XFT Ultrasonic Flowmeter

User Manual

Update Record

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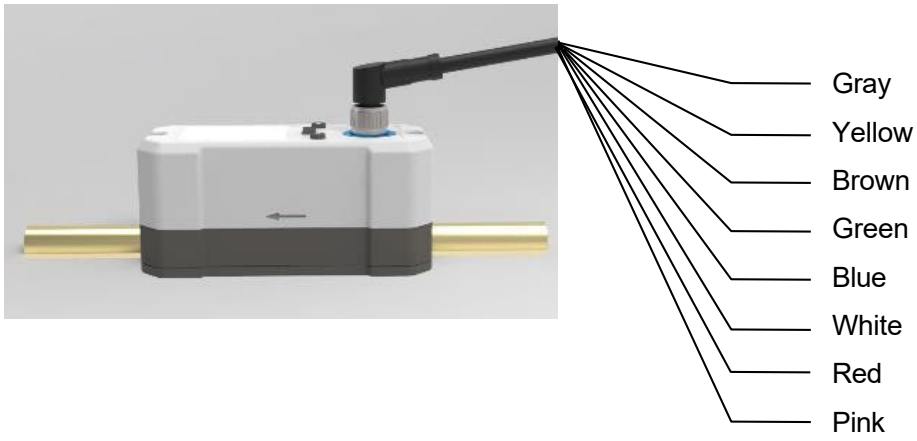
Contents

1 Installation and Wiring

1.1 Installation Instructions

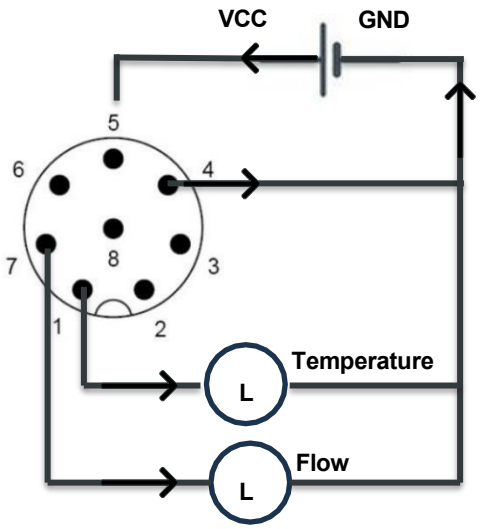
1. Please carefully read "Section 4: Selecting Measurement Points." After selecting the specified location, clean the designated area on the pipe thoroughly and choose a dense part of the pipe material for installation.
2. The central part of the sensor is equipped with a specialized coupling patch, which ensures tight adhesion between the sensor and the pipe wall by pressing the patch against the wall without any air bubbles.
3. Please ensure to completely loosen the pipe clamp bolts when moving the pipe clamp; otherwise, the coupling patch of the sensor may be damaged, leading to measurement failure.
4. The direction of the flow indication arrow on the instrument nameplate must align with the direction of fluid flow in the pipeline.



Function	Identification	Color
Power Supply 10~36VDC	+	Gray
	-	Yellow
RS485	A	Brown
	B	Green
4~20mA (flow rate)	+	Blue
	-	Yellow (power negative)
4~20mA (temperature)	+	White
	-	Yellow (power negative)
/	/	Red

/	/	Pink
Note: The yellow wire, serving as the power negative terminal, also functions as the negative terminal for two sets of 4~20mA outputs.		

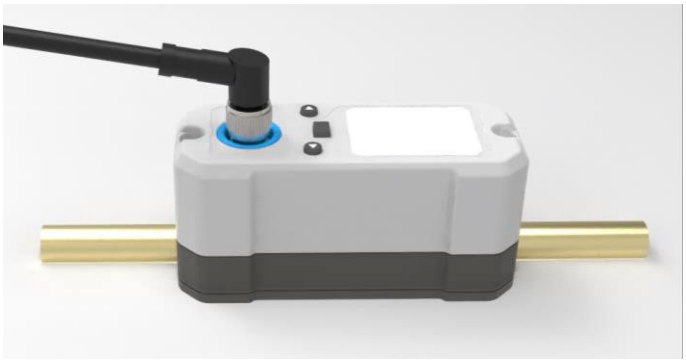
M12 A-CODE 8 PIN Definition



Pin/Color	Definition	Pin/Color	Definition
1/White	T-Out	5/Gray	VCC +
2/Brown	Modbus A+	6/Pink	N/A
3/Green	Modbus B-	7/Blue	F-Out (Flow Rate)
4/Yellow	GND	8/Red	N/A

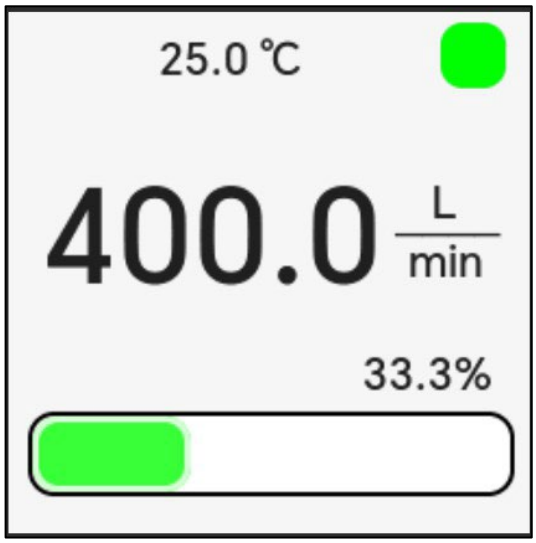
1.2 Quick Installation Steps for Ultrasonic Flow Meter

The XFT ultrasonic flow meter adopts an integrated design and requires only a few simple installation steps. With straightforward parameter settings, it can be directly attached to the pipe section and powered on to achieve flow measurement.

Step 1: Clean the pipe Begin by cleaning the surface of the pipe, removing any loose paint, rust, dirt, or other debris from the surface.	
Step 2: Install the upper and lower pipe clamps Attach the upper and lower pipe clamps to the designated position on the pipe. Securely tighten the four screws connecting the clamps to ensure stability and prevent any loosening.	
Step 3: Install the main unit Attach the main unit to the upper pipe clamp and tighten the two screws.	
Step 4: Power on and begin measurement Take out the cable, connect the plug and tighten it. Connect the other end of the cable to the power supply, then observe the display interface. A small green square in the upper-right corner indicates stable measurement.	

2 Display and Settings

2.1 Display Interface Instructions



Display Area	Display Content	Instructions
Upper display area (sub-display)	Flow, temperature, or accumulated data, choose one.	It can be configured via the display menu, and the cumulative value will automatically reset to zero after exceeding 99999999.9.
	Upper-right corner square color block	Displays red for no signal, yellow for weak signal, and green for normal signal.
Main display area (primary display)	Flow rate, temperature, or cumulative value, choose one.	It can be configured via the display menu, and the cumulative value will automatically reset to zero after exceeding 99999999.9.
Lower display area	Percentage progress bar	Display the 4–20mA corresponding flow output ratio.

2.2 Key Operation Guide

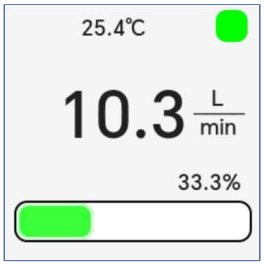
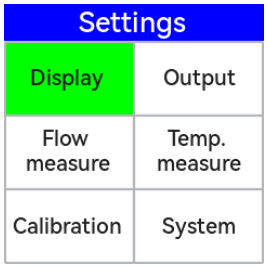
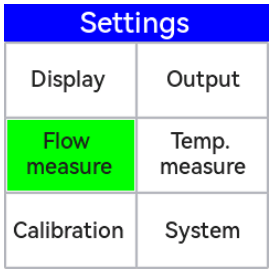
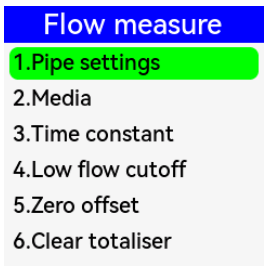
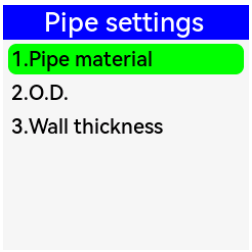
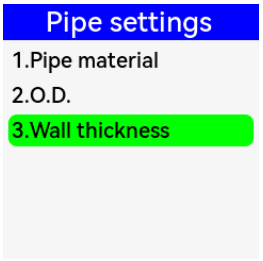
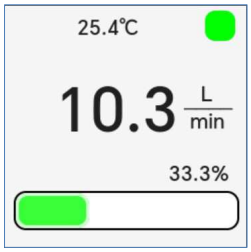
The XFT ultrasonic flowmeter has three buttons, with operation instructions for different levels as shown in the table below:

Button	Display Interface	Level 1 Main Menu Settings Interface	Level 2 submenu interface	Level 3 and Level 4 corresponding setting interfaces		
				Level 3 option setting interface	Level 4 Number Setting Interface	Level 4 Calibration Setting Interface
▲	/	Short press ▲ to select Level 1 setting menu items.	Short press ▲ to select Level 2 submenu items.	Short press ▲ to select Level 3 submenu items.	Short press ▲ to increase the number.	Short press ▲ to increase the value.
■	Long press ■ to enter the main menu interface.	1. Short press ■ to enter Level 2 menu. 2. Long press ■ to return to the display interface.	1. Short press ■ to enter the corresponding settings interface. 2. Long press ■ to return to the main menu settings interface.	1. Short press ■ to enter the option settings interface. 2. Use the keys ▲▼ to select Level 3 submenu items, and press ■ again to save the selection. 3. Long press ■ to discard the selection and return to the previous level.	1. Short press ■ to enter the number settings interface. 2. In the number interface, short press ■ to move the cursor position. 3. Long press ■ to confirm and return to the previous level.	Long press ■ to confirm and return to the previous level.
▼	/	Short press ▼ to select the first-level settings menu item.	Short press ▼ to select the second-level submenu item	Short press ▼ to select the third-level submenu item.	Short press ▼ to decrease the value.	Short press ▼ to decrease the value.

3 Menu Window Description

3.1 Menu Operation Process Description

For example: input the pipe wall thickness as 1.8mm.

Key operation steps	Menu Display
1. Power on the instrument to enter the display interface.	
2. Press and hold the button for 3 seconds to enter the Level 1 main menu settings interface.	
3. Select ▲ ▼ "3. Flow Measurement" using the up and down keys to highlight the menu item	
4. Short press the button for 1 second to enter the Level 2 submenu for flow measurement interface. Use the up and down keys ▲、▼ to select "1. Pipeline Parameters" and highlight the menu item.	
5. Press the button for 1 second to enter the Level 3 submenu for pipeline parameter settings.	
6. Select ▲▼ "3. Wall Thickness" using the up and down keys to highlight the menu item.	
7. Briefly press the button for 1 second to enter the wall thickness numeric setting interface. Use ▲ ▼ the up and down keys to increase or decrease the value, and the button to shift digits, setting the value to 1.8.	
8. Long press the button to save and return to the previous level, then long press three times to go back to the display interface.	

3.2 Menu Interface

The menu is displayed in a hierarchical structure, including display interface, Level 1, Level 2, Level 3, and Level 4. All operations should follow the key operation guidelines outlined in Section 2.2.

Level 1 Main Menu Settings Interface	**Level 2 Submenu Interface**	**Level 3 Settings Interface**	**Function Description**
1. Display	1. Main Display	1. Flow 2. Temperature 3. Totaliser	Select one to display in the middle of the interface. The default display is flow.
	2. Secondary Display	1. Flow 2. Temperature 3. Totaliser	Select one to display at the upper part of the interface. The default display is temperature.
	3. Units	1. L/min 2. GAL/min 3. M^3/h	Selectable units include L/min, GAL/min, and M^3/h. The default unit is L/min.
	4. Flow resolution	1. x0.1 2. x1	x0.1: Display resolution is 0.1 units x1: Display resolution is 1 unit The unit is selected via Display → Units.
	5. Display orientation	1. ↑ 2. ↓ 3. ← 4. →	Choose the direction indicated by the arrow according to actual needs, which will determine the screen's rotation orientation.
2. Output	1. Analog Output	1. Flow	Set the flow rate values corresponding to 4~20mA.
		2. Temperature	Set the temperature values corresponding to 4~20mA. The factory default is 000.0℃ for 4mA and 60.0℃ for 20mA.
	2. Digital Output	1. Baud rate	There are six baud rates available: 4800, 9600, 19200, 38400, 57600, and 115200. The default is 9600.

Level 1 Main Menu Settings Interface	Level 2 Submenu Interface	Level 3 Settings Interface	Function Description
		2. Address Code	Network identification address code ranges from 1 to 247, with the default set to 88.
		check Bit	The options are 1. None, 2. Odd, 3. Even, with the default set to None.
3. Flow measure	1. Pipe settings	1. Pipe material	Optional: 1. Stainless steel, 2. PVC, 3. PPR, 4. Copper, 5. Iron, 6. Others. If "Others" is selected, the system will enter the sound velocity input interface, and users will need to manually input the sound velocity value.
		2. O.D.	DN8/10：13.0 - 18.0mm
			DN15/DN20：18.0 - 28.0mm
			DN25/DN32：28.0 - 44.0mm
			DN40/50：44.0 - 64.0mm
		3. Wall thickness	The adjustable range is (0.5~9.9) mm. Please input the actual pipe wall thickness parameter. An inaccurate parameter input will affect measurement accuracy.
	2. Media	1. Water-base 2. Oil-base 3. Other	Optional water, oil, or other. If "other" is selected, the system will enter the acoustic velocity input interface, requiring the user to manually input the acoustic velocity value.
	3. time constant	1. 0.5s 2. 1s 3. 2s 4. 5s 5. 10s	Enter the damping coefficient, with five selectable damping time options available. The damping function smooths the displayed data. The factory default damping coefficient is 5 seconds.

Level 1 Main Menu Settings Interface	Level 2 Submenu Interface	Level 3 Settings Interface	Function Description
	4. Low flow cut off	The low flow range varies depending on the pipe diameter, as follows: DN10: ≤2.0L/min DN15： ≤5.0L/min DN20： ≤10L/min DN25： ≤15L/min DN32： ≤20L/min DN40： ≤40L/min	Cut off low flow to display a "0" value in the system when the flow is minimal, thereby avoiding invalid accumulation. The factory default value corresponds to half of the maximum low flow cut-off value for the pipe diameter. For example, the default value for DN20 is 5 L/min.
	5. Zero offset	±000.0L/min	This is a less commonly used calibration technique, suitable for experienced operators when conventional zero calibration methods fail to achieve ideal results. This method involves manually adding a compensation value to the measurement to approximate the actual measurement. Typically, this compensation value should be set to zero.
	6. Clear totaliser	1. No 2. Yes	Select "Yes" to clear the accumulated flow value on the instrument.
4. Temperature measure	1. Temp. compensation	±00.0℃	A manual offset value can be set to correct the discrepancy between the displayed temperature and the actual temperature. This interface also shows the compensated temperature.
	2. TSV. compensation	1. Close 2. Open	In specific situations, it is necessary to compensate for acoustic velocity based on the results of the temperature model calculations. By default, this function is turned off and does not need to be activated unless required.
5. Calibration	All calibration options can only be operated when " Password off" changes to " Password on" under 6. System \ Password Settings.		

Level 1 Main Menu Settings Interface	Level 2 Submenu Interface	Level 3 Settings Interface	Function Description
	1. Flow Calibration	K-factor	Also known as the instrument coefficient, it is used to correct flow measurement results. It is calibrated at the factory. Input range: 0.500~1.500. This interface also displays the corrected instantaneous flow value.
		2. Zero Setting	When the fluid is static, the reading of the instrument is referred to as the "zero point." If the "zero point" of the flow meter is not zero, it will be added to the true flow value at any moment, causing measurement deviations in the flow meter. This must be eliminated. Press the button, wait for the progress bar to complete the process, and display "Succeed" to complete the zero point setting.
		3. Zero Clear	1. No; 2. Yes. Select "Yes" to clear the user-set zero point.
	2. Analog trimming	1. Flow	Calibrate the flow rate corresponding to the 4-20mA output value by adjusting the output current using the keys. A precision ammeter can be externally connected to the flowmeter's current output terminals (blue +, yellow -) for calibration.
		2. Temperature (Factory parameters, no customer operation required)	Calibrate the temperature corresponding to the 4-20mA output value by adjusting the output current using the keys. A precision ammeter can be externally connected to the flowmeter's current output terminals (white +, yellow -) for calibration.

Level 1 Main Menu Settings Interface	Level 2 Submenu Interface	Level 3 Settings Interface	Function Description
	3. Expert Mode (Functions under Expert Mode, please refer to section 7: Adjustment and Optimization Guide, or use under the guidance of a professional.)	1. M-factor	1. K1 (0~Minimum Effective Measurement Value) 2. K2 (Minimum Effective Measurement Value~20% FS) 3. K3 (20% FS~40% FS) 4. K4 (40% FS~100% FS) 5. Correction Switch: 1. Off, 2. On The system supports four flow ranges, each corresponding to a K coefficient value. Different pipe diameters have different flow ranges. For example, the flow ranges for DN20 are: K1 (0~10.0 L/min), K2 (10~20.0 L/min), K3 (20~40.0 L/min), K4 (40~100.0 L/min). When the correction switch is turned on, the advanced correction function is activated. When it is turned off, the function is disabled. After the instrument is reset, the segmented K coefficient values will return to their factory default settings.
		2. Window offset	Window compensation for time-of-flight, with DN10 defaulting to 0 μs, and DN15 to DN40 defaulting to -1 μs.
		3. Intricacy caculation	1. Close, 2. Open; It is recommended to turn this on only when there are bubbles in the pipeline, as it can improve flow accuracy. Under normal circumstances, keep it turned off.
		4. Motivational Status	Adjust the excitation status to improve signal quality.

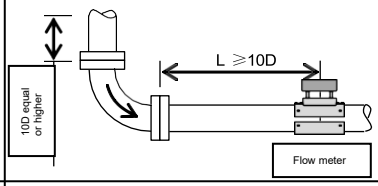
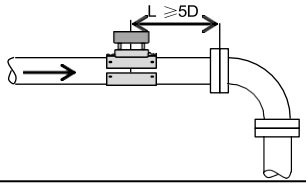
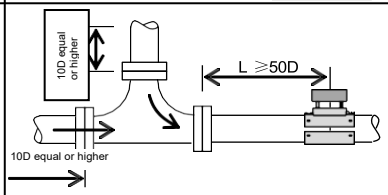
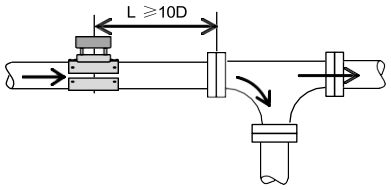
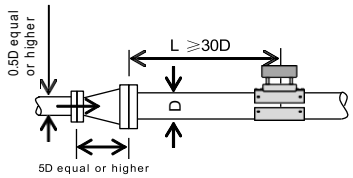
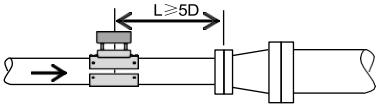
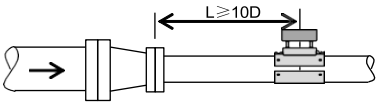
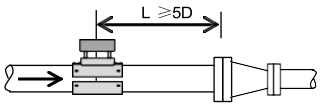
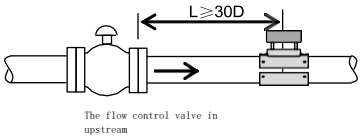
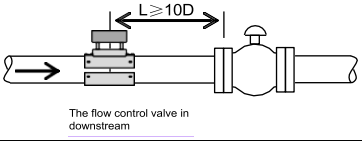
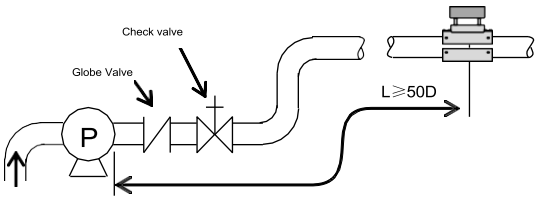
Level 1 Main Menu Settings Interface	Level 2 Submenu Interface	Level 3 Settings Interface	Function Description
	4. Flowrare Tuning	Verify Parameter Pipe Material: xxx Pipe Outer Diameter: xxx Pipe Wall Thickness: xxx Media: xxx OK	The system can automatically retrieve the previously set parameters, including pipe material, pipe outer diameter, pipe wall thickness, and measurement medium. If discrepancies are found in the parameters, users can click the corresponding options to make modifications.
6. System	1. Language	1. Chinese 2. English	Language Selection
	2. Password Settings	1. Reset Password	Factory Default: 9999
		2. Password on/off	Enter the password and display "Enable Password." Long press the button ◉ to confirm and return to the previous menu. The password must be enabled to proceed with step 5: Calibration.
	3. Reset	1. No 2. Yes	Choose "Yes" to clear all configuration parameters and restore them to the original factory default settings. This operation will erase all user data (except for cumulative values) and replace it with factory defaults, so please proceed with caution.
	4. Device info.	1. Model	XFT
		2. Serial Number	"xxxxxxxxxx" is the unique factory number of the instrument, represented by 10 digits.
		Part Number	"xxxxxxx" is represented by 7 characters, including letters and numbers.
		4. Software Version	Initial version V1.0.0
		5. Hardware Version	Initial version V1.0.0

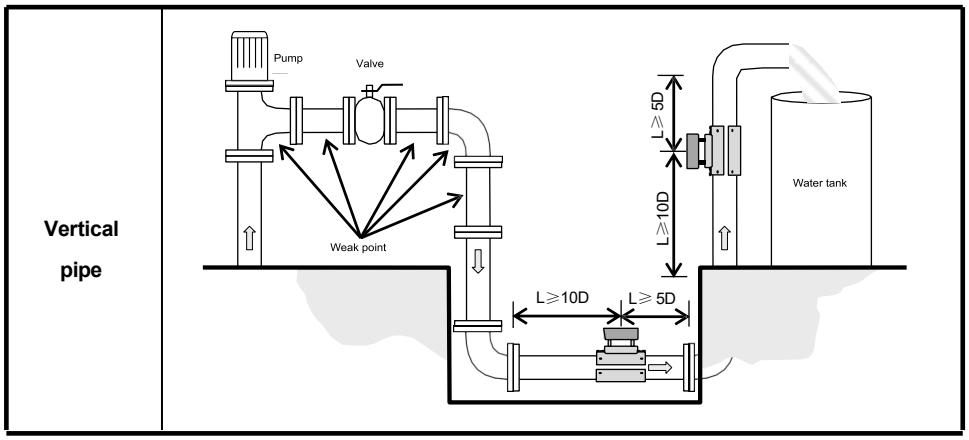
4 Select the measurement point.

This flowmeter is simple and convenient to install. By selecting a suitable measurement point, directly attaching the product's sensor surface to the pipe segment, securing it with clamps, and connecting the power supply, flow measurement can be achieved.

When selecting the measurement point, it is required to choose a section of the pipe where the fluid flow field is evenly distributed to ensure stable measurement. During installation, the following principles should be followed:

- Select a pipe section that is fully filled with fluid, such as a vertical section where fluid ideally flows upward or a horizontal section that remains fully filled.
- The measurement point should be located at least 10 times the pipe diameter (≥10D) upstream and 5 times the pipe diameter (≥5D) downstream from any valves, elbows, reducers, or other devices that disturb the flow field. The recommended straight pipe lengths are shown in the table below.
- Ensure the temperature at the measurement point falls within the instrument's operating temperature range.
- Carefully consider the condition of the pipe’s inner wall, avoiding sections with significant scaling. Select sections of pipe that are uniformly dense and conducive to ultrasonic transmission.

Parts	Upstream	Downstream
90° elbow		
T elbow		
Expanding Pipe		
Shink pipe		
Valves		
Pumps		



5 Communication Protocol

The flowmeter adopts a response communication method, where the host computer sends "commands" to request a response from the subordinate flowmeter. The baud rate for asynchronous communication (Master workstation, computer system, ultrasonic flowmeter) is generally 9600bps. The single-byte data format (10 bits) includes 1 start bit, 1 stop bit, and 8 data bits. The parity bit is set to NONE.

5.1 MODBUS Communication Protocol

This instrument's MODBUS protocol uses the RTU transmission mode, and its checksum is obtained using the CRC-16-MODBUS (polynomial X16+X15+X2+1, mask 0xA001) cyclic redundancy algorithm.

The MODBUS RTU mode transmits data in hexadecimal format.

5.1.1 MODBUS Protocol Function Codes and Formats

The instrument protocol supports the following two MODBUS protocol function codes:

Function Codes	The function data represented
0x03	Reading Registers
0x06	Write a single register.

5.1.2 MODBUS Protocol Function Code 0x03 Usage

The master issues a frame format for reading register information:

Slave Address	Operation Function Code	Register base address	Number of Registers	Checksum

1 byte	1 byte	2 bytes	2 bytes	2 bytes
0x01~0xF7	0x03	0x0000~0xFFFF	0x0000~0x7D	CRC checksum

The format of the slave device response frame:

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

N* = Number of registers to be read.

※ Supports reading data from multiple registers at once.

The instrument address (flowmeter address) ranges from 1 to 247 (hexadecimal: 0x01~0xF7). The address can be found in the menu "Communication Settings\RS485 Address." For example, if the network identification address is displayed as 11, the address of this instrument in the MODBUS protocol would be 0x0B.

The CRC checksum of this instrument uses the CRC-16-MODBUS (polynomial X16+X15+X2+1, mask value 0xA001) cyclic redundancy algorithm. The low byte of the checksum is placed in front, followed by the high byte.

Example 1: In RTU mode, to read the instantaneous flow rate (L/min) of the instrument at address 88 (0x58) in liters, the command to read the data from registers 40001 and 40002 is as follows:

0x58	**0x03**	**0x00 0x00**	**0x00 0x02**	**0xC8 0xC2**
Meter Address	**Function Code**	**Starting Register Address**	**Number of Registers**	**CRC Checksum**

The data returned by the instrument (assuming the current flow rate = 9.9L/min) is:

0x58	**0x03**	**0x04**	**0x00 0x63 0x00 0x00**	**0xC3 0x28**
Meter Address	**Function Code**	**Number of Data Bytes**	**Data (99)**	**CRC Checksum**

Among them, the four bytes 00 63 00 00 represent the actual value of 9.9 multiplied by 10 in output form.

Please note the order in which data is stored in the examples above. When interpreting values using the C programming language, pointers can be used to directly place the required data into the corresponding variable addresses. The commonly used storage order is with the lower byte first. For example, in the case of the 9.9L/min example above, the storage order of the data 00 63 00 00 is 00 00 00 63.

Example 2. In RTU mode, to read the positive cumulative volume (in liters) of the instrument with address 88 (0x58), which involves reading the data from registers 0003 and 0004, the read command is as follows:

0x58	**0x03**	**0x00 0x02**	**0x00 0x02**	**0x69 0x02**
Meter Address	**Function Code**	**Start Register Address**	**Number of Registers**	**CRC Checksum**

The data returned by the instrument (assuming the current positive cumulative volume is 215539.6L) is:

0x58	**0x03**	**0x04**	**0xE3 0x84 0x00 0x20**	**0x45 0x43**
Meter Address	**Function Code**	**Number of Data Bytes**	**Data (2155396)**	**CRC Checksum**

The four bytes 00 00 73 74 represent the hexadecimal value of 2155396, which can be directly converted into decimal.

5.1.3 MODBUS protocol function code 0x06 usage

The frame format for the master device sending a command to read register information:

Slave address	Operation Function Code	Register base address	Number of Registers	Checksum
1 byte	1 byte	2 bytes	2 bytes	2 bytes
0x01~0xF7	0x06	0x0000~0xFFFF	0x0000~0x7D	CRC Checksum

The format of the slave device response frame:

Slave Address	Read operation function code	Number of bytes of data	Data	Checksum
1 byte	1 byte	1 byte	N*x2 bytes	2 bytes
0x01~0xF7	0x06	2xN*	N*x2 data	CRC checksum

N* = Number of data registers.

※ Cross-parameter writing is not supported.

The meter address (flow meter's address) ranges from 1 to 247 (in hexadecimal: 0x01–0xF7). The address can be checked in the menu "Communication Settings \ RS485 Address." For example, if the network identification address is displayed as 11, then the address of this meter in the MODBUS protocol is 0x0B.

The CRC checksum of this meter adopts the CRC-16-MODBUS (polynomial is X16+X15+X2+1, mask is 0xA001) cyclic redundancy algorithm. The lower byte of the checksum comes first, followed by the higher byte.

Example 1: In RTU mode, writing to the meter at address 88 (0x58) with a flow rate offset of + zero point in "L" as the unit (9.9 L/min), i.e., writing data to registers 40017 and 40018. The writing command is as follows:

0x58	0x06	0x00 0x10	0x00 0x02	0x00 0x63 0x00 0x00	0x41 0x13
Meter Address	Function Code	Starting Register Address	Number of Registers	Data	CRC Checksum

The returned data from the meter (current flow rate = 9.9 L/min):

0x58	0x06	0x04	0x00 0x63 0x00 0x00	0xC3 0x7D
Meter Address	Function Code	Data Byte Count	Data (99)	CRC Checksum

Here, the four bytes 00 63 00 00 represent the actual value of 9.9 multiplied by 10, in output form.

Please note the data storage order in the above example. When interpreting the value in C language, you can directly place the necessary data into the respective variable address using a pointer. The commonly used storage order is with the lower byte first. For example, in the 9.9 L/min example above, the storage order of the data 00 63 00 00 is 00 00 00 63.

Example 2: In RTU mode, to write to the meter at address 88 (0x58) to change the instantaneous flow unit, i.e., writing data to register 40008, the write command is as follows:

0x58	0x06	0x00 0x07	0x00 0x01	0x00 0x00	0xC6 0x91
Meter Address	Function Code	Starting Register Address	Number of Registers	Data	CRC Checksum

The returned data from the meter (instantaneous flow unit = L/min):

0x58	0x06	0x02	0x00 0x00	0xA4 0x85
Meter Address	Function Code	Data Byte Count	Data	CRC Checksum

Requirements for writing instantaneous flow unit data: 0 for L/min, 1 for GAL/min.

5.1.4 Error Handling

The error code is only applicable to write operations, and no response is provided for read operation errors.

For example, in RTU mode, if an attempt is made to write data to register 40001 of the device with address 88 (0x58), the device considers the address incorrect and non-writable. The command sent would be:

0x58	0x06	0x00 0x01	0x00 0x01	0x15 0x03
Device Address	Function Code	Starting Register Address	Register Quantity	CRC Checksum

The device returns the error code as follows:

0x58	0x86	0x01	0xD2 0x72
Device Address	Error Code	Error Extension Code	CRC Checksum

5.1.5 MODBUS Register Address List

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

Register address list (read with function code 0x03, write with function code 0x06).

Register Address	Register	Data Description	Data Type	Register Count	Read/Write	Explanation
$0000	40001	Instantaneous Flow/Minute - Low Byte	32 bits uint	2	R	Reading: Actual Value = Read Value / 10
$0001	40002	Instantaneous Flow/Minute - High Byte				
$0002	40003	Positive Cumulative Quantity - Low Byte	32 bits uint.	2	R/W	Read: Actual Value = Read Value / 10 Write: Only 0 can be written to the value
$0003	40004	Positive Cumulative Quantity - High Byte				
$0004	40005	Upstream signal strength UP	16 bits uint.	2	R	Actual value = Read value / 10
$0005	40006	Downstream signal strength DN	16 bits uint.	2	R	Actual value = Read value / 10
$0006	40007	4~20mA output current value	16 bits uint.	2	R	Actual value = Read value / 1000
$0007	40008	Instantaneous flow unit	16 bits uint.	1	R/W	0 for L/min, 1 for GAL/min, 2 for M^3/h
$0008	40009	Cumulative unit	16 bits uint.	1	R	0 for L, 1 for GAL, 2 for M^3/h (Changes according to the unit of instantaneous flow rate)
$0009	40010	Temperature	16 bits uint.	1	R	Reading: Actual Value = Read Value / 100 Writing: Actual Value = Written Value / 100

$000A	40011	Pipe Material	16 bits uint.	1	R/W	0: Stainless steel, 1: PVC, 2: PPR, 3: Copper, 4: Iron, 5: Others
$000B	40012	Outer diameter	32 bits uint.	2	R/W	Read: Actual value = Read value / 10 Write: Actual value = Write value / 10
$000C	40013	Wall thickness	16 bits uint.	1	R/W	Read: Actual value = Read value / 10 Write: Actual value = Write value / 10
$000D	40014	Medium	16 bits uint.	1	R/W	0：Water 1： Oil 2：Others
$000E	40015	Damping	16 bits uint.	1	R/W	0：0.5， 1：1， 2：2， 3：5， 4：10
$000F	40016	Low flow rate cut off	16 bits uint.	1	R/W	Read: Actual value = Read value / 100 Write: Actual value = Write value / 100
$0010	40017	+ Zero Offset - Low Byte	32 bits uint.	2	R/W	Read: Actual Value = Read Value / 10 Write:
$0011	40018	+ Zero Offset - High Byte			R/W	

						Actual Value = Write Value / 10
$0012	40019	- Zero Offset - Low Byte	32 bits uint.	2	R/W	Read: Actual value = Read value / 10 Write: Actual value = Write value / 10
$0013	40020	- Zero Offset - High Byte			R/W	
$0014	40021	+ Temperature Compensation	16 bits uint.	1	R/W	Read: Actual value = Read value / 10 Write: Actual value = Write value / 10
$0015	40022	- Temperature Compensation	16 bits uint.	1	R/W	
$0016	40023	K coefficient - Low byte	16 bits uint.	2	R/W	Read: Actual Value = Read Value / 1000 Write: Actual Value = Write Value / 1000
$0017	40024	Signal quality	16 bits uint.	1	R	The indicator shows red when the value is between 0 and 4, yellow when the value is between 5 and 65, and green when the value is between 66 and 100.
$0018	40025	Model	32 bits uint.	2	R	ASCII code
$0019	40026					
$001A	40027	Series number	32 bits uint.	5	R	ASCII code
$001B	40028					
$001C	40029					
$001D	40030					
$001E	40031					
$001F	40032	Part number		4	R	ASCII Code

$0020	40033		32 bits uint.			
$0021	40034					
$0022	40035					
$0023	40036	Lock Status	32 bits uint.	2	R/W	Read: 1: Unlocked 0: Locked Write: Input the password to unlock; not valid when already unlocked.

Note:

a) The cumulative unit options are as follows:

1. “L” — Liter
2. “Gal” — Gallon

b) 16 bits uint — Represents an unsigned short integer

c) 32 bits uint — Represents an unsigned long integer

6 Appendix — Pipe Diameter Reference Table

Pipe material	Pipe Size	Nominal pipe inner diameter	Adapted Outer Pipe Diameter (mm)	Flow Measurement Range (L/min)	Flow Measurement Range (GPM)
Stainless Steel **PVC** **PPR** **Copper** **Iron** **Others**	3/8”	DN8/10	16.0~18.0	2~30	0.26~7.9
	1/2”	DN15	18.0~23.0	5~60	1.3~15.9
	3/4”	DN20	23.0~28.0	10~100	2.6~26.4
	1”	DN25	28.0~37.0	15~200	3.9~52.8
	1.25”	DN32	37.0~44.0	20~300	5.2~79.3
	1.5”	DN40/50	44.0~52.0	40~400	10.5~105.7

7 Adjustment and Optimization Guide

The measurement results of clamp-on ultrasonic flowmeters are highly dependent on pipe diameter parameters and fluid characteristics. Initial usage may encounter detection anomalies. This section will explain advanced features and parameters related to measurement to facilitate quick on-site troubleshooting of measurement-related issues.

7.1 Advanced Function Introduction

This section will explain some key advanced features in the sensor menu. For instructions on how to use these operations for troubleshooting, please refer to the relevant subsections in Section 7.2

7.1.1 Flow Self-Learning

The sensor has a built-in advanced self-learning function, and it is strongly recommended to perform flow self-learning after each disassembly and reassembly. This operation can improve signal issues to some extent and enhance measurement accuracy.

When the signal indicator light is green, self-learning can improve measurement accuracy to a certain degree.

When the signal indicator light is yellow, red, or blinking, self-learning can partially resolve the abnormal signal indicator issues.

Steps:

1. Ensure the pipe is filled with fluid.
2. Press and hold the confirm key to enter the settings menu, navigate to system → Password Settings →Password off, enter the default password "9999," and then press and hold the confirm key to disable the password.
3. Enter the settings menu, navigate to Calibration → Flowrate Tuning→OK.

7.1.2 Window Offset

The sensors are pre-installed with the widest signal capture range. If the signal indicator light is red or the flow fluctuates significantly, you can try adjusting the window offset to optimize the signal capture capability.

Steps:

1. Ensure the pipe is filled with fluid.
2. Press and hold the confirm key to enter the settings menu, navigate to system → Password Settings →Password off, enter the default password "9999," and then press and hold the confirm key to disable the password.
3. Enter the settings menu, navigate to Calibration → Expert Mode → Window Offset, and set the specific offset value.

7.1.3 Intricacy Calculation

Convolution calculation is an advanced filtering function. When the fluid inside the pipe is complex (e.g., with bubbles or turbulence) and the signal detection is unstable, enabling this function can enhance the stability of flow detection.

If the signal indicator light switches between green and other colors, you can proceed with the following steps:

（1） 1. Press and hold the confirm key to enter the settings menu, navigate to System → Password Settings →Password off, enter the default password "9999," and then press and hold the confirm key to disable the password.

（2） 2. Return to the settings menu, navigate to Calibration → Expert Mode → intricacy Calculation → open, and activate the convolution calculation function.
Attempt to stabilize the signal indicator light to display green consistently.

Note: Enabling this function may reduce the system's responsiveness.

7.1.4 Motivational State

If the flowmeter has no signal and (the indicator light is red), and the self-learning of the flow device or normal switching of the pipe material fails to improve the situation, this function should be used. Continuously adjust the value within the range displayed in the interface until the indicator light turns green, the upper left corner shows a normal flow, and stability is achieved. Then, make additional adjustments a few more times.

(1) Enter the setup interface by long-pressing the confirmation button, then navigate to System → Password Settings →Password off. Enter the password (default is 9999) and long-press the confirmation button to disable the password.

(2) Return to the setup interface, go to Calibration → Motivational State → Adjust the values to meet the following conditions:
a. The upstream signal strength (UP) and downstream signal strength (DN) values should be as low as possible, typically within the range of 100–2600 (the higher the value, the weaker the original signal).
b. The difference between UP and DN should be within 100.

7.1.5 Zero Setting

The "zero point" refers to the state when the pipe is fully filled with fluid, and the flow rate is zero. Correctly setting the zero point can significantly improve the accuracy of flow measurement. If the measured value is not zero while the pipe is fully filled and the actual flow rate is zero, this issue can be resolved through zero-point calibration (similar to taring in weighing).

It is recommended to perform zero-point calibration when the sensor is first installed or after any subsequent removal and reinstallation to ensure optimal performance.

The procedure is as follows:

（1） - Ensure the pipe is fully filled with fluid, and that there is no actual flow.

（2） - Correctly set the pipe parameters (outer diameter, wall thickness, material) and the type of medium.

（3） - Press and hold the confirmation button to enter the settings interface. Navigate to system → Password Settings → Disable Password, input the password (default: 9999), and press and hold the confirmation button to disable the password.

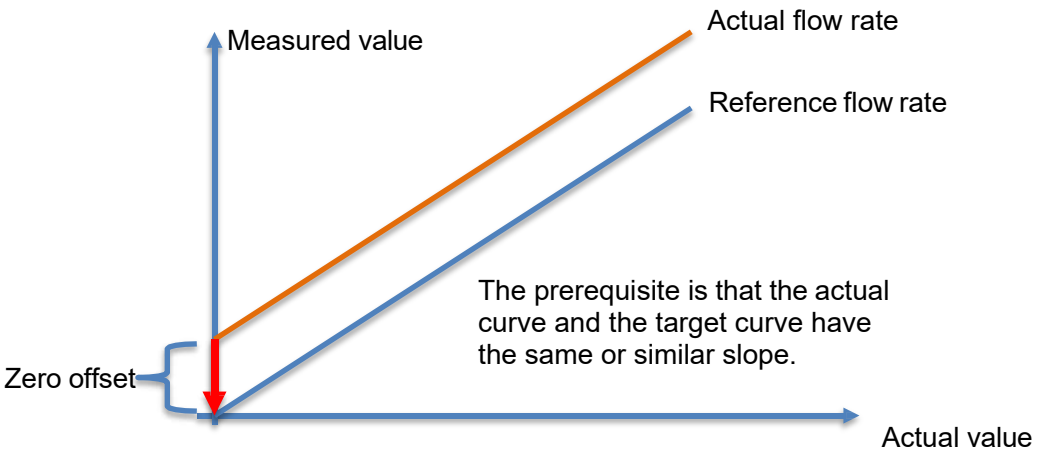
（4） - Enter the settings interface, navigate to Calibration → Flow Calibration → Zero Setting → Progress Bar Reading → Successfully. The zero-point setting is now complete.

7.1.6 Zero Offset

If after completing the zero calibration, a consistent offset relative to the measured flow rate is observed throughout the measurement range, this can be corrected by adjusting the offset value. The default setting is zero.

Operation:

Press and hold the confirmation button → Settings → Flow Measurement → Zero Offset → Set Offset Value (default value is 0).



7.1.7 Low-flow Cut off

To eliminate low flow values from the current measurement, the system displays "0" at low flow rates to avoid invalid accumulation.

After completing the "zero-point calibration," if there are still values under ultra-low flow rates (or zero flow rate), this function can be configured.

If ultra-low flow measurements are needed, the cut-off threshold can be reduced to enable ultra-low flow detection.

For example, if the low-flow cut-off value is set to 0.5 L/min, and the current measurement is 0.4 L/min, the system will display the measurement as 0 L/min. If the current measurement is 0.6 L/min, the system will display it as 0.6 L/min.

Operation:

Press and hold the confirmation button to enter the settings interface → Flow Measurement → Low-Flow Cut-Off → Input Low-Flow Value.

The allowable low-flow range varies based on pipe diameter, as specified below:

DN10: ≤2.0 L/min

DN15: ≤5.0 L/min

DN20: ≤10 L/min

DN25: ≤15 L/min

DN32: ≤20 L/min

DN40: ≤40 L/min

The factory default value corresponds to half of the maximum allowable low-flow value for each pipe diameter. For instance, the default value for DN20 is 5 L/min.

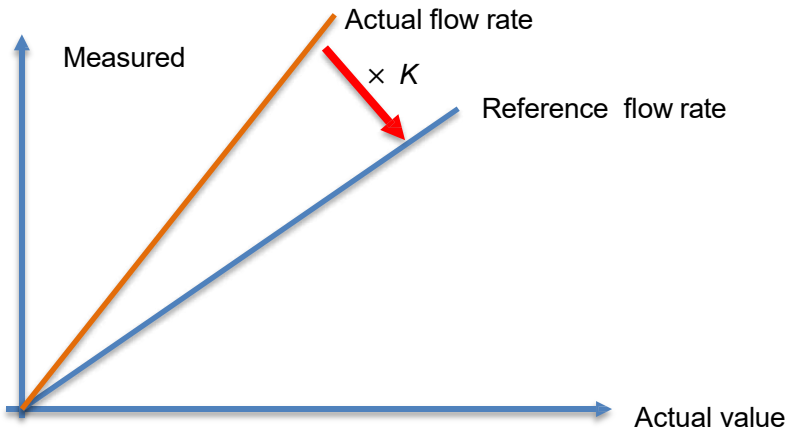
When the current measurement is less than or equal to the low-flow cut-off value, the system displays "0"; when it exceeds the low-flow cut-off value, the actual flow rate is displayed.

7.1.7 Flow Calibration: K Factor

After setting the calibration coefficient K, all flow values measured within the flow range will be multiplied by the K coefficient and then output. The input range is 0.500~1.500, and the interface simultaneously displays the corrected instantaneous flow values.

Operation:

After unlocking the password, press and hold the confirmation button → Calibration → Flow Calibration → K-Factor to make adjustments:



7.1.8 M-factor

By dividing the flow range into four velocity segments and applying different coefficients for correction, the system enhances measurement linearity.

The system supports four flow ranges, each corresponding to a K-factor value. Depending on the pipe diameter, the flow ranges differ:

K1 (0~minimum measurable effective value)

K2 (minimum measurable effective value~20% FS)

K3 (20% FS~40% FS)

K4 (40% FS~100% FS)

For instance, the flow range for DN20 (10–100 L/min) is as follows:

K1 (0–10.0 L/min),

K2 (10–20.0 L/min),

K3 (20–40.0 L/min),

K4 (40–100.0 L/min).

When the correction switch is enabled, the advanced correction function is activated, and it is deactivated when turned off. Upon resetting the instrument, the segmented K-factor values will be restored to factory defaults.

Steps to configure the system:

（1） - Enter setup menu → System Settings → Reset → Yes, to restore factory settings.

（2） - Long press the confirm button to enter the setup menu.System → Password Settings → Disable Password, enter the password (default: 9999), and long press the confirm button to disable the password.

（3） - Enter setup menu → Flow Measurement → Pipe settings → pipe Material/O.D./Wall Thickness, and configure the pipe parameters.

（4） - Enter setup menu → Flow Measurement → Media, and select the corresponding medium type.

（5） - Calibration → Flow Calibration → Zero Setting → Progress Bar Reading → Successfully, zero point setting completed.

（6） - Calibration → Expert Mode → M-factor → a/b/c/d:
a. K1 → Stabilize the system flow rate at any point within the K1 range and input the current flow rate (typically measured using a third-party instrument).
b. K2 → Stabilize the system flow rate at any point within the K2 range and input the current flow rate (typically measured using a third-party instrument).
c. K3 → Stabilize the system flow rate at any point within the K3 range and input the current flow rate (typically measured using a third-party instrument).
d. K4 → Stabilize the system flow rate at any point within the K4 range and input the current flow rate (typically measured using a third-party instrument).

（7） - Calibration → Expert Mode → M-factor→Correction Switch → Open, to activate the advanced correction function.

Note: Although the M-factor flow calibration points can be selected arbitrarily within their respective ranges, the optimal calibration points are actually at four specific flow rates: the minimum measurable effective value (K1), 20% FS (K2), 40% FS (K3), and 100% FS (K4). In practical operation, it is recommended to set the system flow rate for calibration as close as possible to these four points.

Taking a DN20 pipe (10–100 L/min) as an example, the optimal calibration points are 10 L/min (K1), 20 L/min (K2), 40 L/min (K3), and 100 L/min (K4).

7.2 Flow Measurement Abnormality Handling

The sensor's main screen provides a signal quality indicator light to display the ultrasonic signal quality status.

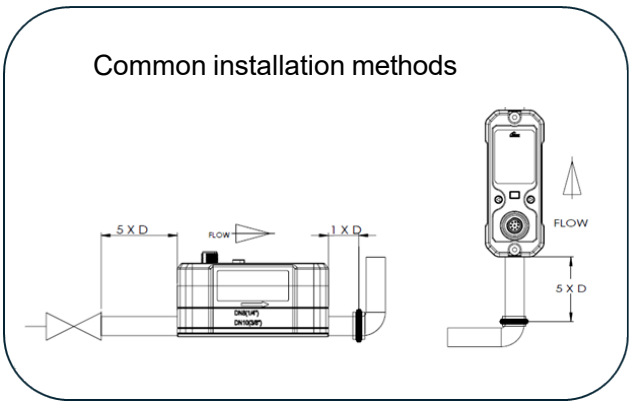
Green: The signal quality meets detection requirements, and the product can operate normally.

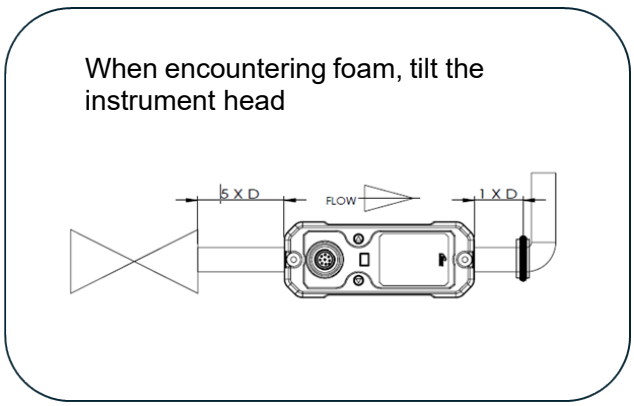
Yellow: The signal quality is slightly poor, which may affect the stability and accuracy of the readings.

Red: The signal quality is very poor or no flow signal is detected, and the product cannot operate normally.

7.2.1 Indicator Light Flickering

If the indicator light flickers, meaning it alternates between green, red, and yellow without stabilizing, one possible cause could be the presence of air bubbles in the pipe. The refraction and scattering effects of the bubbles can weaken the ultrasonic signal, leading to instability in the signal status. If flickering occurs, try tilting the device during installation to minimize the impact caused by the air bubbles.





If instability persists even after side installation, try enabling the "Convolution Calculation" function to improve signal stability.

（1） Access the settings interface by long-pressing the confirmation button: System → Password Settings →Password off. Enter the password (default is 9999) and long-press the confirmation button to disable the password.

（2） Return to the settings interface: Calibration → Expert Mode → Intricacy Calculation → Open. Activate the convolution calculation function and attempt to stabilize the signal indicator light to display green.

Note: Enabling this function may reduce the system's signal response speed.

If the signal indicator light remains red or yellow, refer to Section 7.2.2 Signal Light Color Abnormalities.

7.2.2 Signal Light Color Abnormalities

When the indicator light is yellow or red, follow these steps for troubleshooting:

（1） Ensure that the pipe is fully filled with fluid.

（2） Long-press the confirmation button to enter the settings interface, navigate to Flow Measurement → Pipe Settings → Reset the Pipe material/O.D./wall thickness of the pipe to the correct values.

（3） Long-press the confirmation button to enter the settings interface, navigate to Flow Measurement → Media → Reset to the correct medium.

（4） If the above steps are ineffective, proceed with the following operations:

（5） Long-press the confirmation button to enter the settings interface, navigate to system → Password Settings →Password off, enter the password (default is 9999), and long-press the confirmation button to disable the password.

（6） Long-press the confirmation button to enter the settings interface, navigate to Calibration → Flowrate Tuning → OK.

（7） If the flow indicator light turns green after 2-3 rounds of self-learning, there is no need to continue with the subsequent steps. Otherwise, proceed to the next step.

（8） Long-press the confirmation button to enter the settings interface, navigate to Calibration → Expert Mode → Motivational Status and continuously adjust the mid-range values in the interface. Try to make the indicator light turn green, and the upper-left corner display shows a normal flow rate. Once stabilized, fine-tune the settings further. During the adjustment, ensure that the upstream signal strength (UP) and downstream signal strength (DN) values are kept as low as possible, generally between 100–2600 (a higher value indicates weaker original signals). The difference between UP and DN should ideally be within 100.

（9） If repeated adjustments to the excitation status yield no improvement, consider the following steps:

（10） Enter the settings interface, navigate to Calibration → Expert Mode → Window Offset.

a. For pipes other than DIN10 diameter, use -1 us as the baseline, adjusting by -1 us incrementally. After each adjustment, observe the signal and flow status for 10-30 seconds. If the indicator light does not turn green even after adjusting to -15 us, proceed to step (8).
b. For DIN10 pipe diameters, start with 0 us as the baseline, adjusting by 1 us incrementally. After each adjustment, observe the signal and flow status for 10-30 seconds. If the indicator light does not turn green even after adjusting to 18 us, switch to -1 us as the baseline and adjust incrementally by -1 us. Each adjustment should be followed by a 10-20 second observation of the signal and flow status. If the indicator light does not turn green even after adjusting to -7 us, proceed to step (8).

（11） Remove the meter head, rotate or reposition the pipe clamp, and start again from step (1).

7.3 Flow deviation optimization

7.3.1 Flow Zero Point Adjustment

The zero point refers to the state where the pipe is fully filled with liquid and the actual flow rate is zero. In theory, the sensor's measurement value should be zero at this point. If the sensor does not read zero under such conditions, the following actions can be taken:

（1） Ensure the pipe is fully filled with liquid and there is no actual flow rate.

（2） Correctly set pipe parameters (external diameter, wall thickness, material) and the type of medium.

（3） Long-press the confirmation button to enter the settings interface and navigate to System → Password Settings → Password off. Enter the password, the default password is 9999, then long-press the confirmation button to disable the password.

（4） Long-press the confirmation button to enter the settings interface, and navigate to Calibration → Flow Tuning → OK. If the green flow indicator light is displayed after 2–3 rounds of self-learning, there is no need to proceed with the subsequent steps. Otherwise, continue to step (4).

（5） Enter the settings interface, and navigate to Calibration → Flow Calibration → Zero Setting → Progress Bar Loading → Successfully. Zero-point calibration is completed (tare weight by weighing).

It is recommended to perform zero-point calibration after the initial installation of the sensor or whenever it is reinstalled to achieve optimal performance.

If the zero-point setting fails but requires the output to be zero for flow rates below a certain threshold, the low-flow cut-off can be utilized.

Steps for operation:

Long-press the confirmation button to enter the settings interface → Flow Measurement → Low Flow Cut-Off → Input the low-flow threshold value. This value should be higher than the desired non-display flow rate.

Different pipe diameters have specific allowable ranges for low-flow settings, as follows:

- DN10: ≤2.0L/min
- DN15: ≤5.0L/min
- DN20: ≤10L/min
- DN25: ≤15L/min
- DN32: ≤20L/min
- DN40: ≤40L/min

The factory default value corresponds to half of the maximum allowable low-flow cut-off value for the pipe diameter; for example, the default value for DN20 is 5 L/min.

When the current measurement value is less than or equal to the low-flow cut-off value, it displays as 0. If the measurement value exceeds the low-flow cut-off value, it displays the actual measured flow rate.

For instance:

If the low-flow cut-off value is set to 0.5L/min, a current measurement of 0.4L/min will display as 0L/min.

When the current measurement reaches 0.6L/min, it will display as 0.6L/min.

Low-flow cut-off only addresses display issues at low flow rates without achieving zero-point calibration, so priority should be given to completing the zero-point setup first.

7.3.2 Traffic deviation correction techniques

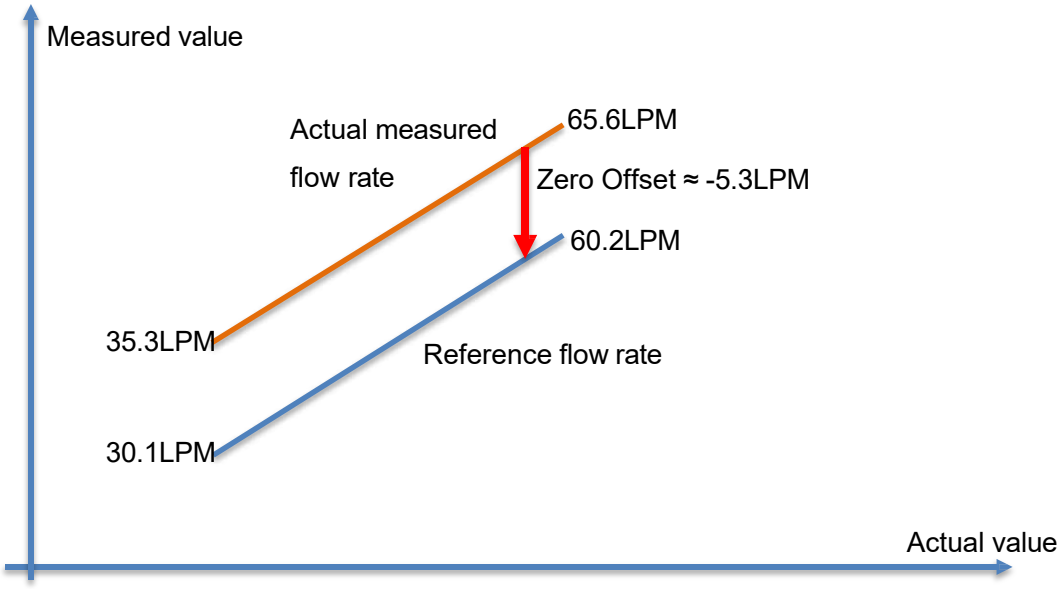
In extreme field conditions, the sensor's measured values may deviate from the expected values (typically measured by third-party sensors), showing overall offset, slope deviation, or nonlinearity. By comparing 2 to 4 characteristic points within the flow range of concern to the customer, the deviation can be determined, and an appropriate correction method can be selected.

Note: It is recommended to complete zero-point calibration on the XFT before conducting flow characteristic point testing.

For example:

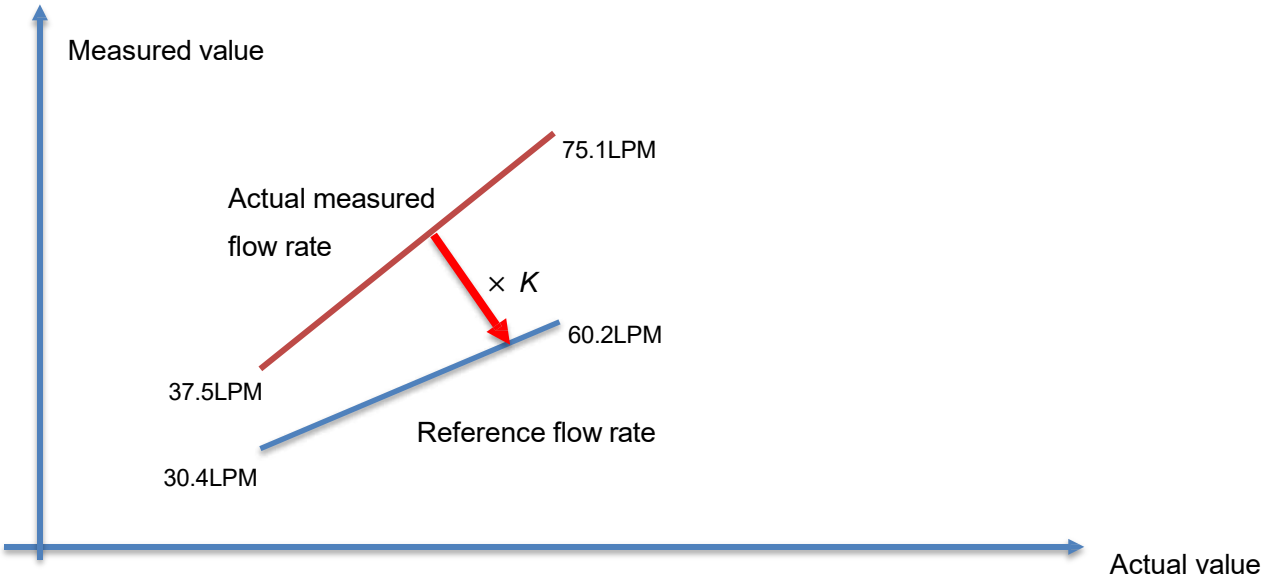
Assume the current XFT is for DN20 with a range of 10 to 100 LPM, focusing on flow rates between 30 and 60 LPM. First, perform zero-point calibration on the XFT. Once the zero-point calibration is successfully completed, adjust the system flow to approximately 30 and 60 LPM (measured by a third-party sensor) and record the flow values measured by XFT.

If the flow values measured by XFT are 35.3 and 65.6 LPM, it can be observed that the flow range of interest exhibits an overall offset of approximately -5.3 LPM.



Press and hold the confirmation button → Settings → Flow Measurement → Zero Offset → Set the offset value to -5.3LPM (default value is 0) to complete the offset configuration.

If the measured flow values of XFT are 37.5 and 75 LPM, it can be observed that the two characteristic points in the target flow range exhibit a fixed ratio:



$$K \approx \frac{30.4LPM}{37.5LPM} \approx \frac{60.2LPM}{75.1LPM} \approx 0.8$$

（1） Press and hold the confirm button to enter the settings menu, navigate to System → Password Settings →Password off, enter the password (default is 9999), and then press and hold the confirm button to disable the password.

（2） Go to the settings menu → Calibration → Flow Calibration → Set the K-factor to 0.8 to complete the adjustment.

The above calibration is effective for single flow points or adjustments within a small range.

7.3.3 On-Site Four-Point Flow Calibration

When the aforementioned methods fail to achieve the desired results, or when linearity across the entire flow range is required, advanced optimization methods can be employed.

Although the multiple K-factor flow calibration points allow for arbitrary selection within the corresponding range, the optimal flow calibration points are, in practice, the minimum measurable effective value (K1), 20% FS (K2), 40% FS (K3), and 100% FS (K4).

In actual operation, unless the system flow cannot be stably set to these four characteristic flow points, the system flow should be calibrated at these four points to achieve the best calibration results.

Assuming that the current XFT is applicable to DN20 with a range of 10–100LPM, the four optimal characteristic flow points should be 10LPM, 20LPM, 40LPM, and 100LPM. During calibration, a third-party flow testing instrument should be used for testing in the system. The system flow should be adjusted to approximately 10LPM, 20LPM, 40LPM, and 100LPM as displayed on the third-party instrument, and settings should be configured while maintaining stability at each flow point.

（1） Reset sensor parameters: press and hold the confirm button to enter the settings menu → System → Reset → Yes, to reset all parameters.

（2） Referencing the flow zero-point adjustment, reconfigure pipe and medium parameters, and perform zero correction.

（3） Calibration → Expert Mode → M-factor→ a/b/c/d

a. K1 → Input 10LPM; at this point, the third-party instrument must show a stable flow rate of approximately 10LPM.

b. K2 → Input 20LPM; at this point, the third-party instrument must show a stable flow rate of approximately 20LPM.

c. K3 → Input 40LPM; at this point, the third-party instrument must show a stable flow rate of approximately 40LPM.

d. K4 → Input 100LPM; at this point, the third-party instrument must show a stable flow rate of approximately 100LPM.

（4） Calibration → Expert Mode → M-factor → Correct Switch → Open, to initiate advanced adjustment.

With the calibration completed, always ensure the system flow aligns with the configured parameters during regular operation. This guarantees optimal performance and enhances the accuracy and reliability of measurement results. For further assistance or inquiries, refer to the support documentation or contact technical support.