RAK3172 Module Quick Start Guide

This guide covers the following topics:

- TheThingsNetwork Guide - How to login, register new accounts and create new applications on TTN.
- RAK3172 TTN OTAA Guide - How to add OTAA device on TTN and what AT commands to use on RAK3172 OTAA activation.
- RAK3172 TTN ABP Guide - How to add ABP device on TTN and what AT commands to use on RAK3172 ABP activation.
- Chirpstack Guide - How to create new applications on Chirpstack.
- RAK3172 Chirpstack OTAA Guide - How to add OTAA device to Chirpstack and what AT commands to use on RAK3172 OTAA activation.
- RAK3172 Chirpstack ABP Guide - How to add ABP device on Chirpstack and what AT commands to use on RAK3172 ABP activation.
- LoRa P2P - Point to point communication between two RAK3172 modules.
- Updating RAK3172-Module FW - Procedures on how to update RAK3172 module firmware.

Prerequisites

What Do You Need?

Before going through the steps in the installation guide of the RAK3172 WisDuo LPWAN Module, make sure to prepare the necessary items listed below:

Hardware Tools

1. RAK3172 WisDuo LPWAN Module
2. Computer
3. USB to UART TTL adapter

Software Tools

1. RAK Serial Port Tool

List of Acronyms

Acronym	Definition
DFU	Device Firmware Upgrade
JTAG	Joint Test Action Group
LoRa	Long Range
OTAA	Over-The-Air-Activation
ABP	Activation-By-Personalization (ABP)
TTN	The Things Network
DEVEUI	Device EUI (Extended Unique Identification)
APPEUI	Application EUI (Extended Unique Identification)
APPKEY	Application Key
DEVADDR	Device Address
NWKSKEY	Network Session Key
APPSKEY	Application Session Key
P2P	Point-to-Point

Product Configuration

Interfacing with RAK3172

RAK3172 module can be configured using AT commands via the UART interface. You need a USB to UART TTL adapter to connect the RAK3172 to your computer's USB port and a serial terminal tool. It is highly recommended to use the RAK Serial Port Tool so you can easily send AT commands and view the replies from the console output.

Connect to the RAK3172

1. Connect the RAK3172 to the serial port of a general-purpose computer (USB port) using a USB to UART TTL adapter like RAKDAP1 , as shown in Figure 1.

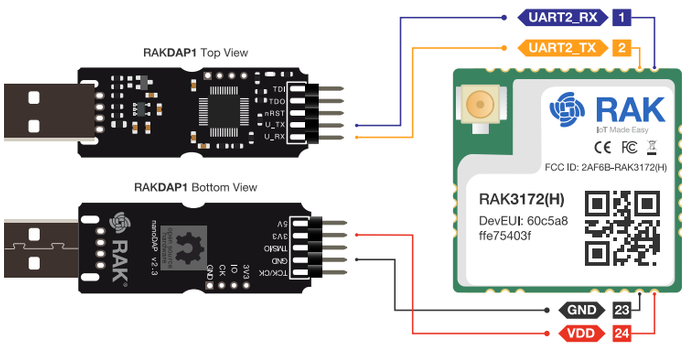

Figure 1: RAK3172 Module Connection

2. Any serial communication tool can be used; but, it is recommended to use the RAK Serial Port Tool .

3. Configure the serial communication tool by selecting the proper port detected by the computer and configure the link as follows:

- Baud Rate: **9600 baud**
- Data Bits: **8 bits**
- Stop Bits: **1 stop bit**
- Parity: **NONE**

Configuring RAK3172

To enable the RAK3172 module as a LoRa P2P module or a LoRaWAN end-device, the module must be configured and parameters must be set by sending AT commands.

The first step is to connect the RAK3172 module to the USB-UART converter computer as described in the previous section. Using a serial communication tool, you can now send commands to the RAK3172. For example, sending `AT` will display `OK`. For the details of all supported AT commands, refer to AT Commands for RAK3172.

Connecting to The Things Network (TTN)

In this section, a quick tutorial guide will show how to connect the RAK3172 module to the TTN platform.

> 📝 **NOTE:**
>
> In this guide, you need to have a working gateway that is connected to TTN or you have to be within coverage of a TTN community network.

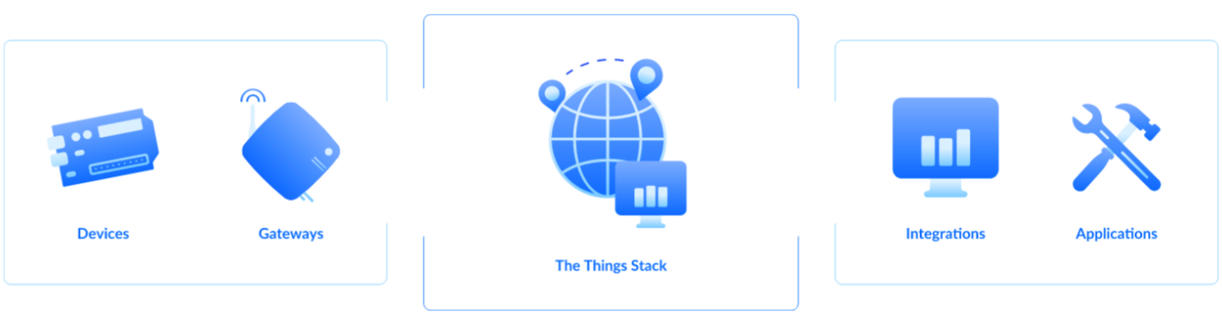

Figure 2: RAK3172 EVB in the context of the TTN

As shown in Figure 2, The Things Stack (TTN V3) is an open-source LoRaWAN Network Server suitable for global, geo-distributed public and private deployments as well as for small, local networks. The architecture follows the LoRaWAN Network Reference Model for standards compliancy and interoperability. This project is actively maintained by The Things Industries .

LoRaWAN is a protocol for low-power wide-area networks. It allows for large scale Internet of Things deployments where low-powered devices efficiently communicate with Internet-connected applications over long-range wireless connections.

The RAK3172 WisDuo module can be part of this ecosystem as a device, and the objective of this section is to demonstrate how simple it is to send data to The Things Stack using the LoRaWAN protocol. To achieve this, the RAK3172 WisDuo module must be located inside the coverage of a LoRaWAN gateway connected to The Things Stack server.

Registration to TTN and Creating LoRaWAN Applications

The first step is to go to The Things Network platform and select a cluster as shown on Figure 3.

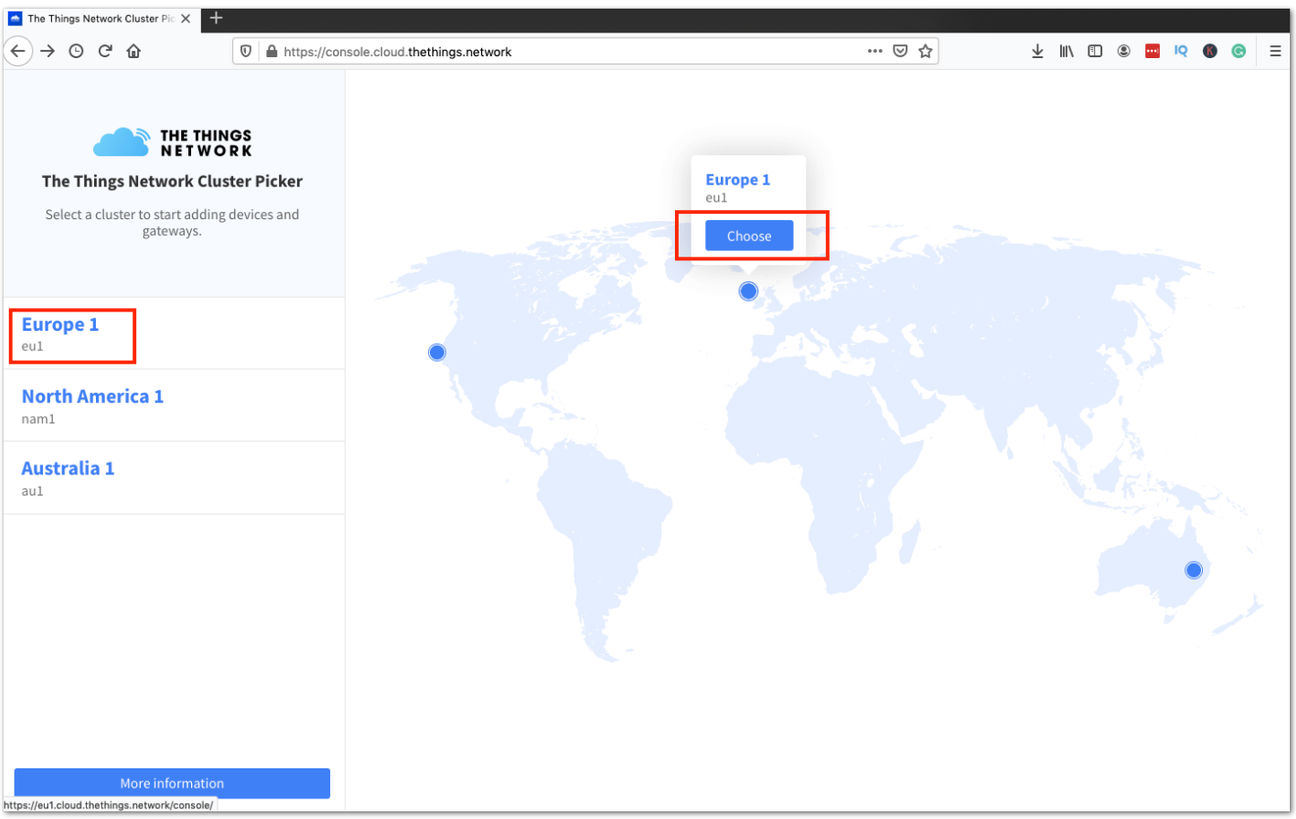

Figure 3: Selecting Cluster in TTN V3

You can use the same login credentials on the TTN V2 if you have one. If you have no account yet, you need to create one.

To register as a new user to TTN, click on **Login with The Things ID** then select **register** on the next page as shown on figures 4 and 5.

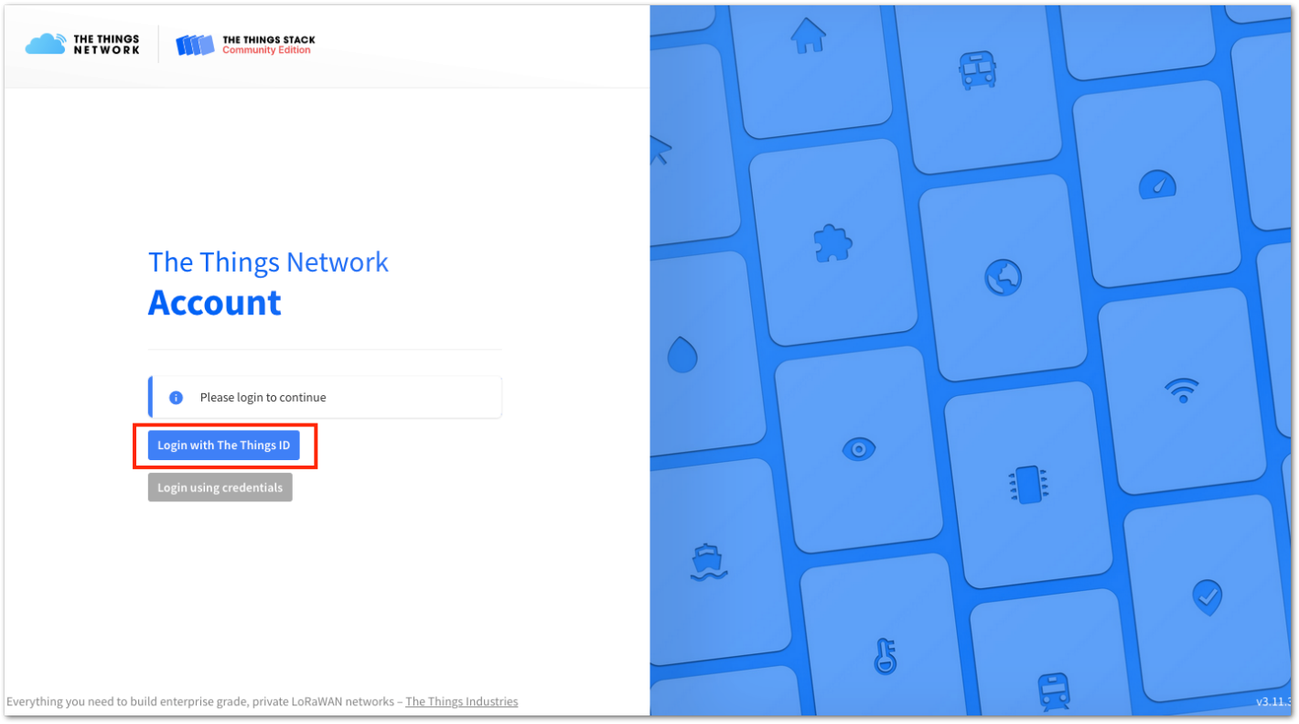

Figure 4: Login using TTN account

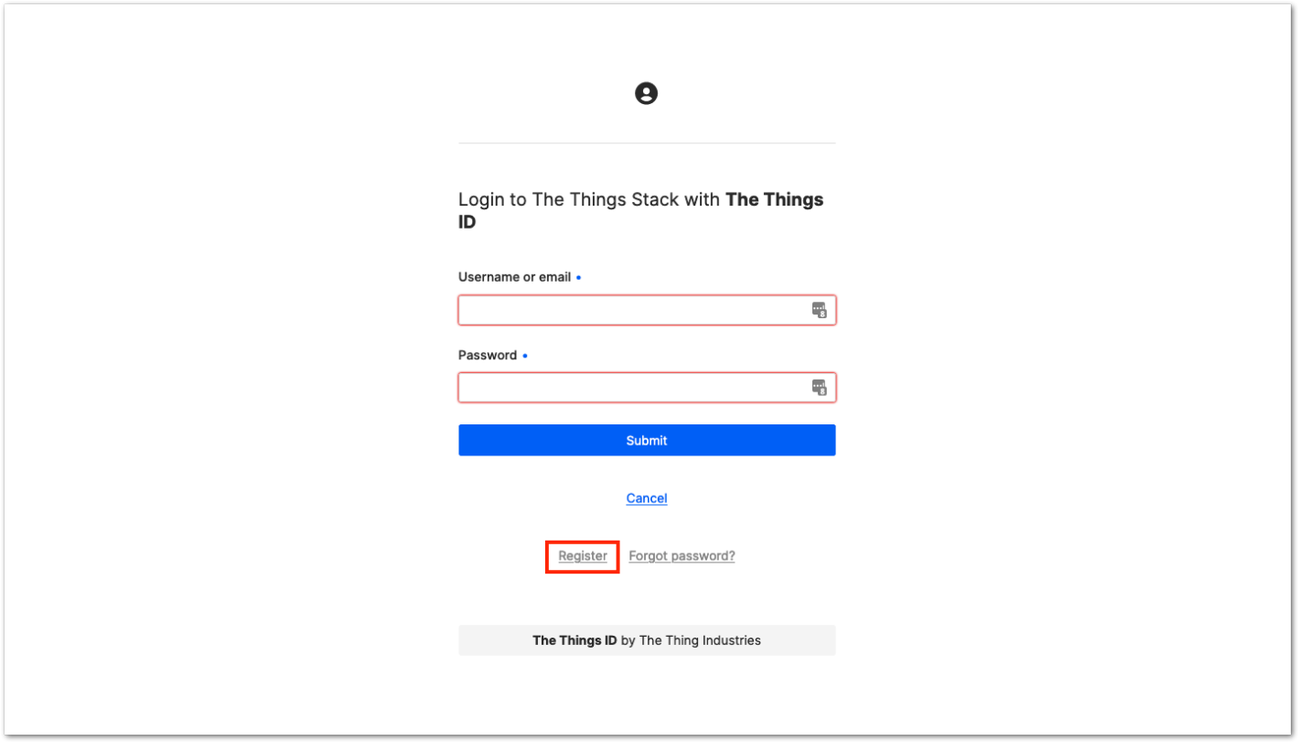

Figure 5: Registration of new account

You should now be on the step of creating your TTN account. Fill all the necessary details and activate your account.

After creating an account, you should login on the platform using your username/email and password then click **Submit** as shown on Figure 6.

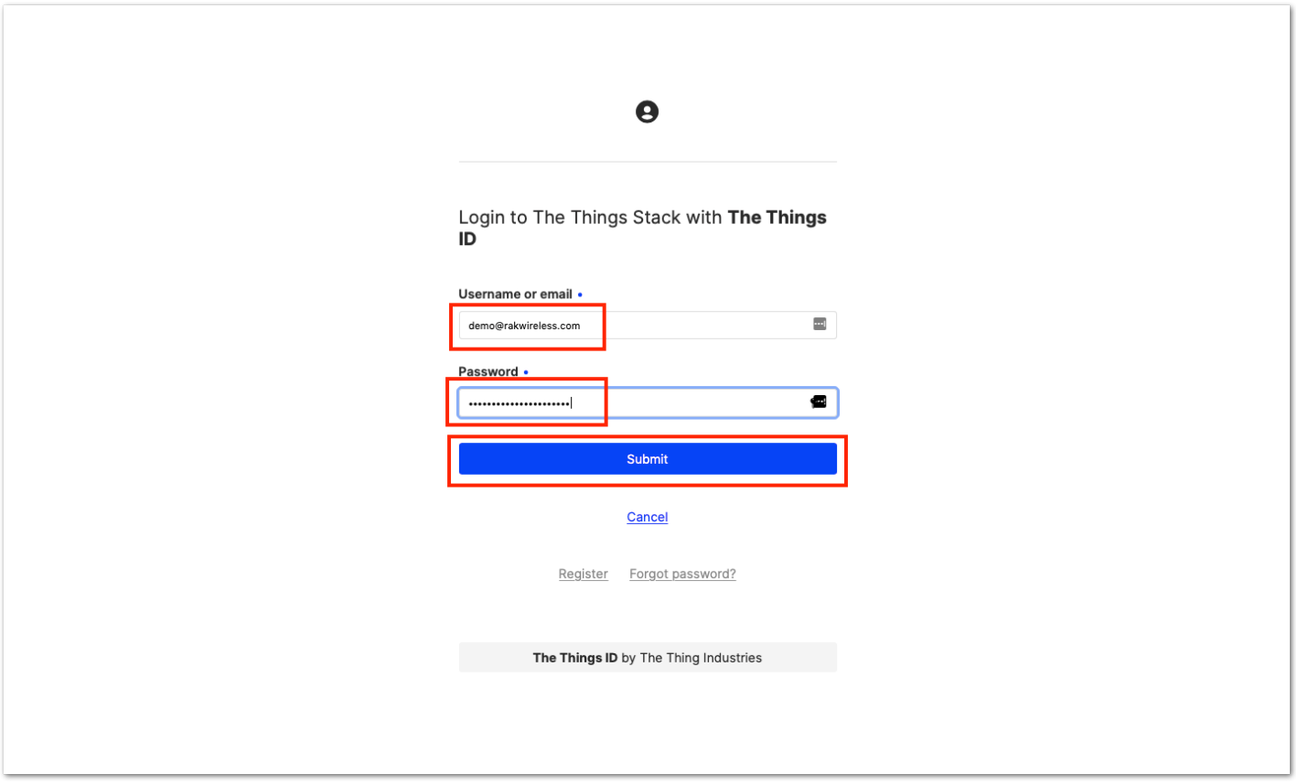

Figure 6: Logging in to TTN platform

You need to click **Authorize** to proceed.

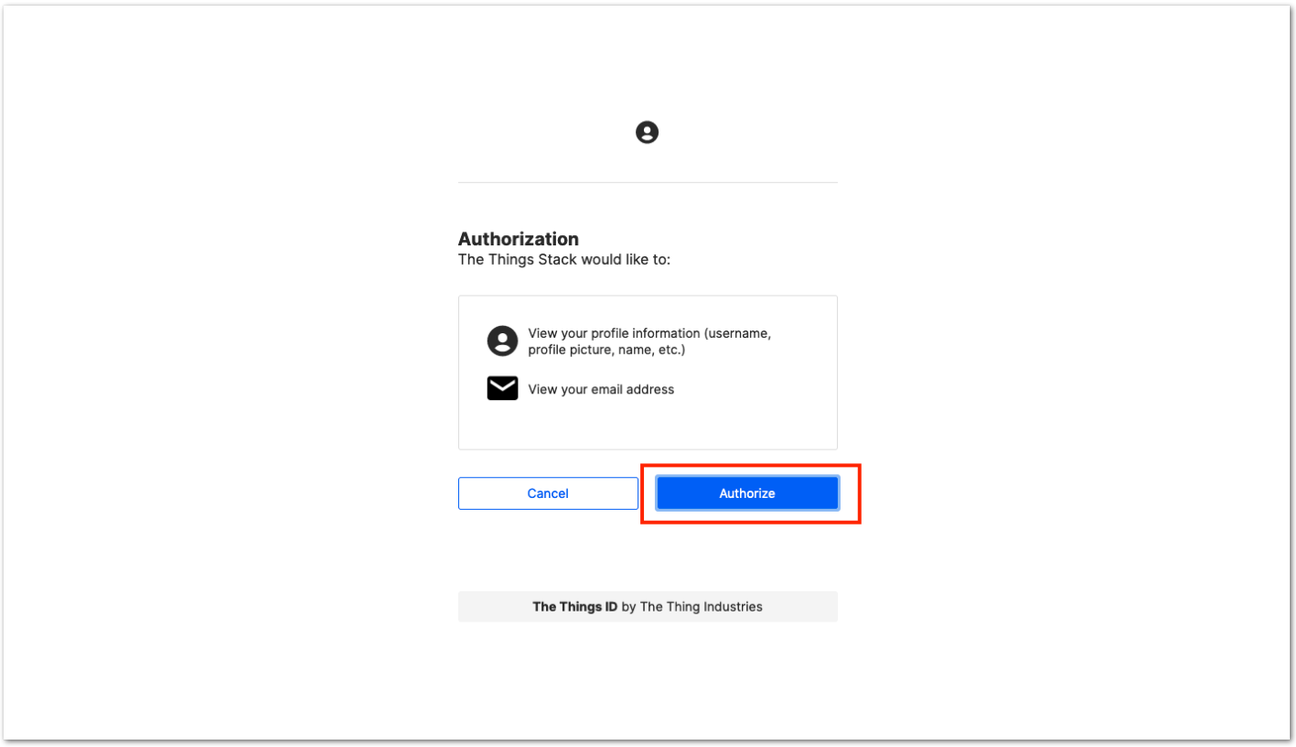

Figure 7: Authorization to TTN

Now that you are logged in to the platform, the next step is to create an application. Click **Create an application**.

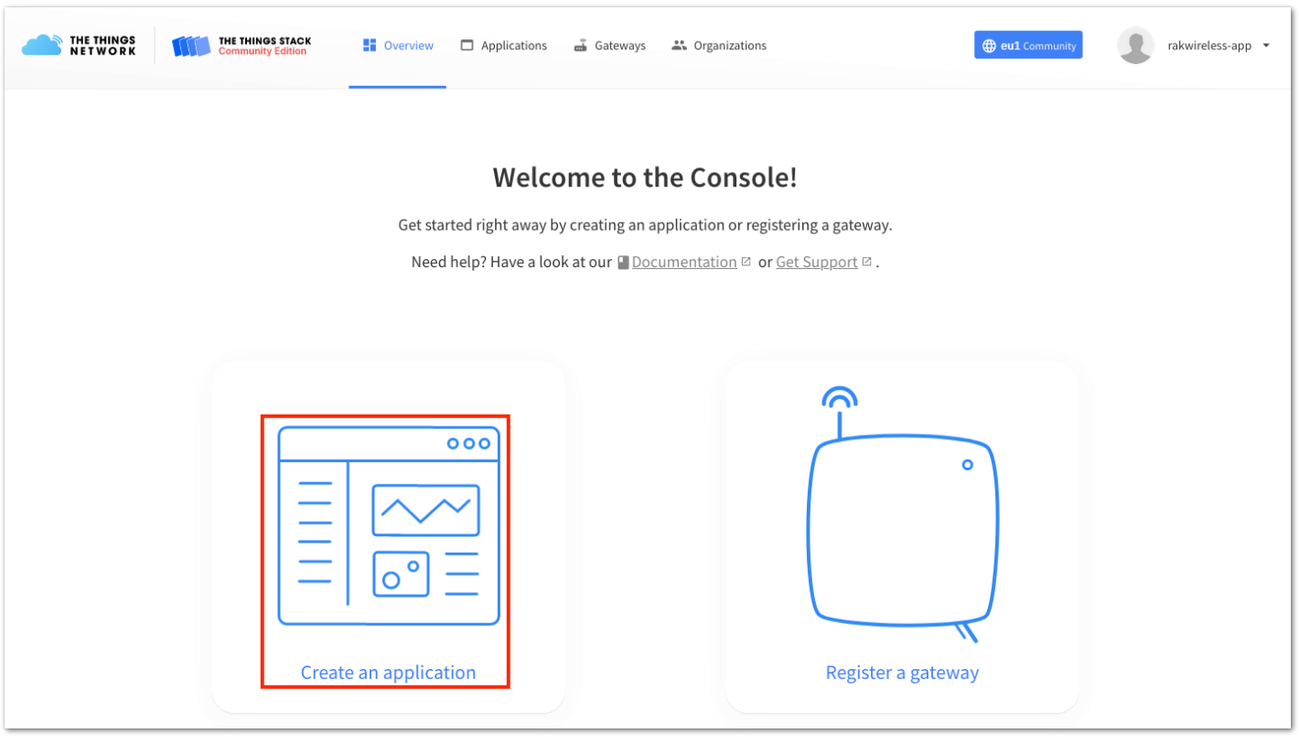

Figure 8: Creating TTN application for your LoRaWAN devices

To have an application registered, you need to input first the specific details and necessary information about your application then click **Create application**.

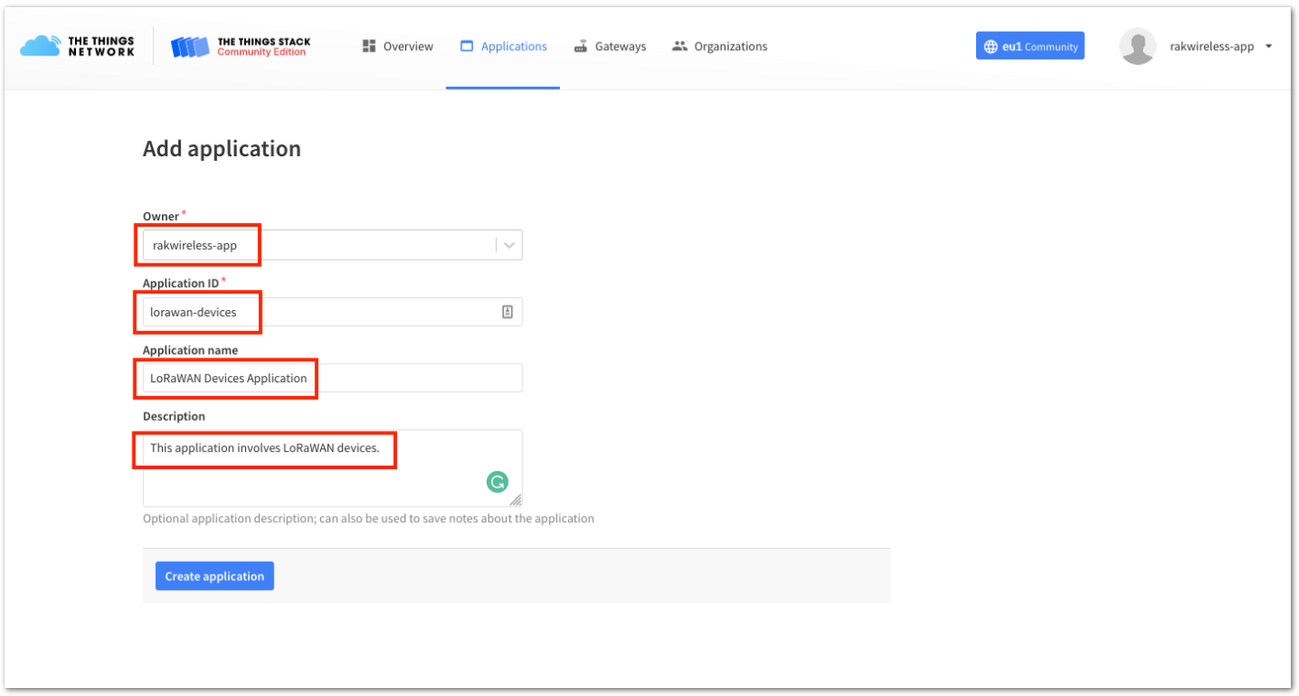

Figure 9: Details of the TTN application

If you had no error during the previous step, you should now be on the application console page. The next step is to add end-devices to your TTN application. LoRaWAN specification enforces that each end-device has to be personalized and activated. There are two options for registering devices depending on the activation mode you select. Activation can be done either via Over-The-Air-Activation (OTAA) or Activation-By-Personalization (ABP).

TTN OTAA Device Registration

You need to go to your application console to be able to register a device. To start adding an OTAA end-device, you need to click **+ Add end device** as shown in Figure 10.

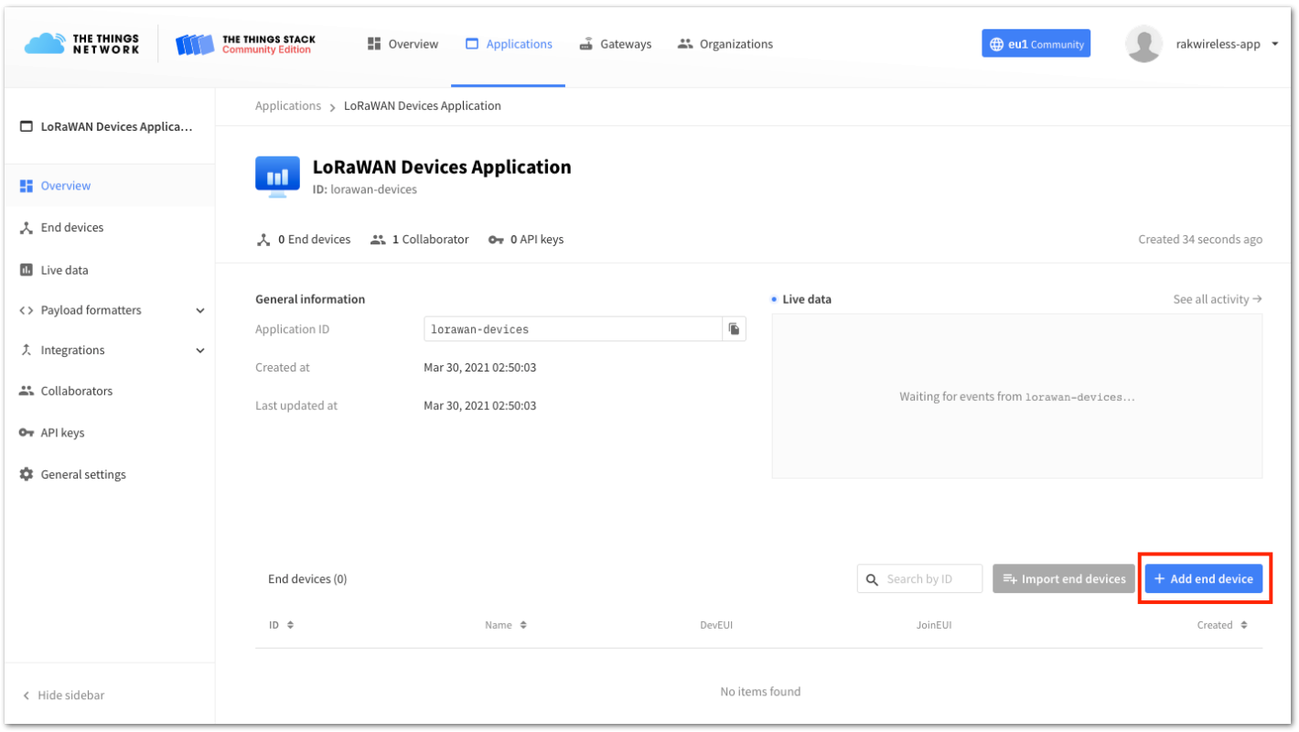

Figure 10: Add end device

To register the module, you need to click first **Manually** then configure the activation method by selecting **Over the air activation (OTAA)** and compatible **LoRaWAN version** then click **Start** button as shown on figures 11 and 12.

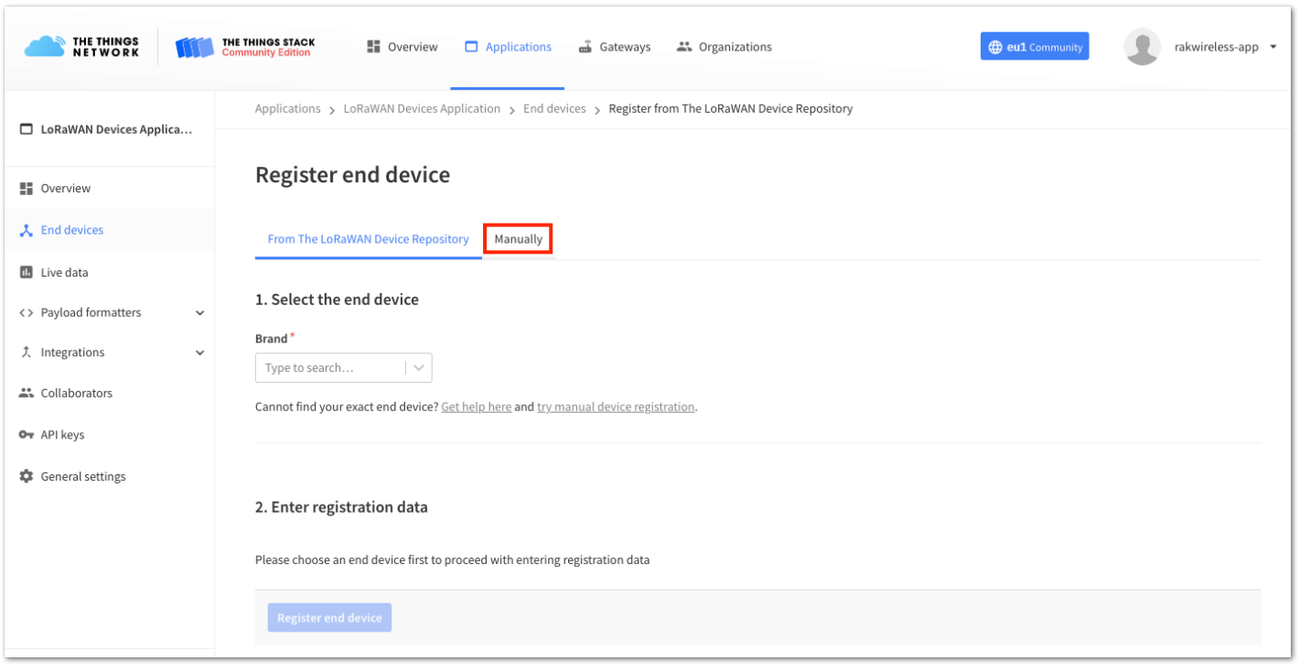

Figure 11: Manually register device to TTN

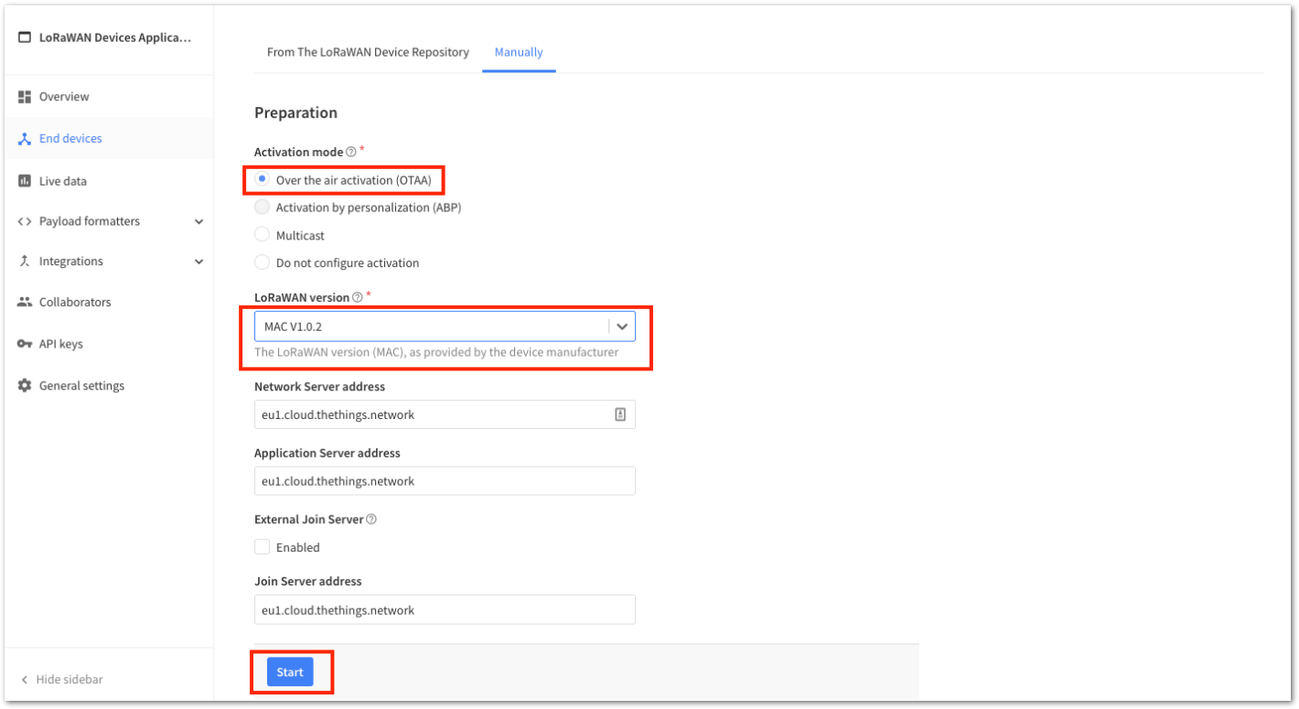

Figure 12: Device activation configuration

Then you need to put a unique **End device ID** and EUIs (**DevEUI** and **AppEUI**) as shown on Figure 13. Check if your module has a DevEUI on sticker or QR that you can scan then use this as the device unique DevEUI.

Optionally, you can add a more descriptive **End device name** and **End device description** about your device.

After putting all the details, you need to click **Network layer settings** to proceed to the next step.

> 📝 **NOTE:**
>
> It is advisable to use a meaningful end-device ID, end-device name and end-device description that will match your device purpose. The end-device ID `rak-device` is for illustration purposes only.

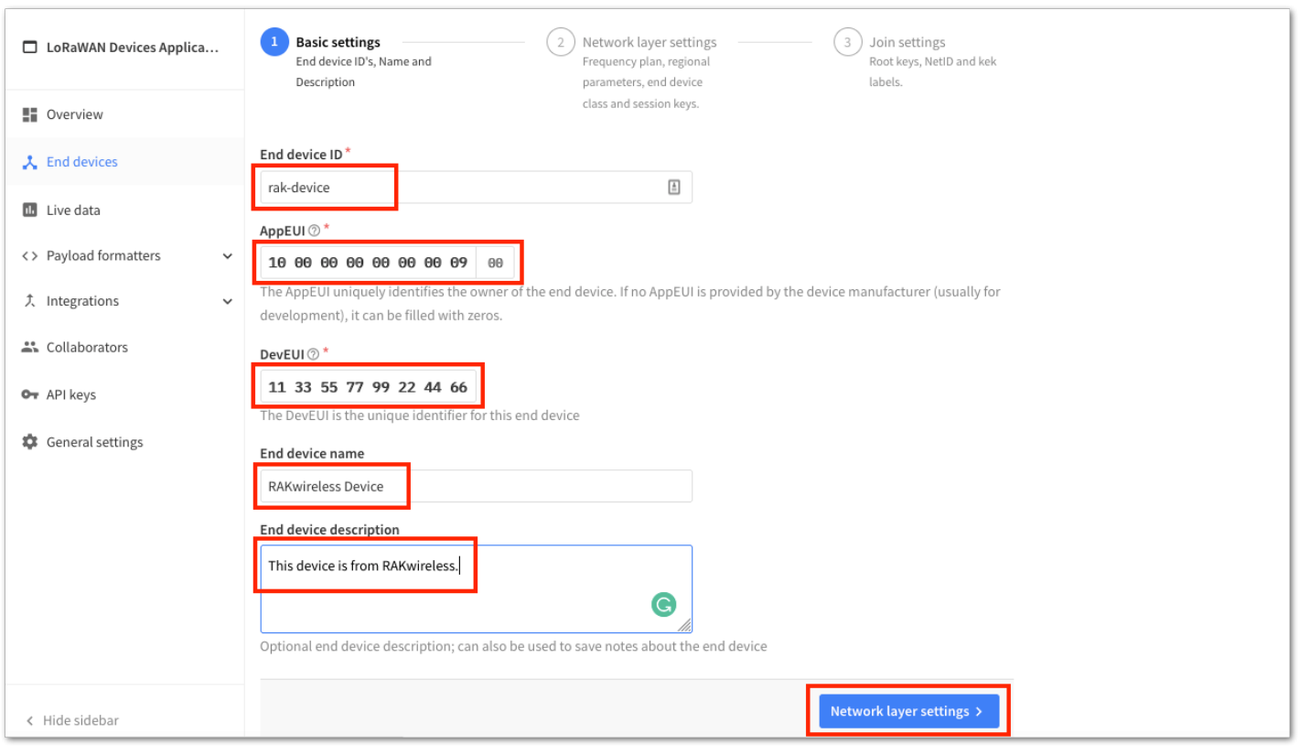

Figure 13: OTAA Device Information

The next step is to set up the **Frequency plan**, a compatible **Regional Parameter version** and the **LoRaWAN class** supported. Then you can click **Join settings**.

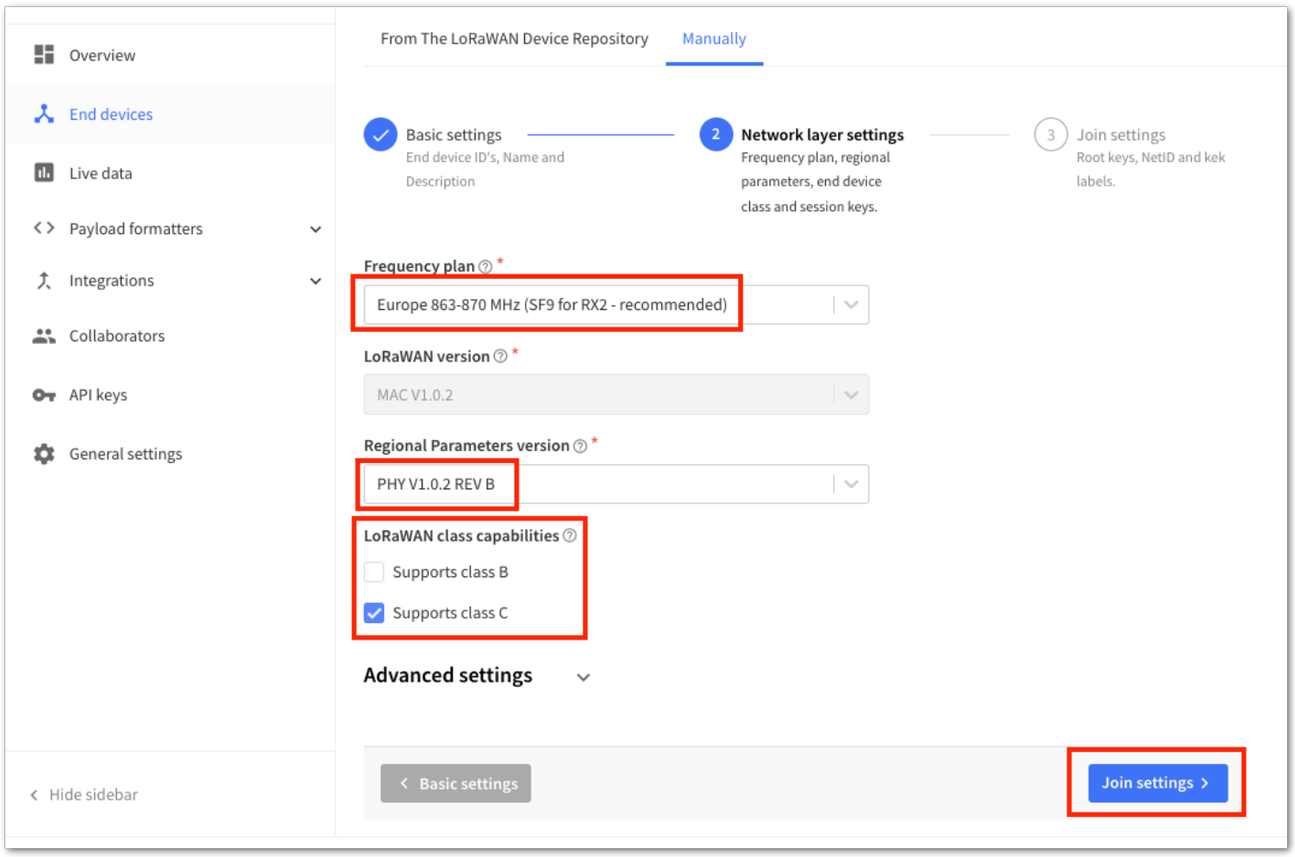

Figure 14: OTAA Configuration

The last step in the registration of a new OTAA end-device is the configuration of the **AppKey**. To get the AppKey, you must click the **generate button**. Then you need to click **Add end device** to finish your new device registration.

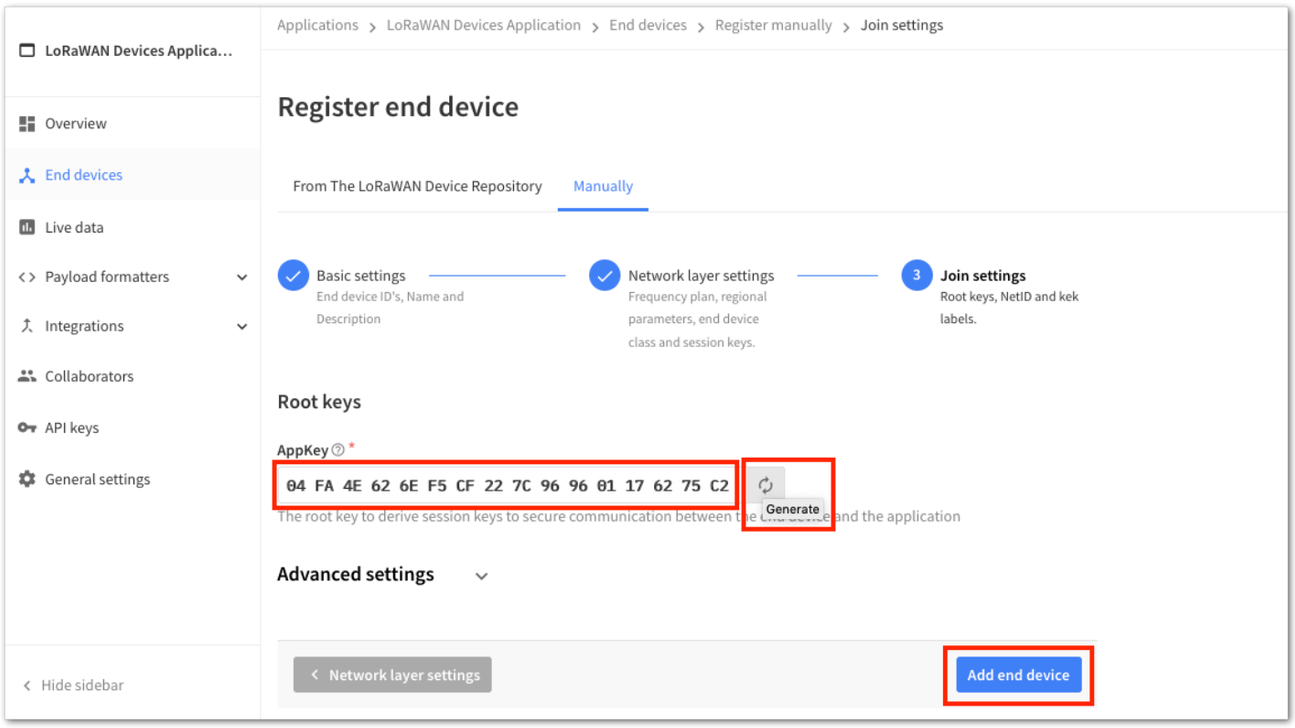

Figure 15: OTAA AppKey generation and device registration

You should now be able to see the device on the TTN console after you fully register your device as shown in Figure 16.

> 📝 **NOTE:**
>
> The **AppEUI**, **DevEUI** and **AppKey** are the parameters that you will need to activate your LoRaWAN end-device via OTAA. The **AppKey** is hidden by default for security reason but you can easily show it by clicking the show button. You can also copy the parameters quickly using the copy button.
>
> The three OTAA parameters on the TTN device console are MSB by default.
>
> These parameters are always accessible on the device console page as shown on Figure 16.

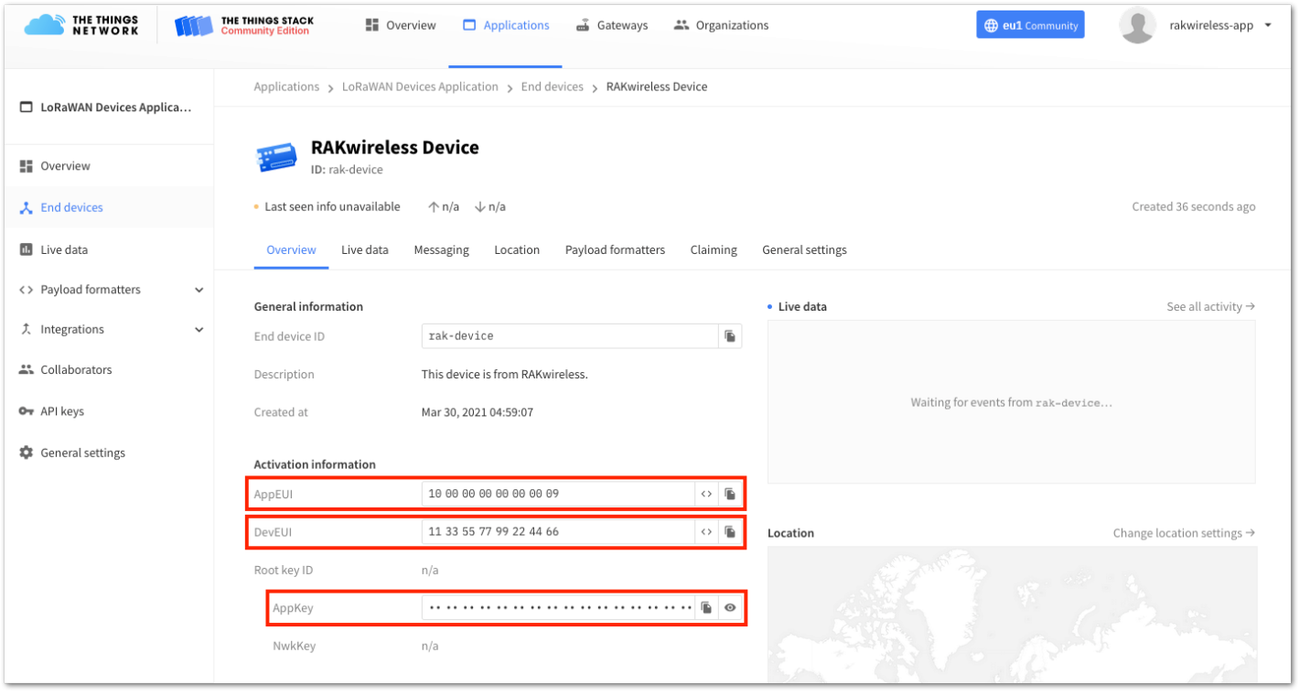

Figure 16: OTAA device successfully registered to TTN

OTAA Configuration for TTN

The RAK3172 module supports a series of AT commands to configure its internal parameters and control the functionalities of the module.

To set up the RAK3172 module to join the TTN using OTAA, start by connecting the RAK3172 module to your computer (see Figure 1) and open the RAK Serial Port Tool. Select the right COM port and set the baudrate to 9600.

It is recommended to start by testing the serial communication and verify that the current configuration is working by sending these two AT commands:

```
AT
```

```
ATE
```

`ATE` will echo the commands you input to the module, which is useful for tracking the commands and troubleshooting.

You will receive `OK` when you input the two commands. After setting `ATE`, you can now see all the commands you input together with the replies. Try again `AT` and you should see it on the terminal followed by `OK` as shown in Figure 17.

> 📝 **NOTE:**
>
> If do not receive an `OK` or any reply, you need to check if the wiring of your UART lines is correct and if the baud is correctly configured to 9600. Also you can check if the device is powered correctly. If you are getting power from USB port, ensure that you have a good USB cable.

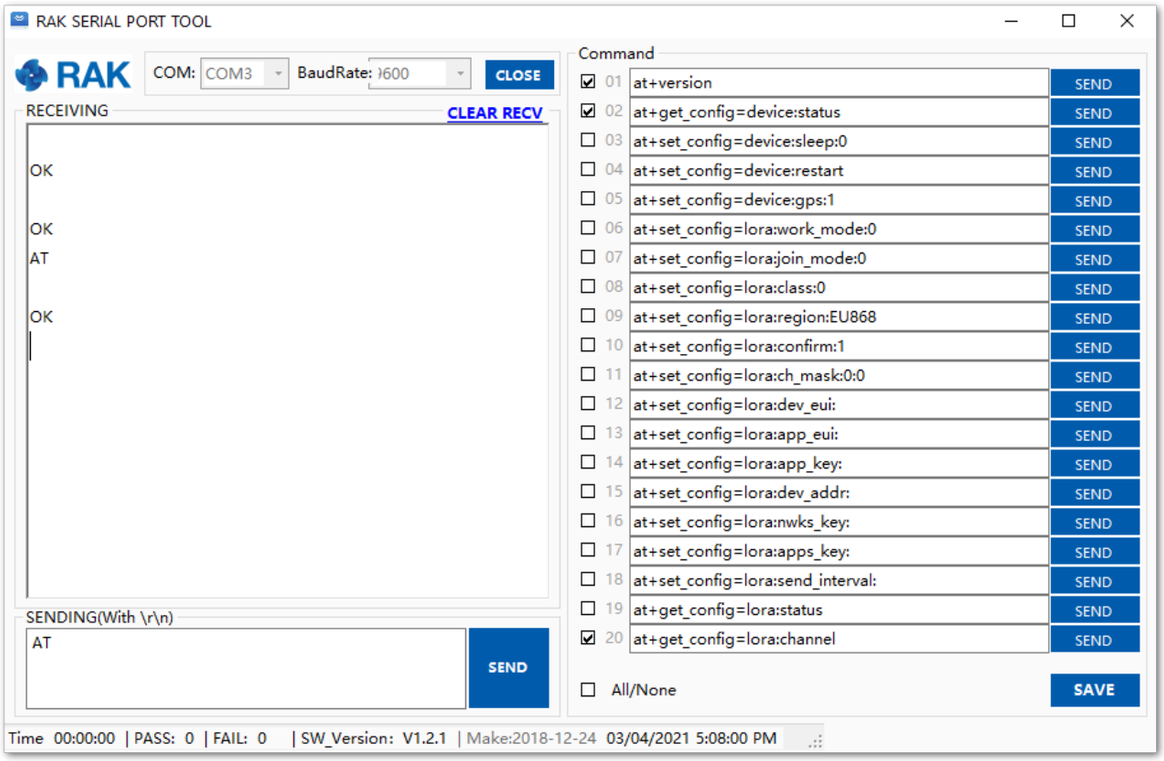

Figure 17: at+version command response

The next step is to configure the OTAA LoRaWAN parameters in RAK3172:

- LoRa work mode: **LoRaWAN**
- LoRaWAN join mode: **OTAA**
- LoRaWAN class: **Class A**
- LoRaWAN region: **EU868**

Set the work mode to LoRaWAN.

```
AT+NWM=1
```

Set the LoRaWAN activation to OTAA.

```
AT+NJM=1
```

Set the LoRaWAN class to Class A.

```
AT+CLASS=A
```

Set the frequency/region to EU868.

```
AT+BAND=4
```

> 📝 **NOTE:**
>
> Depending on the Regional Band you selected, you might need to configure the sub-band of your RAK3172 to match the gateway and LoRaWAN network server. This is especially important for Regional Bands like US915, AU915, and CN470.
>
> To configure the masking of channels for the sub-bands, you can use the AT+MASK command that can be found on the AT Commands Manual .
>
> To illustrate, you can use use sub-band 2 by sending the command `AT+MASK=0002`.

List of band parameter options

Code	Regional Band
0	EU433
1	CN470
2	RU864
3	IN865
4	EU868
5	US915
6	AU915
7	KR920
8 or 8-1	AS923-1
8-2	AS923-2
8-3	AS923-3
8-4	AS923-4

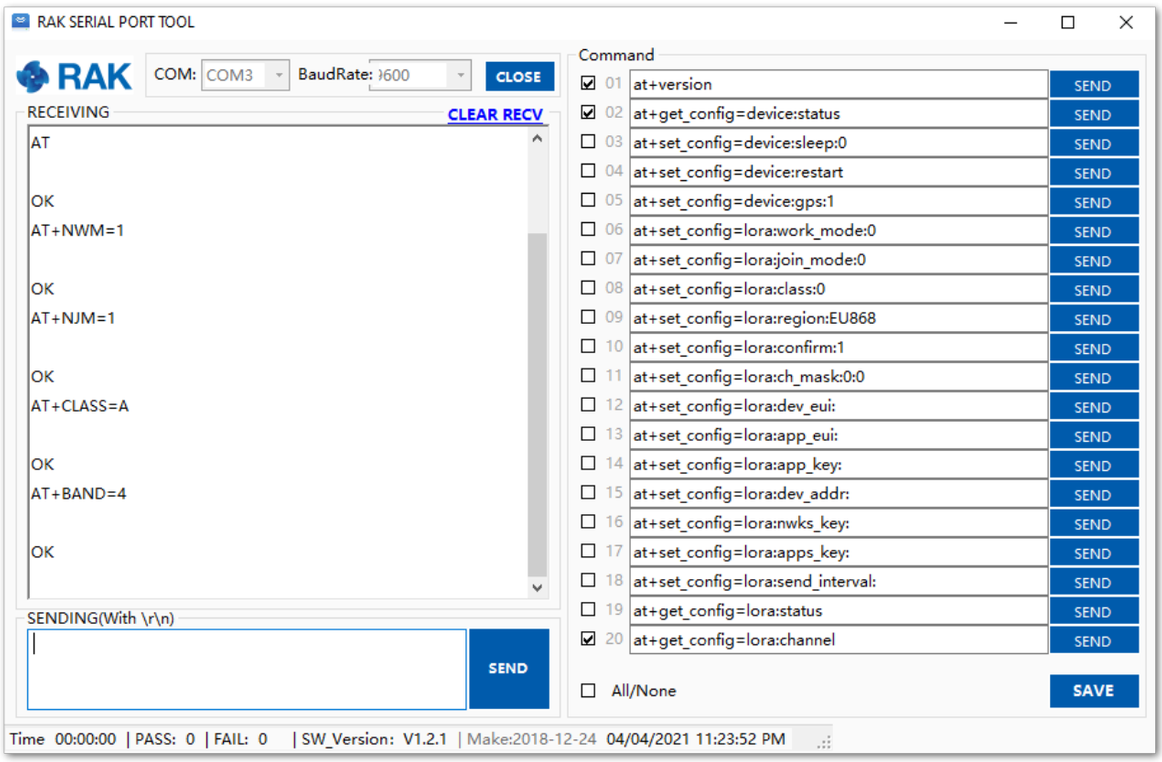

Figure 18: Configuring LoRa Parameters

After configuration of the LoRaWAN parameters, the next step is to set up the EUIs and key. You need the use the values from the TTN console.

- Device EUI: **1133557799224466**
- Application EUI: **1000000000000009**
- Application Key: **04FA4E626EF5CF227C969601176275C2**

Set the Device EUI.

```
AT+DEVEUI=1133557799224466
```

Set the Application EUI.

```
AT+APPEUI=1000000000000009
```

Set the Application Key.

```
AT+APPKEY=04FA4E626EF5CF227C969601176275C2
```

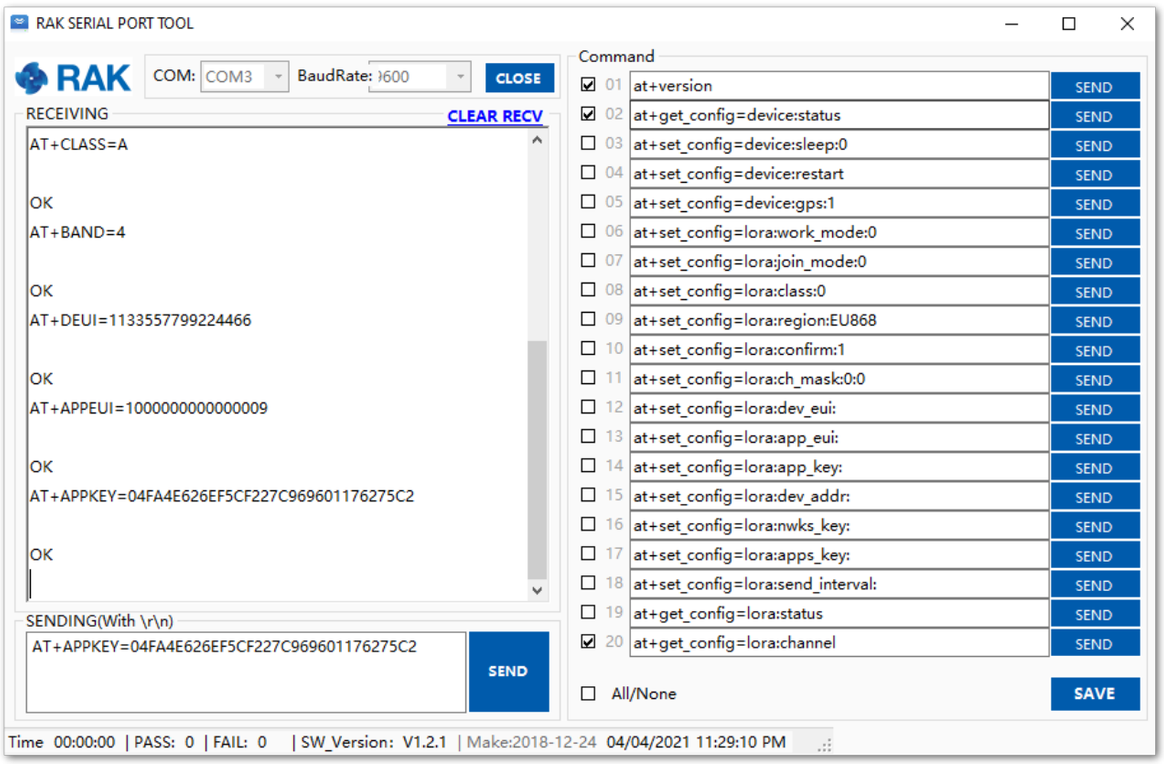

Figure 19: Configuring LoRa Parameters

After EUI and keys configuration, the device can now join the network and send payloads.

```
AT+JOIN=1:0:10:8
```

Join command format: `AT+JOIN=w:x:y:z`

Parameter	Description
w	Join command - 1: joining, 0: stop joining.
x	Auto-join config - 1: auto-join on powerup, 0: no auto-join
y	Reattempt interval in seconds (7-255) - 8 is default.
z	Number of join attempts (0-255) - 0 is default.

After 5 or 6 seconds, if the request was successfully received by a LoRa gateway, you should see `+EVT:JOINED` status reply as shown on Figure 20.

> 📝 **NOTE:**
>
> If the OTAA device failed to join, you need to check if your device is within reach of a working LoRaWAN gateway that is configured to connect to TTN. It is also important to check that all your OTAA parameters (DEVEUI, APPEUI and APPKEY) are correct using the `AT+DEVEUI=?` , `AT+APPEUI=?` and `AT+APPKEY=?` commands. Lastly, ensure that the antenna of your device is properly connected.
>
> After checking all the things above, try to join again.

With the end-device properly activated, you can now try to send some payload after a successful join.

```
AT+SEND=2:12345678
```

Send command format: `AT+SEND=<port>:<payload>`

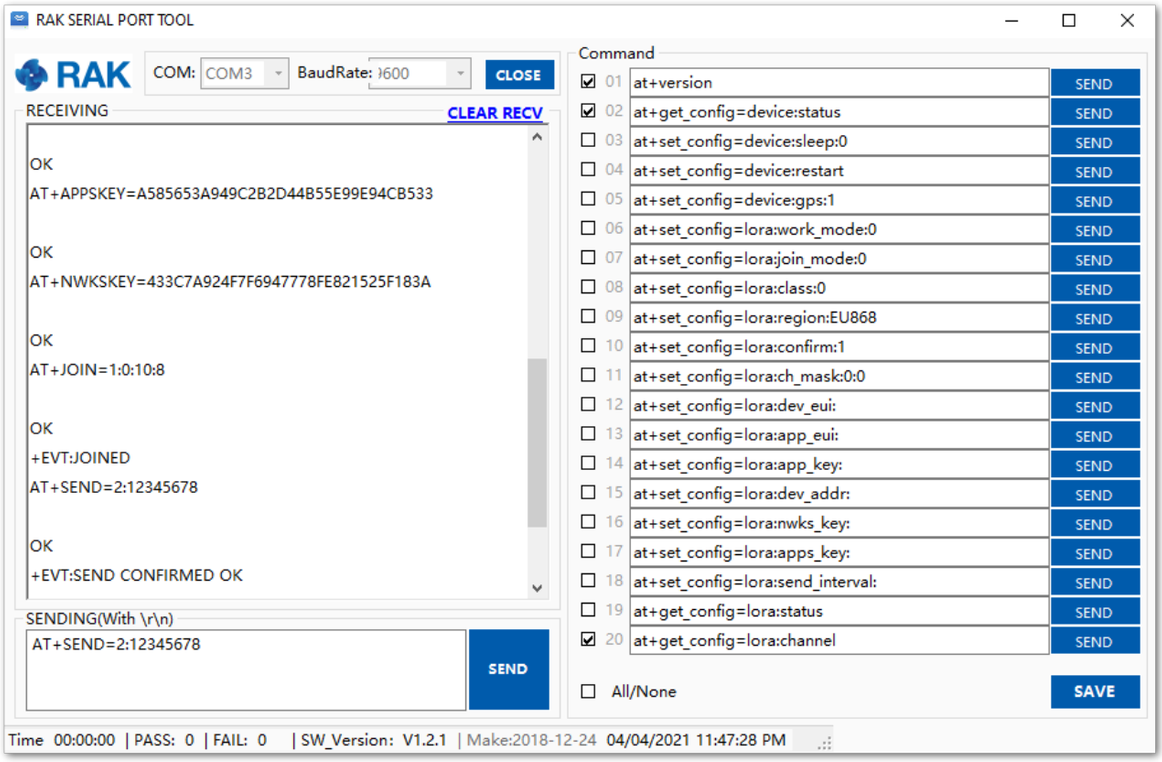

Figure 20: OTAA Test Sample Data Sent via RAK Serial Port Tool

You can see the data sent by the RAK3172 module on the TTN device console *Live data* section. Also, the *Last seen* info should be a few seconds or minutes ago.

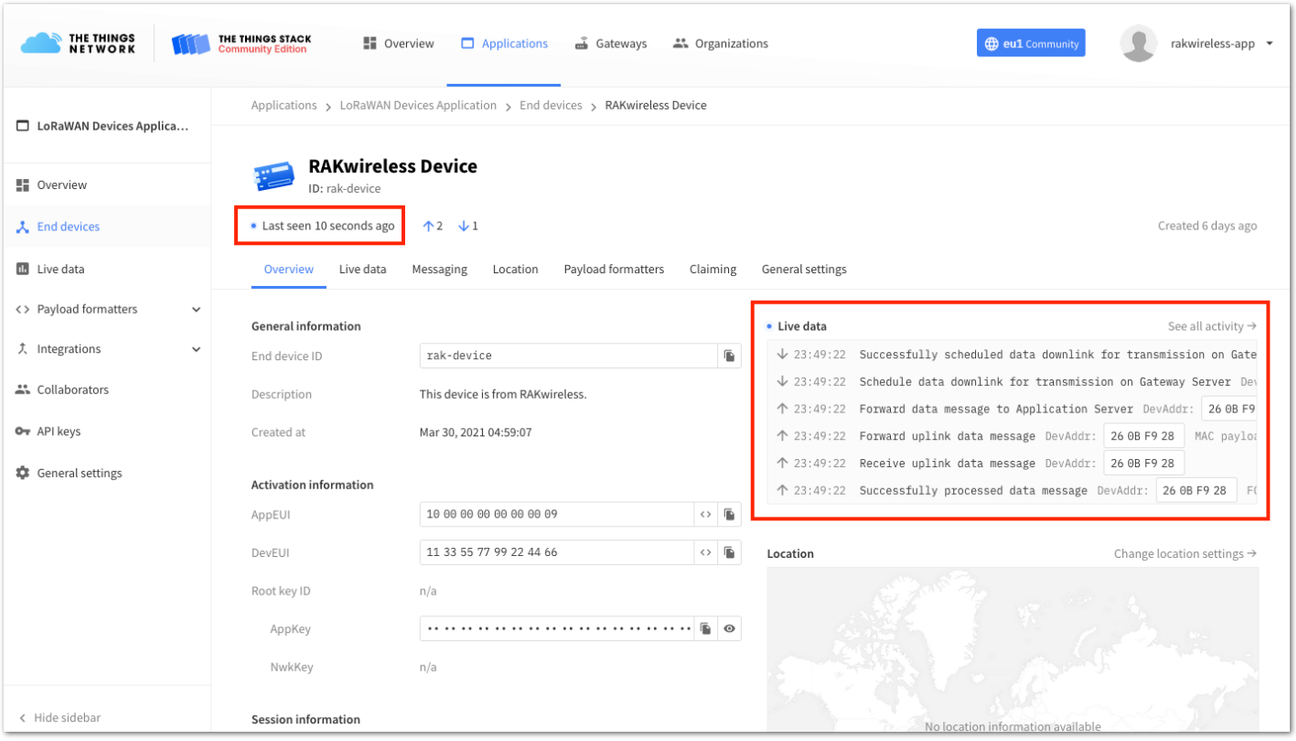

Figure 21: OTAA Test Sample Data Sent Viewed in TTN

TTN ABP Device Registration

To register an ABP device, you need to go to your application console and select the application where you want your device to be added. Then you need to to click **+ Add end device** as shown in Figure 22.

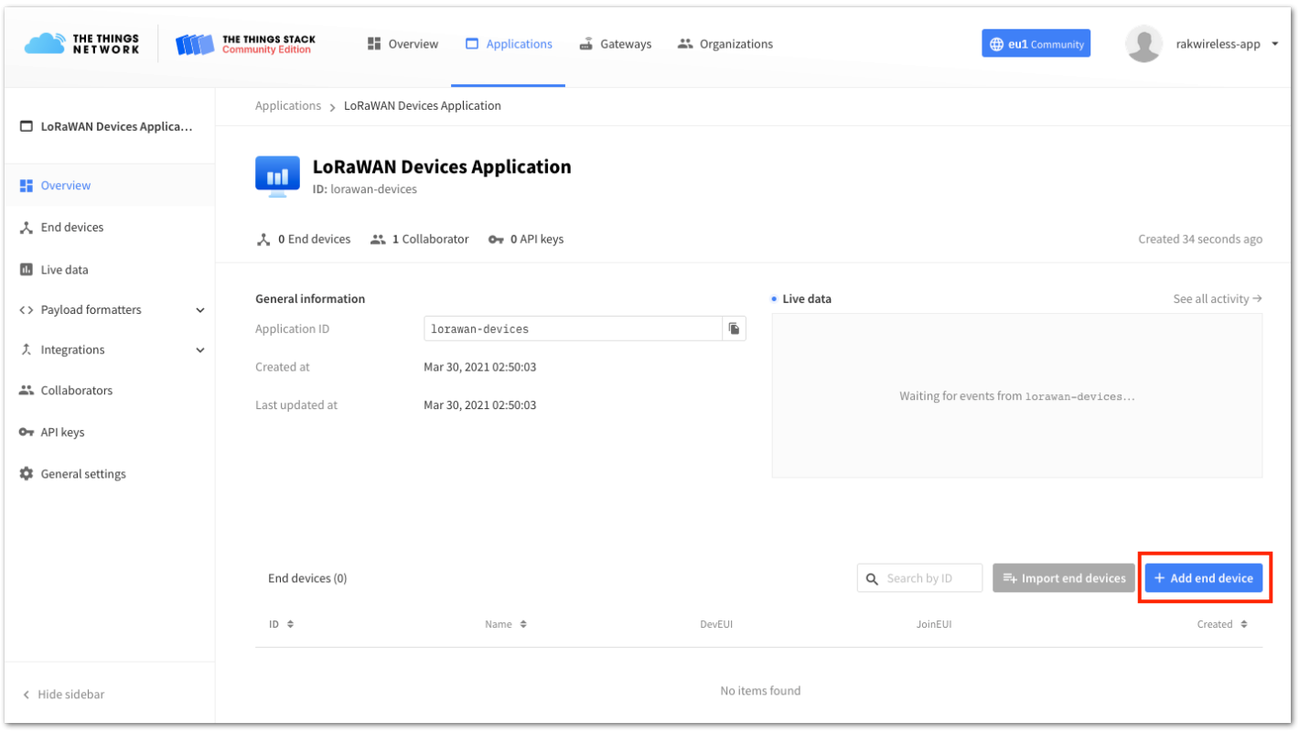

Figure 22: Adding ABP Device

To register the module, you need to click first **Manually** then configure the activation method by selecting **Activation by personalization (ABP)**, compatible **LoRaWAN version** and click **Start** button as shown in figures 23 and 24.

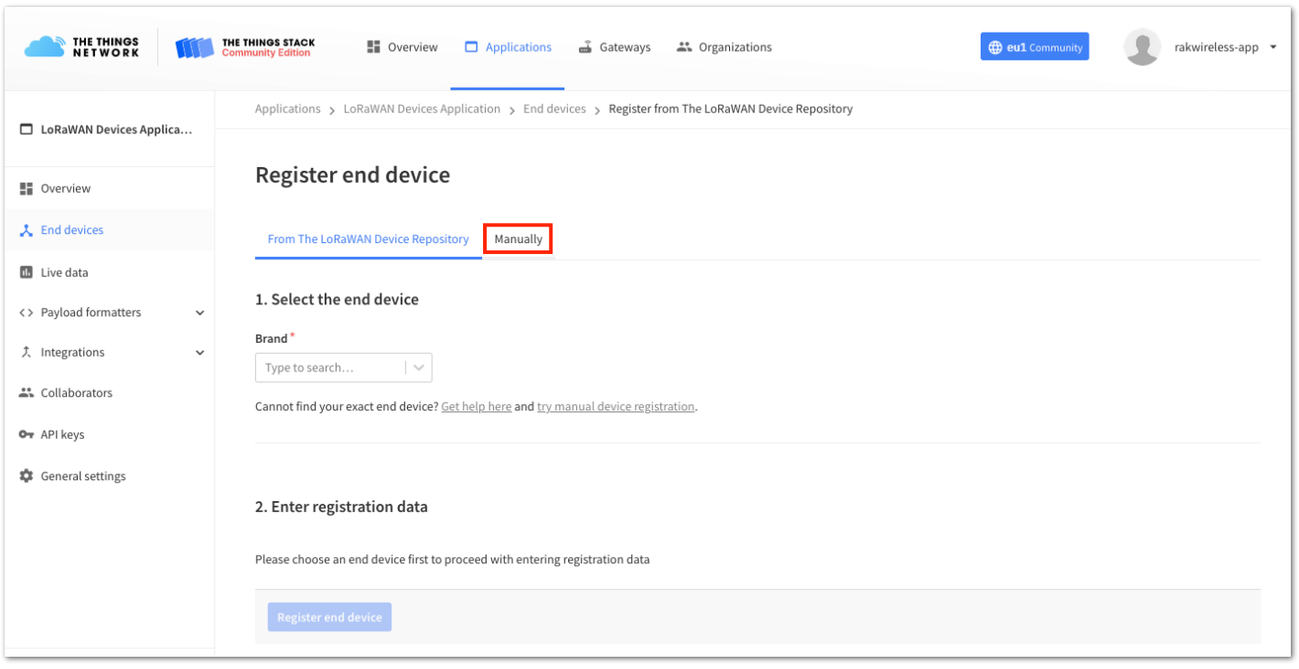

Figure 23: Manually register device to TTN

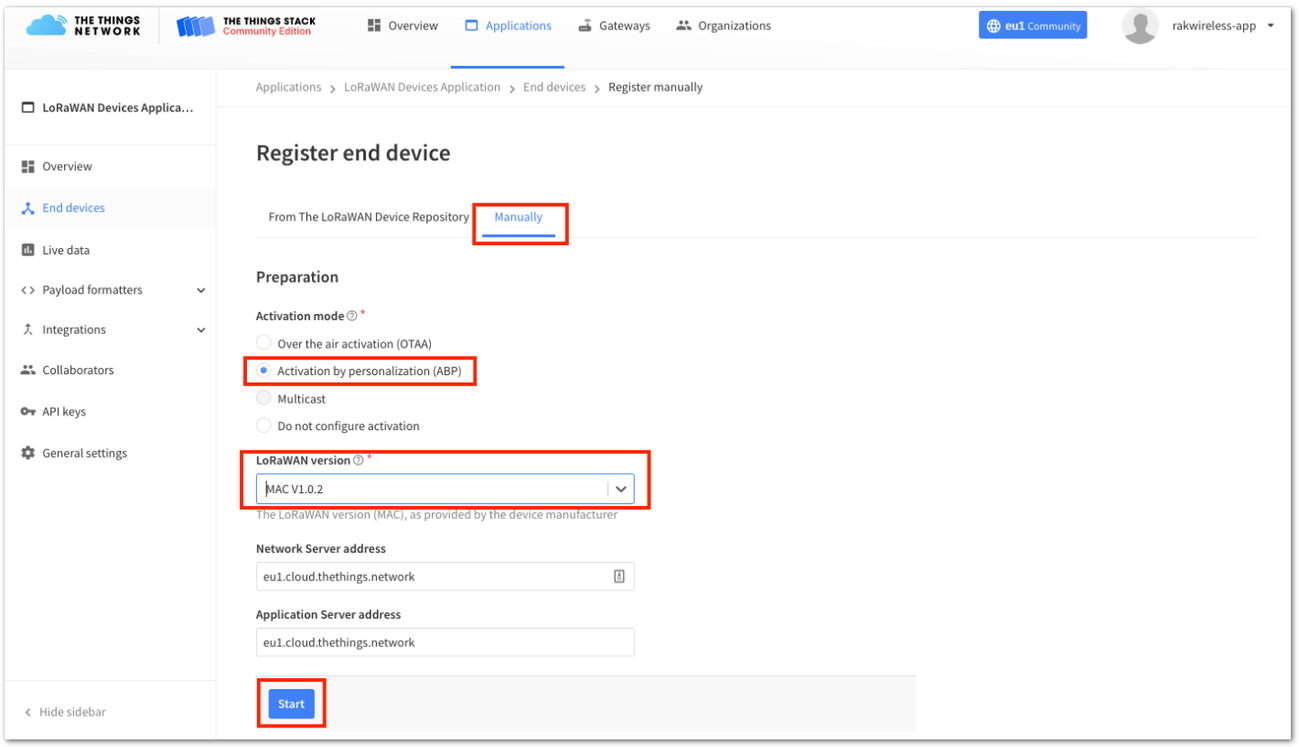

Figure 24: Selecting ABP and LoRaWAN version

At this step, you need to put a unique **End device ID** and **DevEUI** as shown in Figure 25. Check if your module has a DevEUI on sticker or QR that you can scan then use this as the device unique DevEUI.

Optionally, you can add a more descriptive **End device name** and **End device description** about your device.

After putting all the details, you need to click **Network layer settings** to proceed on the next step.

> 📝 **NOTE:**
>
> It is advisable to use a meaningful end-device ID, end-device name and end-device description that will match your device purpose. The end-device ID `rak-device-abp` is for illustration purposes only.

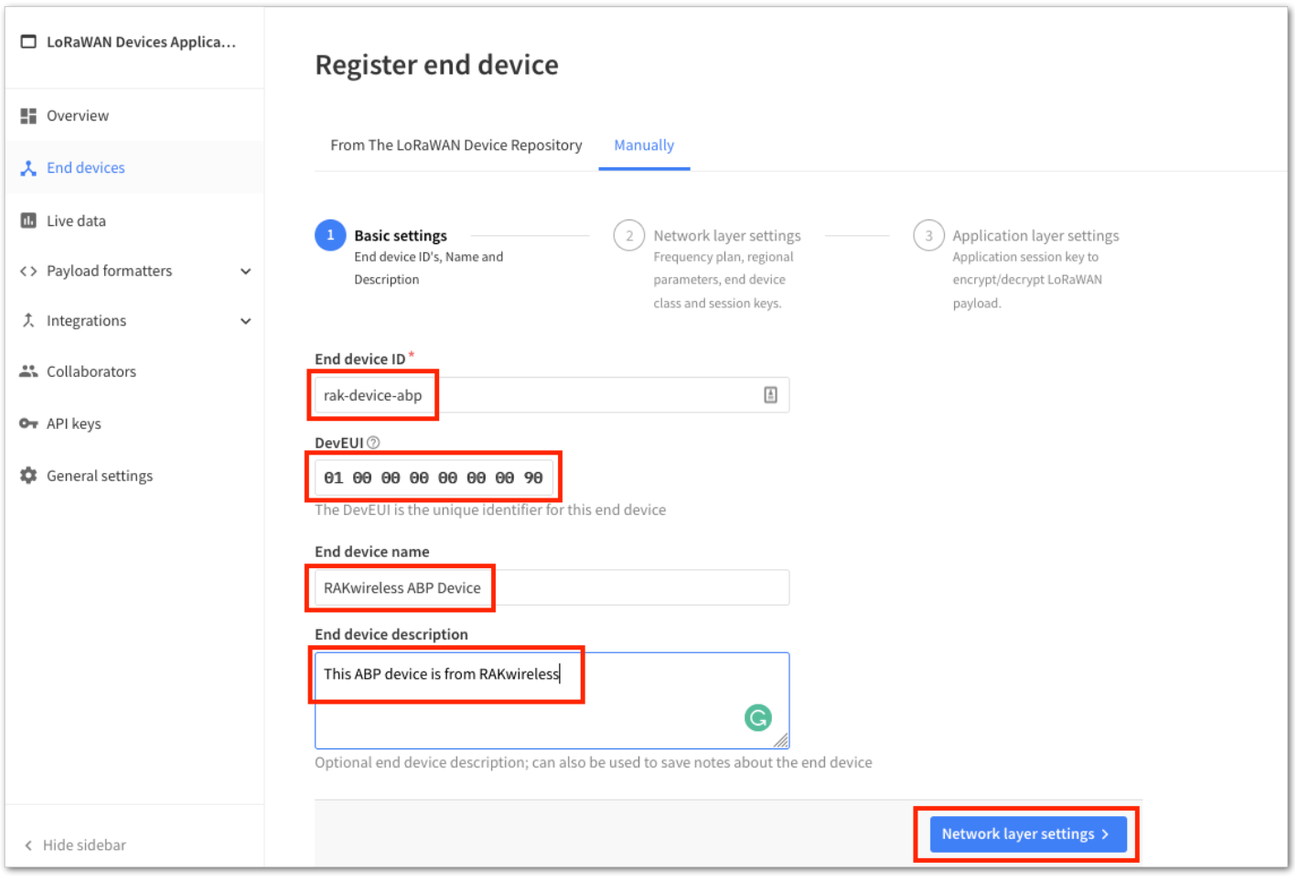

Figure 25: ABP Device Information

The next step is to set up the **Frequency plan**, a compatible **Regional Parameter version** and the **LoRaWAN class** supported. In an ABP device, you also need to generate a **Device Address** and a **NwkSKey** (Network Session Key). Then you can click **Application layers settings**.

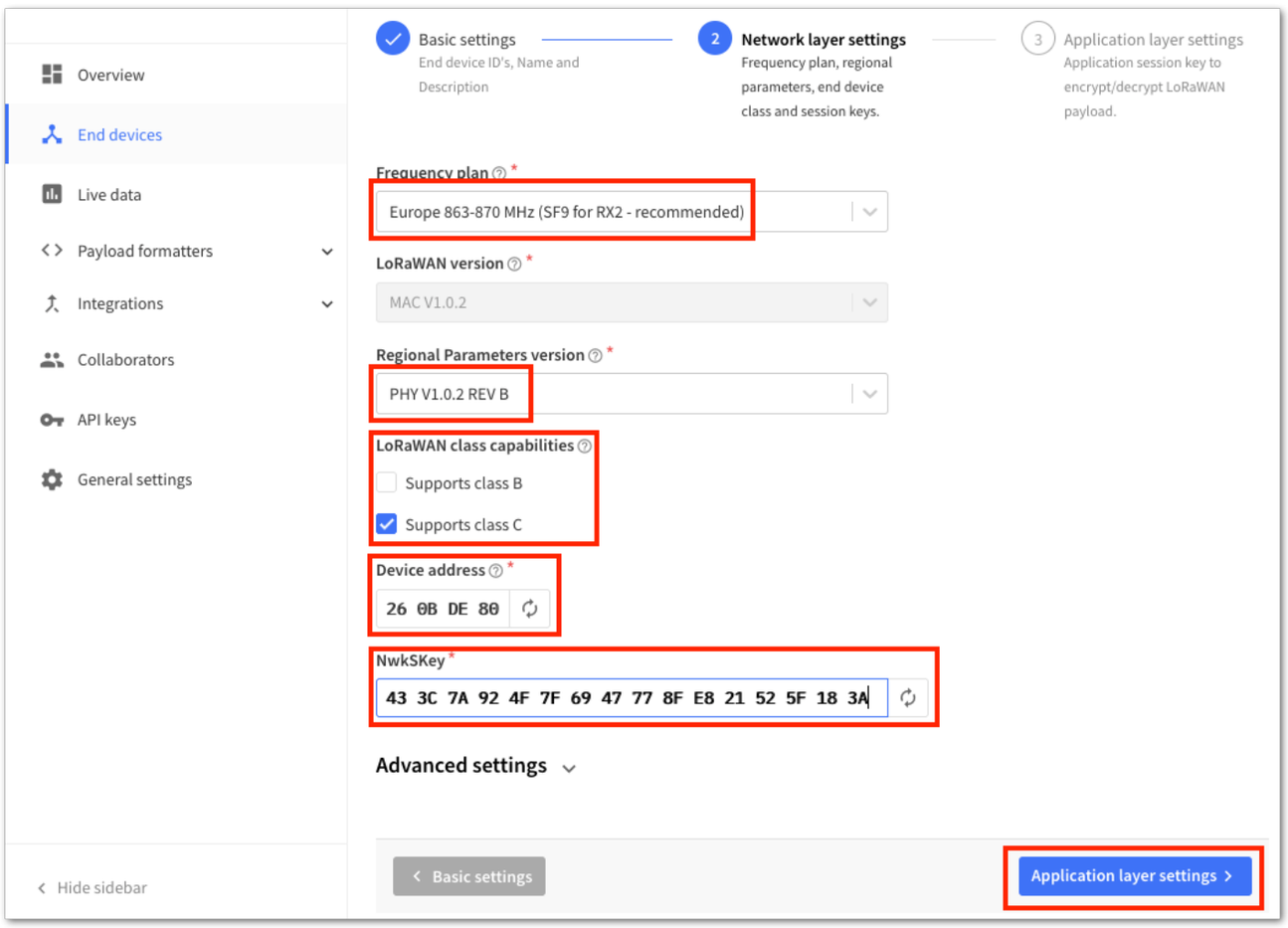

Figure 26: ABP Device Configuration

The last step in the registration of a new ABP end-device is the configuration of the **AppSKey**. To get the AppSKey, you must click the **generate button**. Then you need to click **Add end device** to finish your new device registration.

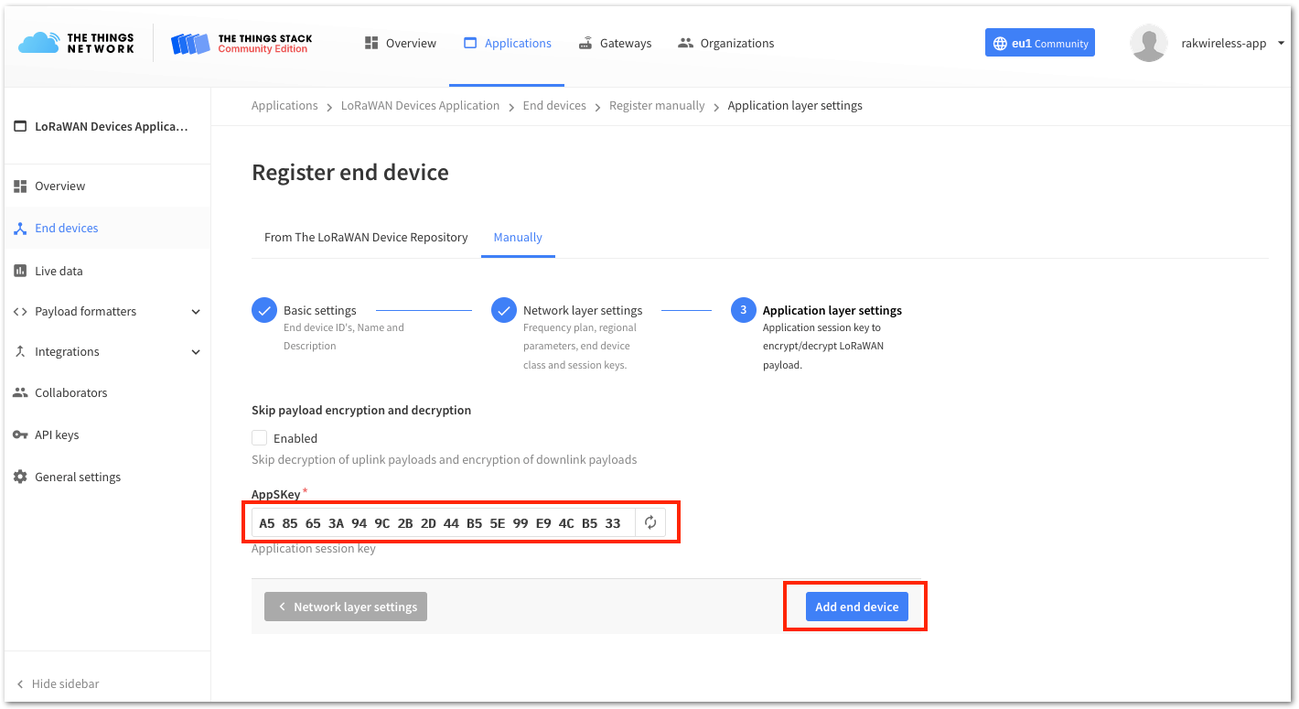

Figure 27: ABP AppSKey generation and device registration

You should now be able to see the device on the TTN console after you fully register your device as shown in Figure 28.

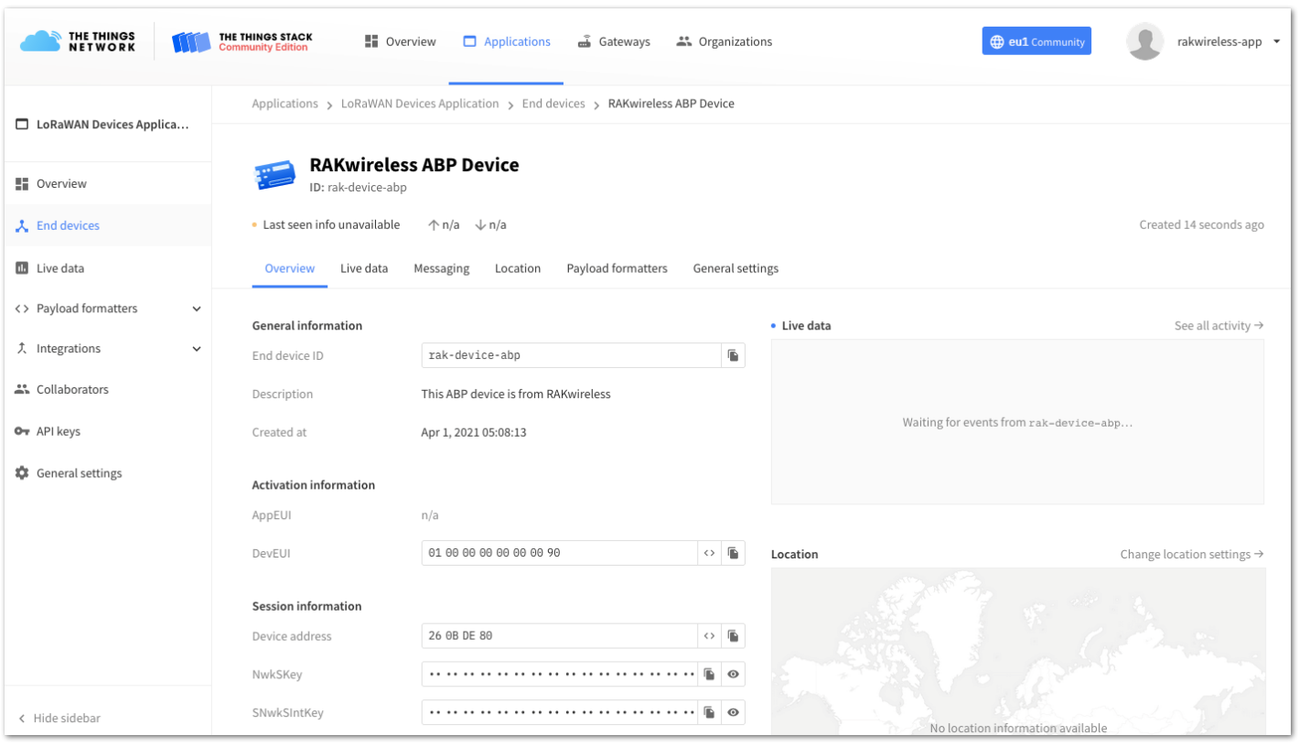

Figure 28: ABP device successfully registered to TTN

ABP Configuration for TTN

To set up the RAK3172 module to join the TTN using ABP, start by connecting the RAK3172 module to the computer (see Figure 1) and open the RAK Serial Port Tool. Select the right COM port and set baudrate to 9600.

It is recommended to start by testing the serial communication and verify the current configuration is working by sending these two AT commands:

```
AT
```

```
ATE
```

ATE will echo the commands you input to the module, which is useful for tracking the commands and troubleshooting.

You will receive OK when you input the two commands. After setting ATE, you can now see all the commands you input together with the replies. Try again AT and you should see it on the terminal followed by OK as shown in Figure 17.

> 📝 **NOTE:**
>
> If do not receive an `OK` or any reply, you need to check if the wiring of your UART lines is correct and if the baud is correctly configured to 9600. Also you can check if the device is powered correctly. If you are getting power from USB port, ensure that you have a good USB cable.

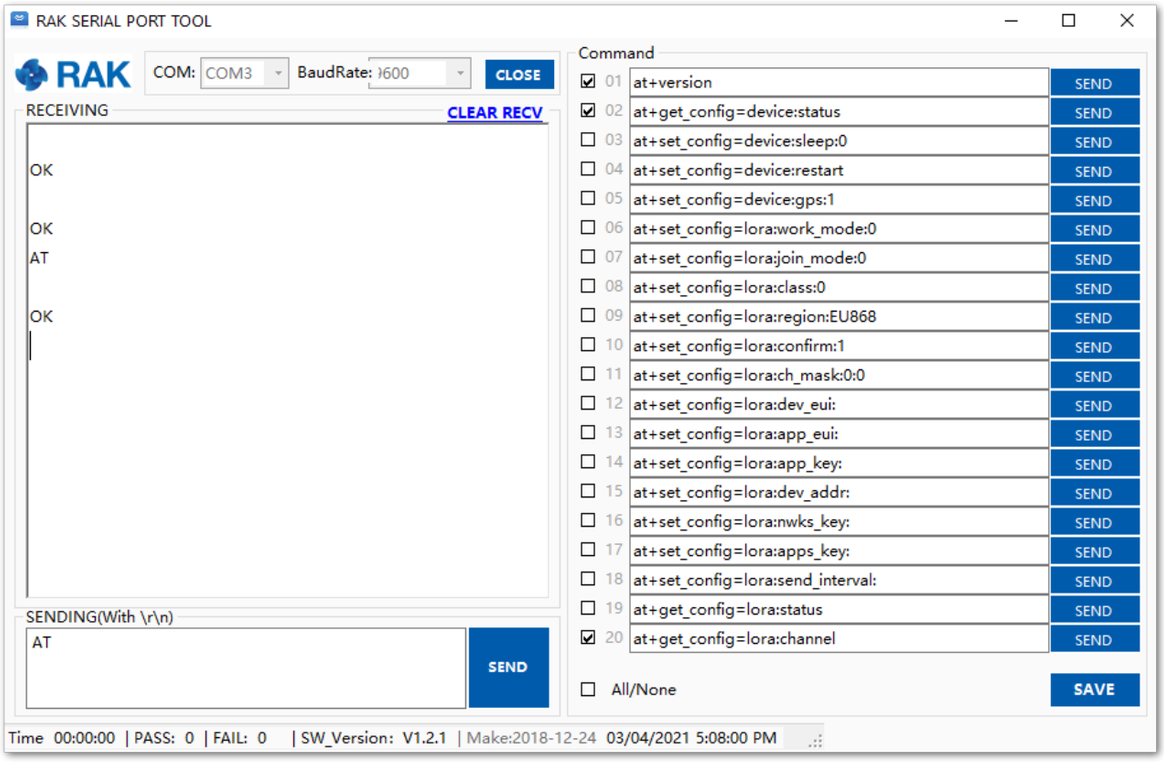

Figure 29: at+version command response

The next step is to configure the ABP LoRaWAN parameters in RAK3172:

- LoRa work mode: **LoRaWAN**
- LoRaWAN join mode: **ABP**
- LoRaWAN class: **Class A**
- LoRaWAN region: **EU868**

Set the work mode to LoRaWAN.

```
AT+NWM=1
```

Set the LoRaWAN activation to ABP.

```
AT+NJM=0
```

Set the LoRaWAN class to Class A.

```
AT+CLASS=A
```

Set the frequency/region to EU868.

```
AT+BAND=4
```

> 📝 **NOTE:**
>
> Depending on the Regional Band you selected, you might need to configure the sub-band of your RAK3172 to match the gateway and LoRaWAN network server. This is specially important on Regional Bands like US915, AU915, and CN470.
>
> To configure the masking of channels for the sub-bands, you can use the AT+MASK command that can be found on the AT Commands Manual .
>
> To illustrate, you can use use sub-band 2 by sending the command `AT+MASK=0002`.

List of band parameter options

Code	Regional Band
0	EU433
1	CN470
2	RU864
3	IN865
4	EU868
5	US915
6	AU915
7	KR920
8 or 8-1	AS923-1
8-2	AS923-2

Code	Regional Band
8-3	AS923-3
8-4	AS923-4

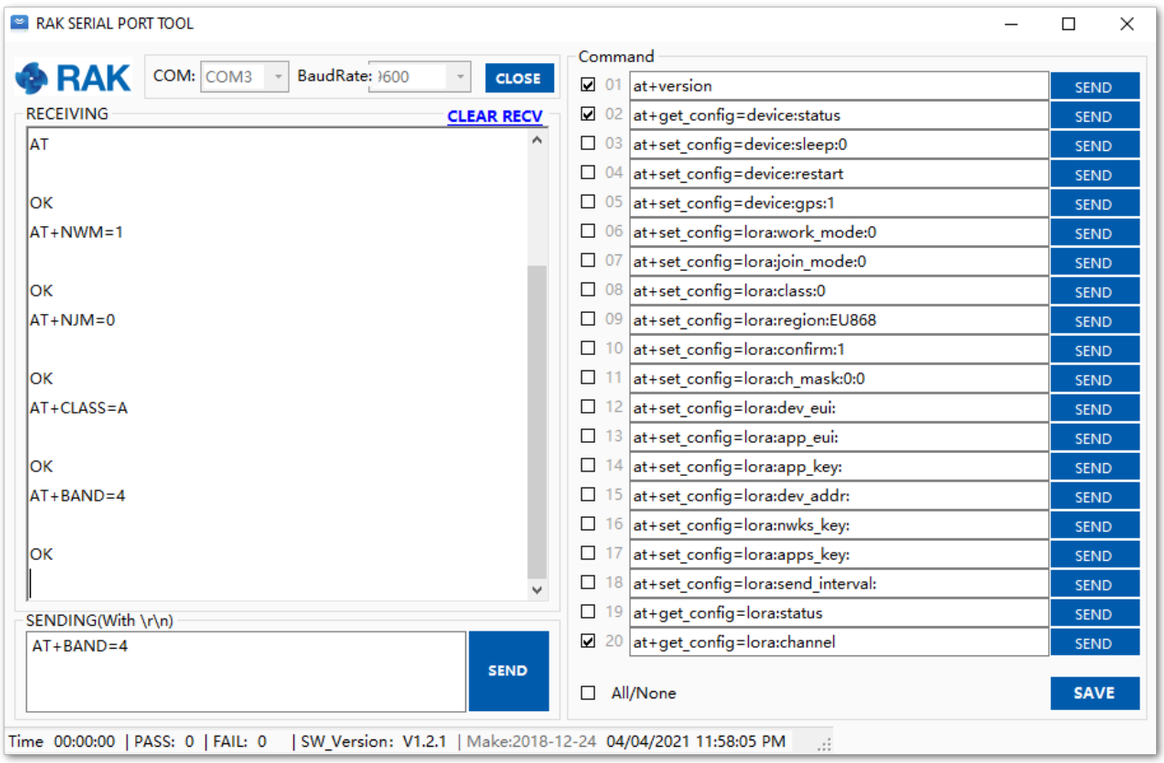

Figure 30: Configuring LoRa Parameters

After configuration of the LoRaWAN parameters, the next step is to setup the device address and sessions keys. You need the use the values from the TTN console.

- Device Address: **260BDE80**
- Application Session Key: **A585903A949C2B2D44B55E99E94CB533**
- Network Session Key: **433C7A924F7F6947778FE821525F183A**

Set the Device Address.

```
AT+DEVADDR=260BDE80
```

Set the Application Session Key.

```
AT+APPSKEY=A585903A949C2B2D44B55E99E94CB533
```

Set the Network Session Key.

```
AT+NWKSKEY=433C7A924F7F6947778FE821525F183A
```

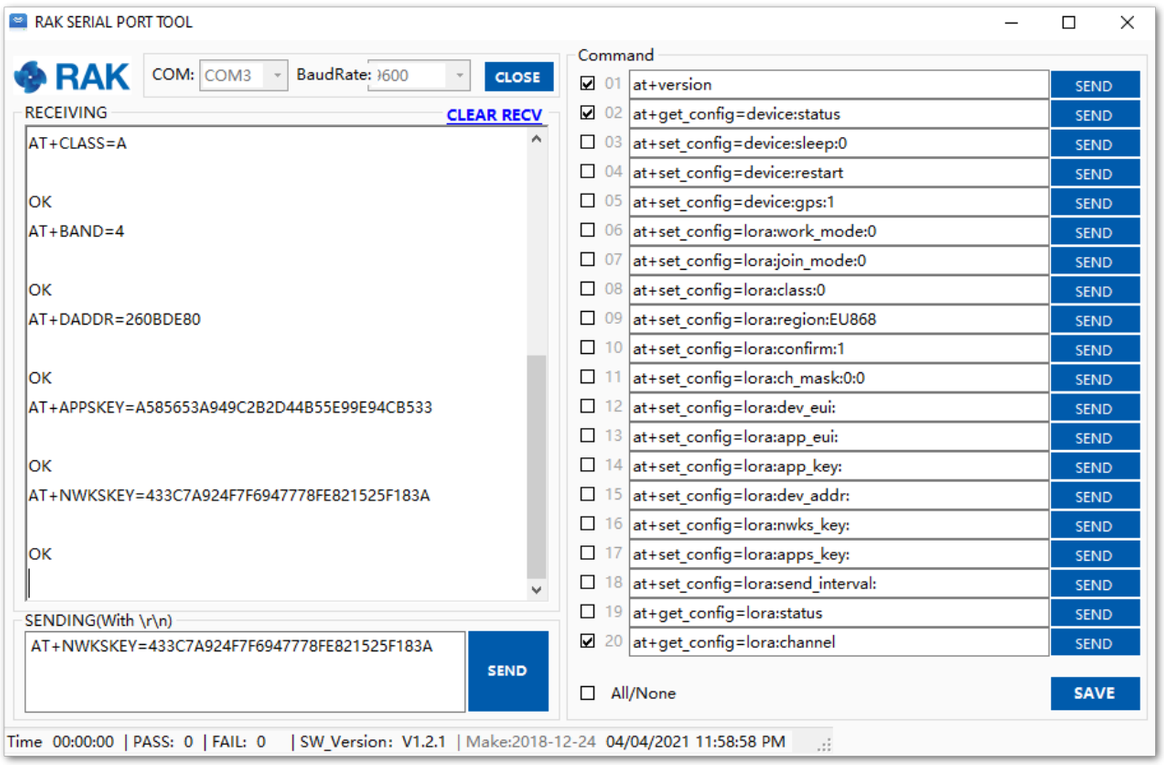

Figure 31: Configuring LoRa Parameters

After EUI and keys configuration, the device can now join the network and send some payload.

```
AT+JOIN=1:0:8:0
```

Join command format: `AT+JOIN=w:x:y:z`

Parameter	Description
w	Join command - 1: joining, 0: stop joining.
x	Auto-join config - 1: auto-join on powerup, 0: no auto-join
y	Reattempt interval in seconds (7-255) - 8 is default.
z	Number of join attempts (0-255) - 0 is default.

With the end-device properly activated, you can now try to send some payload after successful join.

```
AT+SEND=3:12341234
```

Send command format: `AT+SEND=<port>:<payload>`

> 📝 **NOTE:**
>
> If your LoRaWAN payload didn't reach the TTN, check if your device is within reach of a working LoRaWAN gateway that is configured to connect to TTN. It is also important to check that all your ABP parameters (DEVADDR, APPSKEY and NWKSKEY) are correct by using `AT+DEVADDR=?`, `AT+APPSKEY=?` and `AT+NWKSKEY=?` commands. Lastly, ensure that the antenna of your device is properly connected.
>
> After checking all the things above, try to send LoRaWAN payloads again.

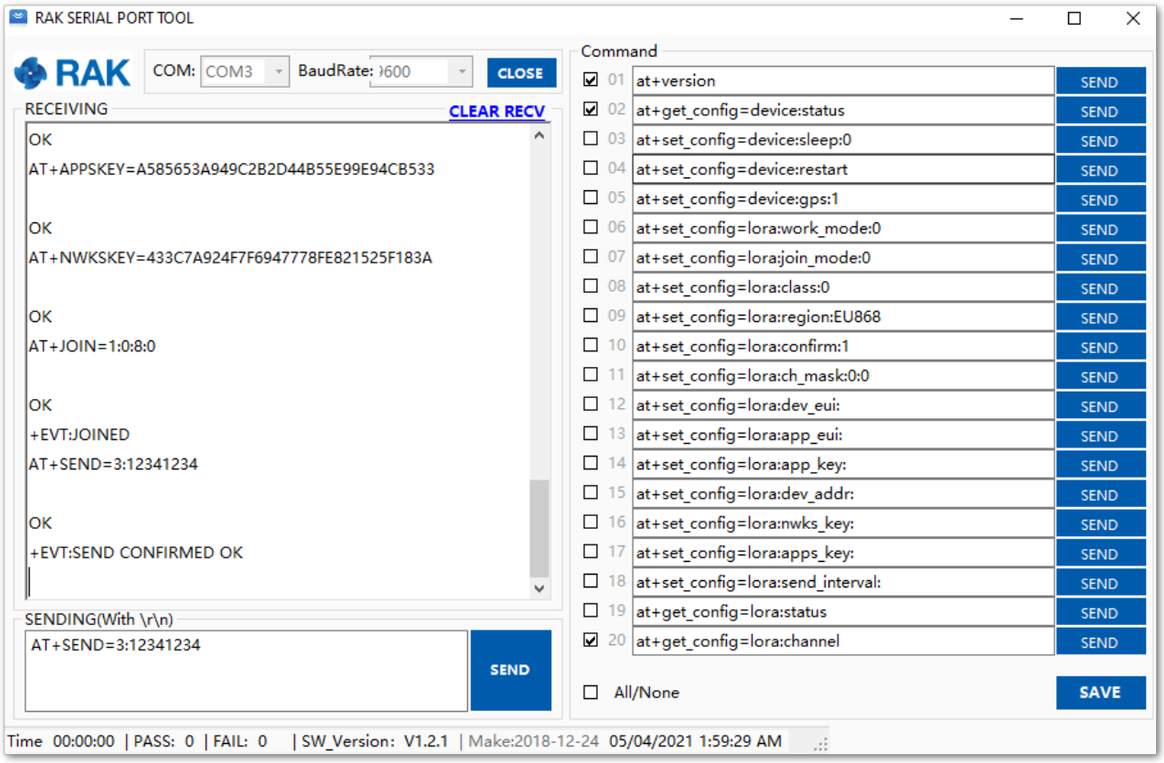

Figure 32: ABP Test Sample Data Sent via RAK Serial Port Tool

You can see the data sent by the RAK3172 module on the TTN device console *Live data* section and the *Last seen* info should be few seconds ago.

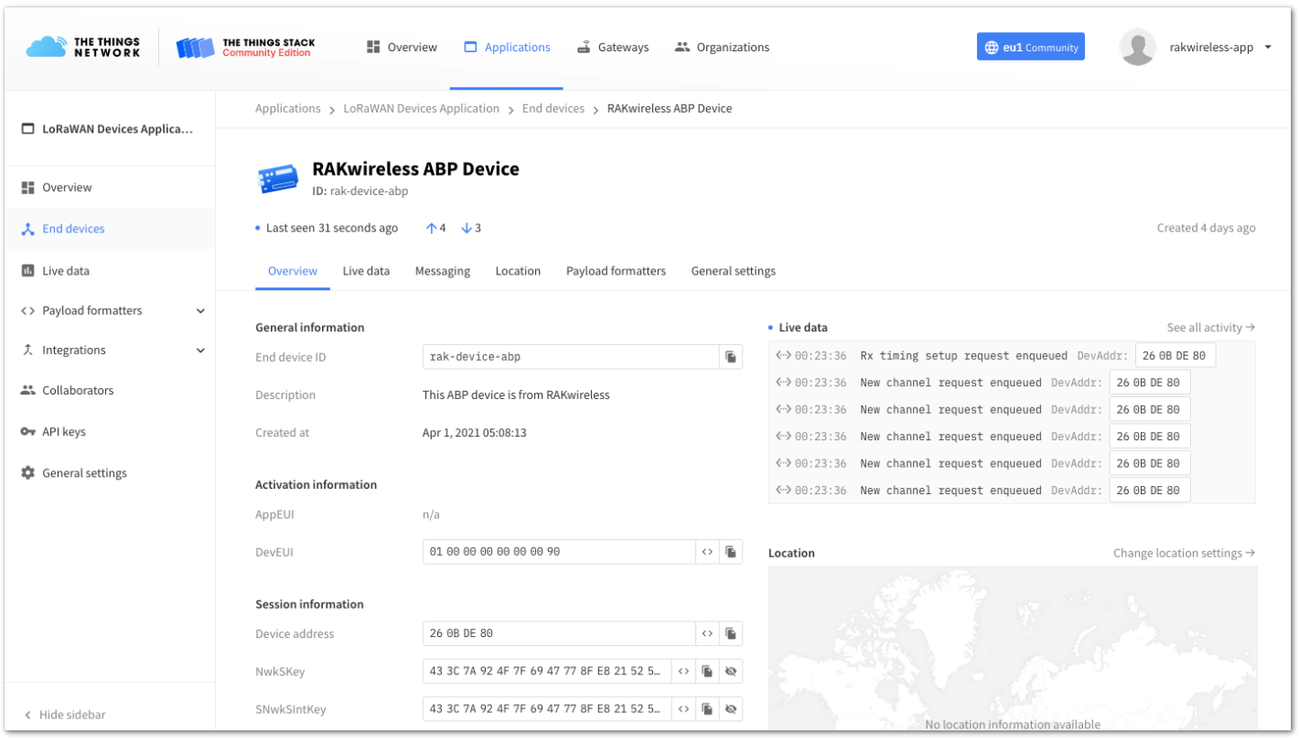

Figure 33: OTAA Test Sample Data Sent Viewed in TTN

Connecting with ChirpStack

In this section, it shows how to connect the RAK3172 module to the ChirpStack platform.

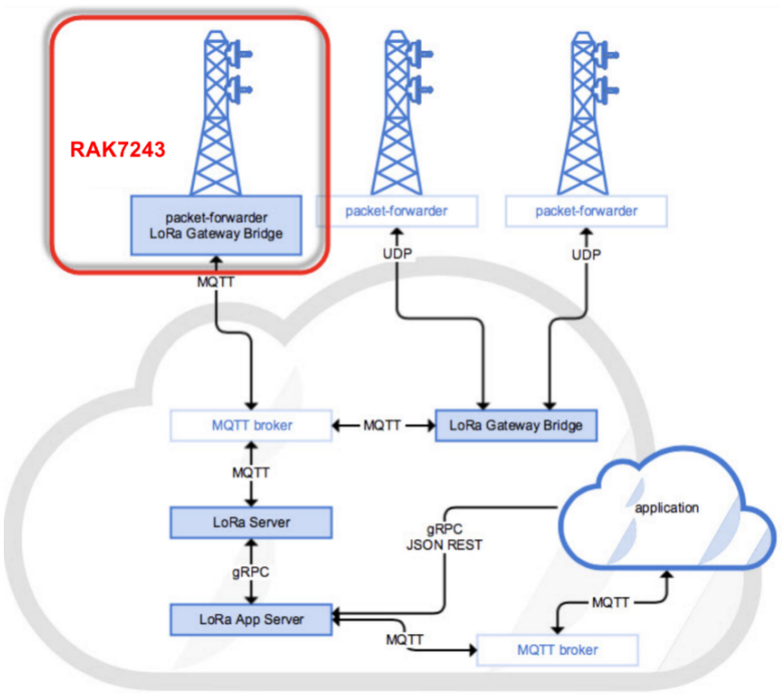

Figure 34: RAK3172 Module in the Context of the ChirpStack Platform

The ChirpStack, previously known as the LoRaServer project, provides open-source components for building LoRaWAN networks. Like in the case of TTN, the RAK3172 module is located in the periphery and will transmit the data to the backend servers through a LoRa gateway. Learn more about ChirpStack .

> 📝 **NOTE:**
>
> It is assumed that you are using a RAK Gateway and its built-in ChirpStack. Also, the gateway with the ChirpStack must be configured successfully. For further information, check the RAK documents for more details.

- In summary, these are the requirements:

1. A ChirpStack online gateway, the frequency band of the nodes should be consistent with the frequency band of the gateway in use.
   - Connect the Gateway with Chirpstack
2. The RAK Serial Port Tool provided by RAK
3. RAK3172 module

> 📝 **NOTE:**
>
> The frequency band used in the demonstration is EU868. Use a high-frequency version of RAK3172. The product number should be “**RAK3172 (H)**”.

Create a New Application

Login to the ChirpStack server using your account and password.

Go to the Application section as shown in the Figure 35.

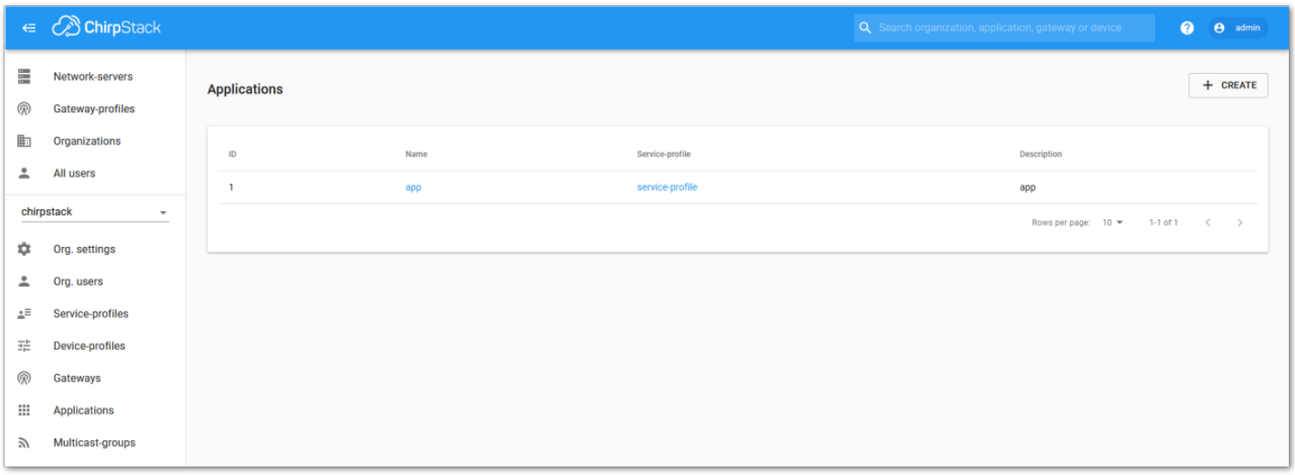

Figure 35: Application Section

By default, you should create a new application, although you can reuse existing ones. For this setup, create a new Application by clicking on the "**CREATE**" button, and fill the required parameters as shown in the Figures 36 and 37.

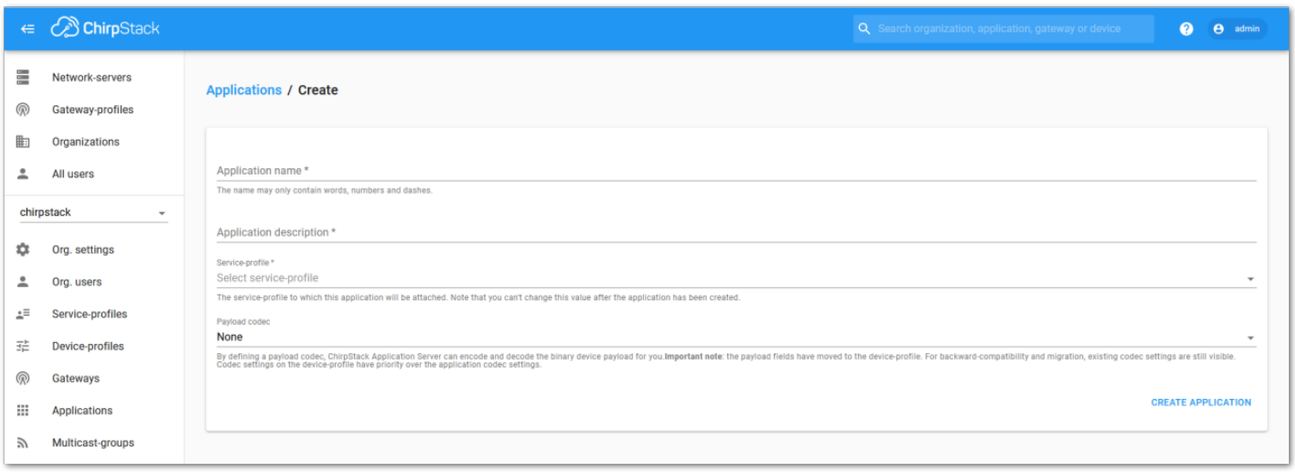

Figure 36: Creating a New Application

- For this setup, create an Application named "**rak_node_test**".

ChirpStack LoraServer supports multiple system configurations, with only one by default.

- **Service profile**: Field is to select the system profile.
- **Payload codec**: It is the parsing method for selecting load data such as parsing LPP format data.

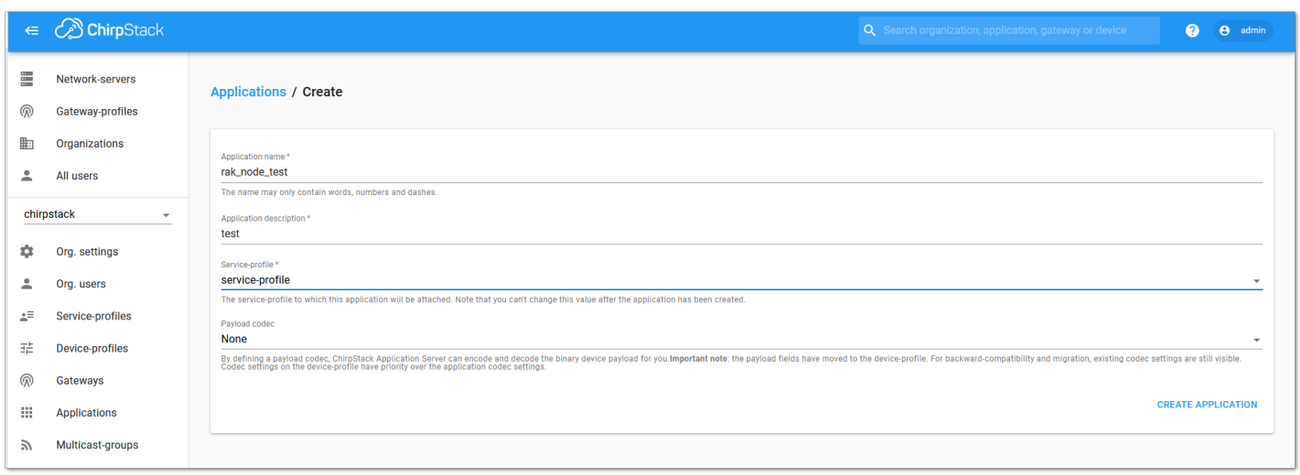

Figure 37: Filling Parameters of an Application

Register a New Device

1. Choose the **Application** created in the previous step, then select the **DEVICES** tab as shown in Figures 38 and 39.

2. Once done, click "**+ CREATE**".

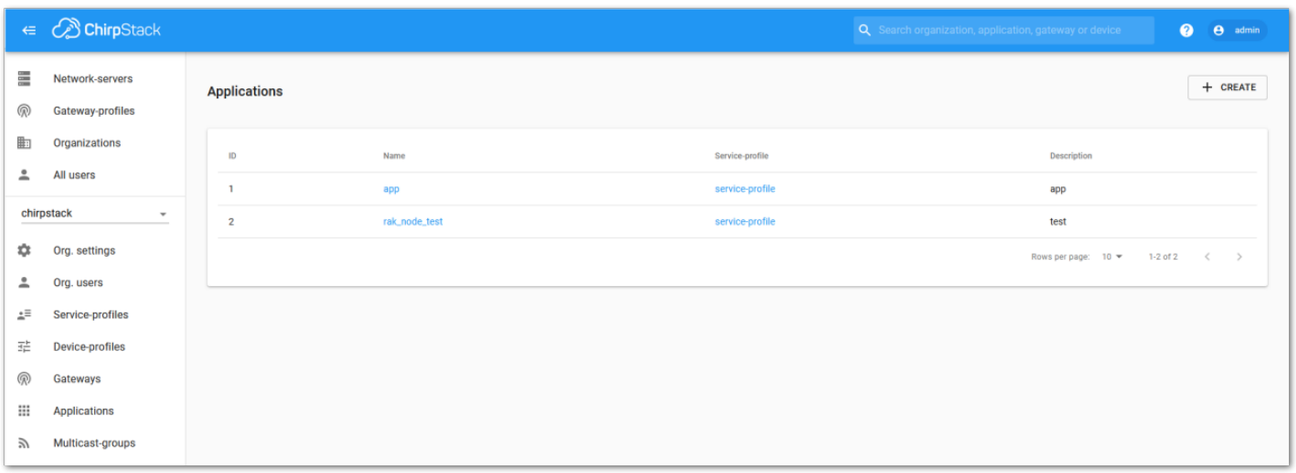

Figure 38: List of Applications Created

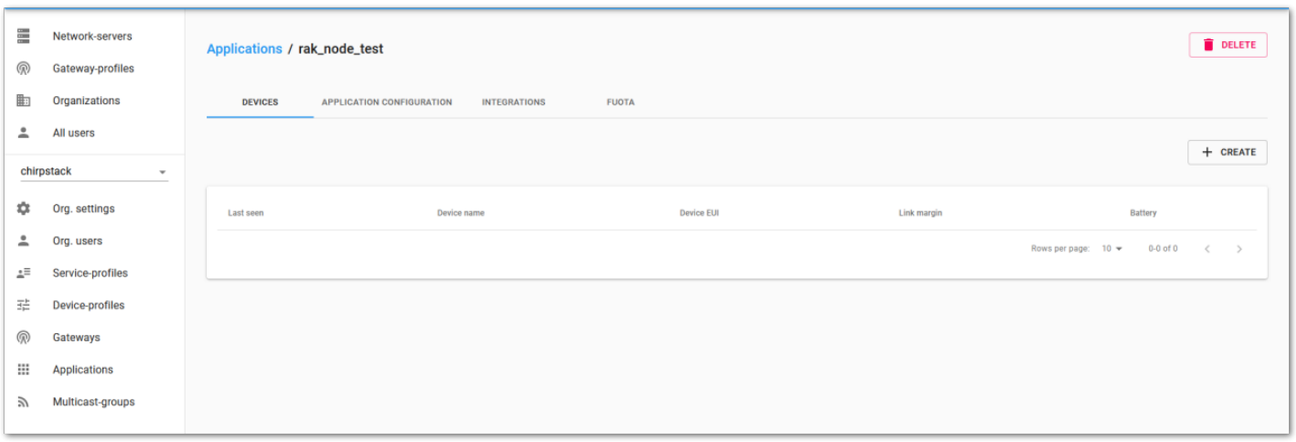

Figure 39: Device Tab of an Application

3. Once inside of the DEVICE tab, create a new device (LoRaWAN node) by clicking on the "**+ CREATE**" button.

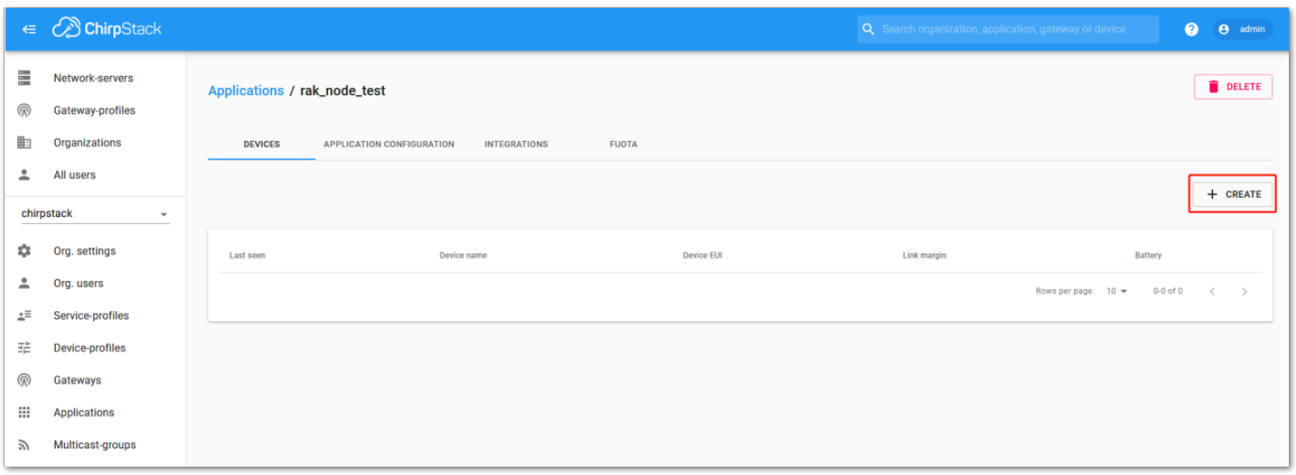

Figure 40: Add a New Device

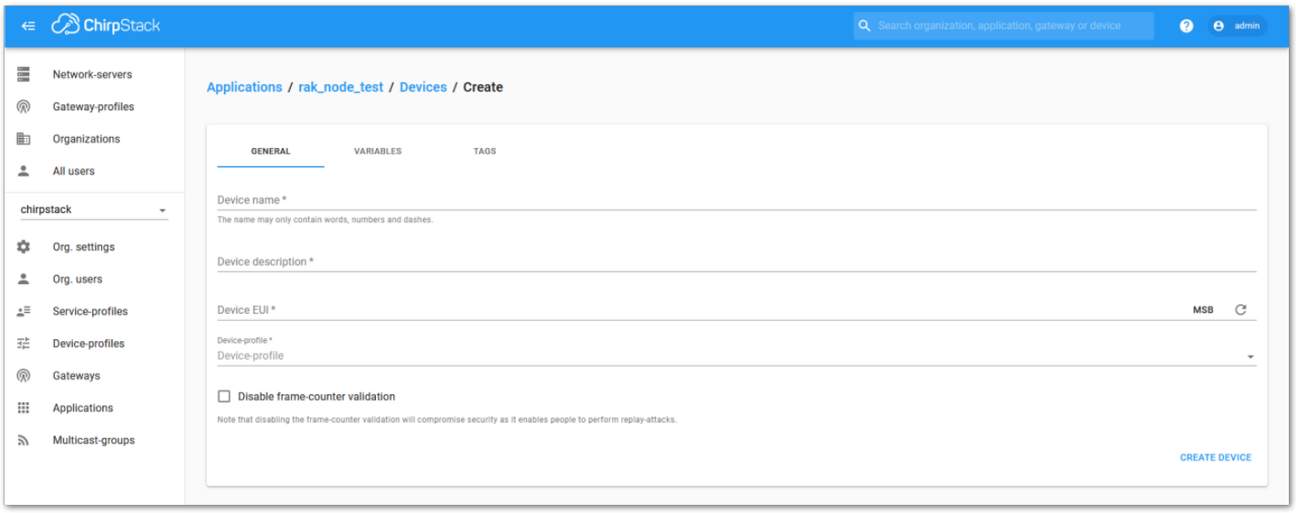

Figure 41: Chirpstack Adding Node into the RAK3172 Module

6. Once the node is created, fill in the necessary data. You can generate a Device EUI automatically by clicking the following icon, or you can write a correct Device EUI in the edit box.

Fill the parameters requested:

- **Device name and Device description**: These are descriptive texts about your device.
- **Device EUI**: This interface allows you to generate a Device EUI automatically by clicking the generate icon. You can also add a specific Device EUI directly in the form.
- **Device Profile**:
  - If you want to join in OTAA mode, select “**DeviceProfile_OTAA**”.
  - If you want to join in ABP mode, select “**DeviceProfile_ABP**”.

> 📝 **NOTE:**
>
> Device profiles **DeviceProfile_OTAA** and **DeviceProfile_ABP** are only available if you are using the built-in Chirpstack LoRaWAN Server of RAK Gateways.
>
> If you have your own Chirpstack installation, you can set up the device profile with `LoRaWAN MAC version 1.0.3` and `LoRaWAN Regional Parameters revision B` to make it compatible with RAK3172.

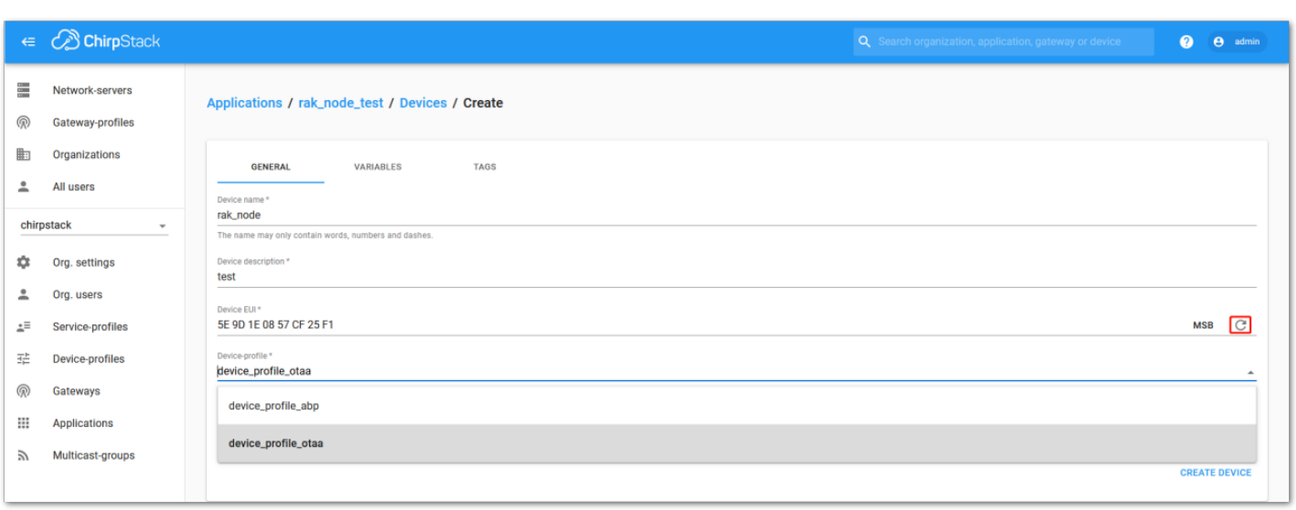

Figure 42: Generate a New Device EUI

Chirpstack OTAA Device Registration

1. If you have selected "**DeviceProfile_OTAA**" as shown in Figure 43, then after the device is created, an Application Key must be also created for this device.

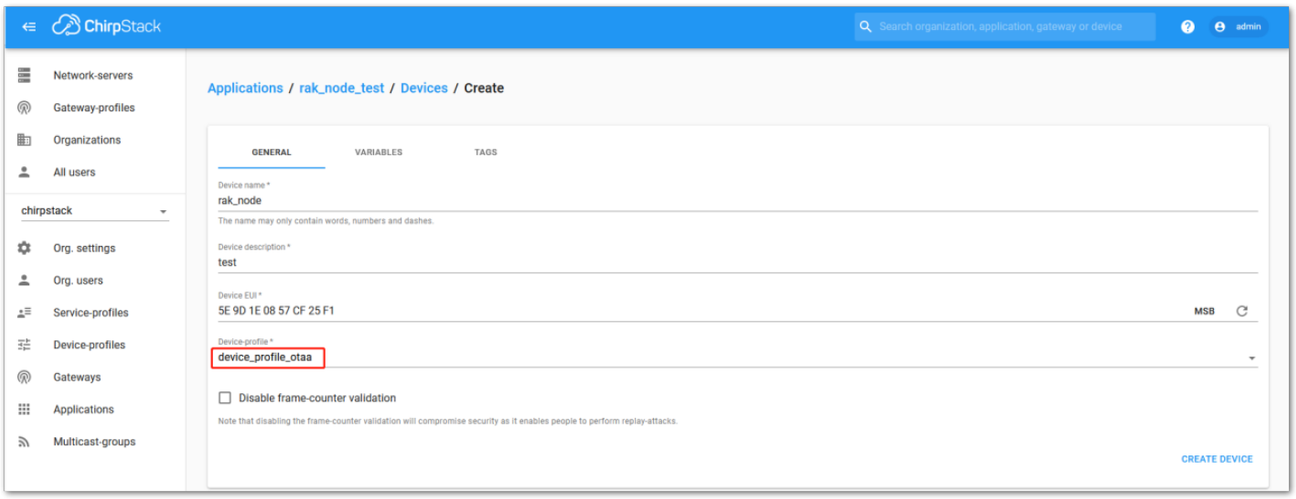

Figure 43: Chirpstack OTAA Activation

2. A previously created Application Key can be entered here, or a new one can be generated automatically by clicking the icon highlighted in red in Figure 44:

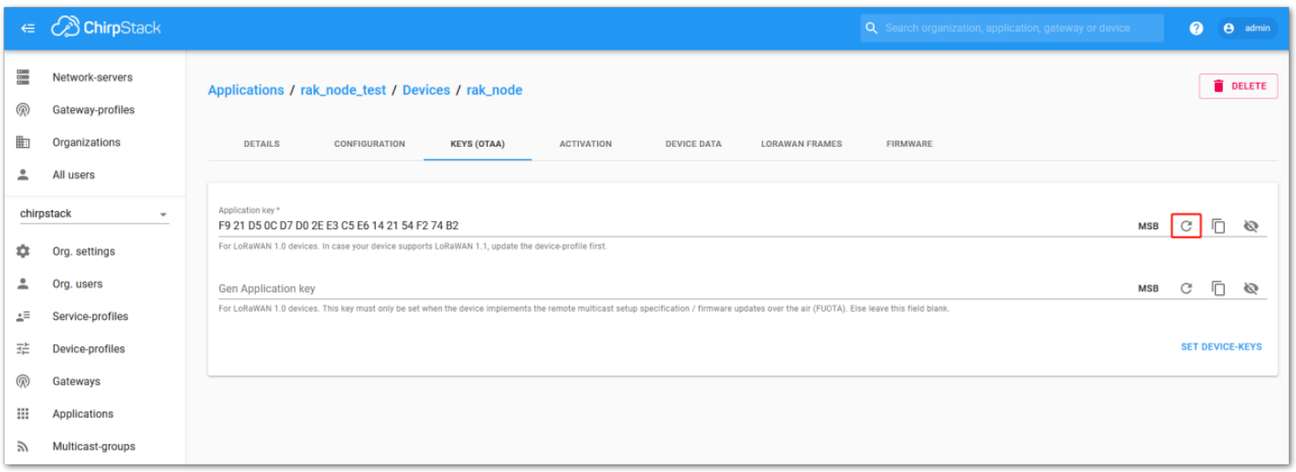

Figure 44: Chirpstack OTAA Set Application Keys

3. Once the Application Key is added in the form, the process can be finalized by clicking on the "**SET DEVICE-KEYS**" button.

- As shown in Figure 45, a new device should be listed in the DEVICES tab. The most important parameters, such as the Device EUI are shown in the summary.

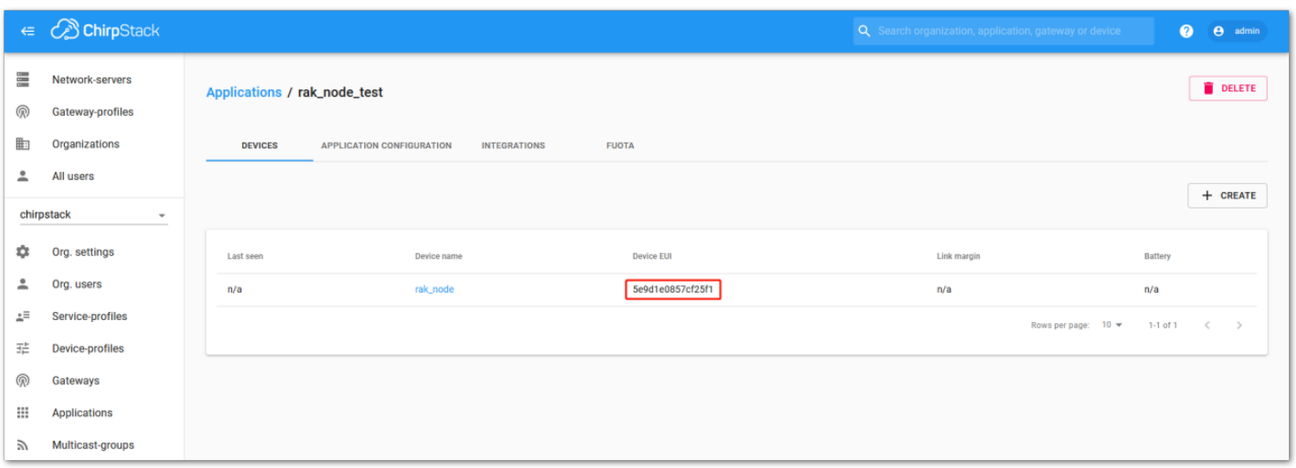

Figure 45: Chirpstack OTAA List of Device in the Device Tab

4. To end the process, it is a good practice to review that the Application Key is properly associated with this device. The Application Key can be verified in the **KEYS(OTAA)** tab as shown in Figure 46.

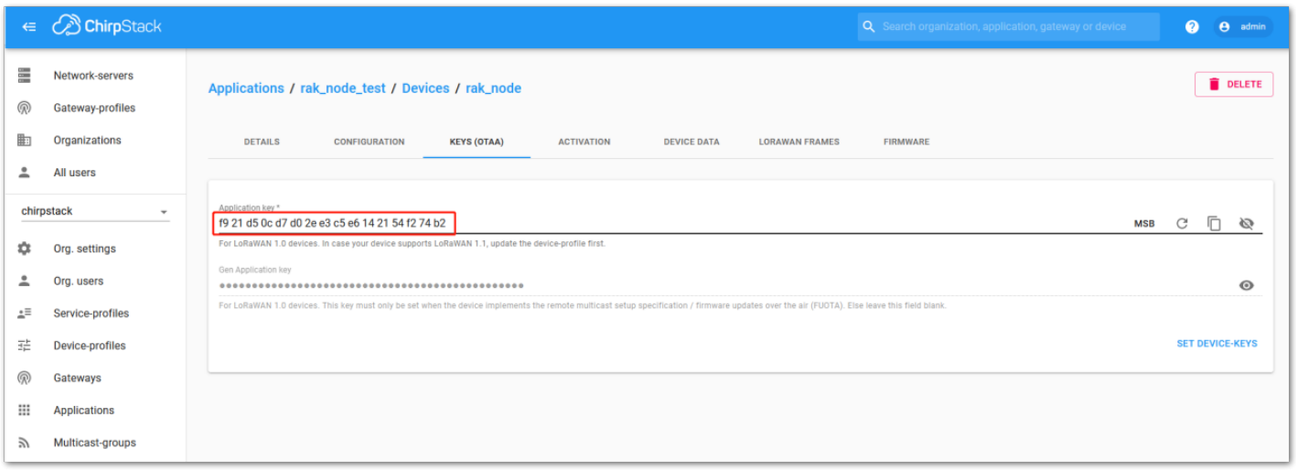

Figure 46: Application Key Associated with the New Device

> 📝 **NOTE:**
>
> Standard OTAA mode requires the **Device EUI**, **Application Key**, and **Application EUI**, but in the ChirpStack's implementation, only the Device EUI and the Application Key are mandatory. The Application EUI is not required and not recorded in the Application tab. Nevertheless, you can reuse the Device EUI as the Application EUI during the configuration in the side of the node.

OTAA Configuration for Chirpstack

The RAK3172 module supports a series of AT commands to configure its internal parameters and control the functionalities of the module.

To set up the RAK3172 module to join the Chirpstack using OTAA, start by connecting the RAK3172 module to the Computer (see Figure 1) and open the RAK Serial Port Tool. Select the right COM port and set baudrate to 9600.

It is recommended to start by testing the serial communication and verify that the current configuration is working by sending these two AT commands:

```
AT
```

```
ATE
```

`ATE` will echo the commands you input to the module, which is useful for tracking the commands and troubleshooting.

You will receive `OK` when you input the two commands. After setting `ATE`, you can now see all the commands you input together with the replies. Try again `AT` and you should see it on the terminal followed by `OK` as shown on Figure 47.

> 📝 **NOTE:**
>
> If do not receive an `OK` or any reply, you need to check if the wiring of your UART lines is correct and if the baud is correctly configured to 9600. Also you can check if the device is powered correctly. If you are getting power from USB port, ensure that you have a good USB cable.

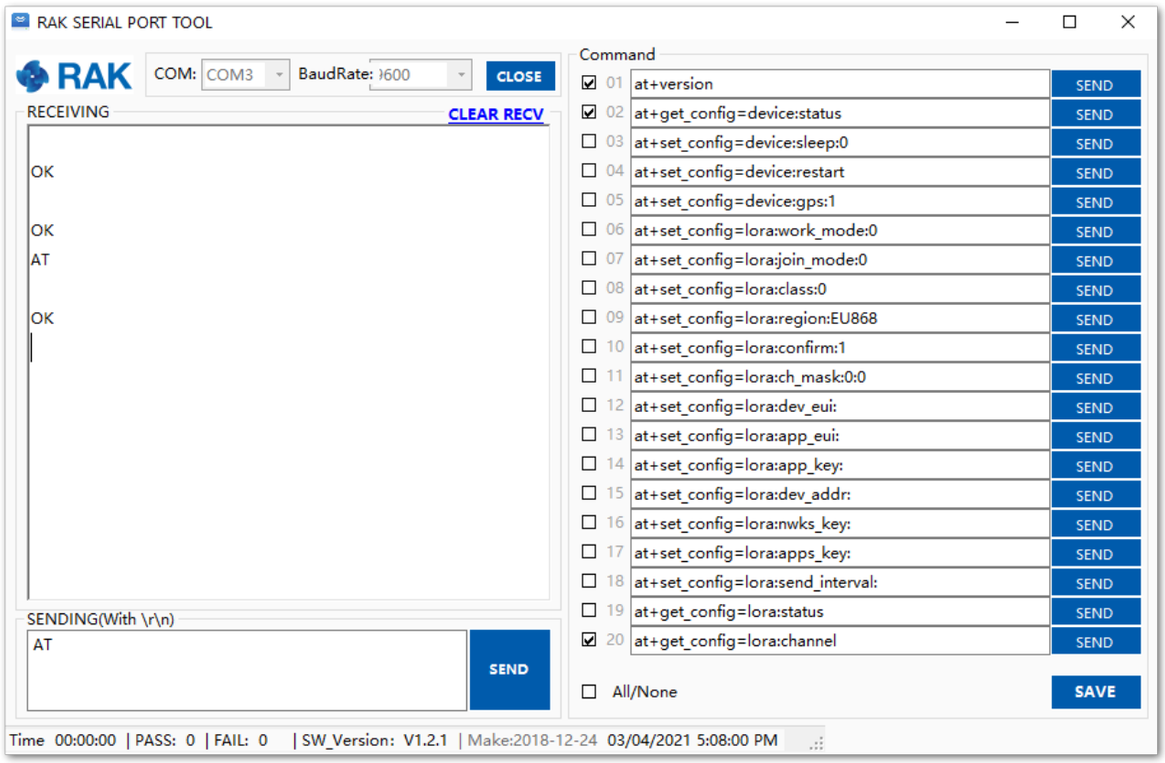

Figure 47: at+version command response

The next step is to configure the OTAA LoRaWAN parameters in RAK3172:

- LoRa work mode: **LoRaWAN**
- LoRaWAN join mode: **OTAA**
- LoRaWAN class: **Class A**
- LoRaWAN region: **EU868**

Set the work mode to LoRaWAN.

```
AT+NWM=1
```

Set the LoRaWAN activation to OTAA.

```
AT+NJM=1
```

Set the LoRaWAN class to Class A.

```
AT+CLASS=A
```

Set the frequency/region to EU868.

```
AT+BAND=4
```

> 📝 **NOTE:**
>
> Depending on the Regional Band you selected, you might need to configure the sub-band of your RAK3172 to match the gateway and LoRaWAN network server. This is specially important for Regional Bands like US915, AU915, and CN470.
>
> To configure the masking of channels for the sub-bands, you can use the AT+MASK command that can be found on the AT Commands Manual .
>
> To illustrate, you can use use sub-band 2 by sending the command `AT+MASK=0002`.

List of band parameter options

Code	Regional Band
0	EU433
1	CN470
2	RU864
3	IN865
4	EU868
5	US915
6	AU915
7	KR920
8 or 8-1	AS923-1
8-2	AS923-2
8-3	AS923-3
8-4	AS923-4

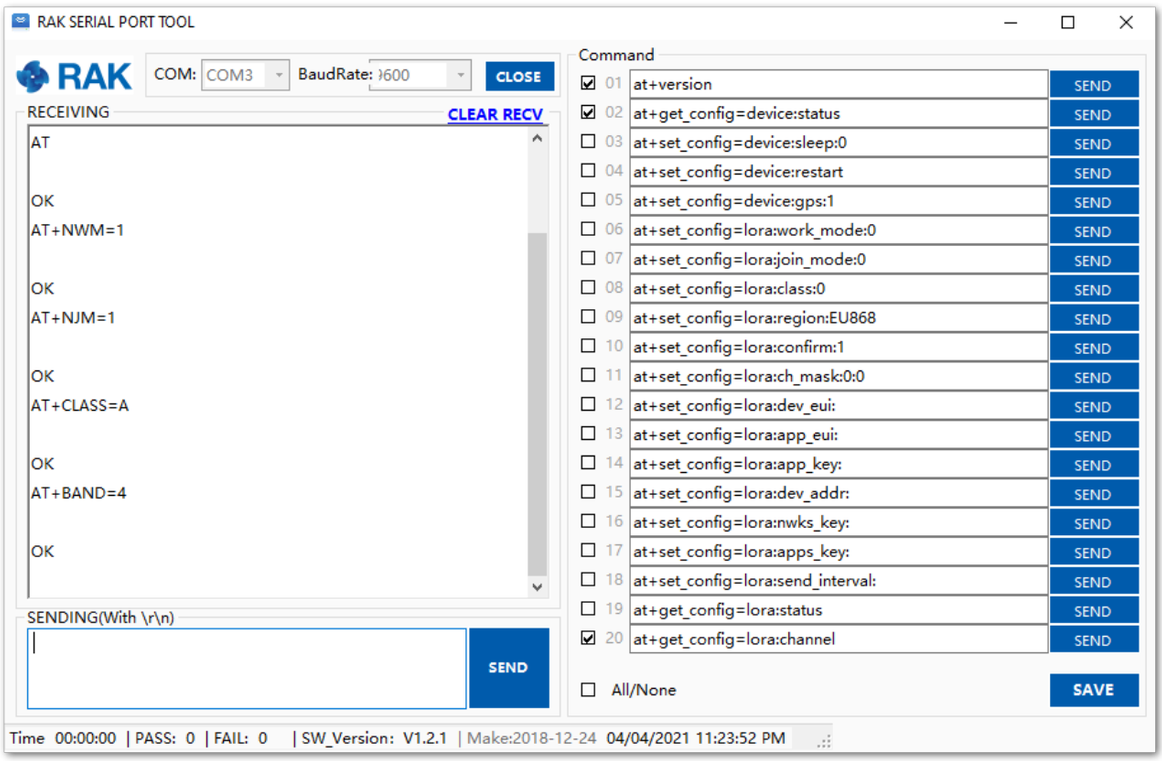

Figure 48: Configuring LoRa Parameters

After configuration of the LoRaWAN parameters, the next step is to set up the DevEUI and AppKey. You need the use the values from the Chirpstack device console.

> 📝 **NOTE:**
>
> The Application EUI parameter is not required in the ChirpStack platform; therefore, it possible to use the same id as the Device EUI.

- Device EUI: **5E9D1E0857CF25F1**
- Application EUI: **5E9D1E0857CF25F1**
- Application Key: **F921D50CD7D02EE3C5E6142154F274B2**

Set the Device EUI.

```
AT+DEVEUI=5E9D1E0857CF25F1
```

Set the Application EUI.

```
AT+APPEUI=5E9D1E0857CF25F1
```

Set the Application Key.

```
AT+APPKEY=F921D50CD7D02EE3C5E6142154F274B2
```

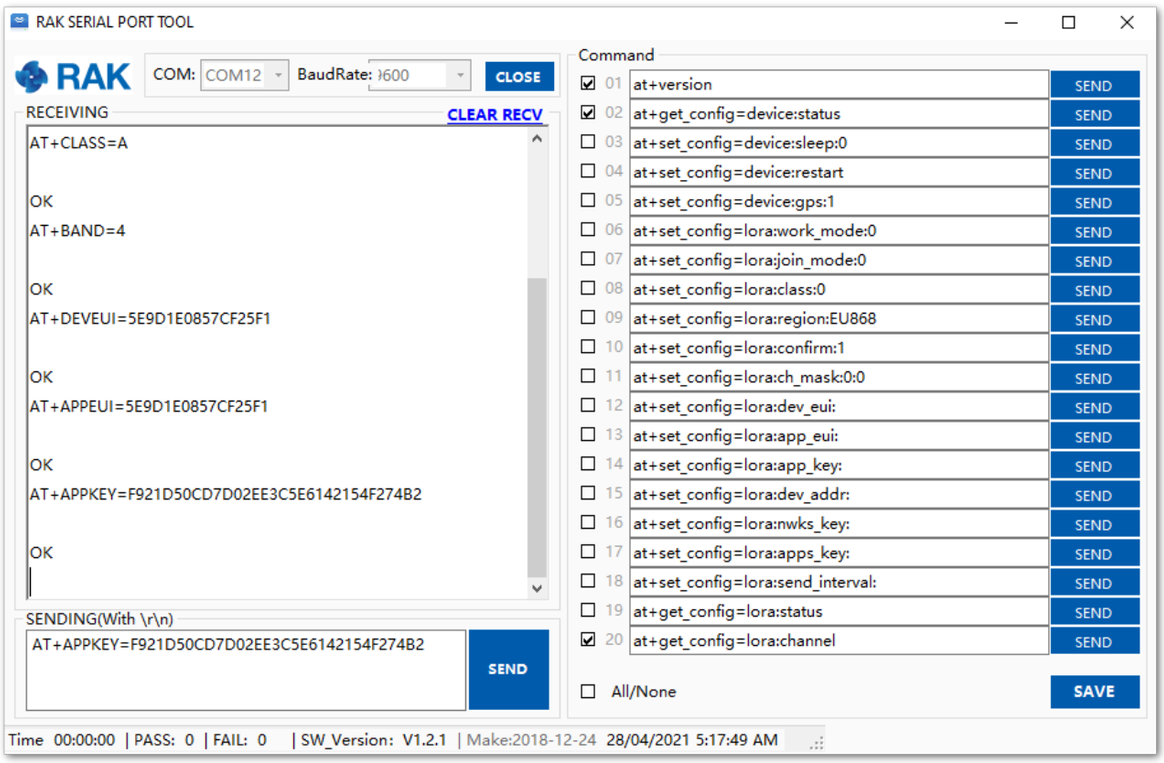

Figure 49: Configuring LoRa Parameters

After EUI and key configuration, the device can now join the network and send some payload.

```
AT+JOIN=1:0:10:8
```

Join command format: `AT+JOIN=w:x:y:z`

Parameter	Description
w	Join command - 1: joining, 0: stop joining.
x	Auto-join config - 1: auto-join on powerup, 0: no auto-join
y	Reattempt interval in seconds (7-255) - 8 is default.
z	Number of join attempts (0-255) - 0 is default.

After 5 or 6 seconds, if the request was successfully received by a LoRa gateway, you should see the JOINED status reply.

> 📝 **NOTE:**
>
> If the OTAA device failed to join, you need to check if your device is within reach of a working LoRaWAN gateway that is configured to connect to Chirpstack. It is also important to check that all your OTAA parameters (DEVEUI and APPKEY) are correct, using the `AT+DEVEUI=?` and `AT+APPKEY=?` commands. Lastly, ensure that the antenna of your device is properly connected.
>
> After checking all the things above, try to join again.

With the end-device properly activated, you can now try to send some payload after a successful join.

```
AT+SEND=2:12345678
```

Send command format: `AT+SEND=<port>:<payload>`

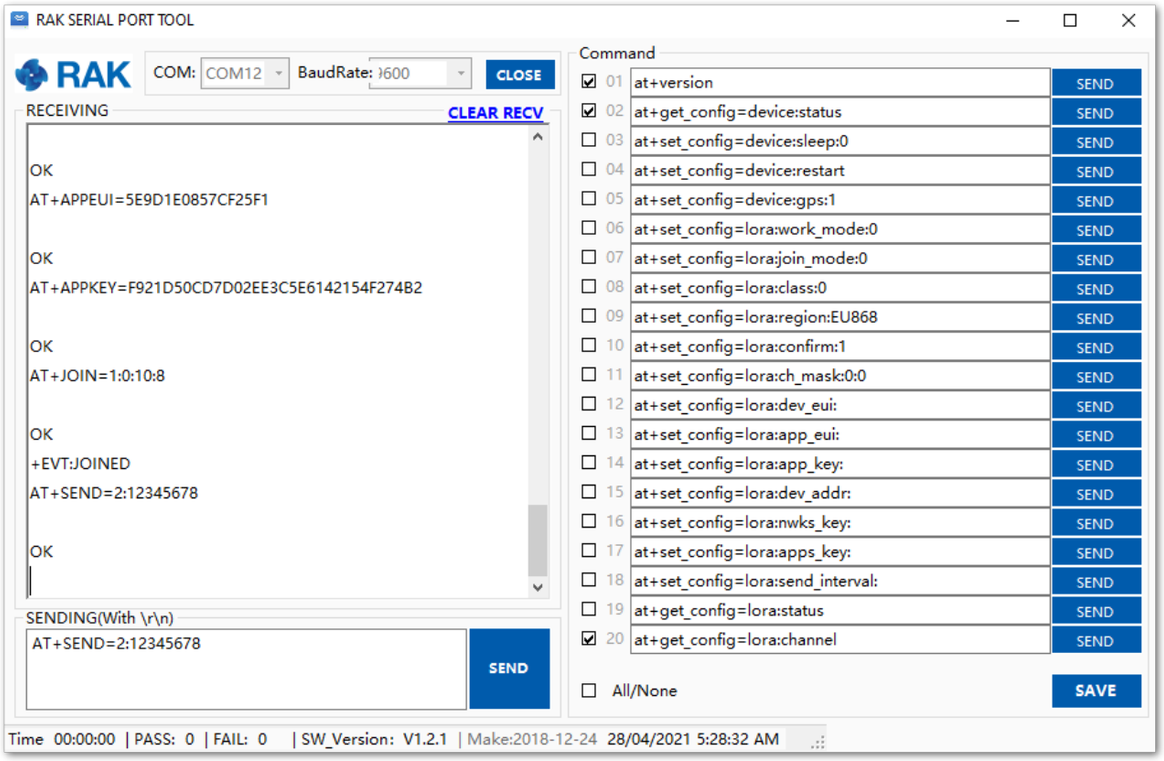

Figure 50: OTAA Test Sample Data Sent via RAK Serial Port Tool

On the ChirpStack platform, you should see the join and uplink messages in the LORAWAN FRAMES tab as shown in Figure 51. By convention, messages sent from nodes to gateways are considered as **Uplinks** while messages sent by gateways to nodes are considered as **Downlinks**.

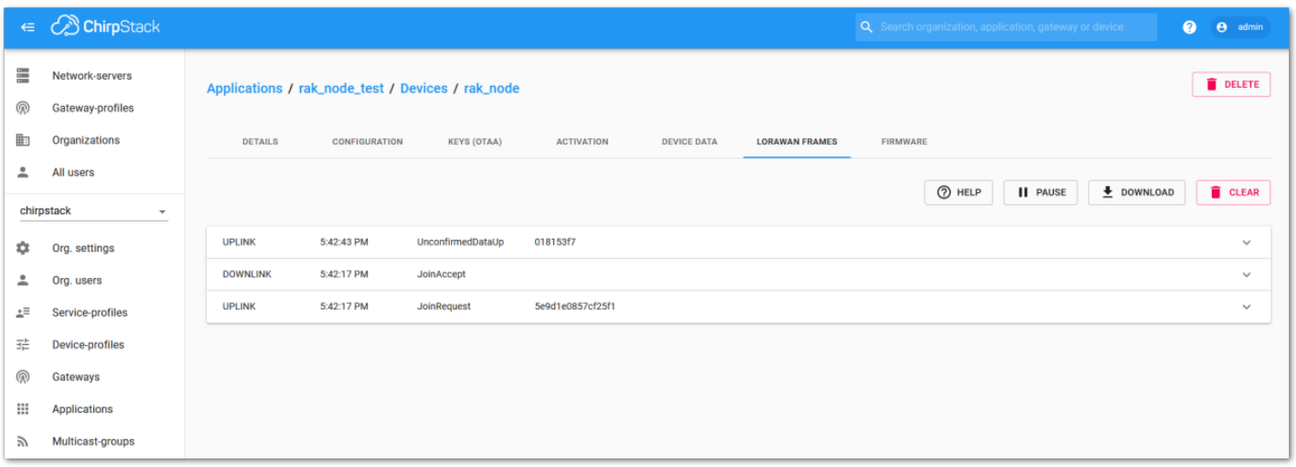

Figure 51: Chirpstack Data Received Preview

Chirpstack ABP Device Registration

During the registration of a new device, if you select “**DeviceProfile_ABP**”, as shown in Figure 52, then the ChirpStack platform will assume that this device will join to the LoRaWAN network using the ABP mode.

> 📝 **NOTE:**
>
> Check "**Disable counting frame verification**". During the test, when the module is restarted, the frame counting number will be also be restarted from zero. This would cause a synchronization problem with the ChirpStack server treating it as a replay attack. For the testing purpose, it is safe to disable this feature, but remember to activate it in a production environment.

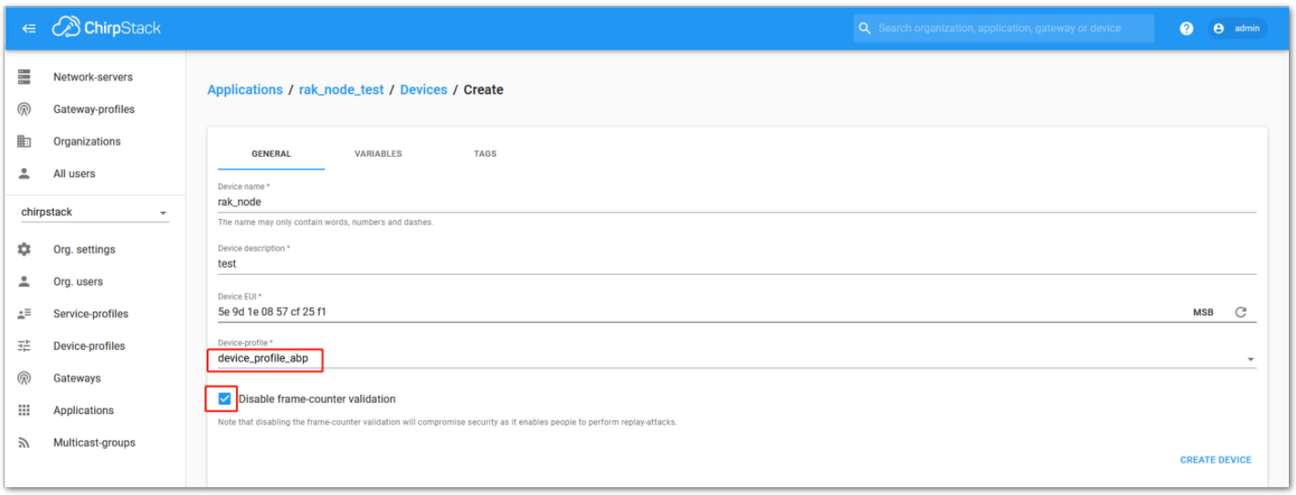

Figure 52: ChirpStack Console, Configuring a Device

After selecting the ABP mode, the following parameters appear in the Activation tab:

2. Then, you can see that there are some parameters for ABP in the **"ACTIVATION"** item:

- **Device address**
- **Network Session Key**
- **Application Session Key**

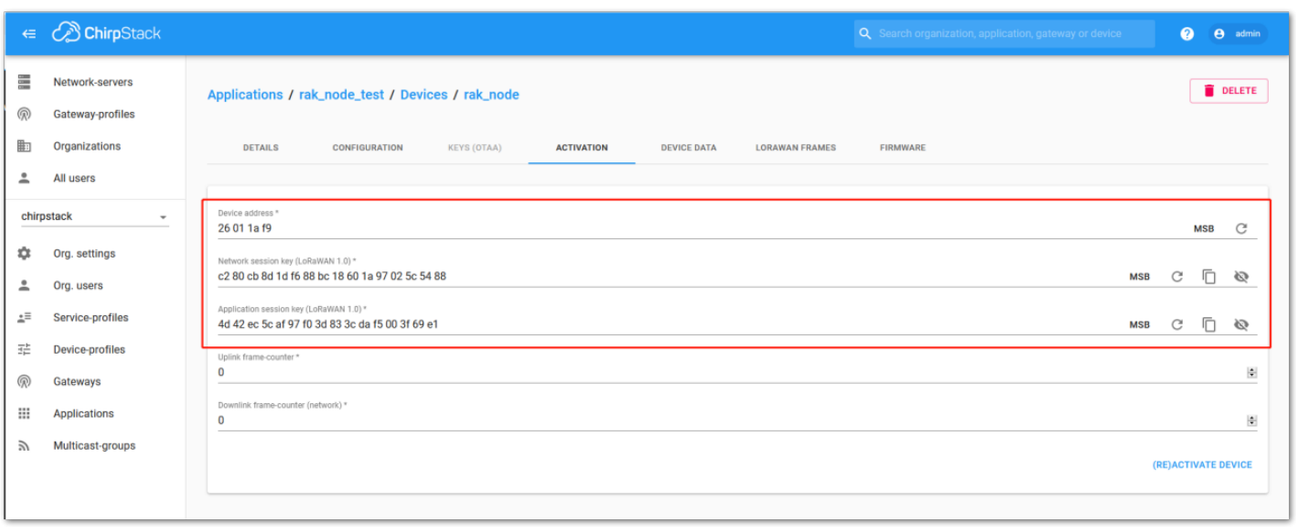

Figure 53: Chirpstack ABP Activation Parameters Needed

- The parameters can be generated as random numbers by the platform or can be set with user values. Once these parameters are filled properly, the process is completed by clicking on the "**ACTIVATE DEVICE**" button.

ABP Configuration for Chirpstack

To set up the RAK3172 module to join the Chirpstack using ABP, start by connecting the RAK3172 module to the Computer (see Figure 1) and open the RAK Serial Port Tool. Select the right COM port and set baudrate to 9600.

It is recommended to start by testing the serial communication and verify that the current configuration is working by sending these two AT commands:

```
AT
```

```
ATE
```

`ATE` will echo the commands you input to the module, which is useful for tracking the commands and troubleshooting.

You will receive `OK` when you input the two commands. After setting `ATE`, you can now see all the commands you input together with the replies. Try again `AT` and you should see it on the terminal followed by `OK` as shown on Figure 54.

> 📝 **NOTE:**
>
> If do not receive an `OK` or any reply, you need to check if the wiring of your UART lines is correct and if the baud is correctly configured to 9600. Also you can check if the device is powered correctly. If you are getting power from USB port, ensure that you have a good USB cable.

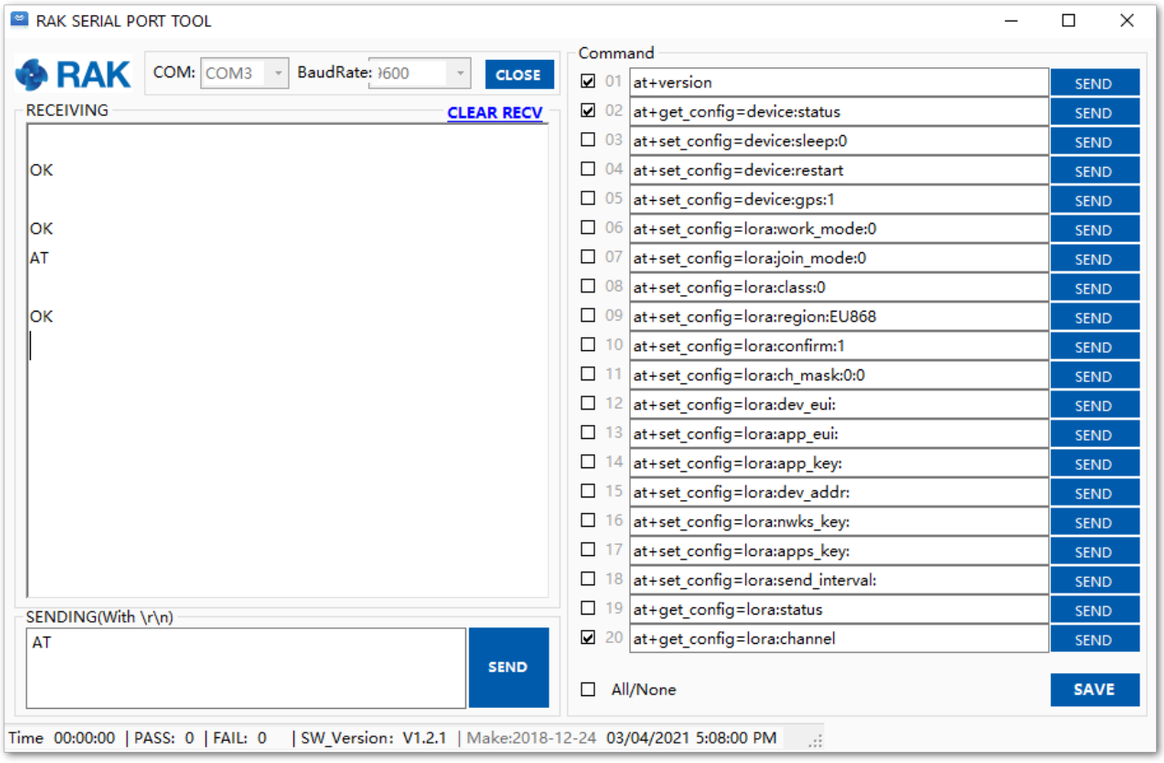

Figure 54: at+version command response

The next step is to configure the ABP LoRaWAN parameters in RAK3172:

- LoRa work mode: **LoRaWAN**
- LoRaWAN join mode: **ABP**
- LoRaWAN class: **Class A**
- LoRaWAN region: **EU868**

Set the work mode to LoRaWAN. It can be set to P2P as well but by default the device is in LoRaWAN mode.

```
AT+NWM=1
```

Set the LoRaWAN activation to ABP.

```
AT+NJM=0
```

Set the LoRaWAN class to Class A.

```
AT+CLASS=A
```

Set the frequency/region to EU868.

```
AT+BAND=4
```

> 📝 **NOTE:**
>
> Depending on the Regional Band you selected, you might need to configure the sub-band of your RAK3172 to match the gateway and LoRaWAN network server. This is specially important on Regional Bands like US915, AU915, and CN470.
>
> To configure the masking of channels for the sub-bands, you can use the AT+MASK command that can be found on the AT Commands Manual.
>
> To illustrate, you can use use sub-band 2 by sending the command `AT+MASK=0002`.

List of band parameter options

Code	Regional Band
0	EU433
1	CN470
2	RU864
3	IN865
4	EU868
5	US915
6	AU915
7	KR920
8 or 8-1	AS923-1
8-2	AS923-2

Code	Regional Band
8-3	AS923-3
8-4	AS923-4

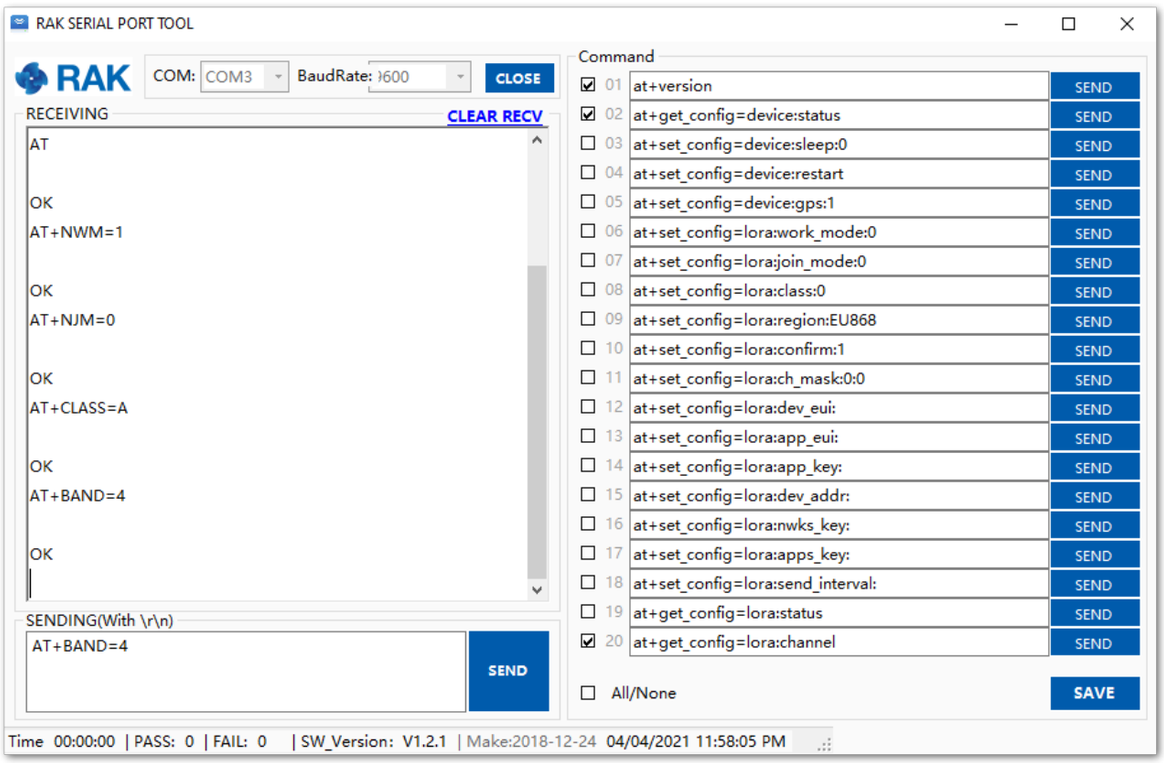

Figure 55: Configuring LoRa Parameters

After configuration of the LoRaWAN parameters, the next step is to setup the device address and session keys. You need the use the values from the TTN device console.

- Device Address: **26011AF9**
- Application Session Key: **4D42EC5CAF97F03D833CDAf5003F69E1**
- Network Session Key: **C280CB8D1DF688BC18601A97025C5488**

Set the Device Address.

```
AT+DEVADDR=26011AF9
```

Set the Application Session Key.

```
AT+APPSKEY=4D42EC5CAF97F03D833CDAf5003F69E1
```

Set the Network Session Key.

```
AT+NWKSKEY=C280CB8D1DF688BC18601A97025C5488
```

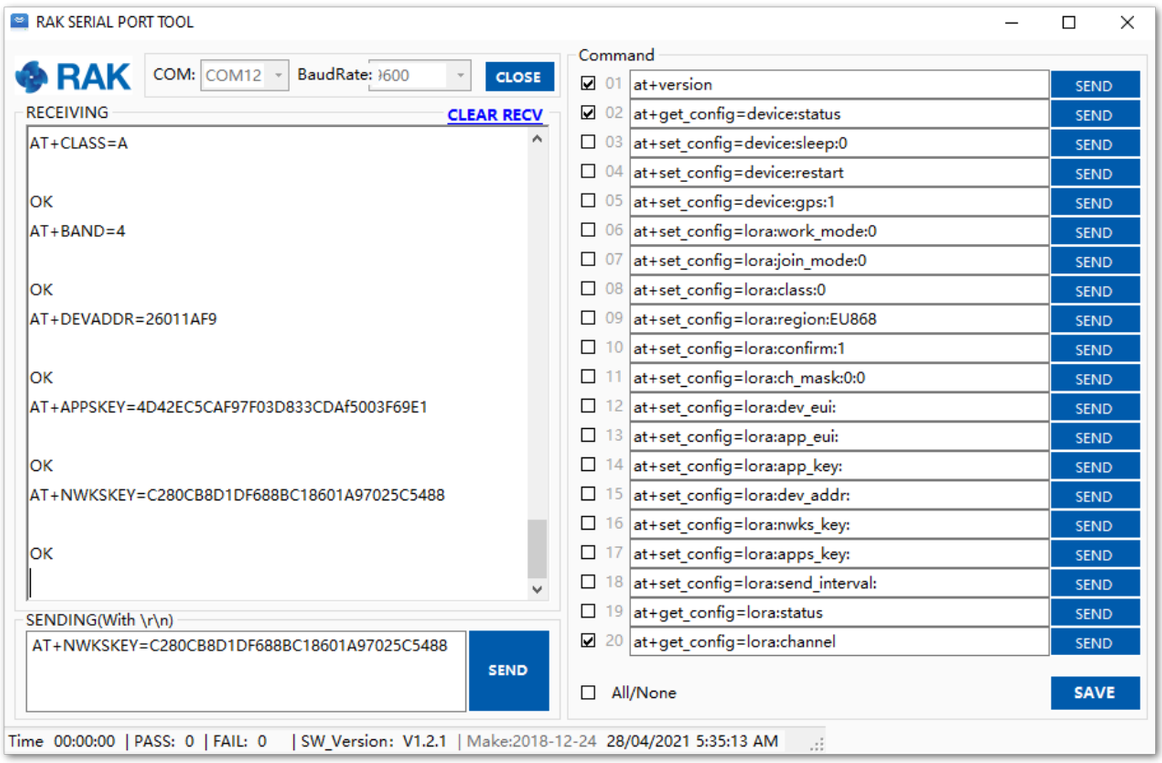

Figure 56: Configuring LoRa Parameters

After EUI and keys configuration, the device can now join the network and send some payload.

```
AT+JOIN=1:0:10:8
```

Join command format: `AT+JOIN=w:x:y:z`

Parameter	Description
w	Join command - 1: joining, 0: stop joining.
x	Auto-join config - 1: auto-join on powerup, 0: no auto-join
y	Reattempt interval in seconds (7-255) - 8 is default.
z	Number of join attempts (0-255) - 0 is default.

After 5 or 6 seconds, if the request was successfully received by a LoRa gateway, then you should see the JOINED status reply.

You can now try to send some payload after successful join.

```
AT+SEND=2:12341234
```

Send command format: `AT+SEND=<port>:<payload>`

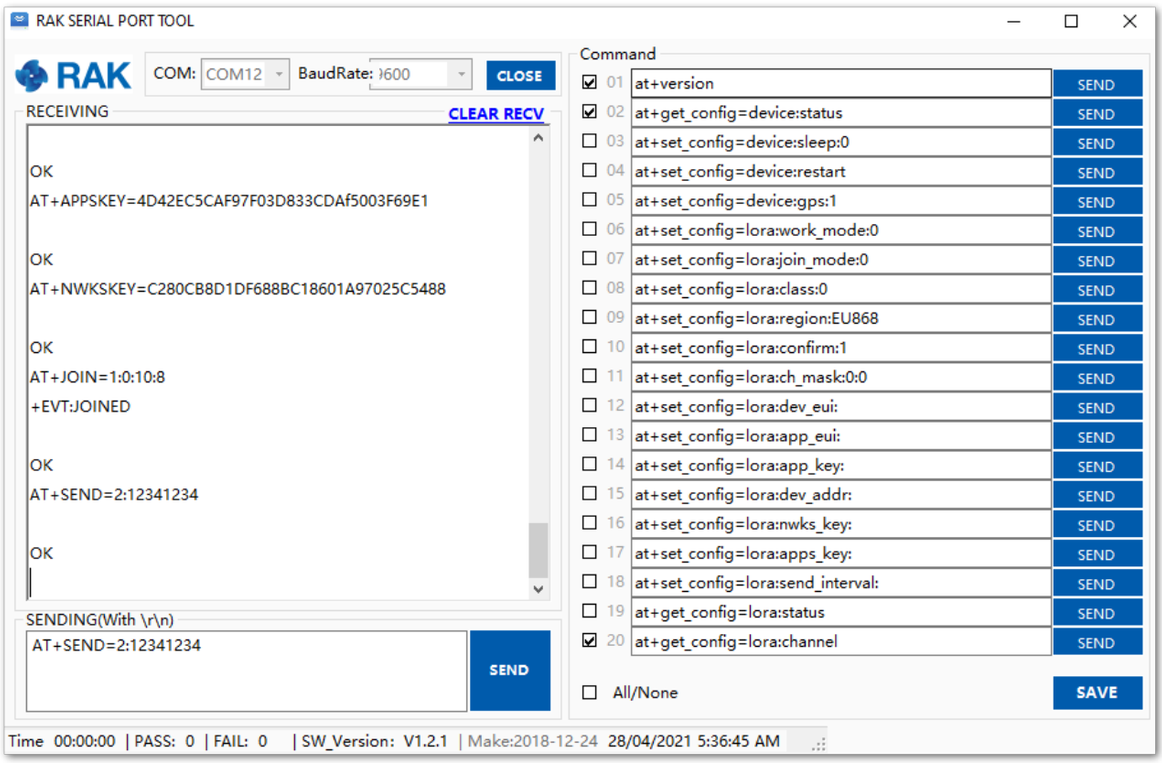

Figure 57: ABP Test Sample Data Sent via RAK Serial Port Tool

LoRa P2P Mode

This section will show you how to set up and connect two RAK3172 units to work in the LoRa P2P mode. The configuration of the RAK3172 units are done by connecting the two modules to a general-purpose computer using a USB-UART converter. The setup of each RAK3172 can be done separately, but testing the LoRa P2P mode will require having both units connected simultaneously. This could be done by having one computer with two USB ports or two computers with one USB port each.

It is recommended to start by testing the serial communication and verify the current configuration is working by sending these two AT commands:

```
AT
```

```
ATE
```

`ATE` will echo the commands you input to the module, which is useful for tracking the commands and troubleshooting.

You will receive `OK` when you input the two commands. After setting `ATE`, you can now see all the commands you input together with the replies.

Try again `AT` and you should see it on the terminal followed by `OK`.

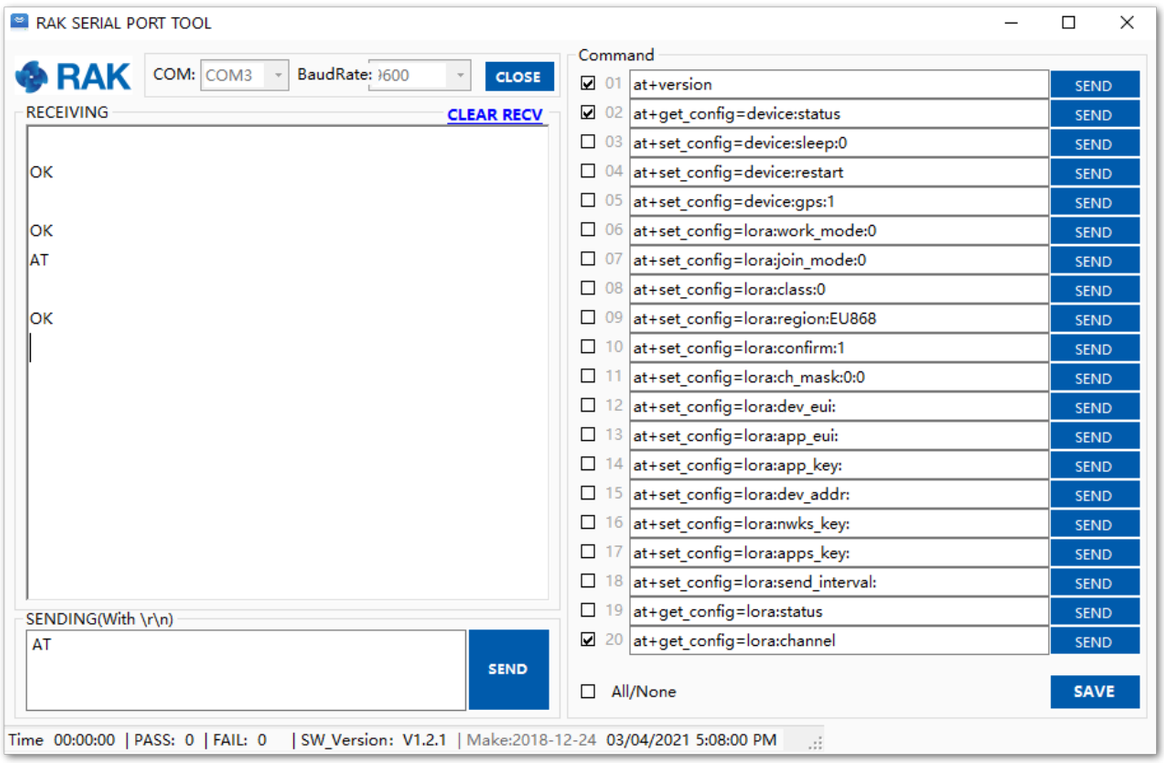

Figure 58: at+version command response

To setup the RAK3172 to work in LoRa P2P mode, you need to input the work mode command on both RAK3172 modules.

```
AT+NWM=0
```

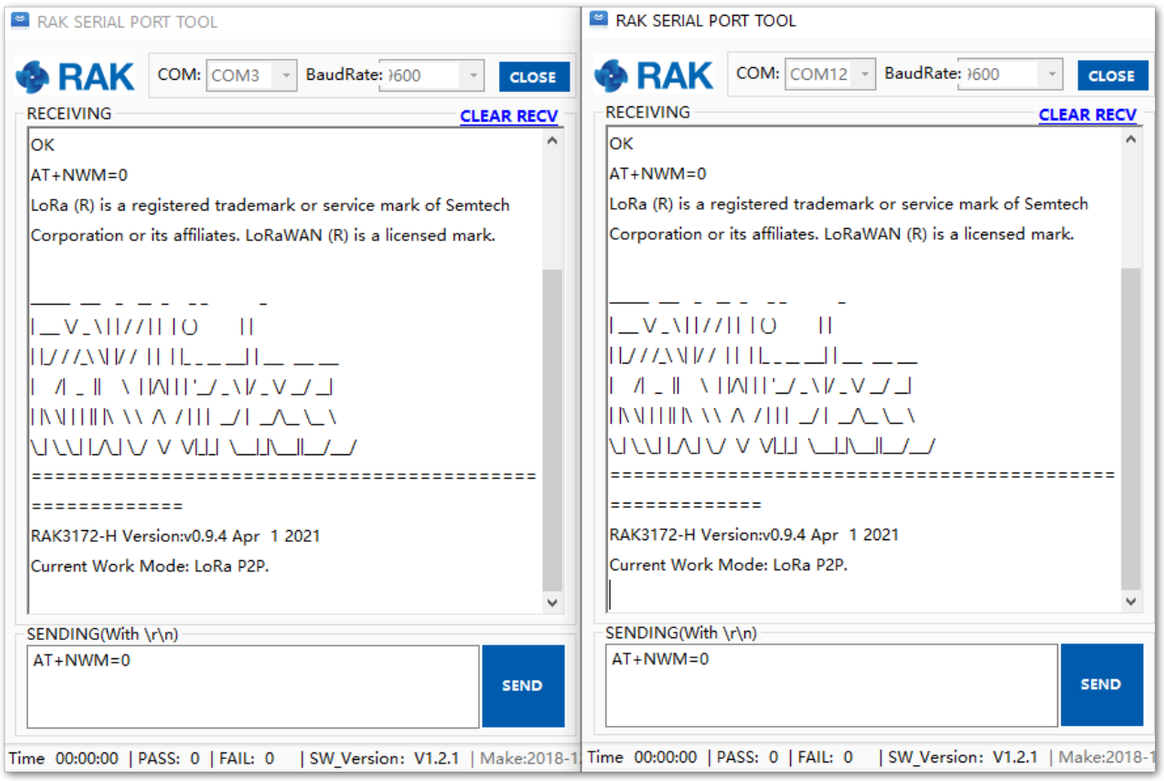

Figure 59: P2P Mode

> 📝 **NOTE:**
>
> You might need to input `ATE` command again to ensure that your succeeding commands on P2P mode echo on the terminal.

For this P2P setup, the LoRa parameters are the following:

- Link frequency: **868000000 Hz**
- Spreading factor: **7**
- Bandwidth: **125 kHz**
- Coding Rate: 0 = **4/5**
- Preamble Length: **10**
- Power: **14 dBm**

We need to input the P2P setup on both RAK3172 modules. The parameters should be exactly the same on the two modules.

```
AT+P2P=868000000:7:125:0:10:14
```

> 📝 **NOTE:**
>
> Refer to the P2P Mode section of the AT command documentation to learn more about the definition of the parameters used.

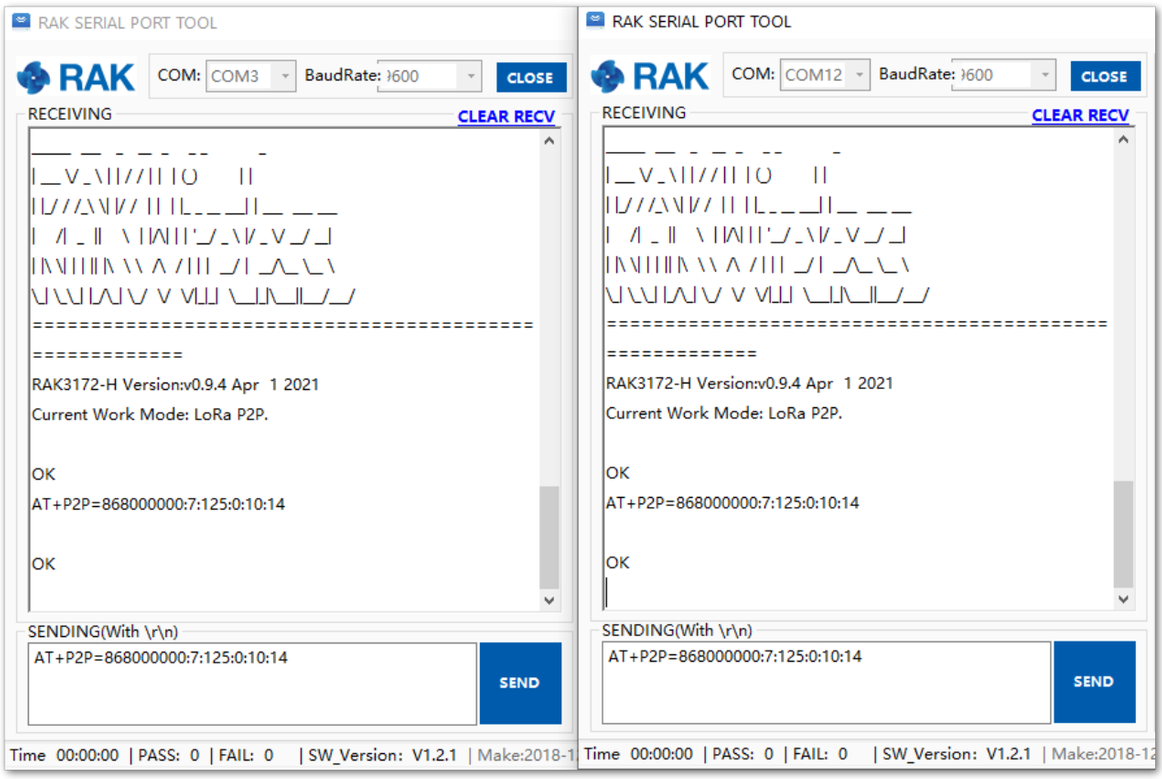

Figure 60: Configuring P2P in both RAK3172 Module

To set one module as receiver (RX), you need set the value of P2P receive command to 65535.

```
AT+PRECV=65535
```

> 📝 **NOTE:**
>
> - If AT+PRECV value is set to 65534, the device will continuously listen to P2P LoRa TX packets without any timeout. This is the same as setting the device in RX mode.
> - If AT+PRECV value is set to 65535, the device will listen to P2P TX without a timeout. But it will stop listening once a P2P LoRa packet is received to save power.
> - If AT+PRECV value is 0, the device will stop listening to P2P TX data. The device is in TX mode.

With one module configured as RX, the other device will be the TX.

You can now try to send a P2P payload.

```
AT+PSEND=11223344
```

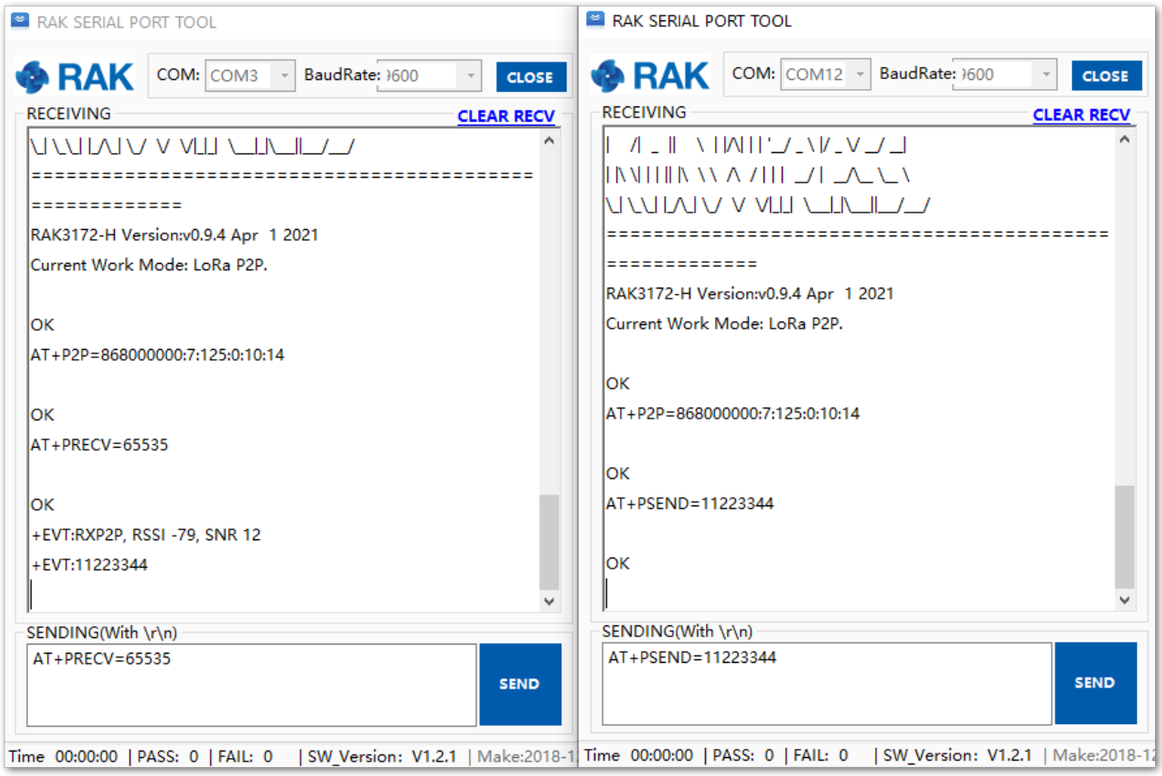

Figure 61: Configuring P2P in both RAK3172 Module

Miscellaneous

Upgrading the Firmware

If you want to upgrade to the latest version firmware of the module, you can follow this section. The latest firmware can be found in the software section of RAK3172 Datasheet.

Firmware Upgrade Through UART2

Minimum Hardware and Software Requirements

Refer to the table for the minimum hardware and software required to perform the firmware upgrade via UART2.

Hardware/Software	Requirement

Hardware/Software	Requirement
Computer	A Windows/Ubuntu/Mac computer
Firmware File	Bin firmware file downloaded from the website
Others	A USB to TTL module

Firmware Upgrade Procedure

Execute the following procedure to upgrade the firmware in Device Firmware Upgrade (DFU) mode through the UART2 interface.

1. Download the latest application firmware of the RAK3172.
   - RAK3172 Datasheet
2. Download the RAK Device Firmware Upgrade (DFU) tool.
   - RAK Device Firmware Upgrade (DFU) Tool
3. Connect the RAK3172 module with a computer through a USB to TTL. Refer to Figure 1.
4. Open the Device Firmware Upgrade tool. Select the serial port and baud rate (9600) of the module and click the "Select Port" button.

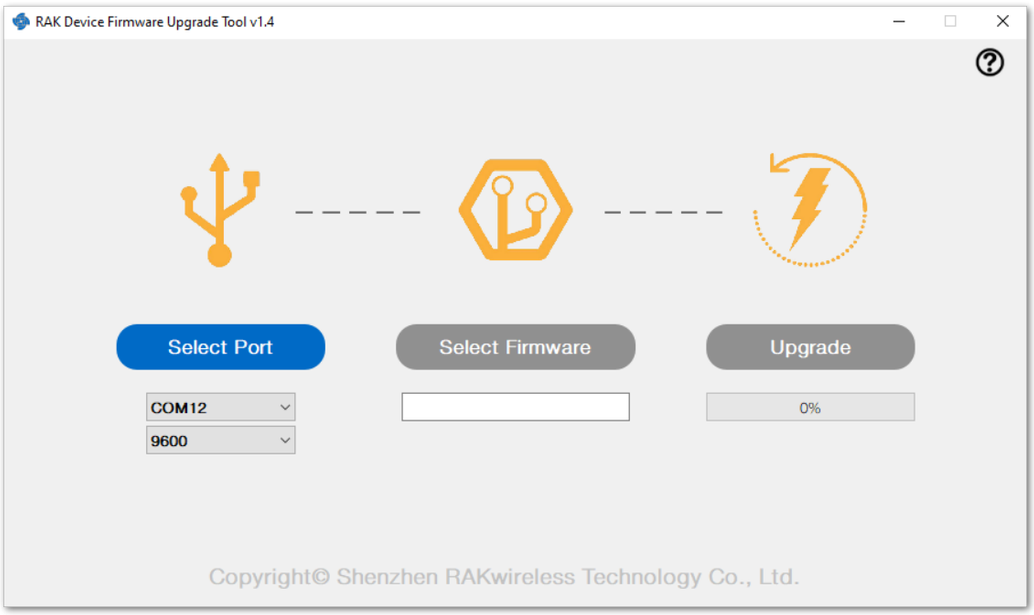

Figure 62: Device Firmware Upgrade Tool

5. Select the application firmware file of the module with the suffix "**.bin**".

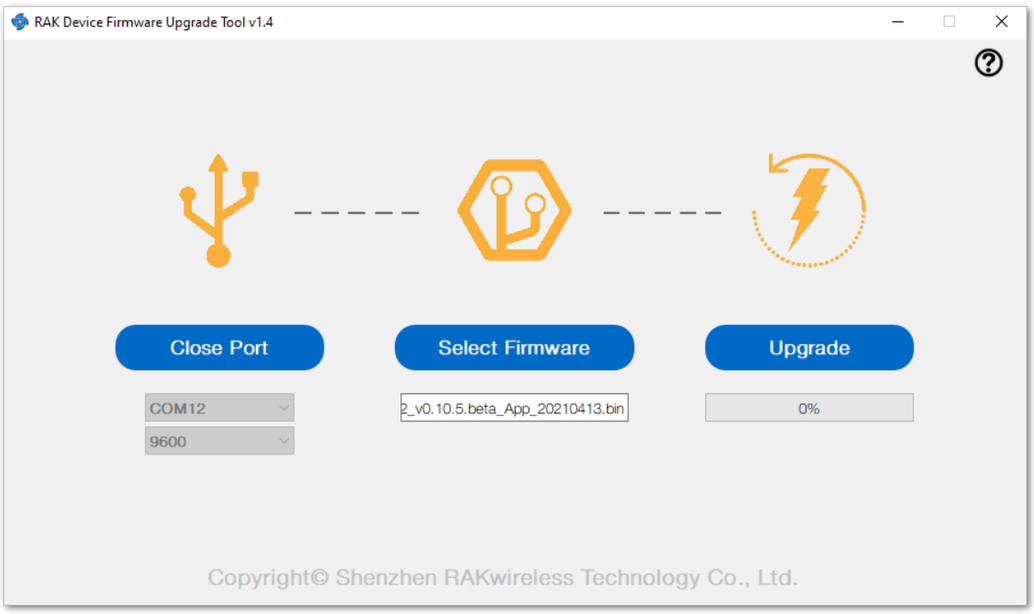

Figure 63: Select Firmware

6. Click the "**Upgrade**" button to upgrade the device. After the upgrade is complete, the RAK3172 module will be ready to work with the new firmware.

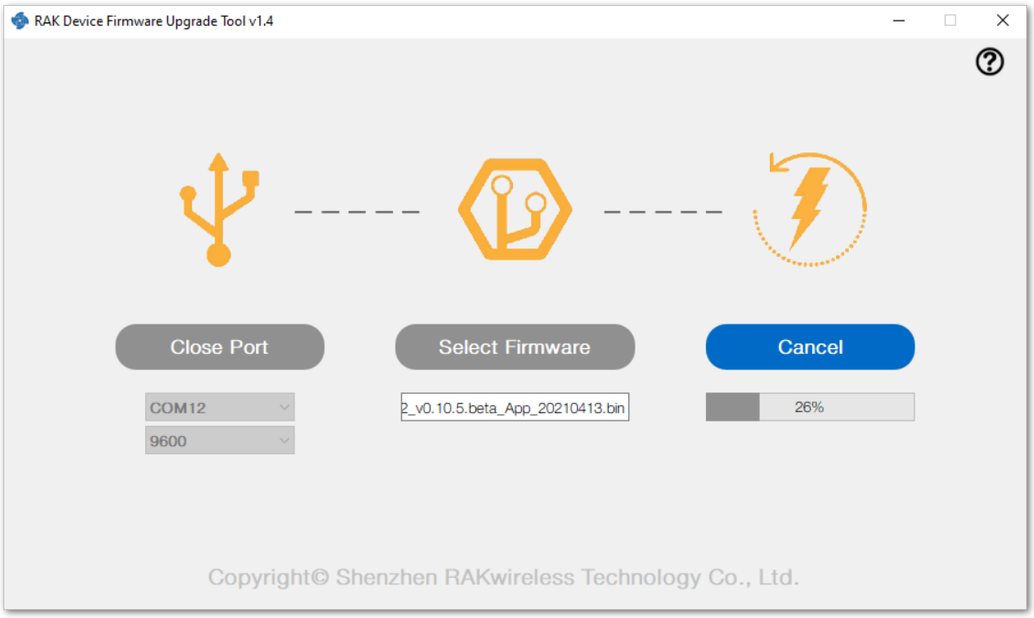

Figure 64: Firmware Upgrading

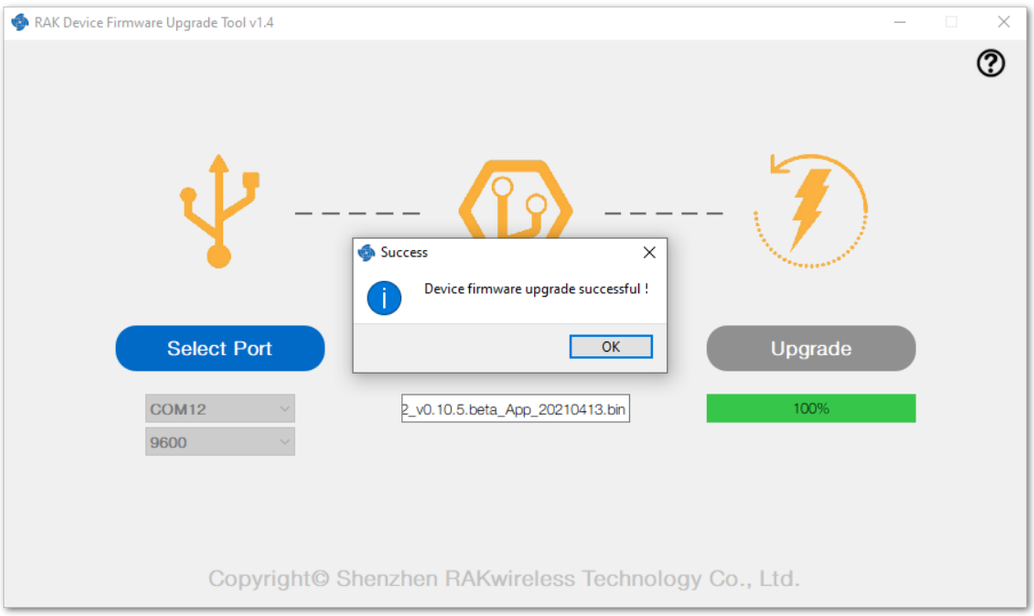

Figure 65: Upgrade Successful

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