Tilt Sensor

Featuring LoRaWAN®

EM320-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 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 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.

❖ Make sure all batteries are newest when install, or battery life will be reduced.

❖ The device must never be subjected to shocks or impacts.

Declaration of Conformity

EM320-TILT is in conformity with the essential requirements and other relevant provisions of the CE, FCC, and RoHS.
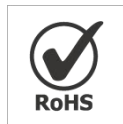
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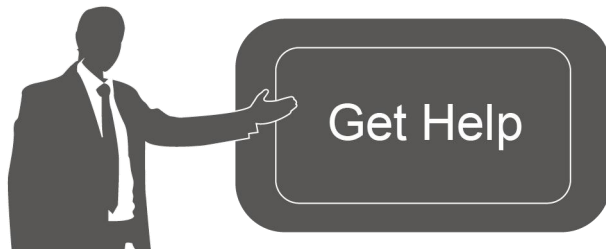
For assistance, please contact Milesight technical support:

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Support portal: support.milesight-iot.com

Tel: 86-592-5085280

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Revision History

Date	Doc Version	Description
Feb.14, 2023	V 1.0	Initial version

Contents

1. Product Introduction

1.1 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.

1.2 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

● Compliant with Milesight IoT Cloud

2. Hardware Introduction

2.1 Packing List
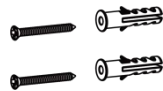
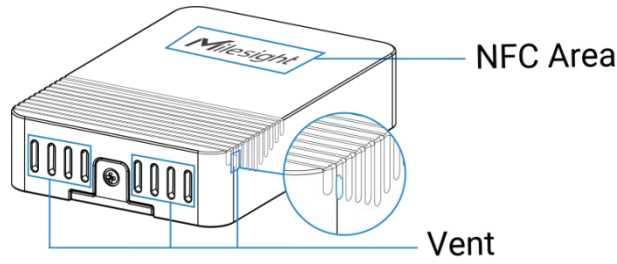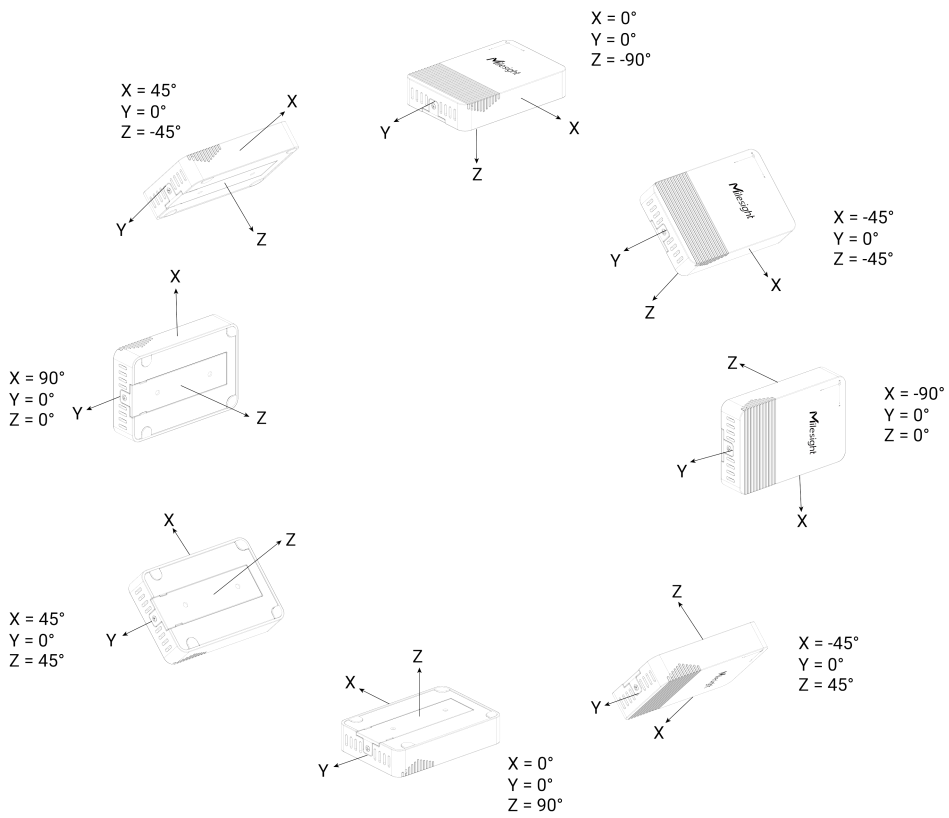| 1 × EM320-TILT Sensor | 2 × Wall Mounting Kits | 1 × Fixing Screw | 1 × Quick Start Guide | 1 × Warranty Card |

⚠ **If any of the above items is missing or damaged, please contact your sales Representative.**
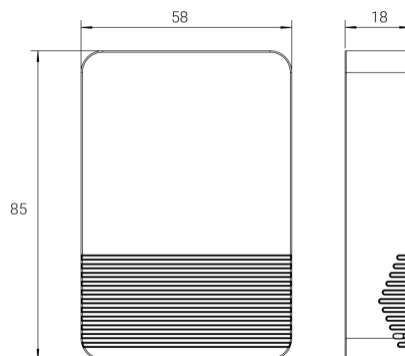
2.2 Hardware Overview

When you install EM320-TILT on site, below is the angle number you can expect with corresponding device gesture.

2.3 Dimensions(mm)

2.4 Power Button

The LED indicator and power button are inside the device. Switch on/off and reset can also be configured via NFC.

Function	Action	LED Indication
Turn On	Press and hold the button for more than 3 seconds.	Off → On
Turn Off	Press and hold the button for more than 3 seconds.	On → Off
Reset	Press and hold the button for more than 10 seconds.	Blink 3 times.
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

EM320-TILT sensor can be monitored and configured via NFC. Please refer the following steps to complete configuration.

1. Download and install "Milesight ToolBox" App from Google Play or Apple App Store.

2. Enable NFC on the smartphone and launch Milesight ToolBox.

3. Attach the smartphone with NFC area to the device to read device information. Basic information and settings of the device will be shown on ToolBox App if it's recognized successfully. You can read and configure the device by tapping the Read/Write device on the App. In order to protect the security of the device, please change password when first configuration. The default password is **123456**.
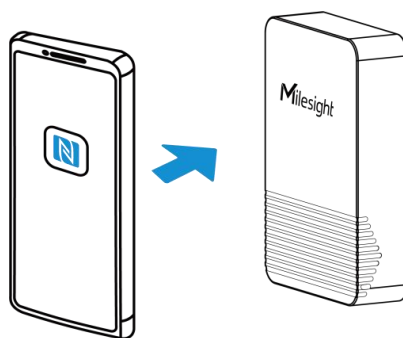
Note:

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) EM320-TILT sensor can also be configured by dedicated NFC reader, which can be purchased from Milesight IoT.

3.2 LoRaWAN Settings

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

Basic LoRaWAN Settings:
Go to **Device > Settings > 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

24E124785C381440

* APP EUI

24e124c0002a0001

* Application Port   –   85   +

Join Type

OTAA

* Application Key

****

LoRaWAN Version

V1.0.3

Work Mode

Class A

Confirmed Mode ⓘ

Rejoin Mode

Set the number of detection signals sent ⓘ

32

ADR Mode ⓘ

Spreading Factor ⓘ

SF10-DR2

TXPower

TXPower0-16 dBm

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 is used for sending and receiving data, default port is 85.
Join Type	OTAA and ABP mode are available.
Application Key	Appkey for OTAA mode, default is 5572404C696E6B4C6F52613230313823.
Device Address	DevAddr for ABP mode, default is the 5th to 12th digits of SN.
Network Session Key	Nwkskey for ABP mode, default is 5572404C696E6B4C6F52613230313823.
Application Session Key	Appskey for ABP mode, default is 5572404C696E6B4C6F52613230313823.
LoRaWAN Version	V1.0.2, V1.0.3 are available.
Work Mode	It's fixed as Class A.
RX2 Data Rate	RX2 data rate to receive downlinks.
RX2 Frequency	RX2 frequency to receive downlinks. Unit: Hz
Spread Factor	If ADR is disabled, the device will send data via this spread factor.
Confirmed Mode	If the device does not receive ACK packet from network server, it will resend data once.
Rejoin Mode	Reporting interval ≤ 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 rate of the device.
Tx Power	Transmit power of the 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 **Settings > LoRaWAN Settings** to select supported frequency and select channels to send

uplinks. Make sure the channels match the LoRaWAN® gateway.

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: Indicates that all channels are disabled

3.3 Basic Settings

Go to **Device > Settings > General Settings** to change the reporting interval, etc.

Reporting Interval	− 1080 + min
Change Password	⬤

Parameters	Description
Reporting Interval	Reporting interval of transmitting current sensor values to network server. Default: 1080 mins, Range: 1-1080 mins
Change Password	Change the password for ToolBox App or software to read/write this device.

3.4 Threshold Settings

Go to **Device > Settings > Threshold Settings** 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	Click **Setting** to set current position of device as initial position to measure the deflection angle. Click **Clear** to change the initial position back to (0.00°, 0.00°, -90.00°). Note: after writing **Setting** or **Clear** configuration, click **Read** to read the device to check if the initial position changes successfully.
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". **Example:** 1) XandYorZ means (X and Y) or Z, that is XandY meets the threshold or Z meets the threshold. 2) 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.

3.5 Maintenance

3.5.1 Upgrade

1. Download firmware from www.milesight-iot.com 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 the upgrade.

2) Only Android version ToolBox supports the upgrade feature.

3.5.2 Backup

EM320-TILT sensor supports configuration backup for easy and quick device configuration in bulk. Backup is allowed only for devices with the same model and LoRaWAN® 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 that saved in the smartphone and click **Write**, then attach it to another device to write configuration.
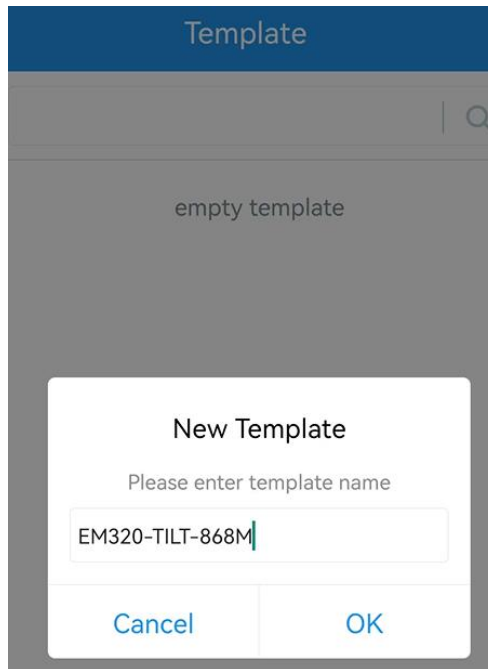
Note: Slide the template item to the left to edit or delete it. Click the template to edit the configurations.
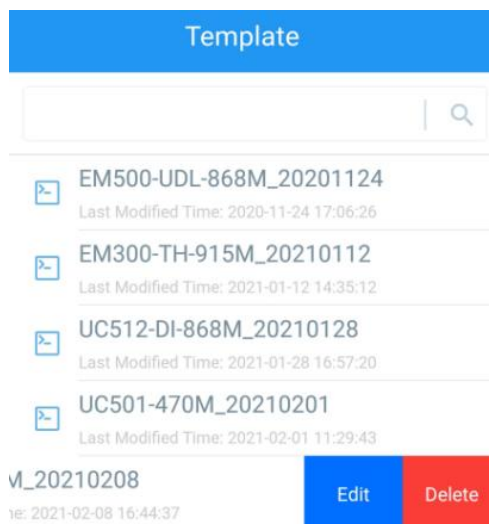
3.5.3 Reset to Factory Default

Please select one of following methods to reset device:

Via Hardware: Hold on reset button inside the device more than 10s.

Via ToolBox App: Go to **Device > Maintenance > Reset** to click **Reset**, then attach smart phone with NFC area to device to complete reset.
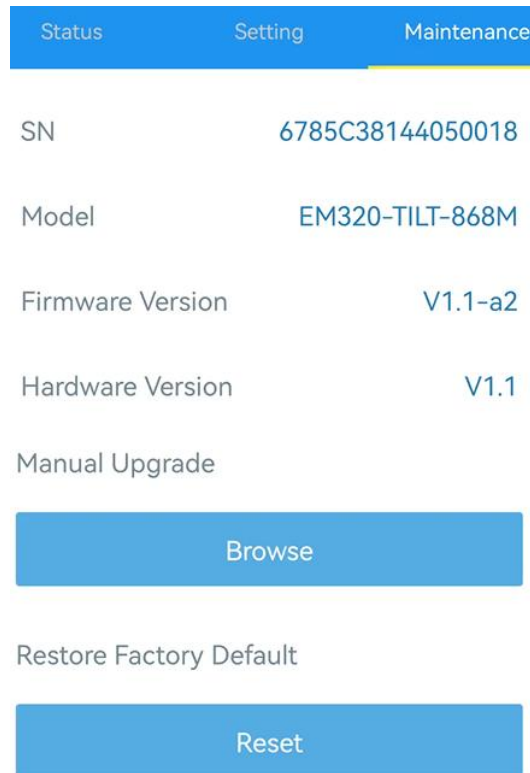
4. Installation

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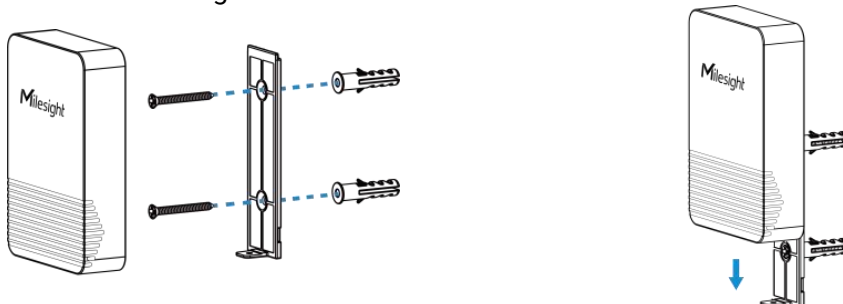
2. Fix the bottom of the device to the cover with a fixing screw.

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.
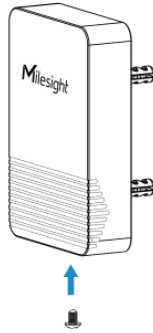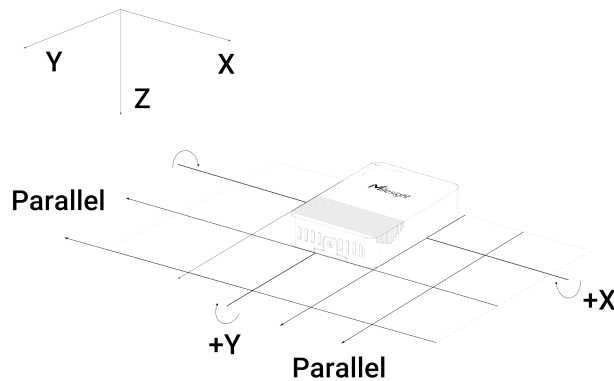

5. Device Payload

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
EM320-TILT sensors report basic information of sensor whenever joining 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 ff166785c38144050018 ff090110 ff0a0101 ff0f00					
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**
ff	0b (Power On)	ff (Reserved)	ff	01 (Protocol Version)	01 (V1.0)
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**
ff	16 (Device SN)	6785c38144050018	ff	09 (Hardware version)	0110 (V1.1)
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**
ff	0a (Software version)	0101 (V1.1)	ff	0f (Device Type)	00 (Class A)

5.2 Sensor Data

EM320-TILT sensors report sensor data according to reporting interval (1080mins by default).

Item	Channel	Type	Description
Battery Level	01	75	UINT8, Unit: %
Angle	03	d4	6 Bytes, INT16 angle_x (2B) + angle_y(2B) + angle_z(2B), Unit:°, Resolution: 0.01° angle_x bit0: 0-normal; 1-trigger angle_y bit0: 0-normal; 1-trigger angle-z bit0: 0-normal; 1-trigger

Example:

017564 03d498fd 44ff 6b22					
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**
01	75 (Battery Level)	64=>100%	03	d4 (Angle)	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=fd 98 => 1111 1101
1001 1000
X_bit0: 0 => normal
Y_bit0: 0 => normal
Z_bit0: 1 => trigger |

5.3 Downlink Commands

EM320-TILT sensors support downlink commands to configure the device. The application port is 85 by default.

Channel	Type	Description
ff	03 (Set Reporting Interval)	2 Bytes, unit: s
	06 (Set Threshold)	9 Bytes: Threshold Type(1B) + Min Threshold (2B) + Max Threshold (2B)+ Alarm Reporting Interval (2B) + Alarm Reporting Time (2B) Threshold Type: Bit0~Bit2: 000-disable 001-below (minimum threshold) 010-over (maximum threshold) 011-within 100-below or above Bit3: X-axis angle Bit4: Y-axis angle Bit5: Z-axis angle Bit6~Bit7: Reserved
	10 (Reboot)	ff (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. |
| | | **Note:** 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=1200s =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. Reboot the device.

ff10ff		
Channel	**Type**	**Value**
ff	10 (Reboot)	ff (Reserved)

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

ff635826597c5a0000		
Channel	**Type**	**Value**
ff	63 (Set Alarm Condition)	5826597c5a0000 = X&Y|Z

5. Set current position as initial position.

ff62ff		
Channel	**Type**	**Value**
ff	62 (Set Initial Position)	ff = set current position as initial position

-END-