Milesight

Tilt Sensor

EM320-TILT

User Guide

# Contents

# Chapter 1. Preface

## Copyright Statement

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## 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 device password when first configuration. The default password is 123456.
> - Do not place the device close to objects with naked flames.
> - Do not place the device where the temperature is below/above the operating range.
> - The device is not intended to be used as a reference sensor, and Milesight will not should responsibility for any damage which may result from inaccurate readings.
> - The device must never be subjected to shocks or impacts.

## Revision History

| Release Date | Version | Revision Content |
|:---:|:---:|:---|
| Feb.14, 2023 | V1.0 | Initial version |

| Release Date | Version | Revision Content |
|---|---|---|
| Aug. 15, 2023 | V1.1 | Add pole mounting plate and installation |

# Chapter 2. Product Introduction

**Overview**

EM320-TILT is an LoRaWAN[®] tilt sensor mainly for angle measurement and asset movement detection. With a compact size and 3-axis accelerometer, EM320-TILT can be installed to the objects easily to measure its X, Y, Z tilt angles. In addition, EM320-TILT supports customizing initial position to detect movement based on angle changes and send threshold alarms. Compliant with Milesight LoRaWAN[®] gateway and Milesight IoT Cloud solution, users can know the angles and tilt threshold alarms in real-time via browser or mobile app remotely.

EM320-TILT can be widely used in tree monitoring, pole lean detection, landslide monitoring, etc.

**Features**

- Built-in MEMS accelerometer sensor to measure the 3-axis angles of any objects

- Flexible threshold condition settings, suitable for different kinds of applications

- Easy to install, suitable for various types of objects as trees, poles, grounds, etc.

- IP67 waterproof enclosure for outdoor applications

- Anti-theft design on back cover to secure firm and sturdy installation

- Ultra-wide-distance wireless transmission up to line of sight of 15km

- Equipped with NFC for one touch configuration

- Function well with standard LoRaWAN[®] gateways and network servers

- Quick and easy management with Milesight IoT Cloud

# Chapter 3. Hardware Introduction

**Packing List**

1 × EM320-TILT Sensor
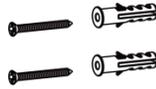
2 × Wall Mounting Kits

1 × Fixing Screw

1 × Pole Mounting Plate

1 × Quick Guide

1 × Warranty Card

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

**Hardware Overview**

NFC Area

Vent
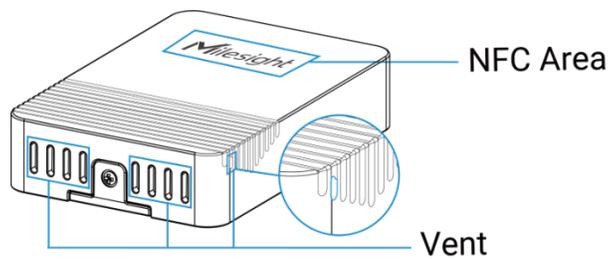
## Dimensions(mm)
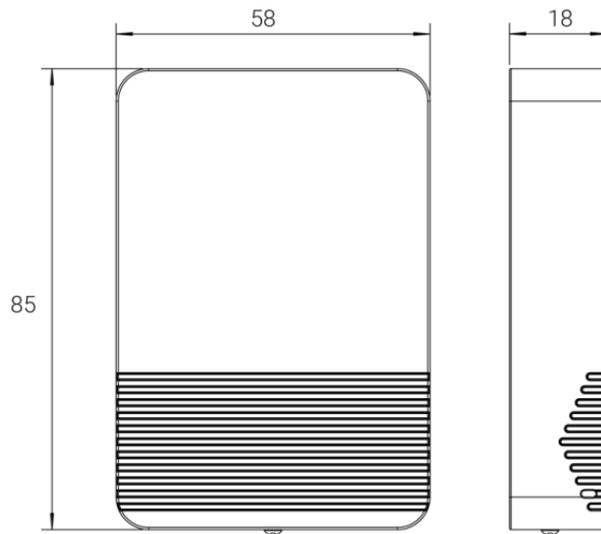


## Power Button

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 |
| 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. |

# Chapter 4. Quick Start

This chapter describe the steps to quickly configure this device. If you requires more advanced settings, please refer to operation guide chapter.

**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.
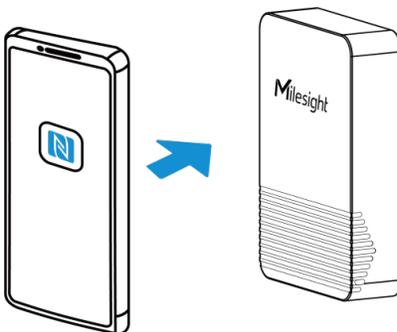


**Configure the Network Setting**

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 | Unique ID of the device which can be found on the device. <br><br> ✎ **Note:** <br> please contact sales for device EUI list if you have many units. |
| 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 | OTAA and ABP are available. <br><br> ✎ **Note:** <br> It's necessary to select OTAA mode if connecting device to Milesight IoT Cloud. |
| Application Key | Appkey for OTAA mode, default value: "Device EUI" + "Device EUI" (since Q4 of 2025). Example: 24e124123456789024e1241234567890 |

| Parameter | Description |
|---|---|
|  | **Note:** <br><br> • The default value of earlier devices is 5572404C696E6B4C6F52613230313823. <br> • Please contact sales before purchase if you require random App Keys. |
| 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 | 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. <br><br> 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. <br><br> **Note:** <br><br> 1. Only OTAA mode supports rejoin mode. <br> 2. The actual sending number is **Set the number of packets sent +1**. |
| Supported Frequency | 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. <br><br> **Examples:** |

| Parameter | Description |
|---|---|
| | 1, 40: Enabling Channel 1 and Channel 40 |
| | 1-40: Enabling Channel 1 to Channel 40 |
| | 1-40, 60: Enabling Channel 1 to Channel 40 and Channel 60 |
| | All: Enabling all channels |
| | Null: Indicate that all channels are disabled |
| ADR Mode | Enable or disable network server to adjust Spreading Factor, Bandwidth an 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 Setting

General settings include the basic parameters of the device.

| Reporting Interval | – 1080 + min |
|---|---|
| Change Password | ⬤ |

| Parameters | Description |
|---|---|
| Reporting Interval | The interval to report current data to network server. Range: 1-1080 minutes, Default: 10 minutes. |
| Change Password | Change the device password for ToolBox App to write this device. |

# Threshold Setting

You can set a relative initial surface to measure the deviance from an initial one, when the device detects the angle of a certain axis reaches the threshold based on the initial position, it will upload the current data instantly.

**Deflection Angle**

Relative Initial Surface (i)  [ Setting ]  [ Clear ]

The triaxial angle relative to the initial face is (0.00°, 0.00°, –90.00°)

**X-axis**

Over / °

Below / °

**Y-axis**

**Z-axis**

Alarm Condition (i)

Alarm Reporting Interval  [ – ]  1  [ + ]  min

Alarm Reporting Times  [ – ]  2  [ + ]

| Parameter | Description |
|---|---|
| Relative Initial Surface | Click **Setting** to set current position of device as initial position to measure the deflection angle.<br><br>Click **Clear** to change the initial position back to (0.00°, 0.00°, -90.00°).<br><br>📝 **Note:**<br>after writing **Setting** or **Clear** configuration, click **Read** to read the device to check if the initial position changes successfully. |

| Parameter | Description |
|---|---|
| Over / ° | The maximum/upper limit of angle threshold. |
| Below / ° | The minimum/lower limit of angle threshold. |
| Alarm Condition | Acceptable elements are "X", "Y", "Z", "and", "or" "only", it takes 2 or 3 axes to complete an expression and the device will only read from left to right. If left blank, it will consider the condition as "or". <br><br> **Example:** <br><br> • XandYorZ means (X and Y) or Z, that is XandY meets the threshold or Z meets the threshold. <br> • XorYandZ means (X or Y) and Z, that is XandZ meets the threshold or YorZ meets the threshold. |
| Alarm Reporting Interval | After the threshold is triggered, the device will detect if the threshold is triggered again according to this reporting interval. |
| Alarm Reporting Times | After the threshold is triggered, the device will detect according to Alarm Reporting Interval and if still triggered, the device will send the certain number of alarms to NS. |

**Example:**

When X axis is detected to 0° (0° - 1.91° = -1.91° < -1°), it will trigger the threshold and upload a alarm package right away. If it changes back to normal, the device will also upload a data package immediately; if not, it will send alarm package after 1 minute. This process will repeat 2 times.

# Maintenance

## Upgrade

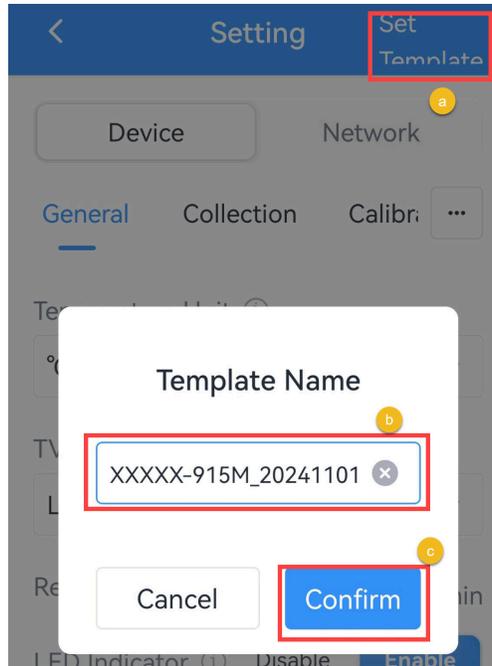This chapter describes the steps to upgrade the device via ToolBox App.

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.
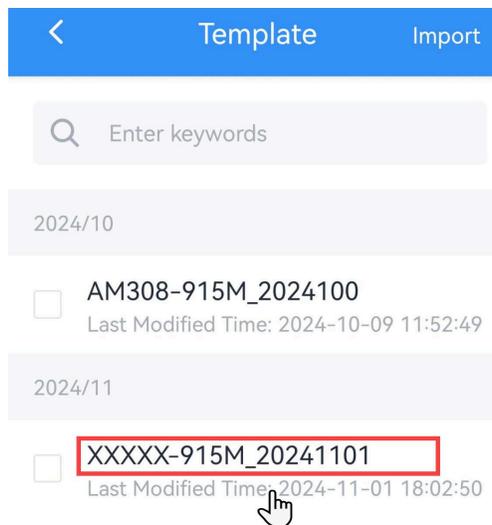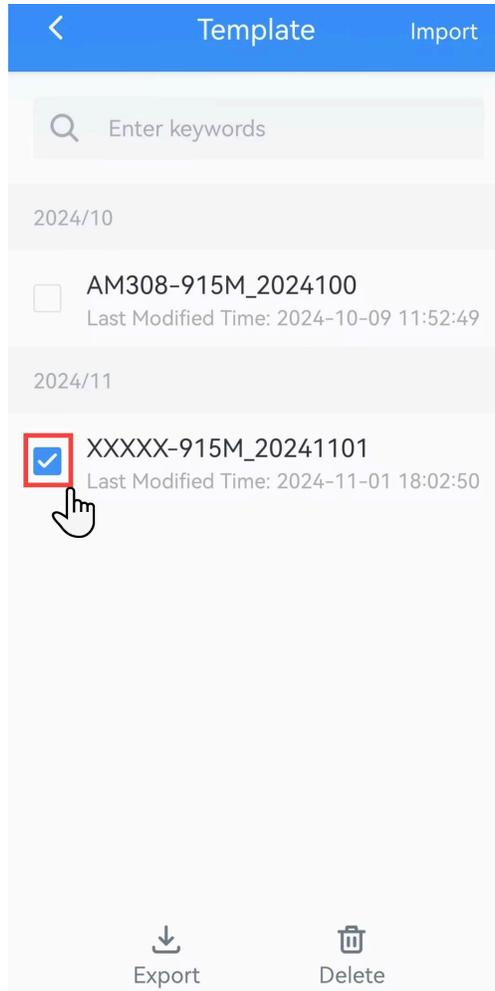


**Export and Delete Template**

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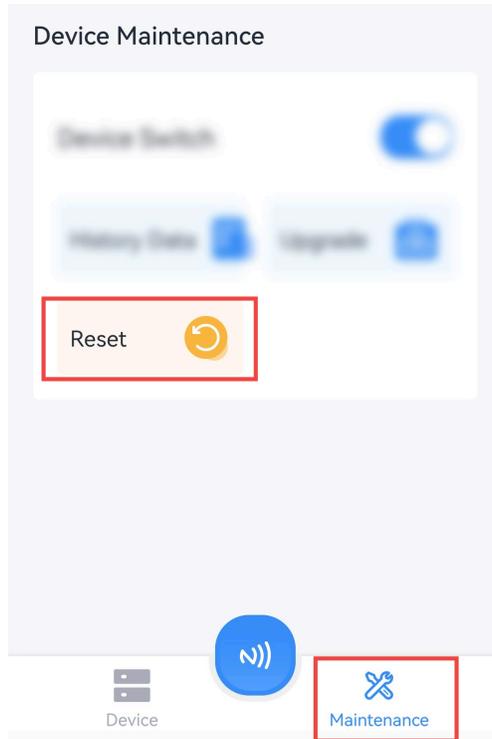
2. Click **Export** to export this template as JSON format file and save it to the smartphone, click **Delete** to delete this template from your ToolBox App.



## 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**

1. Here is the angle reference with difference gesture for installation:
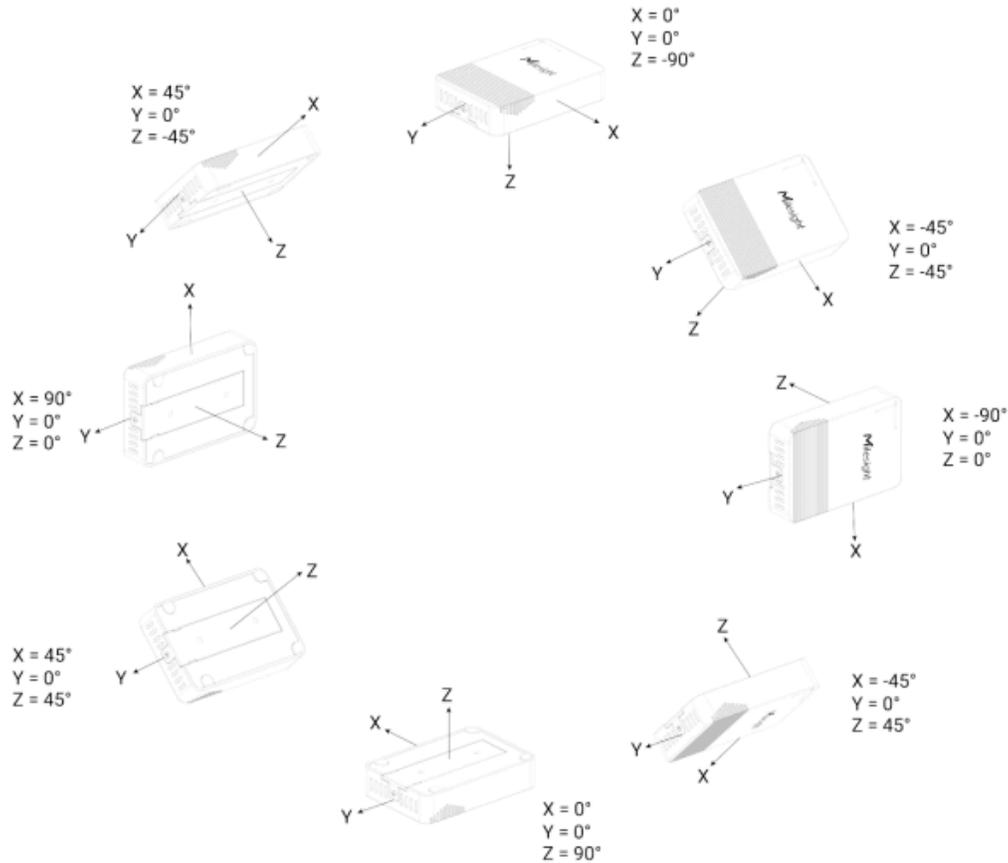


2. Ensure the location of device is within the communication range of LoRaWAN® gateway and keep it away from metal objects.

3. Ensure that the device is tightly attached without any gap to the surface to be measured of a certain object, and one of the 3 axes should be paralleled with the measuring axis of the object, otherwise, the result may not be correct.
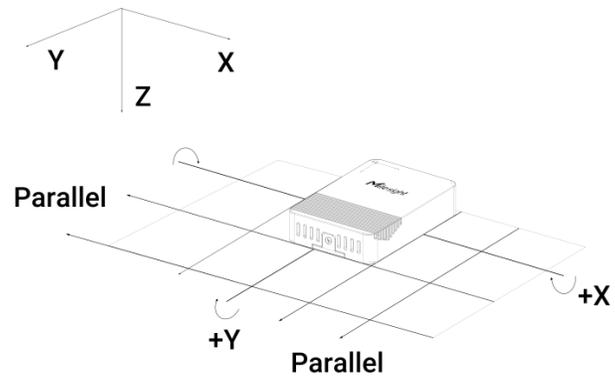
## Installation Steps

The device supports wall mounting or pole mounting.

### Wall Mounting

1. Remove the backplate on the back of the device, screw the wall plugs into the wall and fix the backplate with screws on it, then install back the device. Note that the vent of device should not face upwards when installing.
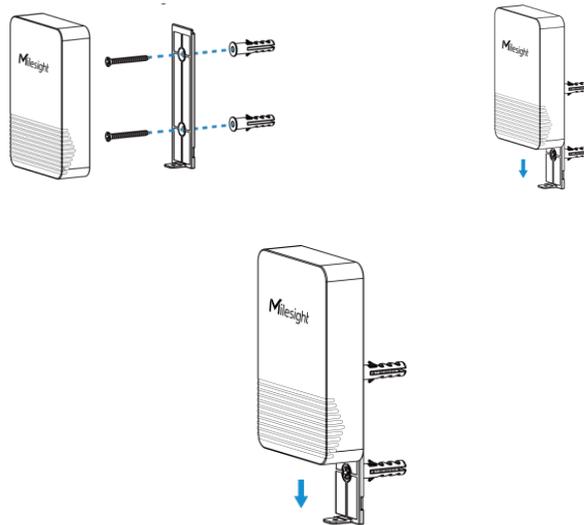


2. Fix the bottom of the device to the cover with a fixing screw.

**Pole Mounting**

Switch the backplate on the back of the device to the pole mounting plate and fix the plate with a screw, then pass a cable tie through the plate and wrap it with device to the pole.
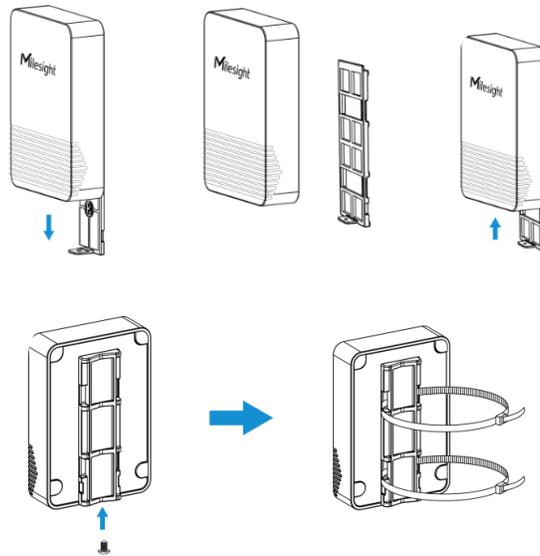
# Chapter 7. Battery Replacing

When the batteries have run out of power, please release the screws behind the rubber feet, and then remove the back cover to replace the new batteries.
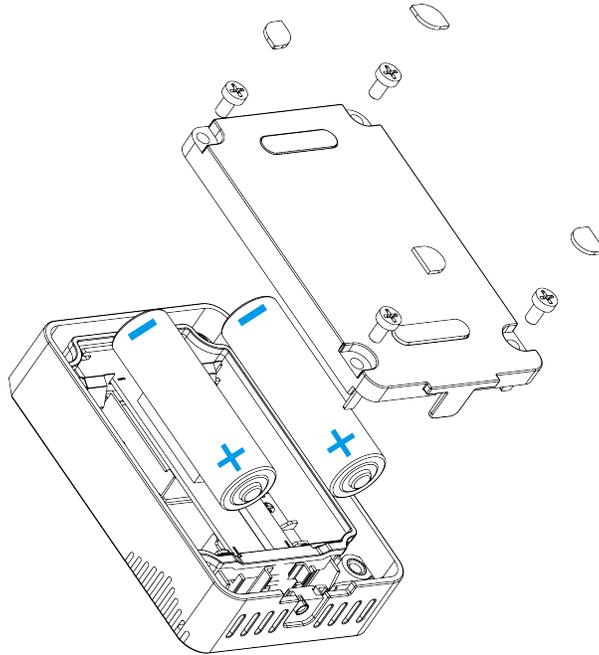


📝 **Note:**

- The device can only be powered by the ER14505 Li-SOCl$_2$ batteries. The alkaline battery is not supported.
- The battery should be removed from the device if it is not to be used for an extended period. Otherwise, the battery might leak and damage the device. Never leave a discharged battery in the battery compartment.
- 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.

| 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 |
| Battery Level | 01 | 75 | 1 | UINT8, Unit: % |
| Angle | 03 | d4 | 6 | angle_x(2B) + angle_y(2B) + angle_z(2B), Unit:°, Resolution: 0.01°<br><br>angle_x bit0: 0-normal; 1-trigger<br><br>angle_y bit0: 0-normal; 1-trigger<br><br>angle-z bit0: 0-normal; 1-trigger |

| Item | Channel | Type | Byte | Description |
|---|---|---|---|---|
|  |  |  |  | **Note:** the angles are based on relative initial surface. |

## Basic Information

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

**Example:**

| ff0bff ff0101 ff166785c38144050018 ff090110 ff0a0101 ff0f00 |||
|---|---|---|
| **Channel** | **Type** | **Value** |
| ff | 0b | ff |
| ff | 01 | 01=V1 |
| ff | 16 | 6785c38144050018 |
| ff | 09 | 0110=V1.1 |
| ff | 0a | 0101=V1.1 |
| ff | 0f | 00: Class A |

## Periodic Report

The device supports to report sensor data according to reporting interval (1080mins by default).

**Example:**

| 017564 03d498fd 44ff 6b22 |||
|---|---|---|
| **Channel** | **Type** | **Value** |
| 01 | 75 | Battery: 64=>100% |
| 03 | d4 | X: 98 fd => fd 98 = (-616-0)/2 * 0.01 = -3.08°  Y: 44 ff => ff 44= (-188-0)/2 * 0.01 = -0.94° |

| 017564 03d498fd 44ff 6b22 | | |
|---|---|---|
| **Channel** | **Type** | **Value** |
| | | Z: 6b 22 => 22 6b= (8811-1)/2 * 0.01= 44.05° |
| | | X_bit0: 0 => normal |
| | | Y_bit0: 0 => normal |
| | | Z_bit0: 1 => trigger |

## Alarm Report

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

1. Angle threshold alarm: report when threshold alarm is triggered.

| 03d498fd 44ff 6b22 | | |
|---|---|---|
| **Channel** | **Type** | **Value** |
| 03 | d4 | X: 98 fd => fd 98 = (-616-0)/2 * 0.01 = -3.08° |
| | | Y: 44 ff => ff 44= (-188-0)/2 * 0.01 = -0.94° |
| | | Z: 6b 22 => 22 6b= (8811-1)/2 * 0.01= 44.05° |
| | | X_bit0: 0 => normal |
| | | Y_bit0: 0 => normal |
| | | Z_bit0: 1 => trigger |

2. Low battery level alarm: report when the battery level drops to 1%.

| 017501 | | |
|---|---|---|
| **Channel** | **Type** | **Value** |
| 01 | 75 | 01=1% |

# Downlink Command

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

## General Setting

| Item | Channel | Type | Byte | Description |
|---|---|---|---|---|
| Reboot | ff | 10 | 1 | ff |
| Report Interval | ff | 03 | 2 | UINT16, Unit: s |

**Example:**

1. Reboot the device.

| ff10ff |
|---|

2. Set report interval as 20 minutes.

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

## Angle Threshold Setting

| Channel | Type | Byte | Description |
|---|---|---|---|
| ff | 06 | 9 | CTRL (1B) + Min (2B) + Max (2B) +Alarm Reporting Interval (2B) + Alarm Reporting Times(2B)<br><br>**CTRL:**<br><br>Bit 0~2:<br><br>000-disable<br><br>001-below (minimum threshold)<br><br>010-over (maximum threshold)<br><br>011-within |

| Channel | Type | Byte | Description |
|---|---|---|---|
| | | | 100-below or over |
| | | | Bit 3~5: |
| | | | 001: X-axis angle |
| | | | 010: Y-axis angle |
| | | | 011: Z-axis angle |
| | | | Bit 6~7: 00 |
| | | | Min./Max. Threshold: INT16/100, Unit: ° |

**Example:**

Set X-axis threshold between 10° and 20°, it will detect the threshold every 1 minute, send alarm 3 times at most.

| ff060ce803d0073c000300 | | |
|---|---|---|
| **Channel** | **Type** | **Value** |
| ff | 06 | 0c => 00 001 100 = when X axis angle is below or over, <br><br> e803 => 03e8=1000/100 = 10.00° <br><br> d007 => 07d0= 2000/100 = 20.00° <br><br> 3c00 => 60 s = 1 min <br><br> 0300 => 00 03 = 3 times |

## Alarm Setting

| Item | Channel | Type | Byte | Description |
|---|---|---|---|---|
| Initial Position | ff | 62 | 1 | ff-set current position as initial position <br><br> fe-set the initial position to (0.00°, 0.00°, -90.00°) |

| Item | Channel | Type | Byte | Description |
|------|---------|------|------|-------------|
| Alarm Condition | ff | 63 | 8 | hex string of ASCII expression; if ASCII expression takes less than 8 bytes, add 0 in the end to meet the size. <br><br> ✏️ **Note:** <br> before setting the condition, ensure the corresponding axis threshold is enabled, or this condition will not work. |

**Example:**

1. Set the alarm condition to be X and Y or Z, before setting ensure X, Y and Z thresholds are enabled.

| ff635826597c5a000000 | | |
|------------------------|------|-------|
| **Channel** | **Type** | **Value** |
| ff | 63 | 5826597c5a000000 = X&Y|Z |

2. Set current position as initial position.

| ff62ff | | |
|--------|------|-------|
| **Channel** | **Type** | **Value** |
| ff | 62 | ff = set current position as initial position |

# 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

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