Capacitive Level Sensor

**Featuring LoRaWAN®**

EM300-CL

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.

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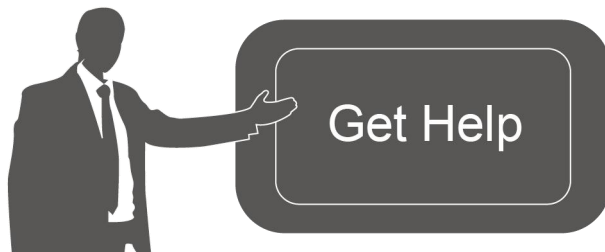
❖ The device must never be subjected to shocks or impacts.

Declaration of Conformity

EM300-CL is in conformity with the essential requirements and other relevant provisions of the CE, FCC, and RoHS.
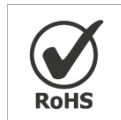
Get Help

For assistance, please contact

Milesight technical support:

Email: iot.support@milesight.com

Support Portal: support.milesight-iot.com

Tel: 86-592-5085280

Fax: 86-592-5023065

Address: Building C09, Software Park III, Xiamen 361024, China

Revision History

Date	Doc Version	Description
Oct. 31, 2023	V 1.0	Initial version
Nov. 15, 2024	V 1.1	Add calibration settings.

Contents

1. Product Introduction

1.1 Overview

EM300-CL is a non-contact liquid level sensor based on LoRaWAN®, which relies on capacitive sensing principle. It is mainly used to monitor hand wash in restrooms and sending out alarms when there is insufficient hand wash left. An alarm will be triggered when the hand wash level approaches the electrode detection sheet, signaling hand wash insufficiency. It can be seamlessly integrated with containers of different shapes and sizes to alert and assure hand wash is replenished on time, promoting the good operation of smart hygiene and cleaning management system.

In addition, with LoRaWAN® technology that supports low power consumption, it allows the built-in high-capacity battery to last for several years without replacement. Moreover, EM300-CL is compatible with both Milesight's gateway and Milesight IoT Cloud to achieve remote monitoring and smart data management, allowing water conservation.

1.2 Features

- High sensitivity real-time liquid level status monitoring, high stability, timely alarm
- Strong anti-interference ability and high accuracy based on electrode pad with 2 electrode plates
- Non-contact liquid level detection for hygiene purposes
- The minimalist and lightweight electrode pad design allows for convenient installation
- IP67 waterproof performance for high applicability
- A built-in 4000mAh replaceable battery and works for 10 years without replacement
- Equipped with NFC for easily configuration
- Ultra-wide-distance transmission up to a line of sight of 10km
- Compliant with standard LoRaWAN® gateways and network servers
- Quick and easy management with Milesight IoT Cloud and Milesight Development Platform

2. Hardware Introduction

2.1 Packing List
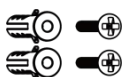
| 1 × EM300-CL Device | 2 × Wall Mounting Kits | 2 × Screw Caps | 1 × Quick Guide |
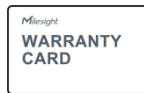
1 ×
Warranty Card

1 × 3M Double Sided
Tape

1 × Cable-tie

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

2.2 Hardware Overview

Waterproof Connector

NFC Area

2.3 Dimensions(mm)

Transceiver:

85.26

27

88.52

105.56

105.56

85.26

27

Electrode Detection Sheet:

56.8mm

Electrode Plate-1   10mm

Electrode Plate-2   10mm

25.5mm

Thickness: 0.2mm

2.4 Power Button

There is a LED indicator and a power button inside the device for emergency reboot or reset.

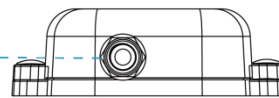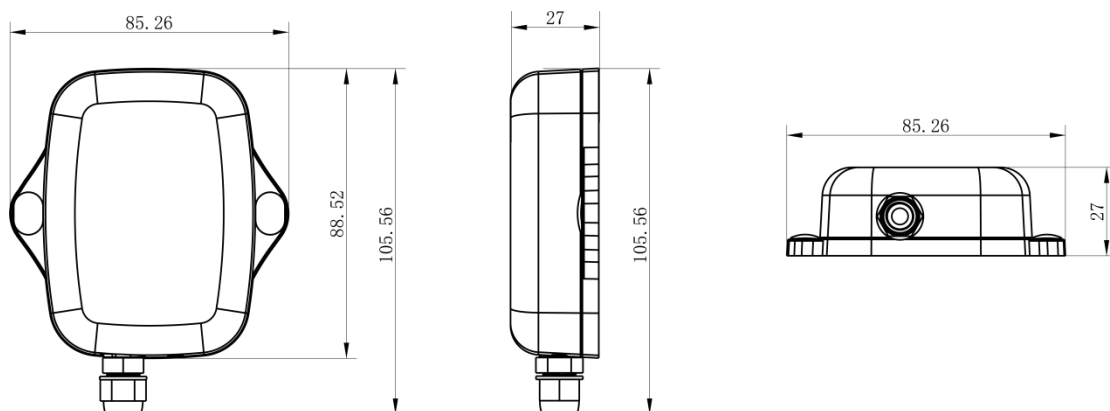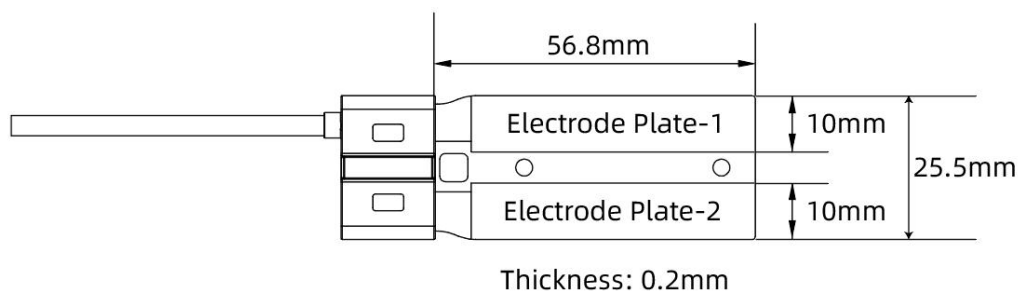| Function	Action	LED Indication
Turn On	Press and hold the button for more than 3 seconds.	Off → On
Turn Off	Press and hold the button for more than 3 seconds.	On → Off
Reset	Press and hold the button for more than 10 seconds.	Blinks quickly.
Check On/Off Status	Quickly press the power button once.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

3. Operation Guide

3.1 NFC Configuration

EM300-CL 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 and click **NFC Read** 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**.
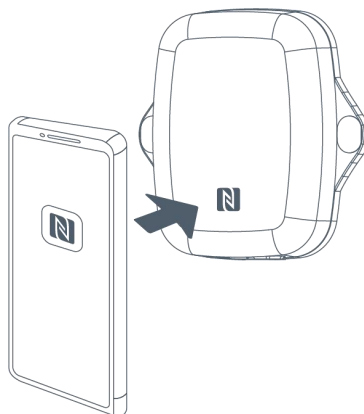
Note:

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.

3.2 LoRaWAN Settings

The device supports to configure join type, App EUI, App Key and other information. You can also keep all settings by default.

Device EUI

24E124862E211417

* APP EUI

24e124c0002a0001

* Application Port

85

LoRaWAN Version

V1.0.3

Work Mode

Class A

Confirmed Mode ⓘ

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. Note: Select OTAA mode if you use Milesight IoT Cloud or Milesight Development Platform to manage devices.
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 and 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
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. **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: Indicate that all channels are disabled Enable Channel Index ⓘ 0-71 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
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 ≤ 35 mins: the device will send a specific number of LinkCheckReq 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. Reporting interval > 35 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. Note: Only OTAA mode supports rejoin mode.

Set the number of packets sent	When the rejoin mode is enabled, set the number of LinkCheckReq packets to send. Note: the actual sending number is **Set the number of packet sent** + 1.
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.

3.3 Basic Settings

Parameters	Description
Reporting Interval	Reporting interval of transmitting battery level and liquid status to network server. Range: 1-1440 mins, Default: 1440 mins
Full Liquid Calibration	When the liquid is full, click the **Calibrate** button to record the full status. After calibrated, the device will report a calibration result packet. **Note:** 1) The device will calibrate once automatically after turning on 20 minutes. 2) The alarm feature will not work if liquid calibration did not proceed. 3) Please re-calibrate it if the full liquid height changes.
Change Password	Change the password for ToolBox App to write this device.

3.4 Advanced Settings

3.4.1 Calibration Settings

EM300-CL detects the liquid level status by judging the capacitance difference values of the two electrode sheets.

| Full | No Sure | No Sure | Empty | Empty |
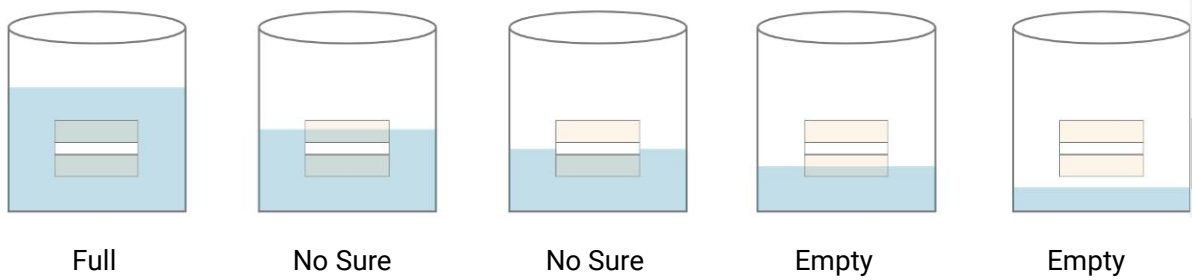
If the device reports error level status, please refer to below checklist:

- The sensor meets the installation requirements.

- The full liquid calibration is operated.

If still not work, please complete below steps to adjust the judgement values.

1. Change reporting interval as 1 minute.

2. Fill the target container with liquid to ensure the liquid level is in the middle of the two electrode sheets.

Note: If the detection liquid is too thick and hangs on the side wall of the container, please wait for the liquid to settle before calibration.
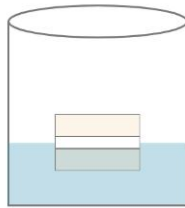
3. Wait for more than 1 minute, then read the device to record the current value $\Delta C1$.

Device	Network

General   Alarm   **Calibration**

C1:Capacitance value of electrode sheet 1

C1':Calibration Value	54.08

C1:Current Value	54

C2:Capacitance value of electrode sheet 2

C2':Calibration Value	55.81

C2:Current Value	55.8

$\Delta C = |C1-C2|$

$\Delta C'$:Calibration Value	1.73

ΔC:Current Value	1.8

4. Add the liquid to the full level of the container, then wait for more than 1 minute and read the device to record the current value $\Delta C2$.

5. Calculate the judgement value result: $|\Delta C2-\Delta C1|$. Example: $\Delta C1=-89$, $\Delta C2=-58$, the result is 31.

6. Write the result to Full liquid judgement value.

Alarm Value Setting ⓘ

Full liquid judgment value $|\Delta C'-\Delta C|$

31

7. Reduce the liquid to below the electrode sheets, or add the liquid to full, then wait for more than 1 minute to read the device to check if the liquid level status is correct.

3.4.2 Alarm Settings

Alarm Reporting ⬤

Collecting Interval − 10 + min

Alarm Reporting Times − 3 +

Alarm Dismiss Report ⓘ ⬜

Parameters	Description
Alarm Reporting	After enabled, the device will report the alarm packet when the liquid level of container is lower than the installation height of detection electrode sheet. Only when the alarm is dismissed and re-triggered, the device will send the alarm again.
Status Detection Interval	The interval to detect liquid status after alarm triggers.
Alarm Reporting Times	Alarm packet report times after alarm triggers.
Alarm Dismiss Report	After enabled, the device will report the alarm dismiss packet once when the liquid of container is changed to full.

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 an upgrade.

2) Only Android version ToolBox supports the upgrade feature.
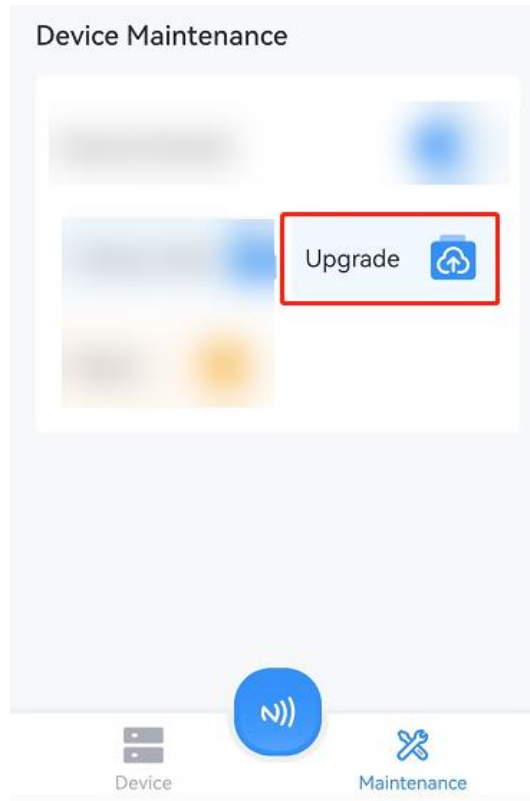
3.5.2 Backup

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. Attach the NFC area of smartphone to the device to read the device.

2. Go to **Settings** page on the App to edit the configuration as required, click **Set Template** to save current configuration as the template in the ToolBox App.
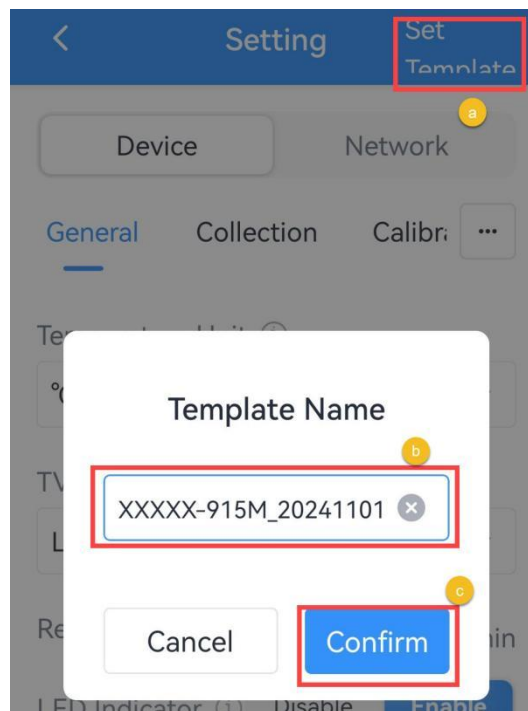
3. Go to **Template** page, select and click the target template, then click **Write** and attach the NFC area of smartphone to the target device to import the configuration.
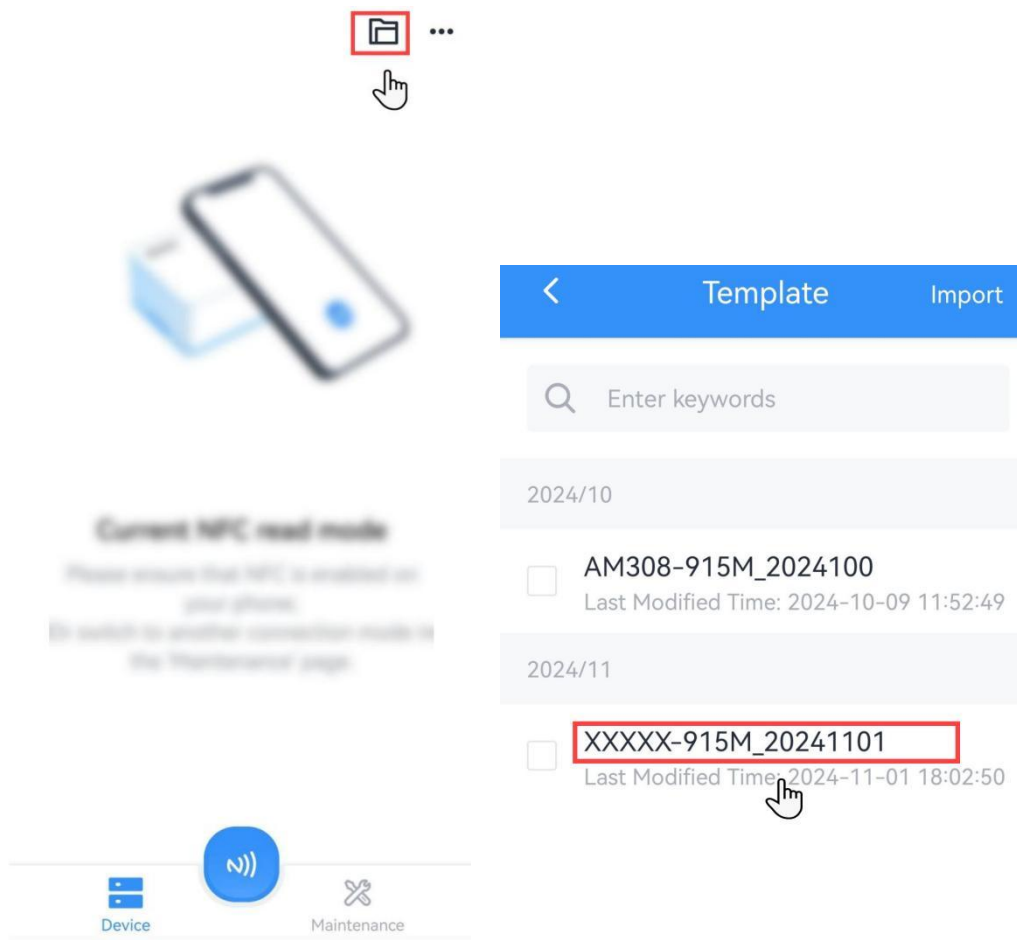
Note: Check the box of target template to delete it, or export this template as JSON format file and save it to the smartphone.
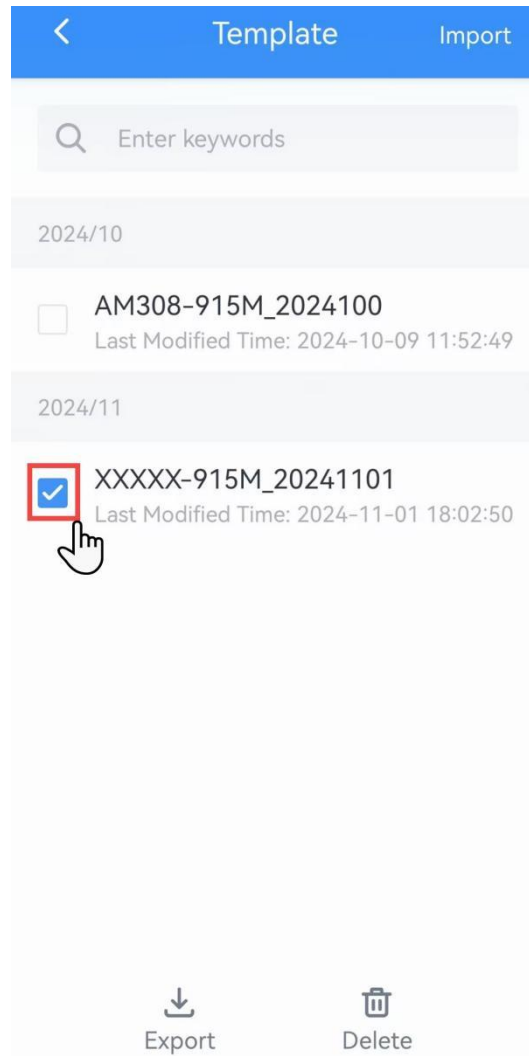
3.5.3 Reset to Factory Default

Please select one of following methods to reset device:

Via Hardware: Hold on power button (internal) for more than 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.
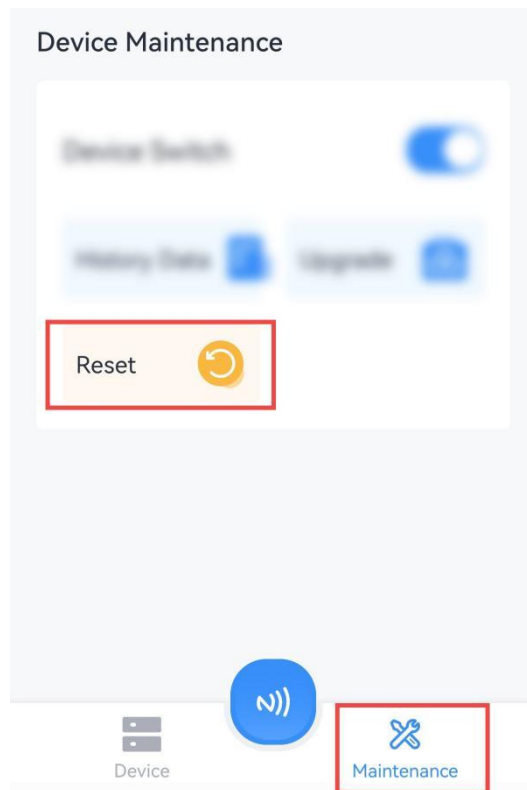
4. Installation

4.1 EM300 Device Installation

1. Attach EM300 device 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.
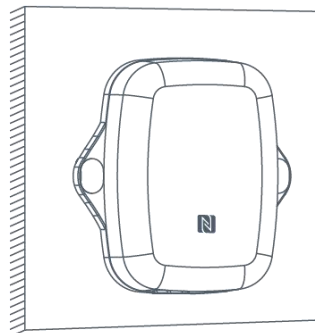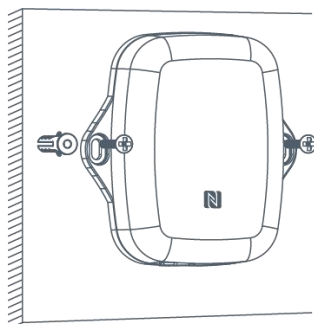
Besides, it can also be mounted to a wall via 3M tape or be mounted to a pole via cable-tie.

4.2 Sensor Installation

Installation Requirements
● This product is not applicable to metal conductive metal containers, absorbent non-metal material containers (cement, wood board, ceramic, tiles, bricks, etc.) or liquid in bags.
● This product is applicable to the containers made up of insulating non-metallic materials and with flat surfaces and uniform thickness, like plastic, glass, acrylic, etc.
● It is suggested that the side walls of container do not exceed 3mm.
● Avoid the detection electrode sheet facing the liquid inlet or the path of the liquid inlet flow.
● Clean the container to avoid the detection results to be affected by silt or other debris.

Installation Steps
1. Attach the detection electrode sheet to the wall of the container seamlessly, aligning it with the bottom of the container to detect the liquid capacity.
2. Fix he detection electrode sheet by a 3M tape or a cable-tie. The protective foam is faced outside.
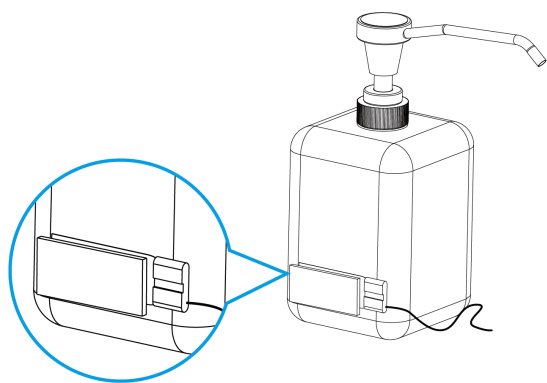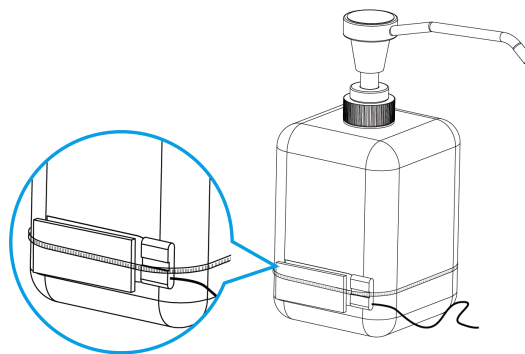
Fixed by 3M Tape   **Fixed by Cable-tie**

Factors Affecting Accuracy
● Avoid detection electrode sheet to be attached by detection liquids, or this will affect the detection results.
● If the detection liquid is too thick, it will hang to the side wall of container, and will delay the time of leak detection and alarm.
● Keep the distance of both detection electrode sheets more than 15cm to avoid detection interference if you have two EM300-CL sensors.

5. Battery Replacing

When the batteries have run out of power, please remove the back cover to replace the new batteries.
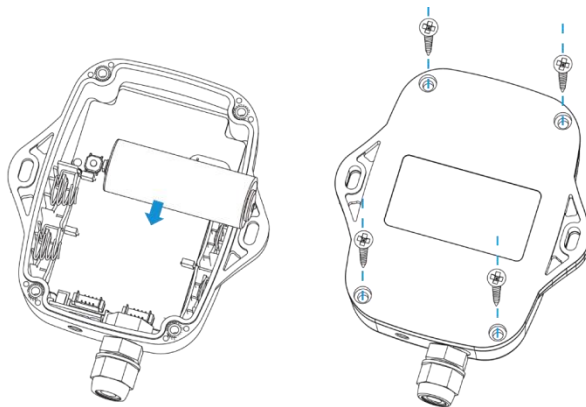
Note:

- EM300 provides 4000mAh version and 8000mAh version. Please do not install 2 batteries on the 4000mAh version, and vice versa. Otherwise, it will cause inaccurate power calculations.
- To reduce the interference of NFC transmission, it is suggested that the battery be installed in the upper location (see figure).
- The device can only be powered by the ER18505 Li-SoCl$_2$ battery. The alkaline battery is not supported.
- The battery 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.

6. Communication Protocol

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.

6.1 Basic Information

EM300 series sensors report basic information of sensor whenever joining the network.

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

Example:

ff0bff ff0101 ff166136c40091605408 ff090300 ff0a0101 ff0f00					
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**
ff	0b (Power On)	ff	ff	01 (Protocol Version)	01 (V1)
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**
ff	16 (Device SN)	6136c40091605408	ff	09 (Hardware Version)	0300 (V3.0)
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**
ff	0a (Software Version)	0101 (V1.1)	ff	0f (Device Type)	00 (Class A)

6.2 Sensor Data

Item	Channel	Type	Description
Battery Level	01	75	UINT8, Unit: %
Liquid Level Status	03	ed	00: Uncalibrated, 01: Full, 02: Empty, ff: Sensor error or not connect
Calibration Status	04	ee	00: Failure; 01: Success
Liquid Level Alarm	83	ed	2 Bytes, Byte 1: 00=Uncalibrated, 01=Full, 02=Empty, ff=Sensor error or not connect Byte 2: 01=Alarm, 00=Alarm dismiss

Examples:

1. Periodic packet: reports according to reporting interval (1440 min by default).

017564 03ed01					
Channel	**Type**	**Value**	**Channel**	**Type**	**Value**
01	75	Battery level: 64 => 100%	03	ed	Liquid status: 01=full

2. Alarm packet: reports according to alarm settings.

83ed00		
Channel	**Type**	**Value**
83	ed	Liquid status: 01=empty

3. Low battery level packet: reports when battery level is below to 1%.

017501		
Channel	**Type**	**Value**

01	75	Battery level: 01 => 1%

6.3 Downlink Commands

EM300-CL supports downlink commands to configure the device. The application port is 85 by default.

Command	Channel	Type	Byte	Description
Reboot	ff	10	1	ff
Reporting Interval	ff	8e	3	00 + Interval Time(2B), unit: min
Status Detection Interval	ff	bb	3	00 + Interval Time(2B), unit: min **Note:** This interval time should be less than reporting interval.
Alarm Reporting	ff	7e	5	CTRL (1B) + 0000 + Alarm Reporting Times (2B) CTRL: 00=Disable, 01=Enable alarm reporting, disable alarm dismiss report 81=Enable alarm reporting and alarm dismiss report
Full Liquid Calibration	ff	62	1	ff
Change Capacitance Value	ff	bf	9	**Byte 1:** 00=All Calibration Values, 02=C1', 04=C2', 06=ΔC' 01= All Judgement Values, 03=Full Liquid Judgement Value, 05=Liquid Shortage Judgement Value, 07=Liquid Shortage 1 Judgement Value, 09=Liquid Shortage 2 Judgement Value **When changing calibration values:** Byte 2-3: C1', UINT16/100 Byte 4-5: C2', UINT16/100 Byte 6-7: ΔC', UINT16/100 Byte 6-9: 0000 **When changing judgement values:** Byte 2-3: Full Liquid Judgement Value $|\Delta C'-\Delta C|$, UINT16/100 Byte 4-5: Liquid Shortage Judgement Value $|\Delta C'-\Delta C|$, UINT16/100 Byte 6-7: Liquid Shortage 1 Judgement

				Value (C1'-C1)&(C2'-C2), UINT16/100
				Byte 8-9: Liquid Shortage 2 Judgement Value (C1'-C1)&(C2'-C2), UINT16/100
Enquiry Calibration Value	ff	be	1	00: Capacitance Calibration Value of Electrode Sheets 01: Capacitance Current Value of Electrode Sheets 02: Judgement Value

Enquiry calibration value reply:

Channel	Type	Enquiry ID	Description
fe	be	00	Byte 1-2: C1', UINT16/100 Byte 3-4: C2', UINT16/100 Byte 5-6: $\Delta C'(|\Delta C2'-\Delta C1'|)$, UINT16/100
		01	Byte 1-2: C1, UINT16/100 Byte 3-4: C2, UINT16/100 Byte 5-6: $\Delta C(|\Delta C2-\Delta C1|)$, UINT16/100
		02	Byte 1-2: Full Liquid Judgement Value $|\Delta C'-\Delta C|$, UINT16/100 Byte 3-4: Liquid Shortage Judgement Value $|\Delta C'-\Delta C|$, UINT16/100 Byte 5-6: Liquid Shortage 1 Judgement Value (C1'-C1)&(C2'-C2), UINT16/100 Byte 7-8: Liquid Shortage 2 Judgement Value (C1'-C1)&(C2'-C2), UINT16/100

Examples:

1. Set reporting interval as 20 minutes.

ff8e 00 1400		
Channel	**Type**	**Value**
ff	8e (Reporting Interval)	14 00=>00 14=>20 mins

2. Reboot the device.

ff10ff		
Channel	**Type**	**Value**
ff	10	ff

3. Enable alarm reporting, set reporting times as 5 and enable alarm dismiss report.

ff7e 81 0000 0500		
Channel	**Type**	**Value**
ff	7e	81=Enable alarm reporting and alarm dismiss report 0500=>00 05=5 reporting times

4. Enquire the calibration value.

ffbe00		
Channel	**Type**	**Value**
ff	be	00=Capacitance Calibration Value of Electrode Sheets

Reply:

febe 00 2015cd15ad00		
Channel	**Type**	**Value**
fe	be	00=Capacitance Calibration Value of Electrode Sheets C1': 2015=>1520=5408/100=54.08 C2': cd15=>15cd=5581/100=55.81 ΔC': ad00=>00ad=173/100=1.73

5. Set the full liquid judgment value as 0.8.

ffbf 03 5000 0000 0000 0000		
Channel	**Type**	**Value**
ff	bf	03=Full Liquid Judgement Value Full Liquid Judgement Value: 50 00=>00 50=80/100=0.8

-END-