

Operating Instructions of Ultrasonic Flowmeter



Preface

Thanks for purchasing the product!

The User's Manual covers functions, settings, wiring and troubleshooting methods of this flowmeter. Please carefully read this manual before use.

After reading the manual, please keep it in a proper place for reference when you operate the flowmeter.

Notes

Any modifications concerning function update in this manual will not be notified.

This manual has been carefully checked, if you find anything improper or any errors, please contact the vendor.

If there are any differences between the flowmeter and its descriptions in this manual, please take the final product as standard.

DO NOT fully or partially reprint or reproduce this manual.

Version

2020-V1

Warnings

For your safety, please carefully read the following safety warnings before use.

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As for the content of these exception clauses, the manufacturer should reserve the right to make any corrections in any form, at any time or for any reason with no need to issue any notifications in advance, and shall bear no responsibilities in any forms arising from the corrections described herein.

1.1 Product Liabilities and Quality Assurance

The purchaser should judge by himself whether the flowmeter is applicable or not, and shall bear related responsibilities. The manufacturer would bear no responsibilities for any consequences arising from the purchaser's misuse of the flowmeter. The purchaser may lose the rights for quality assurance if the flowmeter or the system is installed or operated in a wrong way. In addition, the corresponding "Standard Terms of Sale" is also applicable, and shall be the basic conditions of the Sales Contract.

Information about this file

To avoid any injuries or any damages to the flowmeter, please DO carefully read this file and DO comply with local standards, safety rules and accident prevention rules.

If you can't understand this file, please ask the manufacturer or the vendor for help. As for any property loss or personal injury arising from your misunderstandings, the manufacturer would bear no related responsibilities.

With this manual, you could set up correct operating conditions of this flowmeter to ensure safety and efficiency in use.

In addition, special notes and safety measures will be marked through the following symbols.

Convention of graphic symbols

The following symbols will help you better understand the file.



Warning!

This symbol indicates electrically related safety prompts.



Caution!

Please DO pay attention to this symbol. Any slight negligence may cause severe health hazard and may damage the flowmeter or related equipment and facilities in operation.



Prompts!

The symbol indicates related important information for operation.

1.2 Safety Instructions to Operators



Caution!

For your safety, please carefully read the following safety instructions before use. With this manual, you could set up correct operating conditions of this flowmeter to ensure safety and efficiency in use.

Only certified personnel who have received related training are allowed to install, use, operate and maintain this flowmeter.



Caution!

1. When using the flowmeter in inflammable media, please take measures to prevent from fire or explosion.
2. When operating the flowmeter in hazardous environment, DO follow the correct operation steps.
3. When removing the flowmeter, please follow the fluid OEM's safety instructions to avoid splashing.
4. Pay attention to the flowmeter's probe. Even a minor scratch or incision would influence its accuracy.
5. To get the optimum efficiency, the longest calibration period could not exceed two years.

Chapter II Descriptions of the Flowmeter

2.1 Delivery Scope



Prompts!

Please carefully check whether the packing case is damaged or loaded/unloaded in an improper way or not. If it is damaged, please notify the delivery man and the manufacturer or the consignor and describe the damage in details.



Prompts!

Please check the goods you received with the packing list.



Prompts!

Please check the flowmeter's nameplate and conform whether the scope of supply is identical with your order. Check whether the power information on the nameplate is correct or not; if not, please contact the manufacturer or the dealer.

Structural Configuration of Ultrasonic Flowmeter



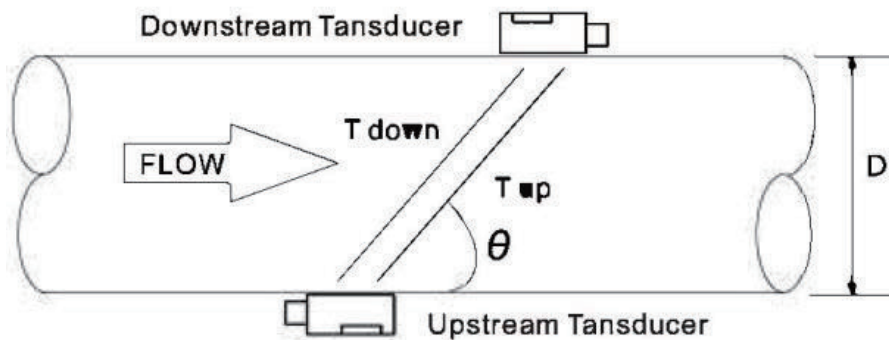
Accessories

1. Carrying Case*1pc.
2. Transmitter (Electronic)*1pc.
3. Transducer (Sensor) *1 pair.
4. Mounting track *1 set, ST or DT
5. The chain *2 pairs
6. Coupling compound (Grease)*1 pc, Battery charge*1pc , Output cable*1pc and Tapeline*1

2.2 Measuring Principle

This series of ultrasonic flowmeter is an industrial time-difference type ultrasonic flowmeter. It applies the latest industrial-level PFGA 700-thousand-gate-array chip, which extremely improves the signal sampling frequency and bubble tolerance rate; the self-developed TGA technology makes it be capable of dealing with more complex logic and calculation to provide more accurate and faster measurements, and ensures the flowmeter could endure non-continuous bubbles or impurities within 5 sec. In addition, it could be installed and operated in a convenient way with no need to break the pipe or cut off the fluid or stop work.

Time-difference type ultrasonic measurement indicates determining the fluid flow along the average velocity with the time difference between two ultrasonic signals transmitting downstream or upstream in the same stroke.



$$V = \frac{MD}{\sin 2\theta} \times \frac{\Delta T}{T_{up} T_{down}}$$

In which,

v Fluid velocity

M Ultrasonic reflections

D Pipe diameter

θ Included angle between ultrasound signal and fluid

T_{up} Time that downstream transducer sends signal to upstream

T_{down} Time that upstream transducer sends signal to downstream

ΔT = T_{up} - T_{down}

2.3 Application Scope

It mainly applies for measuring the flow of homogeneous medium fluid in the following fields:

Domestic wastewater flow measurement, crude oil flow measurement, cementing slurry flow measurement, oily sewage flow measurement in oil fields, water injection flow measurement in oil wells, raw water flow measurement in rivers and reservoirs, tap water flow measurement, process flow measurement of petrochemical products, industrial circulating water flow measurement, water consumption measurement in production, mineral slurry flow measurement, pulp flow measurement, chemical flow measurement, circulated cooling water flow measurement, generating coil cooling water flow measurement (super small diameter), juice flow measurement, milk flow measurement, and so on.

2.4 Nameplate



Prompts!

Please check the nameplate and confirm whether the goods are identical with your order or not. Check whether the power supply on the nameplate is correct or not. The following shows information on the nameplate:

	
Ultrasonic Flowmeter	
Model:	Max. Operating Temperature °C
Specification	Pressure Rating Mpa
Power Supply VDC	Meter Factor
Accuracy Class	Measuring Range
Output	Product No.
	

3.1 Connecting electrical cables



Warning!

Signal cables and power cables must be connected while the power is off.



Warning!

As specified, the meter must be connected to the protective ground terminal to protect operators from electric shock.



Warning!

As for the meters to be used in hazardous areas, please pay attention to the safety and technical prompts as specified in the professional explosion-proof instructions.



Caution!

Please strictly obey the local occupational health and safety regulations. Only trained personnel are allowed to operate on electrical equipment.



Warning!

Voltage difference is not allowed between the measuring transducer and the housing or protective ground cable of the electronic system.

The measuring transducer must be well grounded according to related standard DESIGN CODE OF INSTRUMENT GROUNDING (HT/T 20513-2014).

The ground conductor shall not transmit any disturbance voltage.

The ground conductor is not allowed to connect other electrical equipment.

3.2 Transmitter Connections



3.2.1. Power supply

Please pay special attention to the power supply. Please connect related power supply according to the symbols of connecting terminals.

3.2.2. Transmitter connections

Once the flowmeter is installed at the designated place as required, you can start connections.

Open the case, you can see the connecting terminals on the power board from left to right as follows:

Power	Power switch
Output	4-20mA or RS485
UP	
DN	
Charge	



Warning!

Please ensure that the flowmeter is connected with the power off, and ensure that it has been reliably grounded before use.

3.2.3 Power on

When switching the power on for the first time, the flowmeter will run automatically according to the parameters you put last time (the meter is calibrated before leaving factory). After the flowmeter is installed and powered on, you can check its status in M04 menu; if it displays “*R”, it indicates that the flowmeter is running normally.

If you use the flowmeter in a new environment, you need to input related parameters. Any parameters you input would be kept in its memories forever till you correct them again. If you need to adjust its installation position or the position of the transducer, you need to input and set related parameters again of the flowmeter to ensure normal use.

DO always finish all tasks when running. No matter in any displays, tasks including measurement and output should be finished as usual.

Chapter IV Operation Panel and Quick Start

4.1 Power on



Warning!

Please check the meter is correctly installed or not before power on, including:

Connecting the power supply as specified;

Please check the electrical connection of the supply power is correct or not.

4.2 Boot screen

The flowmeter is composed of the measuring transducer and the signal converter. And the delivery product is ready for putting into use. All operating parameters and settings have been set according to your order requirements.

(1) Boot screen

In normal display, press [∇] and [$\wedge$] keys to switch among NET Total, POS Total and NEG Total.

00 Flow Total *R		
NET	POS	NET
123.4 E+0 m ³		

00 Flow Total *R		
Net	POS	NET
123.4 E+0 m ³		

Go on pressing [∇] to enter 01 menu to display the flow rate, total flow and transient flow. The following shows how to switch between the flow rate and the total flow.

01 Flow Rate *R		
0.00 m/s		
0.000 m ³ /h		

01 Flow Rate *R		
123.4	E+0	m ³
0.000 m ³ /h		

Prompts!

"*R" indicates that the flowmeter is running normally; "D" indicates that the flowmeter is carrying out gain setting; "E" indicates that the flowmeter can't receive any ultrasound signals.

Energy meter display function

Note:

It is a function of energy meter and only the ultrasound heat meter has this function.

Press [Menu] key and digital key [2], i.e.: Menu + 2, to enter 2 heat display interface shown as follows:

02	Heat	*R
100.2		KW
123.4		E+0 GJ

02	Heat	*R
30	2.0	(°C)
123.4		E+0 GJ

Transient heat quantity and temperature automatically switch and display for 6s, and it only displays the inlet temperature and temperature difference. Press ENTER to stop switching, and continuously refresh the display items; press ENTER again to recover.

Press [Menu] key and digital key [3], i.e.: Menu + 3, to enter 3 cold display interface shown as follows:

03	Cool	*R
100.2		KW
123.4		E+0 GJ

03	Cool	*R
28	-2.0	(°C)
123.4		E+0 GJ

Transient cold quantity and temperature automatically switch and display for 6s, and it only displays the inlet temperature and temperature difference. Press ENTER to stop switching, and continuously refresh the display items; press ENTER again to recover display.

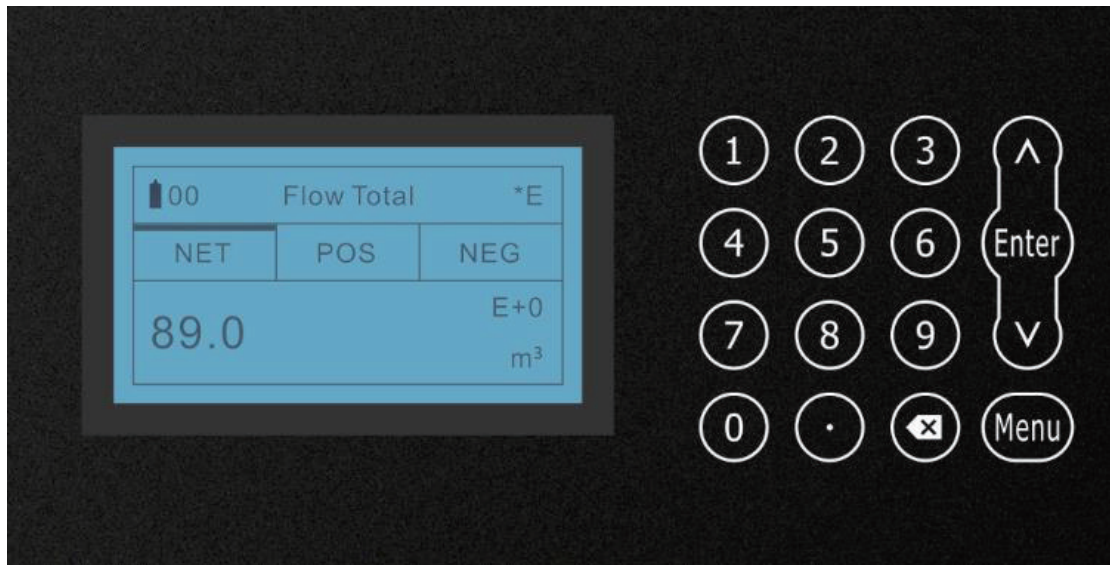


Note:

When using the heat function, the temperature difference displayed is positive, while using the cold function, the temperature difference displayed is negative.

4.3 Keyboard Operation

4.3.1 Descriptions



Use digits [0~9] and [.] to input digits or menu number.

[>] key is used for left backspace or deleting the characters on left.

[>] and [>] keys are used for entering the previous or next menu; the key is plus or minus when inputting digits.

[Menu] key is used for choosing menus. Press the key and then input menu number to enter related menu.

[Enter] key is used for entering the edit mode and confirm the corrections.

4.3.2 Keyboard Operation Methods

The flowmeter menu is divided into six modules according to the functions and field demands.

You can directly input the menu number to enter the menu and you also can switch through [>] and [>] keys.

If you need to correct the flowmeter parameters, please firstly switch to related menu, find out the parameter you want to correct and then press [Enter] to confirm; input the data and then press [Enter] to confirm your corrections.

Chapter V Installation

5.1 Installation, Storage and Prompts



Prompts!

Please carefully check whether the packing case is damaged or loaded/unloaded in an improper way or not. If it is damaged, please notify the delivery man and the manufacturer or the consignor and describe the damage in details.

Prompts!

Please check the goods you received with the packing list.

Prompts!

Please check the nameplate and confirm whether the goods are identical with your order or not. Check whether the power supply on the nameplate is correct or not; if not, please contact the manufacturer or the vendor.



Storage!

- Please store the flowmeter in a dry and dust-free place;
- Avoid long-term direct sunlight;
- Keep the flowmeter in the original packing case;



Prompts!

To ensure reliable installation, DO take the following measures:

Before installing the flowmeter, DO take into account of the flowmeter's diameter, pipe size and installation position. Correct installation could ensure accurate output signals, less maintenance and maximum performance.

5.2 Pipe Design and Selection

The following should be taken into account when selecting a pipe:

5.2.1 Installation Environment

It's better to install the flowmeter indoors; if you have to install it outdoors, you should take measures to avoid direct sunlight or rainwater.

The flowmeter shall be installed away from high temperature, thermal radiation from equipment or corrosive gas.

Ultrasonic flowmeters can't be installed nearby motors, transformers or other power sources that are easy to cause electromagnet interference. DO NOT install ultrasonic flowmeters nearby frequency converters or DO NOT connect it with the distributing cabinet of frequency converters to avoid interference.

In convenience for installation and maintenance, keep sufficient space around the flowmeter.

5.2.2 Support of Flowmeter

Avoid installing the flowmeter on pipes with mechanical vibrations. If you have to install it there, DO take shock absorption measure. You could install a hose for transition, or set support points with absorbing pads on the pipe at 2DN in both upstream and downstream of the flowmeter. Try not to install the flowmeter on the longer overhead pipes because the sagging of pipes would cause leakage between the flowmeter and the flanges. If you have to do it, you must set support points on the pipe at 2DN in both upstream and downstream of the flowmeter.

5.2.3 Requirements on Liquid-receiving Material

The ultrasonic flowmeter could measure single-medium liquid flow; The same medium could be divided into three specifications (low temperature, high temperature and superhigh temperature), different flowmeters should be used for different temperatures.

5.2.4 Dangerous Conditions

You could select the flowmeter with an explosion-proof housing, and intrinsic safety explosion-proof flowmeter with intrinsic safety design circuit to ensure its safety and flame-retardant operation. Each flowmeter should have a nameplate clearly identifying its certifications. Please DO install and use the flowmeter according to the explosion-proof grade and protection grade as shown on the nameplate.



Caution:

DO ensure that the flowmeter is filled. DO NOT make the liquid flow downwards vertically, or it may have bubbles.

5.2.5 Requirements on the front/rear straight pipe sections

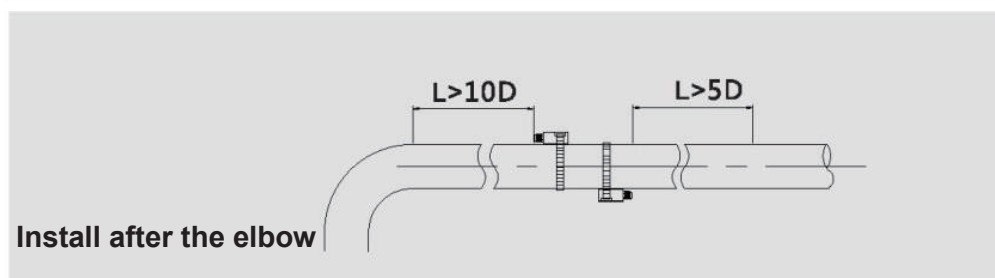
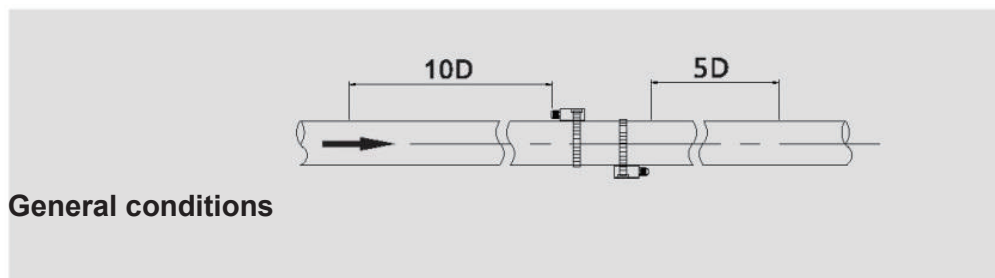
DO ensure a straight pipe section at least ten times of the pipe diameter (D) in the upstream of the flowmeter and at least five times of the pipe diameter (D) in the downstream of the flowmeter. The nominal accuracy depends on the pipe diameters in the upstream; according to the interference, ins

ficient front/rear straight pipe sections may cause about 0.5% deviation.

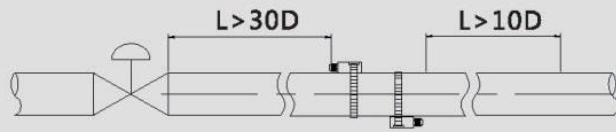


To ensure measurement accuracy of the flowmeter, try to satisfy the following requirements on the length of straight pipe sections installed nearby the flowmeter: upstream $>20D$, downstream $>10D$.

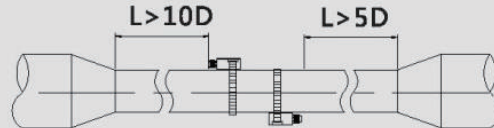
Try not to disturb the upstream flow distribution. Ensure no valves, elbows or triplets; try to install the control devices or throttles in the downstream if any, so as to ensure sufficient pipe flow at the measurement point, details are shown below:



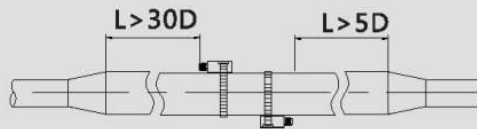
Install after valves



Install on diameter-reduced pipe



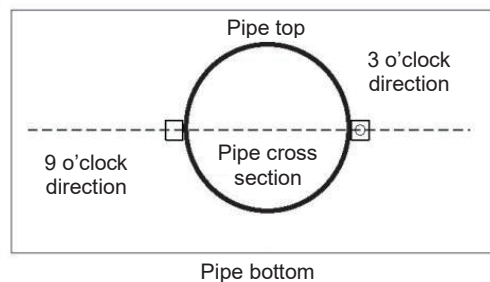
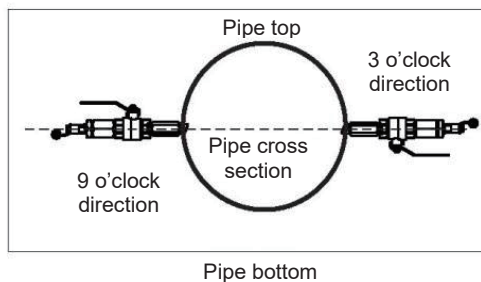
Install on diameter-expanded pipe



5.2.6 Requirements on Transducer Installation Angle



When being installed on horizontal pipes, the transducer should be installed at 3 o'clock or 9 o'clock, i.e. on both sides of the pipe. It's not recommended to install it on top or at bottom of the pipe because it's easy to cause bubbles at the top and accumulate sands or impurities at the bottom.



The measurement point should be in the pipe section with relatively new inner wall with no or relatively less scaling. The pipe must be made of compact material. When selecting the installation point, DO ensure no welding seams or other gaps.

5.3 Transducer Installation



Handling and unpacking

It's better not to unpack it before installing it to designated location to avoid damage.

DO NOT heavily throw the flowmeter or press heavily on it, especially the probe surface, or the sealing surface may be damaged.

After unpacking, protect the probe and converter. DO NOT place the probe at free will on the floor with no cushions or other unsmooth surface.

The flowmeter is kept unused for a long time

After the flowmeter is installed, try not to keep it unused for a long time; if you have to do so, you must take the following measures:

- A. Check the sealability of end covers and connection ports and ensure that no dampness or water enters inside the converter. DO check it regularly and check each measure mentioned above and the connection box at least once per year.
- B. If the converter may be immersed in water (after a heavy rain or thunderstorm), check the converter immediately.



Transducer installation spacing

Before mechanical installation of the ultrasonic flowmeter, please follow the way described in Article [4.4 Quick Start] to set related parameters of the pipe and fluid, and obtain value L of the installation spacing in M14 menu.

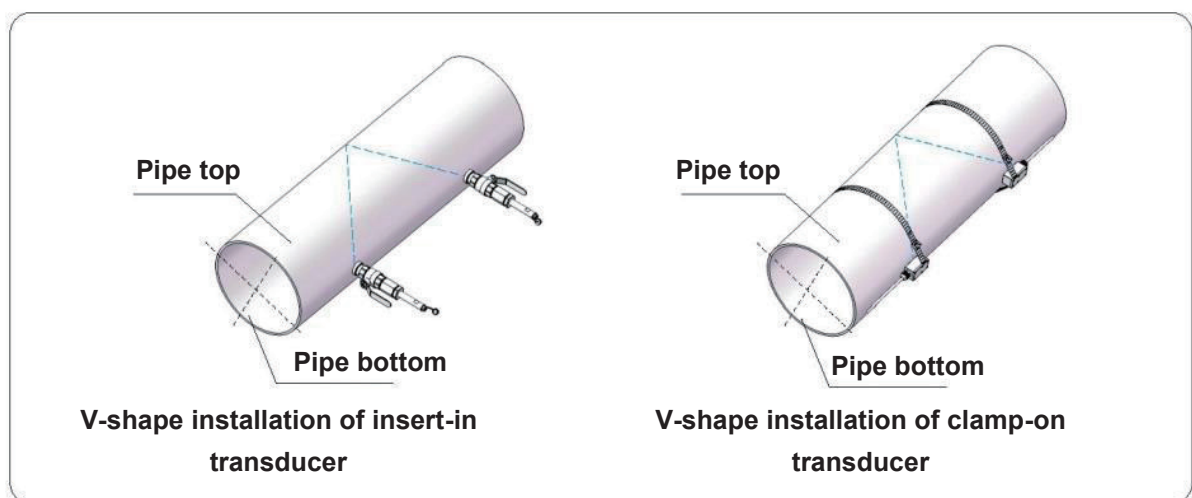
Installation spacing of the clamp-on transducer should be the distance between its two end surfaces; while that of the insert-in transducer should be the distance between the axis center of two transducers.

5.3.1 Transducer Installation Modes

You should choose the way for installation that the client could select a transducer according to the measurement site. Generally, there are two installation methods for transducers: V-shape installation and Z-shape installation.

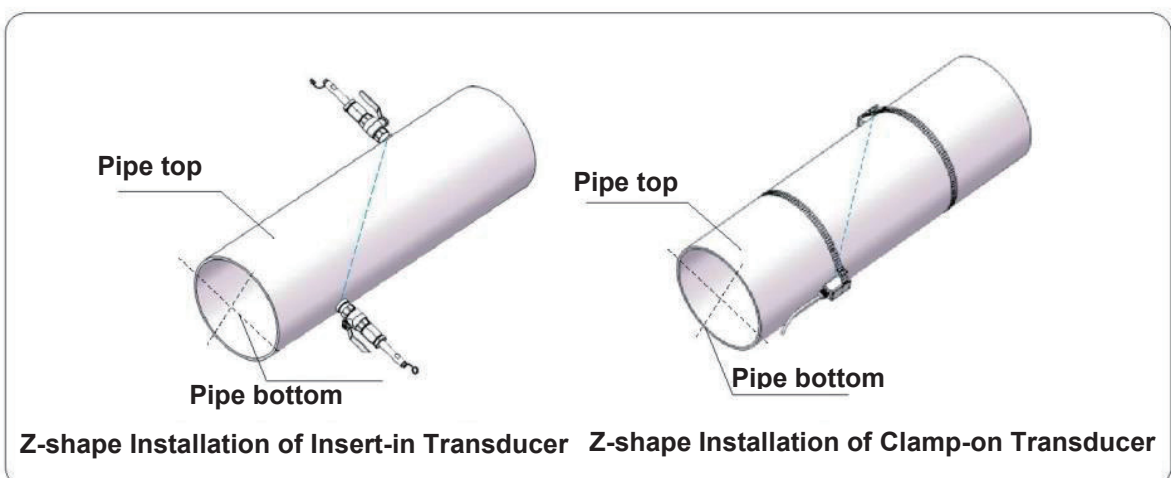
V-shape installation:

Two transducers are installed on one side of the pipe, and the sound wave forms a V-shape reflection path on the pipe wall. This installation method is relatively simple and it is the easiest way. You should keep the two transducers horizontal and make sure the sensing axes are horizontally identical. The signal intensity is relatively weaker than that in Z-shape installation method, so it is widely used for small-diameter installation and better operating conditions.



V-shape installation:

Compared with V-shape installation, Z-shape installation is better in signal intensity; sound waves are transmitted directly in the pipe with no reflection (single sound path) and the signal loss is less, so it is recommended to apply Z-shape installation method on the more complicated site and large-diameter pipes.



5.3.2 Installation steps of the clamp-on transducer are shown below:

Step 1: Firstly, determine the installation site of the two transducers on the pipe and remove all iron rust, paint stains and dirt.

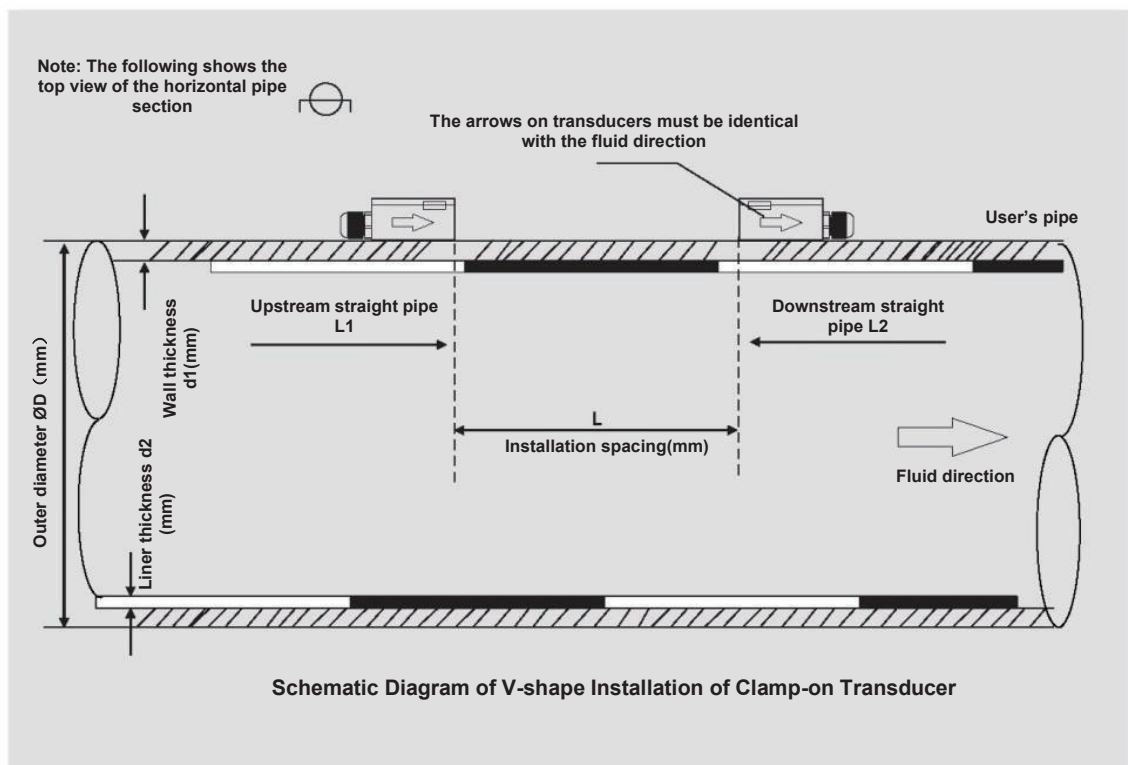
Step 2: Apply enough couplant on the first half (signal generating position) of the transducers and place it on the pipe, press the transducers against the pipe and ensure there are no voids.

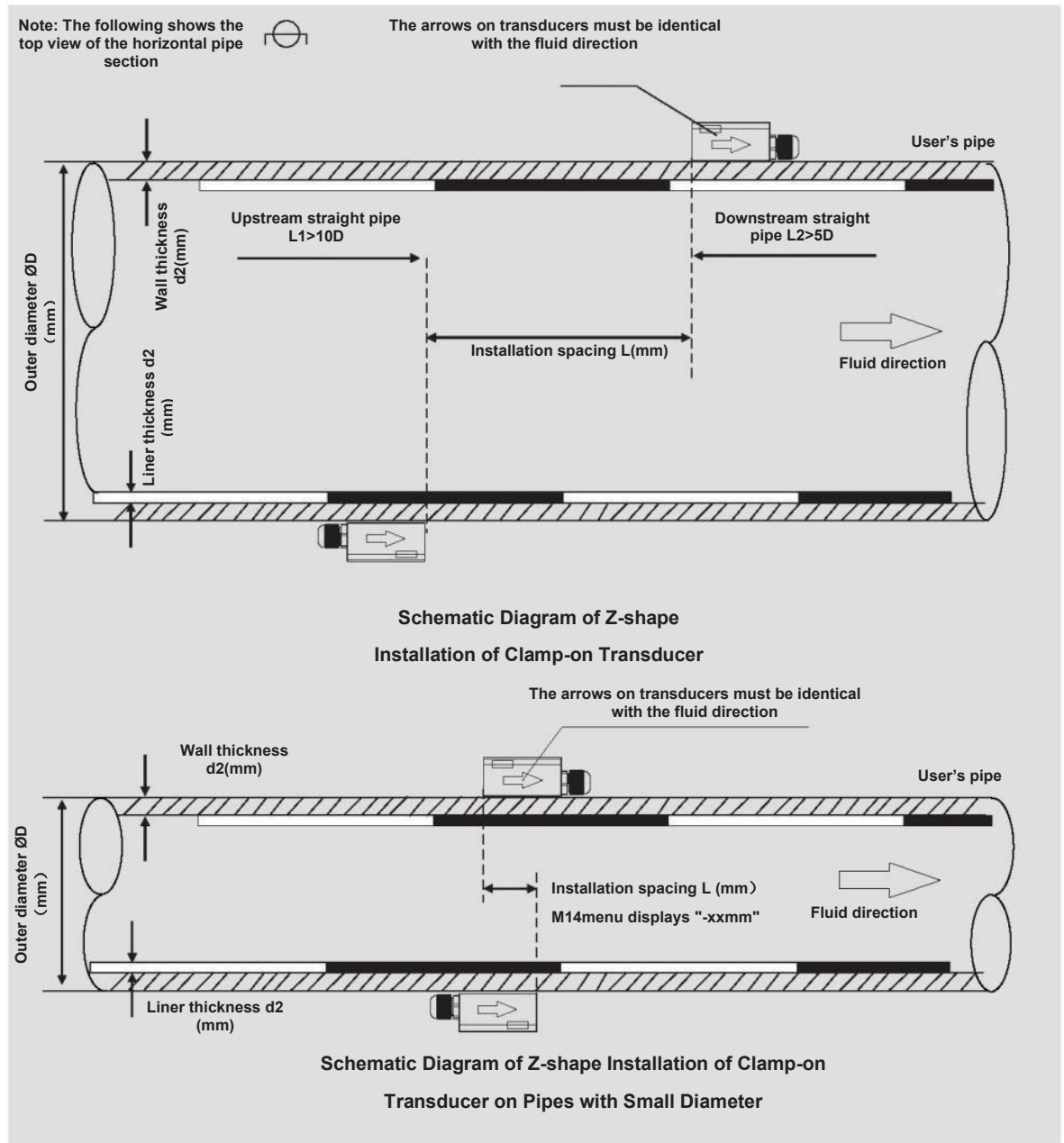
Step3: Lock the steel band clamps and check the installation spacing between the two transducers; slightly adjust the spacing L1 to the value provided in M14 menu of the converter; slightly adjust the two transducers to one horizontal plane.

Step4: Check whether parameters in M04 menu are within normal scope or not.

If not, DO check the following:

- * Check whether related field parameters in the converter are input correctly or not (pipe diameter, wall thickness, material, liner, medium, etc.);
- * Check whether the installation spacing L is identical with the value shown in M14 menu or not;
- * Check whether the transducers are installed in the proper position or not, whether the pipe sections have any scales, distortions or weld seams or not;





5.3.3 Installation of Insert-in Transducers

Installation steps are shown below:

Step 1. Drill holes with 24mm diameter at measuring points. Before drilling, align the hole center of the transducer mounting base with the drill center, and then vertically weld it on the pipe.

Step 2. Turn off the ball valve and tighten it on the mounting base.

Step 3. Rotate the lock nut and loosen the lock ring, retract the transducer into the connecting nut and then tighten the connecting nut on the ball valve.

Step4. Open the ball vale and insert the transducer into the pipe, and measure the length between the outer side and the handle mark (H), trying to make it conform to the following formula:

$$H = 216 - d1 - d2$$

In which:

d1-Pipe wall thickness (mm)

d2-Liner thickness (mm), if there is no liner, then d2=0.

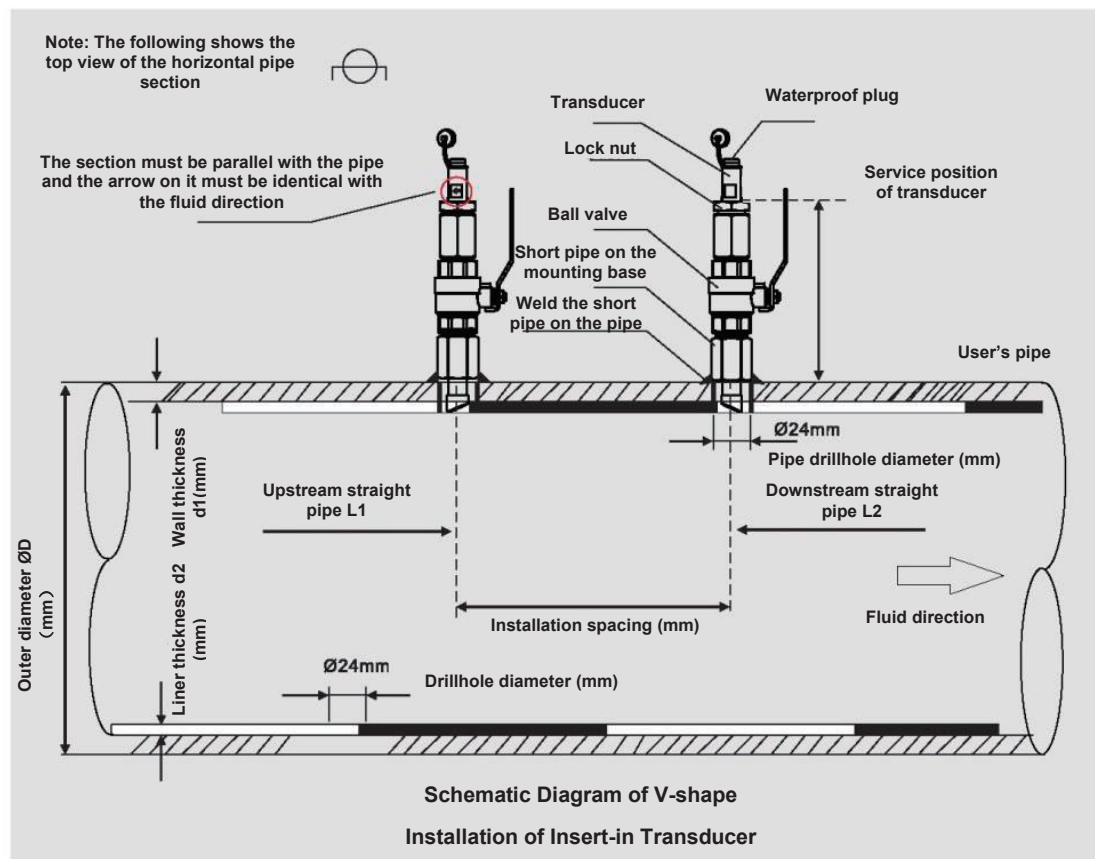
H -Installation height (mm)= Length between the outer side and the handle mark (mm)

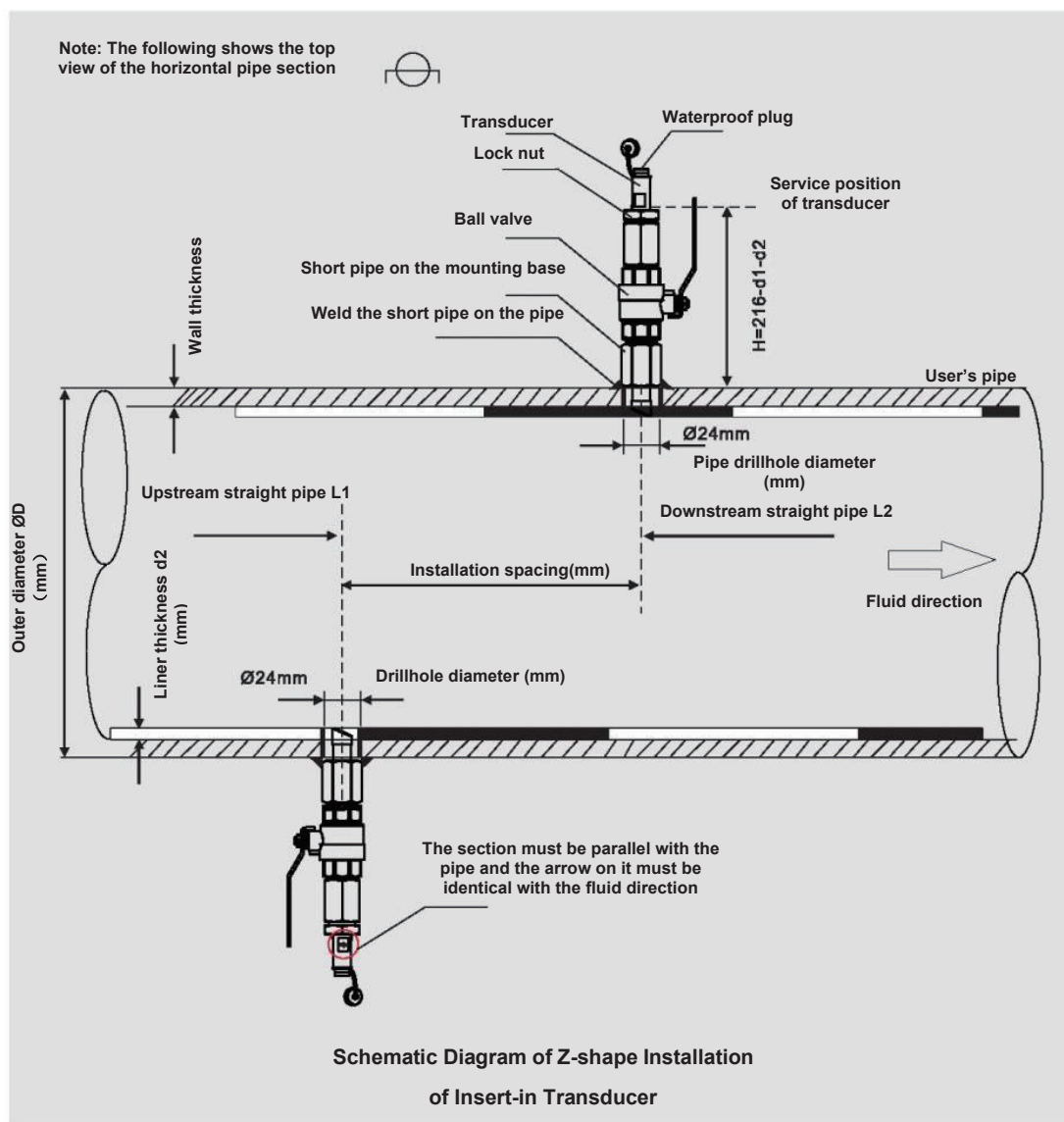
216-Fixed length of standard W1 type insert-in transducer (mm); In special cases, if you need to lengthen the transducer, please contact the manufacturer.

Step5. Slightly tighten the nut to make the lock ring press on the probe, rotate the wrench to make the orientation lever point at the center of two transducers. Please ensure the UP/ DOWN arrows at the transducer marks are identical with the signal direction of the ultrasound transducer, and finally tighten the nut.

Step6. Connect the transducer cables and ensure correct connections of the upstream/downstream transducer.

Step7. Please refer to the schematic diagram for installation:





5.3.4 Confirmation on Installation Quality

On the operation panel, press [Menu]+[4] to enter 04 menu.

04		*R
Status		
Signal	Sound	Time
UP	DN	Q
80.0	80.1	85

Signal intensity (UP/DN indicates upstream/downstream transducer):

This series ultrasonic flowmeter applies 00.0-99.0 to indicate corresponding signal intensity, the bigger the value, the stronger the signal intensity. In normal operation, the signal intensity of the upstream/downstream transducer should be >75 as required. If the signal intensity is less than 75, please check whether the transducer is correctly installed or not again, check whether the couplant is applied properly or not; check whether the upstream/downstream transducer is on the same horizontal plane or not, and check whether the two transducer's installation spacing is identical with the value shown in M14 or not. If the signal intensity still can't reach up to over 75 in V-shape installation, please choose V-shape installation.

Q value (Signal quality):

Q value (Signal quality) indicates the degree of received signals' quality; the flowmeter applies 00.0-99.0 to indicate relative signal quality, the bigger the value, the better the signal quality. In normal conditions, the signal quality (Q value) should be over 75.

Sound velocity:

Vel. value indicates the sound velocity and the actual sound velocity measured by the flowmeter. Under normal conditions, it should be close to the sound velocity shown in M12 menu. If the difference is too big, you should check the installation settings and whether it is properly installed or not.

Transmission time (Ratio):

Transmission time is used for checking whether the installation spacing of two transducers is correct or not; If they are installed correctly, the transmission time should be $100\pm3\%$.

Total transmission time (Unit: us) and time difference (Unit: ns):

When the time difference fluctuates too greatly, the flow and flow rate would change greatly, it indicates that the signal quality is poor, which may be caused by bad pipe conditions, improper installation or parameter errors. Under normal conditions, the fluctuation of time difference should be less than $\pm 20\%$. But when the pipe diameter is too small or the flow rate is extremely low, its fluctuation would exceed the normal value a little.

Chapter VI Operation



Note:

The flowmeter would be calibrated and debugged before leaving factory, and its parameters would be set accurately.

Please carefully read the instructions if necessary.

Non-professionals are not allowed to operate the flowmeter.

6.1 Common Functions

6.1.1 How to Judge its Operating Status

If it displays "*R", it indicates the flowmeter works normally.

If it displays "D", it indicates the flowmeter is carrying out auto gain adjustment before measurement, it is normal most of the time. If it lasts for a long time, it indicates that the flowmeter fails.

If it displays "E", it indicates that the flowmeter can't receive sound wave signals. Please check the connections and installation of transducers. As for more information, please refer to "ERRORS".

6.1.2 Low Flow Cut

M21 menu is the low flow cut menu. The system considers the flow whose absolute value is less than this value as "0", so you can set this parameter to avoid false accumulation of measurement errors of the flowmeter when the actual flow is "0". In general, this parameter is 0.03m/s. When the flow is more than the low flow cut value, the low flow cut value has nothing to do with the measurement result and will have no influences on it.

6.1.3 Zero Point Setting

Any flowmeter has a relative zero point. That is to say, when you judge the flow is zero but the flowmeter doesn't display zero, this value is called zero point. Of course, as for any flow meters, zero point is objective, but its value is controllable. If zero point is not "0", it will cause measurement errors. Moreover, the smaller the measured physical quantity, the greater the error caused by it. Only when zero point is reduced to a certain degree as compared with the measured physical quantity, the error caused by it could be ignored. As for ultrasonic flowmeter, when the flow is smaller, error caused by zero point couldn't be ignored. You need to set zero point to improve the accuracy for small flow measurement. At the time, you need to cut zero point on site.

Cut zero point

M22 menu-Cut-1. Yes, it displays “success” if zero point is cut. and the flowmeter would return to M01 menu.

Reset zero point

M22 menu--Reset-1. Yes

6.1.4 Meter Coefficient

Meter coefficient indicates the specific value of actual flow and the display value of the flowmeter. For example, the actual flow at the measurement point is 3 and the flowmeter displays 2.99, then the meter coefficient is $3/2.99$. Under perfect measurement status, the optimum meter coefficient is "1". However, it's hard to make all flowmeters have the same coefficient in batch production and also because of the changeable environment on site, it's impossible to ensure the meter coefficient of all flowmeters is "1".

Therefore, each flowmeter would be calibrated before leaving factory to get its meter coefficient, which is called K coefficient.

You also could calibrate the flowmeter in service on site through M26 menu.

6.1.5 System Protection

System protection is mainly to avoid abnormal operation of flowmeter in installation or operation because of touching by mistake. When system protection is enabled, you could view the flowmeter but can't correct any parameters.

You could enable or disable this function in M54 menu. You need to enter passcode to activate the function or make alterations.

6.1.6 Current Loop Output

The current loop output accuracy is 0.1%. It is programmable and you can set several output modes like 4~20mA and 0~20mA in M32 menu.

In M32 menu, 4mA/20mA is the minimum/maximum limit value. For example, the flow range in a pipe is 0~1000m³/h, you only need to input 0 and 1,000 respectively in M32 menu. If the flow range is -1,000 ~ 0 ~ 2,000m³/h, and 20 ~ 4 ~ 20mA output is used while not considering the flow direction, you could set 1000 and 2000 as the minimum and maximum limit values respectively in M32 menu.

However, when 0-4-20mA output is used while considering the flow direction, you should consider two different conditions; when the flow direction is reverse, the output current is 0~4mA; when it is forward, the output current is 4~20mA.

“Check” in M32 menu is used for check whether the current loop has been “calibrated” or not.

Detailed operation steps:

Use [$\wedge$][$\vee$] key to switch among “Check 4mA”, “Check 8mA”, “Check 16mA”, “Check 20mA” readings. At the same time, use the precise ammeter to measure the output current of the current loop, calculate the difference between them and check whether it is in the tolerance or not. You could calibrate 4-20mA in M62 menu.



Note

The integrated pulse should be appropriate; if it is too big, the output period would be too long; If it is too small, the relay would operate too frequently, which would influence its service life; and when it is too fast, it would generate pulse loss. It is recommended to apply 1-3 pulse output/sec.

6.1.7 Alarms

Switch output alarm signal is generated through switching on/off OCTs or relays and output to the external circuit, it is generated under the following conditions:

1. Transducers can't receive ultrasound signals;
2. Ultrasound signals that transducers received are too poor;
3. The flowmeter is not under normal operation;
4. The flow is reversed;
5. The analogue output exceeds 100% of the measuring range;
6. The frequency signal exceeds 120% of the measuring range;
7. Transient flow exceeds the settings (use software alarm to set the range of flow. There are two software alarms, which are Alarm #1 and Alarm #2T respectively.

How to set? For example 1: It requires the relay outputs alarm signals when the transient flow exceeds 300~1,000m³/h, settings are as follows:

- (1) Menu 35, Alarm 1#, lower limit 300;
- (2) Menu 35, Alarm 1#, upper limit 1,000;
- (3) Menu 34, Relay Settings-Options-Alarm 1#.

6.1.8 4 -20mA Output Calibration



Note:

Each flowmeter is strictly calibrated before leaving factory. If you are not sure it is calibrated or not, please try not to use this function. If you are sure that the display value is not identical with the actual output current, you could carry out 4-20mA output calibration. Please use M32 menu to check it out first.

Before calibrating the analog input, DO operate the hardware debugging menu as follows:

a) Please input the passcode to enter Menu 62 to carry out 4-20mA calibration function.

b) Use [$\wedge$][V] key to switch and calibrate current loop 4mA output. Use the ammeter to measure the output current of the current loop and adjust the digits displayed at the same time. Observe the ammeter till the reading is 4.00.

c) Use the same method to calibrate 20mA output.

The calibration data would be automatically saved in EEPROM would not lose when the power is cut.

6.1.9 SD Card Operation Instructions

Note: SD card is optional. Please make sure your flowmeter has such function or not.

Specifications and parameters

Data acquisition frequency could be set from 1 to 99999 sec/time as required.

Data acquired: Time/date, transient flow, flow rate, total flow, POS Total and NEG Total.

Data storage format:

a = 2017-11-16,16:21:12

b = + 2.652471E+00 m3/h

c = +9.380460E-02 m/s

d = + 3.520580E+02 m3

e = +3.520580E + 02 m3

f = +0.000000E+00 m3

g = +0.000000E+00 GJ/h

h = +0.000000E+00 GJ

i = +0.000000E + 00 GJ

j = + 0.000000E+00°C

k = +0.000000E+00'Cfile

File system format: FAT16.

File type: Text file (.TXT).

Number of files: 512pcs at maximum.

The file saved each time should be 120 bytes. If the flowmeter saves data once per 5 sec, the file saved in 24 hours is $120 \times 3600 / 5 \times 24 = 2073600 \text{ byte} \sim 2.1 \text{ Mbyte}$; therefore, 1Gbyte SD card could save data for $1024 / 2.1 = 487.6187$ days. When SD card has not enough storage, new data would automatically cover the earliest files.



Note:

On-line installation and mobile SD card

DO plug in/out SD card while the power of flowmeter is cut off. DO NOT plug in/out SD card while processing data. You should process file sheets after the data is saved and stored in your computer. If you directly process sheets in SD card files in your computer, and SD card is deleted in processing, you may lose the data or the data may be damaged.

If you want to plug in/out SD card while the power is on, you need to:

Turn the SD switch to "OFF", and then the memory indicator dies out, at this time you could plug in/out the SD card at free will. Plug in SD card in the slot and turn the switch to "ON", and then the memory indicator comes on, SD card could go on saving data.

6.1.10 Product Serial Number

Each flowmeter is provided with a unique product serial number. The serial number is the unique mark for the manufacturer and users for tracing product information and management. You could view your flowmeter's serial number in M 50 menu.

Note:

Please refer to "Details about Menus" for operation of other menus.

6.2 Description of Operation Menus

6.2.1 Abbreviated codes of menus

Identification	Flow Indication in Level One Menu	Menu Codes and Description
OX	*R- System running normally *E- Signal unknown *D- Adjusting gain	00 flow totalizer
		01 flow rate
		02 heat
		03 cool
		04 measurement status
IX	Installation settings	10 pipe section settings
		11 Liner settings
		12 fluid settings
		13 transducer settings
		14 installation spacing
2X	Calibration settings	20 damping
		21 low flow cut off
		22 zero point settings
		23 totalizer
		24 temperature
		25 power cut compensation
		26 K factor
		27 correction
		28 SQA
3X	Input/output settings	30 serial port settings
		32 current settings

Identification	Flow Indication in Level One Menu	Menu Codes and Description
3X		
		37 SD card settings (optional)
4X	Flow unit options in input/output settings	40 metric unit
		41 flow unit
		42 energy unit
		43 temperature unit
5X	System settings	50 serial number
		51 time and date
		52 key tone
		53 languages
		54 system lock
		55 system reset
6X	Others	60 date totalizer
		61 running time
		62 current calibration
		63 RTD calibration

Note:

Options concerning temperature, cold/heat quantity and energy in the menu could be displayed if only the flowmeter is provided with cool (heat) meter functions.

6.3 Menu Configuration

00

Total Flow

Display flow NET Total

Display flow POS Total

Display flow NEG Total

Press up/down key to switch

00 Flow Total *R	
NET	POS NEG
123.4	E+0 m ³

01

Flow

Display transient flow and transient velocity

NET Total and flow velocity - auto switching and display (6s)

Press ENTER to stop switching and continuously update

Display the current items; Press ENTER again to restore switching.

01 Flow Rate *R	
0.00	m/s
0.000	m ³ /h

01 Flow Rate *R	
123.4	E+0 m/s
0.000	m ³ /h

02

Heat Rate

Display heat total

Transient heat total and temperature - auto switching and display (6s)

Only display inlet temperature and temperature difference

Press ENTER to stop switching and continuously update

Display the current items; Press ENTER again to restore switching.

02 Heat *R	
100.2	KW
123.4	E+0 GJ

02 Heat *R	
30.0	2.0 (°C)
123.4	E+0 GJ

Note:

Only energy meter is provided with this function.

03

Cool Rate

Display cool total

Transient cool total and temperature - auto switching and display (6s)

Only display inlet temperature and temperature difference

Press ENTER to stop switching and continuously update

Display the current items; Press ENTER again to restore switching.

Note:

Only energy meter is provided with this function.

03	Cool	*R
100.2		KW
123.4		E+0 GJ

03	Cool	*R
30.0	-2.0	(°C)
123.4		E+0 GJ

04

Measurement Status

Display upstream/downstream signal intensity and quality. Signal intensity is expressed by digits from 00.0 to 99.9. 00.0 indicates no signals are received; 99.9 indicates the maximum signal intensity. Generally, the bigger the digit, the stronger the signal intensity; the stronger the signal intensity, the stabler the measurement theoretically.

Signal intensity of upstream/downstream transducer should be >75 to ensure normal operation of the flowmeter.

Display the sound velocity and display the actual sound velocity measured by the flowmeter. Under normal conditions, it should be close to the sound velocity shown in M12 menu. If the difference is too big, you should check the installation settings and whether it is properly installed or not.

04	Status	*R
Signal	Sound	Time
UP	DN	Q
80.0	80.1	85

04	Status	*R
Signal	Sound	Time
Vel.	1482	m/s
Ratio	100%	

Transmission Time

Display the average transmission time of ultrasound measured (Unit: us) and upstream/downstream transmission time difference (Unit: ns). The two readings are the main basis for the flowmeter to calculate the flow velocity, especially the transmission time difference could tell whether the flowmeter is running stably or not the most. Under normal conditions, the fluctuation ratio of the transmission time difference should be less than 20%, if it exceeds 20%, it indicates that the system runs unstably, so you should check whether the transducers are installed is proper position or not and whether parameter settings are correct or not.

10

Pipe Section Settings

Pipe Diameter

Enter the outer diameter and wall thickness.

Note: Pipe diameter of this type is from 25mm to 1,200mm.

Select the pipe material in the menu as follows:

- 0.PVC 1.CS Carbon Steel
- 2.SSP (Stainless Steel Pipe)
- 3.CIP (Cast Iron Pipe)
- 4.DIP (Ductile Iron Pipe)
- 5.Copper (Copper Pipe)
- 6. Alu (Aluminum Pipe)
- 7. ACP (Asbestos Cement Pipe)
- 8. FPG (Fiberglass Pipe)
- 9. Others if you choose Item 9, please input the material velocity.

04		Status	*R
Signal	Sound	Time	
Total	185.0	us	
Delta	30.5	ns	

10		Pipe Setting	*R
Size	M.		
OD	108.0	mm	
thk	4.0	mm	

10		Pipe Setting	*R
Size	M.		
Options	0.PVC		
Others	3200	m/s	

11 Lining Setting

Enter liner thickness.

Select the Liner Material.

The following options are available:

0. No liner 1. Tar Epoxy

2. Rubber 3. Mortar

4. PP Polypropylene 5. Polystyrol

6. PS Polystyrene 7. Polyester

8. PE Polyethylene 9. Ebonite

10. Teflon

11. Other, if you choose Item 11, please input the material velocity.

11	Lining Setting	*R
Size	M.	
thk	3.0	mm

11	Pipe Setting	*R
Size	M.	
M.	0.No liner	
Others	2400	m/s

12

Fluid Settings

Select measure medium, the following options are available:

0. Water

1. Water 125 degC

2. Seawater

3. Kerosene

4. Gasoline

5. Fuel Oil

6. Crude Oil

7. Diesel Oi

8. Castor Oil

9. Peanut Oil

10. Alcohol

11. Propane (-45°C)

12. Butane (0°C)

13. Gas #93

14. Other if you choose Item 14, please input the material velocity.

Note: Room temperature is 20 °C by default.

12	Fluid Setting	*R
Type	VIS	
Options	0.Water	
Others	1482.0	m/s

13

Transducer Settings

Select the transducer type:

The following transducer types are available in the menu:

0. Clamped D1

2.Clamped D1U

3 Insert-In

13 Transducer *R		
Type	Method	Mode
Options	0.Clamp D1	

Select the transducer installation methods, the following methods are available:

0.V

1.Z

2.N

Modes

Mode menu is defined by the manufacturer.

Please don't make any alterations.

13 Transducer *R		
Size	Method	Mode
Options	0.V	

13 Transducer *R		
Size	Method	Mode
Options	0.Mode o	
Other	0.000	

14

Installation Spacing

Apply the installation spacing of transducers calculated by the flowmeter according to pipe parameters you set.

14 INST Space *R		
Value	63.2	mm

20

Damping

Damping coefficient is 0~999 sec.

0: Indicates no damping; 999: Indicates the maximum damping.

Damping is used for smoothing the displayed data. In general, you need to enter one digit among 3~10.

20 Damping *R		
Value	6	

21

Low Vel. Cut off

Low Flow Cut off is used to make the system display as "0" value at lower and smaller flows to avoid any invalid totalizing. For example, if the cutoff value is set as 0.03, system will take all the measured flow velocity values from - 0.03 to + 0.03 as "0". Generally, 0.03 is recommended in most applications

21 Low Vel. Cut off *R		
Value	0.03	m/s

22

Zero Point Settings

When the fluid is relatively static, we take the display value of the flowmeter as zero. When the “Zero Point” is not zero, the value would be added to the actually measured value, which would cause deviation, so we need to carry out zero point settings.

Static zero point settings must be carried out after the transducers are installed and the fluid inside the pipe is completely static. Through static zero point settings, “zero point” caused by pipe installation position and different parameters could be eliminated, and the low flow measurement accuracy could be improved.

Select “Yes” to reset zero point. Set the zero point value before clearing. After clearing the original zero point value, you could set static zero point according to the measurement environment on the site.

Set zero point deviation

Enter a deviation added on the measured value to get the actual measured value.

It is not recommended for clients to use by themselves or take it as the standard calibration method.

22 Zero Settings *R		
Cut	Reset	Offset
Options	0. NO	

22 Zero Settings *R		
Cut	Reset	Offset
Options	0. NO	

22 Zero Settings *R		
Cut	Reset	Offset
Value	0.0	m ³ /h

23

Totalizer

Select the flow accumulation type:

- 0. Positive Totalizer POS Total
- 1. Negative Totalizer NEG Total
- 2. Net Totalizer NET Total

Select energy type

- 0. Heat
- 1. Cool

23 Totalizar *R		
Switch	Reset	
Flow	0.POS	0.ON
Energy	0.Heat	0.OFF

Select the flow totalizer you need to reset :

- 0. POS Total
- 1. NEG Total
- 2. NET Total
- 0. Clear all

Select the energy totalizer you need to reset :

- 0. Heat
- 1. Cold
- 2. All

23 Totalizar *R		
Switch	Reset	
Flow	0.POS	
Energy	0.Heat	

24

RTD settings

Select temperature input source

- 0.RTD

RTD indicates Pt1000 platinum resistance;

24 Temperature *R		
Source	Sensitivity	SHC
Options	0.RTD	

Note: This menu is only applicable for energy meter.

Temperature Sensitivity Settings

When the temperature difference is less than the sensitivity you set, the energy would not accumulate and the adjustable range is 0~20 °C. Factory setting is 0.2 °C by default.

24 Temperature *R		
Source	Sensitivity	SHC
Value	0.20	°C

Specific Heat Capacity Settings:

0. CJ128SHC (National Standard)

1. Others

24 Temperature *R		
Source	Sensitivity	SHC
Options	0.CJ128	
Others	4.2	KJ/m ³ °C

25

Power Cut Compensation

Power cut compensation is a function to calculate the current value during the outage based on the average flow before power cut, so as to compensate the total flow.

You could choose to enable/disable the function.

25 PowerDown COMP *R		
Options	0.ON	

26

K Factor

Each flowmeter would be calibrated before leaving factory to get its meter coefficient, which we call the K coefficient.

You also could calibrate the flowmeter in service on site through M26 menu.

25 K Fctor *R		
Value	1.00	

27

Correction

Linear calibration function.

You could choose to enable/disable the function.

This function is enabled by fault in factory settings.

Delay Calibration

This is a technician menu. Please apply the factory settings and DO NOT alter parameters in the menu.

 27	Correction		*R
KArray	Delay	TPC	
Options	0.ON		
Value	*****		

27	Correction		*R
KArray	Delay	TPC	
Value	0.0	us	

Signal Power Control

This is a technician menu. Please apply the factory settings and DO NOT alter parameters in the menu.

27	Correction		*R
KArray	Delay	TPC	
Options	0.Auto		

28

Statistic Analysis

This is a technician menu. Please apply the factory settings and DO NOT alter parameters in the menu.

27		SQA	*R
Set	Reset		
Options	0.On		
Value	0.000		

27		SQA	*R
Set	Reset		
Options	0.Auto		
Value	0.000		

30

Serial Port Settings

RS485

0.2400 None

1.4800 None

2.9600 None

3.19200 None

4.38400 None

5.56000 None

30 RS485 *R		
Set	Order	
Options	0.2400	None
Adr	55	

30 RS485 *R		
Set	Order	
Options	a.1-0	: 3-2

31

AI Settings

AI1 The upper/lower limit input.

AI2 The upper/lower limit input.

31 AI Setting *R		
AI1	AI2	
LowerL	1.0	
UpperL	1000.0	

31 AI Setting *R		
AI1	AI2	
LowerL	1.0	
UpperL	1000.0	

37

SD Card Settings

Options

- a. Flow data
- b. All SD card data acquisition interval could be set.

Time unit is sec and the storage cycle could be set between 1- 99999 s.

37 Micro SD *R		
Options	a. Flow data	
Cycle	60s	

40

Unit System

The following options are available:

- a. Metric b. British

40 Toggle Unit *R		
Options	a. Metric	

41

Flow Unit

The following options are available:

- 0.m³ (Cubic Meters)
- 1.l (Liters)
- 2.GAL (USA Gallons)
- 3.Imp gal (Imperial Gallons)
- 4.mg (Million Gallons)
- 5.cf (Cubic Feet)
- 6.US bbl (USA Barrels)
- 7.Imp bbl (Imperial Barrels)
- 8. Oil bbl (Oil Barrels)

The following options are available:

/Day/Hour/Min/Sec

Factory setting is m³/h.

41 Flow Unit *R		
Unit	MULT.	
Rate	m ³ /h	
Total	m ³	

Flow Accumulation Multiple Factor

a.x 0.001 (E-3)

b.x0.01(E-2)

c.x0.1(E-1)

d.x1(E+0)

e.x 10(E+1)

f.x100(E+2)

g.x1000(E+3)

h.x 10000(E+4)

41		Flow Unit	*R
Unit	MULT.		
Options		d. *1	

42

Energy Unit

The following options are available:

0.Giga Joule (GJ)

1.Kilocalorie (Kcal)

2.MBtu

3.KJ

4.Btu

5.KWh

6.MWh7. TH

42		Energy Unit	*R
Unit	MULT.		
Rate	GJ/h		
Total	GJ		

Energy Accumulation Multiple Factor

a.x 0.001 (E-3)

b.x0.01(E-2)

c.x0.1 (E-1)

d.x1 (E + 0)

e.x10 (E + 1)

f.x100 (E + 2)

g.x1,000 (E + 3)

h.x 10,000 (E+4)

42		Energy Unit	*R
Unit	MULT.		
Options		d. *1	

a. x 0.001 (E-3)	b. x 0.01(E-2)
c.x 0.1(E-1)	d. x 1(E+0)
e. x 10(E+1)	f. x 100(E+2)
g. x 1000(E+3)	h.x 10000(E+4)

43

Temperature Unit

The following options are available:

a. °C

b. °F

 43	Energy Unit		*R
Options	a. °C		

50

Serial Number

Serial number is the only factory code of the flowmeter, and is the unique mark for the manufacturer and the user to trace the product information and its management.

SVN indicates the software version number.

 50	Serial Number		*R
S/N	FT123456		
SVN	V1.12		

51

Time and Date

You could alter time and date in this menu.

 51	Time and Date		*R
Time	13:10:34		
Date	20200101		

M52

Key Tone

You could choose to turn “on/off” the key tone.

 52	Key Ton		*R
Options	0.ON		

53

Languages

You could choose the language for the operation interface in this menu:

0. English

1. Chinese

53 Language *R		
Options	0.Chinese	

54

System lock

You could set operation authority. When the system locks, you could only view the menu but cannot alter any parameters. You could unlock the system by entering correct passcode. The passcode is composed of six digits; If you lose or forget it, please contact the manufacturer.

54 System Lock *R		
Options	0.NO	
Passcode	*****	

55

System Reset

You could reset the flowmeter to the factory defaults in this menu.

55 System Reset *R		
Options	0.NO	
Menu	00	

60

Data totalizer

You could view: Daily Total, Monthly Total and Yearly Total.

In this menu, you could view historical data for a day in the past 31 days, or a month in the past 12 months or a year in the past six years.

60 Data totalizer *R		
Day	Month	Year
Value	9/10	E+0
Menu	129	m ³

61

Running Time

You could view the total run time of the flowmeter.

61 Running Time *R		
Value	500	h

62

CL adjustment

This menu is for current calibration. 4-20mA calibration.

Note: The flowmeter would be calibrated before leaving factory, so it is not recommended for the user to calibrate it.

62 CL Adjust *R		
4mA	Enter to go	
20mA	Enter to go	

63

RTD adjustment

This menu is for RTD calibration.

Note: The flowmeter would be calibrated before leaving factory, so it is not recommended for the user to calibrate it.

63 RTD Adjust *R		
0℃	Enter to go	
180℃	Enter to go	

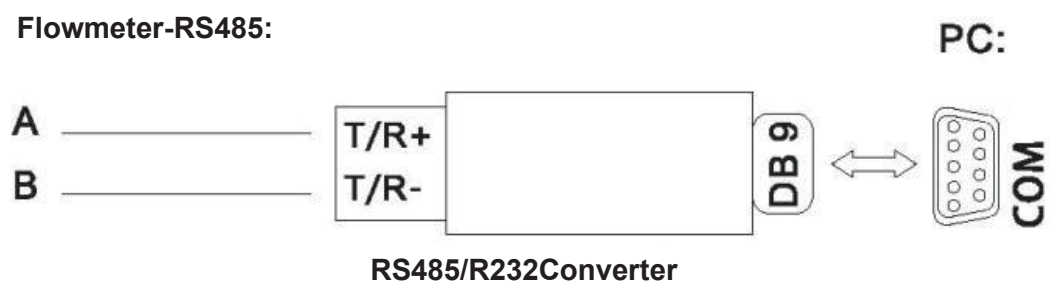
Chapter VIII Communication Interface and Communication Protocol

7.1 General

The flowmeter is provided with an UART protocol, and you also could operate by using RS-485 Modbus. There are two basic structures you could choose for networking, i.e. only applying the analog current output method or directly applying the UART communication method of the flowmeter. The former one is applicable for replacing the old meter in the old monitoring network, while the latter is used for the new monitoring network, which has a lot of advantages like low hardware investment, reliable system operation and etc.

When directly using the UART communication for the monitoring network system, you could use the address identification code as the network address code and use the command extending set with [W] as the communication protocol.

7.2 UART Definition



7.3. Communication Protocol and its Use

The flowmeter supports HL protocol and MODBUS protocol.

7.3.1. HL protocol

The flowmeter applies HL communication protocol. The host device would request the flowmeter to respond after sending a “command”. Asynchronous communication baud rate (Main station: computer system; secondary station: ultrasound flowmeter) is 9,600 BPS in general.

Single byte data format (10 bits): One start bit, one stop bit and eight data bits. Check bit: Non. One data character string is used for indicating the basic command, while one ENTER is used for indicating ending the command. This command is applicable for RS232 and RS485. Common commands are shown below:

Common Communication Commands

Command	Description	Data format
RFR(cr)(lf)	Return to Transient Flow	$\pm d.d\text{d}\text{d}\text{d}\text{d}\text{d}E\pm dd(\text{cr})$ Note 1
RVV(cr)(lf)	Return to Transient Velocity	$\pm d.d\text{d}\text{d}\text{d}\text{d}\text{d}E\pm dd(\text{cr})$
RT+(cr)(lf)	Return to POS Total	$\pm d\text{d}\text{d}\text{d}\text{d}\text{d}\text{d}.dE\pm d(\text{cr})$ Note 2
RT-(cr)(lf)	Return to NEG Total	$\pm d\text{d}\text{d}\text{d}\text{d}\text{d}\text{d}.d\pm d(\text{cr})$
RTN(cr)(lf)	Return to NET Total	$\pm d\text{d}\text{d}\text{d}\text{d}\text{d}\text{d}.d\pm d(\text{cr})$
RTH(cr)(lf)	Return to Total (Heat Quantity)	$\pm d\text{d}\text{d}\text{d}\text{d}\text{d}\text{d}.d\pm d(\text{cr})$
RT-(cr)(lf)	Return to Total (Cold Quantity)	$\pm d\text{d}\text{d}\text{d}\text{d}\text{d}\text{d}.d\pm d(\text{cr})$
RER(cr)(lf)	Return to Energy Transient Quantity	$\pm d.d\text{d}\text{d}\text{d}\text{d}\text{d}E\pm dd(\text{cr})$
RAI(cr)(lf)	Return to Analog Input AI1 Value (temperature, pressure, and etc.)	$\pm d.d\text{d}\text{d}\text{d}\text{d}\text{d}E\pm dd(\text{cr})$
RA2(cr)(lf)	Return to Analog Input AI2 Value (temperature, pressure, and etc.)	$\pm d.d\text{d}\text{d}\text{d}\text{d}\text{d}E\pm dd(\text{cr})$
RID(cr)(lf)	Return to Meter Address Code	ddddd(cr) 5-bit length
RSS(cr)(lf)	Return to Signal Status	UP: dd.d, DN:dd.d, Q=dd(cr)
REC(cr)(lf)	Return to Current Error Code	*R/*D/*E Note 3
RRS(cr)(lf)	Return to Repay Status	ON/OFF (cr)
RDT(cr)(lf)	Current time and date	yy-mm-dd, hh:mm:ss (cr)
RSN(cr)(lf)	Return to Serial Number	ddddd\text{d}t(cr) Note 4
OCT(cr)(lf)	OCT Settings	ddd\text{d}.d(cr) return to "OK" if it is set correctly
SRS(cr)(lf)	Start Ration Control	OK (cr)
P	With check return command prefix	Note 5
W	Network command prefix of digit string address	Note 6

Annotations:

1. (cr) indicates ENTER, its ASCII code value is 0DH. (lf) indicates changing a line and its ASCII code value is 0AH.
2. "d" indicates 0~9 digits and 0 is expressed by + 0.000000E + 00.
3. "d" indicates 0~9 digits and the integral part has no decimal point.
4. dddddd indicates the electronic serial number of the machine.
5. Character P could be added before every basic command, it indicates the feedback data has CRC check. The check sum is obtained through binary addition, which is a cumsum binary system taking the least 8-bit binary data.

For example: Feedback information RT(cr)(lf): +1234567E+0m3(cr)(lf)(corresponding binary data are 2BH, 31H, 32H, 33H, 34H, 35H, 36H, 37H, 45H, 2BH, 30H, 6DH, 33H, 20H, 0DH, 0AH) sum data returned =2BH + 31H + 32H+ 33H + 34H + 35H+ 36H + 37H+45H + 2BH + 30H + 6DH + 33H + 20H = 2F7, and the least 8-bit binary is F7.

Therefore, data of command PRT(cr)(lf) is + 1234567E + 0m3!F7(cr)(lf), "!" as for the delimiter, the first part is the character for summation and the second part is an 1-bit check code.

6. Use of W prefix: W+digit string address code+basic command, the digit string value range is 0~255, divided by 13 (0DH ENTER),10(0AH changing a line). If you want to access to the transient flow velocity of No. 123 flowmeter, you could send command W123DV (cr) (lf), the corresponding binary codes are 57H, 31H, 32H, 33H, 44H, 56H, 0DH and 0AH; only the meters with the same network address and command could have data feedbacks.
7. W and P commands could be combined for use, for example, W123PRT+, which means the network address it reads is the total value of No. 123 flowmeter, its feedback data are accumulated and checked.

7.3.2. MODBUS-I Communication Protocol

MODBUS-I protocol applies RTU transmission mode, and its check code applies CRC-16-IBM (multinomial is $X^{16}+X^{15}+X^2 + 1$, mask code is 0xA001), which is gained through the cyclic redundancy algorithm.

MODBUS-I RTU mode applies the hexadecimal system to transmit data.

1. MODBUS-I protocol function code and format

Function code	Function data indicated
0x03	Read register
0x06	Single write register

2. Use of MODBUS protocol function code 0x03

Information frame format of the read register sent by the host:

Slave address	Operation function code	Register's first address	Number of registers	Check code
1 byte	1 byte	2 bytes	2 bytes	2 bytes
0x01~ 0xF7	0x03	0x0000 ~ 0xFFFF	X0000 ~ 0x7D	CRC Check code

Slave feedback data frame format:

Slave address	Read operation function code	Number of data bytes	Data	Check code
1 byte	1 byte	1 byte	N*x2 bytes	2 bytes
0x01~ 0xF7	0x03	2xN*	N*x2 data	CRC Check code

N* =Number of data registers.

3. MODBUS protocol function code 0x06

Information frame format of the write-in single register sent by the host (function code 0x06):

Slave address	Operation function code	Register's first address	Number of registers	Check code
1 byte	1 byte	2 bytes	2 bytes	2 bytes
0x01~0xF7	0x06	0x0000~0xFFFF	X0000 ~ 0xFFFF	CRC Check code

Slave feedback data frame format (function code 0x06):

Slave address	Operation function code	Register's first address	Number of registers	Check code
1 byte	1 byte	2 bytes	2 bytes	2 bytes
0x01~0xF7	0x06	0x0000~0xFFFF	X0000~0xFFFF	CRC Check code

Flowmeter's address

Value range is 1~247 (hexadecimal system: 0x01~0xF7), the address could be viewed in Menu 30; if the decimal digit displayed in Menu 30 is 11, the flowmeter's address in MODBUS protocol is: 0x0B.

The flowmeter's CRC check code is calculated through CRC-16-IBM (multinomial is $X^{16}+X^{15}+X^2+1$, mask word is 0xA001) cyclic redundancy algorithms, low byte of the check code is in front, followed by the high byte.

For example, transient flow per hour (m³/h) of the flowmeter with 1 (0x01) read address in RTU mode, i.e. data of two read registers 40005 and 40006, the read commands are shown below:

0x01 0x03 0x00 0x04 0x00 0x02 0x85 0xCA

Flowmeter's address function code/First address register/Number of registers/CRC check code

Flowmeter's feedback data (Assuming the current flow=1.234567m³/h):

0x01 0x03 0x04 0x06 0x51 0x3F 0x9E 0x3B 0x32

Flowmeter's address function code/Number of data bytes/Data/CRC check code

In which, four bytes 3F, 9E, 06 and 51 is 1.2345678, which is the single precision float form in IEEE754 format.

Please pay attention to the order of data in the above example. When explaining the value with C language, you could use the pointer to directly input the data required to related address of variable, the common storage order in general is that the low byte is in front. Taking the above 1.2345678m/s example, the storage order of 3F, 9E, 06 and 51 data is 51, 06, 9E and 3F. For example, in RTU mode, alter the address of flowmeter 1 (0x01) to 2 (0x02), i.e. write the data of 44100 register in 0x02,

Write-in commands are shown below:

0x01 0x06 0x10 0x03 0x00 0x02 0xFC 0xCB

Flowmeter's address function code/Register address/Number of registers/ CRC check code

Flowmeter's feedback data:

0x01 0x06 0x10 0x03 0x00 0x02 0xFC 0xCB

Flowmeter's address function code/Register address/Number of registers/CRC check code

4. Error processing

The flowmeter only returns the error code 0x02, it indicates that the first address of data is wrong.

For example, when it only reads 40002 register data with address 1 (0x01) in RTU mode, the meter would consider that the data integrity is destroyed, so it sends the following commands: 0x01 0x03 0x00 0x01 0x00 0x01 0xD5 0xCA

Flowmeter's address/function code/Register address/Number of registers/CRC check code

The flowmeter returns the following error code:

0x01 0x83 0x02 0xC0 0xF1

Flowmeter's address/Error code/Error extension code/CRC check code

5. MODBUS Register Address List

The flow meter MODBUS Register has a read register and a write single register.

a) Read Register Address List (use 0x03 function code to read)

PDU Address	Address	Register	Type	Number	
\$0000	40001	Flow/s - low word	32 bits real	2	
\$0001	40002	Flow/s - high word			
\$0002	40003	Flow/m - low word	32 bits real	2	
\$0003	40004	Flow/m- high word			
\$0004	40005	Flow/h - low word	32 bits real	2	
\$0005	40006	Flow/h - high word			
\$0006	40007	Velocity low word	32 bits real	2	
\$0007	40008	Velocity high word			
\$0008	40009	Positive total low word	32 bits real	2	
\$0009	40010	Positive total high word			
\$000A	40011	Positive total exponent	16 bits int.	1	
\$000B	40012	Negative total low word	32 bits real	2	
\$000C	40013	Negative total high word			
\$000D	40014	Negative total exponent	16 bits int.	1	
\$000E	40015	Net total low word	32 bits real	2	
\$000F	40016	Net total high word			
\$0010	40017	Net total exponent	16 bits int.	1	
\$0011	40018	Energy flow low word	32 bits real	2	
\$0012	40019	Energy flow high word			

\$0013	40020	Energy total(hot) low word	32 bits real	2	
\$0014	40021	Energy total(hot) high word			
\$0015	40022	Energy total(hot) exponent	16 bits int.	1	
\$0016	40023	Energy total(cold) low word	32 bits real	2	
\$0017	40024	Energy total(cold) high word			
\$0018	40025	Energy total(cold) exponent	16 bits int.	1	
\$0019	40026	Up signal low word	32 bits real	2	0 ~ 99.9
\$001A	40027	Up signal high word			
\$001B	40028	Down signal low word	32 bits real	2	0 ~ 99.9
\$001C	40029	Down signal high word			
\$001D	40030	Quality	16 bits int.	1	0 ~ 99
\$001E	40031	Error code char 1	String	1	Refer to "Error Analysis" for detailed codes meanings.
\$003B	40060	Flow velocity unit char 1,2	String	2	Only m/s right now
\$003C	40061	Flow velocity unit char 3,4			
\$003D	40062	Flow rate unit char 1,2	String	2	Note 1
\$003E	40063	Flow rate unit char 3,4			
\$003F	40064	Flow total unit char 1,2	String	1	
\$0040	40065	Energy rate unit char1,2	String	2	Note 2
\$0041	40066	Energy rate unit char 3,4			
\$0042	40067	Energy total unit char 1,2	String	1	
\$0043	40068	Instrument address-low word	32 bits int.	2	

\$0044	40069	Instrument address-high word			
\$0045	40070	Serial number char 1,2	String	4	
\$0046	40071	Serial number char 3,4			
\$0047	40072	Serial number char 5,6	String	4	
\$0048	40073	Serial number char 7,8			
\$0049	40074	Analog Input AI1 Value- low word	32 bits real	2	Returned temperature value with RTD option
\$004a	40075	Analog Input AI1 Value- high word			
\$004b	40076	Analog Input AI2 Value- low word	32 bits real	2	
\$004c	40077	Analog Input AI2 Value- high word			
\$004d	40078	4-20mA Value- low word	32 bits real	2	Unit: mA
\$004e	40079	4-20mA Value- high word			

b) Single Write Register Address List (use 0x06 performance code to write)

PDU Address	Register	Description	Read/W rite	Type	No. registers*
\$1003	44100	Flow meter address (1 - 255)	R/W	16 bits int.	1
\$1004	44101	Communication Baud Rate 0 = 2400, 1 = 4800, 2 = 9600, 3 = 19200, 4 = 38400, 5 = 56000	R/W	16 bits int.	1

Notes:

1. The following flow rate units are available:

0. "m3" Cubic Meter
1. "l" Liters
2. "ga" Gallons
3. "ig" Imperial Gallons
4. "mg" Million Gallons
5. "cf" Cubic Feet
6. "ba" US Barrels
7. "ib" Imperial Barrels

-
8. "ob" Oil Barrels
 2. The following energy units are available!
 0. "GJ" Giga Joule
 1. "Kcal" Kilocalorie
 2. "MB" MBtu
 3. "KJ" Kilojoule
 4. "Bt" Btu
 5. "Ts" US Tonnes
 6. "Tn" US Tons
 7. "kw" Kwh