深圳市瑞科慧联科技有限公司
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RAK833LoRa Gateway

MiniPCIemoduleswith SPI and USBinterface Datasheet V1.3

Contents

1. Functional description

1.1. Overview

The RAK833 is a family of LoRa concentrator cards with mini PCIe form factor based on SX1301, which enables an easy integration into an existing routers and others network equipment with Lora Gateway capabilities.

The card can be used in any embedded platform offering a free mini-PCIe slot with USB and SPI connectivity.

RAK833areacompleteandcostefficientLoRa gateway solutionofferingupto10 programmable parallel demodulation paths. It targeted at smart metering fixed networks and Internet of Things applications with up to 500 nodes per km^2 in moderately interfered environment.ThemoduleshavetheindustrystandardPCIExpressMiniCardformfactor,whichenableseasyintegrationintoanapplicationboardandisalsoidealformanufacturingofsmallseries.

1.2. Product Parameters

Module	Frequency
Protocol	LoRaWAN 1.0.2
Lora Chipset	SX1301
Dual-Band	868MHz,915MHz
Frequency Range	EU 863-870MHz US 923.3-927.5 MHz
Power Input	DC 3.3 ± 5%
Hardware Interface	Mini-PCIE
Software Interface	USB/SPI
Multichannel	8uplinks、1downlink
LEDs	2*LEDs for PA_EN and LNA_EN
USB	USB2.0, USB-to-SPI bridge FT2232H
Node Numbers	500 nodes/km^2
Range	Urban2~4km/Subur5~10km/Open Area>15km
Power Consumption	TX (max): 135 mA RX(all channels):260mA Ldle:71mA
RX Sensitivity	Up to -136. 5dBm@SF12
Max RF Output	Up to +9 dBm
Mean RF Output	Up to +9 dBm
Operation Temperature	-48 to +85° C

Table1: Module Parameters

As described in Figure 1, the RAK833 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 functionallilies. Additional signal conditioning circuitry is implemented for PCI Express Mini Card compliance, and one U. FL connectors are available for external antennas integration.

1.3. Order NO.

Part Number	Description
RAK833-SPI/USB-915	USB and SPI, 923.3MHz-927.5 MHz
RAK833-SPI/USB-868	USB and SPI, 863MHz-870 MHz
RAK833-SPI-915	SPI, 923.3MHz-927.5 MHz
RAK833-SPI-868	SPI, 863MHz-870 MHz

Table2: Module Number
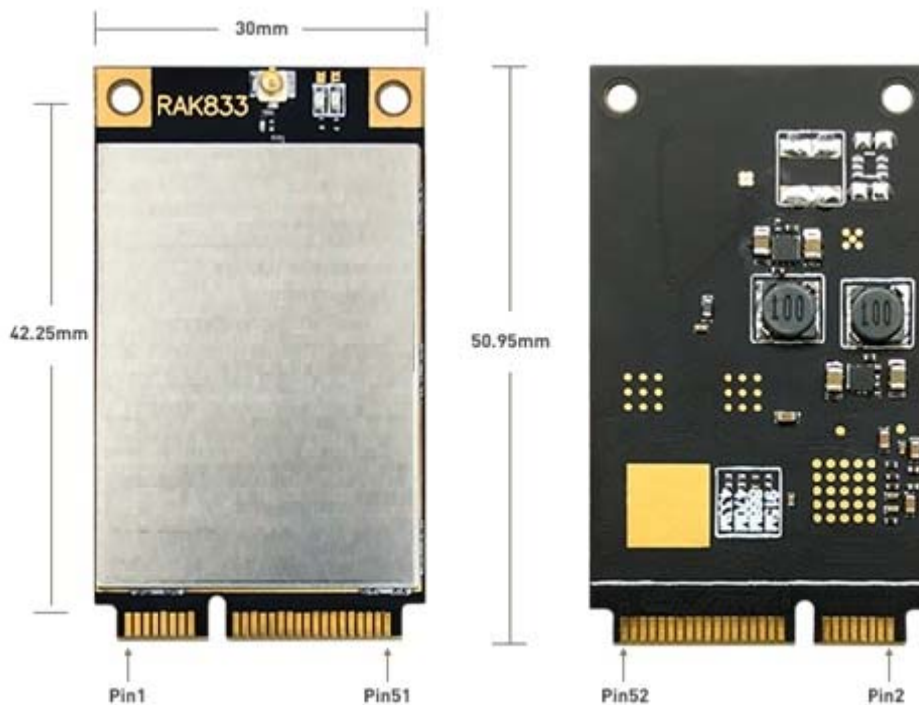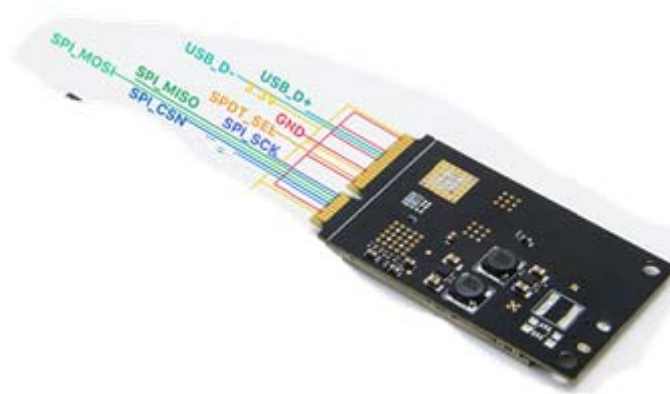
2. Interfaces

2.1. Overview

Figure2:Module View

2.2. Interface

Figure3:Module Interface

2.3. Pin definition with mini-PCIE

No	Mini PCIEx PIN Rev.2.0	RAK833 PIN	Power	I/O	Description	Remarks
1	WAKE#	NC		N/A		Internallynotconnected
2	3.3Vaux	3.3Vaux	3.3Vaux	N/A	RAK833supply input	Connectto3.3V
3	COEX1	NC		N/A		Internallynotconnected
4	GND	GND	GND	N/A	Ground	ConncettoGround
5	COEX2	NC		N/A		Internallynotconnected
6	1.5V	NC		N/A		Internallynotconnected
7	CLKREQ#	NC		N/A		Internallynotconnected
8	UIM_PWR	NC		N/A		Internallynotconnected
9	GND	GND	GND	N/A	Ground	Connecttoground
10	UIM_DATA	NC		N/A		Internallynotconnected
11	REFCLK-	NC		N/A		Internallynotconnected
12	UIM_CLK	NC		N/A		Internallynotconnected
13	REFCLK+	NC		N/A		Internallynotconnected
14	UIM_RESET	NC		N/A		Internallynotconnected
15	GND	GND	GND	N/A	Ground	Connecttoground
16	UIM_SPU	NC		N/A		Internallynotconnected
17	UIM_IC_DM	SPDT_SEL		N/A		Internal 10K ohm pull-up
18	GND	GND	GND	N/A	Ground	Connecttoground
19	N/A	N/A		N/A		N/A
20	W_DISABLE1#	NC		N/A		Internallynotconnected
21	GND	GND	GND	N/A	Ground	Connecttoground
22	PERST#	RESET		I	RAK833resetinput	Active high(≥100ns) for SX1301
23	PERn0	NC		N/A		Internallynotconnected
24	3.3Vaux	3.3Vaux	3.3Vaux	I	RAK833supply input	Connectto3.3V
25	PERp0	NC		N/A		Internallynotconnected

26	GND	GND	GND	N/A	Ground	Connecttoground
27	GND	GND	GND	N/A		Connecttoground
28	1.5V	NC		N/A		Internallynotconnected
29	GND	GND	GND	N/A	Ground	Connecttoground
30	SMB_CLK	NC		N/A		Internallynotconnected
31	PETn0	NC		N/A		Internallynotconnected
32	SMB_DATA	NC		N/A		Internallynotconnected
33	PETp0	NC		N/A		Internallynotconnected
34	GND	GND	GND	N/A	Ground	Connecttoground
35	GND	GND	GND	N/A	Ground	Connecttoground
36	USB_D-	USB_D-	USB	I/O	USBDataLineD-	90-ohm nominal differential impedance. Pull-up,pull-downandseriesresistorsasrequiredby $USB2.0 specifications$ are partof theUSBpin driverand
37	GND	GND	GND	N/A	Ground	Connecttoground
38	USB_D+	USB_D+	USB	I/O	USBDataLineD+	90-ohm nominal differential impedance. Pull-up,pull-downandseriesresistorsasrequiredby $USB2.0 specifications$ are partof theUSBpin driverand neednotbeprovidedexternally.
39	3.3Vaux	3.3Vaux	3.3Vaux	I	RAK833supply input	Connectto3.3V
40	GND	GND	GND	N/A	Ground	Connecttoground
41	3.3Vaux	3.3Vaux	3.3Vaux	I	RAK833supply input	Connectto3.3V
42	LED_WWAN#	NC		N/A		Internallynotconnected
43	GND	GND	GND	N/A	Ground	Connecttoground
44	LED_WLAN#	NC		N/A		Internallynotconnected
45	Reserved	PCIe_SCK		I/O	Host SPI CLK	Max 10MHz clock
46	LED_WPAN#	NC		N/A		Internallynotconnected
47	Reserved	PCIe_MISO		I/O	Host SPI MISO	
48	1.5V	NC		N/A		Internallynotconnected
49	Reserved	PCIe_MOSI		I/O	Host SPI MOSI	
50	GND	GND	GND	N/A	Ground	Connecttoground
51	W_DISABLE2#	PCIe_CSN		I/O	Host SPI CS	
52	3.3Vaux	3.3Vaux	3.3Vaux	I	RAK833supply input	Connectto3.3V

Table3: Pin Definition

2.3.1.Module supply input

RAK833 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).

2.3.2.Antenna RF interfaces

The modules have one RF interfaces over a standard U. FL connectors (Hirose U. FL-R-SMT) with a characteristic impedance of 50. The RF port (ANT1) supports both Tx and Rx, providing the antenna interface.

2.3.3.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.

2.3.4.USB interface

Note: RAK833-SPI don't have this feature

RAK833 card can support the high speed USB to SPI by FT2232H, 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 FT2232H.

2.3.5.RESET

RAK833 card includes the RESET active-high input signal to reset the radio operations as specified by the SX1301 Specification.

2.3.6.SPDT_SEL

RAK833 card includes the SPDT_SEL input for selecting SPI or USB interface. SPDT_SEL="H", USB Port Enable, SPDT_SEL="L", SPI Port Enable. Internal Pull UP, Default USB Port.

3. Electrical specifications

⚠️ StressingthedeviceaboveoneormoreoftheratingslistedintheAbsoluteMaximumRatingsectionmaycausepermanentdamage.Thesearestressratingsonly.OperatingthemoduleattheseoratanyconditionsotherthanthosespecifiedintheOperatingConditionssections(chapter4.1)ofthespecificationshouldbeavoided.ExposuretoAbsoluteMaximumRatingconditionsforextendedperiodsmayaffectdevicereliability.

☞ The Operatingconditionrangedefinethoselimitwithinwhichthefunctionalityofthedeviceisguaranteed.

☞ Whereapplicationinformationisgiven,itisadvisoryonlyanddoesnotformpartofthespecification.

3.1. Absolute maximum rating

☞ LimitingvaluesgivenbelowareinaccordancewiththeAbsoluteMaximumRatingSystem(IEC134).

Symbol	Description	Condition	Min.	Max.	Unit
3.3Vaux	Modulesupplyvoltag	InputDCvoltageat3.3Vauxpins	−0.3	3.	V
USB	USBD+/D-pins	InputDCvoltageatUSBinterfacepins		3.	V
SPDT_SEL	Port select	InputDCvoltageatSPDT_SELinputpins	−0.3	3.	V
RESET	RAK833resetinput	InputDCvoltageat RESET inputpin	−0.3	3.	V
SPI	SPI interface	InputDCvoltageat SPI interfacepin	−0.3	3.	V
Rho_ANT	Antennaruggednes	OutputRFloadmismatchruggednessatANT		10:1	VSWR
Tstg	StorageTemperatur		−40	85	°C

Table4:Absolutemaximumratings

⚠️ Theproductisnotprotectedagainstovervoltageorreversedvoltages.If necessary,voltagespikesexceedingthepowersupplyvoltagespecification,givenintableabove,mustbelimitedtovalueswithinthespecifiedboundariesbyusingappropriateprotectiondevices.

3.2. Maximum ESD

Parameter	Min	Typical	Max	Unit	Remarks
ESDsensitivityforallpinsexceptANT1			1000	V	HumanBodyModelaccordingtoJESD22-A114
ESDsensitivityforANT1			1000	V	HumanBodyModelaccordingtoJESD22-A114
ESDimmunityforANT1			4000	V	ContactDischargeaccordingtoIEC61000-4-2
			8000	V	Air DischargeaccordingtoIEC61000-4-2

Table5:MaximumESDratings

⚠️ RAK833cardareElectrostaticSensitiveDevicesandrequirespecialprecautionswhenhandling.Seesection7.2forESDhandlinginstructions.

3.3. Operating Conditions

☞Unlessotherwiseindicated,alloperatingconditionspecificationsareatanambienttemperatureof25°C.

⚠ **Operation beyondthe operating conditions is not recommended and extended exposure beyondthemmayaffectdevicereliability.**

3.3.1. Operating temperature range

Parameter	Min.	Typical	Max.	Unit	Remarks
Normaloperatingtemperature	−20	+25	+65	°C	Normaloperatingtemperaturerange (fullyfunctionalandmeet3GPPspecifications)
Extendedoperatingtemperature	−40		+85	°C	Extendedoperatingtemperaturerange (RFperformancemaybeaffectedoutside normaloperatingrange,thoughmoduleisfullyfun

Table6:Environmentalconditions

3.3.2. Supply/power pins

Symbol	Parameter	Min.	Typical	Max.	Unit
3.3Vaux	Modulesupplyoperatinginputvol	3.00	3.30	3.60	V

Table7:InputcharacteristicsofSupply/Powerpins

Inputvoltageat**3.3Vaux**mustbeabovethenormaloperatingrangeminimumlimittoswitch-onthemodule.

3.3.3. Current consumption

Mode	Condition	Min	Type	Max	Unit
Idle-Mode	All of the chip on the board enter idle mode or shutdown.	60	100		uA
Active-Mode (TX)	The power of TX channel is 23dBm and 3.3V supply.		TBD		mA
Active-Mode (RX)	TX disabled and shutdown PA.		TBD		mA

Table8:Module3.3Vauxsupplycurrentconsumption

3.3.4. LoRa RF characteristics

The following table gives typically sensitivity level of the RAK833 card

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

Table9:LoRa RF Characteristics

4. Mechanical specifications

RAK833 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 Figure 2. The weight of the RAK833 card is about 9.7 g.
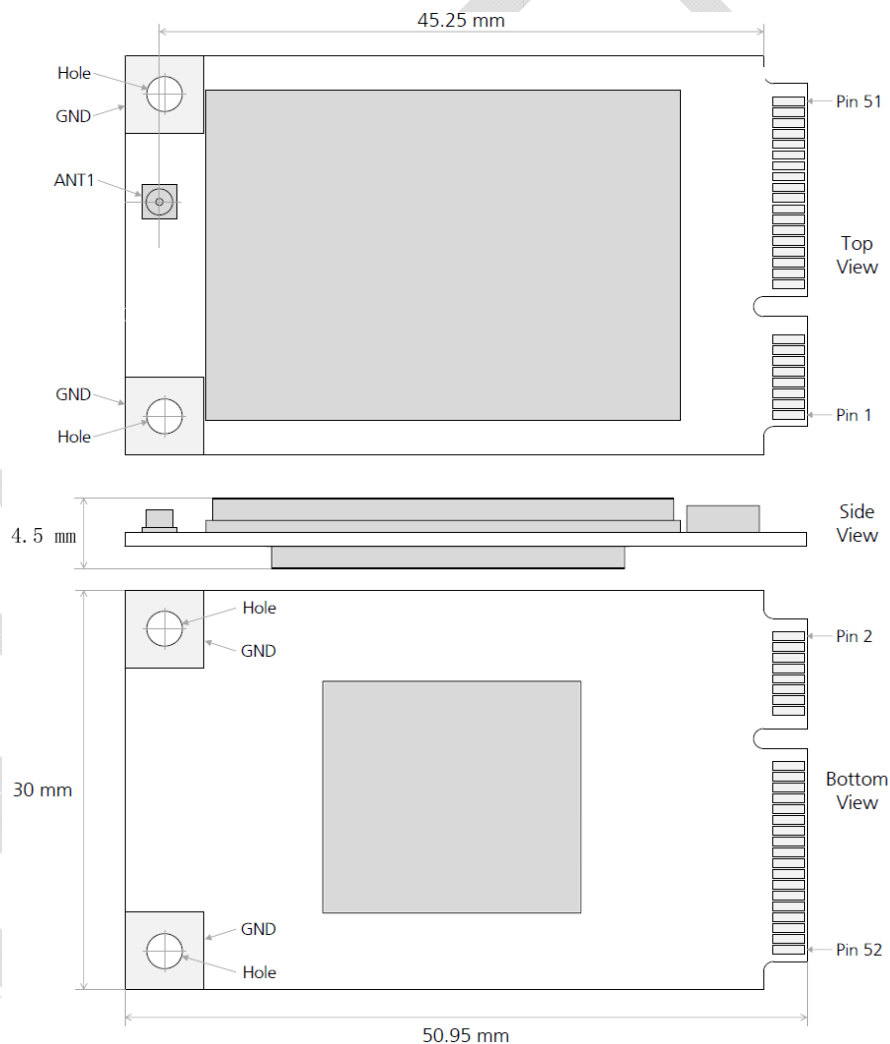

**Figure4:RAK833cardmechanicaldimensions(topview,sideview,bottomview)**

☞ Forfurtherdetailsregardingmechanicalspecificationsseethe*PCIExpressMiniCardElectromechanicalSpecification*[9].
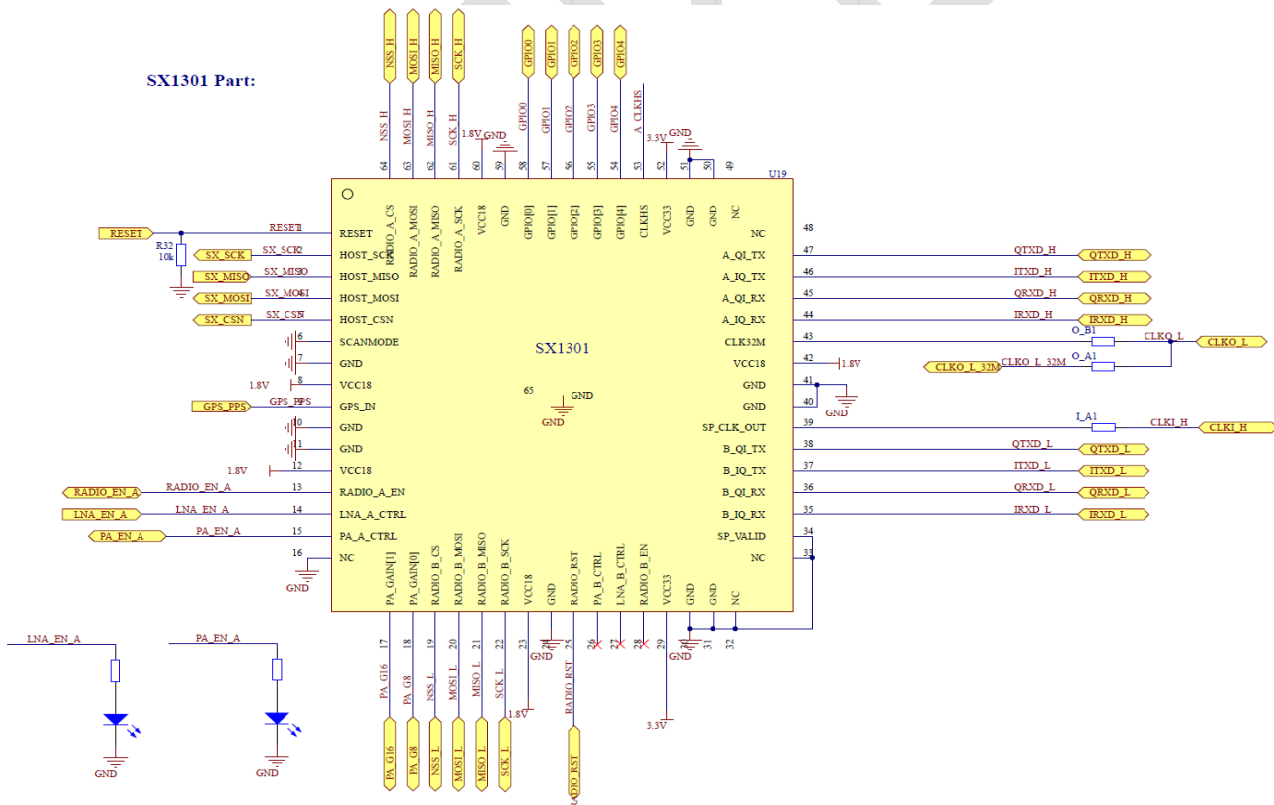
5. RAK833 Module schematic

RAK833 card refer Semtech's reference design of SX1301, add a 4 chancel SPDT to switch SPI of SX1301 to PCI edge connector or FT2232H which convert SPI to USB2.0 interface.
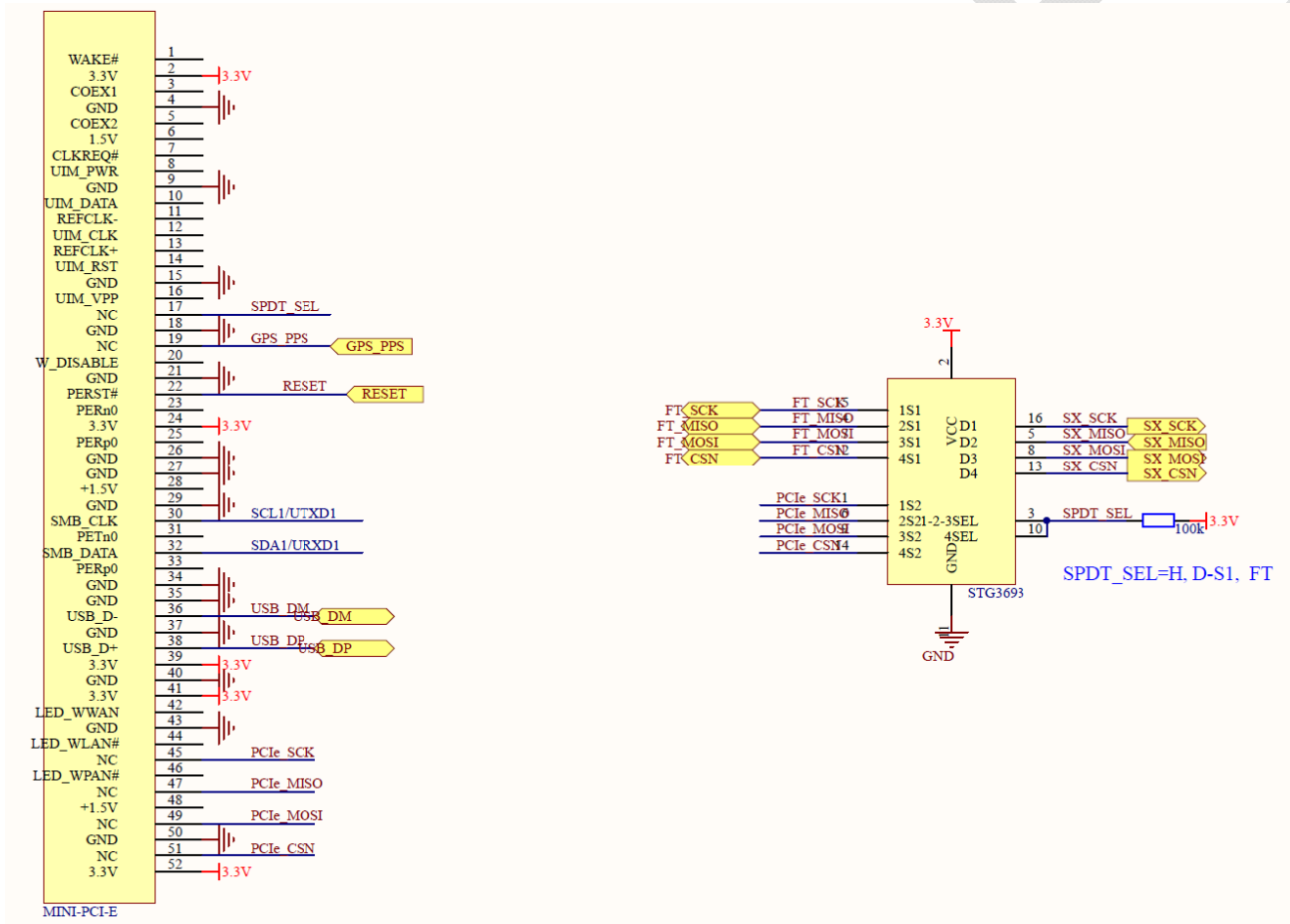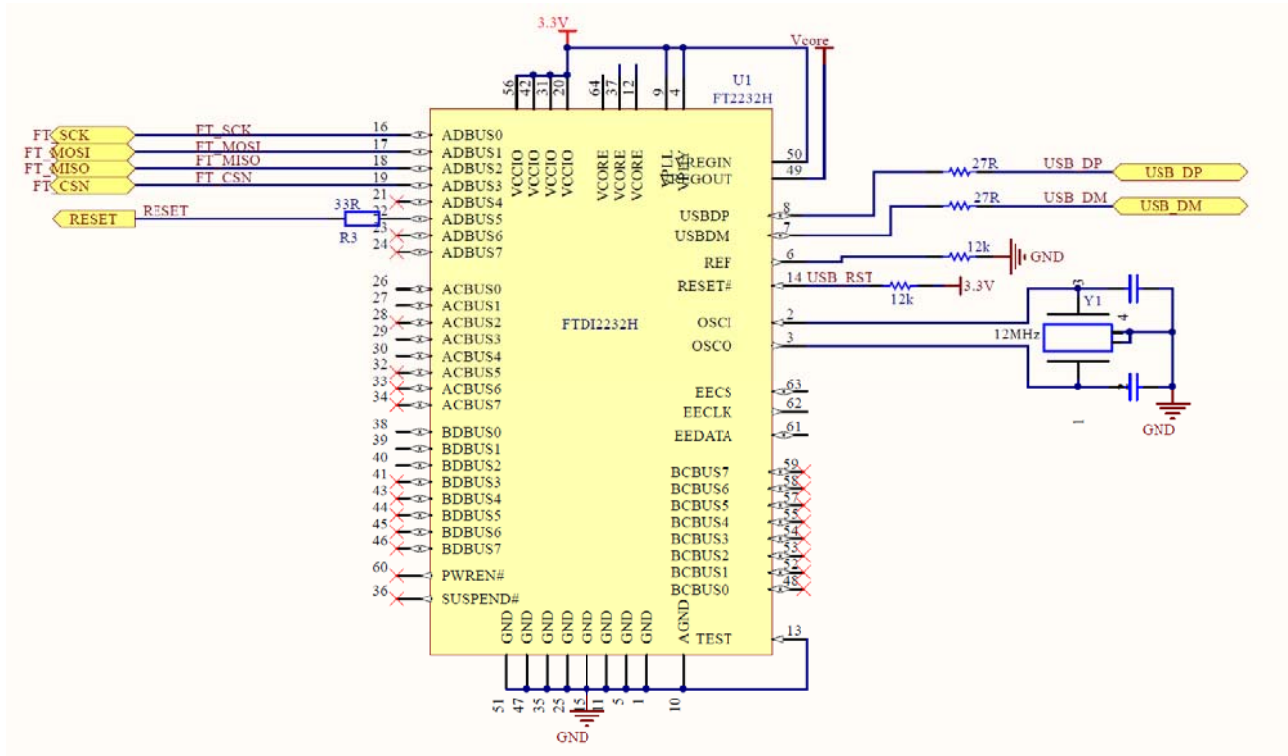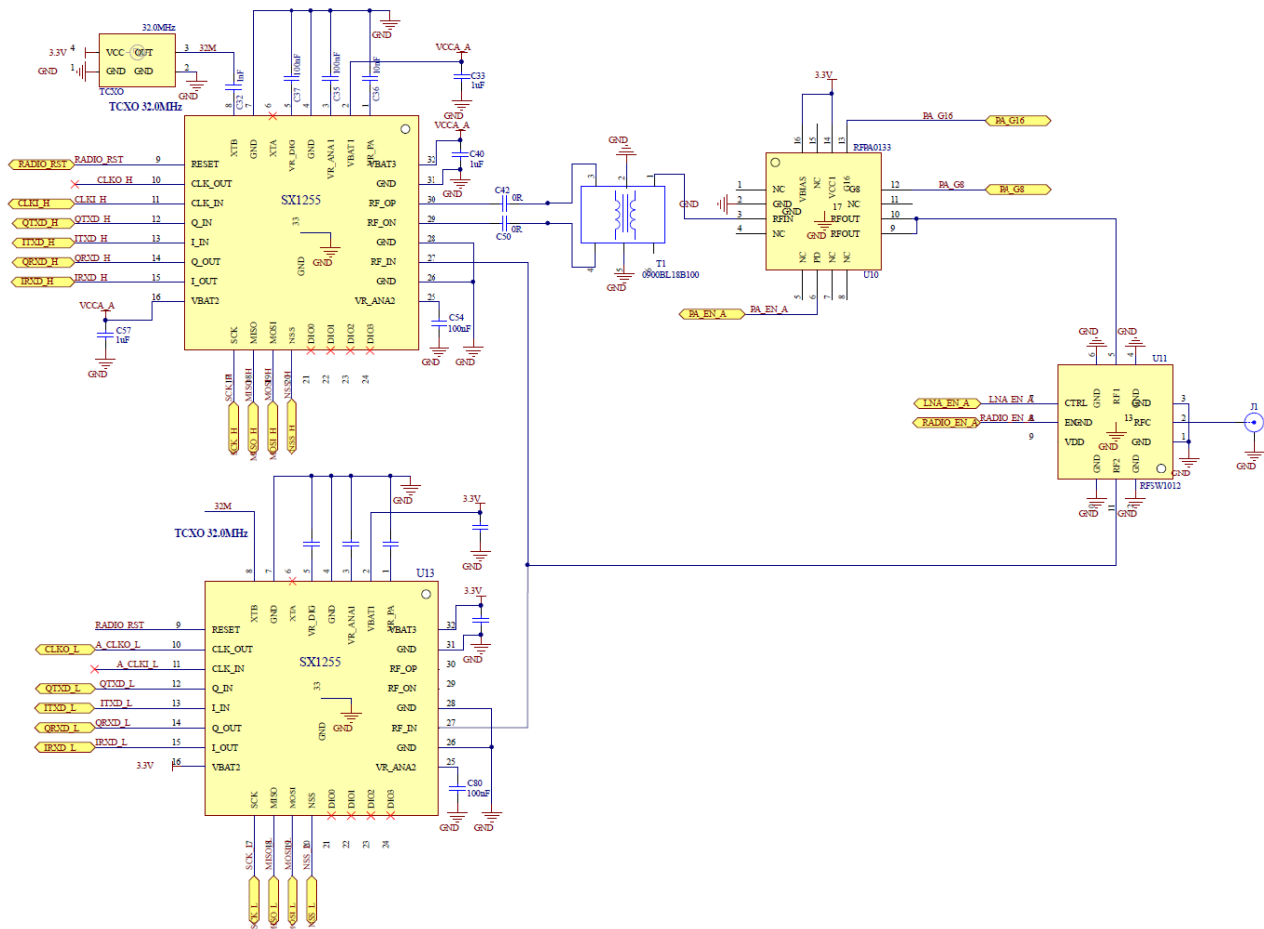
SX1301 Part:

Figure5:RAK833cardinnerschematic.

☞Forfurtherdetailsregardingschematic please refer "SX1301DVK_e286v02a_sch_layout" from Semtech.

6. Reference Application

Figure 4 shows the minimum application schematic of RAK833 card. Uses at lest 3.3V/1A DC power, connect SPI interface or USB interface to the main processor. If use SPI interface SPDT_SEL should be tied to GND otherwise just let this pin open.
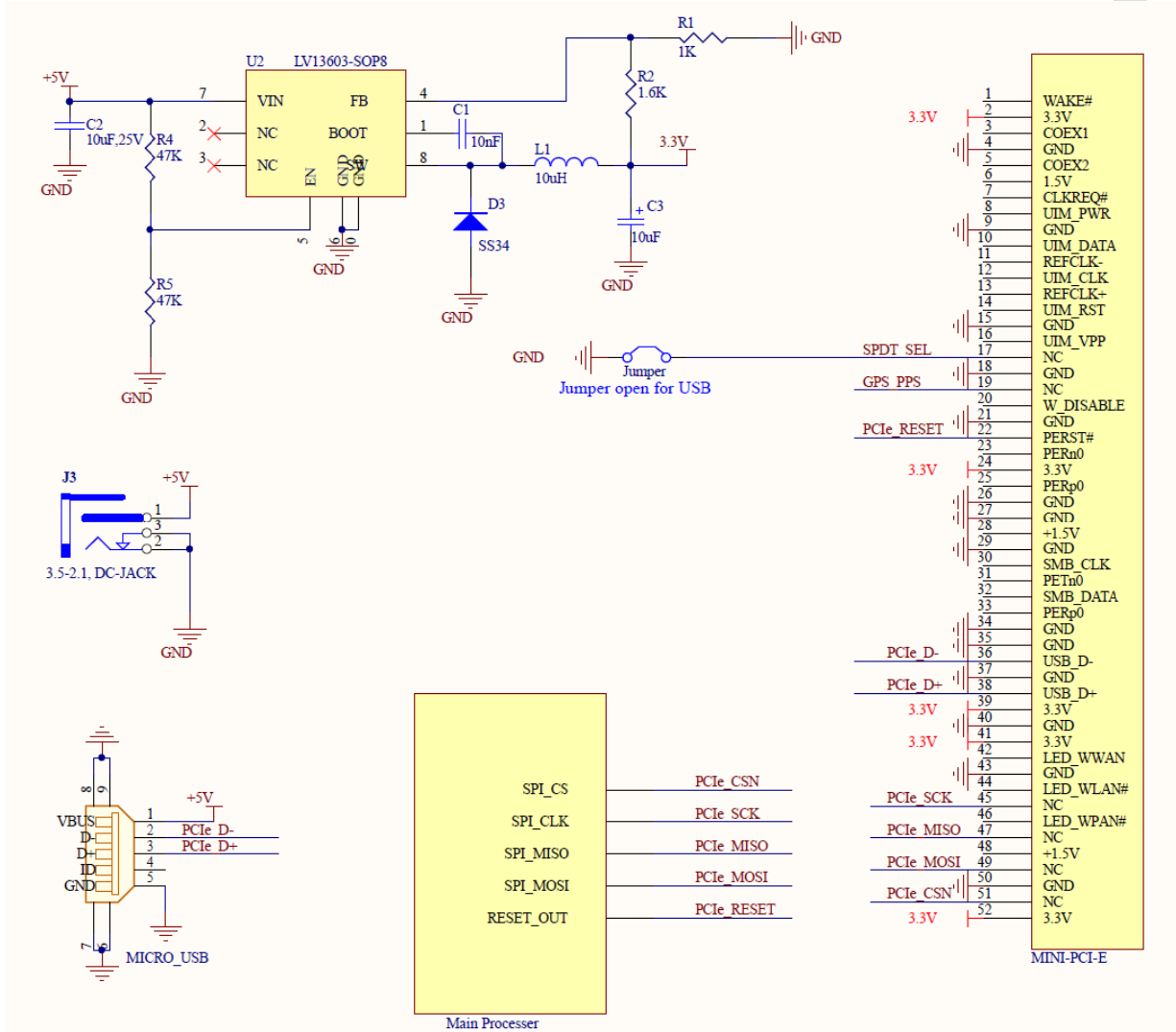

Figure6:RAK833cardreferenceminimum schematic.

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, and (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-RAK833.

Maximum antenna gain allowed for use with this device is 2 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.

7. Contact

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8. Change Note

Version	Date	Change
V1.0	2018-01-11	Draft
V1.1	2018-03-11	Addmodulepicture and fix some mistakes
V1.2	2018-05-11	Fix some description mistake for Part NO and parameters
V1.3	2018-06-19	Adjust the RF parameters and the content for reading.

Manufacture name and address：

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