LGT-92 LoRaWAN GPS Tracker User Manual

Document Version: 1.5.5

Image Version: v1.5.3

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<th>Version</th>
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<th>Date</th>
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<tr>
<td>1.0</td>
<td>Release</td>
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<td>Correct GPS payload format in TTN</td>
<td>2019-Jan-23</td>
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<td>Add more info for 8-Channel Mode Description</td>
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<td>Improve description of Alarm button and Downlink</td>
<td>2019-Jul-22</td>
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<td>Add v1.4 hardware changelog, add USB port functions.</td>
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<td>Date</td>
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<td>1.5.0</td>
<td>Firmware update to v1.5. Add related manual for v1.5. V1.5 firmware has a big change compare to previous one. Please read chapter 2 for detail.</td>
<td>2019-Nov-15</td>
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<td>Add hardware change v1.5. Firmware update to v1.5.3</td>
<td>2020-Jan-18</td>
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<td>1.5.5</td>
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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 based 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 and a 9-axis accelerometer for motion detection. The power for both of the GPS module 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 project**, 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**

LGT-92 LoRa GPS Tracker

LoRaWAN Gateway

LoRaWAN Server
1.2 Specifications

**Micro Controller:**
- STM32L072CZT6 MCU
- MCU: STM32L072CZT6
- Flash: 192KB
- RAM: 20KB
- EEPROM: 6KB
- Clock Speed: 32Mhz

**Common DC Characteristics:**
- Supply Voltage:
  - LGT92-LI: 5V via USB port or Internal li-on battery
  - LGT92-AA v1.3/v1.4: 2.84v ~ 3.6v via screw terminal.
- Operating Temperature: -40 ~ 85° C

**LoRa Spec:**
- Frequency Range,
  - Band 1 (HF): 862 ~ 1020 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
- Logistics and Supply Chain Management
- Human tracking

1.5 Hardware Changelog

LGT-92 v1.5
- GPS module change to L76-L
- Change USB trace so can recharge when power off

LGT-92 v1.4
- Connect GPS 1pps to STM32 PA4
- Change GPS antenna type to Active GPS
- Add Bead and filter capacitor in the GPS VCC
- Change LDO to ME6210A33PG to reduce the idle power consumption.

LGT-92 v1.3:
- Add C25,R1, used to support LGT-92-AA version.
## 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](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](image) | --Without Enclosure  
--With (1.5v) AA type battery holder, no battery.  
--Disable charge circuit  
--Sticker LoRa Antenna  
--Can’t powered by USB port for hardware version < 1.3 | --Asset tracking  
--Long tracking period  
--None-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.
The LG308 is already set to connect to TTN network. What the rest need to is register this device in 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:
Input these keys to their LoRaWAN Server portal. Below is TTN screen shot:

**Add APP EUI in the application**

![Add APP EUI in the application](image1)

**Add APP KEY and DEV EUI**

![Add APP KEY and DEV EUI](image2)
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 no matter if the power switch is on or off. For LGT-92-AA, the USB port is only used for debug or upload firmware, USB port can’t power the device.

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

For firmware v1.4:
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.

For firmware v1.5:
By default, the firmware v1.5 is set to movement detect mode (AT+MD=1). In this mode, if the tracker is static, it will uplink location info every 1 hour (KAT:Keep Alive Time); if the tracker move, it will uplink location info at every 5 minutes (TDC time), tracker will go to static mode if there is no movement for 5 minutes. Each uplink packet includes battery, alarm status & location info, if device fail to get location info, the location field (latitude and longitude) will be set to all 0x00.
2.3 Uplink Payload

The uplink payload here is for v1.5 version firmware. For v1.4 firmware version, please check the user manual: [v1.4 firmware user manual](#).

### 2.3.1 Payload Analyze

The default uplink payload includes totally 11 bytes. (User can use AT+SGM=0 to enable the motion sensor to roll/pitch info from accelerometer. When accelerometer info is enable, total payload will be 15 bytes, please note 15 bytes won’t work on DR0 on US915/AU915 frequency band.)

<table>
<thead>
<tr>
<th>Size(bytes)</th>
<th>4</th>
<th>4</th>
<th>2</th>
<th>1</th>
<th>2 (optional)</th>
<th>2 (optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>Latitude</td>
<td>Longitude</td>
<td>Alarm &amp; BAT</td>
<td>FLAG</td>
<td>Roll</td>
<td>Pitch</td>
</tr>
</tbody>
</table>

**Alarm & BAT:**

<table>
<thead>
<tr>
<th>Size(bit)</th>
<th>1 bit</th>
<th>1 bit</th>
<th>14 bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>reserve</td>
<td>Alarm Indicate</td>
<td>BAT</td>
</tr>
</tbody>
</table>

**FLAG:**

<table>
<thead>
<tr>
<th>Size(bit)</th>
<th>2 bits</th>
<th>1 bit</th>
<th>5 bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>MD</td>
<td>LON</td>
<td>Firmware version</td>
</tr>
</tbody>
</table>

Example: Payload: `0x02863D68 FAC29BAF 4B45 60 04D2 FB2E`
Location info:

- **Latitude:** 02863D68 ⇒ if (0x02863D68 & 0x80000000 = 0):
  
  \[ \text{value} = \frac{02863D68}{1000000} = 42.351976 \]

- **Longitude:** FAC29BAF ⇒ if (0xFAC29BAF & 0x80000000 = 1):
  
  \[ \text{value} = \left(\frac{0xFAC29BAF - 0x10000000}{1000000}\right) = -87.909457 \]

Important note:

a) When power is low (<2.84v), GPS won’t be able to get location info and GPS feature will be disabled and the location field will be filled with 0xFFFFFFF, 0xFFFFFFF.

b) In firmware version v1.5, Roll & Pitch is disabled by default.

c) When enable 9-axis motion sensor, the total payload will be 15 bytes, while US915/AU915 DR0 accept only 11 bytes payload. In this case, the payload on server will be ignore and shows as below:

![Image of payload information]

- **Alarm:** Example: 0x4B & 0x40 >> 6 = 0x01

- **BAT:** Example: 0x4B45 & 0x3FFF ⇒ 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%

- **MD:** Movement Detection mode:

  -- 0x00: Disable Movement detect feature, uplink interval is same as TDC time
-- 0x01: Enable movement detect mode. LGT92 will have a short uplink interval (TDC) when move and will have a long uplink interval (KAT: Keep Alive Time) when not move. This is the default states in firmware v1.5

-- 0x10: Set movement detection to collision detect, Same operation as 0x01 mode but it has a higher thread hold to enable enter the short uplink interval.

-- 0x11: Manual set the movement detection thread hold and frequency so can customized the movement detect thread hold. See AT Command manual.

✓ LON: Enable/Disable LED activity for uplink
   0x00: Disable LED indicator.
   0x01: Enable LED indicator (Default Value)

✓ 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

Add the decoder from this link:
LGT92-v1.5.0_decoder_20191128.txt

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>
<tr>
<td>Confirmed (Set AT+CONFIRM)</td>
<td>Any</td>
<td>05</td>
<td>2</td>
<td>Example: 0x0501: AT+CFM=1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0x0500: AT+CFM=0</td>
</tr>
<tr>
<td>Set AT+CHE</td>
<td>Any</td>
<td>07</td>
<td>2</td>
<td>Total bytes: 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Example: 0x0702: AT+CHE=2</td>
</tr>
<tr>
<td>AT+MD (Movment Detect)</td>
<td>Any</td>
<td>A5</td>
<td>2 or 4</td>
<td>Total bytes: 2 or 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Example: 0xA501: AT+MD=1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0xA5031904: AT+MD=3,25,04</td>
</tr>
<tr>
<td>AT+KAT (Keep Alive Time)</td>
<td>Any</td>
<td>A9</td>
<td>4</td>
<td>Example: 0xA9000258:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Set AT+KAT=0x258=600S</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:

![Downlink Payload Setting in TTN](image)

2.5  LED Status

1) Power on: Green LED on for two seconds.

<table>
<thead>
<tr>
<th>Event</th>
<th>Action</th>
<th>AT+LON to control on/off</th>
<th>AT+MLON to control on/off</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power On</td>
<td>GREEN led on 2 seconds</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Join request</td>
<td>BLUE led fast blink once (200ms)</td>
<td>Yes</td>
<td>N/A</td>
</tr>
<tr>
<td>Join Success</td>
<td>Purple led on 1 second</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Fixing Location</td>
<td>GREEN blinks 200ms per second</td>
<td>Yes</td>
<td>N/A</td>
</tr>
</tbody>
</table>
### 2.6 Button Function

**RESET button:**

Press this button will reboot the device.

**RED button:**

[See work flow](#)

When keep pressing the Alarm button for more than 3 seconds, the tracker will immediately send an empty uplink packet (lat/lon will be all 0x00 in this very first packet to save GPS positioning time) then send a second packet with GPS fix info. After that, the device will send 60 packets with 1 minute interval. The Alarm flag in the payload will be set for the next 60 packets unless use downlink to exit the Alarm mode.

### 2.7 USB Port Function

The USB interface of LGT-92 has below functions:

- Power on the device
- Recharge the LGT-92 battery
- Access UART console of LGT-92
- Upgrade the firmware of LGT-92

### 2.8 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:
Join successful

Join Accept:
DevAddr: 01 20 50
NtxDr00ffset: 0
Rx2B0tRate: 0
ReceiveDelay: 10000 ms
ReceiveDelay: 70000 ms
Roll: -0.0
Pitch: -0.0
South: 22.706657
East: 144.241516

Uplink

ADR Message:
B0tRate 0 change to 3
TxPower 0 change to 1
At sky change to 1

No motion in 5 minutes

 MPU9250 Interrupt

Fix Time: 0 s
Fix Time: 30 s
Fix Time (FINE): 150 s
Fix Time (FINE): 150 s
Roll: 0.77
Pitch: -0.01
South: 22.706054
East: 144.240005

TDC timeout
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 data 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](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

![Keil MDK Installation](image)

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.

![Keil License Management](image)

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-Q8EHZ-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: https://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 How can I tell the firmware version on LGT92?

There are different ways to check the firmware version of LGT92

1. Analyze the uplink payload, try to put payload decoder for v1.4 and v1.5, see which one has a reasonable decode.
2. Use the USB to TTL to access LGT92 and reset the device. The output info will shows the firmware version.
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:

```
LoRa Receiver
Received packet 'Hello,LoRa shield' with RSSI -32
Received packet 'Hello,LoRa shield' with RSSI -32
Received packet 'Hello,LoRa shield' with RSSI -32
```

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</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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</td>
</tr>
<tr>
<td></td>
<td>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)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>ENABLE Channel 0-63</td>
</tr>
<tr>
<td>1</td>
<td>915.2 915.4 915.6 915.8 916 916.2 916.4 916.6</td>
</tr>
<tr>
<td>2</td>
<td>Channel 0-7</td>
</tr>
<tr>
<td>3</td>
<td>916.8 917 917.2 917.4 917.6 917.8 918 918.2</td>
</tr>
<tr>
<td>4</td>
<td>Channel 8-15</td>
</tr>
<tr>
<td>5</td>
<td>918.4 918.6 918.8 919 919.2 919.4 919.6 919.8</td>
</tr>
<tr>
<td>6</td>
<td>Channel 16-23</td>
</tr>
<tr>
<td>7</td>
<td>920 920.2 920.4 920.6 920.8 921 921.2 921.4</td>
</tr>
<tr>
<td>8</td>
<td>Channel 24-31</td>
</tr>
<tr>
<td>9</td>
<td>921.6 921.8 922 922.2 922.4 922.6 922.8 923</td>
</tr>
<tr>
<td>10</td>
<td>Channel 32-39</td>
</tr>
<tr>
<td>11</td>
<td>923.2 923.4 923.6 923.8 924 924.2 924.4 924.6</td>
</tr>
<tr>
<td>12</td>
<td>Channel 40-47</td>
</tr>
<tr>
<td>13</td>
<td>924.8 925 925.2 925.4 925.6 925.8 926 926.2</td>
</tr>
<tr>
<td>14</td>
<td>Channel 48-55</td>
</tr>
<tr>
<td>15</td>
<td>926.4 926.6 926.8 927 927.2 927.4 927.6 927.8</td>
</tr>
<tr>
<td>16</td>
<td>Channel 56-63</td>
</tr>
<tr>
<td>17</td>
<td>915.9 917.5 919.1 920.7 922.3 923.9 925.5 927.1</td>
</tr>
<tr>
<td>18</td>
<td>Channel 64-71</td>
</tr>
<tr>
<td>19</td>
<td>Channels (500KHz, 4/5, Unit: MHz, CHS=0)</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></td>
<td>ID (N/A)</td>
<td>N/A</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.

![T TN Application Configuration](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.

**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+ADDR=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.

7.3 Why I am getting Empty payload?
The LGT-92 payload if include motion sensor will have 15 bytes, according to the LoRaWAN protocol. The LoRaWAN server will discard this payload on DR0 in AU915/US915 bands. So each packet sent in DR0 will be seen as empty payload

User can set the payload to 8 bytes by use the AT Command AT+SGM=1 to disable motion sensor.
7.4 I can’t upload firmware via my ST-Link v2. ?

Make sure you follow exactly the steps and double check wire connection as per [how to upgrade firmware](#).

Note:
1) There are different version ST-Link v2. The white one as below is the most stable and recommended one.
2) The white version ST-Link v2 such as below photo has different hardware version. The original one doesn’t have 3.3v on pin 1/2 and the clone one has 3.3v on pin 1/2. User has to short pin19 (VDD 3.3v) and pin 1/2 (TVCC) for the original one so pin 1/2 has 3.3v power. Otherwise, the original one will have problem to upload firmware to LHT65.
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