FLO-INSTRU

TM601 Ultrasonic Flow Meter

Instruction Manual

Reversion:A

Date:May.2022

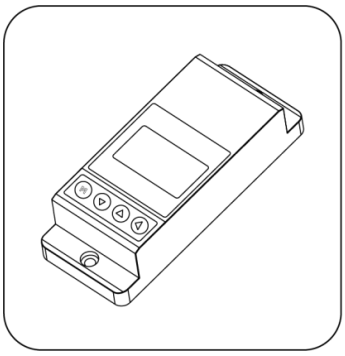
CONTENT

Notice

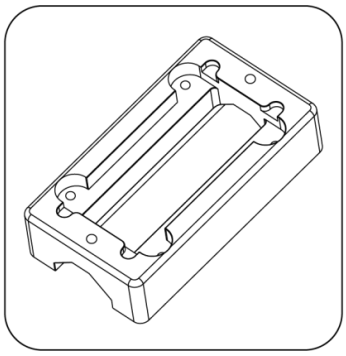
Thank you for choosing Small Pipe Ultrasonic Flowmeter.
This instruction manual contains the important using and operation information of the flow meter. Please read the manual carefully before operation for the expected performance of the flow meter.
Operational mistake would affect the meter's working result, reduce the meter's lifespan or cause some malfunctions.

1.Product component

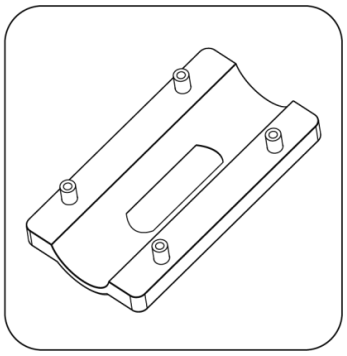
Inspection should be made before installing the flow meter. Check to see if the spare parts are in accordance with the packing list. Make sure that there is no potential damage to the enclosure due to a loose screw or loose wire, which might occur during transportation. Please contact your representative as soon as possible if there is any question.



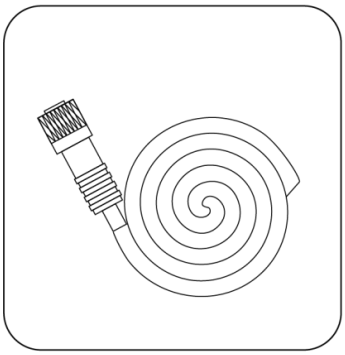
Flow meter



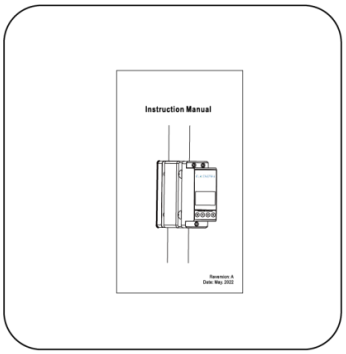
Upper bracket



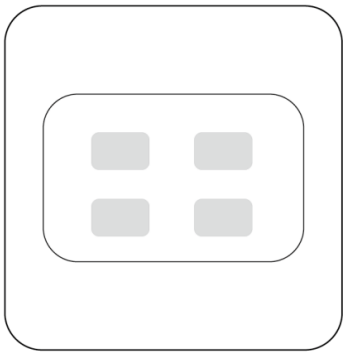
Base bracket



Connecting cables



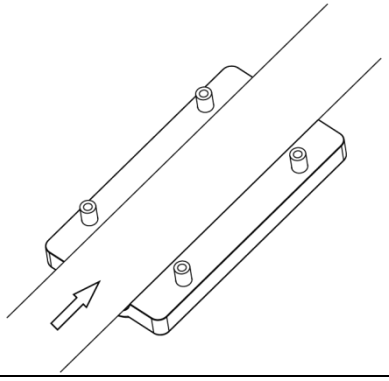
Instruction manual



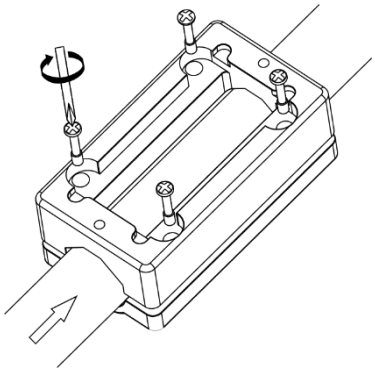
Coupling agent

2.Flow meter installation and connect

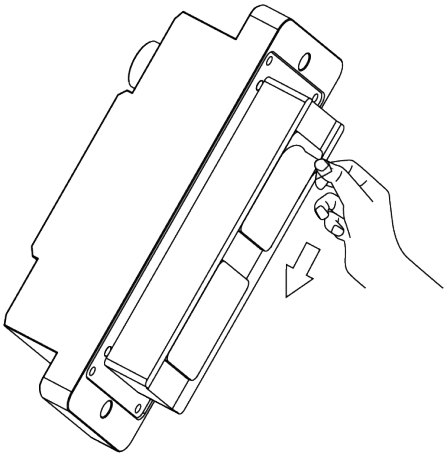
Step1: Make sure no dirt, paint, or other stains on the surface of the tube. If the surface of metal pipes is rough, it needs to be polished with tools. Then put the bottom parts on the side of the pipe.



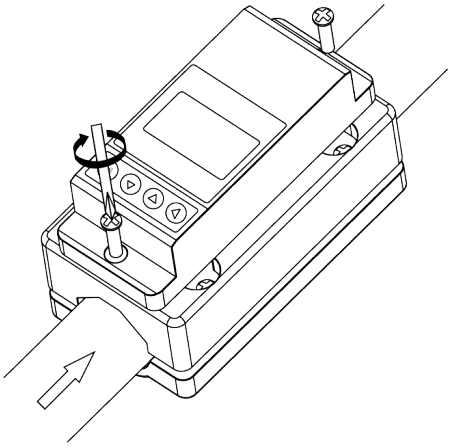
Step2: Align the bracket to the pipe position; Install screw on top part of the bracket, the bottom part of the bracket will automatically connect with the top part. Tighten all four M4 screws.



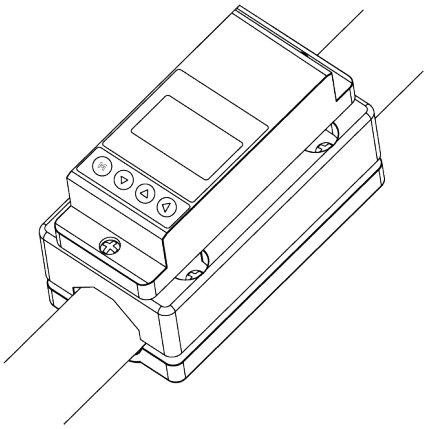
Step3: Take the cover off the sensor.

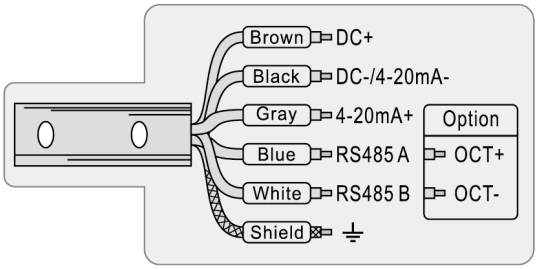


Step4: Put the flow meter into upper bracket, and tighten two M4 screws



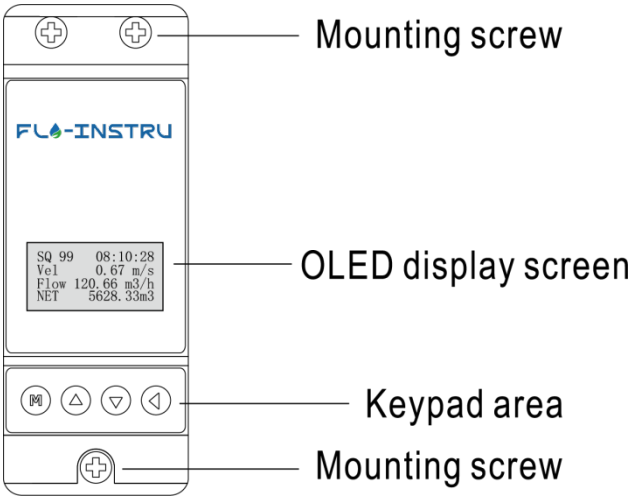
Step5: Take the cover off the sensor.





Wiring diagram

3.Panel function



4.Powering on

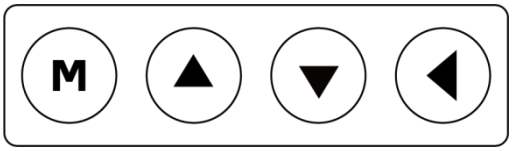
As soon as the Flow meter is switched on, the self-diagnosis program will start to run.	SQ99 12:30:18 3.368 m³/h Net 768.89m³

4.1 Signal Quality (SQ value)

SQ value is short for Signal Quality. It indicates the level of the signal detected. SQ value is indicated by numbers from 099. 00 is the minimum signal could be detected and 99 represents the maximum. Normally, the transducer position should be adjusted repeatedly and coupling compound should be checked frequently until the signal quality detected is as strong as possible.

5.Keypad functions

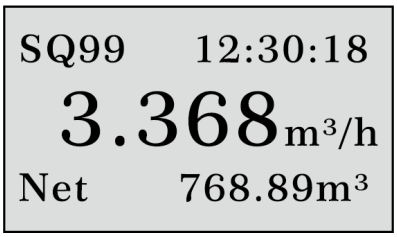
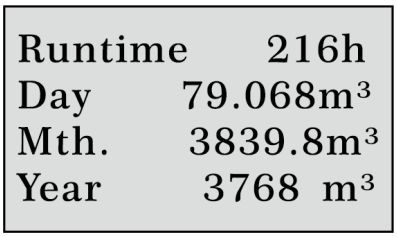
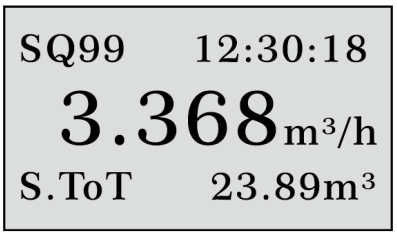
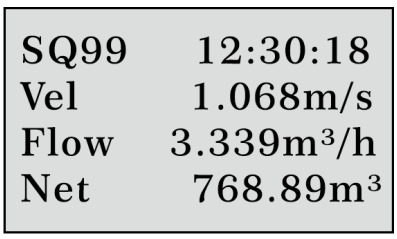
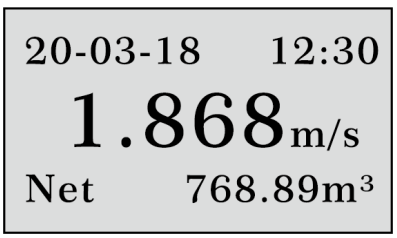
Follow these guidelines when using the flow meter keypad:



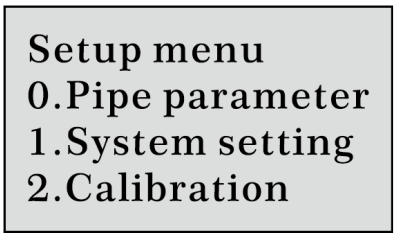
Ⓜ Setting or display mode, when it is on setting mode, it can return to the previous menu, ▼ and ▲ scroll up and down to select the menu, when press ▼ move to next digit, press ▲ and the numbers scroll from 0 to 9, you can select the number. Press ◀ to confirm.

6.Window descriptions

6.1 Display menu

When power is on, The meter will display Flow Rate/Net Totalize. Display signal quality. Time, flow rate and net totalize.	
Press ▼ will display Run time/Daily Totalizer /Month Totalize /Year Totalize, press ▲ will return to previous menu. Display Run time, Date, Month and Year net totalize.	
Press ▼ will display Flow Rate/ S.TOT Totalize, press ▲ will return to previous menu. Display signal quality. Time, flow rate and S.ToT totalize.	
Press ▼ will display Flow Rate/ Velocity/Net Totalize, press ▲ will return to previous menu. Display signal quality. Time, velocity, flow rate and net totalize.	
Press ▼ will display Velocity/Net Totalize. Press ▲ will return to previous menu. Display date and time,velocity and net totalize.	

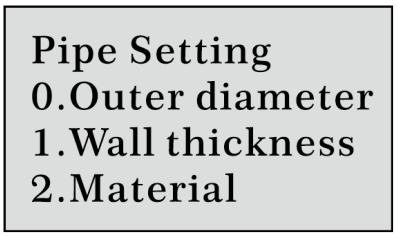
6.2 Setup menu

Press M will display setup menu. The following options are available.(by ▼ or ▲ buttons) 0. **Pipe parameter** 1. **System setting** 2. **Calibration** 3. **Output setting** 4. **History data**	

6.3 Setup menu - Pipe parameter

Press▼, select 0. Pipe parameter, then◀display.
The following options are available. (by▼or▲buttons)

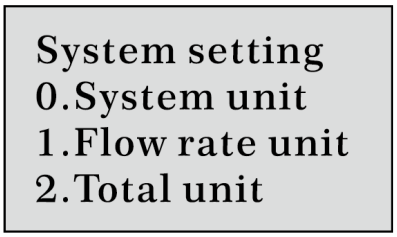
0. **Outer diameter**
1. **Wall thickness**
2. **Material**: Move▼or▲can choose PVC, Carbon steel, Steel, Copper, PVDF, PFA, PTFE, PU pipe etc.
3. **Fluid type**: Move▼or▲can option Water, Sea Water, Oil etc.



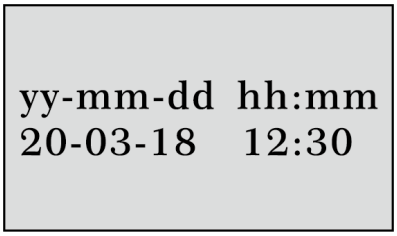
6.4 Setup menu - System setting

Press▼,select 1. System setting, then◀display.
The following options are available. (by▼or▲ buttons)

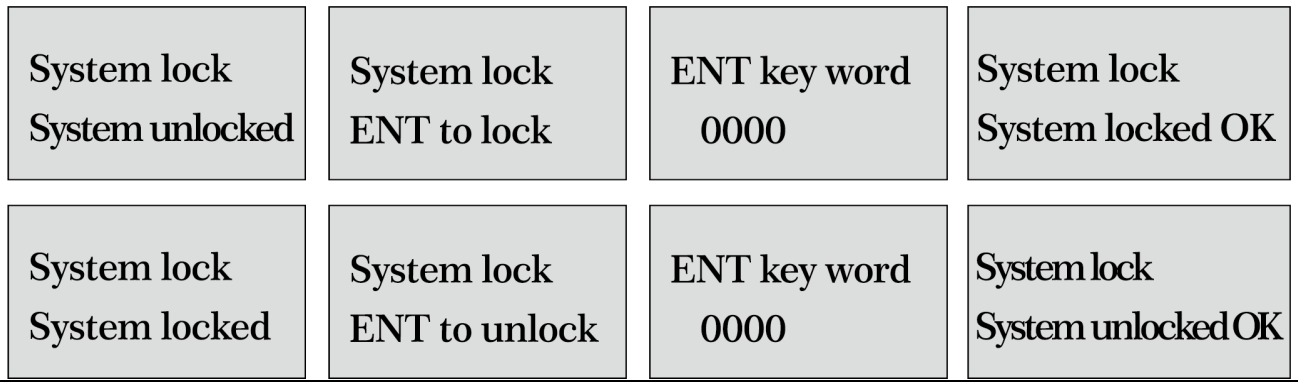
0. **System unit**: Move▼or▲can option Metric, English.
1. **Flow rate unit**: Move▼or▲can option m3/h, LPM, GPM.
2. **Total unit**: Move▼or▲can m3,L,GAL.
3. **Total reset**: All parameters are reset, press◀, move▼or▲arrow to select "YES" or "NO" .After "YES" is selected.



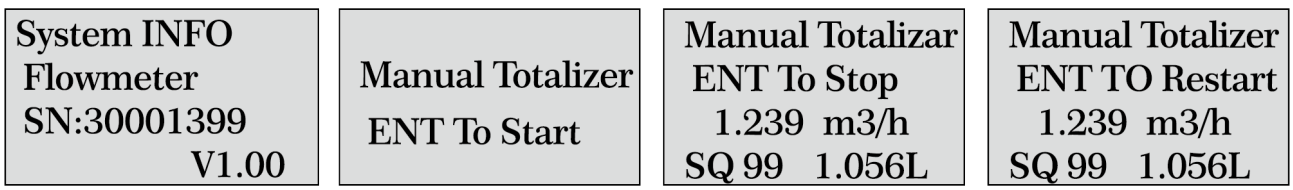
4. **Time set**: When modifying, the default is 30 seconds. Generally, it is unnecessary to modify date time as the system is equipped with a highly reliable perpetual calendar chip.

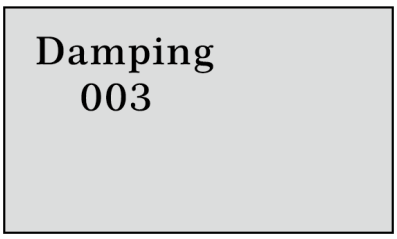
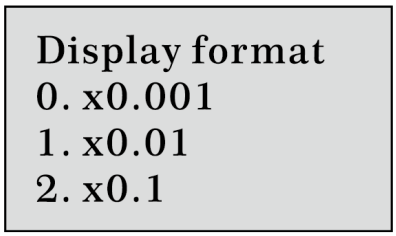


5. **System lock**: Once the system is locked, any modifications to the system are prohibited, but the parameter is readable. "Unlock" using your designated password. The password is composed of 1 to 4 numbers.

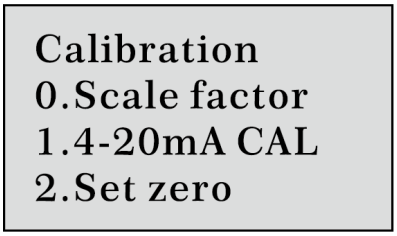
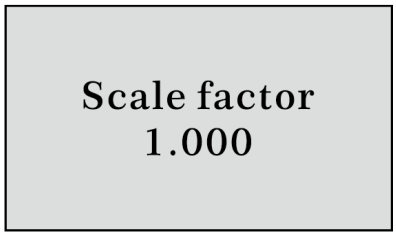
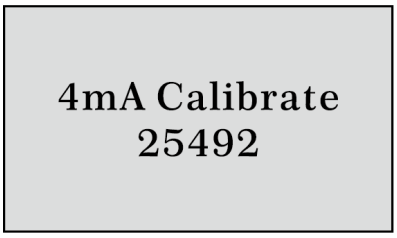
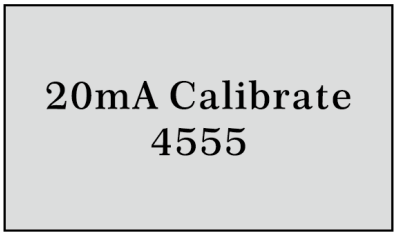


6. System info: Display serial number (SN) of the meter. This SN is the only one assigned to each flow meter ready to leave the factory. The factory uses it for files setup and for management by the user. Press◀5 times to enter Manual Totalizer: The manual totalizer is a separate totalizer. Press◀to start, and press◀to stop it. It is used for flow measurement and calculation.



7. Display dir: Select the display direction of the screen, which can be rotated by 180 degrees.	
8. Damping: When the flow regime is unstable and the Display value changes greatly, damping can be set to adjust the measurement response speed of the product. The unit is in second.	
9. Display format: The display digit of the measured value can be set through the zoom function. It is displayed after the decimal point by default 3 digits. You can choose to display 2 digits after the decimal point,1 digit after the decimal point and 0 digit after the decimal point.	

6.5 Setup menu - Calibration

Press▼, Select 2. Calibration, and then◀display:	
0. **Scale factor** Refers to the ratio between "actual value" and "reading value". For example, when the measurement is 2.00, and it is indicated at 1.98 on the instrument, the scale factor reading is 2/1.98 This means that the best scale factor constant is 1.01.	
1. **4-20mA CAL** Check if the current loop has been calibrated before leaving the factory. Press▼move▲to display 4mA or 20mA, and at The same time, check with an ammeter to verify that Current Loop output displayed values. It is necessary to re-calibrate the current loop, if over the permitted tolerance. The displayed value has no meaning, but is only used for Internal records. Correct only by up and down Key operation, check the displayed value of ammeter (multimeter).	 

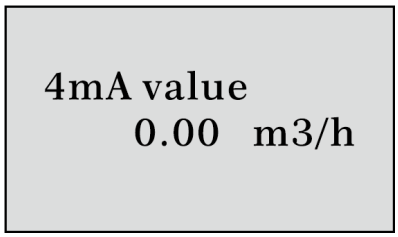
2. **Set zero**: Press reset "Zero Point" which was set by the user. After setting, return to the main interface and the flow is "0". If you return to the main interface, the flow is not "0", the setting is unsuccessful. Check whether the installation is correct or not.	Set zero Ent To set zero Reset zero
3. **Low flow cut** Flow rate falls below the low flow cutoff value. This function can prevent that when the pump stops working and the liquid flows at a low speed in the pipe, data accumulation error caused by continuous reading of flow meter. Input is generally recommended 0.05m/s as the low flow cut-off point.The low flow cut-off value is independent of the measurement results. Generally, pipes made of SS304 or SS316 are with wall thickness of more than 2mm.In practical use, it will receive false signals due to the interference of pipe wall signals, It is recommended that the low flow rate should be cut off at 0.08m/s or above.	Low flow cut 0.0500 m/s
4. **Manual zero** This method is not commonly used and is only suitable for experienced operators. It is not suitable for other parties, Manually input the value and add it to the measured value to obtain the actual value.	Manual zero 0.0000 m3/h
5. **Hi AGC** High gain switch do not needs to be set generally. could try to switch on for special pipes with weak signal detected.	Hi AGC 0. OFF

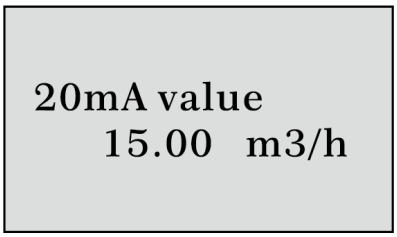
6.6 Setup menu - Output Setting

Press, Select 3, Output setting, and then display:	Output setting 0.RS485 Setup 1.4-20mA range 2.Alarm value
0. **RS485 setup** The window is used to set serial port. Its connection with the equipment of its serial port set of parameters must match. Firstly to choose baud rate: 2400, 4800, 9600, 19200.Secondly to choose: None. Data digit length is 8, Stop bit for a fixed length; Factory serial port parameters default is"9600, 8, None,1".	RS485 Setup 0.Network addr 1.RS485 Baudrate

1. **4-20mA range**

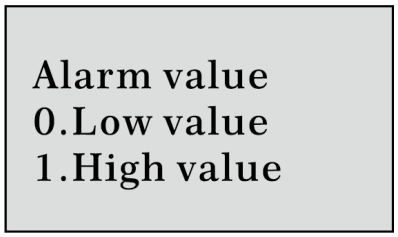
Set the Current Loop output value according to the flow value at 4mA, and 20mA. The flow unit is m3/h.





2. **Alarm value (Option)**

Enter the low alarm value; any measured flow lower than the low value. will activate the alarm in the OCT hardware or relay output signal. Enter the high alarm value; any measured flow higher than the high value, will activate the alarm in the OCT hardware or relay output signal.



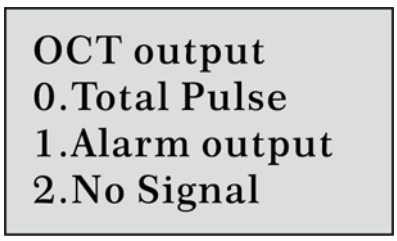
3. **OCT output (Applicable to OCT output model)**

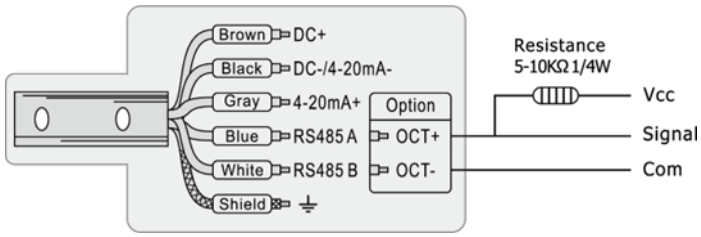
The OCT output in the flow meter is a kind of isolated collector open circuit output with programmable open and close qualifications. The user can program the open and close functions under the following conditions: the system alarm signals are being activated or the totalizer pulse is being transmitted.

Pulses are cumulative output, and the equivalent of each pulse is 0.01L~ 100m3, lt can be set through the menu. The maximum number of pulses output per second is 40.

OCT wiring diagram:

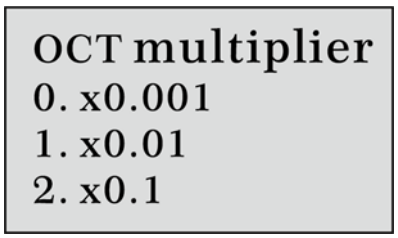
To select OCT output, an external 5-10K pull-up resistor shall be connected at the OCT + end; Add a 5-24V DC power supply at VCC and com ends, as shown in the figure:





4. **OCT multiplier (Applicable to OCT output model)**

Select OCT pulse output multiple.



6.7 Setup menu - History data

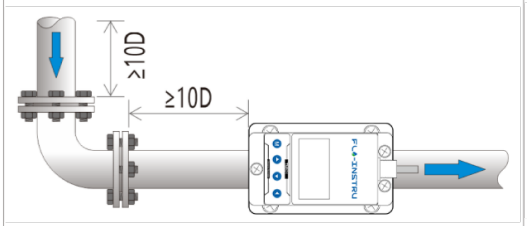
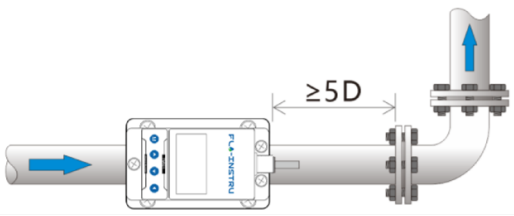
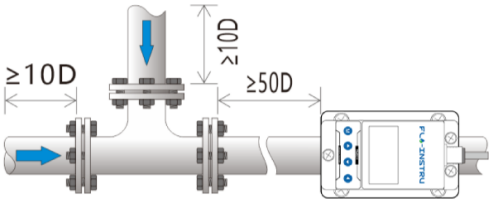
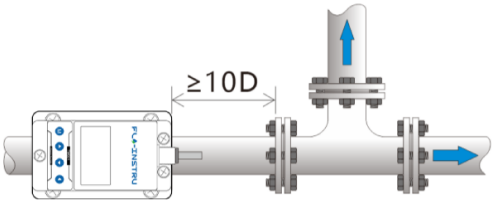
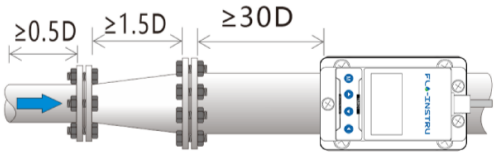
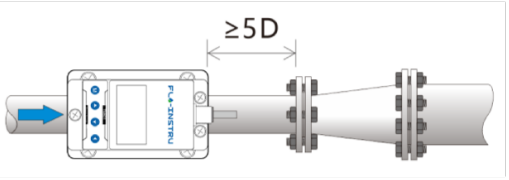
Press ▼, Select 4, History data, and then ◀ display:

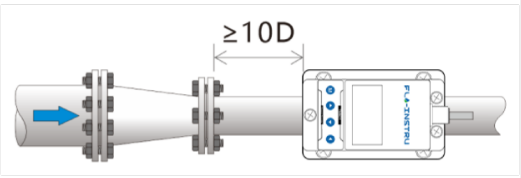
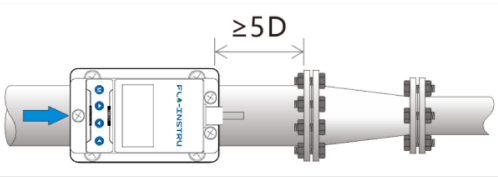
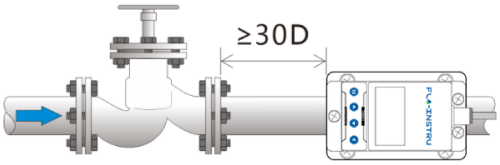
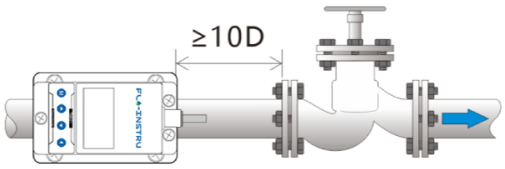
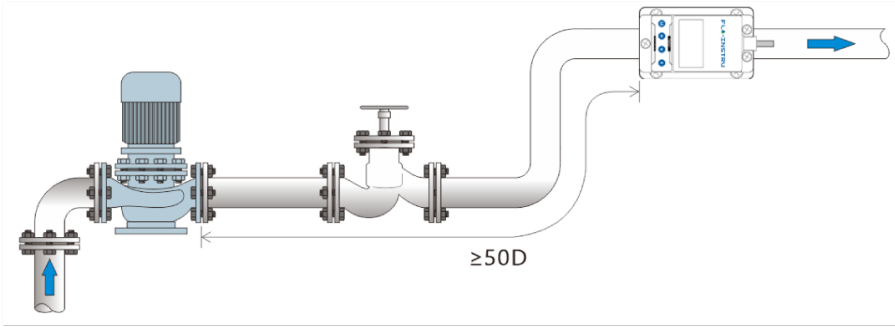
0. By Day: Display Totalizer flow for days
1. By Month: Display Totalizer flow for months.
2. By Year: Display Totalizer flow for years.

7.Working Principle

Products developed by adopting the ultrasonic principle of transit-time difference method (also called the speed difference method) send and receive ultrasonic signals through the sensor. The downstream propagation time is fast and the counter-flow propagation time is slow. We can get transit-time difference, thereby converting the flow velocity and multiplying it by the cross-sectional area of the pipe. flow can be calculated.
For first-time using, kindly refer to the following operation:

Point selection (Installation Position)
The transit-time difference ultrasonic flowmeter can only be well measured when the flow rate is stable, the medium (liquid) in the pipeline is free of impurities and bubbles, and there is a certain pressure (about 0.4MPa)—— This is a necessary basic condition for flowmeter with velocity difference method.
In order to ensure the above conditions, the flowmeter must be installed on the horizontal pipeline or vertical pipeline (the flow direction is from bottom to top to avoid empty pipes or bubbles)
The pipe is filled with liquid, and the temperature is within the specified range. It should be installed on the side of the pipe (at 3:00 or 9:00), as shown in the following diagram:

Installation Point	Straight pipe section in the front of installation point	Straight pipe section in the back of installation point
Elbow		
Three-way Pipe		
Expansion Pipe		

Swaged Pipe		
Valve		
Bump		

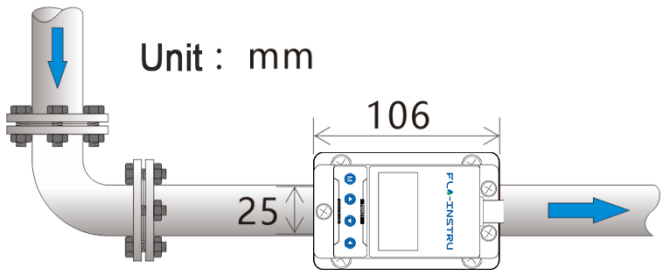
Note: D refers to the diameter of the pipe, such as: the pipe is DN25, 10D is 254mm

Pipeline Treatment

Ultrasonic signals are greatly attenuated in the air, and paint or potholes on the surface of the pipeline will affect the propagation of ultrasonic waves, and surface treatment of the pipeline is required.

The surface of the paint pipe is free from stains, flat and bright. In particular, the surface of the metal pipe should be polished with a grinder, and then scrubbed with clean water.

Refer to the figure below for the grinding area:



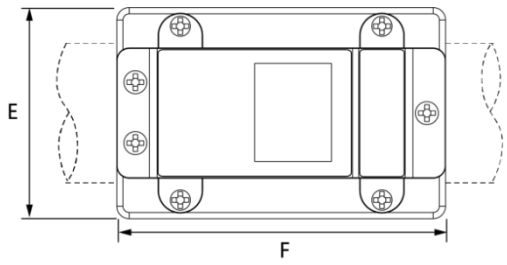
8.Performance index

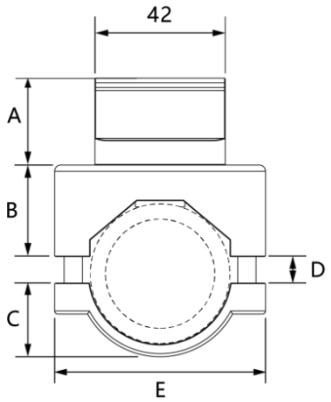
Product: Small Pipe Ultrasonic Flowmeter (Model: TM601)							
Model	Φ9.53	Φ12.7	Φ15	Φ20	Φ25	Φ32	Φ40
OD	9.53	12.7	15	20	25	32	40
OD Range(mm)	9.5-10.5	12.4-13.1	14.5-15.4	16.5-23.0	25.0-30.0	32.0-35.0	38.0-45.0
DN	4	8	10	15	20	25	32
Inch	1/8″	1/4″	3/8″	1/2″	3/4″	1″	1-1/4″
Model	Φ50	Φ63	Φ75	Φ90	Φ110	Φ140	Φ220
OD	50	63	75	90	110	140	220
OD Range(mm)	48.0-54.0	58.0-64.0	72.0-78.0	80.0-92.0	108.0-116.0	132.0-142.0	218.0-228.0
DN	40	50	65	80	100	125	200
Inch	1-1/2″	2″	2-1/2″	3″	4″	5″	8″

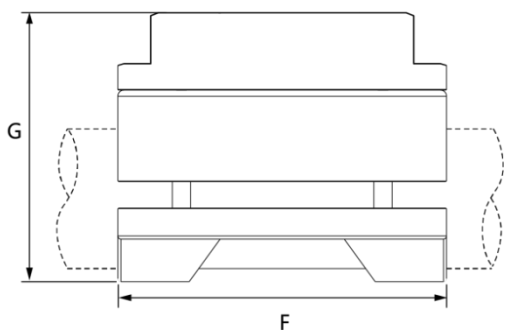
Accuracy	±2.0%(±0.1m/s~±5m/s)
Repeatability	0.8%
Data Storage	Daily, monthly, and annual flow totalizer
Response Time	2s
Analog Output	4-20mA, Maximum load: 750Ω
Alarm Output	OCT upper and lower limit alarm function (optional)
Communication	RS485
Power Supply	9 ~ 36V DC
Cable Length	2m
Keypad	Four touch buttons
Screen	OLED 128*64 display screen
Units	Support metric unit selection, Cubic Meters(m3), Liters(l), USA Gallons(gal)./hour, /min, The factory default unit is cubic meters per hour.
Totalizer	6 bit flow rate totalizer
Liquid	Water, Sea water, Oil, Alcohol...
Piper Material	Carbon Steel, Stainless Steel, Copper, Plastic pipe (PVC, PVDF, PFA, PTFE,PU, PPR, PPH, HDPE, etc.)
Housing Material	Aluminum alloy
Ambient Temperature	0℃- 50℃
Fluid Temperature	0℃- 50℃
Ambient Humidity	RH 0～95%, No condensation
IP Rate	IP54

8.1 Appendix 1—Contrastive table of clamp on specification

Model	A(mm)	B(mm)	C(mm)	D(mm) Max	E(mm)	F(mm)	G(mm) Max	Min Pipe	Max Pipe
-Φ9.53	31	25	7	7.5	58	106	70.5	Φ9.53	Φ12
-Φ12.7	31	25	7	7.5	58	106	70.5	Φ12	Φ14
-Φ15	31	25	7	7.5	58	106	70.5	Φ14	Φ16
-Φ20	31	25	15.8	4	58	106	75.8	Φ20	Φ22
-Φ25	31	25	14.6	4	58	106	74.6	Φ25	Φ28
-Φ32	31	28.5	18.5	4	58	106	82	Φ32	Φ35
-Φ40	31	29.5	23.5	7	68	106	91	Φ38	Φ45
-Φ50	31	36	27	7	78	106	101	Φ48	Φ54
-Φ63	36	41	32	7	91	130	116	Φ58	Φ64
-Φ75	36	46.5	40	7	105	136	129.5	Φ72	Φ78
-Φ90	36	53.5	47	7	119	150	143.5	Φ80	Φ92
-Φ110	36	68	54.5	9	143	174	167.5	Φ108	Φ116







8.2 Appendix 2—Statistical table of applicable range of pipe clamp for clamp on

Model	Pipe material	Nominal inner diameter of pipe	Flow Range (0.1~5m/s) (m3/h)	Flow Range (0.1~5m/s) (L/min)	Flow Range (0.1~5m/s) (US GPM)
TM601	Carbon Steel, Stainless Steel, Copper, Plastic pipe	DN4	0.001~0.143	0.02~2.375	22.802 ~ 3800.306
		DN8	0.003 ~ 0.570	0.02~2.375	0.251 ~ 41.831
		DN10	0.008 ~ 1.283	0.128 ~ 21.377	0.565 ~ 94.119
		DN15	0.014 ~ 2.280	0.228 ~ 38.003	1.004 ~ 167.323
		DN20	0.031 ~ 5.130	0.513 ~ 85.507	2.259 ~ 376.477
		DN25	0.055 ~ 9.121	0.513 ~ 85.507	4.016 ~ 669.292
		DN32	0.086 ~ 14.251	1.425 ~ 237.519	6.275 ~ 1045.769
		DN40	0.123 ~ 20.522	2.052 ~ 342.028	9.035 ~ 1505.907
		DN50	0.219 ~ 36.483	3.648 ~ 608.079	16.063 ~ 2677.167
		DN65	0.342 ~ 57.005	5.700 ~ 950.077	25.098 ~ 4183.074
		DN80	0.493 ~ 82.087	8.209 ~ 1368.110	36.142 ~ 6023.627
		DN100	0.876 ~ 145.932	14.593 ~ 2432.196	36.142 ~ 6023.627
		DN125	1.368 ~ 228.018	22.802 ~ 3800.306	100.394 ~ 16732.296
		DN200	3.502 ~ 583.727	22.802 ~ 3800.306	257.008 ~ 42834.679

9.Communication protocol

This instrument protocol supports the following function codes of the MODBUS protocol:：

Function code	Represents functional data
0x03	Read register

1. MODBUS Protocol function code 0x03 use

The host sends out the frame format of the read register information：

Slave address	Operation function code	Register header address	Register number	check code
1 byte	1 byte	2 bytes	2 bytes	2 bytes
0x01~0xF9	0x03	0x0000~0xFFFF	0x0000~0x7D	CRC check code

Data frame format from the slave：

Slave address	Read operation function code	Number of bytes of data	Data	check code
1 byte	1 byte	1 byte	N*x2 byte	2 byte
0x01~0xF9	0x03	2xN*	N*x2 data	CRC check code

N*＝Number of data registers.

The address of the meter (the address of the flow meter) ranges from 1 to 249 (hex: 0x01 to 0xF9). The address can be viewed in the Menu Network addr. If the decimal number displayed in Menu Network addr is 12, then the address of this meter in the MODBUS protocol is: 0x0C.

The CRC check code of this instrument is obtained by CRC-16-IBM (polynomial X16 + X15 + X2 + 1, mask word 0xA001) cyclic redundancy algorithm, the low byte of the check code is first, and the high byte is after.

2. MODBUS Register address list

The meter's MODBUS register contains a read-only register and a single write register。

a) Read-only register address list (read with 0x03 function code)

Register address	Register	Data description	Date Type	Number of registers	Description
0000	40001	Flow velocity-low byte	32 bits real	2	Unit: m/s
0001	40002	Flow velocity-high byte			
0002	40003	Instantaneous flow rate—low byte	32 bits real	2	
0003	40004	Instantaneous flow rate—high byte			
0004	40005	Flow totalizer—low byte	32 bits real	2	
0005	40006	Flow totalizer—high byte			
0006	40007	Flow totalizer integer—Low byte	32 bits int.	2	
0007	40008	Flow totalizer integer—high byte			
0008	40009	Flow totalizer decimal-low byte	32 bits real	2	
0009	40010	Flow totalizer decimal-low byte			
000A	40011	Today totalizer integer-low byte	32 bits int.	2	
000B	40012	Today totalizer integer—high byte			
000C	40013	Today totalizer decimal-low byte	32 bits real	2	
000D	40014	Today totalizer decimal-high byte			
000E	40015	Monthly totalizer-low byte	32 bits real	2	

000F	40016	Monthly totalizer-low byte			
0010	40017	Yearly totalizer—low byte	32 bits real	2	
0011	40018	Yearly totalizer-high byte			
0012	40019	4-20mA output value—low byte	32 bits real	2	
0013	40020	4-20mA output value—high byte			
0014	40021	Running time—low byte	32 bits int.	2	Unit : s
0015	40022	Running time—high byte			
0016	40023	Meter Serial Number—Character 1,2	String	4	
0017	40024	Meter Serial Number—Character 3,4			
0018	40025	Meter Serial Number—Character 5,6			
0019	40026	Meter Serial Number—Character 7,8			
001A	40027	Date and Time		3	Year,month, day,hour,minute,second
001B	40028				
001C	40029				
001D	40030	Signal Quality Q	16 bits int	1	
001E	40031	Running Status	16 bits int	1	
001F	40032	Meter Address (1-249)	16 bits int		
0020	40033	Communication baud rate 0 =2400, 1 = 4800, 2 = 9600, 3 = 19200	16 bits int		
0021	40034	Flow velocity unit	String		m/s or f/s
0022	40035				
0023	40036	Instantaneous flow rate unit	String		
0024	40037				
0025	40038	Flow totalizer unit	String		

b) Single write register address list (write with 0x06 function code)

Register address	Register	Data description	Read/write	Date Type	Number of Register
1003	44100	Meter Address (1-249)	R/W	16 bits int.	1
1004	44101	Communication baud rate 0 =2400, 1 = 4800, 2 = 9600, 3 = 19200	R/W	16 bits int.	1
1005	44102	Instantaneous flow rate unit	R/W	16 bits int	1
1006	44103	Flow totalizer unit	R/W	16 bits int	1

Note:

1. The instantaneous flow unit has the following options:

0. 0x30 — m3/h	1. 0x31 — LPM	2. 0x32 — GPM

2. The flow totalizer unit has the following options:

0. 0x30 — m3	1. 0x31 — L	2. 0x32 — GAL

3. When changing the address or communication baud rate of the instrument, the instrument will work at the new address or communication baud rate immediately after the instrument returns a response at the original address or communication baud rate.

16 bits int—Represents a short integer，32 bits int—Represents a long integer，32 bits real—Represents a floating point number，String—Represents a string, BCD-Represents a decimal number.

10.Product warranty

Flo-Instruments' products have been strictly tested before leaving factory. If any malfunction occurs, please contact us or our agents immediately and provide details of the malfunction.

Warranty

The warranty is for one full year after the date that product is delivered at the designated place.

Scope of warranty

If any malfunction is caused by within the one-year warranty,we would repair the product free of charge.

The following situations are not covered by the warranty.

If product is not used properly in accordance to the manual or technical requirements (including unsuitable conditions, unsuitable environment, etc.).

If the malfunction is caused by purchasers or purchasers' software.

If product is amended or fixed without permission.