LSN50 LoRa Sensor Node User Manual

Document Version: 1.6.1
Image Version: v1.6

Version	Description	Date
1.0	Release	2018-Dec-4
1.1	Add steps of install STM320x; Add ST-Link Upload firmware method	2018-Dec-27
1.2	Add trouble shooting for UART upload, Add change log for firmware v1.4	2019-Jan-23
1.2.1	More detail description for 8 channel mode and trouble shooting for using in US915/AU915	2019-Feb-21
1.2.2	Modify trouble shooting for upload via Flashloader	2019-Mar-13
1.2.3	Add ISP Mode / Flash mode different/ Add working flow diagram (Chapter 2.1 how it works) Add FAQ for how to configure the Keys	2019-Apr-1
1.5.0	Upgrade to v1.5 version firmware Add ultrasonic sensor support and description. Add downlink description Change decoder for v1.5 Add working flow chart Add Mydevices support	2019-Apr-19
1.5.1	Improve Interrupt feature, change interrupt example to use door sensor	
1.5.2	Various minor text and format edits.	2019-Jun-10
1.6.0	Update to firmware v1.6 version, add 3ADC mode	2019-Aug-7
1.6.1	Trouble shooting for AT Command input Add support for 3 * DS18B20 (MOD4)	2019-Sep-18
1.6.2	Add door sensor detail/ power, Add battery connector info	2019-Dec-13

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1. Introduction

1.1 What is LSN50 LoRa Sensor Node

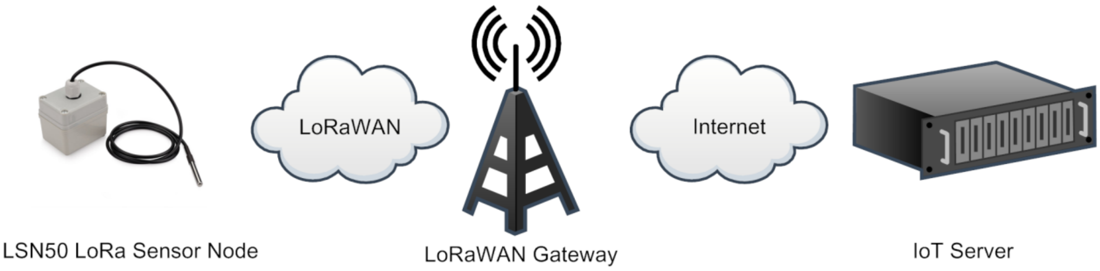
LSN50 is a Long Range LoRaWAN Sensor Node. It is designed for **outdoor data logging** and powered by **Li/SOCl2 battery** for long term use and secure data transmission. It is designed to facilitate developers to quickly deploy industrial level LoRa and IoT solutions. It helps users to turn the idea into a practical application and make the Internet of Things a reality. It is easy to program, create and connect your things everywhere.

It is based on SX1276/SX1278 allows the user 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. It targets professional wireless sensor network applications such as irrigation systems, smart metering, smart cities, smartphone detection, building automation, and so on.

LSN50 uses STM32l0x chip from ST, STML0x is the **ultra-low-power** STM32L072xx microcontrollers incorporate the connectivity power of the universal serial bus (USB 2.0 crystal-less) with the high-performance ARM® Cortex®-M0+ 32-bit RISC core operating at a 32 MHz frequency, a memory protection unit (MPU), high-speed embedded memories (192 Kbytes of Flash program memory, 6 Kbytes of data EEPROM and 20 Kbytes of RAM) plus an extensive range of enhanced I/Os and peripherals.

LSN50 is an **open source product**, it is based on the STM32Cube HAL drivers and lots of libraries can be found in ST site for rapid development.

LSN50 Network Structure



1.2 Specifications

Micro Controller:

- STM32L072CZT6 MCU
- MCU: STM32L072CZT6
- Flash: 192KB
- RAM: 20KB
- EEPROM: 6KB
- Clock Speed: 32Mhz

Common DC Characteristics:

- Supply Voltage: 2.1v ~ 3.6v
- Operating Temperature: -40 ~ 85°C
- I/O pins: Refer to STM32L072 datasheet

LoRa Spec:

- Frequency Range,
  - Band 1 (HF): 862 ~ 1020 Mhz

  or
  - 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.
- LoRaWAN 1.0.2 Specification

Battery:

- Li/SOCI2 un-chargeable battery
- Capacity: 4000mAh
- Self Discharge: <1% / Year @ 25°C
- Max continuously current: 130mA
- Max boost current: 2A, 1 second

Power Consumption

- STOP Mode: 2.7uA @ 3.3v
- LoRa Transmit Mode: 125mA @ 20dBm 44mA @ 14dBm

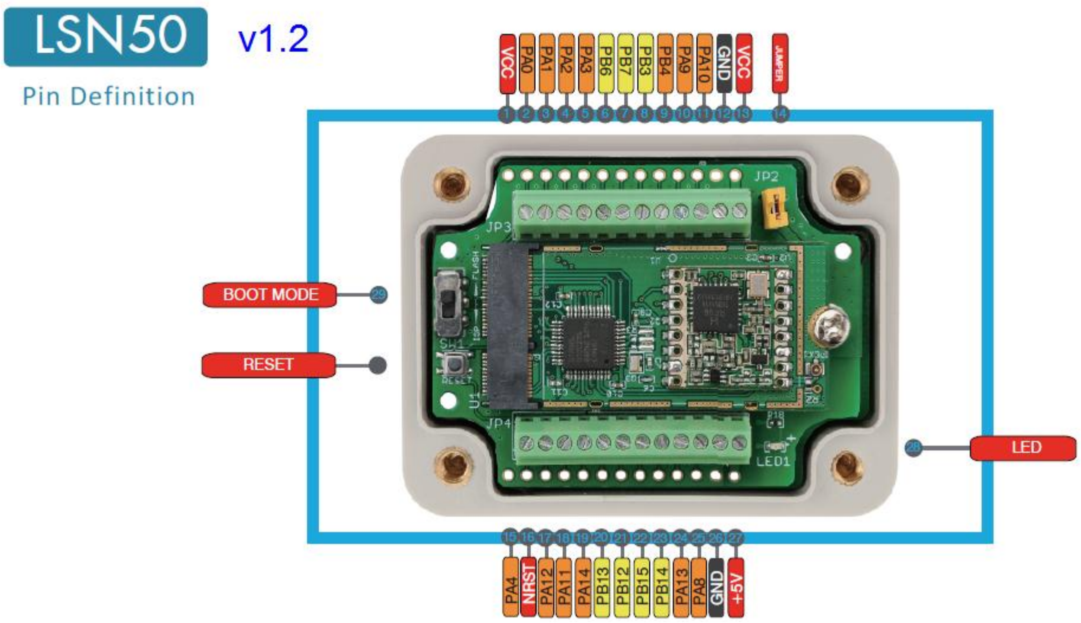
1.3 Features

- LoRaWAN 1.0.2 Class A,Class C
- STM32L072CZT6 MCU
- SX1276/78 Wireless Chip
- Pre-load bootloader on USART1/USART2
- MDK-ARM Version 5.24a IDE
- I2C, LPUSART1, USB, SPI2
- 3x12bit ADC, 1x12bit DAC
- 20xDigital I/Os
- LoRa™ Modem
- Preamble detection
- Baud rate configurable
- CN470/EU433/KR920/US915/IN865
- EU868/AS923/AU915
- Open source hardware / software
- Available Band:433/868/915/920 Mhz
- IP66 Waterproof Enclosure
- Ultra Low Power consumption
- AT Commands to change parameters
- 4000mAh Battery for long term use

1.4 Applications

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

1.5 Pin Definitions



Pin No.	Signal	Direction	Function	Remark
1	VCC(2.9V)	OUTPUT	VCC	Directly connect to main power for board
2	PA0	In/Out	Directly from STM32 chip	Used as ADC in LSN50 image
3	PA1	In/Out	Directly from STM32 chip	
4	PA2	In/Out	Directly from STM32 chip, 10k pull up to VCC	Used as UART_TXD in LSN50 image
5	PA3	In/Out	Directly from STM32 chip, 10k pull up to VCC	Used as UART_RXD in LSN50 image
6	PB6	In/Out	Directly from STM32 chip, 10k pull up to VCC	
7	PB7	In/Out	Directly from STM32 chip, 10k pull up to VCC	
8	PB3	In/Out	Directly from STM32 chip, 10k pull up to VCC	
9	PB4	In/Out	Directly from STM32 chip	
10	PA9	In/Out	Directly from STM32 chip, 10k pull up to VCC	
11	PA10	In/Out	Directly from STM32 chip, 10k pull up to VCC	
12	GND		Ground	
13	VCC(2.9V)	OUTPUT	VCC	Directly connect to main power for board
14	Jumper		Power on/off jumper	
15	PA4	In/Out	Directly from STM32 chip	
16	NRST	In	Reset MCU	

17	PA12	In/Out	Directly from STM32 chip	
18	PA11	In/Out	Directly from STM32 chip	
19	PA14	In/Out	Directly from STM32 chip	
20	PB13	In/Out	Directly from STM32 chip	
21	PB12	In/Out	Directly from STM32 chip	
22	PB15	In/Out	Directly from STM32 chip	
23	PB14	In/Out	Directly from STM32 chip	
24	PA13	In/Out	Directly from STM32 chip	
25	PA8	In/Out	Directly from STM32 chip	Default use to turn on/off LED1 in LSN50 image
26	GND		Ground	
27	+5V	Out	5v output power	Controlled by PB5(Low to Enable, High to Disable)
28	LED1		Controlled by PA8	Blink on transmit
29	BOOT MODE		Configure device in working mode or ISP program mode	Flash: Normal Working mode and send AT Commands ISP: UART Program Mode
30	NRST	In	Reset MCU	

1.6 Hardware Change log

<u>LSN50 v1.2</u>:

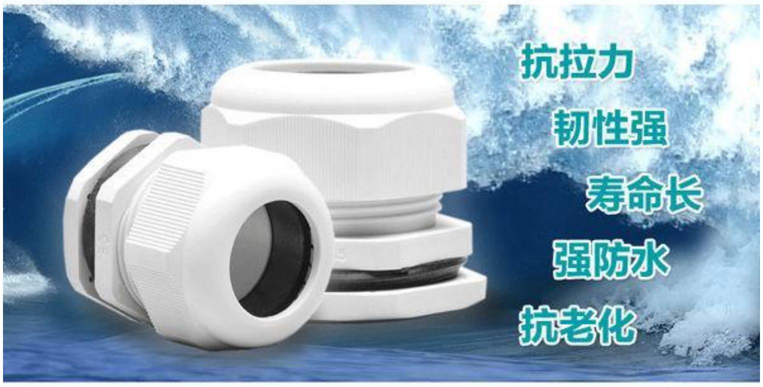
- Add LED. Turn on for every LoRa transmit
- Add pin PA4, PB13, NRST
- Add 5V Output, on/off control by PB5(Low to Enable, High to Disable)

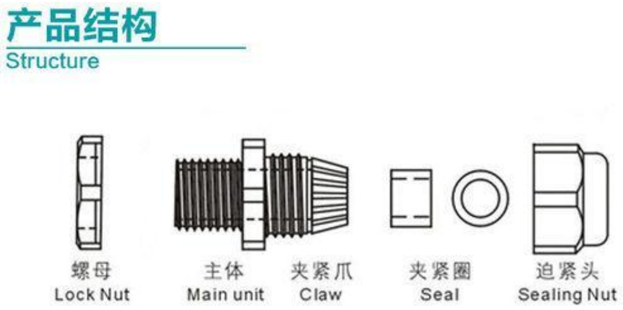
<u>LSN50 v1.3</u>:

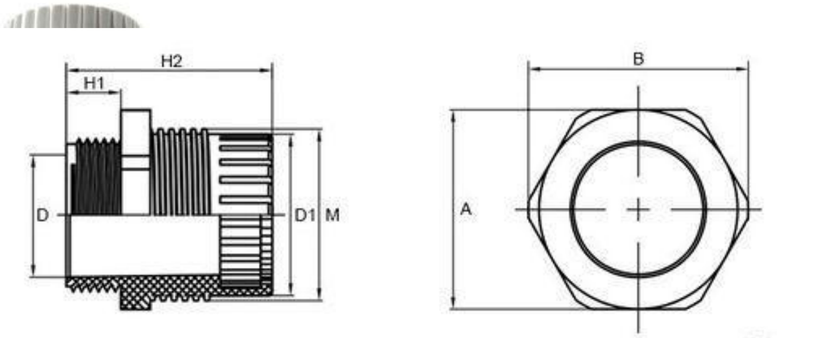
- Add P-MOS to control 5V output

1.7 Hole Option

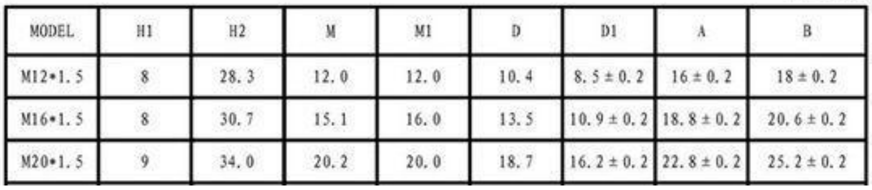
The LSN50 provides different hole size options for different size sensor cable. The options provided are M12, M16 and M20. The definition is as below:







单位：mm



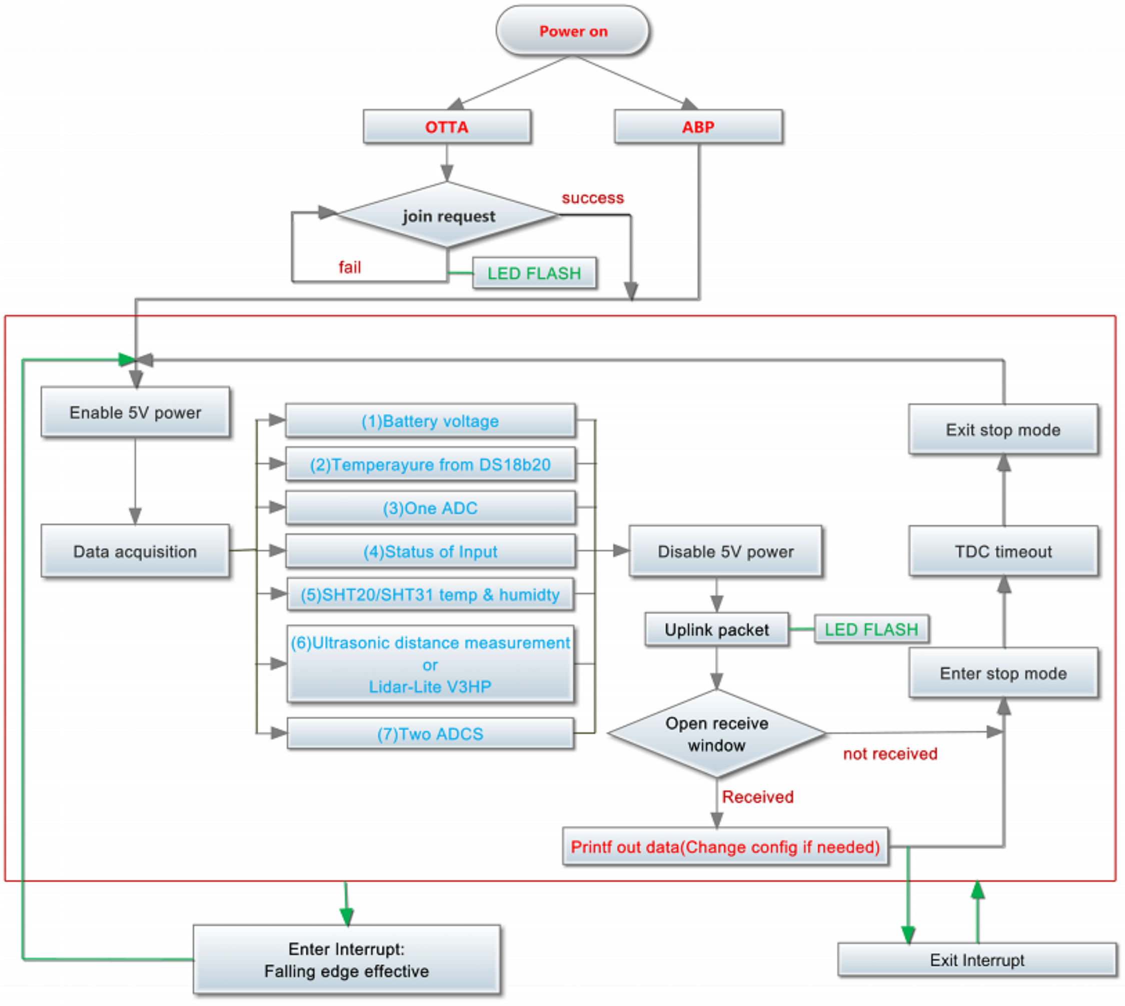
MODEL	H1	H2	M	M1	D	D1	A	B
M12•1.5	8	28.3	12.0	12.0	10.4	8.5±0.2	16±0.2	18±0.2
M16•1.5	8	30.7	15.1	16.0	13.5	10.9±0.2	18.8±0.2	20.6±0.2
M20•1.5	9	34.0	20.2	20.0	18.7	16.2±0.2	22.8±0.2	25.2±0.2

2. Use LSN50 with LoRaWAN firmware

2.1 How it works

The LSN50 is pre-loaded with a firmware and 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 just need to input the OTAA keys in the LoRaWAN IoT server and power on the LSN50. It will automatically join the network via OTAA.

The diagram below shows the working flow in default firmware (Ver 1.6):

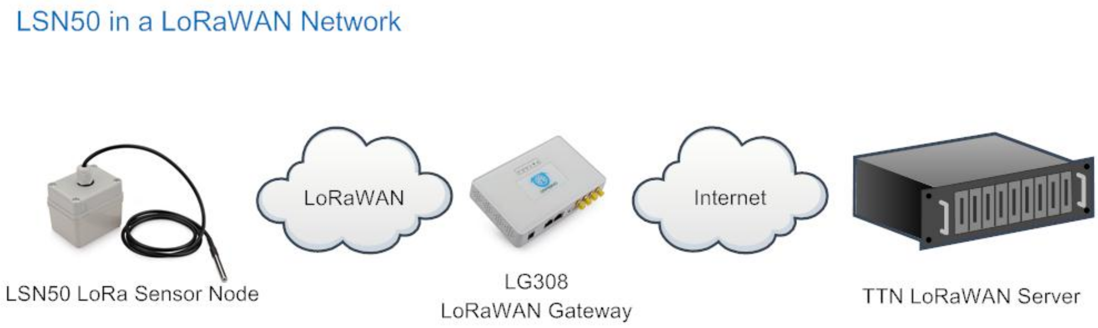


MOD=1(11 Payload)	IIC mode	(1,2,3,4,5)	(default mode)
MOD=2(11 Payload)	Distance mode	(1,2,3,4,6)	
MOD=3(12 Payload)	3ADCS mode	(1,3,4,5,7)	

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 LSN50.

2.2 Quick guide to connect to LoRaWAN server (OTAA)

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

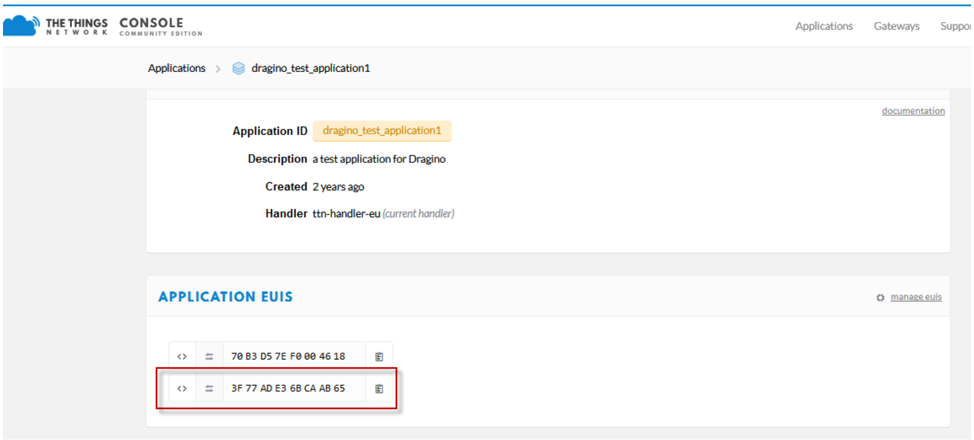


The LG308 is already set to connected to TTN network , so what we need to now is configure the TTN server.

Step 1: Create a device in TTN with the OTAA keys from LSN50.
Each LSN50 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:

Add APP EUI in the application



Application ID dragino_test_application1

Description a test application for Dragino

Created 2 years ago

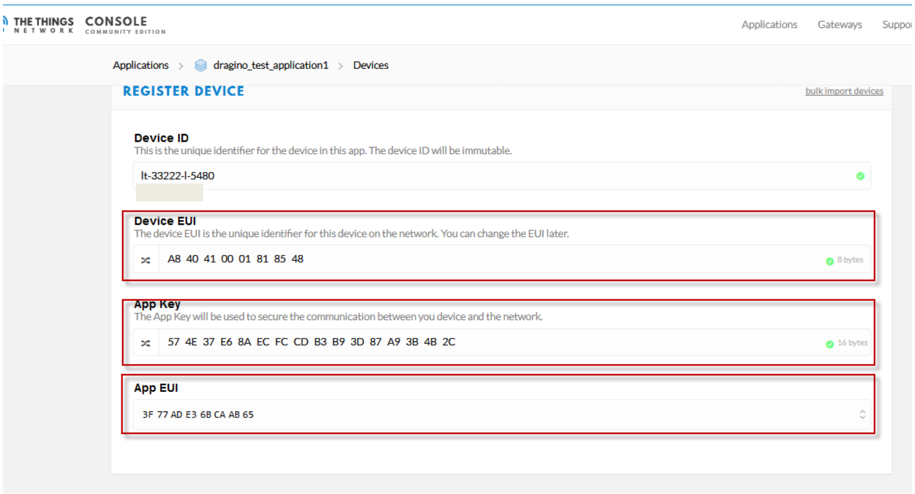
Handler ttn-handler-eu *(current handler)*

APPLICATION EUIS

70 B3 D5 7E F0 00 46 18

3F 77 AD E3 6B CA AB 65

Add APP KEY and DEV EUI


THE THINGS NETWORK
CONSOLE COMMUNITY EDITION
Applications
Gateways
Suppo
Applications > dragino_test_application1 > Devices
bulk import devices

REGISTER DEVICE

Device ID
This is the unique identifier for the device in this app. The device ID will be immutable.

lt-33222-l-5480

Device EUI
The device EUI is the unique identifier for this device on the network. You can change the EUI later.

A8 40 41 00 01 81 85 48 — 8 bytes

App Key
The App Key will be used to secure the communication between you device and the network.

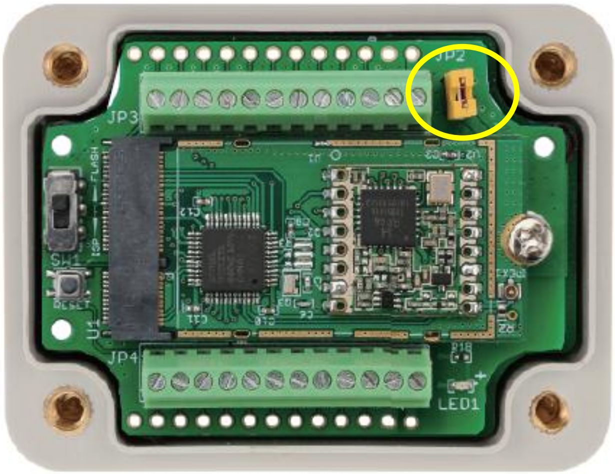
57 4E 37 E6 8A EC FC CD B3 B9 3D 87 A9 3B 4B 2C — 16 bytes

App EUI

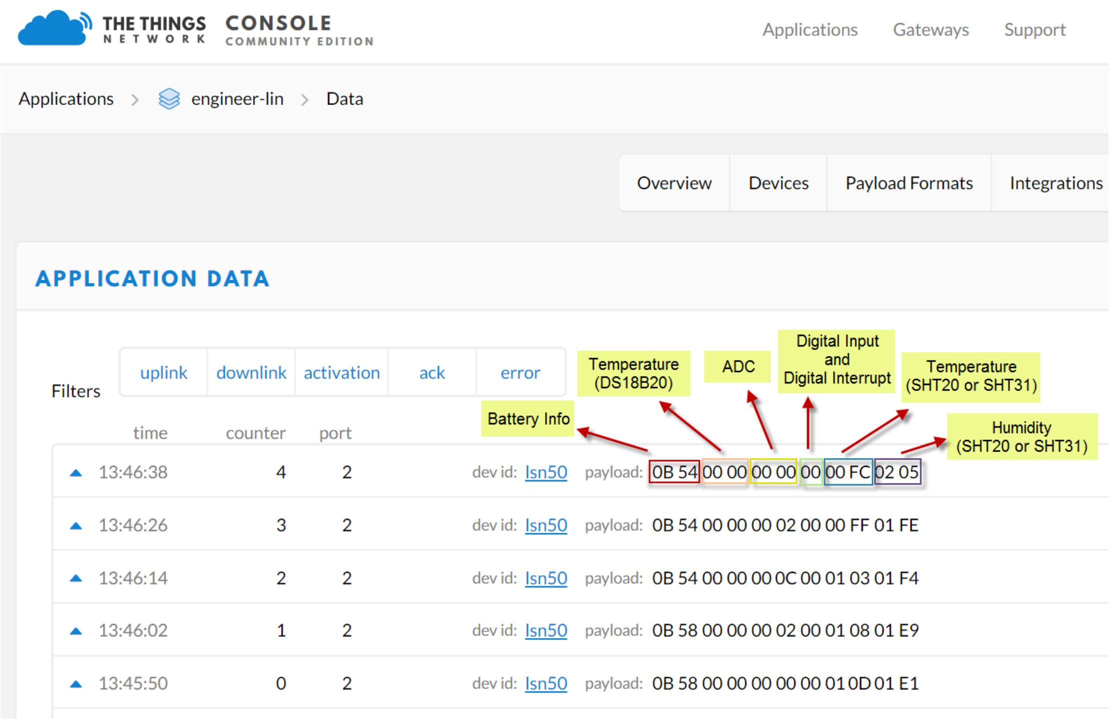
3F 77 AD E3 6B CA AB 65

Step 2: Power on LSN50

Put a Jumper on JP2 to power on the device.



Step 3: The LSN50 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.



Applications > engineer-lin > Data

APPLICATION DATA

Filters

	time	counter	port		
▲	13:46:38	4	2	dev id: lsn50	payload: 0B 54 00 00 00 00 00 00 FC 02 05
▲	13:46:26	3	2	dev id: lsn50	payload: 0B 54 00 00 00 02 00 00 FF 01 FE
▲	13:46:14	2	2	dev id: lsn50	payload: 0B 54 00 00 00 0C 00 01 03 01 F4
▲	13:46:02	1	2	dev id: lsn50	payload: 0B 58 00 00 00 02 00 01 08 01 E9
▲	13:45:50	0	2	dev id: lsn50	payload: 0B 58 00 00 00 00 00 01 0D 01 E1

2.3 Working Mode & Uplink Payload

LSN50 has different working mode for the connections of different type of sensors. This section describes these modes. Use can use the AT Command AT+MOD to set LSN50 to different working modes.

For example:
AT+MOD=2 // will set the LSN50 to work in MOD=2 distance mode which target to measure distance via Ultrasonic Sensor.

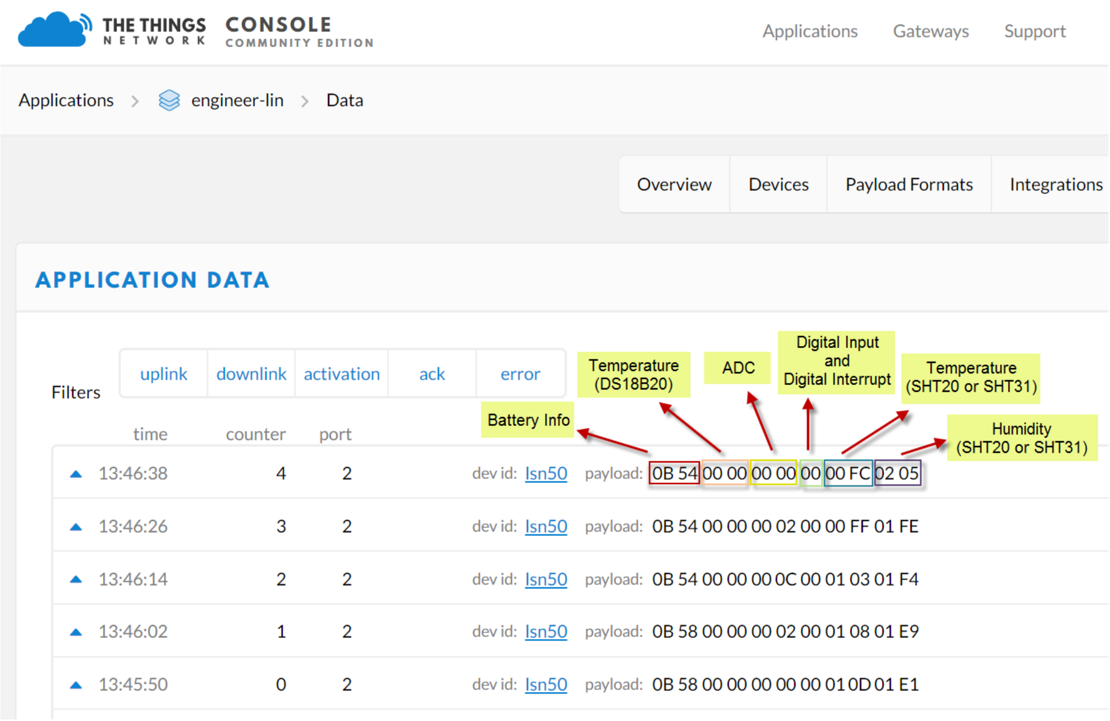
NOTE:

1. Some working modes has payload more than 12 bytes, The US915/AU915/AS923 frequency bands' definition has maximum 11 bytes in **DR0**. Server sides will see NULL payload while LSn50 transmit in DR0 with 12 bytes payload.
2. All modes share the same Payload Explanation from HERE.
3. By default, the device will send an uplink message every 10 minutes.

2.3.1 MOD=1 (Default Mode)

In this mode , uplink payload includes in total 11 bytes. Uplink packets use FPORT=2.

Size(bytes)	**2**	**2**	**1**	**2**	**2**	**2**
Value	BAT	Temperature (DS18B20)	Digital in & Digital Interrupt	ADC	Temperature (SHT20 or SHT31 or Ultrasonic Sensor)	Humidity (SHT20)

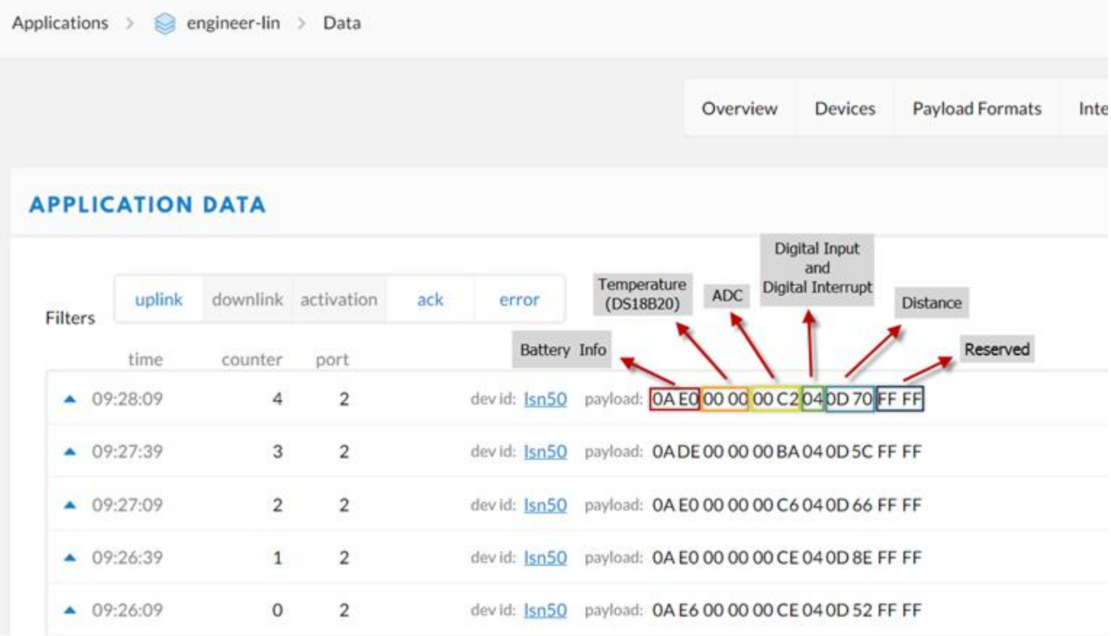

THE THINGS NETWORK CONSOLE COMMUNITY EDITION
Applications
Gateways
Support
Applications > engineer-lin > Data
Overview
Devices
Payload Formats
Integrations
APPLICATION DATA
Filters
uplink
downlink
activation
ack
error
Temperature (DS18B20)
ADC
Digital Input and Digital Interrupt
Temperature (SHT20 or SHT31)
Battery Info
Humidity (SHT20 or SHT31)

```
time       counter  port
13:46:38   4        2     dev id: lsn50   payload: 0B 54 00 00 00 00 00 00 FC 02 05
13:46:26   3        2     dev id: lsn50   payload: 0B 54 00 00 00 02 00 00 FF 01 FE
13:46:14   2        2     dev id: lsn50   payload: 0B 54 00 00 00 0C 00 01 03 01 F4
13:46:02   1        2     dev id: lsn50   payload: 0B 58 00 00 00 02 00 01 08 01 E9
13:45:50   0        2     dev id: lsn50   payload: 0B 58 00 00 00 00 00 01 0D 01 E1
```

2.3.2 MOD=2 (Distance Mode)

This mode is target to measure the distance. The payload of this mode is totally 11 bytes. The 8th and 9th bytes is for the distance.

Size(bytes)	**2**	**2**	**1**	**2**	**2**	**2**
Value	BAT	Temperature (DS18B20)	Digital in & Digital Interrupt	ADC	Distance measure by: 1) LIDAR-Lite V3HP Or 2) Ultrasonic Sensor	Humidity (SHT20)



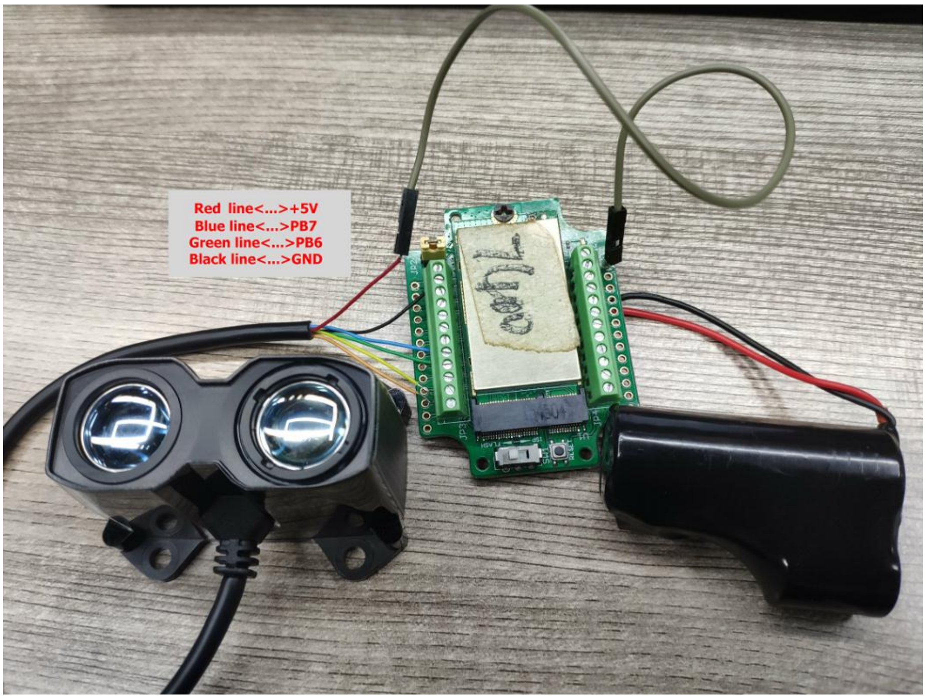
Applications > engineer-lin > Data

APPLICATION DATA

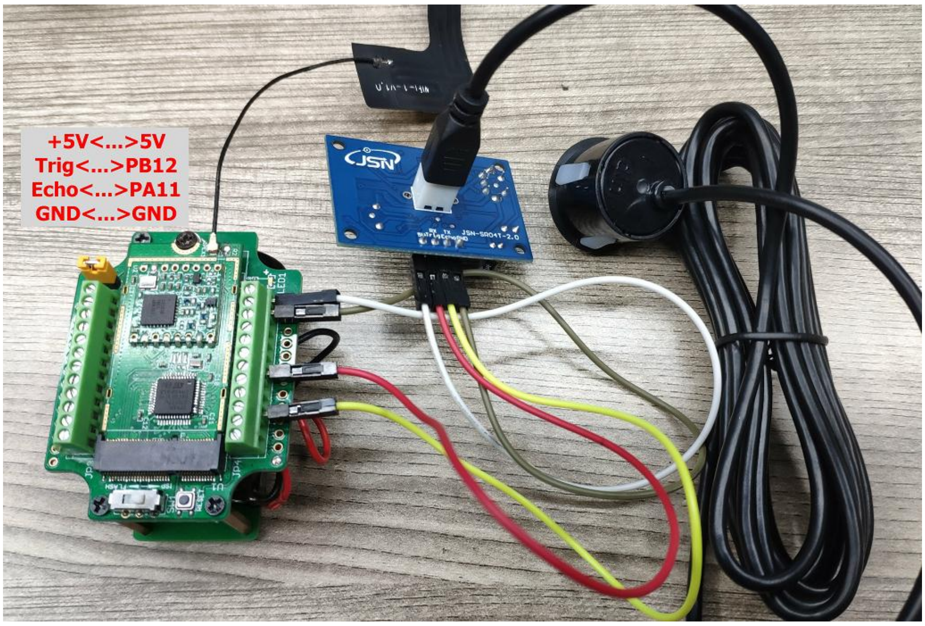
Filters: uplink | downlink | activation | ack | error

time	counter	port		
09:28:09	4	2	dev id: lsn50	payload: 0A E0 00 00 00 C2 04 0D 70 FF FF
09:27:39	3	2	dev id: lsn50	payload: 0A DE 00 00 00 BA 04 0D 5C FF FF
09:27:09	2	2	dev id: lsn50	payload: 0A E0 00 00 00 C6 04 0D 66 FF FF
09:26:39	1	2	dev id: lsn50	payload: 0A E0 00 00 00 CE 04 0D 8E FF FF
09:26:09	0	2	dev id: lsn50	payload: 0A E6 00 00 00 CE 04 0D 52 FF FF

Connection of LIDAR-Lite V3HP:



Connection to Ultrasonic Sensor:

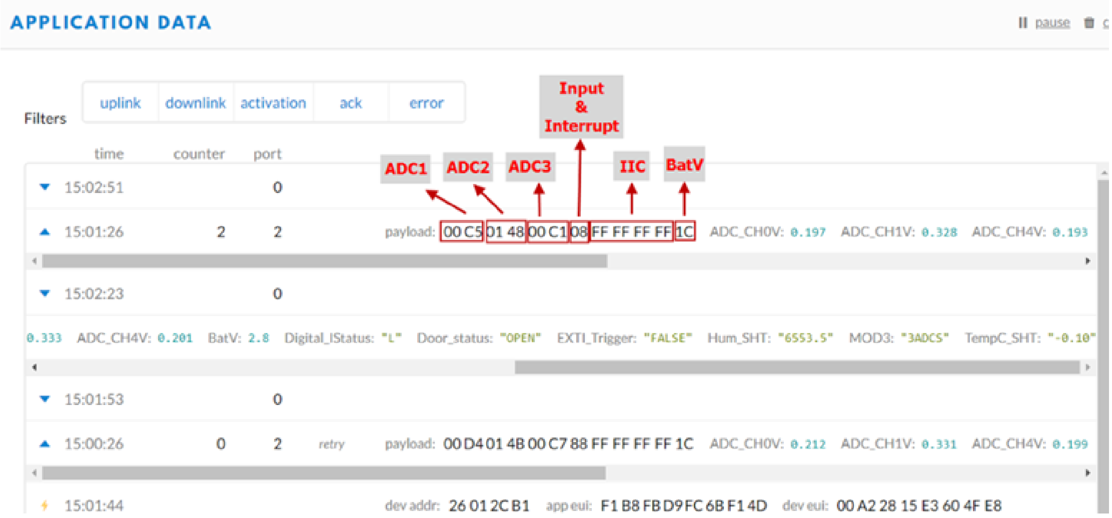


While connecting to Ultrasonic sensor, the sleep current will jump to 250uA. It is recommend to use external power source for ultrasonic sensor.

2.3.3 MOD=3 (3 ADC + I2C)

This mode has total 12 bytes. Include 3 x ADC + 1x I2C

Size(bytes)	**2**	**2**	**2**	**1**	**2**	**2**	**1**
Value	ADC1 (Pin PA0)	ADC2 (PA1)	ADC3 (PA4)	Digital in & Digital Interrupt	Temperature (SHT20 or SHT31)	Humidity (SHT20 or SHT31)	BAT

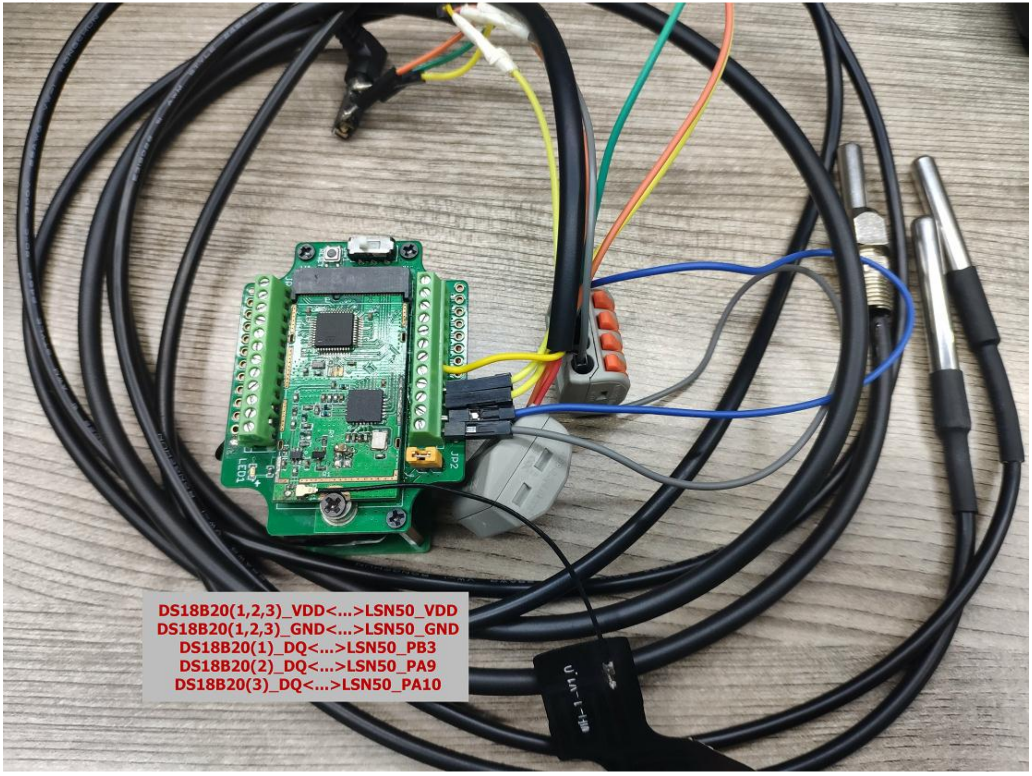


```
time      counter  port
15:02:51            0
15:01:26     2      2          payload: 00 C5 01 48 00 C1 08 FF FF FF FF 1C  ADC_CH0V: 0.197  ADC_CH1V: 0.328  ADC_CH4V: 0.193
15:02:23            0
0.333  ADC_CH4V: 0.201  BatV: 2.8  Digital_IStatus: "L"  Door_status: "OPEN"  EXTI_Trigger: "FALSE"  Hum_SHT: "6553.5"  MOD3: "3ADCS"  TempC_SHT: "-0.10"
15:01:53            0
15:00:26     0      2   retry  payload: 00 D4 01 4B 00 C7 88 FF FF FF FF 1C  ADC_CH0V: 0.212  ADC_CH1V: 0.331  ADC_CH4V: 0.199
15:01:44                       dev addr: 26 01 2C B1  app eui: F1 B8 FB D9 FC 6B F1 4D  dev eui: 00 A2 28 15 E3 60 4F E8
```

2.3.4 MOD=4 (3 x DS18B20)

This mode is supported in firmware version since v1.6.1

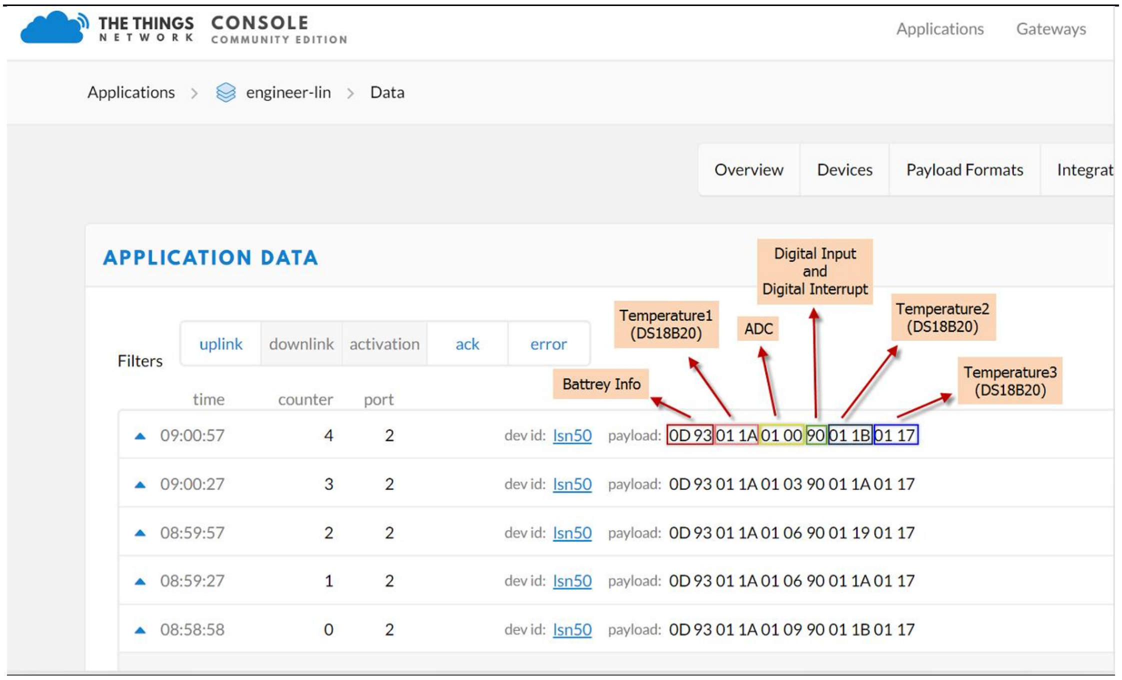
Hardware connection is as below, (Note: R3 & R4 should change from 10k to 4.7k to support DS18B20, Software set to AT+MOD=4)



DS18B20(1,2,3)_VDD<...>LSN50_VDD
DS18B20(1,2,3)_GND<...>LSN50_GND
DS18B20(1)_DQ<...>LSN50_PB3
DS18B20(2)_DQ<...>LSN50_PA9
DS18B20(3)_DQ<...>LSN50_PA10

This mode has total 11 bytes. As shown below:

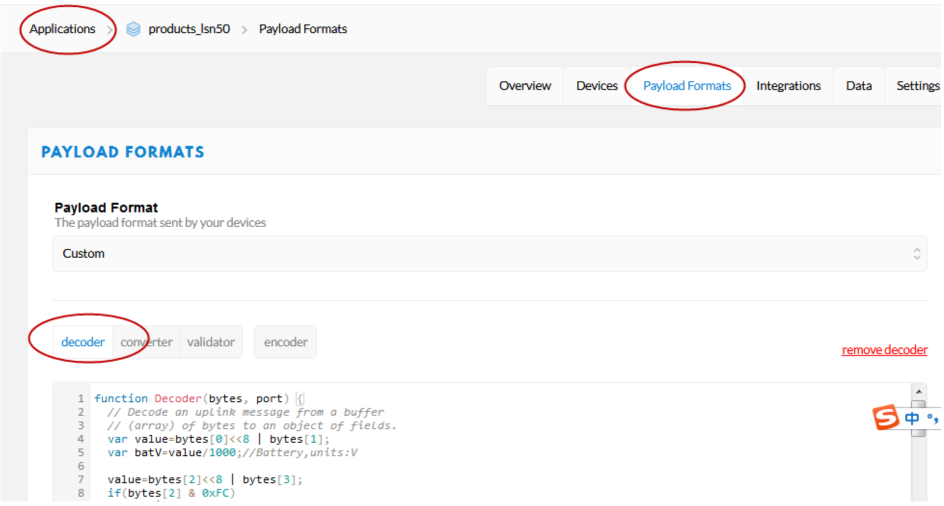
Size(bytes)	2	2	2	1	2	2
Value	BAT	Temperature1 (DS18B20) (PB3)	ADC	Digital in & Digital Interrupt	Temperature2 (DS18B20) (PA9)	Temperature3 (DS18B20) (PA10)



time	counter	port		
▲ 09:00:57	4	2	dev id: lsn50	payload: 0D 93 01 1A 01 00 90 01 1B 01 17
▲ 09:00:27	3	2	dev id: lsn50	payload: 0D 93 01 1A 01 03 90 01 1A 01 17
▲ 08:59:57	2	2	dev id: lsn50	payload: 0D 93 01 1A 01 06 90 01 19 01 17
▲ 08:59:27	1	2	dev id: lsn50	payload: 0D 93 01 1A 01 06 90 01 1A 01 17
▲ 08:58:58	0	2	dev id: lsn50	payload: 0D 93 01 1A 01 09 90 01 1B 01 17

2.3.5 Decode payload in The Things Network

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



Payload Format
The payload format sent by your devices
Custom

```
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

  value=bytes[2]<<8 | bytes[3];
  if(bytes[2] & 0xFC)
```

The payload decoding function is as follows:

```
function Decoder(bytes, port) {
 // Decode an uplink message from a buffer
 // (array) of bytes to an object of fields.
 if(bytes[6] & 0x10)
 {
   var mod4="3DS18B20";  //work mode
 }

 else if(bytes[6] & 0x08)
 {
   var mod3="3ADC";  //work mode
```

```
}

else if(bytes[6] & 0x04)
{
  var mod2="Distance";  //work mode
}

else if(!(bytes[6] & 0x04))
{
  var mod1="IIC";  //work mode
}

if(mod3=="3ADC")
{
var adc_ch0=(bytes[0]<<8 | bytes[1])/1000;//PA0,ADC Channel 0,units:V

var adc_ch1=(bytes[2]<<8 | bytes[3])/1000;//PA1,ADC Channel 1,units:V

var adc_ch4=(bytes[4]<<8 | bytes[5])/1000;//PA4,ADC Channel 4,units:V

var switch_=(bytes[6] & 0x80)? "CLOSE":"OPEN";//PB14,GPIO_MODE_IT_FALLING

var digital_IS=(bytes[6] & 0x02)? "H":"L";//PA12，  Digital Input Status

var exti_trigger=(bytes[6] & 0x01)? "TRUE":"FALSE";//PB14,GPIO_MODE_IT_FALLING

value=bytes[7]<<8 | bytes[8];
if(bytes[7] & 0x80)
{value |= 0xFFFF0000;}
var temp_SHT=(value/10).toFixed(2);//SHT20,temperature,units:℃

value=bytes[9]<<8 | bytes[10];
var hum_SHT=(value/10).toFixed(1);//SHT20,Humidity,units:%

var batV= bytes[11]/10;//Battery,units:V
}

else if((mod1=="IIC")||(mod2=="Distance")||(mod4=="3DS18B20"))
{
var value=bytes[0]<<8 | bytes[1];
batV=value/1000;//Battery,units:V

value=bytes[2]<<8 | bytes[3];
if(bytes[2] & 0x80)
{value |= 0xFFFF0000;}
var tempc1=(value/10).toFixed(2);//DS18B20,PB3,units:℃

adc_ch0=(bytes[4]<<8 | bytes[5])/1000;//PA0,ADC Channel 0,units:V

switch_=(bytes[6] & 0x80)? "CLOSE":"OPEN";//PB14,GPIO_MODE_IT_FALLING

digital_IS=(bytes[6] & 0x02)? "H":"L";//PA12，  Digital Input Status

exti_trigger=(bytes[6] & 0x01)? "TRUE":"FALSE";//PB14,GPIO_MODE_IT_FALLING

if(mod1=="IIC")
{
value=bytes[7]<<8 | bytes[8];
if(bytes[7] & 0x80)
{value |= 0xFFFF0000;}
temp_SHT=(value/10).toFixed(2);//SHT20,temperature,units:℃

value=bytes[9]<<8 | bytes[10];
```

```
 hum_SHT=(value/10).toFixed(1);//SHT20,Humidity,units:%

}
 else if(mod2=="Distance")
{
 value=bytes[7]<<8 | bytes[8];
 var distance=(value/10) .toFixed(1); // Distance,units:cm
}

 else if(mod4=="3DS18B20")
 {
 value=bytes[7]<<8 | bytes[8];
 if(bytes[7] & 0x80)
 {value |= 0xFFFF0000;}
 var tempc2=(value/10).toFixed(2);//DS18B20,PB3,units:℃

 value=bytes[9]<<8 | bytes[10];
 if(bytes[9] & 0x80)
 {value |= 0xFFFF0000;}
 var tempc3=(value/10).toFixed(2);//DS18B20,PB3,units:℃

}
 }

 return {
 BatV:batV,
 TempC1:tempc1,
 TempC2:tempc2,
 TempC3:tempc3,
 ADC_CH0V:adc_ch0,
 ADC_CH1V:adc_ch1,
 ADC_CH4V:adc_ch4,
 Digital_IStatus:digital_IS,
 EXTI_Trigger:exti_trigger,
 Door_status:switch_,
 MOD1:mod1,
 MOD2:mod2,
 MOD3:mod3,
 MOD4:mod4,
 Distance: distance,
 TempC_SHT:temp_SHT,
 Hum_SHT:hum_SHT
 };
}
```

2.4 Payload Explanation and Sensor Interface

2.4.1 Battery Info

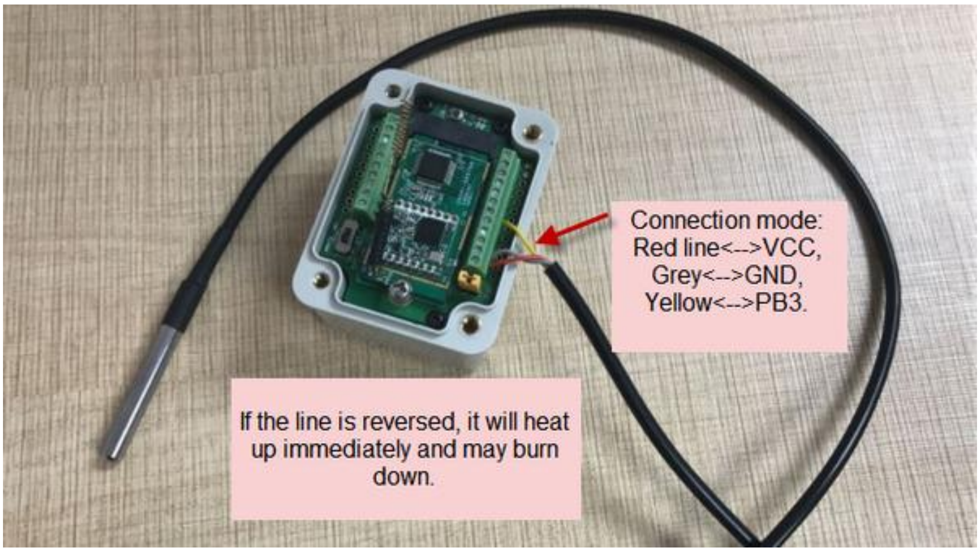
Check the battery voltage for LSN50.
Ex1: 0x0B45 = 2885mV
Ex2: 0x0B49 = 2889mV

2.4.2 Temperature (DS18B20)

If there is a DS18B20 connected to PB3 pin. The temperature will be uploaded in the payload.

More DS18B20 can check the 3 DS18B20 mode

Connection


Connection mode:
Red line<-->VCC,
Grey<-->GND,
Yellow<-->PB3.
If the line is reversed, it will heat up immediately and may burn down.

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.

2.4.3 Digital Input

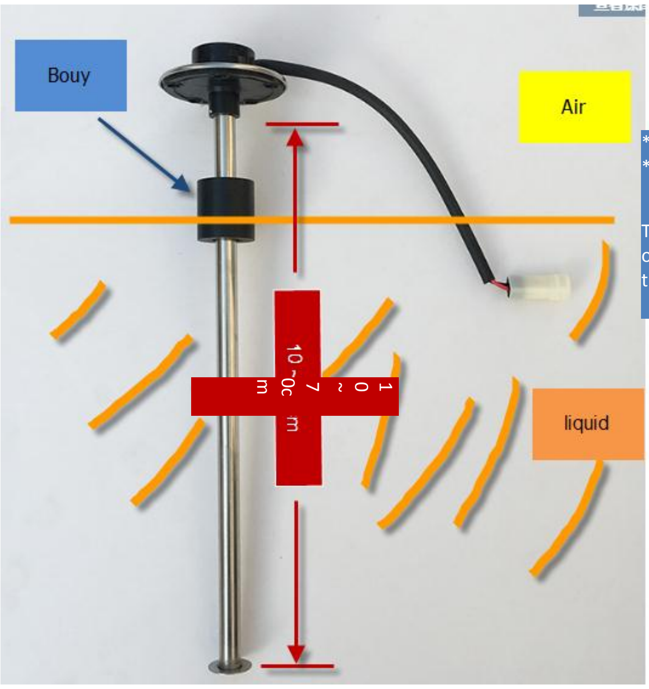
The digital input for pin PA12,

- When PA12 is high, the bit2 of payload byte 6 is 1.
- When PA12 is low, the bit2 of payload byte 6 is 0.

2.4.4 Analogue Digital Converter (ADC)

The ADC monitors the voltage on the PA0 line, in mV.
Ex: 0x021F = 543mv,

Example1: Reading an Oil Sensor (Read a resistance value):



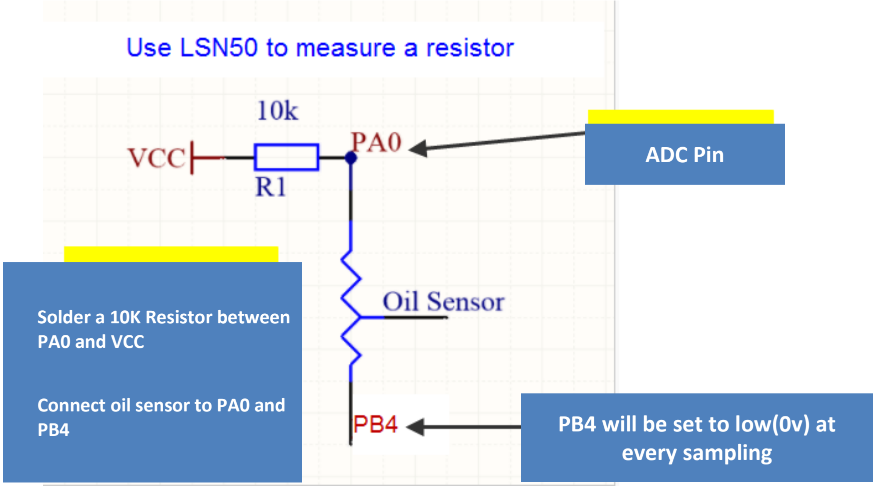
* Bouy on top, the oil sensor act as a 10K resistor.
* Bouy on bottom, it act as a 0ohm resistor,

To get the deep for the liquid, we can measure the output resistance for oil sensor and calculate where the bouy is so to calculate the height of oil.

In the LSN50, we can use PB4 and PA0 pin to calculate the resistance for the oil sensor.

Steps:
1. Solder a 10K resistor between PA0 and VCC.
2. Screw oil sensor's two pins to PA0 and PB4.

The equipment circuit is as below:



ADC Pin

Solder a 10K Resistor between PA0 and VCC

Connect oil sensor to PA0 and PB4

PB4 will be set to low(0v) at every sampling

According to above diagram:

$$(VCC - V_{PA0} \frac{}{10} k = \frac{V_{PA0}}{R_{oil_{sensor}}}$$

So

$$R_{oil_{sensor}} = V_{PA0} \times 10 \frac{K}{(VCC - V_{PA0})}$$

V_{PA0} is the reading of ADC. So if ADC=0x05DC=0.9 v and VCC (BAT) is 2.9v

The $R_{oil_{sensor}} = 0.9 \times \frac{10K}{2.9-0.9} = 4.5\text{K ohm}$

Since the Bouy is linear resistance from 10 ~ 70cm.

The position of Bouy is $\frac{4.5K}{10K} \times (70cm - 10cm) + 10cm = 37cm$, from the bottom of Bouy

2.4.5 Digital Interrupt

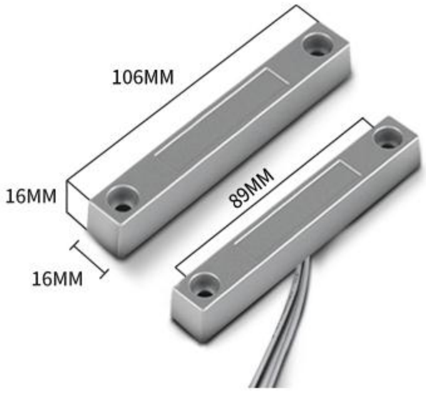
Digital Interrupt refers to pin PB14, and there are different trigger methods. When there is a trigger, the LSN50 will send a packet to the server.

Example to use with door sensor

(Requires firmware > 1.5.1)

The door sensor is shown at right. It is a two wire magnetic contact switch used for detecting the open/close status of doors or windows.

When the two pieces are close to each other, the 2 wire output will be short or open (depending on the type), while if the two pieces are away from each other, the 2 wire output will be the opposite status. So we can use LSN50 interrupt interface to detect the status for the door or window.



Below is the installation example:

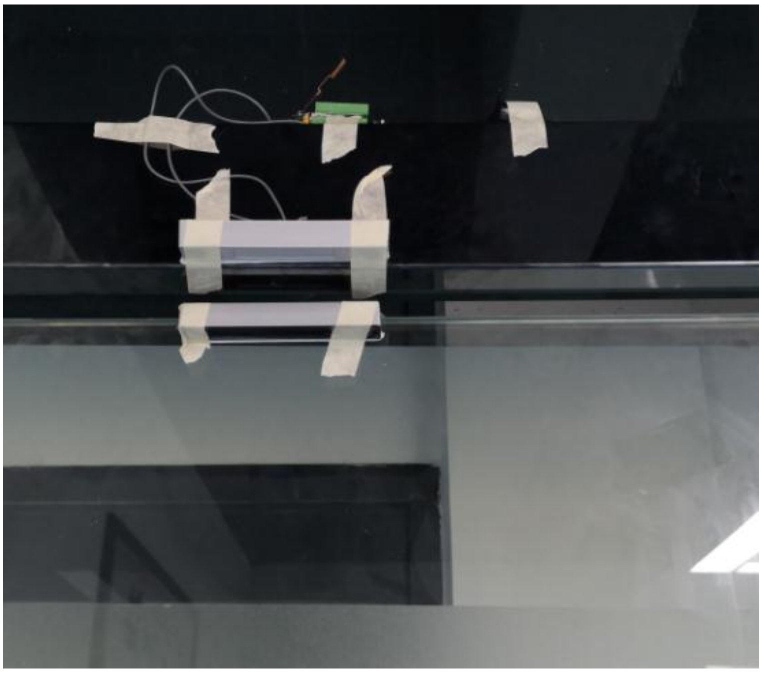
Fix one piece of the magnetic sensor to the door and connect the two pins to LSN50 as follows:

- One pin to LSN50's PB14 pin
- The other pin to LSN50's VCC pin

Install the other piece to the door. Find a place where the two pieces will be close to each other when the door is closed. For this particular magnetic sensor, when the door is closed, the output will be short, and PB14 will be at the VCC voltage.

Door sensors have two types: NC (Normal close) and NO (normal open). The connection for both type sensors are the same. But the decoding for payload are reverse, user need to modify this in the IoT Server decoder.

When door sensor is shorted, there will extra power consumption in the circuit, the extra current is 3v3/R14 = 3v2/1Mohm = 0.3uA which can be ignored.



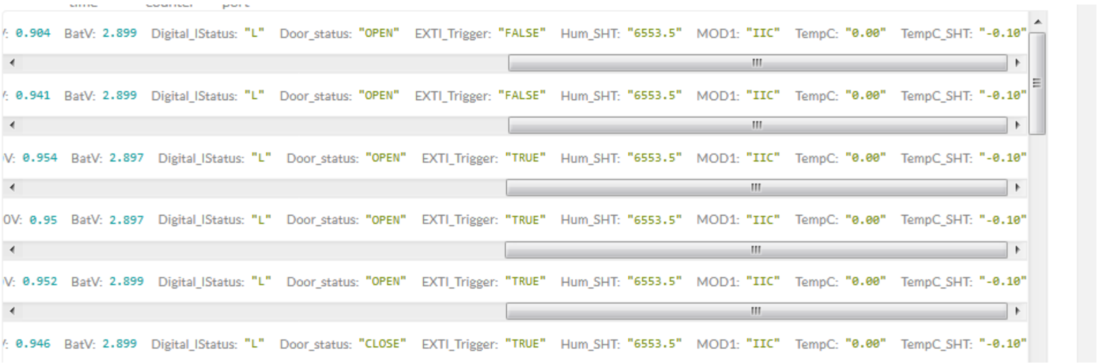
The above photos shows the two parts of the magnetic switch fitted to a door.

The software by default uses the falling edge on the signal line as an interrupt. We need to modify it to accept both the rising edge (0v --> VCC , door close) and the falling edge (VCC --> 0v , door open) as the interrupt.

The command is:

AT+INTMOD=1 //(more info about INMOD please refer AT Command Manual.)

Below shows some screen captures in TTN:



```
/: 0.904  BatV: 2.899  Digital_IStatus: "L"  Door_status: "OPEN"  EXTI_Trigger: "FALSE"  Hum_SHT: "6553.5"  MOD1: "IIC"  TempC: "0.00"  TempC_SHT: "-0.10"
/: 0.941  BatV: 2.899  Digital_IStatus: "L"  Door_status: "OPEN"  EXTI_Trigger: "FALSE"  Hum_SHT: "6553.5"  MOD1: "IIC"  TempC: "0.00"  TempC_SHT: "-0.10"
V: 0.954  BatV: 2.897  Digital_IStatus: "L"  Door_status: "OPEN"  EXTI_Trigger: "TRUE"  Hum_SHT: "6553.5"  MOD1: "IIC"  TempC: "0.00"  TempC_SHT: "-0.10"
0V: 0.95  BatV: 2.897  Digital_IStatus: "L"  Door_status: "OPEN"  EXTI_Trigger: "TRUE"  Hum_SHT: "6553.5"  MOD1: "IIC"  TempC: "0.00"  TempC_SHT: "-0.10"
V: 0.952  BatV: 2.899  Digital_IStatus: "L"  Door_status: "OPEN"  EXTI_Trigger: "TRUE"  Hum_SHT: "6553.5"  MOD1: "IIC"  TempC: "0.00"  TempC_SHT: "-0.10"
/: 0.946  BatV: 2.899  Digital_IStatus: "L"  Door_status: "CLOSE"  EXTI_Trigger: "TRUE"  Hum_SHT: "6553.5"  MOD1: "IIC"  TempC: "0.00"  TempC_SHT: "-0.10"
```

In MOD=1, user can use byte 6 to see the status for door open or close. TTN decoder is as below:

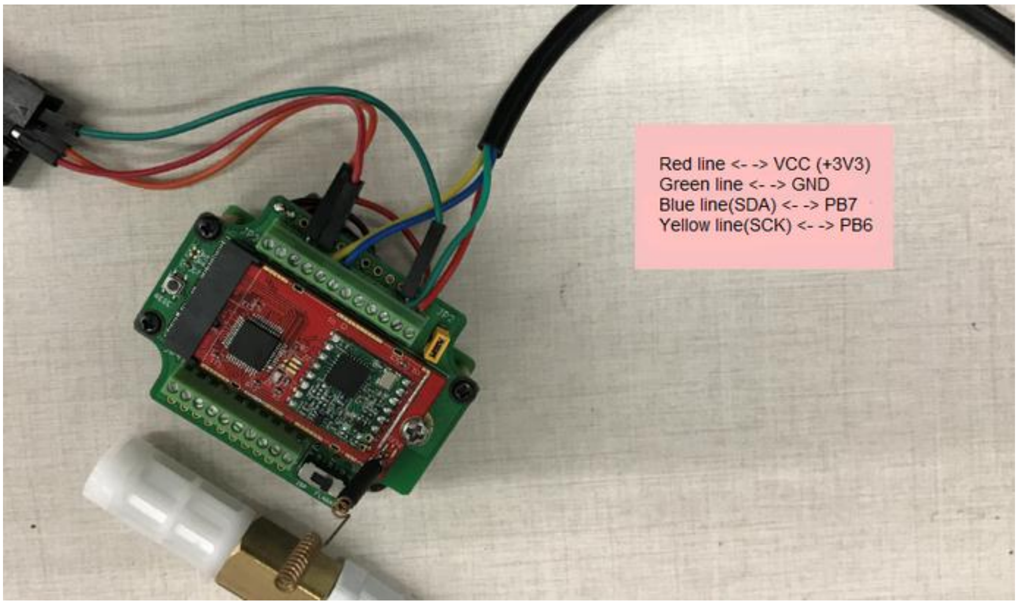
```
switch_=(bytes[6] & 0x80)? "CLOSE":"OPEN";//PB14,GPIO_MODE_IT_FALLING
```

2.4.6 I2C Interface (SHT20)

The PB6(SDA) and PB7(SCK) are I2C interface lines. You can use these to connect to an I2C device and get the sensor data.

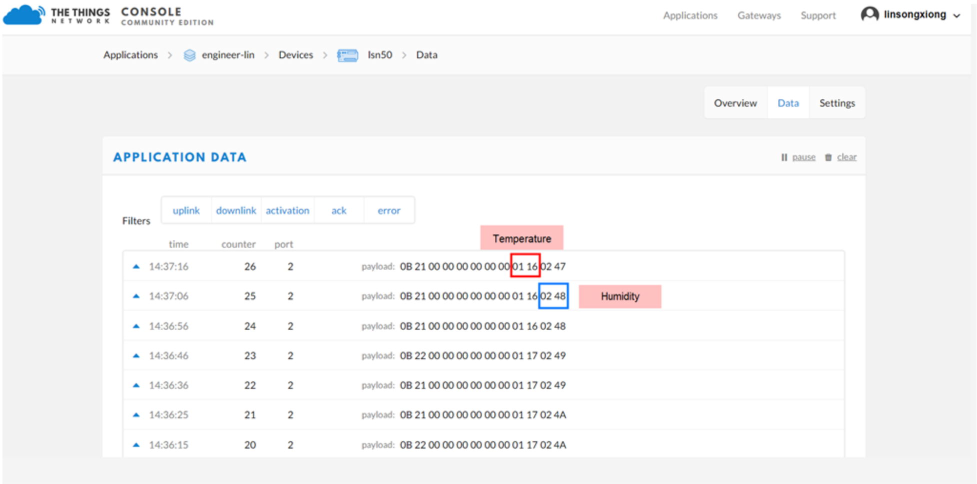
We have made an example to show how to use the I2C interface to connect to the SHT20 Temperature and Humidity Sensor. This is supported in the stock firmware since v1.5 with **AT+MOD=1 (default value).**

Below is the connection to SHT20.



Red line <- -> VCC (+3V3)
Green line <- -> GND
Blue line(SDA) <- -> PB7
Yellow line(SCK) <- -> PB6

The device will be able to get the I2C sensor data now and upload to IoT Server.



```
time      counter  port
14:37:16  26       2     payload: 0B 21 00 00 00 00 00 00 01 16 02 47
14:37:06  25       2     payload: 0B 21 00 00 00 00 00 00 01 16 02 48
14:36:56  24       2     payload: 0B 21 00 00 00 00 00 00 01 16 02 48
14:36:46  23       2     payload: 0B 22 00 00 00 00 00 00 01 17 02 49
14:36:36  22       2     payload: 0B 21 00 00 00 00 00 00 01 17 02 49
14:36:25  21       2     payload: 0B 21 00 00 00 00 00 00 01 17 02 4A
14:36:15  20       2     payload: 0B 22 00 00 00 00 00 00 01 17 02 4A
```

Convert the read byte to decimal and divide it by ten.

Example:

Temperature: Read:0116(H) = 278(D) Value: 278 /10=27.8℃;
Humidity: Read:0248(H)=584(D) Value: 584 / 10=58.4, So 58.4%

If you want to use other I2C device, please refer the SHT20 part source code as reference.

2.4.7 Distance Reading

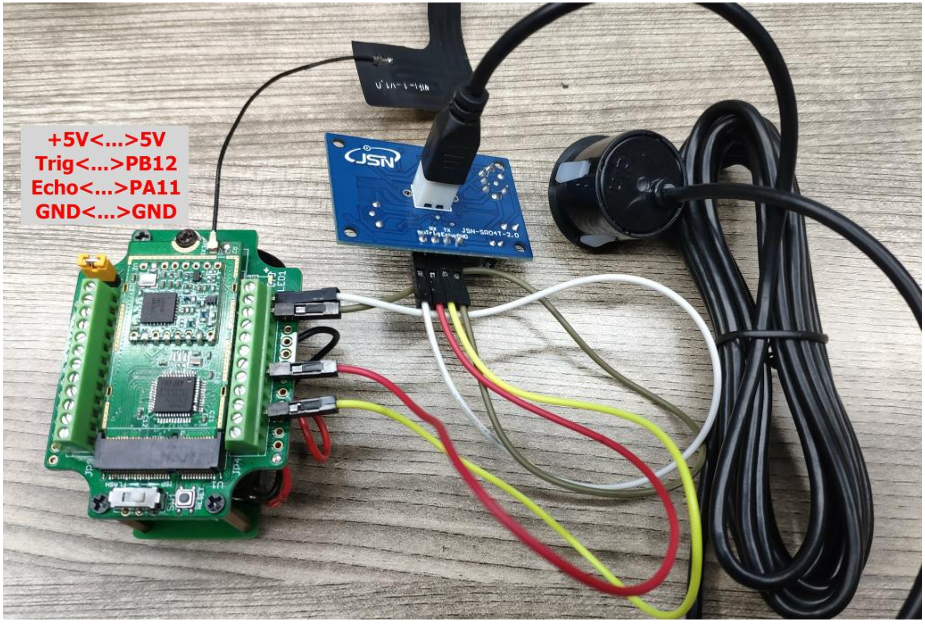
Refer Ultrasonic Sensor section.

2.4.8 Ultrasonic Sensor

The LSN50 v1.5 firmware supports ultrasonic sensor (with AT+MOD=2) such as SEN0208 from DF-Robot. This Fundamental Principles of this sensor can be found at this link: https://wiki.dfrobot.com/Weather_-_proof_Ultrasonic_Sensor_with_Separate_Probe_SKU___SEN0208

The LSN50 detects the pulse width of the sensor and converts it to mm output. The accuracy will be within 1 centimeter. The usable range (the distance between the ultrasonic probe and the measured object) is between 24cm and 600cm.

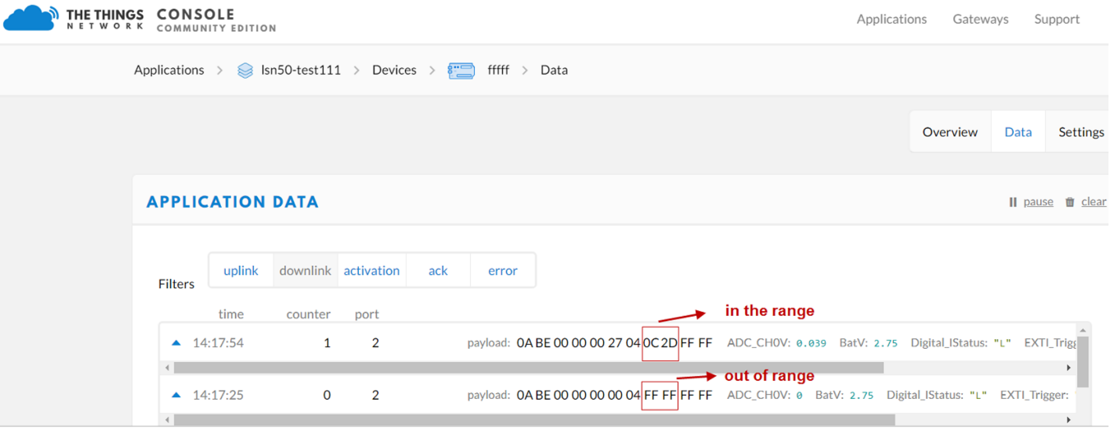
The picture below shows the connection:



Connect to the LSN50 and run **AT+MOD=2** to switch to ultrasonic mode (ULT). The ultrasonic sensor uses the 8th and 9th byte for the measurement value.

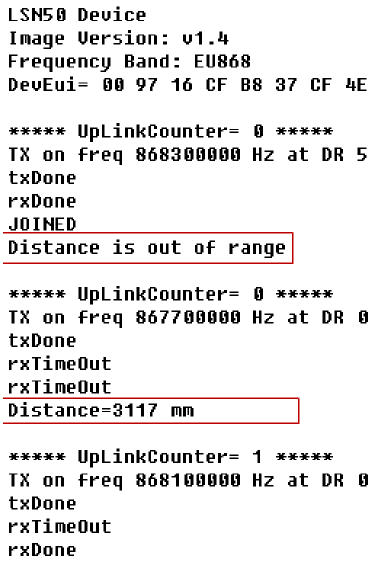
Example:

Distance: Read:0C2D(Hex) = 3117(D) Value: 3117 mm=311.7 cm



```
time      counter  port
14:17:54  1        2     payload: 0A BE 00 00 00 27 04 0C 2D FF FF  ADC_CH0V: 0.039  BatV: 2.75  Digital_IStatus: "L"  EXTI_Trig
14:17:25  0        2     payload: 0A BE 00 00 00 00 04 FF FF FF FF  ADC_CH0V: 0  BatV: 2.75  Digital_IStatus: "L"  EXTI_Trigger:
```

You can see the serial output in ULT mode as below:



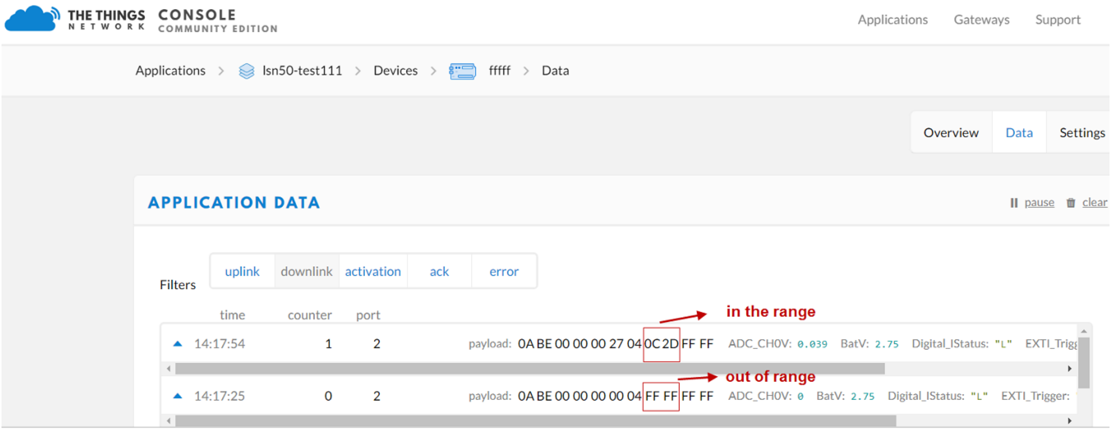
```
LSN50 Device
Image Version: v1.4
Frequency Band: EU868
DevEui= 00 97 16 CF B8 37 CF 4E

***** UpLinkCounter= 0 *****
TX on freq 868300000 Hz at DR 5
txDone
rxDone
JOINED
Distance is out of range

***** UpLinkCounter= 0 *****
TX on freq 867700000 Hz at DR 0
txDone
rxTimeOut
rxTimeOut
Distance=3117 mm

***** UpLinkCounter= 1 *****
TX on freq 868100000 Hz at DR 0
txDone
rxTimeOut
rxDone
```

In TTN server:



```
time      counter  port
14:17:54  1        2     payload: 0A BE 00 00 00 27 04 0C 2D FF FF   ADC_CH0V: 0.039   BatV: 2.75   Digital_IStatus: "L"   EXTI_Trig
14:17:25  0        2     payload: 0A BE 00 00 00 00 04 FF FF FF FF   ADC_CH0V: 0   BatV: 2.75   Digital_IStatus: "L"   EXTI_Trigger:
```

2.4.9 +5V Output

Since v1.2 hardware version, a +5v output is added in the hardware. The +5V output will be valid for every sampling. LSN50 will enable +5V output before all sampling and disable the +5v After all sampling.

2.5 Downlink Payload

By default, LSN50 prints the downlink payload to console port.

Downlink Control Type	FPort	Type Code	Downlink payload size(bytes)
TDC (Transmit Time Interval)	Any	01	4
RESET	Any	04	2
AT+CFM	Any	05	4
INTMOD	Any	06	4

Examples

Set TDC

If the payload=0100003C, it means set the END Node’s TDC to 0x00003C=60(S), while type code is 01.

Payload: 01 00 00 1E TDC=30S

Payload: 01 00 00 3C TDC=60S

Reset

If payload = 0x04FF, it will reset the LSN50

CFM

Downlink Payload: 05000001, Set AT+CFM=1 or 05000000 , set AT+CFM=0

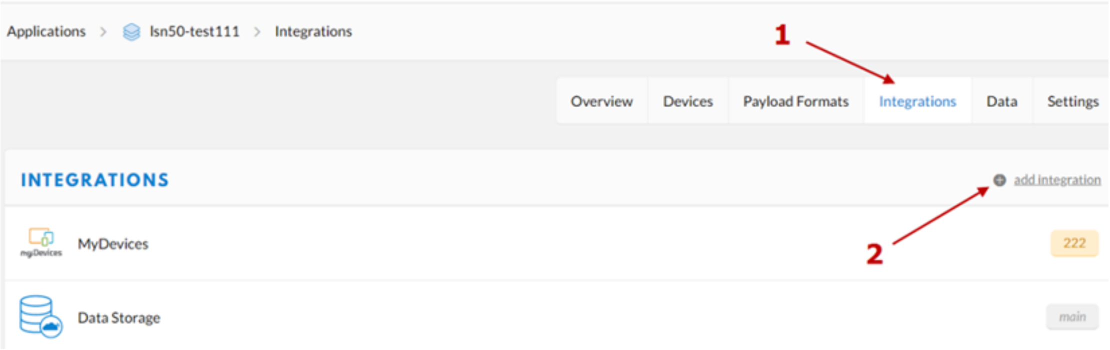
INTMOD

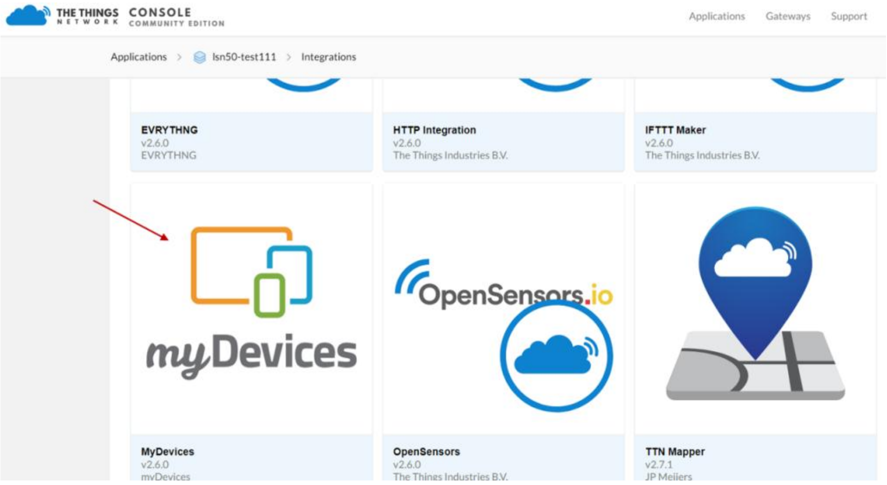
Downlink Payload: 06000003, Set AT+INTMOD=3

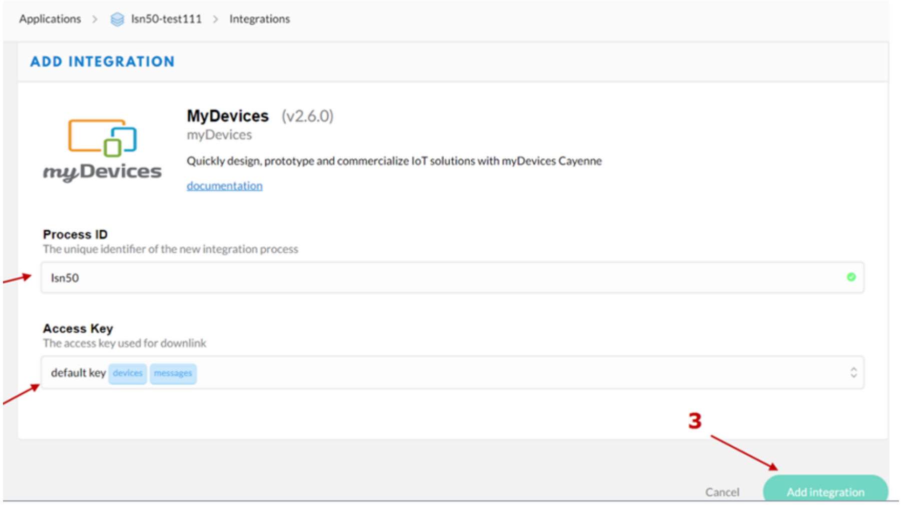
2.6 Show Data in Mydevices IoT Server

Mydevices provides a human friendly interface to show the sensor data, once we have data in TTN, we can use Mydevices to connect to TTN and see the data in Mydevices. 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 Mydevices you will need to add integration. To add the Mydevices integration, perform the following steps:





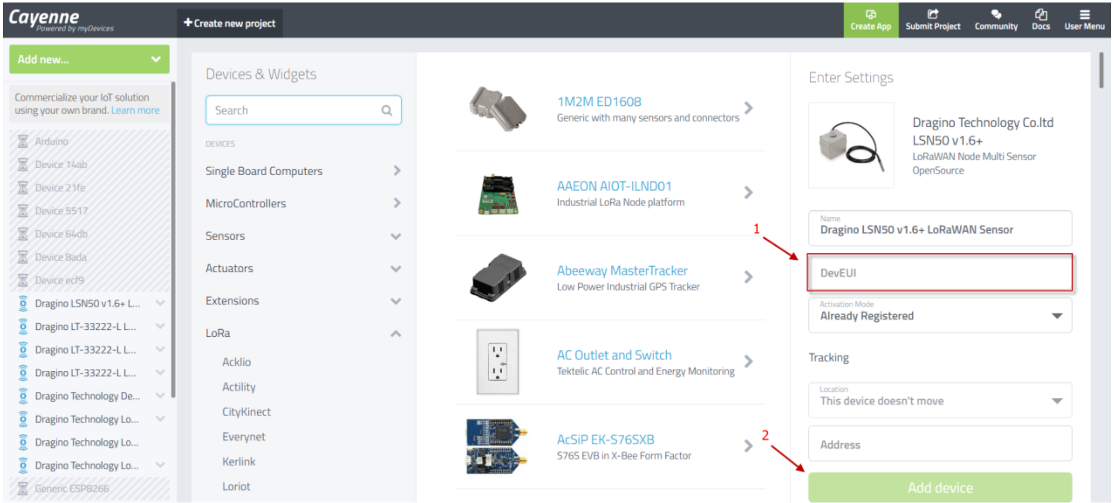


MyDevices (v2.6.0)
myDevices
Quickly design, prototype and commercialize IoT solutions with myDevices Cayenne
documentation

Process ID
The unique identifier of the new integration process
lsn50

Access Key
The access key used for downlink
default key devices messages

Step 3: Create an account or log in Mydevices.
Step 4: Search the LSN50 and add DevEUI.
Use the LSN50 v1.6+ for the firmware version > v1.6 under LoRa --> The things network



Enter Settings

Dragino Technology Co.ltd
LSN50 v1.6+
LoRaWAN Node Multi Sensor
OpenSource

Name: Dragino LSN50 v1.6+ LoRaWAN Sensor

DevEUI

Activation Mode: Already Registered

Tracking

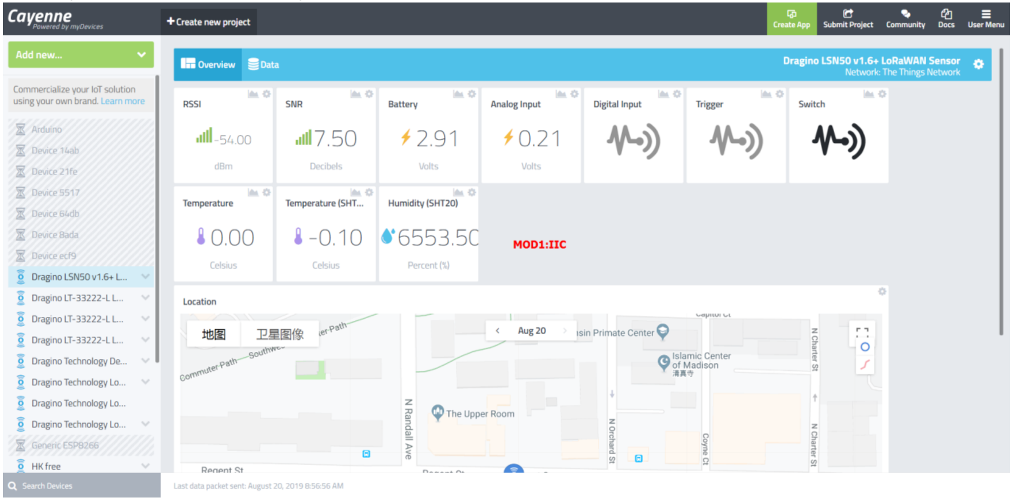
Location: This device doesn't move

Address

Add device

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

Example for AT+MOD=1 plus SHT20 + DS18B20 sensor:



Dragino LSN50 v1.6+ LoRaWAN Sensor
Network: The Things Network

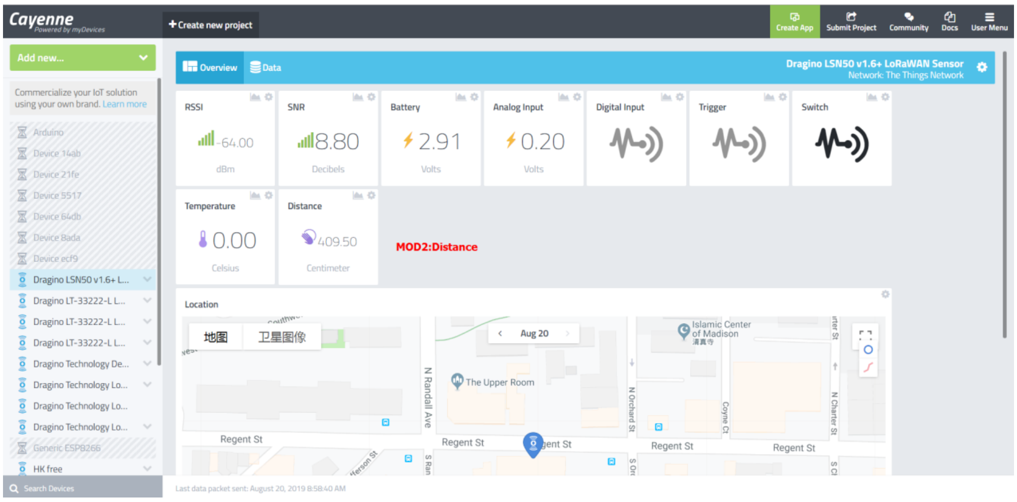
RSSI -54.00 dBm
SNR 7.50 Decibels
Battery 2.91 Volts
Analog Input 0.21 Volts
Digital Input
Trigger
Switch
Temperature 0.00 Celsius
Temperature (SHT... -0.10 Celsius
Humidity (SHT20) 6553.50 Percent (%)

MOD1:IIC

Location

Last data packet sent: August 20, 2019 8:56:56 AM

MOD=2



Dragino LSN50 v1.6+ LoRaWAN Sensor
Network: The Things Network

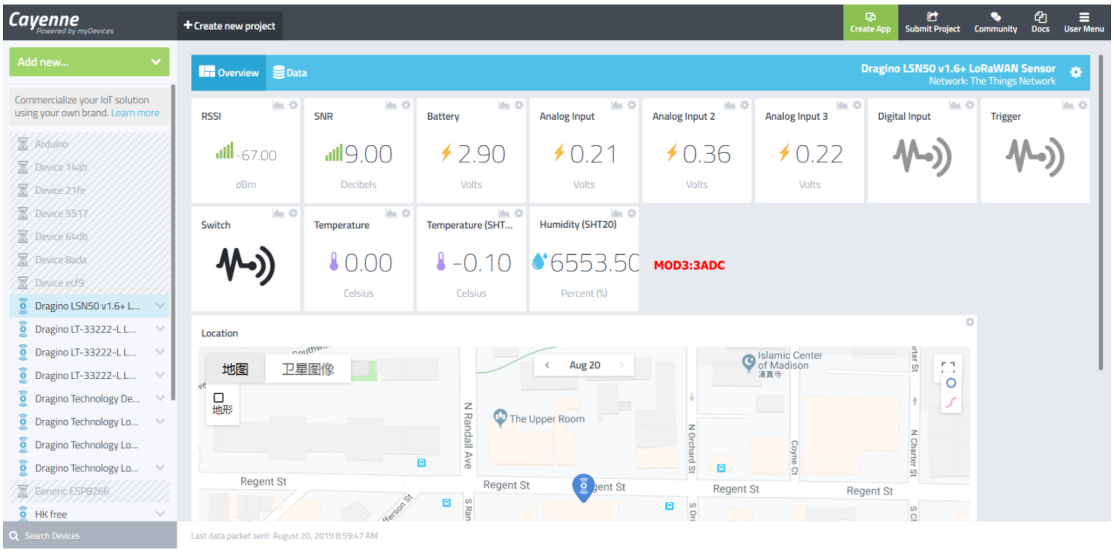
RSSI -64.00 dBm
SNR 8.80 Decibels
Battery 2.91 Volts
Analog Input 0.20 Volts
Digital Input
Trigger
Switch
Temperature 0.00 Celsius
Distance 409.50 Centimeter

MOD2:Distance

Location

Last data packet sent: August 20, 2019 8:58:40 AM

MOD=3.


Cayenne
Powered by myDevices
+Create new project
Create App
Submit Project
Community
Docs
User Menu
Add new...
Commercialize your IoT solution using your own brand. Learn more
Arduino
Device 14ab
Device 21fe
Device 5517
Device 64db
Device 8ada
Device ecf9
Dragino LSN50 v1.6+ L...
Dragino LT-33222-L L...
Dragino LT-33222-L L...
Dragino LT-33222-L L...
Dragino Technology De...
Dragino Technology Lo...
Dragino Technology Lo...
Dragino Technology Lo...
Generic ESP8266
HK free
Search Devices
Overview
Data
Dragino LSN50 v1.6+ LoRaWAN Sensor
Network: The Things Network
RSSI
-67.00
dBm
SNR
9.00
Decibels
Battery
2.90
Volts
Analog Input
0.21
Volts
Analog Input 2
0.36
Volts
Analog Input 3
0.22
Volts
Digital Input
Trigger
Switch
Temperature
0.00
Celsius
Temperature (SHT...
-0.10
Celsius
Humidity (SHT20)
6553.50
Percent (%)
MOD3:3ADC
Location
地图
卫星图像
地形
Aug 20
The Upper Room
Islamic Center of Madison
Regent St
N Randall Ave
N Orchard St
Coyne Ct
N Charter St
Last data packet sent: August 20, 2019 8:59:47 AM

2.7 Firmware Change Log

V1.6.1 Firmware (Not release):

- Add 3 x DS18B20 mod

V1.6 Firmware:

- Improve Interrupt feature.
- Downlink to change AT+CFM. Downlink to change AT+INTMOD
- Add 3ADC + I2C mode.
- Fix power consumption bug in v1.5.
- Fix SHT20, SHT31 reading bug.

V1.5 Firmware:

- Add ultrasonic sensor support.
- Add AT+MOD command to select difference sensors: (Ultrasonic, I2C) (See update AT Command manual)
- Add Downlink command to change TDC and reset the device.
- Add AT+TXP command to be able manually set the exact TX Gain (See update AT Command manual)

V1.4 Firmware:

- Adjust payload, the default firmware include SHT20 and SHT31, If there is no SHT20, SHT31, the related filed will show FF FF FF FF
- Adjust 868 & 915 payload into 11 bytes, now 868 & 915 has same payload
- Fix the 85 degree bug for DS18B20
- Add new AT command which can adjust RX window time for LG01/LG02
- Add AT command to print all parameters.
- Any FPORT can accept downlink message and print.

v1.3 Firmware:

- Add new AT Commands: AT+CHS & AT+CHE
- Change AT+FDR command. This command will reset to factory except the keys
- +5v power will only enable when read sensor data
- Optimize OTAA join procedure. The first 50 joins will act as per LoRaWAN request(request join every few seconds), if devices have not joined in network, the Join Interval will extend to 30 minutes. If devices still not join at 200 tries, it will restart and start to Join again.
- Now print Device Model/Frequency bands/ Image Version/Dev EUI at start.

V1.2 Firmware:

- Support Class C
- After the configuration key can be stored in. No need to configure again even after power off.
- Add auto send feature after power on
- Solve negative temperature issue.
- Support Mydevices_LPP payload, user need to recompile firmware again.

V1.1 Firmware:

- Support Battery Voltage(mV) ,the data of Oil Sensor ,the data of DS18B20, Digital I/0, ADC_IN1(PA1),

- Proximity switch, I2C Device Example

V1.0 Firmware:

- Support ADC monitoring (See how to in the case study of Oil Sensor) and DS18B20 (See how to in the case study of DS18B20)

2.8 Battery Analysis

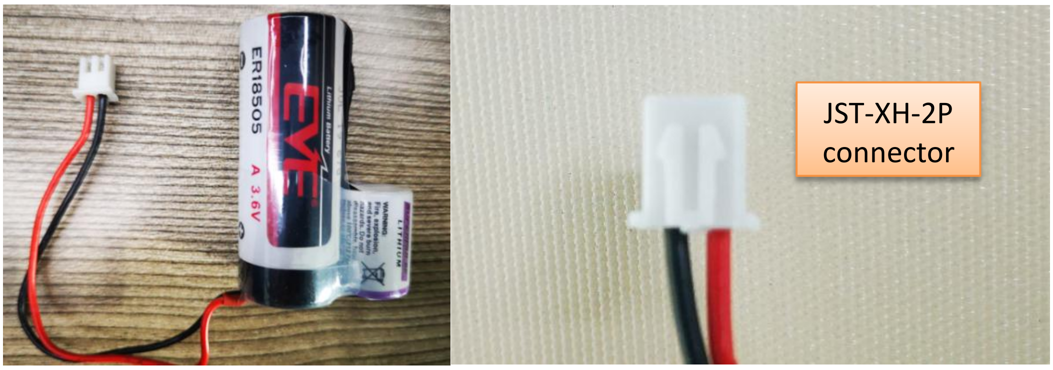
2.8.1 Battery Type

The LSN50 battery is a combination of a 4000mAh Li/SOCI2 Battery and a Super Capacitor. The battery is non-rechargeable battery type with a low discharge rate (<2% per year). This type of battery is commonly used in IoT devices such as water meter.

The battery is designed to last for more than 5 years for the LSN50.

The battery related documents as below:

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



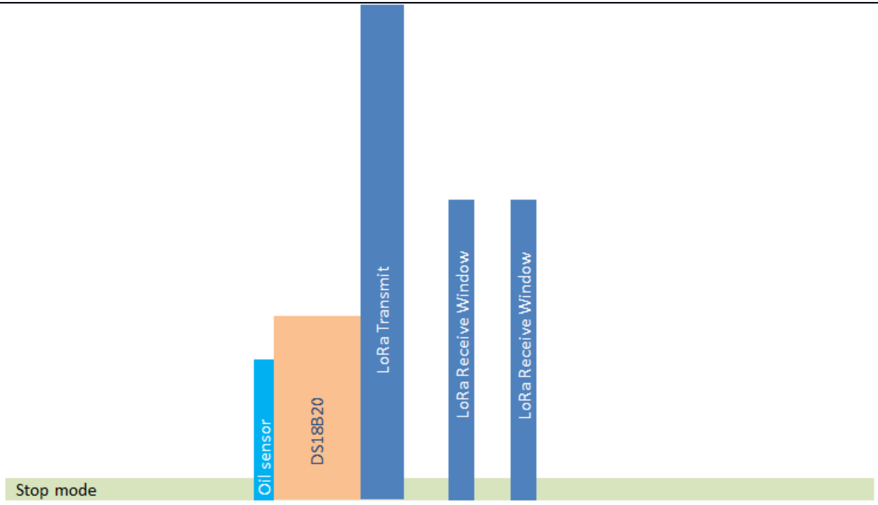
JST-XH-2P connector

2.8.2 Power consumption Analyze

In a minimum system with DS18B20 and Oil Sensor and default firmware, the power consumption includes:

1. Deep Sleep (Stop mode) for STM32. ~ 5uA
2. Sampling current while reading DS18B20 and Oil Sensor
    - Oil Sensor sampling time: 200us, current: 0.3mA
    - DS18B20 sampling time: 750ms, current: 0.64mA
    - Above power should add 8mA CPU power in working mode.
3. LoRaWAN transmit and receive time consumption. The LoRa TX / RX time and power can be found in the LoRa calculator tool.

In a typical LoRaWAN data transmit. The energy profile is as below:



LoRaWAN Energy Profile in one period

In the LoRaWAN protocol, the device will transfer in different LoRa Radio, and have different energy profile in LoRa part. We can calculate the battery life in two cases:

1) Lower power LoRa radio. Device has a good signal to gateway
2) Higher power LoRa radio. Device has a poor signal to gateway

Low Power Case:

- Radio Parameter: SF7, 125kHz, 20dbm
- Transmit interval: 15 minutes.
- Payload: 8 Bytes.

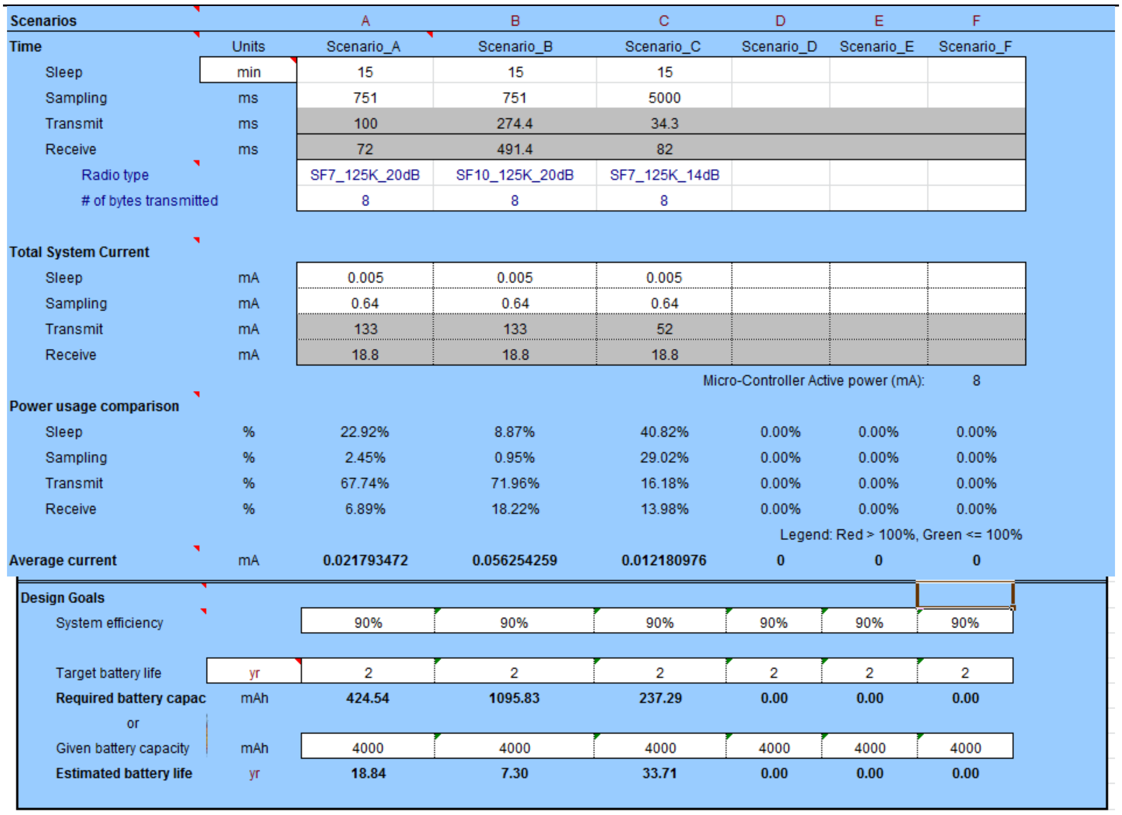
High Power Case:

- Radio Parameter: SF10, 125kHz, 20dbm
- Transmit interval: 15 minutes.
- Payload: 8 Bytes.

To simplify the calculation, we can:

- Combine oil sensor and DS18B20 sampling energy together to **751ms@8.64ma**
- Combine the two RX windows together.

There is a power consumption tool for easy analysis. Below is the analysis result.



Scenarios		A	B	C	D	E	F
Time	Units	Scenario_A	Scenario_B	Scenario_C	Scenario_D	Scenario_E	Scenario_F
Sleep	min	15	15	15			
Sampling	ms	751	751	5000			
Transmit	ms	100	274.4	34.3			
Receive	ms	72	491.4	82			
Radio type		SF7_125K_20dB	SF10_125K_20dB	SF7_125K_14dB			
# of bytes transmitted		8	8	8			
Total System Current							
Sleep	mA	0.005	0.005	0.005			
Sampling	mA	0.64	0.64	0.64			
Transmit	mA	133	133	52			
Receive	mA	18.8	18.8	18.8			
				Micro-Controller Active power (mA):			8
Power usage comparison							
Sleep	%	22.92%	8.87%	40.82%	0.00%	0.00%	0.00%
Sampling	%	2.45%	0.95%	29.02%	0.00%	0.00%	0.00%
Transmit	%	67.74%	71.96%	16.18%	0.00%	0.00%	0.00%
Receive	%	6.89%	18.22%	13.98%	0.00%	0.00%	0.00%
					Legend: Red > 100%, Green <= 100%		
Average current	mA	**0.021793472**	**0.056254259**	**0.012180976**	**0**	**0**	**0**
Design Goals							
System efficiency		90%	90%	90%	90%	90%	90%
Target battery life	yr	2	2	2	2	2	2
Required battery capac	mAh	**424.54**	**1095.83**	**237.29**	**0.00**	**0.00**	**0.00**
or							
Given battery capacity	mAh	4000	4000	4000	4000	4000	4000
Estimated battery life	yr	**18.84**	**7.30**	**33.71**	**0.00**	**0.00**	**0.00**

Note: Ignore the 18 year result, because the battery has a max 2% discharge per year.

2.8.3 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.

2.8.4 Replace the battery

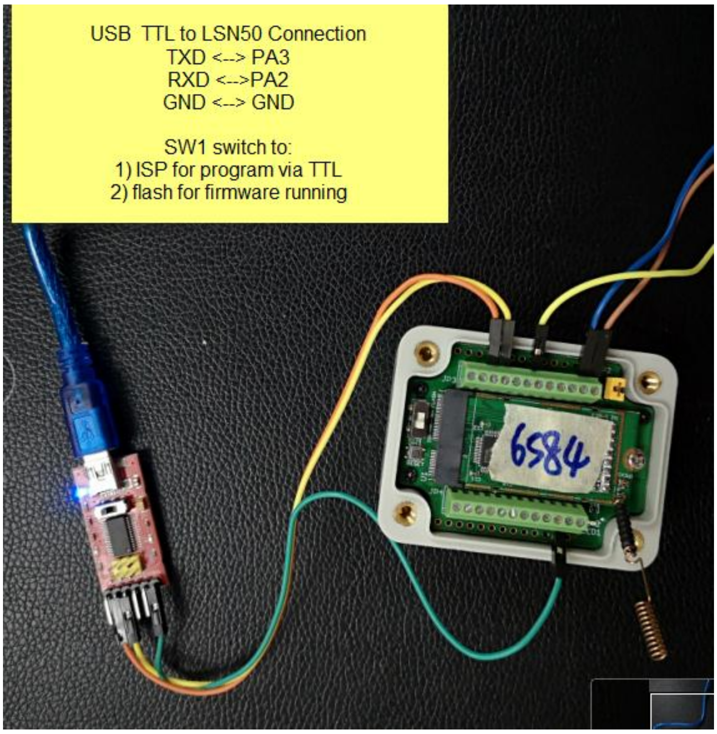
You can change the battery in the LSN50.The type of battery is not limited as long as the output is between 3v to 3.6v. On the main board, there is a diode (D1) between the battery and the main circuit. If you need to use a battery with less than 3.3v, please remove the D1 and shortcut the two pads of it so there won't be voltage drop between battery and main board.

The default battery pack of LSN50 includes a ER18505 plus super capacitor. If user can't find this pack locally, they can find ER18505 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)

3. Using the AT Commands

3.1 Access AT Commands

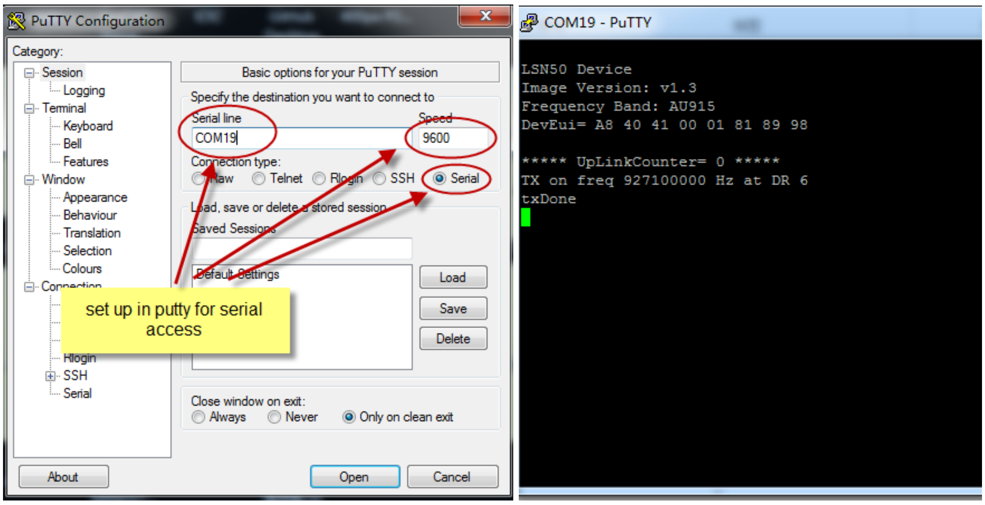
LSN50 supports AT Command set in the stock firmware. You can use a USB to TTL adapter to connect to LSN50 for using AT command, as below.



USB TTL to LSN50 Connection
TXD <--> PA3
RXD <-->PA2
GND <--> GND

SW1 switch to:
1) ISP for program via TTL
2) flash for firmware running

In the PC, you need to set the serial baud rate to **9600** to access the serial console for LSN50. LSN50 will output system info once power on as below:



Serial line: COM19
Speed: 9600
Connection type: ○ Raw ○ Telnet ○ Rlogin ○ SSH ● Serial
Close window on exit: ○ Always ○ Never ● Only on clean exit

set up in putty for serial access

```
LSN50 Device
Image Version: v1.3
Frequency Band: AU915
DevEui= A8 40 41 00 01 81 89 98

***** UpLinkCounter= 0 *****
TX on freq 927100000 Hz at DR 6
txDone
```

Below are the available commands, a more detailed AT Command manual can be found at [AT Command Manual](http://www.dragino.com/downloads/index.php?dir=LSN50-LoRaST/&file=DRAGINO_STM_AT_Commands_v1.3.pdf)

(http://www.dragino.com/downloads/index.php?dir=LSN50-LoRaST/&file=DRAGINO_STM_AT_Commands_v1.3.pdf)

AT+<CMD>?	: Help on <CMD>
AT+<CMD>	: Run <CMD>
AT+<CMD>=<value>	: Set the value
AT+<CMD>=?	: Get the value

General Commands

AT	: Attention

AT?	: Short Help
ATZ	: MCU Reset
AT+TDC	: Application Data Transmission Interval

Keys, IDs and EUIs management

AT+APPEUI	: Application EUI
AT+APPKEY	: Application Key
AT+APPSKEY	: Application Session Key
AT+DADDR	: Device Address
AT+DEUI	: Device EUI
AT+NWKID	: Network ID (You can enter this command change only after successful network connection)
AT+NWKSKEY	: Network Session Key Joining and sending date on LoRa network
AT+CFM	: Confirm Mode
AT+CFS	: Confirm Status
AT+JOIN	: Join LoRa? Network
AT+NJM	: LoRa? Network Join Mode
AT+NJS	: LoRa? Network Join Status
AT+RECV	: Print Last Received Data in Raw Format
AT+RECVB	: Print Last Received Data in Binary Format
AT+SEND	: Send Text Data
AT+SENB	: Send Hexadecimal Data

LoRa Network Management

AT+ADR	: Adaptive Rate
AT+CLASS	: LoRa Class(Currently only support class A
AT+DCS	: Duty Cycle Setting
AT+DR	: Data Rate (Can Only be Modified after ADR=0)
AT+FCD	: Frame Counter Downlink
AT+FCU	: Frame Counter Uplink
AT+JN1DL	: Join Accept Delay1
AT+JN2DL	: Join Accept Delay2
AT+PNM	: Public Network Mode
AT+RX1DL	: Receive Delay1
AT+RX2DL	: Receive Delay2
AT+RX2DR	: Rx2 Window Data Rate
AT+RX2FQ	: Rx2 Window Frequency
AT+TXP	: Transmit Power

Information

AT+RSSI	: RSSI of the Last Received Packet
AT+SNR	: SNR of the Last Received Packet
AT+VER	: Image Version and Frequency Band
AT+FDR	: Factory Data Reset
AT+PORT	: Application Port
AT+CHS	: Get or Set Frequency (Unit: Hz) for Single Channel Mode
AT+CHE	: Get or Set eight channels mode, Only for US915, AU915, CN470

3.2 Common AT Command Sequence

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

If device has not joined network via OTAA:

```
AT+FDR
AT+NJM=0
```

```
ATZ
```

If device already joined network:

```
AT+NJM=0
ATZ
```

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

See Sect 6.7

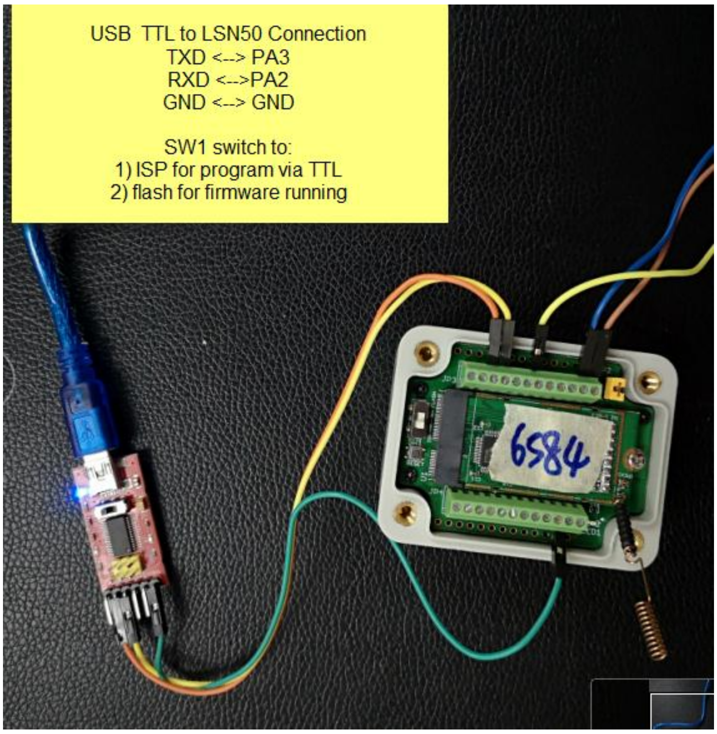
4. Upload Firmware

Notes:

- Since image v1.3, the firmware will show version info during boot. If your device doesn't show version info, you may have a very old image version.
- Always run AT+FDR to reset parameters to factory default after an update image.
  If the update is from image >= v1.3 to another image version >=v1.3, then the keys will be kept after running AT+FDR.
  Otherwise (e.g. from v1.2 to v1.3), AT+FDR may erase the keys.

4.1 Upload Firmware via Serial Port

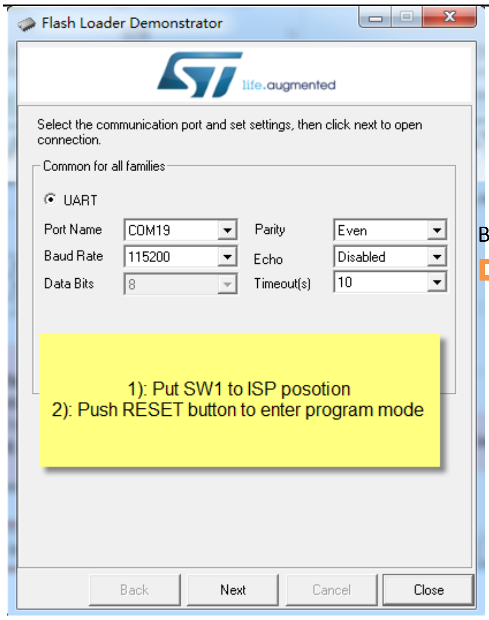
The LSN50's AT Command port can be used for firmware upgrade. The hardware connection for upgrade firmware is as below:


USB TTL to LSN50 Connection
TXD <--> PA3
RXD <-->PA2
GND <--> GND
SW1 switch to:
1) ISP for program via TTL
2) flash for firmware running
6584

Step1: Download flash loader.

Step2: Download the LSN50 Image files.

Step3: Open flashloader; choose the correct COM port to update



Select the communication port and set settings, then click next to open connection.

Common for all families

● UART

Port Name: COM19

Baud Rate: 115200

Data Bits: 8

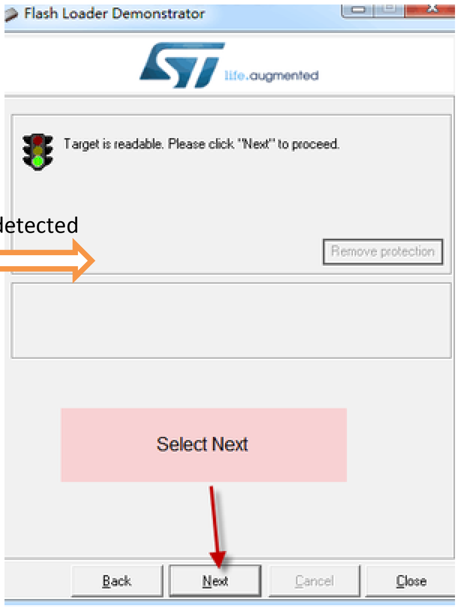
Parity: Even

Echo: Disabled

Timeout(s): 10

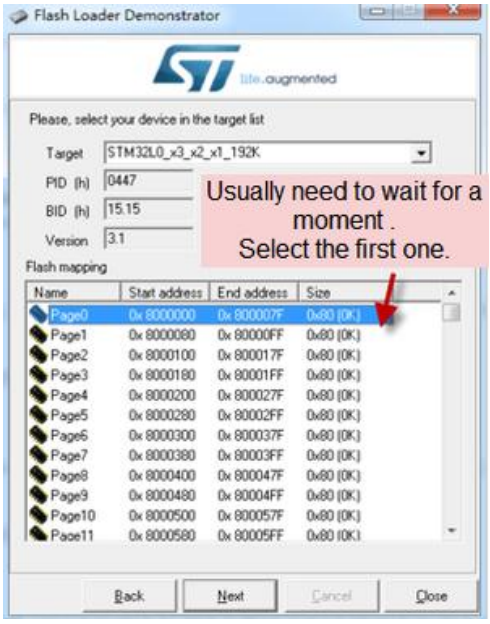
1): Put SW1 to ISP posotion
2): Push RESET button to enter program mode

Board detected



Target is readable. Please click "Next" to proceed.

Select Next



Please, select your device in the target list

Target: STM32L0_x3_x2_x1_192K

PID (h): 0447

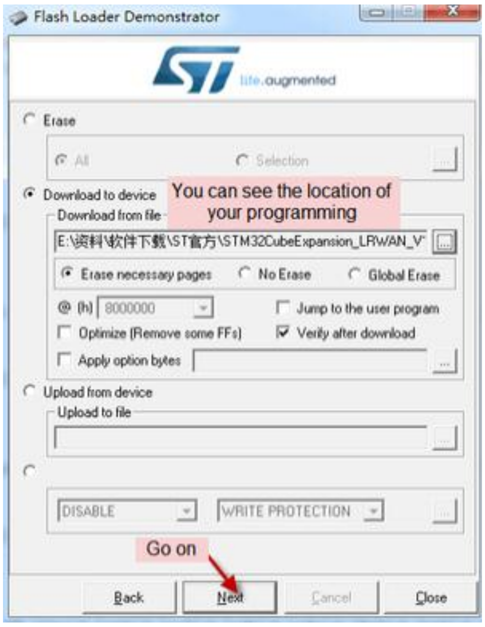
BID (h): 15.15

Version: 3.1

Usually need to wait for a moment .
Select the first one.

Flash mapping

Name	Start address	End address	Size
Page0	0x 8000000	0x 800007F	0x80 (OK)
Page1	0x 8000080	0x 80000FF	0x80 (OK)
Page2	0x 8000100	0x 800017F	0x80 (OK)
Page3	0x 8000180	0x 80001FF	0x80 (OK)
Page4	0x 8000200	0x 800027F	0x80 (OK)
Page5	0x 8000280	0x 80002FF	0x80 (OK)
Page6	0x 8000300	0x 800037F	0x80 (OK)
Page7	0x 8000380	0x 80003FF	0x80 (OK)
Page8	0x 8000400	0x 800047F	0x80 (OK)
Page9	0x 8000480	0x 80004FF	0x80 (OK)
Page10	0x 8000500	0x 800057F	0x80 (OK)
Page11	0x 8000580	0x 80005FF	0x80 (OK)



○ Erase

● All ○ Selection

● Download to device

Download from file

E:\资料\软件下载\ST官方\STM32CubeExpansion_LRWAN_V

● Erase necessary pages ○ No Erase ○ Global Erase

@ (h) 8000000

□ Jump to the user program

□ Optimize (Remove some FFs)

☑ Verify after download

□ Apply option bytes

○ Upload from device

Upload to file

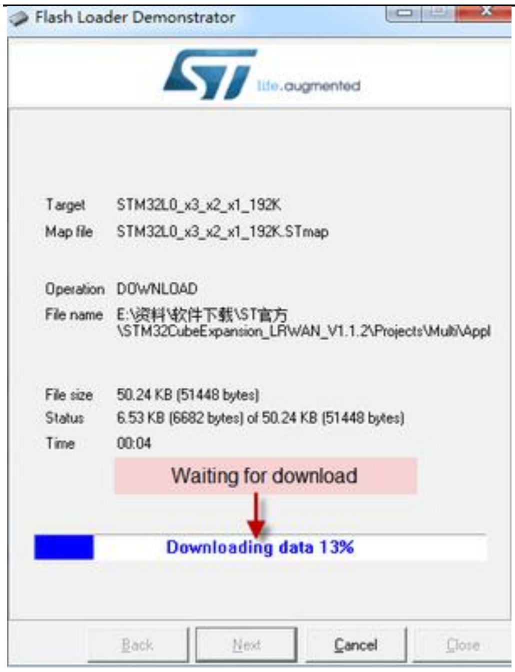
○

DISABLE

WRITE PROTECTION

You can see the location of your programming

Go on



Flash Loader Demonstrator

Target STM32L0_x3_x2_x1_192K

Map file STM32L0_x3_x2_x1_192K.STmap

Operation DOWNLOAD

File name E:\资料\软件下载\ST官方\STM32CubeExpansion_LRWAN_V1.1.2\Projects\Multi\Appl

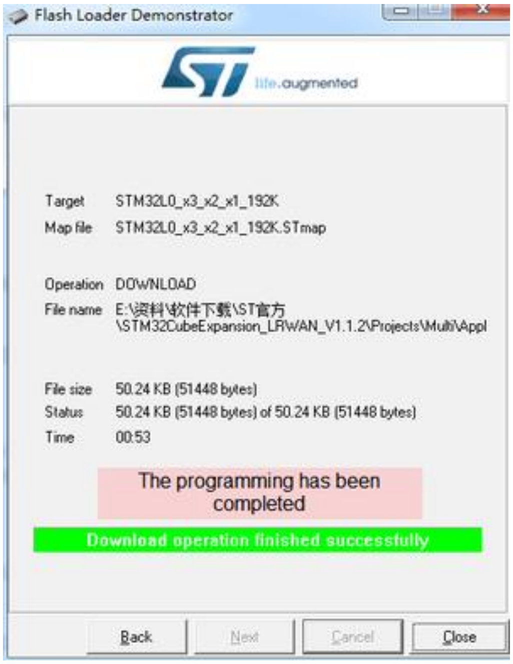
File size 50.24 KB (51448 bytes)

Status 6.53 KB (6682 bytes) of 50.24 KB (51448 bytes)

Time 00:04

Waiting for download

Downloading data 13%



Flash Loader Demonstrator

Target STM32L0_x3_x2_x1_192K

Map file STM32L0_x3_x2_x1_192K.STmap

Operation DOWNLOAD

File name E:\资料\软件下载\ST官方\STM32CubeExpansion_LRWAN_V1.1.2\Projects\Multi\Appl

File size 50.24 KB (51448 bytes)

Status 50.24 KB (51448 bytes) of 50.24 KB (51448 bytes)

Time 00:53

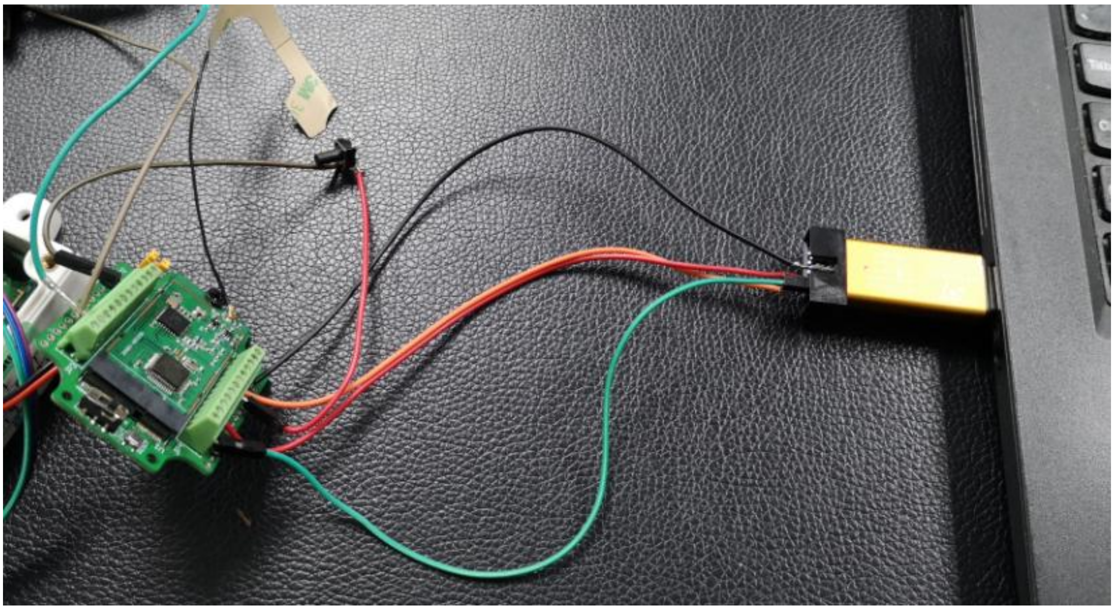
The programming has been completed

Download operation finished successfully

Step4: Switch SW1 back to flash state and push the RESET button.
The LSN50 will then run the new firmware.

4.2 Upload Firmware via ST-Link V2

You can use ST-LINK to upgrade firmware into LSN50. The hardware connection for upgrade firmware is as below:



Connection:

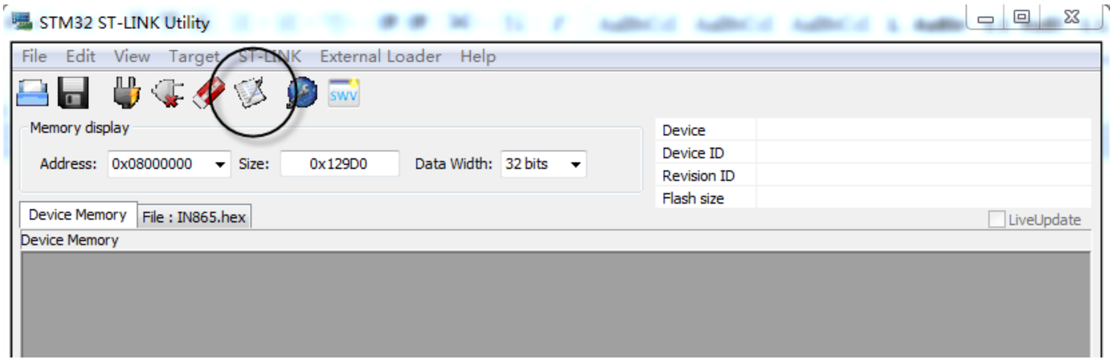
- ST-LINK v2 GND <--> LSN50 GND
- ST-LINK v2 SWCLK <--> LSN50 PA14
- ST-LINK v2 SWDIO <--> LSN50 PA13
- ST-LINK v2 RST <-->LSN50 NRST.

Step1: Install ST-LINK driver first and then install ST-LINK Utility

Step2: Download the LSN50 Image files.

Step3: Open ST-LINK utility, **file --> open file** to select the image to be upgraded.

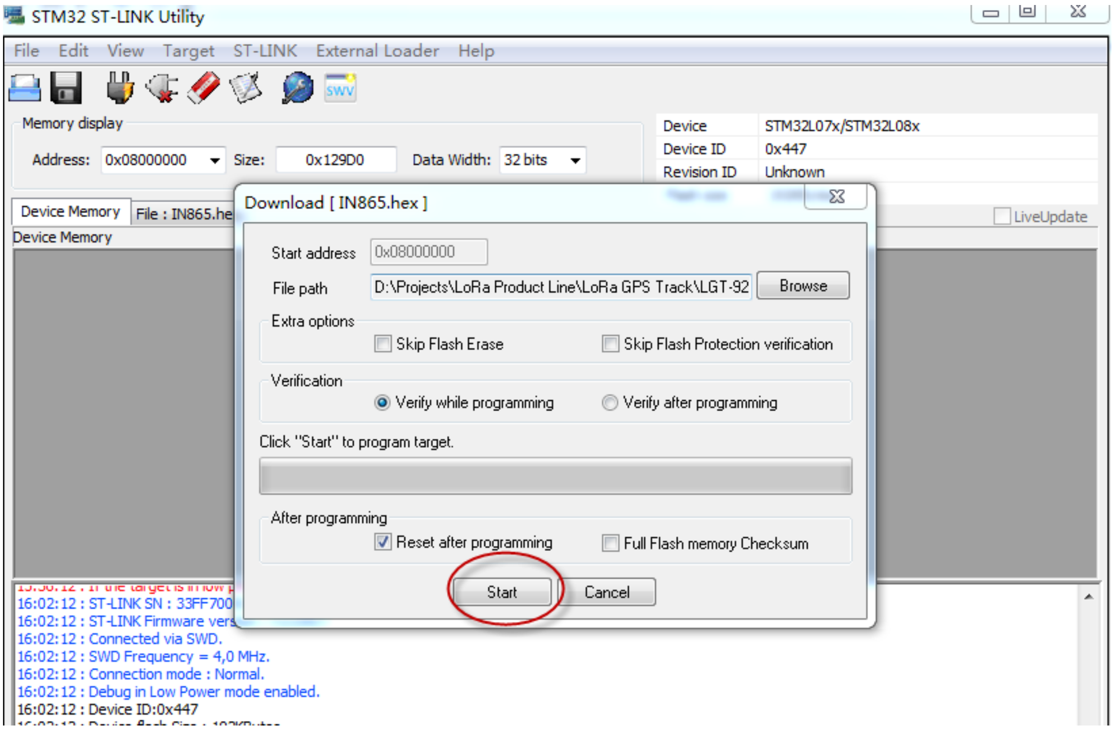
Step4: Click the "**Program Verify**" button on ST-LINK.



Address: 0x08000000 Size: 0x129D0 Data Width: 32 bits

Step5: The led on the ST-LINK adapter will now blinking, and the ST-Link utility will pop up a download window. Click the start button to download the image to LSN50.

NOTE: If this step fails, ST-LINK can’t establish connection to LSN50, please try to swap SWDIO & SWCLK pin. Some ST-LINK v2 devices are incorrectly marked.



Address: 0x08000000 Size: 0x129D0 Data Width: 32 bits

Device	STM32L07x/STM32L08x
Device ID	0x447
Revision ID	Unknown

Start address 0x08000000

File path D:\Projects\LoRa Product Line\LoRa GPS Track\LGT-92

Extra options

□ Skip Flash Erase □ Skip Flash Protection verification

Verification

● Verify while programming ○ Verify after programming

Click "Start" to program target.

After programming

☑ Reset after programming □ Full Flash memory Checksum

```
16:02:12 : ST-LINK SN : 33FF700
16:02:12 : ST-LINK Firmware vers
16:02:12 : Connected via SWD.
16:02:12 : SWD Frequency = 4,0 MHz.
16:02:12 : Connection mode : Normal.
16:02:12 : Debug in Low Power mode enabled.
16:02:12 : Device ID:0x447
```

5. Developer Guide

5.1 Source Code

Software Source Code Download Link.
(https://github.com/dragino/LoRa_STM32/tree/master/STM32CubeExpansion_LRWAN)

Hardware Source Code Download Link
(https://github.com/dragino/Lora/tree/master/LSN50)

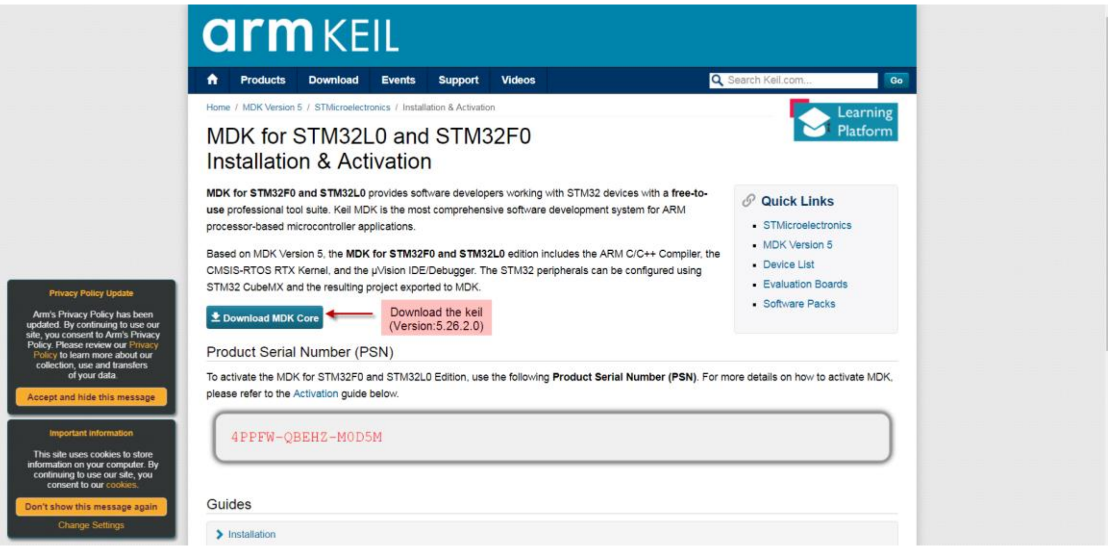
5.2 Compile Source Code

5.2.1 Set up Keil Compile Environment

Assuming you already have Keil uVision5 installed, the steps below show how to install the MDK support and get a license.

1: Open the **Webpage**: http://www2.keil.com/stmicroelectronics-stm32/mdk

2: Download the **Keil MDK**:



Home / MDK Version 5 / STMicroelectronics / Installation & Activation

MDK for STM32L0 and STM32F0
Installation & Activation

MDK for STM32F0 and STM32L0 provides software developers working with STM32 devices with a **free-to-use** professional tool suite. Keil MDK is the most comprehensive software development system for ARM processor-based microcontroller applications.

Based on MDK Version 5, the **MDK for STM32F0 and STM32L0** edition includes the ARM C/C++ Compiler, the CMSIS-RTOS RTX Kernel, and the µVision IDE/Debugger. The STM32 peripherals can be configured using STM32 CubeMX and the resulting project exported to MDK.

Download the keil (Version:5.26.2.0)

Product Serial Number (PSN)

To activate the MDK for STM32F0 and STM32L0 Edition, use the following **Product Serial Number (PSN)**. For more details on how to activate MDK, please refer to the Activation guide below.

4PPFW-QBEHZ-M0D5M

Guides

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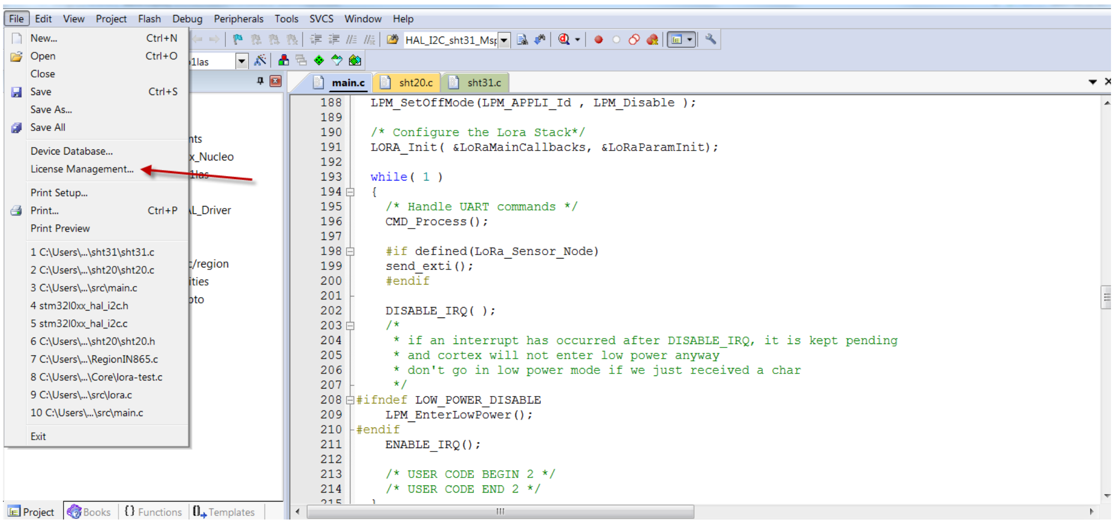
3: Login with an account that has administration rights.

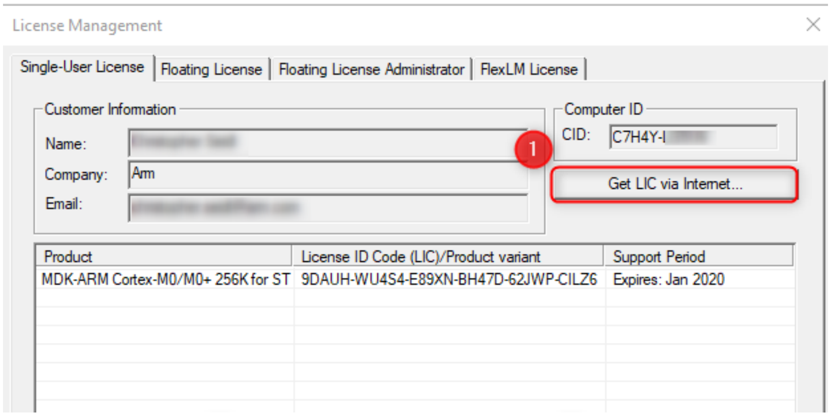
4: Right-click the µVision icon and select **Run as Administrator…** from the context menu.

5: Open the dialog **File — License Management...** and select the **Single-User License tab**.



```
  LPM_SetOffMode(LPM_APPLI_Id , LPM_Disable );

  /* Configure the Lora Stack*/
  LORA_Init( &LoRaMainCallbacks, &LoRaParamInit);

  while( 1 )
  {
    /* Handle UART commands */
    CMD_Process();

    #if defined(LoRa_Sensor_Node)
    send_exti();
    #endif

    DISABLE_IRQ( );
    /*
     * if an interrupt has occurred after DISABLE_IRQ, it is kept pending
     * and cortex will not enter low power mode anyway
     * don't go in low power mode if we just received a char
     */
#ifndef LOW_POWER_DISABLE
    LPM_EnterLowPower();
#endif
    ENABLE_IRQ();

    /* USER CODE BEGIN 2 */
    /* USER CODE END 2 */
```

6: Click the button **Get LIC via Internet...**, then click the button **OK** to register the product. This action opens the License Management page on the Keil web site.



Name: [redacted]

Company: Arm

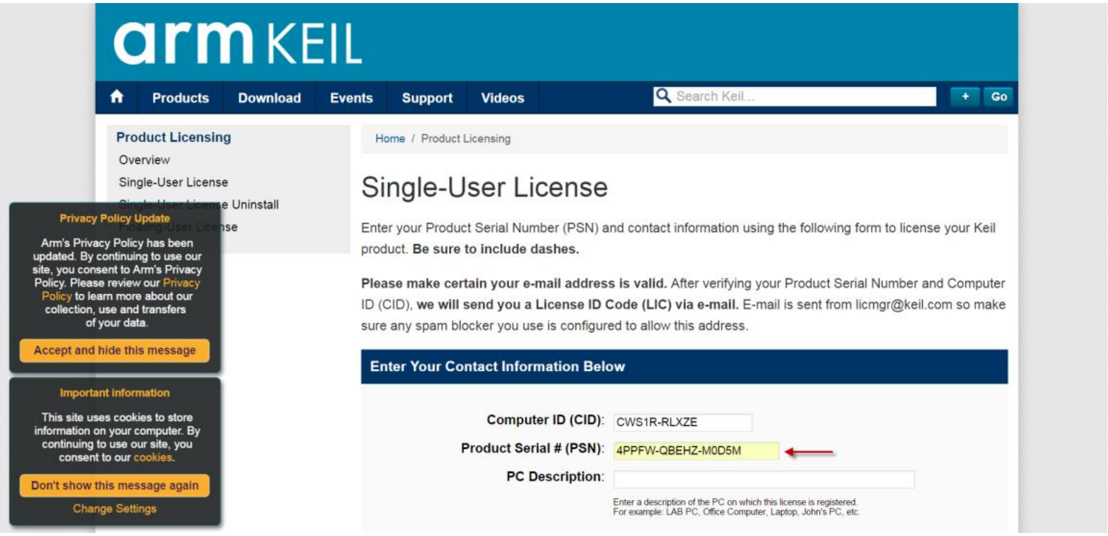
Email: [redacted]

CID: C7H4Y-I[redacted]

Product	License ID Code (LIC)/Product variant	Support Period
MDK-ARM Cortex-M0/M0+ 256K for ST	9DAUH-WU4S4-E89XN-BH47D-62JWP-CILZ6	Expires: Jan 2020

7: Enter the **Product Serial Number 4PPFW-QBEHZ-M0D5M** along with your contact information and click the button **Submit**. An e-mail is sent back with the **License ID Code (LIC)** within a few minutes.

(1)



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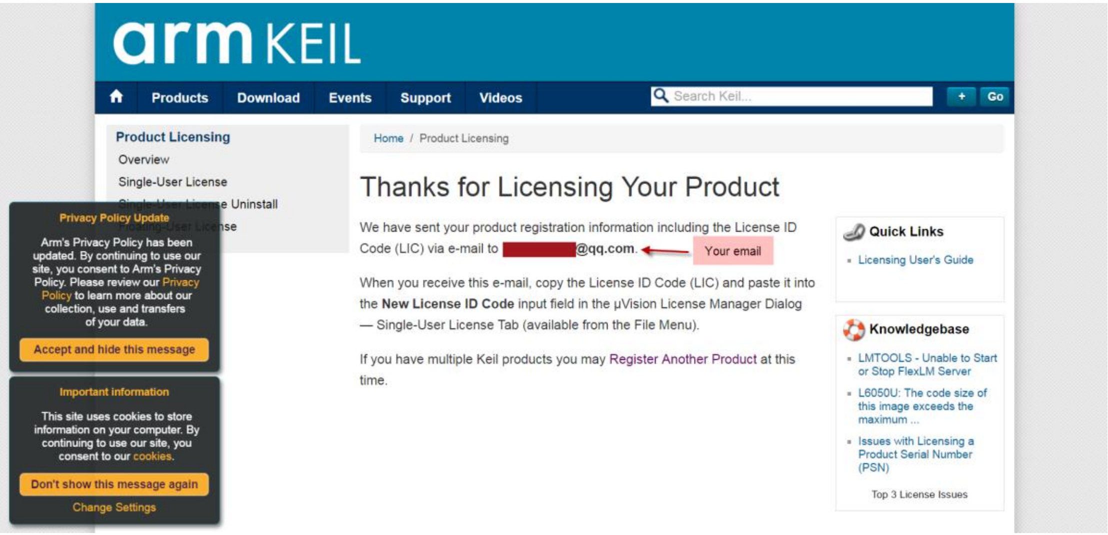
Enter Your Contact Information Below

Computer ID (CID): CWS1R-RLXZE
Product Serial # (PSN): 4PPFW-QBEHZ-M0D5M
PC Description:

Enter a description of the PC on which this license is registered.
For example: LAB PC, Office Computer, Laptop, John's PC, etc.

(2)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Single-User License
Single-User License Uninstall
Floating-User License
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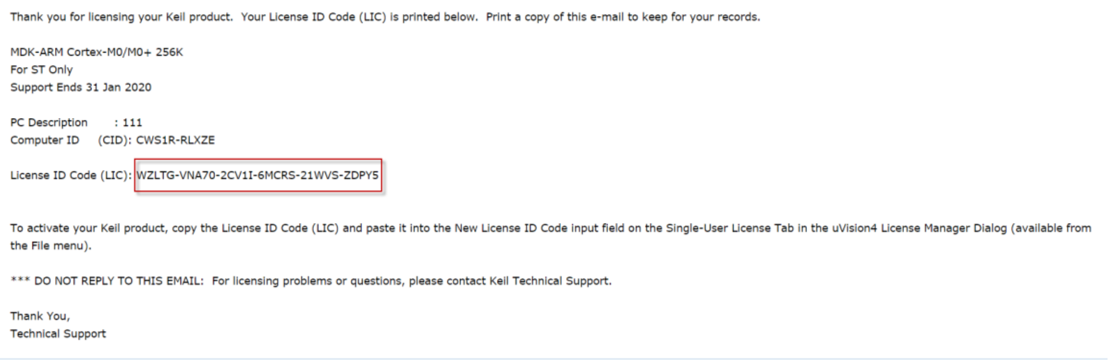
Thank you for licensing your Keil product. Your License ID Code (LIC) is printed below. Print a copy of this e-mail to keep for your records.

MDK-ARM Cortex-M0/M0+ 256K
For ST Only
Support Ends 31 Jan 2020

```
PC Description      : 111
Computer ID    (CID): CWS1R-RLXZE

License ID Code (LIC): WZLTG-VNA70-2CV1I-6MCRS-21WVS-ZDPY5
```

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Thank You,
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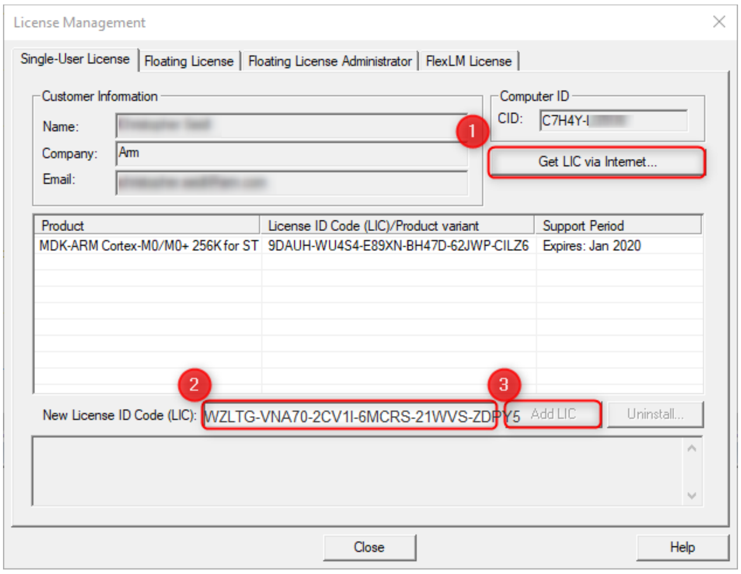


License Management

Single-User License | Floating License | Floating License Administrator | FlexLM License

Customer Information

Name: [redacted]

Company: Arm

Email: [redacted]

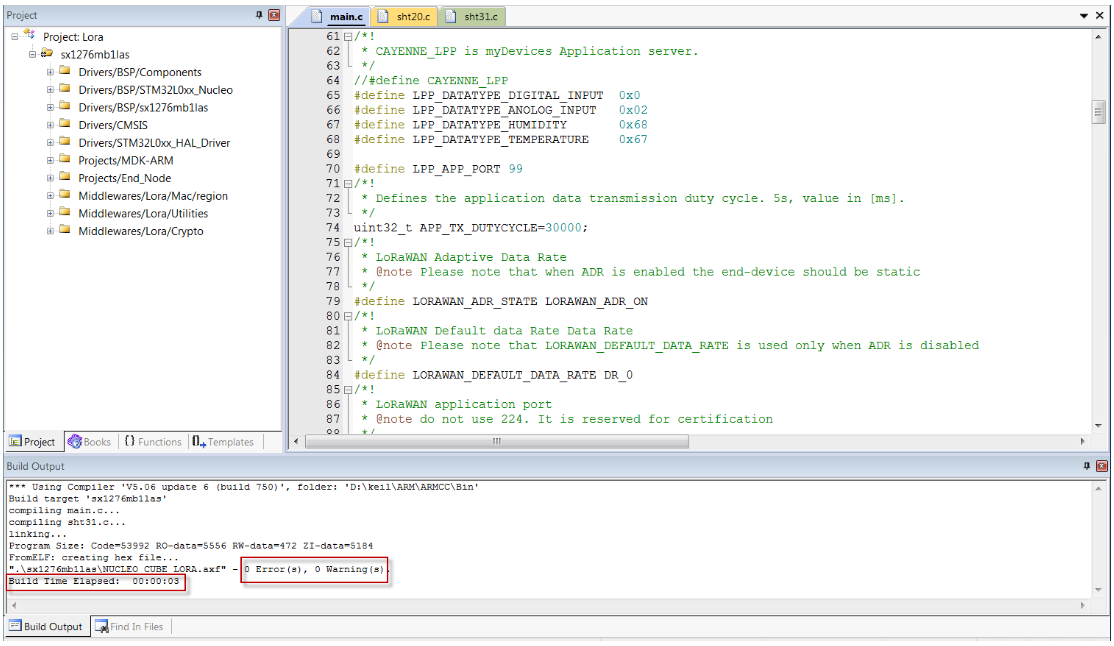
Computer ID

CID: C7H4Y-I[redacted]

Product	License ID Code (LIC)/Product variant	Support Period
MDK-ARM Cortex-M0/M0+ 256K for ST	9DAUH-WU4S4-E89XN-BH47D-62JWP-CILZ6	Expires: Jan 2020

New License ID Code (LIC): WZLTG-VNA70-2CV1I-6MCRS-21WVS-ZDPY5

9: Finish



```
/*!
 * CAYENNE_LPP is myDevices Application server.
 */
//#define CAYENNE_LPP
#define LPP_DATATYPE_DIGITAL_INPUT  0x0
#define LPP_DATATYPE_ANOLOG_INPUT   0x02
#define LPP_DATATYPE_HUMIDITY       0x68
#define LPP_DATATYPE_TEMPERATURE    0x67

#define LPP_APP_PORT 99
/*!
 * Defines the application data transmission duty cycle. 5s, value in [ms].
 */
uint32_t APP_TX_DUTYCYCLE=30000;
/*!
 * LoRaWAN Adaptive Data Rate
 * @note Please note that when ADR is enabled the end-device should be static
 */
#define LORAWAN_ADR_STATE LORAWAN_ADR_ON
/*!
 * LoRaWAN Default data Rate Data Rate
 * @note Please note that LORAWAN_DEFAULT_DATA_RATE is used only when ADR is disabled
 */
#define LORAWAN_DEFAULT_DATA_RATE DR_0
/*!
 * LoRaWAN application port
 * @note do not use 224. It is reserved for certification
```

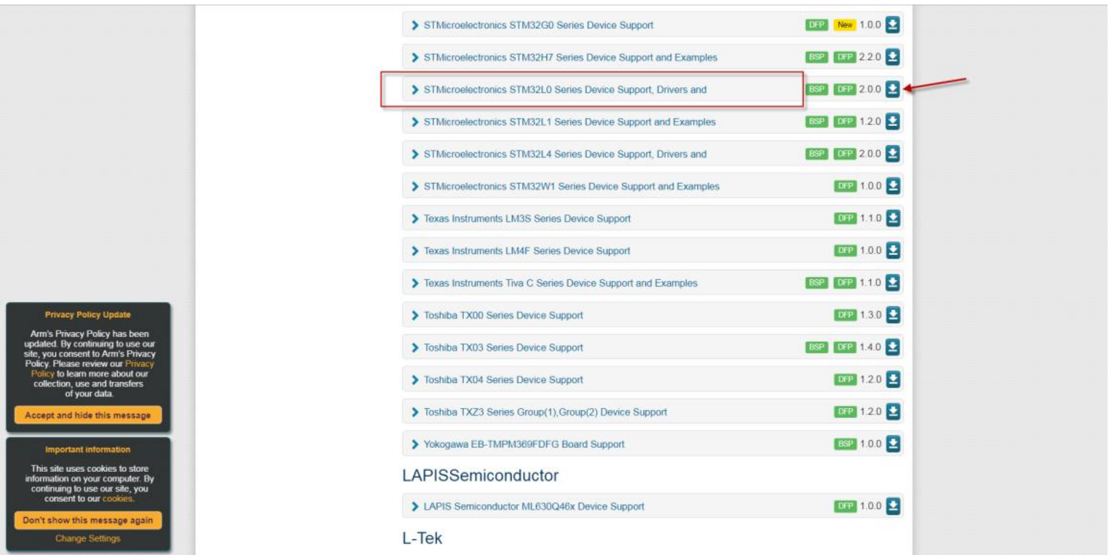
Build Output

```
*** Using Compiler 'V5.06 update 6 (build 750)', folder: 'D:\keil\ARM\ARMCC\Bin'
Build target 'sx1276mb1las'
compiling main.c...
compiling sht31.c...
linking...
Program Size: Code=53992 RO-data=5556 RW-data=472 ZI-data=5184
FromELF: creating hex file...
".\sx1276mb1las\NUCLEO CUBE LORA.axf" - 0 Error(s), 0 Warning(s).
Build Time Elapsed:  00:00:03
```

5.2.2 Install STM32L0 Series Device

1: **Open** the webpage: http://www.keil.com/dd2/pack/eula-container;

2: **Find** the **STMicroelectronics STM32L0 Series Device** and **download** it.



STMicroelectronics STM32G0 Series Device Support	DFP New	1.0.0
STMicroelectronics STM32H7 Series Device Support and Examples	BSP DFP	2.2.0
STMicroelectronics STM32L0 Series Device Support, Drivers and	BSP DFP	2.0.0
STMicroelectronics STM32L1 Series Device Support and Examples	BSP DFP	1.2.0
STMicroelectronics STM32L4 Series Device Support, Drivers and	BSP DFP	2.0.0
STMicroelectronics STM32W1 Series Device Support and Examples	DFP	1.0.0
Texas Instruments LM3S Series Device Support	DFP	1.1.0
Texas Instruments LM4F Series Device Support	DFP	1.0.0
Texas Instruments Tiva C Series Device Support and Examples	BSP DFP	1.1.0
Toshiba TX00 Series Device Support	DFP	1.3.0
Toshiba TX03 Series Device Support	BSP DFP	1.4.0
Toshiba TX04 Series Device Support	DFP	1.2.0
Toshiba TXZ3 Series Group(1),Group(2) Device Support	DFP	1.2.0
Yokogawa EB-TMPM369FDFG Board Support	BSP	1.0.0
LAPISSemiconductor		
LAPIS Semiconductor ML630Q46x Device Support	DFP	1.0.0
L-Tek		

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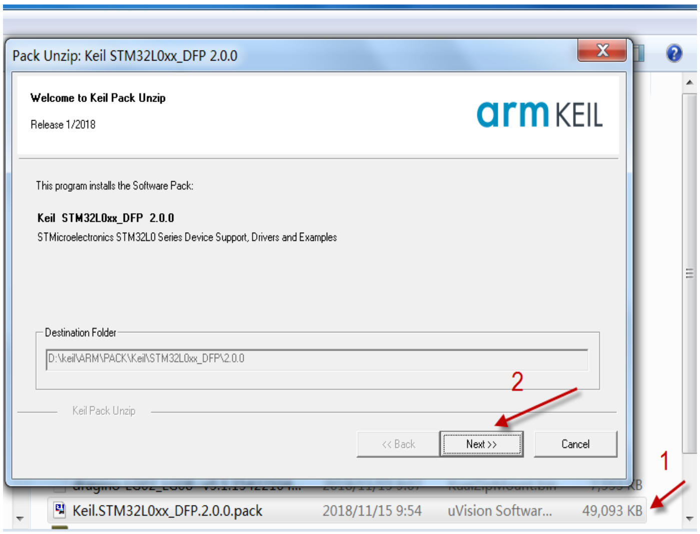
3: Find the Software Pack and install it.



Pack Unzip: Keil STM32L0xx_DFP 2.0.0

Welcome to Keil Pack Unzip

Release 1/2018

This program installs the Software Pack:

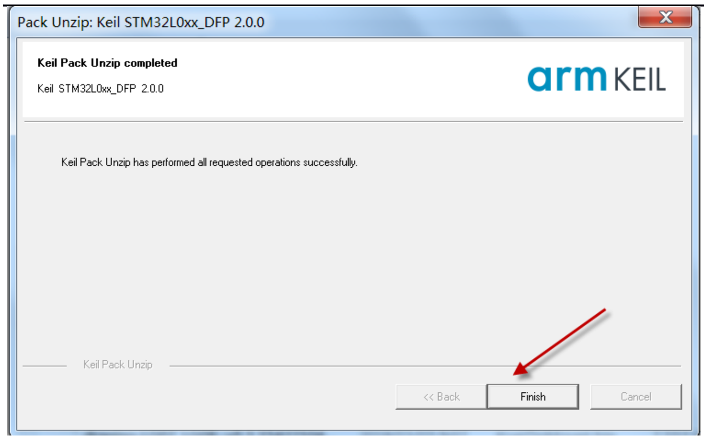
Keil STM32L0xx_DFP 2.0.0

STMicroelectronics STM32L0 Series Device Support, Drivers and Examples

Destination Folder: D:\keil\ARM\PACK\Keil\STM32L0xx_DFP\2.0.0

Keil Pack Unzip

Keil.STM32L0xx_DFP.2.0.0.pack 2018/11/15 9:54 uVision Softwar... 49,093 KB



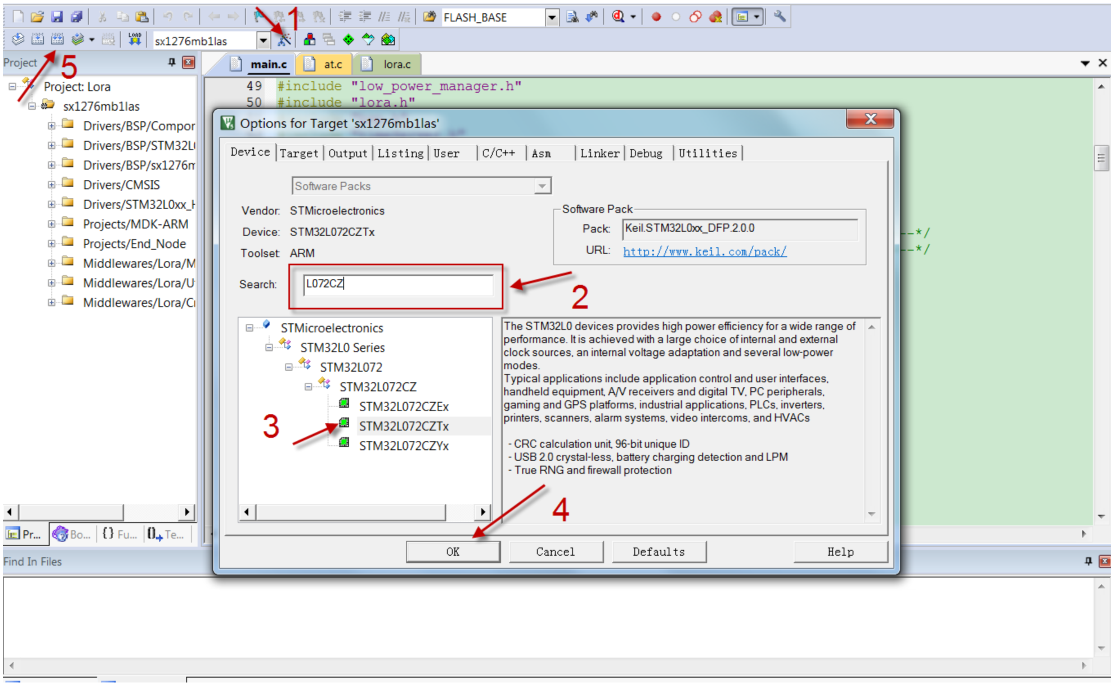
Pack Unzip: Keil STM32L0xx_DFP 2.0.0

Keil Pack Unzip completed

Keil STM32L0xx_DFP 2.0.0

Keil Pack Unzip has performed all requested operations successfully.

4: **Add** the Device, then you can **rebuild** the project.



Options for Target 'sx1276mb1las'

Vendor: STMicroelectronics
Device: STM32L072CZTx
Toolset: ARM
Search: L072CZ

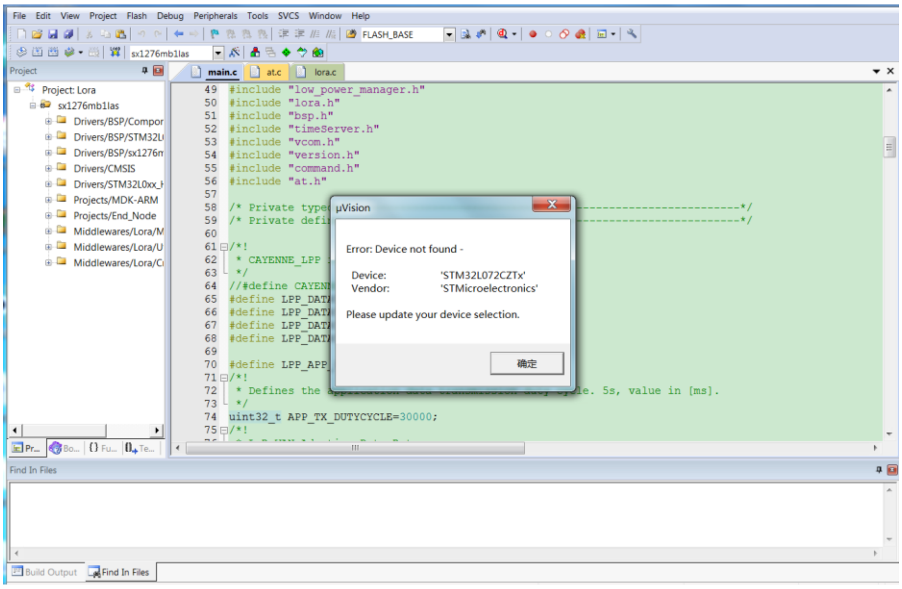
Software Pack
Pack: Keil.STM32L0xx_DFP.2.0.0
URL: http://www.keil.com/pack/

The STM32L0 devices provides high power efficiency for a wide range of performance. It is achieved with a large choice of internal and external clock sources, an internal voltage adaptation and several low-power modes.
Typical applications include application control and user interfaces, handheld equipment, A/V receivers and digital TV, PC peripherals, gaming and GPS platforms, industrial applications, PLCs, inverters, printers, scanners, alarm systems, video intercoms, and HVACs

- CRC calculation unit, 96-bit unique ID
- USB 2.0 crystal-less, battery charging detection and LPM
- True RNG and firewall protection

```
49 #include "low_power_manager.h"
50 #include "lora.h"
```

Note: If you don't add the Device, then Keil will report this error:



```
#include "low_power_manager.h"
#include "lora.h"
#include "bsp.h"
#include "timeServer.h"
#include "vcom.h"
#include "version.h"
#include "command.h"
#include "at.h"

/* Private type                            -------------------------*/
/* Private defi                            -------------------------*/

/*!
 * CAYENNE_LPP
 */
//#define CAYENN
#define LPP_DATA
#define LPP_DATA
#define LPP_DATA
#define LPP_DATA

#define LPP_APP_
/*!
 * Defines the                          le. 5s, value in [ms].
 */
uint32_t APP_TX_DUTYCYCLE=30000;
/*!
```

µVision

Error: Device not found -

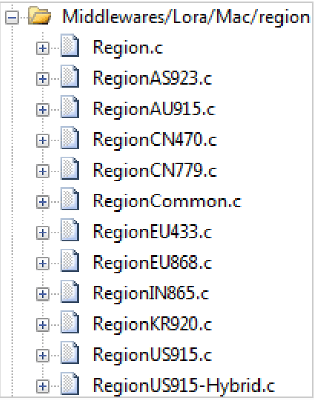
Device: 'STM32L072CZTx'
Vendor: 'STMicroelectronics'

Please update your device selection.

确定

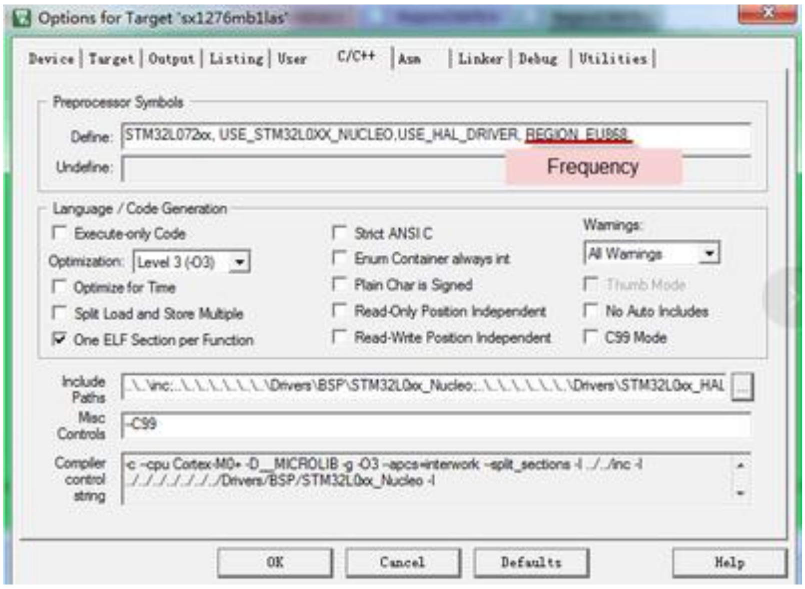
5.2.3 Compile Source Code

1. Download the source code from Software Source Code Download Link.
2. Use Keil to open the project file: STM32CubeExpansion_LRWAN/Projects/Multi/Applications/LoRa/DRAGINO-LRWAN(AT)/MDK-ARM/STM32L072CZ-Nucleo/Lora.uvprojx
3. In Keil, you can see what frequency band the code support.



Middlewares/Lora/Mac/region
- Region.c
- RegionAS923.c
- RegionAU915.c
- RegionCN470.c
- RegionCN779.c
- RegionCommon.c
- RegionEU433.c
- RegionEU868.c
- RegionIN865.c
- RegionKR920.c
- RegionUS915.c
- RegionUS915-Hybrid.c

4. If you want to change frequency, modify the Preprocessor Symbols.
   For example, change EU868 to US915



Preprocessor Symbols

Define: STM32L072xx, USE_STM32L0XX_NUCLEO,USE_HAL_DRIVER, REGION_EU868

Undefine:

Frequency

Language / Code Generation

- □ Execute-only Code
- Optimization: Level 3 (-O3)
- □ Optimize for Time
- □ Split Load and Store Multiple
- ☑ One ELF Section per Function
- □ Strict ANSI C
- □ Enum Container always int
- □ Plain Char is Signed
- □ Read-Only Position Independent
- □ Read-Write Position Independent
- Warnings: All Warnings
- □ Thumb Mode
- □ No Auto Includes
- □ C99 Mode

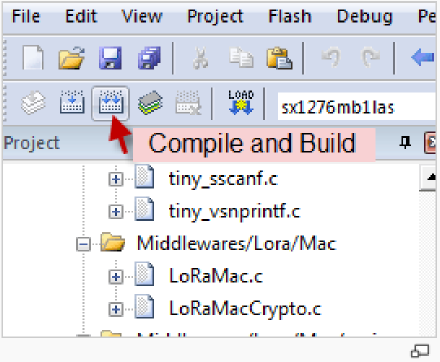
Include Paths: ..\..\inc;..\..\..\..\..\..\..\Drivers\BSP\STM32L0xx_Nucleo;..\..\..\..\..\..\..\Drivers\STM32L0xx_HAL

Misc Controls: --C99

Compiler control string:

```
-c --cpu Cortex-M0+ -D__MICROLIB -g -O3 --apcs=interwork --split_sections -I ../../inc -I
../../../../../../../Drivers/BSP/STM32L0xx_Nucleo -I
```

5. Compile and build



Compile and Build

6. FAQ

6.1 Why there is 433/868/915 version?

Different countries have different rules for the ISM band for LoRa. Although the LoRa chip can support a wide range of Frequencies, we provide different versions of the hardware for best tune of the LoRa hardware part.

6.2 What is the frequency range of LT LoRa part?

Different LT version supports different frequency range, below is the table for the working frequency and recommend 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

6.3 How 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.

6.4 Can I use Private LoRa protocol?

The stock firmware is based on LoRaWAN protocol. You can use a private LoRa protocol in LSN50. This section describes an example for base LoRa transfer. It is a reference/demo and we do not provide further software development support on this topic.

In this demo, we will show the communication between LoRa Shield and LSN50, both of them using the basic LoRa library. LSN50 will send a message to a LoRa Shield and the LoRa Shield will print it to the console.

LoRa Shield + UNO:

Use the LoRa Library and upload the LoRa Receive Sketch to Arduino.

Refs:

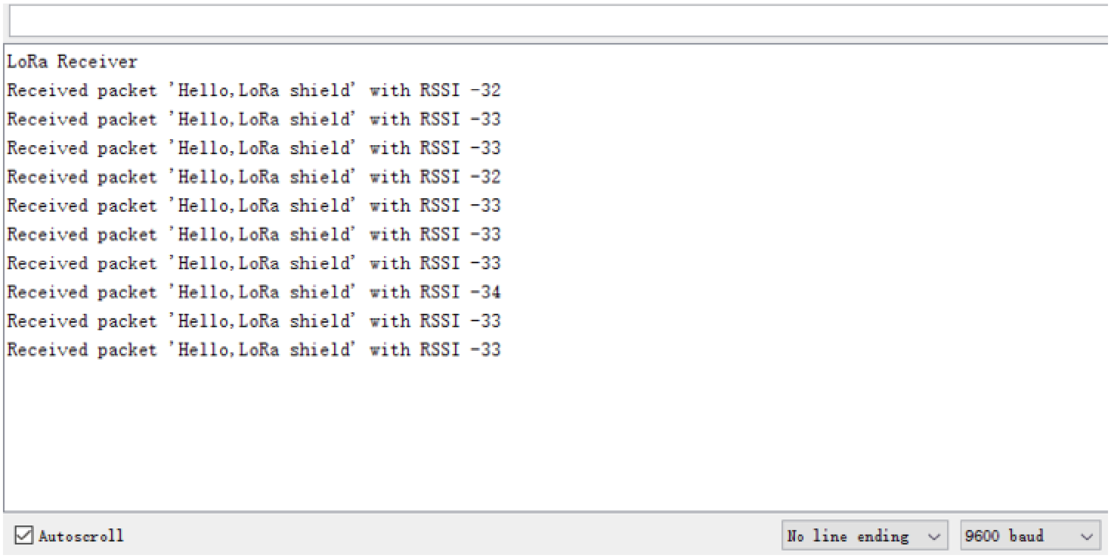
http://www.dragino.com/downloads/index.php?dir=LSN50-LoRaST/LoRa_Raw_Example/Arduino/&file=LoRa.zip
http://www.dragino.com/downloads/downloads/LSN50-LoRaST/LoRa_Raw_Example/Arduino/LoRaReceiver.ino

Open the serial monitor to Arduino. The device acts as a LoRa Receiver and listen on the frequency 868.3Mhz by default.

LSN50:

Use the <LoRa RAW code> . The project file is in: MDK-ARM\STM32L072CZ-Nucleo\ Lora.uvprojx

Compile it and Upload it to LSN50, the LSN50 will transfer on the frequency 868.3Mhz.
In the Arduino Console, it will see the received packets as below.



```
LoRa Receiver
Received packet 'Hello,LoRa shield' with RSSI -32
Received packet 'Hello,LoRa shield' with RSSI -33
Received packet 'Hello,LoRa shield' with RSSI -33
Received packet 'Hello,LoRa shield' with RSSI -32
Received packet 'Hello,LoRa shield' with RSSI -33
Received packet 'Hello,LoRa shield' with RSSI -33
Received packet 'Hello,LoRa shield' with RSSI -33
Received packet 'Hello,LoRa shield' with RSSI -34
Received packet 'Hello,LoRa shield' with RSSI -33
Received packet 'Hello,LoRa shield' with RSSI -33
```

6.5 How to set up LSN50 to work in 8 channel mode

By default, the frequency bands US915, AU915, CN470 work in 72 frequencies. 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 in 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, the end node will use all channels (0~71) for OTAA Join process. After the OTAA Join, the end node will use these all 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 it difficult for the devices to Join the TTN network and uplink data. To solve this issue, you can access the device via the AT commands and run:

AT+CHE=2
ATZ

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

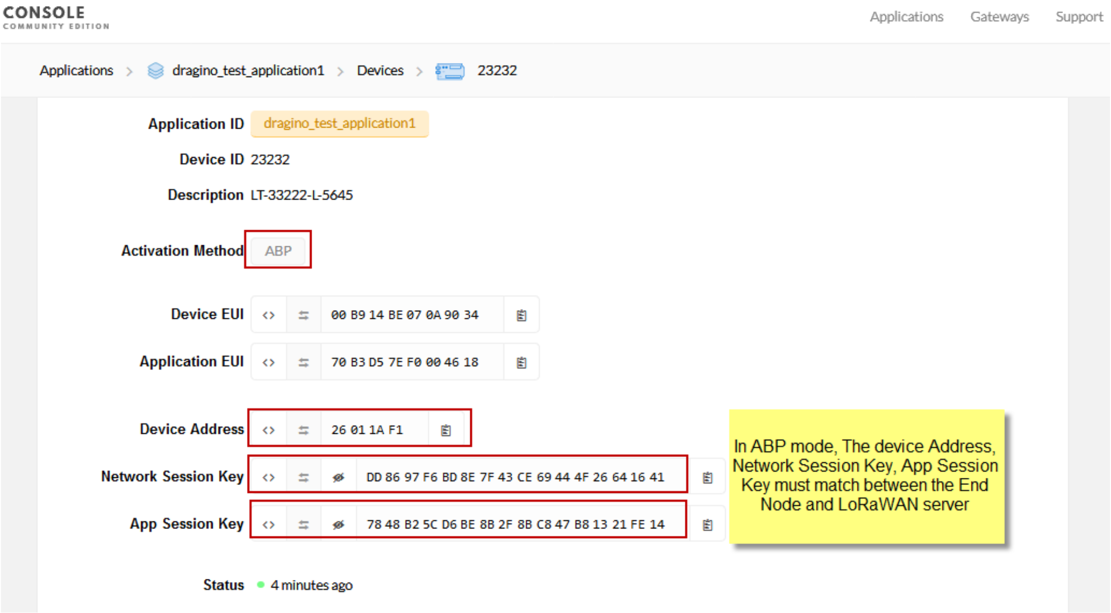
The **AU915** band is similar. Below are the AU915 Uplink Channels.

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

6.6 How to set up LSN50 to work with Single Channel Gateway such as LG01/LG02?

In this case, users need to set LSN50 to work in ABP mode and transmit in only one frequency.
Assume we have a LG02 working in the frequency 868400000 now, below is the steps.

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.



Application ID dragino_test_application1

Device ID 23232

Description LT-33222-L-5645

Activation Method ABP

Device EUI 00 B9 14 BE 07 0A 90 34

Application EUI 70 B3 D5 7E F0 00 46 18

Device Address 26 01 1A F1

Network Session Key DD 86 97 F6 BD 8E 7F 43 CE 69 44 4F 26 64 16 41

App Session Key 78 48 B2 5C D6 BE 8B 2F 8B C8 47 B8 13 21 FE 14

Status 4 minutes ago

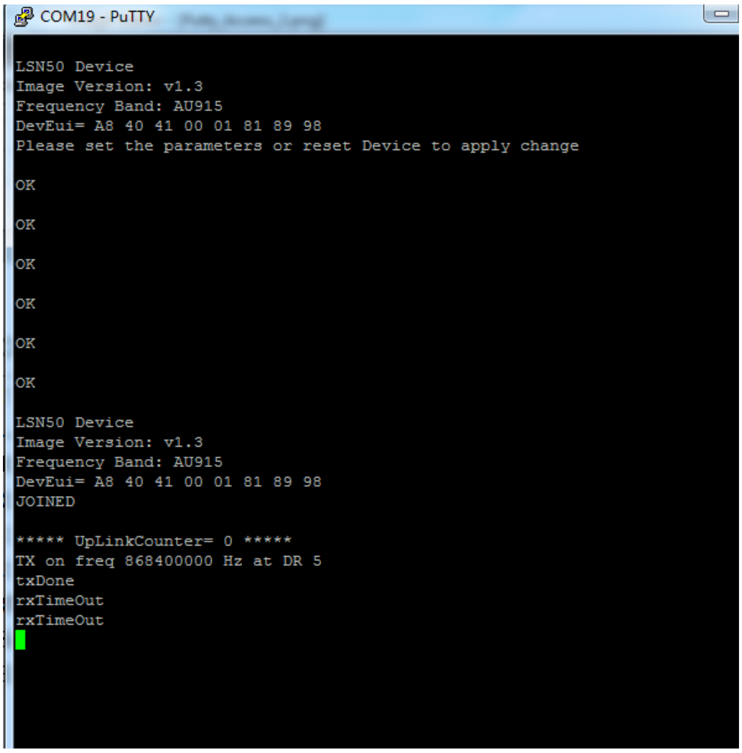
In ABP mode, The device Address, Network Session Key, App Session Key must match between the End Node and LoRaWAN server

Note: You need to make sure the above three keys match in the device and in TTN. You can change them either in TTN or in the Device to make them match. In TTN, NETSKEY and APPSKEY can be configured in the setting page, but the Device Addr is generated by TTN. You can also change the Device ADDR in TTN by using the The Things Network CLI.

Step2: Run AT commands to make the LSN50 work in Single frequency and ABP mode.
Below are the AT commands:

```
AT+FDR   Reset Parameters to Factory Default, Keys Reserve
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=300000  Set transmit interval to 5 minutes
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 below:



```
LSN50 Device
Image Version: v1.3
Frequency Band: AU915
DevEui= A8 40 41 00 01 81 89 98
Please set the parameters or reset Device to apply change

OK

OK

OK

OK

OK

OK

LSN50 Device
Image Version: v1.3
Frequency Band: AU915
DevEui= A8 40 41 00 01 81 89 98
JOINED

***** UpLinkCounter= 0 *****
TX on freq 868400000 Hz at DR 5
txDone
rxTimeOut
rxTimeOut
```

6.7 How to configure the EUI keys in LSN50?

The early version of LSN50 firmware doesn’t have pre-configured keys.
It is recommended that you update the image to the latest version before configure the keys.
Refer upgrade image to update the firmware to the latest version.
Run AT commands to set the keys to desired keys; refer AT Command manual.

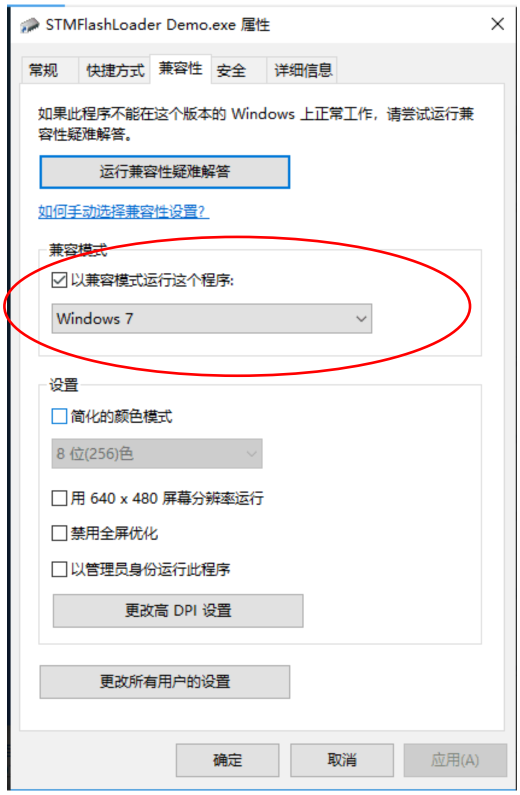
7. Trouble Shooting

7.1 Connection problem when uploading 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.



如果此程序不能在这个版本的 Windows 上正常工作，请尝试运行兼容性疑难解答。

兼容模式

☑ 以兼容模式运行这个程序:

Windows 7

设置

□ 简化的颜色模式

8 位(256)色

□ 用 640 x 480 屏幕分辨率运行

□ 禁用全屏优化

□ 以管理员身份运行此程序

4. We have seen cases where the FT232 USB TTL adapter has a reliability issue with the PC USB chipset (Intel). In this case, even though points 1 and 2 above work, it still has a reliability issue for uploading. If this happens, change to a different PC or change the USB to TTL adapter to solve the issue.

7.2 Why I can’t join TTN in US915 / AU915 bands?

It is due to channel mapping. Please see the Eight Channel Mode section above for details.

7.3 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.

8. Order Info

Part Number: **LSN50-XX-YY**

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

YY:

- **12**: With M12 waterproof cable hole
- **16**: With M16 waterproof cable hole
- **20**: With M20 waterproof cable hole
- **NH**: No Hole

9. Packing Info

Package Includes:

- LSN50 LoRa Sensor Node x 1

Dimension and weight:

- Device Size: 8 x 6.5 x 5 cm
- Device Weight: 137g
- Package Size / pcs : 9 x 7 x 6cm
- Weight / pcs : 160g

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

11. References

- Product Page
  (http://www.dragino.com/products/lora/item/128-lsn50.html)

- Data Sheet
  (http://www.dragino.com/downloads/index.php?dir=datasheet/EN/&file=Datasheet_LoRaSensorNode.pdf)

- Image Download
  (https://github.com/dragino/LoRa_STM32/tree/master/LSN50.hex)

- AT Command Manual
  (http://www.dragino.com/downloads/index.php?dir=LSN50-LoRaST/&file=DRAGINO_STM_AT_Commands_v1.3.pdf)