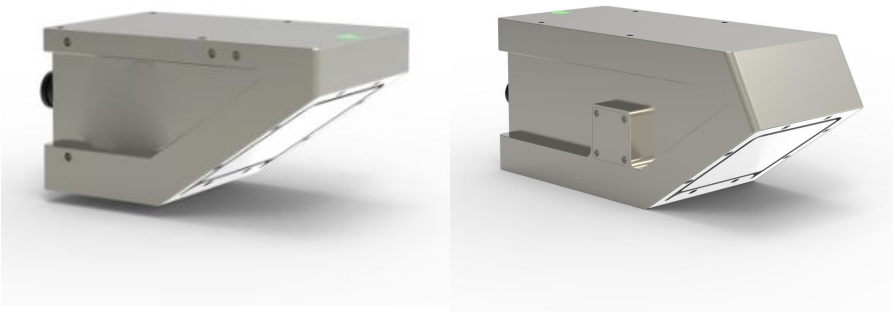
Radar Flow Meter

(Water Surface Velocity,Level,Flow)

JW-RD-600(HJ03)



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Note

Users of this manual must be aware of the dangers that this instrument and its accessories may pose.

All operators should be familiar with the safety instructions and warnings in this section before operating this instrument. Failure to follow the operating instructions may reduce the performance of the instrument or cause harm to humans.

Cautions and restrictions on use

Note: The design and manufacture of radar flowmeter products are safe and reliable. Please use them correctly (in accordance with the text shown) and fully observe the following precautions, which will not cause harm to the instrument and human body.

Example：

⚠ Instructions: Attention / Warning
Please refer to the precautions during transportation, use and maintenance.
Things to note are as follows:

Operating environment and power consumption precautions

⚠ WARNING: Do not use the instrument in locations where flammable or explosive gases are or may be present.
⚠ Note: Do not expose the instrument to water or place it in water.
⚠ Note: Do not place the instrument in extreme temperatures and avoid static electricity.

Instrument operation

⚠ Note: Regardless of the use, storage or transportation of the instrument, it should be handled with care and not damaged.
⚠ Note: The installation and setting of this radar flowmeter can only be installed and operated by professional technicians.
⚠ Note: Please do not disassemble or modify the radar flow meter, otherwise the warranty will not be given.
⚠ Note: If the instrument fails, please be sure to send it to our company for after-sale repair. Do not disassemble it by yourself!

RS232 interface,RS485 interface

⚠ Warning: The system equipment or computer equipment connected to the RS232 interface or RS485 must comply with the BS EN60950 / IEC950 standard.

Instrument parts

⚠ WARNING: This instrument is not equipped with internal spare parts and you must not disassemble the instrument parts without authorization.

Hazardous Substance Management

When discarding BGT-RD103, please observe the hazardous substance management regulations and dispose of as waste electronic / electrical products.

⚠ Warning: Do not dispose of used equipment in classified waste or municipal waste.

Use restrictions

The design of JW-RD-600(HJ03) meets the requirements of regularity and safety.

Statement

JW-RD-600(HJ03) is designed to meet and adhere to the requirements of low voltage specifications.

Contents

1. Product Introduction

1.1 Introduction

JW-RD-600(HJ03) radar flowmeter is a non-contact integrated flow monitoring equipment which can realize non-contact real-time measurement of water level, velocity and flow in rivers, open channels, reservoirs, sewage pipe network, flood prevention and early warning, etc. According to the built-in software algorithm, calculate and output the instantaneous cross-section flow and cumulative flow, output the flow rate and water level, easily connect with the database platform, and view the measurement information on the cloud platform. Support digital (RS485, RS232) or analog (4~20mA) transmission of measurement results, using standard Modbus RTU protocol, RTU using hydrological protocol SL651 protocol, in order to meet the personalized needs of customers, we can also provide custom protocol.

BGT-RD103 radar flowmeter supports digital (RS485, RS232) or analog (4~20mA) transmission interface. BGT-RD103 radar flowmeter has the characteristics of low power consumption, small size, high reliability, simple operation and convenient maintenance; the measurement process is not affected by environmental factors such as temperature, air pressure, sediment, dust, river pollutants, floating objects on the water surface and air.

1.2 Specification features

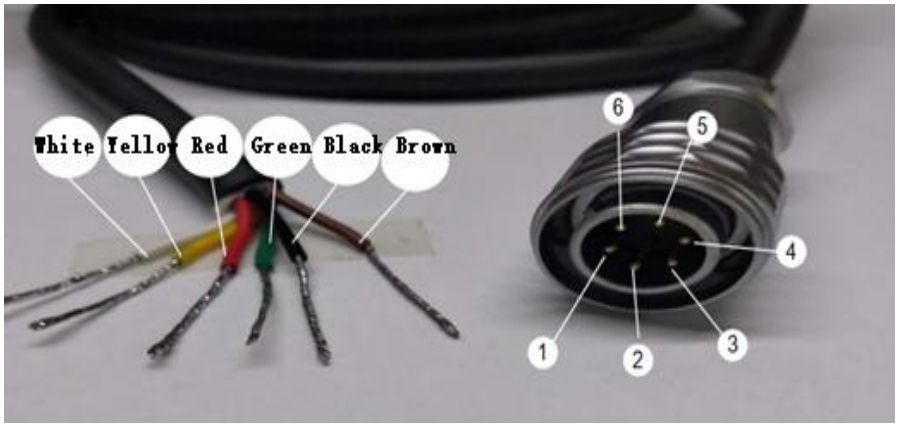
1.2.1 Equipment features

1) Small size, high reliability, simple operation and convenient maintenance;
2) It is not affected by temperature, sediment, dust, river pollutants, floating objects on the water surface, air pressure and other environmental factors;
3) It is used for non-contact flow measurement in open channel, river channel, irrigation channel, underground drainage network, flood control and other occasions;
4) Non contact measurement,convenient measurement,no pollution to the environment;
5) It has a rainy day mode to prevent interference caused by rain;
6) The waterproof grade is IP68, which can effectively prevent the internal devices from getting damp;
7) Low power consumption, solar power supply, easy installation and maintenance free;

1.2.2 Electrical characteristics

1) 7~30V / 5.5~32V (optional) power supply, wide power supply voltage facilitates the selection of power supply mode;
2) Low working current and standby current, solar power supply, easy installation and maintenance free;
3) Lightning protection circuit, can lightning protection 6KV, Thunderstorm Day can effectively protect equipment against lightning stroke;
4) The test precision is high and the data is stable. Ensure the accuracy of the test effectively;
5) Support RS485, RS232, 4~20mA and other wired communication modes;

1.2.3 Pin configuration



1	Brown	7~30V/ 5.5~32V DC power supply
2	Black	GND
3	Green	TXD_A(232_TX/485_A+)
4	Red	RXD_B(232_RX/485_B-)
5	Yellow	IOUT(4-20mA positive, reserved)
6	White	IOUT(4-20mA negative, reserved)

1.3 Measurement principle

JW-RD-600(HJ03) radar flowmeter adopts planar microwave technology, uses Doppler radar principle to measure surface velocity of water flow, and uses built-in microstrip radar technology to measure water level. According to the velocity area method, the cross-section area is converted from the measured water level, and then the average velocity is converted from the surface velocity combined with the cross-section parameters. The empirical formula of the velocity distribution of circular, rectangular and trapezoidal open channel cross-section is established, and the hydraulic model algorithm is used to calculate the discharge. It is a non-contact type, which can accurately measure the flow without changing the boundary conditions of channels, rivers and pipelines Flow measuring instrument.

1.3.1 Principle of velocity measurement

The radar flow meter uses the principle of Doppler radar speed measurement. When measuring the speed of the water surface, the radar velocity sensor emits microwaves to the water surface. After encountering the water surface, the microwaves will be absorbed and reflected. A part of the reflected wave is received by the flowmeter probe, and then converted into an electrical signal. The Doppler frequency shift is processed by the measurement circuit, and then the water flow velocity can be calculated by using a signal processing algorithm such as FFT according to the above principle.

The principle of Doppler velocimetry is as follows: When the radar wave transmitting source and the target are relatively stationary, the receiving frequency and the transmitting frequency are equal:

$$f_R = f_0 = \frac{c_0}{\lambda} \qquad 1.1$$

When the position of the transmitting wave source is fixed and the moving target moves in the direction of the wave source relative to the transmitting wave source, the speed of the radar wave for the moving target increases to $c_0 + v$, and the number of wavelengths of the radar wave reaching the moving target in a unit time is the receiving frequency. for:

$$f_R' = \frac{c_0 + v}{\lambda} \quad 1.2$$

Doppler shift:

$$f_D = f_R' - f_0 \quad 1.3$$

Movement speed of the moving target:

$$v = f_D \cdot \lambda = \frac{f_D}{f_0} \cdot c_0 \quad 1.4$$

When the value is positive, it means that the speed is in the same direction as the transmitted wave, and the negative sign is in the reverse direction; the speed of the moving target is proportional to the frequency shift, then:

$$v = \left(\frac{f_R'}{f_0} - 1 \right) \cdot c \quad 1.5$$

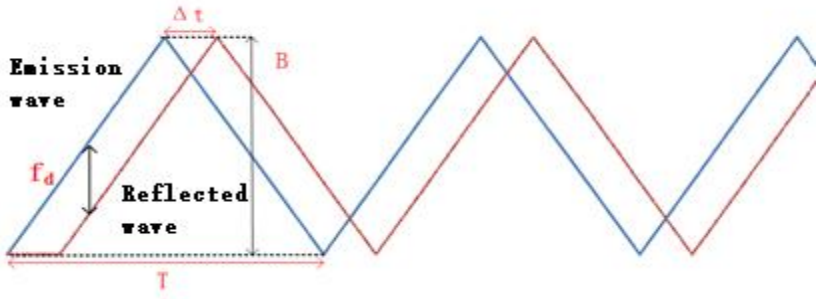
When measuring the speed of the river water surface, the radar velocity sensor emits microwaves to the water surface. After encountering water waves, blisters, and floating objects (measured moving targets), the microwaves will be absorbed and reflected, and a part of the reflected waves will be received and converted by the probe. The electrical signal is processed by the measurement circuit and the Doppler frequency shift is measured, and then the flow velocity of the water body can be calculated through the FFT floating-point operation according to the above principle. Because the radar wave emission direction and the direction of the water current usually have a certain angle, and the simultaneous transmission and reception requires a distance back and forth, the above results need to be corrected. The corrected actual water flow speed is (α represents the radar wave emission direction and the horizontal direction angle):

$$v = \frac{1}{2} \left(\frac{f_R'}{f_0} - 1 \right) \cdot c_0 / \cos\alpha \quad 1.6$$

According to the above formula, the velocity of the water body can be obtained.

1.3.2 Principle of water level measurement

The water level adopts FMCW modulation, and the triangle wave is used as the modulation signal. The working process is as follows: first, the voltage modulation circuit generates a triangular wave voltage and inputs it to a VCO (voltage-controlled oscillator) to generate electromagnetic waves with a frequency change. The frequency of the electromagnetic wave changes according to the modulation voltage law. The electromagnetic waves emitted by the antenna are reflected back after being reflected by the measured object. Waves, electromagnetic waves from the beginning to the target, reflected by the target and then returned to the antenna within the time period of the radar transmission frequency has changed, the radar antenna couples the echo signal with the transmitted signal to obtain the difference frequency signal, the target's distance and speed information It is included in the frequency of the difference frequency signal. Because the difference frequency signal is very weak, it is processed by the pre-amplification and filtering circuit of the radar sensor, and the signal is sent to the ADC (analog-to-digital converter) of the MCU. The MCU analyzes the ADC collected by the FFT algorithm. The frequency of the difference frequency is obtained from the waveform. Finally, the distance from the measured target to the sensor is calculated by the derived formula.



When the radar wave transmitting source and target are relatively stationary, the radar transmitting frequency bandwidth is B, the time from when the radar wave is transmitted back to the radar antenna is Δ t, the frequency of the triangular wave is f, and the frequency of the difference frequency signal is fd. Derived as follows: (S: distance from radar board to target, T: period of triangle wave)

$$\Delta t = \frac{2S}{c_0}$$

$$T = \frac{1}{2f}$$

$$S = \frac{f_d C_0}{4fB}$$

In the above formula, **C0** is the speed of light, f is the frequency of the modulated triangle wave, **B** is the radar sweep frequency bandwidth, and **fd** is the difference frequency signal obtained by the **MCU** analysis, so the only fd can calculate the distance between the radar board and the target.

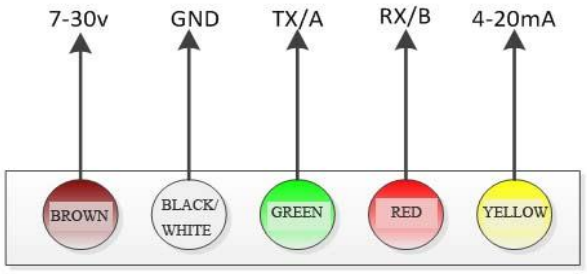
1.3.3 Flow measurement principle

The average velocity can be obtained and converted by the radar velocity probe, and the water depth can be obtained and converted by the radar water level probe. The cross-section flow is equal to the average velocity x the cross-sectional area of the flow and the shore coefficient. In the open channel of irrigation area, the common section types of open channel are rectangular, trapezoidal or U-shaped; the commonly used slope is the longitudinal slope of trunk and branch canals; the two commonly used roughness are concrete channel wall and masonry channel wall. For these common open channels, the bottom slope and roughness are determined. In the velocity distribution of the cross-section, the velocity has strong symmetry. Moreover, the upstream and downstream straight sections of the cross-section of the irrigation area are long, and the cross-section is symmetrical, so the velocity distribution has the characteristics of good symmetry. According to the cross-section form, bottom (longitudinal) slope and roughness, the distribution of convective velocity field is modified; the main turbulence mathematical model used is RNG (renormalization group) κ - ε model, with high calculation accuracy, good numerical stability and moderate amount of calculation data.

2. Product Introduction

2.1 Wiring

As shown in the figure below, brown line is the positive input of power supply, black / white is GND line, TX (green a) is RS232 output interface or RS485 positive pole of radar flowmeter, RX (red b) is RS232 input interface or RS485 negative pole of integrated radar flowmeter, the maximum transmission distance of RS232 communication interface is about 15m; the maximum transmission distance of RS485 interface is about 1.5km, and the yellow line is the positive pole of 4-20mA (reserved).



2.2 Settings

Communication format
Communication interface: RS485
Baud rate: settable (9600 by default)
Check bit: None
Data bit: 8bit
Stop bit: 1

2.3 Wired mode description

JW-RD-600(HJ03) radar flowmeter is compatible with the standard MODBUS-RTU communication protocol.
Our company can also provide customized communication protocol for users.
JW-RD-600(HJ03) radar flowmeter has two working modes: normal operation and regular sleep.
When the sleep time register is set to 0, the device is in normal working mode. If it is greater than 0, it will enter into the timing sleep mode. After the equipment measurement is completed, it will sleep according to the set sleep time (minutes), and the measurement will continue until the sleep time.

2.3.1 Normal operation

Radar flowmeter is in continuous working state, continuous sampling measurement, relatively high power consumption, return to the latest measurement results, fast response, good real-time performance.

2.3.2 Sleep mode

After setting the dormancy time of the equipment, the flowmeter will measure and save the latest flow rate, water level and other data before entering the sleep mode. When the sleep time is set, it will exit the sleep mode, and the flowmeter will be awakened automatically. The wake-up flowmeter will measure

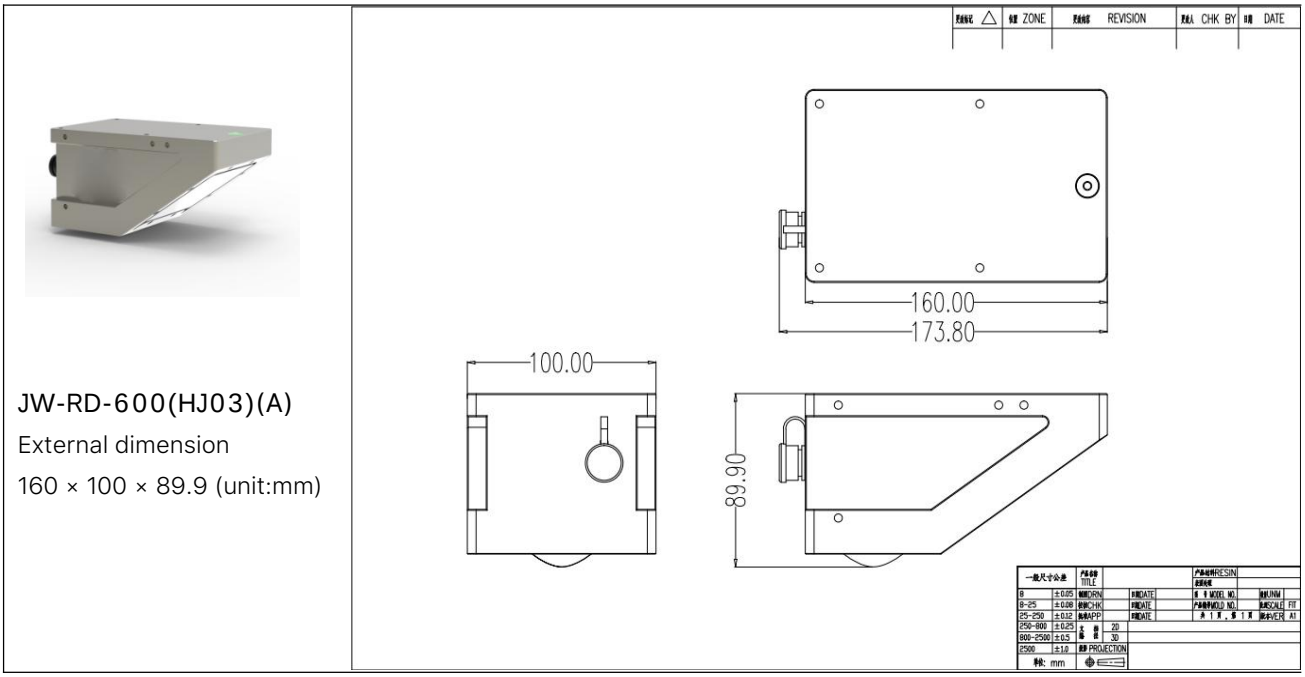
the latest flow after wake-up in the shortest time **(note that the cumulative flow at this time is the product of the latest measured flow after wake-up and sleep time, plus the accumulated flow before sleep).**

Because in this period of dormancy, there may be unpredictable flow changes, which will lead to the instability of the flow velocity during the dormancy period, resulting in the statistical cumulative flow during the dormancy period will be different from the actual cumulative flow. In order to ensure the accuracy of the accumulated flow, it is suggested that the sleep time should not be set too long or the flowmeter should not be put into sleep or power down mode. **(Note: sleep time can be set)**

3. Product Installation

3.1 Instrument structure and appearance dimension drawing

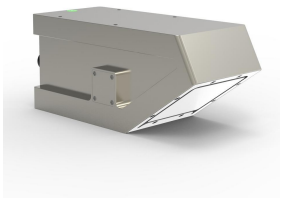
3.1.1 Appearance and dimension of BGT-RD103 instrument



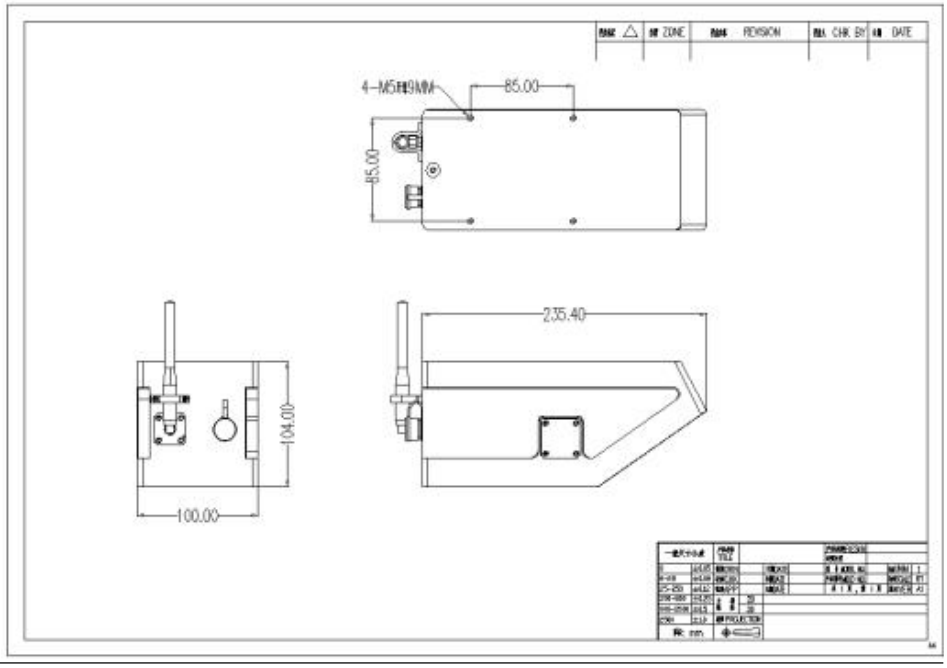
JW-RD-600(HJ03)(A)

External dimension

160 × 100 × 89.9 (unit:mm)

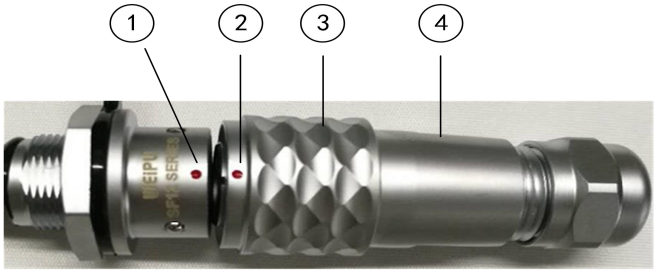


JW-RD-600(HJ03)(B)
External dimension
235.4×100×104 (unit:mm)



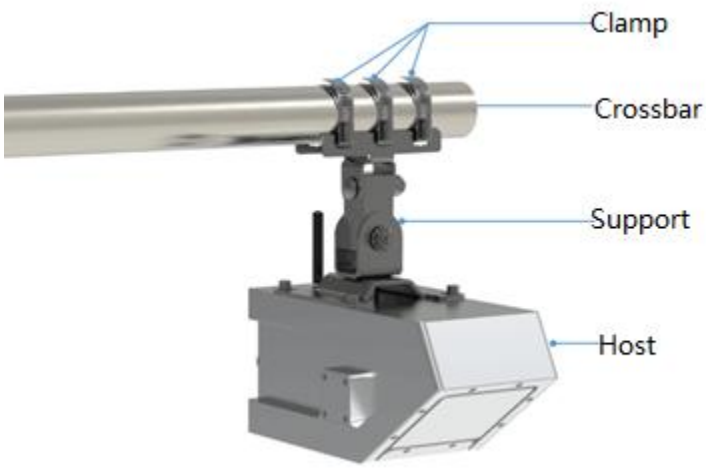
3.2 Plug installation

As shown in the figure below, when the cable is inserted into the instrument, hold the position of the cable line (4), align the red dot (2) of the cable plug with the red dot (1) of the instrument interface, and plug it in when you hear a sound. When pulling it out, hold the position of the cable (3) and pull it out.



3.3 Site installation

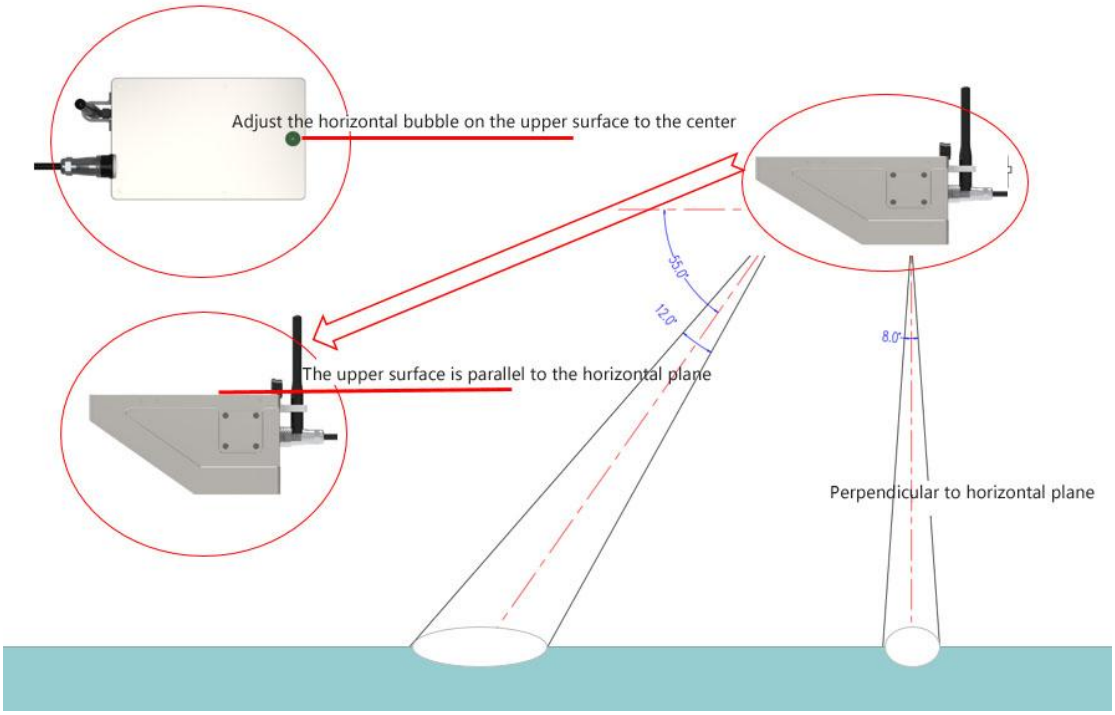
3.3.1 Instrument installation method and direction



The installation direction is shown in the figure above. Three clamps fix the bracket and instrument on the cross bar (diameter range: 40-85mm). During installation, keep the upper surface of the instrument and the river level **(Note: adjust the bubble of the level meter to the middle)**. The installation direction is suggested: the flow relative to the flow velocity measurement is facing.

3.3.2 Selection of measuring points

When selecting the installation site, it is necessary to ensure that the radar wave covers the water surface to avoid the influence of floating objects, vortices and aquatic plants. It is also necessary to avoid the measurement error caused by the radar wave covering the ground due to the river bed silting in low water period and the swing of the main channel. The transmitting angle of radar water level sensor is 8° and the coverage is approximately circular; the transmitting angle of radar velocity sensor is 12° and the coverage is approximate ellipse, as shown in the figure below



The relationship between the diameter of a circle and distance is shown in the following table:

Installation height(m)	Velocity meter covers diameter range(m)	Water level gauge covers diameter range(m)
0.2	0.073	0.028
0.5	0.168	0.07
1	0.325	0.14
2	0.64	0.28
3	0.955	0.42
5	1.585	0.7
7	2.215	0.98

The selection of channel measurement points should follow the following main principles:

1) The channel is straight, the foundation is fixed and the section is regular and stable, which is convenient for equipment installation;

2) The flow is smooth and uniform, and is not affected by vortex, gate opening and closing and backwater of canal system structures;

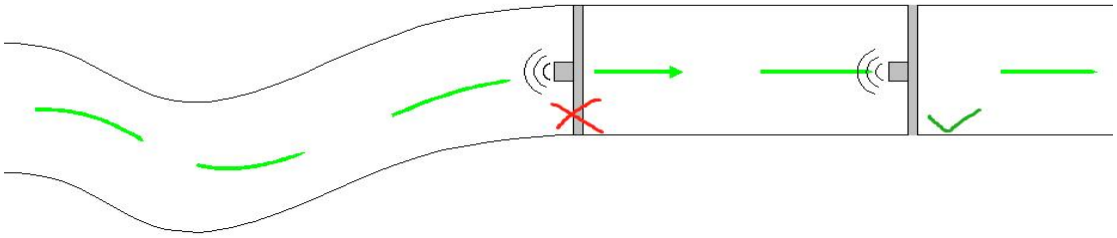
3) The measuring section is perpendicular to the flow direction;

4) There should be no buildings, trees or weeds near the section that will affect the flow, and will not be affected by the discharge when it is downstream of the building;

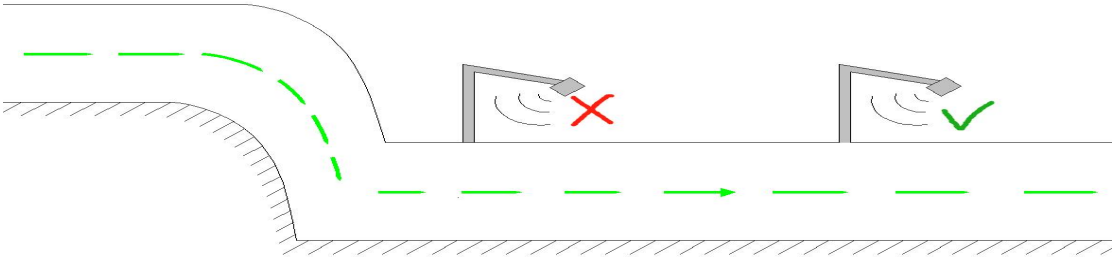
5) It should not be installed in the place with serious siltation, water grass or debris.

For non-contact measurement equipment such as radar flowmeters, the installation points should be avoided as follows

1) Avoid places where the direction of the river or channel water flow changes, and try to ensure that the water flow direction is parallel to the radar flowmeter installation direction;



2) Avoid the direction of the flow rate probe of the radar meter facing the large drop current;



3) Avoid installation above the gate and above the cistern with undercurrent. The typical feature of this scenario is the lowering of the water level, but the undercurrent under the water surface cannot cause a stable flow velocity on the surfaceand is not suitable for the installation point;

4) Avoid installation points located at the exit of culverts, mountain pass air ducts, etc., where wind is likely to rise. Wind has a certain effect on low flow velocity measurement.

3.3.3 Precautions

1. When the instrument is installed, the upper surface is level with the river surface;
2. Do not install the instrument at the corner;
3. Do not install the instrument at the height drop;
4. Do not install the instrument on the water surface with vortex.

4. Communication protocol

4.1 Modbus-RTU protocol

The communication mode of Modbus protocol is single-master/multi-slave mode. Only the master station can issue an inquiry. The slave station performs the processing required by the inquiry and responds with information.

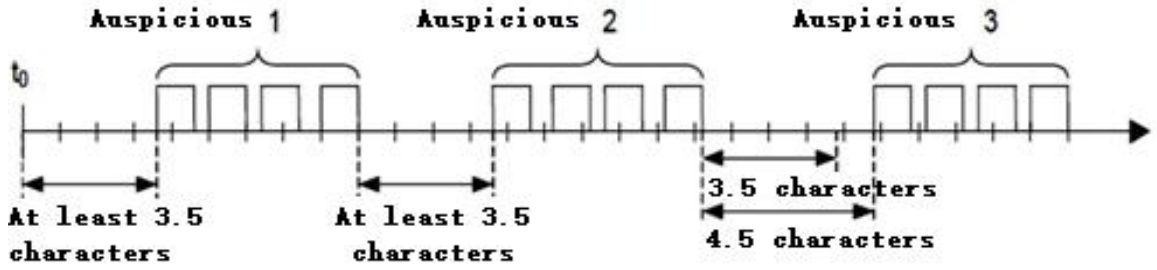
4.1.1 Modbus-RTU transmission mode

When the device uses the RTU (Remote Terminal Unit) mode to communicate on the Modbus serial link, each 8-bit byte in the message contains two 4-bit hexadecimal characters. The main advantage of this mode is higher data density and higher throughput than ASCII mode at the same baud rate. Each message must be transmitted in a continuous stream of characters.

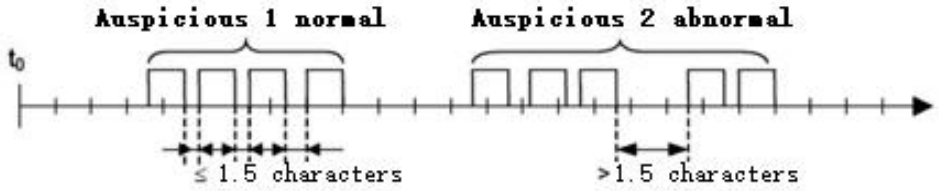
Frame description:

Device address	Function code	Data	CRC
1 byte	1byte	0~252 byte	2 byte CRC low CRC high

The message frame is distinguished by an idle interval with a duration of at least 3.5 characters, called t3.5. This module uses the standard t3.5 as the idle interval. RTU frame transmission idle interval distinction diagram is as follows



If the idle interval between two characters is greater than 1.5 character time, the message frame is considered incomplete and should be discarded by the receiving node. This idle time is called t1.5, and this module uses the standard t1.5 time. RTU frame transmission judging abnormal frame idle interval diagram is as follows



4.1.2 Modbus-RTU data model

Modbus is based on a series of data models with different characteristics. The two basic models used

by the equipment are as follows:

Register type	Object type	Access type	Content
Input register	16-bit	Read only	I/O system provides this type of data
Holding register	16-bit	Read and write	Change this type of data through the application

4.1.3 Commonly used function codes of Modbus-RTU

Function code name	Function code
Read input register	0x04
Read holding register	0x03
Write a single holding register	0x06
Write multiple holding registers	0x10

4.1.3.1 Read holding register (0x03)

Read the current value of the holding register 0x001B baud rate.

Request message

Slave address	Function code	Register address	Number of registers	CRC check value
80	03	00 1B	00 01	EA 1C

Response message

Slave address	Function code	Number of bytes	Register value	CRC check value
80	03	02	00 01	45 9A

Note: The CRC check value will change with the change of the register value in the response message

The current baud rate value is 1 (9600bps).

4.1.3.2 Read input register (0x04)

Read the input voltage value of the input register 0x000D.

Request message

Slave address	Function code	Register address	Number of registers	CRC check value
80	04	00 0D	00 01	BE 18

Response message

Slave address	Function code	Number of bytes	Register value	CRC check value
80	04	02	00 78	85 0C

Note: The CRC check value will change with the change of the register value in the response message

The current input voltage value is 0x0078 (0x0078/10=12V).

4.1.3.3 Write a single holding register (0x06)

Set the holding register 0x001B in slave address 0x80 and the baud rate is 0x01 (9600bps).

Request message

Slave address	Function code	Register address	Register value	CRC check value
80	06	00 1B	00 01	26 1C

Response message

Slave address	Function code	Register address	Register value	CRC check value
80	06	00 1B	00 01	26 1C

4.1.3.4 Write multiple holding registers (0x10)

Set the holding register 0x000F in the slave address 0x80 to 0x01 (circular), the holding register 0x0010, the distance from the water level gauge to the bottom of the channel is 0x64 (1.0m), and the holding register 0x0011 the radius of the circular channel to 0x64 (1.0m)

Request message

Slave address	Function code	Starting address	Number of registers	Number of bytes	Register value	CRC check value
80	10	00 0F	00 03	06	00 01 00 64 00 64	56 04

Response message

Slave address	Function code	Starting address	Number of registers	CRC check value
80	10	00 0F	00 03	AE 1A

Note: The CRC check value will change with the change of the register value in the request message

4.1.4 Cyclic Redundancy Check (CRC)

CRC is the most commonly used error check code in the field of data communication. Its characteristic is that the length of the information field and the check field can be arbitrarily selected (using the CRC-16 check code agreed by the standard modbus).

The use of CRC-16 check code:

According to the Modbus protocol, the information sending form of conventional RS485 communication is as follows:

Address	Function code	Data information	CRC check value
1byte	1byte	N byte	2byte

CRC check is the check value of the previous data content, which is a 16-bit data. When sending, the low 8 bits are first and the high 8 bits are last.

The receiver uses the same calculation method to calculate the check code of the information field and compares it with the actual check code received. If it is equal, the information is correct, and if it is not equal, the information is wrong.

CRC-16 check code calculation method:

```
*pucFrame is the first address of the data to be verified, usLen is the length of the data to be verified. The
return value is the verification result.USHORT usMBCRC16( UCHAR * pucFrame, USHORT usLen )
{
        UCHAR ucCRCHi = 0xFF;
        UCHAR ucCRCLo = 0xFF;
        int iIndex;
        while( usLen-- )
       {
          iIndex = ucCRCLo ^ *( pucFrame++ );
        ucCRCLo = ( UCHAR )( ucCRCHi ^ aucCRCHi[iIndex] );
        ucCRCHi = aucCRCLo[iIndex];
```

```
        }
        return ( USHORT )( ucCRCHi << 8 | ucCRCLo );
}
static const UCHAR aucCRCHi[] = {
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x00, 0xC1, 0x81, 0x40,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40, 0x01, 0xC0, 0x80, 0x41, 0x01, 0xC0, 0x80, 0x41,
    0x00, 0xC1, 0x81, 0x40
};
static const UCHAR aucCRCLo[] = {
    0x00, 0xC0, 0xC1, 0x01, 0xC3, 0x03, 0x02, 0xC2, 0xC6, 0x06, 0x07, 0xC7,
0x05, 0xC5, 0xC4, 0x04, 0xCC, 0x0C, 0x0D, 0xCD, 0x0F, 0xCF, 0xCE, 0x0E,
    0x0A, 0xCA, 0xCB, 0x0B, 0xC9, 0x09, 0x08, 0xC8, 0xD8, 0x18, 0x19, 0xD9,
    0x1B, 0xDB, 0xDA, 0x1A, 0x1E, 0xDE, 0xDF, 0x1F, 0xDD, 0x1D, 0x1C, 0xDC,
    0x14, 0xD4, 0xD5, 0x15, 0xD7, 0x17, 0x16, 0xD6, 0xD2, 0x12, 0x13, 0xD3,
    0x11, 0xD1, 0xD0, 0x10, 0xF0, 0x30, 0x31, 0xF1, 0x33, 0xF3, 0xF2, 0x32,
    0x36, 0xF6, 0xF7, 0x37, 0xF5, 0x35, 0x34, 0xF4, 0x3C, 0xFC, 0xFD, 0x3D,
    0xFF, 0x3F, 0x3E, 0xFE, 0xFA, 0x3A, 0x3B, 0xFB, 0x39, 0xF9, 0xF8, 0x38,
    0x28, 0xE8, 0xE9, 0x29, 0xEB, 0x2B, 0x2A, 0xEA, 0xEE, 0x2E, 0x2F, 0xEF,
    0x2D, 0xED, 0xEC, 0x2C, 0xE4, 0x24, 0x25, 0xE5, 0x27, 0xE7, 0xE6, 0x26,
    0x22, 0xE2, 0xE3, 0x23, 0xE1, 0x21, 0x20, 0xE0, 0xA0, 0x60, 0x61, 0xA1,
    0x63, 0xA3, 0xA2, 0x62, 0x66, 0xA6, 0xA7, 0x67, 0xA5, 0x65, 0x64, 0xA4,
    0x6C, 0xAC, 0xAD, 0x6D, 0xAF, 0x6F, 0x6E, 0xAE, 0xAA, 0x6A, 0x6B, 0xAB,
    0x69, 0xA9, 0xA8, 0x68, 0x78, 0xB8, 0xB9, 0x79, 0xBB, 0x7B, 0x7A, 0xBA,
    0xBE, 0x7E, 0x7F, 0xBF, 0x7D, 0xBD, 0xBC, 0x7C, 0xB4, 0x74, 0x75, 0xB5,
    0x77, 0xB7, 0xB6, 0x76, 0x72, 0xB2, 0xB3, 0x73, 0xB1, 0x71, 0x70, 0xB0,
    0x50, 0x90, 0x91, 0x51, 0x93, 0x53, 0x52, 0x92, 0x96, 0x56, 0x57, 0x97,
    0x55, 0x95, 0x94, 0x54, 0x9C, 0x5C, 0x5D, 0x9D, 0x5F, 0x9F, 0x9E, 0x5E,
    0x5A, 0x9A, 0x9B, 0x5B, 0x99, 0x59, 0x58, 0x98, 0x88, 0x48, 0x49, 0x89,
    0x4B, 0x8B, 0x8A, 0x4A, 0x4E, 0x8E, 0x8F, 0x4F, 0x8D, 0x4D, 0x4C, 0x8C,
    0x44, 0x84, 0x85, 0x45, 0x87, 0x47, 0x46, 0x86, 0x82, 0x42, 0x43, 0x83,
    0x41, 0x81, 0x80, 0x40
};
```

4.1.5 Response to abnormal communication

When the master station device sends a request to the slave station device, the master station hopes to get a normal response. The inquiry of the master station may cause one of the following four events:

----If the slave device receives a request without communication error and can process the inquiry normally, the slave device will return a normal response.

----If the slave does not receive the request due to a communication error, it cannot return a response. The master station program will be processed as timeout.

----If the slave station receives the request, but detects a communication error (parity, CRC...), then the master station program that cannot return a response will be processed as timeout.

----If the slave device receives a request without communication error, but cannot handle the request (for example, if a request is made to read an input register that does not exist), the slave station will return an abnormal response to notify the client of the error the reason.

The abnormal response message has two different fields from the normal response message:

Function code field: In a normal response, the function code field of the response from the slave is assigned the function code of the original request. The MSB of all function codes is 0 (their values are lower than hexadecimal 80). In the abnormal response, the MSB of the function code of the slave station is set to 1. This makes the function code value in the abnormal response higher than the function code value in the normal response by hexadecimal 80.

By setting the function code MSB, the application program of the master station can identify the abnormal response and can detect the data field of the abnormal code. Data field: In a normal response, the slave station can return data or statistical values (any information required in the request) in the data field.

In the exception response, the slave station returns an exception code in the data field. This explains the cause of the exception. The exception response message of all supported function codes is the function code plus 0x80.

All abnormal function codes are 0x83, 0x84, 0x86, 0x88, 0x90, 0x97.

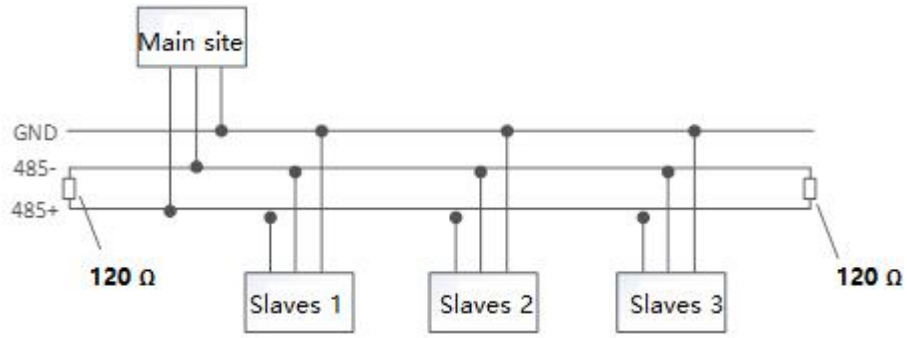
The abnormal response message corresponding to function code 0x06 is as follows:

Slave address	Function code	Exception code	CRC check value
80	86	01	3D 88

Exception code	Exception name	Description
01	Illegal function code	Function code cannot be recognized, not within 0x00~0x0F
02	Illegal data address	Data address exceeds definition
03	Illegal data value	Value outside of register storage
04	Slave device failure	Unrecoverable error

4.1.6 Terminal resistance

In the process of network construction, if the network is terminated and embedded to connect to other Modbus devices, a 120 ohm terminal matching resistor needs to be connected at the end of the network..



4.2 Equipment debugging

4.2.1 Device address

The device address can be set by setting the value of the holding register address 0x001C, and the range can be set from 1 to 200. The factory default slave address is 0x80. After the slave address is set successfully, it will be saved automatically. (Can be set through our company's professional debugging software)

Example for setting the device address to 0x01

Request message

Slave address	Function code	Register address	Register value	CRC check value
80	06	00 1C	00 01	97 DD

Response message

Slave address	Function code	Register address	Register value	CRC check value
80	06	00 1C	00 01	97 DD

When you forget the device address, you can specify the device address as 0xFF, and query the register address 0x001C through the Modbus protocol 03 function code to obtain the real address of the device.

Note: When using this method to query the device address, only one device can be connected to the 485 bus.

Example of querying device address

Request message

Slave address	Function code	Register address	Register value	CRC check value
FF	03	00 1C	00 01	50 12

Response message

Slave address	Function code	Number of bytes	Register value	CRC check value
80	03	02	00 80	85 FA

Note: The CRC check value will change with the change of the register value in the response message

The register value 0x0080 in the response message is the real device address of the device.

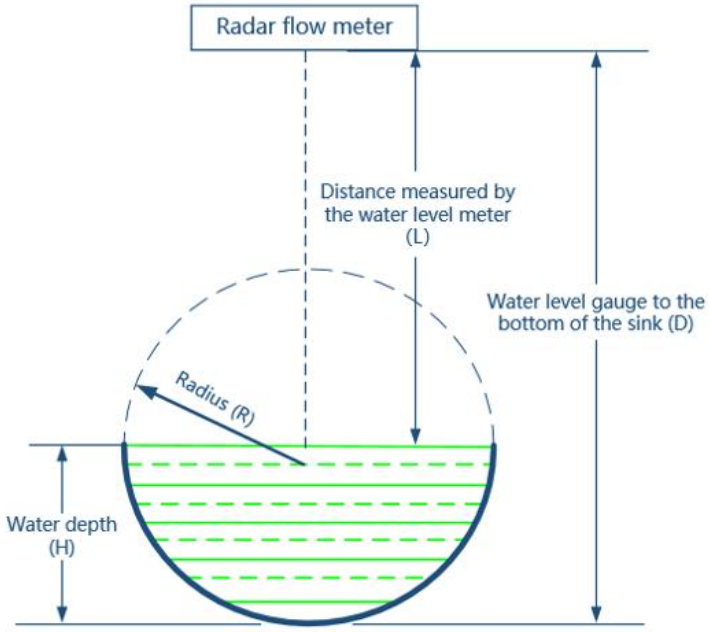
4.2.2 Channel shape

The device supports three basic types of water channel shapes, which are circular, trapezoidal and U-shaped. Rectangular and triangular water channels can be obtained by adjusting the length of the bottom and top sides of the trapezoid. Drain parameters support Modbus protocol 0x06 and 0x10 function code setting, support 0x03 function code reading. Set the register of the channel shape to 0x000F, the value is as follows

Register value	Description
0x01	Round
0x02	Trapezoid
0x03	U type

4.2.2.1 Circular water channel

The parameters that need to be set for a circular channel are the channel shape, the distance from the flowmeter to the bottom of the channel, and the radius of the circular channel. The distance from the flowmeter to the bottom of the channel and the radius of the circular channel need to be written after magnifying the actual value by 100 times. For example, the actual value is 1.23 The value written in m is 123. Note that you need to convert the decimal value into hexadecimal and then enter it (123 corresponds to hexadecimal 7B).



The address of the holding register corresponding to the parameters of the circular channel

Function	Register address	Number of registers
Canal shape	0x000F	1
Distance from the water level gauge to the bottom of the canal	0x0010	1
Round canal radius	0x0011	1

Example of setting circular channel parameters
Set the shape of the canal to a circle and send a request message
(the response message is the same as the request message)

Slave address	function code	Register address	Register value	CRC Check value
80	06	00 0F	00 01	66 18

Set the distance from the water level meter to the bottom of the canal to 1.0m in decimal (100 times magnification is 100, which is equal to 0x64 in hexadecimal), and send the request message (the response message is the same as the request message)

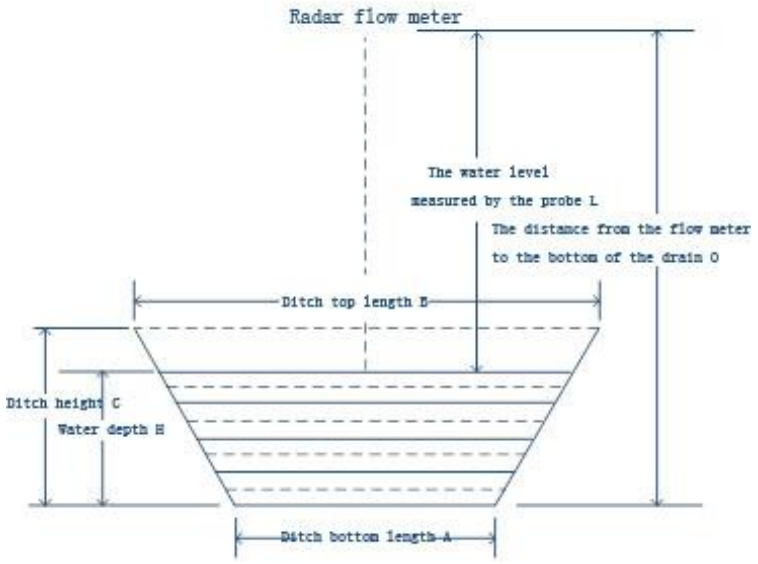
Slave address	function code	Register address	Register value	CRC Check value
80	06	00 10	00 64	97 F5

Set the circular canal radius to 1.0m and send the request message (the response message is the same as the request message)

Slave address	function code	Register address	Register value	CRC Check value
80	06	00 11	00 64	C6 35

4.2.2.2 Trapezoidal Channel

The parameters required for the trapezoidal canal are the shape of the canal, the distance from the radar flow meter to the bottom of the canal, the length of the bottom of the trapezoidal canal, the length of the top of the trapezoidal canal, and the height of the trapezoidal canal. The distance from the radar flow meter to the bottom of the canal, the length of the bottom edge of the trapezoidal canal, the length of the top edge of the trapezoidal canal, and the height of the trapezoidal canal need to be enlarged by 100 times. If the actual value is 1.23m, the value written is 123. Note that The decimal value is converted into hexadecimal and brought in (123 corresponds to 7B in hexadecimal).



Holding register address corresponding to the trapezoidal channel parameter
response message is the same as the request message)

Function	Register address	Number of registers
Canal shape	0x000F	1
Distance from the radar flow meter to the bottom of the canal	0x0010	1
Length of bottom of trapezoidal canal	0x0012	1
Top of trapezoidal canal	0x0013	1
Trapezoidal channel height	0x0014	1

Example of setting trapezoidal channel parameters
Set the channel shape to trapezoidal and send the request message (the response message is the same as the request message)

Slave address	Function code	Register address	Register value	CRC Check value
80	06	00 0F	00 02	26 19

Set the distance from the radar flow meter to the bottom of the canal to 1.0m in decimal (100 times magnification is 100, which is equal to 0x64 in hexadecimal), and send the request message (the response message is the same as the request message)

Slave address	Function code	Register address	Register value	CRC Check value
80	06	00 10	00 64	97 F5

Set the bottom length of the trapezoidal canal to 1.0m and send the request message (the response message is the same as the request message)

Slave address	Function code	Register address	Register value	CRC Check value
80	06	00 12	00 64	36 35

Set the top edge length of the trapezoidal canal to 1.0m, and send the request message (the response message is the same as the request message)

Slave address	Function code	Register address	Register value	CRC Check value
80	06	00 13	00 64	67 F5

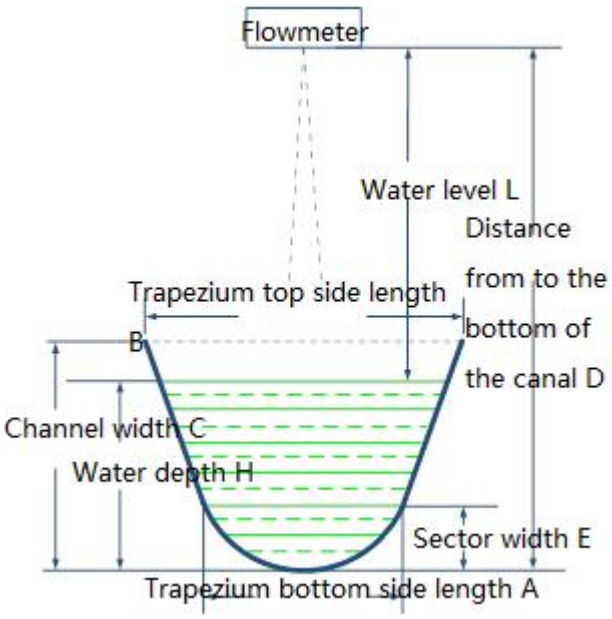
Set the trapezoidal canal height to 1.0m and send the request message (the response message is the same as the request message)

Slave address	Function code	Register address	Register value	CRC Check value
80	06	00 14	00 64	D6 34

4.2.2.3 U-shaped channel

The parameters required for the U-shaped canal are the shape of the canal, the distance from the radar flow meter to the bottom of the canal, the height of the fan, the length of the bottom edge of the trapezoidal part, the length of the top edge of the trapezoidal part, and the height of the canal. The distance from the radar flow meter to the bottom of the canal, the height of the fan, the length of the bottom of the trapezoidal part, the length of the top of the trapezoidal part, and the height of the canal

need to be enlarged by 100 times the actual value. If the actual value is 1.23m, the value written is 123. You need to convert the decimal value into hexadecimal and bring it in (123 corresponds to 7B in hexadecimal).



Holding register address corresponding to U-shaped channel parameter

Function	Register address	Number of registers
Canal shape	0x000F	1
Distance from the radar flow meter to the bottom of the canal	0x0010	1
Sector height	0x0011	1
Length of bottom edge of trapezoidal part	0x0012	1
Top side of trapezoidal part	0x0013	1
Canal height	0x0014	1

Example of setting U-shaped channel parameters

Set the channel shape to U-shaped, and send the request message (the response message is the same as the request message)

Slave address	function code	Register address	Register value	CRC Check value
80	06	00 0F	00 03	E7 D9

Set the distance from the radar flow meter to the bottom of the canal to 1.0m in decimal (100 times magnification is 100, which is equal to 0x64 in hexadecimal), and send the request message (the response message is the same as the request message)

Slave address	Function code	Register address	Register value	CRC Check value
80	06	00 10	00 64	97 F5

Set the sector height to 1.0m, and send the request message (the response message is the same as the request message)

Slave address	Function code	Register address	Register value	CRC Check value
80	06	00 11	00 64	C6 35

Set the bottom length of the trapezoid part to 1.0m, and send the request message (the response message is the same as the request message)

Slave address	Function code	Register address	Register value	CRC Check value
80	06	00 12	00 64	36 35

Set the top edge length of the trapezoid part to 1.0m and send the request message (the response message is the same as the request message)

Slave address	Function code	Register address	Register value	CRC Check value
80	06	00 13	00 64	67 F5

Set the height of the trapezoidal part to 1.0m and send the request message (the response message is the same as the request message)

Slave address	Function code	Register address	Register value	CRC Check value
80	06	00 14	00 64	D6 34

4.2.3 River types

Different river types correspond to different built-in filtering schemes. In case of uncertainty, this setting can be used by default. Set the river type register to 0x0016.

Register value	Description
0x01	Straight
0x02	normal type
0x03	Turbulent
0x04	Inclined
0x05	Splash type

Example of setting river type

Request message sent (response message is the same as request message)

Slave address	Function code	Register address	Register value	CRC Check value
80	06	00 16	00 01	B7 DF

4.2.4 Noise threshold

The noise threshold is used to set the signal extraction threshold. If the signal strength of the device (obtained through the input register) is lower than the set value, the noise is not picked up. This item usually does not need to be adjusted. According to the factory default, the signal is weak when the installation distance is long and the flow rate is low. It needs to be adjusted according to the signal

strength of the scene. The threshold of the flow meter is generally not lower than 400. The register that sets the flow meter noise threshold is 0x000B.
Example of setting the flow meter noise threshold to 1000
Request message sent (response message is the same as request message)

Slave address	Function code	Register address	Register value	CRC Check value
80	06	00 0B	03 E8	E6 A7

4.2.5 Anemometer radar wave direction

Velocity meter radar wave directions are forward, countercurrent and bidirectional. The flow meter radar wave is in the same direction as the river flow (the relative flow measurement direction is away from the water flow), and the flow meter is set to collect only the downstream speed. The reverse direction of the radar wave and the river is the countercurrent (the relative velocity measurement direction is the oncoming water flow). When set to the countercurrent, the velocity meter only collects the countercurrent velocity. When set to bi-directional, the flow meter automatically recognizes the flow direction and collects the flow rate of the forward and reverse flow. It is recommended to install counter current (factory default). The counter current has anti-rain function. Set the register of the radar wave direction of the flow meter to 0x0018. The values are as follows:

Register value	Description
0x01	Downstream
0x02	countercurrent
0x03	Two way(automatic)

Example of setting the direction of the radar wave
Request message sent (response message is the same as request message)

Slave address	Function code	Register address	Register value	CRC Check value
80	06	00 18	00 02	96 1D

4.2.6 Filtering times

The larger the number of filtering is, the smaller the value fluctuation is, the more stable the measurement result is, but the real-time performance is weakened. Normal default is fine. The register for setting the filtering times of the flow meter is 0x000D, and the register for setting the filtering times of the water level meter is 0x000E.

Example of setting the flowmeter filter times to 20
Request message sent (response message is the same as request message)

Slave address	function code	Register address	Register value	CRC Check value
80	06	00 0D	00 14	06 17

Example of setting the water level gauge filtering times to 5
Request message sent (response message is the same as request message)

Slave address	Function code	Register address	Register value	CRC Check value
80	06	00 0E	00 05	36 1B

4.2.7 Measure time

1. High signal strength: stable value will be measured in about 30s.
2. The signal strength is relatively weak: Although the measured result takes a long time (2min) at this time, the measurement performance for low flow rate is high at this time, and the obtained result is also stable.

4.2.8 Measurement results

The measurement results are stored in the holding register and the input register, which can be read through the Modbus protocol 0x03 or 0x04 function code (recommended to use the 0x04 function code to read the input register). Read the relevant register through the debugging assistant (such as MODBUS debugging assistant), please note that the value read out at this time is hexadecimal, so it needs to be converted to decimal for the convenience of calculation. For example: Now the flow rate is to be queried, then the value read from the 0x0001 register is 0x7B, and 0x7 converted to decimal is 123. At this time, the actual flow rate needs to be reduced by 1000 times (0.123m / s). It should be noted here that the values stored in the registers are all enlarged values (the description in the "Description" column in the table below refers to the values stored in the registers are enlarged), so the extracted values To reduce the corresponding multiple. (Note: the waiting time for each query command is 100ms)

Read by 0x03 function code, the holding register address is as follows (Hexadecimal)

Function	Register address	Unit	Description
Flow velocity	0x0001	m/s	1000 times magnified
Water level	0x0002	m	1000 times magnified
Empty height	0x0003	m	1000 times magnified
Instantaneous flow	0x0004	m^3/s	1000 times magnified
Cumulative flow (higher 16 bits)	0x0005	m^3	1000 times magnified after merged
Cumulative flow (middle 16 digits)	0x0006		
Cumulative flow (lower 16 bits)	0x0007		
Flow rate signal strength	0x0008	/	/
Water level signal strength (reserved)	0x0009	/	/
Flow direction	0x000A	/	Reverse: 0 Forward: 1
Accident details	0x0021	/	(Reserved)
Vertical angle	0x0022	°	enlarged 100 times
Input voltage	0x0023	V	enlarged 10 times

Read by 0x04 function code, the holding register address is as follows

Function	Register address	Unit	Description
Flow velocity	0x0001	m/s	1000x magnified
Water level	0x0002	m	1000x magnified
Empty height	0x0003	m	1000x magnified
Small Instantaneous flow	0x0004	m^3/s	1000x magnified
Cumulative traffic (higher 16 bits)	0x0005	m^3	1000x magnification after merging

Cumulative traffic (middle 16 bits)	0x0006		
Cumulative traffic (lower 16 bits)	0x0007		
Velocity signal intensity	0x0008	/	/
Water level signal strength (reserved)	0x0009	/	/
Flow direction	0x000A	/	Reverse is 0
accident details	0x000B	/	Forward direction is 1
Vertical angle	0x000C	°	(Reserved)
Input voltage	0x000D	V	100 times magnified
Software version number	0x000E		High 8 bit plus low 8 bit combination
Large instantaneous flow (high 16 bits)	0x000F	m^3/s	1000 times magnified
Large instantaneous flow (lower 16 bits)	0x0010	m^3/s	1000 times magnified

Note: In order to process the decimal part, the flow rate, water level, air height, etc. are all enlarged. After reading the value, it needs to be reduced. For example, if the read flow rate is 1000, the real flow rate is 1m/s.
The instantaneous flow of the input register address 0x04 only supports the storage of small flow, the range is 0-65.535 m^3/s, if the instantaneous flow value is large, you can read registers 0x0F and 0x10, and the storage range is 0- 4294967.296 m^3/s. When the instantaneous flow rate value is less than 65.535 m^3/s, the value of 0x04 and 0x10 registers are equal.

Example of reading a single input register by 0x04 function code (reading flow velocity)
Request message sent

Slave address	Function code	starting address	Number of registers	CRC Check value
80	04	00 01	00 01	7E 1B

Response message

Slave address	Function code	Number of data bytes	Register value	CRC Check value
80	04	02	00 7B	C5 0D

Note: The CRC check value will change with the change of the register value in the response message.
0x04 function code can read multiple continuous registers, read all measurement results by 0x04 function code

Request message sent

Slave address	Function code	Starting address	Number of registers	CRC Check value
80	04	00 01	00 10	7E 1E

Response message

Slave address	80
function code	04
Number of data bytes	20
Velocity	01 CD
Water level	04 01
Empty height	08 75
Small Instantaneous flow	8F 34
Cumulative traffic (higher 16 bits)	00 08

Cumulative traffic (middle 16 bits)	94 4B
Cumulative traffic (lower 16 bits)	EB 6A
Velocity signal intensity	02 F7
Water level signal strength	00 00
Flow direction	00 01
accident details	02 97
Vertical angle	14 96
Input voltage	00 76
Software version number	02 04
Large instantaneous flow (high 16 bits)	00 00
Large instantaneous flow (lower 16 bits)	8F 34
CRC check value	12 34

Note: The CRC check value in the response message will change due to the actual measured value change.

5. Register List

Holding Register List

Add. Hex	Name	Description	Data range	Default value	Read and write status
1	Flow velocity	Unit: m / s 1000 times the flow velocity	0~65535	0	Read-only
2	Water level	Unit: m 1000 times the water level value	0~65535	0	Read-only
3	Empty height	Unit: m 1000 times the empty height	0~65535	0	Read-only
4	Small Instantaneous flow	Unit: m^3 / s 1000 times the instantaneous flow	0~65535	0	Read-only
5	Cumulative traffic (higher 16 bits)	Unit: m^3 1000 times the cumulative flow	0~65535	0	Read-only
6	Cumulative traffic (middle 16 bits)		0~65535	0	Read-only
7	Cumulative traffic (lower 16 bits)		0~65535	0	Read-only
8	Velocity signal intensity	Current signal strength	0~65535	0	Read-only
9	Water level signal strength	Water level current signal strength	0~65535	0	Read-only
A	Flow direction	0x00: Reverse 0x01: forward	0~1	0	Read-only
B	Flow noise threshold	Set / Query the flow noise threshold	0~65535	800	Read and write

C	Water level noise threshold (reserved)	Set / Query water level noise threshold	0~65535	500	Read and write
D	Velocity filtering times	Set / Query the number of flow rate filters	1~30	20	Read and write
E	Water level filtering times	Set / Query the number of water level filters	1~30	5	Read and write
F	Canal shape	0x01: Round 0x02: trapezoid 0x03: U type	1-3	0	Read and write
10	Distance from the water level gauge to the bottom of the canal	Unit: m Support decimal, write after 100 times magnification	0~65535	0	Read and write
11	Round canal radius / U-shaped canal fan height	Unit: m Support decimal, write after 100 times magnification	0~65535	0	Read and write
12	Length of bottom of trapezoidal channel U-shaped canal trapezoidal part bottom length	Unit: m Support decimal, write after 100 times magnification	0~65535	0	Read and write
13	Top of trapezoidal canal The top edge of the trapezoidal part of the U-shaped channel	Unit: m Support decimal, write after 100 times magnification	0~65535	0	Read and write
14	Trapezoidal channel height U-shaped canal height	Unit: m Support decimal, write after 100 times magnification	0~65535	0	Read and write
15	Shore factor	Instantaneous flow scale factor, default 1.0 Support decimal, write after 100 times magnification	0~65535	100	Read and write
16	River type	0x01: Straight 0x02: Normal type 0x03: Turbulent 0x04: inclined 0x05: Splash type	1~5	2	Read and write
17	Anemometer position	0x01: 1 0x02: 2 0x03: 3	1~3	2	Read and write
18	Anemometer radar wave direction	0x01: Forward 0x02: reverse 0x03: bidirectional(automatic)	1~3	2	Read and write

19	Maximum flow rate	0x00: not limited Support decimal, write after 100 times magnification	0~65535	0	Read and write
1A	Clear accumulated traffic	0x01: Clear	0~1	0	Read and write
1B	Serial baud rate	0x01: 9600 0x02: 19200 0x03: 56000 0x04: 115200	1~4	1	Read and write
1C	Device address	Set / read device address	1~200	0x80	Read and write
1D	Manual vertical angle acquisition	The device automatically acquires an angle every 20s 0x01: Manual acquisition once	0~1	0	Read and write
1E	Horizontal angle	Unit: ° Manually enter horizontal angle, decimals are not supported	0~60	0	Read and write
1F	Rainy mode	0x01: turn on 0x02: close	1~2	1	Read and write
20	Sleep time	Unit: minute Sleep time after a single measurement cycle	0~65535	0	Read and write
21	accident details	Reserve	-	-	-
22	Vertical angle	Unit: ° Vertical angle value after 100 times magnification	0~65535	0	Read-only
23	Input voltage	Unit: V Input voltage value after 10 times magnification	0~65535	0	Read-only
24	Software version number	Software version number 8-bit plus 8-bit combination For example, 0x0102 corresponds to the version number V1.2	0~65535	0	Read-only
25	Reset	0x01: Restore factory default settings	0~1	0	Read and write
2C	Still water height setting	The water level is less than this value, and the flow output is 0 Support decimal, write after 100 times magnification	0~65535	0	Read and write
2D	Maximum fluctuation limit	Reserve			
2E	4-20mA output selection	0x01: empty height 0x02: water level	1~2	1	Read and write

Note: The register address 0x2C can set the static water height. When the static water height is set, when the

measured water level is less than the static water height, the flow output is zero, so as to avoid the dead water in the channel due to the influence of wind, resulting in flow output and error This kind of situation occurs when it becomes larger **(don't confuse the static water height with the installation height)**.

Input Register List

1	Flow velocity	Unit: m / s 1000 times the flow velocity	0~65535	0
2	Water level	Unit: m 1000 times the water level value	0~65535	0
3	Empty height	Unit: m 1000 times the empty height	0~65535	0
4	Small Instantaneous flow	Unit: m^3 / s 1000 times the instantaneous flow	0~65535	0
5	Cumulative traffic (higher 16 bits)	Unit: m^3 1000 times the cumulative flow	0~65535	0
6	Cumulative traffic (middle 16 bits)		0~65535	0
7	Cumulative traffic (lower 16 bits)		0~65535	0
8	Velocity signal intensity	Current signal strength	0~65535	0
9	Water level signal strength	Water level current signal strength	0~65535	0
A	Flow direction	0x00: Reverse 0x01: forward	0~1	0
B	Accident details	Statistics failure information	-	-
C	Vertical angle	Unit: ° Vertical angle value after 100 times magnification	0~65535	0
D	Input voltage	Unit: V Input voltage value after 10 times magnification	0~65535	0
E	Software version number	Software version number 8-bit plus 8-bit combination For example, 0x0102 corresponds to the version number V1.2	0~65535	0
F	Large instantaneous flow (higher 16 bits)	Unit: m^3 / s 1000 times the instantaneous flow	0~65535	0
10	Large instantaneous flow (lower 16 bits)		0~65535	0
11	Reserved	Reserved	-	-
12	Reserved	Reserved	-	-
13	Accumulated flow overflow times	Used to count cumulative traffic overflow times	0~65535	1
14	Temperature	Unit: ℃ Temp value after 100 times magnification	0~65535	0

Note: The instantaneous flow of register address 0x04 only supports the storage of small flow, the range is 0-65.535 m^3 / s. If the instantaneous flow value is large, you can read the registers 0x0F and 0x10, the storage range is 0- 4294967.296 m^3 / s. When the instantaneous flow value is less than 65.535 m^3 / s, the 0x04 and 0x10 register values are equal.

6. Technical Parameters

Model	JW-RD-600(HJ03)(A)	JW-RD-600(HJ03)(B)
Flow measurement system		
Measurement principle	Planar Microstrip Array Antenna CW + FMCW	
Operating mode	automatic, telemetry	
Applicable environment	24 hours, rainy	
Operating temperature	-30~80℃	
Operating Voltage	7~30VDC	
Working current	12VDC input, working mode: ≤28mA; standby mode: <1mA	
Protection class	IP68	
Lightning protection level	6KV	
physical dimension	160×100×89.9(mm)	235.4×100×104(mm)
weight	Less than 1kg	Less than 1.5kg
Radar wave velocity sensor		
Radar frequency	24GHz	
Maximum range	40m	
Velocity measurement range	0.03~20m/s	
Speed measurement accuracy	±0.01m/s ; ±1%FS	
Antenna angle	12°	
Measurement direction	Automatic identification of water flow direction, built-in vertical angle correction	
Radar water level sensor		
Radar frequency	60GHz	80GHz
Measuring range	0.2~7m	0.4~40m
measurement accuracy	±2mm	±3mm
Antenna angle	8°	8°
Data transmission system		
Digital transmission method	RS485 / RS232, 4~20mA, 4G/LoRa (wireless option)	

7. Warranty

The supplier guarantees that the JW-RD-600(HJ03) instrument has no defects in terms of performance and quality at the time of sale. For problems that occur during use, the company only repairs or replaces instruments that fail under correct use conditions.
Before the instrument needs to be repaired, please contact the supplier first; the returned product must be well packaged to ensure that the instrument is not damaged due to transportation.

7.1 Warranty period

The free warranty period for users is one year (calculated from the date of purchase). For instruments beyond the warranty period, the company will provide paid repairs.

7.2 Warranty coverage

During the warranty period, the company only repairs products that fail under correct usage conditions for free.

Failures caused by the following conditions are not covered by the warranty:

-overdue warranty;

-Failure to comply with the requirements of the product instruction manual, use, maintenance and cause damage;

-Damage caused by private dismantling (private dismantling and repairing) not authorized by the company;

-Other non-quality causes such as natural disasters, mechanical damage, etc.

Appendix A: Frequently Asked Questions

1. Question: Why does the host computer not receive any data?

Answer:

1) Check whether the power supply voltage is within 7~30VDC, and re-power on after confirmation;
2) Check whether the communication mode, serial port number, and baud rate are correct;
3) Check whether the communication protocol is operated according to the instructions, and check whether the instructions are correct;
4) Try to change a USB to 485 communication line to test again

2. Question: Why is the measured value always 0?

Answer:

1) Confirm whether the radar transmitter probe is aimed at the measurement target;
2) Whether the measuring distance is within the reasonable range of the probe test.

3. Question: Why does the measured value jump frequently and greatly?

Answer:

1) Check whether the power supply voltage is too low;
2) Whether there are obstacles in the measurement range;
3) Whether the probe is installed firmly and the radar flowmeter is installed parallel to the horizontal plane;
4) Check for vortexes.

4. Question: Why is the measured value not updated?

Answer:

1) Check if the water surface freezes due to seasonal reasons;
2) Check whether the measurement is inaccurate due to radar waves covering the ground due to low water period or main tank swing.

5. Question: Used to measure water surface flow when flooding occurs. The water flow is very fast, the water is turbulent, the water surface is rough, and there are many debris and floating objects. Can the radar flowmeter be used to obtain accurate measurement results in this case?

Answer: Yes. The turbulent water current and the floating objects on the water surface can provide a good return signal for the radar speed probe. Please note that in this case, the radar speed probe will read multiple speeds in different directions. The radar speed probe will measure these speeds and get the average speed.

6. Question: The roughness of the water surface is good, and the water surface has ripples, but the reading of the radar speed probe is still high and/or far below my expectations.

Answer: Make sure not to be too far away from the water surface when measuring. The specific distance is sometimes difficult to determine because the measurement result is a function of the amount of signal returned to the radar speed probe. The returned signal is directly related to the distance of the radar speed measuring probe from the water surface and the roughness of the water surface. The closer the radar speed probe is to the surface of the water, the best measurement effect is even when the water velocity is low. Regularly observe whether the cross arm or other fixing mechanism where the flowmeter is installed is tilted or loosened due to external forces (such as strong wind).

7. Question: I am measuring the water flow velocity which is lower than 0.60m/s visually, but the reading is higher than expected.

Answer: Check the influence of wind on the water surface. Wind may affect the measurement of low-speed water flow (such as water flow below 0.50m/s). If possible, measure in two directions, one direction is the direction of the water flow toward the radar speed measuring probe, and the other is the direction of the water flow away from the radar speed measuring probe. Try to point the radar speed probe to the same place for measurement.

Appendix B: Shipping List

Shipping List Table

radar flow meter	pcs	1	Host
Product Manual	pdf electronic version	1	Accessories
Mounting brackets, screws, clamps	set	1	Accessories
Communication Cable	m	5	Accessories