LT Series LoRa IO Controller User Manual

Document Version: 1.3

Firmware Version: V1.2

Version	Description	Date
1.0	Release	2018-Sep-26
1.0.2	Add 8 channels mode for US915, AU915, CN470	2018-Oct-24
1.0.3	Add current measure photo	2018-Nov-2
1.0.4	Add Cayenne connection guide	2018-Nov-24
1.1	Add downlink trouble shooting, Add Hardware Source code link. Add change log for v1.1. (related to Downlink, Payload part) Add TTN payload format	2019-Jan-24
1.1.1	Add more info for 8 channel mode descript and troubleshooting while use US915 and AU915	2019-Feb-21
1.1.2	Modify trouble shooting for upload via FlashLoader, Correct the TTN payload decoder	2019-Apr-26
1.2.0	Add Counting Mode. Improve description of single channel gateway compatible.	
1.2.1	Adjust Downlink instruction while using with LG01-N and LG02	2019-5-7
1.2.2	Add new feature on downlink, able to control the relay base on timing.	
1.3	Various minor text and format edits.	2019-6-4

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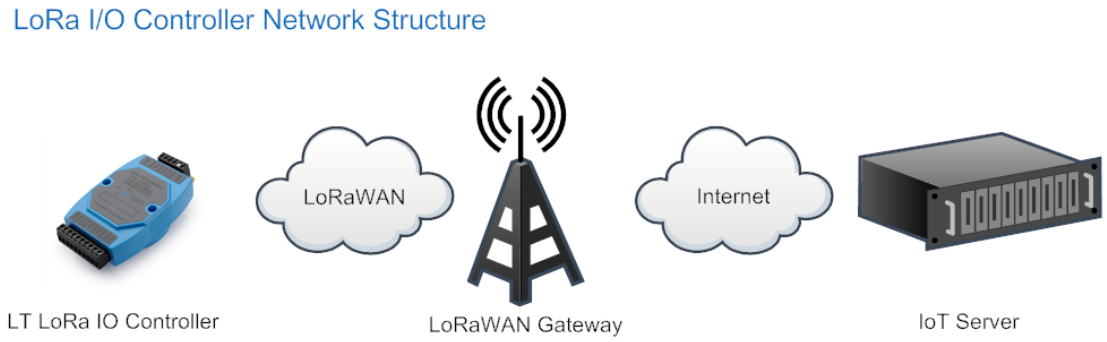
1 Introduction

1.1 What is LT Series I/O Controller

The Dragino LT series I/O Modules are long range LoRaWAN I/O Controllers. The controllers contain various I/O Interfaces including: analog current input, analog voltage input, relay output, digital input and digital output. The LT I/O Modules are designed to simplify the installation of I/O monitoring facilities.

The LT I/O Controllers allow the user to send data over extremely long ranges. They provides long range spread spectrum communication and high interference immunity whilst minimizing power consumption. They target professional wireless sensor network applications such as irrigation systems, smart metering, smart cities, smartphone detection, building automation, and so on.

The LT I/O Controllers aim to provide a simple plug and play, low cost installation by using LoRaWAN wireless technology.
The use environment includes:
1) If the area has LoRaWAN service coverage, the I/O controller can just be installed and configured to connect to the LoRaWAN provider via wireless.
2) A user can set up a LoRaWAN gateway locally and configure the controller to connect to the gateway via wireless.



1.2 Specifications

Hardware System:

- STM32L072CZT6 MCU
- SX1276/78 Wireless Chip
- Power Consumption:
  - Idle: 4mA@12v
  - 20dB Transmit: 34mA@12v

Interface for Model: LT33222-L:

- 3 x Digital Input (Max, 6V)
- 3 x Digital Output (Max output, 36V,450mA)
- 2 x Relay Output (5A@250VAC / 30VDC)
- 2 x 0~20mA Analog Input (res:0.01mA)
- 2 x 0~30V Analog Input (res:0.01v)
- Power Input 7~ 24V DC.

LoRa Spec:

- Frequency Range:
  - Band 1 (HF): 862 ~ 1020 Mhz
  - Band 2 (LF): 410 ~ 528 Mhz
- 168 dB maximum link budget.
- +20 dBm - 100 mW constant RF output vs.
- +14 dBm high efficiency PA.
- Programmable bit rate up to 300 kbps.
- High sensitivity: down to -148 dBm.
- Bullet-proof front end: IIP3 = -12.5 dBm.
- Excellent blocking immunity.
- Low RX current of 10.3 mA, 200 nA register retention.
- Fully integrated synthesizer with a resolution of 61 Hz.
- FSK, GFSK, MSK, GMSK, LoRaTM and OOK modulation.
- Built-in bit synchronizer for clock recovery.
- Preamble detection.
- 127 dB Dynamic Range RSSI.
- Automatic RF Sense and CAD with ultra-fast AFC.
- Packet engine up to 256 bytes with CRC.

1.3 Features

- LoRaWAN Class A & Class C protocol
- Optional Customized LoRa Protocol
- Frequency Bands: CN470/EU433/KR920/US915/EU868/AS923/AU915
- AT Commands to change parameters
- Remote configure parameters via LoRa Downlink
- Firmware upgradeable via program port
- Counting Input

1.4 Applications

- Smart Buildings & Home Automation
- Logistics and Supply Chain Management
- Smart Metering
- Smart Agriculture
- Smart Cities
- Smart Factory

1.5 Hardware Variants

Model	Photo	Description
LT33222-L		✓ 3 x Digital Input ✓ 3 x Digital Output ✓ 2 x Relay Output (5A@250VAC / 30VDC) ✓ 2 x 0~20mA Analog Input (res:0.01mA) ✓ 2 x 0~30V Analog Input (res:0.01v) ✓ 1 x Counting Port

1.6 Firmware Change log

Image v1.2

- Add counting feature

Image v1.1

- Voltage and Current reserve three decimal, previously two
- Allow use of any Fport for downlink
- Add AT+CFG to print all settings
- Fix current and voltage glith bug

2 Operation Mode

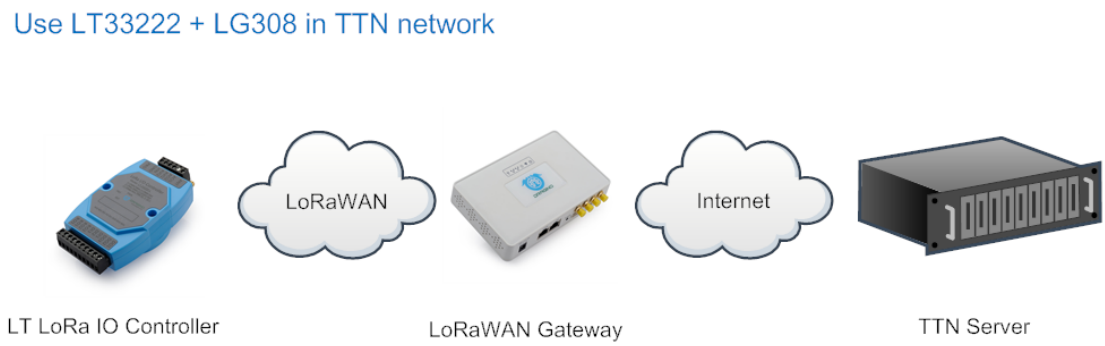
2.1 How it works

The LT Controller is configured as LoRaWAN OTAA Class A mode by default. It has pre-programmed OTAA keys to join a network. To connect to a local LoRaWAN network, you just need to input the OTAA keys into the network server and power on the LT Controller. It will then automatically join the network via OTAA.

In case you can't use the pre-programmed OTAA keys in the network server and have to use assigned keys from the network server, you can use the AT Commands to set the keys in the devices.

2.2 Joining a LoRaWAN Network

Following is an example of how to join the The Things Network (TTN). Shown below is the network overview including a LG308 device acting as the LoRaWAN gateway.

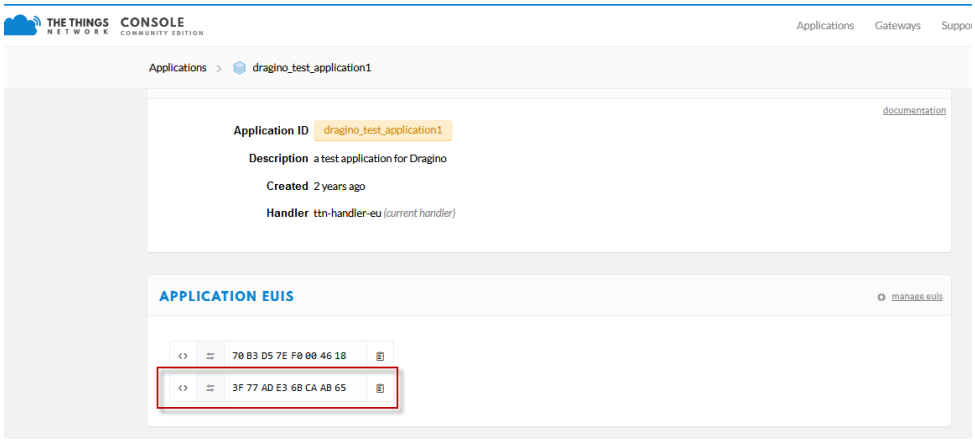


The LG308 is set up by default to connect to the TTN network, so it is simply necessary to configure TTN Server to recognise the device.

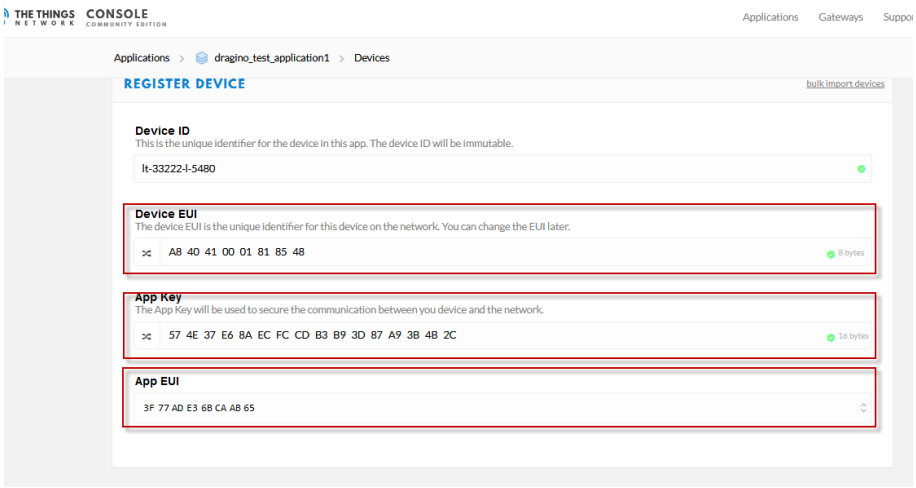
Step 1: Create a device in TTN with the OTAA keys from LT IO controller.
Each LT is shipped with a sticker with the default device EUI as shown below:

You can enter these keys in the LoRaWAN Server portal as shown below..

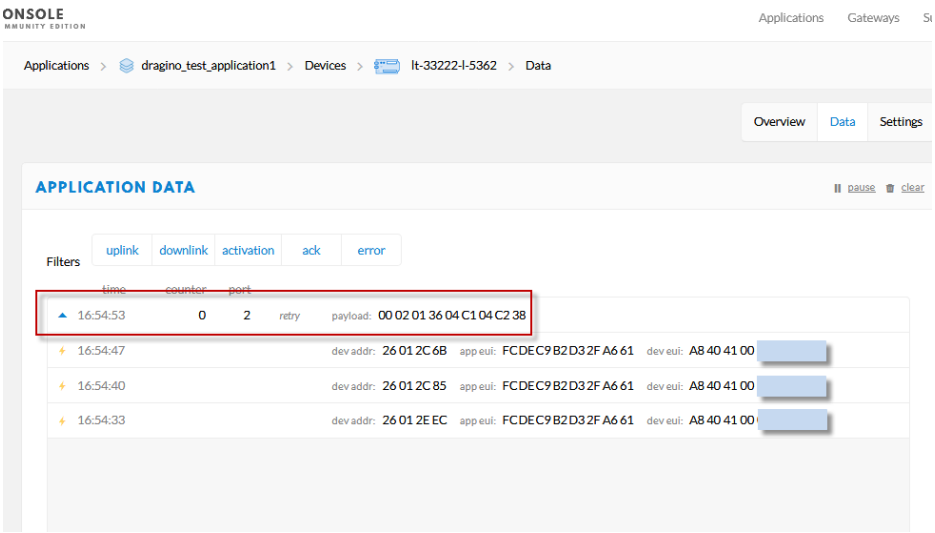
Add APP EUI in the application.



Add APP KEY and DEV EUI



Step 2: Power on the LT device and it will automatically join the TTN network. After successfully joining, it will start to upload messages to TTN and you will see the messages appearing in the panel.



2.3 Uplink Payload (AT+MOD=1, general mode)

The uplink payload is 9 bytes in total. Uplink packets use FPORT=2.
By default one uplink packet is sent every 10 minutes.

Size(bytes)	2	2	2	2	1
Value	ACI1 Current	ACI2 Current	AVI1 Voltage	AVI2 Voltage	* (see below)

* This byte is a combination of bits for RO1, RO2, DI3, DI2, DI1, DO3, DO2 and DO1 as shown below.

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
RO1	RO2	DI3	DI2	DI1	DO3	DO2	DO1

- ✓ RO is for relay. ROx=1 : Close, ROx=0 : Open.
- ✓ DI is for digital input. DIx=1: high or float, DIx=0: low.
- ✓ DO is for digital output. DOx=1: output low, DOx=0: high or float.

Example Payload

For example, if the payload is: 1310 1300 04AB 04AC AA then the values of the interface signals are as follows:

Byte 1 – 2 : 0x1310
ACI1 channel current is 0x1310/1000=4880 (dec) / 1000=4.880mA

Byte 3 – 4 : 0x1300
ACI2 channel current is 0x1300/1000=4.864mA

Byte 5 – 6 : 0x04AB
AVI1 channel voltage is 0x04AB/1000=1.195V

Byte 7 – 8 : 0x04AC
AVI2 channel voltage is 0x04AC/1000=1.196V

Byte 9 : 0xAA = 10101010(B) means :

- ✓ [1] RO1 relay channel is closed and the RO1 LED is ON.
- ✓ [0] RO2 relay channel is open and RO2 LED is off;
- ✓ [1] DI3 channel is high input and DI3 LED is off;
- ✓ [0] DI2 channel is low input and DI2 is on;
- ✓ [1] DI1 channel is low input and DI1 is on;
- ✓ [0] DO3 channel output state:
  - DO3 is float if there is no load between DO3 and V+.;
  - DO3 is high if there is a load between DO3 and V+.
  - DO3 LED is off in both case
- ✓ [1] DO2 channel output is low and DO2 LED is on.
- ✓ [0] DO1 channel output state:
  - DO1 is float if there is no load between DO1 and V+.;
  - DO1 is high if there is a load between DO1 and V+.
  - DO1 LED is off in both case

TTN Payload Format

```
function Decoder(bytes, port) {
  // Decode an uplink message from a buffer
  // (array) of bytes to an object of fields.

  var value=bytes[0]<<8 | bytes[1];
  if(bytes[0] & 0x80)
  {value |= 0xFFFF0000;}
   var ACI1=(value/1000).toFixed(3);  //ACI1 Current, units:mA

  value=bytes[2]<<8 | bytes[3];
  if(bytes[2] & 0x80)
  {value |= 0xFFFF0000;}
  var ACI2=(value/1000).toFixed(3);  // ACI2 Current, units:mA

  value=bytes[4]<<8 | bytes[5];
  if(bytes[4] & 0x80)
  {value |= 0xFFFF0000;}
  var AVI1=(value/1000).toFixed(3);  // AVI1 voltage, units:V

  value=bytes[6]<<8 | bytes[7];
  if(bytes[6] & 0x80)
  {value |= 0xFFFF0000;}
  var AVI2=(value/1000).toFixed(3);  // AVI2 voltage, units:V

  value=bytes[8]
  var DO1=(value&0x01)? "L":"H";  //DO1，Digital Output Status
  var DO2=(value&0x02)? "L":"H";  //DO2，Digital Output Status
  var DO3=(value&0x04)? "L":"H";  //DO3，Digital Output Status
  var DI1=(value&0x08)? “H":"L";  //DI1，Digital Input Status
  var DI2=(value&0x10)? "H":"L";  //DI2，Digital Input Status
  var DI3=(value&0x20)? "H":"L";  //DI3，Digital Input Status
  var RO2=(value&0x40)? "ON":"OFF";  //RO2，Relay Status
  var RO1=(value&0x80)? "ON":"OFF";  //RO1，Relay Status
```

```
return {
      ACI1_mA:ACI1,
      ACI2_mA:ACI2,
      AVI1_V:AVI1,
      AVI2_V:AVI2,
      DO1_status:DO1,
      DO2_status:DO2,
      DO3_status:DO3,
      DI1_status:DI1,
      DI2_status:DI2,
      DI3_status:DI3,
      RO1_status:RO1,
      RO2_status:RO2,
  };
}
```

2.4 Uplink Payload (AT+MOD=2, Counting Mode)

AT+MOD=2 is counting mode.
In this mode DI3 can be used to count the falling / raising signal at this pin

To use counting mode, please run:

AT+MOD=2
ATZ

Other AT Commands:

AT+TRIG=0,100, 3 (set D3 port to trigger on low level, valid signal is 100ms)
AT+TRIG=1,100, 3 (set D3 port to trigger on high level, valid signal is 100ms)
AT+CLRCOUNT clear all countings

Payload: Total 16 Bytes.

Size(bytes)	2	4	4	4	1	1
Value	BAT	COUNT1	COUNT2	COUNT3	* (see below)	*

* This byte is a combination of bits for RO1, RO2, DI3, DI2, DI1, DO3, DO2 and DO1 as shown below:

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
RO1	RO2	FIRST	N/A	N/A	DO3	DO2	DO1

BAT: Battery voltage for LT-33222-L's internal MCU supply voltage.
Ex1: 0x0CE4 = 3.3v

COUNTx: Counting number, HEX format.
Ex1: 0x0CE4 = 3300

FIRST: while uplink count = 0, this value is 1, means this packet is the first packet after JOIN the network.

Note: this 16 byte payload will be blank for the 915Mhz DR0 mode which only supports a one byte payload.

TTN Payload Format

```
function Decoder(bytes, port) {
  // Decode an uplink message from a buffer
  // (array) of bytes to an object of fields.

  var value=bytes[0]<<8 | bytes[1];
  var batV=value/1000;//Battery,units:V
  var count1=bytes[2]<<24 | bytes[3]<<16 | bytes[4]<<8 | bytes[5]; //
Count1,units:times;
   var count2=bytes[6]<<24 | bytes[7]<<16 | bytes[8]<<8 | bytes[9]; //
Count2,units:times;
    var count3=bytes[10]<<24 | bytes[11]<<16 | bytes[12]<<8 | bytes[13]; //
Count3,units:times;
  value=bytes[14];
  var DO1=(value&0x01)? "L":"H";     //DO1，Digital Output Status
  var DO2=(value&0x02)? "L":"H";     //DO2，Digital Output Status
  var DO3=(value&0x04)? "L":"H";     //DO3，Digital Output Status
  var First=(value&0x20)? "Yes":"No";   //First，First payload for join network
  var RO2=(value&0x40)? "ON":"OFF";  //RO2，Relay Status
  var RO1=(value&0x80)? "ON":"OFF";  //RO1，Relay Status

  return {
      BatV:batV,
      Count1_times:count1,
      Count2_times:count2,
      Count3_times:count3,
      DO1_status:DO1,
      DO2_status:DO2,
      DO3_status:DO3,
      First_status:First,
      RO1_status:RO1,
      RO2_status:RO2,
  };
}
```

2.5 Downlink Payload

Downlink Control Type	FPort	Type Code	Downlink payload size(bytes)
TDC (Transmit Time Interval)	Any	01	4
Digital Output (DO1, DO2, DO3)	Any	02	4
Relay Output (RO1, RO2)	Any	03	3
RESET	Any	04	2
Relay Output CTL (RO1, RO2)	Any	05	5

The FPort is not fixed.
If the payload=0100003C, then the type code is 01, and the END Node's TDC is set to 0x00003C=60(S).

Example Downlink payload setting in TTN:

If payload = 0x02010001, it means set DO1 to low, DO2 to high and DO3 to low (assuming pull-up loads are fitted to all DOx terminals).

Type code 02 means Digital Output.

If payload = 0x030100, it means set RO1 to Close and RO2 to Open.

If payload = 0x04FF, it will reset the LT.

Type 05: (Applicable for firmware since v1.3)
This is to control the relay output.
It include four bytes as follows:

First Byte: Type code (0x05)

Second Byte: Inverter Mode
01: Relays will change back to original state after timeout.
00: Relays will change to an inverter state after timeout

Third Byte: Control Method and Ports status:

Second Byte	Status
0x11	RO1 and RO2 set to NO
0x10	RO2 to NO, RO1 to NC
0x01	RO2 to NC, RO1 to NO
0x00	RO1 and RO2 to NC.

Fourth Byte:
Latching time. Unit: ms

Example payloads:

a) 05 01 11 07 D0
Relay1 and Relay2 will be set to NO , last 2 seconds, then change back to original state.

b) 05 01 10 07 D0
Relay1 will change to NC, Relay2 will change to NO, last 2 seconds, then both change back to original state.

c) 05 00 01 07 D0
Relay1 will change to NO, Relay2 will change to NC, last 2 seconds, then Relay1 will change to NC, Relay2 will change to NO.

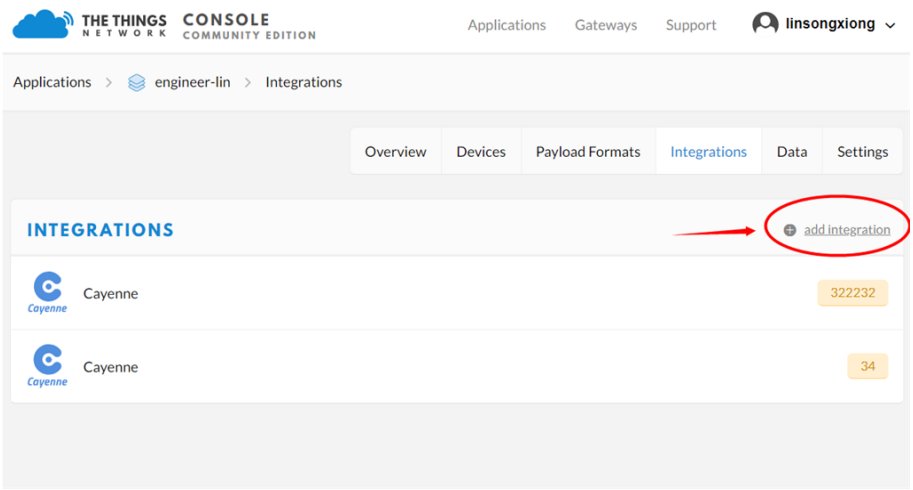
d) 05 00 00 07 D0
Relay1 and Relay2 will change to NC, last 2 seconds, then both change to NO.

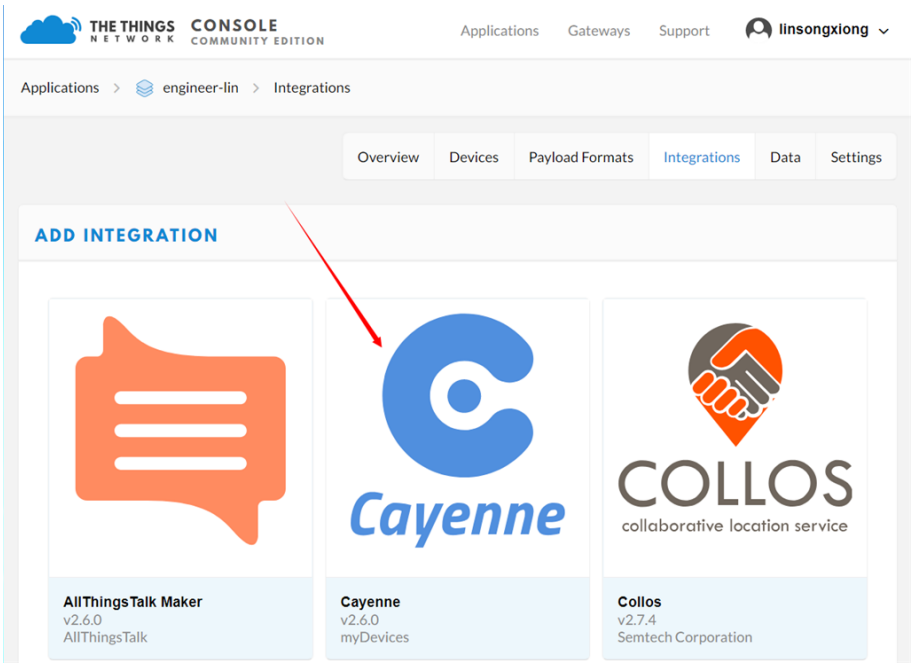
2.6 Show Data on Cayenne

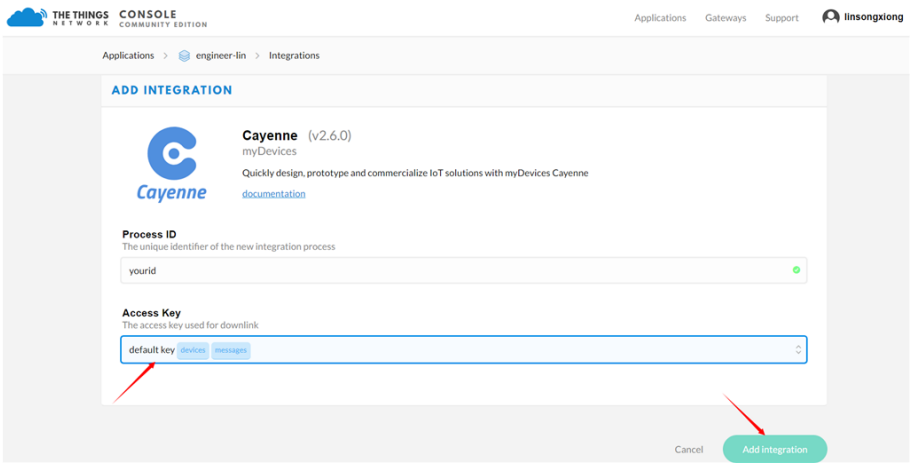
Cayenne provides a human friendly interface to show the sensor data. Once you have data in TTN, you can use Cayenne to connect to TTN and see the data in Cayenne. Below are the steps.

Step 1: Be sure that your device is programmed and properly connected to the network at this time.

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

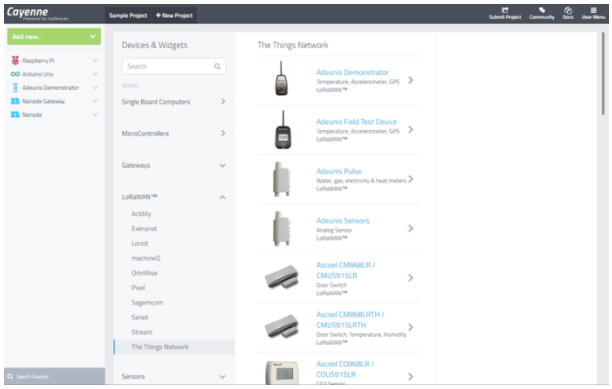


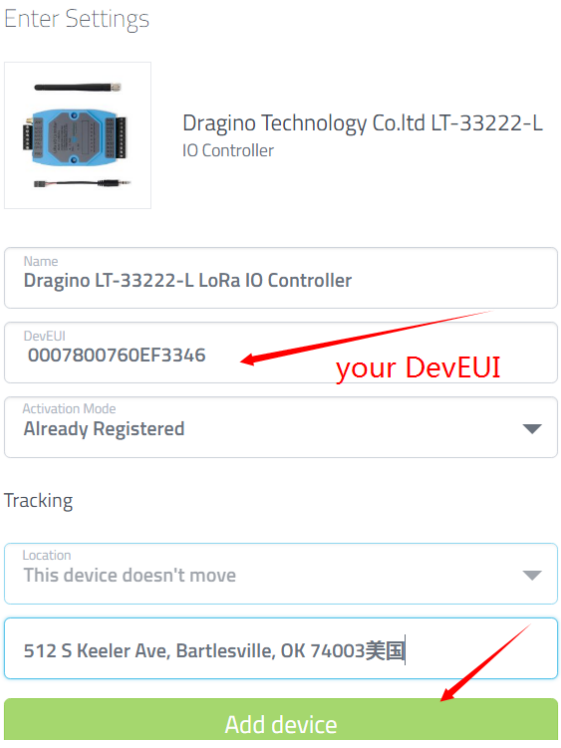


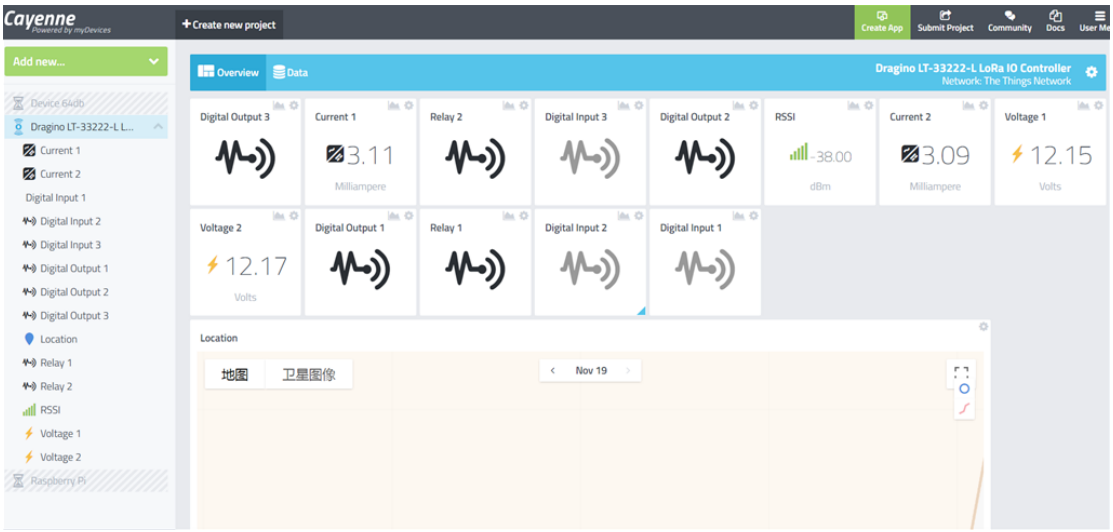


Step 3: Create an account or log in in the mydevices cayenne.

Step 4: Search the LT-33222and add DevEUI

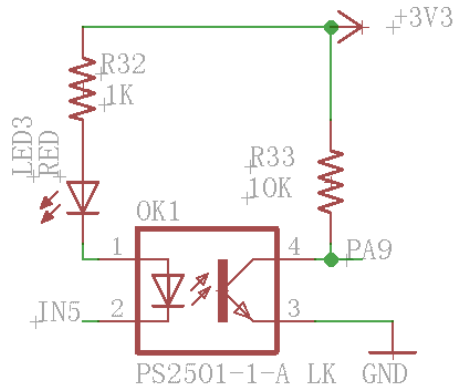




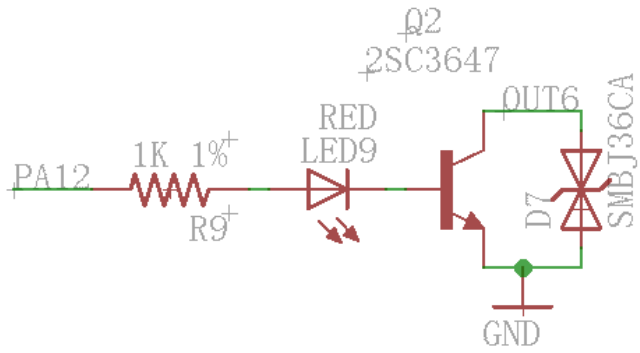

Cayenne
Powered by myDevices
+Create new project
Create App
Submit Project
Community
Docs
Add new...
Overview
Data
Dragino LT-33222-L LoRa IO Controller
Network: The Things Network
Device 6400
Dragino LT-33222-L L...
Current 1
Current 2
Digital Input 1
Digital Input 2
Digital Input 3
Digital Output 1
Digital Output 2
Digital Output 3
Location
Relay 1
Relay 2
RSSI
Voltage 1
Voltage 2
Raspberry Pi
Digital Output 3
Current 1
3.11
Milliampere
Relay 2
Digital Input 3
Digital Output 2
RSSI
-38.00
dBm
Current 2
3.09
Milliampere
Voltage 1
12.15
Volts
Voltage 2
12.17
Volts
Digital Output 1
Relay 1
Digital Input 2
Digital Input 1
Location
地图
卫星图像
Nov 19

2.7 Interface Detail

Digital Input Port: DI1 / DI2 / DI3



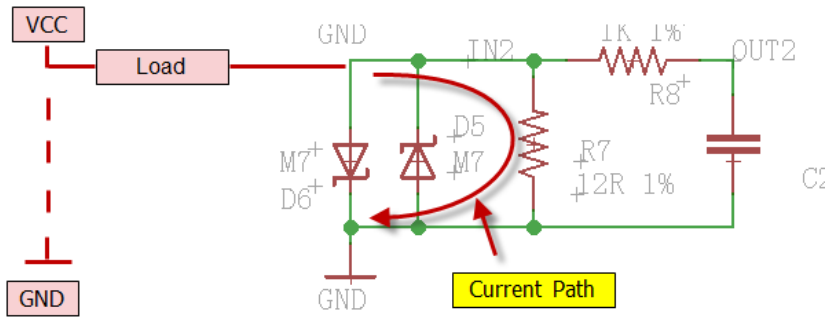
Digital Output Port: DO1 / DO2 / DO3



Analog Input Interface

The analog input interface is as shown below. The LT will measure the IN2 voltage so to calculate the current passing through the Load.

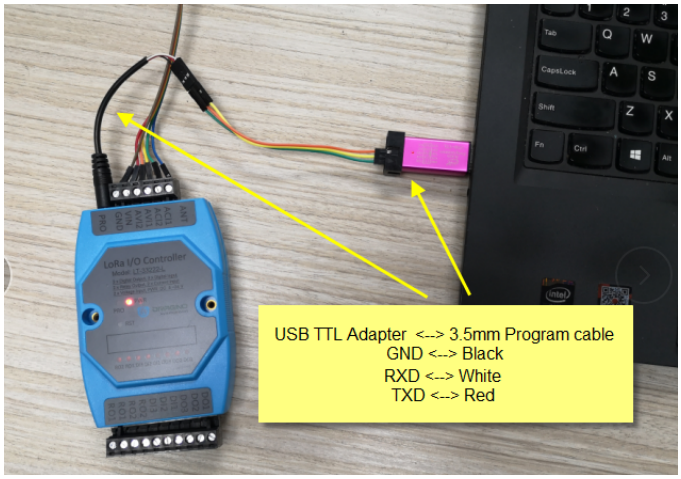
The formula is: AC2 = (IN2 voltage) / 12



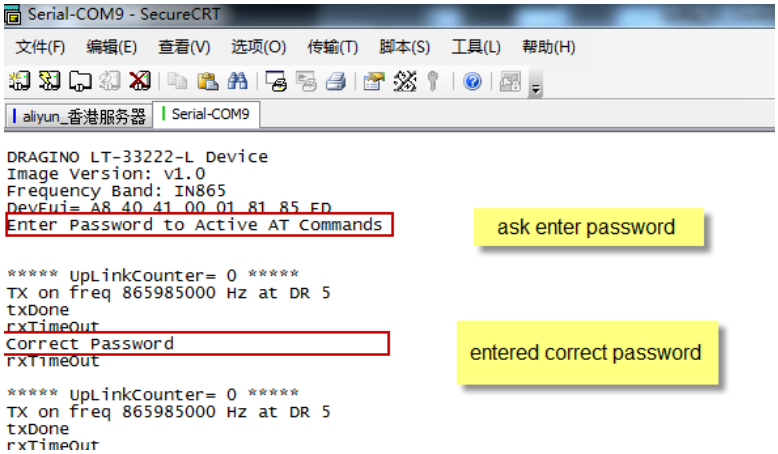
3 Use AT Command

3.1 Access AT Command Serial Port

The LT device supports the AT Command set via a serial port.
You can use a USB to TTL adapter plus the 3.5mm plug Program Cable to connect to the LT to your PC for using the AT commands, as below.



In the PC, you need to set the **serial tool** (such as putty, SecureCRT) baud rate to **9600** to access to access serial console for LT.
The AT Command facility is disabled by default, and you need to enter the password (default:**123456**) to enable the AT Commands facility as shown below.



Below is a list of the available AT commands.
A more detailed AT Command manual can be found at AT Command Manual (http://www.dragino.com/downloads/index.php?dir=LT_LoRa_IO_Controller/LT33222-L/)

AT+<CMD>? : Help on <CMD>
AT+<CMD> : Run <CMD>
AT+<CMD>=<value> : Set the value
AT+<CMD>=? : Get the value
ATZ: Trig a reset of the MCU
AT+FDR : Reset Parameters to Factory Default, Keys Reserve
AT+DEUI : Get or Set the Device EUI
AT+DADDR : Get or Set the Device Address
AT+APPKEY : Get or Set the Application Key
AT+NWKSKEY : Get or Set the Network Session Key
AT+APPSKEY : Get or Set the Application Session Key
AT+APPEUI : Get or Set the Application EUI
AT+ADR : Get or Set the Adaptive Data Rate setting. (0: off, 1: on)
AT+TXP : Get or Set the Transmit Power (0-5, MAX:0, MIN:5, according to LoRaWAN Spec)
AT+DR : Get or Set the Data Rate. (0-7 corresponding to DR_X)
AT+DCS : Get or Set the ETSI Duty Cycle setting – 0=disable, 1=enable - Only for testing
AT+PNM : Get or Set the public network mode. (0: off, 1: on)
AT+RX2FQ : Get or Set the Rx2 window frequency
AT+RX2DR : Get or Set the Rx2 window data rate (0-7 corresponding to DR_X)
AT+RX1DL : Get or Set the delay between the end of the Tx and the Rx Window 1 in ms
AT+RX2DL : Get or Set the delay between the end of the Tx and the Rx Window 2 in ms
AT+JN1DL : Get or Set the Join Accept Delay between the end of the Tx and the Join Rx Window 1 in ms
AT+JN2DL : Get or Set the Join Accept Delay between the end of the Tx and the Join Rx Window 2 in ms
AT+NJM : Get or Set the Network Join Mode. (0: ABP, 1: OTAA)
AT+NWKID : Get or Set the Network ID
AT+FCU : Get or Set the Frame Counter Uplink
AT+FCD : Get or Set the Frame Counter Downlink
AT+CLASS : Get or Set the Device Class
AT+JOIN : Join network
AT+NJS : Get OTAA Join Status
AT+SENDB : Send hexadecimal data along with the application port

AT+SEND : Send text data along with the application port
AT+RECVB : Print last received data in binary format (in hex)
AT+RECV : Print last received data in raw format
AT+VER : Get current image version and Frequency Band
AT+CFM : Get or Set the confirmation mode (0-1)
AT+CFS : Get confirmation status of the last AT+SEND (0-1)
AT+SNR : Get the SNR of the last received packet
AT+RSSI : Get the RSSI of the last received packet
AT+TDC : Get or set the application data transmission interval in ms
AT+PORT : Get or set the application port
AT+DISAT : Disable AT commands
AT+PWORD : Set password, max 9 digits
AT+CHS : Get or Set Frequency (Unit: Hz) for Single Channel Mode
AT+CHE : Get or Set 8 channels mode. Only for US915, AU915, CN470
AT+CFG : Print all settings

3.2 Common AT Command Sequences

3.2.1 Multi-channel ABP mode (Use with SX1301/LG308)

If the device has not joined network yet:

123456
AT+FDR
123456
AT+NJM=0
ATZ

If the device has already joined the network:

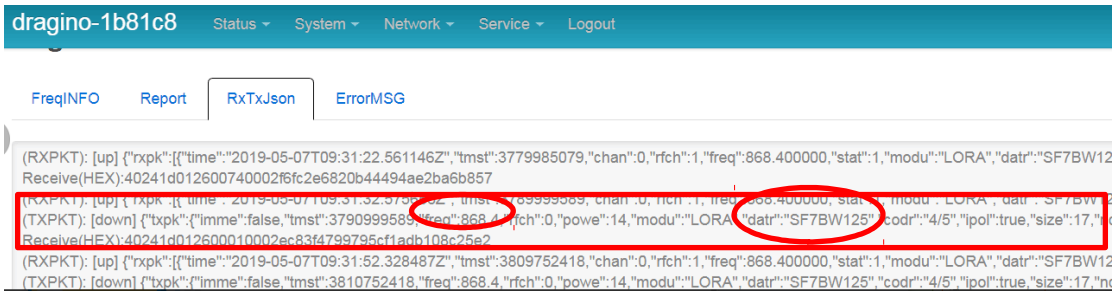
AT+NJM=0
ATZ

3.2.2 Single-channel ABP mode (Use with LG01/LG02)

123456 Enter Password to have AT access.
AT+FDR Reset Parameters to Factory Default, Keys Reserve
123456 Enter Password to have AT access.
AT+CLASS=C Set to work in CLASS C
AT+NJM=0 Set to ABP mode
AT+ADR=0 Set the Adaptive Data Rate Off
AT+DR=5 Set Data Rate
AT+TDC=60000 Set transmit interval to 60 seconds
AT+CHS=868400000 Set transmit frequency to 868.4Mhz
AT+RX2FQ=868400000 Set RX2Frequency to 868.4Mhz (according to the result from server)
AT+RX2DR=5 Set RX2DR to match the downlink DR from server. see below
AT+DADDR=26 01 1A F1 Set Device Address to 26 01 1A F1, this ID can be found in the LoRa Server portal.
ATZ Reset MCU

Notes:

1. Make sure the device is set to ABP mode in the IoT Server.
2. Make sure the LG01/02 gateway RX frequency is exactly the same as AT+CHS setting.
3. Make sure SF / bandwidth setting in LG01/LG02 match the settings of AT+DR. refer this link to see what DR means.
4. The command AT+RX2FQ and AT+RX2DR set the downlink parameters. You can check the actual downlink parameters to be used in the RxTxJson screen as shown below.
   e.g. the RX2FQ should be 868400000 and RX2DR should be 5.



3.2.3 Change to Class C

From ABP, CLASS A to OTAA, CLASS C

AT+NJM=1
AT+CLASS=C
ATZ

From OTAA, CLASS A to OTAA, CLASS C

If sensor JOINED
AT+CLASS=C
ATZ

4 FAQ

4.1 Why there are 433/868/915 versions?

Different countries have different rules for the ISM band used for LoRa. Although the LoRa chip can support a wide range of frequencies, we provide different versions for best tuning of the LoRa radio system.

4.2 What is the frequency range of LT LoRa device?

Different LT versions support different frequency ranges. Below is the table for the working frequency and recommended bands for each model :

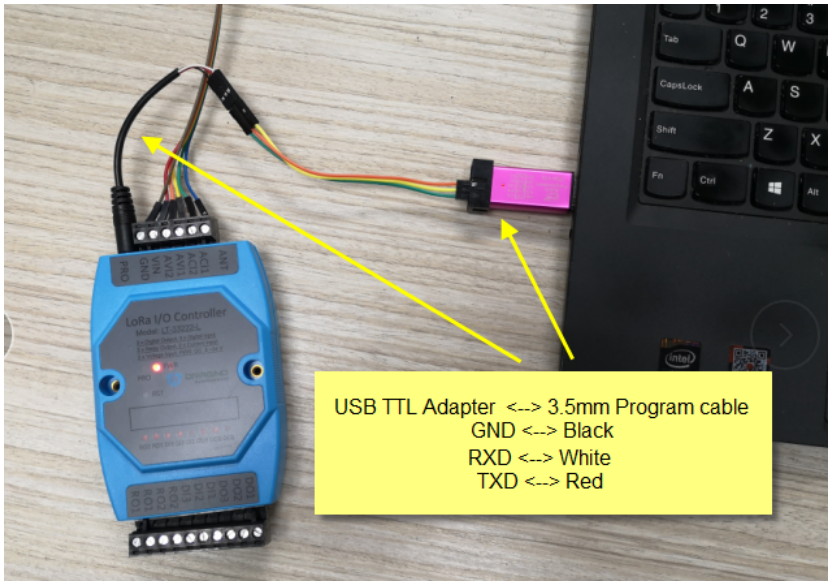
Version	LoRa IC	Working Frequency	Best Tune Frequency	Recommend Bands
433	SX1278	Band2(LF): 410 ~525 Mhz	433Mhz	CN470/EU433
868	SX1276	Band1(HF): 862~1020 Mhz	868Mhz	EU868
915	SX1276	Band1(HF): 862 ~1020 Mhz	915Mhz	AS923/AU915/ KR920/US915

4.3 How to upgrade the firmware image?

The LT LoRaWAN Controller is shipped with a 3.5mm cable. The cable is used to upload image to LT to:

- Support new features.
- Make bug fixes.
- Change LoRaWAN bands.

This photo shows the hardware connection to upload an image to the LT:



Step 1: Download flash loader.
(https://www.st.com/content/st_com/en/products/development-tools/software-development-tools/stm32-software-development-tools/stm32-programmers/flasher-stm32.html)

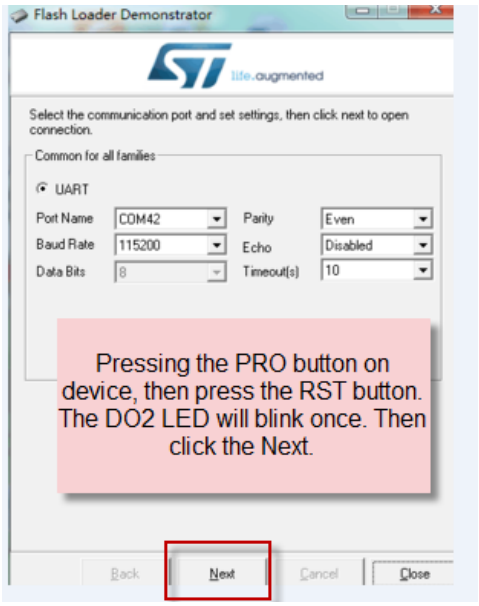
Step 2: Download the LT Image files.
(http://www.dragino.com/downloads/index.php?dir=LT_LoRa_IO_Controller/LT33222-L/image/)

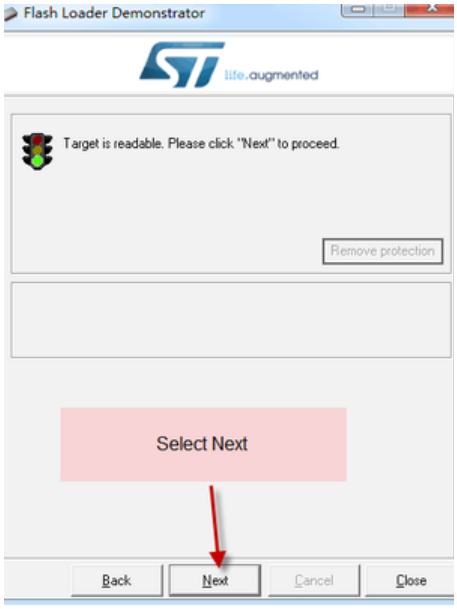
Step 3: Open flashloader; choose the correct COM port to update.

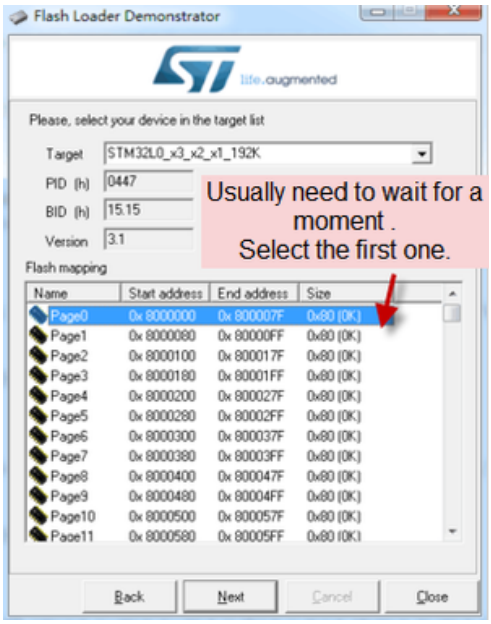
Hold down the PRO button and then momentarily press the RST reset button and the DO2 led will change from OFF to ON

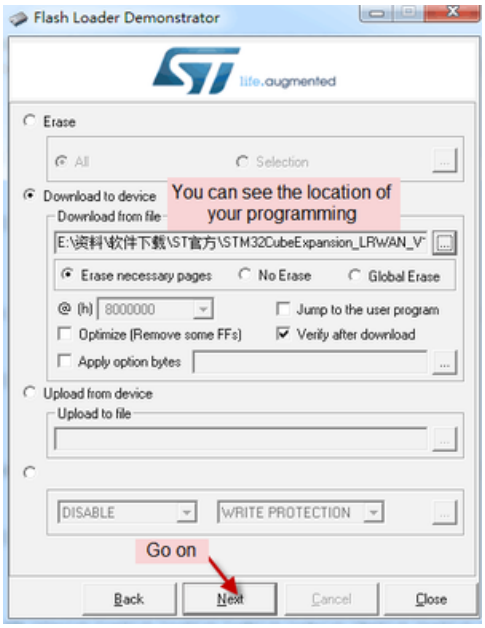
The following screen shots show the process.

Board detected









Notice: The pin mapping for the programming cable is shown below:

4.4 How to change the LoRa Frequency Bands/Region

Refer to the previous section – How to upgrade the firmware image.
When downloading the firmware image, choose the correct image file to match the LT model and required band.

4.5 How to set up LT to work in 8 channel mode

By default, the frequency bands US915, AU915, CN470 operate over 72 frequency channels. Many gateways are 8 channel gateways, and in this case the OTAA join time and uplink schedule is long and unpredictable, while the end node is hopping the 72 frequencies.

You can configure the end node to work in 8 channel mode by using the AT+CHE command. The 500kHz channels are always included for OTAA.

For example, in US915 band, the frequency table is as below. By default, an end node will use all channels (0~71) for the OTAA Join process. After the OTAA Join, the end node will use all these channels (0~71) to send uplink packets.

CHE	US915 Uplink Channels(125KHz,4/5,Unit:MHz,CHS=0)								
0	ENABLE Channel 0-63								
1	902.3	902.5	902.7	902.9	903.1	903.3	903.5	903.7	Channel 0-7
2	903.9	904.1	904.3	904.5	904.7	904.9	905.1	905.3	Channel 8-15
3	905.5	905.7	905.9	906.1	906.3	906.5	906.7	906.9	Channel 16-23
4	907.1	907.3	907.5	907.7	907.9	908.1	908.3	908.5	Channel 24-31
5	908.7	908.9	909.1	909.3	909.5	909.7	909.9	910.1	Channel 32-39
6	910.3	910.5	910.7	910.9	911.1	911.3	911.5	911.7	Channel 40-47
7	911.9	912.1	912.3	912.5	912.7	912.9	913.1	913.3	Channel 48-55
8	913.5	913.7	913.9	914.1	914.3	914.5	914.7	914.9	Channel 56-63
Channels(500KHz,4/5,Unit:MHz,CHS=0)									
	903	904.6	906.2	907.8	909.4	911	912.6	914.2	Channel 64-71

When you use the TTN network, the US915 frequency bands use are:

- ✓ 903.9 - SF7BW125 to SF10BW125
- ✓ 904.1 - SF7BW125 to SF10BW125
- ✓ 904.3 - SF7BW125 to SF10BW125
- ✓ 904.5 - SF7BW125 to SF10BW125
- ✓ 904.7 - SF7BW125 to SF10BW125
- ✓ 904.9 - SF7BW125 to SF10BW125
- ✓ 905.1 - SF7BW125 to SF10BW125
- ✓ 905.3 - SF7BW125 to SF10BW125
- ✓ 904.6 - SF8BW500

Because the end node is now hopping in 72 frequency, it makes the devices hard to Join the TTN network and send uplink data.
To solve this issue, you can access the device via AT Command and run:

AT+CHE=2

ATZ

to set the end node to work in 8 channel mode. The device will then work in Channel 8-15 & 64-71 for OTAA, and channel 8-15 for Uplink.

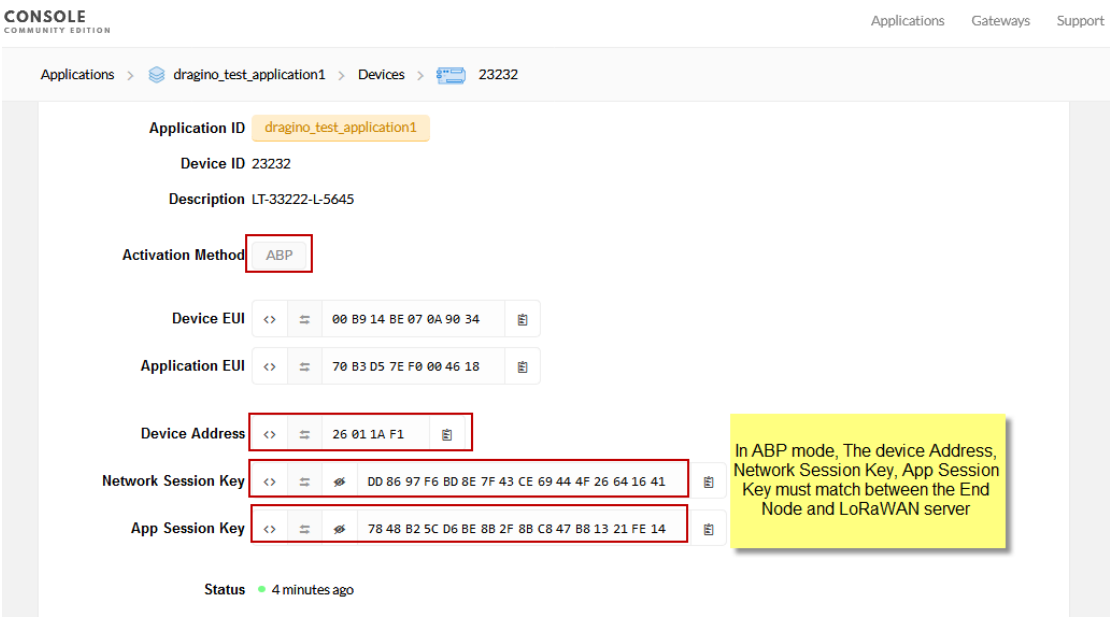
AU915 is similar. Below is the AU915 Uplink Channels.

CHE	AU915 Uplink Channels(125KHz,4/5,Unit:MHz,CHS=0)								
0	ENABLE Channel 0-63								
1	915.2	915.4	915.6	915.8	916	916.2	916.4	916.6	Channel 0-7
2	916.8	917	917.2	917.4	917.6	917.8	918	918.2	Channel 8-15
3	918.4	918.6	918.8	919	919.2	919.4	919.6	919.8	Channel 16-23
4	920	920.2	920.4	920.6	920.8	921	921.2	921.4	Channel 24-31
5	921.6	921.8	922	922.2	922.4	922.6	922.8	923	Channel 32-39
6	923.2	923.4	923.6	923.8	924	924.2	924.4	924.6	Channel 40-47
7	924.8	925	925.2	925.4	925.6	925.8	926	926.2	Channel 48-55
8	926.4	926.6	926.8	927	927.2	927.4	927.6	927.8	Channel 56-63
Channels(500KHz,4/5,Unit:MHz,CHS=0)									
	915.9	917.5	919.1	920.7	922.3	923.9	925.5	927.1	Channel 64-71

4.6 How to set up LT to work with Single Channel Gateway such as LG01/LG02?

In this case, you need to set the LT-33222-L to work in ABP mode and transmit on only one frequency. Assume we have a LG02 working in the frequency 868400000. Below are the steps to set up single channel mode.

Step1: Log in TTN, Create an ABP device in the application and input the network session key (NETSKEY), app session key (APPSKEY) from the device.

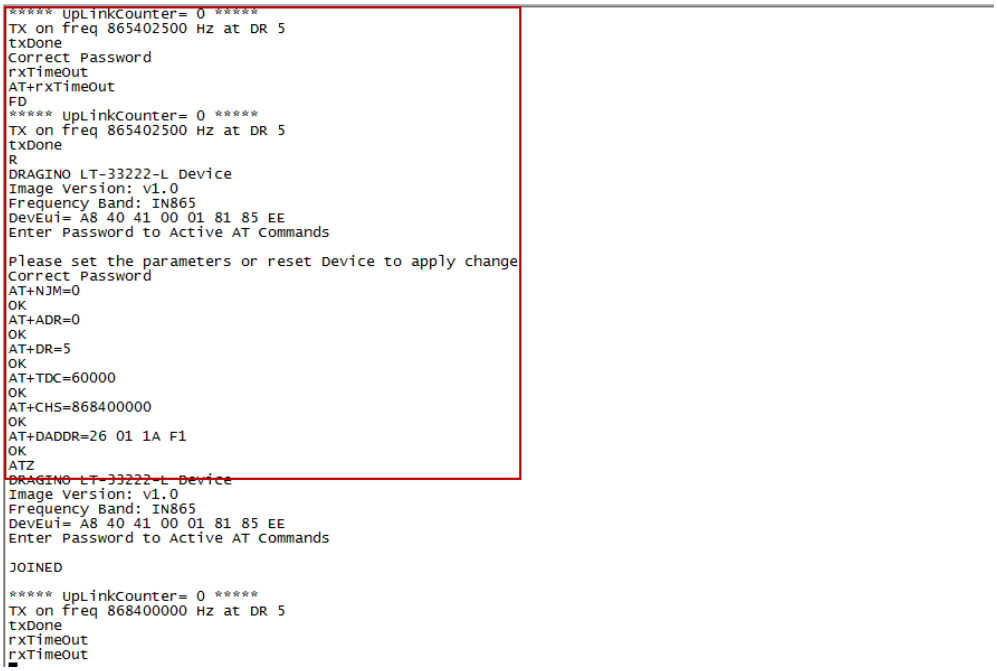


Note: You need to make sure above three codes match. You can change the codes either in TTN or in the Device to make then match. In TTN, NETSKEY and APPSKEY can be configured in the setting page, but Device Addr is generated by TTN.

Step2: Run AT Command to make LT work in Single frequency & ABP mode. Below is the AT commands:

123456 Enter Password to have AT access.
AT+FDR Reset Parameters to Factory Default, Keys Reserve
123456 Enter Password to have AT access.
AT+NJM=0 Set to ABP mode
AT+ADR=0 Set the Adaptive Data Rate Off
AT+DR=5 Set Data Rate (Set AT+DR=3 for 915 band)
AT+TDC=60000 Set transmit interval to 60 seconds
AT+CHS=868400000 Set transmit frequency to 868.4Mhz
AT+DADDR=26 01 1A F1 Set Device Address to 26 01 1A F1
ATZ Reset MCU

As shown in below:



5 Trouble Shooting

5.1 Downlink doesn't work

By default, the LT device will open two RX windows to get downlink message after uplink. If the server's radio parameter does not match with the radio parameters in downlink, the message won't arrive.
In the UART access to LT, you will see the message:

txDone
rxTimeout
rxTimeout

If you see this output:

txDone
rxDone
rxTimeout

Then it means the downlink message arrived but did not parse correctly. In this case, user need to set FPORT=2 in the server side for the downlink message.

5.2 Connection problem while using USB <----> TTL to upload firmware.

Issue: While using USB to TTL to upload firmware via UART interface. It works for several times but most of times it fails.

Checklist:
1. Double check if follow up exactly the steps as manual.

2. Check if hardware works fine:
a) check if AT command works,
b) check if ISP / flash switch works: PA12 will have different output level while set the ISP/Flash Switch in different position.
c) check if reset button works.

3. If you use Windows10 system. Please change the flash loader to run in Windows7 compatibility mode.

4. We see a case the FT232 USB TTL adapter has reliability issue with the PC USB chipset(Intel). In this case, even point 1 & 2 work, it still has serious reliability issue for uploading. If this happen, change a PC or change a USB to TTL adapter will solve.

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

It is about the channels mapping. Please see Sect 4.5 (How to set 8 Channel Mode) above for details.

6 Order Info

General Version:

1. **LT-33222-L-EU433**: LT with frequency bands EU433
2. **LT-33222-L-EU868**: LT with frequency bands EU868
3. **LT-33222-L-KR920**: LT with frequency bands KR920
4. **LT-33222-L-CN470**: LT with frequency bands CN470
5. **LT-33222-L-AS923**: LT with frequency bands AS923
6. **LT-33222-L-AU915**: LT with frequency bands AU915
7. **LT-33222-L-US915**: LT with frequency bands AU915
8. **LT-33222-L-IN865**: LT with frequency bands AU915
9. **LT-33222-L-CN779**: LT with frequency bands AU915

7 Packing Info

Package Includes:

- ✓ LT I/O Controller x 1
- ✓ Stick Antenna for LoRa RF part x 1
- ✓ Bracket for controller x1
- ✓ Program cable x 1

Dimension and weight:

- ➢ Device Size: 13.5 x 7 x 3 cm
- ➢ Device Weight: 105g
- ➢ Package Size / pcs : 14.5 x 8 x 5 cm
- ➢ Weight / pcs : 170g

8 Support

1. 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 above mentioned schedule.
2. Provide as much information as possible regarding your enquiry (product models, accurately describe your problem and steps to replicate it etc) and send an email to:

support@dragino.com

9 Reference

- Product Page
- Image Download
- AT Command Manual
- Hardware Source