# **RAK3172 Module Quick Start Guide**

This guide covers the following topics:

- The Things Network 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** 

# **BAK**<sup>®</sup> Documentation Center

Acronym	Definition
DFU	Device Firmware Upgrade
JTAG	Joint Test Action Group
LoRa	Long Range
ΟΤΑΑ	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<sup>C</sup>, as shown in Figure 1.

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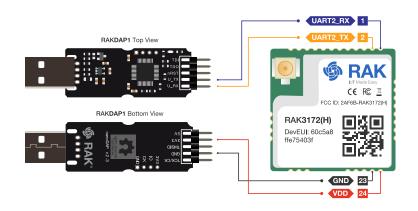


Figure 1: RAK3172 Module Connection

- 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.

#### VOTE:

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 2.

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 <sup>™</sup> and select a cluster as shown on Figure 3.

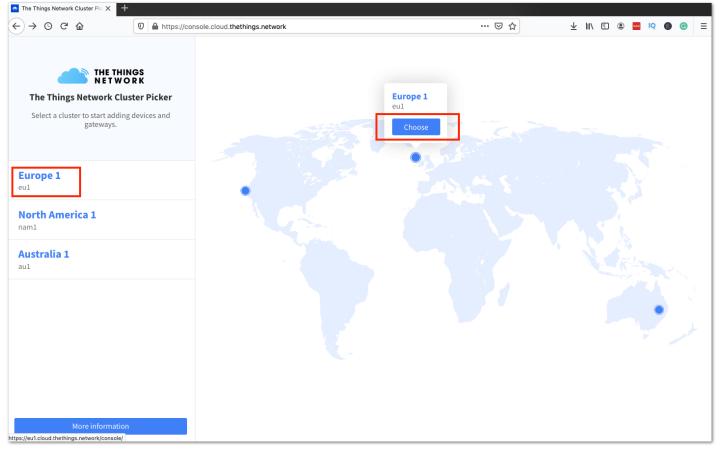


Figure 3: Selecting Cluster in TTN V3

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.

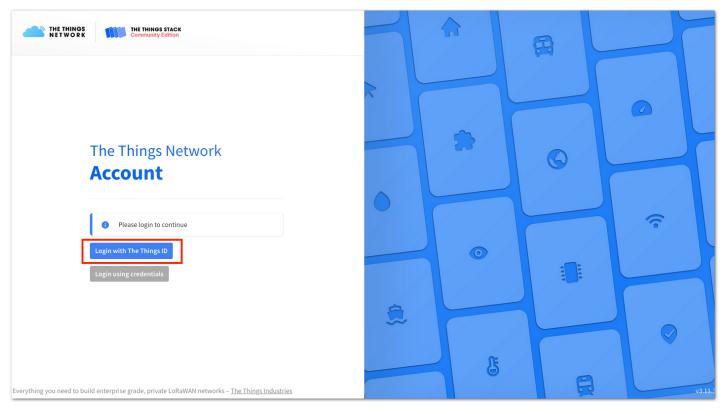


Figure 4: Login using TTN account

Θ
Login to The Things Stack with <b>The Things</b> I <b>D</b>
Username or email •
Password •
Submit
Cancel
Register Forgot password?
The Things ID by The Thing Industries

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.

Θ	
Authorization The Things Stack would like to:	
<ul> <li>View your profile information (username, profile picture, name, etc.)</li> <li>View your email address</li> </ul>	
Cancel Authorize	]
The Things ID by The Thing Industries	

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**.

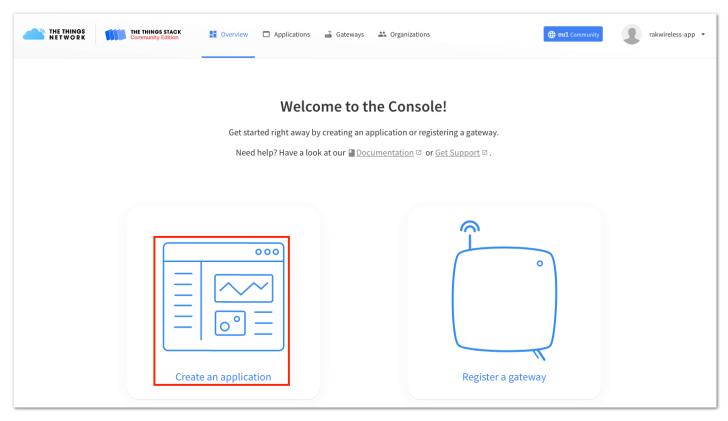


Figure 8: Creating TTN application for your LoRaWAN devices

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

THE THINGS THE THINGS STACK Community Edition	Applications  Gateways  Comparison  Gateways  Gateway	<pre> eu1Community rakwireless-app • </pre>
Add application		
Owner * rakwireless-app		
Application ID * lorawan-devices Application name	Ē	
LoRaWAN Devices Application Description		
This application involves LoRaWAN devices.	e notes about the application	
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.

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THE THINGS TACK Community Edition II Overview Applications 🗳 Gateways 🏔 Organizations 🕀 eu1 Community advireless-app 🗸								
LoRaWAN Devices Applica	Applications > LoRaWAN Dev							
Overview	LoRaWAN Devices Application ID: lorawan-devices							
🙏 End devices	🙏 0 End devices 🛛 🚢 1 Col	laborator 🛛 🗛 0 API keys					Created 34 seconds ago	
Live data								
<> Payload formatters ~	General information			<ul> <li>Live data</li> </ul>			See all activity →	
	Application ID	lorawan-devices	<b></b>					
↑ Integrations ~	Created at	Mar 30, 2021 02:50:03						
🚢 Collaborators	I anti-undertendert	Mar 20, 2021 02-50-02			Waiting for ever	nts from lorawan-devices		
🗣 API keys	Last updated at	Mar 30, 2021 02:50:03						
General settings								
	End devices (0)	Name ¢	DevEUI		Q Search by ID JoinEUI	≂+ Import end device:	Add end device	
< Hide sidebar			No item	is found				

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.

	THE THINOS STACK Community Edition       Image: Overview       Applications       Image: Organizations       Image: Organizations <t< th=""></t<>
LoRaWAN Devices Applica	Applications > LoRaWAN Devices Application > End devices > Register from The LoRaWAN Device Repository
	Register end device
Overview	
🙏 End devices	From The LoRaWAN Device Repository Manually
Live data	
<> Payload formatters ~	1. Select the end device
尤 Integrations ✓	Brand * Type to search
🚢 Collaborators	Cannot find your exact end device? Get help here and try manual device registration.
O∓ API keys	
General settings	
	2. Enter registration data
	Please choose an end device first to proceed with entering registration data
	Register end device

Figure 11: Manually register device to TTN

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LoRaWAN Devices Applica	From The LoRaWAN Device Repository Manually	
Overview	Preparation	
🙏 End devices	Activation mode 🔿 *	
🗓 Live data	Over the air activation (OTAA)	
<> Payload formatters ~	<ul> <li>Activation by personalization (ABP)</li> <li>Multicast</li> </ul>	
↑ Integrations ~	O not configure activation	
😩 Collaborators	LoRaWAN version ⑦ * MAC V1.0.2	~
🗛 API keys	The LoRaWAN version (MAC), as provided by the device manufacture	
🔅 General settings	Network Server address	
	eu1.cloud.thethings.network	±
	Application Server address	
	eu1.cloud.thethings.network	
	External Join Server 🗇	
	Enabled	
	Join Server address	
	eu1.cloud.thethings.network	
< Hide sidebar	Start	

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 <code>rak-device</code> is for illustration purposes only.

LoRaWAN Devices Applica	1     Basic settings     2     Network layer settings     3     Join settings       End device ID's, Name and     Frequency plan, regional     Root keys, NetID and kek       Description     parameters, end device     labels.
Overview	class and session keys.
Lend devices	End device ID *
🔝 Live data	rak-device
<> Payload formatters ~	10 00 00 00 00 00 00 00 00 00
大 Integrations ~	The AppEUI uniquely identifies the owner of the end device. If no AppEUI is provided by the device manufacturer (usually for development), it can be filled with zeros.
Lollaborators	DevEUI ③ *
🗣 API keys	11 33 55 77 99 22 44 66 The DevEUI is the unique identifier for this end device
🗱 General settings	End device name RAKwireless Device End device description This device is from RAKwireless. Optional end device description; can also be used to save notes about the end device
< Hide sidebar	Network layer settings >

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**.

Overview	From The LoRaWAN Device Repository Manually
<ul> <li>End devices</li> <li>Live data</li> <li>Payload formatters</li> </ul>	Basic settings       2       Network layer settings       3       Join settings         End device ID's, Name and       Frequency plan, regional       Root keys, NetID and kek         Description       parameters, end device       labels.         class and session keys.
↑ Integrations ~ Collaborators	Frequency plan ()*         Europe 863-870 MHz (SF9 for RX2 - recommended)
API keys	LoRaWAN version <sup>®</sup> * MAC V1.0.2
Ceneral settings	Regional Parameters version ②*   PHY V1.0.2 REV B     LoRaWAN class capabilities ⑦   Supports class B   Supports class C   Advanced settings ✓
≺ Hide sidebar	< Basic settings V Join settings 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.

LoRaWAN Devices Applica	Applications > LoRaWAN Devices Application > End devices > Register manually > Join settings				
Overview	Register end device				
Lend devices	From The LoRaWAN Device Repository Manually				
IL Live data					
<> Payload formatters ~	Basic settings Network layer settings 3 Join settings Root keys, NetID and kek				
↑ Integrations 🗸	Description parameters, end device labels. class and session keys.				
🚓 Collaborators	Root keys				
🗣 API keys	АррКеу ② *				
🗱 General settings	04 FA 4E 62 6E F5 CF 22 7C 96 96 01 17 62 75 C2 🗘				
	The root key to derive session keys to secure communication between the Generate and the application				
	Advanced settings v				
< Hide sidebar	< Network layer settings Add end device				

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 enddevice 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.

	THE THINGS STACK Community Edition	view 🗖 Applications 🝶 Gateways 🚢 Organiza	tions	eu1 Community     rakwireless-app
LoRaWAN Devices Applica	Applications > LoRaWAN De	vices Application > End devices > RAKwireless Device		
	Darriele	Bardar		
Overview	RAKwireles	s Device		
🙏 End devices	<ul> <li>Last seen info unavailable</li> </ul>	$^n n/a ↓ n/a$		Created 36 seconds ago
Live data	Overview Live data	Messaging Location Payload formatters Claiming	General settings	
<> Payload formatters ~	General information		Live data	See all activity →
↑ Integrations ~	End device ID	rak-device		
👪 Collaborators	Description	This device is from RAKwireless.		
Or API keys	Created at	Mar 30, 2021 04:59:07	Waiting	for events from rak-device
General settings	Activation information			
	AppEUI	10 00 00 00 00 00 09 <>		
	DevEUI	11 33 55 77 99 22 44 66 <>	Location	Change location settings $ ightarrow$
	Root key ID	n/a	A South	
	АррКеу	••••••		
	NwkKey	n/a		

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:



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.

	Command	
RAK COM: COM3  BaudRate: 1600  CLOSE	☑ 01 at+version	SEND
RECEIVING CLEAR RECV	☑ 02 at+get_config=device:status	SEND
	03 at+set_config=device:sleep:0	SEND
ок	04 at+set_config=device:restart	SEND
	05 at+set_config=device:gps:1	SEND
ок	06 at+set_config=lora:work_mode:0	SEND
AT	07 at+set_config=lora:join_mode:0	SEND
	08 at+set_config=lora:class:0	SEND
ок	09 at+set_config=lora:region:EU868	SEND
	□ 10 at+set_config=lora:confirm:1	SEND
	□ 11 at+set_config=lora:ch_mask:0:0	SEND
	□ 12 at+set_config=lora:dev_eui:	SEND
	□ 13 at+set_config=lora:app_eui:	SEND
	□ 14 at+set_config=lora:app_key:	SEND
	□ 15 at+set_config=lora:dev_addr:	SEND
	16 at+set_config=lora:nwks_key:	SEND
	□ 17 at+set_config=lora:apps_key:	SEND
	18 at+set_config=lora:send_interval:	SEND
SENDING(With \r\n)	□ 19 at+get_config=lora:status	SEND
AT	☑ 20 at+get_config=lora:channel	SEND
SEND	All/None	SAVE

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.



Set the LoRaWAN activation to OTAA.

AT+NJM=1

Set the LoRaWAN class to Class A.

AT+CLASS=A

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Set the frequency/region to EU868.

# AT+BAND=4 Image: 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 Image.

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

RAK SERIAL PORT TOOL	-	$\Box$ ×
	Command	
BaudRate: )600 - CLOSE	☑ 01 at+version	SEND
RECEIVING CLEAR RECV	☑ 02 at+get_config=device:status	SEND
AT	03 at+set_config=device:sleep:0	SEND
	04 at+set_config=device:restart	SEND
ок	05 at+set_config=device:gps:1	SEND
AT+NWM=1	06 at+set_config=lora:work_mode:0	SEND
	07 at+set_config=lora:join_mode:0	SEND
ок	08 at+set_config=lora:class:0	SEND
AT+NJM=1	09 at+set_config=lora:region:EU868	SEND
	10 at+set_config=lora:confirm:1	SEND
ок	11 at+set_config=lora:ch_mask:0:0	SEND
AT+CLASS=A	12 at+set_config=lora:dev_eui:	SEND
	13 at+set_config=lora:app_eui:	SEND
ок	14 at+set_config=lora:app_key:	SEND
AT+BAND=4	15 at+set_config=lora:dev_addr:	SEND
	16 at+set_config=lora:nwks_key:	SEND
ок	17 at+set_config=lora:apps_key:	SEND
v	18 at+set_config=lora:send_interval:	SEND
, SENDING(With \r\n)	19 at+get_config=lora:status	SEND
	☑ 20 at+get_config=lora:channel	SEND
SEND	All/None	SAVE
Time 00:00:00   PASS: 0   FAIL: 0   SW_Version: V1.2.1   Make:2018-12	-24 04/04/2021 11:23:52 PM:	

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: **10000000000000**
- Application Key: 04FA4E626EF5CF227C969601176275C2

```
Set the Device EUI.
```

AT+DEVEUI=1133557799224466

Set the Application EUI.

AT+APPEUI=10000000000000000

Set the Application Key.

AT+APPKEY=04FA4E626EF5CF227C969601176275C2

🖼 RAK SERIAL PORT TOOL	-	
	Command	
RAK COM: COM3 V BaudRate: 1600 V CLOSE	☑ 01 at+version	SEND
RECEIVING CLEAR RECV	☑ 02 at+get_config=device:status	SEND
AT+CLASS=A ^	03 at+set_config=device:sleep:0	SEND
	04 at+set_config=device:restart	SEND
ок	05 at+set_config=device:gps:1	SEND
AT+BAND=4	06 at+set_config=lora:work_mode:0	SEND
	07 at+set_config=lora:join_mode:0	SEND
ок	08 at+set_config=lora:class:0	SEND
AT+DEUI=1133557799224466	09 at+set_config=lora:region:EU868	SEND
	10 at+set_config=lora:confirm:1	SEND
ок	11 at+set_config=lora:ch_mask:0:0	SEND
AT+APPEUI=1000000000000009	12 at+set_config=lora:dev_eui:	SEND
	13 at+set_config=lora:app_eui:	SEND
ок	14 at+set_config=lora:app_key:	SEND
AT+APPKEY=04FA4E626EF5CF227C969601176275C2	□ 15 at+set_config=lora:dev_addr:	SEND
	□ 16 at+set_config=lora:nwks_key:	SEND
ОК	17 at+set_config=lora:apps_key:	SEND
v	18 at+set_config=lora:send_interval:	SEND
sENDING(With \r\n)	19 at+get_config=lora:status	SEND
AT+APPKEY=04FA4E626EF5CF227C969601176275C2	☑ 20 at+get_config=lora:channel	SEND
SEND	All/None	SAVE
Time 00:00:00   PASS: 0   FAIL: 0   SW_Version: V1.2.1   Make:2018-12	-24 04/04/2021 11:29:10 PM;	

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.
х	Auto-join config - 1: auto-join on powerup, 0: no auto-join
У	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.

#### VOTE:

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.

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

AT+SEND=2:12345678

	Command	
RAK COM: COM3 - BaudRate: )600 - CL	ose 01 at+version	SEND
RECEIVING CLEAR R	<u>CV</u> 02 at+get_config=device:status	SEND
	▲ 03 at+set_config=device:sleep:0	SEND
OK	04 at+set_config=device:restart	SEND
AT+APPSKEY=A585653A949C2B2D44B55E99E94CB533	05 at+set_config=device:gps:1	SEND
	06 at+set_config=lora:work_mode:0	SEND
ЭК	07 at+set_config=lora:join_mode:0	SEND
AT+NWKSKEY=433C7A924F7F6947778FE821525F183A	08 at+set_config=lora:class:0	SEND
	09 at+set_config=lora:region:EU868	SEND
ЭК	10 at+set_config=lora:confirm:1	SEND
AT+JOIN=1:0:10:8	□ 11 at+set_config=lora:ch_mask:0:0	SEND
	□ 12 at+set_config=lora:dev_eui:	SEND
ЭК	□ 13 at+set_config=lora:app_eui:	SEND
+EVT:JOINED	□ 14 at+set_config=lora:app_key:	SEND
AT+SEND=2:12345678	□ 15 at+set_config=lora:dev_addr:	SEND
	□ 16 at+set_config=lora:nwks_key:	SEND
ок	□ 17 at+set_config=lora:apps_key:	SEND
+EVT:SEND CONFIRMED OK	↓ 18 at+set_config=lora:send_interval:	SEND
SENDING(With \r\n)	□ 19 at+get_config=lora:status	SEND
AT+SEND=2:12345678	☑ 20 at+get_config=lora:channel	SEND
SEN	All/None	SAVE

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.

	THE THINGS STACK Community Edition	view 🗖 Applications 🕳 Gateways	🐣 Organizatio	ations 💮 eu1 Community rakwireless-	app 🔻
LoRaWAN Devices Applica	Applications > LoRaWAN De	vices Application > End devices > RAKwire	less Device		
	RAKwireles	Davica			
Overview	ID: rak-device	S Device			
🙏 End devices	<ul> <li>Last seen 10 seconds ago</li> </ul>	<b>↑</b> 2 <b>↓</b> 1		Created 6 days	ago
Live data	Overview Live data	Messaging Location Payload formate	ers Claiming	General settings	
<> Payload formatters ~	General information			Live data     See all activit	ty →
↑ Integrations ~	End device ID	rak-device	6	$\psi$ 23:49:22 Successfully scheduled data downlink for transmission on G	Gate
👪 Collaborators	Description	This device is from RAKwireless.		$\psi$ 23:49:22 Schedule data downlink for transmission on Gateway Server	
O∓ API keys	Created at	Mar 30, 2021 04:59:07		<ul> <li>↑ 23:49:22 Forward data message to Application Server DevAddr: 26 0E</li> <li>↑ 23:49:22 Forward uplink data message DevAddr: 26 0B F9 28 MAC pa</li> </ul>	
🕸 General settings	Activation information			<ul> <li>↑ 23:49:22 Receive uplink data message DevAddr: 26 0B F9 28</li> <li>↑ 23:49:22 Successfully processed data message DevAddr: 26 0B F9 28</li> </ul>	F
	AppEUI	10 00 00 00 00 00 00 09	↔ 🖺		
	DevEUI	11 33 55 77 99 22 44 66	↔ 🖺	Location Change location setting	gs →
	Root key ID	n/a			
	АррКеу	•••••	••••• 🖺 📀		
	NwkKey	n/a			
< Hide sidebar	Session information			No location information available	1000

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.

# **BAK**<sup>°</sup> Documentation Center

	THE THINOS STACK Community Edition	Applications	🖁 Gateways 🛛 🚢 Organizatio	ons		eu1 Community	rakwireless-app 👻
LoRaWAN Devices Applica	Applications > LoRaWAN Devices	Application					
Overview	ID: lorawan-devices	ces Application					
🙏 End devices	🙏 0 End devices 🛛 🚢 1 Collabo	erator 💁 0 API keys					Created 34 seconds ago
Live data							
<> Payload formatters ~	General information			Live data			See all activity →
	Application ID 1	orawan-devices	6				
🚜 Collaborators	Created at Ma	r 30, 2021 02:50:03					
	Last updated at Ma	r 30, 2021 02:50:03			Waiting for ever	nts from lorawan-devices	
🗣 API keys							
General settings							
	End devices (0)			Q	Search by ID	=+ Import end devices	+ Add end device
	ID \$	Name 🗢	DevEUI		JoinEUI		Created 🗢
< Hide sidebar			No iten	ns found			

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.

	THE THINGS STACK Organizations Applications Applications Gateways Corganizations
LoRaWAN Devices Applica	Applications > LoRaWAN Devices Application > End devices > Register from The LoRaWAN Device Repository
	Register end device
Overview	Register end device
🙏 End devices	From The LoRaWAN Device Repository Manually
Live data	
<> Payload formatters ~	1. Select the end device
↑ Integrations ~	Brand * Type to search
👪 Collaborators	Cannot find your exact end device? Get help here and try manual device registration.
🗣 API keys	
General settings	
	2. Enter registration data
	Please choose an end device first to proceed with entering registration data
	Register end device

Figure 23: Manually register device to TTN

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	THE THINGS STACK Community Edition 🗈 Overview 🗅 Applications 🗟 Gateways 🛣 Organizations 🕀 eul Community Community
LoRaWAN Devices Applica	Applications > LoRaWAN Devices Application > End devices > Register manually
Overview	Register end device
🙏 End devices	From The LoRaWAN Device Repository Manually
👪 Live data	
<> Payload formatters ~	Preparation
大 Integrations ~	Activation mode () *
2 Collaborators	Activation by personalization (ABP)
	Multicast
Ov API keys	O Do not configure activation
General settings	LoRaWAN version ⑦ * MAC V1.0.2 ✓ The LoRaWAN version (MAC), as provided by the device manufacturer
	Network Server address
	eul.cloud.thethings.network
	Application Server address
	eu1.cloud.thethings.network
< Hide sidebar	Start

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.

LoRaWAN Devices Applica	Register end device
Overview	
🙏 End devices	From The LoRaWAN Device Repository Manually
Live data	Basic settings       2       Network layer settings       3       Application layer settings
<> Payload formatters ~	End device ID's, Name and         Frequency plan, regional         Application session key to           Description         parameters, end device         encrypt/decrypt LoRaWAN
九 Integrations  ✓	class and session keys. payload.
2 Collaborators	rak-device-abp
O₊ API keys	DevEUI <sup>©</sup>
General settings	01 00 00 00 00 00 90
	The DevEUI is the unique identifier for this end device End device name
	RAKwireless ABP Device
	End device description
	This ABP device is from RAKwireless
	G
	Optional end device description; can also be used to save notes about the end device
< Hide sidebar	Network layer settings >

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**.

	Overview End devices	End device ID's, Name and Frequencies Description parameters	work layer settings uency plan, regional meters, end device and session keys.	<ul> <li>Application layer settings Application session key to encrypt/decrypt LoRaWAN payload.</li> </ul>
	Live data	Frequency plan ⑦* Europe 863-870 MHz (SF9 for RX2 - recommended)		
<> 大	Payload formatters ~	LoRaWAN version ⑦ * MAC V1.0.2		
**	Collaborators API keys	Regional Parameters version ⑦ * PHY V1.0.2 REV B	· ~	
\$	General settings	LoRaWAN class capabilities ⑦ Supports class B Supports class C Device address ⑦ *		
		26 0B DE 80 ¢ NwkSKey* 43 3C 7A 92 4F 7F 69 47 77 8F E8 21 52	2 5F 18 3A	
		Advanced settings 🗸		
< н	ide sidebar	< Basic settings		Application layer 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.

THE THINGS STACK Overview Applications 🗳 Gateways 🏝 Organizations 🕀 eul Community Edition rakwireless-app -							
LoRaWAN Devices Applica	Applications > LoRaWAN Devices Application > End devices > Register manually > Application layer settings						
Overview	Register end device						
👗 End devices	From The LoRaWAN Device Repository Manually						
Live data							
<> Payload formatters ~	Basic settings Network layer settings 3 Application layer settings Application layer set						
↑ Integrations ∨	Description parameters, end device encrypt/decrypt LoRaWAN class and session keys. payload.						
🚢 Collaborators	Skip payload encryption and decryption						
🗣 API keys	Enabled Skip decryption of uplink payloads and encryption of downlink payloads						
🔹 General settings	AppSKey*       A5 85 65 3A 94 9C 2B 2D 44 B5 5E 99 E9 4C B5 33						
< Hide sidebar							

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.

THE THINGS STACK Community Edition I Overview Applications Gateways Corganizations I Community Edition rakwireless-app -					
Applications > LoRaWAN Devices Application > End devices > RAKwireless ABP Device					
	RAKwireles	s ABP Device			
Overview	ID: rak-device-abp				
🙏 End devices	Last seen info unavailable	↑ n/a ↓ n/a			Created 14 seconds ago
1. Live data	Overview Live data	Messaging Location Payload formatte	rs General sett	ings	
<> Payload formatters ~	General information			Live data	See all activity →
大 Integrations v	End device ID	rak-device-abp	Ē		
2 Collaborators	Description	This ABP device is from RAKwireless			
Ov API keys	Created at	Apr 1, 2021 05:08:13		Waiti	ng for events from rak-device-abp
🔅 General settings	Activation information				
	AppEUI	n/a			
	DevEUI	01 00 00 00 00 00 00 90	$\leftrightarrow$	Location	Change location settings →
	Session information				
Device address 26 08 DE 80 <>					
	NwkSKey	•••••	• • • • • •		
< Hide sidebar	SNwkSIntKey		• • • • • •		No location information available

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:



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.

	Command	
RAK COM: COM3 V BaudRate: 1600 V CLO	E 01 at+version	SEND
RECEIVING CLEAR REC	v 02 at+get_config=device:status	SEND
	03 at+set_config=device:sleep:0	SEND
ок	04 at+set_config=device:restart	SEND
	05 at+set_config=device:gps:1	SEND
ок	06 at+set_config=lora:work_mode:0	SEND
AT	07 at+set_config=lora:join_mode:0	SEND
	08 at+set_config=lora:class:0	SEND
ок	09 at+set_config=lora:region:EU868	SEND
	□ 10 at+set_config=lora:confirm:1	SEND
	□ 11 at+set_config=lora:ch_mask:0:0	SEND
	□ 12 at+set_config=lora:dev_eui:	SEND
	□ 13 at+set_config=lora:app_eui:	SEND
	□ 14 at+set_config=lora:app_key:	SEND
	15 at+set_config=lora:dev_addr:	SEND
	16 at+set_config=lora:nwks_key:	SEND
	□ 17 at+set_config=lora:apps_key:	SEND
	18 at+set_config=lora:send_interval:	SEND
ENDING(With \r\n)	19 at+get_config=lora:status	SEND
AT	20 at+get_config=lora:channel	SEND
SEND	All/None	SAVE

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.

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#### 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  $\square$ .

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

e	Regional	Band	
	AS923-3		
	AS923-4		
RAK SERIAL PORT TOOL			- 🗆 X
		Command	
BaudRate: )600	* CLOSE	☑ 01 at+version	SEND
RECEIVING	CLEAR RECV	☑ 02 at+get_config=device:status	SEND
AT	^	03 at+set_config=device:sleep:0	SEND
		04 at+set_config=device:restart	SEND
ок		05 at+set_config=device:gps:1	SEND
AT+NWM=1		06 at+set_config=lora:work_mode:0	SEND
		07 at+set_config=lora:join_mode:0	SEND
ок		08 at+set_config=lora:class:0	SEND
AT+NJM=0		09 at+set_config=lora:region:EU868	SEND
		10 at+set_config=lora:confirm:1	SEND
ок		11 at+set_config=lora:ch_mask:0:0	SEND
AT+CLASS=A		12 at+set_config=lora:dev_eui:	SEND
		□ 13 at+set_config=lora:app_eui:	SEND
ок		□ 14 at+set_config=lora:app_key:	SEND
AT+BAND=4		15 at+set_config=lora:dev_addr:	SEND
		16 at+set_config=lora:nwks_key:	SEND
ок		17 at+set_config=lora:apps_key:	SEND
	~	□ 18 at+set_config=lora:send_interval:	SEND
sending(With \r\n)		□ 19 at+get_config=lora:status	SEND
AT+BAND=4		☑ 20 at+get_config=lora:channel	SEND
	SEND	All/None	SAVE

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

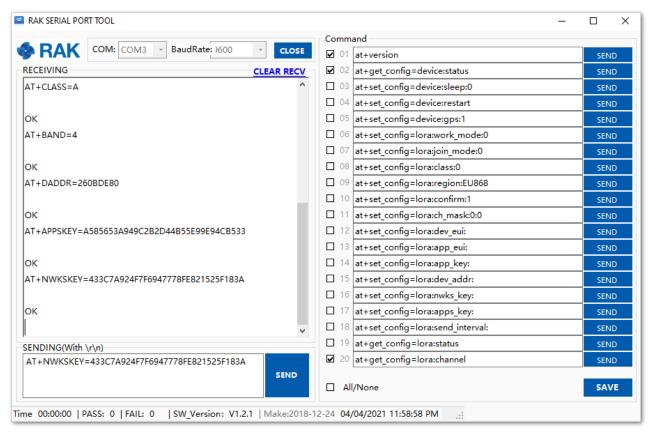


Figure 31: Configuring LoRa Parameters

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.
Х	Auto-join config - 1: auto-join on powerup, 0: no auto-join
у	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.

BRAK COM: COM3 - BaudRate: )600		Comm	and		
RAK COM: COM3  BaudRate: )600	CLOSE	☑ 01	at+version	SEN	D
RECEIVING	CLEAR RECV	✓ 02	at+get_config=device:status	SEN	D
ОК	^	03	at+set_config=device:sleep:0	SEN	D
AT+APPSKEY=A585653A949C2B2D44B55E99E94CB533		04	at+set_config=device:restart	SEN	D
		05	at+set_config=device:gps:1	SEN	D
ОК		06	at+set_config=lora:work_mode:0	SEN	D
AT+NWKSKEY=433C7A924F7F6947778FE821525F183A		07	at+set_config=lora:join_mode:0	SEN	D
		08	at+set_config=lora:class:0	SEN	D
ОК		09	at+set_config=lora:region:EU868	SEN	D
AT+JOIN=1:0:8:0		10	at+set_config=lora:confirm:1	SEN	D
		11	at+set_config=lora:ch_mask:0:0	SEN	D
ок		12	at+set_config=lora:dev_eui:	SEN	D
+EVT:JOINED		13	at+set_config=lora:app_eui:	SEN	D
AT+SEND=3:12341234		14	at+set_config=lora:app_key:	SEN	D
		15	at+set_config=lora:dev_addr:	SEN	D
ок		16	at+set_config=lora:nwks_key:	SEN	D
+EVT:SEND CONFIRMED OK		17	at+set_config=lora:apps_key:	SEN	D
	~	18	at+set_config=lora:send_interval:	SEN	D
SENDING(With \r\n)		19	at+get_config=lora:status	SEN	D
AT+SEND=3:12341234		☑ 20	at+get_config=lora:channel	SEN	D
	SEND		/None	SAV	/E

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.

	THE THINOS STACK Community Edition	view 🗖 Applications 🗳 Gateways 🚢 Organizat	tions 🜐 eu1 Community rakwireless-app 👻					
	Applications > LoRaWAN Devices Application > End devices > RAKwireless ABP Device							
LoRaWAN Devices Applica								
Overview     Overview     RAKwireless ABP Device     ID: rak-device-abp								
🙏 End devices	<ul> <li>Last seen 31 seconds ago</li> </ul>	↑4 ↓3	Created 4 days ago					
II Live data	Overview Live data	Messaging Location Payload formatters General set	ettings					
<> Payload formatters ~	General information		• Live data See all activity →					
t Integrations v	End device ID	rak-device-abp	↔ 00:23:36 Rx timing setup request enqueued DevAddr: 26 0B DE 80					
2 Collaborators	Description	This ABP device is from RAKwireless	↔ 00:23:36 New channel request enqueued DevAddr: 26 08 DE 80					
🗣 API keys	Created at	Apr 1, 2021 05:08:13	<ul> <li>↔ 00:23:36 New channel request enqueued DevAddr: 26 0B DE 80</li> <li>↔ 00:23:36 New channel request enqueued DevAddr: 26 0B DE 80</li> </ul>					
General settings			↔ 00:23:36 New channel request enqueued DevAddr: 26 08 DE 80					
General Settings	Activation information		↔ 00:23:36 New channel request enqueued DevAddr: 26 0B DE 80					
	AppEUI	n/a						
	DevEUI	01 00 00 00 00 00 90 🗘 👘	Location Change location settings $\rightarrow$					
	Session information							
	Device address	26 OB DE 80 🗘 🖷						
	NwkSKey	43 3C 7A 92 4F 7F 69 47 77 8F E8 21 52 5 💠 🖺 🗞						
< Hide sidebar	SNwkSIntKey	43 3C 7A 92 4F 7F 69 47 77 8F E8 21 52 5 🗘 <b>i</b> 🗞	No location information available					

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.

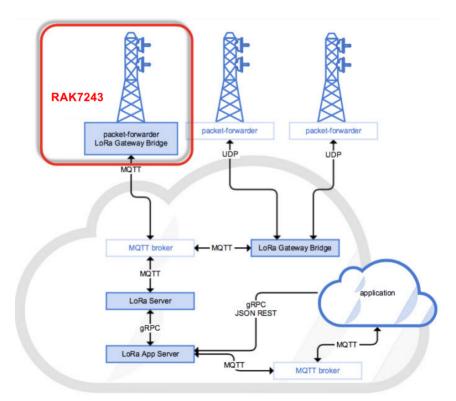


Figure 34: RAK3172 Module in the Context of the ChirpStack Platform

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 2.

#### VOTE:

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.

⇔	ChirpStack				Q Search organization, application, gateway or device	? \varTheta admin
	Network-servers	Applications	Applications			+ CREATE
R	Gateway-profiles					
	Organizations	ID	Name	Service-profile	Description	
<u>*</u>	All users	1	арр	service-profile	арр	
chirp	ostack -				Rows per page: 10 🔻 1-	1 of 1 < >
٠	Org. settings					
<u>*</u>	Org. users					
≛≡	Service-profiles					
	Device-profiles					
R	Gateways					
	Applications					
2	Multicast-groups					

#### 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.

Æ	ChirpStack	Q. Search organization, application, gateway or device 🕘 et admin
	Network-servers Gateway-profiles	Applications / Create
	Organizations	
*	All users	Application name * The name may only contain words, numbers and dashes.
chirp	stack -	Application description *
٠	Org. settings	Apprication description -
*	Org. users	Select service-profile
<u>⊥</u> ≡	Service-profiles	The service-profile to which this application will be attached. Note that you can't change this value after the application has been created. Payload codec
計	Device-profiles	None  We defining a payload codes, ChirpStack Application Server can encode and decode the binary device payload for you Important note: the payload fields have moved to the device-profile. For backward-compatibility and migration, existing codes settings are still visible. Codes settings on the device-profile have priority over the application codes settings.
R	Gateways	Codec settings on the device-profile have priority over the application codec settings.
	Applications	CREATE APPLICATION
2	Multicast-groups	

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.

€	ChirpStack	Q Search organization, application, gateway or device ? 🕒 admin
	Network-servers	Applications / Create
$\bigcirc$	Gateway-profiles	
	Organizations	Application name *
÷	All users	The name may only contain words, numbers and dashes.
chirp	ostack 👻	Application description *
٠	Org. settings	test Sarvice-profile *
+	Org. users	service-profile -
±≡	Service-profiles	The service-profile to which this application will be attached. Note that you can't change this value after the application has been created. Payload codec
크는	Device-profiles	None By defining a payload codec, ChirpStack Application Server can encode and decode the binary device payload for you Important note: the payload fields have moved to the device-profile. For backward-compatibility and migration, existing codec settings are still visible.
Ŵ	Gateways	By defining a payload codec, ChirpStack Application Server can encode and decode the binary device payload for you.Important note: the payload fields have moved to the device-profile. For backward-compatibility and migration, existing codec settings are still visible. Codec settings on the device-profile have priority over the application codec settings.
	Applications	CREATE APPLICATION
۳	Multicast-groups	



- 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".

€	ChirpStack				Q Search organization, application, gateway or device	e admin
	Network-servers	Applications	Applications			+ CREATE
$\mathbb{R}$	Gateway-profiles	Applications				
	Organizations	ID	Name	Service-profile	Description	
<u>.</u>	All users	1	арр	service-profile	арр	
chirp	ostack -	2	rak_node_test	service-profile	test	
٠	Org. settings				Rows per page: 10 🔻	1-2 of 2 < >
<u>*</u>	Org. users					
≛≡	Service-profiles					
	Device-profiles					
R	Gateways					
	Applications					
2	Multicast-groups					



	Network-servers Gateway-profiles	Applications / ra	Applications / rak_node_test				
	Organizations	DEVICES	APPLICATION CONFIGURATION INTEGRATIONS	FUOTA			
*	All users		-				+ CREATE
chirpstack -							T CREATE
¢	Org. settings	Last seen	Device name	Device EUI	Link margin	Battery	
<u>*</u>	Org. users				Rows	:perpage: 10 ▾ 0-0 of 0	< >
.≞≡	Service-profiles						
	Device-profiles						
$\bigcirc$	Gateways						
	Applications						
2	Multicast-groups						



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

€	ChirpStack				Q Search organization, application,	gateway or device	? 😝 admin
0.0 10 10	Network-servers	Applications / ra	ak node test				<b>DELETE</b>
R	Gateway-profiles						
Ð	Organizations	DEVICES	APPLICATION CONFIGURATION INTEGRATIONS	FUOTA			
*	All users						+ CREATE
chir	pstack -						UNERTE
¢	Org. settings	Last seen	Device name	Device EUI	Link margin	Battery	
*	Org. users				R	tows per page: 10 👻 0-0 of	f0 < >
±≡	Service-profiles						
	Device-profiles						
R	Gateways						
	Applications						
٣	Multicast-groups						

Figure	40:	Add	а	New	Device
1.19410		7100	<i>u</i>	14011	00000

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€	ChirpStack	Q Search organization, application, gateway or device	e admin
©	Network-servers Gateway-profiles Organizations	Applications / rak_node_test / Devices / Create	
chirp	All users	Device name *	
\$	Org. settings	The name may only contain words, numbers and dashes. Device description *	
• •	Org. users Service-profiles	Device EUI *	C
밵	Device-profiles	Device-profile* Device-profile	•
@ 	Gateways Applications	Disable frame-counter validation Note that disabiling the frame-counter validation will compromise security as it enables people to perform replay-attacks.	
2	Multicast-groups	CREAT	E DEVICE



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 builtin 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.

€	ChirpStack	Q. Search organization, application, gateway or device	admin
	Network-servers Gateway-profiles	Applications / rak_node_test / Devices / Create	
	Organizations	GENERAL VARIABLES TAGS	
chirp	All users	Device name * rak_node The name may only contain words, numbers and dashes.	_
۵	Org. settings	The mane may driv concern words, nonneers and desires. Device description * test	
* *	Org. users Service-profiles	Device RUI * 5E 9D 1E 08 57 CF 25 F1 MSB 2	C
	Device-profiles	Device-profile * jevice_profile_otaa	<u>.</u>
® 	Gateways	device_profile_abp	
2	Multicast-groups	device_profile_otaa	ICE

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.

€	ChirpStack	Q. Search organization, application, gateway or device 🕑 🔒 admin	þ
• ®	Network-servers Gateway-profiles	Applications / rak_node_test / Devices / Create	
• <b>I</b>	Organizations All users	GENERAL     VARIABLES     TAGS       Device name*     *	
chirp	ostack +	rak_node The name may only contain words, numbers and dashes.	
\$	Org. settings	Device description * test	
	Org. users Service-profiles	Device EUI * 5E 9D 1E 08 57 CF 25 F1	
	Device-profiles	Device_profile * device_profile.otaa	
$\mathbb{R}$	Gateways		
	Applications	Disable frame-counter validation Note that disabiling the frame-counter validation will compromise security as it enables people to perform replay-attacks.	
Ψ	Multicast-groups	CREATE DEVICE	



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:

€	ChirpStack	Q. Search organization, application, gateway or device 📀 😝 admin
2 2 2	Network-servers	Applications / rak_node_test / Devices / rak_node
R	Gateway-profiles	
	Organizations	DETAILS CONFIGURATION KEYS (OTAA) ACTIVATION DEVICE DATA LORAWAN FRAMES FIRMWARE
*	All users	
chirpstack -		Application key* F9 21 D5 0C D7 D0 2E E3 C5 E6 14 21 54 F2 74 B2
\$	Org. settings	For LoRaWAN 1.0 devices. In case your device supports LoRaWAN 1.1, update the device-profile first.
*	Org. users	Gen Application key
±≡	Service-profiles	For LoRaWAN 1.0 devices. This key must only be set when the device implements the remote multicast setup specification / firmware updates over the air (FUOTA). Else leave this field blank.
幸	Device-profiles	SET DEVICE-KEYS
R	Gateways	
	Applications	
2	Multicast-groups	

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.

	ChirpStack						?	0 -	dmin
	Network-servers	Applications / ra	ak_node_test					📋 DEL	ETE
$\bigcirc$	Gateway-profiles								
	Organizations	DEVICES	APPLICATION CONFIGURATION	INTEGRATIONS FUOTA					
<u>.</u>	All users								
chirp	ostack -							+ CRE	ATE
\$	Org. settings	Last seen	Device name	Device EUI	Link margin	E	Battery		
<u>.</u>	Org. users	n/a	rak_node	5e9d1e0857cf25f1	n/a	r	n/a		
≛≡	Service-profiles					Rows per page: 10 👻	1-1 of 1	< )	>
	Device-profiles								
$\mathbb{R}$	Gateways								
	Applications								
2	Multicast-groups								

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.

€	ChirpStack	Q Search organization, application, gateway or device	?	θ	admin
	Network-servers	Applications / rak_node_test / Devices / rak_node		💼 DE	ELETE
R	Gateway-profiles				
	Organizations	DETAILS CONFIGURATION KEYS (OTAA) ACTIVATION DEVICE DATA LORAWAN FRAMES FIRMWARE			
<u>*</u>	All users				
chirp	ostack -	Application key* 19 21 d5 0c d7 d0 2e e3 c5 e6 14 21 54 t2 74 b2 MSB	G	6	8
۵	Org. settings	For LoRaWAN 1.0 devices. In case your device supports LoRaWAN 1.1, update the device-profile first.			_
<u>.</u>	Org. users	Gen Application kay			o
≞≡	Service-profiles	For LoRaWAN 1.0 devices. This key must only be set when the device implements the remote multicast setup specification / firmware updates over the air (FUOTA). Else leave this field blank.			
	Device-profiles		SET D	VICE-	ŒYS
R	Gateways				_
	Applications				
2	Multicast-groups				

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.

		Comm	and	
RAK COM: COM3  BaudRate: )600	* CLOSE	☑ 01	at+version	SEND
ECEIVING	CLEAR RECV	☑ 02	at+get_config=device:status	SEND
		03	at+set_config=device:sleep:0	SEND
ок		04	at+set_config=device:restart	SEND
		05	at+set_config=device:gps:1	SEND
эк		06	at+set_config=lora:work_mode:0	SEND
AT		07	at+set_config=lora:join_mode:0	SEND
		08	at+set_config=lora:class:0	SEND
ж		09	at+set_config=lora:region:EU868	SEND
		10	at+set_config=lora:confirm:1	SEND
		11	at+set_config=lora:ch_mask:0:0	SEND
		12	at+set_config=lora:dev_eui:	SEND
		13	at+set_config=lora:app_eui:	SEND
		14	at+set_config=lora:app_key:	SEND
		15	at+set_config=lora:dev_addr:	SEND
		16	at+set_config=lora:nwks_key:	SEND
		17	at+set_config=lora:apps_key:	SEND
		18	at+set_config=lora:send_interval:	SEND
ENDING(With \r\n)		19	at+get_config=lora:status	SEND
AT		20	at+get_config=lora:channel	SEND
	SEND		l/None	SAVE

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.



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  $\Box$ .

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

RAK SERIAL PORT TOOL	-	$\Box$ ×							
	Command								
BaudRate: )600 - CLOSE	☑ 01 at+version	SEND							
RECEIVING CLEAR RECV	☑ 02 at+get_config=device:status	SEND							
AT	03 at+set_config=device:sleep:0	SEND							
	04 at+set_config=device:restart	SEND							
ок	05 at+set_config=device:gps:1	SEND							
AT+NWM=1	□ <sup>06</sup> at+set_config=lora:work_mode:0	SEND							
	07 at+set_config=lora:join_mode:0	SEND							
ок	08 at+set_config=lora:class:0	SEND							
AT+NJM=1	09 at+set_config=lora:region:EU868	SEND							
	10 at+set_config=lora:confirm:1	SEND							
ок	11 at+set_config=lora:ch_mask:0:0	SEND							
AT+CLASS=A	12 at+set_config=lora:dev_eui:	SEND							
	13 at+set_config=lora:app_eui:	SEND							
ок	□ 14 at+set_config=lora:app_key:	SEND							
AT+BAND=4	15 at+set_config=lora:dev_addr:	SEND							
	□ 16 at+set_config=lora:nwks_key:	SEND							
ок	□ 17 at+set_config=lora:apps_key:	SEND							
v	18 at+set_config=lora:send_interval:	SEND							
, SENDING(With \r\n)	19 at+get_config=lora:status	SEND							
	☑ 20 at+get_config=lora:channel	SEND							
SEND	All/None	SAVE							
Time 00:00:00   PASS: 0   FAIL: 0   SW_Version: V1.2.1   Make:2018-12	ime 00:00:00   PASS: 0   FAIL: 0   SW_Version: V1.2.1   Make:2018-12-24 04/04/2021 11:23:52 PM:								

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

RAK SERIAL PORT TOOL	-	
	Command	
RAK COM: COM12 V BaudRate: 1600 V CLOSE	☑ 01 at+version	SEND
RECEIVING CLEAR RECV	☑ 02 at+get_config=device:status	SEND
AT+CLASS=A	03 at+set_config=device:sleep:0	SEND
	04 at+set_config=device:restart	SEND
ок	05 at+set_config=device:gps:1	SEND
AT+BAND=4	06 at+set_config=lora:work_mode:0	SEND
	07 at+set_config=lora:join_mode:0	SEND
OK	08 at+set_config=lora:class:0	SEND
AT+DEVEUI=5E9D1E0857CF25F1	09 at+set_config=lora:region:EU868	SEND
	10 at+set_config=lora:confirm:1	SEND
OK	11 at+set_config=lora:ch_mask:0:0	SEND
AT+APPEUI=5E9D1E0857CF25F1	12 at+set_config=lora:dev_eui:	SEND
	13 at+set_config=lora:app_eui:	SEND
OK	14 at+set_config=lora:app_key:	SEND
AT+APPKEY=F921D50CD7D02EE3C5E6142154F274B2	15 at+set_config=lora:dev_addr:	SEND
	16 at+set_config=lora:nwks_key:	SEND
ОК	17 at+set_config=lora:apps_key:	SEND
v	18 at+set_config=lora:send_interval:	SEND
SENDING(With \r\n)	19 at+get_config=lora:status	SEND
AT+APPKEY=F921D50CD7D02EE3C5E6142154F274B2	☑ 20 at+get_config=lora:channel	SEND
SEND	All/None	SAVE
Time 00:00:00   PASS: 0   FAIL: 0   SW_Version: V1.2.1   Make:2018-12	2-24 28/04/2021 5:17:49 AM	

Figure 49: Configuring LoRa Parameters

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

	AT+J0IN=1:0:10:8				
--	------------------	--	--	--	--

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

Parameter	Description
W	Join command - 1: joining, 0: stop joining.
х	Auto-join config - 1: auto-join on powerup, 0: no auto-join
У	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

RAK SERIAL PORT TOOL						- [
6 D 4 1/		C	Com	nma	nd	
BaudRate: 1600	CLOSE	6	☑ (	01	at+version	
RECEIVING	CLEAR RECV	6	2 (	)2	at+get_config=device:status	
	^			)3 [	at+set_config=device:sleep:0	
ок				)4 [	at+set_config=device:restart	
AT+APPEUI=5E9D1E0857CF25F1				)5	at+set_config=device:gps:1	
				)6	at+set_config=lora:work_mode:0	
ок				)7	at+set_config=lora:join_mode:0	
AT+APPKEY=F921D50CD7D02EE3C5E6142154F274B2				8	at+set_config=lora:class:0	
				)9	at+set_config=lora:region:EU868	
ок			1	10	at+set_config=lora:confirm:1	
AT+JOIN=1:0:10:8			1	11	at+set_config=lora:ch_mask:0:0	
			1	12	at+set_config=lora:dev_eui:	
ок			1	13	at+set_config=lora:app_eui:	
+EVT:JOINED			1	14	at+set_config=lora:app_key:	
AT+SEND=2:12345678			1	15	at+set_config=lora:dev_addr:	
			1	16	at+set_config=lora:nwks_key:	
ок			1	17	at+set_config=lora:apps_key:	
	~		1	18	at+set_config=lora:send_interval:	
sENDING(With \r\n)			1	19	at+get_config=lora:status	
AT+SEND=2:12345678		6	2	20	at+get_config=lora:channel	
	SEND					

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**.

€	ChirpStack							<b>Q</b> Search organization, application, gateway or device	? \varTheta admin
	Network-servers	Applications / r	ak_node_test / D	evices / rak_node					<b>DELETE</b>
R	Gateway-profiles								
	Organizations	DETAILS	CONFIGURATION	KEYS (OTAA)	ACTIVATION	DEVICE DATA	LORAWAN FRAMES	FIRMWARE	
*	All users							⑦ HELP Ⅱ PAUSE	CLEAR
chir	pstack -								GLEAR
۵	Org. settings	UPLINK	5:42:43 PM	UnconfirmedDataUp	018153f7				~
*	Org. users	DOWNLINK	5:42:17 PM	JoinAccept					~
±=	Service-profiles	UPLINK	5:42:17 PM	JoinRequest	5e9d1e0857cf25f1				~
	Device-profiles								
R	Gateways								
	Applications								
2	Multicast-groups								

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.

€	ChirpStack	Q. Search organization, application, gateway or device 🕑 😝 admin
R	Network-servers Gateway-profiles	Applications / rak_node_test / Devices / Create
•	Organizations All users	GENERAL     VARIABLES     TAOS       Device name *
chirp	ostack +	rak_node The name may only contain words, numbers and dashes.
۵	Org. settings	Device description * test
<u>*</u>	Org. users	Device EUI *
±≡	Service-profiles	5e 9d 1e 08 57 cf 25 f1 MSB C
랊	Device-profiles	Device-profile * device_profile.abp
R	Gateways	
	Applications	Disable frame-counter validation Note that disabiling the frame-counter validation will compromise security as it enables people to perform replay-attacks.
٣	Multicast-groups	CREATE DEVICE

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

€	ChirpStack		?	•	admin
• •	Network-servers Gateway-profiles Organizations	Applications / rak_node_test / Devices / rak_node			DELETE
÷	All users				
chirp	ostack +	Device address * 26 01 1a f9		MSB	C
≎ ∸	Org. settings Org. users	Network session key (LoRaWAN 1.0)* c2 80 cb 8d 1d f6 88 bc 18 60 1a 97 02 5c 54 88 MSB	C	6	Q
*=	Service-profiles	Application session key (LoRaWAN 1.0)*           4d 42 ec 5c af 97 f0 3d 83 3c da f5 00 3f 69 e1	C		8
₩ ®	Device-profiles Gateways	Uplink frame-counter * 0			٤
	Applications	Downlink frame-counter (network) * 0			٤
2	Multicast-groups		(RE)ACT	IVATE D	EVICE

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:



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

You will receive or 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.

	Command	
RAK COM: COM3 V BaudRate: 1600 V CLO	E 01 at+version	SEND
RECEIVING CLEAR REC	v 02 at+get_config=device:status	SEND
	03 at+set_config=device:sleep:0	SEND
ок	04 at+set_config=device:restart	SEND
	05 at+set_config=device:gps:1	SEND
ок	06 at+set_config=lora:work_mode:0	SEND
AT	07 at+set_config=lora:join_mode:0	SEND
	08 at+set_config=lora:class:0	SEND
ок	09 at+set_config=lora:region:EU868	SEND
	□ 10 at+set_config=lora:confirm:1	SEND
	□ 11 at+set_config=lora:ch_mask:0:0	SEND
	□ 12 at+set_config=lora:dev_eui:	SEND
	□ 13 at+set_config=lora:app_eui:	SEND
	□ 14 at+set_config=lora:app_key:	SEND
	15 at+set_config=lora:dev_addr:	SEND
	16 at+set_config=lora:nwks_key:	SEND
	□ 17 at+set_config=lora:apps_key:	SEND
	18 at+set_config=lora:send_interval:	SEND
ENDING(With \r\n)	19 at+get_config=lora:status	SEND
AT	20 at+get_config=lora:channel	SEND
SEND	All/None	SAVE

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.

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#### 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
<b>NOTE:</b> 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 <sup>™</sup> 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

e	Regional	Band	
	AS923-3		
	AS923-4		
RAK SERIAL PORT TOOL			- 🗆 X
		Command	
Search COM: COM3 BaudRate: )60	0 • CLOSE	☑ 01 at+version	SEND
RECEIVING	CLEAR RECV	☑ 02 at+get_config=device:status	SEND
AT	^	□ <sup>03</sup> at+set_config=device:sleep:0	SEND
		04 at+set_config=device:restart	SEND
ок		05 at+set_config=device:gps:1	SEND
AT+NWM=1		06 at+set_config=lora:work_mode:0	SEND
		07 at+set_config=lora:join_mode:0	SEND
ок		08 at+set_config=lora:class:0	SEND
AT+NJM=0		09 at+set_config=lora:region:EU868	SEND
		10 at+set_config=lora:confirm:1	SEND
ок		11 at+set_config=lora:ch_mask:0:0	SEND
AT+CLASS=A		12 at+set_config=lora:dev_eui:	SEND
		13 at+set_config=lora:app_eui:	SEND
ок		□ 14 at+set_config=lora:app_key:	SEND
AT+BAND=4		15 at+set_config=lora:dev_addr:	SEND
		□ 16 at+set_config=lora:nwks_key:	SEND
ОК		17 at+set_config=lora:apps_key:	SEND
	~	□ 18 at+set_config=lora:send_interval:	SEND
اہ SENDING(With \r\n)		□ 19 at+get_config=lora:status	SEND
AT+BAND=4		✓ 20 at+get_config=lora:channel	SEND
	SEND	All/None	SAVE

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

🖴 RAK SERIAL PORT TOOL	_	$\Box$ ×
	Command	
RAK COM: COM12  BaudRate: 1600  CLOSE	☑ 01 at+version	SEND
RECEIVING CLEAR RECV	☑ 02 at+get_config=device:status	SEND
AT+CLASS=A	03 at+set_config=device:sleep:0	SEND
	04 at+set_config=device:restart	SEND
ок	05 at+set_config=device:gps:1	SEND
AT+BAND=4	06 at+set_config=lora:work_mode:0	SEND
	07 at+set_config=lora:join_mode:0	SEND
ок	08 at+set_config=lora:class:0	SEND
AT+DEVADDR=26011AF9	09 at+set_config=lora:region:EU868	SEND
	10 at+set_config=lora:confirm:1	SEND
ок	11 at+set_config=lora:ch_mask:0:0	SEND
AT+APPSKEY=4D42EC5CAF97F03D833CDAf5003F69E1	12 at+set_config=lora:dev_eui:	SEND
	13 at+set_config=lora:app_eui:	SEND
ок	14 at+set_config=lora:app_key:	SEND
AT+NWKSKEY=C280CB8D1DF688BC18601A97025C5488	□ 15 at+set_config=lora:dev_addr:	SEND
	□ 16 at+set_config=lora:nwks_key:	SEND
ок	17 at+set_config=lora:apps_key:	SEND
~	18 at+set_config=lora:send_interval:	SEND
sENDING(With \r\n)	19 at+get_config=lora:status	SEND
AT+NWKSKEY=C280CB8D1DF688BC18601A97025C5488	☑ 20 at+get_config=lora:channel	SEND
SEND	All/None	SAVE
Time 00:00:00   PASS: 0   FAIL: 0   SW_Version: V1.2.1   Make:2018-12	-24 28/04/2021 5:35:13 AM	

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.
х	Auto-join config - 1: auto-join on powerup, 0: no auto-join
у	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>

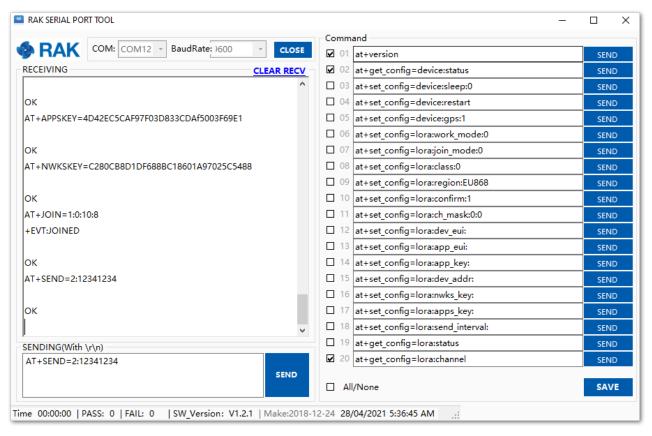


Figure 57: ABP Test Sample Data Sent via RAK Serial Port Tool

## 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:



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.

RAK SERIAL PORT TOOL	_	
	Command	
RAK COM: COM3 - BaudRate: )600 - CLOSE	☑ 01 at+version	SEND
RECEIVING CLEAR RECV	☑ 02 at+get_config=device:status	SEND
	03 at+set_config=device:sleep:0	SEND
ок	04 at+set_config=device:restart	SEND
	05 at+set_config=device:gps:1	SEND
ок	06 at+set_config=lora:work_mode:0	SEND
AT	07 at+set_config=lora:join_mode:0	SEND
	08 at+set_config=lora:class:0	SEND
ок	09 at+set_config=lora:region:EU868	SEND
	10 at+set_config=lora:confirm:1	SEND
	11 at+set_config=lora:ch_mask:0:0	SEND
	12 at+set_config=lora:dev_eui:	SEND
	13 at+set_config=lora:app_eui:	SEND
	14 at+set_config=lora:app_key:	SEND
	15 at+set_config=lora:dev_addr:	SEND
	16 at+set_config=lora:nwks_key:	SEND
	□ 17 at+set_config=lora:apps_key:	SEND
	18 at+set_config=lora:send_interval:	SEND
' SENDING(With \r\n)	19 at+get_config=lora:status	SEND
AT	☑ 20 at+get_config=lora:channel	SEND
SEND	All/None	SAVE
me 00:00:00   PASS: 0   FAIL: 0   SW_Version: V1.2.1   Make:2018-12	-24 03/04/2021 5:08:00 PM:	

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.

RAK SERIAL PORT TOOL		RAK SERIAL P	ORT TOOL	
RAK COM: COM3 - BaudRat	e: )600 - CLOSE	<b>SAK</b>	COM: COM12 - BaudRa	ate: )600 - CLOSE
RECEIVING	CLEAR RECV	RECEIVING		CLEAR RECV
ок	^	ОК		^
AT+NWM=0		AT+NWM=0		
LoRa (R) is a registered trademark or service	e mark of Semtech	LoRa (R) is a re	egistered trademark or servi	ce mark of Semtech
Corporation or its affiliates. LoRaWAN (R) is	a licensed mark.	Corporation of	r its affiliates. LoRaWAN (R) i	s a licensed mark.
I_V_\II//IIIO II				
			/	
RAK3172-H Version:v0.9.4 Apr 1 2021		RAK3172-H Ve	rsion:v0.9.4 Apr 1 2021	
Current Work Mode: LoRa P2P.		Current Work	Mode: LoRa P2P.	
	~			
sending(With \r\n)		SENDING(With	\r\n)	
		SEINDING(WIth	\r\n)	

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.

🚔 RAK SERIAL PORT TOOL	RAK SERIAL PORT TOOL			
RECEIVING COM: COM3 CLOSE CLOSE	RECEIVING         COM: COM12 · BaudRate: 3600 · CLOSE			
======================================	======================================			
OK AT+P2P=868000000:7:125:0:10:14	OK AT+P2P=868000000:7:125:0:10:14			
ок	ок			
SENDING(With \r\n)	SENDING(With \r\n)			
AT+P2P=868000000:7:125:0:10:14	AT+P2P=868000000:7:125:0:10:14			
Time 00:00:00   PASS: 0   FAIL: 0   SW_Version: V1.2.1   Make:2018-1	Time 00:00:00   PASS: 0   FAIL: 0   SW_Version: V1.2.1   Make:2018-12			

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.

RAK SERIAL PORT TOOL	🖴 RAI	K SERIAL POF	RT TOOL	
BaudRate: )600		RAK	COM: COM12 - BaudRate: )600	CLOSE
RECEIVING	CLEAR RECV RECE	EIVING		CLEAR REC
	^   /	1_1_\1/	\  '_/_\/_V_/_	1
	\\			
==========				
RAK3172-H Version:v0.9.4 Apr 1 2021	===			
Current Work Mode: LoRa P2P.	===		==	
	RAK	3172-H Versi	on:v0.9.4 Apr 1 2021	
ок	Curr	rent Work Me	ode: LoRa P2P.	
AT+P2P=868000000:7:125:0:10:14				
	ок			
ок	AT+	P2P=868000	000:7:125:0:10:14	
AT+PRECV=65535				
	ОК			_
ок	AT+	PSEND=1122	3344	
+EVT:RXP2P, RSSI -79, SNR 12				
+EVT:11223344	ок			
	~			
SENDING(With \r\n)	SENI	DING(With \r	\n)	
AT+PRECV=65535	AT+	PSEND=112	23344	

# 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

Figure 61: Configuring P2P in both RAK3172 Module

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.

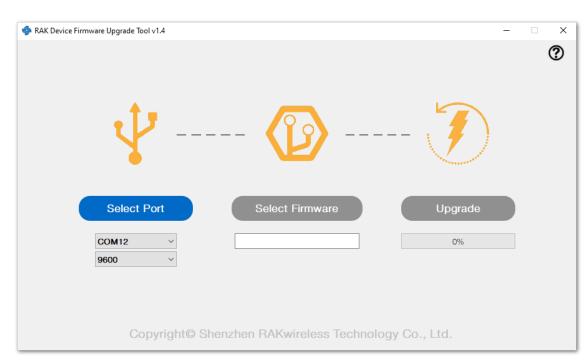


Figure 62: Device Firmware Upgrade Tool

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

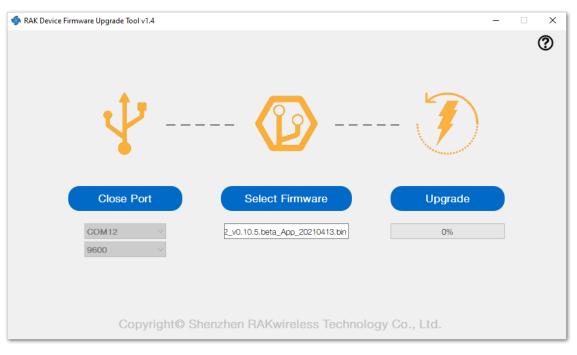


Figure 63: Select Firmware

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.

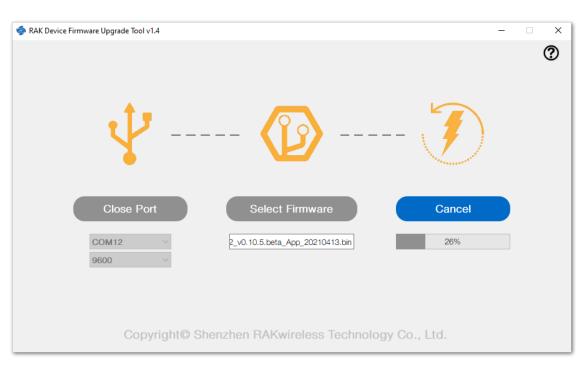


Figure 64: Firmware Upgrading

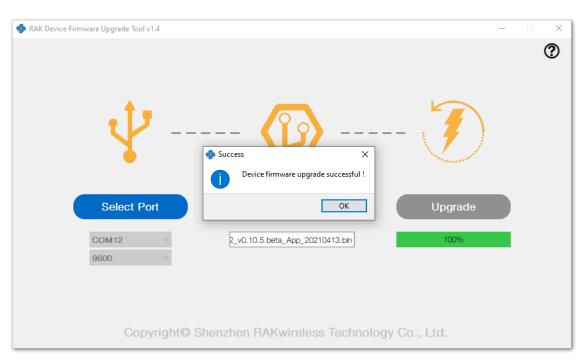


Figure 65: Upgrade Successful

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