DDS20-LB/LS -- LoRaWAN Ultrasonic Liquid Level Sensor User Manual

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on 2025/04/11 15:48

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1. Introduction

1.1 What is LoRaWAN Ultrasonic liquid level Sensor

The Dragino DDS20-LB/LS is a **LoRaWAN Ultrasonic liquid level sensor** for Internet of Things solution. It uses **none-contact method** to measure the **height of liquid** in a container without opening the container, and send the value via LoRaWAN network to IoT Server.

The DDS20-LB/LS sensor is installed directly below the container to detect the height of the liquid level. User doesn't need to open a hole on the container to be tested. The none-contact measurement makes the measurement safety, easier and possible for some strict situation.

DDS20-LB/LS uses **ultrasonic sensing technology** for distance measurement. DDS20-LB/LS is of high accuracy to measure various liquid such as: **toxic substances**, **strong acids**, **strong alkalis** and **various pure liquids** in high-temperature and high-pressure airtight containers.

The LoRa wireless technology used in DDS20-LB/LS 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.

DDS20-LB/LS **supports BLE configure** and **wireless OTA update** which make user easy to use.

DDS20-LB/LS is powered by **8500mAh Li-SOCI2 battery** or **solar powered + Li-ion battery** , it is designed for long term use up to 5 years.

Each DDS20-LB/LS 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
- Bands: CN470/EU433/KR920/US915/EU868/AS923/AU915/IN865
- Ultra-low power consumption
- Liquid Level Measurement by Ultrasonic technology
- Measure through container, No need to contact Liquid
- Valid level range 20mm - 2000mm
- Accuracy: ±(5mm+S*0.5%) (S: Measure Value)
- Cable Length : 25cm
- Support Bluetooth v5.1 and LoRaWAN remote configure
- Support wireless OTA update firmware
- AT Commands to change parameters
- Downlink to change configure
- IP66 Waterproof Enclosure
- 8500mAh Li/SOCl2 Battery (DDS20-LB)
- Solar panel + 3000mAh Li-ion battery (DDS20-LS)

1.3 Specification

Common DC Characteristics:

- Supply Voltage: Built-in Battery , 2.5v ~ 3.6v
- Operating Temperature: -40 ~ 85°C

LoRa Spec:

- Frequency Range, Band 1 (HF): 862 ~ 1020 Mhz
- Max +22 dBm constant RF output vs.
- RX sensitivity: down to -139 dBm.
- Excellent blocking immunity

Battery:

- Li/SOCI2 un-chargeable battery
- Capacity: 8500mAh
- Self-Discharge: <1% / Year @ 25°C
- Max continuously current: 130mA
- Max boost current: 2A, 1 second

Power Consumption

- Sleep Mode: 5uA @ 3.3v
- LoRa Transmit Mode: 125mA @ 20dBm, 82mA @ 14dBm

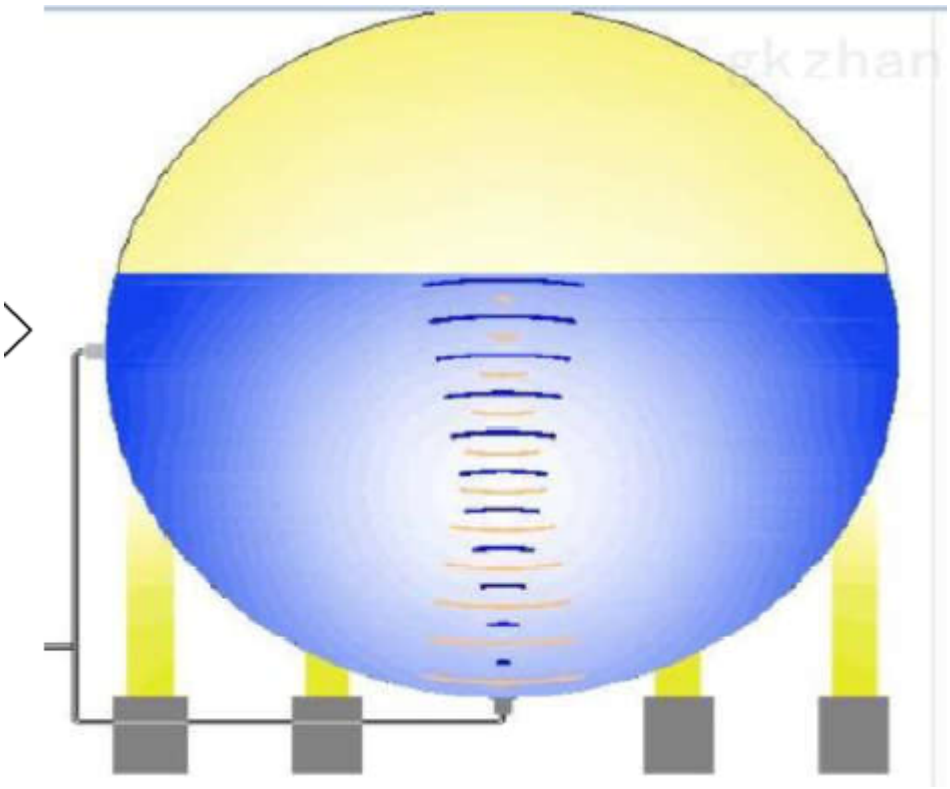
1.4 Suitable Container & Liquid

- Solid Wall container such as: steel, iron, glass, ceramics, non-foaming plastics etc.
- Container shape is regular, and surface is smooth.
- Container Thickness:
  - Pure metal material. 2~8mm, best is 3~5mm
  - Pure non metal material: <10 mm
- Pure liquid without irregular deposition.

1.5 Install DDS20-LB/LS

Step 1: **Choose the installation point.**

DDS20-LB/LS **MUST** be installed on the container bottom middle position.



Step 2: **Polish the installation point.**

For Metal Surface with paint, it is important to polish the surface, first use crude sand paper to polish the paint level , then use exquisite sand paper to polish the metal level to make it shine & smooth.

No polish needed if the container is shine metal surface without paint or non-metal container.

Step3: Test the installation point.

Power on DDS20-LB/LS, check if the blue LED is on, If the blue LED is on, means the sensor works. Then put ultrasonic coupling paste on the sensor and put it tightly on the installation point.

It is necessary to put the coupling paste between the sensor and the container, otherwise DDS20-LB/LS won't detect the liquid level.

After paste the DDS20-LB/LS well, power on DDS20-LB/LS. In the first 30 seconds of booting, device will check the sensors status and BLUE LED will show the status as below. After 30 seconds, BLUE LED will be off to save battery life.

LED Status:

- **Onboard LED**: When power on device, the onboard LED will fast blink 4 times which means detect the sensor well.
- **BLUE LED always ON**: Sensor is power on but doesn't detect liquid. There is problem in installation point.
- **BLUE LED slowly blinking**: Sensor detects Liquid Level, The installation point is good.

DDS20-LB/LS will enter into low power mode at 30 seconds after system reset or power on, Blue LED will be off after that.

Note : Ultrasonic coupling paste is subjected in most shipping way. So the default package doesn't include it and user needs to purchase locally.

Step4: Install use Epoxy ab glue.

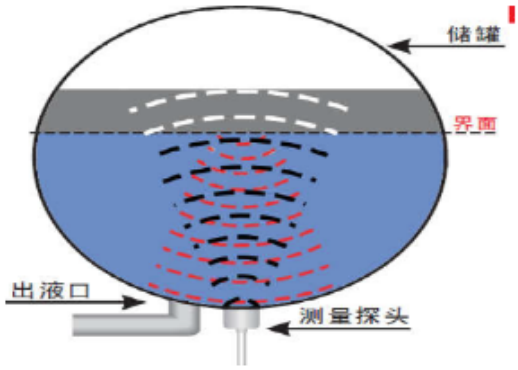
Make sure the ultrasonic coupling paste is applied on the sensor and close to the mounting point. After the sensor is working properly, remove the ultrasonic coupling agent on the sensor and the mounting point, and use AB epoxy glue to fix the sensor to the mounting point.

(**Note :** Ultrasonic coupling agent is used to help the sensor determine the installation point of the liquid in the detection container, and epoxy AB glue is used to fix the probe. The two need to be used one after the other.)

Prepare Eproxy AB glue.

Put Eproxy AB glue in the sensor and press it hard on the container installation point.

Reset DDS20-LB/LS and see if the BLUE LED is slowly blinking.



Note :

1: Eproxy AB glue needs 3~ 5 minutes to stable attached. we can use other glue material to keep it in the position.

2: Eproxy AB glue is subjected in most shipping way. So the default package doesn't include it and user needs to purchase locally.

1.6 Applications

- Smart liquid control solution
- Smart liquefied gas solution

1.7 Precautions

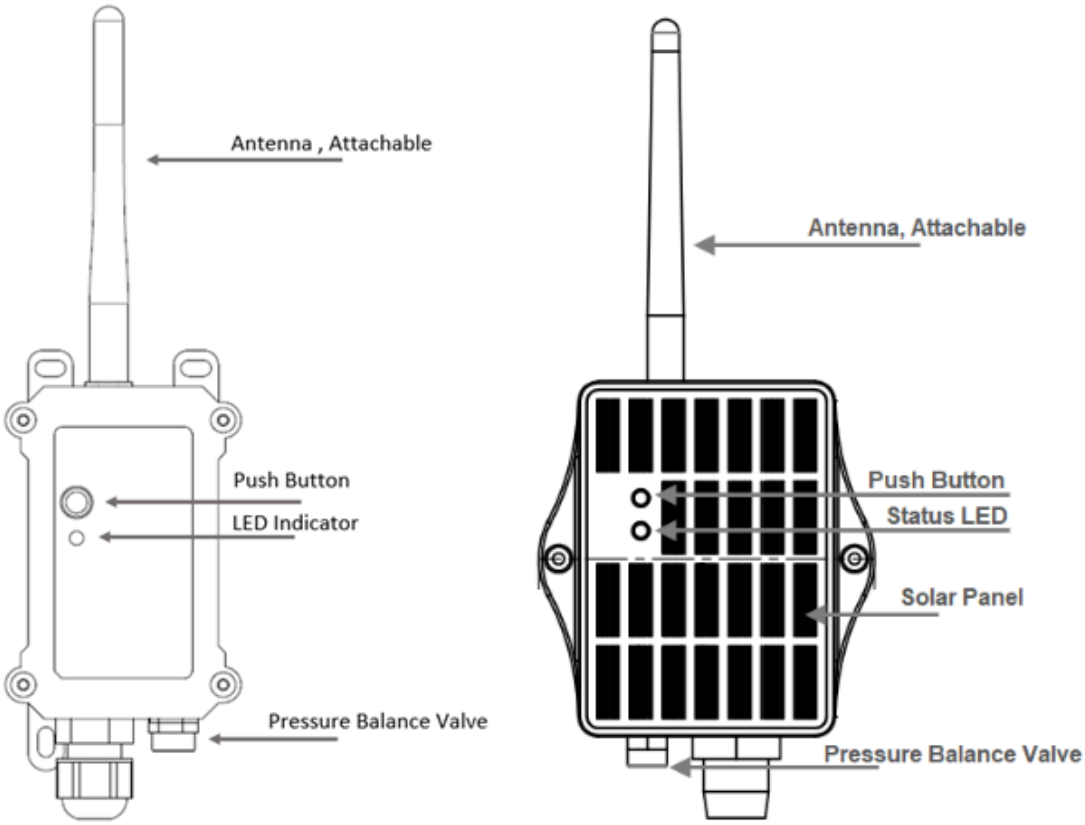
- At room temperature, containers of different materials, such as steel, glass, iron, ceramics, non-foamed plastics and other dense materials, have different detection blind areas and detection limit heights.
- For containers of the same material at room temperature, the detection blind zone and detection limit height are also different for the thickness of the container.
- When the detected liquid level exceeds the effective detection value of the sensor, and the liquid level of the liquid to be measured shakes or tilts, the detected liquid height is unstable.

1.8 Sleep mode and working mode

Deep Sleep Mode: Sensor doesn't have any LoRaWAN activate. This mode is used for storage and shipping to save battery life.

Working Mode: In this mode, Sensor will work as LoRaWAN Sensor to Join LoRaWAN network and send out sensor data to server. Between each sampling/tx/rx periodically, sensor will be in IDLE mode), in IDLE mode, sensor has the same power consumption as Deep Sleep mode.

1.9 Button & LEDs



Behavior on ACT	Function	Action
Pressing ACT between 1s < time < 3s	Send an uplink	If sensor is already Joined to LoRaWAN network, sensor will send an uplink packet, **blue led** will blink once. Meanwhile, BLE module will be active and user can connect via BLE to configure device.
Pressing ACT for more than 3s	Active Device	**Green led** will fast blink 5 times, device will enter **OTA mode** for 3 seconds. And then start to JOIN LoRaWAN network. **Green led** will solidly turn on for 5 seconds after joined in network. Once sensor is active, BLE module will be active and user can connect via BLE to configure device, no matter if device join or not join LoRaWAN network.
Fast press ACT 5 times.	Deactivate Device	**Red led** will solid on for 5 seconds. Means device is in Deep Sleep Mode.

1.10 BLE connection

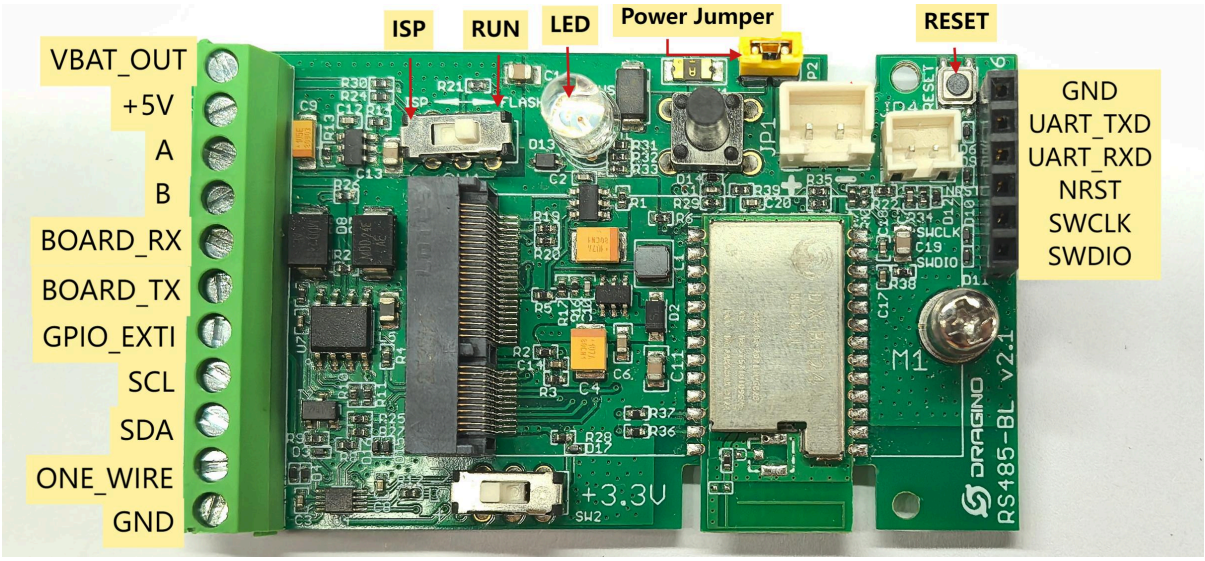
DDS20-LB/LS support BLE remote configure.

BLE can be used to configure the parameter of sensor or see the console output from sensor. BLE will be only activate on below case:

- Press button to send an uplink
- Press button to active device.
- Device Power on or reset.

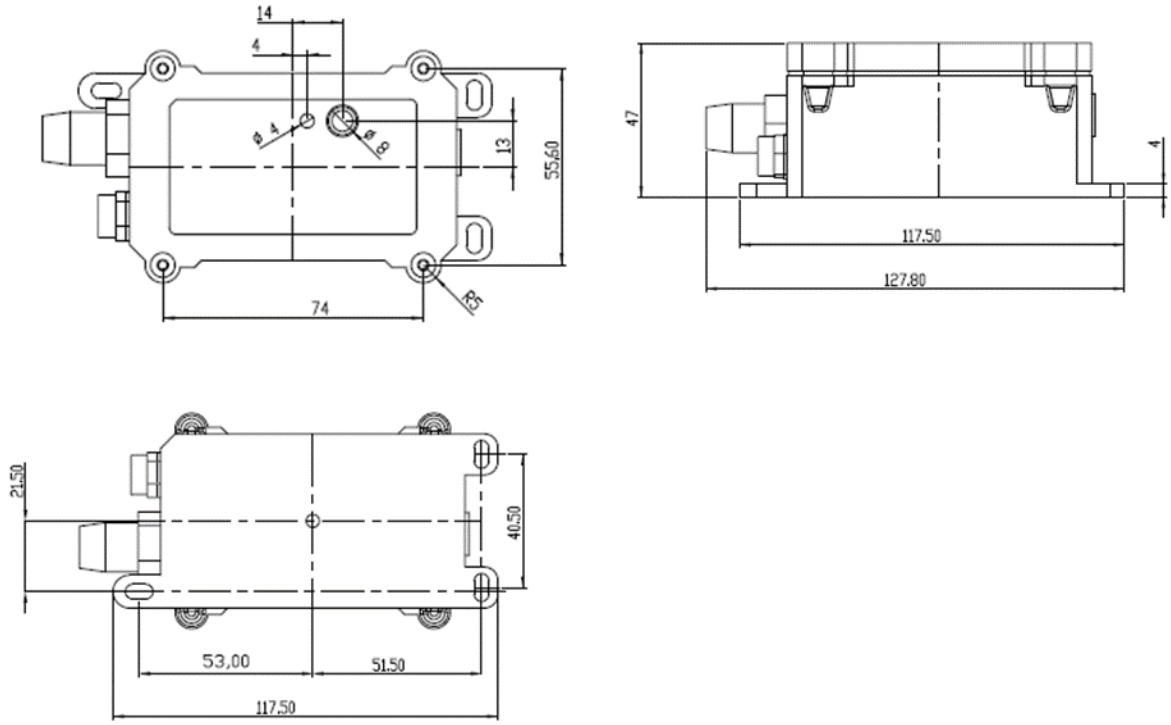
If there is no activity connection on BLE in 60 seconds, sensor will shut down BLE module to enter low power mode.

1.11 Pin Definitions

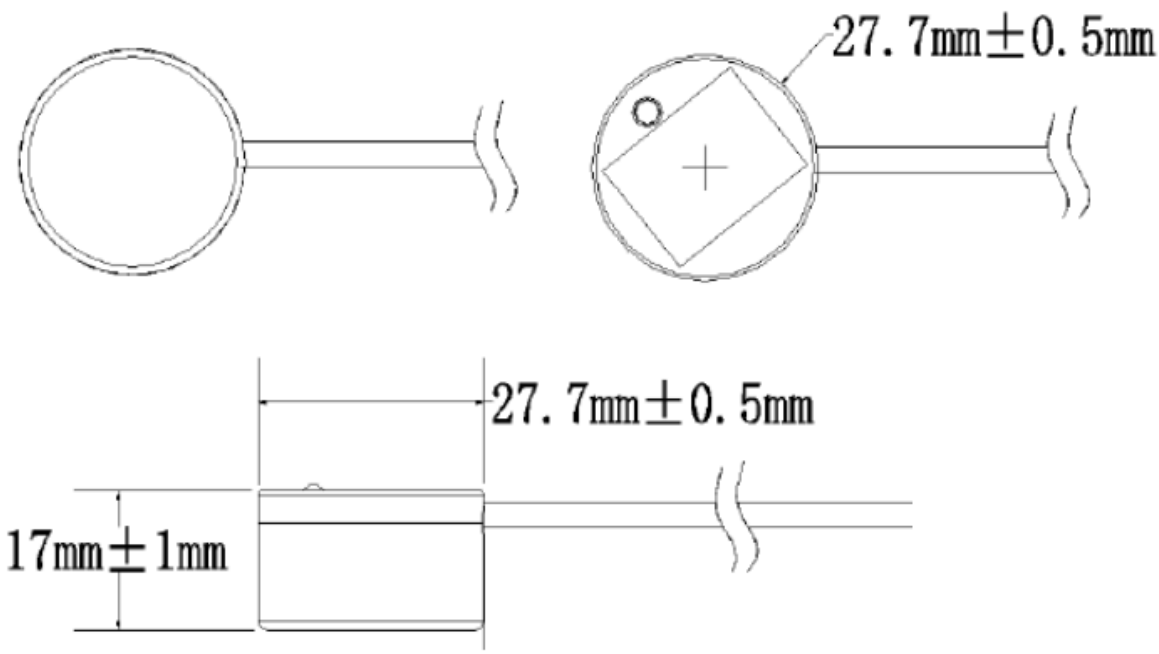


1.12 Mechanical

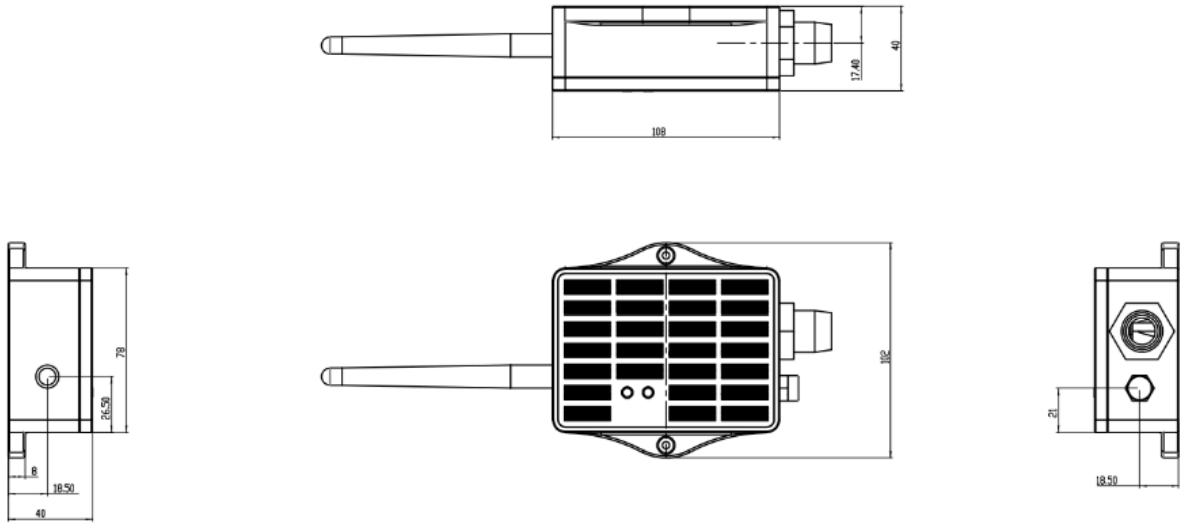
1.12.1 for LB version



Probe Mechanical:



1.12.2 for LS version



2. Configure DDS20-LB/LS to connect to LoRaWAN network

2.1 How it works

The DDS20-LB/LS 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 press the button to activate the DDS20-LB/LS. It will automatically join the network via OTAA and start to send the sensor value. The default uplink interval is 20 minutes.

2.2 Quick guide to connect to LoRaWAN server (OTAA)

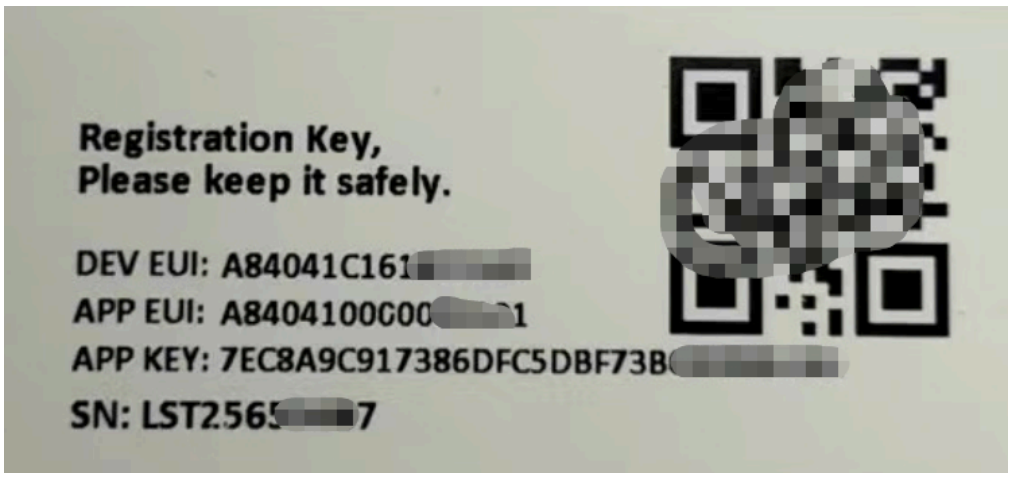
Following is an example for how to join the TTN v3 LoRaWAN Network. Below is the network structure; we use the LPS8v2 as a LoRaWAN gateway in this example.

The LPS8v2 is already set to connected to TTN network , so what we need to now is configure the TTN server.

DDS20-LB in a LoRaWAN Network

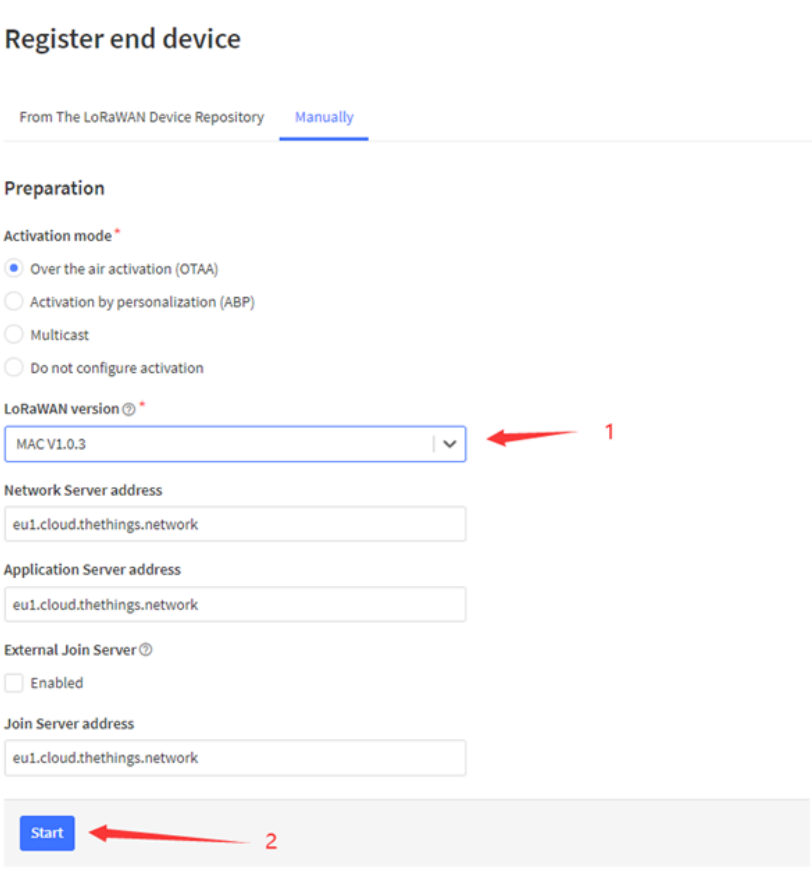
Step 1: Create a device in TTN with the OTAA keys from DDS20-LB/LS.

Each DDS20-LB/LS is shipped with a sticker with the default device EUI as below:

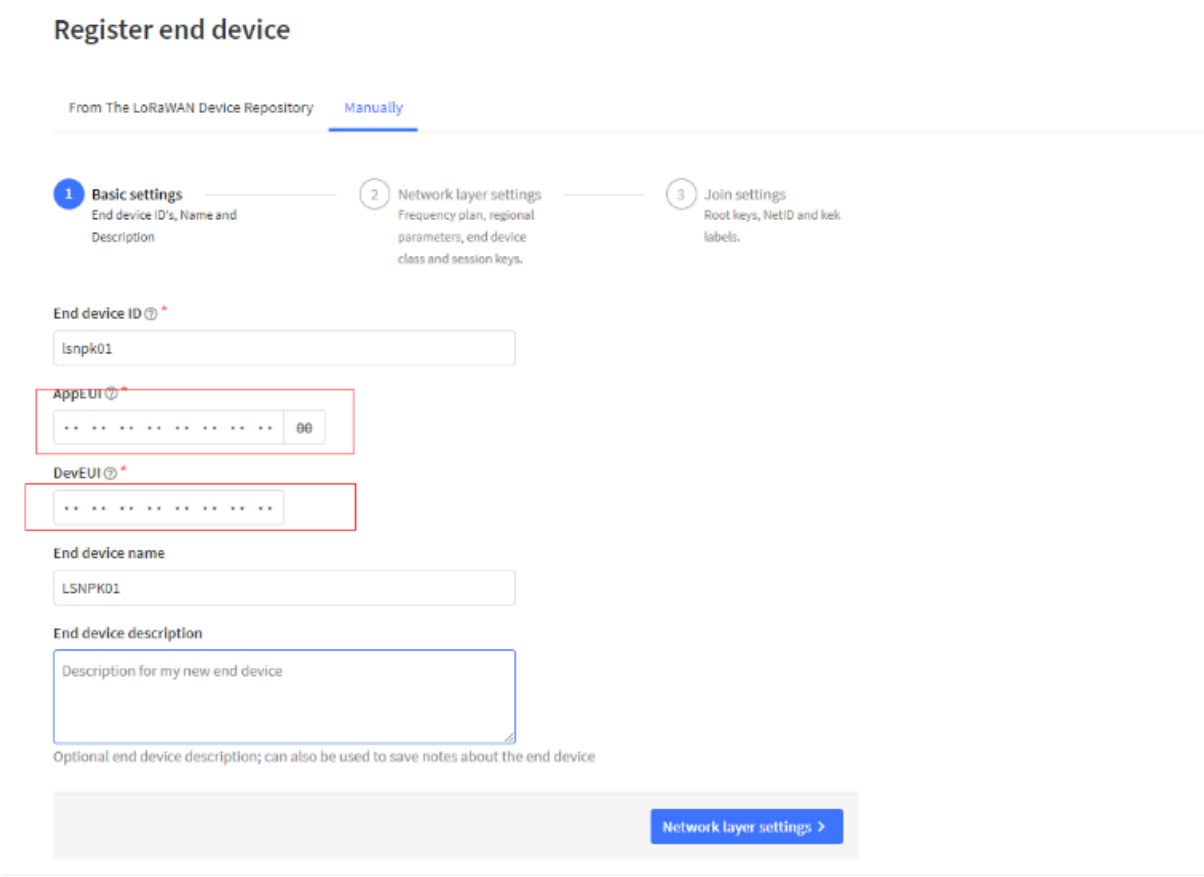


You can enter this key in the LoRaWAN Server portal. Below is TTN screen shot:

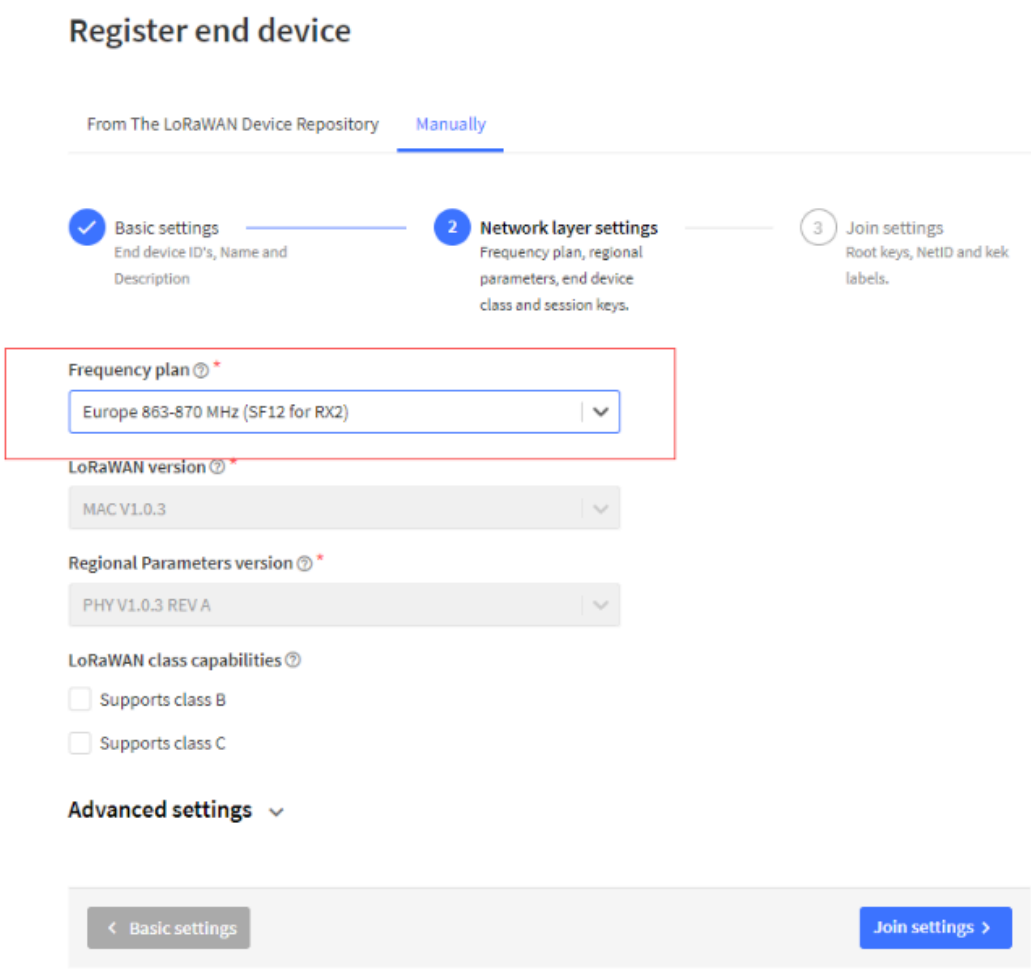
Register the device



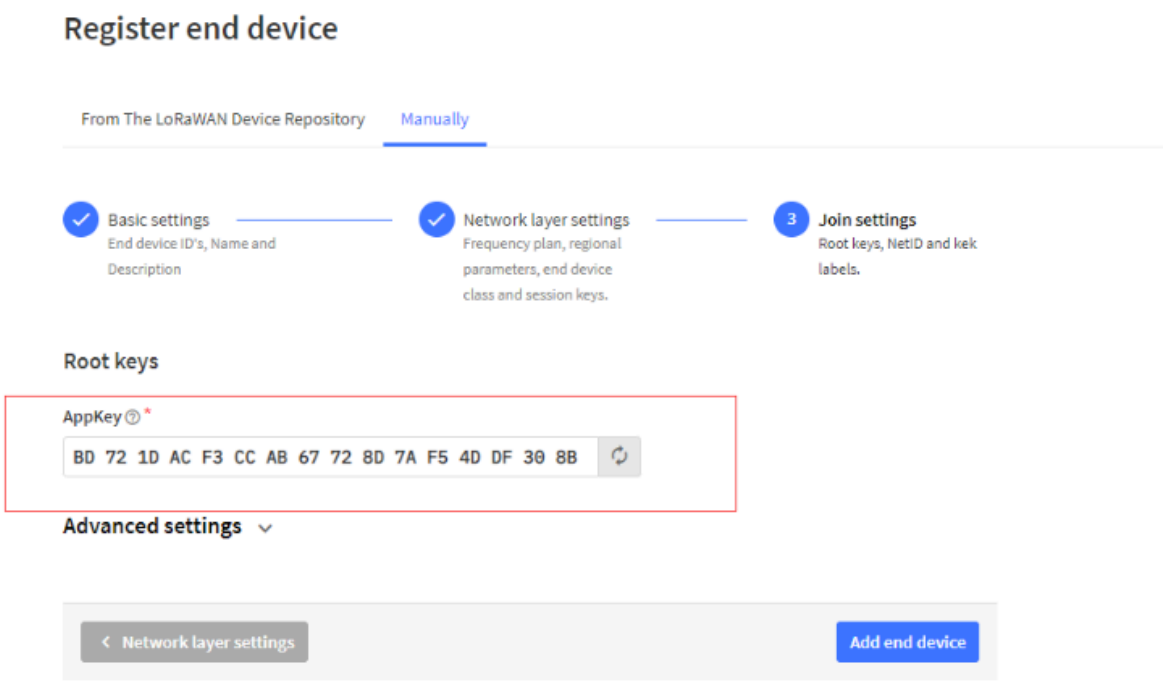
Add APP EUI and DEV EUI



Add APP EUI in the application


Register end device
From The LoRaWAN Device Repository
Manually
Basic settings
End device ID's, Name and Description
2
Network layer settings
Frequency plan, regional parameters, end device class and session keys.
3
Join settings
Root keys, NetID and kek labels.
Frequency plan *
Europe 863-870 MHz (SF12 for RX2)
LoRaWAN version *
MAC V1.0.3
Regional Parameters version *
PHY V1.0.3 REV A
LoRaWAN class capabilities
Supports class B
Supports class C
Advanced settings
Basic settings
Join settings

Add APP KEY



Step 2: Activate on DDS20-LB/LS

Press the button for 5 seconds to activate the DDS20-LB/LS.

Green led will fast blink 5 times, device will enter **OTA mode** for 3 seconds. And then start to JOIN LoRaWAN network. **Green led** will solidly turn on for 5 seconds after joined in 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

DDS20-LB/LS will uplink payload via LoRaWAN with below payload format:

Uplink payload includes in total 8 bytes.

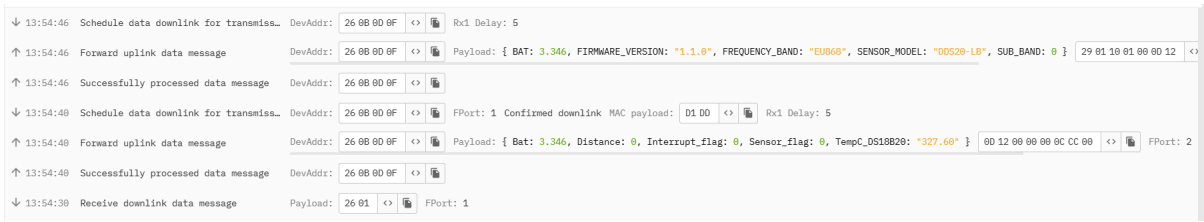
Size(bytes)	2	2	1	2	1
Value	BAT	Distance (unit: mm)	Digital Interrupt (Optional)	Temperature (Optional)	Sensor Flag

2.3.1 Device Status, FPORT=5

Users can use the downlink command(**0x26 01**) to ask DDS20-LB/LS to send device configure detail, include device configure status. DDS20-LB/LS will uplink a payload via FPort=5 to server.

The Payload format is as below.

Device Status (FPORT=5)					
Size(bytes)	**1**	**2**	**1**	**1**	**2**
Value	Sensor Model	Firmware Version	Frequency Band	Sub-band	BAT



Sensor Model: For DDS20-LB/LS, this value is 0x29

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

Frequency Band:

0x01: EU868

0x02: US915

0x03: IN865

0x04: AU915

0x05: KZ865

0x06: RU864

0x07: AS923

0x08: AS923-1

0x09: AS923-2

0x0a: AS923-3

0x0b: CN470

0x0c: EU433

0x0d: KR920

0x0e: MA869

Sub-Band:

AU915 and US915: value 0x00 ~ 0x08

CN470: value 0x0B ~ 0x0C

Other Bands: Always 0x00

Battery Info:

Check the battery voltage.

Ex1: 0x0B45 = 2885mV

Ex2: 0x0B49 = 2889mV

2.3.2 Battery Info

Check the battery voltage for DDS20-LB/LS.

Ex1: 0x0B45 = 2885mV

Ex2: 0x0B49 = 2889mV

2.3.3 Distance

Get the distance. Flat object range 20mm - 2000mm.

For example, if the data you get from the register is **0x06 0x05**, the distance between the sensor and the measured object is

0605(H) = 1541 (D) = 1541 mm.

- If the sensor value is 0x0000, it means system doesn't detect ultrasonic sensor.
- If the sensor value lower than 0x0014 (20mm), the sensor value will be invalid.

2.3.4 Interrupt Pin

This data field shows if this packet is generated by interrupt or not. Click here for the hardware and software set up.

Example:

0x00: Normal uplink packet.

0x01: Interrupt Uplink Packet.

2.3.5 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.

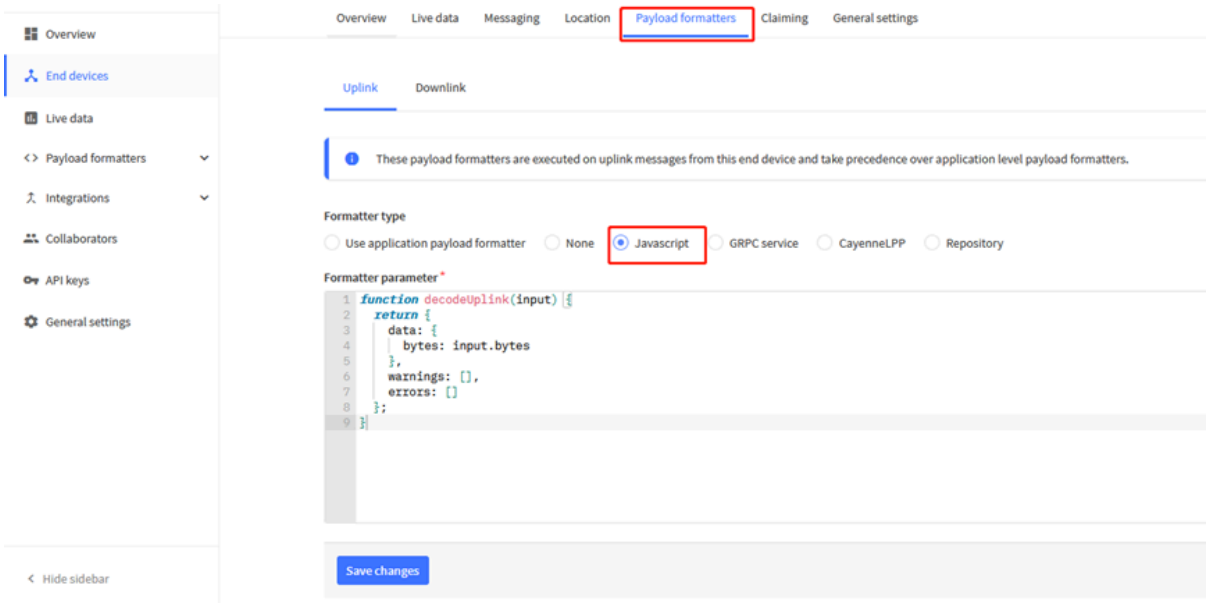
2.3.6 Sensor Flag

0x01: Detect Ultrasonic Sensor

0x00: No Ultrasonic Sensor

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 V3 is here:

DDS20-LB/LS TTN V3 Payload Decoder: ttps://github.com/dragino/dragino-end-node-decoder

2.4 Uplink Interval

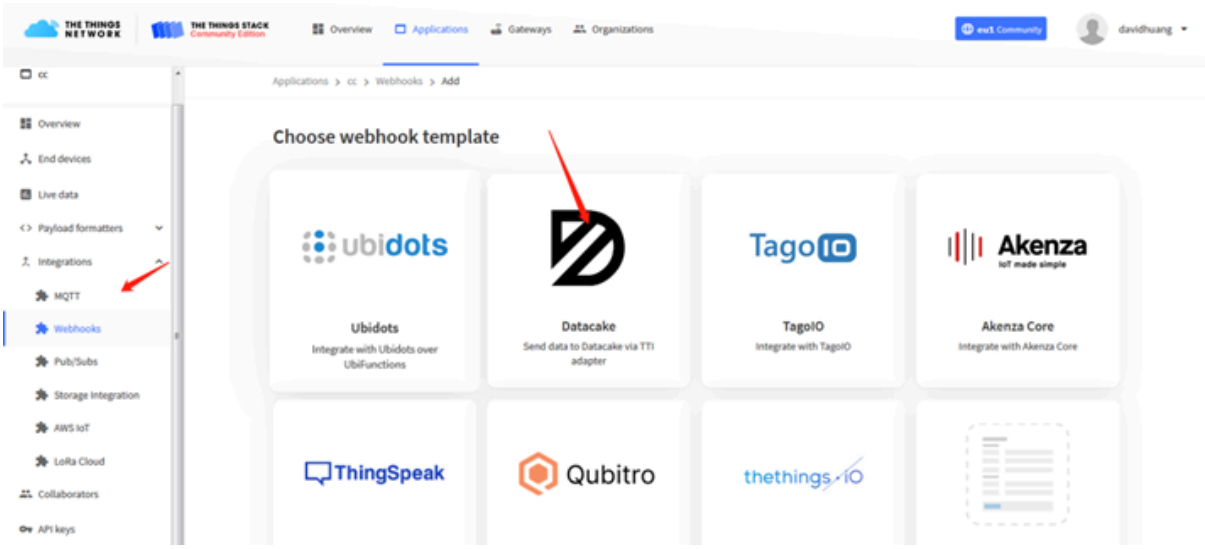
The DDS20-LB/LS by default uplink the sensor data every 20 minutes. User can change this interval by AT Command or LoRaWAN Downlink Command. See this link: Change Uplink Interval

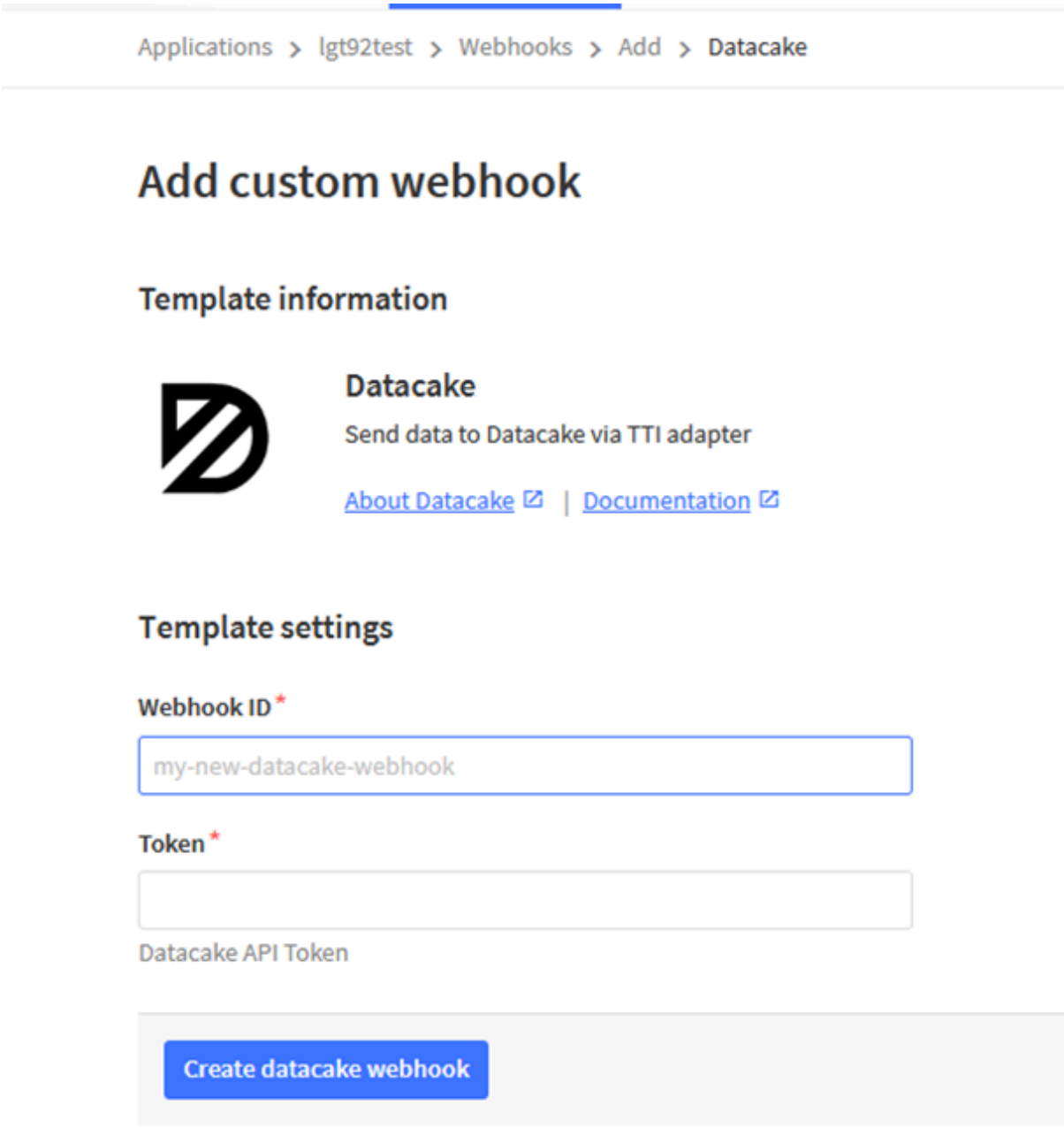
2.5 Show Data in DataCake IoT Server

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.

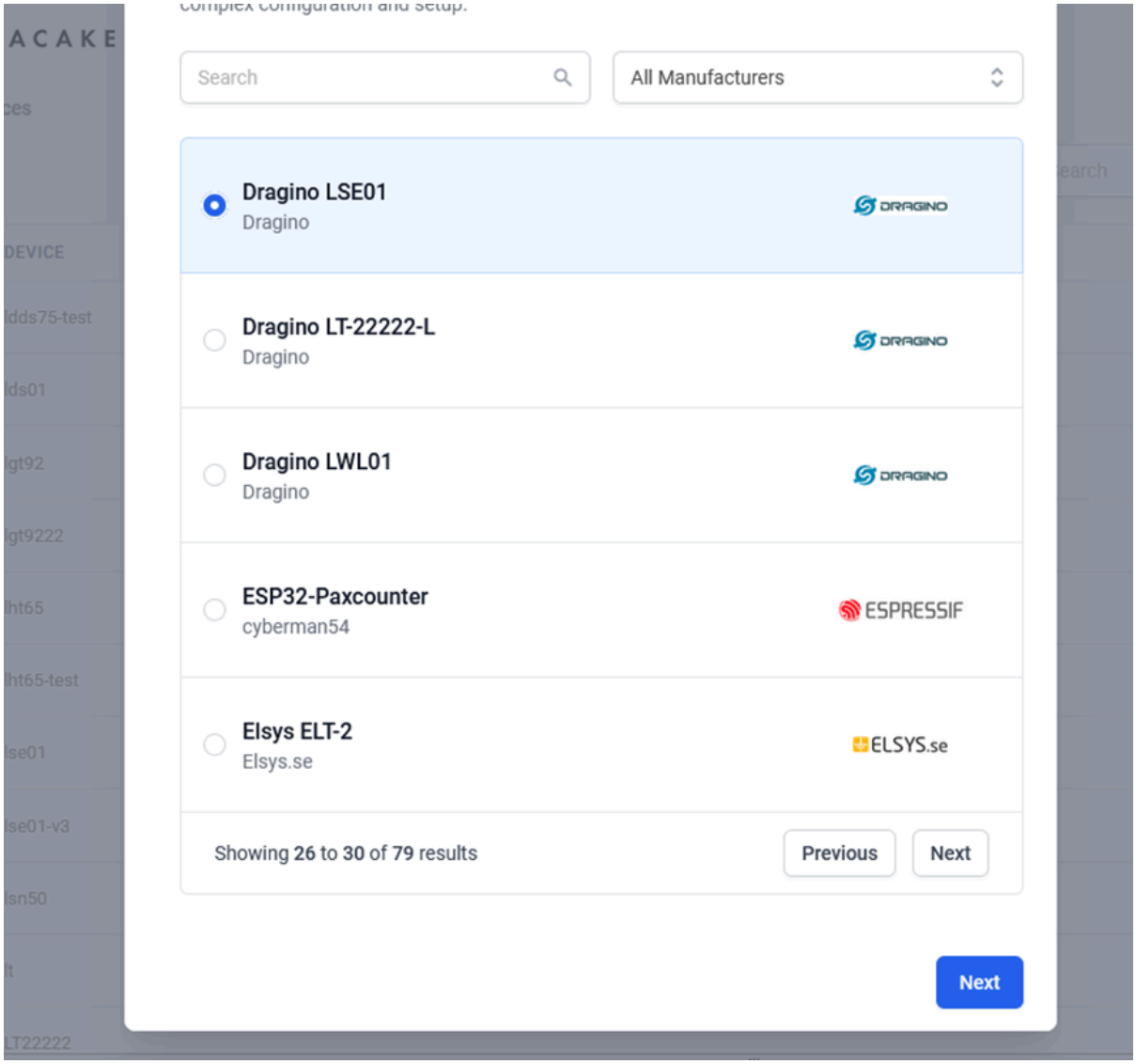
Step 2: To configure the Application to forward data to DATACAKE you will need to add integration. To add the DATACAKE integration, perform the following steps:



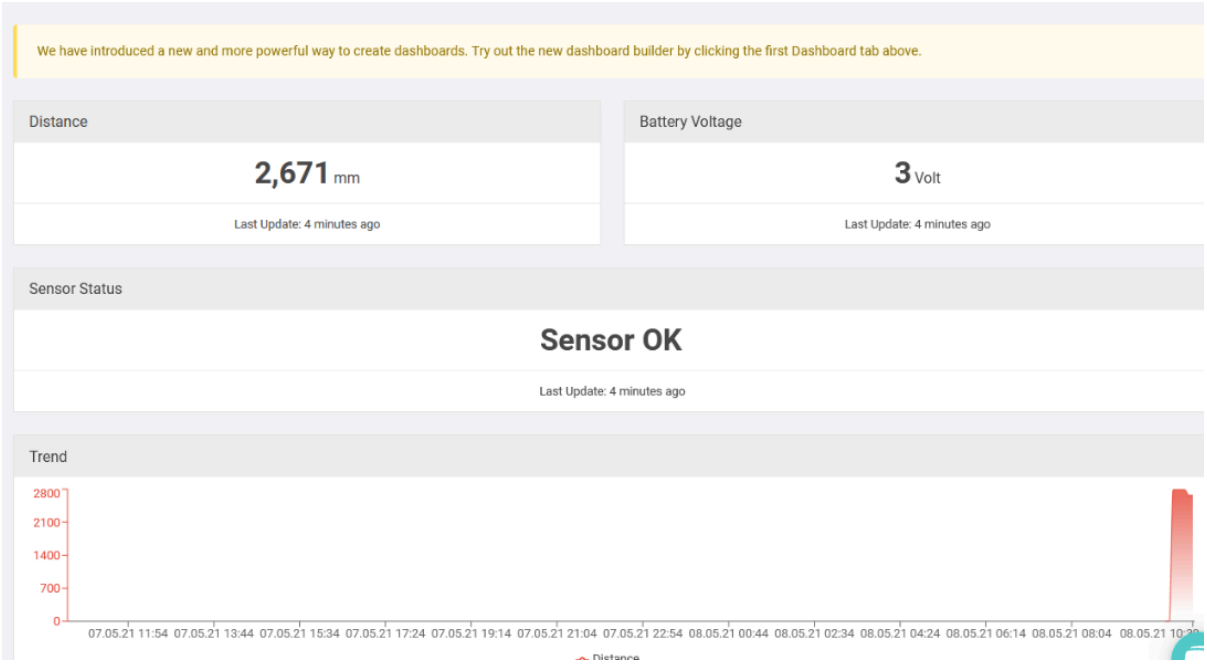


Step 3: Create an account or log in Datacake.

Step 4: Search the DDS20-LB/LS and add DevEUI.



After added, the sensor data arrive TTN V3, it will also arrive and show in Datacake.



2.6 Datalog Feature

Datalog Feature is to ensure IoT Server can get all sampling data from Sensor even if the LoRaWAN network is down. For each sampling, DDS20-LB/LS will store the reading for future retrieving purposes.

2.6.1 Ways to get datalog via LoRaWAN

Set PNACKMD=1, DDS20-LB/LS will wait for ACK for every uplink, when there is no LoRaWAN network, DDS20-LB/LS will mark these records with non-ack messages and store the sensor data, and it will send all messages (10s interval) after the network recovery.

- a) DDS20-LB/LS will do an ACK check for data records sending to make sure every data arrive server.
- b) DDS20-LB/LS will send data in **CONFIRMED Mode** when PNACKMD=1, but DDS20-LB/LS won't re-transmit the packet if it doesn't get ACK, it will just mark it as a NONE-ACK message. In a future uplink if DDS20-LB/LS gets a ACK, DDS20-LB/LS will consider there is a network connection and resend all NONE-ACK messages.

2.6.2 Unix TimeStamp

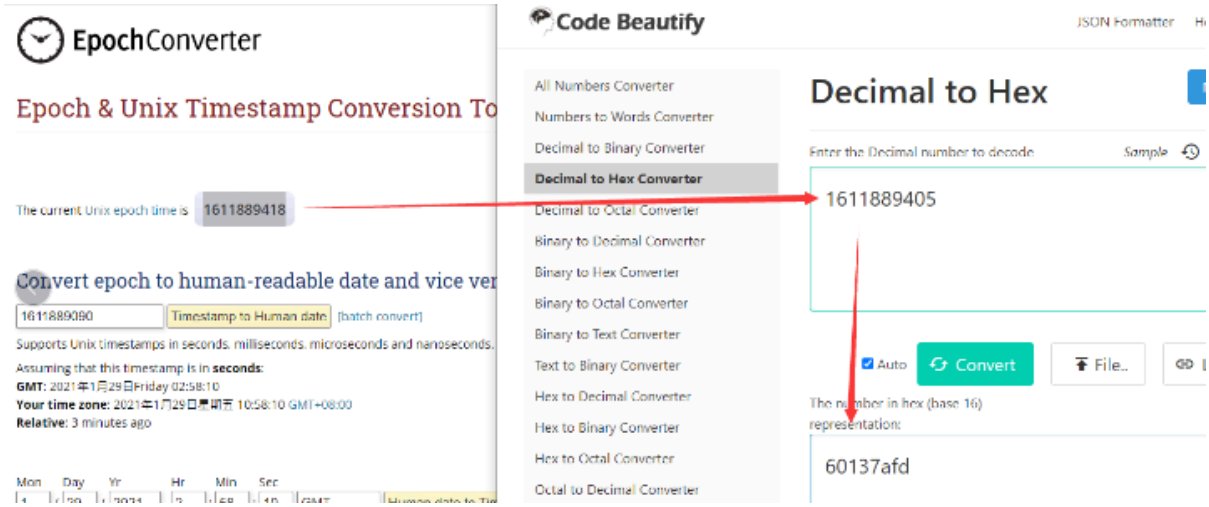
DDS20-LB/LS uses Unix TimeStamp format based on

Size (bytes)	4	1
DeviceTimeAns Payload	32-bit unsigned integer : Seconds since epoch*	8bits unsigned integer: fractional-second in ½^8 second steps

Figure 10 : DeviceTimeAns payload format

User can get this time from link: https://www.epochconverter.com/ :

Below is the converter example



So, we can use AT+TIMESTAMP=1611889405 or downlink 3060137afd00 to set the current time 2021 – Jan -- 29 Friday 03:03:25

2.6.3 Set Device Time

User need to set **SYNCMOD=1** to enable sync time via MAC command.

Once DDS20-LB/LS Joined LoRaWAN network, it will send the MAC command (DeviceTimeReq) and the server will reply with (DeviceTimeAns) to send the current time to DDS20-LB/LS. If DDS20-LB/LS fails to get the time from the server, DDS20-LB/LS will use the internal time and wait for next time request (AT+SYNCTDC to set the time request period, default is 10 days).

Note: LoRaWAN Server need to support LoRaWAN v1.0.3(MAC v1.0.3) or higher to support this MAC command feature, Chirpstack,TTN V3 v3 and loriot support but TTN V3 v2 doesn't support. If server doesn't support this command, it will through away uplink packet with this command, so user will lose the packet with time request for TTN V3 v2 if SYNCMOD=1.

2.6.4 Poll sensor value

Users can poll sensor values based on timestamps. Below is the downlink command.

Downlink Command to poll Open/Close status (0x31)			
1byte	**4bytes**	**4bytes**	**1byte**
31	Timestamp start	Timestamp end	Uplink Interval

Timestamp start and Timestamp end-use Unix TimeStamp format as mentioned above. Devices will reply with all data logs during this period, using the uplink interval.

For example, downlink command

Is to check 2021/11/12 12:00:00 to 2021/11/12 15:00:00's data

Uplink Internal =5s, means DDS20-LB/LS will send one packet every 5s. range 5~255s.

2.7 Frequency Plans

The DDS20-LB/LS uses OTAA mode and below frequency plans by default. Each frequency band use different firmware, user update the firmware to the corresponding band for their country.

http://wiki.dragino.com/xwiki/bin/view/Main/End%20Device%20Frequency%20Band/

3. Configure DDS20-LB/LS

3.1 Configure Methods

DDS20-LB/LS supports below configure method:

- AT Command via Bluetooth Connection (**Recommended**): BLE Configure Instruction.
- AT Command via UART Connection : See UART Connection.
- LoRaWAN Downlink. Instruction for different platforms: See IoT LoRaWAN Server section.

3.2 General Commands

These commands are to configure:

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

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

http://wiki.dragino.com/xwiki/bin/view/Main/End%20Device%20AT%20Commands%20and%20Downlink%20Command/

3.3 Commands special design for DDS20-LB/LS

These commands only valid for DDS20-LB/LS, as below:

3.3.1 Set 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

3.3.2 Set Interrupt Mode

Feature, Set Interrupt mode for GPIO_EXTI of pin.

When AT+INTMOD=0 is set, GPIO_EXTI is used as a digital input port.

AT Command: AT+INTMOD

Command Example	Function	Response
AT+INTMOD=?	Show current interrupt mode	0 OK the mode is 0 =Disable Interrupt
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

4. Battery & Power Consumption

DDS20-LB use ER26500 + SPC1520 battery pack and DDS20-LS use 3000mAh Recharable Battery with Solar Panel. See below link for detail information about the battery info and how to replace.

Battery Info & Power Consumption Analyze .

5. OTA Firmware update

User can change firmware DDS20-LB/LS to:

- Change Frequency band/ region.
- Update with new features.
- Fix bugs.

Firmware and changelog can be downloaded from : **Firmware download link**

Methods to Update Firmware:

- (Recommanded way) OTA firmware update via wireless: **http://wiki.dragino.com/xwiki/bin/view/Main/Firmware%20OTA%20Update%20for%20Sensors/**
- Update through UART TTL interface: **Instruction**.

6. FAQ

6.1 What is the frequency plan for DDS20-LB/LS?

DDS20-LB/LS use the same frequency as other Dragino products. User can see the detail from this link: Introduction

6.2 Can I use DDS20-LB/LS in condensation environment?

DDS20-LB/LS is not suitable to be used in condensation environment. Condensation on the DDS20-LB/LS probe will affect the reading and always got 0.

7. Trouble Shooting

7.1 Why I can't join TTN V3 in US915 / AU915 bands?

It is due to channel mapping. Please see below link: Frequency band

7.2 AT Command 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.

7.3 Why i always see 0x0000 or 0 for the distance value?

DDS20-LB/LS has a strict **installation requirement**. Please make sure the installation method exactly follows up with the installation requirement. Otherwise, the reading might be always 0x00.

If you have followed the instruction requirement exactly but still see the 0x00 reading issue, please. please double-check the decoder, you can check the raw payload to verify.

8. Order Info

Part Number: DDS20-LB-XX or DDS20-LS-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:

- DDS20-LB or DDS20-LS LoRaWAN Ultrasonic Liquid Level 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.cc.