Soil Moisture, Temperature, and Electrical Conductivity Solution

USER MANUAL

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1. Solution Overview

1.1. Description

The Soil Moisture, Temperature, and Electrical Conductivity Solution consists of the RAK Sensor Hub and soil sensor RK520-02. This solution provides accurate measurements with a sensor equipped with built-in temperature compensation and a probe that can be permanently embedded in the ground and linked to a data recorder for continuous testing. This comprehensive monitoring system is well-suited for various applications, including agriculture, turf farming, water conservation, and soil testing.

With the plug-and-play feature of the Sensor Hub, the Soil Moisture, Temperature, and Electrical Conductivity Solution comes with pre-installed components ready for easy installation and connection. The sensor provides highly accurate soil readings, with the Sensor Hub collecting and transmitting the data via LoRaWAN or NB-IoT/CAT M1.

The Sensor Hub's connectivity function allows for versatile data transmission to the cloud using the two most commonly used communication protocols in IoT. This versatility ensures that data is readily available for storage, visualization, and in-depth analysis, enabling informed decision-making based on comprehensive knowledge of Soil Moisture, Temperature, and Electrical Conductivity levels.

1.2. Features

- Support LoRaWAN and NB-IoT/LTE CAT-M wireless communication modes.
- Support LoRa® frequency band: CN470, EU868, IN865, RU864, US915, AU915, KR920, & AS923-1/2/3/4
- Easy to install and configure
- Configurable network access with the WisToolBox mobile app
- High precision
- Fully sealed structure, and good waterproof performance
- Can be placed at any depth underground (up to 5000 mm)

- Low power design
- Support solar panel and 12 V_{DC} power adapter for power supply

2. Hardware Introduction

2.1. Device List

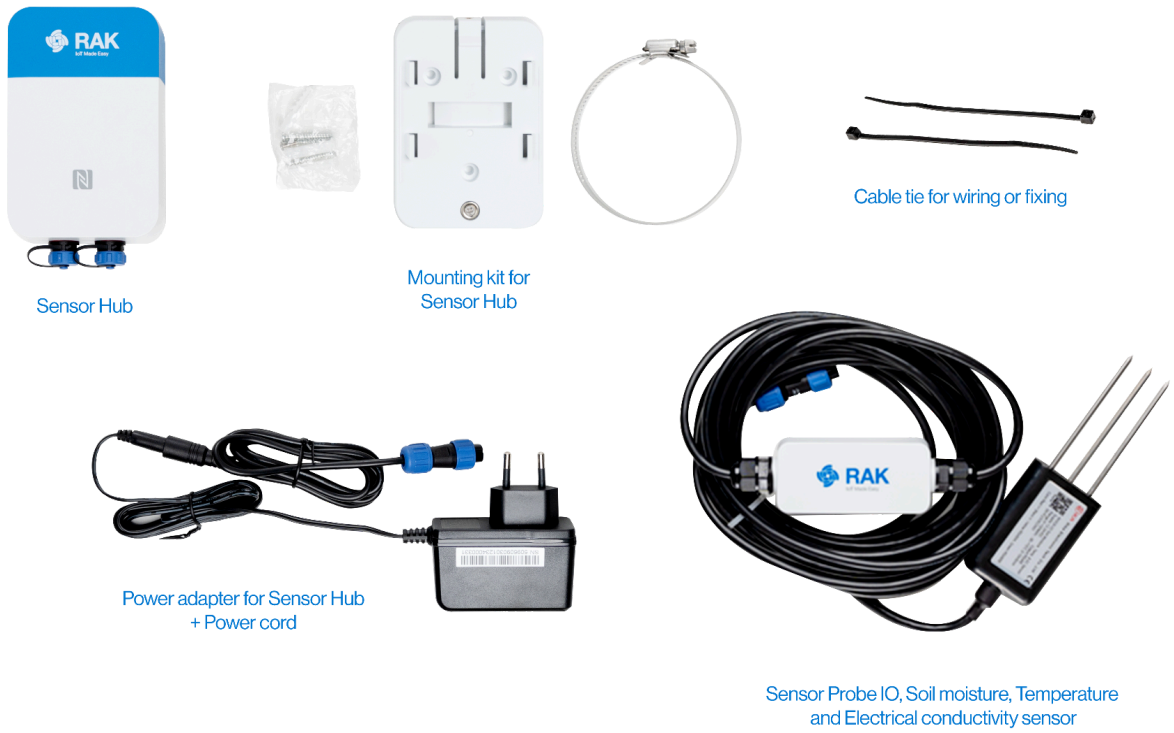

Figure 1: Device List

Table 1: Device List

DEVICE LIST	DESCRIPTION
1 x Sensor Hub 1 x Mounting Kit	Sensor Hub + Sensor Hub Installation Kit
1 x Soil Moisture, Temperature, and Electrical Conductivity Sensor 1 x Sensor Probe IO	Sensor Probe IO + Soil Moisture, Temperature, and Electrical Conductivity Sensor
1 x Power Adapter 1 x Power Cable	Sensor Hub Power Adapter + Power Cable
1 x Cable Tie	For wiring or fixing

2.2. Hardware Specifications

2.2.1. Sensor Hub Datasheet

For more technical specifications about the Sensor Hub, refer to the Sensor Hub Datasheet.

2.2.2. Sensor Probe IO + Soil Moisture, Temperature, and Electrical Conductivity Sensor Datasheet

Sensor Probe IO Datasheet

- For details, refer to the Probe IO Datasheet.

RK520-02 Soil Moisture, Temperature and EC (Electrical Conductivity) Sensor Datasheet:

Table 2: Soil Moisture, Temperature, and EC Sensor Datasheet

PARAMETER	TECHNICAL SPECIFICATIONS		
	MOISTURE	TEMPERATURE	EC
Range	0-100 % (m^3/m^3) 0-50% (m^3/m^3)	-30° C - +70° C	0-10mS/cm
Precision	±2% (0-50%) ±3% (51-100%)	± 0.5° C	± 3%FS
Output Signal	RS485, 0-2V		
Response Time	<1s		
Effective Measurement Area	Probe as the center Diameter: 70 mm Height: 70 mm		
Housing	ABS		
Dimensions	45*15*145 mm (Probe: 3* Ø3*70 mm) Length: 70 mm Width: Ø3 mm Height: 3 mm		

Operating Temperature	-40° C ~ +80° C
IP Rating	IP68
Storage	10-60° C @ 20%~90%RH
Probe Material	316L Stainless Steel

2.2.3. Solar Cell System Datasheet

2.2.3.a. Definition of Terms

Table 3: List of Abbreviations

ABBREVIATION	DEFINITION
BMS	Battery Management System
BMU	Battery Management Unit
BOL	Begin of Life
Bus-bar	Battery Pole Connecting Rod
CMC	Cell Manager Circuit
EOL	End of Life
HV	High Voltage
LV	Low Voltage
OCV	Open Circuit Voltage
SOC	Stage of charge

Table 4: Terminologies

TERMINOLOGY	DEFINITION
Battery Cell	Commonly known as a battery. It is the fundamental unit of energy storage, which converts chemical energy to electrical energy.

Battery Module	The intermediate energy storage unit comprises several individual cells, circuitry components, and electrical and communication interfaces.
Battery Pack	A comprehensive power system consisting of multiple battery modules and circuits working together to supply power to electrical devices.
Rated Voltage	Refers to the approximate voltage value that a battery is designed to operate at or provide.
Capacity	The amount of electrical charge that a fully charged battery can store and subsequently provide to a device or system. Unit: Ampere-hours (Ah)
Energy Capacity	The total amount of energy that a fully charged battery can deliver under specific conditions. Unit: Watt-hours (Wh) or kilowatt-hours (kWh)
Rated Capacity	At the beginning of life (BOL), the minimum capacity that a fully charged battery can provide is at a discharge rate of 1 C (discharge C-rate).
Unit	**V:** Volt, Voltage
	A: Ampere, current
	Ah: Ampere-hour, charge
	Wh: Watt-hour, electrical energy
	Ω: Ohm, Electrical resistance
	° C: degrees Celsius, temperature
	mm: millimeter, length
	s: seconds, time
	kg: kilogram, weight
	Hz: Hertz, frequency

2.2.3.b. Main Specifications

Table 5. Technical Parameters

PARAMETER	TECHNICAL SPECIFICATIONS	REMARK
Battery Model	RAK9154	
Battery Cell Model	Rechargeable cylindrical lithium-ion battery H18650CH	H18650CH or equivalent product
Rated Capacity	5200 mAh	5.2 Ah
Rated Voltage	10.8 V	Single battery voltage 3.6 V
Operating Voltage Range	9 V～12.6 V	
Rated Power	56.16 Wh	
SOC Transportation Range	50%	
Operating Temperature	Charging temperature: 0° C ~ 45° C Discharge temperature: -20° C ～ 60° C	
Storage Temperature	-20° C～ 60° C	More than three months @25° C
Operating Humidity	20 ~ 80%RH	
PV Input	18 V / 1.0 A	Typical
Maximum PV Input Voltage	30 V	Open circuit voltage
Maximum Continuous Charging Current	0.2 C (1.0 A)	Limited by solar charger

Maximum Continuous Discharging Current	0.4 C (2.0 A)	
Δ Voltage	≤ 20 mV	SOC 30%～60%; rest for at least 2 hours after charging or discharging
Weight	0.85 kg	
Dimensions	Length: 180 (±3) mm Width: 130 (±3) mm Height: 60 (±3) mm	

2.2.3.c. Interfaces

Battery System Structure

As shown in **Figure 2,** the RAK9154 battery system comprises two sets of three 2600 mAh battery units connected in series. The system also incorporates one (1) BMS board integrated with an 18 V input solar charger.

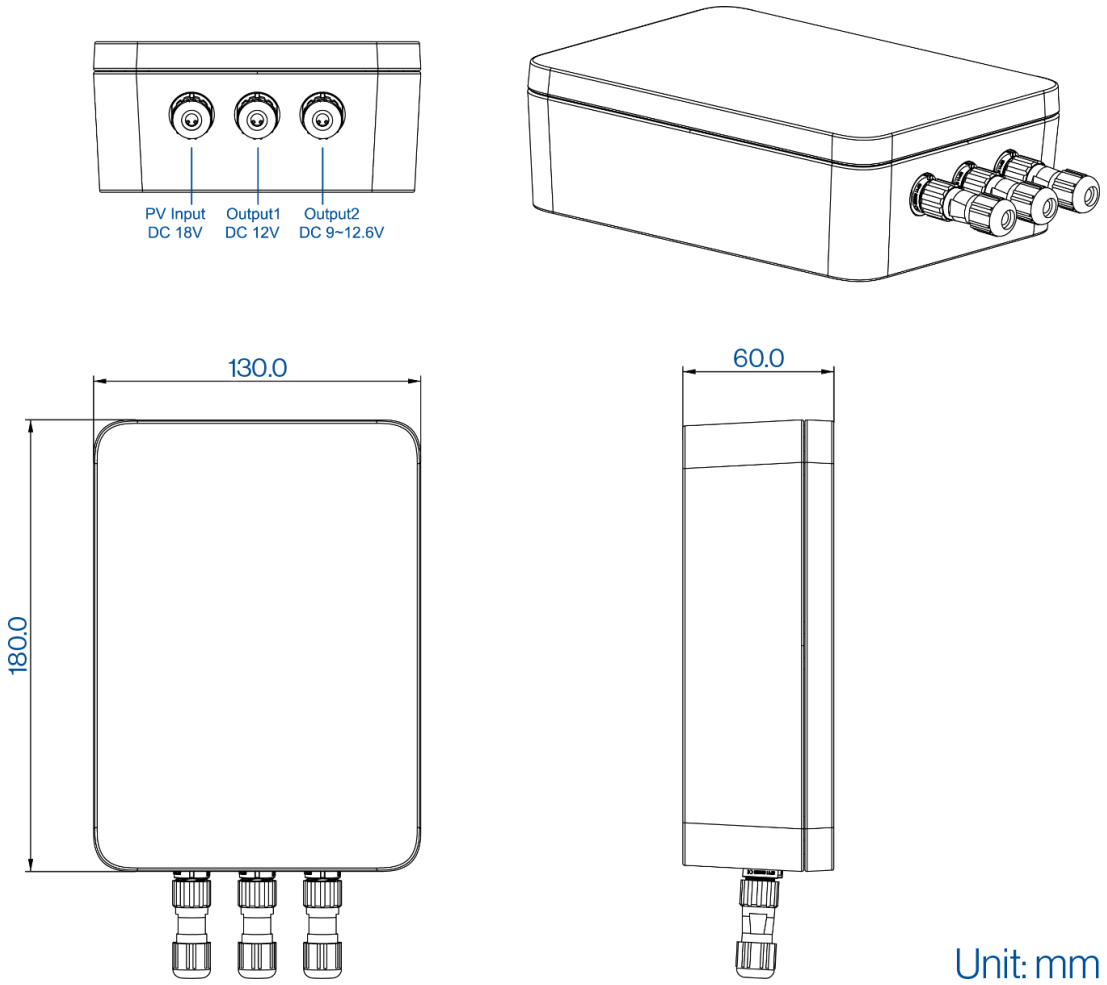

Figure 2: RAK9154 battery system

2.2.3.d. Electrical Characteristics

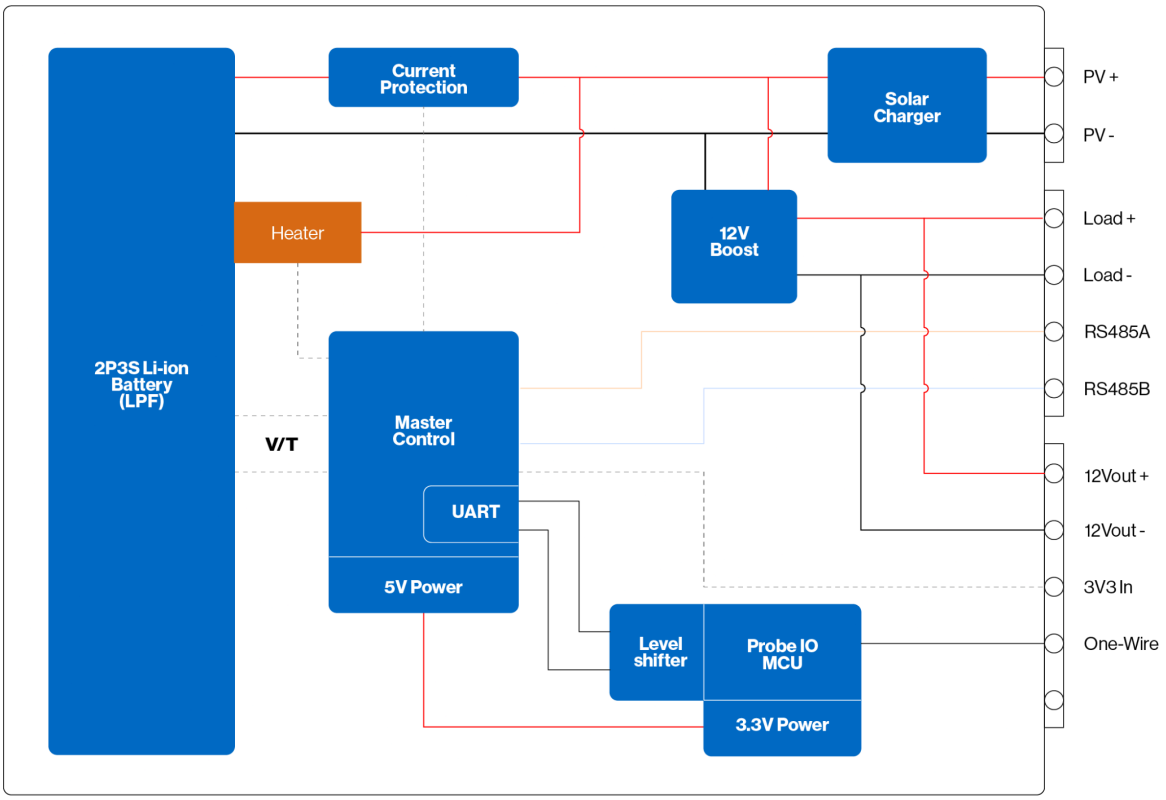

Figure 3: RAK9154 Electrical Diagram

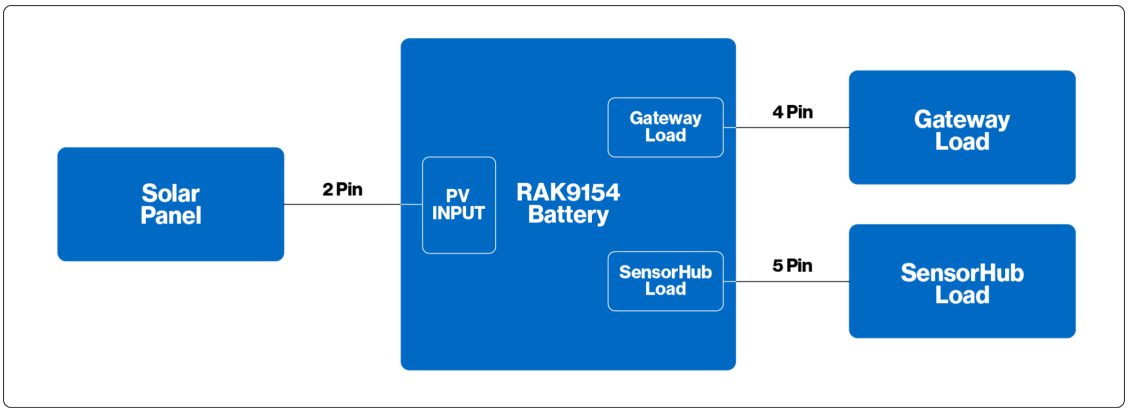

Figure 4: System Circuit Diagram

Table 6. Battery System Panel Connector

CONNECTOR	CONNECTOR SOCKET MODEL	CONNECTOR PLUG MODEL	DEFINITION	REMARK
Gateway Load	SP1110/P4	SP1110/P4-N	Pin1: P+	SP11 IP67 Rated Current: 2 A Contact diameter: 0.75 mm * 4
			Pin2: P-	
			Pin3: R485A	
			Pin4: RS485B	
Sensor Hub Load	SP1110/P5	SP1110/P5-N	Pin1: P+	SP11 IP67 Rated Current: 2 A Contact Diameter: 0.75 mm * 5
			Pin2: P-	
			Pin3: TXD	
			Pin4: 3V3_In	
			Pin5: RXD	
PV Input	SP1110/P2	SP1110/P2-N	Pin1: PV+	SP11 IP67 Rated Current: 1 A Contact Diameter: 1.0 mm * 2
			Pin2: PV-	

2.2.3.e. Sensor Characteristics

Table 7. Sensor Data Definitions

REGISTER NAME	FUNCTION CODE	REGISTER ADDRESS	DATA LENGTH	SENSOR CODE	RATIO	UNIT	RESOLUTION	RANGE	PRECISION
Temperature	0x03	0x0000	2	0x67	0.1	°C	0.1 ° C	-30~70 °C	±0.5 ° C
Moisture	0x03	0x0001	2	0x70	0.1	%	0.1° %	0~100% (m^3/m^3)	±2% (0~50%) ±3% (51~100%)
EC	0x03	0x0002	2	0xC0	0.001	mS/cm	0.001mS/cm	0~10mS/cm	±3%FS

Table 8. Data Format

SENSOR DATA UNIT	ID (CHANNEL)	TYPE	DATA
Temperature	1 Byte	1 Byte	2 Bytes
Moisture	1 Byte	1 Byte	2 Bytes
EC Sensor	1 Byte	1 Byte	2 Bytes

Data Sample 1:

Payload (hex) received data: ***016700fe0270029e03C00041***

Table 9. Sensor Data Sample 1

SENSOR DATA UNIT	ID (CHANNEL)	TYPE	DATA
Temperature	01	67	00fe
Moisture	02	70	029e
EC Sensor	03	C0	0041

`0167 (temperature) - data 00fe:`

- 00fe (hexadecimal) = 254 (decimal)
- 254×0.1 (conversion factor) = **25.4°C**

`0270 (moisture) - data 029e:`

- 029e (hexadecimal) = 670 (decimal)
- 670×0.1 (conversion factor) = **67%**

`03c0 (EC) - data 0041:`

- 0041 (hexadecimal) = 65 (decimal)
- 65×0.001 (conversion factor) = **0.065mS/cm**

2.2.3.f. Environmental Requirements

Transportation Requirements:

WARNING

- When transporting the battery, avoid severe vibrations, shaking, and exposure to sunlight or rain.
- Do not invert the battery to prevent potential short circuits.

Storage Requirements

Store the module in a partially charged state, typically around 40 % state of charge (SOC). Ensure the storage environment meets the following requirements:

Table 10. Storage Temperature and Humidity Requirements

PARAMETER	VALUE	REMARK
Temperature	-30° C to 50° C, 40% SOC	Storage time < 3 months
	0° C to 25° C, 40% SOC	Storage time > 3 months
Humidity	2%RH to 90%RH	< 85% Recommended

- **Storage Environment:**
  - Store the product in a clean, ventilated, and cool environment.
  - Avoid direct sunlight, high temperature, corrosive gas, severe vibration, mechanical shaking, and heavy pressure.
  - Keep it away from heat sources and store below 1,500 meters altitude, with the atmospheric pressure between 86 kPa and 106 kPa.
- **Maintenance:**
  - Charge and discharge the device once a month while storing it at room temperature or in a dry and ventilated environment.
  - If storing the device takes more than 30 days, adjust the SOC to 40% after charging.

The operation of the product must adhere to the operating instructions. Any installation, maintenance, and use of this product must strictly comply with relevant safety regulations.

WARNING

- Avoid storing or using the product in high temperature environments and keep it away from heat sources. Temperatures outside the safe range can significantly reduce the performance and lifespan of the product and may even cause serious consequences such as combustion and explosion.

- Do not store or use the product in environments with high static electricity or high electromagnetic radiation. Doing so may damage the electronic components of the battery, leading to safety hazards.
- Avoid exposing the battery to water or immersing it in water. Otherwise, it may result in internal short circuits, loss of function, or abnormal chemical reactions, leading to fire, smoke explosion, and other incidents.
- If you notice any smoking, heating, discoloration, deformation, or any other abnormalities during the use, storage, transportation, and service of the product, contact a professional immediately for assistance.
- Do not discard waste batteries in fires or incinerators. Waste batteries should be recycled by professional institutions or organizations.
- It is strictly prohibited to place heavy objects on top of the product or stack them on top of each other.
- Although this module is not a high-voltage energy storage device, improper operation and use of the device may lead to serious consequences such as combustion and explosion.
- Only professional technicians must handle the installation and maintenance of the battery system. All operations must strictly adhere to relevant safety regulations. Non-professionals are strictly prohibited from installing, maintaining, and misusing the battery system.
-

3. Prerequisites

Before proceeding with each step for using the Soil Moisture, Temperature, and Electrical Conductivity Solution, make sure to have all the necessary items listed below:

3.1. Hardware

- Sensor Hub Soil Moisture, Temperature, and Electrical Conductivity Solution
- Solar Battery Lite for Sensor Hub (Optional)
- Additional accessories: Probe Cable, Probe Splitter, and Power Supply (numbers and variations depending on the use case)
- An Android or iOS mobile device with Bluetooth and NFC

3.1.2. Software

- WisToolBox

4. Solution Configuration

4.1. Sensor Hub Setup

4.1.1. SIM Card Installation

If the selected solution uses the NB-IoT/LTE CAT-M wireless communication mode, follow these steps to insert a SIM card. If you opt for the LoRaWAN wireless communication mode, skip this section, as a SIM card is not required.

1. Remove the back cover by unscrewing the four screws with a cross screwdriver.

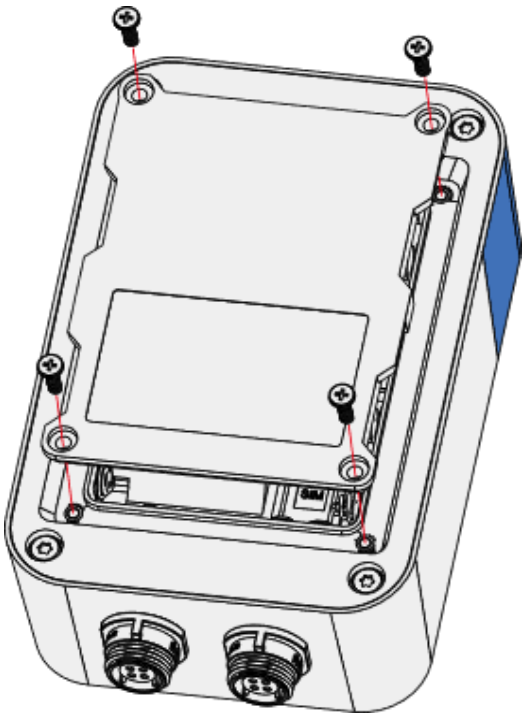

Figure 5: Remove the back cover

2. Insert the SIM card into the groove, then gently push it into the card slot.

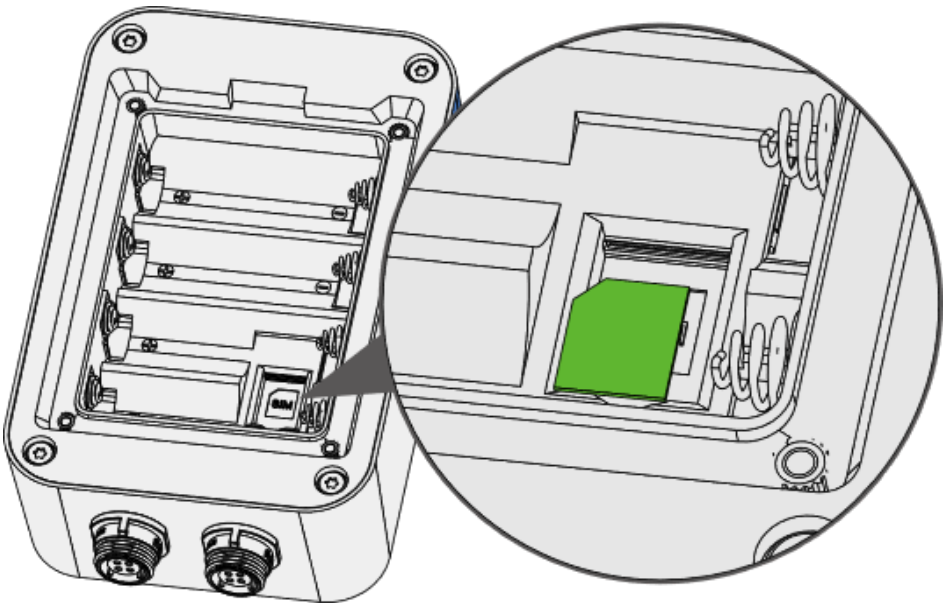

Figure 6: Insert the SIM card

4.1.2. Sensor Hub Mounting

4.1.2.a. Wall Mounting

1. Use a 5 mm drill bit to drill holes in the wall, then insert the screw anchors into the holes.

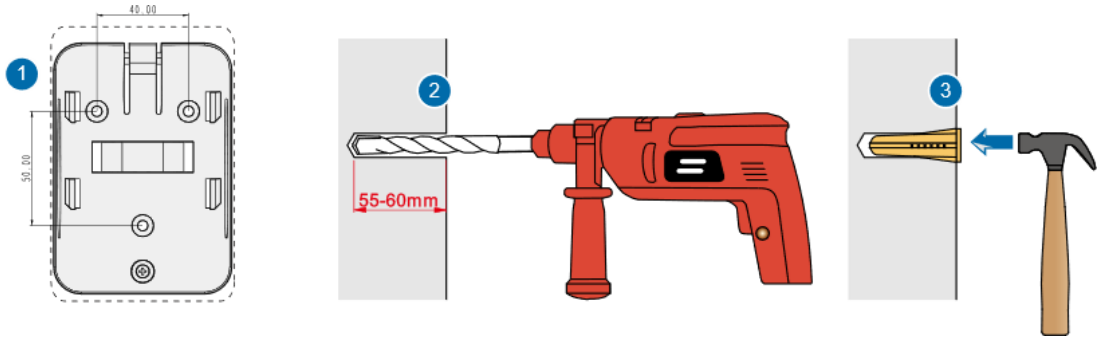

Figure 7: Installation Preparation

2. Secure the mounting bracket to the wall by using self-tapping screws.

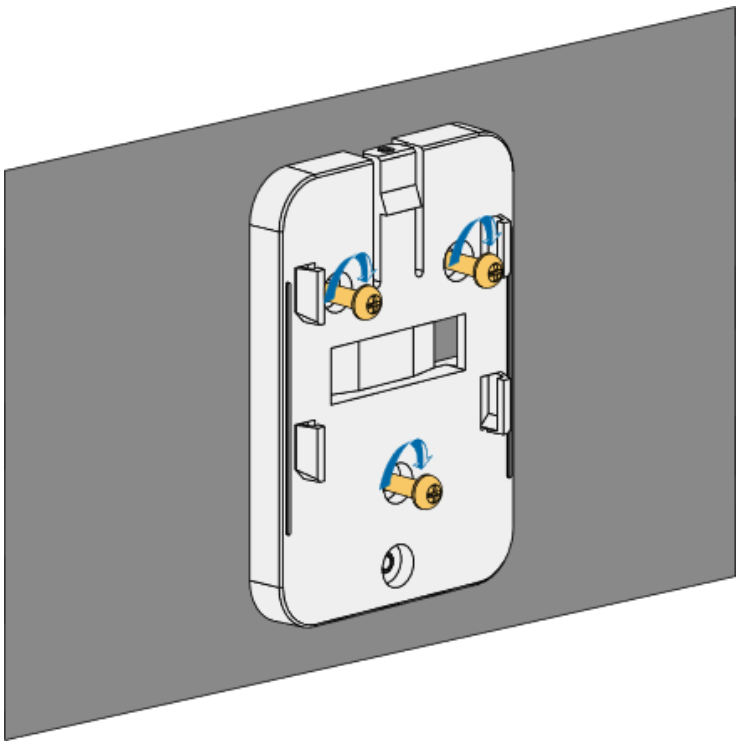

Figure 8: Secure the mounting bracket

3. Align the device's hanging tab with the slots on the bracket, and then insert the tab into the slots. Pull the device downwards until it snaps into place.

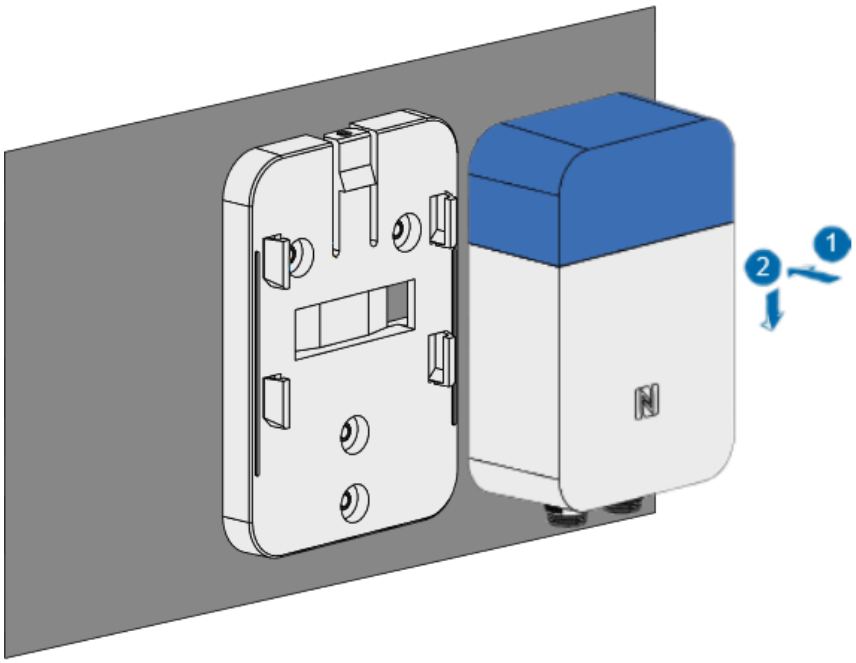

Figure 9: Align the device with the hanging tabs

4.1.2.b. Pole Mounting

1. Fix the mounting bracket to the pole using a steel strap.

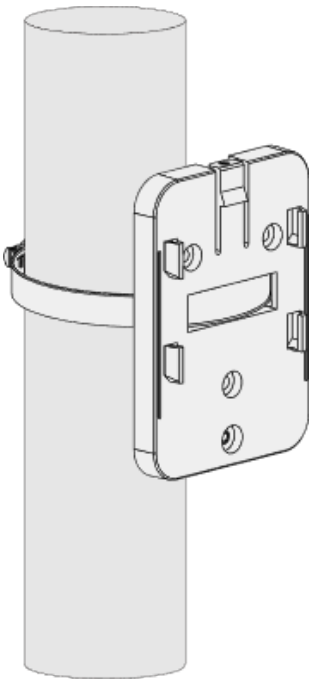

Figure 10: Fix the mounting bracket

NOTE

Mount the bracket on a pole with a 50-80 mm diameter. For larger poles, use a bigger steel strap. The standard kit does not include a larger steel strap. Purchase separately if needed.

2. Align the hanging tab of the device with the slots on the bracket, then insert the tab into the slots. Gently pull the device downwards until it securely snaps in place.

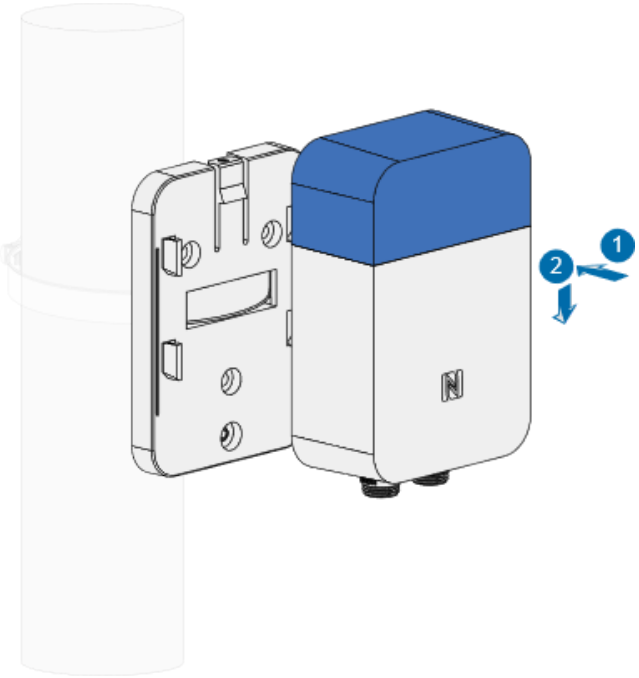

Figure 11: Device installation

3. Insert a security screw at the top to fasten the device and the bracket together.

Figure 12: Lock the device and the bracket

4.2. RAK2560 WisNode Sensor Hub + Soil Moisture, Temperature, and Electrical Conductivity Sensor

4.2.1. Sensor Probe IO + Soil Moisture, Temperature, and Electrical Conductivity Sensor Installation

The Soil Moisture, Temperature, and Electrical Conductivity Sensor comes pre-assembled with Sensor Probe IO by default at the factory. Therefore, no additional assembly is required.

Figure 13: Sensor Probe IO and the Soil Moisture, Temperature, and Electrical Conductivity Sensor

4.2.2. Sensor Hub + Sensor Probe IO + Soil Moisture, Temperature, and Electrical Conductivity Sensor Installation

1. Connect the Sensor Probe IO to the Sensor Hub using the SP11 connector.
2. Align the white dot mark on the Sensor Probe IO SP11 connector plug with the white dot mark on the Sensor Hub SP11 connector socket and push the plug firmly into the socket.
3. Once connected, tighten the locking nut to secure the connection of the SP11 connector. The Sensor Probe IO can be connected to any Sensor Hub SP11 connector port.

Refer to the actual use and connect to the appropriate port, as shown in **Figure 14.**

Figure 14: Connect Sensor Probe IO

Figure 15: Installation completed

4.3. Power Supply Setup

Sensor Hub uses Sensor Probe IO to connect the soil moisture, temperature, and electrical conductivity combo sensors. Consequently, it cannot be powered by batteries alone and requires a connection to either a solar panel or a 12 V_{DC} power supply for operation.

4.3.1. RAK9154 Solar Battery Installation

NOTE

Mount the bracket on a pole with a 50-80 mm diameter. For larger poles, use a bigger steel strap. The standard kit does not include a larger steel strap. Purchase separately if needed.

1. Secure the mounting bracket to the pole using two steel straps.

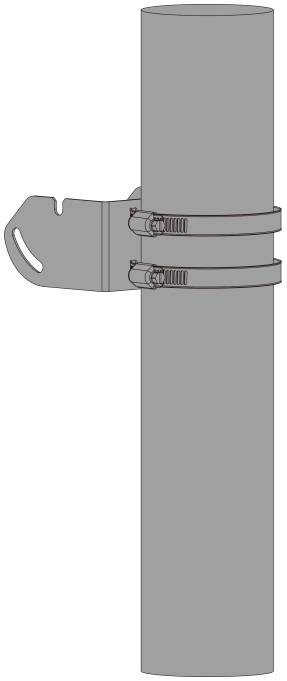

Figure 16: Secure the mounting bracket

2. Attach the mounting plate to RAK9154 with two (2) M3 screws.

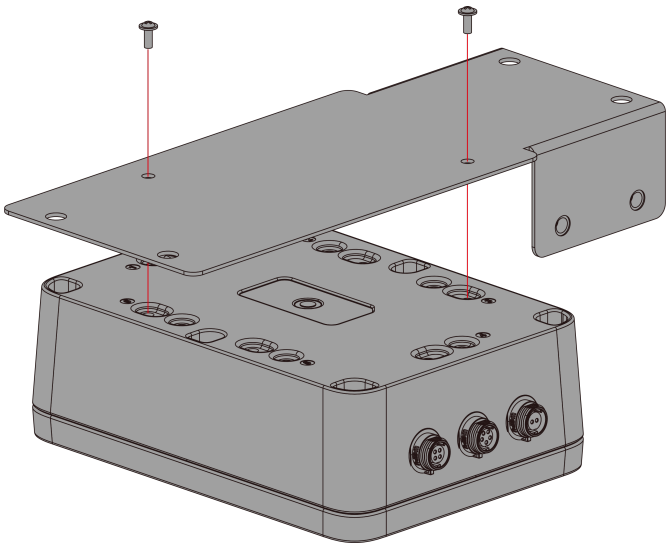

Figure 17 : Secure the mounting plate

3. Install the RAK9154 to the back of the solar panel using four (4) screws and nuts.

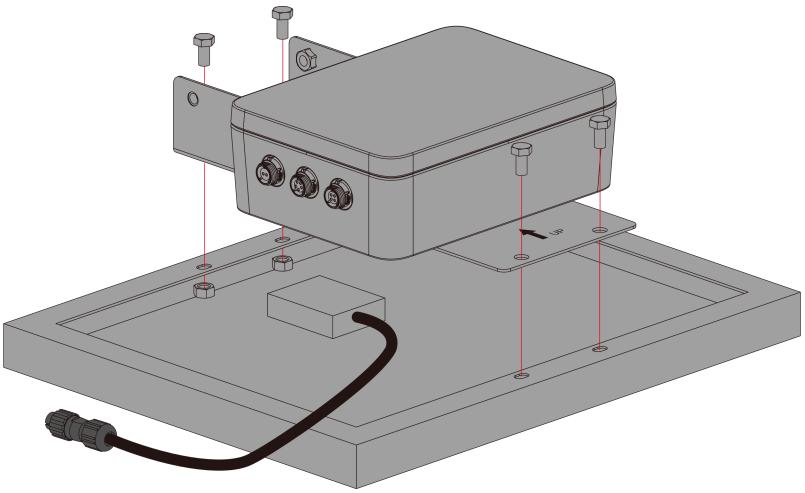

Figure 18 : Attach RAK9154 to solar panel

4. Connect the cable from the solar panel to the PV Input connector of RAK9154. Install two (2) M6 screws on the mounting plate with a clearance of about 3 mm.

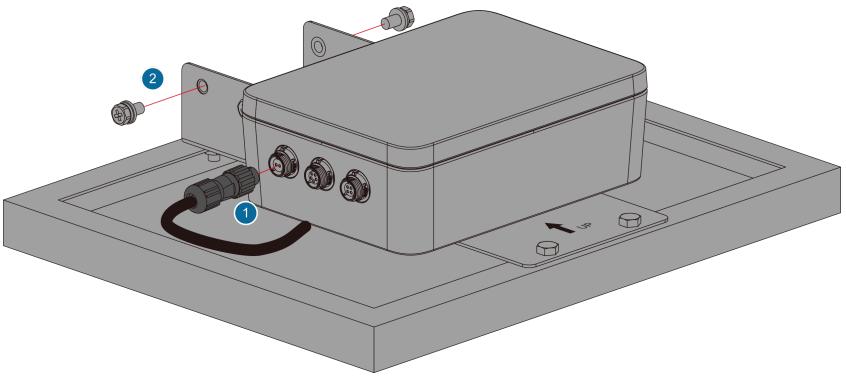

Figure 19：RAK9154 and Solar Panel Connection

5. Suspend the solar panel on the mounting bracket, adjust its angle and direction, and then tighten the two (2) M6 screws along with the remaining two screws.

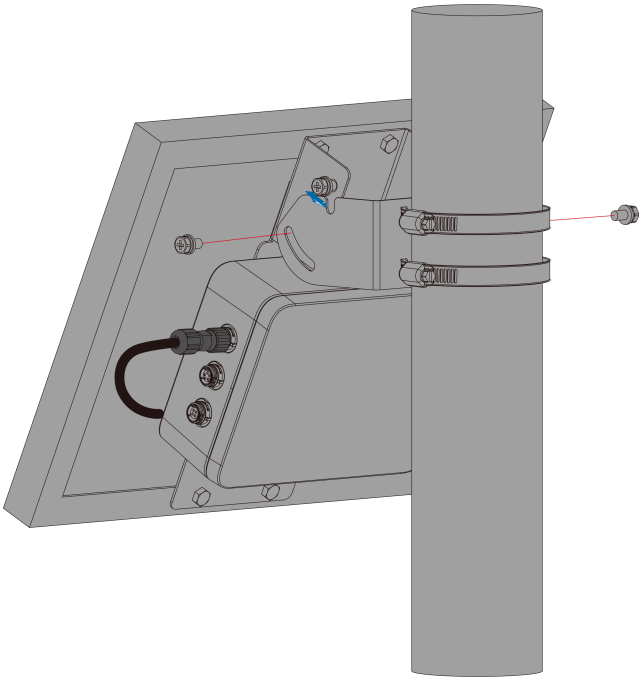

Figure 20：Install the solar panel combination

6. Connect Sensor Hub with RAK9154. Use a cable to connect the remaining connection ports of the Sensor Hub to the Output 1 SP11 connection port of the RAK9154 lithium battery.

NOTE

When connecting to RAK9154, ensure that the Sensor Hub is connected to the Output 1 connection port.

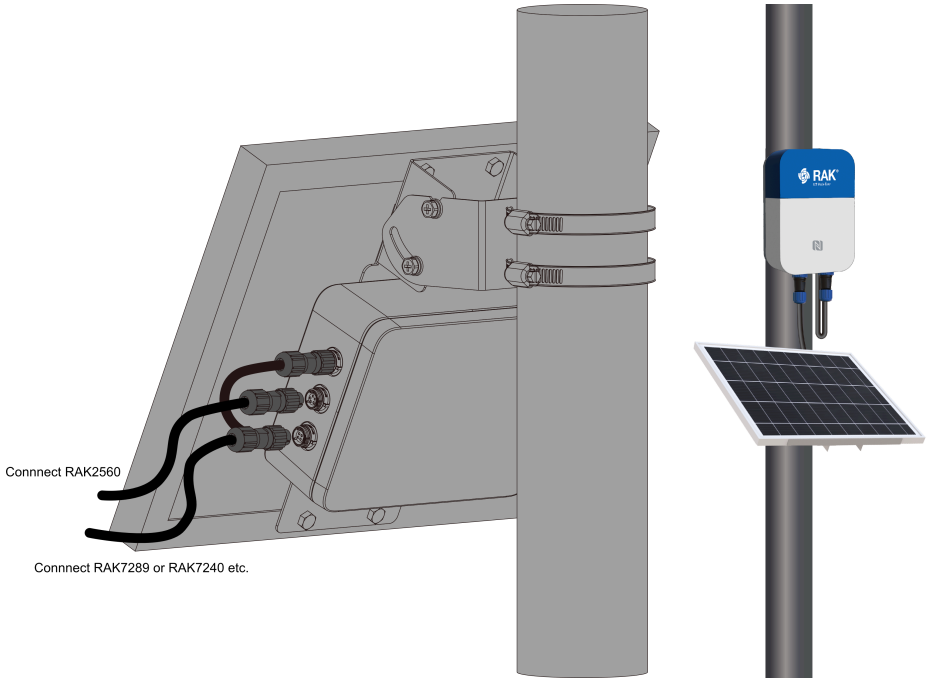

Figure 21：Connect Sensor Hub and RAK9154

7. Once the connection is complete, the Sensor Hub is ready to be powered up.

4.3.2. 12 V_{DC} Power Supply Installation

1. Connect the power adapter and the external power cable of the Sensor Hub through the circular DC interface.

Figure 22：Connect the power adapter

2. Connect the external power cable to the Sensor Hub through the SP11 connector.
3. Align the white dot symbol on the SP11 connector plug of the external power cable with the white dot mark on the Sensor Hub SP11 connector socket and push the plug firmly into the socket.
4. After the plug and socket are connected, tighten the locking nut to secure the SP11 connector. The external power cable can connect to any Sensor Hub connection port.

Figure 23：Connect the external power

5. Software Configuration Guide

5.1. Sensor Hub Configuration

5.1.1. Power Up Sensor Hub

After installing all hardware components, connect the power supply. If the power supply consists of a solar panel and a battery, the device will power on automatically once all hardware has been installed.

WARNING

To prevent damage to the device, refrain from powering up the Sensor Hub before connecting it to the sensor. It is advisable to use the 12 V_{DC} adapter provided with the Sensor Hub for optimal performance.

5.1.2. Connect Sensor Hub to WisToolBox

1. Download and install the WisToolBox app on your smart mobile device. The WisToolBox app is available for download from the Apple App Store and the Android Google Play Store.
2. Initiate the app and confirm that NFC and Bluetooth are enabled on your mobile device. Click on **START.**

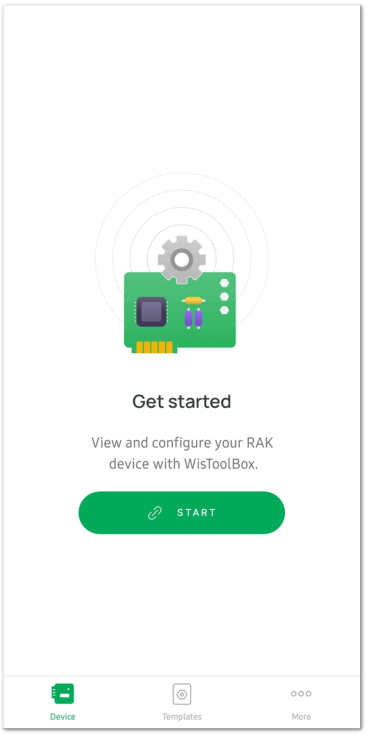

Figure 24: Start App

3. On the **Select Connection Mode** menu, choose **NFC Activation**.

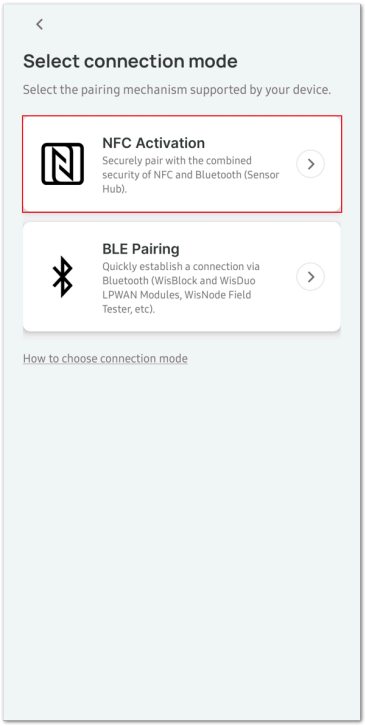

Figure 25: Select **NFC Activation**

4. Select the **Sensor HUB** option in the device selection interface to establish a connection.

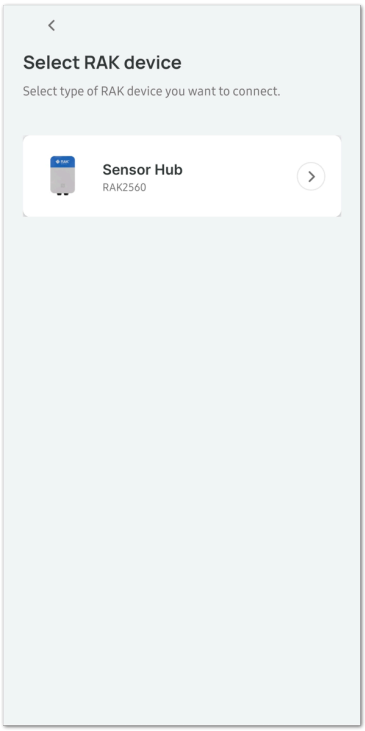

Figure 26: Select **Sensor Hub**

5. Click the **CONNECT** button to initiate the scanning process for devices.

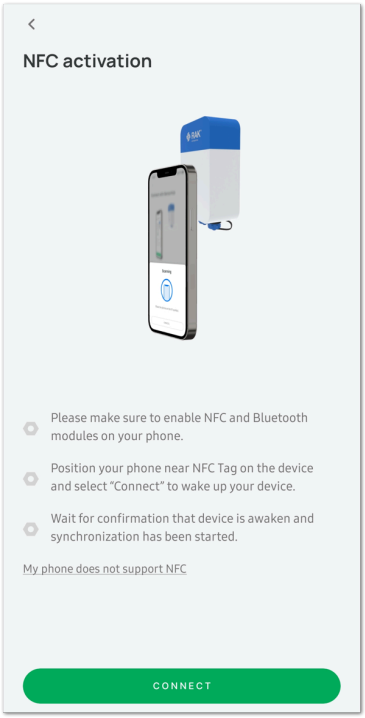

Figure 27: Click on the **CONNECT** button

6. Hold your mobile device close to the **N** symbol on the Sensor Hub device.

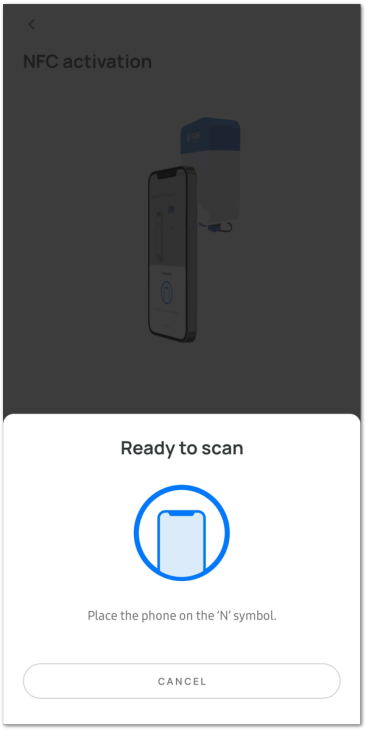

Figure 28: Scanning in progress

NOTE

The detection of the Sensor Hub device indicates that the device has been successfully powered up.

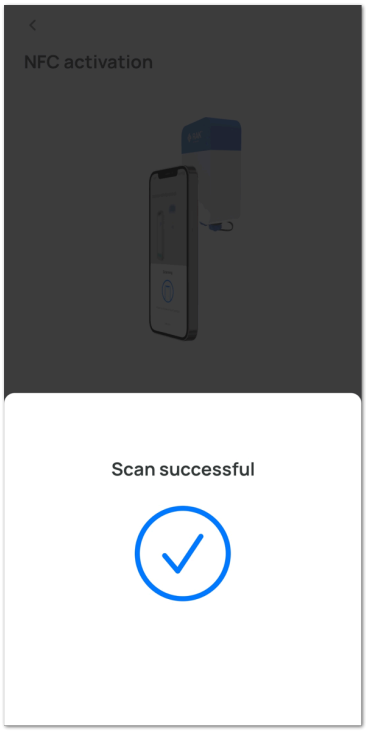

Figure 29: Scan Successful

7. After the connection is established, there will be a synchronization of device data. This process may take some time.

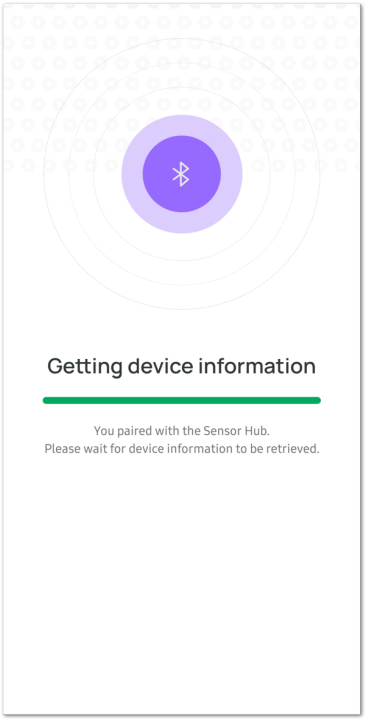

Figure 30: Sync Device

NOTE

- By default, if no connection is established within 30 seconds, the BLE broadcast of the Sensor Hub will automatically shut down. Connect the RAK device immediately after turning on or restarting the power to establish a connection.
- Certain Android smartphones may necessitate enabling GPS to connect to BLE. Enabling GPS does not involve using or sharing sensitive information with the app.

8. Upon completion of data synchronization, the app will automatically transition to the **SENSOR HUB INFO** page.

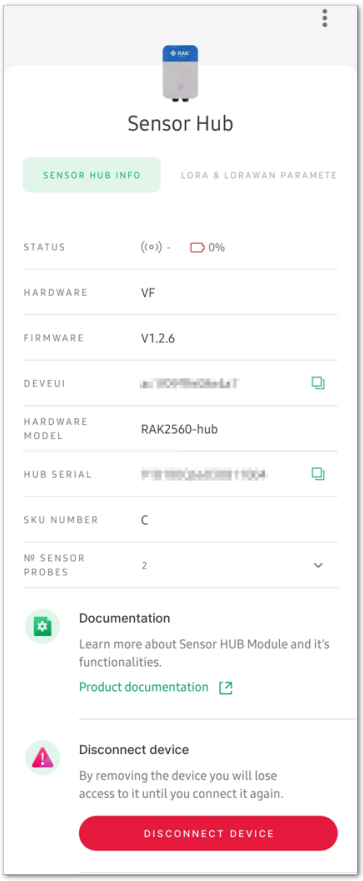

Figure 31: **SENSOR HUB INFO** page

9. While on the **SENSOR HUB INFO** page, configure the Uplink Settings according to the selected network.

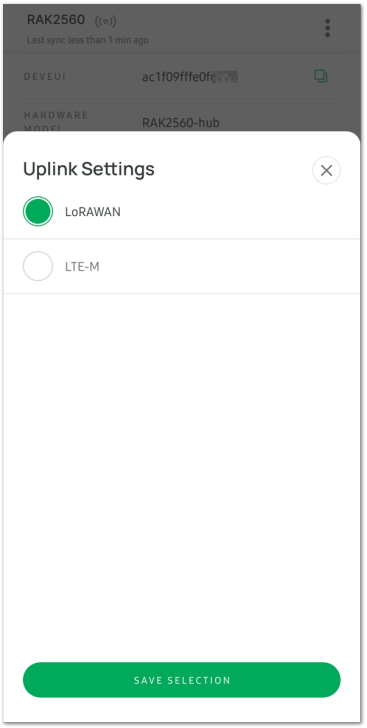

Figure 32: Uplink Settings option

10. Once configured, click **SAVE SELECTION**, and then the **APPLY** button to implement the configuration options.

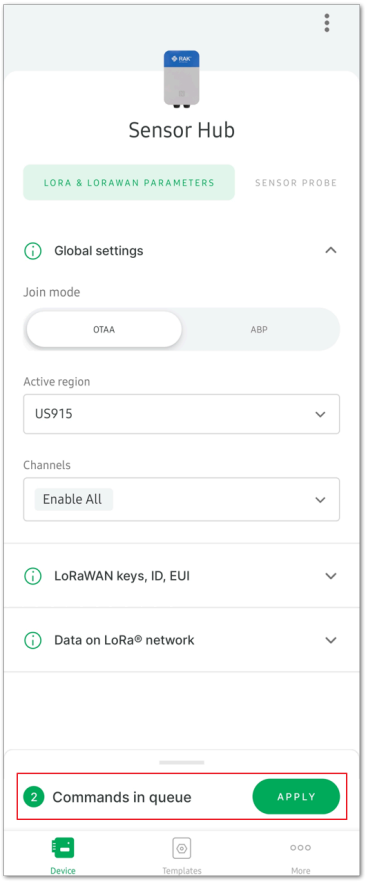

Figure 33: Apply the configuration options

After a few seconds, the synchronization progress will be completed, concluding this process.

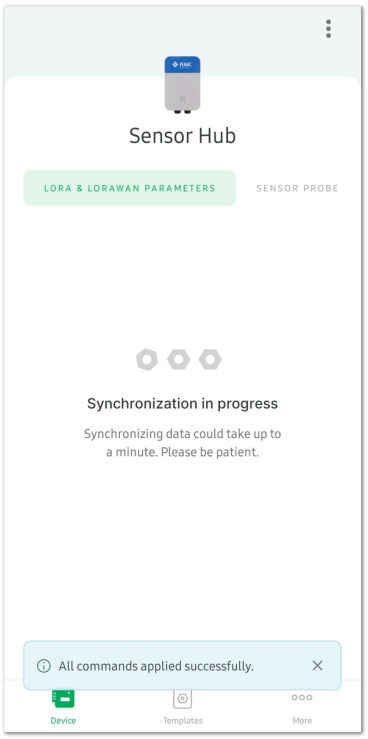

Figure 34: Commands applied successfully

5.1.3. Sensor Hub Network Configuration

5.1.3.a. LoRaWAN Configuration

This section focuses on configuring LoRaWAN parameters and joining the network. Before proceeding with the following steps, ensure that the gateway and Sensor Hub are connected to the server.

Refer to the **Connect the Gateway to the Server** and **Connect Sensor Hub to the Server** sections for detailed instructions.

1. Click on the **LORA & LORAWAN PARAMETERS** tab. Configure the following parameters:

- **Global settings**

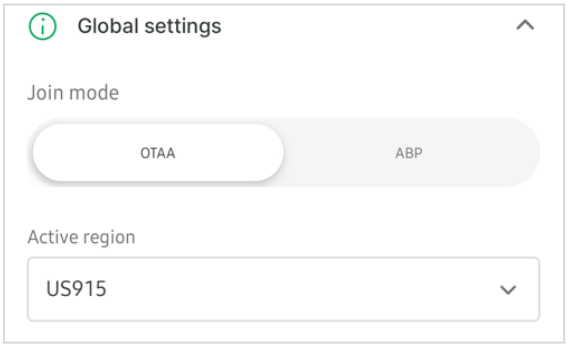

Figure 35：Global settings

- **Join Mode:** Configure the Join mode based on the device's network access mode: **Over-The-Air Activation (OTAA)** or **Activation By Personalization (ABP)**. Make sure it matches the join mode registered on the network server.
- **Active Region:** Set the Active region to the device's frequency plan. Ensure that it is consistent with the gateway and device frequency plan registered on the network server.
  Supported frequency bands: CN470, RU864, IN865, EU868, US915, AU915, KR920, AS923-1/2/3/4.

- **LoRaWAN keys, ID, EUI**
  - For the **OTAA** join mode, configure the following parameters: **Application EUI**, **Application key**, and **Device EUI**.

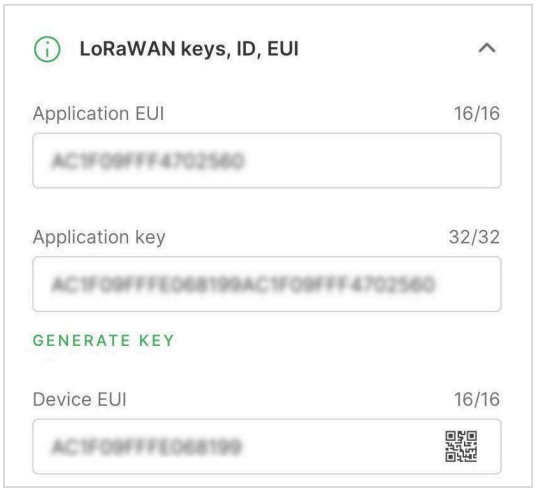

Figure 36：OTAA join mode configuration

- **Application EUI:** Confirm that it matches the device's Application EUI as registered in the network server.
- **Application Key:** Verify its alignment with the device's Application key registered in the network server. Click **GENERATE KEY** to create a new key if needed.
- **Device EUI:** Confirm that it matches the Device EUI registered in the network server.

- For the **ABP** join mode, configure the required parameters: **Application session key**, **Device address**, and **Network session key**.

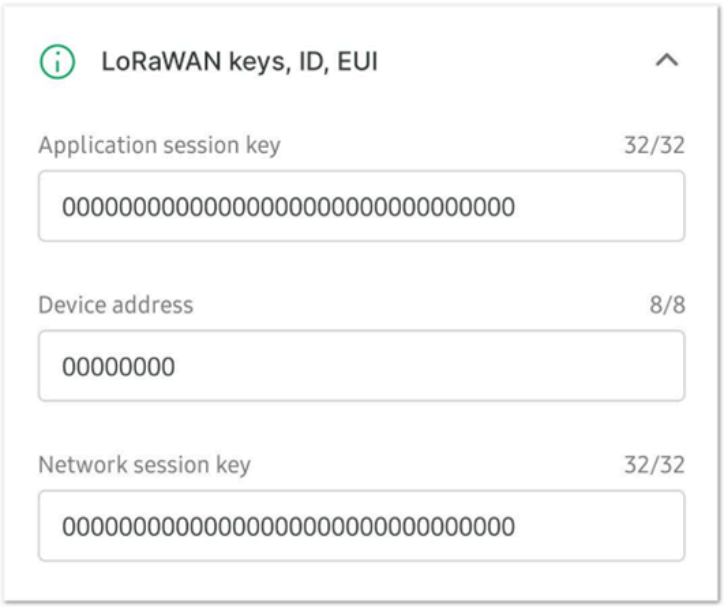

Figure 37: ABP join mode

- **Data on LoRa® network**

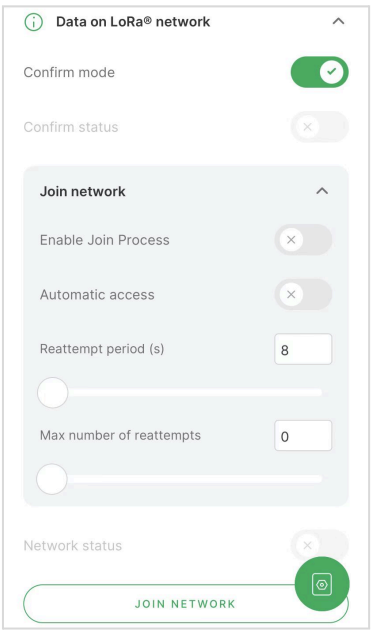

Figure 38：Data on LoRa® network

  - **Confirm mode:** Message confirmation mode.
  - **Enable Auto Join:** Determine whether to activate automatic network access. When enabled, the device will join the network automatically upon powering up.
  - **Network Status:** Indicates the status of the network connection. It will activate automatically once connected to the network.
  - **ADR:** The Adaptive Data Rate optimizes data rates in the network. Toggle the button to enable or disable it.
  - **JOIN NETWORK:** After completing the network parameter, click the **JOIN NETWORK** button to run the join network command.

2. After clicking **JOIN NETWORK**, a Message sent message will appear, indicating that the join network command has been sent.

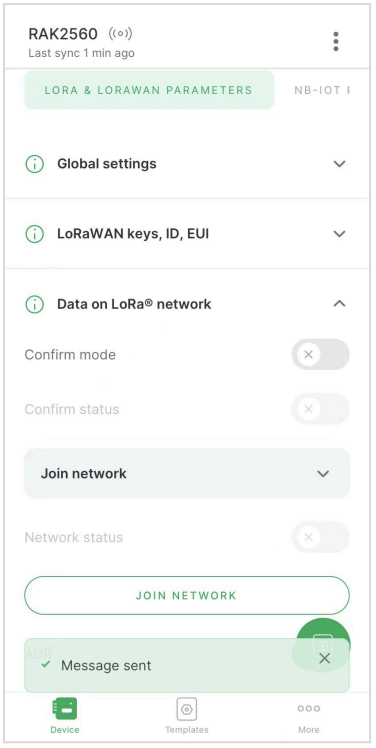

Figure 39：Join the network

5.1.3.b. NB-IoT/LTE CAT-M1 Configuration

This section primarily introduces the configuration of LTE-M network parameters. If you are using the NB-IoT/LTE CAT-M1 network, after connecting the device, select **LTE-M** in the **Uplink Settings** options on the **SENSOR HUB INFO** interface to display the **LTE-M PARAMETERS** configuration tab.

1. Click the **LTE-M PARAMETERS** tab and check the following parameters to ensure that the network is working properly.

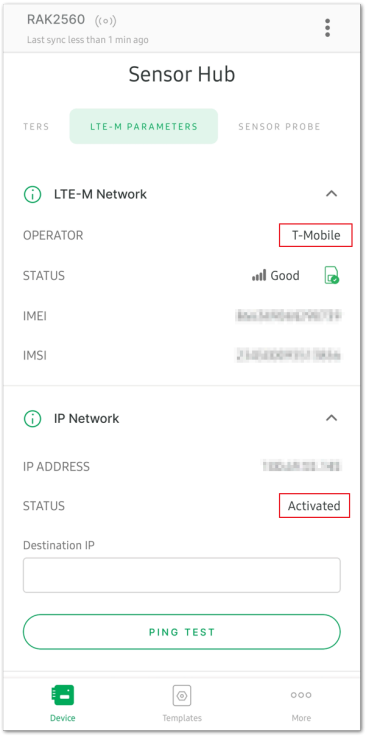

Figure 40：View the LTE-M Parameters tab

- **LTE-M Network**
  - **OPERATOR:** Shows the Network operator. If the operator's name is displayed, it indicates that the device has recognized the SIM card. For example, *T-MOBILE*.
- **IP Network**
  - **STATUS:** If the status is Activated, it signifies that the network of the SIM card is functioning normally.

2. Select the **Application** option to configure the cellular network parameters.

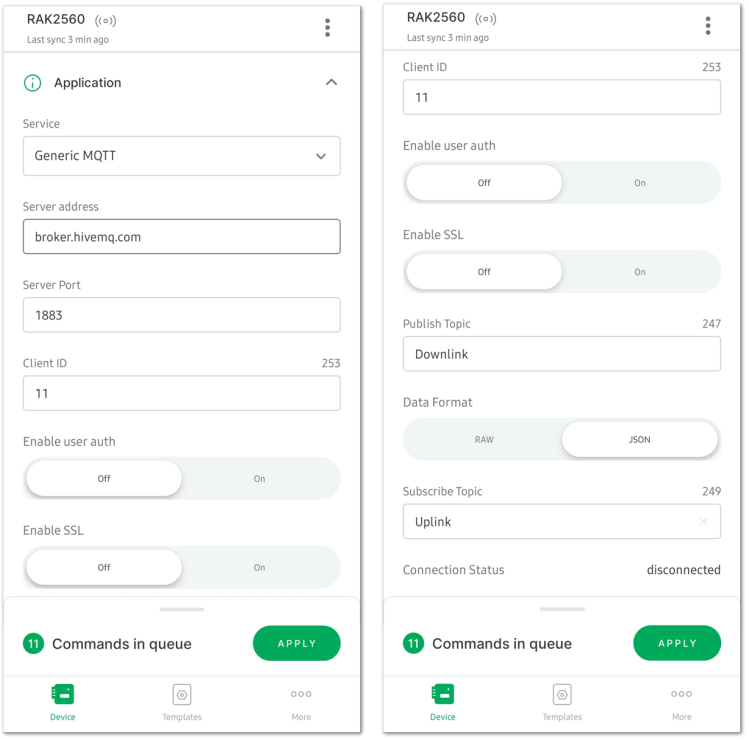

Figure 41: Configure the cellular network parameters

- **Service:** Choose a service, either AWS IoT Core or Generic MQTT. For this guide, use Generic MQTT as an example.
- **Server address:** Input the server address. Using the external MQTT broker as an example, enter *broker.hivemq.com*. Enter the address based on your specific use case.
- **Server Port:** Specify the server port according to your configuration.
- **Client ID:** Set the client ID for your device.
- **Enable user auth:** Decide whether to activate user authentication for your device.
- **Enable SSL:** Decide whether to activate SSL (Secure Sockets Layer) for secure communication.
- **Publish Topic:** Specify the topic for publishing messages.
- **Data Format:** Select **JSON** as the preferred format for data transmission.
- **Subscribe Topic:** Subscribe to the topic for receiving incoming messages, as illustrated in this example.

3. Following the configuration, click **APPLY** in the command list at the bottom of the interface to implement the changes. If the message **All**

commands applied successfully appears, it indicates a successful configuration modification.

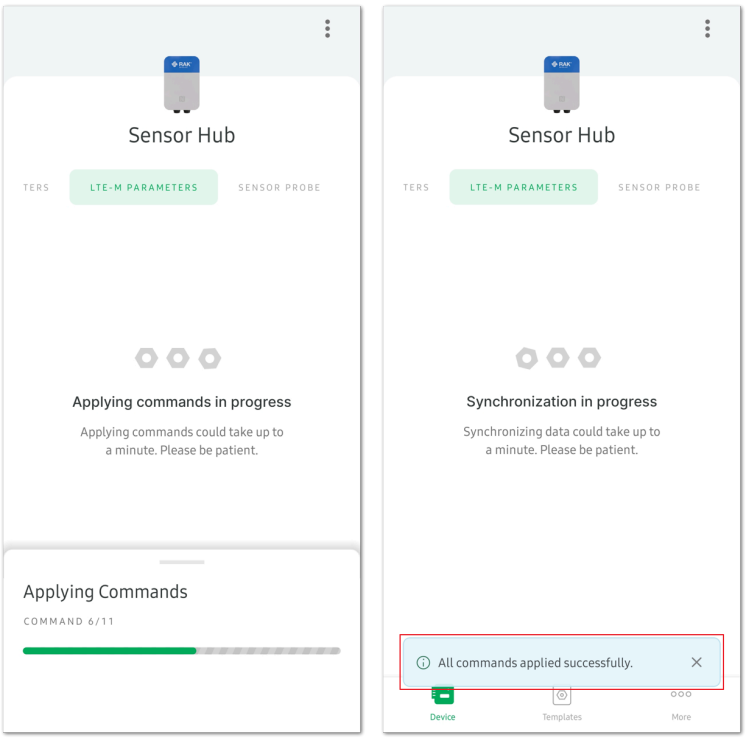

Figure 42: Apply the modified configuration

4. When configured correctly and successfully connected to the server, the **Connection Status** will show as connected.

Figure 43: Successfully connected to the server

5.1.4. Sensor Configuration

This section details the configuration process of the Soil Moisture, Temperature, and Electrical Conductivity solution. It shows how to access the monitoring data and device details of Soil Moisture, Temperature, and Electrical Conductivity solutions. Additionally, there's an option to configure other information for each monitoring parameter, such as the uplink data sending period and threshold.

1. To start with, click the **SENSOR PROBE** tab to display the connected Soil Moisture, Temperature, and Electrical Conductivity on the interface.

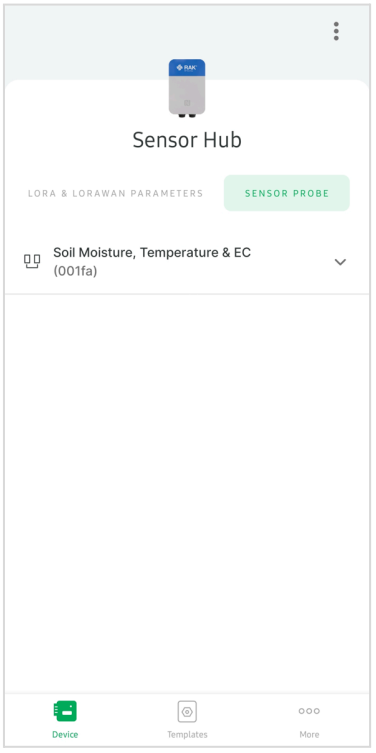

Figure 44：Soil Moisture, Temperature, and EC Sensor

2. Click the dropdown to expand the details of the soil moisture, temperature, and EC sensor:

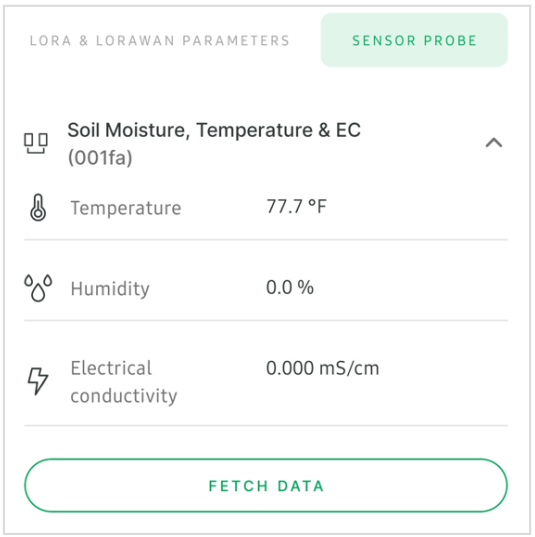

Figure 45：Details of the soil moisture, temperature, and EC sensor

- **Humidity:** Soil moisture
- **Electric conductivity:** Soil electrical conductivity

- **FETCH DATA:** Update the monitoring data from the sensor
- **Device details:** Device details of the soil sensor

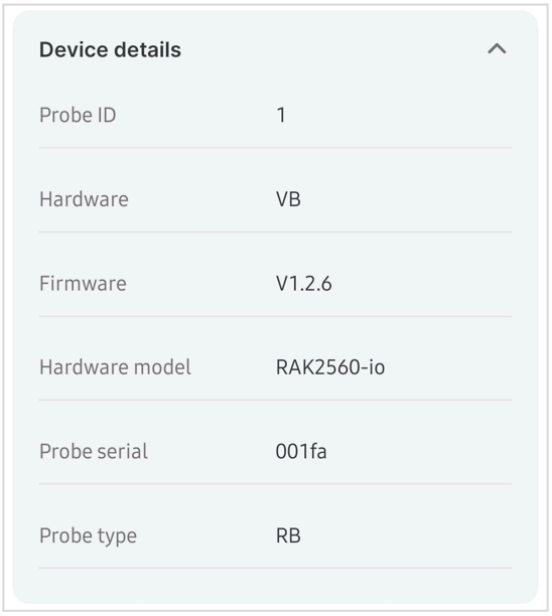

Figure 46：Device details

3. Set the periodic uplink data sending, threshold, and other related information of the sensor. The following takes the temperature parameter as an example.

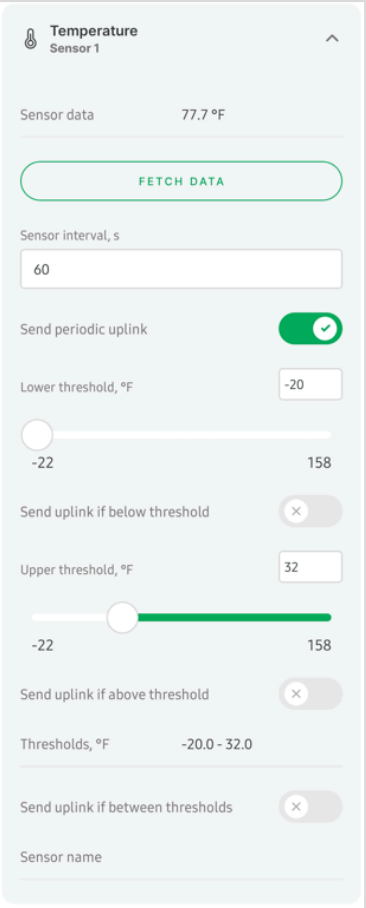

Figure 47: Set the sensor parameters

- **Sensor data:** Data from the sensor.
- **FETCH DATA:** Update the latest sensor data.
- **Send uplink if the value changes:** Send uplink data if the sensor data changes.
- **Sensor interval(s):** The payload sending interval in seconds. It determines how often the sensor sends uplink data to the server, with a range interval from 60~86,400 seconds. Set this parameter when the Send periodic uplink is enabled.
- **Send periodic uplink:** Send uplink data periodically, according to the sensor interval.
- **Lower threshold, °F:** Specifies the minimum acceptable value.
- **Send uplink if below threshold:** Trigger the transmission of uplink data if the value falls below the lower threshold.
- **Upper threshold, °F:** Maximum acceptable value.

- **Send uplink if above threshold:** Send uplink data if the value exceeds the upper threshold.
- **Threshold, °F:** Threshold range.
- **Send uplink if between thresholds:** Send uplink data if the value falls within the specified threshold range.

4. After completing the modifications, a message **Commands in queue** will appear at the bottom of the interface. Click **APPLY** to send the parameter update commands.

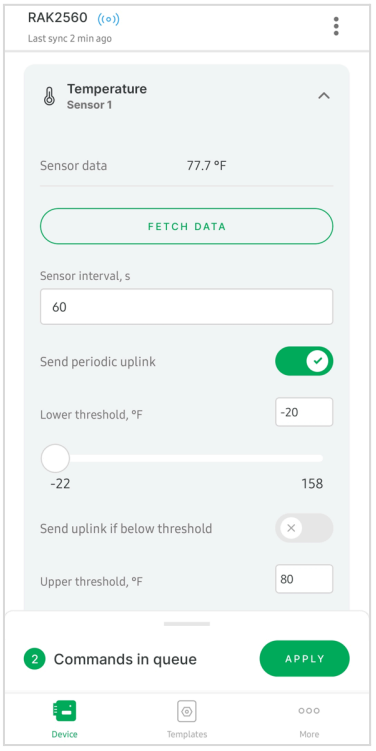

Figure 48：Apply commands

5. When the message **All commands applied successfully** appears on the interface, it indicates that the parameter update commands have been successfully sent.

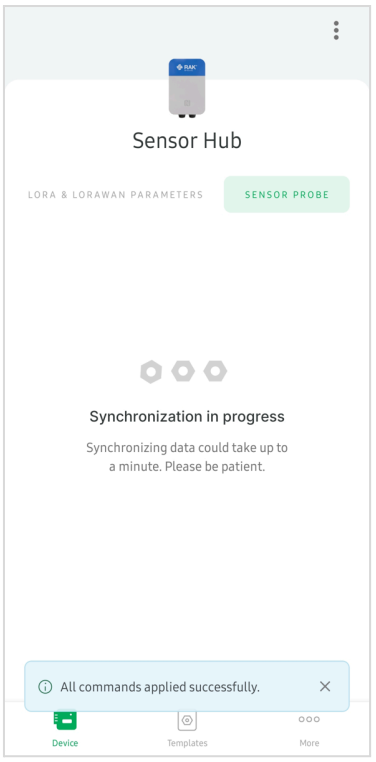

Figure 49: Applied successfully

Other Operations

- **REMOVE SENSOR PROBE:** Removes a sensor.
- **RESTORE TO DEFAULT SETTINGS:** Restore the Sensor Probe to the default settings.
- **UPGRADE SENSOR PROBE:** Upgrade the Sensor Probe firmware.

6. Network Server and Visualization Configuration

This section outlines the operational steps for connecting the device to the network server in both the LoRaWAN and NB-IoT application scenarios.

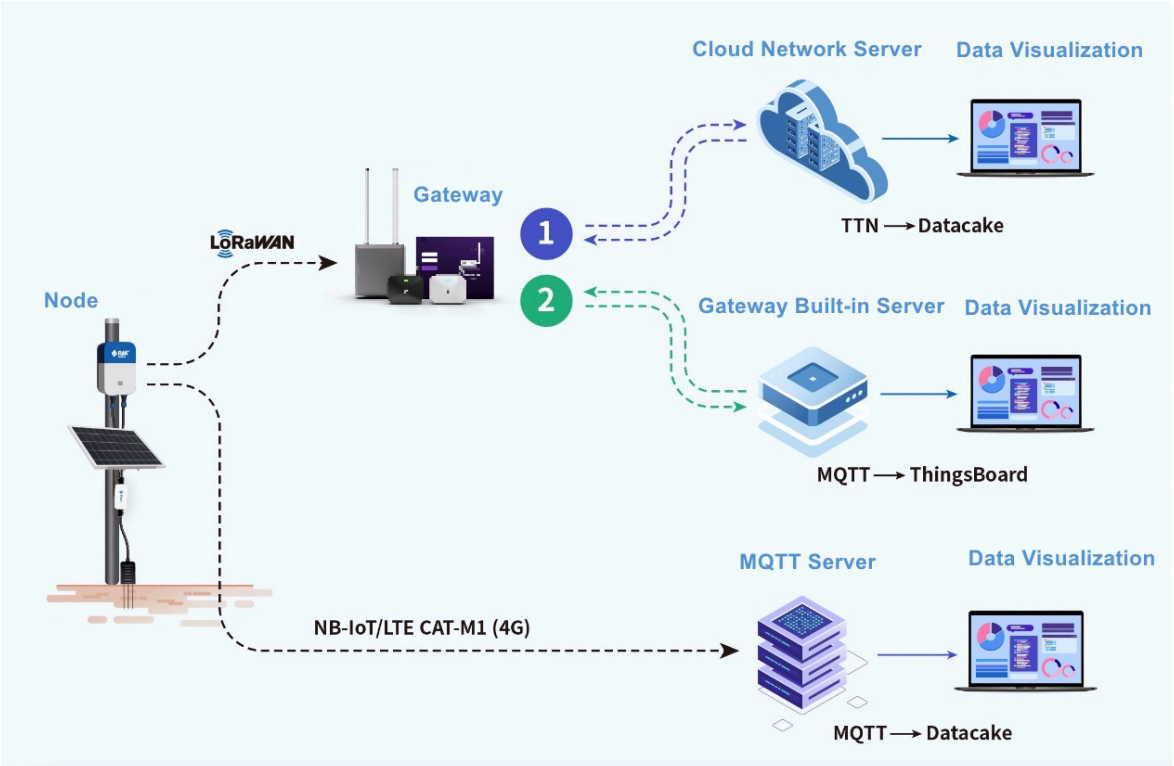

Figure 50: Application scenarios

6.1. LoRaWAN Application

6.1.1. Cloud Network Server Setup

The cloud network server deployment scenario involves connecting the gateway and devices to third-party cloud network servers. This server integrates visualization applications to manage soil moisture, temperature, and EC in real time.

This section provides instructions on creating a Datacake visualization application using the TTN v3 cloud network server.

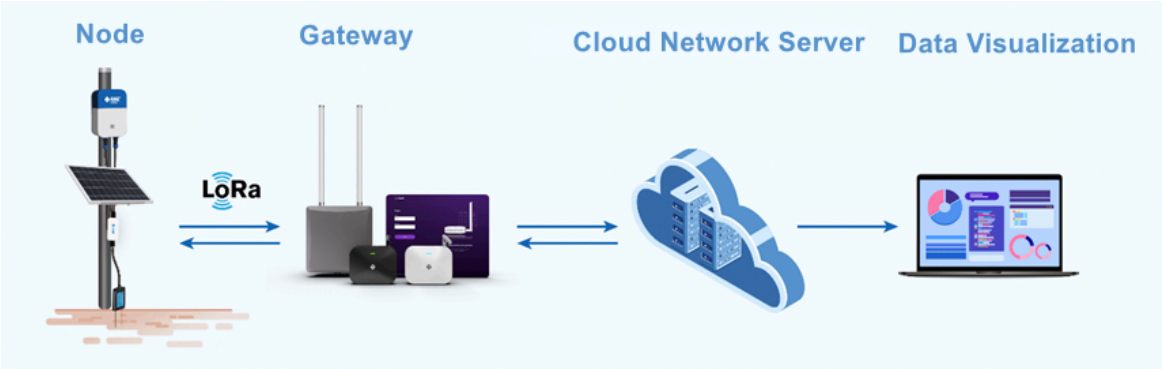

Figure 51: Cloud Network Server Application Flow

6.1.1.a. Connect Gateway to TTN

For this example, you will use the TTNv3 cloud server and RAK7289 V2 WisGate Edge Lite 2 to demonstrate how to connect the RAK business gateway to a cloud server.

Register the Gateway

1. Register an account and log in to the TTN v3 website. If you already have a TTN account, you can log in using your **The Things ID** credentials.

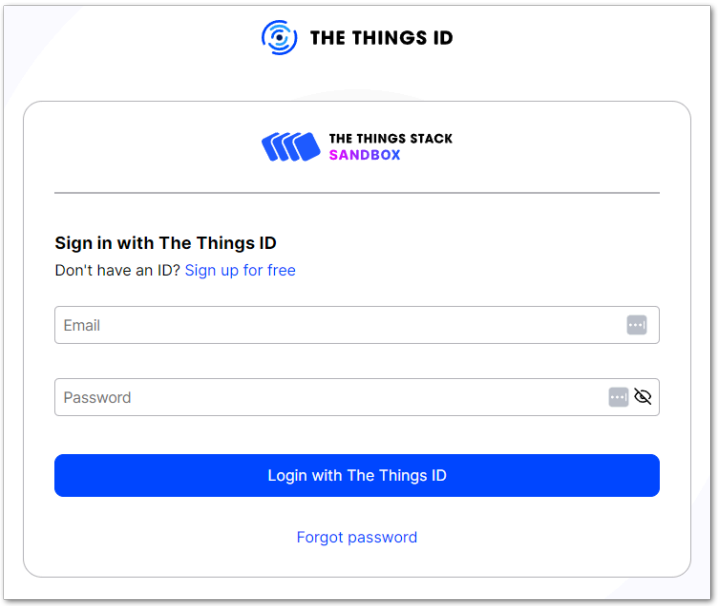

Figure 52: Log in to the TTN website

2. Once logged into the site, click on **Register a gateway** to begin the registration process for a new gateway.

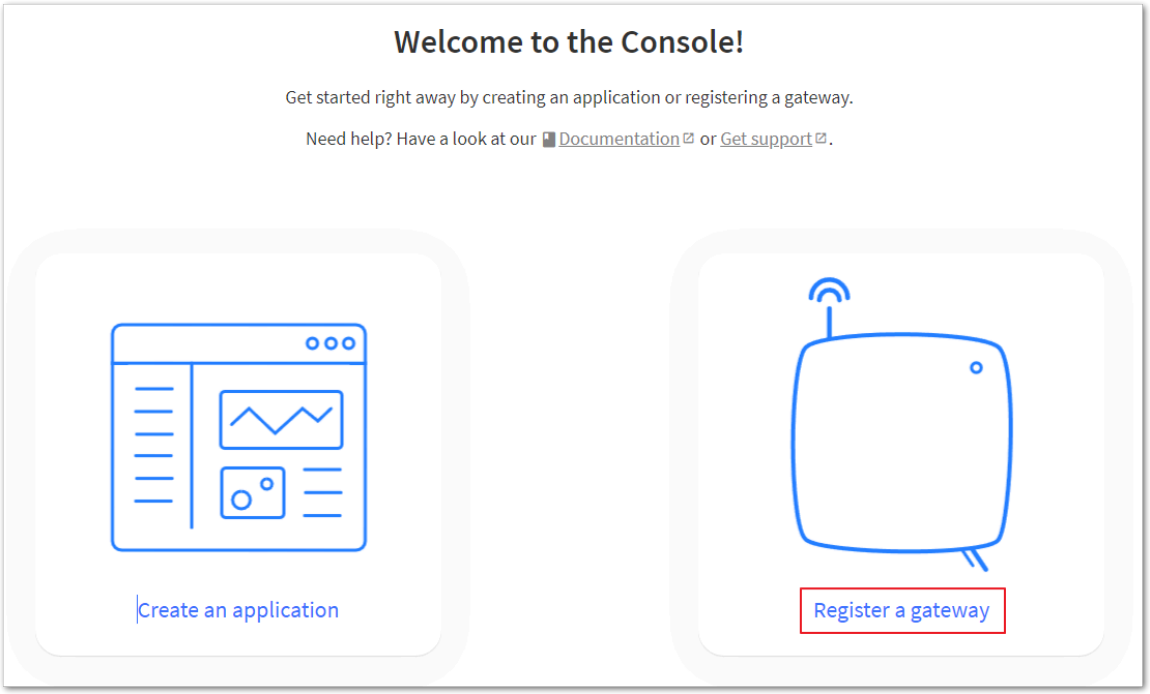

Figure 53: TTN home page

3. Input the Gateway EUI and then click on **Confirm** to proceed.

   The Gateway EUI serves as a distinct 64-bit extended identifier for the gateway, accessible from the Overview page of the gateway management platform or from the label situated behind the gateway.

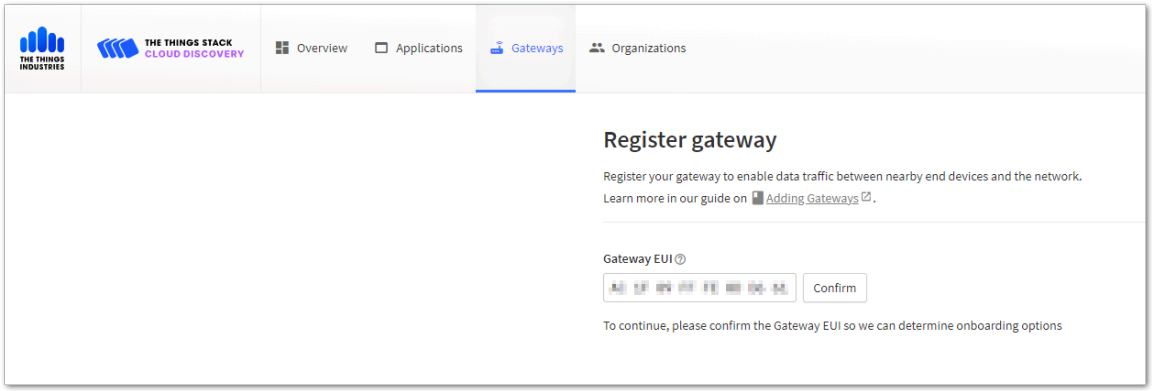

Figure 54: Enter the Gateway EUI

4. Choose the appropriate frequency plan used by the gateway, and click **Register gateway** to complete the registration process of the gateway.

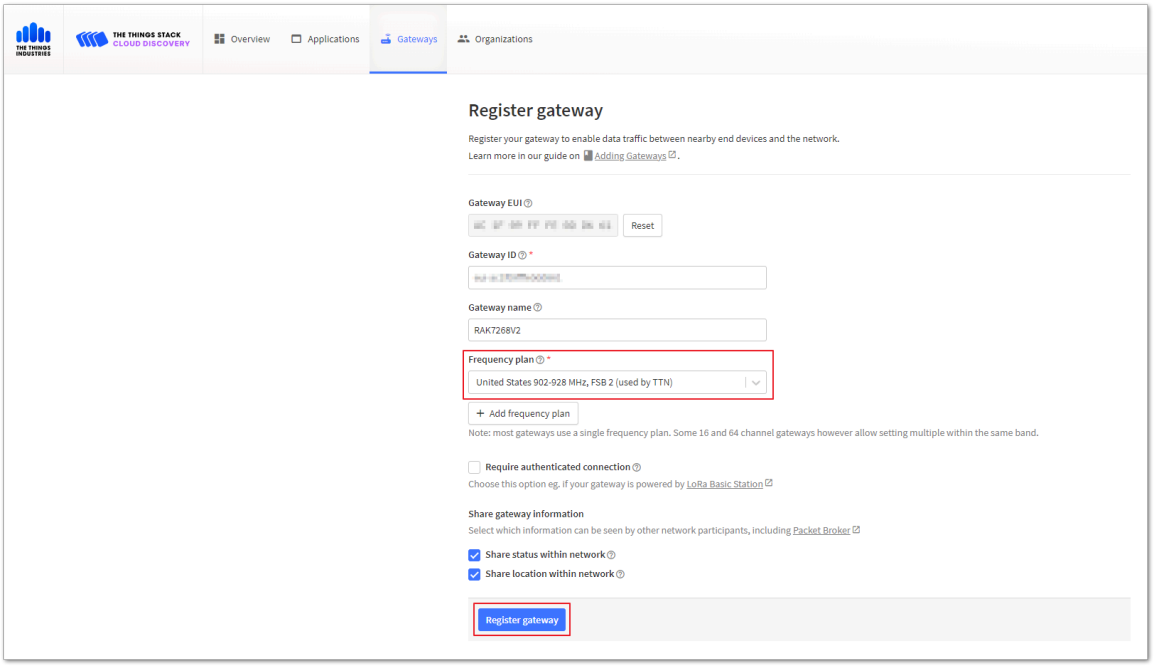

Figure 55: Configure the gateway frequency

Your gateways dashboard should look the same with **Figure 56**.

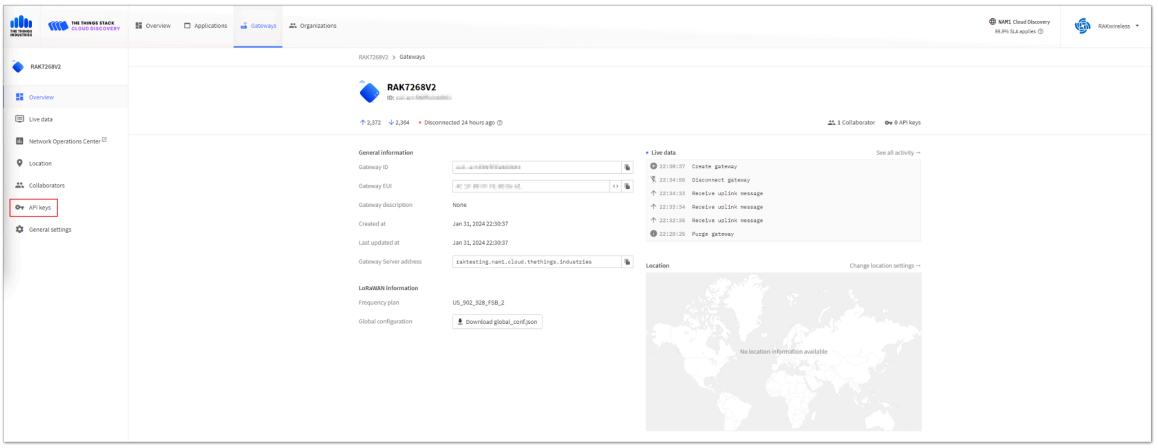

Figure 56: Successfully registered the gateway

Generate a Token

TTNv3 supports TLS server authentication and client tokens, which require trust files and keys to configure the gateway and successfully connect to the network.

1. To generate a key file, navigate to **API keys** from the **Overview** page of the registered gateway, then click **Add API key**.

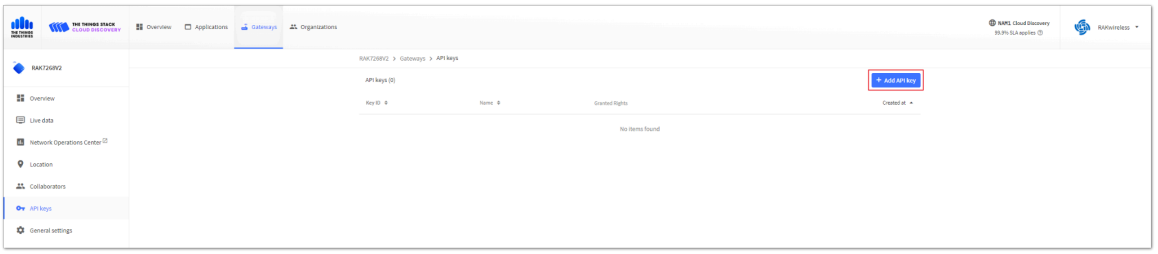

Figure 57: Add API keys

2. In the **Add API key** page, set the **Name** field, tick off the checkboxes, then click **Create API key**.

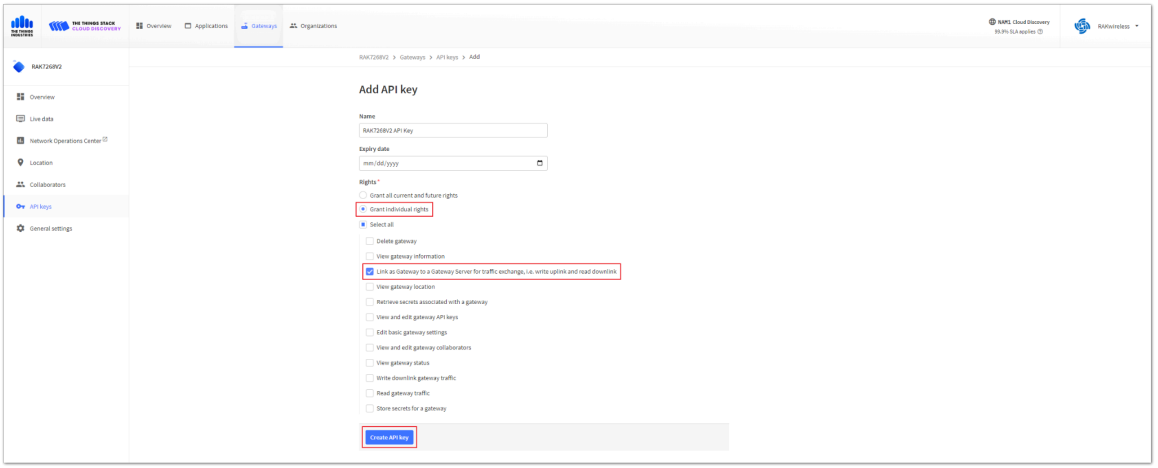

Figure 58: Configure the API Key

3. A new window pops up with the generated key. Copy the new API key by clicking the icon and then the **I have copied the key** button.

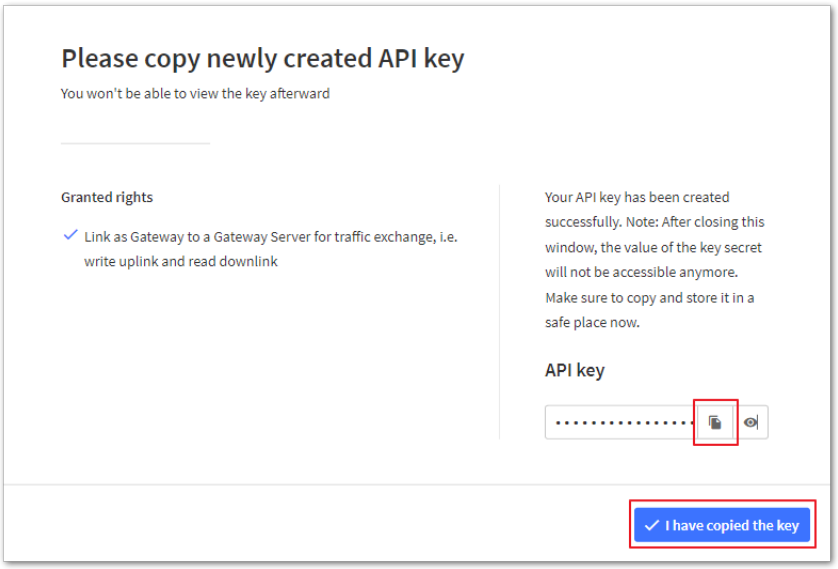

Figure 59: Copy and save the API Key

Register the Gateway

1. Navigate back to the gateway management platform Web UI. Click on the left navigation bar to access the **LoRa > Configuration** tab. Complete the following settings and save them.
    - **Basics Station Server Type:** LNS Server
    - **Server URL:** `wss://eu1.cloud.thethings.network`
    - **Server Port:** `8887`
    - **Authentication Mode:** TLS server & Client Token Authentication
    - **Trust (CA Certificate):** Click the link to download.
    - **Client Token:** Copied API Keys

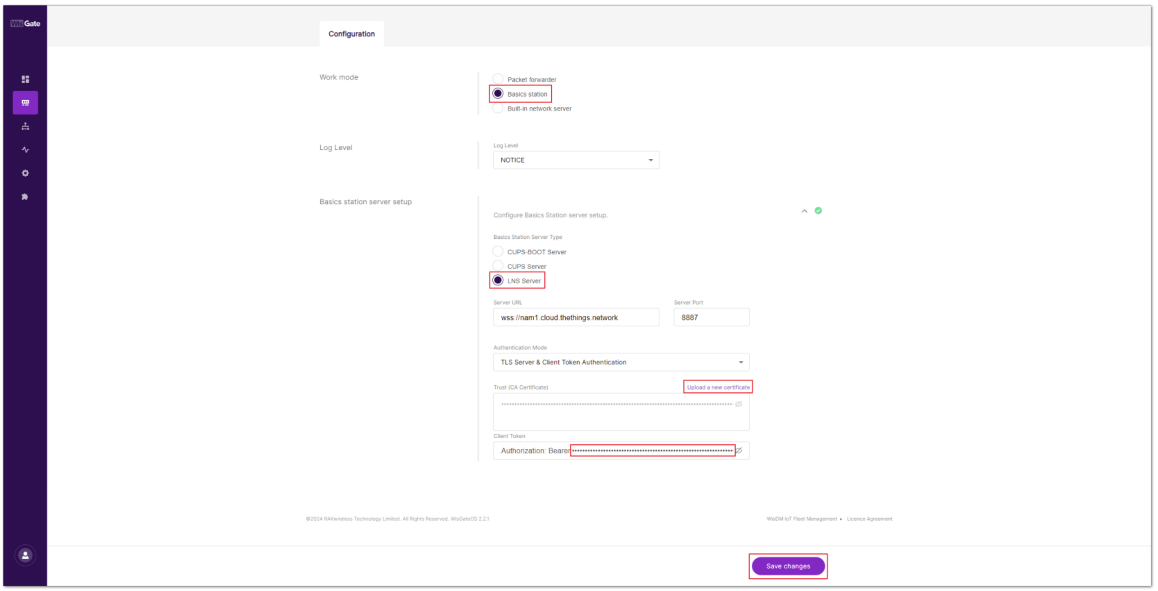

Figure 60: Configure the gateway

2. After saving the changes, return to the TTN gateway interface, and navigate to the **Gateways** tab to confirm that the gateway is now connected to TTNv3 as a Basics Station.

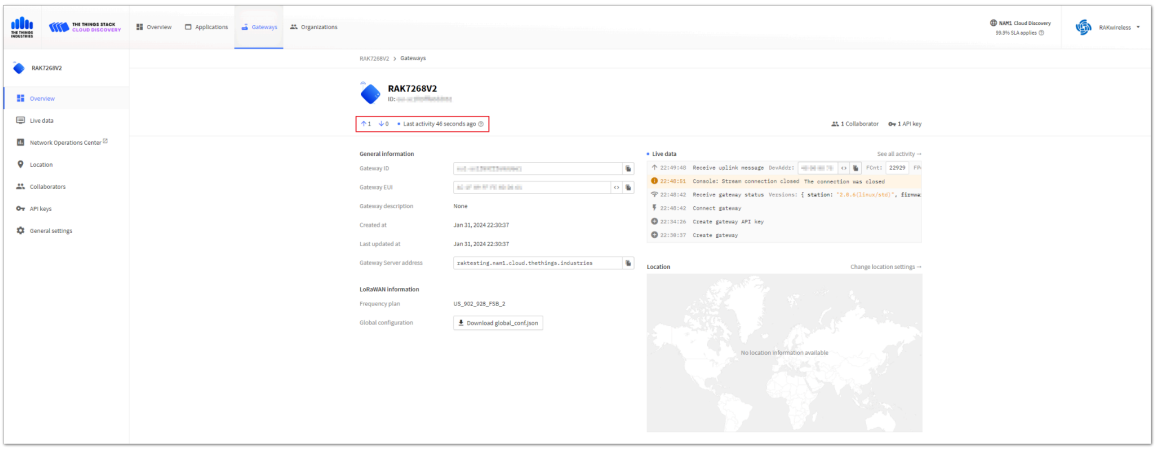

Figure 61: Gateway connected successfully

6.1.1.b. Connect Sensor Hub to TTN

1. Return to the TTNv3 homepage and select **Create an application** to add a node.

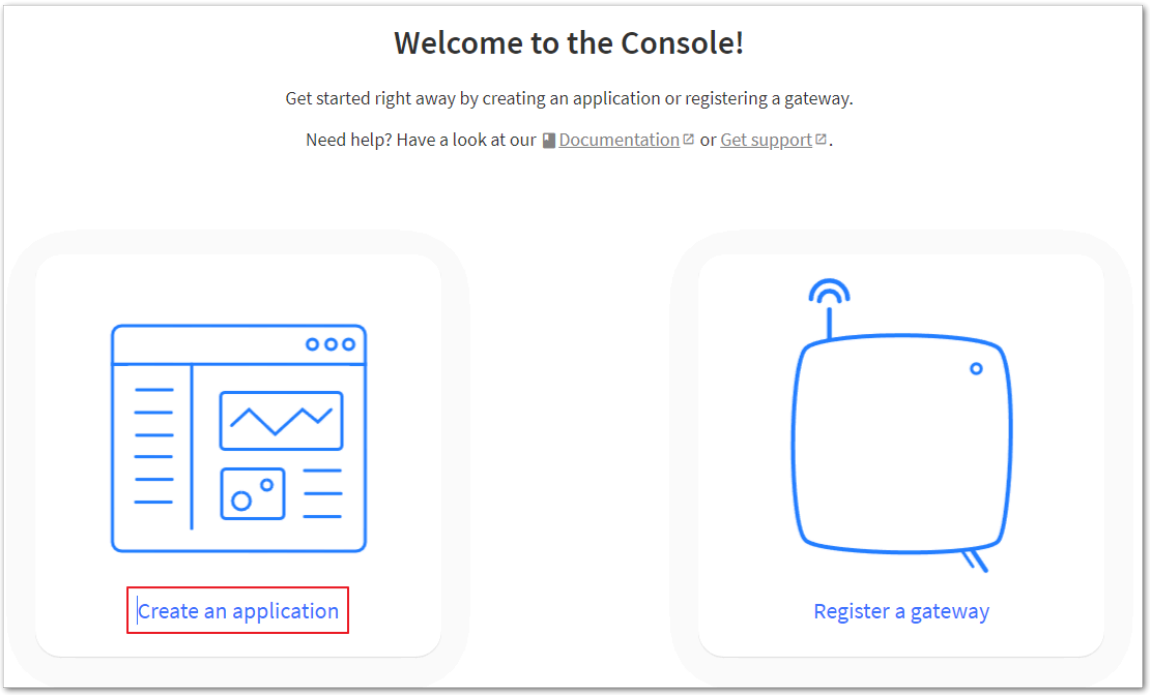

Figure 62: Select Create an Application

2. Click **+Create application** to initiate the creation of a node.

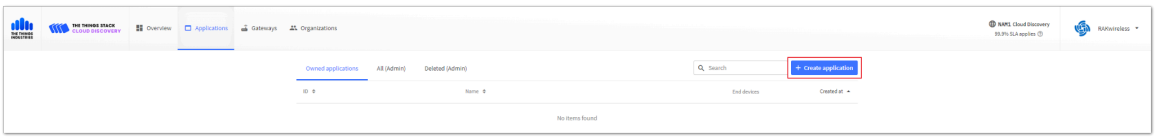

Figure 63: Create a new application

3. Enter the desired **Application ID** in the provided field, then click on **Create application**.

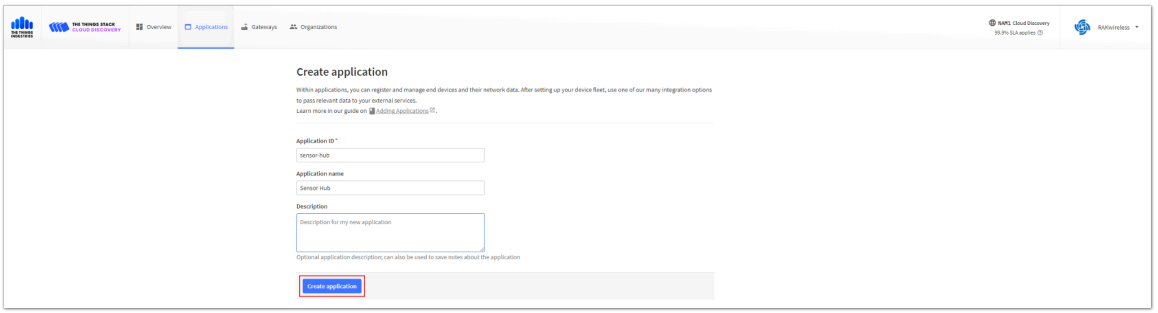

Figure 64: Fill in the Application ID field

4. Click on the **+Register end device** button to add a new end device to the application.

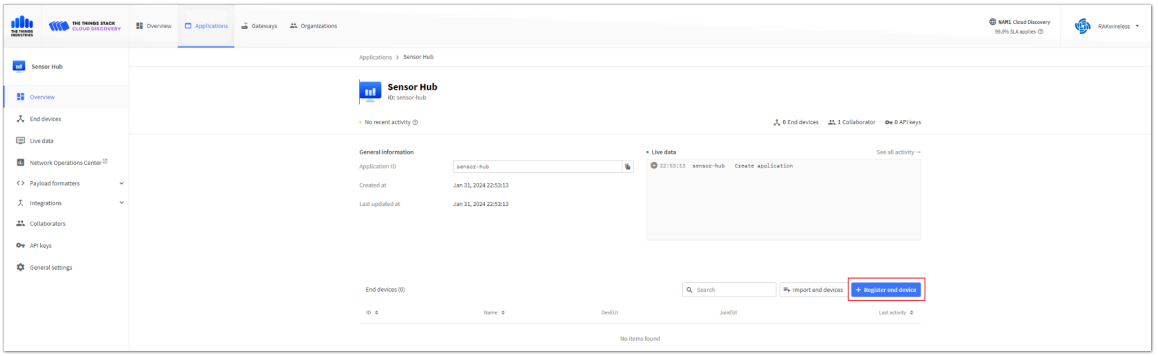

Figure 65: Add the end device

5. Set the parameters of the end device, as shown in **Figure 66.**

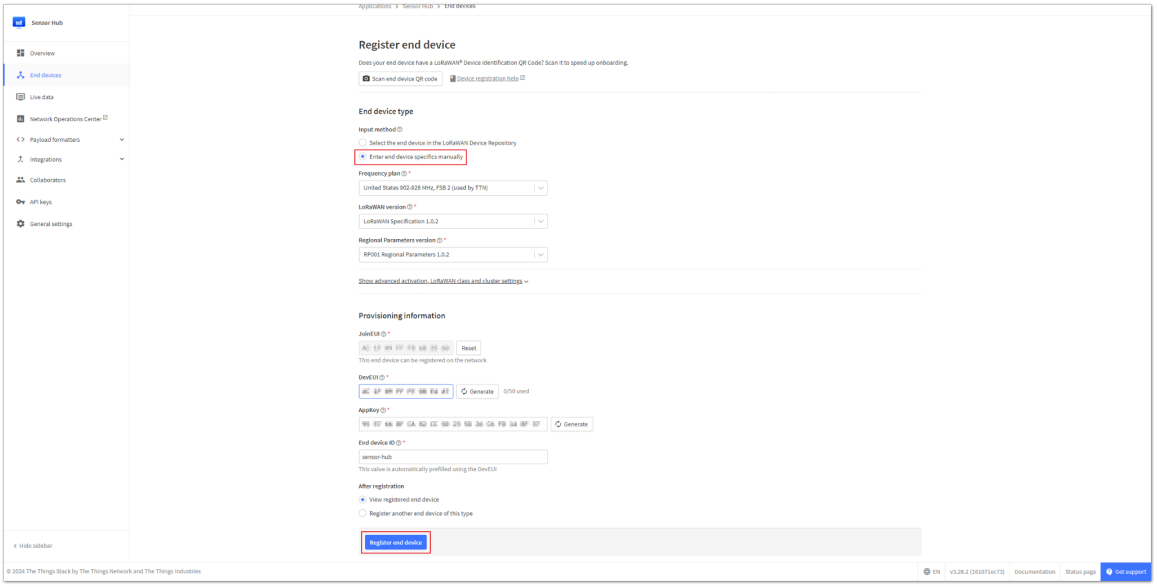

Figure 66: End device parameters

- **JoinEUI, DevEUI**, and **AppKey** can be automatically generated by clicking Generate on the TTN web page, or they can be customized by the user.

NOTE

Ensure that the three parameters - **JoinEUI**, **DevEUI**, and **AppKey** - are consistent with the parameters set in the WisToolBox application.

6. After completing the settings, return to the WisToolBox app, and click **JOIN NETWORK** to send the end device network join request.

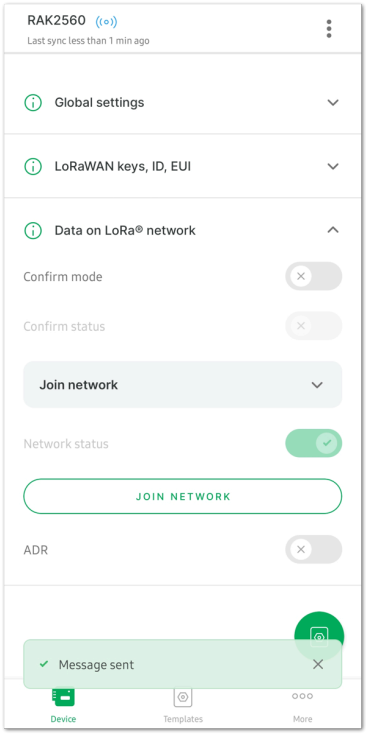

Figure 67: Sending end device network join request

7. As shown in **Figure 68**, the Sensor Hub has successfully joined the TTNv3 network server.

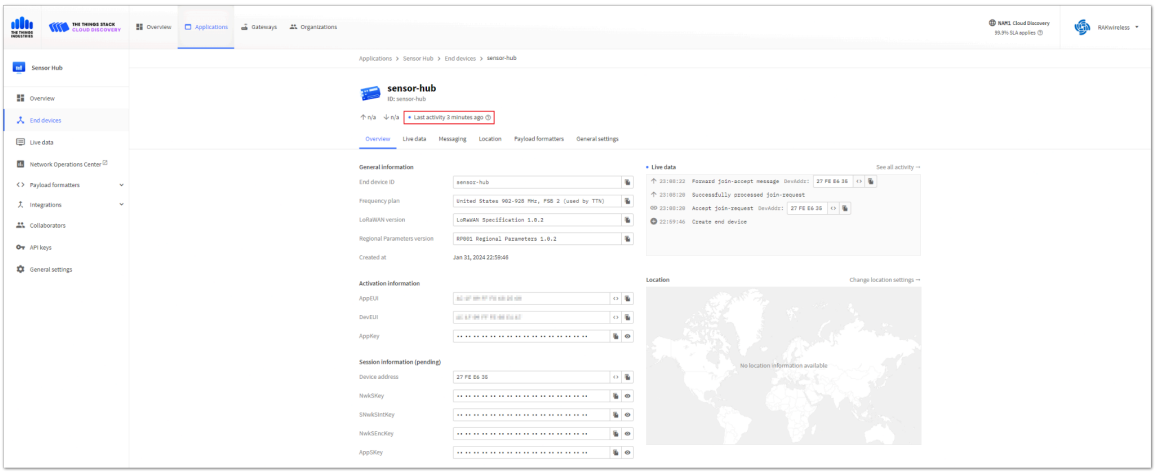

Figure 68: Successfully joined the TTNv3 network server

6.1.1.c. Visualize Data Through Datacake

Datacake is a versatile IoT platform. It offers a range of features tailored for effective data visualization and management, making it a preferred choice for IoT projects requiring efficient monitoring and analysis.

Create Datacake Integration

1. In the TTN console, navigate to **Integrations** on the sidebar, proceed to the **Webhooks** section, and click **+Add Webhooks** to set up an integration.

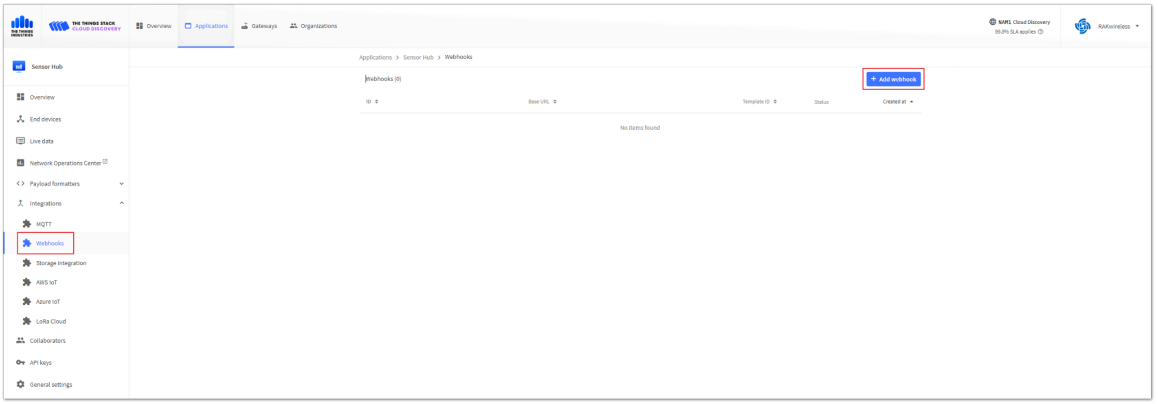

Figure 69: Adding an integration

2. From the list of webhook templates, select the **Datacake** template.

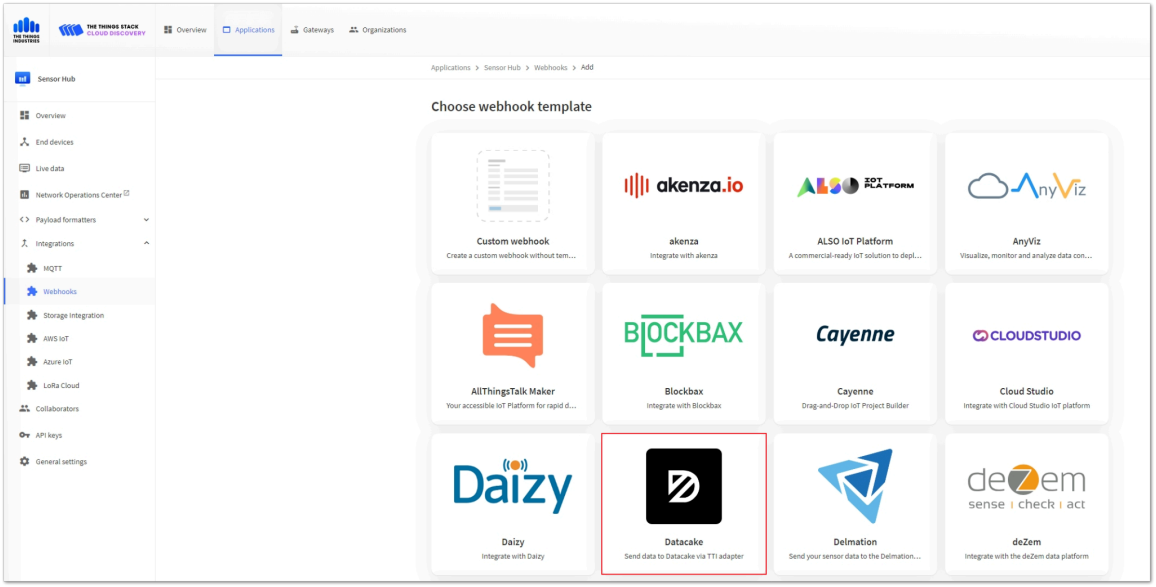

Figure 70: Select the **Datacake** template

3. Generate an API key for webhook authentication on Datacake. To get started, register a Datacake account, and then log in.

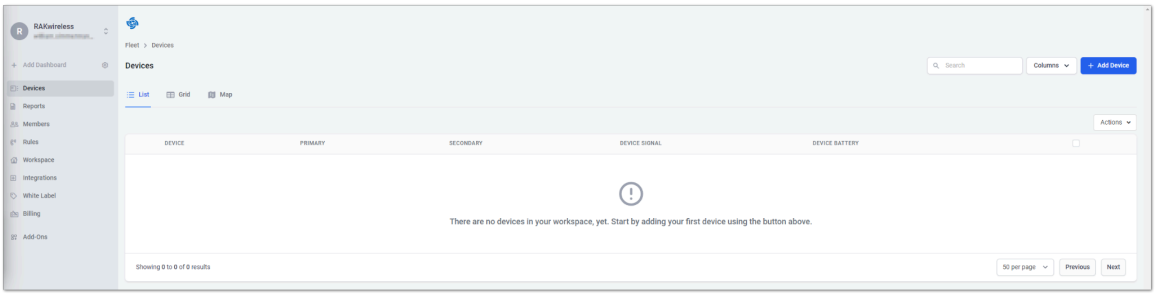

Figure 71: Datacake IoT platform main page

4. Navigate to the Datacake workspace. Select **Members** on the sidebar, and switch to the **API Users** tab, and then click the **Add API User** button.

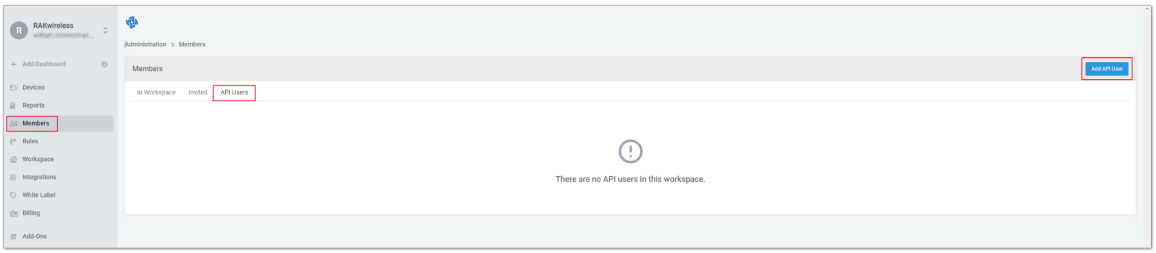

Figure 72: Add API User

5. Enter the name of the API User, for instance, **TTS API**. Set the relevant parameters accordingly and click **Save** to finalize the creation process.

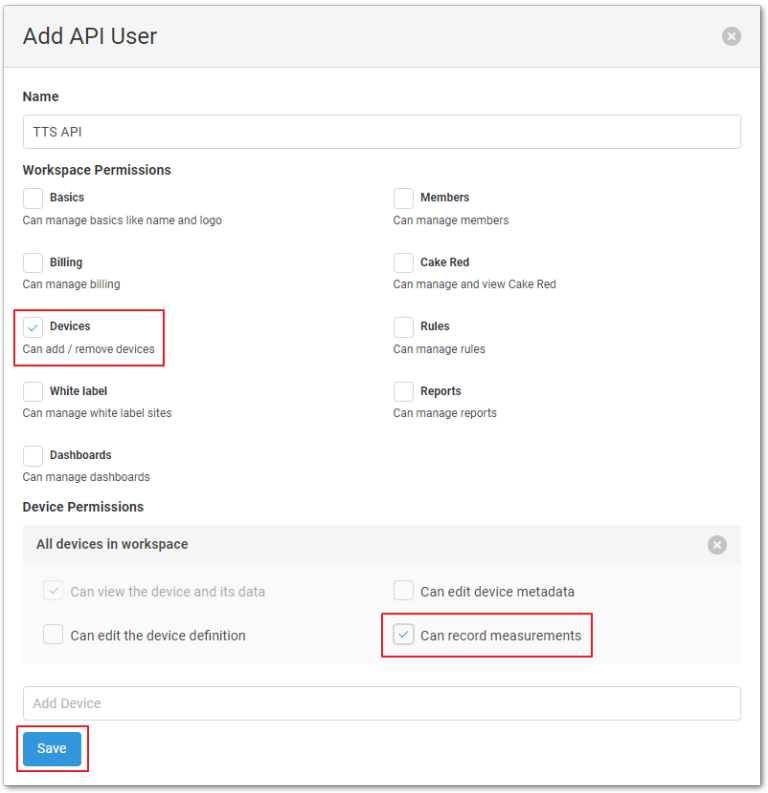

Figure 73: Set Parameters

6. Click the **Copy** button to copy the generated Datacake API Token.

Figure 74: Copy the generated Datacake API Token

7. Back on the TTN website, enter **Sensorhub** in the **Webhook ID** field (as an example), and paste the Datacake API Token you previously copied into the **Token** field. Click the **Create Datacake Webhook** button to generate the Datacake Webhook.

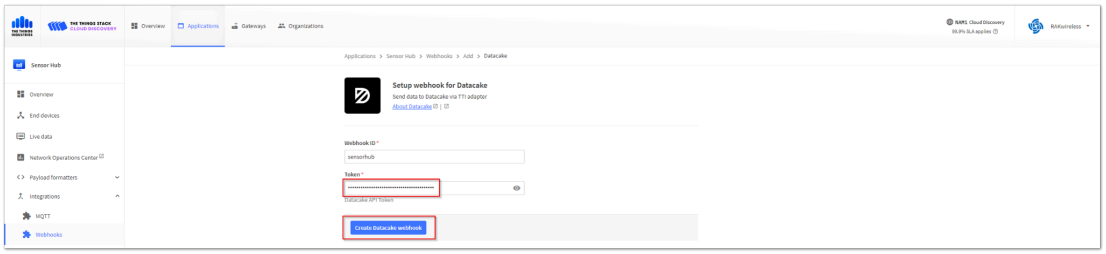

Figure 75: Create the Datacake Webhook

Add Sensor Hub to Datacake

1. To add a new device, select **Devices** in the sidebar and click the **+Add Device button**.

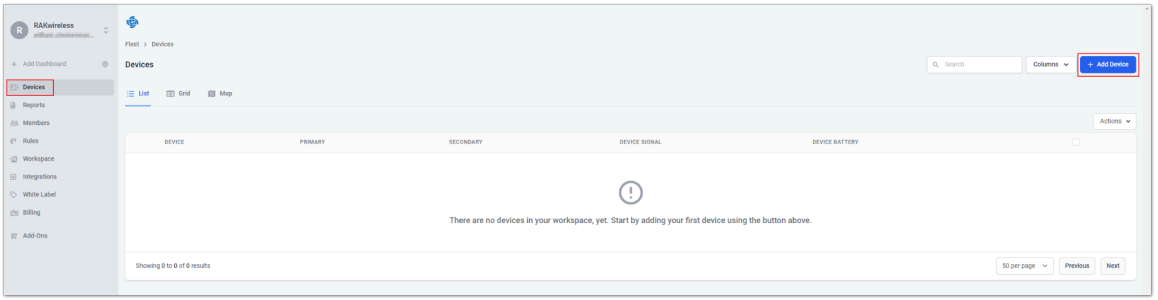

Figure 76: Add a device

2. Choose **LoRaWAN** from the options and click **Next** to proceed.

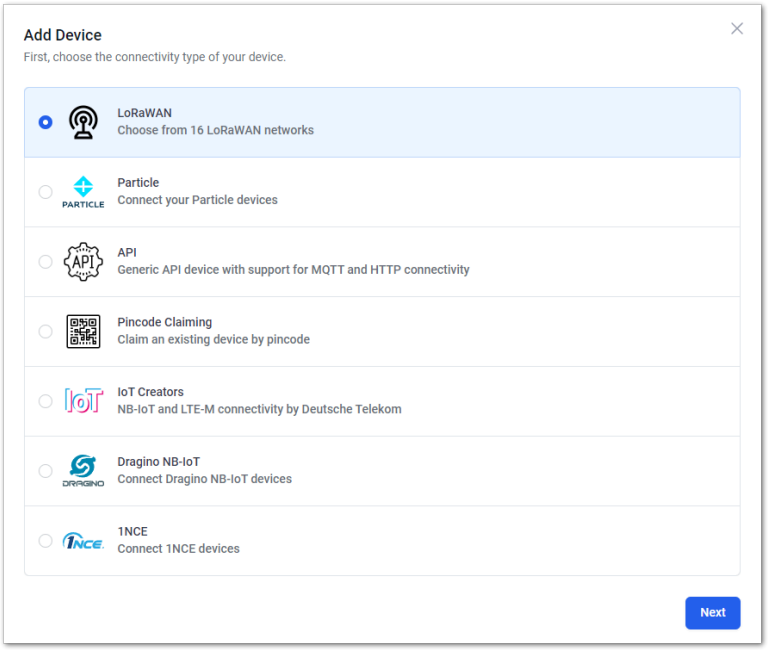

Figure 77: Select **LoRaWAN**

3. As the Sensor Hub is a new device, no pre-existing template exists. Create a template by clicking **New Product**, enter the **Product Name,** and click **Next** to proceed.

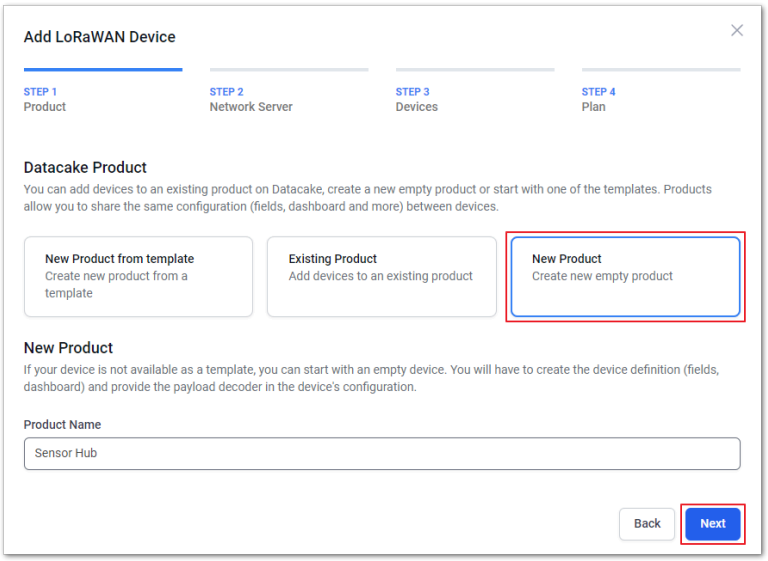

Figure 78: Create a New Product

4. Choose a network server for your device. In this guide, select **The Things Stack V3**, then click **Next** to continue.

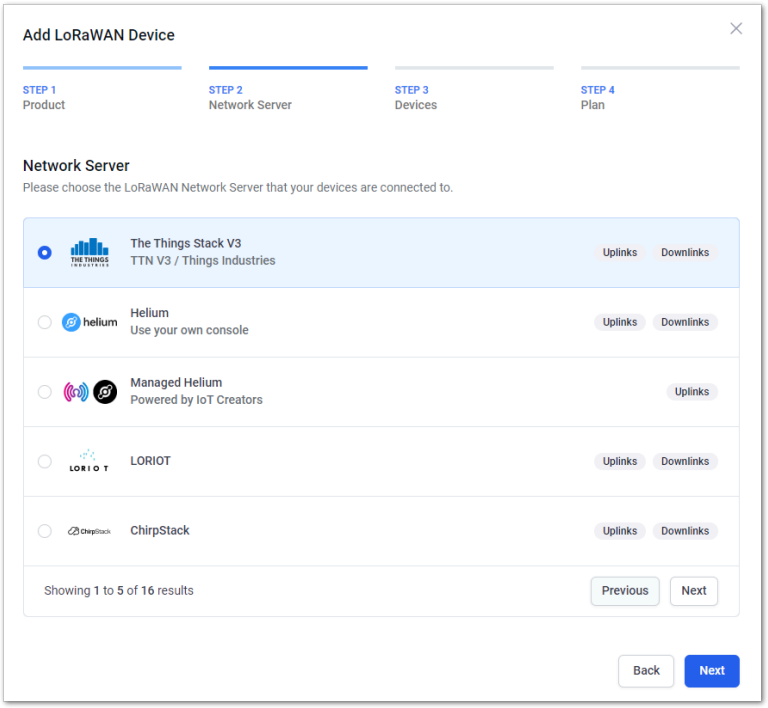

Figure 79: Select the Things Stack V3

5. In the **STEP 3 Devices** tab, enter the device **DEVEUI** and **NAME** fields, and click **Next** to continue.

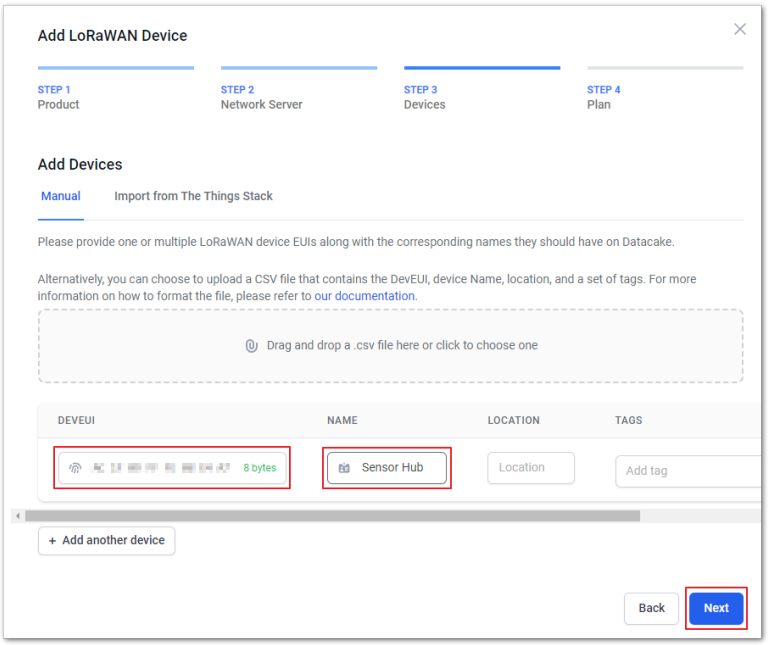

Figure 80: Add DEVEUI and Name

6. In **Step 4 Plan**, select the preferred subscription plan, and click **Add 1 device** to add the device. For this example, choose **Free**.

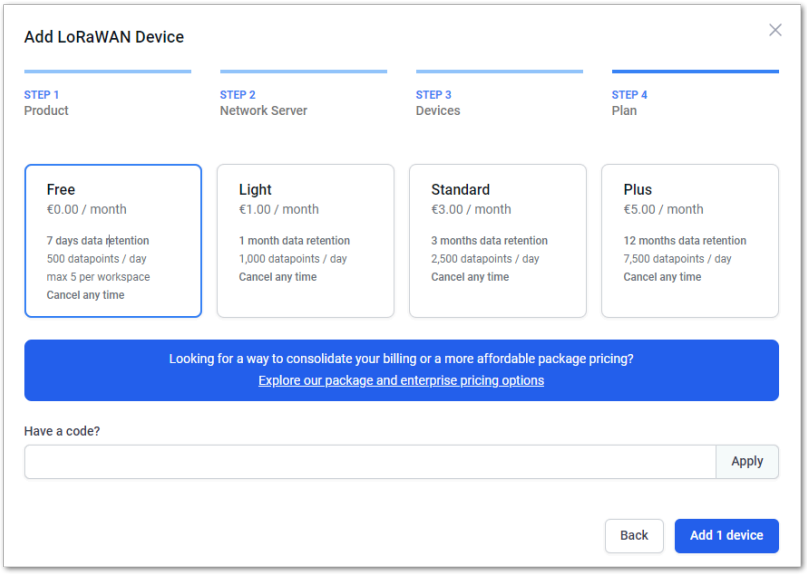

Figure 81: Select a subscription plan

7. The registered device can now be viewed on the **Devices** tab.

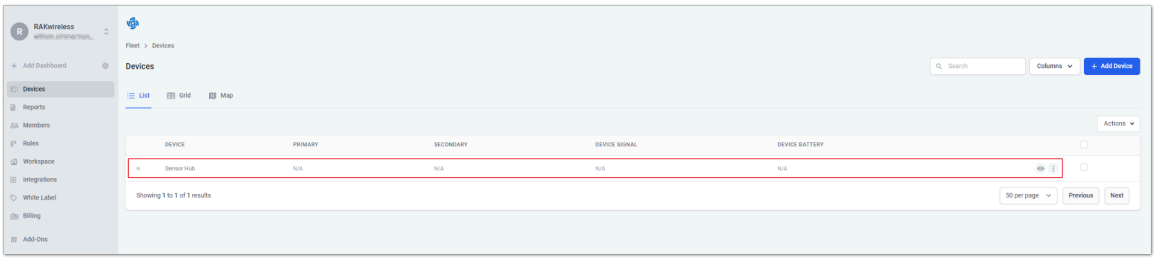

Figure 82: Registered device

Create a Payload Decoder

1. Click the successfully registered device and go to the **Configuration** tab. Scroll down to the **Payload Decoder** field, then copy and save the decoder code.

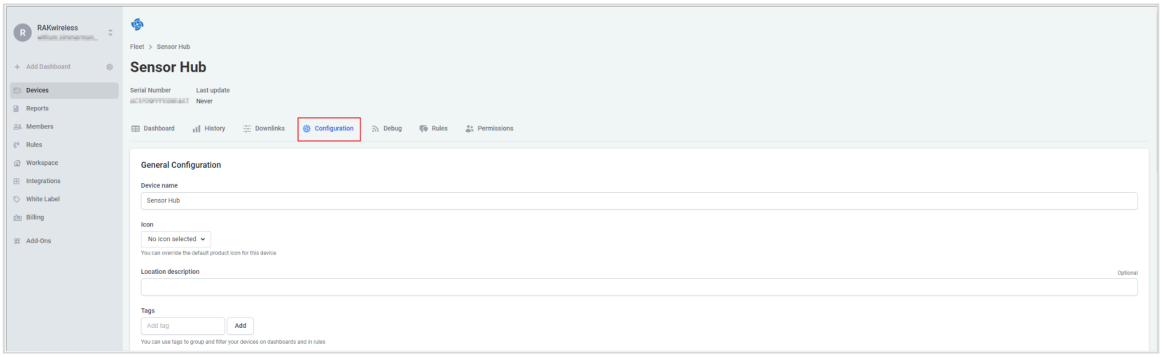

Figure 83: Configuration tab

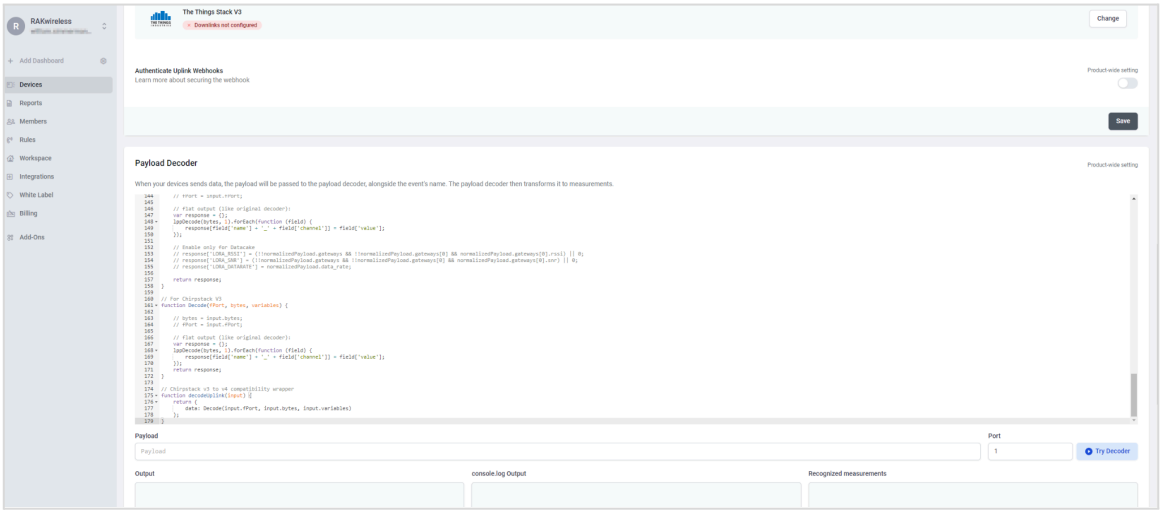

Figure 84: Decoder code

```
function Decoder(bytes, port) {
    var decoded = {};
    var str = bin2HexStr(bytes);
    var i = 0;
    while (i < str.length) {
        var channelId = parseShort(str.slice(i, i + 4), 16);
        var value = parseShort(str.slice(i + 4, i + 8), 16);
        i += 8;
        switch (channelId) {
            case 0x0167:
                decoded.temperature = value / 10.0;
                break;
            case 0x0270:
                decoded.humidity = value / 10.0;
                break;
            case 0x03C0:
                decoded.electric_conductivity = value / 1000.0;
                break;
            default:
                break;
        }
    }
    try {
             decoded.lorawan_rssi = (port && port.metadata &&
port.metadata.rssi) || 0;
              decoded.lorawan_snr = (port && port.metadata &&
port.metadata.snr) || 0;
           decoded.lorawan_datarate = (port && port.metadata &&
port.metadata.data_rate) || '';
    } catch (e) {
        console.log('Failed to read gateway metadata');
    }

    return decoded;
}
```

```
function bin2HexStr(bytesArr) {
    var str = '';
    for (var i = 0; i < bytesArr.length; i++) {
        var tmp = (bytesArr[i] & 0xff).toString(16);
        if (tmp.length == 1) {
            tmp = '0' + tmp;
        }
        str += tmp;
    }
    return str;
}

// convert string to short integer
function parseShort(str, base) {
    var n = parseInt(str, base);
    return (n << 16) >> 16;
}

// convert string to triple bytes integer
function parseTriple (str, base) {
var n = parseInt (str, base);
    return (n << 8) >> 8;
}
```

2. Displace the menu bar with the **+Add Field** section, and click **+Add Field.**

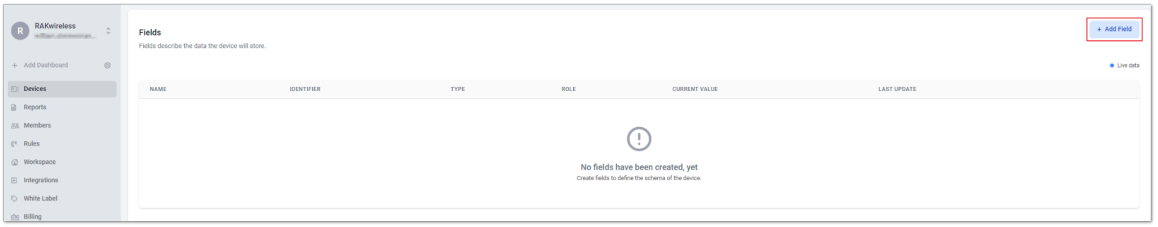

Figure 85: Add field

3. The **Add Field** window appears. Complete the fields shown in **Figure 86** to configure the stored data in the device.

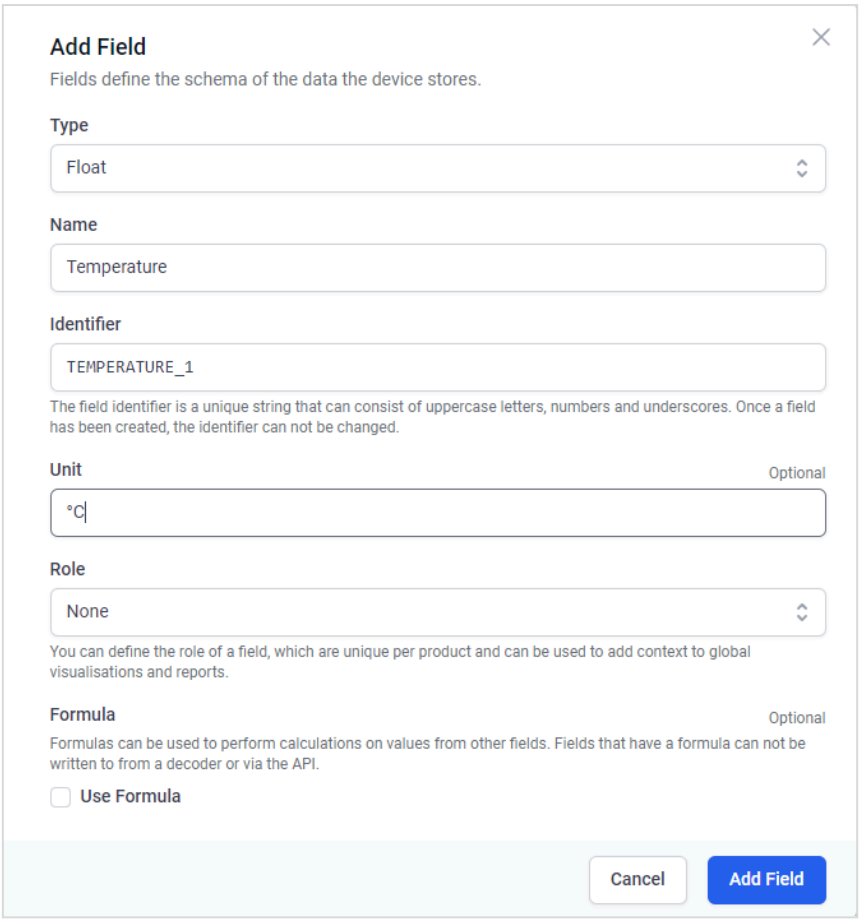

Figure 86: Configuration fields

NOTE

- Enter an appropriate name in the **Name** field.
- The **Identifier** field will be automatically filled in based on the name.
- When an uplink is received, refresh the page and the **CURRENT VALUE** field will be updated.
- Leave everything else as default and click **Add Field** to complete the setup.

4. When completed, it will look the same, as shown in **Figure 87**.

Figure 87: Successfully added fields

Create a Dashboard

1. To create a dashboard, click the **edit mode** switch on the **Dashboard** tab of the device on Datacake.

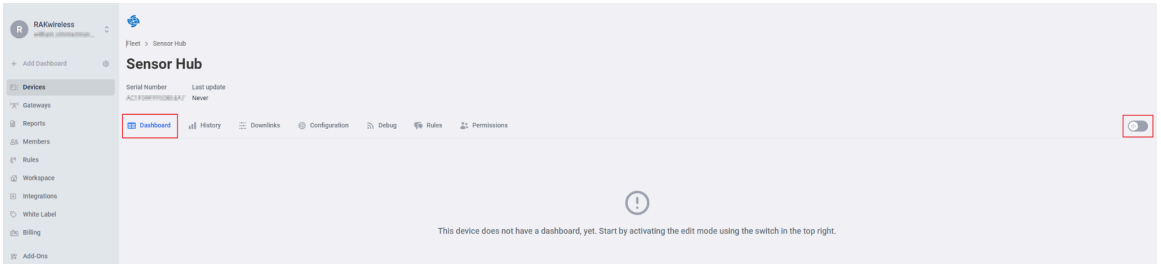

Figure 88: Turn on the edit mode switch

2. Click **+Add Widget** to add a visualization widget.

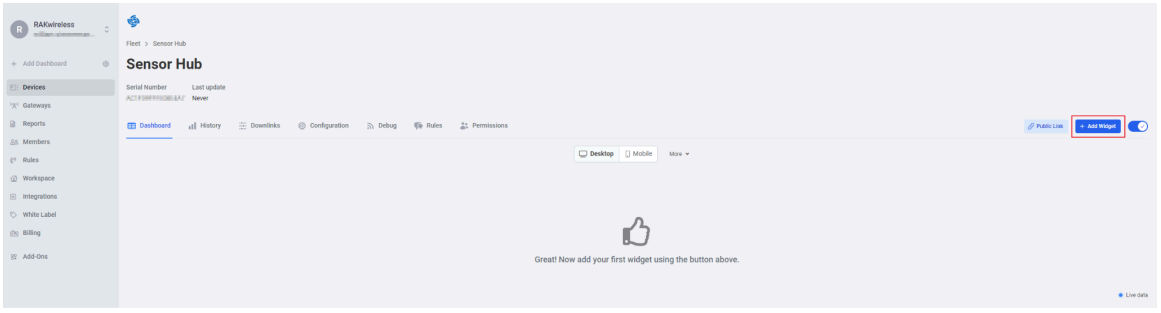

Figure 89: Add visualization widget

3. Select **Value** from the menu to create a new dashboard.

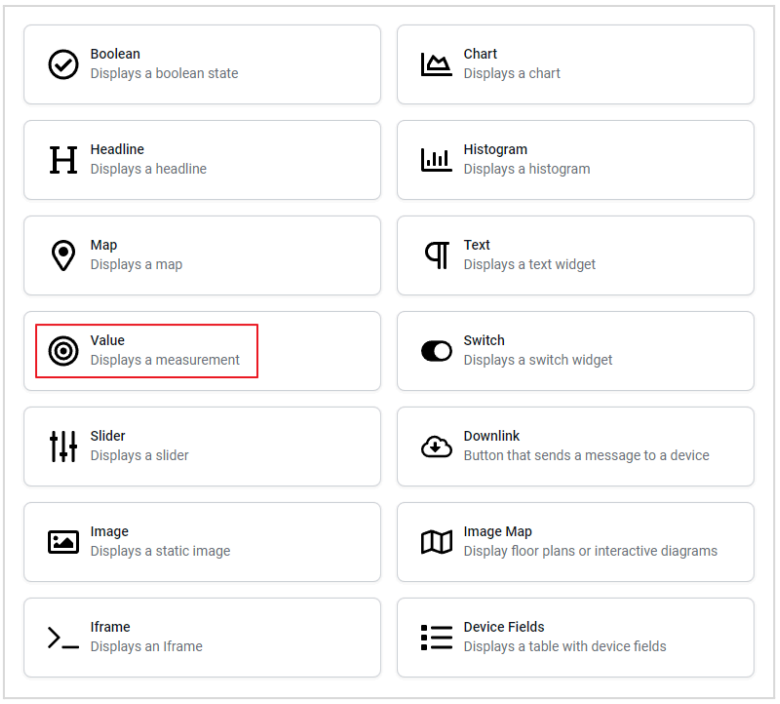

Figure 90: Select **Value** to create a new dashboard

NOTE

You can select different types of widgets to accommodate various data formats.

4. In the **Title** field under the **Basics** tab, name the widget as **Temperature**.

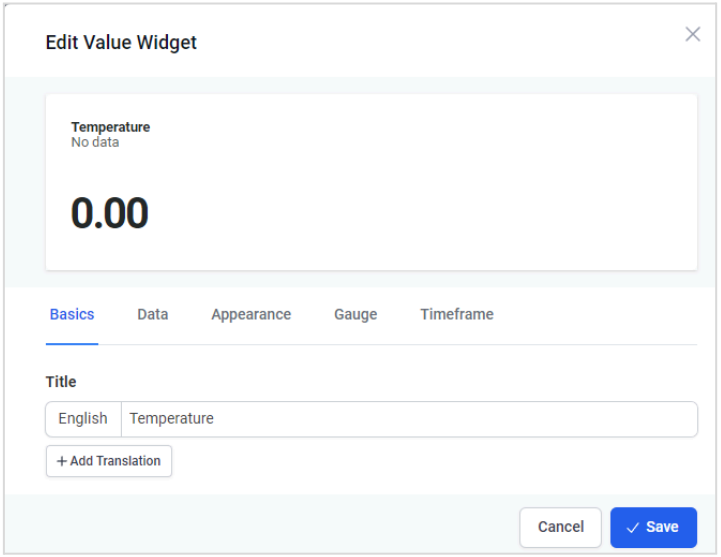

Figure 91: Name the widget

5. Under the **Data** tab, click the **Field** tab dropdown arrow, select **Temperature**, and set the unit to **° C**.

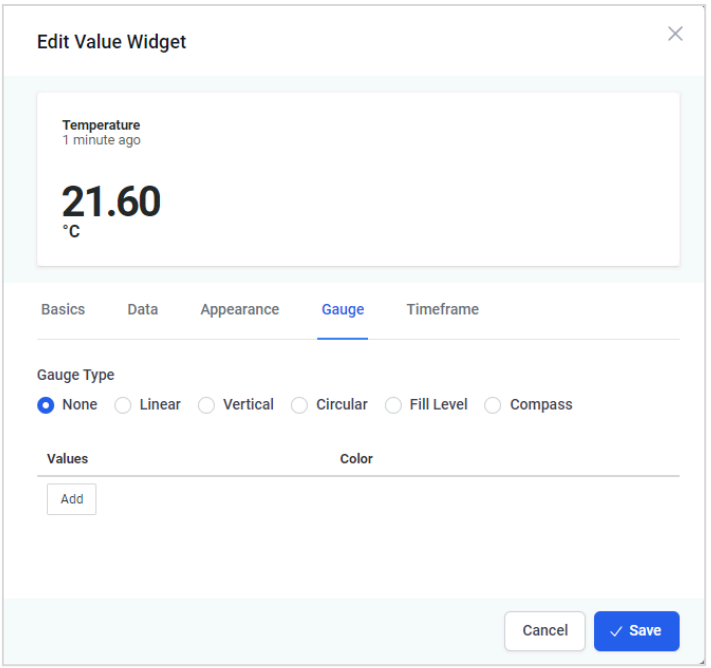

Figure 92: Set the unit

6. On the **Gauge** tab, select the gauge type and color, set the range of values for the widget, and then click **Save.**

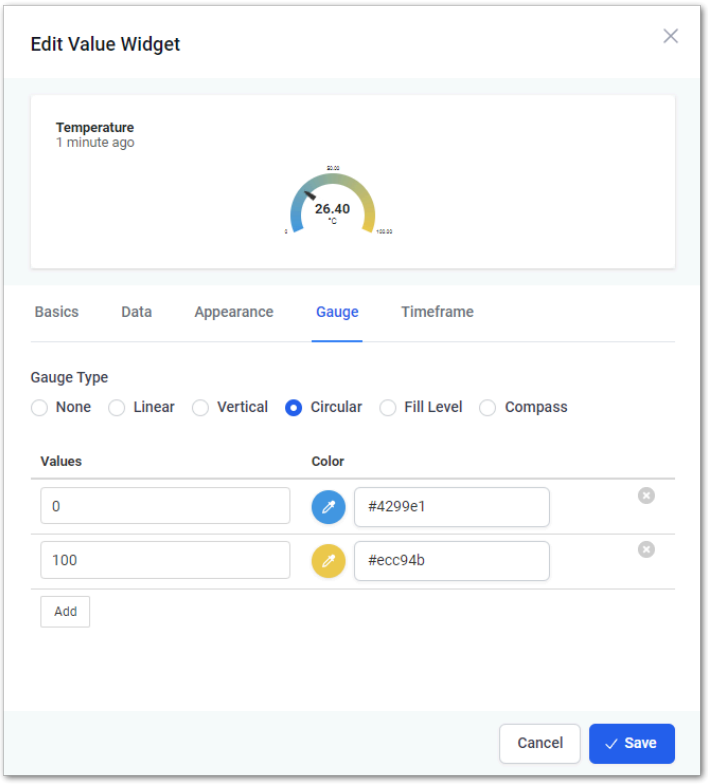

Figure 93: Set the widget type

7. To add more parameter widgets, ensure the **edit mode** switch is **ON**, then click the **+Add Widget** button again.

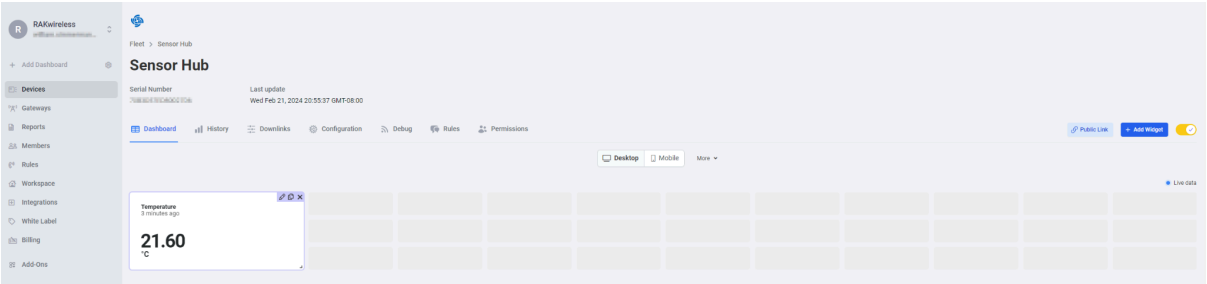

Figure 94: Added Widget

8. When you finish adding the widgets, turn off the **edit mode** switch to save the edits.

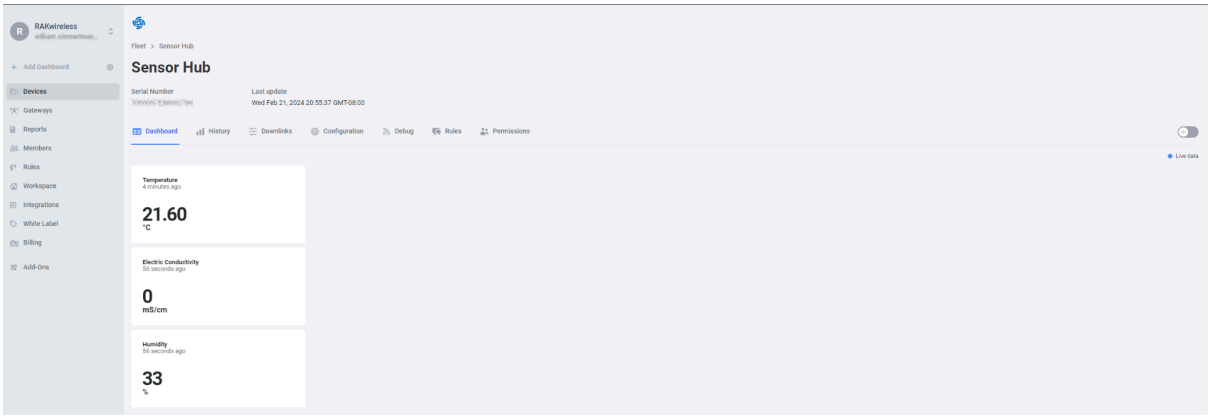

Figure 95: Save the edits

9. Return to the WisToolBox APP, and click **JOIN NETWORK** to send the end device network access request. Once the request is successfully returned, the data will be uploaded within 60 seconds.

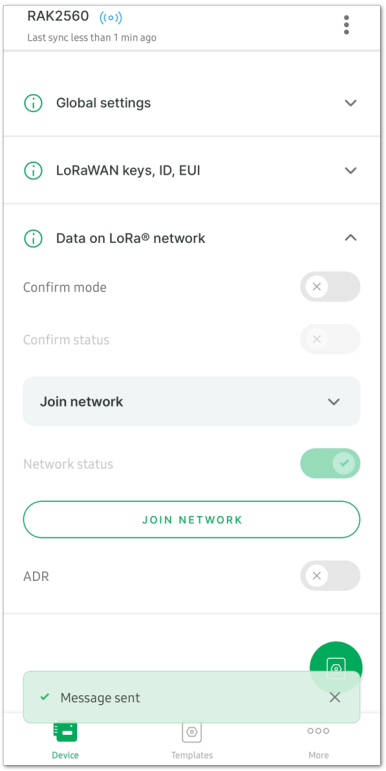

Figure 96: Send the end device network access request

6.1.2. Built-In Network Server Setup

The RAK gateway comes with a built-in NS, which eliminates the need to deploy NS in the cloud or locally. This gateway is suitable for small-sized industrial application scenarios and offers various advantages such as cost savings, reduced R&D investment, high execution efficiency, and shorter delays.

The built-in network server of the RAK gateway provides MQTT and HTTP integration that allows for post-processing data and implementing solutions based on the needs.

This section will use the public MQTT broker integration as an example to demonstrate how to use the built-in network server to create a visualization application on ThingsBoard.

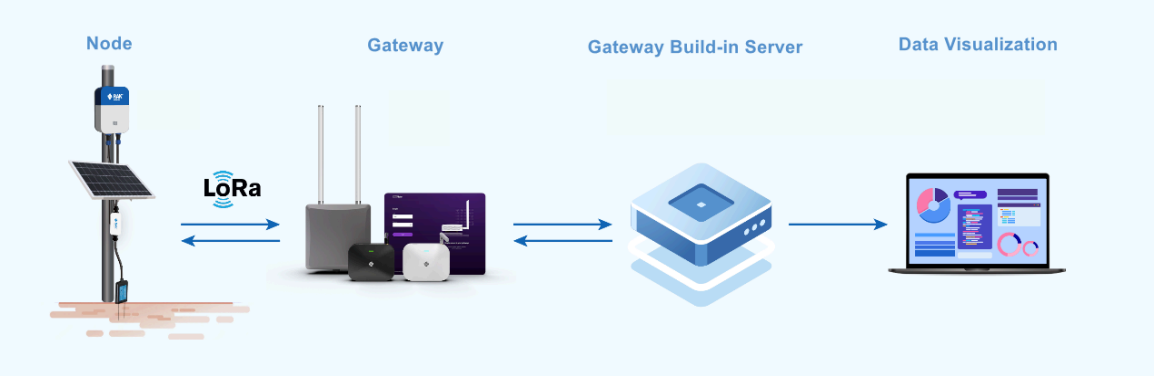

Figure 97：Gateway Built-in Server Application Flow

6.1.2.a. Configure the ThingsBoard

1. Log in to ThingsBoard. If you don't have an account yet, create one before proceeding.

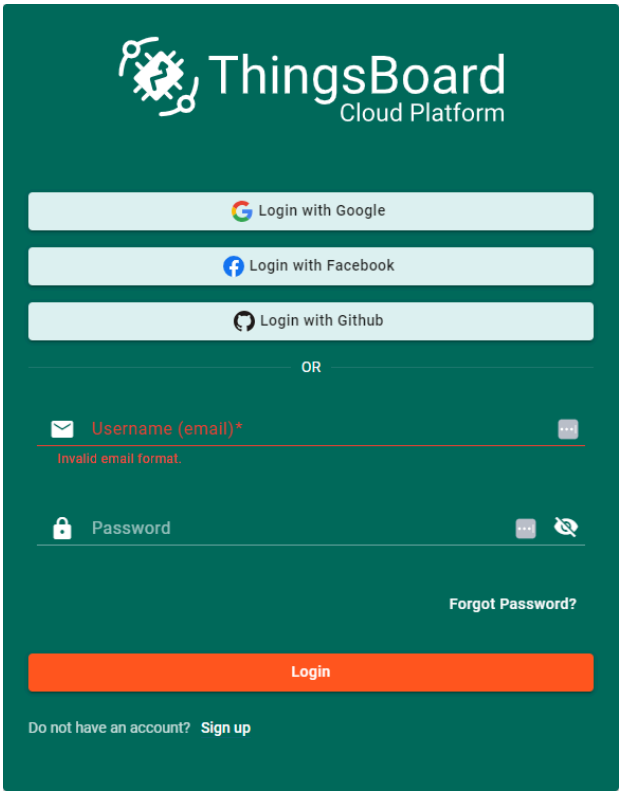

Figure 98: Sign up on ThingsBoard

2. After successfully logging in, you will be directed to the ThingsBoard homepage.

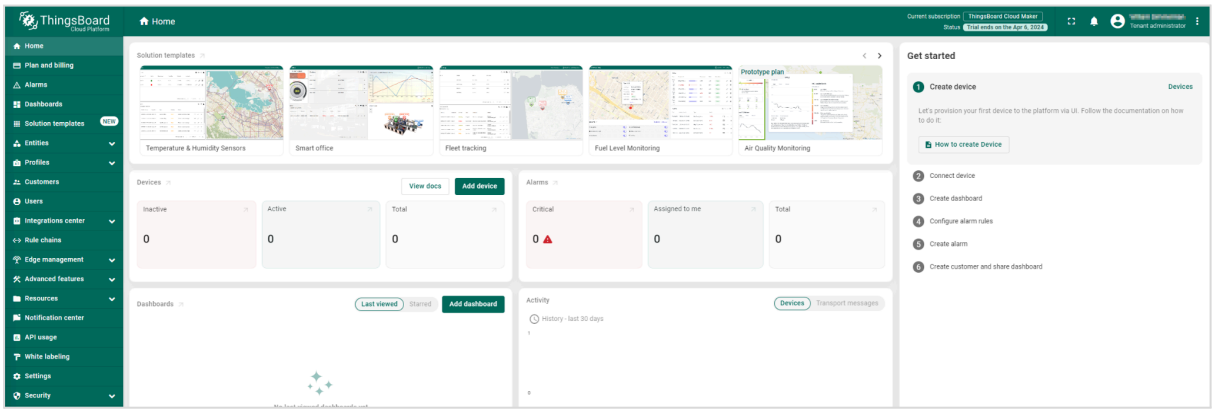

Figure 99：ThingsBoard homepage

3. Navigate to the **Integration center > Data converters** menu bar to create a data converter for the uplink data.

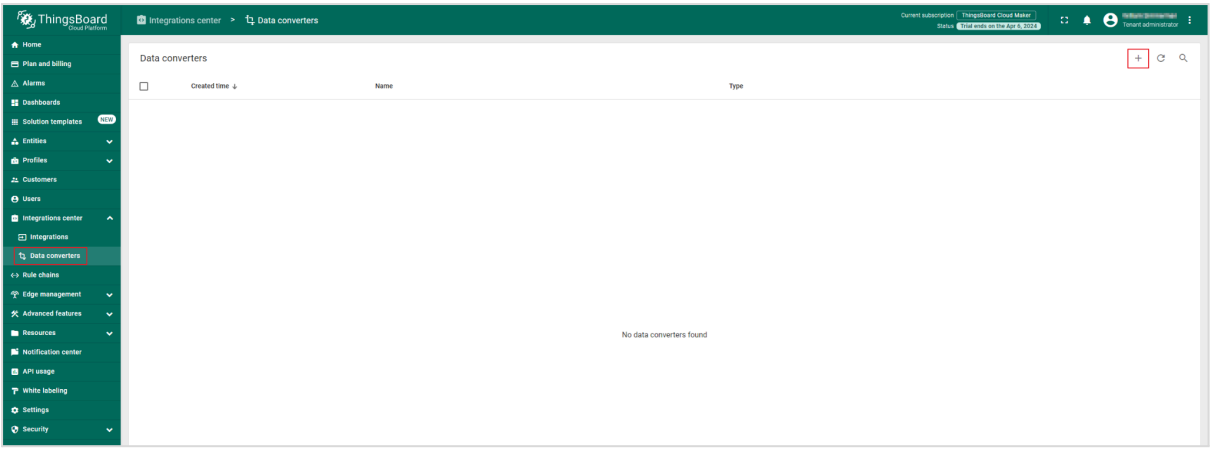

Figure 100：Create a data converter for the uplink

4. Click the **Add Data Converter** icon (+) and choose the **Create new converter** option.

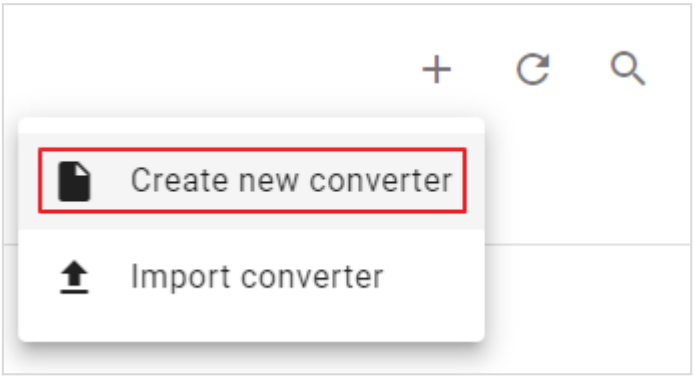

Figure 101：Select Create new converter

5. Enter the name of the decoder in the **Name** field (for example, *Uplink decoder*), leave the **Type** field as **Uplink**, and select the **JavaScript** option.

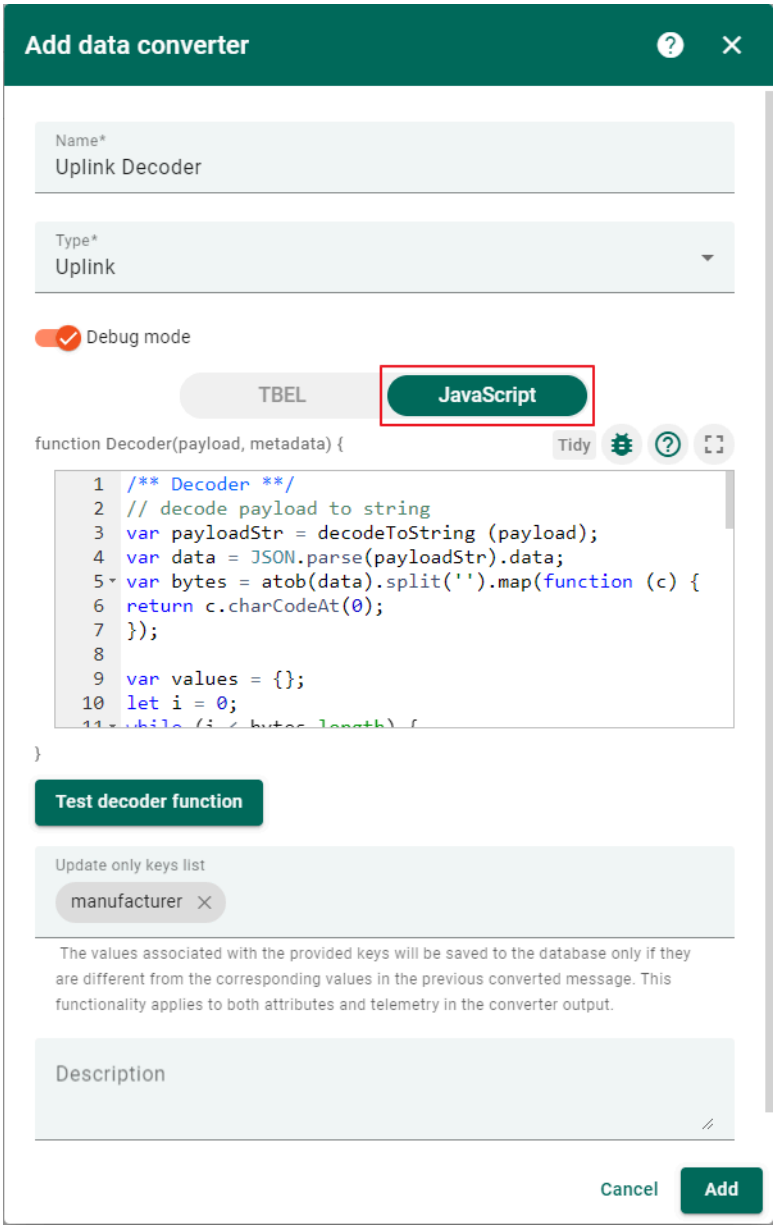

Figure 102：Add Data Converter

6. Edit the decoder code by copying the following code into the edit box. Click **Add** to include the uplink decoder.

```
/** Decoder **/
// decode payload to string
var payloadStr = decodeToString (payload);
var data = JSON.parse(payloadStr).data;
var bytes = atob(data).split('').map(function (c) {
return c.charCodeAt(0);
});
```

```
var values = {};
let i = 0;
while (i < bytes.length) {
var channelId = (bytes[i] << 8) | bytes[i + 1];
var value = (bytes[i + 2] << 8) | bytes[i + 3];
i += 4;
switch (channelId) {
case 0x0167:
values.temperature = value / 10.0;
break;
case 0x0270:
values.humidity = value / 10.0;
break;
case 0x03C0:
values.electric_conductivity = value / 1000;
break;
default:
break;
}
}
var integrationName = 'MQTT Integration';
var deviceName = 'dev_ac1f09fffe0903ec';
var result = {
deviceName: deviceName,
attributes: {
integrationName: metadata['integrationName'],
temperature: values.temperature,
humidity: values.humidity,
pressure: values.electric_conductivity,
},
};

/** Helper functions **/

function decodeToString(payload) {
```

```
return String.fromCharCode.apply(String, payload);
}

return result;
```

7. Navigate to the Integration **Center > Integrations** menu and click the **Add Integration** icon (+) to add the MQTT integration.

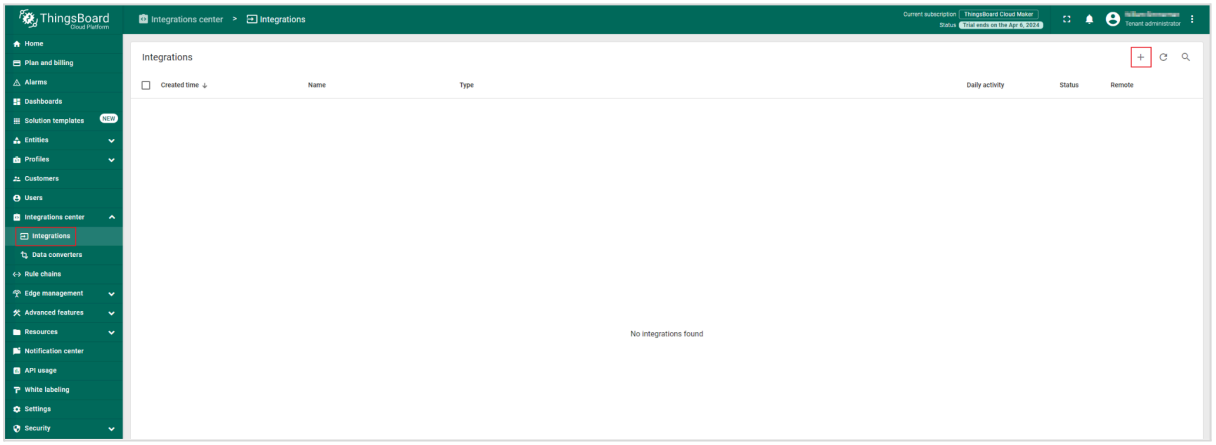

Figure 103：Add the MQTT integration

8. Enter the name of the integration (for example, *MQTT Integration*) in the **Name** field and select **MQTT** in the Type drop-down menu. Click **Next** to continue.

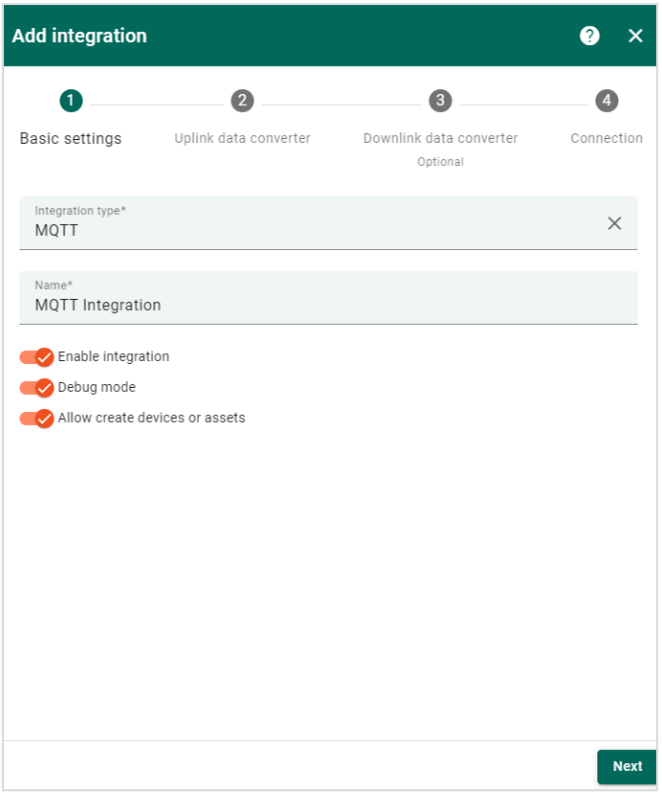

Figure 104：Fill in the integration name

9. In the **Uplink data converter** options, click Select **Existing** to choose the previously created decoder (Uplink Decoder), then click **Next.**

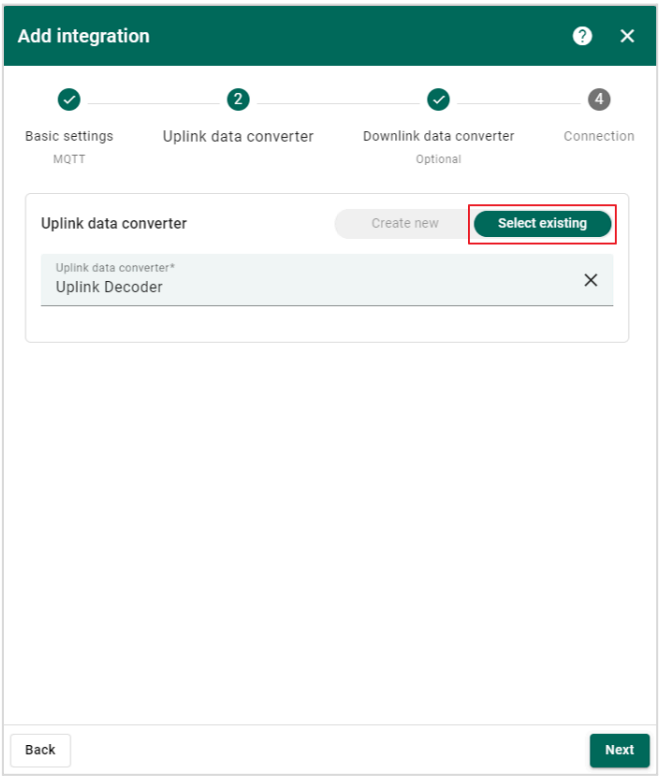

Figure 105: Select the created decoder

10. In the **Downlink data converter** interface, no configuration is necessary and just click **Skip** to bypass this setup.
11. Configure connection options. **Host** is the MQTT broker address used for messages. The Host of the external MQTT broker used in this example is *broker.hivemq.com*. You can choose to use other brokers with a different Host.
12. Enter the address *broker.hivemq.com* in the **Host** field, with the port number 1883. Click the **Add topic filter** button to configure the subscription topic.

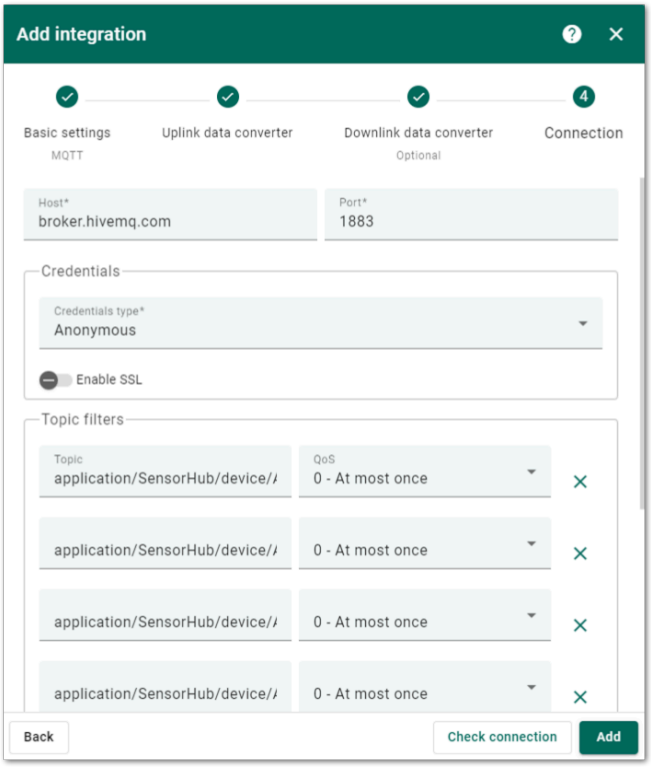

Figure 106: Configure the connection options

Configure the subscription topic

```
application/{{application_name}}/device/{{device_EUI}}/join
application/{{application_name}}/device/{{device_EUI}}/rx
application/{{application_name}}/device/{{device_EUI}}/tx
application/{{application_name}}/device/{{device_EUI}}/ack
application/{{application_name}}/device/{{device_EUI}}/status
```

- **application_name:** The application ID created in the gateway.
- **device_EUI:** The device EUI of the end device.

Modify the parameter values corresponding to the topics based on the actual application created and the device used.

NOTE

These values in the subscription topic must be all lowercase. For example, *application/1/device/0123456789abcdef/join*.

13. After configuring the details, click on **Add** to save and complete the settings.

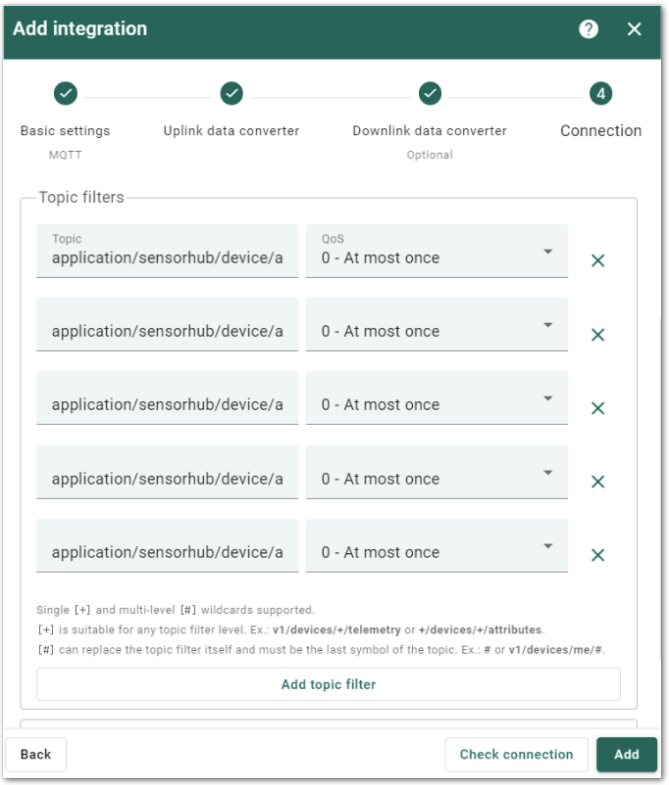

Figure 107: Configure and add the subscription topics

6.1.2.b. Configure the Gateway

This section will use the RAK7268 V2 WisGate Edge Lite 2 as an example.

1. To access the gateway web management platform, refer to the WisGateOS V2 user manual for details.

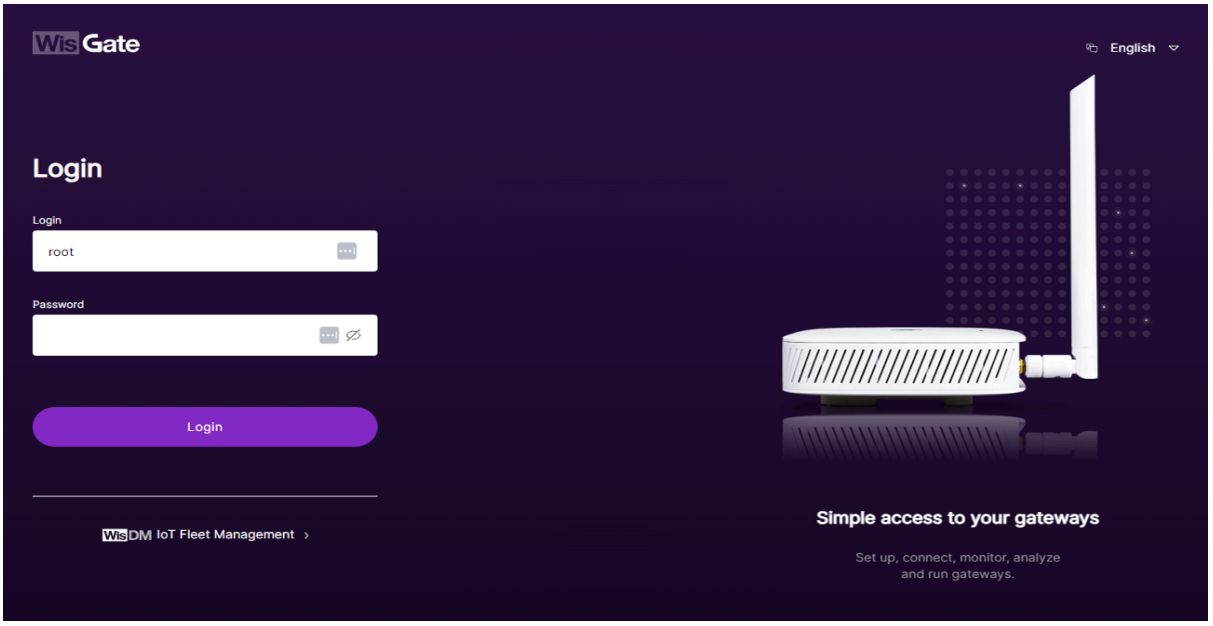

Figure 108: WisGate OS Web Management Platform

2. After successfully logging in, navigate to the **LoRa®** menu in the left navigation tree and set the **Work mode** of the gateway to **Built-in network server**.

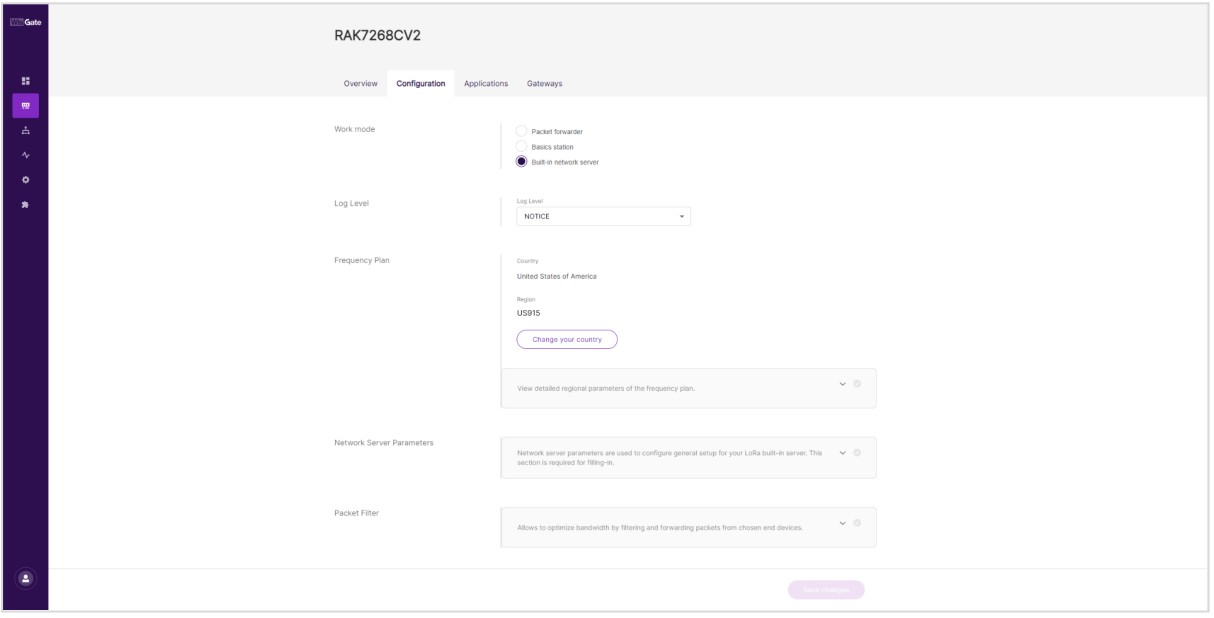

Figure 109: Set the Work mode

3. Once done with the setting, click the Applications tab, then the **Add application** button. You can also **click add one now** text link to add a new application.

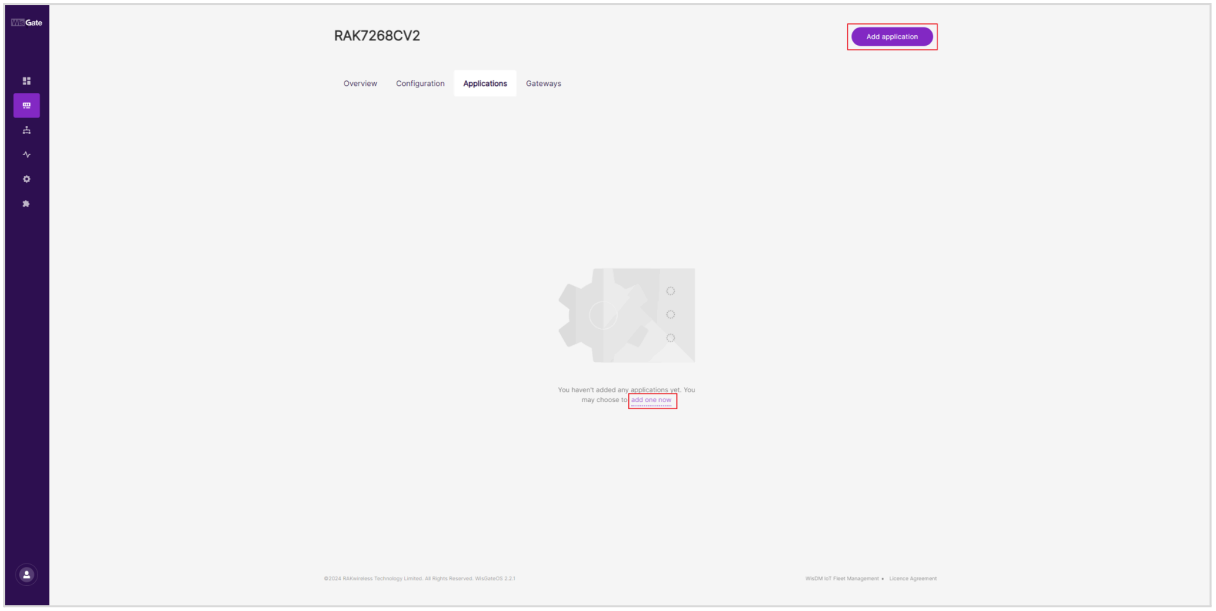

Figure 10: Applications tab

4. Configure the following information: **Application name**, **Application description**, and **Application Type**.

- **Unified Application Key:** Choose this option if all devices will use the same application key. Once selected, a field for the application key appears, where you can manually type in an application key or click the **Autogenerate** button to generate one.

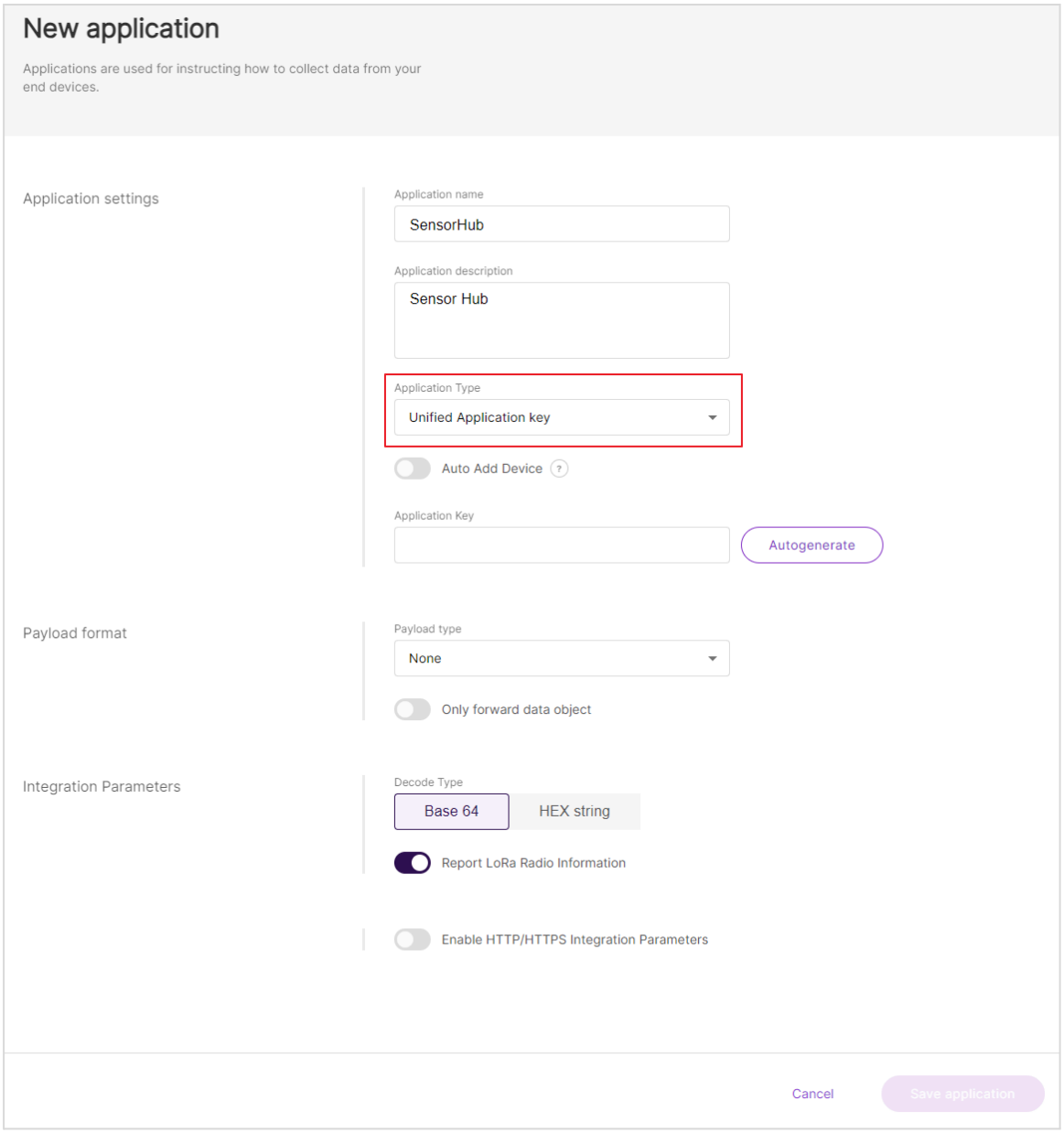

Figure 111: Configure the Application

- After enabling the Auto Add Device option, configure the **Application EUI option**. The value needs to be consistent with the node value. Once you have verified the application EUI and key, the device will be added automatically to the application.

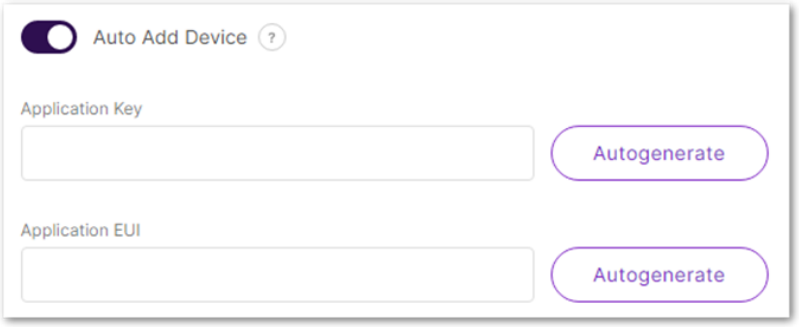

Figure 112: Auto Add Device

NOTE

You can obtain the values by either querying the end device or generating it automatically and modifying the corresponding value of the device synchronously.

5. Once you've completed the configuration, click on **Save Application** to add the new application.
6. In the application list, locate the newly created application and navigate to the **End devices** tab. If you've enabled the **Auto Add Device** function, the device will be automatically registered upon the addition request.

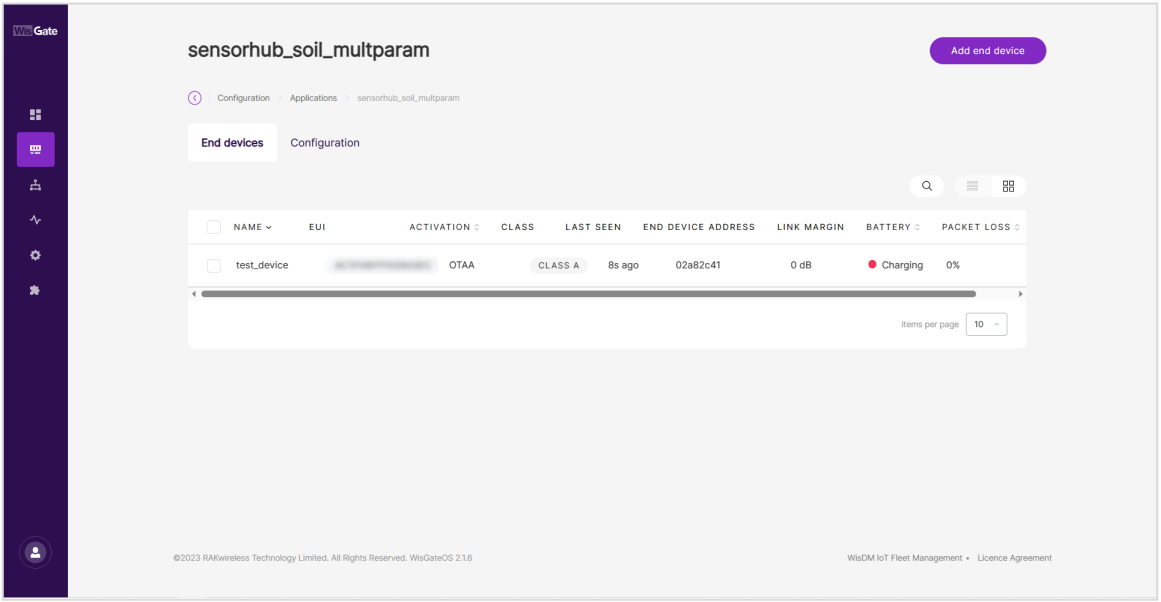

Figure 113: End devices tab

7. Click the **Add end device** button. In the **End device information** interface, fill in the following information:
   - **Activation Mode:** Select the activation mode of the device, OTAA or ABP.
     - Choosing the **ABP mode** will pop up two additional fields, **Application Session Key** and **Network Session Key**.
       In this example, use OTAA activation mode.
   - **End device (group) name:** Enter the name of the end device or the group it belongs to.
   - **End device description (optional):** A description of the end device.
   - **Class:** Select **Class A** for the device's operating mode.
   - **Frame Counter Width:** Keep the default value.
   - **LoRaWAN MAC Version:** The protocol version (v1.0.3) of the end device.
8. After completing, click the **Add End Devices** to proceed to the next step.

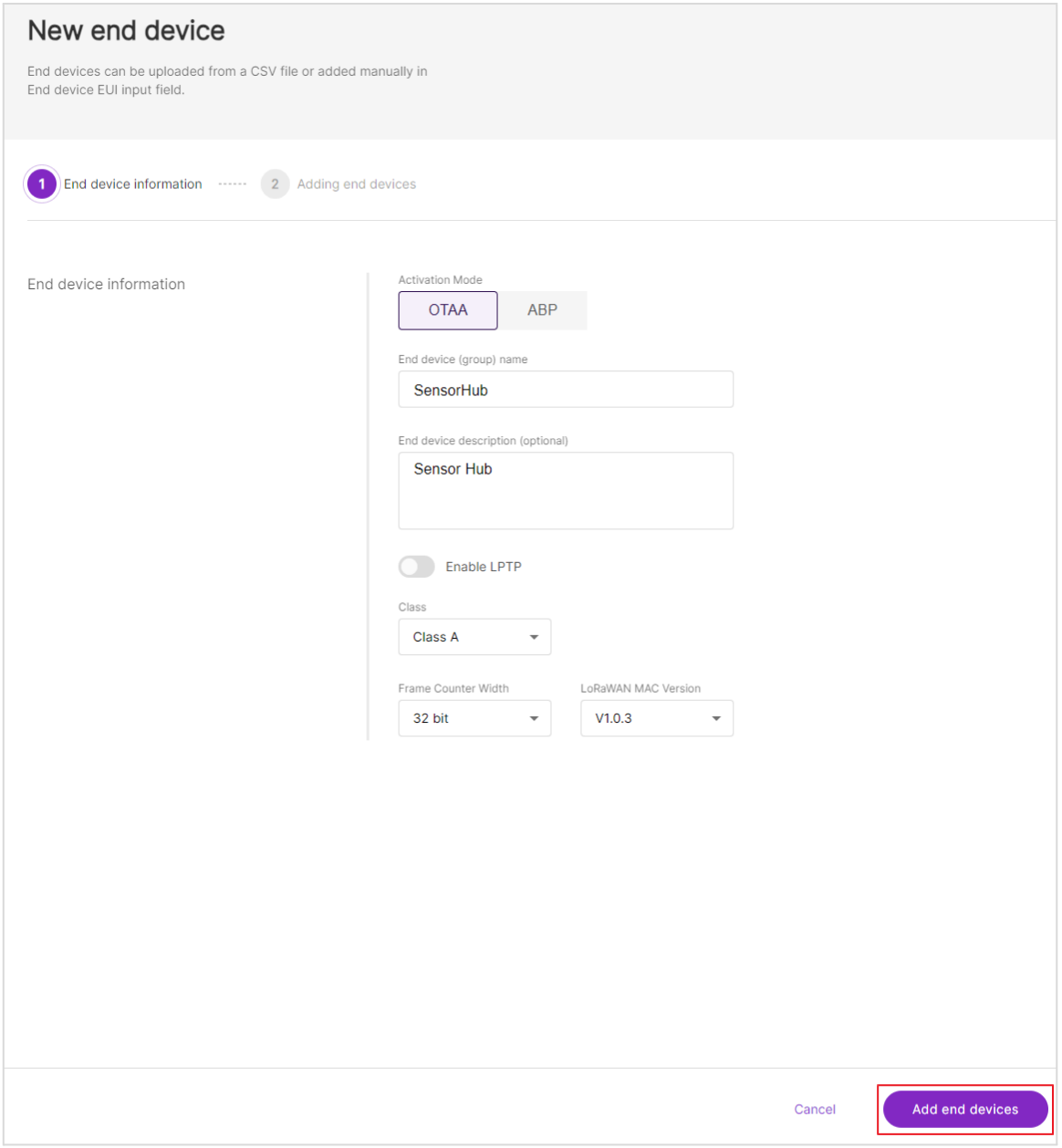

Figure 114: Add new end devices

9. In the **Adding End Dev**ices interface, enter the device EUI in the **End Device EUI (Main)** field and select the **Add to End Devices** list button. Then click **Add end devices** to complete adding the end device.

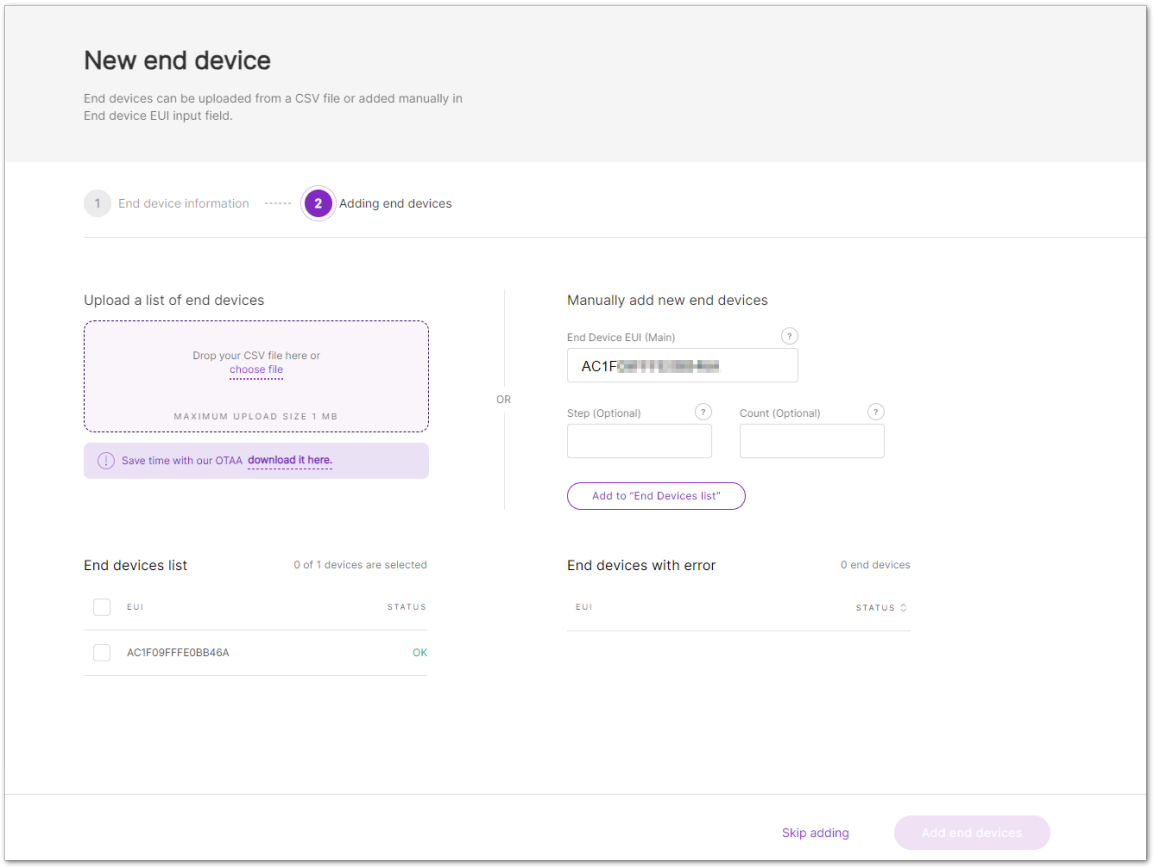

Figure 115: Add the device to the device list

NOTE

- The device EUI configured here must match the end device. You can either obtain it by querying the end device or entering one (1) EUI and synchronously updating the corresponding value of the end device.
- If the EUI is correct, the device will appear in the End devices list.
- If the EUI is incorrect, the device will be displayed in the End devices with an error section.

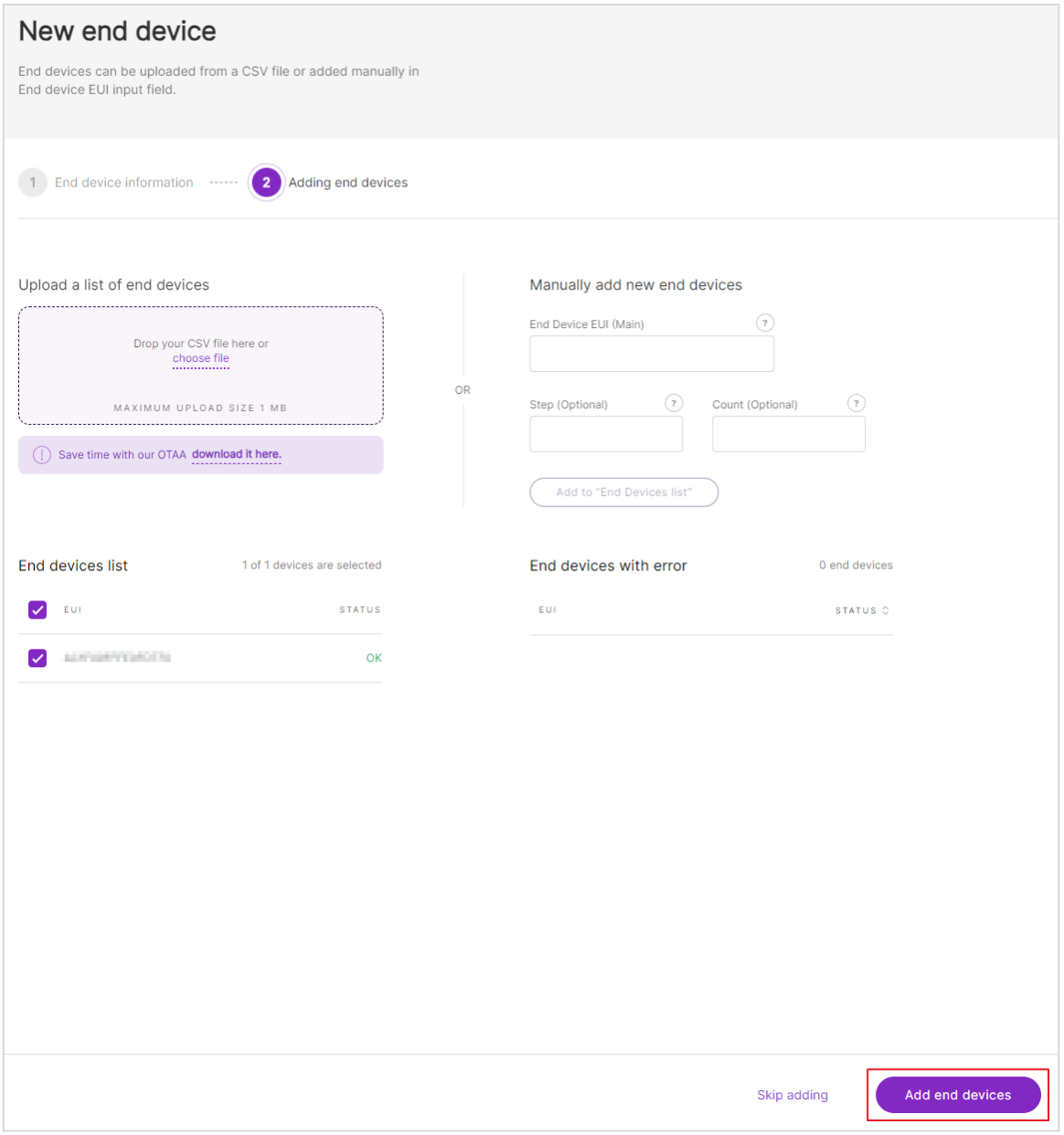

Figure 116: Complete the end device addition

10. Click the **Add** button to confirm adding the device.

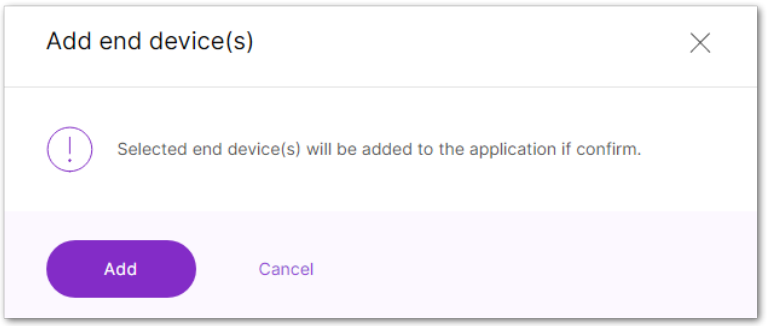

Figure 117 : Confirm to add the end device

11. When finished, enter the **End devices** interface, where you can see the created end device.

6.1.2.c. Connect the Sensor Hub to the Built-In Network Server

For specific configuration on how to connect Sensor Hub to the server, refer to **Sensor Hub Network Configuration > LoRaWAN Application Scenario**.

Once completed, the device will join the network. As shown in **Figure 118**, the end device Sensor Hub has successfully connected to the gateway's built-in server.

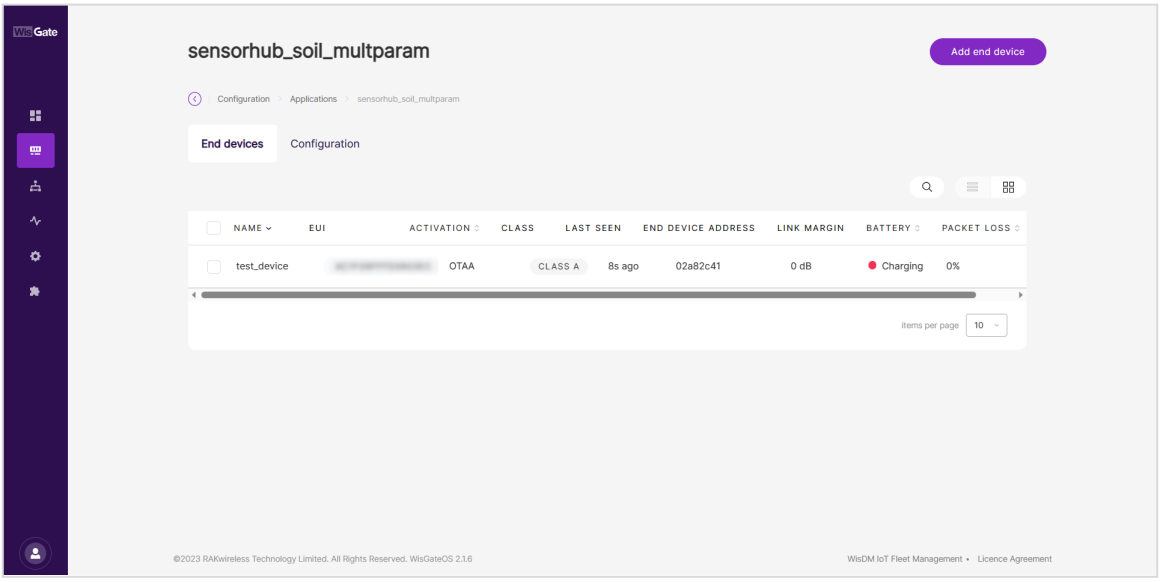

Figure 118: End device Sensor Hub has been connected

6.1.2.d. Configure the MQTT Integration

1. Navigate to the **LoRa®** > **Configuration** > **Integration Interface Parameters** section.
2. Toggle the **Enable Integration Interface** option and select **Generic MQTT** as the **Integration mode.**

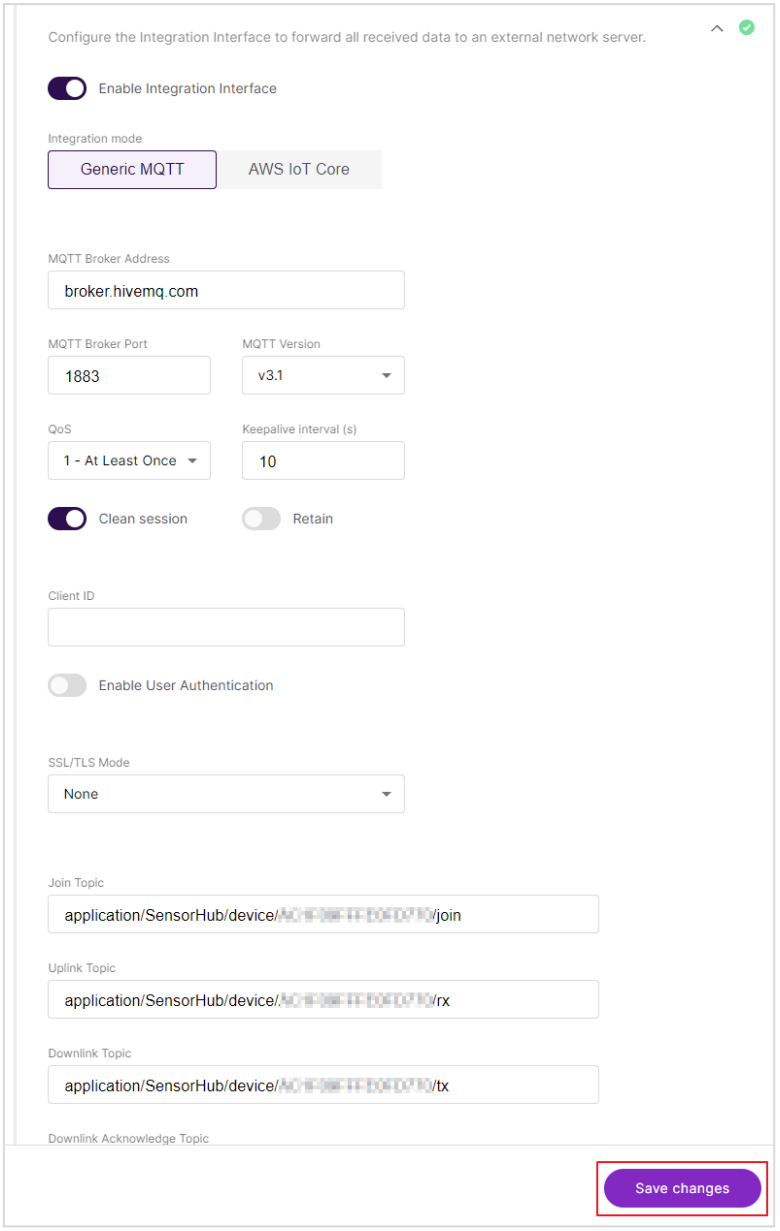

Figure 119: Set Up MQTT Integration

3. In the **MQTT Broker Address** option, enter `broker.hivemq.com`, then click **Save Changes**.
4. After the device has joined and has been sending uplink data, check the uplink data in **ThingsBoard > Integrations > Your Integration > Events**.

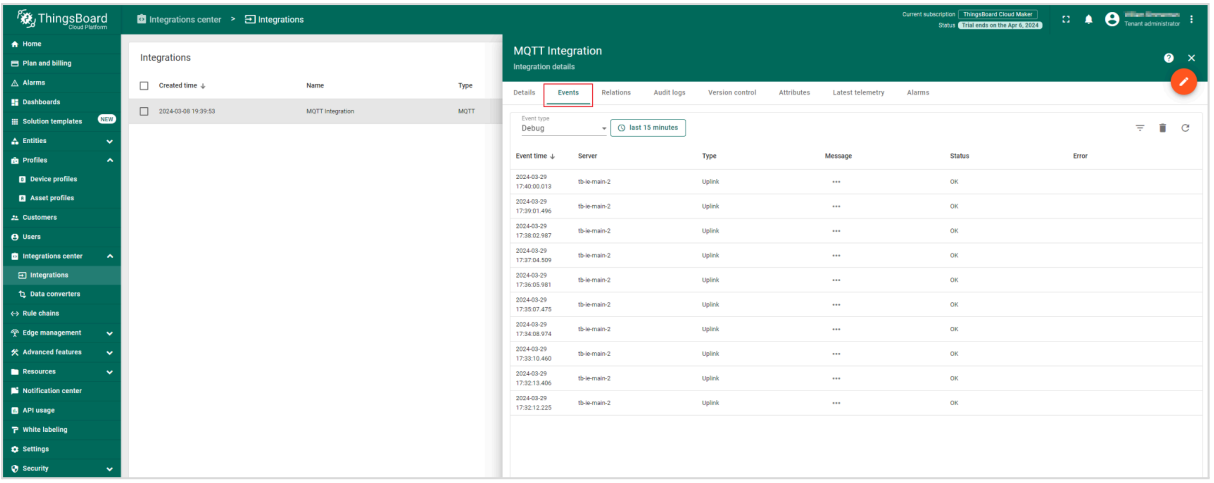

Figure 120: View the gateway uplink data

6.1.2.e. Visualize Data Through ThingsBoard

1. After creating the data converter, integrating, and obtaining some data in the **Event** tab, check the automatically created devices based on the decoder in the **Entities > Devices > Groups tab.**

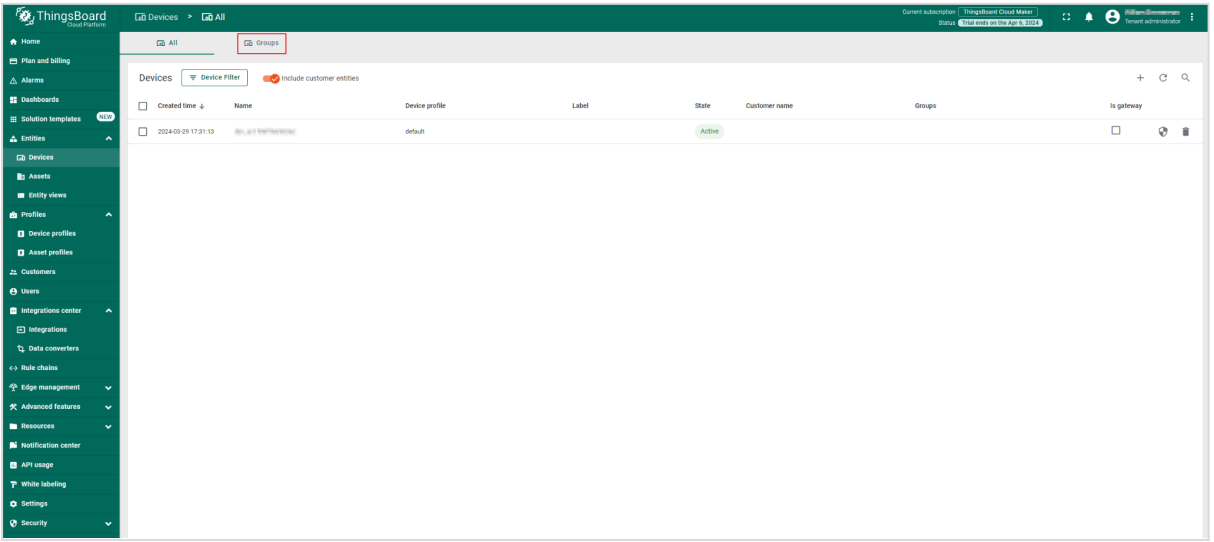

Figure 121: Check the device

2. Click the group named **All** in the **Device Groups** menu to automatically create a decoder device.

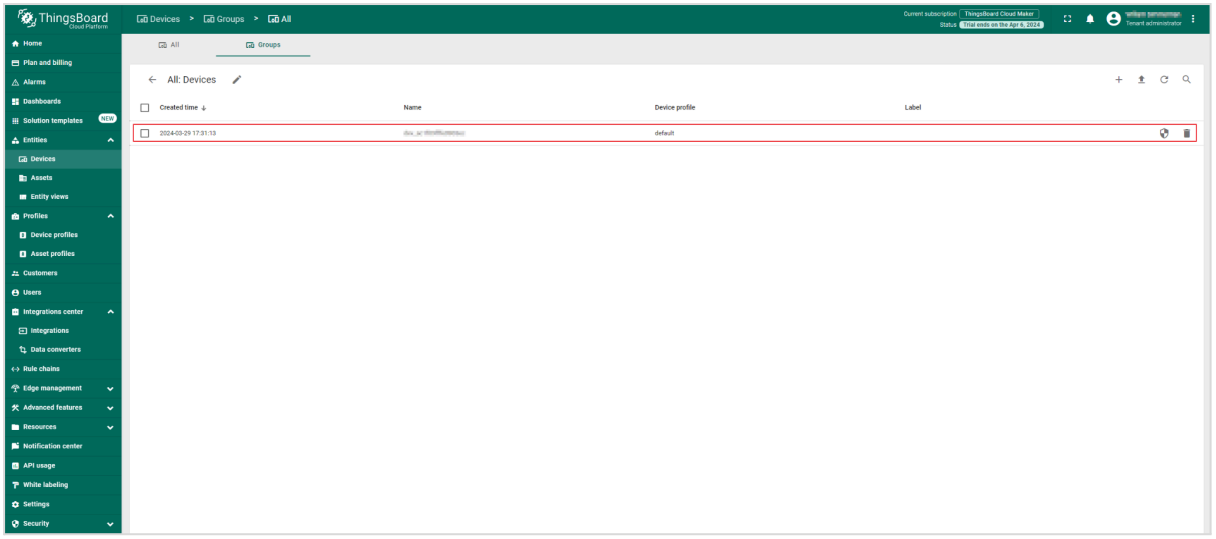

Figure 122: Automatically created decoder device

3. Click the device, navigate to the **Attributes** tab, and check on the node data.

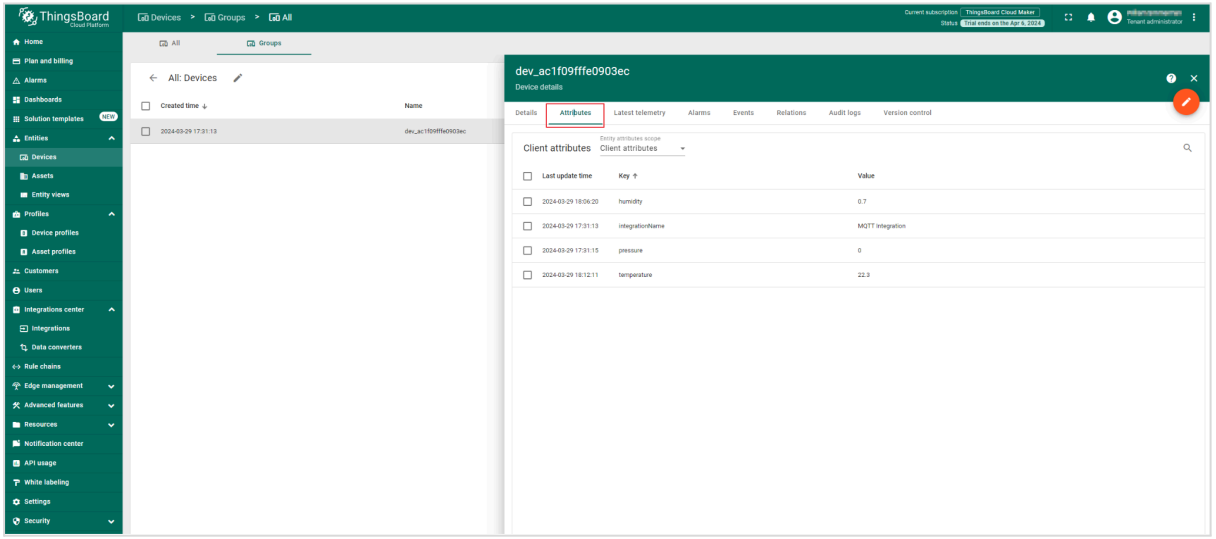

Figure 123: Data visualization

4. To visualize the data, simply select the values you wish to display, then click the **Show on widget** button.

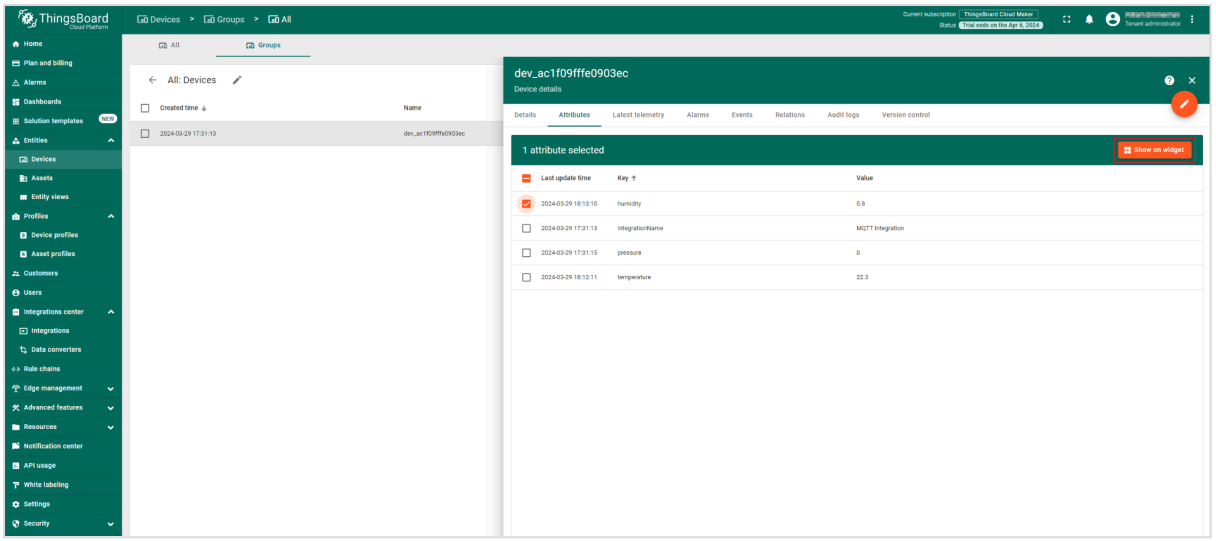

Figure 124: Select the value

5. On the next page, select the desired widget for the data from the **Current Bundle** drop-down menu. In this example, choose **Humidity**.

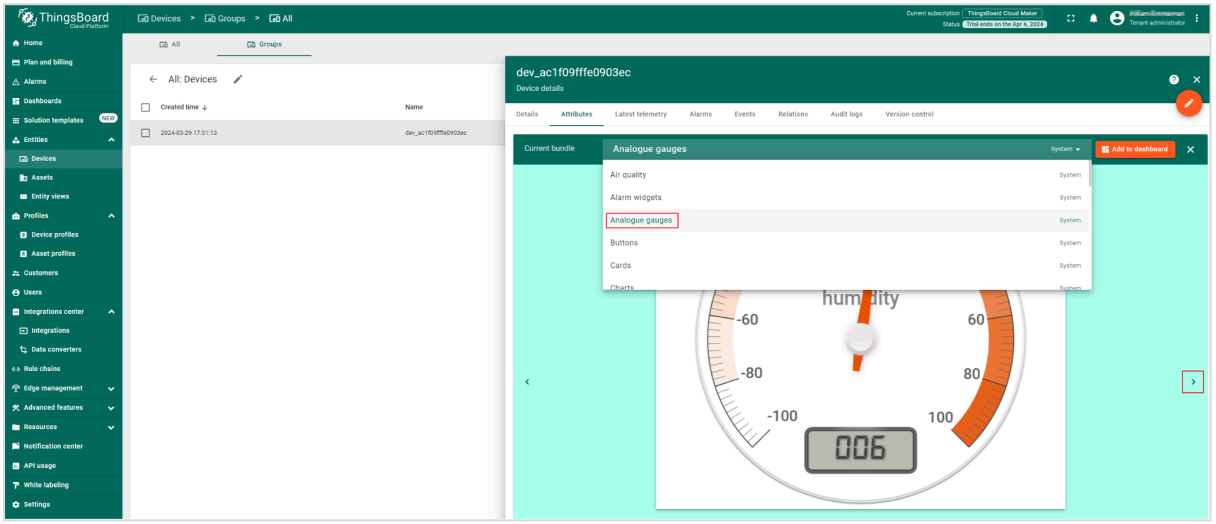

Figure 125: Select widget for data

6. After selecting the widget, click **Add to Dashboard** to proceed.

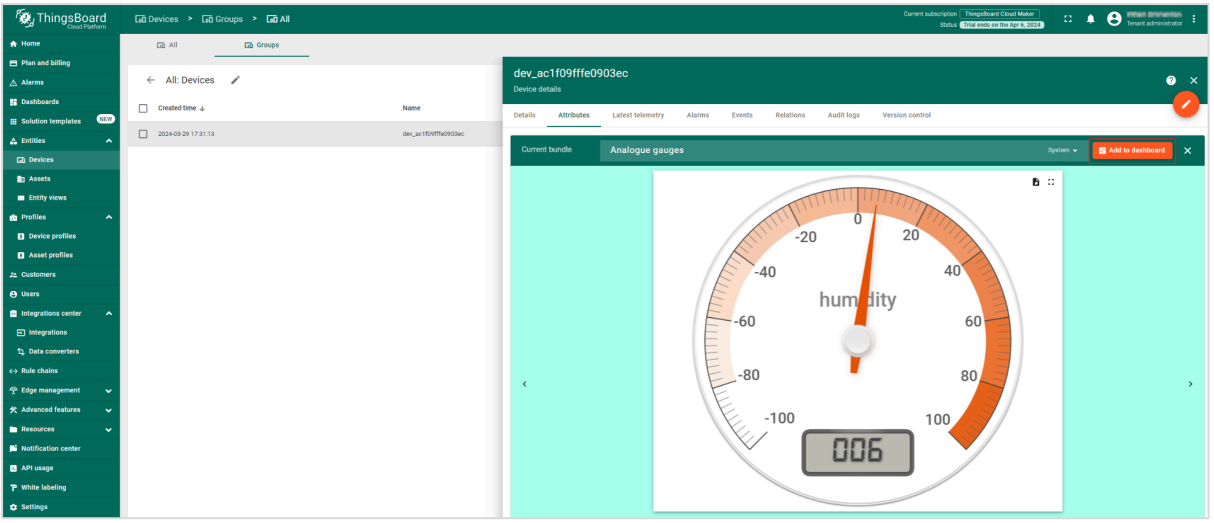

Figure 126: Selecting a widget

7. The **Add widget** to the dashboard window will appear. By default, there is no dashboard in the profile, so you need to select **Create a new dashboard** and enter a name for the dashboard in the **new dashboard title** field.
    - In this guide, name the dashboard ***sensorhub_soil_multparam***.

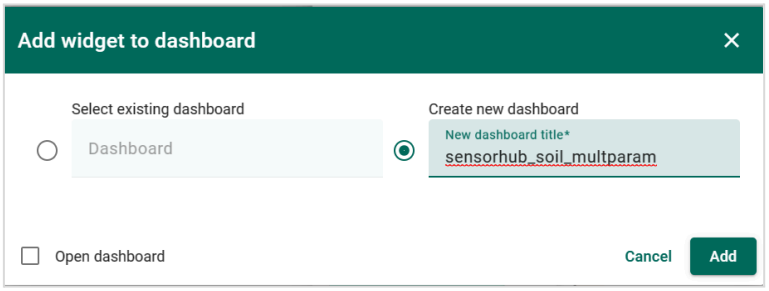

Figure 127: Enter the dashboard name

8. After setting the name of the dashboard, click the **Add** button to add more widgets. Alternatively, check the **Open dashboard** option to automatically open the created dashboard after adding the widget.

NOTE

If the **Open dashboard** option is not selected, you can still easily view the added widgets via **Dashboard groups** > **All** > **[Group Name]**.

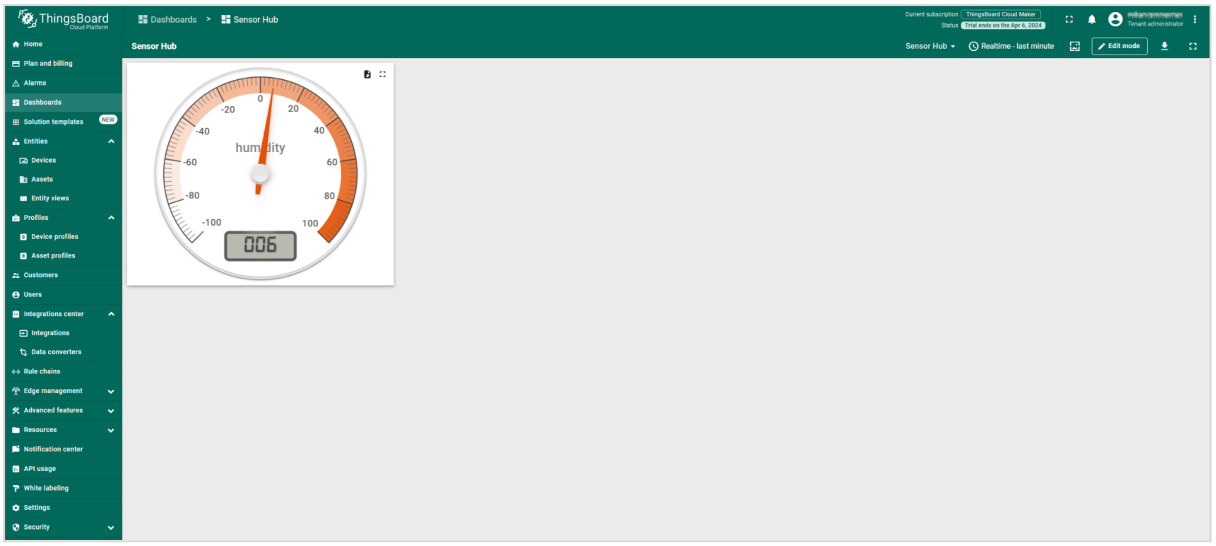

Figure 128: Dashboard created

9. You can visualize other data from the device following the same steps as above. The only difference is that when adding the widget, instead of **Creating a new dashboard**, click on **Select existing dashboard.**

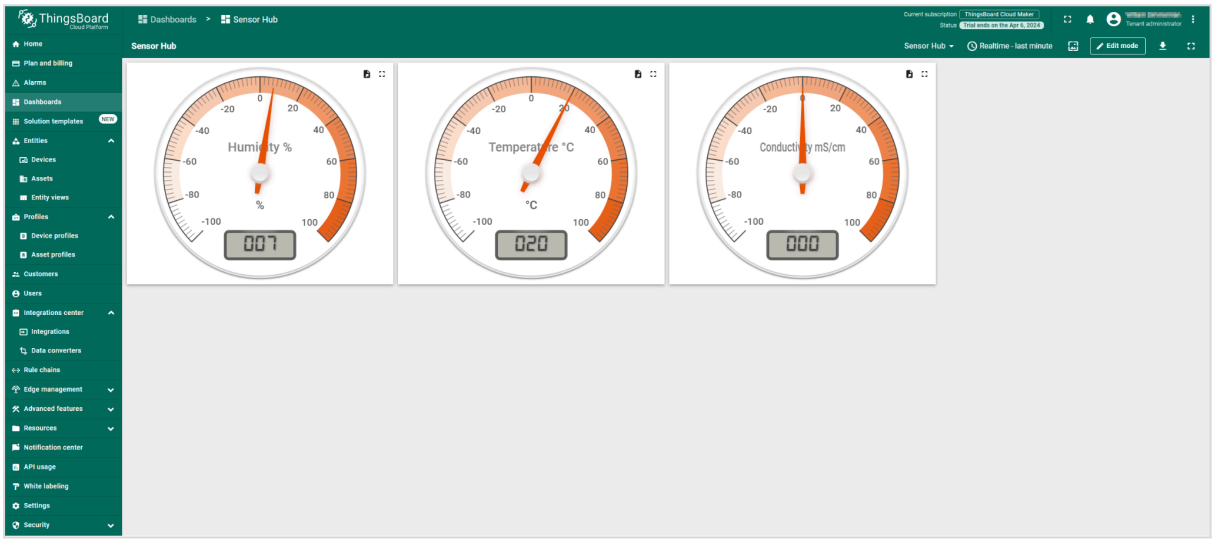

Figure 129: Adding widgets

6.2. NB-IoT/LTE CAT-M1 Application

6.2.1. Connect Sensor Hub to MQTT Server

In the **Network Server and Visualization Configuration** section, the server has been set as a public MQTT broker: `broker.hivemq.com`. You can also choose other brokers or servers, such as AWS IoT Core(optional), according to the actual usage scenario.

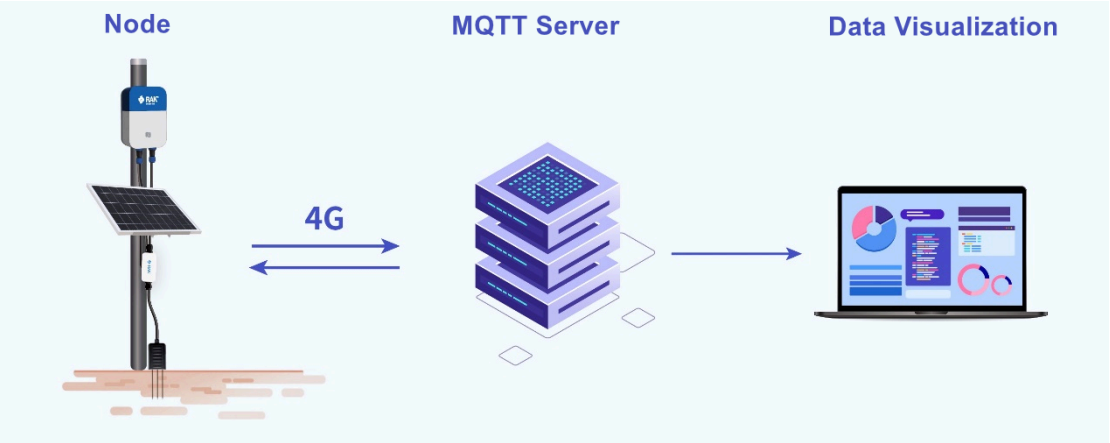

Figure 130: NB-IoT LTE CAT-M1 Application Scenario

6.2.2. Visualize Data Through Datacake

In this example, you will use Datacake as the visualization platform. Datacake is a versatile IoT platform designed to visualize data from nodes in a user-friendly manner.

To get started, you can create an account on the official website and log in.

6.2.2.a. Add SensorHub to Datacake

1. After logging in to your account, navigate to the **Devices** tab and click **+ Add Device** to proceed with adding the Sensor Hub end device.

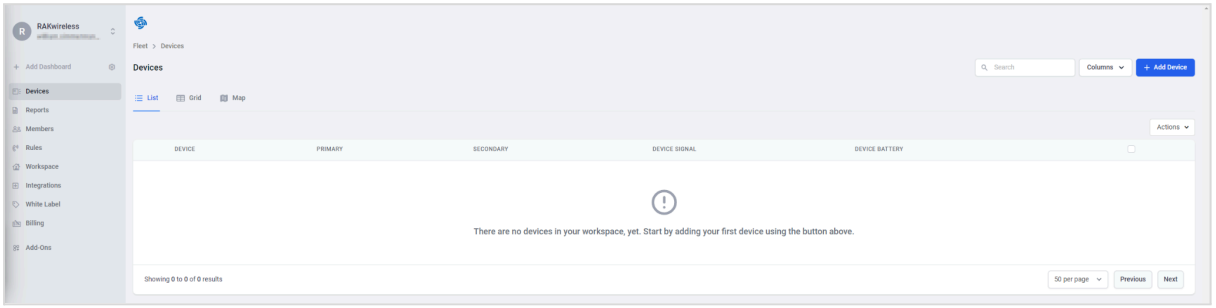

Figure 131: Add the end device, SensorHub

2. Select the **API** option and click **Next** to proceed.

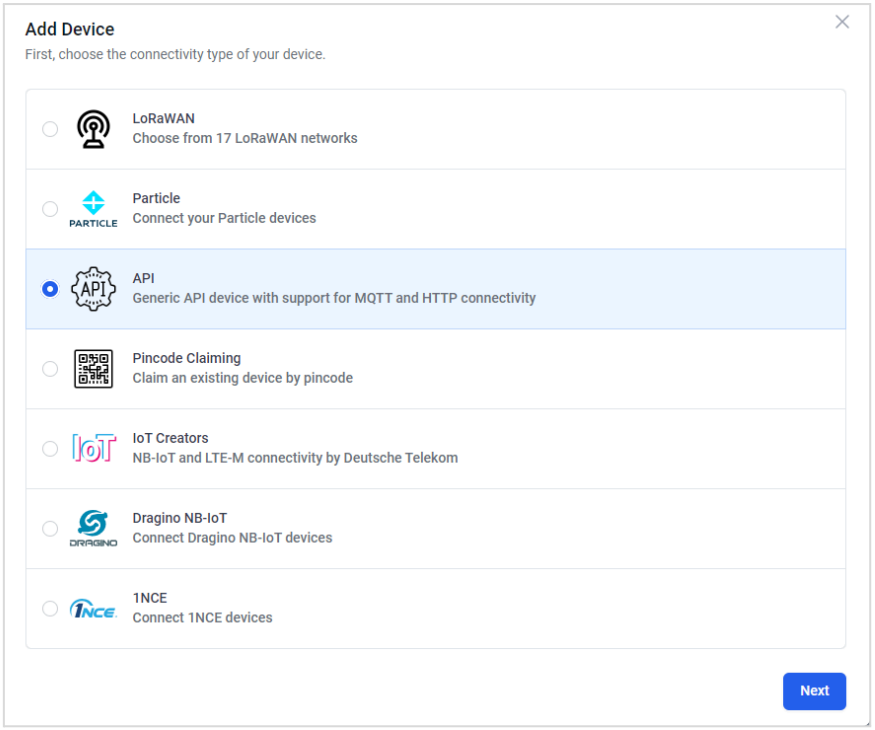

Figure 132: Select API

3. As the device is new and there's no ready-made template, choose **New Product** from the **Datacake Product** options. Enter the device name in the **Product Name** field, then click **Next** to proceed.

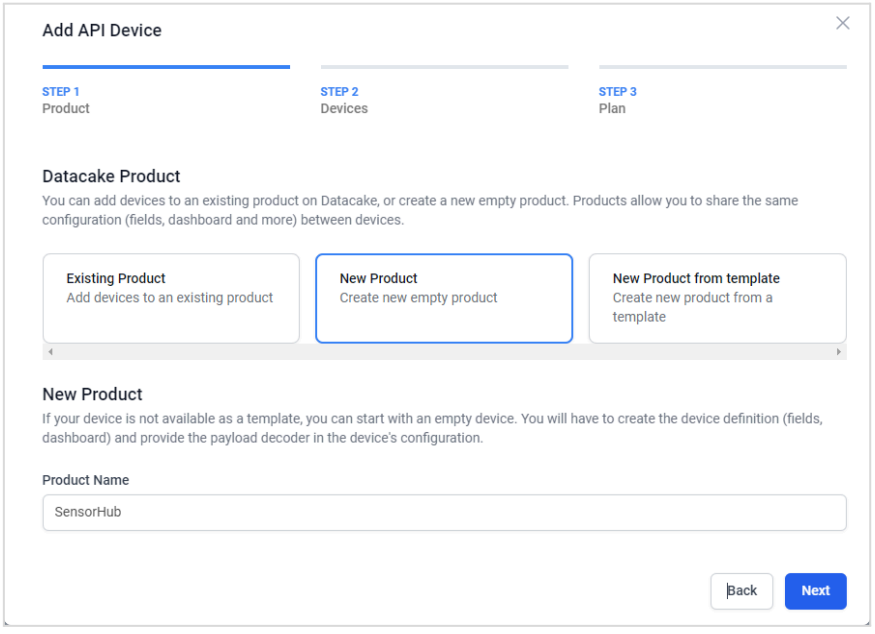

Figure 133: Select New Product

4. The **SERIAL NUMBER** field can be left blank. Datacake will randomly generate a serial number for the device, then click **Next**.

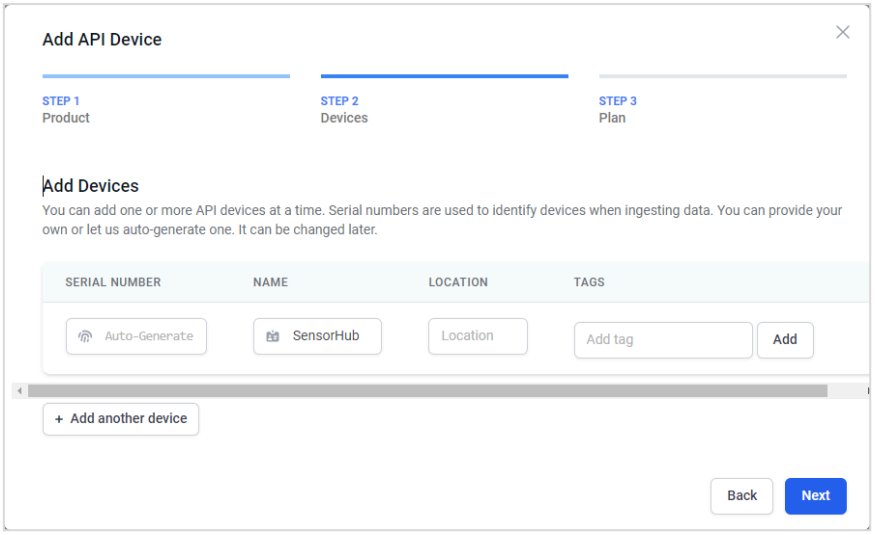

Figure 134: Keep the serial number

5. Select the preferred subscription plan, then click **Add 1 device**. For this example, choose **Free**.

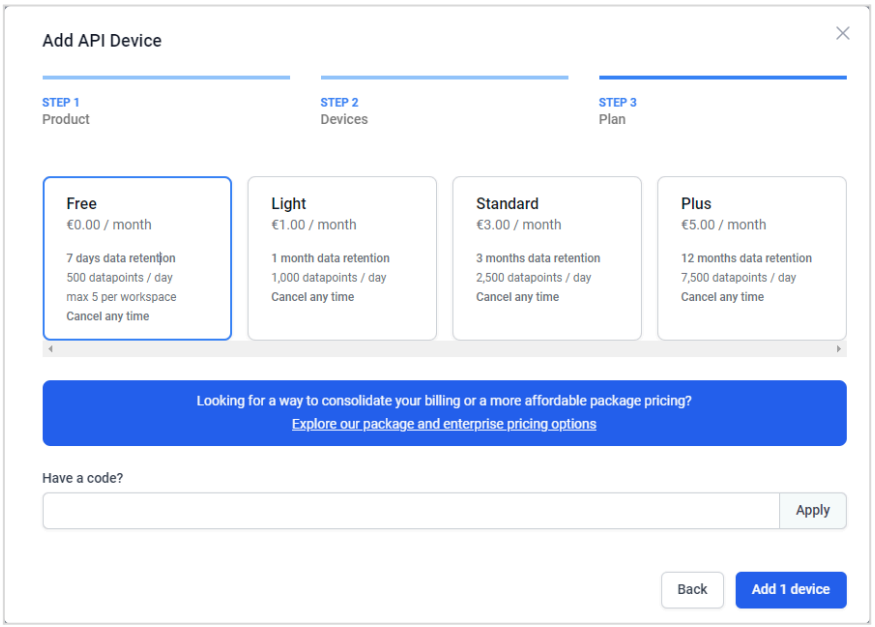

Figure 135: Select a subscription plan

6. The registered device can now be viewed on the **Devices** tab.

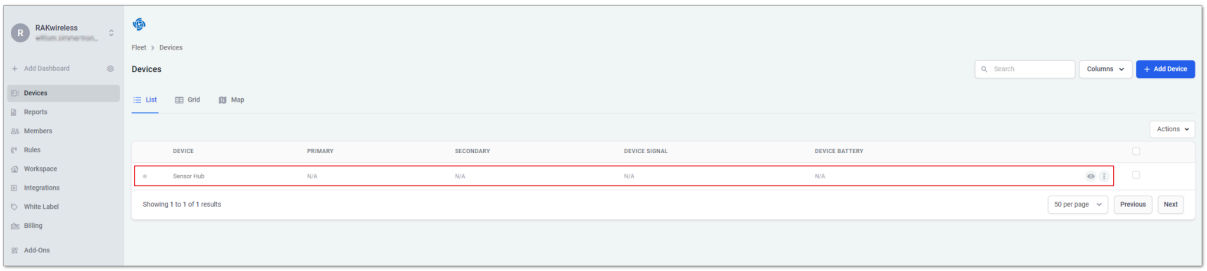

Figure 136: Registered device

6.2.2.b. MQTT Configuration

1. Click the name of the device you just created in the list to enter the interface, then select the **Configuration** tab.

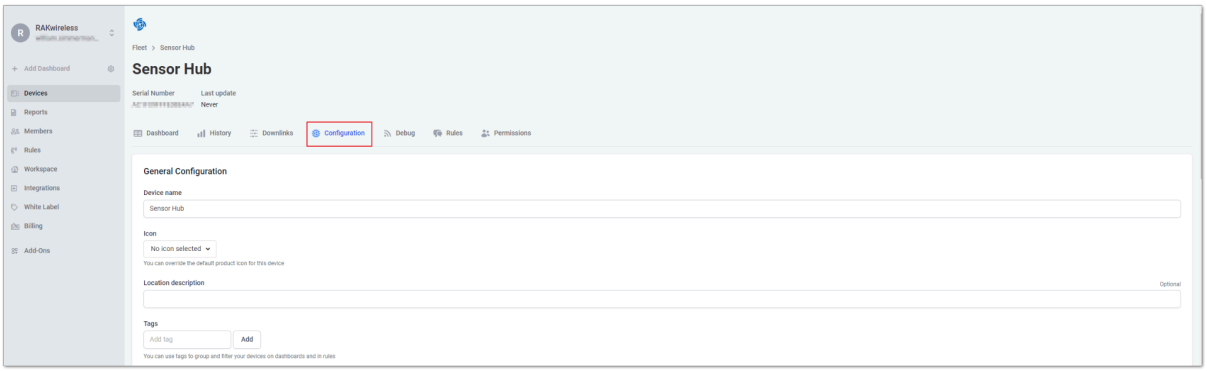

Figure 137: Configuration tab

2. Scroll down to the **API Configuration** option and copy the **Serial number**. Save it locally for later use.

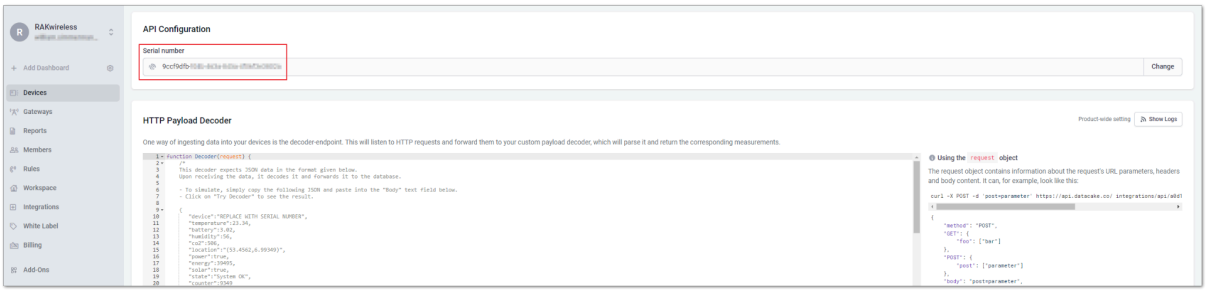

Figure 138: Copy the serial number

3. Continue scrolling down to the **MQTT Configuration** option and configure the external MQTT Broker.
4. Click **+Add new MQTT server** and configure the relevant parameters.

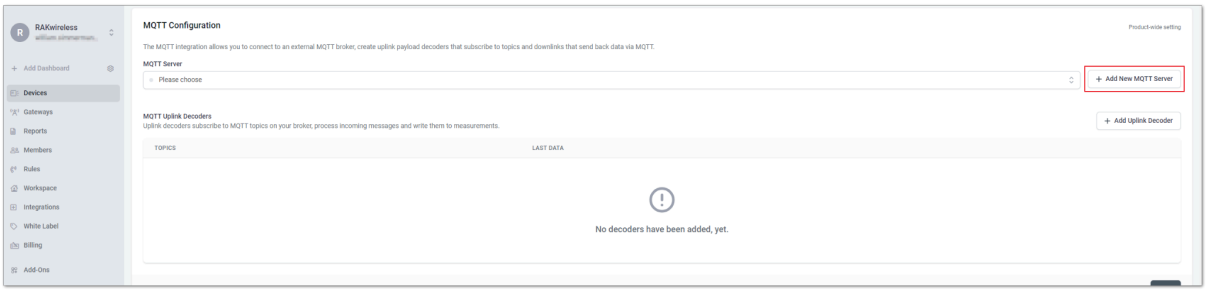

Figure 139: Configure the external MQTT Broker

5. Fill in the relevant information based on the actual server used, then click **Test Connection** to verify whether Datacake can successfully connect to the MQTT Broker. The information shown in **Figure 140** is just an example.

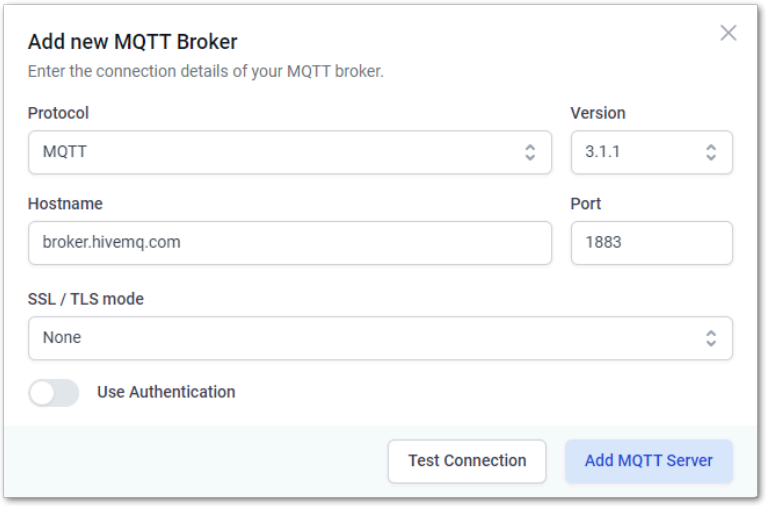

Figure 140: Configure the relevant parameters

NOTE

If SSL/TLS encryption and authentication are set for more secure communication, ensure to configure them accordingly in this section. However, for this example, you can skip this option.

6. If the connection is successful, you will see the message **Connection successful**. Click **Add MQTT Server** to complete the addition of the MQTT server.

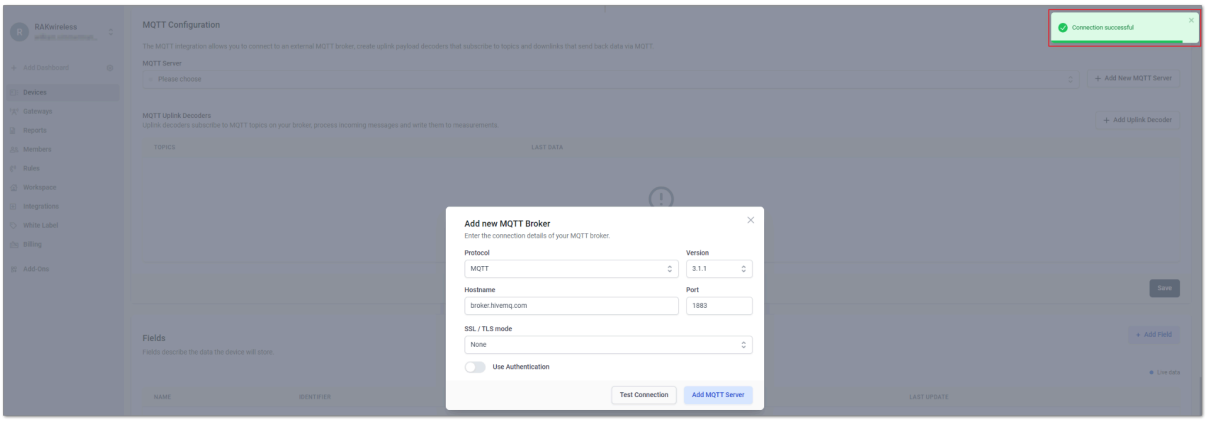

Figure 141: Configure the relevant parameters

7. After successfully adding the MQTT server, click on **+Add Uplink Decoder** to add a decoder.

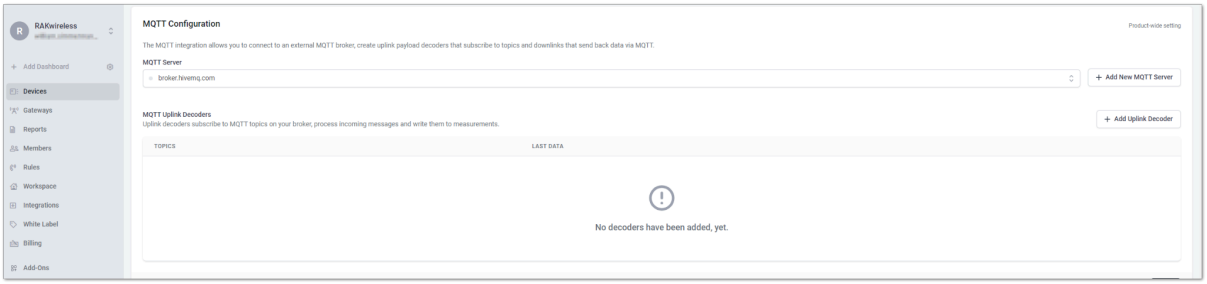

Figure 142: Add Uplink decoder

8. A new window will appear and fill in the fields according to your project.

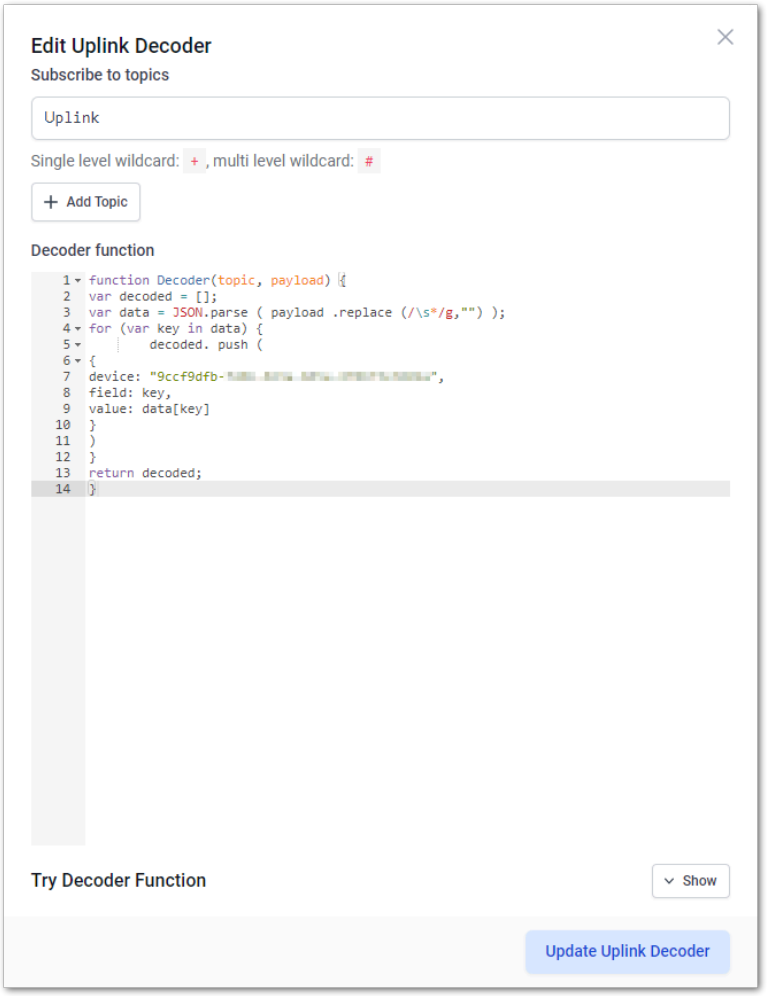

Figure 143: Add Decoder

- **Subscribe to topics**: Configure the subscription topics, that is, the value of the **Publish Topic** configured in the **Network Server and Visualization Configuration** section.
- **Decoder function:** Copy the following decoding code and paste it into the **Decoder function** space.

```
function Decoder(topic, payload) {
var decoded = [];
    var data = JSON.parse ( payload .replace (/\s*/g,"") );
    for (var key in data) {
        decoded. push (
            {
                device: "ddc5e012-30e4-4091-a050-b7318bacb209",
```

```
                field: key,
                value: data[key]
            }
        )
    }
    return decoded;
}
```

NOTE

In the above code, make sure that the parameter **serial_number** (device: "ddc5e012-30e4-4091-a050-b7318bacb209",) matches the serial number saved locally earlier.

9. Once completed, click **Add uplink decoder**.
10. In the **Fields** option, click **+Add Field** to show the monitoring values of the devices. Each device can create a certain number of fields, also known as a ***data point***.

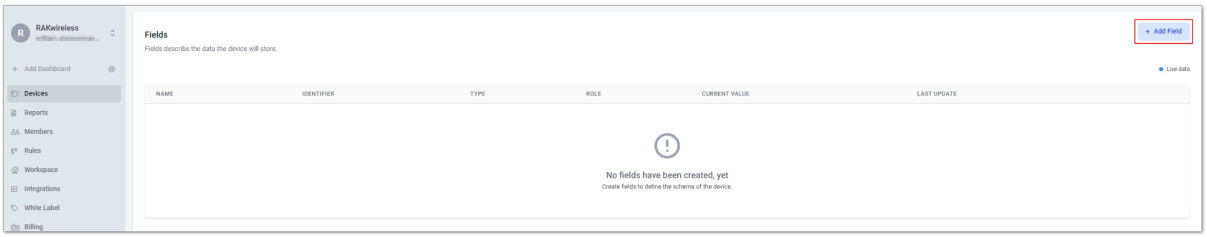

Figure 144: Add Field

11. Set the necessary parameters of the **Field**. For **Fields** with multiple data points, add them one by one. Once done, click **Add Field**.

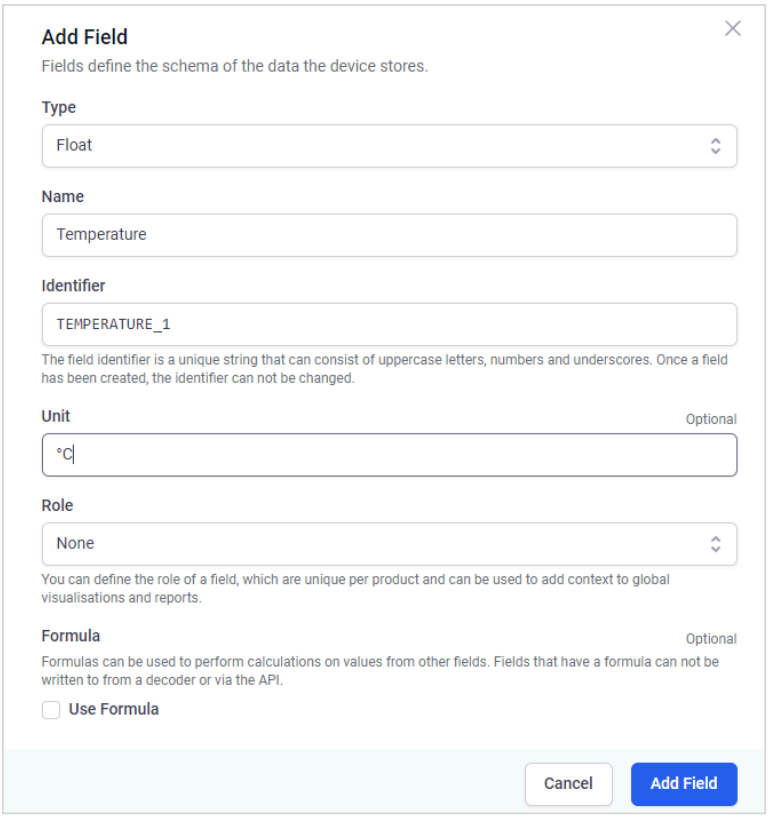

Figure 145: Set the related parameters of the field

NOTE

The **Identifier** field will be automatically filled based on the name.

12. Once the uplink data is received, the **Current value** column in the **Fields** list will display the current monitoring value from the sensor.

Figure 146: Added sensor monitoring values

6.2.2.c. Create a Dashboard to Visualize Data

Dashboards can be customized depending on the specific needs and preferences of a project. Follow the steps below to add widgets and visualize the data.

1. On the device details page, navigate to the **Dashboard** tab, then toggle on the edit mode switch .
2. Click on the **+ Add Widget** button to add a widget for visualizing data.

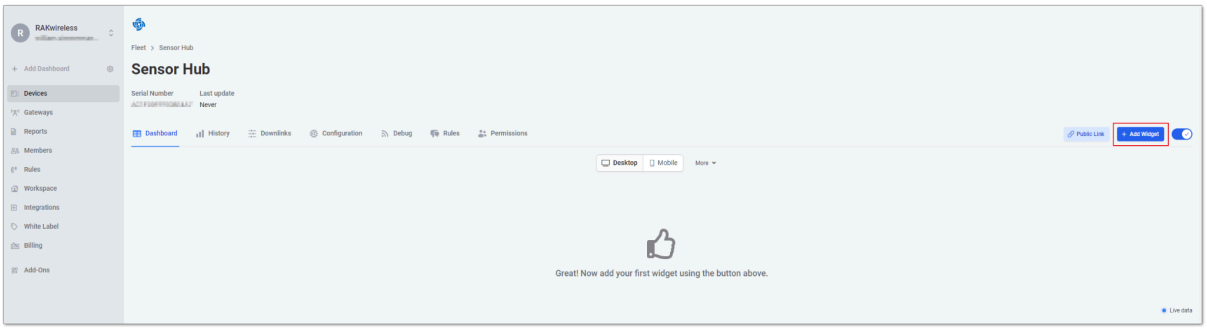

Figure 147: Open the edit mode

3. Choose what type of widgets you want to display. For this example, select **Value** to visualize temperature monitoring values.

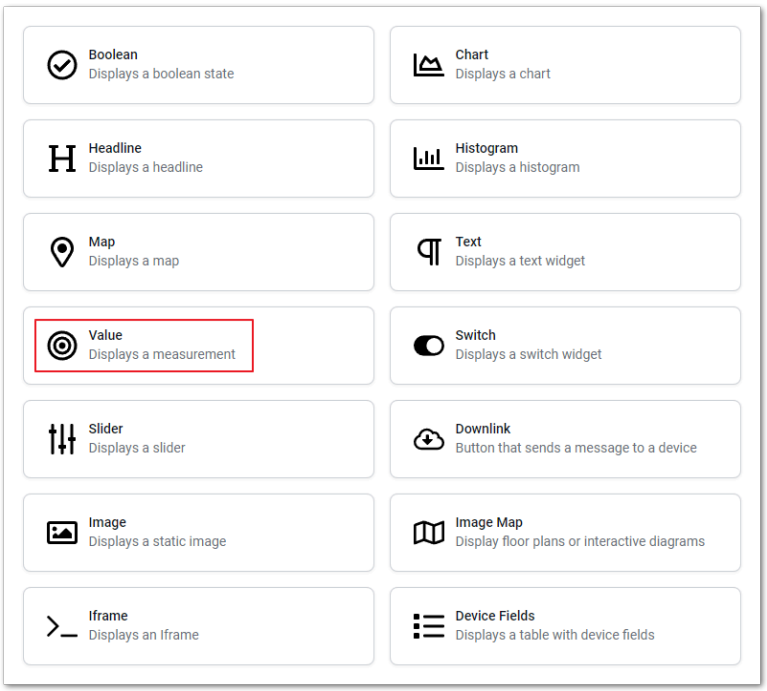

Figure 148: Select and add widgets for visualizing data

4. Go to the **Data** tab and choose the data you want to visualize from the available **Field** options. For this example, select **Temperature** and set the unit of the field to **° C**.

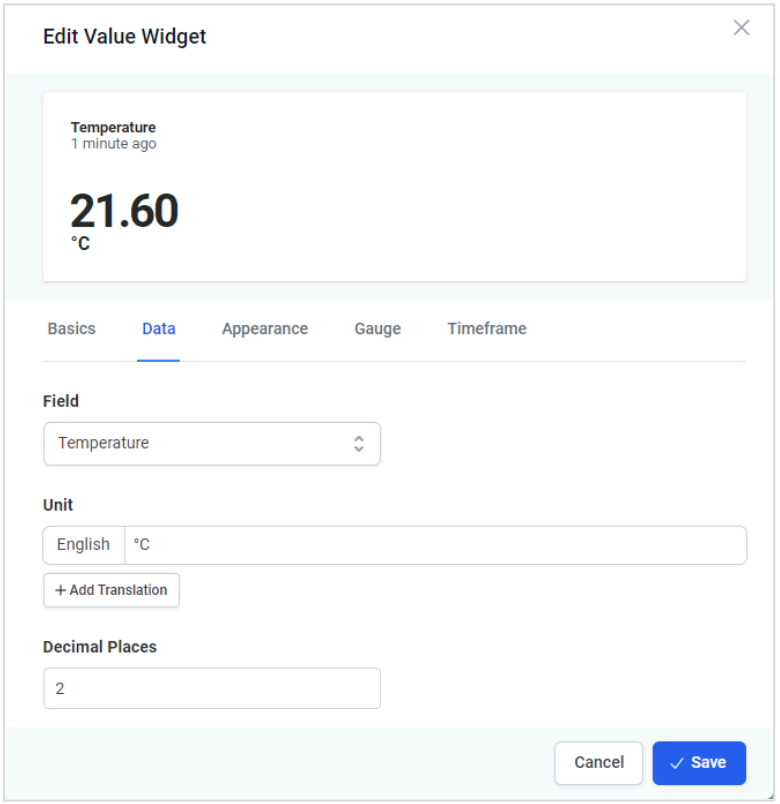

Figure 149: Select the visualization data field

5. After configuring the widget, click **Save**. You should now see the successfully created Temperature widget on the Dashboard interface.

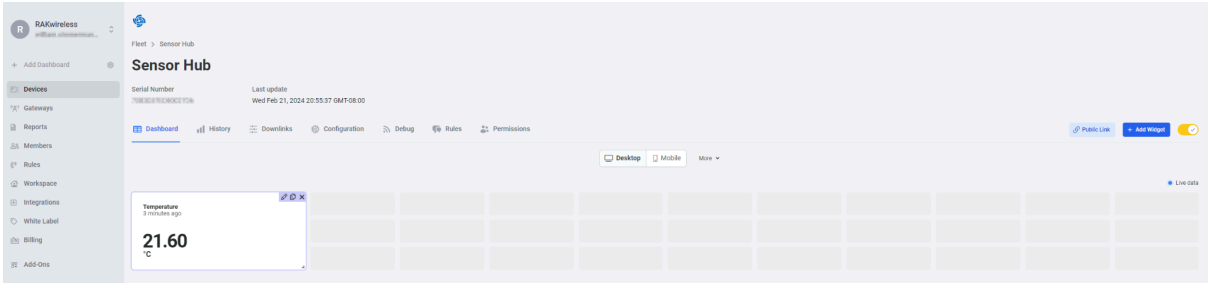

Figure 150: Successfully created Temperature widget

6. To add more parameter widgets, click the **+Add Widget** button again with the edit mode toggle switch **ON**, then repeat **Steps 3-5**.
7. Once done with the Dashboard configuration, turn off the **edit mode** switch to save the settings.

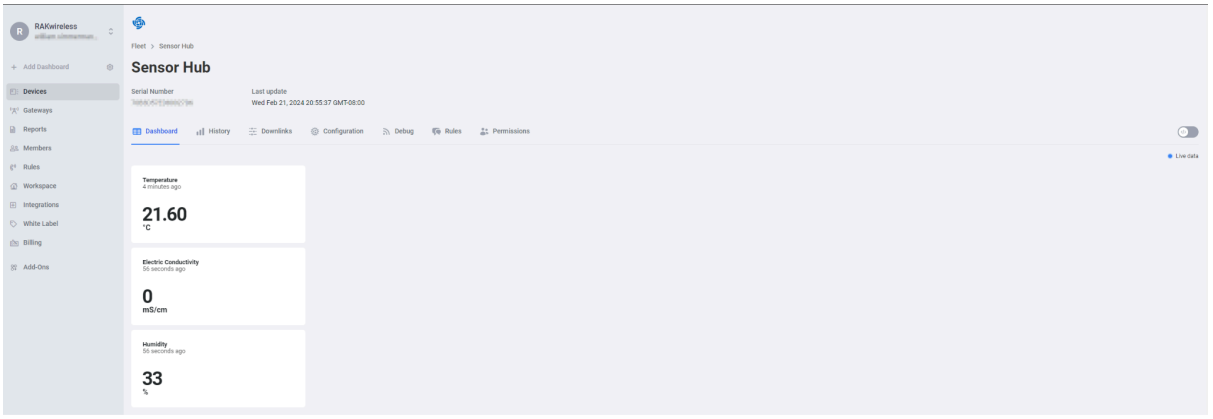

Figure 151: Weather Station data visualization