SenseCAP LoRaWAN Sensor User Manual

Version: V1.0
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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 LoRaWAN 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.

It is recommended that you use the SenseCAP LoRaWAN Gateway. You can have out-of-the-box experiences without complex operations. We also provide the SenseCAP Portal, where you can view the data and manage the device when the device is powered on, and you can use the API for integrated development. SenseCAP LoRaWAN Gateway can use SenseCAP Server, The Things Network Server, and Chirp Stack Server to build your applications.

SenseCAP LoRaWAN Sensor Nodes can work with third-party standard LoRaWAN gateways. For users who already have an existing LoRaWAN gateway, please kindly refer to this tutorial about connecting SenseCAP Sensor Nodes with your gateway.
Sensor Node Controller
- LoRa Communication module
- Ultra-low power microcontroller
- Battery

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

Power Switch
Configuration Mode (SET)
Reset Button
LED
Serial Port
Board Connector
2 Key Parameters of the Sensor Node

2.1 Introduction of Key Parameters

Using the LoRaWAN protocol generally involves the following parameters.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device EUI</td>
<td>Unique identification of device, one of the network join parameters.</td>
</tr>
<tr>
<td>Device Code</td>
<td>For device binding and API call.</td>
</tr>
<tr>
<td>App EUI</td>
<td>Unique identification of application, one of the network join parameters.</td>
</tr>
<tr>
<td>App Key</td>
<td>Application key, one of the network join parameters.</td>
</tr>
</tbody>
</table>

2.2 Get Device EUI, App EUI and Key

(1) Device EUI and Device Code is on the SenseCAP product label.

Tips: Device Code is not the App Key!

(2) SenseCAP Sensor Node’s App EUI and App Key have been flashed into the device by Seeed. Use HTTP API to get App EUI and App Key. You can use a browser to issue an HTTP GET request.

Curl:

```
https://sensecap.seeed.cc/makerapi/device/view_device_info?nodeEui=2CF7F12014700297&deviceCode=34BF25920A4EFB8F4
```

In the API, replace the Device EUI and device Code with your own Device EUI and Device Code respectively. And you will get the following response:

<table>
<thead>
<tr>
<th>dev_eui</th>
<th>Device EUI</th>
</tr>
</thead>
<tbody>
<tr>
<td>app_eui</td>
<td>App EUI</td>
</tr>
<tr>
<td>app_key</td>
<td>App Key</td>
</tr>
</tbody>
</table>
{  
  "code": "0",  
  "data": {  
    "nodeEui": "2CF7F12014700297",
    "deviceCode": "34BF25920A4EFBF4",
    "lorawanInformation": {  
      "dev_eui": "2CF7F12014700297",
      "app_eui": "8000000000000006",
      "app_key": "6FD0EF47C6E00F1921A08C2E94E8E5"
    }
  },  
  "time": 0.019
}

**Tips:** The SenseCAP LoRaWAN Sensor can modify to EUI and Key. Please refer to the following sections.
3 Connect to Gateway and Servers.

3.1 Configuration Overview

### Device Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LoRaWAN MAC version</td>
<td>1.0.2</td>
</tr>
<tr>
<td>LoRaWAN Regional Parameters revision</td>
<td>B</td>
</tr>
<tr>
<td>Join Type</td>
<td>OTAA</td>
</tr>
<tr>
<td>Device EUI</td>
<td>Refer to section 2 for details.</td>
</tr>
<tr>
<td>App EUI</td>
<td>Refer to section 2 for details.</td>
</tr>
<tr>
<td>App Key</td>
<td>Refer to section 2 for details.</td>
</tr>
</tbody>
</table>

### Frequency Plans

#### EU868 (LoRa-S-868-XXX-XX)

**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 (LoRa-S-915-XXX-XX)

<table>
<thead>
<tr>
<th>Channel</th>
<th>0 to 7</th>
<th>8 to 15</th>
<th>16 to 23</th>
<th>24 to 31</th>
<th>32 to 39</th>
<th>40 to 47</th>
<th>48 to 55</th>
<th>56 to 63</th>
</tr>
</thead>
<tbody>
<tr>
<td>902.3</td>
<td>903.9</td>
<td>905.5</td>
<td>907.1</td>
<td>908.7</td>
<td>910.3</td>
<td>911.9</td>
<td>913.5</td>
<td></td>
</tr>
<tr>
<td>902.5</td>
<td>904.1</td>
<td>905.7</td>
<td>907.3</td>
<td>908.9</td>
<td>910.5</td>
<td>912.1</td>
<td>913.7</td>
<td></td>
</tr>
<tr>
<td>902.7</td>
<td>904.3</td>
<td>905.9</td>
<td>907.5</td>
<td>909.1</td>
<td>910.7</td>
<td>912.3</td>
<td>913.9</td>
<td></td>
</tr>
<tr>
<td>902.9</td>
<td>904.5</td>
<td>906.1</td>
<td>907.7</td>
<td>909.3</td>
<td>910.9</td>
<td>912.5</td>
<td>914.1</td>
<td></td>
</tr>
<tr>
<td>903.1</td>
<td>904.7</td>
<td>906.3</td>
<td>907.9</td>
<td>909.5</td>
<td>911.1</td>
<td>912.7</td>
<td>914.3</td>
<td></td>
</tr>
<tr>
<td>903.3</td>
<td>904.9</td>
<td>906.5</td>
<td>908.1</td>
<td>909.7</td>
<td>911.3</td>
<td>912.9</td>
<td>914.5</td>
<td></td>
</tr>
<tr>
<td>903.5</td>
<td>905.1</td>
<td>906.7</td>
<td>908.3</td>
<td>909.9</td>
<td>911.5</td>
<td>913.1</td>
<td>914.7</td>
<td></td>
</tr>
<tr>
<td>903.7</td>
<td>905.3</td>
<td>906.9</td>
<td>908.5</td>
<td>910.1</td>
<td>911.7</td>
<td>913.3</td>
<td>914.9</td>
<td></td>
</tr>
</tbody>
</table>

**125kHz DR0 to DR3**
<table>
<thead>
<tr>
<th>Channel 64 to 71 500kHz DR4</th>
<th>Sub-band 1</th>
<th>Sub-band 2</th>
<th>Sub-band 3</th>
<th>Sub-band 4</th>
<th>Sub-band 5</th>
<th>Sub-band 6</th>
<th>Sub-band 7</th>
<th>Sub-band 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>903</td>
<td>904.6</td>
<td>906.2</td>
<td>907.8</td>
<td>909.4</td>
<td>911</td>
<td>912.6</td>
<td>914.2</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
3.2 Connect to the SenseCAP Gateway (Recommend Product)

It only takes 4 steps to get started and install.

Step 1: Scan code to bind the Gateway and Sensors.

Step 2: Turn on the Gateway and Sensors.
Step3: Log on to the SenseCAP Portal to view the data.

Step4: Install the gateway and sensors.

Refer to SenseCAP LoRaWAN Gateway for more details:
https://www.seeedstudio.com/LoRaWAN-Gateway-EU868-p-4305.html
3.3 Connect to a Standard LoRaWAN Gateway

SenseCAP Sensor Nodes support standard LoRaWAN 1.0.2 protocol, making it possible to connect to standard LoRaWAN gateways and servers.

3.3.1 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.
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.

3.3.2 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**

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

3.3.3 Connect to the Gateway (LPS8) and TTN Server

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 (LPS8-915MHz) is taken as an example to explain how to configure the communication parameters of the Sensor Node.
You can learn more about LPS8 Gateway: https://www.seeedstudio.com/LPS8-Indoor-LoRaWAN-Gateway-Included-SX1308-LoRa-Concentrator-p-4251.html

1) Gateway Registration on TTN

TTN website: https://www.thethingsnetwork.org
Follow the instruction to create your account, and access “Console”.

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.

2) Create an Application

TTN console → Application → Add application

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.
# ADD APPLICATION

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>①</td>
<td>Application → Application EUIS → Manage EUIs.</td>
</tr>
<tr>
<td>②</td>
<td>→ Add EUI.</td>
</tr>
<tr>
<td>③</td>
<td>→ Enter the node’s AppEui that you got in the 3.1 step.</td>
</tr>
<tr>
<td>④</td>
<td>→ Add EUI.</td>
</tr>
</tbody>
</table>

## APPLICATION OVERVIEW

- **Application ID**: sensecap-node
- **Description**: sensecap add node
- **Created**: 30 minutes ago
- **Handler**: ttn-handler-eu (current handler)

## APPLICATION EUIS

- ① Manage EUIS
3) **Sensor Node Registration on TTN**

Application → Devices → register device

1. Device ID: Enter a unique name.
2. Device EUI: Enter the node’s Device EUI that you got in the previous 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.
4) Gateway Settings

Find radio settings or frequency settings in the background of the gateway. Configure the gateway as Sub-band 2. Please refer to the Configuration Overview for channel settings.

![Gateway Settings](image-url)
5) Power on

Refer to the previous steps.
6) Checking Data on the TTN

On the Device Overview page, Status turns green.

On the Data page, data package is uploaded. For the format of the payload, refer to the Decoding section.
4 How to Modify the Key Parameters

4.1 Preparation

<table>
<thead>
<tr>
<th>Tools</th>
<th>USB to TTL Serial Tool *1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software</td>
<td>SenseCAP Node Configuration Tool</td>
</tr>
</tbody>
</table>

Windows: SenseCAP-Node-Configuration-Tool-x.x.x.exe
Mac: SenseCAP-Node-Configuration-Tool-x.x.x.dmg
Download: https://github.com/Seeed-Solution/SenseCAP-Node-Configuration-Tool/releases/tag/v1.0.3

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

<table>
<thead>
<tr>
<th>USB to TTL Serial Tool</th>
<th>Sensor Node</th>
</tr>
</thead>
<tbody>
<tr>
<td>RX</td>
<td>TX</td>
</tr>
<tr>
<td>TX</td>
<td>RX</td>
</tr>
<tr>
<td>GND</td>
<td>GND</td>
</tr>
<tr>
<td>Baud Rates</td>
<td>115200</td>
</tr>
</tbody>
</table>

Install the SenseCAP Node Configuration Tool.
Select the COM Port that your tool uses, and click “CONNECT”. Power the Sensor Node.
Press “SET” button on the Sensor Controller, meanwhile press “RESET” once, and you will see “SenseCAP”.

Welcome to SenseCAP console command-line tool
You can change the device configuration by commands.
Command description:
[r] Read the current device configuration
[c] Set the device configuration
[u] Upgrade the firmware
[F] Return to console center
Device Type: LoRaWAN
Device EUI: 2CF7F12010700054
App EUI: 8000000000000000
App Key: 00E1B64631F610D9125EBDE00EF861C7
Data Interval: 10 minutes
Battery: 100%
Hardware version: v1.0
Software version: v3.1
Please enter your command with Enter
4.2 Modify the Device EUI, App EUI & Key and Data interval

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

(2) For example: modify the Device EUI
    ① Write the new Device EUI.
    ② Click “WRITE”
1. Device EUI: 2CF7F12010700054
2. Read, Write, Update FW buttons

- Device Type: LoRaWAN
- App EUI: 8000000000000006
- App Key: 00E1B64631F6109125EBDE0EF61C7
- Data Interval: 10 minutes
- Battery: 100%
- Software Version: v3.1

Welcome to SenseCAP console command-line tool.
You can change the device configuration by commands.

1. Read the current device configuration
2. Set the data update interval in minutes
3. Set the device EUI
4. Set the App EUI
5. Set the App Key
6. Upgrade the firmware
7. Return to console center

Device Type: LoRaWAN
Device EUI: 2CF7F12010700054
App EUI: 8000000000000006
App Key: 00E1B64631F6109125EBDE0EF61C7
Data interval: 10 minutes
Battery: 100%
Hardware version: v1.0
Software firmware: v3.1

Please enter your command with enter.
4.3 **Modify the Sub-band**

Example:
You can type commands at the green cursor: b
Set the sub-band to 7: 7
5 Decoding

TTN payload decoding script for SenseCAP LoRaWAN:
https://github.com/Seeed-Solution/TTN-Payload-Decoder/

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

Note:
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 the 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: 0101108068000001021088F400008CFF

Divide the data into 3 sections
|   | Temperature | 010110B0680000 | 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°C.  |
|   | 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.  |

**Example 2:**

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**.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>CRC</td>
<td>9802</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The CRC verification part.</td>
</tr>
</tbody>
</table>
5.2 Battery Information

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: 000700640005000101105866000001021070F80000443E

Battery Info: 00070064000500

Measurement Info: 0101105866000001021070F80000443E

Example:

Battery & TH Sensor measurement packet: 000700640005000101105866000001021070F80000443E

Divide the data into 3 sections

<table>
<thead>
<tr>
<th></th>
<th>Battery</th>
<th>00070064000500</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Temperature</td>
<td>01011058660000</td>
</tr>
</tbody>
</table>

01 is the channel number.

0110 is 0x1001 (little-endian byte order), which is the measurement ID for air temperature.
<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>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°C.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Humidity</td>
<td>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.</td>
</tr>
<tr>
<td>3</td>
<td>CRC</td>
<td>443E The CRC verification part.</td>
</tr>
</tbody>
</table>
6 Device Installation

6.1 Installing Sensor Node

6.1.1 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
6.1.2 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.
6.1.3 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.

- **Use outdoors for a long time**

  If the sensor has wires, install threaded tubes:
7 Trouble Shooting

7.1 Sensor Node not join the network, how to do?

1. Check the gateway channels configuration. Make sure the gateway and Sensor Node have the same uplink and downlink channels.
2. Check the gateway real-time log and RESET the sensor to see if there are any sensor data packets. If there are packets, check whether the gateway is sending downlink packets.
3. If the channels and other configurations are correct and the gateway logs do not have packets, please contact technical support.

7.2 Why is the new sensor’s battery not 100%?

Battery power detection is not high-precision. Its principle is to measure the supply voltage, when the power is turned on and repeatedly RESET, the voltage is unstable, so it is not 100%. When the sensor is stable, the power will be more accurate.

7.3 Why can't I get into configuration mode with the USB to TTL serial tool?

1. Make sure the RX/TX/GND connection is correct.
2. Keep the pins in close contact during communication.
3. Operation of sensor entering configuration mode: Turn on the switch, long press SET, and press RESET at the same time.

7.4 Support

Support is provided Monday to Friday, from 09:00 to 18:00 GMT+8. Due to different time zones we cannot offer live support. However, your questions will be answered as soon as possible in the before-mentioned schedule.

Provide as much information as possible regarding your enquiry (product models, accurately describe your problem and steps to replicate it etc.) and send a mail to: sensecap@seeed.cc