LMDS200 LoRaWAN Microwave Radar Sensor Manual

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1.0	Release	2021-Nov-25
1.1	Fix unit typo	2021-Dec-27

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1. Introduction

1.1 What is LMDS200 Microwave Radar Distance Sensor

The Dragino LMDS200 is a LoRaWAN Microwave Radar distance sensor. It uses 24Ghz Microwave to detect the distance between sensor and different objects. Compare vs ultrasonic or Lidar measurement method, Microwave Radar is more reliable for condensation / dusty environment. It can sense correct distance even there is water or thick dust on top of the sensor.

The LMDS200 can be applied to scenarios such as horizontal distance measurement, parking management system, object proximity and presence detection, intelligent trash can management system, robot obstacle avoidance, automatic control, sewer, etc.

LMDS200 can measure two distances: the closest object and next object behind the closest one.

LMDS200 supports Alarm Feature, user can set the LMDS200 to uplink data in a short interval when the distance is out of configured range.

The LoRa wireless technology used in LMDS200 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.

LMDS200 is powered by 8500mAh Li-SOCI2 battery, it is designed for long term use up to 5 years.

Each LMDS200 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.
*Battery life depends on how often to send data, please see battery analyzer.

1.2 Features

- ✓ LoRaWAN 1.0.3 Class A
- ✓ Ultra-low power consumption
- ✓ Microwave Radar for distance detection
- ✓ Short uplink interval for Distance Alarm
- ✓ Monitor Battery Level
- ✓ Bands: CN470/EU433/KR920/US915/EU868/AS923/AU915/IN865
- ✓ AT Commands to change parameters
- ✓ Uplink on periodically
- ✓ Downlink to change configure
- ✓ 8500mAh Battery for long term use
- ✓ Wall Mountable
- ✓ Outdoor Use

1.3 Radar probe specification

- ✓ Measuring Method: FMCW
- ✓ Frequency: 24.000 ~ 24.500 GHz
- ✓ Measurement output power: 6dBm
- ✓ Measure range: 0.5 ~ 20m
- ✓ Accuracy: ±0.1m
- ✓ Resolution: 0.01m
- ✓ Horizontal Angel: 78°
- ✓ Vertical Angel: 23°

1.4 Storage & Operation Temperature

-20°C to +85°C

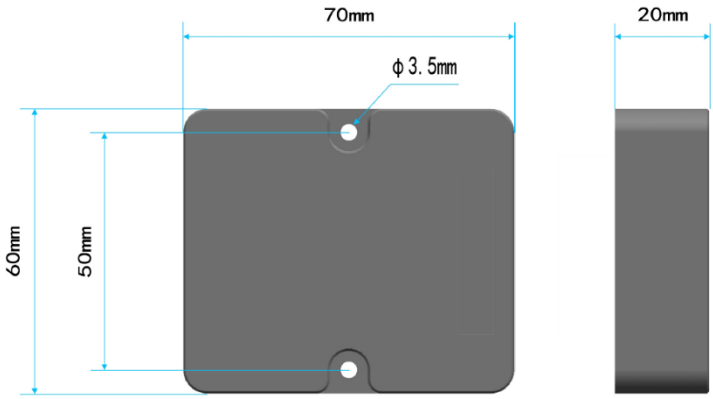
1.5 Applications

- ✧ Horizontal distance measurement
- ✧ Liquid level measurement
- ✧ Parking management system

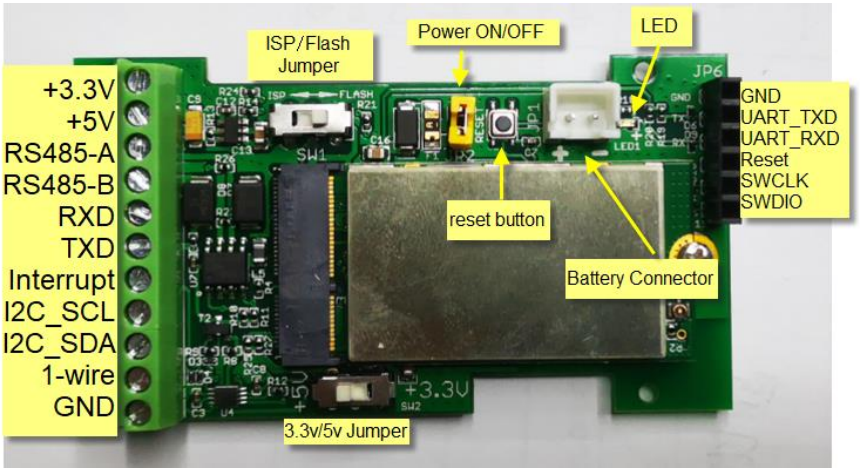
- ✧ Object proximity and presence detection
- ✧ Intelligent trash can management system
- ✧ Robot obstacle avoidance
- ✧ Automatic control
- ✧ Sewer
- ✧ Bottom water level monitoring

1.6 Installation

Sensor measure direction and angle is as below. When install the sensor, please make sure the sensor direct to object.



1.7 Pin Definitions and Switch



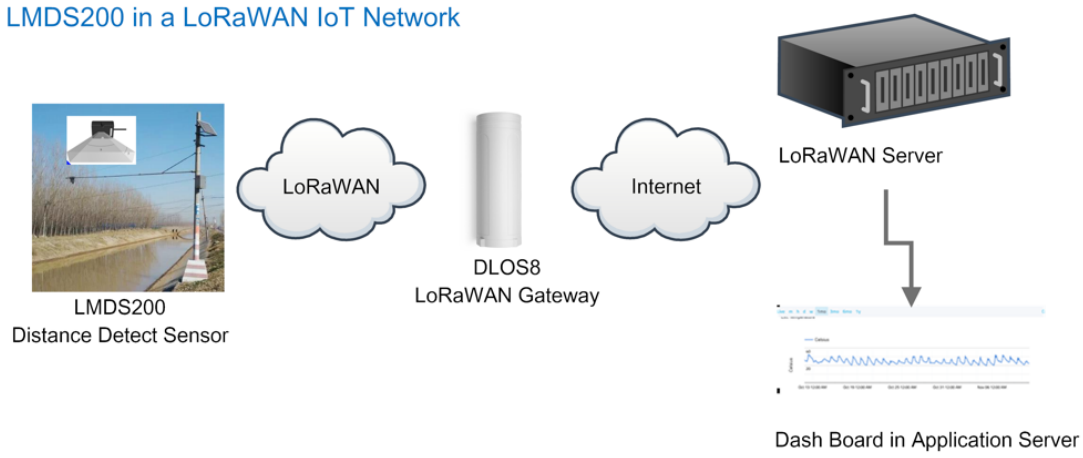
2. Operation Mode

2.1 How it works?

Each LMDS200 is shipped with a worldwide unique set of OTAA keys. To use LMDS200 in a LoRaWAN network, user needs to input the OTAA keys in the LoRaWAN network server. So LMDS200 can join the LoRaWAN network and start to transmit sensor data.

2.2 Example to use for LoRaWAN network

This section shows an example of how to join the TTN V3 LoRaWAN IoT server. Usages with other LoRaWAN IoT servers are similar.



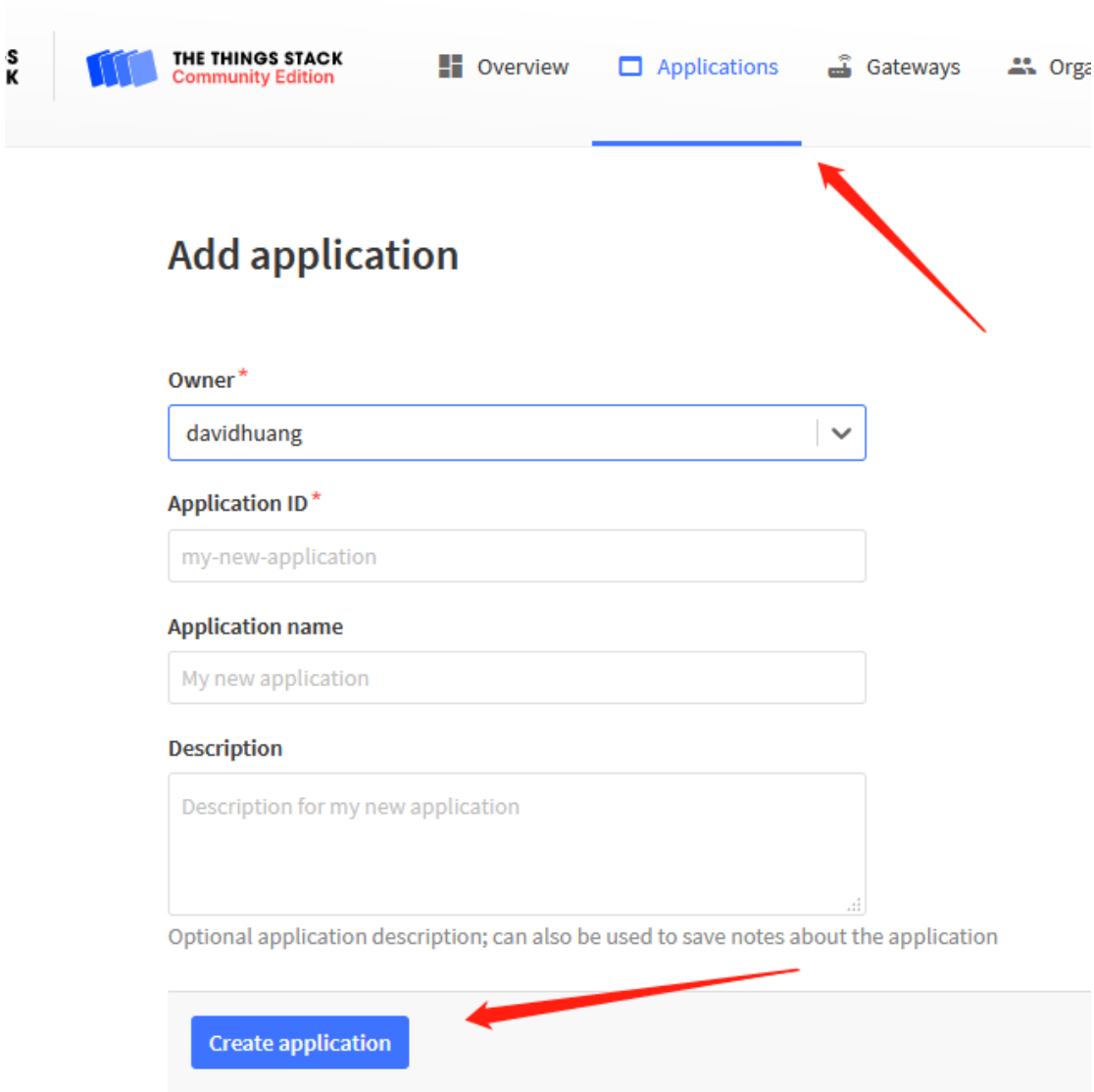
✓ In this user case, the LMDS200 is installed on top of river to detect the water level and send the level info to the LoRaWAN server. The LMDS200 will uplink different types of messages to the LoRaWAN server. See Uplink payload for detail.

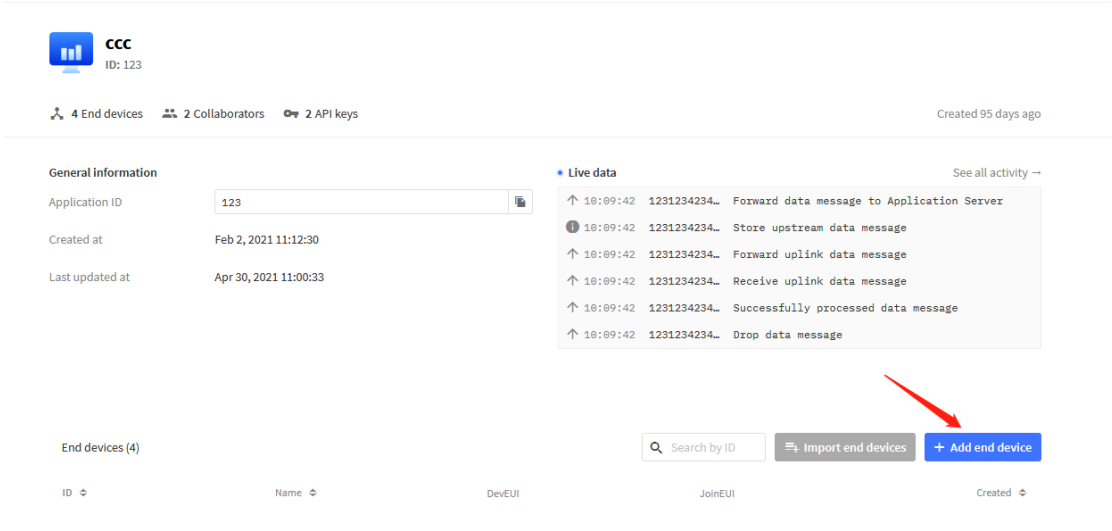
Assume the LoRaWAN Gateway DLOS8 is already set to connect to the TTN V3 network . We need to add the LMDS200 device in TTN V3:

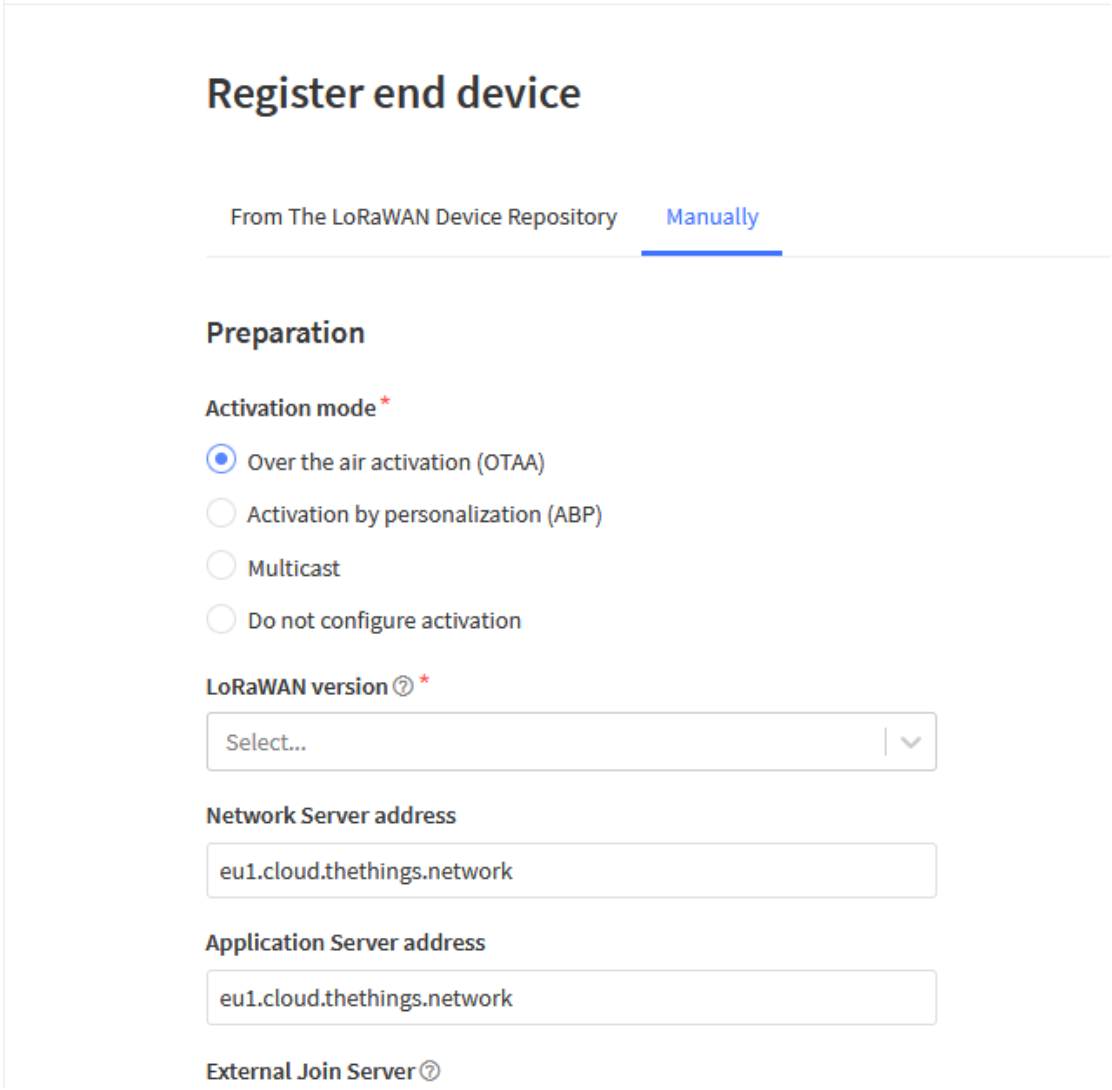
Step 1: Create a device in TTN V3 with the OTAA keys from LMDS200.
Each LMDS200 is shipped with a sticker with the default device EUI as below:

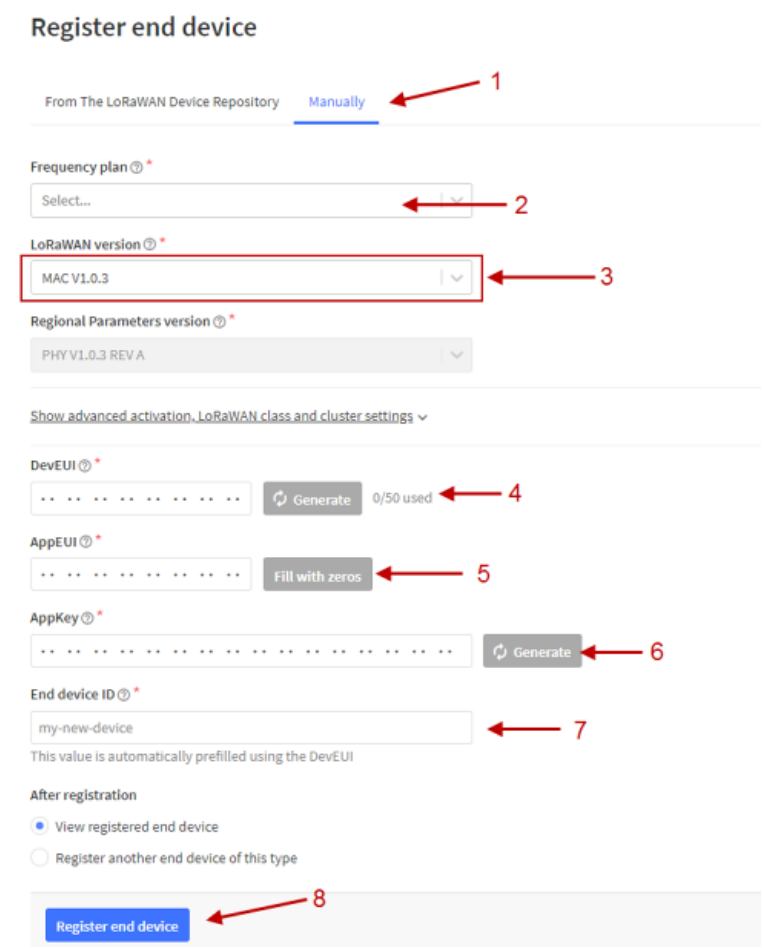
Users can enter these keys in the LoRaWAN Server portal. Below is the TTN V3 screenshot:

Add APP EUI in the application.



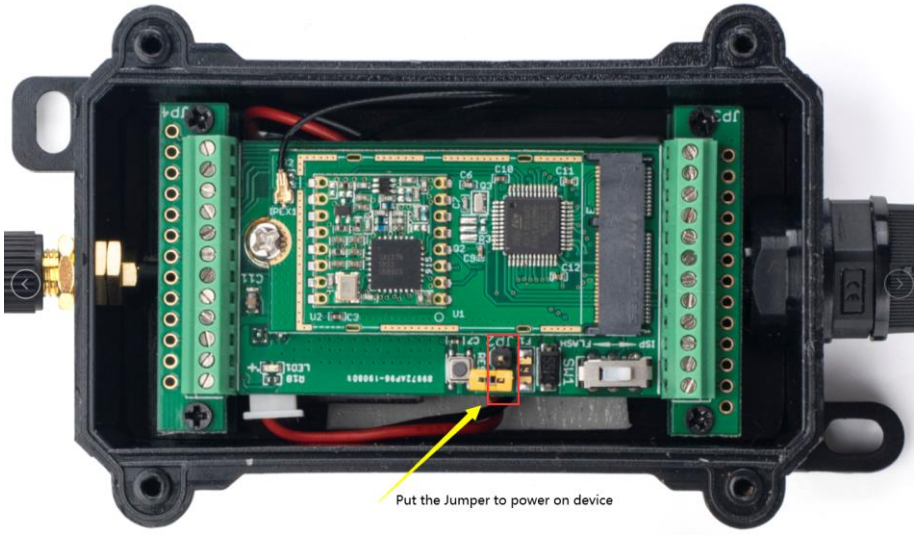

ccc
ID: 123
4 End devices
2 Collaborators
2 API keys
Created 95 days ago
General information
Application ID
123
Created at
Feb 2, 2021 11:12:30
Last updated at
Apr 30, 2021 11:00:33
Live data
See all activity →
10:09:42 1231234234… Forward data message to Application Server
10:09:42 1231234234… Store upstream data message
10:09:42 1231234234… Forward uplink data message
10:09:42 1231234234… Receive uplink data message
10:09:42 1231234234… Successfully processed data message
10:09:42 1231234234… Drop data message
End devices (4)
Search by ID
Import end devices
+ Add end device
ID
Name
DevEUI
JoinEUI
Created


Register end device
From The LoRaWAN Device Repository
Manually
Preparation
Activation mode *
Over the air activation (OTAA)
Activation by personalization (ABP)
Multicast
Do not configure activation
LoRaWAN version *
Select...
Network Server address
eu1.cloud.thethings.network
Application Server address
eu1.cloud.thethings.network
External Join Server



Add APP KEY and DEV EUI

Step 2: Power on LMDS200



Put the jumper to power on LMDS200 and it will auto-join to the TTN V3 network. After join success, it will start to upload sensor data to TTN V3 and the user can see it in the panel.

2.3 Uplink Payload

Uplink payloads have two types:

- Distance Value: Use FPORT=2
- Other control commands: Use other FPORT fields.

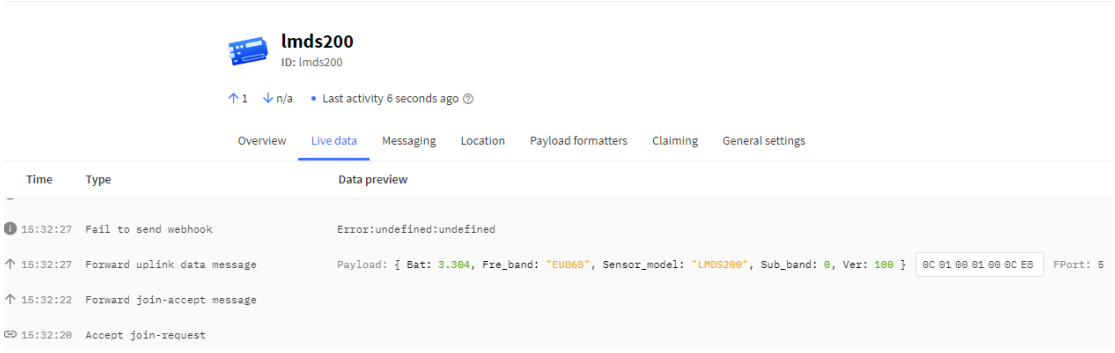
The application server should parse the correct value based on FPORT settings.

2.3.1 Device Status, FPORT=5

Include device configure status. Once LMDS200 Joined the network, it will uplink this message to the server.

Users can also use the downlink command (0x26 01) to ask LMDS200 to resend Device Status.

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



- **Sensor Model**: For LMDS200, this value is 0x0C
- **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.

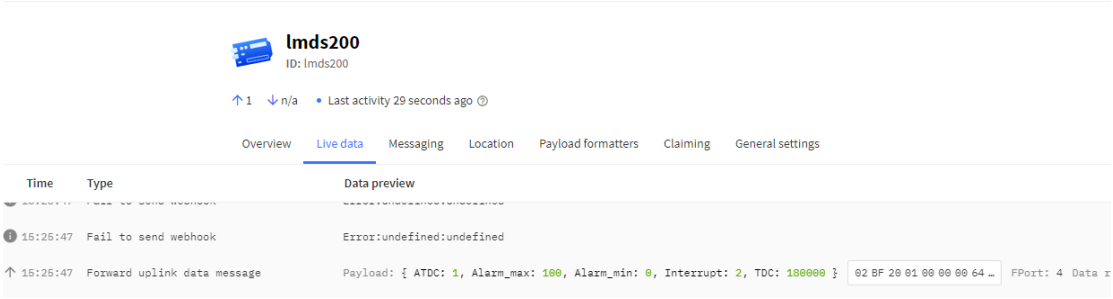
  Ex1: 0x0B45 = 2885mV

  Ex2: 0x0B49 = 2889mV

2.3.2 Sensor Configuration, FPORT=4

LMDS200 will only send this command after getting the downlink command (0x26 02) from the server.

Sensor Configuration FPORT=4				
Size (bytes)	**3**	**1**	**4**	**1**
Value	TDC (unit: sec)	ATDC (unit: min)	Alarm Settings	Interrupt Settings



2.3.3 Distance, Uplink FPORT=2

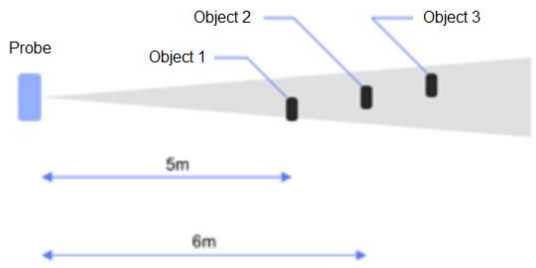
LMDS200 will send this uplink **after** Device Status once join the LoRaWAN network successfully. And LMDS200 will:

a) periodically send this uplink every 1 hour (TDC time), this interval can be changed.
b) periodically send this uplink every 1 minute in Alarm Mode.
c) send this uplink while there is interrupt event.

Uplink Payload totals 11 bytes.

Distance Value, FPORT=2				
Size (bytes)	**2**	**2**	**2**	**1**
Value	BAT	Object1 Distance	Object2 Distance	Status & Alarm

Status & Alarm field			
Size (bit)	**6**	**1**	**1**
Value	DALARM Counter	Distance Alarm 0: Normal Value 1: Distance Alarm	Interrupt Alarm 0: No Alarm 1: external Interrupt Alarm



Object1 Distance:

Distance between sensor probe to the first object. (unit: cm)

For example, if the data you get from the register is 0x00 0x73, the distance between the sensor and the measured object is

0073(H) = 115 (D) = 115 cm.

Notice: There are two special values for object 1 distance:

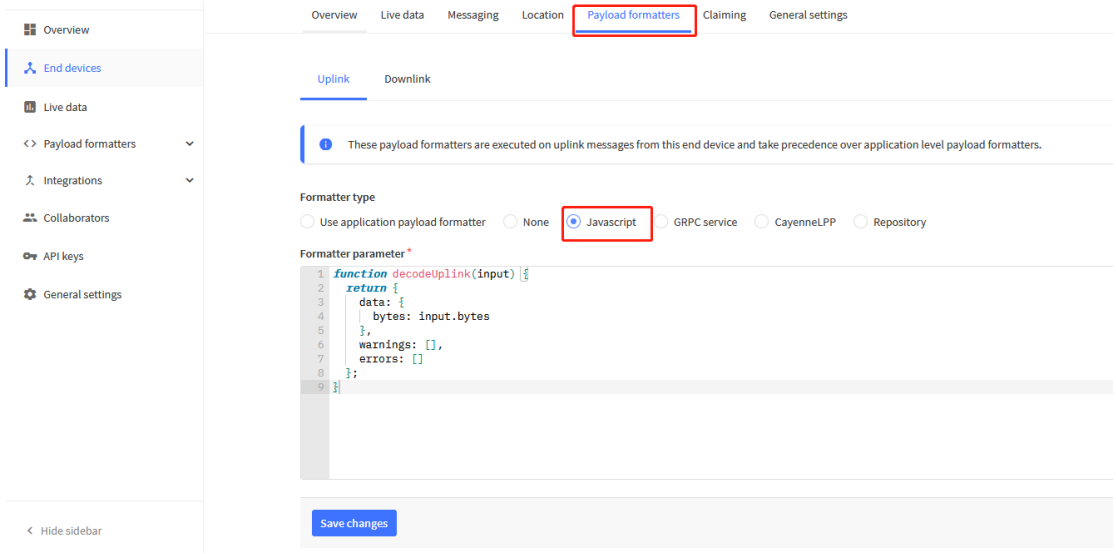
- **0x0001**: Probe not detected
- **0x0002**: Reading Invalid (exceed the valid range of the probe)

Object2 Distance:

Distance between sensor probe to the second object. (unit: cm)

DALARM Counter : Alarm Counter.

2.3.4 Decoder in TTN V3



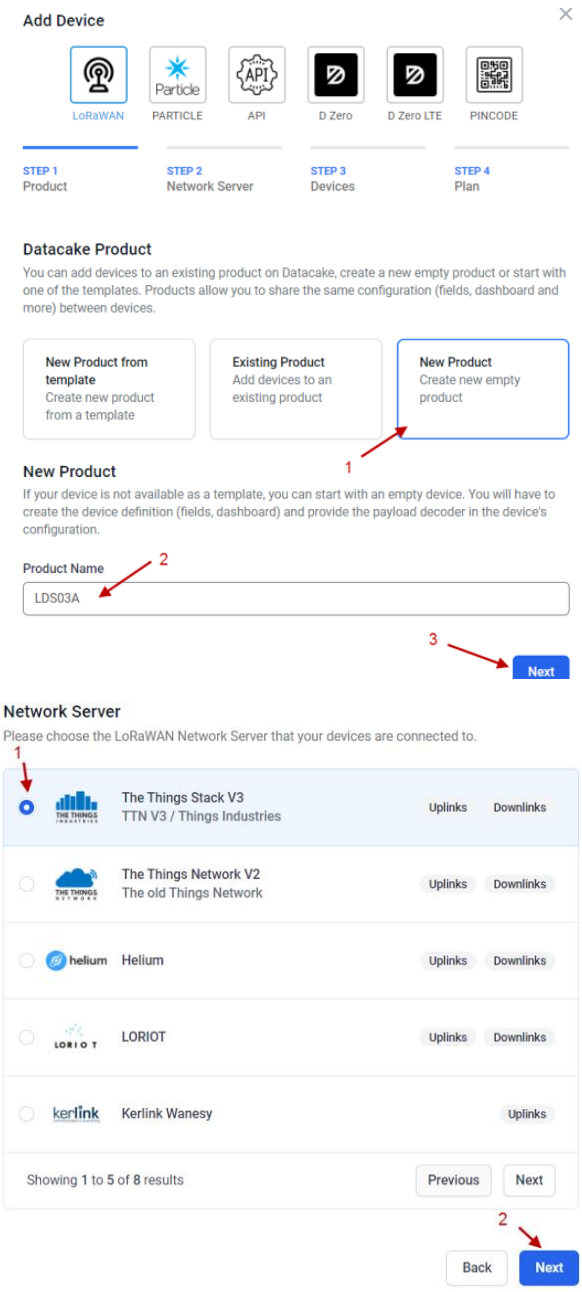
Please check the decoder from this link:
https://www.dragino.com/downloads/index.php?dir=LoRa_End_Node/LMDS200/payload_decode/

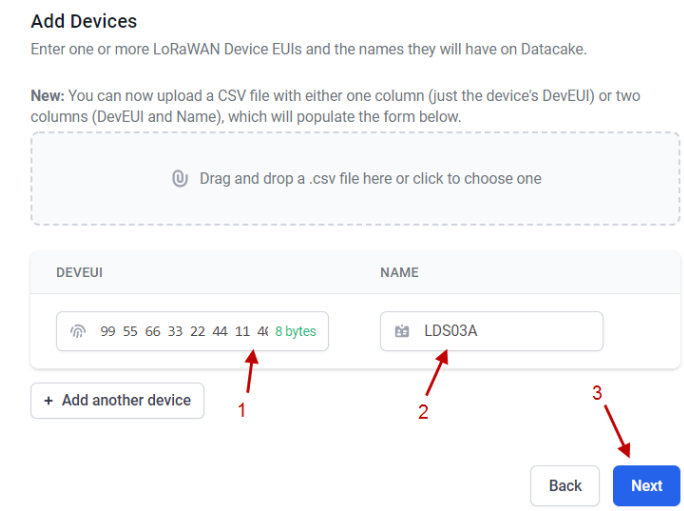
2.4 Show data on Datacake

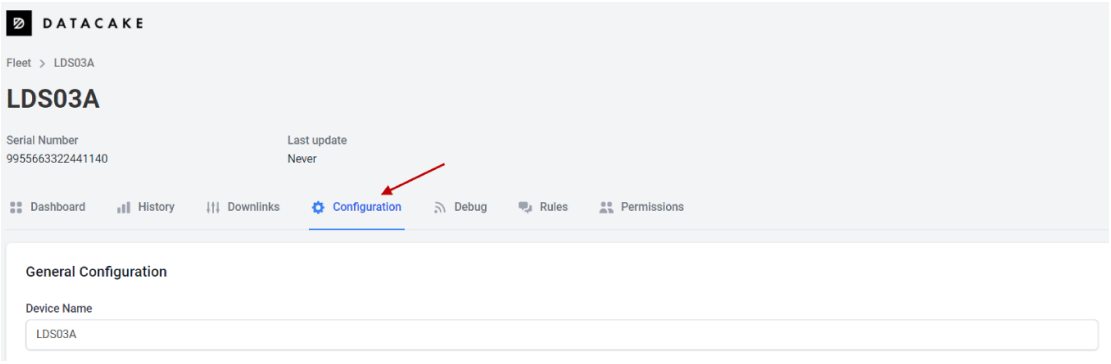
Datacake IoT platform provides a human-friendly interface to show the sensor data, once we have sensor data in TTN V3, we can use Datacake to connect to TTN V3 and see the data in Datacake. Below are the steps:

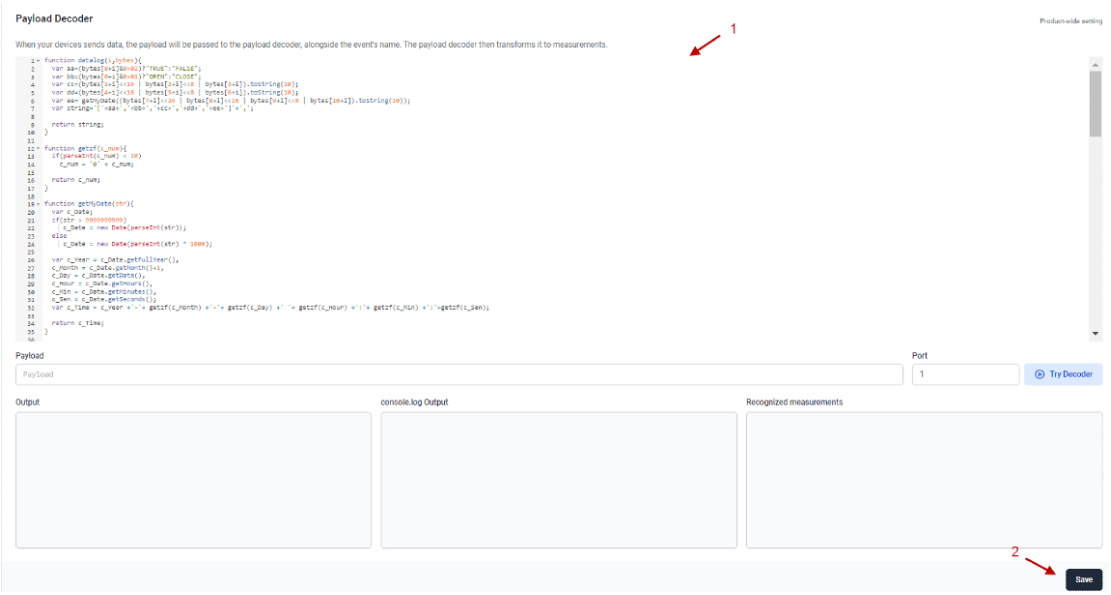
Step 1: Link TTNv3 to Datacake
https://docs.datacake.de/lorawan/lns/thethingsindustries#create-integration-on-tti

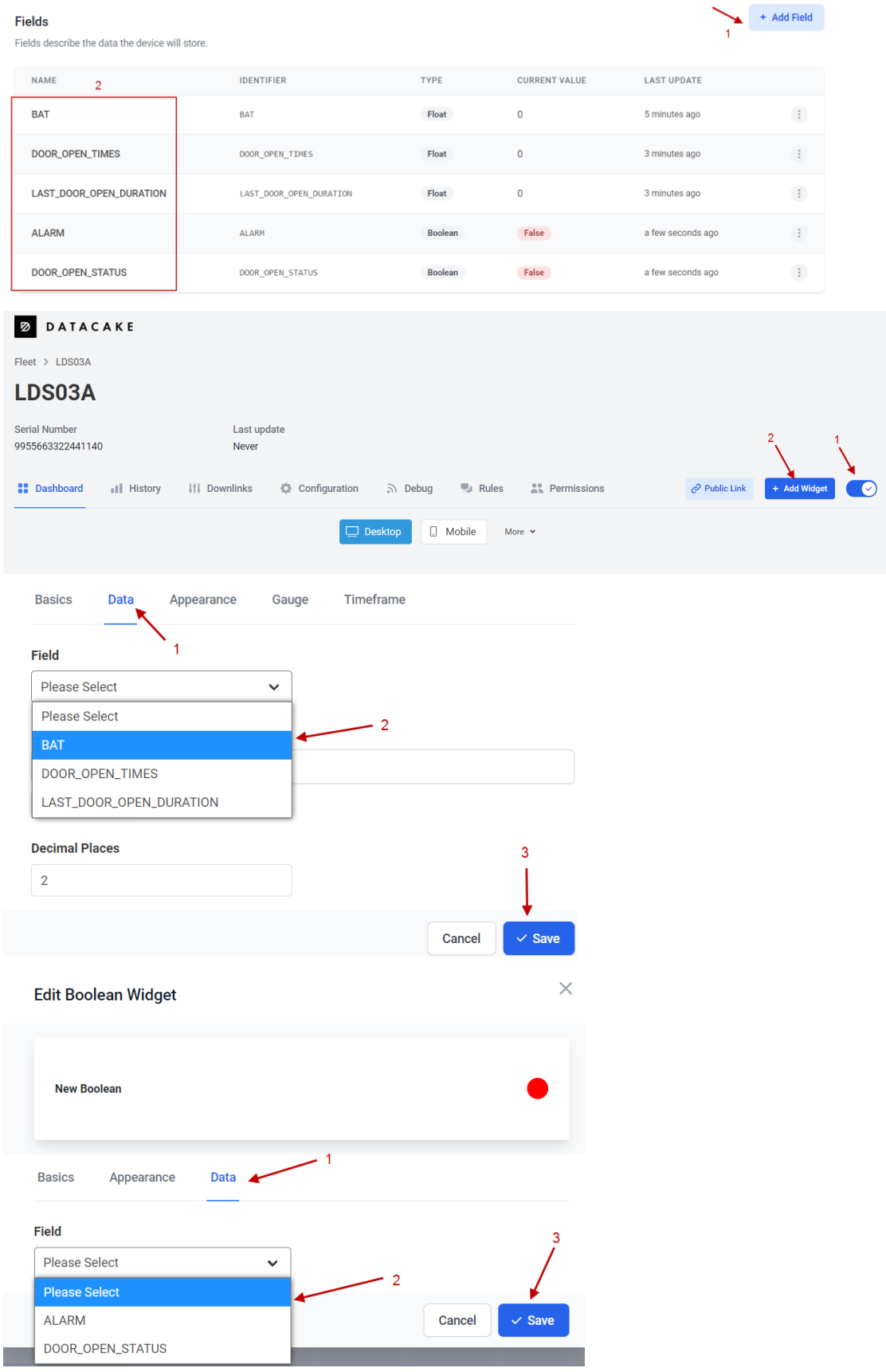
Step 2: Configure LMDS200 in Datacake

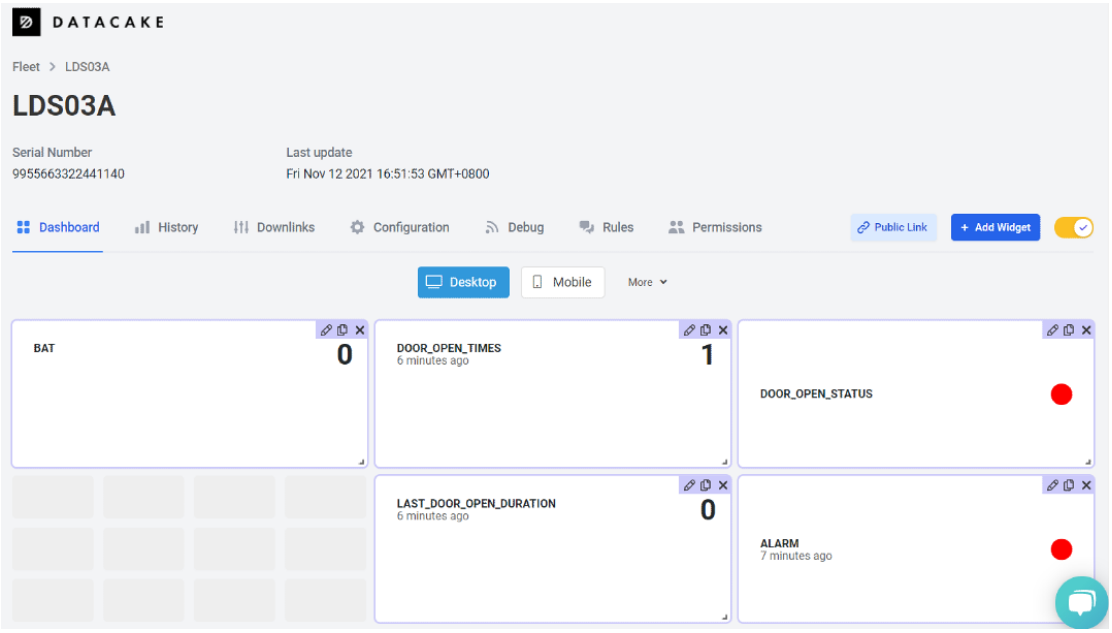



Add Devices
Enter one or more LoRaWAN Device EUIs and the names they will have on Datacake.
New: You can now upload a CSV file with either one column (just the device's DevEUI) or two columns (DevEUI and Name), which will populate the form below.
Drag and drop a .csv file here or click to choose one
DEVEUI
NAME
99 55 66 33 22 44 11 4(8 bytes
LDS03A
+ Add another device
1
2
3
Back
Next


DATACAKE
Fleet > LDS03A
LDS03A
Serial Number
9955663322441140
Last update
Never
Dashboard
History
Downlinks
Configuration
Debug
Rules
Permissions
General Configuration
Device Name
LDS03A


Payload Decoder
When your devices sends data, the payload will be passed to the payload decoder, alongside the event's name. The payload decoder then transforms it to measurements.
1
Payload
Port
Try Decoder
Output
console.log Output
Recognized measurements
2
Save


Fields
Fields describe the data the device will store.
+ Add Field
1
2
NAME
IDENTIFIER
TYPE
CURRENT VALUE
LAST UPDATE
BAT
BAT
Float
0
5 minutes ago
DOOR_OPEN_TIMES
DOOR_OPEN_TIMES
Float
0
3 minutes ago
LAST_DOOR_OPEN_DURATION
LAST_DOOR_OPEN_DURATION
Float
0
3 minutes ago
ALARM
ALARM
Boolean
False
a few seconds ago
DOOR_OPEN_STATUS
DOOR_OPEN_STATUS
Boolean
False
a few seconds ago
DATACAKE
Fleet > LDS03A
LDS03A
Serial Number
995566322441140
Last update
Never
2
1
Dashboard
History
Downlinks
Configuration
Debug
Rules
Permissions
Public Link
+ Add Widget
Desktop
Mobile
More
Basics
Data
Appearance
Gauge
Timeframe
1
Field
Please Select
Please Select
BAT
DOOR_OPEN_TIMES
LAST_DOOR_OPEN_DURATION
2
Decimal Places
2
3
Cancel
Save
Edit Boolean Widget
New Boolean
Basics
Appearance
Data
1
Field
Please Select
Please Select
ALARM
DOOR_OPEN_STATUS
2
3
Cancel
Save


DATACAKE
Fleet > LDS03A
LDS03A
Serial Number
9955663322441140
Last update
Fri Nov 12 2021 16:51:53 GMT+0800
Dashboard
History
Downlinks
Configuration
Debug
Rules
Permissions
Public Link
+ Add Widget
Desktop
Mobile
More
BAT
0
DOOR_OPEN_TIMES
6 minutes ago
1
DOOR_OPEN_STATUS
LAST_DOOR_OPEN_DURATION
6 minutes ago
0
ALARM
7 minutes ago

3. Configure LMDS200 via AT Command or LoRaWAN Downlink

Use can configure LMDS200 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 LMDS200, they are:

- **General Commands**.

  These commands are to configure:

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

  They are the same for all Dragino Devices which support DLWS-005 LoRaWAN Stack(Note**).

  These commands can be found on the wiki:

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

- **Commands special design for LMDS200**

  These commands are only valid for LMDS200, as below:

3.1 Set Transmit Interval Time(0x01)

Feature: Change LoRaWAN End Node Transmit Interval. Default Value: 3600000 = 1 hour

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

3.2 Set Alarm Transmit Interval Time(0x0D)

Feature: Change LoRaWAN End Node Alarm Transmit Interval. Default Value: 1 minute

AT Command: AT+ATDC

Command Example	Function	Response
AT+ATDC?	Show current alarm transmit Interval	1 OK the interval is 1 minute
AT+ATDC=1	Set Alarm Transmit Interval	OK Set alarm transmit interval to 1 min

Downlink Command: 0x0D

Format: Command Code (0x0D) followed by 1 byte for time value.

If the downlink payload=0D02, it means set the END Node's Alarm Transmit Interval to 2 minutes, while type code is 0D.

3.3 Set Alarm Distance (0xA2)

LMDS02 supports Alarm Feature, when LMDS02 detect the distance exceed the alarm settings, LMDS02 will Enter Alarm Mode and use the ATDC interval (default is 1 minute) to uplink Distance value. Alarm mode will last for 60 uplinks (default 1 hour) and can be close by downlink command 0xA300.

Note: Alarm mode only valid for the Distance 1(the Closest Object)

User can set Alarm Distance to enable/disable Alarm Mode.

AT+ALARMC=AABBCCDD

- AABB: Hex value for Alarm low threshold, CCDD: Hex value for Alarm high threshold
- When 0xAABB=0, and 0xCCDD≠0, Alarm trigger when higher than max
- When 0xAABB≠0, and 0xCCDD =0xFFFF, Alarm trigger when lower than min
- When 0xAABB≠0 and 0xCCDD≠0, Alarm trigger when higher than max or lower than min

Example:

AT+ALARMC=006400C8 // Alarm when < 100 or higher than 200.

- Downlink Payload:

  0x(A2 00 01 00 00) // Same as AT+ALARMC=00010000

3.4 Enter/Exit Alarm Mode (0xA3)

Feature: Enter/Exit Alarm mode:

AT Command: AT+ALARM=0(Exit Alarm Mode or AT+ALARM=1 (Enter Alarm Mode)

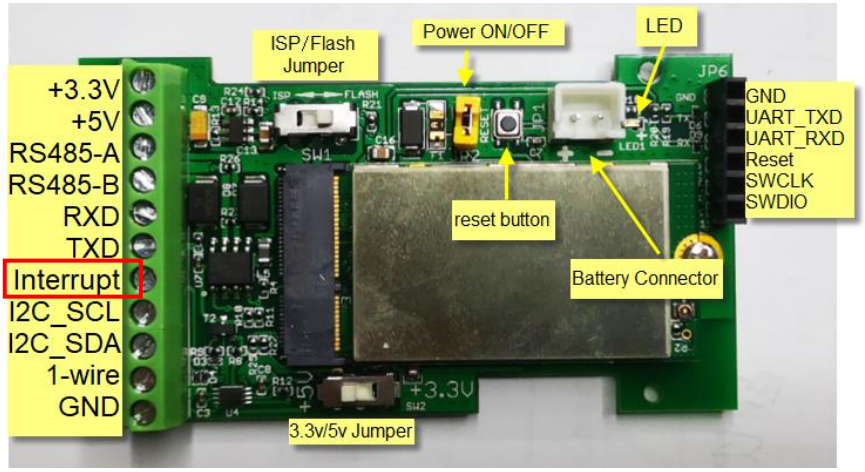
Downlink Command:

0xA3 00 // Exit Alarm Mode.

0xA3 01 // Enter Alarm Mode. Enter Alarm mode will use ATDC interval in the next 59 uplinks.

3.5 Set Interrupt Mode (0x06)

Feature, Set Interrupt mode for Interrupt Pin.



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

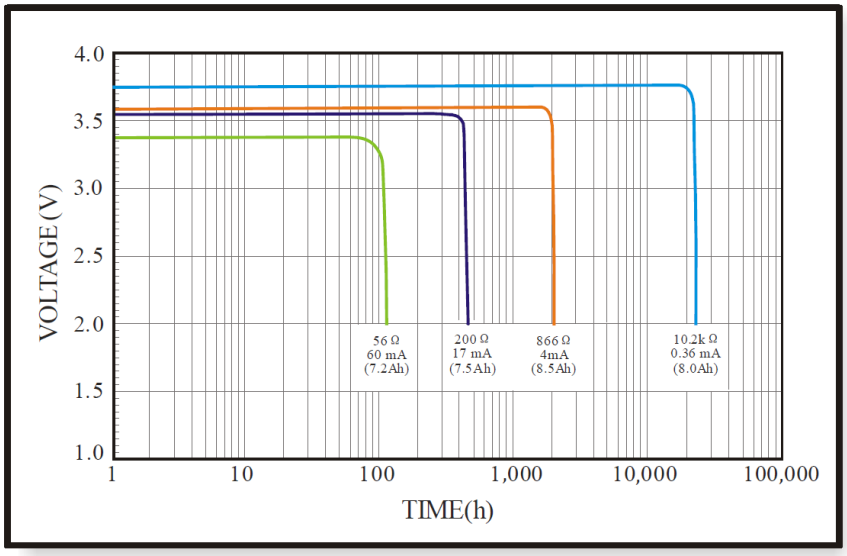
4. Battery & how to replace

4.1 Battery Type

LMDS200 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 LMDS200:
LMDS200: 2.45v ~ 3.6v

4.2 Replace Battery

Any battery with range 2.45 ~ 3.6v can be a replacement. We recommend to use Li-SOCI2 Battery. And make sure the positive and negative pins match.

4.3 Power 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.

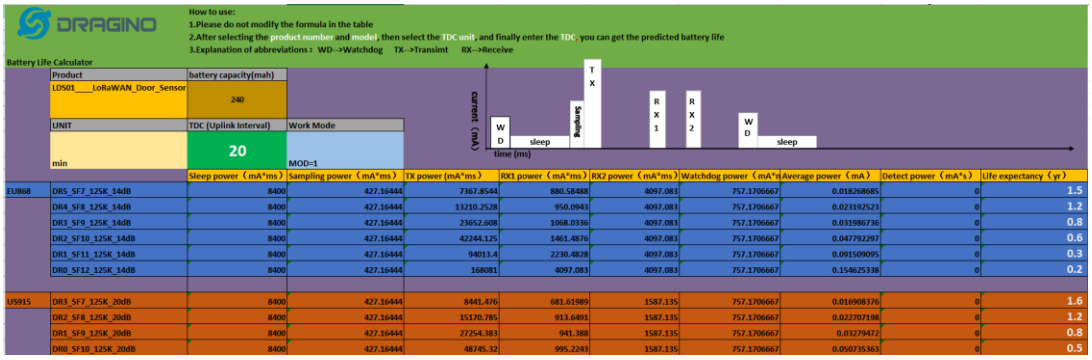
Instruction to use as below:

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.



		Sleep power（mA*ms）	Sampling power（mA*ms）	TX power (mA*ms)	RX1 power（mA*ms）	RX2 power（mA*ms）	Watchdog power（mA*ms）	Average power（mA）	Detect power（mA*s）	Life expectancy（yr）
EU868	DR5_SF7_125K_14dB	8400	427.16444	7367.8544	880.58488	4097.083	757.1706667	0.018268685	0	1.5
	DR4_SF8_125K_14dB	8400	427.16444	13210.2528	950.0941	4097.083	757.1706667	0.023192523	0	1.2
	DR3_SF9_125K_14dB	8400	427.16444	23652.608	1068.0336	4097.083	757.1706667	0.031986736	0	0.8
	DR2_SF10_125K_14dB	8400	427.16444	42244.125	1461.4876	4097.083	757.1706667	0.047792297	0	0.6
	DR1_SF11_125K_14dB	8400	427.16444	94013.4	2230.4828	4097.083	757.1706667	0.091509095	0	0.3
	DR0_SF12_125K_14dB	8400	427.16444	168081	4097.083	4097.083	757.1706667	0.154625138	0	0.2
US915	DR3_SF7_125K_20dB	8400	427.16444	8441.476	681.61989	1587.135	757.1706667	0.016908376	0	1.6
	DR2_SF8_125K_20dB	8400	427.16444	15170.785	913.6491	1587.135	757.1706667	0.022707198	0	1.2
	DR1_SF9_125K_20dB	8400	427.16444	27254.383	941.388	1587.135	757.1706667	0.03279472	0	0.8
	DR0_SF10_125K_20dB	8400	427.16444	48745.32	995.2243	1587.135	757.1706667	0.050735363	0	0.5

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

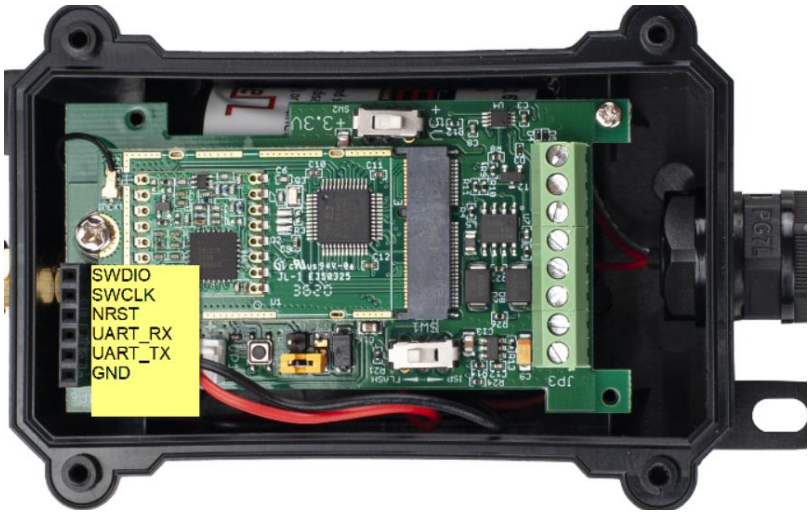
You can change the battery in the LMDS200.The type of battery is not limited as long as the output is between 3v to 3.6v.

The default battery pack of LMDS200 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)

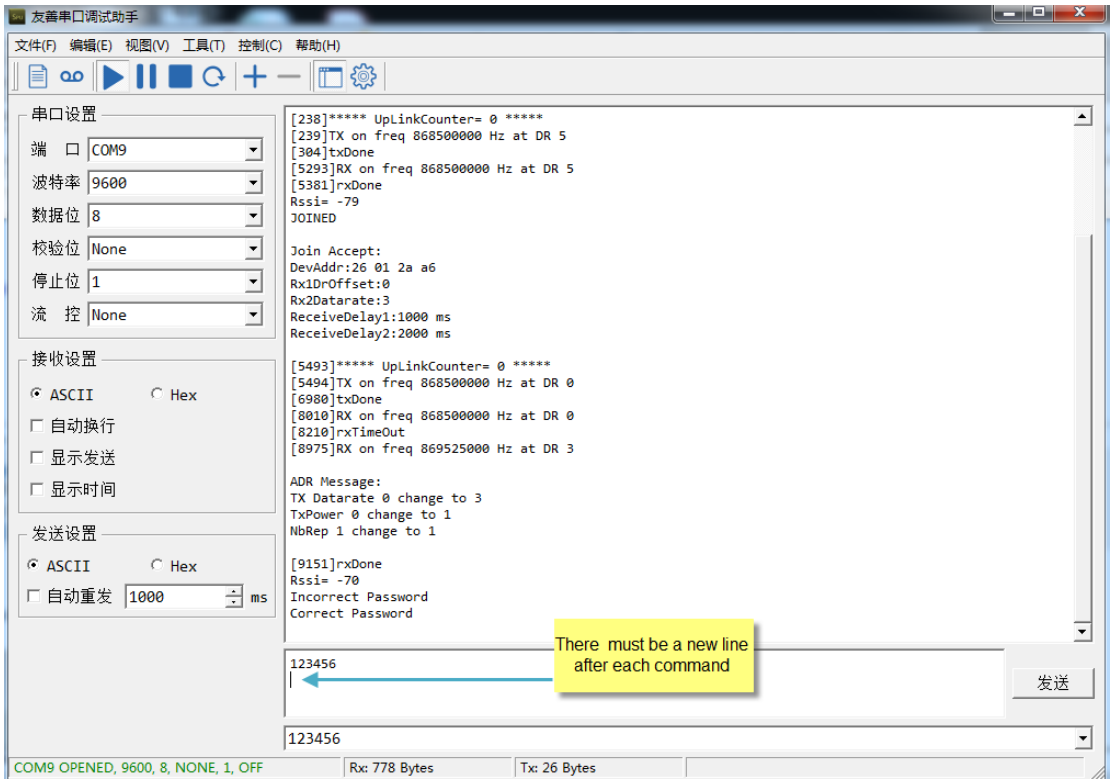
5. FAQ

5.1 How to use AT Command to configure LMDS200

LMDS200 UART connection photo



In the PC, you need to set the serial baud rate to **9600** to access the serial console for LMDS200. LMDS200 will output system info once power on as below:



5.2 How to upgrade the firmware?

A new firmware might be available for:

- ✓ Support new features
- ✓ For bug fix
- ✓ Change LoRaWAN bands.

Instruction for how to upgrade:
https://wiki.dragino.com/index.php?title=Firmware_Upgrade_Instruction_for_STM32_base_products#Hardware_Upgrade_Method_Support_List

Firmware location:
https://www.dragino.com/downloads/index.php?dir=LoRa_End_Node/LMDS200/Firmware/

5.3 How to change the LoRa Frequency Bands/Region?

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

6. Trouble Shooting

7. Order Info

Part Number: **LMDS200-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

8. Packing Info

Package Includes:

- ✓ LMDS200 Microwave Radar Sensor x 1

9. 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 inquiry (product models, accurately describe your problem and steps to replicate it etc) and send a mail to

support@dragino.com