# Ultrasonic Doppler Flowmeter

Note: due to the fact that the product is constantly updating, product specifications and installation instruction may not be consistent with the latest products. We may not be able to issue notice on the changes of product itself and the instructions to every customer, if needed, please contact our company's sales staff. Changes including, but not limited to the following contents:

Product function, structure, shape, color, etc.

Software functions, structure & display method, operation process, etc.

## I. Introduction

### Product Introduction

The product is a kind of sensor that measures flow velocity and flow rate in natural waters, channels or pipes.

The flowmeter is divided into two parts: sensor and host, connected by cable.

To be able to measure flow velocity and flow rate in channels and rivers, the water level has to be 20 cm higher than the sensor.



To be able to measure flow velocity and flow rate in pipeline and culvert, water level has to be more than 20 cm higher than the sensor, tubing inner diameter has to be ≥500 mm.

### 1.1 Operating Principle

The sensor is fitted with two energy converters, one for transmission, one for receiving. On the premise that the sensor is facing the water flow direction, i.e. countercurrent direction:

1.When water is static, the transmission and receiving frequencies are the same.

2.The faster the velocity is, the faster frequency the sensor receives signal, and it will be higher than transmission signal.

3.The slower the velocity is, the slower frequency the sensor receives signal, and it will be lower than transmission signal.

On the premise that the sensor is on the water flow direction, i.e. current direction:

1.When water is static, the transmission and receiving frequencies are the same.

2.The faster the velocity is, the faster frequency the sensor receives signal, but it will be lower than transmission signal.

3.The slower the velocity is, the slower frequency the sensor receives signal, but

it will be lower than transmission signal.

Hardware and software can calculate water flow direction and velocity.

The sensor has to be installed facing the water flow direction

## 1.2 Technical Parameters

Initials for Field Irrigation Doppler flowmeter: FIDF

Model no. for river channel flowmeter: GRCF

Non-full pipe flowmeter model: DTF

Structure: split type;

Measurement categories: velocity, flow, water depth, water temperature

Level of protection: IP68

Purpose: on-line measurement

Velocity measuring range: the standard is 0.04 m/s ~ 5.00 m/s (the sensor is 20 cm above minimum depth) ;Other velocity range can be customized.

The velocity measurement resolution: 1 mm/s;

Velocity measurement precision: ±2～4% of measuring velocity;

Water depth measurements: 0.02 m ~ 10.00 m; Resolution: 2 mm accuracy: ±0.5%;



Temperature range: 0～60ºC; resolution: 0.1ºC;

Flow range: 10 L/s ~ 99999999 cubic meters/hour

Power supply: battery, 12 VDC;

Output signal (battery): RS485;

RS485 output signal content: flow velocity, instantaneous flow, cumulative flow, water level and temperature；

Output signal (external power supply) : 4-20 mA;

4-20 ma output signal content: instantaneous flow rate；

Cable length between sensor and transmitter: 10 m;

Types of channels subjected to measurement: pipeline, channels, natural stream and rivers;

PH value requirement: PH between 6 ~ 8, no corrosive effect on sensor.

Liquid temperature requirement: 0 ~ 50 ℃；

Liquid pressure requirement: natural environment condition, 1 standard atmospheric pressure；

Power supply for flowmeter is 11 ~ 14 VDC, power supply current is 250 mA.

Continuous working power consumption: 14V×200ma=14V×0.25A=3.50W。

Softwares:

Data acquisition system 1 set low power consumption GPRS wireless data acquisition and transmission software

Integral management system 1 set low power consumption GPRS wireless data acquisition server software

## 1.3 Standard Measurement State

After powering up, flow velocity and flow rate will be provided after 60 s, then one set of data will be provided every 15~20s.

Under standard measuring status, signal 485 from sensor is directly connected with host. The host will output flow velocity and flow rate signals from 485 interface.

## 1.4 Displace interface (press up and down bottom to switch these two display interfaces)



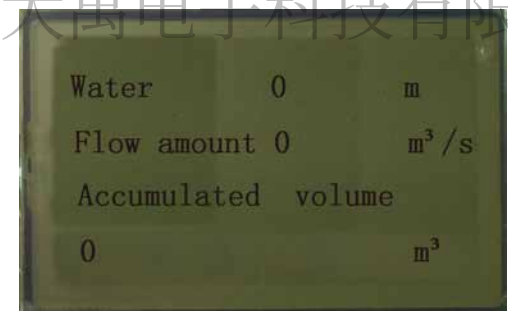



Fig. 1: Water level, Instantaneous Flow Rate and Accumulative Amount

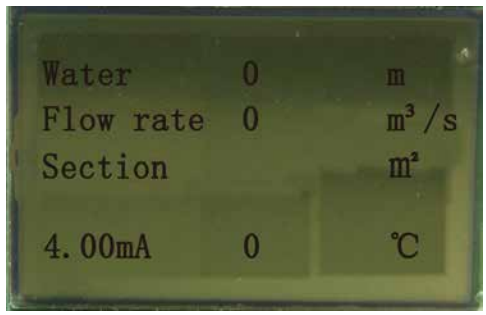



Fig. 2: Flow Rate, Flow Velocity, Cross-Sectional Area, Current and Water Temperature

Default start screen display: water level, instantaneous flow and accumulative

amount

1.5 Product figure

Fig. 3 Sensor Diagram




Fig. 4 Host Diagram

II. Product Installation

2.1 Installation condition and position inside channels

① Measurement in the rivers, channels can be conducted as long as the lowest water level is 20 cm above the sensor.

② Flowmeter sensor standard pressure is 100 kpa, namely pressure at 10 meters of water depth. If more pressure withstand ability is needed, please specify before issuing order, maximum pressure withstand achievable is 1000 KPa, i.e. at 100 m of

water depth.

③ Ultrasonic Doppler flowmeter is applicable for water with less than 20 kg/m of solid contents, velocity of 5.0 m/s or less. Product can be customized if more flow velocity range is required, maximum velocity achievable is 10.0 m/s.

④ Ultrasonic Doppler flowmeter shall be installed at locations with steady flow. If flow is not smooth, in most cases is turbulent flow, will resulted in large measurement deviation.



Fig. 5 Smooth Flow Channels

⑤ On the upstream of ultrasonic Doppler flowmeter installation position, straight channel length 20 times of the channel width shall be set; and straight channel length 5 times of the channel width shall be set at downstream locations.

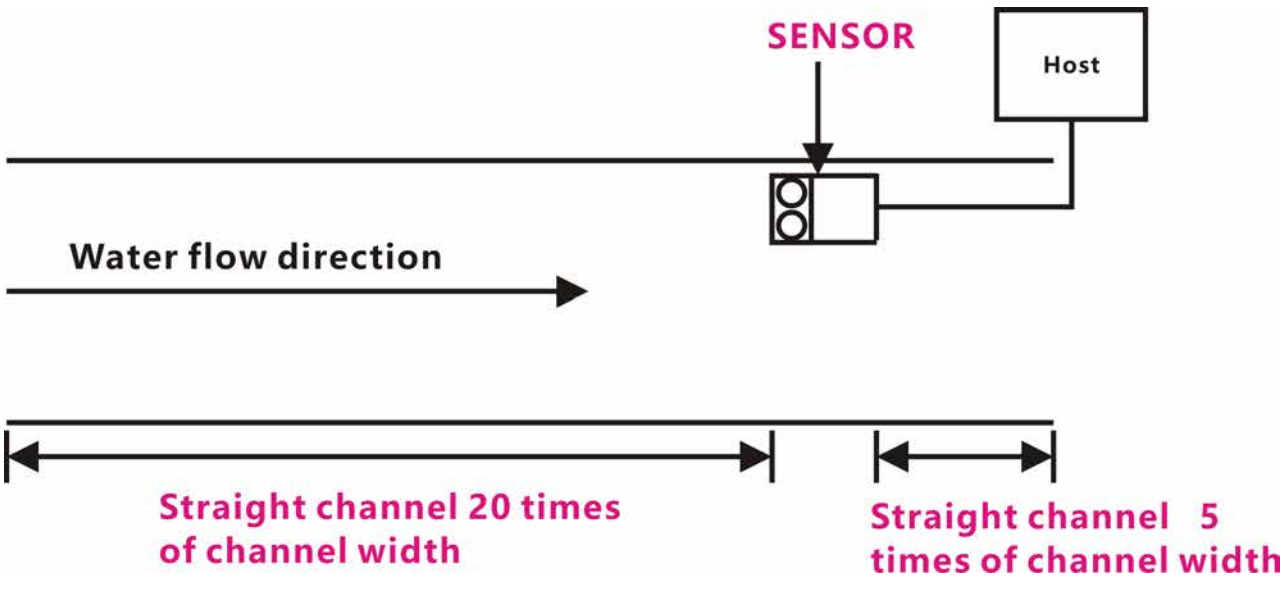


Fig. 6 Requirements for Straight Channels Upstream and Downstream of Sensor Installation

Fig. 7 Requirements for Straight Channels Upstream and Downstream of Sensor Installation



For some of the sites, due to channel condition limitation, the 20 times width requirements for upstream channel and 5 times width requirements for downstream channels cannot be met. The minimum requirement is straight channel 5 times of channel width on upstream and 3 times of channel width downstream. However, this will lead to increase of deviation, which is specifically determined by site condition.

For example, in the figure below: because it is a mountain area, with turns of channels, which does not meet the straight channel requirement for upstream section, the actual flow velocity at installation point is 0.90～0.95 m/s, actual measured value is 0.65～0.80 m/s.

Fig. 8 Straight Channel Upstream of Sensor Installation Cannot Meet 20 Times Requirement

⑥ In case of installation location is downstream of gate (straight channel length is 30 times width or more), pay special attention of water surface and see if it is steady.

If the sensor installation location is already 30 times width away from the gate, but the water surface is still turbulent, then increase the distance until the water is steady. There is not limitation for this distance, it can be 60 times of the width or 80 times--until the water is smooth.

Fig. 9 Gate Site Flow Condition

The figure below shows the actual installation position, which is 50 times width away from the gate until the water is steady. Installation point is at the red circled area in the figure below.



Fig. 10 Installation Position is 50 Time Width Away Downstream of the Gate

⑦ Determine installation height

Sensor's ideal height is 100 mm- 250 mm from the channel bottom, determined by minimum water level at the channel.

Sensors should be installed on the bottom of the channel, if channel bottom has a lot of sediment, mud, grass or a stone that may roll around, installation position can be raised slightly higher, in order to avoid the sensor being covered by sediment and aquatic plants , or stone impact damage.

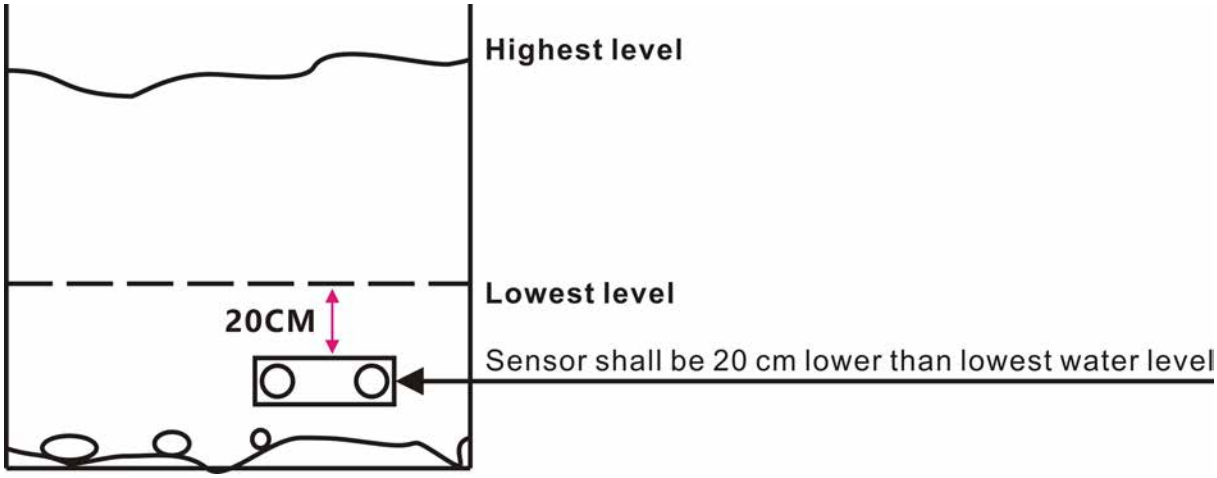



Fig. 11 Sensor Shall be 20 cm Lower than Lowest Water Level

⑧ Selection of horizontal installation position

Channels with less than 20 m of width, if its section is rectangular, then installation point is at 15-20% of the entire channel. This is because this location's flow velocity is closer to the average velocity than other locations.



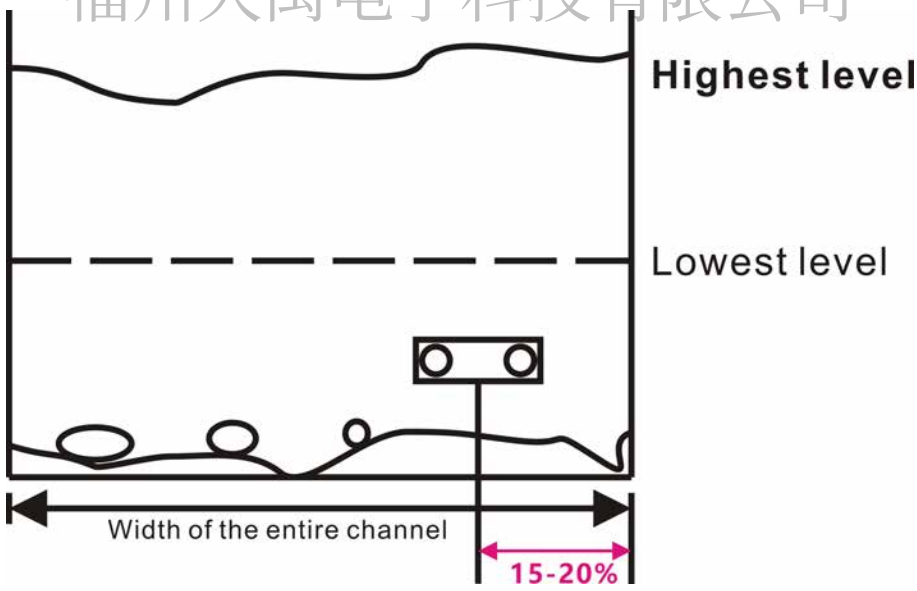



Fig. 12 Rectangular Channel Installation Position Requirements

Trapezoidal channel installation: sensors shall be installed in slope and bottom border, also known as "toe". At the same time: sensor is 20 cm below the lowest water level.

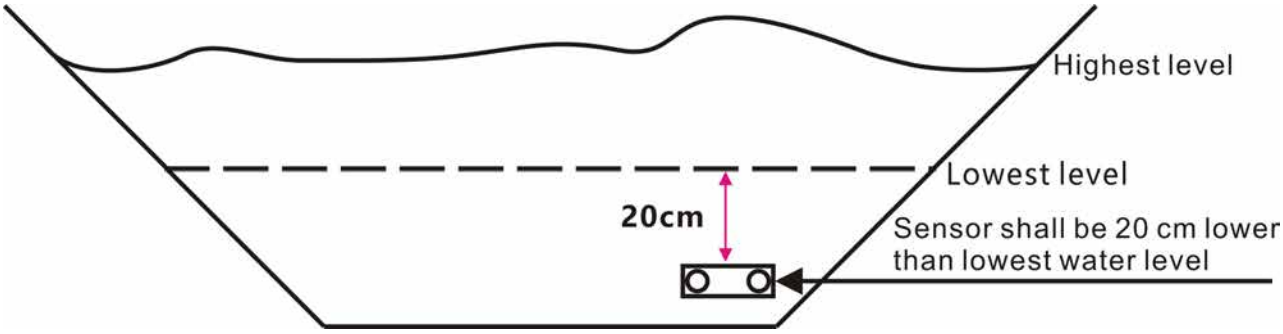



Fig. 13 Trapezoidal Channel Installation Position Requirements

⑨ Sensor shall be facing water flow direction

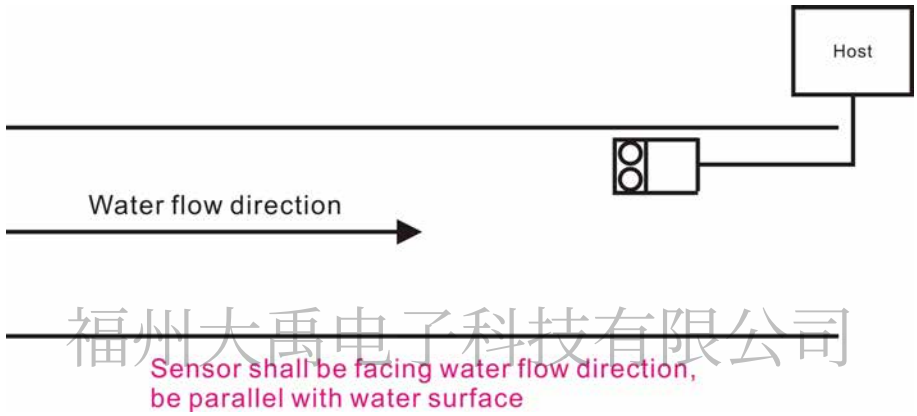



Fig. 10 Sensor Horizontal Installation Requirements

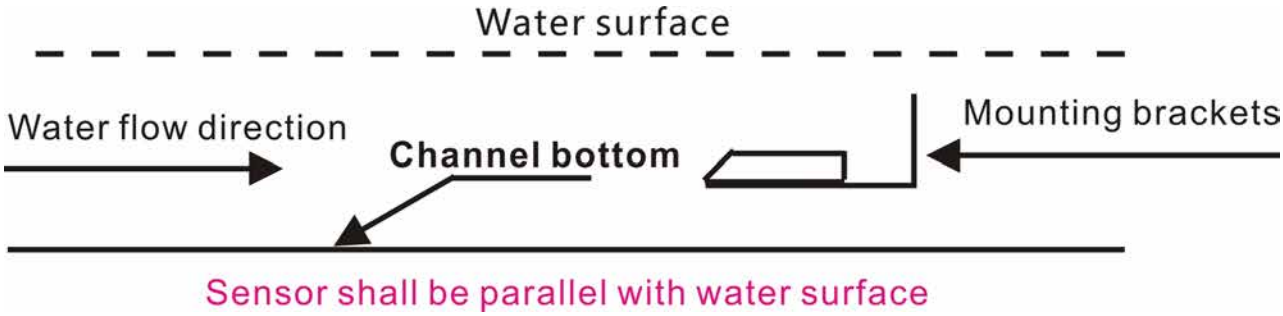



Fig. 14 Sensor Horizontal Installation Requirements

⑩ For upstream waste or floating objects, grid shall be used to filter the upstream channel, and the distance between grid and sensors is more than 5 times of channel width.

## 2.2 Installation Position and Location within Pipelines or Culverts

① Installation in the pipelines can be conducted as long as the lowest water level is 20 cm above the sensor, pipeline inner diameter ＞500 mm for measurement. Measurement can be conducted even if the pipeline is not full. Select a place where the water flow is stable, the upstream of the installation position shall have a straight channel 20 times of pipe inner diameter, and a straight channel 5 times of pipe inner diameter downstream.

② Select locations with steady flow for installation. If flow is not smooth, in most cases is turbulent flow, will resulted in large measurement deviation. Two situations may occur: one, great turbulence in data records; two, measured data is smaller than actual value;

③ Take the sediment and sludge in the pipeline into account, if there is sludge, the sensor should avoid sludge during installation.

For upstream waste or floating objects, grid shall be used to filter the upstream pipeline, and the distance between grid and sensors is more than 5 times of pipeline inner diameter.

## 2.3 Installation Condition and Position in River Channel

① For wider river channels, such as natural rivers, flood discharge channels of large reservoirs, ship channels at dams, spillways of hydropower stations, flow rates from the two banks to the middle are large, and if the flow rate is to be measured, the flow rate is more complicated because at different position flow rates are different.



In this case, in addition to meet the conditions of installation in channel, generally require multiple point velocity data. 3 senors are required at least, one at each bank and one in the middle.

Such as dividing a river of 30 m wide into 10 equal sections.

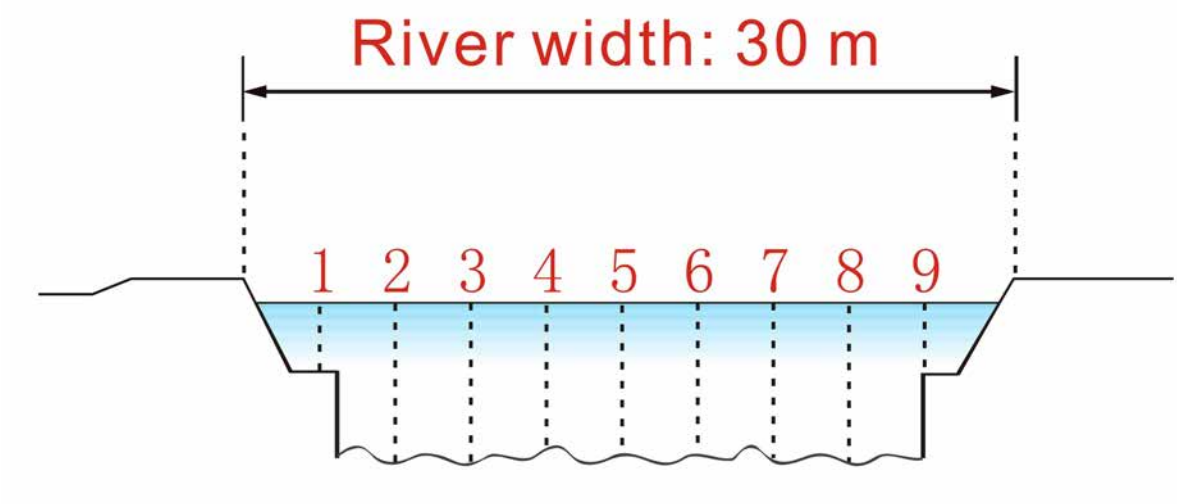



Fig. 15 Dividing River Width

One sensor is fitted on both sides and the middle of the river, which are all connected to one host.

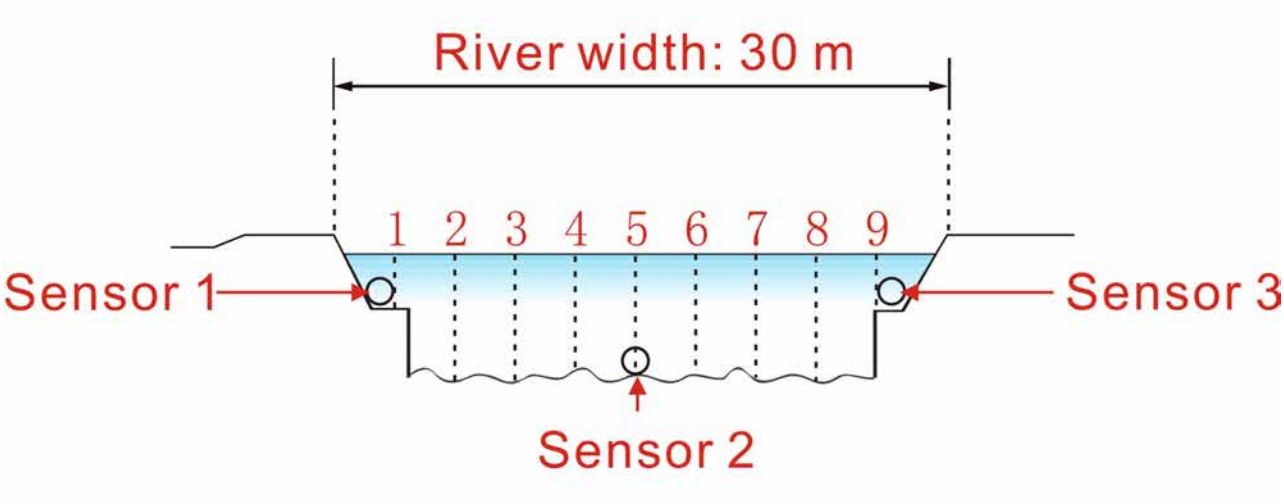



Fig. 16 Installation Diagram of 3 Sensors

In order to improve the accuracy of measurement, install 5 sensors.

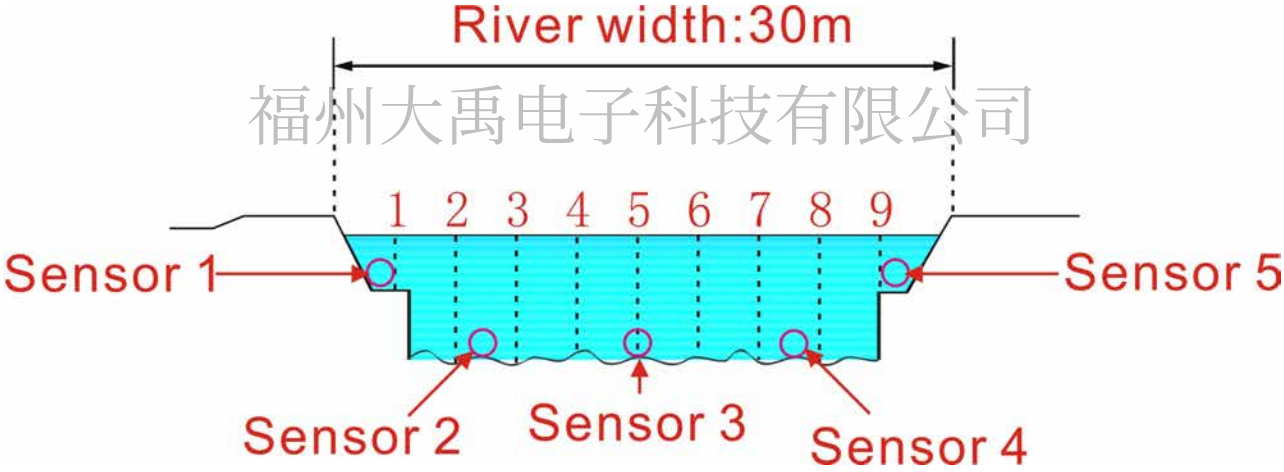



Fig. 17 Installation Diagram of 5 Sensors

② Ensure that the lowest water level in the dry season is 20 cm above the sensor, this does not include flow measurements conducted other than dry seasons.

③ Determine whether the site measurement point is suitable for installation: there are quite a few natural rivers, it is difficult to install with bracket, in order to install the sensor, it is necessary to use the excavator to block the water flow and form the site convenient for construction, in this case, Consideration should be given to using non-contact river flow meters to measure.

The site below is a typical case of a river flow meter that is less suitable for use

with contact. There is no place where the bracket can be installed, and the construction was aided by the use of large machinery to make water in the water.

Fig. 18 Wide River Channel with no Supports Around



In this site, the sensor is difficult to be fixed, and the cable after installation can not be fixed at the bottom of the river channel. The cable is directly suspended from the water surface and is led to the instrument box on the shore side, problem is easy to appear under the large wind.

Fig. 19 Completed Installation in Wide River Channel

There is a rectangular section channel shown below, but the water in it is shallow, and rocks are washed away by water, which can easily damage the sensor. In such site, non-contact radar flowmeter is suggested to be adopted.

Fig. 19 Channels with Shallow Water and Washed-away Rocks



## 2.4 Bracket Installation and Wiring within Channel

**Special Note: the flow rate of 0.20 m/s is set as standard, as the water flow speed is doubled every time, the destructive power to the surrounding objects is increased by 50-64 times!**

① Ways of fixing sensor in channels

In the following installation, the outgoing line behind the sensor must be protected with PVC, PE or galvanized pipe, so that the cable will not be stressed due to the impact of water flow, nor can the cable be allowed to hang the floating objects or garbage.

On the premise that water cut-off, the sensor can be fixed on the cement floor at the bottom of the channel, and if the bottom of the channel is mud, it needs to be fixed by a cement platform.

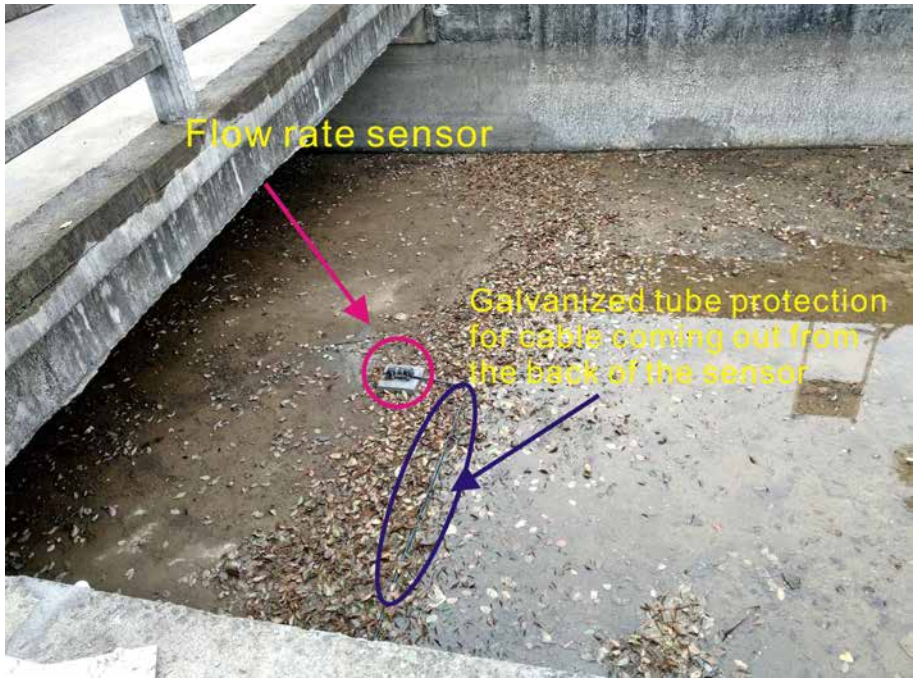



Fig. 20 Installation in Water Cut-off Channel

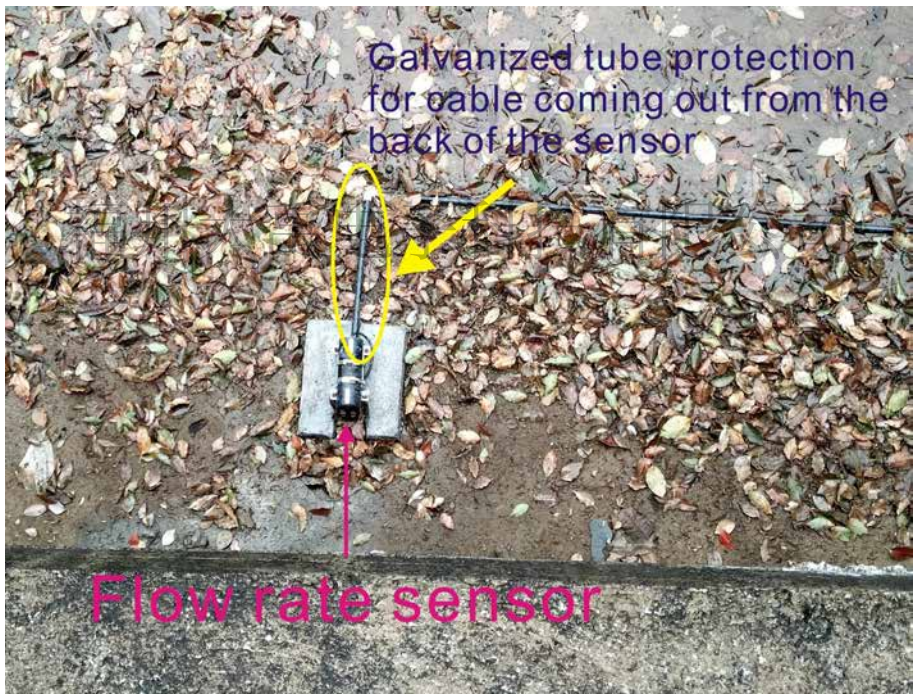



Fig. 21 Cement Platform for Installation at the Bottom of the Channel

In the channel with sludge and deposits, the installed cement platform enable the sensor to be higher than the deposit, making it harder for the sensor to be covered by the deposit.

Cables coming out from the back of the sensor are directly protected by tubing.

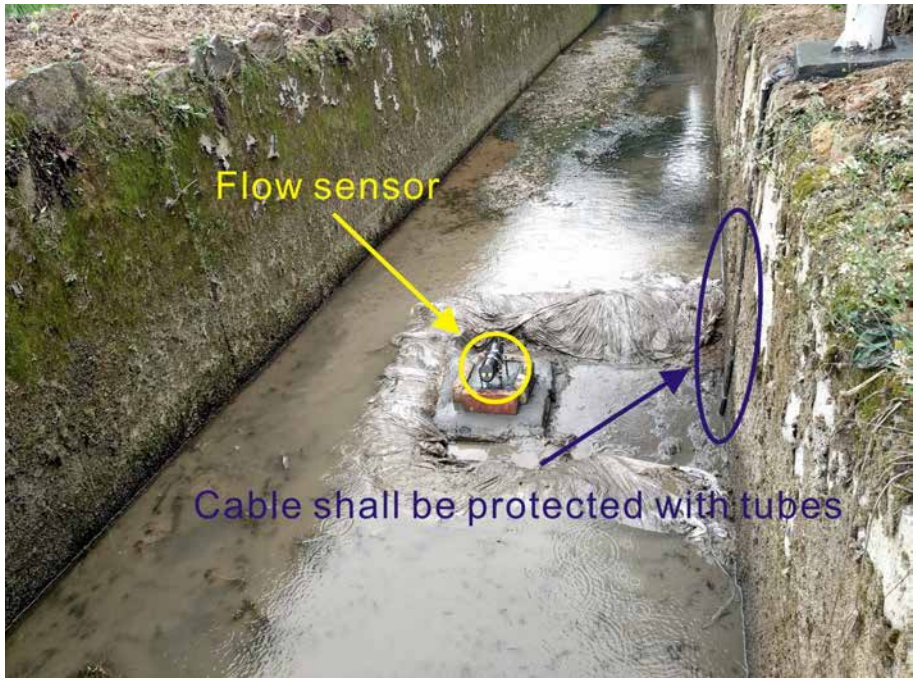



Fig. 27 Installation Mode for Channels with Silt Deposit

Installed with stainless steel bracket:



Fig. 24 Installation Diagram for 5 m-Wide Channel

Fig. 24 Installation Diagram for 4.5 m-Wide Channel

## 2.5 Bracket Installation and Wiring within Pipe



If installation is carried out within the pipe, do not have to stop supplying water, lay down the bracket from the top of pipe for fixation. General pipe, within 2000 mm, can be installed in center, sensor shall be fixed at the bottom of pipe with bracket. Bracket shall be made in "L" form, sensor shall be fixed at the bottom of L-shaped bracket, deep into the pipe, facing the water flow direction.

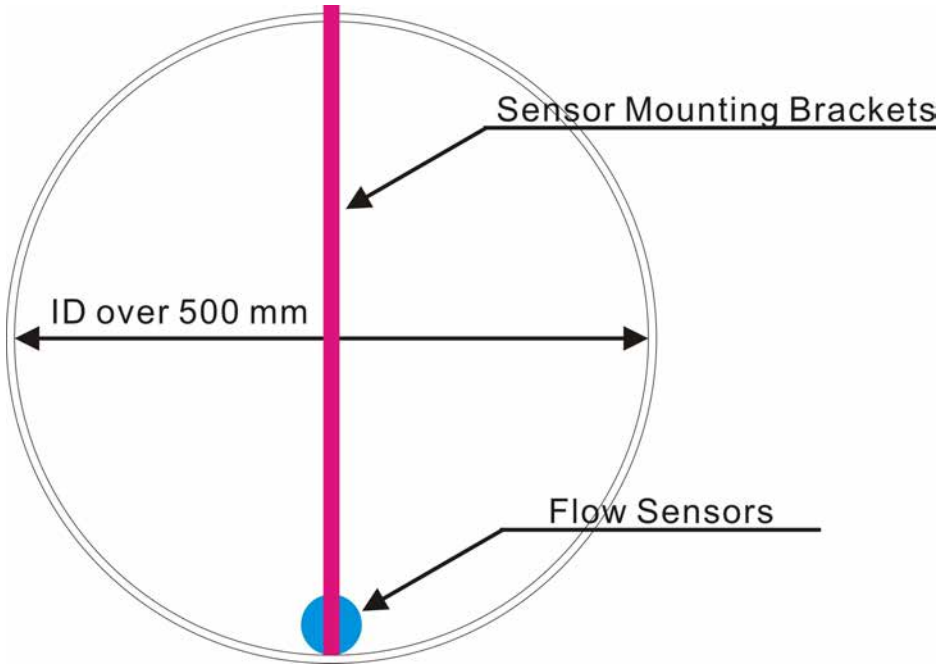


Fig. 25 Front View for Installation within Pipe

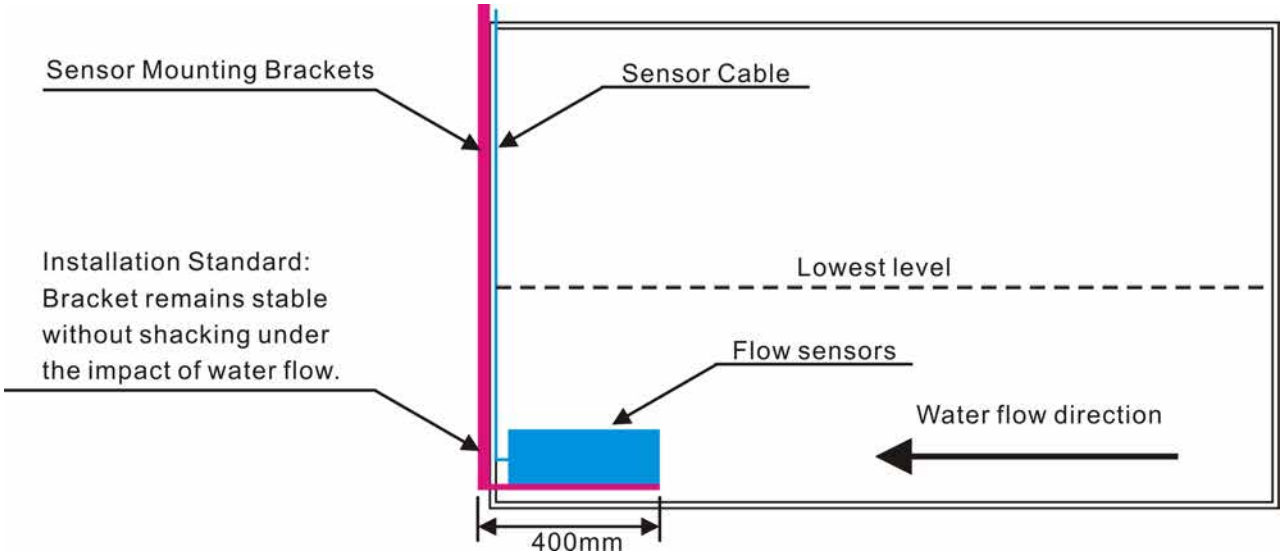



Fig. 26 Front View for the Installation within Pipe

If there is silt deposit at the bottom of pipe, lift up the sensor or tilt it to either side of the pipe.



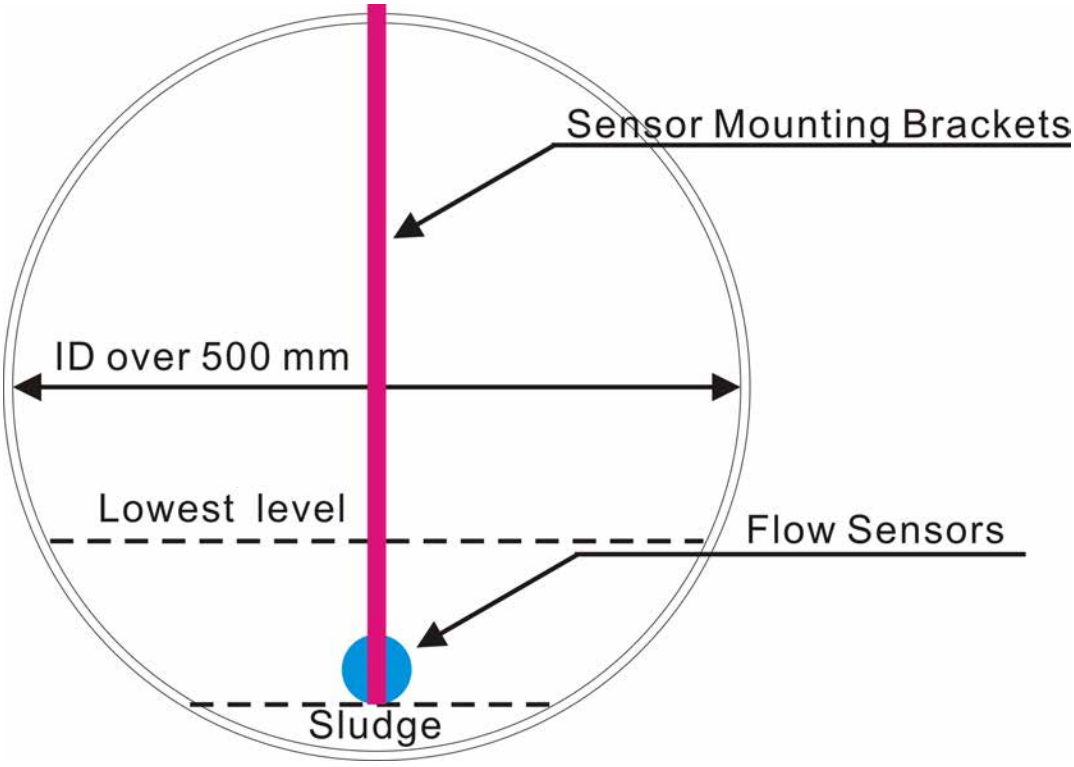



Fig. 27 Installation Mode for Pipe with Silt Deposit

As shown in the figure below, it is installation method for pipe with diameter of 800 mm:



Fig.: 28 Installation Diagram of Φ800 mm Pipe

As shown in the figure below, the installation is carried out within a Φ1000 mm pipe, the cable of sensor is led to the host through a vertical galvanized tube:

Fig. 29 Installation Diagram of Φ1000 mm Effluent Discharge Pipe


Fig. 30 Installation Diagram within Square Culvert

## 2.6 Field Bracket Installation and Wiring within River Channel

Installation within river channel is realized through bracket on the side. All cables are protected with PVC pipe, outgoing lines of sensor are also protected. As there is a lot of silt in river in this field, ultrasonic water gauge is applied instead of pressure sensor to measure the water level to avoid blocking.



Fig. 31 Installation within River Channel

## 2.7 Installation Notes

● Before fixing sensor to base, wrap the sensor with over 2 mm-thick rubber cover which can be replaced with car inner tube to separate the sensor from metal clamp and base.

Fig. 32 Wrapping up Sensor with over 2 mm-thick Rubber Cover

Fig. 33 Fixing the Covered Sensor on Base with Clamp


Fig. 34 Fixing the Sensor on Bracket

● Outgoing lines of sensor must be protected with PVC, PE, PR and galvanized pipe to avoid cracking, separation under the long-term impact of water flow and scratch or cut by objects. With the protective tube, cable is led out of water in downstream direction of sensor along bottom or inner wall of channel.

● Outlet on the back of sensor shall be protected and fixed to reduce the long-term impact of water flow. Protective tube can be applied to withstand the impact of water flow. Water flow may directly break the cable or wear out the jacket of cable.

● As there is ventilation duct within the communication cable of sensor, the bending degree shall be no more than 80°. After leading the communication cable out of water, connect it with common cable to make the ventilation duct open downwards to avoid blocking.

The 485 and 12VDC cables on the sensor must be separately combined with two pieces of 2-core shield cables.

● Don't pull or swing the cable or strike the sensor shell. Don't hang weight on the cable. Cable must be fixed on the cement wall of channel without swinging.

● Power can only be supplied through battery or solar energy. If applying 220 VAC mains power supply, convert it into 12 VDC current with linear power supply, instead of switch power supply.

● If flow velocity is larger than 1.0 m/s, the strength of bracket shall be over 3 times the current strength to ensure that it will not be carried away or broken by rip current. Diagonal bracing shall be made in the horizontal direction to keep the sensor stable without displacement, shaking or drifting.



● If cable needs to be lengthened, gas cable shall be applied to ensure that the lengthened part will not be leaking, bent or blocked under high humidity and low condensation conditions. 12 VDC cable can be lengthened to 200 m with 0.75 $mm^2$ two-core shield cable. 485 output cable can be lengthened to 200 mm with 0.75 $mm^2$ two-core shield cable.

## 2.8 Installation Steps

① Fixed bracket shall be mounted first to ensure the stability and reliability at the maximum flow velocity of two times.

② Sensor shall be fixed on the installation base.

③ All protective tubes for crossing wiring of sensor shall be fixed. Tube in water shall be fixed with at least one clamp every 0.5 m. Outlet behind the sensor shall be specially protected and fixed to ensure that protective tube can completely withstand the impact of water flow and protect the outgoing line of sensor.

Or outgoing line of sensor will be broken.

④ Send order through laptop to check the measuring data

⑤ If flow velocity is close to the actual value, combine 485 line with RTU or other receiving devices on-site.

⑥ Clean the garbage in upstream of sensor.

## 2.9 Product Wiring Diagram

Special note: before combining sensor with host, power off the host, or the sensor will crash and cannot work.

In case of this situation, send the sensor back to manufacturer for repair.

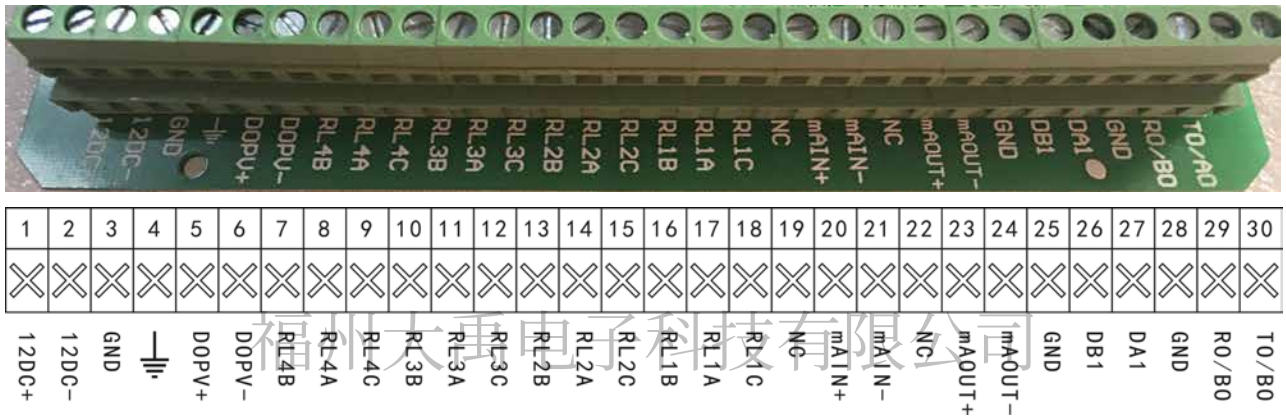


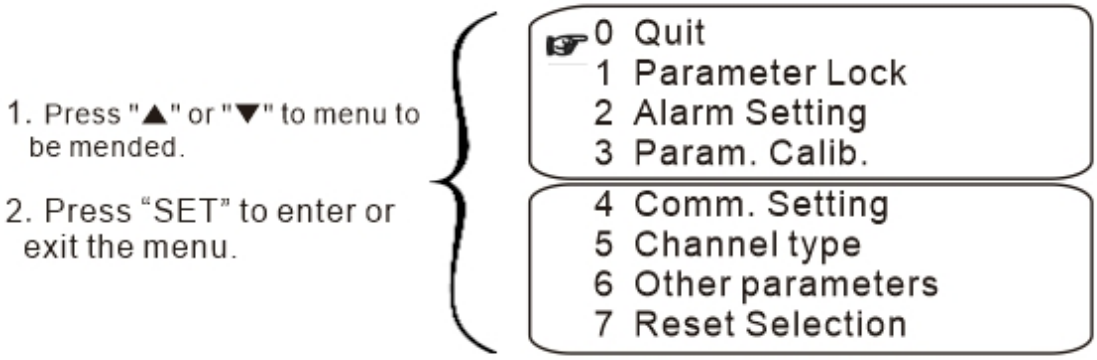


Fig. 38 Host Wiring Instructions

III Operation Menu

Press Set bottom for 3 seconds in operation mode interface to enter into Level 1 menu interface:

◆Level 1 menu interface without locked parameters:



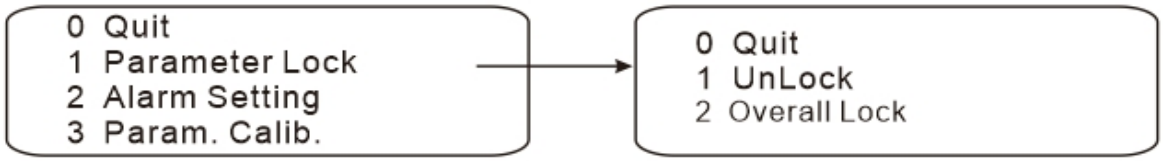

◆"1 Parameter locking"

1."0 Quit": choose this item and press Set bottom to get back to operation mode interface.

2."1 UnLock": menu is not locked, can be mended.

3."2 Overall Lock": menu is locked. If you have finished setting and do not allow any amendment, press this bottom to lock the menu. Person who want to mend the settings have to enter the password to unlock the menu. The initial password of the current meter is 25, user can change it (please remember the password, or have to contact the manufacturer to retrieve the password).

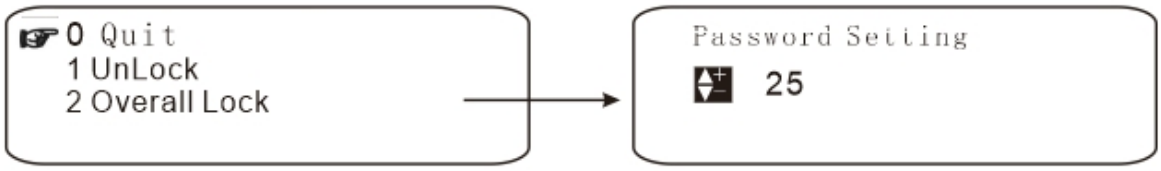





★ **If parameters are not locked, press Set bottom to enter into the parameter locking interface:**

**UnLock:** all menus can be mended.

**Overall Lock:** menu can be mended after inputting password.




★ **If parameters are locked, press Set bottom to enter into the unlocking interface:**


◆**"2 Alarm settings"**

1. Instantaneous flow rate alarm modes: there are three modes, including



" Close ": turn off the alarm mode.

" High Alarm ": if preset alarm value is 100 $m^3/h$, it will start alarming when the instantaneous flow rate exceeds 100 $m^3/h$.

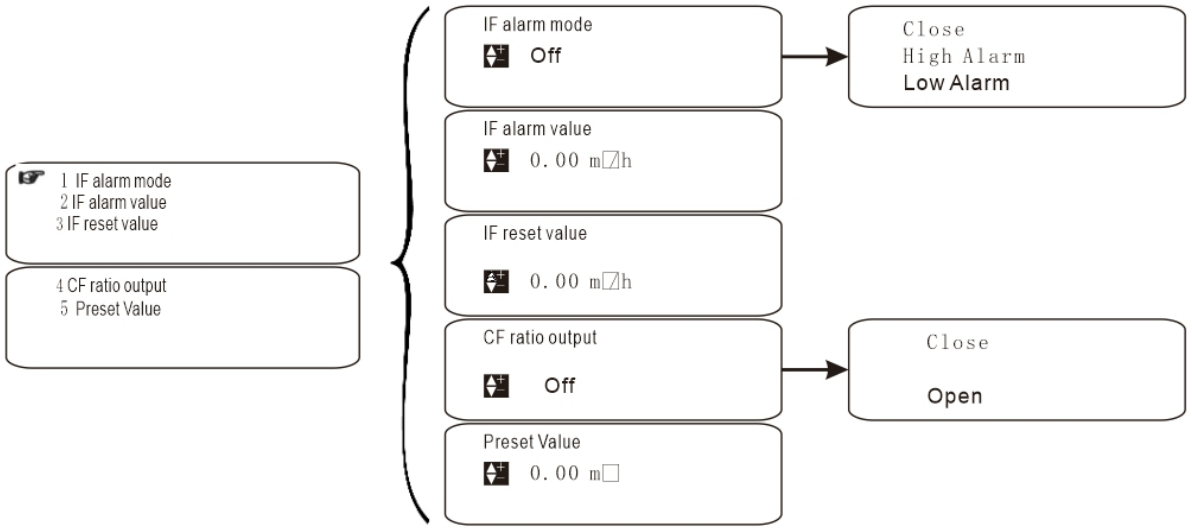
" Low Alarm ": if preset alarm value is 100 $m^3/h$, it will start alarming when the instantaneous flow rate is lower than 100 $m^3/h$.

2. Instantaneous flow rate alarm value: it starts to alarm when the preset instantaneous flow rate is reached.

3. Return different of instantaneous flow rate alarm value: in order to avoid frequent start and stop of relay caused by fluctuation of instantaneous flow rate, a fluctuation range needs to be set.

4. Cumulative flow rate proportional output

5. Preset cumulative flow rate: if preset cumulative flow rate is 2500 $m^3$, the relay will start to work after the accumulated value of flow rates reaches 2500 $m^3$.




**◆"3 Parameter calibration" (this menu is applicable only when the output current is between 4 and 20 mA)**

If the output current value is inconsistent with the calculated value, the parameters need to be modified. Power off the instrument firstly, then put the multimeter to 20 ma position, combine the positive anode of multimeter to "mA1+" terminal of flow meter and negative anode to the "GND" terminal on the right side of "mA1+" terminal and power on. Measure the current after 1 min.



1.4 mA correction:

Tip: as common multimeter has deviation, the difference between the measured value and actual value can be neglected if it is within ±0.01-0.02 mA.

Enter into 4 mA correction menu, there will be a number which has been set while leaving the factory, providing that it is "3100". Press the bottom to bring the number up, the value displayed on the multimeter is the current output current value.

If the current value on multimeter is lower than 4 mA, increase the number until the current value on multimeter reaches 4 mA. Exit the 4 mA correction menu to enter the 20 mA correction menu.

If the current value displayed on the multimeter is higher than 4 mA, decrease the number until the value reaches 4 mA. Exit the 4 mA correction menu to enter the 20 mA correction menu.

2. 20 mA correction:

Enter into 20 mA correction menu, there will be number which has been set while leaving the factory, providing that it is "7200". Press the bottom to bring the number up, the value displayed on the multimeter is the current output current value.

If the current value on multimeter is lower than 20 mA, bring the number up until the current value on multimeter reaches 20 mA. Exit the 20 mA correction menu.

If the current value displayed on the multimeter is higher than 20 mA, decrease the number until the value reaches 20 mA. Exit the 20 mA correction menu.

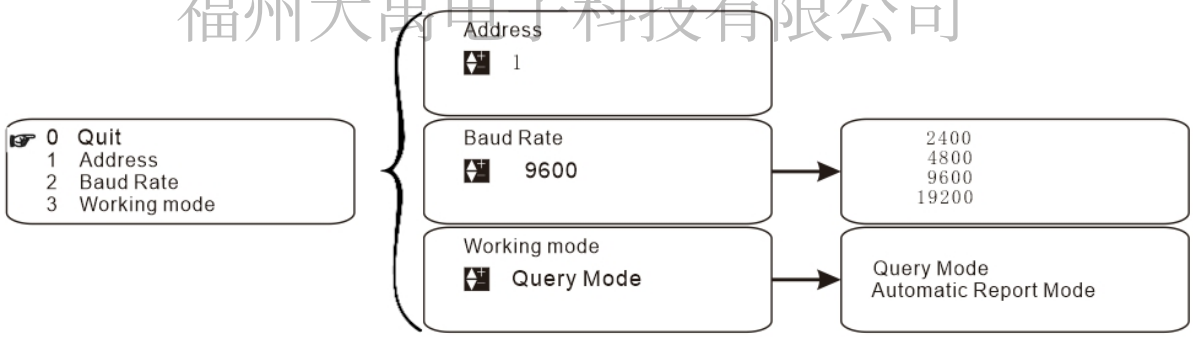

**◆"4 Communication setting" (this menu is only applicable to 485 output)**

1. Communication address: any number between 1 and 32 is applicable, take 1 as the default.

2. Baud rate: anyone between 2400, 4800, 9600 and 19200 is applicable, take 9600 as the default.

3. Working mode: the process of sending the data after receiving an instruction from the upper machine, query mode is defaulted. This is standard MODBUS protocol. If the protocol is prepared by us, we will make it an automatic report mode, that is meter can automatically send the measured data to upper machine without receiving the instruction from it.






**◆"5 Channel type"**

Following types of channels can applicable to flow rate calculation only in "Start" working status. All units below are m.

1. Square pipe: need to input side length of channel.

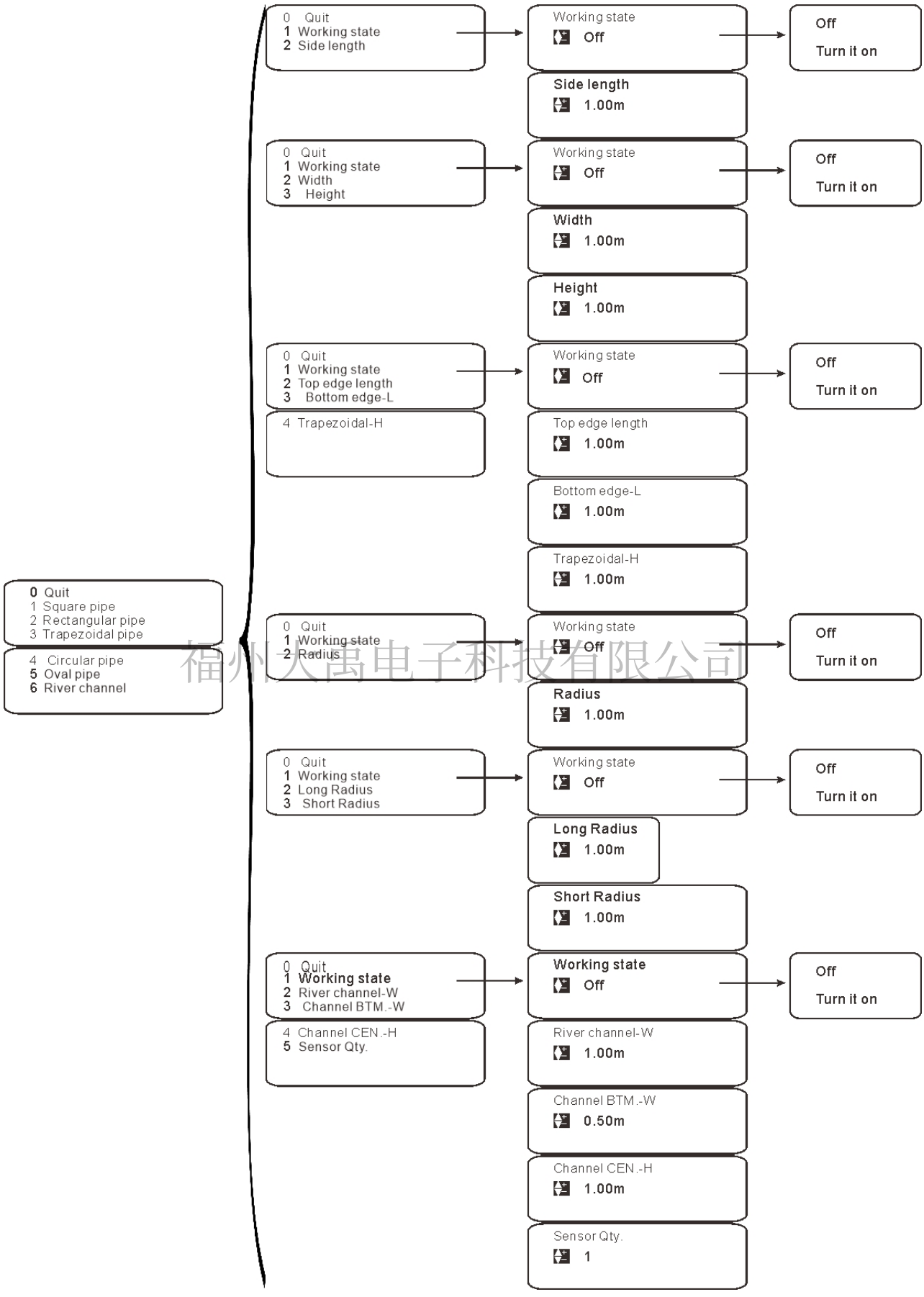
2. Rectangular pipe: need to input the width and height of channel.

3. Trapezoidal pipe: need to input the lengths of bottom edge and top edge and the height of channel.

4. Circular pipe: need to input the diameter.

5. Oval pipe: need to input the long radius and short radius.

6. River channel: need to input the width, bottom width and central height of river channel as well as the number of sensors.



◆**“6 Other parameters"**

1. 20mA flow value: the corresponding flow rate value of 20 mA when the output is 4-20 mA.

2. 4mA flow value: the corresponding flow rate value of 4 mA when the output is 4-20 mA, it is defaulted as 0.00 $m^3$/h.

3. Cumulative flow: the value from which the water yield is started to be accumulated, e.g.: if the cumulative water yield is 100 t/h, it means that the water yield is started to be added up from 100 t/h.

4. Cum. flow reset: it is defaulted as "No". If choosing "Yes", the current cumulative yield will be reset to 0.

5. Flow unit: $m^3$/h, $m^3$/s and l/s.

6. Interface switch: if choosing "Yes", the interface will be switched. If choosing "No", the interface will not be switched. There are two kinds of interfaces, one displays "water level, flow rate and cumulative water yield" and the other one displays "flow velocity and sectional area".

Shortcut: in start interface, press up and down bottoms to switch these two display interfaces.

7. Offset Amount: if measured water level is 10 cm higher than the actual level, it will be changed to -0.10 m. If measured water level is 3 cm lower than the actual value, it will be changed to 0.03 m.

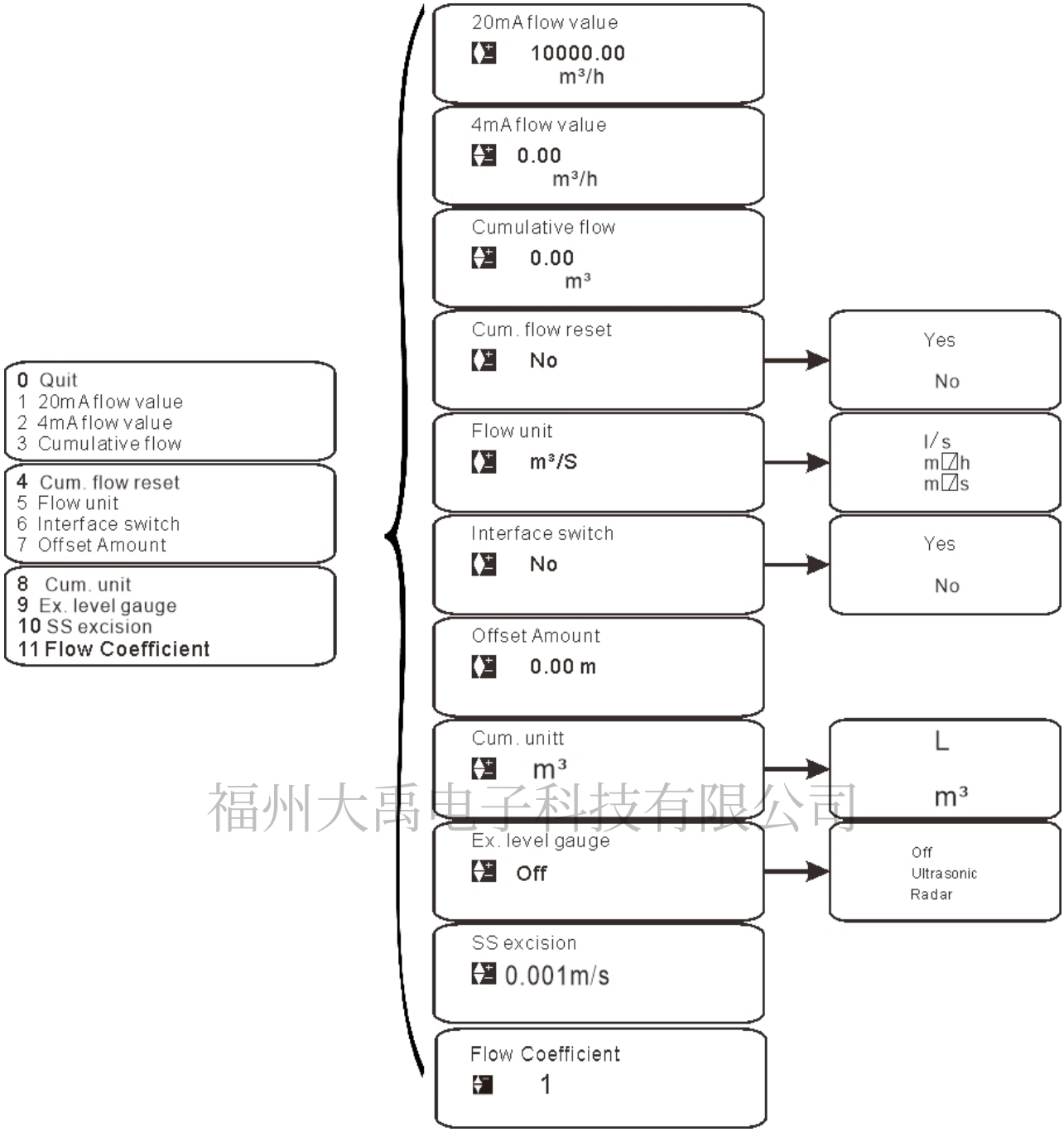


If the set offset is 10 cm, the system will automatically multiply upon the offset until the measured water level is 1 cm or larger.

8. Accumulative amount unit: the unit of cumulative water yield, which is $m^3$ or L.

9. External level gauge: ultrasonic water level gauge or radar level gauge can be mounted to measure the water level.

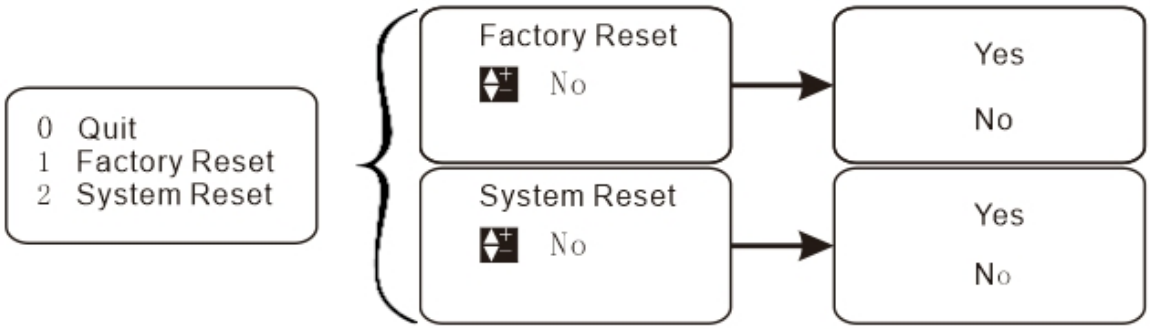
10. Small signal excision: in order to avoid the impact of small flow velocity on measurement, set a minimum flow velocity, like 0.05 m/s, so that the flow rate will not be counted when the flow velocity is 0.05 m/s or below. This problem is usually encountered when measuring in upstream of gate or in case of backflow.



◆**“7 Reset option"**

Factory reset: return to the status of leaving the factory. No: exit. Factory setting is defaulted as "No".

System reset: Yes: reset the system settings. No: exit. Factory setting is defaulted as "No". (Please do not modify it, it is for factory set)




IV Some incorrect installation cases

4.1.1 Installing right in front of the gate, too close to the gate, water flow is turbulent.

4.1.2 Installing with T-shaped bracket, the sensor is suspended in the water, easy to swing under the impact of water flow, so that, the measured result will be 0 or close to 0.

If have to apply T-shaped bracket, the bracket shall be made of I-beam steel, instead of reinforcing bar and meet the specification below:

1、The width of channel shall be within 2 m, horizontal beam shall be made of two pieces of No. 12 I-beam steel which shall be parallel, the size of each is 120×74×5.0 mm. Welding butt at four places shall be provided between the two pieces of I-beam steel to ensure the stability.

T-shaped bracket

2、If the channel width is within 5 m, horizontal beam shall be made of two pieces of No. 24 a I-beam steel which shall be parallel, the size of each is 240×116×8 mm. Welding butt at four places shall be provided between the two pieces of I-beam steel to ensure the stability.