



LSN50 LoRa Sensor Node User Manual

Document Version: 1.6.4 Image Version: v1.6.3

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	2019-Feb-21
	US915/AU915	
1.2.2	Modify trouble shooting for upload via Flashloader	2019-Mar-13
1.2.3	Add ISP Mode / Flash mode different/	2019-Apr-1
	Add working flow diagram (Chapter 2.1 how it works)	
	Add FAQ for how to configure the Keys	
1.5.0	Upgrade to v1.5 version firmware	2019-Apr-19
	Add ultrasonic sensor support and description.	
	Add downlink description	
	Change decoder for v1.5	
	Add working flow chart	
	Add Mydevices support	
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	2019-Sep-18
	Add support for 3 * DS18B20 (MOD4)	
1.6.2	Add door sensor detail/ power, Add battery connector info	2019-Dec-13
1.6.3	Add firmware version 1.6.2 change log, Add support for HX711 Weight Sensor	2019-Dec-31
1.6.4	Add New AT Command for 1.6.3. Add LSN50 v2.0 Hardware info.	2020-Apr-27
	Add battery measure suggestion	



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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



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): 902 ~ 928Mhz
- 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 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

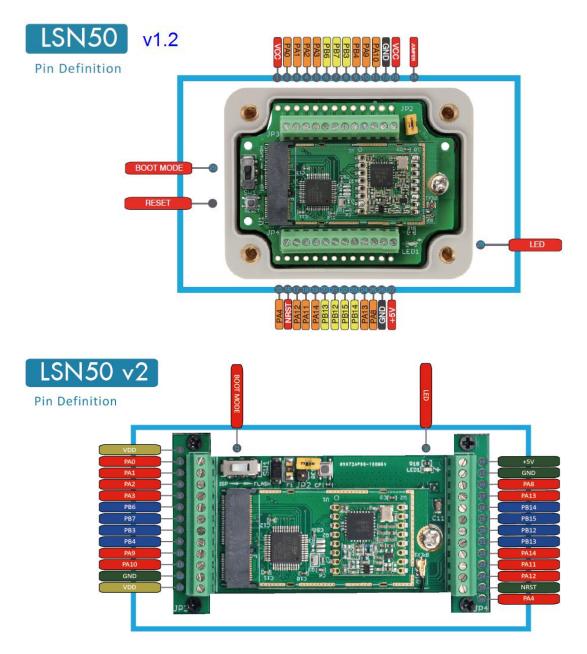
- LoRaWAN 1.0.2 Class A, Class C
- STM32L072CZT6 MCU
- SX1276/78 Wireless Chip
- Pre-load bootloader on USART1/USART2
- MDK-ARM Version 5.24a IDE
- I2C, LPUSART1, USB, SPI2
- 3x12bit ADC, 1x12bit DAC
- 20xDigital I/Os
- LoRa[™] Modem
- Preamble detection
- Baud rate configurable
- CN470/EU433/KR920/US915/IN865
- 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



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



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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 LED2 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

LSN50 v2.0:

Change to a new enclosure. Improve with external antenna, IP68, ear hook.

LSN50 v1.3

Add P-MOS to control 5V output

LSN50 LoRa Sensor Node User Manual



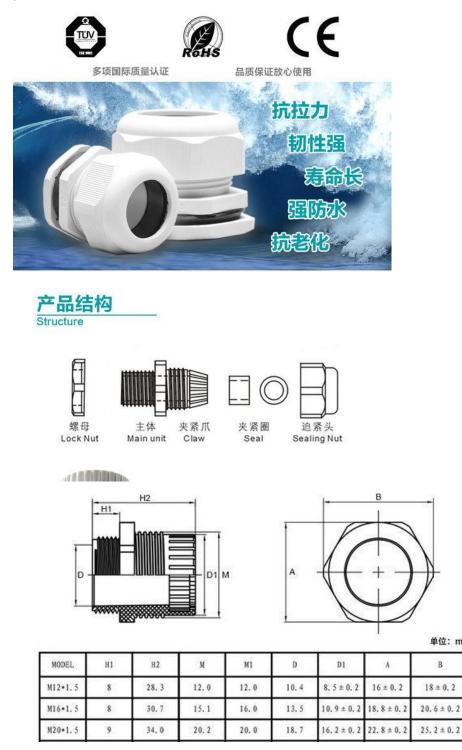
LSN50 v1.2:

- 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)



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

В

 18 ± 0.2

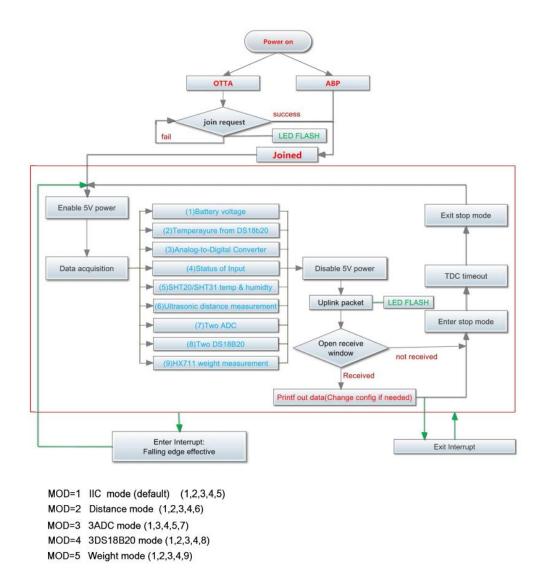


2. Use LSN50 with LoRaWAN firmware

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 1.6.2):



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 <u>use AT Commands</u> 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 <u>TTN LoRaWAN Network</u>. Below is the network structure; we use the <u>LG308</u> as a LoRaWAN gateway in this example.

LSN50 in a LoRaWAN Network



The LG308 is already set to connected to <u>TTN network</u>, 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

DNSOLE MEMORY EDITION	Applications	Gateways	Suppo
Applications > 🤤 dragino_test_application1			
Application ID dragino_test_application1 Description a test application for Dragino Created 2 years ago Handler ttn-handler-eu (current handler)		documentar	tion
APPLICATION EUIS		Ø manage e	uis
↔ 二 76 B3 D5 7E F0 00 46 18 E ↔ 二 3F 77 AD E3 68 CA A8 65 E			

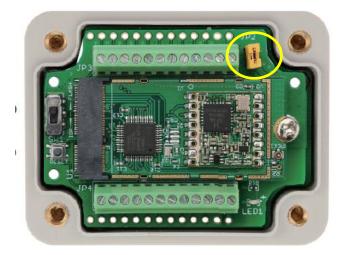
Add APP KEY and DEV EUI

T W O R K COMM	NSOLE NUMBER OF CONTRACT OF CONTRACT.	Applications Gateways
	Applications > 🤤 dragino_test_application1 > Devices	
	REGISTER DEVICE	bulk import de
	Device ID This is the unique identifier for the device in this app. The device ID will be immutable.	
	1-33222-1-5480	G
	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.	
	x 57 4E 37 E6 8A EC FC CD B3 B9 3D 87 A9 3B 4B 2C	🥑 16 byte
	App EUI	



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.

▲	HE THINGS		DLE TY EDITION					Applica	tions	Gateways	Support		
Applications	pplications > 😂 engineer-lin > Data												
						Ov	erview	Devices	Payloa	ad Formats	Integrations		
APPLIC	ATION	DATA											
Filters	uplink	downlink	activation	ack	error	Temperati (DS18B2		NDC	ital Input and I Interrupt	Tempera (SHT20 or 2			
	time	counter	port		Battery Info	-		\uparrow		(SH	Humidity T20 or SHT31)		
▲ 10	3:46:38	4	2		dev id: Isn50	payload:)B 54 <mark>00</mark>	00 00 00 00	00 FC 02				
^ 13	3:46:26	3	2		dev id: Isn50	payload: C)B 54 00	00 00 02 00	00 FF 01	. FE			
▲ 13	3:46:14	2	2		dev id: Isn50	payload: C)B 54 00	00 00 0C 00	01 03 01	. F4			
1	3:46:02	1	2		dev id: <u>Isn50</u>	payload: C)B 58 00	00 00 02 00	01 08 01	. E9			
• 13	3:45:50	0	2		dev id: <u>Isn50</u>	payload: C)B 58 00	00 00 00 00	010D01	.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 <u>MOD=2 distance mode</u> 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 **DRO**. Server sides will see NULL payload while LSn50 transmit in DRO 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 5 minutes.

2.3.1 MOD=1 (Default Mode)

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

ze(byte	es 2		2		1	2	2	2	2	
lue	BA		perature 8B20)	0	Digital in & Digital nterrupt	ADC	Temperature (SHT20 or SH Ultrasonic Se	IT31 or	Humidity (SHT20)	
THE THINGS CONSOLE Applications Gateways										
Applicatio	ns > 😂	engineer-lin	> Data							
						Overv	riew Devices	Payload Forr	mats Integratio	
APPL	ICATIOI	downlink	activation	ack	error	Overv Temperature (DS18B20)	ADC.	jital Input and Te	mats Integration emperature 20 or SHT31)	
Filters	s uplink time	downlink	port	ack	Battery Info	Temperature (DS18820)	ADC Digit.	gital Input and al Interrupt (SHT	emperature	
Filters	uplink	downlink	port 2	ack	Battery Info dev id: Isn50	Temperature (DS18820) payload: OB 5	ADC.	pital Input and State al Interrupt 000 FC 02 05	emperature 20 or SHT31) Humidity	
Filters	time 13:46:38	downlink counter 4	port 2 2	ack	Battery Info dev id: Isn50 dev id: Isn50	Temperature (DS18820) payload: OB 5		pital Input and transformed and the second s	emperature 20 or SHT31) Humidity	
Filters	uplink time 13:46:38 13:46:26	downlink counter 4 3	port 2 2	ack	Battery Info dev id: Isn50 dev id: Isn50 dev id: Isn50	Temperature (DS18820) payload: OB 5 payload: OB 5		pital Input and al Interrupt 000 FC 02 05 000 FF 01 FE 0 01 03 01 F4	emperature 20 or SHT31) Humidity	



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(byte	s)	2	2	1	2	2 2		2	
/alue	BA		nperature 18B20)	Digital in & Digital Interrupt	ADC	Distance me 1) LIDAR-Lit Or 2) Ultrasoni	e V3HP	Humidity (SHT20)	
	~								
pplications	> 🤤 ei	ngineer-lin	> Data						
						Overview	Devices	Payload Formats	Inte
APPLIC	ATION	DATA							
		Pain				Di	gital Input		
	uplink		activation	ack error	Tempera (DS188)	ture Digi	gital Input and tal Interrupt	Distance	
Filters			activation	Real Property in the second se		ture Digi	and	Distance	
	uplink time	downlink		Real Property in the second se	(DS18B)	ture Digi	and tal Interrupt	Reserved	
Filters	uplink time	downlink counter	port	Batte	(DS188) ery Info	ture ADC Digi	and tal Interrupt	Reserved	
Filters	uplink time 28:09	downlink counter 4	port 2	Batte	(DS188) ry Info 0 payload: 0 0 payload: 0	ture ADC Digi	and tal Interrupt 204 DD 70 FF	Reserved FF	
Filters	uplink time 28:09 27:39	downlink counter 4 3	port 2 2	Batte devid: Isn devid: Isn	(DS188) ry Info payload: [payload: C payload: C	ADC Digit	and tal Interrupt 2040D 70 FF A 04 0D 5C FF 6 04 0D 66 FF	FF FF	

Connection of LIDAR-Lite V3HP:





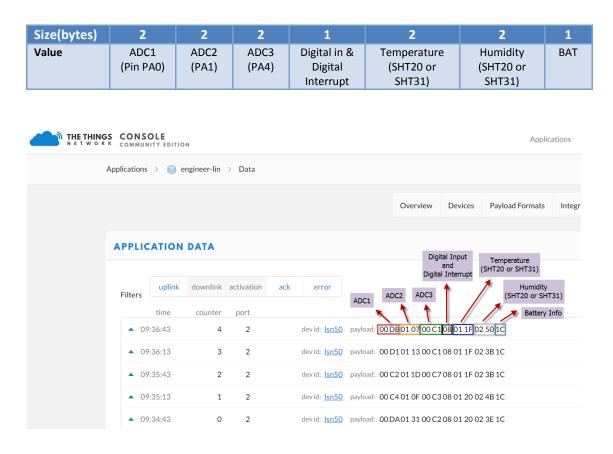
Connection to Ultrasonic Sensor:

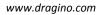


While connecting to Ultrasonic sensor, the sleep current will jump to 250uA. It is recommend to use external power source for ultrasonic sensor.

2.3.3 MOD=3 (3 ADC + I2C)

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







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)



This mode has total 11 bytes. As shown below:

	Size(byte	s)	2		2	2		1			2		2	
Applications > @ engineer-lin > Data APPLICATION DATA Overview Devices Payload Formats Integrat Image: Stress of the stress of t	Value		BAT		OS18B20	-	C	Digi	ital		DS18B20)	. Т	emperature3 (DS18B20) (PA10)	
Applications > engineer-lin > Data Applications > engineer-lin > Data Overview Devices Payload Formats Integrat APPLICATION DATA Digital Input end Upital Interrupt Digital Input end Upital Interrupt Temperature2 (DS18820) Temperature2 (DS18820) Temperature3 (DS18820) Filters upink devidit Isn50 payload: DD 9301 1A01 00 9001 1BD 117 09:00:27 3 2 devidit Isn50 payload: DD 9301 1A01 06 9001 1901 17 08:59:57 2 2 devidit Isn50 payload: DD 9301 1A01 06 9001 1901 17 08:59:27 1 2 devidit Isn50 payload: OD 9301 1A01 06 9001 1A01 17					ы						Applications (Gateways		
Digital Input and Digital Input Digital Input and Digital Input and Digital Input and Digital Input and Digital Input and Digital Input and Digital Input and Digital Input and Digital Input Digital Input and Digital Input (DS18820) Filters Digital Apput and Digital Input and Digital Input and Digital Input (DS18820) Filters Temperature3 (DS18820) 09:00:57 4 2 devid: Isn50 payload: DD93011A0100 P001180117 09:00:27 3 2 devid: Isn50 payload: DD93011A0106 90 01190117 08:59:57 2 2 devid: Isn50 payload: 0D93011A0106 90 01190117 08:59:27 1 2 devid: Isn50 payload: 0D93011A0106 90 011A0117			e o mino											
And Digital Interrupt Imperature of the port 09:00:27 3 2 devid: Isn50 payload: 0D 93 01 1A 01 03 90 01 1A 01 17 08:59:57 2 devid: Isn50 payload: 0D 93 01 1A 01 06 90 01 19 01 17 08:59:27 1 2 <th colsp<="" td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Ove</td><td>rview D</td><td>evices</td><td>Payload Formats</td><td>Integra</td><td>t</td></th>	<td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>Ove</td> <td>rview D</td> <td>evices</td> <td>Payload Formats</td> <td>Integra</td> <td>t</td>								Ove	rview D	evices	Payload Formats	Integra	t
and Digital Interrupt Imperature 2 (DS18820) Imperature 2 (DS18820) Temperature 2 (DS1820) Temperature 2 (DS18820)														
Uplink downlink activation ack error CDS18820 ADC (DS18820) time counter port Battrey Info Temperature3 09:00:57 4 2 devid: Isn50 payload: DD 93 01 1A 01 00 P0 D1 1B D1 17 09:00:27 3 2 devid: Isn50 payload: OD 93 01 1A 01 03 90 01 1A 01 17 08:59:57 2 2 devid: Isn50 payload: OD 93 01 1A 01 06 90 01 19 01 17 08:59:27 1 2 devid: Isn50 payload: OD 93 01 1A 01 06 90 01 1A 01 17	API	PLIC	ATION	DATA			.		and	errupt	Temperature2			
time counter port Battrey Info (D518820) • 09:00:57 4 2 devid: Isn50 payload: (DD 9301 1A01 00 9001 1B) 17 • 09:00:27 3 2 devid: Isn50 payload: 0D 93 01 1A 01 03 90 01 1A 01 17 • 08:59:57 2 2 devid: Isn50 payload: 0D 93 01 1A 01 06 90 01 19 01 17 • 08:59:27 1 2 devid: Isn50 payload: 0D 93 01 1A 01 06 90 01 1A 01 17	Fil	ters	uplink	downlink	activation		(DS		ADC	/	(DS18B20)	ture3		
09:00:27 3 2 devid: Isn50 payload: 0D 93 01 1A 01 03 90 01 1A 01 17 08:59:57 2 2 devid: Isn50 payload: 0D 93 01 1A 01 06 90 01 19 01 17 08:59:27 1 2 devid: Isn50 payload: 0D 93 01 1A 01 06 90 01 19 01 17			time	counter	port	Ba		~/		/	(DS18E			
08:59:57 2 2 devid: Isn50 payload: 0D 93 01 1A 01 06 90 01 19 01 17 08:59:27 1 2 devid: Isn50 payload: 0D 93 01 1A 01 06 90 01 19 01 17	<u>.</u>	▲ 09	:00:57	4	2	devid: Isn5	payloa	d: 0D 93 01 1	LA 01 00 90	01 1B <mark>01</mark>	17			
08:59:27 1 2 devid: Isn50 payload: 0D 93 01 1A 01 06 90 01 1A 01 17	2	▲ 09	:00:27	3	2	devid: Isn5	0 payloa	d: 0D 93 01 1	LA 01 03 90	01 1A 01	17			
		• 08	:59:57	2	2	devid: Isn5	payloa	d: 0D 93 01 1	LA 01 06 90	01 19 01	17			
▲ 08:58:58 0 2 devid: Isn50 payload: 0D 93 01 1A 01 09 90 01 1B 01 17		▲ 08	:59:27	1	2	devid: Isn5	0 payloa	d: 0D 93 01 1	LA 01 06 90	01 1A 01	17			
		a 08	:58:58	0	2	devid: Isn5	payloa	d: 0D 93 01 1	LA 01 09 90	01 1B 01	17			



2.3.5 MOD=5(Weight Measurement by HX711)



This mode is supported in firmware version since v1.6.2.

Notes about hardware connection:

- 1) Don't connect the HX711 module VCC to LSN50 3.3v VCC, in this case, the LSn50 will always power on HX711 and the battery will run out soon.
- 2) HX711 support 5v VCC, but while connect the LSN50's +5V to HX711 VCC, the value from HX711 is not stable.
- 3) Connect LSn50 +5V to HX711 VCC via a LDO module is stable.

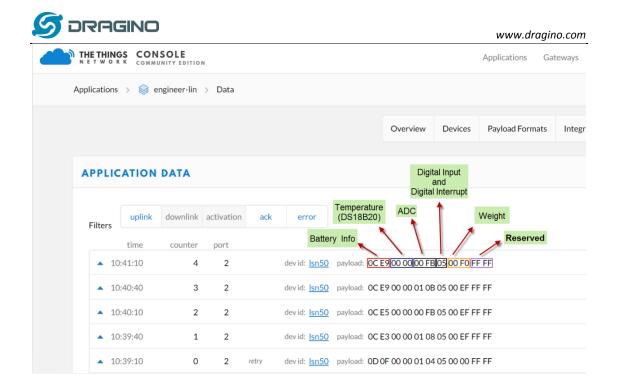
Each HX711 need to be calibrated before used. User need to do below two steps:

- a) Zero calibration. Don't put anything on load cell and run **AT+WEIGRE** to calibrate to Zero gram.
- b) Adjust calibration factor (default value 400): Put a known weight thing on load cell and run AT+WEIGAP to adjust the Calibration Factor.
 For example:

AT+WEIGAP =403.0 Response: Weight is 401 g

Check the response of this command and adjust the value to match the real value for thing.

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



2.3.6 Decode payload in The Things Network

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

Applications >>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>				
	Overview Dev	vices Payload Formats	Integrations Data	Settings
PAYLOAD FORMATS				
Payload Format The payload format sent by your devices				
Custom				٢
decoder converter validator encoder			remove	edecoder
<pre>1 function Decoder(bytes, port) [{] 2 // Decode an uplink message from a buffer 3 // (array) of bytes to an object of fields. 4 var value-bytes[0]<8 bytes[1]; 5 var batV-value/1000;//Sattery.units:V 6 7 value-bytes[2]<8 bytes[3]; 8 if(bytes[2] & 0xFC)</pre>			7	Ĵ • •,

The payload decoder function for TTN are here: LSN50 TTN Payload Decoder:

http://www.dragino.com/downloads/downloads/LSN50-LoRaST/Payload_decoder/



2.4 Payload Explanation and Sensor Interface

2.4.1 Battery Info

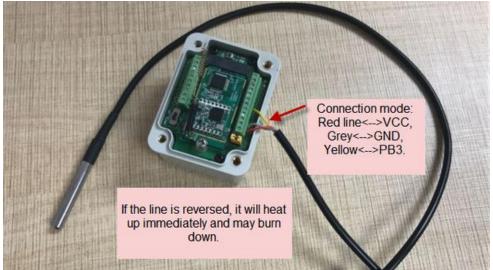
Check the battery voltage for LSN50. Ex1: 0x0B45 = 2885mV Ex2: 0x0B49 = 2889mV

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 <u>3 DS18B20 mode</u>

Connection



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

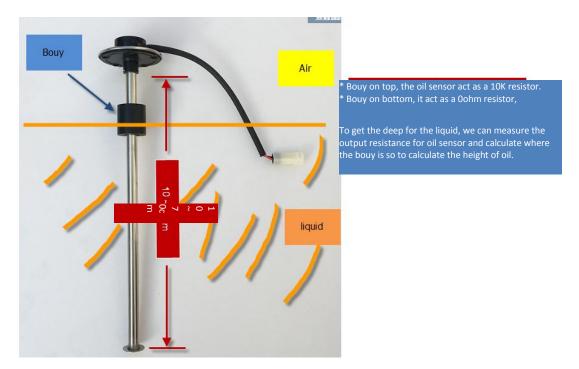
The digital input for pin PA12,

- 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 PAO line, in mV. Ex: 0x021F = 543mv,



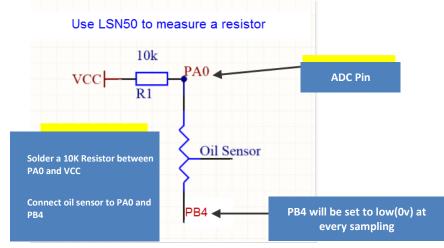
Example1: Reading an Oil Sensor (Read a resistance value):

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 equipment circuit is as below:





According to above diagram:

$$(VCC - V_{PA0} \frac{1}{10} k = \frac{V_{PA0}}{R_{oilsensor}}$$

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

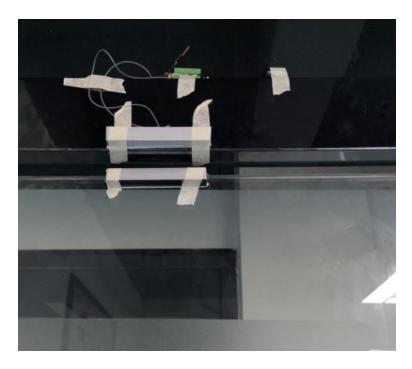
- One pin to LSN50's PB14 pin
- The other pin to LSN50's VCC pin

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:

	Set of the set	councer poin	-										
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"
•										III			+
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"
•													•
/: 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"
•													Þ
V: 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"
•													•
/: 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:

door= (bytes[6] & 0x80)? "CLOSE":"OPEN";



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).**

<image>

Below is the connection to SHT20.

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

	SOLE	N					Applications G	ateways Support	闪 linsongxiong 🗸
Application	is > 🤤 ei	ngineer-lin	> Devices	> 📰 Isn50 >	Data				
							Overvi	ew Data Settings	
APPLI	CATION	DATA						II pause 🛢 clea	r.
Filters	uplink	downlink	activation	ack error]				
	time 4:37:16	counter 26	port 2	payload: OB	Temperature 21 00 00 00 00 00 00 00 01 16 02 47				
	4:37:06	25	2	payload: 0B	21 00 00 00 00 00 00 01 16 02 48	Humidity			
	4:36:56	24	2	payload: OB	21 00 00 00 00 00 00 01 16 02 48				
· · ·	4:36:46	23	2	payload: OB	22 00 00 00 00 00 00 01 17 02 49				
•	4:36:36	22	2	payload: OB	21 00 00 00 00 00 00 01 17 02 49				
•	4:36:25	21	2	payload: OB	21 00 00 00 00 00 00 01 17 02 4A				
	4:36:15	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: $278 / 10=27.8^{\circ}$; 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: <u>https://wiki.dfrobot.com/Weather</u>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 $\underline{AT+MOD=2}$ 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

	CONSC K COMMUNI	DLE ITY EDITIO	N						Applicatio	ons Gatewa	ays Su	upport
,	Applications	> 🤘 Is	sn50-test11	1 > Devic	es 👌 📴	🚍 fffff >	Data					
										Overview	Data	Settings
	APPLIC	ΑΤΙΟΝ	DATA								II paus	se 🛍 <u>clea</u>
	Filters	uplink	downlink	activation	ack	error						
		time	counter	port				in the range				
	▲ 14:	17:54	1	2		payload: 04	BE 00 00 00 27 04 0C 2D FF FF	ADC_CH0V: 0.039 B	atV: 2.75	Digital_IStatus:	"L" EXT	1_Trig
	 14: 	17:25	0	2		payload: O A	A BE 00 00 00 00 00 04 FF FF FF FF	out of range ADC_CH0V: 0 BatV:	2.75 Digit	tal_IStatus: "L"	EXTI_Tri	¢gger:



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

DevEui= 00 ***** UpLi TX on free rxDone JOINED Distance i ***** UpLi TX on free txDone rxTimeOut Distance=3 ***** UpLi TX on free	Band: EU868) 97 16 CF B8 37 CF 4E nkCounter= 0 ***** 868300000 Hz at DR 5 s out of range nkCounter= 0 ***** 8677000000 Hz at DR 0 117 mm nkCounter= 1 ***** 868100000 Hz at DR 0							
txDone rxTimeOut								
rxDone								
In TTN ser	ver:							
					Applicat	ions Gatew	rays Su	pport
	NGS CONSOLE). Data		Applicat	ions Gatew	rays Su	pport
		ces > 📺 fffff	> Data		Applicat	ions Gatew	rays Su	pport
	NGS CONSOLE	ces > 🔚 fffff	> Data		Applicat	ions Gatew Overview	rays Su Data	pport Settings
	Applications > 🛞 Isn50-test111 > Devi	ces > 📻 fffff	> Data		Applicat		Data	Settings
	NGS CONSOLE	ces > 📻 fffff	> Data		Applicat		Data	
	Applications > In South Stress Community EDITION Applications > In South Stress Community EDITION APPLICATION DATA				Applicat		Data	Settings
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	Applications > Solutions > Solutions > Applications > Solutions >	ack erro		► in the range FF ADC_CH0V: 0,039		Overview	Data II paus	Settings
	Applications > Interference in the second se	ack erro	,			Overview	Data II paus	Settings

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.

Since firmware v1.6.3, The 5V output time can be controlled by AT Command.

AT+5VT=1000

Means set 5V valid time to have 1000ms. So the real 5V output will actually have 1000ms + sampling time for other sensors.

2.4.10 Weigh Sensor HX711

Since v1.6.2 firmware, LSN50 support Weigh Sensor HX711.

LSN50 LoRa Sensor Node User Manual





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

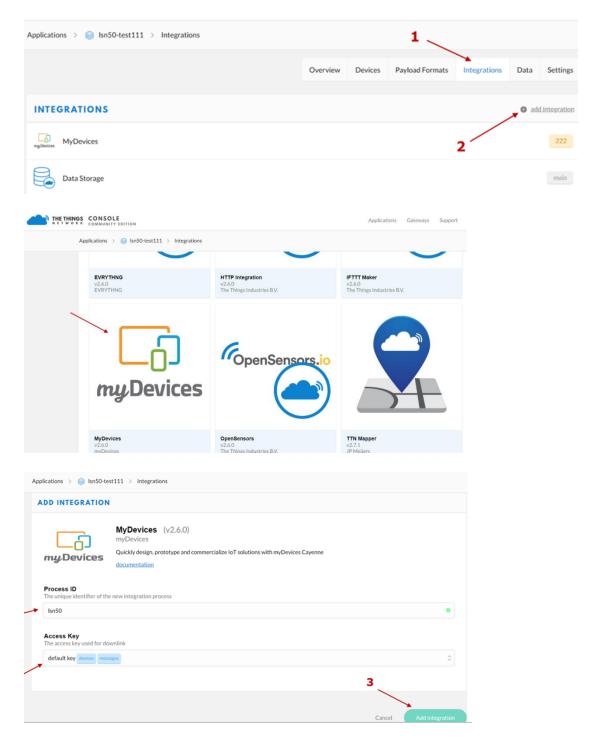


2.6 Show Data in Mydevices IoT Server

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:

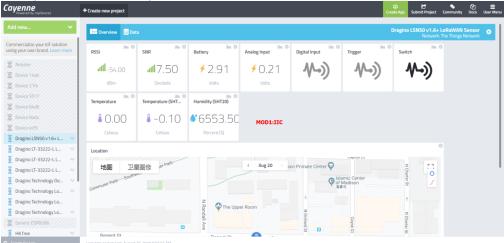




Step 3: Create an account or log in Mydevices. Step 4: Search the LSN50 and add DevEUI. Use the LSN50 v1.6+ for the firmware version > v1.6 under LoRa --> The things network

Cayenne Powered by myDevices	+ Create new project					لوم Create App	ල් 🔍 එය Submit Project Community Docs	E User Menu
Add new 🗸	Devices & Widgets					Enter Settings		1
Commercialize your IoT solution using your own brand. Learn more	Search	Q	6K	1M2M ED1608 Generic with many sensors and connectors	>		Dragino Technology Co.ltd	. '
🕱 Arduino	DEVICES		and the second s				LSN50 v1.6+	
🕱 Device 14ab	Single Board Computers	>				0	LoRaWAN Node Multi Sensor OpenSource	
🛣 Device 21fe	MicroControllers			AAEON AIOT-ILNDO1 Industrial LoRa Node platform	>			
Device 5517	wicrocontrollers			industrial cona node platform		Name		
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Device Bada	Actuators	~		Abeeway MasterTracker		DevEUI		
Device ecf9				Low Power Industrial GPS Tracker	>	Deveor		
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🕱 Generic ESP8266	Loriot							

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



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



Cayenne Powered by myDevices	+ Create new project		다 다 아파
Add new	Cverview SData		Dragino LSN50 v1.6+ LoRaWAN Sensor Network: The Things Network
Commercialize your IoT solution using your own brand. Learn mor	RSSI SNR Battery	Analog Input Digital Input Trigger	i≜ © i≜ © Switch
🛣 Arduino 🕱 Device 14ab	JIII-64.00 JIII8.80 ≠ 2.91	≠0.20 小) 小	L)) //-))
E Device 21fe	dBm Decibels Volts	Volts	
Device 5517	Temperature Distance		
Device Bada Device ecf9 Dragino LSN50 v1.6+ L	Celsius Centimeter		
Dragino LT-33222-L L Dragino LT-33222-L L Dragino LT-33222-L L Dragino LT-33222-L L Dragino Technology De	Location 地图 卫星图像	< Aug 20 > ¢ latamic Cr at R %	enter 19 File
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MOD=3.

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Commercialize your IoT solution using your own brand. Learn more	RSSI 🖮 Ф	SNR 🖮 🗘	Battery	Analog Input	Analog Input 2	Analog Input 3	Digital Input	Trigger
Arduino	ull -67.00	.00.elltı	≠ 2.90	≁ 0.21	≁ 0.36	≁ 0.22	₩-))	₩-))
Device 21fe	dBm	Decibels	Volts	Volts	Volts	Volts		
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2.7 Firmware Change Log

Firmware download link

V1.6.3 Firmware(Not Release)

- Add AT+5VT command to control 5v output time.
- Fix payload order error generate in v1.6.2

V1.6.2 Firmware

- Add mode 5: weight mode by HX711 sensor
- Update LoRaWAN stack to DR-LWS-002

V1.6.1 Firmware:

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



2.8.2 Power consumption Analyze

When connect to different sensors, it is good to test the power consumption with the sensor working. User can remove the ON/OFF Jumper of LSN50, and connect a multimeter between the two pins of this header and measure the current to know the whole system power consumption. Because the sleep mode will have as low as 10uA, at least 4.5 digit multimeter is required to measure this level of current. A victor VC86E is recommended.

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

1. Deep Sleep (Stop mode) for STM32. ~ 5uA

LSN50 LoRa Sensor Node User Manual



- 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 <u>power consumption tool</u> for easy analysis. Below is the analysis result.



www.dragino.com

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 transmit	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			
				Micr	o-Controller Act	ive power (mA):	8
ower 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	l: Red ≻ 100%,	Green <= 1009
verage current	mA	0.021793472	0.056254259	0.012180976	0	0	0
Design Goals							
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

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)

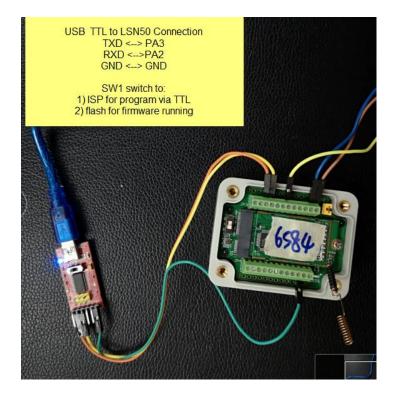
3. Using the AT Commands

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.

LSN50 LoRa Sensor Node User Manual





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:

🔤 友善串口调试助手		- D X
文件(F) 编辑(E) 视图(V) 工具(T) 控制(C) 帮助(H)	
_ 串口设置	[238]***** UpLinkCounter= 0 *****	<u> </u>
端口COM9 -	[239]TX on freq 868500000 Hz at DR 5 [304]txDone	
,	[5293]RX on freq 868500000 Hz at DR 5	
波特率 9600 💌	[5381]rxDone Rssi= -79	
数据位 8 ▼	JOINED	
校验位 None ▼	Join Accept:	
校验位 None	DevAddr:26 01 2a a6 Bx1DrOffset:0	
流控 None 👤	Rx2Datarate:3	
元 fr None	ReceiveDelay1:1000 ms ReceiveDelay2:2000 ms	
┌ 接收设置	[5493]***** UpLinkCounter= 0 *****	
● ASCII C Hex	[5494]TX on freq 868500000 Hz at DR 0	
	[6980]txDone [8010]RX on freq 868500000 Hz at DR 0	
□ 自动换行	[8210]rxTimeOut [8975]RX on freq 869525000 Hz at DR 3	
□ 显示发送		
□ 显示时间	ADR Message: TX Datarate 0 change to 3	
	TxPower 0 change to 1 NbRep 1 change to 1	
│		
○ ASCII ○ Hex	[9151]rxDone Rssi= -70	
□ 自动重发 1000 📑 ms		
L		•
	There must be a new line 123456 after each command	_
		发送
	123456	•
COM9 OPENED, 9600, 8, NONE, 1, OFF	Rx: 778 Bytes Tx: 26 Bytes	

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=LSM	N50-
LoRaST/&file=DRAGINO_STM_AT_Commands_v1.3.pdf)	

AT+ <cmd>?</cmd>	: Help on <cmd></cmd>
AT+ <cmd></cmd>	: Run <cmd></cmd>
AT+ <cmd>=<value></value></cmd>	: Set the value
AT+ <cmd>=?</cmd>	: Get the value
General Commands	
AT	: Attention
AT?	: Short Help
ATZ	: MCU Reset
AT+TDC	: Application Data Transmission Interval
Keys, IDs and EUIs man	-
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 Manage	ment
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
	. Indistitut lower
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
	i det di det frequency (dinti fizz for dingle channel mode



AT+CHE

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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 <u>Sect 6.7</u>



4. Upload Firmware

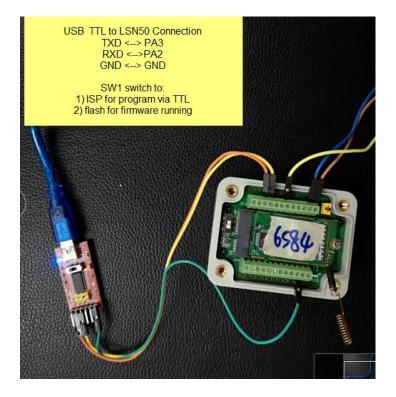
Notes:

- 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:



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

Step2: Download the <u>LSN50 Image files</u>.

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



Iragino.	

Flash Loader Demonstrat	tor		Fla	sh Loader Demons	trator		
5	life.augmented				1ife.au	gmented	
Select the communication port	and set settings, then clic	k next to open					
connection. Common for all families				Target is readable.	Please click "Nex	" to proceed.	
				•			
• UART							
Port Name COM19		ven 💌	Board deteo	ted			
Baud Rate 115200		isabled 🗾		<u> </u>		Remo	ve protection
Data Bits 8	✓ Timeout(s) 1	0 🔹					
1): Put SV	V1 to ISP posotion	1					
2): Push RÉSET bu	itton to enter prog	am mode					
				s	elect Next		
					1		
Back	Next Cance	Close		Beak	Next	Cancel	Close
Dack			J	Back	Hex	Cancel	Liose
5	Ilfe.augmented				57 110	augmented	
lease, select your device in th	ie target list		C	Erase			
Target STM32L0_x3_x2	_x1_192K	-		C AL	C S	election	
PID (h) 0447	Usually need	to wait for	2 6	Download to device	You can se	e the locatio	n of
BID (h) 15.15			a	- Download from file		ogramming	
Version 3.1		nent.		E:\资料\软件下载	NST官方\STM32	CubeExpansion	LRWAN V
sh mapping	Select the	e first one.		Erase necessa		A COLORADO DO	-
	End address Size	1			ny pages i P		Global Erase
Page0 0x 8000000	0x 800007F 0x80 (@ (h) 8000000	*	Jump to the	
Page1 0x 8000080	0x 80000FF 0x80 (C Optimize (Rema		Verity after	download
Page2 0x 8000100	0x 800017F 0x80 (Apply option by	Aes		
Page3 0x 8000180	0x 90001FF 0x80 (3490	0	Upload from device			
Page4 0x 8000200	0x 800027F 0x80 (Upload to file			
Page5 0x 8000280 Page6 0x 8000300	0x 80002FF 0x80 (
Page6 0x 8000300 Page7 0x 8000380	0x 800037F 0x80 (0x 80003FF 0x80 (1
Page7 0x 8000380 Page8 0x 8000400	0x 800047F 0x80 (C				
Page9 0x 8000480	0x 80004FF 0x80 (-			
Page10 0x 8000500	0x 800057F 0x80 (DISABLE	* WRITE	PROTECTION	*
Page11 0x 8000580	0x 80005FF 0x80 0			G	o on		
				0			
Real I	Next Caric	- I Ow		Back	Next	Cancel	Close
Back	Town	el Qose		Face	Tow	Tauring	7010

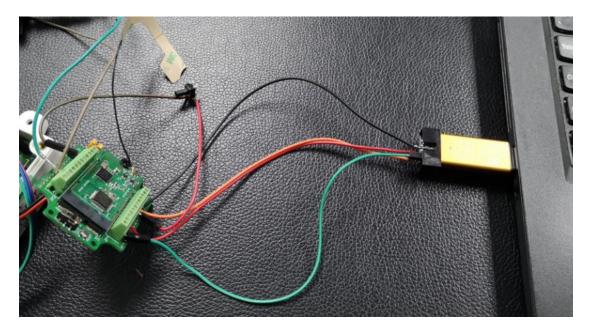


Step4: Switch SW1 back to flash state and push the RESET button. The LSN50 will then run the new firmware.



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.

🖫 STM32 ST-LINK Utility	ce adoce adoce a ado	
File Edit View Target ST-DNK External Loader Help		
🖴 🖥 🖕 🕼 🛠 🐼 🍺 🔜		
Memory display	Device	
Address: 0x08000000 ▼ Size: 0x129D0 Data Width: 32 bits ▼	Device ID	
Address. 0x0000000 V Size. 0x12500 Data Width. 32 bits V	Revision ID	
	Flash size	
Device Memory File : IN865.hex		LiveUpdate
Device Memory		

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.

LSN50 LoRa Sensor Node User Manual



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.

🖫 STM32 ST-LINK Utility			
File Edit View Target ST-LINK External Loader Help			
🖴 🖥 🖐 🐗 🔗 🇭 📾			
Memory display	Device	STM32L07x/STM32L08x	
Address: 0x08000000 ▼ Size: 0x129D0 Data Width: 32 bits ▼	Device ID	0x447	
	Revision ID	Unknown	
Device Memory File : IN865.he Download [IN865.hex]			LiveUpdate
Device Memory Start address 0x08000000			
File path D:\Projects\LoRa Product Line\LoRa GP	5 Track/LGT-92	Browse	
Extra options			
Skip Flash Erase Sk	ip Flash Protection	n verification	
Verification			
Verify while programming	rify after programm	ning	
Click "Start" to program target.			
After programming		_	
	ll Flash memory Ch	necksum	
	in identification of the		
Start Cancel			
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 : Connection mode : Normal. 16:02:12 : Debug in Low Power mode enabled.			
16:02:12 : Device ID:0x447			
Reconstrate Device Alek Clear & Konzolater			



5. Developer Guide

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)

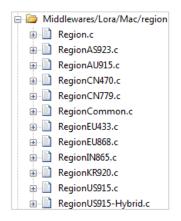
LSN50 is an open source project, developer can use compile their firmware for customized applications. User can get the source code from:

- Software Source Code: <u>https://github.com/dragino/LoRa_STM32/tree/master/STM32CubeExpansion_LRWAN</u>
- Hardware Design files: <u>https://github.com/dragino/Lora/tree/master/LSN50</u>
- Compile instruction: http://wiki.dragino.com/index.php?title=Firmware Compile Instruction -- STM32

Use Keil to open project file:

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

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



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



200000	12.11		
Preproces	sor Symbols		
Define:	STM32L072x, USE_STM3	2L0XX_NUCLEO.USE_HAL_DRIVER. REGIO	IN EUDSS
Undefine:	[Fr	equency
Language	/ Code Generation		
F Execut	le-only Code	F Strict ANSI C	Warnings:
Optimization	n: Level 3 (-03) 💌	Finum Container always int	Al Warnings 💌
C Optimiz		F Plain Char is Signed	Thumb Mode
T Split La	and Store Multiple	Read-Only Position Independent	No Auto Includes
P One E	LF Section per Function	F Read-Write Postion Independent	C99 Mode
Include Paths		ers\BSP\STM32L0x_Nucleo:\.\.\.\.	\Drivers\STM32LOx_HAL
Misc Controls	-C99		
Compiler control string	c -cpu Cotex-M0+-DMI	CROLIB-g-O3 -apcs+interwork -split_section P/STM32L0x_Nucleo -I	s I.J./nc I

2. Compile and build



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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
915	SX1276	Band1(HF):902 ~928 Mhz	915Mhz	AS923/AU915/ KR920/US915

6.3 How to change the LoRa Frequency Bands/Region?

You can follow the instructions for <u>how to upgrade image</u>. 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 <<u>LoRa RAW code</u>> . The project file is in: MDK-ARM\STM32L072CZ-Nucleo\ Lora.uvprojx

<u>Compile</u> it and <u>Upload</u> 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
```

Autoscroll

No line ending \vee 9600 baud \vee

6.5 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.

<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.

5 DRAGINO			www.dre	agino.com
CONSOLE			Applications Gatew	ays Support
Applications > 🤤 dragino_test_application1 > Devices >	23232			
Application ID dragino_test_application1				
Device ID 23232				
Description LT-33222-L-5645				
Activation Method ABP				
Device EUI 🔷 🖆 00 B9 14 BE 07	A 90 34 E			
Application EUI 🔷 🛱 70 B3 D5 7E F0	9 46 18 🖹			
Device Address 💠 🏛 26 01 1A F1	Ē	_	In ABP mode, The device Address,	
Network Session Key <> = # DD 86 97 F	BD 8E 7F 43 CE 69 44 4F 26 64 16 41	Ē	Network Session Key, App Session Key must match between the End	
App Session Key 💠 🚍 🛷 78 48 82 5	D6 BE 8B 2F 8B C8 47 B8 13 21 FE 14	Ē	Node and LoRaWAN server	
Status • 4 minutes ago				

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 <u>The Things Network CLI</u>.



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

AT+FDRReset Parameters to Factory Default, Keys ReserveAT+NJM=0Set to ABP modeAT+ADR=0Set the Adaptive Data Rate OffAT+DR=5Set Data Rate (Set AT+DR=3 for 915 band)AT+TDC=300000Set transmit interval to 5 minutesAT+CHS=868400000Set transmit frequency to 868.4MhzAT+DADDR=26011AAT2Reset MCU

As shown below:

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	
ricabe beb bile parameters or rebet betribe ob appris change	
OK	
OK	
OK	
OK	
UR .	
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	

6.6 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 <u>upgrade_image</u> to update the firmware to the latest version. Run AT commands to set the keys to desired keys; refer <u>AT Command manual</u>.



7. Trouble Shooting

7.1 Connection problem when uploading firmware.

Please refer to this link:

http://wiki.dragino.com/index.php?title=Firmware_Upgrade_Instruction_for_STM32_base_products.

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

Might relate to this:

http://wiki.dragino.com/index.php?title=LoRaWAN Communication Debug#Notice of US915.2FCN470.2FAU915 Frequency band



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 or LSN50-v2-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 (LSN50 v2 doesn't have this version)
- NH: No Hole

9. Packing Info

For LSN50:

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

For LSN50 v2:

Package Includes:

- LSN50 v2 LoRa Sensor Node x 1
- External antenna x 1
- Spring Antenna (evaluate purpose)

Dimension and weight:

- Device Size: 10 x 4.0 x 4.2 cm
- Device Weight: 137g
- Package Size / pcs : 9 x 7 x 6 cm
- 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_LoRaS ensorNode.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)
- ♦ Mechanical Drawing: LSN50 v1: LSN50 v2:

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- -Reorient or relocate the receiving antenna.
- -Increase the separation between the equipment and receiver.
- —Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- -Consult the dealer or an experienced radio/TV technician for help.

The distance between user and products should be no less than 20cm