MFCL

MICRO ULTRASONIC FLOWMETER

Instructions Manual

Distributed by

imsystem ITALY
Technologies for Automation

Tel. +39 070 402252 mobile +39 328 1761599

info@imsystem.com www.imsystem.com

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Content

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1 Overview

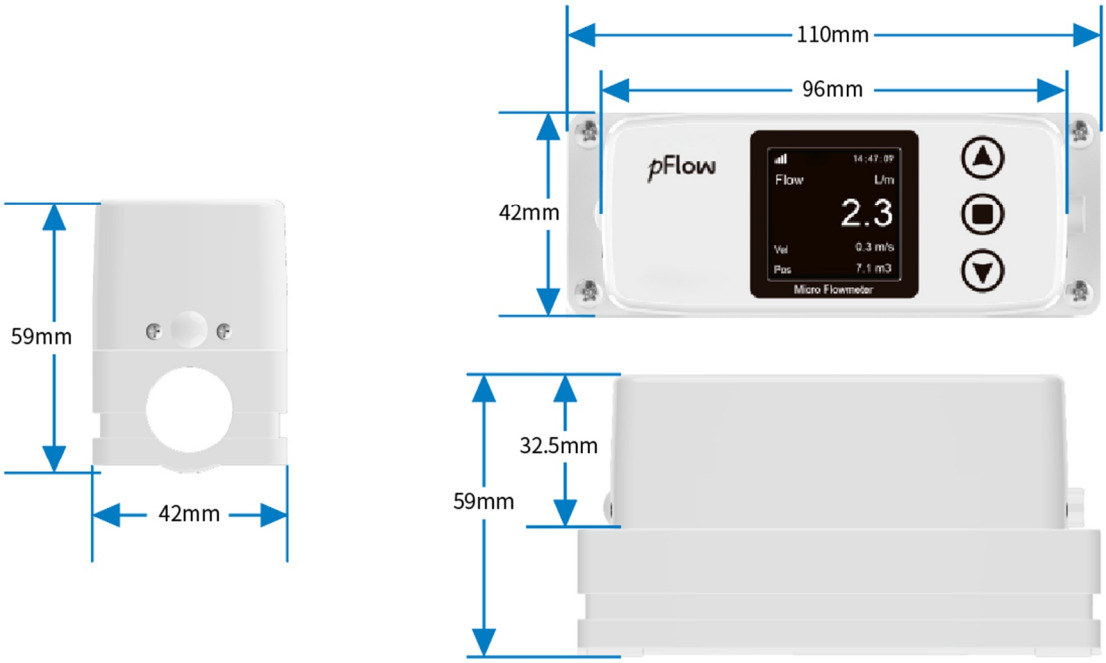
MFCL Micro Flowmeter adopts the measurement principle of ultrasonic-time method, relies on high-reliability signal processing circuits, and accurately measures flow rate through complex algorithms such as sampling, calculation, and correction. The product is designed with an integrated external clamping structure for quick and easy installation and operates without direct contact with the fluid medium, effectively avoiding interference with existing production processes. Accurate flow measurement can be realized in just a few simple steps. For small pipe diameter flow measurement needs, MFCL clamp-on Micro Flowmeter is undoubtedly the best choice.

2 Product Features

- Easy installation, No breaking pipeline
- No need to adjust, Clip on to measure
- LCD color display screen
- 360° rotatable display screen

3 Technical Parameter

3.1 Dimension



3.2 Product Categories

Model	Specifications	Content Color	Description		
			Output	Application Industry	Pipe Size
MFCL	EM - DN10	Green text on black background	4~20mA	Equipment Matching	DN10
	HC - DN10	White text on black background	4~20mA	Healthcare	DN10
	AQC - DN10	Blue text on black background	4~20mA	Aquaculture	DN10
	AGC - DN10	Green text on black background	4~20mA	Agriculture	DN10

Noted:

Products have been configured with application industry options at the factory, please refer to the tabel above.

3.3 Technical Index

Performance Index	
Flow velocity	0.03m/s ~5.0m/s
Accuracy	±2%,（0.3m/s ~5m/s）
Repeatability	0.4%
Pipe Size	DN10
Medium	Water
Pipe Material	Stainless Steel, PVC, Copper, PPR
Functional Index	
Communication Interface	RS485, Support FUJI Protocol and MODBUS Protocol
Output	4~20mA
Power Supply	10～36VDC/500mA
Keyboard	3 touch keys
Display Screen	1.54"LCD color screen, resolution 240*240
Temperature	Transmitter: 14℉ to 122℉ (-10℃ ~ 50℃) Transducer: 32℉ to 140℉ (0℃ ~ 60℃)
Humidity	Relative humidity 0~99%, No condensation
IP	IP54
Physical Characteristics	
Transmitter	All-in-one
Transducer	Clamp on
Cable	Φ5 six core cable, standard length: 2m

- The accuracy is obtained by Gentos flow calibration facilities. Errors may occur due to the type of pipeline, fluid type, temperature, etc. used by the customer.

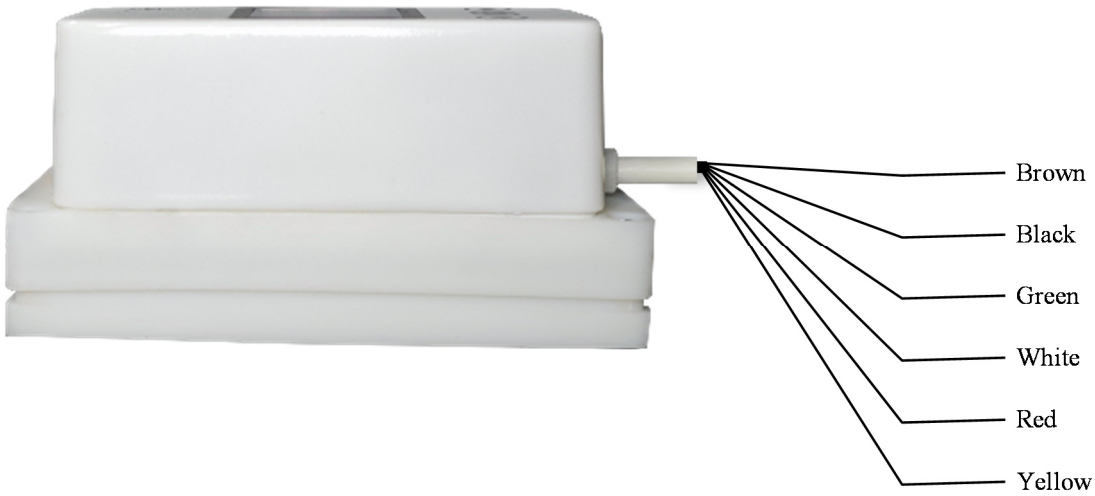
4 Installation and Wiring

4.1 Installation Description

1. Carefully read "Section 7. Choose Measurement Point". After the designated location is selected, the area outside the pipe to be installed must be cleaned, and select the dense part of the pipe for installation.
2. The special coupling sticker of the company is pasted on the center of the sensor, tear off the release film during installation, the sensor will be coupling paste extrusion to the pipe wall, so that the sensor and the pipe wall between the tight fit, no air bubbles exist. Random also equipped with coupling agent, can replace the coupling paste, can be applied to the coupling agent in the coupling paste bit use.
3. The direction of the arrow on the nameplate of the instrument should be consistent with the direction of the fluid in the pipeline.

4.2 Meter Wiring

Refer to the following diagram for meter wiring



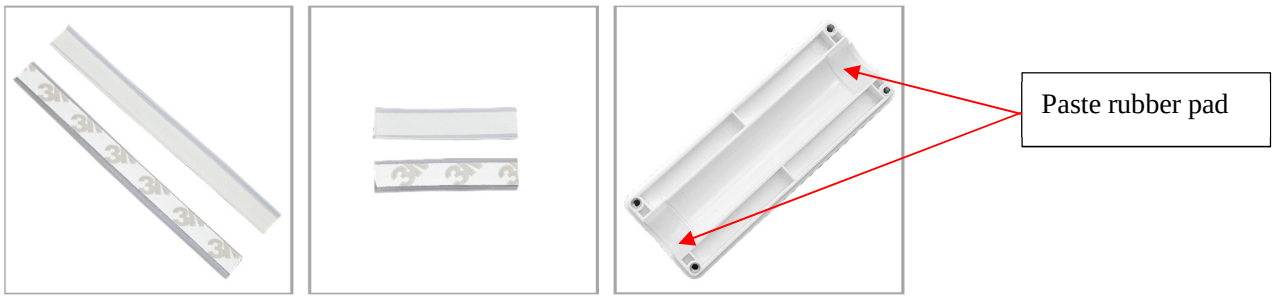
Function	Identifier	Color
Power Supply （10~36VDC）	+	Brown
	-	Black
RS485	A	Green
	B	White
4~20mA	+	Red
	-	Yellow

4.3 Fast installation steps of MFCL Micro Flowmeter

This device adopts integrated design. It is easy to install and set parameters in a few steps. It can be directly clamped on the pipe section. After connected to the power supply, the device can realize flow measurement.

Step 1 Cleaning pipes Perform pipe surface treatment to remove impurities such as paint, rust, dirt, etc. that are easily removed from the surface.	
Step 2 Installation of Pipe Clamp Snap the upper and lower pipe clamps to the selected location on the pipe. If looseness is found, adhesive pads may be applied to the inside of the lower clamps to enhance the tightening effect.	
Step 3 Tighten the screws. Tighten the 4 screws connecting the upper and lower hose clamps securely to ensure stability and no looseness.	
Step 4 Power on and start measurement Set the actual pipe outer diameter, wall thickness and pipe parameters through the "Pipe Parameter Setting" menu item to make the measurement more accurate.	

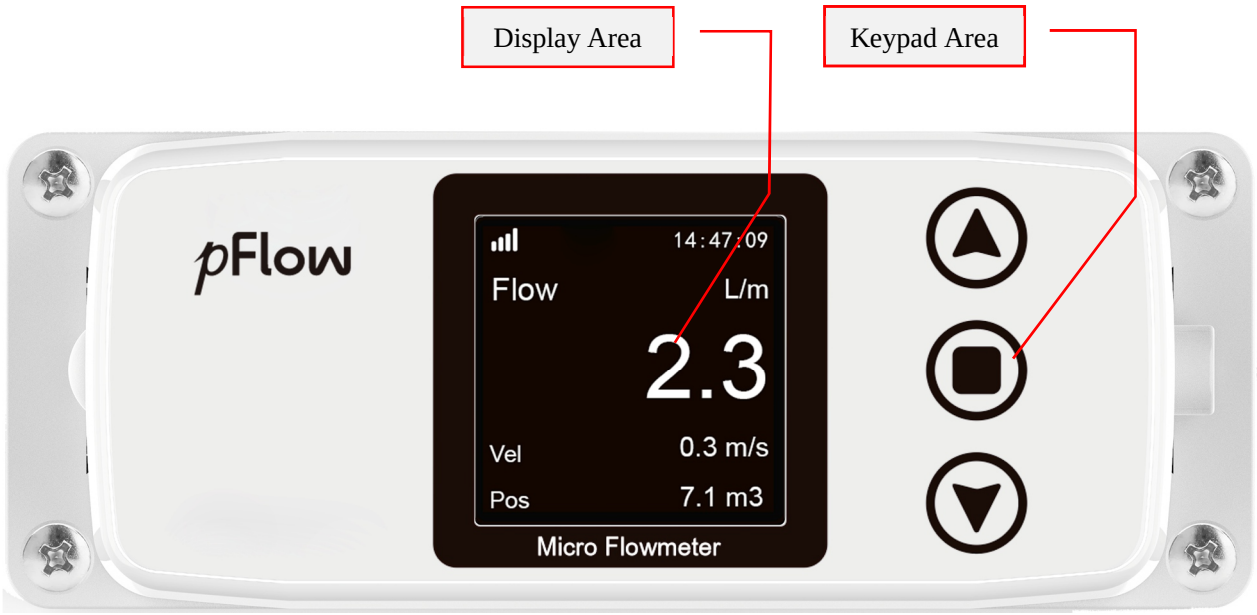
- If the pipe clamp is still loose after locking, the black rubber pad (2mm thick) attached to the accessory bag can be pasted on both sides of the inner wall of the pipe clamp.



5 Display and Settings

5.1 Display Description

Display Type	Display Content	Description
Upper part of display area		Indicates measurement status: Display  : Indicates normal measurement Display ··· : Indicates that the signal is being searched
	18:19:35	Display the current time
Central part of the display area	Flow rate	Display instantaneous flow rate
Lower part of the display area	Flow velocity	Display of instantaneous flow velocity
	Cumulative amount	Display cumulative flow rate Automatically clears when the cumulative flow value reaches 999999999.9.



5.2 Key Description

The MFCL micro device has three buttons, and the operation instructions are shown in the following table:

Key	Main menu	Main menu interface	Sub-menu interface	Setting interface		
				Option Setting	Digital Setting	Calibration Setting interface
▲	/	Press up to select main menu item	Press up to select Sub-menu menu item	Press up to select sub-menu item	Press to increase the number	Press to increase value
■	Press and hold to enter the main menu screen	1.Press to enter the secondary menu 2.Press and hold to return to the display interface	1.Press to enter the setting interface 2.Press and hold to return to the main menu interface	1.Press to enter the option setting interface 2.In the sub-menu items, press to save settings and return to the previous level. 3.Press and hold to save settings and return to the previous level.	1.Press to enter the digital setting interface 2.Press in the digital interface and move the cursor bit. 3.Press and hold to confirm and return to the previous level	1.Press and hold to confirm and return to the previous level
▼	/	Press down to select main menu item	Press down to select sub-menu item	Press down to select sub-menu item	Press to reduce the number	Press to decrease the value

6 Menu Window Description

6.1 Menu Interface

Main menu interface	Sub-menu interface	Setting interface	Description
1. Pipe Setup	1.Pipe Material	1.Stainless Steel 2.PVC. 3.Copper 4.PPR	Select the pipe material. In the setting interface, there will be a check mark on the right side of the selected item. The same goes for the following.
	2. Outside Diameter	Different pipe diameter specifications correspond to different pipe outer diameter ranges.	Enter the outer diameter of the pipe and set the pipe diameter parameters of the purchased product. The pipe outer diameter range has been set at the factory. For more details, please refer to Appendix 1—Pipe Diameter Comparison Table. For example: if you select DN10 steel pipe, the effective input range of the pipe outer diameter is (12~18.5) mm.

Main menu interface	Sub-menu interface	Setting interface	Description
	3.Wall Thickness	0.5mm~1/3 pipe outer diameter	The minimum value is 0.5mm, and the maximum value cannot exceed 1/3 of the outer diameter of the pipe. (Different pipe diameter specifications correspond to different pipe wall thickness ranges.) Please enter the actual pipe wall thickness parameters. Inaccurate parameter input will affect the measurement accuracy.
2.Output Setup	1.4~20mA	1. Mode	1.Flow mode: Set the current loop output to 4~20mA corresponding to the flow rate 2.Flow rate mode: Set the current loop output to 4~20mA corresponding to the flow rate
		2. Current Loop 4mA	Set the corresponding value of the current loop 4mA output
		3. Current Loop 20mA	Set the corresponding value of the current loop 20mA output
	2.RS485 Setup	1. Baud rate	There are 8 baud rates to choose from, 4800, 9600, 19200, 38400, 50400, 57600, 76800, 115200
		2.Network ID	The network identification address code is taken from 1 to 247
3.Unit Setup	1. System units	1.Metric unit , 2.imperial unit	Select metric, imperial units
	2. Flow unit	1.m3/h, 2.m3/m, 3.L/h, 4.L/m, 5.Gal/h, 6.Gal/m	Select instantaneous flow units
	3. Total unit	1.m3, 2.L, 3.Gal	Select cumulative flow units
4.System Setup	1. Clear Totalizer	1. No, 2. Yes	Clear the accumulation, select "Yes" to clear the accumulation.
	2.Damping Factor	1~99 seconds	Enter the damping coefficient, which acts as a smoothing factor for the displayed data. Usually a value between 3 and 10 is entered in the application.
	3.Low Flow Cut Off	≤0.25m/s	Cut out for low flow rates. This allows the system to display a "0" value at low flow rates to avoid ineffective accumulation. The factory default cutout value is 0.03m/s.
	4.Date- time	1. Date 2. Time	Set current time, year-month-day, hour:minute:second
	5. Language	1.English 2.Chinese	Chinese-English Selection

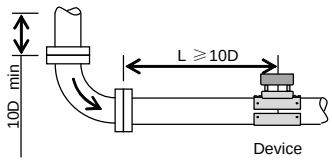
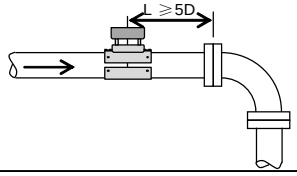
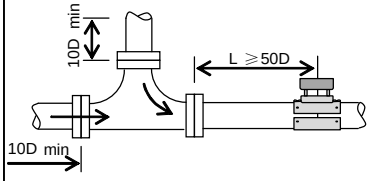
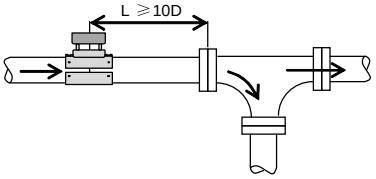
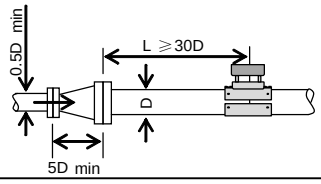
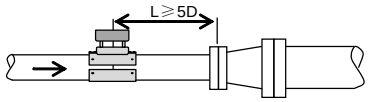
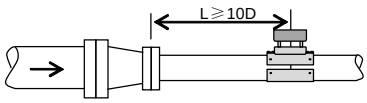
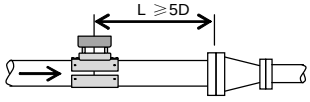
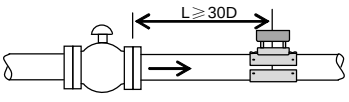
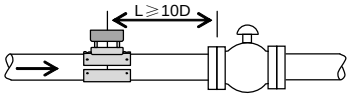
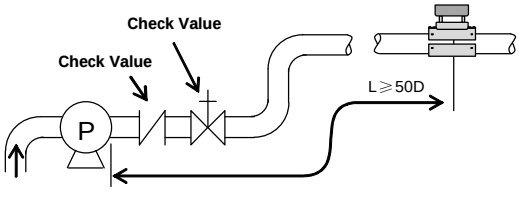
Main menu interface	Sub-menu interface	Setting interface	Description
	6.Screen Orientation	1. 0° .2. 90° . 3. 180 ° .4. 270°	Rotate the screen to set the direction of the screen display, and the key functions will automatically adapt with the screen direction change
	7.System Lock	xxxxxx	Enter the new password, prompted to close the system lock or open the system lock, choose to open the system lock, the system is locked, prohibit any modification of the parameters of the operation, can only view the main interface parameters, thus protecting the normal operation of the instrument. The only way to "unlock" is to enter the original password correctly. The password is a 6-digit number. "000000" is invalid password.
	8.Buzzer Switch	1. Close, 2. Open	Setting the on/off state of the buzzer
	9. Factory Data Reset	1. No 2. Yes	Clear all setup parameters and restore them to the original factory defaults. Select "Yes", this operation will erase all user data (except cumulative amount) and change them to the factory defaults, so please be careful with this operation.
5.Calibration Setup	1.4-20mA Calibration	1.4mA Calibration 2.20mA Calibration	Adjust the output current with the ▲ key and ▼ key. External precision ammeter to flow meter current output (red +, yellow -)
	2.Set Zero	1. No 2. Yes	When the fluid is static, the value of the instrument is called the "zero point". When the meter's "zero point" is not zero, at any moment the zero point will be superimposed on the true value of the flow rate, so that the measurement of the meter deviation. It must be removed. Select "Yes" and wait for the process to complete.
	3. Clear Zero	1. No 2. Yes	The set zero point is restored. Select "Yes" to clear the user-set "zero point".
	4. K Factor	0.5~1.5	Known as the meter K-factor, it is used to correct flow measurements. (Factory Calibrated)
6. Device information	1.Serial Number	vxxxxxxx	Factory Number
	2.Firmware Number	V1.x.x	Software Version

7 Choose Measurement Point

The device is simple and convenient to install. As long as a suitable measuring point is selected, Clamp the product sensor surface on the pipe section directly and fix the pipe clamp, and then the power is turned on, the flow measurement can be realized.

When selecting measuring points, it is required to select pipe sections with uniform fluid flow field distribution to ensure measurement accuracy. The following principles shall be followed during installation:

- Select a pipe segment that is filled with fluid, such as the vertical part of the pipe line (the fluid is better to flow upward) or the horizontal pipe segment that is filled with fluid.
- The measuring point should be on a uniform straight pipe section with 10 times the diameter (10D) from the upstream and 5 times the diameter (5D) from the downstream. There are no valves, elbows, reducers and other devices interfering with the flow field within this range. The length of the straight pipe section is recommended to use the values shown in the following table.
- Ensure that the temperature at the measuring point is within the working range.
- Fully consider the scaling condition on the inner wall of the pipe, try to select the pipe section without scaling for measurement, and select the pipe section of uniform and dense pipes so as to make ultrasonic transmission easier.

Name	Straight length of Upstream piping	Straight length of Downstream piping
90°bend		
Tee		
Diffuser		
Reducer		
Value	 **Flow controlled upstream**	 **Flow controlled downstream**
Pump		

8 Communication Protocol

The device adopts response communication mode, and the upper computer sends "command" to request the lower device to respond. The baud rate of asynchronous communication (main workstation, computer system, micro flowmeter) is generally 9600bps. Single byte data format (10 bits): 1 start bit, 1 stop bit and 8 data bits. Check bit: NONE.

8.1 FUJI Protocol

The FUJI protocol of the instrument adopts the response communication mode, and the upper computer sends a "command" to require the instrument to respond. The baud rate of asynchronous communication (main workstation, computer system, secondary workstation, micro flowmeter) is generally 9600bps. Single byte data format (10 bits): 1 start bit, 1 stop bit and 8 data bits. Check bit: NONE.

The basic command is represented by a data string, and the command ends with a carriage return newline character. The feature is that the data length is random. Common commands are shown in the following table:

Communication Command

Command	Command Meanings	Data Format
DQD(cr)(lf)	Return daily instantaneous flow	±d.dddddd E±dd(cr)Note 1
DQH(cr)(lf)	Return hourly instantaneous flow	±d.dddddd E±dd(cr)
DQM(cr) (lf)	Return instantaneous flow per minute	±d.dddddd E±dd(cr)
DQS(cr) (lf)	Return instantaneous flow per second	±d.dddddd E±dd(cr)
DV(cr) (lf)	Return instantaneous flow velocity	±d.dddddd E±dd(cr)
DI+(cr) (lf)	Return positive accumulative flow	±dddddddE±d(cr)Note 2
DID(cr) (lf)	Return instrument identification code (address code)	ddddd(cr)5 bits in length
DL(cr) (lf)	Return signal strength	UP:dd.d, DN:dd.d, Q=dd(cr)
ESN(cr) (lf)	Return electronic serial number	ddddddd(cr)(lf) Note 3
W	Digital string address networking command prefix	Note 4
P	Prefix of back haul command with verification	
&	Function sign of Command "Add"	

Note：

1. (cr) indicates a carriage return,and its ASCII code value is 0DH. (lf) indicates a line feed, and its ASCII code value is 0AH.
2. d denotes a number from 0 to 9, with a value of 0 denoted as +0.000000E+00.

   d denotes a number from 0 to 9, with no decimal point in the integer part before "E".
3. The ddddddd eight digits indicate the electronic serial number of the machine and the “t” indicates the machine code.
4. If there are multiple traffic meters in the data network at the same time then the basic commands cannot be used individually and must be prefixed with W before they can be used, otherwise it will cause multiple traffic meters to answer at the same time, resulting in system confusion.

（1）P Prefix

The character P can be added before each basic command,indicating that the data returned with a CRC checksum. The checksum is obtained by binary addition.

For example, if the data returned by the command DI+ (CR) (the corresponding binary data are 44H, 49H, 2BH, 0DH) is +1234567E+0m3 (CR) (the corresponding binary data are 2BH, 31H, 32H, 33H, 34H, 35H, 36H, 37H, 45H, 2BH, 30H, 6DH, 33H, 20H, 0DH, and 0AH) then the data returned by the command PDI+ (CR) is +1234567E+0m3 !F7 (CR), "!" indicates that it is preceded by the summation character and followed by two bytes of checksum (2BH+31H+32H+33H+34H+35H+ 36H+37H+45H+2BH+30H+6DH+33H+20H=(2)F7H).

Note that "!" can be preceded by no data and there may be a space character.

（2）W Prefix

The usage of W prefix is W + digit string address code (must be 5 digits) + basic command, the digit string value range 0~65535 removes 13 (0DH carriage return), 10 (0AH line feed), 42 (2AH*), 38 (26H&). For example, to access the instantaneous flow rate of flow table No. 12345, the command W012345DV (CR) can be issued, and the corresponding binary code is 57H, 31H, 32H, 33H, 34H, 35H, 44H, 56H, 0DH.

（3）& Functional Symbols

& Functional symbols can be up to five basic commands (can be prefixed with P) together to form a composite command transmitted to the flow meter, the device at the same time to answer. For example, it is requested to send back 1. instantaneous flow, 2. instantaneous flow rate, 3. positive accumulation volume, 4. negative accumulation volume, 5. net cumulative volume of flow meter No. 4321 at the same time, and with the calibration, the command is sent as follows:

W04321PDQD&PDV&PDI+&PDI-&PDIN（CR）

The data returned simultaneously at one time may be as follows:

+0.000000E+00m3/d! AC（CR）

+0.000000E+00m/s! 88（CR）

+1234567E+0m3! F7（CR）

+0.000000E+0m3! DA（CR）

+0.000000E+0 m3! DA（CR）

8.2 MODBUS Communication Protocol

The MODBUS protocol of the device uses RTU transmission mode, and its check digit is obtained by using CRC-16-IBM (polynomial is X16+X15+X2+1, and the mask word is 0xA001) cyclic redundancy algorithm.

MODBUS RTU mode uses hexadecimal to transmit data.

8.2.1 MODBUS Protocol Function Code and Format

The device protocol supports the following two function codes of the MODBUS protocol:

Function Code	Function Data Represented
0x03	Read Register
0x06	Write Single Register

8.2.2 MODBUS Protocol Function Code 0x03 Usage

The host sent a read register information frame format：

Slave Address	Function Code	Register First Address	Number of Register	Check Code
1 byte	1 byte	2 bytes	2 bytes	2 bytes
0x01~0xF7	0x03	0x0000~0xFFFF	0x0000~0x7D	CRC Check Code

Slave return data frame format：

Slave Address	Read Operation Function Code	Bytes of Data	Data	Check Code
1 byte	1 byte	1 byte	N*x2 bytes	2 bytes
0x01~0xF7	0x03	2xN*	N*x2 data	CRC Check Code

N*＝Number of registers for data.

Device address (address of the device) ranges from 1 to 247 (hexadecimal: 0x01 to 0xF7), the address can be viewed in the menu "Communication Settings \ RS485 Address", such as the display of the network identification address of 11, then the device in the MODBUS protocol address is: 0x0B.

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

Example 1: To read the instantaneous flow rate (m3/h) in hourly units of the device with address 1 (0x01) in RTU mode, i.e., to read the data in the two registers 40005 and 40006, the read command is as follows:

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

Device Address Function Code Register First Address Number of Register CRC Check Code

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

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

Device Address Function Code Bytes of Data Data（1.2345678） CRC Check Code

The four bytes of 3F 9E 06 51 four bytes is the IEEE754 format single-precision floating-point form of 1.2345678.

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

Example 2. Reading the positive cumulative volume (m3) in m3 of the device at address 1 (0x01) in RTU mode, i.e., reading the data in the three registers at register addresses 0008, 0009 and 000A, the read command is as follows:

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

Devicer Address Function Code Register First Address Number of Register CRC Check Code

The data returned by the meter is (assuming current positive accumulation = 2.46m3)：

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

Device Address Function Code Register First Address Data（246*10-2） CRC Check Code

The four bytes of 00 00 00 F6 is 246 hexadecimal, which is directly convert hexadecimal data to decimal.

The two bytes of FF FE are -2 power of the 10. As shown in the table below:

MODBUS Data	Corresponding Index Unit	
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}
Positive, negative, net accumulation and energy accumulation are included.		

Example 3. Changing the address of a meter with address 1 (0x01) to 2 (0x02) in RTU mode, i.e., writing the data in the device 44100 register to 0x02, the write command is as follows:

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

Device Address Function Code Register Address Register Data CRC Check Code

The data returned by meter：

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

Device Address Function Code Register Address Register Data CRC Check Code

8.2.3 Error Handling

Only one error code will be returned by device,which is 0x02 indicating a data first address error.

For example, if you read only the 40002 register data of a device with address 1 (0x01) in RTU mode, the meter will think that the data integrity destroyed and send the command

0x01	0x03	0x00 0x01	0x00 0x01	0xD5 0xCA
Device Address	Function Code	Register First Address	Number of Register	CRC Check Code

The error code returned by meter：

0x01	0x83	0x02	0xC0 0xF1
Device Address	Error Code	Error Extension Code	CRC Check Code

8.2.4 MODBUS Register Address List

The MODBUS registers of this device contain read-only registers and single write registers.

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

Register Address	Register	Data Description	Data Type	Number of Register	Description
$0000	40001	Instantaneous flow/sec - low byte	32 bits real	2	
$0001	40002	Instantaneous flow/sec - high byte			
$0002	40003	Instantaneous flow/minute - low byte	32 bits real	2	
$0003	40004	Instantaneous flow/minute - high byte			
$0004	40005	Instantaneous flow/hour - low byte	32 bits real	2	
$0005	40006	Instantaneous flow/hour - high byte			
$0006	40007	Flow velocity - low byte	32 bits real	2	
$0007	40008	Flow velocity - high byte			
$0008	40009	Positive accumulative flow - low byte	32 bits int.	2	
$0009	40010	Positive accumulative flow - high byte			
$000A	40011	Positive accumulative flow－index	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	R=0x52 G=0x47 I=0x49
$001E	40031	Error code - characters 3,4	Reserved		
$001F	40032	Error code - characters 5,6	Reserved		
$003B	40060	Flow velocity unit - characters 1,2	String	2	
$003C	40061	Flow velocity unit - characters 3,4			
$003D	40062	Instantaneous flow unit - characters 1,2	String	2	
$003E	40063	Data Description			
$003F	40064	Instantaneous flow/sec - low byte	String	1	

Note：

a) a) The units of accumulation are available as follows:

1. “m3” －Cubic Meter
2. “L” －Litre
3. “Gal” －Gallon

b) When changing the address or communication baud rate of the device.the device will work according to the new address or communication baud rate immediately after returning the response with the original address or communication baud rate.

c) 16 bits int-represents a short integer, 32 bits int-represents a long integer, 32 bits real-represents a floating point number and String-represents a string.

9 Appendix 1—Pipe Diameter Comparison Table

Model	Pipe Material	Nominal Inner Diameter of Pipe	Applicable Range of Pipe Outer Diameter (mm)	Measurable Flow Range [0.03m/s ~5m/s] (m3/h)
MFCL	Stainless Steel PVC PPR Copper	DN10	13.5~18.5	0.01~1.5