



TM602 Ultrasonic Flow Meter

Instruction Manual



Reversion:A
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Notice

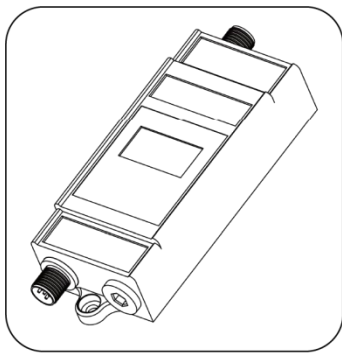
Thank you for choosing Small Pipe Ultrasonic Flowmeter.

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.

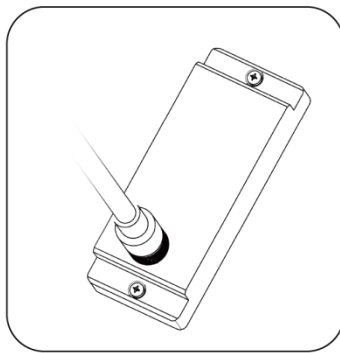
Operational mistake would affect the meter's working result, reduce the meter's lifespan or cause some malfunctions.

1.Product component

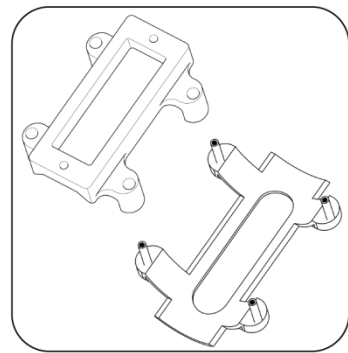
Inspection should be made before installing the flow meter. Check to see if the spare parts are in accordance with the packing list. Make sure that there is no potential damage to the enclosure due to a loose screw or loose wire, which might occur during transportation. Please contact your representative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



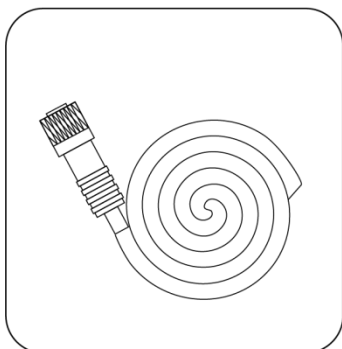
Flow meter



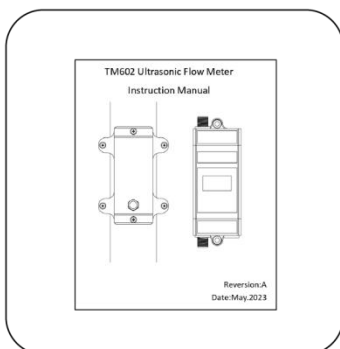
Upper bracket



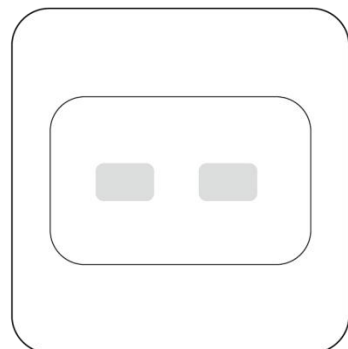
Base bracket



Connecting cables



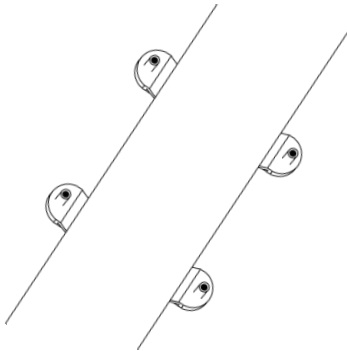
Instruction manual



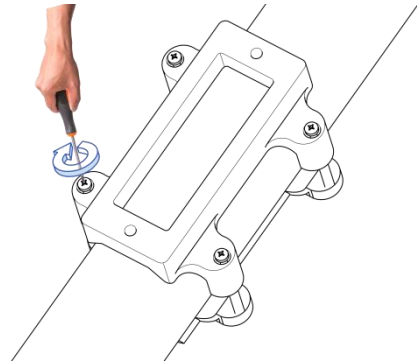
Coupling agent

2.Flow meter installation and connect

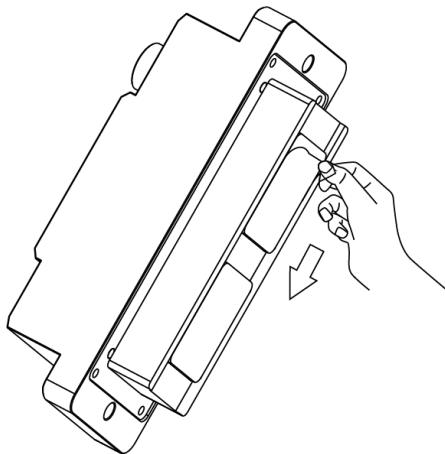
Step1: Make sure no dirt, paint, or other stains on the surface of the tube. If the surface of metal pipes is rough, it needs to be polished with tools. Then put the bottom parts on the side of the pipe.



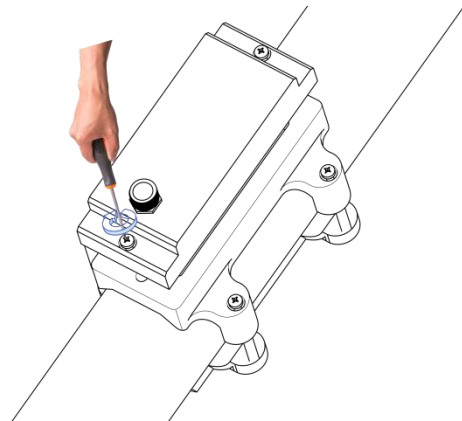
Step2: Align the bracket to the pipe position; Install screw on top part of the bracket, the bottom part of the bracket will automatically connect with the top part. Tighten all four M4 screws.



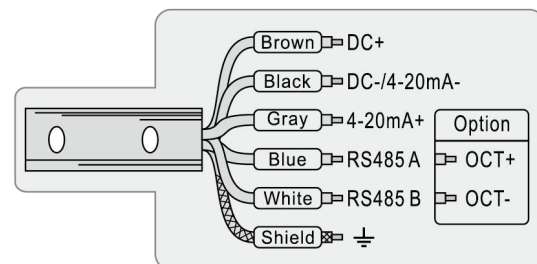
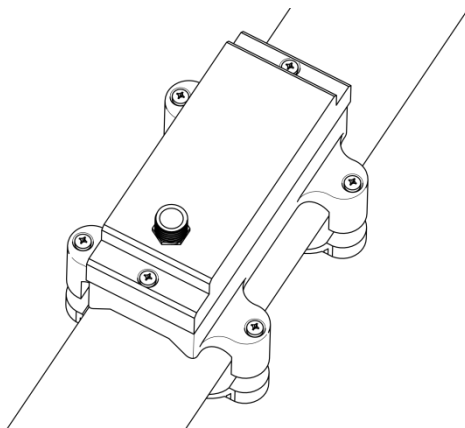
Step3: Take the cover off the sensor.



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

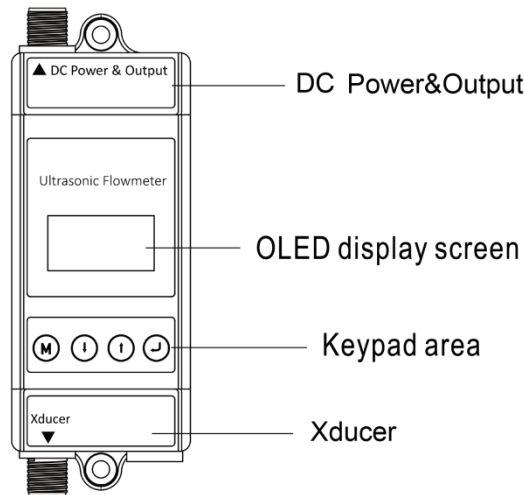


Step5: Installation Finished.



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.

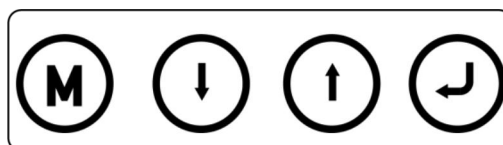
SQ99	12:30:18
3.368 m ³ /h	
Net	768.89m ³

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

1 6.1 Display menu

<p>When power is on, The meter will display Flow Rate/Net Totalize. Display signal quality. Time, flow rate and net totalize.</p>	<p>SQ99 12:30:18 3.368m³/h Net 768.89m³</p>
<p>Press \downarrow will display Run time/Daily Totalizer /Month Totalize /Year Totalize, press \uparrow will return to previous menu. Display Run time, Date, Month and Year net totalize.</p>	<p>Runtime 216h Day 79.068m³ Mth. 3839.8m³ Year 3768 m³</p>
<p>Press \downarrow will display Flow Rate/ S.TOT Totalize, press \uparrow will return to previous menu. Display signal quality. Time, flow rate and S.ToT totalize.</p>	<p>SQ99 12:30:18 3.368m³/h S.ToT 23.89m³</p>
<p>Press \downarrow will display Flow Rate/ Velocity/Net Totalize, press \uparrow will return to previous menu. Display signal quality. Time, velocity, flow rate and net totalize.</p>	<p>SQ99 12:30:18 Vel 1.068m/s Flow 3.339m³/h Net 768.89m³</p>
<p>Press \downarrow will display Velocity/Net Totalize. Press \uparrow will return to previous menu. Display date and time,velocity and net totalize.</p>	<p>20-03-18 12:30 1.868m/s Net 768.89m³</p>

2 6.2 Setup menu

<p>Press \mathcal{M} will display setup menu. The following options are available.(by \downarrow or \uparrow buttons)</p> <ol style="list-style-type: none"> 0. Pipe parameter 1. System setting 2. Calibration 3. Output setting 4. History data 	<p>Setup menu 0.Pipe parameter 1.System setting 2.Calibration</p>
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3 6.3 Setup menu - Pipe parameter

<p>Press \downarrow, select 0. Pipe parameter, then \leftarrow display. The following options are available. (by \downarrow or \uparrow buttons)</p> <ol style="list-style-type: none"> 0. Outer diameter 1. Wall thickness 2. Material: Move \downarrow or \uparrow can choose PVC, Carbon steel, Steel, Copper, PVDF, PFA, PTFE, PU pipe etc. 3. Fluid type: Move \downarrow or \uparrow can option Water, Sea Water, Oil etc. 	<p style="text-align: center;">Pipe Setting 0.Outer diameter 1.Wall thickness 2.Material</p>
---	--

4 6.4 Setup menu - System setting

<p>Press \downarrow, select 1. System setting, then \leftarrow display. The following options are available. (by \downarrow or \uparrow buttons)</p> <ol style="list-style-type: none"> 0. System unit: Move \downarrow or \uparrow can option Metric, English. 1. Flow rate unit: Move \downarrow or \uparrow can option m³/h, LPM, GPM. 2. Total unit: Move \downarrow or \uparrow can m³,L,GAL. 3. Total reset: All parameters are reset, press \leftarrow, move \downarrow or \uparrow arrow to select "YES" or "NO". After "YES" is selected. 	<p style="text-align: center;">System setting 0.System unit 1.Flow rate unit 2.Total unit</p>
<p>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.</p>	<p style="text-align: center;">yy-mm-dd hh:mm 20-03-18 12:30</p>

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.





System lock System unlocked	System lock ENT to lock	ENT key word 0000	System lock System locked OK
System lock System locked	System lock ENT to unlock	ENT key word 0000	System lock System unlocked OK


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 \leftarrow 5 times to enter Manual Totalizer: The manual totalizer is a separate totalizer. Press \leftarrow to start, and press \leftarrow to stop it. It is used for flow measurement and calculation.

System INFO Flowmeter SN:30001399 V1.00	Manual Totalizer ENT To Start	Manual Totalizar ENT To Stop 1.239 m ³ /h SQ 99 1.056L	Manual Totalizer ENT TO Restart 1.239 m ³ /h SQ 99 1.056L
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<p>7. Display dir: Select the display direction of the screen, which can be rotated by 180 degrees.</p>	<p>Display dir 0.Normal 1.Inversion</p>
<p>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.</p>	<p>Damping 003</p>
<p>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.</p>	<p>Display format 0. x0.001 1. x0.01 2. x0.1</p>

5 6.5 Setup menu - Calibration

<p>Press , Select 2. Calibration, and then  display:</p>	<p>Calibration 0.Scale factor 1.4-20mA CAL 2.Set zero</p>
<p>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.</p>	<p>Scale factor 1.000</p>
<p>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.</p> <p>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).</p>	<p>4mA Calibrate 25492</p> <p>20mA Calibrate 4555</p>

<p>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.</p>	<p>Set zero Ent To set zero Reset zero</p>
<p>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.</p>	<p>Low flow cut 0.0500 m/s</p>
<p>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.</p>	<p>Manual zero 0.0000 m³/h</p>
<p>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.</p>	<p>Hi AGC 0. OFF</p>

6.6 Setup menu - Output Setting

<p>Press , Select 3, Output setting, and then  display:</p>	<p>Output setting 0. RS485 Setup 1. 4-20mA range 2. Alarm value</p>
<p>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".</p>	<p>RS485 Setup 0. Network addr 1. RS485 Baudrate</p>

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.

4mA value
0.00 m³/h

20mA value
15.00 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.

Alarm value
0.Low value
1.High value

3. OCT output (Applicable to OCT output model)

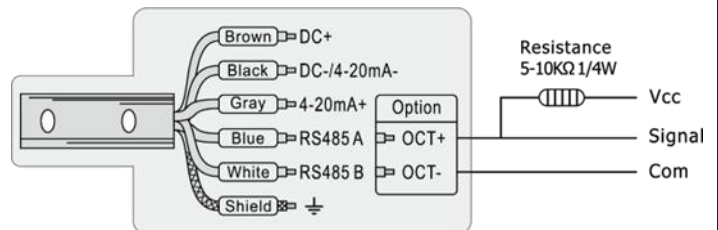
The OCT output in the flow meter is a kind of isolated collector open circuit output with programmable open and close qualifications. The user can program the open and close functions under the following conditions: the system alarm signals are being activated or the totalizer pulse is being transmitted.

Pulses are cumulative output, and the equivalent of each pulse is 0.01L~ 100m³, It 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:

OCT output
0.Total Pulse
1.Alarm output
2.No Signal



4. OCT multiplier (Applicable to OCT output model)

Select OCT pulse output multiple.

OCT multiplier
0. x0.001
1. x0.01
2. x0.1

7 6.7 Setup menu - History data

Press \downarrow , Select 4, History data, and then \downarrow 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.

History data
0.By Day
1.By Month
2.By Year

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:

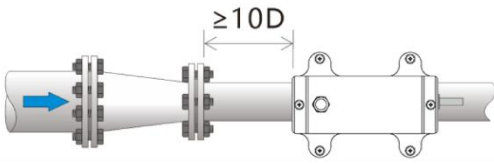
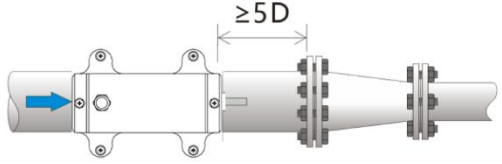
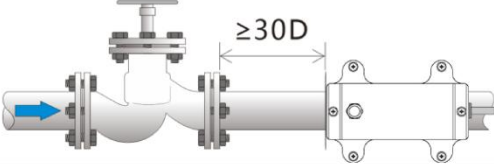
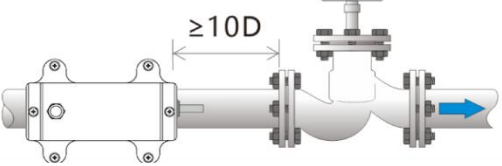
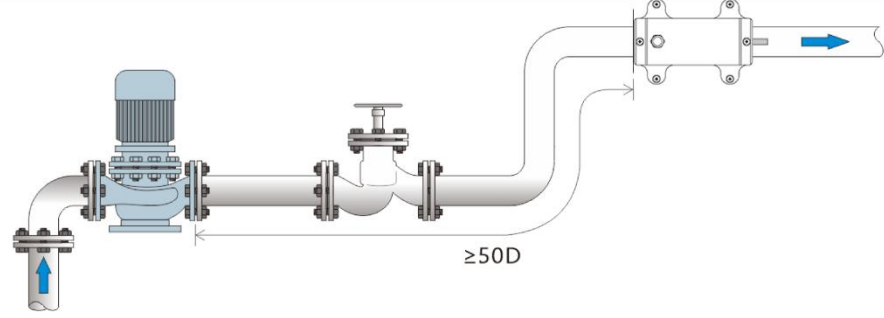
Point selection (Installation Position)

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		

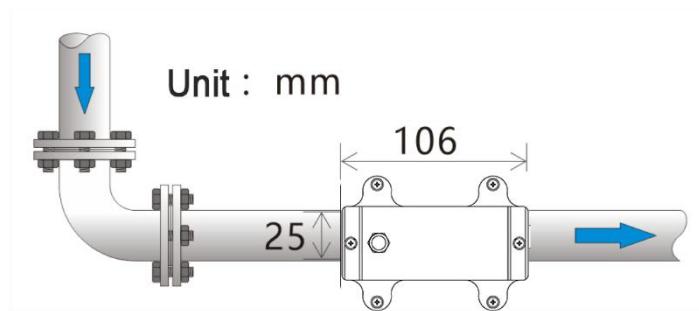
Note: D refers to the diameter of the pipe, such as: the pipe is DN25, 10D is 254mm

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:

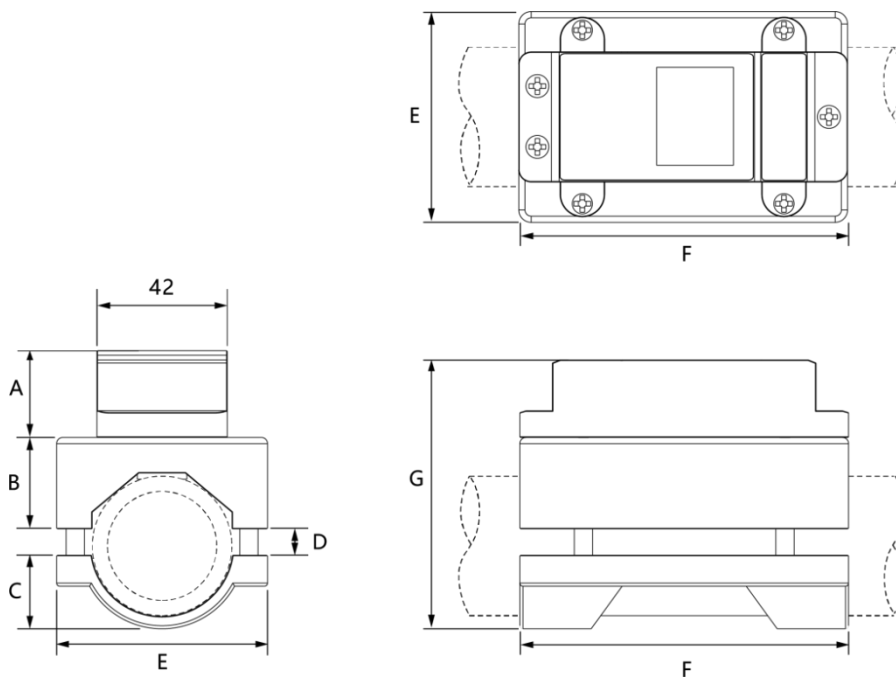


8. Performance index

Product: Small Pipe Ultrasonic Flowmeter (Model: TM601)							
Model	Φ 9.53	Φ 12.7	Φ 15	Φ 20	Φ 25	Φ 32	Φ 40
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	Φ 50	Φ 63	Φ 75	Φ 90	Φ 110		
OD	50	63	75	90	110		
OD Range(mm)	48.0-54.0	58.0-64.0	72.0-78.0	80.0-92.0	108.0-116.0		
DN	40	50	65	80	100		
Inch	1-1/2"	2"	2-1/2"	3"	4"		
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(m ³), 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°C - 50°C						
Fluid Temperature	0°C - 110°C						
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	40	25	7	8	58	106	80	Φ9.5	Φ11.5
Φ12.7	40	25	7	8	58	106	80	Φ12	Φ13.5
Φ15	40	25	7	8	58	106	80	Φ14	Φ16
Φ20	40	25	15.8	5	58	106	85.8	Φ20	Φ23
Φ25	40	25	14.6	6	58	106	85.6	Φ25	Φ30
Φ32	40	28.5	18.5	4	58	106	91	Φ32	Φ35
Φ40	40	29.5	23.5	8	68	106	101	Φ38	Φ45
Φ50	40	36	27	7	78	106	110	Φ48	Φ54
Φ63	45	41	32	8	91	130	126	Φ58	Φ64
Φ75	45	46.5	40	7	105	136	138.5	Φ72	Φ78
Φ90	45	53.5	47	8	119	150	153.5	Φ88	Φ96
Φ110	45	68	54.5	9	143	174	176.5	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) (m ³ /h)	Flow Range (0.1~5m/s) (L/min)	Flow Range (0.1~5m/s) (US GPM)
TM602	Carbon Steel, Stainless Steel, Copper, Plastic pipe	DN4	0.003~0.142	0.047~2.374	0.013 ~ 0.627
		DN8	0.011 ~ 0.570	0.190~9.496	0.050 ~ 2.509
		DN10	0.026 ~ 1.282	0.427 ~ 21.366	0.113 ~ 5.644
		DN15	0.046 ~ 2.279	0.760 ~ 37.984	0.201 ~ 10.034
		DN20	0.103 ~ 5.128	1.709 ~ 85.464	0.452 ~ 22.577
		DN25	0.182 ~ 9.116	3.039 ~ 151.935	0.803 ~ 40.137
		DN32	0.285 ~ 14.244	4.748 ~ 237.399	1.254 ~ 62.714
		DN40	0.410 ~ 20.511	6.837 ~ 341.854	1.806 ~ 90.309
		DN50	0.729 ~ 36.464	12.155 ~ 607.741	3.211 ~ 160.549
		DN65	1.140 ~ 56.976	18.992 ~ 949.595	5.017 ~ 250.857
		DN80	1.641 ~ 82.045	27.348 ~ 1367.417	7.225 ~ 361.234
		DN100	2.917 ~ 145.858	48.619 ~ 2430.963	12.844 ~ 642.194

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 $X^{16} + X^{15} + X^2 + 1$, 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 — m ³ /h	1. 0x31 — LPM	2. 0x32 — GPM
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2. The flow totalizer unit has the following options:

0. 0x30 — m ³	1. 0x31 — L	2. 0x32 — GAL
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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.