LoRaWAN Gateway and Wireless Sensor
User Guide

How to Work with 3rd-party Standard LoRaWAN Gateway or TTN Server

Version: V1.3
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1 Product Introduction

SenseCAP is an industrial wireless sensor network that integrates easy-to-deploy hardware and data API services, enabling low-power, long-distance environmental data collection. SenseCAP includes several versions, such as LoRaWAN, LoRaPP, etc.

SenseCAP LoRaWAN version products include LoRaWAN Gateways and Sensor Nodes. Based on the LoRaWAN protocol, it can realize one-to-many, long-distance networking and bilateral communication. The LoRaWAN Gateway supports Ethernet and 4G. The Sensor Node is powered by a high-capacity battery that lasts up to 3 years (if uploading data once every hour). It also supports hot-swap, making it easy for maintenance and upgrading.

Main Features:
- Gateway: High-performance Cortex A8 1GHz processor
- Gateway uses multiple methods to connect to the Internet: 4G and Ethernet
- Gateway supports third-party TTN account and server
- Sensors support LoRaWAN v1.0.2 protocol and are suitable for standard LoRaWAN Gateway
- Super long-distance communication: 10km in the line-of-sight scenario, 2km in the urban scenario
- Industrial protection rating IP66-rated enclosure, suitable for the outdoor environment at -40℃~70℃
- Easy-to-deploy, enabling people without engineering background to install the devices quickly
LoRaWAN Gateway:

LoRaWAN Sensor Node:

Sensor Node Controller
- LoRa Communication module
- Ultra-low power microcontroller
- Battery

Sensor Probe
- Hot swap connector
- Different sensor probe
- Replaceable

Power Switch
Mode Button
Reset Button
LED
UART
Board Connector
2 Gateway Network Configuration

2.1 The gateway connects to the Internet

2.1.1 Installing Antenna

Screw clockwise to install the 4G and LoRa antennas onto the gateway.

2.1.2 Connecting to the Internet

There are two ways to connect to the Internet. Choose the one that works for you.

(1) Connecting to Ethernet Cable
Unscrew to open the protection cap, plug the Ethernet cable through the cap and then into the Ethernet port. Screw to fasten this part.
(2) Connecting to 4G

Use the hex key (included in the package) to unscrew the 6 screws and open the lid.

Swipe downward to open the SIM card socket, insert the Micro SIM card and swipe upward to lock the SIM card socket. Make sure it is installed correctly and close the lid with the screws.
2.1.3 Connecting to Power Cable

Unscrew to take off the power cap, plug in the extension cord and screw to fasten it onto the gateway. The other end of the extension cord is connected to the power adapter.

Notice: Make sure all antennas are correctly installed before powering on the gateway. Please note the device should be POWERED OFF when installing the antenna, or the antenna circuits might be damaged.

2.1.4 The Function of the Red LED

LED Status
After powering on the device
1. Stays ON for 2–3 seconds, then turns OFF
2. Stays OFF for 1 minute, then starts flash
3. LED flashing means it is connecting to Internet
4. LED stays ON when connected to Internet
2.2 Setting the APN

Prepare a router, and the network connection is shown in the figure:

(1) Check the IP of "sensecap" in the background of the router.
(2) Enter IP in the browser: IP:8000
   If the IP is 192.168.1.1, enter 192.168.1.1:8000

(3) User: sensecap
    Password: sensecap!!!
(4) Click the "Cellular" button.
① Cellular Mode: AUTO (default), Gateway automatically selects mode.
② 3G/2G APN Settings: when the mode is 3G/2G, the APN information of SIM card operator needs to be filled in.
③ 4G APN Settings: optional.

(5) Click “APPLY”. Then “CHECK CONNECTION”, if return “cellular technology powered and connected”, it means ok.
3 Add Gateway to User’s TTN Server

The SenseCAP LoRaWAN Gateway supports connecting to the user's own The Things Network account and server.

Learn more about TTN: https://www.thethingsindustries.com/docs/
3.1 Gateway Network Configuration

3.1.1 Installing Antenna

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3.1.2 Connecting to the Internet

There are two ways to connect to the Internet. Choose the one that works for you.

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Notice: Make sure all antennas are correctly installed before powering on the gateway. Please note the device should be POWERED OFF when installing the antenna, or the antenna circuits might be damaged.

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After powering on the device
1. Stays ON for 2–3 seconds, then turns OFF
2. Stays OFF for 1 minute, then starts flash
3. LED flashing means it is connecting to Internet
4. LED stays ON when connected to Internet
3.2 Setting the Gateway Service Address

Prepare a router, and the network connection is shown in the figure:

(6) Check the IP of "sensecap" in the background of the router.
(7) Enter IP in the browser: IP: 8000
   If the IP is 192.168.1.1, enter 192.168.1.1:8000

(8) User: sensecap
    Password: sensecap!!!
(9) LoRa→Use Seeed’s Server→Off Button
Server Address: Please input your Server Address.
Refer to the website:

v3.13.2
Uplink / Downlink Port (default): **1700**

(11) APPLY.
3.3 Gateway Registration on TTN

TTN website: https://www.thethingsnetwork.org
TTN console: https://console.cloud.thethings.network/
Tip: v2 will be discontinued and v3 is recommended.
(1) Follow the instruction to create your account, and access “Console”.

(2) Register Gateway
1. Gateway EUI: View the labels on the gateway. Select 'I’m using the legacy packet forwarder'.
2. Frequency Plan: View the labels on the gateway.

<table>
<thead>
<tr>
<th>Region</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU868</td>
<td>Europe 863-870 MHz (SF9 for RX2 -recommended)</td>
</tr>
<tr>
<td>US915</td>
<td>United States 902-928 MHz, FSB 2 (used by TTN)</td>
</tr>
<tr>
<td>AU915</td>
<td>Australia 915-928 MHz, FSB 2 (used by TTN)</td>
</tr>
<tr>
<td>AS923-1</td>
<td>Asia 920-923 MHz</td>
</tr>
<tr>
<td>AS923-2</td>
<td>Asia 923-925 MHz</td>
</tr>
</tbody>
</table>
LoRaWAN options

**2** Frequency plan

Europe 863-870 MHz (SF9 for RX2 - recommended)

Schedule downlink late

- **Enabled**
  - Enable server-side buffer of downlink messages

**Enforce duty cycle**

- **Enabled**
  - Recommended for all gateways in order to respect spectrum regulations

**Schedule any time delay**

530 milliseconds

Configure gateway delay (minimum: 130ms, default: 530ms)

3. Other use default.

4. Create Gateway.

Gateway Status displays connected, indicating successful registration.
4 Add Sensor Node to User’s TTN Server

4.1 Get Node’s EUI and Key

(1) DeviceEUI and DeviceCode is on the SenseCAP product label.

(2) SenseCAP sensor device’s AppEUI and AppKey have been flash into the device by Seeed. Use HTTP API to retrieve App EUI and App Key. You can use browser to issue an HTTP GET request.

Curl:
https://sensecap.seeed.cc/makerapi/device/view_device_info?nodeEui=2CF7F12014700297&deviceCode=34BF25920A4EFBF4

In the API, replace the DeviceEUI and deviceCode with your own DeviceEUI and DeviceCode respectively. And you will get the following response.

```json
{
    "code": "0",
    "data": {
        "nodeEui": "2CF7F12014700297",
        "deviceCode": "34BF25920A4EFBF4",
        "lorawanInformation": {
            "dev_eui": "2CF7F12014700297",
            "app_eui": "8000000000000006",
            "app_key": "6FD0EF47CBC6E00F1921A08C2E94E8E5"
        }
    },
    "time": 0.019
}
```
4.2 Add Application and AppEUI

(1) TTN console → Application → Add application
(2)

Add application

① Application ID: Enter a unique name.
② Description: Enter a description.
③ Add application.
4.3 Add Sensor Node to TTN

(1) Application → End Devices → Add end device

(2) Register end device

1. Select the end device

- **Brand**: SenseCAP
- **Model**: SenseCAP Wireless Air Temperature and Humidity Sensor - LoRaWAN
- **Hardware / Firmware Version**: Usually choose the latest
- **Device ID**: Enter a unique name.

*MAC V1.0.2, PHY V1.0.2 REV B, Over the air activation (OTA), Class A*

It measures temperature and humidity in the atmosphere. It's designed with a 2-in-1 sensor, a custom battery, and an industry-grade enclosure, optimized for outdoor use cases that need reliable data collection for years.

Product website 🌐
2. Enter registration data

**Frequency plan**: View the labels on the Node.

<table>
<thead>
<tr>
<th>Country</th>
<th>Frequency Range</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU868</td>
<td>Europe 863-870 MHz (SF9 for RX2 - recommended)</td>
<td></td>
</tr>
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<td>US915</td>
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<tr>
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<td>Asia 920-923 MHz</td>
<td></td>
</tr>
<tr>
<td>AS923-2</td>
<td>Asia 923-925 MHz</td>
<td></td>
</tr>
</tbody>
</table>

**Device EUI**: Enter the node’s Device EUI that you got in the 3.1 step.

**App Key**: Enter the node’s App Key that you got in the previous step.

**App EUI**: Enter the node’s App EUI.

7. Register end device.
4.4 Connect the Node to TTN

4.4.1 Power on

The power switch is hidden inside the device. Open the device and turn on the power before installing the sensors. Here is the step-by-step instruction:

1) Loosen the Sensor Probe by turning the cap counterclockwise. Use the white cap opener to make this process easier. The image below uses TH Sensor as an example and applies to all other SenseCAP sensors.

![Image of TH Sensor](image1.png)

2) After opening the device, turn the switch to “ON”, and the LED on the lower right corner will flash, indicating that the power is on. Wait for about 10 seconds, then the LED will flash quickly for 2 seconds, indicating that the device is connected to the network.

![Image of switch](image2.png)

3) After the device is connected to the network, connect the Sensor Probe back with the Sensor Node Controller by turning it clockwise. Please note that the labels on both parts should be aligned as shown in the image below, otherwise the two parts will not be attached to function properly and data will not be uploaded.

![Image of correct alignment](image3.png)
4.4.2 Sensor Node Working Status

You can refer to the LED indicator for the Sensor Node for its working status. Please see the status explanations in the image below:

![LED Status explanation](image)

- **LED Status**
  - After powering on the device:
    1. LED flashes once after powering on, then turn OFF
    2. After 10 seconds, LED flashes quickly for 2 seconds, indicating it has joined the network
    3. After joining the network, the LED stays off to save energy
    4. Push the reset button to re-join the network if the LED does not start flashing 15 seconds after powering on

4.4.3 Checking Sensor Node Connection to the TTN

On the Data page, data package is uploaded. For the format of the payload, refer to the Decoding section.
## APPLICATION DATA

<table>
<thead>
<tr>
<th>Filters</th>
<th>time</th>
<th>counter</th>
<th>port</th>
<th>state</th>
<th>payload</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>19:25:48</td>
<td>4</td>
<td>2</td>
<td>retry</td>
<td>01 01 10 90 65 00 00 01 02 10 78 E6 00 00 92 AF</td>
</tr>
<tr>
<td></td>
<td>19:25:47</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>19:25:25</td>
<td>4</td>
<td>2</td>
<td>confirmed</td>
<td>01 01 10 90 65 00 00 01 02 10 78 E6 00 00 92 AF</td>
</tr>
<tr>
<td></td>
<td>19:25:05</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>19:25:04</td>
<td>2</td>
<td>2</td>
<td>confirmed</td>
<td>01 06 00 00 00 00 00 2F 87</td>
</tr>
<tr>
<td></td>
<td>19:24:48</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>19:24:47</td>
<td>1</td>
<td>2</td>
<td>confirmed</td>
<td>01 06 00 00 00 00 00 2F 87</td>
</tr>
<tr>
<td></td>
<td>19:24:30</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>19:24:29</td>
<td>0</td>
<td>2</td>
<td>confirmed</td>
<td>00 00 00 03 03 00 02 00 07 00 44 00 3C 00 01 01 00 00 01 01 01 02 00 99 00 30 12 01 03 00</td>
</tr>
<tr>
<td></td>
<td>19:24:19</td>
<td>dev addr: 26 01 27DB</td>
<td>app uli: 80 00 00 00 00 00 00 06</td>
<td>dev uli: 2C F7 F1 20 14 70 02 97</td>
<td></td>
</tr>
</tbody>
</table>
5 Add Gateway to ChirpStack LoRaWAN Network Server Stack

ChirpStack provides open-source components for LoRaWAN networks. Together they form a ready-to-use solution including an user-friendly web-interface for device management and APIs for integration.

SenseCAP LoRaWAN Gateway has already integrated with ChirpStack LoRaWAN Network Server stack (hereinafter called the "ChirpStack LoRa Server"). The following LoRa Server components are accessible and configurable in Gateway: ChirpStack Gateway Bridge, ChirpStack Network Server and ChirpStack Application Server.

5.1 Turn on ChirpStack LoRa Server Mode

Prepare a router, and the network connection is shown in the figure:

(1) Check the IP of "sensecap" in the background of the router.
(2) Enter IP in the browser: IP:8000
   If the IP is 192.168.1.1, enter 192.168.1.1:8000
(3) User: sensecap
    Password: sensecap!!!

(4) Turn off the “Use Seeed’s Server”, and turn on “Use Local LoRa Server”.

(5) Turn on the “Use LoRa Server” button, and apply. (“LoRa Server” is the name of ChirpStack LoRa Server)
5.2 ChirpStack LoRa Server Configuration

First, click the “Start” button to start the service.

(1) ChirpStack Gateway Bridge:
Refer to: [https://www.chirpstack.io/gateway-bridge/](https://www.chirpstack.io/gateway-bridge/)
It converts LoRa® Packet Forwarder protocols into a ChirpStack Network Server common data-format (JSON and Protobuf).
For security reasons, this file is read-only.
(2) ChirpStack Network Server:
Refer to: https://www.chirpstack.io/network-server/

The responsibility of the Network Server component is the de-duplication of received LoRaWAN frames by the LoRa® gateways and for the collected frames handle the: Authentication; LoRaWAN mac-layer (and mac-commands); Communication with the ChirpStack Application Server; Scheduling of downlink frames.

In general, the default configuration is used. Please refer to the official tutorial before making any modifications. Click "APPLY" to save the configuration after making changes. Then, click "STOP" in "Application Server Status" and finally click "START" to make the configuration take effect.

(3) ChirpStack Application Server:
Refer to: https://www.chirpstack.io/application-server/

It is responsible for the device "inventory" part of a LoRaWAN infrastructure, handling of join-request and the handling and encryption of application payloads.

In general, the default configuration is used. Please refer to the official tutorial before making any modifications. Click "APPLY" to save the configuration after making changes. Then, click "STOP" in "Application Server Status" and finally click "START" to make the configuration take effect.
(4) If you have the wrong configuration, click "RESET" to restore the default configuration.
5.3 MQTT Bridge Configuration

The MQTT Bridge is able to publish all the uplink data from devices to your remote MQTT broker, and also subscribe downlink topic. Please visit ChirpStack(https://www.chirpstack.io/application-server/integrations/mqtt/) for more information about scheduling downlink data.

5.3.1 Gateway Configuration

(1) Click “Use MQTT Bridge”.

(2) After filling in each parameter, click "APPLY".

① MQTT Server address: mqtt://xxx.xx or mqtts://xxx.xx

If xxx.xx (IP) is 111.230.200.102, the address is mqtt://111.230.200.102 or mqtts://111.230.200.102
If xxx.xx (url) is mybroker.com, the address is mqtt:// mybroker.com or mqtts:// mybroker.com

② MQTT Server ’s Port.
In general, mqtt corresponds to port 1883 and mqtts to port 8883.
Keepalive:
60 is default value. When the MQTT connection between the Gateway and the Server is disconnected over 60 seconds, it determines that the client is offline.
0 means turn off the keepalive function.

CleanSession:
true: the gateway reconnects to the network after a power outage or disconnection, and cannot receive data from MQTTpub to the gateway for that period.
false: the gateway reconnects to the network after a power outage or disconnection, and can receive data from MQTTpub to the gateway for that period.

Username: Null if none, depending on the server configuration.

Password: Null if none, depending on the server configuration.

Client ID: Custom the name, and each Client ID is unique to the same MQTT server.

Publish QoS: 0, 1 or 2. (refer to the MQTT rules)

Subscribe QoS: 0, 1 or 2. (refer to the MQTT rules)
(3) It is off by default and can generally be ignored: Verify server certificate.
If true, the server certificate is verified against the list of supplied CAs.
If false, the server certificate is verified against your self-signed certificate.
(4) Check Status: Disconnected / Reconnecting / Connected.
### 5.3.2 MQTT Client Configuration

For details, please refer to: [https://www.chirpstack.io/application-server/integrations/events/#ack](https://www.chirpstack.io/application-server/integrations/events/#ack)

**ApplicationID**: the Application ID.

![ChirpStack Application Management](image)

**DevEUI**: Device EUI.

1. **Device data subscription**
   
   application/[ApplicationID]/device/[DevEUI]/event/up

   e.g. application/1/device/2cf7f1202100029b/event/up

2. **Join packet subscription**

   application/[ApplicationID]/device/[DevEUI]/event/join

   e.g. application/1/device/2cf7f1202100029b/event/join

3. **Status packet subscription**

   application/[ApplicationID]/device/[DevEUI]/event/status

   e.g. application/1/device/2cf7f1202100029b/event/status
5.3.3 Scheduling a Downlink

The default topic for scheduling downlink payloads is:

application/[ApplicationID]/device/[DevEUI]/command/down

The ApplicationID and DevEUI of the device will be taken from the topic.

Example payload:

```
{
    "confirmed": true,  // whether the payload must be sent as confirmed data down or not
    "fPort": 10,       // FPort to use (must be > 0)
    "data": ":...",     // base64 encoded data (plaintext, will be encrypted by ChirpStack Network Server)
    "object": {        // decoded object (when application coded has been configured)
        "temperatureSensor": {"1": 25},  // when providing the 'object', you can omit 'data'
        "humiditySensor": {"1": 32}
    }
}
```
5.4 ChirpStack Application Server

5.4.1 Log on to the background

According to the Gateway IP obtained in Section 4.1, log in the Web UI.
The login address: IP:8080 (if IP is 192.168.8.100, enter 192.168.8.100:8080)
Username(default): admin
Password(default): admin

5.4.2 Add the Network-servers

![Network-servers](image-url)
① Network-server name: custom name.
② Network-server server: the default value is localhost:8005

Refer to: https://www.chirpstack.io/network-server/install/config/. You can modify it in the “Network Server Configuration”.
5.4.3 Create the Gateway-profiles

1. Name: custom name.
2. Enabled channels: 0, 1, 2
   EU channels: 0, 1, 2
US902-923 channels (sub-band 2): 8, 9, 10, 11, 12, 13, 14, 15, 65

③ Network-server: select the Network-server you created earlier.

Click the “CREATE GATEWAY-PROFILE”.

5.4.4 Create the Service-profiles
① Service-profile name: custom name.
② Network-server: select the Network-server you created earlier.
③ Add gateway meta-data: select it.
④ Default values are usually used.
5.4.5  Create the Device-profiles

① Device-profile name: custom name.
② Network-server: select the Network-server you created earlier.
③ LoRaWAN MAC version: 1.0.2 (only for SenseCAP Node)
④ LoRaWAN Regional Parameters revision: B  (only for SenseCAP Node)
⑤ Max EIRP: 0
⑥ Uplink interval (seconds): 3600
   Be consistent with the node's upload interval.

Click the “JOIN(OTAA/ABP)”, and select “Device supports OTAA”.

To get a SenseCAP Sensor Node on quick decoding, we provide a piece of code.

Click the “CODEC”, and select “Custom JavaScript codec functions”.

Then view [https://github.com/Seeed-Solution/TTN-Payload-Decoder/blob/master/decoder.js](https://github.com/Seeed-Solution/TTN-Payload-Decoder/blob/master/decoder.js), please copy the code to “function decode” FUNC.

```javascript
function Decoder (bytes, port) {
    // init
    var bytesString = bytes2HexString(bytes)
        .toLocaleUpperCase();
    ..........

    return binaryData.toString()
        .replace(/,/g, "");
}
```
Add the return value at the end:

```
return Decoder(bytes, fPort);
```

Finally, click "Create".
5.5 Add Sensor Node to ChirpStack LoRa Server

5.5.1 Get Node’s EUI and Key

Refer to section 3.1.

5.5.2 Create an Application

![Applications](image)

① Application name: custom name.
② Application description: custom description.
③ Service-profile: select the Service-profile you created earlier.
5.5.3 Create a Gateway
① Gateway name: custom name.
② Gateway description: custom description.
③ Gateway ID: the gateway EUI, see the gateway’s label.
④ Network-server: select the Network-server you created earlier.
⑤ Gateway-profile: select the Gateway-profile you created earlier.
⑥ Default values are usually used.
5.5.4 Create a Device

1. Device name: custom name.
3. Device EUI: the Node's EUI.
4. Device-profile: select the Device-profile you created earlier.
5. Don't check and ignore it.

Click “Create” and enter the App KEY (Application Key, refer to section 3.1).
5.5.5 Power on

The power switch is hidden inside the device. Open the device and turn on the power before installing the sensors. Here is the step-by-step instruction:

4) Loosen the Sensor Probe by turning the cap counterclockwise. Use the white cap opener to make this process easier. The image below uses TH Sensor as an example and applies to all other SenseCAP sensors.

5) After opening the device, turn the switch to “ON”, and the LED on the lower right corner will flash, indicating that the power is on. Wait for about 10 seconds, then the LED will flash quickly for 2 seconds, indicating that the device is connected to the network.

6) After the device is connected to the network, connect the Sensor Probe back with the Sensor Node Controller by turning it clockwise. Please note that the labels on both parts should be aligned as shown in the image below, otherwise the two parts will not be attached to function properly and data will not be uploaded.

5.5.6 Sensor Node Working Status

You can refer to the LED indicator for the Sensor Node for its working status. Please see the status
5.5.7 Checking Data Upload

On the “DEVICE DATA” page in the web, you can view the data that the gateway has received from the Sensor Node.

To get measurement ID information, please visit:

https://sensecap-docs.seeed.cc/sensor_types_list.html
5.6 Add a 3rd Part Node Device

(1) Refer to the previous section to configure the gateway.
(2) Add a new device to Application.

(3) Refer to data parsing and tutorials for third-party devices.
6 The Node Connects to a Standard Gateway

SenseCAP Sensor Nodes are designed on The Things Network LoRaWAN servers, the firmware supports standard LoRaWAN 1.0.2 protocol, making it possible to connect to other 3rd-party LoRaWAN gateways and servers.

6.1 Node Frequency Plans

<table>
<thead>
<tr>
<th>Frequency Plans</th>
<th>EU868</th>
<th>US915</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uplink:</td>
<td>868.1 - SF7BW125 to SF12BW125</td>
<td>903.9 - SF7BW125 to SF10BW125</td>
</tr>
<tr>
<td></td>
<td>868.3 - SF7BW125 to SF12BW125 and SF7BW250</td>
<td>904.1 - SF7BW125 to SF10BW125</td>
</tr>
<tr>
<td></td>
<td>868.5 - SF7BW125 to SF12BW125</td>
<td>904.3 - SF7BW125 to SF10BW125</td>
</tr>
<tr>
<td></td>
<td>867.1 - SF7BW125 to SF12BW125</td>
<td>904.5 - SF7BW125 to SF10BW125</td>
</tr>
<tr>
<td></td>
<td>867.3 - SF7BW125 to SF12BW125</td>
<td>904.7 - SF7BW125 to SF10BW125</td>
</tr>
<tr>
<td></td>
<td>867.5 - SF7BW125 to SF12BW125</td>
<td>904.9 - SF7BW125 to SF10BW125</td>
</tr>
<tr>
<td></td>
<td>867.7 - SF7BW125 to SF12BW125</td>
<td>905.1 - SF7BW125 to SF10BW125</td>
</tr>
<tr>
<td></td>
<td>867.9 - SF7BW125 to SF12BW125</td>
<td></td>
</tr>
<tr>
<td></td>
<td>868.8 – FSK</td>
<td></td>
</tr>
<tr>
<td>Downlink:</td>
<td>Uplink channels 1-9 (RX1)</td>
<td>Uplink:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>903.9 - SF7BW125 to SF10BW125</td>
</tr>
<tr>
<td></td>
<td></td>
<td>904.1 - SF7BW125 to SF10BW125</td>
</tr>
<tr>
<td></td>
<td></td>
<td>904.3 - SF7BW125 to SF10BW125</td>
</tr>
<tr>
<td></td>
<td></td>
<td>904.5 - SF7BW125 to SF10BW125</td>
</tr>
<tr>
<td></td>
<td></td>
<td>904.7 - SF7BW125 to SF10BW125</td>
</tr>
<tr>
<td></td>
<td></td>
<td>904.9 - SF7BW125 to SF10BW125</td>
</tr>
<tr>
<td></td>
<td></td>
<td>905.1 - SF7BW125 to SF10BW125</td>
</tr>
<tr>
<td></td>
<td></td>
<td>869.525 - SF9BW125 (RX2 downlink only)</td>
</tr>
<tr>
<td>905.3</td>
<td>SF7BW125 to SF10BW125</td>
<td></td>
</tr>
<tr>
<td>904.6</td>
<td>SF8BW500</td>
<td></td>
</tr>
</tbody>
</table>

Downlink:
- 923.3 - SF7BW500 to SF12BW500
- 923.9 - SF7BW500 to SF12BW500
- 924.5 - SF7BW500 to SF12BW500
- 925.1 - SF7BW500 to SF12BW500
- 925.7 - SF7BW500 to SF12BW500
- 926.3 - SF7BW500 to SF12BW500
- 926.9 - SF7BW500 to SF12BW500
- 927.5 - SF7BW500 to SF12BW500
6.2 A Standard LoRaWAN Gateway Configuration Example

Typically, the LoRaWAN gateway needs to set the server address and uplink and downlink channel parameters for the end device. Refer to the gateway user manual to configure the server. Here, a common LoRaWAN gateway (US915) is taken as an example to explain how to configure the communication parameters of the Sensor Node.

The detailed configuration parameters for the Sensor Node are described here:
https://github.com/Jenkinlu001/SenseCAP-LoRaWAN/tree/master/LoRaWAN_Node_Parameters

6.2.1 Radio Settings

Find radio settings or frequency settings in the background of the gateway.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>radio 0 enable</td>
<td>√</td>
</tr>
<tr>
<td>Radio_0 frequency</td>
<td>904300000</td>
</tr>
<tr>
<td>Radio_0 for tx</td>
<td>√</td>
</tr>
<tr>
<td>Radio_0 tx min frequency</td>
<td>923000000</td>
</tr>
<tr>
<td>Radio_0 tx max frequency</td>
<td>928000000</td>
</tr>
<tr>
<td>radio 1 enable</td>
<td>√</td>
</tr>
<tr>
<td>Radio_1 frequency</td>
<td>905000000</td>
</tr>
</tbody>
</table>
6.2.2 Channel Settings

Please refer to the items in the following image for channel settings.
6.2.3 Power on

Refer to section 4.5.5

6.2.4 Sensor Node Working Status

Refer to section 4.5.6
6.2.5 Checking Data Upload

On the log page in the background of the gateway, you can view the data that the gateway has received from the Sensor Node.
6.3 Modify Node's EUI, KEY, and Duty

Connect serial ports (as shown in the image below), turn on the power, launch the serial port monitoring tool on your computer, set the Baud Rate as 115200.

(1) Use the USB to TTL wire (Please leave power port, aka 3V3 unconnected):

```
TX---RX  
RX---TX  
GND---GND
```

(2) Install the Serial Tool. Download via: https://github.com/Seeed-Solution/SenseCAP-Node-Configuration-Tool/releases/tag/v1.0.2

Windows: SenseCAP-Node-Configuration-Tool-1.x.x.exe
Mac: SenseCAP-Node-Configuration-Tool-1.0.2-mac.zip
(3) Select the COM Port that your tool uses, and click "CONNECT".
Press “SET” button on the Sensor Controller, meanwhile flip the switch to “ON”, and you will see “SenseCAP”.

(4) ①Device EUI (16 bit) ②App EUI (16 bit) ③App Key (32 bit) ④Data Interval (Sensor collection cycle)
(5) For example: modify the Device EUI

① Write the new Device EUI.
② Click “WRITE”
The Main Menu shows up, with respective commands. (Use other Serial Port Tool)

# [r] Read the current device configuration
# [i] Set the data update interval in minutes
# [d] Set the Device EUI
# [a] Set the App EUI
# [k] Set the App Key
# [u] Upgrade the firmware
# [h] Return to console center
6.4 Modify the Data Interval Remotely

(1) Using the Network Server’s portal or API to send downlink command, then the Node will respond to the ack.

Note: The downlink command takes effect and responds the next time the node uploads data.

(2) Select Port 2, Downlink as follow:

```
<table>
<thead>
<tr>
<th>0x00</th>
<th>0x89</th>
<th>0x00</th>
<th>prepareId_L</th>
<th>prepareId_H</th>
<th>duty_L</th>
<th>duty_H</th>
<th>crc-L</th>
<th>crc-H</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x00</td>
<td>Fixed field</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0x89</td>
<td>Fixed field</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0x00</td>
<td>Fixed field</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>prepareId_L</td>
<td>Command ID low byte, you can customize the values, it allow each command ID to be the same</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>prepareId_H</td>
<td>Command ID high byte, you can customize the values, it allow each command ID to be the same</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>duty_L</td>
<td>Data interval low byte, you can set the data interval, unit: minute</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>duty_H</td>
<td>Data interval high byte, you can set the data interval, unit: minute</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>crc-L</td>
<td>CRC low byte, it's calculated by the CRC-16/CCITT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>crc-H</td>
<td>CRC low byte, it's calculated by the CRC-16/CCITT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

(3) When you send the downlink command, the Node responds to the ack command.

```
<table>
<thead>
<tr>
<th>0x00</th>
<th>0x1F</th>
<th>0x00</th>
<th>prepareId_L</th>
<th>prepareId_H</th>
<th>result</th>
<th>0x00</th>
<th>crc-L</th>
<th>crc-H</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x00</td>
<td>Fixed field</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0x1F</td>
<td>Fixed field</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0x00</td>
<td>Fixed field</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>prepareId_L</td>
<td>Command ID low byte, it is the same as the downlink command</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>prepareId_H</td>
<td>Command ID high byte, it is the same as the downlink command</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>result</td>
<td>If the downlink command is in force, it responds 0x01, else it responds 0x00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0x00</td>
<td>Fixed field</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>crc-L</td>
<td>CRC low byte, it’s calculated by the CRC-16/CCITT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>crc-H</td>
<td>CRC low byte, it’s calculated by the CRC-16/CCITT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

For example: Set the Node’s data interval is 10 minutes.

Send the downlink command (HEX):

```
00 89 00 11 22 0A 00 38 B4
```

ACK Response:

```
00 1F 00 11 22 01 00 78 0F
```

---

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6.4.1 Modify the Data Interval via the Chirpstack

(1) Click to “Application→Devices→Node→DETAILS”

(2) Enqueue downlink payload:
   a) Port: 2
   b) Select “Confirmed downlink”.
   c) Input the Base64 command, Set the Node’s data interval is 10 minutes, and send the downlink command (HEX): 00 89 00 11 22 0A 00 38 B4
   Then, use a hex to base64 tool (https://cryptii.com/pipes/hex-to-base64).

So, the base64 command is AIkAESIKADI0
d) Click the “ENQUEUE PAYLOAD”, the “downlink queue” will display command. 
When the command disappears after you refresh, the command has been sent.
7 Decoding

In the gateway or server background, similar packets can be viewed. (If the data is encrypted, it usually needs to be decrypted using base64)

Notice:
With successful access to the network, please connect the Sensor Probe back to the Sensor Node Controller by turning it clockwise. Please note the labels on both sides should be aligned as the image below, or it will not be put back in the right way. When the Sensor Probe is connected to the Sensor Node Controller correctly, the device can upload data.
7.1 Packet Parsing

Packet Initialization

After being powered on or reboot, SenseCAP Sensor Nodes will be connected to the network using OTAA activation method. Each Sensor Node will send data packets to the server, including the following data:

**Initial packets** (no need to learn about these initial packets)
- One packet with device info including hardware version, software version, battery level, sensor hardware & software version, sensor EUI, power, and sensor power time counter at each channel.

**Measurement data packets**

The only thing we should pay attention to is the sensor measurement data packets.

Packet Structure

The structure of the frame is shown in the image below.

<table>
<thead>
<tr>
<th>channel</th>
<th>frame type</th>
<th>frame content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 byte</td>
<td>2 bytes</td>
<td>≥ 4 bytes</td>
</tr>
</tbody>
</table>

1 byte for channel, default as 1, means the sensor has been well connected.

2 bytes for frame type, in this case, it will be 0110 and 0210, means temperature value and humidity value

4 bytes for content, is the sensor value with CRC
The frame content is sent in little-endian byte order

7.1.1 Example 1 - Air Temperature & Humidity Sensor:

Air Temperature & Humidity Sensor measurement packet: 01011080680000001021088F400008CFF

Divide the data into 3 sections
|   | Air Temperature | 01011080680000 | 01 is the channel number.  
|   |               | 0110 is 0x1001 (little-endian byte order), which is the measurement ID for air temperature.  
|   |               | 80680000 is actually 0x00068B00, whose equivalent decimal value is 26800. Divide it by 1000, and you’ll get the actual measurement value for air temperature as 26.8℃.  
|   | Air Humidity   | 01021088F40000 | 0210 is 0x1002 (little-endian byte order), which is the measurement ID for air humidity.  
|   |               | 88F40000 is actually 0x0000F488, whose equivalent decimal value is 62600. Divide it by 1000, and you’ll get the actual measurement value for air humidity as 62.6%RH.  
|   | CRC           | 8CFF           | The CRC verification part.  

7.1.2 Example 2 - CO2 Sensor:

CO2 Sensor measurement packet: 010410E08D05009802

Divide the data into 3 sections:

|   | CO2         | 010410E08D0500 | 01 is the channel number.  
|   |            | 0410 is 0x1004 (little-endian byte order), which is the measurement ID for CO2.  

`E08D0500` is actually `0x00058DE0`, whose equivalent decimal value is `364000`. Divide it by `1000`, and you'll get the actual measurement value for CO2 as `364ppm`.

| 3 | CRC | 9802 | The CRC verification part. |

### 7.1.3 Example 3 - Soil Moisture and Temperature Sensor:

Soil Moisture and Temperature Sensor measurement packet: `010610007D0000010710725100009A21`

Divide the data into 3 sections

| 1 | Soil Temperature | 010610007D0000 | 01 is the channel number. |
|   |                  | 0710 is 0x1007 *(little-endian byte order)*, which is the measurement ID for soil temperature. |
|   |                  | 007D0000 | is actually 0x00007D00, whose equivalent decimal value is `32000`. Divide it by `1000`, and you'll get the actual measurement value for Soil Temperature as `32.0°C`. |

| 2 | Soil Moisture | 01071072510000 | 0710 is 0x1007 *(little-endian byte order)*, which is the measurement ID for soil moisture. |
|   |              | 72510000 | is actually 0x00005172, whose equivalent decimal value is `20850`. Divide it by `1000`, and you'll get the actual measurement value for Soil Moisture. |
7.1.4 Example 4 – Light Intensity Sensor:

Light Intensity Sensor measurement packet: 010310A0320000C3B6

Divide the data into 3 sections

<table>
<thead>
<tr>
<th>1</th>
<th>Light Intensity</th>
<th>010310A0320000</th>
<th>01 is the channel number. 0310 is 0x1003 (little-endian byte order), which is the measurement ID for Light Intensity. A0320000 is actually 0x00032A0, whose equivalent decimal value is 12960. Divide it by 1000, and you’ll get the actual measurement value for Light Intensity as 12.96 Lux.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>CRC</td>
<td>C3B6</td>
<td>The CRC verification part.</td>
</tr>
</tbody>
</table>

7.1.5 Example 5 – Barometric Pressure Sensor:

Barometric Pressure Sensor measurement packet: 010510284A140652B7

Divide the data into 3 sections

<table>
<thead>
<tr>
<th>1</th>
<th>Barometric Pressure</th>
<th>010510284A1406</th>
<th>01 is the channel number. 0510 is 0x1003 (little-endian byte order), which is the measurement ID for Barometric Pressure.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>284A1406 is actually 0x06144A28, whose equivalent decimal value is 101993000. Divide it by 1000, and you’ll get the actual measurement value for Barometric Pressure as 101993 Pa.</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>CRC</td>
<td>52B7</td>
<td></td>
</tr>
</tbody>
</table>

The CRC verification part.

To get more measurement ID, please visit [https://sensecap-docs.seeed.cc/sensor_types_list.html](https://sensecap-docs.seeed.cc/sensor_types_list.html)
7.2 Exception

Please note the counter number. After 10 packets, it will follow one special packet with battery info. You can either ignore this packet or get rid of the battery info in your code.

Original Info: 0007006400050001011058660000001021070F80000443E

Battery Info: 00070064000500

Measurement Info: 01011058660000001021070F80000443E

Example:

Battery & TH Sensor measurement packet: 0007006400050001011058660000001021070F80000443E

Divide the data into 3 sections

<table>
<thead>
<tr>
<th></th>
<th>Battery</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>00070064000500</td>
<td>01011058660000</td>
</tr>
<tr>
<td>2</td>
<td>01011058660000</td>
<td>01 is the channel number. 0110 is 0x1001 (little-endian byte order), which is the measurement ID for air temperature.</td>
</tr>
</tbody>
</table>
5860000 is actually 0x0000658, whose equivalent decimal value is 26200. Divide it by 1000, and you’ll get the actual measurement value for air temperature as \(26.2{\text{°C}}\).

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Humidity</td>
<td>01021070F80000 0210 is 0x1002 ((\text{little-endian byte order})), which is the measurement ID for air humidity. 70F80000 is actually 0x0000F870, whose equivalent decimal value is 63600. Divide it by 1000, and you’ll get the actual measurement value for air humidity as 63.6%RH.</td>
</tr>
<tr>
<td>3</td>
<td>CRC</td>
<td>443E</td>
</tr>
</tbody>
</table>
8 Device Installation

In this chapter, we will introduce the gateway and sensor nodes, their respective installation processes, as well as the dos and don’ts. Before installing, please check the part list to ensure nothing is missing.
8.1 Part List

8.1.1 Gateway Part List

The LoRa Gateway comes with a standard antenna. If you need ultra-long-distance communication, you will need to purchase a high-gain fiberglass antenna.

<table>
<thead>
<tr>
<th>Item</th>
<th>Name</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LoRa Gateway</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>LoRa Antenna</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>4G Antenna</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Allen Hex Key</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Mounts</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>Power Adapter</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>Power Extension Cable (5M)</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>Ferrules / Aluminum piece</td>
<td>2 / 2</td>
</tr>
<tr>
<td>9</td>
<td>M5 Self-drilling Screw</td>
<td>8</td>
</tr>
<tr>
<td>10</td>
<td>Antenna Lightning Protector (*Optional)</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>LoRa Fiberglass Omni Antenna (*Optional)</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>LoRa Antenna Brackets (*Optional)</td>
<td>1</td>
</tr>
</tbody>
</table>
8.1.2 Sensor Node Part List

The accessories for different sensors may vary. The common parts are as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Name</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sensor</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Bracket</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>M4 Self-drilling Screw</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>M3 Self-drilling Screw</td>
<td>2</td>
</tr>
</tbody>
</table>

8.1.3 Other Accessories & Tool List

For installing in different scenarios, you might need to purchase extra accessories or tools.

<table>
<thead>
<tr>
<th>Item</th>
<th>Name</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND Copper Wire (2.5mm²)</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Pliers</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>M4x12 Grounding Screw</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Waterproof Self-adhesive Tape (to protect antenna connection part)</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>M6 Self-drilling Screw (to install the gateway on the wall)</td>
<td>4</td>
</tr>
</tbody>
</table>
8.2 Gateway Installation

8.2.1 Gateway Installation Methods

- Installing on a pole (Use the Mounts)

Firstly, use M5 self-drilling screws (included in the package) to fasten the 4 brackets onto the gateway. And then use cable ties to fasten the gateway onto the pole. The recommended pole diameter is 70mm.

Put cable ties through the holes of the bracket and pull to fasten onto the pole. To get a better communication range, it is recommended to mount the gateway 3 meters above the ground. If there are tall buildings around, the gateway should be kept away from the building or mounted on top of the tall building.
● Installing on a pole (Use the Ferrules and Aluminum pieces)
Firstly, use M5 self-drilling screws (included in the package) to fasten the 2 Aluminum pieces onto the gateway. And then use ferrules to fasten the gateway onto the pole. The recommended pole diameter is 76mm.

Note: If the pole is made of metal, the antenna should be pulled higher than the metallic part of the pole, or the communication signal will have interfered.

● Installing on the Wall
Firstly, use M5 self-drilling screws (included) to fasten the 4 brackets onto the enclosure of the gateway (refer to the image below for directions). And then fasten the gateway onto the wall with screws.
Note: The screws (that fasten gateway onto the wall) are not included in the package. Please prepare screws according to the wall materials (recommended screw diameter: 6mm).

8.2.2 Installation Precautions

1) In mountainous or thunderstorm-stricken areas, please take lightening protection measures. For the fiberglass LoRa antenna, you will need to install a lightening arrester and make sure it is connected to the ground. Besides, the gateway should be mounted lower than the lightening rod.

2) When installing the gateway in the outdoor environment, the connected part should be protected with waterproof tape, to enhance waterproof performance and lengthen device lifespan. As shown below, use self-adhesive tape to protect the connection. Take a rubber tape at the length of 10cm – 15cm, pull it to twice of that length wind the tape clockwise to the connected part of the antenna.
8.2.3 Installing Fiberglass LoRa Antenna

There are two kinds of LoRa antennas: the normal LoRa antenna (included in the package), and the fiberglass LoRa antenna (to be purchased separately). We will introduce how to install the fiberglass LoRa antenna.

1) Fasten the lightening arrester onto the antenna port.

**Note:** The tape must be wound clockwise because the antenna is fastened clockwise. Otherwise, the antenna may loosen.

If the sensor has wires, install threaded tubes:
2) As shown in the image below, please fasten the fiberglass antenna onto the base part, and then fasten the whole part onto the vertical cylinder (maximum cylinder diameter: 50mm).

3) Use a 1-meter antenna feed line to connect the lightening arrester with the fiberglass antenna.

8.2.4 Installing Ground Cable

Here we will connect the lightening arrester to the GND screw port on the gateway with a ground cable, and then connect the whole device to the ground. The image below shows the location of the GND port at the backside of the gateway.

1) Prepare two copper cables, a shorter one (approx. 30cm) for connecting the lightening arrester with the GND screw port (on the gateway), and a longer one for connecting the device to the ground.

2) Fasten the lightening arrester to the short copper cable with screws, and then connect the two copper cables to the GND screw port. Use the screw to connect and fasten them.

3) Once the two cables are connected, connect the other end of the long cable to the ground. Depending on your actual installation environment, you can connect it to the ground directly or connect it to the copper ground bars.
8.3 Installing Sensor Node

8.3.1 Installing the Sensor Node Bracket

Specially designed for installing SenseCAP Sensor Nodes, the bracket consists of a bracket and a sliding cap. With designated screw-holes, the bracket helps fasten the Sensor Node firmly onto a pole or a wall.

1) To install on a pole, you can use zip ties to fasten the bracket (recommended pole dimension is 50-70mm in diameter). Please refer to the following image for bracket directions.

2) To install on the wall or other surfaces, you can use self-drilling screws to fasten the bracket onto the surface.
### 8.3.2 Installing Sensor Nodes

After installing brackets, let's install sensors.

1) The Sensor Probe should be placed vertically downward with the label facing outward. Be consistent with the bracket gap. Make sure the circle part in the middle of Sensor Node is aligned with the middle of the bracket, and then press the Sensor Node to fit into the bracket. A click/snap sound indicates that the Sensor Node has been installed successfully. Try to manually twist it to make sure the Sensor Node is locked to the bracket securely.

2) Secure by fastening the bracket cap as instructed in the image.

3) Place two self-drilling screws on the bracket to increase firmness and help prevent theft.

**Note:** Do not insert the Sensor Node into the bracket from the top, or it will not fasten the onto the bracket securely.
8.3.3 **Dos and Don’ts in Installing Sensor Probes**

The same instruction applies to installing the different Sensor Nodes. However, there are some tips to keep in mind when installing certain Sensor Nodes.

- **Light Sensor**

  The Sensor Probe of the Light Sensor needs to be placed vertically upward, and there should not be anything obstructing sunlight from the Sensor Probe.

- **CO2 Sensor**

  The Sensor Probe can be fastened with self-drilling screws. Please refer to the image below for the probe direction. The end without the cables should point downward to prevent rain or dust from getting into the probe. Also, the device should be in a place with good ventilation.