LoRa Edge™ Tracker

Reference Design User Guide

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1. Introduction

Welcome to the LoRa Edge™ Tracker Reference Design User Guide. In this guide, we introduce you to the Semtech LoRa Edge Tracker Reference Design V1.0 and explain how to set it up with a network server and the associated mobile application, LoRa Edge Config.

The reference design consists of the following components:

- LR1110-based LoRa Basics™ Modem-E
- STM32WB55RG processor
- Accelerometer sensor
- Hall Effect sensor

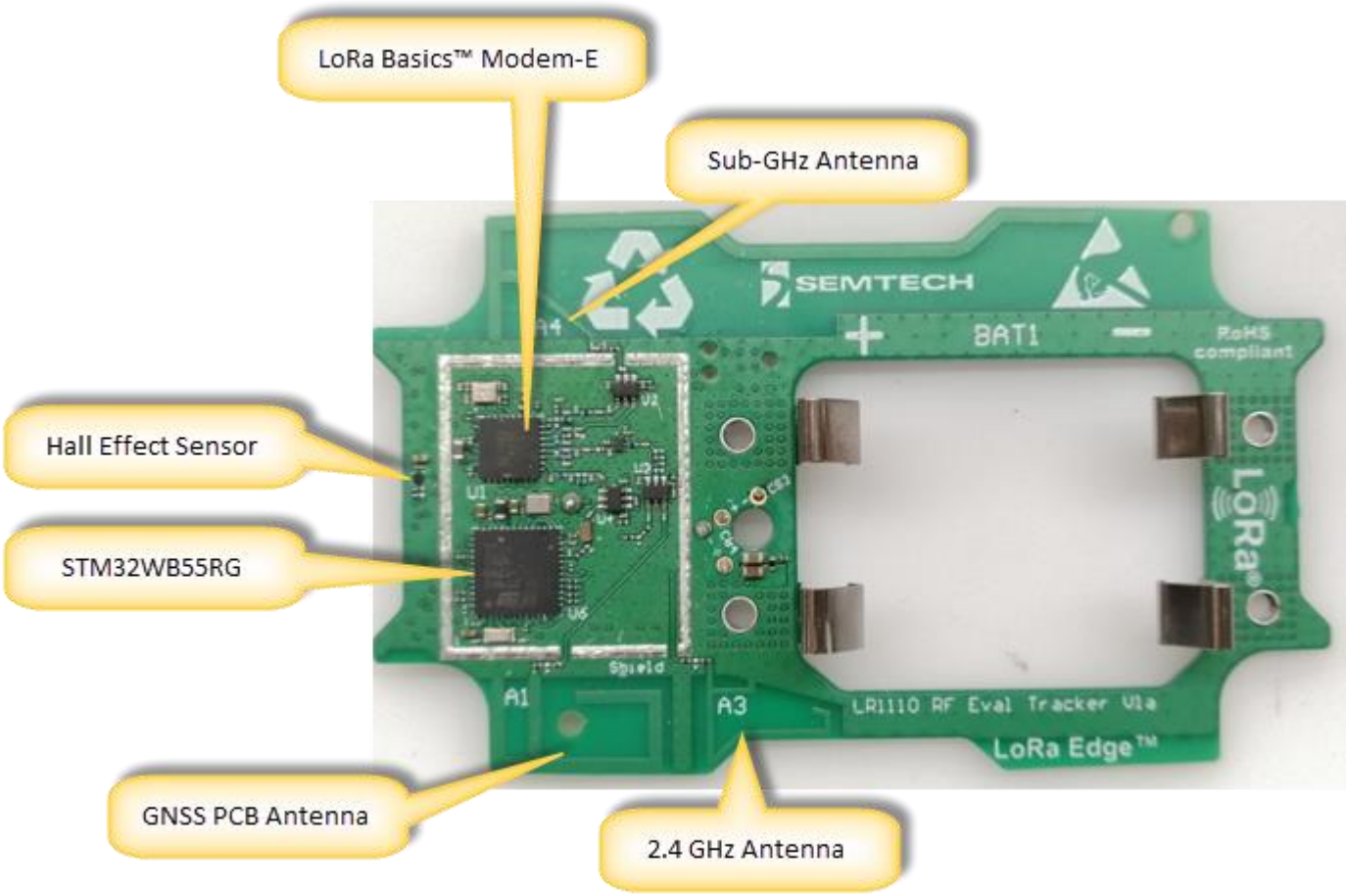


Figure 1: LoRa Edge Tracker Reference Design V1.0 Tracking Device (Bottom)

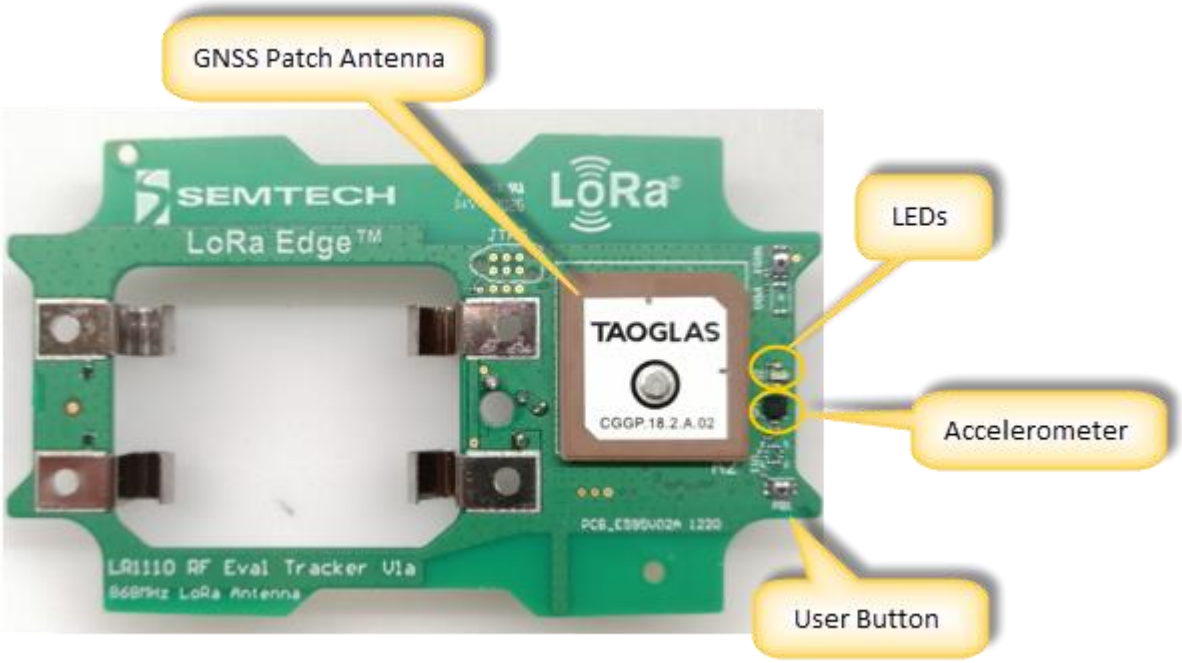


Figure 2: LoRa Edge Tracker Reference Design V1.0 Tracking Device Top

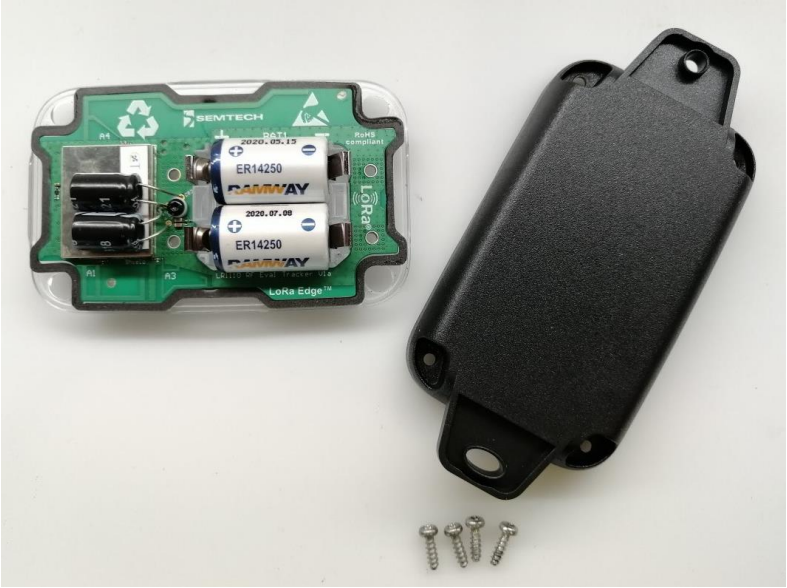


Figure 3: LoRa Edge Tracker Reference Design V1.0 Tracking Device (Full)

Figure 4: LoRa Edge Tracker Reference Design V1.0 Tracking Device (Enclosure)

2. Quick Start

This section provides a quick explanation of how to set up the tracking, how to pair it with the associated mobile application, and how to connect it to the services it supports. For additional details, see Set up and Operate the Semtech LoRa Edge Tracker Reference Design.

Note: The Semtech LoRa Edge Tracker Reference Design tracking devices are shipped in airplane mode to prevent them from transmitting while in transport.

Take the following steps to get started

1) From a web browser, open the LoRa Cloud™ portal (https://www.loracloud.com/)

   a) Create an account

   b) Make sure you are logged in, and then go to the LoRa Cloud Device & Applications Services page)

   c) In the left pane, click **Manage Tokens**

   d) Copy the value of the created token

   e) Create a QR code with your token using either an online QR-code generator tool (for example https://www.qr-code-generator.com/) or similar.

   f) Save your QR Code

2) Download and install the **LoRa Edge Config** mobile application from the Google Play store

   Note: The mobile app is only available for Android devices.

   a) On the pop up titled **LoRa Cloud authentication token not set**. **Do you want to set is now?** click **Yes**

   b) Allow LoRa Edge Config to take pictures and record video and then scan the QR code you previously generated

   c) On the pop up titled **Almanac URL**, You can either use the default Almanac URL or change to a different URL:

   d) To use the default Almanac URL (https://dms.loracloud.com) click **Later**

   e) To change the Almanac URL, click **Change Now**, and then enter the new URL

   f) Once you have scanned the QR code, the almanac will be obtained and downloaded automatically.

   g) Open the LoRa Edge Config app, click the menu icon( ), and select **Settings:** Settings

   h) Go to the **Settings** page

   i) In the **Inspector** section, change the **Inspector mode** to from *Basic* mode to *Advanced*

j) Go back to the **Home** page

k) Click on the **Start Scan** button  and allow LoRa Edge Config to access your mobile device's location

3) Put your LoRa Edge Tracker Reference Design device in BLE pairing mode by placing the provided magnet with the notch side down against the oval hole on the device, and then place the flat side of the magnet directly against the device, as illustrated in Figure 5.

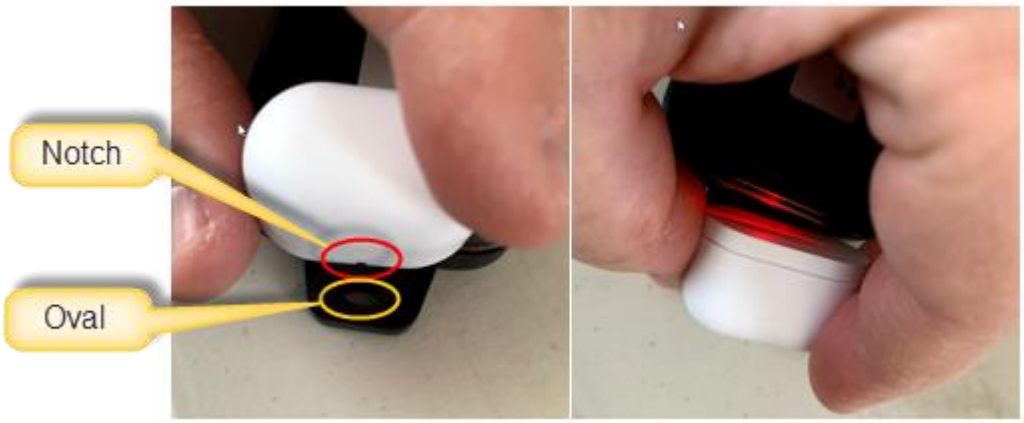


Figure 5: Tracker in BLE Pairing Mode

a) When the red LED blinks, the LoRa Edge Tracker Reference Design device is in pairing mode. It will remain in this mode for 30 seconds.

b) Go back to the mobile application and open the **Scanner** page.

i) You should see the name of your LoRa Edge Tracker Reference Design device displayed, as illustrated in Figure 6:

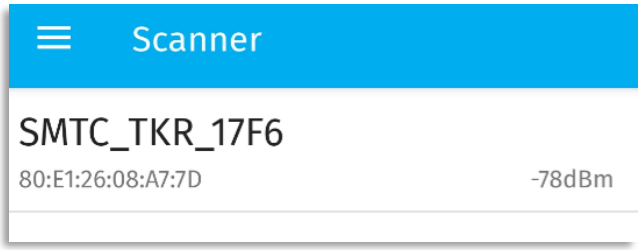


Figure 6: Tracker Detected by Application

Note: The last four digits are the DevEUI LSB, which must be the same as the DevEUI printed on the tracking device label.

ii) Connect the LoRa Edge Tracker Reference Design device with the application

(1) The red LED is fixed once a connection is established.

(2) There is a connection timeout of two minutes. This timeout is refreshed after each user action in the app.

(3) There is an overall connection timeout of five minutes.

iii) Once connected, take the following steps, in order:

(1) In the **Version and FUOTA** section (refer to Figure 62):

(a) Click **Update application firmware** to update your application firmware when a new version is available

(b) Click **Update LoRa Basics Modem-E firmware** to check if a new version is available

ii) In the **GNSS** section (refer to Figure 64):

(1) Update the almanac by clicking **Update almanac**

(2) Set your GNSS assistance position

iii) In the **Miscellaneous** section (refer to Figure 66):

(1) Disable Airplane mode

iv) In the **LoRaWAN®** section (refer to Figure 63):

(1) Specify whether to enable or disable **Semtech Join Server mode**

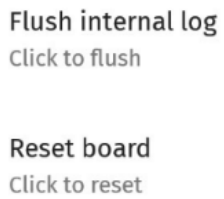
Note: If the Semtech *Join Server* mode is enabled, the Semtech *derive keys* algorithm will be used. If the Semtech *Join Server* mode is disabled, the Semtech *derive keys* algorithm **will not** be used.

(2) Get/Set the DevEUI, JoinEUI and AppKey, which are needed to register your device

(3) Disconnect the app from the LoRa Edge Tracker Reference Design device by clicking on the left-arrow icon: 

Note: When you leave the **Configuration** page, the LoRa Edge Tracker Reference Design device will be automatically disconnected.

(4) In the **LoRa Edge Tracker Reference Design Reset** section: **Reset board** allows you to restart the LoRa Edge Tracker Reference Design application firmware.



Note: When the LoRa Edge Tracker Reference Design device resets, it goes into BLE pairing mode again, and stays in that mode for 30 seconds.

v) The LoRa Edge Config application will then start

vi) Register your device

3. Hardware Overview

3.1 Absolute Maximum Ratings

Table 1: Absolute Maximum Ratings

Item	Minimum	Typical	Maximum	Unit
Maximum Supply Voltage	-0.5	3.3	3.9	V
Operating Temperature	-40	25	85	ºC
Maximum RF Input Level			+10	dBm

3.2 Architecture

The architecture of the Semtech LoRa Edge Tracker Reference Design has the following characteristics:

1) LR1110 Wi-Fi and GNSS capabilities

2) GNSS antenna diversity

   a) Patch antenna

   b) PCB antenna

3) STM32WB55 with BLE port configuration and update

4) 2400 mAh battery

5) 52 x 85 x 27mm IP66 Housing

6) LEDs

7) 3-Axis & Hall Effect Sensors

8) Maximum transmit output power = +22dBm

9) Typical sensitivity level:

   a) LoRa:

      i) -140dBm at SF12 BW 125 kHz

      ii) -127dBm at SF7 BW 125 kHz

   b) GNSS: -134dBm

3.3 LoRa Edge Tracker Reference Design Diagram

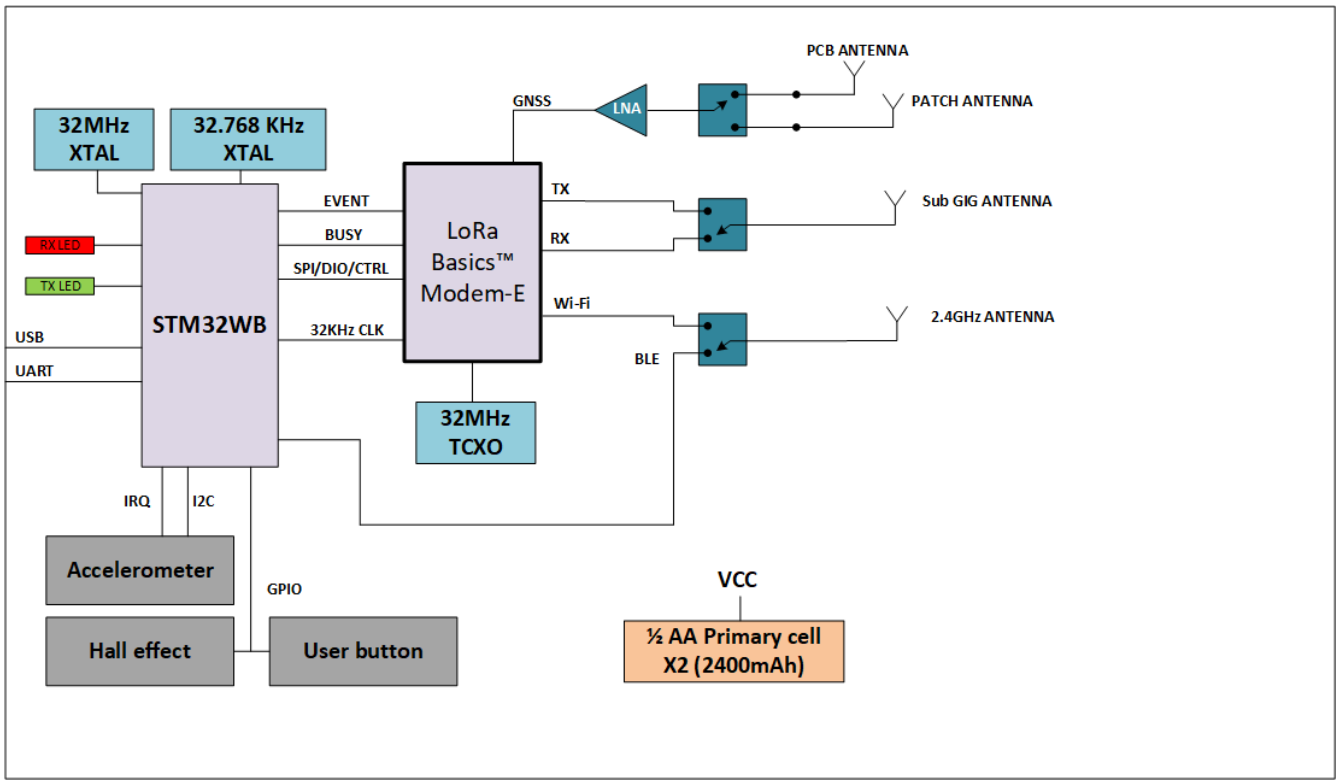


Figure 7: LoRa Edge Tracker Reference Design Block Diagram

- The LoRa Basics Modem-E is an ultra-low power platform that integrates a long-range LoRa transceiver, multi-constellation scanner, and passive Wi-Fi AP MAC address scanner targeting asset management applications.
- The STM32WB55XX multiprotocol wireless and ultra-low-power devices embed a powerful and ultra-low-power radio, compliant with the Bluetooth® Low Energy SIG specification v5.0 and with IEEE 802.15.4-2011. They contain a dedicated Arm® Cortex® -M0+ for performing all real-time low-layer operations.

The control signals from/to the MCU to and the LoRa Basics Modem-E are:

- 1 x SPI: coming from MCU to the LoRa Basics Modem-E SPI interface
- LoRa Basics Modem-E SPI interface Reset / Event / Busy line
- 1 x I2C: coming from MCU to the accelerometer sensor I2C interface
- GPIO for Hall Effect sensor and user button

- Control lines for SPDT
    - Two from the MCU, for GNSS antenna diversity and Wi-Fi/BLE selection
    - One from the LoRa Basics Modem-E, for LoRa RX/TX path selection

3.4 Power Consumption

Table 2: Typical Current Consumption at 3.3V

MODE	DESCRIPTION	TYPICAL CURRENT CONSUMPTION	UNIT
SLEEP MODE WITHOUT SUPER CAP	-	9	µA
SLEEP MODE WITH SUPER CAP	-	16.4	µA
TX ON AT 22DBM 915MHZ (PA BOOST)	TX Continuous	134	mA
TX ON AT 14DBM 868MHZ (PA BOOST)	TX Continuous	86	mA
TX BLE ON AT 0DBM	Advertisement	11.1	mA
WI-FI SCAN		12.3	mA
GNSS SCAN		15.2 (Semi coherent research phase) 5.7 (coherent research phase)	mA

3.5 Power Consumption Profile

This chapter describes several power consumption profiles with standard parameter settings

The power consumption of the LoRa radio will be not addressed because it depends on the region and the Adaptive Data Rate (ADR) strategy employed.

3.5.1 Scan Data with Default Accuracy Parameters

The power consumption profile has the following parameters:

- GNSS Scan mode: assisted
- GNSS Search mode: Default
- GNSS Antenna selection: both
- Wi-Fi Channels: Chan_1 / Chan_6 / Chan_11
- Wi-Fi Nb retrials: 5
- Wi-Fi Max result: 10

Figure 8 shows the power consumption profile when using the default accuracy parameters:

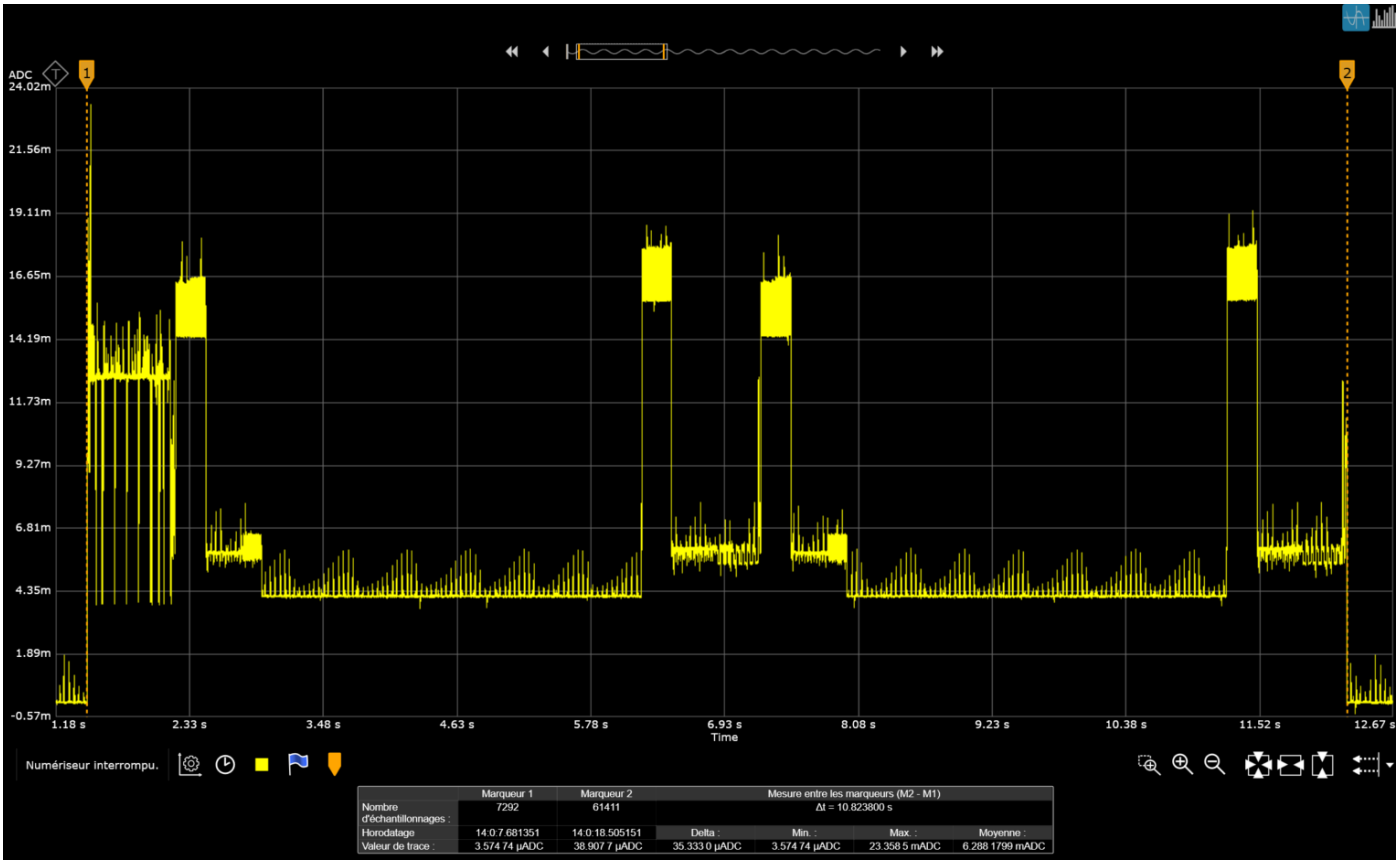


Figure 8: Power Consumption Profile Scan using the Default Parameters

The complete scan power consumption is about 6.28mA / 10.8 sec, therefore 18.89µAh

If we split the power consumption by functionality, we get:

- **Wi-Fi:** 12.46mA / 0.737 sec, therefore, 2.55µA
- **GNSS Scan (x 2):** (5.819mA / 5.024 sec) x 2 , corresponding to 16.26µA
- **Sensor readings (accelerometer / hall effect / charge):** 8.53mA / 0.041 sec, corresponding to 0.09µA

3.5.2 Scan Data with High Accuracy Parameters

Power consumption profile with the following parameters:

- GNSS Scan mode: Assisted
- GNSS Search mode: Best effort
- GNSS Antenna sel: Both
- Wi-Fi Channels: ALL
- Wi-Fi Nb retrials: 10
- Wi-Fi Max result: 32

Here is the power consumption profile when we use high-accuracy parameters:

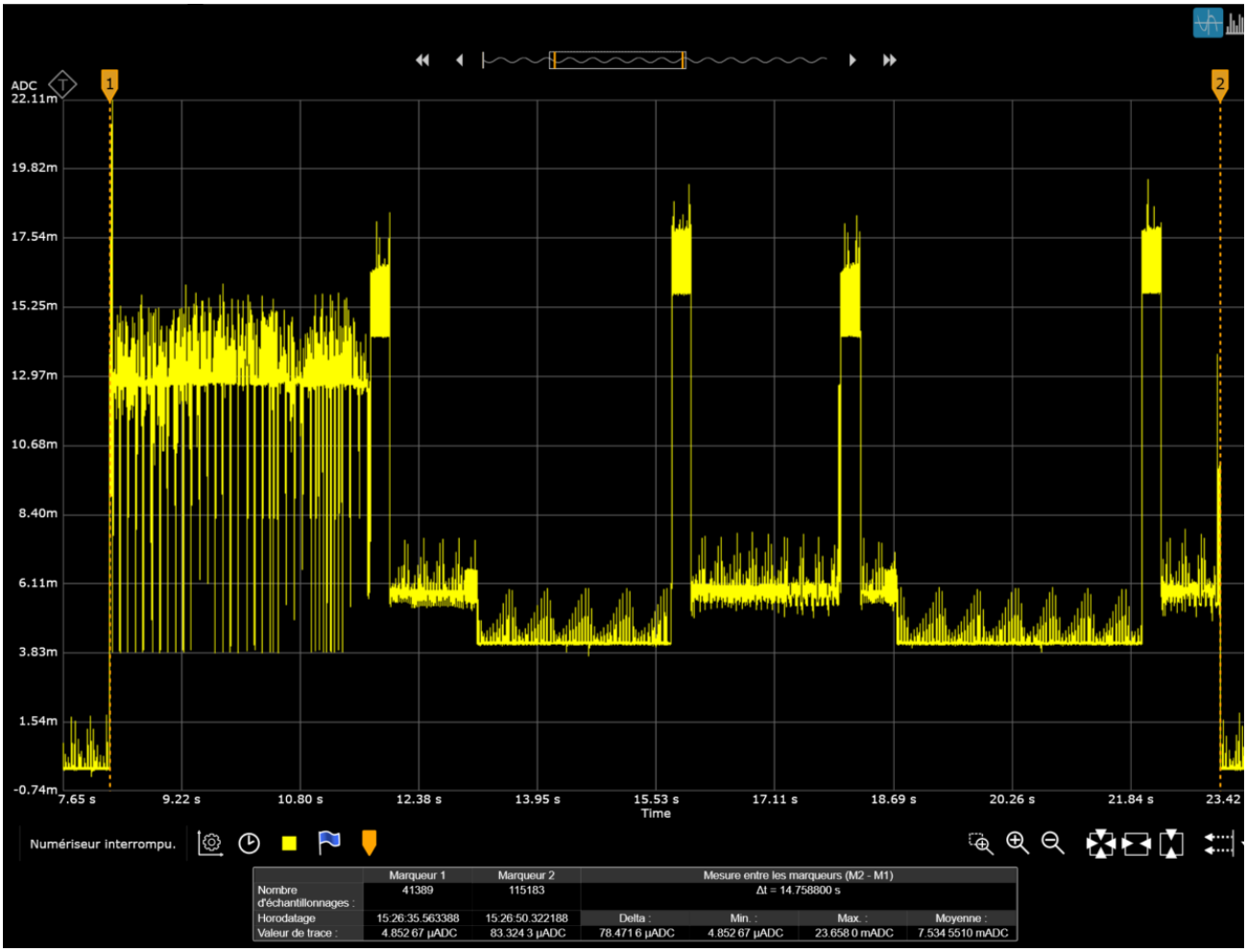


Figure 9: Power Consumption Profile Scan using High-Accuracy Parameters

The complete scan power consumption is about 7.53mA / 14.75 sec, therefore 30.9 µAh

If we split the power consumption data by functionality:

- **Wi-Fi:** 12.8 mA / 3.43 sec, corresponding to 12.2µA
- **GNSS Scan (x2 dual constellation):** (5.94mA / 1.29 sec) x 2, therefore 18.6µA

  Note: This power consumption value varies in function of the number of detected Wi-Fi access points or GNSS satellites

- **Sensor readings (accelerometer / hall effect / charge):** 8.53mA / 0.041 sec, therefore 0.09µA

3.5.3 Sleep Current

Figure 10: Power Consumption Profile in Sleep Mode

The average sleep current is approximately:

- 10.85µAh (without super-capacitors)
- 18.85µAh (with super-capacitors)

Each peak represents the accelerometer output data rate, here 100ms.

3.6 Antenna Performance

The antenna radiation patterns have been measured in a free space condition. The measurement setup and the device orientation are shown in Figure 11.

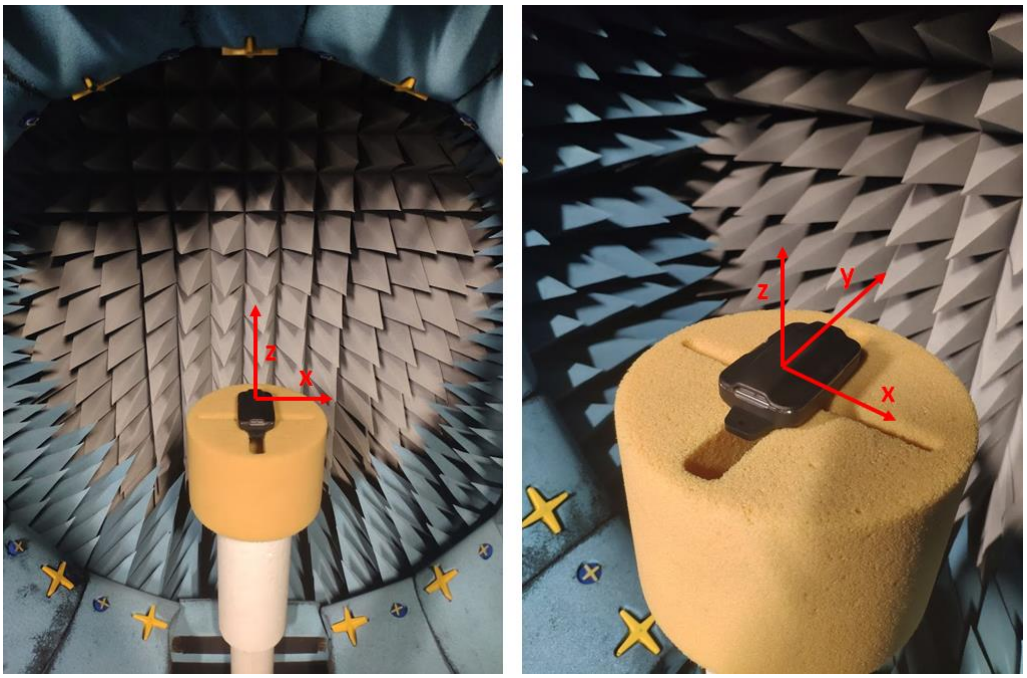


Figure 11: Radiation Diagram Measurement Setup

3.6.1 LoRa Antenna Radiation Pattern

The 3-D radiation pattern of the LoRa antenna of each tracker type (868MHz or 915MHz) has been measured at the antenna operating frequency, as shown in the following sections.

3.6.1.1 868MHz Antenna

The 3-D radiation pattern at 868MHz is shown in Figure 12, whereas the 2-D cuts in the various planes are shown in Figure 13, Figure 14, and Figure 15.

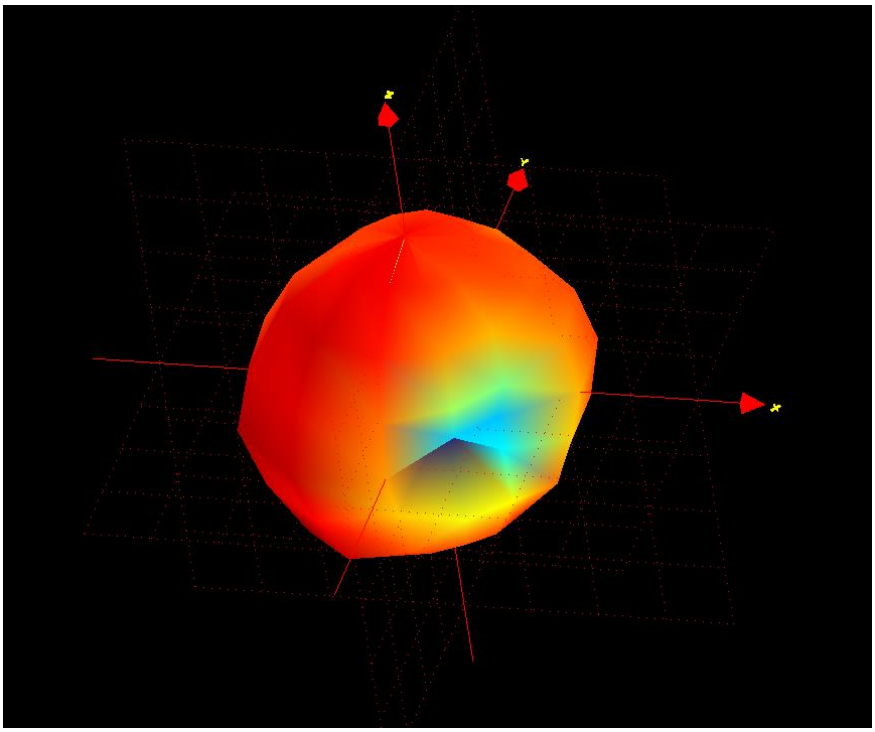


Figure 12: 3-D Pattern for Total Gain @ 868MHz

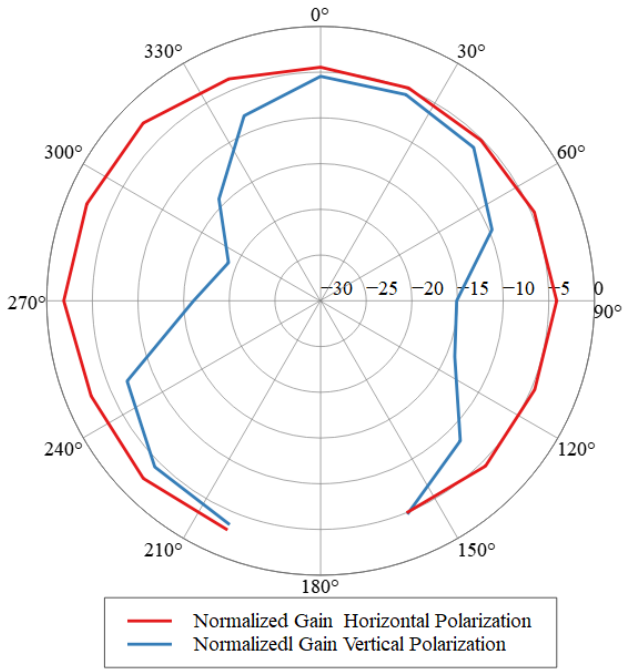


Figure 13: 2-D Radiation pattern planar cut XoZ plane @868MHz

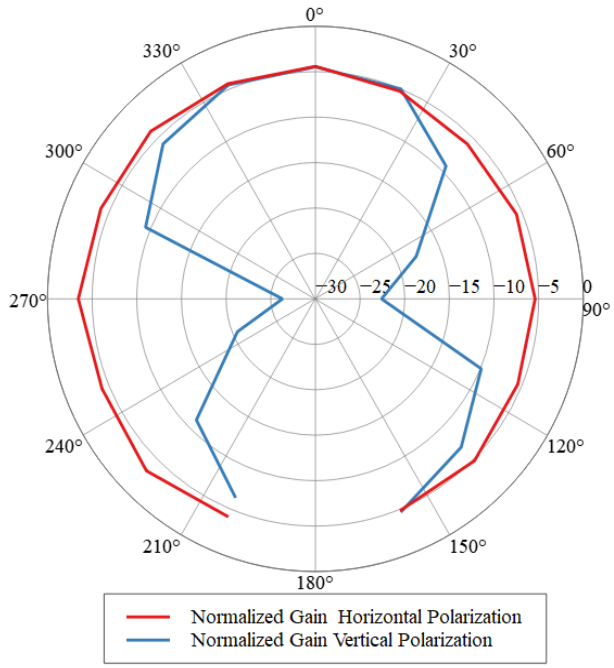


Figure 14: 2-D Radiation pattern planar cut YoZ plane @868MHz

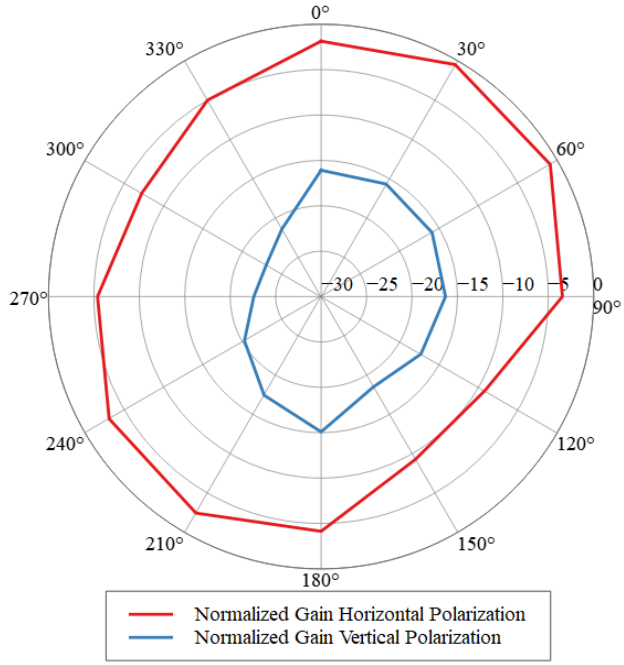


Figure 15: 2-D Radiation pattern planar cut XoY plane @868MHz

3.6.1.2 915MHz Antenna

The 3-D radiation pattern at 915MHz is shown in Figure 16, whereas the 2-D cuts in the various planes are shown in Figure 17, Figure 18 and Figure 19.

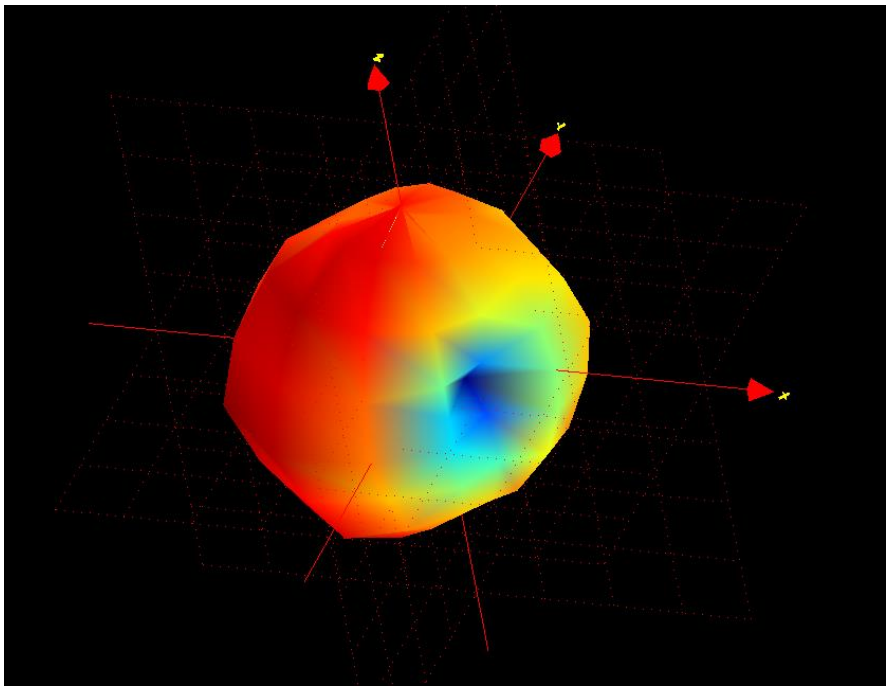


Figure 16: 3-D Pattern for Total Gain 915MHz

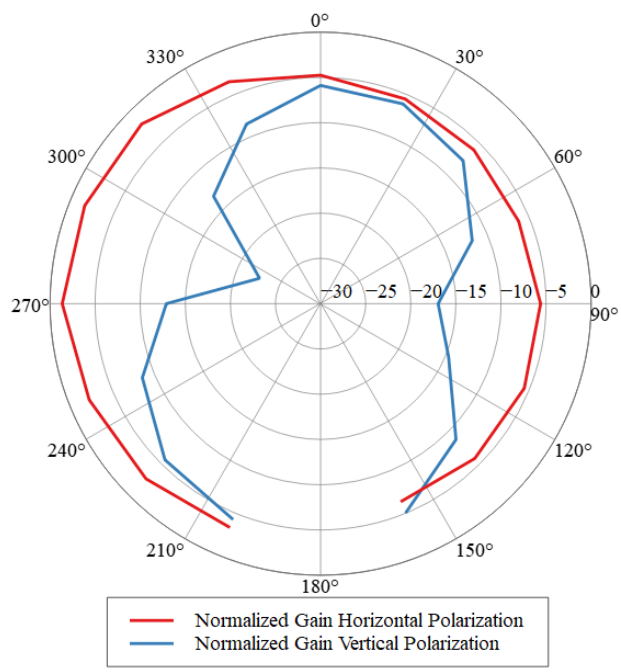


Figure 17: 2-D Radiation pattern planar cut XoZ plane @915MHz

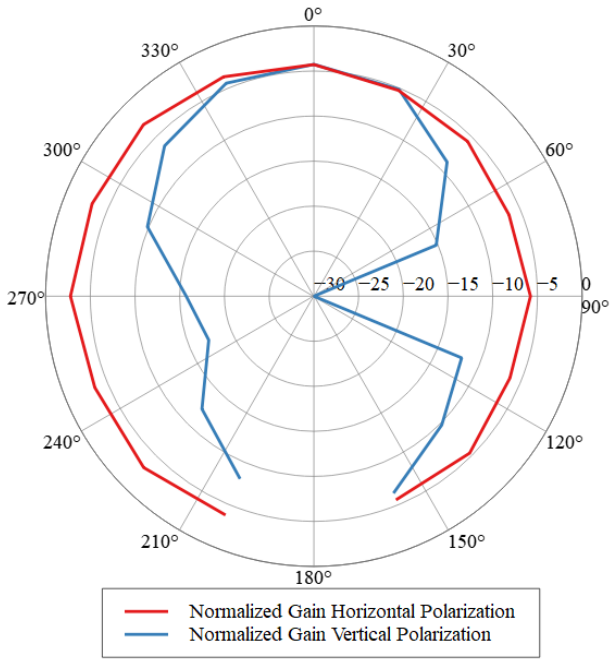


Figure 18: 2-D Radiation pattern planar cut YoZ plane @915MHz

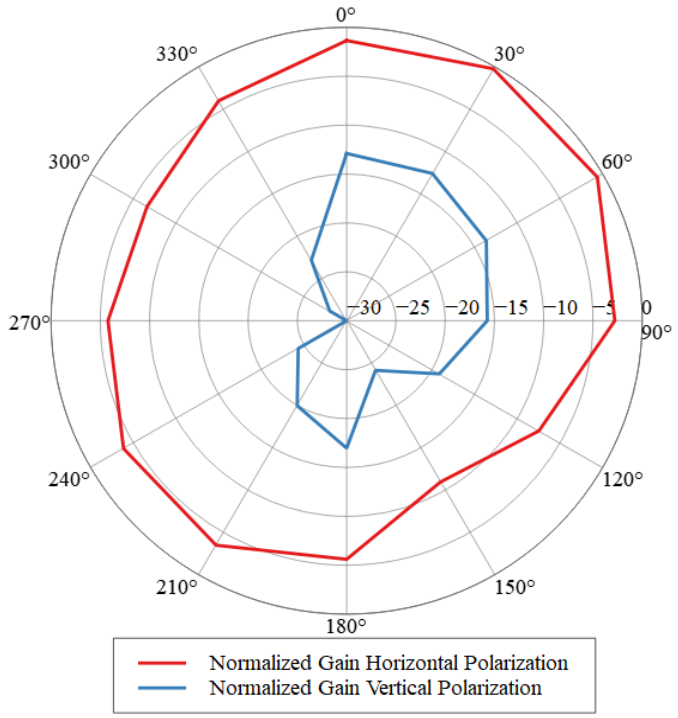


Figure 19: 2-D Radiation pattern planar cut XoY plane @915MHz

3.6.2 GNSS Antenna Radiation Pattern

The 3-D radiation pattern of the GNSS PCB antenna at 1.575GHz is shown in Figure 20

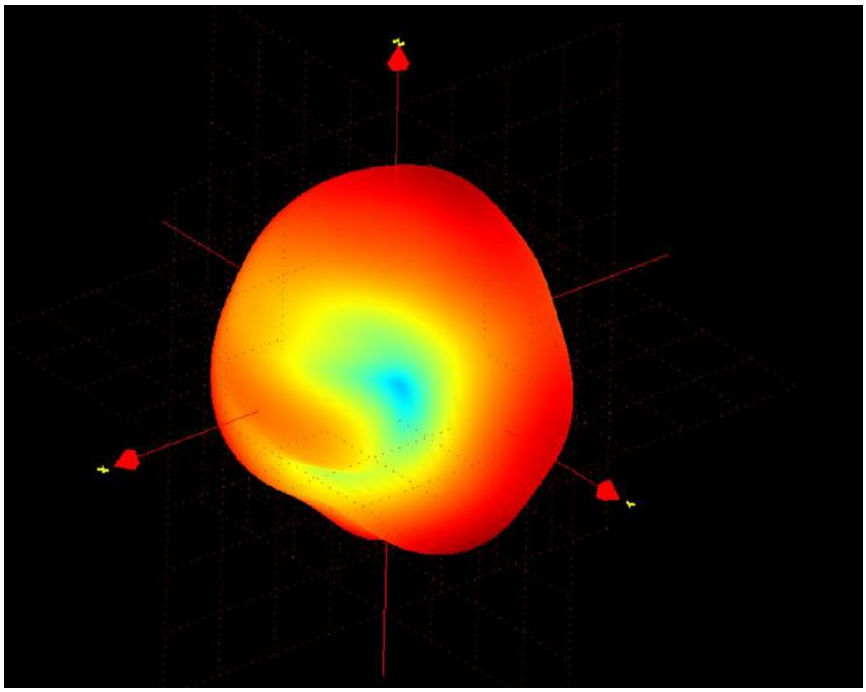


Figure 20: 3D radiation pattern of the GNSS PCB antenna

3.6.3 2.4GHz Antenna Radiation Pattern

The 3-D radiation pattern of the 2.4GHz antenna at 2440MHz is shown in Figure 12**Error! Reference source not found.** whereas the 2D cuts in the various planes are shown in **Error! Reference source not found.**.

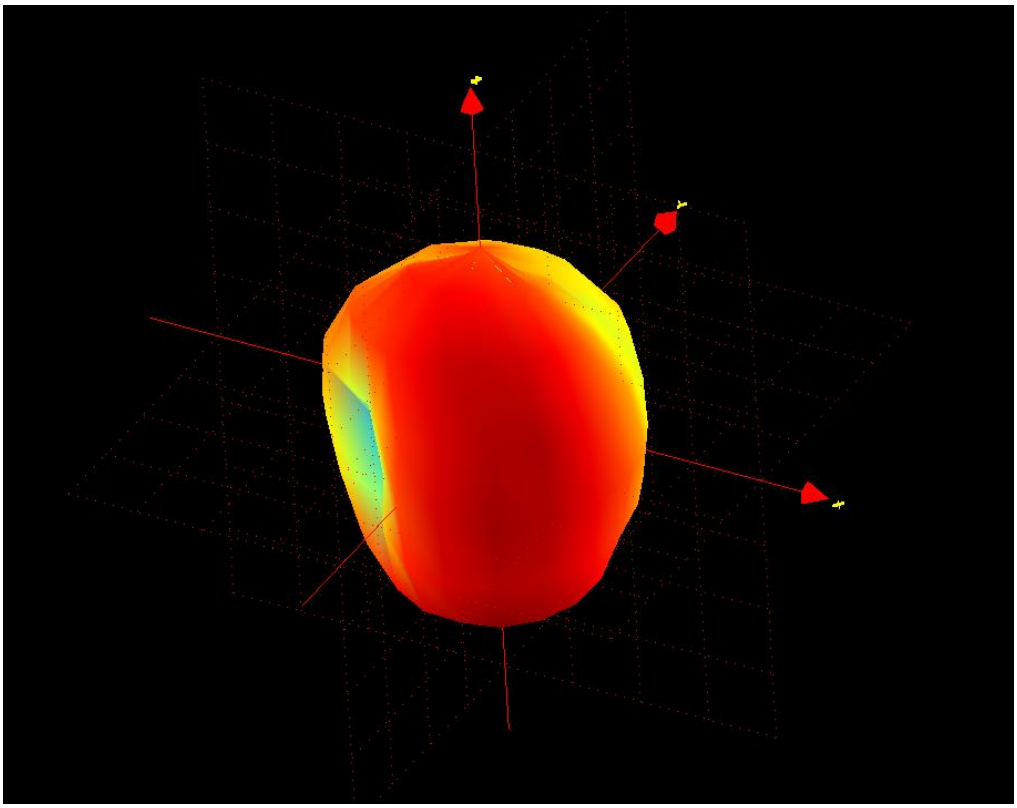


Figure 21: 3D pattern for total Gain @2440MHz

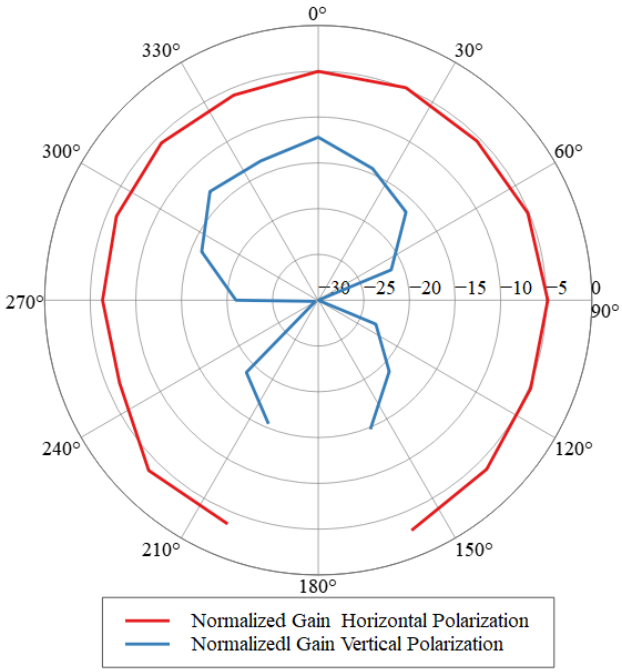


Figure 22: 2-D Radiation pattern planar cut XoZ plane @2440MHz

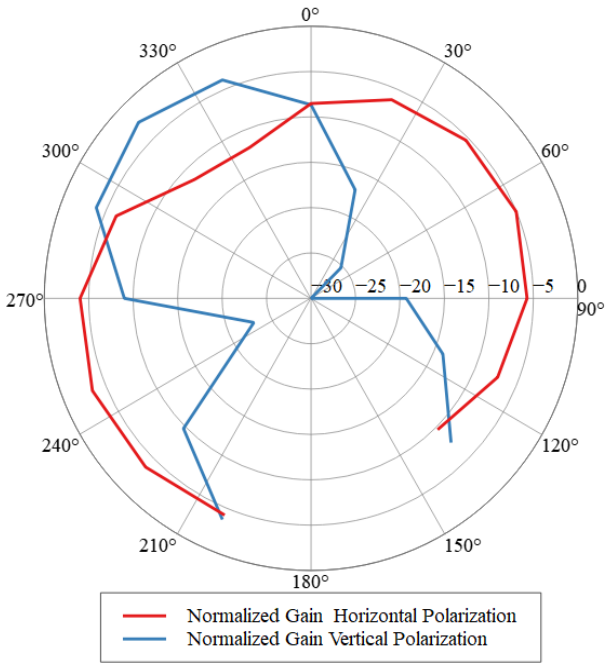


Figure 23: 2-D Radiation pattern planar cut YoZ plane @2440MHz

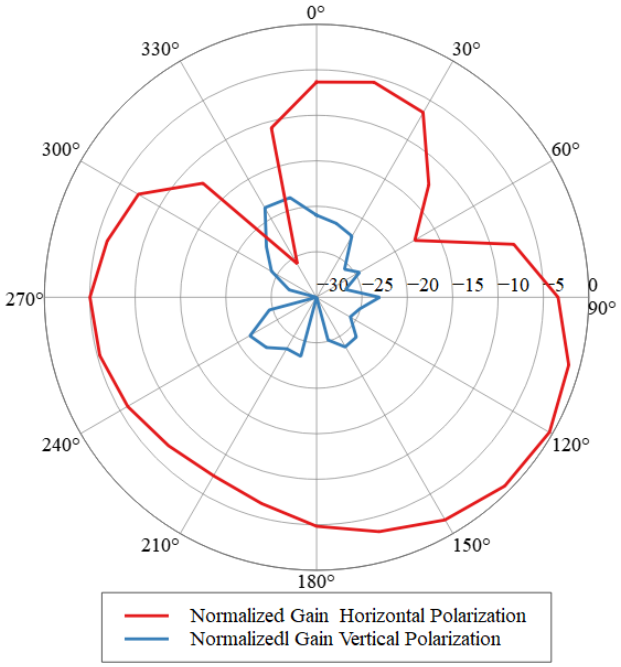


Figure 24: 2-D Radiation pattern planar cut XoY plane @2440MHz

3.7 QR Code description

The printed QR code on the label integrates the device Identification in the QR Codes as defined by the LoRa Alliance®.

Figure 25: EU Label

Figure 26: US Label

The QR code contains the following information:

- **Preface:** LW
- **SchemaID:** D0
- **JoinEUI:** (00-16-C0-01-FF-FE-00-01 in this example)
- **DevEUI:** (00-16-C0-01-F0-00-14-9A in this example)
- **ProfileID:** 016A-0001
- **OwnerToken:** 4A21235D: pin of the LoRa Basics Modem-E
- **SerNum of Mfg Serial Number:** YYWWNNNNNN (Year, Week, Serial Number)
- **CheckSum:** (CRC-16/MODBUS)

The information contained in the QR-code represents 58 bytes of data:

```
LW:D0:0016C001FFFE0001:0016C001F000149A:016A0001:O4A21235D
```

With the CRC we have 64 bytes of data:

```
LW:D0:0016C001FFFE0001:0016C001F000149A:016A0001:O4A21235D:C11F2
```

4. Software Overview

Two software pieces are delivered in conjunction to the LoRa Edge Tracker Reference Design:

1) LoRa Edge Tracker Reference Design Firmware
2) LoRa Edge Config (mobile application)

4.1 LoRa Edge Tracker Reference Design Firmware

The firmware source code can be found in the LoRa GitHub repository:

https://github.com/Lora-net/lora_edge_tracker_ref_design

The repository contains the SDK source code as well as a Keil project and a GCC makefile.

The LoRa Edge Tracker Reference Design SDK contains the following applications you can use to illustrate the capabilities of the LoRa Edge Tracker Reference Design:

- Main_tracker.c: detailed in the LoRa Edge Config Overview section below
- Main_loramac_a.c: A simple application connecting the tracking device to a network server and sending uplinks periodically.
- Main_test_wifi.c: A simple application performing a periodic Wi-Fi scan
- Main_test_tx_continuous: An application putting the tracking device in continuous transmit mode
- Main_BLE_Standalone: An application that starts only the BLE thread
- Main_low_power: Puts the tracking device in the lowest-possible power mode

4.1.1 LoRa Edge Config Overview

The LoRa Edge Config application is highly-configurable through BLE connectivity.

The following capabilities are embedded in the application:

- LoRaWAN® connectivity in both the EU868 and US915 regions
- Wi-Fi passive scanning with configurable parameters
- GNSS scanning with configurable parameters
- Motion detection
- BLE connectivity:
    - Firmware Updates Over-the-Air (FUOTA)
        - LoRa Edge Config mobile application
        - LoRa Basics Modem-E
    - Almanac update
- Semtech LoRa Cloud Device and Application Services:
    - Differential Almanac update
    - GNSS position assistance update
    - Streaming

When LoRa Edge Config is launched for the first time, it starts in Bootloader mode. If an application is installed, it takes the following actions:

- Connects to a LoRaWAN network server using the Semtech LoRa Cloud Join Server's key derivation algorithm
- When motion is detected, the LoRa Edge Tracker Reference Design device:
    - Sends a Wi-Fi scan / NAV message every X seconds or minutes, as defined by the user
    - Starts a passive Wi-Fi scan / NAV message that is sent eight times once motion is no longer detected
- Switches to BLE mode when the Hall Effect sensor detects the presence of a magnet
- Sends a "keep alive" frame when in static mode (every X minutes/hours, as defined by the user)

The scan data triggers X minutes of inactivity, as defined by the user.

BLE Mode

Communications in BLE mode include:

- Configuring the parameters of the tracking device
- Updating the almanac
- Updating the modem firmware
- Applying firmware updates to the LoRa Edge Config application over-the-air

Shipping Mode

The tracking devices are shipped in Airplane Mode. To switch from Airplane mode to the default operation mode, configure the tracker device accordingly using the smartphone application over a BLE connection.

LED Indicators:

- LED blinks red every 100 milliseconds during a 30-second period indicating that :the tracker is in BLE pairing mode
- LED is solid red (no blinking): the tracking device is connected.
- LED is solid orange: The BLE connection has been requested by the user (via the magnet) but the tracker is busy.

  Note: The LED remains fixed while the tracker is busy. It shuts down when the tracker is idle (the orange LED is turned off) and then the BLE thread starts.

- LED flashes red once over the course of 25 milliseconds indicating that the tracker is launching a GNSS or Wi-Fi scan.

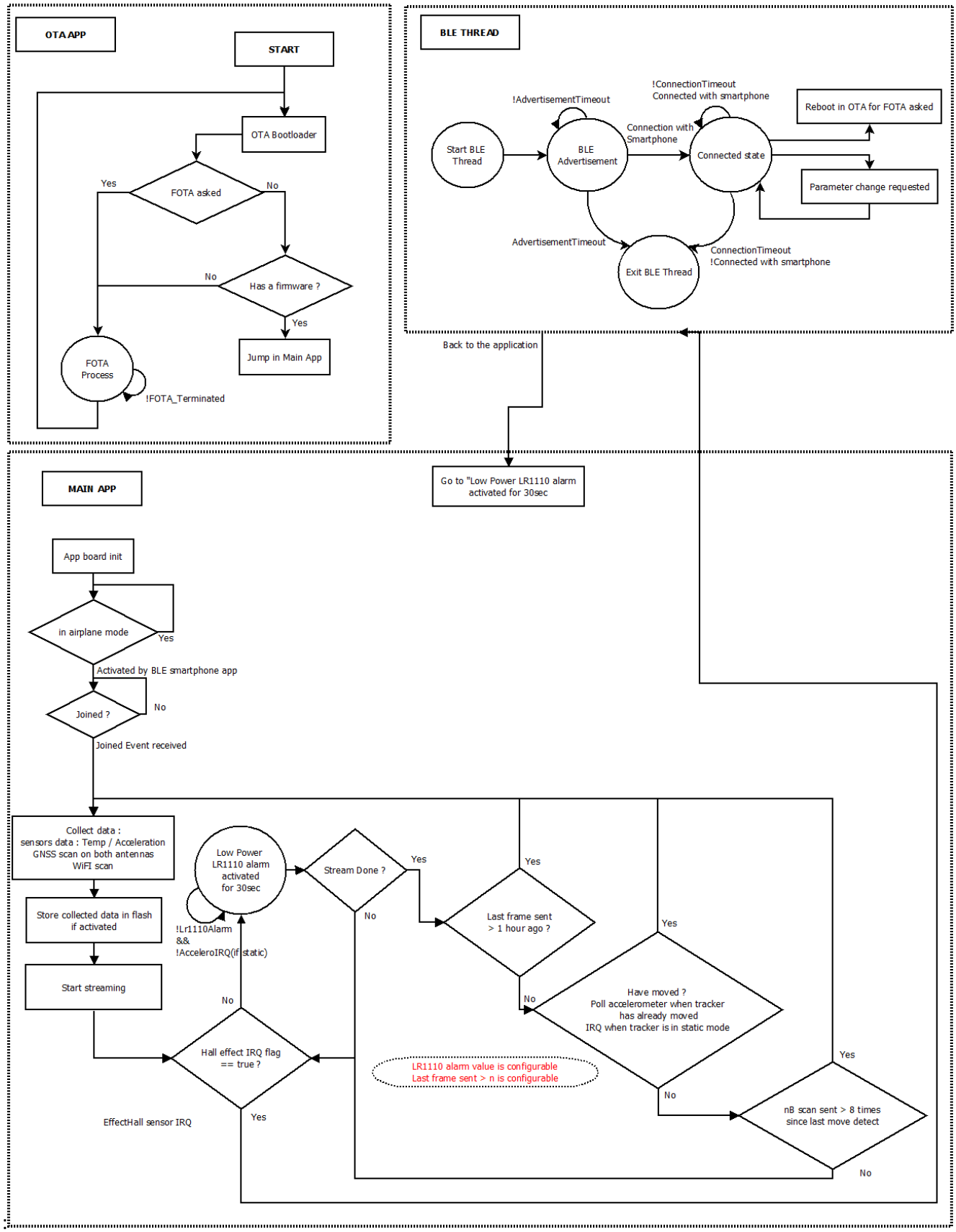


Figure 27: Tracker application flow

4.1.2 Firmware Software Development Kit Overview

The tracker firmware software development kit (SDK) contains several layers, as illustrated in Figure 28.

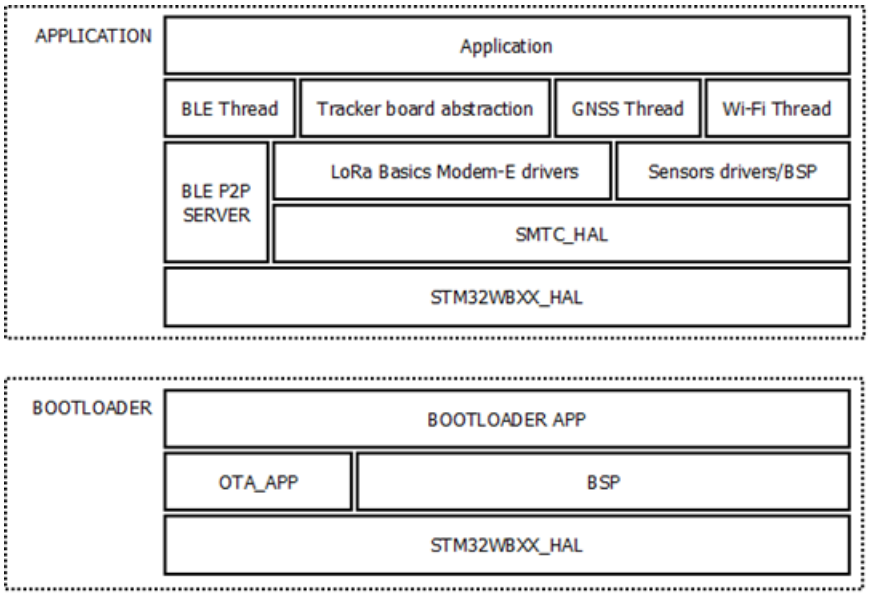


Figure 28: LoRa Edge Tracker Reference Design Firmware SDK Layers

The complete firmware is composed of:

- An application
- A bootloader that manages application firmware updates over-the-air

The firmware (bootloader + application) is programmed into the M4 core of the STM32WB.

Semtech uses the STM32WBXX_HAL, provided by STMicroelectronics. Semtech provides an abstraction, called SMTC_HAL, which aims to be a HAL common to all Semtech firmware.

- This SMTC_HAL contains the following files: smtc_hal_adc.c
- smtc_hal_gpio.c
- smtc_hal_flash.c
- smtc_hal_mcu.c
- smtc_hal_rng.c
- smtc_hal_rtc.
- smtc_hal_spi.c
- smtc_hal_i2c.c
- smtc_hal_tmr.c
- smtc_hal_tmr_list.c
- smtc_bsp_uart.c
- smtc_bsp_watchdog.c

The LoRa Basics Modem-E drivers layer is an implementation of the drivers for the LR1110 modem in the C programming language. This layer handles Wi-Fi and GNSS scans over LoRaWAN. It does not involve any state machine or high level API

The GNSS, Wi-Fi and BLE thread layers provide high-level APIs to run easily a state machine for the following tasks:

- GNSS scanning, with given parameters
- Wi-Fi scanning, with given parameters
- BLE connections between the tracking device and the mobile device running LoRa Edge Config

4.1.2.1 Payload Format Specification

The payload shall be in a Tag or Type / Length / Value (TLV) format. Commonly used as data communication protocol, TLV is an encoding scheme used for information elements in a communication protocol.

The **Tag** and **Length** are fixed in size (1 bytes), and the size of the **Value** field is variable. These fields are used as follows:

Tag: A binary code, often simply alphanumeric, which indicates the kind of field that this part of the message represents:

Length: The size of the value field (typically in bytes);

Value: Variable-sized series of bytes which contains data for this part of the message.

Tag and **Length** are a fixed size of one byte. This means that there are 256 Opcodes with a length of 256 bytes possible, which is sufficient to cover all possible commands.

Table 3: Tracker Payload TLV Format

Tag	Len	Value	
0	1	2	Len

Payload Content:

Table 4: Interface Command Input

Tag	Description	Notes
NAV from PCB antenna	NAV message scanned on the GNSS PCB antenna	
NAV from Patch antenna	NAV message scanned on the GNSS Patch antenna	
Data from Wi-Fi scan	Data from Wi-Fi scan	
Data from accelerometer	Data collected from accelerometer	
Modem charge value	Modulation of a given radio	Value in mAh
Tracker board voltage	MCU Interval voltage	Value in mV

Payload Format:

Table 5: Table 4 Interface Payload Format

Command	Tag	Len	Value	Comment
NAV from PCB antenna	0x06	variable	NAV	
NAV from Patch antenna	0x07	variable	NAV	
Data from Wi-Fi scan	0x08	variable	[RSSI (1 byte)] [MAC (6 bytes)]	Mac in big endian
Data from accelerometer	0x09	9	[move_history (1 byte)] [x (2 bytes)] [y (2 bytes)] [z (2 bytes)] [temperature (2 bytes)]	The value larger than one byte are in **big endian**
Modem charge value	0x0A	4	Charge in mAh	The value larger than one byte are in **big endian**
Tracker board voltage	0x0B	2	Voltage in mV	The value larger than one byte are in **big endian**

Example:

Payload:

```
07460142E1092808C23CA944A72AE9034452B5BB61A600E0A4F28EC5300F80511D2886367D8
6B25A9C95F4C5186C90C09432E3D41ECA28DC53B8A99640D3249874557F1FD7873F01
```

[TAG][LEN][NAV]

In this case:

```
[07][46][0142E1092808C23CA944A72AE9034452B5BB61A600E0A4F28EC5300F80511D
2886367D86B25A9C95F4C5186C90C09432E3D41ECA28DC53B8A99640D3249874557F1FD
7873F01]
```

`0x07` is the tag of the patch antenna

`0x46` is the length of the NAV

`0815AF18D6C7AFDC18A200197033F44DA674DA884EF86A`

[TAG][LEN][RSSI][MAC] [RSSI][MAC] [RSSI][MAC]

In this case

`[08][15][AF][18D6C7AFDC18][A2]00197033F44D][A6][74DA884EF86A]`

`0x06` is the tag of the Wi-Fi scan

`0x15` is the length of the Wi-Fi scan

RSSI in an int8 value

Data from accelerometer:

- X / Y / Z acceleration are represented in milli-g
- Temperature is represented in °C
- Move history bit field :
    - This bit field represents a movement history from the tracking device for each of the last eight uplinks

Table 6: Move History Bit Field

	MSB							LSB
Bit	7	6	5	4	3	2	1	0
Uplink Fcnt	Fcnt -7	Fcnt -6	Fcnt -5	Fcnt -4	Fcnt -3	Fcnt -2	Fcnt -1	Fcnt

Each bit represents whether or not the tracker has moved:

- 0: LoRa Edge Tracker Reference Design device has not moved
- 1: LoRa Edge Tracker Reference Design device has moved

Examples:

Move History Bit Field: 0b 0000 0001. This means that the tracking device has moved on last uplink.

Move History Bit Field: 0b 0001 0000. This means that the tracking device moved four uplinks ago.

Move History Bit Field: 0b 1001 0001. This means that the tracker moved seven uplinks ago, four uplinks ago, and again just now.

4.1.2.2 Configurable Tracking Device Parameters

This chapter describes the mobile application specification for the Semtech LoRa Edge Tracker Reference Design. The main goal of this application is to connect a mobile device, such as a smartphone, to the tracking device though a BLE connection. Once connected, the app can read and write a number of parameters, update the LoRa Basics Modem-E, update the LoRa Edge Config firmware and update the almanac.

The communication shall be in a TLV format, as is used for the payload. The supported configurable parameters by the LoRa Edge Config application are:

Table 7: Configurable Parameters

Command	Tag	Len	Value	Comment
Read FW version	0x01	0	Return len 3 (Major/Minor/SubMinor)	
Set LoRaWAN DevEUI	0x02	8		MSB First
Get LoRaWAN DevEUI	0x03	0	Return len 8	
Set LoRaWAN JoinEui	0x04	8		MSB First
Get LoRaWAN JoinEui	0x05	0	Return len 8	
Set LoRaWAN AppKey	0x06	16		MSB First
Get LoRaWAN AppKey	0x07	0	Return len 16	
Set GNSS feature enable	0x08	1	Return len 1 0 = disable / 1 = enable	
Get GNSS feature enable	0x09	0		
Set GNSS Constellation	0x0A	1	0 = GPS only / 1 = BEIDOU only / 2 = GPS & BEIDOU	
Get GNSS Constellation	0x0B	0	Return len 1	
Set GNSS assistance position	0x0C	8	Return len 8 4 bytes for Latitutde / 4 bytes for Longitude	Bytes 0 to 3 = Latitude Bytes 4 to 7 = longitude
Get GNSS assistance position	0x0D	0		
Set GNSS antenna used	0x0E	1	Return len 1 1 = Patch / 2 = PCB / 3 = both	
Get GNSS antenna used	0x0F	0		
Set GNSS Scan mode	0x10	1	Return len 1 1 = Assisted / 2 = Autonomous	
Get GNSS Scan mode	0x11	0		
Set GNSS search mode	0x14	1	Return len 1 0 = Default / 1 = Best effort	
Get GNSS search mode	0x15	0		
Set Wi-Fi feature enable	0x16	1	Return len 1 0 = disable / 1 enable	
Get Wi-Fi feature enable	0x17	0		
Set Wi-Fi Channels	0x18	2	Return len 2	

Command	Tag	Len	Value	Comment
Get Wi-Fi Channels	0x19	0	Bit field on 2 bytes	
Set Wi-Fi Type	0x1A	1	Return len 1 1 = type B / 2 = Type G/N	
Get Wi-Fi Type	0x1B	0		
Set Wi-Fi Scan Mode	0x1C	1	Return len 1 1 = mode Beacon / 2 = Mode Beacon & Packet	
Get Wi-Fi Scan Mode	0x1D	0		
Set Wi-Fi retrials	0x1E	1	Return len 1 1 to 255	
Get Wi-Fi retrials	0x1F	0		
Set Wi-Fi Max results	0x20	1	Return len 1 1 to 32	
Get Wi-Fi Max results	0x21	0		
Set Wi-Fi Timeout	0x22	2	Return len 2 20 to 5000	
Get Wi-Fi Timeout	0x23	0		
Set use accelerometer	0x24	1	Return len 1 0 = disable / 1 enable	
Get use accelerometer	0x25	0		
Set Scan Interval	0x26	2	Return len 2 10 to 1800	
Get Scan Interval	0x27	0		
Set Keep alive frame interval	0x28	2	Return len 2 10 to 1440	
Get Keep alive frame interval	0x29	0		
Flush Internal log	0x2A	0	Return len 0	
Reset board	0x2B	0	Return len 0	
Set Almanac update	0x2C	12	Return len 12 Block ID [2 bytes]/ almanac fragment [10 bytes]	
Get last almanac update date	0x2D	4	Return len 4 Date in second	
Fuota Modem start	0x31	146	Block ID [2 bytes]/ modem image fragment [144 bytes]	
Get hardware version	0x32	0	Return len 4	
Get LoRaWAN Stack Version	0x33	0	Return len 2	
Get Modem Version	0x34	0	Return len 3 (Major/Minor/SubMinor)	
Set Region	0x35	1	1 Means EU868 / 3 means US915	
Get Region	0x36	0	1 Means EU868 / 3 means US915	
Set Airplane mode	0x37	1	0 means disable / 1 means enable	
Get Airplane mode	0x38	0	0 means disable / 1 means enable	
Get Pin	0x39	0	Return len 4	MSB First
Set usage of Semtech LoRa Cloud Join Server	0x3A	1	0 = Disable / 1 = Enable	
Get usage of Semtech LoRa Cloud Join Server	0x3B	0	0 = Disable / 1 = Enable	

Command	Tag	Len	Value	Comment
Set Do/Don't perform GNSS When Wi-Fi result is enough	0x3C	1	0 = Disable / 1 = Enable	
Get Do/Don't perform GNSS When Wi-Fi result is enough	0x3D	0	0 = Disable / 1 = Enable	
Set ADR Profile	0x3E	1		
Get ADR Profile	0x3F	0		
Get Board Voltage	0x40	0	Return voltage in mV on 2 bytes	
Set Internal Log	0x41	1	0 = Disable / 1 = Enable	
Get Internal Log	0x42	0		
Read Internal Log	0x43	146	See chapter	

4.1.2.3 How to Flash M0+ Dedicated to BLE

The Semtech LoRa Edge Tracker Reference Design already has a BLE stack programmed into the M0+ core. However, if for some reason the stack needs to be reprogrammed or updated, here are the steps to follow.

1) Install STM32CubeProgrammer:

2) Install the STM32WB Cube Package:

Figure 29: Install STM32WBxx Package

Once installed, the necessary .bin file(s) are in the following folder:

C:\Users\...\STM32Cube\Repository\STM32Cube_FW_WB_V1.8.0\Projects\STM32WB_Copro_Wireless_Binaries\STM32WB5x

Copy and paste the **.bin** file(s) into the **STM32CubeProgrammer bin** folder:

C:\Program Files\STMicroelectronics\STM32Cube\STM32CubeProgrammer\bin

3) Switch the STM32WB55 to bootloader mode

   a) Maintain the BOOT0 pin in high level while the tracker is resetting
   b) Connect STM32WB55 USE lines to a computer/laptop

4) Open a Command Prompt window

a) Navigate to the STM32CubeProgrammer bin folder:

```
cd C:\Program
Files\STMicroelectronics\STM32Cube\STM32CubeProgrammer\bin
```

b) Delete the existing firmware:

```
STM32_Programmer_CLI.exe -c port=usb1 –fwdelete
```

c) Read and upgrade the FUS version:

```
STM32_Programmer_CLI.exe -c port=usb1 -r32 0x20030030 1
```

```
C:\Program Files\STMicroelectronics\STM32Cube\STM32CubeProgrammer\bin>STM32_Programmer_CLI.exe -c port=usb1 -r32 0x20030030 1
      -------------------------------------------------------------------
                        STM32CubeProgrammer v2.3.0
      -------------------------------------------------------------------



USB speed   : Full Speed (12MBit/s)
Manuf. ID   : STMicroelectronics
Product ID  : DFU in FS Mode
SN          : 20893277554D
FW version  : 0x011a
Device ID   : 0x0495
Device name : STM32WBxx
Flash size  : 1 MBytes
Device type : MCU
Device CPU  : Cortex-M0+/M4


Reading 32-bit memory content
  Size          : 4 Bytes
  Address:      : 0x20030030

0x20030030 : 01010000
```

Figure 30: Check FUS Version

If the **FUS version** is as follows, install the stack firmware:

0x20030030: 00050300: FUSv0.5.3:

```
STM32_Programmer_CLI.exe -c port=usb1 -fwupgrade
stm32wb5x_FUS_fw_1_0_2.bin 0x080EC000 firstinstall=0

0x20030030: 01000100 or 01000200: FUSv1.0.x

STM32_Programmer_CLI.exe -c port=usb1 -fwupgrade
stm32wb5x_FUS_fw.bin 0x080EC000 firstinstall=0

0x20030030: 01010000: FUSv1.1.0 => Up to date
```

Command to install the stack firmware:

```
STM32_Programmer_CLI.exe -c port=usb1 -fwupgrade
stm32wb5x_BLE_Stack_full_fw.bin 0x080CB000 firstinstall=1
```

```
erasing sector 0232 @: 0x080e8000 done
erasing sector 0233 @: 0x080e9000 done
erasing sector 0234 @: 0x080ea000 done
erasing sector 0235 @: 0x080eb000 done
erasing sector 0236 @: 0x080ec000 done
erasing sector 0237 @: 0x080ed000 done
erasing sector 0238 @: 0x080ee000 done
erasing sector 0239 @: 0x080ef000 done
erasing sector 0240 @: 0x080f0000 done
erasing sector 0241 @: 0x080f1000 done
erasing sector 0242 @: 0x080f2000 done
erasing sector 0243 @: 0x080f3000 done
Download in Progress:
                                                  100%

File download complete
Time elapsed during download operation: 00:00:03.591

FUS state is WIRELESS_STACK_UPGRADE_ONGOING

FUS status is FUS_IMAGE_NOT_AUTHENTIC

FUS state is FUS_IDLE

FUS status is FUS_NO_ERROR

Firmware Upgrade process started ...

Updating firmware ...
Waiting for firmware upgrade end

FUS state is WIRELESS_STACK_UPGRADE_ONGOING

FUS status is FUS_NO_ERROR

FUS state is FUS_ERROR

FUS status is FUS_NOT_RUNNING
Firmware Upgrade Success
```

Figure 31: Flash BLE Stack Firmware

4.1.3 Mobile Application: LoRa Edge Config

LoRa Edge Config is a mobile application developed to accompany the LoRa Edge Tracker Reference Design. The purpose of this app is to help users configure and update tracking devices.

4.1.3.1 Starting Screen

The key elements on this screen are the menu icon and the scanning icon, as shown in Figure 32

Figure 32: LoRa Edge Config Starting-Screen

4.1.3.2 Settings Page

On the **Settings** page, you can configure the following items.

- **Device filter:** Select the type of devices to display when conducting a scan:
  - Show all devices
  - Show only Semtech LoRa Edge Tracker Reference Design devices
  - Show only devices with custom name prefixes
- **Inspector Mode:** Selecting *Advanced mode* will display all parameters on the **Parameters** page. Selecting **Basic mode** will cause the **Parameters** page to display only profile data.
- **Share latest internal log file:** Send the latest internal log file to someone (for example, via email)
- **Authentication Token:** The authentication token generated by the LoRa Cloud Device Join service. Clicking on the token will open the smartphone camera application and allow you to scan the QR code containing the authentication token generated by the LoRa Cloud Device Join service.

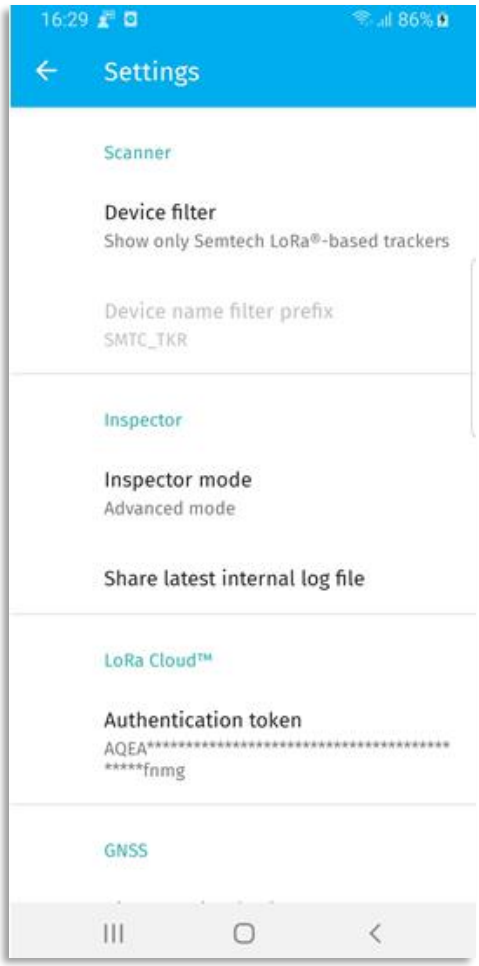


Figure 33: Settings Page - Top

- **Almanac Cloud URL:** the URL used by the app to fetch the almanac
- **Almanac:** The version of the locally-installed almanac
- **Firmware manifest URL:** The URL of the firmware manifest for the LoRa Edge Config application and the modem

- **LoRa Basics Modem-E firmware:** Firmware version currently installed on the Basic Modem-E
- **Tracker app firmware:** Notice of the firmware version currently installed on the LoRa Edge Tracker Reference Design devices
- **Get firmware from USB storage:** When checked, fetches the active firmware update from the USB storage location

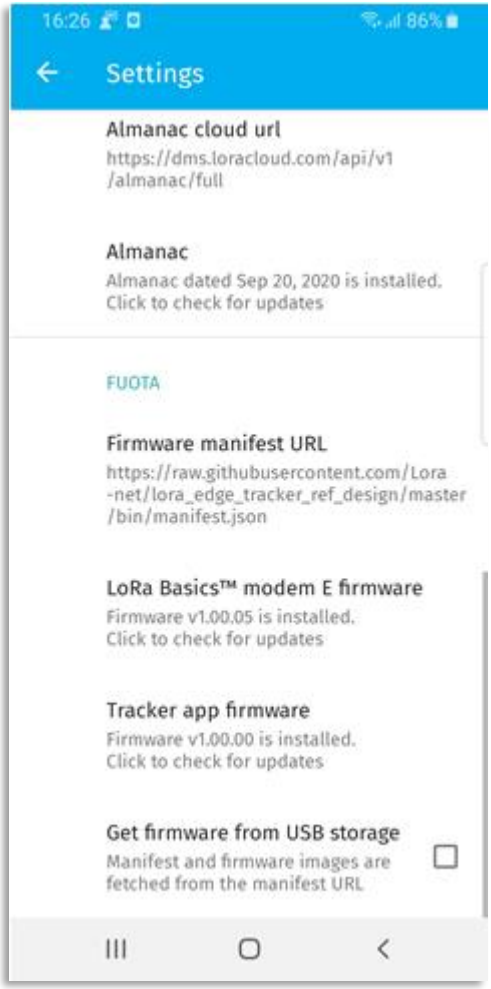


Figure 34: Settings Page - Bottom

4.1.3.3 Scanner Page

The **Scanner** page contains the following elements:

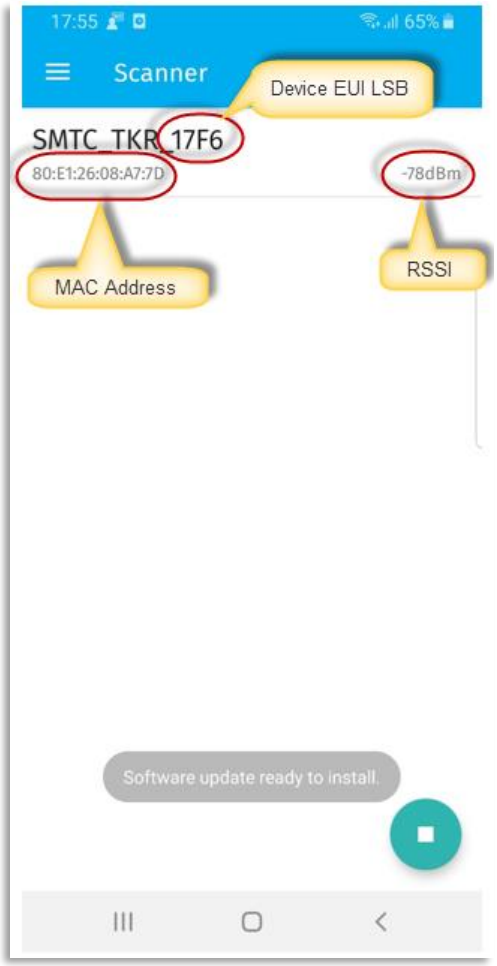


Figure 35: Scan Page

4.1.3.4 Configuration Page

There are two types of configuration pages, *Basic* and *Advanced*. In *Basic* mode, the profile parameter is pushed to the tracker. In *Advanced* mode, users can access all parameters.

4.1.3.4.1 Advanced Settings

LoRa Edge Config has a number of features and functions. It can be used to update both the LoRa Edge Tracker Reference Design application firmware on a device and to update the modem firmware. Additionally, the app will indicate, in the **Versions and FUOTA** section of the user interface, whether updates are available.

The **Versions and FUOTA** section displays the following information and functionality:

- **Application Firmware Version:** The LoRa Edge Tracker Reference Design firmware application version(Major/Minor/SubMinor)
- *Function – Update Application firmware:* Used to update the application firmware when an update is available. When the application firmware is updated, the tracker will be reset.
- **LoRaWAN Protocol Version:** The wireless stack firmware version (this is the LoRaWAN stack version) (Major/Minor)
- **LoRa Basics Modem-E firmware version:** The version of the LoRa Basics Modem-E firmware in use *Function – Update LoRa Basics Modem-E firmware:* Used to launch a firmware update over the air **(**FUOTA) for the end node. When the firmware is updated, the tracker will be reset.
- **Hardware Version:** The version of the LoRa Edge Tracker Reference Design hardware

Note: If the update button is greyed-out, it means that the versions are already up-to-date.

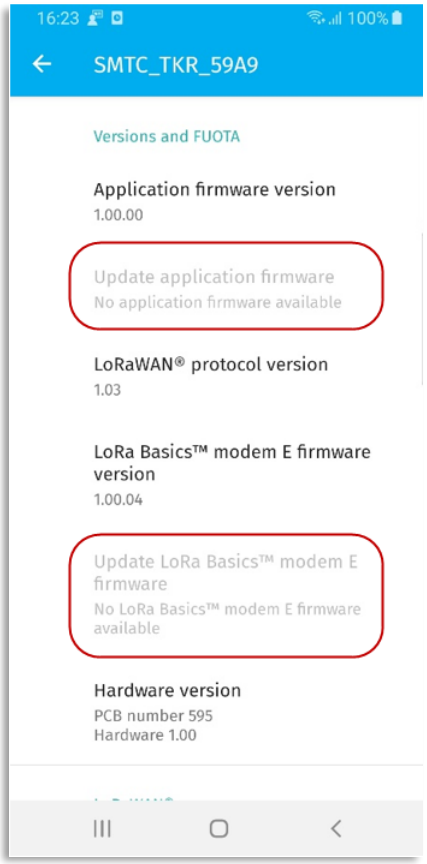


Figure 36: Version and FUOTA Section

The **LoRaWAN** section displays the LoRaWAN key information:

- **LoRaWAN Device EUI:** The Device EUI (If if the Device EUI hasn't been changed, this is also the Chip EUI)
- **LoRaWAN Join EUI:** The LoRaWAN Join EUI
- **LoRaWAN App Key:** The LoRaWAN AppKey (when the tracking device doesn't use the Semtech Device Join service)

- **LoRaWAN Region:** The LoRaWAN Region (EU868/US915). When the region is changed, the tracking device will bereset.
- **Semtech LoRa Cloud Join Server mode:** Checking this box will cause the tracker to use the Semtech LoRa Cloud Join Server. Changing this parameter will reset the tracker.
- **LR1110 PIN code:** The LR1110 PIN necessary for claiming the device
- **ADR profile when tracker is moving:** The adaptive data rate (ADR) strategy to be used when the tracker is moving. The choices are:
    - Network controlled
    - Mobile low power
    - Long range low power
    - Custom profile

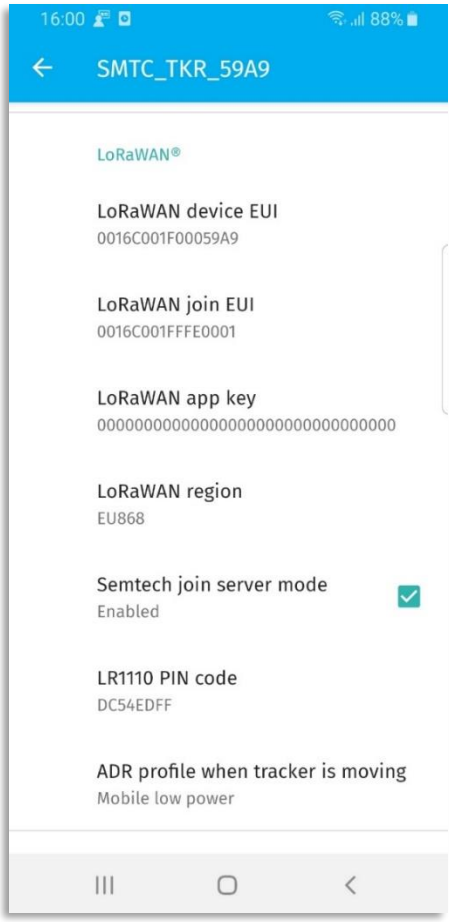


Figure 37: LoRaWAN Section

If you want to use GNSS estimation for the LoRa Edge Tracker Reference Design, you must enable it by checking the **GNSS feature** checkbox in the **GNSS** section of the LoRa Edge Config user interface (as illustrated in Figure 38), which will update the almanac.

Note: You might need to scroll down past the **LoRaWAN** section to see the **GNSS feature** checkbox

The **GNSS** section displays the GNSS parameters and associated functionality, as illustrated in Figure 38:

- **GNSS feature:** Enable or disable GNSS scanning
- **Almanac updated on:** Date of the most recent almanac update
- **Update almanac:** Used to update the Almanac. If the button is greyed-out, the almanac is already up-to-date
- **GNSS constellation:** The GNSS constellation used
- **GNSS assistance position:** The latitude and longitude used to enhance the accuracy of locating a device indoors
- **Set GNSS assistance position with last known location:** Uses the last known GPS location of the tracking device to aid in locating the device with a GNSS scan
- **GNSS antenna:** Allows you to select the GNSS antenna to be used for scanning
- **GNSS scan type:** Select the type of GNSS scan to perform
- **GNSS search mode:** Select the GNSS serach mode
- *Function – Force GNSS scan after Wi-Fi scan***:** If checked, causes a GNSS scan to be conducted if the Wi-Fi scan is not sufficient to determine the location of the device.

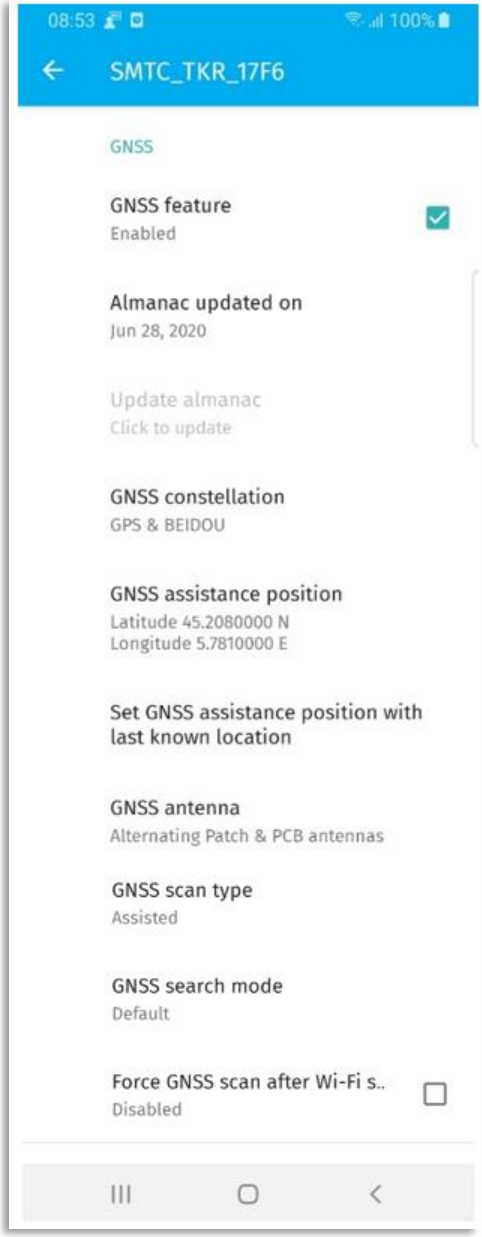


Figure 38: GNSS Section

You can set the device to receive position assistance data at your approximate location. The input will take "+" for positive latitude (North) and "-" for negative latitude (South). Similarly for positive longitude (East) use "+" and use "-" for negative longitude (West). The display will ALWAYS show "N" or "E" after latitude or longitude respectively, even if you are at southern latitudes or western longitudes. The minus sign (-) sign however, takes precedence. To facilitate setting the assistance position, you can use the **Set GNSS assistance position with last known location** option, as shown in Figure 39.

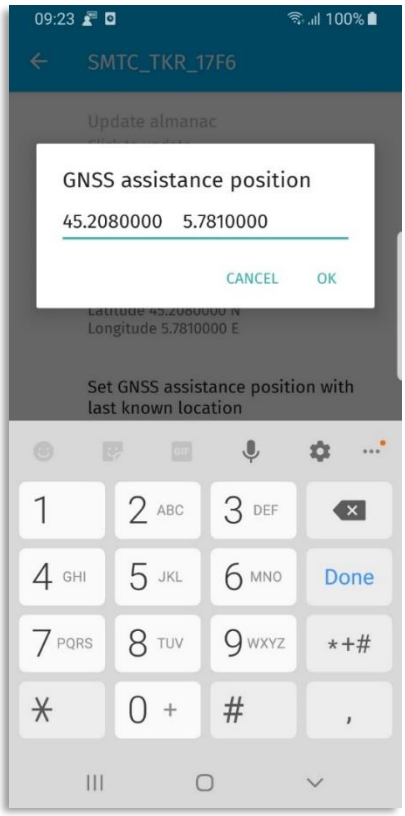


Figure 39: GNSS Assistance Position

If you want to use Wi-Fi to scan for a LoRa Edge Tracker Reference Design device, enable Wi-Fi scanning by checking the **Wi-Fi feature** box in the LoRa Edge Config application.

Note: You might need to scroll down past the **GNSS** section to find this:

The **Wi-Fi** section (Figure 40) displays the following Wi-Fi scan parameters:

- **Wi-Fi feature:** Enable or disable Wi-Fi scanning
- **Wi-Fi channels:** Select which Wi-Fi channels to use when scanning
- **Wi-Fi Type:** Select the type of Wi-Fi to use for scanning (802.11 a, 802.11b, 802.11d, 802.11g, 802.11n)
- **Wi-Fi scan mode:** Select Beacon mode (scan Wi-Fi beacons only) or Beacon and Packet mode (scan both Wi-Fi beacons and data packets)
- **Wi-Fi retries:** Specify the number of times to conduct a Wi-Fi scan for a tracker
- **Wi-Fi max results:** The maximum number of MAC addresses returned
- **Wi-Fi timeout (ms):** Time (in milliseconds) after which a Wi-Fi scan will cease if no trackers have been located

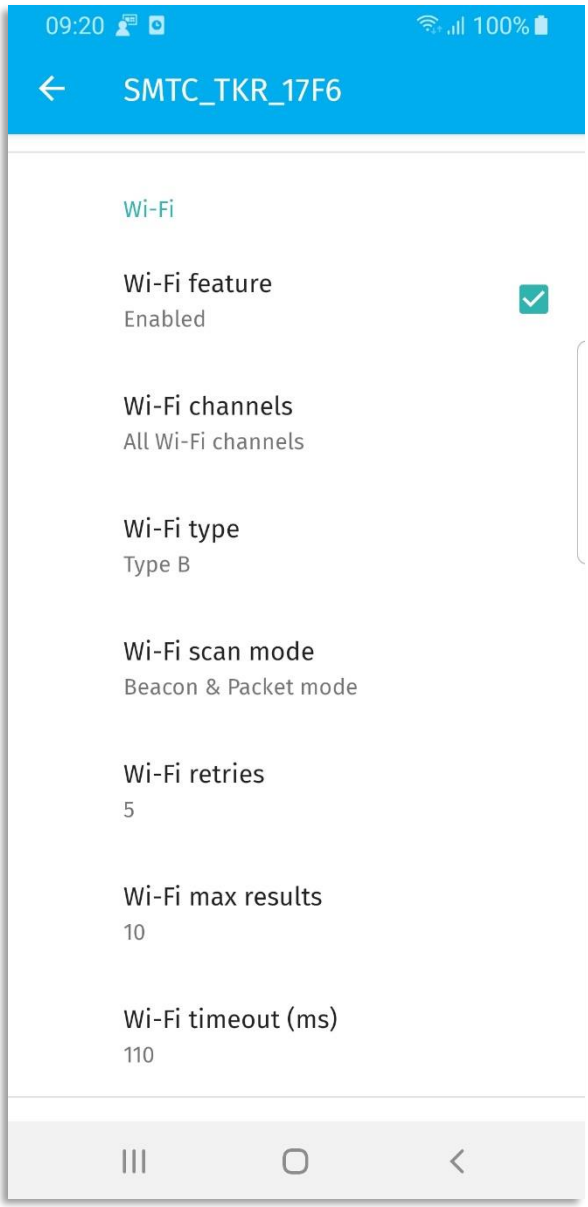


Figure 40: Wi-Fi Section

The **Miscellaneous** section displays the following additional parameters and functionality not categorized elsewhere:

- *Function – Airplane mode:* Enables or disables Airplane Mode. Changing this option will reset the tracking device.
- *Function* – Use accelerometer: Enables or disables the acceleromter
- **Scan interval (seconds):** The duration of the scan interval, in seconds
- **Keep alive frame interval (minutes)** The duration between keep-alive transmissions, in minutes
- **Board voltage:** The voltage of the board
- *Function – Internal log*: Enables and activates, or disables and stops, logging
- *Function – Read internal log*: Allows the internal log to be read
- *Function – Flush field test log:* Deletes the internal log

- *Function – Reset board:* Causes the tracker to be reset

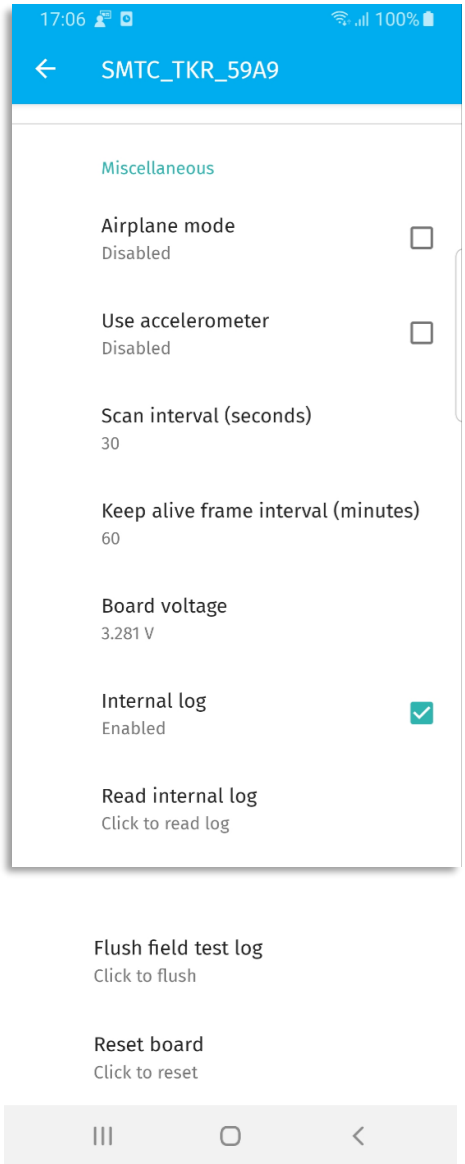


Figure 41: Miscellaneous Section

4.1.3.4.2 Basic Settings

To facilitate tracking device configuration, you can use the *Basic* mode setting. To access this setting, open the **Settings** screen and set **Inspector Mode** to *Basic Mode*.

The basic settings include:

- **Data rate:** The data rate for transmitting packets
  - Low Data Rate:
    - use accelerometer = enable
    - Scan interval = 1800s (30min)
  - Medium Data Rate:
    - use accelerometer = enable
    - Scan interval = 600s (10min)
  - Default Data Rate:
    - use accelerometer = enable
    - Scan interval = 300s (5min)
  - High Data Rate:
    - use accelerometer = disable
    - Scan interval = 30s
- **Accuracy:** The type of accuracy required when scanning for the location of a tracker

  Note: When these settings are applied, the rest of the parameters remain unchanged

  - Default accuracy
    - GNSS Scan mode: assisted
    - GNSS Search mode: Default
    - GNSS Antenna sel: both
    - Wi-Fi Channels: Chan_1 / Chan_6 / Chan_11
    - Wi-Fi Nb retrials: 5
    - Wi-Fi Max result: 10
  - High accuracy
    - GNSS Scan mode: assisted
    - GNSS Search mode: Best effort
    - GNSS Antenna sel: both
    - Wi-Fi Channels: ALL
    - Wi-Fi Nb retrials: 10
- **Wi-Fi Max result:** 32
- **GNSS feature:** Enables or disables GNSS scanning functionality
- **Wi-Fi feature:** Enables or disables Wi-Fi scanning functionality
- **GNSS assistance position**: The latitude and longitude to use for enhancing the geolocation accuracy of tracking devices
- **Airplane mode:** Enables or disables Airplane mode

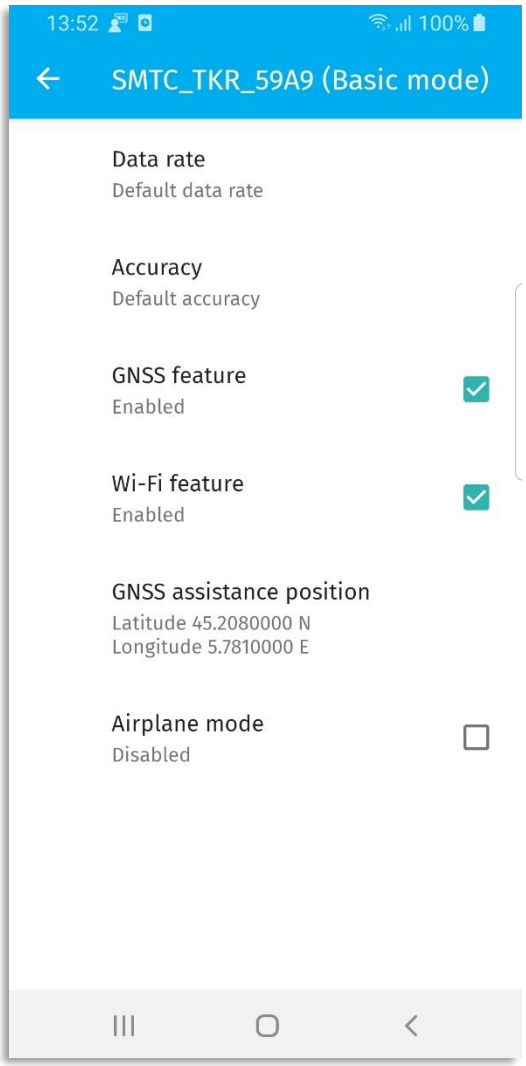


Figure 42: Basic Settings Page

4.1.3.5 Activate and Read the Internal Log

The LoRa Edge Tracker Reference Design can store the following data in its internal flash memory:

- Wi-Fi passive scan results
- GNSS scanresutls from both antennas
- Acceleration values
- Temperature values

4.1.3.5.1 Activate the Internal Log

To activate the internal log, the parameter **Internal log** checkbox in the **Miscellaneous** section must be checked, as shown in Figure 43:

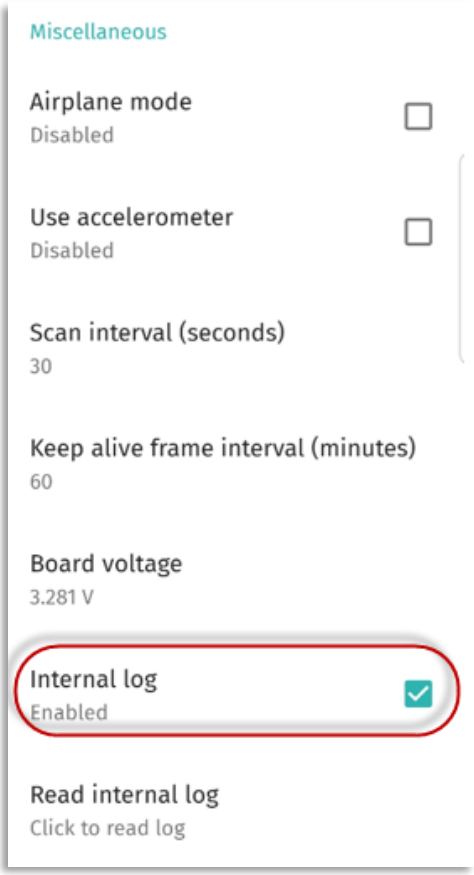


Figure 43: Enable and Activate Internal Logging

4.1.3.5.2 Read the internal log

To read the internal log, in the **Miscellaneous** section of the page, click **Read internal log**. The application will start to download the internal log from the tracking device, as illustrated in Figure 44.

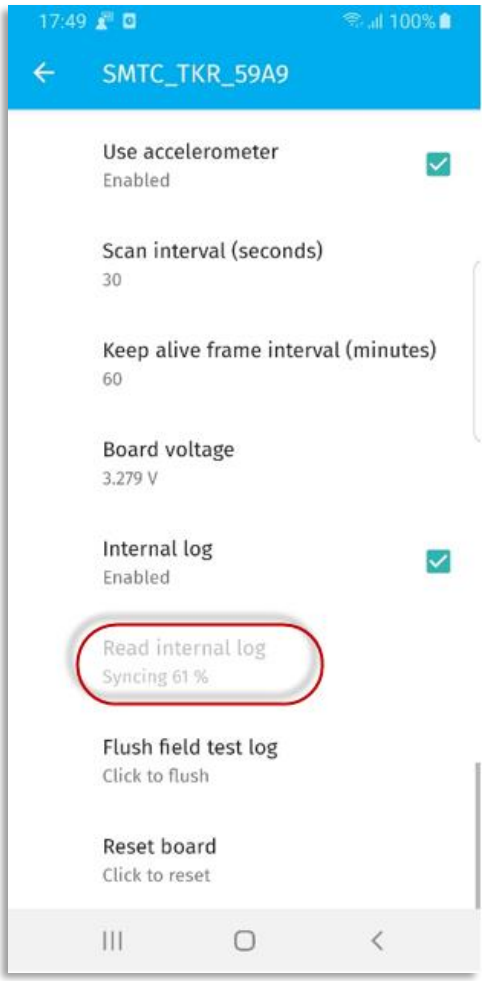


Figure 44: Read Internal Log

Once the internal log is fully received by the mobile application, a pop-up dialog box (Figure 45) with the following choices is displayed

- **SHARE**: An email will be sent (to an address defined by the user) containing the file internal_log_date.txt.
- **LATER**: The log file will not be sent. However, it will be stored in the USB storage. The email will be not sent. However, the log file can be shared by clicking on **Share latest internal log file** in the settings.

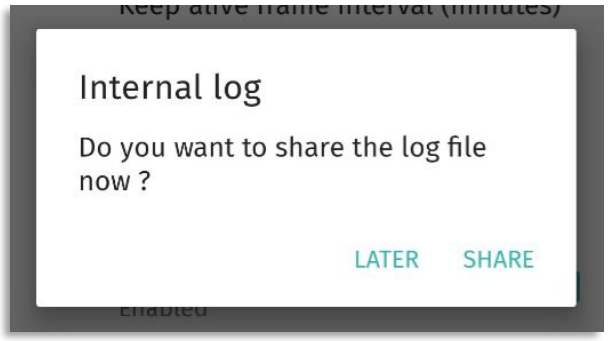


Figure 45: Internal Log Dialog Box

Once the internal log file is received, it can be pushed through a Python script. The Python script will parse and push the data to the LoRa Cloud solver, which will resolve the positions and return a *.kml file.

Figure 46 shows a sample of an internal log file

```
[2020-8-26 10:48:36.000] [72 - 4] 144,0,1044
[2020-8-26 10:48:36.000] [73 - 5] 34.56
[2020-8-26 10:48:36.000] [74 - 2] 010109100B68080201A859820051006852EDE525656F51A4F6D24CE2707650BD6A8B8D9F6DB3FACA4CE344CB67F582125807A4CAAABD39D918E394D566A010EB8145C0A
[2020-8-26 10:48:36.000] [75 - 1] 01010A100B6808022BA95ED6E263000052A916A7A20050A892B184E3507A50154764905F54A39A4B9032FB9960D5E684D00F72D8205E5512AB427024B3878B8053AD647
[2020-8-26 10:50:22.000] [76 - 4] 64,0,1044
[2020-8-26 10:50:22.000] [77 - 5] 33.28
[2020-8-26 10:50:22.000] [78 - 2] 010110100B6808E212A8D4F0DAB133015435DD10A068A2A85EBD2E609FF259EDF745CC81EDB0BA68A602FF9C62D5C26CE28697CDAA5F303B1384,0,0,0
[2020-8-26 10:50:22.000] [79 - 1] 010110100B68082215A8D3212337C40052994DB09F104DA496FAAAC96EB25185D2236942EEA33AA18799434A4515C08A460C118AEA01DEFAF55282D51723C43E9034AB3
[2020-8-26 10:51:34.000] [80 - 4] -257,0,1044
[2020-8-26 10:51:34.000] [81 - 5] 33.28
[2020-8-26 10:51:34.000] [82 - 2] 010115100B6808023FA90253D83728515251F9E7AD474AA4B619CEC4BE04505D69A77902EDB0EA6C28E63EF0669513867889A6CA6AA4F95C18518A55457FE51AE0A4C2A
[2020-8-26 10:51:34.000] [83 - 1] 010115100B68080213A9C76888B147515227AF71AF77FAA8A2C428E0F0B451F5A60760620AA0FA081BF9049A6235A69BC386A6C3EADD1CB5FB6895551F53CC3086C5B6A
[2020-8-26 10:52:50.000] [84 - 4] -96,0,1044
[2020-8-26 10:52:50.000] [85 - 5] 33.28
[2020-8-26 10:52:50.000] [86 - 2] 010119100B6808622BA9BE7BE360C0245283F618613F3AA46E07ECB50F47512D27A5B79E5CB1FAABAE4B03146015D094CA8939CDAAB4442AECE59FD55F1D9C1B964A83E
[2020-8-26 10:52:50.000] [87 - 1] 01011A100B6808622BA91AE6EA60B05052235428AF07F8A4EE0D13DD0070481D16546B1F40935AF8090E3B4B42D5FF8015F661802A1805A113E1A541AC01C2064D58275
[2020-8-26 10:54:5.000] [89 - 4] -241,0,1044
[2020-8-26 10:54:5.000] [90 - 5] 34.56
[2020-8-26 10:54:5.000] [91 - 2] 01011E100B68082215A9E7EFA833485552C75242C028FDA4CE47ADD5507A487DA94C617F8AA27A39B6677DB84635DF03F0F512C02A0F9E80132EA5C1716C2556430E475F
[2020-8-26 10:54:5.000] [92 - 1] 01011E100B6808220FA8317D71EC130352C9A5749C28A7A4123A8D5A9FA449557A00805D29A11A71B7047BE847F5FD65BF06B48AEA66401018328A55F966D0196036ABA9
[2020-8-26 10:54:5.000] [93 - 3] 68:A3:78:11:B9:14,CHANNEL_1,TYPE_B,-92,0,0,0,0
[2020-8-26 10:54:5.000] [93 - 3] 68:A3:78:11:B9:13,CHANNEL_1,TYPE_B,-90,0,0,0,0
[2020-8-26 10:54:5.000] [93 - 3] 68:A3:78:11:B9:15,CHANNEL_1,TYPE_B,-91,0,0,0,0
[2020-8-26 10:55:48.000] [94 - 4] 32,0,1044
[2020-8-26 10:55:48.000] [95 - 5] 37.12
[2020-8-26 10:55:48.000] [96 - 2] 010124100B6808E228A90F9951D60368523DAC475D07F8A44E1AE2CF0070503542A5547F49B1BAF8331FC30860D5F78FA60996C42A7D89E2EB62,0,0,0
[2020-8-26 10:55:48.000] [97 - 1] 010125100B68080229A9DF86CCD6236D525555F390804BA4020D60C0CEA449D59A8D779DE5A33A7DB64403C04195A74F5CFDC08A2A6B31D017840A55598550198025C1A
[2020-8-26 10:55:48.000] [98 - 3] B8:26:6C:A5:1E:05,CHANNEL_1,TYPE_B,-87,0,0,0,0
[2020-8-26 10:55:48.000] [98 - 3] 68:A3:78:88:9B:07,CHANNEL_1,TYPE_B,-89,0,0,0,0
[2020-8-26 10:57:2.000] [99 - 4] -96,0,1044
[2020-8-26 10:57:2.000] [100 - 5] 38.40
[2020-8-26 10:57:2.000] [101 - 2] 010129100B6808820FA877BD81E9075552258EE8BC30D2A48A81E5B87E24489D1421E2838992BAAD3E65BDD1479533446186A3842A3531C9EB6FA5C1452C295675BA696
[2020-8-26 10:57:2.000] [102 - 1] 010129100B6808422BA8C5DC9B5E007C50CF7F836600D0A4FA6164B90E90487DE4637A1D40908A273BC907C021753F2D367D004A2ACAE6A4F5000AD5E33DD6188036ABA
[2020-8-26 10:57:2.000] [103 - 3] 84:A1:D1:6A:42:DA,CHANNEL_1,TYPE_B,-95,0,0,0,0
[2020-8-26 10:57:2.000] [103 - 3] 70:FC:8F:49:78:37,CHANNEL_1,TYPE_B,-95,0,0,0,0
[2020-8-26 10:57:2.000] [103 - 3] E4:9E:12:CA:FB:C8,CHANNEL_1,TYPE_B,-88,0,0,0,0
[2020-8-26 10:57:2.000] [103 - 3] 14:0C:76:A5:99:AC,CHANNEL_1,TYPE_B,-95,0,0,0,0
[2020-8-26 10:57:2.000] [103 - 3] 68:A3:78:88:9B:07,CHANNEL_1,TYPE_B,-94,0,0,0,0
```

Figure 46: Sample Internal Log Content

Each line in the log file has the following format:

```
[Timestamp][Job counter - Job Type][DATA]
```

There are five possible job types:

1. GNSS NAV message on PCB antenna
2. GNSS NAV message on Patch antenna
3. Wi-Fi passive scan
4. Acceleration value [X,Y,Z]
5. Temperature in °C

To flush the internal log, click **Flush internal log**. The log will be flushed after the BLE connection ceases.

4.1.3.5.3 Push the Internal Log and Get the Tracker Locations

Download the latest LR1110 software packages, available in GitHub at https://github.com/Lora-net/lr1110_evk/wiki/Software-packages.

Unzip the file and follow the installation instructions available here:

https://github.com/Lora-net/lr1110_evk/blob/master/host/doc/install_instructions.md

Once the software is installed:

1) Open a command window

   a) Navigate to the folder where the internal log file is located
   b) Change the directory to that folder using the **cd** command:

```
cd <your_path>
```

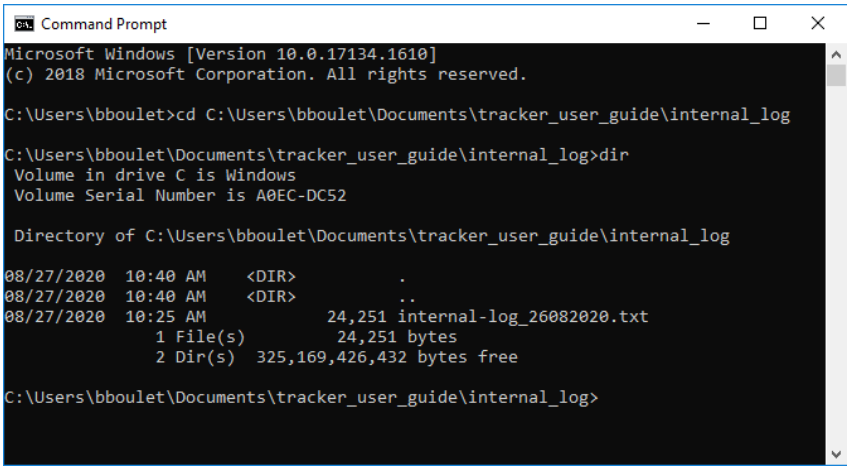


Figure 47: Navigate to the *Internal Log* Folder

2) Use the `FieldTestPost` command to push the internal log to the LoRa Cloud:

```
FieldTestPost -k kml_name.kml -v -u user_define_location
internal_log_date.txt internal_log_date_result.log
user_define_location glsAuthenticationToken dasAuthenticationToken
```

where:

–k: Generates the KML file

–v: Adds verbosity

–u: Defines a static location to be used as reference coordinate, rather than the one in the result file. The format is <latitude>,<longitude>,<altitude>

glsAuthenticationToken: LoRa Cloud Geolocation Service token: https://www.loracloud.com/portal/geolocation/token_usage

Here is an example of a `FieldTestPost` command:

```
FieldTestPost -k internal-log-27-08-2020-08-30-23.kml -v -u
45.240061,5.890768,100 internal-log-27-08-2020-08-30-23.txt internal-
log-27-08-2020-08-30-23.log 45.240061,5.890768,100
AQEAAda2xKcqKu1538j040KguvsqD7CvRPytnfJfMMYQcRHgGO+P
```

During the process you should see these logs:

Figure 48: FieldTestPost Log Example

When the logs have been pushed, a .kml file associated with the internal log should be available in the same folder as the original internal log file.

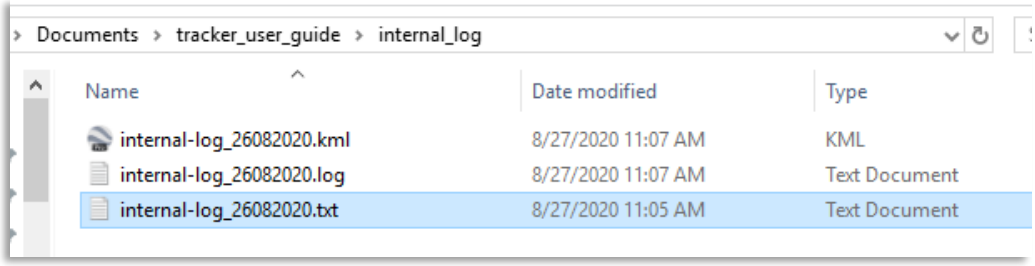


Figure 49: Files generated by the *.kml file

The *.kml file can be opened with Google Earth Pro:

Figure 50: Positions on Google Earth (©Google, 2020)

The yellow pushpin icons represent the location of the tracking devices as determined by the Wi-Fi scan. To obtain the Wi-Fi data related to each location, click on the yellow pushpin. The following information is displayed (as illustrated in Figure 51):

- Date
- Number of MAC address seen
- Access points information

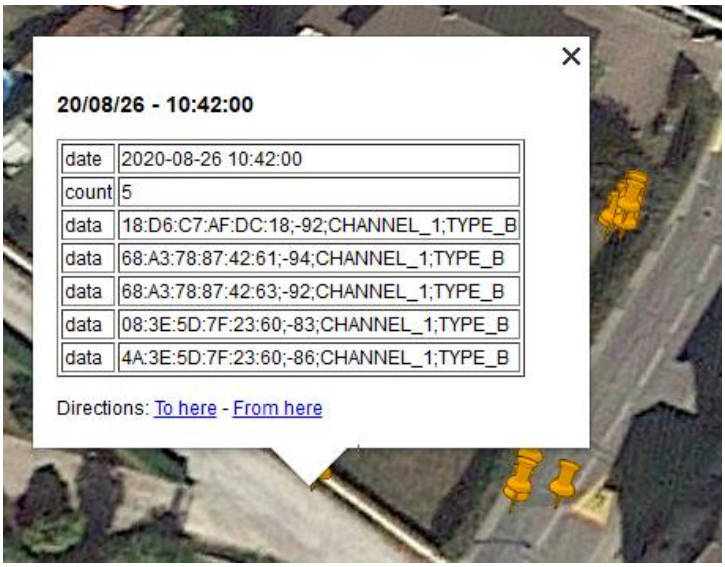


Figure 51: Information Data from a Wi-Fi Scan (©Google, 2020)

The green pushpin icons represent the tracking device locations as determined by a GNSS scan. To obtain the GNSS data related to each location, click on the green pushpin. The following information is displayed, as illustrated in Figure 52

- Date
- Number of satellites seen on GPS constellation
- Number of satellites seen on BEIDOU constellation
- Navigation message

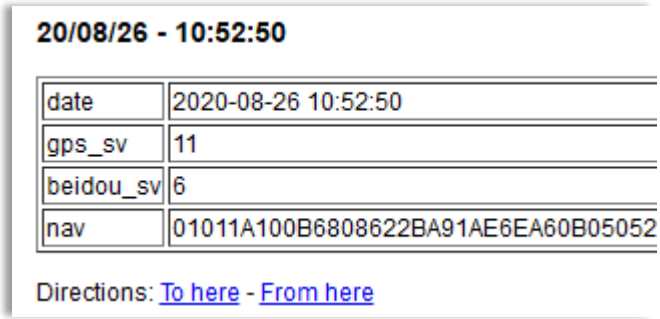


Figure 52: GNSS Position Information

4.1.3.6 FUOTA Files Through USB Storage

LoRa Edge Config allows you to update the application and device firmware via files copied into the appropriate Semtech folder for your mobile device. For instance, **>GalaxyS8\Phone\Semtech**.

To activate this service, on the **Settings** page, check the **Get firmware from USB storage** checkbox.

A Semtech folder will be created at the root folder in the USB storage of your mobile device.

Inside the folder, a **manifest.json** file shall be included to specify the path of the firmware to be updated.

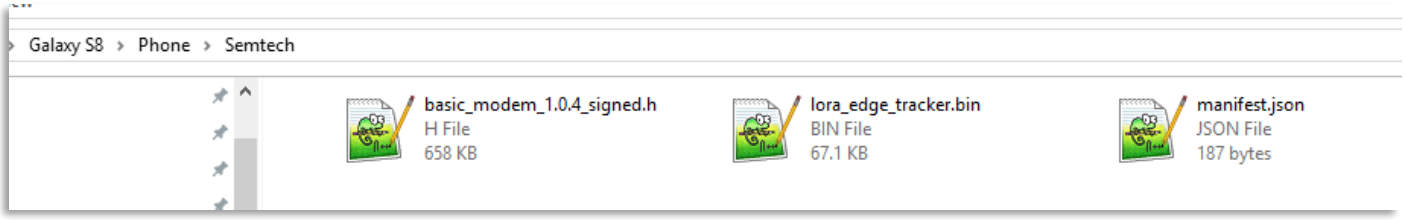


Figure 53: Semtech folder

The manifest.json file must have the following format:

```
{
"lora_modem": {
    "version": "1.00.04",
    "url": "basic_modem_1.0.4_signed.h"
    },
    "tkr_app": {
    "version": "0.01.03",
    "url": "lora_edge_tracker.bin"
    }
}
```

4.1.3.7 Troubleshooting Firmware Updates Over the Air

4.1.3.7.1 Application Update

If something goes wrong during the application update (a disconnection for instance) the application firmware will be removed from the LoRa Edge Tracker Reference Design device, however, the bootloader will still be there.

In this case, the device will restart and will stay in bootloader mode:

- The tracker will stay in pairing mode (the red led will blink) with the following name advertised: *SMTC_THR_OTA*

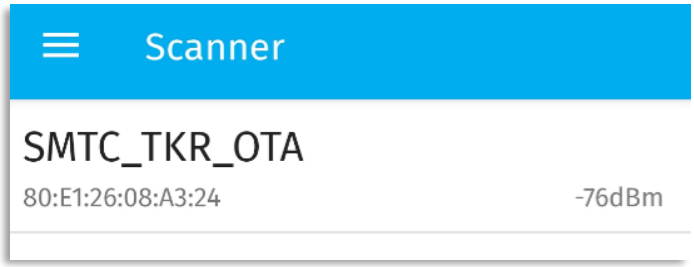


Figure 54: LoRa Edge Tracker Reference Design device in bootloader mode

- Once connected to the tracker the app will fail to retrieve the LoRa Tracker configuration parameters but you will be able to update the application firmware, as shown in Figure 55.

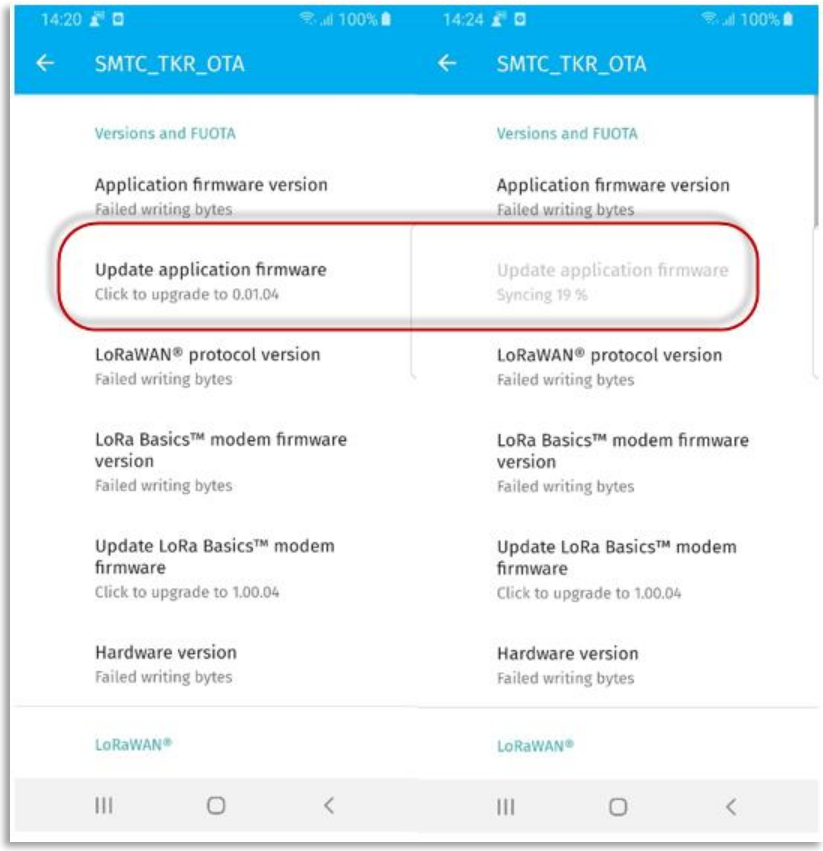


Figure 55: Flashing the Application from the Bootloader

4.1.3.7.2 LoRa Basics Modem-E Update

If something goes wrong during the LoRa Basics Modem-E update (a disconnection for instance) there will be no LoRa Basics Modem-E firmware in the tracking device but the application will start anyway.

- The tracking device will stay in pairing mode (the red led will blink) with the name *SMTC_TKR_XXX* advertised
- Once connected to the tracking device, the app will fail to retrieve the LoRa Basics Modem-E parameters but you will be able to update the LoRa Basics Modem-E firmware

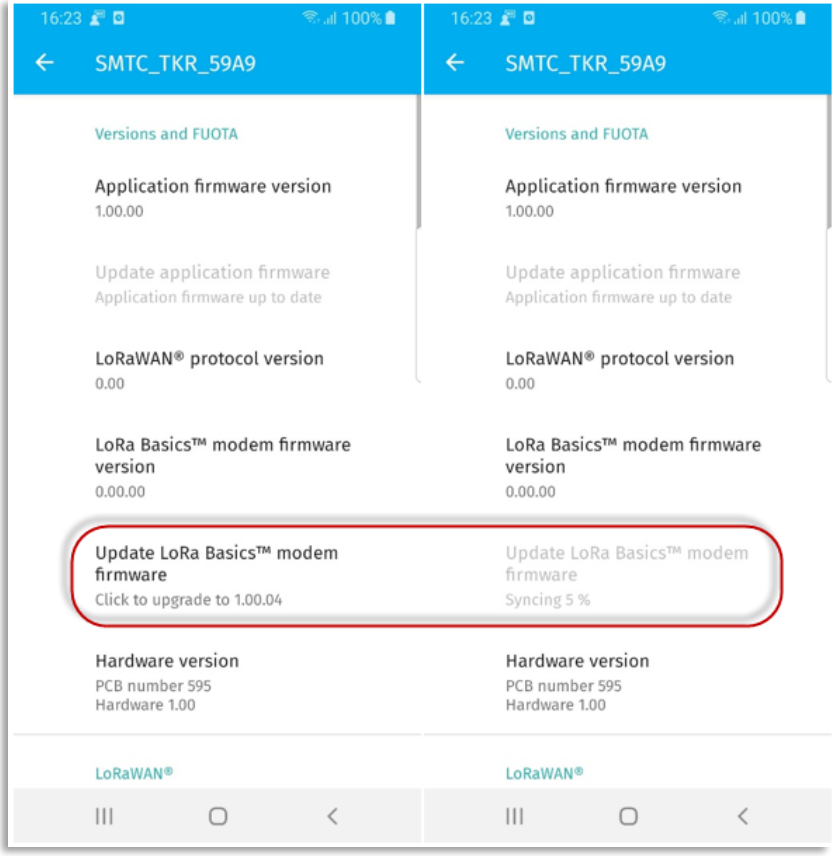


Figure 56: Flash LoRa Basics Modem-E Firmware

5. Setting Up the Semtech LoRa Edge Tracker Reference Design

5.1 Set up and Operate the Semtech LoRa Edge Tracker Reference Design

The Semtech LoRa Edge Tracker Reference Design devices are shipped in airplane mode to ensure that they do not transmit while in transport. This section provides the instructions for setting up these devices.

5.1.1 Downloading and Installing the Mobile Application

The first step in setting up your devices is to download, install and run the mobile application: LoRa Edge Config. This app allows you to configure your Semtech LoRa Edge Tracker Reference Design devices. LoRa Edge Config is available through Google Play for Android devices under the name **LoRa Edge Config**. Once the application is downloaded to your mobile device, run the application.

5.1.2 Set Up LoRa Edge Config to Retrieve Position Assistance Data

In order to achieve aided GNSS location data, you need to bridge the device to the LoRa Cloud Device & Application Services. Upon launching the app, you will be asked for to allow LoRa Edge Config to access your photos and media. To use this feature, you must agree to allow this access.

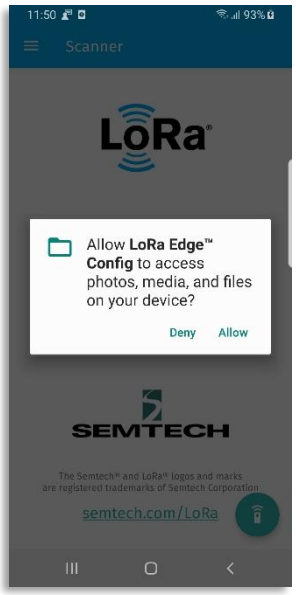


Figure 57: Allow LoRa Edge Config to Acces Photos, Media and Files on Your Device

Follow the steps below to create a QR code for the LoRa Cloud Device & Application Services token:

1) Login to the LoRa Cloud website (https://www.loracloud.com/)

2) Navigate to **LoRa Cloud Device & Application Services**->**Manage Tokens**

3) Copy the value of your created token

4) Create a QR code with your token using either an online QR-code generator tool (for example https://www.qr-code-generator.com/ or similar)

   a) On the mobile application, when asked for **LoRa Cloud Authentication**, allow the app to take a picture of your created QR code.

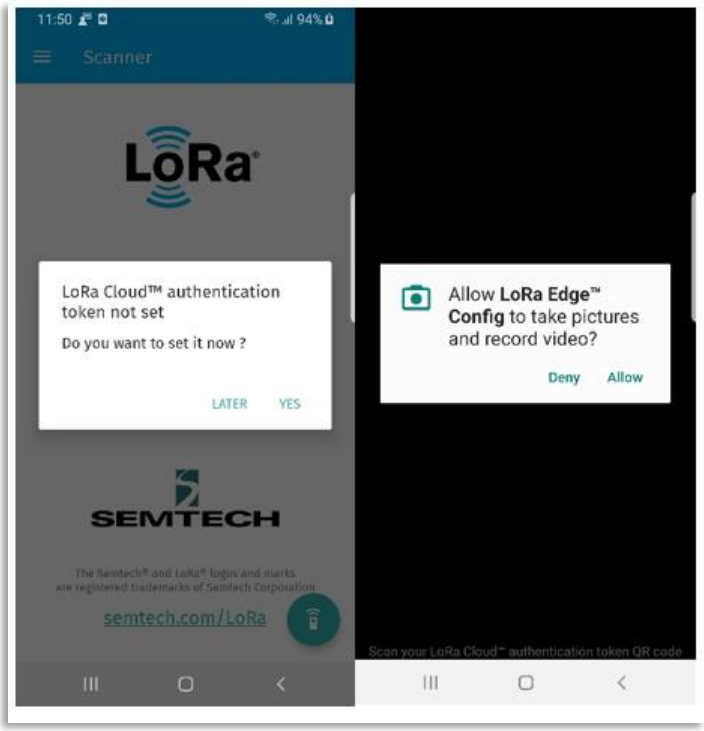


Figure 58: Authentication Token Generation

Once the token is set, the almanac will be automatically fetched and installed.

5.1.3 Pairing a LoRa Edge Tracker Reference Design over Bluetooth

Once a LoRa Edge Tracker Reference Design device is in pairing mode, click the **Pair** button the on main screen of the LoRa Edge Config app (Figure 59)

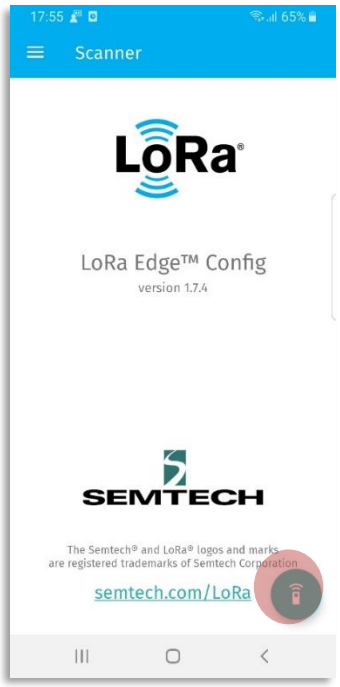


Figure 59: Pair the LoRa Edge Tracker Reference Design with the Smartphone App

Allow the app to access your mobile device's location:

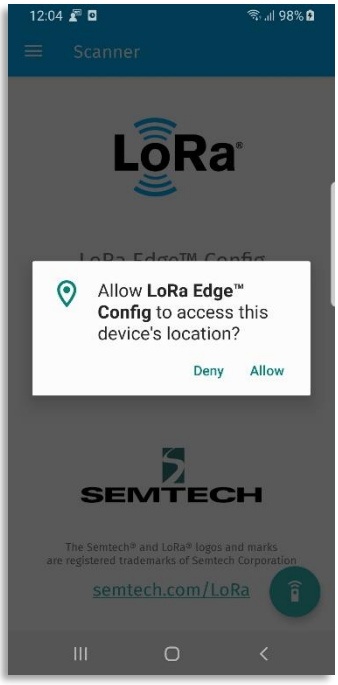


Figure 60: Allow LoRa Edge Config to Access this Device's Location

This should quickly pair your mobile device to your LoRa Edge Tracker Reference Design device, as illustrated in Figure 61.

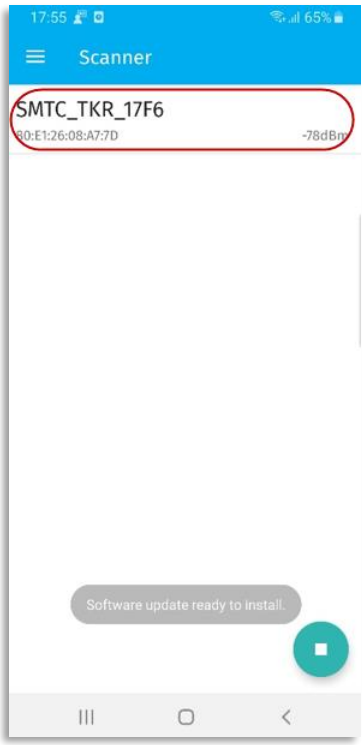


Figure 61: Paired Device Listed on Scanner Page

By default, only the devices in pairing mode with the prefix *SMTC_TKR_* will be displayed. This can be changed in the **Settings** page.

5.1.4 Set Up the LoRa Edge Tracker Reference Design

The mobile application has a number of features and functions. It can update both the LoRa Edge Tracker Reference Design application firmware on the device and the modem firmware. If there are updates for either, LoRa Edge Config will indicate that updates are available in the **Versions and FUOTA** section of the **Settings** page.

The **Versions and FUOTA** section displays the installed versions of the LoRa Edge Tracker Reference Design, as well as LoRa Basics Modem-E firmware.

Note: If the **Update** buttons are greyed-out, no version updates are available.

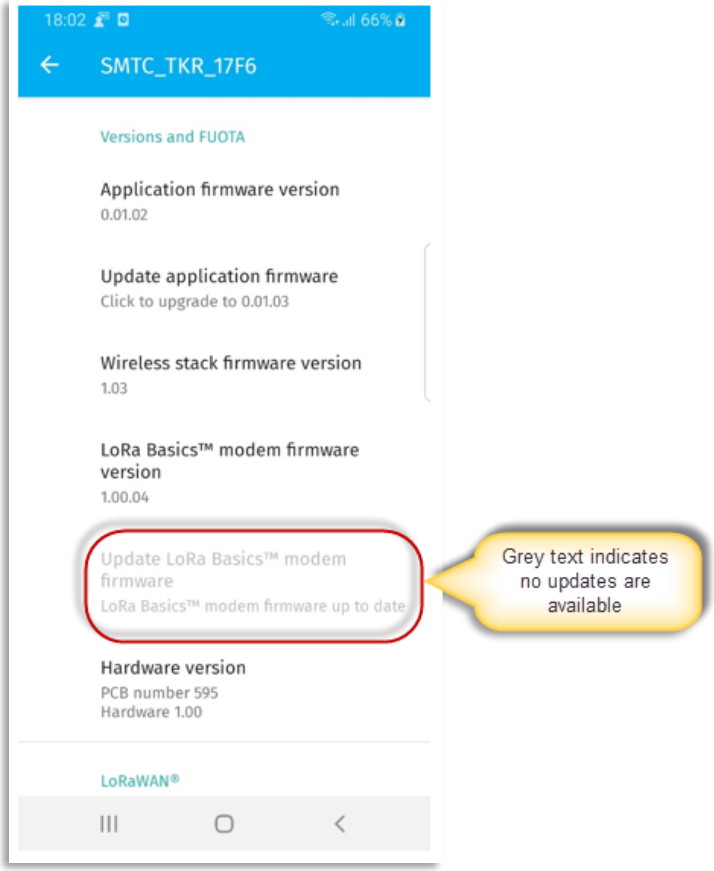


Figure 62: Version and FUOTA Settings

The **LoRaWAN** section displays the keys used to claim and resgister the device:

- If **Semtech LoRa Cloud Join Server** mode is enabled (Figure 63), the *derive keys* algorithm will be used to get the DevEUI, JoinEUI and PIN so you can claim and register your device.

- If the Semtech LoRa Cloud Join Server mode is **not** enabled, the *derive keys* algorithm will not be used. You will need to get or set the DevEUI, JoinEUI and AppKey in another way.

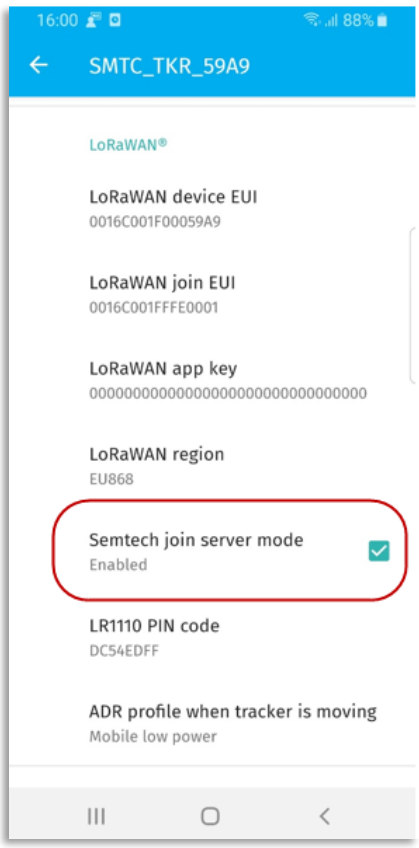


Figure 63: LoRaWAN® Settings

If you want to use GNSS estimation for the LoRa Edge Tracker Reference Design, it must be enabled by checking the **GNSS feature** box in the mobile app. Enabling the GNSS feature will also update the almanac.

Note: You might need to scroll down past the **LoRaWAN** section on the screen:

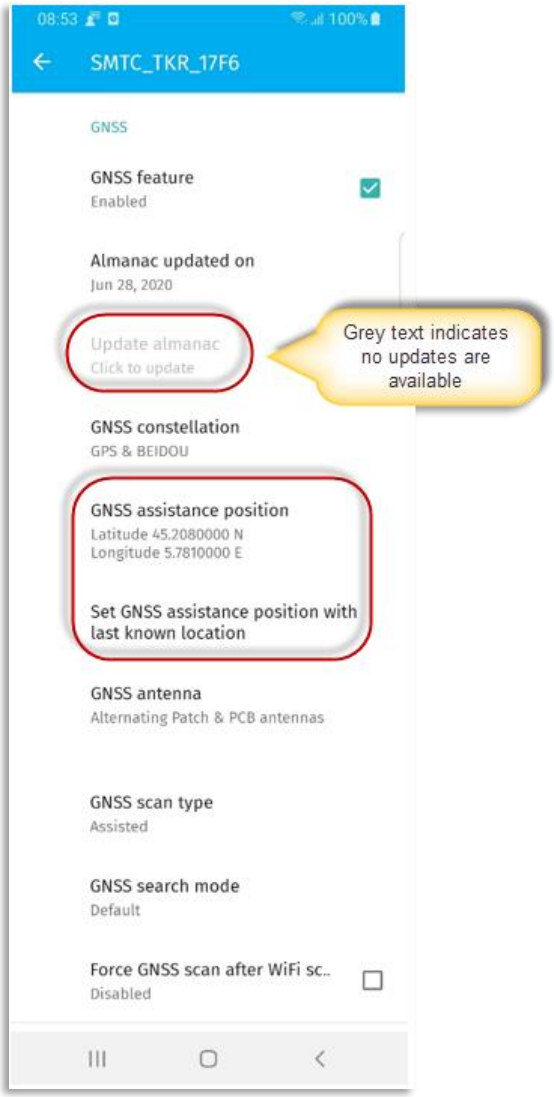


Figure 64: GNSS Settings

You can set the device to receive assistance information at your approximate location.

Note: The input will take "+" for positive latitude (North) and "-" for negative latitude (South). Similarly for positive longitude use "+" for positive (East) and "-" for negative (West). The display will ALWAYS show "N" or "E" after latitude or longitude respectively, even if you are at southern latitudes or western longitudes. The "-" sign however, takes precedence. To facilitate setting the assistance position, you can use the **Set GNSS assistance position with last known location** option (Figure 64 and Figure 65)

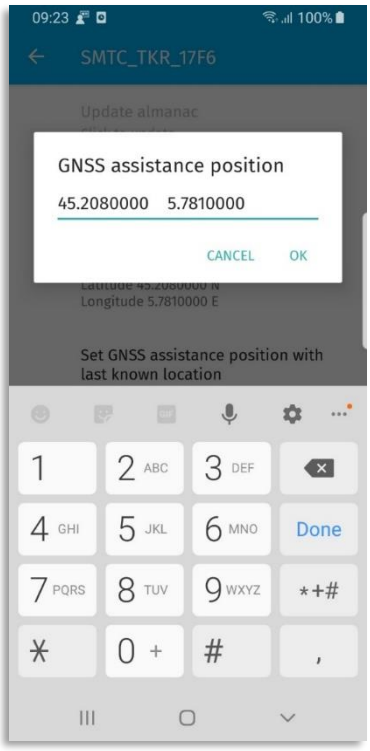


Figure 65: GNSS Assistance Position

The **Miscellaneous** settings section (Figure 66) displays various, uncatagorized parameters needed for setting up the device:

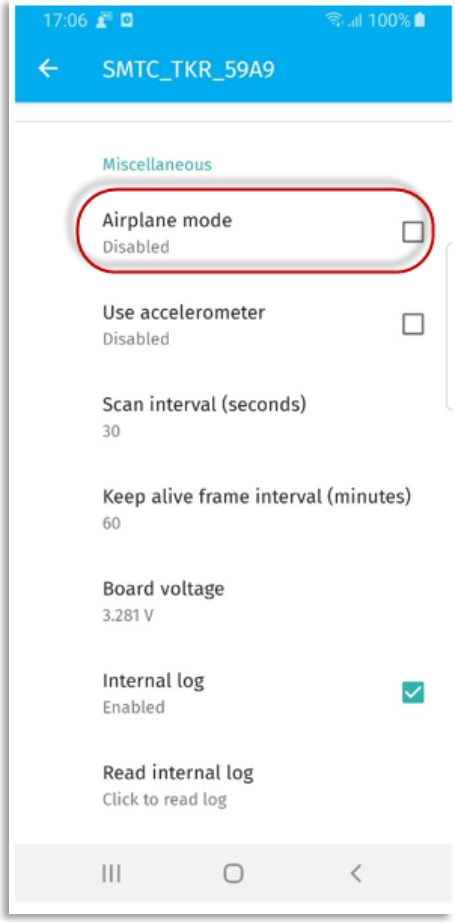


Figure 66: "Miscellaneous" Settings

- To leave *Airplane Mode*, uncheck the **Airplane mode** box.
- **Use accelerometer** allows the triggering of geolocation LoRaWAN packet transmissions upon detection of movement
- **Scan interval** corresponds to the Wi-Fi and GNSS scan period. Every Scan interval, a Wi-Fi scan is launched, followed by a GNSS scan.
- Keep alive frame interval
- **Board voltage** indicates the supply battery voltage
- The LoRa Edge Tracker Reference Design is able to locally record the Wi-Fi and GNSS scan data. This can be enabled by checking the **Internal Log** checkbox. The **Read Internal Log** option allows sending the scan data to the smartphone or mobile device.

5.2 Claim a LoRa Edge Tracker Reference Design Tracking Device

Before the LoRa Edge Tracker Reference Design device can be claimed using the LoRa Cloud Device Join service, you must have a LoRa Cloud Services account. To setup your account, in a web browser, navigate to https://www.loracloud.com and click **Get Started**.

Figure 67: LoRa Cloud Portal "Get Started" Page

You will be presented with an option to **Log In** or **Sign Up**. If you don't already have an account, sign up for one using your email address and a strong password.

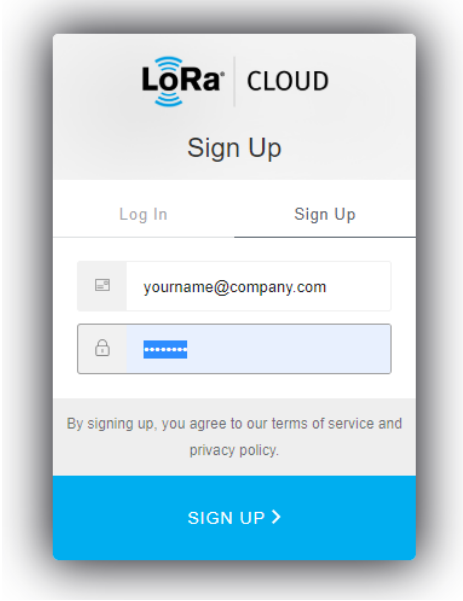


Figure 68: LoRa Cloud Sign Up

You will be sent a confirmation email for your new account. In the email, click the confirmation link. The login page will open. After logging into your account, accept the **Terms & Conditions of Use** to activate your account.

To claim a device:

1. Open a web browser and navigate to https://www.loracloud.com.
2. Click **Get Started** and then select **LoRa Cloud Device Join**, as illustrated in Figure 69

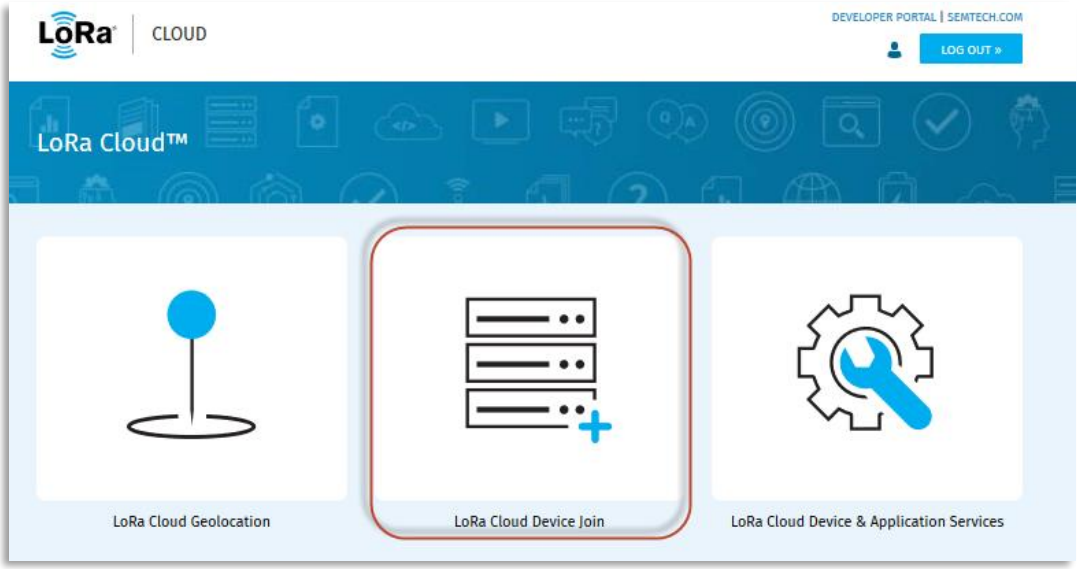


Figure 69: LoRa Cloud Device Join Option

3. In the left navigation pane, click **Network Servers**

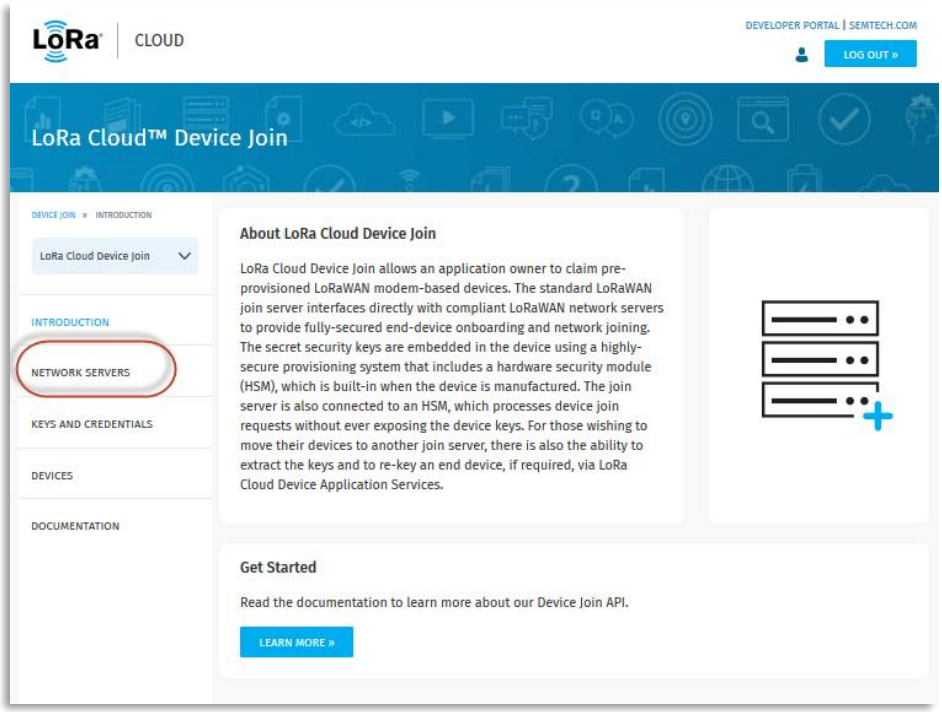


Figure 70: LoRa Cloud Device Join Service

4. To create an Application Owner, click **Manage Owners** (Figure 71)

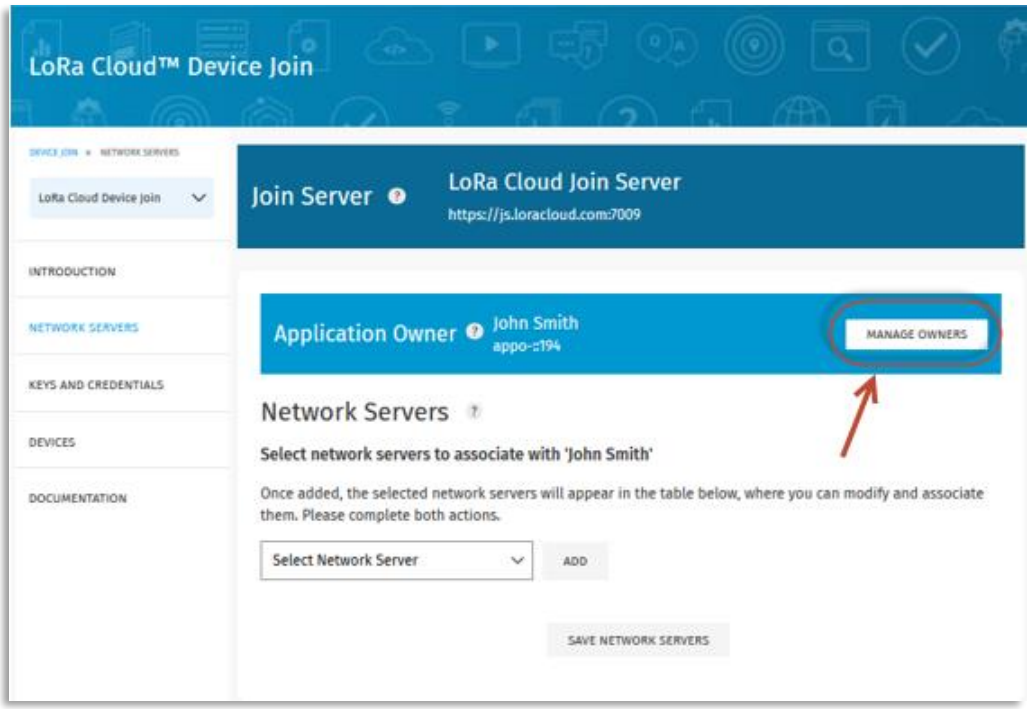


Figure 71: Application Owners - Manage Owners

5. On the **Manage Application Owners** page, enter the name of the application owner and then click **Create a New Owner**:

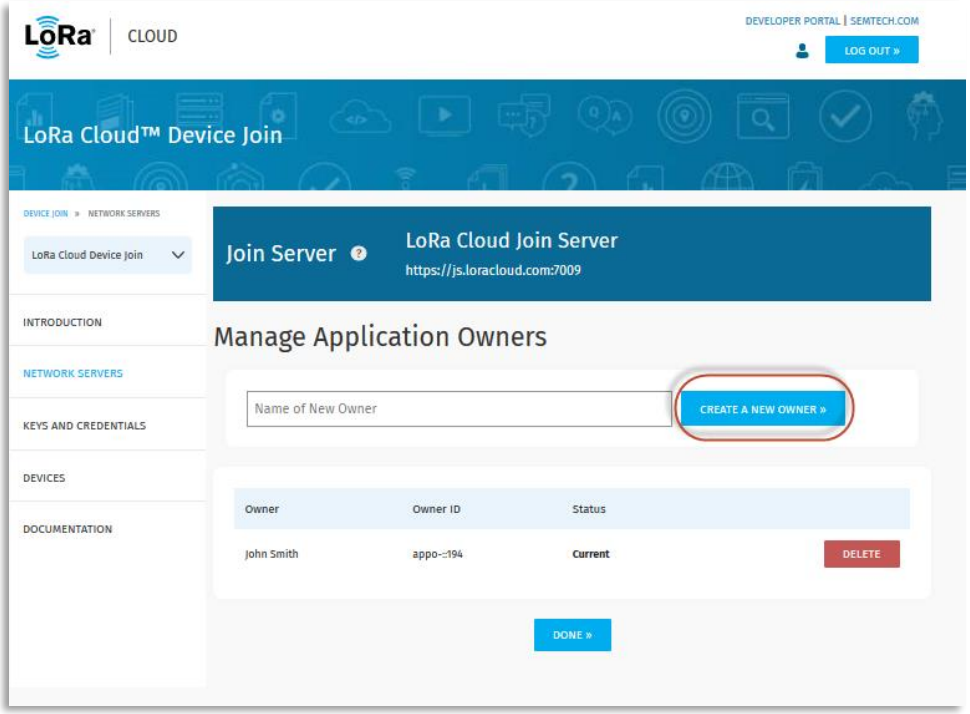


Figure 72: Create a New Owner

6. Next, in the left navigation pane, select **Devices.**

Note: If no application owners have been created, the **Devices** option will not be visible.

7. On the **Join Server** page, under the **Devices** header, you will have two options: **Claim Individual Device** or **Bulk Upload (CSV)**, as illustrated in Figure 73.

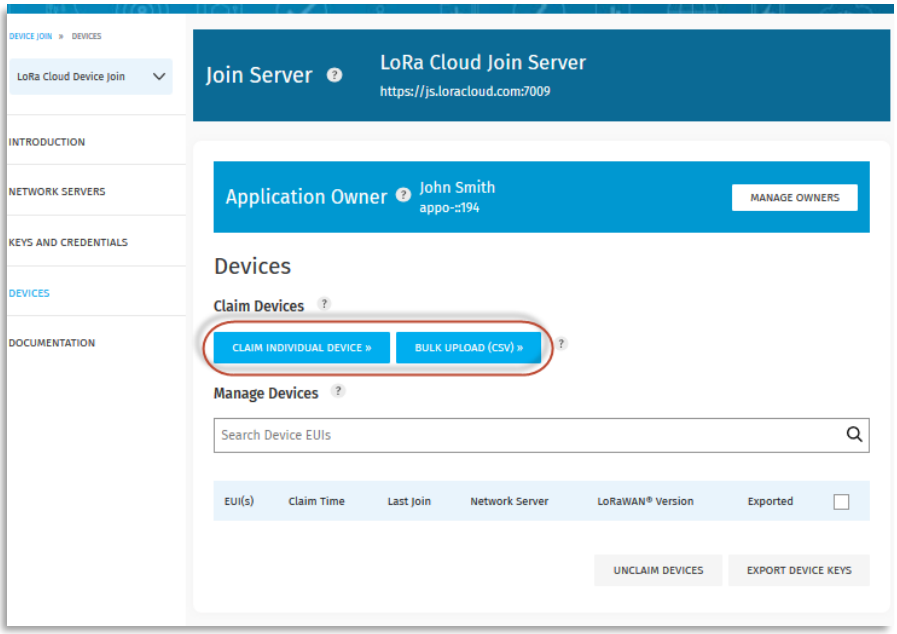


Figure 73: LoRa Cloud Join Server Device Claim Options

8. If you select **Claim Individual Device** you will be presented with the form illustrated in Figure 74. As was previously discussed, you can get the required information for each LoRa Edge Tracker Reference Design device directly, as described in the API.

Figure 74: Claim Device

Enter the EUI and the PIN (Claim) retrieved from the tracker and click **Claim Device**. If the EUI and PIN have a match on the LoRa Cloud Device Join server, the device will be added to your list of available devices. Alternatively, you can click **Bulk Upload (CSV)**. If you use this option you will need upload a CSV file with the same information (for each device you're claiming) that you entered into the online form.

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