Ultrasonic Flowmeter Instruction Manual

Model: D118

pFlow

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Notice

Thank you for purchasing the D118 Ultrasonic Flowmeter of our company.

This operation manual contains important information on the use and operation of the flowmeter. To prevent damage to the flowmeter and improper use, please read this manual carefully to ensure the flowmeter performs at its best.

This operation manual will introduce how to use the flowmeter in a step-by-step manner, starting from the product composition of the flowmeter, covering installation, wiring, quick setup, and other contents, making it easier for you to use the flowmeter.

By learning more about menu settings, you can make the flowmeter's powerful function options and output functions meet your higher requirements.

Warning

The "Warning Signs" or "Warnings" on this manual and the flowmeter mean that if the relevant requirements are not followed and corresponding measures are not taken, there is a potential risk of personal injury or damage to the flowmeter.

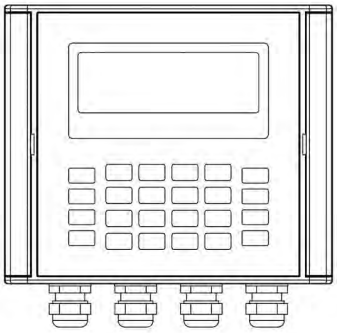
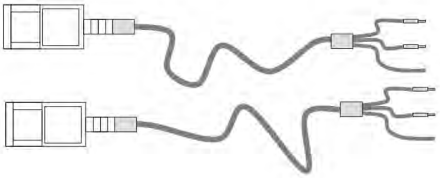
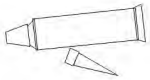
Caution

The "Caution Signs" or "Cautions" on this manual and the flowmeter mean that if the relevant requirements are not followed and corresponding measures are not taken, there may be a potential risk of damaging the flowmeter or causing it to fail to measure normally.

Some contents in this manual may differ from the flowmeter you purchased, depending on the configuration requirements at the time of purchase; on the other hand, due to product design changes and upgrades, they may not be noted in the manual. Please refer to the flowmeter's display interface, and pay attention to the version number and additional attached instructions.

Product Components

Before installing the flowmeter, please check whether the spare parts match the contents of the packing list to ensure there is no potential damage, loose screws, etc. If you have any questions, please contact the supplier in a timely manner.

Transmitter	Transducers
	
Accessories	**Documents**
 Pipe Straps  Coupling compound  Card Reader  Screws and plastic bushings	 1. Instruction Manual 2. Packing List 3. Certified 3-Point Factory Calibration 4. Application Worksheet

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Update Information:

1 Transmitter Installation and Wiring

1.1 Transmitter Installation and Power Wiring

1.1.1 Transmitter Installation

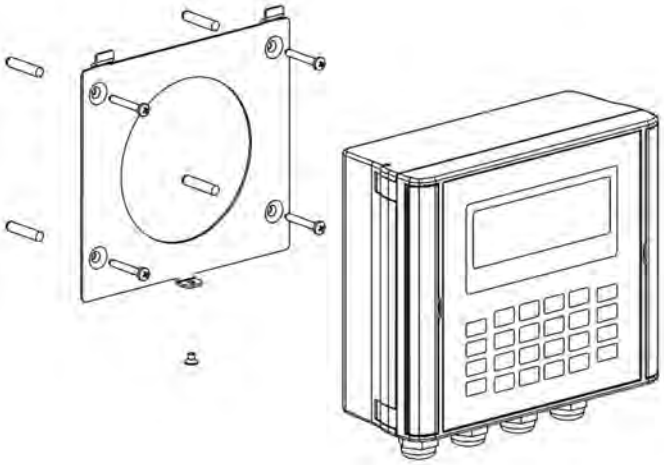


Figure 1: Host Installation Exploded View

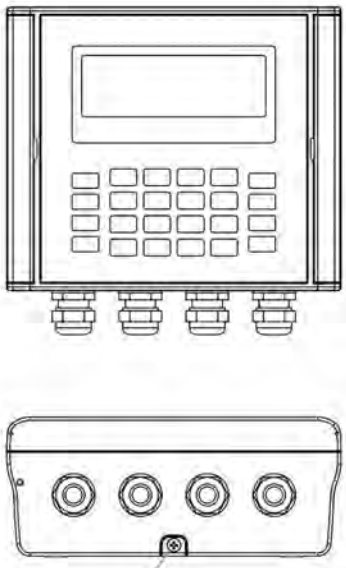


Figure 2

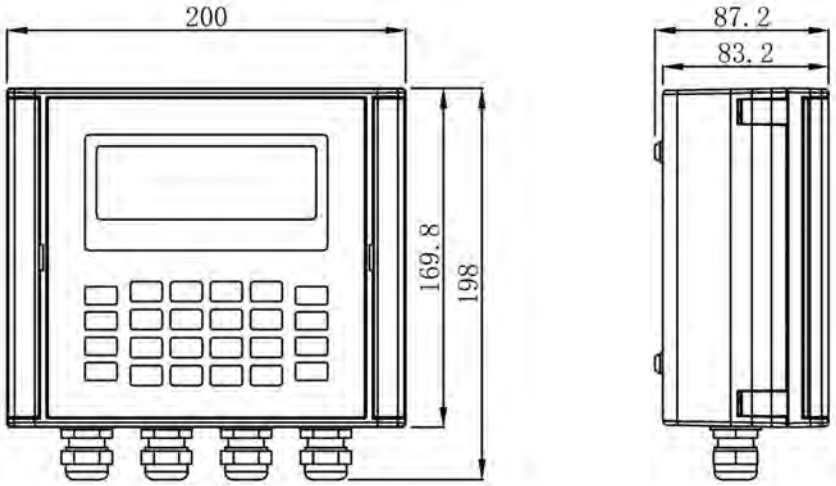


Figure 3: Host Overall Dimension Drawing (Unit: mm)

1. Take out 4 sets of self-tapping rubber plug combination screws (PA4*30) from the random accessories and fix the mounting bracket on the wall (refer to Figure 1).
2. Hang the host on the mounting bracket, and then lock and fix it with M4 countersunk screws (refer to Figure 2).
3. Figure 3 shows the overall dimension drawing of the host.

1.1.2 Power Supply Type

Customers should pay special attention to the power supply type of the flowmeter when wiring.

The standard power supply provided by the manufacturer is 90~245VAC.

To ensure the normal operation of the transmitter, the following aspects should be noted during wiring:

Ensure that the power connection is consistent with the specifications displayed on the transmitter nameplate.

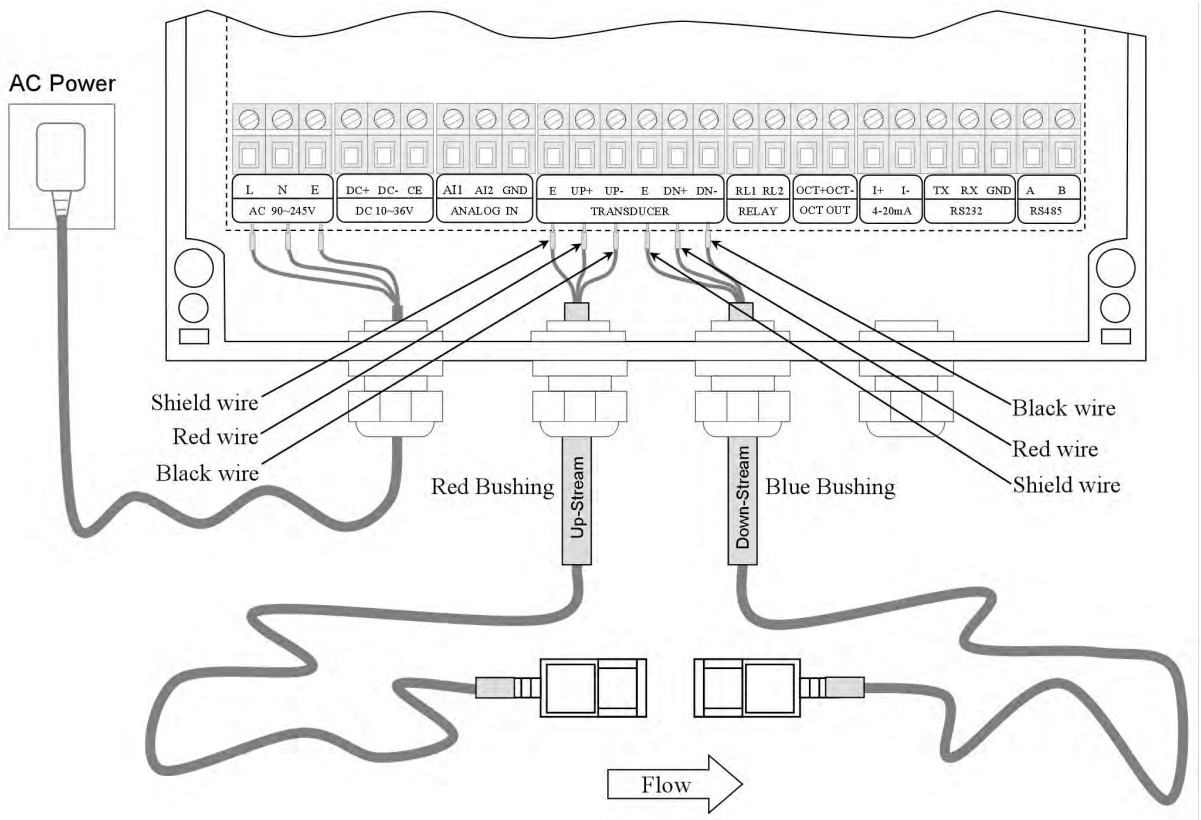
The transmitter can be connected to two types of power supplies: AC 90~245V and DC 10~36VDC.。

1.1.3 Transmitter Wiring

Once the flowmeter has been installed in the designated position as required, wiring can begin.

Open the upper cover of the transmitter, and you can see the wiring ports on the power board. From left to right, they are:

AC Power (AC 90~245V), DC Power (DC 10-36V), 4-20mA Analog Signal Input (ANALOG IN), Transducer Wiring (TRANSDUCER), Relay Output (RELAY), OCT Output (OCT OUT), 4-20mA Output (4-20mA), RS232 Output (RS232), RS485 Output (RS485). For specific wiring, please refer to the following figure:



Warning

Wiring of the instrument must be carried out after power is cut off. The instrument must be reliably grounded before installation and use.

Only one type of power supply (AC or DC) can be used. AC and DC power supplies cannot be connected simultaneously.

1.2 Power-On

After the flowmeter is powered on, it will display the startup screen.

If it is used for the first time or installed at a new installation site, parameters for the new installation site need to be entered. Any parameters entered by the user will be permanently saved until the user modifies them again.

When the user changes parameters or moves the sensor, the instrument will immediately recalculate and adjust automatically, and work according to the newly entered parameters by the user.

1.3 Keyboard

The flowmeter keyboard is shown in the following figure, with explanations as follows:

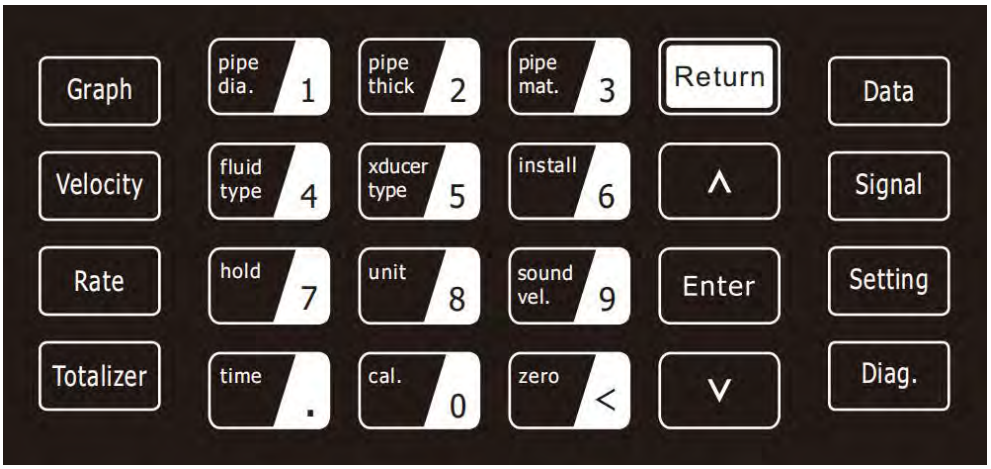
cal. 0 ~ sound vel. 9 and time . are used for entering numbers. zero < is used for left backspace.

∧ and ∨ are used for up and down selection.

Press Setting to enter the settings window interface for parameter settings; all parameter settings are performed through this interface.

Press Enter to enter/confirm the selected item. Data is used to enter the TF card storage interface.

Graph, Velocity, Rate, Totalizer, Data, Signal, Setting, Diag. buttons are used to enter the "Curve", "Flow Velocity", "Instantaneous Flow Rate", "Cumulative Quantity", "Data Storage", "Signal Quality", "Parameter Settings", and "Data Diagnosis" window interfaces respectively.

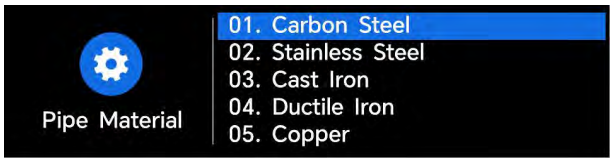
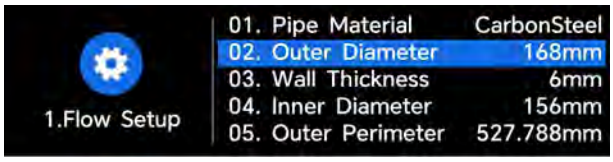


1.4 Keyboard Operation Type

The flowmeter adopts a window-based software design. All parameter settings are performed in the menu. Press Setting to enter the settings window, use the up and down buttons to select each settings window, press Enter to select or enter the menu item where the cursor is located for settings. The number buttons are used for entering numbers in the parameter input state. Return is used for returning.

1.4.1 Operation Process Example

For example: Steps to select the pipe material as stainless steel and the pipe outer diameter as 219mm:

1. After turning on the device, enter the flow data display window interface. There are 6 such interfaces, which can be switched to for viewing by pressing [∧] [∨].	
2. Press [Setting] to enter the settings window interface.There are 8 such interfaces, which can be switched to by pressing [∧] [∨].	
3. In the settings window interface, press [Enter] to enter the menu options, and use [∧] [∨] to select. In this example, select the 01.Pipe Material menu item.(abbreviated as "1-01" menu item), then press [Enter] to enter the pipe material submenu.	
4. In the pipe material submenu, use [∧] [∨] to select the required pipe material.In this example, select “02. Stainless Steel” (abbreviated as "1-01-02"), then press [Enter] to return to the previous menu.	
5. Repeat steps 1~3, use [∧] [∨] to select the 02.Outer Diameter menu item.(abbreviated as "1-02" menu item), then press [Enter] to enter the pipe outer diameter data input interface. Enter 219 and press [Enter] to return to the previous menu.	
6. In this example, the pipe material has been modified to stainless steel and the pipe outer diameter to 219mm. Press [Return] twice to return to the flow display window interface.	

Caution

In the example, the "01. Pipe Material" menu item in the "1. Flow Measurement Settings" window can be abbreviated as the "1-01 menu item".

The submenu item 02. Stainless Steel under Pipe Material can be abbreviated as the "1-01-02 menu item". The rest of the menu items are abbreviated in the same way, and the abbreviated form will be used in the following text.

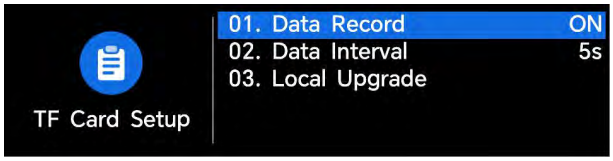
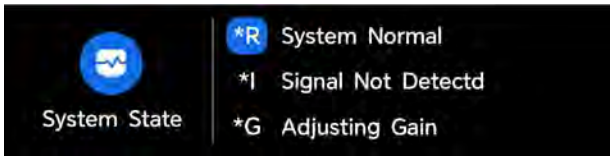
1.5 Flowmeter Window Introduction

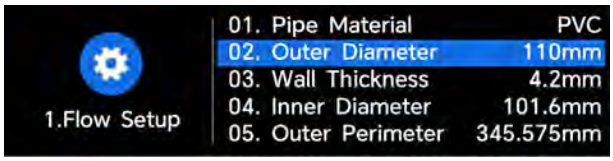
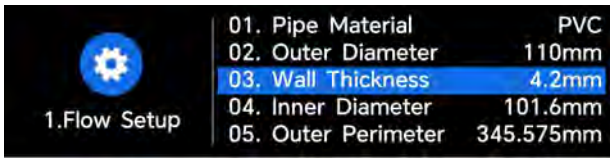
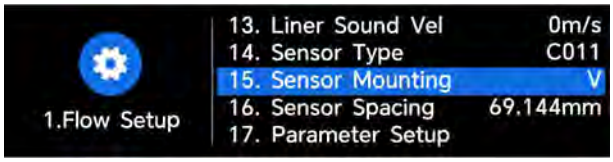
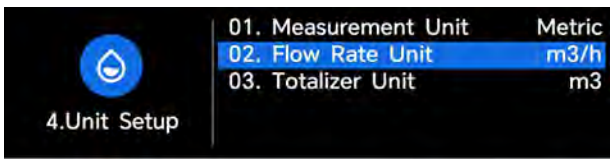
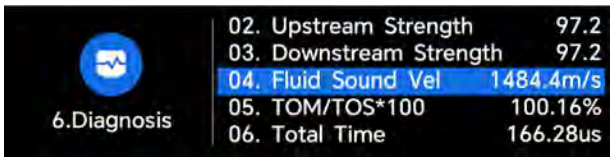
Windows are arranged according to the following rules:

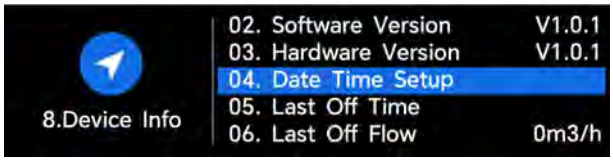
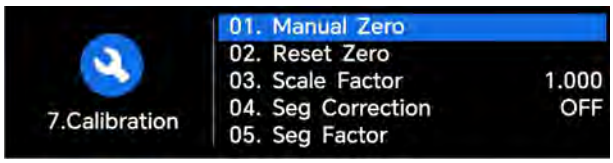
Window Type	Function Description
Flow Data Display Window (Initial screen)	There are 6 display interfaces, which can display instantaneous flow rate, instantaneous flow velocity, positive/negative/net cumulative flow rate, daily/monthly/yearly cumulative quantity, current system working status, etc.
Flow Setup Window	Initial parameter operation window. Parameters such as pipe outer diameter, pipe wall thickness, fluid type, sensor type, sensor installation method, etc., need to be entered, and the installation distance is displayed.
In/Output Setup Window	Input and output configuration window. It includes serial port parameters, current loop output, OCT output, relay output, buzzer output, alarm output, batch controller output, TF card settings, etc.
Totalizer Setup Window	Totalizer operation window. It can set the totalizer to be on/off or perform a "reset to zero" operation on it.
Unit Setup Window	Flow unit selection window. Units such as cubic meters, liters, or other units can be selected.
Select Setup Window	Includes settings for damping coefficient, low flow rate cutoff value, password protection, signal hold, negative flow switch, etc.
Diagnosis Window	Flowmeter working status check window. It includes signal quality (Q value), upstream and downstream signal strength, signal time transmission ratio, total propagation time, propagation time difference, Reynolds number, etc.
Calibration Window	Includes zero point cutoff, zero point recovery, instrument coefficient, segmental correction coefficient, current loop output calibration, etc.
Device Info Window	Includes serial number, software and hardware version numbers, date/time, last power-off time, total number of power-offs, etc.

2 Quick Setting Menu Description

2.1 Shortcut Key Description

Press [Graph] Press this button to enter the curve dynamic display interface, press the [∧] or [∨] to switch between instantaneous flow rate/flow velocity curves.	
Press [Velocity] Press to display the flow velocity.	
Press [Rate] Press to display the instantaneous flow rate.	
Press [Totalizer] Press to display positive, negative, and net cumulative flow rates.	
Press [Data] Press to enter the 2-09 menu item (TF Card Settings interface), where the collection interval time can be modified.	
Press [Signal] Press to enter the “6. Diagnosis” Window interface, which displays signal quality, upstream and downstream signal strength, etc.	
Press [Setting] Press this button to enter the “1. Flow Setup” Window. All parameter settings are accessed and completed through pressing [Setting].	
Press [Diag.] Press to display the system working status.	

Press pipe dia. 1 Enter 1-02 Out Diameter menu item.	
Press pipe thick 2 Enter 1-03 Wall Thickness menu item.	
Press pipe mat. 3 Enter 1-01 Pipe Material menu item.	
Press fluid type 4 Enter 1-07 Fluid Type menu item.	
Press xducer type 5 Enter 1-14 Sensor Type menu item.	
Press install 6 Enter 1-15 Sensor Mounting menu item.	
Press hold 7 Press hold 7 to hold the current total flow value, press hold 7 again to resume refreshing the cumulative quantity value.	
Press unit 8 Enter 4-02 Flow Rate Unit menu item.	
Press sound vel. 9 Enter 6-04 Fluid Sound Velocity menu item.	

Press cal. 0 Manual calibration (correcting the instrument K coefficient). Press Enter to start timing and accumulate the net flow rate. After accumulating for a period of time, check the net cumulative quantity on the standard meter within the same time. Press Enter to enter the net cumulative quantity from the standard meter, then press Enter again. If the ratio is between 0.5 and 1.5, the K coefficient correction is successful. if not, please do not correct it. Press Enter to exit the correction mode.	
Press time . Enter 8-04 Date Time Setup menu item.	
Press zero < Enter 7-01 Set Zero menu item.	

Caution

Shortcut keys are valid in the Flow Data Display Window and Settings Window interfaces, functioning to quickly access the operation and setting menu items. They are invalid in the data input state.

2.2 Quick Setup of Instrument Parameters

For example, take the installation of a clamp-on sensor for measurement: measuring a carbon steel pipe with a specification of DN200, pipe outer diameter of 219mm, pipe wall thickness of 6mm, measuring water as the medium, no lining material, and V-type installation type. The operation steps are as follows:

(For the usage instructions of insertion sensor settings, please refer to the appendices.)

Step 1: Select Pipe Material

Press [Setting] to enter the Settings Window interface. Select "1.Flow Setup", press [Enter] then select "01.Pipe Material", press [Enter] again, and select "01.Carbon Steel". Press [Enter] to save and return.

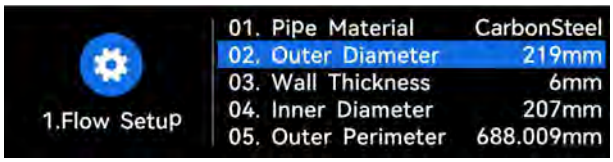
(The above operation is abbreviated as: Press [Setting] to enter 1-01 menu item, and select 01.Carbon Steel)

【Press [pipe mat. 3] to quickly enter 1-01 menu item.】

Step 2: Setup Outer Diameter

Press [Setting] and enter 1-02 menu item, then press [Enter] and enter 219mm, press [Enter] again to save and return.

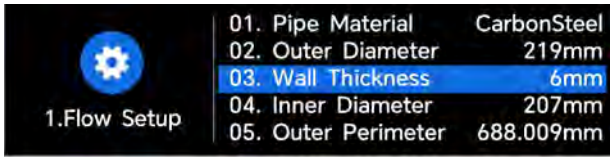
【Press [pipe dia. 1] to quickly enter 1-02 menu item.】



Step 3: Set Pipe Wall Thickness

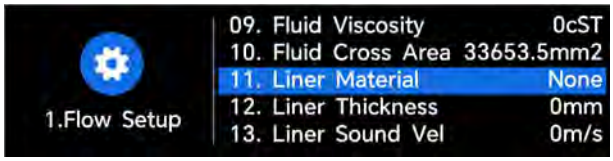
Press [Setting] and enter 1-03 menu item, then press [Enter] and enter 6mm, then press [Enter] again to save and return.

【Press [pipe thick 2] to quickly enter 1-03 menu item.】



Step 4: Set Liner Material

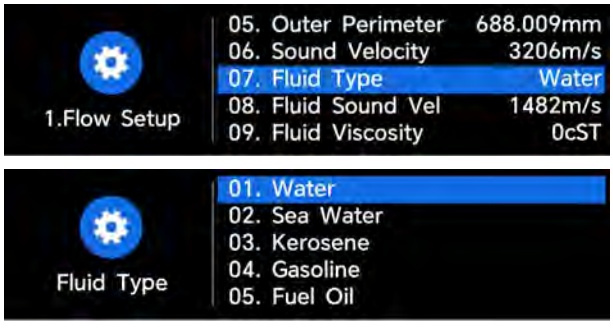
Press [Setting] and enter 1-11 menu item, then select 01.None.



Step 5: Fluid Type

Press [Setting] and enter 1-07 menu item, then press [Enter] and select "01. Water", then press [Enter] again to save and return.

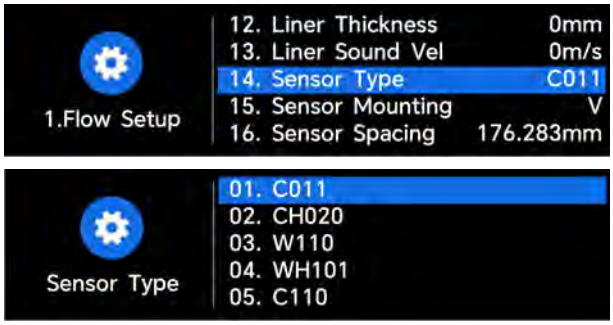
【Press [fluid type 4] to quickly enter 1-07 menu item.】



Step 6: Flow Sensor Type

Press Setting and enter 1-14 menu item, then press Enter and select "01. C011", then press Enter again to save and return.

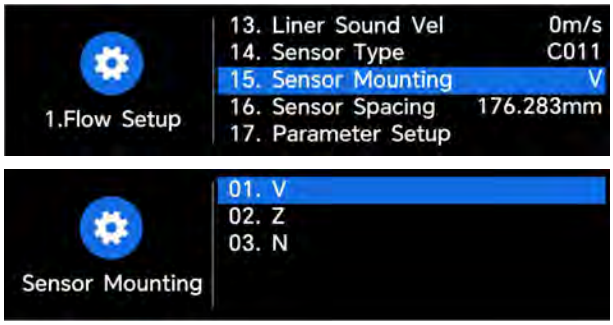
【Press xducer type 5 to quickly enter 1-14 menu item.】



Step 7: Sensor Installation Method

Press Setting and enter 1-15 menu item, then press Enter and select "01. V", then press Enter again to save and return.

【Press install 6 to quickly enter 1-15 menu item.】



Step 8: Adjust Sensor Installation Spacing

Press Setting and enter 1-16 menu item, and install the sensor according to the displayed installation spacing and the selected installation method (see Chapter 4 Sensor Installation).

Step 9: Check Instantaneous Flow Rate

Press Rate and enter the instantaneous flow rate interface and check the instantaneous flow rate.

Caution

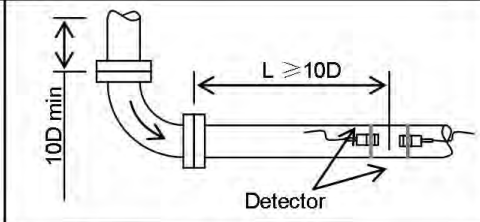
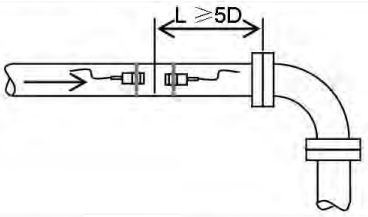
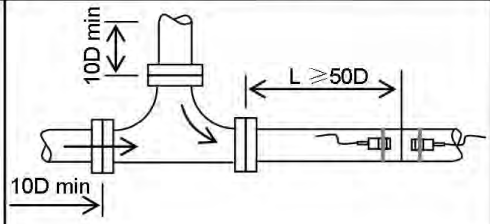
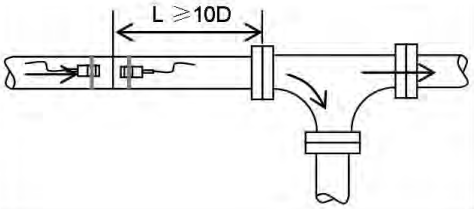
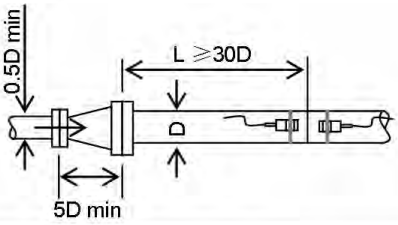
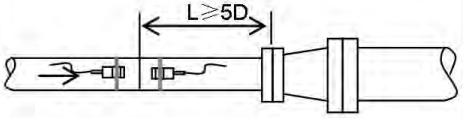
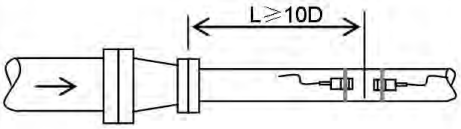
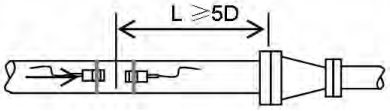
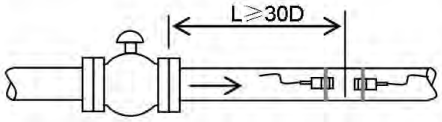
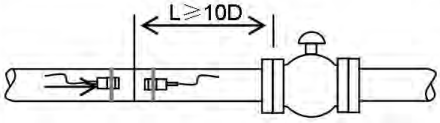
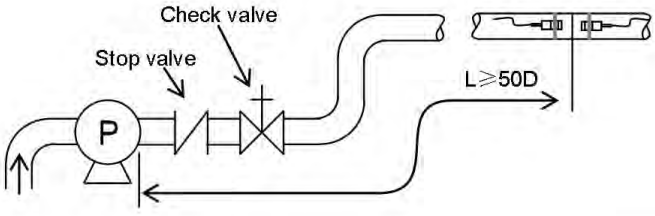
The above refers to the installation of a clamp-on sensor, where the installation spacing is the distance between the opposite end faces of the two sensors (As below picture shows).

3 Measuring Point Selection

The installation of ultrasonic flowmeter is the simplest among various types of flowmeters. It can be completed in only three steps: selecting an appropriate measuring point, entering the pipe parameters of the measuring point into the flowmeter, installing the sensor on the pipe, and then starting the measurement.

To ensure measurement accuracy, priority should be given to selecting a pipe section with a uniform fluid flow field distribution as the measuring point. The specific point selection and installation must follow the following principles:

- Select a pipe section that is completely filled with fluid, such as the vertical part of the pipeline (preferably with upward fluid flow) or a horizontal pipe section filled with fluid.
- Ensure that there are sufficient uniform straight pipe sections before and after the measuring point. The length of the straight pipe section upstream of the measuring point should be no less than 10 times the pipe diameter, and the downstream length should be no less than 5 times the pipe diameter. There should be no valves, elbows, reducers, or other devices that may interfere with the flow field within this range. The recommended lengths of straight pipe sections are shown in the following table.
- Accurately locate the sensor installation position. When installing on a horizontal pipe section, the sensor should be fixed at the "3 o'clock" or "9 o'clock" position of the pipe. Installation at the "6 o'clock" position (to avoid the influence of sediment at the bottom of the pipe) and "12 o'clock" position (to avoid signal attenuation caused by bubbles or cavitation at the top of the pipe) is strictly prohibited.
- Confirm that the ambient temperature at the measuring point meets the requirements. The temperature at the measuring point must be within the operating temperature range specified for the flowmeter to avoid affecting the equipment operation and measurement accuracy due to excessive temperature.
- Evaluate the scaling condition of the inner pipe wall. Priority should be given to selecting a pipe section with no scaling on the inner wall; if there is scaling on the inner wall and the pipe section cannot be replaced, the scaling layer should be regarded as the pipe lining and included in the calculation when entering the pipe parameters to correct the measurement error.
- Select a suitable pipe material. A pipe with uniform material and dense structure should be selected to ensure that ultrasonic waves can be stably transmitted in the pipe and reduce signal loss.

Name	Straight length of upstream piping	Straight length of downstream piping
90° bend		
Tee		
Diffuser		
Reduce		
Valve	 Flow controlled upstream	 Flow controlled downstream
Pump		

4 Sensor Installation

4.1 Sensor Installation Precautions

Before installing the sensor, the area outside the pipe where the sensor is to be installed must be cleaned to remove rust and paint, and a dense part of the pipe material should be selected for sensor installation. Apply sufficient coupling agent to the center part of the sensor and the pipe wall, squeeze the coupling agent to ensure there are no air bubbles between the sensor and the pipe wall, and then tightly attach the sensor to the pipe wall and fasten it with a strap.

The sensor installation must follow the following steps:

1. Apply a sufficient amount of coupling agent evenly to the center area of the sensor and the corresponding installation point on the pipe wall. After application, gently press the sensor to completely squeeze out the air bubbles in the coupling agent, ensuring no air bubbles remain between the sensor and the pipe wall.
2. Attach the sensor tightly to the pipe wall, and securely fix it with a dedicated strap (pipe tie) or fixing device to prevent the sensor from shifting during use.

Caution:

1. The two sensors should be installed in the horizontal direction of the pipe axis, and their installation directions should be parallel in the same direction.
2. During the installation process, it is necessary to strictly check the fitting state between the sensor and the pipe wall. Air bubbles, gravel, or other foreign objects are strictly prohibited to prevent signal attenuation or distortion; for horizontal pipes, the sensor should be installed at the "3 o'clock" or "9 o'clock" position of the pipe cross-section to avoid interference from bubbles that may exist in the upper part of the pipe.
3. The sensor installation spacing is the sensor installation distance given in menu 1-16 of the window.
4. If horizontal symmetrical installation cannot be achieved due to space constraints at the installation site, the installation angle can be adjusted (vertical installation or inclined installation), but it is necessary to ensure that the pipe is always filled with liquid and there are no bubbles remaining in the upper part of the pipe to avoid affecting the measurement accuracy.

4.2 Installation of Clamp-on Sensors

There are three installation types for clamp-on sensors, namely V-type, Z-type, and N-type.

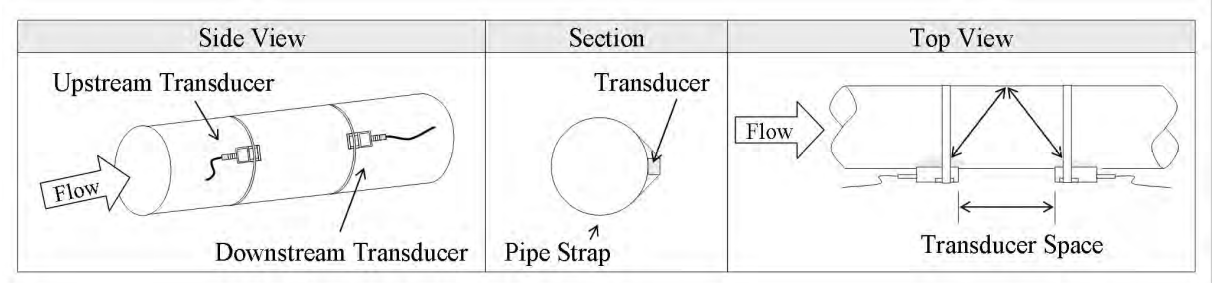
Generally, for pipes with a diameter of 100~300mm (4 " ~12 "), the V-type can be selected first; if the V-type fails to detect a signal or the signal quality is poor, the Z-type should be selected; for pipes with a diameter of more than 300mm (12 ") or cast iron pipes, the Z-type should be preferred.

The N-type is rarely used and is suitable for pipes with a diameter of less than 50mm (2 ").

4.2.1 V-Type

The V-type is the standard installation method under normal circumstances, which is easy to use and accurate in measurement. It can measure pipes with a diameter range of 25mm (1 ") to approximately 400mm (16 "). When installing the sensors, pay attention to aligning the two sensors horizontally, and their center lines should be horizontally consistent with the pipe axis.

(Refer to the V-type installation diagram)

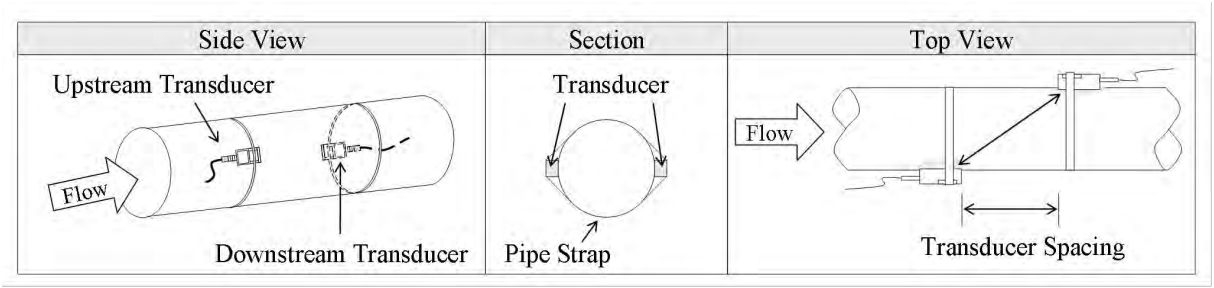


4.2.2 Z-Type

When the pipe diameter is large, or due to suspended solids in the liquid, excessive scaling on the inner pipe wall, or too thick lining, the flowmeter installed using the V-method has a weak signal, resulting in the instrument being unable to work normally, the Z-type should be selected for installation. The reason is that when using the Z-method, the ultrasonic waves are directly transmitted in the pipe without reflection (this is called a single acoustic path), and the signal attenuation is small.

The Z-type can measure pipes with a diameter range of 100mm (4 ") to approximately 5000mm (200 "). In actual flowmeter installation, it is recommended to use the Z-method for pipes with a diameter of more than 300mm (12 ").

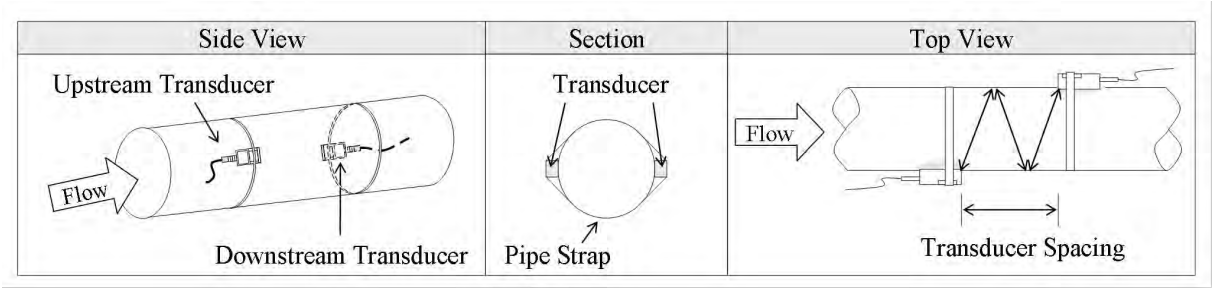
(Refer to the Z-type installation diagram)



4.2.3 N-Type (Rarely Used)

When installing using the N-type, the ultrasonic beam is reflected twice in the pipe and passes through the fluid three times (three acoustic paths), which is suitable for measuring small-diameter pipes. The N-type improves the measurement accuracy by extending the ultrasonic transmission distance (it is a rarely used method).

(Refer to the N-type installation diagram)



4.3 Installation Inspection

Installation inspection refers to checking whether the sensor installation is appropriate and whether it can receive correct, sufficiently strong ultrasonic signals that enable the machine to work normally, so as to ensure the long-term reliable operation of the instrument. By checking the received signal strength, signal quality, total transmission time, time difference, and transmission time ratio, it can be determined whether the installation is optimal.

Installation quality directly affects the accuracy of measurement values and the long-term reliability of the instrument. Although in most cases, measurement results can be obtained by simply applying coupling agent to the sensor and attaching it to the outer wall of the pipe, to ensure measurement accuracy and long-term reliable operation of the instrument, the following inspections are still required.

4.3.1 Signal Strength

Signal strength (press Signal or select window 6 to view the displays of menus 6-02 and 6-03) refers to the strength of the received signals in the upstream and downstream directions. The flowmeter uses numbers from 00.0 to 99.9 to represent the relative signal strength. 00.0 means no signal is received; 99.9 means the maximum signal strength.

In general, the greater the signal strength, the more stable the measurement value, and the more reliable the long-term operation.

During installation, the position of the sensor should be adjusted as much as possible and the sufficiency of the coupling agent should be checked to ensure the maximum signal strength is obtained.

The normal working condition of the system is that the signal strength in both directions is greater than 65.0. When the signal strength is too low, the sensor installation position, installation spacing, and whether the pipe is suitable for installation should be rechecked, or the installation method should be changed.

4.3.2 Signal Quality (Q Value)

Signal quality, referred to as Q value for short (displayed by pressing Signal or displayed in menu 6-01 of the window menu), refers to the quality of the received signal. The flowmeter uses numbers from 00 to 99 to represent the signal quality. 00 means the worst signal quality; 99 means the best signal quality.

In general, the sensor position should be adjusted repeatedly or the sufficiency of the coupling agent should be checked to maximize the signal quality as much as possible.

4.3.3 Total Propagation Time and Propagation Time Difference

Press Signal (or select menus 6-06/07 in the window menu). The "total propagation time and propagation time difference" displayed in menu items 06 and 07 can reflect whether the installation is appropriate, because the internal measurement calculation of the flowmeter is based on these two parameters. Therefore, when the "time difference" reading fluctuates too much, the displayed flow rate and flow velocity will also jump sharply. If this occurs, it indicates that the signal quality is too poor, which may be caused by poor pipeline conditions, improper sensor installation, or incorrect parameter input.

Under normal circumstances, the fluctuation of the time difference should be less than ±20%. However, when the pipe diameter is too small or the flow velocity is too low, the fluctuation of the time difference may be slightly larger.

4.3.4 Sound Velocity Ratio

The sound velocity ratio (signal time transmission ratio) is used to confirm whether the installation spacing between the sensors is correct. Under correct installation, the sound velocity ratio should be 97%~103%. The sound velocity ratio can be checked in menu 6-05 of the window menu.

Caution

When the sound velocity ratio is outside the range of 97%~103%, check the following:

Whether the parameters (pipe outer diameter, pipe wall thickness, pipe material, lining material, etc.) are correctly input.

Whether the sensor installation spacing is consistent with the data displayed in menu 1-16 of the window menu.

Whether the sensors are installed on the same axis of the pipe, whether there is too thick scaling, and whether the pipe at the installation point is elliptically deformed.

4.3.5 Issues to Note During Installation

1. Ensure accurate input of pipe parameters: The pipe material, outer diameter, wall thickness, and other parameters must be correctly entered in strict accordance with the actual pipe conditions. Incorrect parameters will directly lead to deviations in the sensor installation position or spacing, making the equipment unable to work normally.
2. Optimize sensor installation and signal debugging: When installing the sensor, apply a sufficient amount of coupling agent between the sensor and the pipe wall to ensure tight fitting. At the same time, observe the "signal strength" and "signal quality value" displayed on the flowmeter, and slowly move the sensor near the installation point until the position with the strongest signal strength and the largest signal quality value is found, then fix the sensor.

3. Verify the sensor installation spacing: The actual installation spacing of the sensors must be consistent with the standard value given in "menu 1-16 Sensor Installation Spacing" of this manual.
4. Troubleshoot abnormal signal strength: If the signal strength always shows "0.00", it indicates that the flowmeter has not received the ultrasonic signal. The following aspects need to be checked:
   a) Whether the pipe parameters are correctly entered;
   b) Whether the pipe is too old and the inner lining is too thick;
   c) Whether the pipe is not filled with fluid;
   d) Whether the installation position is too close to valves or elbows, interfering with the flow field;
   e) Whether there are too many bubbles in the fluid, hindering signal transmission.
5. Avoid electromagnetic interference environments: Avoid installing the flowmeter in areas with strong electromagnetic interference such as frequency converters and high-power motors. A strong electromagnetic environment will cause the signal reception strength to be too low or fluctuate frequently, affecting the stable operation of the equipment.
6. Verification operation after installation: After the entire installation is completed, restart the flowmeter and power it on again. After the equipment starts up, check whether all entered parameters are correct and whether the displayed results such as flow rate and flow velocity are normal.

5 Operation Instructions

5.1 System Working Status Judgment

Press Diag.. If *R is displayed in the window, it indicates that the instrument is working normally. If *I is displayed, it indicates that the instrument is not working normally and no received signal is detected. If *G is displayed, it indicates that the instrument is performing gain adjustment.

5.2 Low Flow Rate Cutoff Value

Menu item 5-02 (Low Flow Rate Cutoff Value) of the instrument is a critical parameter for the ultrasonic flowmeter to determine whether the flow rate is included in the measurement. When the absolute value of the fluid flow velocity in the pipe is lower than this set value, the system will automatically determine the flow rate as "0", so as to filter out the measurement error caused by slight interference in the zero-flow state and avoid the accumulation of false flow rates. In conventional use scenarios, this parameter is set to 0.03m/s by default.

When the actual flow velocity of the fluid in the pipe is higher than the set low flow rate cutoff value, this parameter will not have any impact on the normal measurement of the flowmeter, and the calculation results of real-time flow velocity, instantaneous flow rate, and cumulative flow rate can all remain accurate.

5.3 Zero Point Cutoff

When the measured fluid is in a static state (no flow), various measuring instruments usually produce a "zero-point flow", that is, the measured value displayed by the instrument is not "0". This non-zero displayed value is called the "zero point". For all measuring instruments, the smaller the zero-point value, the smaller the interference to the measurement result, and the better the basic accuracy of the instrument.

If the zero-point value is not "0", it will directly lead to measurement errors. Moreover, the impact of this error is inversely proportional to the measured fluid flow rate: the smaller the actual fluid flow rate, the larger the relative error caused by the zero point; only when the zero-point value is much smaller than the measured physical quantity, and its impact on the measurement result is small enough to be acceptable, the zero-point error can be ignored.

For an ultrasonic flowmeter with high accuracy requirements, when measuring small flow rates, the impact of zero-point error cannot be ignored, and it must be corrected through the "zero-point cutoff" setting to improve the measurement accuracy under small flow rate conditions.

The static zero-point cutoff operation can be performed through menu item 7-01: after pressing Enter, wait for the system to prompt that the operation is completed. It should be particularly noted that if this function is performed when the fluid is flowing (non-static), the flowmeter will display "0" during dynamic measurement; if this problem occurs, the zero-point recovery operation can be performed through menu item 7-02 to reset the normal measurement function of the flowmeter.

5.4 Instrument Coefficient

The instrument coefficient is a core parameter to measure the measurement accuracy of the instrument, defined as the ratio of the "true value of the measured physical quantity" to the "indicated value of the instrument". For example, when the actual value of the measured physical quantity is 2.00, if the indicated value of the instrument is 1.98, the instrument coefficient of the instrument is 2.00/1.98. Ideally, the instrument coefficient should be constantly 1, and the indicated value is completely consistent with the true value; however, during the mass production of instruments, due to factors such as manufacturing accuracy, it is difficult to ensure that the coefficient of each instrument is 1, and the degree of difference between the coefficients of multiple instruments is called the "consistency" of the instruments.

In actual use scenarios, in addition to the consistency difference of the instrument itself, factors such as the material, wall thickness, and inner wall condition of different pipes will also cause measurement deviations, thereby generating new instrument coefficient correction requirements. The core purpose of setting this parameter is to correct the error caused by pipe differences and ensure the accuracy of the measurement results. It should be particularly noted that the instrument coefficient must be accurately input based on the results obtained from the actual calibration experiment and cannot be set arbitrarily. The specific input operation can be completed through menu item 7-03.

5.5 4~20mA Current Loop Output

The current loop output accuracy of the flowmeter is 0.1%, which is fully programmable and can be set to various output modes such as 4~20mA and 0~20mA. Select the mode in menu 2-02-01 (Current Loop Output Mode).

Enter the corresponding value for the current loop 4mA output in menu item 2-02-02, and enter the corresponding value for the current loop 20mA output in menu item 2-02-03.

For example, if the flow range of a certain pipe is 0~1000m³/h, enter 0 in menu item 2-02-02 and 1000 in menu item 2-02-03.

Use menu item 2-02-05 to verify whether the current loop itself has been "calibrated". The verification method is as follows:

Enter menu item 2-02-05, press Enter and use ∧ or ∨ to sequentially display the words "4mA" and "20mA". At the same time, use a precision ammeter to measure the output current of the current loop, calculate the error between the two, and check whether it is within the allowable error range. If it is not satisfied, calibrate the current loop with reference to Section 5.10 of this chapter.

View the current output current value of the current loop through menu 2-02-04, which changes with the flow rate.

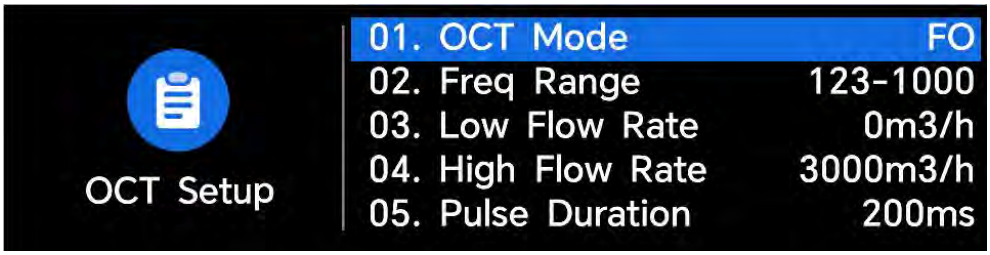
5.6 Frequency Output

The flowmeter has a frequency signal output function, where the frequency level represents the magnitude of the instantaneous flow rate. The user can set the frequency range and the corresponding instantaneous flow rate range by themselves.

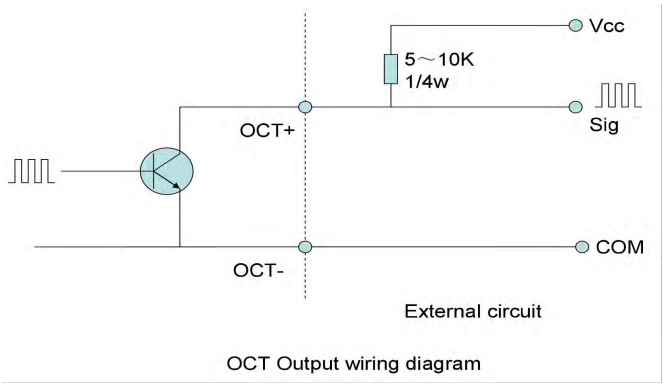
For example (Flow range: 0 - 3000m³/h, Output frequency: 123 - 1000Hz):

1. Enter menu item 2-03 (OCT Output Setup), select "01. OCT Output Mode", then select "13. Frequency Output"
2. In menu item 2-03-02 (Frequency Output Range), enter the lower limit frequency of 123, confirm, then enter the upper limit frequency of 1000
3. In menu item 2-03-03 (Frequency Output Lower Limit Flow Rate), enter 0
4. In menu item 2-03-04 (Frequency Output Upper Limit Flow Rate), enter 3000

The interface after parameter setting is displayed as follows:



Typical wiring diagram for OCT output (Refer to the OCT output wiring diagram):



OCT Output wiring diagram

5.7 Cumulative Pulse Output

The flowmeter generates a cumulative pulse output to an external counting device for each unit flow rate passing through, and the output can only be realized through OCT or relay. It is necessary to select cumulative output in "2-03" (OCT Output Settings) or "2-04" (Relay Output Settings).

OCT Output Positive Cumulative Pulse Setting (Example: Each pulse represents 0.135m³, pulse width 200ms)

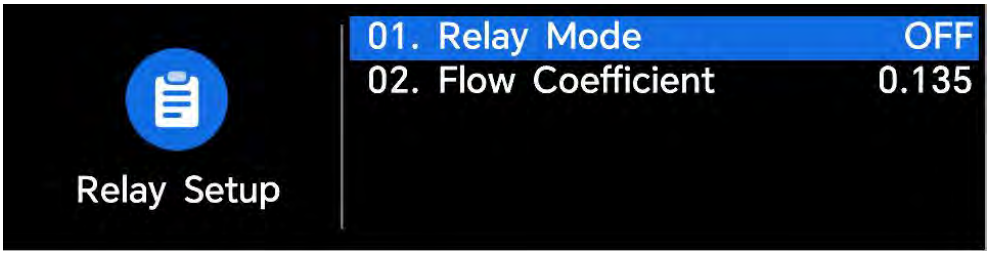
1. Enter menu item 2-03 (OCT Output Setup), select "01.OCT Output Mode", then select "10. Positive Cumulative Pulse Output"
2. Select m3 in menu item 4-03 (Totalizer Unit)
3. Enter 200 (value range: 1~1000) in menu item 2-03-05 (Pulse Duration)
4. Enter 0.135 (value range: 0.001~10000) in menu item 2-03-06 (Flow Cumulative Trigger Coefficient)

The interface after parameter setting is displayed as follows:

Relay Output Positive Cumulative Pulse Setting (Example: Each pulse represents 0.135m³)

1. Enter menu item 2-04 (Relay Output Setup), select "01. Relay Output Mode", then select "10. Positive Pulse Cumulative Output"
2. Select m3 in menu item 4-03 (Totalizer Unit)
3. Enter 0.135 in menu item 2-04-02 (Flow Cumulative Trigger Coefficient)

The interface after parameter setting is displayed as follows:



Caution

The cumulative pulse size should be appropriate. If it is too large, the output cycle will be long; if it is too small, the relay will act frequently, affecting its service life and easily causing pulse loss. It is recommended to use a rate of 1~60 pulses per minute.

5.8 Alarm Signal Output

This ultrasonic flowmeter can generate two types of alarm signals: sound alarm (built-in buzzer, select the buzzer trigger source in menu 2-05-01) and switch output alarm (output through OCT or relay on/off).

The switch output alarm is triggered in the following situations:

1. The sensor cannot receive the ultrasonic signal
2. The ultrasonic signal received by the sensor is too weak
3. The flowmeter does not enter the normal measurement state
4. Reverse flow occurs
5. The analog output exceeds 100% of the range
6. The frequency signal exceeds 120% of the range
7. The instantaneous flow rate exceeds the set range (use alarms 1 and 2 to set the flow range. The menu is located in "2-06" (Alarm Setup)

Example 1: Relay output alarm when the instantaneous flow rate is 300~1000m³/h

1. Enter 300 in menu item 2-06-01 (Alarm 1 Lower Limit Flow Rate)
2. Enter 1000 in menu item 2-06-02 (Alarm 1 Upper Limit Flow Rate)
3. Select "07. Alarm 1 Out of Limit" in menu item 2-04-01 (Relay Mode)

Example 2: OCT output alarm when the instantaneous flow rate is 100~500m³/h, and relay output alarm when the instantaneous flow rate is 600~1000m³/h

1. Enter 100 in menu item 2-06-01 (Alarm 1 Lower Limit Flow Rate)
2. Enter 500 in menu item 2-06-02 (Alarm 1 Upper Limit Flow Rate)
3. Enter 600 in menu item 2-06-03 (Alarm 2 Lower Limit Flow Rate)
4. Enter 1000 in menu item 2-06-04 (Alarm 2 Upper Limit Flow Rate)
5. Select "07. Alarm 1 Out of Limit" in menu item 2-03-01 (OCT Output Mode)
6. Select "08. Alarm 2 Out of Limit" in menu item 2-04-01 (Relay Output Mode)

5.9 Batch Control Output

The batch controller can perform quantitative control on the flow rate. The built-in batch controller of the flowmeter can be controlled through the keyboard, and the output can use OCT or relay.

Select the control method in menu item 2-07-01 (Select Control Signal), such as "Key Press Start". Select "09. Quantitative Output" in menu 2-03-1 (OCT Output Mode) or menu 2-04-1 (Relay Output Mode), and then the OCT or relay output terminal will generate an output signal.

Enter the quantitative value in menu 2-07-02 (Batch Controller). After entering, press  as prompted to start the batch controller.

5.10 4-20mA Current Loop Output Calibration

Caution

Under normal circumstances, do not perform this operation unless the user finds that the current value displayed when checking the current loop using menu 2-02-05 is inconsistent with the actual output current value. Because each flowmeter has undergone strict calibration by the manufacturer before leaving the factory.

The analog output calibration method is as follows:

Enter menu item 7-06, press Enter to enter the password input mode, and enter the password "115800". Press Enter to submit the password. After the window displays "Please Press Confirm", press Enter again to enter the 4mA calibration state.

Use a precision ammeter to measure the output current of the current loop, and at the same time adjust the output value through ^ or v. Observe the ammeter reading until it displays "4.00mA", and then the 4mA calibration is completed.

Press Enter to switch to the 20mA calibration state. The operation method is the same as the 4mA calibration (adjust the output current through the buttons until the precision ammeter displays "20.00mA").

The calibration results will be automatically stored in the EEPROM built into the device, and the data will not be lost after power failure.

5.11 TF Card Operation Instructions

5.11.1 Technical Specifications

Capacity: Standard configuration is 16GB (since TF cards are fashionable consumer goods with rapid updates, the specific configuration is subject to the actual product).

Data collection interval: The user can set it arbitrarily between 1 and 3600 seconds according to needs. It can be set by pressing the Data button.

Data storage content: Date/time, instantaneous flow rate, flow velocity, net cumulative quantity, positive cumulative quantity, negative cumulative quantity.

Data storage format: 1=25-08-10,16:27:33

2=+1.741873E+02m3/h

3=+2.531482E+00m/s

4=+2.817220E+02m3

5=+2.817603E+02m3

6=-3.825382E-02m3

File system format: FAT32

File storage type: Text file (.TXT)

Number of files: More than 1000 (when the instrument is working and the collection switch is turned on, the TF card generates 1 file per day)

File name format: 8-digit number, where yyyy is the year, mm is the month, and dd is the day. For example, 20250516 represents May 16, 2025.

The size of each stored data is 120 bytes. If the storage interval is set to 5 seconds, the size of the file stored in 24 hours is 1203600/524＝2073600 bytes≈2.1MB. Then, a 1GB card can store data for 1024/2.1=487.6≈487 days. When the TF card capacity is insufficient, the new data will automatically overwrite the file with the earliest date.

5.11.2 Installation and Removal of TF Card

The user must insert or remove the TF memory card when the power is cut off.

Caution

When operating the TF memory card, do not insert or remove the memory card randomly, otherwise, the files or file system of the TF memory card may be damaged, the stored flow data may be lost, and the TF memory card may not work normally.

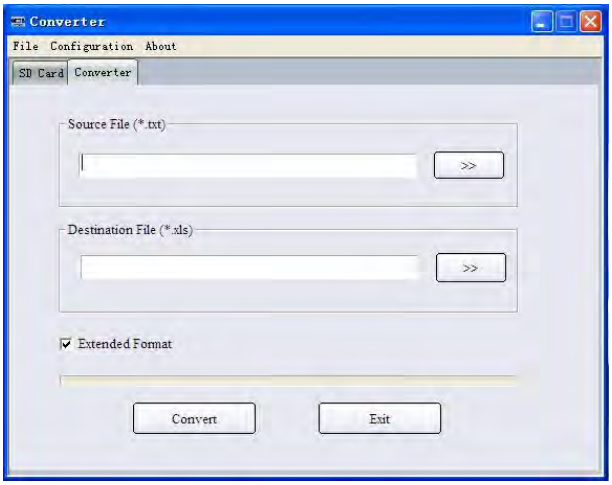
5.11.3 Offline Data Reading

Remove the TF card installed in the flowmeter instrument, insert it into a TF card reader, and directly copy the flow data files stored in the card to a computer through the card reader for subsequent data analysis, statistics, and other processing operations.

If it is necessary to convert the data file format (such as converting the original .TXT format to an XLS spreadsheet format that is easy to edit), the dedicated software "Converter.exe" can be used.

The operation steps are as follows:

1. Place the "Converter.exe" software and the TXT format files in the card reader into the same new folder.
2. Open the software, click the "Offline" button to enter the file conversion interface, and then click the "Converter" tab to enter the format conversion operation interface.



3. Click the "≫" button on the right side of "Source File(*.txt)" to enter the new folder, select and open the TXT file to be converted. The "Destination File (.xls)" column will automatically generate the XLS file path in the new folder.
4. Click the "Convert" button. When the interface displays "Conversion Completed!", the format conversion is completed, facilitating diversified processing and application of offline data.

5.12 Instrument Serial Number

The flowmeter uses a unique Electronic Serial Number (ESN) to distinguish each flowmeter, facilitating management by the manufacturer and the user. Use menu 8-01 to check the ESN.

Caution

For the operation of other menus, please refer to the "Detailed Explanation of Window Menus" chapter.

6 Detailed Explanation of Window Menus

6.1 Window Menu Overview

Flow Data Display Window
01.Flow Rate/Velocity
02.POS/NEG/NET Totalizer
03.POS Daily/Monthly/Yearly Totalizer
04.NEG Daily/Monthly/Yearly Totalizer
05.NET Daily/Monthly/Yearly Totalizer
06.System State
1.Flow Measurement Setting Window
01.Pipe Material
02.Outer Diameter
03.Wall Thickness
04.Inner Diameter
05.Outer Perimeter
06.Sound Velocity
07.Fluid Type
08.Fluid Sound Velocity
09.Fluid Viscosity
10.Fluid Cross Area
11.Liner Material
12.Liner Thickness
13.Liner Sound Velocity
14.Sensor Type
15.Sensor Mounting
16.Sensor Spacing
17.Parameter Setup

2.In/Output Setup Window
01.RS485 Setup
02.CL Output Setup
03.OCT Setup
04.Relay Setup
05.Beeper Setup
06.Alarm Setup
07.Flow Batch Setup
08.CL Input Setup
09.TF Card Setup
3.Totalizer Setup Window
01.Totalizer Reset
02.POS Totalizer
03.NEG Totalizer
04.NET Totalizer
05.Historical Totalizer
06.Totalizer Mult
4.Unit Setup Window
01.Measurement Unit
02.Flow Rate Unit
03.Totalizer Unit
5.Select Setup Window
01.Damping
02.Low Flow Cutoff
03.Manual Zero
04.System Lock
05.Auto Correction
06.Signal Hold
07.Empty Pipe
08.NEG Flow Switch
09.Max Flow Vel

10.Backlit Option
11.Velocity Change
6.Diagnosis Window
01.Signal Quality
02.Upstream Strength
03.Downstream Strength
04.Fluid Sound Vel
05.TOM/TOS*100
06.Total Time
07.Delta Time
08.Reynolds Number
09.Reynolds Factor
10.Spacing Correction
11.Manual Totalizer
7.Calibration Window
01.Set Zero
02.Reset Zero
03.Scale Factor
04.Seg Correction
05.Seg Factor
06.CL Adjusting
07.AI Adjusting
8.Device Info Window
01.S/N
02.Software Version
03.Hardware Version
04.Date Time Setup
05.Last Off Time
06.Last Off Flow
07.Working Timer
08.Total Work Time
09.ON/OFF Time
10.ON/OFF Number

Caution

In the overview table, the "01. Pipe Material" menu item in the "1. Flow Measurement Setting" window can be abbreviated as "1-01 Pipe Material". The rest of the menu items are abbreviated in the same way, and the abbreviated form will be used in the text.

6.2 Flow Data Display Window

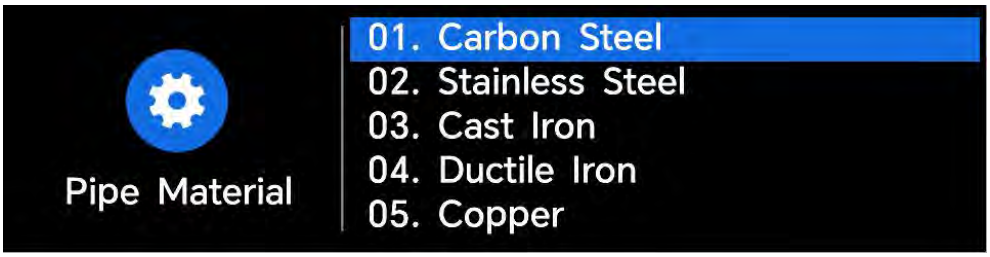
After power-on, the flow data display window is entered automatically. By operating ^ or v you can switch and select among 6 different data display windows in sequence.

Flow Data Display Window	Description
1. Flow Rate/Velocity	Displays instantaneous flow rate and instantaneous flow velocity
2. POS/NEG/NET Totalizer	Displays the current positive, negative, and net cumulative quantities
3. POS Daily/Monthly/Yearly Totalizer	Displays the positive cumulative quantities of the current year, month, and day respectively. To query historical cumulative quantities, enter the "3. Totalizer Settings" submenu window, then select the "Historical Cumulative Quantity Query" option to query.
4. NEG Daily/Monthly/Yearly Totalizer	Displays the negative cumulative quantities of the current year, month, and day respectively.
5. NET Daily/Monthly/Yearly Totalizer	Displays the net cumulative quantities of the current year, month, and day respectively.
6. System State	*R indicates the system is working normally *I indicates no signal detected *G indicates gain adjustment in progress

6.3 Flow Measurement Setting Window

1.Flow Measurement Setting Window Menu Items	
1-01.**Pipe Material**	1-10.**Fluid Cross Area**
1-02.**Outer Diameter**	1-11.**Liner Material**
1-03.**Wall Thickness**	1-12.**Liner Thickness**
1-04.**Inner Diameter**	1-13.**Liner Sound Velocity**
1-05.**Outer Perimeter**	1-14.**Sensor Type**
1-06.**Sound Velocity**	1-15.**Sensor Mounting**
1-07.**Fluid Type**	1-16.**Sensor Spacing**
1-08.**Fluid Sound Velocity**	1-17.**Parameter Setup**
1-09.**Fluid Viscosity**	

6.3.1 Pipe Material



The following pipe materials are available for selection (use the ^, v to select, press the Enter after selection to save and exit the selection mode):

1. Carbon Steel
2. Stainless Steel
3. Cast Iron
4. Ductile Iron
5. Copper
6. PVC
7. Aluminum
8. Asbestos
9. FiberGlass-Epoxy
10. Other

Item 10 "Others" is used to input other materials not included in the previous 9 items. If the user selects.

6.3.2 Enter Pipe Outer Diameter

If the known parameter is the pipe outer diameter, enter it directly in the 1-02. Pipe Outer Diameter menu item; alternatively, enter the pipe outer circumference in the 1-05. Pipe Circumference menu item. The pipe outer diameter must be greater than 15mm and less than 6000mm.

Note: Only one of the pipe outer diameter or pipe outer circumference needs to be entered.

6.3.3 Enter Pipe Wall Thickness

The pipe wall thickness must be entered.

6.3.4 Enter Pipe Inner Diameter

If the pipe outer diameter (or outer circumference) and pipe wall thickness have been entered, this setting can be skipped.

6.3.5 Enter Pipe Circumference

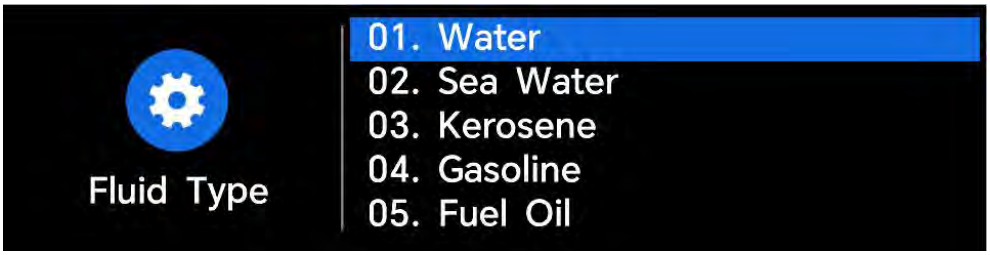
If the known parameter is the pipe outer circumference, enter it in the 1-05. Pipe Circumference menu item.

6.3.6 Enter Pipe Sound Velocity

This can only be entered when "10. Others" is selected in the 1-01. Pipe Material menu item.

When materials 1~9 are selected, this option is not accessible, and the system automatically calculates using built-in parameters.

6.3.7 Select Fluid Type



The following fluids are available for selection (use the ∧ or ∨ to select, press 确认 after selection to save and exit the selection mode):

1. Water
2. Sea Water
3. Kerosene
4. Gasoline
5. Fuel Oil
6. Crude Oil
7. Propane(-45℃)
8. Butane(0℃)
9. Other
10. Diesel Oil
11. Castor Oil
12. Peanut Oil
13. Gasoline90#
14. Gasoline93#
15. Alcohol
16. Water(125℃)

"Others" can refer to any fluid, but the corresponding sound velocity must be entered in the 1-08. Fluid Sound Velocity menu item.

6.3.8 Enter Fluid Sound Velocity

Enter the sound velocity of the measured fluid. This can only be entered when "Others" is selected in the 1-07. Fluid Type menu item. Otherwise, the default sound velocity of the fluid listed in this menu item is displayed and cannot be modified.

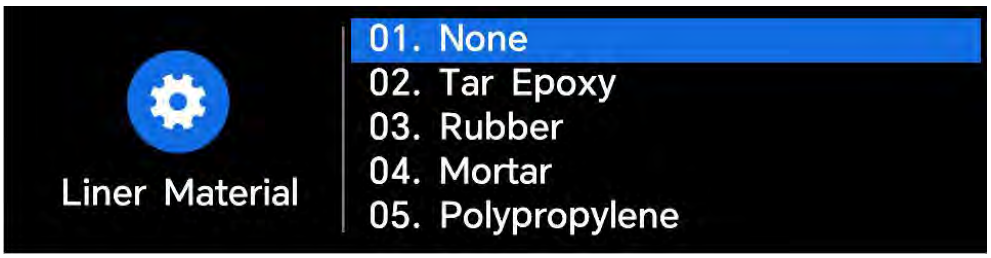
6.3.9 Enter Fluid Viscosity

Enter the kinematic viscosity coefficient of the measured fluid. This is only accessible when "Others" is selected in the 1-07. Fluid Type menu item. For fluids other than "Others" listed in this menu item, this entry is not required, and the machine uses the default value.

6.3.10 Fluid Cross-Sectional Area

Displays the current fluid cross-sectional area.

6.3.11 Select Lining Material



The following options are available:

1. None
2. Tar Epoxy
3. Rubber
4. Mortar
5. Polypropylene
6. Polystyrol
7. Polystyrene
8. Polyester
9. Polyethylene
10. Ebonite
11. Teflon
12. Other

Item 12 "Others" is used to input other materials not included in the previous 10 items. After selecting "Others", the lining sound velocity must be entered in the 1-13. Lining Sound Velocity menu item.

6.3.12 Enter Lining Thickness

This can only be set when a specific lining is selected in the 1-11. Lining Material menu item.

6.3.13 Enter Lining Sound Velocity

Sound velocity setting is only allowed when "Others" is selected in the 1-11. Lining Material menu item; for other options, only the lining sound velocity specified in this menu can be viewed.

6.3.14 Select Sensor Type

This window is used to select the sensor type:

1. Clamp-on Type C011
2. High-Temperature Clamp-on Type CH020
3. Insertion Type W110

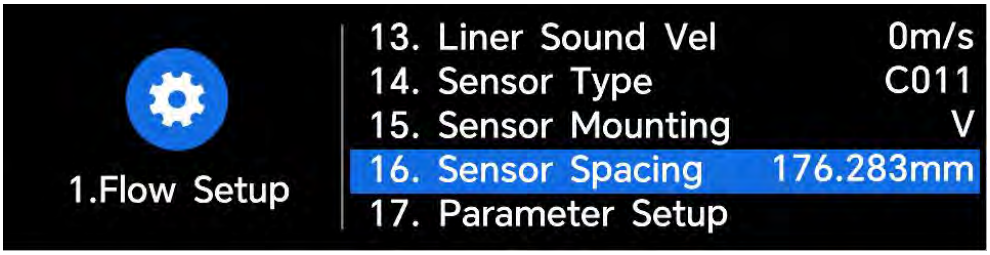
4. High-Temperature Insertion Type WH101
5. Clamp-on Type C110

6.3.15 Select Sensor Installation Method

Three installation methods are available:

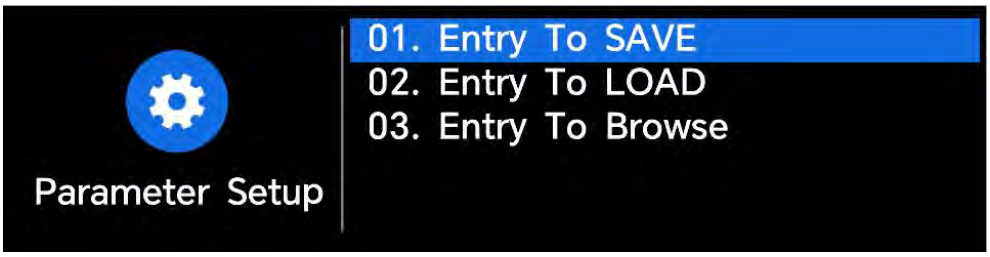
1. V-type
2. Z-type
3. N-type (for small pipes)

6.3.16 Select Sensor Installation Spacing



The user must install the sensor according to this dimension (note: the installation distance must be accurately measured during installation). This data is automatically calculated by the machine after the user inputs the pipe parameters.

6.3.17 Save Installation Point Parameters



Supports saving and retrieving up to 10 sets of pipe installation and usage parameters. Three working modes are available:

1. Save installation point parameters
2. Retrieve installation point parameters
3. Browse installation point parameters

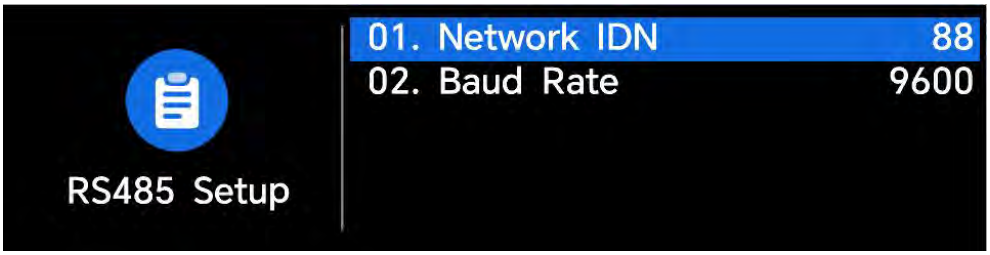
When "Save Parameters" is selected and the "Confirm" button is pressed, the window will display 10 group address numbers and original parameters. The user can use the up/down arrow buttons to move to the selected address number, and press the "Confirm" button to store the currently used parameters in this address space.

When "Retrieve Parameters" is selected, select the address number and press the "Confirm" button. The system retrieves the parameters, calculates them, and automatically jumps to the "16. Sensor Installation Spacing" option to display the installation distance.

6.4 Input/Output Setting Window

2.Input/Output Setting Window Menu Items	
2-01.**RS485 Setup**	2-06.**Alarm Setup**
2-02.**CL Output Setup**	2-07.**Flow Batch Setup**
2-03.**OCT Setup**	2-08.**CL Input Setup**
2-04.**Relay Setup**	2-09.**TF Card Setup**
2-05.**Beeper Setup**	

6.4.1 Serial Port Setting



1. Network Address Code

   The system identification code ranges from 1 to 247, used to identify the device in a network environment.

2. Baud Rate

   This menu is used to set the serial port, which is used for communication with other devices. The serial port parameters of devices connected via the serial port must match. The data in the menu represents the baud rate, which can be selected from 2400, 4800, 9600, 19200, 38400, 56000.

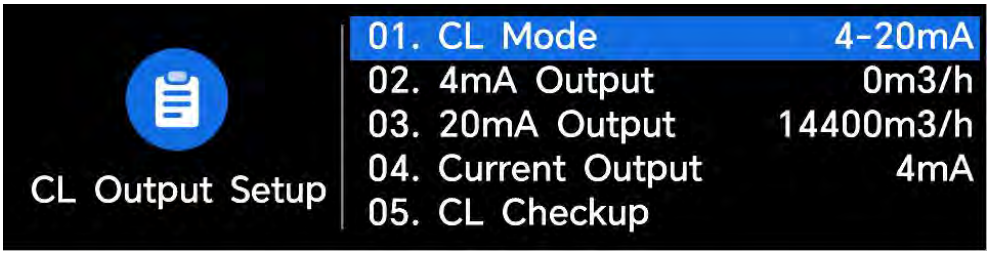
   Data bit length is fixed at 8 bits

   Parity mode is none

   Stop bit length is fixed at 1 bit

   The default serial port parameters at the factory are "9600, 8, no parity, 1".

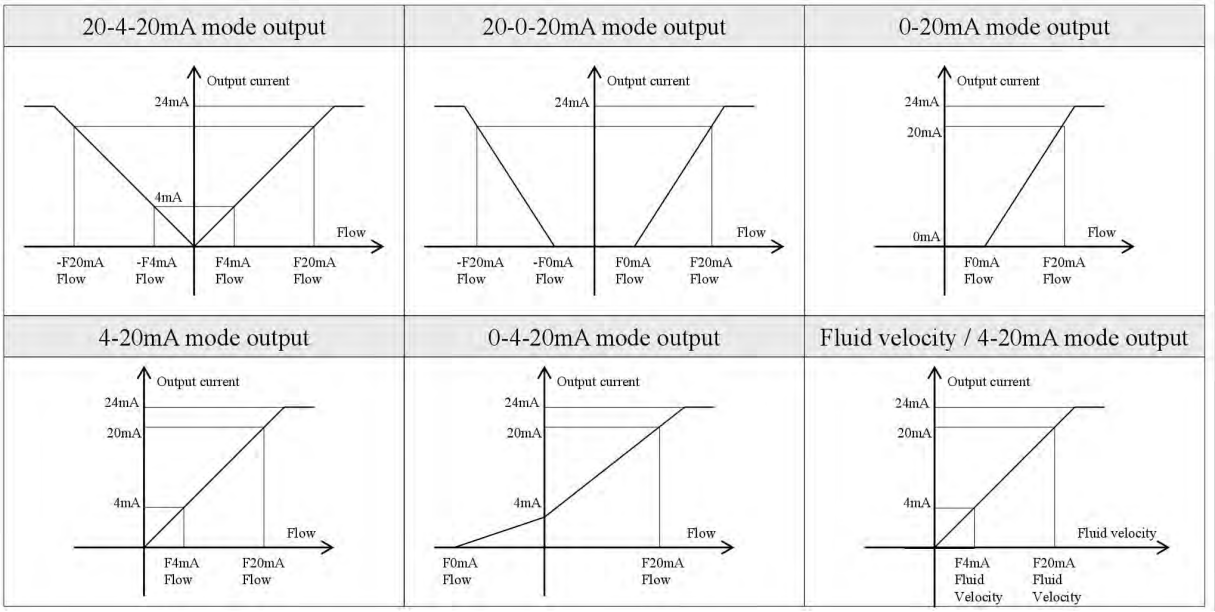
6.4.2 Current Loop Output Setting



1. Current Loop Output Mode Selection

1.	4-20mA	Set the output range to 4-20mA mode
2.	0-20mA	Set the output range to 0-20mA mode
3.	20-4-20mA	Set the current loop output range to 20-4-20mA
4.	0-4-20mA	Set the current loop output range to 0-4-20mA
5.	20-0-20mA	Set the current loop output range to 20-0-20mA
6.	4-20mA vs. Vel	Set the 4-20mA current loop output to correspond to flow velocity

For the characteristics of various current output modes, refer to the following diagrams. The user can select the appropriate mode according to actual needs.



In the above six characteristic diagrams, F_{0mA} or F_{4mA} flow rate refers to the value entered by the user in the 2-02-02 menu, and F_{20mA} flow rate refers to the value entered in the 2-02-03 menu. For 4-20mA and 0-20mA modes, F_{0mA} (or F_{4mA}) and F_{20mA} can take positive or negative flow values as long as they are not equal. For 20-4-20mA and 20-0-20mA modes, the flowmeter ignores the positive/negative of the actual flow rate, and both F_{0mA} (or F_{4mA}) and F_{20mA} must take positive values.

In 0-4-20mA mode, F_{0mA} must take a negative value, and F_{20mA} must take a positive value. In the 4-20mA vs. Velocity mode, the output current represents the flow velocity.

2. Current Loop 4mA Output Corresponding Value

Set the flow value corresponding to the current loop output of 4mA or 0mA. The flow unit used is consistent with that in the 4-02 menu item.

When "1. Current Loop Output Mode" is set to "4-20mA vs. Velocity" mode, the unit of this value is m/s.

3. Current Loop 20mA Output Corresponding Value

   Set the flow value corresponding to the current loop output of 20mA. The flow unit used is consistent with that in the 4-02 menu item.

   When "1. Current Loop Output Mode" is set to "4-20mA vs. Velocity" mode, the unit of this value is m/s.

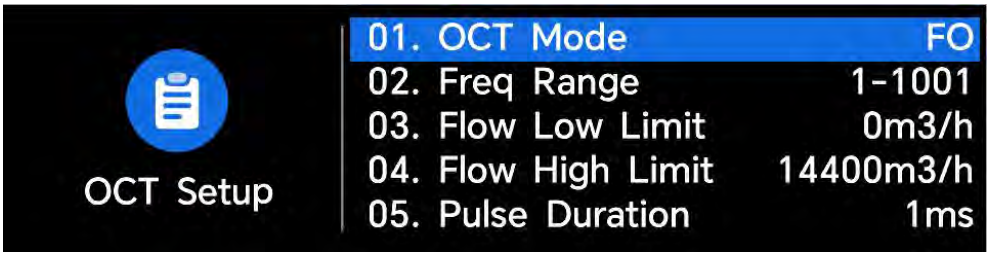
4. Current Loop Current Output Value

   Displays the actual current value output by the current loop. For example, if 10.00mA is displayed, it indicates that the output value of the current loop is 10.00mA. If there is a large deviation between the output value of the current loop and the displayed value in this window, the user should re-calibrate the current loop.

5. Current Loop Output Verification

   The function of this menu item is to check whether the current loop of the flowmeter has been calibrated. During use, press Enter and use ^ or v to call up the displayed values of 0mA, 4mA...20mA respectively. At the same time, use a precision ammeter to connect to the "I+" and "I-" terminals of the current loop output for measurement, and check whether the measured value is consistent with the displayed value. If the measured value exceeds the allowable error range, the current loop needs to be re-calibrated.

6.4.3 OCT Output Setting



1. OCT Output Mode

   This menu item is used to set the output trigger event source of the hardware OCT output component. The available trigger events are:

1. Alarm on No Signal	2. Alarm on Weak Signal
3. Abnormal Measurement Status	4. Alarm on Reverse Flow
5. Analog Output Overrange 100%	6. Frequency Output Overrange 120%
7. Alarm 1 Overlimit	8. Alarm 2 Overlimit
9. Quantitative Output	10. Positive Cumulative Pulse Output
11. Negative Cumulative Pulse Output	12. Net Cumulative Pulse Output
13. Frequency Output	14. Measurement Medium Sound Velocity Change
15. Turn Off OCT Output	

2. Frequency Output Range

   Set the upper and lower limit frequency values of the frequency output signal. The upper limit frequency value must be greater than the lower limit frequency value, with a range of 0-9999Hz.

   Note: The frequency signal output is from the OCT port. Therefore, to output a frequency signal, the OCT must be set to frequency signal output mode (select 14. Frequency Output in the "2-03-01 OCT Output Mode" menu item).

3. Frequency Output Lower Limit Flow Rate

   Set the flow value corresponding to the lower limit frequency point of the frequency signal, i.e., the flow value when the frequency output signal is at the lower limit frequency value. For example, if the lower limit frequency value is set to 1000Hz and the lower limit flow rate is set to 100m³/h, a frequency output of 1000Hz indicates that the flow rate measured by the flowmeter is 100m³/h.

4. Frequency Output Upper Limit Flow Rate

   Set the flow value corresponding to the upper limit frequency point of the frequency signal, i.e., the flow value when the frequency output signal is at the upper limit frequency value. For example, if the upper limit frequency value is set to 3000Hz and the upper limit flow rate is set to 1000m³/h, a frequency output of 3000Hz indicates that the flow rate measured by the flowmeter is 1000m³/h.

5. Pulse Duration

   The pulse duration can be set within the range of 1~1000ms.

6. Flow Cumulative Trigger Coefficient

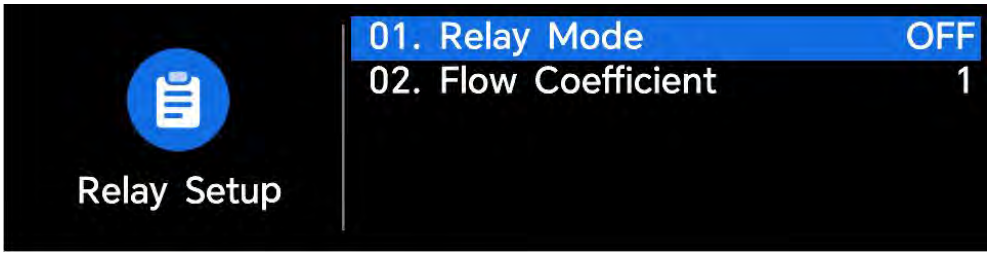
   Used to set the flow cumulative trigger coefficient, i.e., the cumulative flow value represented by each rising edge pulse output.

Precautions

The pulse period must be at least the value set in "2-03-05 Pulse Duration".

For example: If the time is set to 200ms in the 2-03-05 menu item, the maximum number of pulses that can be output per second is 5. If the trigger coefficient is set to 1.20, the maximum pulse value per second shall not exceed 5×1.2=6, i.e., no more than 6 unit quantities per second. The cumulative unit can be changed in the 4-03 menu item, so this value needs to be adjusted according to actual conditions.

6.4.4 Relay Output Setting



1. Relay Output Mode

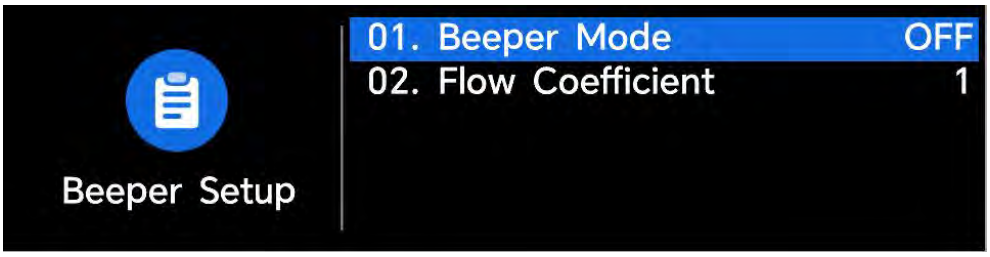
   This menu item is used to set the output trigger event (source) of the hardware RELAY output component. The RELAY is a single-pole normally open type, used to control external devices. The available trigger events are one of the following:

1. Alarm on No Signal	2. Alarm on Weak Signal
3. Abnormal Measurement Status	4. Alarm on Reverse Flow
5. Analog Output Overrange 100%	6. Frequency Output Overrange 120%
7. Alarm 1 Overlimit	8. Alarm 2 Overlimit
9. Quantitative Output	10. Positive Cumulative Pulse Output
11. Negative Cumulative Pulse Output	12. Net Cumulative Pulse Output
13. Measurement Medium Sound Velocity Change	14. Key Press
15. Turn Off Relay Output	

2. Flow Cumulative Trigger Coefficient

Used to set the flow cumulative trigger coefficient, i.e., the cumulative flow value represented by each rising edge pulse output.

6.4.5 Buzzer Output Setting



1. Buzzer Output Mode

The trigger source signal of the buzzer can be one of the following:

1. Alarm on No Signal	2. Alarm on Weak Signal
3. Abnormal Measurement Status	4. Alarm on Reverse Flow
5. Analog Output Overrange 100%	6. Frequency Output Overrange 120%
7. Alarm 1 Overlimit	8. Alarm 2 Overlimit
9. Quantitative Output	10. Positive Cumulative Pulse Output
11. Negative Cumulative Pulse Output	12. Net Cumulative Pulse Output
13. Measurement Medium Sound Velocity Change	14. Key Press
15. Turn Off Beeper Output	

2. Flow Cumulative Trigger Coefficient

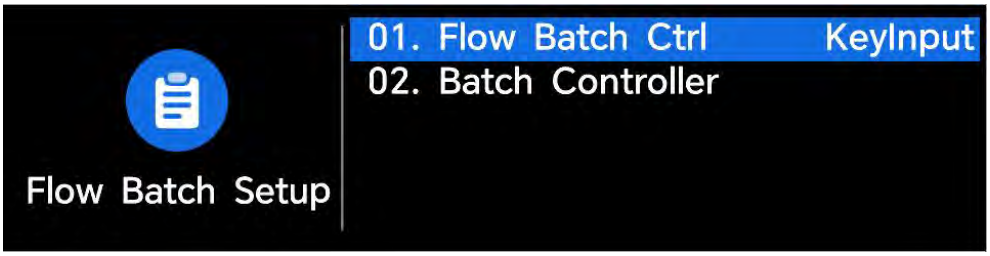
Used to set the flow cumulative trigger coefficient, i.e., the cumulative flow value represented by each rising edge pulse output.

6.4.6 Alarm Output Setting

1. Alarm 1 Lower Limit Flow Rate
2. Alarm 1 Upper Limit Flow Rate
3. Alarm 2 Lower Limit Flow Rate
4. Alarm 2 Upper Limit Flow Rate

Enter the upper and lower limit values of the alarm flow rate. Under the condition that the corresponding alarm is enabled in the "2-03. OCT Output Setting", "2-04. Relay Output Setting", and "2-05. Buzzer Output Setting" menu items, any measured flow rate value below or above these limits will trigger the alarm output of the hardware OCT, relay, and buzzer.

6.4.7 Batch Controller Output



1. Batch Control Signal

This menu item is used to select the start control signal of the quantitative controller. The following options are available:

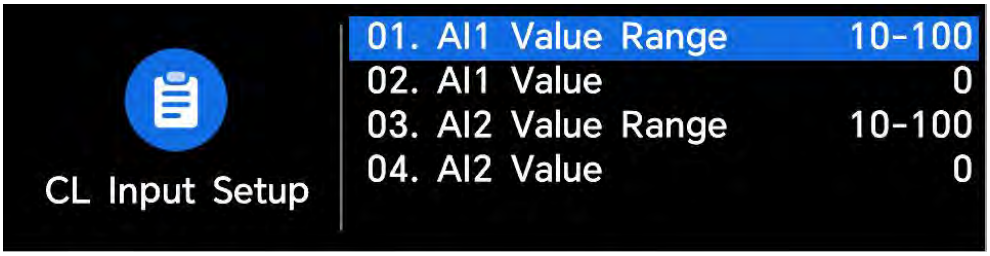
1. Start by press the down key	Press  to start
2. AI1 Rising Edge Start	Start by the rising edge of analog AI1
3. AI2 Rising Edge Start	Start by the rising edge of analog AI2

2. Batch Controller

The batch controller is also called a quantitative controller. The flowmeter has a built-in batch controller, whose start control signal can be controlled by keyboard keys or analog inputs AI1 and AI2, and the output signal can be output from the relay or OCT.

The quantitative value needs to be entered in this menu, and wait for startup after input. The following figure shows an example of starting by key press; press  to start.

6.4.8 Current Loop Input Setting



1. AI1 Analog Input Value Range

   This menu item is used to input the temperature or pressure values corresponding to the analog signals 4mA and 20mA. In the figure, 10 represents the value corresponding to 4mA, and 100 represents the value corresponding to 20mA.

2. Display Current Value of Analog Input AI1

   Displays the temperature or pressure value corresponding to the analog input AI1.

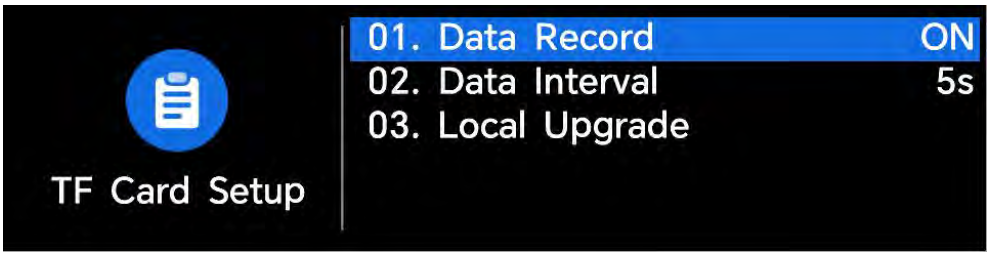
3. AI2 Analog Input Value Range

   This menu item is used to input the temperature or pressure values corresponding to the analog signals 4mA and 20mA. In the figure, "10" represents the value corresponding to 4mA, and "100" represents the value corresponding to 20mA.

4. Display Current Value of Analog Input AI2

   Displays the temperature or pressure value corresponding to the analog input AI2.

6.4.9 TF Card Setting



1. Collection Switch

1. Off	Disable TF card collection function
2. On	Enable TF card collection function; refer to Chapter 5.11 for TF card operation instructions

2. Data Collection Interval

   The user can set it arbitrarily between 1 and 3600 seconds according to needs.

3. Local Upgrade

   The user can upgrade the instrument firmware through the TF card.

6.5 Totalizer Setting Window

3.Totalizer Window menu item.	
3-01. **Totalizer Reset**	3-04. **NET Totalizer**
3-02. **POS Totalizer**	3-05. **Totalizer Mult**
3-03. **NEG Totalizer**	3-06. **Historical Totalizer**

6.5.1 Clear Totalizer

Reset the totalizer and clear all parameter settings to restore factory default values. Press Enter and use ∧ or ∨ to select the corresponding menu item, and press Enter to execute the corresponding operation. The following options are available:

1. None
2. ALL Totalizer
3. POS Totalizer
4. NEG Totalizer
5. Reset

To clear all setting parameters and restore to the original factory default values, select "05. Restore Factory Settings" in this window, and the flowmeter will automatically restore the factory default settings.

Caution

Selecting and executing the 3-01-05. Restore Factory menu will clear all user data (except cumulative quantity, power-on/off records, and installation point parameters) and restore them to factory default values. Please operate with caution.

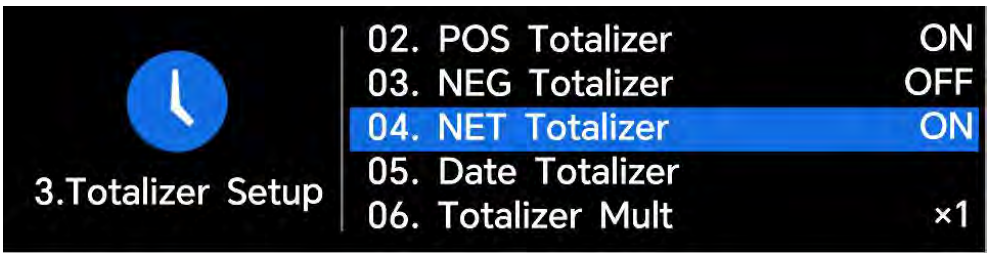
6.5.2 Positive Totalizer Switch

Turn the positive totalizer on or off. When set to "On", the flowmeter accumulates the flow rate. When set to "Off", the display of the positive cumulative quantity in the total quantity window will no longer change. The factory default value is "On".

6.5.3 Negative Totalizer Switch

Turn the negative totalizer on or off. When set to "On", the flowmeter accumulates the negative flow rate. When set to "Off", the display of the negative cumulative quantity in the total quantity window will no longer change. The factory default value is "Off".

6.5.4 Net Totalizer Switch



Turn the net totalizer on or off. When set to "On", the flowmeter accumulates the net flow rate. When set to "Off", the display of the net cumulative quantity in the total quantity window will no longer change. The factory default value is "On".

6.5.5 Historical Totalizer Query

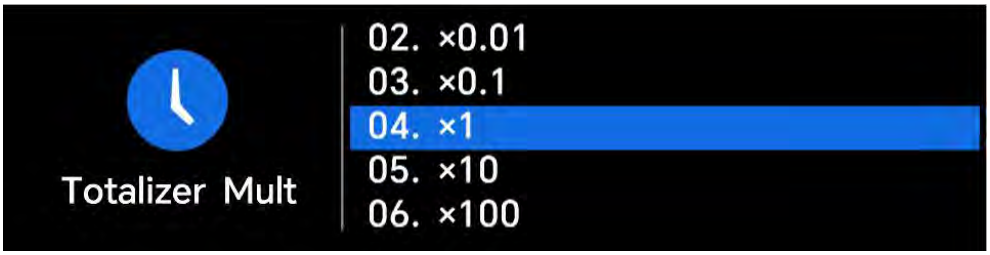
This window allows querying the total cumulative quantity for any of the previous 64 operating days, any of the previous 64 operating months, and any of the previous 5 operating years.

Use Enter, ∧ or ∨ to select to browse daily, monthly, or yearly cumulative content.

1. View by Day
2. View by Month
3. View by Year

Use ∧ or ∨ to browse the total flow rate for a specific day, month, or year.

6.5.6 Select Totalizer Multiplication Factor

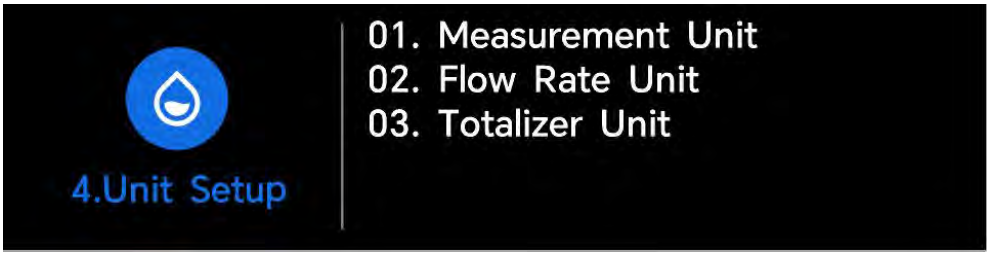


The multiplication factor is used to expand the representation range of the totalizer. The multiplication factor acts on the positive, negative, and net totalizers simultaneously. The following factors can be selected according to the actual flow rate:

1. x 0.001
2. x 0.01
3. x 0.1
4. x 1
5. x 10
6. x 100
7. x 1000
8. x 10000
9. None

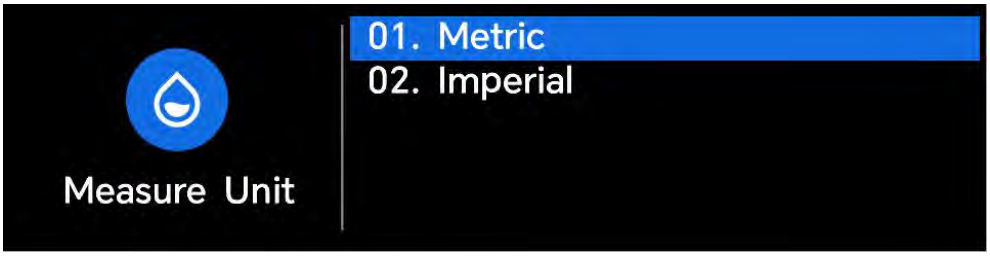
Factory default multiplication factor: ×1.

6.6 Flow Unit Setting Window



4.Unit Setup Window menu item.
4-01. **Measurement Unit**
4-02. **Flow Rate Unit**
4-03. **Totalizer Unit**

6.6.1 Metric/Imperial Unit Selection

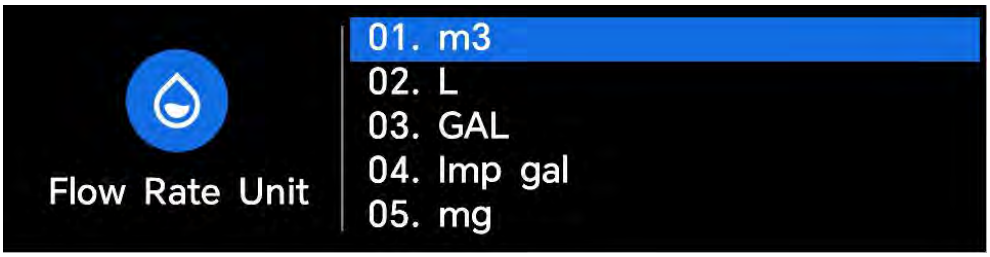


Select the measurement unit system. The available options are:

1. Metric
2. Imperial

Factory default: Metric.

6.6.2 Instantaneous Flow Rate Unit Selection



Select the flow and time units for the instantaneous flow rate.

Flow units available:

1.	m3	Cubic Meter	6.	cf	Cubic Foot
2.	l	Liter	7.	US bbl	US Barrel, Liquid Barrel
3.	Gal	US Gallon	8.	Imp bbl	Imperial Barrel
4.	Imp gal	Imperial Gallon	9.	Oil bbl	Oil Barrel
5.	mg	Mega Gallon			

Time units available: /d (per day), /h (per hour), /m (per minute), /se (per second). Factory default unit: m^3/h.

6.6.3 Cumulative Flow Rate Unit Selection

The units available for selecting the totalizer flow rate are the same as the flow units in "4-02. Instantaneous Flow Rate Unit". The user can select according to actual needs. Factory default unit: Cubic Meter (m^3).

6.7 Selection Setting Window

5.Select Setup Window menu item.	
5-01. **Damping**	5-07. **Empty Pipe**
5-02. **Low Flow Cutoff**	5-08. **NEG Flow Switch**
5-03. **Manual Zero**	5-09. **Max Flow Vel**
5-04. **System Lock**	5-10. **Backlit Option**
5-05. **Auto Correction**	5-11. **Velocity Change**
5-06. **Signal Hold**	

6.7.1 Enter Damping Coefficient

The damping coefficient ranges from 0 to 999 seconds.

0: No damping; 999: Maximum damping.

Damping functions to smooth the displayed data. Its principle is similar to a first-order RC low-pass filter, and the damping coefficient value is equivalent to the time constant of the circuit. Usually, a value between 3 and 10 is entered in applications.

6.7.2 Enter Low Flow Rate Cutoff Value

Cut off the low flow rate. To make the system display "0" at low flow rates and avoid invalid accumulation. For example, if the cutoff value is set to 0.03, the machine treats all measured values within the flow velocity range of ±0.03 as "0". Usually, 0.03 is entered in applications.3

6.7.3 Manually Set Zero Offset

This is an uncommon calibration method, suitable for experienced operators to manually enter an offset value superimposed on the measured value to obtain the true value in scenarios where other zero calibration methods are difficult to work effectively. Example:

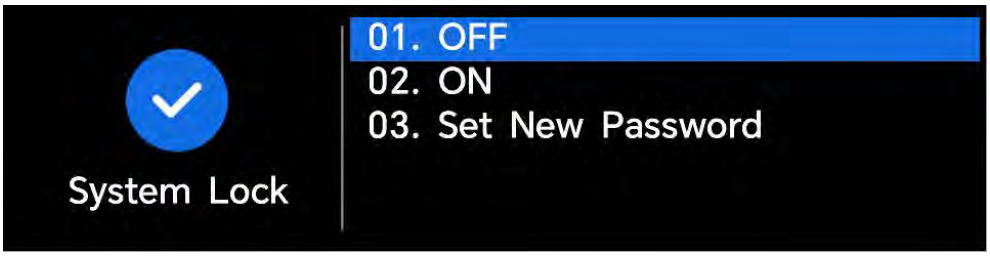
Actual measured value＝250 m^3/h

Offset＝10 m^3/h

Flowmeter display＝240 m^3/h

In general, this value should be set to "0".

6.7.4 System Lock



The password protection function is similar to locking the instrument. After being enabled, only parameters can be viewed, not modified, to avoid misoperation by irrelevant personnel.

Operation instructions:

1. Enable: Enter the 5-04 System Lock menu item, enter the factory password 115800, select "02. On", press Enter to save and return to the previous menu. At this time, parameters can only be viewed.
2. Disable: Enter this menu, select "01. Off", press Enter to restore the normal parameter query and modification functions.
3. Set New Password: Select "03. Set New Password". The new password will be required to enter this menu later. Please remember it.

6.7.5 Power-Off Automatic Correction

The power-off cumulative flow automatic compensation function can estimate and compensate for the cumulative flow missed during the power-off period. The estimation is based on the average of the instantaneous flow rate before power-off and after power-on multiplied by the power-off time.

1. Off	Cancel the power-off cumulative flow automatic compensation function
2. On	Enable the power-off cumulative flow automatic compensation function

6.7.6 Signal Hold

Set to hold the last data when the signal deteriorates. Selecting "On" will make the flowmeter "hold" the last measured value when the measurement was normal when the signal deteriorates, to ensure uninterrupted measurement of cumulative flow data.

1. Off	Disable the function of holding the last data when the signal deteriorates
2. On	Enable the function of holding the last data when the signal deteriorates

6.7.7 Empty Pipe Status

Set the empty pipe status. This value is used to deal with possible empty pipe problems. In the empty pipe state, the flowmeter may display "normal operation" because the signal is transmitted through the pipe wall. To avoid this situation, set this value so that the flowmeter stops measuring when the signal is less than this value. If the flowmeter can automatically stop measuring in the empty pipe situation, a value between 30 and 40 also needs to be entered in this window to ensure that the flowmeter does not measure in the empty pipe state.

6.7.8 Negative Flow Switch

Turn the negative flow totalizer on or off. Factory default value: "Off".

1. Off	Select to turn off the negative flow totalizer. The display of the negative cumulative flow rate in the "Flow Data Display" main window will no longer change.
2. On	Select to turn on the negative flow totalizer. The flowmeter accumulates the negative flow rate.

6.7.9 Maximum Flow Velocity

When the actual flow velocity exceeds the set value, this set value can be modified to improve flow stability. The maximum settable value is 12m/s, and the factory default value is 5.5m/s.

6.7.10 Backlight Control

Enter the backlight display control time. This function is used to set the control duration of the backlight display. After the set time is reached, the screen display will automatically turn off to save power. The factory default control time is 0, and the screen is in a continuous display state.

6.7.11 Medium Sound Velocity Change

This menu item displays the threshold value of the built-in sound velocity comparator. Specifically, when the sound velocity of the measured medium exceeds the set threshold value, an alarm signal will be generated and output. This alarm signal can be output through a relay or OCT. By setting this value, the D118 ultrasonic flowmeter can issue an alarm signal when the sound velocity of the medium changes.

To output an alarm signal through a relay, select 14. "Fluid Sound Velocity Changed" in the 2-03-01 menu item.

To output an alarm signal through OCT, select 13. "Fluid Sound Velocity Changed" in the 2-04-01 menu item.

6.8 Diagnosis Window

6.Diagnosis Window menu item.	
6-01. **Signal Quality**	6-07. **Delta Time**
6-02. **Upstream Strength**	6-08. **Reynolds Number**
6-03. **Downstream Strength**	6-09. **Reynolds Factor**
6-04. **Fluid Sound Vel**	6-10. **Spacing Correction**
6-05. **TOM/TOS*100**	6-11. **Manual Totalizer**
6-06. **Total Time**	

6.8.1 Signal Quality

6.8.2 Upstream Signal Strength

6.8.3 Downstream Signal Strength

Menu items 6-01 ~ 6-03 display the signal quality (Q value) and upstream/downstream signal strength detected by the instrument.

Signal quality: Expressed by numbers from 00 to 99, where 00 means the worst and 99 means the best. Generally, the normal working condition requires the signal quality to be greater than 50.

Signal strength: Expressed by numbers from 00.0 to 99.9. 00.0 indicates no signal received, and 99.9 indicates the maximum signal. Under normal working conditions, the signal strength should be ≥65.

6.8.4 Fluid Sound Velocity

Displays the fluid sound velocity detected by the instrument. Under normal working conditions, this value should be approximately equal to the value entered by the user in the 1-08. Fluid Sound Velocity menu item (only when "Others" is selected in the 1-07. Fluid Type menu item can the fluid sound velocity be entered). If there is a large difference between the two, there may be errors in the sensor installation point or the data in the 1-08. Fluid Sound Velocity menu item.

6.8.5 Signal Time Transmission Ratio

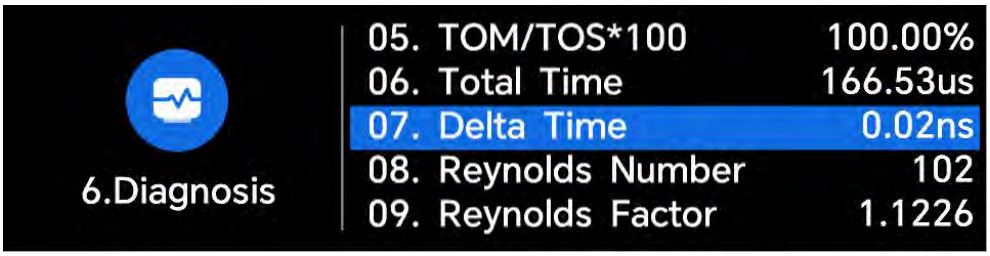
This parameter displays the percentage of the transmission time calculated by the flowmeter according to the user's set conditions and the actual measured transmission time.

Under normal working conditions, this value ranges from 100±3%. If this value differs greatly from this range, the user needs to check whether the input parameters are accurate, especially whether the sound velocity of the fluid is precise and whether the sensor installation is appropriate.。

Note that this data is meaningless when the system is not in the normal measurement state.

6.8.6 Total Propagation Time

6.8.7 Delta Time



Menu items 6-06~6-07 display the average ultrasonic transmission time (unit: μs) and upstream/downstream transmission time difference (unit: ns) detected by the flowmeter.

These two readings are the main basis for the flowmeter to calculate the flow velocity, especially the transmission time difference, which best reflects whether the machine is working stably. Under normal working conditions, the fluctuation rate of the transmission time difference should be less than 20%. If it is greater than this value, it indicates that the system is working unstably. The user should check whether the sensor installation point is appropriate and whether the set parameters are correct.

6.8.8 Reynolds Number

6.8.9 Reynolds Coefficient

Menu items 6-08~6-09 display the Reynolds number calculated by the current flowmeter and the velocity correction coefficient value (also called the pipe factor) currently used by the flowmeter. This correction coefficient is usually the coefficient between the line average velocity and the surface average velocity in the pipe.

6.8.10 Spacing Correction

1. No	Select No to disable installation spacing correction
2. Yes	Select Yes to enable installation spacing correction

6.8.11 Manual Totalizer

The manual totalizer is an independent totalizer. Press Enter to start it, and press Enter again to stop it. This totalizer is used for flow rate calculation, verification, and estimation.

6.9 Calibration Window

7.Calibration Window menu item.	
7-01. **Set Zero**	7-05. **Seg Factor**
7-02. **Reset Zero**	7-06. **CL Adjusting**
7-03. **Scale Factor**	7-07. **AI Adjusting**
7-04. **Seg Correction**	

6.9.1 Clean Zero Point

When the fluid is in a static state, the indicated value of the instrument is defined as the "zero point". If the "zero point" of the flowmeter is not zero, this zero point will be superimposed on the true flow value at any time, leading to measurement deviations of the flowmeter.

The zero point cutoff setting should be carried out after the sensor is installed and the flow in the pipe is completely static. This operation can eliminate the "zero point" problem caused by differences in pipe installation positions and parameters, and improve the accuracy of low-flow measurement.

Press Enter and wait for the process to complete. After the progress is completed, one of the following prompt messages will appear:

1. Zero point setting successful, return to the flow interface.
2. No signal displayed, zero point setting failed.
3. Zero point > 0.5m/s, zero point setting failed.

Press Enter again to return to the previous menu.

Caution

If this function is performed when there is flow, the flow display will be "0". The zero point can be restored using the 7-02 menu item.

6.9.2 Reset Zero

1. No	Select No to not perform the zero point recovery operation
2. Yes	Select Yes to restore the cut-off zero point

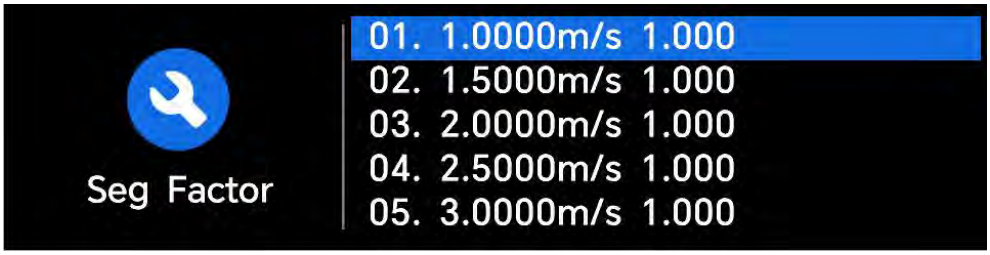
6.9.3 Scale Factor

The instrument coefficient (also called the scale factor or flow correction coefficient) is used to correct the measurement result. The user can input a value other than "1" according to the actual calibration result.

6.9.4 Segmental Correction Switch

1. Off	Do not use the segmental correction function (selected during calibration)
2. On	Enable the segmental correction function

6.9.5 Segmental Correction Coefficient



Enter the password "115800" and press Enter to enter the segmental correction coefficient interface. Up to 12 sets of correction coefficients can be set for segmental correction of the measurement result. The user can input the actual scale factor according to the calibration result. After entering, move the cursor to 13. Save and press Enter to save the modified value.

6.9.6 Current Loop Output Calibration

Refer to Section 5.10 "4-20mA Current Loop Output Calibration" for details.

6.9.7 AI Input Calibration

Connect a standard 20mA current signal to the AI port, enter the password 115800 to enter calibration, and use ∧ or ∨ to calibrate the displayed AI analog value to the upper limit of the AI range.

6.10 Device Information Window

8.Device Info Window menu item.	
8-01. **S/N**	8-06. **Last Off Flow**
8-02. **Software Version**	8-07. **Working Timer**
8-03. **Hardware Version**	8-08. **Total Work Time**
8-04. **Date Time Setup**	8-09. **ON/OFF Time**
8-05. **Last Off Time**	8-10. **ON/OFF Number**

6.10.1 Serial Number

Displays the Electronic Serial Number (ESN) of the device. This serial number is unique to each flowmeter leaving the factory. The manufacturer establishes a machine file using this serial number, and the user can use it for instrument management.

6.10.2 Software Version

Displays the version number information of the software currently running in the instrument. This version number is an important identifier for distinguishing different release versions of the instrument software.。

6.10.3 Hardware Version

Displays the instrument hardware version number.

6.10.4 Date/Time

Modify the system date and time. The time is in 24-hour format.

Press Enter to display the prompt "-" and then modify it.

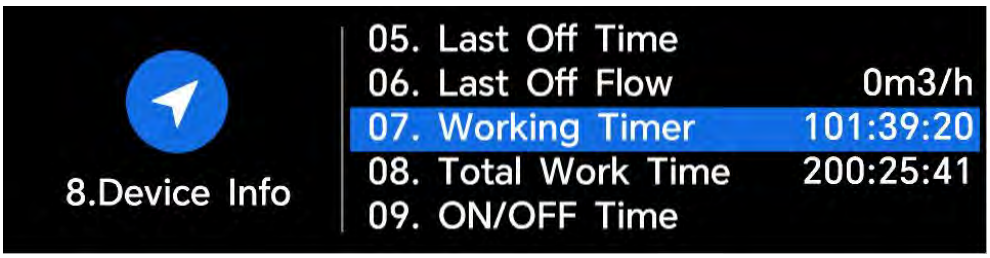
6.10.5 Last Power-Off Time

Displays the time of the last power-off.

6.10.6 Last Power-Off Flow Rate

Displays the instantaneous flow rate at the last power-off.

6.10.7 Working Timer



Displays the cumulative working time of the flowmeter since the last "reset", shown as hours: minutes: seconds. To reset, press Enter and select "Yes".

6.10.8 Total Work Time

Displays the total working time of the flowmeter since leaving the factory.

6.10.9 Power-On/Off Time Query

Query the power-off/power-on time and corresponding flow rate.

1. Power-Off Time Flow Rate	After pressing the "Enter" button to enter, 64 power-off time records are displayed. Click on a time option to display the instantaneous flow rate corresponding to that time.
2. Power-On Time Flow Rate	The operation logic is the same as above. You can query a certain power-on time and the corresponding instantaneous flow rate.

6.10.10 Total Number of Power-Offs

Displays the total number of power-offs of the flowmeter since leaving the factory.

7 Product Overview

7.1 Product Introduction

This ultrasonic flowmeter is a general-purpose time-difference ultrasonic liquid flowmeter designed with ARM chips and low-voltage wide-pulse transmission technology. It is suitable for continuous measurement of homogeneous liquids without high-concentration suspended particles or gases in industrial environments.

7.2 Product Features

Compared with conventional flowmeters or other ultrasonic flowmeters, this product not only has the significant advantages of high accuracy, high reliability, high performance, and low price but also has the following highlights:

1. Adopts large-scale integrated circuit design with a small number of hardware components. It supports low-voltage operation and multi-pulse transmission, and has the characteristics of low power consumption, high reliability, strong anti-interference ability, and good applicability; equipped with optimized intelligent signal adaptive processing technology, users do not need to make any circuit adjustments, and the operation is as simple as using a multimeter.
2. The software design is fully window-based. Parameters or types such as pipe diameter, pipe material, wall thickness, fluid type, and output signal can be easily set through windows, and it supports switching between metric and imperial units.
3. Has daily, monthly, and yearly flow cumulative functions, which can record the cumulative flow of the previous 64 operating days, 64 operating months, and 5 operating years; at the same time, it has a power-on/off management function, which can record the previous 64 power-on and power-off times and corresponding instantaneous flow rates, and can automatically compensate for the flow rate during the power-off period.
4. The instrument is equipped with a TF card as standard, which can store flow data for at least 1000 days, and the minimum data storage interval can be set to 1 second.
5. Built-in seven-digit positive, negative, and net flow totalizers with multiplication factors work in parallel, and a built-in batch (quantitative) controller, which can easily realize quantitative control.。

In terms of measurement technology, the flowmeter adopts a high-resolution, high-linearity, and high-stability time measurement circuit with a resolution of 0.04nS, combined with a 32-bit long digital processing program in the machine, ensuring higher resolution and a larger measurement range.

7.3 Working Principle

The flowmeter adopts the time-difference measurement principle. It uses the propagation of ultrasonic waves emitted by the sensor in the flowing fluid: the propagation speed of sound waves in the downstream direction will increase, while it will decrease in the upstream direction. There will be different transmission times for the same propagation distance. The flow velocity of the measured fluid is measured according to the relationship between the transmission time difference and the flow velocity of the measured fluid.

The flow velocity of the fluid at different positions in the pipe is different: the flow velocity at the center of the pipe is faster than that near the pipe wall. The flow velocity distribution of the fluid in the pipe can be represented by a flow velocity cross-sectional distribution diagram. By setting the flowmeter and considering the influence of the flow velocity cross-sectional distribution, the average flow velocity can be calculated, and then the volume flow rate of the fluid can be obtained according to the cross-sectional area of the pipe.

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

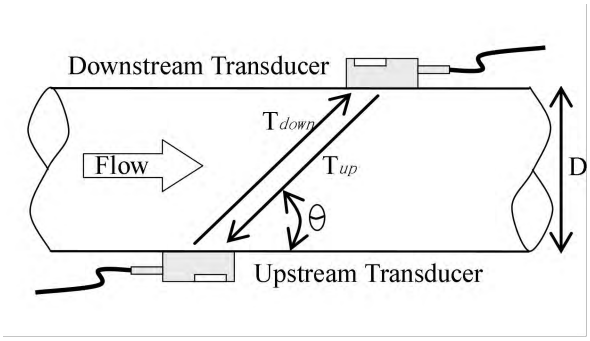


Diagram description:

V：Fluid Velocity

M：Number of Ultrasonic Reflections

D：Pipe Diameter

θ：Angle between Ultrasonic Signal and Fluid

T_{up}：Time for Signal Emitted by Downstream Sensor to Reach Upstream

T_{down}：Time for Signal Emitted by Upstream Sensor to Reach Downstream

$\Delta T = T_{up} - T_{down}$

7.4 Application Scope

Applicable to media such as water, sewage, seawater, acid-base solutions, edible oil, diesel oil, crude oil, alcohol, beer, etc.;

Covers water supply plants and sewage treatment plants;

Can be used in plant irrigation scenarios;Involves the metallurgical and mining fields;

Applied in the petroleum and chemical industries;

Suitable for the food and pharmaceutical fields;

Also can be used in energy-saving monitoring, water-saving management, flow inspection, flow tracking and collection, flow computerized management, monitoring network systems, and other scenarios.

7.5 Specifications

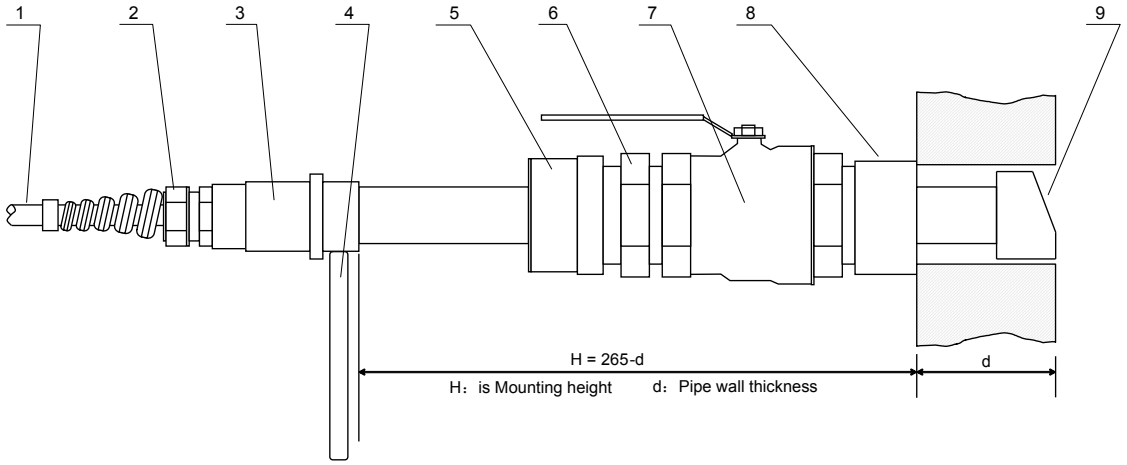
Performance specifications	
Measurable Flow Velocity Range	±0.01m/s～±12 m/s （±0.03 ft/s～±40 ft/s）
Accuracy	±0.5%
Repeatability	0.1%
Pipe Size Range	Clamp-on type: 25mm~5000 mm (1″~200″) Insertion type: 50mm~5000 mm (2″~200″)
Function specifications	
Output	Analog output: 4～20mA, maximum load 750Ω Pulse output: 0 ～ 9999Hz, OCT output (maximum and minimum frequencies adjustable) Relay output: max. frequency 1Hz (1A@125VAC or 2A@30VDC)
Communication	RS485, available to MODBUS protocol
TF Card	Storage period: More than 1000 days Storage interval: 1～3600 seconds
Power Supply	90～245VAC（48～63Hz）or 10～36VDC
Keyboard	24-key touch keyboard
Display Screen	3.71-inch TFT color screen
Temperature	Transmitter ambient temperature: -10℃～50℃ Sensor medium temperature: -40℃～80℃ (standard)
Humidity	Up to 99% RH, non-condensing.
Physical specifications	
Transmitter	Die-cast aluminum chassis, IP rating: IP65
Transducer/Sensor	Sealed design, IP rating: IP68 Standard cable length: 9m, can be extended to 305m
Weight	Transmitter: Approximately 2.2kg Clamp-on sensor: Approximately 2kg per pair Insertion sensor: Approximately 4kg per pair

8 Appendix 1 - W110 Insertion Flow Sensor and Its Installation

8.1 Overview

The W110 insertion flow sensor (hereinafter referred to as the insertion sensor) is installed on carbon steel pipes through ball valves (if installed on plastic or other material pipes, additional mounting clamps may need to be purchased). The maximum installation pipe diameter of the insertion sensor is DN5000mm, the measurement temperature range is -40~+80oC, the standard cable length is 9 meters, and it can be extended to 300 meters.

The specific structure of the insertion sensor is shown in the following figure. Its mounting base is welded on the measured pipe section. The inserted sensor is connected to the mounting base through a ball valve. When the sensor is removed, the ball valve can be closed, so that pressure installation and removal can be realized. At the same time, the connecting nut adopts an O-ring sealing structure to ensure the safety of installation and use.



W110 insertion sensor structure diagram

1. Cable
2. Anti-bending fastener
3. Connector
4. Directional rod
5. Nut
6. Connecting nut
7. Ball valve
8. Mounting base
9. Probe

8.2 Measuring Point Selection

To obtain the strongest signal and the best measurement accuracy, it is crucial to ensure the correct sensor installation spacing. For example, the selection of measuring points refers to Chapter 3.0.

8.3 Installation Spacing Determination

The installation spacing of the insertion sensor refers to the center distance between the installation holes of the two flow sensors. After entering the correct parameters, check the number displayed in the 1-16 menu item of the display window (1. Flow Measurement Settings\16. Sensor Installation Spacing), and calculate the center hole distance L between the two sensors (unit: mm) according to the following formula:

L=SP+34 (unit: mm)

Where SP is the Spacing value (unit: mm) displayed in the 1-16 menu item after entering the pipe parameters such as pipe inner diameter and pipe wall thickness.

Installation method is as follows:

1. Drill a hole at the determined measuring point (if pressure drilling is required, refer to the operation instructions of Gentos Company's DDK electric pressure drilling machine or related pressure drilling equipment). The drill bit diameter is 40mm. Before drilling, align the center of the hole of the sensor mounting base with the center of the drilling hole, and then weld it vertically on the pipe.

2. Close the ball valve and tighten it on the mounting base.
3. Unscrew the positioning sleeve and loosen the lock ring, retract the sensor into the connecting nut, and then tighten the connecting nut on the ball valve.
4. Open the ball valve, insert the sensor into the pipe, and measure the dimension from the outside of the pipe to the directional rod at the same time to make it conform to the following formula:

   H＝265-d

   Where: H—Installation height: Height from the center of the positioning rod to the outer wall of the pipe (mm)

   265—Constant(mm)

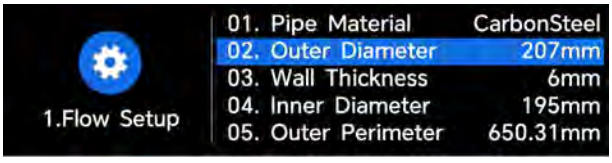
   d—Pipe wall thickness(mm)
5. Tighten the nut slightly, rotate the directional rod so that the directional rod points to the outside of the two sensors and the axis of the directional rod is consistent with the pipe axis. Finally, tighten the screw and screw the positioning sleeve on the connecting nut.
6. Correctly connect the upstream and downstream (red for upstream, blue for downstream) sensor cables to the transmitter terminals.

Important Note

For horizontal measurement pipes, the sensor must be installed at the positive side position (i.e., 3 o'clock or 9 o'clock position), because bubbles or cavitation often accumulate in the upper part of the pipe, and sediment is present at the bottom, which can cause signal attenuation.

8.4 Menu Setting Description

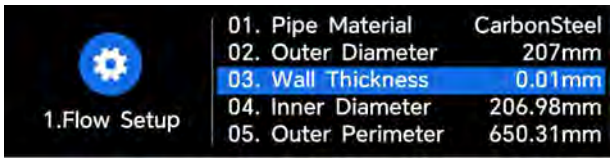
For example, when measuring a carbon steel pipe with a diameter of DN200, pipe outer diameter of 219mm, pipe wall thickness of 6mm, pipe inner diameter of 207mm, water as the measuring medium, no lining material, and Z-type installation method, the basic pipe parameters for sensor menu setting are as follows:

Step 1: Select Pipe Material Press Setting and enter 1-01 menu item, select 01. Carbon Steel. Press Enter to save and return. 【Press pipe mat. 3 to quickly enter 1-01 menu item.】	
Step 2: Set Pipe Outer Diameter Press Setting and enter1-02 menu item, then press Enter and enter 207mm (for insertion sensors, the pipe outer diameter is the pipe inner diameter value), press Enter again to save and return. 【Press pipe dia. 1 to quickly enter 1-02 menu item.】	

Step 3: Set Pipe Wall Thickness

Press Setting and enter 1-03 menu item, then press Enter and enter 0.01mm, press Enter again to save and return.

【Press pipe thick 2 to quickly enter 1-03 menu item.】



Step 4: Flow Sensor Type

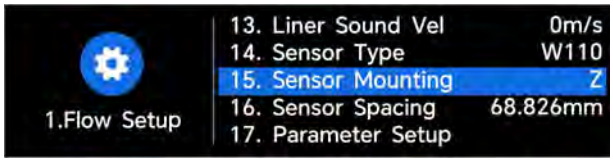
Press Setting and enter 1-14 menu item, then press Enter and select "03. W110", press Enter again to save and return.

【Press xducer type 5 to quickly enter 1-14 menu item.】

Step 5: Sensor Installation Method

Press Setting and enter 1-15 menu item. Then press Enter to select "02. Z", press Enter again to save and return.

【Press install 6 to quickly enter 1-15 menu item.】



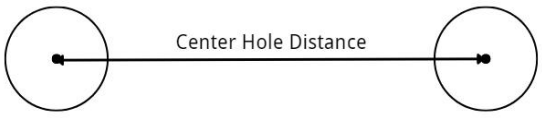
Step 6: Adjust Sensor Installation Spacing

Press Setting and enter 1-16 menu item and install the sensor according to the displayed installation spacing and the selected installation method.

For other settings, refer to the relevant chapters in the manual.

Special Note

Since drilling is required when installing the W110 insertion sensor, and the hole position cannot be changed after drilling, it is necessary to confirm and verify that the pipe section parameters are set correctly before drilling. Then calculate the drilling center spacing L = SP + 34 (mm) according to the SP value displayed in the 1-16 menu item for drilling. The drilling spacing in this case is 68.826 + 34 = 102.826mm. (As below picture shows).

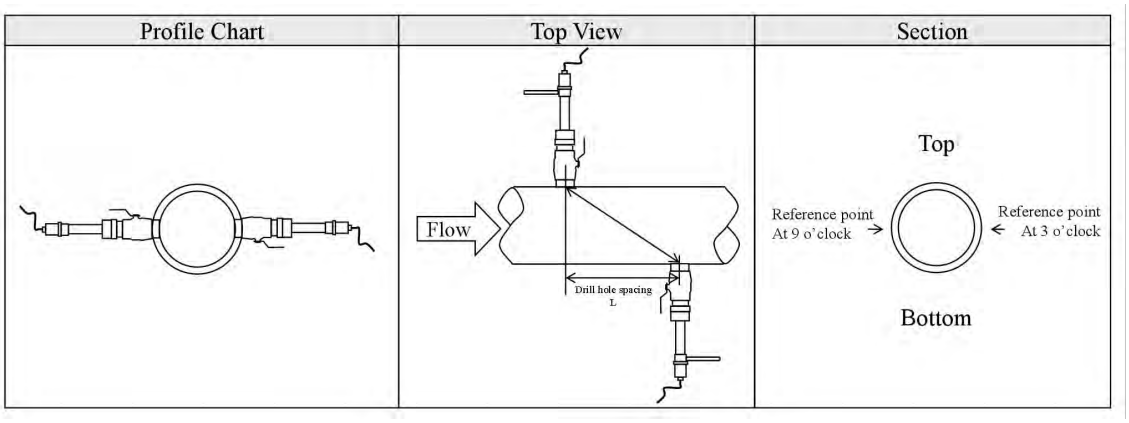


8.5 Installation Method

The insertion flow sensor has two installation methods: Z-type installation and V-type installation. The appropriate method should be selected according to specific application conditions, which is set by the 1-15 menu item.

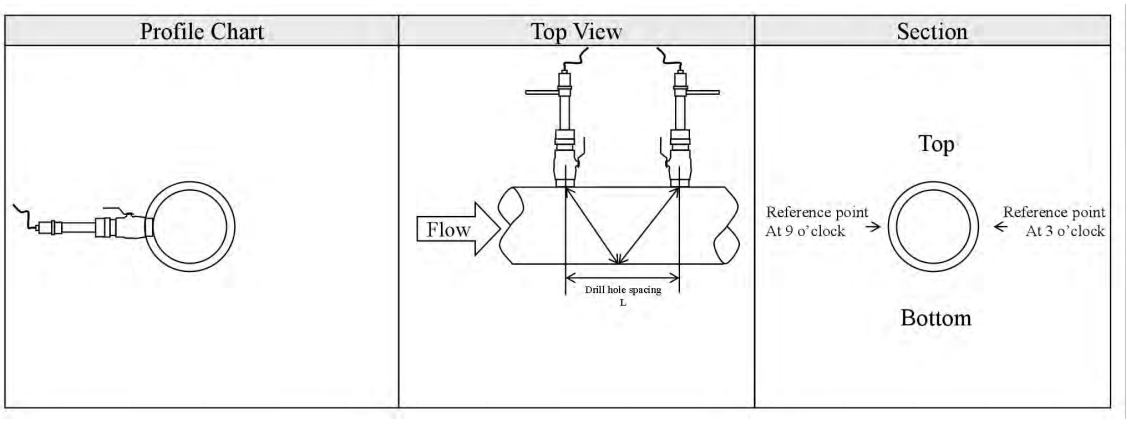
8.5.1 Z-Type

The Z-type installation method is applicable to pipes with a diameter of 50mm~5000mm and is the most commonly used installation method for insertion sensors (see the following figure). The Z-type installation method is more suitable for pipe sections with serious scaling or rust on the inner wall, and has the advantages of strong signals and high measurement accuracy. When adopting the Z-type installation method, it must be ensured that the two sensors and the central axis of the pipe are in the same plane, and this plane should not be in the vertical position of 6 o'clock or 12 o'clock. (See the following figure)



8.5.2 V-Type

The V-type installation method is applicable to pipes with a diameter of 300mm~1200mm and is used when only one side installation is possible on site (e.g., the other side is against a wall) (see the following figure).

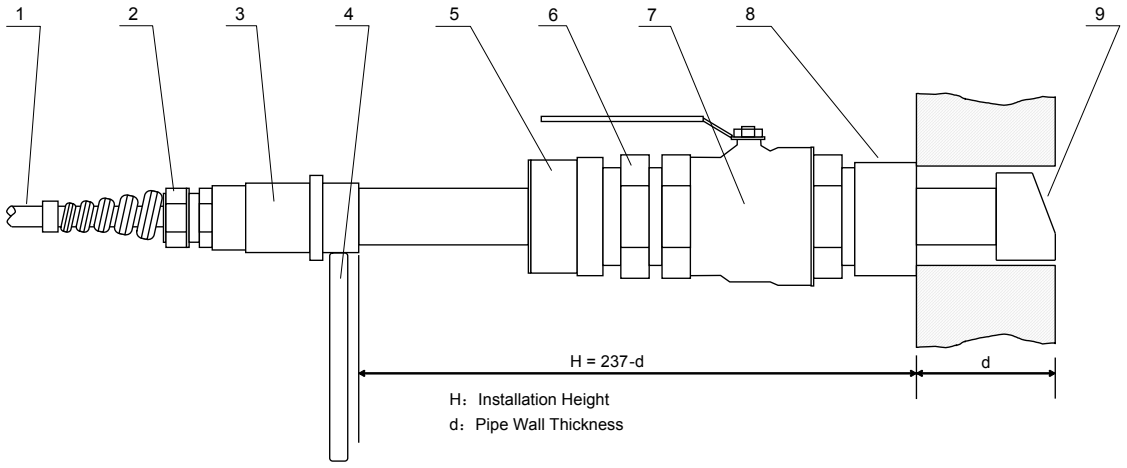


9 Appendix 2 - WH101 High-Temperature Insertion Sensor and Its Installation

9.1 Overview

The WH101 high-temperature insertion flow sensor (hereinafter referred to as the high-temperature insertion sensor) can measure temperatures in the range of -40~+150oC. Its mounting base is welded on the measured pipe section. The inserted probe is connected to the mounting base through a ball valve. When the probe is removed, the ball valve can be closed, so that pressure installation and removal can be realized. At the same time, the connecting nut adopts an O-ring sealing structure to ensure the safety of installation and use. The sensor length is 237mm, suitable for pipes with a wall thickness of ≤24mm.

The specific structure of the insertion sensor is shown in the following figure. Its mounting base is welded on the measured pipe section. The inserted sensor is connected to the mounting base through a ball valve. When the sensor is removed, the ball valve can be closed, so that pressure installation and removal can be realized. At the same time, the connecting nut adopts an O-ring sealing structure to ensure the safety of installation and use.



WH101 insertion sensor structure diagram

1. High-temperature cable
2. Lock head
3. Connector
4. Directional rod
5. Nut
6. Connecting nut
7. Ball valve
8. Mounting base
9. Probe

9.2 Measuring Point Selection

To obtain the strongest signal and the best measurement accuracy, it is crucial to ensure the correct sensor installation spacing. For example, the selection of measuring points refers to Chapter 3.0.

9.3 Installation Spacing Determination

The installation spacing of the insertion sensor refers to the center distance between the installation holes of the two flow sensors. After entering the correct parameters, check the number displayed in the 1-16 menu item of the display window (1. Flow Measurement Settings\16. Sensor Installation Spacing), and calculate the center hole distance L between the two sensors (unit: mm) according to the following formula:

L=SP+34 (unit: mm)

Where SP is the Spacing value (unit: mm) displayed in the 1-16 menu item after entering the pipe parameters such as pipe inner diameter and pipe wall thickness.

Installation method is as follows:

1. Drill a hole at the determined measuring point (if pressure drilling is required, refer to the operation instructions of Gentos Company's DDK electric pressure drilling machine or related pressure drilling equipment). The drill bit diameter is 40mm. Before drilling, align the center of the hole of the sensor mounting base with the center of the drilling hole, and then weld it vertically on the pipe.
2. Close the ball valve and tighten it on the mounting base.
3. Unscrew the nut and loosen the lock ring, retract the sensor into the connecting nut, and then tighten the connecting nut on the ball valve.
4. Open the ball valve, insert the sensor into the pipe, and measure the dimension from the outside of the pipe to the surface at the same time to make it conform to the following formula:

   H＝237-d

   Where: H—Installation height: Height from the center of the positioning rod to the outer wall of the pipe (mm)

   237—Sensor length (mm)

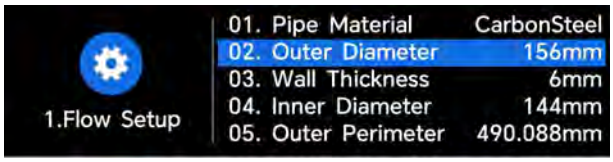
   d—Pipe wall thickness (mm)
5. Tighten the nut slightly, rotate the directional rod so that the directional rod points to the outside of the two sensors and the axis of the directional rod is consistent with the pipe axis. Finally, tighten the screw and screw the positioning sleeve on the connecting nut.
6. Correctly connect the upstream and downstream (red for upstream, blue for downstream) sensor cables to the transmitter terminals.

Important Note

For horizontal measurement pipes, the sensor must be installed at the positive side position (i.e., 3 o'clock or 9 o'clock position), because bubbles or cavitation often accumulate in the upper part of the pipe, and sediment is present at the bottom, which can cause signal attenuation.

9.4 WH Series Insertion Sensor Menu Setting Description

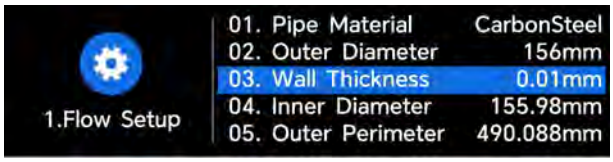
For example, when measuring a carbon steel pipe with a diameter of DN150, pipe outer diameter of 168mm, pipe wall thickness of 6mm, pipe inner diameter of 156mm, water as the measuring medium, no lining material, the basic pipe parameters for sensor menu setting are as follows:

Step 1: Select Pipe Material Press Setting and enter 1-01 menu item, then select "01.Carbon Steel". Press Enter to save and return. 【Press pipe mat. 3 to quickly enter1-01 menu item.】	
Step 2: Set Pipe Outer Diameter Press Setting and enter 1-02 menu item. Then press Enter and enter 156mm **(for insertion sensors, the pipe outer diameter is the pipe inner diameter value)**, then press Enter to save and return. 【Press pipe dia. 1 to quickly enter 1-02 menu item.】	

Step 3: Set Pipe Wall Thickness

Press Setting and enter 1-03 menu item, then press Enter and enter 0.01mm. Press Enter to save and return.

【Press pipe thick 2 to quickly enter 1-03 menu item.】



Step 4: Flow Sensor Type

Press Setting and enter 1-14 menu item, then press Enter and select "04. WH101". Press Enter to save and return.

【Press xducer type 5 to quickly enter 1-14 menu item.】

Step 5: Sensor Installation Method

Press Setting and enter 1-15 menu item. Press Enter and select "02. Z". Press Enter to save and return.

【Press install 6 to quickly enter 1-15 menu item.】

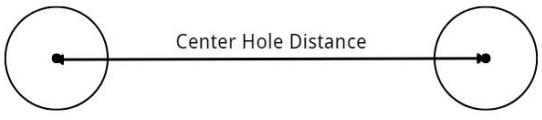
Step 6: Adjust Sensor Installation Spacing

Press Setting to enter the 1-16 menu item, and install the sensor according to the displayed installation spacing and the selected installation method.

For other settings, refer to the relevant chapters (W110 Insertion Flow Sensor Installation) in the manual.

Special Note

Since drilling is required when installing the WH101 insertion sensor, and the hole position cannot be changed after drilling, it is necessary to confirm and verify that the pipe section parameters are set correctly before drilling. Then calculate the drilling center spacing L = SP + 34 (mm) according to the SP value displayed in the 1-16 menu item for drilling. The drilling spacing in this case is 46.226 + 34 = 80.226mm. (As below picture shows).

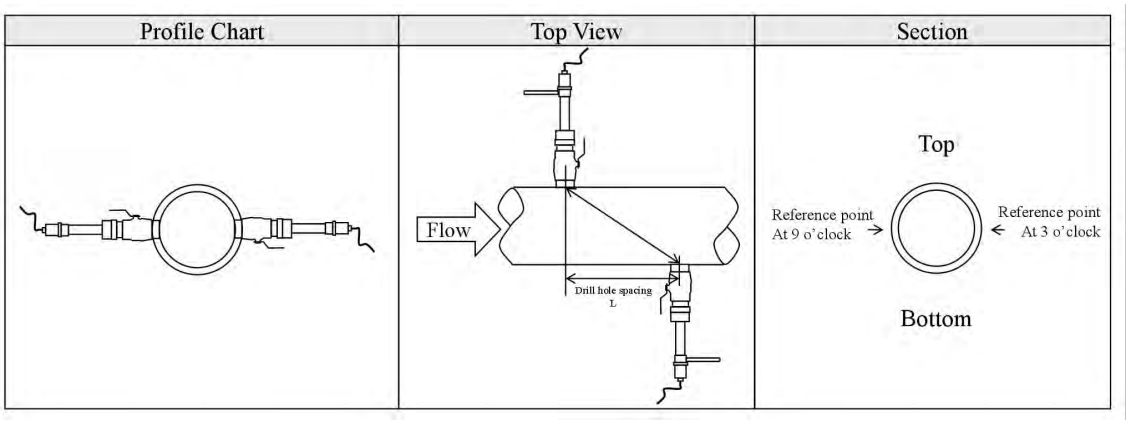


9.5 Installation Method

The WH series insertion sensor has two installation methods: Z-type installation and V-type installation. The appropriate method should be selected according to specific application conditions, which is set by the 1-15 menu item.

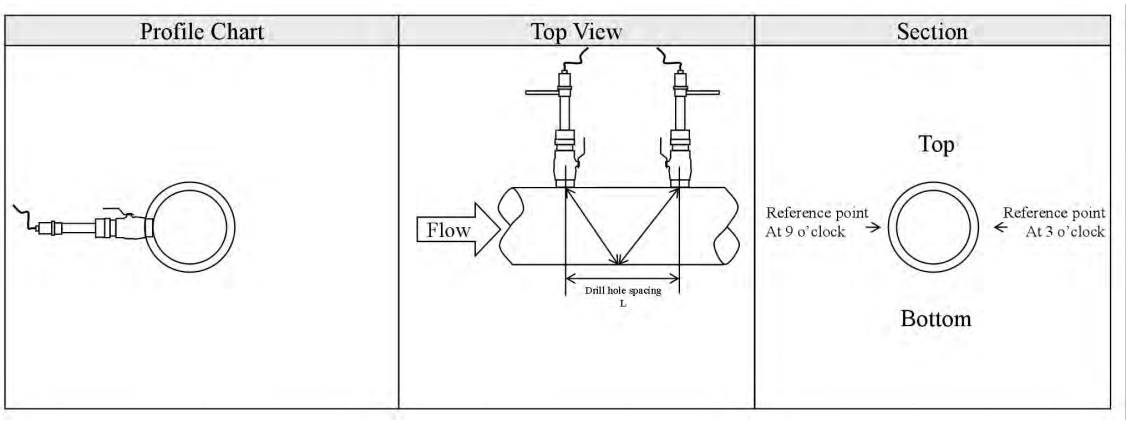
9.5.1 Z-Type

The Z-type installation method is applicable to pipes with a diameter of 50mm~5000mm and is the most commonly used installation method for insertion sensors (see the following figure). The Z-type installation method is more suitable for pipe sections with serious scaling or rust on the inner wall, and has the advantages of strong signals and high measurement accuracy. When adopting the Z-type installation method, it must be ensured that the two sensors and the central axis of the pipe are in the same plane, and this plane should not be in the vertical position of 6 o'clock or 12 o'clock.



9.5.2 V-Type

The V-type installation method is applicable to pipes with a diameter of 300mm~1200mm and is used when only one side installation is possible on site (e.g., the other side is against a wall) (see the following figure).



10 Appendix 3 - Common Fluid Data Sheet

Fluid	Sound Velocity (m/s)	Viscosity
Water 20℃	1482	1.0
Water 50℃	1543	0.55
Water 75℃	1554	0.39
Water100℃	1543	0.29
Water125℃	1511	0.25
Water150℃	1466	0.21
Water175℃	1401	0.18
Water200℃	1333	0.15
Water225℃	1249	0.14
Water250℃	1156	0.12
Acetone	1190	
Methanol	1121	
Ethanol	1168	

Fluid	Sound Velocity (m/s)	Viscosity
Alcohol	1440	1.5
Glycol	1620	
Glycerol	1923	1180
Gasoline	1250	0.80
Benzene	1330	
Toluene	1170	0.69
Kerosene	1420	2.3
Petroleum	1290	
Turpentine	1280	
Jet Fuel	1298	
Peanut Oil	1472	
Castor Oil	1502	

10.1 Sound Velocity of Common Materials

Pipe Material	Sound Velocity (m/s)
Steel	3206
ABS	2286
Aluminum	3048
Brass	2270
Cast Iron	2460
Bronze	2270
Fiber Reinforced Plastic (FRP)	3430
Glass	3276
Polyethylene	1950
PVC	2540

Pipe Lining	Sound Velocity (m/s)
Teflon	1225
Titanium	3150
Cement	4190
Asphalt	2540
Enamel	2540
Glass	5970
Plastic	2280
Polyethylene	1600
Polytetrafluoroethylene (PTFE)	1450
Rubber	1600

10.2 Sound Velocity in Water (1 atm) at Different Temperatures

T (℃)	V (m/s)	T (℃)	V (m/s)	T (℃)	V (m/s)
0	1402.3	34	1517.7	68	1554.3
1	1407.3	35	1519.7	69	1554.5
2	1412.2	36	1521.7	70	1554.7
3	1416.9	37	1523.5	71	1554.9
4	1421.6	38	1525.3	72	1555.0
5	1426.1	39	1527.1	73	1555.0
6	1430.5	40	1528.8	74	1555.1
7	1434.8	41	1530.4	75	1555.1
8	1439.1	42	1532.0	76	1555.0
9	1443.2	43	1533.5	77	1554.9
10	1447.2	44	1534.9	78	1554.8
11	1451.1	45	1536.3	79	1554.6
12	1454.9	46	1537.7	80	1554.4
13	1458.7	47	1538.9	81	1554.2
14	1462.3	48	1540.2	82	1553.9
15	1465.8	49	1541.3	83	1553.6
16	1469.3	50	1542.5	84	1553.2
17	1472.7	51	1543.5	85	1552.8
18	1476.0	52	1544.6	86	1552.4
19	1479.1	53	1545.5	87	1552.0
20	1482.3	54	1546.4	88	1551.5
21	1485.3	55	1547.3	89	1551.0
22	1488.2	56	1548.1	90	1550.4
23	1491.1	57	1548.9	91	1549.8
24	1493.9	58	1549.6	92	1549.2
25	1496.6	59	1550.3	93	1548.5
26	1499.2	60	1550.9	94	1547.5
27	1501.8	61	1551.5	95	1547.1
28	1504.3	62	1552.0	96	1546.3
29	1506.7	63	1552.5	97	1545.6
30	1509.0	64	1553.0	98	1544.7
31	1511.3	65	1553.4	99	1543.9
32	1513.5	66	1553.7		
33	1515.7	67	1554.0		

Refer to the sound velocity of other fluids and materials, please contact the factory.

11 Appendix 4 - Network Usage and Communication Protocol

11.1 Overview

The transmitter provides an RS-485 communication interface with a complete communication protocol, which can be connected to the RS-485 bus.

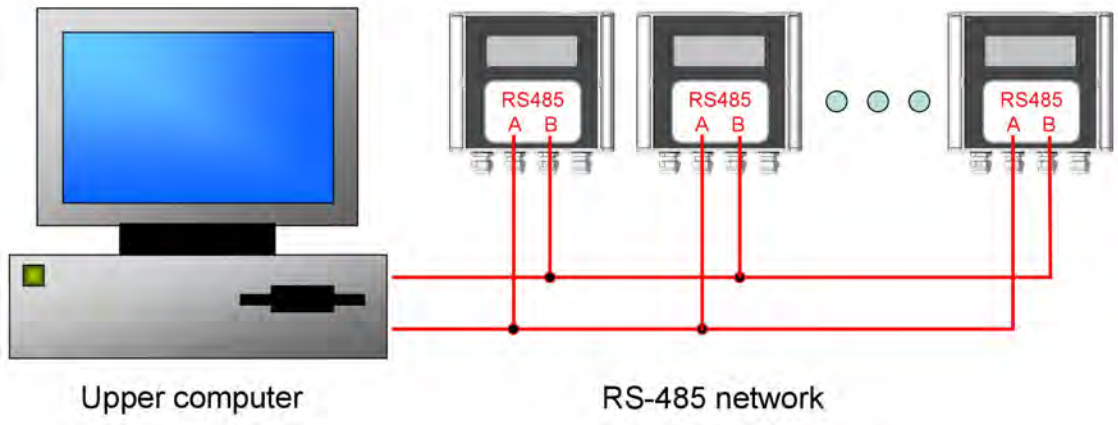
Two basic structures can be selected for networking: either only using the analog current output method of the flowmeter or directly using the RS485 serial port communication method of the flowmeter. The former is suitable for replacing obsolete instruments in old measurement and control networks, while the latter is used for new measurement and control network systems, which has the advantages of low hardware investment and reliable system operation.

When directly using the serial port communication method to implement the measurement and control network system, the address identification code of the flowmeter (Menu 46) is used as the network address code, and the extended command set with [W] is used as the communication protocol to facilitate remote data collection.

For the data transmission link, RS-485 can be used directly for short distances (0~1000 meters).

Data transmission adopts the command-response mode, that is, the upper computer sends a command, and the flowmeter makes a corresponding response.

11.2 RS485 Connection



Upper computer RS-485 network data acquisition system diagram

Note: When using flowmeters for networking, the following network address identification codes cannot be used for the flowmeters: 13 (0DH carriage return), 10 (0AH line feed), 42 (2AH *), 38 (26H &). This network address identification code is set in M46.

11.3 Communication Protocol and Its Usage

11.3.1 MODBUS-I Communication Protocol

The MODBUS-I protocol of this instrument uses the RTU transmission mode, and its check code is obtained using the CRC-16-MODBUS (polynomial X16+X15+X2+1, mask 0xA001) cyclic redundancy algorithm.

The MODBUS-I RTU mode transmits data in hexadecimal.

1. MODBUS-I Protocol Function Codes and Formats

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

Function Code	Performance Data
0x03	Read register
0x06	Write single register

2. MODBUS Protocol function code 0x03 usage

The host sends out the read register information frame format:

Slave Address	Operation Function Code	First Address Register	Register Number	Verify Code
1 byte	1 byte	2 bytes	2 bytes	2 bytes
0x01~0xF7	0x03	0x0000~0xFFFF	0x0000~0x7D	CRC(Verify)

The slave returns the data frame format:

Slave Address	Read Operation Function Code	Number of Data Bytes	Data Bytes	Verify Code
1 byte	1 byte	1 byte	N*x2 byte	2 bytes
0x01~0xF7	0x03	2xN*	N*x2	CRC(Verify)

N*＝data register number

3. MODBUS Protocol function code 0x06 usage

Format of the information frame sent by the host to write a single register (Function Code 0x06):

Slave Address	Operation Function Code	Address Register	Register Data	Verify Code
1 byte	1 byte	2 bytes	2 bytes	2 bytes
0x01~0xF7	0x06	0x0000~0xFFFF	0x0000~0xFFFF	CRC(Verify)

Format of the data frame returned by the slave (Function Code 0x06):

Slave Address	Operation Function Code	Address Register	Register Data	Verify Code
1 byte	1 byte	2 bytes	2 bytes	2 bytes
0x01~0xF7	0x06	0x0000~0xFFFF	0x0000~0xFFFF	CRC(Verify)

The instrument address (flowmeter address) ranges from 1 to 247 (hexadecimal: 0x01～0xF7), which can be viewed in Menu 46. For example, if the decimal number displayed in Menu 46 is 11, the address of this instrument in the MODBUS protocol is: 0x0B.

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

Example 1: In RTU mode, read the instantaneous flow rate (m3/h) of the instrument with address 1 (0x01) in hours, that is, read the data of two registers: 40005 and 40006. The read command is as follows:

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

Instrument Address Function Code First Address Register Register Number CRC Verify Code

The data returned by the instrument (assuming the current flow rate = 1.234567m3/h):

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

Instrument Address Function Code Number of Data Bytes Data(1.2345678) CRC Verify Code

Among them, the four bytes 3F 9E 06 51 are the IEEE754 format single-precision floating-point form of 1.2345678.

Please note the order of data storage in the above example. When interpreting values using C language, you can use pointers to directly put the required data into the corresponding variable address. The commonly used storage order is low byte first. For example, in the above example of 1.2345678m/s, the storage order of the data 3F 9E 06 51 is 06 51 3F 9E.

Example 2: In RTU mode, read the positive cumulative quantity (m3) of the instrument with address 1 (0x01) in m3, that is, read the data of three registers: 0008, 0009, and 000A. The read command is as follows:

0x01 0x03 0x00 0x08 0x00 0x03 0x84 0x09

Instrument Address Function Code First Address Register Register Number CRC Verify Code

The data returned by the instrument (assuming the current positive cumulative quantity = 2.46m3):

0x01 0x03 0x06 0x00 0xF6 0x00 0x00 0xFF 0xFE 0x29 0x10

Instrument Address Function Code Number of Data Bytes Data(246*10-2) CRC Verify Code

Among them, the four bytes 00 00 00 F6 are the hexadecimal of 246, that is, directly convert the hexadecimal data to decimal.

Among them, the two bytes FF FE are 10 to the power of -2. As shown in the following table:：

MODBUS Data	**Corresponding Exponential Unit/Value**	
FFFD	x0.001(1E-3)	10^{-3}
FFFE	x0.01	10^{-2}
FFFF	x0.1	10^{-1}
0000	x1	10^{0}
0001	x10	10^{1}
0002	x100	10^{2}
0003	x1000	10^{3}
0004	x10000(1E+4)	10^{4}

Example 3: In RTU mode, change the address of the instrument with address 1 (0x01) to 2 (0x02), that is, write 0x02 into the data of register 44100 of the flowmeter. The write command is as follows:

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

Instrument Address Function Code Register Address Register Data CRC Verify Code

The data returned by the instrument is:

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

Instrument Address Function Code Register Address Register Data CRC Verify Code

4. Error Handling

This instrument only returns one error code 0x02, indicating an incorrect starting data address.

For example, in RTU mode, only reading the data of register 40002 of the instrument with address 1 (0x01) is considered to damage the data integrity by the instrument. The sent command is:

0x01 0x03 0x00 0x01 0x00 0x01 0xD5 0xCA

Instrument Address Function Code First Address Register Register Number CRC Verify Code

The error code returned by the instrument is:

0x01 0x83 0x02 0xC0 0xF1

Instrument Address Error Code Error Extension Code CRC Verify Code

5. MODBUS Register Address List

The MODBUS registers of this instrument include read-only registers and single-write registers.

a) Read-Only Register Address List (Read with 0x03 Function Code)

Register Address	Register	Data Description	Data Type	Number of Registers	Description
$0000	40001	Instantaneous Flow Rate/Second - Low Byte	32 bits real	2	
$0001	40002	Instantaneous Flow Rate/Second - High Byte			
$0002	40003	Instantaneous Flow Rate/Minute - Low Byte	32 bits real	2	
$0003	40004	Instantaneous Flow Rate/Minute - High Byte			
$0004	40005	Instantaneous Flow Rate/Hour - Low Byte	32 bits real	2	
$0005	40006	Instantaneous Flow Rate/Hour - High Byte			
$0006	40007	Flow Velocity - Low Byte	32 bits real	2	
$0007	40008	Flow Velocity - High Byte			
$0008	40009	Positive Cumulative Quantity (Totalizer) - Low Byte	32 bits int.	2	
$0009	40010	Positive Cumulative Quantity (Totalizer) - High Byte			
$000A	40011	Positive Cumulative Quantity (Totalizer) - Exponent	16 bits int.	1	
$000B	40012	Negative Cumulative Quantity (Totalizer) - Low Byte	32 bits int.	2	
$000C	40013	Negative Cumulative Quantity (Totalizer) - High Byte			

$000D	40014	Negative Cumulative Quantity (Totalizer) - Exponent	16 bits int.	1	
$000E	40015	Net Cumulative Quantity (Totalizer) - Low Byte	32 bits int.	2	
$000F	40016	Net Cumulative Quantity (Totalizer) - High Byte			
$0010	40017	Net Cumulative Quantity (Totalizer) - Exponent	16 bits int.	1	
$0016	40023	Upstream Signal Strength - Low Byte	32 bits real	2	0～99.9
$0017	40024	Upstream Signal Strength - High Byte			
$0018	40025	Downstream Signal Strength - Low Byte	32 bits real	2	0～99.9
$0019	40026	Downstream Signal Strength - High Byte			
$001A	40027	Signal Quality	16 bits int.	1	0～99
$001B	40028	4~20mA Output Current Value - Low Byte	32 bits real	2	Unit: mA
$001C	40029	4~20mA Output Current Value - High Byte			
$001D	40030	Error Code - Characters 1,2	String	3	For the specific meaning of the code, refer to the "Error Handling" chapter
$001E	40031	Error Code - Characters 3,4			
$001F	40032	Error Code - Characters 5,6			
$003B	40060	Flow Velocity Unit - Characters 1,2	String	2	Currently supports: m/s
$003C	40061	Flow Velocity Unit - Characters 3,4			
$003D	40062	Instantaneous Flow Rate Unit - Characters 1,2	String	2	Note 1
$003E	40063	Instantaneous Flow Rate Unit - Characters 3,4			
$003F	40064	Cumulative Quantity(Totalizer) Unit - Characters 1,2	String	1	
$0043	40068	Instrument Address - Low Byte	32 bits int.	2	
$0044	40069	Instrument Address - High Byte			

$0045	40070	Instrument Serial Number - Characters 1,2	String	4	
$0046	40071	Instrument Serial Number - Characters 3,4			
$0047	40072	Instrument Serial Number - Characters 5,6			
$0048	40073	Instrument Serial Number - Characters 7,8			
$0049	40074	Analog Input AI1 Value - Low Byte	32 bits real	2	
$004a	40075	Analog Input AI1 Value - High Byte			
$004b	40076	Analog Input AI2 Value - Low Byte	32 bits real	2	
$004c	40077	Analog Input AI2 Value - High Byte			

b) Single-Write Register Address List (Write with 0x06 Function Code)

Register Address	Register	Data Description	Read/ Write	Data Type	Number of Registers
$1003	44100	Instrument Address (1-247)	R/W	16 bits int.	1
$1004	44101	Communication Baud Rate 0= 2400, 1 = 4800, 2 = 9600, 3 = 19200 ,4= 38400	R/W	16 bits int.	1

Notes:

1. The available totalizer units are as follows:
   1) m3 (Cubic Meter)
   2) l (Liter)
   3) Gal (US Gallon)
   4) Imp gal (Imperial Gallon)
   5) mg (Mega Gallon)
   6) cf (Cubic Foot)
   7) US bbl (US Barrel, Liquid Barrel)
   8) Imp bbl (Imperial Barrel)
   9) Oil bbl (Oil Barrel)
2. When changing the instrument address or communication baud rate, the instrument returns a response with the original address or communication baud rate and then immediately works with the new address or communication baud rate.
3. 16 bits int. - Short integer, 32 bits int. - Long integer, 32 bits real - Floating-point number, String - String.