LGT-92 LoRaWAN GPS Tracker User Manual

Document Version: 1.4.0

Image Version: v1.4

<table>
<thead>
<tr>
<th>Version</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Release</td>
<td></td>
</tr>
<tr>
<td>1.0.1</td>
<td>Correct GPS payload format in TTN</td>
<td>2019-Jan-23</td>
</tr>
<tr>
<td>1.0.2</td>
<td>Add more info for 8-Channel Mode Description</td>
<td>2019-Feb-21</td>
</tr>
<tr>
<td>1.0.3</td>
<td>Add LED description, Buttons, correct accelerometer payload info</td>
<td>2019-Mar-29</td>
</tr>
<tr>
<td>1.4.0</td>
<td>Add LGT-92-AA board description and photo</td>
<td>2019-May-11</td>
</tr>
<tr>
<td></td>
<td>Add Software/hardware change log</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Change Payload to add Alarm flag</td>
<td></td>
</tr>
<tr>
<td>1.4.1</td>
<td>Correct payload format</td>
<td>2019-May-14</td>
</tr>
<tr>
<td></td>
<td>More description on the Payload</td>
<td></td>
</tr>
<tr>
<td>1.4.2</td>
<td>FAQ:AT_ERROR, Battery Percentage info, FAQ for battery lift time, Video</td>
<td>2019-Jun-17</td>
</tr>
<tr>
<td></td>
<td>instruction for single channel mode.</td>
<td></td>
</tr>
<tr>
<td>1.4.3</td>
<td>Improve description of Alarm button and Downlink ,</td>
<td>2019-Jul-22</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. Introduction .......................................................................................................................... 5
   1.1 What is LGT-92 LoRa GPS Tracker ................................................................................. 5
   1.2 Specifications ..................................................................................................................... 6
   1.3 Features ............................................................................................................................. 7
   1.4 Applications ....................................................................................................................... 7
   1.5 Hardware Changelog ........................................................................................................ 7
   1.6 Variants ............................................................................................................................. 8

2. Use LGT-92 with stock LoRaWAN firmware .................................................................... 9
   2.1 How it works? ...................................................................................................................... 9
   2.2 Quick guide to connect to LoRaWAN server (OTAA) .................................................. 10
   2.3 Uplink Payload ................................................................................................................ 13
      2.3.1 Payload Analyze ......................................................................................................... 13
      2.3.2 Add Payload format in TTN ....................................................................................... 14
   2.4 Downlink Payload .......................................................................................................... 16
   2.5 LED Status ....................................................................................................................... 16
   2.6 Button Function .............................................................................................................. 17
   2.7 Firmware Change Log ...................................................................................................... 17

3. Use AT Command .............................................................................................................. 18
   3.1 Access AT Command ...................................................................................................... 18
   3.2 Common AT Command Sequence ................................................................................... 20
      3.2.1 Multi-channel ABP mode (Use with SX1301/LG308) ............................................. 20
      3.2.2 Single-channel ABP mode (Use with LG01/LG02) .................................................. 20

4. Upload Firmware .............................................................................................................. 21

5. Developer Guide ................................................................................................................. 23
   5.1 Source Code .................................................................................................................... 23
   5.2 Compile Source Code ..................................................................................................... 23
      5.2.1 Set up Keil compile environment ............................................................................. 23
      5.2.2 Install STM32L0 Series Device .............................................................................. 26
      5.2.3 Compile Source Code ............................................................................................ 27

6. FAQ ..................................................................................................................................... 29

LGT-92 LoRa GPS Tracker User Manual
6.1 What is the lifetime for battery? ................................................................. 29
6.2 Why there is 433/868/915 version? ................................................................. 29
6.3 What is the frequency range of LT LoRa part? .............................................. 29
6.4 How to change the LoRa Frequency Bands/Region? ..................................... 30
6.5 Can I use Private LoRa protocol? ................................................................. 30
6.6 How to set up LGT-92 to work in 8 channel mode in US915, AU915, CN470 bands? .......... 31
6.7 What is the pin mapping for the USB program cable? ................................... 32
6.8 How to set up LGT-92 to work with Single Channel Gateway such as LG01/LG02? .......... 33

7. Trouble Shooting ............................................................................................. 34
7.1 Why I can’t join TTN in US915/AU915 bands? ............................................. 34
7.2 I see AT_ERROR when I type commands? .................................................... 34

8. Order Info ....................................................................................................... 35

9. Packing Info ................................................................................................... 35

10. Support .......................................................................................................... 35

11. Reference ....................................................................................................... 36
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.

**LGT-92 in a LoRaWAN Network**
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
  - 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

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Photo</th>
<th>Hardware Difference</th>
<th>Target Application</th>
</tr>
</thead>
</table>
| LGT-92-LI   | ![LGT-92-LI Photo](image) | --With Enclosure  
--With 1000mA li-on battery  
--Enable charge circuit  
--FPC internal LoRa Antenna  
--Can power by USB port | --Real time tracking  
--Short tracking period  
--Rechargeable |
| LGT-92-AA   | ![LGT-92-AA Photo](image) | --Without Enclosure  
--With (1.5v) AA type battery holder, no battery.  
--Disable charge circuit  
--Sticker LoRa Antenna  
--Can’t powered by USB port (to be fixed) | --Asset tracking  
--Long tracking period  
--Not rechargeable |
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 TTN LoRaWAN Network. Below is the network structure, we use LG308 as LoRaWAN gateway in this example.

LGT-92 in a LoRaWAN Network

The LG308 is already set to connect to TTN network. 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**

![TTN screen shot showing APP EUI](image)

**Add APP KEY and DEV EUI**

![TTN screen shot showing APP KEY and DEV EUI](image)
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)

<table>
<thead>
<tr>
<th>Size(bytes)</th>
<th>Value</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Alarm &amp; BAT</th>
<th>Roll</th>
<th>Pitch</th>
</tr>
</thead>
</table>

Alarm & BAT:

<table>
<thead>
<tr>
<th>Size(bit)</th>
<th>Value</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 bit</td>
<td>reserve</td>
<td>Alarm Indicate</td>
</tr>
<tr>
<td>1 bit</td>
<td>Alarm Indicate</td>
<td>BAT</td>
</tr>
</tbody>
</table>

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

Location info:

- Latitude: 06765f => if (0x06765f & 0x800000 = 0): value = 0x06765f /10000 = 42.3519
- Longitude: F2960a => if (0xF2960a & 0x800000 = 1):
  \[
  value = (0xf2960a - 0x 1000000)/10000 -87.9094
  \]

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 0xFFFFF, 0xFFFFF 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:

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

- Alarm: Ex1: 0x4B & 0x40 >> 6 = 0x01
- BAT: Ex1: 0x4B45 & 0x3FF => 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%

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 0xFFFFF.

- Roll: 0x04D2 = if (0x04D2 & 0x8000 = 0 ): value = 0x04D2 / 100 = +1234 ⇒ 12.34 degree
- Pitch: 0xFB2E =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

Add below code:

```javascript
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)
    {
```
value = 0xFFFF0000;
}
var roll = value/100; // roll, units: °
value = bytes[10] << 8 | bytes[11];
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];
if (bytes[0] & 0x80)
{
    value = 0xFFFF00000000;
}
if (bytes[3] & 0x80)
{
    value2 = 0xFFFF00000000;
}
if (value == 0xFFFF0000 && value2 == 0xFFFF0000)
{
    // 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:
2.4 Downlink Payload

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

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:

2.5 LED Status

See work flow
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>? : Help on <CMD>
AT+<CMD> : Run <CMD>
AT+<CMD>=<value> : Set the value
AT+<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: https://youtu.be/H-45v5-xl-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.
Step 5: The led on the ST-LINK adapter will now blinking, once see it blinks; release the reset button on the LGT-92.

Step 6: 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.
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](http://www2.keil.com/stmicroelectronics-stm32/mdk)
2. Download the keil:
3. Login with an account that has administration rights.
4. Right-click the µVision icon and select Run as Administrator... from the context menu.
5. Open the dialog File — License Management... and select the Single-User License tab.
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.
7: Enter the Product Serial Number 4PPFW-QBEHZ-M0D5M along with your contact information and click the button Submit. An e-mail is sent back with the License ID Code (LIC) within a few minutes.

(1)

(2)

(3)
8: To activate the Software Product, enter the LIC in the field **New License ID Code (LIC)** of the dialog **License Management**... and click **Add LIC**.

9: Finish
5.2.2 Install STM32L0 Series Device

1: **Open** the web: [http://www.keil.com/dd2/pack/eula-container](http://www.keil.com/dd2/pack/eula-container);

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

3: **Find** the Software Pack and **installs** it;

4: **Add** the Device, then you can **rebuild** the project.
Notice: If without add the Device, the keil would report this error.

5.2.3 Compile Source Code
1. Download the source code from Software Source Code Download Link.
2. Use Keil to open the project file:
   STM32CubeExpansion_LRWAN/Projects/Multi/Applications/LoRa/DRAGINO-LRWAN(AT)/MDK-ARM/STM32L072CZ-Nucleo/Lora.uvprojx
3. In Keil, you can see what frequency band the code support.
4. If you want to change frequency, modify the Preprocessor Symbols. For example, change EU868 to US915.

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:

<table>
<thead>
<tr>
<th>Version</th>
<th>LoRa IC</th>
<th>Working Frequency</th>
<th>Best Tune Frequency</th>
<th>Recommend Bands</th>
</tr>
</thead>
<tbody>
<tr>
<td>433</td>
<td>SX1278</td>
<td>Band2(LF): 410~525 Mhz</td>
<td>433Mhz</td>
<td>CN470/EU433</td>
</tr>
<tr>
<td>868</td>
<td>SX1276</td>
<td>Band1(HF): 862~1020 Mhz</td>
<td>868Mhz</td>
<td>EU868</td>
</tr>
</tbody>
</table>
6.4 How to change the LoRa Frequency Bands/Region?
User can follow the introduction for how to upgrade image. 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 <LoRa Library> and upload the LoRa _Receive_ 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 `<LoRa RAW code>` . 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:
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.

<table>
<thead>
<tr>
<th>CHE</th>
<th>US915 Uplink Channels(125KHz,4/5,Unit:MHz,CHS=0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>ENABLE Channel 0-63</td>
</tr>
<tr>
<td>1</td>
<td>902.3 902.5 902.7 902.9 903.1 903.3 903.5 903.7 Channel 0-7</td>
</tr>
<tr>
<td>2</td>
<td>903.9 904.1 904.3 904.5 904.7 904.9 905.1 905.3 Channel 8-15</td>
</tr>
<tr>
<td>3</td>
<td>905.5 905.7 905.9 906.1 906.3 906.5 906.7 906.9 Channel 16-23</td>
</tr>
<tr>
<td>4</td>
<td>907.1 907.3 907.5 907.7 907.9 908.1 908.3 908.5 Channel 24-31</td>
</tr>
<tr>
<td>5</td>
<td>908.7 908.9 909.1 909.3 909.5 909.7 909.9 910.1 Channel 32-39</td>
</tr>
<tr>
<td>6</td>
<td>910.3 910.5 910.7 910.9 911.1 911.3 911.5 911.7 Channel 40-47</td>
</tr>
<tr>
<td>7</td>
<td>911.9 912.1 912.3 912.5 912.7 912.9 913.1 913.3 Channel 48-55</td>
</tr>
<tr>
<td>8</td>
<td>913.5 913.7 913.9 914.1 914.3 914.5 914.7 914.9 Channel 56-63</td>
</tr>
<tr>
<td></td>
<td>Channels(500KHz,4/5,Unit:MHz,CHS=0)</td>
</tr>
<tr>
<td>903</td>
<td>904.6 906.2 907.8 909.4 911 912.6 914.2 Channel 64-71</td>
</tr>
</tbody>
</table>

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.

AU915 is similar. Below is the AU915 Uplink Channels.

<table>
<thead>
<tr>
<th>CHE</th>
<th>AU915 Uplink Channels(125KHz,4/5,Unit:MHz,CHS=0) ENABLE Channel 0-63</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>915.2 915.4 915.6 915.8 916 916.2 916.4 916.6 Channel 0-7</td>
</tr>
<tr>
<td>1</td>
<td>916.8 917 917.2 917.4 917.6 917.8 918 918.2 Channel 8-15</td>
</tr>
<tr>
<td>2</td>
<td>918.4 918.6 918.8 919 919.2 919.4 919.6 919.8 Channel 16-23</td>
</tr>
<tr>
<td>3</td>
<td>920 920.2 920.4 920.6 920.8 921 921.2 921.4 Channel 24-31</td>
</tr>
<tr>
<td>4</td>
<td>921.6 921.8 922 922.2 922.4 922.6 922.8 923 Channel 32-39</td>
</tr>
<tr>
<td>5</td>
<td>923.2 923.4 923.6 923.8 924 924.2 924.4 924.6 Channel 40-47</td>
</tr>
<tr>
<td>6</td>
<td>924.8 925 925.2 925.4 925.6 925.8 926 926.2 Channel 48-55</td>
</tr>
<tr>
<td>7</td>
<td>926.4 926.6 926.8 927 927.2 927.4 927.6 927.8 Channel 56-63</td>
</tr>
<tr>
<td>8</td>
<td>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</td>
</tr>
</tbody>
</table>

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

![USB Micro-B](image)

<table>
<thead>
<tr>
<th>Pin</th>
<th>Color</th>
<th>USB Pin</th>
<th>UART pin</th>
<th>ST-Link Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Red</td>
<td>VCC</td>
<td>N/A</td>
<td>+5V</td>
</tr>
<tr>
<td>2</td>
<td>White</td>
<td>D- (N/A)</td>
<td>LGT-RXD</td>
<td>SWDIO</td>
</tr>
<tr>
<td>3</td>
<td>Green</td>
<td>D+(N/A)</td>
<td>LGT-TXD</td>
<td>SWCLK</td>
</tr>
<tr>
<td>4</td>
<td>ID (N/A)</td>
<td>N/A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Black</td>
<td>GND</td>
<td>GND</td>
<td>GND</td>
</tr>
</tbody>
</table>
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: https://youtu.be/32eLnlYoLoI)

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

![TTN Application](image)

**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 [The Things Network CLI](https://ttnc.org/).

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

- **AT+FDR**  Reset Parameters to Factory Default, Keys Reserve
- **AT+NJM=0**  Set to ABP mode
- **AT+ADR=0**  Set the Adaptive Data Rate Off
- **AT+DR=5**  Set Data Rate (Set AT+DR=3 for 915 band)
- **AT+TDC=300000**  Set transmit interval to 5 minutes
- **AT+CHS=868400000**  Set transmit frequency to 868.4Mhz
- **AT+DADDR=26 01 1A F1**  Set Device Address to 26 01 1A F1
- **ATZ**  Reset MCU

As shown in below:
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 variants 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
- TTN Frequency Bands