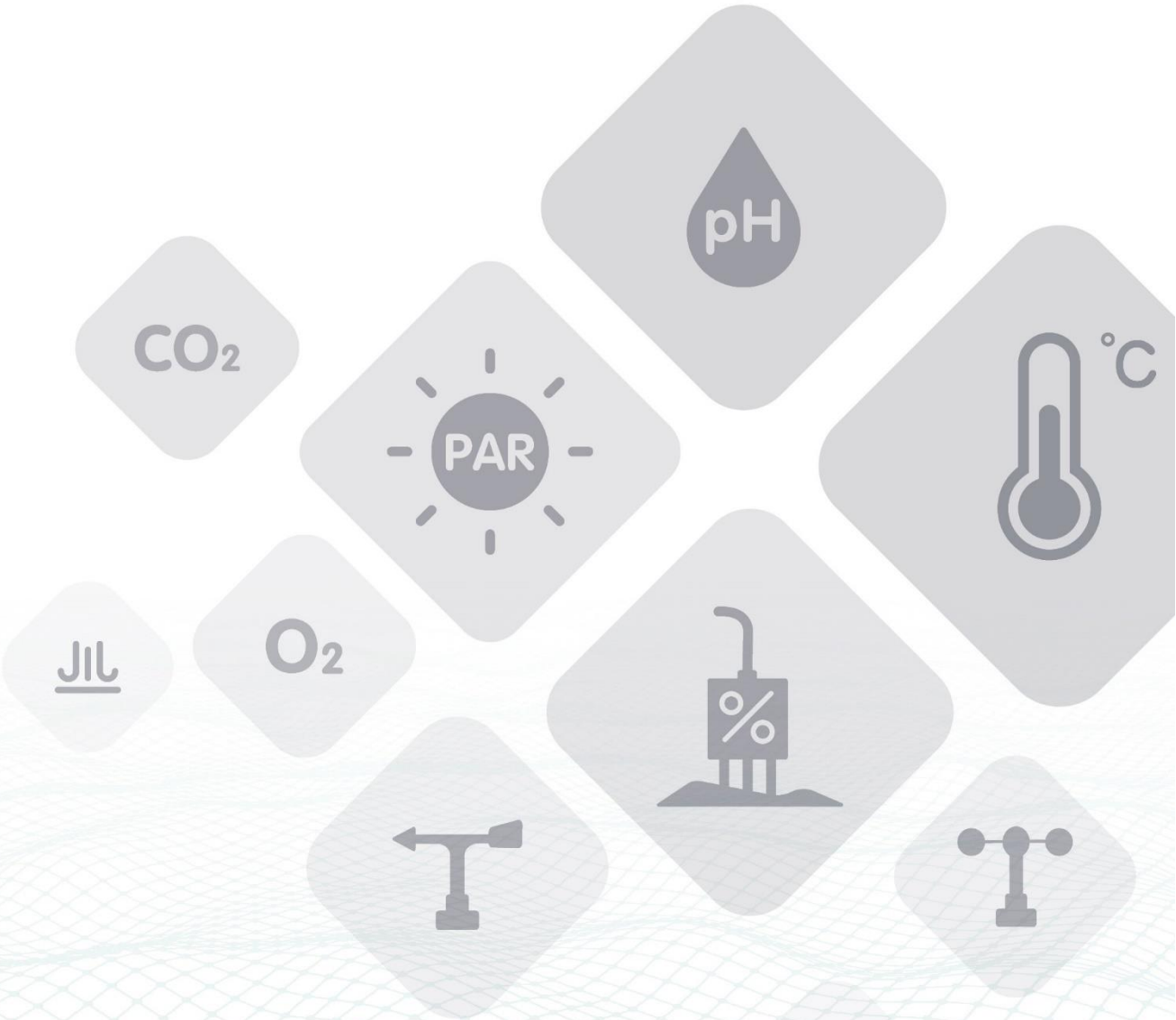
SENSECAP

LoRaWAN Gateway and Wireless Sensor User Guide

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

Version: V1.2



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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

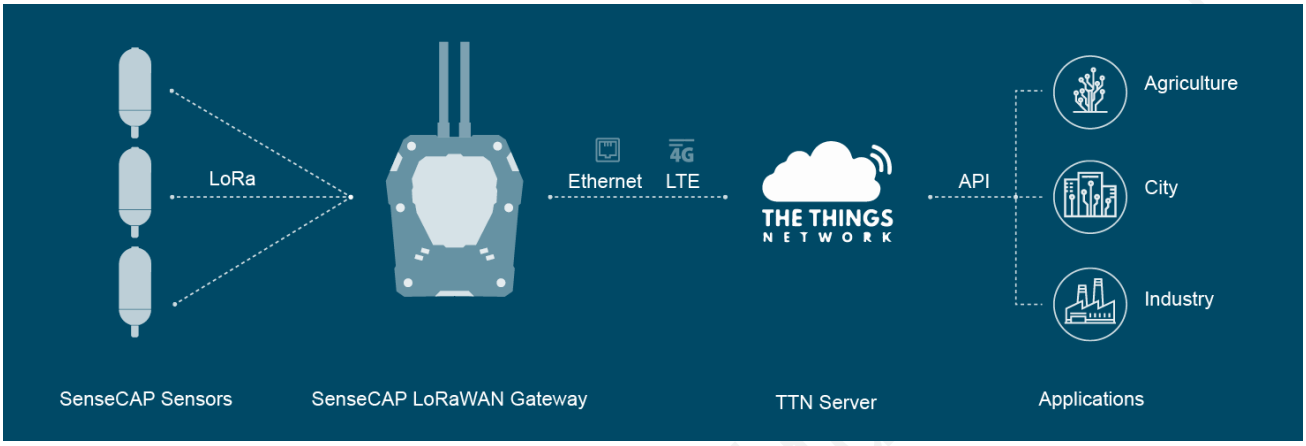
LoRaWAN Gateway:

LoRaWAN Sensor Node:

2 Add Gateway to User's TTN Server

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

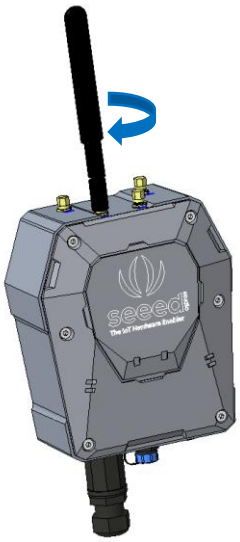
Learn more about TTN: https://www.thethingsnetwork.org/docs/



2.1 Gateway Network Configuration

2.1.1 Installing Antenna

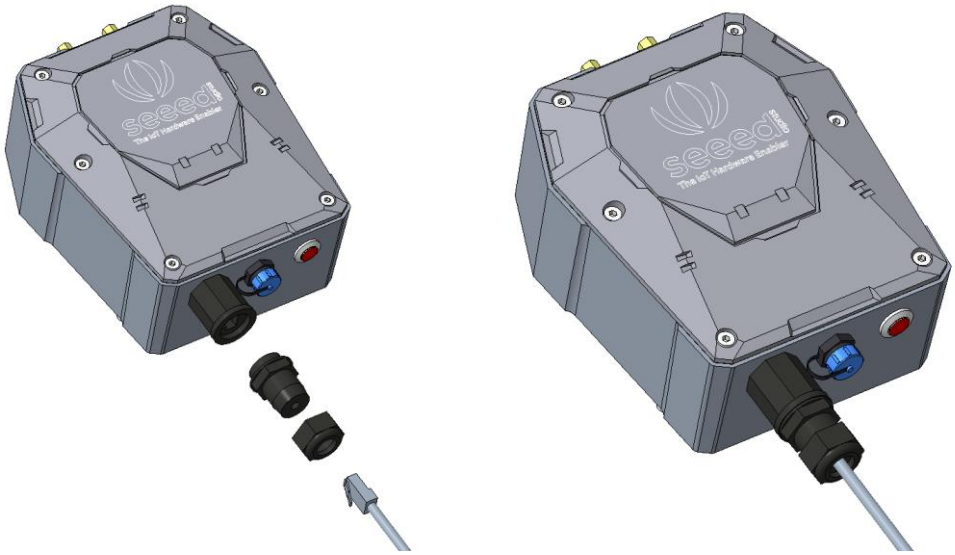
Screw clockwise to install the 4G and LoRa antennas onto the gateway.



2.1.2 Connecting to the Internet

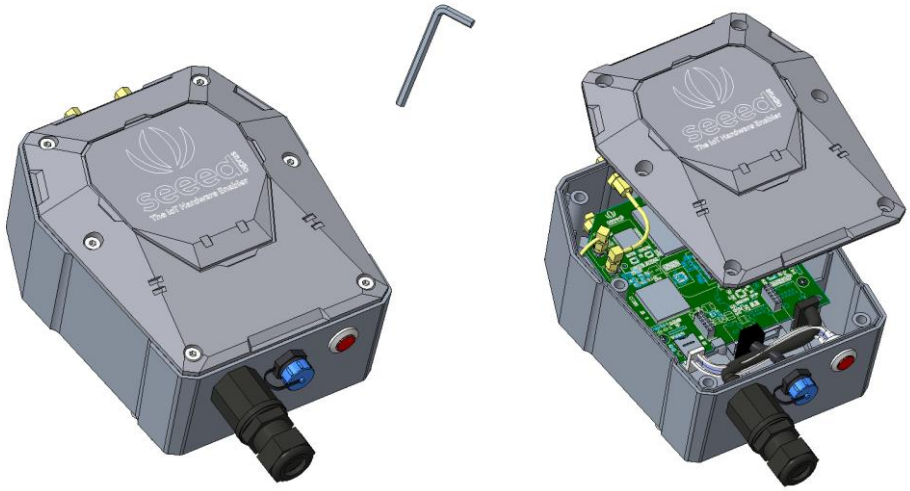
There are two ways to connect to the Internet. Choose the one that works for you.

(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.

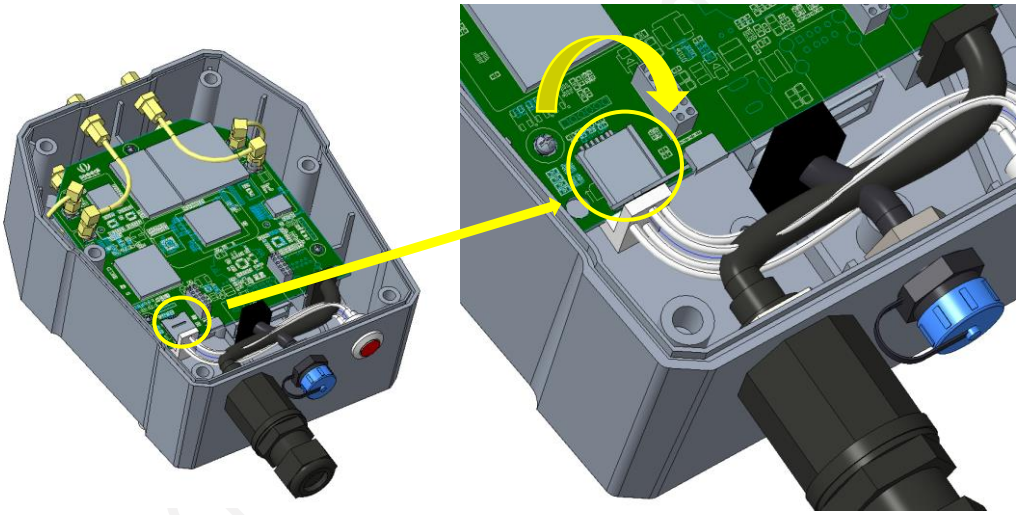


(2) Connecting to 4G

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

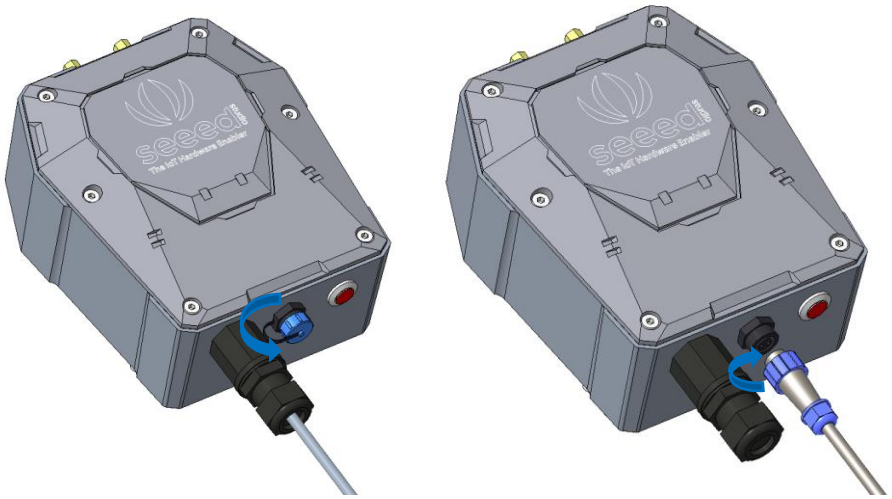


Swipe downward to open the SIM card socket, insert the Micro SIM card and swipe upward to lock the SIM card socket. Make sure it is installed correctly and close the lid with the screws.



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.

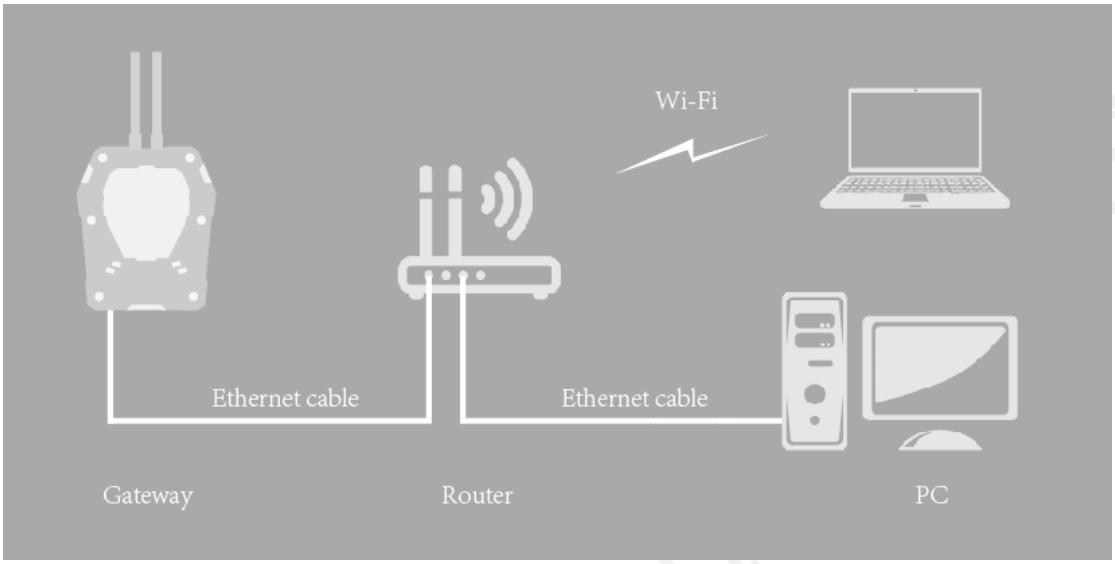


Notice: Make sure all antennas are correctly installed before powering on the gateway. Please note the device should be POWERED OFF when installing the antenna, or the antenna circuits might be damaged.

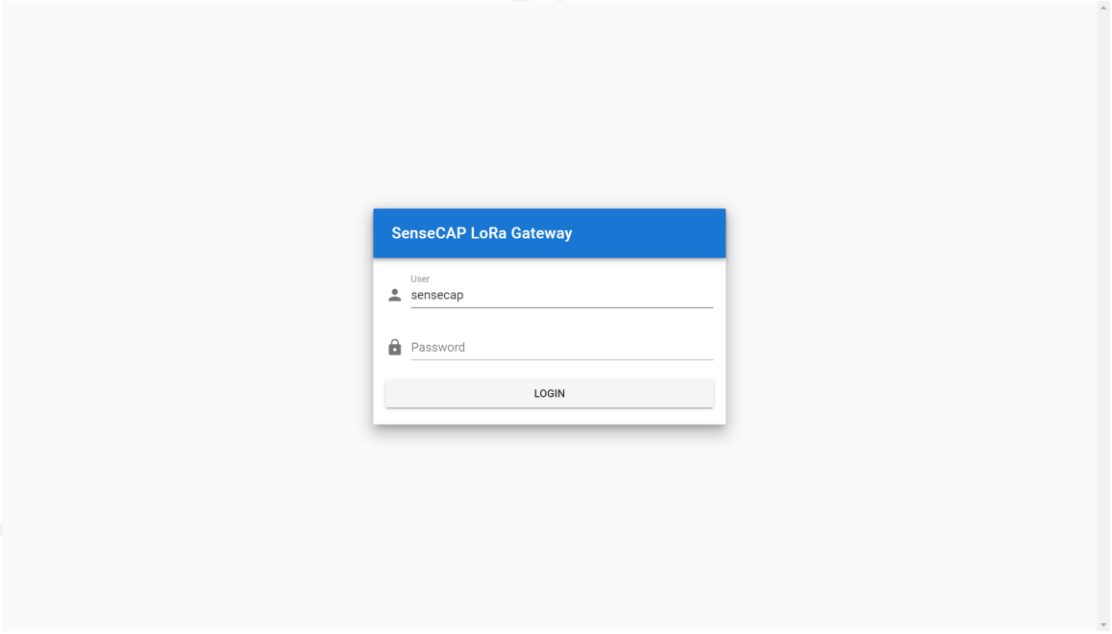
2.1.4 The Function of the Red LED

2.2 Setting the Gateway Service Address

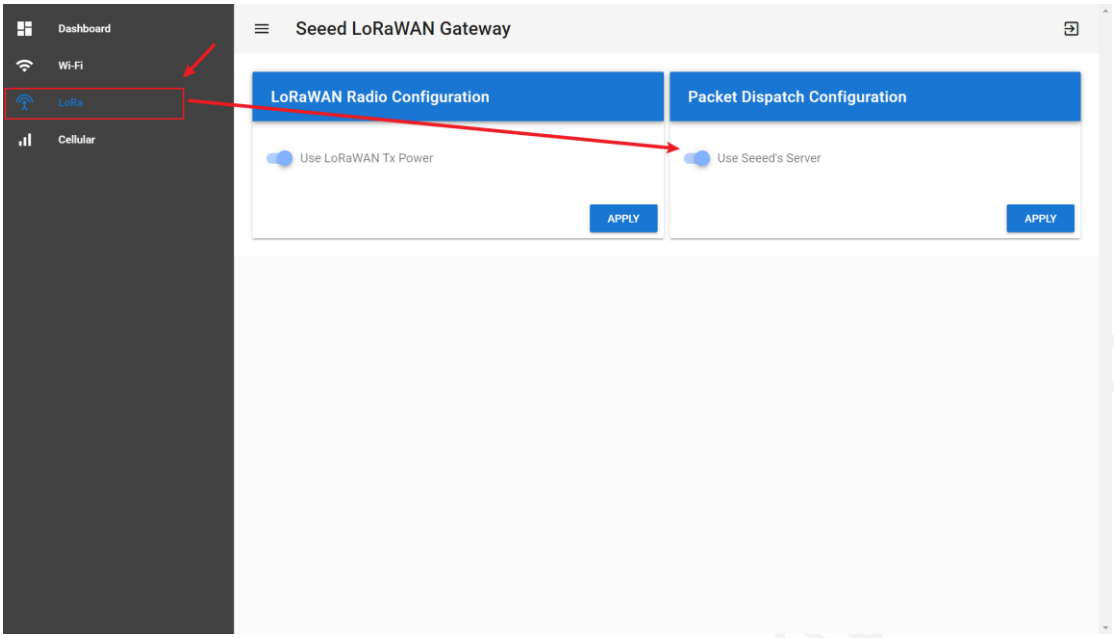
Prepare a router, and the network connection is shown in the figure:



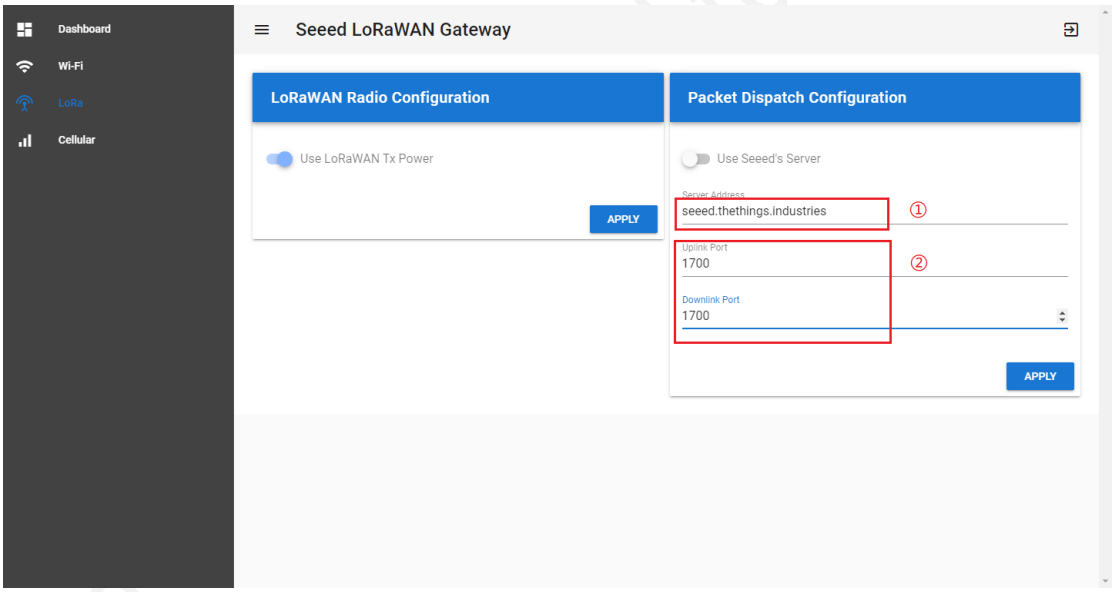
(1) Check the IP of "sensecap" in the background of the router.
(2) Enter IP in the browser: IP:8000
If the IP is 192.168.1.1, enter 192.168.1.1:8000



(3) User: sensecap
Password: sensecap!!!
(4) LoRa→Use Seeed's Server→Off Button



(5)



① Server Address: Please input your Server Address.

Refer to the table or website: https://www.thethingsnetwork.org/docs/gateways/packet-forwarder/semtech-udp.html#router-addresses

Router address	Region
router.eu.thethings.network	EU 433 and EU 863-870
router.us.thethings.network	US 902-928
router.cn.thethings.network	China 470-510 and 779-787
router.as.thethings.network	Southeast Asia 923 MHz

router.as1.thethings.network	Southeast Asia 920-923 MHz
router.as2.thethings.network	Southeast Asia 923-925 MHz
router.kr.thethings.network	Korea 920-923 MHz
router.jp.thethings.network	Japan 923-925 MHz (with EIRP cap according to Japanese regulations)
thethings.meshed.com.au	Australia 915-928 MHz
as923.thethings.meshed.com.au	Australia (Southeast Asia 923MHz frequency plan)
ttn.opennetworkinfrastructure.org	Switzerland (EU 433 and EU 863-870)

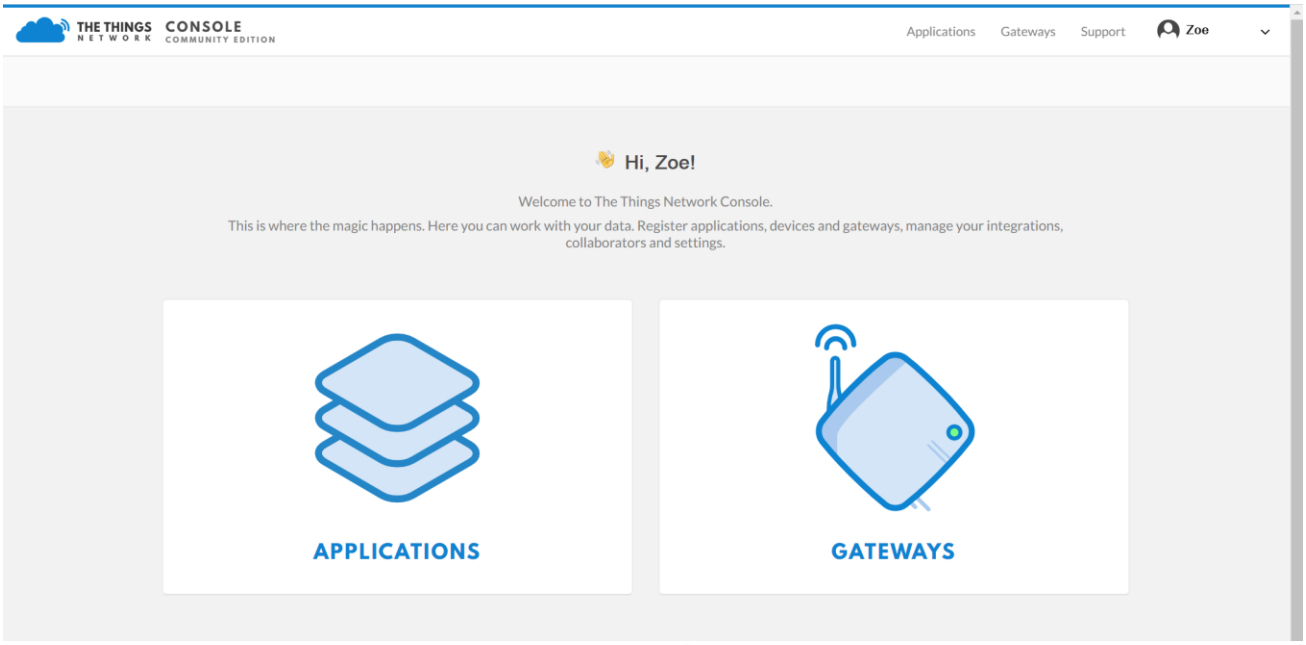
② Uplink / Downlink Port (default): 1700

(6) APPLY.

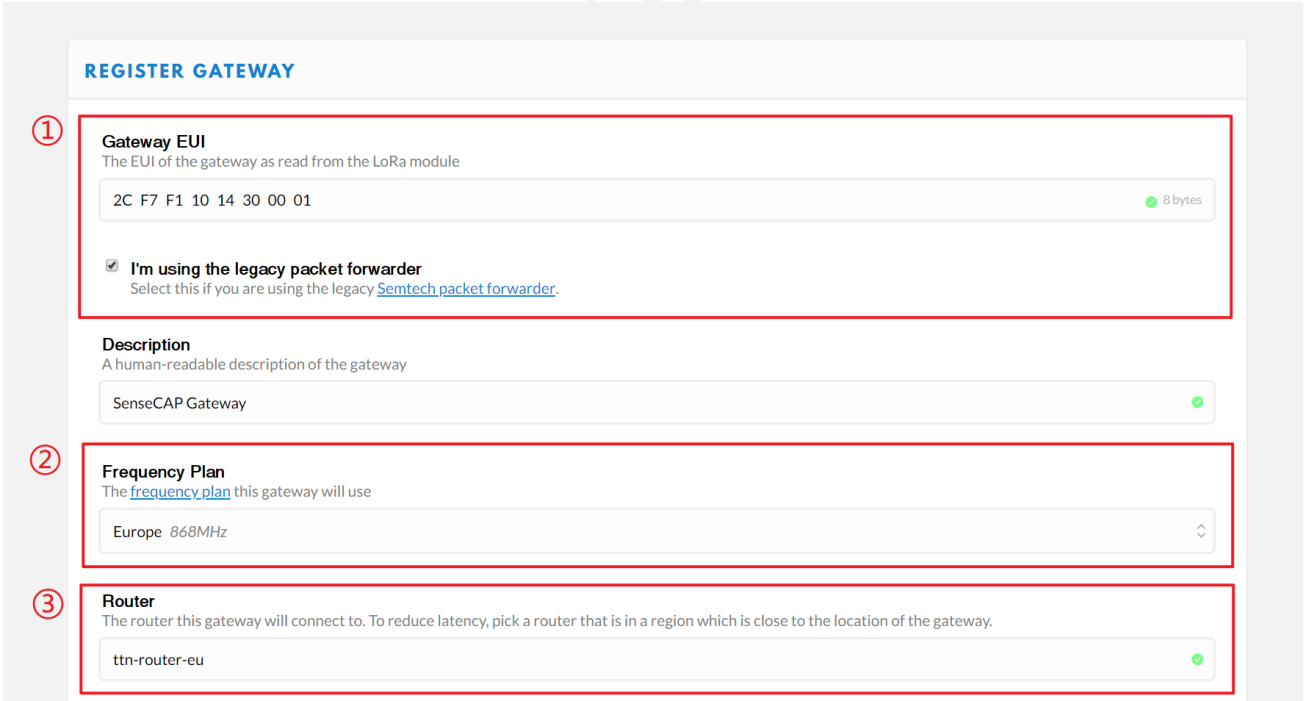
2.3 Gateway Registration on TTN

TTN website: https://www.thethingsnetwork.org

(1) Follow the instruction to create your account, and access “Console”.



(2) Register Gateway

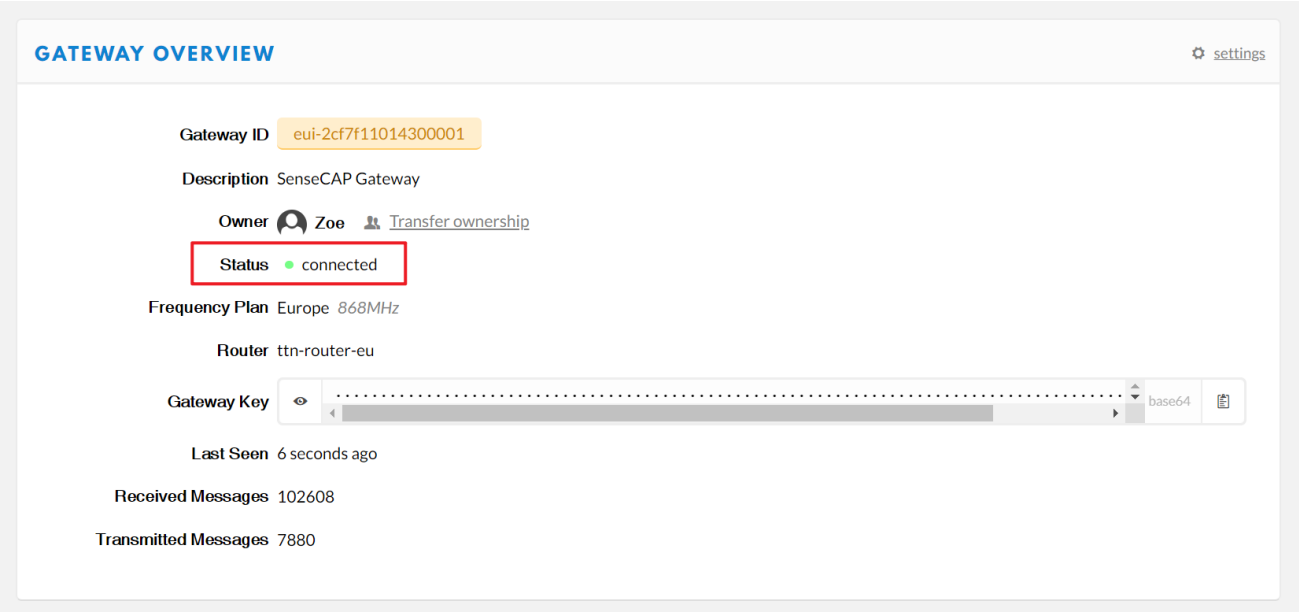


① Gateway EUI: View the labels on the gateway.
Select ‘I’m using the legacy packet forwarder’.

② Frequency Plan: View the labels on the gateway.

③ Router: Select the router that is right for you.

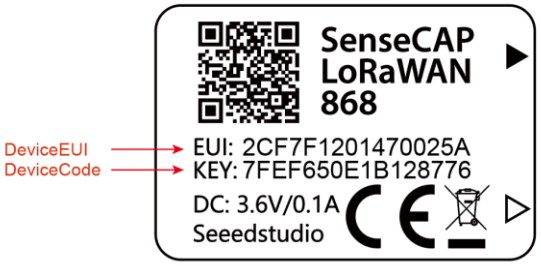
④ Register.
Gateway Status displays connected, indicating successful registration.



3 Add Sensor Node to User's TTN Server

3.1 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
```

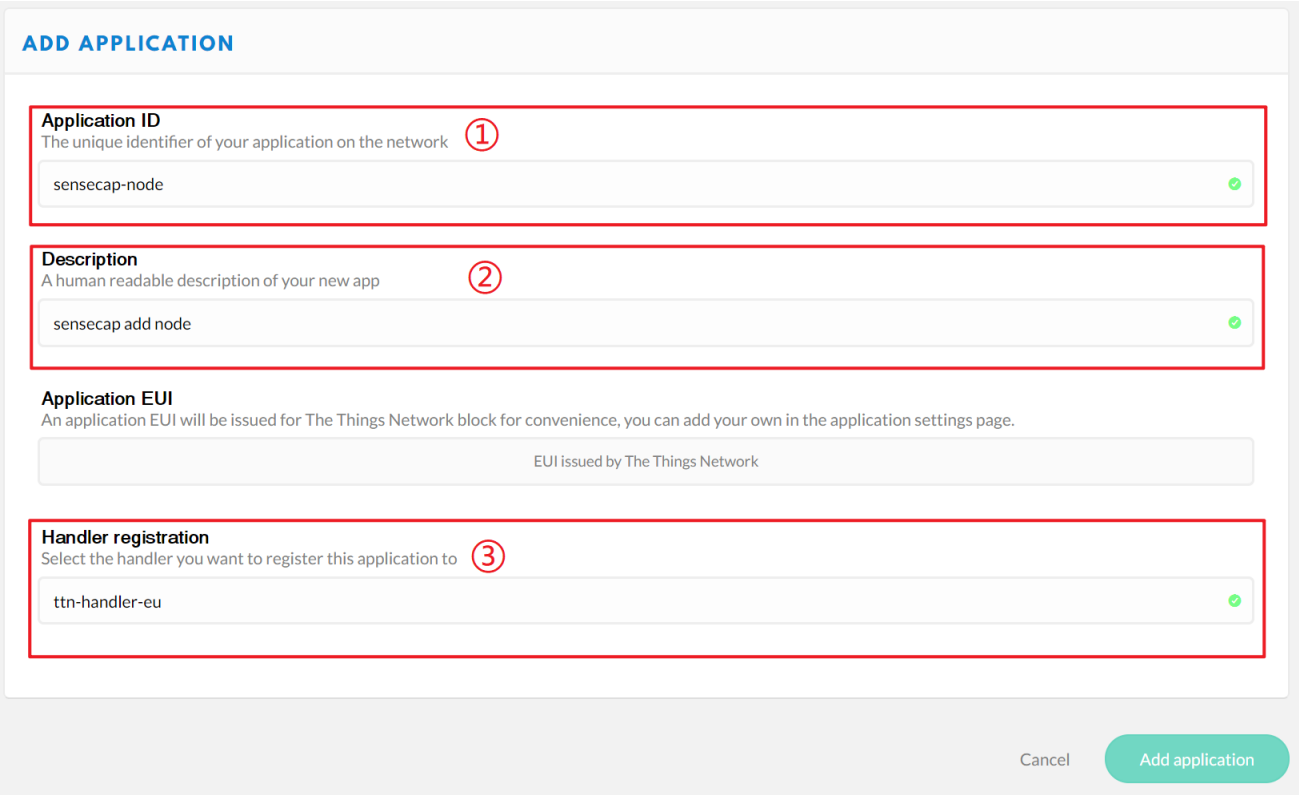
In the API, replace the DeviceEUI and deviceCode with your own DeviceEUI and DeviceCode respectively. And you will get the following response.

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

3.2 Add Application and AppEUI

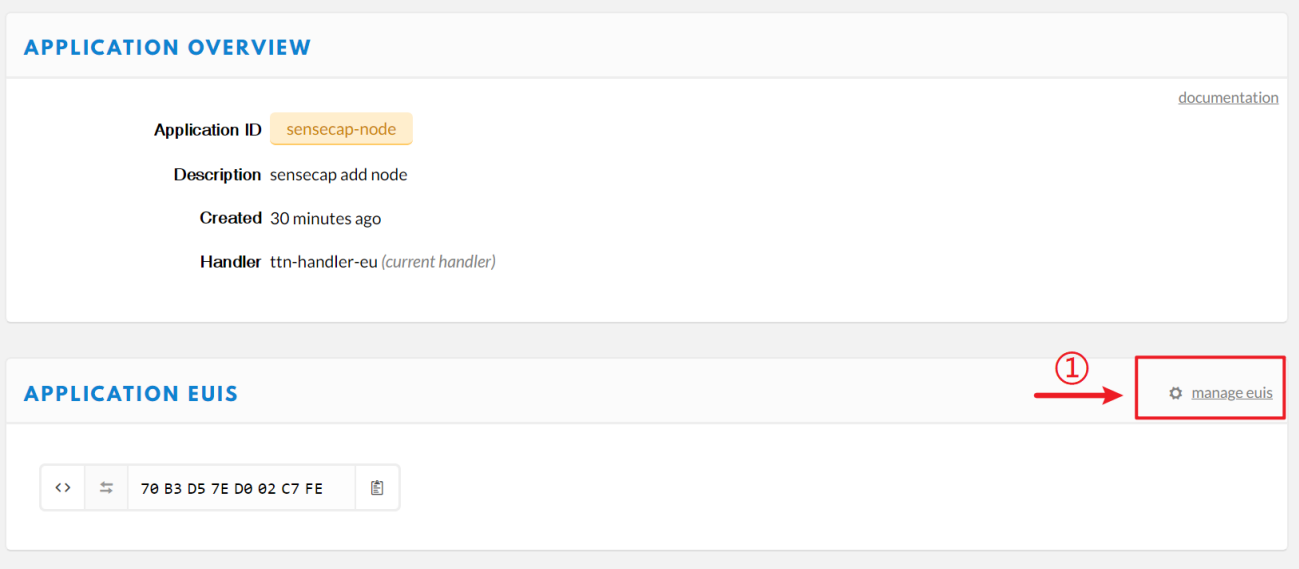
(1) TTN console → Application → Add application

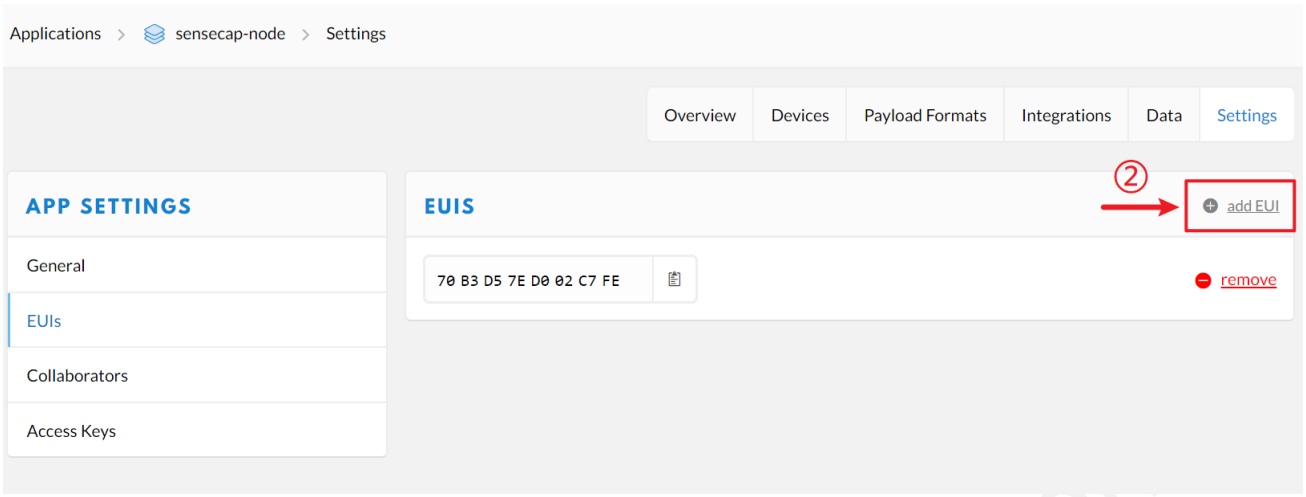
(2)

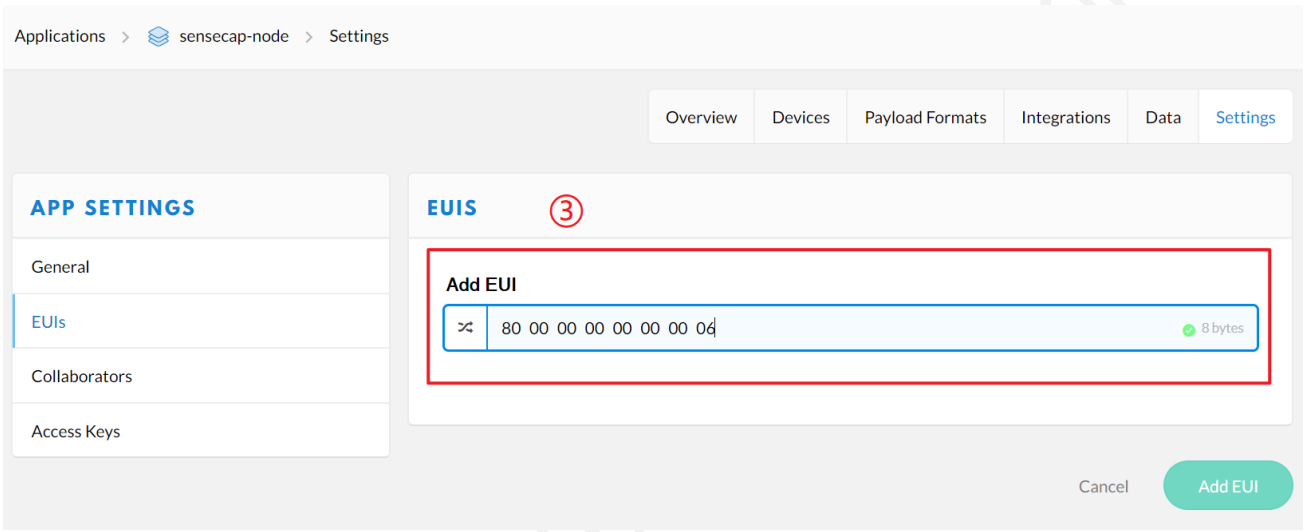


① Application ID: Enter a unique name.
② Description: Enter a description.
③ Handler registration: Select the same handler as the gateway router.
④ Add application.

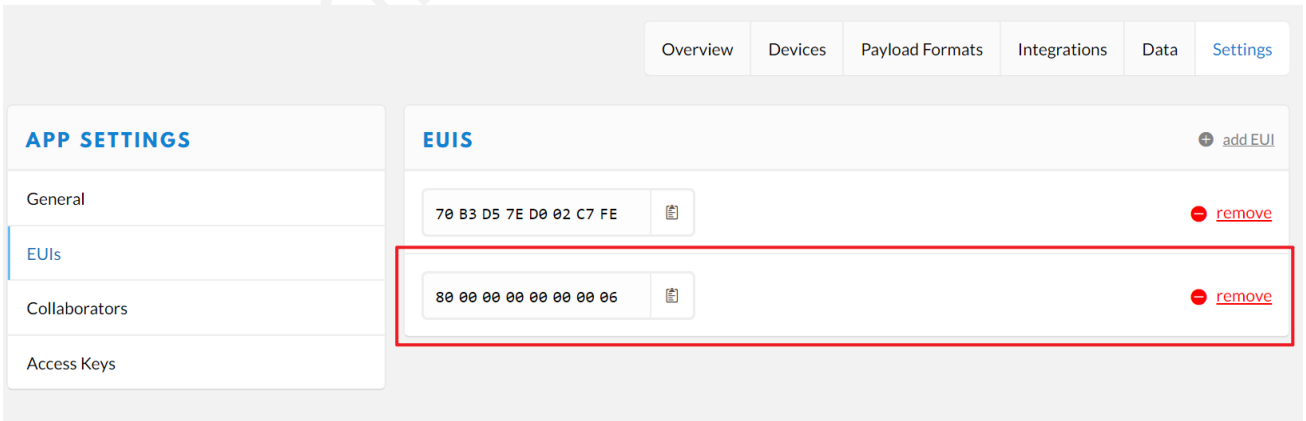
(3)





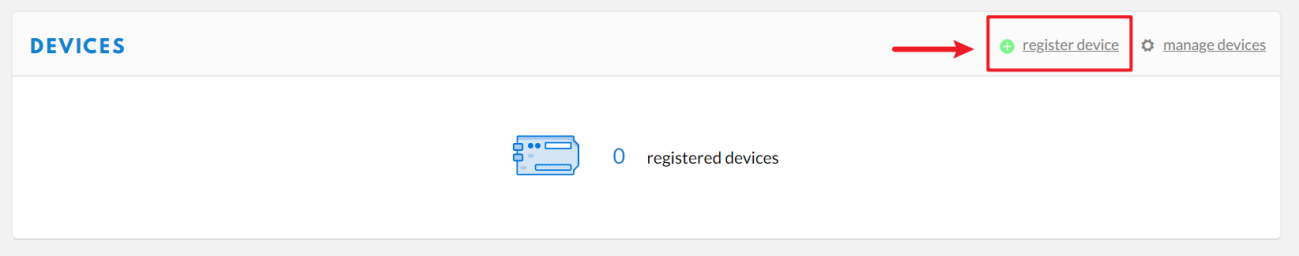


① Application → Application EUIS → Manage EUIs.
② →Add EUI.
③ Enter the node's AppEui that you got in the 3.1 step.
④ →Add EUI.

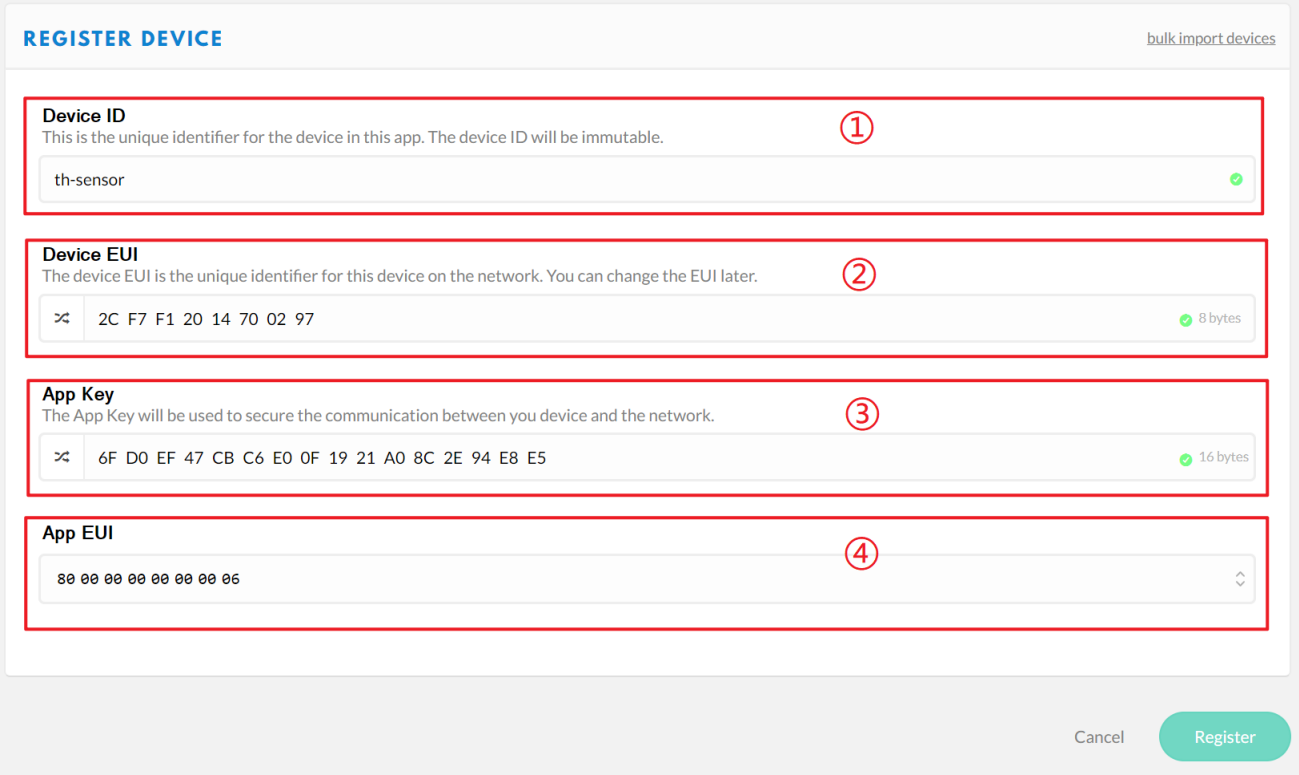


3.3 Sensor Node Registration on TTN

(1) Application → Devices → register device



(2)



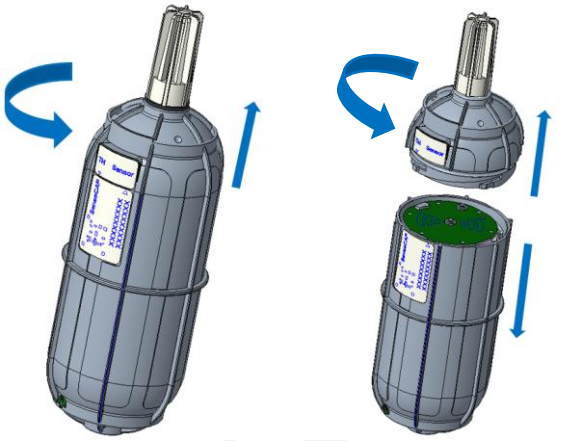
① Device ID: Enter a unique name.
② Device EUI: Enter the node's Device EUI that you got in the 3.1 step.
③ App Key: Enter the node's App Key that you got in the previous step.
④ App EUI: Select the node's App EUI.
⑤ Register.

3.4 Connect the Node to TTN

3.4.1 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.

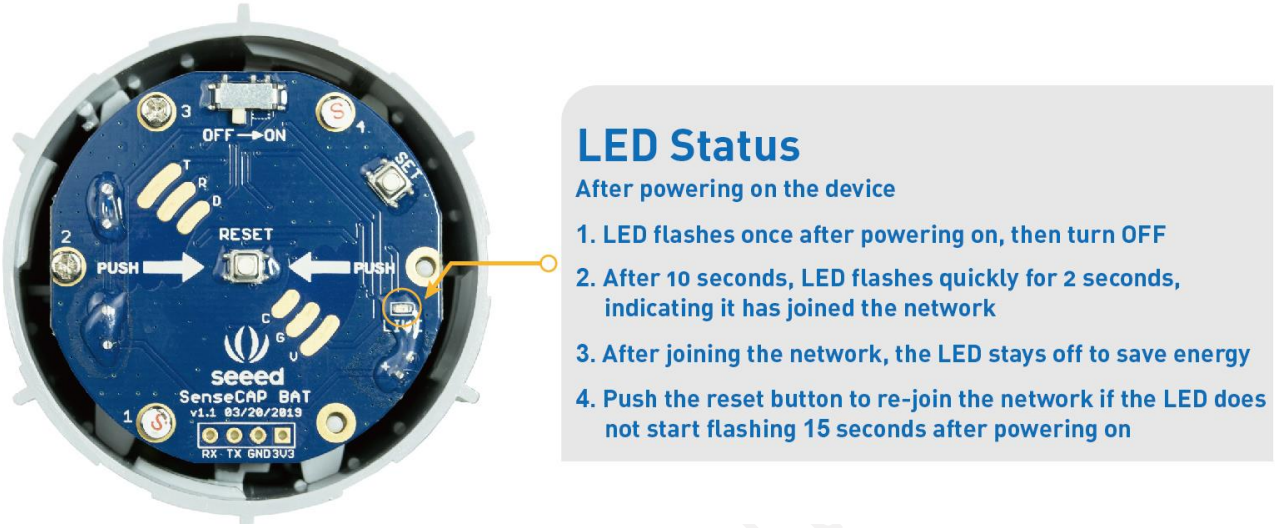


2) After opening the device, turn the switch to “ON”, and the LED on the lower right corner will flash, indicating that the power is on. Wait for about 10 seconds, then the LED will flash quickly for 2 seconds, indicating that the device is connected to the network.

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.

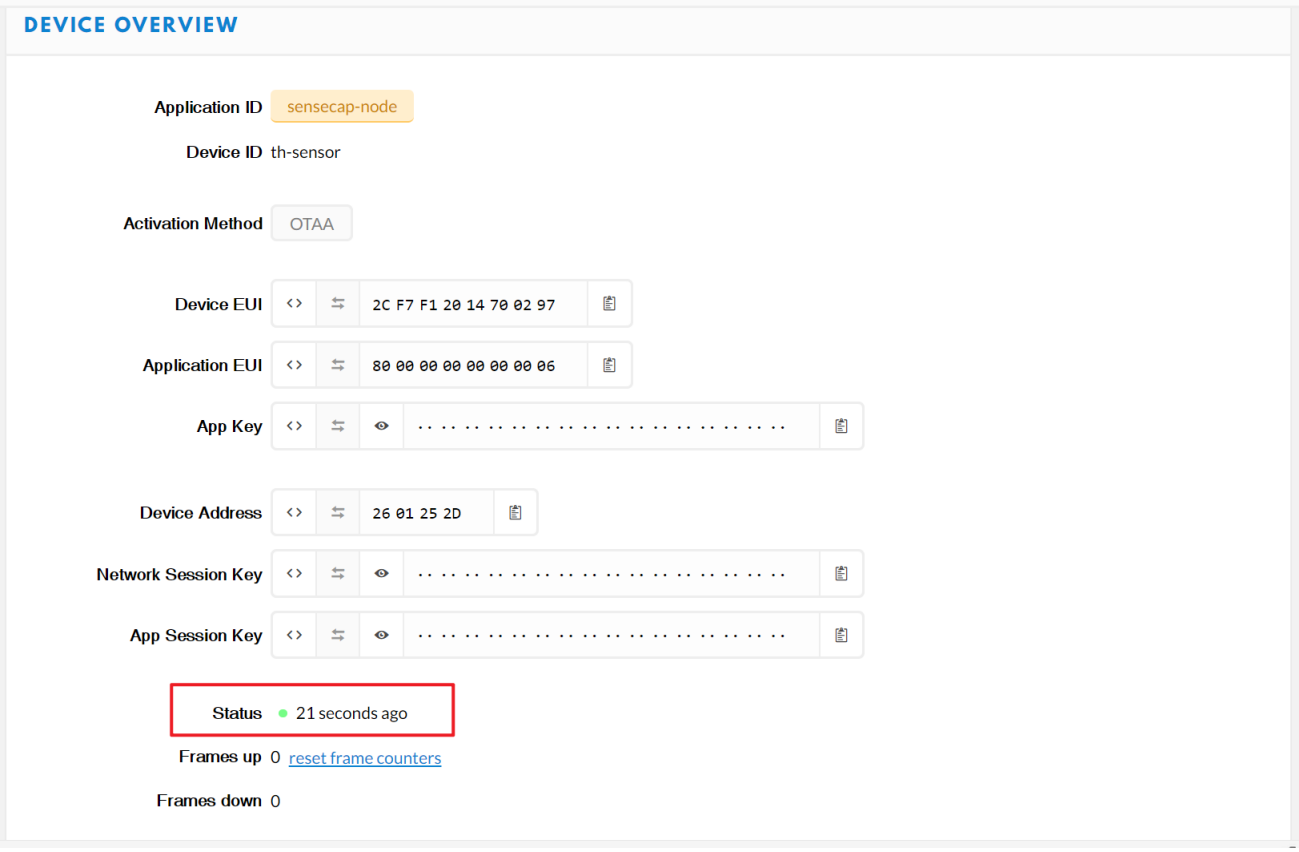
3.4.2 Sensor Node Working Status

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

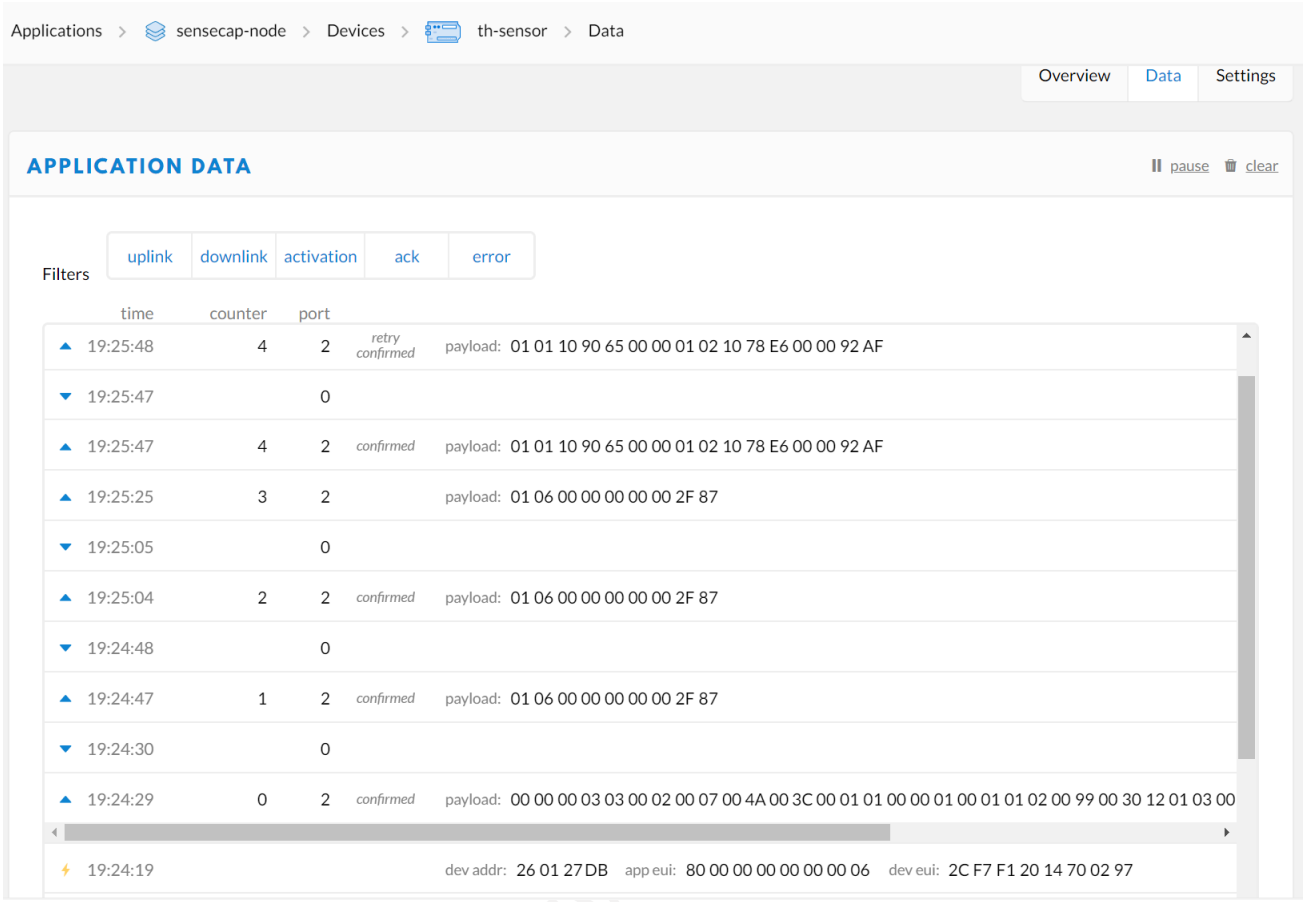


3.4.3 Checking Sensor Node Connection to the TTN

(1) On the Device Overview page, Status turns green.

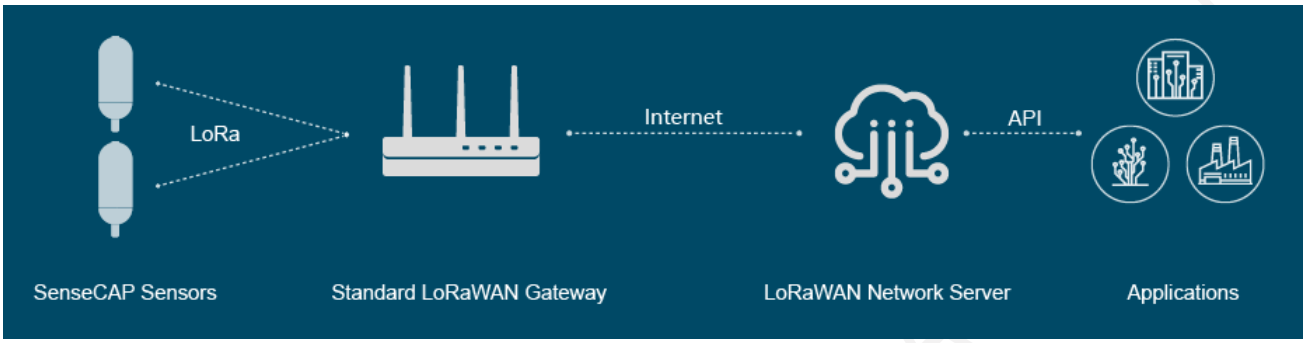


(2) On the Data page, data package is uploaded. For the format of the payload, refer to the Decoding section.



4 Connect to the Standard LoRaWAN 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.



4.1 Node Frequency Plans

Frequency Plans	
EU868	Uplink: 868.1 - SF7BW125 to SF12BW125 868.3 - SF7BW125 to SF12BW125 and SF7BW250 868.5 - SF7BW125 to SF12BW125 867.1 - SF7BW125 to SF12BW125 867.3 - SF7BW125 to SF12BW125 867.5 - SF7BW125 to SF12BW125 867.7 - SF7BW125 to SF12BW125 867.9 - SF7BW125 to SF12BW125 868.8 – FSK Downlink: Uplink channels 1-9 (RX1) 869.525 - SF9BW125 (RX2 downlink only)
US915	Uplink: 903.9 - SF7BW125 to SF10BW125 904.1 - SF7BW125 to SF10BW125 904.3 - SF7BW125 to SF10BW125 904.5 - SF7BW125 to SF10BW125 904.7 - SF7BW125 to SF10BW125 904.9 - SF7BW125 to SF10BW125 905.1 - SF7BW125 to SF10BW125

	905.3 - SF7BW125 to SF10BW125 904.6 - SF8BW500 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

4.2 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

4.2.1 Radio Settings

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

radio 0 enable√

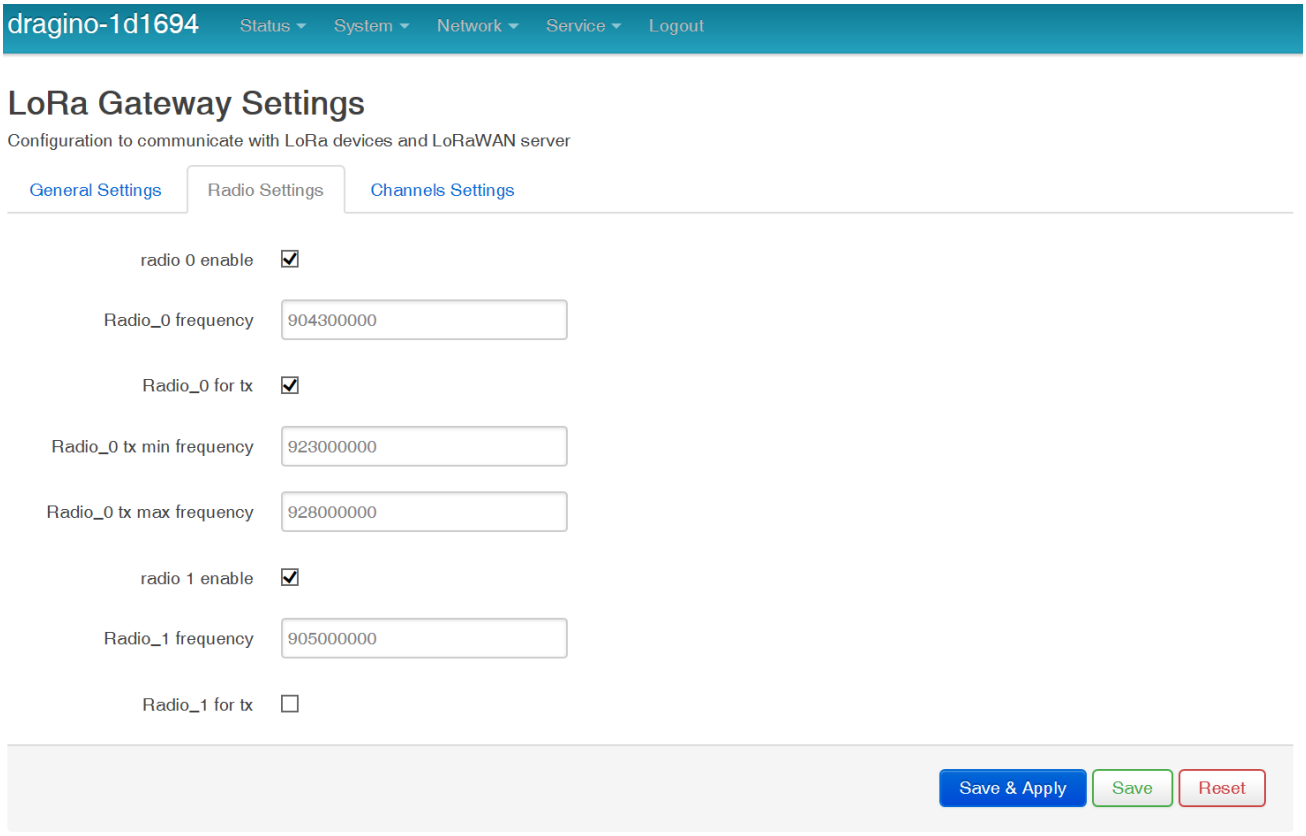
Radio_0 frequency: 904300000

Radio_0 for tx√

Radio_0 tx min frequency: 923000000
Radio_0 tx max frequency: 928000000

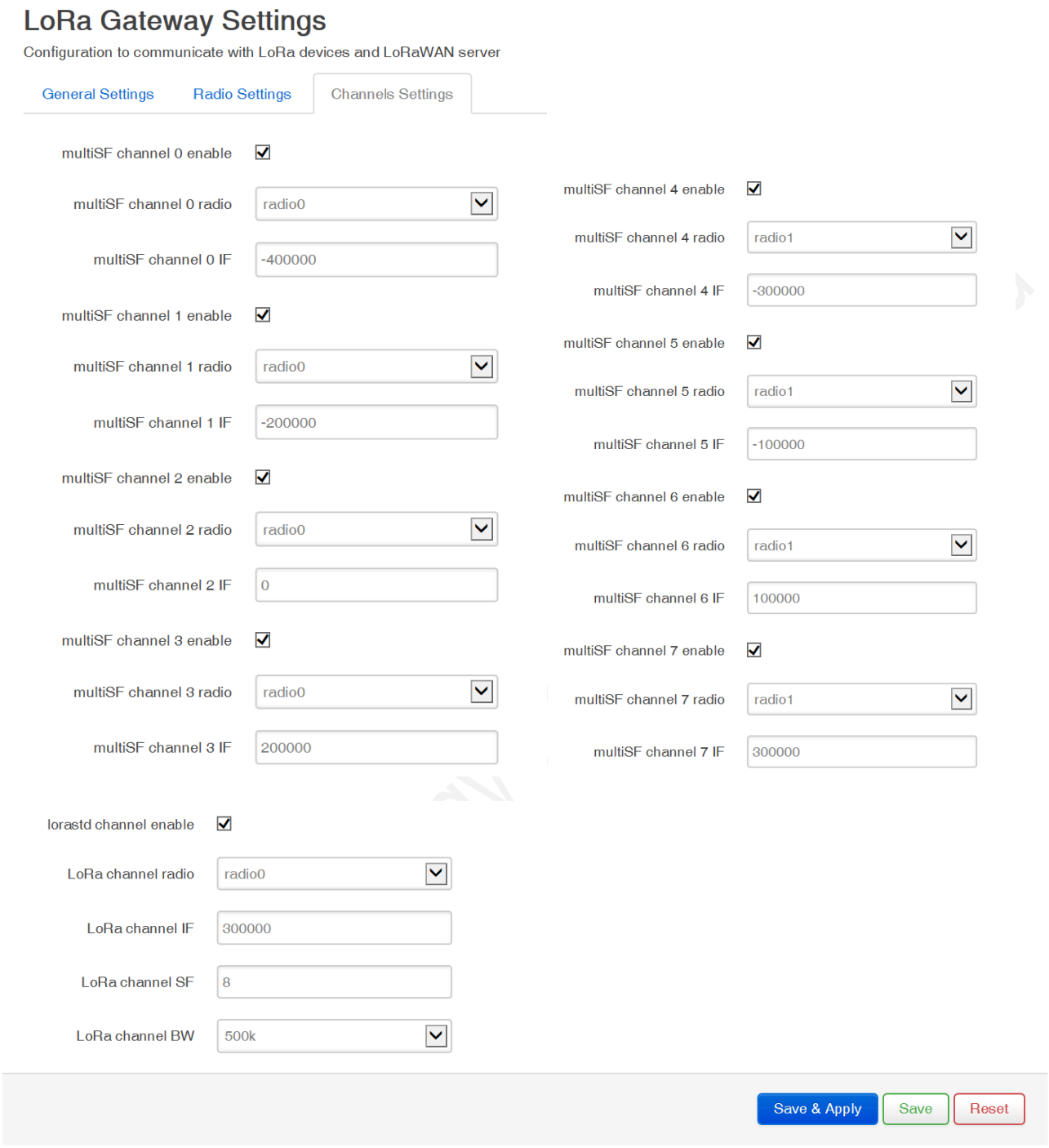
radio 1 enable√

Radio_1 frequency: 905000000



4.2.2 Channel Settings

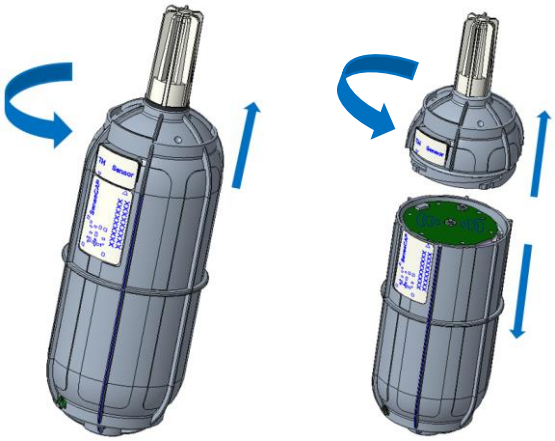
Please refer to the items in the following image for channel settings.



4.2.3 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.

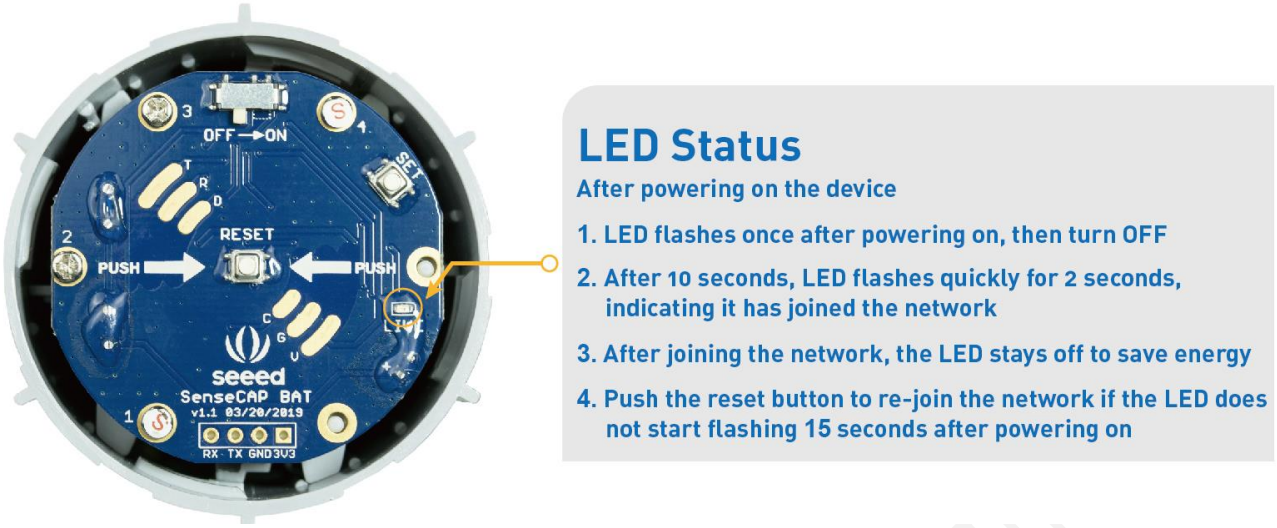


5) After opening the device, turn the switch to “ON”, and the LED on the lower right corner will flash, indicating that the power is on. Wait for about 10 seconds, then the LED will flash quickly for 2 seconds, indicating that the device is connected to the network.

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.

4.2.4 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:



4.2.5 Checking Data Upload

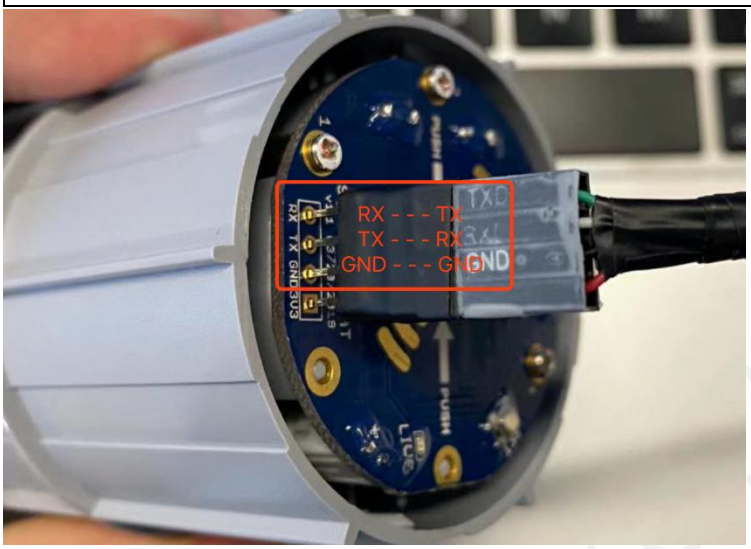
On the log page in the background of the gateway, you can view the data that the gateway has received from the Sensor Node.

4.3 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.

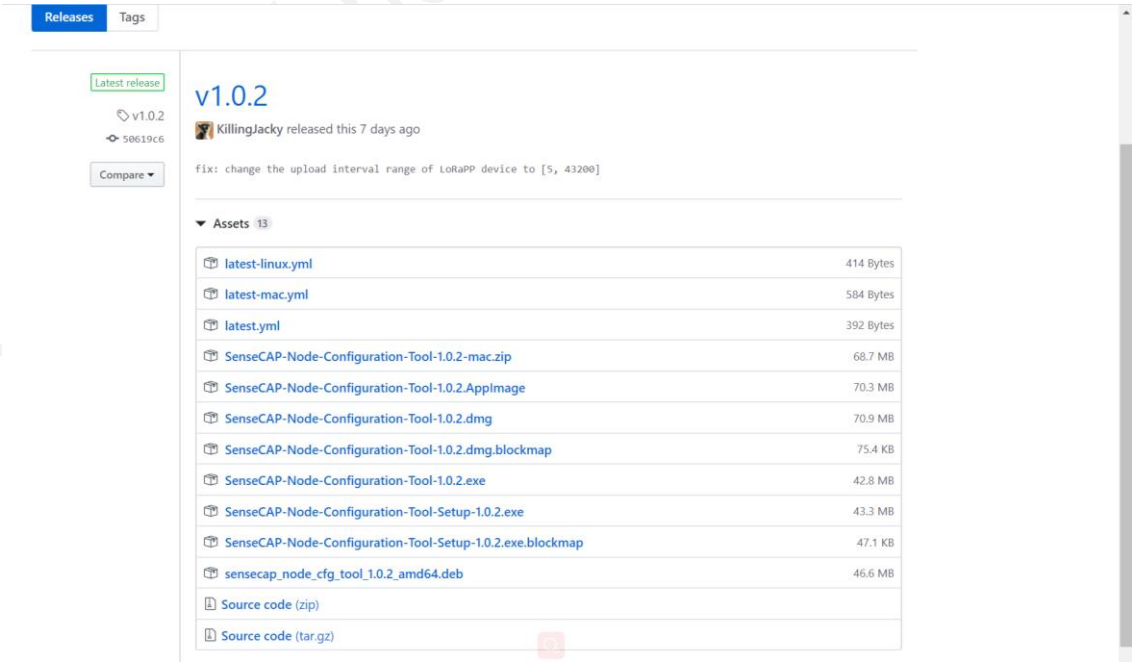
(1) Use the USB to TTL wire (Please leave power port, aka 3V3 unconnected):

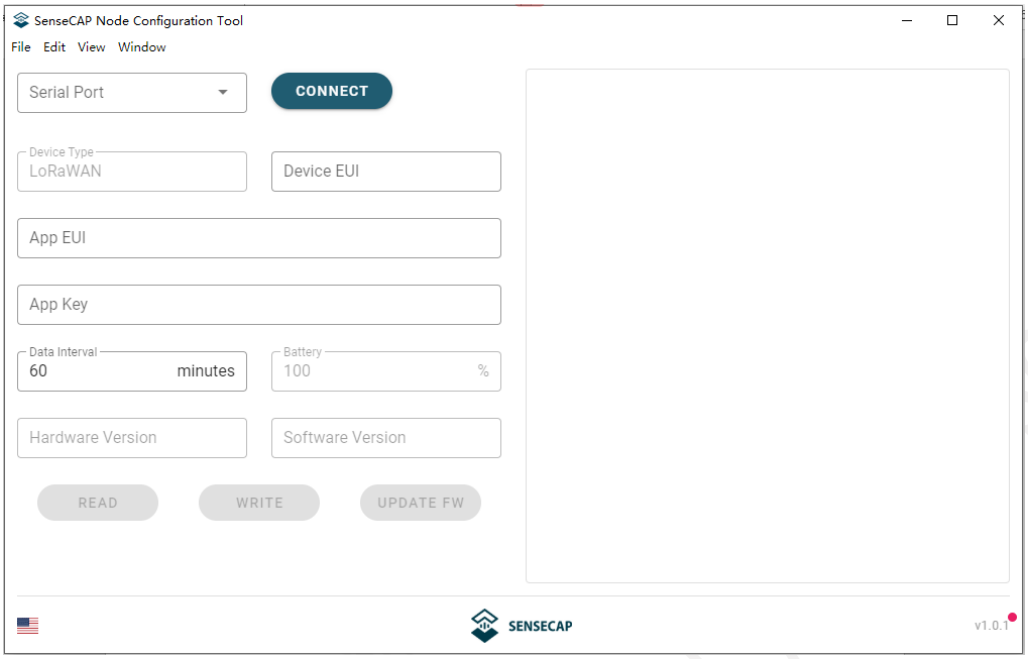
TX---RX RX---TX GND---GND



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

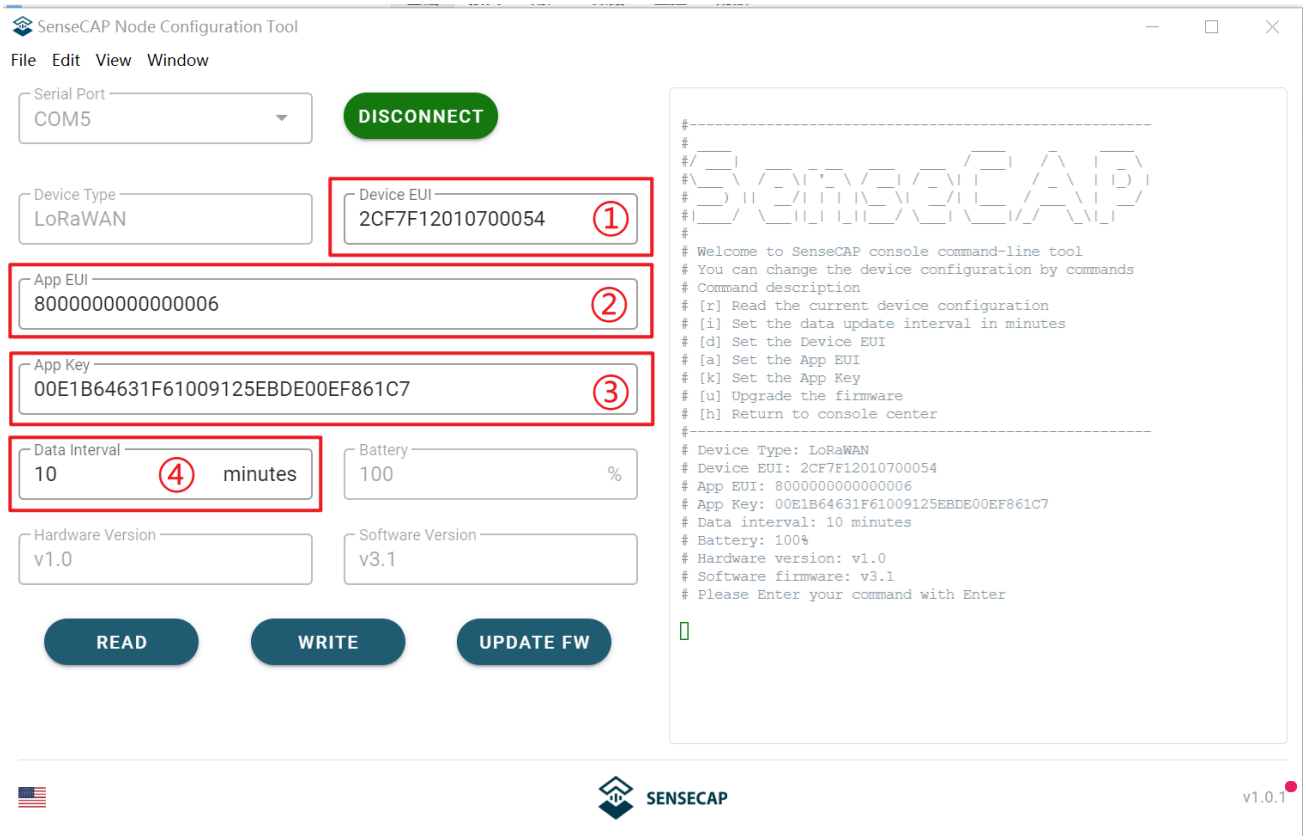
Windows: SenseCAP-Node-Configuration-Tool-1.x.x.exe
Mac: SenseCAP-Node-Configuration-Tool-1.0.2-mac.zip





(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”.

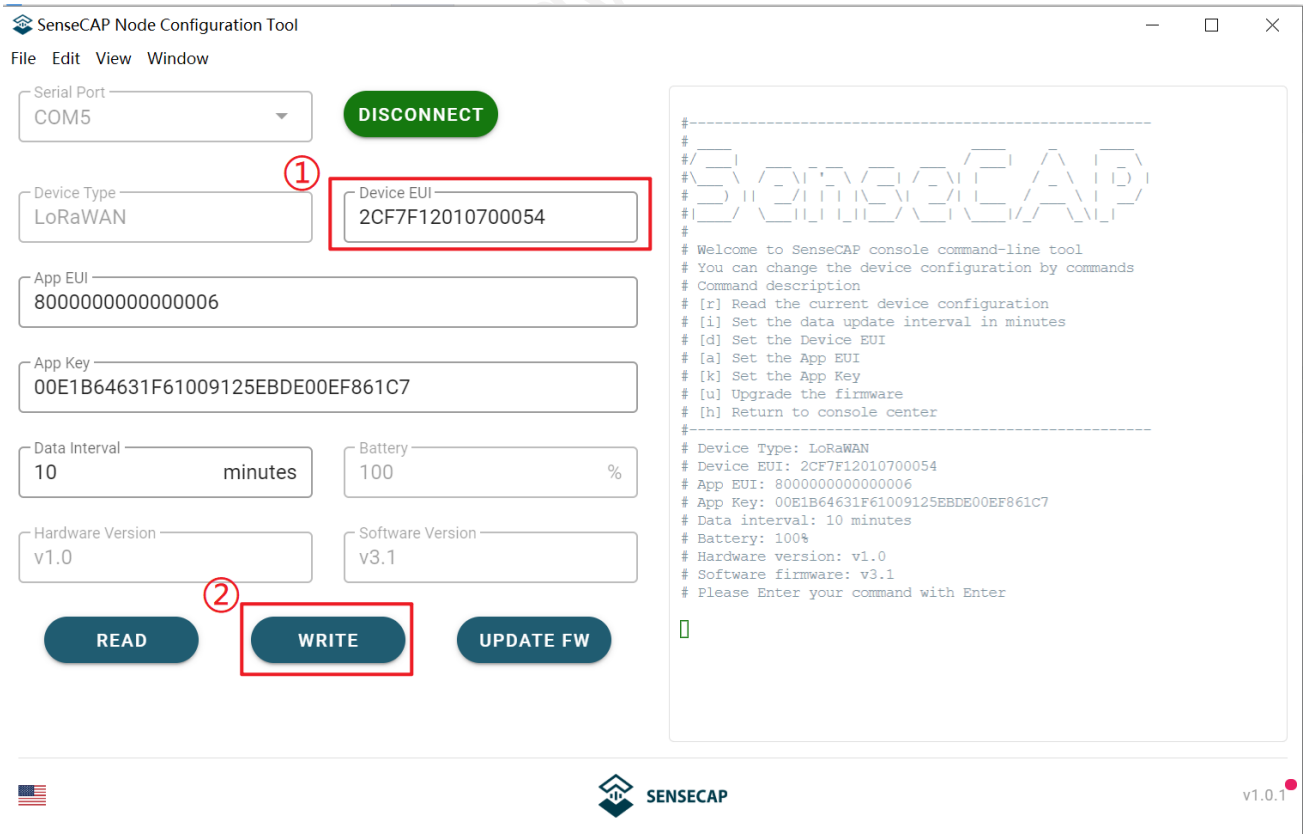
(4) ①Device EUI (16 bit) ②App EUI (16 bit) ③App Key (32 bit) ④Data Interval (Sensor collection cycle)



(5) For example: modify the Device EUI

① Write the new Device EUI.

② Click “WRITE”

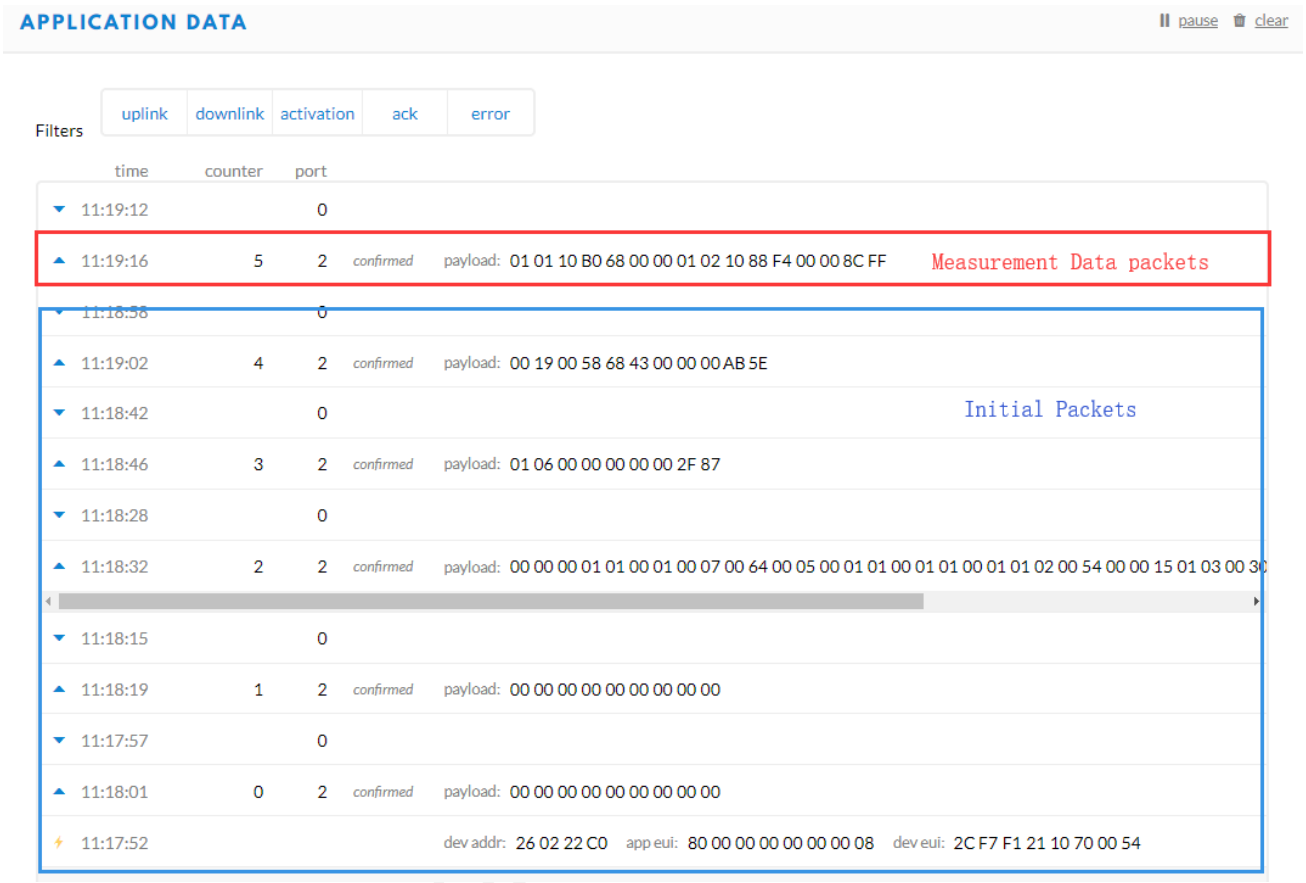


(6) The Main Menu shows up, with respective commands. (Use other Serial Port Tool)

[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

5 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.

5.1 Packet Parsing

Packet Initialization

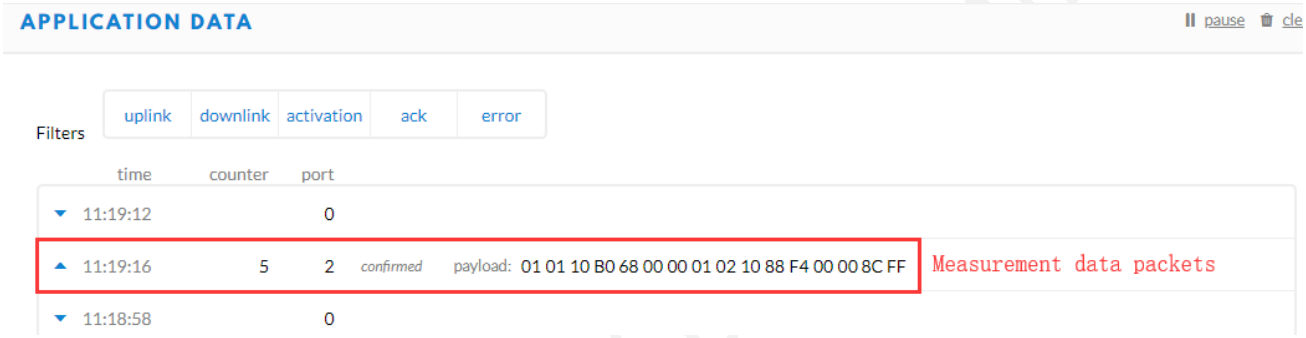
After being powered on or reboot, SenseCAP Sensor Nodes will be connected to the network using OTAA activation method. Each Sensor Node will send data packets to the server, including the following data:

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.

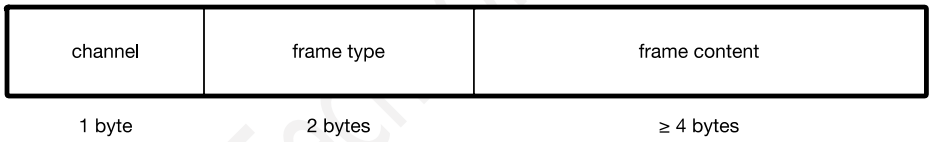
Measurement data packets

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.



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

Example 1:

Air Temperature & Humidity Sensor measurement packet: 010110B0680000010210 88F400008CFF

Divide the data into 3 sections

1	Temperature	0101 10B0680000	01 is the channel number. 0110 is 0x1001 *(little-endian byte order)* , which is the measurement ID for air temperature. B0680000 is actually 0x000068B0, whose equivalent decimal value is 26800. Divide it by 1000, and you' ll get the actual measurement value for air temperature as **26.8℃**.
2	Humidity	0102 1088F40000	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.
3	CRC	8CFF	The CRC verification part.

Example 2:

CO2 Sensor measurement packet: 0104 10E08D0500 9802

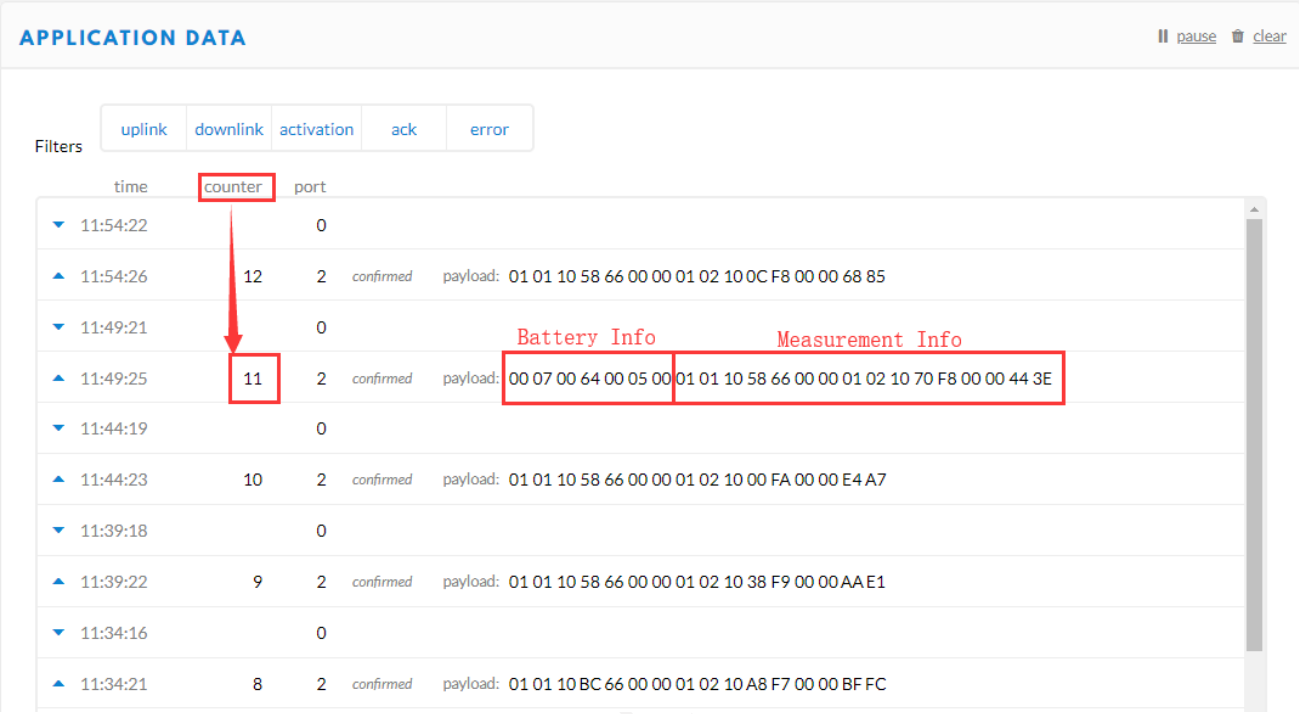
Divide the data into 3 sections

1	CO2	0104 10E08D0500	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.

5.2 Exception

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



Original Info: 0007006400050001011058660000010210 70F80000443E

Battery Info: 00070064000500

Measurement Info: 0101105866000001021070F80000443E

Example:

Battery & TH Sensor measurement packet: 0007006400050001011058660000010210 70F80000443E

Divide the data into 3 sections

1	Battery	00070064000500	
2	Temperature	0101105866000 0	01 is the channel number. 0110 is 0x1001 *(little-endian byte order)* , which is the measurement ID for air temperature.

			58660000 is actually 0x00006658, whose equivalent decimal value is 26200. Divide it by 1000, and you' ll get the actual measurement value for air temperature as **26.2℃**.
2	Humidity	01021070F80000	0210 is 0x1002 *(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.
3	CRC	443E	The CRC verification part.

6 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.

6.1 Part List

6.1.1 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.

Item	Name	Quantity
1	LoRa Gateway	1
2	LoRa Antenna	1
3	4G Antenna	1
4	Allen Hex Key	1
5	Mounts	4
6	Power Adapter	1
7	Power Extension Cable (5M)	1
8	Ferrules / Aluminum piece	2 / 2
9	M5 Self-drilling Screw	8
10	Antenna Lightning Protector (*Optional)	1
11	LoRa Fiberglass Omni Antenna (*Optional)	1
12	LoRa Antenna Brackets (*Optional)	1

6.1.2 Sensor Node Part List

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

Item	Name	Quantity
1	Sensor	1
2	Bracket	1
3	M4 Self-drilling Screw	4
4	M3 Self-drilling Screw	2

6.1.3 Other Accessories & Tool List

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

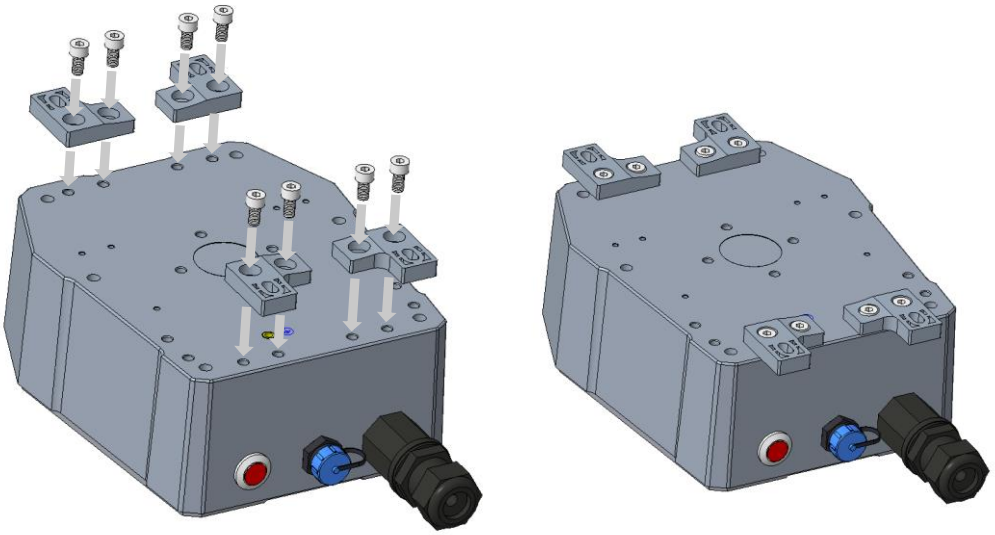
Item	Name	Quantity
1	GND Copper Wire (2.5mm^2)	2
2	Pliers	1
3	M4x12 Grounding Screw	1
4	Waterproof Self-adhesive Tape (to protect antenna connection part)	1
5	M6 Self-drilling Screw (to install the gateway on the wall)	4

6.2 Gateway Installation

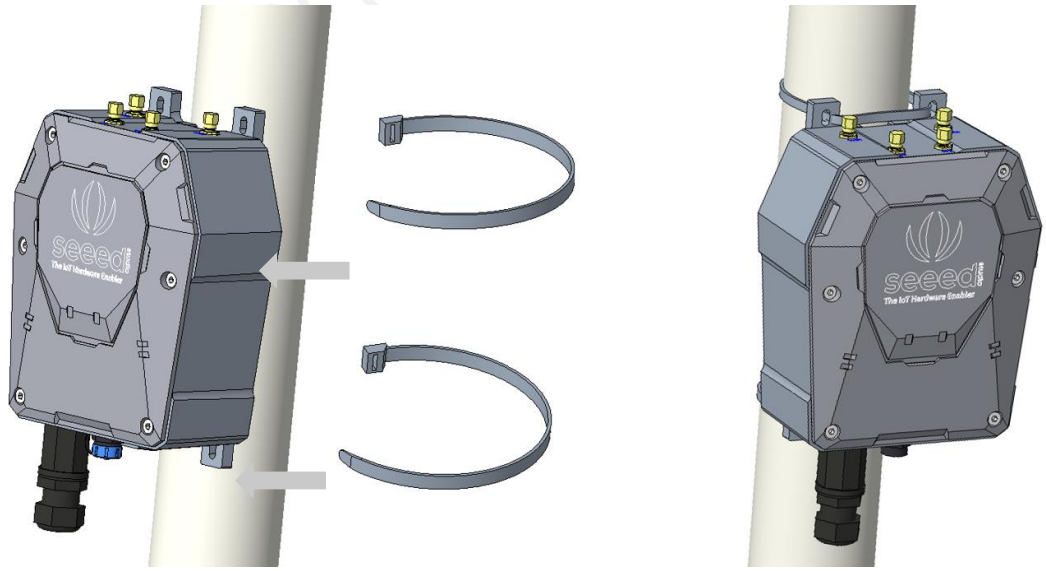
6.2.1 Gateway Installation Methods

- **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.

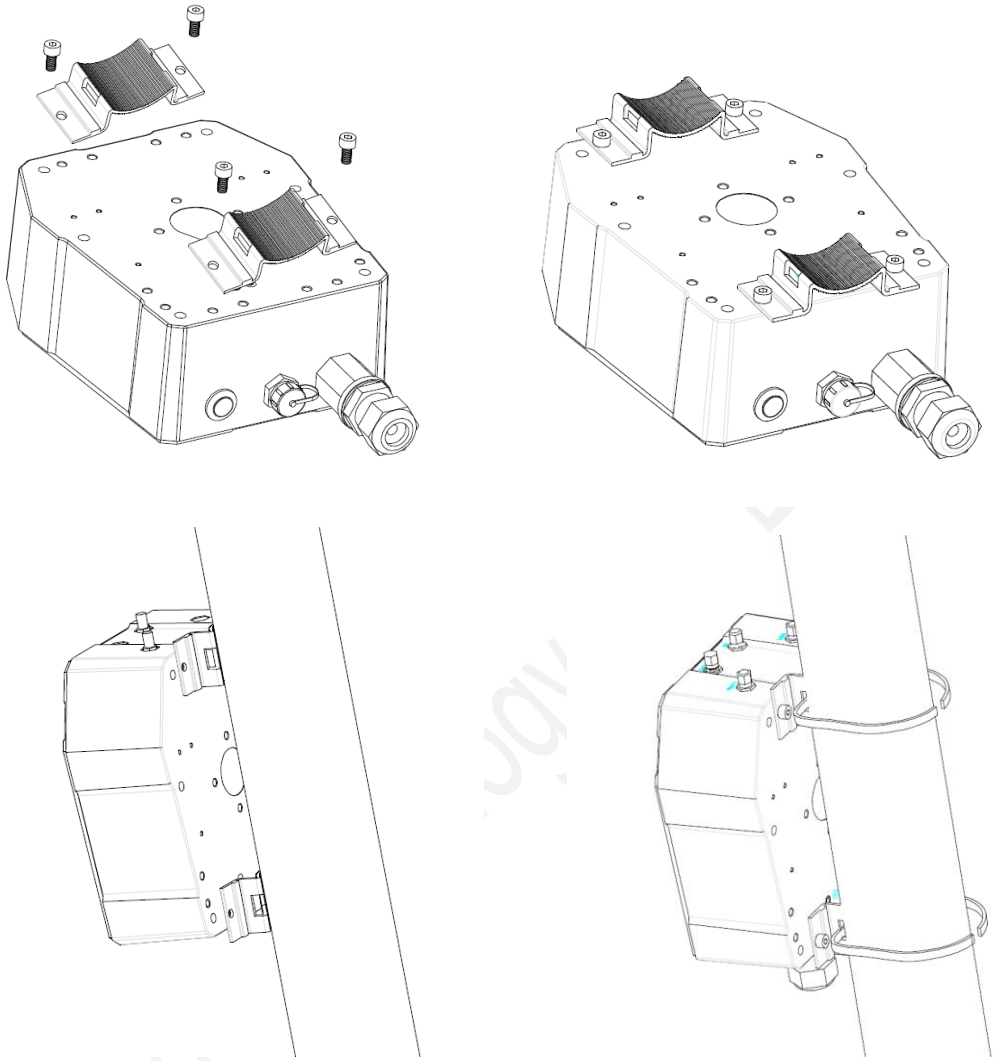


Put cable ties through the holes of the bracket and pull to fasten onto the pole. To get a better communication range, it is recommended to mount the gateway 3 meters above the ground. If there are tall buildings around, the gateway should be kept away from the building or mounted on top of the tall building.



- **Installing on a pole (Use the Ferrules and Aluminum pieces)**

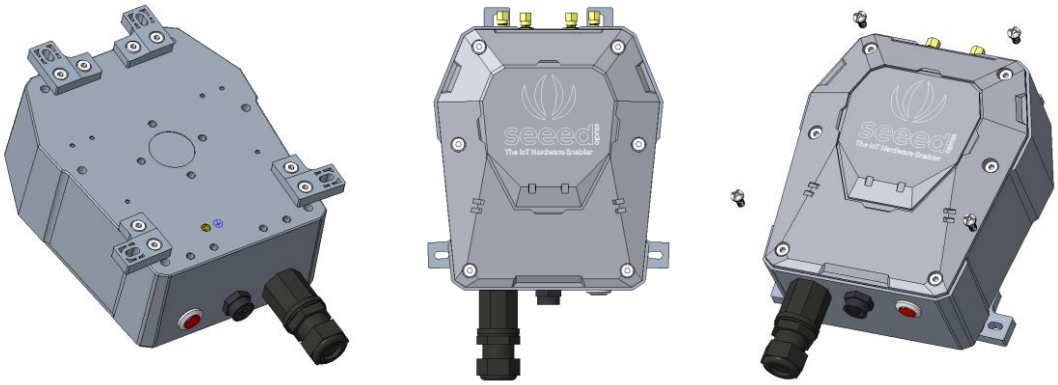
Firstly, use M5 self-drilling screws (included in the package) to fasten the 2 Aluminum pieces onto the gateway. And then use ferrules to fasten the gateway onto the pole. The recommended pole diameter is 76mm.



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.

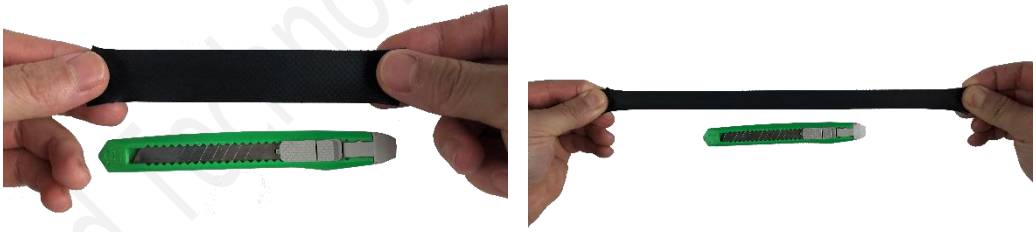


Note: The screws (that fasten gateway onto the wall) are not included in the package. Please prepare screws according to the wall materials (recommended screw diameter: 6mm).

6.2.2 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.

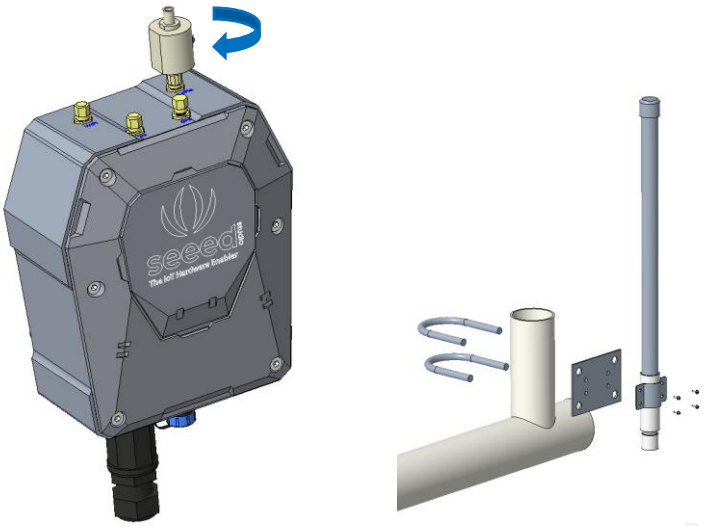
Note: The tape must be wound clockwise because the antenna is fastened clockwise. Otherwise, the antenna may loosen.

If the sensor has wires, install threaded tubes:

6.2.3 Installing Fiberglass LoRa Antenna

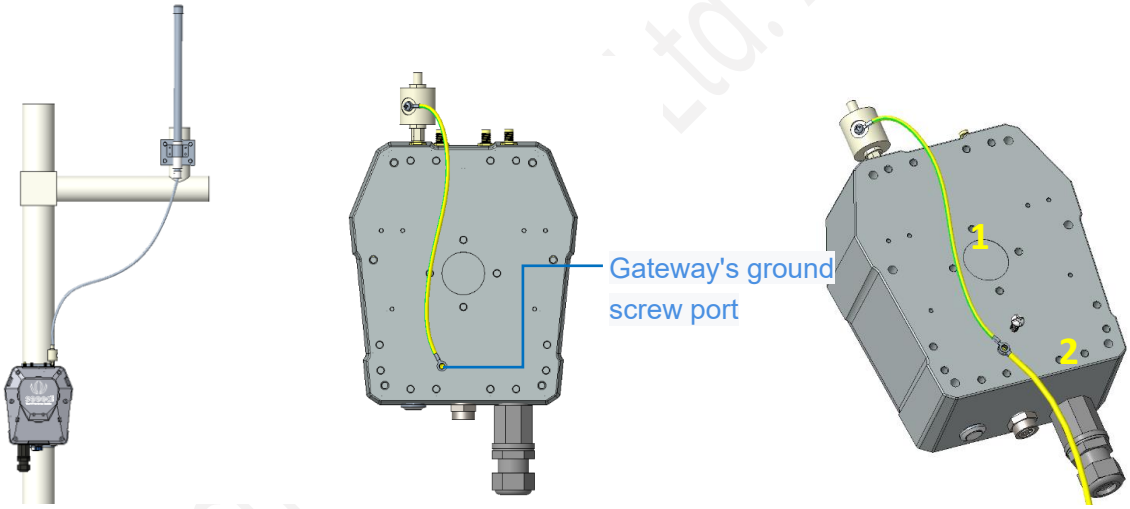
There are two kinds of LoRa antennas: the normal LoRa antenna (included in the package), and the fiberglass LoRa antenna (to be purchased separately). We will introduce how to install the fiberglass LoRa antenna.

1) Fasten the lightening arrester onto the antenna port.



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.



6.2.4 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.

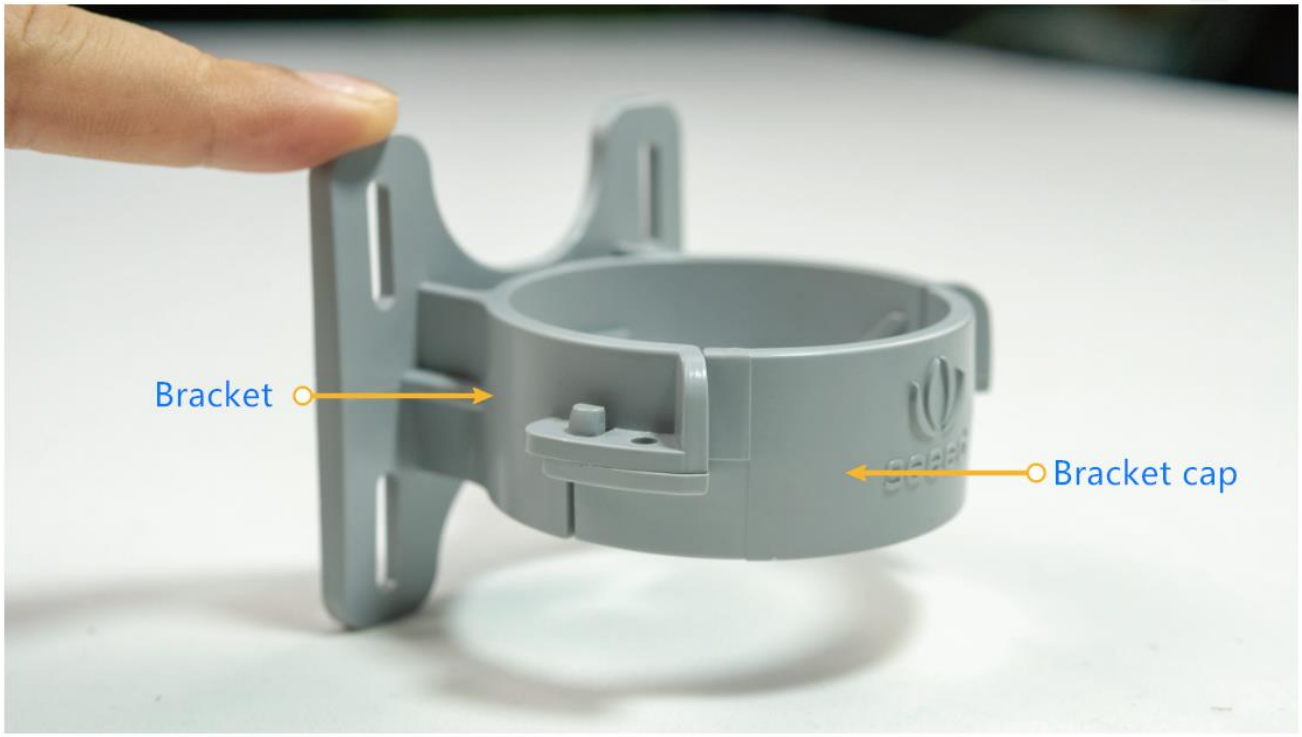
2) Fasten the lightening arrester to the short copper cable with screws, and then connect the two copper cables to the GND screw port. Use the screw to connect and fasten them.

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.

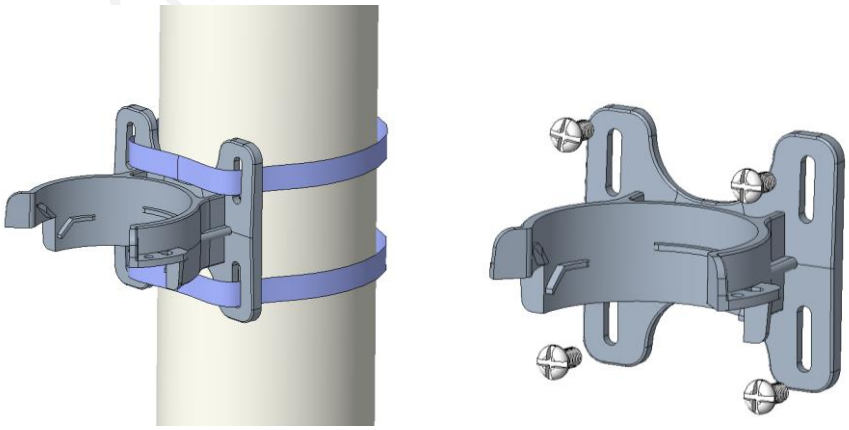
6.3 Installing Sensor Node

6.3.1 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.

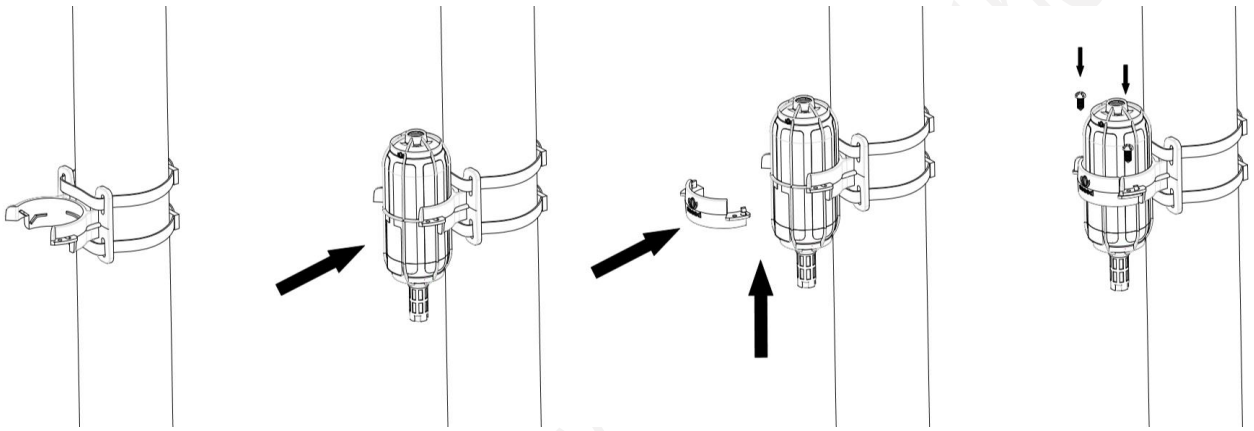


2) To install on the wall or other surfaces, you can use self-drilling screws to fasten the bracket onto the surface.

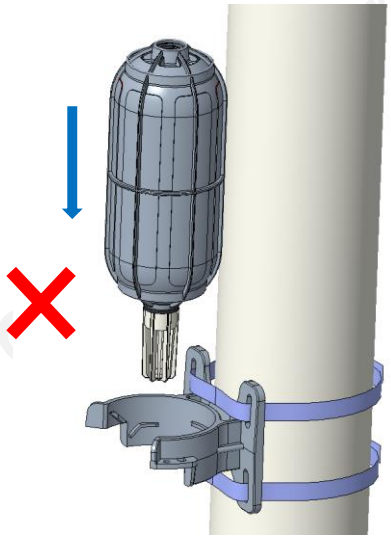
6.3.2 Installing Sensor Nodes

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.

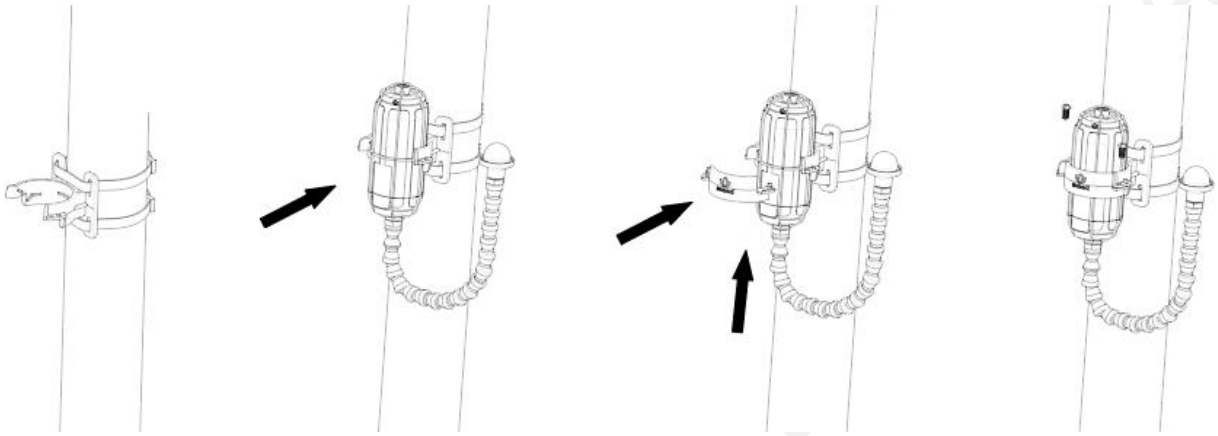


6.3.3 Dos and Don'ts in Installing Sensor Probes

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.