Radar Distance / Level Sensor

EM410-RDL

User Guide

Safety Precautions

Milesight will not shoulder responsibility for any loss or damage resulting from not following the instructions of this operating guide.

- The device must not be disassembled or remodeled in any way.
- In order to protect the security of the device, please change the device password when first configuration. Default password is 123456.
- The device is not intended to be used as a reference sensor, and Milesight won't should responsibility for any damage which may result from inaccurate readings.
- Do not place the device near naked flames, heat source (such as oven), or expose it to sunlight, cold source, liquid, and with extreme temperature changes.
- Do not place the device in places where the temperature is below/above the operating range.
- Remove the battery from the device if it is not to be used for an extended period. Otherwise, the battery might leak and damage the device.
- The device must never be subjected to shocks or impacts.

Declaration of Conformity

EM410-RDL is in conformity with the essential requirements and other relevant provisions of the CE, FCC, and RoHS.

For assistance, please contact

Milesight technical support:

Email: iot.support@milesight.com

Support Portal: support.milesight-iot.com

Tel: 86-592-5085280

Fax: 86-592-5023065

Address: Building C09, Software Park III, Xiamen 361024, China

Revision History

Date	Doc Version	Description
Sept. 12, 2024	V1.0	Initial version
Nov. 29, 2024	V1.1	1. Add Cellular Version. 2. Modify Antenna installation steps and Mounting Bracket Appearance.
Jan. 16, 2025	V1.2	Add Tank Mode.

Contents

1. Product Introduction

1.1 Overview

EM410-RDL is a non-contact Radar Distance/Level Sensor that adopts Millimeter Wave Radar technology. By using millimeter-wave signals at higher frequencies, it provides more stable performance over longer distances, and is less affected by environmental conditions. It can detect the distance between the sensor and liquid of various types, unaffected by temperature, dust, condensate etc. With IP68 waterproof and sealed enclosure, it can withstand the worst environment, while maintaining the measurement accuracy, and does not require routine maintenance.

Milesight offers LoRaWAN® version and Cellular version to meet different communication needs. The LoRaWAN® version can be integrated with Milesight LoRaWAN® gateway and Milesight Development Platform, enabling remote and visual management of all sensor data. The Cellular version supports multiple application modes to be compatible with IoT platforms.

EM410-RDL can used in sewers, rivers, impounding reservoir, storage tanks and other locations that require to measure distance and level.

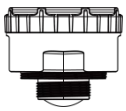
1.2 Features

- 8° Radar beam angle can be focused on the target fluid, enabling accurate measurement of liquid level
- Wide measuring range of 0.3m to 12m with small blind zone
- Not affected by dust, condensate, temperature, acoustic noise, etc
- Non- invasive liquid level monitoring, can detect hazardous or non-hazardous liquids
- External antenna or internal antenna versions are optional for various applications
- Built-in 3-axis accelerometer sensor to monitor device tilt status
- Support to check radar-echo curve and one-click diagnostic to calibrate the distance, ensuring the accurate measurement under different environments
- Support blind zone alarm when the ranging results are within the blind zone
- Adopt PVDF material, offering excellent corrosion resistance, wear resistance and compressive strength for harsh environments
- IP68 waterproof design, resistant in fresh water to a maximum depth of 1m for up to 48 hours
- Thread design for common tank installation without extra accessories needed
- Store up to 4,000 historical records locally and support retransmission to prevent data loss
- Easy configuration via NFC and Bluetooth

- Support management and OTA upgrade via Milesight Development Platform
- Function well with standard LoRaWAN® gateways and network servers (LoRaWAN® Version Only)
- Support multiple network protocols to be compatible with IoT platforms (Cellular Version Only)

2. Hardware Introduction

2.1 Packing List

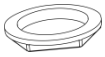


1 × EM410-RDL Sensor

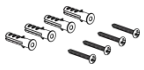
1× Mounting Bracket

1 × Bubble Level

1 × Waterproof Tape



1 × G1$^1/_2$ Nut



4 × Wall Mount Screw Kits

1 × O-ring Seal

1 × ER34615 Li-SoCl$_2$ Battery

1 × SMB Magnetic Antenna with Screw Kits (External Antenna Version Only)

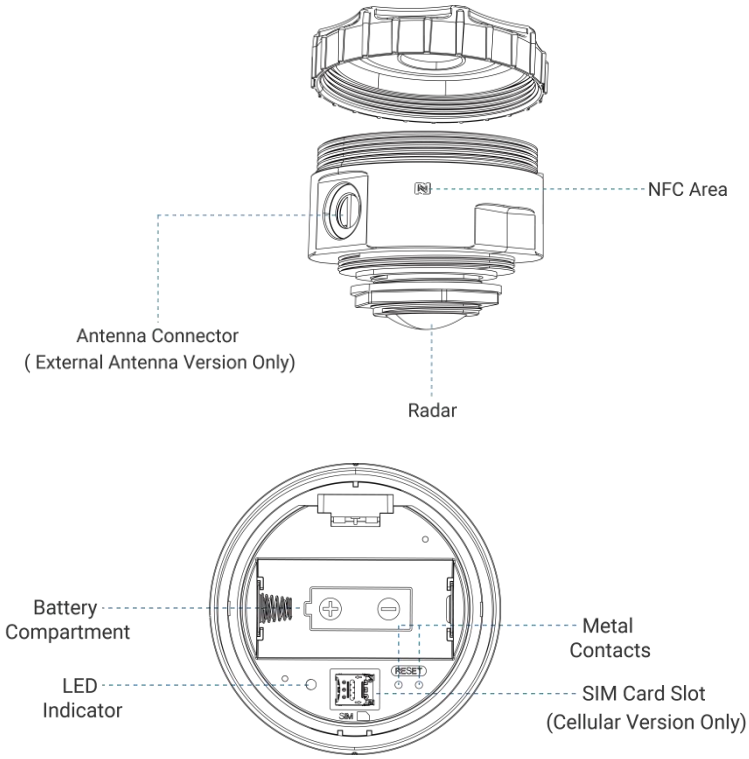
1 ×Antenna Cable Gland (External Antenna Version Only)

1 × Warranty Card

1 × Quick Guide

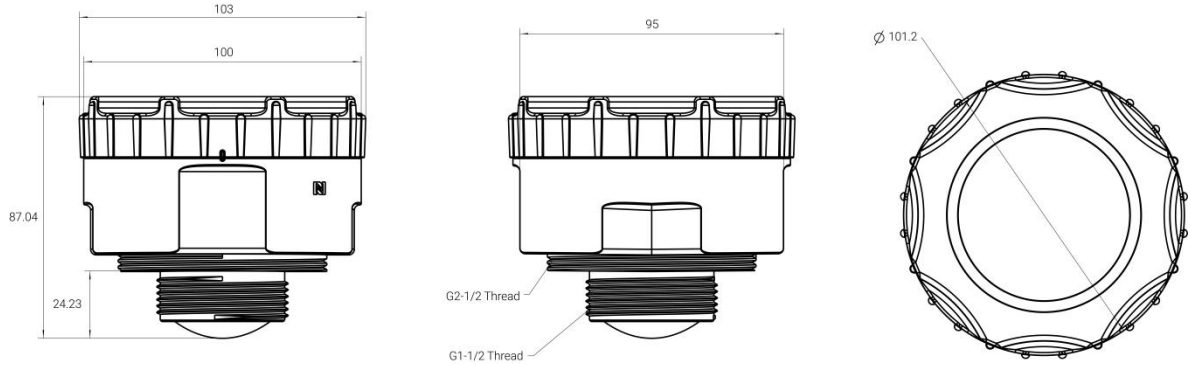
If any of the above items is missing or damaged, please contact your sales representative.

2.2 Hardware Overview

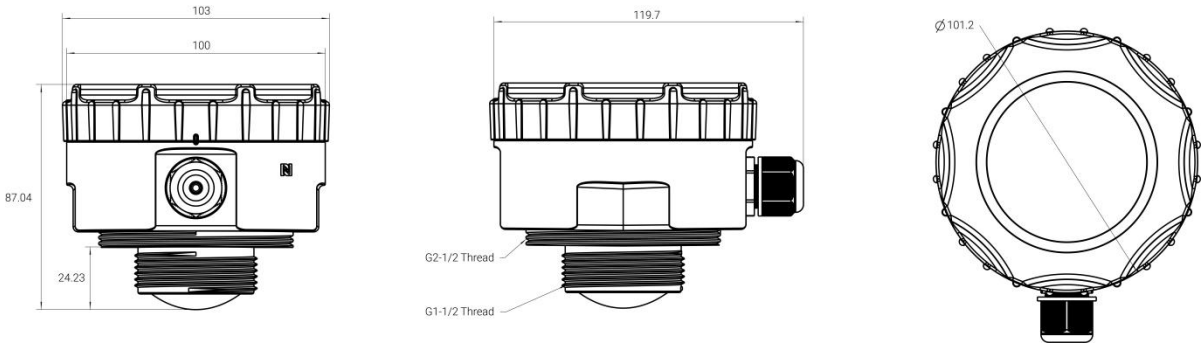


2.3 Dimensions (mm)

Internal Antenna Version:



External Antenna Version:



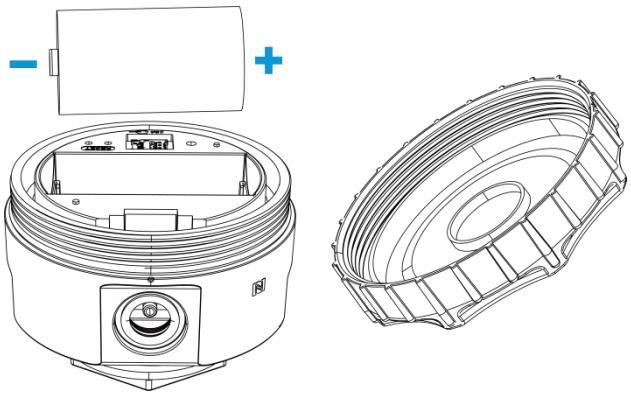
2.4 LED Indicator Descriptions

Function	Action	LED Indication
Power On	Install the New Battery	Lights up for 3s
Power Off	Remove Battery	Turns off
Reboot	Create short circuit with the two metal contacts for over 3s	Blinks Slowly
Reset to Factory Default	Create short circuit with the two metal contacts for over 10s	Blinks Quickly
Check On/Off Status	Create short circuit with the two metal contacts within 3s	Light On: Device is on Light Off: Device is off

3. Accessories Installation

3.1 Battery Installation

Unscrew the top cover counterclockwise, install the batteries according the following picture, the device will turn on automatically and the LED indicator will turn on for 3s.

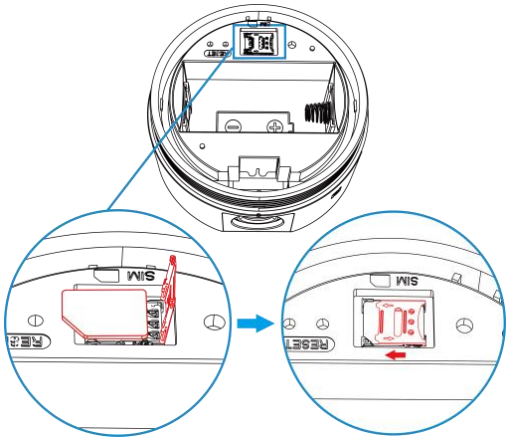


Note:

- The device can only be powered by ER34615 Li-SoCl$_2$ battery. The alkaline battery is not supported.
- The battery should be removed from the device if it is not used for an expended period.

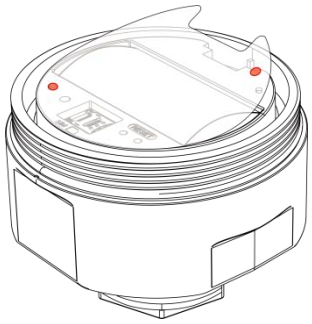
3.2 SIM Card Installation (Cellular Version Only)

Remove the slot cover, insert SIM card (3FF), and then replace slot cover back.

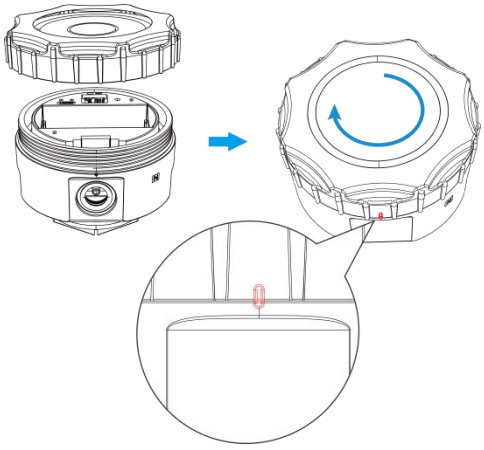


3.3 Waterproof Cover Fixed

Attach the waterproof cover to the device with aligning the two red dots as shown in the diagram, and press waterproof cover firmly with your hand.

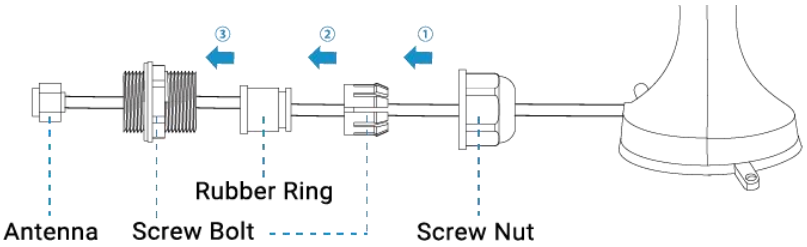


Screw the top cover clockwise until the edge marks are aligned.

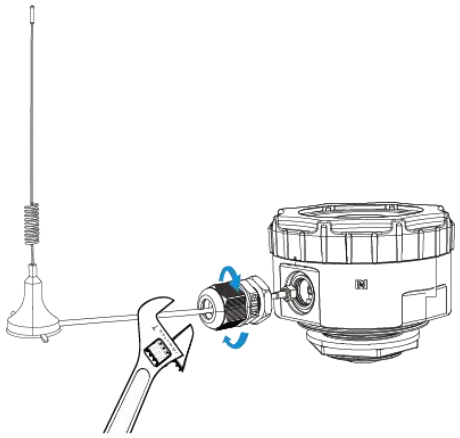


3.4 Antenna Installation (External Antenna Version Only)

Install the waterproof connector as shown in the diagram:



And then connect the antenna to antenna connector of the device and use an adjustable wrench to tighten the waterproof connector.



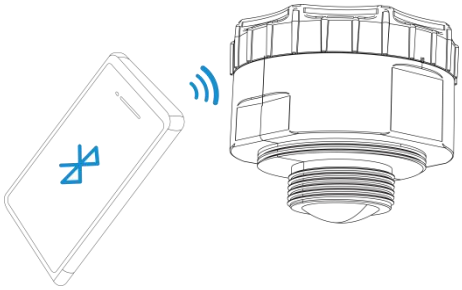
4. Operation Guide

4.1 NFC & Bluetooth Configuration

After the device is powered on, it can be configured via Bluetooth or NFC. Bluetooth is recommended for the first time installation.

Bluetooth Configuration:

1. Download and install "Milesight ToolBox" App on an Bluetooth-supported smart phone.
2. Enable Bluetooth and location function on the smart phone.
3. Open "Milesight ToolBox" App, select Bluetooth method and search for the target device to connect, and then enter the Bluetooth password to read/write the device until App shows a successful prompt. It's suggested to configure a device password for security. (Default password: 123456)



Note:

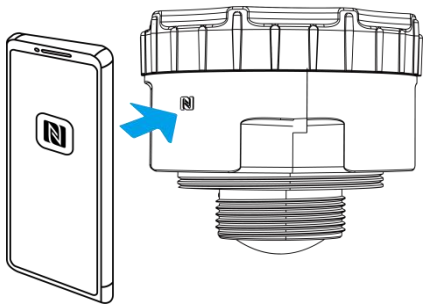
1) The Bluetooth connection will be terminated if there's no data interaction within 3 minutes. It

will request to connect again.

2) The device can connect to only one phone via Bluetooth. For example, if the device is connected to smart phone A via Bluetooth, the connection will be terminated after it is connected to smartphone B.

NFC Configuration:

1. Download and install "Milesight ToolBox" App on an NFC-supported smart phone.
2. Enable NFC on the smartphone and open "Milesight ToolBox" App.
3. Open "Milesight ToolBox" App, attach the smartphone with NFC area to read/write the device until App shows a successful prompt. It's suggested to configure a device password for security. (Default password: 123456)



4. Basic information and settings of devices will be shown on ToolBox if it's recognized successfully.

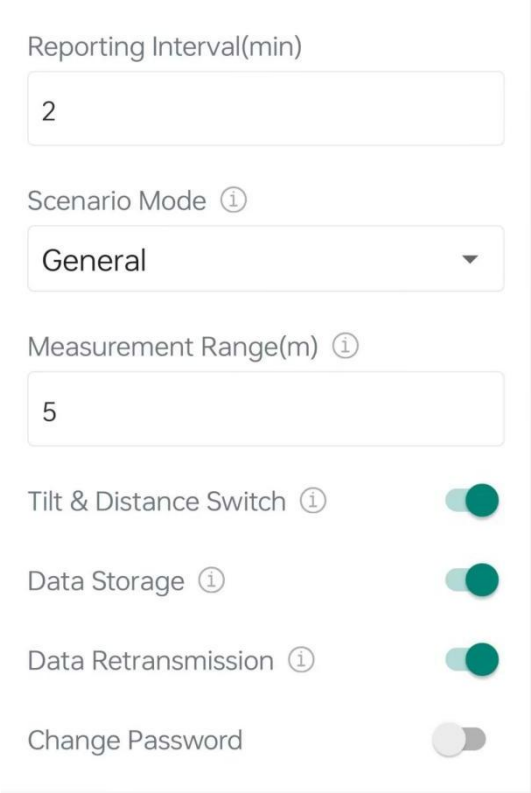
Note:

1) Ensure the location of smartphone NFC area and it's recommended to take off phone case.

2) If the smartphone fails to read/write configurations via NFC, keep the phone away and back to try again.

4.2 General Settings

Go to **Device > Setting > General** of ToolBox App to change the reporting interval, etc.



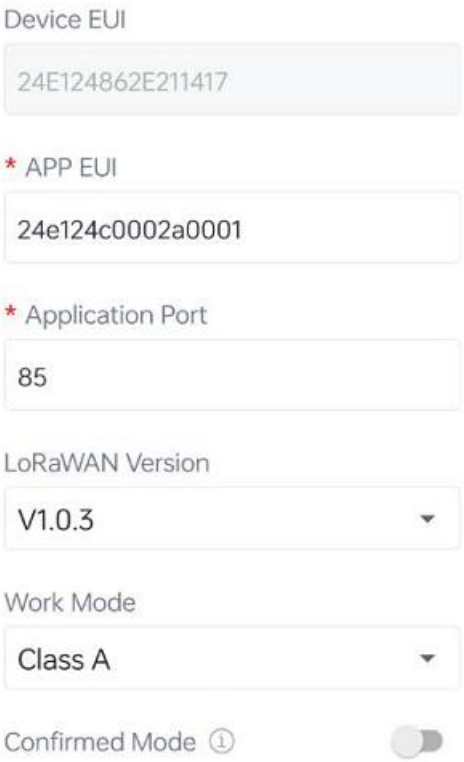
Parameters	Description
Reporting Interval	Reporting interval of transmitting data to server. Default: 1440 minutes, range: 1~1440 minutes.
Scenario Mode	**General:** Suitable for calm liquid surfaces **Rainwater Well:** Suitable for rainwater well **Wastewater Well:** Suitable for wastewater well **Tank:** Suitable for liquid storage tank scenarios (LoRaWAN® Version Only.) **Note:** When you use Tank mode, it will measure the height from the liquid surface to the bottom. When you use other modes, it will measure the height from the device to the liquid surface.
Measurement Range	The maximum distance between target surfaces and device.
Tank Depth (LoRaWAN® Version Only)	The maximum distance between the device and bottom of the tank.
Tilt & Distance Switch	When detecting that the offset angle is greater than 15 degrees, turn off the distance measuring function.
Data Storage	Disable or enable data storage locally.
Data	Enable or disable data retransmission.

Retransmission	
Change Password	Change the password for ToolBox App to access this device.

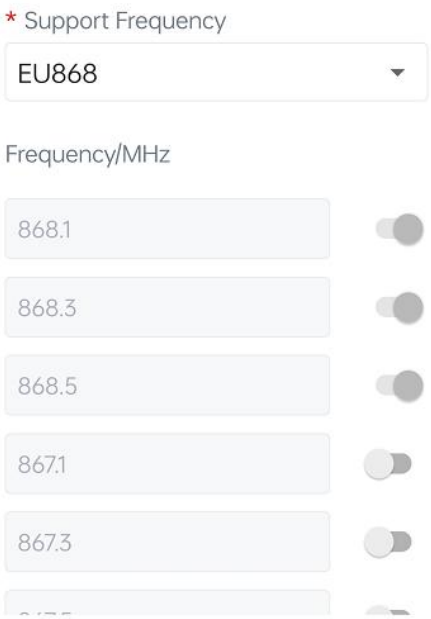
4.3 Communication Settings

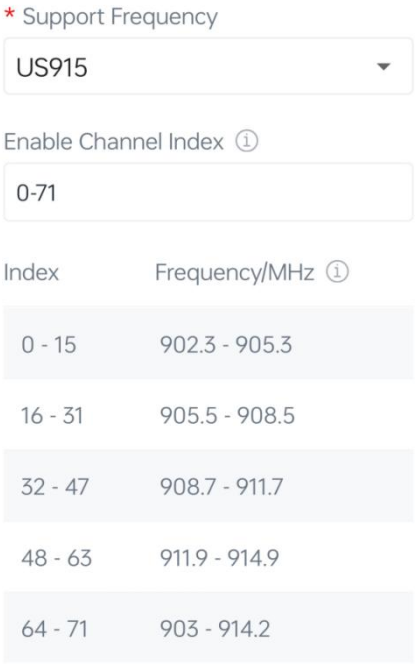
4.3.1 LoRaWAN® Settings (LoRaWAN® Version Only)

Go to **Device > Setting > Network** of ToolBox App to configure join type, App EUI, App Key and other information. You can also keep all settings by default.



Parameters	Description
Device EUI	Unique ID of the device which can also be found on the label.
App EUI	Default App EUI is 24E124C0002A0001.
Application Port	The port used for sending and receiving data, default port is 85.
LoRaWAN® Version	V1.0.2, V1.0.3 are available.
Work Mode	It's fixed as Class A.
Confirmed Mode	If the device does not receive ACK packet from network server, it will resend data once.
Join Type	OTAA and ABP mode are available.

Application Key	Appkey for OTAA mode, default is 5572404C696E6B4C6F52613230313823.
Rejoin Mode	Reporting interval ≤ 35 mins: the device will send a specific number of LinkCheckReq MAC packets to the network server every reporting interval or 2*reporting interval to validate connectivity; If there is no response, the device will re-join the network. Reporting interval > 35 mins: the device will send a specific number of LinkCheckReq MAC packets to the network server every reporting interval to validate connectivity; If there is no response, the device will re-join the network. **Note:** Only OTAA mode supports rejoin mode.
Set the number of packets sent	When rejoin mode is enabled, set the number of LinkCheckReq packets sent. **Note:** the actual sending number is **Set the number of packets sent** + 1.
Network Session Key	Nwkskey for ABP mode, default is 5572404C696E6B4C6F52613230313823.
Application Session Key	Appskey for ABP mode, default is 5572404C696E6B4C6F52613230313823.
Device Address	DevAddr for ABP mode, default is the 5th to 12th digits of SN.
Channel	Enable or disable the frequency to send uplinks.  If frequency is one of CN470/AU915/US915, enter the index of the channel that you want to enable and make them separated by commas. **Examples:** 1, 40: Enabling Channel 1and Channel 40 1-40: Enabling Channel 1 to Channel 40

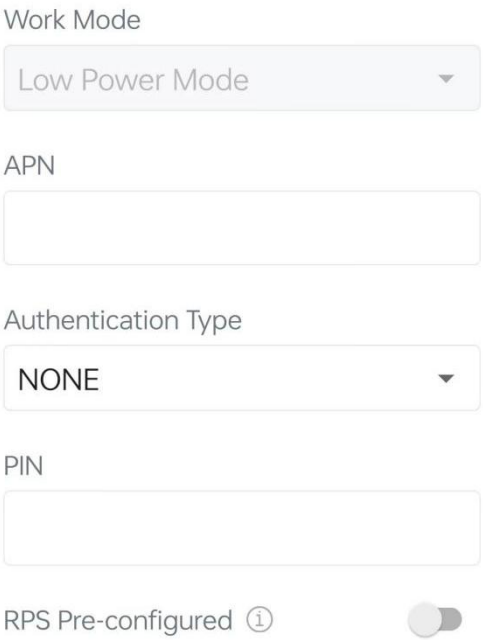
	1-40, 60: Enabling Channel 1 to Channel 40 and Channel 60 All: Enabling all channels Null: Indicates that all channels are disabled 
ADR Mode	Allow network server to adjust datarate of the device.
Spread Factor	If ADR is disabled, the device will send data via this spread factor.
Tx Power	Transmit power of device.
RX2 Data Rate	RX2 data rate to receive downlinks.
RX2 Frequency	RX2 frequency to receive downlinks. Unit: Hz

Note:

1) Please contact Milesight sales team for device EUI list if there are many units.
2) Please contact Milesight sales team if you need random App keys before purchase.
3) Select OTAA mode if you are using Milesight Development Platform to manage devices.

4.3.2 Cellular Settings (Cellular Version Only)

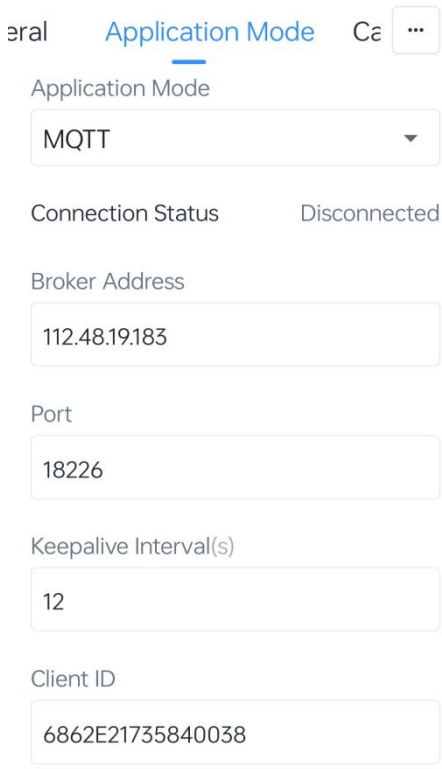
Go to **Device > Setting > Network** of ToolBox App to configure the application mode and server information.



Parameters	Description
Work Mode	**Low Power Mode:** the device will power off the cellular module to save power after sending uplinks. Only when the device sends uplinks, it can receive downlink commands.
APN	The Access Point Name for dialing up network connection provided by local ISP. The max length is 31 characters.
Authentication Type	NONE, PAP and CHAP are optional.
PIN	Enter a 4-8 characters PIN code to unlock the SIM.
RPS Pre-configured	Enable or disable request a pre-configured profile from Milesight Development Platform or other RPS server.

4.3.3 Application Mode Settings (Cellular Version Only)

Go to **Device > Setting > Application Mode** of ToolBox App to configure the application mode and server information.



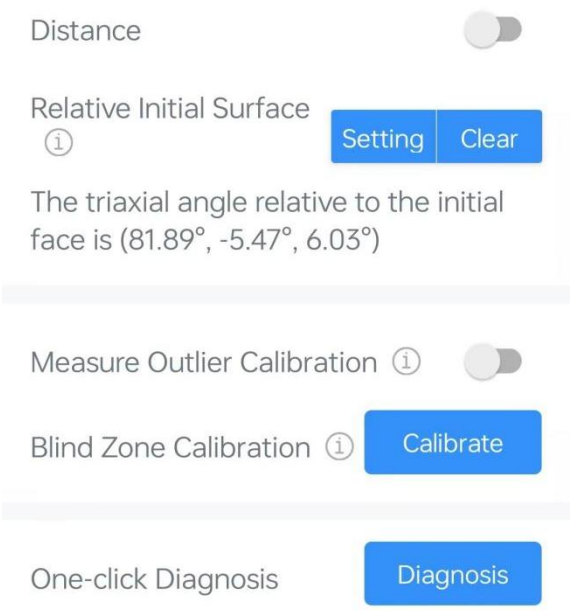
Parameters	Description
Application Mode	Select from MQTT, TCP, AWS, UDP, and Milesight Development Platform.
MQTT	
Broker Address	Fill in MQTT broker address to receive data.
Port	Fill in MQTT broker port to receive data.
Client ID	Client ID is the unique identity of the client to the server, it must be unique when all clients are connected to the same server.
User Credentials	
Enable	Enable user credentials.
Username	The username used for connecting to MQTT broker.
Password	The password used for connecting to MQTT broker.
TLS	
Enable	Enable the TLS encryption in MQTT communication.
TLS Version	It's fixed as TLS v1.2.
CA File	Import the CA.crt file.
Client Certificate	Import the client certificate.
Client Key	Import the client key.
MQTT Topic	
Uplink Topic	Receive periodic reports, threshold alarms, etc. Default: em/[SN]/uplink

Downlink Topic	Send downlink commands. Default: em/[SN]/downlink
TCP	
Server Address	Fill in the TCP server address (IP/domain name).
Port	Fill in the TCP server port. Range: 1-65535.
Retry Interval	Device waits before attempting to reconnect to the TCP server after a failed connection attempt.
Retry Times	The number of times that a device will attempt to reconnect to the TCP server after a failed connection attempt.
AWS	
Server Address	Fill in the AWS server domain name which the data sends to.
CA File	Import the CA.crt file.
Client Certificate	Import the client certificate.
Client Key	Import the client key.
UDP	
Server Address	Fill in the UDP server address (IP/domain name).
Port	Fill in the UDP server port. Range: 1~65535.

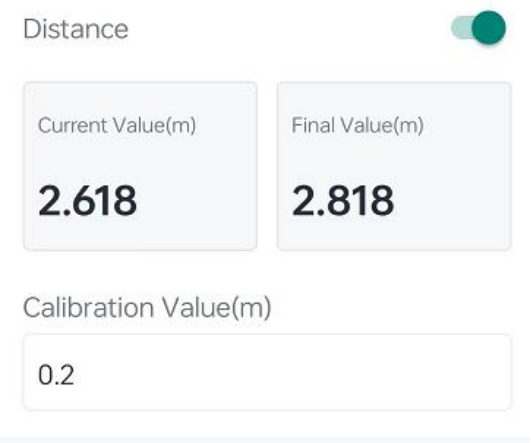
4.4 Advanced Settings

4.4.1 Calibration Settings

Go to **Device > Setting > Device > Calibration** to enable calibration.

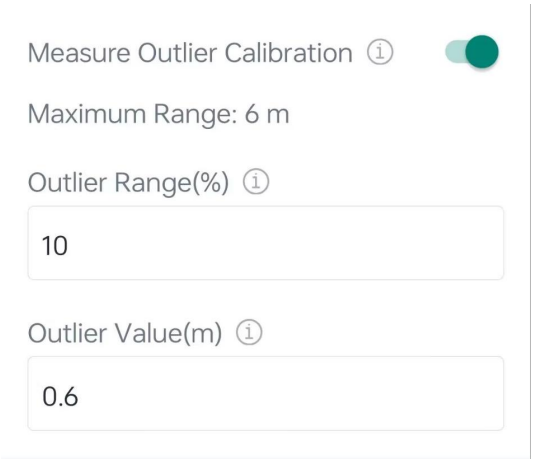


- **Numerical Calibration**: users can define calibration value to correct every distance.



- **Relative Initial Surface:** Click **Setting** to read the triaxial angle relative to the current surface, to adjust the current device position as “Normal”.

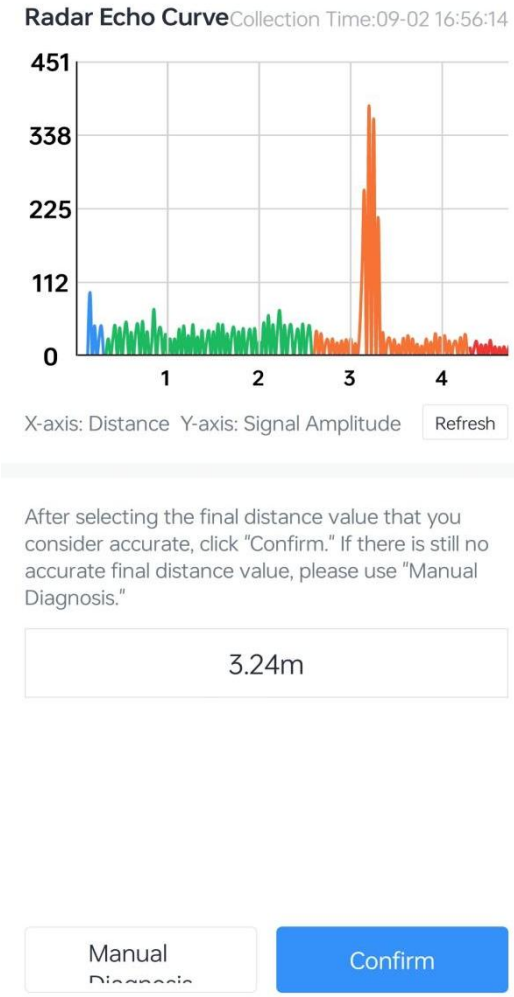
- **Measure Outlier Calibration**: users can define either outlier range or outlier value. When the device distance value exceeds the outlier range (or range) compared to the previous value, the device will measure the distance once again. Outlier Value=Max.Range*Outlier Range.

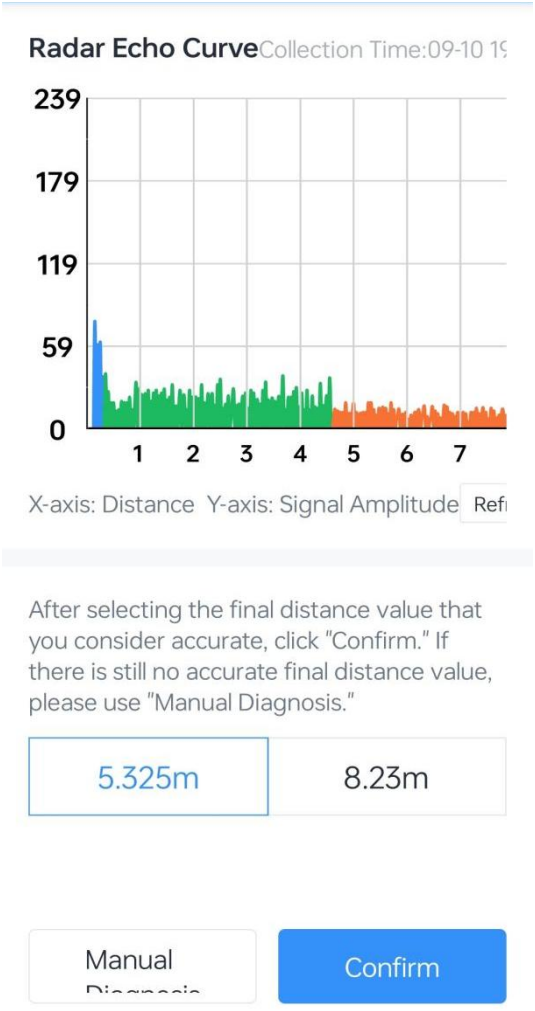


- **Blind Zone Calibration:** If calibrated, an alarm packet will be reported once if the liquid level distance falls within the blind zone. Please ensure there is not any objects within the blind zone when calibration and it is recommended to calibrate it after device installation.

- **One-click Diagnosis:** This only appears when connecting device via Bluetooth mode. When the collected distance is not consistent with the actual situation, you can use this function.

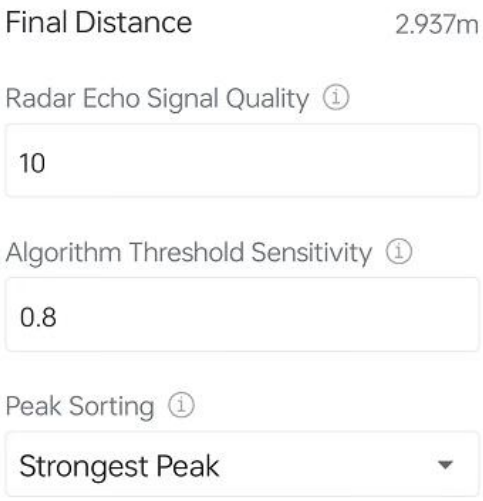
Step 1: Click Diagnosis to show the current Radar Echo Curve. If the collected distance has only one value, it means the nearest signal amplitude is equal to the strongest signal. If two values appear, it means one represents the nearest signal amplitude and another represents the strongest signal.





Step 2: Choose a collected distance value that is closer to the actual distance, and click Confirm to finish configuration or click Refresh to get a new collected distance.

Step 3: If the distance value is still not accurate, click **Manual Diagnosis** to set the relevant parameters:



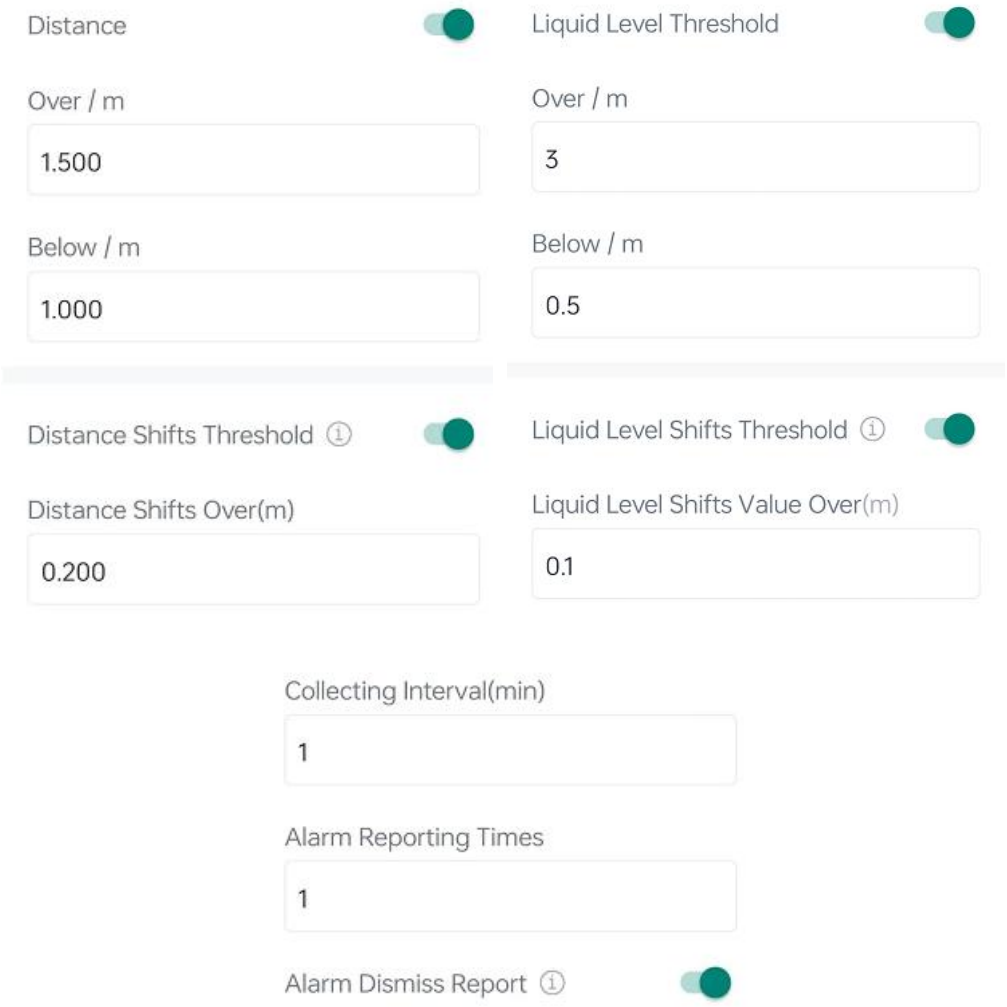
Parameters	Description
Radar Echo Signal Quality	If the liquid level has significant foam, numerous foreign objects, or the measurement signal is unstable and the peak is not clear, adjust this value upwards. **Note:** The larger the value, the greater the power consumption.
Algorithm Threshold Sensitivity	The device requires only one target to measure. When a large number of targets are detected, the sensitivity can be appropriately decreased; when no targets are detected, the sensitivity can be appropriately increased.
Peak Sorting	According to the radar echo curve and the actual scene situation, the peak with the nearest signal amplitude or the strongest peak can be selected as the effective target.

Note: If appear "Disabled", reset **Relative Initial Surface** or disable **Tilt & Distance Switch**.

Step 4: When adjusting parameters, click Refresh Final Distance to confirm the final distance value. Once you've obtain the desired final distance value, click the arrow on the upper left corner to return to the home page.

4.4.2 Threshold Settings

Go to **Device > Setting > Device > Threshold** to configure distance threshold or distance shifts threshold settings.



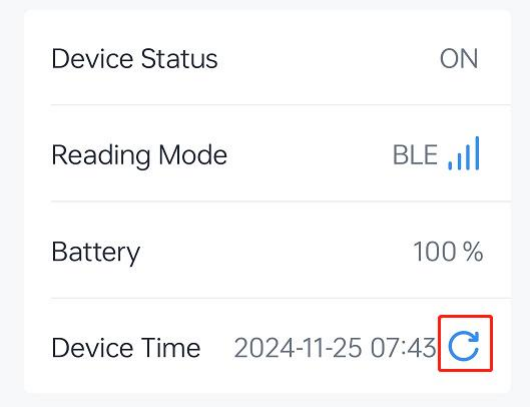
Parameters	Description
Distance / Liquid Level Threshold	When the distance/liquid level is over or below the threshold value, the device will report alarm packets.
Distance / Liquid Level Shifts Threshold	When this function is enabled, the device will report alarm packets when the absolute value of the difference between the two collected values exceeds the set threshold.
Collecting Interval(min)	The interval to detect distance/liquid level, this should be smaller than or equal to the reporting interval.
Alarm Reporting Times	Set the number of alarm reports to be sent after the threshold is triggered, the default is 1.
Threshold Dismiss Report	When the collected distance/liquid level value changes from outside the threshold to within the threshold, a threshold release packet will be reported.

4.4.3 Data Storage

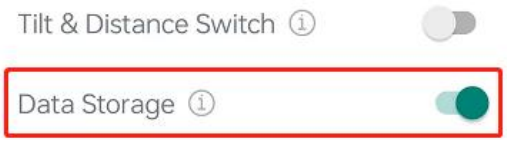
EM410-RDL sensor supports storing more than 2000 data records locally and exporting data via ToolBox App. The device will record the data according to the reporting interval even not joining to network.

Here are the steps for storage:

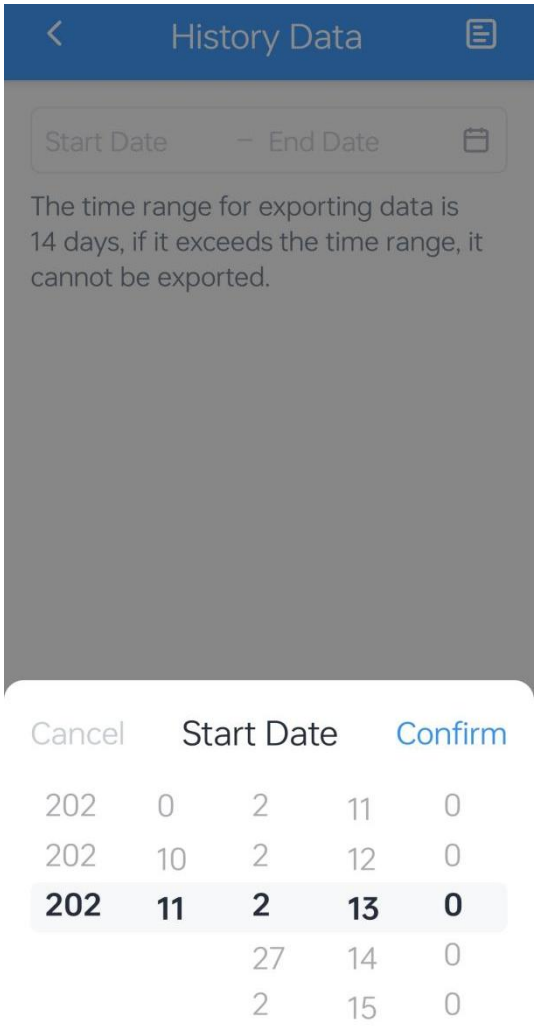
1. Ensure the device time is correct, go to **Device > Basic Information**, click to sync the time.



2. Go to **Device > Setting > General** to enable **Data Storage** feature.



3. Go to **Maintenance,** click **History Data**, then select the data period and click **Confirm** to export data. The maximum export data period on ToolBox App is 14 days.

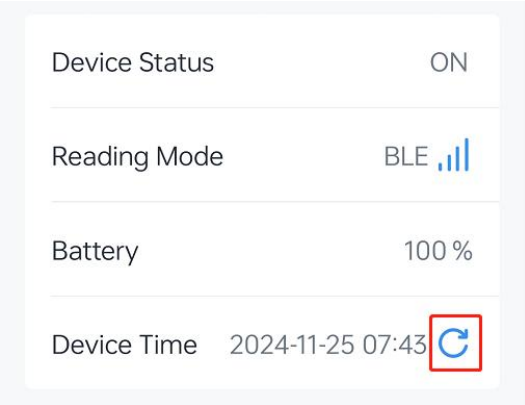


4.4.4 Data Retransmission

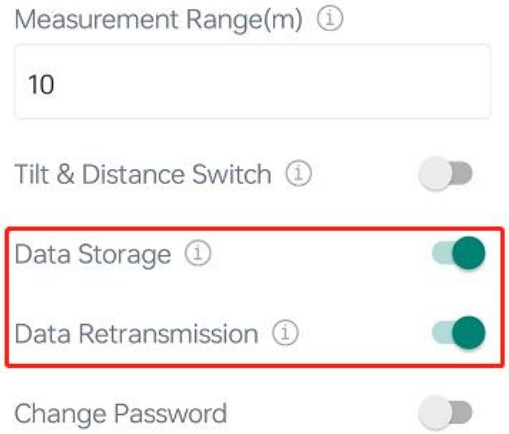
EM410-RDL sensor supports data retransmission to ensure the server can get all data even if the network is down for some time.

Here are the steps for retransmission:

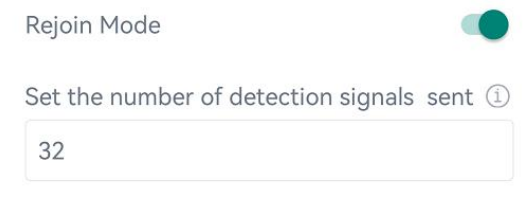
1. Ensure the device time is correct, go to **Device > Basic Information,** please click to sync the time.



2. Go to **Device > Setting > General** to enable **Data Storage** and **Data Retransmission** feature.



3. For LoRaWAN® Version, it is necessary to go to **Device > Setting > Network > LoRaWAN** to enable rejoin mode to ensure the device to know and record the time when it disconnects from network server. For example, the device will send LinkCheckReq MAC packets to the network server regularly to check any network disconnection; if there is no response for 32+1 times, the join status will change to de-activated and the device will record a data lost time point (the time it reconnected to the network).



4. After the network connection is restored, the device will send the lost data from the point in time when the data was lost according to the data retransmission interval (600s by default).

Note:

1) If the device is rebooted or re-powered when data retransmission is not completed, the interrupted retransmission data will be retransmitted first after the network is reconnected to the network, and then the newly triggered retransmission data will be transmitted.

2) If the network is disconnected again during data retransmission, it will only send the latest disconnection data.

3) The retransmission data format is started with “20ce”, which is different from periodic reports.

4) Data retransmission will increase the uplinks and shorten the battery life.

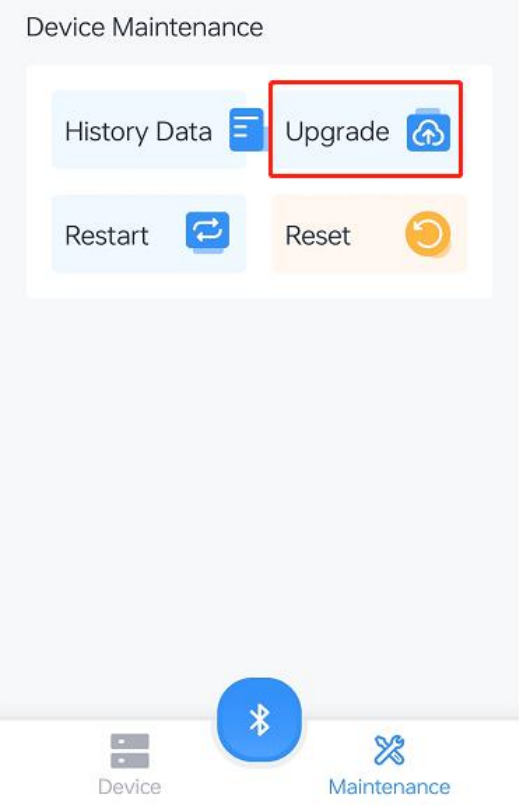
5) For cellular version, this feature is not supported when application mode is UDP.

4.5 Maintenance

4.5.1 Upgrade

1. Download firmware from Milesight website to your smartphone.

2. Go to **Maintenance** page of ToolBox App, and tap **Upgrade** to import firmware and upgrade the device..

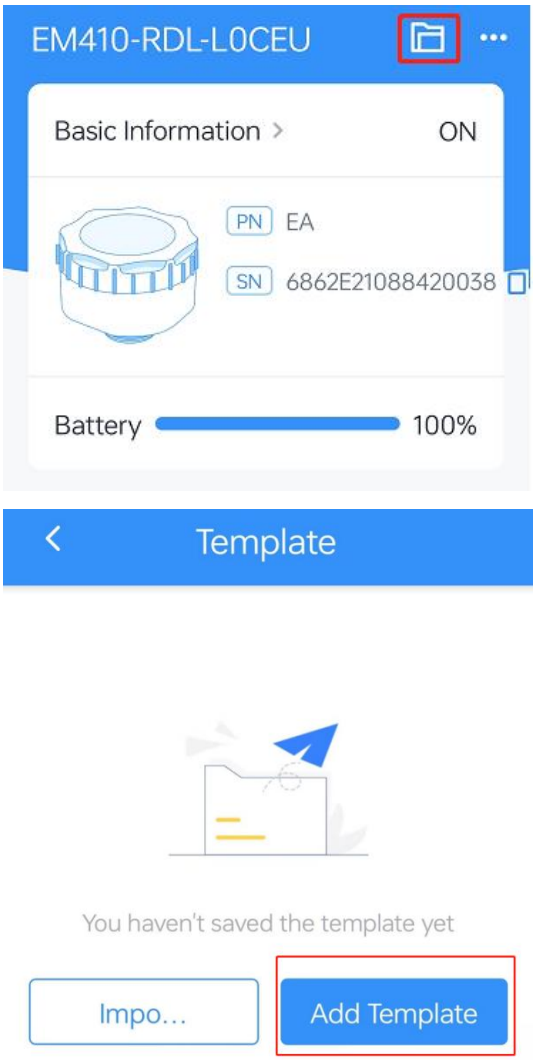


]

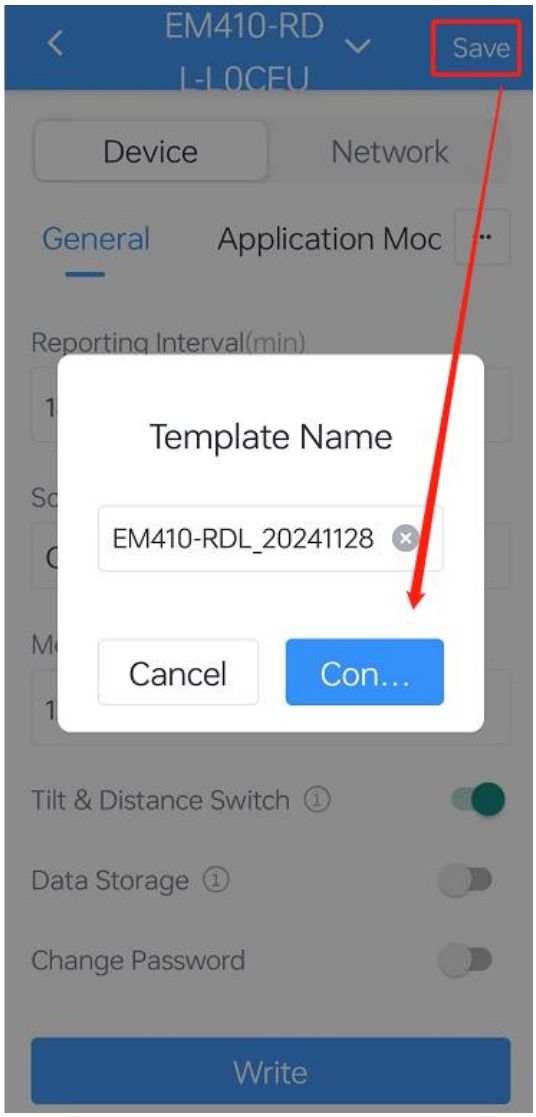
4.5.2 Backup

EM410-RDL supports configuration backup for easy and quick device configuration in bulk. Backup is allowed only for devices with the same model and frequency band.

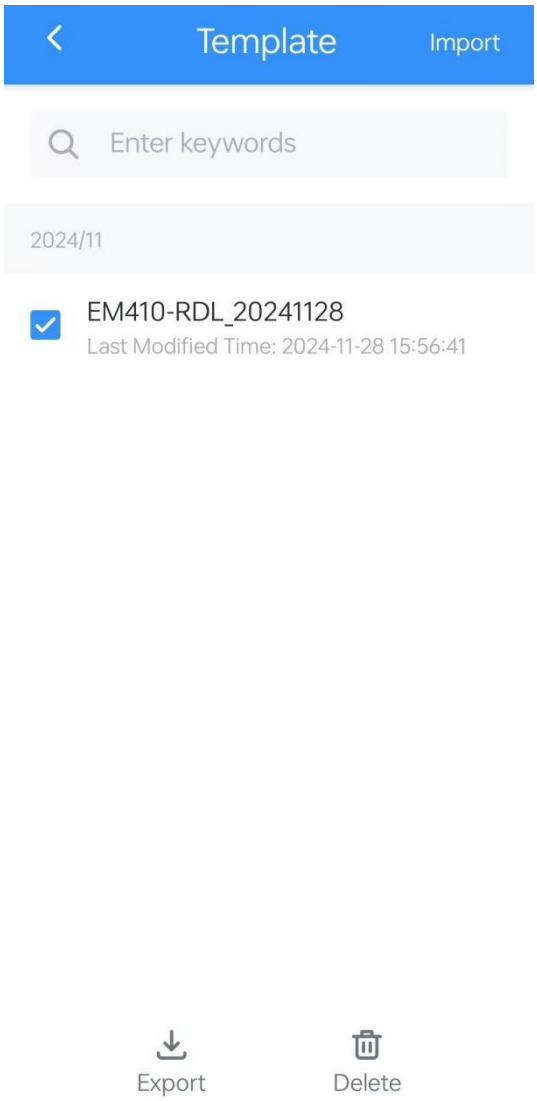
1. Click  to go to **Template** page in the App, click **Add Template** to save the current settings as a template. The saved templates are also editable..



2. Modify the configuration and click to **save** it, then attach the smartphone to another device, click **Write** to reuse the template.

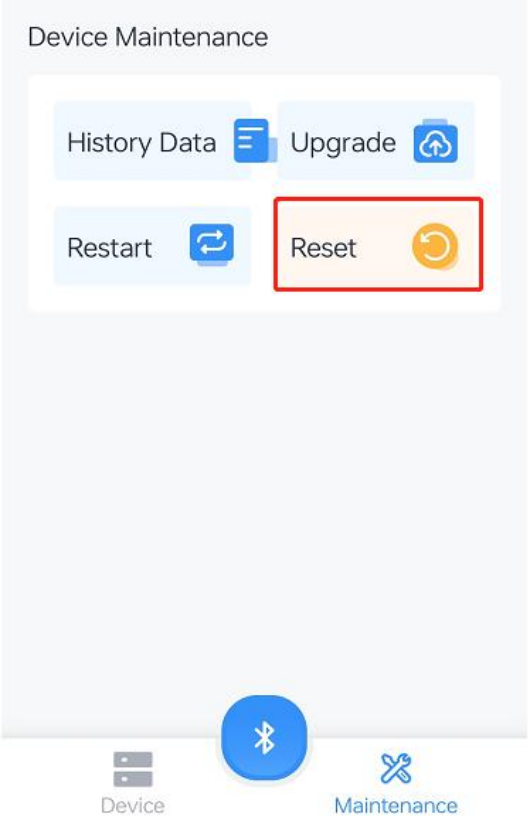


Note: Check the box to export or delete the template. Click the template to edit the configurations.



4.5.3 Reset to Factory Default

Go to **Maintenance** to click **Reset.**

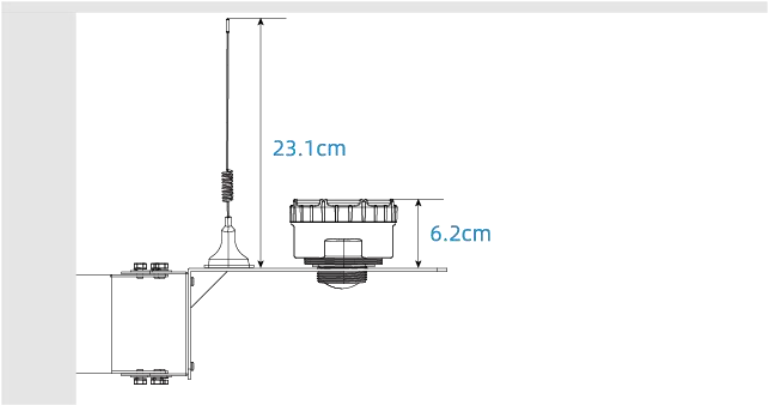


5. Installation

5.1 Mounting Bracket Installation

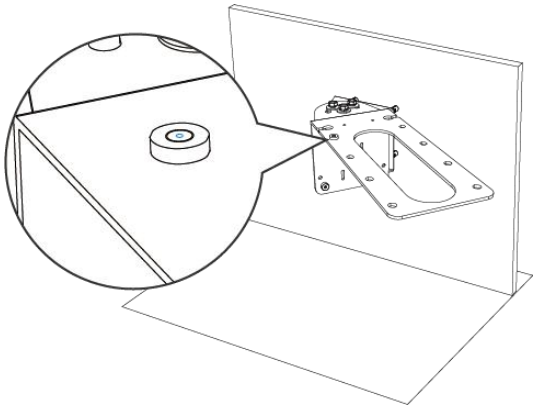
Step 1: Locate Position

- Avoid placing the device near any metal objects, water outlets, stairs and other obstacles;
- Please consider the height of the equipment and other factors (such as the height of antenna, the thickness of the manhole cover) to ensure that the equipment does not interfere with normal usage after installation.



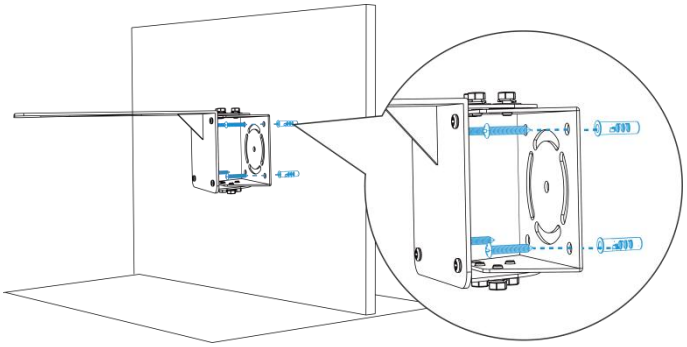
Step 2: Adjust Level

Attach the bubble level to the bracket surface to ensure the bracket is parallel.

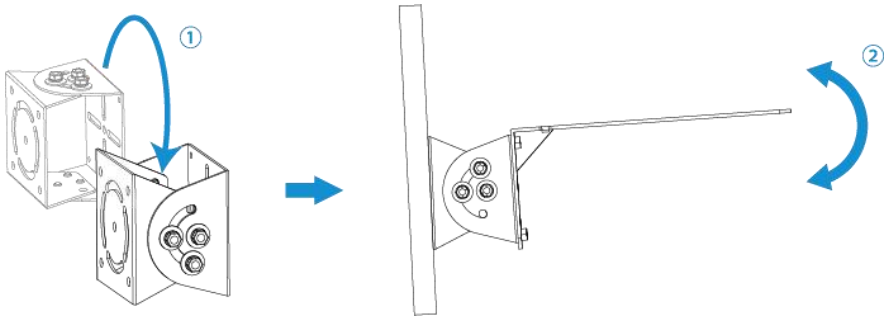


Step 3: Fix Mounting Bracket

Drill 4 holes according to the mounting bracket holes. Fix the wall plugs to the wall holes, then fix the mounting bracket to the wall plugs via mounting screws.

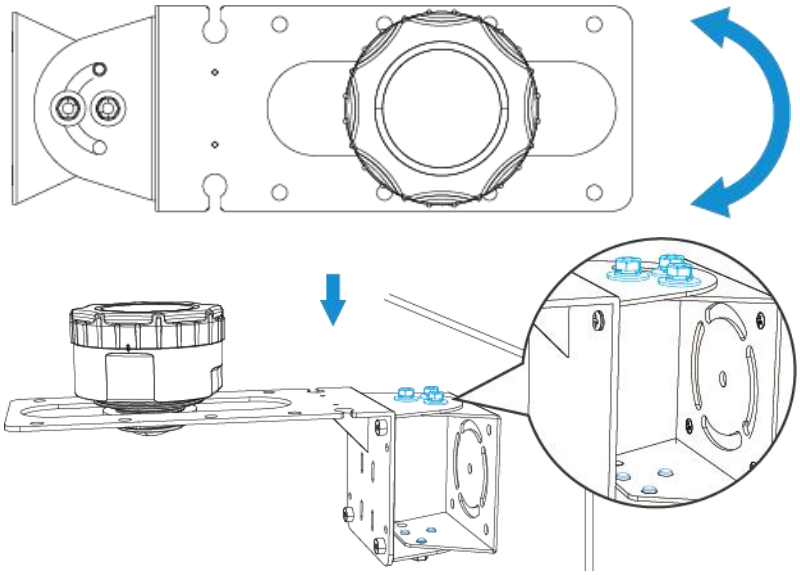


Note: If the wall is inclined, you can first rotate the bracket assembly 90 ° clockwise or counterclockwise, and then adjust the horizontal plane up or down as needed based on the actual situation.



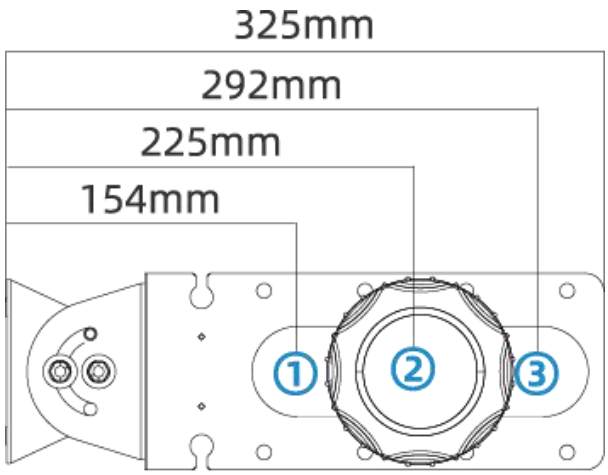
Step 4: Adjust Mounting Bracket Angle

Loosen the two nuts on both the upper and lower tracks of the bracket, adjust the bracket to the appropriate angle, then use a wrench to tighten all six nuts with flat washers.



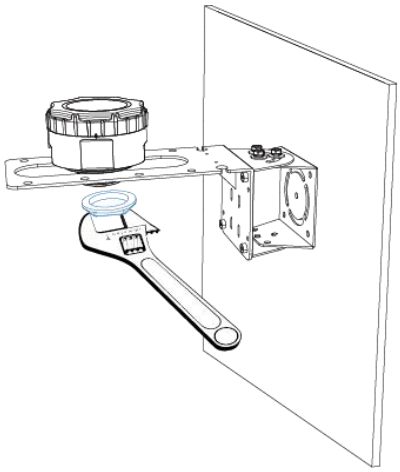
Step 5: Select the device installation location on the bracket according to the installation height.

Installation Height	Recommend Location
1 ~ 2m	1
2.1 ~ 3m	2
3.1 ~ 6m	3



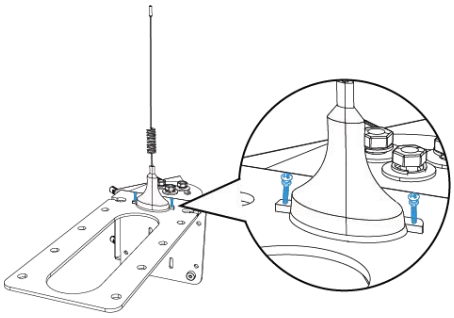
Step 6: Fix Device

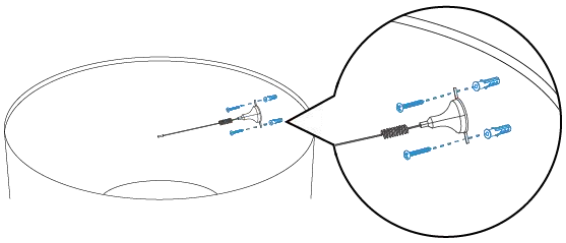
Place the device onto the mounting bracket, adjust it to an appropriate position, and then tighten it with G1$^{1}/_{2}$ nut. The torque for tightening the G1$^{1}/_{2}$ nut with a wrench should not exceed 4 N •m.



Step 7: Fix Antenna (External Antenna Version Only)

The antenna can be secured to the mounting bracket with screws, or it can be fastened to the sewer wall with bolts and screws. Additionally, it can be attached to any metal surface using the magnetic base at the bottom of the antenna.

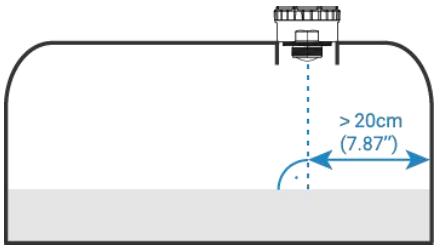




5.2 Tank Installation

Step 1: Locate the Device Installation Position

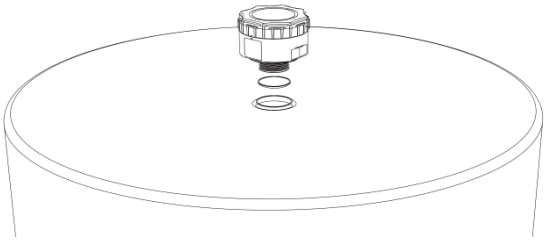
- Place it away from the tank wall more than 20cm;
- Perpendicular to the measured liquid and with no obstacles between the device and the measured liquid.



Step 2: Fix Device

The device has G1 ½"and G2 ½" thread opening to allow it to be screwed into an existing applicable thread opening of a tank. An O-ring is supplied and should be used to ensure a watertight seal.

When tanks' mounting hole is unavailable or where it is undesirable to cut a mounting hole in the tank, an adapter can be installed on the top surface of the tank and the sensor can be mounted on this adapter. Adapters for different sized need to be purchased separately. The device should be threaded and screwed onto the adapter firmly to make a good seal. The O-ring shown below seals the non-invasive adapter to the bottom of the sensor's main enclosure.



Installation Note:

1. The installation location of the device should avoid strong vibrations, direct sunlight, and exposure to rain or snow.
2. Do not place the device near objects that emit intense heat, strong electromagnetic fields, or radioactive materials.
3. It is recommended to attach the magnetic base of external antenna to a manhole cover or other metal surface to ensure a good signal.
4. After installation, please check the tilt status and distance measurement in the ToolBox App, and adjust the installation position, direction, or related parameters based on the results: Advanced Settings.

6. Communication Protocol

6.1 LoRaWAN® Version

All data are based on following format (HEX), the Data field should follow little-endian:

Channel1	Type1	Data1	Channel2	Type2	Data2	Channel 3	...
1 Byte	1 Byte	N Bytes	1 Byte	1 Byte	M Bytes	1 Byte	...

For decoder examples please find files on https://github.com/Milesight-IoT/SensorDecoders.

6.1.1 Basic Information

EM410-RDL sensor reports basic information whenever it joins the network.

Channel	Type	Byte	Description
ff	0b (Power On)	1	ff
	01 (Protocol Version)	1	01=>V1
	fe (Reset Report)	1	ff

	16 (Device SN)	8	16 digits
	09 (Hardware Version)	2	01 00 => V1.0
	0a (Firmware Version)	2	01 14 => V1.14
	0f (Device Type)	1	00: Class A
	ff (TSL Version)	2	0100

Example:

ff0bff ff0101 fffeff ff166862e21141780013 ff090100 ff0a0101 ff0f00 ffff0100					
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**
ff	0b (Power On)	ff (Reserved)	ff	01 (Protocol Version)	01 (V1)
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**
ff	fe (Reset Report)	ff	ff	16 (Device SN)	6791d19 6040500 05
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**
ff	09 (Hardware Version)	0100 (V1.0)	ff	0a (Firmware Version)	0101 (V1.1)
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**
ff	0f (Device Type)	00 (Class A)	ff	ff (TSL Version)	0100 (V1.0)

6.1.2 Sensor Data

Channel	Type	Byte	Description
01	75(Battery Level)	1	UINT8, Unit: %, [1-100]
04	82(Distance/Liquid Level)	2	INT16, Unit: mm
05	00(Device Position)	1	00: Normal, 01: Tilt(horizontal offset angle ≥ 15°)
06	c7(Radar Signal Strength)	2	INT16*0.01, Unit: dBm
84	82(Distance/Liquid Level)	3	● Byte 1-2: Distance/Liquid Level, INT16, Unit: mm ● Byte 3: 01-Alarm; 00-Alarm dismiss
94	82(Distance/Liquid Level Shifts	5	● Byte 1-2: Distance/Liquid Level, INT16, Unit: mm

	Threshold)		● Byte 3-4: Distance/Liquid Level Shifts, INT16, Unit: mm ● Byte 5: 02
b4	82(Blind Zone)	3	● Byte 1-2: Distance, INT16, Unit: mm ● Byte 3: ➢ 00-Alarm dismiss ➢ 01-Alarm ■ No target within 30cm, report distance as fffd ■ Have target within 30cm, report the distance ➢ 02-Cannot collect the target, report distance as fffd ➢ 03-Sensor Abnormal, report distance as ffff
20	ce(Historical Data)	11	● Byte 1-4: Unix Timestamp ● Byte 5-6: Distance/Liquid Level, INT16, Unit: mm ● Byte 7-8: Temperature, INT16*0.1, Unit: °C ● Byte 9-10: Distance Mutation, INT16, Unit: mm ● Byte 11: Alarm Status ➢ Bit0: Threshold Alarm ➢ Bit1: Threshold Alarm Dismiss ➢ Bit2: Blind Zone Alarm ➢ Bit3: Blind Zone Alarm Dismiss ➢ Bit4: Distance/Liquid Level Shifts Threshold Alarm ➢ Bit5: Device Position ➢ Bit6-7: 00

Examples:

1. Periodic packet:

017562 0482aa0c 06c70303 050000					
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**

01	75 (Battery Level)	62=>98%	04	82 (Distance/Liquid Level)	aa0c => 0caa =>3242 mm
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**
06	c7(Radar Signal Strength)	03 03=> 771*0.01=7.71 dBm	05	00(Device Position)	00: Normal

2. Threshold Alarm: report when distance/liquid level reaches the threshold.

8482 c827 01 9482 c827850c 02		
Channel	**Type**	**Value**
84	82 (Distance/Liquid Level)	Distance/Liquid Level: c8 27 => 27 c8 =10184mm = 10.184m 01= Alarm
94	82(Distance/Liquid Level Shifts Threshold)	Distance/Liquid Level Shifts Threshold: c8 27 => 27 c8 =10184mm = 10.184m 85 0c => 0c 85=3205mm = 3.205m 02=Alarm

3. Blind Zone alarm packet: report when the target value reaches the blind zone.

b482 ac00 01		
Channel	**Type**	**Value**
b4	82(Blind Zone)	ac 00 => 00 ac = 172mm = 0.172m 01=calibrated distance

6.1.3 Downlink Commands

EM410-RDL supports downlink commands to configure the device. Application port is 85 by default.

Channel	Type	Byte	Description
ff	10 (Reboot)	1	ff (Reserved)
	bd(UTC Time Zone)	2	INT16/60
	28(Query Device Status)	1	01
	8e (Reporting Interval)	3	● Byte 1: 00 ● Byte 2-3: Reporting Interval, UINT16, Unit: min, Range: 1~1440
	1b(Measurement Range)	5	● Byte 1: ➢ 00 = General Mode; ➢ 01 = Rainwater Well Mode; ➢ 02 = Wastewater Well Mode

			➢ 03 = Tank Mode ● Byte 2-3: 0000 ● Byte 4-5: Max. Measuring Range, UINT16, Unit: mm
	3e (Tilt & Distance Switch)	1	01 = Enable; 00 = Disable
	68(Data Storage)	1	01 = Enable; 00 = Disable
	69(Data Retransmission)	1	01 = Enable; 00 = Disable
	6a(Data Retransmission Interval)	3	● Byte 1: 00 ● Byte 2-3: Interval time, Unit: s
	ab(Distance Calibration)	3	● Byte 1: 01-Enable; 00-Disable ● Byte 2-3: Calibration Value, INT16, Unit: mm
	1c(Recollecting of Measure Outlier Calibration)	2	● Byte 1: Recollecting Times, UINT 8, Range: 1~3 ● Byte 2: Recollecting Interval, UNIT 8, Unit: s, Range: 1~10
	06 (Set Threshold Alarm)	9	● Byte 1: ➢ Bit2~Bit0: 000-disable 001-below 010-over 011-within 100-below or over 101-Distance shifts over ➢ Bit5~Bit3: 001-Distance threshold alarm; 010-Distance shifts threshold alarm ➢ Bit6: 0 ➢ Bit7: 0-disable threshold dismiss report 1-enable threshold dismiss report

			• Byte 2-3: Min. Value, INT16, Unit: mm • Byte 4-5: Max. Value or distance shifts value, INT16, Unit: mm • Byte 6-9: 00000000
	f2(Alarm Reporting Times)	2	UINT16, Range: 1~1000, Default: 1
	27(Clear History Data)	1	01
	2a(Device Calibration)	1	01-Blind Zone Calibration
f9	12 (Scenario Mode)	1	00 = General Mode; 01 = Rainwater Well Mode; 02 = Wastewater Well Mode 03 = Tank Mode
	39(Collecting Interval)	2	Unit: min, Range: 1~1440
	14(Radar Echo Signal Quality)	2	INT16, Range: -10~35
	15(Algorithm Threshold Sensitivity)	2	INT16*0.1, Range: 0.1~1
	16(Peak Sorting)	1	00-Nearest Peak; 01-Strongest Peak

Example:

1. Set time zone as UTC-4.

ffbd10ff		
Channel	**Type**	**Value**
ff	bd	10 ff=> ff 10 = -240/60=-4 the time zone is UTC-4

2. Set reporting interval as 4 minutes.

ff8e 00 0400		
Channel	**Type**	**Value**
ff	8e (Reporting Interval)	04 00 => 00 04 = 4 minutes

3. Reboot the device.

ff10 ff		
Channel	**Type**	**Value**
ff	10 (Reboot)	ff (Reserved)

4. Set the device as Wastewater Well mode.

f912 02

Channel	Type	Value
f9	12 (Scenario Mode)	02 = Wastewater Well Mode

5. Disable “Tilt & Distance Switch” feature.

ff3e 00		
Channel	**Type**	**Value**
ff	3e (Tilt & Distance Switch)	00 = disable

6. When the distance is below 1m or over 10m, the sensor will send threshold alarm.

ff06 8c e803 1027 00000000		
Channel	**Type**	**Value**
ff	06 (Set Threshold Alarm)	8c=10 001 100: 100=below or over 001=Distance threshold alarm 10=enable threshold dismiss report Min: e8 03 => 03 e8 = 1000 mm = 1m Max: 10 27 => 27 10 = 10000 mm =10m

7. When the distance shifts is over 0.5m, the sensor will send threshold alarm.

ff06 95 0000 f401 00000000		
Channel	**Type**	**Value**
ff	06 (Set Threshold Alarm)	95=10 010 101: 101=Distance shifts over 010=Distance shifts threshold alarm 10=enable threshold dismiss report Min: 0000 Distance shift value: f4 01 => 01 f4 = 500 mm=0.5m

6.1.4 Historical Data Enquiry

EM410-RDL supports sending downlink commands to enquire historical data for specified time point or within a certain time range. Before utilizing this feature, it is import to make sure the device time is correct and data storage feature was enable to store the data.

Command format:

Channel	Type	Byte	Description
fd	6b (Enquire data in time point)	4	unix timestamp
	6c (Enquire data in time range)	8	● Byte 1-4: Start time, unix timestamp

			• Byte 5-8: End time, unix timestamp
	6d (Stop query data report)	1	ff
ff	6a(Report Interval)	3	• Byte 1: 01 • Byte 2-3: Unit: s, Range: 30~1200s (60s by default)

Reply format:

Channel	Type	Byte	Description
fc	6b/6c	1	00: data enquiry success; 01: time point or time range invalid; 02: no data in this time or time range.
20	ce (Historical Data)	11	• Byte 1-4: Unix Timestamp • Byte 5-6: Distance/Liquid Level, INT16, Unit: mm • Byte 7-8: Temperature, INT16*0.1, Unit: °C • Byte 9-10: Distance/Liquid Level Shifts, INT16, Unit: mm • Byte 11: Alarm Status ➢ Bit0: Threshold Alarm ➢ Bit1: Threshold Alarm Dismiss ➢ Bit2: Blind Zone Alarm ➢ Bit3: Blind Zone Alarm Dismiss ➢ Bit4: Distance/Liquid Level Shifts Threshold Alarm ➢ Bit5: Device Position ➢ Bit6-7: 00

Note:

1. The device only uploads no more than 300 data records per range inquiry.
2. When enquiring about the data in time point, it will upload the data that is the closest to the search point within the reporting interval range. For example, if the device's reporting interval is 10 minutes and users send a command to search for 17:00's data, if the device finds there is

data stored in 17:00, it will upload these data. If not, it will search for data between 16:50 to 17:10 and upload the data which is the closest to 17:00.

Example:

1. Enquire historical data between 2024/9/7 15:28:22 to 2024-9-11 15:28:22.

fd6c 9600dc66 9646e166		
Channel	**Type**	**Value**
fd	6c (Enquire data in time range)	Start time: 9600dc66 => 66dc0096 = 1725694102s =2024/9/7 15:28:22 End time: 9646e166 => 66e14696 =1726039702 s =2024-9-11 15:28:22

Reply:

fc6c00		
Channel	**Type**	**Value**
fc	6c (Enquire data in time range)	00: data enquiry success

20ce b443e166 ac0c be00 0000 20			
Channel	**Type**	**Time Stamp**	**Value**
20	ce (Historical Data)	b443e166 => 66e143b4 = 1726038964s = 2024-9-11 15:16:04	Distance/Liquid Level: ac0c => 0cac =3244mm=3.244m Temperature: be00 => 00be = 190*0.1=19°C Distance shifts: 0000 Alarm Status: 20=0010 0000=>Tilt

6.2 Cellular Version

6.2.1 AWS/MQTT Topics

When the device is connected to AWS/MQTT server, the bi-directional communication uses different default topics. MQTT topics support to be changed as required.

Topic	Content
em/[SN]/uplink	Receive periodic reports, threshold alarms, etc.
em/[SN]/downlink	Send downlink commands

6.2.2 Uplink Data

All data are based on following format (HEX):

Start	ID	Packet	FLAG	TSL	Reserved	Software	Hardwar

		Length		Version		Version	e Version
02	0101	2 Bytes	00	0101	01	4 Bytes	4 Bytes
SN	**IMEI**	**IMSI**	**ICCID**	**Signal**	**Data Length**	**Data1**	...
16 Bytes	15 Bytes	15 Bytes	20 Bytes	1 Byte	2 Bytes	N Bytes	...

Example:

02 0101 005D 00 0101 01 30313031 30313031
3637343944313930353436393030333 1
3836383530383036343830373335 30
3436303034333232343231333131 30
3839383630343132313032323730303632383537
09 0007
01756404823B01

Type	Content
Start	02
ID	0101
Packet Length	00 5d=93 bytes
FLAG	00
TSL Version	0101=V1.1
Reserved	01
Software Version	30 31 30 31 => 0101=V1.1
Hardware Version	30 31 30 31 => 0101=V1.1
SN	3637343944313930353436393030333 1=>6749D19054 690031
IMEI	3836383530383036343830373335 30 =>868508064807350
IMSI	3436303034333232343231333131 30 => 460043224213110
ICCID	3839383630343132313032323730303632383537 => 89860412102270062857
Network Signal	09=>9 asu
Data Length	0007=>7 Bytes
Data	See details below

Data part is based on Channel+Type+Data, the Data field should follow little-endian:

Channel	Type	Byte	Description
01	75(Battery Level)	1	UINT8, Unit: %, [1-100]
04	82(Distance/Liquid Level)	2	INT16, Unit: mm
05	00(Device Position)	1	00: Normal, 01: Tilt(horizontal offset angle ≥ 15°)

06	c7(Radar Signal Strength)	2	INT16*0.01, Unit: dBm
84	82(Distance/Liquid Level Alarm)	3	● Byte 1-2: Distance/Liquid Level, INT16, Unit: mm ● Byte 3: 01-Alarm; 00-Alarm dismiss
94	82(Distance/Liquid Level Shifts Threshold)	5	● Byte 1-2: Distance/Liquid Level, INT16, Unit: mm ● Byte 3-4: Distance/Liquid Level Shifts, INT16, Unit: mm ● Byte 5: 02
b4	82(Blind Zone)	3	● Byte 1-2: Distance, INT16, Unit: mm ● Byte 3: ➢ 00-Alarm dismiss ➢ 01-Alarm ■ No target within 30cm, report distance as fffd ■ Have target within 30cm, report the distance ➢ 02-Cannot collect the target, report distance as fffd ➢ 03-Sensor Abnormal, report distance as ffff
20	ce(Historical Data)	11	● Byte 1-4: Unix Timestamp ● Byte 5-6: Distance, INT16, Unit: mm ● Byte 7-8: Temperature, INT16*0.1, Unit: °C ● Byte 9-10: Distance Mutation, INT16, Unit: mm ● Byte 11: Alarm Status ➢ Bit0: Threshold Alarm ➢ Bit1: Threshold Alarm Dismiss ➢ Bit2: Blind Zone Alarm ➢ Bit3: Blind Zone Alarm Dismiss ➢ Bit4: Distance Shifts Threshold Alarm ➢ Bit5: Device Position

			➢ Bit6-7: 00

Examples:

1. Periodic uplink:.

017562 0482a60c 06c7c8ff 050000					
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**
01	75 (Battery)	62 => 98%	04	82 (Distance/Liquid Level)	a60c => 0ca6 =>3238 mm
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**
06	c7(Radar Signal Strength)	03 03=> 771*0.01=7 .71dBm	05	00 (Device Position)	00=Normal

2. Threshold Alarm: report when distance reaches the threshold.

8482 c827 01 9482 c827850c 02		
Channel	**Type**	**Value**
84	82 (Distance/Liquid Level)	Distance/Liquid Level: c8 27 => 27 c8 =10184mm = 10.184m 01= Alarm
94	82(Distance/Liquid Level Shifts Threshold)	Distance/Liquid Level Shifts Threshold: c8 27 => 27 c8 =10184mm = 10.184m 85 0c => 0c 85=3205mm = 3.205m 02=Alarm

3. Blind Zone alarm packet: report when the target value reaches the blind zone.

b482 ac00 01		
Channel	**Type**	**Value**
b4	82(Blind Zone)	ac 00 => 00 ac = 172mm = 0.172m 01=calibrated distance

6.2.3 Downlink Commands

EM410-UDL supports downlink commands to configure the device. Note that it can only receive downlink commands within the 8s after sending uplink packets.

Channel	Type	Byte	Description
ff	10 (Reboot)	1	ff (Reserved)
	bd(UTC Time Zone)	2	INT16/60
	28(Query Device Status)	1	01

	8e (Reporting Interval)	3	● Byte 1: 00 ● Byte 2-3: Reporting Interval, UINT16, Unit: min, Range: 1~1440
	1b(Measurement Range)	5	● Byte 1: ➢ 00 = General Mode; ➢ 01 = Rainwater Well Mode; ➢ 02 = Wastewater Well Mode ➢ 03 = Tank Mode ● Byte 2-3: 0000 ● Byte 4-5: Max. Measuring Range, UINT16, Unit: mm
	3e (Tilt & Distance Switch)	1	01 = Enable; 00 = Disable
	68(Data Storage)	1	01 = Enable; 00 = Disable
	69(Data Retransmission)	1	01 = Enable; 00 = Disable
	6a(Data Retransmission Interval)	3	● Byte 1: 00 ● Byte 2-3: Interval time, Unit: s
	ab(Distance Calibration)	3	● Byte 1: 01-Enable; 00-Disable ● Byte 2-3: Calibration Value, INT16, Unit: mm
	1c(Recollecting of Measure Outlier Calibration)	2	● Byte 1: Recollecting Times, UINT 8, Range: 1~3 ● Byte 2: Recollecting Interval, UNIT 8, Unit: s, Range: 1~10
	06 (Set Threshold Alarm)	9	● Byte 1: ➢ Bit2~Bit0: 000-disable 001-below 010-over 011-within 100-below or over 101-Distance shifts over ➢ Bit5~Bit3: 001-Distance threshold alarm; 010-Distance shifts threshold

			alarm ➢ Bit6: 0 ➢ Bit7: 0-disable threshold dismiss report 1-enable threshold dismiss report ● Byte 2-3: Min. Value, INT16, Unit: mm ● Byte 4-5: Max. Value or distance shifts value, INT16, Unit: mm ● Byte 6-9: 00000000
	f2(Alarm Reporting Times)	2	UINT16, Range: 1~1000, Default: 1
	27(Clear History Data)	1	01
	2a(Device Calibration)	1	01-Blind Zone Calibration
f9	12 (Scenario Mode)	1	00 = General Mode; 01 = Rainwater Well Mode; 02 = Wastewater Well Mode
	39(Collecting Interval)	2	Unit: min, Range: 1~1440
	14(Radar Echo Signal Quality)	2	INT16, Range: -10~35
	15(Algorithm Threshold Sensitivity)	2	INT16*0.1, Range: 0.1~1
	16(Peak Sorting)	1	00-Nearest Peak; 01-Strongest Peak

Example:

1. Set time zone as UTC-4.

ffbd10ff		
Channel	**Type**	**Value**
ff	bd	10 ff => ff 10 = -240/60=-4 the time zone is UTC-4

2. Set reporting interval as 4 minutes.

ff8e 00 0400		
Channel	**Type**	**Value**
ff	8e (Reporting Interval)	04 00 => 00 04 = 4 minutes

3. Reboot the device.

ff10 ff		
Channel	**Type**	**Value**
ff	10 (Reboot)	ff (Reserved)

4. Set the device as Wastewater Well mode.

f912 02		
Channel	**Type**	**Value**
f9	12 (Scenario Mode)	02 = Wastewater Well Mode

5. Disable “Tilt & Distance Switch” feature.

ff3e 00		
Channel	**Type**	**Value**
ff	3e (Tilt & Distance Switch)	00 = disable

6. When the distance is below 1m or over 10m, the sensor will send threshold alarm.

ff06 8c e803 1027 00000000		
Channel	**Type**	**Value**
ff	06 (Set Threshold Alarm)	8c=10 001 100: 100=below or over 001=Distance threshold alarm 10=enable threshold dismiss report Min: e8 03 => 03 e8 = 1000 mm = 1m Max: 10 27 => 27 10 = 10000 mm =10m

7. When the distance shifts is over 0.5m, the sensor will send threshold alarm.

ff06 95 0000 f401 00000000		
Channel	**Type**	**Value**
ff	06 (Set Threshold Alarm)	95=10 010 101: 101=Distance shifts over 010=Distance shifts threshold alarm 10=enable threshold dismiss report Min: 0000 Distance shift value: f4 01 => 01 f4 = 500 mm=0.5m

--------END---------