EM400-UDL (NB Version)

Ultrasonic Distance Sensor

User Guide

Contents

Chapter 1. Preface

Copyright Statement

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
June 15, 2023	V1.0	Initial version

Chapter 2. Product Introduction

Overview

EM400-UDL is a non-contact ultrasonic distance sensor designed for liquid level distance measurement. It features multiple selective probes with varying detecting ranges to meet diverse requirements. With high protection IP rating and waterproof enclosure, EM400-UDL can withstand harsh environments, and it can work up to 10 years with two 9000 mAh batteries.

The NB-IoT/Cat.M version not only supports multiple application modes to compatible with IoT platforms, but also is equipped with GNSS for tracking and security purposes.

EM400-UDL can be used in outdoor applications such as water level measurement in static or slow-flowing water bodies, monitoring fill level of water tanks, etc.

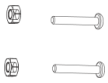
Features

- Selective probes vary from 25 to 1000 cm for multiple applications
- Two built-in 9000 mAh replaceable batteries that work for up to 10 years without replacement
- Equipped with NTC temperature sensor for the detection and alarm of burning
- Built-in 3-axis accelerometer sensor to monitor device tilt status
- Damp-proof coating inside and IP67 waterproof enclosure for outdoor applications
- Equipped with GNSS positioning for tracking
- Support cumulative number report function for power saving
- Support multiple network protocols to be compatible with IoT platforms

Chapter 3. Hardware Introduction

Packing List

1 × EM400-UDL Device



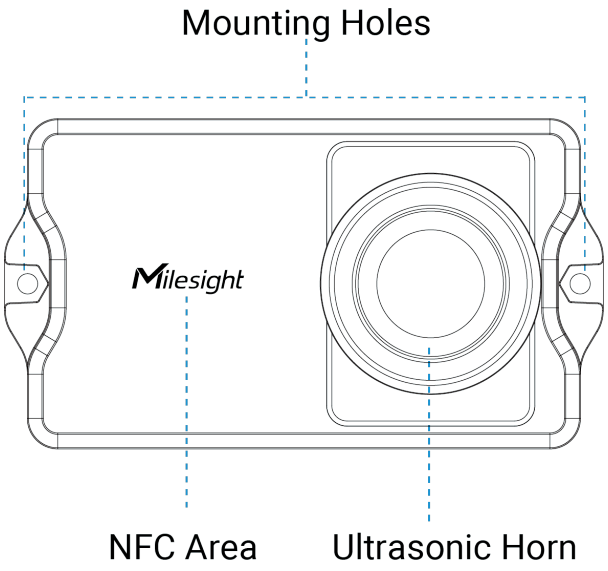
2 × Wall Mounting Kits

1 × Quick Guide

1 × Warranty Card

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

Hardware Overview



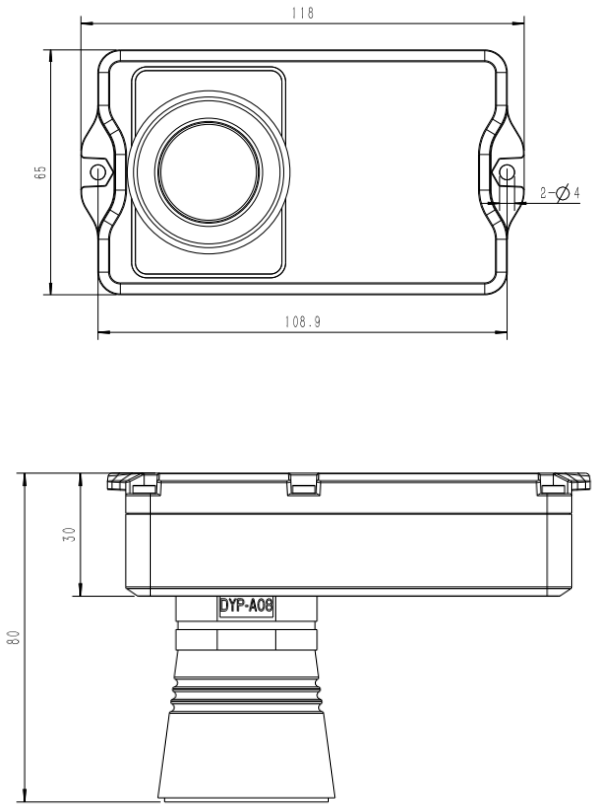
Button and LED Indicator

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

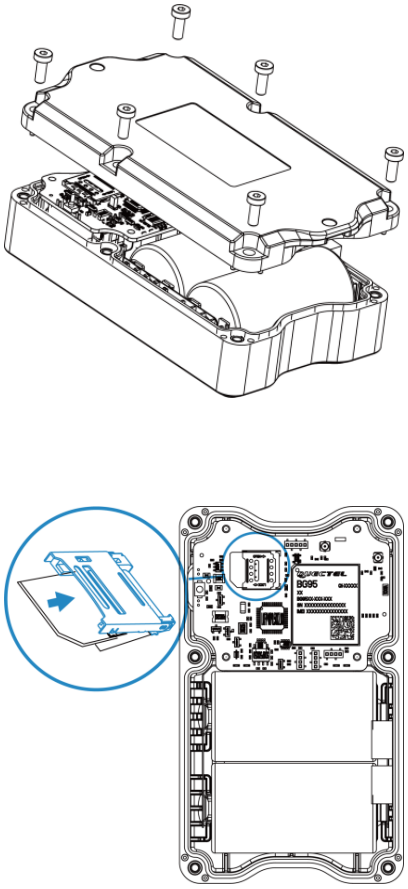
Function	Action	LED Indicator
Reset to Factory Default	Press and hold the button for more than 10 seconds.	Blinks quickly
Check On/Off Status	Quickly press the power button once.	Light On: device is on.
		Light Off: device is off.

Dimensions(mm)



Chapter 4. SIM Installation

Release the screws and back cover, insert the SIM card (3FF), then replace the back cover to the device and fix the screws.



Note:

1. PSM (Power Saving Mode) is required for the SIM card.
2. The device does not support hot plugging (also called hot swapping), please reboot the device after inserting the SIM card.
3. When a new SIM card is inserted to the device for the first time, it will take about 2 minutes to register to network; next time the registration time will be shorten to 30s.
4. When the device does not send data, the device will go to sleep mode and the network status will be unregistered.

Chapter 5. Operation Guide

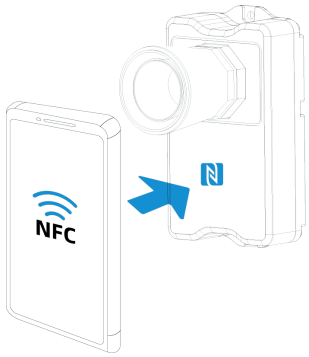
Access the Sensor

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.

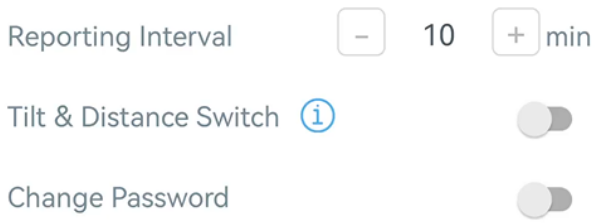
Note:

- 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.

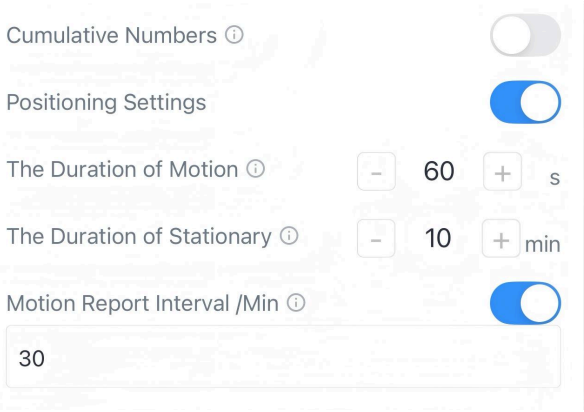


General Settings

General settings include the basic parameters of the device.



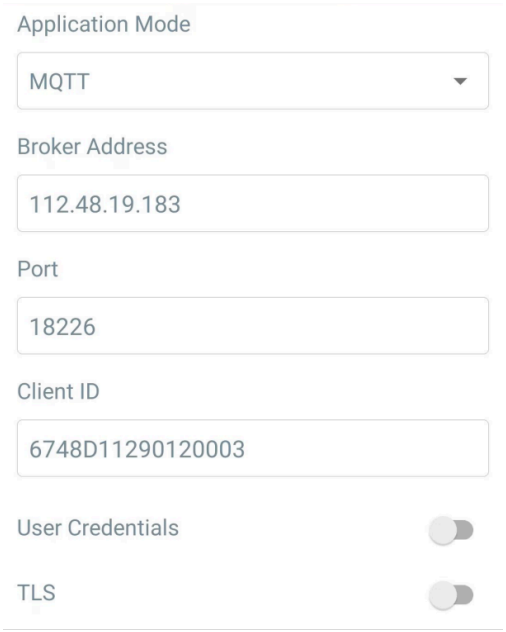
Parameter	Description
Reporting Interval	Reporting interval of transmitting data to server. 30 minutes as default, range: 1~1440 minutes.
Tilt & Distance Switch	When detecting that the offset angle is greater than 20 degrees, turn off the distance sensor.
Change Password	Change the password for ToolBox App to write this device.



Parameter	Description
Cumulative Numbers	Store this number of periodic packets to report together.
Positioning Settings	Enable GNSS positioning. When the device is on motion status, it will only upload positioning data instead of distance data.

Parameter	Description
The Duration of Motion	When device is detected to move beyond this duration, it will upload a GNSS data packet.
The Duration of Stationary	When device is detected to stop moving beyond this duration, it will upload a GNSS data packet.
Motion Report Interval/Min	The interval to report GNSS data during the motion.

Application Mode Setting



Parameters	Description
Application Mode	Select from AWS, TCP, UDP, and MQTT.

Parameters	Description
AWS	
Server Address	Fill in the AWS server domain name which the data sends to.
CA File	Import the CA.crt file.

Parameters	Description
AWS	
Client Certificate	Import the client certificate.
Client Key	Import the client key.

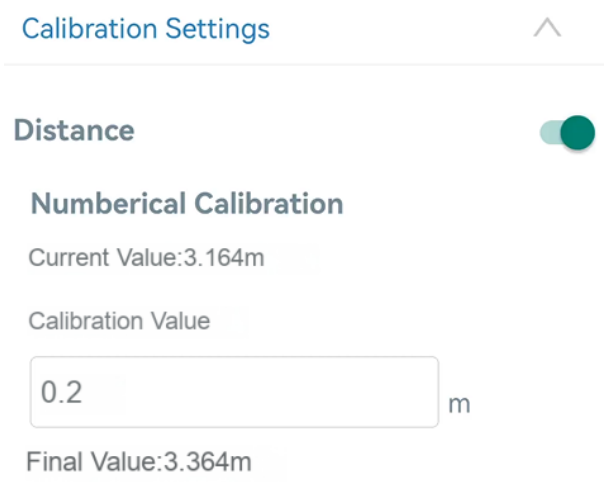
Parameters	Description
TCP/UDP	
Server Address	Fill in the TCP/UDP server address (IP/domain name).
Server Port	Fill in the TCP/UDP server port. Range: 1-65535.

Parameters	Description
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.
Protocol	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.

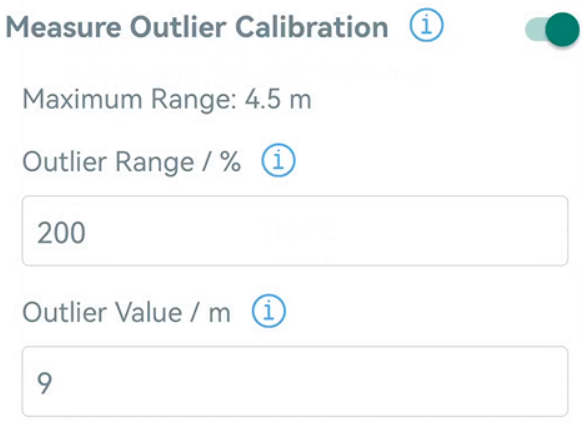
Calibration Settings

The device supports two calibration types.

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

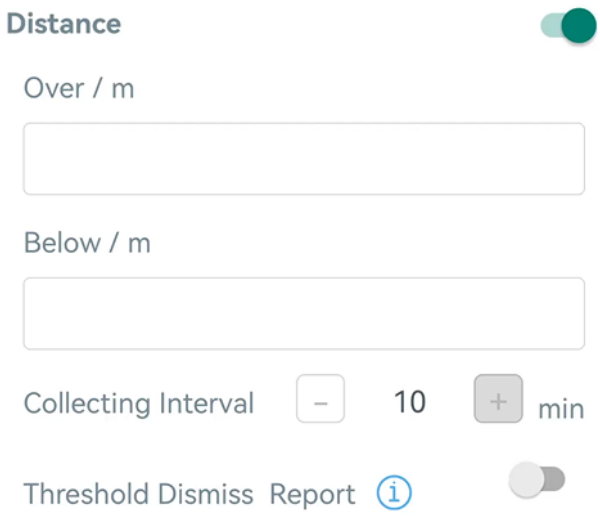


Measure Outlier Calibration: When the device distance value exceeds the outlier range (or range) comparing to the last value, the device will measure the distance **once again**.



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.



Parameters	Description
Collecting Interval	Collecting interval of ultrasonic sensor to detect distance. Range: 1~1080min
Threshold Dismiss Report	When the collected value changes from outside the threshold to within the threshold, a threshold dismiss packet will be reported.

Maintenance

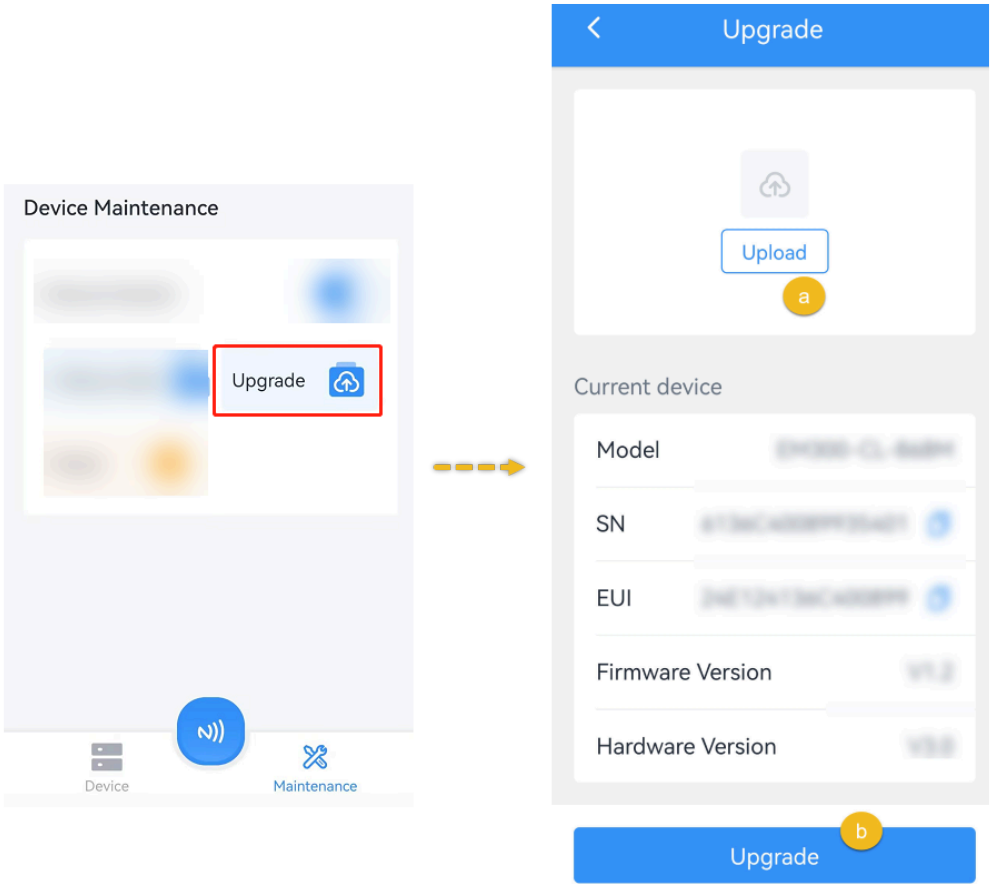
Upgrade

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.

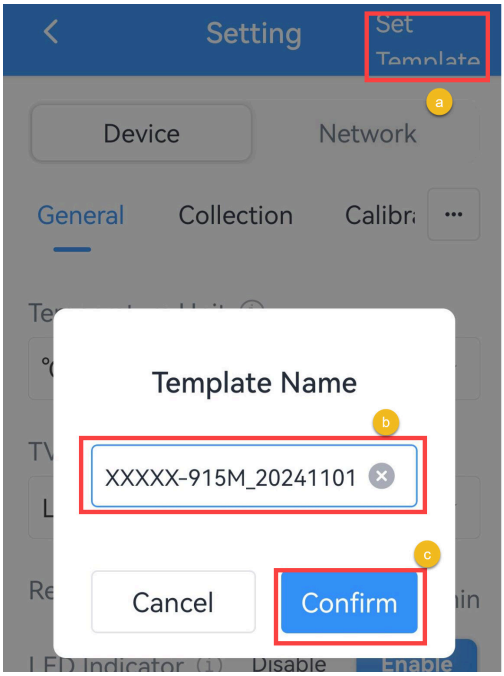


Backup and Restore

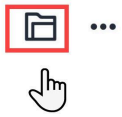
This device supports configuration backup for easy and quick device configuration in bulks. Backup and restore is allowed only for devices with the same model and frequency band.

Backup and Restore

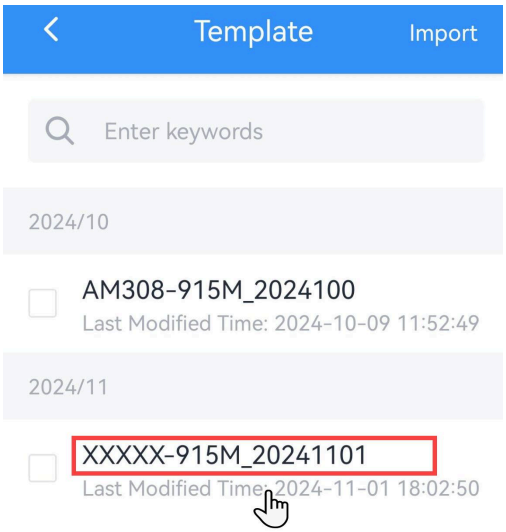
1. Launch ToolBox App, attach the NFC area of smartphone to the device to read the configuration.
2. Edit the configuration as required, click **Set Template** to save current configuration as a template to the ToolBox App.



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

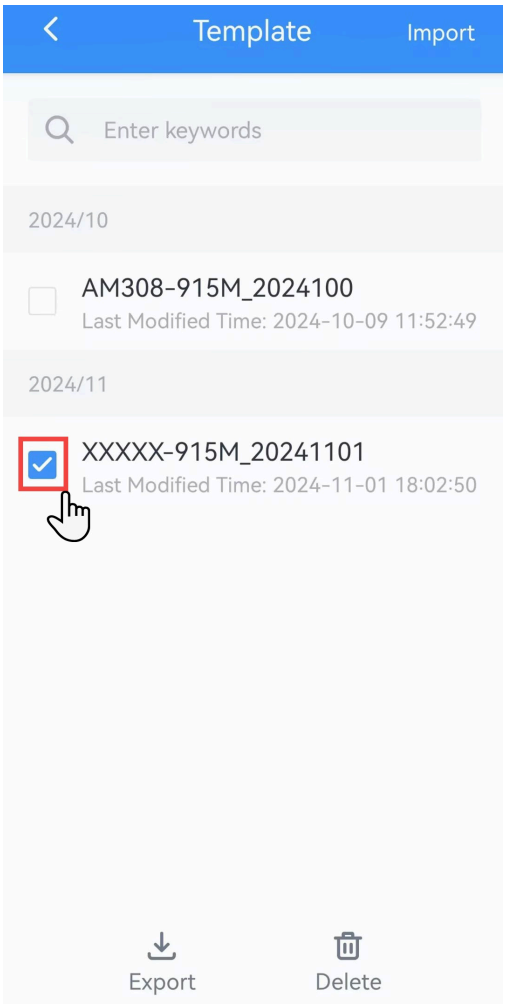


4. Select and click the target template, click **Write** to import the configuration to target devices.



Export and Delete Template

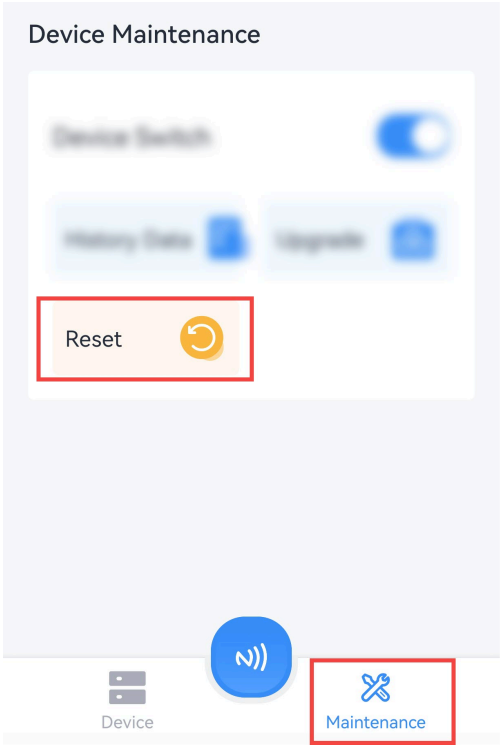
1. Check the box of the target template.
2. Click **Export** to export this template as JSON format file and save it to the smartphone, click **Delete** to delete this template from your ToolBox App.



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.


Device Maintenance
Reset
Device
Maintenance

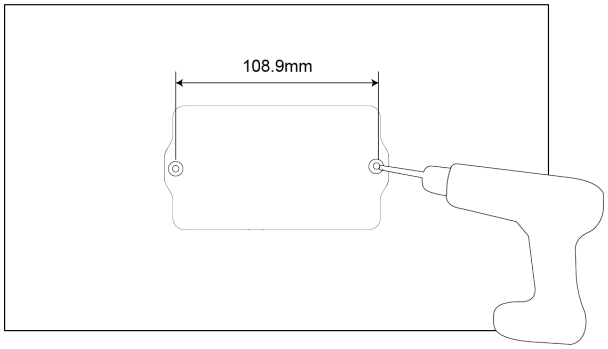
Chapter 6. Installation

Installation location

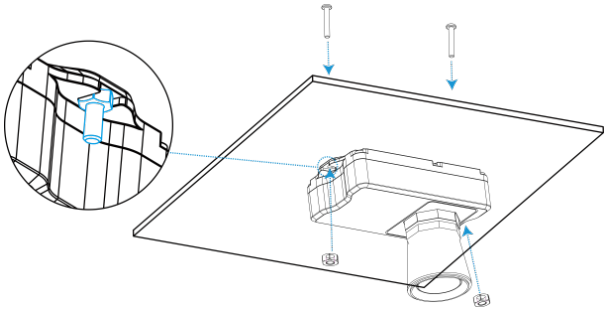
- In order to provide the best data transmission, please ensure the device is deployed within the signal range of the base station and keep it away from metal objects and obstacles.
- The device must be placed in a horizontal position above the detected object so that it has a clear path to the object. The ultrasonic sensor delivers optimal measurement performance when installed perpendicular to the detected 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.
- Do not install the ultrasonic sensor above the influent stream to ensure the measured surface rather than the incoming stream.
- The device is not suitable for snow level detection. Please contact us to order a customized version if needed.
- The measurement accuracy of the device may be affected by environmental factors at the installation location, such as solar radiation and water surface fluctuations.

Installation Steps

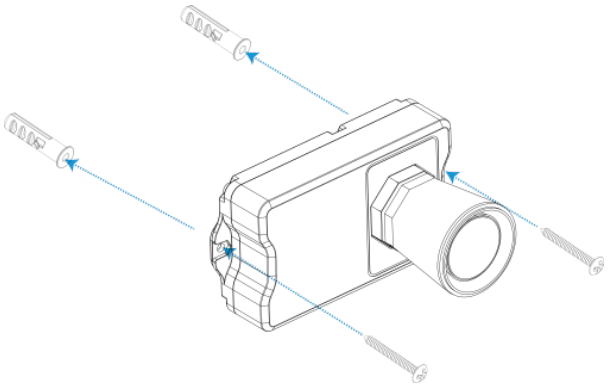
Step 1: Drill two holes on the container cover according to the location of device mounting holes.



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.

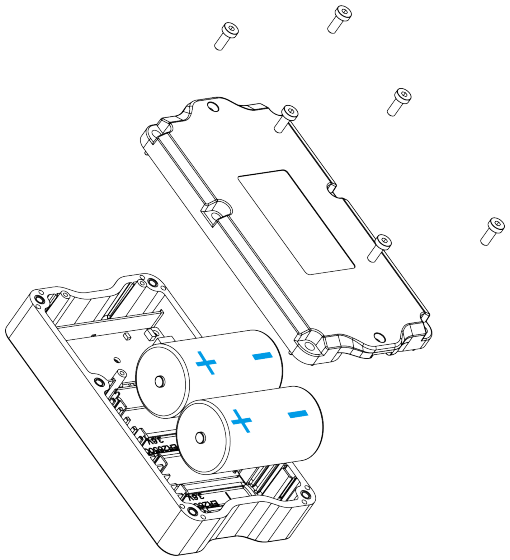


Besides, the device can also be fixed by two M4 mounting screws and wall plugs.



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-$SoCl_2$ 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

AWS/MQTT Topics

When the device is connected to AWS/MQTT server, the bi-directional communication uses different topics.

Topic	Content
em/[SN]/status	Receive periodic reports, threshold alarms, etc.
em/[SN]/cmd/update	Send downlink commands
em/[SN]/cmd/update/accepted	Receive success ACK of downlink commands **Note:** users need to send downlink command to enable ACK feature first.

Uplink Data

This chapter describes the reported data of the device.

All data are based on following format (HEX):

Start	ID	Packet Length	FLAG	Frame Counter	Protocol Version	Software Version	Hardware Version
02	0001	2 Bytes	00	0000	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 0001 005f 00 0000 01 30313031 30313030 3637343844313132393031323030303 3 38363835303830363139323435313 3 343630303833383833383036363836 38393836303462383130323263303435363638 36 10 000E 01750103677D000482FDFF050000	
Type	**Content**
Start	02
ID	0001
Packet Length	00 5f = 95 bytes
FLAG	00
Frame Counter	0000
Protocol Version	01=V1
Software Version	30 31 30 31 => 0101=V1.1
Hardware Version	30 31 30 30 => 0100=V1.0
SN	36 37 34 38 44 31 31 32 39 30 31 32 30 30 30 33=>6748d11290120003
IMEI	38 36 38 35 30 38 30 36 31 39 32 34 35 31 33 =>868508061924513
IMSI	34 36 30 30 38 33 38 38 33 38 30 36 36 38 36 => 460083883806686
ICCID	38 39 38 36 30 34 62 38 31 30 32 32 63 30 34 35 36 36 38 36 => 898604b81022c0456686
Network Signal	10=>16 asu
Data Length	0e=>14 Bytes
Data	See details below **Note:** Data part is based on the format `Channel + Type + Data`, the Data field should follow little-endian.

Periodic Report

Item	Channel	Type	Byte	Description
Battery Level	01	75	1	UINT8, Unit: %
Temperature	03	67	2	INT16/10, Unit: °C
Distance	04	82	2	INT16, 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°)
Location	06	88	9	**Byte 1-4**: INT32/1000000 **Byte 5-8**: INT32/1000000 **Byte 9**: motion status, 20=unknown, 21=start moving, 22=in motion, 23=stop moving **Note:** If the device fails to get GNSS data, the latitude or longitude will show `ffffffff`.

Example:

1. The device supports to report sensor data according to reporting interval*cumulative numbers (30 mins*12 by default) when the device is stationary.

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

2. Report when positioning setting is enabled and the device is in motion.

050001 0688 73c177019cff080722		
Channel	**Type**	**Value**
05	00	01=Tilt
06	88	Latitude: 73c17701=>01 77 c1 73=24625523/1000000=24.625523 Longitude: 9cff0807=>07 08 ff 9c=118030236/1000000=118.030236 22=in motion

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, INT16, 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.

Important:
The device can only receive downlink commands within the 10s after sending uplink packets.

General Settings

Item	Channel	Type	Byte	Description
Reboot	ff	10	1	ff
Collect Interval	ff	02	2	UINT32, Unit: s
Report Interval	ff	03	4	UINT32, Unit: s
Tilt & Distance Switch	ff	3e	1	00 = Disable; 01 = Enable
Distance Measurement	ff	56	1	00 = Disable; 01 = Enable
Position Setting	ff	a0	1	00 = Disable; 01 = Enable
Duration of Motion and Stationary	ff	58	5	Byte 1: duration of motion, unit: s Byte 2-5: duration of stationary, unit: s
Motion Report Interval	ff	8e	5	Byte 1: 00 = Disable; 01 = Enable Byte 2-5: report interval, unit: s
Cumulative Numbers	ff	9e	2	Byte 1: 00 = Disable; 01 = Enable Byte 2: Cumulative numbers

Example:

1. Reboot the device.

ff10ff

2. Set report interval as 20 minutes.

ff03b0040000		
Channel	**Type**	**Value**
ff	03	b0 04 00 00 => 00 00 04 b0 = 1200s = 20 minutes

3. Enable “Tilt & Distance Switch” feature.

ff3e01		
Channel	**Type**	**Description**
ff	3e	01 = Enable

4. Set duration of motion to 50s and duration of stationary to 180s.

ff5832b4000000		
Channel	**Type**	**Value**
ff	58	Duration of motion: 32=50s Duration of stationary: b4 00 00 00=00 00 00 b4=180s

Threshold Alarm Setting

Channel	Type	Byte	Description
ff	06	9	CTRL(1B)+Min(2B)+Max(2B)+00000000(4B) **CTRL**: Bit2~Bit0: • 000-disable • 001-below • 010-above • 011-within • 100-below or above

Channel	Type	Byte	Description
			Bit5~Bit3: 001 Bit6=0 Bit7: • 0 - disable threshold dismiss report • 1 - enable threshold dismiss report

Example:

When the distance is below 1 m or above 3 m, the sensor will send threshold alarm.

ff06 8c e803 b80b 0000 0000		
Channel	**Type**	**Value**
ff	06	CTRL: 8c=10 001 100 100=below or above 10=enable threshold dismiss report Min: e8 03=> 03 e8 =1000mm =1m Max: b80b => 0b b8 =3000mm =3m

ACK Setting

Channel	Type	Byte	Description
ff	9f	1	00 = Disable; 01 = Enable

Example:

Enable ACK feature.

ff9f01		
Channel	**Type**	**Value**
ff	9f	01 = Enable

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

TEL: +86-592-5085280

FAX: +86-592-5023065

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