



User Manual for

# WisLink-LoRa Concentrator Module

Mini PCI-e Edition

## RAK2247 SPI or USB

Version V1.0 | December2018



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# 1 Overview

## 1.1 Introduction

The RAK2247 is a LoRa concentrator module with the mini PCIe form factor based on SX1301, which enables an easy integration into an existing routers and others network equipment with LoRa Gateway capabilities. It can be used in any embedded platform offering a free mini-PCIe slot with SPI or USB connection.

RAK2247 is a complete and cost efficient LoRa gateway solution offering up to 10 programmable parallel demodulation paths. It targets at smart metering fixed networks and Internet of Things applications with up to 500 nodes per km<sup>2</sup> in moderately interfered environment. The modules have the industry standard PCI Express Mini Card form factor, which enables easy integration into an application board and is also ideal for manufacturing of small series.

The main features are listed below:

- Compatible with Mini PCI-e Edition specification with metal cooling fin.
- SX1301 base band processor emulates 49 x LoRa demodulators 10 parallel demodulation paths.
- 2 x SX125x Tx/Rx front-ends high/ low frequency.
- Build in FT2232H to convert SPI interface of SX1301 to USB2.0.
- Voltage of Mini PCI-e is 3.3v, compatible with 3G/LTE card of Mini PCI-e type.
- Supports US915 region.
- Supports optional SPI or USB interfaces.

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## 1.2 Package Contents



RAK2247 board  
(1x)



LoRa Antenna of N-Type  
Male connector(1x)

Figure1 | Package Contents

## 2 LoRa Concentrator Module RAK2247

### 2.1 Overview

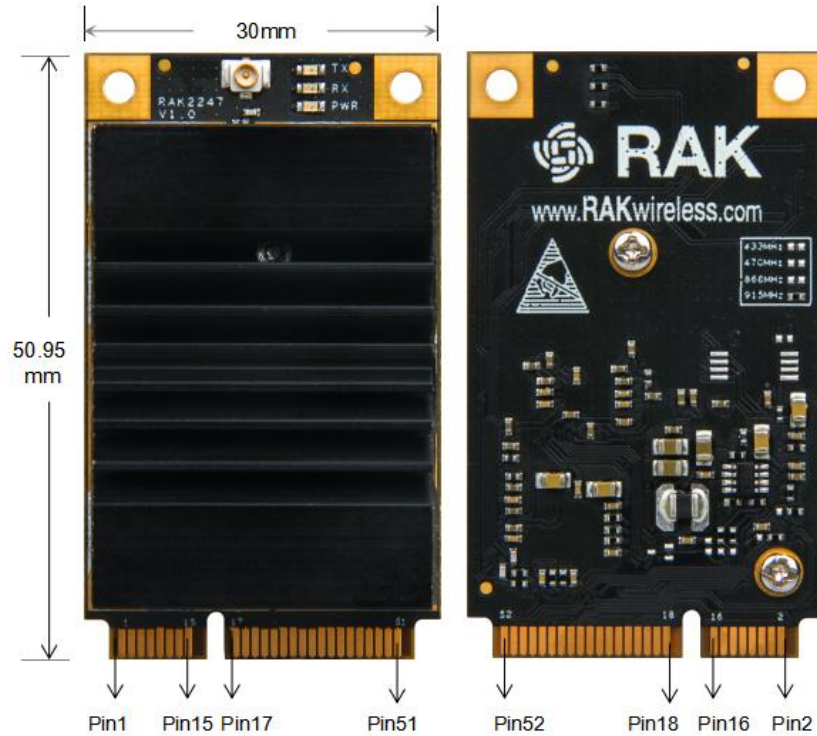


Figure2 | Module View

### 2.2 Block Diagram

The block diagram of RAK2247-SPI shown as below.

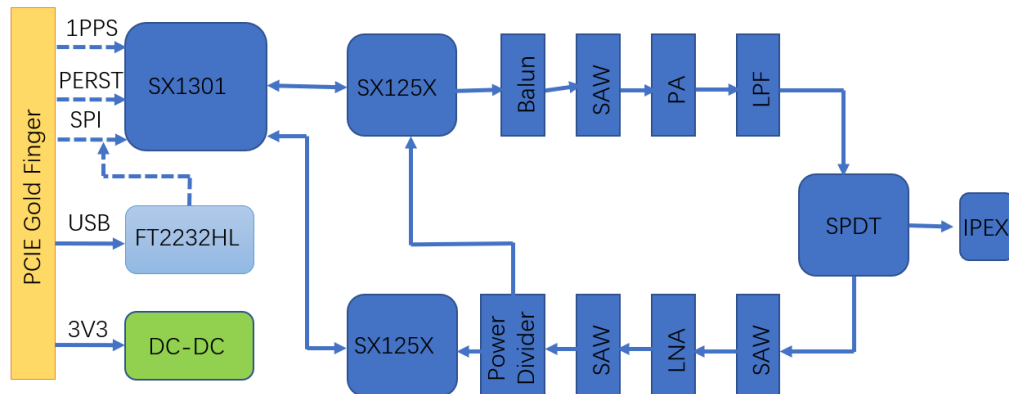


Figure3 | RAK2247-SPI block diagram

As described in Figure 3, the RAK2247 card integrates one SX1301 chip and two SX1255/7 and other chip for RF signal, which represents the core of the device, providing the related LoRa modem and processing functionalities. Additional signal conditioning circuitry is implemented for PCI Express Mini Card compliance, and one UFL connectors are available for external antennas integration.

## 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 )
North America	US: 923.3-927.5Mhz

Table 1 | Operating Frequencies

## 2.4 Pin Definition

No	Mini PCIe PIN Rev. 2.0	RAK2247 PIN	Power	I/O	Description	Remarks
1	WAKE#	NC		N/A		Internally not connected
2	3.3Vaux	3.3Vaux	3.3Vaux	N/A	RAK2247 power supply input	Connect to 3.3 V
3	COEX1	NC		N/A		Internally not connected
4	GND	GND	GND	N/A	Ground	Connect to Ground
5	COEX2	NC		N/A		Internally not connected
6	1.5V	NC		N/A		Internally not connected
7	CLKREQ#	NC		N/A		Internally not connected
8	UIM_PWR	NC		N/A		Internally not connected
9	GND	GND	GND	N/A	Ground	Connect to ground
10	UIM_DATA	NC		N/A		Internally not connected
11	REFCLK-	NC		N/A		Internally not connected
12	UIM_CLK	NC		N/A		Internally not connected
13	REFCLK+	NC		N/A		Internally not connected
14	UIM_RESET	NC		N/A		Internally not connected
15	GND	GND	GND	N/A	Ground	Connect to ground
16	UIM_SPU	NC		N/A		Internally not connected
17	UIM_IC_DM	NC(5V optional For PA)		N/A		Internally not connected



18	GND	GND	GND	N/A	Ground	Connect to ground
19	Reserved	1PPS		N/A		Internal connection 1PPSfor SX1301
20	W_DISABLE1#	NC		N/A		Internally not connected
21	GND	GND	GND	N/A	Ground	Connect to ground
22	PERST#	RESET		I	RAK2247 reset input	Active high( $\geq 100\text{ns}$ ) for SX1301 reset.
23	PERn0	NC		N/A		Internally not connected
24	3.3Vaux	3.3Vaux	3.3Vaux	I	RAK2247 supply	Connect to 3.3 V
25	PERp0	NC		N/A		Internally not connected
26	GND	GND	GND	N/A	Ground	Connect to ground
27	GND	GND	GND	N/A		Connect to ground
28	1.5V	NC		N/A		Internally not connected
29	GND	GND	GND	N/A	Ground	Connect to ground
30	SMB_CLK	NC		N/A		Internally not connected
31	PETn0	NC		N/A		Internally not connected
32	SMB_DATA	NC		N/A		Internally not connected
33	PETp0	NC		N/A		Internally not connected
34	GND	GND	GND	N/A	Ground	Connect to ground
35	GND	GND	GND	N/A	Ground	Connect to ground
36	USB_D-	USB_D-	USB	I/O	USB Data Line D-	90-ohm nominal differential impedance. Pull-up, pull-down and series resistors as required by USB 2.0 specifications are part of the USB pin driver and need not be
37	GND	GND	GND	N/A	Ground	Connect to ground
38	USB_D+	USB_D+	USB	I/O	USB Data Line D+	90-ohm nominal differential impedance. Pull-up, pull-down and series resistors as required by USB 2.0 specifications are part of the USB pin driver and need not be
39	3.3Vaux	3.3Vaux	3.3Vaux	I	RAK2247 supply	Connect to 3.3 V
40	GND	GND	GND	N/A	Ground	Connect to ground
41	3.3Vaux	3.3Vaux	3.3Vaux	I	RAK2247 supply	Connect to 3.3 V
42	LED_WWAN#	NC		N/A		Internally not connected
43	GND	GND	GND	N/A	Ground	Connect to ground
44	LED_WLAN#	NC		N/A		Internally not connected
45	Reserved	PCIe_SCK		I/O	Host SPI CLK	Max 10MHz clock
46	LED_WPAN#	NC		N/A		Internally not connected
47	Reserved	PCIe_MISO		I/O	Host SPI MISO	
48	1.5V	NC		N/A		Internally not connected
49	Reserved	PCIe_MOSI		I/O	Host SPI MOSI	
50	GND	GND	GND	N/A	Ground	Connect to ground
51	W_DISABLE2#	PCIe_CSN		I/O	Host SPI CS	

52	3.3Vaux	3.3Vaux	3.3Vaux	I	RAK2247 supply	Connect to 3.3 V
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*Table 2 | Pin Definition*

## 2.5 Power Supply

RAK2247 card must be supplied through the 3.3Vaux pins by a DC power supply. The voltage must be stable, because during this operation the current drawn from 3.3Vaux can vary significantly, based on the power consumption profile of the SX1301 chip (see SX1301 DS).

## 2.6 SPI Interface

A SPI interface is provided on the PCIe\_SCK, PCIe\_MISO, PCIe\_MOSI, PCIe\_CSN pins of the system connector. The SPI interface gives access to the configuration register of SX1301 via a synchronous full-duplex protocol. Only the slave side is implemented.

## 2.7 USB Interface

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Note: RAK2247-SPI version don't have this interface.

RAK2247 card can support the high speed USB to SPI by FT2232HL, it includes a high-speed USB 2.0 compliant interface with maximum 480 Mb/s data rate, representing the interface for any communication with an external host application processor. The module itself acts as a USB device and can be connected to any USB host equipped with compatible drivers. For more information, please refer to the data sheet of FT2232HL.

## 2.8 1PPS

RAK2247 card includes the 1PPS input for received packets time-stamped.

## 2.9 RESET

RAK2247 card includes the RESET active-high input signal to reset the radio operations as specified by the SX1301 Specification.

## 2.10 Antenna RF Interface

The modules have one RF interfaces over a standard UFL connectors (Hirose U. FL-R-SMT) with a characteristic impedance of 50OHM. The RF port (J1) supports both Tx and Rx, providing the antenna interface.

## 2.11 Electrical Characteristics

Stressing the device above one or more of the ratings listed in the Absolute Maximum Rating section may cause permanent damage. These are stress ratings only. Operating the module at these or at any conditions other than those specified in the Operating Conditions sections of the specification should be avoided.

Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability. The operating condition range define those limit within which the functionality of the device is guaranteed.

Where application information is given, it is advisory only and does not form part of the specification.

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### 2.11.1 Absolute Maximum Rating

Limiting values given below are in accordance with the Absolute Maximum Rating System (IEC 134).

Symbol	Description	Condition	Min.	Max.
3.3Vaux	Module supply voltage	Input DC voltage at 3.3Vaux pins	-0.3V	3.6V
USB	USB D+/D- pins	Input DC voltage at USB interface pins		3.6V
SPDT_SEL	Port select	Input DC voltage at SPDT_SEL input pins	-0.3V	3.6V
RESET	RAK2247 reset input	Input DC voltage at RESET input pin	-0.3V	3.6V
SPI	SPI interface	Input DC voltage at SPI interface pin	-0.3V	3.6V
GPS_PPS	GPS 1 pps input	Input DC voltage at GPS_PPS input pin	-0.3V	3.6V
Rho_ANT	Antenna ruggedness	Output RF load mismatch ruggedness at ANT1		10:1VSWR
Tstg	Storage Temperature		-40°C	85°C

Table 3 | Absolute maximum ratings

The product is not protected against overvoltage or reversed voltages. If necessary, voltage spikes exceeding the power supply voltage specification, given in table above, must be limited to values within the specified boundaries by using appropriate protection devices.



### 2.11.2 Maximum ESD

Parameter	Min	Typical	Max	Remarks
ESD sensitivity for all pins except ANT1			1000V	Human Body Model according to JESD22-A114
ESD sensitivity for ANT1			1000V	Human Body Model according to JESD22-A114
ESD immunity for ANT1			4000V	Contact Discharge according to IEC 61000-4-2
			8000V	Air Discharge according to IEC 61000-4-2

Table 4 | Maximum ESD ratings

Note: RAK2247 card are Electrostatic Sensitive Devices and require special precautions when handling.

### 2.11.3 Operating Conditions

Input voltage at 3.3Vaux must be above the normal operating range minimum limit to switch-on the module.

Symbol	Parameter	Min.	Typical	Max.
3.3Vaux	Module supply operating input voltage <sup>14</sup>	3.00V	3.30V	3.60V

Table 5 | PowerSupply Range

### 2.11.4 Power Consumption

Mode	Condition	Min	Type	Max
Idle-Mode	All of the chip on the board enter idle mode or shutdown.		68uA	
Active-Mode(TX)	TX enabled and RX disabled.		440mA	
Active-Mode(RX)	TX disabled and RX enabled.		470mA	

Table 6 |Module 3.3Vaux supply current consumption

### 2.11.5 RF Characteristics

The following table gives typically sensitivity level of the RAK2247 card.

Signal Bandwidth/[KHz]	Spreading Factor	Sensitivity/[dBm]
500	12	-134
500	7	-120

Table 7 |LoRa RF Characteristics

## 2.12 Mechanical Dimensions

RAK2247 card are fully compliant to the 52-pin PCI Express Full-Mini Card Type F2 form factor, with top-side and bottom-side keep-out areas, with 50.95 mm nominal length, 30 mm nominal width and all the other dimensions as defined by the PCI Express Mini Card Electromechanical Specification [9] except for the card thickness (nominal value is 3.7 mm), as described in the next figure.

The weight of the RAK2247 card is about 9.7 g.KHz

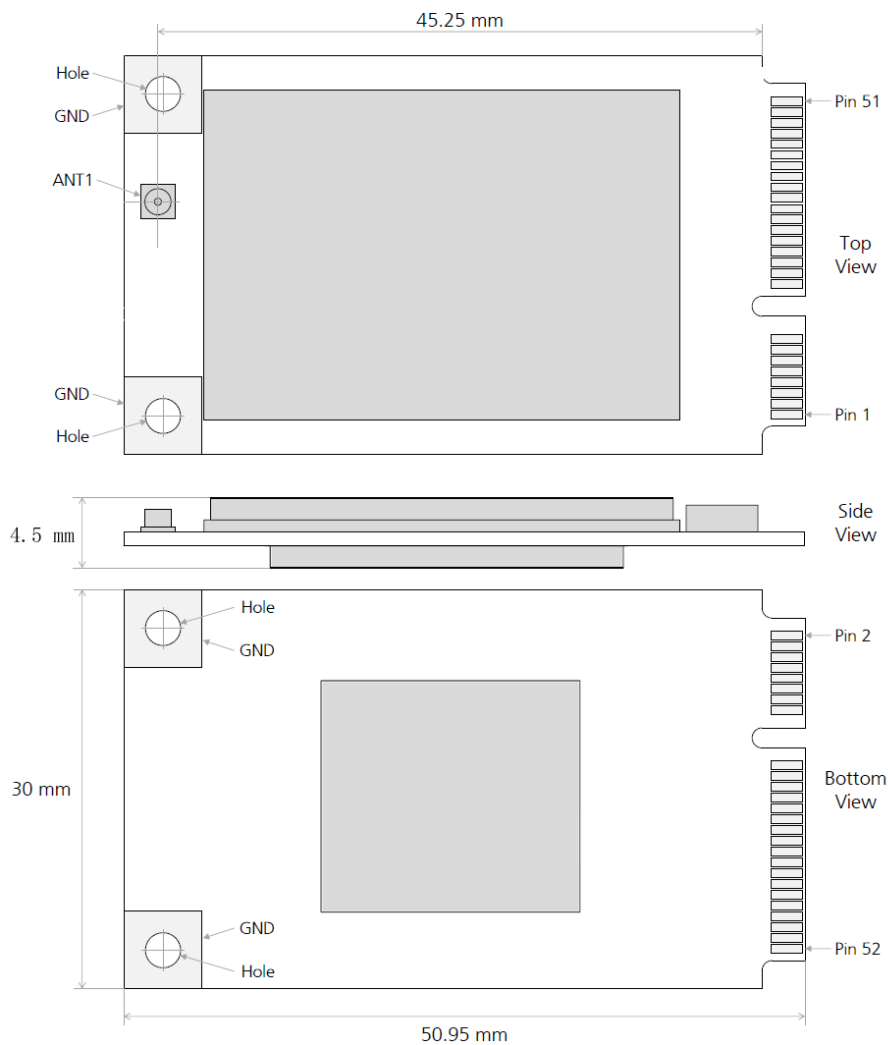


Figure 4| RAK2247 card mechanical dimensions (top view, side view, bottom view)

For further details regarding mechanical specifications see the PCI Express Mini Card Electromechanical Specification.

### 3 LoRa Antenna

#### 3.1 Overview



Figure 5|LoRa Antenna Overview

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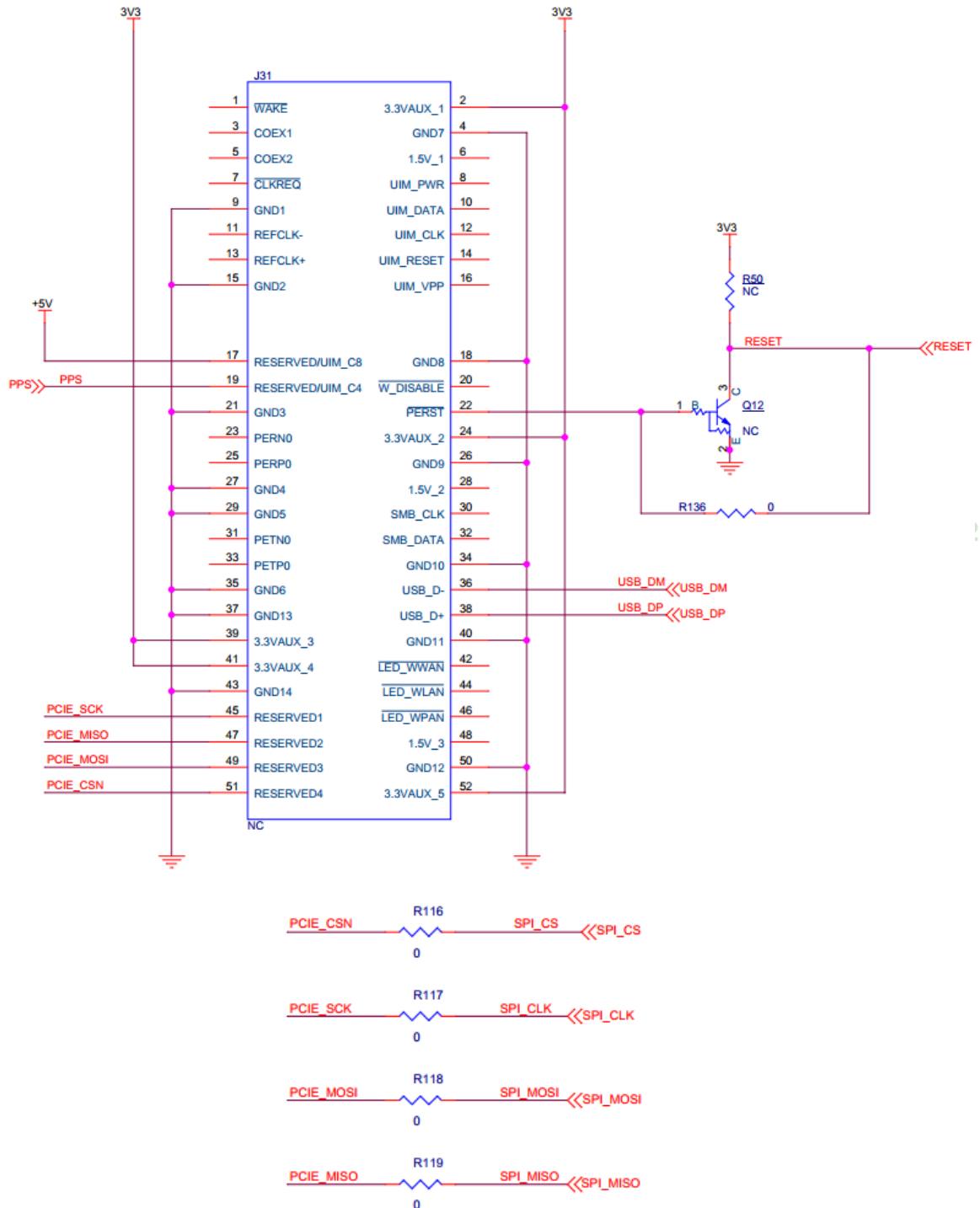
#### 3.2 Antenna Parameter

Items	Specifications
VSWR(Voltage Standard Wave Radio)	1:1.5
Gain	5.8 dBi
WorkingTemperature&Humidity	T:-35 °C ~ +80 °C, H: 0% ~ 95%
StorageTemperature&Humidity	T:-40 °C ~ +85 °C, H: 0% ~ 95%

Table 8| LoRa Antenna Parameter

## 4 Schematics Reference

RAK2247 card refer to Semtech's reference design of SX1301, the SPI interface or USB interface, which convert SPI to USB2.0 by FT2232H, can be used on PCIE connector.



## 5 Warning

**FCC Warning:** This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions.

- (1) This device may not cause harmful interference;
- (2) This device must accept any interference received, including interference that may cause undesired operation.

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. When the module is installed in the host device, the FCC ID label must be visible through a window on the final device or it must be visible when an access panel, door or cover is easily removed. If not, a second label must be placed on the outside of the final device that contains the following text: —Contains FCC ID: 2AF6B-RAK2247.

Maximum antenna gain allowed for use with this device is 5.8 dBi.

This module complies with FCC radiation exposure limits set forth for an uncontrolled environment .This equipment should be installed and operated with minimum distance 20 cm between the radiator& your body.

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### **Manufacture name and address:**

Shenzhen Rakwireless Technology Co., Ltd.

Room 506, Bldg B, New Compark, Pingshan First Road, Taoyuan Street, XiLi town, Nanshan District, Shenzhen, China

### **Integration instructions for host product manufacturers according to KDB 996369 D03OEM**

#### **Manual v01**

#### 2.2 List of applicable FCC rules

The modular complies with Part 15.247 of the FCC Rules.

#### 2.3 Specific operational use conditions

This module is stand-alone modular. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system.

#### 2.4 Limited module procedures

Not applicable

2.5 Trace antenna designs

Not applicable

2.6 RF exposure considerations

To maintain compliance with FCC's RF Exposure guidelines, This equipment should be installed and operated with minimum distance of 20cm from your body.

2.7 Antennas

This radio transmitter FCC ID: **2AF6B-RAK2247** has been approved by Federal Communications Commission to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Antenna Description	Antenna Type	Modulation Type	Impedance (Ω)	Maximum antenna gain(dBi)
Lora Antenna	Monopole	Chirp Modulation	50	5.8dBi

2.8 Label and compliance information

The final end product must be labeled in a visible area with the following" Contains

FCC ID: **2AF6B-RAK2247**"

2.9 Information on test modes and additional testing requirements

Host manufacturer is strongly recommended to confirm compliance with FCC requirements for the transmitter when the module is installed in the host.

2.10 Additional testing, Part 15 Subpart B disclaimer

Host manufacturer is responsible for compliance of the host system with module installed with all other applicable requirements for the system such as Part 15 B

## 6 Revision History

Revision	Description	Date
1.0	Initial version	2018-12-21

Table 9 | Revision History

## 7 Document Summary

**Document Name:** WisLink-LoRa RAK2247 User Manual  
**Release Date:** December2018  
**Revision Number:** V1.0

Prepared by	Checked by:	Approved by:
Penn	Jeff	

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