Environment Monitoring Sensor

Featuring LoRaWAN®

EM300 Series

User Guide

Applicability

This guide is applicable to EM300 series sensors shown as follows, except where otherwise indicated.

Model	Description
EM300-TH	Temperature and Humidity Sensor
EM300-MCS	Magnet Switch Sensor
EM300-SLD	Spot Leak Detection Sensor
EM300-ZLD	Zone Leak Detection Sensor
EM300-DI	Pulse Counter Sensor

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.

❖ 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.

❖ 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.

❖ Make sure electronic components do not drop out of the enclosure while opening.

❖ When installing the battery, please install it accurately, and do not install the reverse or wrong model.

❖ Make sure both batteries are newest when install, or battery life will be reduced.
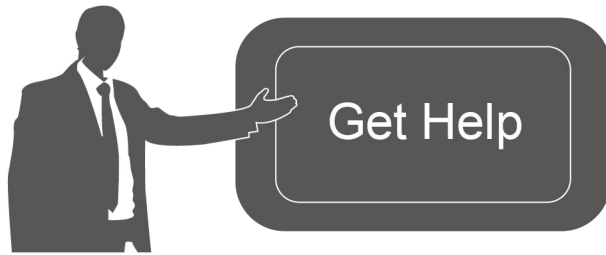
❖ The device must never be subjected to shocks or impacts.

Declaration of Conformity

EM300 series is in conformity with the essential requirements and other relevant provisions of the CE, FCC, and RoHS.

Revision History

Date	Doc Version	Description
Oct. 14, 2020	V 1.0	Initial version
Oct. 21, 2020	V 1.1	Model name change and pictures replace
Nov. 19, 2020	V 2.0	Layout replace
Mar. 4, 2021	V 2.1	Layout update
July 5, 2021	V 2.2	Delete USB Type-C description
Dec. 7, 2021	V 2.3	Add alarm setting, change SN to 16 digits
Nov. 24, 2022	V 2.4	1. Add EM300-DI model 2. Add Milesight D2D feature 3. Add data storage feature 4. Add time synchronization and data retransmission feature

Contents

1. Product Introduction

1.1 Overview

EM300 series is a sensor mainly used for outdoor environment through wireless LoRaWAN®
network. EM300 device is battery powered and designed for multiple mounting ways. It is
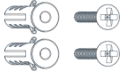equipped with NFC (Near Field Communication) and can easily be configured by a smartphone.

Sensor data are transmitted in real-time using 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

- Up to 11 km communication range
- Easy configuration via NFC
- Standard LoRaWAN® support
- Milesight IoT Cloud compliant
- Low power consumption with 4000mAh replaceable battery

2. Hardware Introduction

2.1 Packing List

| 1 × EM300 Sensor | 2 × Wall Mounting Kits | 2 × Screw Caps | 1 × Quick Guide |

| 1 × Warranty Card | 3M Double Sided Tape(SLD or MCS Sensor Only) | Mounting Screws (SLD or MCS Sensor Only) |

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

2.2 Hardware Overview
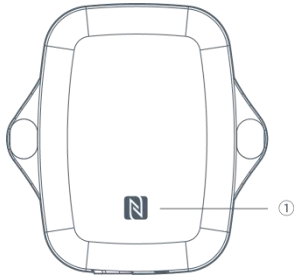
Front View:

① NFC Area

Bottom View:

② Vent

③ Waterproof Connectors

(For EM300-DI/MCS/SLD/ZLD)

2.3 GPIO Wiring (EM300-DI)

Reed Switch Meter

GPIO
(Red)

GND
(Black)

EM300-DI

2.3 Dimensions(mm)

85.26

88.52

105.56

27

105.56

85.26

27
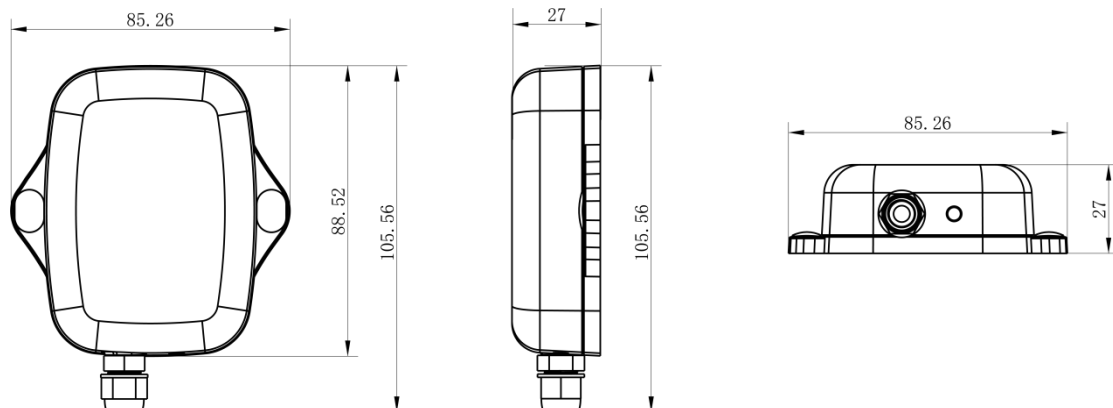
2.4 Power Button

Note: 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

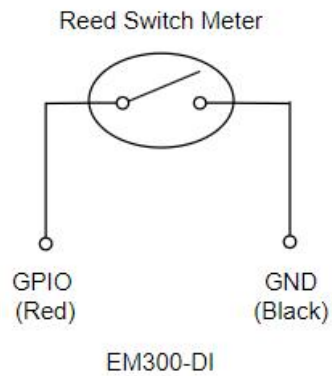EM300 series can be monitored and configured via NFC. Please refer the following steps to complete configuration.

1. Download and install "Milesight ToolBox" App from Google Play or Apple 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**.
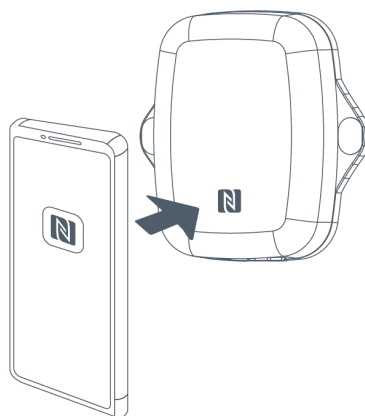
Note:

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) EM300 series can also be configured by dedicated NFC reader provided by Milesight IoT or you can configure it via TTL interface inside the device.
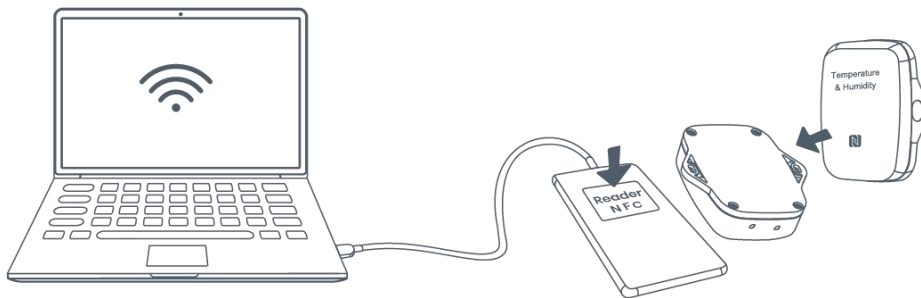
3.2 LoRaWAN Settings

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

Basic LoRaWAN Settings:

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

Device EUI

24E124136C379287

* APP EUI

24e124c0002a0001

* Application Port   –   85   +

Join Type

OTAA   ▼

* Application Key

****

LoRaWAN Version

V1.1.0   ▼

Work Mode

Class A ▾

RX2 Data Rate

DR0 (SF12, 125 kHz) ▾

RX2 Frequency

921900000

Confirmed Mode ⓘ ⬭

Rejoin Mode ⬤

Set the number of detection signals sent ⓘ

4

ADR Mode ⓘ ⬤

Spreading Factor ⓘ

SF10-DR2 ▾

TXPower

TXPower0-14 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 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, V1.1 are available.
Work Mode	It's fixed as Class A.
RX2 Data Rate	RX2 data rate to receive downlinks or send D2D commands.
RX2 Frequency	RX2 frequency to receive downlinks or send D2D commands. 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	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.
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 datarate 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** to select supported frequency and select channels to send uplinks. Make sure the channels match the LoRaWAN® gateway.
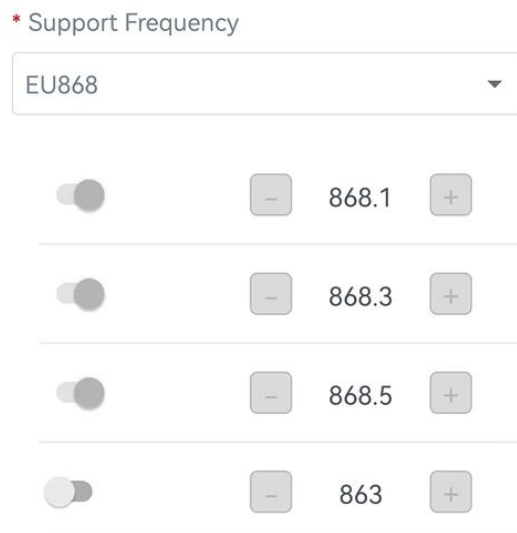
If frequency is one of CN470/AU915/US915, you can enter the index of the channel that you want to enable in the input box, making them separated by commas.

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 Time synchronization

ToolBox App Sync:

Go to **Device -> Status** of ToolBox App to click **Sync** to sync the time.

Network Server Sync:

Go to **Device > Settings > LoRaWAN Settings** of ToolBox App to change device LoRaWAN® version as 1.0.3 or above, the network server will use MAC command to assign the time to device every time it joins the network.

Note:

1) This function is only applicable to network server using LoRaWAN® 1.0.3 or 1.1 version.

2) Network server will sync the time which time zone is UTC+0 by default. It's suggested to sync the time via ToolBox App to change the time zone.

3.4 Basic Settings & Interface Settings

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

Parameters	Description
Reporting Interval	Reporting interval of transmitting current sensor values to network server. Default: 10 min
Temperature Unit	Change the temperature unit displayed on the ToolBox. **Note:** 1) The temperature unit in the reporting package is fixed as °C. 2) Please modify the threshold settings if the unit is changed.
Change Password	Change the password for ToolBox App or software to read/write this device.

For EM300-DI, go to **Device > Settings > Interface Settings** to modify configurations.

Parameters	Description
Interface Type	Change the interface type of GPIO interface. Counter and Digital is available, counter as default.
Pulse Filter	When the function is enabled, pulse with a rate of more than 250us can be counted.
Modify Count Value	Set the initial counting value.

3.5 Advanced Settings

3.5.1 Calibration Settings

ToolBox supports temperature and humidity calibration. Go to **Device > Setting > Calibration Settings** to type the calibration value and save, the device will add the calibration value to raw value.

3.5.2 Threshold Settings

Go to **Device > Setting > Threshold Settings** to enable the threshold settings and input the threshold. EM300 series will upload the current data once instantly when the temperature threshold is triggered. Note that when you change the temperature unit, please re-configured the threshold.

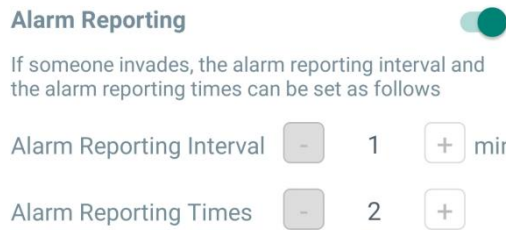### 3.5.3 Alarm Settings

Go to **Device > Setting > Alarm Settings** to enable the alarm settings. When EM300 detects door status change or water leakage, it will report the alarm according to reporting interval and reporting times setting.

3.5.4 Data Storage

EM300 series sensor supports storing more than 2000 data records locally and exports data via ToolBox App. The device will record the data according to reporting interval and even joining network.

1. Go to **Device > Setting > General Settings** to enable data storage feature.
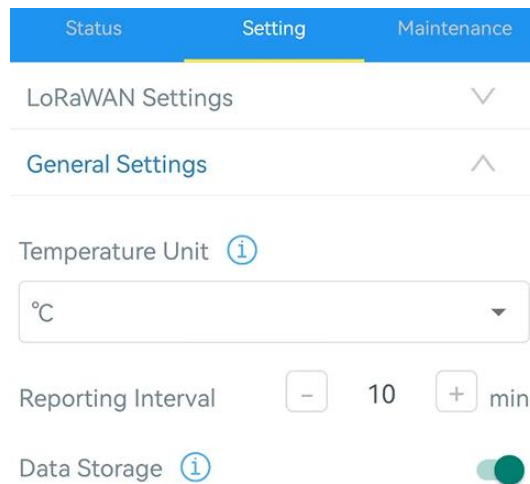
2. Go to **Device > Maintenance**, click **Export**, then select the data time range and click **Confirm** to export data. ToolBox App can only export last 14 days' data.

3. Click **Data Cleaning** to clear all stored data inside the device.

3.5.4 Data Retransmission

EM300 series sensor supports data retransmission to ensure network server can get all data even if network is down for some times. There are two ways to get the lost data:

● Network server sends downlink commands to to enquire the historical data for specifying time range, see section 5.4;

● When network is down if no response from LinkCheckReq MAC packets for a period of time, the device will record the network disconnected time and re-transmit the lost data after device re-connects the network.

Here are the steps for data retransmission:

1. Ensure the device time is correct (see section 3.4);

2. Enable data storage feature and data retransmission feature;
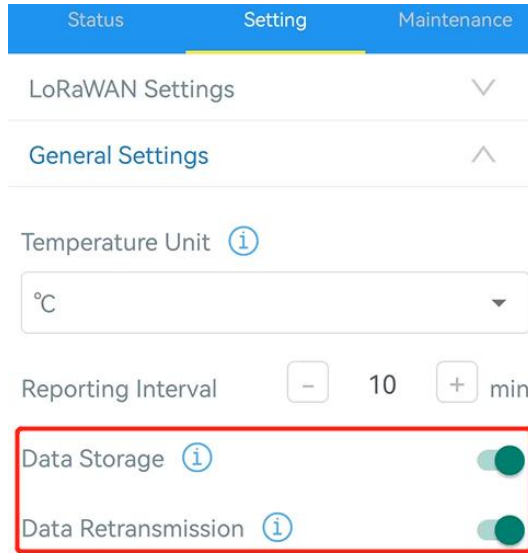
3. Go to **Device > Setting > General Settings** to enable rejoin mode feature and set the number of packets sent. Take below as example, the device will send LinkCheckReq MAC packets to the network server at least every 30 minutes to check if the network is disconnected; if there is no response for 8 times (8 * 30 mins = 240 mins =4 hours), the device will record a data lost time point (disconnected time minus 4 hours).
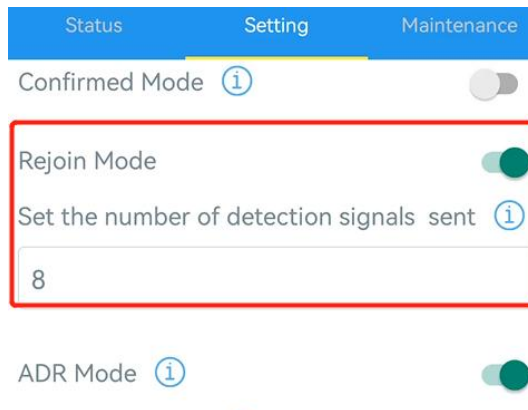
4. After the network connected back, the device will send the lost data from the point in time when the data was lost according to the reporting interval.

Note:

1) If the device is rebooted or re-power when data retransmission is not completed, the device will re-send all retransmission data again after device is reconnected to the network;

2) If the network is disconnected again during data retransmission, it will only send the latest disconnected data;

3) The retransmission data format is started with "20ce", please refer to see section 5.4.

4) Data retransmission will increase the uplinks and shorten the battery life.

3.5.5 Milesight D2D Settings

Milesight D2D protocol is developed by Milesight and used for setting up transmission among Milesight devices without gateway. When the Milesight D2D settings is enabled, EM300-TH/EM300-ZLD/ EM300-SLD/EM300-MCS can work as D2D controller to send control commands to trigger Milesight D2D agent devices.

1. Configure RX2 datarate and RX2 frequency in LoRaWAN® settings, it is suggested to change the default value if there are many LoRaWAN® devices around.

2. Go to **Device > Setting > D2D Settings** to enable Milesight D2D feature.

3. Define an unique D2D key which is the same as Milesight D2D agent devices. (Default D2D key: 5572404C696E6B4C6F52613230313823)
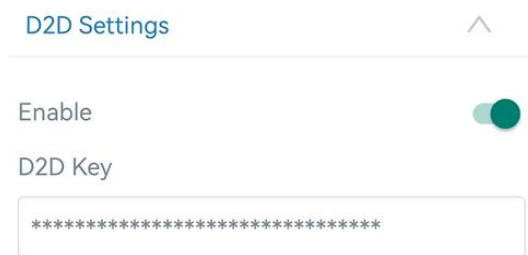
4. Enable one of status mode and configure 2-byte hexadecimal Milesight D2D command. When the status is triggered, EM300 series sensor will send this control command to corresponding Milesight D2D agent devices. Take EM300-ZLD as example below:

Note:

1) If you enable **LoRa Uplink**, a LoRaWAN® uplink packet that contains the sensor status or temperature threshold alarm will be sent to gateway after the Milesight D2D control command packet. Otherwise, sensor status or threshold alarm will not send to LoRaWAN® gateway.

2) If you want to enable **Temperature Threshold Trigger Status: Trigger** or **Temperature Threshold Trigger Status: not triggered**, please enable and configure temperature threshold feature under **Threshold Settings**.

3.6 Maintenance

3.6.1 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 an upgrade.

2) Only Android version ToolBox supports the upgrade feature.

Status	Setting	Maintenance

SN	6136B26167392109
Model	EM300-ZLD-915M
Firmware Version	V1.1-a1
Hardware Version	V3.0
Manual Upgrade	

Browse

3.6.2 Backup

EM300 devices support 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 which saved in the smartphone and click **Write**, then attach to another device to write configuration.
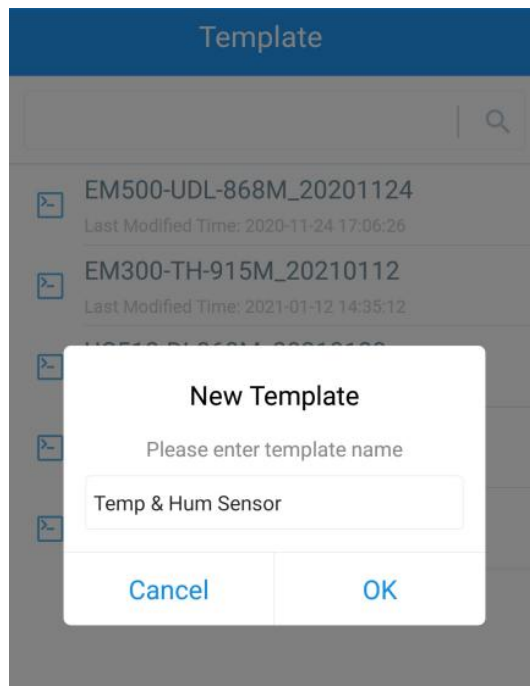
Note: Slide the template item left to edit or delete the template. Click the template to edit the configurations.

3.6.3 Reset to Factory Default

Please select one of following methods to reset device:

Via Hardware: Hold on power button (internal) for more than 10s until LED blinks.
Via ToolBox App: Go to **Device > Maintenance** to click **Reset**, then attach smart phone with NFC area to device to complete reset.

4. Installation

1. Attach EM300 to the wall and mark the two holes on the wall. The connecting line of two holes must be a horizontal line.

2. Drill the holes according to the marks and screw the wall plugs into the wall.

3. Mount the EM300 to the wall via mounting screws.

4. Cover the mounting screws with screw caps.
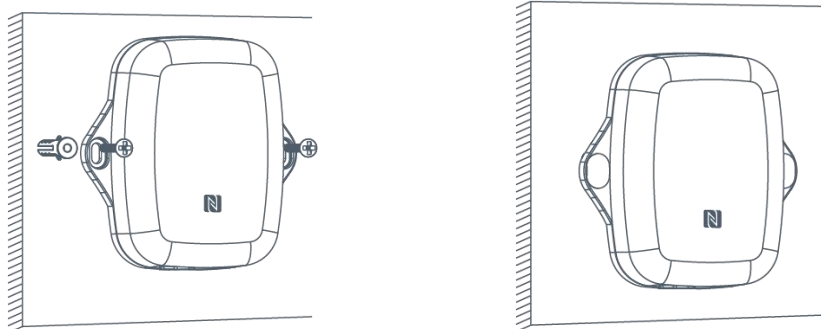
5. For leak detection senor, install the probe/cable to the place where liquid may leak; for magnet switch sensor, install the magnet beside the door/window; for pulse counter, connect the wires to a pulse meter.

Note: For SLD sensor, please ensure the metal pins of the probe are flat on the floor; for ZLD sensor, the cable can't be twined or accumulated together. The probe or cable of water leakage sensor should be placed in an area of concern where water from a leak would likely accumulate.
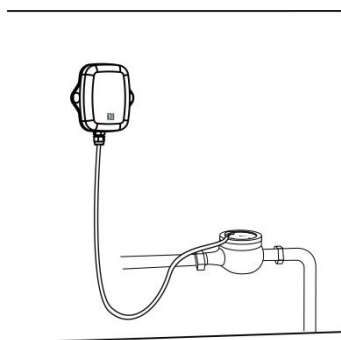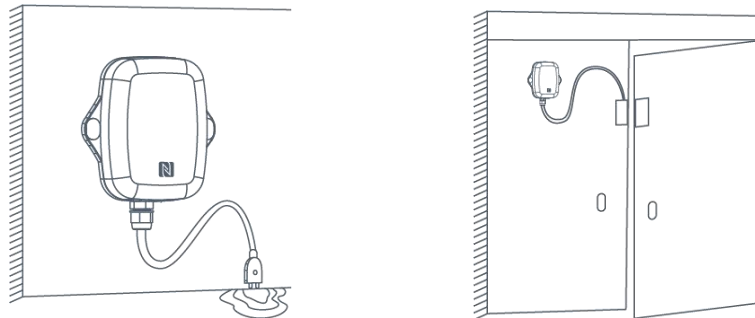
5. Device Payload

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

EM300 series 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
	0f(Device Type)	00: Class A, 01: Class B, 02: Class C
	16(Device SN)	16 digits

Example:

ff 09 01 00 ff 0a 01 02 ff 0f 00					
Channel	Type	Value	Channel	Type	Value
ff	09 (Hardware version)	0100 (V1.0)	ff	0a (Software version)	0102(V1.2)
Channel	Type	Value			
ff	0f (Device Type)	00 (Class A)			

5.2 Sensor Data

EM300 series sensors report sensor data according to reporting interval (10min by default).
Battery level is reported every 6 hours.

Channel	Type	Description
01	75(Battery Level)	UINT8, Unit: %
03	67 (Temperature)	INT16, Unit: °C
04	68(Humidity)	INT8, Unit: %
05	00(Water Leakage Status)	00: Not water leaked 01: Water is leaked
06	00(Magnet Status)	00: Magnet switch close 01: Magnet switch open
05	c8(Counter)	4 bytes, unsigned
05	00(Digital)	00: low 01: high

Examples:

EM300-SLD/ZLD:

Channel	Type	Value	Channel	Type	Value
01	75 (Battery)	64 => 100%	03	67 (Temperature)	10 01 => 01 10 = 272 Temp=272*0.1=27.2°C
Channel	Type	Value	Channel	Type	Value
04	68 (Humidity)	71=>113 Hum=113*0.5=56.5%	05	00	01=>Water is leaked

<p></p>

EM300-DI (Counter):

Channel	Type	Value	Channel	Type	Value
01	75 (Battery)	64 => 100%	03	67 (Temperature)	1e 01 => 01 1e = 286 Temp=286*0.1=28.6°C
Channel	Type	Value	Channel	Type	Value
04	68 (Humidity)	5e=>94 Hum=94*0.5=47%	05	c8 (Counter)	06 00 00 00=> 00 00 00 00=6

5.3 Downlink Commands

EM300 series 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 Alarm)	9 Bytes, CTRL (1B) + Min (2B) + Max (2B) +00000000(4B) CTRL: Bit0~Bit2: 000 - disable 001 - below (minimum threshold) 010 - above (maximum threshold)

		011 - within
		100 - below or above
		Bit3~Bit7: 11001
	10 (Reboot)	ff(Reserved)
	79(Set D2D settings)	4 Bytes, Number(1B)+Function(1B)+D2D Command(2B) **Number:** 01 -Temperature threshold trigger 02 -Temperature threshold doesn't trigger 03 - Status trigger 04 -Status doesn't trigger **Function:** 00 -Only use LoRaWAN 01 -Only use D2D 03 -Use D2D&LoRaWAN Uplink
	4e (Pulse counter)	0100-Clean the count 0101-Stop counting 0102-Start counting

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. Reboot the device.

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

3. Set a temperature threshold as below 15°C or above 30°C.

ff 06 cc96002c0100000000		
Channel	**Type**	**Value**

ff	06 (Set Threshold Alarm)	CTRL:cc =>11001100 100 = below or above Min:96 00=> 00 96 = 15°C Max: 2c 01=>01 2c = 30°C

4. Set D2D settings of temperature threshold trigger.

ff 79 01011001		
Channel	**Type**	**Value**
ff	79 (Set D2D settings)	Number: 01, temperature threshold trigger Function: 01, only use D2D D2D Command: 1001=>0110

5.4 Historical Data Enquiry

EM300 series sensor supports sending downlink commands to enquire historical data for specified time point or time range. Before that, ensure the device time is correct and data storage feature was enabled to store the data.

Command format:

Channel	Type	Description
fd	6b (Enquire data in time point)	4 Bytes, unix timestamp
fd	6c (Enquire data in time range)	Start time (4 bytes) + End time (4 bytes), Unix timestamp
fd	6d (Stop query data report)	ff
ff	6a (Report Interval)	2 Byte, unit:s, Range: 30~1200s (60s by default)

Reply format:

Channel	Type	Description
fc	6b/6c	00: data enquiry success 01: time point or time range invalid 02: no data in this time or time range
20	ce (Historical Data)	Data time stamp (4 Bytes) + Data Contents (Mutable)

Data format:

Sensor	Description
EM300-TH	Temperature + Humidity

EM300-MCS	Temperature + Humidity + Status
EM300-SLD/EM300-ZLD	Temperature + Humidity + Leakage status
EM300-DI	Temperature + Humidity + Interface Type + Counter + Digital

Note:

1. The device only uploads no more than 300 data records per range enquiry.

2. When enquiring the data in time point, it will upload the data which is closest to the search point within the reporting interval range. For example, if the device's reporting interval is 10 minutes and users send command to search for 17:00's data, if the device find there is data stored in 17:00, it will upload this data; if not, it will search for data between 16:50 to 17:00 and upload the data which is closest to 17:00.

Example:

1. Enquire historical data between 2022/10/28 14:15:00 to 2022/10/28 15:45:00.

fd6c 64735b63 7c885b63		
Channel	**Type**	**Value**
fd	6c (Enquire data in time range)	Start time: 64735b63 => 63466974 = 1666937700 =2022/10/28 14:15:00 End time: 7c885b63 => 635b887c = 1666943100 =2022/10/28 15:45:00

Reply:

fc6c00		
Channel	**Type**	**Value**
fc	6c (Enquire data in time range)	00: data enquiry success

20ce 0d755b63 0f01 6a 02 06000000 00			
Channel	**Type**	**Time Stamp**	**Value**
20	ce (Historical Data)	0d755b63 => 2022/10/28 14:22:05	Temperature: 0f01=>010f=27.1°C Humidity: 6a=>106=53% Interface Type: 02=Counter; (01=Digital) Counter: 06 00 00 00=> 00 00 00 06 =6 Digital: 00=> low

-END-