# MINIRADAR SMARTLINE
# S-810-L  / S-810-EL / S-812-L

**CONTACT RADAR 76-81GHz FMCW**

## WATER LEVEL SENSORS

## OPERATING MANUAL
## Local & Wireless setup

See also the SERVICE pages on SMERI
website: tutorial for wireless programming

SERVICE -  TUTORIAL

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# 1. Warranty and service scope of radar

The warranty period of the radar level sensor is one year from the date of delivery. This warranty is only limited to the users of the original buyer or the designated dealer, and does not apply to users who use it wrongly for human reasons, transform, neglect or damage it due to accidents and abnormal use.

For the faulty radar level sensor returned within the scope of warranty, free maintenance is provided. To obtain warranty service, please contact the after-sales service department and attach the fault description. With the permission of our company, send the radar sensor to the after-sales service department.

If the radar level sensor has expired the warranty period or it is confirmed that the failure is caused by misuse, modification, negligence, accident and abnormal conditions, the maintenance cost budget will be provided according to the relevant maintenance charge standard, and the maintenance will be carried out after it is approved. After the radar level sensor is repaired, it is sent back to the customer, and the customer needs to pay the maintenance and transportation costs.

## 2. Unpacking inspection and precautions

### 2.1 Unpacking inspection

- Instruction manual

- Certificate of conformity

- Packing list

- Radar Level Sensor

- Check the name, model and other contents on the nameplate

- Check whether the radar sensor housing is intact and observe

- Check the random items against the packing list

- Check whether the specifications, models and accessories are correct and complete according to the packing list of the radar level sensor. If there is any problem, please contact the customer service center in time for replacement.

### 2.2 Precautions

- Please read this manual before installing the radar level sensor.

- Modifications due to product upgrading are subject to change without notice. Please refer to the real object.

## 3. Storage and transportation

### 3.1 Storage conditions

- Temperature：–40～+85 ℃

- Use the original packaging

## 3.2 Transport the product to the measuring place

- Use the original packaging to transport the radar sensor to the measuring place.

- Collision, dampness and chemical erosion shall be prevented during transportation and storage.

# 4. Product introduction

## 4.1 Product Overview

77-81Ghz frequency modulated continuous wave (FMCW) radar products (also known as millimeter wave radar) adopt the millimeter wave band with higher frequency than Ku band radar. They have important applications in long-range target detection, long-range imaging, multispectral imaging in strong smoke and dust environment, and can detect smaller targets than microwave radar and achieve more accurate positioning, with higher resolution and stronger confidentiality.

As a 80GHz band radar used in the field of industrial measurement, high-precision,non-contact level and liquid level measurement has incomparable advantages over other ordinary microwave pulse radars and guided wave radars. With extremely narrow beam and penetration ability, it can better adapt to ultra complex working conditions without weakening the measurement performance.

## 4.1 Technical Parameters

| TECHNICAL DATA | |
|---|---|
| Housing | ABS, PVDF or inox 304 |
| Antenna | Lenses; in PP |
| Beam angle | 3° (3,5° model in PVDF) |
| Measuring range | Depends on the model, up to 30 m |
| Accuracy | ±5 mm (10 m) / ±12 mm (20 m) / ±15 mm (30 m) (±2 mm model in PVDF) |
| Signal output | 4-20 mA; RS845 |
| Power supply | Two-wire 24 Vcc (22...30 V) |
| Operating temperature | -20...+70 °C (-40...85 °C model in PVDF) |
| Operating humidity | 0...95% RH |
| Housing material | ABS, inox 304, PVDF |
| Protection class | IP66/67 (IP68 model in PVDF) |
| Electrical connection | S-810-L/S-812-EL: screened cable outlet PUR, 1 m standard; other on request  S-812-L: double cable gland M12x1.5 |
| Operation | App RadarMe on smartphone (Bluetooth) |
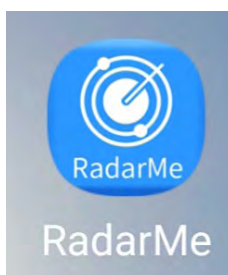


App RadarMe for
Anadroid, Apple systems

## 4.2 Outer Dimensions

Unit:mm

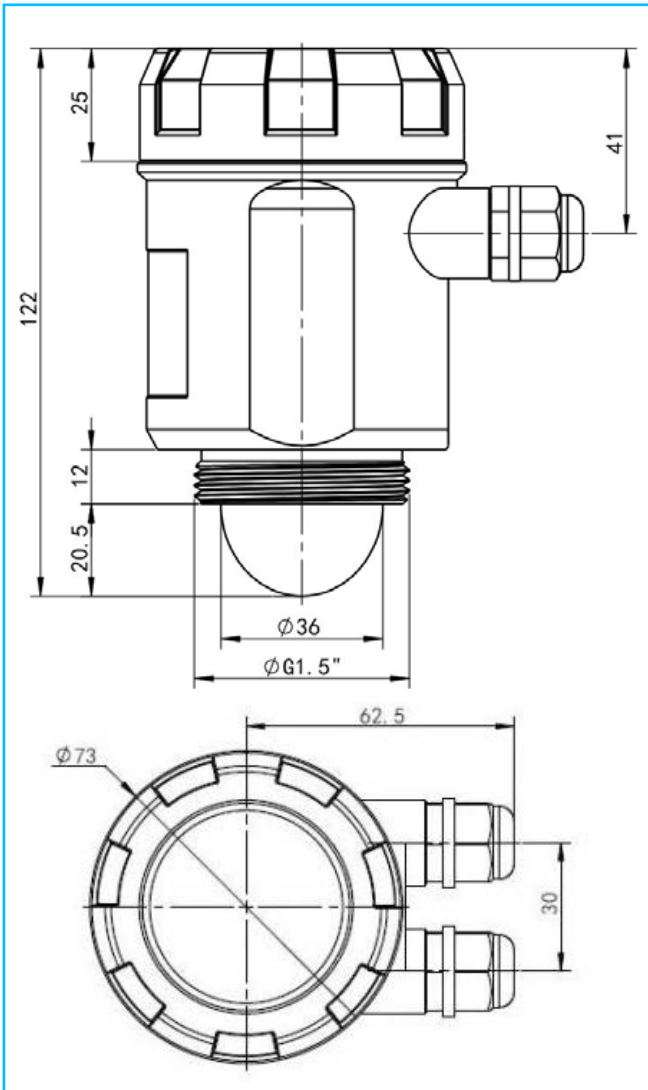**S-810-L : stainless steel 304**,
thread, flange connection
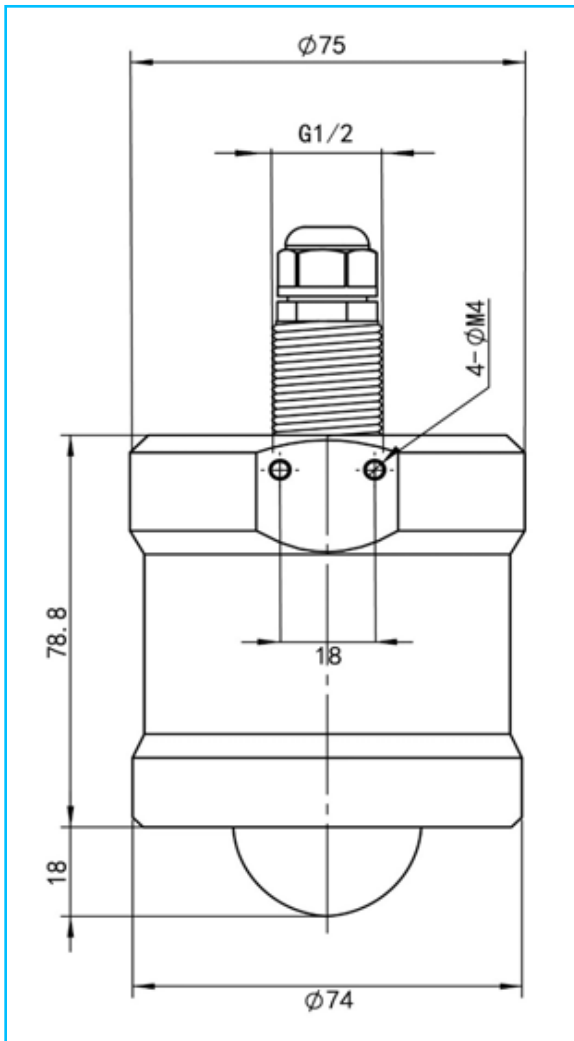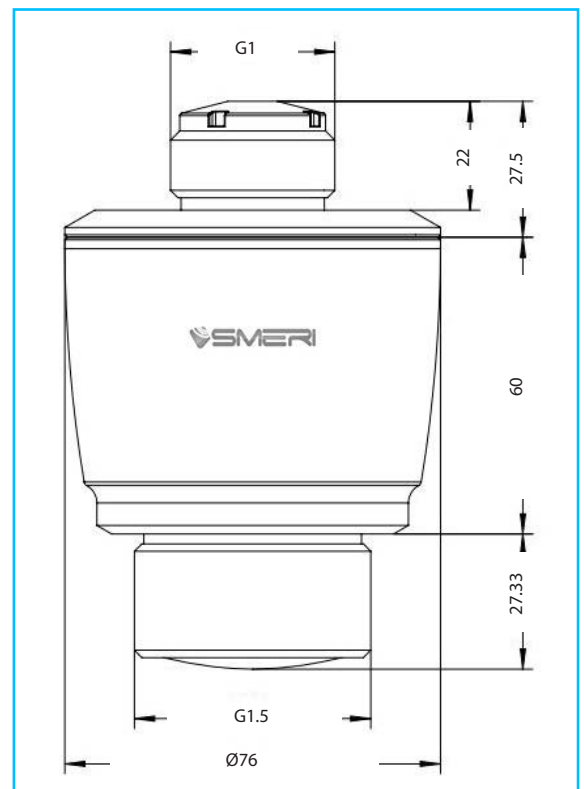


**S-810-L : ABS**,
threaded connection
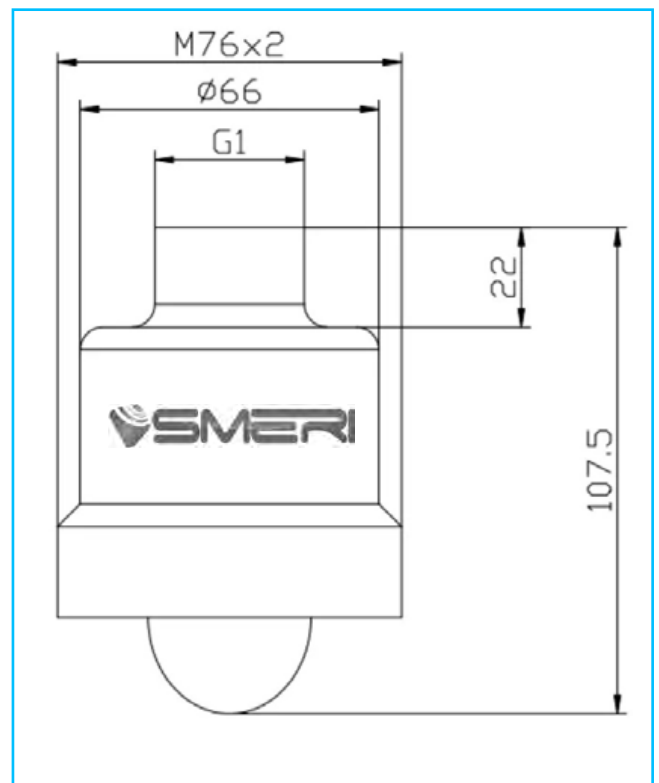
## 4.2 Outer Dimensions

Unit:mm

**S-812-L : ABS**, threaded connection



**S-810-EL PVDF**, threaded connection

# 5. Installation

Two points need to be paid attention to during installation:
(1) Ensure that the meter is perpendicular to the water surface
(2) Avoid the emission beam irradiating the interference object and generating false echoes.
Please check the following points for typical operating conditions.

➢ Ensure that the water level sensor is installed perpendicular to the water surface, and the tilt will weaken the received signal amplitude and affect the normal ranging.
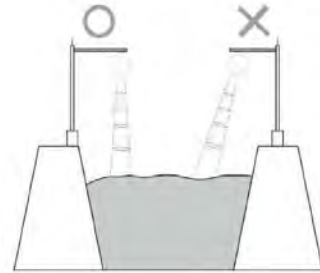
➢ Make sure that there are no interfering objects within the beam range, such as river banks.
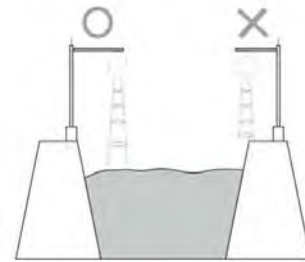
➢ The installation of the instrument should be at least 20cm away from the side wall, and the installation of the underground pipe network should be as close to the center of the water well as possible, otherwise the well wall will easily generate interference signals, which will affect the measurement and judgment, as shown in the figure below.
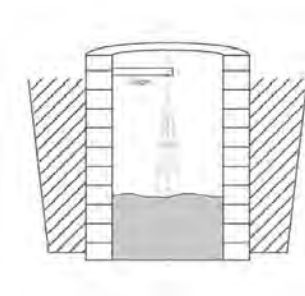
**Preparation before installation**

● Understand the internal structure and pipeline arrangement of the storage tank, and obtain information such as the diameter and range of the tank.

● Tools needed: flat-blade screwdriver (3*75mm), wire stripper (7mm²), hand knife, pipe wrench, DC 24V power supply.

● Avoid installing the radar in a central location or close to the edge of the container



Conical          Parabolic          Flat

√   Correct installation

✗   Wrong installation
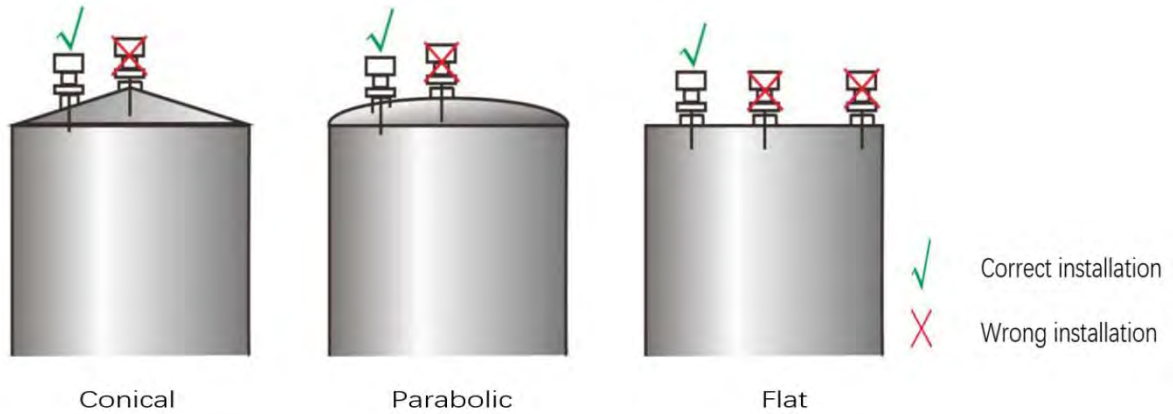
● Avoid false wave diagram
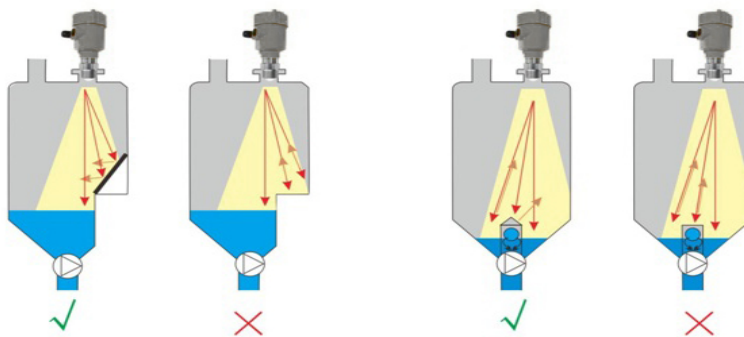


● Treatment of stairs and grille tanks
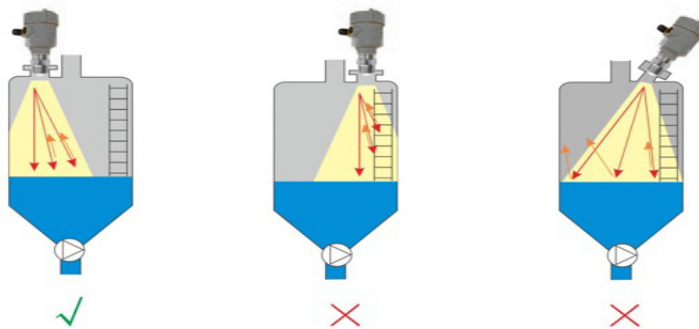


● Treatment of wall hanging and grille tanks

# Wiring

Blue: DC24V –

Red: DC24V +
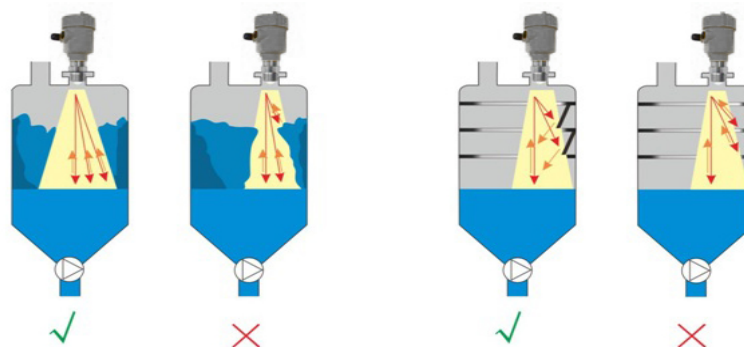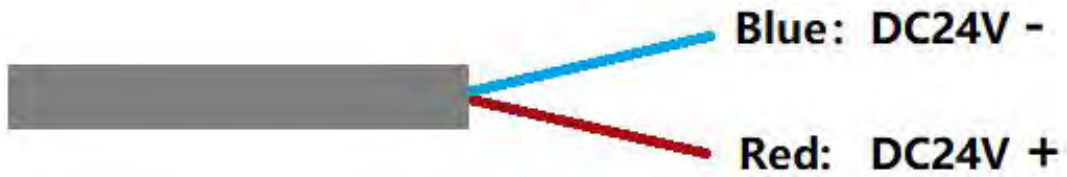
**Model S-810-L / S-810-EL**: comes with a 10m shielded cable output with two conductors; the red core is connected to the positive terminal of the power supply, while the black core is connected to the negative terminal.

**Moedel S-812-L**: is equipped with two M12x1.5 cable glands and an internal terminal block.

| CONDUCTOR/TERMINAL | |
|---|---|
| RED（＋） | 24V DC positive pole |
| BLUE（-） | 24V DC negative pole |
| RS-485 (+) | RS-485 positive pole |
| RS-485 (-) | RS-485 negative pole |
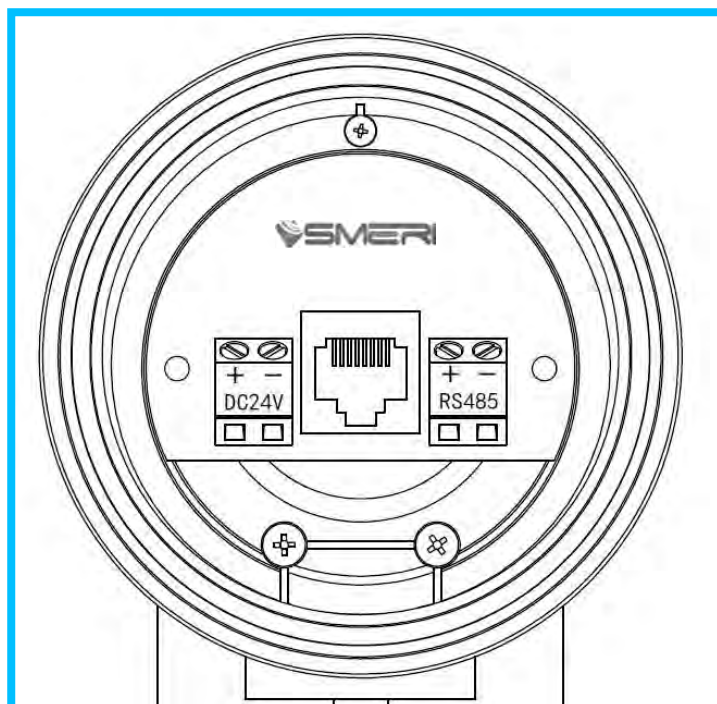
## 6. Radar wireless operation

### Debugging and setting

MINIRADAR S-810/S-812 performs liquid level measurement tasks according to the settings, which can be modified via Bluetooth and APP on mobile.

App RadarMe on Play Store for Android/Apple

See also the SERVICE pages on SMERI website: tutorial for wireless programming

### Software Setting

Open the APP in the Mobile Phone to display the device connection interface, as shown in the figure below:
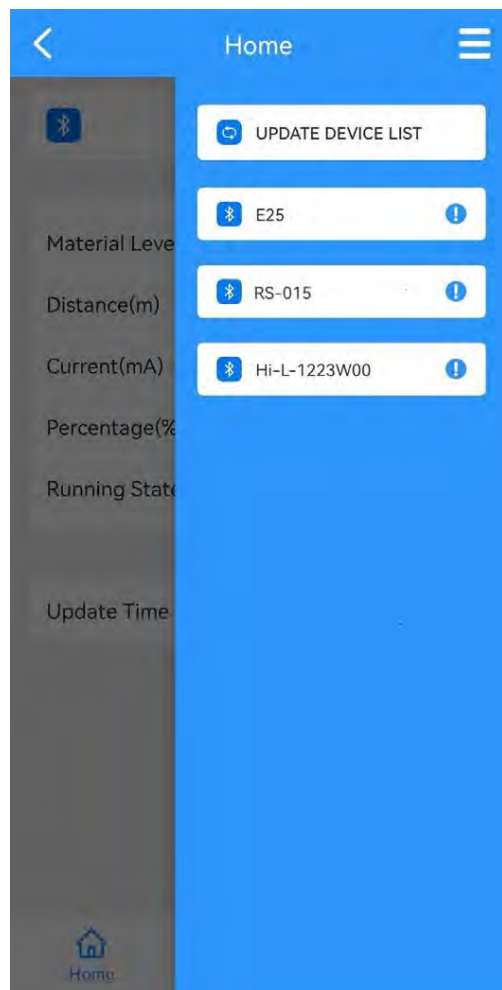
SERVICE - TUTORIAL



Click the name of the device to be set to enter the main interface, as shown in the figure.
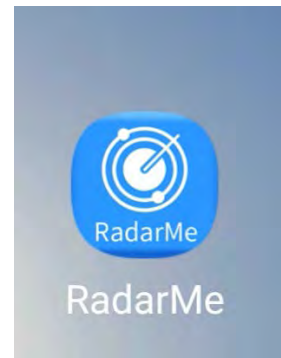
## Main interface
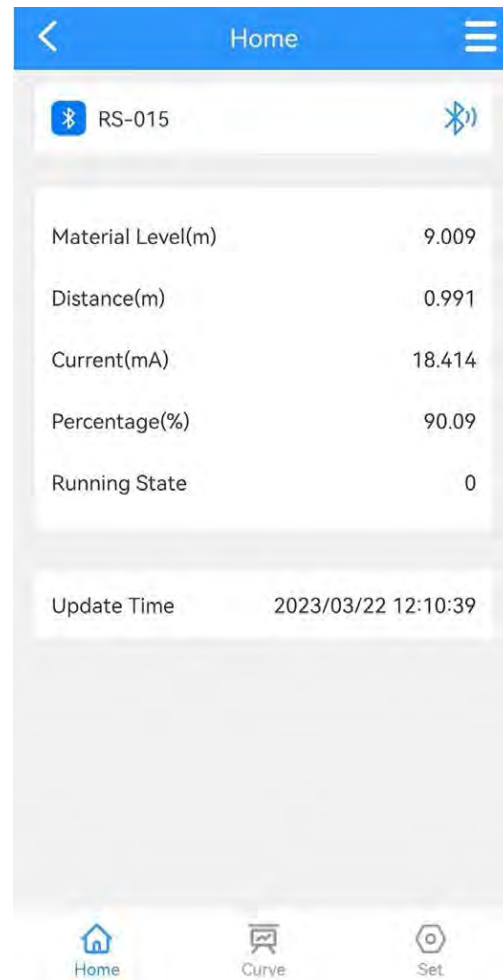


**Home**

**Material Level:** Liquid Level Value

**Distance:** The distance from radar sensor to the liquid surface.

**Current:** Analog signal output corresponding to liquid level

**Percentage:** The percentage of liquid level and max range

**Running State:** Working stage = 0 is work well, = 1 is error.

Click the "Curve" button at the bottom of the screen to enter the echo curve interface, as shown in the following figure.

## Echo Curve Interface
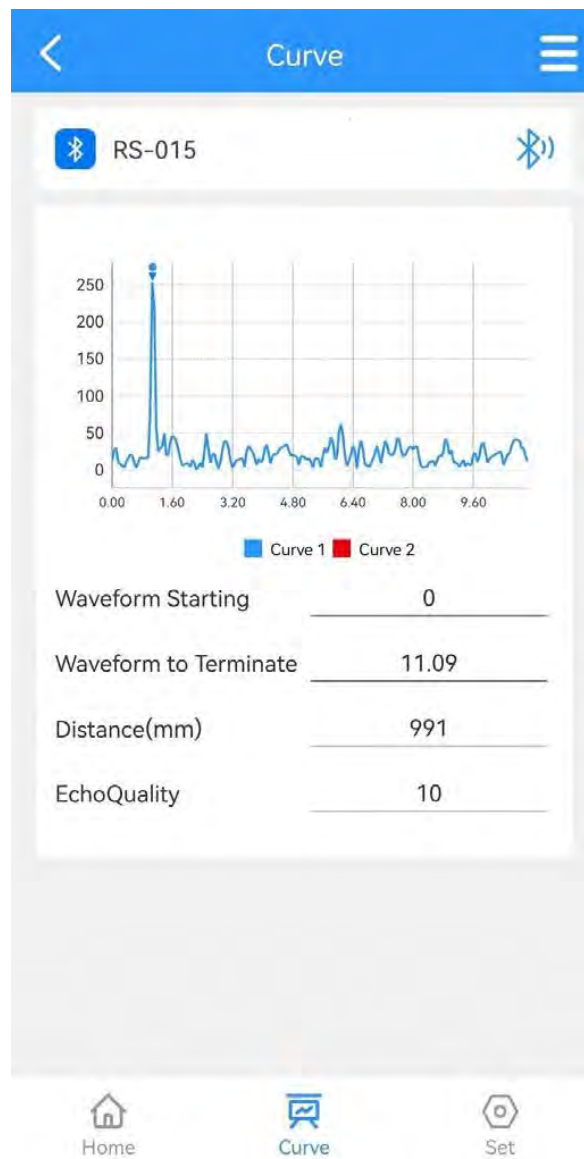


**Waveform Starting:** The starting position of the waveform

**Waveform to terminate:** The stopping position of the waveform

**Distance:** The distance from radar sensor to the liquid surface.

**Echo Quality:** The quality of Echo, unit is DB.

Click the "Set" button at the bottom of the screen to enter the parameter setting interface, as shown in the figure below.

## Setting
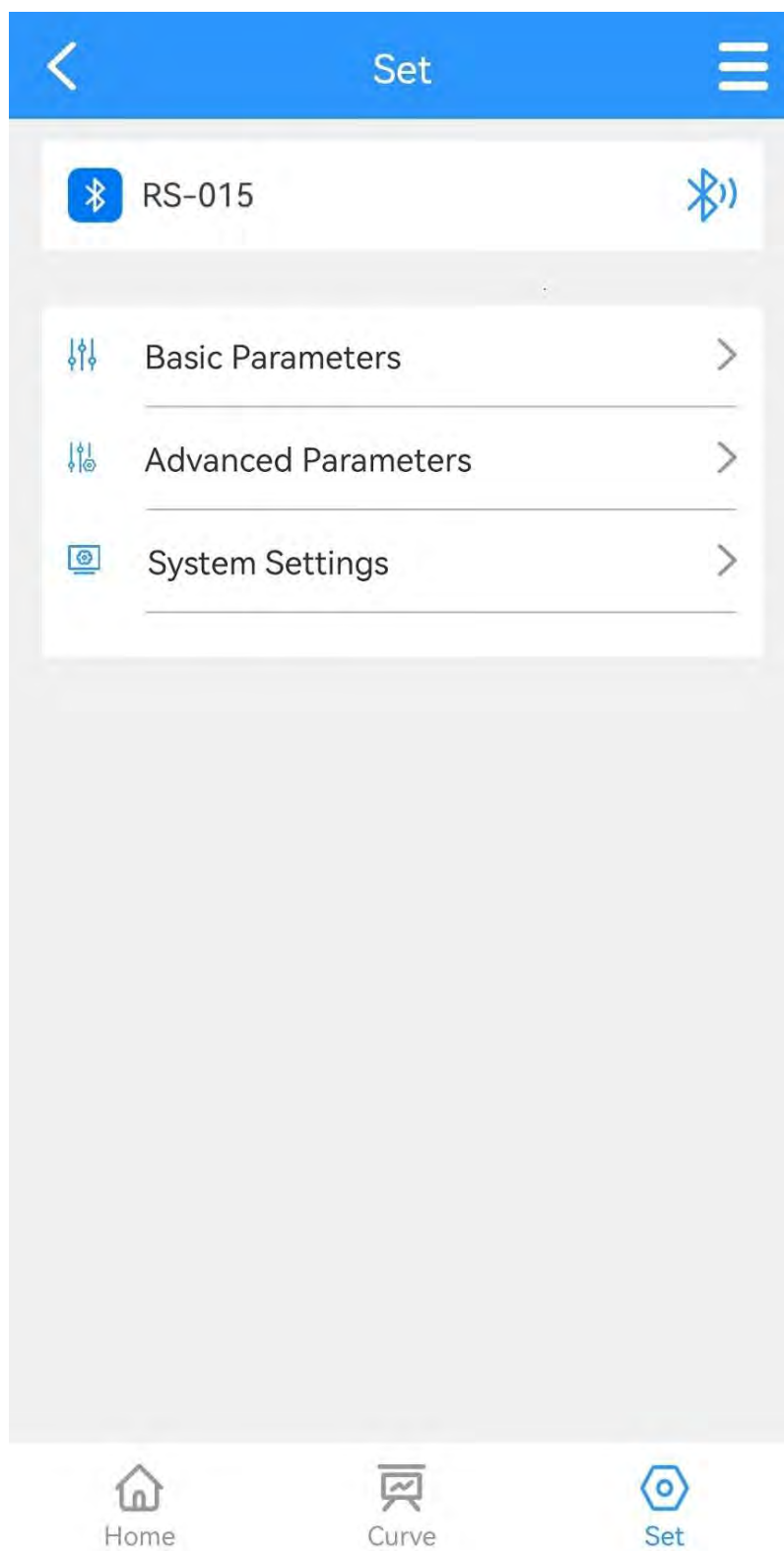
**Basic Parameters**

Click "Basic parameters" on the interface to open the menu below:



Set the "Range" according to the working conditions and directly click the number input box behind to modify it.

The rest of the parameters are modified in the same way.

Click the "Read" button to refresh the parameters.
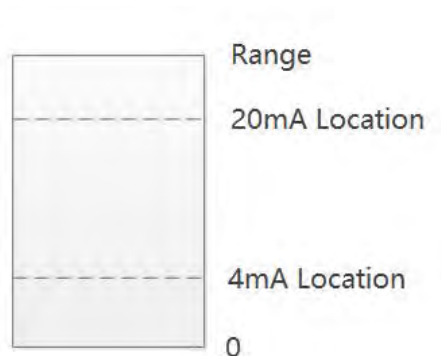


As shown in the figure, when the liquid level is lower than 4mA Location, the main interface displays the liquids level as 0;

when the liquid level is higher than the 20mA location, the main interface displays the liquid level value as the value of 20mA location.

## Basic Parameters

**Range**: max Measure range

**Migration Amount**: range less then max measure range

**4mA Location:** liquid level value corresponding to 4mA

**20mA Location**: liquid level value corresponding to 20mA

**Blind Area**: areas that cannot be measured by radar sensor.

**Damping Time**: speed at which the actual liquid level is displayed on screen. The longer the damping time value, the slower the response.

**Device Address**: Device No, can be modified.

**Baud Rate**: default Baud Rate is 9600

**False Echo Position One**: location of the first false echo. If you know the location of the obstacle and input the level value, the system will automatically block this false echo.

**False Echo Position Two**: location of the second false echo. If you know the location of the obstacle and input the level value, the system will automatically block this false echo.

**False Echo Position Three**: location of the third false echo. If you know the location of the obstacle and input the level value, the system will automatically block this false echo.

## Advanced Parameters
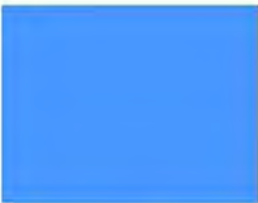
**Advanced Parameters**

**Threshold Value:**  setting parameters used to distinguish between signals and noise.It is recommended to use default parameters. If you have any requirements, please contact company technical support.

**Threshold Amplitude**: threshold value used to distinguish between signal and noise, with a minimum parameter setting of no less than 6. It is recommended to use default parameters. If you have any requirements, please contact company technical support.

**Echo Window:**  setting an area centered around the echo signal, only searching for echo signals within the area, and echo signals outside the area are invalid. It is recommended to use default parameters. If you have any requirements, please contact company technical support.

**Rate of Level Change**: the maximum allowable level change rate for each detection. It is recommended to use default parameters. If you have any requirements, please contact company technical support.

**Fixed Offset:** it is recommended to use the default automatic gain mode and not modify it. If you have other requirements, please contact company technical support.

**Gain Mode**: gain mode is divided into manual adjustment signal gain mode and automatic adjustment signal gain mode. When gain model = 0, it is in automatic gain mode; Gain model = 1, in manual gain mode Automatic gain can be automatically adjusted based on the strength of the ADC signal

It is recommended to use the default automatic gain mode and not modify it. If you have other requirements, please contact company technical support.

**Gain One**: signal gain control value in the TIA gain chip is between 0-3, and manual adjustment is not required in automatic gain mode.

**Gain Two**: signal gain control value in the VGA gain chip is between 0-24, and manual adjustment is not required in automatic gain mode

It is recommended to use default parameters. If you have any requirements, please contact company technical support.

**False Wave Threshold:** used in conjunction with false echo position: The false wave threshold only takes effect when the false echo position is specified. The false wave threshold is a multiplier coefficient used to filter the height of false echoes.

It is recommended to use default parameters. If you have any requirements, please contact company technical support.

**Echo Width**: default parameters are not recommended for modification. If you have any requirements, please contact company technical support.

**Power**: when Power is configured to 0, the PGA gain is adjusted first, and the TIA gain is not automatically increased. It is recommended to use the default of 0.

**Power One**: this parameter is for the search target mode;

When Power 1 is set to 1, it means that the target is the distance corresponding to the maximum amplitude of the echo that exceeds the set threshold, which is the maximum value search. When Power 1 is set to 0, it means that the target is identified as the distance corresponding to the target with the echo exceeding the set threshold and the farthest forward in distance.

It is recommended to use the default parameter 1 and search by the maximum value. If you have any requirements, please contact company technical support.


**Backup the parameters:** After the working parameters are backed up, if there is an error in manually modifying the parameters and the original working parameters are forgotten, the working parameters can be " restore" in the basic settings.
**Restore the parameters:** It is used to restore the backup parameters.

# 7.Radar local operation

## Parameter setting user interface

The radar **S-812-L** uses a key mode for parameter setting, and the key functions are shown in Figure.
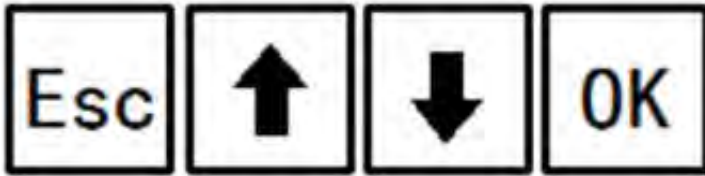
| Key | Function |
|-----|----------|
| ESC | Back / Enter echo wave interface |
| UP | Up shift/ Increase key |
| DN | Down shift / Shift key |
| OK | Ok key / Enter setting parameter interface |

## Main interface of Radar Level Transmitter

| 1 | Work instructions | Flashing reminder when working |
|---|---|---|
| 2 | Level display | Level value（m/cm/mm/ft） |
| 3 | Error code | 00：No error（Does not show error）<br>01：No target detected<br>02：Level value jumped<br>08：Communication error |

## Wave interface of Radar Level Transmitter

| ① | Gap value |
|---|---|
| ② | Echo quality |
| ③ | Echo position |

# 7.1 Radar Level Transmitter parameter menu

## User parameter menu description

| | | |
|---|---|---|
| User Para | Basic setup | Range |
| | | Offset |
| | | Pos:4ma |
| | | Pos:20ma |
| | | Blind |
| | | Damping Time |
| | | Device ID |
| | | Baud Rate |
| | Backup Para | |
| | Restore Para | |

- **Basic setup**：

  **Range**（**500~50000**）**mm**：Depends on working conditions；farthest distance the radar can measure.

  **Offset**（**-9999~9999**）**mm**：Depends on working conditions.

  **(Pos:4ma):** level corresponding to 4mA current output，unit: mm.

  **(Pos:20ma)**：level corresponding to 20mA current output，unit: mm.

  **Blind**：230mm to the measuring range, can be set according to specific working conditions.

  **Damping time**：to improve stability of the measured output value, a larger [Damping time] can be set to stabilize the measured value and increase the anti-interference ability.

  **Device ID**：address of the slave during 485 communications, is the address of the local machine (value range: 1-99, default value is 1).

  **Baud rate**：The baud rate of this machine during 485 communications is 9600 by default.

- **Backup Parameter**：

  After the working parameters are backed up, if you forget the original working parameters after manually modifying the parameters and forget the original working parameters, you can "Restore Parameter" in the menu.

- **Restore Parameter**：Used to restore the backed up user parameters.

## 7.2 Software configuration instructions

**Press the key to set the parameters**

● **Instrument connection**

The power cord is connected to the DC 24V terminal of the instrument, please pay attention to the positive and negative poles, and do not connect them wrongly.

● **Set instrument parameters**

Facing the display window of the instrument, press the "**OK**" button, the meter will display "**Main menu**" , as shown in the figure below：
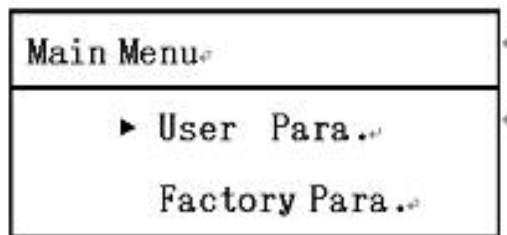


press the "**OK**" button to enter the "**User Para**".
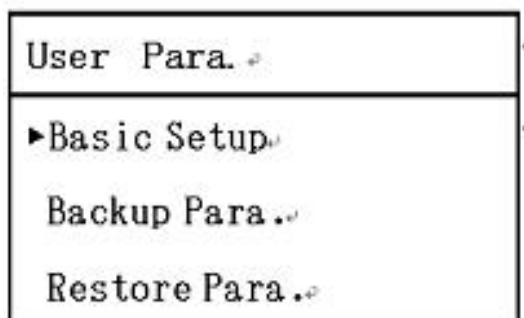


Press "**OK**" button to enter "**Basic Setup**".

Set the "**Range**" according to the working conditions, press "OK", after the range value is reversed, use the "**Upshift**" and "**Downshift**" button to input the range value, and then press the **"OK"** button to confirm.

Press **"Downshift"** button to select "Offset", press "**OK**" to reverse the migration value, enter the migration value, and press "**OK**" to confirm.

The same steps can be used to modify "**Pos:4ma**"/"**Pos:20ma**"/"**Blind**"/"**Damping Time**". After the modification, press the "**Backspace**" key to return to the "**User Para**" interface.

When the display type is set to level,the main interface shows the actual level value. When the display type is set to Ullage, the main interface displays the Ullage measured by the radar. Set the display type as required.

**Pos:4ma** and **Pos:20ma** must be within the range. The relationship between the 4mA position, 20mA position and the range is shown in the figure below:
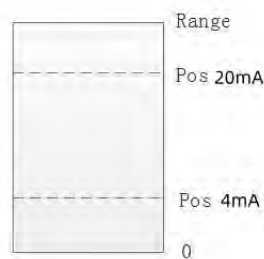


If the level lower than **Pos:4ma**, the main interface shows that the level is **0**, and if the level higher than **Pos:20ma**, the main interface shows that the level is **Pos:20ma**.

**Backup the parameters:** After the working parameters are backed up, if there is an error in manually modifying the parameters and the original working parameters are forgotten, the working parameters can be " restore" in the basic settings.
**Restore the parameters:** It is used to restore the backup parameters.

# 8.Radar Modbus communication

## Radar **S-810-L in ABS, S-810-EL** and **S-812-L**
Modbus connection
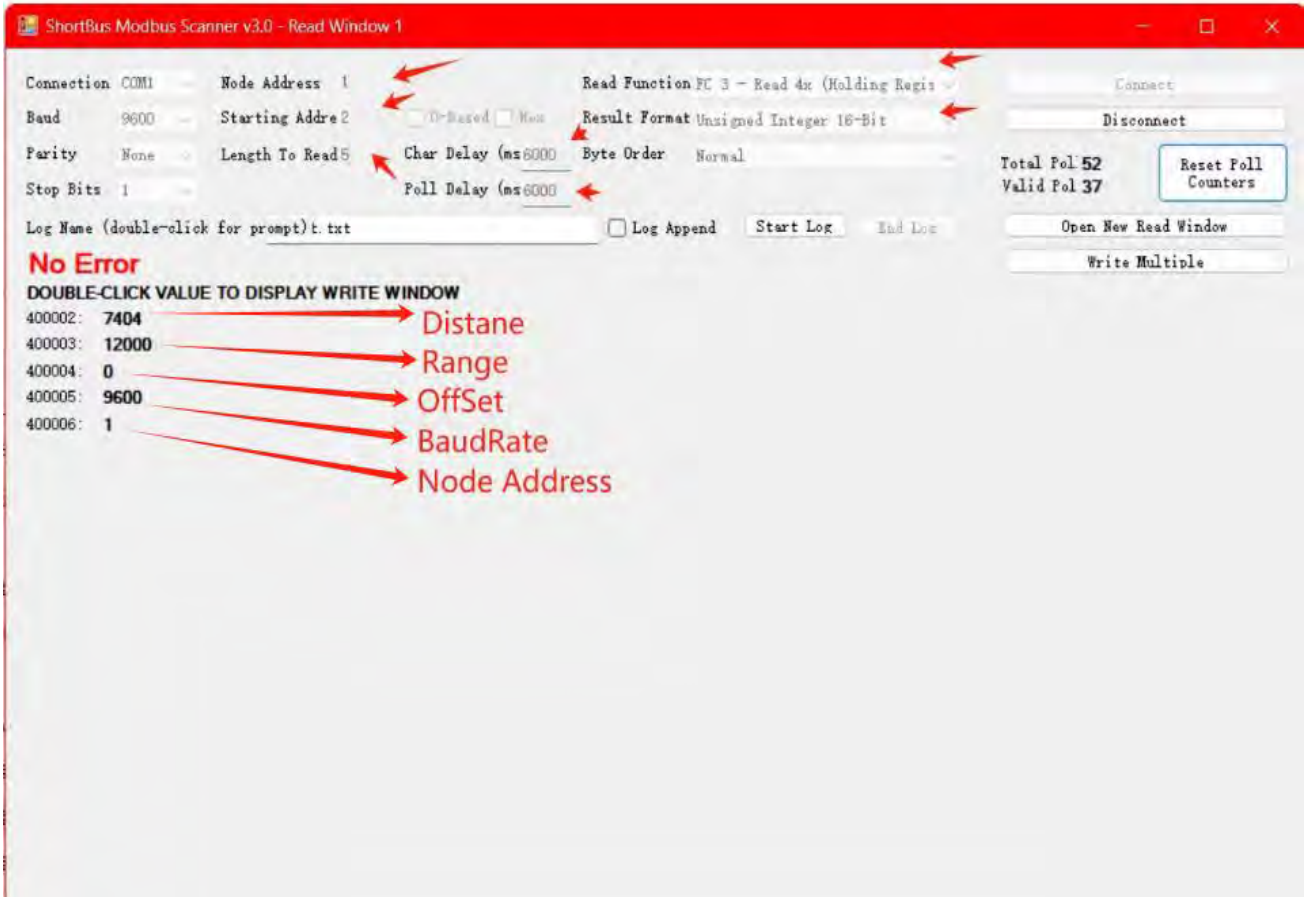


## 1: Read Paras, Use Command 0x03

Register List:

| Address | Description | Data Type | Remark |
|---------|-------------|-----------|--------|
| 0002H | Current Level | 16 bit uinsigned integer | Unit: mm |
| 0003H | Measure Range | 16 bit uinsigned integer | Unit: mm |
| 0004H | Base Offset | 16 bit signed integer | Unit: mm |
| 0005H | Baudrate | 16 bit uinsigned integer | Unit: bps |
| 0006H | Device ID | 16 bit uinsigned integer | Value: 1-255 |

## 2: Write Paras, Use Command 0x10

Register List:

| Address | Description | Data Type | Remark |
|---------|-------------|-----------|--------|
| 0003H | Measure Range | 16 bit uinsigned integer | Unit: mm |
| 0004H | Base Offset | 16 bit signed integer | Unit: mm |
| 0005H | Baudrate | 16 bit uinsigned integer | Unit: bps |
| 0006H | Device ID | 16 bit uinsigned integer | Value: 1-255 |

## 1. Function code 03 (Read input register)

**Frame format:**

Upper computer sends device address Function code Register start address Number of registers 16-bit CRC checksum

Radar replies: device address Function code Number of bytes Data 16-bit CRC checksum

Note: Support different register start addresses, different number of registers to read.

| name | register address | byte count |
|---|---|---|
| Level/1000 (m) | 0x01 | 2 |
| Range (mm) | 0x02 | 2 |
| Migration (mm) | 0x03 | 2 |
| baud rate | 0x04 | 2 |
| device address | 0x05 | 2 |

### PC program

| device address | 0x01 (default) | 0th byte |
|---|---|---|
| function code | 0x03 | 1st byte |
| Register Starting Address | Data type: 16-bit unsigned integer | 2nd and 3rd bytes |
| Number of registers | Data type: 16-bit unsigned integer | 4th and 5th bytes |
| 16-bit CRC checksum | | 6th and 7th bytes |

### Radar:

| device address | 0x01 (default) | 0th byte |
|---|---|---|
| function code | 0x03 | 1st byte |
| byte count | | 2nd byte |
| Level/1000 (m) | Data type: 16-bit unsigned integer, unit: mm | 3rd and 4th bytes |
| range (mm) | Data type: 16-bit unsigned integer, unit: mA | 5th and 6th bytes |
| Migration (mm) | Data type: 16-bit unsigned integer, unit: % | 7th and 8th bytes |
| baud rate | Data type: 16-bit unsigned integer, unit: bit/s | Bytes 9 and 10 |
| device address | Data type: 16-bit unsigned integer | 11th and 12th bytes |
| 16-bit CRC checksum | | 13th and 14th bytes |

Example:

Reads level, range, migration, baud rate, and device address:

**01 03 00 01 00 05 D4 09**

**01 03 0A 79 B7 7D 00 00 00 25 80 00 01 E8 DC**

Reads only the range:

**01 03 00 02 00 02 65 CB**

**01 03 04 7D 00 00 00 E2 5F**

2. **Function Code 16 (Modify Register)**

**Frame format:**

Upper computer sends: device address Function code Register start address Number of registers

Number of bytes Data written 16-bit CRC checksum

Radar Response: device address function code register start address number of registers 16-bit CRC checksum
Note: Supports writing to different register start addresses and different numbers of registers.

| name | register address | value range |
|---|---|---|
| Range(mm) | 0x02 | [50,32000] |
| Migration (mm) | 0x03 | [-10000, 10000] |
| baud rate | 0x04 | [1200,57600] |
| device address | 0x05 | [1,255] |

**PC program**

| device address | 0x01 (default) | 0th byte |
|---|---|---|
| function code | 0x10 | 1st byte |
| Register Starting Address | | 2nd and 3rd byte |
| Number of registers | | 4th and 5th bytes |

| byte count | | 6th byte |
|---|---|---|
| Range (mm) | Data type: 16-bit unsigned integer, unit: mA | 7th and 8th bytes |
| Migration (mm) | Data type: 16-bit unsigned integer, unit: % | 9th and 10th bytes |
| baud rate | Data type: 16-bit unsigned integer, unit: bit/s | 11th, 12th bytes |
| device address | Data type: 16-bit unsigned integer | 13th and 14th bytes |
| 16-bit CRC checksum | | 15th, 16th bytes |

**Radar:**

| device address | 0x01 (default) | 0th byte |
|---|---|---|
| function code | 0x10 | 1st byte |
| Register Starting Address | Data type: 16-bit unsigned integer | 2nd and 3rd byte |
| Number of registers | Data type: 16-bit unsigned integer | 4th and 5th bytes |
| 16-bit CRC checksum | | 6th and 7th bytes |

**Example:**

Modify the range, migration volume:
**01 10 00 02 00 02 04 13 88 00 64 F7 33**

**01 10 00 02 00 02 E0 08**

Modify the range only:
**01 10 00 02 00 01 02 13 88 AA E4**

**01 10 00 02 00 01 A0 09**

### 3.   Function code 0x48 (ADC waveform handshaking)

**Frame format:**

PC program sends: device address Function code 0x00 0x00 0x13 0x88 16-bit CRC checksum

Radar Reply: device address Function code 0x00 0x00 0x13 0x88 16-bit CRC checksum

**PC program**

| device address | 0x01 (default) | Byte 0 |
|---|---|---|
| function code | 0x48 | 1st byte |
| | 0x00 | 2nd Byte |
| | 0x00 | 3rd byte |
| | 0x13 | 4th byte |
| | 0x88 | 5th byte |
| 16-bit CRC checksum | | 6th and 7th bytes |

**Radar:**

| device address | 0x01 (default) | 0th byte |
|---|---|---|
| function code | 0x48 | 1st byte |
| | 0x00 | 2nd byte |
| | 0x00 | Byte 3 |
| | 0x13 | 4th byte |
| | 0x88 | 5th byte |
| 16-bit CRC checksum | | 6th and 7th bytes |

Example:
**01 48 00 00 13 88 EC 92**

**01 48 00 00 13 88 EC 92**

## 4.    Function code 0x47 (ADC waveform)

### PC grogram

| device address | 0x01 (default) | 0th byte |
|---|---|---|
| function code | 0x47 | 1st byte |
|  | 0x00 | 2nd byte |
|  | 0x00 | 3rd byte |
| Number of Waveform Points | 2048 points | 4th and 5th bytes |
| 16-bit CRC checksum |  | 6th and 7th bytes |

### Radar:

| device address | 0x01 (default) | 0th byte |
|---|---|---|
| function code | 0x47 | 1st byte |
| Number of Waveform Points | 2048 points | 2nd and 3rd bytes |
| waveform |  |  |
| 16-bit CRC checksum |  |  |

Example: **01 47 00 00 08 00 B2 05**
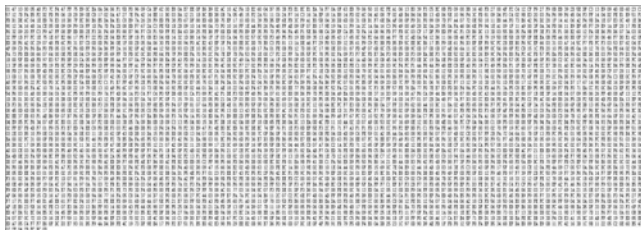


## 5.  Error Code

### Read Register Address Error Radar Response:

| device address | 0x01 (default) | 0th byte |
|---|---|---|
| function code | 0x83 | 1st byte |
|  | 0x02 | 2nd byte |
| 16-bit CRC checksum |  | 3rd and 4th bytes |

### Read register count error radar reply:

| device address | 0x01 (default) | 0th byte |
|---|---|---|
| function code | 0x83 | 1st byte |
|  | 0x03 | 2nd byte |
| 16-bit CRC checksum |  | 3rd and 4th bytes |

**Write Register Address Error Radar Response:**

| device address | 0x01 (default) | 0th byte |
|---|---|---|
| function code | 0x90 | 1st byte |
|  | 0x02 | 2nd byte |
| 16-bit CRC checksum |  | 3rd and 4th bytes |

**Write register number error radar reply:**

| device address | 0x01 (default) | 0th byte |
|---|---|---|
| function code | 0x90 | 1st byte |
|  | 0x03 | 2nd byte |
| 16-bit CRC checksum |  | 3rd and 4th bytes |

**Write byte count error, parameter error radar reply:**

| device address | 0x01 (default) | 0th byte |
|---|---|---|
| function code | 0x90 | 1st byte |
|  | 0x04 | 2nd byte |
| 16-bit CRC checksum |  | 3rd and 4th bytes |

**Feature Code Error Radar Response:**

| device address | 0x01 (default) | 0th byte |
|---|---|---|
| function code | Error Function Code Highest Position I | 1st byte |
|  | 0x01 | 2nd byte |
| 16-bit CRC checksum |  | 3rd and 4th bytes |

## 6. CRC calculation checksum formula

**CRC16_MODBUS**：The polynomial $x16 + x15 + x2 + 1$ (0x8005), with initial value 0xFFFF, low before and high after, results in an iso-or with 0x0000.

# 9. Maintenance

➢ Pay attention to keep the radar level sensor clean, try to  be waterproof, moisture-proof , anti-corrosion and avoid violent collisions and blows from other objects.

➢ Avoid direct sunlight on the main body of radar level sensor, keep away from heat sources and pay attention to ventilation. If the ambient temperature exceed the rated temperature,corresponding cooling protection  measures should be taken.

➢ When the ambient temperature is too low, an instrument protection box or other protective devices can be used for antifreeze protection, and keep the radar dry.

➢ The radar should be tested regularly ( the frequency determined by the user according to the specific situation).

# 10. Fault handling

| Symptoms | Cause of issue | Solution |
| --- | --- | --- |
| No display | Power Supply | Check whether the DC 24V voltage and current meet the requirements or |
| | Wiring | Check the wiring |
| Unstable Value | Strong fluctuating | Change  the  installation  position  of the radar or reduce the fluctuation of the object to be measured. |
| | Weak Echo | Try angle alignment or rotate the radar mount. |
| | Strong Electromagnetic interference | Connect to the host to the ground or add a shield. |

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