

RAK11300 Module Quick Start Guide

This guide covers the following topics:

- [TheThingsNetwork Guide](#) - How to login, register new accounts and create new applications on TTN.
- [RAK11300 TTN OTAA Guide](#) - How to add OTAA device on TTN and what AT commands to use on RAK11300 OTAA activation.
- [RAK11300 TTN ABP Guide](#) - How to add ABP device on TTN and what AT commands to use on RAK11300 ABP activation.
- [Chirpstack Guide](#) - How to create new applications on Chirpstack.
- [RAK11300 Chirpstack OTAA Guide](#) - How to add OTAA device to Chirpstack and what AT commands to use on RAK11300 OTAA activation.
- [RAK11300 Chirpstack ABP Guide](#) - How to add ABP device on Chirpstack and what AT commands to use on RAK11300 ABP activation.
- [Updating RAK11300-Module FW](#) - Procedures on how to update RAK11300 module firmware.

Prerequisites

What Do You Need?

Before going through the steps of installing the RAK11300 WisDuo LPWAN Module, make sure to prepare the necessary items listed below:

Hardware Tools

1. [RAK11300 WisDuo LPWAN Module](#)
2. Windows PC
3. USB to UART TTL adapter
4. USB connection and cable for UF2 firmware update

Software Tools

1. Serial Terminal software like [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

Product Configuration

Interfacing with RAK11300

RAK11300 module can be configured using AT commands via the UART interface. You need a USB to UART TTL adapter to connect the RAK11300 to the PC's USB port and a serial terminal tool. You can use [RAK Serial Port Tool](#), so you can easily send AT commands and view the replies from the console output.

You can also use the USB pins of RAK11300 to send AT commands and update the firmware via `.uf2` firmware file.

Connect to the RAK11300

USB Connection

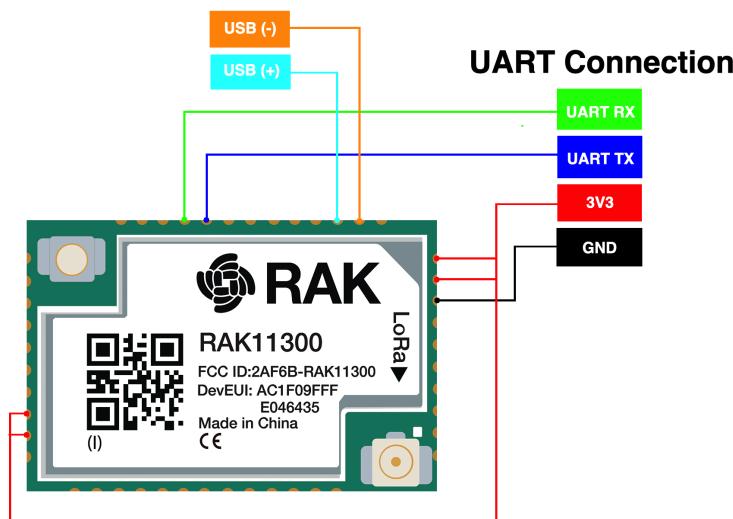


Figure 1: RAK11300 Module Connection

1. Connect the UART pins of RAK11300 to the USB port of a general-purpose computer using a USB to UART TTL adapter like [RAKDAP1](#).
2. You can also establish a direct USB connection to the USB Data pins (+) and (-) of the RAK11300. However, you still need to power the RAK11300 via external 3.3 V on the VDD lines. You cannot use VBUS of the USB port of the PC because it is still at 5V level.
3. Prepare a serial terminal software like the [RAK Serial Port Tool](#).
4. Configure the serial communication tool by selecting the proper port detected by the computer and configure the link as follows:
 - Baud Rate: **115200 baud**
 - Data Bits: **8 bits**
 - Stop Bits: **1 stop bit**
 - Parity: **NONE**

Configuring RAK11300

The first step is to connect the RAK11300 module to the USB-UART converter computer as described in the previous section. Using a serial communication tool, you can now send commands to RAK11300. For example, sending the `AT` will display `OK`. For the details of all supported AT commands, refer to the [AT Command Manual](#).

NOTE

You can also send AT command via the USB pins of RAK11300.

Connecting to The Things Network (TTN)

In this section, a quick tutorial guide will show how to connect the RAK11300 module to the TTN platform.

NOTE

In this guide, you need to have a working gateway that is connected to TTN, or you have coverage of the TTN community network.

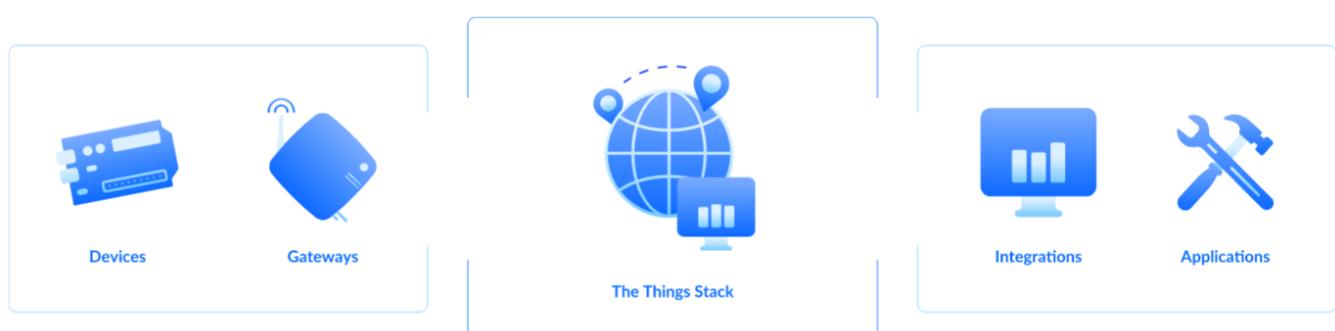


Figure 2: RAK11300 EVB in the context of the TTN

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 RAK11300 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 RAK11300 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

1. The first step is to go to [The Things Network platform](#) and select a cluster, as shown in **Figure 3**.

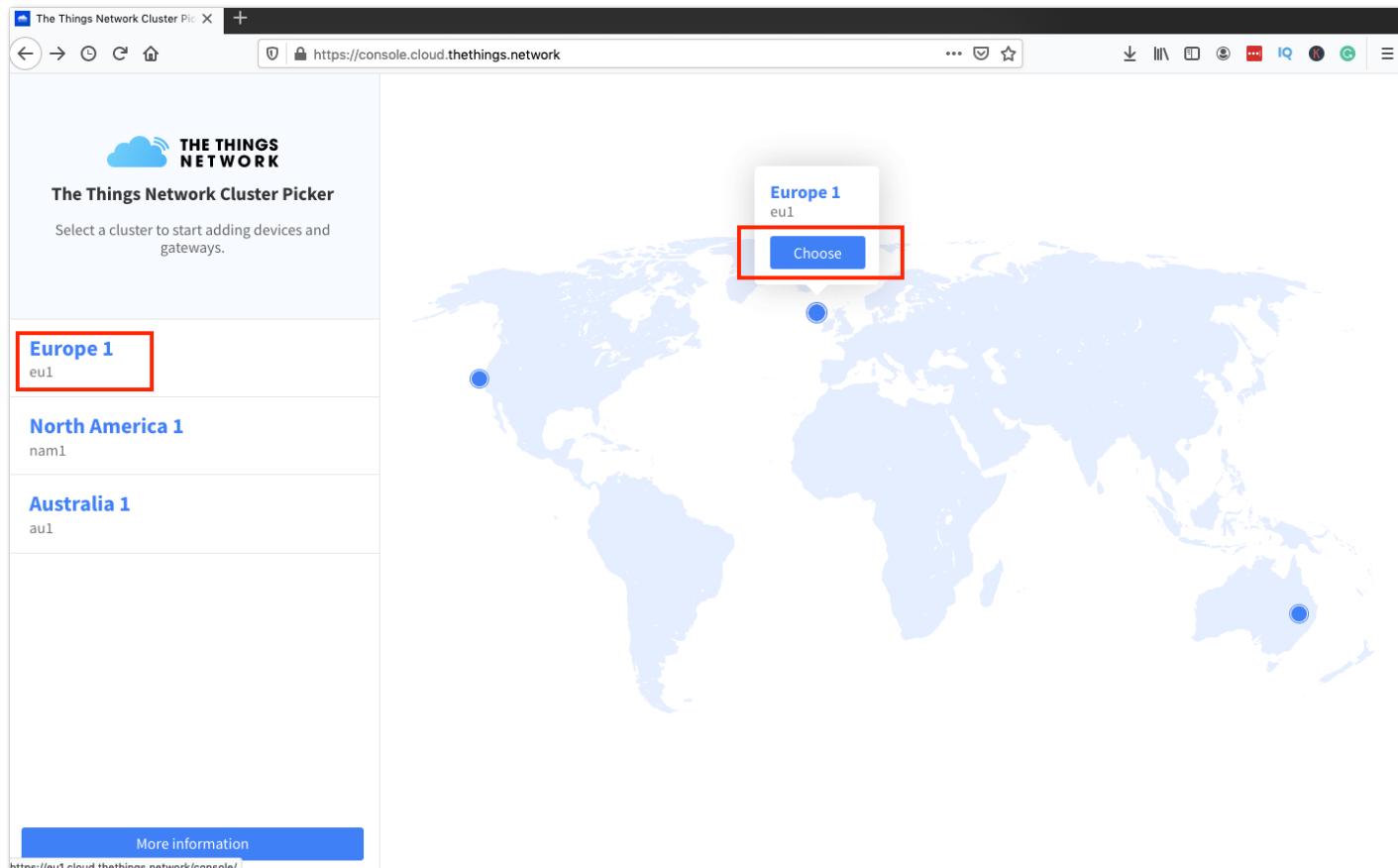


Figure 3: Selecting Cluster in TTN V3

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.

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

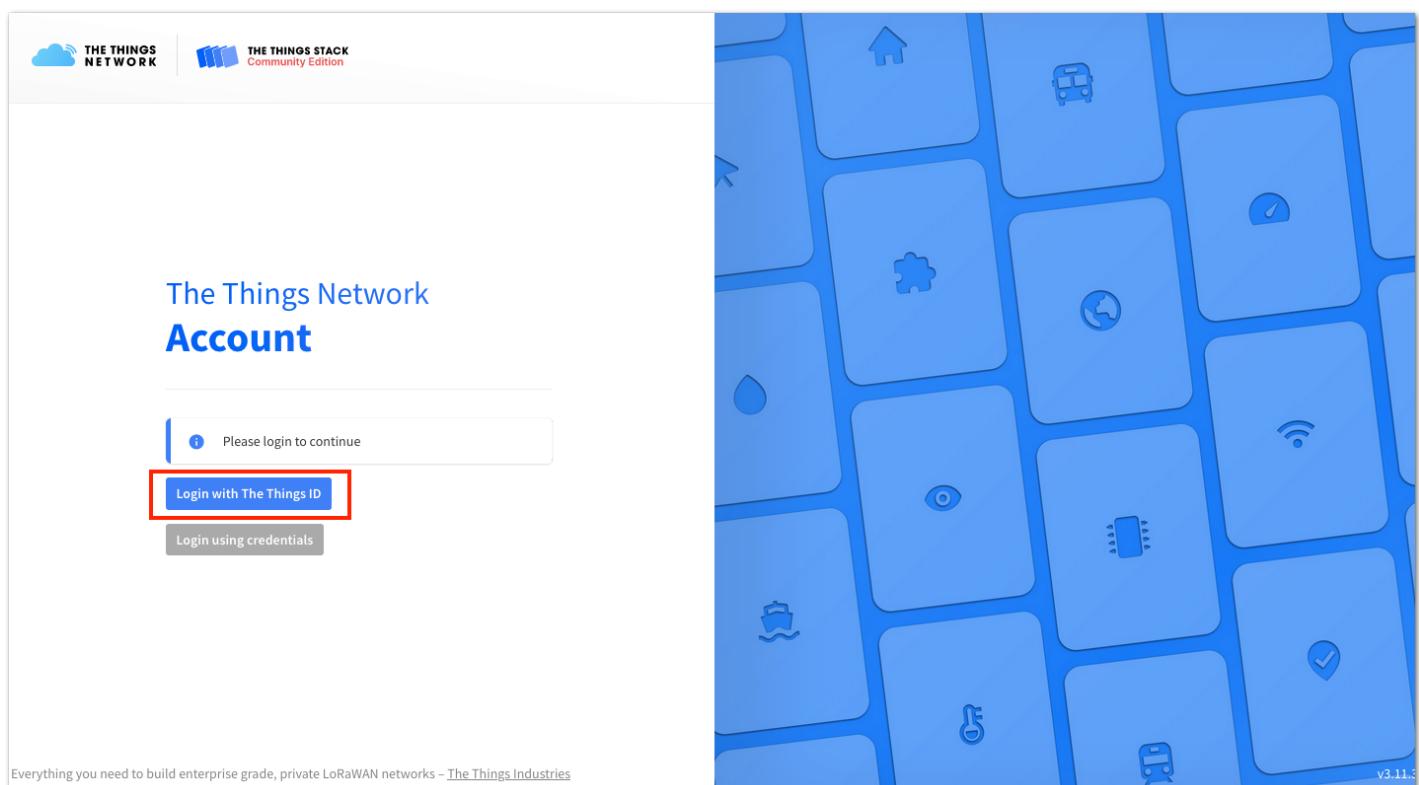


Figure 4: Login using TTN account

Login to The Things Stack with **The Things ID**

Username or email *

Password *

Submit

Cancel

Register

Forgot password?

The Things ID by The Thing Industries

Figure 5: Registration of new account

3. You should now be on the step of creating your TTN account. Fill in all the necessary details and activate your account.
4. After creating an account, you should log in on the platform using your username/email and password, then click **Submit**, as shown in **Figure 6**.



Login to The Things Stack with **The Things ID**

Username or email •
demo@rakwireless.com

Password •
.....

Submit

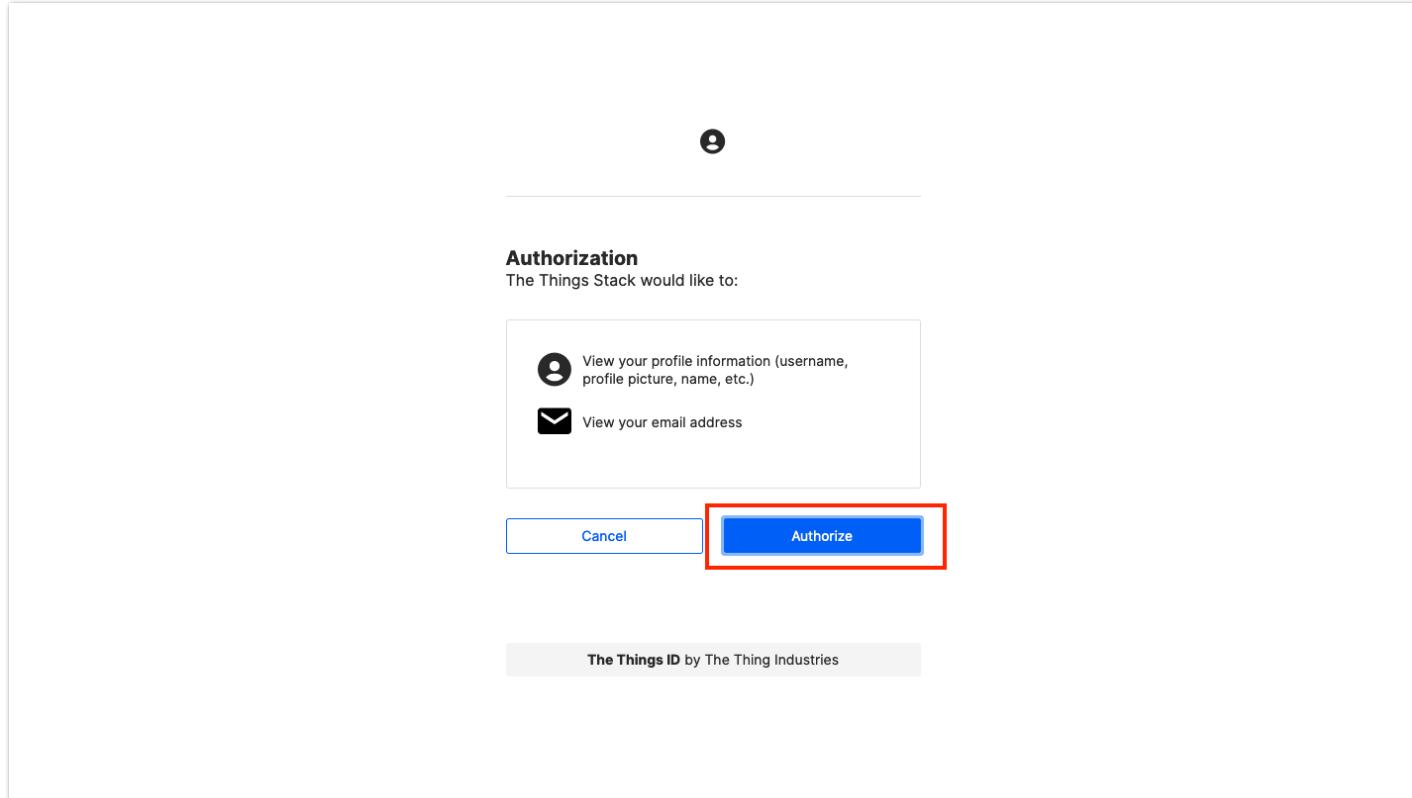
Cancel

[Register](#) [Forgot password?](#)

The Things ID by The Thing Industries

Figure 6: Logging in to TTN platform

5. Click **Authorize** to proceed.



Authorization
The Things Stack would like to:

View your profile information (username, profile picture, name, etc.)

View your email address

Cancel Authorize

The Things ID by The Thing Industries

Figure 7: Authorization to TTN

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

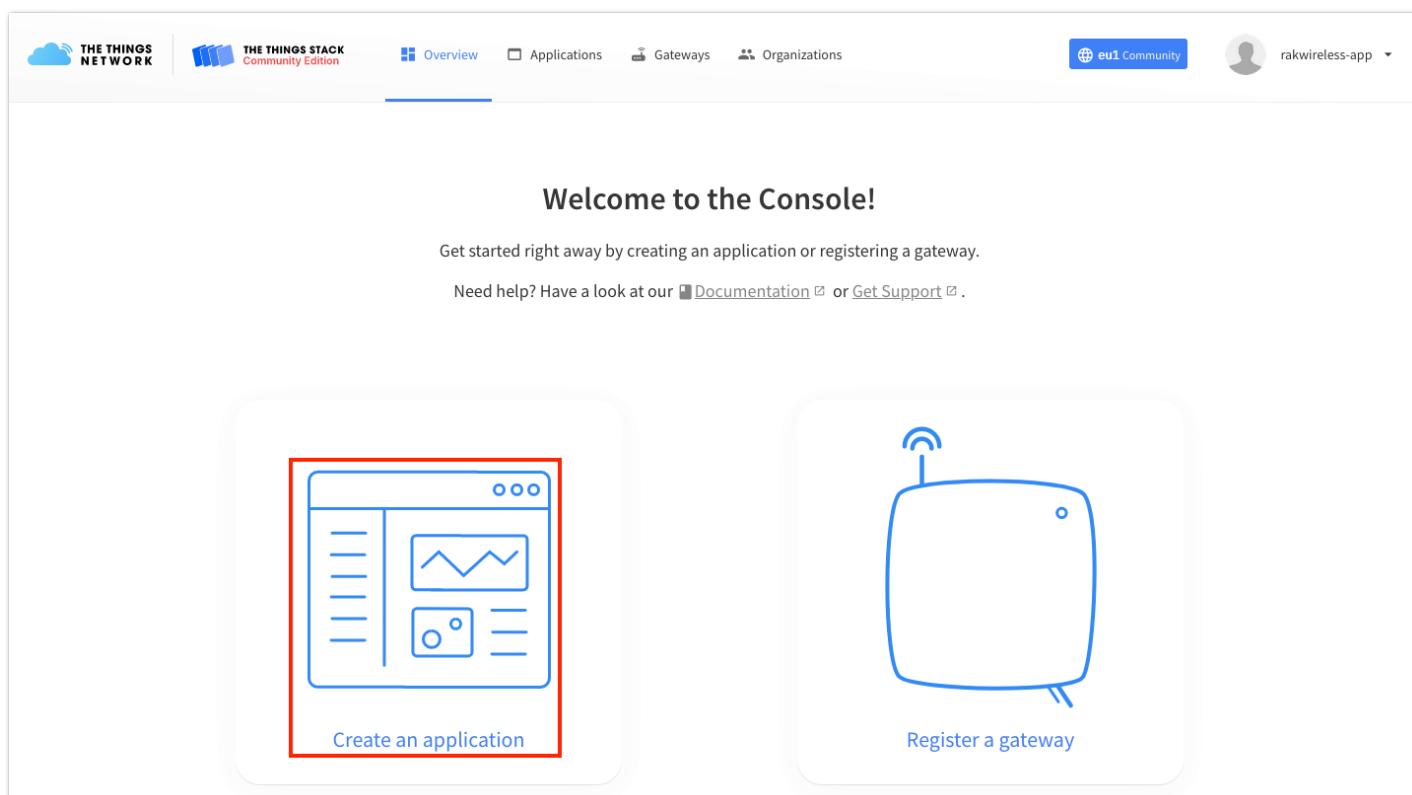


Figure 8: Creating TTN application for your LoRaWAN devices

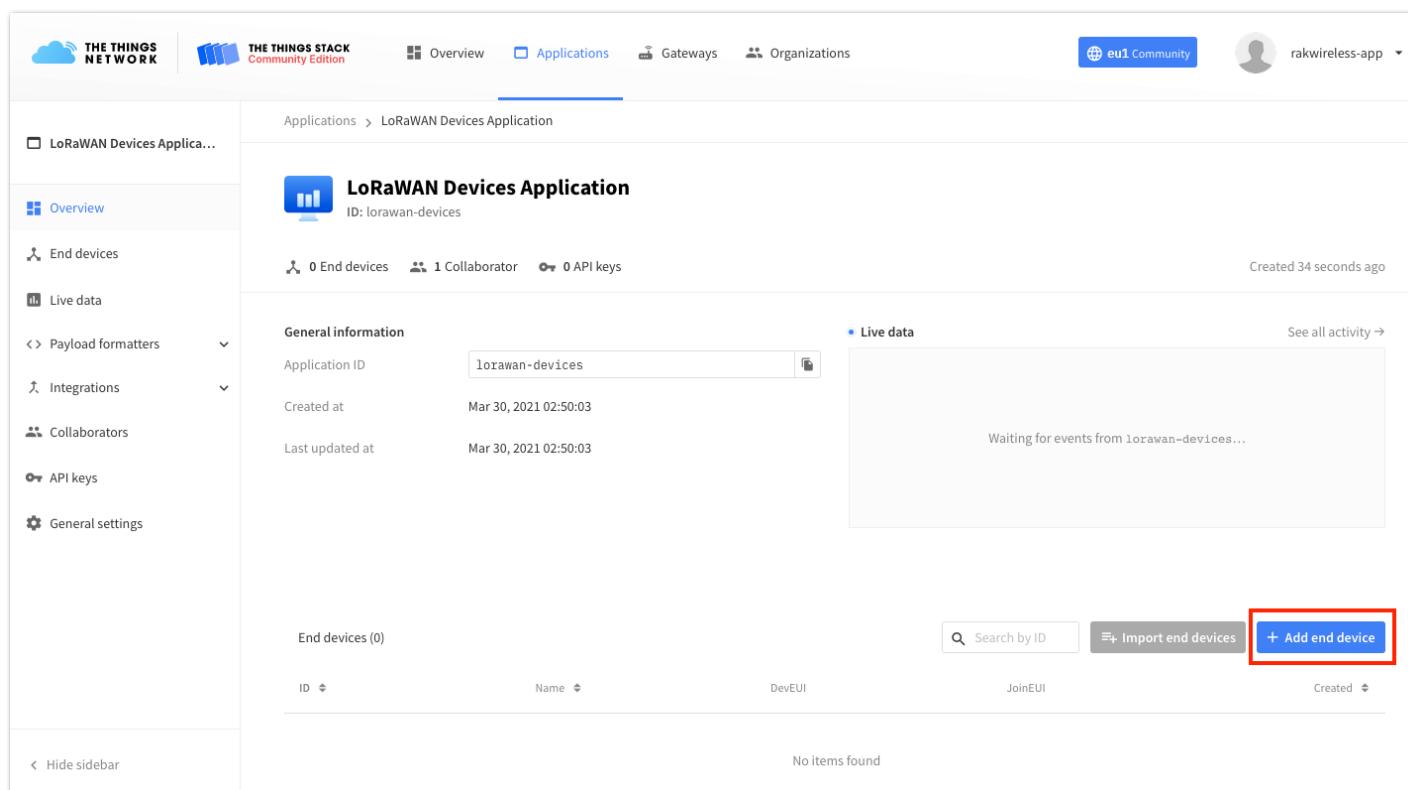
- To have an application registered, input first the specific details and necessary information about your application, then click **Create application**.

Figure 9: Details of the TTN application

If there is no error on 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 selected. Activation can be done either via Over-The-Air-Activation (OTAA) or Activation-By-Personalization (ABP).

TTN OTAA Device Registration

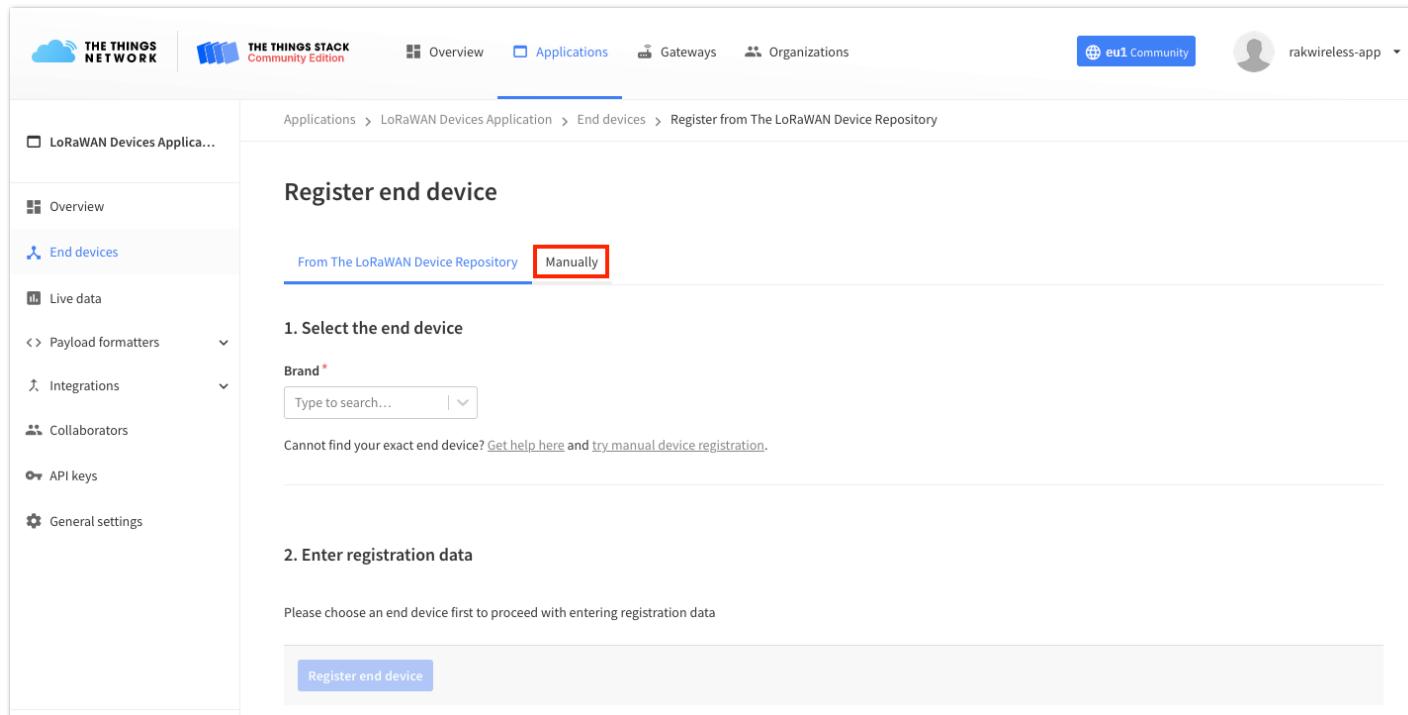
- Go to your application console to be able to register a device. To start adding an OTAA end-device, you need to click **+ Add end device**, as shown in **Figure 10**.



The screenshot shows the THE THINGS NETWORK Application Overview interface. On the left, a sidebar menu includes options like Overview, End devices, Live data, Payload formatters, Integrations, Collaborators, API keys, and General settings. The main content area displays the 'LoRaWAN Devices Application' with the ID 'lorawan-devices'. It shows 0 end devices, 1 collaborator, and 0 API keys. The application was created on Mar 30, 2021 at 02:50:03 and last updated on the same day. A 'Live data' section indicates it is waiting for events from 'lorawan-devices...'. Below this, there is a table for managing end devices with columns for ID, Name, DevEUI, JoinEUI, and Created. A red box highlights the '+ Add end device' button.

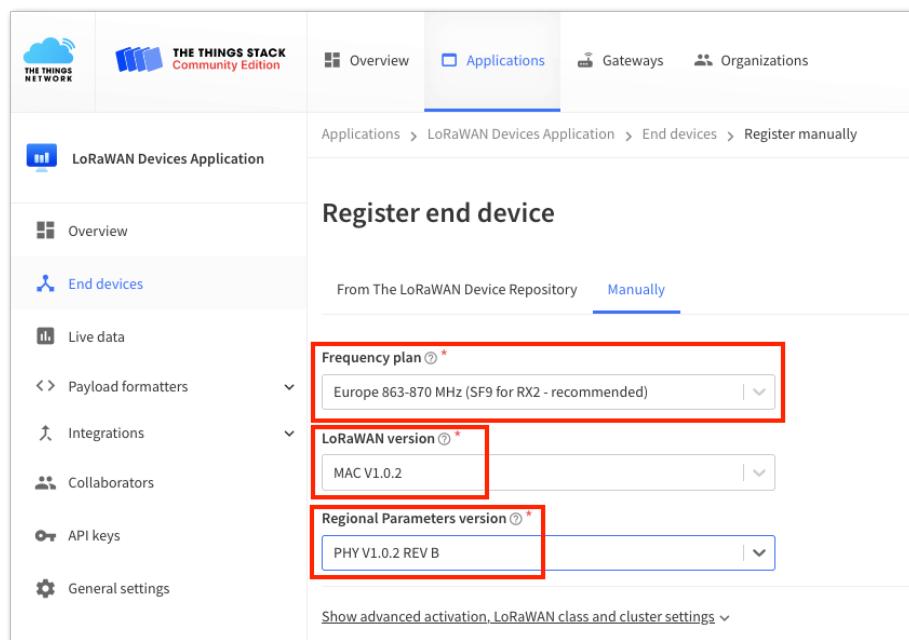
Figure 10: Add end device

2. To register the module, you need to click first **Manually** then configure the **Frequency Plan**, **LoRaWAN Version**, and **Regional Parameter version**, as shown in **Figure 11** and **Figure 12**. By default, TTN V3 will be setting your device via OTAA mode.



The screenshot shows the 'Register end device' page within the THE THINGS NETWORK Application Overview. The sidebar menu is identical to Figure 10. The main content area shows the path 'Applications > LoRaWAN Devices Application > End devices > Register from The LoRaWAN Device Repository'. It has two tabs: 'From The LoRaWAN Device Repository' (selected) and 'Manually' (highlighted with a red box). The 'Manually' tab contains two sections: '1. Select the end device' and '2. Enter registration data'. In '1. Select the end device', there is a 'Brand*' dropdown with a search bar and a note: 'Cannot find your exact end device? [Get help here](#) and [try manual device registration](#)'. In '2. Enter registration data', there is a note: 'Please choose an end device first to proceed with entering registration data' and a blue 'Register end device' button.

Figure 11: Manually register device to TTN



The screenshot shows the 'Register end device' page. On the left sidebar, 'End devices' is selected. The main form has 'Manually' selected under 'From The LoRaWAN Device Repository'. Three fields are highlighted with red boxes: 'Frequency plan' (set to 'Europe 863-870 MHz (SF9 for RX2 - recommended)'), 'LoRaWAN version' (set to 'MAC V1.0.2'), and 'Regional Parameters version' (set to 'PHY V1.0.2 REV B').

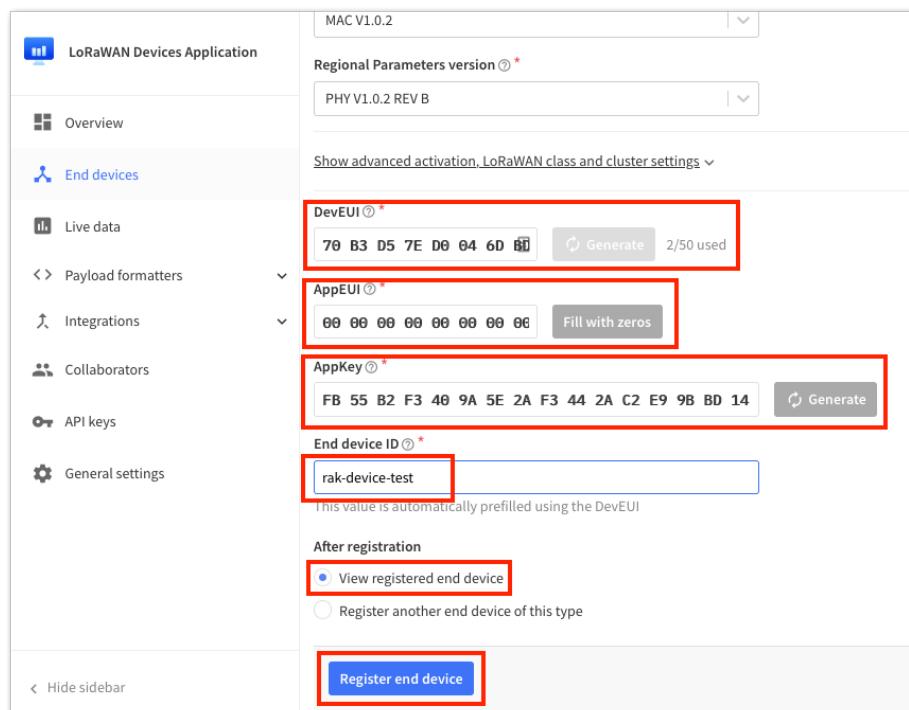
Figure 12: Device configuration

- Then input the OTAA joining parameters **DevEUI**, **AppEUI**, and **AppKey**. You can click generate button on the side of the parameters **DevEUI** and **AppKey** to generate unique combinations. If your device has **DevEUI** on its label or sticker, you must use it to make sure your device uniqueness. The **AppKey** needs to be generated. **AppKey** can be left as all zero or with a specific hexadecimal value. Also, you can add a more descriptive **End device ID** for your device.

NOTE

It is advisable to use a meaningful **End device ID** that will match your device purpose. The End device ID `rak-device-test` is for illustration purposes only.

- After putting all the details, click **Register end device** to end your device registration, as shown in **Figure 13**.



The screenshot shows the 'Register end device' page. The sidebar shows 'Overview', 'End devices' (selected), 'Live data', 'Payload formatters', 'Integrations', 'Collaborators', 'API keys', and 'General settings'. The main form has fields for 'DevEUI' (set to '70 B3 D5 7E D0 04 6D'), 'AppEUI' (set to '00 00 00 00 00 00 00 00'), 'AppKey' (set to 'FB 55 B2 F3 40 9A 5E 2A F3 44 2A C2 E9 9B BD 14'), and 'End device ID' (set to 'rak-device-test'). A note below says 'This value is automatically prefilled using the DevEUI'. Under 'After registration', 'View registered end device' is selected. At the bottom is a large blue 'Register end device' button.

Figure 13: OTAA 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 14**.

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 reasons, 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 in **Figure 14**.

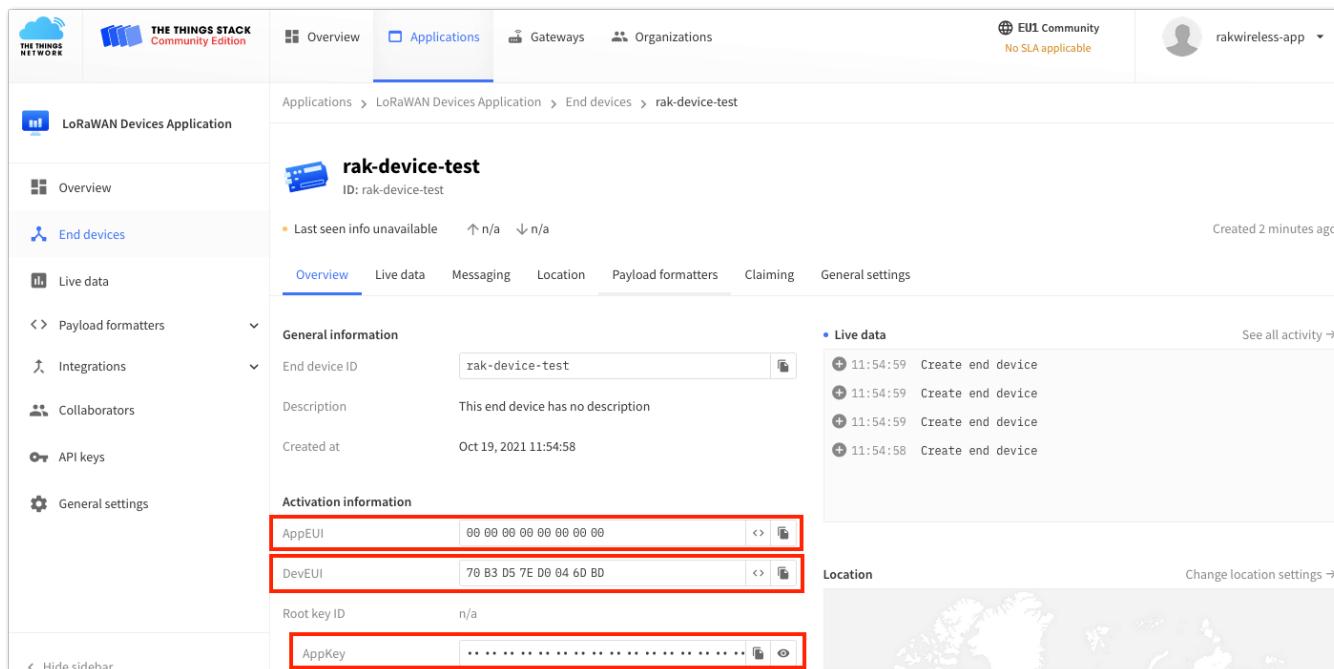


Figure 14: OTAA device successfully registered to TTN

OTAA Configuration for TTN

The RAK11300 module supports a series of AT commands to configure its internal parameters and control the functionalities of the module.

1. To set up the RAK11300 module to join the TTN using OTAA, start by connecting the RAK11300 module to your computer and open the Serial terminal like the RAK Serial Port Tool. Select the correct COM port and set the baud rate to 115200.

It is recommended to start by testing the serial communication and verify that the current configuration is working by sending a simple **AT** command:

```
AT
```

```
OK
```

You will receive **OK** when you input the **AT** command.

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. Also, you can check if the device is powered correctly. If you are getting power from a USB port, make sure that you have a good USB cable.

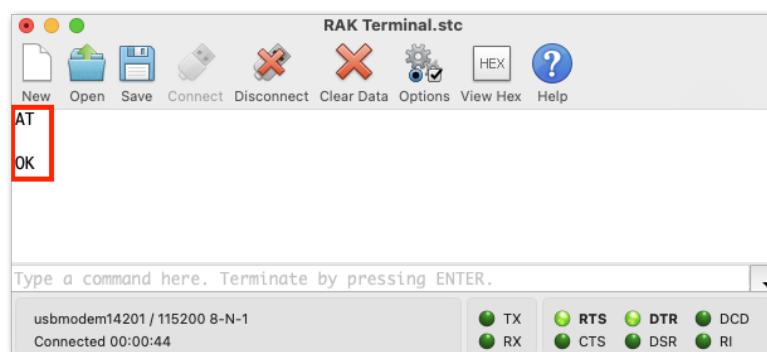


Figure 15: at+version command response

2. The next step is to configure the OTAA LoRaWAN parameters in RAK11300:

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

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=5
```

NOTE

Depending on the Regional Band you selected, you might need to configure the sub-band of your RAK11300 to match the gateway and LoRaWAN network server. This is especially 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 Command Manual](#).

To illustrate, you can use sub-band 2 by sending the command `AT+MASK=2`.

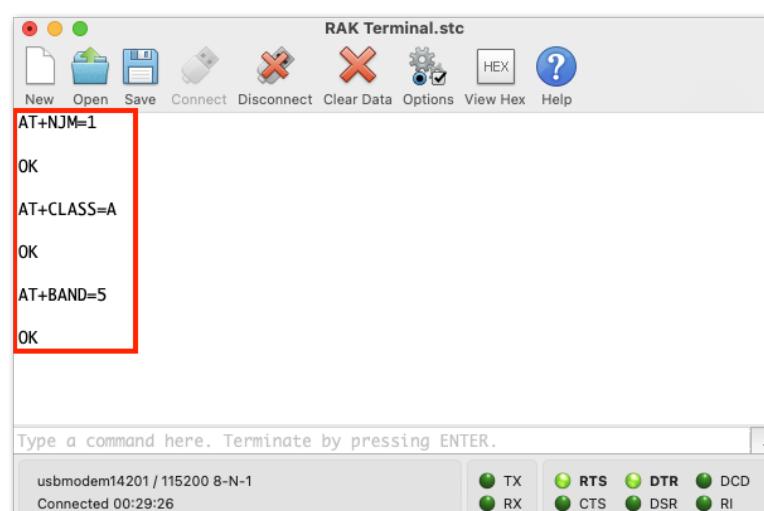


Figure 16: Configuring LoRa Parameters

List of band parameter options

Code	Regional Band
0	AS923-1
1	AU915
2	CN470
3	CN779
4	EU433
5	EU868
6	KR920
7	IN865
8	US915
9	AS923-2
10	AS923-3
11	AS923-4
12	RU864

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

- Device EUI: **70B3D57ED0046DBD**
- Application EUI: **0000000000000000**
- Application Key: **FB55B2F3409A5E2AF3442AC2E99BBD14**

Set the Device EUI.

```
AT+DEVEUI=70B3D57ED0046DBD
```

Set the Application EUI.

```
AT+APPEUI=0000000000000000
```

Set the Application Key.

```
AT+APPKEY=FB55B2F3409A5E2AF3442AC2E99BBD14
```

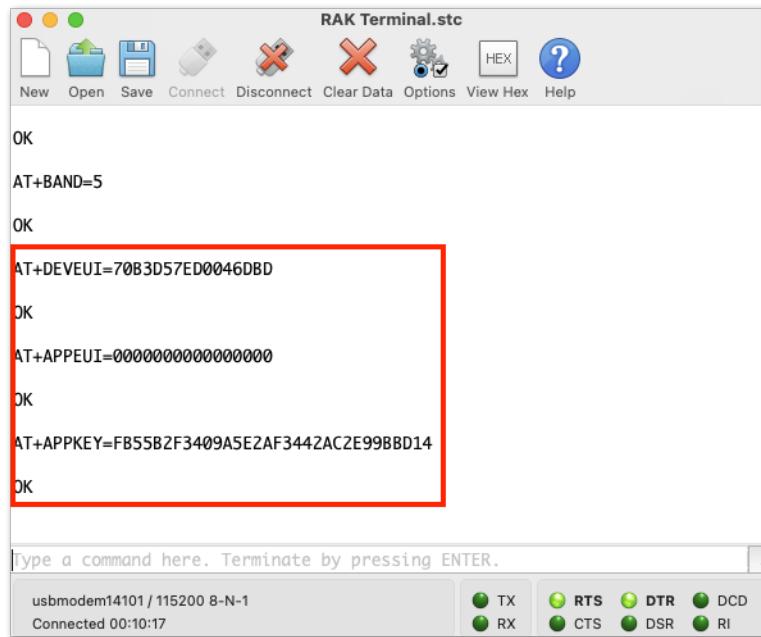


Figure 17: Configuring LoRa Parameters

- After EUI and keys configuration, you need to restart the device for the changes to take effect. You can do this by inputting the `ATZ` command or pushing the reset button. The Serial port connection is lost after the `ATZ` command or pushing the reset button. The connection must be re-established on the connected computer before log output can be seen or AT commands can be entered again. You must be able to see the summary of configurations when you reconnect your device.

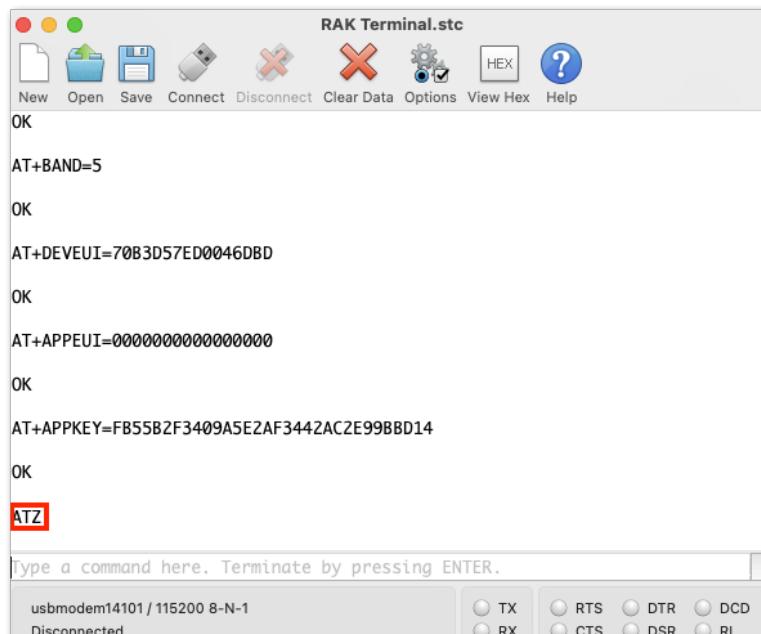


Figure 18: Reset the Device

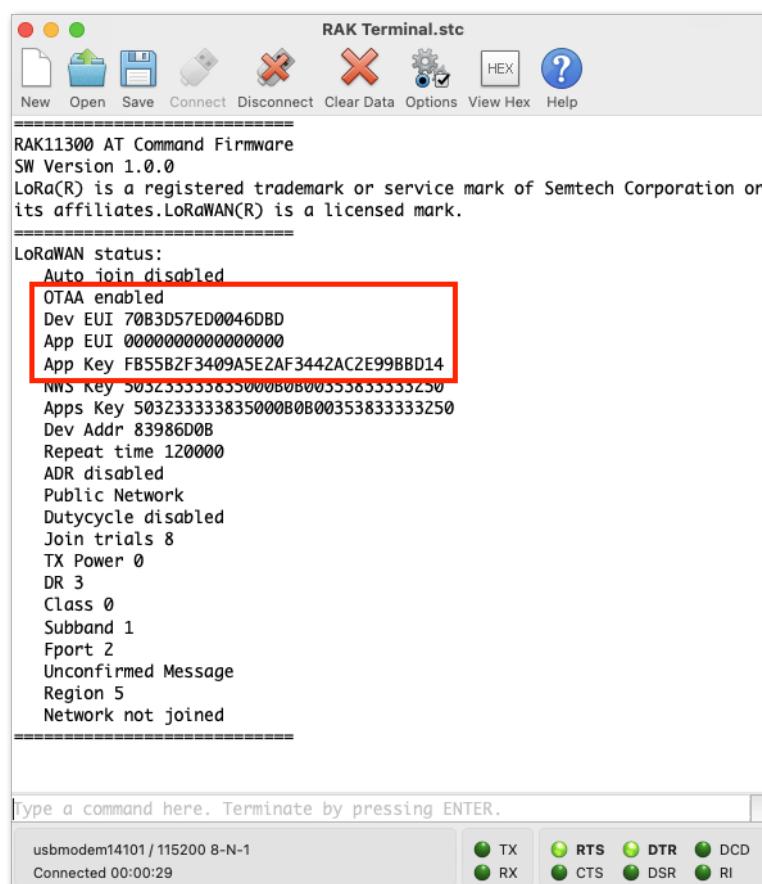


Figure 19: Summary of Device Parameters

4. After checking if the parameters are properly set, you can now join the network and send the payload.

AT+JOIN=1:1:10:8

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 power up, 0: no auto-join
y	Reattempt interval in seconds (7-255) - This is currently fixed to 30 sec.
z	Number of join attempts (0-255) - 0 is default.

After 5 or 6 seconds, if the request is successfully received by a LoRa gateway, then you should see the `AT+JOIN=SUCCESS` status reply, as shown in **Figure 20**.

NOTE

If the OTAA device join failed, 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 by using `AT+DEVEUI=?`, `AT+APPEUI=?`, and `AT+APPKEY=?` commands. Lastly, make sure 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 successful join.

```
AT+SEND=2:1234
```

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

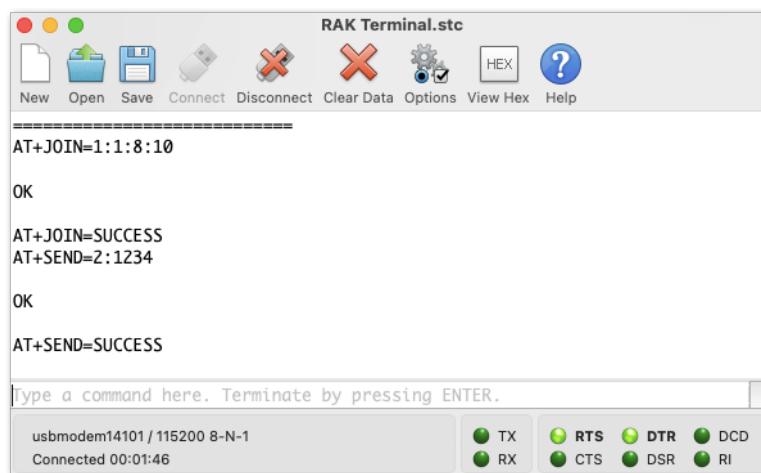
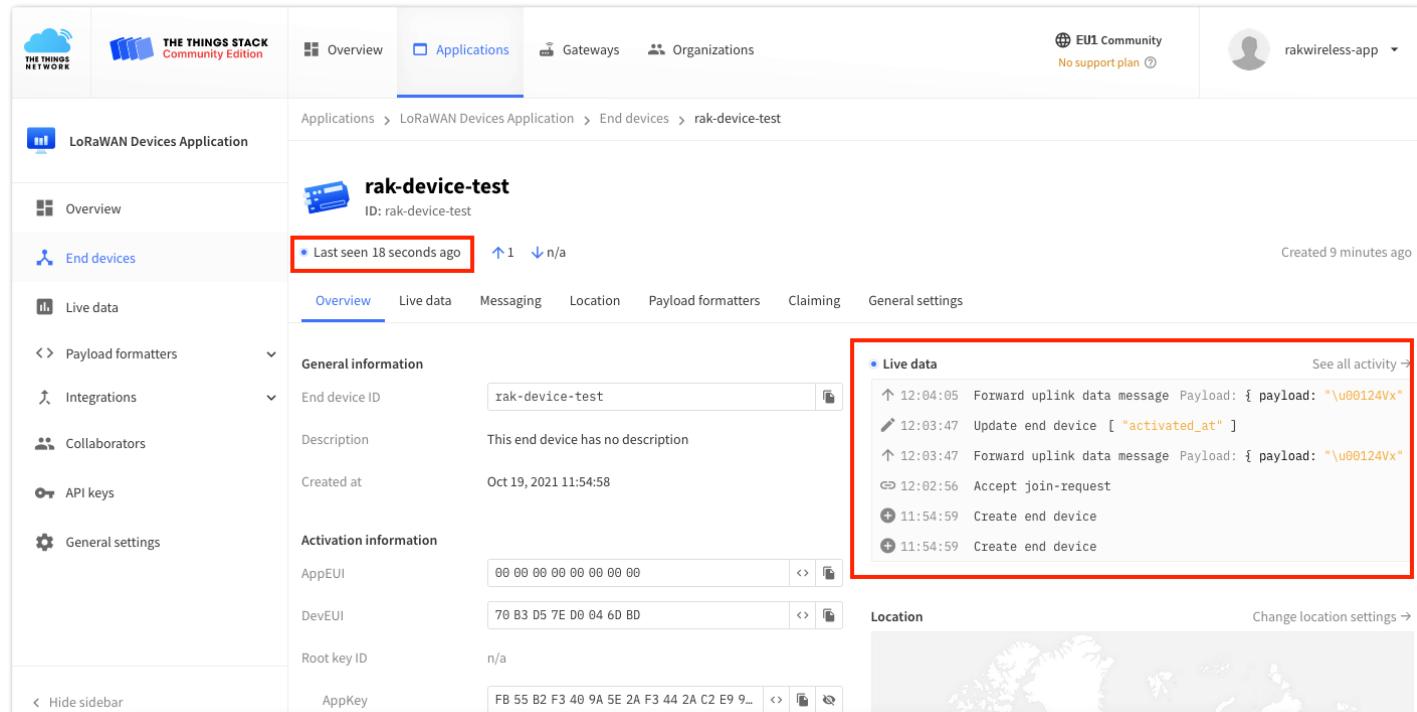


Figure 20: OTAA Joining and Sample payload

- You can see the data sent by the RAK11300 module on the TTN device console *Live data* section. Also, the *Last seen* info should be a few seconds or minutes ago.



The screenshot shows the THE THINGS STACK Community Edition interface. The left sidebar has sections for Overview, Applications, Gateways, Organizations, and a user profile for 'rakwireless-app'. The main area is titled 'LoRaWAN Devices Application' and shows a list of devices under 'Applications > LoRaWAN Devices Application > End devices > rak-device-test'. The device 'rak-device-test' is selected, showing its details. The 'Last seen' timestamp is '18 seconds ago'. The 'Live data' tab is selected, displaying a list of recent events:

- 12:04:05 Forward uplink data message Payload: { payload: "\u000124Vx" }
- 12:03:47 Update end device ["activated_at"]
- 12:03:47 Forward uplink data message Payload: { payload: "\u000124Vx" }
- 12:02:56 Accept join-request
- 11:54:59 Create end device
- 11:54:59 Create end device

Figure 21: OTAA Test Sample Data Sent Viewed in TTN

TTN ABP Device Registration

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

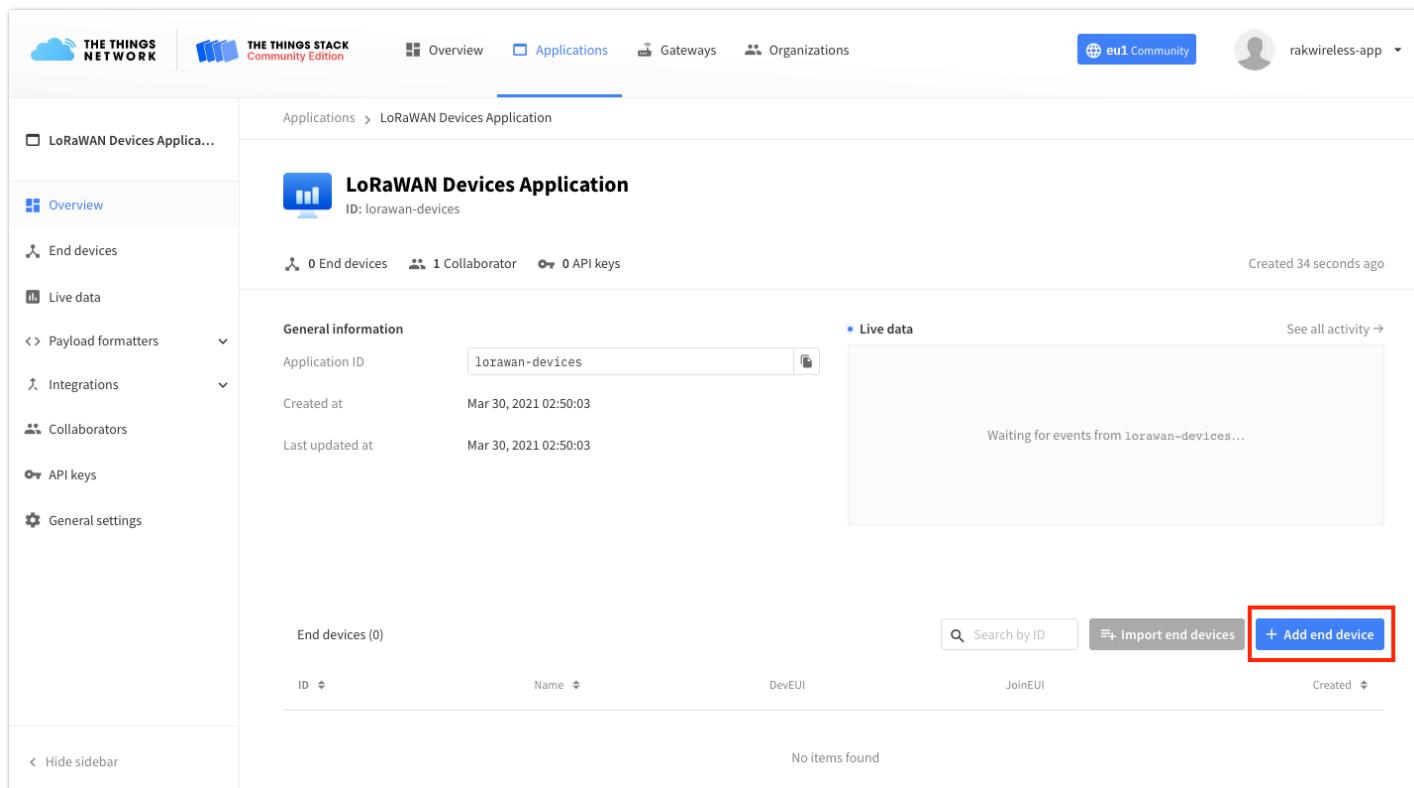


Figure 22: Adding ABP Device

- To register the module as an ABP device, you need to select **Manually** then click **Show advance activation, LoRaWAN class and cluster settings**. This will allow you to change the activation mode to **Activation by personalization (ABP)**, as shown in **Figure 23** and **Figure 24**. By default, TTN V3 registers a device via OTAA, so you need to make sure ABP is selected. You can also enable other **LoRaWAN class capabilities** here.

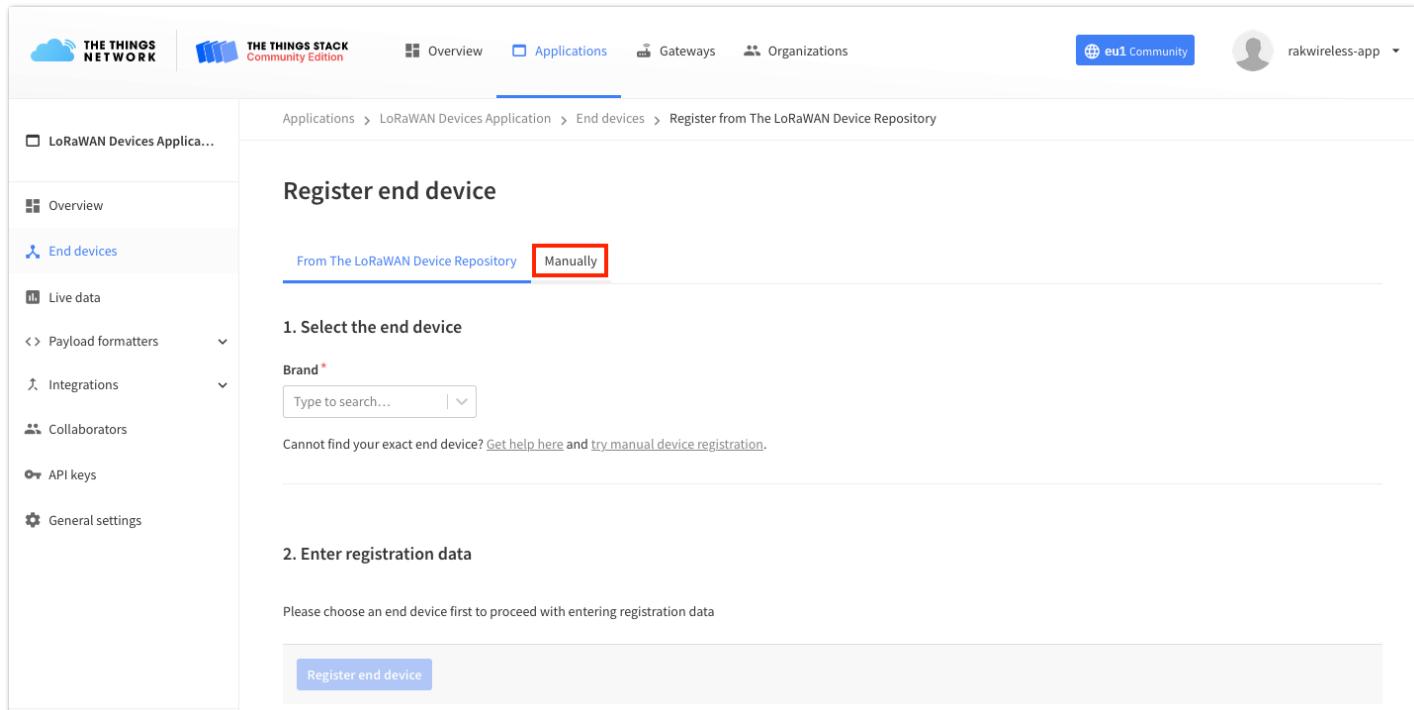
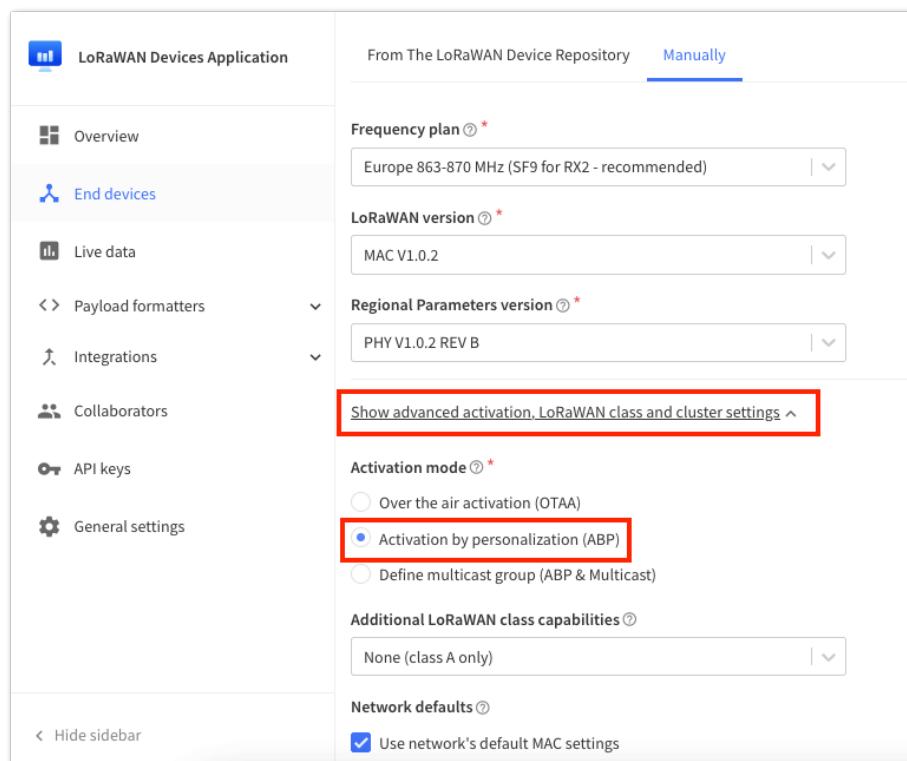


Figure 23: Manually register device to TTN



The screenshot shows the 'LoRaWAN Devices Application' configuration page. On the left is a sidebar with options: Overview, End devices (selected), Live data, Payload formatters, Integrations, Collaborators, API keys, and General settings. The main area has tabs: 'From The LoRaWAN Device Repository' (selected) and 'Manually'. Under 'Frequency plan', 'Europe 863-870 MHz (SF9 for RX2 - recommended)' is selected. Under 'LoRaWAN version', 'MAC V1.0.2' is selected. Under 'Regional Parameters version', 'PHY V1.0.2 REV B' is selected. A red box highlights the 'Show advanced activation, LoRaWAN class and cluster settings' button. Under 'Activation mode', 'Activation by personalization (ABP)' is selected (radio button highlighted). Other options include 'Over the air activation (OTAA)' and 'Define multicast group (ABP & Multicast)'. Under 'Additional LoRaWAN class capabilities', 'None (class A only)' is selected. Under 'Network defaults', the 'Use network's default MAC settings' checkbox is checked.

Figure 24: Selecting ABP and LoRaWAN version

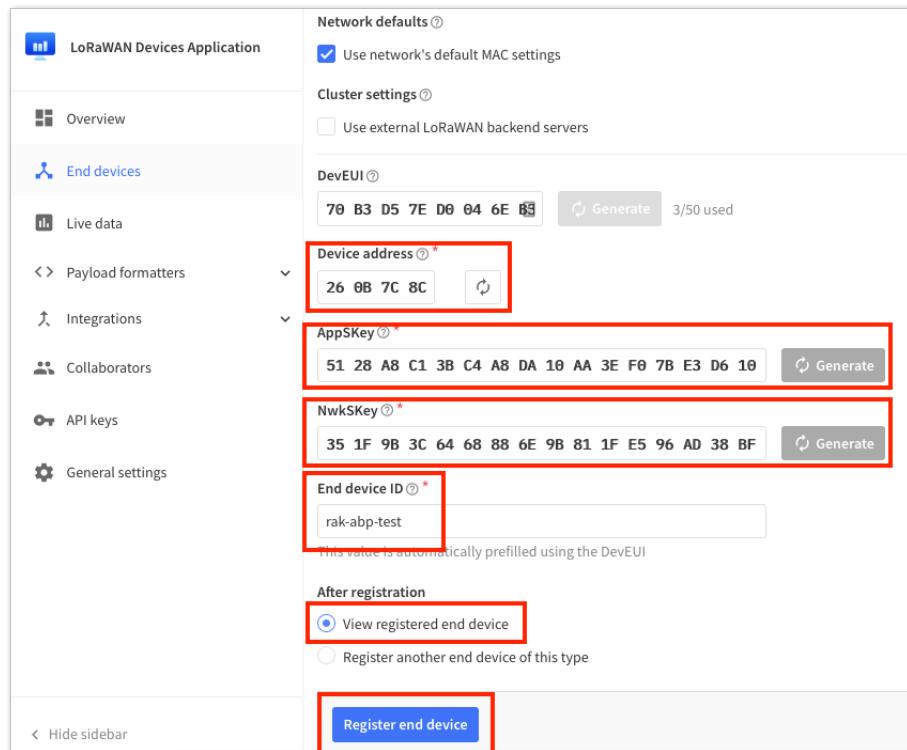
- At this step, input the ABP parameters needed by the device. You need to generate the parameters by clicking the Generate button. You must have values for **Device address**, **AppSKey**, and **NwkSKey**. The DevEUI is not really needed in ABP, but you can add that, too. Check if your module has a DevEUI on the sticker or QR that you can scan. You can use this as the DevEUI.

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

NOTE

It is advisable to use a meaningful **End device ID** that will match and describe your device purpose. The End device ID `rak-abp-test` is for illustration purposes only.

- After all is configured, you can now click **Register end device** button.



The screenshot shows the 'LoRaWAN Devices Application' configuration page with the 'End devices' tab selected. The sidebar includes: Overview, End devices (selected), Live data, Payload formatters, Integrations, Collaborators, API keys, and General settings. The main area shows 'Network defaults' with the 'Use network's default MAC settings' checkbox checked. Under 'Cluster settings', the 'Use external LoRaWAN backend servers' checkbox is unchecked. In the 'DevEUI' section, a DevEUI is listed: `70 B3 D5 7E D0 04 6E B3`. Below it, there are fields for 'Device address' (containing `26 0B 7C 8C`), 'AppSKey' (containing `51 28 A8 C1 3B C4 A8 DA 10 AA 3E F0 7B E3 D6 10`), and 'NwkSKey' (containing `35 1F 9B 3C 64 68 88 6E 9B 81 1F E5 96 AD 38 BF`). Under 'End device ID', the value `rak-abp-test` is entered. A note below says: 'This value is automatically prefilled using the DevEUI'. Under 'After registration', the 'View registered end device' radio button is selected. At the bottom is a large blue 'Register end device' button.

Figure 25: ABP Device Configuration

5. You should now be able to see the device on the TTN console after you fully registered your device, as shown in **Figure 26**.

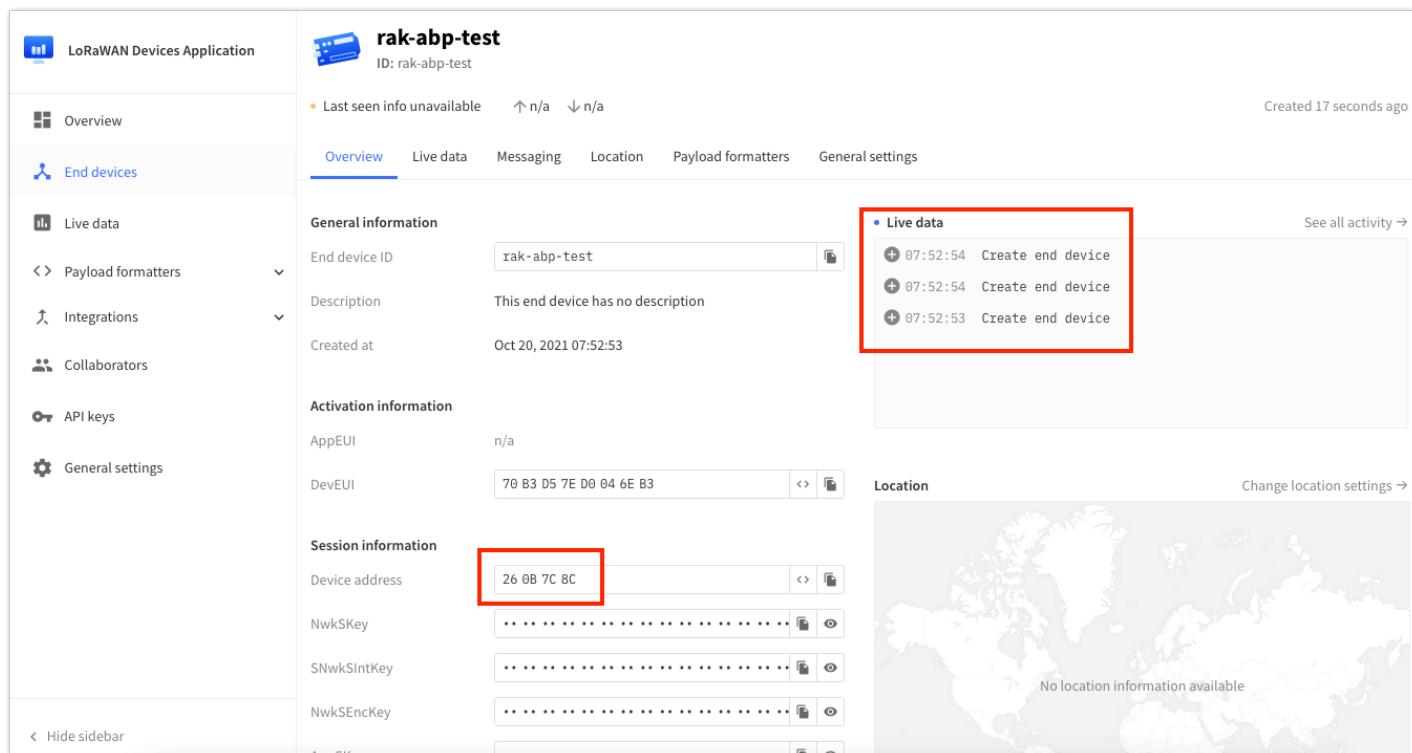


Figure 26: ABP device successfully registered to TTN

ABP Configuration for TTN

1. To set up the RAK11300 module to join the TTN using ABP, start by connecting the RAK11300 module to the computer and configure it using a Serial terminal software like the RAK Serial Port Tool. Select the correct COM port and set the baud rate to 115200.

It is recommended to start by testing the serial communication and verify the current configuration is working by sending the basic `AT` command:

```
AT
```

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 115200. Also, you can check if the device is powered correctly. If you are getting power from a USB port, make sure that you have a good USB cable.

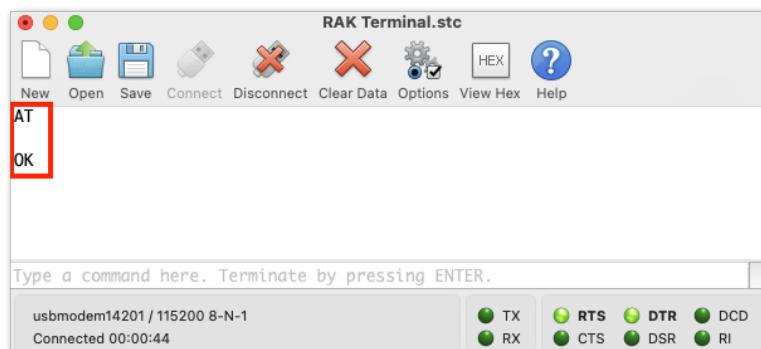


Figure 27: at+version command response

2. The next step is to configure the ABP LoRaWAN parameters in RAK11300:

- LoRaWAN join mode: **ABP**

- LoRaWAN class: **Class A**
- LoRaWAN region: **EU868**

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=5
```

NOTE

Depending on the Regional Band you selected, you might need to configure the sub-band of your RAK11300 to match the gateway and LoRaWAN network server. This is especially 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 Command Manual](#).

To illustrate, you can use sub-band 2 by sending the command `AT+MASK=2`.

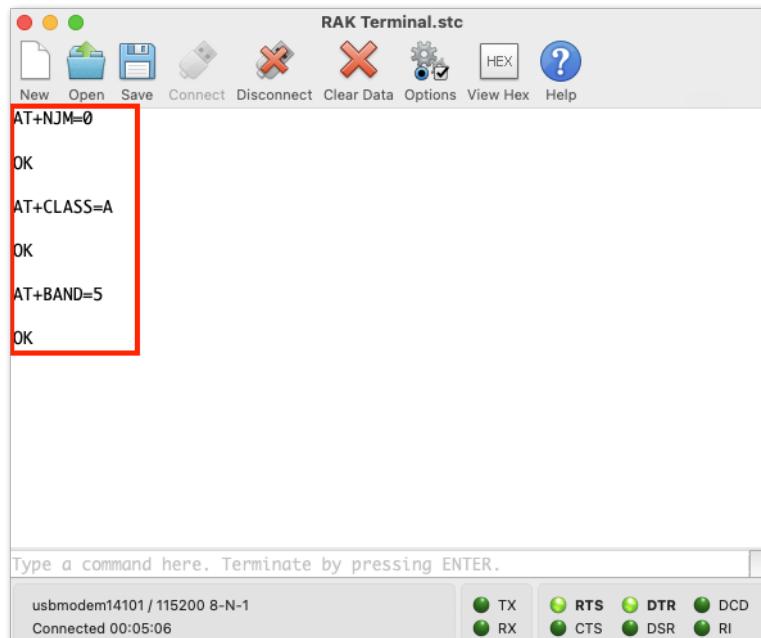


Figure 28: Configuring LoRa Parameters

List of band parameter options

Code

Regional Band

0

AS923-1

Code	Regional Band
1	AU915
2	CN470
3	CN779
4	EU433
5	EU868
6	KR920
7	IN865
8	US915
9	AS923-2
10	AS923-3
11	AS923-4
12	RU864

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

- Device Address: **260B7C8C**
- Application Session Key: **5128A8C13BC4A8DA10AA3EF07BE3D610**
- Network Session Key: **351F9B3C6468886E9B811FE596AD38BF**

Set the Device Address.

```
AT+DEVADDR=260B7C8C
```

Set the Application Session Key.

```
AT+APPSKEY=5128A8C13BC4A8DA10AA3EF07BE3D610
```

Set the Network Session Key.

```
AT+NWKSKEY=351F9B3C6468886E9B811FE596AD38BF
```

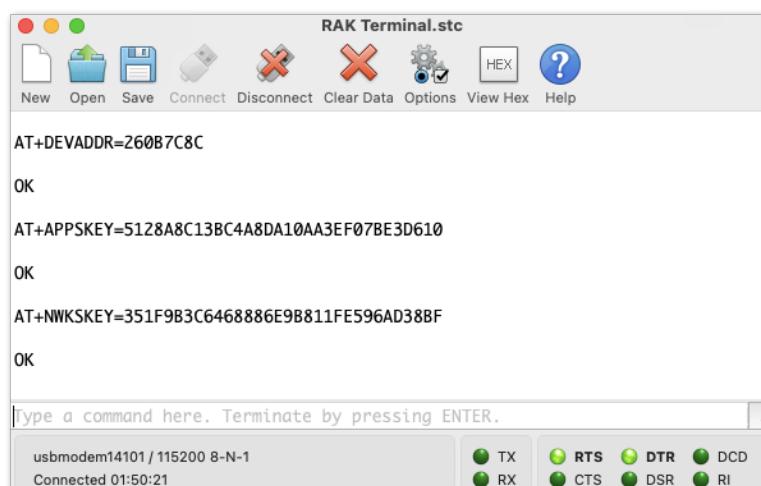


Figure 29: Configuring LoRa Parameters

- After the Device address and sessions keys configuration, you need to restart the device for the changes to take effect. You can do this by either inputting the `ATZ` command or pushing the reset button. The Serial port connection is lost after the ATZ command or pushing the reset button. The connection must be re-established on the connected computer before log output can be seen or AT commands can be entered again. You must be able to see the summary of configurations when you reconnect your device.

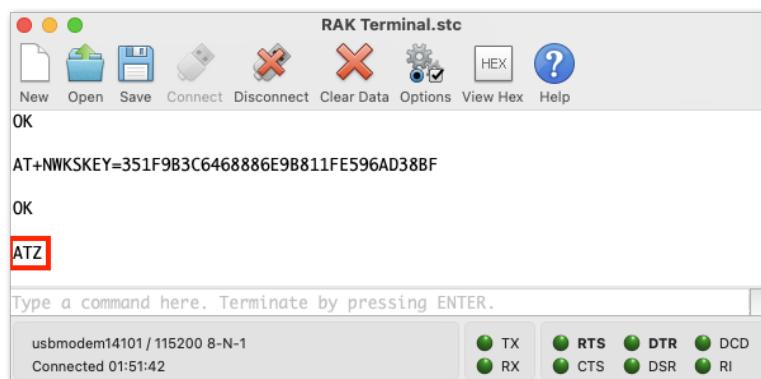


Figure 30: Reset the Device

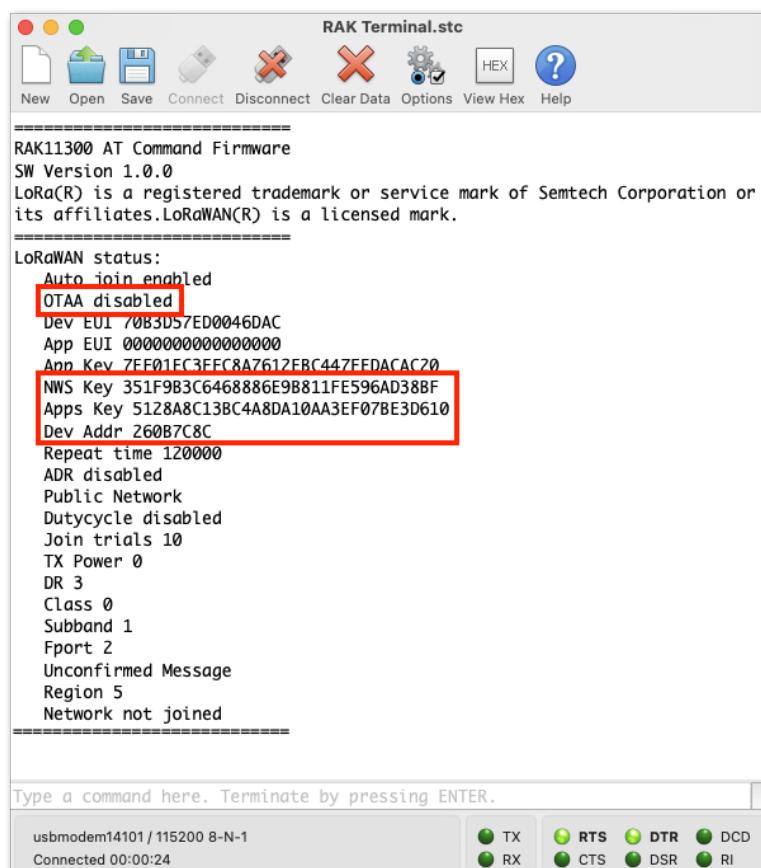


Figure 31: Summary of Device Parameters

- After checking if the parameters are properly set, you can now join the network and send the payload.

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

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 power up, 0: no auto-join
y	Reattempt interval in seconds (7-255) - This is currently fixed to 30 sec.
z	Number of join attempts (0-255) - 0 is default.

6. With the end-device properly activated, you can now try to send some payload after successful join. In ABP, there will be no `AT+JOIN=SUCCESS` reply on the join command.

```
AT+SEND=2:1234
```

7. 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, make sure that the antenna of your device is properly connected.

After checking all the things above, try to send LoRaWAN payloads again.

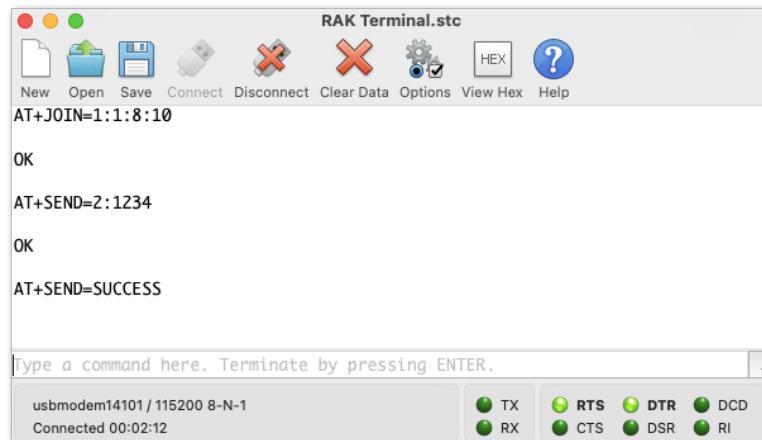


Figure 32: ABP Uplink Sent to TTN server

8. You can see the data sent by the RAK11300 module on the TTN device console *Live data* section and the *Last seen* info should be few seconds ago.

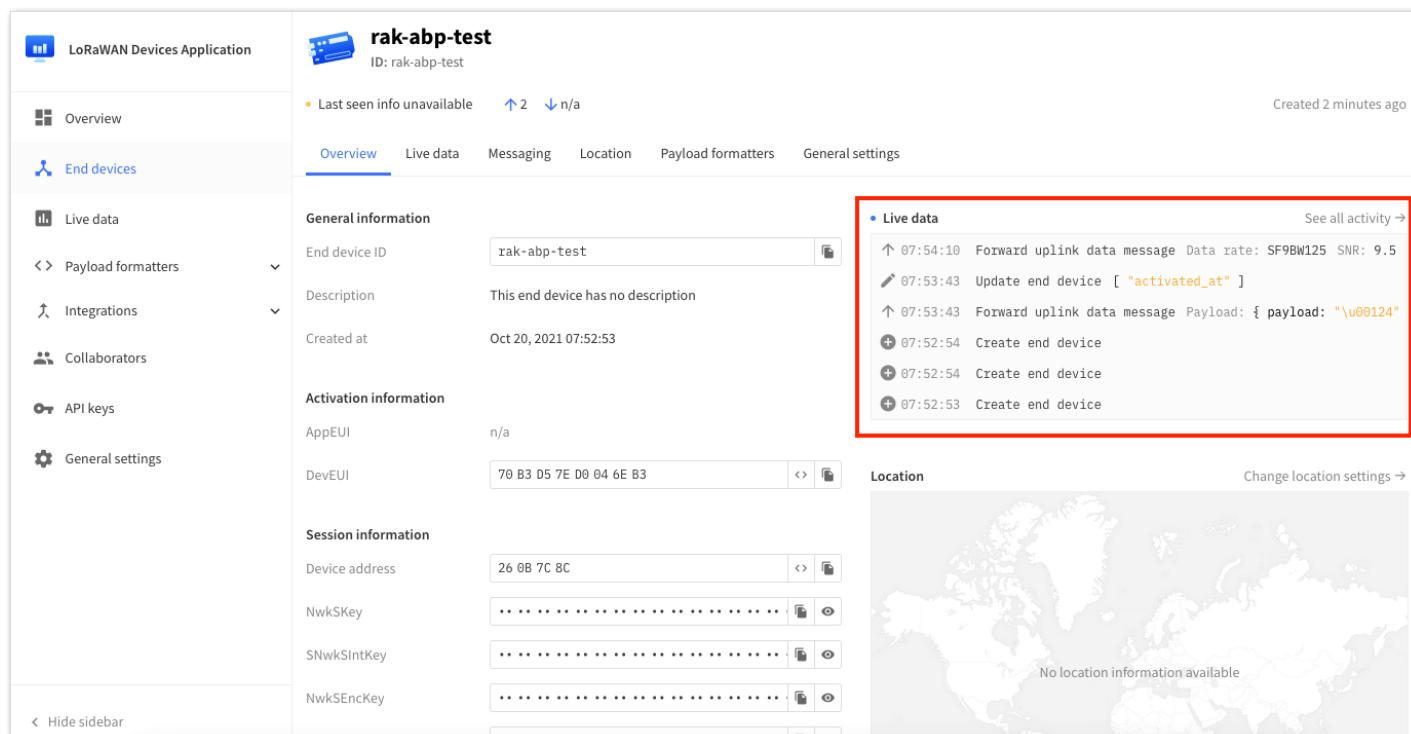


Figure 33: OTAA Test Sample Data Sent Viewed in TTN

NOTE

The module is not tracking the frame counters when it resets via `ATZ` or when power is recycled. To continuously receive ABP packets even when the device resets, you need to enable `Resets Frame Counters` in Network Layer configuration under the general settings section of the device in the TTN V3 console.

Connecting with ChirpStack

In this section, it shows how to connect the RAK11300 module to the ChirpStack platform.

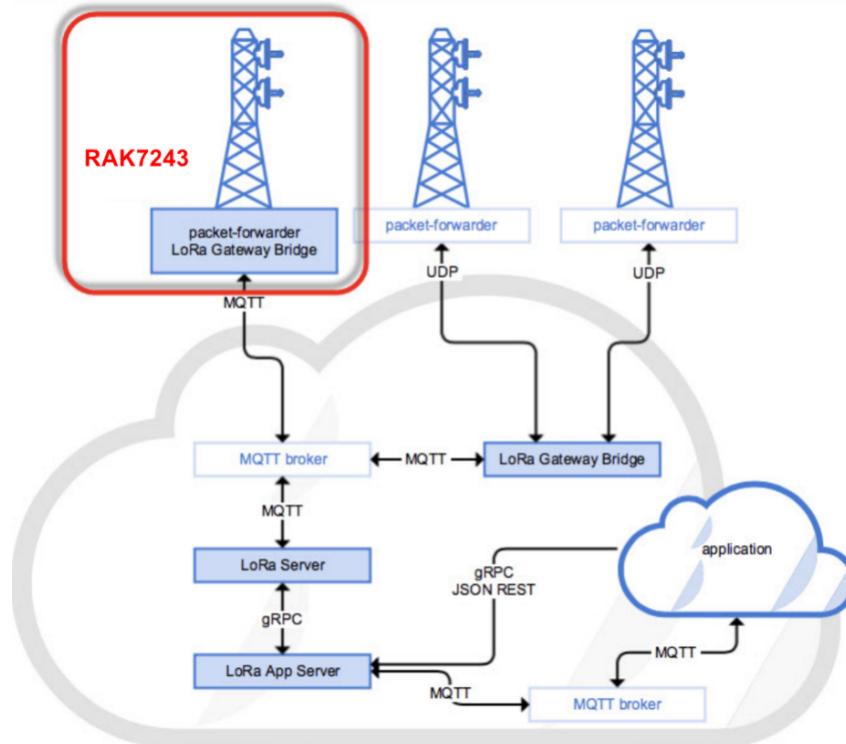


Figure 34: RAK11300 Module in the Context of the ChirpStack Platform

The ChirpStack, previously known as the LoRaServer project, provides open-source components for building LoRaWAN networks. Like the case of the TTN, the RAK11300 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 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.

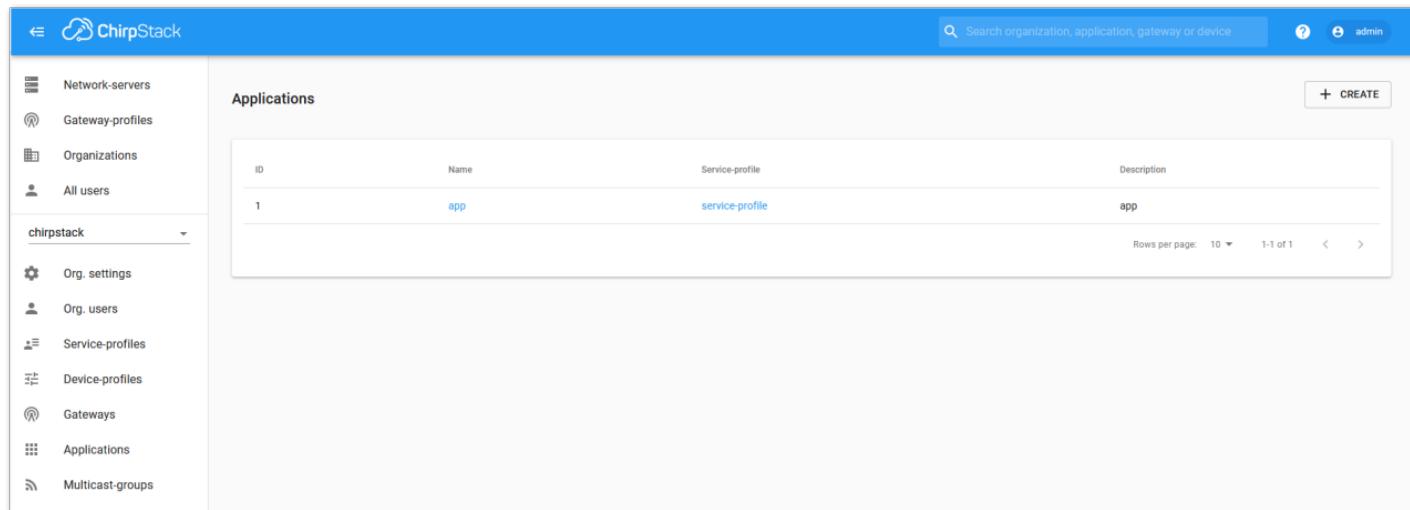
- In summary, these are the requirements:
 1. Have a ChirpStack online gateway. The frequency band of the nodes should be consistent with the frequency band of the gateway in use.
 - [Connect the Gateway with Chirpstack](#)
 2. The RAK Serial Port Tool provided by RAK
 3. RAK11300 module

NOTE

The frequency band used in the demonstration is EU868. Use a high-frequency version of RAK11300. The product number should be **RAK11300**.

Create a New Application

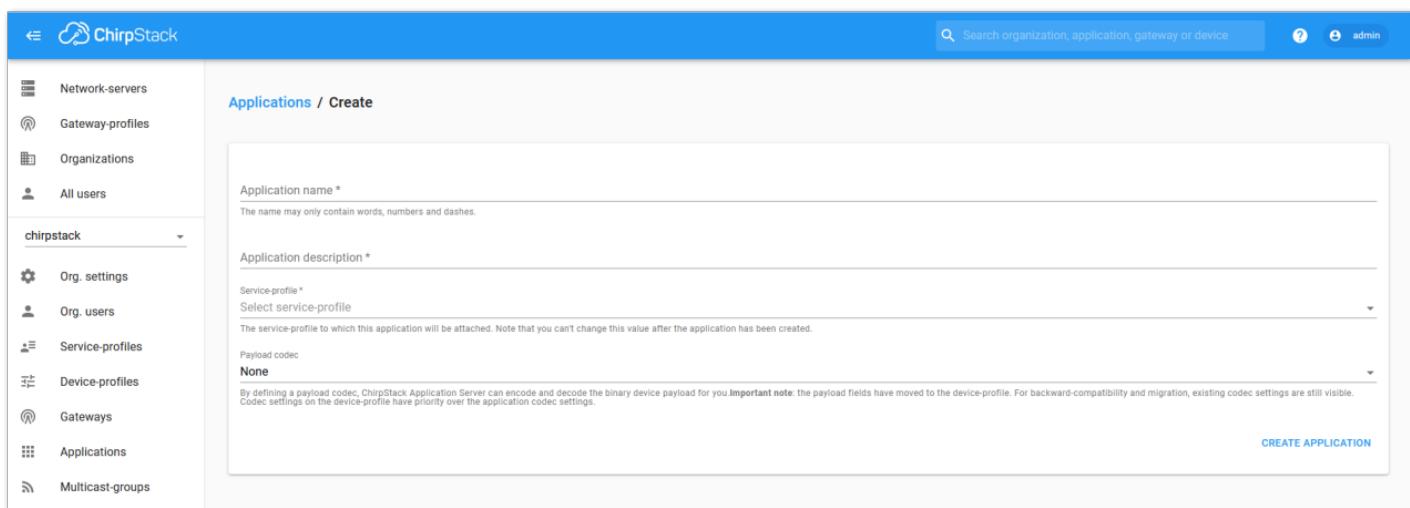
1. Login to the ChirpStack server using your account and password.
2. Go to the Application section, as shown in **Figure 35**.



ID	Name	Service-profile	Description
1	app	service-profile	app

Figure 35: Application Section

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



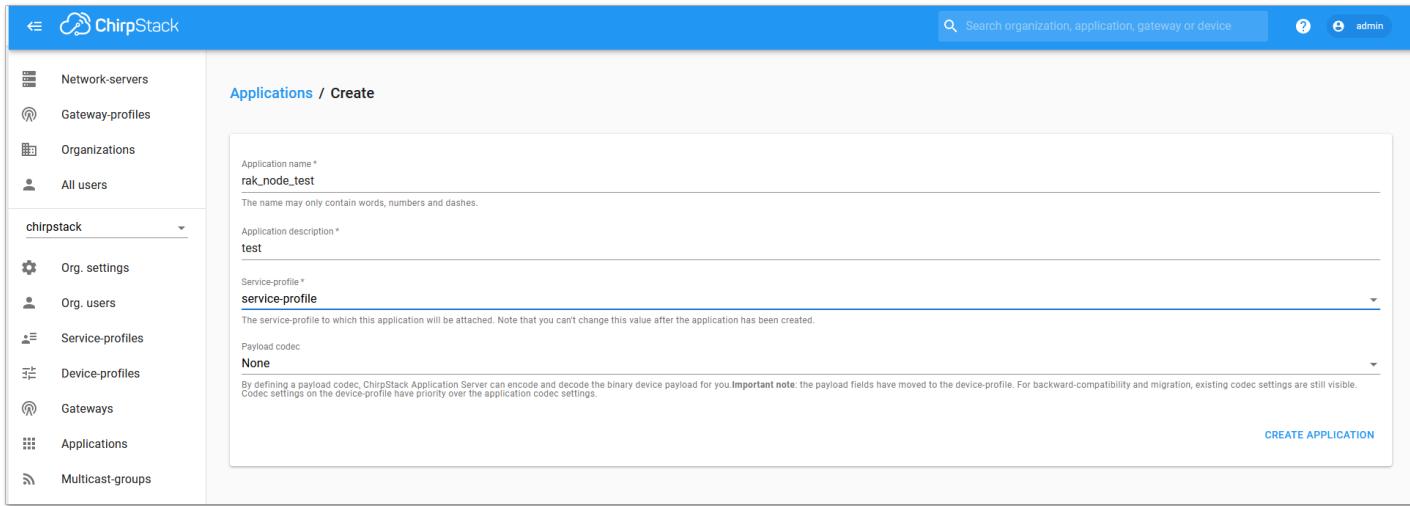
The screenshot shows the ChirpStack Documentation Center interface. On the left is a sidebar with various system management options like Network-servers, Gateway-profiles, Organizations, All users, and chirpstack (which is currently selected). The main content area is titled 'Applications / Create'. It contains fields for 'Application name *' (with a note: 'The name may only contain words, numbers and dashes.'), 'Application description *' (with a note: 'The service-profile to which this application will be attached. Note that you can't change this value after the application has been created.'), 'Service-profile *' (set to 'service-profile'), and 'Payload codec' (set to 'None'). At the bottom right of the form is a blue 'CREATE APPLICATION' button.

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.

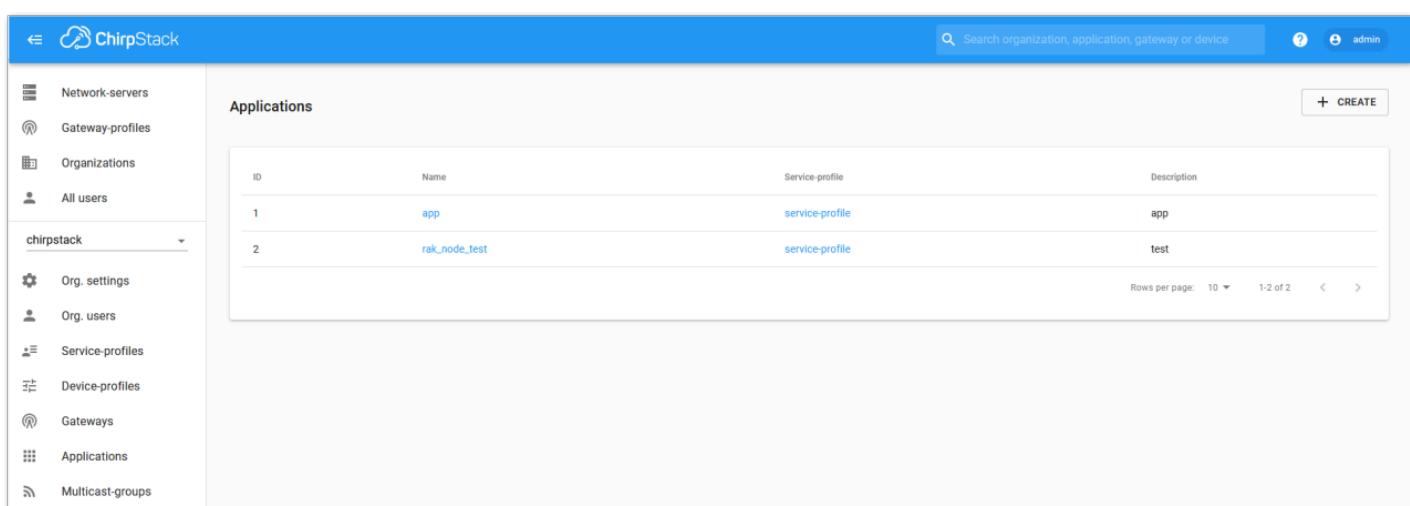


This screenshot shows the same 'Applications / Create' form as Figure 36, but with different parameter values. The 'Application name *' field now contains 'rak_node_test'. The 'Application description *' field contains 'test'. The 'Service-profile *' field is set to 'service-profile'. The 'Payload codec' field is set to 'None'. The rest of the interface is identical to Figure 36.

Figure 37: Filling Parameters of an Application

Register a New Device

- Choose the **Application** created in the previous step, then select the **DEVICES** tab, as shown in **Figure 38** and **Figure 39**.
- Once done, click **+ CREATE**.



The screenshot shows a table titled 'Applications' listing two entries. The first entry is 'app' (ID 1) with a 'service-profile' and a 'Description' of 'app'. The second entry is 'rak_node_test' (ID 2) with a 'service-profile' and a 'Description' of 'test'. The table has columns for 'ID', 'Name', 'Service-profile', and 'Description'. In the top right corner of the table header, there is a blue '+ CREATE' button. The sidebar on the left is identical to Figure 36.

Figure 38: List of Applications Created

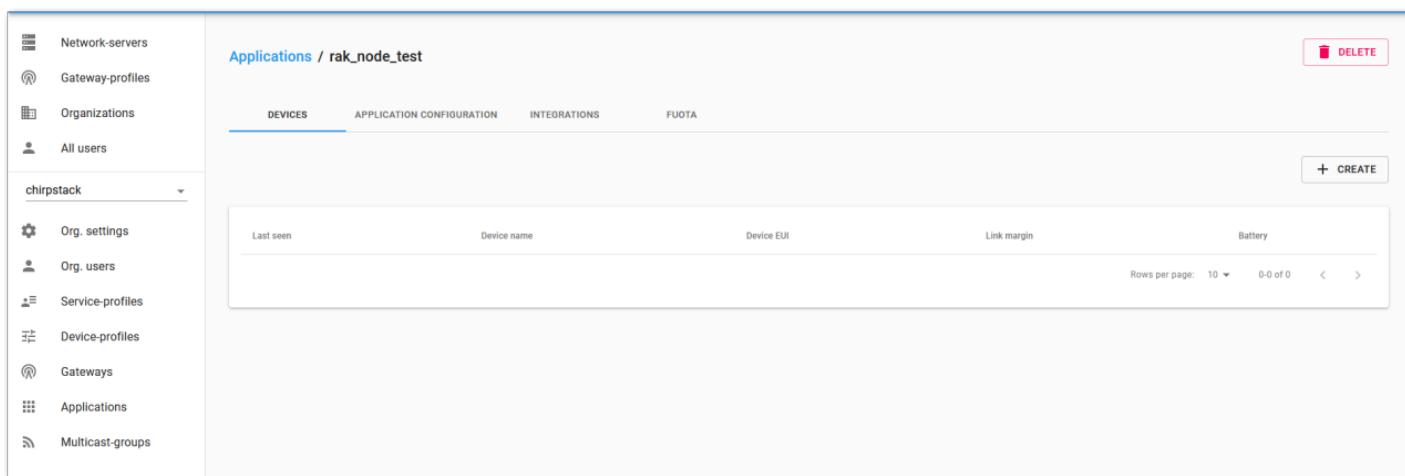


Figure 39: Device Tab of an Application

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

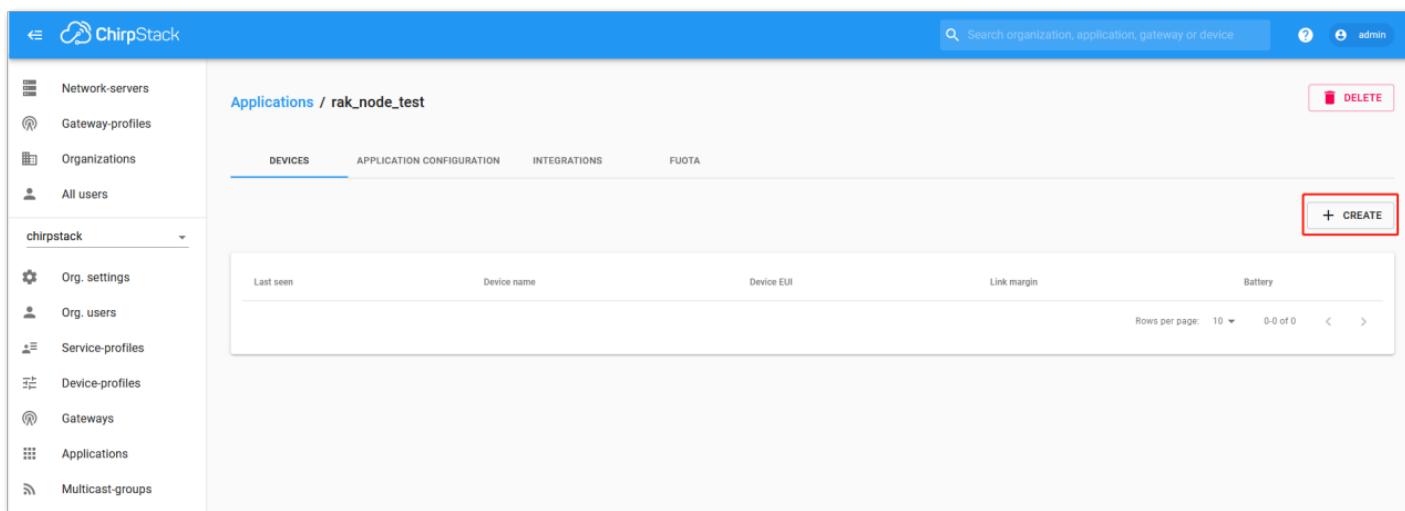


Figure 40: Add a New Device

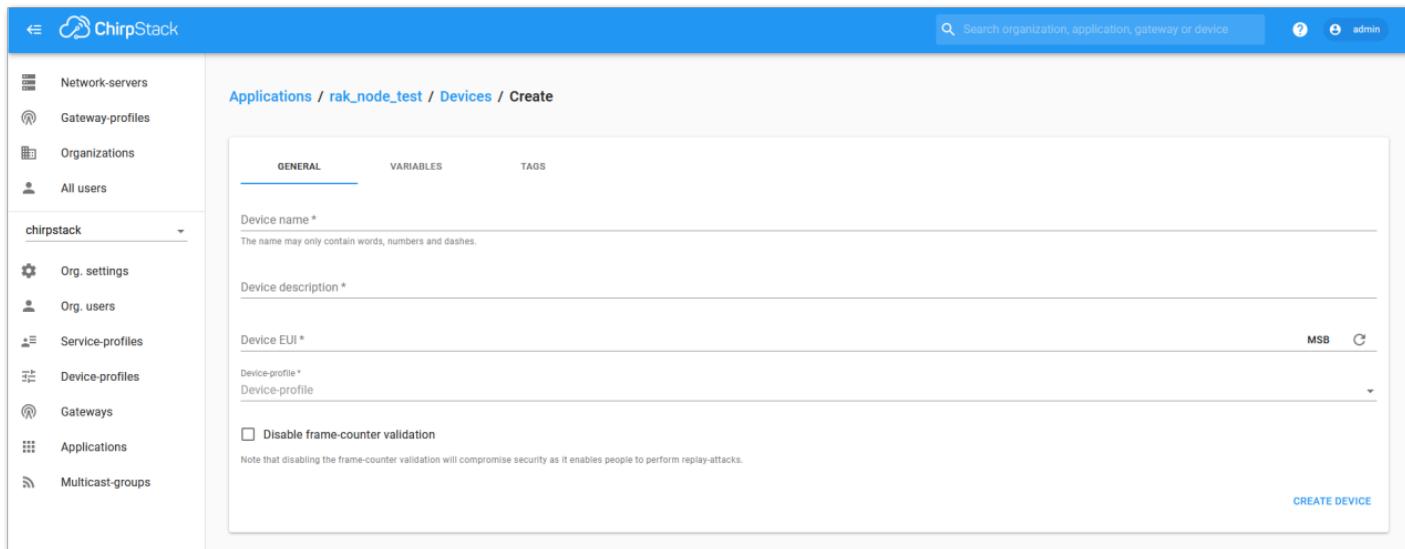


Figure 41: Chirpstack Adding Node into the RAK11300 Module

7. 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 in 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 RAK11300.

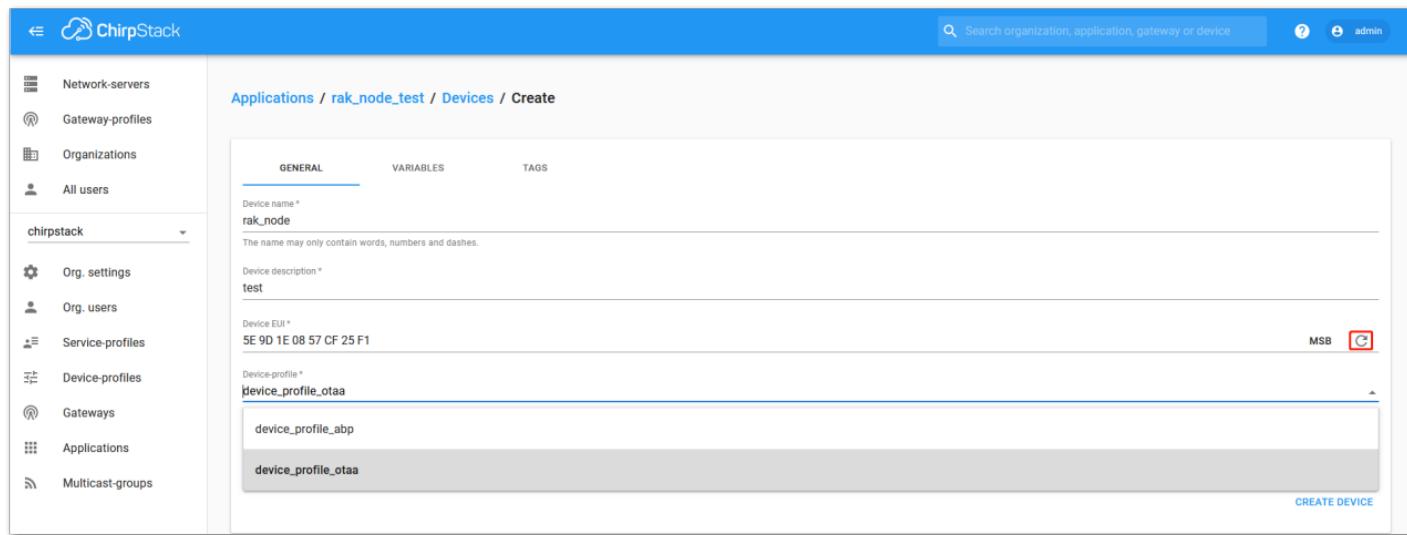


Figure 42: Generate a New Device EUI

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.

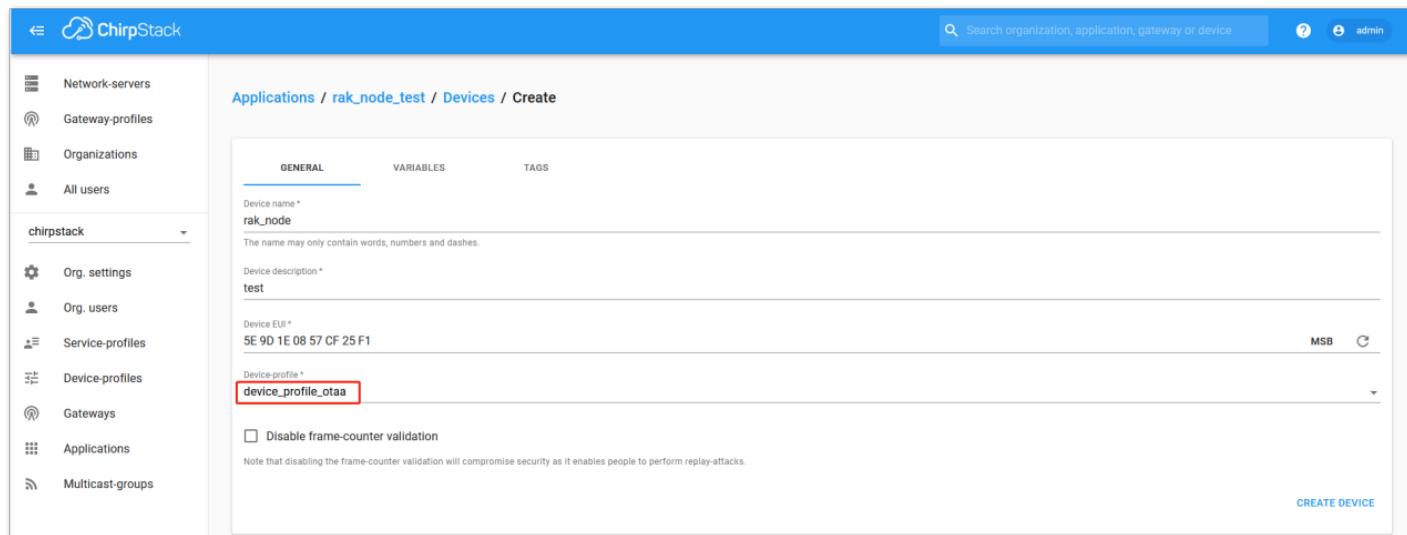
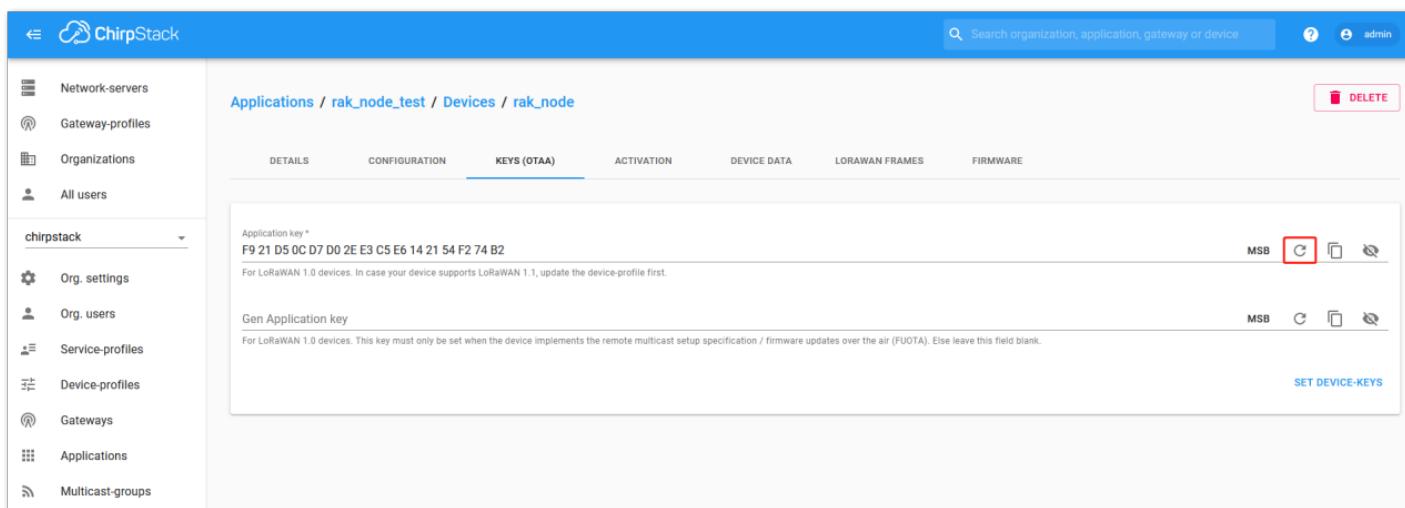


Figure 43: Chirpstack OTAA Activation

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**:

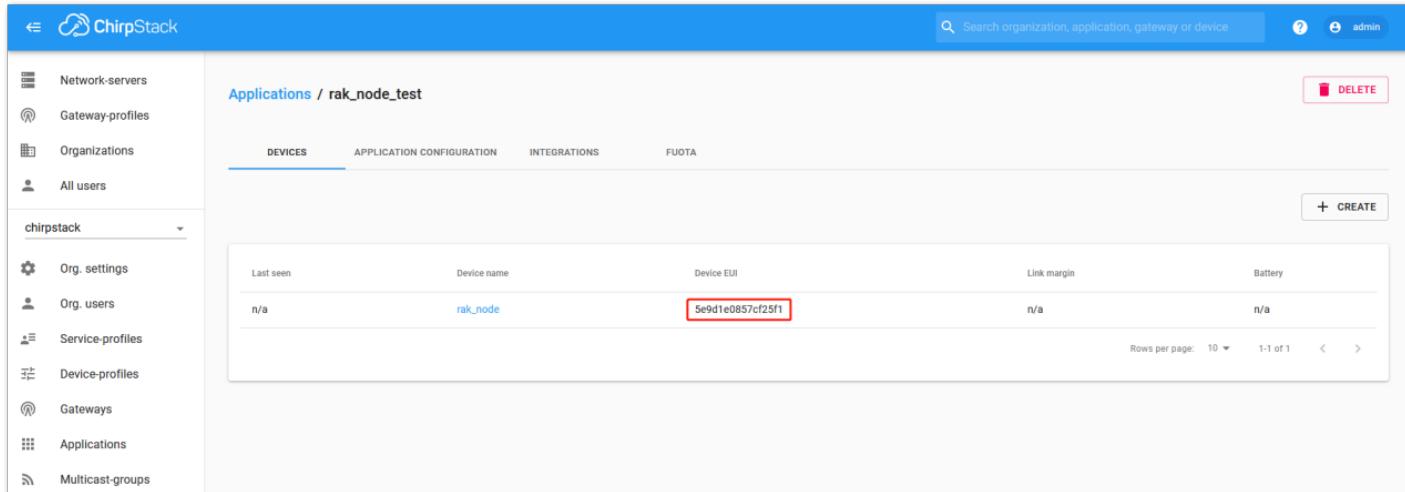


The screenshot shows the ChirpStack interface for setting application keys. On the left sidebar, under the 'chirpstack' section, there are several options: Network-servers, Gateway-profiles, Organizations, All users, Org. settings, Org. users, Service-profiles, Device-profiles, Gateways, Applications, and Multicast-groups. The main content area is titled 'Applications / rak_node_test / Devices / rak_node'. Below this, there are tabs: DETAILS, CONFIGURATION, KEYS (OTAA) (which is selected), ACTIVATION, DEVICE DATA, LORAWAN FRAMES, and FIRMWARE. The KEYS (OTAA) tab has two input fields: 'Application key*' containing the value 'F9 21 D5 0C D7 D0 2E E3 C5 E6 14 21 54 F2 74 B2' and 'Gen Application key' which is currently empty. There are also 'MSB' and 'SET DEVICE-KEYS' buttons.

Figure 44: Chirpstack OTAA Set Application Keys

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

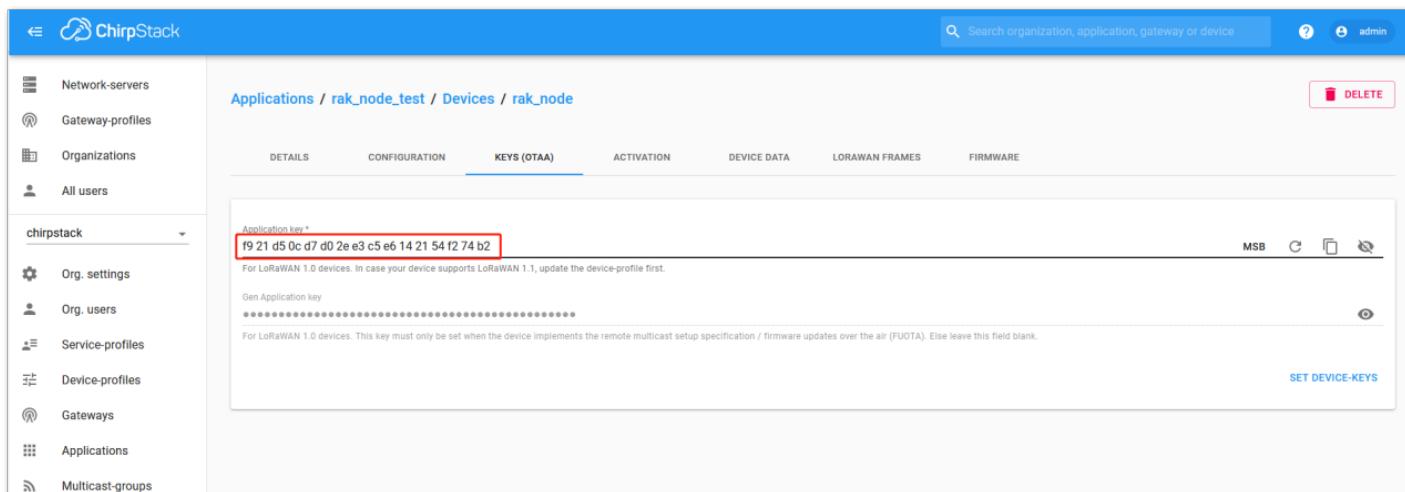
- As shown in **Figure 45**, a new device should be listed in the DEVICES tab. The most important parameters, such as the Device EUI are shown in the summary.



The screenshot shows the ChirpStack interface for listing devices. The left sidebar is identical to Figure 44. The main content area is titled 'Applications / rak_node_test'. Below this, there are tabs: DEVICES (which is selected), APPLICATION CONFIGURATION, INTEGRATIONS, and FUOTA. The DEVICES tab displays a table with one row. The columns are: Last seen, Device name, Device EUI, Link margin, and Battery. The 'Device name' is 'rak_node' and the 'Device EUI' is '5e9d1e0857cf25f1'. There is a '+ CREATE' button at the top right of the table. At the bottom right, there are buttons for 'Rows per page: 10', '1-1 of 1', and navigation arrows.

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**.



The screenshot shows the ChirpStack interface for verifying the application key. The left sidebar is identical to Figure 44. The main content area is titled 'Applications / rak_node_test / Devices / rak_node'. Below this, there are tabs: DETAILS, CONFIGURATION, KEYS (OTAA) (selected), ACTIVATION, DEVICE DATA, LORAWAN FRAMES, and FIRMWARE. The KEYS (OTAA) tab shows the 'Application key*' field with the value 'F9 21 D5 0C D7 D0 2E E3 C5 E6 14 21 54 F2 74 B2' highlighted with a red box. There is also a 'Gen Application key' field with a series of asterisks and a 'SET DEVICE-KEYS' button.

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 on the side of the node.

OTAA Configuration for Chirpstack

The RAK11300 module supports a series of AT commands to configure its internal parameters and control the functionalities of the module.

1. To set up the RAK11300 module to join the Chirpstack using OTAA, start by connecting the RAK11300 module to your computer and open the Serial terminal like the RAK Serial Port Tool. Select the correct COM port and set the baud rate to 115200.

It is recommended to start by testing the serial communication and verify that the current configuration is working by sending a simple `AT` command:

```
AT
OK
```

You will receive `OK` when you input the `AT` command.

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. Also, you can check if the device is powered correctly. If you are getting power from a USB port, make sure that you have a good USB cable.

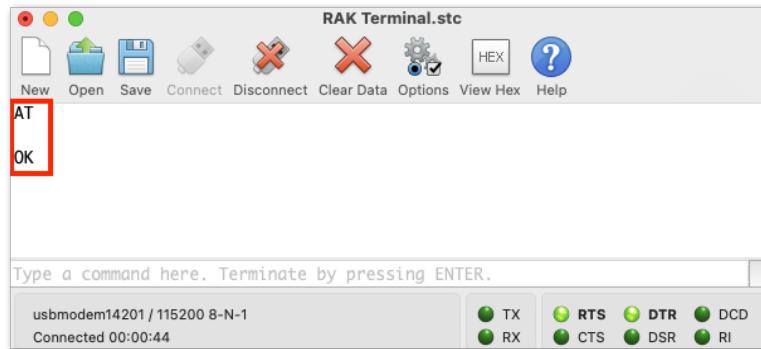


Figure 47: at+version command response

2. The next step is to configure the OTAA LoRaWAN parameters in RAK11300:

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

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=5
```

NOTE

Depending on the Regional Band you selected, you might need to configure the sub-band of your RAK11300 to match the gateway and LoRaWAN network server. This is especially 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 Command Manual](#).

To illustrate, you can use sub-band 2 by sending the command `AT+MASK=2`.

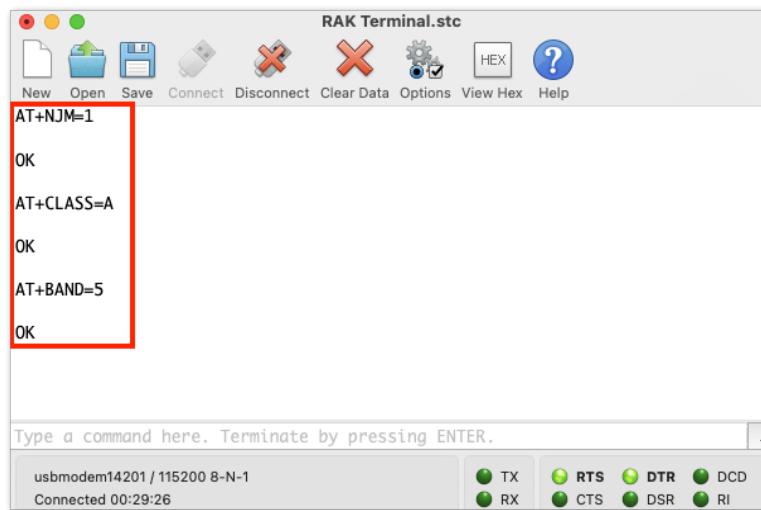


Figure 48: Configuring LoRa Parameters

List of band parameter options

Code	Regional Band
0	AS923-1
1	AU915
2	CN470
3	CN779
4	EU433
5	EU868

Code	Regional Band
6	KR920
7	IN865
8	US915
9	AS923-2
10	AS923-3
11	AS923-4
12	RU864

3. After the configuration of the LoRaWAN parameters, the next step is to set up the EUIs and key. You need to use the values from the Chirpstack console you configured in the earlier steps.

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

NOTE

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

Set the Device EUI.

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

Set the Application EUI.

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

Set the Application Key.

```
AT+APPKEY=F921D50CD7D02EE3C5E6142154F274B2
```

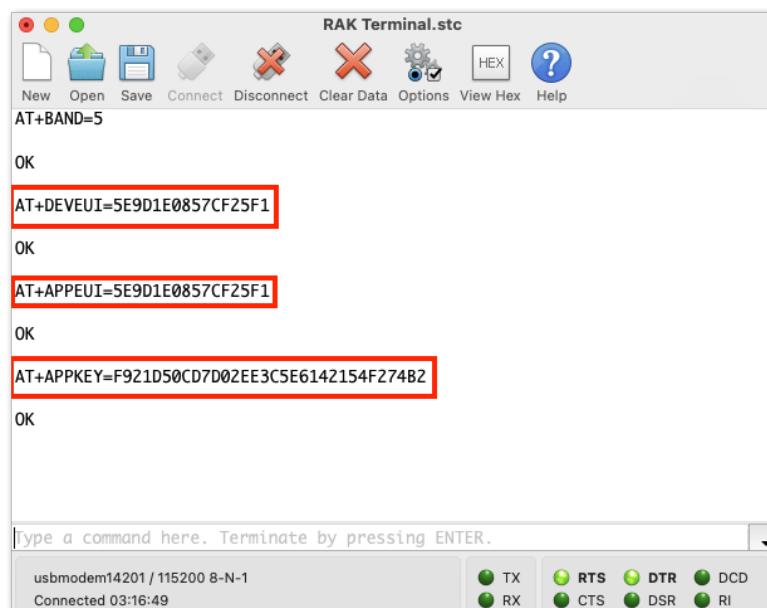


Figure 49: Configuring LoRa Parameters

- After EUI and keys configuration, you need to restart the device for the changes to take effect. You can do this by inputting the `ATZ` command or pushing the reset button. The Serial port connection is lost after the `ATZ` command or pushing the reset button. The connection must be re-established on the connected computer before log output can be seen or AT commands can be entered again. You must be able to see the summary of configurations when you reconnect your device.

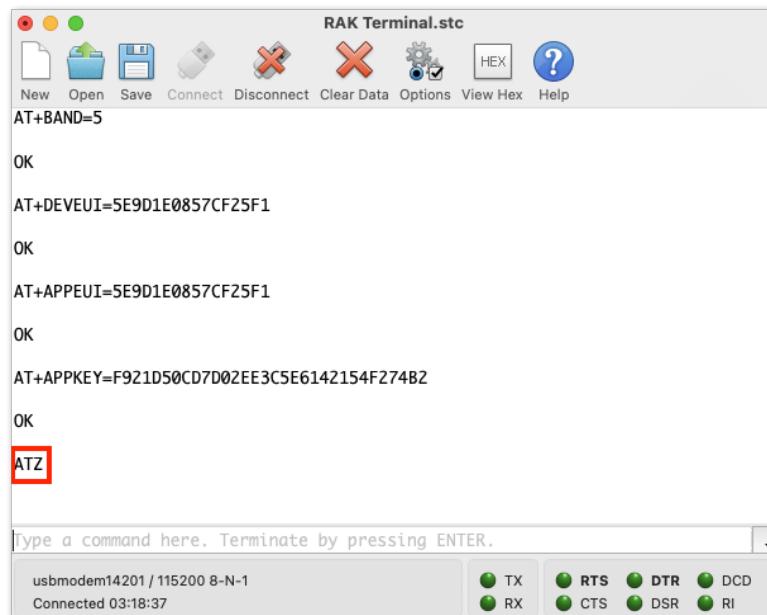


Figure 50: Reset the Device

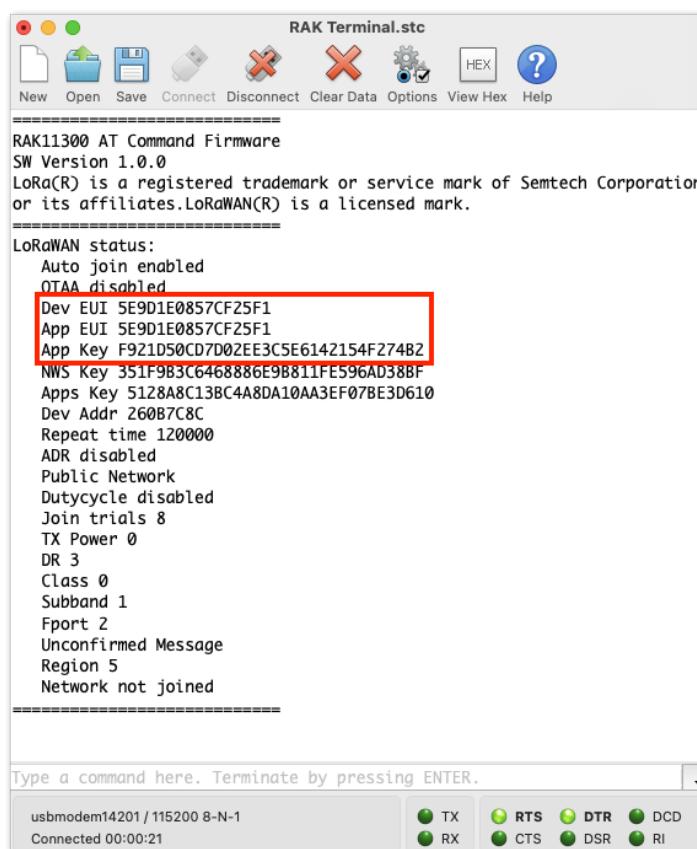


Figure 51: Summary of Device Parameters

5. After checking if the parameters are properly set, you can now join the network and send the payload.

AT+JOIN=1:1:10:8

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 power up, 0: no auto-join
y	Reattempt interval in seconds (7-255) - This is currently fixed to 30 sec.
z	Number of join attempts (0-255) - 0 is default.

After 5 or 6 seconds, if the request is successfully received by a LoRa gateway, then you should see the **AT+JOIN=SUCCESS** status reply, as shown in **Figure 20**.

NOTE

If the OTAA device join failed, 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 by using **AT+DEVEUI=?**, **AT+APPEUI=?**, and **AT+APPKEY=?** commands. Lastly, make sure that the antenna of your device is properly connected.

After checking all the things above, try to join again.

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

AT+SEND=2:1234

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

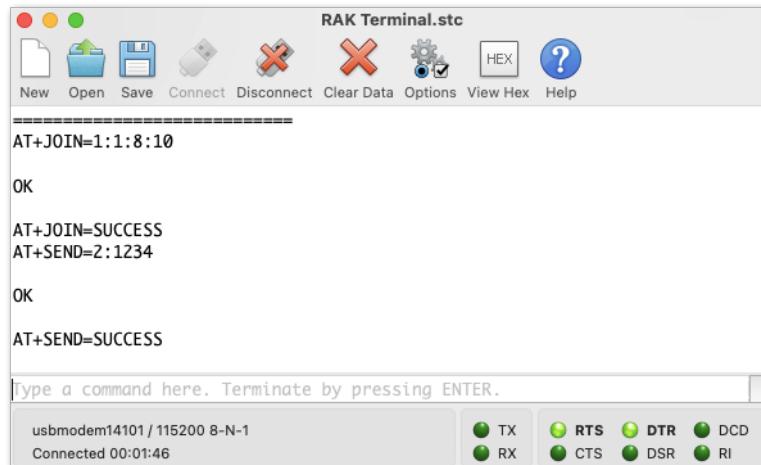
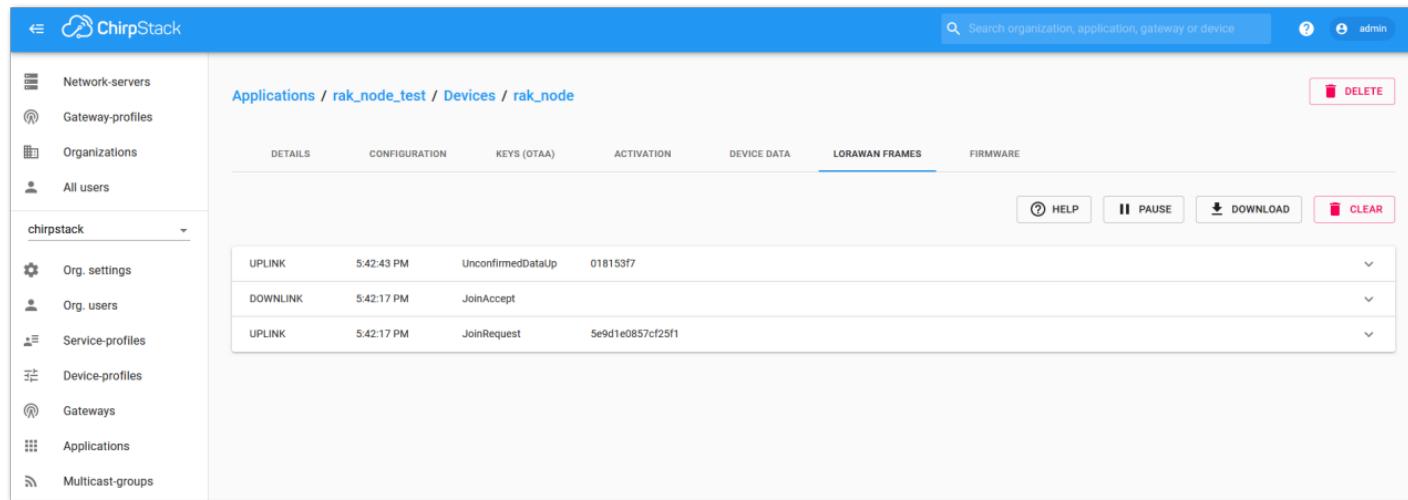


Figure 52: OTAA Joining and Sample payload

8. 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**.



The screenshot shows the ChirpStack web interface. The left sidebar shows a navigation tree with categories like Network-servers, Gateway-profiles, Organizations, All users, and chirpstack. The main area is titled "Applications / rak_node_test / Devices / rak_node". The "LORAWAN FRAMES" tab is selected. Below it, there is a table with the following data:

	UPLINK	5:42:43 PM	UnconfirmedDataUp	018153f7
	DOWNLINK	5:42:17 PM	JoinAccept	
	UPLINK	5:42:17 PM	JoinRequest	5e9d1e0857cf25f1

Figure 53: Chirpstack Data Received Preview

Chirpstack ABP Device Registration

1. 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 the LoRaWAN network using the ABP mode.

NOTE

Check the **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.

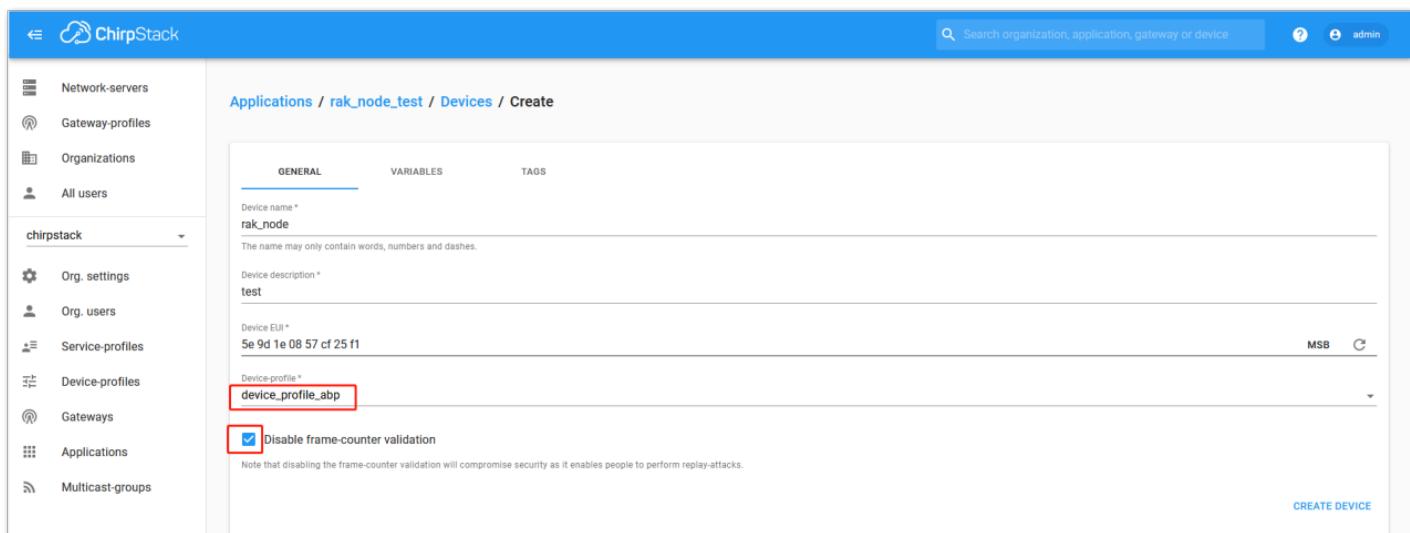


Figure 54: ChirpStack Console, Configuring a Device

- After selecting the ABP mode, the following parameters appear in the Activation tab. Then, you can see that there are some parameters for ABP in the **ACTIVATION** item:

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

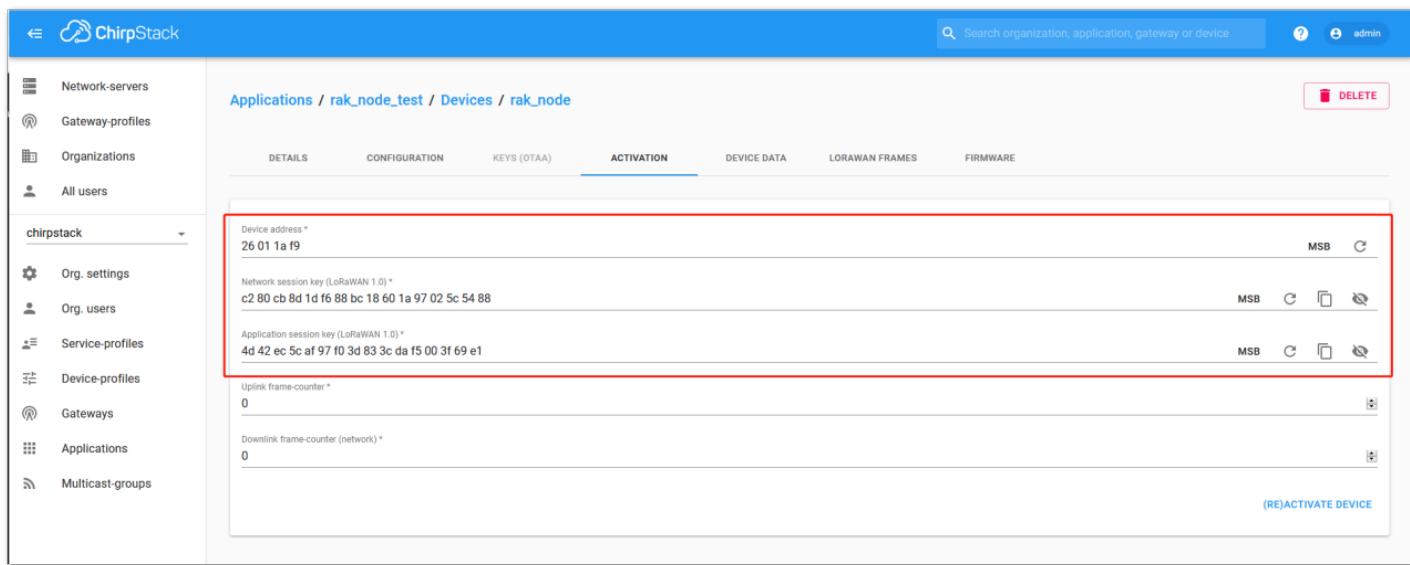


Figure 55: Chirpstack ABP Activation Parameters Needed

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

ABP Configuration for Chirpstack

- To set up the RAK11300 module to join the Chirpstack using ABP, start by connecting the RAK11300 module to the computer and configure it using a Serial terminal software like the RAK Serial Port Tool. Select the correct COM port and set the baud rate to 115200.

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

```
AT
```

 **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 115200. Also, you can check if the device is powered correctly. If you are getting power from a USB port, ensure that you have a good USB cable.

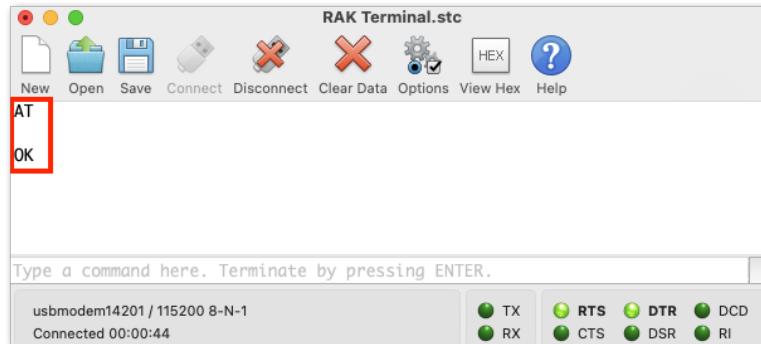


Figure 56: at+version command response

2. The next step is to configure the ABP LoRaWAN parameters in RAK11300:

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

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=5
```

 **NOTE**

Depending on the Regional Band you selected, you might need to configure the sub-band of your RAK11300 to match the gateway and LoRaWAN network server. This is especially 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 Command Manual](#).

To illustrate, you can use sub-band 2 by sending the command `AT+MASK=2`.

List of band parameter options

Code

Regional Band

Code	Regional Band
0	AS923-1
1	AU915
2	CN470
3	CN779
4	EU433
5	EU868
6	KR920
7	IN865
8	US915
9	AS923-2
10	AS923-3
11	AS923-4
12	RU864

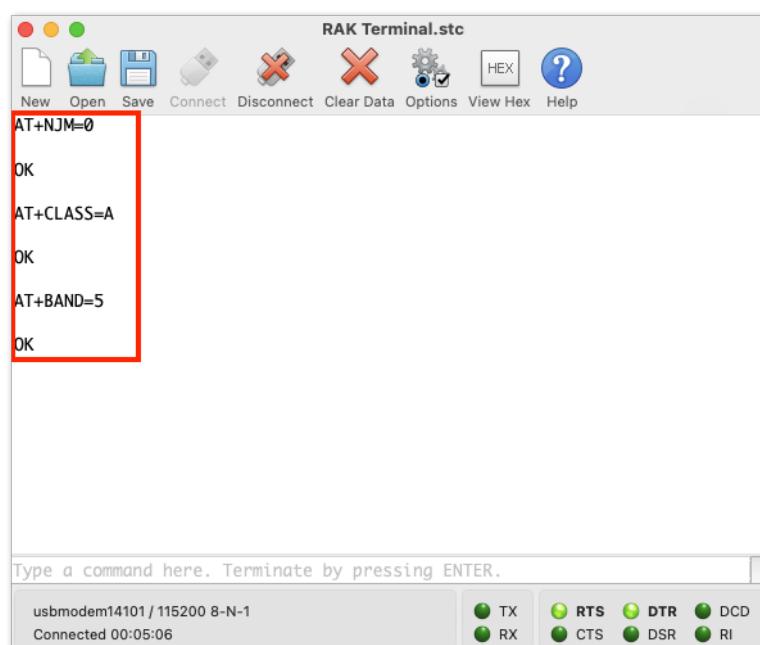


Figure 57: Configuring LoRa Parameters

3. After configuration of the LoRaWAN parameters, the next step is to set up the device address and sessions keys. You need to use the values from the TTN 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
```

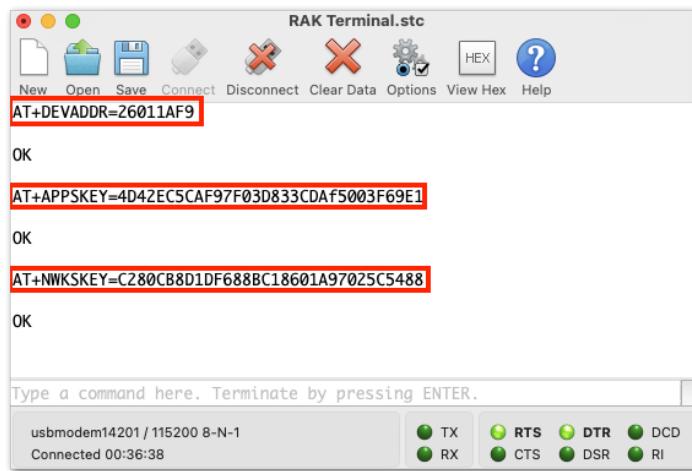


Figure 58: Configuring LoRa Parameters

- After the Device address and sessions keys configuration, you need to restart the device for the changes to take effect. You can do this by inputting the `ATZ` command or pushing the reset button. The serial port connection is lost after the `ATZ` command or pushing the reset button. The connection must be re-established on the connected computer before log output can be seen or AT commands can be entered again. You must be able to see the summary of configurations when you reconnect your device.

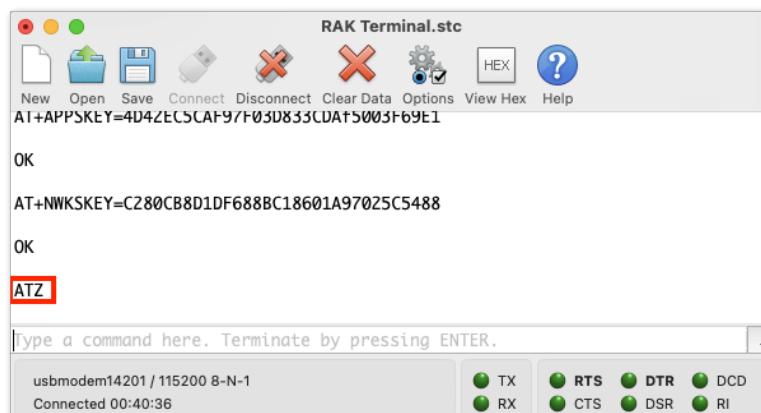


Figure 59: Reset the Device

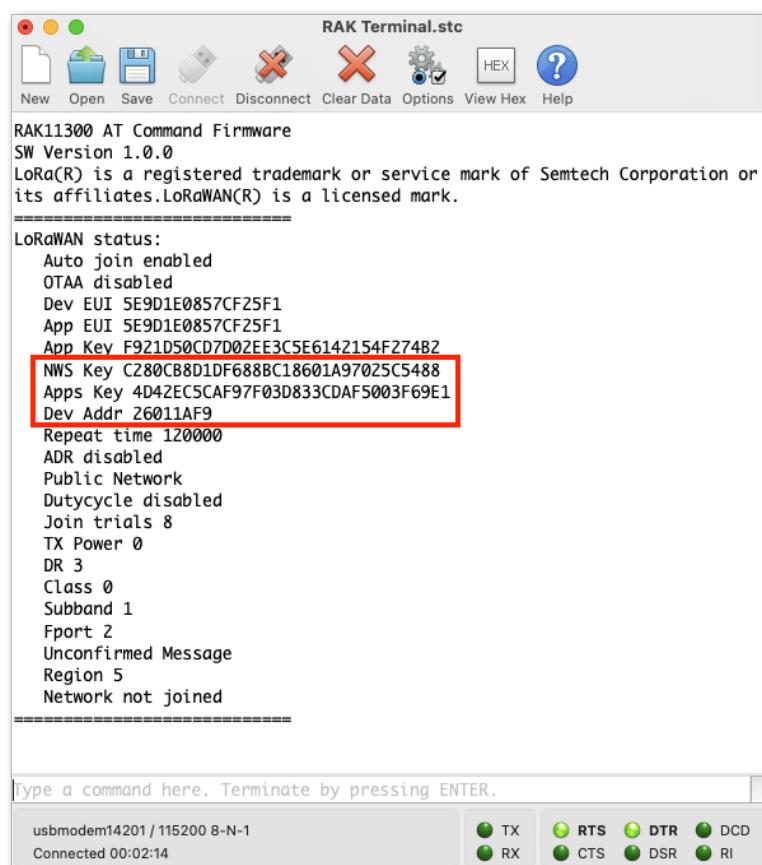


Figure 60: Summary of Device Parameters

5. After checking if the parameters are properly set, you can now join the network and send the payload.

AT+JOIN=1:1:10:8

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 power up, 0: no auto-join
y	Reattempt interval in seconds (7-255) - This is currently fixed to 30 sec.
z	Number of join attempts (0-255) - 0 is default.

6. With the end-device properly activated, you can now try to send some payload after successful join. In ABP, there will be no `AT+JOIN=SUCCESS` reply on the join command.

AT+SEND=2:1234

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

NOTE

If your LoRaWAN payload didn't reach the Chirpstack server, check if your device is within reach of a working LoRaWAN gateway that is configured to connect to the Chirpstack server. 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.

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 [RAK11300 Datasheet](#).

Firmware Upgrade Through USB

Minimum Hardware and Software Requirements

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

Hardware/Software	Requirement
Computer	A Windows/Ubuntu/Mac computer
USB Connection	RAK11300 main board should have a USB connector
Firmware File	.uf2 firmware file downloaded from the website

Firmware Upgrade Procedure

Execute the following procedure to upgrade the firmware via USB using the `.uf2` firmware file.

1. Download the latest application firmware of the RAK11300.
 - [RAK11300 Firmware](#)
2. Connect the RAK11300 module to the computer via USB. If your main board has no USB connection, you won't be able to upload the `.uf2` firmware file.
3. Activate RAK11300 USB bootloader mode. There are two possible ways to do this.
 - Reset the module twice by momentarily shorting the reset pin to the ground.
 - Hold the BootSel button in the RAK11300 module, reset the module (short the reset pin to ground for at least 2 seconds), then wait for the USB Mass Storage `RPI-RP2` before releasing the BootSel button.

You need to do either of the two options until the USB Mass Storage `RPI-RP2` shows on your computer.

4. Copy the **firmware.uf2** file to the `RPI-RP2` Mass Storage device.

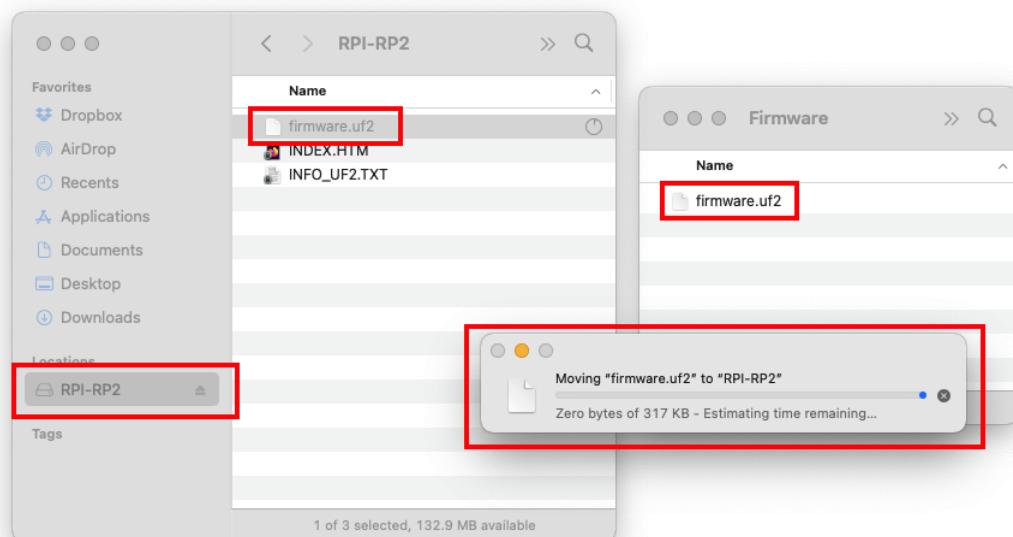


Figure 61: Drag the firmware.uf2 file to RPI-RP2 USB Mass Storage

5. You need to reset the device after updating the .uf2 firmware file.

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