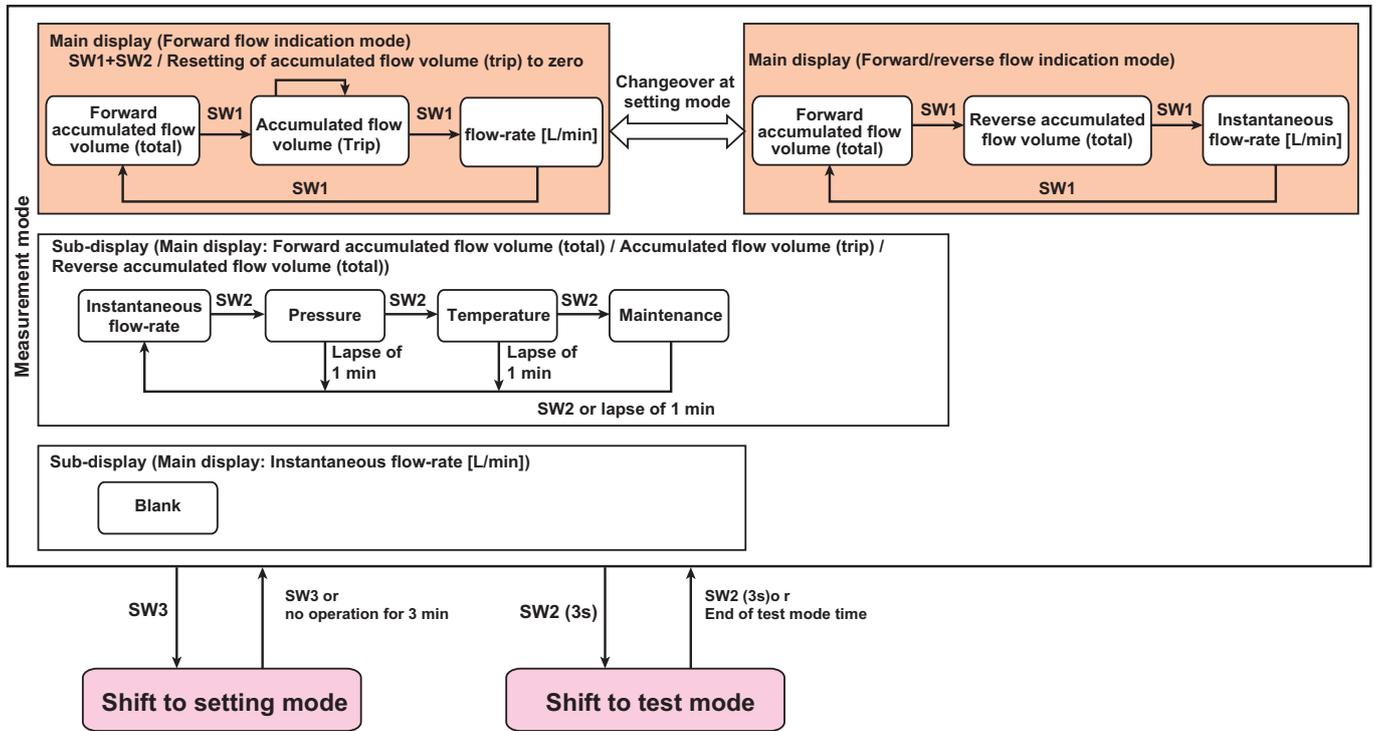


Fig. 4-2 Figure of button operations in measurement mode and shifts to various modes

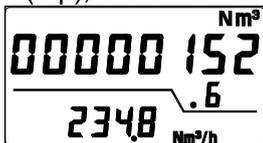
B. Functions in each mode

1) Measurement mode (usually)

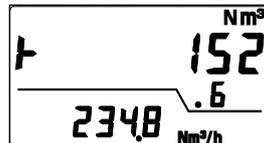
• Indication of main display (upper column)

In the case of [Forward flow indication mode]

- a) Each time “SW1” is pressed, the main display indicates in order of the accumulated flow volume (trip), the instantaneous flow-rate [L/min] and the forward accumulated flow volume (total).
- b) When “SW1” and “SW2” are pressed simultaneously during the indication of the accumulated flow volume (trip), the accumulated trip volume is reset to zero.



Indication of forward Accumulated flow volume (Total) (Example)



Indication of accumulated flow volume (Trip) (Example)



Indication of instantaneous flow-rate [L/min] (Example)

- c) When the accumulated flow volume (trip) overflows from 9999999.9 (999999999 for 100 ~ 200 mm dia.), the indication shows 0000000.0 (000000000 for 100 ~ 200 mm dia.) without zero suppression and integrating operation is continued.



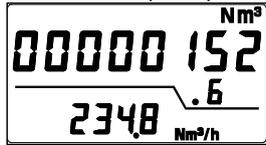
Without overflow  
(Accumulated flow volume (Trip)  
152.6 [Nm<sup>3</sup>])  
Indication of accumulated flow volume (Trip) (Example)



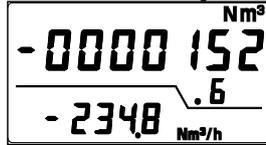
With overflow  
(Accumulated flow volume (Trip)  
10000152.6 [Nm<sup>3</sup>])  
Indication of accumulated flow volume (Trip) (Example)

In the case of [Forward/reverse flow indication mode]

(4) Each time “SW1” is pressed, the main display indicates in order of the reverse accumulated flow volume (total), the instantaneous flow-rate [L/min] and the forward accumulated flow volume (total).



Indication of forward accumulated flow volume (total) (Example)



Indication of reverse accumulated flow volume (Total) (Example)



Indication of instantaneous flow-rate [L/min] (Example)

· Indication of sub-display (lower column)

In the case of [Main display: Forward accumulated flow volume (total), accumulated flow volume (trip), and reverse accumulated flow volume (total)]

Each time “SW2” is pressed,” the indication changes in order of pressure, temperature, maintenance<sup>\*1)</sup> and instantaneous flow-rate.

When one minute elapses during the indication of pressure, temperature or maintenance, the indication is shifted to the instantaneous flow-rate automatically.

\*1) In the indication of maintenance, “0” is indicated. ...in case of 25 ~ 80 mm dia.

In the case of [Main display: Instantaneous flow-rate [L/min]]

The sub-display shows blank.

## 2) Test mode

The test mode is a function that releases low flow cutoff temporarily.

- Perform the test mode in a state of no flow. When “SW2” is pressed for 3 seconds or more during the measurement mode, the mode is shifted to the test mode so that a very small flow-rate can be measured.
- During the test mode, a unit of the sub-display (“Nm<sup>3</sup>/h”, “kPa”, “°C”, “NL/min”) blinks at the intervals of 0.5 seconds.
- Test mode times of three kinds of 3 minutes, 60 minutes, and no limit can be selected in the setting mode. When the set time elapses, the test mode is automatically shifted to the measurement mode. When the “SW2” is pressed for 3 seconds or more once again during the test mode, it is shifted to the measurement mode.
- When an indicated value of the instantaneous flow-rate is a flow-rate value of (+)0.1 or more, there is a possibility of leakage\* at the downstream side.
- When an indicated value of the instantaneous flow-rate is a flow-rate value of -0.1 or less, there is a possibility of leakage\* at the upstream side.  
\*Possibility of leakage: As an indicated value includes offset of zero flow-rate, inside convection, etc., it indicates only a possibility.
- An instantaneous flow-rate during the test mode is indicated by rounding at 3<sup>rd</sup> decimal place.  
Example) Indication: 0 to 0.004 [Nm<sup>3</sup>/h] → 0.00 [Nm<sup>3</sup>/h]  
Indication: -0.004 to 0 [Nm<sup>3</sup>/h] → -0.00 [Nm<sup>3</sup>/h]

## 3) Setting mode

- Press “SW3” to shift the flow meter to the setting mode. To shift from the setting mode to the measurement mode, press the “SW3” again. When no operation is made for 3 minutes in the setting mode, it is shifted to the measurement mode automatically.  
Press the “SW3” with the M4 hexagonal wrench provided as accessory, etc.  
(Note: “SW3” may be broken if pressed by a sharp pointed tool.)
- In the setting mode, setting details shown in the “Table 3-1 or Table 3-2 Various setting items and details in setting mode” (P.8 to P.9) can be changed.
- See figures of changeover of indication of various setting modes in Fig. 4-3. (P.17 to P.18) for button operation methods in the setting mode.

- Details about setting items -

● [F1] Indication/output

In the indication/output, “forward flow (d.F.)” measurement or “forward/reverse flow (d.r.F)” measurement is selected.

When the “forward flow” measurement is selected, the “forward accumulated flow volume (Total)” or the “accumulated flow volume (Trip)” can be indicated on the main display by button operation. When the instantaneous flow-rate is set with the analog output (4-20 mA), 4 mA becomes zero flow-rate.

When the “forward/reverse flow” is selected, the “forward accumulated flow volume (Total)” or “reverse accumulated flow volume (Total)” can be indicated on the main display by button operation. The trip function cannot be used. When the instantaneous flow-rate is set with the analog output (4-20 mA), 12 mA becomes the zero flow-rate.

See “4. Description of operation of display section” about the button operation.

● [F2] Analog output FS (Full Scale) flow-rate

This function sets a full scale flow-rate value when the instantaneous flow-rate is set with the analog output. On delivery from factory, the flow-rate value shown in the Table 3-1 or Table 3-2 is set. When in use with the NORMAL conversion set to “With (ON)” set a NORMAL conversion value.

● [F3] Contact output changeover

An output signal of the open drain output 2 is selected from “pulse output (reverse flow) (PULS)” or “flow-rate upper/lower limit alarm output (AL)”.

● [F4] Output pulse unit

A unit of the output pulse is selected.

The unit is reflected in the output unit pulses of the open drain output 1 (forward flow pulse output) and the open drain output 2 (reverse flow pulse output).

Note that, when used in the NORMAL conversion mode, the unit cannot be set to 10 [NL/P] but set to 100 [NL/P] even when 10 is selected.

In case of 100 mm or more diameter, output can not be conducted accurately with 3600Nm<sup>3</sup>/h or more if normal calculate mode is set to 0.1 [Nm<sup>3</sup>/P]

● [F5] Alarm output contact state

Either “normal open (n.OP)” or “normal close (n.CL)” is selected as the contact state of the flow-rate upper/lower limit alarm output.

● [F6] Alarm output lower limit flow-rate

A lower limit side flow-rate value of the flow-rate upper/lower limit alarm output is set. When in use with the NORMAL conversion set to “With (ON)” set the NORMAL conversion value.

● [F7] Alarm output upper limit flow-rate

An upper limit side flow-rate value of the flow-rate upper/lower limit alarm output is set. When in use with the NORMAL conversion set to “With (ON)” set the NORMAL conversion value.

● [F8] Alarm judgment value hysteresis width

A flow-rate width for stopping the alarm output is set for the flow-rate value set at the upper limit side and the lower limit side of the flow-rate upper/lower limit alarm output. When in use with the NORMAL conversion set to “With (ON)” set the NORMAL conversion value.

For example, when an upper limit side flow-rate value is set to 1000 [Nm<sup>3</sup>/h] and a lower limit side flow-rate value to 200 [Nm<sup>3</sup>/h], and when an alarm judgment value hysteresis width is set to 10 [Nm<sup>3</sup>/h], an alarm is outputted when the flow-rate increases to 1000 [Nm<sup>3</sup>/h] or more at the upper limit side and the alarm output is stopped when it decreases to less than 990 [Nm<sup>3</sup>/h]. Similarly at the lower limit side, an alarm is outputted when the flow-rate decreases to 200 [Nm<sup>3</sup>/h] or lower and the alarm output is stopped

when it increases to more than 210 [Nm<sup>3</sup>/h].

●[F9] Moving average times

Moving average times of the indication and output of the instantaneous flow-rate are selected. The moving average times are set to 4 times in factory default setting. Measurement values of the most recent 4 times are employed.

In usual use, the change of the moving average times is not necessary, but they can be set by selecting from “No moving average (01)”, “twice (02)”, “4 times (04)”, “8 times (08)”, and “16 times (16).”

●[F10] NORMAL conversion

Either “With (ON)” or “Without (OFF)” of the NORMAL conversion function is selected.

As the factory default setting of this flow meter, the NORMAL conversion is set to “With (ON)”, so that the NORMAL conversion is carried out. In the mode of the NORMAL conversion set to “With (ON)” the flow-rate unit of the display section becomes “Nm<sup>3</sup>” at the upper column and “Nm<sup>3</sup>/h” at the lower column. The accumulated flow volume indication, instantaneous flow-rate indication, and output signal all correspond to flow in NORMAL.

When “Without (OFF)” is selected for the NORMAL conversion, it is actual flow measurement. In the NORMAL conversion set to “Without (OFF)” the flow unit of the display section becomes “m<sup>3</sup>” at the upper column and “m<sup>3</sup>/h” or “L/min” at the lower column. The accumulated flow volume indication, instantaneous flow-rate indication and output signal all correspond to actual flow.

In the NORMAL conversion function, the flow is converted into the flow in NORMAL (flow-rate at 0°C·1atm) based on temperature t [°C] measured simultaneously with the flow and pressure p [kPa].

Internal arithmetic is carried out as follows in the conversion:

$$Q_n = T_0 / (T_0 + t) \times (P_1 + p) / P_0 \times Q_r$$

Where  $Q_r$ : Actual flow-rate [m<sup>3</sup>/h]  $Q_n$ : NORMAL flow-rate [Nm<sup>3</sup>/h]

$T_0$ : 273.15[K] (Absolute temperature of 0(C)  $t$ : Fluid temperature [(C]

$P_0$ : 101.33[kPa abs] (Absolute pressure of 1 atm)

$P_1$ : Atmospheric pressure of working environment (Atmospheric pressure of working environment is set on F15 in the setting mode.)

$p$ : Pressure (Gauge pressure) [kPa]

When both of the external output function and the NORMAL conversion are used, it is recommended that output constant be set referring to Table 3-3 (P.11).

●[F14 (for 25 ~ 80 mm) or F13 (for 100 ~ 200 mm)] Changover of current output

An output signal of the current output is selected from the “instantaneous flow-rate (FLO)”, “Pressure (PrS)” and “temperature (tEP)”.

Figure of changeover of indication of various setting modes is shown below.  
 (Example of 25mm to 80mm dia.)

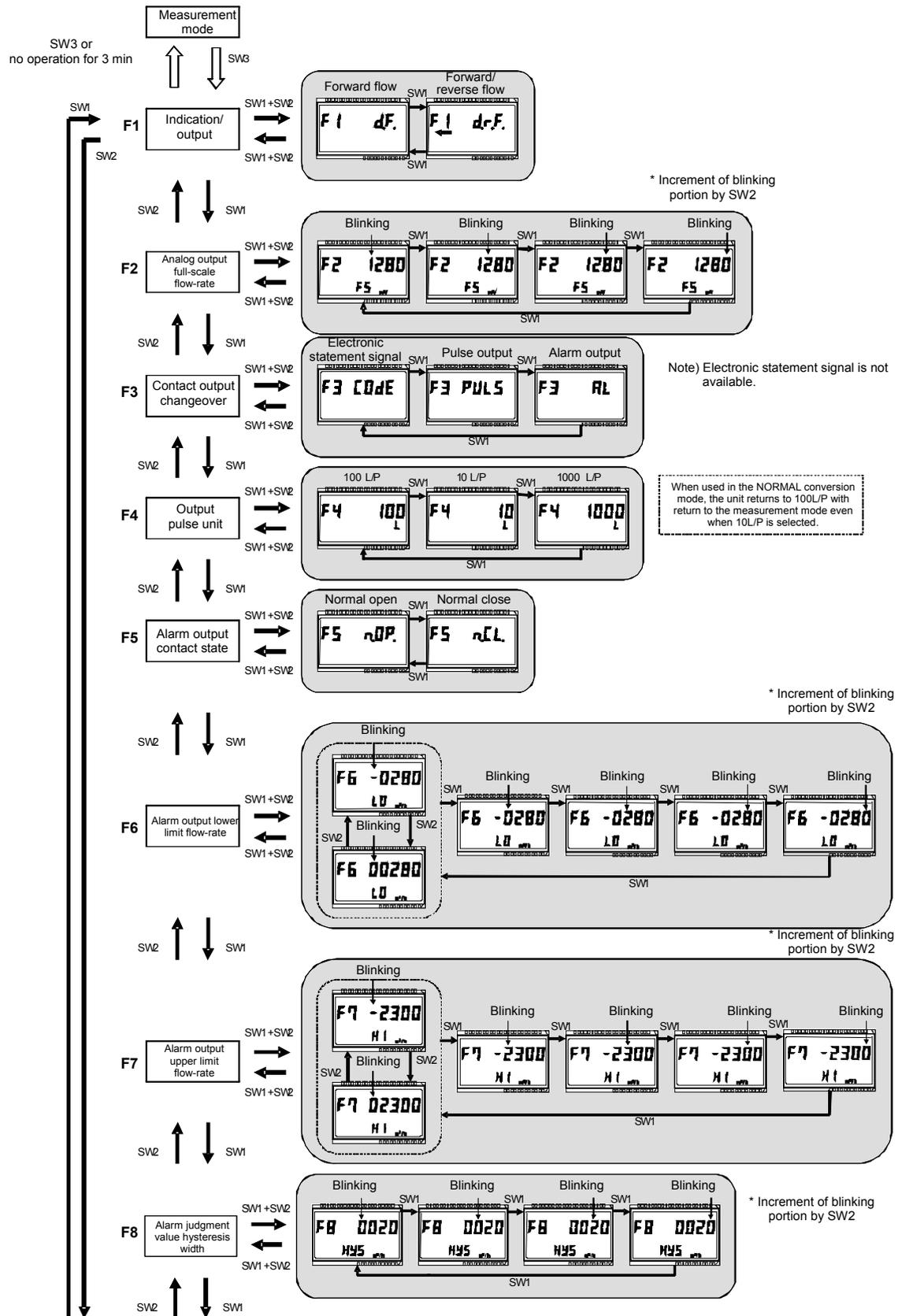


Fig. 4-3 (- 1/2) Figure of changeover of indication of various setting modes

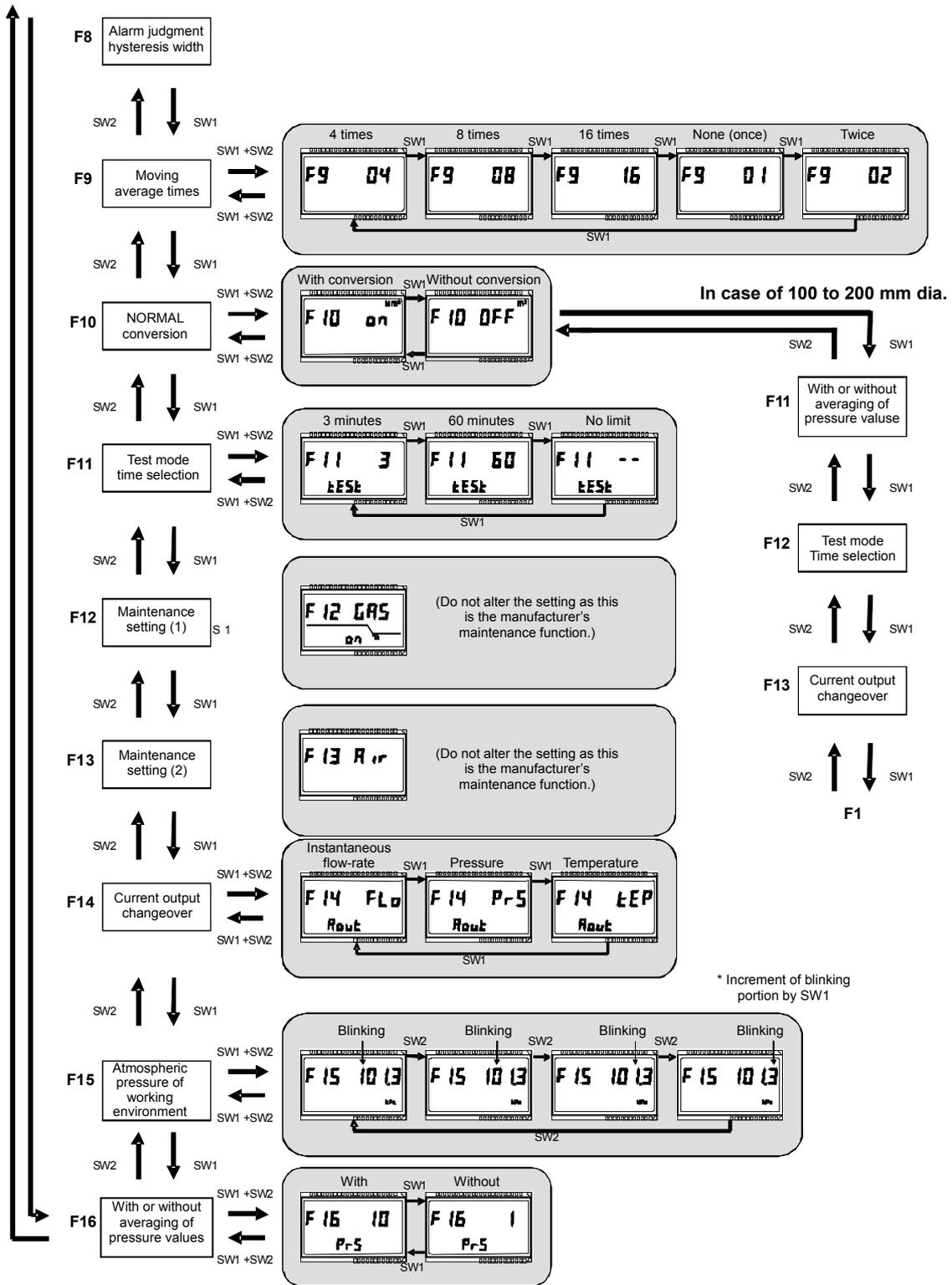


Fig. 4-3 (- 2/2) Figure of changeover of indication of various setting modes

## 5. Wiring with a power supply and a remote display (External Power Supply Type)

Please be sure to conduct the wire connection using the optional cable for external connection as follows.

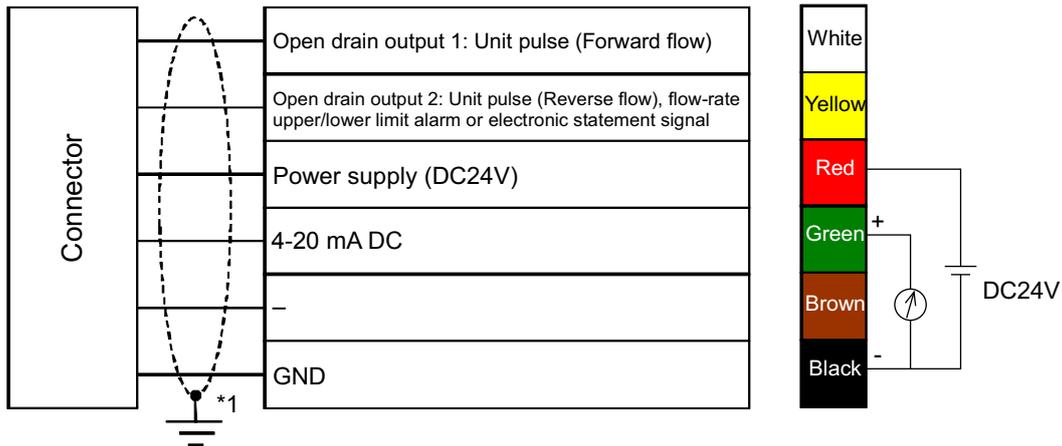


Fig. 5-1 External Connection Cable Wiring Drawing for External Power Supply Type

- The main body and GND are electrically common.
- Use an isolated power supply and a remote display as necessary.

\*1: When installing the flow meter around an electric noise source, ground the braided shield of the external connection cable.

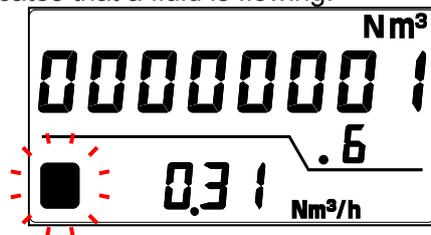
Note1) Be sure to cut the root of cable of the blown lead wire and avoid contacting others since blown lead wire is not be used.

When shorting, "ALRM2" will be blinking.

Note2) Do not perform the insulation resistance and withstand voltage test.

## 6. Procedures of operation start

When starting operation, open a valve gradually, and confirm that the pilot lamp is blinking. The blinking of the pilot lamp indicates that a fluid is flowing.



## 7. Alarm indication

### 1) Measurement abnormality

If ultrasonic signals are weak or cannot be received, "ALARM1" lights up and the instantaneous flow-rate shows "0.00." (100 mm ~ 200 mm [0.0]) Accumulation of flow volume is stopped keeping indication of an accumulated flow volume value just before an abnormality and an analog output outputs 4 mA.

Check whether or not foreign materials that obstruct the transmission of the ultrasonic signals are contained and whether or not fluids like oil are adhering to or accumulating on the ultrasonic sensors and inside the main body of the flow meter. If no adhesion or accumulation of foreign materials is observed or if the "ALARM1" still lights up even after the removal of the foreign materials, contact our branch or sales office nearby.



(Note) Behavior in starting the operation

When the flow meter is installed and it starts operating, pressure changes so sharply from the atmospheric air that the ALARM1 may light up in a rare case. When a fluid is stabilized by the pressure in an operation state, the ALARM1 is turned off. (This is not an abnormality.)

2) Low battery voltage alarm [Built-in battery type]

When a battery voltage becomes low due to power consumption, the “ALARM2” is turned on before the measurement is stopped.

Even when the “ALARM2” is displayed, the measurement can be continued for about one month (at normal temperature). Earlier replacement of the battery is recommended. When replacing the battery, contact our branch or sales office nearby.

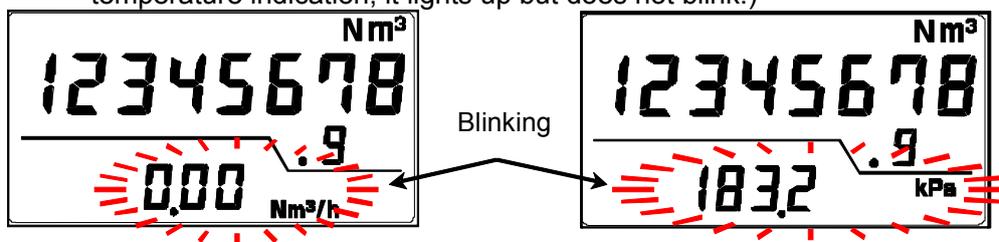


3) Abnormality of pressure value

If an abnormality of a pressure value is detected, followings are indicated according to the details of the main display:

In the case of [Main display: Forward accumulated flow volume (total), accumulated flow volume (trip), and reverse accumulated flow volume (total)]

Instantaneous flow-rate indication and pressure indication of the sub-display blink. (For temperature indication, it lights up but does not blink.)



In the case of [Main display: Instantaneous flow-rate [L/min]]

“Err” blinks on the sub-display.



If an abnormality of a pressure value is detected, the instantaneous flow-rate shows 0, the pressure shows a numerical value just before indicating an abnormality, and an analog output outputs 4 mA. Accumulation of flow volume is stopped keeping indication of an accumulated flow volume value just before an abnormality on the main display.

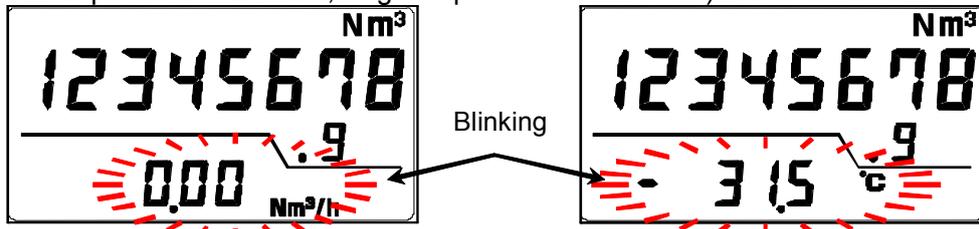
If a pressure abnormality is indicated, contact our branch or sales office nearby.

#### 4) Abnormality of temperature value

If an abnormality of a temperature value is detected, followings are indicated according to the details of the main display:

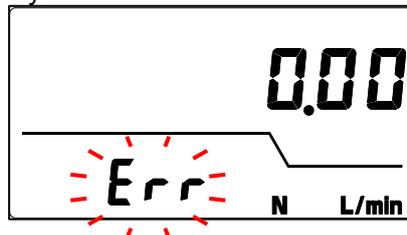
In the case of [Main display: Forward accumulated flow volume (total), accumulated flow volume (trip), and reverse accumulated flow volume (total)]

Instantaneous flow-rate indication and temperature indication of the sub-display blink. (For pressure indication, it lights up but does not blink.)



In the case of [Main display: Instantaneous flow-rate [L/min]]

“Err” blinks on the sub-display.



If an abnormality of a temperature value is detected, the instantaneous flow-rate shows 0, temperature shows a numerical value just before indicating an abnormality, and an analog output outputs 4 mA. Accumulation of flow volume is stopped keeping indication of an accumulated flow volume value just before an abnormality on the main display.

Confirm that a fluid in use is air. If a temperature abnormality is indicated while in use of air, contact our branch or sales office nearby.

## 8. Treatment on power failure [External power supply type]

### 1) Detection of power failure

The drop of a power source voltage to  $18 \pm 1.1V$  or lower is judged to be a power failure. As a result, the measurement is stopped and the LED display is turned off.

### 2) Reset from power failure

When a power source voltage rises to  $18.8 \pm 1.1V$  or higher, the measurement is resumed and the LED is turned on.

Accumulated flow volume is memorized every 5 minutes after power is supplied. At the time of recovery from power failure, the accumulated flow volume memorized just before the power failure is restored and the accumulation is resumed from that value.

At the time of recovery from power failure, the LED display of the upper column indicates the accumulated flow volume. Note that, when in use of the trip accumulation, the trip accumulated value is reset to zero.

## 9. Battery life [Built-in battery type]

The life of the built-in battery is 10 years. (This is the life at the environment temperature of  $20^{\circ}C$ . The battery life fluctuates depending on the temperature of installation environment.)

\* In the case the battery run out earlier due to reasons of high environment temperature, etc., the battery is possible to be replaced at our plant as a fare-paying service. Contact our branch or sales office nearby.

## 10.Troubleshooting

Timing	Phenomenon	Possible cause	Countermeasure
Immediately after installation	ALARM1 lights up.	A fluid other than air is used.	Check whether or not "For safe and proper use" [P2 - P3] and "Specifications" [P23 - P24] are satisfied.
		The flow meter is used outside specification range (installation conditions, pressure, temperature, etc.)	
		Adhesion and/or accumulation of foreign materials inside the measuring part and/or to the ultrasonic sensors	Check for the presence of foreign materials, and remove them, if any.
		There is a large electric noise source near the flow meter.	Take a countermeasure of eliminating the noise source or shielding the meter. When using the external connection cable, ground the braided shield. [See P19.]
	Accumulation does not start immediately after installation	During adjustment operation by pressure fluctuation	Confirm that a partition line between the main display and the sub-display is blinking. Blinking stops in about one minute to start accumulation.
Instantaneous flow-rate of a negative value is indicated.	Flow direction of a fluid is opposite to the flow direction of the flow meter.	Check whether or not the arrow direction on the external surface of the flow meter corresponds to the flow direction of a fluid.	
After start operation	ALARM2 lights up.	Low battery voltage	This indicates the built-in battery life is ending. (Contact our sales office nearby.)
	Sub-display blinks. (Instantaneous flow-rate / pressure indications blink.)	Failure of pressure sensor	Contact our sales office nearby.
	Sub-display blinks. (Instantaneous flow-rate / temperature indications blink.)	A fluid other than air is used.	Check whether or not "For safe and proper use" [P2 - P3] and "Specifications" [P23 - P24] are satisfied.
	Instantaneous flow-rate appears to be wavering.	Pressure is fluctuating frequently.	The flow meter is working normally. To perform more accurate measurement, it is recommended that the flow meter be installed at a place having less pressure fluctuation.
		There are flow pulsations.	The flow meter is working normally. To perform more accurate measurement, it is recommended that the flow meter be installed at a place having less flow pulsations.
		There is a governor near the meter.	The flow meter is working normally. To perform more accurate measurement, it is recommended that the flow meter be installed at a remote place from the governor. (See Fig. 2-2. [P6].)
	Instantaneous flow-rate is not zeroed in spite that air is not flowing.	There is convection flow in the piping	The flow meter is working normally.
		Test mode is turned on.	Confirm that unit of sub-display is blinking. (See test mode [P14].)
	Instantaneous flow-rate is too large.	Straight pipe length is insufficient.	Provide a straight pipe of recommended length at the upstream and downstream of the flow meter depending on a piping situation. (See Fig. 2-1. [P5].)
		"Flow in NORMAL (Nm <sup>3</sup> )" indication is selected.	Check whether or not unit matching usage is selected. (When changing the unit, see setting of flow meter [P8 - P9 onward].)
	Instantaneous flow-rate appears to remain unchanged.	Excessive air more than specification is flowing.	Use the flow meter within the specification range. (See [P23 to P24] for the specifications.)
	Instantaneous flow-rate is too small.	Straight pipe length is insufficient.	Provide a straight pipe of recommended length at the upstream and downstream of the flow meter depending on a piping situation. (See Fig. 2-1. [P5].)
		"Actual flow (m <sup>3</sup> )" is selected.	Check whether or not the unit matching the usage is selected. (When changing the unit, see setting of flow meter [P8 - P9 onward].)
	Partition line is blinking.	During adjustment operation by pressure fluctuation	Confirm that a partition line between the main display and the sub-display is blinking. Blinking stops in about one minute to start accumulation.
"0" of high order digit of accumulated flow volume is not indicated.	Accumulated flow volume (Trip) indication is selected.	The flow meter is working normally. (To return the indication to forward accumulated flow volume (total), see the Description of operation of display section [P11 onward].)	

If any phenomenon cannot be solved even by taking the corrective actions above, contact our sales office nearby.

# 11. Specifications

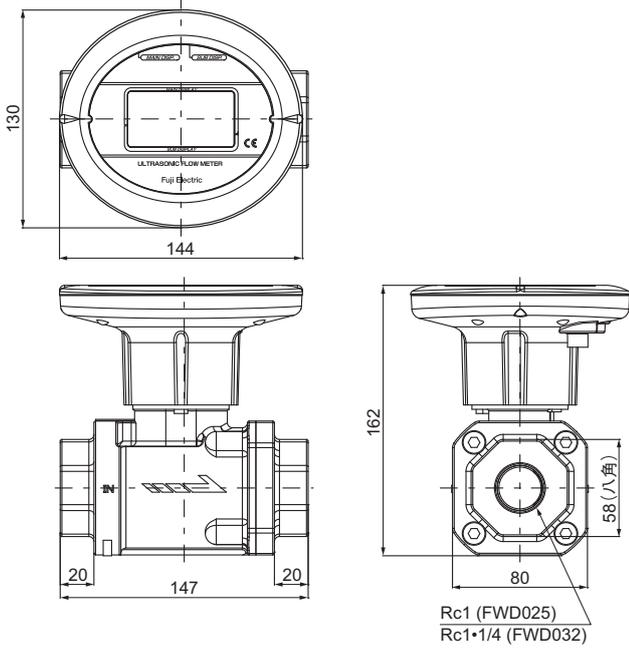
## 1) Specifications

Nominal diameter (mm)		25, 32, 40, 50, 65, 80, 100, 150, 200			
Power supply		DC24V±10% or Built-in battery type			
Applicable fluid		Air (Mainly air used in factories) or Nitrogen			
Temperature and humidity of fluid		-10~60°C, 90%RH or less			
Working pressure		0~Less than 1MPa (Gauge pressure)			
Flow-rate range (Actual flow) Accuracy	Nominal diameter (mm)	Flow-rate range (m <sup>3</sup> /h)	Accuracy		Low flow cutoff (m <sup>3</sup> /h)
	25	±0.6~35	±2.0% of rate	±5.0% of rate	±0.1
	32	±1.1~65	±3.5~35m <sup>3</sup> /h	±0.6~3.5m <sup>3</sup> /h	±0.2
	40	±1.3~80	±6.5~65m <sup>3</sup> /h	±1.1~6.5m <sup>3</sup> /h	±0.2
	50	±2.5~150	±8~80m <sup>3</sup> /h	±1.3~8m <sup>3</sup> /h	±0.4
	65	±4~240	±15~150m <sup>3</sup> /h	±2.5~15m <sup>3</sup> /h	±0.6
	80	±5~300	±24~240m <sup>3</sup> /h	±4~24m <sup>3</sup> /h	±0.8
	100	±10~500	±30~300m <sup>3</sup> /h	±5~30m <sup>3</sup> /h	±2.6
	150	±24~1200	±50~500m <sup>3</sup> /h	±10~50m <sup>3</sup> /h	±5.0
	200	±40~2000	±120~1200m <sup>3</sup> /h	±24~120m <sup>3</sup> /h	±9.0
Accuracy of conversion into NORMAL		±2.5% of rate (at 0.5MPa and normal temperature)			
Display	Accumulated flow volume	Forward flow indication mode	Accumulated flow volume (Total)		
		Reverse flow indication mode	Accumulated flow volume (Trip)		
	Instantaneous flow-rate	Forward flow indication mode	Forward accumulated flow volume (Total)		
		Reverse flow indication mode	Reverse accumulated flow volume (Total)		
	Temperature	main display or sub-display			
Pressure	3 digits				
Alarm	ALARM 1 (lights up): When an ultrasonic signal is small or cannot be received				
	ALARM 2 (blinks): When a communication line is short-circuited				
Output *1	Current output	ALARM 2 (lights up): When a battery voltage is low [Built-in battery type]			
		Sub-display (blinks): When temperature and pressure values show an abnormality			
Connection method	Current output	4~20mA DC (±0.5% FS), Load resistance:400Ω, "Instantaneous flow-rate", "pressure" and "temperature" are switched and selected by a button.			
	Contact output	2 output circuits of open drain outputs			
	Nominal diameter 25,32mm	Maximum load : 24VDC 10mA, Maximum frequency: 10Hz, Duty: 35~65%			
Installation position	Nominal diameter 40 to 80mm	screw connection (25mm: R1, 32mm: R1-1/4)			
	Nominal diameter 100 to 200mm	Wafer (Installation between JIS10K)			
Installation place	JIS 10K flange				
Storage temperature	Horizontally and vertically				
Material of fluid touching portions	Flow meter body: Aluminum alloy, PPS, fluorosilicone rubber etc				
Installation place	Indoors and outdoors (conforming to IP64)				
Storage temperature	-20 to +70° C, No dew condensation				

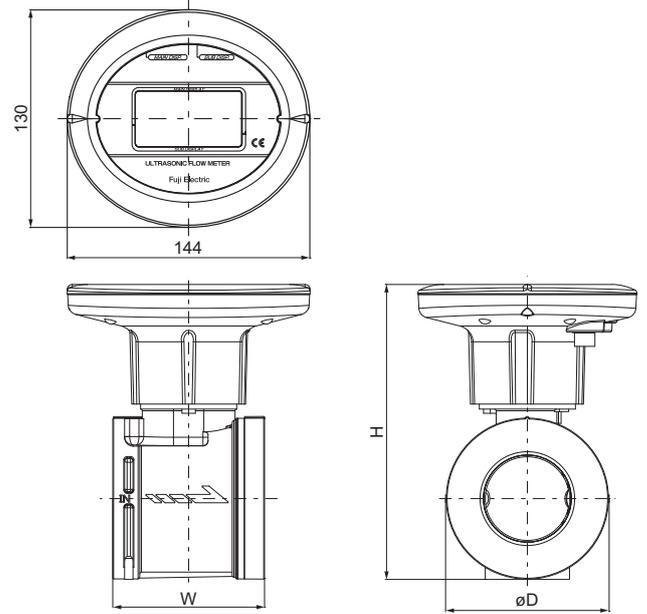
\*1 Outside application in case of Battery type.

2) Outline diagram (Unit: mm)

Nominal diameter 25, 32mm

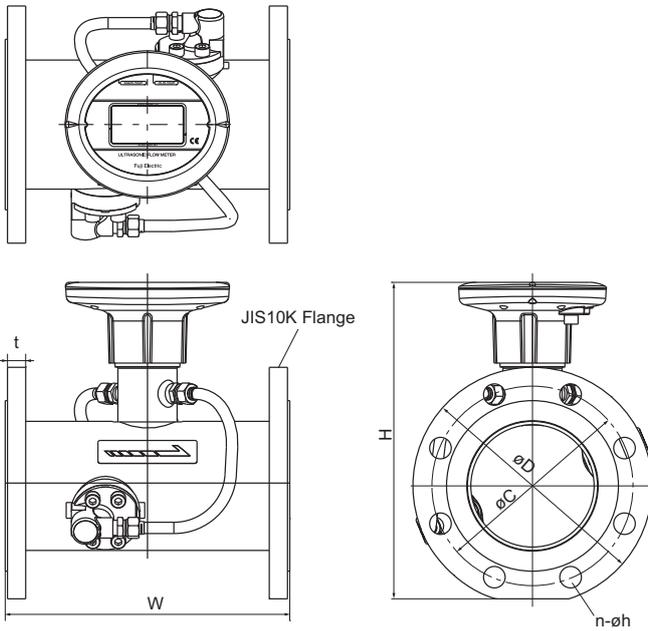


Nominal diameter 40 to 80mm



Type	W	H	øD	Mass. (kg)
FWD040	76	163	82	1.1
FWD050	90	176	97	1.3
FWD065	108	197	116	1.6
FWD080	117	220	127	1.8

Nominal diameter 100 to 200mm



Type	W	H	øD	øC	t	n	øh	Mass. (kg)
FWD100	250	280	210	175	18	8	19	10.0
FWD150	300	341	280	240	22	8	23	18.3
FWD200	350	391	330	290	22	12	23	24.1

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