Milesight



EM41x-RDL (LoRaWAN® Version)

Radar Distance / Level Sensor

User Guide

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Chapter 1. Preface

Copyright Statement

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Milesight reserves the right to change this guide and the specifications without prior notice. The latest specifications and user documentation for all Milesight products are available on our official website http://www.milesight.com

Safety Instruction

These instructions are intended to ensure that user can use the product correctly to avoid danger or property loss. Milesight will not shoulder responsibility for any loss or damage resulting from not following the instructions of this operating guide.

CAUTION:

Injury or equipment damage may be caused if any of these cautions are neglected.

- 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 close to objects with naked flames.
- Do not place the device in where the temperature is below/above the operating range.
- The device must never be subjected to shocks or impacts.

Revision History

Release Date	Version	Revision Content
Sept. 12, 2024	V1.0	Initial version
Nov. 29, 2024	V1.1	Modify Antenna installation steps and Mounting Bracket Appearance.

Release Date	Version	Revision Content
Jan. 16, 2025	V1.2	Add Tank Mode.
Nov. 28, 2025	V1.3	1. Add ATEX Instructions; 2. Add NPT Thread Version. 3. Battery pre-installed in the device and removed from packing list.

Chapter 2. Product Introduction

This chapter describes basic product information.

Overview

EM41x-RDL is a non-contact Radar Distance/Level Sensor that adopts Millimeter Wave Radar technology. By measuring 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. It also complies with ATEX(Zone 0) standards and offers excellent resistance to corrosion and wear.

The LoRaWAN® version can be integrated with Milesight LoRaWAN® gateway and Milesight Development Platform, enabling remote and visual management of all sensor data.

EM41x-RDL can be used in sewers, rivers, impounding reservoir, storage tanks and high-salt mist environments (including seawater, high-concentration brine), and other locations that require to measure distance and level. It has the following features:

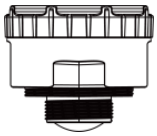
- 8° Radar beam angle can be focused on the target fluid, enabling accurate measurement of liquid level
- Wide measuring range of 0.3m to 12m with small blind zone
- Not affected by dust, condensate, temperature, acoustic noise, etc
- Non- invasive liquid level monitoring, can detect hazardous or non-hazardous 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
- Supports ATEX Zone 0, and is suitable for special requirements for the performance of the product.

  Ex marking as below: Ex ia IIC T4 Ga (EM411-RDL Only)
- Thread design for common tank installation without extra accessories needed
- Store 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

Packing List

This chapter describes the packing list. You can verify the contents against the following list to ensure all items are present. If any of them is missing or damaged, you can contact your sales representative.



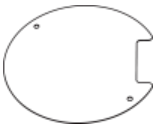
1 × EM41x-RDL Sensor



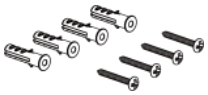
1 × Mounting Bracket



1 × Bubble Level



1 × Waterproof Tape



4 × Wall Mount Screw Kits



1 × O-ring Seal

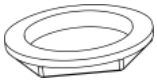


1 × Quick Guide

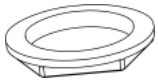


1 × Warranty Card

Accessories Exclusively for G/NPT Thread Version



1 × G1$^{1/2}$ Nut



1 × NPT1$^{1/2}$ Nut

Accessories Exclusively for External Antenna Version



1 × SMB Magnetic Antenna with Screw Kits



1 × Antenna Cable Gland

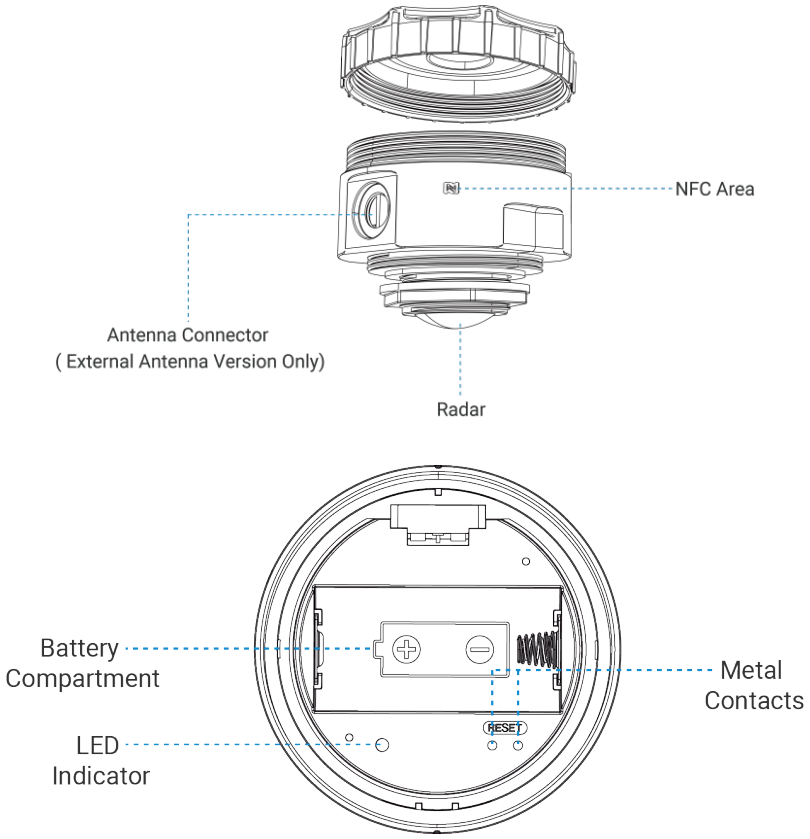
Hardware Components

Main Components

The following figure shows the main components of the device.

Instructions for instruments with license certificates:

- For equipment that has been certified (such as with explosion-proof certification), the corresponding technical parameter descriptions provided at the time of delivery are applicable.
- All licenses and certification certificates can be obtained by contacting our company.



For the description of each component, refer to the following table.

Name	Description
Antenna	External antenna version allows for the attachment of an external antenna to enhance wireless communication range and reliability. The non-external antenna version features an integrated antenna.
NFC area	Allows for wireless configuration through mobile phone NFC.
Radar	Critical component in the ultrasonic system for energy transmission and amplitude transformation.
Battery Compartment	Houses the battery for power supply.
LED Indicator	Indicates the device status.

Name	Description
Metal Contacts	Used for reboot and reset functions by short-circuiting.

LED Indicator Description

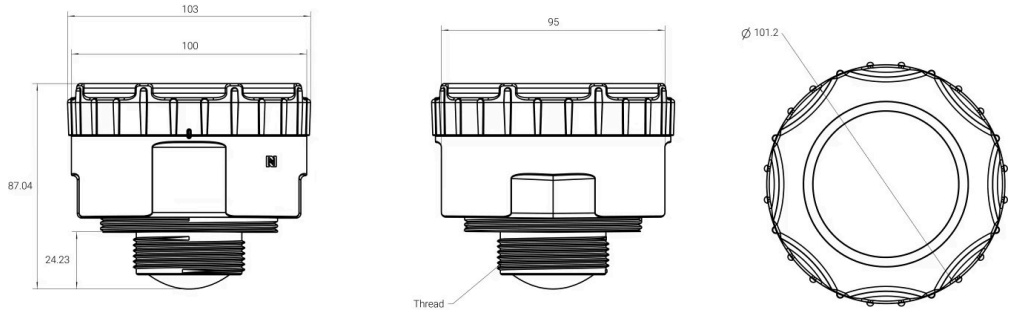
The device has two internal metal contacts and an LED indicator for emergency reboot and reset functions. For the functions of the metal contacts and the corresponding LED indicator status, refer to the following table.

Function	Action	LED Indicator
Power On	Install the New Battery	Lights up for 3s
Power Off	Remove Battery	On → 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.

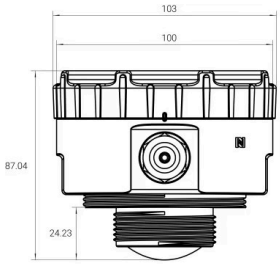
Device Dimensions

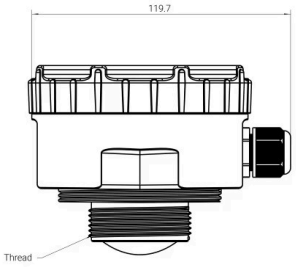
The following figure shows the device dimensions (unit: mm).

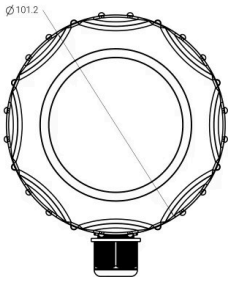
Internal Antenna Version



External antenna version

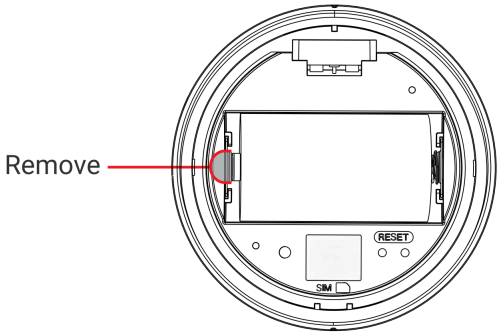

103
100
87.04
24.23


119.7
Thread


Ø101.2

Chapter 3. Hardware Installation

This section describes how to install the accessories and device. Before installing accessories, please remove the battery insulation sheet, and the device will automatically power on.

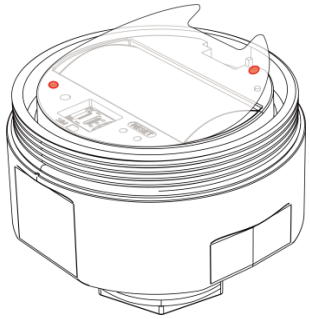


Fix the Waterproof Cover

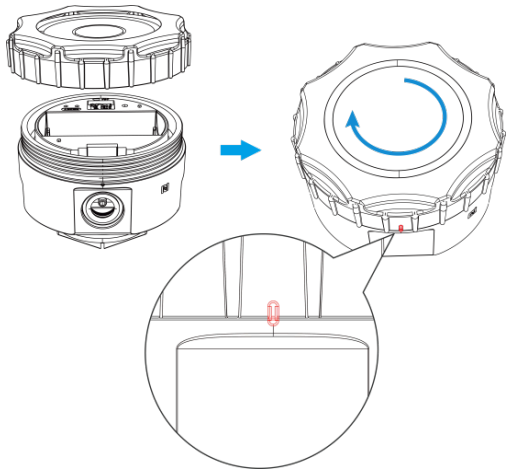
This chapter describes how to fix the waterproof cover.

Steps:

1. 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.



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

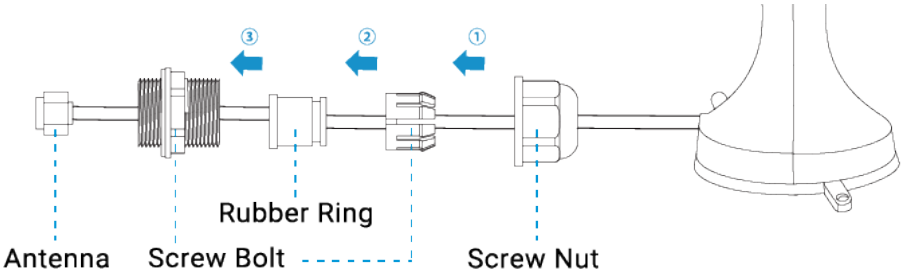


Install the External Antenna (External Antenna Version Only)

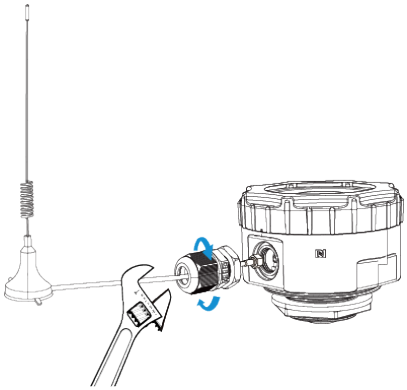
This chapter describes how to install the external antenna.

Steps:

1. Install the antenna cable gland as shown in the diagram.



2. Connect the antenna to antenna connector of the device and use an adjustable wrench to tighten the waterproof connector.



Install the Device

Installation Location Requirements:

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.

Maintenance After Device Installation: Anti-static measures need to be taken, such as wiping with a damp cloth to remove any possible static electricity.

Bracket Installation

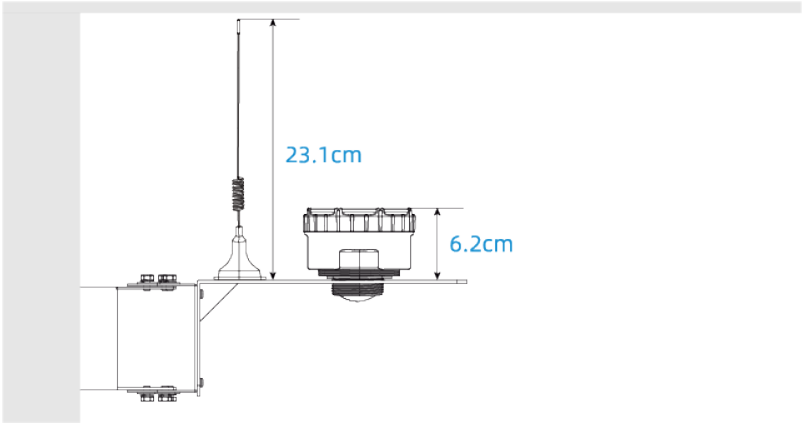
Preparation:

- Electric drill
- Wrench
- Mounting bracket
- Bubble level
- M4 mounting screws and wall plugs
- $G1^{1/2}$ or $NPT1^{1/2}$ nut
- External antenna accessories (Optional)

Steps:

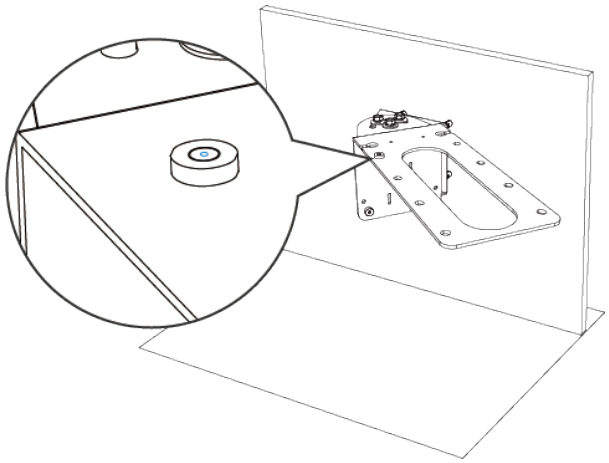
1. Locate the device installation position.

    - 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.



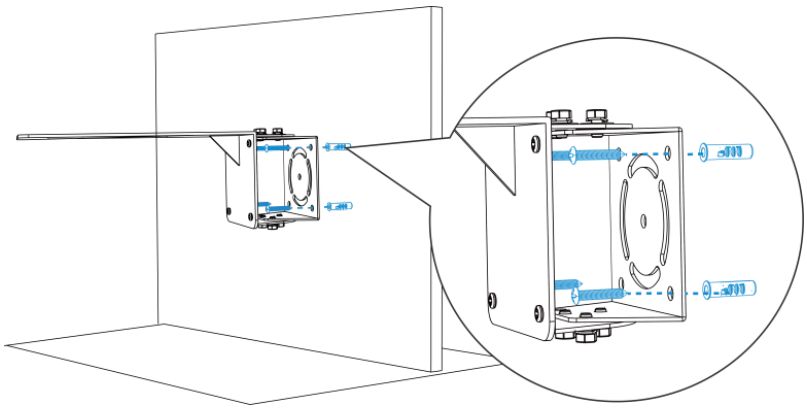
2. Adjust Level.

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



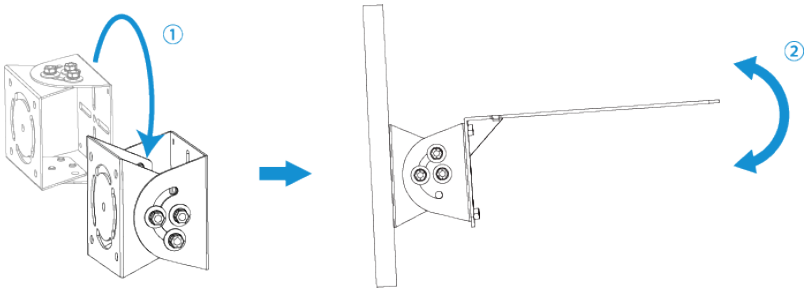
3. Fix the mounting bracket.

    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.



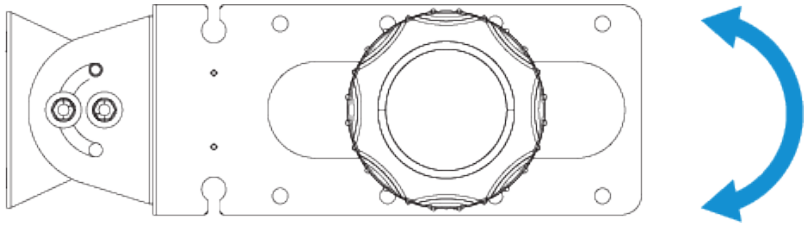
Tip:

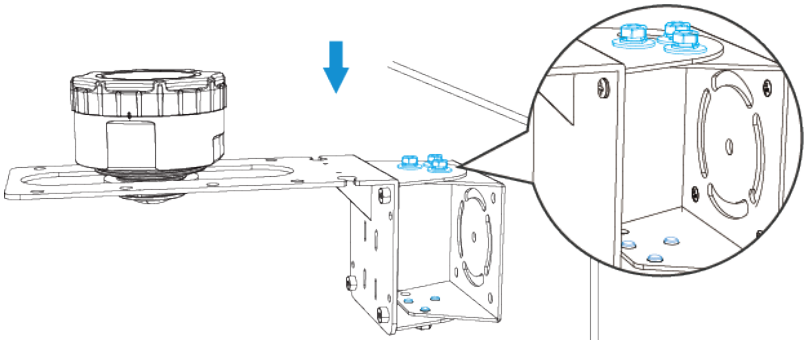
If the wall is inclined, you can first rotate the bracket assembly 90°clockwise or counterclockwise, and then adjust the horizontal plane up or down as needed based on the actual situation.



4. Adjust Mounting Bracket Angle.

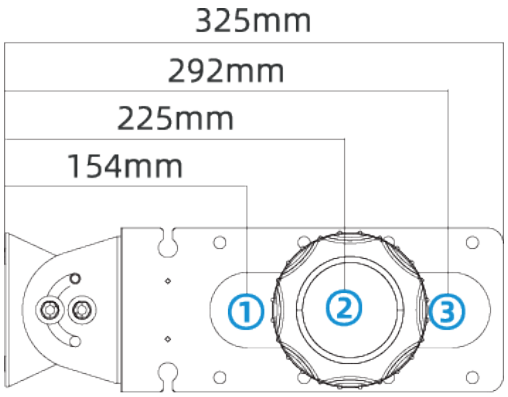
   Loosen the two nuts on both the upper and lower tracks of the bracket, adjust the bracket to the appropriate angle, then use a wrench to tighten all six nuts with flat washers.





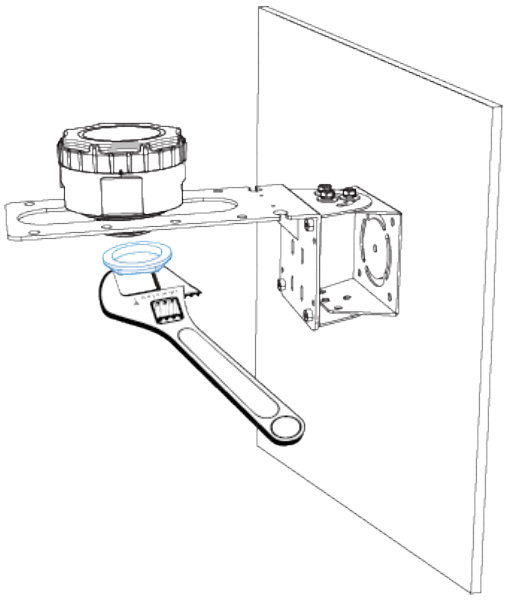
5. Select the device installation location on the bracket according to the installation height.

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



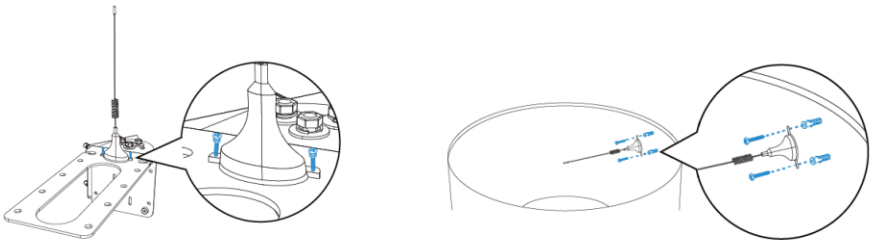
6. Fix Device.

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



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.



8. After installation, refer to the Configure Calibration Parameters to check the tilt status and perform the following installation calibration.
   - Relative Initial Surface
   - Blind Zone Calibration

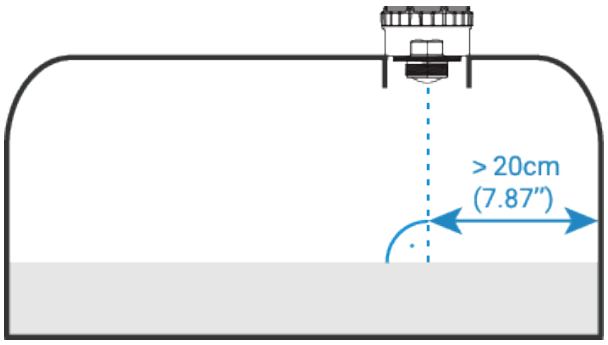
Thread Installation

Preparation:

- Metric ruler
- O-ring seal
- G$1^{1/2}$ or NPT$1^{1/2}$ nut

Steps:

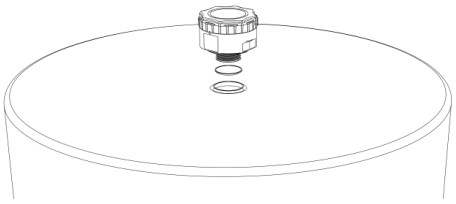
1. Locate the Device Installation Position.
    - Place it away from the tank wall more than 20cm;
    - Perpendicular to the measured liquid and with no obstacles between the device and the measured liquid.



2. Fix the device.

    The device has G1 ½" or NPT1 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 the mounting hole on the tank does not match the sensor, an adapter can be installed on the top surface of the tank to mount the sensor. Adapters for different sizes need to be purchased separately. The device should be threaded and screwed firmly onto the adapter to ensure a good seal. The O-ring shown below seals the connection between the adapter and the bottom of the sensor's main enclosure.



3. After installation, refer to the Configure Calibration Parameters to check the tilt status and perform the following installation calibration.

    - Relative Initial Surface
    - Blind Zone Calibration

Battery Replacement

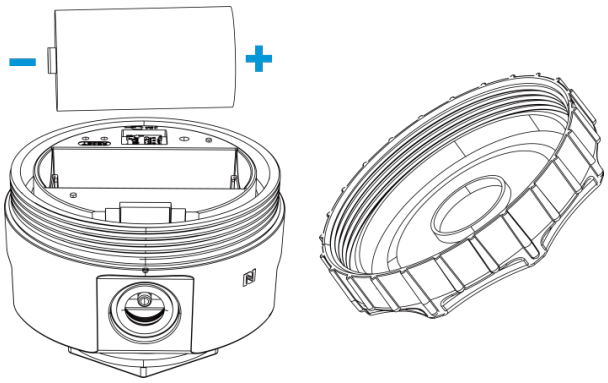
This chapter describes how to replace the battery when the device runs out of power.

Battery Requirements:

- Power the device by ER34615 Li-$SoCl_2$ battery. Alkaline battery is not supported.
- Remove battery from the device if it is not used for an extended period.
- Always replace with new battery. Using old batteries may reduce battery life or lead to inaccurate power level calculations.
- Do not open and replace battery cell when an explosive atmosphere is present.
- If the equipment requires [explosion-proof certification for use in explosive areas, and ATEX certification for the usage area], only batteries manufactured by specialized battery manufacturers (EM34615 -3.6V battery) are permitted to be used.

Steps:

1. Unscrew the top cover counterclockwise.
2. Install the battery, the device will turn on automatically and the LED indicator will turn on for 3s.



Chapter 4. ToolBox App Configuration

The Milesight ToolBox app can be used to configure the device. This chapter describes ToolBox related configuration.

Access the Sensor

After the device is powered on, it can be accessed using NFC or Bluetooth. It is recommended to access the device using Bluetooth for the first time installation and configure device and network parameters.

Access the Sensor Using Bluetooth

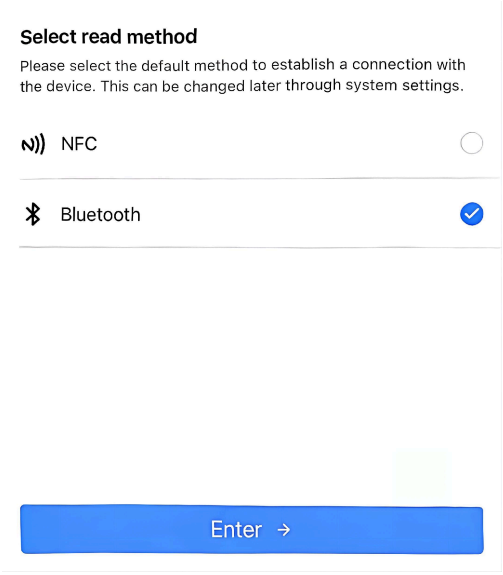
This section describes how to access the device using Bluetooth. The device can connect to only one phone via Bluetooth.

Note:
The Bluetooth connection will be terminated if there's no data interaction within 3 minutes. Please reconnect as needed.

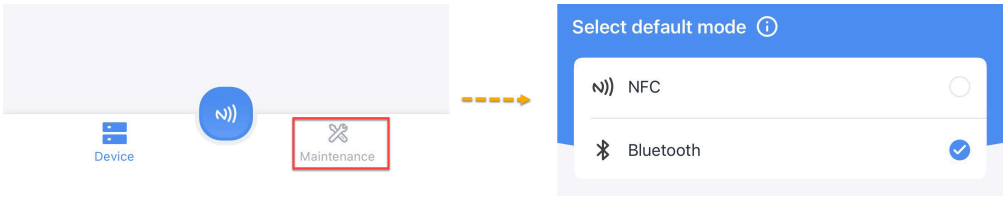
Steps:

1. Download Milesight ToolBox app from Google Play or Apple Store.
2. Enable the Bluetooth and location functions on the smart phone.
3. Launch ToolBox.

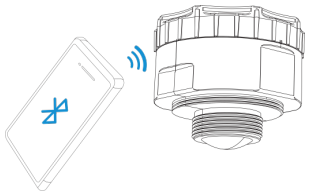
    a. Upon first launch, the following page is displayed. Select **Bluetooth** and click **Enter**.



b. Upon subsequent launches, Click **Maintenance** on the home page, and then select **Bluetooth**.



4. Click to scan the devices around and select the target device to connect. The default Bluetooth name is model -XXXXXX (5th to 11 st of device SN) and the default device password is 123456.



5. Enter a new password and click the **Confirm**. Password length: between 8 and 12 characters.

> **Tip:**
> It is recommended to change a new password for security.

6. If the device is recognized successfully, the homepage is displayed. For a description of the homepage, refer to the following table.

Item	Description
Basic Information	Shows basic device information and sync the system time.
Setting	Sets the device and network parameters.
	Imports, adds, exports or deletes a template.
	Sets the language, shows NFC positions and checks the version.

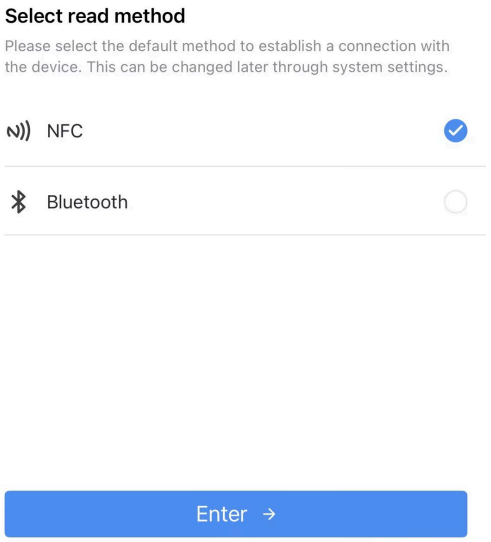
Access the Device Using NFC

This section describes how to access the device using NFC.

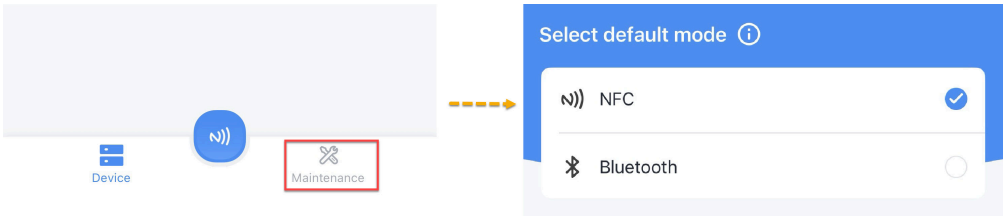
Steps:

1. Download Milesight ToolBox app from Google Play or Apple Store.
2. Enable the NFC function on the smart phone.
3. Launch ToolBox.

   a. Upon first launch, the following page is displayed. Select **NFC** and click **Enter**.

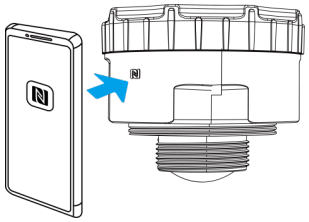


   b. Upon subsequent launches, Click **Maintenance** on the home page, and then select **NFC**.



4. (Optional) To locate the NFC detection areas of the phone and the device, click **Can't find the NFC location**.
5. Put the NFC detection area of the phone close to the NFC antenna of the device.

> **Tip:**
> It is recommended to take off the phone case.



6. Click . If the device is recognized successfully, the homepage is displayed.

> **Troubleshooting:**
> If read fails, move the phone away and reposition it close to the sensor to try again.

For a description of the homepage, refer to the following table.

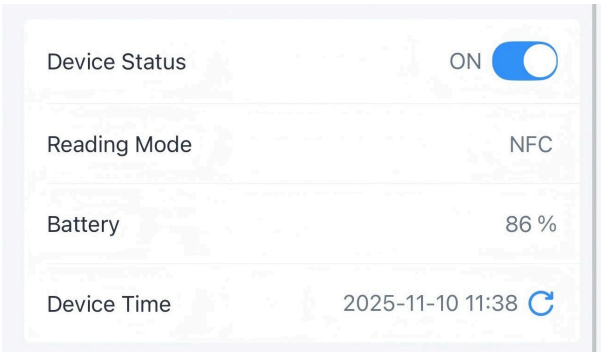
Item	Description
Basic Information	Shows basic device information and sync the system time.
Setting	Sets the device and network parameters.
	Imports, adds, exports or deletes a template.
	Sets the language, shows NFC positions and checks the version.

Synchronize Device Time

This section describes how to sync the device time.

Synchronize the Time Manually Through ToolBox

1. On the homepage of ToolBox, click **Basic Information**.
2. Click to synchronize the time.



3. (Optional) If the read method is **NFC**, put the NFC detection area of the phone close to the NFC antenna of device. If the read method is **Bluetooth**, please skip to the next step.
4. If the time is synchronized successfully, the following page is displayed.



Sync successfully!

Synchronize the Time Automatically Through a LoRaWAN® Network Server

Prerequisite: The LoRaWAN® network server supports the device time synchronization feature.

1. Set the LoRaWAN® version of the device to **V1.0.3**. For details, refer to Configure Basic Network Parameters.
2. Connect the device to the network server. Once the device successfully joins the network, it sends a MAC command to query the time from the network server.

Note:

- This only supports to get the time but not time zone. The time zone can be configured by ToolBox App or downlink command.
- The device will send the DeviceTimeReq command every 5 days since the last sync.

Configure Network Parameters

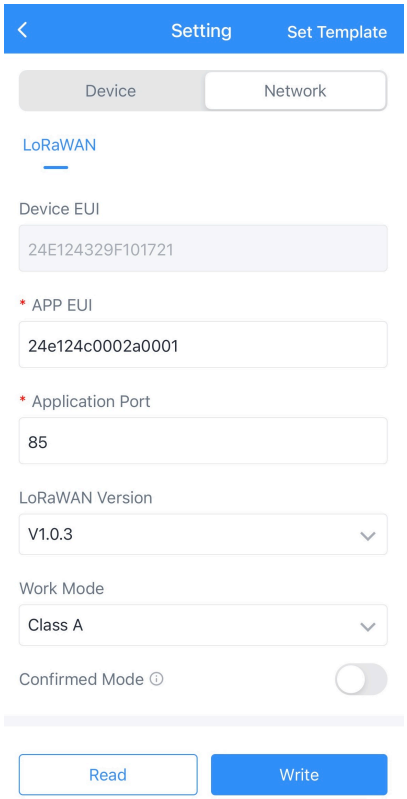
This section describes how to configure the LoRaWAN® parameters. Among them, the joining type and the frequency must be configured. If the two parameters are not configured, the device cannot join the network.

Configure the Joining Type and the Frequency

This section describes how to configure the joining type and the frequency. They must be properly configured, otherwise the device cannot join the network.

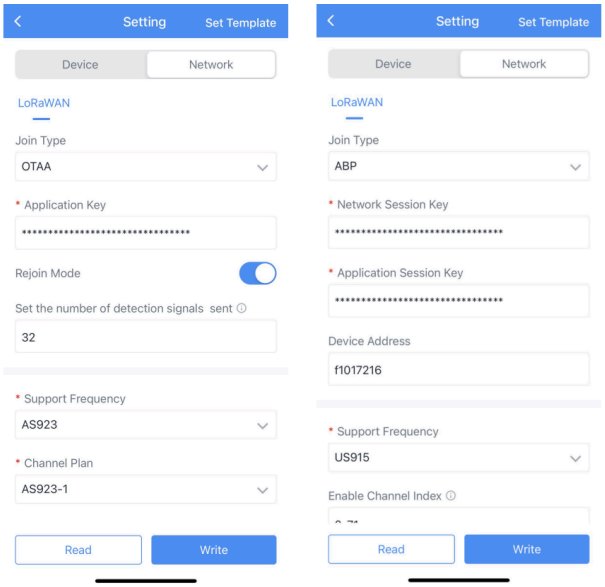
Steps:

1. On the homepage of ToolBox, click **Setting** to enter the **Setting** page.
2. Click **Network**. The **Network** page is displayed, see the following figure.



3. From the **Join Type** selection box, select **OTAA** or **ABP** as needed. The following page is displayed correspondingly.

> **Note:**
> OTAA is required if you connect the device to the Milesight IoT Cloud Platform or Milesight Development Platform.



4. Configure **Join Type** related parameters as needed. Use default values unless otherwise specified.

   - If **OTAA** is selected, configure **Application Key** and **Rejoin Mode** as needed. For details, refer to the following table.

Parameter	Description
Application Key	Appkey for OTAA mode. Default: **Device EUI + Device EUI** (since Q4 of 2025). Example: 24e124123456789024e1241234567890. Default value of earlier devices: 5572404C696E6B4C6F52613230313823. **Tip:** Contact sales before purchase if you need random App keys.
Rejoin Mode	Rejoin mode for OTAA mode. Reporting interval≤35 minutes: the device will send a specific number of LinkCheckReq MAC packets every reporting interval or every double reporting interval to validate connectivity.

Parameter	Description
	Reporting interval > 35 minutes: the device will send a specific number of LinkCheckReq MAC packets every reporting interval to validate connectivity. If there is no response, the device will re-join the network. When **Rejoin Mode** is enabled, enter a number in the **Set the number of detection signals sent** text box. The actual sending number is the configured number +1.

- If **ABP** is selected, configure **Network Session Key**, **Application Session Key** and **Device Address** as needed. For details, refer to the following table.

Parameter	Description
Network Session Key	Nwkskey for ABP mode. Default: **5572404C696E6B4C6F52613230313823**.
Application Session Key	Appskey for ABP mode. Default: **5572404C696E6B4C6F52613230313823**.
Device Address	DevAddr for ABP mode. Default: 5^{th} to 12^{th} digits of SN.

5. Select a frequency from the **Support Frequency** selection box as needed. The frequency must be the same as that of the gateway configured on the gateway web GUI.
6. If **CN470**, **US915** or **AU915** is selected, enter the index of the channel that you want to enable in the **Enable Channel Index** input box. The channel indexes should be separated by commas.

   Examples:

   - 1, 40: Enables channel 1 and channel 40

   - 1-40: Enables channel 1 to channel 40

   - 1-40, 60: Enables channel 1 to channel 40 and channel 60

   - Null: Indicates that all channels are disabled
7. Click **Write** in the lower right corner.
8. (Optional) If the read method is **NFC**, put the NFC detection area of the phone close to the NFC antenna of device. If the read method is **Bluetooth**, please skip to the next step.

9. If the configuration succeeds, the following page is displayed.



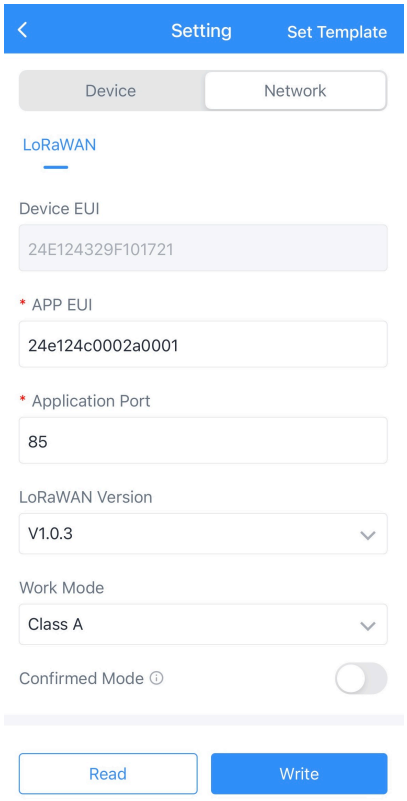
Write successfully!

Configure Other LoRaWAN® Parameters

This section describes how to configure the LoRaWAN® parameters of the device.

Steps:

1. On the homepage of ToolBox, click **Setting** to enter the **Setting** page.
2. Click **Network**. The **Network** page is displayed, see the following figure.



3. Configure the parameter as needed. Use default values unless otherwise specified. For a description of the parameters, refer to the following table.

Parameter	Description
Device EUI	Unique ID of the device labelled on the device housing. **Tip:** For bulk deployments, contact sales to request the device EUI list.
App EUI	The default App EUI (join EUI) is 24E124C0002A0001.
Application Port	Port used for sending and receiving data. Default: **85**.
LoRaWAN® Version	Options: **V1.0.2**, **V1.0.3**.
Work Mode	Fixed value: **Class A**.
Confirmed Mode	If it is enabled, the device retransmits data when the device does not receive ACK packet from the network server.
Join Type	Refer to Configure the Joining Type and the Frequency.
Supported Frequency	Refer to Configure the Joining Type and the Frequency.
ADR Mode	Enables the network server to adjust the spreading factor, the bandwidth and the transmission power to optimize data rates, airtime and energy consumption in the network.
Spreading Factor	If ADR mode is disabled, the device sends uplink data using this spreading factor. A higher spreading factor increases transmission range but reduces data rate and increases power consumption. This parameter varies with **Supported Frequency**.
Tx Power	Defined by the LoRa Alliance. Specifies the strength of the radio signal transmitted by the device.
RX2 Data Rate	Data rate for receiving downlink commands on the RX2 window.
RX2 Frequency	Frequency for receiving downlink commands on the RX2 window. Unit: Hz.

4. Click **Write** in the lower right corner.

5. (Optional) If the read method is **NFC**, put the NFC detection area of the phone close to the NFC antenna of device. If the read method is **Bluetooth**, please skip to the next step.
6. If the configuration succeeds, the following page is displayed.



Write successfully!

Configure Device Parameters

This section describes how to configure device parameters.

Change the Device Password

It is recommended to change the device password upon initial configuration for security purposes. This section describes how to change the password.

Steps:

1. On the homepage, click **Setting** to enter the **Setting** page.
2. In the **General** page, enable **Change Password**.
3. In the **New Password** text box, enter the new password as prompted.
4. In the **Confirm Password** text box, enter the password again.
5. Click **Write** in the lower right corner.
6. (Optional) If the read method is **NFC**, put the NFC detection area of the phone close to the NFC antenna of device. If the read method is **Bluetooth**, please skip to the next step.
7. If the password was changed successfully, the following page is displayed.



Write successfully!

Configure Basic Device Parameters

This section describes how to configure the basic parameters of the device, which includes:

- Reporting interval
- Scenario Mode
- Measurement Range
- Tank Depth
- Tilt & Distance Switch
- Data Storage
- Data Retransmission
- Device password

Steps:

1. On the homepage of ToolBox, click **Setting** to enter the **Setting** page.
2. In the **General** page, configure the following device parameters as needed.

Parameter	Description
Reporting Interval	Reporting interval of transmitting data to server. Default: 1440 minutes, range: 1~1440 minutes.
Scenario Mode	Options: **General:** Suitable for calm liquid surfaces **Rainwater Well:** Suitable for rainwater well

Parameter	Description
	Wastewater Well: Suitable for wastewater well **Tank:** Suitable for liquid storage tank scenarios **Note:** In Tank mode, the device measures the height from the liquid surface to the bottom. In other modes, it measures the distance from the device to the liquid surface.
Measurement Range	The maximum distance between target surfaces and device.
Tank Depth	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	Disables or enables data storage. For details, refer to Configure the Data Storage&Retransmission.
Data Retransmission	Disables or enables data retransmission. For details, refer to Configure the Data Storage&Retransmission.
Change Password	Refer to Change the Device Password.

3. Click **Write** in the lower right corner.
4. (Optional) If the read method is **NFC**, put the NFC detection area of the phone close to the NFC antenna of device. If the read method is **Bluetooth**, please skip to the next step.
5. If the configuration succeeds, the following page is displayed.



Write successfully!

Configure the Data Storage & Retransmission

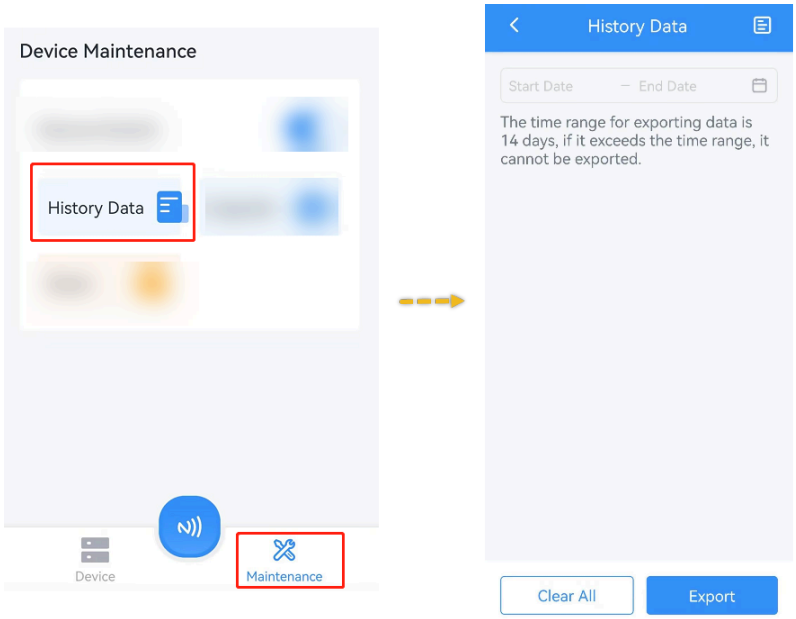
The device supports data storage and data retransmission to ensure data integrity. This section describes how to configure data storage and retransmission.

Export the Local Data

The device supports storing up to 2,000 historical records locally. Data will continue to be saved even when the network is de-activated. However, as the ToolBox App limits data exports to the most recent 14-day period, regular exports are necessary to avoid data loss.

Steps:

1. Sync the time to ensure the data is stored in correct time.
2. On the homepage of ToolBox, click **Setting** to enter the **Setting** page.
3. Enable **Data Storage**.
4. Return to the homepage and click **Maintenance** in the lower right corner.
5. Click **Export**, select the data time range and click **Save** to export data.



Enable Data Retransmission

Data retransmission allows the network server receives all data, even after temporary network outages. The reported format of retransmission data will include timestamps and is different from periodic report data.

Steps:

1. On the homepage, click **Setting** to enter the **Setting** page.
2. Enable **Data Storage** and **Data Retransmission**.
3. Click **Network** to enter the **Network** page.
4. Set Join Type to **OTAA**, enable **Rejoin Mode** and set the number of packets sent.
5. Click **Write** in the lower right corner.
6. (Optional) If the read method is **NFC**, put the NFC detection area of the phone close to the NFC antenna of device. If the read method is **Bluetooth**, please skip to the next step.
7. If the configuration succeeds, the following page is displayed.



Write successfully!

Note:

1. Data retransmission increases the uplink traffic and shortens the battery life.
2. If the device reboots or loses power during data retransmission, it restarts and resends the entire retransmission dataset after reconnecting to the network.
3. If a new network disconnection occurs during an ongoing retransmission, only the data logged during this latest outage will be sent upon reconnection.
4. The default report data retransmission interval is 600s, this can be changed via downlink command.

Query Historical Data

The device supports querying historical data for a specific time range via downlink command. The retransmission data format includes timestamps and differs from the periodic report format. For details, refer to Historical Data Query Commands.

Configure Calibration Parameters

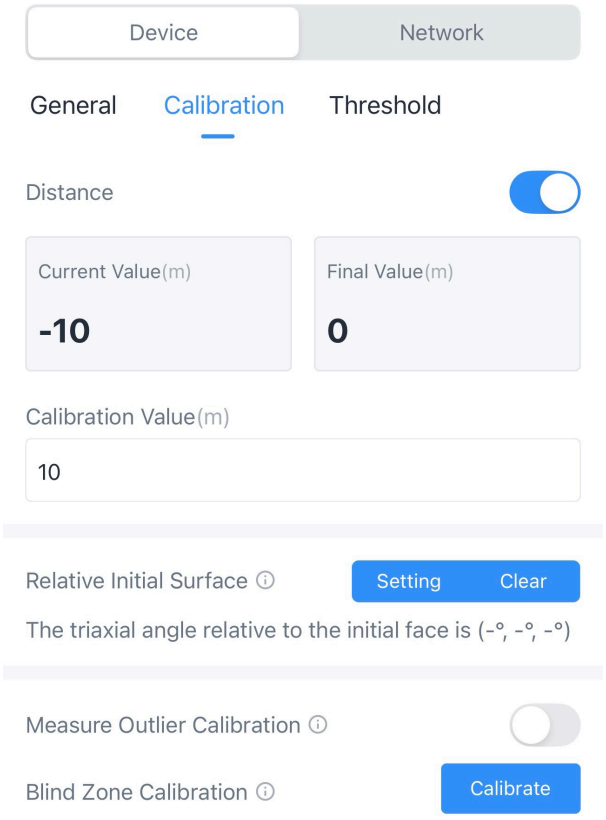
This section describes how to configure calibration types. The device supports several calibration types. They can be enabled simultaneously. Please calibrate the device during on-site installation, otherwise, the calibration may not take effect.

Recommended Scenarios for Different Calibration Types:

Calibration Type	Description	When to Use
Numerical calibration	Apply a fixed offset to all distance measurements	Consistent fixed error in measurements
Relative initial surface	Set current surface as reference plane	During device installation to define "Normal" position
Measure outlier calibration	Discard and recalibrate readings beyond set range	When measurements show unrealistic spikes
Blind zone calibration	Detect liquid level in blind zone and trigger alarm	To monitor level entry into non-measurable zone
One-click Diagnosis	Manually select accurate distance from echo curve	Readings mismatch reality (Bluetooth read method only)

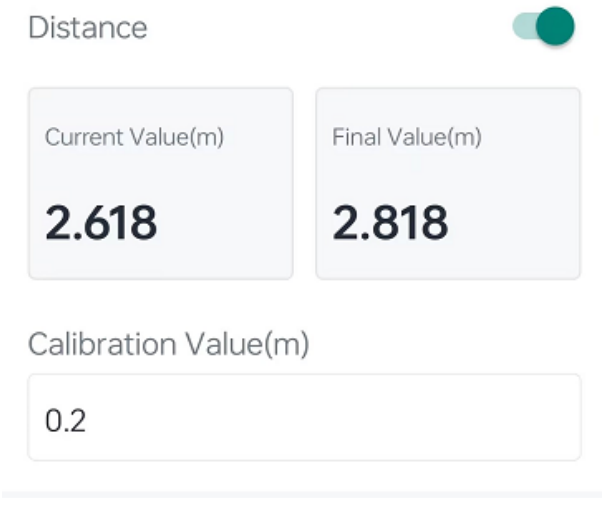
Steps:

1. On the homepage of ToolBox, click **Setting** to enter the **Setting** page.
2. Click **Calibration**. The following page is displayed.



3. Configure calibration types.

   - **Numerical Calibration**
     a. Enable **Distance**.
     b. Enter a value in the **Calibration Value** text box. Value range: -10.000 - 10.000.



   - **Relative Initial Surface**

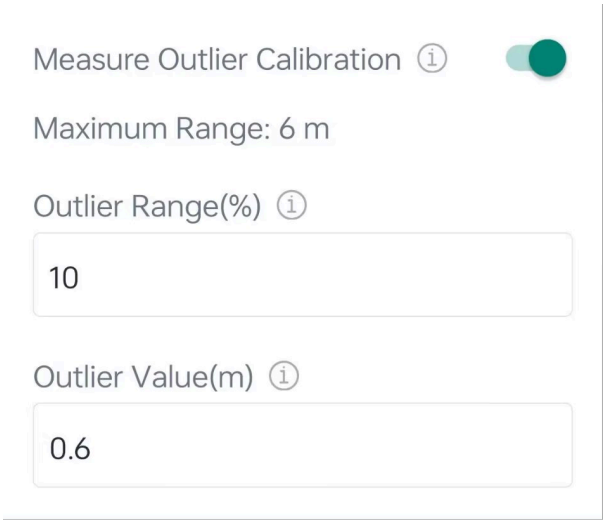
a. Click **Setting** to read the triaxial angle relative to the current surface, to adjust the current device position as “Normal”.



◦ **Measure Outlier Calibration**

a. Enable **Measure Outlier Calibration**.

b. Enter a value in the **Outlier Range** or the **Outlier Value** text box. For details, refer to the following table.



Parameter	Description
Outlier Range / %	Value range: 0.1 - 100, Unit: %.
Outlier Value / M	Value range: 0.01 - 10, Unit: m.

◦ **Blind Zone Calibration**

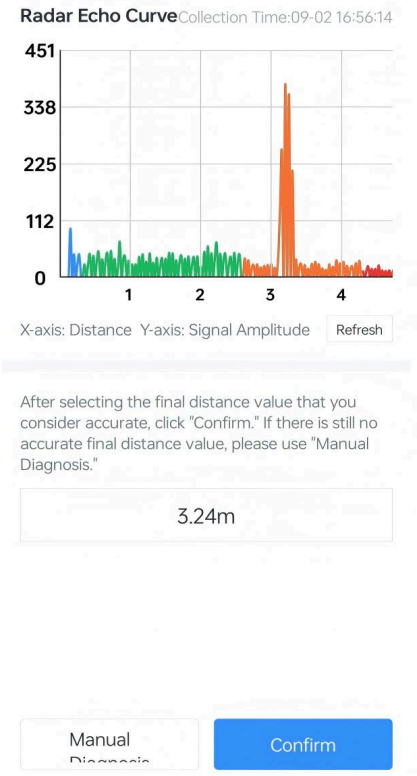
a. Click **Calibrate**. Please ensure there are no objects in the blind zone during calibration.

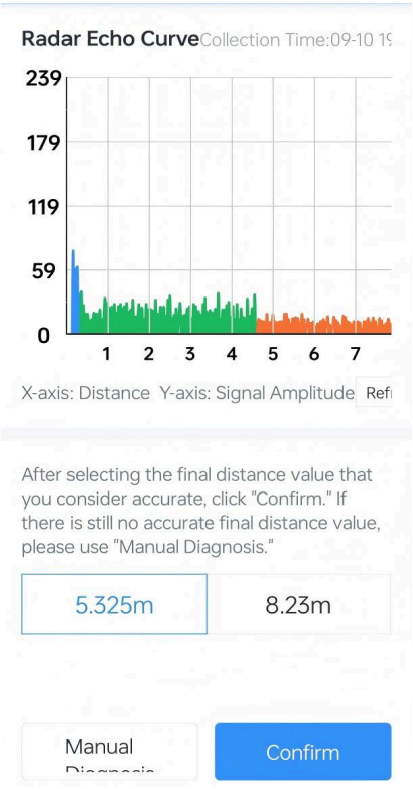


◦ **One-click Diagnosis**

a. Click Diagnosis to show the current Radar Echo Curve.

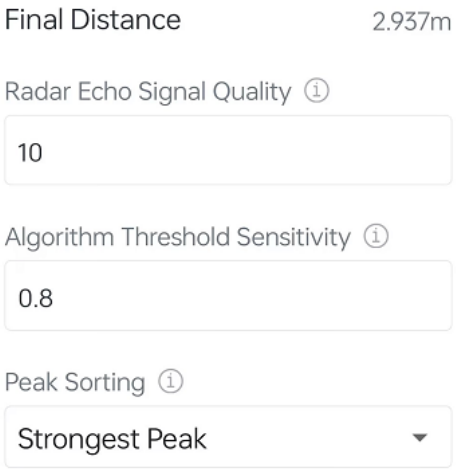
- If the collected distance has only one value, it means the nearest signal amplitude is equal to the strongest signal.
- If two values appear, it means one represents the nearest signal amplitude and another represents the strongest signal.





b. 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.

c. If the distance value is still not accurate, click **Manual Diagnosis**, the following page is displayed. For details, refer to the following table.



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.

> **Troubleshooting:**
> If “Disabled” appears, reset **Relative Initial Surface** or disable **Tilt & Distance Switch**.

d. 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. Click **Write** in the lower right corner.
5. (Optional) If the read method is **NFC**, put the NFC detection area of the phone close to the NFC antenna of device. If the read method is **Bluetooth**, please skip to the next step.
6. If the configuration succeeds, the following page is displayed.



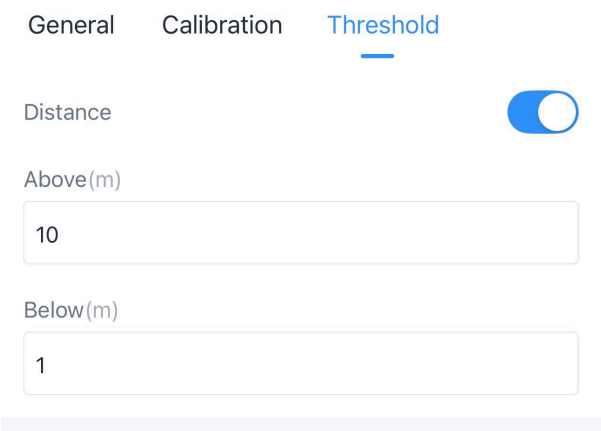
Write successfully!

Configure the Distance Threshold

This section describes how to configure the distance threshold. The device supports two types of distance threshold alarms.

Distance Threshold Alarm

When current value is over or below the value, the device will report a threshold alarm packet once instantly. Only after the previous alarm is cleared and the threshold is re-triggered, the device sends a new alarm.



Steps:

1. On the homepage of ToolBox, click **Setting** to enter the **Setting** page.
2. Click **Threshold** and enable **Distance**
3. Configure the following threshold parameters.

Parameters	Description
Above/Below	Distance / Liquid level threshold.
Collecting Interval	The interval to detect distance/liquid level, this should be smaller than or equal to the reporting interval.
Alarm Reporting Times	Alarm packet report times after threshold alarm triggers. Default is 1.
Alarm Dismiss Report	When enabled, the device reports the current value to signal that the alarm has cleared once the reading returns to within the threshold range.

4. Click **Write** in the lower right corner.
5. (Optional) If the read method is **NFC**, put the NFC detection area of the phone close to the NFC antenna of device. If the read method is **Bluetooth**, please skip to the next step.

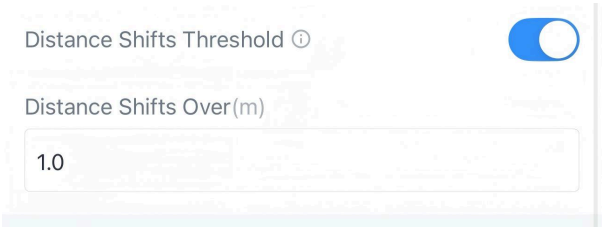
6. If the configuration succeeds, the following page is displayed.



Write successfully!

Distance Shift Threshold

The device will report an alarm packet when the absolute value of the difference between the current value and the last collected value exceeds the threshold value.



Steps:

1. On the homepage of ToolBox, click **Setting** to enter the **Setting** page.
2. Click **Threshold** and enable **Distance Shift Threshold**.
3. Configure the following threshold parameters.

Parameters	Description
Distance Shifts Over	When enabled, the device triggers an alarm if the absolute change in value exceeds the set threshold.
Collecting Interval	The interval to detect distance/liquid level, this should be smaller than or equal to the reporting interval.

4. Click **Write** in the lower right corner.

5. (Optional) If the read method is **NFC**, put the NFC detection area of the phone close to the NFC antenna of device. If the read method is **Bluetooth**, please skip to the next step.
6. If the configuration succeeds, the following page is displayed.



Write successfully!

Maintain the Device

This section describes how to maintain the device.

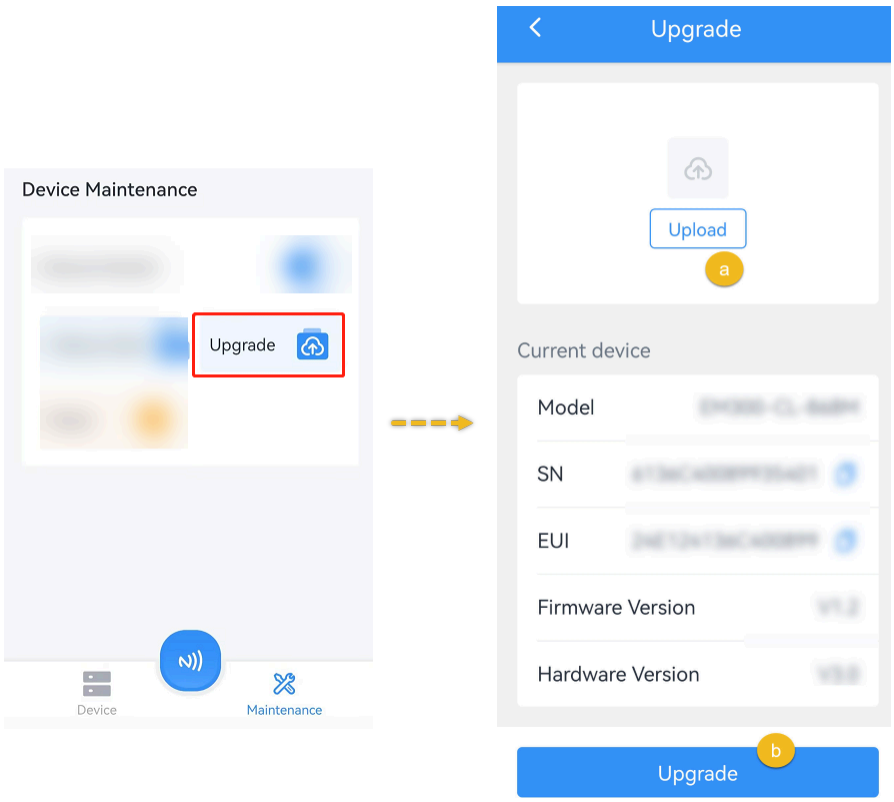
Upgrade

Important:
This device only supports upgrading via Bluetooth mode.

This chapter describes how to upgrade the device. Any operation on ToolBox is not allowed during upgrading, otherwise the upgrading will be interrupted, or even the device will break down.

Steps:

1. Download firmware from Milesight official website and save it to the smart phone.
2. Launch ToolBox and click **Maintenance** in the lower right corner of the homepage.
3. Click **Upgrade** to import firmware and upgrade the device.
4. Click **Upgrade** to upgrade the device.



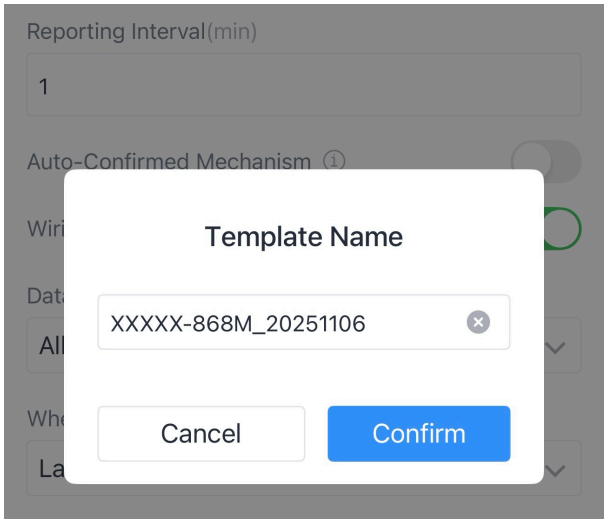
Configure a Template for Configuration Backup

This device supports configuration backup, which enables quick and easy batch configuration. This function only applies for devices of the same model and LoRaWAN® frequency band.

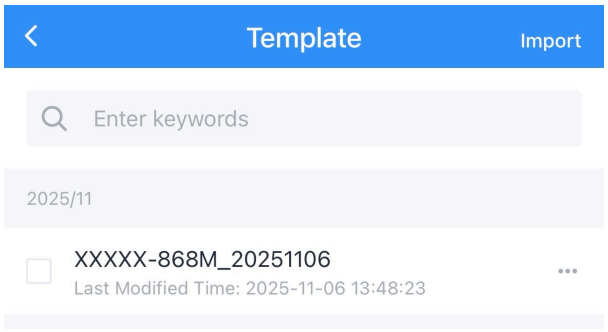
Set a Template

Steps:

1. On the homepage of ToolBox, click . The **Template** page is displayed.
2. Click **Add Template** in the bottom.
3. Click **Save** in the upper right corner. The **Template Name** page is displayed.



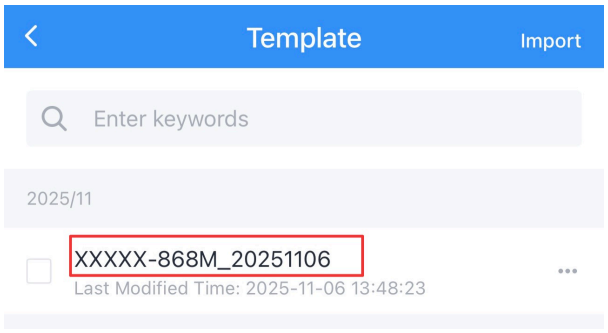
4. Click **Confirm** to save the current configuration as a template. The following page is displayed.



Write the template configuration to the target device

Steps:

1. Click the saved template. Caution: Do not select the template.



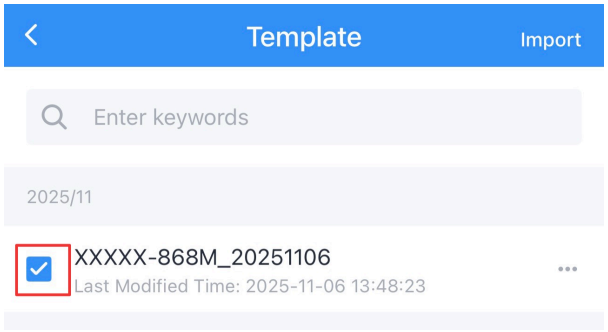
2. In the displayed page, click **Write** in the bottom and put the NFC detection area of the phone close to the NFC antenna of the target device. If the configuration is written to the target device, the following page is displayed.



Write successfully!

Export and Delete a Template

1. Select the checkbox of the target template as shown in the following figure.



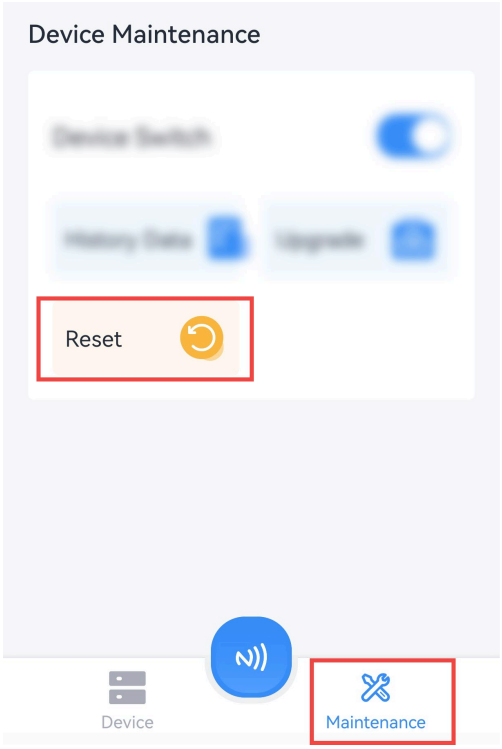
2. Click **Export** to export this template as a JSON format file and save it to the smart phone.
3. Click **Delete** and Confirm to delete this template from ToolBox.

Reset the Device

This section describes how to reset the device in ToolBox. Additionally, the device supports hardware reset. See LED Indicator Description for details.

Steps:

1. On the homepage of ToolBox, click **Maintenance** in the lower right corner. The **Maintenance** page is displayed, see the following figure.



2. Click **Reset**.
3. In the displayed dialog box, click **Confirm**.
4. Put the NFC detection area of the phone close to the NFC antenna of the device. If the device is successfully reset, the following page is displayed.



Write successfully!

Chapter 5. Uplink Packets and Downlink Commands

The device uses the standard Milesight IoT payload format based on IPSO. This chapter describes the uplink data packets and downlink commands supported by the device. They are all structured in the following format, the Data field should follow **little endian**:

Channel 1	Type 1	Data 1	Channel 2	Type 2	Data 2	Channel 3	...
1 Byte	1 Byte	N Bytes	1 Byte	1 Byte	N Bytes	1 Byte	...

All explanations and examples in this document are based on the HEX format. For all the Milesight IoT decoder examples, refer to the files available on https://github.com/Milesight-IoT/SensorDecoders.

Uplink Packets

This section describes the uplink packets reported by the device.

Basic Information Packet

When joining the network, the device reports a packet containing the basic device information to the gateway.

Packet description:

Item	Channel	Type	Byte	Description
Power On	ff	0b	1	Device is on
Protocol Version	ff	01	1	Example: 01=V1
Hardware Version	ff	09	2	Example: 03 10 = V3.1
Software Version	ff	0a	2	Example: 03 01 = V3.1
Device Type	ff	0f	1	00: Class A, 01: Class B, 02: Class C, 03: Class C to B
Serial Number	ff	16	8	16 digits
TSL Version	ff	ff	2	Example: 01 00=>V1.0
Reset Report	ff	fe	1	ff, report after reset to factory default

Example:

ff0bff ff0101 fffeff ff166862e21141780013 ff090100 ff0a0101 ff0f00 ffff0100		
Channel	**Type**	**Value**
ff	0b	ff
ff	01	Protocol Version: 01=V1
ff	16	SN: 6862e21141780013
ff	09	Hardware Version: 0100=V1.0
ff	0a	Software Version: 0101=V1.1
ff	0f	00: Class A
ff	ff	TSL Version: 0100=V1.0

Periodically Reported Data Packet

The device reports a sensor data packet at a configured interval.

Packet description:

Item	Channel	Type	Byte	Description
Battery Level	01	75	1	UINT8, Unit: %
Distance/Liquid Level	04	82	2	INT16, Unit: mm
Device Position	05	00	1	00: Normal, 01: Tilt (horizontal offset angle ≥ 15°)
Radar Signal Strength	06	c7	2	INT16/100, Unit: dBm

Example:

017562 0482aa0c 06c70303 050000		
Channel	**Type**	**Value**
01	75	Battery: 62=>98%
04	82	Distance/Liquid Level: aa0c => 0caa =>3242 mm

017562 0482aa0c 06c70303 050000		
Channel	**Type**	**Value**
06	c7	Radar Signal Strength:03 03=> 771/100=7.71dBm
05	00	Device Position: 00 = Normal

Alarm Packet

The device reports the following two types of alarm packets.

Packet description:

Item	Channel	Type	Byte	Description
Distance/Liquid Level Alarm	84	82	3	**Byte 1-2**: Distance/Liquid Level, INT16, Unit: mm **Byte 3**: 01-Alarm; 00-Alarm dismiss
Distance/Liquid Level Shifts Threshold	94	82	5	**Byte 1-2**: Distance/Liquid Level, INT16, Unit: mm **Byte 3-4**: Distance/Liquid Level Shifts, INT16, Unit: mm **Byte 5**: 02
Blind Zone	b4	82	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

Example 1:

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

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

Example 2:

Blind Zone Alarm: report when the target value reaches the blind zone.

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

Downlink Commands

Downlink commands can be used for remote control of device through a network server. The downlink port (application port) is 85 by default and can be configured through ToolBox.

Commands for General Setting

The device supports multiple commands for general setting.

Command description:

Item	Channel	Type	Byte	Description
Reboot	ff	10	1	ff
UTC Time Zone	ff	bd	2	INT16/60
Clear History Data	ff	27	1	01
Query Device Status	ff	28	1	01
Data Storage	ff	68	1	00: Disable, 01: Enable
Data Re-transmission	ff	69	1	00: Disable, 01: Enable
Data Retrans-mission Interval	ff	6a	3	Byte 1: 00 Byte 2-3: UINT16, Unit: s, Range: 30~1200, De-fault: 600
Reporting Interval	ff	8e	3	**Byte 1**: 00 **Byte 2-3**: Reporting Interval, UINT16, Unit: min, Range: 1~1440
Scenario Mode	f9	12	1	00 = General Mode; 01 = Rainwater Well Mode; 02 = Wastewater Well Mode 03 = Tank Mode
Measure-ment Range	ff	1b	5	**Byte 1**: 00 = General Mode; 01 = Rainwater Well Mode; 02 = Wastewater Well Mode; 03 = Tank Mode **Byte 2-3**: 0000

Item	Channel	Type	Byte	Description
				Byte 4-5: Max. Measuring Range, UINT16, Unit: mm
Set Tilt & Distance Switch	ff	3e	1	01 = Enable; 00 = Disable

Example 1:

Reboot the device.

ff10ff

Example 2:

Set reporting interval as 20 minutes.

ff6ab004		
Channel	**Type**	**Value**
ff	6a	b004=>04b0=1200s

Example 3:

Set the time zone as UTC-4.

ffbd10ff		
Channel	**Type**	**Value**
ff	bd	10 ff => ff 10 = -240/60=-4

Example 4:

Set the device as Wastewater Well mode.

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

Commands for Calibration Setting

The device supports multiple commands for calibration setting.

Command description:

Item	Channel	Type	Byte	Description
Device Calibration	ff	2a	1	01-Blind Zone Calibration
Distance Calibration	ff	ab	3	**Byte 1**: 01-Enable; 00-Disable **Byte 2-3**: Calibration Value, INT16, Unit: mm
Recollecting of Measure Out-lier Calibration	ff	1c	2	**Byte 1**: Recollecting Times, UINT 8, Range: 1~3 **Byte 2**: Recollecting Interval, UNIT 8, Unit: s, Range: 1~10
Radar Echo Signal Quality	f9	14	2	INT16, Range: -10~35
Algorithm Thresh-old Sensitivity	f9	15	2	INT16/10, Range: 0.1~1
Peak Sorting	f9	16	1	00-Nearest Peak; 01-Strongest Peak

Example:

Select the strongest peak as the effective target.

f91601		
Channel	**Type**	**Description**
f9	16	01 = Strongest Peak

Commands for Threshold Alarm Setting

The device supports the threshold alarm setting command.

Command description:

Item	Channel	Type	Byte	Description
Collecting Interval	f9	39	2	Unit: min, Range: 1~1440
Set Threshold Alarm	ff	06	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
Alarm Reporting Times	ff	f2	2	UINT16, Range: 1~1000, Default: 1

Example:

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

ff06 8c e803 1027 00000000		
Channel	**Type**	**Description**
ff	06	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

Commands for Historical Data Query

The device can query historical data for a specified time point or range through downlink commands. The specified time point can use Unix Timestamp Converter to calculate. The prerequisites are that the device time is correct and the **data storage function** is enabled. The device uploads a maximum of 300 data records per range query.

When querying data for a specific time point, the device uploads the record closest to the requested time within the current reporting interval. For example, with a 10-minute reporting interval, a query for 17:00 will return the exact record if it exists. Otherwise, the device searches for data within a tolerance of ±10 minutes (16:50 to 17:10) and uploads the record closest to 17:00.

Command format:

Item	Channel	Type	Description
Query data for a specified time point	fd	6b	4 Bytes, Unix timestamp
Query data for a specified time range	fd	6c	Start time (4 bytes) + end time (4 bytes), Unix timestamp
Stop data query report	fd	6d	ff
Report interval	ff	6a	3 bytes **Byte 1:** 01

Item	Channel	Type	Description
			Byte 2-3: interval time, unit:s, range: 30-1200 s, default: 60s

Reply format:

Channel	Type	Description
fc	6b/6c	00: data query success 01: invalid time point or time range 02: no data for this time point or time range
20	ce	Data time stamp (4B) + Interface Status (1B) + Pulse Counter (4B)

Example:

Enquire the historical data in a time range.

fd6c 64735b63 7c885b63		
Channel	**Type**	**Value**
fd	6c	Start time: 64 73 5b 63 => 63 5b 73 64 = 1666937700s End time: 7c 88 5b 63 => 63 5b 88 7c = 1666943100s

Reply:

fc6c00		
Channel	**Type**	**Value**
fc	6c	00: Enquiry success

20ce 0d755b63 ac0c be00 0000 20			
Channel	**Type**	**Time Stamp**	**Value**
20	ce	0d 75 5b 63 => 63 5b 75 0d=1666938125s	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

Chapter 6. Services

Milesight provides customers with timely and comprehensive technical support services. End-users can contact your local dealer to obtain technical support. Distributors and resellers can contact directly with Milesight for technical support.

Technical Support Mailbox: iot.support@milesight.com

Online Support Portal: https://support.milesight-iot.com

Resource Download Center: https://www.milesight.com/iot/resources/download-center/

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