User Manual of SRM200A

1. Introduction

The SRM200A is a quad mode module supporting Sigfox, BLE, WiFi and GPS.

This Module able to transmit and receive messages using the SIGFOX network.

The typical applications can be used as a low power tracking device.

The application use WIFI or GPS to determine location. It will then transmit the location information via SIGFOX.

It also will transmit other information like temperature, accelerometer, and so on.

2. Hardware Architecture:

2.1 Main Chipset Information

Item	Vendor	Part Number
SigFox	STMicroelectronics	S2-LP
BLE	NORDIC semiconductor	nRF52832
WIFI	ESPRESSIF	ESP8285
GPS(GLONASS)	UBLOX	UBX-G8020

2.2 Circuit Block Diagram

The major internal and external block diagram of SRM200A is illustrated in Figure 1-1.
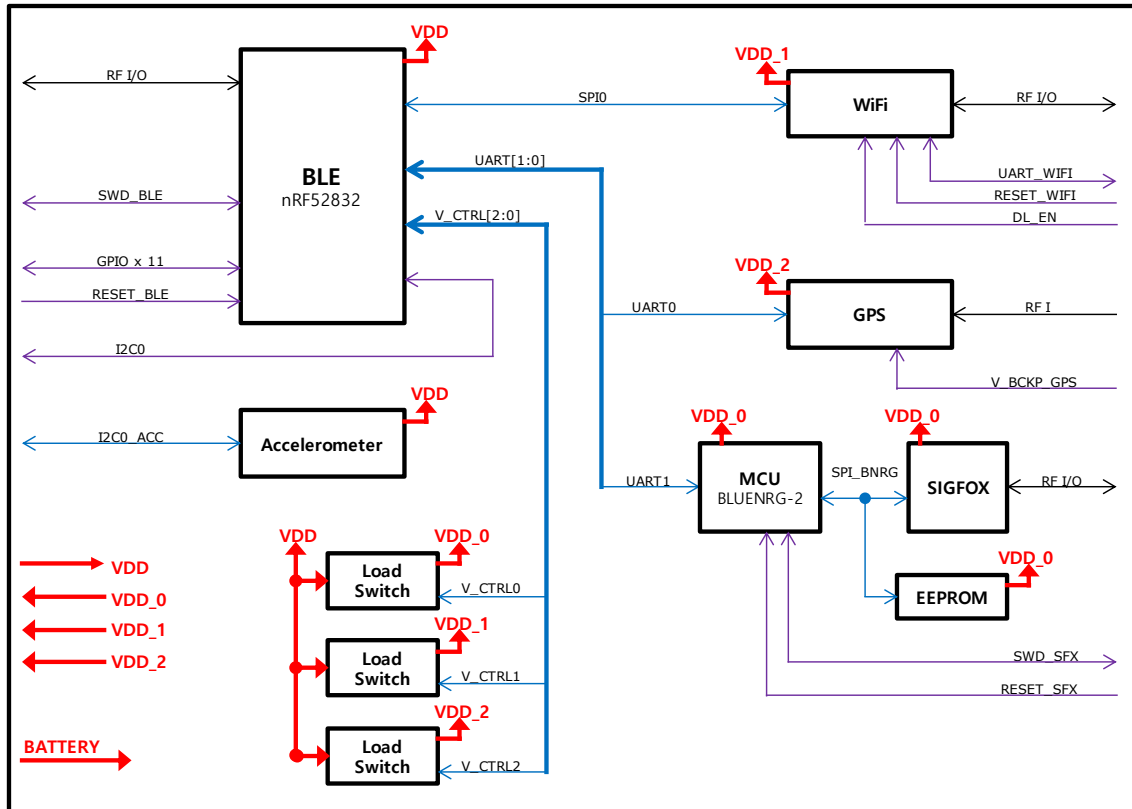

Figure 1-1 SRM200A block diagram and System Interface

3. Operational Description

-SIGFOX

SIGFOX able to transmit and receive messages using the SIGFOX network.
This module address the RC1(Europe), RC2(North America), RC3(Japan), RC4(Australia, new Zealand), RC5(Korea)

-BLE

Bluetooth 4.2 optimized for low-power applications.
The RADIO contains a 2.4 GHz radio receiver and a 2.4 GHz radio transmitter that is compatible with Nordic's proprietary 1 Mbps radio modes in addition to 1 Mbps *Bluetooth®* low energy mode.

-WIFI

ESP8285 implements TCP/IP, the full 802.11 b/g/n/e/i WLAN MAC protocol and Wi-Fi 2.4GHz.
Direct specification. It supports not only basic service set (BSS) operations under the distributed control function (DCF) but also P2P group operation compliant with the latest Wi-Fi P2P protocol. Low level protocol functions are handled automatically by ESP8285.
• RTS/CTS
• acknowledgement
• fragmentation and defragmentation
• aggregation
• frame encapsulation (802.11h/RFC 1042)
• automatic beacon monitoring / scanning, and
• P2P Wi-Fi direct
Passive or active scanning, as well as P2P discovery procedure is performed autonomously once initiated by the appropriate command. Power management is handled with minimum interaction with host to minimize active duty period.

-GPS (GLONASS)

The application use GPS(GLONASS) to determine location. It will then transmit the location information via SIGFOX. It also will transmit other information like temperature, accelerometer, and so on.

-NFC

Type 2 near field communication (NFC-A) tag with wakeup-on-field and touchto-pair capabilities

3.1 Features

- SIGFOX
> Sigfox up-link and down-link functionality controlled by CLI commands
> Temperature sensor
> Ultra-low power consumption
> High performance narrow-band Sigfox

- BLE
> Based on Nordic Semiconductor nRF52832 Bluetooth Smart Soc
  (ARM Cortex –M4F, 512KB flash, and 64KB RAM embedded)
> Ultra-low power multiprotocol support
> BLE Wireless application
> Bluetooth specification Version 4.2 (LE single mode) compliant
> External interface: 32 GPIO pins for NFC(tag), SPI, TWI, UART, Crystal (32.768 KHz) and ADC

-WIFI
> 2.4 GHz receiver
> 2.4 GHz transmitter
> High speed clock generators and crystal oscillator
> Real-Time Clock
> Bias and regulators
> Power management

-GPS (GLONASS)
> down to 1 s acquisition time
> up to 18 Hz navigation update rate in single GNSS mode
> Supports GPS and GLONASS as well as SBAS and QZSS
> Supports u-blox's AssistNow Online / AssistNow Offline A-GNSS services and is OMA SUPL 1.0 compliant
> Supports u-blox's AssistNow Autonomous (no connectivity required)
> Supports crystal oscillator and TCXO
> Supports a built-in DC/DC converter and an intelligent, user configurable power management
> Supports data logging, odometer, geo-fencing, spoofing detection, and message integrity protection.

-NFC
> Wake-on-field low power field detection (SENSE) mode
> Frame assemble and disassemble for the NFC-A frames specified by the NFC Forum
> Programmable frame timing controller
> Integrated automatic collision resolution, CRC and parity functions

3.2 Time base of the RF frequency

-SIGFOX

For Sigfox RF frequency, a TCXO(50MHz) is a clock reference.

-BLE

Using external 32.768 kHz crystal for RTC.

The 64 MHz crystal oscillator (HFXO) is controlled by a 32 MHz external crystal.

-WIFI

The high frequency clock on ESP8285 is used to drive both transmit and receive mixers.

This clock is generated from internal crystal oscillator and external crystal. The crystal frequency is 26 MHz.

-GPS(GLONASS)

The RTC is driven internally by a 32.768 Hz oscillator, which makes use of an external RTC crystal.

For GPS(GLONASS) RF frequency, a TCXO(26MHz) is a clock reference.

3.3 Transmission

-SIGFOX

The Tx path produces a DBPSK-modulated signal. Modulate RF signal generated by the synthesizer. The modulated RF signal is fed to the integrated RX/TX switch and antenna interface and then out of the S2-LP.

-BLE

The RADIO contains a 2.4 GHz radio receiver and a 2.4 GHz radio transmitter that is compatible with Nordic's proprietary 1 Mbps radio modes in addition to 1 Mbps *Bluetooth®* low energy mode.

-WIFI

The 2.4 GHz transmitter up-converts the quadrature baseband signals to 2.4 GHz, and drives the antenna with a high-power CMOS power amplifier. The function of digital calibration further improves the linearity of the power amplifier, enabling a state of art performance of delivering +19.5 dBm average power for 802.11b ransmission and +16dBm for 802.11n transmission.

Additional calibrations are integrated to offset any imperfections of the radio, such as:

• Carrier leakage

• I/Q phase matching

• Baseband nonlinearities

These built-in calibration functions reduce the product test time and make the test equipment unnecessary.

3.4 Receiver

-SIGFOX

The Rx path is able to receive sub-1GHz signal and the noise amplifier is built in the inside of the chip, it amplifies the received signal by the low noise amplifier according to the receiving intensity, and the amplified signal is converted into the digital signal through the ADC, Packets will be interpreted.

-BLE

The RADIO contains a 2.4 GHz radio receiver and a 2.4 GHz radio transmitter that is compatible with Nordic's proprietary 1 Mbps radio modes in addition to 1 Mbps *Bluetooth®* low energy mode.

-WIFI

The 2.4-GHz receiver down-converts the RF signals to quadrature baseband signals and converts them to the digital domain with 2 high resolution high speed ADCs. To adapt to varying signal channel conditions, RF filters, automatic gain control (AGC), DC offset cancelation circuits and baseband filters are integrated within ESP8285.

-GPS(GLONASS)

u-blox 8 GNSS chips are single GNSS receivers which can receive and track either GPS or GLONASS signals. By default the u-blox 8 receivers are configured for GPS, including SBAS and QZSS reception. If power consumption is a key factor, then QZSS and SBAS should be disabled.

-NFC

The NFCT peripheral (referred to as the 'NFC peripheral' from now on) supports communication signal interface type A and 106 kbps bit rate from the NFC Forum.

3.5 Product Details

-SIGFOX

> Data Modulation

   TX : DBPSK

   RX : 2GFSK

> Frequency :

Sigfox zone	Uplink/TX (MHz)	Sigfox zone
RC2	902.1375 ~ 904.6625	RC2
RC4	920.7375 ~ 923.2625	RC4

-BLE

> Data Modulation : GFSK

> Frequency : 2402-2480MHz

-WIFI

> Data Modulation :

   DSSS:CCK,BPSK,QPSK for 802.11b

   OFDM:BPSK,QPSK,16QAM,64QAM for 802.11g,n (HT20)

> Frequency Range : RC1,RC3, RC5 는 2412-2472MHz / RC2, RC4는 2412-2462MHz

-GPS

> Data Modulation : BPSK

> Frequency :

   GPS : 1575.42MHz

-NFC

> NFC-A listen mode operation

   13.56 MHz input frequency

   Bit rate 106 kbps

3.6 Output Power tolerance

- SIGFOX   Output power : +/- 2dB
- BLE Output power : +/- 4.0dB
- WIFI Output power : + 2dB

3.7 SRM200A Category of signal

1) **Categorization as Correlated or Completely Uncorrelated**

For the purposes of this guidance, transmitter output signals are considered *correlated* if <u>any</u> of the following are true:

- The same digital data are transmitted from two or more antennas in a given symbol period, even with different coding or phase shifts; or.
- Correlation between two transmitted signals exists at any frequency and time delay; or.
- Multiple transmitter outputs serve to focus energy in a given direction or to a given receiver; or.
- The operating mode combines correlated techniques with uncorrelated techniques.

Otherwise, the output signals are considered *completely uncorrelated*.

3.8 Simultaneous transmission

	B LE	SIGFOX	2.4GHz WiFi	GPS
B LE		O	O	O
SIGFOX	O		N/A	N/A
2.4GHz WiFi	O	N/A		N/A
GPS	O	N/A	N/A	

4. Installation Guide

- Contents

- Installation Figure

5.Contact Address

54-11, DongtanHana1(i)-gil, Hwaseong-si, Gyeonggi-do, 18423, Korea (Republic Of)

6.Manufacturer

SJIT Co.,Ltd

\<FCC Warning Statements\>

FCC Part 15.19 Statements:	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.
FCC Part 15.21 statement	Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.
\<Regulatory notice to host manufacturer according to KDB 996369 D03 OEM Manual v01r01\>	
2.2 List of applicable FCC rules	This module has been granted modular approval as below listed FCC rule parts. -FCC Rule parts 15C(15.247)
2.3 Summarize the specific operational use conditions	-The OEM integrator should use equivalent antennas which is the same type and equal or less gain then an antenna listed in this instruction manual.
2.4 Limited module Procedures	This module is certified as limited modular approval because of lack of both conditions of SMA type connector antenna and power supply regulation, so the host manufacturer needs to be followed the installation guidance explained below. **1. Antenna Installation Guidance** 1) The host device equipped with this transmitter module must be installed by a professional installer who is trained regarding the antenna installation conditions as outlined below:. 1) The antenna used must be used in the specified antenna type and maximum antenna gain as listed below: -. Antenna type: Half Wave dipole **[table below]** If a different type or higher gain antenna is used, additional authorization is required. 2) The OEM manufacturer, responsible for installing this module into the host device, must ensure that end-users do not have access to the antenna and connector, in compliance with FCC Section 15.203. 3) the antenna connector must not be accessible to the end-user when installed into the host device and the host device must ensure the module and antenna are installed in accordance with the installation guidance. **2. Installation guidance for power supply regulation** This module does not have it`s own power supply regulation. Therefore, Host product in which this module is installed must be followed module manufacturer`s installation guidance to provide the correct input voltages (2.7-3.6 Vdc) to this module from host device`s power supply regulation circuitry. Verification testing shall be performed according to the provided test guidance in this documents. This is to ensure that the module, when installed and operated under the host product`s operating conditions and voltage regulation range, remains compliant with FCC requirements. ✓ **Host Product Test Guidance** : The radiated signal level of the fundamental frequency and radiated spurious emissions measurements shall be performed while varying the hosts supply voltage between 85% and 115% of the nominal rated supply voltage. For battery operated equipment, the equipment tests shall be performed using a new battery. At low battery voltage levels, the module input level may drop to 0V,

Frequency band	SIGFOX (INNO-ADI-0269)	BLE (W5E-WO-03)	WLAN (INNO-FWFSWS-151)
SIGFOX (900 MHz)	1.98 dBi		
BLE (2.4 GHz)		3.05 dBi	
WLAN (2.4 GHz)			4.44 dBi

otherwise shall be maintained within the operating voltage range.

The verification testing results while varying the host operating voltages must be meet the following criteria:

- The radiated signal level of fundamental frequency bands must be lower than EIRP listed below respectively

Technologies	Frequency bands	EIRP
SIgfox (RC2)	902.1375 ~ 904.6625	27.48 dBm
Sigfox (RC4)	920.7375 ~ 923.2625	27.48 dBm
BLE	2402-2480	8.05 dBm
WIFi 2.4 GHz	2412-2472	18.44 dBm

- Radiated spurious emissions measurements must be lower than module`s highest value in the harmonic frequencies of fundamental frequency bands.

Trace antenna designs	- This module is using Trace Antenna Design. Module integration guidelines must be closely followed. Compliance of host integrations of the module is limited to hosts adaptation designs which are identical to SJIT's reference designs explained in this documents. Host integrations with adaption designs deviating from SJIT`s reference design require either class 2 permissive change to this modular approval or a separate host approval with different FCC ID.
RF exposure considerations	The module has been certified for integration into products only by OEM integrators under the following condition: - The antenna(s) must be installed such that a minimum separation distance of at least 20 cm is maintained between the radiator (antenna) and all persons at all times. - The transmitter module must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with FCC multi-transmitter product procedures. - Mobile use As long as the three conditions above are met, further transmitter testing will not be required. OEM integrators should provide the minimum separation distance to end users in their end-product manuals.
Antennas list	* FCC requirements for antenna list This module is certified with the following antenna. - Type: External Antenna(Dipole antenna) - Max. peak Antenna gain

Frequency band	SIGFOX (INNO-ADI-0269)	BLE (W5E-WO-03)	WLAN (INNO-FWFSWS-151)
SIGFOX (900 MHz)	1.98 dBi		
BLE (2.4 GHz)		3.05 dBi	
WLAN (2.4 GHz)			4.44 dBi

Any new antenna type, higher gain than listed antenna should be met the requirements of FCC rule 15.203 and 2.1043 as permissive change procedure. The use of a different trace layout other than approved requires a Class II Permissive Change or a New Grant as appropriate.

End Product Labeling	The module is labeled with its own FCC ID. If the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. In that case, the final end product must be labeled in a visible area with the following: -　　　Contains FCC ID: 2BEK7SRM200A

Information on test modes and additional testing requirements	OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, additional transmitter in the host, etc.).
Additional testing, Part 15 Subpart B disclaimer	Note that a host manufacture is recommended to use D04 Module Integration Guide recommending as "best practice" RF design engineering testing and evaluation in case non-linear interactions generate additional non-compliant limits due to module placement to host components or properties For standalone mode, reference the guidance in D04 Module Integration Guide and for simultaneous mode; see D02 Module Q&A Question 12, which permits the host manufacturer to confirm compliance.
Manual Information To the End User	The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module or change RF related parameters in the user manual of the end product.
How to make changes	Since only Grantees are permitted to make permissive changes, when the module will be used differently than granted, please contact the module manufacture on below contact information. -. Contact information: wskim@seongji.co.kr/ +82-31-223-7048

4. Antenna Trace Design for Host devices

a) Trace layout and dimensions including specific designs for each type:

1) Layout of trace design, parts, antenna, connectors, and isolation requirements;

All RF trace must be 50 ohm line. Connectors are required to use SMA Type connector. And Antenna is required to use dipole antenna manufactured by Inno-Link. Co., Ltd..

But, you must not give to access to antenna connector to user when you install this module into devices to be compliance with FCC section 15.203.

2) Boundary limits of size, thickness, length, width, shape(s), dielectric constant, and impedance must be clearly described for each type of antenna;

Antenna should be used only SMA type antenna manufactured by Inno-Link Co., Ltd.. Different antenna type is not acceptable.

3) Different antenna length and shapes affect radiated emissions, and each design shall be considered a different type; e.g., antenna length in multiple(s) of frequency wavelength and antenna shape (traces in phase) can affect antenna gain and must be considered;

Different antenna is unacceptable.

b) Appropriate parts by manufacturer and specifications.

1) For Sigfox antenna, INNO-ADI-0269 or similar part manufactured by Inno-Link. Co., Ltd.

2) For Wi-Fi 2.4 GHz antenna, INNO-EL9SWS-151 or similar part manufactured by Inno-Link. Co., Ltd.

3) For BT LE antenna, INNO-EL9SWS-151 or similar part manufactured by Inno-Link. Co., Ltd.

c) Test procedures for design verification.

The manufacturer should verify that the antenna trace design on the PCB board is compliance with this Antenna Trace Design documents.

You connect the antenna connector of the device to the input of a measurement instrument. And you set the measurement instrument to the proper options for each frequency bands and conduct the test to get the output power from the antenna connector. The permissible output power range is in below table to verify the antenna trace design is appropriate for this documents.

BAND	Output power	Tolerance
WIFI	+12.0dBm	+2dB
BT LE	+4.0dBm	+/-4dB
Sigfox RC2/ RC4	+23.5dBm	+/- 2dB

d) Production test procedures for ensuring compliance.
The host product itself is required to comply with all other applicable FCC equipment authorization regulations, requirements.
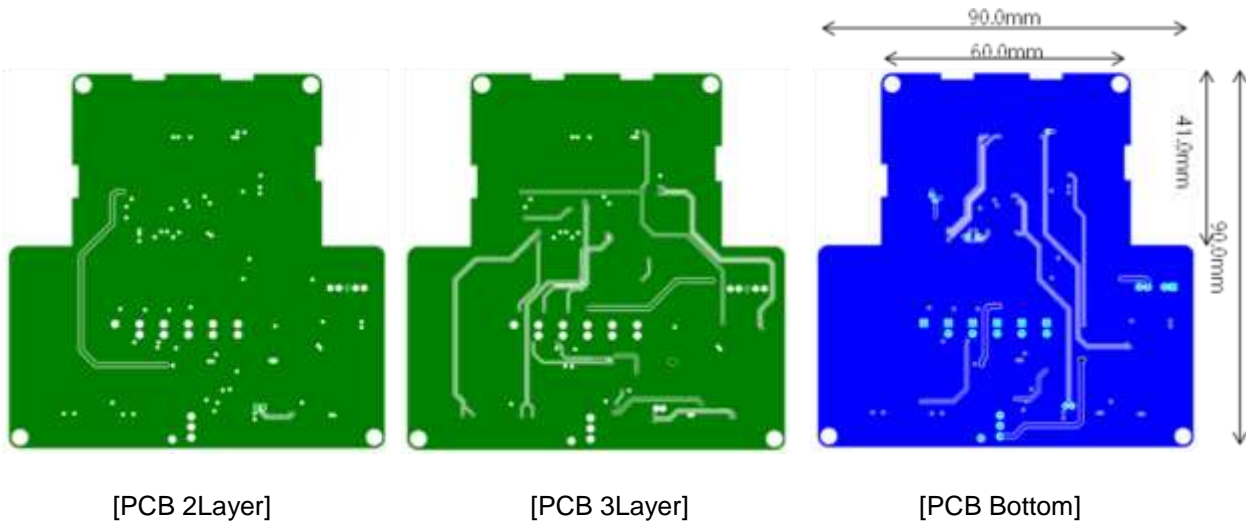So, the host device should be tested for unintentional radiators under Part 15 subpart B for non-transmitter functions on the transmitter module as appropriate.

4) The above data is to be provided by a Gerber file (or equivalent) for PCB layout.
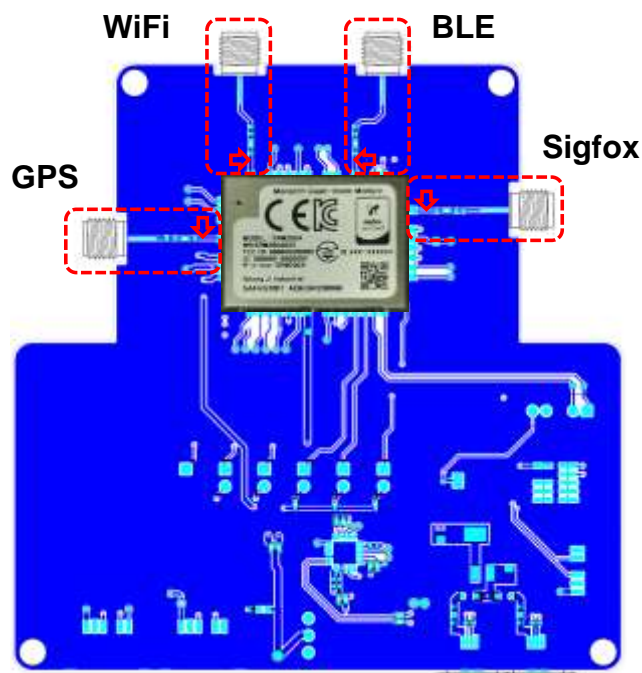
➡ : 50 ohm matching parrern

[PCB Top]

[PCB 2Layer]   [PCB 3Layer]   [PCB Bottom]

[Antenna application PCB information]

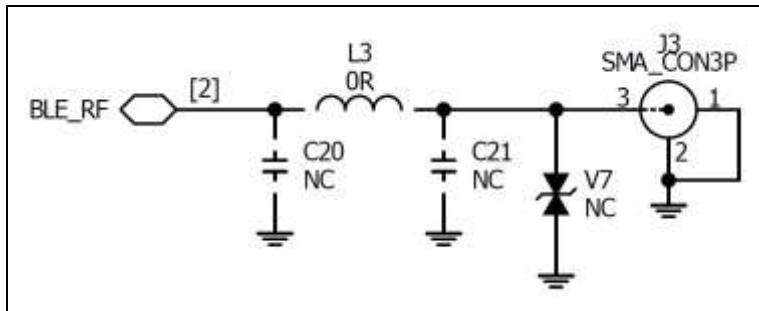- **PCB : 4-layer, 1.6mm**

- **Impedance line width : 0.315mm**

- **Clearance : 0.25mm**

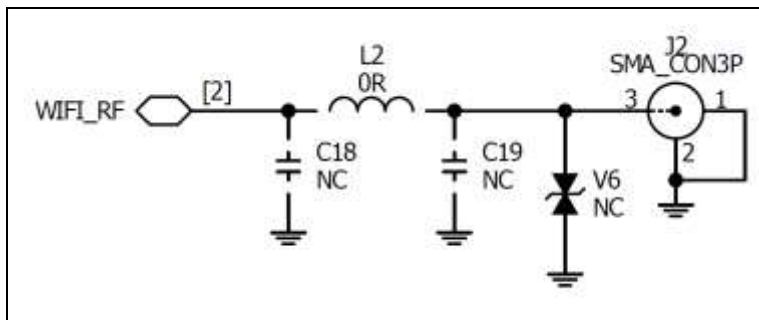- **FR4 PCB εr = 4.3**

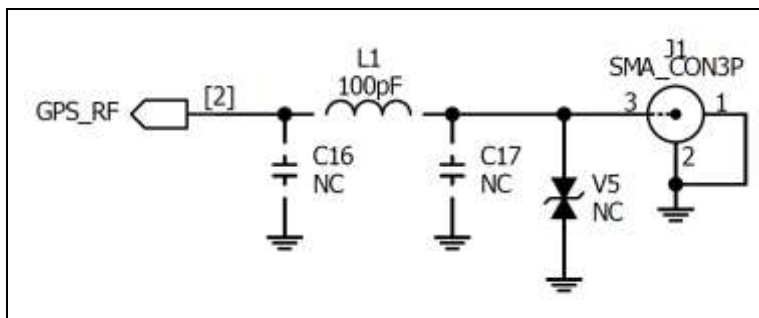**[Sigfox Antenna Matching value]**
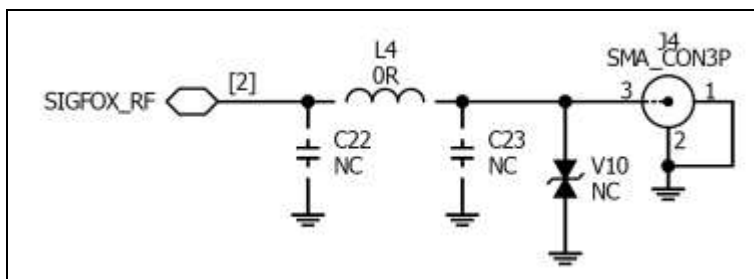
[BLE Antenna Matching value]

[WiFi Antenna Matching value]

[GPS Antenna Matching value]

<ISED Statement>

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

This device may not cause interference.

This device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence.

L'exploitation est autorisée aux deux conditions suivantes :

L'appareil ne doit pas produire de brouillage;

L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

The antenna(s) must be installed such that a minimum separation distance of at least 20 cm is maintained between the radiator (antenna) and all persons at all times.

l'exposition aux RF L'antenne (ou les antennes) doit être installée de façon à maintenir à tout instant une distance minimum de au moins 20 cm entre la source de radiation (l'antenne) et toute personne physique.

This radio transmitter [32019-SRM200A] has been approved by Innovation, Science and Economic Development Canada 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.

* IC requirements for antenna list

This module is certified with the following antenna.

- Type: External Antenna(Dipole antenna)

- Max. peak Antenna gain

Frequency band	SIGFOX (INNO-ADI-0269)	BLE (W5E-WO-03)	WLAN (INNO-FWFSWS-151)
SIGFOX (900 MHz)	1.98 dBi		
BLE (2.4 GHz)		3.050 dBi	
WLAN (2.4 GHz)			4.44 dBi

Ce transmetteur radio [32019-SRM200A] a été approuvé par Innovation, Sciences et Développement économique Canada pour fonctionner avec les types d'antennes listés ci-dessous, avec le gain maximal admissible indiqué. Les types d'antennes non inclus dans cette liste et ayant un gain supérieur au gain maximal indiqué pour tout type listé sont strictement interdits pour une utilisation avec cet appareil.

Exigences d'IC pour la liste des antennes

Ce module est certifié avec l'antenne suivante :

Type : Antenne externe (antenne dipôle)

Gain maximal de l'antenne en crête

Bande de fréquences	SIGFOX (INNO-ADI-0269)	BLE (W5E-WO-03)	WLAN (INNO-FWFSWS-151)
SIGFOX (900 MHz)	1.98 dBi		
BLE (2.4 GHz)		3.050 dBi	
WLAN (2.4 GHz)			4.44 dBi

The module is labeled with its own ISED Certificate number. If the ISED Certificate number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. In that case, the final end product must be labeled in a visible area with the following:

Contains IC: 32019-SRM200A

Le module est étiqueté avec son propre numéro de certificat ISED. Si le numéro de certificat ISED n'est pas visible lorsque le module est installé à l'intérieur d'un autre appareil, alors l'extérieur de l'appareil dans lequel le module est installé doit également afficher une étiquette faisant référence au module inclus. Dans ce cas, le produit final doit être étiqueté dans une zone visible avec les éléments suivants :

Contient IC: 32019-SRM200A