LGT-92 LoRaWAN GPS Tracker User Manual

Document Version: 1.6.5

Image Version: v1.6.5

Version	Description	Date
1.0	Release	2018-Dec-12
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 Add Software/hardware change log Change Payload to add Alarm flag	2019-May-11
1.4.1	Correct payload format More description on the Payload	2019-May-14
1.4.2	FAQ:AT_ERROR, Battery Percentage info, FAQ for battery lift time, Video instruction for single channel mode.	2019-Jun-17
1.4.3	Improve description of Alarm button and Downlink ,	2019-Jul-22
1.4.4	Add v1.4 hardware changelog, add USB port functions.	

	Change power voltage. Add trouble shooting for empty payload.	
1.5.0	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.	2019-Nov-15
1.5.1	Add work flow for v1.5 , LED status.	2019-Nov-28
1.5.2	Fix work flow error. Add new downlink payload in 1.5	2019-Nov-29
1.5.3	Modify description of Alarm Button	2019-Dec-12
1.5.4	Add hardware change v1.5. Firmware update to v1.5.3	2020-Jan-18
1.5.5	Add trouble shooting for upload firmware fail	2020-Feb-01
1.6.4	Add Mydevice Support, update to firmware 1.6.4	2021-Jan-15
1.6.5	Modify LED boot status	2021-Mar-29

LGT-92 LoRaWAN GPS Tracker User Manual

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 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
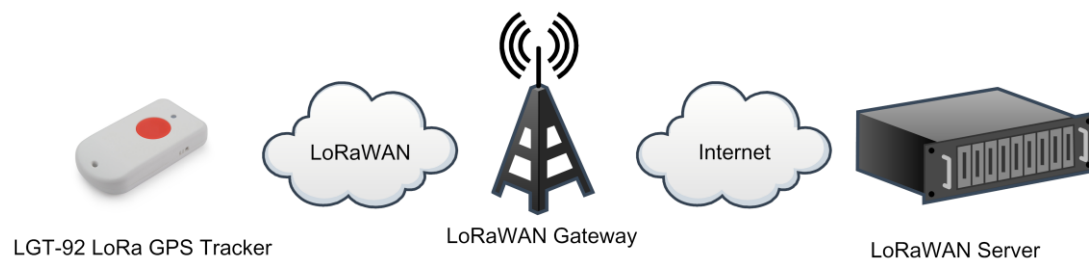
1.2   Specifications

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.

DRAGINO

1.6   Variants

Part Number	Photo	Hardware Difference	Target Application
LGT-92-LI		--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		--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.
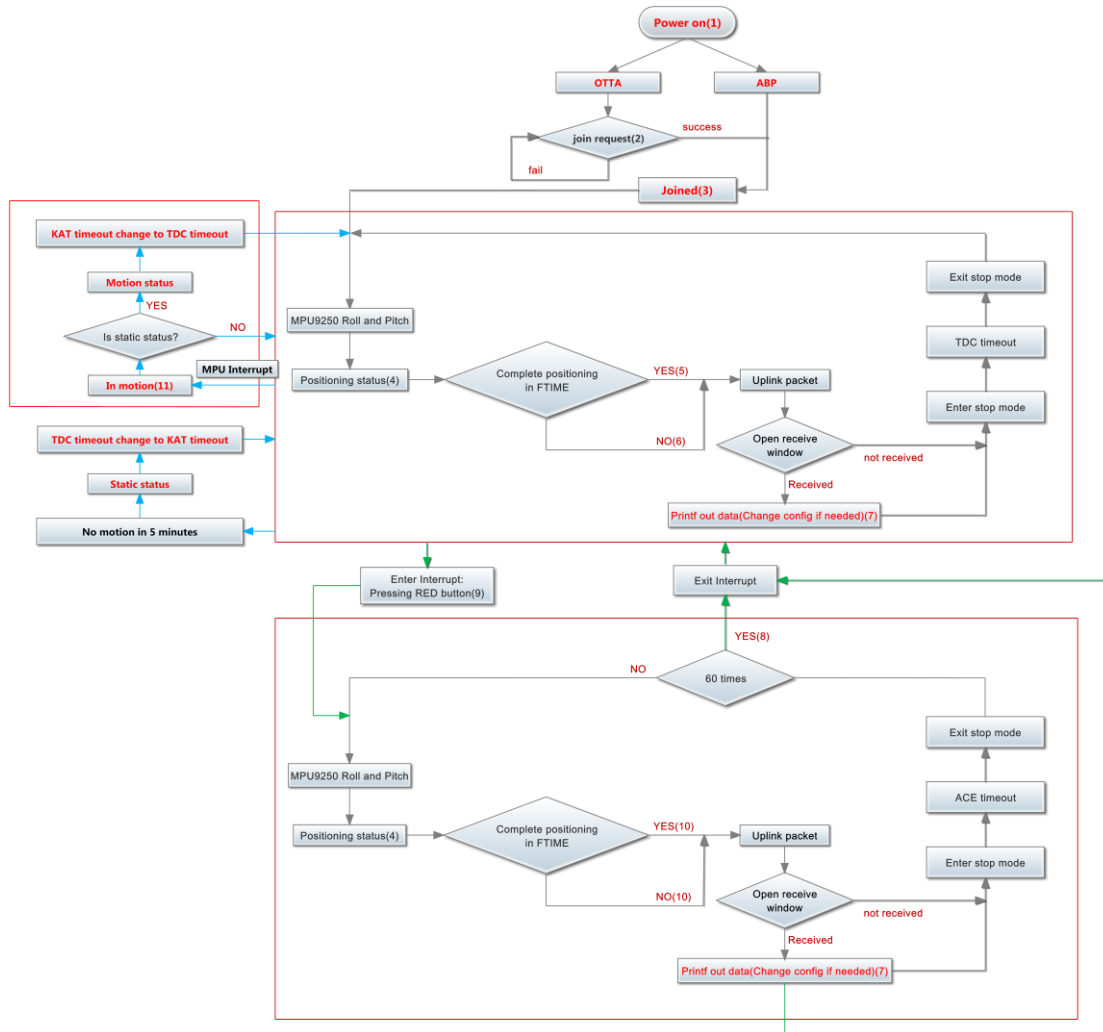
In case user can't set the OTAA keys in the LoRaWAN OTAA server and has to use the keys from the server. User can use AT Command to set the keys in LGT-92.

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.

LGT-92 in a LoRaWAN Network

The LG308 is already set to connect to TTN network . What the rest need to is register this device in TTN:
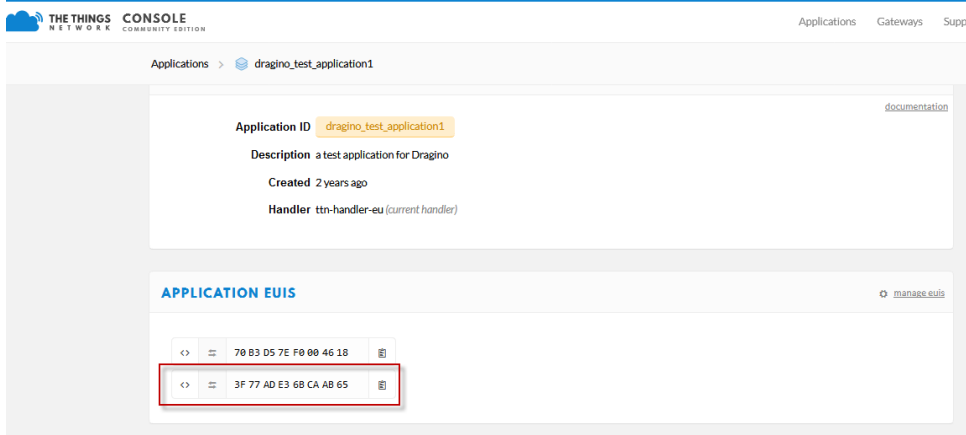
Step 1: Create a device in TTN with the OTAA keys from LGT-92.

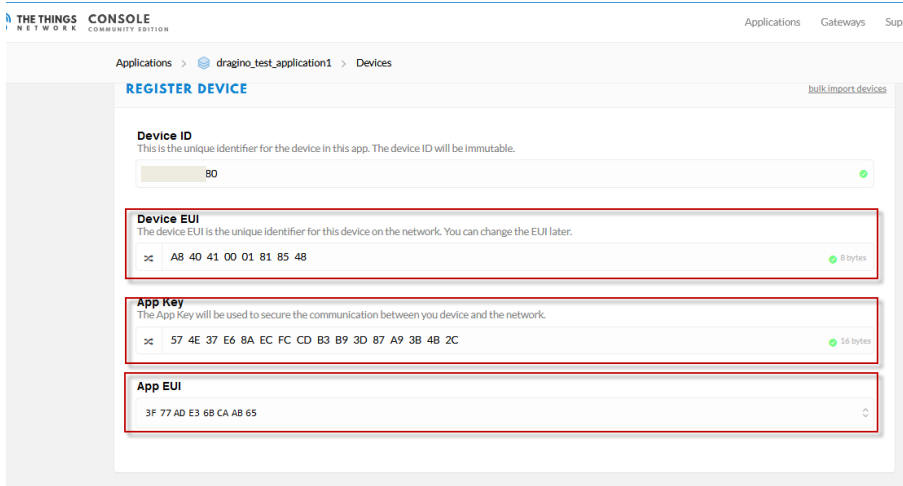Each LGT-92 is shipped with a sticker with the default device EUI as below:

Input these keys to their LoRaWAN Server portal. Below is TTN screen shot:

Add APP EUI in the application

Add APP KEY and DEV EUI

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.
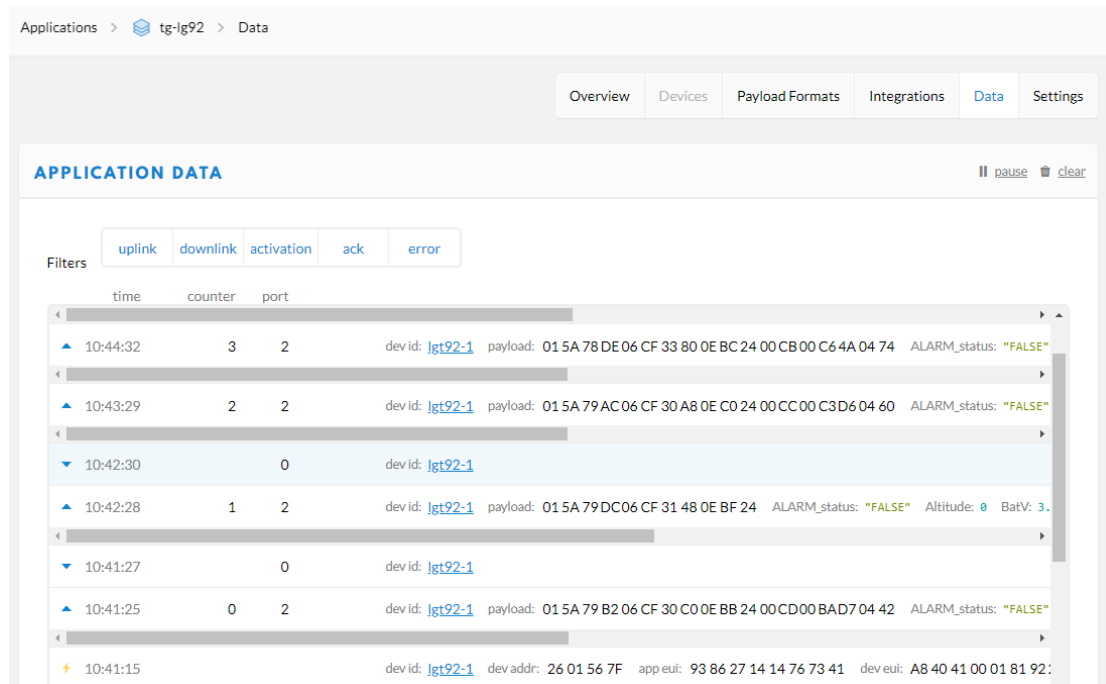
2.3 Uplink Payload

The uplink payload here is for v1.6.4 version firmware. For v1.4/1.5 firmware version, please check the user manual: v1.4 firmware user manual, v1.5 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 18 bytes, please note 18 bytes won't work on DR0 on US915/AU915 frequency band.)

Size (bytes)	4	4	2	1	2 (optional)	2 (optional)	1 (optional)	2 (optional)
Value	Latitude	Longitude	Alarm & BAT	FLAG	Roll	Pitch	HDOP	Altitude

Alarm & BAT:

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

FLAG:

Size(bit)	2 bits	1bit	5 bits
Value	MD	LON	Firmware version

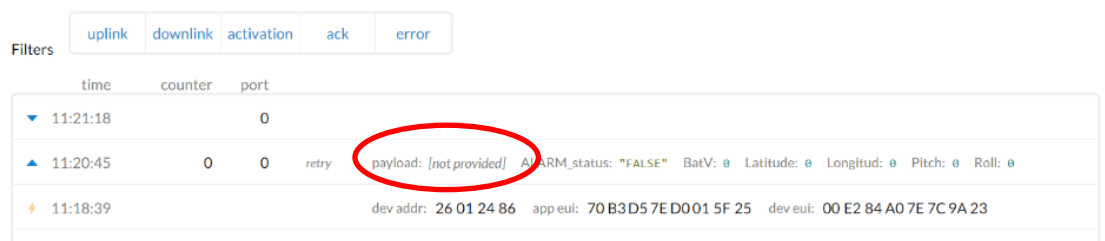**Example: Payload: 0x02863D68 FAC29BAF 4B45 60 04D2 FB2E**

Location info:

✓   Latitude: 02863D68⇒ *if (0x02863D68& 0x80000000 = 0):*

value = 02863D68 /1000000 = 42.351976

✓   Longitude: FAC29BAF ⇒ *if (0xFAC29BAF & 0x80000000 = 1):*

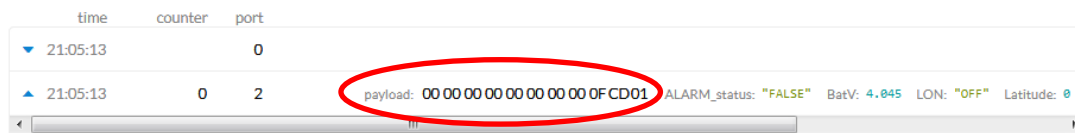*value = (0xFAC29BAF – 0x 100000000)/1000000 =-87.909457*

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 0x0FFFFFFF, 0x0FFFFFFF.

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:

d)   While GPS can't get location info after timeout(FTIME Parameter), the latitude and longitude will be filled with all 0x00:

✓   **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
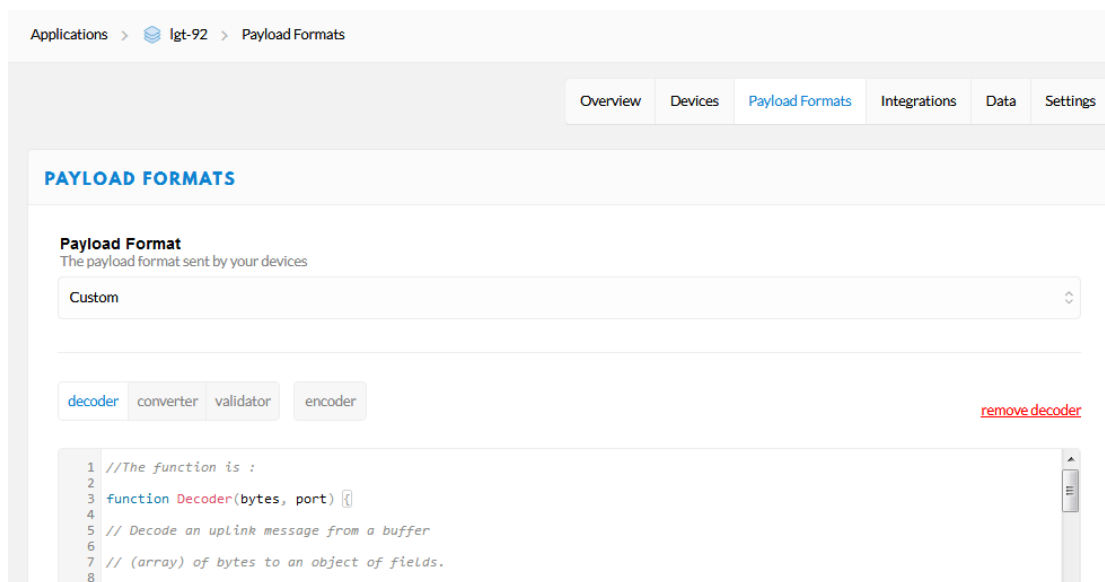
✓ *Altitude:* 0780: value = 0x 0780 / 100 =19.2m;

✓ *HDOP:* AB =if(bytes[15] > 0): value =0xAB/100=1.71;

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:

http://www.dragino.com/downloads/index.php?dir=LGT_92/Decoder/

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

◄ | ▬ | ►

▲ 20:54:17   ×   ×   *historical*   payload: 01 5A 78 DA 06 CF 34 A8 0F D7 01   ALARM_status: "FALSE"   BatV: 4.055   LON: "OFF"   Latitude: 22.

◄ | ►

01 5A 77 F0 06 CF 34 E8 0F CD 01   ALARM_status: "FALSE"   BatV: 4.045   LON: "OFF"   Latitude: 22.70616   Longitud: 114.242792   MD: "Disable"   Pitch: 0   Roll: 0

◄ | ▬ | ►

▲ 20:43:48   ×   ×   *historical*   payload: 01 5A 75 2A 06 CF 37 D0 0F CD 01   ALARM_status: "FALSE"   BatV: 4.045   LON: "OFF"   Latitude: 22.

◄ | ▬ | ►

2.4 Configure LGT92 via AT or Downlink

User can configure LGT92 via AT Commands or LoRaWAN Downlink Commands

There are two kinds of Commands:

✓   **Common Commands**: They should be available for each sensor, such as: change uplink interval, reset device. For firmware v1.6.4, user can find what common commands it supports:

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

✓   **Sensor Related Commands**: These commands are special designed for LGT92.   User can see these commands in this user manual.

2.4.1 Sensor related commands:

Set Transmit Interval

Set device uplink interval.

➢   AT Command:

AT+TDC=N

Example: AT+TDC=30000. Means set interval to 30 seconds

➢   Downlink Payload (prefix 0x01):

0x01 aa bb cc   // Same as AT+TDC=0x(aa bb cc)

Set Alarm Packet transmission interval

Set alarm packet transmit interval

➢   AT Command:

AT+ACE=xx.

  Example: AT+ACE=60000   → Set Alarm Packet Interval to 60 seconds. LGT92 will send
        every 60 seconds in Alarm mode, Default Value: 60000

➢   Downlink Payload (prefix 0xB1):

0xB1 00 00 3C   //Same as AT+ACE=60000

Exit Alarm

Server send downlink command to exit Alarm mode

➢   AT Command:

No AT Command

➢   Downlink Payload (prefix 0x02):

0x02 01   // Exit Alarm Mode

Set keep alive time data transmission interval

Set Keep Alive Time (in ms)

➢ AT Command:

AT+KAT=xx.

Example: AT+KAT=600000 → Set KAT to 600 seconds.

➢ Downlink Payload (prefix 0xA9):

0xA9 00 02 58   //Same as AT+KAT=600000

Disable/Enable LED flash

Disable/Enable LED flash for position, downlink and uplink

➢ AT Command:

AT+LON=xx.   (Disable (0), Enable (1), default:1)

Example: AT+LON=0 → Disable LED for position, downlink and uplink.

➢ Downlink Payload (prefix 0xAE):

0xAE 00   //Same as AT+LON=0

Disable/Enable LED status for movement detect (Debug Only)

User can use this feature to check and set thread hole of movement detect

➢ AT Command:

AT+MLON=xx.   (Disable (0), Enable (1), default:0)

Example: AT+MLON=1 → Enable LED flash while detect movement.

➢ Downlink Payload (prefix 0xAF):

0xAF 01   //Same as AT+MLON=1

Movement Detect Mode

Set movement detect mode

➢ AT Command:

AT+MD=xx.   (0:Disable,1:Move,2:Collide,3:Customized)

Example:

AT+MD=0   → Disable movement detect

AT+MD=1   → Detect on move

AT+MD=2   → Detect on collide。

AT+MD=3,200,11   → Set to customized mode with threshold 200 and ODR 100,
    threshold and ODR must < 255, Adjust these two values will have different sensitivity
    for motion detect

Threshold: Motion Interrupt sensitivity.

This register holds the threshold value for the Wake on Motion Interrupt for accel x/y/z axes. LSB = 4mg. Range is 0mg to 1020mg

ODR(output data rate): Motion sensor output data rate.

For MD=1, device will use threshold 0x0C and ODR: 0x02, equal to AT+MD=3,12,2

➢ Downlink Payload (prefix 0xA5):

0xA5 01   // Same as AT+MD=1

0xA5 03 19 04   //Same as AT+MD=3,25,04

Enable/Disable motion sensor and HDOP/Altitude

Include/exclude motion sensor value in payload

➢ AT Command:

AT+SGM=0 or 1   (0: Enable, 1 Disable)

  Example: AT+SGM=0   → Add HDOP/Altitude/Pitch/roll in payload.

If motion sensor disable: total payload become 11 bytes

If motion sensor enable: total payload become 18 bytes

➢ Downlink Payload (prefix 0xB0):

0xB0 01   //Set AT+SGM=1

Set MAX GPS position time

Set max positioning time, default is 150 seconds. LGT92 will try to get location info within this period. If fail in this time, LGT92 will use 000000 for latitude and longitude.

If AT+FTIME=0. The GPS module will be always powered and positioning. This will highly increase the power consumption (up to 50mA). When AT+FTIME=0, it will improve fix accuracy and shorten the acquire time for next uplink.

➢ AT Command:

AT+FTIME=xx   → Set to use xx as max fix time.

Example: AT+FTIME=150

➢ Downlink Payload (prefix 0xAA):

0xAA 00 96   //Set AT+FTIME =150

Set PDOP value for GPS fix accuracy

PDOP(Position Dilution of Precision) filter, LGT92 will only accept GPS data with a lower PDOP value than pre-configure PDOP value. If device can't get a valid GPS packet within FTIME timeout, it will use the GPS data with lowest PDOP value to server.

A GPS packet with lower PDOP has higher accuracy. PDOP default value is 3.0

➢   AT Command:
AT+PDOP=2.5   → Set PDOP to 2.5

➢   Downlink Payload (prefix 0xAD):
0xAD 00 0A   //Set AT+PDOP =1   (0x0A / 10 =1)
0xAD 00 16   //Set AT+PDOP =2.5   (0x16 / 10 =1)

Set GPS navigation mode

Set navigation mode. (L70-RL doesn't support option 5，L76-L support all)

➢   AT Command:
AT+NMEA886=0   default
AT+NMEA886=1   Normal mode: For general purpose
AT+NMEA886=2   Fitness mode: For running and walking purpose that the low-speed (<5m/s) movement will have more effect on the position calculation.
AT+NMEA886=3   Aviation mode: For high-dynamic purpose that the large-acceleration movement will have more effect on the position calculation.
AT+NMEA886=4   Balloon mode: For high-altitude balloon purpose that the vertical movement will have more effect on the position calculation.
AT+NMEA886=5   Stationary mode: For stationary applications that zero dynamics is Assumed

➢   Downlink Payload (prefix 0xAB):
0xAB 01   //Set AT+NMEA886=1

Set GPS search mode

Set search mode. (for L76-L only)

➢   AT Command:
NMEA353:
0:GPS module factory default value
1:GPS+GLONASS
2:GPS+BeiDou
3:GPS+Galileo

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4:GPS+GLONASS+Galileo

➢ Downlink Payload (prefix 0xAC):

0xAC 01   //Set AT+ NMEA353=1

2.5   Integrate with Mydevice

Mydevices provides a human friendly interface to show the sensor data, once we have data in TTN, we can use Mydevices to connect to TTN and see the data in Mydevices. Below are the steps:

Step 1: Be sure that your device is programmed and properly connected to the network at this time.
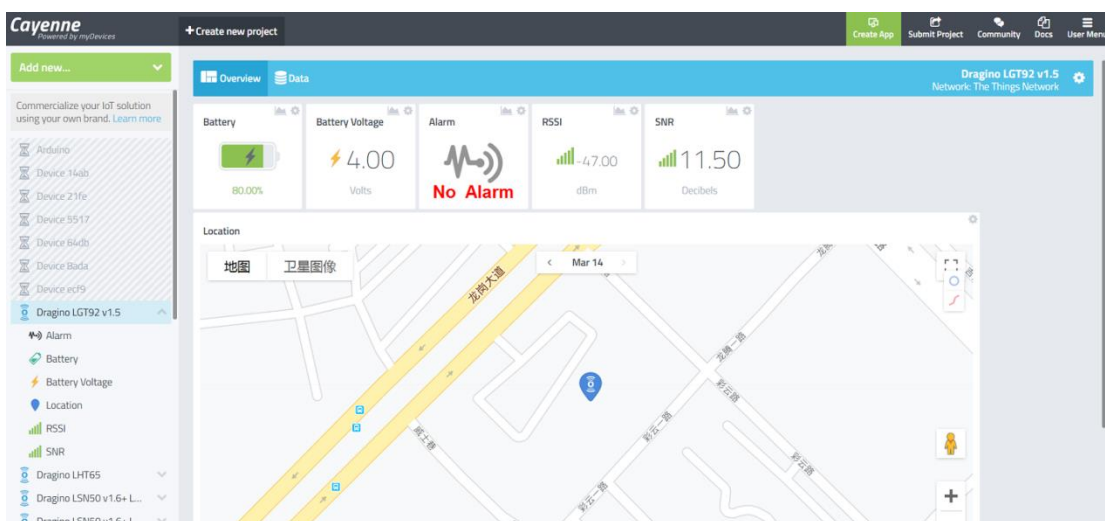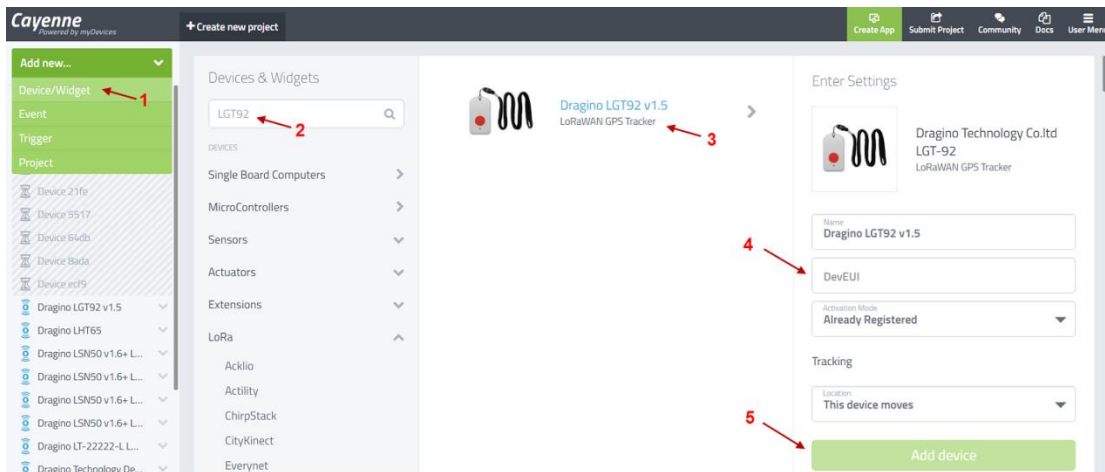
Step 2: To configure the Application to forward data to Mydevices you will need to add integration. To add the Mydevices integration, perform the following steps:
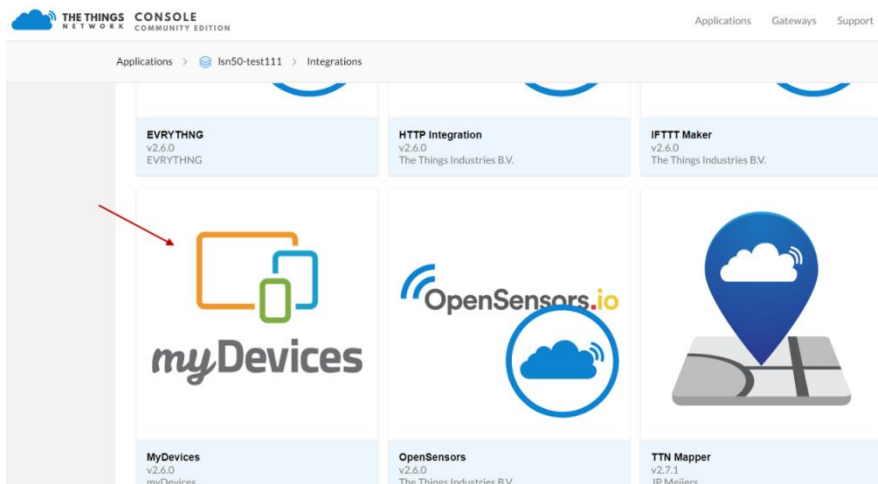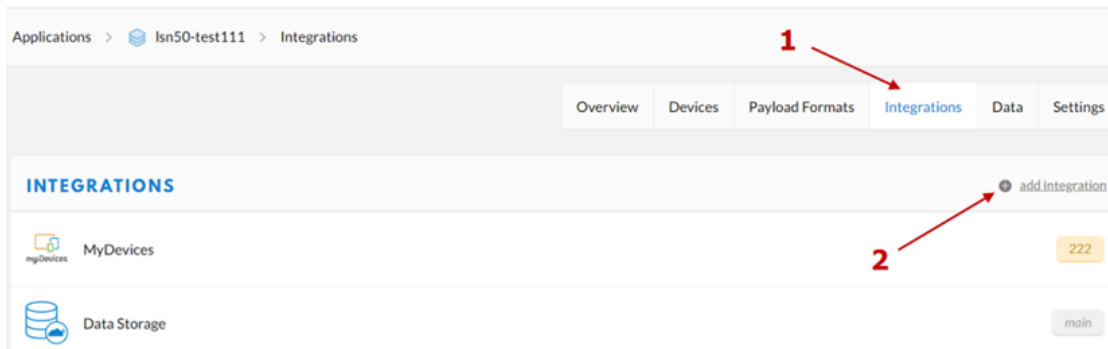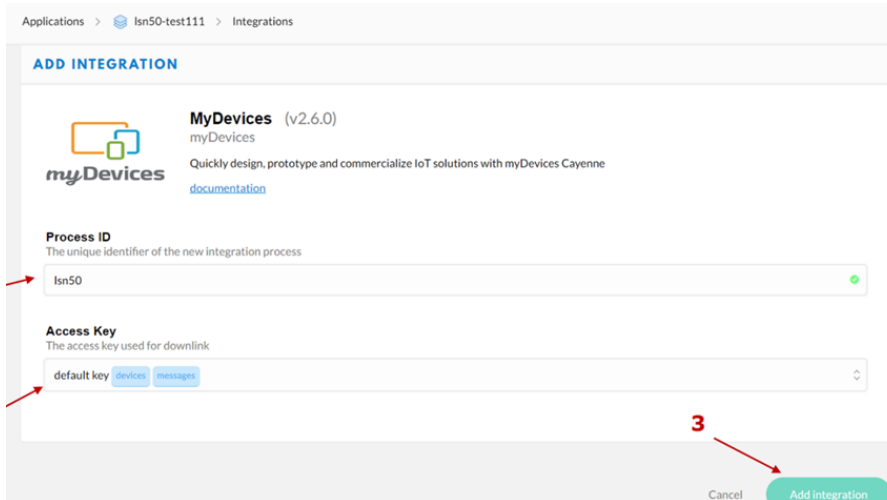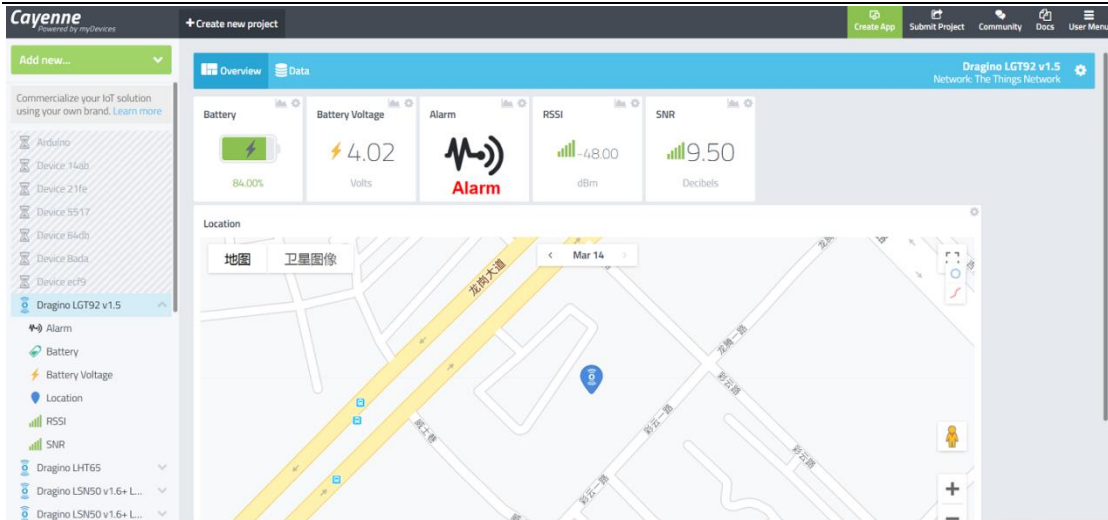
Step 3: Create an account or log in Mydevices.

Step 4: Search LGT92-v1.5 and add DevEUI.

2.6 LED Status

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

Event	Action	AT+LON to control on/off	AT+MLON to control on/off
Power On	BLUE, RED , Green flash once	N/A	N/A
Join request	BLUE led fast blink once (200ms)	Yes	N/A
Join Success	Purple led on 1 second	N/A	N/A
Fixing Location	GREEN blinks 200ms per second	Yes	N/A
Fixed and uplink	BLUE blinks twice (200ms per blink)	Yes	N/A
Fail Fix and uplink	RED blinks twice (200ms per blink)	Yes	N/A
Enter Alarm mode	RED on five seconds	N/A	N/A
Uplink under Alarm	RED on one second	Yes	N/A
Exit Alarm	BLUE on one second	Yes	N/A
Downlink Modify TDC	GREEN led on 1 second	Yes	N/A
Movement Detect	RED on 500ms	N/A	Yes

2.7 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.

In Alarm mode, use can use downlink command to exit Alarm or fast press 5 times the Alarm button, after fast press 5 times the alarm button, green LED will be on for 5 seconds which mean exit Alarm mode. And Alarm flag will be set to false.

2.8   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

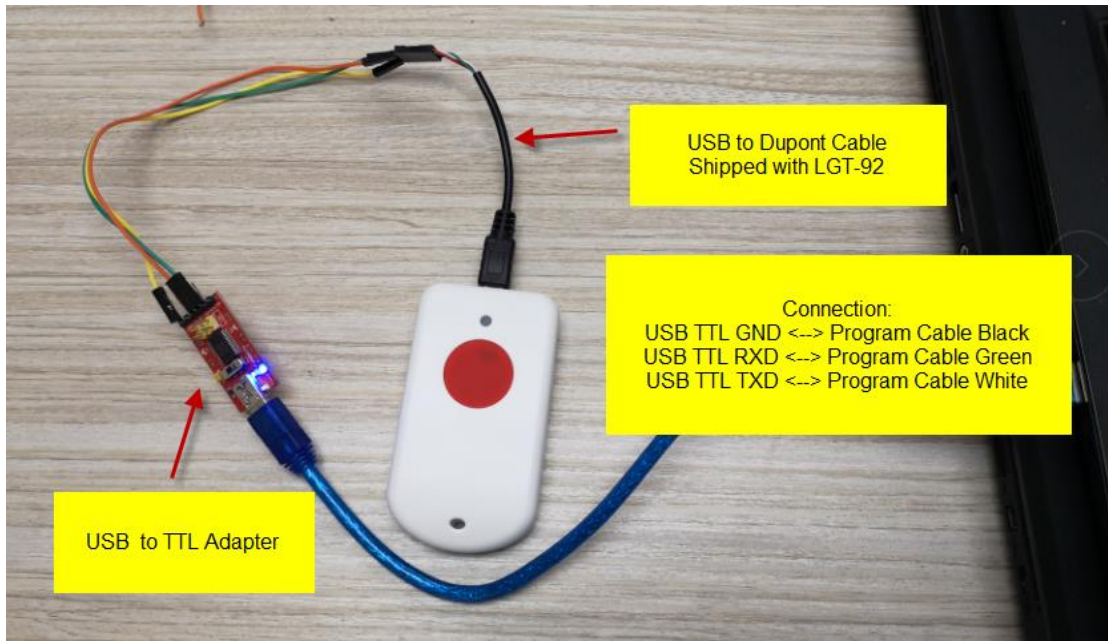✓   Upgrade the firmware of LGT-92

## 2.9   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:
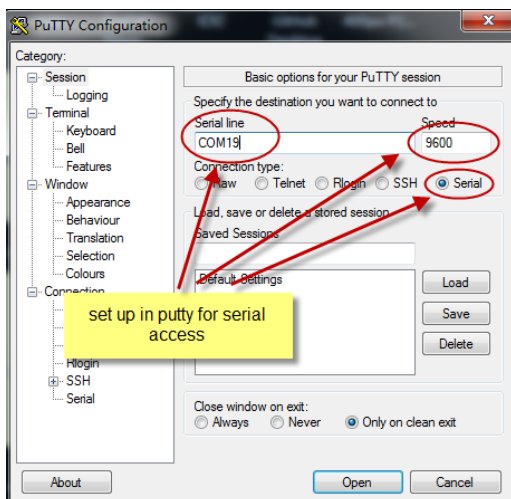
```
LGT-92 Device
Image Version: v1.5.0
LoRaWan Stack: DR-LWS-001
Frequency Band: EU868
DevEui= 00 03 A4 0D 79 E9 5D 2A

[2085]***** UpLinkCounter= 0 *****
[2485]TX on freq 868300000 Hz at DR 5
[2551]txDone
[7541]RX on freq 868300000 Hz at DR 5
[7628]rxDone
rssi= -48
JOINED    ──────────────▶  Join successful

Join Accept:
DevAddr:26 01 28 5b
Rx1DrOffset:0
Rx2Datarate:3
ReceiveDelay1:1000 ms
ReceiveDelay2:2000 ms

Roll=0.80  Pitch=3.98
South: 22.706657
East: 114.241516

[20765]***** UpLinkCounter= 0 *****
[21165]TX on freq 867500000 Hz at DR 0
Update Interval: 300000 ms
[22652]txDone                              ──────▶  Uplink
[23682]RX on freq 867500000 Hz at DR 0
[23882]rxTimeOut
[24647]RX on freq 869525000 Hz at DR 3

ADR Message:
Datarate 0 change to 3
TxPower 0 change to 1     ──────────▶  ADR
NbRep 1 change to 1

[24823]rxDone
rssi= -37
```

```
In Motion
In Motion
In Motion     ──────▶  MPU9250 Interrupt
In Motion
In Motion

Roll=0.77  Pitch=4.01
South: 22.706364
East: 114.242035

[332669]***** UpLinkCounter= 1 *****
[333069]TX on freq 867700000 Hz at DR 3
Update Interval: 300000 ms
[333279]txDone
[334274]RX on freq 867700000 Hz at DR 3
[334314]rxTimeOut
[335274]RX on freq 869525000 Hz at DR 3
[335314]rxTimeOut
Enter static mode   ──────▶  No motion in 5 minutes

OK
In Motion
Exit static mode    ──────▶  static status change to motion

Fix Time:3 s
Fix Timeout (FTIME):150 s

Fix Time:33 s
Fix Timeout (FTIME):150 s    ──────▶  positioning status

Fix Time:63 s
Fix Timeout (FTIME):150 s

Roll=0.75  Pitch=4.00
South: 22.706261
East: 114.242523

[512500]***** UpLinkCounter= 2 *****
[512900]TX on freq 867100000 Hz at DR 3
Update Interval: 300000 ms   ──────▶  TDC timeout
[513130]txDone
[514125]RX on freq 867100000 Hz at DR 3
```

Below are the available commands, a more detail AT Command manual can be found at <u>AT Command Manual</u>

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

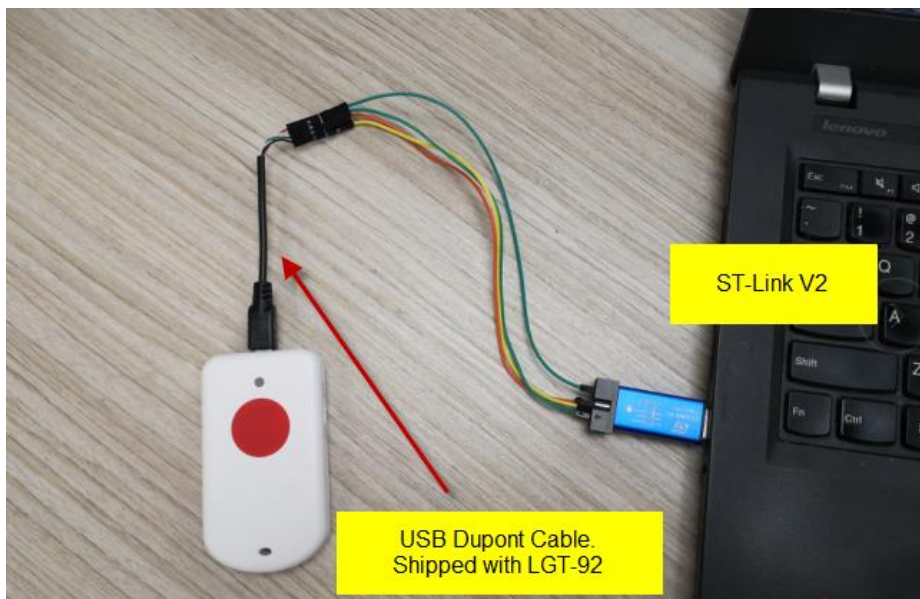AT+NJM=0

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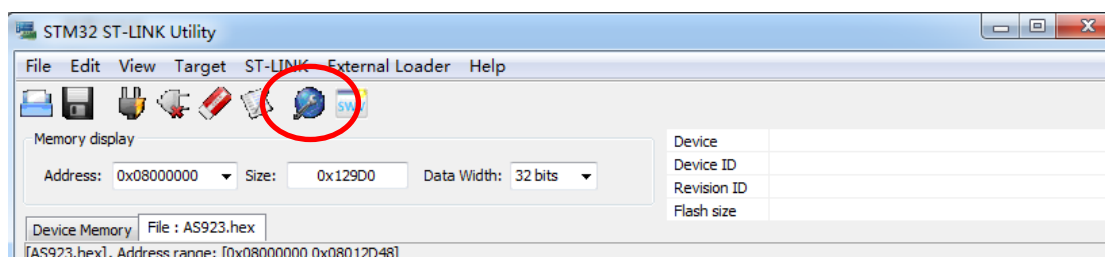
Step5: The led on the ST-LINK adapter will now blinking, once see it blinks; release the reset button on the LGT-92.

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.
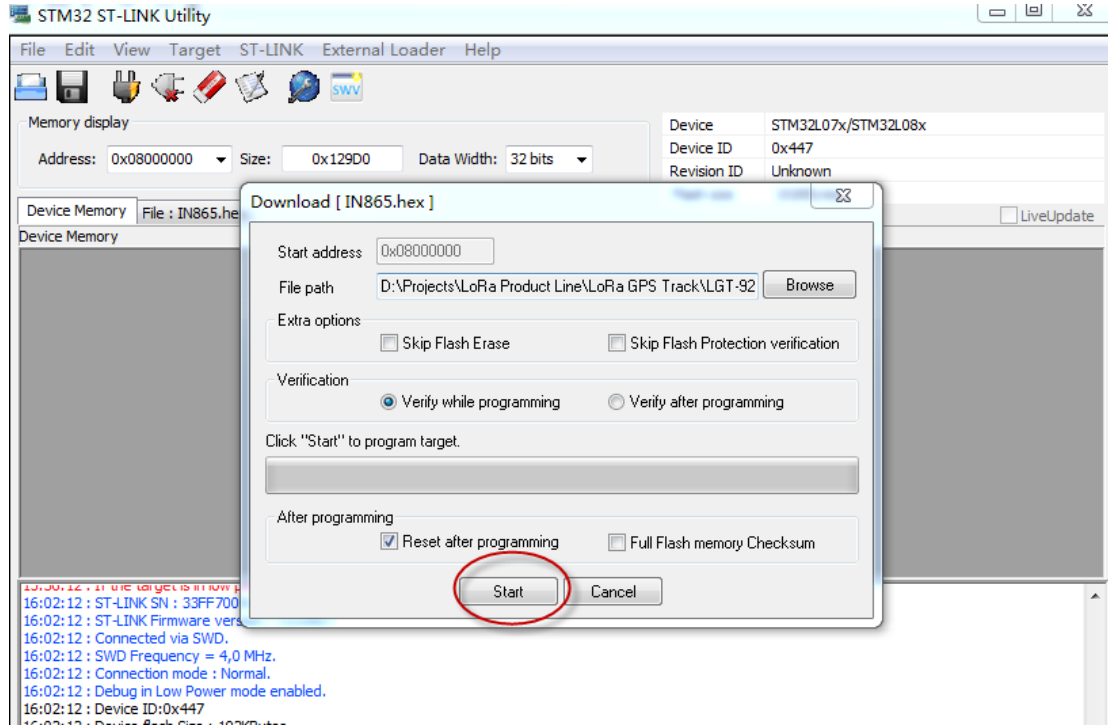
5.   Developer Guide

5.1   Source Code

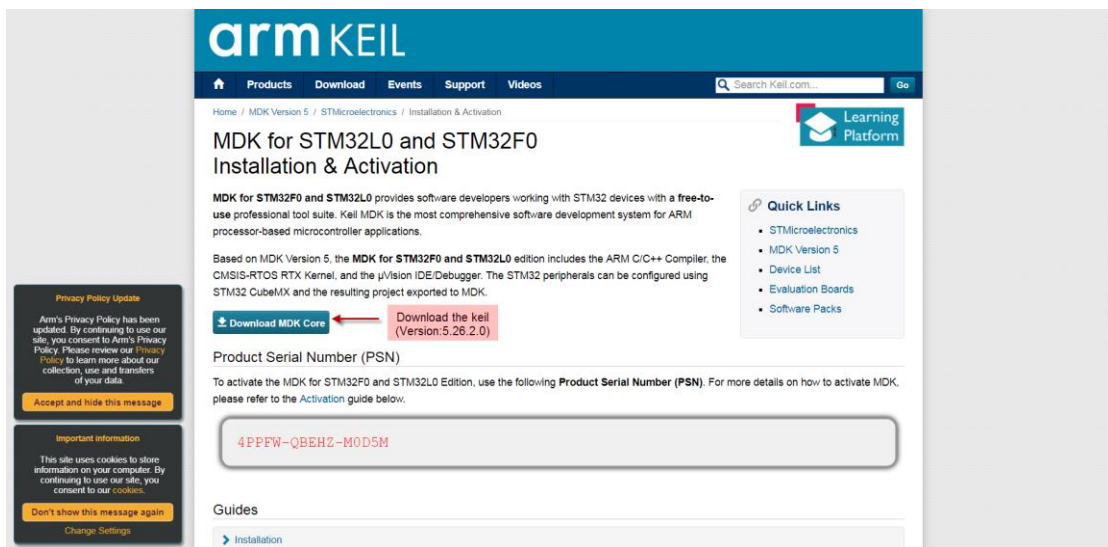Software Source Code Download Link.

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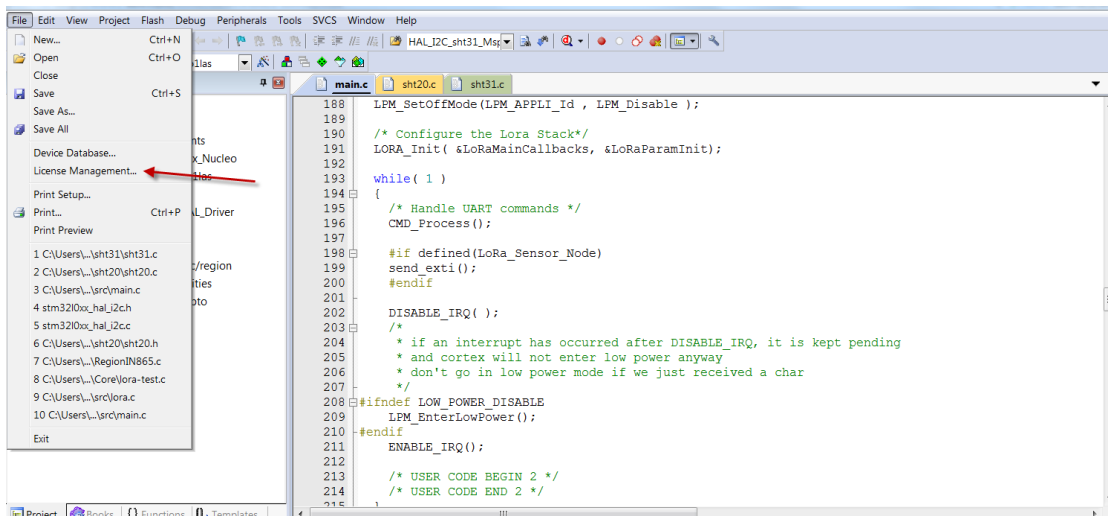
1: Open the **web**: http://www2.keil.com/stmicroelectronics-stm32/mdk

2: Download the **keil**:

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**.
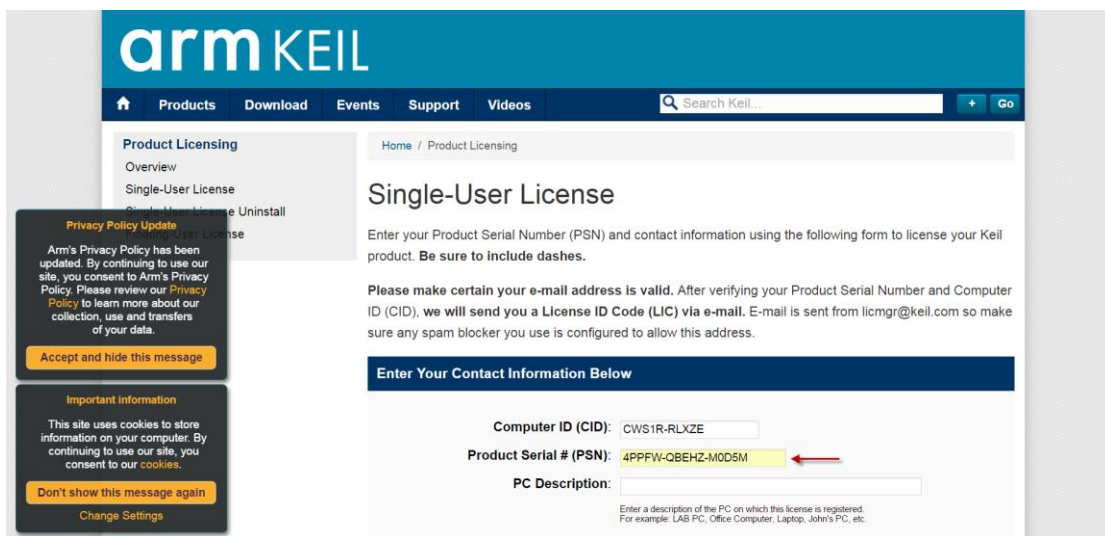

6: Click the button **Get LIC via Internet...**, then click the button **OK** to register the product. This action opens the

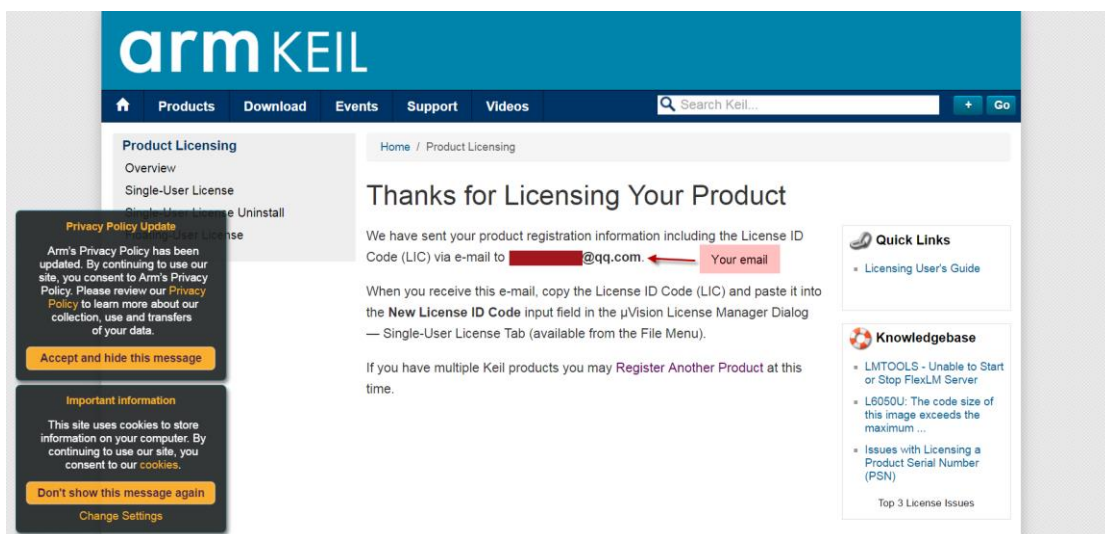   License Management page on the Keil web site.
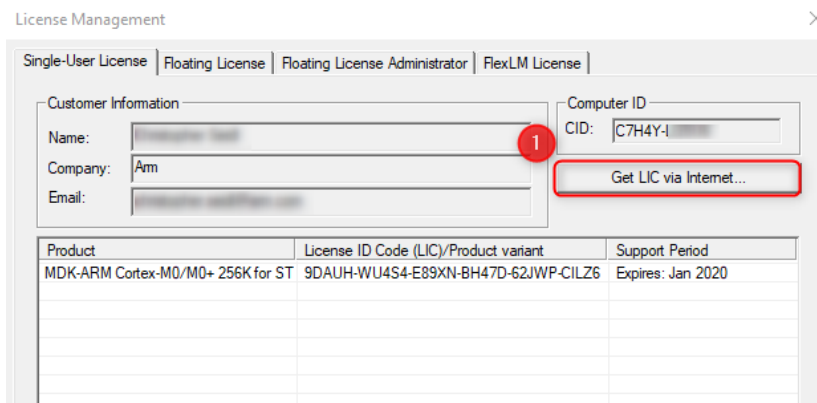
7: Enter the **Product Serial Number 4PPFW-QBEHZ-M0D5M** along with your contact information and click the

button **Submit**. An e-mail is sent back with the **License ID Code (LIC)** within a few minutes.

(1)

(2)

(3)

Thank you for licensing your Keil product. Your License ID Code (LIC) is printed below. Print a copy of this e-mail to keep for your records.

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

PC Description   : 111
Computer ID   (CID): CWS1R-RLXZE

License ID Code (LIC): WZLTG-VNA70-2CV1I-6MCRS-21WVS-ZDPY5

To activate your Keil product, copy the License ID Code (LIC) and paste it into the New License ID Code input field on the Single-User License Tab in the uVision4 License Manager Dialog (available from the File menu).
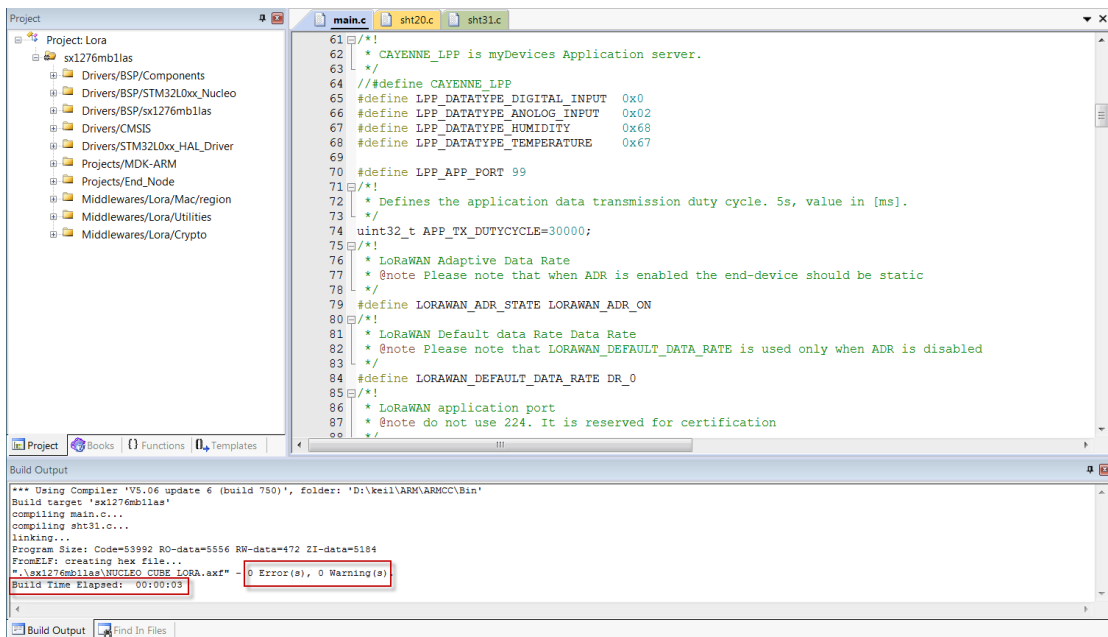
*** DO NOT REPLY TO THIS EMAIL: For licensing problems or questions, please contact Keil Technical Support.

Thank You,
Technical Support

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**.
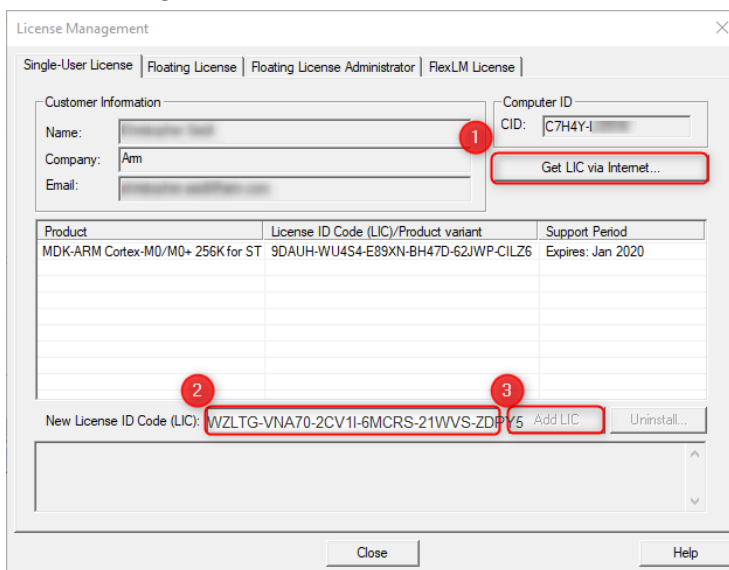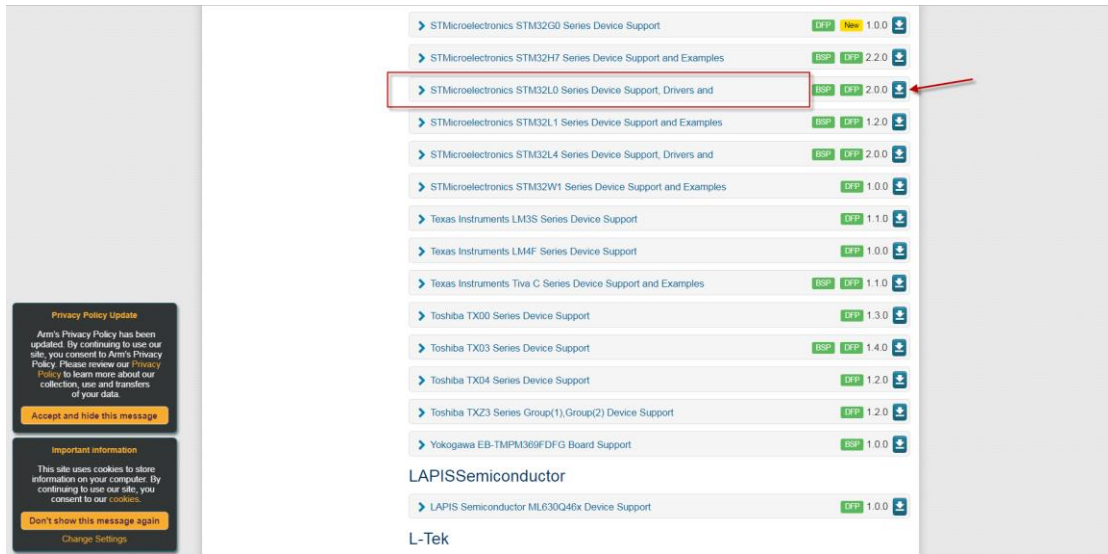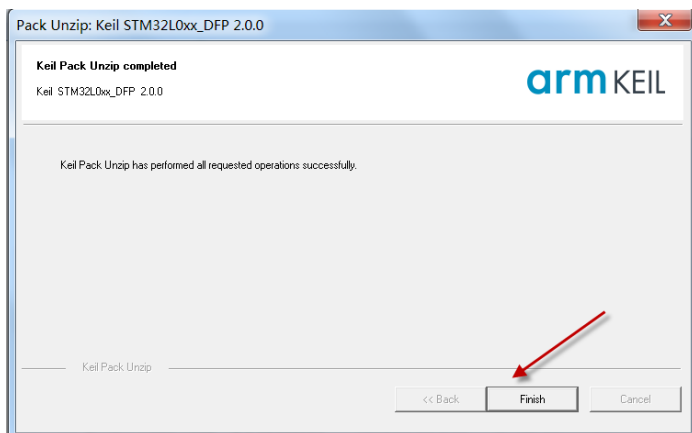

9:Finish

5.2.2 Install STM32L0 Series Device

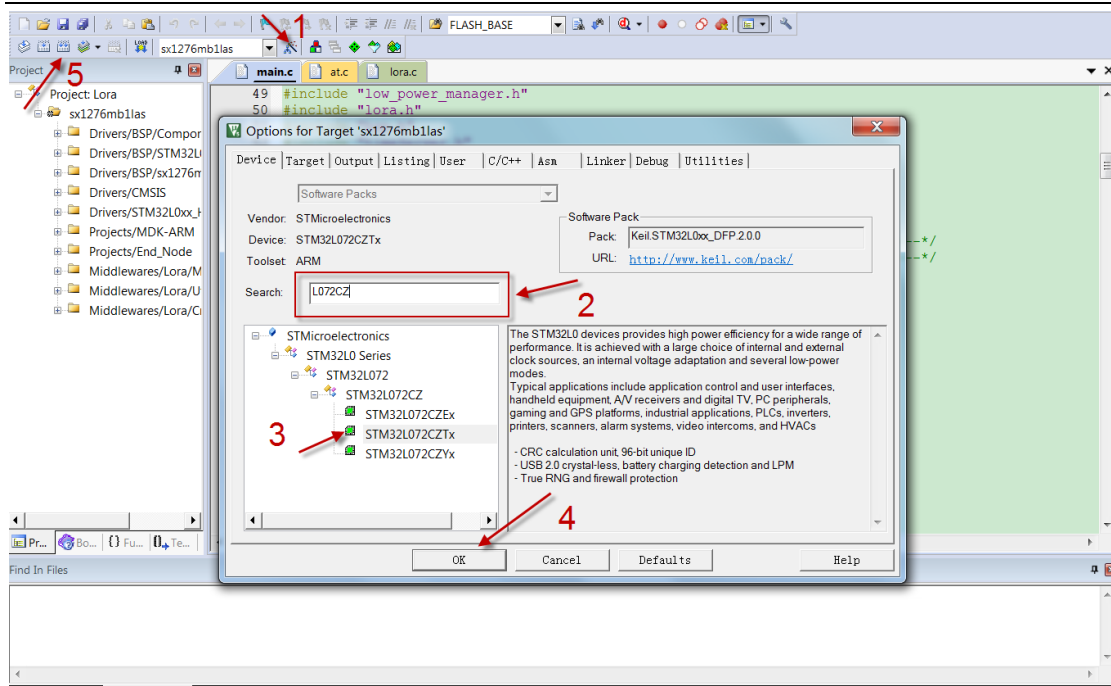1:**Open** the web: https://www.keil.com/dd2/pack/#/eula-container ;

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

3:Find the Software Pack and installs it;
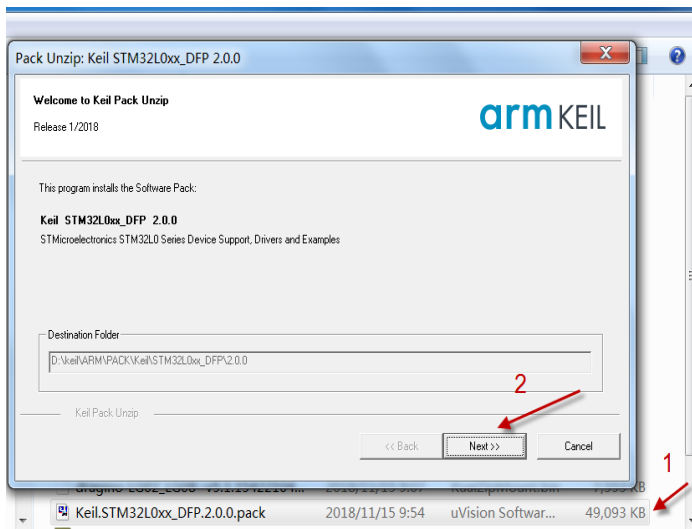
4:**Add** the Device ,then you can **rebuild** the project.

Notice: If without add the Device, the keil would report this error.
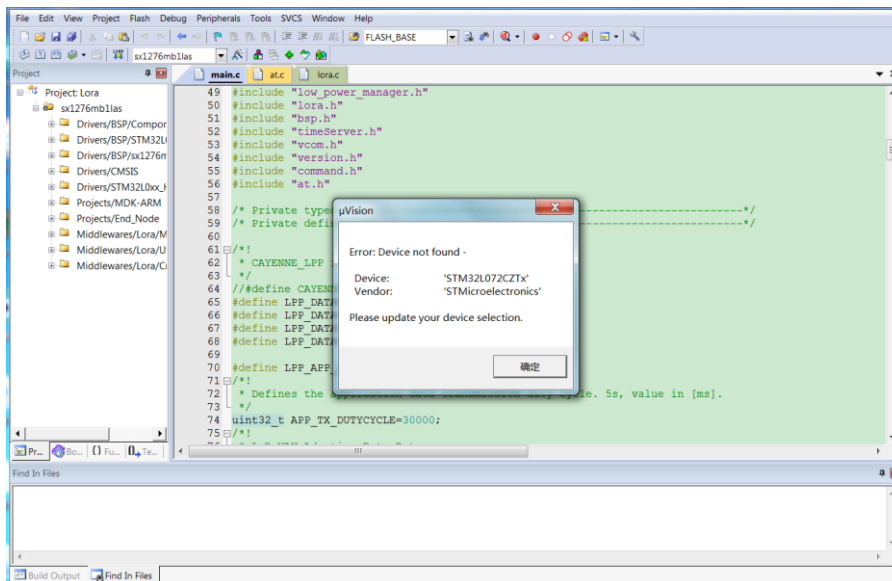
5.2.3   Compile Source Code

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.
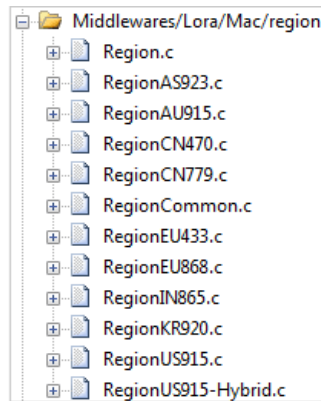
4.   If you want to change frequency, modify the Preprocessor Symbols. For example, change EU868 to US915
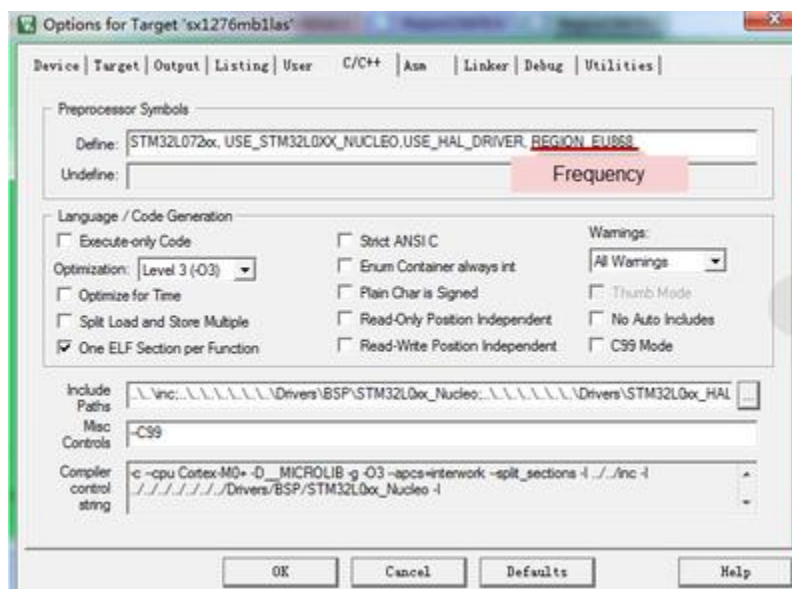
5.   Compile and build
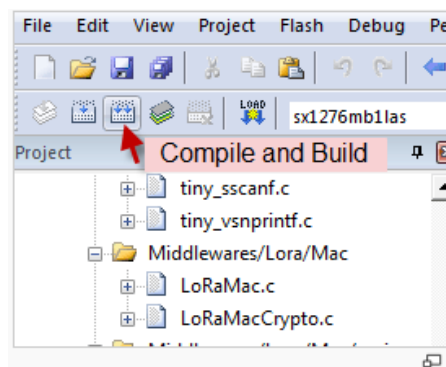
6.   FAQ

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.
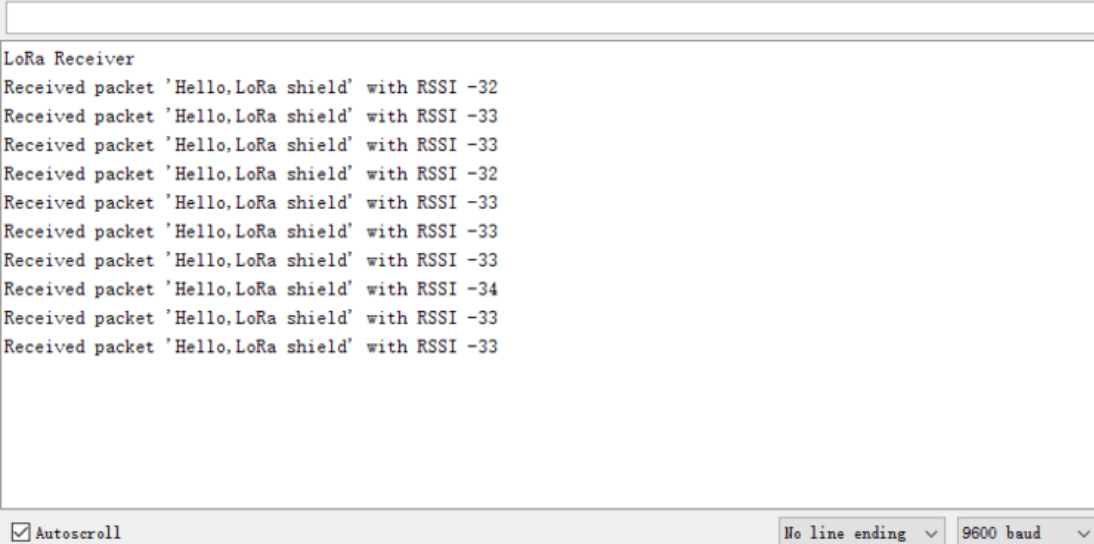

LoRa Shield + UNO:

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 -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 ∨   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	903.5	903.7	Channel 0-7
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	908.3	908.5	Channel 24-31
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 64-71

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.

AU915 is similar. Below is the AU915 Uplink Channels.

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	916.6	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	921.4	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

6.7   What is the pin mapping for the USB program cable?
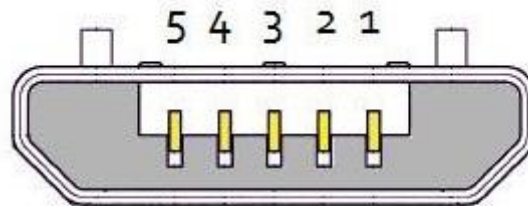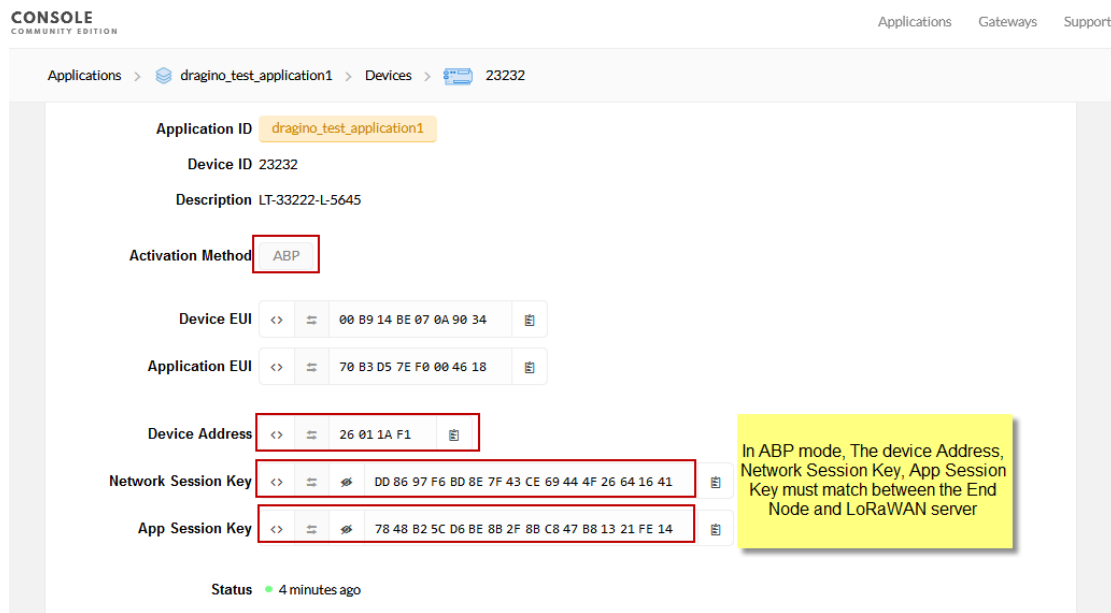
USB Micro-B

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: 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.

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+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.

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.
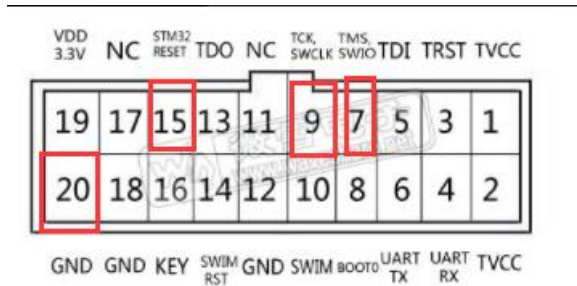
8.   Order Info

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](#)