80GHz FMCW

RADAR LEVEL SENSOR

Operating Manual

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1. Product introduction

Feature

Radar sensor is one kind of level measuring instrument which uses FMCW special millimeter wave technology, the working frequency is 76-81GHz. The max range can reach 30m, and the blind zone is 10cm. High working frequency and large bandwidth makes measurement accuracy higher. The product provides fixed bracket, 3.6V lithium battery power and multiple communication options. It is no need filed wiring that makes installation easier.

The main benefits of Radar sensor are：

- Based on the complementary metal-oxide-semiconductor transistor CMOS components with high compact architecture, gives higher signal to noise ratio and smaller blind zone.
- 5GHz working bandwidth means higher measurement resolution and accuracy.
- 6°antenna beam angle, so the interference in the environment has less impact on the instrument and the installation is more convenient.
- Integrated design, small size.
- The display console and level indicator are separated, customized available.
- Supporting wireless transmission of NB, Lora, and 4G etc. Upload cycle can be configured.
- Low continuous operation, life span is more than 3 years.
- Upload alarm information when the water level exceeds the upper or lower limit (configurable).
- Wireless debugging of mobile phone is convenient for maintenance of on-site personnel (Bluetooth debugging is supported in subsequent versions)

2. Technical Specifications

Application	Water Level Measurement
Measuring Range	0~35m
Antenna Type	Integrated lens antenna design
Installation method	Thread/ Bracket
Beam angle	6/ 8°
Ambient Temperature	(-40~85) ℃
Accuracy	±3mm
Signal Output	(4~20) mA HART/ RS485 MODBUS-RTU/ 4G
Working Frequency	(76~81) GHz
Protection Grade	IP67

Unit	Code	Parameters
Lens	B	With lens, beam angle 6°
	A	Integrated lens 8°(Thread G1.5)-Bluetooth
Material	4	304
	3	Engineering plastics
Communication	A	4G All networks
	L	LoRa Communication
	A	Two-Wire(4~20)mA
	H	Two-Wire(4~20)mA HART
	Y	Special Custom
Connection mode	E	Top thread NPT3/4 Bottom thread NPT 1 ½
	G	Thread G1½
	R	Top thread NPT3/4 Bottom thread NPT2
	T	Thread G2
	U	M24*1.5
	Y	Special Custom
Installation bracket	W	With installing bracket
	N	Without installing bracket
Battery	B0	With disposable lithium battery（19AH sleep function only 4G version is applicable）
	N	Without battery
	Y	Special Custom
Measuring Range	1	15m
	2	30m
	3	35m
	Y	Special Custom
Cable length	1	5m
	2	10m
	Y	Special Custom
Special Custom	Y	Special Custom

3. Dimension

Product dimensions（8°）

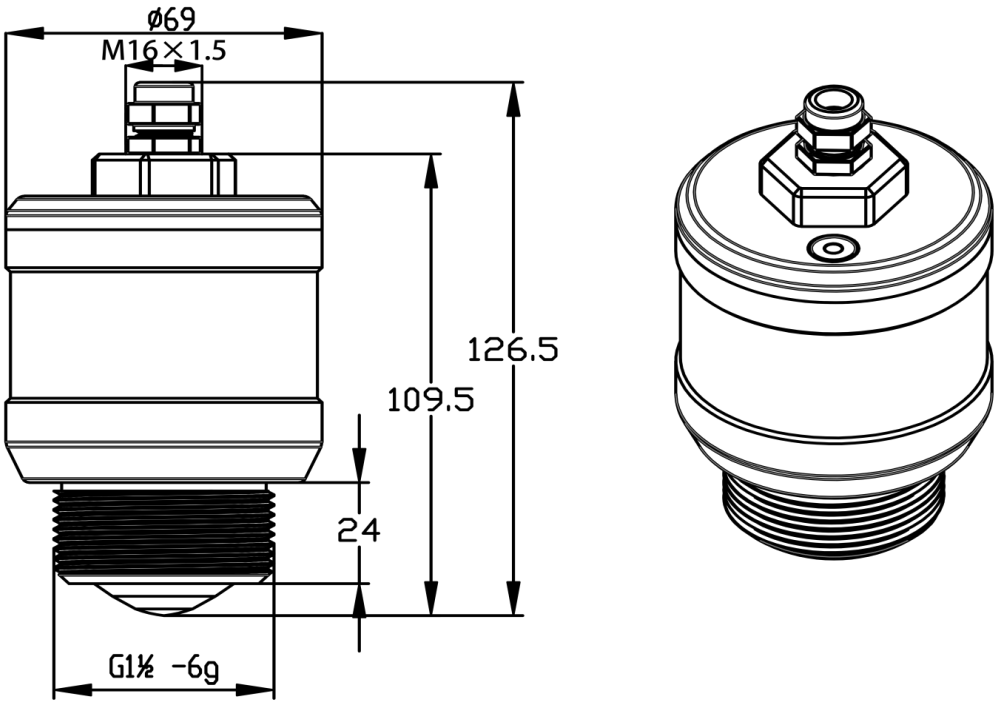


Fig.3– 1 Diagram of instrument structure size

4. Installation

Considerations when installing:

(1) Ensure the instrument is perpendicular to the water surface.

(2) Avoid the emission beam exposure to the jamming object, which will produce a false echo. See the following points for the typical working conditions.

■ Ensure the radar level transmitter is installed perpendicular to the water surface, and the tilt will weaken the signal amplitude and affect the normal range.

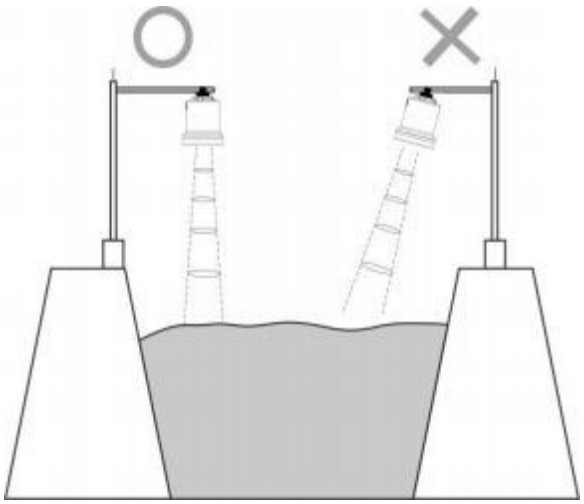


Fig. 4- 1 Diagram of the instrument installation location

■ Ensure that there are no interference within the beam range, such as the riverbank.

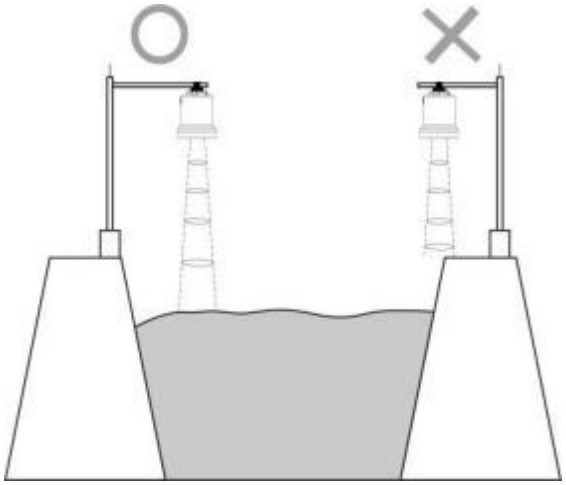


Fig. 4-2 Diagram of the instrument installation location

■ The instrument is installed at least 20cm away from the side wall, and the underground pipe network is installed as closer to the center of the well, otherwise the well will generate interference signals, which will affect the measurement, as shown in Fig. 4-3.

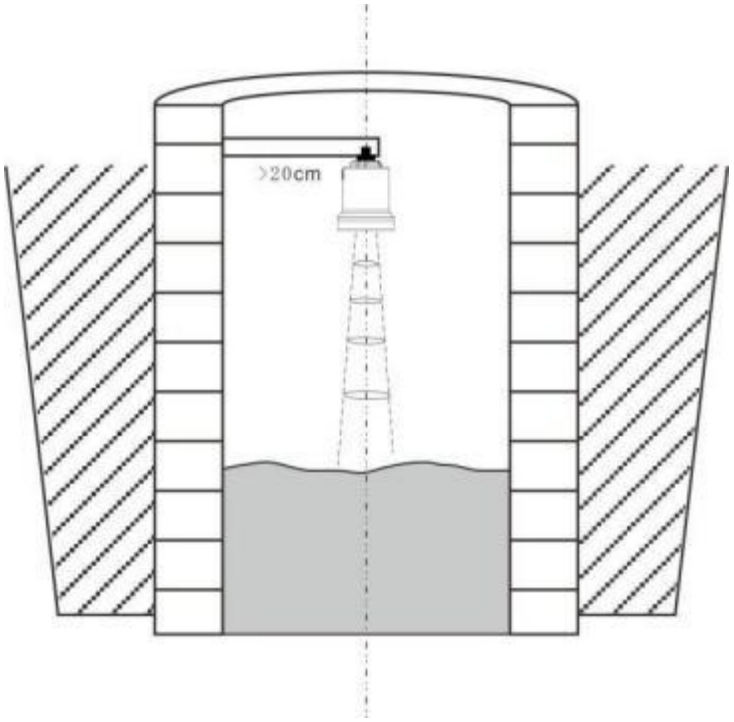
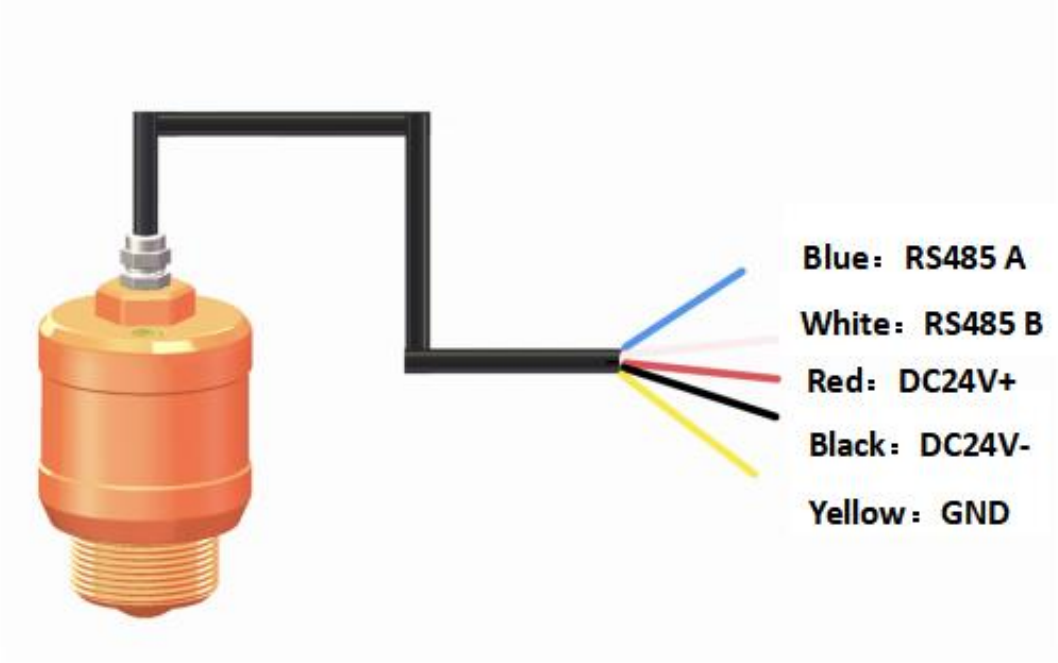


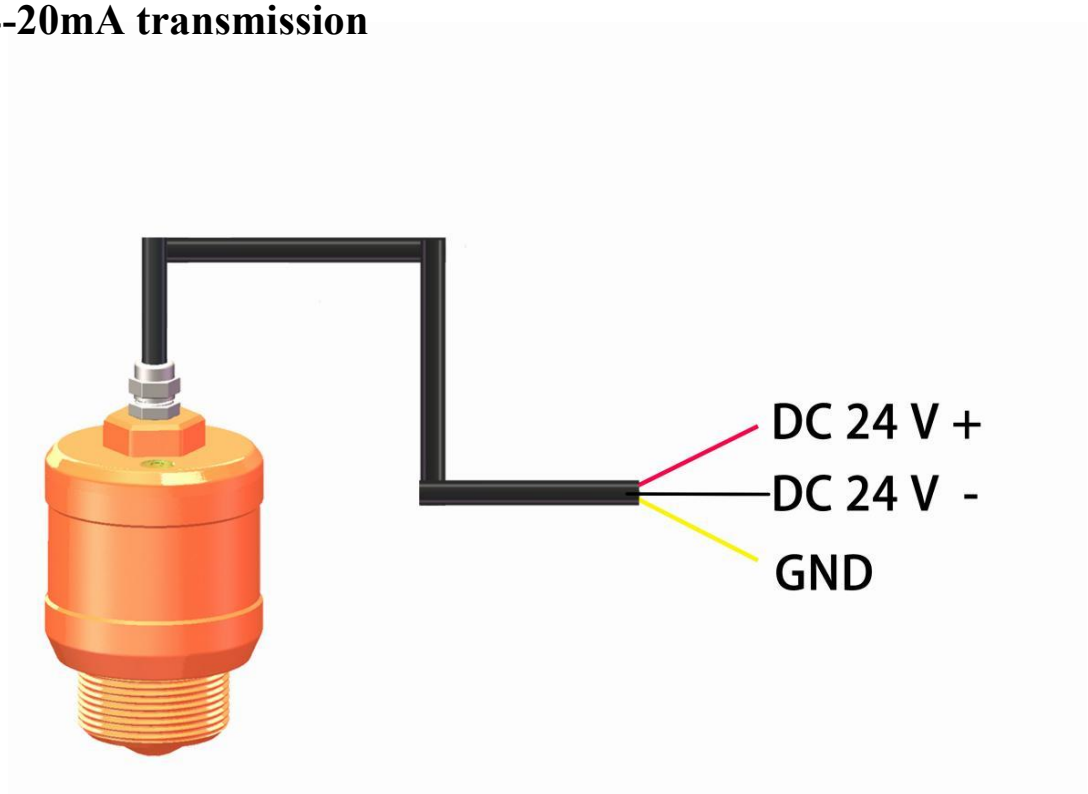
Fig.4–3 Installation is at least 20cm away from the wall

5. Wiring

5.1 RS485 transmission



5.2 4-20mA transmission



6. Operation of the Radar Level Transmitter

6.1 [Basic]

6.1.1 [Low Calibration]

[Low Calibration] see the figure below for specific definitions.

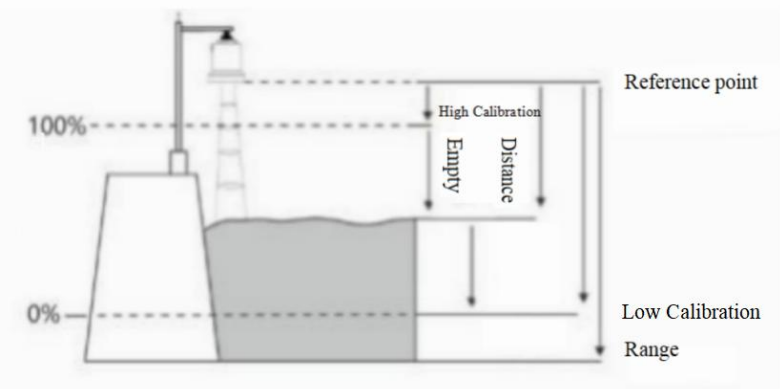


Fig.6– 1Low Calibration interface and definition

Table6–1 Low Calibration Description

Parameter Name	**Low Calibration**
Parameter range (m)	0. 1~ **range**
Default value (m)	30
Association configuration	If sets **Min adjustment** <**Max adjustment**+0. 1， then **Min adjustment** =（ **Max adjustment**+0. 1）；
Special matters	**Min adjustment** is independent of the **measuring range**, it only affects the calculation of the material level.

6.1.2 [High Calibration]

[High Calibration] means high calibration point, refer to Fig. 6- 10 for specific meaning

Table6–2 High Calibration Description

Parameter Name	**High Calibration**
Parameter range (m)	0 ~ （**Low Calibration**-0. 1)
Default value (m)	0
Association configuration	If sets **Max adjustment** > (**Min adjustment**-0. 1)， then **Max adjustment** = (**Min adjustment**-0. 1)；
Special matters	**Max adjustment** is independent of the blind zone， it only affects empty height.

6.1.3 [Range]

[Range] In order to obtain the correct measurement results, the range of the instrument needs to be set. The specific meaning is shown in the table.

Table6– 3 Range Description

Parameter Name	**Measuring Range**
Parameter range (m)	1~30
Default value (m)	10
Association configuration	If sets measuring range < (blind zone+0. 1m), then it is automatically set to (blind zone+0. 1m) 。
Option significance	Processing of the algorithm ignores the echo outside the range, and reasonably setting the range can avoid multiple reflection interference and the interference signal outside the possible range.
Special matters	This range does not refer to the remote measurement limit of the instrument and is only used as the limited algorithm area. Instrument measurement limits are shown in the Technical Specification section.

Note: The blind zone and range determine the specific range of the algorithm application, which can be set reasonably to avoid interference and false echoes to achieve fast and stable measurement.

6.1.4 [Blind Zone]

See the table below for the details.

Table6–4 Blind Zone Description

Parameter Name	**Blind zone**
Parameter range (m)	0~ (**Measuring range**-0. 1)
Default value (m)	0
Association configuration	If sets blind zone > (measuring range-0. 1), then blind zone= (measuring range-0. 1).
Option significance	The algorithm will ignore the echo within the blind zone, and this option can be used to avoid near-end interference。
Special matters	This blind area does not refer to the proximal measurement limit of the instrument and is only used as a limited algorithm area. Instrument measurement limits are shown in the Technical Specification section.

6.1.5 [Damping]

[Damping] is used to smooth the sudden changes in the measurement results, that is, the damping filter. For example, if the damping time is 2 seconds, the measured object position changes step by step at time t, and the measurement output value will slowly change. In the first 2 seconds, 63.2% of the change is completed, and in the 10th second (5 times Setting value) follow to the actual position, as shown in the figure below.

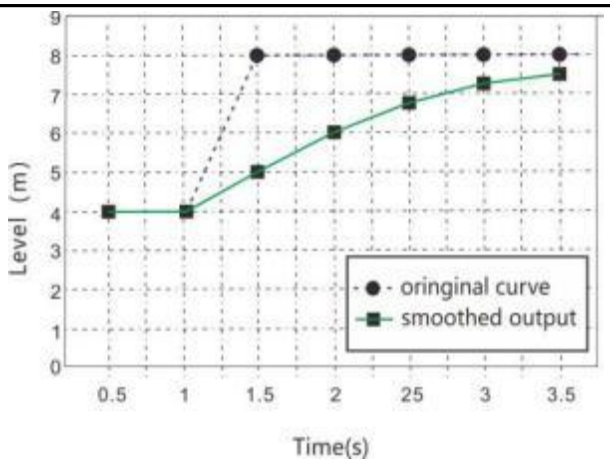


Fig. 6－9 Damping editing interface and meaning

Table6-5 Damping Description

Parameter Name	**Damping time**
Parameter range (S)	0 ~**600**
Default value (S)	**5**
Association configuration	None
Option significance	Damping output to improve signal stability
Special matters	This parameter is not used due to short measurement time

6.1.6 [Media Type]

[Media Type] Select Solid or Liquid according to the real situation.

6.1.7 [Vessel Type]

[Vessel Type]Select Big, Small, Fast or Test according to the real situation.If you select a Vessel type, the default parameters are adjusted according to the following table.

Parameter	**Vessel type specification**
Big	Damp: 10s, this parameter pursues the stability of measurement output
Small	Damp: 5s, suitable for most working conditions
Fast	Damp: 5s, suitable for fast measurement conditions
Test	Damp: 0s, suitable for infield test

6.2 [Advanced]

6.2.1 [False Echo Study]

[False Echo Study] It concludes False echo Begin, False echo End and False echo intensity. Learn false echoes containing known obstacles in the container, and form a background noise screening curve (threshold curve).

6.2.2 [Sensor offset]

[Sensor offset] corrects the deviation between the ideal measurement and the actual measurement. The Settings have been completed before delivery.

6.2.3 [Bus address]

This function is only applicable to digital communication. When two or more instruments are connected to the upper machine using HART communication interface, it is necessary to use this function to set the instrument to multi-point operation mode.

6.2.4 [Output Mode]

Select the direction of [Output mode] according to customer's requirements.

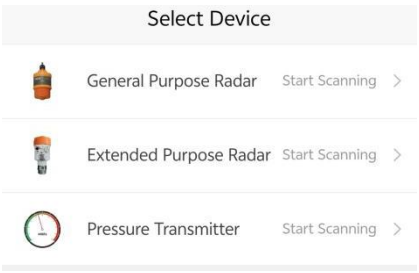
6.2.5[Current simulation]

[Current simulation] The loop current is fixed to output a specific current value, which is used to check whether the 4-20mA output loop current is normal or abnormal.

6.2.6.[Current function]

[Current function] indicates that the instrument will display your set mA value when the instrument is in fault. You can set the actual output current value when the instrument encounters a wave loss fault.

7. Bluetooth Connection



7.1 Firstly, please install the APP.

7.2 Secondly, open your mobile phone' s Bluetooth.

7.3 Thirdly, open the app, pop up the first one,

General Purpose Radar. As shown as Fig1.Then the page will automatically pop up the Bluetooth name of the closed radar.

Press [Set up], enter into the Set page. If not, please press [Refresh].

As shown as Fig2.

7.4 Please according to your needs to set the [Basic],

[Advanced], [Echo], [Unit select] and [Bluetooth Name].

Press [Read] to read the parameters set by radar. When completed editing operation, press [Write].

Note: Here will introduced the main parameter settings. Please do not modify the password setting section(Service and Factory). If need, please contact the manufacturer.

7.4.1[Basic]

Parameter	Introduction
Low Level	0.1~**range. Generally Low level= Range.**
High Level	0~**Low Calibration-0.1. Generally High level= 0.**
Range	According to your needs.
Blind Zone	used to correct the reference point of the sensor.
Damping	Generally set it **5.**
Media Type	Select liquid or solid.
Vessel Type	Select Big, Small, Fast or Test.

7.4.2[Advanced]

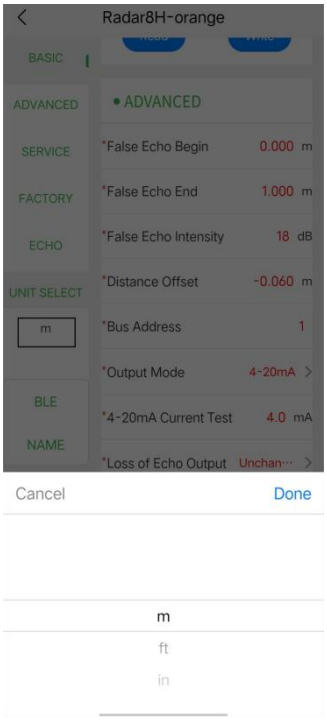
Parameter	Introduction
False Echo Begin	learn false echoes containing known obstacles in the container, and form a background noise screening curve (threshold curve).
False Echo End	
False Echo Intensity	
Distance Offset	Corrects the deviation between the ideal measurement and the actual measurement.
Bus Address	This function is only applicable to digital communication.
Output Mode	Select 4-20mA or 20-4mA.
4-20mA Current Test	To check whether the 4-20mA output loop current is normal or abnormal.
Loss of Echo Output	Select Unchanged, it will no change when the radar is in fault. Select 22mA, it will display 22mA when the radar is in fault. Select 3.6mA, it will display 3.6mA when the radar is in fault.

7.4.3[Echo]

Press [Echo] to check the echo curve.
Press [Click Here To Close The Popup] to exit.
D represents distance value,
and L represents level value.
As shown as Fig.2.

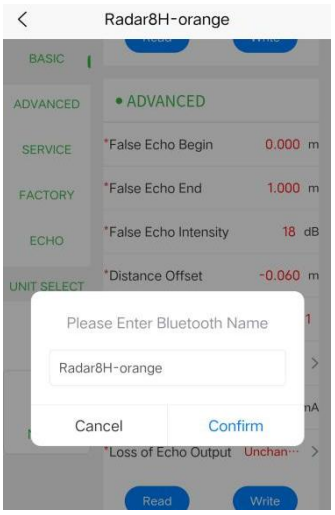
7.4.4 [Unit select]

Press the [Unit select] to change the unit according to your needs.
As shown as Fig.3.



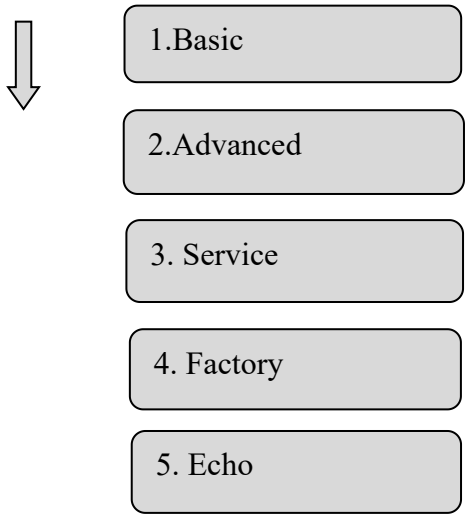
7.4.5[Bluetooth Name]

Press [NAME] to change the Bluetooth name.
As shown as Fig.4.

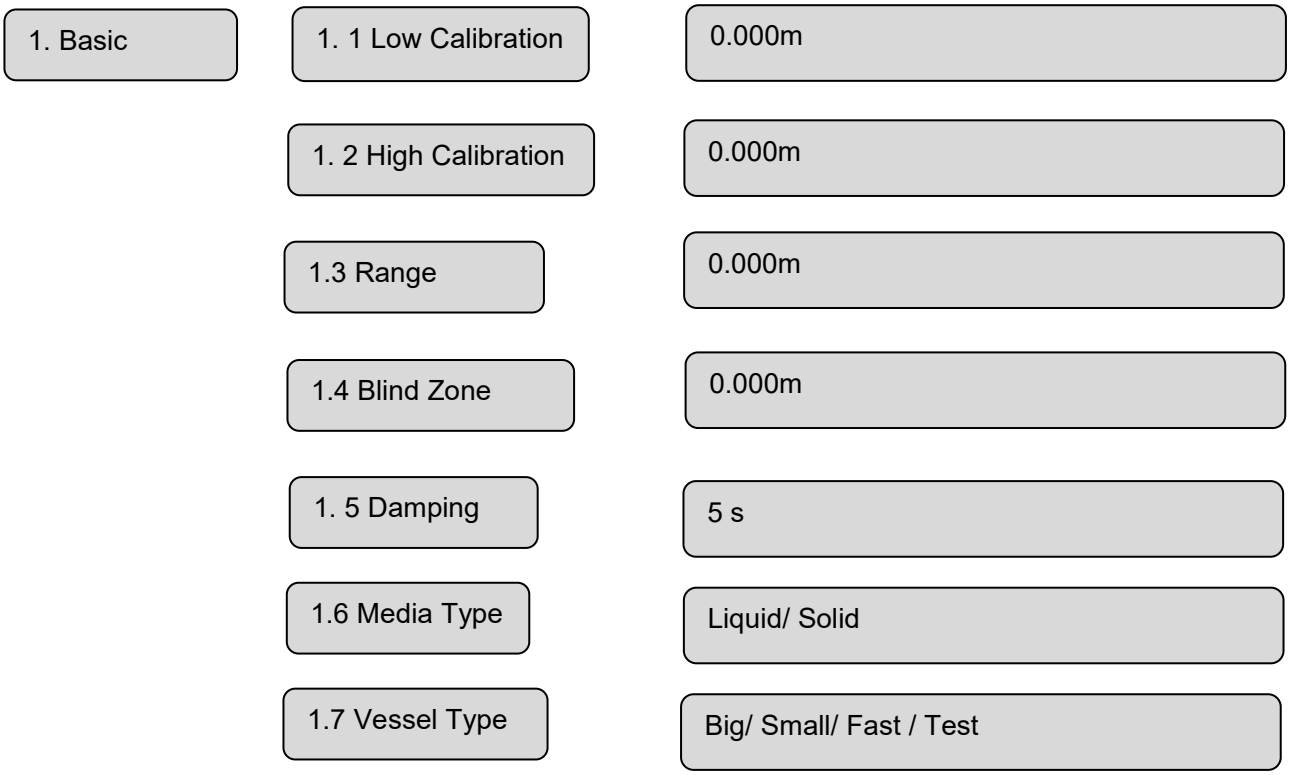


8. Menu Tree

8.1 First-level menu tree view



8.2 Secondary menu tree- Basic



8.3 Secondary menu tree- Advanced

2. Advanced	2.1 False Echo Begin	0.000m
	2.2 False Echo End	0.000m
	2.3 False Echo Intensity	Xx dB
	2.4 Distance Offset	0.000m
	2.5 Bus Address	Modbus Hart 1 0
	2.6 Output Mode	4-20mA/ 20-4mA
	2.7 Current Simulation	0.0mA
	2.8 Current Function	Unchanged/ 22mA/ 3.6mA

8.4 Secondary menu tree- Service

3. Service	3.1 Echo Rate	
	3.2 Window Setting	
	3.3 Window Time	
	3.4 Echo scale	
	3.5 Echo Lock	Lock/ Unlock
	3.6 1 Filtering	Open/ Close
	3.7 2 Filtering	Open/ Close
	3.8 Response Rate	0.0%
	3.9 Threshold Width	
	3.10 Threshold Strength	

9. Glossary

Beam Angle: The beam width that is 3 dB lower than the maximum value as the limit. The beam angle of DAR-8H is 6°, as shown in Fig. 9- 1.

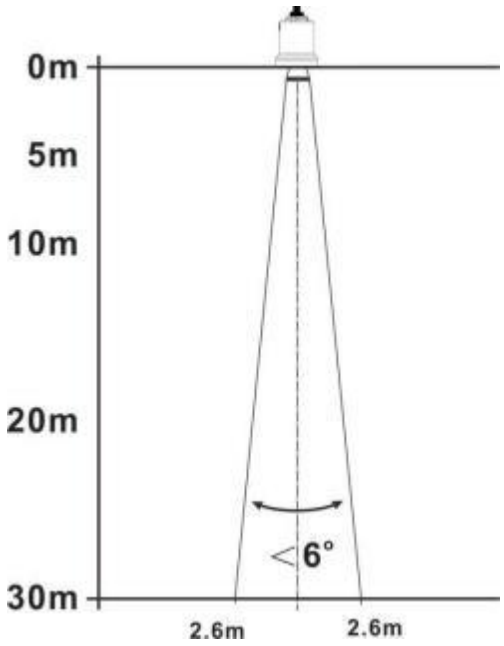


Fig. 9 - 1 Diagram of the space geometry of the radar beam of the instrument

Range resolution: The range resolution refers to how far apart two objects close together, the level radar can distinguish two objects instead of one and can measure their respective distances. If the distance between two objects is less than the range resolution of the level radar, the radar can only measure one distance value, which is not equal to the distance value of any one of them, but the combination of the distance values of the two objects. The frequency modulation bandwidth of ADR -8H is B=5GHz, and the minimum distance resolution=light speed/working bandwidth/2 ≈3cm.

Measurement accuracy: If there is only one object and this object has moved a small distance, whether the level radar can recognize the distance change. The index that distinguishes the moving distance of a single object is called accuracy. The intermediate frequency signal of ADR-8H is analyzed by its own algorithm, and the measurement accuracy is 0.5mm.

Blind zone: (1) Refers to the measurement limit of the near end of the meter, the instrument cannot measure in the blind zone.

Echo: the reflected signal received by the radar.

Launch cone: the extension of the antenna beam angle.

False echo: Any echo that is not generated by the desired target. Generally speaking, false echoes are generated by obstacles in the container.。

Multiple echoes: multiple reflection echoes appearing at the target echo distance, which may be 2 times or 3 times.

Measuring range: (1) Refers to the farthest measurement limit of the instrument (2) Specially, refers to the farthest distance artificially set, beyond this distance, the instrument is not considered when processing data.

Repeatability: the degree of deviation of multiple measurements of the same variable under the same conditions.

Threshold curve: A curve that changes with time. As a threshold, echoes exceeding it are considered valid.

10. Communication protocol

10.1 Water level transmitter adopts serial port communication, and the default

Communication parameters	Serial port level	Baud rate	Parity	Data bit	Stop bit
Serial port	RS485	9600	None	8	1

parameters are as follows：

10.2 Communication protocol format

The external communication of the level gauge adopts ModBus RTU communication protocol, and each complete data frame includes: address code, function code, data, and packet tail. The end of the packet is the CRC16 checksum data of the data frame, with low bytes at the beginning and high bytes at the end. The default address of the level gauge radar at the factory is 1. The radar address can be changed through display and control, or modified through commands.

The request command format and radar response data format are described as follows:

(1) Request command format：

Device address	Function code	Register address	Number of registers	CRC
(1 byte)	0x03	(2 byte)	(2 byte)	(2 byte)

(2) Request command reply data format：

Device address	Function code	Length of data	Data	CRC
(1 byte)	0x03	(1 byte)	(Length of data * 2 byte)	(2 byte)

(3) Set command format：

Device address	Function code	Register address	Number of registers	Length of data	Data	CRC
(1 byte)	0x10	(2 byte)	(2 byte)	(1 byte)	(x byte)	(2 byte)

(4) Set command reply data format：

Device address	Function code	Register address	Data	CRC
(1 byte)	0x10	(2 byte)	(2 byte)	(2 byte)

10.3 Read level

Address	Function code	Register address	Number	CRC	Instruction
01	03	0000	0001	840A	space(unit：mm)
01	03	0002	0001	25CA	level(unit：mm)

10.4 Parameters of register

Parameter	Register address	Function code	Data type	Instruction
Low calibration	0x2000	0x03,0x10	uint32	
High calibration	0x2002	0x03,0x10	uint32	
Far range	0x2004	0x03,0x10	uint32	
Near range	0x2006	0x03,0x10	uint32	

Damping	0x2008	0x03,0x10	uint16	0-99
Medium type	0x2009	0x03,0x10	uint16	0-solid, 1-liquid
Vessel type	0x200A	0x03,0x10	uint16	0-large volume, 1-small volume, 2-fast filling, 3-test
False echo start	0x200B	0x03,0x10	uint32	
False echo end	0x200D	0x03,0x10	uint32	
False echo strength	0x200F	0x03,0x10	uint32	
Sensor offset	0x2011	0x03,0x10	uint16	
Bus address	0x2012	0x03,0x10	uint16	1-127
Output mode	0x2013	0x03,0x10	uint16	0:4~20mA,1:20-4mA
mA simulation	0x2014	0x03,0x10	uint16	
mA function	0x2015	0x03,0x10	uint16	0-hold 1-22mA 2-3.6mA
Echo rate	0x2016	0x03,0x10	uint16	0--99
Window range	0x2017	0x03,0x10	uint16	0--10000
Window time	0x2018	0x03,0x10	uint16	0--600
Echo scale	0x2019	0x03,0x10	uint16	0--99
School lock	0x201A	0x03,0x10	uint16	0-lock，2-unclock
1 filtering	0x201B	0x03,0x10	uint16	0-open，1-close
2 filtering	0x201C	0x03,0x10	uint16	0-open，1-close
Response rate	0x201D	0x03,0x10	uint16	0--30000
Threshold width	0x201E	0x03,0x10	uint16	0--200
Threshold strength	0x201F	0x03,0x10	uint16	0--100
Measuring mode	0x2020	0x03,0x10	uint16	0-space, 1-level, 2-porpotion
Sensor unit	0x2021	0x03,0x10	uint16	0-m, 1-cm,2-mm
Language	0x2022	0x03,0x10	uint16	0-Chinese, 1-English
LCD contrast	0x2023	0x03,0x10	uint16	40--100