



LGT-92 LoRaWAN GPS Tracker User Manual

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Version	Description	Date
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1.0.1	Correct GPS payload format in TTN	2019-Jan-23
1.0.2	Add more info for 8-Channel Mode Description	2019-Feb-21
1.0.3	Add LED description, Buttons, correct accelerometer payload info	2019-Mar-29
1.4.0	Add LGT-92-AA board description and photo	2019-May-11
	Add Software/hardware change log	
	Change Payload to add Alarm flag	
1.4.1	Correct payload format	2019-May-14
	More description on the Payload	
1.4.2	FAQ:AT_ERROR, Battery Percentage info, FAQ for battery lift time, Video	2019-Jun-17
	instruction for single channel mode.	
1.4.3	Improve description of Alarm button and Downlink ,	2019-Jul-22





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1. Introduction

1.1 What is LGT-92 LoRa GPS Tracker

LGT-92 is a Long Range / low power consumption LoRaWAN GPS tracker. LGT-92 gets user's location info via GPS and sends it to IoT server via LoRaWAN wireless network.

Compare to traditional GPS trackers (base on GPRS or Cellular network), LGT-92 use much lower power consumption hence can last for longer time. It doesn't need cellular service; system integrator can build their tracking network base on LoRaWAN technology or Join the device to existing LoRaWAN network

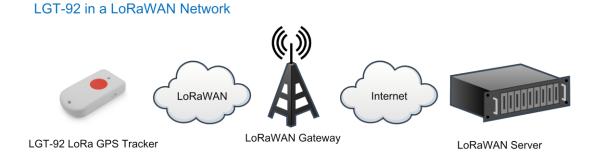
LGT-92 uses STM32l0x chip from ST, STML0x is the ultra-low-power STM32L072xx microcontrollers incorporate the connectivity power of the universal serial bus (USB 2.0 crystal-less) with the high-performance ARM[®] Cortex[®]-M0+ 32-bit RISC core operating at a 32 MHz frequency, a memory protection unit (MPU), high-speed embedded memories (192 Kbytes of Flash program memory, 6 Kbytes of data EEPROM and 20 Kbytes of RAM).

LGT-92 includes a low power GPS module L70 and a 9-axis accelerometer for motion and attitude detection. The power for both of the GPS module and accelerometer can be controlled by MCU to achieve the best energy profile for different applications.

LGT-92 series products include two major variants:

- LGT-92-LI: is powered by 1000mA rechargeable Li-on battery and charge circuit, which target for real time tracking with short tracking uplink.
- LGT-92-AA: Disable the charge circuit to get the lowest power consumption and power directly by 2 x 1.5v AA battery. This is designed for asset tracking where only need to uplink a few times every day.

LGT-92 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.





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

LoRa Spec:

- Frequency Range,
 - ✓ Band 1 (HF): 862 ~ 1020 Mhz
 - or
 - ✓ Band 2 (LF): 410 ~ 528 Mhz
- 168 dB maximum link budget.
- +20 dBm 100 mW constant RF output vs.
- +14 dBm high efficiency PA.
- Programmable bit rate up to 300 kbps.
- High sensitivity: down to -148 dBm.
- Bullet-proof front end: IIP3 = -12.5 dBm.
- Excellent blocking immunity.
- Low RX current of 10.3 mA, 200 nA register retention.
- Fully integrated synthesizer with a resolution of 61 Hz.
- FSK, GFSK, MSK, GMSK, LoRaTM and OOK modulation.
- Built-in bit synchronizer for clock recovery.
- Preamble detection.
- > 127 dB Dynamic Range RSSI.
- Automatic RF Sense and CAD with ultra-fast AFC.
- Packet engine up to 256 bytes with CRC.
- LoRaWAN 1.0.2 Specification

Battery:

- 1000mA Li-on Battery power (for model LGT-92-LI)
- > 2 x AA battery holder for 1.5v AA battery power (for model LGT-92-AA)

Power Consumption

Sleeping Mode: 77uA (for model LGT-92-LI), 17uA (for model LGT-92-AA)



- LoRa Transmit Mode: 125mA @ 20dBm 44mA @ 14dBm
- Tracking: max: 38mA

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
- ✓ Preamble detection
- ✓ Frequency bands CN470/EU433/KR920/US915/IN865
- ✓ EU868/AS923/AU915
- ✓ Open source hardware / software
- ✓ Regular/ Real-time GPS tracking
- ✓ Built-in 9 axis accelerometer (MPU9250)
- ✓ Motion sensing capability
- ✓ Power Monitoring
- ✓ Charging circuit via USB port (for model LGT-92-LI)
- ✓ 1000mA Li-on Battery power (for model LGT-92-LI)
- ✓ 2 x AA battery holder for 1.5v AA battery (for model LGT-92-AA)
- ✓ Tri-color LED, Alarm button

1.4 Applications

- ✓ Smart Buildings & Home Automation
- ✓ Logistics and Supply Chain Management
- ✓ Significant Assets management.
- ✓ Human tracking

1.5 Hardware Changelog

LGT-92 v1.3:

✓ Add C25,R1, used to support LGT-92-AA version.



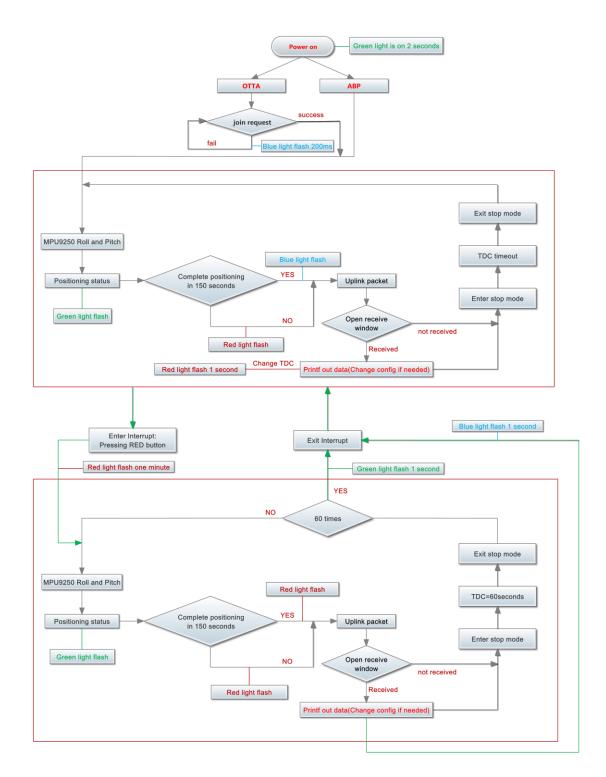
1.6 Variants

Part Number	Photo	Hardware Difference	Target Application
LGT-92-LI		With Enclosure	Real time tracking
	· ·	With 1000mA li-on battery	Short tracking period
		Enable charge circuit	Rechargeable
		FPC internal LoRa Antenna	
		Can power by USB port	
LGT-92-AA		Without Enclosure	Asset tracking
		With (1.5v) AA type battery	Long tracking period
		holder, no battery.	Not rechargeable
		Disable charge circuit	
		Sticker LoRa Antenna	
		Can't powered by USB port (to	
		be fixed)	

2. Use LGT-92 with stock LoRaWAN firmware

2.1 How it works?

The LGT-92 is pre-loaded with a firmware and is configured as LoRaWAN OTAA Class A mode by default. It has OTAA keys to join LoRaWAN network. To connect a local LoRaWAN network, user just need to input the OTAA keys in the LoRaWAN IoT server and power on the LGT-92. It will auto join the network via OTAA.





In case user can't set the OTAA keys in the LoRaWAN OTAA server and has to use the keys from the server. User can use AT Command to set the keys in LGT-92.

2.2 Quick guide to connect to LoRaWAN server (OTAA)

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

LGT-92 in a LoRaWAN Network



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

Step 1: Create a device in TTN with the OTAA keys from LGT-92.

Each LGT-92 is shipped with a sticker with the default device EUI as below:





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

Add APP EUI in the application

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

Add APP KEY and DEV EUI

THETHINGS CONSOLE	Applications	Gateways	Suppo
Applications > is dragino_test_application1 > Devices			
REGISTER DEVICE		bulk import devic	<u>es</u>
Device ID This is the unique identifier for the device in this app. The device ID will be immutable.			
80		•	
Device EUI The device EUI is the unique identifier for this device on the network. You can change the EUI later.		🔗 8 bytes	
App Key The App Key will be used to secure the communication between you device and the network. S7 4E 37 E6 8A EC FC CD B3 B9 3D 87 A9 3B 4B 2C		16 bytes	
App EUI 3F 77 AD E3 6B CA AB 65		0	
		,	J.



Step 2: Power on LGT-92 LoRaWAN GPS Tracker by using the on board switch. For LGT-92-LI, user can power it by USB cable as well.

Step 3: LGT-92 will auto join to the TTN network. After join success, LGT92 will start to upload message to IoT server.

By default, the upload period is 5 minutes. In the start of each period, LGT-92 will try to get GPS signal and the green LED will blink. Once LGT-92 get the GPS info, it will upload a LoRa message include battery / GPS info/ X,Y axis info. If LGT-92 can't get GPS info into 2 minutes, it will still upload the message but the GPS info will be all 00.



2.3 Uplink Payload

2.3.1 Payload Analyze

The uplink payload includes totally 12 bytes. Uplink packets use FPORT=2 and every 5 minutes send one uplink by default. (User can use AT+SGM=0 to disable the motion sensor to get 8 payload)

Size(bytes)	3	3	2	2	2
Value	Latitude	Longitude	Alarm & BAT	Roll	Pitch

Alarm & BAT:

Size(bit)	1 bit	1bit	14 bits
Value	reserve	Alarm Indicate	BAT

Example: Payload: 0x06765F F2960A 4B45 04D2 FB2E

Location info:

- ✓ Latitude: $06765f \Rightarrow if (0x06765f \& 0x800000 = 0)$: value = 0x06765f / 10000 = 42.3519
- ✓ Longitude: F2960a ⇒ *if* (0xF2960a & 0x800000 = 1): value = (0xf2960a - 0x 100000)/10000 -87.9094

Important note:

- a) When power is low, GPS won't be able to get location info and software will disable GPS fixing and send out 0x0FFFFF, 0x0FFFFF to server.
- b) When enable 9-axis motion sensor, the total payload will be 12 bytes, while US915 DR0 accept only 11 bytes payload. In this case, the payload on server will be ignore and shows as below:

ilters	uplink time 11:21:18	downlink	activation	ack	error							
	time	counter	port									
▼ 11	:21:18		0									
1 1	:20:45	0	0	retry	payload: [not p	rovided] Al	ARM_status:	"FALSE"	BatV: 0 l	atitude: 0	Longitud: 0	Pitch: 0
+ 11	:18:39				dev addr: 26)1 24 86 a	app eui: 70 B	3 D5 7E D	001 5F 25	dev eui:	00 E2 84 A0) 7E 7C 9A

c) While GPS can't get location info after timeout, the payload will be 000000 & 000000:

▼ 11:18:12		0			
11:17:39	0	2	retry	payload: 00 00 00 00 00 00 0FED ALARM_status: "FALSE" BatV: 4.077 Latitude: 0 Longitud: 0 Pitch	0 F

- ✓ Alarm: Ex1: 0x4B & 0x40 >> 6 = 0x01
- ✓ BAT: Ex1: 0x4B45 & 0x3FFF \Rightarrow 2885 (mV).



The battery info shows the current voltage, for LGT-92-LI version which powered by li-on battery. User can use below mapping to indicate the battery in percentage:

- > 4.0v : 80% ~ 100%
- ➤ 3.85v ~3.99v: 60% ~ 80%
- ➤ 3.70v ~ 3.84v: 40% ~ 60%
- ➤ 3.40v ~ 3.69v: 20% ~ 40%
- ➤ < 3.39v: 0~20%</p>

When voltage is lower than 2.84v, GPS module will not able to get GPS fix, device will disable latitude and longitude and the related field will be both filled with 0x0FFFFF.

- ✓ Roll: 04D2 = *if* (0x04D2 & 0x8000 = 0): *value* = 0x04D2 / 100 = +1234 ⇒ 12.34 degree
- ✓ Pitch: FB2E =if (0xFB2E & 0x8000 = 1): value =(0xFB2E 0x10000)/100(dec) ⇒ -12.34 degree

2.3.2 Add Payload format in TTN

In TTN, use can add a custom payload so it shows friendly.

In the page Applications --> Payload Formats --> Custom --> decoder

lications > 🥪 Igt-92 🚿 Payload Formats						
	Overview	Devices	Payload Formats	Integrations	Data	Setting
AYLOAD FORMATS						
Payload Format The payload format sent by your devices						
Custom						\$
decoder converter validator encoder					remove	decode
<pre>1 //The function is : 2 3 function Decoder(bytes, port) { 4 5 // Decode an uplink message from a buffer 6 7 // (array) of bytes to an object of fields. 8</pre>						- III

Add below code:

```
function Decoder(bytes, port) {
    // Decode an uplink message from a buffer
    // (array) of bytes to an object of fields.
    var alarm=(bytes[6] & 0x40)?true:false;//Alarm status
    value=((bytes[6] & 0x3f) <<8) | bytes[7];
    var batV=value/1000;//Battery,units:Volts
    value=bytes[8]<<8 | bytes[9];
    if(bytes[8] & 0x80)
    {</pre>
```



```
value |=0xFFFF0000;
  }
  var roll=value/100;//roll,units: °
  value=bytes[10]<<8 | bytes[11];</pre>
  if(bytes[10] & 0x80)
  {
    value |=0xFFFF0000;
  }
  var pitch=value/100; //pitch,units: °
  var json={
   roll:roll,
   pitch:pitch,
   batV:batV,
    alarm:alarm
  };
  var value=bytes[0]<<16 | bytes[1]<<8 | bytes[2];</pre>
  if(bytes[0] & 0x80)
  {
    value |=0xFFFFF000000;
  }
  var value2=bytes[3]<<16 | bytes[4]<<8 | bytes[5];</pre>
  if(bytes[3] & 0x80)
  {
   value2 |=0xFFFFFF000000;
  }
  if (value == 0x0FFFFF && value2 == 0x0FFFFF)
  {
    //gps disabled (low battery)
  } else if (value === 0 && value2 === 0) {
   //gps no position yet
  } else {
    json.latitude=value/10000;//gps latitude,units: °
    json.longitude=value2/10000;//gps longitude, units: °
  }
  return json;
}
```

Save the change the uplink message will be parsed. As below:



lications	> 🤤 Ig	t-92 → Da	ata										
							Overview	Devices	Payload Form	nats In	tegrations	Data	Setti
DDUIG	ATION												
PPLIC	ATION	DATA										II paus	
Filters	uplink	downlink	activatio	on ack	error								
	time	counter	port										
▲ 16	:38:03	10	2		devid: <u>lgt25268243</u>	payloa	d: 03 77 90	C 11 6D 48 0D	C3BAC1 14 5E	BatV: 3.5	23 Latitude	22.7228	Lon
•					III								- F
▲ 16	:35:02	×	×	historical	devid: <u>lgt25268243</u>	payloa	d: 03 77 94	A 116D 470D	A5 42 4B EF 88	BatV: 3.4	93 Latitude	22.7226	Lon
•													•
▲ 16	:35:02	9	2		devid: <u>lgt25268243</u>	payloa	d: 03 77 94	A 116D 47 0D	A5 42 4B EF 88	BatV: 3.4	93 Latitude	22.7226	Lon
•					III								•
	:31:35		2	confirmed ack	devid: lgt25268243	app id:	lgt-92						
10			~	ack									

2.4 Downlink Payload

Downlink Command	FPort	Code	Payload size (bytes)	Function
TDC				Set AT+TDC
(Transmit Time	Any	01	4	Ex: 0x0100012C (set time to 300s
Interval)				(0x12C))
				Exit Alarm Interrupt
Exit alarm	Any	02	2	Ex: 0x0201
				Reset Device
RESET	Any	04	2	Ex: 0x04FF

The FPort no fix , if the payload=0100003C, means to control the END Node's TDC to 0x00003C=60(S), while type code is 01.

Example Downlink payload setting in TTN:

DOWNLIN	IK			
Schedulin	g		FPort	
replace	first	last	2	Confirmed
Payload				
bytes	fields	01 00 00 3C		o 4 bytes

2.5 LED Status

<u>See work flow</u> LGT-92 LoRa GPS Tracker User Manual



2.6 Button Function

RESET button:

Press this button will reboot the device.

RED button:

See work flow

When press the Alarm button, Alarm flag in the payload will be set for the next 60 packets unless use downlink to exit the Alarm mode.

2.7 Firmware Change Log

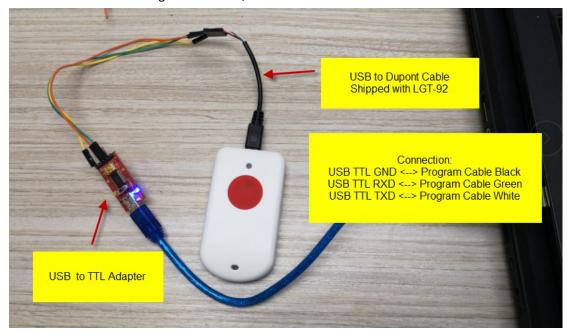
See this link.



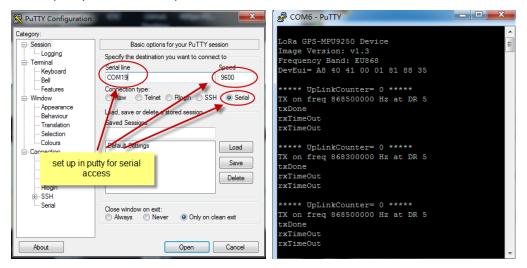
3. Use AT Command

3.1 Access AT Command

LGT-92 supports AT Command set in stock firmware. User can use a USB to TTL adapter to connect to LGT-92 for using AT command, as below.



In PC, User needs to set serial tool baud rate to **9600** to access serial console for LGT-92. LGT-92 will output system info once power on and user will be able to send AT commands:





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

Command Manual

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

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

Keys, IDs and EUIs management

AT+APPEUI: Application EUI

AT+APPKEY: Application Key

AT+APPSKEY: Application Session Key

AT+DADDR: Device Address

AT+DEUI: Device EUI

AT+NWKID: Network ID(You can enter this command change only after successful network

connection)

AT+NWKSKEY: Network Session Key

Joining and sending date on LoRa? network

AT+CFM: Confirm Mode

AT+CFS: Confirm Status

AT+JOIN: Join LoRa? Network

AT+NJM: LoRa? Network Join Mode

AT+NJS: LoRa? Network Join Status

AT+RECV: Print Last Received Data in Raw Format

AT+RECVB: Print Last Received Data in Binary Format

AT+SEND: Send Text Data

AT+SENB: Send Hexadecimal Data

LoRa network management

AT+ADR: Adaptive Rate

AT+CLASS: LoRa Class(Currently only support class A

AT+DCS: Duty Cycle Setting

AT+DR: Data Rate (Can Only be Modified after ADR=0)

AT+FCD: Frame Counter Downlink

- AT+FCU: Frame Counter Uplink
- AT+JN1DL: Join Accept Delay1



AT+JN2DL: Join Accept Delay2 AT+PNM: Public Network Mode AT+RX1DL: Receive Delay1 AT+RX2DL: Receive Delay2 AT+RX2DR: Rx2 Window Data Rate AT+RX2FQ: Rx2 Window Frequency AT+TXP: Transmit Power

Information

AT+RSSI: RSSI of the Last Received Packet

AT+SNR: SNR of the Last Received Packet

AT+VER: Image Version and Frequency Band

AT+FDR: Factory Data Reset

AT+PORT: Application Port

AT+CHS: Get or Set Frequency (Unit: Hz) for Single Channel Mode

AT+CHE: Get or Set eight channels mode, Only for US915, AU915, CN470

3.2 Common AT Command Sequence

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

If device has not joined network via OTAA:

AT+FDR AT+NJM=0 ATZ

If device already joined network:

AT+NJM=0 ATZ

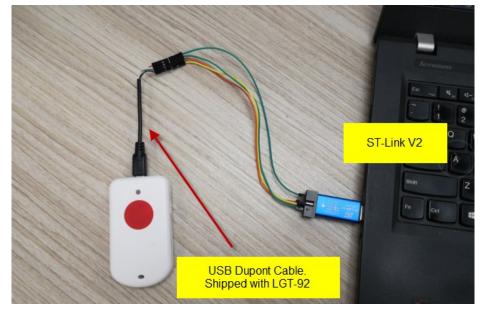
3.2.2 Single-channel ABP mode (Use with LG01/LG02)

See this link



4. Upload Firmware

User can use the LGT-92's USB port to upgrade firmware into it. The hardware connection for upgrade firmware is as below:



Connection:

- ✓ ST-LINK v2 5.0v <--> Dupont red pin
- ✓ ST-LINK v2 GND <--> Dupont black pin
- ✓ ST-LINK v2 SWCLK <--> Dupont green pin
- ✓ ST-LINK v2 SWDIO <--> Dupont white pin
- ✓ LGT-92 power can be on or off.

Video Instruction is here: <u>https://youtu.be/H-45v5-xI-U</u>

Text step as below:

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

Step2: Download the LGT-92 Image files.

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

Step4: Keep pushing the small reset button on LGT92 and then click the blue global "**settings**" button on ST-LINK.

STM32 ST-LINK Utility	
File Edit View Target ST-LINK External Loader Help	
🖴 🖬 🖐 🗣 🔗 🕵 🔎	
Memory display	Device
Address: 0x08000000 ▼ Size: 0x129D0 Data Width: 32 bits ▼	Device ID
	Revision ID
	Flash size
Device Memory File : AS923.hex	
[AS923.hex], Address range: [0x08000000 0x08012D48]	



Step5: The led on the ST-LINK adapter will now blinking, once see it blinks; release the reset button on the LGT-92.

Step6: The led on the ST-LINK adapter will now blinking, once see it blinks; release the reset button on the LGT-92. The ST-Link utility will pop up a download window. Click the start button to download the image to LGT-92.

stm32 st-link Utility	lo lo x
File Edit View Target ST-LINK External Loader Help	
🖴 🖥 🖕 🕼 💋 🚳 🔜	
Memory display Device STM32L07x/STM32L08x	
Address: 0x08000000 V Size: 0x129D0 Data Width: 32 bits V 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 GPS Track\LGT-92 Browse	
Extra options	
🗌 Skip Flash Erase 📃 Skip Flash Protection verification	
Verification	
Verify while programming	
Click "Start" to program target.	
After programming	
Reset after programming Full Flash memory Checksum	
10.00.12.11 UIE target is innow p	
16:02:12 : ST-LINK SN : 33FF700	
16:02:12 : Connected via SWD.	
16:02:12 : SWD Frequency = 4,0 MHz. 16:02:12 : Connection mode : Normal.	
16:02:12 : Debug in Low Power mode enabled.	
16:02:12 : Device ID:0x447	



5. Developer Guide

5.1 Source Code

Software Source Code Download Link. Hardware Source Code Download Link

5.2 Compile Source Code

5.2.1 Set up Keil compile environment

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

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

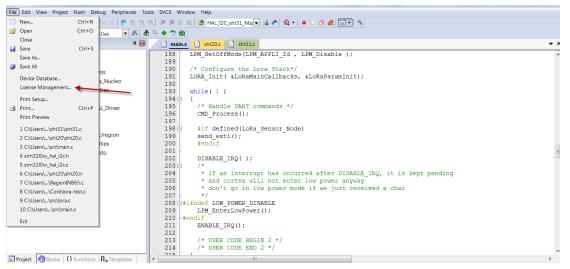
2: Download the keil:

	armkeil		
		Search Kell.com	Go
	Home / MDK Version 5 / STMicroelectronics / Installation & Activation	Lear	ning
	MDK for STM32L0 and STM32F0 Installation & Activation	Platt	form
	MDK for STM32F0 and STM32L0 provides software developers working with STM32 devices with a free-to- use professional tool suite. Kell MDK is the most comprehensive software development system for ARM processor-based microcontroller applications.	 Quick Links STMicroelectronics 	
	Based on MDK Version 5, the MDK for STM32F0 and STM32L0 edition includes the ARM C/C++ Compiler, the CMSIS-RTOS RTX Kernel, and the µVision IDE/Debugger. The STM32 peripherals can be configured using	Device List	
Privacy Policy Update	STM32 CubeMX and the resulting project exported to MDK.	Evaluation Boards Software Packs	
Arm's Privacy Policy has been updated. By continuing to use our	★ Download MDK Core ★ Download the keil (Version:5.26.2.0)	Soltwale Paths	
site, you consent to Arm's Privacy Policy. Please review our Privacy Policy to learn more about our	Product Serial Number (PSN)		
collection, use and transfers of your data. Accept and hide this message	To activate the MDK for STM32F0 and STM32L0 Edition, use the following Product Serial Number (PSN). For please refer to the Activation guide below.	more details on how to activate	MDK,
Important information	4PPFW-QBEHZ-M0D5M		
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Change Settings	> Installation		

3: Login with an account that has administration rights.

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

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



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



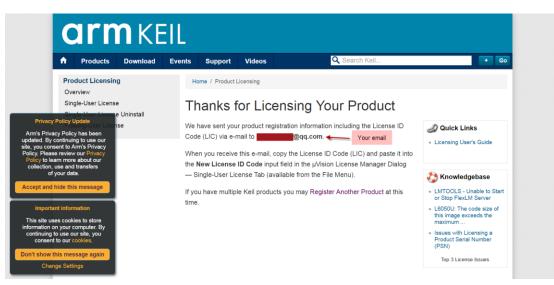
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Product		License ID Code (LIC)/Product variant	Support Period
	Cortex-M0/M0+ 256K for ST	License ID Code (LIC)/Product variant 9DAUH-WU4S4-E89XN-BH47D-62JWP-CILZ6	

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

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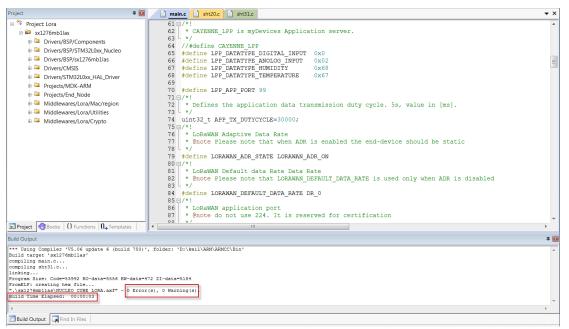
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MDK-ARM Cortex-M0/M0+ 256K
For ST Only
Support Ends 31 Jan 2020
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9:Finish





5.2.2 Install STM32L0 Series Device

1:**Open** the web:<u>http://www.keil.com/dd2/pack/eula-container;</u>

2:Find the STMicroelectronics STM32L0 Series Device and download it;

	STMicroelectronics STM32G0 Series Device Support	DFP New 1.0.0 👤
	STMicroelectronics STM32H7 Series Device Support and Examples	BSP DFP 2.2.0 👱
	STMicroelectronics STM32L0 Series Device Support, Drivers and	BSP DFP 2.0.0 👤
	STMicroelectronics STM32L1 Series Device Support and Examples	BSP DFP 1.2.0 👤
	STMicroelectronics STM32L4 Series Device Support, Drivers and	BSP DFP 2.0.0 👤
	STMicroelectronics STM32W1 Series Device Support and Examples	DFP 1.0.0 👤
	> Texas Instruments LM3S Series Device Support	DFP 1.1.0 👤
	> Texas Instruments LM4F Series Device Support	DFP 1.0.0 👤
	> Texas Instruments Tiva C Series Device Support and Examples	BSP DFP 1.1.0
Privacy Policy Update Am's Privacy Policy has been updated. By continuing to use our site, you, concent to Am's Privacy	Toshiba TX00 Series Device Support	DFP 1.3.0 👤
	Toshiba TX03 Series Device Support	BSP DFP 1.4.0 👤
Policy. Please review our Privacy Policy to learn more about our collection, use and transfers of your data.	Toshiba TX04 Series Device Support	DFP 1.2.0 👤
Accept and hide this message	Toshiba TXZ3 Series Group(1),Group(2) Device Support	DFP 1.2.0 👤
Important information	Yokogawa EB-TMPM369FDFG Board Support	ESP 1.0.0 👤
This site uses cookies to store information on your computer. By continuing to use our site, you	LAPISSemiconductor	
consent to our cookies. Don't show this message again	> LAPIS Semiconductor ML630Q46x Device Support	DFP 1.0.0 👤
Change Settings	L-Tek	

3:Find the Software Pack and installs it;

Welcome to Keil Pack Unzip	
Release 1/2018	armkeil
This program installs the Software Pack:	
Keil STM32L0xx_DFP 2.0.0	
STMicroelectronics STM32L0 Series Device Support, Drivers and Example	\$
Destination Folder	
D:\kei\ABM\PACK\Kei\STM32L0xx_DFP\2.0.0	
	2
——— Keil Pack Unzip ————	
	<< Back Next>>> Cancel
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4:Add the Device ,then you can rebuild the project.



 Imain
) 😂 🖬 🍠 🕺 🤐 🛍 🖌 🗠 🤞 💌 🗟 🌾 🔍 🔹 । 🔶 📀 💩 💷 🔍 🤌 🕮 🕮 🍬 - 🗮 🛛 🗱 🛛 sx1276mb1las Project: Lora џ 🖬 v × 😂 sx1276mb1las × Options for Target 'sx1276mb1las' Drivers/BSP/Compor 🗉 📮 Drivers/BSP/STM32Li Device Target | Output | Listing | User | C/C++ | Asm | Linker | Debug | Utilities | 🛛 📮 Drivers/BSP/sx1276m Drivers/CMSIS Software Packs B Drivers/STM32L0xx_F Vendor: STMicroelectronics Software Pack Projects/MDK-ARM Pack: Keil.STM32L0xx_DFP.2.0.0 Device: STM32L072CZTx Projects/End_Node URL: http://www.keil.com/pack/ Toolset ARM 🐵 📮 Middlewares/Lora/M Middlewares/Lora/U L072CZ Search: 2 B Middlewares/Lora/C The STM32L0 devices provides high power efficiency for a wide range of performance. It is achieved with a large choice of internal and external clock sources, an internal voltage adaptation and several low-power STMicroelectronics 🗄 🍄 STM32L0 Series locks B STM32L072 modes. Typical applications include application control and user interfaces, handheld equipment AV receivers and digital TV, PC peripherals, gaming and GPS platforms, industrial applications, PLCs, inverters, printers, scanners, alarm systems, video intercoms, and HVACs STM32L072CZ 3 STM32L072CZTx - CRC calculation unit, 96-bit unique ID - USB 2.0 crystal-less, battery charging detection and LPM - True RNG and firewall protection STM32L072CZYx 4 4 🖻 Pr... 🎯 Bo... | { } Fu... | 🛈 , Te. Find In Files Cancel Defaults OK Help **4** 🖸

Notice: If without add the Device, the keil would report this error.

File Edit View Project Flash Debug Peripherals Tools SVCS Window Help
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Project 9 🔟 🗋 main.e 🗋 atc 🗋 Ionac 🔍 💌 🗙
B % Project Lora 49 #include "low power manager.h"
siz76mbllas 50 #include "lora.h"
52 #include "timeServer b"
Drivers/BSP/STM32U S3 #include "vcom.h"
Given/bs//sx12/01 54 #include "Version.n"
Image: Privers/CMSIS 55 #include "command.h" Image: Privers/STM32L0x F 56 #include "at.h"
58 /* Private type µVision
W [™] Projectifind_Node 59 /* Private defit
■ Middlewares/Lora/U 61 □/*! Error: Device not found -
Middlewares/Lora/Ci 62 * CAYENNE_LPP
63 L */ Device: 'STM32L072CZTx' 64 //#define CAYEN Vendor: 'STMicroelectronics'
65 #define LPP DAT
66 #define LPP_DATI Please update your device selection.
67 #define LPP DATI 68 #define LPP DATI
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70 #define LPP_APP
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Build Output Find In Fies

5.2.3 Compile Source Code

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

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🖨 🦾 Mi	ddlewares/Lora/Mac/region
÷	Region.c
D	RegionAS923.c
÷	RegionAU915.c
D	RegionCN470.c
D	RegionCN779.c
D	RegionCommon.c
÷	RegionEU433.c
D	RegionEU868.c
±	RegionIN865.c
÷	RegionKR920.c
÷	RegionUS915.c
±	RegionUS915-Hybrid.c

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

Preprocessor Symbols		
Define: STM32L072x, USE_STM32	2L0XX_NUCLEO,USE_HAL_DRIVER, REGIO	N EU858
Undefine:	Fr	equency
Language / Code Generation		
Execute-only Code	Strict ANSI C	Warnings:
Optimization: Level 3 (-03) 💌	Enum Container always int	All Warnings 🗨
Optimize for Time	Plain Char is Signed	Thumb Mode
Split Load and Store Multiple	Read-Only Position Independent	No Auto Includes
One ELF Section per Function	Read-Write Position Independent	C99 Mode
Include Paths Misc Controls -C99	ers\BSP\STM32LQoc_Nucleo:\.\.\.\.\.\.	\Drivers\STM32L0x_HAL
Compiler control string	ROLIB g -03 -apcs+interwork -split_section /STM32LDox_Nucleo -I	s-I//nc-I

5. Compile and build





6. FAQ

6.1 What is the lifetime for battery?

It is hard to get an exact lifetime for the battery, the actually lifetime for battery depends on the battery type, GPS signal strength, upload periodically, use environment (indoor/outdoor). For example, if the lgt-92 is placed in indoor environment, it will take 150 seconds to try to get GPS fix and final it will fix fail. If the lgt-92 is placed outdoor, it will normally take less than 10 seconds after the first fix. The power consumption and battery life are quite different.

A reference lifetime of a full charge battery on LGT-92-LI: If lgt-92 is placed outdoor, and transmission periodically is 5 minutes. The device can last about 19 days. Please note this is an ideal case on the GPS signal strength. Actually battery use time is affected by many factors as mention above

6.2 Why there is 433/868/915 version?

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

6.3 What is the frequency range of LT LoRa part?

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

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



6.4 How to change the LoRa Frequency Bands/Region?

User can follow the introduction for <u>how to upgrade image</u>. When download the images, choose the required image file for download.

6.5 Can I use Private LoRa protocol?

The stock firmware is based on LoRaWAN protocol. User can use a private LoRa protocol in LGT-92, this section describe an example for base LoRa transfer. It is a reference/demo and we didn't provide further software develop support on this topic.

In this demo, we will show the communication between LoRa Shield and LGT-92, both of them use the basic LoRa library. LGT-92 will send a message to LoRa Shield and LoRa Shield will print it to the console.

LoRa Shield + UNO:

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

LGT-92:

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

Compile it and Upload it to LGT-92, the LGT-92 will transfer on the frequency 868.3Mhz.

In Arduino Console, it will see:

LoRa Rece	eiver			
Received	packet	'Hello,LoRa	shield'	with RSSI -32
Received	packet	'Hello,LoRa	shield'	with RSSI -33
Received	packet	'Hello,LoRa	shield'	with RSSI -33
Received	packet	'Hello,LoRa	shield'	with RSSI -32
Received	packet	'Hello,LoRa	shield'	with RSSI -33
Received	packet	'Hello,LoRa	shield'	with RSSI -33
Received	packet	'Hello,LoRa	shield'	with RSSI -33
Received	packet	'Hello,LoRa	shield'	with RSSI -34
Received	packet	'Hello,LoRa	shield'	with RSSI -33
Received	packet	'Hello,LoRa	shield'	with RSSI -33

Autoscroll

No line ending \lor 9600 baud



6.6 How to set up LGT-92 to work in 8 channel mode in US915, AU915, CN470 bands?

By default, the frequency bands US915, AU915, CN470 works in 72 frequencies. Many gateways are 8 channel gateways, in such case, the OTAA joined time and uplink schedule is **long and unpredictable** while the end node hopping in 72 frequencies.

User can configure the end node to work in 8 channel models by using the AT+CHE command, the 500kHz channels are always includes for OTAA.

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

CHE	US915 Uplink Channels(125KHz,4/5,Unit:MHz,CHS=0)										
0	ENABLE Channel 0-63										
1	902.3	902.5	902.7	902.9	903.1	903.3	3.3 903.5 903.7 Channel				
2	903.9	904.1	904.3	904.5	904.7	904.9	905.1	905.3	Channel 8-15		
3	905.5	905.7	905.9	906.1	906.3	906.5	906.7	906.9	Channel 16-23		
4	907.1	907.3	907.5	907.7	907.9	908.1	8.1 908.3 908.5 Channel 2				
5	908.7	908.9	909.1	909.3	909.5	909.7	909.9	910.1	Channel 32-39		
6	910.3	910.5	910.7	910.9	911.1	911.3	911.5	911.7	Channel 40-47		
7	911.9	912.1	912.3	912.5	912.7	912.9	913.1	913.3	Channel 48-55		
8	913.5	913.7	913.9	914.1	914.3	914.5	914.7	914.9	Channel 56-63		
	Channels(500KHz,4/5,Unit:MHz,CHS=0)										
	903 904.6 906.2 907.8 909.4 911 912.6 914.2 Channel 64-72								Channel 64-71		

When user uses the TTN network, the US915 frequency bands use are:

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

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

```
AT+CHE=2
ATZ
```

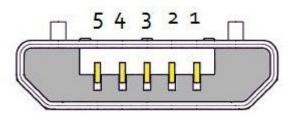


to set the end node to work in 8 channel mode. The device will work in Channel 8-15 & 64-71 for OTAA, and channel 8-15 for Uplink.

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

AU915 is similar. Below is the AU915 Uplink Channels.

6.7 What is the pin mapping for the USB program cable?



USB Micro-B

Pin	Color	USB Pin	UART pin	ST-Link Pin
1	Red	VCC	N/A	+5V
2	White	D- (N/A)	LGT-RXD	SWDIO
3	Green	D+(N/A)	LGT-TXD	SWCLK
4		ID (N/A)	N/A	
5	Black	GND	GND	GND



6.8 How to set up LGT-92 to work with Single Channel Gateway such as LG01/LG02?

In this case, users need to set LGT-92 to work in ABP mode & transmit in only one frequency. Assume we have a LG02 working in the frequency 868400000 now, below is the steps. (Video Instruction: <u>https://youtu.be/32eLnlYoLol</u>)

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

CONSOLE COMMUNITY EDITION		Applications Gateways	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 ··· <th< th=""><th></th><th></th><th></th></th<>			
Device Address 💠 😄 26 01 1A F1 📓		In ABP mode, The device Address,	
Network Session Key 💠 🛱 💋 00 86 97 F6 BD 8E 7F 43 CE 69 44 4F 26 64 16 41	Ē	Network Session Key, App Session Key must match between the End Node and LoRaWAN server	
	Ē		
Status • 4 minutes ago			

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

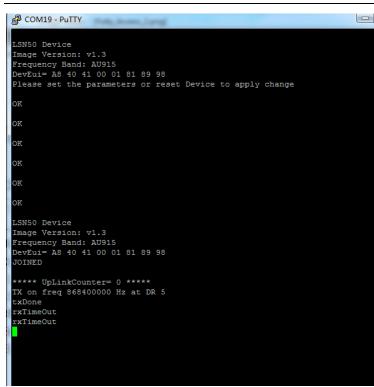
<u>Step2:</u> Run AT Command to make LGT-92 work in Single frequency & ABP mode. Below is the AT commands:

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=26 01 1A F1Set Device Address to 26 01 1A F1ATZReset MCU

As shown in below:



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7. Trouble Shooting

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

It is about the channels mapping. Please see this link for detail.

7.2 I see AT_ERROR when I type commands?

When you type command, it is possible that the GPS communication conflict with TTL input so you see AT_ERROR. Especially the TDC time is short while GPS fix in a short period.

To overcome this issue, you can:

- 1) Try to type the command in a txt file and paste it to the console to shorter the input time for command.
- 2) Try to run AT+FDR first to reset the device to factory default and type.



8. Order Info

See <u>variants</u> first: Part Number: LGT-92-XX-YYY

XX: Major variant model

- ✓ LI: Li-on battery version
- ✓ DE: AA battery version

YYY: 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

9. Packing Info

Package Includes:

- ✓ LGT-92 LoRa GPS Tracker x 1
- ✓ USB recharge & program cable x 1

Dimension and weight:

- ✓ Device Size: 85 x 48 x 15 cm
- ✓ Device Weight: 50g

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. Reference

- ♦ Product Page , DataSheet
- ♦ Image Download
- ♦ AT Command Manual
- ♦ <u>TTN Frequency Bands</u>