LoRaWAN Soil NPK Sensor User Manual

Document Version: 1.0
Image Version: v1.0

Version	Description	Date
1.0	Release	2021-May-10

1. Introduction

1.1 What is LoRaWAN Soil NPK Sensor

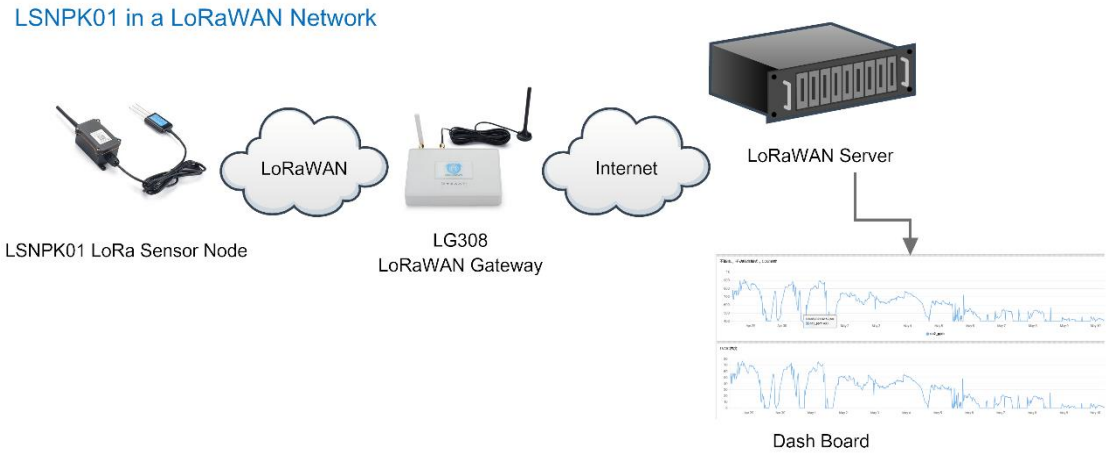
The Dragino LSNPK01 is a **LoRaWAN Soil NPK Sensor** for IoT of Agriculture. It is designed to measure the Soil Fertility Nutrient and provide a plant growing reference. The probe is IP68 waterproof and can be buried into soil for long term use.

LSNPK01 detects soil's **Nitrogen, Phosphorus, and Potassium** use TDR method, and uploads these values via wireless to LoRaWAN IoT Server.

The LoRa wireless technology used in LSNPK01 allows device to send data and reach extremely long ranges at low data-rates. It provides ultra-long range spread spectrum communication and high interference immunity whilst minimizing current consumption.

LSNPK01 is powered by **8500mAh Li-SOCI2 battery**, it is designed for long term use up to 5 years.

Each LSNPK01 is pre-load with a set of unique keys for LoRaWAN registrations, register these keys to local LoRaWAN server and it will auto connect after power on.



1.2 Features

- ✧ LoRaWAN 1.0.3 Class A
- ✧ Ultra-low power consumption
- ✧ Monitor Soil Nitrogen
- ✧ Monitor Soil Phosphorus
- ✧ Monitor Soil Potassium
- ✧ Monitor Battery Level
- ✧ Bands: CN470/EU433/KR920/US915/EU868/AS923/AU915/IN865
- ✧ AT Commands to change parameters
- ✧ Uplink on periodically
- ✧ Downlink to change configure
- ✧ IP66 Waterproof Enclosure
- ✧ IP68 rate for the Sensor Probe
- ✧ 8500mAh Battery for long term use

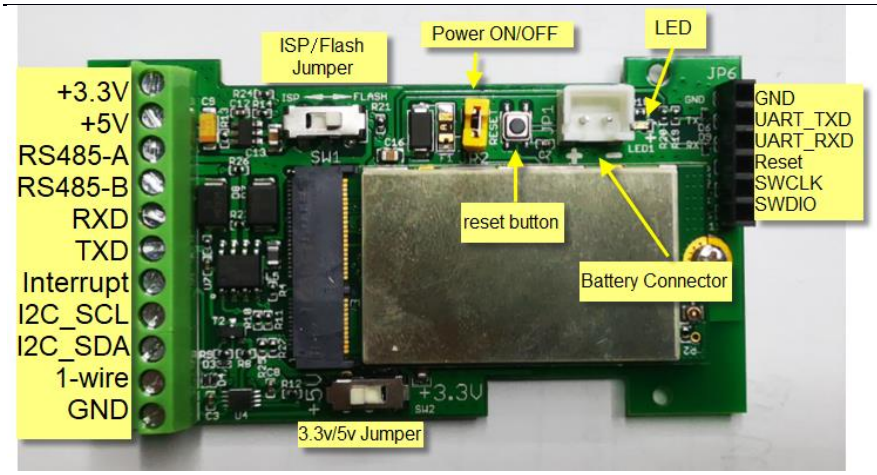
1.3 NPK Probe Specification

- ✧ Range 1-1999 mg/kg
- ✧ Resolution: 1 mg/kg
- ✧ Accuracy: ±2%FS
- ✧ Material: Stainless Steel Probe
- ✧ IP68 Protection
- ✧ Length: 2 meters

1.4 Applications

- ✧ Smart Agriculture

1.5 Pin mapping and power on


ISP/Flash Jumper
Power ON/OFF
LED
+3.3V
+5V
RS485-A
RS485-B
RXD
TXD
Interrupt
I2C_SCL
I2C_SDA
1-wire
GND
GND
UART_TXD
UART_RXD
Reset
SWCLK
SWDIO
reset button
Battery Connector
3.3v/5v Jumper

2. Configure LSNPK01 to connect to LoRaWAN network

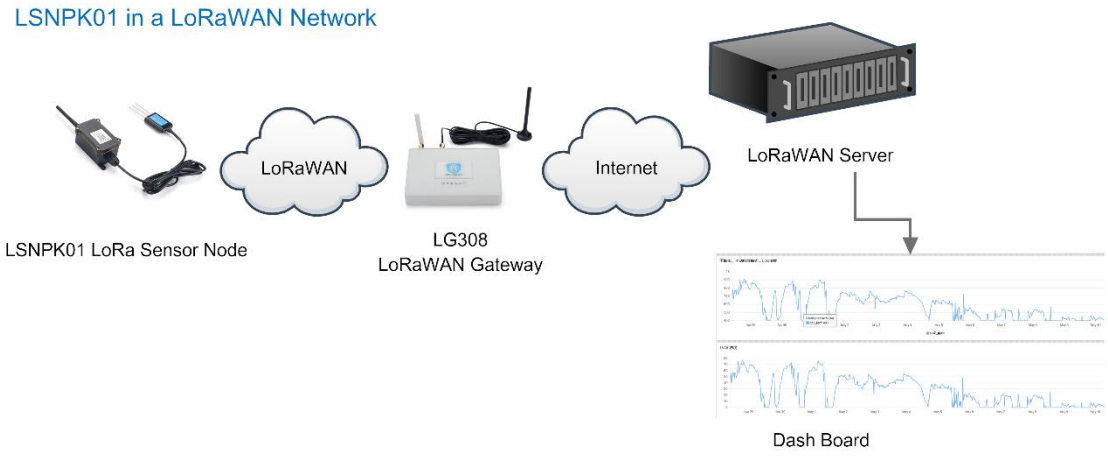
2.1 How it works

The LSNPK01 is configured as LoRaWAN OTAA Class A mode by default. It has OTAA keys to join LoRaWAN network. To connect a local LoRaWAN network, you need to input the OTAA keys in the LoRaWAN IoT server and power on the LSNPK01. It will automatically join the network via OTAA and start to send the sensor value. The default uplink interval is 20 minutes.

In case you can't set the OTAA keys in the LoRaWAN OTAA server, and you have to use the keys from the server, you can use AT Commands to set the keys in the LSNPK01.

2.2 Quick guide to connect to LoRaWAN server (OTAA)

Following is an example for how to join the TTN v3 LoRaWAN Network. Below is the network structure; we use the LG308 as a LoRaWAN gateway in this example.

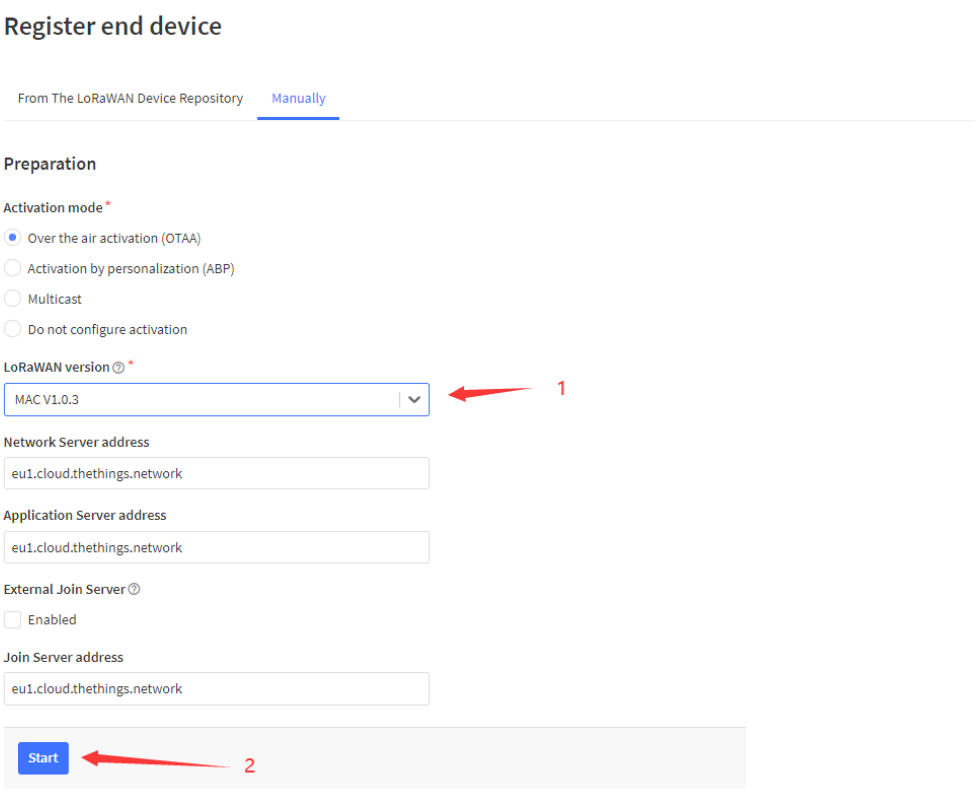


The LG308 is already set to connected to TTN network , so what we need to now is configure the TTN server.

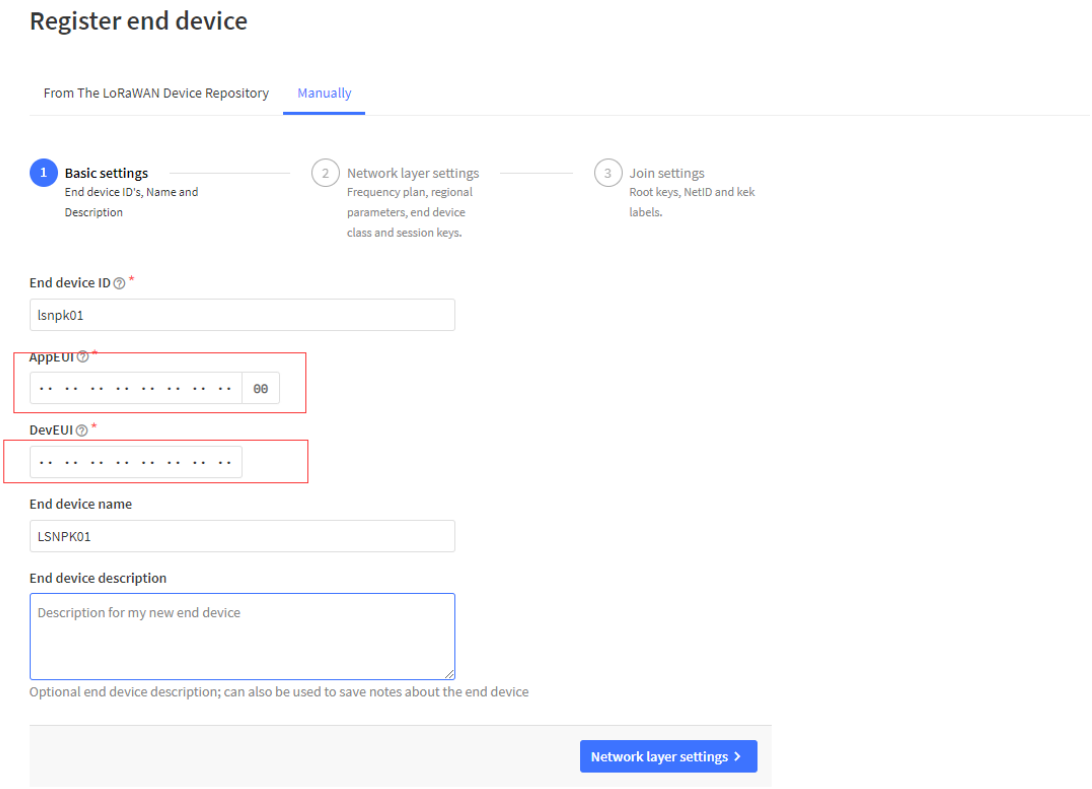
Step 1: Create a device in TTN with the OTAA keys from LSNPK01.
Each LSNPK01 is shipped with a sticker with the default device EUI as below:

You can enter this key in the LoRaWAN Server portal. Below is TTN screen shot:

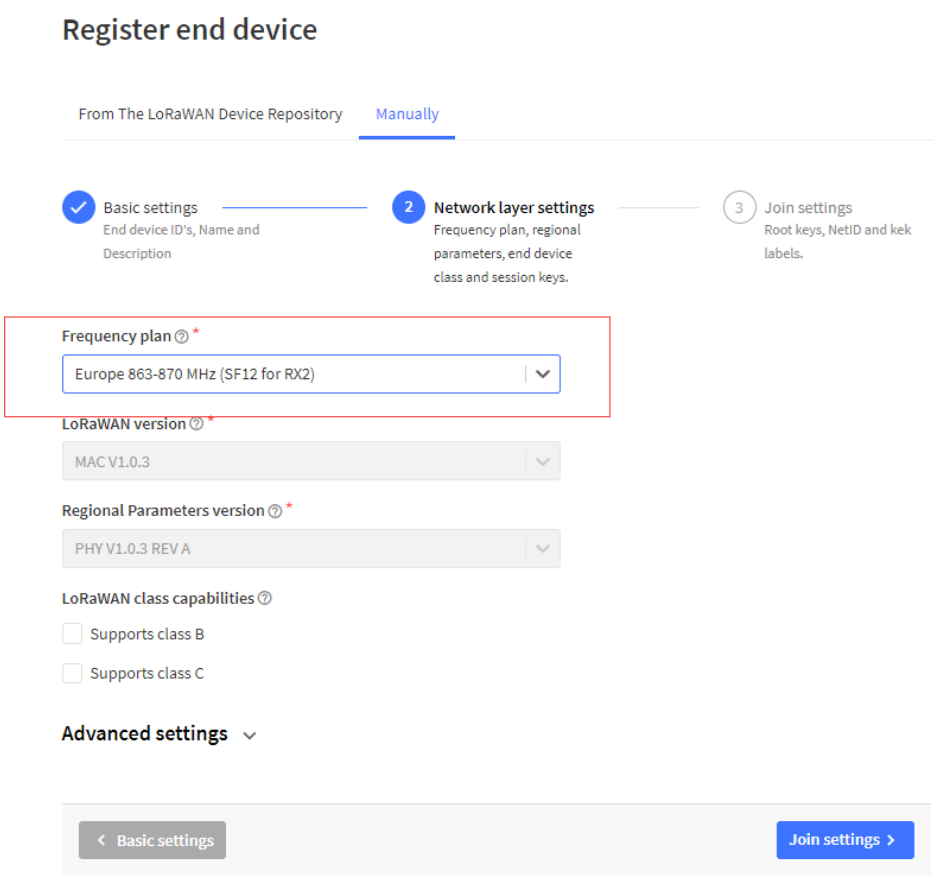
Register the device



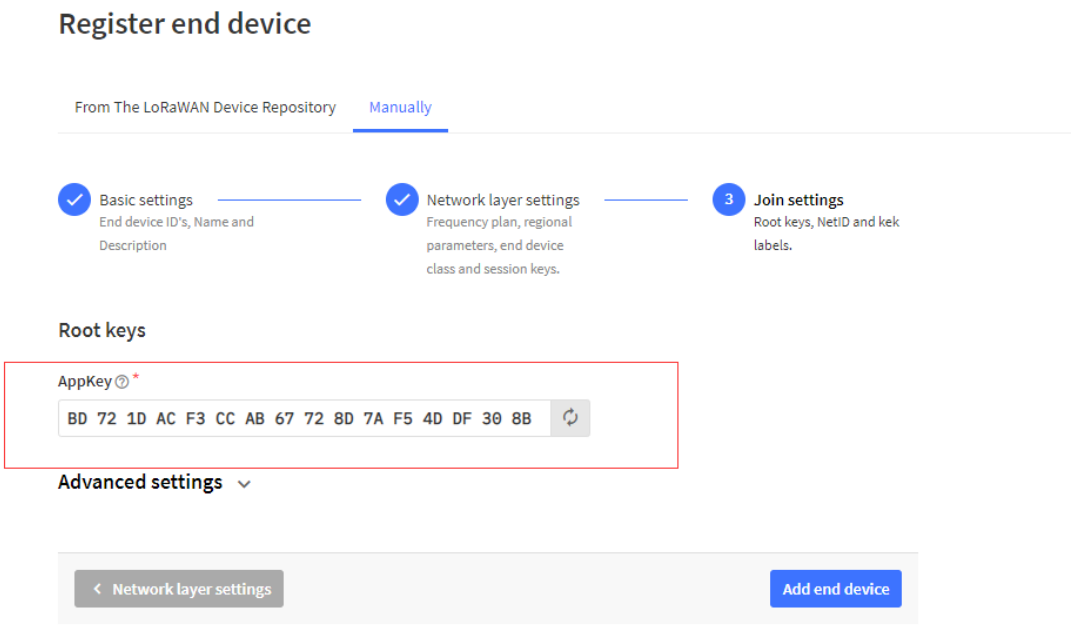
Add APP EUI and DEV EUI



Add APP EUI in the application



Add APP KEY



Step 2: Power on LSNPK01

Put a Jumper on JP2 to power on the device. (The Switch must be in FLASH position).

Step 3: The LSNPK01 will auto join to the TTN network. After join success, it will start to upload messages to TTN and you can see the messages in the panel.

2.3 Uplink Payload

LSNPK01 will uplink payload via LoRaWAN with below payload format:

Uplink payload includes in total 11 bytes.

Size (bytes)	2	2	2	2	2	1
Value	BAT	Temperature (Optional)	Soil Nitrogen	Soil Phosphorus	Soil Potassium	Digital Interrupt And Message Type

2.3.1 Battery Info

Check the battery voltage for LSNPK01.
Ex1: 0x0B45 = 2885mV
Ex2: 0x0B49 = 2889mV

2.3.2 DS18B20 Temperature sensor

This is optional, user can connect external DS18B20 sensor to the +3.3v, 1-wire and GND pin . and this field will report temperature.

Example:
If payload is: 0105H: (0105 & FC00 == 0), temp = 0105H /10 = 26.1 degree
If payload is: FF3FH : (FF3F & FC00 == 1) , temp = (FF3FH - 65536)/10 = -19.3 degrees.

2.3.3 Soil Nitrogen

Got the Soil Nitrogen, Unit: mg/kg
Example:

0x0020(H) = 32(D) = 32mg/kg

2.3.4 Soil Phosphorus

Got the Soil Phosphorus, Unit: mg/kg
Example:

0x0025(H) = 37(D) = 37mg/kg

2.3.5 Soil Potassium

Got the Soil Potassium, Unit: mg/kg
Example:

0x0030(H) = 48(D) = 48mg/kg

2.3.6 Interrupt Pin & Message Type

The lower four bits of this data field shows if this packet is generated by interrupt or not. Click here for the hardware and software set up.

Example:

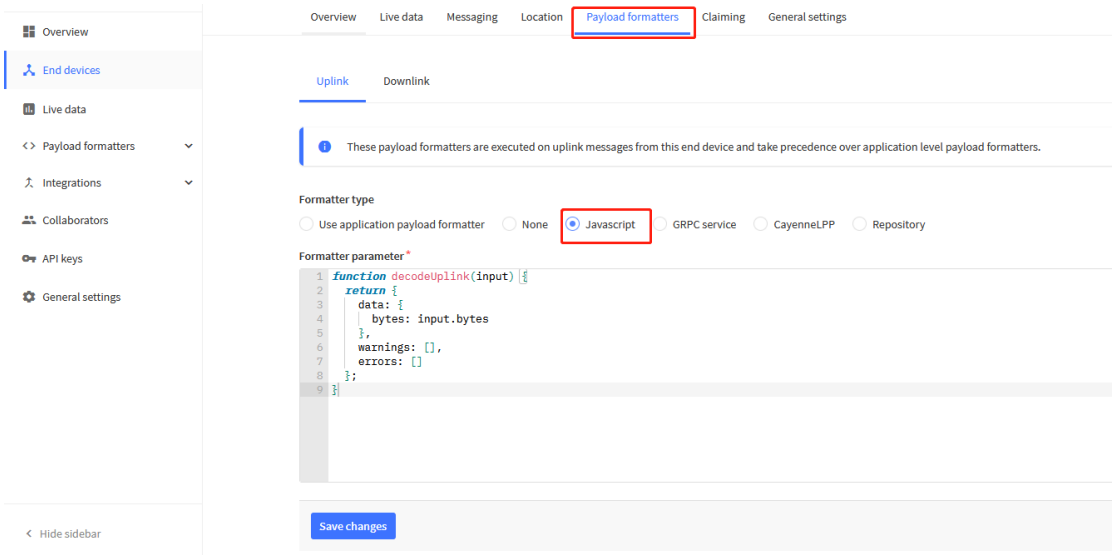
0x(x0): Normal uplink packet.
0x(x1): Interrupt Uplink Packet.

The higher four bits of this data field shows the message type:

Message Type Code	Description	Payload
0x(1x)	Normal Uplink	Normal Uplink Payload
0x(2x)	Reply configures info	Configure Info Payload

2.3.7 Decode payload in The Things Network

While using TTN network, you can add the payload format to decode the payload.



The payload decoder function for TTN is here:
LSNPK01 TTN Payload Decoder:
https://www.dragino.com/downloads/index.php?dir=LoRa_End_Node/LSNPK01/Decoder/

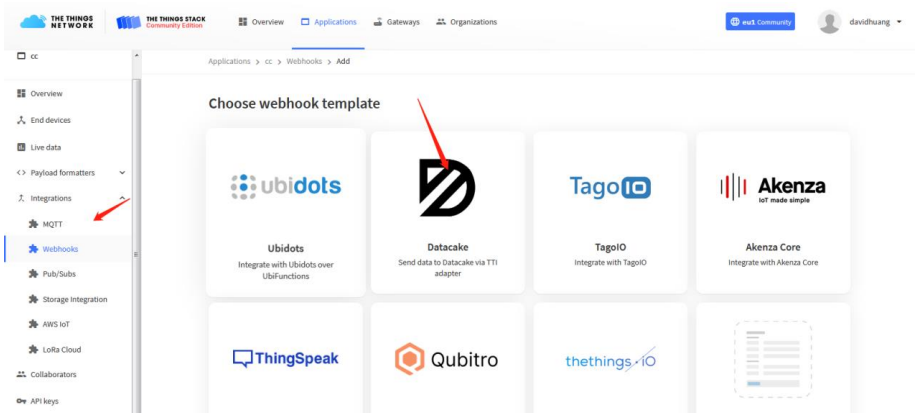
2.4 Uplink Interval

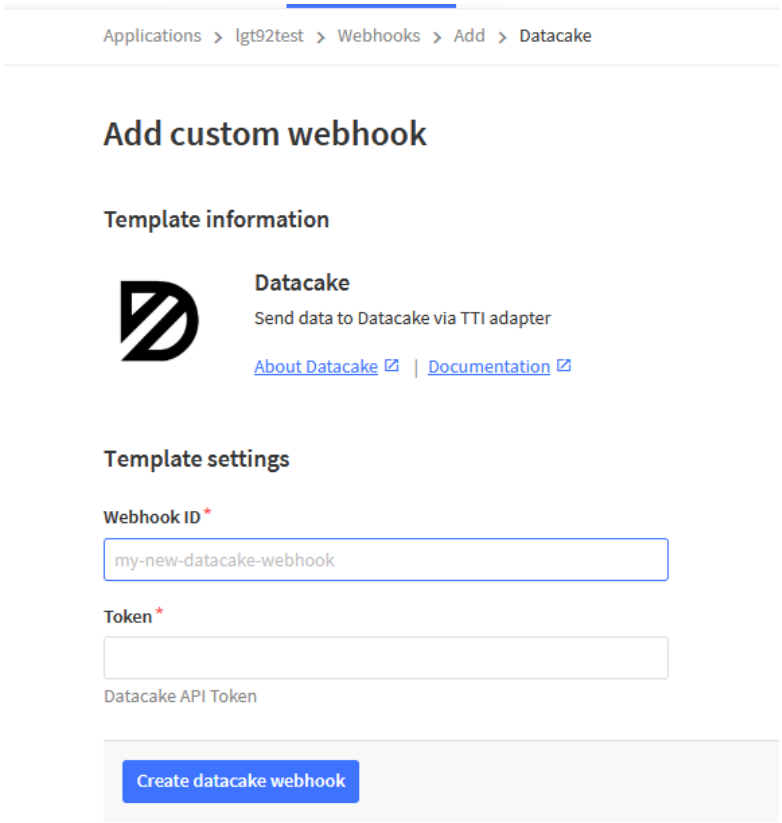
The LSNPK01 by default uplink the sensor data every 20 minutes. User can change this interval by AT Command or LoRaWAN Downlink Command. See this link:
http://wiki.dragino.com/index.php?title=End_Device_AT_Commands_and_Downlink_Commands#Change_Uplink_Interval

2.5 Show Data in DataCake IoT Server

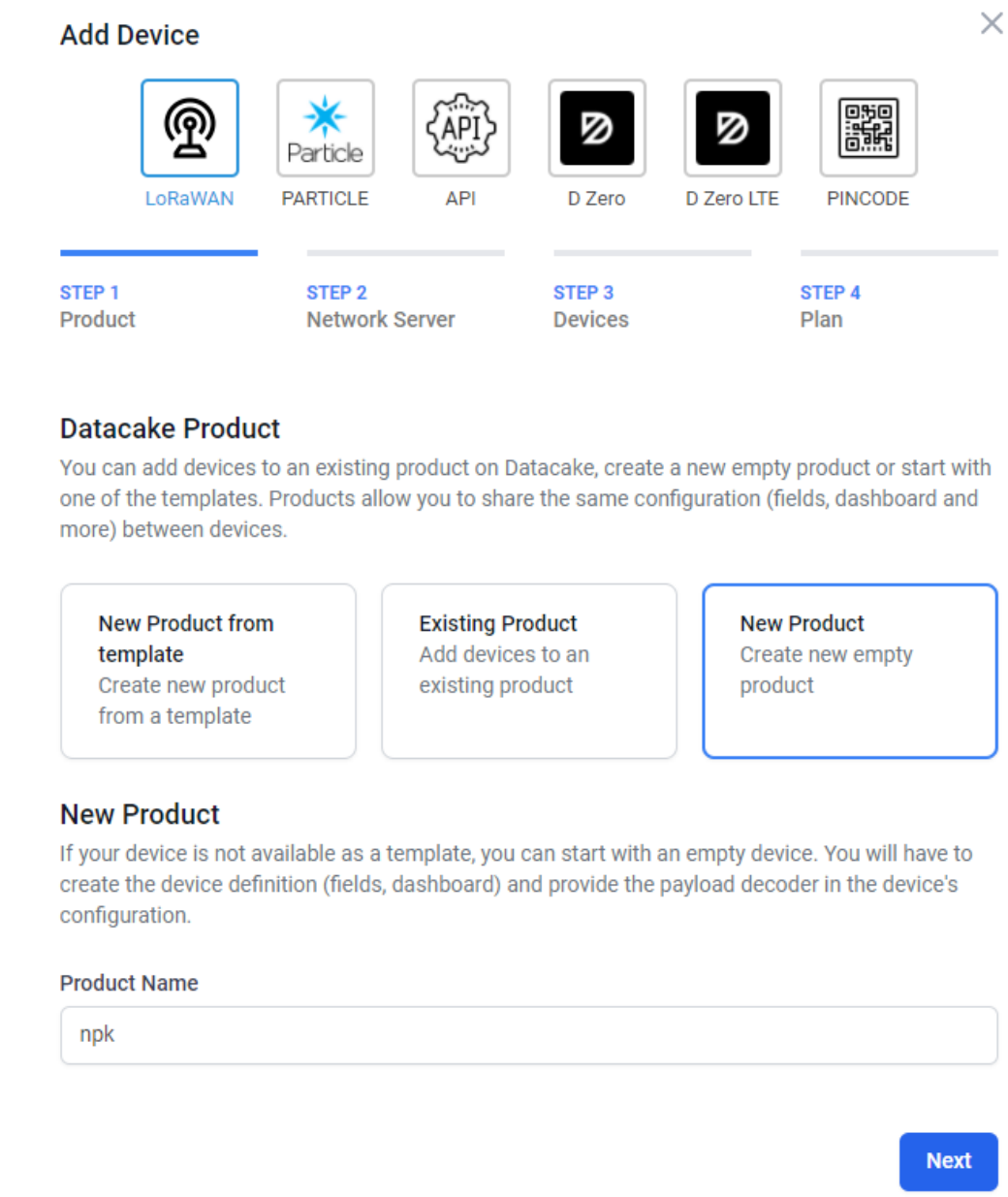
DATACAKE provides a human friendly interface to show the sensor data, once we have data in TTN, we can use DATACAKE to connect to TTN and see the data in DATACAKE. Below are the steps:

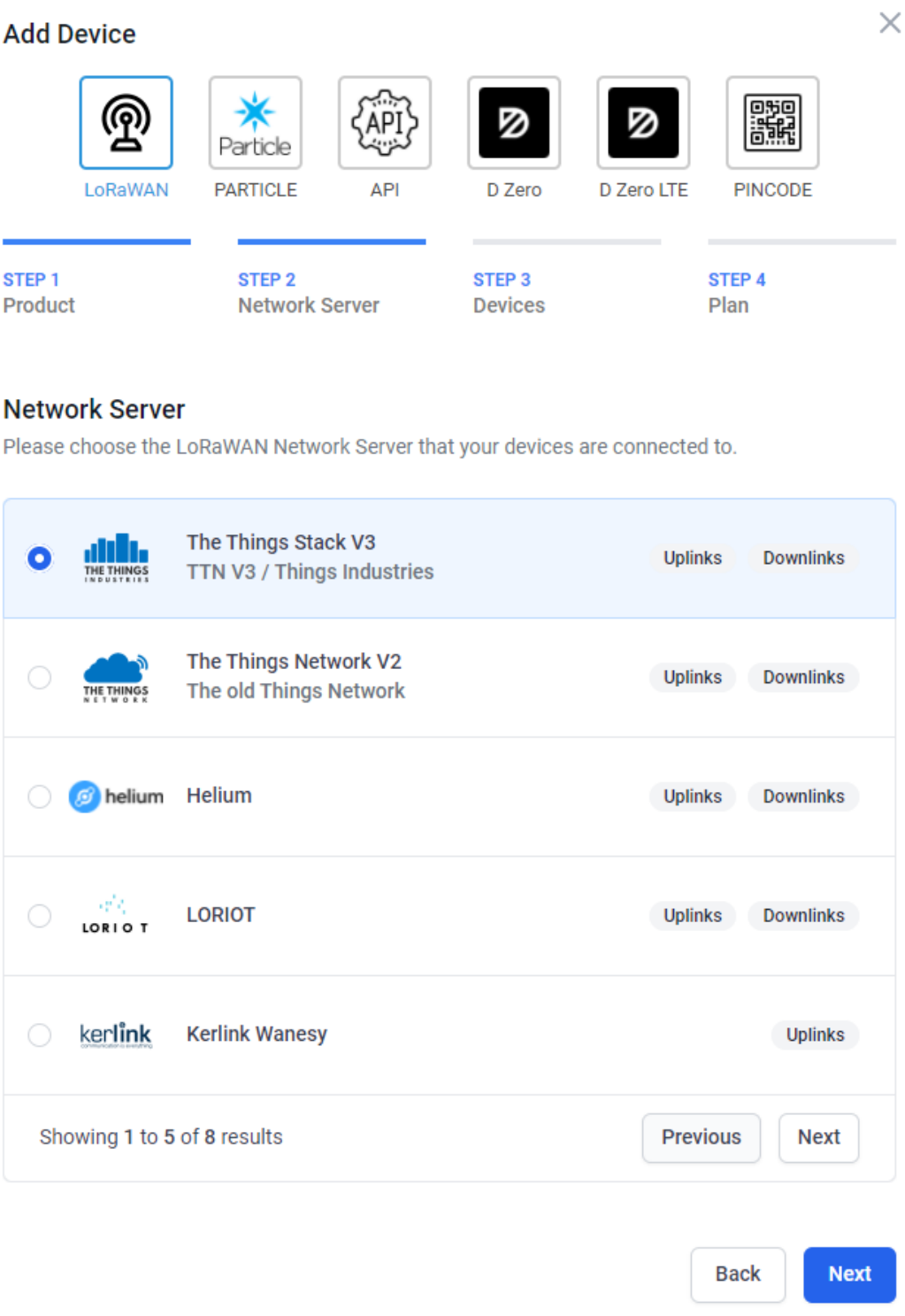
Step 1: Be sure that your device is programmed and properly connected to the network at this time.
Step 2: To configure the Application to forward data to DATACAKE you will need to add integration. To add the DATACAKE integration, perform the following steps:

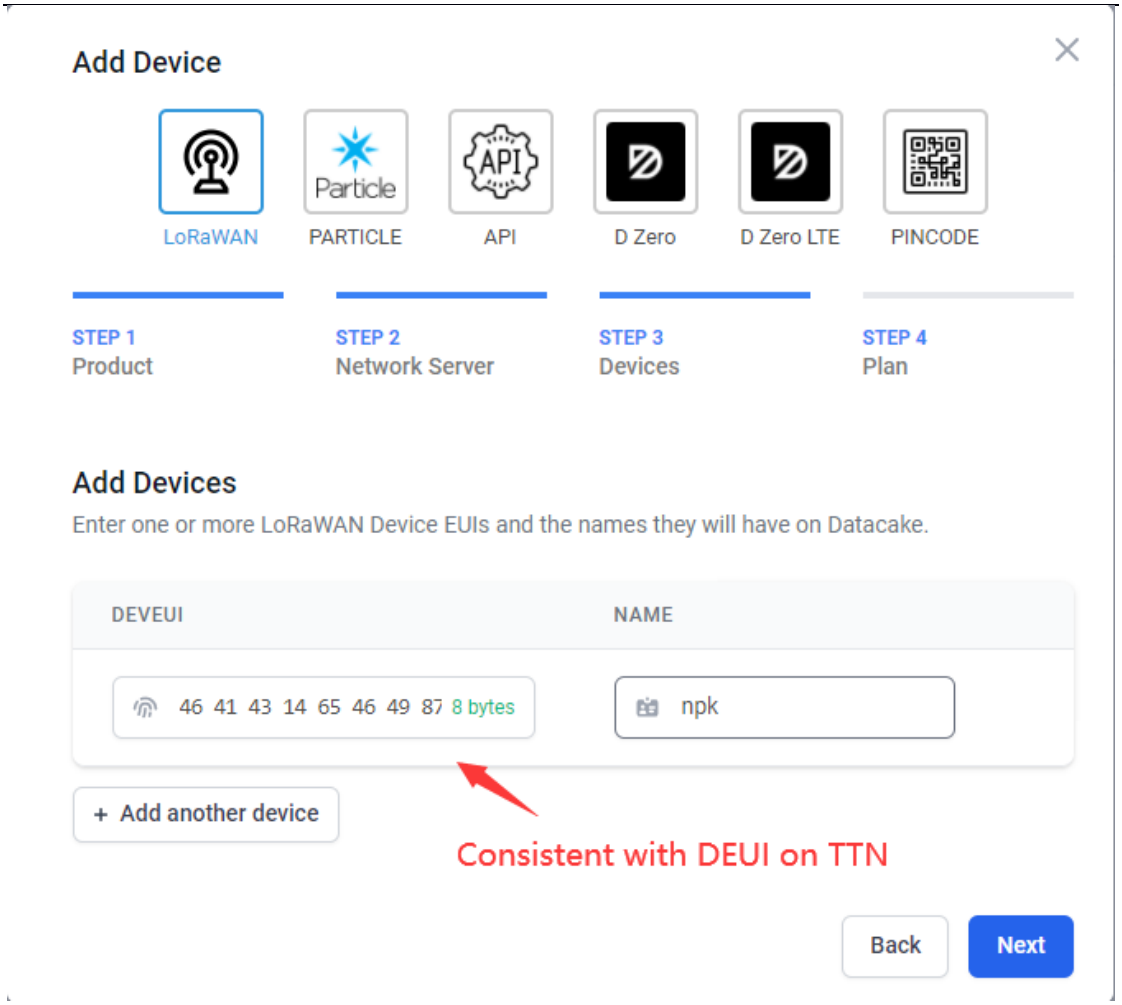




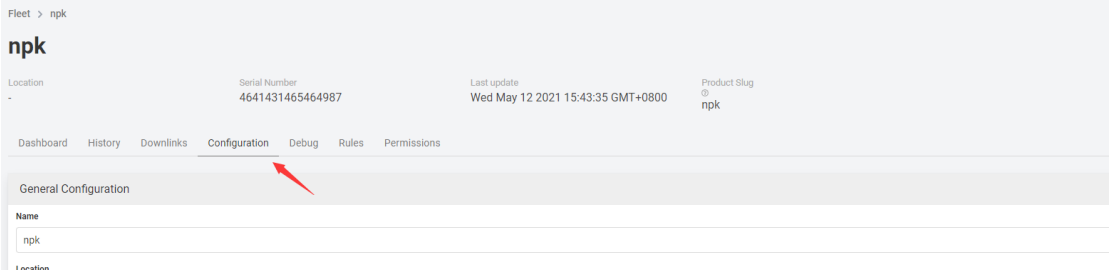
Step 3: Create an account or log in Datacake.
Step 4: Create LSNPK01 product.

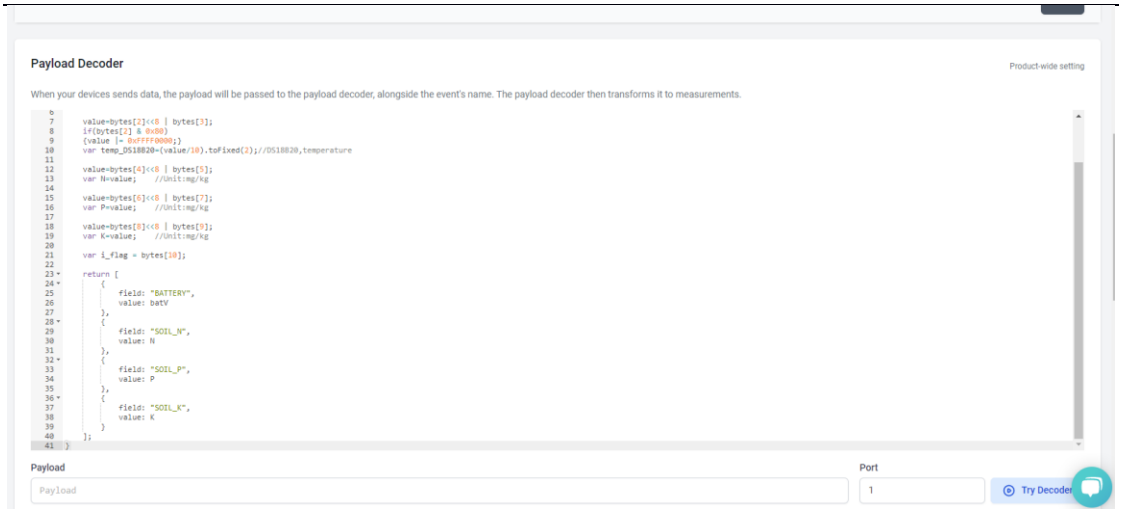

Add Device
LoRaWAN
PARTICLE
API
D Zero
D Zero LTE
PINCODE
STEP 1
Product
STEP 2
Network Server
STEP 3
Devices
STEP 4
Plan
Datacake Product
You can add devices to an existing product on Datacake, create a new empty product or start with one of the templates. Products allow you to share the same configuration (fields, dashboard and more) between devices.
New Product from template
Create new product from a template
Existing Product
Add devices to an existing product
New Product
Create new empty product
New Product
If your device is not available as a template, you can start with an empty device. You will have to create the device definition (fields, dashboard) and provide the payload decoder in the device's configuration.
Product Name
npk
Next

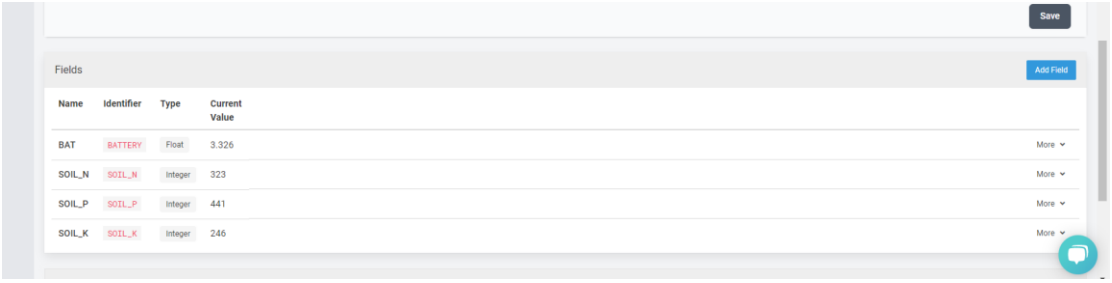

Add Device
LoRaWAN
PARTICLE
API
D Zero
D Zero LTE
PINCODE
STEP 1
Product
STEP 2
Network Server
STEP 3
Devices
STEP 4
Plan
Network Server
Please choose the LoRaWAN Network Server that your devices are connected to.
The Things Stack V3
TTN V3 / Things Industries
Uplinks
Downlinks
The Things Network V2
The old Things Network
Uplinks
Downlinks
Helium
Uplinks
Downlinks
LORIOT
Uplinks
Downlinks
Kerlink Wanesy
Uplinks
Showing 1 to 5 of 8 results
Previous
Next
Back
Next



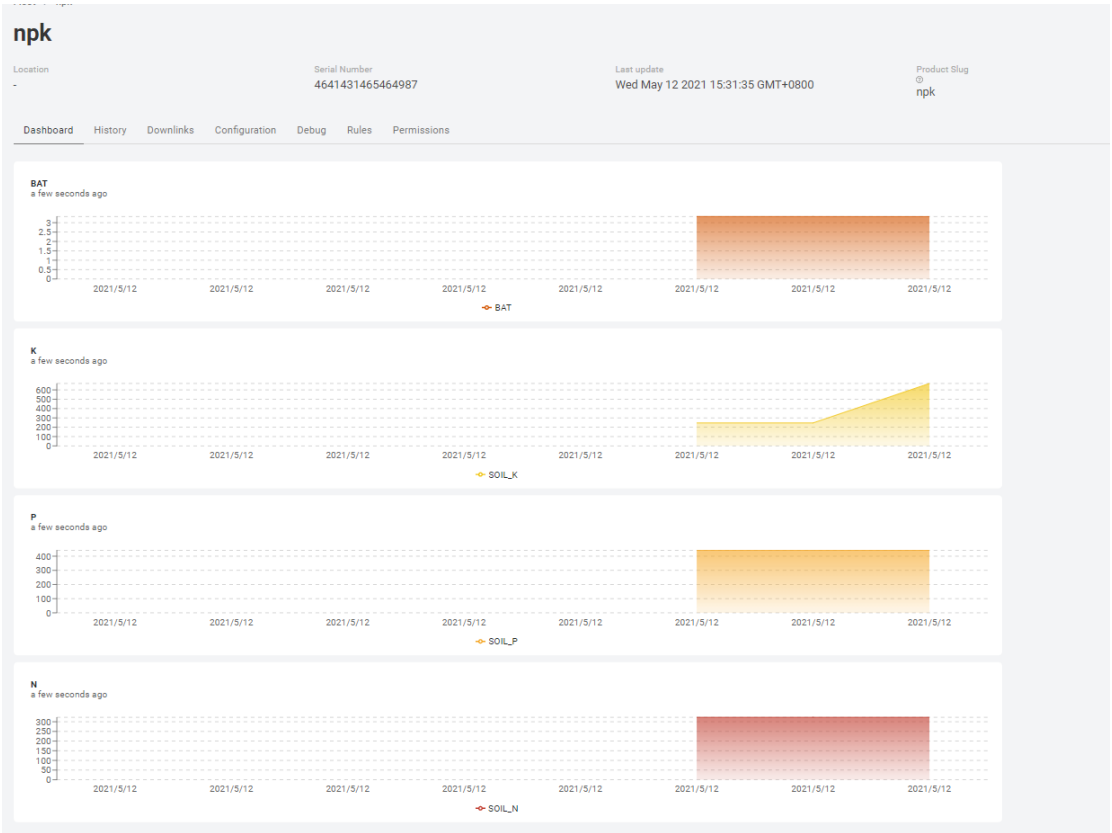
Step 5: add payload decode
Download Datacake decoder from:
https://www.dragino.com/downloads/index.php?dir=LoRa_End_Node/LSNPK01/Decoder/







After added, the sensor data arrive TTN, it will also arrive and show in Mydevices.



2.6 Frequency Plans

The LSNPK01 uses OTAA mode and below frequency plans by default. If user want to use it with different frequency plan, please refer the AT command sets.

2.6.1 EU863-870 (EU868)

Uplink:
868.1 - SF7BW125 to SF12BW125
868.3 - SF7BW125 to SF12BW125 and SF7BW250
868.5 - SF7BW125 to SF12BW125
867.1 - SF7BW125 to SF12BW125
867.3 - SF7BW125 to SF12BW125
867.5 - SF7BW125 to SF12BW125
867.7 - SF7BW125 to SF12BW125
867.9 - SF7BW125 to SF12BW125
868.8 - FSK

Downlink:
Uplink channels 1-9 (RX1)
869.525 - SF9BW125 (RX2 downlink only)

2.6.2 US902-928(US915)

Used in USA, Canada and South America. Frequency band as per definition in LoRaWAN 1.0.3 Regional document.

To make sure the end node supports all sub band by default. In the OTAA Join process, the end node will use frequency 1 from sub-band1, then frequency 1 from sub-band2, then frequency 1 from sub-band3, etc to process the OTAA join.

After Join success, the end node will switch to the correct sub band by:

- Check what sub-band the LoRaWAN server ask from the OTAA Join Accept message and switch to that sub-band
- Use the Join successful sub-band if the server doesn't include sub-band info in the OTAA Join Accept message (TTN v2 doesn't include)

2.6.3 CN470-510 (CN470)

Used in China, Default use CHE=1
Uplink:
486.3 - SF7BW125 to SF12BW125
486.5 - SF7BW125 to SF12BW125
486.7 - SF7BW125 to SF12BW125
486.9 - SF7BW125 to SF12BW125
487.1 - SF7BW125 to SF12BW125
487.3 - SF7BW125 to SF12BW125
487.5 - SF7BW125 to SF12BW125
487.7 - SF7BW125 to SF12BW125

Downlink:
506.7 - SF7BW125 to SF12BW125
506.9 - SF7BW125 to SF12BW125
507.1 - SF7BW125 to SF12BW125
507.3 - SF7BW125 to SF12BW125
507.5 - SF7BW125 to SF12BW125

507.7 - SF7BW125 to SF12BW125
507.9 - SF7BW125 to SF12BW125
508.1 - SF7BW125 to SF12BW125
505.3 - SF12BW125 (RX2 downlink only)

2.6.4 AU915-928(AU915)

Frequency band as per definition in LoRaWAN 1.0.3 Regional document.

To make sure the end node supports all sub band by default. In the OTAA Join process, the end node will use frequency 1 from sub-band1, then frequency 1 from sub-band2, then frequency 1 from sub-band3, etc to process the OTAA join.

After Join success, the end node will switch to the correct sub band by:

- Check what sub-band the LoRaWAN server ask from the OTAA Join Accept message and switch to that sub-band
- Use the Join successful sub-band if the server doesn't include sub-band info in the OTAA Join Accept message (TTN v2 doesn't include)

2.6.5 AS920-923 & AS923-925 (AS923)

Default Uplink channel:
923.2 - SF7BW125 to SF10BW125
923.4 - SF7BW125 to SF10BW125

Additional Uplink Channel:
(OTAA mode, channel added by JoinAccept message)

AS920~AS923 for Japan, Malaysia, Singapore:
922.2 - SF7BW125 to SF10BW125
922.4 - SF7BW125 to SF10BW125
922.6 - SF7BW125 to SF10BW125
922.8 - SF7BW125 to SF10BW125
923.0 - SF7BW125 to SF10BW125
922.0 - SF7BW125 to SF10BW125

AS923 ~ AS925 for Brunei, Cambodia, Hong Kong, Indonesia, Laos, Taiwan, Thailand, Vietnam:
923.6 - SF7BW125 to SF10BW125
923.8 - SF7BW125 to SF10BW125
924.0 - SF7BW125 to SF10BW125
924.2 - SF7BW125 to SF10BW125
924.4 - SF7BW125 to SF10BW125
924.6 - SF7BW125 to SF10BW125

Downlink:
Uplink channels 1-8 (RX1)
923.2 - SF10BW125 (RX2)

2.6.6 KR920-923 (KR920)

Default channel:

922.1 - SF7BW125 to SF12BW125
922.3 - SF7BW125 to SF12BW125
922.5 - SF7BW125 to SF12BW125

Uplink: (OTAA mode, channel added by JoinAccept message)
922.1 - SF7BW125 to SF12BW125
922.3 - SF7BW125 to SF12BW125
922.5 - SF7BW125 to SF12BW125
922.7 - SF7BW125 to SF12BW125
922.9 - SF7BW125 to SF12BW125
923.1 - SF7BW125 to SF12BW125
923.3 - SF7BW125 to SF12BW125

Downlink:
Uplink channels 1-7(RX1)
921.9 - SF12BW125 (RX2 downlink only; SF12BW125 might be changed to SF9BW125)

2.6.7 IN865-867 (IN865)

Uplink:
865.0625 - SF7BW125 to SF12BW125
865.4025 - SF7BW125 to SF12BW125
865.9850 - SF7BW125 to SF12BW125

Downlink:
Uplink channels 1-3 (RX1)
866.550 - SF10BW125 (RX2)

2.7 LED Indicator

The LSNPK01 has an internal LED which is to show the status of different state.

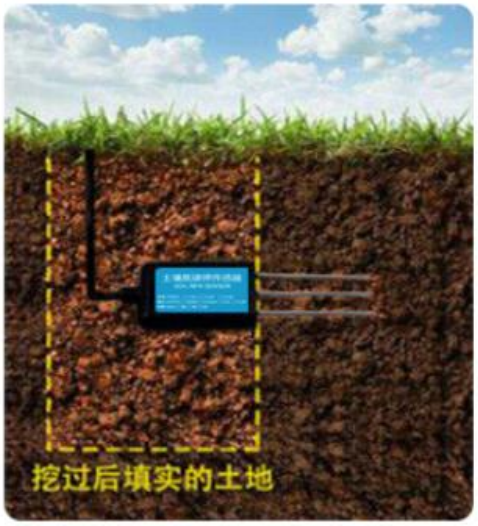
- The sensor is detected when the device is turned on, and it will flash 4 times quickly when it is detected.
- Blink once when device transmit a packet.

2.8 Installation in Soil

Measurement the soil surface

Choose the proper measuring position. Avoid the probe to touch rocks or hard things. Split the surface soil according to the measured deep. Keep the measured as original density. Vertical insert the probe into the soil to be measured. Make sure not shake when inserting.

Dig a hole with diameter > 20CM.
Horizontal insert the probe to the soil and fill the hole for long term measurement.



2.9 Firmware Change Log

Firmware download link:
http://www.dragino.com/downloads/index.php?dir=LoRa_End_Node/LSNPK01/Firmware/

Firmware Upgrade Method:
http://wiki.dragino.com/index.php?title=Firmware_Upgrade_Instruction_for_STM32_base_products#Introduction

3. Configure LSNPK01 via AT Command or LoRaWAN Downlink

Use can configure LSNPK01 via AT Command or LoRaWAN Downlink.

- AT Command Connection: See FAQ.
- LoRaWAN Downlink instruction for different platforms:

http://wiki.dragino.com/index.php?title=Main_Page#Use_Note_for_Server

There are two kinds of commands to configure LSNPK01, they are:

- **General Commands**.

  These commands are to configure:

  - ✓ General system settings like: uplink interval.
  - ✓ LoRaWAN protocol & radio related command.

  They are same for all Dragino Device which support DLWS-005 LoRaWAN Stack. These commands can be found on the wiki:

  http://wiki.dragino.com/index.php?title=End_Device_Downlink_Command

- **Commands special design for LSNPK01**

  These commands only valid for LSNPK01, as below:

3.1Set Transmit Interval Time

Feature: Change LoRaWAN End Node Transmit Interval.

AT Command: AT+TDC

Command Example	Function	Response
AT+TDC=?	Show current transmit Interval	30000 OK the interval is 30000ms = 30s
AT+TDC=60000	Set Transmit Interval	OK Set transmit interval to 60000ms = 60 seconds

Downlink Command: 0x01

Format: Command Code (0x01) followed by 3 bytes time value.
If the downlink payload=0100003C, it means set the END Node's Transmit Interval to 0x00003C=60(S), while type code is 01.

- Example 1: Downlink Payload: 0100001E // Set Transmit Interval (TDC) = 30 seconds
- Example 2: Downlink Payload: 0100003C // Set Transmit Interval (TDC) = 60 seconds

3.2Set Interrupt Mode

Feature, Set Interrupt mode for GPIO_EXIT.

AT Command: AT+INTMOD

Command Example	Function	Response
AT+INTMOD=?	Show current interrupt mode	0 OK the mode is 0 = No interruption
AT+INTMOD=2	Set Transmit Interval 0- (Disable Interrupt), 1- (Trigger by rising and falling edge), 2- (Trigger by falling edge) 3- (Trigger by rising edge)	OK

Downlink Command: 0x06

Format: Command Code (0x06) followed by 3 bytes.

This means that the interrupt mode of the end node is set to 0x000003=3 (rising edge trigger), and the type code is 06.

- Example 1: Downlink Payload: 06000000 // Turn off interrupt mode
- Example 2: Downlink Payload: 06000003 // Set the interrupt mode to rising edge trigger

3.3Get Firmware Version Info

Feature: use downlink to get firmware version.

Downlink Command: 0x26

Downlink Control Type	FPort	Type Code	Downlink payload size(bytes)
Get Firmware Version Info	Any	26	2

- Reply to the confirmation package: 26 01
- Reply to non-confirmed packet: 26 00

Device will send an uplink after got this downlink command. With below payload:

Configures info payload:

Size (bytes)	1	1	1	2	1	4	1
Value	Software Type	Frequency Band	Sub-band	Firmware Version	Sensor Type	Reserve	Message Type Always 0x(2x)

Software Type: Always 0x03 for LSNPK01

Frequency Band:

*0x01: EU868

*0x02: US915
*0x03: IN865
*0x04: AU915
*0x05: KZ865
*0x06: RU864
*0x07: AS923
*0x08: AS923-1
*0x09: AS923-2
*0xa0: AS923-3

Sub-Band: value 0x00 ~ 0x08

Firmware Version: 0x0100, Means: v1.0.0 version

Sensor Type:
0x01: LSE01
0x02: LDDS75
0x03: LDDS20
0x04: LLMS01
0x05: LSPH01
0x06: LSNPK01

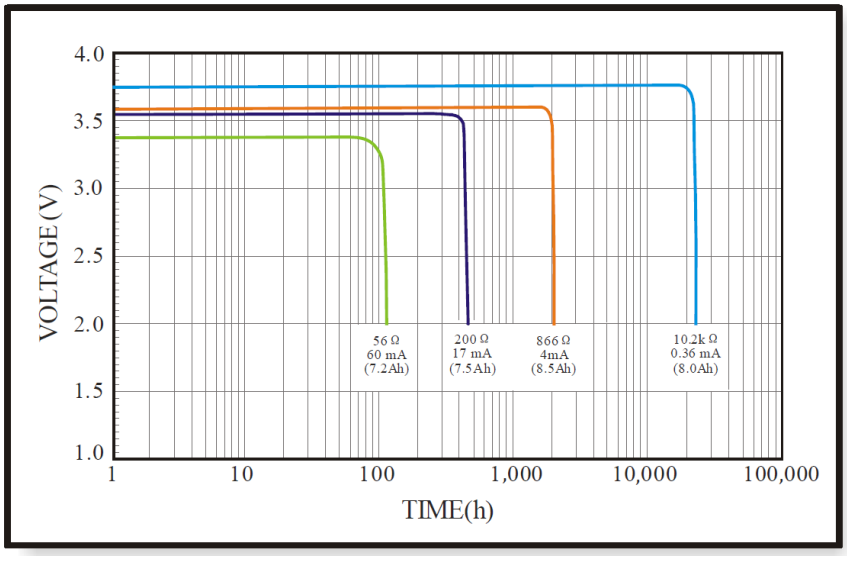
4. Battery & How to replace

4.1Battery Type

LSNPK01 is equipped with a 8500mAH ER26500 Li-SOCI2 battery. The battery is un-rechargeable battery with low discharge rate targeting for 8~10 years use. This type of battery is commonly used in IoT target for long-term running, such as water meter.

The discharge curve is not linear so can't simply use percentage to show the battery level. Below is the battery performance.

1. Typical discharge profile at +20℃(Typical value)



Minimum Working Voltage for the LSNPK01:
LSNPK01: 2.45v ~ 3.6v

4.2Replace Battery

Any battery with range 2.45 ~ 3.6v can be a replacement. We recommend to use Li-SOCl2 Battery. And make sure the positive and negative pins match.

4.3Power Consumption Analyze

Dragino Battery powered product are all runs in Low Power mode. We have an update battery calculator which base on the measurement of the real device. User can use this calculator to check the battery life and calculate the battery life if want to use different transmit interval.

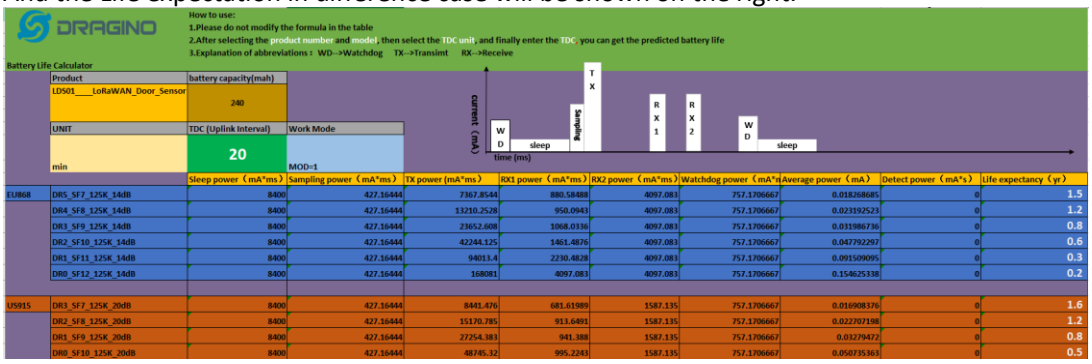
Instruction to use as below:

Step 1: Downlink the up-to-date DRAGINO_Battery_Life_Prediction_Table.xlsx from:
https://www.dragino.com/downloads/index.php?dir=LoRa_End_Node/Battery_Analyze/

Step 2: Open it and choose

- Product Model
- Uplink Interval
- Working Mode

And the Life expectation in difference case will be shown on the right.



The battery related documents as below:

- Battery Dimension,
- Lithium-Thionyl Chloride Battery datasheet, Tech Spec
- Lithium-ion Battery-Capacitor datasheet, Tech Spec

4.3.1 Battery Note

The Li-SICO battery is designed for small current / long period application. It is not good to use a high current, short period transmit method. The recommended minimum period for use of this battery is 5 minutes. If you use a shorter period time to transmit LoRa, then the battery life may be decreased.

4.3.2 Replace the battery

You can change the battery in the LSNPK01.The type of battery is not limited as long as the output is between 3v to 3.6v. On the main board, there is a diode (D1) between the battery and the main circuit. If you need to use a battery with less than 3.3v, please remove the D1 and shortcut the two pads of it so there won't be voltage drop between battery and main board.

The default battery pack of LSNPK01 includes a ER26500 plus super capacitor. If user can't find this pack locally, they can find ER26500 or equivalence, which will also work in most case. The SPC can enlarge the battery life for high frequency use (update period below 5 minutes)

5. Use AT Command

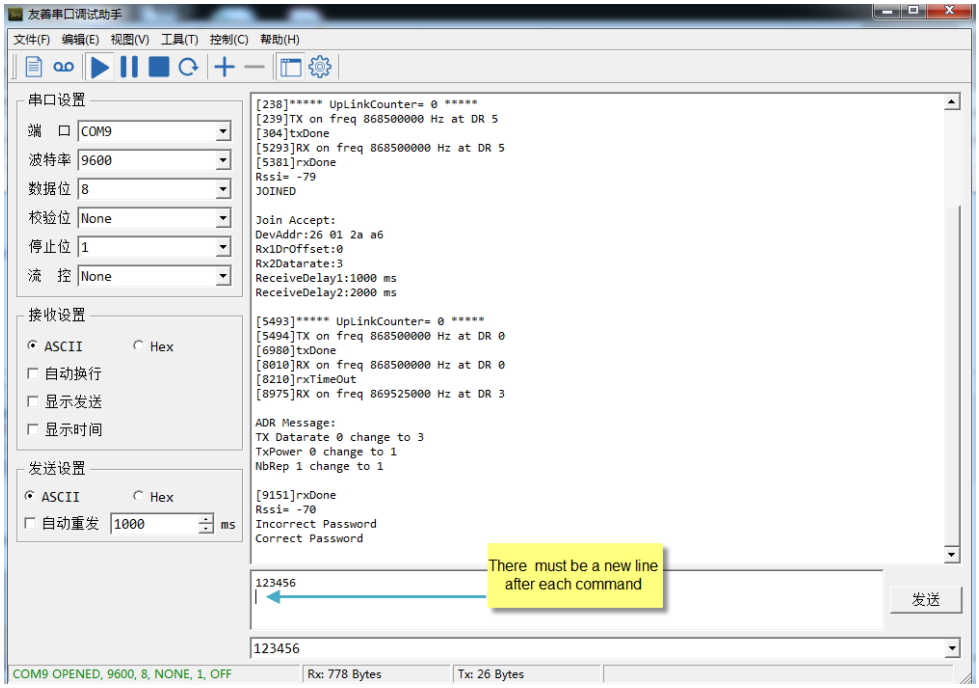
5.1 Access AT Commands

LSNPK01 supports AT Command set in the stock firmware. You can use a USB to TTL adapter to connect to LSNPK01 for using AT command, as below.

Connection:

USB TTL GND <----> GND
USB TTL TXD <----> UART_RXD
USB TTL RXD <----> UART_TXD

In the PC, you need to set the serial baud rate to **9600** to access the serial console for LSNPK01. LSNPK01 will output system info once power on as below:



Valid AT Command please check Configure Device.

6. FAQ

6.1How to change the LoRa Frequency Bands/Region

You can follow the instructions for how to upgrade image.
When downloading the images, choose the required image file for download.

7. Trouble Shooting

7.1 AT Commands input doesn't work

In the case if user can see the console output but can't type input to the device. Please check if you already include the **ENTER** while sending out the command. Some serial tool doesn't send **ENTER** while press the send key, user need to add ENTER in their string.

8. Order Info

Part Number: **LSNPK01-XX**

XX: The default frequency band

- **AS923**: LoRaWAN AS923 band
- **AU915**: LoRaWAN AU915 band
- **EU433**: LoRaWAN EU433 band
- **EU868**: LoRaWAN EU868 band
- **KR920**: LoRaWAN KR920 band
- **US915**: LoRaWAN US915 band
- **IN865**: LoRaWAN IN865 band
- **CN470**: LoRaWAN CN470 band

9. Packing Info

Package Includes:

- LSNPK01 LoRaWAN Soil NPK Sensor x 1

Dimension and weight:

- Device Size: cm
- Device Weight: g
- Package Size / pcs : cm
- Weight / pcs : g

10. Support

- Support is provided Monday to Friday, from 09:00 to 18:00 GMT+8. Due to different timezones we cannot offer live support. However, your questions will be answered as soon as possible in the before-mentioned schedule.
- Provide as much information as possible regarding your enquiry (product models, accurately describe your problem and steps to replicate it etc) and send a mail to

support@dragino.com