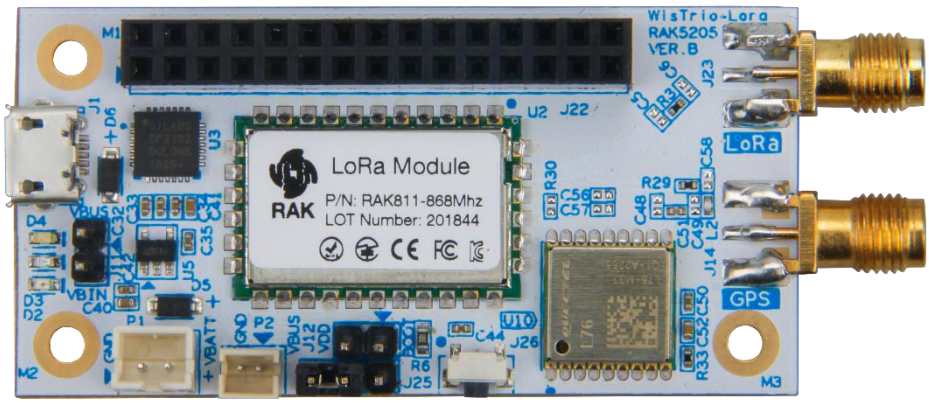
User Manual for

WisTrio LoRa Tracker

96Boards IoT Standardization

RAK5205

Version V1.3 | November 2018



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1 Overview

1.1 Introduction

The RAK5205 LoRa tracker board is built on SX1276 LoRaWAN modem with low power microcontroller STM32L1, integrated the GPS module. It is a feature-packed sensor board that provides various interfaces for featured applications development.

This is the best sensor board available in the market, ideal as a quick prototyping tool for Internet-of-Things and LoRaWAN Network integration. It is perfect for IoT applications such as asset tracking, smart vehicle management and location-based services. Most importantly, application development environments such as the CooCox IDE and Kiel are all supported, users can quickly develop own applications.

The main features are listed below:

- Compatible with 96Boards IoT Edition Specification.
- With SX1276 LoRa long range and L76-L GPS modems which allow to enable the GPS low power mode.
- Integrated the ultra-low power microcontroller ARM Cortex-M3 STM32L1.
- Built-in environmental sensor BME680 (gas, pressure, humidity, temperature) and 3-axis MEMS sensor LIS3DH (accelerometer).
- SMA/IPEX antenna optional for LoRa and GPS.
- Supports latest LoRaWAN 1.0.2 protocol, activation by OTAA/ABP.
- Supports programmable bit rate up to 300kbps.
- Supports rechargeable battery through micro USB or 5V solar charging ports.
- Supports sleep mode, the power consumption down to 16μA.
- Supports global license-free ISM band (EU433, CN470, EU868, US915, AS923, AU915, KR920 and IN865).
- Supports I2C, GPIOs, UART and ADC interfaces.

1.2 Package Contents

RAK5205 board (1x) | LoRa Modem Antenna (1x) | GPS Antenna (1x) | Micro USB cable (1x)

***Image 1** | Package Contents*

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2 WisTrio LoRa Tracker RAK5205

2.1 Overview

The picture below shows the top view and external interfaces of the RAK5205 LoRa tracker board.

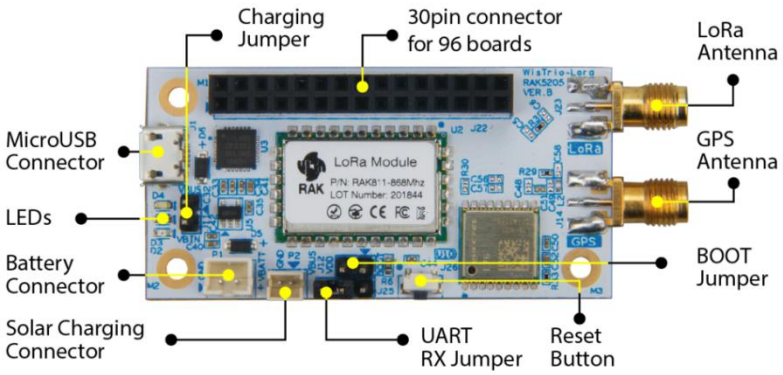

Image 2 | RAK5205 Board Interface

The dimension and underside of the board is shown below. Sensor ICs are also labeled for your reference.

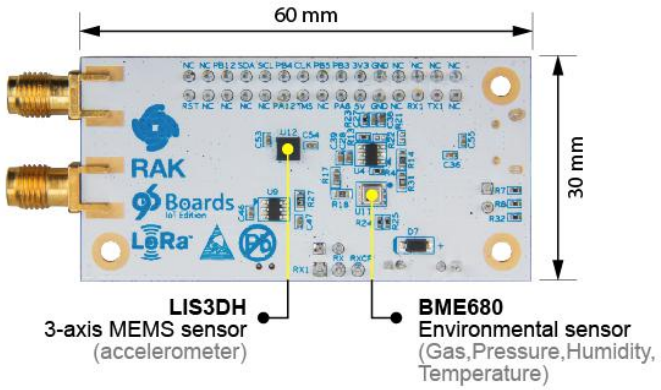

Image 3 | RAK5205 Board Dimension

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2.2 Functional Diagram

The block diagram below shows internal architecture and external interfaces:

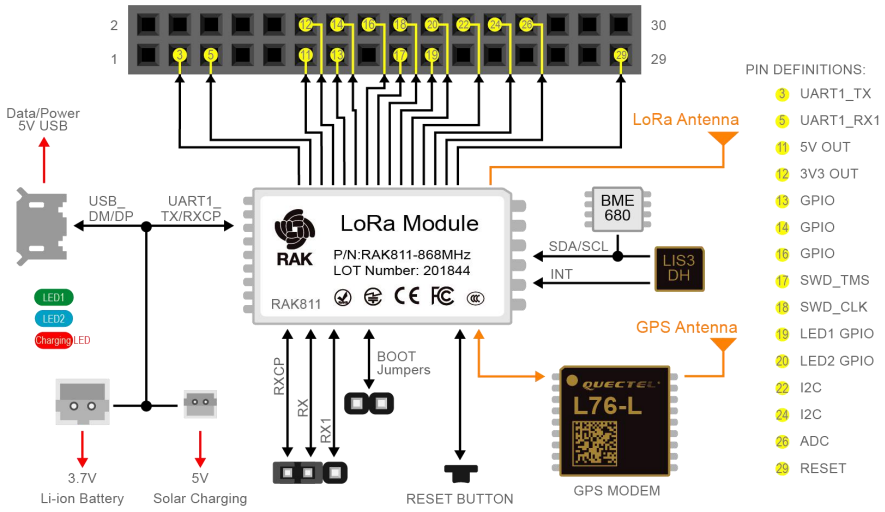

Image 4 | Functional Diagram

2.3 Interfaces

It is built around RAK811 module and compatible with 96Boards. It provides the following interfaces, headers, jumpers, button and connectors:

- Micro USB
- 30-pin 96Boards Headers (UART, RESET, GPIOS, I2C, ADC)
- 2-pin USB Boot jumper
- 3-pin UART RX jumper
- 2-pin Battery female interface
- 2-pin Solar Panel female interface
- LEDs
- Reset Button

It has two SMA/IPEX Antenna connectors:

- GPS antenna
- LoRa antenna

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2.4 Operating Frequencies

The board supports all LoRaWAN frequency channels as below. Which is easy to configure while building the firmware from the source code.

Region	Frequency (MHz)
Europe	EU433 EU868
China	CN470
North America	US915
Asia	AS923
Australia	AU915
Korea	KR920
Indian	IN865

Table 1 | Operating Frequencies

2.5 Board Pin Out

Here are the six connectors for RAK5205 tracker board: P1, P2, J11, J12, J22 and J25.

2.5.1 P1

(Pin1 connected to VBATT, Pin2 connected to GND) Li-ion battery connector.

2.5.2 P2

(Pin1 connected to VBUS, Pin2 connected to GND) Solar cell interface.

2.5.3 J11

Pin1 is connected to VBUS. Pin2 is connected to VBIN. Without a battery connection, the J11 needs to be short-circuited with a jumper. Instead, the J11 needs to be kept open.

2.5.4 J12

Pin1 is connected to BOOT0. Pin2 is connected to VDD. Enter flash mode through jumper short circuit and open into normal mode.

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2.5.5 J22

30pins, follow the 96Board's pin definition.

Pin	Pin Name	Description
1-2	NC	NC
3	UART1_TX	UART1_TX
4	NC	NC
5	UART1_RX1	UART1_RX1 (need to connect RX pin and RX1 pin of J25 via jumper if user wants to use this UART interface).
6-8	NC	NC
9-10	GND	GND
11	VCC_{IN}	$5V_{OUT}$
12	VCC_3V3	3V3 OUT
13	PA8	GPIO Pin
14	PB3	GPIO Pin
15	NC	NC
16	PB5	GPIO Pin
17	SWD_TMS	GPIO Pin / R21, R22 pull-up 10K resistor can be used as JTAG interface
18	SWD_CLK	
19	LED1_PA12	GPIO Pin
20	LED2_PB4	GPIO Pin
21	NC	NC
22	SCL	I2C
23	NC	NC
24	SDA	I2C
25	NC	NC
26	PB12	ADC Interface
27-28	NC	NC
29	RST	Reset Pin
30	NC	NC

Table 2 | Pin Descriptions

2.5.6 J25

(RX1, RX, RXCP) J22 and USB UART share. If you use the UART of J22, you need to connect Rx and RX1 pins. If you use USB UART, you need to connect Rx and RXCP pins.

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2.6 Micro-B USB Interface

A Standard Micro-B USB compliant with USB 2.0 standard specification is used to provide an interface to connect to a PC for control of the board and firmware upgrade. The Micro-B USB pin definition is shown below:

Pin	Description
1	USB_VBUS (+5V)
2	USB_DM
3	USB_DP
4	NC
5	GND

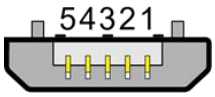

Table 3 | Micro-B USB Pin Descriptions

2.7 LEDs

Three LEDs are used to indicate operating status, here are their functions:

Green LED: STATUS – Defined by user.

Blue LED: STATUS – Defined by user.

Red LED: Charging Status – indicates the Li-ion Battery is charging.

2.8 RESET Push Button

Reset Push Button is used to reset the RAK811 module. To reset the module push the Reset Button for 1 second.

2.9 Working Mode

The board supports to enable the GPS low power mode, it has a 3-axis MEMS Sensor LIS3DH, which can detect the user's motion status, when the device is stationary, it will enter the low power sleep mode, reducing the overall power consumption and increase battery life. The power consumption as shown in the following table.

Mode	Power consumption
Sleep mode	14.5μA (Min)
Normal mode	174mA (Max) @ 20dBm and GPS enable

Table 4 | Power consumption

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2.10 Power Requirements

The RAK5205 LoRa tracker board has an operating voltage of 3.7V. It can be powered by micro USB with 5V Max.

Image 5 | *Powered by Micro USB*

The board can also be powered by a 3.7V Li-Ion battery. You can connect a 5V solar panel charger to recharge the Li-Ion battery.

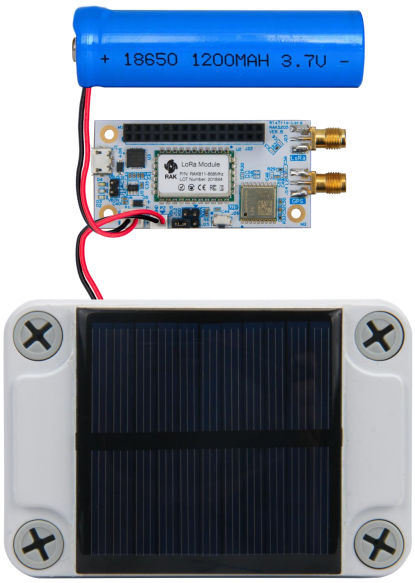

Image 6 | *Charging with 5V Solar*

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2.11 Environmental Requirements

The table below lists the operation and storage temperature requirements:

Parameter	Min.	Typical	Max.
Operation Temp. Range	-35 ºC	+25 ºC	+60 ºC
Extended Temp. Range	-40 ˚C		+80 ˚C
Storage Temp. Range	-40 ˚C		+80 ˚C

Table 5 *| Electrical Characteristics*

2.12 Mechanical Dimensions

Here is the detailed dimension of RAK5205 LoRa tracker:

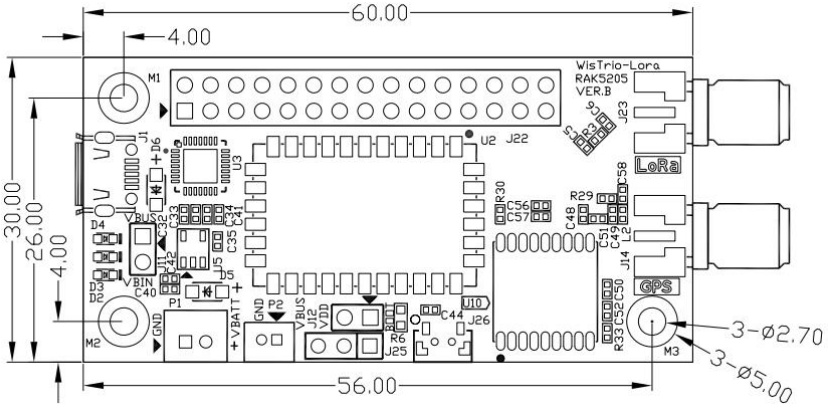

Image 7 *| Mechanical Dimensions*

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3 LoRa Antenna

3.1 Overview

The LoRa antenna and interfaces are shown below.

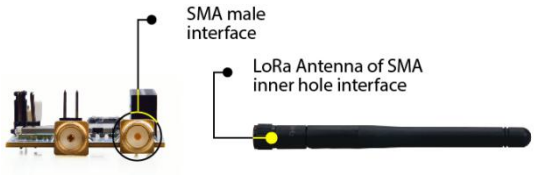

Image 8 | LoRa Antenna and SMA interface

Here is the IPEX LoRa Antenna interface:

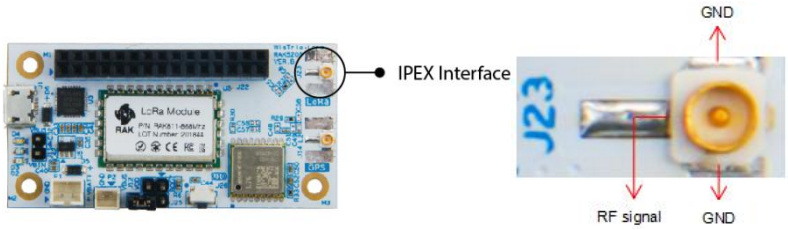

Image 9 | LoRa IPEX interface

3.2 LoRa Antenna Dimension

The SMA antenna's mechanical dimension is shown below:

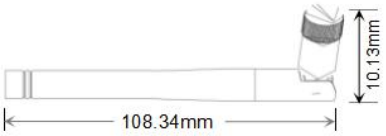

Image 10 | LoRa Antenna Dimension

3.3 LoRa Antenna Parameter

Items	Specifications
VSWR (Voltage Standard Wave Radio)	1:1.5
Gain	2.0dbm
Working Temperature & Humidity	T:-35 ºC ~ +80 ºC, H: 0% ~ 95%
Storage Temperature & Humidity	T:-40 ºC ~ +85 ºC, H: 0% ~ 95%

Table 6 | LoRa Antenna Parameter

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4 GPS Antenna

4.1 Overview

The GPS antenna and interfaces for RAK5205 tracker board is shown below.

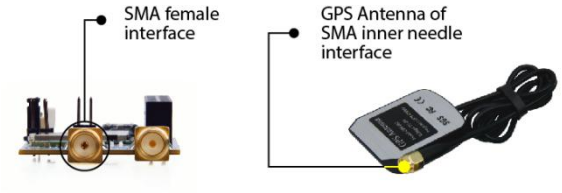

Image 11 | GPS Antenna and SMA interface

Here is the IPEX GPS Antenna interface:

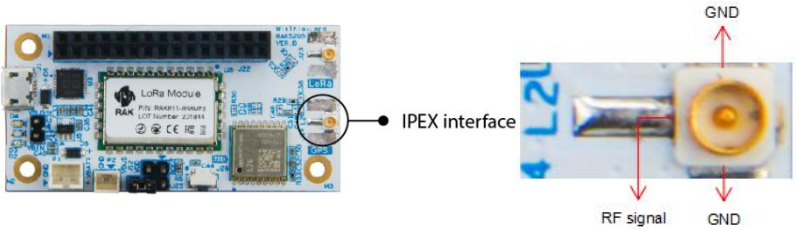

Image 12 | GPS IPEX interface

4.2 GPS Antenna Dimensions

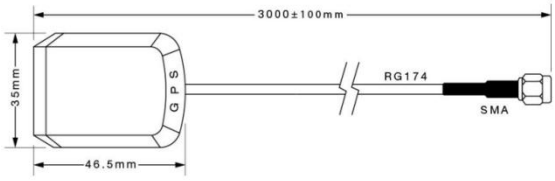

Image 13 | GPS Antenna Dimensions

4.3 GPS Environmental Requirements

The antenna environmental requirements are listed in the table below:

Conditions	Temperature	Humidity
Working	-35 ºC ~ +80 ºC	0% ~ 95%
Storage	-40 ºC ~ +85 ºC	0% ~ 95%

Table 7 | GPS Environmental Requirements

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4.4 GPS Antenna Parameter

Antenna specifications are listed in the table below:

Item	Specifications	PET
Range of Receiving Frequency	1575.42±1.1	±2.5
Center Frequency (MHz) w/ 30mm2 GND plane	1575.42	±3.0
Bandwidth (MHz) (Return Loss ≤ -10dB)	≥10	±0.5
VSWR (in Center Frequency)	≤2.0	±0.5
Gain (Zenith) (dBi Typ) w/ 70mm2 GND Plane	4.5	±0.5
Axial Ratio (dB) w/ 70mm2 GND Plane	3.0	±0.2
Polarization	Righ-Handed Circular	-
Impedance (Ω)	50	-
Frequency Temparature Coefficient (ppm/ºC)	0±10	-

Table 8 | GPS Antenna Parameter

Amplifier Specifications are listed in the table below:

Item	Specifications
Frequency Range	1575.42 MHz
Gain	27 dB
VSWR	≤ 2.0 V
Noise Coefficient	≤ 2.0 dBm
DC Voltage	3 ~ 5 V
DC Current	5 ± 2 mA

Table 9 | Amplifier Specifications

Environmental test performance specifications are listed below:

Item	Normal Temp.	High Temp.[1]	Low Temp.[2]
Amplifier Gain	27dB ± 2.0	27dB ± 2.0	27dB ± 2.0
VSWR	≤ 2.0	≤ 2.0	≤ 2.0
Noise Coefficient	≤ 2.0	≤ 2.0	≤ 2.0

1. *High temperature test: soap in temperature (85º C) and humidity (95%) chamber for 24-hour and return to normal temperature (at least for 1-hour) without visual shape change.*
2. *Low temperature test: soap in temperature (-40º C) chamber for 24-hour and return to normal temperature (at least for 1-hour) without visual shape change.*

Table 10 | Environmental Test Performance

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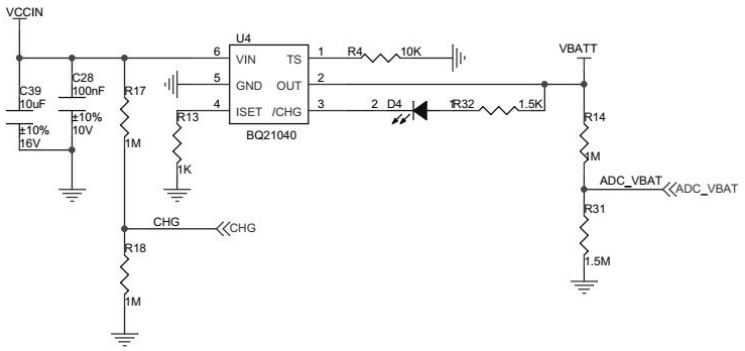
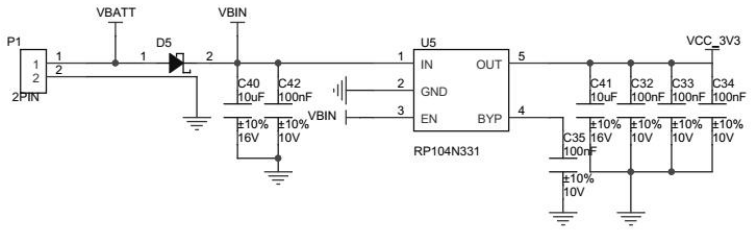
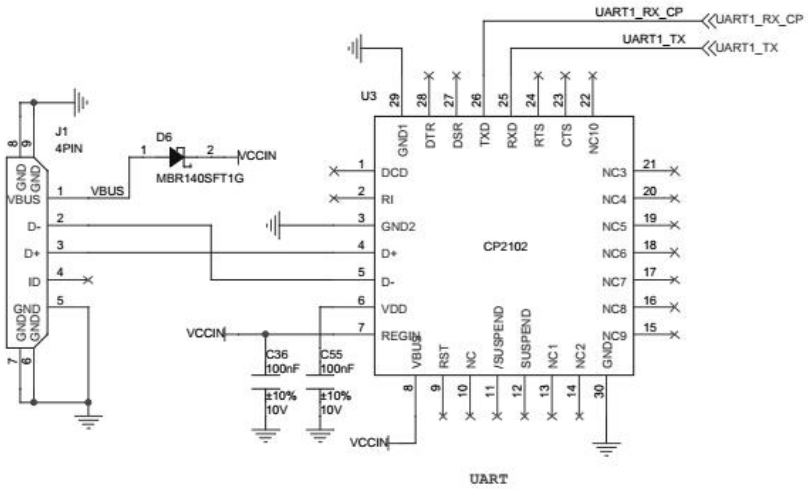
5 Schematics

The Component schematics diagram of the RAK5205 are shown below:







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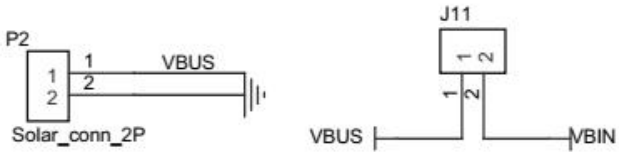

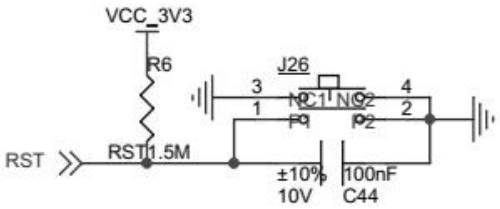

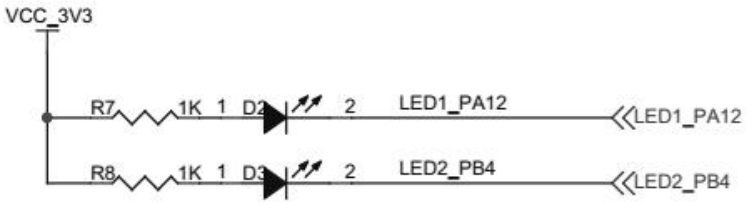

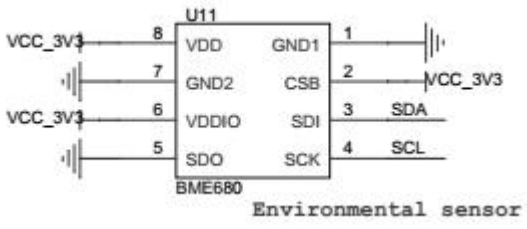

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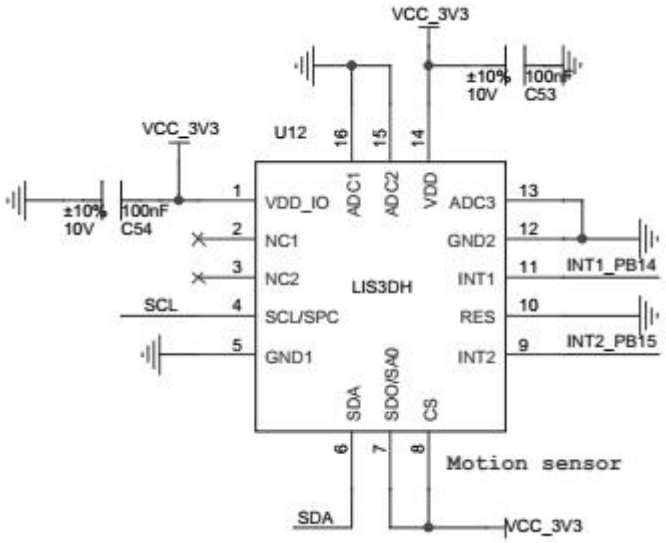

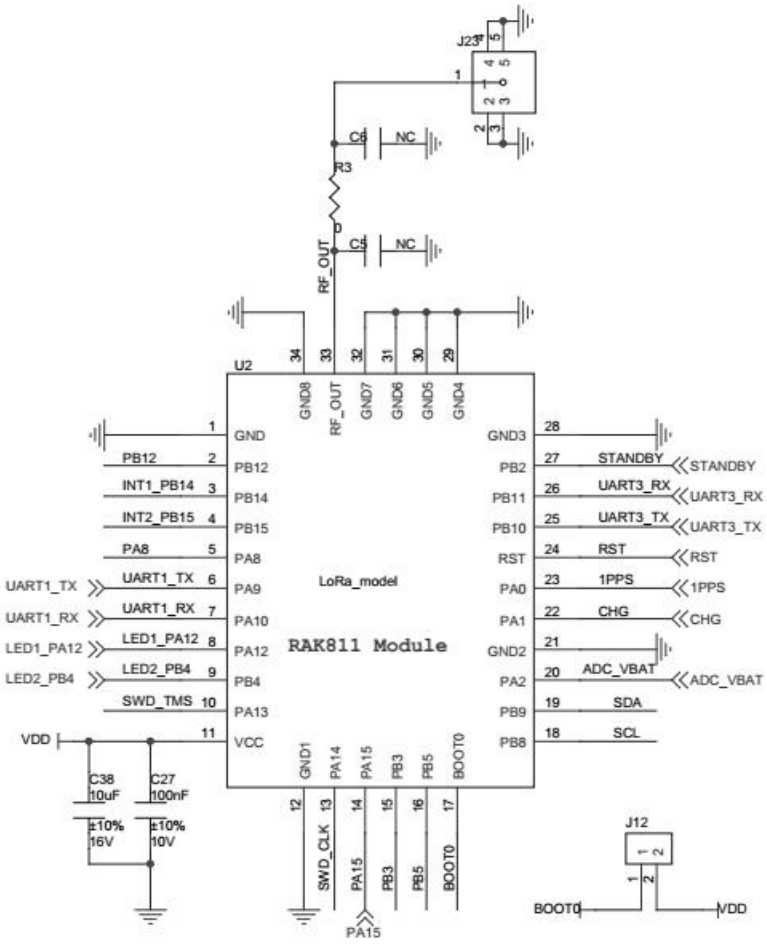

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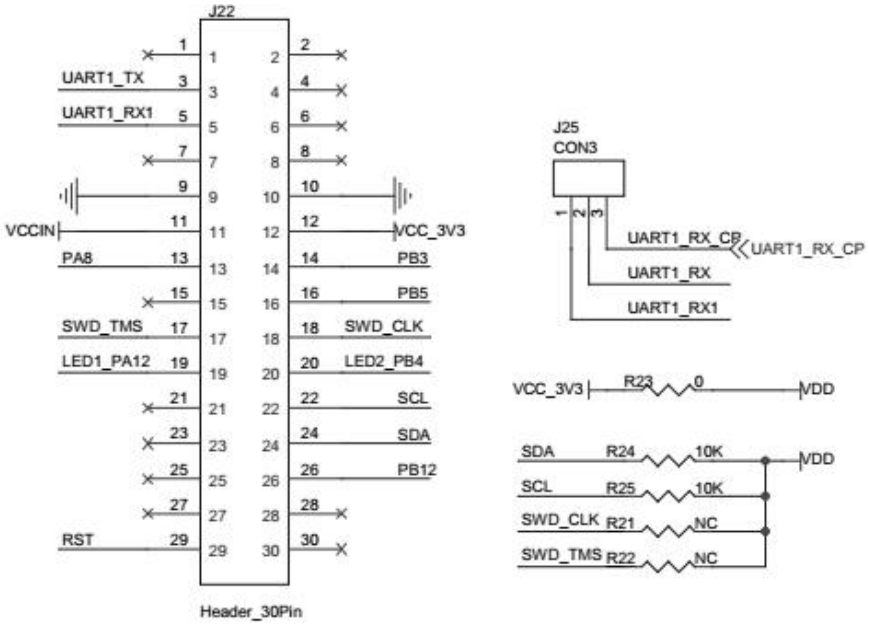

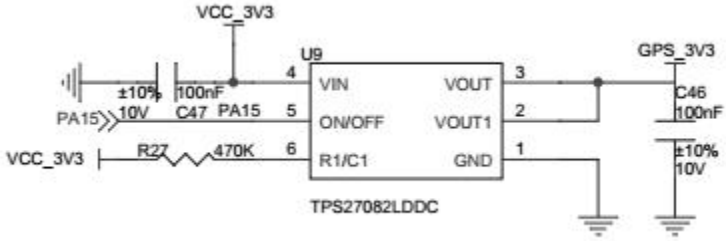

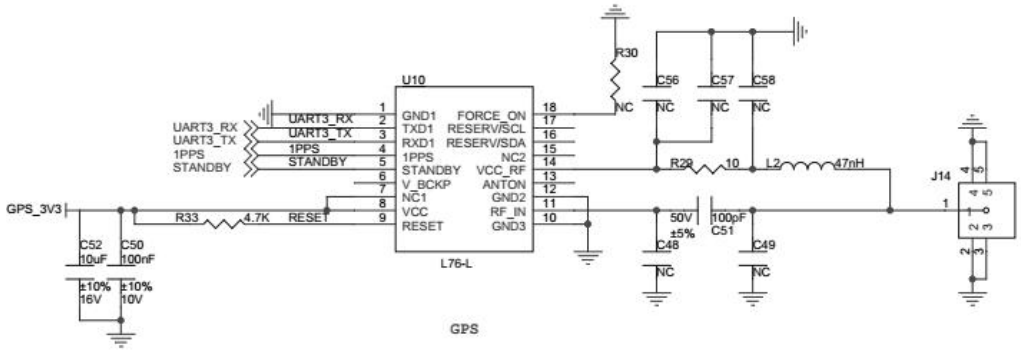

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6 Usage and Examples

We are going to use CooCox IDE to view and build the firmware. Download the source code from the provided GIT repository. All the necessary software should be installed earlier.

6.1 Source Code

All application source codes are available on GIT repository. You can either download the source zip from the GIT repository or you can also clone. The source code link is: https://github.com/RAKWireless/RAK811_LoRaNode

6.2 Required Software

To start with developing the application over the RAK5205 LoRa tracker board you may need to download the following software. All the software provided below are based on Windows operating system.

6.2.1 USB Driver

WisTrio-LoRa-RAK5205/Tools/CP210x_Windows_Drivers.zip

6.2.2 CooCox IDE

WisTrio-LoRa-RAK5205/Tools/CoIDE_V2Beta_20170117.exe

6.2.3 Flash Loader

WisTrio-LoRa-RAK5205/Tools/Flash_Loader_Demonstrator.zip

6.2.4 Tool Chain

WisTrio-LoRa-RAK5205/Tools/gcc-arm-none-eabi-5_4-2016q3-20160926-win32.exe

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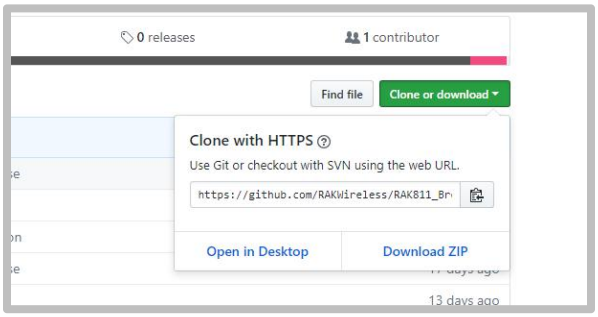
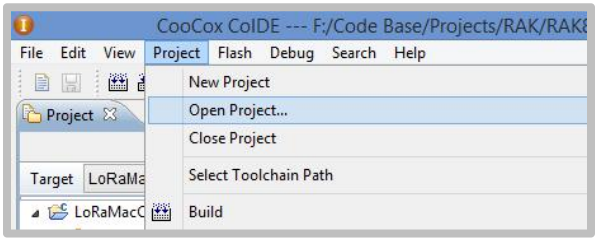
6.3 Importing Source Code

Download it from the GIT URL indicated in Source Code Section of this manual.



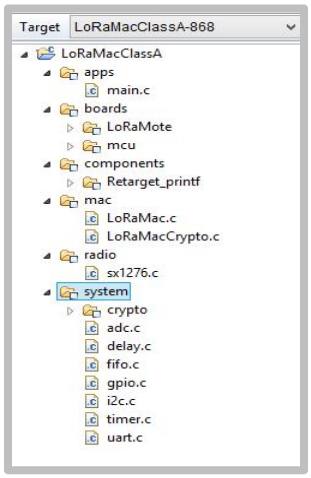
Screenshot 1 | *Download Source code from Github*

Extract the downloaded ZIP file and run CooCox CoIDE. Open project from the menu.



Screenshot 2 | *Open Project in CooCox CoIDE*

After opening the project, you will see the following project structure in CooCox CoIDE:



Screenshot 3 | *Project Directory*

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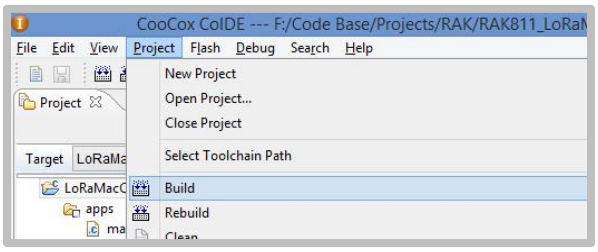
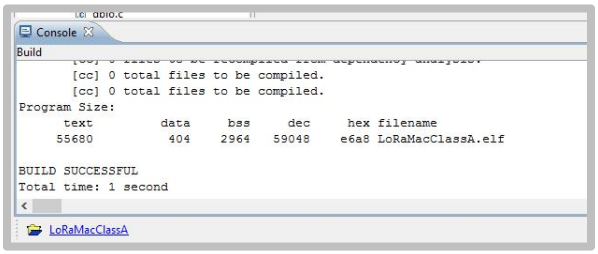
Build the current project with the target frequency band of 868MHz for example:



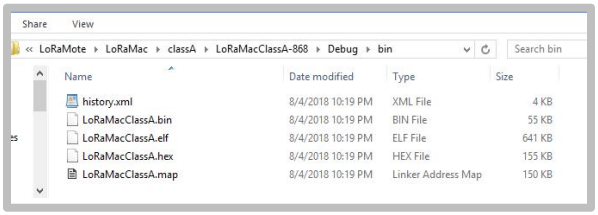
Screenshot 4 | *Build Project*

The following window will appear together with the build status.



Screenshot 5 | *Build Status*

To find the build executable file, click the **LoRaMacClassA** folder as shown below. Follow the path to the bin directory where you can find the executable files.



Screenshot 6 | *Bin Directory*

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6.4 Uploading Firmware

6.4.1 Install the “CP210x_windows_Drivers” driver

Connect the board to the computer via a Micro USB cable and you'll find the COM port for RAK5205 LoRa tracker in the device manager.

6.4.2 Install the Flash Loader Demonstrator

It is recommended to use Flash Loader Demonstrator to upgrade the RAK5205 LoRa tracker board to the latest version.

6.4.3 Connect the BOOT jumper

The bootpin of the board needs to be raised to 3.3V when upgrading, so you need to connect the BOOT0 and VDD pin of J12 by using a jumper. Also, make sure that the RX pin of J25 is connected to the RXCP pin.

***Image 14** | Connect the boot jumper*

6.4.4 Upgrade the firmware

Select the COM Port for the board, the Baud Rate is “115200”, as shown in the following figure.

***Screenshot 7** | Install Flash Loader Demonstrator*

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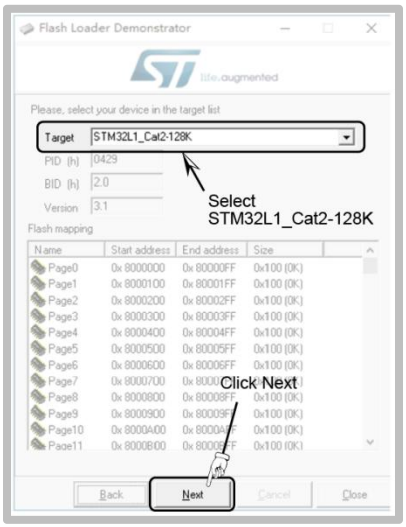
Reconnect the RAK5205 or press the reset button if prompted.

Screenshot 8 | *Reconnect then click Next*

Select “STM32L1_Cat2-128K” then click “Next”.



Screenshot 9 | *Select device*

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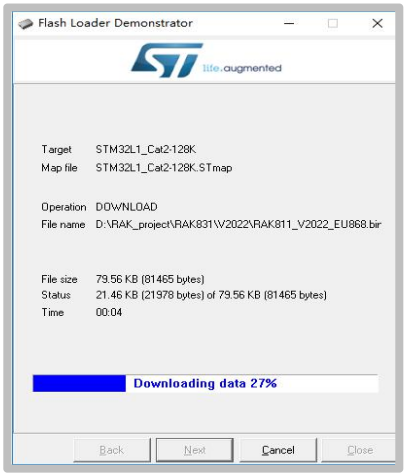
Select “Download to device” then navigate to location of bin file. Click “Next” when finished. This will start the download process:

Screenshot 10 | *Download to Device*



Screenshot 11 | *Downloading progress*

After finishing the download, close the Demonstrator program, disconnect the RAK5205 and remove the jumper of J12.

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8 Revision History

Revision	Description	Date
1.0	Initial version	2018-09-10
1.1	Improved Layout and content	2018-11-06
1.2	Modify the picture and the context	2018-11-10
1.3	Add the IPEX Antenna interface picture	2018-11-14

Table 11 | Revision History

9 Document Summary

Document Name: WisTrio LoRa Tracker RAK5205 User Manual
Product Name: RAK5205
Release Date: November 2018
Revision Number: V1.3

Prepared by	Checked by:	Approved by:
Hairui & Penn	Steven	

About RAKwireless:

RAKwireless is the pioneer in providing innovative and diverse cellular and LoRa connectivity solutions for IoT edge devices. It's easy and modular design can be used in different IoT applications and accelerate time-to-market turnover. For more information, please visit RAKwireless website at www.rakwireless.com.

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