



# Tilt Sensor

Featuring LoRaWAN®

**EM310-TILT**

User Guide



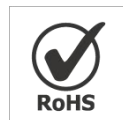
## Safety Precautions

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

- ❖ The device must not be disassembled or remodeled in any way.
- ❖ In order to protect the security of the device, please change the device password when first configuration. The default password is 123456.
- ❖ The device is not intended to be used as a reference sensor, and Milesight won't shoulder 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 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.
- ❖ The device must never be subjected to shocks or impacts.

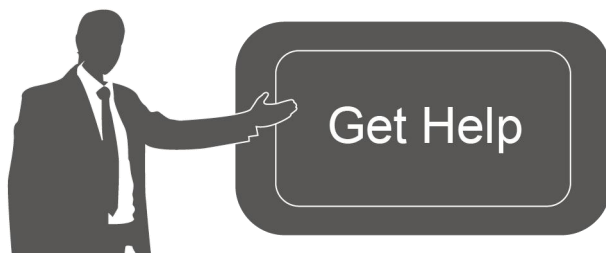
## Declaration of Conformity

EM310-TILT conforms with the essential requirements and other relevant provisions of the CE, FCC, and RoHS.



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## Revision History

Date	Doc Version	Description
July 7, 2022	V 1.0	Initial version

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# 1. Product Introduction

## 1.1 Overview

EM310-TILT is a LoRaWAN® tilt sensor mainly for angle measurement and asset movement detection. With a compact size and 3-axis accelerometer, EM310-TILT can easily be installed on the objects to measure their X, Y, Z tilt angles. It can also detect the movement based on angle changes and send threshold alarms. It is equipped with NFC (Near Field Communication) and can easily be configured by a smartphone.

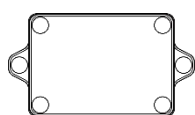
Sensor data are transmitted in real-time using the standard LoRaWAN® protocol. LoRaWAN® enables encrypted radio transmissions over long distance while consuming very little power. The user can obtain sensor data and view the trend of data change through Milesight IoT Cloud or through the user's own Network Server.

## 1.2 Features

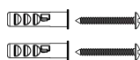
- Built-in MEMS 3-axis accelerometer to measure the 3-dimensional tilt angles of objects
- Flexible threshold condition settings, suitable for different kinds of applications
- Easy to install, suitable for various types of objects such as trees, poles, grounds, etc.
- IP67 waterproof enclosure for outdoor applications and easy to clean
- Up to 15 km communication range
- Easy configuration via NFC
- Standard LoRaWAN® support
- Milesight IoT Cloud compliant
- Low power consumption with 7000 mAh replaceable batteries

## 2. Hardware Introduction

### 2.1 Packing List



1 × EM310-TILT  
Device



2 × Mounting  
Kits



2 × Screw Caps



1 ×  
Warranty Card

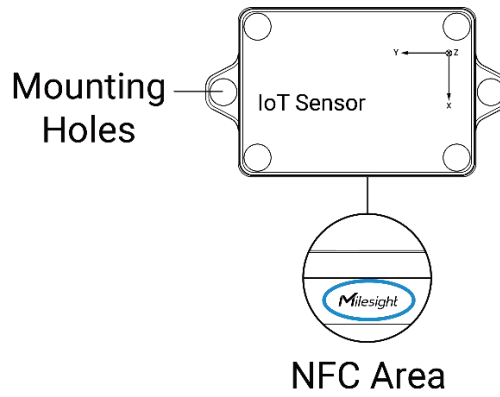


1 ×  
Quick Guide

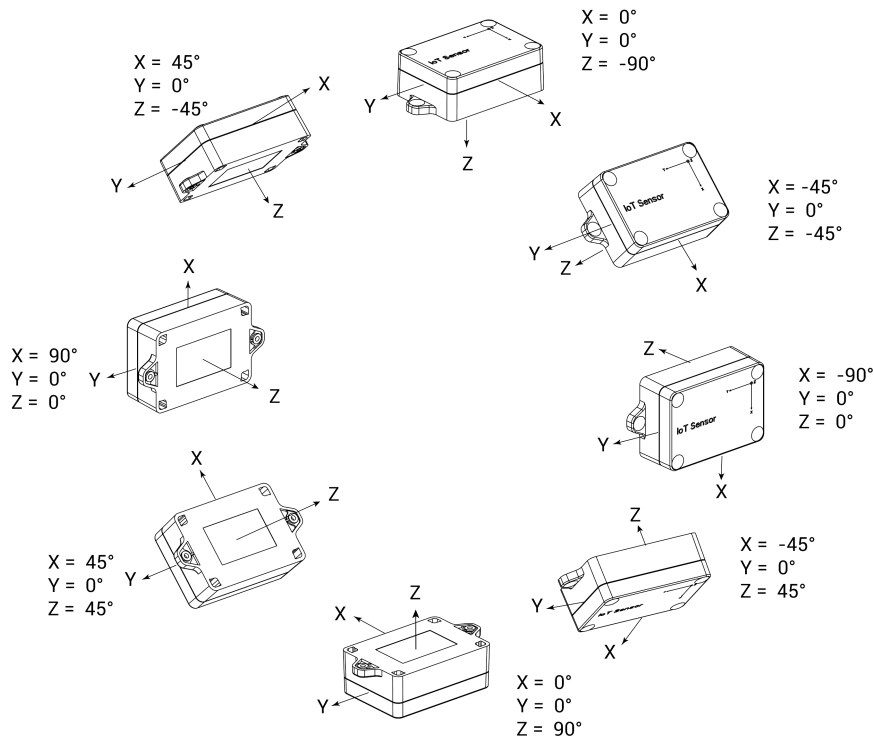


**If any of the above items is missing or damaged, please contact your sales representative.**

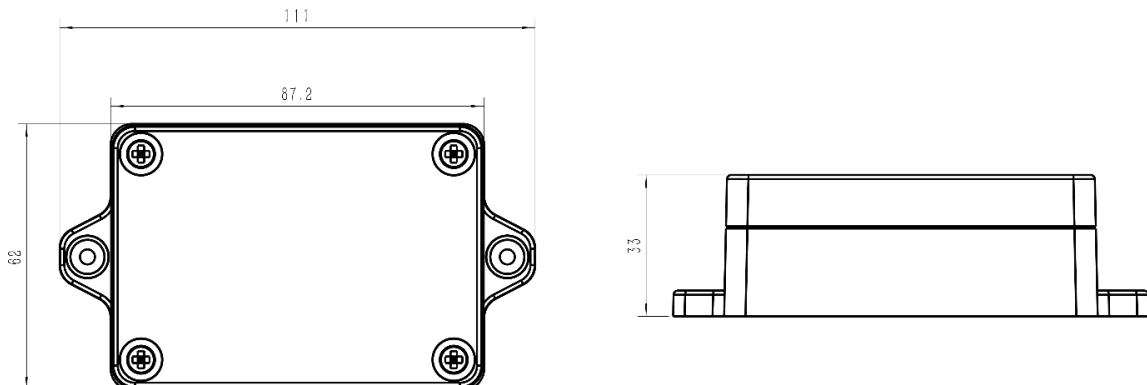
## 2.2 Hardware Overview



When you install EM310-TILT on site, below is the angle number you can expect with corresponding device gesture.



## 2.3 Dimensions (mm)



## 2.4 Power Button

EM310-TILT can be switched on/off via NFC. Besides, users can use power button to switch on/off and reset the device manually.

Function	Action	LED Indication
Switch On	Press and hold the button for more than 3 seconds.	Off → On
Switch Off	Press and hold the button for more than 3 seconds.	On → Off
Reset	Press and hold the button for more than 10 seconds.	Quickly Blinks
Check On/Off Status	Quickly press the power button.	Light On: Device is on Light Off: Device is off

## 3. Operation Guide

### 3.1 NFC Configuration

EM310-TILT can be configured via NFC.

1. Download and install “Milesight ToolBox” App from Google Play or App Store.
2. Enable NFC on the smartphone and open “Milesight ToolBox” App.
3. Attach the smartphone with NFC area to the device to read the basic information.



4. Basic information and settings of devices will be shown on ToolBox if it's recognized successfully. You can read and configure the device by tapping the Read/Write button on the App. In order to protect the security of devices, password validation is required when first configuration. The default password is **123456**.

**Note:**

- 1) Ensure the location of smartphone NFC area and it's recommended to take off phone case.
- 2) If the smartphone fails to read/write configurations via NFC, keep the phone away and back to try again.
- 3) EM310-TILT can also be configured by dedicated a NFC reader provided by Milesight IoT or you can configure it via the TTL interface inside the device.

### 3.2 LoRaWAN Settings

LoRaWAN settings are used for configuring the transmission parameters in LoRaWAN® network.

#### Basic LoRaWAN Settings:

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

Device EUI

\* APP EUI

\* Application Port  85

Join Type

\* Application Key

LoRaWAN Version

Work Mode

RX2 Data Rate

RX2 Frequency

Confirmed Mode

Rejoin Mode

Set the number of detection signals sent

ADR Mode

Spreading Factor

TXPower



Parameters	Description
Device EUI	Unique ID of the device which can also be found on the label.
App EUI	Default App EUI is 24E124C0002A0001.
Application Port	The port used for sending and receiving data and the default port is 85.
Join Type	OTAA and ABP mode are both available.
Application Key	Appkey for OTAA mode, which can be changed, is default as 5572404C696E6B4C6F52613230313823.
Device Address	DevAddr for ABP mode , which can be changed, is default as the 5 <sup>th</sup> to 12 <sup>th</sup> digits of SN.
Network Session Key	Nwkskey for ABP mode, which can be changed, is default as 5572404C696E6B4C6F52613230313823.
Application Session Key	Appskey for ABP mode, which can be changed, is default as 5572404C696E6B4C6F52613230313823.
LoRaWAN Version	V1.0.2, V1.0.3 and V1.1.0 are available.
Work Mode	This device supports Class A only.
Spread Factor	If ADR is disabled, the device will send data via this spread factor.
RX2 Data Rate	RX2 data rate to receive downlinks.
RX2 Frequency/MHz	RX2 frequency to receive downlinks.
Confirmed Mode	If the device does not receive ACK packet from network server, it will resend data once.
Rejoin Mode	Reporting interval $\leq$ 30 mins: the device will send a specific number of LinkCheckReq MAC packets to the network server every 30 mins to validate connectivity; If there is no response, the device will re-join the network. Reporting interval $>$ 30 mins: the device will send a specific number of LinkCheckReq MAC packets to the network server every reporting interval to validate connectivity; If there is no response, the device will re-join the network.
Set the number of packets sent	When rejoin mode is enabled, set the number of LinkCheckReq packets sent.
ADR Mode	Allow network server to adjust data transmission rate of the device.
Tx Power	Transmit power of device.

**Note:**

- 1) Please contact sales for device EUI list if there are many units.
- 2) Please contact sales if you need random App keys before purchase.
- 3) Select OTAA mode if you use Milesight IoT cloud to manage devices.
- 4) Only OTAA mode supports rejoin mode.

**LoRaWAN Frequency Settings:**

Go to “**Setting -> LoRaWAN Settings**” of ToolBox App to select supported frequency and select channels to send uplinks. Make sure the channels match the LoRaWAN® gateway.

\* Support Frequency

AS923

<input checked="" type="checkbox"/>	-	923.2	+
<input checked="" type="checkbox"/>	-	923.4	+
<input type="checkbox"/>	-	922.2	+
<input type="checkbox"/>	-	922.4	+
<input type="checkbox"/>	-	922.6	+

If frequency is one of CN470/AU915/US915, you can enter the index of the channel that you want to enable in the input box, making them separated by commas.

**Examples:**

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: Indicating that all channels are disabled

\* Support Frequency

AU915

Enable Channel Index ⓘ

0-71

Index	Frequency/MHz ⓘ
0 - 15	915.2 - 918.2
16 - 31	918.4 - 921.4
32 - 47	921.6 - 924.6
48 - 63	924.8 - 927.8

**Note:**

For -868M model, the default frequency is EU868;

For -915M model, the default frequency is AU915.

### 3.3 Basic Settings

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

Reporting Interval  1080  min

Change Password

Parameters	Description
Reporting Interval	Reporting interval of transmitting data to network server. Default: 1080 mins, Range: 1-1080 mins
Change Password	Change the password for ToolBox App or software to access this device.

### 3.4 Threshold Settings

Go to “**Device -> Setting -> Threshold Settings**” of ToolBox App to enable the threshold settings and input the angle threshold. You can set a relative initial surface to measure the deviance from

an initial one and if 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 ⓘ 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 ⓘ

Alarm Reporting Interval  1  min

Alarm Reporting Times  2

Parameters	Description
Initial Position	<p>Click "Setting" to set current position of device as initial position to measure the deflection angle.</p> <p>Click "Clear" to change the initial position back to (0.00°, 0.00°, -90.00°).</p> <p><b>Note:</b> after writing "Setting" or "Clear" configuration, click "Read" to read the device to check if the initial position changes successfully.</p>
Over / °	The maximum/upper limit of angle threshold.
Below / °	The minimum/lower limit of angle threshold.
Alarm Condition	<p>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".</p> <p><b>Example:</b></p> <p>1) XandYorZ means (X and Y) or Z, that is XandY meets the threshold or Z meets the threshold.</p> <p>2) XorYandZ means (X or Y) and Z, that is XandZ meets the threshold or YorZ meets the threshold.</p>

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  $0^\circ$  ( $0^\circ - 1.91^\circ = -1.91^\circ < -1^\circ$ ), 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.

**Deflection Angle**

Relative Initial Surface ⓘ Setting Clear

The triaxial angle relative to the initial face is  
(1.91°, -2.03°, -87.21°)

**X-axis**

Over / °

Below / °

**Y-axis**

**Z-axis**

Alarm Condition ⓘ

Alarm Reporting Interval  1  min

Alarm Reporting Times  2

## 3.5 Maintenance

### 3.5.1 Upgrade

1. Download firmware from Milesight website to your smartphone.
2. Open Toolbox App and click "Browse" to import firmware and upgrade the device.

**Note:**

- 1) Operation on ToolBox is not supported during a firmware upgrade.
- 2) Only Android version ToolBox supports the upgrade feature.

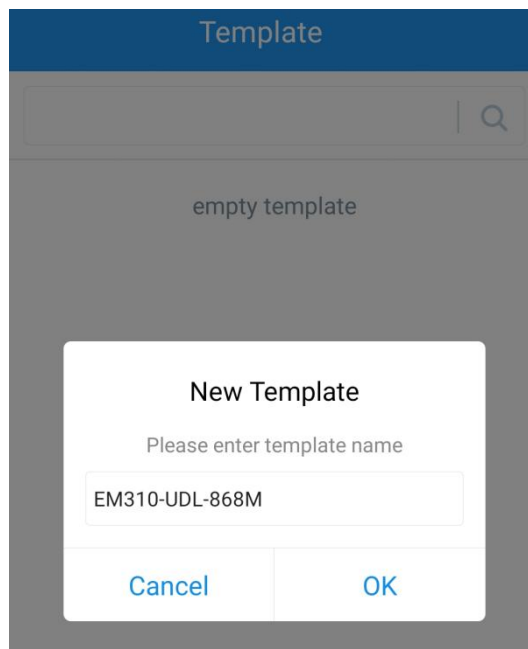
Status	Setting	Maintenance
SN	6713B44501730017	
Model	EM310-TILT-470M	
Firmware Version	V1.1	
Hardware Version	V1.0	
Manual Upgrade		

[Browse](#)






### 3.5.2 Backup

EM310-TILT supports configuration backup for easy and quick device configuration in bulk. Backup is allowed only for devices with the same model and LoRa frequency band.

1. Go to "Template" page on the App and save current settings as a template. You can also edit the template file.
2. Select one template file which saved in the smartphone and click "Write", then attach to another device to write configuration.



**Note:** Slide the template item left to edit or delete the template. Click the template to edit the configurations.

Template	
<input type="text"/>	<input type="text"/>
 EM500-UDL-868M_20201124 Last Modified Time: 2020-11-24 17:06:26	
 EM300-TH-915M_20210112 Last Modified Time: 2021-01-12 14:35:12	
 UC512-DI-868M_20210128 Last Modified Time: 2021-01-28 16:57:20	
 UC501-470M_20210201 Last Modified Time: 2021-02-01 11:29:43	
 M_20210208 Last Modified Time: 2021-02-08 16:44:37	<span>Edit</span> <span>Delete</span>

### 3.5.3 Reset to Factory Default

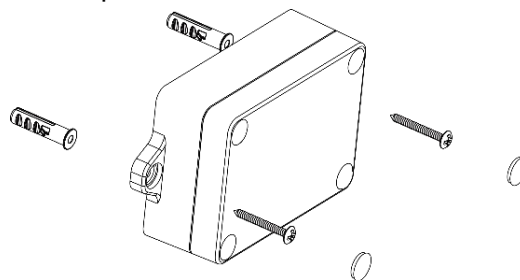
Please select one of following methods to reset device:

**Via Hardware:** Hold on power button (internal) for more than 10 s.

**Via ToolBox App:** Go to “**Device -> Maintenance**” to click “Reset”, then attach smartphone with NFC area to device to complete the reset process.

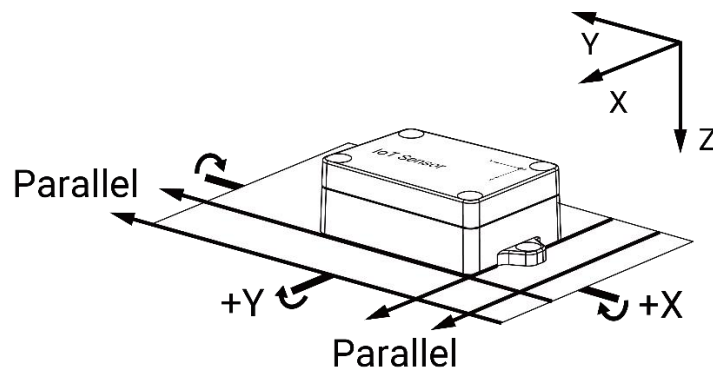
## 4. Installation

1. Fix the wall plugs into the wall, then fix the device to the wall plugs with screws.
2. Cover the screws with screw caps.



#### Installation location:

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



## 5. Device Payload

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

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

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

### 5.1 Basic Information

EM310-TILT reports basic information of sensor whenever it joins the network.

Channel	Type	Description
ff	01 (Protocol Version)	01=>V1
	09 (Hardware Version)	01 40 => V1.4
	0a (Software Version)	01 14 => V1.14
	0b (Power On)	Device is on
	0f (Device Type)	00: Class A, 01: Class B, 02: Class C
	16 (Device SN)	16 digits

**Example:**

ff0bff ff0101 ff166713b31056670013 ff090100 ff0a0100 ff0f00					
Channel	Type	Value	Channel	Type	Value
ff	0b (Power On)	ff (Reserved)	ff	01 (Protocol Version)	01 (V1)
ff	16 (Device SN)	6713b3105 6670013	ff	09 (Hardware version)	0100 (V1.0)
ff	0a (Software version)	0100 (V1.0)	ff	0f (Device Type)	00 (Class A)



## 5.2 Sensor Data

EM310-TILT reports all sensor data according to reporting interval (1080 mins by default) or when threshold is triggered.

Channel	Type	Description
01	75 (Battery Level)	UINT8, Unit: %
03	cf (Angle)	7 bytes, Byte 1-6: XYZ angles, UINT16, Unit: 0.01° Byte 7: whether the angle reaches threshold, Bit 0: x; Bit 1: y; Bit 2: z

**Example:**

017562 03cf 6fff a500 4c22 07					
Channel	Type	Value	Channel	Type	Value
01	75 (Battery)	62 => 98%	03	cf (Angle)	X: 6f ff => ff 6f = -145*0.01 = -1.45° Y: a5 00 => 00 a5 = 165 * 0.01 = 1.65° Z: 4c 22 => 22 4c = 8780 * 0.01 = 87.80° 07 => 0111 = x, y, z all reached threshold

## 5.3 Downlink Commands

EM310-TILT supports downlink commands to configure the device. Application port is 85 by default.

Channel	Type	Description
ff	03 (Set Reporting Interval)	2 Bytes, unit: s
	10 (Reboot Device)	ff
	06 (Set Threshold)	9 bytes: 1 byte(Threshold type)+ 2 bytes(Min threshold) + 2 bytes (Max threshold) +2 bytes(Alarm reporting interval) + 2 bytes(Alarm reporting times) <b>Threshold type:</b>

		Bit 0~2: 000-disable 001-below (minimum threshold) 010-above (maximum threshold) 011-within 100-below or above Bit 3: X-axis angle Bit 4: Y-axis angle Bit 5: Z-axis angle Bit 6~7: reserved
	62 (Set Initial Position)	ff-set current position as initial position fe-set the initial position to (0.00°, 0.00°, -90.00°)
	63 (Set Alarm Condition)	8 bytes, hex string of ASCII expression; if ASCII expression takes less than 8 bytes, add 0 in the end to meet the size. <b>Note:</b> before setting the condition, ensure the corresponding axis threshold is enabled, or this condition will not work.

**Example:**

1. Set reporting interval as 20 minutes.

ff03b004		
Channel	Type	Value
ff	03 (Set Reporting Interval)	b0 04 => 04 b0 = 1200 s = 20 minutes

2. 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 (Set Threshold)	0c => 00 001 100 = when X axis angle is below or above, e803 => 1000 = 10.00° d007 => 2000 = 20.00° 3c00 => 60 s = 1 min 0300 => 00 03 = 3 times

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

<b>ff635826597c5a0000</b>		
<b>Channel</b>	<b>Type</b>	<b>Value</b>
ff	63 (Set Alarm Condition)	5826597c5a0000 = X&Y Z

4. Set current position as initial position.

<b>ff62ff</b>		
<b>Channel</b>	<b>Type</b>	<b>Value</b>
ff	62 (Set Initial Position)	ff = set current position as initial position

**-END-**