

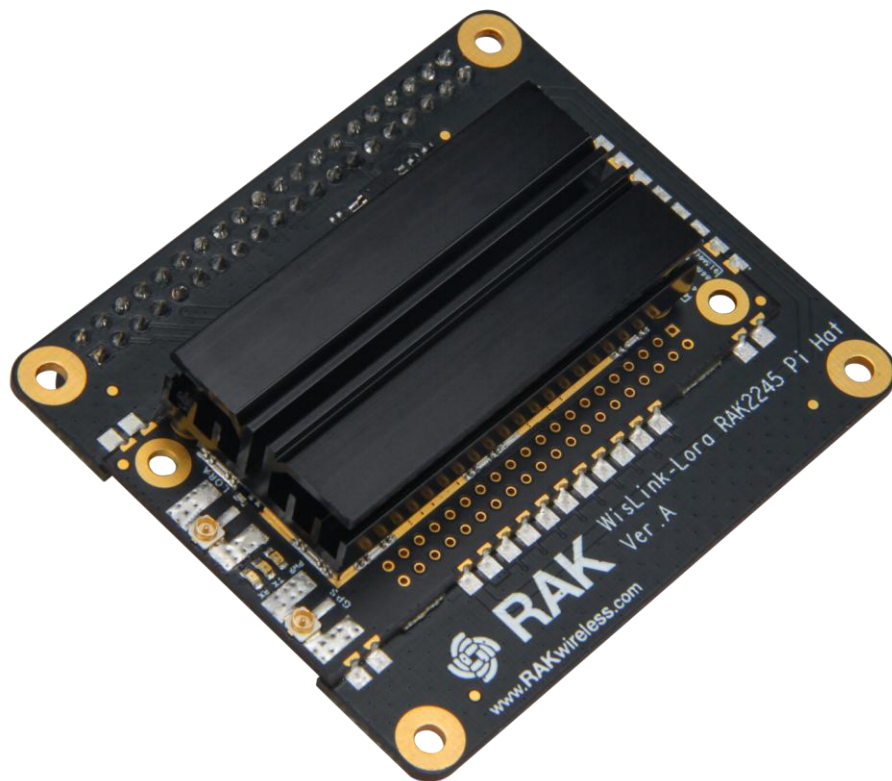
User Manual for

WisLink-LoRa Concentrator Module

Raspberry Pi HAT Edition

RAK2245 Pi HAT

Version V1.2 | February 2019



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1 Overview

1.1 Introduction

RAK2245 Pi HAT is a module with Raspberry Pi form factor. It can be plugged into Raspberry Pi such as Raspberry Pi 3 Model B+ as a complete RF front end of LoRa gateway. It supports eight channels and is available for LoRaWAN global frequency bands. The board is the smallest LoRaWAN gateway concentrator which integrates the Ublox MAX-7Q GPS Module and heat sink.

The board can provide low data rate LoRa radio links in ultra-fast speed. It is powered by a Semtech SX1301 transceiver concentrator that is capable of managing packets from many remotely dispersed end-points. Two Semtech SX125X are integrated for RF front end I/Q transceivers.

The RAK2245 Pi HAT is a complete and cost efficient LoRa gateway solution that can help you develop a full LoRa system. This is an economical way to create different solutions like smart grid, intelligent farm and other IoT applications. It is also ideal for manufacturing small series that can expand into more applications.

1.2 Main Features

- Compatible with Raspberry Pi 3 Model B+ edition.
- Integrated Ublox MAX-7Q GPS Module and heat sink.
- SX1301 base band processor, emulates 49 x LoRa demodulators, 10 parallel demodulation paths, supports 8 uplink / 1 downlink channels.
- 2 units of SX125x Tx/Rx front-ends for high/ low frequency.
- Supports 5V power supply, integrated level conversion circuit.
- TX power up to 27dBm, RX sensitivity down to -139dBm@SF12, BW 125KHz.
- Supports latest LoRaWAN 1.0.2 protocol.
- Supports global license-free frequency band (EU433, CN470, EU868, US915, AS923, AU915, KR920, IN865 and AS920).
- Supports SPI, UART, I2C interface.



1.3 Package Contents

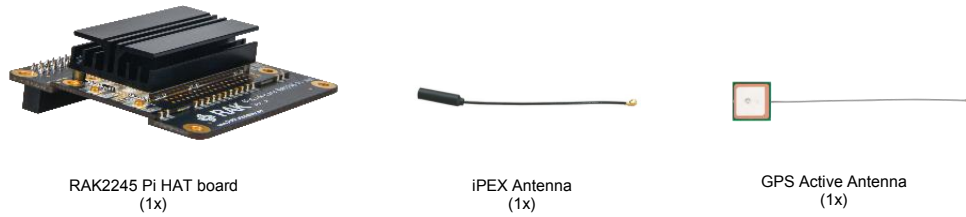


Figure 1 | Package Contents

2 RAK2245 Pi HAT Board

2.1 Overview

RAK2245 Pi HAT module with Raspberry Pi connector is shown below, it has outer dimensions of 56.00 x 65.00 x 22.00 mm (± 2 mm).

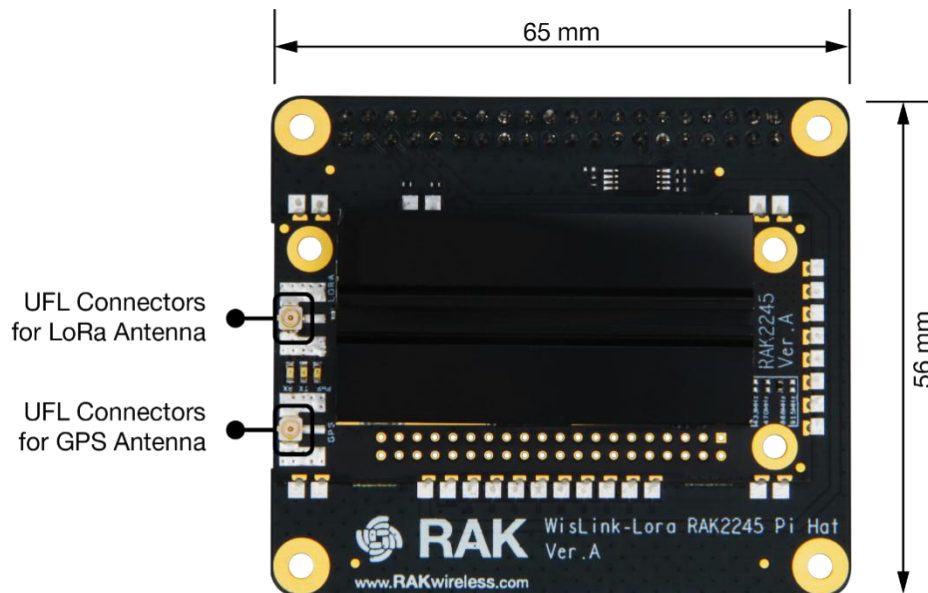


Figure 2 | RAK2245 Pi HAT Overview



2.2 Block Diagram

The block diagram of RAK2245 Pi HAT shown as below.

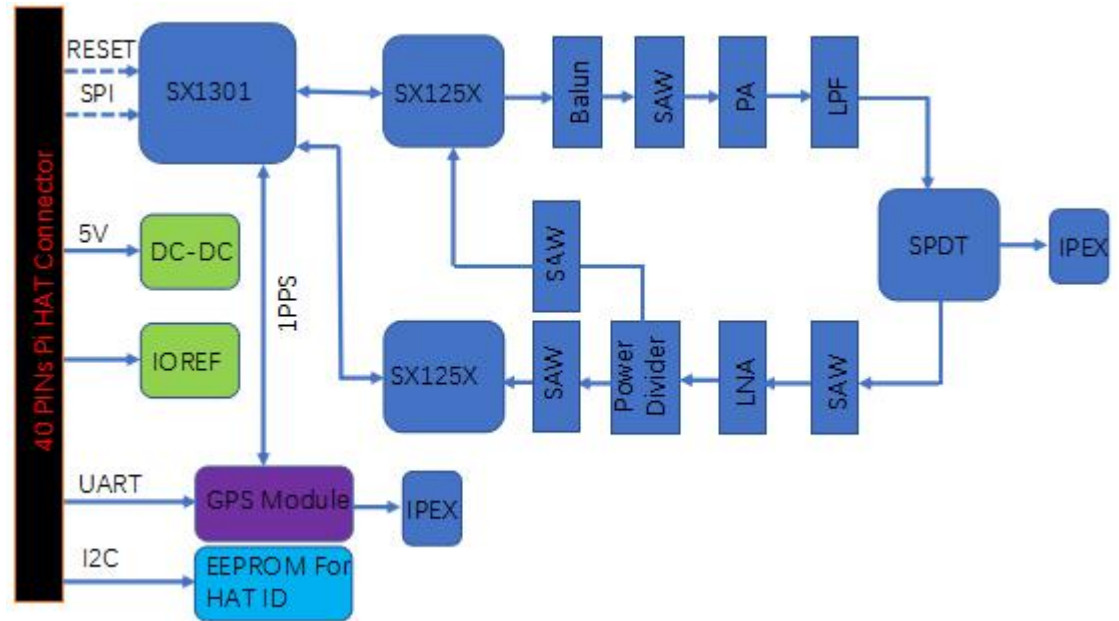


Figure 3 | RAK2245 Pi HAT Block Diagram

The SX1301 digital baseband chip contains 10 programmable reception paths. Those paths have differentiated levels of programmability and allow different use cases. It is important to understand the differences between those demodulation paths to make the best possible use from the system.

2.3 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, AS920
Australia	AU915
Korea	KR920
Indian	IN865

Table 1 | Operating Frequencies



2.4 Pin Definition

The pin connector of RAK2245 Pi HAT is located at the bottom side. Refer to the diagram and table below for the description and numbering of each pins.

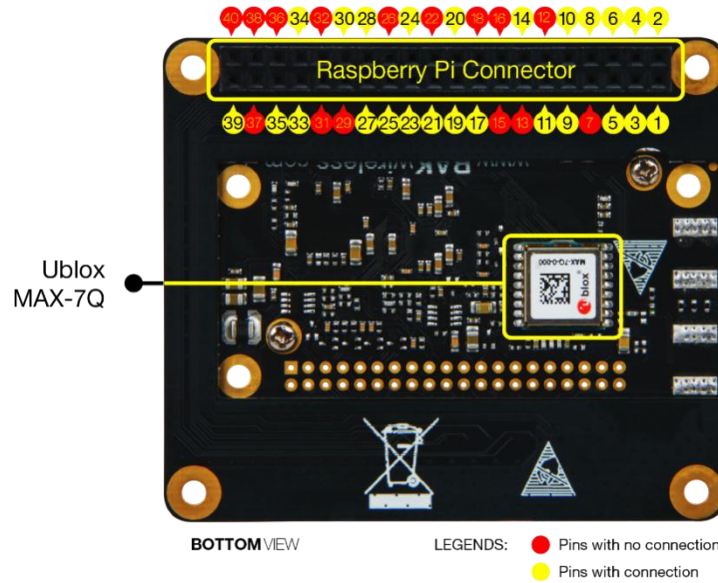


Figure 4 | Raspberry Pi Connector Overview

Pin	Name	Description
1	3.3V	3.3V Supply Voltage
3	SDA	I2C_SDA (Connect to GPS Module I2C_SDA)
5	SCL	I2C_SCL (Connect to GPS Module I2C_SCL)
7	NC	No Connection
9	GND	GND
11	RESET	SX1301 RESET (GPIO17 of RASPBERRY PI)
13	NC	No Connection
15	NC	No Connection
17	3.3V	3.3V Supply Voltage

Pin	Name	Description
2	+5V	+5V Supply Voltage
4	+5V	+5V Supply Voltage
6	GND	GND
8	UART_RXD	It should be connected to RASPBERRY PI's UART_TXD. This pin is connected to GPS Module's UART_RXD internally.
10	UART_TXD	It should be connected to RASPBERRY PI's UART_RXD. This pin is connected to GPS Module's UART_TXD internally.
12	NC	No Connection
14	GND	GND
16	NC	No Connection
18	NC	No Connection

Continuation:



Pin	Name	Description	Pin	Name	Description
19	SPI_MOSI	It should be connected to RASPBERRY PI's SPI_MOSI. This pin is connected to SX1301's SPI_MOSI internally.	20	GND	GND
21	SPI_MISO	It should be connected to RASPBERRY PI's SPI_MISO. This pin is connected to SX1301's SPI_MISO internally.	22	NC	No Connection
23	SPI_CLK	It should be connected to RASPBERRY PI's SPI_SCLK. This pin is connected to SX1301's SPI_CLK internally.	24	SPI_CS	It should be connected to RASPBERRY PI's SPI_CE0. This pin is connected to SX1301's SPI_CS internally.
25	GND	GND	26	NC	No Connection
27	ID_SD	I2C_SDA for HAT ID EEPROM	28	ID_SC	I2C_SCL for HAT ID EEPROM
29	NC	No Connection	30	GND	GND
31	NC	No Connection	32	NC	No Connection
33	RESET_GPS	GPS Module reset PIN (GPIO13 of Raspberry Pi)	34	GND	GND
35	STANDBY_GPS	GPS Module standby PIN (GPIO19 of Raspberry Pi)	36	NC	No Connection
37	NC	No Connection	38	NC	No Connection
39	GND	GND	40	NC	No Connection

Table 2 | Pin Definitions

2.5 Power Supply

RAK2245 Pi HAT module is powered through 5V or 3.3V power pins.

2.6 SPI Interface

The pin connector provides an SPI connection which allows direct access to the Sx1301 SPI interface. This gives the target system the possibility to use existing SPI interfaces to communicate with the module.

Note: Please reset SX1301 via PIN 11 after turning on RAK2245 Pi HAT.



2.7 UART and I2C

UART and I2C connections are also included on the pin connector. These connections allow direct access to the GPS module. The 1PPS is connected internally to SX1301.

2.8 Digital IOs

There are two digital IO PINs, which give the user an interface to reset the GPS module or set it into standby mode.

2.9 LEDs

3 x Green LED for indicating the status of PWR, TX, RX.

2.10 Antenna RF Interface

The modules have two RF interfaces for LoRa and GPS antennas over the standard UFL connectors (Hirose U. FL-R-SMT). It has a characteristic impedance of 50OHM and supports both Tx and Rx via RF ports, providing the antenna interface.

2.11 Electrical Characteristics

The following are the electrical characteristics of RAK2245 Pi HAT. Please contact us if you need other details and/or parameter for your project.

IMPORTANT: *Stress exceeding of one or more of the limiting values listed under "Absolute Maximum Ratings" may cause permanent damage to the radio module.*

2.11.1 Absolute Maximum Rating

The values and range given below are all in accordance with Absolute Maximum Rating System (IEC 134).

Parameter	Description	Min.	Typ.	Max.
Supply Voltage (VDD)	Input DC voltage	-0.3V	5.0V	5.5V
Operating Temperature	Temperature Range	-40°C		+85°C
RF Input Power				-15dBm

Table 3 | Absolute Maximum Ratings



Note: With RF output power level above +15 dBm a minimum distance to a transmitter should be 1 m for avoiding too large input level.

2.11.2 Maximum ESD

The table below lists the maximum ESD.

Parameter	Min	Typical	Max	Remarks
ESD sensitivity for all pins except ANT1			1 kV	Human Body Model according to JESD22-A114
ESD sensitivity for ANT1			1 kV	Human Body Model according to JESD22-A114
ESD immunity for ANT1			4 kV	Contact Discharge according to IEC 61000-4-2
			8 kV	Air Discharge according to IEC 61000-4-2

Table 4 | Maximum ESD Ratings

Note: The module is an Electrostatic Sensitive Device and require special precautions when handling.

2.11.3 Operating Conditions

The table below lists the operation temperature range.

Parameter	Min.	Typical	Max.	Remarks
Normal operating temperature	−20°C	+25°C	+65°C	Fully functional and meets 3GPP specifications
Extended operating temperature	−40°C	+25°C	+85°C	RF performance may be affected if outside the normal operating range, but the module is still fully functional

Table 5 | Operation Temperature Range

2.11.4 Power Consumption

Mode	Condition	Min	Typical	Max
Active-Mode(TX)	TX enabled and RX disabled.		336mA	
Active-Mode(RX)	TX disabled and RX enabled.		360mA	

Table 6 | Power Consumption



2.12 RF Characteristics

2.12.1 Transmitter RF Characteristics

The RAK2245 Pi HAT has an excellent transmitter performance. It is highly recommended to use an optimized configuration for the power level configuration, which is part of the HAL. This results in a mean RF output power level and current consumption.

PA Control	DAC Control	MIX Control	DIG Gain	Nominal RF Power Level [dBm]
0	3	8	0	-6
0	3	10	0	-3
0	3	14	0	0
1	3	9	3	4
1	3	8	0	8
1	3	9	0	10
1	3	11	0	12
1	3	12	0	14
1	3	13	0	16
2	3	12	0	17
2	3	13	0	19
2	3	14	0	20
3	3	10	0	0
3	3	11	0	0
3	3	12	0	25
3	3	13	0	26
3	3	14	0	27

Table 7 | RF Output Power Level

T=25°C, V_{DD}=5V (Typical) if nothing else stated.

Parameter	Condition	Min	Typ.	Max
Frequency Range		863 MHz		870 MHz
Modulation Techniques	FSK/LoRaTM			
TX Frequency Variation vs. Temperature	Power Level Setting : 20	-3 KHz		+3 KHz
TX Power Variation vs. Temperature		-5 dBm		+5 dBm
TX Power Variation		-1.5 dBm		+1.5 dBm

Table 8 | TX RF Characteristics



2.12.2 Receiver RF Characteristics

We recommended you to use optimized RSSI calibration values which is part of HAL v3.1. For both Radio 1 and 2, the RSSI-offset should be set to -169. The following table gives typical sensitivity level of RAK2245 Pi HAT.

Signal Bandwidth/[KHz]	Spreading Factor	Sensitivity/[dBm]
125	12	-139
125	7	-126
250	12	-136
250	7	-123
500	12	-134
500	7	-120

Table 9 | RX RF Characteristics

3 Source Codes

Here is the open source code link:

<https://github.com/RAKWireless/RAK2245-LoRaGateway-RPi-LoRa-Gateway-OS>

4 Setup Network Server and Frequencies

The default Settings are Bulit-In LoraServer and EU868. If you get the others frequency, you must setup it firstly. For the detailed setup steps, please refer to the

[Get Start with RAK LoRa Develop Kit.pdf](#)

5 Contact Information

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6 Revision History

Revision	Description	Date
1.0	Initial version	2018-12-21
1.1	Modify Pin definition	2019-01-23
1.2	Add source codes chapter	2019-02-14

7 Document Summary

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Prepared by	Checked by:	Approved by:
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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 .

For more information, please visit RAKwireless website at www.rakwireless.com.