

# INSTRUCTION MANUAL

UL400

## CLAMP-ON TYPE ULTRASONIC FLOWMETER

Thank you for purchasing our ultrasonic flow meter.

The Instruction Manual describes the standard specifications, installation procedure, operating methods, and handling precautions of the UL400 Clamp-on Type Ultrasonic Flow Meter. Be sure to read it prior to using it.

### STORAGE

If the instrument not used just after receipt of it, be sure to store it at the place as outlined below:

- Free from rain or water splash
- Stable temperature and humidity (0 to 50°C, 90%RH or less)
- Free from vibration
- Free from the corrosive gases



**TOKYO KEISO CO., LTD.**

B-06-E01

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## ■ NOTATION RULES

### Safety symbols

The manual uses the following symbols to describe what is strictly prohibited or cared about for your safety, and what should be observed in handling the product. Be sure to read the notices marked with those symbols.



If this indication is disregarded and this instrument is operated incorrectly, serious injury or fatal accident may result.



If this indication is disregarded and this instrument is operated incorrectly, injury or property damage may result.



Indicating procedures or information required to operate this product.

## ■ OPERATIONAL NOTES

### WARNING

This product is delivered after manufacturing and adjustment. Inspections have been conducted based on the optimum quality control method for industrial instruments. If any attempt is made to modify or change this instrument, it may fail to perform as intended or incompatibility or accidents may result. Do not modify or change this instrument in any way. If it is necessary to modify or change it, contact Tokyo Keiso Co., Ltd.

### CAUTION

The material of this product is described in the Approval drawing. Although we make every effort to select the optimal material for the customer's specifications, it may not be perfect due to the presence of foreign matter. Thus you are responsible for checking anti-corrosive and compatibility.

### WARNING

Be sure to operate the instrument within the ranges of the specifications for fluid pressure and temperature listed in the Approval drawing. If the instrument is operated out of these ranges, it may become defective or be damaged.

### WARNING

Although this product is delivered after manufacturing, adjustment and inspections have been conducted based on the optimum quality control method for industrial instruments, an unexpected defect may occur. If this product is used for process control that may result in a critical safety problem, take all necessary actions to maintain safety.

### CAUTION

Use this product only as an industrial instrument.

### WARNING

This UL400 converter belongs to "permanent connected" instrument. The power line should be connected to a "Switch" (or "Circuit Breaker") to be able to turn off the UL400 in any situation. Please confirm the following items when installing the switch:

1. Please consider the safety issue in factory to decide the location of the switch.
2. The switch should be easy for operation.
3. An indication is necessary for notifying which switch connected to UL400 converter.
4. Confirm that the power is turn off before opening the UL400 cover.

### WARNING

When removing this product from your process for maintenance or inspection, make sure there is no object to be measured remaining in the instrument. If the object is corrosive or toxic, the operator may be adversely affected.

# 1. OUTLINE

The UL400 is a clamp-on type ultrasonic flow meter capable of measuring a flow rate in the metal or plastic piping with a nominal diameter of 25~400 mm (UL430) or 25~1000 mm (UL450). An ultrasonic sensor is installed on the existing piping from the exterior by the clamp-on system, and the flow rate can be easily measured without contacting the measuring fluid because of no moving part or pressure loss. Pay special attention in installing the ultrasonic sensor because the measuring accuracy and stability very depend on the installation of the sensor.

# 2. CONTENTS OF PRODUCT

The UL400 is delivered, including the following. If you find any thing missing, contact our dealer.

No.	Contents	Quantity
1	Converter (UFC430/450)	1
2	Sensor (UFS430 / UFS450)	2
3	Signal cable in 10m (standard) with connector	2
4	Band to install sensor	1
5	Installation rail	2
6	Grease for sensor	1
7	Instruction manual	1
8	DATA Card	1
9	Support for 2" Pipe installation (* NOTE1)	2
10	Spare Fuse (* NOTE2)	2

<Note>

\* Note 1: Only supplied for 2" Pipe installation required.

\* Note 2: Subsidiary within the converter.

# 3. GENERAL PRECAUTIONS NOTES NOTES

## 3.1 Power supply

Pay attention to the following for the power supply to connect.

### 1) Voltage

Use the power source in the range of 100 to 240V for AC type converter (working voltage range: AC85~264V).

Use the power source 24DC for DC type converter (working voltage range: DC20~30V).

### 2) Frequency

Make it 50/60Hz for AC power source.

### 3) Common use with other power supply

Be sure to use the power supply for instrumentation, and avoid the common use with the power source for power.

### 4) Noise

When sources of a noise such as an inverter are located near, be sure remove a noise at the generation source

side using a noise filter.

### 5) Instantaneous power failure

Since it is an electric device, be careful not to cause instantaneous power failure.

## 3.2 Measurable fluid NOTES

Although any liquids can be measured, there is the following restriction.

### 1) Flow velocity

The minimum full scale which can be set up is 0.3 m/s in flow velocity conversion, but it cannot be correctly measured in the line in very slow velocity. Calculate the flow velocity in a full scale by the following formula, and confirm that the flow velocity is 0.3m/s or more.

Measurement accuracy is deteriorated at flow velocity of 1 m/s or less.

$$V = \frac{10^4 Q}{9\pi D^2}$$

$V$  : Flow velocity (m/s)

$Q$  : Flow rate (m<sup>3</sup>/h)

$D$  : Inside dia. of pipe (mm)

### 2) Reynolds number

When the Reynolds number "Re" calculated by the above formula is 10000 or less, the measurement becomes less accurate. Especially in case of the fluid of the high viscosity and the piping in small diameter, keep it in mind that Reynolds number becomes smaller.

$$Re = \frac{10^7 \rho Q}{9\mu\pi D}$$

$\rho$  : Density (g/cm<sup>3</sup>)

$Q$  : Flow rate (m<sup>3</sup>/h)

$\mu$  : Viscosity (mPa·s)

$D$  : Inside dia. of pipe (mm)

### 3) Acoustic velocity

The acoustic velocity of the fluid which can be setup is 1000 to 2500m/s.

### 4) Solids and bubbles

The UL400 has higher bubble resistance and slurry resistance than the conventional clamp-on type ultrasonic flow meters, but is not suitable for large quantity of them.

### 5) Kinematic viscosity (mm<sup>2</sup>/s)

Kinematic viscosity can be setup is 0.3~40 mm<sup>2</sup>/s.

### 6) Fluid temperature

Max 90°C (the temperature of the surface on the pipe).

### 3.3 Notes on measuring piping NOTES

#### 1) Measurable piping

Pipes which can be measured are as follows :

- Nominal diameter : 25 ~ 400mm (UL430) , 25~1000mm(UL450)
- Material :           Metals  
                          Plastic (PP, PVC, PVDF etc.)

#### 2) Installation position of ultrasonic sensor

- Avoid a welding line portion to install the ultrasonic sensor.
- For piping of an old iron, the ultrasonic wave may not be transmitted correctly due to the rust or corrosion etc., and the measurement may not be correctly made. In this case, the position to install the sensor is to be changed, and the proper place is to be selected.
- If there are the rust and thick coating at a place where the sensor is to be installed on the surface of piping, remove them.

## 4. SELECTION OF INSTALLATION PLACE

### 4.1 Converter NOTES

Regarding the installation place, the following conditions should be taken into consideration :

- 1) A place where the ambient temperature is  $-25^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ , and the humidity is less than 90%RH (without dew).  
In order that it can be used for the long time in the stabilized condition, it is recommended that it is to be installed in the place at normal temperature and humidity as much as possible.  
However, if it is less than  $-10^{\circ}\text{C}$  inside the converter, the indicator does not operate correctly.
- 2) A place with little vibration.
- 3) A place with little dust and corrosive gas.  
When unavoidably installing the converter in a place with much corrosive gas, perform the air purge.
- 4) A place where the sunshine does not hit directly.
- 5) A place where there is no possibility of this products inking into water.  
The waterproof is IP65 (Jet-proof).
- 6) A place without a possibility of bringing about the inductive interference.  
Avoid installing it near to the power apparatus etc.
- 7) A place where the maintenance and inspection can be easily performed.

### 4.2 Ultrasonic sensor NOTES

To install the ultrasonic sensor, take the following conditions into account :

- 1) **For outdoor installation, take suitable shading and waterproofing measures.**  
In case of installation in the field, consider the suitable shading and waterproofing measures to avoid the direct sunshine and rainwater.
- 2) **The piping should be always filled with water.**  
If the piping is not filled with water, a measurement error may result. Avoid a line where the fluid flows out of the piping at the time of stopping the flow, and select a place where the piping is always filled with water.
- 3) **The flat piping wall of at least 350mm or more is required.**  
In order to install a sensor rail, the flat tube wall of at least 350mm or more is required.  
(For more than 200mm in nominal diameter, 650mm is required.) Select an appropriate place.
- 4) **Avoid the place where the extremely big vibration, for instance, behind the pump and so on is expected.**  
The adhesion of the ultrasonic sensor to the tube wall is worsened by the vibration, which may result in poor

accuracy.

**5) Secure the required upstream and downstream straight lengths.**

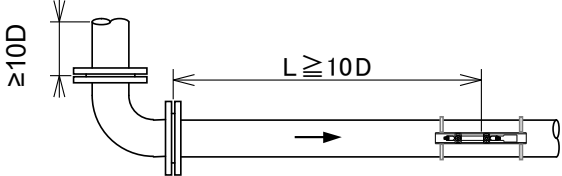
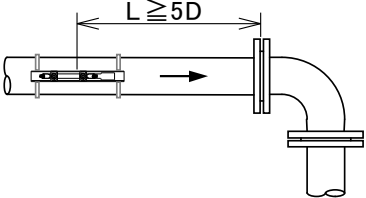
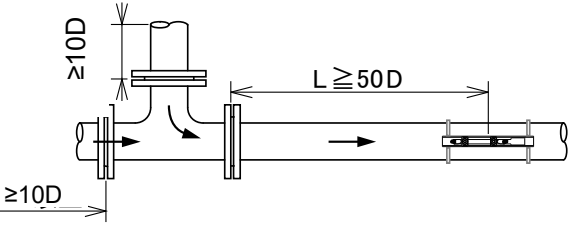
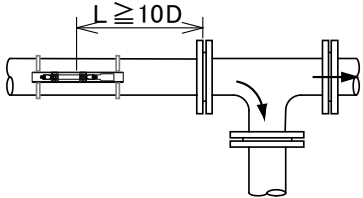
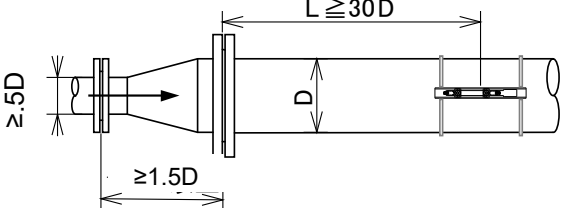
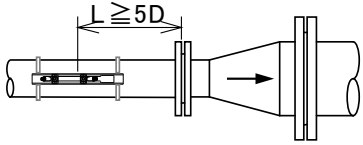
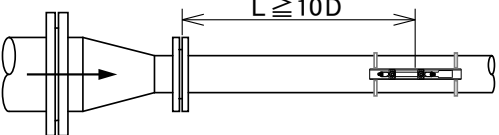
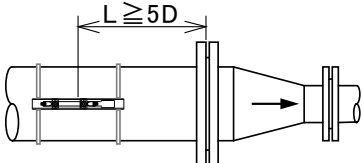
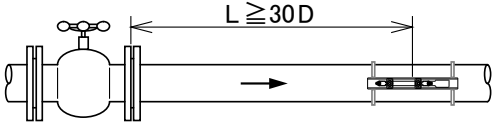
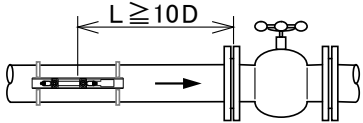
In order to obtain the flow with the axial symmetry, the below-mentioned straight pipe lengths are required. Otherwise, the accuracy will be out of the accuracy range.

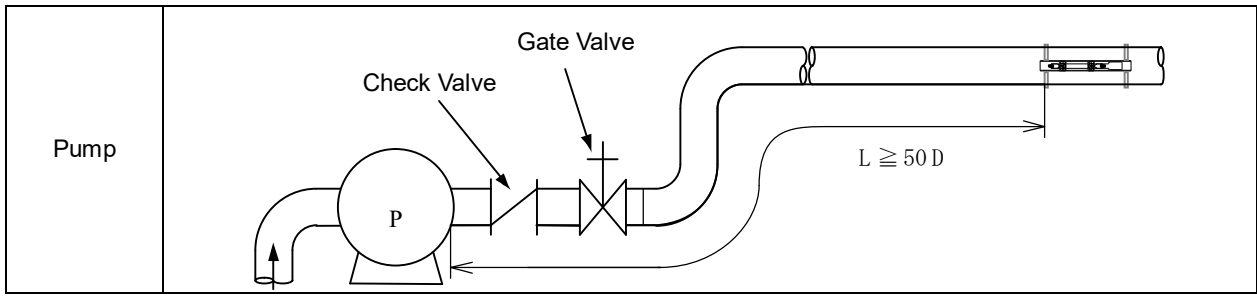
※If the required straight lengths cannot be secured, measurement may go out of our accuracy range.

If a whirlpool or revolving stream is observed, make the straight pipe lengths longer or install a rectifier.

Table of required straight run – up stream and down stream

D : Pipe Nominal Diameter

Division	Upstream Straight Pipe Length	Downstream Straight Pipe Length
90°Bend		
Tee		
Expanding Pipe		
Contracting Pipe		
Valves	 <p data-bbox="491 1729 810 1780">When controlling the flow rate with the upstream valve</p>	 <p data-bbox="1040 1729 1359 1780">When controlling the flow rate with the downstream valve</p>



Source : Japanese Industrial Standards Committee JEMIS-032

**6) In performing the measurement of flow rate of a liquid mixture process, install a sensor downstream more than 30D away from the point of being mixed.**

The measurement made near to the mixing point may cause the fluctuation of output.

**7) Other notes**

The other notes are shown in Fig. 4.1 to Fig. 4.5. Refer to these figures carefully. Pay attention to them.

Prevent the air bubbles from collecting at the top of pipe by either installing it upward or raising the flow velocity.

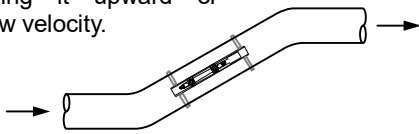


Fig 4.1

Install it at the lower position of pipe in discharge and delivery lines.

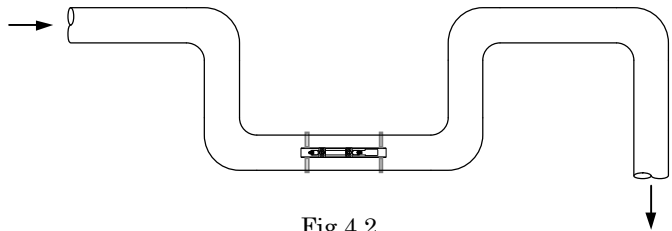


Fig 4.2

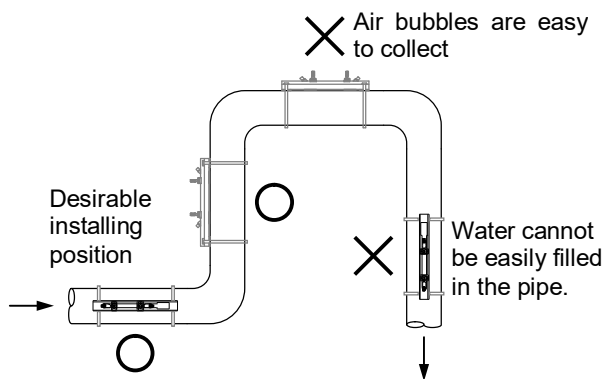


Fig 4.3

Avoid the influence by the air bubbles, making the ultrasonic transmitting face to be parallel.

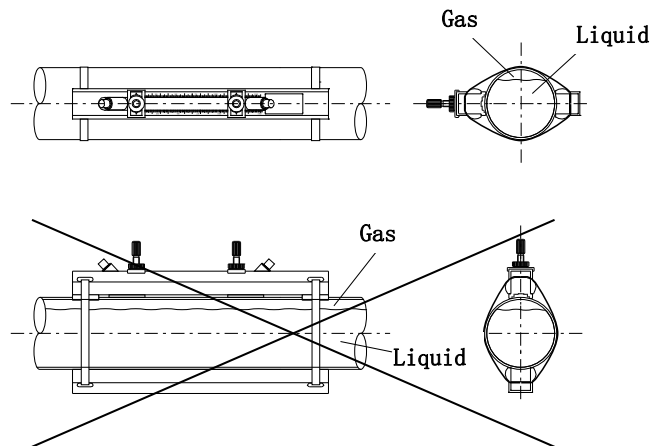


Fig 4.4

Avoid the influence by cavitation by installing a flow adjustment valve downstream.

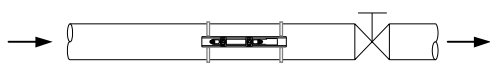


Fig 4.5

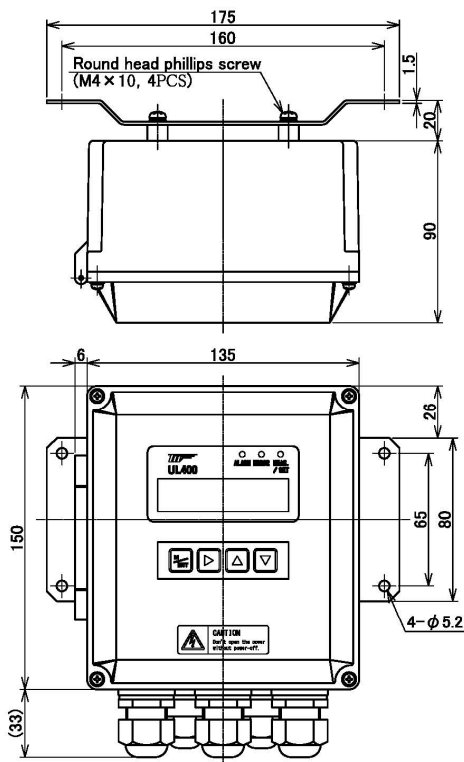


## 5. INSTALLATION

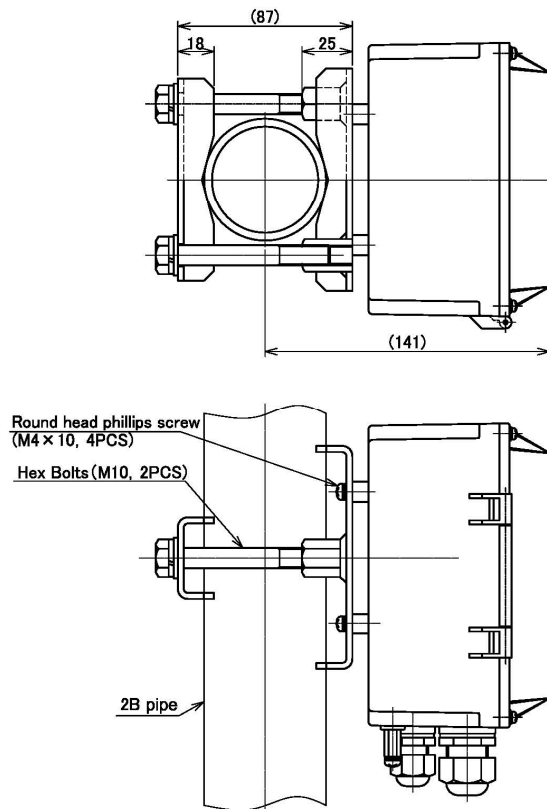
### 5.1 Installation of converter

There are two types of installation available, one is wall mounts type, the other is 2B installation. In either case, mount it by making the cable entry part downward. If mounted sideward or upward, it may result in causing the malfunction.

a) Wall mounts type



b) 2B mounts type



### 5.2 Wiring of converter NOTES

#### 5.2.1 Notes in wiring

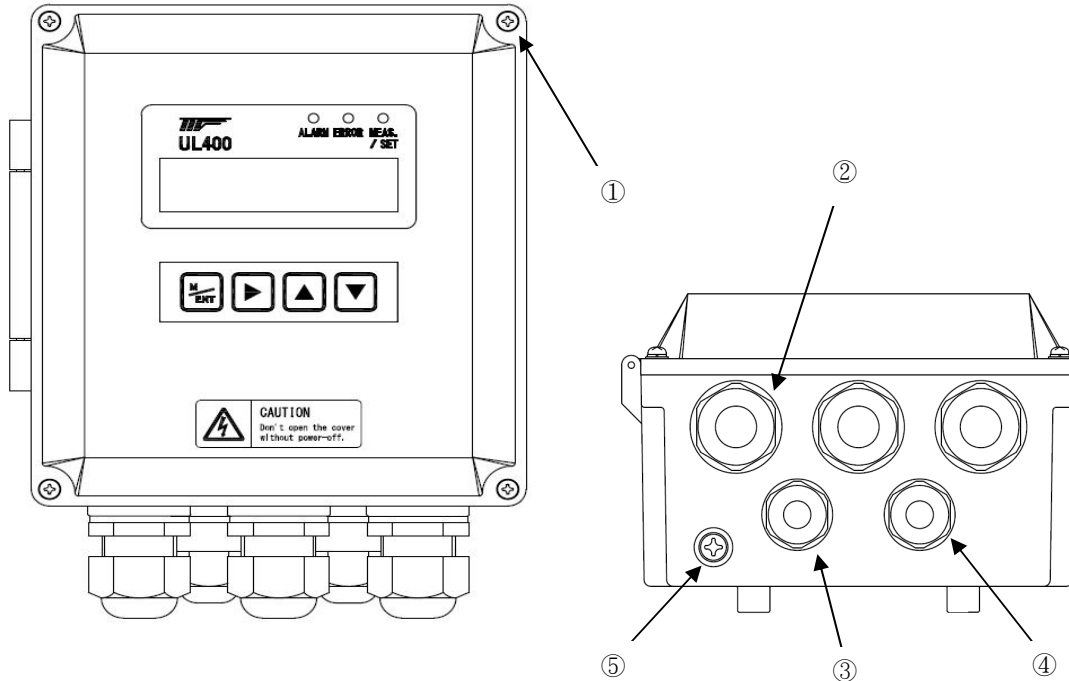
- 1) The signal cable and output signal cable between the ultrasonic sensor and converter should be separated from the power supply line or power line etc. Lay the cables not to approach the power apparatus. It is recommended that the electric wire tube is used for the separation of each cable.
- 2) When connecting the exclusive cable, insert the wire into the waterproof connector in the back in the receptacle side, and turn it clockwise securely until it clicks.
- 3) When connecting cable core to the terminal, insert it to the back of the terminal, but do not fasten the terminal screw too much. Otherwise, the screw may happen to break.

- 4) Ensure waterproofing processing of cable entries.

### 5.2.2 Terminals

When opening the cover of UL400 converter, there are the terminals to connect the electric wire.

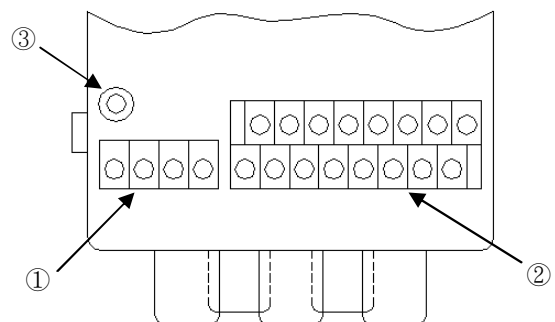
- Release 4 cover screws to open the UL400 cover. There are 3 waterproof connectors for common cable, 2 waterproof connectors for sensor connection and 1 cable ground connector.



No.	Name
①	Cover Screw
②	Waterproof connector for common cable
③	Waterproof connector for upstream sensor connection
④	Waterproof connector for downstream sensor connection
⑤	Cable ground

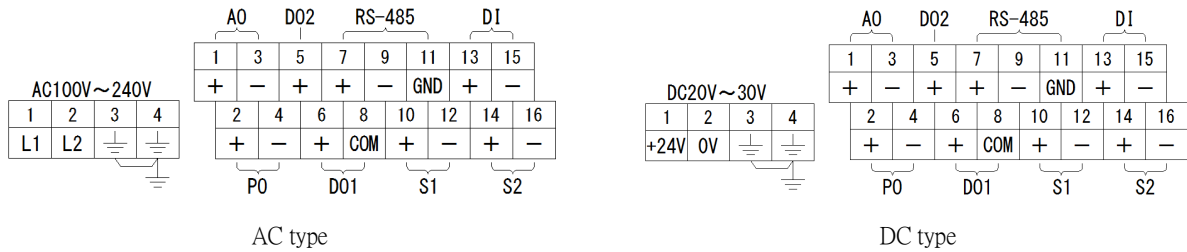
- Interior terminal layout

No	Name
①	Power supply terminal
②	Signal terminal
③	Fuse holder



- Enlarged View of Terminal Block

UL400 supply AC and DC type to choose, there are different representations according to them.



Connector	Sign Polarity	Contents	Connector
AC Type power supply terminal	1	L1	Power supply ( AC100~240V )
	2	L2	
	3, 4	⏏	
DC type power supply terminal	1	+24V	power supply ( DC20~30V )
	2	0V	
	3, 4	⏏	
Signal terminal	1	AO+	Analog output, output current DC4-20mA
	3	AO-	
	6	DO1+	Status output DO1 (Open collector)
	5	DO2+	Status output DO2 (Open collector)
	8	DCOM	Status output common
	7	RS485+	RS485 +
	9	RS485-	RS485 -
	11	RS485 GND	RS485 ground
	13	DI+	Totalizing reset input (Short trigger)
	15	DI-	
	2	PO+	Totalizing pulse output (Open collector)
	4	PO-	
	10	S1+	Upstream sensor terminal
	12	S1-	
14	S2+	Downstream sensor terminal	
16	S2-		

### 5.2.3 Cable

#### 1) Cable between ultrasonic sensor and converter

It is recommended to use the attached exclusive coaxial cable. Unless otherwise specified, the standard cable is 10m in length.

#### 2) Cable for power supply and output signal

Use the cables whose outside diameter is 6 to 12. (Customer's scope of supply)  
(Vinyl sheathed cable, Vinyl cable etc.)


#### 3) RS485 signal cable

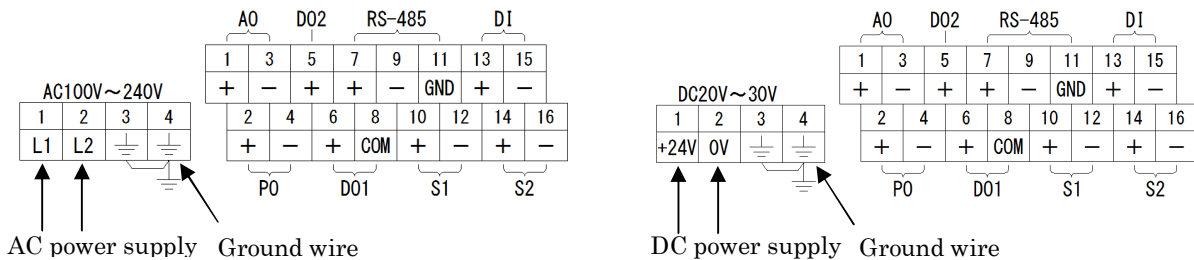
Please prepare it when needed.

### 5.2.4 Wiring between ultrasonic sensor and converter

For the connection of the ultrasonic sensor to the converter, use Y-type connector at both ends of the exclusive cable. The words "S1" and "S2" are shown at the part of signal terminal block of converter. Connect the upstream sensor cable to the "S1" side, and the downstream sensor cable to the "S2" side. The transparent coated wire of sensor cable is "+" and the black coated wire is "-".

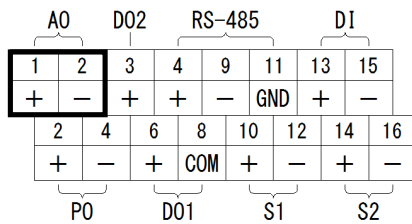
### 5.2.5 Wiring of power supply Caution

- 1) It is to be confirmed that the voltage of converter conforms to the supply voltage to be connected.
- 2) Wire a power supply to L1 and 2 L2 of when using AC type.
- 3) Connect the positive of the power supply to +24 V and the negative to 0 V when using DC type.
- 4) Concerning the power supply, use the power supply for the instrumentation, and avoid sharing the power supply with the one for the power.
- 5) Confirm that the supply voltage is within the specified range by the terminal of converter.
- 6) Wire Ground terminal to the  terminal of the power supply. (Class D grounding, The allowable resistance is 100 or less)



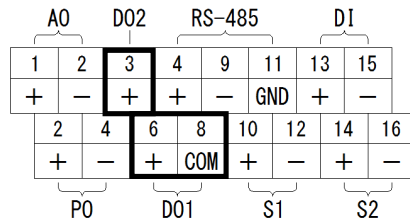
### 5.2.6 Wiring of Analog Output

To use the analog output function, connect a receiver to AO + and AO - of signal terminal. The allowable load resistance is 500 or less.



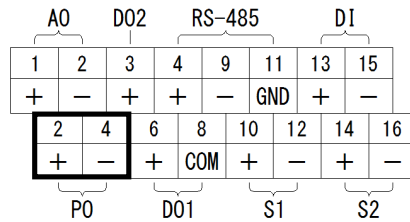
### 5.2.7 Wiring of Status Output (DO1 and DO2)

To use the status output function, connect a receiver to the signal terminals DO1 and DCOM, DO2 and DCOM. The status output of this instrument is open collector type. The load voltage and current should be DC 30V and 50 mA or less, and be sure to insert a current limiting resistor. Low level is below than 2V.



### 5.2.8 Wiring of Totalizing Pulse Output

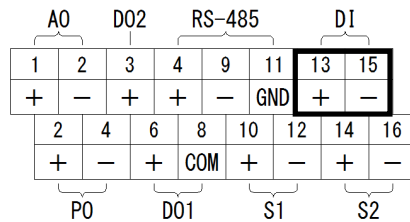
To use the totalizing pulse output function, connect a receiver to PO+ and PO- of signal terminal. The pulse output of this instrument is open collector type. The load voltage and current should be DC30V and 50 mA or less, and be sure to insert a current limiting resistor. Low level is below than 2V.



### 5.2.9 Wiring of totalizing reset terminal

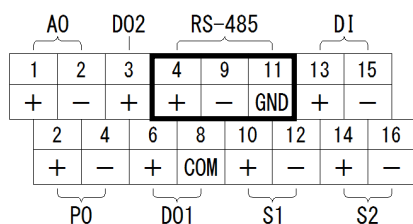
To reset a totalizing display value from the outside, connect a contact (one-shot) to DI+ and DI- of signal terminal.

Remark) if the contact is closed, the counter function can't work. Be sure not to reset it in close status.



### 5.2.10 Wiring of RS-485 serial output

To use the communication function, connect a communication cable to RS485+, RS485- and RS485 GND of signal terminal.



### 5.2.11 Power fuse

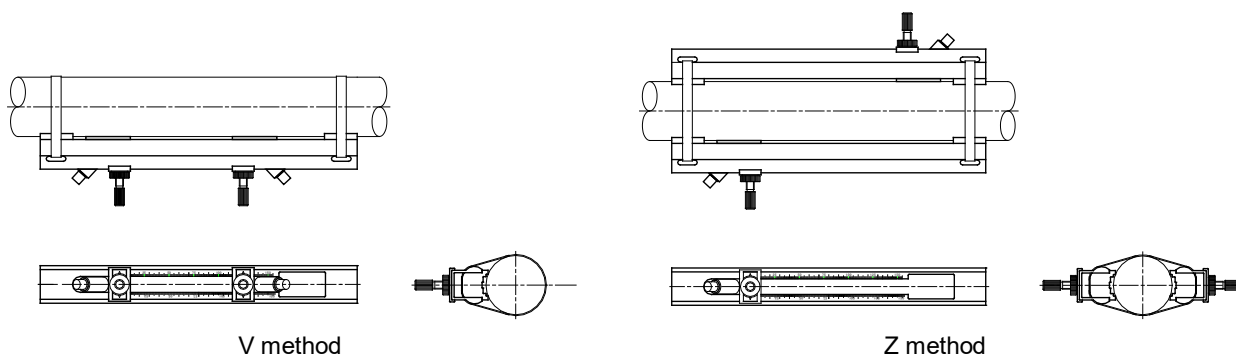
A spare fuse is included in the product.

To change power fuse, unplug the original fuse vertically and insert the spare to the end vertically.

## 5.3 Installation of ultrasonic sensor Notes

### 5.3.1 Installation of ultrasonic sensor

There are two ultrasonic sensors mounting methods available, "V" path (reflex mode) and "Z" path (Diagonal mode), depending on the kind of piping and the pipe diameter.



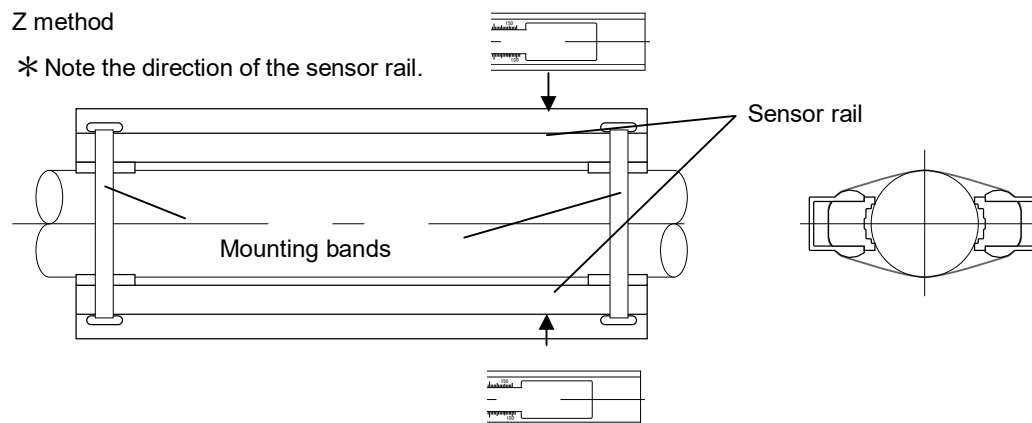
#### a) Mounting of the sensor rail

Using the mounting bands, mount the piping as shown in the figure below.

Note: When mounting to the horizontal piping, ensure that an ultrasonic wave transmission route is made horizontal. If the transmission route is made vertical, the bubbles in the pipe may block transmission of the ultrasonic wave, disabling normal operation.

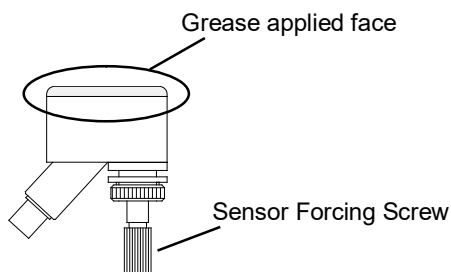
Z method

\* Note the direction of the sensor rail.



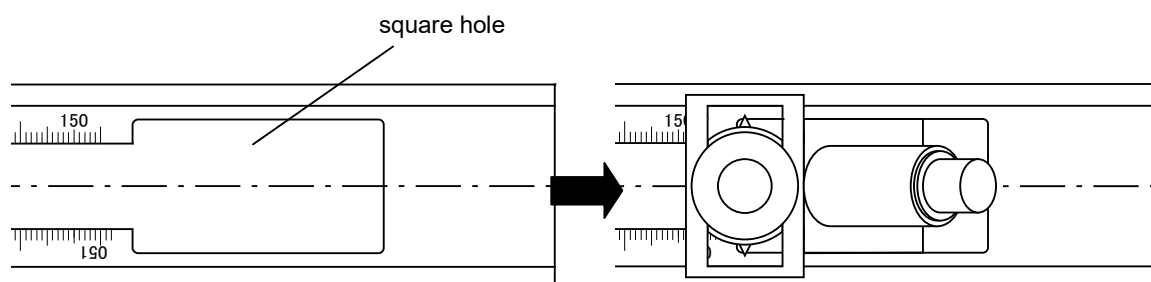
**b) Application of grease**

Apply the grease to the face where the ultrasonic sensor touches the wall tube in order to eliminate the air space between the ultrasonic sensor and the wall tube.



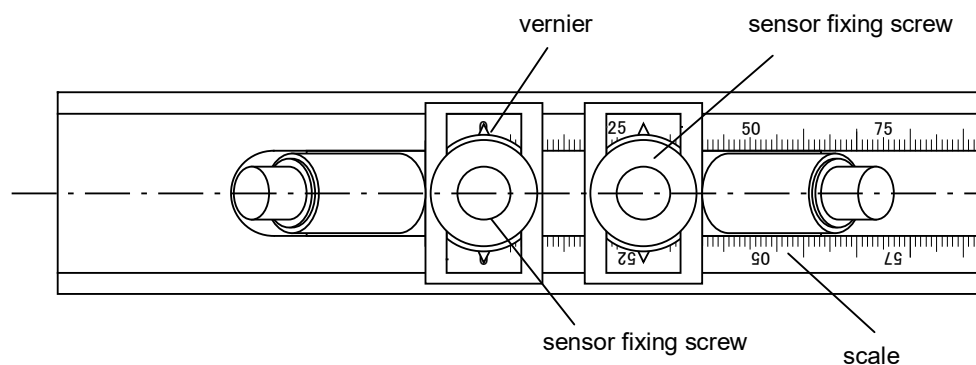
**c) Mounting of the ultrasonic sensor**

Put the ultrasonic sensor into the rail through a square hole. When this is done, turn the sensor pressing screw fully counterclockwise to keep the grease applied inside the rail, so that the applied grease will not be adhered to unintended areas of the piping or the rail.



**d) Setup of distance between sensors**

By inputting the data required for the converter, the distance between sensors is automatically calculated and displayed. (Confirm the Install Distance (Distance between sensors) of 『6.6.2 Setup of Basic Parameters [1.BASIC] 』) Turn the sensor fixing screw counterclockwise to loosen it, and align the tip of the vernier with the scale to set up the distance between the sensor.



**5.3.2 Fixation of ultrasonic sensor**



Note

After the fixation to piping is completed, a sensor pressing screw is turned clockwise to make the sensor stick

firmly to the piping.

### 5.3.3 Connection of Exclusive Cable Note

After fixing the sensor, connect S1 (upstream side) and S2 (downstream side) of a signal cable correctly.

### 5.3.4 Waterproof measure for sensor

The waterproof class of UL400 is IP65. Sensor may be flooded by dew condensation on insulation materials or rainwater accumulated in a waterproof cover when outdoor installation, so please set the drainage holes.

When installing the ultrasonic sensor onto the outdoor piping:

- Waterproof property of the sensor is assured only after connecting the exclusive signal cable. After fixing the sensor, be sure to connect the cable, or take some water resisting measure.
- Grease for a coupling may be washed away by rainwater, impairing long-term stability. If this is case, it is recommended to take some water resisting measure in the field.



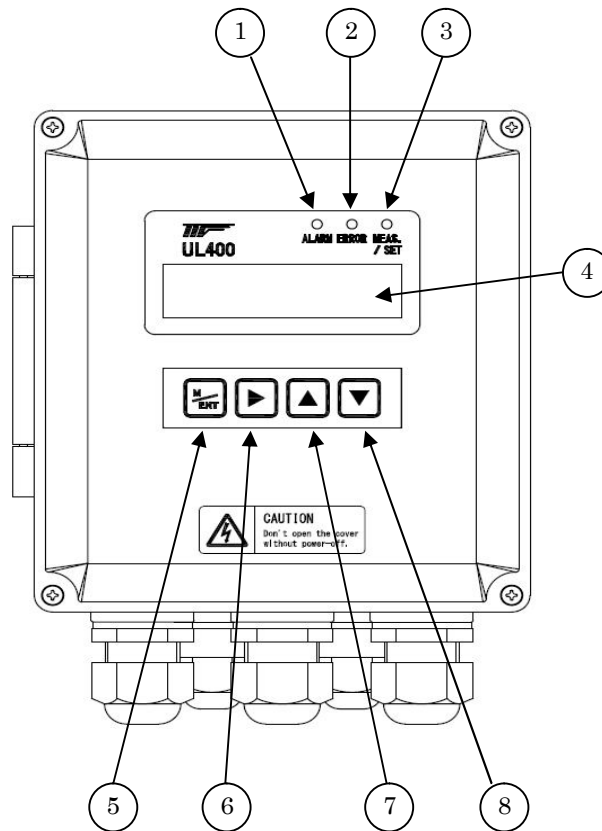
## 6. OPERATION OF CONVERTER

### 6.1 Necessity of setup

If the specifications are presented at the time of ordering the UL400 ultrasonic flowmeter, it will be delivered with the prescribed data set up in the converter with Tag No. (If you confirm the combination method of converter and sensors and mount the sensors to the piping according to the install distance set up in the converter, it can be operated only by making zero point adjustment described later.)

If the above setup is not made, or if the operation conditions are changed, the setup is to be performed in accordance with the below-mentioned procedure.

### 6.2 Operation part



No.	Name	Function
①	Alarm LED	working correctly⇒ LED off, alarm happen⇒ LED on
②	Error LED	working correctly⇒ LED off, error happen⇒ LED on
③	Status LED	Green: forward flow / Orange: reverse flow / Red: setting now
④	LCD display	Display of flow rate, tantalization and setup parameter
⑤	M/ENT key	Switch the measuring and setting mode. Decision of setup
⑥	SHIFT key	Refer to 6.3 Basic Key Operation
⑦	UP key	
⑧	DOWN key	

Refer to 7.2.2 for more detailed functions of LED.





### 6.3 Basic key operation

There are 4 setting keys including M/ENT in the converter of UL400.

Holding down M/ENT can switch the operation mode between measurement and setup.

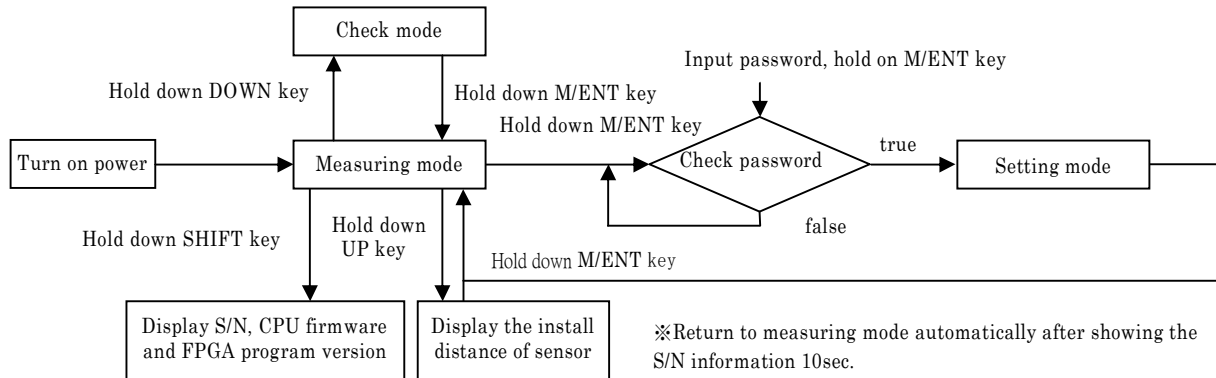
To change parameter, go to the setting mode and use setting keys to change its setting. In a parameter menu, when a setting value is not right, an error message is displayed. Recheck the contents of the setting and redo the setup.

• Functions of Setting Keys

Name	Operating condition	
	Measuring mode	Setting mode
M/ENT key (MENU/ENTER key) 	Holding down to enter setting mode by inputting the right password	Determine parameter and numerical value Return to measuring mode by holding down the M/ENT key
UP key 	Holding down to display the install distance of sensor. After 10sec, return to measuring mode automatically.(refer to 6.6.2.12)	Change parameter menu/item Increase the setting value
DOWN key 	Holding down to enter the check mode.	Change parameter menu/item Decrease the setting value
SHIFT key 	Holding down to display the S/N, CPU firmware and FPGA program version. After 10 sec, return to measuring mode automatically.	Enter the parameter menu/item. Shift the numeric position of setting value

## 6.4 Flowchart for data setup

There are measuring, setting and check three kinds of mode for UL400 as shown below. The movement between each mode is performed by M/ENT, SHIFT, UP and DOWN key.



### 6.4.1 Measuring mode

The measured flow rate is displayed and output in the LCD screen according to setting parameters of converter. What is displayed and output can be changed by setting.

### 6.4.2 Setting mode

This mode is to setup various parameters of the converter. Holding down M/ENT key in the measuring mode to input the password and then press M/ENT key. If the password is correct, the mode is changed over. Password has two kinds. The user password default is "0000" and can be changed. The maker password does not make public and only for maintenance staffs. Inputting the user password can choose 1.Basic~6.Advanced parameter menu. Inputting the marker password can choose 1.Basic ~ 7.Maker Param. parameter menu. Measurement and output continues in the setting mode, but the mode 『AO test』, 『PulseOut test』, 『Flow test』of『7.Maker Param.』, the output changes according to the setting test. Setting mode consists of 7 kinds of parameter menu depending on the function.

#### 1. Basic ..... Setup of basic items

Set up or change the basic items related to measurement, such as the piping dimensions, full-scale flow rate, etc.

#### 2. Totalization ..... Totalizing setup

Set up totalizing function.

#### 3. Display ..... Display setup

Set up LCD Screen display in measuring mode.

#### 4. Operation ..... Setup of measurement parameter

Set up the items related to measurement operation.

#### 5. Communication ..... Setup of communication function

Set up the items related to communication function and others.

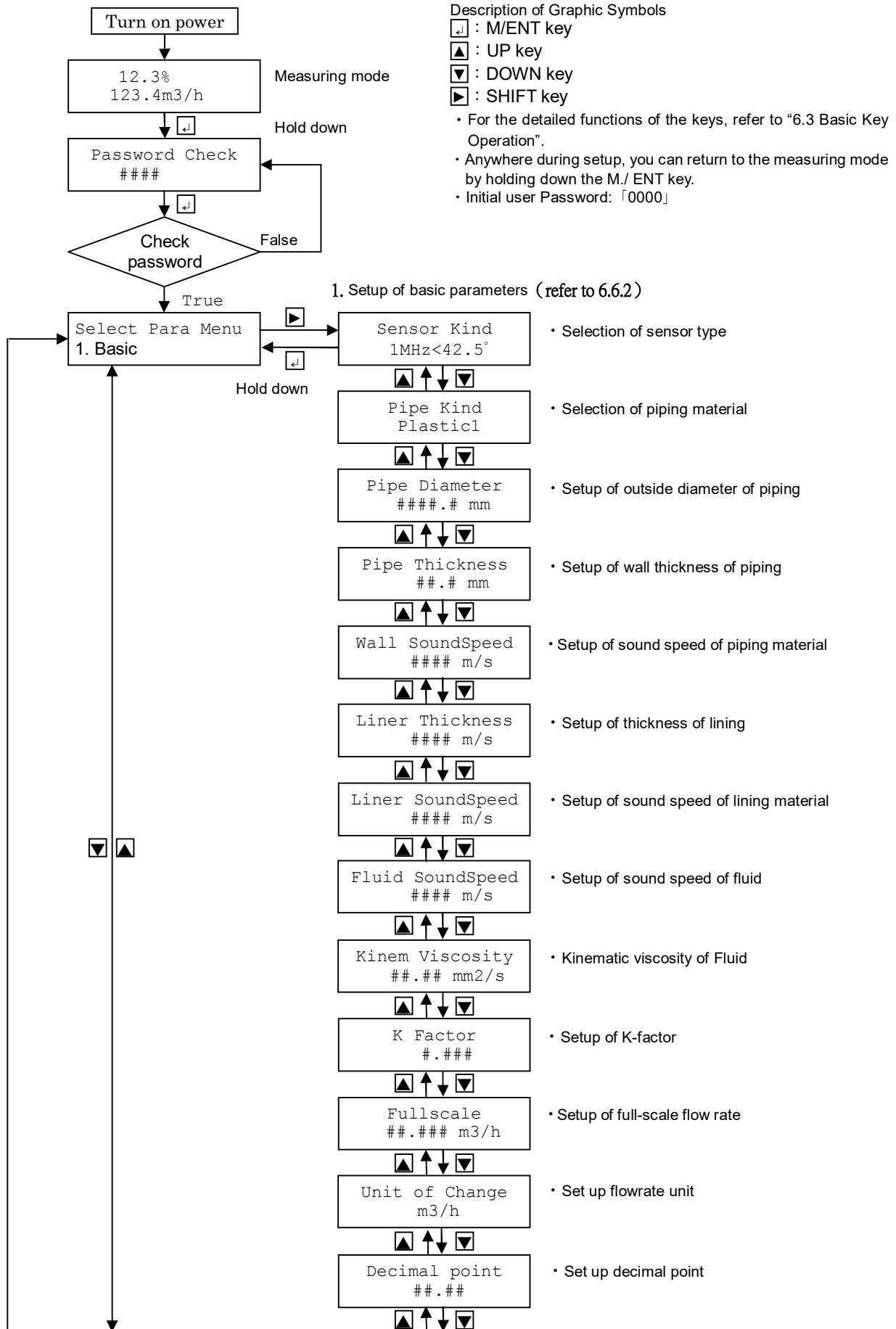
#### 6. Advanced ..... Setup of Advanced function

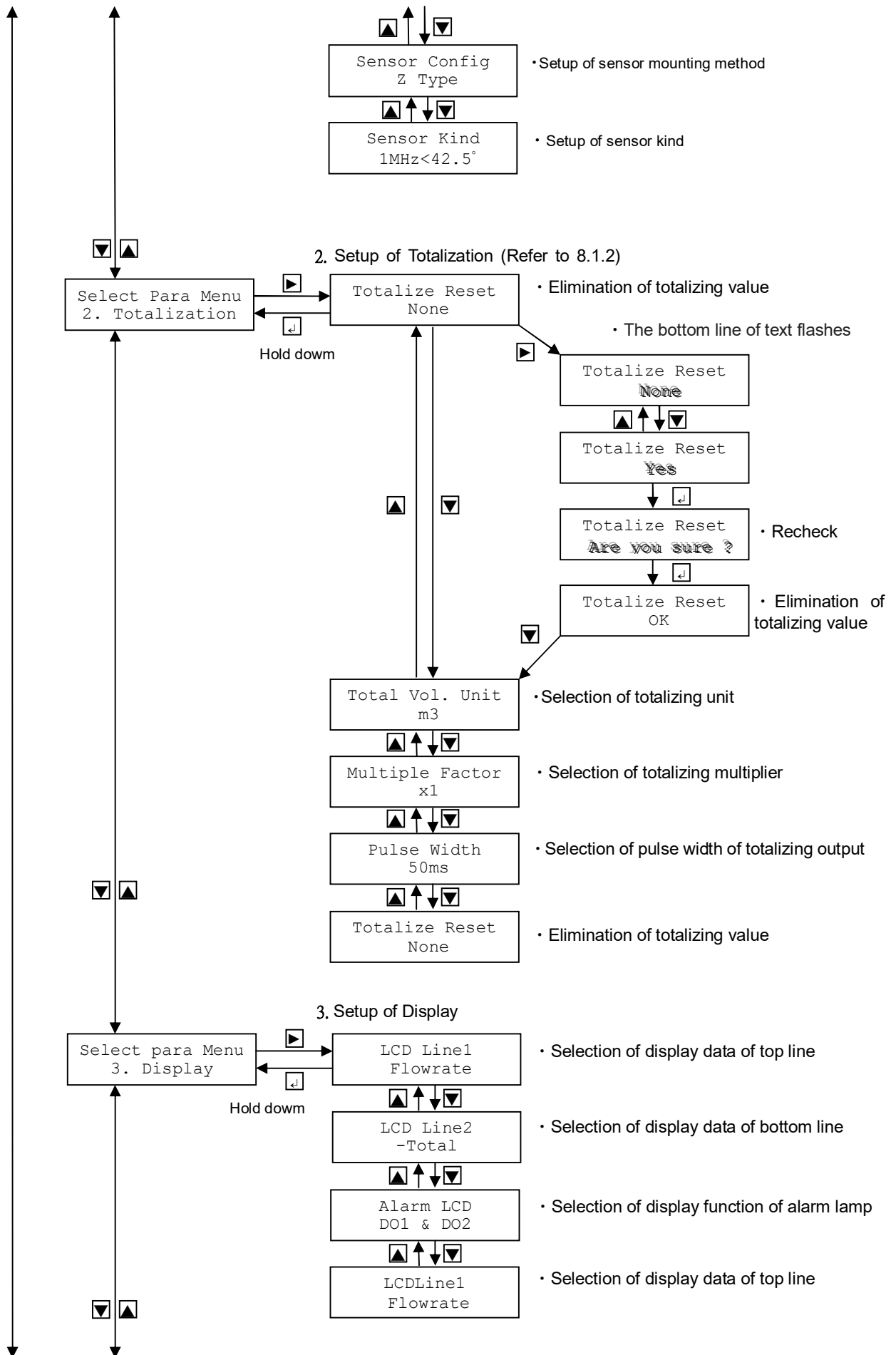
Set up user password and the default of totalizing value.

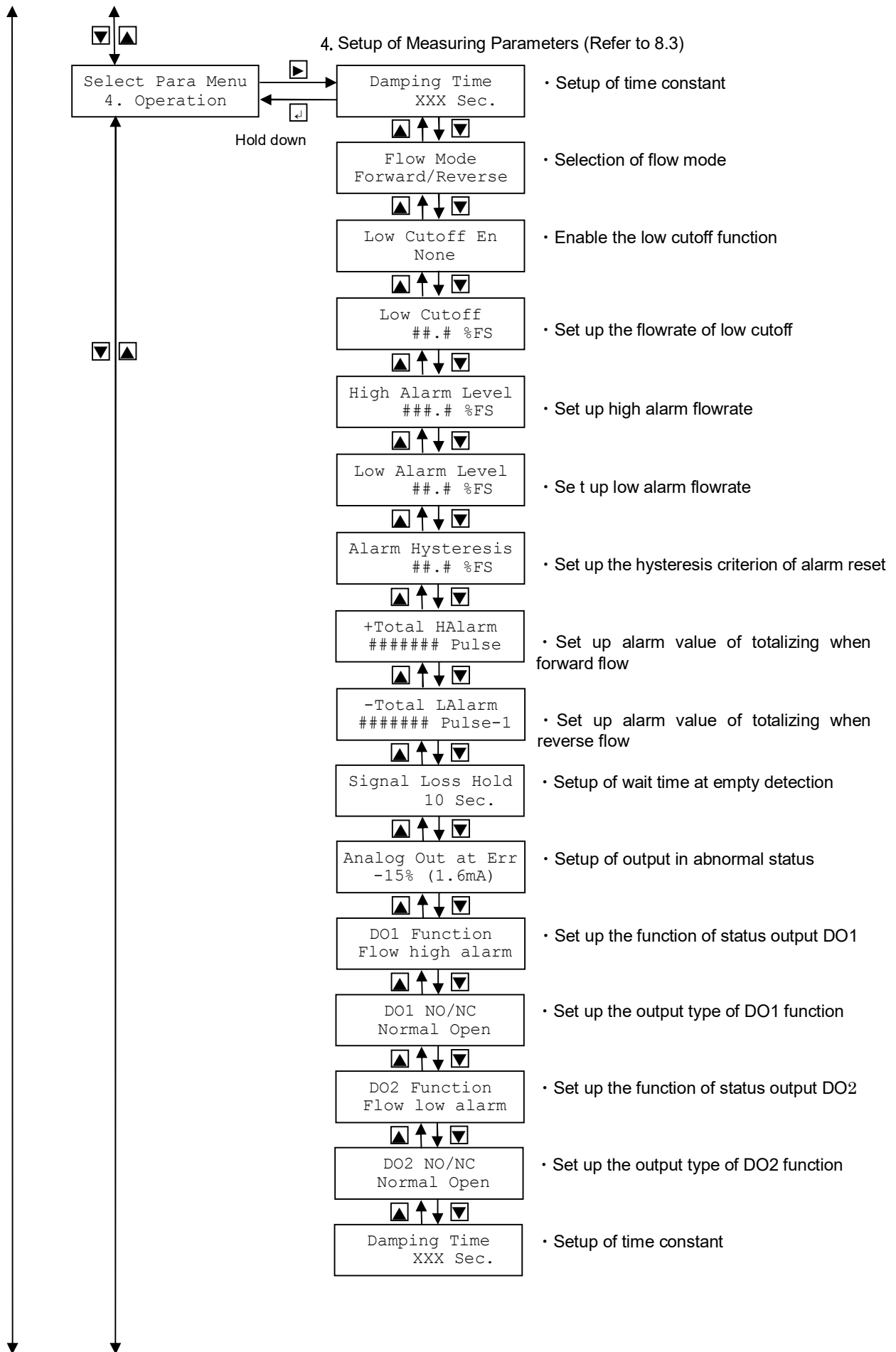
#### 7. Maker Param. .... Maker parameters

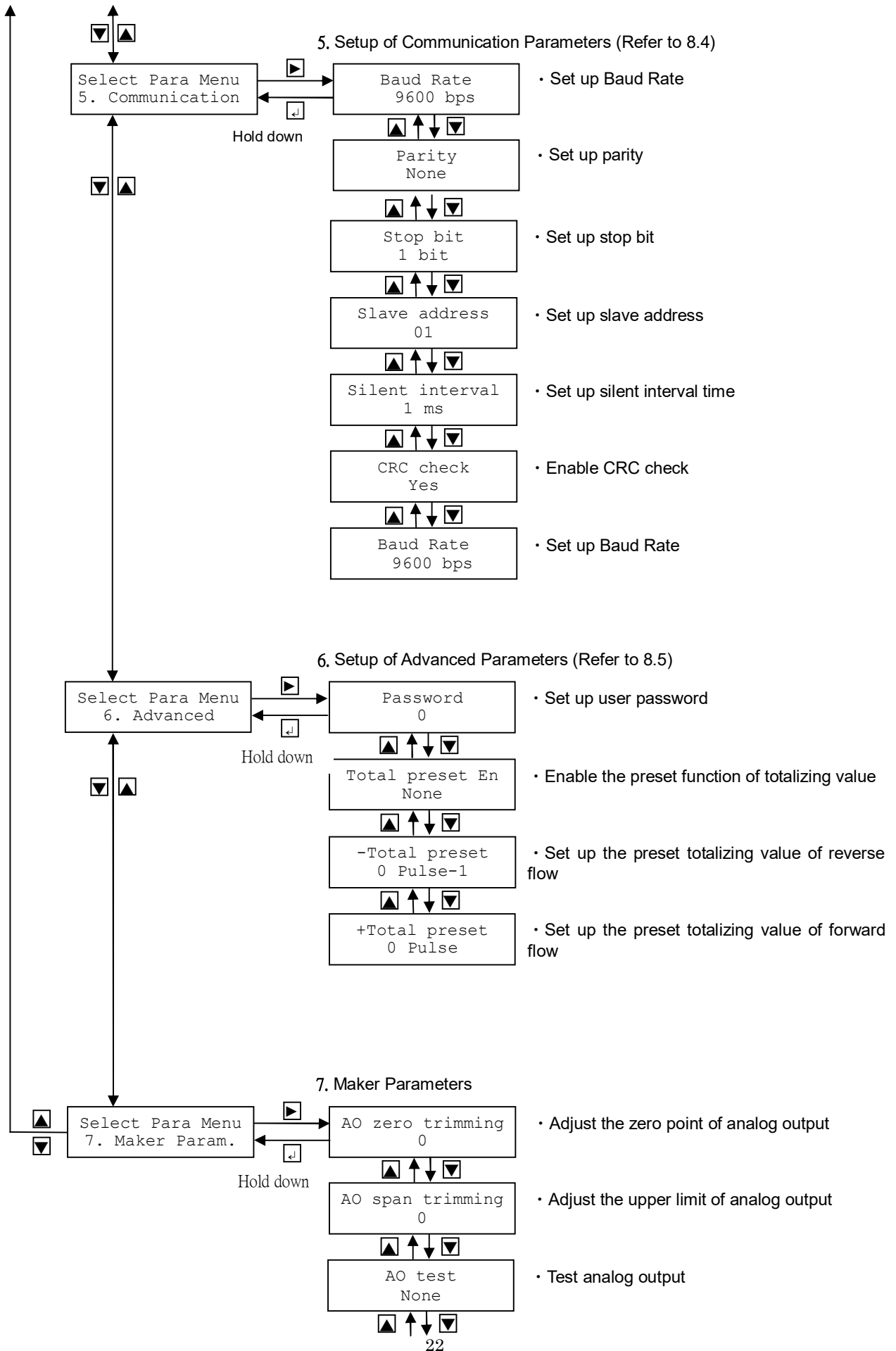
Initialize the parameters and change measurement parameters without needed change generally.

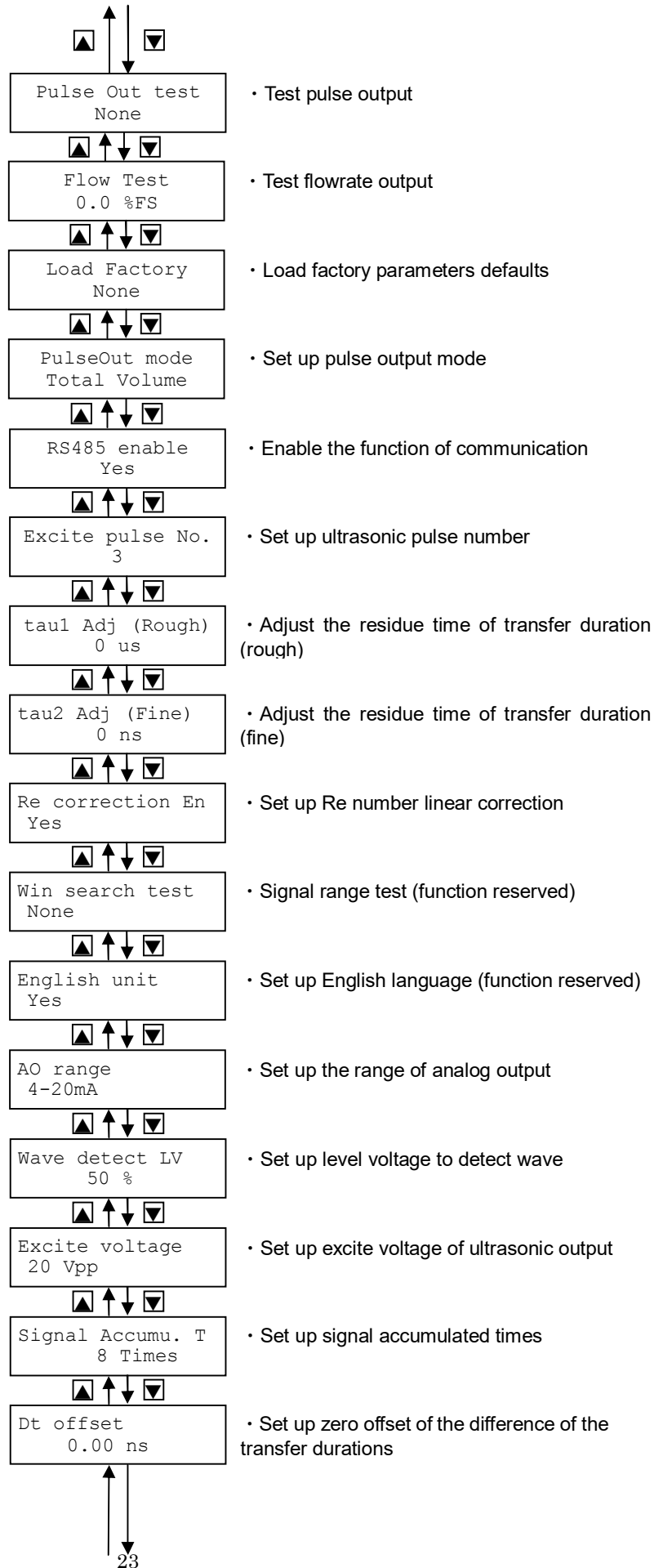
Flowchart of setting mode



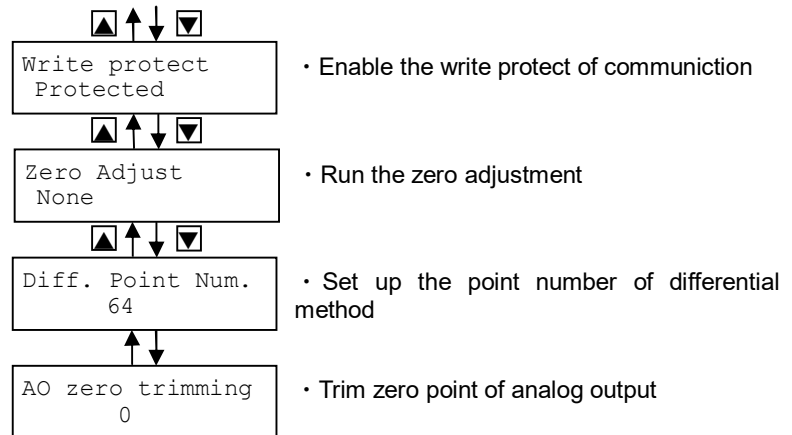












### 6.4.3 Check mode

Check the output function of UL400 or confirm the error message when error occurs. There are 4 check functions following below.

1. Analog Check ..... Check the analog output function
2. DO Check ..... Check the status output(alarm contact ) function
3. Pulse Check ..... Check the pulse output function of totalizing or flowrate
4. Error Check ..... Check the message when setting error

### 6.4.4 Display the install distance of sensor

The theoretical distance (Ini Dist) of sensor can be showed. In addition, the measured fluid sound speed (Spd) and recommended distance (Dis) can also be showed. Please refer to 6.6.2 14) for more information.

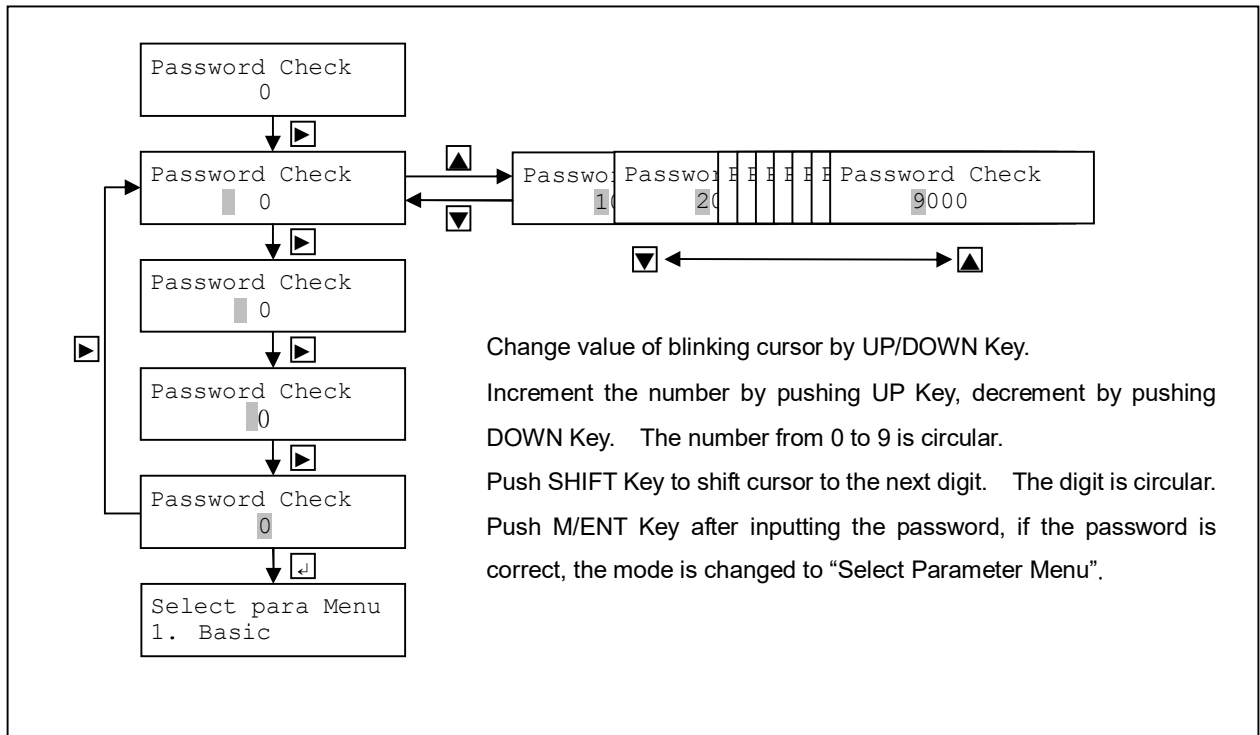
## 6.5 Setting procedure of parameters

### 6.5.1 Input of password

Hold down M/ENT key in the measuring mode to check password before entering setting mode. Use UP, DOWN, and SHIFT keys to input a 4-digit number and press the M/ENT key. If the user password is correct, the control shifts to the parameter setting mode.

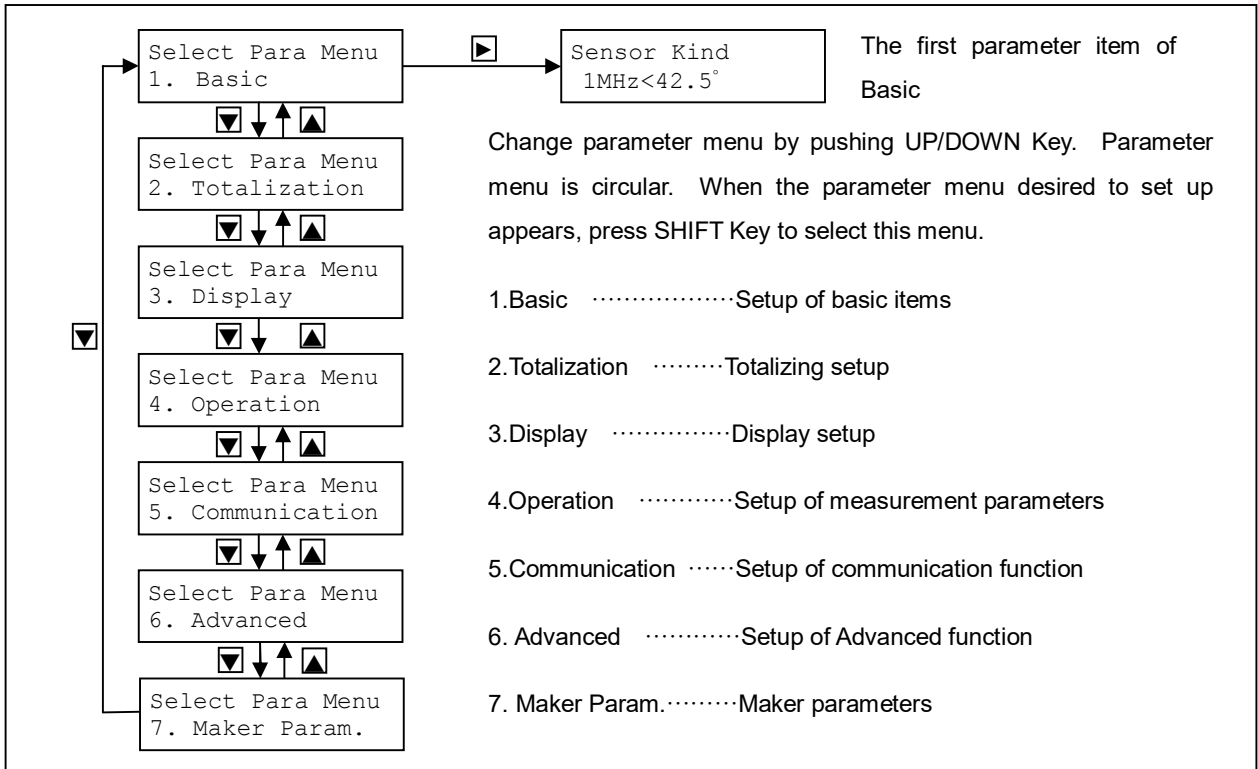
**NOTE: Initial Password is "0000"**

- The method of password input



### 6.5.2 Select parameter menu

Use the UP and DOWN keys to change the parameter menu, and press the SHIFT key to select the parameter menu.

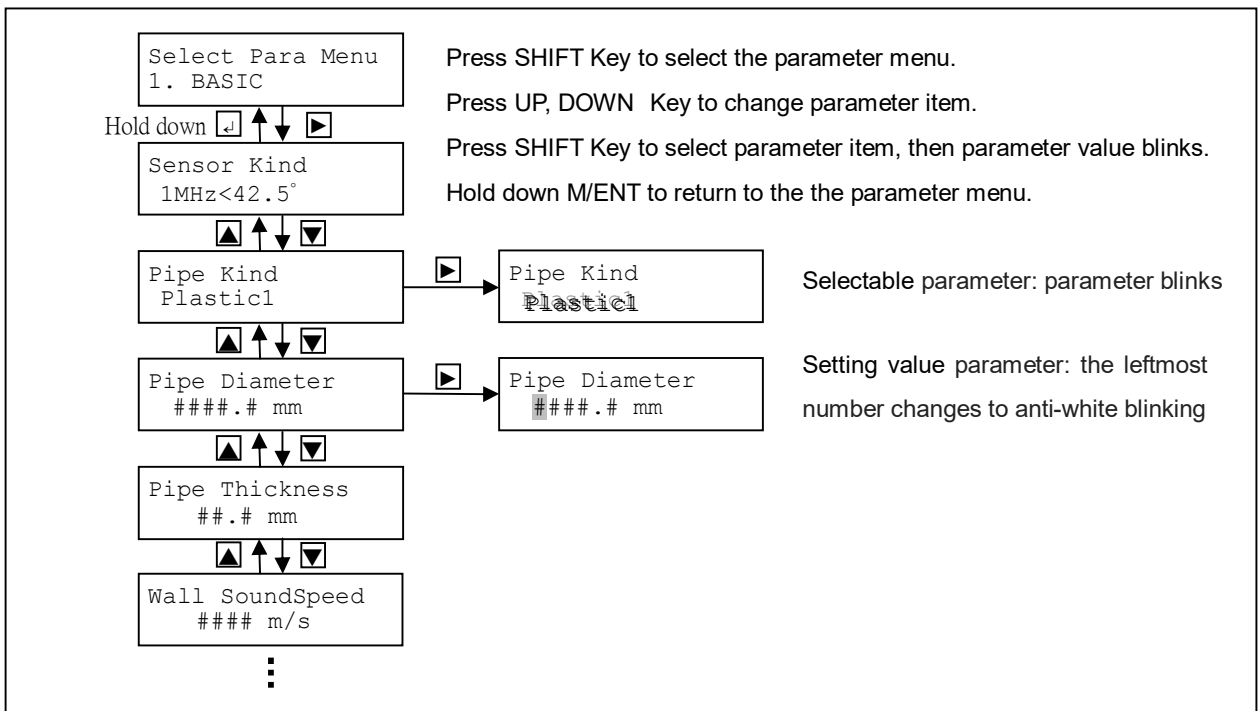


### 6.5.3 Setting Parameters

After pressing SHIFT Key to select the parameter menu, use the UP and DOWN keys to change the parameter item. When press SHIFT key to select the desired item, the parameter will blink. Change a value with the UP and DOWN, press SHIFT to set the parameter. Press M/ENT key to confirm the change after finishing setting.

#### Select parameter item:

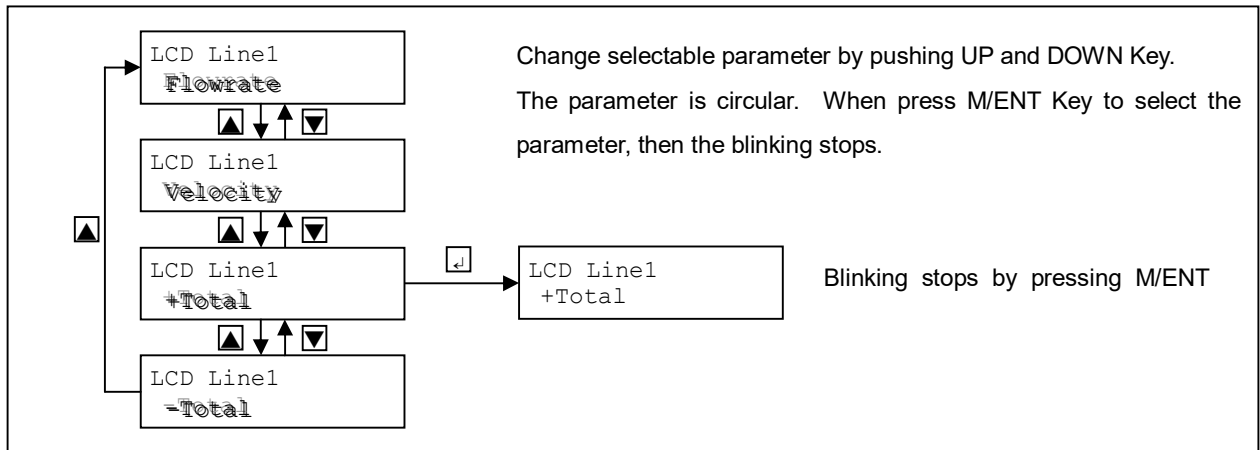
Example) Setting of basic item [1. BASIC]



There are two type of parameter setting, one is selectable parameter. The other is setting value parameter. See the following procedure for each setting type.

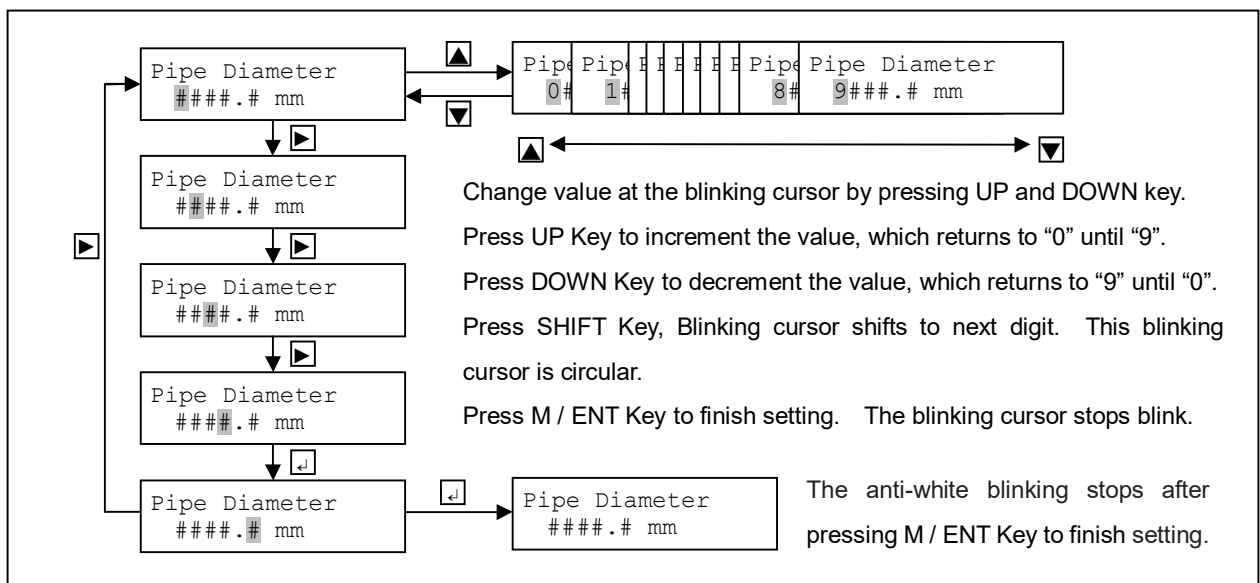
1) Selectable parameter

Example) Select the display of LCD top line [ LCD Line1 ]



2) Setting Value

Example) Set the diameter of pipe [ Pipe Diameter ]



## 6.5.4 Parameters

### Input of Password

Parameter Menu	Contents chosen by the UP/DOWN/SHIFT key Setup Range: Lower line of LCD	Initial Value
[Display]: Top line of LCD		
Input of Password	0000 to 9999	0000

### Parameter Menu

Parameter Menu	Item changed with UP, DOWN, and SHIFT Keys Setup Range: Bottom Line of LCD
[Display]: Top Line of LCD	
Selection of Parameter Menu Select Para Menu	Setup of Basic Items 1. Basic
	Setup of Totalizing 2. Totalization
	Setup of Display 3. Display
	Setup of measurement parameters 4. Operation
	Setup of communication function 5. Communication
	Setup of advanced function 6. Advanced
	Maker parameters (only pass maker's password) 7. Maker Param.

#### 1. Basic Setup of Basic Items

Parameter name(Top Line of LCD)	Selectable items/setting value range (Bottom Line of LCD)	Initial Value
Senor Kind	1MHz<42.5°, 2MHz<42.5°, 1MHz<30.0°	2MHz<42.5°
Pipe Kind	Plastic1, Plastic2, Metal	Plastic1
Pipe Diameter	8.0 ~ 2000.9 mm	114.0 mm
Pipe Thickness	1.0 ~ 50.0 mm	6.6 mm
Wall Sound Speed	500 ~ 5000 m/s	2120 m/s
Liner Thickness	0.0 ~ 20.0 mm	0.0 mm
Liner Sound Speed	500 ~ 5000 m/s	2120 m/s
Fluid Sound Speed	1000 ~ 2500 m/s	1482 m/s
Kinem Viscosity	0.30 ~ 40.00 mm2/s	1.00 mm2/s
K Factor	0.450 ~ 2.200	1.000
Full scale	1 ~ 9999	50.00
Unit of Change	mL/s, mL/min, L/min, L/h, m3/h, km3/h	m3/h
Decimal point	#####, #,####, ##,###, #.###	##.##
Sensor Configuration	V Type, Z Type	V Type

#### 2. Totalization Setup of Totalizing

Parameter name(Top Line of LCD)	Selectable items/setting value range (Bottom Line of LCD)	Initial Value
Totalize Reset	None, Yes	None
Total Vol. Unit	mL, L, m3, km3	m3

Multiple Factor	x0.1, x1, x10, x100, x1000	x1
Pulse Width	0.5ms, 1ms, 5ms, 10ms, 50ms, 100ms, 500ms, 1s	5ms

### 3. Display Setup of Display

Parameter name	Selectable items/setting value range	Initial Value
LCD Line1	Flowrate, Velocity, +Total, -Total	Flowrate
LCD Line2	Flowrate/%, Velocity/%, +Total, -Total	+Total
Alarm LED	None, DO1 & DO2, DO1, DO2	DO1 & DO2

### 4. Operation Setup of Measurement Parameters

Parameter name	Selectable items/setting value range	Initial Value
Damping Time	0 ~ 100 sec	2 sec
Flow Mode	Forward only, Forward/Reverse	Forward only
Low Cutoff En	None, Yes	Yes
Low CutOff	0.0 ~ 30.0 %FS	2.0 %FS
High Alarm Level	0.0 ~ 150.0 %FS	100.0 %FS
Low Alarm Level	-99.9 ~ 99.9 %FS	0.0 %FS
Alarm Hysteresis	0.0 ~ 30.0 %FS	0.0 %FS
+Total HAlarm	0 ~ 9999999 Pulse	9000000 Pulse
-Total LAlarm	0 ~ 9999999 Pulsex-1	9000000 Pulsex-1
Signal Loss Hold	1 ~ 30 sec	10 sec
Analog Out at Err	-15%(1.6mA), 125%(24mA), 0%(4mA), Hold	-15%(1.6mA)
DO1 Function	None, Flow alarm Hi, Flow alarm Lo, +Total alarm, -Total alarm, Flow direction, Signal Loss	Flow alarm Hi
DO1 NO / NC	NO, NC	NO
DO2 Function	None, Flow alarm Hi, Flow alarm Lo, +Total alarm, -Total alarm, Flow direction, Signal Loss	Flow alarm Lo
DO2 NO / NC	NO, NC	NO

### 5. Communication Setup of Communication Function

Parameter name	Selectable items/setting value range	Initial Value
Baud Rate	2400bps, 4800bps, 9600bps, 19200bps, 38400bps	9600bps
Parity	Odd, Even, None	None
Stop bit	1 bit, 2 bit	1 bit
Slave address	1 ~ 99	1
Silent interval	0 ~ 10 ms	1 ms
CRC check	None, Yes	Yes

## 6. Advanced Setup of Advanced Function

Parameter name	Selectable items/setting value range	Initial Value
Password	0 ~ 9999	0
Total preset En	None, Yes	None
+Total preset	0 ~ 9999999 Pulse	0 Pulse
-Total preset	0 ~ 9999999 Pulsex-1	0 Pulsex-1

## 7. Maker Param. Maker Parameters

Parameter name	Selectable items/setting value range	Initial Value
AO zero trimming	-100 ~ 100	0
AO span trimming	-100 ~ 100	0
AO test	None, 1mA, 4mA, 8mA, 12mA, 16mA, 20mA, 24mA	None
Pulse Out test	None, 0.5pps: 1pps, 5pps, 10pps, 50pps, 100pps, 500pps, 1000pps	None
Flow Test	0.0 ~ 125.0 %FS	0.0 %FS
Load Factory	None, Yes	None
Pulse Out mode	Total Volume, Flow Rate	Total Volume
RS485 enable	None, Yes	Yes
Excite pulse No.	1 ~ 8	3
tau1 Adj (Rough)	-999 ~ 999 us	0 us
tau2 Adj (Fine)	-9999 ~ 9999 ns	0 ns
Re correction En	None, Yes	Yes
Win search test	None, Yes	None
English unit	None, Yes	Yes
AO range	4-20mA, 0-20mA	4-20mA
Wave detect LV	1 ~ 20 %Vmax	5 %Vmax
Excite voltage	20Vpp, 40Vpp	20Vpp
Signal Accumu. T	1 ~ 8	4
Dt offset	-300.00 ~ 300.00 ns	0.00 ns
Write protect	protected, writable	protected
Zero Adjust	None, Yes	None
Diff Point Num	8~130	64

## 6.6 Setup of measuring conditions

It is necessary to input the data of piping, fluid and roughly expected flow rate. After checking these data, input the data of "1. BASIC" in the setting mode.

### 6.6.1 Necessary data

Sensor Kind, Pipe Kind, Pipe Diameter, Pipe Thickness, Wall Sound Speed, Liner Thickness, Liner Sound Speed, Fluid Sound Speed, Kinematic Viscosity, K Factor, Full scale, Sensor Mounting Method,

### 6.6.2 Setup of basic parameters [ 1.Basic ]

This menu is to set the basic data required for measurement.

- 1) Go to the basic parameter menu

Turn on the power switch, the LCD display starts. (Final countdown 5sec after displaying UL400)

Tokyo Keiso  
Flow Meter

UL400 Ultrasonic  
Starting.....5

After a while, the flow rate or error message is displayed on LCD.

(If the setup of the piping, etc. is not matching, an error message appears, such as "SIGNAL LOSS.")

XX.XX m3/h  
+xxxxxxxx m3 x1

( Example of flow rate indication )

Signal Loss####  
+xxxxxxxx m3 x1

( Example of error message )

After displaying flow rate or error message, hold down M/ENT key to change to the setting Mode. As the password input screen appears, input the user password. The initial value is "0000." If the password is correct, the parameter menu appears. Select "1. BASIC" by UP/DOWN keys and press the M/ENT key, the parameter item appears.

Password  
####

#### 1) Sensor Kind (Selection of Sensor Kind)

Select a kind of the sensor. The following shows the differences in characteristics, depending on the sensor kind.

Selection Item	Sensor Kind
1MHz<42.5°	1MHz sensor with incident angle 42.5°
2MHz<42.5°	2MHz sensor with incident angle 42.5°
1MHz<30.0°	1MHz sensor with incident angle 30.0°

Sensor Kind  
2MHz<42.5°

#### 2) Pipe Kind (Selection of Piping Material)

Select the piping material. The kind of piping and the operating conditions for every selection item are



shown below.

Selection Item	Operation condition
Plastic1	Piping material is plastic. (PVC etc.)
Plastic2	Piping material is PVDF or PP.
Metal	Piping material is metal. (SGP, SUS, etc.)

Pipe Kind  
Plastic1

**3) Pipe Diameter (Outside diameter of piping)**

Input the outside diameter of piping.

Table 1: Refer to "Outside diameter of wall thickness for general piping."

Pipe Diameter  
114.0 mm

**4) Pipe Thickness (Wall thickness of piping)**

Input the wall thickness of piping.

Table 1: Refer to "Outside diameter of wall thickness for general piping."

Pipe Thickness  
6.6 mm

**5) Wall SoundSpeed (Sound speed of piping material)**

Input the sound speed of piping material.

Table 2: Refer to "Sound velocity by piping materials."

Wall SoundSpeed  
2120 m/s

**6) Liner Thickness (Setup of lining thickness)**

Input liner thickness.

If not using liner, set up to "0.0" mm (initial setup value).

Liner Thickness  
0.0 mm

**7) Liner SoundSpeed (Sound speed of lining material)**

Set up the sound speed of lining material.

When no lining is used (when the liner thickness has been set up to 0.0 mm), set sound speed to 2120 m/s (initial setup value).

Refer to Table 2. "Sound velocity by piping materials."

Liner SoundSpeed  
2120 m/s

Note ) if the liner doesn't stick together entirely with the piping material, the liner may separate from the pipe because of aging. In this case the pipe may not transfer ultrasonic signal. In addition, different materials of liner may hinder ultrasonic signal transfer. If use liner, contact agent in advance.

**8) Fluid SoundSpeed (Sound speed of measuring fluid)**

Input the sound speed of measuring fluid.

Table 3: Refer to "Sound velocity and kinematic viscosity by liquids".

Fluid SoundSpeed  
1482 m/s

**9) Kinem Viscosity (Kinematic Viscosity of Fluid)**

Set up the kinematic viscosity of measuring fluid.

Table 3: Refer to "Sound velocity and kinematic viscosity by liquids."

Kinem Viscosity  
1.00 mm<sup>2</sup>/S

**10) K Factor (Detector constant)**

K Factor  
1.000

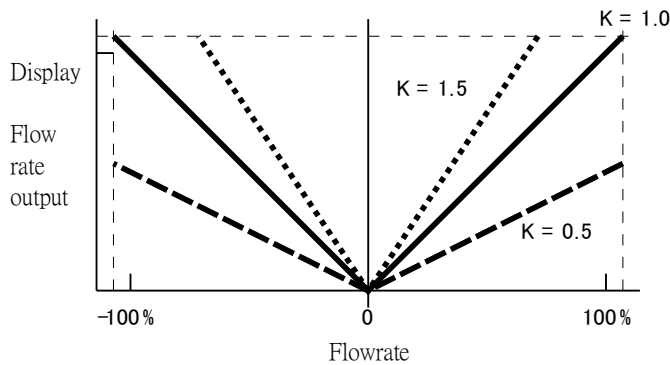
Input the detector constant.

If high-accuracy calibration is provided in the measurement line of the flow meter, it is possible to adjust the flow rate by using the detector constant. As adjustment is allowed at any point, it is also possible to adjust only at one point the flow rate of the fluid which has a high deviation such as non-Newtonian fluid.

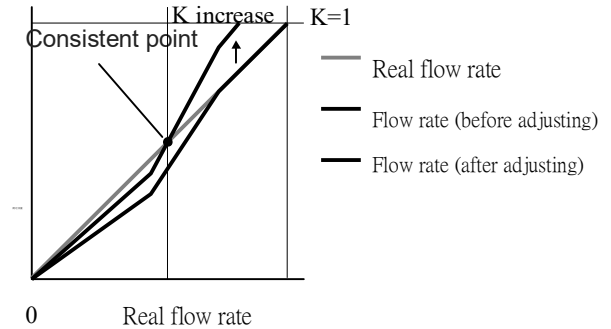
The detector constant is a multiplication factor, and the display and output flow rate are as follows:

$$\text{Display/Output flow rate} = \text{Internal measured flow rate} \times \text{Detector constant}$$

• The Change of Display/Output Flow Rate by Detector Constant



• Example when calibrating one point

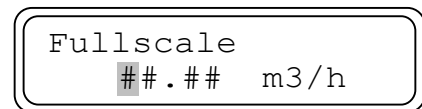


### 11) Fullscale (Setup of Full-Scale Flow Rate)

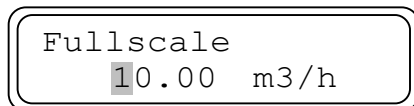
A full-scale flow rate can be set up within a flow rate setup range suitable for a pipe diameter. The decimal point position selected here are reflected on the flow rate display in the measuring mode. Setup of the full-scale flow rate consists of two phases, one is ① input of numerical value, the other is ② Setup of the decimal point position, which are described below.

#### ① Input of numerical value

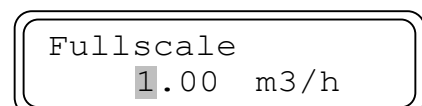
Input the numerical value of the full-scale flow rate. Input a 4-digit numerical value without considering the currently displayed unit of flow rate and decimal point position. After inputting for the lowest digit, press the SHIFT key to go to ② Setup of the decimal point position.



Example) When you want to set the full-scale flow rate to 100 m3/h, input "1000" or "100" without considering the current decimal point position or the unit.



or



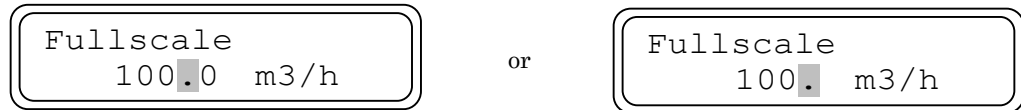
#### ② Setup of the decimal point position

Set the decimal point position of the full-scale flow rate with the UP and DOWN keys. After selecting it correctly, press the SHIFT key to return to ① input of numerical value.

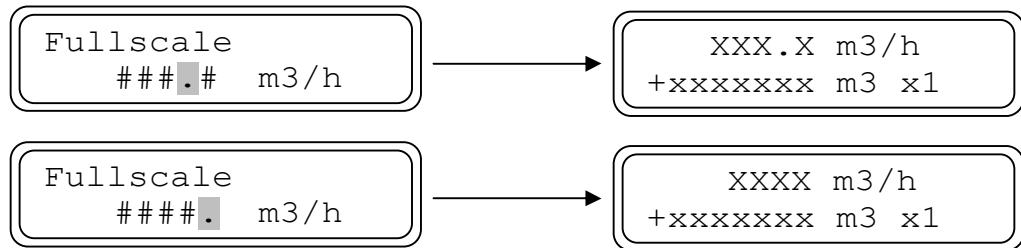


(Example) When you want to set the full-scale flow rate to 100 m3/h, change the decimal point position

to "100.0" or "100" .



The decimal point position selected here is reflected on the flow rate display in the measuring mode. If the full-scale flow rate is set up to "###.0," for example, the actual flow rate is displayed down to the 1nd decimal place in the measuring mode. If it is set to "####." however, the flow rate is the same, but the decimal places are not displayed. Select the decimal point position as required.



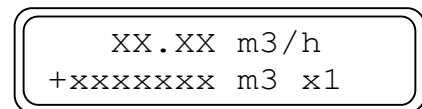
After correctly setting up the full-scale flow rate as instructed above, press the M/ENT key. The setup is saved to go to the next menu.

**12) Sensor Config (Sensor Mounting Method)**

Select "V Type" or "Z Type" with the UP and DOWN keys according to the mounting method of UL400 sensors.

**13) Completion of basic parameters setup**

After setting up all of the above-mentioned parameters, hold down M/ENT key to change over the converter to the measuring mode.



**14) After completion of setup of basic parameters, Confirm Install Distance(Distance between Sensors)**

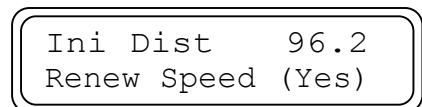
Converter will display Install Distance by holding down the UP key when measuring mode. This is the best Install Distance calculated according to the setup of the pipe and fluid.

"Ini Dist", "Spd" and "Dis" means the theoretical distance, measured fluid sound speed and recommended distance.

User can initially install the sensors according to the theoretical distance, and then adjust the sensor distance by the information of recommended distance. The recommended distance will vary if user change the sensor distance. The

sensor distance and recommended distance will gradually become the same by repeatedly adjusting the sensor distance and this will be the best install distance. The LCD will show "Renew Speed (No)" if user push SHIFT key. By pushing the UP key, it will be changed to show "Renew Speed (Yes)". If user push M/ENT key in this situation, the parameter of flow sound speed will be updated by the measured sound speed.

Please mount the sensors with the best Install Distance between the upstream and downstream sensor. (refer to 『Setup of distance between sensors of 5.3.1 Installation of ultrasonic sensor』)



### 6.6.3 Errors under setting up

If there is any incorrect parameter in the setup data, setting error may occur in UL400. In this case the measuring result may be incorrect. Confirm the cause happened and correct it. User can confirm the error message by check mode. The possible setting errors and causes are described below.

Error Message	Causes and Corrections
Propagation Err. (Signal transmission duration error)	UL400 can calculate the theory duration of transmission according to the set parameters of [1.Basic]. Generally to say, the theory duration is very close to actual duration measured. When the difference of actual duration and theory duration are larger then 5%, error will happen. Check the setting value of [1.Basic] is correct or not.
FS vs Pipe Err. (Velocity range error)	UL400 can calculate the theory velocity of full scale when the pipe is full of water according to the set parameters of [1.Basic]. When the theory velocity is smaller than 0.3m/s or bigger than 10m/s, error will happen. Check the set data of pipe diameter, wall thickness, Full Scale of [1.Basic] are correct or not.
FS vs Pulse Err. (Pulse width error)	The number of pulse may be too small to output enough pulse correctly. If the max number of pulse calculated according to full scale flow rate is bigger than the set number of pulse of [2.Totalizaiton], error will happen. Refer to the content of [8.1.1], set correct parameter.

## 6.7 Zero point adjustment

Before initially starting operation of the UL400, be sure to confirm the following and carry out zero point adjustment. The ultrasonic sensors have been installed correctly. The piping, on which the ultrasonic sensors have been installed, is fully filled with water. The operation mode of the converter is the measuring mode.

In measuring mode, holding down Up and Down key at the same time, LCD shows zero point adjustment mode. There are two kinds of zero point adjustments; actual zero adjustment (Adjust) to be carried out when a flow of the fluid is still, and initial zero adjustment (Reset) to be carried out when a flow of the fluid cannot be stopped.



### 6.7.1 Flow of zero point adjustment

Zero point adjustment is carried out in the following sequence.

- ① Get the first data of ultrasonic transfer durations difference.
- ② Get all the data of ultrasonic transfer durations differences between 10sec after the first.
- ③ Set the average of all differences to zero point.

Assume that there is no deviation of the zero point when Initial Zero Adjustment.

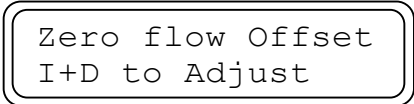
#### • Differences in Zero Point Adjustments

	Actual Zero Adjustment	Initial Zero Adjustment
Zero Point Adjustment	Conducted	assuming that there is no deviation of the zero point

### 6.7.2 Actual zero point adjustment

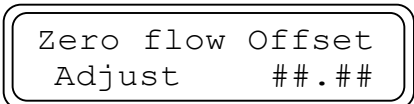
This adjustment is performed when the flow of fluid has stopped. Press Shift key and select Adjust in zero point adjustment mode.

“Zero flow Offset, I+D to Adjust” Appears in the LCD screen.  
Press the Up and DOWN key at the same time to start actual zero point adjustment. Once zero point adjustment starts,



Zero flow Offset  
I+D to Adjust

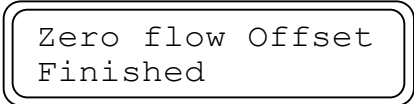
“Zero flow Offset, Adjust ##.##” Appears in the LCD screen.  
A numerical value appears in the bottom line and starts zero point adjustment, which ends in 10 seconds.



Zero flow Offset  
Adjust ##.##

After zero point adjustment,

“Zero flow Offset, Finished” Appears in the LCD screen.  
Hold down M/ENT key to return to the measuring mode.



Zero flow Offset  
Finished

### 6.7.3 Initial zero adjustment

This zero point adjustment is carried out when a flow of the fluid cannot be stopped. In this adjustment, assume there is no deviation of the zero point and determine a tentative zero point to measure a flow rate.

Press Shift key to select Reset in zero point adjustment mode.

“Zero flow Offset, I+D to Reset” Appears in the LCD screen.



Zero flow Offset  
I+D to Reset

If you want to conduct zero point adjustment, press the UP/DOWN key at the same time to start Initial Zero Adjustment.  
It is finished immediately.

“Zero flow Offset, Finished” Appears in the LCD screen.



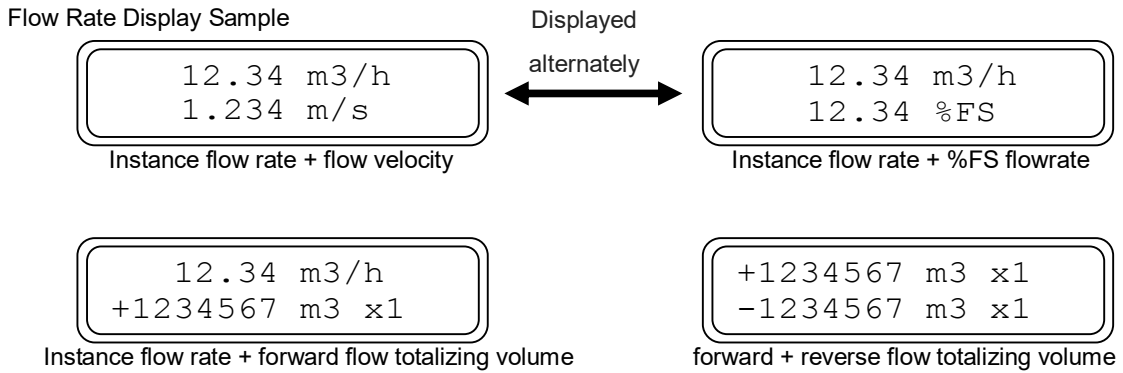
Zero flow Offset  
Finished

Hold down M/ENT key to return to the measuring mode.

## 7. OPERATIONS

### 7.1 Displaying during operation

Once measurement starts, the following display appears. LCD screen displays the result of measurement immediately in measuring mode.



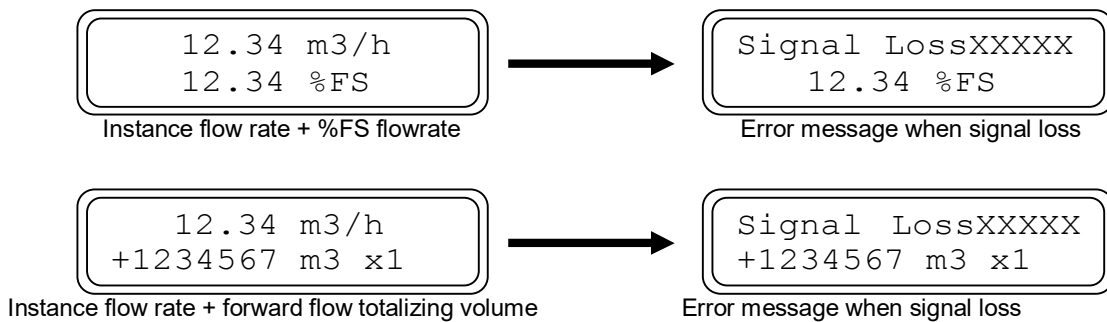
To change the Displaying, refer to “8.2 Setup of Display [ 3.DISPLAY ] ”.

### 7.2 Messages during operation

If an error occurs during measurement, an error message appears in the LCD screen. There are three LED above the LCD will indicate the status of UL400 operation.

#### 7.2.1 Display of signal loss

When UL400 cannot read the signal correctly, the LCD upper line will display “Signal Loss” message and counter the time after signal loss.



## 7.2.2 The status display of LED

There are three LEDs to indicate the status of UL400 operation.

ALARM LED		
Color	Display	Status
Red	Off	Flowrate is between Low Alarm and High Alarm flowrate
	On	Flowrate is lower than Low Alarm or higher than High Alarm flowrate
	flash	

If there is hysteresis parameter setup, Alarm Led turns off will change according to setup parameter. Refer to 8.3.8 for more detail introduce.

ERROR LED		
Color	Display	Status
Red	Off	Normal
	On	Signal Loss
	flash	Unstable ultrasonic signal

MES./SET LED (Measurement and setup LED)		
Color	Display	Status
Red	On	When RS485 error, keep 1 sec on.
	Low frequent flash	In setting mode
Green	On	Normal, forward flow
Orange	On	Normal, reverse flow
	High frequent flash	During RS485 communication
	Low frequent flash	Zero point adjustment mode

High frequent Flash is the 5Hz frequent flash, Low frequent flash is the 1Hz frequent flash.

## 8. CHANGE OF VARIOUS SETUPS

Now you have completed the preparation so far, The UL400 is ready for basic measurement. You can further change various setups such as totalizing output, status output, flow rate display data, and so on. The following describes various setups and their change methods.

### 8.1 Setup of totalizing output [2.Totalization] and measuring direction [4.Operation – Flow Mode]

The UL400 provides forward and reverse measurement and totalizing. This menu is to set up the flow measuring direction and the totalizing function.

#### 8.1.1 Calculation of each preset value of totalizing output function

When setting up a totalizing output, it is necessary to consider the combination of full-scale flow rate, the number of output pulse per second, and the input pulse width specification at a receiver side. The value which can be set up is to be calculated from the following table.

Pulse width	Maximum output pulses per second pps(PULSE/s)	Select the pulse width depending on "pps" which are obtained by converting the number of output pulse in the full-scale flow rate. (Pay attention to the specification of the receiver.)
0.5ms	1000	
5ms	100	
50ms	10	
100ms	5	
500ms	1	
1s	0.5	

Flow rate unit \ Totalization volume unit	Totalization volume unit			
	mL	L	m3	km3
mL/s	1	103	106	109
mL/min	60	60•103	60•106	60•109
L/min	60•10 <sup>-3</sup>	60	60•103	60•106
L/h	3600•10 <sup>-3</sup>	3600	3600•103	3600
m3/h	3600•10 <sup>-6</sup>	3600•10 <sup>-3</sup>	3600	3600•10 <sup>-3</sup>
km3/h	3600•10 <sup>-9</sup>	3600•10 <sup>-6</sup>	3600•10 <sup>-3</sup>	3600•10 <sup>-6</sup>

Calculation example of the number of output pulse]

In case of 300m3/h of full-scale flow rate, totalization unit "L", and totalization multiplier x100 (100L / 1 pulse)

$$\frac{\text{Volume per second in full-scale flow}}{\text{Volume per pulse}} = \frac{300 \text{ [m3/h]}}{100 \text{ [L/PULSE]}} = \frac{\frac{300}{3600 \cdot 10^{-3}} \text{ [L/s]}}{100 \text{ [L/PULSE]}} = 0.83 \text{ [pps]}$$

Accordingly, 0.8 to 0.9 pulses per second are outputted.

In this case, the settable pulse width for the UL400 is 0.5 ms to 500 ms. 1 sec can not be used because the number of output pulse is not enough. At this time, not only the error message appears in check mode, but also Alarm LED flashes to alarm user.



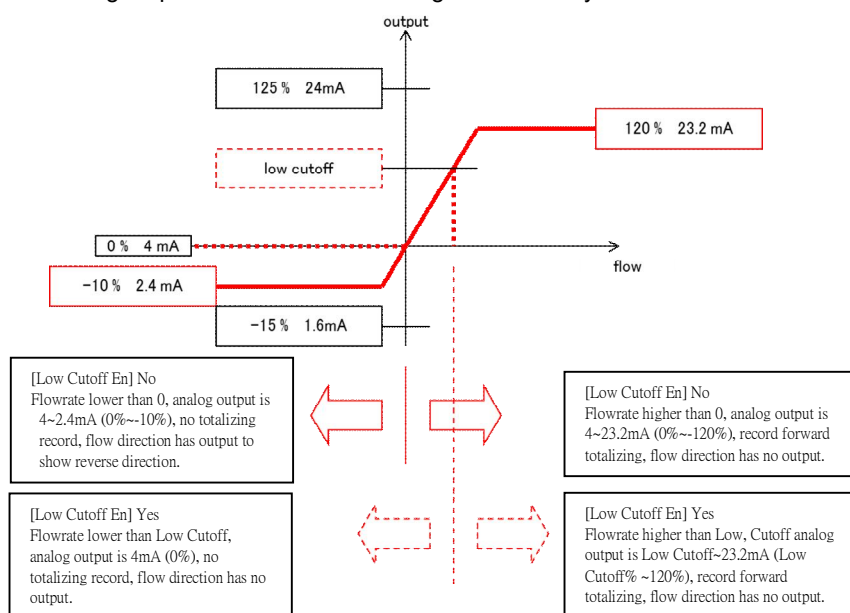
## 8.1.2 The relationship of totalizing and measuring direction (Flow Mode)

In UL400, the selection of the totalizing function are closely related with the measuring method. The flow rate measurement in the reverse direction is not made depending on the selection of Flow Mode items. The following shows the relations and output between the Flow Mode items and the measuring direction.

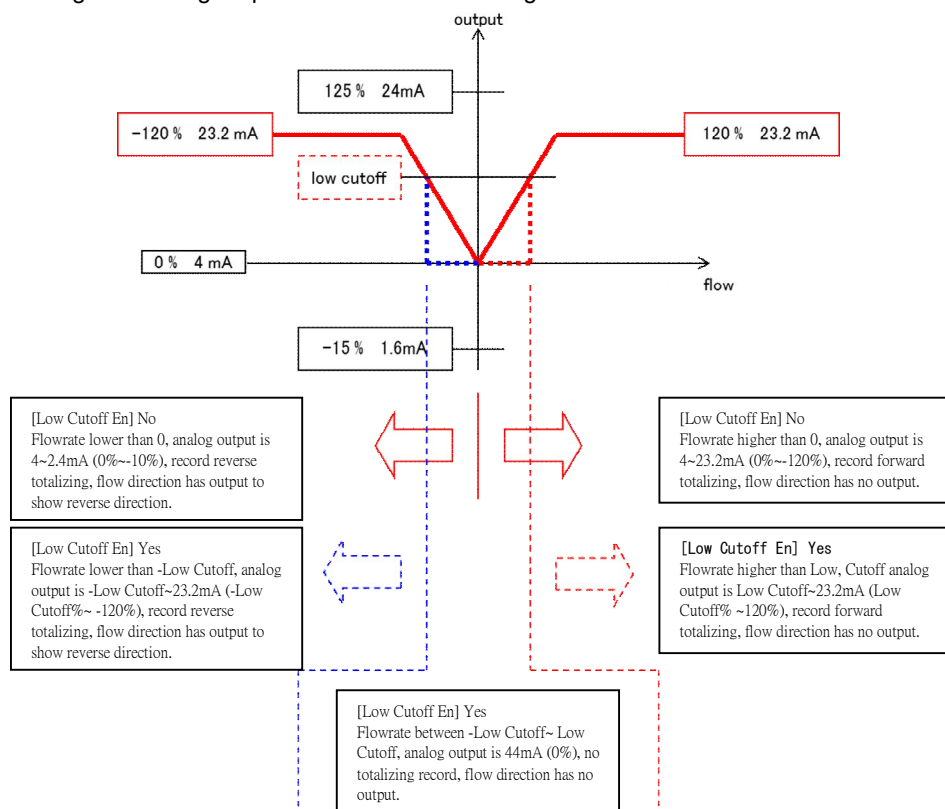
Flow Mode items and different measuring direction

Flow Mode item	Measuring direction	Direction detect (DO output)	Totalizing record method
Forward Only	Forward measurement only	Active	Records only forward measurement
Forward / Reverse	Both forward and reverse measurement	Active	Records forward and reverse flow rates individually

Totalizing and analog output method when selecting Forward Only.



• Totalizing and analog output method when selecting Forward/Reverse.



※The flow rate showed on LCD display or accessed from RS485 can be applied from -200%FS to +200%FS.

## Change measuring direction and totalizing output

The following describes the flow measuring direction and the setup method of the totalizing function:

### 1) Go to the Totalization parameter menu

Select "2.Totalization" in the parameter menu and press Shift key.

Select Para Menu  
2. Totalization

### 2) Totalize Reset (Clear the totalizing count)

Select whether to clear the totalizing count recorded in the converter, default is "None". If you select "Yes" by pressing M/ENT key, the reconfirmation "Are you sure ?" appears. If you press M/ENT again, "OK" appears to have the totalizing count cleared. If select "None" when the reconfirmation appears, the totalizing count is not reset.

Totalize Reset  
None

Totalize Reset  
Yes

Totalize Reset  
Are you sure ?

Totalize Reset  
OK

### 3) Total Vol. Unit (Select the unit for totalizing)

Select the unit of flow rate used for totalizing. This unit may differ from the unit of full-scale flow rate.

Total Vol. Unit  
m3

### 4) Multiplic Factor (Select the totalizing multiplier)

Select a totalizing multiplier.

Multiplic Factor  
x100

### 5) Pulse Width (Select the totalizing output pulse width)

Select the totalizing output pulse width.

Pulse Width  
500ms

### 6) Go to the Operation parameter menu.

Select "4.Operation" in the parameter menu, press SHIFT key.

Select Para Menu  
4. Operation

### 7) Flow Mode (Select flow mode item)

Use UP or DOWN key to change over to "Flow Mode", select desired "Forward only" or "Forward/Reverse".

Flow Mode  
Forward/Reverse

### 8) Return to the measuring mode

You can return to the measuring mode by holding down M/ENT key.

Now, you have finished the setup of the measuring direction and the totalizing output function.

## 8.2 Setup of Display [ 3.DISPLAY ]

The display contents of the LCD screen in UL400 can be changed. This menu is to set up the display contents.

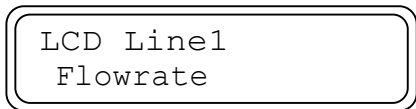
### 1) Go to the Display parameter menu

Select "3.DISPLAY" in the parameter menu and press SHIFT key.



### 2) Change the display content of LCD 1 Line[LCD Line1], [LCD Line2]

Select the contents to be displayed in the LCD screen in the measuring mode. The following shows the display contents for each item.



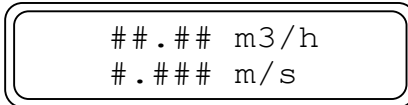
• Different Display Contents by Selection Item

Selection Item	Display Contents in LCD	
	Top line	Bottom line
Flow rate (/%)	Display instant flow rate	Alternative display instant flow rate and %FS flow rate, but when LCD Line1 display Flowrate, Line1 display %FS flow rate only.
Velocity (/%)	Display instant velocity	Alternative display instant velocity and %FS flow rate, but when LCD Line1 display velocity, Line1 display %FS flow rate only.
+Total	Display forward totalizing	Display forward totalizing
-Total	Display reverse totalizing	Display reverse totalizing

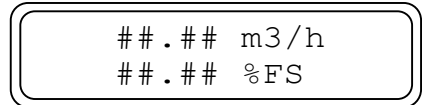
• Display example

• Display instant flow rate and velocity (Alternative display velocity and %FS flow rate in line 2)

Top line : Flowrate

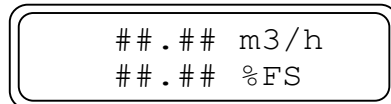


Bottom line : Velocity/%



• Display instant flow rate and %FS flow rate

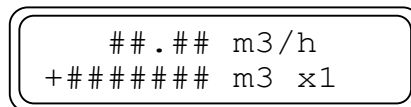
Top line : Flowrate



Bottom line : Flowrate/%

• Display instant flow rate and forward totalizing

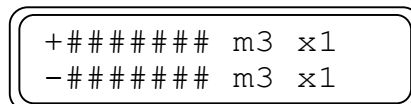
Top line : Flowrate



Bottom line : +Total

• Display forward and reverse totalizing

Top line : +Total



Bottom line : -Total

### 3) Change the display method of Alarm LED(Alarm LED)

Selection Item	Active method of alarm LED
None	Even DO has output, alarm LED won't light up.
DO1 & DO2	When DO1 or DO2 has output, alarm LED light up.
DO1	Only DO1 has output, alarm LED light up.
DO2	Only DO2 has output, alarm LED light up.

Refer to 8.3.13 for the setup of DO1 and DO2.

### 4) Return to the measuring mode

You can return to the measuring mode by holding down M/ENT key.  
Now, you are finished with setting up the display.

### 8.3 Setup of measurement parameters [ 4.Operation ]

This menu is to set up operations related to flow rate measurement.

#### 1) Go to the Operation parameter menu

Select "4.Operation" in the selection menu and press SHIFT key.

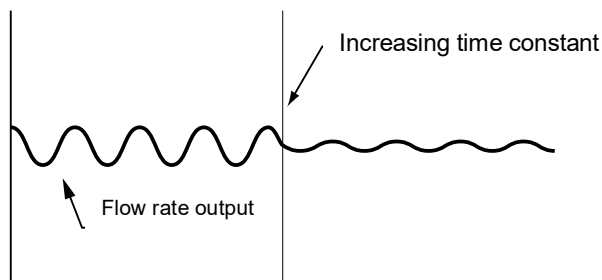
Select Para Menu  
4. Operation

#### 2) Damping Time (Setup of time constant)

Set responsiveness (follow-up) of display and output of flow rate  
If the bigger the value is, the longer the responsiveness is.  
If the display is unstable because of a big flow rate fluctuation,  
change to a higher value.

Damping Time  
### Sec.

- Decreased flow rate fluctuation by increasing Time Constant.



#### 3) Flow Mode (Set up flow direction measurement mode)

The setup of flow direction measurement mode is limited to (Forward only) or (Forward/Reverse). The parameter of Flow Mode affects the method of the analog and totalizing output. More detail affect, refer to 8.1.2.

Flow Mode  
Forward only

#### 4) Low Cutoff En (Enable the function of Low Cutoff)

Select whether to enable Low Cutoff function. The effect of Low Cutoff function is shown the following.

Low Cutoff En  
Yes

#### 5) Low Cutoff (Setup of low flow rate cutoff)

Set low flow rate cutoff in order to stabilize the zero point and prevent erroneous totalizing. If the flow rate is lower than the setup cutoff value, its display and totalizing output will be 0 for both forward and reverse directions, but analog output depends on the setup of Flow Mode. More detail affect, refer to 8.1.2

Low Cutoff  
2.0 %FS

#### 6) High Alarm Level (Setup of high flow rate alarm)

Set high flow rate alarm in order to inform whether the flow rate is beyond the high alarm limit. According to the setting method of DO, the output of DO can inform the customer whether high flow rate alarm has been triggered.

High Alarm Level  
100.0 %FS

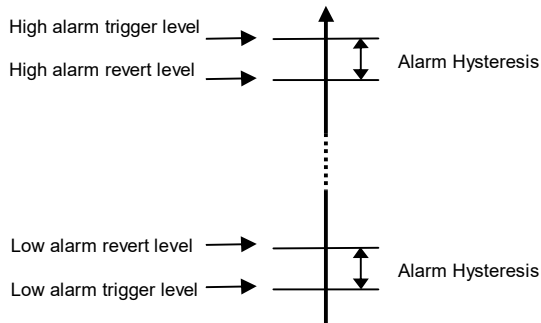
#### 7) Low Alarm Level (Setup of low flow rate alarm)

Set low flow rate alarm in order to inform whether the flow rate is lower than the low alarm limit. According to the setting method of DO, the output of DO can inform the customer whether high flow rate alarm has been triggered.

Low Alarm Level  
10.0 %FS

**8) Alarm Hysteresis (setup of Alarm Hysteresis)**

Setting Alarm Hysteresis can have the triggered alarm to revert. Suitable hysteresis can void alarm to repeat trigger and revert quickly near the alarm level.



Alarm Hysteresis  
0.0 %FS

**9) +Total HAlarm (forward totalizing volume alarm)**

Set **forward totalizing volume alarm** to inform whether the **forward totalizing volume** is beyond the alarm limit. According to the setting function of DO, the output of DO can inform the customer whether **+ Total HAlarm** has been triggered.

+Total HAlarm  
9000000 Pulse

**10) -Total LAlarm (reverse totalizing volume alarm)**

Set **reverse totalizing volume alarm** to inform whether the **reverse totalizing volume** is beyond the alarm limit. According to the setting function of DO, the output of DO can inform the customer whether **-Total HAlarm** has been triggered.

-Total LAlarm  
9000000 Pulse-1

**11) Signal Loss Hold (Setup of Wait Time at Empty Detection)**

Set the wait time until the "Signal Loss" occurs.

Signal Loss Hold  
10 Sec.

**12) Analog Out at Err (set up the output in error status)**

Set up the analog output when the "Signal Loss" happens.

Analog Out at Err  
-15% (1.6mA)

If the UL400 fails to receive an ultrasonic signal during measurement, an error message "Signal Loss" is displayed; it does not result from instantaneous signal shutoff due to mixture of bubbles in the fluid or noise in order to prevent malfunctioning of external control.

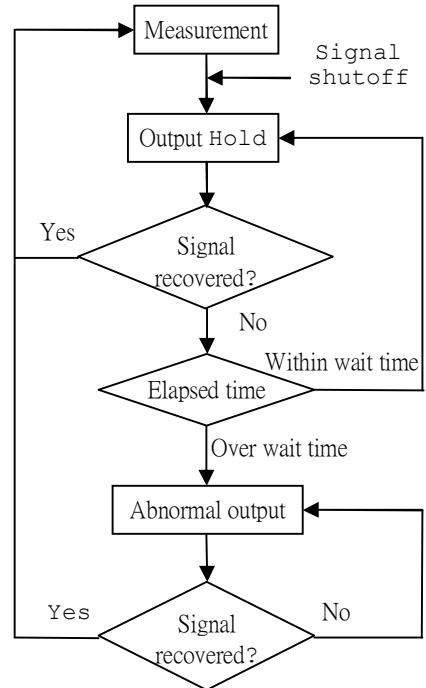
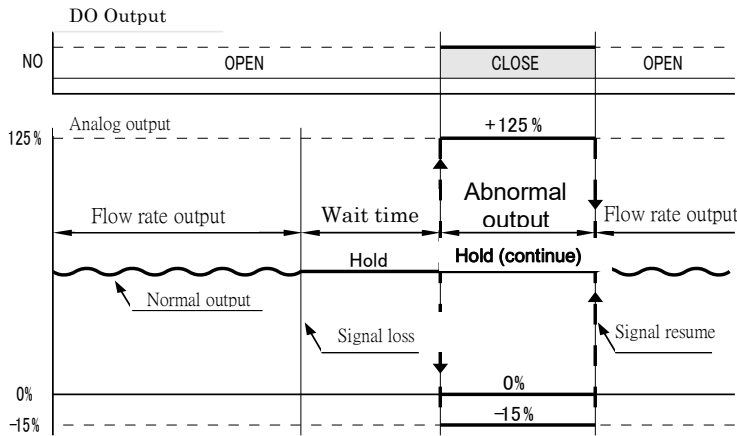
The last measured flow rate is continuously displayed and output within the setup time of "Signal Loss Hold" after the converter has failed to receive the ultrasonic signal for some reason.

If the converter can receive it successfully in the meantime, flow rate measurement is resumed. If it fails, however, an error message "Signal Loss" appears to change analog output to the setup value of "Analog Out at Err". If "Signal Loss" has been selected in setup of DO status output, it is also output. The error message continues to be output until the ultrasonic signal is received. Upon reception, the error message is cleared to

resume flow rate measurement.

At the time of error occurrence of “Signal Loss”, “+125%”, “0%”, and “-15%” of “Analog Out at Err” are changed to the analog output setup percentage values. If “Hold” is selected, flow rate output maintains the last measured value, even if the error occurs. Even in this case, however, the “Signal Loss” status is output.

- Setup of Signal Loss Hold, Analog Out at Err and relations with Signal Loss status



### 13) DO1 Function · DO2 Function (Select ion of status output)

User can set up any output method of DO1 and DO2 according to user requirement. There are alarm types, status or errors of Flow high alarm, Flow low alarm, +Total alarm, -Total alarm, Flow direction and Signal loss to select. If select Flow direction, the status is output in reverse flow. This selection is related to setup of Flow Mode, refer to the description of 8.1.2. If want to cancel the function of status output, you can select “None”.



- DO setup example

- DO1 is set to high flow rate alarm, DO2 is set to low flow rate alarm

DO1 : Flow high alarm

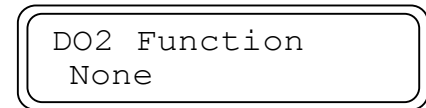
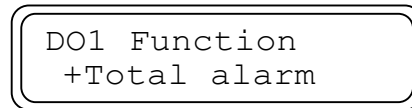
DO2 : Flow low alarm



- DO1 is set to forward flow total alarm, DO2 is set to None.

DO1 : +Total alarm

DO2 : None



- DO1 is set to reverse flow output, DO2 is set to signal loss output

DO1 : Flow direction

DO2 : Signal loss



**14) DO1 NO / NC, DO2 NO / NC ( Setup of the contact method of status output )**

Set up the normal status of DO. If the setting is Normal Open, it means the contact is open in normal status. The contact is changed to short if there is status output. If the setting is Normal Close, it means the contact is short in normal status. The contact is changed to open if there is status output.

DO1 NO / NC Normal Open
----------------------------

**15) Return to the measuring mode**

Hold down M/ENT key to return to the measuring mode.

Now, you have finished the setup of the measurement parameters.



## 8.4 Setup of communication function [ 5.Communication ]

UL400 provides RS485 communication function. User can access the measurement data and set parameters by computer. This menu is to set up the communication protocol and parameters.

### 1) Go to the Communication parameter menu

Select "5.Communication" in the parameter menu, and press SHIFT key.

Select Para Menu  
5. Communication

### 2) Baud Rate (Setup of RS-485 baud rate)

Set an RS-485 baud rate, select one of 2400bps · 4800bps · 9600bps · 19200bps · 38400bps.

Baud Rate  
9600 bps

### 3) Parity (Setup of parity)

Set the parity for RS-485 communication, select one of Odd, Even, None.

Parity  
None

### 4) Stop bit (Setup of stop bit)

Set the stop bits for RS-485 communication, select 1 bit or 2 bit.

Stop bit  
1 bit

### 5) Slave address (Setup of slave address)

Set UL400 communication address. The range is 01~99, default is 01

Slave address  
01

### 6) Silent interval (Set up the wait time of communication response delay)

Set the wait time of communication response delay, the range is 1~10 ms.

Silent interval  
1 ms

### 7) CRC check (Set up whether to check CRC)

Set up whether to check CRC. If the setting is None, UL400 doesn't check CRC is right or not when receiving message.

CRC check  
Yes

### 8) Return to the measuring mode

Hold down M/ENT key to return to the measuring mode.

Now, you are finished with setup of the communication parameters.

## 8.5 Setup of advanced parameters [ 6.Advanced ]

The user password and preset totalizing are recorded in advanced parameters menu of UL400. This menu is to setup the advanced parameters.

**1) Go to the Advanced parameters menu**

Select "6.Advanced" the selection menu, and press SHIFT key.

```
Select Para Menu
6. Advanced
```

**2) Password (Setup of user password)**

Set the user password of UL400, the default is 0000, customer can reset it, the range is 0000~9999.

```
Password
0
```

**3) Total preset En (Enable the function of preset totalizing)**

Set up whether to enable the function of preset totalizing, the default is "None", select "Yes" to enable this function.

```
Total preset En
None
```

**4) +Total preset (Set up the forward flow preset totalizing)**

Set up the forward flow preset totalizing, the range is 0~9999999.

```
+Total preset
0 Pulse
```

**5) -Total preset (Set up the reverse flow preset totalizing)**

Set up the reverse flow preset totalizing, the range is 0~9999999.

```
-Total preset
0 Pulse-1
```

## 8.6 Setup of maker parameters [ 7.Maker Param. ]

The maker parameters of UL400 contain the parameters of analog output fine adjustment, output test, and ultrasonic signal adjustment. Changing the maker parameters by user is not recommended. If needed, contact salesman to confirm the content to be adjusted.

## 9. CHECK MODE

In check mode, user can confirm the analog output, status output and pulse output of UL400 and check the error message when setting error occurs. In measuring mode, hold down “DOWN” key to go to check mode. Select item to be checked by pressing UP and DOWN key. In check mode, hold down M/ENT to return to measuring mode. The following is to describe the using method of check mode.

### 9.1 Analog output check [ 1. Analog Check ]

This item can check whether the analog output is correct or not.

**1) Go to the analog output item of the check mode menu**

Select “1. Analog Check” in the check mode menu and press SHIFT key. The preset value is 1mA, at this time the analog output is 1mA.

Check Item Menu  
1. Analog Check

**2) Select the analog output range**

Press SHIFT key to select analog output range. The ranges of 0%(4mA), 10%(5.6mA), 25%(8mA), 50%(12mA), 75%(16mA), 100%(20mA) and 120%(23.2mA) are circular when changing.

Analog Check  
0 mA

Analog Check  
4 mA

**3) Confirm the analog output of fine adjustment**

Use UP or DOWN key to adjust the value of analog output. One press can change 1%.

Analog Check  
5 mA

**4) Return to the check mode menu**

Hold down M/ENT key to return to the check mode menu.

### 9.2 Check of status output [ 2. Relay Check ]

This item can check whether the DO output is correct or not.

**1) Go to the status output item of the check mode menu.**

Select “2. Relay Check” in the check mode menu, press SHIFT key. The preset is “D.O.1 Open”, it means DO1 is open.

Check Item Menu  
2. Relay Check

Relay Check  
D.O.1 Open

**2) Select the gate of status output**

Press SHIFT key to select the gate of status output, UL400 provides DO1 and DO2 two gates.

Relay Check  
D.O.2 Open

**3) Control the output Open or Close of status output**

Use UP or DOWN key to control the output Open or Close of status output. Open means the circuit is not conducted, Close means the circuit is short.

Relay Check  
D.O.2 Close

**4) Return to the check mode menu**

Hold down M/ENT key to return to the check mode menu.

### 9.3 Check of pulse output [ 3. Pulse Check ]

This item can check whether the totalizing output is correct or not.

- 1) Go to the pulse output item of check mode menu.**  
Select "3. Pulse Check" in the check mode menu, press SHIFT key. The preset is 0pps, it means the output is 0 Pulse per second.
- 2) Select the stall of pulse output.**  
Press SHIFT key to select a stall. The stalls of 0pps, 1 pps, 5pps, 10pps, 100pps, and 1000pps are cycle when changing.
- 3) Return to the check mode menu**  
Hold down M/ENT key to return to the check mode menu.

Check Item Menu  
3. Pulse Check

Pulse Check  
0 pps

Analog Check  
1 pps

### 9.4 Check setting error message [ 4. Error Check ]

This item can check setting error message.

- 1) Go to the setting error message item of check mode menu.**  
Select "4. Error Check" in the check mode menu, press SHIFT key. "No Set Err" appears when without setting error.
- 2) Change the error message.**  
If setting error occurs, the error message appears. If there are more than two setting errors, press Up or Down key to show the message. The possible setting errors of UL400 are "Propagation Err.", "FS vs Pipe Err." and "FS vs Pulse Err." Refer to 6.6.3 error messages.
- 3) Return to the check mode menu**  
Hold down M/ENT key to return to the check mode menu.

Check Item Menu  
4. Error Check

Error Check  
No Set Err.

Error Check  
Propagation Err.

Error Check  
FS vs Pipe Err.

Error Check  
FS vs Pulse Err.

Table 1 General piping outside diameter/thickness  
Stainless pipe SUS304TP, 316TP, JIS G3459

Nominal Dia		Dia (mm)	Thickness(mm)		
A	B		Sch.10	20	40
25	1	34.0	2.8	3.0	3.4
32	1¼	42.7	2.8	3.0	3.6
40	1½	48.6	2.8	3.0	3.7
50	2	60.5	2.8	3.5	3.9
65	2½	76.3	3.0	3.5	5.2
80	3	89.1	3.0	4.0	5.5
90	3½	101.6	3.0	4.0	5.7
100	4	114.3	3.0	4.0	6.0
125	5	139.8	3.4	5.0	6.6
150	6	165.2	3.4	5.0	7.1
200	8	216.3	4.0	6.5	8.2
250	10	267.4	4.0	6.5	9.3
300	12	318.5	4.5	6.5	10.3

General piping outside diameter/thickness  
Stainless pipe Large size JIS G3468

Nominal Dia		Dia (mm)	Thickness(mm)		
A	B		Sch.10	20	40
150	6	165.2	3.4	5.0	7.1
200	8	216.3	4.0	6.5	8.2
250	10	267.4	4.0	6.5	9.3
300	12	318.5	4.5	6.5	10.3
350	14	355.6	5.0		
400	16	406.4	5.0		
450	18	457.2	5.0		
500	20	508.0	5.5		
550	22	558.8	5.5		
600	24	609.6	6.5		
650	26	660.4	8.0		
700	28	711.2	8.0		
750	30	762.0	8.0		
800	32	812.8	8.0		
850	34	863.6	8.0		
900	36	914.4	8.0		
1000	40	1016.0	9.5		

General piping outside diameter/thickness  
Carbon Steel Pipe SGP JIS G3452

Nominal Dia		Dia (mm)	Thickness (mm)
A	B		
25	1	34.0	3.2
32	1¼	42.7	3.5
40	1½	48.6	3.5
50	2	60.5	3.8
65	2½	76.3	4.2
80	3	89.1	4.2
90	3½	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
350	14	355.6	7.9
400	16	406.4	7.9
450	18	457.2	7.9
500	20	508.0	7.9

General piping outside diameter/thickness  
Pressure Carbon Steel Pipe STGP370, 410 JIS G3454

Nominal Dia		Dia (mm)	Thickness(mm)			
A	B		Sch.10	20	30	40
25	1	34.0	—	—	—	3.4
32	1¼	42.7	—	—	—	3.6
40	1½	48.6	—	—	—	3.7
50	2	60.5	—	3.2	—	3.9
65	2½	76.3	—	4.5	—	5.2
80	3	89.1	—	4.5	—	5.5
90	3½	101.6	—	4.5	—	5.7
100	4	114.3	—	4.9	—	6.0
125	5	139.8	—	5.1	—	6.6
150	6	165.2	—	5.5	—	7.1
200	8	216.3	—	6.4	7.0	8.2
250	10	267.4	—	6.4	7.8	9.3
300	12	318.5	—	6.4	8.4	10.3
350	14	355.6	6.4	7.9	—	—
400	16	406.4	6.4	7.9	—	—
450	18	457.2	6.4	7.9	—	—
500	20	508.0	6.4	9.5	—	—
550	22	558.8	6.4	9.5	—	—
600	24	609.6	6.4	9.5	—	—
650	26	660.4	7.9	12.7	—	—

City Pipelines Rigid PVC fiber tube JIS K6742

Nominal Dia	Dia (mm)	Thickness (mm)
25	32.0	3.5
30	38.0	3.5
40	48.0	4.0
50	60.0	4.5
75	89.0	5.9
100	114.0	7.1
150	165.0	9.6

Rigid PVC fiber tube JIS K6741

Nominal Dia	VP		VU	
	Dia (mm)	Thickness (mm)	Dia (mm)	Thickness (mm)
25	32.0	3.1	—	—
30	38.0	3.1	—	—
40	48.0	3.6	48.0	1.8
50	60.0	4.1	60.0	1.8
65	76.0	4.1	76.0	2.2
75	89.0	5.5	89.0	2.7
100	114.0	6.6	114.0	3.1
125	140.0	7.0	140.0	4.1
150	165.0	8.9	165.0	5.1
200	216.0	10.3	216.0	6.5
250	267.0	12.7	267.0	7.8
300	318.0	15.1	318.0	9.2
350	—	—	370.0	10.5
400	—	—	420.0	11.8
450	—	—	470.0	13.2
500	—	—	520.0	14.6
600	—	—	630.0	17.8
700	—	—	732.0	21.0
800	—	—	835.0	23.9

Table2 Sound velocity by piping materials (m/s)

Piping material	Sound velocity by piping materials (m/s)
Carbon steel (C ≤ 0.3%)	3064
Carbon steel (C > 0.3%)	3173
Stainless steel	3120
Cast iron	2125
Aluminum	3269
Titanium	2975
PVC	2120
Polypropylene	2400
Polyethylene	1950
PVDF	1923
PMMA	2968

Table3 Sound velocity and kinematic viscosity (m/s, 20°C)

Liquid	Velocity(m/s)	Kinematic viscosity(mm2/s)
water	1482	1.004
Deuterated water	1388	1.129
Glycerin	1923	11.885
Acetic methyl	1181	0.411
Acetic ethyl	1164	0.499

Table4 Temperature and sound velocity of water

Temperature [°C]	+0	+1	+2	+3	+4	+5	+6	+7	+8	+9
0	1402.39	1407.37	1412.23	1416.99	1421.63	1426.16	1430.59	1434.91	1439.13	1443.25
10	1447.27	1451.19	1455.02	1458.75	1462.38	1465.93	1469.39	1472.76	1476.04	1479.23
20	1482.34	1485.37	1488.32	1491.19	1493.98	1496.69	1499.32	1501.88	1504.37	1506.78
30	1509.13	1511.40	1513.60	1515.74	1517.81	1519.81	1521.75	1523.62	1525.73	1527.18
40	1528.86	1530.49	1532.06	1533.56	1535.02	1536.41	1537.75	1539.03	1540.26	1541.43
50	1542.55	1543.62	1544.64	1545.60	1546.52	1547.38	1548.20	1548.97	1549.69	1550.36
60	1550.99	1551.57	1552.10	1552.59	1553.04	1553.44	1553.79	1554.11	1554.38	1554.61
70	1554.80	1554.95	1555.05	1555.12	1555.15	1555.13	1555.08	1554.99	1554.86	1554.70
80	1554.49	1554.25	1553.97	1553.66	1553.31	1552.92	1552.50	1552.05	1551.56	1551.03
90	1550.48	1549.88	1549.26	1548.60	1547.91	1547.19	1546.44	1545.65	1544.83	1543.99

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Table 5 Temperature and kinematic viscosity of water

Temperature [°C]	Kinematic viscosity [mm2/s]	Temperature[°C]	Kinematic viscosity [mm2/s]	Temperature[°C]	Kinematic viscosity [mm2/s]
0	1.792	40	0.6578	80	0.3654
5	1.519	45	0.6020	85	0.3449
10	1.307	50	0.5537	90	0.3263
15	1.139	55	0.5117	95	0.3096
20	1.004	60	0.4750	100	0.2944
25	0.8928	65	0.4425		
30	0.8008	70	0.4138		
35	0.7234	75	0.3883		