



Single Channel LoRa IoT Kit v2 User Manual

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	to Mydevices	





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1 Overview

1.1 What is Dragino Single Channel LoRa IoT Kit v2?

Dragino Single Channel LoRa IoT Kit v2 is designed to facilitate beginners and developers to quickly learn LoRa and IoT technology. 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. A number of telecom operators are currently rolling out networks, but because LoRa operates in the open spectrum you can also set up your own network.

The LoRa IoT kit v2 shows how to build a LoRa network, and how to use the network to send data from a LoRa sensor node to the cloud server. Depends on the actually use environment, the LoRa gateway will connect your other LoRa nodes up to 500 ~ 5,000 meters.

1.2 What can you learn from the kit?

The goals through this LoRa IoT kit v2:

- ✓ Understand the structure of an Internet of Things network, and how does an IoT network works
- ✓ Learn coding method for Arduino micro controller
- ✓ Learn some common sensors.
- ✓ Learn some basic commands for Linux and
- ✓ Learn about LoRa and how to set up a LoRa network.
- ✓ Learn different way to connect LoRa network to IoT Server and compare their advantages / disadvantages.





1.3 What parts Dragino LoRa IoT v2 includes?

Single Channel LoRa IoT Kit Packing List.

- ✓ 1 x LG01-N single channel LoRa Gateway
- ✓ 1 x LoRa end node (LoRa Shield + Arduino UNO)
- ✓ 1 x LoRa end node (LoRa/GPS Shield + Arduino UNO)
- ✓ 1 x flame Sensor
- ✓ 1 x relay
- ✓ 1 x photosensitive sensor
- ✓ 1 x buzzer
- ✓ 1 x ultrasonic sensor
- ✓ 1 x DHT11 temperature and humidity sensor
- ✓ 20 x dupont cable (male to male)
- ✓ 20 x dupont cable (female to female)
- ✓ 20 x dupont cable (male to female)



2 Preparing

In the kit, there are two LoRa End Node, they are LoRa Shield + UNO and LoRa/GPS Shield + UNO. Both of them use Arduino UNO as MCU to control the LoRa transceiver.

We need to program the Arduino UNO during our testing to support the required functions for end nodes. To finish this, we need to install some software and library first.

2.1 Software for End Node

2.1.1 Install Arduino IDE and CH340 driver

First download and install Arduino IDE. This is the tool to program the Arduino UNO.

The Arduino UNO in the kit is clone version and is equipped with CH340 USB to UART chip. We need to install CH340 driver in the PC to let the Arduino IDE program it via USB. If we successful install the driver, a comport will show in the system device manager:



After install the driver, start Arduino and we will be able to use the board Arduino UNO and corresponding COM port to program UNO now.





We can enable compilation and upload in Arduino \rightarrow File \rightarrow Preference. This will help us in debug.

👓 LoRaReceiv	er Arduino 1.8.5					
File Edit Ske	Preferences					
00 🗈	Settings Network					
LoRaReceiv	Sketchbook location:					
#include <sp:< th=""><th>C:\Users\edwin\Documents\Ar</th><th>duino</th></sp:<>	C:\Users\edwin\Documents\Ar	duino				
#include (Lol	Editor language:	English (English)				
void setup()	Editor font size:	12				
Serial.beg	Interface scale:	Automatic 100 🗘 🌾 (requires restart of Arduino)				
while (! <mark>Se</mark> :	Show verbose output during:	🔽 compilation 👿 upload				

2.1.2 Install LoRa Library for Arduino

In our examples, we will use two different LoRa libraries for End Node to build different type of LoRa network. They are:

- Arduino-LMIC : LoRaWAN library to configure the End node as a standard LoRaWAN end node.
- LoRa-raw: This is a simple library for LoRa transmit & receive, all data transfer without ID control, encryption. If user wants to develop a LoRa network with private LoRa protocol, he can modify base on this Library.

We also need to install some libraries to connect to different sensors:

- > <u>DHTlib</u>: This is the library to use DHT11 temperature & humidity sensor.
- > <u>TinyGPS</u>: Library for LoRa GPS Shield to get the GPS data.

Download all above libraries and put them in the Arduino \rightarrow Libraries directory

are → arduino-1.8.5-windows → arduino-1.8.5 → libraries → v 4 / 搜索 libraries							
包含到库中 ▼ 共	淳▼	新建文件夹			:== ▼ [
	*	名称	修改日期	类型	大小		
ire		퉬 Adafruit_Circuit_Playground	2017/7/18 23:21	文件夹			
		퉬 arduino-Imic	2018/12/28 20:16	文件夹			
		鷆 arduino-LoRa-master	2018/11/12 20:58	文件夹			
		鷆 Bridge	2016/8/25 17:20	文件夹			
件	=	鷆 Esplora	2015/5/20 17:10	文件夹			
ne		🌗 Ethernet	2017/10/2 15:37	文件夹			
		퉬 Firmata	2017/3/19 0:47	文件夹			



2.2 Prepare for LG01-N Gateway

In LoRa IoT Kit v2, we use LG01-N as LoRa Gateway. Unlike LG01-P in v1 kit, the LG01-N has its own LoRa utility and not need to program it via Arduino. Since we need to connect to Internet IoT Server, we need to configure the LG01-N to have internet access.

2.2.1 Configure LG01-N for internet connection.

Below steps show how to set up LG01-N to use WiFi for internet access.

Step1:

Connect PC to LG01-N's LAN port via RJ45 cable and set up PC Ethernet port to DHCP. PC will then get IP from LG01-N. The ip range is 10.130.1.xx Use browser to access the LG01-N via IP 10.130.1.1. (Recommend use Chrome here)

Step2:

Open a browser in the laptop and type http://10.130.1.1/cgi-bin/luci/admin User will see the login interface of LG01-N. The account for Web Login is: User Name: root Password: dragino 🖉 dragino-168cb0 - LuCI 🗙 ← → C 🗋 10.130.1.1/cgi-bin/luci/admin dragino-168cb0 Authorization Required Please enter your username and password. root Username root Password dragino 🖸 Login 🛛 🙆 Reset DRAGINO TECHNOLOGY CO., LIMITED

Step3:

In network -> Wireless, select radio0 interface and scan.

dragino-1b828	8 Status - System - Network - Service -	AUTO REFRESH ON
radio0: Master "drag	jino-1b8288"	
Wireless Ov	verview	
🙊 radio0	Generic MAC80211 802.11bgn Channel: 11 (2.462 GHz) Bitrate: ? Mbit/s	Restart Scan Add
60	SSID: dragino-1b8288 Mode: Master BSSID: A8:40:41:1B:82:88 Encryption: None	Disable Edit Remove

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Step4:

Select the wireless AP and join the wifi network:

dragino-1b82	88 Status -					AUTO REFRESH ON	
Join Network: Wireless Scan							
Signal S	SID	Channel	Mode	BSSID	Encryption		
<u> </u>	Iragino-office	8	Master	50:64:2B:1A:B8:4D	mixed WPA/WPA2 - PSK	Join Network	
🚮 84% C	ChinaNet-gLnb	2	Master	A4:29:40:66:F4:E7	mixed WPA/WPA2 - PSK	Join Network	
dragino-1b828	8 Status -	System - Net	work - Se	ervice - Logout			
Joining Network: "dragino-office" Replace wireless configuration Check this option to delete the existing networks from this radio. WPA passphrase Specify the secret encryption key here. Name of the new network The allowed characters are: A=2, a=2, 0=9 and							
Create / Assign firewall-zone wan: wan: provide the firewall zone you want to assign to this interface. Select <i>unspecified</i> to remove the interface from the associated zone or fill out the <i>create</i> field to define a new zone and attach the interface to it.							
Back to scan res	sults					Submit	

Step5:

In network->wireless page, disable WiFi AP network. Notice: After doing that, you will lose connection if your computer connects to the LG01-N via its WiFi network.

dragino-1b82	88 Status - System -	- Network - Service	- Logout	UNSAVE	D CHANGES: 13	AUTO REFRESH ON		
radio0: Master "dragino-1b8288"								
Wireless Overview								
👳 radio0	Generic MAC80211 8 Channel: 11 (2.462 GHz)	802.11bgn Bitrate: ? Mbit/s		Restart	Scan	Add		
0%	SSID: dragino-1b8288 M BSSID: A8:40:41:1B:82:88	Disable	Edit	Remove				
0%	SSID: dragino-office Mod BSSID: 50:64:2B:1A:B8:4	Disable	Edit	Remove				
Associated Stations								
Network	MAC-Address	Host	Signal / Noise	RX Ra	ate / TX Rate			
		No info	ormation available					

(Note: make sure click the Save & Apply after configure)



After successful associate, the WiFi network interface can be seen in the same page and see LG01-N get the ip from the uplink router.

dragino-1b8288 Status -			AUTO REFRESH ON
WAN WWAN LAN			
Interfaces			
LAN 愛罗 (点型 樂) br-lan	Protocol: Static address Uptime: 2h 0m 4s MAC: A8:40:41:1B:82:8B RX: 1.40 MB (13346 Pkts.) TX: 2.79 MB (10321 Pkts.) IPv4: 10.130.1.1/24	Restart Stop	Edit Delete
WAN E eth1	Protocol: DHCP client MAC: A8:40:41:1B:82:8A RX: 4.30 MB (51840 Pkts.) TX: 55.77 KB (429 Pkts.)	Restart Stop	Edit Delete
WWAN	Protocol: DHCP client Uptime: 0h 6m 6s MAC: A8:40:41:1B:82:88 RX: 549.38 KB (5659 Pkts.) TX: 14.90 KB (94 Pkts.) IPv4: 10.130.2.169/24	Restart Stop	Edit Delete
Add new interface			
		Save	& Apply Save Reset





2.2.2 Download putty tool to access LG01-N via SSH

It will be helpful to see the LG01-N inside Linux system to understand the data flow and debug.

User can access to the Linux console via SSH protocol. Make sure your PC and the LG01-N is in the same network, then use a SSH tool (such as <u>putty</u>) to access it. Below are screenshots:

🕵 PuTTY Configuration	
Putty Configuration Category: Session Logging Terminal Keyboard Bell Features Window Appearance Behaviour Input device's IP Port:22 Type: SSH Data Proxy Tehet Riogin SSH Serial Close window on ext:	IP address: IP address of LG01-N Port: 22 User Name: root Password: dragino (default)
Always Never Only on clean About Open	Cancel

After log in, you will be in the Linux console and can input commands here.



So we have prepare what we need and let's go for the examples!



3 Example 1: Test a LoRaWAN network

This example describes how to use LG01-N, LoRa Shield & LoRa GPS Shield to set up a LoRaWAN network and connect it to <u>TTN LoRaWAN Server</u>. It also shows how to use external application server to monitor / manage the LoRa Nodes.



Operate Principle:

- > LG01N/OLG01N running packet forward and will forward the uplink LoRa packet from end node to LoRaWAN server.
- > It will also forward downlink LoRa packet from LoRaWAN server to end node.
- > The end node can use OTAA or ABP mode in the LoRaWAN protocol.

Limitation:

- > The LG01 only support one LoRaWAN frequency for uplink. So the end node should be set to fix frequency.
- > If end node use muliply frequencies to transfer, The LG01 will only be able to receive the same frequency set in LG01N.



3.1 Typology and Data Flow

The network topology and dataflow for the example is as below:

Topology for Thethingsnetwork Connection:



In next section we will start to configure for this example.



3.2 Create a gateway in TTN Server

Step 1: Get a Unique gateway ID.

Every LG01-N has a unique gateway id. The id can be found at LoRaWAN page:

dragino-1b6fc4 Status				
LoRa Gateway Se Configuration to communicate with	ettings I LoRa devices ar	nd LoRaWAN :	server	
LoRaWAN Server Settin	ngs			
Service Provider	The Things Net	vork	Ŧ	
Server Address	ttn-router-eu		v	
Server Port	1700			
Gateway ID	a840411b6fc441	150		
Mail Address	dragino-1b6fc4@	@dragino.com		
Latitude	22.73			
Longtitude	114.23			
RadioMode	A for RX, B for T	X	v	

The gateway id is: a840411b6fc44150

Step 2: Sign up a user account in TTN server





Step 3: Create a Gateway in TTN

HINGS	CONSOLE	Applications Gateways Support 👔 edwin
		Hi, edwin!
	Welcome to Th This is where the magic happens. Here you can work with your d	 I hings Network Console. ata. Register applications, devices and gateways, manage your integrations,
	collabo	ators and settings.
	-	\sim
	APPLICATIONS	GATEWAYS

又忤止) 编辑(L) 荁有(V) 历史(L) →登(L) .		
The Things Network Console ×	and one bit while the	
← → ♂ ☆	https://console. thethingsnetwork.org /gateways/regist 器	III\ 🗭
JD 京东商城		
THE THINGS CONSOLE COMMUNITY EDITION		Applications Gatev
Ga	teways > Register	
	Gateway EUI The EUI of the gateway as read from the LoRa module	
Put the Gateway ID here	A8 40 41 1b 6f c4 41 50	8 bytes
Must use legacy packet forward	Vm using the legacy packet forwarder Select this if you are using the legacy <u>Semtech packet forwarder</u> .	
	Description A human-readable description of the gateway	
	LG02-Gateway-1	٥
	Frequency Plan The frequency plan this gateway will use	
Chaose the right frequency	Europe 868MHz	\$
plan and router	Router The router this gateway will connect to. To reduce latency, pick a router that is in a region which is close to the location of the gateway.	
	ttn-router-eu	0

After create the gateway, we can see the gateway info, as below, the Status shows "not connected" because the LG01-N doesn't configure to send update status yet.

GATEWAY OVERVIEW		© settings
Gateway ID	eui-a840411b	
Description	LG02-Gateway-1	
Owner	👔 edwin 💵 <u>Transfer ownership</u>	
Status	not connected	
Frequency Plan	Europe 868MHz	
Router	ttn-router-eu	
Gateway Key	● (III) base6	4 🖹



3.3 Configure LG01-N Gateway

3.3.1 Configure to connect to LoRaWAN server

We should configure the LG01-N now to let it connect to TTN network. Make sure your LG01-N has Internet Connection first.

Step1: Configure LG01-N to act as LoRaWAN forwarder mode

dragino-189	93c4 State	us - System -	Network -	Service -	Logout	
Single Cl Configuration to c	nannel L	ORA GAte h LoRa devices an	WAY d LoRaWAN s	erver		
LUNAWAN 3	Server Setti	ngs		_		
	IoT Service	LoRaWan/RAW	forwarder	*		
-	Debug Level	Little message o	utput	•		

Step2: Input server info and gateway id

Choose the correct the server address and gateway ID.

dragino-	1b8288 Sta		
LoRa (Configuration	Gateway Son to communicate wit	Gettings ith LoRa devices and LoRaWAN server	
LoRaWA	N Server Setti	tings	
	Service Provider	The Things Network	
	Server Address	ttn-router-eu 🔻	
	Server Port	1700	
	Gateway ID	a840411b	
	Mail Address	edwin@dragino.com	
	Latitude	22.73	
	Longtitude	114.23	

Check Result

After above settings, the LG01-N will be able to connect to TTN, as shown in below:





3.3.2 Configure LG01-N's LoRa Radio frequency

Now we should configure LG01-N's radio parameter to receive the LoRaWAN packets. We are using 868.1Mhz and other parameters as below:

Radio Settings	
Radio settings for Channel	
Frequency (Unit:Hz)	868100000
Spreading Factor	SF7 •
Coding Rate	4/5 *
Signal Bandwidth	125 kHz •
Preamble Length	8
LoRa Sync Word	 (a) Length range: 6 ~ 65536 52
	Value 52(0x34) for LoRaWAN
Encryption Key	Encryption Key

This parameters set is for uplink (receive data for LoRa End Node). According to LoRaWAN spec, the downlink radio parameters frequency is defined by network server (TTN). LG01-N will adjust downlink parameters according to info from TTN.



3.4 Create LoRa Shield End Node

3.4.1 Hardware Connection



There are three sensors connect to the LoRa Shield + UNO. These sensors are flame sensors, DHT11 (Temperature & Humidity sensor) and Relay. Please use the connection as we show in the photo.

Note: There is a trick in above connection, the relay connects to VIN. In this case, The UNO can only be power via USB port. If user need to power via DC power adapter, please use another 5v pin to power the relay.

3.4.2 Set up OTAA device in TTN and upload sketch to UNO

Here we set up the LoRa Shield + UNO as an OTAA device in TTN. We will tell the difference of OTAA and ABP mode later.

CONSOLE COMMUNITY EDITION			Applications	Gateways	Sup
Applications > 🤤 dragino_test_application1					
APPLICATION EUIS				🌣 manage	euis
〈> 二 70 B3 D5 7E F0 00 46 18 首					
DEVICES			register device	🌣 manage dev	ices
	5	registered devices			

<u>Step 1</u>: Create an OTAA device in TTN server -- > Application page.



The serial number of your radio module, similar to a MAC address	
× A8 40 41 12 34 56 78 90	🔗 8 bytes
Application EUI	
70 B3 D5 7E F0 00 46 18	٢

For this device, set up to use Cayenne payload, so TTN can parse the sensor data properly.

	Overview	Devices	Payload Formats	Integrations	Data	Settings
PAYLOAD FORMATS						
Payload Format The payload format sent by your devices						
Cayenne LPP						٢

<u>Step 2</u>: Modify the LMIC library

To use LoRaWAN with LG01-N, we need to modify the LMIC library to support single channel mode.

Find the <u>Arduino LMIC</u> install path in Arduino library. Before compiling the code, user needs to change the Frequency Band to use with LG01-N. The change is in the file

arduino\lib	oraries\ar	duino-Imic	\src\	lmic	\config	g.h. (Changes	are as	below	1:
-------------	------------	------------	-------	------	---------	--------	---------	--------	-------	----

<pre>#define CFG_eu868 1 //#define CFG_us915 1 //#define CFG_au921 1 //#define CFG_as923 1</pre>	Choose the Frequency LoRaWAN	Band, same as in server		
<pre>//#define CFG_in866 1 #define LG02_LG01 1</pre>	uncomment this for	LG01 / LG02		
<pre>//US915: DR_SF10=0, DR_SF2 // DR_SF12CR=8, DR_S =#if defined(CFG_us915) && // CFG_us915 CFG_as923 #define LG02_UPFREQ 9023 #define LG02_DNWFREQ 9233 #define LG02_RXSF 3 #define LG02_RXSF 3 #define LG02_TXSF 8 #elif defined(CFG_eu868) & // CFG_eu868</pre>	<pre>=1, DR_SF8=2, DR_SF7= :F11CR=9, DR_SF10CR=10 defined(LG02_LG01) 20000 000000</pre>	-3, DR_SF8C=4 b, DR_SF9CR=11, DI LG02_UPFREQ:End D LG02_DNWFREQ:End LG02_RXSF: End Devi LG02_TXSF: End Devi US02_TXSF: End Devi US015/AS923: 92330 EU868: 869525000, SF	R SF8CR=12. DR SF7CR Jevice Uplink Frequency I Device Uplink Frequency ce Uplink (transmit) SF ce Downlink (receive) SF o default value: 0000 , SF12BW500 F12BW125	
<pre>//EU868: DR_SF12=0, DR_SF1 #define LG02_UPFREQ 8681 #define LG02_DNWFREQ 8695 #define LG02_RXSF 5 #define LG02_RXSF 5 #define LG02_TXSF 0 -#endif</pre>	1=1, DR_SF10=2, DR_SF .00000 .25000 // DR_SF7 // DR_SF12	F9=3, DR_SF8=4, D	R_SF7=5, DR_SF7B=1, DR_I	SK, DR_NONE



<u>Step 3</u>: Input keys in Arduino Sketch and upload to device.

The sketch for this example is <u>lora_shield_cayenne_and_ttn-otaaClient.ino</u>. Download and open it, we need to modify the keys to match the keys in TTN. Get Device EUI/Application EUI & APP Key from TTN and put them in the sketch, make sure the Device EUI and Application Key are lsb and the APP key is msb.

ons > 🥪 dragino_test_	application1 > Devices > 📰 otaa-device-1			
Application ID Device ID	dragino_test_application1 OTAA needs Device EUI, Application Key, APP Key. otaa-device-1 While put these keys in Arduino-LMIC library. Make sure the Device EUI and Application key are in Isb			
Activation Method	ОТАА			
Device EUI	<> = b [0x90, 0x78, 0x56, 0x34, 0x12, 0x41, 0x40, 0xA8] E			
Application EUI	<> = b (0x18, 0x46, 0x00, 0xF0, 0x7E, 0xD5, 0xB3, 0x70)			
Арр Кеу	↔			
Device Address	↔ # 26 01 2D 5E			
Network Session Key				
App Session Key	◇ ☆ ● ・・・・・			
thn-otaa #include (SPI. h) // This EVI must be in // first. When copying // the bytes. For TIM // 0x70.	little-endian format, so least-significant-byte an EUI from thnctl output, this means to reverse issued EUIs the last bytes should be 0xD5, 0xB3,			
static const u1_t PROG void os_getArtEui (u1_	<pre>MAPPEVI[8]={ 0x18, 0x46, 0x00, 0xF0, 0x7E, 0xD5, 0xE3, 0x70 }; * buf) { memcpy_P(buf, APPEVI, 8);}</pre>			
<pre>// This should also be static const u1_t PROG void os_getDevEui (u1_</pre>	in little endian format. see above. HEM DEVEUT[8]={ 0x90, 0x78, 0x56, 0x34, 0x12, 0x41, 0x40, 0xA8 }: ** buf) { memcpy_P(buf, DEVEUT, 8);}			
// This key should be in big endian format (or, since it is not really a // number but a block of memory, endianness does not really apply). In // practice, a key taken from ttnctl can be copied as=is. // The key shown here is the semtech default key.				
static const u1_t PROG void os_getDevKey (u1_	<pre>LEM APPKEY[16] = { 0xC3, 0x95, 0x15, 0x93, 0xAD, 0x55, 0x1A, 0x83, 0x2F, 0x31, 0x25, 0xB6, 0x7A, 0xF5, 0x74, 0x1D }: ** buf) { memcpy_P(buf, APPKEY, 16):}</pre>			
Upload the cod	e to UNO:			
Auto Format Archive Sketch Fix Encoding & Rel Serial Monitor	oad Ctrl+Shift+M			

 Fix Encoding & Reload

 Serial Monitor
 Ctrl+Shift+M

 Serial Plotter
 Ctrl+Shift+L

 WiFi101 Firmware Updater
 Port: "Arduino/Genuino Uno"

 Port: "COM3"
 >

 Get Board Info
 Programmer: "AVRISP mkII"

 Burn Bootloader
 >



<u>Step 4</u>: Analyze output result

From output of LoRa Node Serial Monitor, we can see it send Joining after start(TX), then get join ACK (RX), then upload the data to TTN (TX).

e ttn-a	BP Arbuino 18.5	COM12 (Arduino/Genuino Uno)
		χ.
th-abp		Connect to TTN and Send data to mydevice cayenne(Use DHT11 Sensor):
1	/***	RXMODE_RSSI
2	* Copyright (c) 2019	########### COUNT=1 ###########
3	*	The temperature and humidity:
4	* Permission is here	[28.00°C, 63.00%]
5	* obtaining a copy o	6024: engineUpdate, opmode=0x8
6	\ast to do whatever the	Packet queued
- 7	* including, but not	9013: EV_JOINING
8	* NO WARRANTY OF ANY	10182: engineUpdate, opmode=0xc
9	*	196226: engineUpdate, opmode=0xc
10	* This example sends	196532: TXMODE, freq=868100000, len=23, SF=7, BW=125, CR=4/5, IH=0
11	* world!", using fre	503011: RXMODE_SINGLE, freq=868100000, SF=7, BW=125, CR=4/5, IH=0, rxsyms=255
12	* the The Things Net	514692: JaccRX1, dataLen=33
		515265: EV_JOINED
USIN		515290: engineUpdate, opmode=0x808
US10		516157: TXMODE, freq=868100000, len=20, SF=7, BW=125, CR=4/5, IH=0
USIN		570725: RXMODE_SINGLE, freq=868100000, SF=7, BW=125, CR=4/5, IH=0, rxsyms=255

From gateway logread, we can see the data send from end node (txpk), dats get from server(rxpk).

dragino-1b6fb0 Status + System + Network + Service + Logout
Logread Gateway Log shows TX / RX LoRa Packet FreqINFO Report RxTxJson
(TYDK): [down] ["twk"-"imma" false "imet"-3667324079 "fron"-868.1 "rfeb":0 "powe" 14 "modu":" ODA" "datr" "SE7BW125" "codr" "4/5" "inon" true "cize"-23 "pere"
[TARK). [down] rubria [mine lates inits
(RXPK): [up] {"xxpk": {{"time":"2018-10-19T15:49:50.666162Z", "timst":3666685421, "chan":0, "rfch":1, "freq":868.100000, "stat":1, "modu": "LORA", "datr":"SF7BW125";"
Receive(HEX):20INFO
(RXPK): [up] {"rxpk": [{"time":"2018-10-19T15:49:51.310837Z", "tmst":3667330098, "chan":0, "rfch":1, "freq":868.100000, "stat":1, "modu":"LORA", "datr":"SF7BW125","
Receive(HEX):00184600f07ed5b37090785634124140a83717b0b3a635
(RXPK): [up] {"rxpk": {{"time":"2018-10-19T15:51:12.288134Z", "timst":3748307397, "chan":0, "rfch":1, "freq":868.100000,"stat": 1, "modu":"LORA", "datr":"SF7BW125",
(1XPK): [down] {bpk*;[imme:talse;imst:3/5330/39/, "reg"3868.1, "rfch"), "powe":14, "modu":"LORA", "datr:"SF/BW125", "codr:"4/5", "ipof:true,"size":33, "ncrc" Device (USD) 2004 [CSD) 2004 [CSD] 2004
Receive(int_A)_202007511125300feb005301731e00030063496009348967620113601266315350351 (PXPK/v. fun_Property [Primary="30148140] 1011161416576274747" "imprime" 3752787077 "inters": 0.56454100000 "retef": 4 "module": 1. ODA" "date: "SEFRM436" 1
(KAPK). [ub] { Kkp. [{ unite _2016-10-13115:51:10.760142, unite _375216777, cital .0, itch _1, iteq _060.100000, stat _1, itedu _ LORA, dat _ SP16W125, Darabia/DEF121201547511263456405801731abb130346404809abb27d3b11ach1338415555354
(RXPK): [up] ["xxpk";["ime";"2018-10-19115-51:17.4191932" "Imst":3753438456 "chan":0."fch":1."freq":868.100000."stat":1."modu":"LORA":"datr":"SF7BW125"."
Receive(HEX):40b32f01268000000169595d797e72e6ad20f6927984a9d0ae4a
(RXPK): [up] {"rxpk": [{"time": "2018-10-19T15:51:17.5296062", "tmst": 3753548866, "chan": 0, "rfch": 1, "freq": 868.100000, "stat": 1, "modu": "LORA", "datr": "SF7BW125", "
Receive(HEX):40b32f0126800100014c2175b7f5071dfead622d5abdbacc81c1
(RXPK): [up] {"rxpk":[["time":"2018-10-19T15:52:20.726452Z","tmst":3816745715,"chan":0,"rfch":1,"freq":868.100000,"stat":1,"modu":"LORA","datr":"SF7BW125","
Receive(HEX):40b32f0126800200013092d245bf71eabc672b4a9f9b799a19c1
(RXPK): [up] {"rxpk":[{"time":2018-10-19115:53:24.02990227:"timst":3880049163,"chan":0,"rfch":1,"freq":868.100000,"stat":1,"modu":"LORA","dat":"SF7BW125","
Receive(HEA)/40.52/01/26500.50001800/2265862/80069160519151015200 [DVDK/v. tool [mone]/[mone]/[mone]/[mone]/40.41.4074.64.73.2461907 [mone]/2042/65290 [mone]/0.1666/14.16666/959 400000 [mone]/4.16766/14.16666

In TTN-Gateway page, we can also see the traffic.

	1	https://	/console. theth	ingsne	etwor	'k.org /gateways/eu	ii-a84	器 90% ··· ☆ Q 搜索 III ●	•
ONSO	TTN	V Traffice dev	e Page shows ice status	the	Γ			Applications Gateways	_
Gate	ways	> 🏷	eui-a840411b6fb	04150	>	Traffic ^{beta}			
	A 2	23:56:34	868.1	lora	TTN Send a Join reply. LoRa 4/5 SF 7 BW 125 61.7 End node must get this packet	TTN Send a Join reply. LoRa End node must get this packet ize: 26 bytes			
	▲ 2	23:55:30	868.1	lora	4/5 <mark> </mark>	Immeditely send message after joir	a Uplink 1 success	to finish Join. The frquency shows use 868.1Mhz ize: 26 bytes frequency must be the same	
	▲ 2	23:54:27	868.1	lora	4/5	SF 7 BW 125	61.7	as the "LG02_DNWFREQ" in ize: 26 bytes	
	^ 2	23:53:24	868.1	lora	4/5	SF 7 BW 125	61.7	TTN Get Join request	
	^ 2	23:52:20	868.1	lora	4/5	SF 7 BW 125	61.7	1 dev addr: 16 01 2F B3 payload size: 26 bytes	
[A 2	23:51:17	868.1	lora	4/5	SF 7 BW 125	61.7	0 dev and r: 26 01 2F B3 paylered size: 26 bytes	
[+ 2	23:51:16	868.1		4/5	SF 7 BW 125	71.9		
Ì	/ 2	23:51:12	868.1		4/5	SF 7 BW 125	61.7	app eui: 70 B3D5 7E F0 00 46 18 dev eui: A8 40 41 12 34 56 78	

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Note: The LG02_DNWFREQ value in Arduno_LMIC/src/Imic/config.h should match downlink frequency from TTN. TTN shows 868.1 here, So LG02_DNWFREQ should be 868100000

After success Joined, we can see the data in the device page:

APPL	APPLICATION DATA										Ŵ
Filter	uplink	downlink	activation	ack	error						
	time	counter	port								
	11:57:36	8	1		payload: 01	67 01 0E 02 68 7C 03 01 01	digital_out_3: 1	relative_humidity_2: 62	temperature_1	27	
	11:56:33	7	1		payload: 01	67 01 0E 02 68 7A 03 01 01	digital_out_3: 1	relative_humidity_2: 61	temperature_1	27	
	11:55:30	6	1		payload: 01	67 01 18 02 68 78 03 01 01	digital_out_3: 1	relative_humidity_2: 60	temperature_1	28	
	11:54:28	5	1		payload: 01	67 01 18 02 68 76 03 01 01	digital_out_3: 1	relative_humidity_2: 59	temperature_1	28 9	1%

3.4.3 Configure to connect to Mydevices Application Server

In TTN, we can see the raw data, now we try to connect it to the application server. <u>Step 1</u>: Add Mydevice in Application page

Applications >	➢ Isn50-test111 → Integrations				1			
			Overview	Devices	Payload Formats	Integrations	Data	Settings
INTEGRAT	IONS						add	lintegration
myDevices MyDev	vices					2		222
Data St	torage							main
THE THINGS	CONSOLE COMMUNITY EDITION			Applicat	ions Gateways Suppo	rt		
Ar	oplications > 🤤 Isn50-test111 > Integrations		-		\smile			
	EVRYTHNG v2.6.0 EVRYTHNG	HTTP Integration v2.6.0 The Things Industries B.V.		IFTTT Maker v2.6.0 The Things Industr	ries B.V.			
	my Devices	OpenSense	ors.io					
	MyDevices v2.6.0 mvDevices	OpenSensors v2.6.0 The Things Industries B.V.		TTN Mapper v2.7.1 JP Meiiers				



DD INTEGRATIO	4		
۲. ה	MyDevices (v2.6.0) myDevices		
	Quickly design, prototype and commercialize IoT solutions with myDevices Cayenne		
ingreences	documentation		
Isn50	е пен япод ацон рожеза		0
Access Key The access key used for d	ownlink		
default key devices me	sages		0
		3	
			*



Step2: Log in Mydevices account and add devices.

Cayenne Powered by myDevices + Create new project					Create App Sub	🖻 🔍
Add new Y	LoRa					
evice/Widget						
igger	🛞 acklio	Actility		6	ker link	of LORIO T
Protection Dragino LT-33222-L L V	Acklio	Actility	CityKinect	everynet Everynet	Kerlink	Loriot
Dragino Technology Lo V Dragino Technology Lo V Generic ESP8266	Objenious tre Brugeer Talette	≪ OrbiWise	pixelnetworks	Sagemcom	SEMTECH	♦ senet
Raspberry Pi Raspberry Pi	Objenious	OrbiWise	Pixel Networks	Sagemcom	Semtech	Senet
Raspberry (P) Sparkfeun ESPR266 Thi	SenRa	₩ Spark∝	iotx	🕎 swisscom		X-TELIA
	SenRa	Spark	Stream	Swisscom	The Things Network	X-Telia



Add DevEUI of the End node

Enter Settings	
Dragino Technology Development Kit Development Kit	
This device uses Cayenne LPP	
Name Dragino Technology Development Kit	
DevEUI your DevEUI	
Activation Mode Already Registered	
Tracking	
Location This device doesn't move	
Independence, KS 67301美国	
Add device	

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After above steps, we can now the sensor data in Mydevices:





3.4.4 Use downlink message to control relay

We can use either TTN or Cayenne to control the relay.

Control relay via TTN:

The string for ON is: 03 00 64 FF

The string for OFF is: 03 00 00 FF

In put above value in the TTN Downlink payload, we can see the relay can switch between

Applications	> 🥪 lora-shield	d > Devic	es 🔉 🚛	shield-	otta								
DOWNLI	NK												
Scheduli	ing					FPG	ort						
replace	first la	ast	1			1						🗹 C	onfirme
Payload			_										
bytes	fields	03 00 64 F	F										🥑 4 bytes
											~	2	
													•
													Se
THE THINGS													
NETWORK	CONSOLE	DN								Applicatio	ons Gate	ways S	Support
Appl		lora-shield	Devices	> 📻 :	shield-otta	> Data				Applicatio	ons Gate	ways S	Support
Appl		lora-shield	Devices	> 🚍 :	shield-otta	> Data				Applicatio	ons Gate	ways S	Support
Appl	CONSOLE COMMUNITY EDITION	on lora-shield ⇒	Devices	> 📰 :	shield-otta	> Data				Applicatio	ons Gate Overview	ways S	Support Setti
Appl		on Iora-shield ⇒	Devices	> 🚝 :	shield-otta	> Data				Applicatio	ons Gate Overview	ways S	Support Setti
Appl	CONSOLE COMMUNITY EDITION	lora-shield	Devices	> 📰 :	shield-otta	> Data				Applicatio	ons Gate Overview	Data	Support Setti
Appl	CONSOLE COMMUNITY EDITION	I DATA	Devices	> 📻 :	shield-otta	> Data				Applicatio	Overview	Data	Support Setti
Appl	CONSOLE COMMUNITY EDITION lications > Image:	I DATA	Devices	> 🚍 : ack	shield-otta	> Data				Applicatio	Overview	Data	Support Setti
Appl	CONSOLE COMMUNITY EDITION lications > @ 1 .PPLICATION Filters uplink time	I DATA	Devices	> 📻 : ack	shield-otta	> Data				Applicatio	ons Gate	Data	Support Setti
Appl d downlink ssa and reply	CONSOLE COMMUNITY EDITION lications > @ 1 PPLICATION Filters uplink time 11:40:58	DVATA downlink counter 39	Devices activation port 1	> 🐖 :	error payload: 01	> Data	58 58 03 01 01 C	04 00 01	digital_in_4: 1	Applicatio	ons Gate Overview is on : 1 relative	bumidity_2	Support Setti USE 1 c
Appl d downlink ess and reply	CONSOLE COMMUNITY EDITION lications > Image: Imag	IDATA downlink counter 39 38	Devices activation port 1 0	> 📻 :	error payload: 01	> Data 67 00 E6 02 4 tprovided]	58 58 03 01 01 C	04 00 01	digital_in_4: 1	Applicatio	ons Gate Overview is on : 1 relative.	ways S Data II par	Support Setti
Appl d downlink sss and reply	CONSULE COMMUNITY EDITION lications > Image:	IDATA downlink counter 39	activation port 1 0	> E t	error payload: 01 payload: (no appid: lora-	> Data	58 58 03 01 01 C	04 00 01	digital_in_4: 1	Applicatio	ons Gate Overview is on : 1 relative,	ways S Data	Support Setti 2: 44 1
Appl d downlink sss and reply	CONSULE COMMUNITY EDITION lications > Image: Imag	IDATA Ora-shield Ora-s	activation port 1 0 1 0	> () :	error payload: 01 payload: [no appid: lora- payload: 03	> Data 67 00 E6 02 d tprovided] shield 00 64 FF	58 58 03 01 01 C	04 00 01	digital_in_4: 1	Applicatio	Overview is on : 1 relative,	Data	Support Setti 2: 44 (
d downlink ess and reply	CONSULE COMMUNITY EDITIO lications > PPLICATION Filters uplink time 11:40:35 11:41:43 11:41:42 11:42:34	Incra-shield > Incra-shield >	activation port 1 0 1 1 0 1 0	> E i i	error payload: 01 payload: (no app id: lora- payload: 03 payload: 01	 > Data 67 00 E6 02 4 tprovided] shield 00 64 FF 67 00 E6 02 4 	58 58 03 01 01 0 58 58 03 01 00 0	04 00 01	digital_in_4: 1 digital_in_4: 1	Applicatio	ons Gate Overview is on : 1 relative, is off • relative,	ways S Data II par humklity_2	Support Setti
d downlink	COMMUNITY EDITION lications > Image:	IDATA downlink counter 39 38 37	activation port 1 0 1 0 1 0 1 0	> E i i	error payload: 01 payload: 03 payload: 03 payload: 03	 > Data 67 00 E6 02 6 ctprovided shield 67 00 E6 02 6 	58 58 03 01 01 C	04 00 01	digital_in_4: 1 digital_in_4: 1	Application	ons Gate Overview is on : 1 relative. is off : 0 relative.	ways S Data II na humkdity,2	Support Setti 2: 44 (,



Control relay via Cayenne

In Cayenne, just click the digital output button, it will auto send out the command strings: ON: 03 00 64 FF , OFF is: 03 00 00 FF



Cayenne will pass the string to TTN and TTN will show as above. In the serial monitor of End Node, we can see below output if downlink string arrives:

💿 lora_shield_cayenne_and_ttn-abpClient Arduino 1.8.5	COM12 (Arduino/Genuino Uno)
文件 编辑 项目 工具 帮助	发送
Ina shield cavenne and theatsClient	[25. 00°C, 66. 00%]
49 static const u1_t PROGMEM APPSKEY	3955087: engineUpdate, opmode=0x908
50	3957856: TXMODE, freq=868100000, len=23, SF=7, BW=125, CR=4/
51// LoRaWAN end-device address (De	Packet queued
52 static const u4_t DEVADDR = 0x260	4012411: RXMODE_SINGLE, freq=868100000, SF=7, BW=125, CR=4/5
53	4022496: Received downlink, window=RX1, port=1, ack=0
54 // These callbacks are only used	4022541: EV_TXCOMPLETE (includes waiting for RX windows)
55// left empty here (we cannot le	Received :
56 // DISABLE_JOIN is set in config.	3 0 64 FF
57 <pre>void os_getArtEui (u1_t* buf) {</pre>	Set pin to HIGH.
58 <pre>void os_getDevEui (u1_t* buf) { }</pre>	4028292: engineUpdate, opmode=0x810
59 <pre>void os_getDevKey (u1_t* buf) { }</pre>	4030903: TXMODE, freq=868100000, len=12, SF=7, BW=125, CR=4/
60	4085487: RXMODE_SINGLE, freq=868100000, SF=7, BW=125, CR=4/5_
•	4124275: RXMODE_SINGLE, freq=869525000, SF=9, BW=125, CR=4/5
Lésus.	4188702: EV_TXCOMPLETE (includes waiting for RX windows)
avruude done. Thank you.	4188747: engineUpdate, opmode=0x900
	-
	▼ 自动漆屏



3.4.5 Test with Interrupt

The temperature & humidity in this example are updated periodically (once several minutes/hours), in some case, we need to update the data once an action is happen. So we need to use interrupt.

The DO pin of Flame sensor is high in normal case. While it detects a flame, this pin will become low and act as an external interrupt for Arduino. The Arduino UNO will then immediately upload the temperature and humidity to TTN

	THE THING	GS CON	SOLE	N				Applications	Gateways	Support	6) linsc
A	pplications	> 🥪 la	ora-shield	Devices	> :==	shield-otta	a > Data					
									0	verview	Data	Settin
	APPLIC	ATION	DATA								II paus	e tit cle
	Filters	uplink	downlink	activation	ack	error	The flame so interrup	ensor ot				
		time	counter	port			[
	▲ 11 <	1:29:51	6	1		payload: 0	1 67 00 E6 02 68 5A 03 01 00 04 00 01	digital_in_4: 1 dig	ital_out_3: 0	relative_hum	idity_2:	45 t
	▲ 11	1:29:28	5	1		payload: 0	1 67 00 E6 02 68 5A 03 01 00 04 00 00	digital_in_4: 0 dig	ital_out_3: 0	relative_hum	idity_2:	45 t
	^ 11	1:29:21	4	1		payload: 0	1 67 00 E6 02 68 5A 03 01 00 04 00 01	digital_in_4: 1 dig	ital_out_3: 0	relative_hum	idity_2:	45 t
	 11 	1:28:58	3	1		payload: 0	1 67 00 E6 02 68 5A 03 01 00 04 00 00	digital_in_4: 0 dig	ital_out_3: 0	relative_hum	idity_2:	45 t
	< 1											,

Then we can see on the cayenne:

Cayenne	+ Create new project	Create App Submit Project Community Docs User N
Add new 🗸	III Overview 2041a	Dragino Technology Development Kit 🎸
Arduino Device 2.16 Device 5517 Device 64db Oragino UT-33222-L L	RSSI Max SNR Max Temperature (1) Max Humidity (2) Max Digital Output (3) Digital Input (4) atll 65:00 atll 9:00 \$ 46:00 Image: Additional additionadditionadditional additionadditional additinadditional additinaddi	Have fire,the DO pin of flame sensor is low
Dragno Technology De Cagno Technology Le Cagno Technology Le Cagno Technology Le Cagnos ES78066 Rospharry B Rospharry B Rospharry B Sparking S5980565 TM.	Location 地理 卫星图作 (Ian 17) (under Water And Constrained Constrai	
	3 contrad	*



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Iora_shiel	d_cayenne_and_ttn-otaaClient Arduino 1.8.5	COM12 (Arduino/Genuino Uno)
文件 調題 印	2日 工具 報助	
lora_shield_c	cayenne_and_th-otaaClient	3002238: engineUpdate, opmode=0x908
230 vo	oid setup() {	Have fire, the tem###################################
231	<pre>Serial.begin(9600);</pre>	The temperature and humidity:
232	<pre>while(!Serial);</pre>	[23.00°C, 45.00%]
233	Serial.println("Connec	3003454: engineUpdate, opmode=0x108
234		Haveerature is send
235	<pre>pinMode(ctl_pin, OUTPUT)</pre>	########### COUNT=7 ###########
236	pinMode(flame_pin, INPUT	The temperature and humidity:
237	attachInterrupt(1,fire,	[23.00°C, 45.00%]
238		3010302: engineUpdate, opmode=0x108
239	<pre>#ifdef VCC_ENABLE</pre>	Have fire, the temperature is send
240	// For Pinoccio Scout b	3109920: engineUpdate, opmode=0x108
241	pinMode(VCC_ENABLE, OUT	3110383: TXMODE, freq=868100000, len=26, SF=7, BW=125, CR=4/5, IH=0
٠.	m	3166736: RXMODE_SINGLE, freq=868100000, SF=7, BW=125, CR=4/5, IH=0, rxsyms=255
上有成功。	le dans Thank sou	3205524: RXMODE_SINGLE, freq=869525000, SF=9, BW=125, CR=4/5, IH=0, rxsyms=255
avrduo		3269940: EV_TXCOMPLETE (includes waiting for RX windows)
		3269986: engineUpdate, opmode=0x900

3.5 Create LoRa/GPS Shield End Node

3.5.1 Hardware connection

The method to use LoRa/GPS Shield is similar with LoRa Shield. Below is the hardware connection of LoRa GPS Shield.



3.5.2 Set up ABP device in TTN and upload software to UNO

In LoRa Shield, we set up OTAA for connection. In this example, we will try ABP mode.

<u>Step 1</u>: Create an ABP device in TTN server -- > Application page. And change it to ABP mode.



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				_
CONSOLE			Applications	Gateways Su
Applications > 🥪 dragino_test_applic	ation1			
APPLICATION EUIS				o manage euis
↔	3 (1)			
DEVICES			register device	manage devices
	5 registered devices			
Applications > 🥪 dragino_test_application1 >	Devices > 📰 edwintest1 > Settings			
		Overview	Data Settings	
DEVICE SETTINGS	SETTINGS			
General	Description A human-readable description of the device			
			0	
	Device EUI The serial number of your radio module, similar to a MAC address			
	∞ 00 BA DE A0 36 70 68 72		🖉 8 bytes	
	Application EUI			
	70 B3 D5 7E F0 00 46 18		\$	
	Activation Method			

<u>Step 2</u>: Input keys into Arduino Sketch.

The sketch for the LoRa /GPS Shield is LoRa GPS Sketch c	<u>ode</u>
Applications \rangle \otimes dragino_test_application1 \rangle Devices \rangle $=$ edwintest1	TTN LOPOWAN End Dovico page
Application ID dragino_test_application1	The Long walk Lind Device page
Device ID edwintest1	
Activation Method ABP	Make sure the Network Session Key and App Session
Device EUI <> 또 00 BA DE A0 36 70 68 72 발	Key are in MSB order
Application EUI <> ニ 70 B3 D5 7E F0 00 46 18 皆	
Device Address \leftrightarrow \pm 26 01 1C 22	
Network Session Key <> = 💉 msb { 0x9A, 0xEA, 0xD0, 0x93, 0x06	, 0xE3, 0x2B, 0x73, 0xDD, 0x54, 0x7B, 0x8B, 0xFF,
App Session Key <>	. 0xCE, 0x40, 0xA2, 0xA3, 0xEE, 0x7B, 0xDF, 0xDC,

S DRAGINO			ww	w.dragino.com
ttn-abp #include (Imic. h)	Arduino Sketc	h ttn-abp		
#include <spi.h> #include <spi.h> // LoRaWAN NwkSKey, network session key</spi.h></spi.h>		Input the ke	ys from TTN]
<pre>// This is the default Semtech key, which is // network. static const PROGMEM u1_t INWESKET[16] = { 0x4</pre>	used by the early prototype IIN 9A, 0xEA, 0xD0, 0x93, 0x06, 0xE3,	0x2B, 0x73, 0xDD, 0x54,	Ox7E, Ox8E, OxFF, OxDC,	0x20, 0xF9 };
<pre>// LoRaWAN AppSKey, application session key // This is the default Semtech key, which is // network. static const u1_t PROGMEN APPSKEY[16] = { 0x1</pre>	used by the early prototype IIN 86, 0x07, 0x58, 0x85, 0xE4, 0xCE,	0x40, 0xA2, 0xA3, 0xEE,	Ox7B, OxDF, OxDC, Ox23,	0x0E, 0x2B };
// LoRaWAN end-device address (DevAddr) static const u4_t DEVADDR = 0x26011C22 ; //	< Change this address for every	node!		

Choose Arduino UNO to upload the sketch to LoRa GPS Shield and UNO

	Auto Format	Curi	- 1	
	Archive Sketch			
	Fix Encoding & Reload			
	Serial Monitor	Ctrl-	+Shift+M	
	Serial Plotter	Ctrl+	+Shift+L	
	WiFi101 Firmware Updater			
			10 C	
ſ	Board: "Arduino/Genuino Uno"			>
ſ	Board: "Arduino/Genuino Uno" Port: "COM3"			> >
	Board: "Arduino/Genuino Uno" Port: "COM3" Get Board Info			> >
Ĺ	Board: "Arduino/Genuino Uno" Port: "COM3" Get Board Info Programmer: "AVRISP mkII"		ļ	> >
Ĺ	Board: "Arduino/Genuino Uno" Port: "COM3" Get Board Info Programmer: "AVRISP mkII" Burn Bootloader			>

All other steps are similar with how we use with LoRa Shield. Below are the outputs for reference:

Output from LoRa GPS Shield:

文件 编辑 项目 工具 帮助	COM12 (Arduino/Genuino Uno)	×
		发送
tin-otaa		^
62 // The key shown he	803657: engineUpdate, opmode=0x808	
63 static const u1_t P	809092: TXMODE, freq=868100000, len=24, SF=7, BW=125, CR=4/5, IH=0	
64 void os_getDevKey (867344: RXMODE_SINGLE, freq=868100000, SF=7, BW=125, CR=4/5, IH=0, rxsyms=255	
65	906132: RXMODE_SINGLE, freq=869525000, SF=9, BW=125, CR=4/5, IH=0, rxsyms=255	
	970667: EV_TXCOMPLETE (includes waiting for RX windows)	
66 static osjob_t send	971317: engineUpdate, opmode=0x900	
67		
68 // Schedule TX ever	The lengtitude and letitude and eltitude and	
69 // cycle limitation	Ine longtitude and latitude and altitude are:	
70 const unsigned IX_I	4786638: engineUpdate, opmode=0x908	
71	4791947: TXMODE, freq=868100000, len=24, SF=7, BW=125, CR=4/5, IH=0	
72// Pin mapping	Packet queued	
73 const lmic_pinmap 1	4850199: RXMODE_SINGLE, freq=868100000, SF=7, BW=125, CR=4/5, IH=0, rxsyms=255	
	4888923: RXMODE_SINGLE, freq=869525000, SF=9, BW=125, CR=4/5, IH=0, rxsyms=255	
上传成功。	4953334: EV_TXCOMPLETE (includes waiting for RX windows)	
avrdude done. Thank you.	4953379: engineUpdate, opmode=0x900	
	- raaf) ↓ 金融級 nnap ↓ 車面	*



Upload GPS data to TTN:

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	time	counter	port														
▲ 1	7:54:23	5	1		payload: (3 88 03	3 77 A5 1	L6D4C00) 2E FE	gps_3.altitud	le: 120.3	gps_3.latit	ude: 22.7	237 g	ps_3.lon	gitude	1
· 1	7:53:19	4	1		payload: (3 88 03	8 77 A5 1	L6D4C00	2E FE	gps_3.altitud	le: 120.3	gps_3.latit	ude: 22.7	237 g	ps_3.lon	gitude	1
▲ 1	7:52:15	3	1		payload: (3 88 03	8 77 A5 1	L6D4C00	2E FE	gps_3.altitud	le: 120.3	gps_3.latit	ude: 22.7	237 g	ps_3.lon	gitude	1
▲ 1	7:51:12	2	1		payload: (3 88 03	8 77 A5 1	L6D4C00	2E FE	gps_3.altitud	le: 120.3	gps_3.latit	ude: 22.7	237 g	ps_3.lon	gitude	1
7:50:08		1 1		payloa	d: 03 88 0	3 77 A5	116D4C	00 2E FE	gps_3.	altitude: 120.	3 gps_3.	latitude: 22.	.7237 gp	is_3.lon	gitude: 1	114.20	92

Output in Cayenne:

Remove





www.dragino.com

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3.6 Conclusion and limitation

3.6.1 Overview for the example

This example shows how to set up a simple LoRaWAN network with public server. The LoRaWAN specification is for easy deploy the IoT network base on LoRa wireless. It contains the encryption, MAC control, device management etc. More info about LoRaWAN, please see <u>this link</u>.

There are some frequently ask points for the example:

1/ Difference between OTAA & ABP mode:

We have tested OTAA and ABP mode for LoRaWAN. They are two different modes. In OTAA mode, we can see the device will send a join request, the IoT server will send back a Join confirm with dynamic device address, network session key and app session key. Then the device will use these key to communicate with the LoRaWAN server. This make sure the device will only communicate with one server.

In ABP mode, it will use the FIX device address, network session key and app session key. It doesn't have join process. So in theory, any server with match keys is possible to decrypt the data from this end device.

We can see OTAA has better security than ABP mode.

2/ AES 128 encryption:

The data between end device and server are AES128 encryption. So the gateway can't parse the packets, it just forward them.

3/ LoRaWAN Network Server:



A LoRaWAN network server is necessary in a LoRaWAN network for device control/management/data management. If user wants to build the NS, there are some open sources LoRaWAN NS such as <u>LoRaServer</u> can be used. And some gateways already include LoRaWAN NS (this is also a plan for LG01-N).

4/ Downlink message

In this example, we use LoRaWAN Class A. The end node will open two short downlink windows after each uplink. More info about LoRaWAN class A, please refer<u>LoRaWAN specification</u>.



3.6.2 Limitations

The LG01-N is a single channel gateway (Same for LG02). And there are limitations: <u>1/ It works only on one frequency at a time</u>. It can support multiply end nodes, but all end nodes must transmit data at the same frequency so the LG01-N can receive it. For example: if the End node transmits at 868.1Mhz, The LG01-N's RX setting must be 868.1Mhz so to receive this packet.

<u>2/ It works only for one DR at a time.</u> DR specifies the Spreading Factor and Bandwidth. In LG01-N, even the rx frequency match , if DR doesn't match, it still can't get the sensor data.

3/ LoRaWAN compatible issue

In LoRaWAN protocol, the LoRaWAN end nodes send data in a hopping frequency. Since LG01-N only supports one single frequency, it will only be able to receive the packets sent from the same radio parameters (frequency & DR) in LG01-N.

For example, in EU868, a standard LoRaWAN device may send the data in eight frequencies with different Frequency & SF, such as:

LMIC_setupChannel(0, 868100000, DR_RANGE_MAP(DR_SF12, DR_SF7),	BAND_CENTI);	// g-band
LMIC_setupChannel(1, 868300000, DR_RANGE_MAP(DR_SF12, DR_SF7B),	BAND_CENTI);	// g-band
LMIC_setupChannel(2, 868500000, DR_RANGE_MAP(DR_SF12, DR_SF7),	BAND_CENTI);	// g-band
LMIC_setupChannel(3, 867100000, DR_RANGE_MAP(DR_SF12, DR_SF7),	BAND_CENTI);	// g-band
LMIC_setupChannel(4, 867300000, DR_RANGE_MAP(DR_SF12, DR_SF7),	BAND_CENTI);	// g-band
LMIC_setupChannel(5, 867500000, DR_RANGE_MAP(DR_SF12, DR_SF7),	BAND_CENTI);	// g-band
LMIC_setupChannel(6, 867700000, DR_RANGE_MAP(DR_SF12, DR_SF7),	BAND_CENTI);	// g-band
LMIC_setupChannel(7, 867900000, DR_RANGE_MAP(DR_SF12, DR_SF7),	BAND_CENTI);	// g-band
LMIC_setupChannel(8, 868800000, DR_RANGE_MAP(DR_FSK, DR_FSK),	BAND_MILLI);	// g2-band

So the LG01-N will only able to receive the 868100000, SF7 packet and will not receive others. Means only one packet will arrive the TTN server in every 8 packet sent from the LoRaWAN end node.

If user wants to receive all packets from LoRaWAN end node, user needs to set up the LoRaWAN node to send packets in a single frequency.

4/ Downlink & OTAA issue

According to the LoRaWAN class A spec, the end node will open two receive windows to get the message from LoRaWAN server for OTAA or downlink function. These two receive windows are quite short (milliseconds), if LoRa packet from the gateway can't reach End Node in the receive window time, the end node won't get the rx message and Downlink / OTAA won't work.



In our example, the Arduino LMIC library is modified to enlarge the RX window to let OTAA & downlink works.



4 Example 2: Test with a MQTT IoT Server

This example describes how to use LG01-N, LoRa Shield & LoRa GPS Shield to set up a LoRa network and connect it to <u>ThingSpeak IoT Server</u>.

A Video Instruction of this example can be found at this url: https://youtu.be/asoNyFYZamO

4.1 Typology and Data Flow

The network topology and dataflow for the example is as below:

Topology for ThingSpeak Connection:



In next section we will start to configure for this example.



4.2 Set up sensor channels in ThingSpeak

Step 1: Log in ThingSpeak and set up channels

ThingSpeal	C [™] Channels -	Apps - C	ommunity	Support +		Comme	ercial Use	How to Buy	Account -	Sign Out
New Channel	My Channels Watched Chi Public Chan Seer	Apps C	1	apport		e contrata F E	Hellos Hello Collect data from anothe Chick New C channels with Click on the entries in th channels with Learn to cree Learn more Exampp Arduin Arduin EsPaze Neddo son Need to son Need to son	in a ThingSpeak er channel, or fror hannel to create: column headers at column or clic th that tag, att column or clic that tag, att column or clic t	channel from a 4 m the web. a new ThingSpe: of the table to so k on a tag to sho xplore and trans ak Channels.	Jevice, ak ort by the w form data.
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up two channels Id 1: Temperatu Id 2: Humidity ThingSpea New Cha	:: I re K [™] channels - Nnel	Apps - C	ommunity	Support -	Help	Comme	rcial Use	How to Buy	Account +	Sign Out
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- Longitude: Specify the longitude position in decimal degrees. For example, the longitude of the city of London is -0.1275.
- Elevation: Specify the elevation position meters. For example, the elevation of the city of London is 35.052.
- Video URL: If you have a YouTube[™] or Vimeo[®] video that displays your channel

Field 8

Metadata





Step 2: Get MQTT keys for these channels.

Go to Account \rightarrow My profile and get the MQTT API Key

☐ ThingSpeak [™]	" Channels - Apps - Community Si	upport - Commercial Use How to Buy Account - Sign O
Edit MathWorks Account	settings	Units Used with using any out of the second se
Edit MathWorks commun	ity information	API Requests
		Get Channel List
ThingSpeak settin	gs	GET https://api.thingspeak.com/channels.json?api_key=0QU8LUU03QKX26NR
		Create a Channel
Time Zone	Change Time Zone	<pre>POST https://api.thingspeak.com/channels.json</pre>
User API Key	0QU8LUUOJQKX26NR	Clear a Channel Feed
	Generate New API Key	DELETE https://api.thingspeak.com/channels/CHANNEL_ID/feeds.json api_key=00UBLUU03QKX26NR
MQTT API Key	BYR3I5ECL787PHG9	Delete a Channel
	Generate New MQTT API Key	DELETE https://api.thingspeak.com/channels/CH4NHEL_ID api_key=0QUBLUUDJQCX26HR
	2	Update Channel Metadata
		PUT https://api.thingspeak.com/channels.json api_key=QUBLUU002QCX20HR name=Changed Channel Hame

Go to channel page: get the sensor channel:

Channel ID: This is the remote Channel ID in ThingSpeak

Author: User Name for MQTT connection

Write API Key: API key for each channel

Channels - Apps - Community S	upport - Commercial Use How to Buy Account - Sign Out
Test from the DHT11 and Flame channel ID 662338 Author engineerIn Access: Private	sensor
Private View Public View Channel Settings Sharing API Ke	ys Data Import / Export
Write API Key Key EVDKI16NV993M4XS Generate New Write API Key	Help API keys enable you to write data to a channel or read data from a private channel. API keys are auto-generated when you create a new channel. API Keys Settings • Write API Key: Use this key to write data to a channel. If you feel your key has been compromised, click Generate New Write API Key. • Read API Key: Use this key to allow other people to view your private channel feeds and charts. Click Generate New Read API Key to generate an additional word bue key bearem.
Read API Keys Key RUGYWWIVTLU44X8M	Note: Use this field to enter information about channel read keys. For example, add notes to keep track of users with access to your channel. API Requests Update a Channel Feed



4.3 Simulate MQTT uplink via PC's MQTT tool

This step is not necessary, it just to help user to understand the MQTT protocol and simulate the MQTT connection to ThingSpeak. And check if the account info is valid and correct.

In the PC, download and install <u>MQTT.fx</u>. Open MQTT.fx and configure add a new MQTT client, as below:

Broker Address: mqtt.thingspeak.com Broker Port: 1883 Client ID: User Defined

Edit Connection Profiles	
M2M Eclipse ThingSpeak	Connection Profile
mydevices	Profile Name ThingSpeak
	Broker Address mqtt.thingspeak.com Broker Port 1883 Client ID Desktop_Client Cenerate
	General User Credentials SSL/TLS Proxy Last Will and Testament
	User Name dragino Password
Add a new MQTT Add a new MQTT Client Profile	Input User ID and MQTT API from Input User ID and MQTT API from ThingSpeak Account→My Profile
+ -	Revert OK Apply

After add the profile, connect it and publish to the corresponding Channel with correct API key. MQTT API see this document:

II MQ	2TT.fx - 1.3.1			100, phy latence (see) from a first strength	**			- 0 ×
File	Extras Help							
	ThingSpeak			Connect Disconnect		Replace Chanr	nel ID and	e O
Pu	blish Subscri	ibe	Scripts	Broker Status Log	7	API he	re	
				channels/200893/publish/B9Z0R2 FY		 Publish 	QoS 0 QoS 1	QoS 2 Retained OST
				field1=36&field2=87&status=MQTTPUBLISH				
						Data to be se	ent, update	2
						both field1 & t	field2 of th	lis 🛛
						Citan	iici	

If update successful, we can see the update in the channel:



🖵 ThingSpeak™	Channels -	Apps				How to Buj		Sign Out
Add Visualizations	Data Export					MATLAB Analysis	MATLAB Visu	alization
Channel Stats Created: 11 months ago Updated: less than a minute Last entry: less than a minute Entries: 1762	ago te ago							
Field 1 Chart			Вþ	× ×	Field 2 Chart		в р 🖊 х	
75 50 25 0	est Channel Fr	om Drag	gino	•	100 201 90 90	nnel From Dragino		
-25 14. Nov	15. Nov 16	Nov 1 Date	7. Nov 18. Nov ThingSpeak	com	80 09:00 10:00	11:00 12:00 Date	13:00 ThingSpeak.com	

4.4 Try MQTT Publish with LG01-N Linux command

This step is also not necessary; it is to show the basic command used for MQTT connection and will help for further debug when connection fails.

First, we need to make sure the LG01-N has internet access. We can log in the SSH and ping an Internet address and see if there is reply. As below:



LG01-N has built-in Linux utility **mosquitto_pub**. We can use this command to publish the data to ThingSpeak.

The command to update a feed is as below:

mosquitto_pub -h mqtt.thingspeak.com -p 1883 -u dragino -P QZXTxxxxxO2J -i dragino_Client -t channels/200893/publish/B9Z0R25QNVEBKIFY -m "field1=34&field2=89&status=MQTTPUBLISH"

(Make sure the $\ensuremath{^{\prime\prime\prime\prime}}$ is included, otherwise only one data will be uploaded)

Below is the output window:

🔚 172.31.255.254 - SecureCRT	
文件(F) 编辑(E) 查看(V) 选项(O) 传输(T) 脚本(S) 工具(L) 帮助(H)	
\$\$ \$\$ [] \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	
172.31.255.254	
root@dragino-146d78:~# mosquitto_pub -h mqtt.thingspeak.com -p 1883 -u d proot@dragino_22 -i dragino_client -t channels/200893/publish/B9 field1=34&field2=89&status=MQTTPUBLISH" root@dragino-146d78:~# ■	ragino -P Q .FY -m "

After running this command, we can see the data are updated to ThingSpeak, which has same result as what we did at mqtt.fx.

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So we success to use LG01-N to uplink data to ThingSpeak, the **mosquitto_pub** command is executed in the Linux side, finally, we will have to call **mosquitto_pub** command while the LoRa sensor data arrive. We will explain how to do that in next step.



4.5 Configure LG01-N Gateway

4.5.1 Publish Logic

In LG01-N (firmware version > LG02_LG08--build-v5.1.1545908833-20181227-1908), there is a built-in script to process the MQTT data. The logic of this flow is as below:

How MQTT script works:



Operate Principle:

- > LoRa End Node sends the data to gateway in specify format: <node_ID>value
- > Gateway get the data and will put the data in corresponding files under /var/iot/channels.
- > MQTT Process Script will publish data to remote channel according to the pre-configure mapping

Step1: Configure LG01-N to act as MQTT mode

dragino-1b7060 st	
LoRa Gateway S Configuration to communicate w	Settings vith LoRa devices and LoRaWAN server
LoRaWAN Server Set	tings
IoT Service	LoRaRAW forward to MQTT sen 🔻
Debug Level	Little message output
Service Provider	The Things Network
Step2: Configure MQTT s	erver info
MQTT Server Settings Configuration to communicate with MQTT server	
Configure MQTT Server	
Select Server ThingSpeak M	4QTT *

Lises Name (u)	dessioned
Oser Name [-u]	dragino i
Password [-P]	32W6GMEXYTEQ7049
Client ID [-i]	dragino_Client

In step 2, we have below settings:

- ✓ UserName[-u option]: Input Author (user name for MQTT Connection)
- ✓ Password[-P option]: Input MQTT API key

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- ✓ Client_ID[-i]: dragino_Client (can put any string)
- Because we choose Thingspeak so we have below pre-set options but not show in web
 - Broker Address[-h]: mqtt.thingspeak.com
 - Broker Port[-p]: 1883
 - Topic Format[-t]: channels/CHANNEL/publish/WRITE_API.
 - Data String Format[-m]: DATA&status=MQTTPUBLISH

And we configure this channel:

- ✓ Local Channel ID: 10009
- ✓ Remote Channel ID: 396640
- ✓ Write_api_key: Write API key for this channel.

In the mqtt script, the upper **CHANNEL** will be replaced by the parameter (remote channel in IoT server). and the **WRITE_API** will be replaced by the settings in write api key. The **DATA** will be replaced by the value stored in the /var/iot/channels/LOCAL_CHANNEL file.

MQTT script will keep checking the files in /var/iot/channels/. If it finds a match Local channel, then the MQTT script will send out the data of this local channel to a remote channel according to the setting above.

User can also enable MQTT debug level and run logread in Linux console to see how the mqtt command is compose. Below is an example:

Tue Nov	27 15:07:43	2018	kern.notice	syslog:	[IOT.MQTT]:	Found Local Channels:
Tue Nov	27 15:07:49	2018	kern.notice	syslog:	[IOT.MQTT]:	Check for sensor update
Tue Nov	27 15:07:49	2018	kern.notice	syslog:	[IOT.MQTT]:	Found Local Channels:
Tue Nov	27 15:07:55	2018	kern.notice	syslog:	[IOT.MQTT]:	Check for sensor update
Tue Nov	27 15:07:55	2018	kern.notice	syslog:	[IOT.MOTT]:	Found Local Channels:
Tue Nov	27 15:07:59	2018	kern.notice	syslog:	[IOT]: Int	ernet Connection Check: FAIL
Tue Nov	27 15:08:01	2018	kern.notice	syslog:	[IOT.MQTT]:	Check for sensor update
Tue Nov	27 15:08:01	2018	kern, notice	syslog:	[IOT.MOTT]:	Found Local Channels:
Tue Nov	27 15:08:02	2018	kern.notice	syslog:	[IOT]: DNS	Resolve Check: FAIL
Tue Nov	27 15:08:03	2018	kern.notice	syslog:	[IOT.MQTT]:	Server:Port mgtt.mydevices.com:1883
Tue Nov	27 15:08:03	2018	kern.notice	syslog:	[IOT. MOTT]:	Topic Format: v1/USERNAME/things/CLIENTID/data/CHANNEL
Tue Nov	27 15:08:03	2018	kern.notice	syslog	IOT.MQTT]:	Data Format: DATA
Tue Nov	27 15:08:09	2018	kern.notice	syslog:	[IOT.MQTT]:	Check for sensor update
Tue Nov	27 15:08:09	2018	kern.notice	syslog:	[IOT.MQTT]:	Found Local Channels: 100
Tue Nov	27 15:08:09	2018	kern, notice	systog:	[IOT.MOTT]:	Find Match Entry for 100
Tue Nov	27 15:08:09	2018	kern, notice	syslog:	IOT.MOTT1:	[-t] v1/e74b78d0-3858-11e7-afce-8d5fd2a310a7/thinos/2b1fab30-3859-11e7-afce-8d5fd2a310a7/data/0
Tue Nov	27 15:08:09	2018	kern, notice	syslog:	IOT. HOIT :	[-m] temp.c=30.2
root@dra	gino-193a18	-#				
		-				

4.5.2 Configure LG01-N's Radio frequency

Now we should configure LG01-N's radio parameter to receive the LoRaWAN packets. We are using 868.0Mhz (868000000 Hz) as below:



 dra	ain	$\sim com$
		1.0000
 	9	
	-	

22.73 114.23 range 5 ~ 20 dBm					
114.23 range 5 ~ 20 dBm					
range 5 ~ 20 dBm					
868000000					
SF7	· _ 2	_			
4/5	•				
125 kHz	Ŧ				
8					
2 Length range: 6 ~ 65536					
52					
Value 52(0x34) for LoRaWAN				,	
Encryption Key			3		
	808000000 SF7 4/5 125 kHz 8 @ Length range: 8 ~ 65538 52 @ Value 52(0x34) for LoRaWAN Encryption Key	866000000 2 SF7 • 4/5 • 125 kHz • 8 • • Length range: 6 - 65536 52 • • Value 52(0x34) for LoRalWAN Encryption Key •	886000000 SF7 2 4/5 + 125 kHz + 8 - @ Length range: 6 - 65536 - 52 - @ Value 52(0x34) for LoRaWAN - Encryption Key -	888000000 SF7 • 2 4/5 • 125 M4/2 • 8 @ Length range: 6 - 65536 52 @ Value 52(0x3) for LORaWAN Encryption Key 3	86600000 SF7 • 2 45 • • 125 MHz • 8 @ Length range 6 - 65536 52 @ Value 52(0x34) for LoRaWAN Encryption Kay 3



4.6 Create LoRa Shield End Node

4.6.1 Hardware Connection



There are three sensors connect to the LoRa Shield + UNO. These sensors are flame sensors, DHT11 (Temperature & Humidity sensor) and Relay. Please use the connection as we show in the photo.

Note: There is a trick above, the relay is connected to VIN. In this case, The UNO can only be power via USB port. If need to power via DC power adapter, please use another 5v pin to power relay.

Upload <u>this sketch</u> to the UNO, this sketch will send temperature and humidity data to gateway at every 60 seconds. If there is a flame detect, it will then immediately send the value to gateway and then upload to the IoT Server.



4.6.2 Test with uplink

After we upload the sketch to UNO, we can see below output from Arduino

MQTT_DHT11_and_Flame_sensor_Client_updata_to_ThingSpectrum	ak 💿 COM12 (Arduino/Genuino Uno)	ا ص
文件 編編 项目 工具 帮助		
MQTT_DHT11_and_Flame_sensor_Client_updata_to_ThingSpeak_	The temperature and humidity:	
1 #include <dht.h></dht.h>	[24.00°C, 65.00%]	
2 #include <spi.h></spi.h>	The packet is send successful	
3 #include <lora.h></lora.h>	############## COUNT=4 ####################################	
4	The temperature and humidity:	
5// Singleton instance of	[24.00°C, 65.00%]	
6	The packet is send successful	
7 dht DHT:	############# COUNT=5 ####################################	
8 #define DHT11 PIN A0	The temperature and humidity:	
9 const int flame pin=3: /	[24.00°C, 65.00%]	
10 float temperature, humidit	The packet is send successful	
11 char tem $1[8] = \{ " \setminus 0" \}$ hum	1 ############ COUNT=6 ####################################	
- I - 9 ata.	The temperature and humidity:	
avrdude done. Thank you.	[24.00°C, 65.00%]	
and a south a main your	The packet is send successful	

And we can see the logread of gateway as below, means the packet arrive gateway:

5 10.130.2.125 - SecureCRT
文件(F) 編攝(E) 查看(V) 选项(O) 传输(T) 脚本(S) 工具(L) 帮助(H)
3 33 (J 43)A (h) (h) (h) (F) (A) (A) (A) (A) (A) (A) (A) (A) (A) (A
10.130.2.125
23405312#30 Swn Jan 20 do 2525:58 2019 user.notice root: [ToT.WOTT]: Find Match Entry for 5678
Sun Jan 20 02:152:58 2019 User.notice root: [zot.w071] [-t] (tannel]/682338/publiste/dxW/TVWKLI6N/993MAXS Sun Jan 20 02:152:58 2019 User.notice root: [zot.w071] [-e][id]u/20.0001[id]u/20.0001[id]u/20.0001[id]u/20.0001
Sun Jan 20 02:53:57 2019 daemon, finfo 1001_pkr_fwd[26279]; Sun Jan 20 02:53:57 2019 daemon, finfo 1001_pkr_fwd[26279]; Sun Jan 20 02:53:57 2019 daemon, finfo 1001_pkr_fwd[26279];
28/16/12/e00 bit for an and the second for the second seco
Sun Jan 20 023338 2009 user.instite root: [101:NQTT: [-t] channels/68238/publis/i/VOKIIANN973MAXS
Sun Jan (D. 02:15): 2019 User instrict for Journey (July 1997): Leng Tretoures, one refuzers, sources and references.
2843339250 2843239250
Sun Jan 20 02:14138 2019 User, notice root: 101.Mgtr] : Find Match Birty Tor 30/8 Sun Jan 20 02:14138 2019 User, notice root: 101.Mgtr] : Find Match Birty Tor 30/8
Sun Jan 20 02:5413 2019 User, notice root: [107.MGT1]: L-M] TieloI=26.08Tielo2-39.088tatus=MQTTUBLISH Sun Jan 20 02:55139 2019 daemon, info [00]_mbt_t_Mdt[26279]:
Sun Jan 20 02:55:19 2019 daemon, 1nro 1g01_pkr_twd[26279]: RxtX~ Receive(HEX):3c353637383e6669956c64313d32362e30266669656c643 23d53392e30
Sun Jan 20 02:55:22 2019 user, notice root: [IoT.MQTT] [-t] channels/62388/publish/EVDKII6Nv993M4xs
Sun Jan 20 02:55:52 2019 user.notice root: [IOT.MQTT]: [m] field1=28.0&field2=59.0&status=MQTTPUBLISH Sun Jan 20 02:55:558 2019 daemon.info.j0ju_pkf_tm(26279):
Sun Jan 20 02:55:58 2019 daemon.info 1g01_pkt_fwd[26279]: RXTX~ Receive(HEX):3c353637383e6669656c64313d32362e30266669656c643 23d36332e30
Sun Jan 20 02:55:58 2019 user.notice root: [IoT.WQTT] : -tind Match Entry for 5678 Sun Jana 20 02:55:58 2019 user.notice root: IIoT.WQTT] : -to:tannels/682386/publish/gVokII660v993M4xs
Sun Jan 20 02:55:58 2019 user.notice root: [IoT.MgTT]: [-m] field1=26.0&field2=63.0&status=MgTTPUBLISH Sun Jan 20 02:56:58 2019 deemon,info 1001.bkt.mdt[26:279]:
Sun jan 20 02:56:58 2019 daemon.info 1g01_pkt_fwd[26279]: Rxtx∼ Receive(HEX):3c351617383e6669656c64313d32362e30266669656c643 2dd8302e30
Sun Jan 20 02:577-04 2019 user_notice root: [IoT.MgTT]: Find Match Entry for 5678 Sun Jan 20 02:577-04 2019 user_notice root: IoT.MgTT]: LotLannels/(#3288/nublish/cynct16wy093Maxs
Sun Jan 20 02:57:24 2019 user.notice root: [toT.HQTT]: [-#] field=26.0&field2=60.0&field2=
Sun jan 20 02:57:58 2019 daemon.info 1g01_pkt_fwd[26279]: RXTX- Receive(HEX):3c333637383e6669656c64313d32362e30266669656c643 2741318243.
Sun Jan 20 02:5540 2019 user notice root: [IoT.MQTT] - Erind Match Entry for 5678 Sun Jan 20 02:5540 2019 user notice root: IoT WUTT] - Erind Match Entry for 5678
San Jan 20 02:55:04 2019 user instice rost: [sof.wg7r]: [=0] fieldi=26.0&field2=58
Sun 10 02:58:58 2019 daemoni.inf 0 1901_ktr_md(26279]: RXTX~ Receive(HEX):3c353637383e66669656c64313d32362e30266669656c643 23d45323-3a
Sen Jan 20 02:5594 2019 User-notice root: [IoT.NQTT] Erind Match Entry for 5678
Sun Jan 20 02:59:04 2019 User.institute Toot: [101:N4TT]: [10] Field 2-60.248/statutereptronaution
Sun jan 20 02:59:59 2019 daemon. Hint 100
Subjects of the second se
Sun Jan 20 05100162 2019 User Inot LE FOULT [CILTART] : L-CL Charles 2602360 (but Fail Versa) Mark 20 05100162 2019 User Inot LE FOULT [CILTART] : L-CL Charles 2602360 (but Fail Versa) Mark 2000 (but Fail Versa
Sun Jan D 05:00:18 2019 Odemon. HID 100_kk_lM0[202:9]: RXTX- Receive(MEX):2623067783e66669656c6413d32362e10266669656c64323d35392e10
Sun Jan 20 Sidi 20 Just indi te root: [Id]:Martin [Id]: Find Match Entry Tor Jost
Sun Jan 20 voluti v Zus user inolitie ruoti teolitie ruoti in in in recularge van recularge van teologi van teolog
Sum Jan 20 v3:v0:39 duar user.notic.envolt.lonk.mpr://molecviai.shine.mederive(max):s3:3903-30400009050604323050200200000905060432305012800 Sum Jan 20 03:02:04 2019 user.notic.envolt.lonk.mpr://s678
Sun Jan 20 usiuciei zus user.notice root: lioi.ngtrii L-ti Internets/deczas/publits/vuclus/devas/publis/sun/vuclus/devas/publis/sun/vuclus/devas/publis/sun/vuclus/devas/publis/sun/vuclus/devas/publis/sun/vuclus/devas/publis/sun/vuclus/devas/publis/sun/vuclus/devas/publis/sun/vuclus/devas/publis/sun/vuclus/devas/publis/sun/vuclus/devas/publis/sun/vuclus/devas/publis/sun/vuclus/devas/publis/sun/vuclus/devas/publis/sun/vuclus/devas

Finally, we can see on the ThingSpeak:

	blic view Channel	settings snaring	APT Keys L	Jata Import / Export		
Add Visualizatio	ns 🛛 Add Widge	ets 🖉 Export re	ecent data		MATLAB Analysis	MATLAB Visualization
nannel St reated: <u>about 17 h</u> ast entry: <u>2 minuts</u> ntries: 30	als oursago £ABR	c	₽ ≠ ×	Field 2 Chart		С С / х
28 - 27 26 - 24 -	est from the DHT11	and Flame senso	r	40 Test from the DH	T11 and Flame se	nsor



4.6.3 Test with interrupt by flame detect

The DO pin of Flame sensor is high in normal state. When a flame is detected, the DO pin of Flame sensor will become low, then, the UNO generates an external interrupt, and immediately uploads the temperature and humidity to the server.

The DO pin of Flame sensor is low when a flame is detected, and we can see on the Serial Monitor:

MQTT_DHT11_and_Flame_sensor_Client_updata_to_ThingSpeak_ Arduino 1	COM12 (Arduino/Genuino Uno)
文件 编辑 项目 工具 帮助	
	################ COUNT=2 ####################################
MOTT_DHT11_and_Flame_sensor_Client_updata_to_ThingSpeak_	The temperature and humidites.
73 void fire() // Interrupt	ine temperature and numidity:
74 {	[26.00°C, 61.00%]
75 Serial.println("Have fire,	The packet is send successful
76 dhtTem();	############# COUNT=3 ####################################
<pre>77 dhtWrite();</pre>	The temperature and humidity:
78 LoRa. beginPacket();	[26.00°C, 61.00%]
79 LoRa. print ((char *) datasen	The packet is send successful
80 LoRa. endPacket();	############ COUNT=4 ####################################
81}	The temperature and humidity:
82	[26.00°C, 59.00%]
83 void SendData()	The packet is send successful
1日 上形成功。	Have fire, the temperature is send
avrdude done. Thank you.	The temperature and humidity:
and a det a strong straining your	[26, 00°C, 59, 00%]

Similarly, we can see the logread of gateway via SSH access:





Finally, we can see on the ThingSpeak:

	k ™ Channels -	Apps - Comr	munity Supp	port -	Commercial Use	How to Buy	Account -	Sign Ou
Private View Pub	ic View Channel S	Settings Sharing	g API Keys	Data Import / Export				
Add Visualization:	; 🛃 Add Widge	ets 🛛 🛛 Export r	ecent data		MATLAB	Analysis	MATLAB Visuali:	ation
reated: <u>about17 hor</u> ast entry: <u>2 minutes</u> ntries: 30	LS <u>irsago</u> Ago	¢	₽ / ×	Field 2 Chart		c	9 # X	



4.6.4 Test with downlink

The http downlink feature is now support since firmware LG02_LG08--build--v5.2.1560931576--20190619-1607.

ThingSpeak downlink command can be found in TalkBack App.

The **Command String input box** is the command you want to send to LoRa device.

1 🖬 h	ttps://thingspeal	<.com/apps/t	alkbacks/	306 器 [80%	☆ ⊻	Q、搜索		111/	9	
▼ 天猫618											
🖵 Th	ingSpeak™	Channels -	Apps -	Community	Support +		Commercial Use	How to Buy	Account +	Sign	
			All Apps			Add a TalkBack (Command				
Name	s	test	MATLAB	Analysis		POST https://api	.thingspeak.com/talkback	s/30660/commands.;	json		
TalkB	ack ID:	30660	MATLAB	Visualizations		api_key=32	IX4Y9HTCZNH9YO				
ADLK		272845	Plugins		_	Get a TalkBack C	ommand				
APTN	ey:	JZ3X4Y	ThingTweet			GET https://api	thingspeak.com/talkbacks,	/30660/commands/C	DHWND_ID.json?	api_key=	
		Rege	TimeCor	ntrol		•	m				
		_	React			Update a TalkBa	ck Command				
Create	ted: 2019-01		TalkBack	TalkBack PUT https://api.thingspeak.co				.com/talkbacks/30660/commands/COMMAND_ID.json			
Logge	d to Channel:	dragino	·····	IF		ap1_key=J23	AYSHICZNH9YO				
						Execute the Next	TalkBack Command				
						POST https://api api_key=323	.thingspeak.com/talkback X4Y9MTCZNH9YO	s/30660/commands/	execute.json		
Com	mands					Update a Chann	el and Execute the Next	TalkBack Comm	nand		
Position Command ID		nd ID	Command string			POST https://api field1=70	.thingspeak.com/update.j	son			
1	1 16007288		DownlinkTest			api_key=P07KV/S0FSQEY0H6 talkback_key=323X4Y9HTC2N+9Y0					
Positio	n Command strin	B				Get the Last Exe	uted Command				

Execute The next Talkback Command is the API to get one command from the commands queue.

We can test in the web with this API. Format is:

https://api.thingspeak.com/talkbacks/XXXXX/commands/execute.json?api_key=XXXXXXXXX Result as below:

Apps - TalkBack -	ThinoSpec X api.thingspeak.com/talkbacks/30 X +
$\leftarrow \rightarrow \bigcirc \bigcirc$	🛈 🔒 https://api.thingspeak.com/talkbacks/30660/commands 🗸 🎇 🚥 🏠 👱 🔍
🖨 京东商城 🔳 天雄	曲618
JSON 原始数据	头 头
保存复制全部折叠	全部展开
id: 1	16007322
command_string:	"DownlinkTest"
position: r	null
executed_at:	"2019-06-19T13:35:03Z"
created_at:	"2019-06-19T13:34:592"

We can also test this API in LG01-N Linux console:

By using:

🖥 172.31.255.254 - SecureCRT
文件(F) 编辑(E) 查看(V) 选项(O) 传输(T) 脚本(S) 工具(L) 帮助(H)
29 第 二 39 月 19 12 11 11
172.31.255.254
root@dragino-1b9e2c:~# curl -k https://api.thingspeak.com/talkbacks/30660/commands/execute.json?api_key=JZ3X4Y9MTCZNH9YO

rootddragino-lb9e2c:-# curl -k https://api.thingspeak.com/talbbacks/30660/commands/execute.json?api_key=223X4Y9Mt2ENN9Y0
{"id":16007340,"command_string":"DownlinkTest", "position":null,"executed_at":"2019-06-19T13:40:02Z","created_at":"2019-06-19T13:39:58Z"})



To get this result automatically in LG01-P and send out via LoRa, we can configure as below:

查看网站信息)-1b9e2c Stai	tus - System - Network - Service - Logout
HTTP / HTTPS http/https connection to IoT Serve	er
General Settings	
Enable SSL Connection	
Enable HTTP Downlink	✓ Ø Forward downlink data via LoRa
Downlink URL	https://api.thingspeak.com/talkback
Downlink Datatype	Json - One Level
Downlink Parameter	command_string
Downlink Poll Interval	5
	@ unit:seconds.
	Save & Apply

- > Because URL is https, So need to Enable SSL Connection
- > Downlink URL use the URL we use in Web and Curl
- > Downlink datatype for ThingSpeak is Json.
- Downlink Parameter is command_string. We will fetch the value of command_string from the downlink data string.
- LG01-N will poll the URL every 5 seconds. When there is valid command_string found, it will send out via LoRa (Radio parameter is defined in LoRaWAN gateway Radio settings or Radio2 settings for LG02)

Result in the LoRa Shield:

The temperature and humidity: [30.00°C.86.00%]	
Packet Sent ########### COUNT=26 ###########	
The temperature and humidity: [30.00°C,87.00%]	E
Packet Sent Received nacket : DownlinkTest	
	-
	▼ Clear output



4.7 Conclusion and limitation

4.7.1 Overview for the example

This example shows how to set up a simple LoRa network with ThingSpeak IoT server. In this example, we use the raw LoRa protocol (private protocol) for transmission. It is simpler compare via LoRaWAN protocol

There are some frequently ask points for the example:

1/ Difference between LoRaWAN & Private LoRa protocol:

- The private LoRa protocol here doesn't have MAC control/management, (of course developer can develop this). In LoRaWAN protocol, this feature is supported already.
- The transmission is unencrypted in this example, user can see the data in gateway. In LoRaWAN, the transmission is designed in AES encryption.
- Private LoRa protocol means the gateway only works with specify LoRa End node which runs the same protocol, the gateway can't work with a standard LoRaWAN devices.
- Private LoRa protocol doesn't need the LoRaWAN IoT Server. Gateway can send data to user defined IoT server, in terms the gateway and the server can communicate with each other.
- User can more features in the private protocol such as MAC control, encryption, that is how LoRaWAN protocol comes, the advantage of LoRaWAN protocol is that it is designed for carrier level use, and developer can use it directly with many features and compatible with the LoRaWAN node from different manufacturers.



5 Order Info

LoRa_IoT_Kit-v2-XXX-YYY

XXX: Frequency Band

433: For Bands: EU433, CN470 868: For Bands: EU868,IN865 915: For Bands: US915,AU915,AS923,KR920

YYY: 4G Cellular Option

EC25-E: EMEA, Korea, Thailand, India.

EC25-A: North America/ Rogers/AT&T/T-Mobile.

EC25-AU: Latin America, New Zeland, Taiwan

EC25-J: Japan, DOCOMO/SoftBank/ KDDI

More info about valid bands, please see EC25-E product page

(https://www.quectel.com/product/ec25.htm)



6 FAQ & Trouble Shooting

6.1 I can't upload sketch to LoRa Shield in MAC OS, shows " dev/cu.usbmodem1421 is not available "

Error Info as below:

Arduino: 1.8.3 (Mac OS X), Board: "Arduino/Genuino Uno" Archiving built core (caching) in: /var/folders/jq/8fnvlfj90tgbnbcyd16_bbw00000gn/T/arduino_cache_833512/core/core_arduino _avr_uno_fc9a32205aafa27e4eda988d5ed9b7ac.a Sketch uses 20142 bytes (62%) of program storage space. Maximum is 32256 bytes. Global variables use 1189 bytes (58%) of dynamic memory, leaving 859 bytes for local variables. Maximum is 2048 bytes. Board at /dev/cu.usbmodem1421 is not available

The Arduino UNOs in the Kit are clone version and use CH340 USB to serial chip. User has to install the CH340 driver in PC to make it work. Above issue means the MAC OS doesn't has CH340 driver.

6.2 My IoT Kit has the model LG01-P instead of LG01-N, Can I still use this manual.

The gateway part of this manual is for LG01-N, if user has the LG01-P version, please check the LG01-P gateway manual.



6.3 Duplicate library issue while upload in Arduino IDE 1.8.10.

While compile the LMIC library in Arduino IDE 1.8.10. This error will happen:

💿 ttn-abp Arduino 1.8.10	-	٥	×
File Edit Sketch Tools Help			
			ø
tr-ab			
/			\$
Error compiling for board ArduinolGenuino Uno.	Copy e	rror mess	ages
C (VSF13 (JIL858) (ESALO) (SLUULIO-1-0-10-8/IR008) (SLUULIO-1.0-10-(IL10-8) (SLUULIO-300-(ISLO) (SLUU) ALCO-142). (IIL821) (SLUULIO-1-0-10-8) (SLUULIO-1.0-10-10-10-10-10-10-10-10-10-10-10-10-10			^
C:\Users\ghiasal\AppBata\Local\Temp\l\ccbuBooN.ltrans.o: In function `calcReWindow':			
Gr\Dseralghiasal\Desktop\arduino-1.8.10-windows\arduino-1.8.10\libraries\arduino-lmic-master\srclimic/lmic.c:406: undefined reference to 'table_get_ostime'			
C:\Users\ghiasal\Desktop\arduino-1.8.10-windows\arduino-1.8.10\libraries\arduino-lmic-master\src\lmic/lmic.c:408: undefined reference to `table_get_ostime'			
C:\Usera\ghiasi\AgpOnta\Local\Temp\l\cdxuBooK.ltrans0.ltrans.o: In function `initDefaultChannels':			
C:\Usersighiassi\Desktop\ardmino-1.8.10-windows\ardmino-1.8.10\iibraries\ardmino-lmic-master\arc\lmic/lmic.c:564: undefined reference to `table_get_g4'			
C:\Users\ghiasal\dgpData\Local\Temp\l\ccbuBooN.ltrans0.ltrans.o: In function 'tadio_irg_handler':			
C:\Ugers/ghiasal\Desktop\ardwino-1.8.10-windows\ardwino-1.8.10\likraries/ardwino-lmic-master\srcllmic/radio.c:752: undefined reference to 'table_get_u2'			
C:\Users\phiasal\AppData\Local\Temp\l\ccbuBook.ltrans.c: In function 'schedRel2':			
C:\Users\ghiasal\Desktop\arduino-1.8.10-windows\arduino-1.8.10\libraries\arduino-lmic-master\sro\lmic/lmic.c1369: undefined reference to `table_get_ostime'			
collect2.exe: error: 1d returned 1 exit status			
Multiple libraries were found for "lmic.h" Used: C:\Users\phiasal\Desktop\ardmino-1.8.10-windows\ardmino-1.8.10\hirstes\ardmino-lmic-master Multiple libraries were found for "SRL#" Used: C:\Users\phiasal\Desktop\ardmino-1.8.10-windows\ardmino-1.8.10\hirstes\SFI Using library ardmino-lmic-master at version 1.5.0 ardmino-2 in folder: C:\Users\phiasal\Desktop\ardmino-1.8.10\hirstes\SFI Using library SFI at version 1.0 in folder: C:\Users\phiasal\Desktop\ardmino-1.8.10\hirstes\SFI esting status 1 Form compiling for hoard Ardmino/Genuto Dno.			
			~

To solve this, user can modify the file:

~/Dev/Arduino.app/Contents/Java/hardware/arduino/avr/platform.txt

, Change the compile flag from –Os to –O2. Like below:





6.4 How can I set to use CN470 band?

```
12 //#define CFG_au921 1
12 //#define CFG_as923 1
13
      //#define CFG in866 1
14
       #define LG02 LG01 1
15
16
       //US915: DR_SF10=0, DR_SF9=1, DR_SF8=2, DR_SF7=3, DR_SF8C=4
// DR_SF12CR=8, DR_SF11CR=9, DR_SF10CR=10, DR_SF9CR=11, DR_SF8CR=12, DR_SF7CR
17
18
18 // DR SF12CR=8, DR SF11CR=9, DR SF10CR=10, DR SF9CR=.
19 D#if defined(CFG_us915) && defined(LG02_LG01)
20 // CFG_us915 || CFG_as923
21 #define LG02 UPFREQ 902320000
22 #define LG02_DNWFREQ 923300000
23 #define LG02_RXSF 3 // DR_SF7 For LG01/LG02 Tx
24 #define LG02_RXSF 8 // DR_SF12CR For LG02/LG02 Rx
25 #define LG02_TXSF 8 // DR_SF12CR For LG02/LG02 Rx
25
26
       #elif defined(CFG_eu868) && defined(LG02_LG01)
      // CFG_eu868
//EU866: DR_SF12=0, DR_SF11=1, DR_SF10=2, DR_SF9=3, DR_SF8=4.
21
                                                                                                                         DR SF7=5, DR SF7B=1, DR FSK, DR
      #define LG02_UPFREQ 505300000
#define LG02_DNWFREQ 505300000
28
29
      #define LG02_RXSF 0
#define LG02_TXSF 0
                                                       // DR_SF7 For LG01/LG02 Tx
30
31
                                                            // DR_SF12 For LG02/LG02 Rx
32
       #endif
33 -
```



7 Technical 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



8 Reference

- 1) LORaWAN official website. And Technicel document for LoRaWAN.
- 2) LG01-N LoRa Gateway User Manual
- 3) LoRa Low Energy design guide and Calculator Tool.
- 4) About Distance: LoRa Modem Design Guide
- 5) <u>SX1276 download resource</u>.
- 6) User Manual: LG01-N, LoRa Shield, LoRa/GPS Shield