



LSN50 LoRa Sensor Node User Manual

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Version	Description	Date
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1.	In	troduc	tion	4
	1.1	What	is LSN50 LoRa Sensor Node	4
	1.2	Speci	fications	5
	1.3	Featu	ıres	6
	1.4	Appli	cations	6
	1.5	Pin D	efinition	7
	1.6	Hard	ware Change log	8
	1.7		Option	
	1.7	TIDIE		9
2.	U	se LSN	50 with stock LoRaWAN firmware	. 10
	2.1	How	it works?	.10
	2.2	Quick	guide to connect to LoRaWAN server (OTAA)	.10
	2.3	Uplin	k Payload	.13
	2.	3.1	Payload for EU868 like	.13
	2.	3.2	Payload for US915 like	.13
	2.	3.3	Decode payload in The Things Network	
	2.4	Paylo	ad explain and sensor interface	. 15
	2.	4.1	Battery Info	. 15
	2.	4.2	Temperature (DS18B20)	.15
	2.	4.3	Digital Input	.16
	2.	4.4	ADC	.16
	2.	4.5	Digital Interrupt	.17
	2.	4.6	I2C Interface (SHT20)	.19
	2.	4.7	+5V output	.20
	2.5	Dowr	nlink Payload	.20
	2.6	Firmv	vare Change Log	.20
	2.7	Batte	ry Analyze	.20
	2.	7.1	Battery Type	.20
	2.	7.2	Power consumption Analyze	.21
	2.	7.3	Battery notice	.23
	2.	7.4	Replace the battery	.23
3.	U	se AT C	Command	.24
	3.1	Acces	s AT Command	.24
	3.2		non AT Command Sequence	
	5.2	Conn		.20



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		3.2.1	Multi-channel ABP mode (Use with SX1301/LG308)	26
		3.2.2	Single-channel ABP mode (Use with LG01/LG02)	26
4.		Uploa	d Firmware	27
5.		Devel	oper Guide	29
	5.2	1 Soi	ırce Code	29
	5.2	2 Coi	npile Source Code	29
		5.2.1	Set up Keil compile environment	29
		5.2.2	Compile Source Code	32
6.		FAQ		
	6.2	1 Wh	ny there is 433/868/915 version?	
	6.2	2 Wh	nat is the frequency range of LT LoRa part?	
	6.3	3 Ho	w to change the LoRa Frequency Bands/Region?	
	6.4	4 Cai	n I use Private LoRa protocol?	
	6.5	5 Ho	w to set up LSN50 to work in 8 channel mode in US915, AU915, CN470 bands?	35
	6.6	6 Ho	w to set up LSN50 to work with Single Channel Gateway such as LG01/LG02?	
7.		Order	Info	38
8.		Packir	ng Info	
9.		Suppo	rt	38
10).	Refere	ence	



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/SOCI2 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



LSN50 LoRa Sensor Node



LoRaWAN Gateway



IoT Server



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</p>
- 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

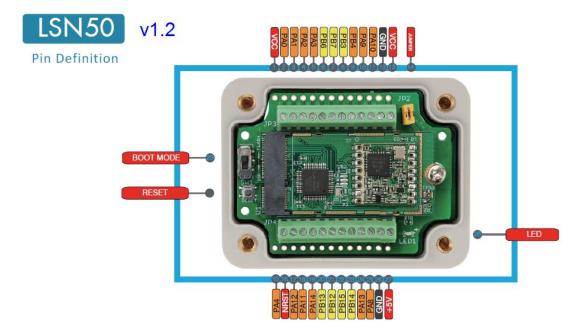
- ✓ LoRaWAN 1.0.2 Class A,Class C
- ✓ STM32L072CZT6 MCU
- ✓ SX1276/78 Wireless Chip
- ✓ Pre-load bootloader on USART1/USART2
- ✓ MDK-ARM Version 5.24a IDE
- ✓ I2C,LPUSART1,USB,SPI2
- ✓ 3x12bit ADC, 1x12bit DAC
- ✓ 20xDigital I/Os
- ✓ LoRa[™] Modem
- ✓ Preamble detection
- ✓ Baud rate configurable
- ✓ 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 Definition



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	



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			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	
30	NRST	In	Reset MCU	

1.6 Hardware Change log

LSN50 v1.2:

- ✓ 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)

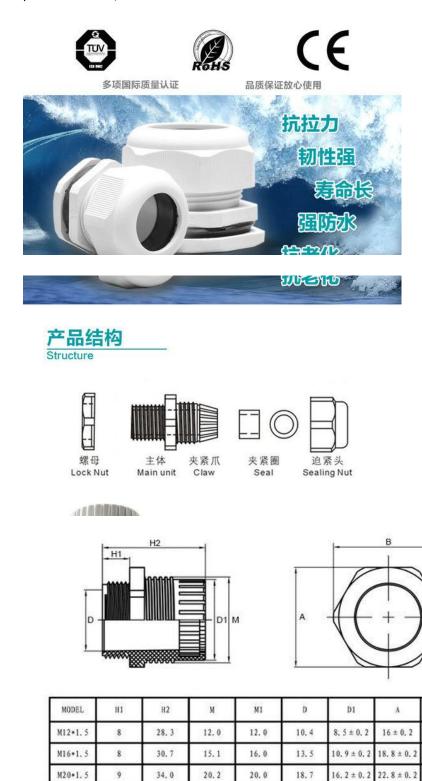
LSN50 v1.3:

✓ Add P-MOS to control 5V output



1.7 Hole Option

The LSN50 provide different hole size option for different size sensor case. the option now provided is M12/M16 and M20. The definition is as below:



单位: mm

В

18 ± 0.2

20.6±0.2

25.2 \pm 0.2



2. Use LSN50 with stock 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, user just need to input the OTAA keys in the LoRaWAN IoT server and power on the LSN50. It will auto join the network via OTAA.

In case user can't set the OTAA keys in the LoRaWAN OTAA server and has to use the keys from the server. User can <u>use AT Command</u> to set the keys in LSN50.

2.2 Quick guide to connect to LoRaWAN server (OTAA)

Here is an example for how to join the <u>TTN LoRaWAN Network</u>. Below is the network structure, we use <u>LG308</u> as LoRaWAN gateway in this example.

LSN50 in a LoRaWAN Network



The LG308 is already set to connect to <u>TTN network</u>. So what we need to now is only configure the TTN:

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:





User can enter this key in their LoRaWAN Server portal. Below is TTN screen shot:

Add APP EUI in the application

CONNECLE	Applications	Gateways	Suppor
Applications > 🤤 dragino_test_application1			
Application ID dragino_test_application1 Description a test application for Dragino Created 2 years ago Handler thr-handler-eu (current handler)		documentat	ion
APPLICATION EUIS		🌣 manage et	<u>sit</u>
 → 二 78 B3 D5 72 F9 00 46 18 割 → 二 3F 77 AD E3 68 CA A8 65 割 			

Add APP KEY and DEV EUI

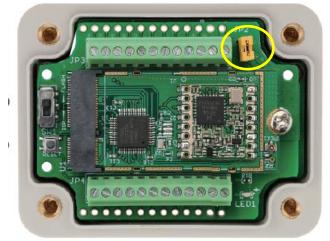
THE THINGS	CONSOLE COMMUNITY ENTITION	Applications	Gateways	Suppo
	Applications > is dragino_test_application1 > Devices			
	REGISTER DEVICE		bulk import devi	285
	Device ID This is the unique identifier for the device in this app. The device ID will be immutable.			
	BO		0	
	Device EUI The device EUI is the unique identifier for this device on the network. You can change the EUI later.		👩 8 bytes	
			o bytes	
	App Key The App Key will be used to secure the communication between you device and the network.			1
	57 4E 37 E6 8A EC FC CD B3 B9 3D 87 A9 3B 4B 2C		🥑 16 bytes	
	App EUI			Í.
	3F 77 AD E3 6B CA AB 65		0	





Step 2: Power on LSN50

Put a Jumper on JP2 to power on the device.



Step 3: and it will auto join to the TTN network. After join success, it will start to upload message to TTN and user can see in the panel.

	COMMUN	DLE	4						Applicati	ons Gatew	ays S	upport	A linsongxiong
App	lications	> 🤤 er	ngineer-lin	> Devices	> 🥅	Isn50 >	Data						
										Overview	Data	Settings	
A	PPLIC	ATION	DATA								II pau	ise 🝵 clear	
	Filters	uplink	downlink	activation	ack	error]						
	• 14:	time :37:16	counter 26	port 2		payload: OE	Temperature 3 21 00 00 00 00 00 00 00 01 16 02 47						
	▲ 14:	:37:06	25	2		payload: OE	3 21 00 00 00 00 00 00 01 16 02 48	Humidity					
	▲ 14:	:36:56	24	2		payload: OE	3 21 00 00 00 00 00 00 01 16 02 48						
	▲ 14:	:36:46	23	2		payload: OE	3 22 00 00 00 00 00 00 01 17 02 49						
	• 14:	:36:36	22	2		payload: OE	3 21 00 00 00 00 00 00 01 17 02 49						
	▲ 14:	:36:25	21	2		payload: OE	3 21 00 00 00 00 00 00 01 17 02 4A						
	^ 14:	:36:15	20	2		payload: OE	3 22 00 00 00 00 00 00 01 17 02 4A						



2.3 Uplink Payload

In LoRaWAN protocol, the frequency band US915/AS923/AU915 required that the payload is less than 12 bytes, otherwise LoRaWAN server won't accept the payload in in some SF settings.

8 byte payload, valid for all bands

THE THINGS CONSO								Application	is Gate	eways Su
Appl	lications	> 🥥 dı	ragino_test_a	pplication1	> Devices > 📰 Isn50-abp > I	Data				
								Overview	Data	Settings
A	PPLIC	ATION	DATA		Temperature				II paus	e 🖀 <u>clear</u>
		uplink	downlink	activation	(DS18B20) Dig	gital Input	ADC			
	Filters	time	counter	port						
	▲ 17:	:41:57	38	2	payload: 0B 6B 00 FD 00 00 2C	00	Digital Interrupt			Â
	▲ 17:	:40:57	37	2	payload: 0B 6B 00 FD 00 00 26	00				
	▲ 17:	:39:57	36	2	payload: 0B 6B 00 FB 00 00 2A	.00				=

2.3.1 Payload for EU868 like

The payload for EU868/IN865/CN470/CN779/EU433/KR920 is:

The uplink payload includes totally 12 bytes. Uplink packets use FPORT=2 and every 10 minutes send one uplink by default.

Size(bytes)	2	2	1	2	1	2(optional*)	2(optional*)
Value	BAT	Temperature	Digital	ADC	Digital	Temperature	Humidity
	(DS18B20)		in		Interrupt	(SHT20)	(SHT20)

*: SHT20 payload is not included in default firmware.

2.3.2 Payload for US915 like

The payload for US915/AU915/AS923 is totally 8 bytes:

Size(bytes)	2	2	1	2	1
Value	BAT	Temperature	Digital	ADC	Digital
		(DS18B20)	in		Interrupt



2.3.3 Decode payload in The Things Network

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

```
Applications
               products_lsn50 > Payload Formats
                                                                               Payload Formats
                                                              Overview Devices
                                                                                             Integrations Data Settings
    PAYLOAD FORMATS
      Payload Format
                    ent by your devices
       Custom
       decoder com
                  rter validator encoder
                                                                                                        remove decode
           function Decoder(bytes, port) [{]

' Decode an uplink message from a buffer

in the an object of fields.
                                                                                                             5+
             // Decode an upLink message from a buj
// (array) of bytes to an object of fi
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 function is :
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)
   {value |= 0xFFFF0000;}
   var tempc=(value/10).toFixed(2);//DS18B20,PB3,units: °C
   var digital_IS=(bytes[4] & 0x01)? "H":"L";//PA12, Digital Input Status
   var adc_ch0=(bytes[5]<<8 | bytes[6])/1000;//PA0,ADC Channel 0,units:V
   var exti_trigger=bytes[7]? "TRUE":"FALSE";//PB14,GPIO_MODE_IT_FALLING
 '*you need define USE SHT20 in keil then rebuild project
   value=bytes[8]<<8 | bytes[9];
   if(bytes[8] & 0xFC)
   {value |= 0xFFFF0000;}
    var temp_SHT=(value/10).toFixed(2);//SHT20,temperature,units: °C
    value=bytes[10]<<8 | bytes[11];
    var hum_SHT=(value/10).toFixed(1);//SHT20,Humidity,units:%
*/
   return {
          BatV:batV,
          TempC:tempc,
          Digital_IStatus:digital_IS,
          ADC_CH0V:adc_ch0,
          EXTI_Trigger:exti_trigger,
          //TempC_SHT:temp_SHT,
          //Hum_SHT:hum_SHT
  };
```

And the uplink payload will show as below:



Filters	uplink	downlink	activation	ack	error					
	time	counter	port							
▲ 23	3:36:49	292	2	de	/id: <u>lsn50-test1</u>	payload: OAA5	5 FE EF 00 00 9F 0	D ADC_CHOV: 0	.159 BatV: 2.725	Digital_IStatus
•					III					
	devi	d: <u>lsn50-tes</u>	<u>t1</u> payload: (DA A7 FE EF	00 0A 00 00	ADC_CHOV: 0.16	BatV: 2.727 Dig	ital_IStatus: "L"	EXTI_Trigger: "FAL	SE" TempC: "-
							III			
•										
 2 	3:34:49	290	2	de	/id: <u>lsn50-test1</u>	payload: OAA	1 FE EF 00 00 9F 0	D ADC_CHOV: 0	.159 BatV: 2.724	Digital_IStatus

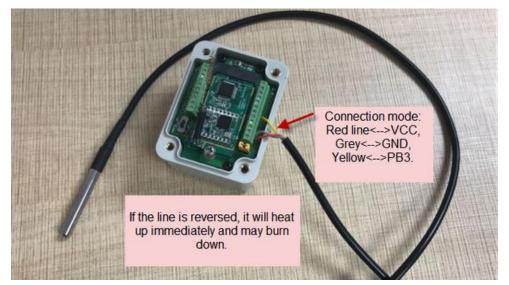
2.4 Payload explain and sensor interface

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. <u>Connection</u>:



Example:

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



2.4.3 Digital Input

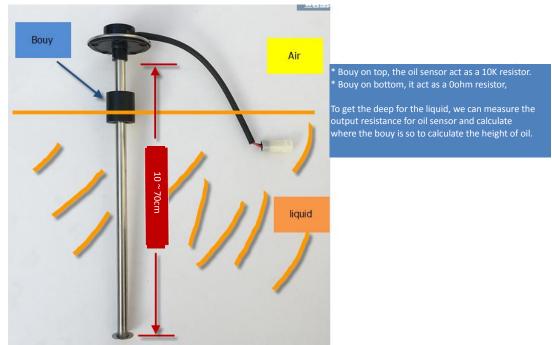
The digital input for PA12:

00 represents PA12 is low, 01 represents a high level.

2.4.4 ADC

Monitor the voltage in PAO, in mv. Ex: 0x021F = 543mv,

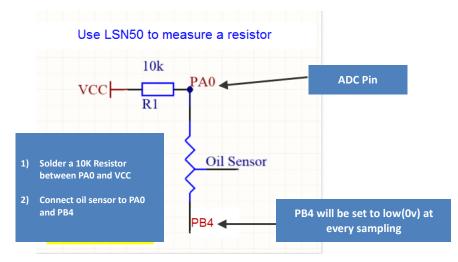




In the LSN50, we can use PB4 and PA0 pin to calculate the resistance for the oil sensor. Steps:

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

The equip circuit is as below:





According to above photo:

$$(\text{VCC} - V_{PA0})/10k = V_{PA0}/R_{oil_sensor}$$

So

$$R_{oil_sensor} = V_{PA0} \times 10K/(VCC - V_{PA0})$$

 $\mathit{V_{PA0}}\,$ 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 $10 \sim 70$ cm.

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 refer to the pin PB14, it is trailing edge trigger. When there is a trigger, the LSN50 will send a packet to the server.

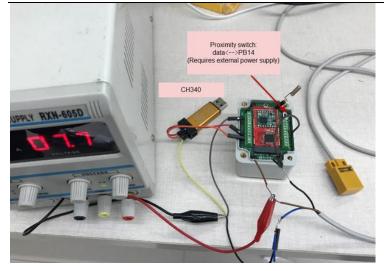
Example to use approximate switch with Digital Interrupt

The Hall element is a magnetic sensing element. A switch made of a Hall element is called a Hall switch. When the magnetic object moves closer to the Hall switch, the Hall element on the switch detection surface changes the internal circuit state of the switch due to the Hall effect, thereby identifying the presence of a magnetic object nearby, thereby controlling the on or off of the switch. The detection object of such a proximity switch must be a magnetic object.





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2.4.6 I2C Interface (SHT20)

PB6(SDA) and PB7(SCK) are I2C interface. User can use it to connect to I2C device and get the sensor data.

We have made an example to show how to use the I2C interface to connect to SHT20 Temperature and Humidity Sensor. This is not support in the stock firmware, user need to compile a new firmware with **USE_SHT20** defined. As shown below

🖫 Options for Target 'sx1276mb1las'							
Device Target Output Listing Vser	C/C++ Asm Linker Debug	Utilities					
Preprocessor Symbols Define: STM32L072x, USE_STM32L0XX_NUCLEO, USE_HAL_DRIVER, REGION_EU868 USE_SHT20 Undefine:							
Language / Code Generation Strict ANSI C Warnings: Execute-only Code Strict ANSI C Warnings: Optimization: Level 3 (O3) Enum Container always int All Warnings Optimize for Time Plain Char is Signed Thumb Mode Split Load and Store Multiple Read-Only Position Independent No Auto Includes Include Paths Misc -C99							
Controls Compiler c-cpu Cortex-M0+ -D_MICROLIB -g -03apcs=interworksplit_sections -I//inc -I							
OK	Cancel Defaults	Help					

Then upload this firmware to LSN50 and do below connection:

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. if user want to use their own I2C device, he can refer the SHT20 part source code as reference.



2.4.7 +5V output

Since v1.2 hardware version, a +5v output is added in the hardware. The +5V output will be valid for every sampling.

2.5 Downlink Payload

By default, LSn50 will print the downlink payload to console port. It won't do any action on that.

2.6 Firmware Change Log

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 Cayenne_LPP payload, user need to recompile firmware again. see this link this link

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)

2.7 Battery Analyze

2.7.1 Battery Type



LSN50 Battery is composed by a 4000mAh Li/SOCI2 Battery and Super Capacitor. The battery is un-rechargeable one time battery with low discharge rate (<2% per year). This type of battery is commonly used in IoT target for long term running, such as water meter.

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

The battery related documents as below:

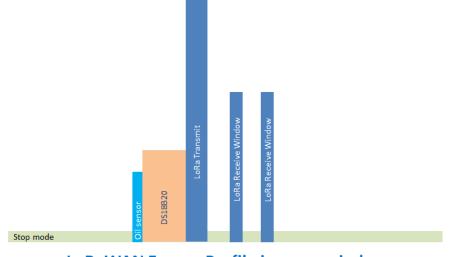
- ✓ <u>Battery Dimension</u>,
- ✓ Lithium-Thionyl Chloride Battery datasheet, Tech Spec
- ✓ Lithium-ion Battery-Capacitor datasheet, Tech Spec

2.7.2 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 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 case:

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

Lower 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 two RX window together.

cenarios		А	В	С	D	Е	F
ime	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 transmitt	ted	8	8	8			
otal 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			
ower usage comparison					o-Controller Act		
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%
							Green <= 100%
verage current	mA	0.021793472	0.056254259	0.012180976	0	0	0
Design Goals	•	· · · · · · · · · · · · · · · · · · ·		, ,	,	ļ	
System efficiency		90%	90%	90%	90%	90%	90%
Target battery life	уг	2	2	2	2	2	2
Required battery capa	c 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

There is a power consumption tool for easy analyze. And below is the analyze result.

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



2.7.3 Battery notice

The Li-SICO battery is designed for small current / long period application. It is not good to use high current, short period transmit. The recommend min period for use this battery is 5 minutes. If user use a shorter period time to transmit LoRa. The battery life may be decreased.

2.7.4 Replace the battery

User can replace the battery to other battery for LSN50. In the mother board, there is a diode (D1) between the battery and the main circuit. If user needs 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.



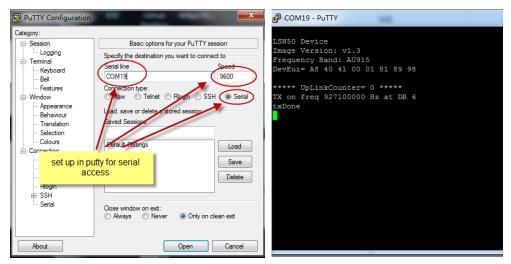
3. Use AT Command

3.1 Access AT Command

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



In PC, User needs to set serial tool baud rate to **9600** to access serial console for LSN50. LSN50 will output system info once power on and access to:





Below are the available commands, a more detail AT Command manual can be found at AT

Command Manual

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

General Command 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)

AT+FDRReset Parameters to Factory Default, Keys ReserveAT+NJM=0Set to ABP modeAT+ADR=0Set the Adaptive Data Rate OffAT+DR=5Set Data RateAT+TDC=300000Set transmit interval to 5 minutesAT+CHS=868400000Set transmit frequency to 868.4MhzAT+DADDR=26 01 1A F1Set Device Address to 26 01 1A F1ATZReset MCU



4. Upload Firmware

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



Step1: Download <u>flash loader</u>.

Step2: Download the LSN50 Image files.

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

Flash Loader Demonstrator		Flash Loader Demonstrator	
life.augmented		IIIe.augmented	
Select the communication port and set settings, then click next to open connection. Common for all families C UART		Target is readable. Please click "Next" to procee	d.
Port Name COM19 Parity Even Baud Rate 115200 Echo Disabled Data Bits 8 Timeout(s) 10	Board detected		Remove protection
1): Put SW1 to ISP posotion 2): Push RESET button to enter program mode			
		Select Next	
		1	
Back Next Cancel Close		Back Next Cance	<u>C</u> lose



т

	ler Demonstrator		9	Flash Loader Demonstrator	OB
		nted		Life.augmented	
lease, selec	t your device in the target list		C	^C Erase	
Target	STM32L0_x3_x2_x1_192K	-		C Al C Selection	
	Usually ne	eed to wait for a	6	Download to device You can see the location	nof
	n	noment.		Download from file your programming	_
		the first one.		E:\资料\软件下载\ST官方\STM32CubeExpansion_L	RWAN_V
sh mapping	and the second se				Global Erat
lame	the second s	Size		@ (h) 8000000 - Jump to the	
Page0 Page1	an operation an operation	0x80 (0K)		Optimize (Remove some FFs) Verity after d	
Page1 Page2		0x80 (0K)		Apply option bytes	01110000
Page3		0x80 (0K)			
Page4	0x 8000200 0x 800027F	0x80 (0K)	C	Upload from device	
Page5		0x80 (0K)		Upload to file	
Page6		0x80 (0K)			
Page7		0x80 (0K)	0	0	
Page8 Page9		0x80 (0K) 0x80 (0K)			
Page10		0x80 (0K)		DISABLE VRITE PROTECTION	Ψ.
Page11		0x80 (0K) *		0	25/ /
				Go on	
	a			Back Next Cancel	1
<u></u>	Back Next	Gancel Qose		Back Next Cancel	Q
lash Load	der Demonstrator	mented	🧼 Flash Loader	r Demonstrator	x
					_
Target	STM32L0_x3_x2_x1_192K		Target S	STM32L0_x3_x2_x1_192K	
887 B	STM32L0_x3_x2_x1_192K STM32L0_x3_x2_x1_192K.STm	ър		STM32L0_x3_x2_x1_192K STM32L0_x3_x2_x1_192K.STmap	
0.00000000	STM32L0_x3_x2_x1_192K.STm D0WNL0AD			5TM32L0_x3_x2_x1_192K.STmap	
Map file	STM32L0_x3_x2_x1_192K.STm		Map file S Operation D File name E	5TM32L0_x3_x2_x1_192K.STmap	Appl
Map file Operation File name	STM32L0_x3_x2_x1_192K.STm D0WNL0AD		Map file S Operation D File name E	STM32L0_x3_x2_x1_192K.STmap DOWNL0AD E-V资料收住下载\ST官方	Appl
Map file Dperation File name File size	STM32L0_x3_x2_x1_192K.STm DOWNLOAD E:设料软件下载\ST官方 \STM32CubeExpansion_LRWA	N_V1.1.2\Projects\Multi\Appl	Map file S Operation D File name E File size 5	STM32L0_x3_x2_x1_192K.STmap DOWNLOAD E:读料收件下载\ST官方 STM32CubeExpansion_LFIWAN_V1.1.2\Projects\Multi\	Appl
Map file Operation File name File size Status	STM32L0_x3_x2_x1_192K.STm DOWNLOAD E:设料软件下载\ST官方 \STM32CubeExpansion_LRWAI 50.24 KB (51448 bytes)	N_V1.1.2\Projects\Multi\Appl	Map file S Operation D File name E V File size 5 Status 5	STM32L0_x3_x2_x1_192K.STmap DOWNLDAD E:设料收件下號\ST官方 .STM32CubeExpansion_LRWAN_V1.1.2\Projects\Mubi\ 50.24 KB (51448 bytes)	Appl
Map file	STM32L0_x3_x2_x1_192K.STm DOWNLOAD E:设料设计下载\ST官方 \STM32CubeExpansion_LRWA 50.24 KB (51448 bytes) 6.53 KB (6682 bytes) of 50.24 KJ	N_V1.1.2\Projects\Multi\Appl 8 (51448 bytes)	Map file S Operation D File name E V File size 5 Status 5	STM32L0_x3_x2_x1_192K.STmap DOWNLDAD E:设料试饮作下载\ST官方 STM32CubeExpansion_LRWAN_V1.1.2\Projects\Multi\ 50.24 KB (51448 bytes) 50.24 KB (51448 bytes) of 50.24 KB (51448 bytes)	Appl

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

Close

Back

Next

Cancel

Close

Cancel

Next

Back.



5. Developer Guide

5.1 Source Code

Software Source Code Download Link. Hardware Source Code Download Link

5.2 Compile Source Code

5.2.1 Set up Keil compile environment

Assume you already have Keil uVision5 installed. Below step shows how to install MDK support and get license.

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

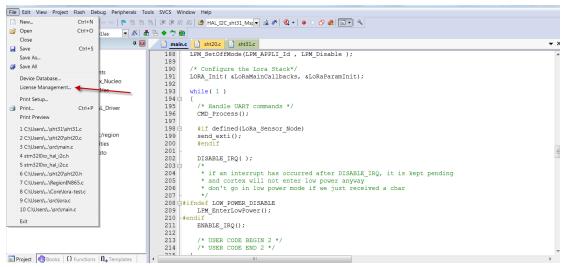
2: Download the keil:

	arm KEIL	
	♠ Products Download Events Support Videos	Search Keil.com
	Home / MDK Version 5 / STMicroelectronics / Installation & Activation	Learning
	MDK for STM32L0 and STM32F0 Installation & Activation	Platform
	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.	 Quick LinksSTMicroelectronics
	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 u//sion IDE/Debugger. The STM32 peripherals can be configured using	MDK Version 5 Device List
Privacy Policy Update	STM32 CubeMX and the resulting project exported to MDK.	Evaluation Boards
Arm's Privacy Policy has been updated. By continuing to use our site, you consent to Arm's Privacy	Download MDK Core Download the keil (Version:5.26.2.0)	Software Packs
Policy. Please review our Privacy Policy to learn more about our collection, use and transfers	Product Serial Number (PSN)	
of your data. Accept and hide this message	To activate the MDK for STM32F0 and STM32L0 Edition, use the following Product Serial Number (PSN) . For please refer to the Activation guide below.	more details on how to activate MDK,
Important Information	4PPFW-QBEHZ-MOD5M	
This site uses cookies to store information on your computer. By continuing to use our site, you consent to our cookies.)
Don't show this message again	Guides	
Change Settings	> Installation	

3: Login with an account that has administration rights.

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

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



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.



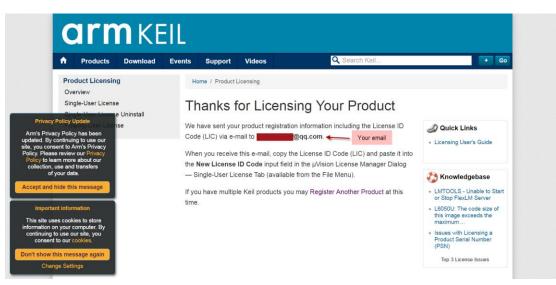
ense Management	icense Floating License Administrator	FexI M License	
Customer Information		Computer ID CID: [C7H4Y-I Get LIC via Inten	net
Product MDK-ARM Cortex-M0/M0+	License ID Code (LIC)/Pro 256K for ST 9DAUH-WU4S4-E89XN-E	oduct variant Support Period 3H47D-62JWP-CILZ6 Expires: Jan 202	20

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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Product Licensing	Home / Product Licensing		
Single-User License Single-User License Uninstall Privacy Policy Update Arm5 Privacy Policy Nas been updated. By continuing to use even site, you consent to Arm5 Privacy Policy. Please review our Privacy Policy to learn more about our collection, use and transfers of your data.	product. Be sure to include dashes. Please make certain your e-mail addr ID (CID), we will send you a License I sure any spam blocker you use is config) and contact information using the following form to ess is valid. After verifying your Product Serial Nun D Code (LIC) via e-mail. E-mail is sent from licmgr(ured to allow this address.	nber and Computer
Important Information This site uses cockies b store information on your computer. By contributing to use our aske, you consent to use cookes. Don't show this message again Change Settings	Enter Your Contact Information B Computer ID (CIE Product Serial # (PSN PC Descriptio): CWS1R-RLXZE	

(2)





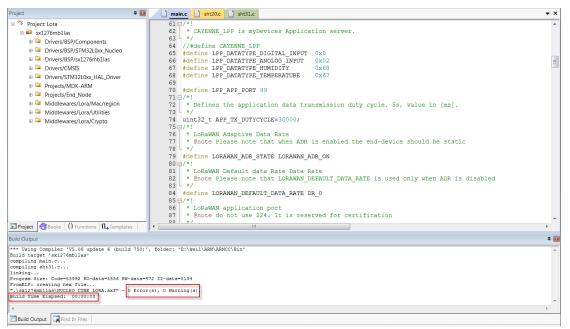
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MDK-ARM Cortex-M0/M0+ 256K
For ST Only
Support Ends 31 Jan 2020
PC Description : 111
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Management... and click Add LIC. License Management Single-User License | Floating License | Floating License Administrator | FlexLM License | Computer ID -Customer Information CID: C7H4Y-I (in some Name: Company: Arm Get LIC via Internet Email: License ID Code (LIC)/Product variant Product 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 Close Help

9:Finish





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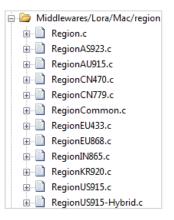


5.2.2 Compile Source Code

- 1. Download the source code from <u>Software Source Code Download Link</u>.
- 2. Use Keil to open the project file:

STM32CubeExpansion_LRWAN/Projects/Multi/Applications/LoRa/DRAGINO-LRWAN(AT)/MD K-ARM/STM32L072CZ-Nucleo/Lora.uvprojx

3. In Keil, you can see what frequency band the code support.



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

Preomoses	sor Symbols			
Define:		2L0XX_NUCLEO.USE_HAL_DRIVER. REGI	and the second se	
Undefine:		F	requency	
Language	/ Code Generation			
F Execut	te-only Code	F Strict ANSI C	Warnings:	
Optimization	n: Level 3 (-03) 💌	Finan Container always int	Al Warnings 💌	
Cotimize for Time		F Plain Char is Signed	Thumb Mode	
Split La	ad and Store Multiple	F Read-Only Position Independent	No Auto Includes	
🔽 One El	LF Section per Function	F Read-Write Position Independent	C99 Mode	
Include Paths	[.\.\nc;\.\.\.\.\Dh	vers\BSP\STM32LQxx_Nucleo:.\.\.\.\.\	.\Drivers\STM32LOx_HAL	
Misc Controls	-C99			
		CROLIB-g-O3-apcs-interwork -splt_section P/STM32L0x_Nucleo-4	ns I.J.Anc I	

5. Compile and build



LSN50 LoRa Sensor Node User Manual



6. FAQ

6.1 Why there is 433/868/915 version?

Different country has different rules for the ISM band for using the LoRa. Although the LoRa chip can support a wide range of Frequency, we provide different version for best tune in the LoRa part. That is why we provide different version of LoRa.

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	Recommend Bands
			Frequency	
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?

User can follow the introduction for <u>how to upgrade image</u>. When download 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. User can use a private LoRa protocol in LSN50, this section describe an example for base LoRa transfer. It is a reference/demo and we didn't provide further software develop support on this topic.

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

LoRa Shield + UNO:

Use the <<u>LoRa Library</u>> and upload the <u>LoRa Receive</u> Sketch to Arduino. Open the serial monitor to Arduino, it acts as a LoRa Receiver and listen on the frequency: 868.3Mhz

LSN50:

Use the <<u>LoRa RAW code</u>>. 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 Arduino Console, it will see:

LoRa Rece	eiver			
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

Autoscroll

No line ending \lor 9600 baud



6.5 How to set up LSN50 to work in 8 channel mode in US915, AU915, CN470 bands?

By default, the frequency bands US915, AU915, CN470 works in 72 frequencies. And many gateways is 8 channel gateways, in such case, the OTAA joined time and uplink schedule is long and unpredictable while the LSN50 hopping in 72 frequency.

User can configure the LSN50 to work in 8 channel models by using the AT+CHE command. For example, in US band, the table is as below. If we run AT+CHE=2. The device will work in Channel 8-15

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	



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 & transmit in only one frequency. Assume we have a LG02 working in the frequency 868400000 now, below is the steps.

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

CONSOLE COMMUNITY EDITION						Applications Gateway	s Support
Applications > 🥪 dragino_test_applica	ation1 >	Devices > 📰 2	3232				
Application ID drag Device ID 23232 Description LT-332		pplication1					
Activation Method ABP	•						
Device EUI 〈〉	± 00 €	39 14 BE 07 0A 90 34	Ē				
Application EUI ↔	≒ 70 €	33 D5 7E F0 00 46 18	Ť.				
Device Address <>	⇒ 26 €	91 1A F1 🖹			_	In ABP mode, The device Address,	
Network Session Key ↔	÷ ø	DD 86 97 F6 BD 8E 7	'F 43 CE	69 44 4F 26 64 16 41	Ē	Network Session Key, App Session Key must match between the End	
App Session Key ↔	≒ ø	78 48 B2 5C D6 BE 8	B 2F 8B	C8 47 B8 13 21 FE 14	Ē	Node and LoRaWAN server	
Status • 4 m	ninutes ago						

Note: user just need to make sure above three keys match, User can change either in TTN or Device to make then match. In TTN, NETSKEY and APPSKEY can be configured by user in setting page, but Device Addr is generated by TTN. User can also change the Device ADDR in TTN by using the <u>The Things Network CLI</u>.

<u>Step2:</u> Run AT Command to make LSN50 work in Single frequency & ABP mode. Below is 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 in below:



www.dragino.com

B COM19 - PuTTY	
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	
0K	
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	



7. 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

8. 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

9. Support

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

support@dragino.com



10. Reference

- ♦ Product Page , DataSheet
- ♦ Image Download
- ♦ AT Command Manual