



EM400-MUD (LoRaWAN® Version)

Multifunctional Ultrasonic Distance 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
March 30, 2023	V1.0	Initial version

Chapter 2. Product Introduction

Overview

EM400-MUD is a multifunctional ultrasonic distance sensor designed to detect small-range areas and small blind spots. It features switchable pre-set modes for different applications. EM400-MUD is also equipped with a 3-axis accelerometer and temperature sensor to detect device status. With high protection IP rating and waterproof enclosure, EM400-MUD can withstand harsh environments and operate up to 10 years using two 9000 mAh batteries.

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

EM400-MUD is specifically designed for medium or large trash bins and parking lot.

Features

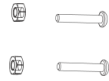
- 3-450 cm wide detection range with small blind zone
- Equipped with NTC temperature sensor for the detection and alarm of trash burning
- Built-in 3-axis accelerometer sensor to monitor device tilt status
- Damp-proof coating inside and IP67 waterproof enclosure for outdoor applications
- Two built-in 9000 mAh replaceable batteries that work for up to 10 years without replacement
- Equipped with NFC for one touch configuration, support card emulation mode
- Equipped with three pre-set modes for different applications: standard mode, bin mode, Parking lot mode
- Ultra-wide-distance wireless transmission up to line of sight of 15 km
- Function well with standard LoRaWAN[®] gateways and network servers
- Compatible with Milesight IoT Cloud and Milesight Development Platform for remote management

Chapter 3. Hardware Introduction

Packing List



1 × EM400-MUD Device



2 × Wall Mounting Kits



1 × Quick Guide



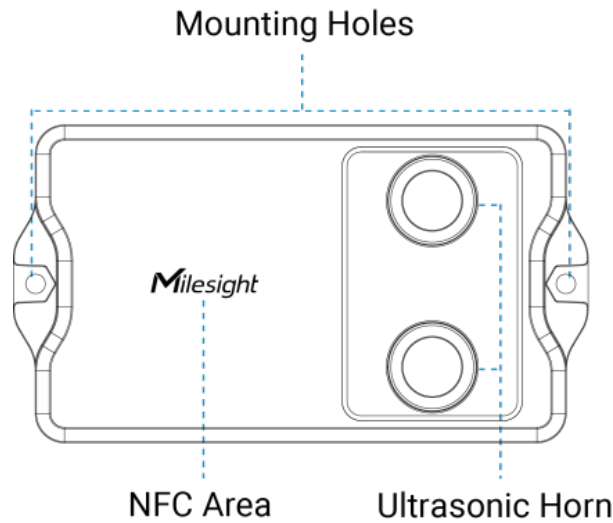
1 × Warranty Card



Note:

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

Hardware Overview



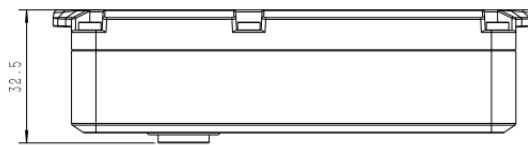
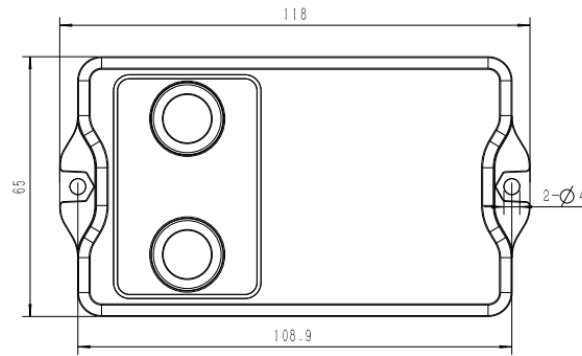
Button and LED Indicator

There is a LED indicator and a power button inside the device for emergency reboot or reset.

Function	Action	LED Indicator
Power On	Press and hold the button for more than 3 seconds.	Off → On
Power Off		On → Off


Function	Action	LED Indicator
Reset to Factory Default	Press and hold the button for more than 10 seconds.	Blinks quickly
Check On/Off Status	Quickly press the power button once.	Light On: device is on.
		Light Off: device is off.

Dimensions(mm)



Chapter 4. Quick Start

Access the Sensor via NFC

1. Download and install “Milesight ToolBox” App from Google Play or Apple Store on an NFC-supported smartphone.
2. Enable NFC function on the smartphone.
3. Launch Milesight ToolBox, and select the default mode as NFC.
4. Attach the smart phone with NFC area to the device and click  to read device information. Basic information, data, and settings of the device will be shown on the Milesight ToolBox App if it's recognized successfully.
5. Adjust the settings on the App, then attach the smartphone with NFC area to the device and click **Write** to write the settings. After writing, reread the device to check if the configuration is written well.



Note:

- Ensure the location of smartphone NFC area and it's recommended to take off phone case.
- If the smart phone fails to read/write configurations via NFC, keep the phone away and back to try again.
- The default device password is 123456. Please change a new password for security.



Configure the Network Setting

1. Go to **Network** settings page, select the join type as OTAA or ABP as required.

**Note:**

OTAA mode is required if you connect device to Milesight IoT Cloud or Milesight Development Platform.

2. Select supported frequency the same as LoRaWAN[®] gateway.

**Note:**

Set the channel index as 8-15 for US915 or AU915 if using default settings of Milesight gateways.

Device
Network

LoRaWAN

* Support Frequency

US915

Enable Channel Index ⓘ

8-15



Index	Frequency/MHz ⓘ
0 - 15	902.3 - 905.3
16 - 31	905.5 - 908.5
32 - 47	908.7 - 911.7
48 - 63	911.9 - 914.9
64 - 71	903 - 914.2



3. Keep other settings by default and click **Write** to save the settings.

Chapter 5. Operation Guide

LoRaWAN Settings

This chapter describes the LoRaWAN[®] network settings of device.

Parameter	Description
Device EUI	<p>Unique ID of the device which can be found on the device.</p> <div style="border: 1px solid #ccc; background-color: #e6f2ff; padding: 10px; margin-top: 10px;">  Note: please contact sales for device EUI list if you have many units. </div>
App EUI	The default App EUI (join EUI) is 24E124C0002A0001.
Application Port	The port used for sending and receiving data, the default port is 85.
LoRaWAN [®] Version	V1.0.2 and 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	<p>OTAA and ABP mode are available.</p> <div style="border: 1px solid #ccc; background-color: #e6f2ff; padding: 10px; margin-top: 10px;">  Note: it's necessary to select OTAA mode if connecting device to Milesight IoT Cloud or Milesight Development Platform. </div>
Application Key	Appkey for OTAA mode, default value: "Device EUI" + "Device EUI" (since Q4 of 2025). Example: 24e124123456789024e1241234567890

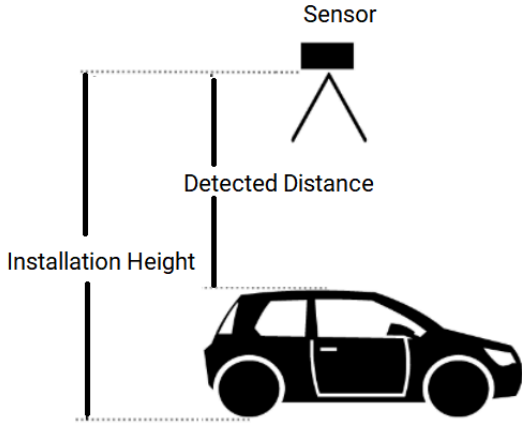
Parameter	Description
	<div style="background-color: #e6f2ff; padding: 10px; border-radius: 5px;">  Note: <ul style="list-style-type: none"> The default value of earlier devices is 5572404C696E6B4C6F52613230313823. Please contact sales before purchase if you require random App Keys. </div>
Network Session Key	Nwkskey for ABP mode, the default is 5572404C696E6B4C6F52613230313823.
Application Session Key	Appskey for ABP mode, the default is 5572404C696E6B4C6F52613230313823.
Device Address	DevAddr for ABP mode, default is the 5 th to 12 th digits of SN.
Rejoin Mode	<p>Reporting interval ≤ 35 mins: the device will send a specific number of Link-CheckReq MAC packets to the network server every reporting interval or every double reporting interval to validate connectivity; If there is no response, the device will re-join the network.</p> <p>Reporting interval > 35 mins: the device will send a specific number of Link-CheckReq MAC packets to the network server every reporting interval to validate connectivity; If there is no response, the device will re-join the network.</p> <div style="background-color: #e6f2ff; padding: 10px; border-radius: 5px;">  Note: <ol style="list-style-type: none"> 1. Only OTAA mode supports rejoin mode. 2. The actual sending number is Set the number of packets sent +1. </div>
Supported Frequency	<p>Enable or disable the frequency to send uplinks. If frequency is one of CN470/AU915/US915, enter the index of the channel to enable in the input box, making them separated by commas.</p> <p>Examples:</p>

Parameter	Description
	<p>1, 40: Enabling Channel 1 and Channel 40</p> <p>1-40: Enabling Channel 1 to Channel 40</p> <p>1-40, 60: Enabling Channel 1 to Channel 40 and Channel 60</p> <p>All: Enabling all channels</p> <p>Null: Indicate that all channels are disabled</p>
ADR Mode	Enable or disable network server to adjust Spreading Factor, Bandwidth and Tx Power to optimize data rates, airtime and energy consumption in the network.
Spreading Factor	If ADR mode is disabled, the device will send uplink data following this SF parameter. The higher the spreading factor, the longer the transmission distance, the slower the transmission speed and the more the consumption.
Tx Power	Tx power (transmit power) refers to the strength of the outgoing signal transmitted by the device. This is defined by LoRa alliance.
RX2 Data Rate	RX2 data rate to receive downlinks.
RX2 Frequency	RX2 frequency to receive downlinks. Unit: Hz

General Settings

General settings include the basic parameters of the device.



Parameter	Description
Device Mode	Select from Standard Mode, Bin Mode or Parking Lot Mode.
Reporting Interval	<p>Reporting interval of transmitting data to server.</p> <p>Standard Mode: 10 minutes as default, range: 1~1080 minutes;</p> <p>Bin mode: 20 minutes as default, range: 1~1080 minutes;</p> <p>Parking Lot Mode: 1080 minutes as default, range: 1~1080 minutes. If the sensor detects the occupancy status change, it will report immediately.</p>
Collecting Interval	Collecting interval of measuring distance on Parking Lot Mode. Default: 20s; Range: 1~600s
Installation Height	<p>Set the installation height between device and ground when in Parking Lot Mode. Default: 3m; Range: 0.030~4.500m</p> <p>Threshold Distance Value (Δ) is 1m as default, triggering logic is as below:</p> <ul style="list-style-type: none"> • Installation Height - Detected Distance $>$ Δ, the sensor will reports occupied immediately. • Installation Height - Detected Distance $<$ Δ, the sensor will reports vacant immediately. 

Parameter	Description
Tilt & Distance Switch	When detecting that the offset angle is greater than 20 degrees, turn off the distance sensor.
Change Password	Change the password for ToolBox App to write this device.

Calibration Settings

The device supports two calibration types.

Numerical Calibration: Add the calibration to the collected value, the device will display and report the final value.

Calibration Settings ^

Distance

Numerical Calibration

Current Value:3.164m

Calibration Value

0.2

 m

Final Value:3.364m

Measure Outlier Calibration: When the device distance value exceeds the outlier range (or range) comparing to the last value, the device will measure the distance **once again**.

Measure Outlier Calibration (i)

Maximum Range: 4.5 m

Outlier Range / % (i)

Outlier Value / m (i)

Distance Threshold Settings

The device will detect whether the distance reaches the threshold according to collecting interval. If threshold is triggered, it uploads the current data once instantly. Only when the threshold alarm is dismissed and re-triggered, the device will send the threshold alarm again.



Note:

threshold setting is only for bin mode and standard mode.

Distance (i)

Over / m

Below / m

Collecting Interval 1 min

Threshold Dismiss Report (i)

Parameters	Description
Collecting Interval	Collecting interval to detect distance, this should be smaller than or equal to reporting interval.

Parameters	Description
Threshold Dismiss Report	When the collected value changes from outside the threshold to within the threshold, a threshold release packet will be reported.

Maintenance

Upgrade

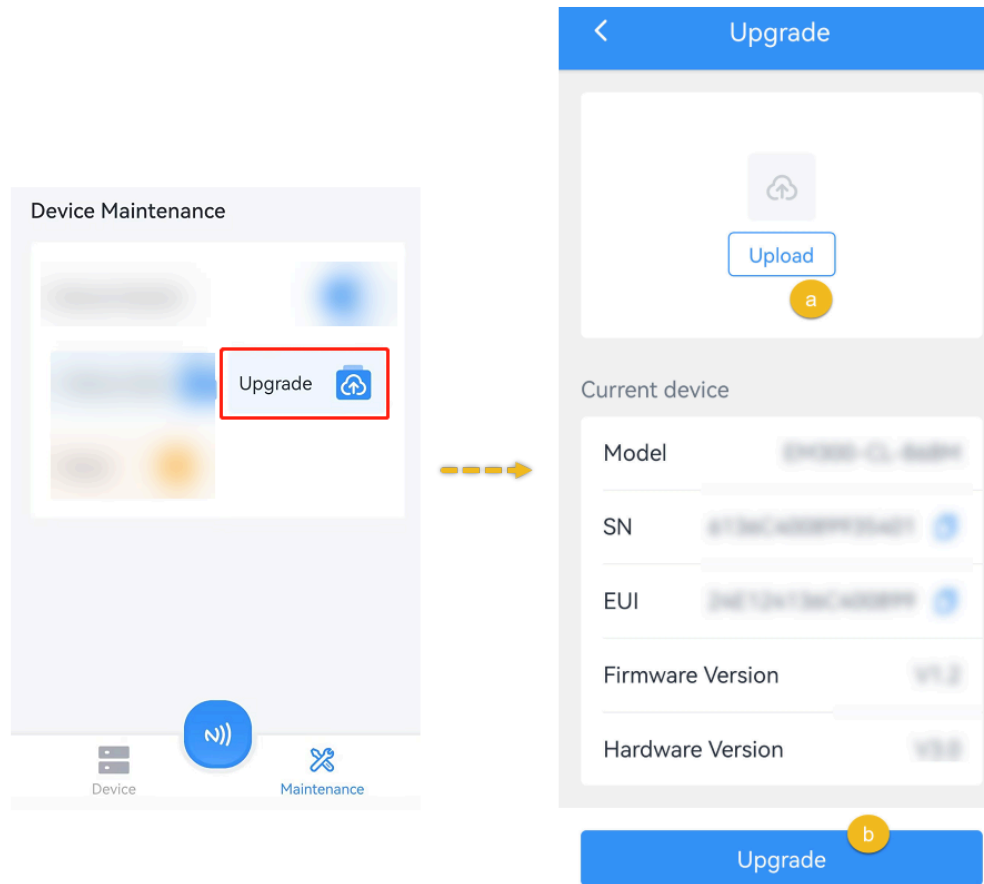
This chapter describes the steps to upgrade the device via ToolBox App.

1. Download firmware from Milesight official website to your smartphone.
2. Read the target device via ToolBox App, click **Upgrade** to upload the firmware file.
3. Click **Upgrade** to upgrade the device.



Note:

- Operation on ToolBox is not supported during an upgrade.
- Only Android version ToolBox supports the upgrade feature.

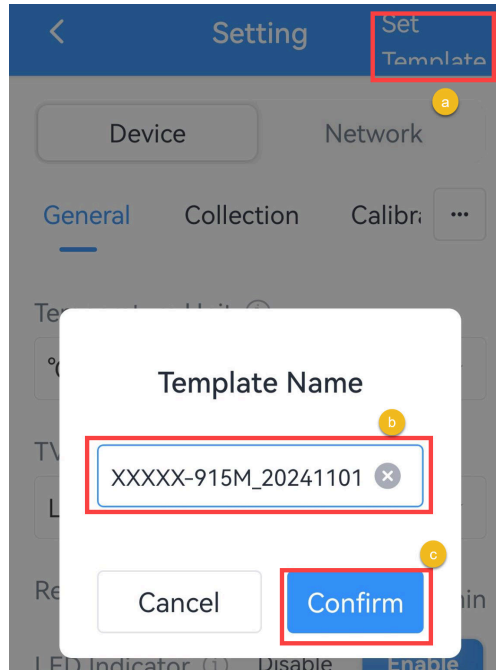


Backup and Restore

This device supports configuration backup for easy and quick device configuration in bulks. Backup and restore is allowed only for devices with the same model and frequency band.

Backup and Restore

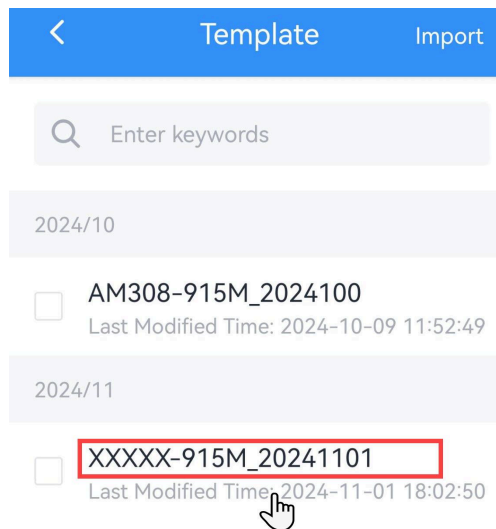
1. Launch ToolBox App, attach the NFC area of smartphone to the device to read the configuration.
2. Edit the configuration as required, click **Set Template** to save current configuration as a template to the ToolBox App.



3. Go to **Device >Template** page.

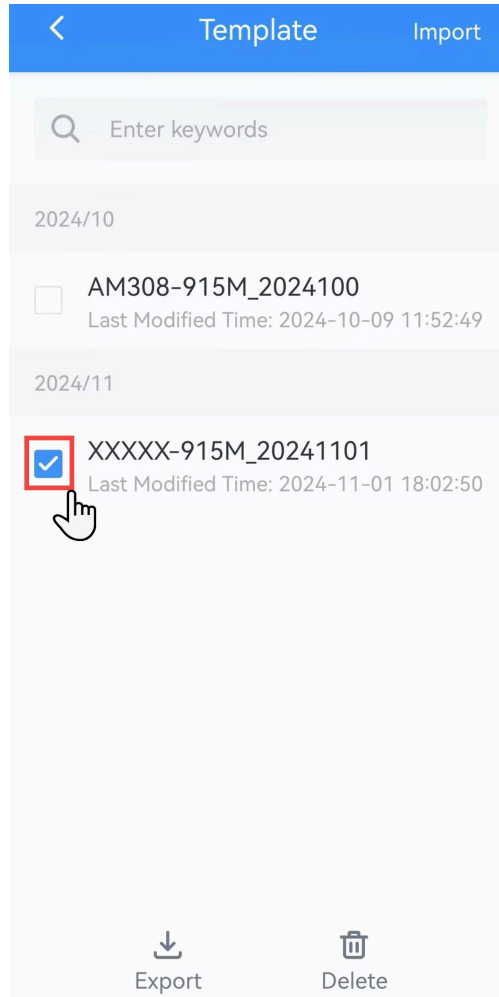


4. Select and click the target template, click **Write** to import the configuration to target devices.



Export and Delete Template

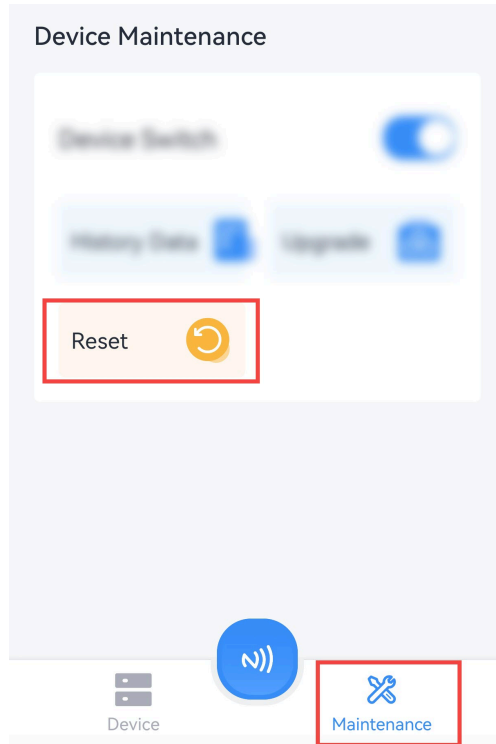
1. Check the box of the target template.
2. Click **Export** to export this template as JSON format file and save it to the smartphone, click **Delete** to delete this template from your Toolbox App.



Reset to Factory Default

Via Hardware: Hold on the reset button for more than 10s until the LED indicator quickly blinks.

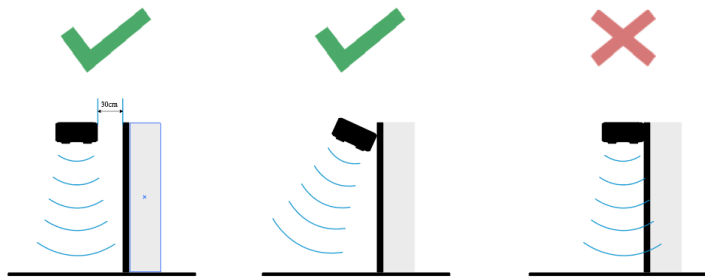
Via Toolbox App: Click **Reset** and attach the smartphone to device to reset the device.



Chapter 6. Installation

Installation location

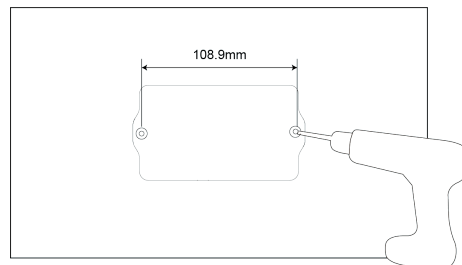
- In order to provide the best data transmission, please ensure the device is deployed within the signal range of the LoRaWAN[®] gateway and keep it away from metal objects and obstacles.
- The device must be placed in a horizontal position above the detected object so that it has a clear path to the object.
- The device should be installed at least 30cm away from the side-wall without obstructions blocking the ultrasonic signal. If the device needs to be installed on the side wall, please ensure the ultrasonic horn is away from the side wall.



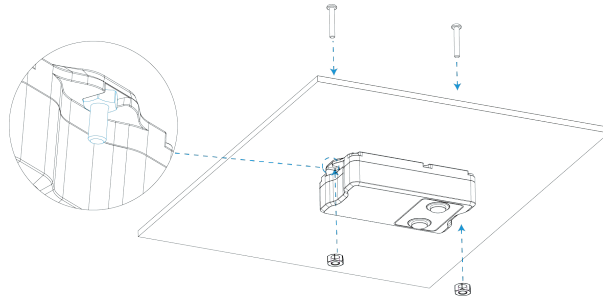
- When EM400-MUD is in waste bin mode, place the device in the center of waste bin mode and here are some recommended sizes of waste bins: when the height is 88cm, the minimum radius should be 24cm.

Installation Steps

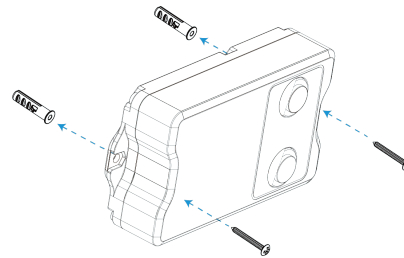
Step 1: Drill two holes on the container cover according to the location of device mounting holes.



Step 2: Put the device under container cover and align the holes in order to perfectly screw the bolts into the holes from the other side of the cover.

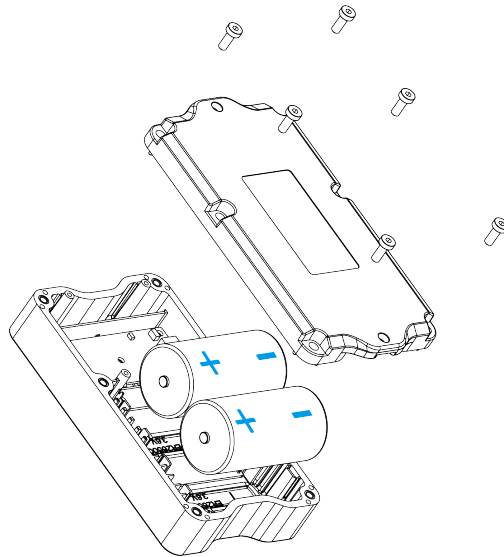


Besides, the device can also be fixed by two M4 mounting screws and wall plugs.



Chapter 7. Battery Replacing

When the batteries have run out of power, please remove the back cover to replace the new batteries.



Note:

- The device can only be powered by the ER26500 Li-SoCl₂ batteries. The alkaline battery is not supported.
- The batteries should be removed or replaced from the device if it is not used for an extended period.
- Ensure all replacing batteries are newest; otherwise, it may shorten battery life or cause inaccurate power calculations.

Chapter 8. Uplink and Downlink

Overview

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

Channel1	Type1	Data1	Channel2	Type2	Data2	Channel3	...
1 Byte	1 Byte	N Bytes	1 Byte	1 Byte	N Bytes	1 Byte	...

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

Uplink Data

This chapter describes the reported data of the device.

Basic Information

The device will report a basic information packet whenever joining the network.

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


Example:

ff0bff ff0101 ff166329c42503920003 ff090100 ff0a0101 ff0f00		
Channel	Type	Value
ff	0b	ff
ff	01	01=V1
ff	16	6329c42503920003

ff0bff ff0101 ff166329c42503920003 ff090100 ff0a0101 ff0f00		
Channel	Type	Value
ff	09	0100=V1.0
ff	0a	0101=V1.1
ff	0f	00: Class A

Periodic Report

The device supports to report sensor data according to reporting interval.

Item	Channel	Type	Byte	Description
Battery Level	01	75	1	UINT8, Unit: %
Temperature	03	67	2	INT16/10, Unit: °C
Distance	04	82	2	UINT16, Unit: mm  Note: When the device collect the sensor data out of measuring range, it will report fffd.
Device Position	05	00	1	00: Normal (horizontal offset angle < 20°) 01: Tilt (horizontal offset angle ≥ 20°)

Example:

017564 0367f800 04820101 050000		
Channel	Type	Value
01	75	Battery: 64=>100%
03	67	Temperature: f8 00 => 00 f8 = 248/10 =24.8 °C
04	82	Distance: 01 01 => 01 01 = 257mm =0.257m
05	00	Device Position: 00 = Normal

Alarm Report

The device supports to report below types of alarm report packets.

Item	Channel	Type	Byte	Description
Temperature Threshold Alarm	83	67	3	Byte 1-2: Temperature, INT16/10, Unit: °C Byte 3: 00=Alarm dismiss, 01=Alarm
Distance Threshold Alarm	84	82	3	Byte 1-2: Distance, UINT16, Unit: mm Byte 3: 00=Alarm dismiss, 01=Alarm

Example:

1. Distance Threshold: report when distance reaches the threshold or returns back to normal value.

8482330701		
Channel	Type	Value
84	82	33 07 =>07 33 = 1843mm = 1.843m Alarm Status: 01= Alarm

2. Temperature Threshold: report when the abrupt change of temperature is greater than 5 °C.

8367220101		
Channel	Type	Value
83	67	22 01 =>01 22 = 290/10 = 29°C Alarm Status: 01= Alarm

Downlink Command

This device supports downlink commands for configuration and control. The downlink application port is 85 by default.

General Settings

Item	Channel	Type	Byte	Description
Reboot	ff	10	1	ff
Collect Interval	ff	02	2	UINT16, Unit: s
Report Interval	ff	03	2	UINT16, Unit: s
Device Mode	ff	71	1	00 = Standard Mode; 01 = Bin Mode; 02 = Parking Lot Mode
Height Threshold in Parking Lot Mode	ff	70	2	UINT16, Unit: mm
Installation Height	ff	77	2	UINT16, Unit: mm
Tilt & Distance Switch	ff	3e	1	00 = Disable; 01 = Enable
Distance Measurement	ff	56	1	00 = Disable; 01 = Enable

Example:

1. Reboot the device.

ff10ff

2. Set report interval as 20 minutes.

ff03b004		
Channel	Type	Value
ff	03	b004=>04b0=1200s=20 minutes

3. Set the device as standard mode.

ff7100		
Channel	Type	Value
ff	71	00 = Standard Mode

4. Enable "Tilt & Distance Switch" feature.

ff3e01		
Channel	Type	Description
ff	3e	01 = Enable

5. Set the installation height as 4.5m.

ff779411		
Channel	Type	Value
ff	77	94 11 => 11 94 =4500mm =4.5m

6. Set the height threshold in parking lot mode as 0.03m.

ff701e00		
Channel	Type	Value
ff	70	1e 00 => 00 1e =30mm =0.03m

Threshold Alarm Setting

Channel	Type	Byte	Description
ff	06	9	CTRL(1B)+Min(2B)+Max(2B)+00000000(4B) CTRL:

Channel	Type	Byte	Description
			Bit2~Bit0: <ul style="list-style-type: none"> • 000-disable • 001-below • 010-above • 011-within • 100-below or above Bit5~Bit3: <ul style="list-style-type: none"> • 001-Standard Mode • 010-Bin Mode Bit6=0 Bit7: <ul style="list-style-type: none"> • 0 - disable threshold dismiss report • 1 - enable threshold dismiss report

Example:

When the distance is below 20cm or above 80cm, the sensor will send threshold alarm.

ff068c c800 2003 00000000		
Channel	Type	Value
ff	06	CTRL: 8c=10 001 100 100=below or above 001=standard mode 10=enable threshold dismiss report Min: c8 00 => 00 c8 = 200 mm = 20cm Max: 2003 => 03 20 = 800 mm = 80cm

Chapter 9. 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/>

MILESIGHT CHINA

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Add: Building C09, Software Park Phase III, Xiamen 361024, Fujian, China