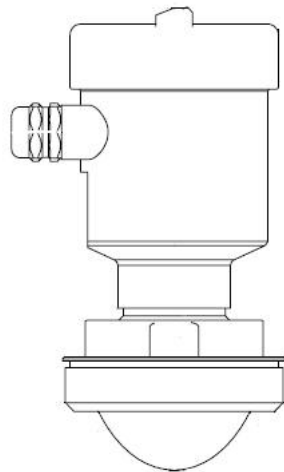


76-81GHz Continuous Frequency Modulation Wave Radar Level Meter

Instruction Manual



Product Introduction

Product Overview

The 76-81GHz radar level sensor is a radar product using the principle of frequency modulated continuous wave (FMCW), which can be widely used to measure the distance, material height, volume, weight and open channel flow of liquids, slurries and viscous, and can also be used to measure solid media such as powders, granules and blocks. It measures reliably even in dusty, agitated applications. Supports 2-wire and 4-wire applications. The maximum range of the product can reach 120m, and the minimum blind area can reach 0.08m. Due to its higher operating frequency and shorter wavelength, it is particularly suitable for solid-state applications, and the way in which electromagnetic waves are transmitted and received through a lens antenna has unique advantages in high dust, harsh temperature environments (+200°C).

Measuring Principle

The radar level gauge transmits a frequency modulated continuous wave signal (76-81GHz) through the antenna, the frequency increases linearly, and is transmitted in space at the speed of light, and is reflected on the surface of the measured medium, and is received by the same antenna, and the frequency difference between the transmitted signal frequency and the received signal frequency is proportional to the measured distance. The frequency spectrum of the reflected echo is obtained by Fast Fourier Transform (FFT), and the distance of the target to be measured is calculated.

Key Advantages:

- Transmit frequencies up to 76-81GHz enable a more compact RF architecture with a higher signal-to-noise ratio.
- The 5GHz operating bandwidth enables the product to have higher measurement resolution and measurement accuracy, and can be used at the metrology level.
- The narrowest 3° antenna beam angle has more concentrated energy, stronger anti-interference ability and higher reliability.
- The measurement blind area is smaller, and the measurement of small cans will also achieve better results.
- Shorter wavelengths provide better reflective properties for small particles and inclined media surfaces.
- Sensitive measurement, fast refresh speed, small antenna size, easy installation, rugged and maintenance-free.
- Non-contact measurement, no wear, no contamination, can measure liquid and solid media.
- With the technology of two-wire loop power supply, the power supply voltage and output signal are transmitted through a two-core cable, which saves costs.
- Using advanced microprocessor and unique echo processing technology, it can be applied to a variety of complex working conditions. It is almost unaffected by complex working conditions such as temperature, pressure, water vapor, dust, etc.
- The transmitting power is very low, and it can be installed in various metal and non-metal containers, and there is no harm to the human environment.
- The display with buttons makes it easy to set the parameters of the instrument.

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● Technical Specifications

Transmit frequency	76-81GHz, FM sweep frequency width 5GHz
Measuring Range	(0.08~120) m
Measurement Accuracy	±1mm
Beam Angle	3°、8°
Constant Range of Used Dielectric	≥2
Power Supply Range	(18~28) VDC (<1W)、220VAC
Methods of Communication	HART/MODBUS bus
Signal Output	4~20mA/HART bus or RS485/MODBUS bus
Fault Output	3.6mA, 22mA, hold
On-site Operation/Programming	128×64 dot matrix display/four buttons Configurable host computer setting software
Ambient Temperature/Humidity	(-40~85)°C/≤95%RH
Housing Material	Aluminum alloy or stainless steel are optional
Antenna Type	Lens antenna, can be equipped with lens antenna shield/anti-corrosion antenna/antenna heat sink/quartz isolation flange
Process Pressure	(-0.1~4)MPa
Product Dimension	φ100*270mm
Cable Entry	M20*1.5 / NPT1/2 "
Recommended Cables	AWG18 / 0.75mm ²
Protection Level	IP68
Install Method	Threads or Flanges
Net/Gross Weight	2.480Kg/2.995Kg
Package Dimension	28*28*32cm

● Installation

Basic Requirements

When the antenna emits microwave pulses, they all have a certain emission angle. There must be no obstruction in the area radiated by the microwave emission angle between the lower edge of the thread or flange and the surface of the medium to be measured. Therefore, the installation should avoid the facilities in the warehouse as much as possible, such as: ladders, limit switches, heating equipment, brackets, etc. Failure to do so will result in a measurement error. In addition, it should be noted that the microwave emission angle radiation area must not intersect with the feed stream. If necessary, it is necessary to carry out "False Echo" when the position is empty. When installing the instrument, it should also be noted that the highest material level shall not enter the measurement blind area of the instrument, and the instrument must be kept at a certain distance from the silo wall. The instrument is installed so that the antenna is emitted in a direction perpendicular to the surface of the medium to be measured. Installation occasions that avoid vibration. Instruments installed in explosion-proof areas must comply with the national installation regulations for explosion-proof hazardous areas.

Recommended Installation Location

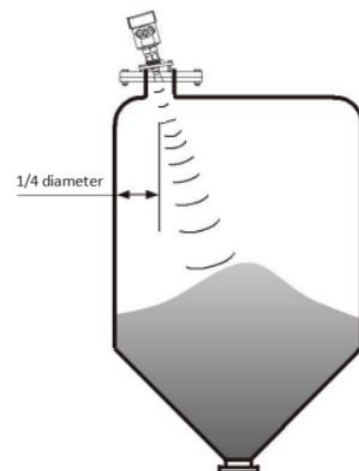
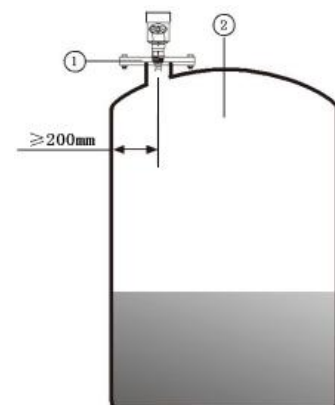
Installed at the diameter of the silo ($1/4-1/6$), keep a minimum horizontal distance of 200mm from the silo wall otherwise it is likely to produce false readings, and the instrument needs to be installed vertically (flange surface horizontal) when measuring liquids.

Note: (1) Datum

(2) Container center or axis of symmetry

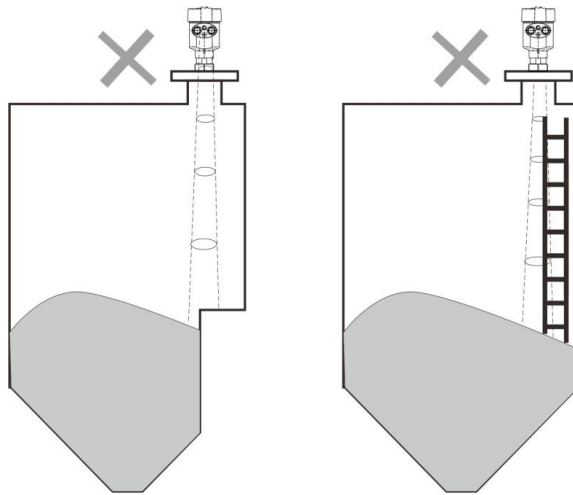
The silo body with stockpile is perpendicular to the incident surface

Because the inclined solid surface will cause echo attenuation, and even the problem of loss of signal, the lens antenna should be as perpendicular as possible to the material surface, if the material surface is uneven, the universal flange is recommended to adjust the angle of the lens antenna.

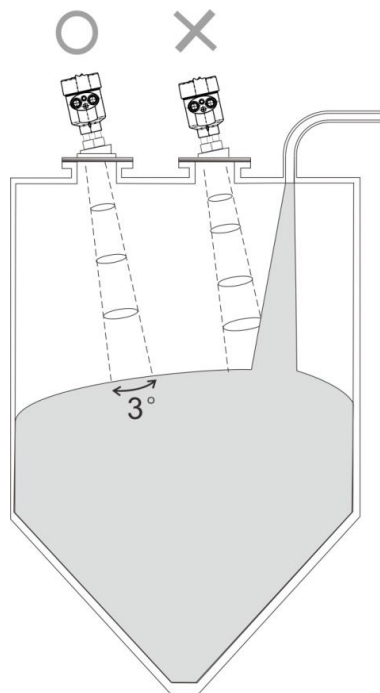


Typical Installation Errors

- Ensure that there are no interferences in the beam range, such as ladders, steps, etc. As shown in the figure below:



- When measuring solid materials, the instrument should be installed to ensure that the antenna beam avoids the feed port and is perpendicular to the material surface, as shown in the figure below:



● **Electrical Connections**

All electrical connections must be carried out under power-off conditions, please follow the requirements of local electrical installation regulations. All operations on the electrical components of the instrument must be carried out by professionally trained personnel. Please check the nameplate of the meter to ensure that the product specifications provided meet your requirements. Please ensure that the supplied supply voltage is consistent with the requirements on the meter nameplate.

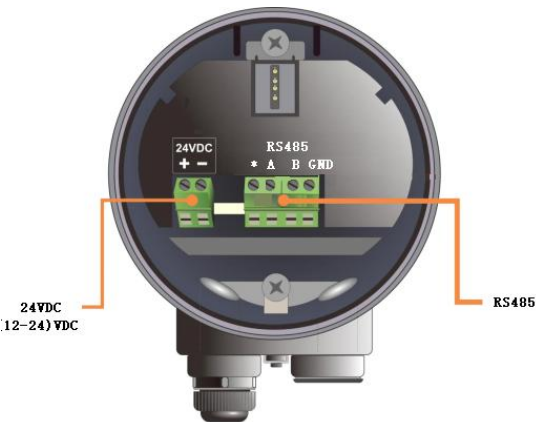
Cable Selection

Model	Cable Requirements
(4~20) mA/HART (2-wire system)	• The power supply and output current signals share a two-core shielded cable
(4~20) mA/HART (4-wire system) RS485/MODBUS (4-wire)	• The power supply and current signals are separated and two two-core shielded cables are used
General Requirements	• Cable specifications: AWG18 or 0.75mm² recommended • The specific supply voltage range can be found in the technical data on the nameplate of the instrument • For the intrinsically safe type, a safety barrier must be added between the power supply and the instrument

Wiring Diagram



Schematic diagram of two-wire instrument wiring



Schematic diagram of four-wire RS485 instrument wiring

Communication & Debugging

The instrument can be debugged by LCD on site, or on PC with the optional host computer software. Communication between the radar instrument and the PC is carried out in the following ways:

1. USB to RS485 serial port cable (four-wire system);
2. USB to TTL serial cable (two-wire system);
3. USB to Hart-modem (two-wire system) for communication;
4. Debugging through mobile phone Bluetooth makes on-site debugging safer and more convenient;
5. 4G network, remote debugging through remote module.

● Meter Operation

• Button Description

The product display module consists of 4 buttons and 128×64 dot matrix LCD screen. The display system has 4 display interface modes:

【Run Mode】 : Displays the system running status and current measurement data

【Echo Mode】 : Displays the echo status currently measured by the system

【Setup Mode】 : Set various data parameters for system operation

【Input Mode】 : Enter the numeric value, number, or character of the parameter

The functions of the 4 buttons in different display modes are also different

• Measurement Interface Description

Description of the key function when running the measurement interface

Marking	Function	Keyboard
①	-Switch to the setting parameter interface	OK
②	- NULL	↑
③	- NULL	↶
④	-Toggle to the Echo Curve interface	BK

- The Run Measurement interface is displayed as follows:

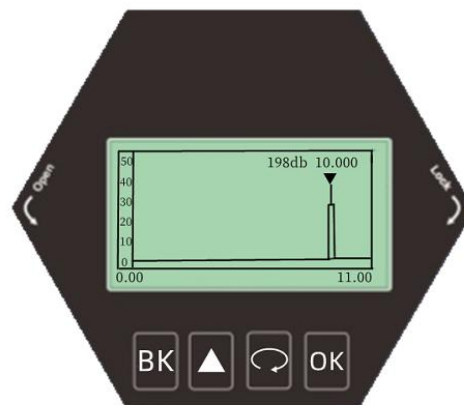


Run Measurement Interface

- **Description of the echo curve interface**

Marking	Function	Keyboard
①	-Switch to the Run Measurement interface	OK
②	-Null	↑
③	-Show/hide threshold curves	↺
④	-Switch to the Run Measurement interface	BK

- Under the Run Measurement interface, press the [BK] button to enter the echo curve interface



Echo curve interface

- On the echo curve interface, press the [BK] button to switch the echo curve interface to the running measurement interface.

Echo interface, specifically:

- The 198db number indicates the maximum echo intensity in the range, a good metal reflector, the echo intensity should be about 200dB, if the echo intensity is less than 60dB, it indicates that the echo signal is weak, and technicians need to check accordingly.

● Parameter Summary Table

【Basic Settings】

【Basic Setting】 menu item can implement a variety of functions, as shown in the following table. With these parameter settings, a fast start-up of the level sensor can be achieved. Select 【Basic Setting】 and press 【OK】 to enter the options interface, the list of options is shown in the following table:

Basic Settings menu option

Default location	Menu items
•	High Low Calib
	Range
	Deadband
	Damping
	Media Type
	Vess Type

【Advanced Settings】

Select 【Advanced Setting】 and press 【OK】 to enter the options interface, as shown in the following table:

Advanced settings menu options

Default location	Menu items
•	False Echo
	Sensor Offset
	Bus Address
	Output Mode
	Current Sim
	Current Func

【Service】

Select 【Service】 and press 【OK】 to enter the options interface, and the list of options is shown in the following table:

Service menu options

Default location	Menu items
•	Echo Rate
	Window Set
	Echo Scale
	Echo Lock
	1st Filtering
	2st Filtering
	Response Rate
	Threshold Set

【Display】

Select **【Display】** and press **【OK】** to enter the options interface, and the list of options is shown in the following table:

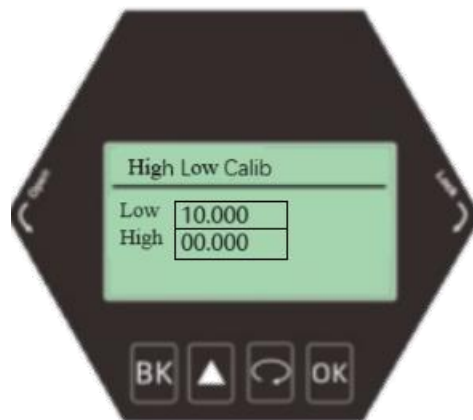
Display menu options

Default location	Menu items
•	Display Mode
	Sensor Units
	Language
	LCD Contrast

• Menu Option Operation Settings

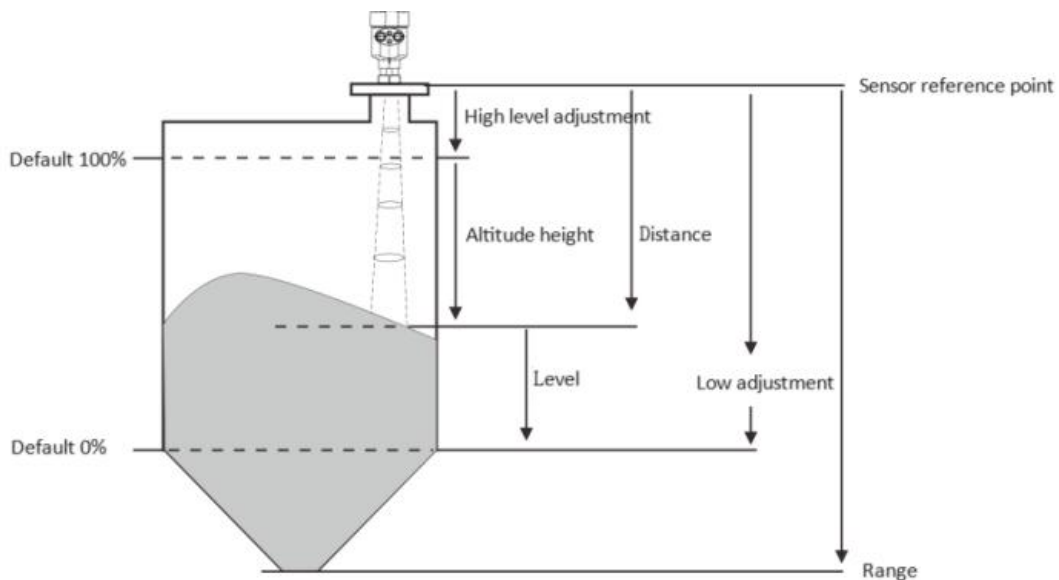
· Basic settings menu operation

- Press 【↶】 to enter the basic menu option 【High Low Calib】
- 【Low Setting】 is related to the signal output value, and together with the 【High Setting】, it maps the correspondence between the measured value and the current output (4-20mA). Select 【High Low Calib】 in the 【Basic Setting】 menu, press the 【OK】 button to enter 【High Low Calib】, press the 【OK】 button to edit the operation, and press 【BK】 to exit.



The editing interface for high and low settings

- 【High Low Calib】The high level corresponds to the full material position, and the low position corresponds to the empty position, as shown in the following figure:



- Press **【↶】** to enter the basic settings menu option **【Range】**

In order to obtain accurate results, it is necessary to set the measuring range of the instrument. Select the **【Basic Setting】** menu, enter the **【Range】** option, and if you need to modify the value, press the **【OK】** button to edit the operation. Press **【BK】** to exit.

Significance: Echoes larger than the range are not selected.



- Press **【↶】** to enter the basic settings menu option **【Deadband】**

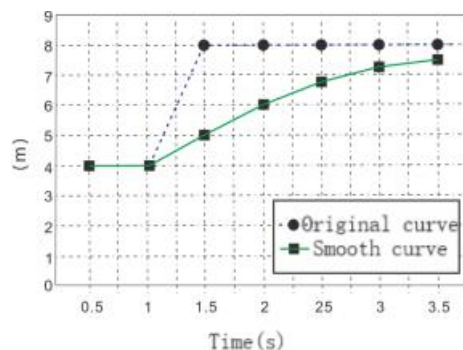
In order to obtain the correct measurement result, it is necessary to set the blind zone range of the instrument. Select the **【Basic Settings】** menu, enter the **【Deadband】** option, and if you need to modify the value, press the **【OK】** button to edit the operation. Press **【BK】** to exit.

Significance: Together with the measuring Range, the measuring range of the meter is determined.



- Press the **【↶】** button to enter the **【Damping】**

In order to improve the stability of the measured output value, a larger **【Damping】** can be set to stabilize the measured value and increase the anti-interference ability. For example, if the Damping is 2 seconds, the position of the measured object changes in step at time t , and the measured output value follows to the actual position of the measured object after 10 seconds. Press the **【OK】** button to complete the editing operation, and press **【BK】** to exit. It is shown below:



- Press the **【↶↷】** key to enter the **【Media Type】**
Set **【Media Type】** to select liquid and solid, press the **【OK】** button to edit the operation, and press **【BK】** to exit. It is shown below:



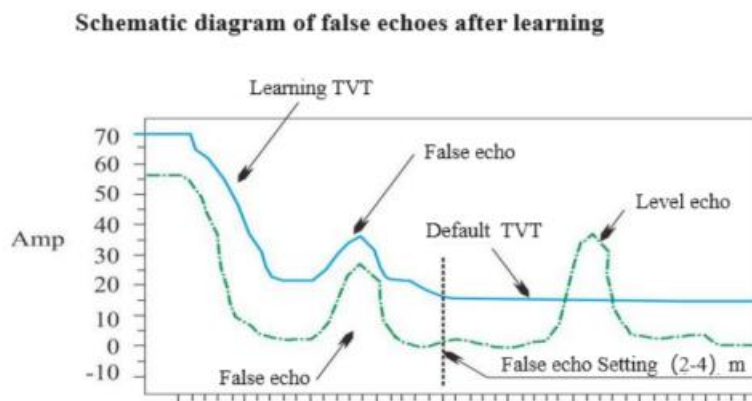
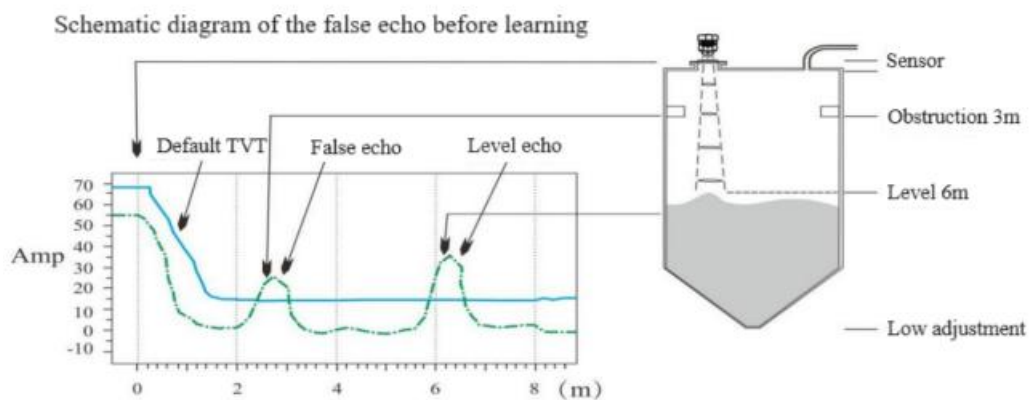
- Press the **【↶↷】** key to enter the **【Vess Type】**
Set the **【Vess Type】** to select the corresponding container according to the on-site container, and press the **【OK】** button to edit the operation. Press **【BK】** to exit. It is shown below:



● Advanced Settings Menu Operation

- Press the **【OK】** button to enter the basic settings menu bar, and then press **【↶】** to enter the **【Advanced Settings】** menu

Press the **【OK】** key to enter the **【False Echo】** setting, **【False Echo】** can learn the false echo containing the container of known obstacles, and form a screening curve (threshold curve) of background noise, you need to set the **【Start and End Value】** and **【Intensity】** before learning the false echo. Press the **【OK】** button to complete the editing operation, and press **【BK】** to exit. It is shown below:



- Press the 【↶↷】 key to enter the 【Sensor Offset】

Set 【Sensor Offset】 to correct the deviation between the ideal measured value and the actual measured value. The setting has been completed before leaving the factory, press the 【OK】 button to edit the operation, and press 【BK】 to exit. It is shown below:



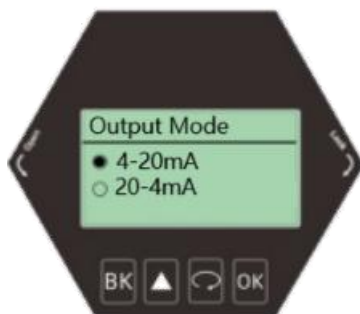
- Press the 【↶↷】 key to enter the 【Bus Address】

This function is only applicable to RS485MODBUS communication, when two or more meters are connected to the host computer using the HART communication interface, this function needs to be used to set the meter to multipoint working mode. Press the 【OK】 button to complete the editing operation, and press 【BK】 to exit. It is shown below:



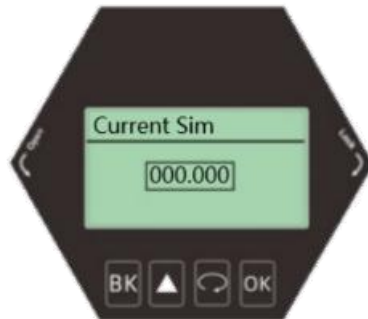
- Press the 【↶↷】 key to enter the 【Output Mode】

Select the direction of 【Output Position】 according to the customer's requirements, press the 【OK】 button to edit the operation to complete, and press 【BK】 to exit.



- Press the **【↶↷】** button to enter the **【Current Sim】**

Set **【Current Sim】** to calibrate the error value of the current output, it has been calibrated before leaving the factory, press the **【OK】** button to edit the operation, and press **【BK】** to exit. It is shown below:



- Press the **【↶↷】** key to enter the **【Current Func】**

Set **【Current Func】** to set the value of the actual output current when the meter encounters a wave loss fault. Press the **【OK】** button to complete the editing operation, and press **【BK】** to exit. It is shown below:



● Service Menu Operations

- Press the **【OK】** button to enter the basic settings menu bar, and then press **【↶↷】** to enter the **【Service】** menu

- Press the **【↶↷】** key to enter the **【Echo Rate】**

【Echo Rate】 is used to adjust the speed of waveform change, the larger the value, the slower and more stable the waveform change, and the smaller the value, the faster the waveform change speed. Press the **【OK】** button to complete the editing operation, and press **【BK】** to exit. It is shown below:



- Press the **【↶↷】** key to enter the **【Window Set】**

【Window Set】 is used to search the front and back range after the waveform is locked. If the current echo is lost, or the echo is not tracked because it is loaded and unloaded too quickly, it will search for the strongest echo and confirm the current echo. If a previously lost echo is being recovered, the previous lost echo will not be confirmed. Time is the speed at which the echo is tracked. Press the **【OK】** button to complete the editing operation, and press **【BK】** to exit. It is shown below:



- Press the **【↶↷】** key to enter the **【Echo Scale】**

The **【Echo Scale】** window assures that the echo is greater than the percentage of echoes in the window. Press the **【OK】** button to complete the editing operation, and press **【BK】** to exit. It is shown below:



- Press the **【↶↷】** key to enter **【Echo Lock】**

【Echo Lock】 If you select the agitator, you are looking for signals within this window range (here the window range refers to the parameters set in the previous window). If you unlock it, you are looking for a signal all the way. Press the **【OK】** button to complete the editing operation, and press **【BK】** to exit. It is shown below



- Press the **【↶↷】** key to enter the **【1st Filter】**

【1st Filter】 can be turned on or off according to the waveform in a small range measurement environment. Press the **【OK】** button to complete the editing operation, and press **【BK】** to exit. It is shown below:



- Press the **【↶↷】** key to enter the **【2st Filter】**

【2st Filter】 is an interface filter, which can be turned on or off according to the waveform in a large-range measurement environment, and should not be used if the blind area is too small. Press the **【OK】** button to complete the editing operation, and press **【BK】** to exit. It is shown below:



- Press the **【↶↷】** key to enter the **【Response Rate】**

【Response Rate】 is used to adjust the response rate of the instrument to the increase of the actual material level, and the response rate will automatically change when the rate and time settings are changed. The general solids rate is set slightly larger and liquids slightly smaller. Press the **【OK】** button to complete the editing operation, and press **【BK】** to exit. It is shown below:



- Press the **【↶↷】** key to enter the **【Threshold Set】**

【Threshold Set】 Set the threshold size of the effective echo, the larger the threshold setting, the stronger the effective echo amplitude is required, which is conducive to eliminating the interference of small signal clutter. Press the **【OK】** button to complete the editing operation, and press **【BK】** to exit. It is shown below:



● Display Menu Operations

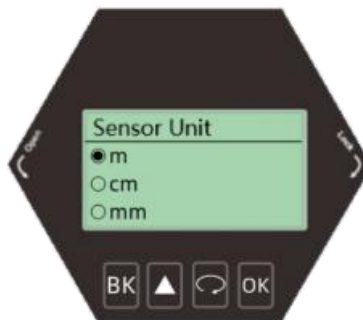
- Press the 【↶↷】 button to enter the 【Display Mode】

Set 【Display Mode】 to display three modes: level, air height and proportion, press 【OK】 to edit the operation, and press 【BK】 to exit. It is shown below:



- Press the 【↶↷】 key to enter the 【Sensor Unit】

Change the unit according to your needs: The default unit is m, press the 【OK】 button to complete the editing operation, and press 【BK】 to exit. It is shown below:



· Press the 【↶↷】 key to enter 【Language】 to select Chinese and English, press the 【OK】 key to edit the operation to complete, and press 【BK】 to exit. It is shown below:

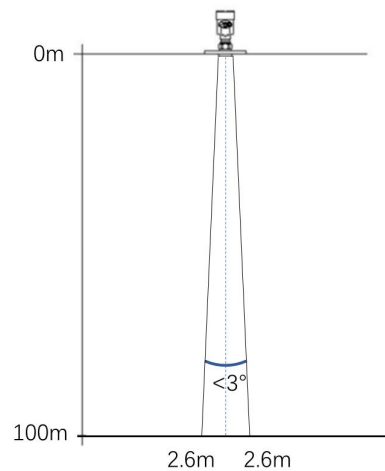


- Press the 【↶↷】 button to enter the 【LCD Contrast】

Set 【LCD Contrast】 to adjust the brightness of the display, select 【LCD Contrast】, press the 【OK】 button to edit the operation, and press 【BK】 to exit. It is shown below:



Appendix: Glossary



Beam angle: The beamwidth bounded by 3 dB below the maximum. The minimum beam angle is 3° , as shown in the figure above.

Range Resolution: Range resolution refers to the ability of a radar to distinguish between two objects that are close together. If the separation between two objects is less than the range resolution of the level radar, then the radar can only measure one distance value, which is not equal to the distance value of any one of the objects, but is the sum of the distance values of the two objects. FM bandwidth $B = 5.1\text{GHz}$, minimum distance resolution $= C/2B \approx 3\text{cm}$.

Accuracy: If there is only one object and the object has moved a small distance, the level radar can detect the change in distance. The metric that distinguishes the distance traveled by a single object is called accuracy. The IF signal is analyzed by its own algorithm, and the measurement accuracy is 0.1mm.

Ambient temperature: The temperature of the surrounding air that comes into contact with the device's enclosure.

Blind zone: refers to the measurement limit of the proximal end of the instrument, which cannot be measured by the instrument in the blind zone

dB (decibels): A unit that represents the amplitude of a signal.

Dielectric constant (DK): The ability of a dielectric to store electrical energy under the induction of an electromagnetic field. It is often referred to as the relative permittivity. The growth of the dielectric constant is directly proportional to the growth of the echo amplitude. The relative vacuum/dry air dielectric constant is 1.

Echo: The reflected signal received by the radar.

Transmit cone: An extension of the beam angle of the antenna.

False Echo: Any echo that is not generated by the desired target. In general, false echoes are generated by the obstruction of the container.

Multiple echoes: Multiple reflected echoes that occur at the target echo distance, possibly 2 times, 3 times.

Polarization: The property of an emitted electromagnetic wave that describes the direction and amplitude of an electric field vector that changes over time.

Range: (1) refers to the farthest measurement limit of the instrument (2) special, refers to the maximum distance set artificially, beyond which the instrument does not consider when processing data.

Repeatability: The degree of deviation of the results by measuring the same reflected target multiple times in the same test environment.

Speed of light: Symbol C, electromagnetic wave velocity (including electromagnetic waves and light in free space. The speed of light is 299,792,458 meters per second.

Threshold Curve: A curve over time that acts as a threshold above which echoes are considered valid.