QUECTEL

FCS950R Hardware Design

Wi-Fi&Bluetooth Module Series

Version: 1.0.0

Date: 2023-06-13

Status: Preliminary

At Quectel, our aim is to provide timely and comprehensive services to our customers. If you require any assistance, please contact our headquarters:

Quectel Wireless Solutions Co., Ltd.
Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai 200233, China
Tel: +86 21 5108 6236
Email: info@quectel.com

Or our local offices. For more information, please visit:
http://www.quectel.com/support/sales.htm.

For technical support, or to report documentation errors, please visit:
http://www.quectel.com/support/technical.htm.
Or email us at: support@quectel.com.

Legal Notices

We offer information as a service to you. The provided information is based on your requirements and we make every effort to ensure its quality. You agree that you are responsible for using independent analysis and evaluation in designing intended products, and we provide reference designs for illustrative purposes only. Before using any hardware, software or service guided by this document, please read this notice carefully. Even though we employ commercially reasonable efforts to provide the best possible experience, you hereby acknowledge and agree that this document and related services hereunder are provided to you on an "as available" basis. We may revise or restate this document from time to time at our sole discretion without any prior notice to you.

Use and Disclosure Restrictions

License Agreements

Documents and information provided by us shall be kept confidential, unless specific permission is granted. They shall not be accessed or used for any purpose except as expressly provided herein.

Copyright

Our and third-party products hereunder may contain copyrighted material. Such copyrighted material shall not be copied, reproduced, distributed, merged, published, translated, or modified without prior written consent. We and the third party have exclusive rights over copyrighted material. No license shall be granted or conveyed under any patents, copyrights, trademarks, or service mark rights. To avoid ambiguities, purchasing in any form cannot be deemed as granting a license other than the normal non-exclusive, royalty-free license to use the material. We reserve the right to take legal action for noncompliance with abovementioned requirements, unauthorized use, or other illegal or malicious use of the material.

Trademarks

Except as otherwise set forth herein, nothing in this document shall be construed as conferring any rights to use any trademark, trade name or name, abbreviation, or counterfeit product thereof owned by Quectel or any third party in advertising, publicity, or other aspects.

Third-Party Rights

This document may refer to hardware, software and/or documentation owned by one or more third parties ("third-party materials"). Use of such third-party materials shall be governed by all restrictions and obligations applicable thereto.

We make no warranty or representation, either express or implied, regarding the third-party materials, including but not limited to any implied or statutory, warranties of merchantability or fitness for a particular purpose, quiet enjoyment, system integration, information accuracy, and non-infringement of any third-party intellectual property rights with regard to the licensed technology or use thereof. Nothing herein constitutes a representation or warranty by us to either develop, enhance, modify, distribute, market, sell, offer for sale, or otherwise maintain production of any our products or any other hardware, software, device, tool, information, or product. We moreover disclaim any and all warranties arising from the course of dealing or usage of trade.

Privacy Policy

To implement module functionality, certain device data are uploaded to Quectel's or third-party's servers, including carriers, chipset suppliers or customer-designated servers. Quectel, strictly abiding by the relevant laws and regulations, shall retain, use, disclose or otherwise process relevant data for the purpose of performing the service only or as permitted by applicable laws. Before data interaction with third parties, please be informed of their privacy and data security policy.

Disclaimer

a) We acknowledge no liability for any injury or damage arising from the reliance upon the information.
b) We shall bear no liability resulting from any inaccuracies or omissions, or from the use of the information contained herein.
c) While we have made every effort to ensure that the functions and features under development are free from errors, it is possible that they could contain errors, inaccuracies, and omissions. Unless otherwise provided by valid agreement, we make no warranties of any kind, either implied or express, and exclude all liability for any loss or damage suffered in connection with the use of features and functions under development, to the maximum extent permitted by law, regardless of whether such loss or damage may have been foreseeable.
d) We are not responsible for the accessibility, safety, accuracy, availability, legality, or completeness of information, advertising, commercial offers, products, services, and materials on third-party websites and third-party resources.

Copyright © Quectel Wireless Solutions Co., Ltd. 2023. All rights reserved.

Safety Information

The following safety precautions must be observed during all phases of operation, such as usage, service or repair of any cellular terminal or mobile incorporating the module. Manufacturers of the cellular terminal shall notify users and operating personnel of the following safety information by incorporating these guidelines into all manuals of the product. Otherwise, Quectel assumes no liability for customers' failure to comply with these precautions.

	Full attention must be given to driving at all times in order to reduce the risk of an accident. Using a mobile while driving (even with a handsfree kit) causes distraction and can lead to an accident. Please comply with laws and regulations restricting the use of wireless devices while driving.
	Switch off the cellular terminal or mobile before boarding an aircraft. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. If there is an Airplane Mode, it shall be enabled prior to boarding an aircraft. Please consult the airline staff for more restrictions on the use of wireless devices on an aircraft.
	Wireless devices may cause interference on sensitive medical equipment, so please be aware of the restrictions on the use of wireless devices when in hospitals, clinics or other healthcare facilities.
	Cellular terminals or mobiles operating over radio signal and cellular network cannot be guaranteed to connect in certain conditions, such as when the mobile bill is unpaid or the (U)SIM card is invalid. When emergency help is needed in such conditions, use emergency call if the device supports it. In order to make or receive a call, the cellular terminal or mobile must be switched on in a service area with adequate cellular signal strength. In an emergency, the device with emergency call function cannot be used as the only contact method considering network connection cannot be guaranteed under all circumstances.
	The cellular terminal or mobile contains a transceiver. When it is ON, it receives and transmits radio frequency signals. RF interference can occur if it is used close to TV sets, radios, computers or other electric equipment.
	In locations with explosive or potentially explosive atmospheres, obey all posted signs and turn off wireless devices such as mobile phone or other cellular terminals. Areas with explosive or potentially explosive atmospheres include fuelling areas, below decks on boats, fuel or chemical transfer or storage facilities, and areas where the air contains chemicals or particles such as grain, dust or metal powders.

About the Document

Revision History

Version	Date	Author	Description
-	2023-06-13	Jason YI	Creation of the document
1.0.0	2023-06-13	Jason YI	Preliminary

Contents

Safety Information ... 3
About the Document ... 4
Contents ... 5
Table Index ... 7
Figure Index ... 8

1 Introduction ... 9
1.1. Special Mark ... 9

2 Product Overview ... 10
2.1. Key Features ... 11
2.2. Functional Diagram ... 12

3 RF Performances ... 13
3.1. Wi-Fi Performances ... 13
3.2. Bluetooth Performances ... 15

4 Application Interfaces ... 16
4.1. Pin Assignment ... 16
4.2. Pin Description ... 17
4.3. Power Supply ... 20
4.4. Wi-Fi Application Interfaces ... 21
4.4.1. SDIO Interface ... 21
4.5. Bluetooth Application Interfaces ... 23
4.5.1. PCM Interface ... 23
4.5.2. UART ... 25
4.6. RF Antenna Interface ... 27
4.6.1. Reference Design ... 27
4.6.2. Antenna Design Requirements ... 28
4.6.3. RF Routing Guidelines ... 28
4.6.4. RF Connector Recommendation ... 30

5 Electrical Characteristics & Reliability ... 32
5.1. Absolute Maximum Ratings ... 32
5.2. Power Supply Ratings ... 32
5.3. Power Consumption ... 33
5.3.1. Wi-Fi Power Consumption ... 33
5.3.2. Bluetooth Power Consumption ... 34
5.4. Digital I/O Characteristics ... 34
5.5. ESD Protection ... 35
5.6. Thermal Dissipation ... 35

6 Mechanical Information ... 37
6.1. Mechanical Dimensions ... 37
6.2. Recommended Footprint ... 39

6.3. Top and Bottom Views 40

7 Storage, Manufacturing & Packaging 41

7.1. Storage Conditions 41
7.2. Manufacturing and Soldering 42
7.3. Packaging Specifications 44
7.3.1. Carrier Tape 44
7.3.2. Plastic Reel 45
7.3.3. Mounting Direction 45
7.3.4. Packaging Process 46

8 Appendix References 47

Table Index

Table 1: Special Mark 9
Table 2: Basic Information........ 10
Table 3: Key Features........ 11
Table 4: Wi-Fi Performances 13
Table 5: Bluetooth Performances........ 15
Table 6: I/O Parameter Definition........ 17
Table 7: Pin Description 17
Table 8: SDIO Interface Trace Length Inside the Module (Unit: mm)........ 23
Table 9: PCM Interface Clock Specifications........ 25
Table 10: PCM Interface Timing........ 25
Table 11: Antenna Design Requirements 28
Table 12: Absolute Maximum Ratings (Unit: V) 32
Table 13: Module Power Supply Ratings (Unit: V) 32
Table 14: Power Consumption in Low Power Modes........ 33
Table 15: Power Consumption in Non-signalling Mode (Unit: mA) 33
Table 16: Power Consumption in Non-signalling Mode 34
Table 17: VDD_IO High Level I/O Requirements (Unit: V)........ 34
Table 18: VDD_IO Low Level I/O Requirements (Unit: V)........ 35
Table 19: Recommended Thermal Profile Parameters........ 43
Table 20: Carrier Tape Dimension Table (Unit: mm)........ 44
Table 21: Plastic Reel Dimension Table (Unit: mm)........ 45
Table 22: Related Documents 47
Table 23: Terms and Abbreviations 47

Figure Index

Figure 1: Functional Diagram 12
Figure 2: Pin Assignment (Top View) 16
Figure 3: Reference Design for Power Supply 20
Figure 4: Power-up Timing 20
Figure 5: Wi-Fi Application Interface Connection 21
Figure 6: SDIO Interface Connection (1-bit Mode) 21
Figure 7: SDIO Interface Connection (4-bit Mode) 22
Figure 8: Bluetooth Application Interface Connection 23
Figure 9: PCM interface Timing (Long Frame Sync) 24
Figure 10: PCM interface Timing (Short Frame Sync) 24
Figure 11: UART Connection with Host Supporting Software Flow Control 26
Figure 12: UART Connection with Host Supporting Hardware Flow Control 26
Figure 13: UART Connection with Host Not Supporting Flow Control 26
Figure 14: Reference Design of RF Antenna Interface 27
Figure 15: Microstrip Design on a 2-layer PCB 28
Figure 16: Coplanar Waveguide Design on a 2-layer PCB 29
Figure 17: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground) 29
Figure 18: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground) 29
Figure 19: Dimensions of the Receptacle (Unit: mm) 30
Figure 20: Specifications of Mated Plugs 31
Figure 21: Space Factor of Mated Connectors (Unit: mm) 31
Figure 22: Placement and Fixing of the Heatsink 36
Figure 23: Top and Side Dimensions 37
Figure 24: Bottom Dimensions (Bottom View) 38
Figure 25: Recommended Footprint 39
Figure 26: Top and Bottom Views 40
Figure 27: Recommended Reflow Soldering Thermal Profile 42
Figure 28: Carrier Tape Dimension Drawing 44
Figure 29: Plastic Reel Dimension Drawing 45
Figure 30: Mounting Direction 45
Figure 31: Packaging Process 46

1 Introduction

This document defines the FCS950R and describes its air interfaces and hardware interfaces, which are connected with your application. The document provides a quickly insight into interface specifications, RF performance, electrical and mechanical details, as well as other related information of the module.

1.1. Special Mark

Table 1: Special Mark

Mark	Definition
[…]	Brackets ([…]) used after a pin enclosing a range of numbers indicate all pins of the same type. For example, SDIO_DATA[0:3] refers to all four SDIO pins: SDIO_DATA0, SDIO_DATA1, SDIO_DATA2, and SDIO_DATA3.

2 Product Overview

FCS950R is a low-energy and high-performance IEEE 802.11a/b/g/n/ac Wi-Fi 5 and Bluetooth 4.2 module supporting 2.4 GHz&5 GHz dual-band and 1T1R mode with maximum data transmission rate up to 433.3 Mbps. It provides Wi-Fi functions with an SDIO 3.0 interface, and Bluetooth functions with a UART and a PCM interface.

It is an SMD module with compact packaging. Related information is listed in the table below:

Table 2: Basic Information

FCS950R	
Packaging type	LCC
Pin counts	44
Dimensions	(12.0 ±0.15) mm × (12.0 ±0.15) mm × (2.35 ±0.2) mm
Weight	Approx. 0.58 g

2.1. Key Features

Table 3: Key Features

Basic Information	
Protocol and Standard	● Wi-Fi protocols: IEEE 802.11a/b/g/n/ac ● Bluetooth protocol: Bluetooth 4.2 ● All hardware components are fully compliant with EU RoHS directive
Power Supplies	**VBAT Power Supply:** ● 3.0–3.6 V ● Typ.: 3.3 V **VDD_IO Power Supply:** ● 1.62–3.6 V ● Typ.: 1.8/3.3 V
Temperature Ranges	● Operating temperature [1]: 0 °C to +70 °C ● Storage temperature: -55 °C to +125 °C
EVB Kit	FCS950R-M.2
RF Antenna Interface	
Wi-Fi/Bluetooth Antenna Interface	● ANT_WIFI/BT ● 50 Ω characteristic impedance
Application Interface	
Wi-Fi Application Interface	SDIO 3.0
Bluetooth Application Interfaces	UART, PCM

[1] To meet the normal operating temperature range requirements, it is necessary to ensure effective thermal dissipation, e.g., by adding passive or active heatsinks, heat pipes, vapor chambers, etc. Within this range, the module's indicators comply with IEEE and Bluetooth specification requirements.

2.2. Functional Diagram

The main components of the block diagram are explained below.

1. Main chip
2. Radio frequency
3. Peripheral interfaces

3 RF Performances

3.1. Wi-Fi Performances

Table 4: Wi-Fi Performances

<table>
<tr><th colspan="5">Operating Frequency</th></tr>
<tr><td colspan="5">● 2.4 GHz: 2.400–2.4835 GHz
● 5 GHz: 5.150–5.850 GHz</td></tr>
<tr><th colspan="5">Modulation</th></tr>
<tr><td colspan="5">DBPSK, DQPSK, CCK, BPSK, QPSK, 16QAM, 64QAM, 256QAM</td></tr>
<tr><th colspan="5">Operating Mode</th></tr>
<tr><td colspan="5">● AP
● STA</td></tr>
<tr><th colspan="5">Transmission Data Rate</th></tr>
<tr><td colspan="5">● 802.11b: 1 Mbps, 2 Mbps, 5.5 Mbps, 11 Mbps
● 802.11a/g: 6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps, 24 Mbps, 36 Mbps, 48 Mbps, 54 Mbps
● 802.11n: HT20 (MCS 0–7), HT40 (MCS 0–7)
● 802.11ac: VHT20 (MCS 0–8), VHT40 (MCS 0–9), VHT80 (MCS 0–9)</td></tr>
<tr><th colspan="2" rowspan="2">Condition (VBAT = 3.3 V; Temp.: 25 °C)</th><th rowspan="2">EVM</th><th colspan="2">Typ.; Unit: dBm; Tolerance: ±2 dB</th></tr>
<tr><th>Transmitting Power</th><th>Receiving Sensitivity</th></tr>
<tr><td rowspan="6">2.4 GHz</td><td>802.11b @ 1 Mbps</td><td rowspan="2">≤ 35%</td><td>21.5</td><td>-97</td></tr>
<tr><td>802.11b @ 11 Mbps</td><td>18</td><td>-89</td></tr>
<tr><td>802.11g @ 6 Mbps</td><td>≤ -5 dB</td><td>21.5</td><td>-92.5</td></tr>
<tr><td>802.11g @ 54 Mbps</td><td>≤ -27 dB</td><td>15</td><td>-75</td></tr>
<tr><td>802.11n, HT20 @ MCS 0</td><td>≤ -5 dB</td><td>21.5</td><td>-91.5</td></tr>
<tr><td>802.11n, HT20 @ MCS 7</td><td>≤ -28 dB</td><td>14</td><td>-72</td></tr>
</table>

	802.11n, HT40 @ MCS 0	≤ -5 dB	21.5	-89
	802.11n, HT40 @ MCS 7	≤ -28 dB	14	-70
5 GHz	802.11a @ 6 Mbps	≤ -5 dB	16.5	-90
	802.11a @ 54 Mbps	≤ -25 dB	14	-72
	802.11n, HT20 @ MCS 0	≤ -5 dB	16.5	-89
	802.11n, HT20 @ MCS 7	≤ -27 dB	13	-70
	802.11n, HT40 @ MCS 0	≤ -5 dB	16.5	-86.5
	802.11n, HT40 @ MCS 7	≤ -27 dB	13	-68
	802.11ac, VHT20 MCS 0	≤ -5 dB	16.5	-89
	802.11ac, VHT20 MCS 8	≤ -30 dB	12	-65
	802.11ac, VHT40 @ MCS 0	≤ -5 dB	16.5	-86.5
	802.11ac, VHT40 @ MCS 9	≤ -32 dB	11	-62.5
	802.11ac, VHT80 @ MCS 0	≤ -5 dB	16.5	-83
	802.11ac, VHT80 @ MCS 9	≤ -32 dB	11	-59

3.2. Bluetooth Performances

Table 5: Bluetooth Performances

<table>
<tr><th colspan="3">Operating Frequency</th></tr>
<tr><td colspan="3">2.400–2.4835 GHz</td></tr>
<tr><th colspan="3">Modulation</th></tr>
<tr><td colspan="3">GFSK, π/4-DQPSK, 8-DPSK</td></tr>
<tr><th colspan="3">Operating Mode</th></tr>
<tr><td colspan="3">● Classic Bluetooth (BR + EDR)
● Bluetooth Low Energy (BLE)</td></tr>
<tr><th rowspan="2">Condition (VBAT = 3.3 V; Temp.: 25 °C)</th><th colspan="2">Typ.; Unit: dBm; Tolerance: ±2 dB</th></tr>
<tr><th>Transmitting Power</th><th>Receiving Sensitivity</th></tr>
<tr><td>BR</td><td>8.5</td><td>-91</td></tr>
<tr><td>EDR (π/4-DQPSK)</td><td>8.5</td><td>-96.5</td></tr>
<tr><td>EDR (8-DPSK)</td><td>8.5</td><td>-97</td></tr>
<tr><td>BLE (1 Mbps)</td><td>5</td><td>-95</td></tr>
</table>

4 Application Interfaces

4.1. Pin Assignment

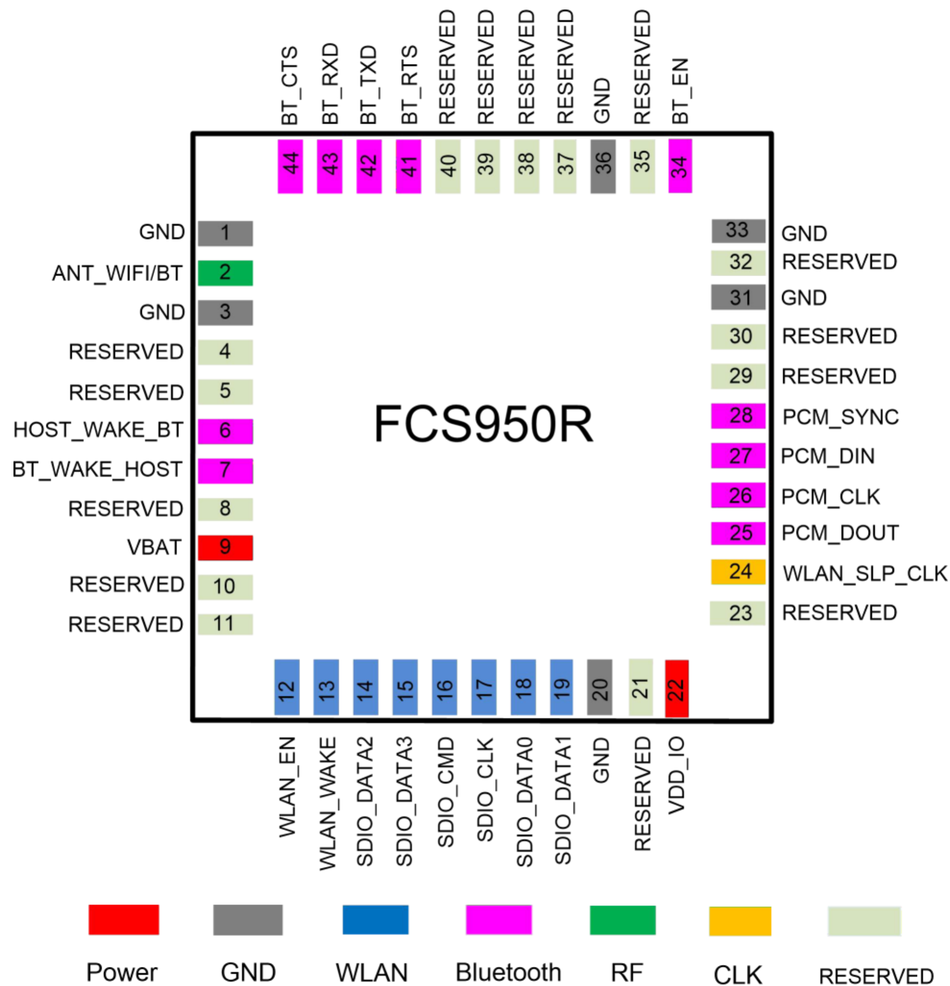


Figure 2: Pin Assignment (Top View)

NOTE

1. Keep all RESERVED and unused pins unconnected.
2. All GND pins should be connected to ground.

4.2. Pin Description

Table 6: I/O Parameter Definition

Type	Description
AIO	Analog Input/Output
DI	Digital Input
DO	Digital Output
DIO	Digital Input/Output
PI	Power Input

DC characteristics include power domain and rate current.

Table 7: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VBAT	9	PI	Main power supply for the module	Vmin = 3.0 V Vnom = 3.3 V Vmax = 3.6 V	It must be provided with sufficient current of at least 0.6 A.
VDD_IO	22	PI	Power supply for module's I/O pins	Vmin = 1.62 V Vnom = 1.8/3.3 V Vmax = 3.6 V	It must be provided with sufficient current of at least 0.2 A.
GND	1, 3, 20, 31, 33, 36				
Wi-Fi Application Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
WLAN_EN	12	DI	Wi-Fi function enable control	VDD_IO	Active high. If unused, pull it up to VDD_IO with a 100 kΩ resistor.

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
WLAN_WAKE	13	DO	Wi-Fi wakes up host		Active high.
SDIO_DATA2	14	-	NC (1-bit mode)		Supports 1-bit or 4-bit mode.
		DIO	SDIO data bit 2 (4-bit mode)		
SDIO_DATA3	15	-	NC (1-bit mode)		
		DIO	SDIO data bit 3 (4-bit mode)		
SDIO_CMD	16	DIO	SDIO command		
SDIO_CLK	17	DI	SDIO clock		
SDIO_DATA0	18	DIO	SDIO data bit 0		
SDIO_DATA1	19	DO	IRQ (1-bit mode)		
		DIO	SDIO data bit 1 (4-bit mode)		
Bluetooth Application Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
BT_EN	34	DI	Bluetooth enable control	VDD_IO	Active high. If unused, pull it up to VDD_IO with a 100 kΩ resistor.
HOST_WAKE_BT	6	DI	Host wakes up Bluetooth		Active high.
BT_WAKE_HOST	7	DO	Bluetooth wakes up host		
PCM_DOUT	25	DO	PCM data output		
PCM_CLK	26	DI	PCM clock		
PCM_DIN	27	DI	PCM data input		
PCM_SYNC	28	DI	PCM data frame sync		
BT_RTS	41	DO	Request to send signal from the module		
BT_TXD	42	DO	Bluetooth UART transmit		

BT_RXD	43	DI	Bluetooth UART receive		
BT_CTS	44	DI	Clear to send signal to the module		
RF Antenna Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ANT_WIFI/BT	2	AIO	Wi-Fi/Bluetooth antenna interface		50 Ω characteristic impedance.
Other Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
WLAN_SLP_CLK	24	DI	Wi-Fi sleep clock	VDD_IO	External 32.768 kHz clock input. If unused, keep it open.
RESERVED Pins					
Pin Name	**Pin No.**				**Comment**
RESERVED	4, 5, 8, 10, 11, 21, 23, 29, 30, 32, 35, 37–40				Keep them open.

4.3. Power Supply

The module is powered by VBAT, and it should use a power supply chip that can provide sufficient current of at least 0.6 A. To ensure better power supply performance, it is recommended to parallel a 22 μF decoupling capacitor and three filter capacitors (100 nF, 33 pF and 10 pF) near the module's VBAT pin. Meanwhile, it is recommended to add a TVS near the VBAT to improve the surge voltage bearing capacity of the module. In principle, the longer the VBAT trace, the wider it should be.

The reference circuit for module's power supply is shown in the figure below:

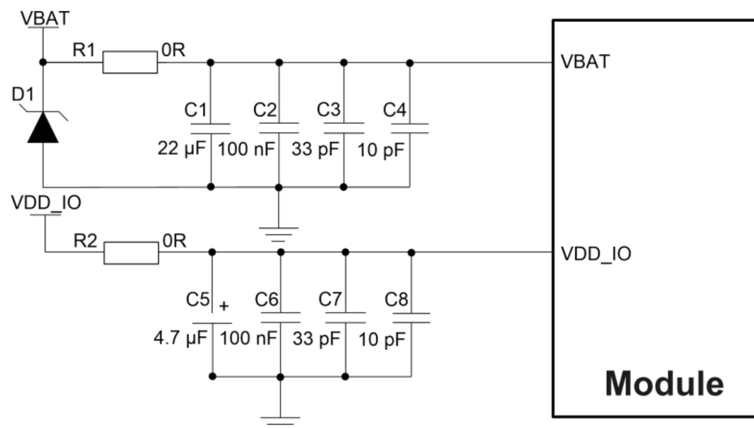


Figure 3: Reference Design for Power Supply

The following figure shows the recommended power-up timing of the module.

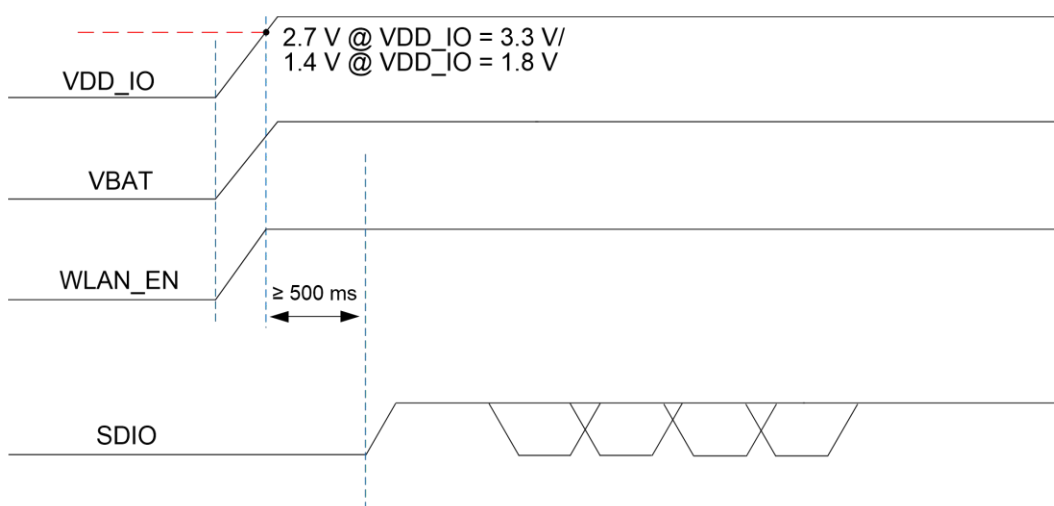


Figure 4: Power-up Timing

4.4. Wi-Fi Application Interfaces

Wi-Fi application interface connection between the module and the host is illustrated in the figure below.

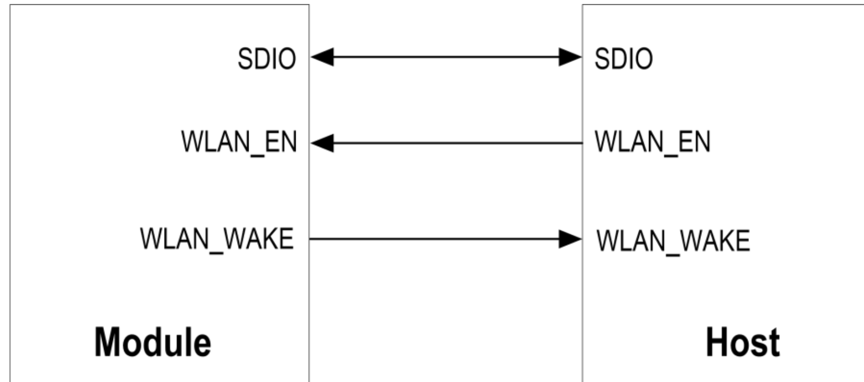


Figure 5: Wi-Fi Application Interface Connection

4.4.1. SDIO Interface

The module supports 1-bit or 4-bit SDIO 3.0 interface. It can detect the SDIO mode of the host automatically when it is connected. SDIO interface connection between the module and the host is illustrated in the following figure.

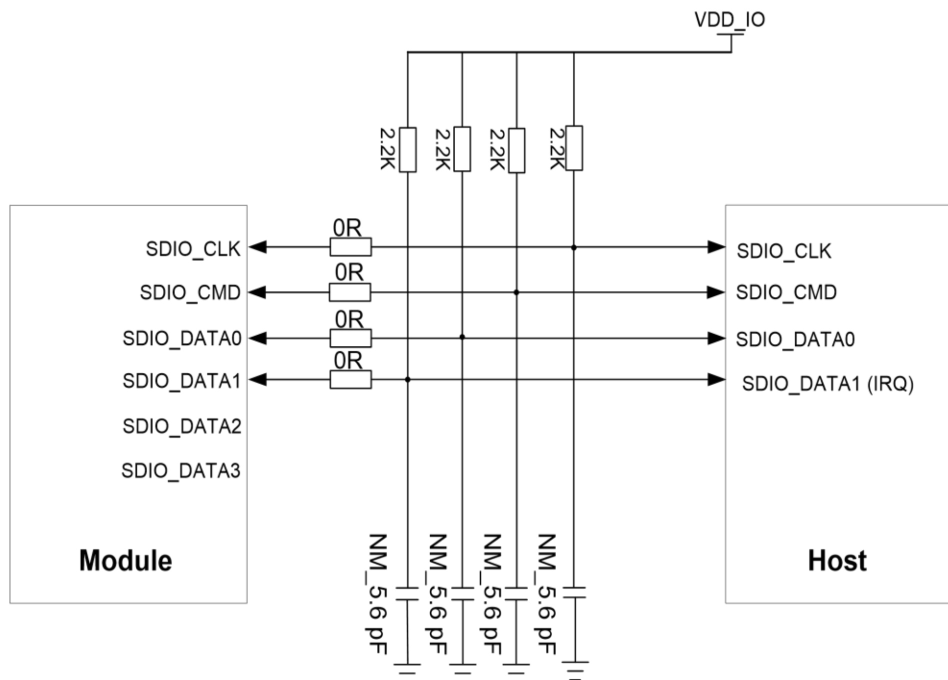


Figure 6: SDIO Interface Connection (1-bit Mode)

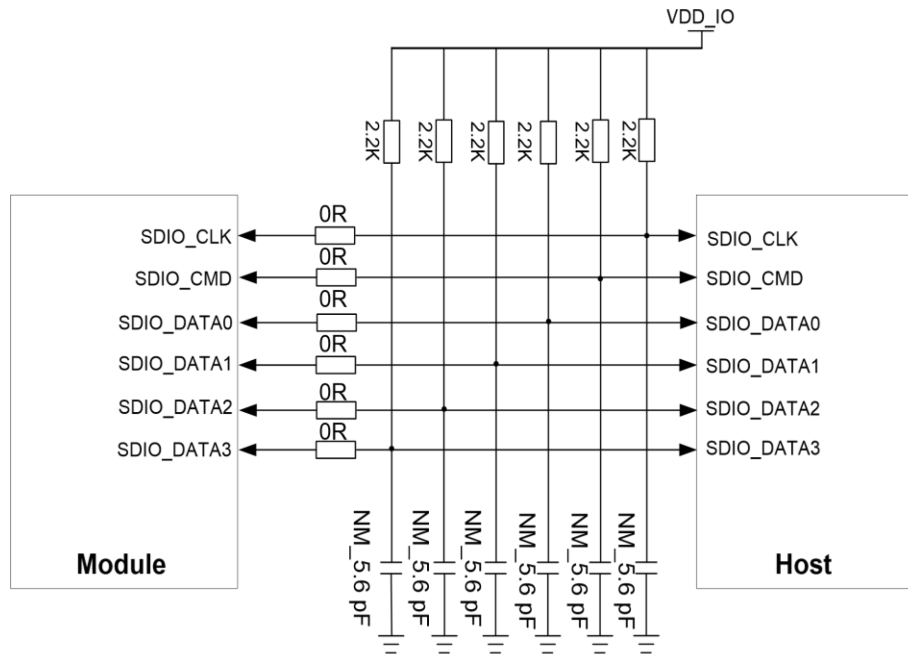


Figure 7: SDIO Interface Connection (4-bit Mode)

To ensure compliance of interface design with the SDIO 3.0 specification, it is recommended to adopt the following principles:

- Add 0 Ω resistors in series and 5.6 pF capacitors (not mounted by default) between the module and the host. All resistors and capacitors should be placed close to the module.
- To avoid the impact of jitter, pull up SDIO signal traces (SDIO_CLK, SDIO_CMD, and SDIO_DATA[0:3]) to VDD_IO with 2.2 kΩ resistors.
- The impedance of SDIO signal trace is 50 Ω ±10 %. Route the SDIO traces in inner layer of the PCB, and surround the traces with ground on that layer and with ground planes above and below. And the SDIO_CLK signal trace should be routed with ground surrounded separately.
- Keep SDIO signals far away from other sensitive circuits/signals such as RF circuits and analog signals, as well as noise signals such as clock signals and DC-DC signals.
- SDIO signal traces (SDIO_CLK and SDIO_DATA[0:3]/SDIO_CMD) need to be equal in length (less than 2.5 mm distance between the traces) and the total routing length of each signal trace is less than 63.5 mm. The total trace inside the module is 11 mm, so the exterior total trace length should be less than 52.5 mm.
- Ensure the SDIO signal traces a complete reference ground and keep them free of stubs. Keep the adjacent trace clearance twice the trace width and the load capacitance of SDIO bus less than 15 pF.
- The vias of SDIO signal traces (SDIO_CLK and SDIO_DATA[0:3]/SDIO_CMD) should be less than 4.

Table 8: SDIO Interface Trace Length Inside the Module (Unit: mm)

Pin No.	Pin Name	Length
16	SDIO_CMD	10.90
17	SDIO_CLK	10.87
15	SDIO_DATA3	10.92
14	SDIO_DATA2	10.77
18	SDIO_DATA0	10.85
19	SDIO_DATA1	10.89

4.5. Bluetooth Application Interfaces

Bluetooth application interface connection between the module and the host is illustrated in the figure below.

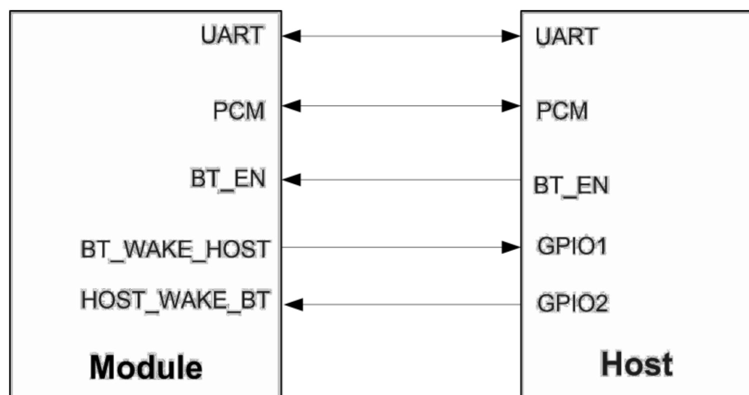


Figure 8: Bluetooth Application Interface Connection

4.5.1. PCM Interface

The module provides a PCM interface for Bluetooth audio application. It supports the following features:

- Both master and slave modes
- Programmable long/short frame synchronization
- 8-bit A-law/μ-law, 13/16-bit linear PCM format
- Symbol expansion and zero padding for 8-bit and 13-bit samples

- Fill audio gain to 13-bit sampling
- PCM master clock output: 64 kHz, 128 kHz, 256 kHz or 512 kHz
- SCO/eSCO link

PCM interface timing is shown below:

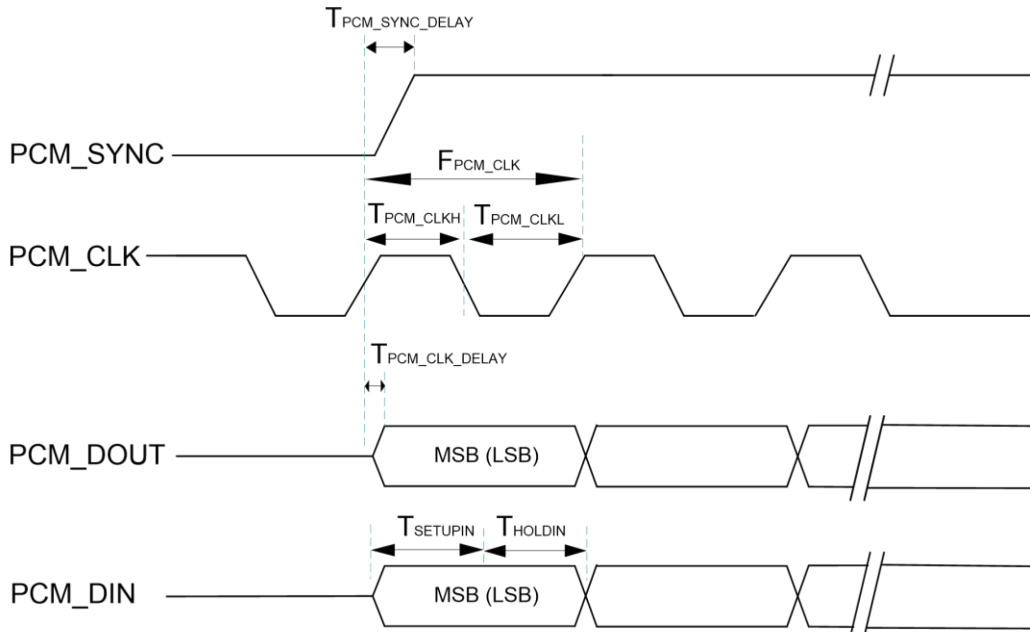


Figure 9: PCM interface Timing (Long Frame Sync)

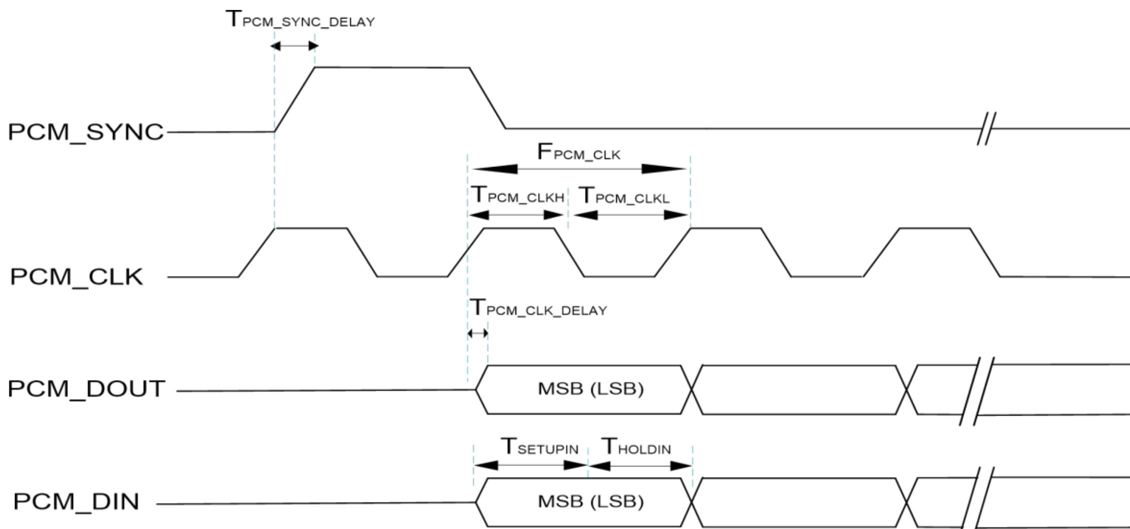


Figure 10: PCM interface Timing (Short Frame Sync)

Table 9: PCM Interface Clock Specifications

Parameter	Description	Min.	Typ.	Max.	Unit
F_{PCM_CLK}	Frequency of PCM_CLK (master)	64	-	512	kHz
F_{PCM_SYNC}	Frequency of PCM_SYNC (master)	-	8	-	kHz
F_{PCM_CLK}	Frequency of PCM_CLK (slave)	64	-	512	kHz
F_{PCM_SYNC}	Frequency of PCM_SYNC (slave)	-	8	-	kHz
D	Data size	8	8	16	bits
N	Number of slots per frame	1	1	1	slots

Table 10: PCM Interface Timing

Parameter	Description	Min.	Typ.	Max.	Unit
T_{PCM_CLKH}	High period of PCM_CLK	980	-	-	ns
T_{PCM_CLKL}	Low period of PCM_CLK	970	-	-	ns
$T_{PCM_SYNC_DELAY}$	Delay time from PCM_CLK high to PCM_SYNC high	-	-	75	ns
$T_{PCM_CLK_DELAY}$	Delay time from PCM_CLK high to valid PCM_DOUT	-	-	125	ns
$T_{SETUPIN}$	Set-up time for PCM_DIN valid to PCM_CLK low	10	-	-	ns
T_{HOLDIN}	Hold time for PCM_CLK low to PCM_DIN invalid	125	-		ns

4.5.2. UART

The module supports a Bluetooth HCI (Host Controller Interface) UART defined by Bluetooth 4.2 protocol. It supports hardware flow control (RTS/CTS), and can be used for data transmission with the host. The baud rate, which is 115200 bps by default, can be up to 4 Mbps.

The voltage range of the Bluetooth UART is determined by VDD_IO. It is necessary to monitor the consistency of the voltage range between the host and Bluetooth UART. If necessary, adopt a voltage-level translator.

The UART connection between the module and the host supporting software flow control is as below:

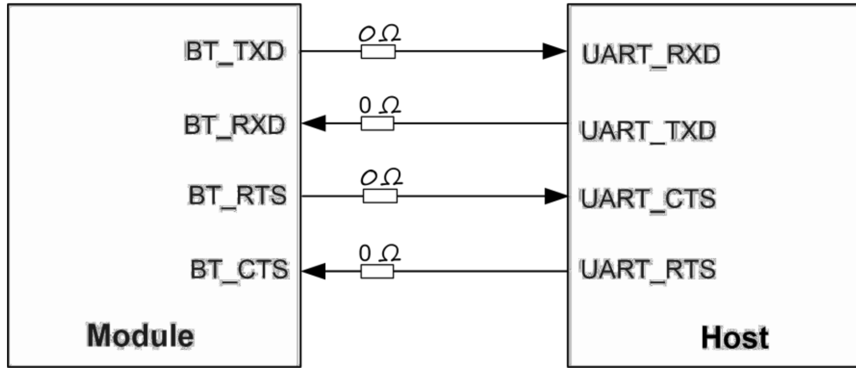


Figure 11: UART Connection with Host Supporting Software Flow Control

The UART connection between the module and the host supporting hardware flow control is as below:

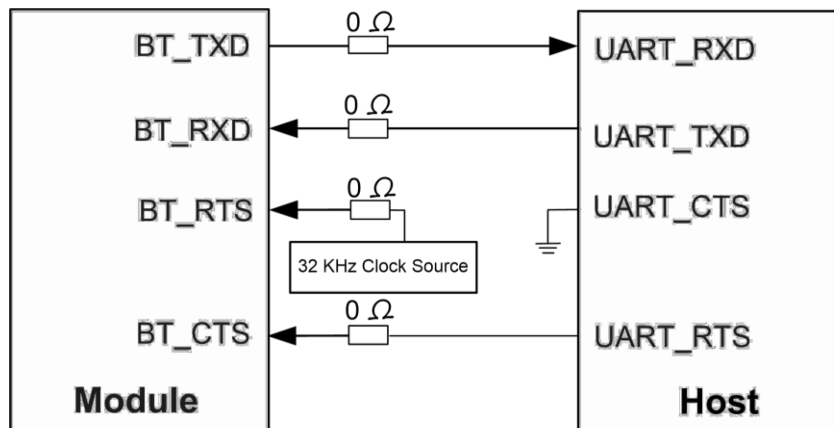


Figure 12: UART Connection with Host Supporting Hardware Flow Control

The UART connection between the module and the host not supporting flow control is as below:

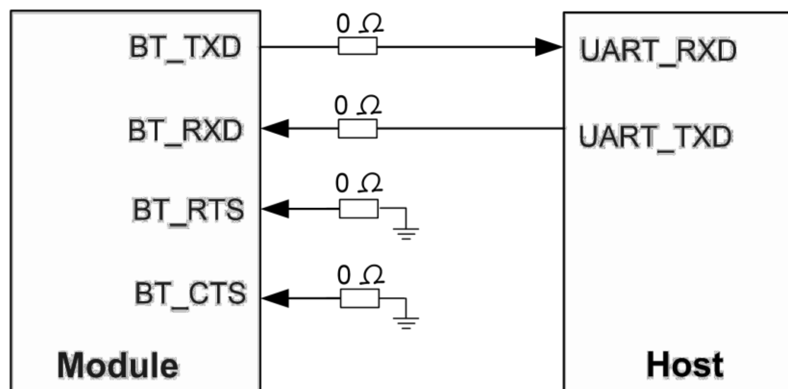


Figure 13: UART Connection with Host Not Supporting Flow Control

NOTE

1. When paired with Quectel's LTE modules, you need to pay attention to the input and output of BT_CTS and BT_RTS.
2. Reserve 0 Ω resistors between the module and host for Bluetooth signaling test.

4.6. RF Antenna Interface

Appropriate antenna type and design should be used with matched antenna parameters according to specific application. It is required to perform a comprehensive functional test for the RF design before mass production of terminal products. The entire content of this chapter is provided for illustration only. Analysis, evaluation and determination are still necessary when designing target products.

The module provides one RF antenna interface (ANT_WIFI/BT), and the RF port requires 50 Ω characteristic impedance.

4.6.1. Reference Design

A reference circuit for the RF antenna interface is shown below. It is recommended to reserve a π-type matching circuit and add an ESD protection component for better RF performance. Reserved matching components (C1, R1, C2 and D1) should be placed as close to the antenna as possible. C1, C2 and D1 are not mounted by default. The parasitic capacitance of TVS should be less than 0.05 pF and R1 is recommended to be 0 Ω.

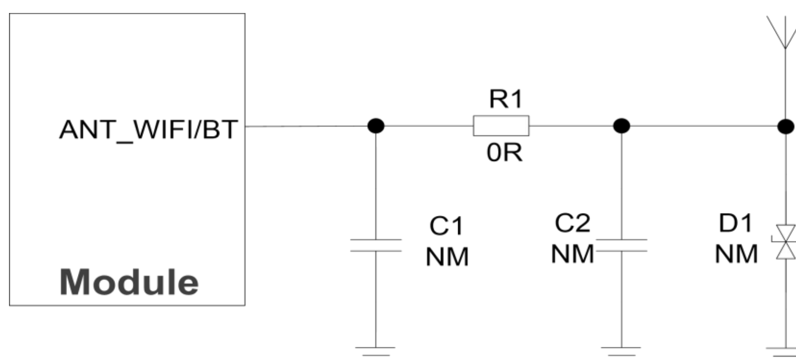


Figure 14: Reference Design of RF Antenna Interface

4.6.2. Antenna Design Requirements

Table 11: Antenna Design Requirements

Parameter	Requirement [2]
Frequency Ranges (GHz)	● 2.400–2.4835 ● 5.150–5.850
Cable Insertion Loss (dB)	< 1
VSWR	≤ 2 (Typ.)
MAX Gain (dBi)	1.14
Max Input Power (W)	50
Input Impedance (Ω)	50
Polarization Type	Vertical

4.6.3. RF Routing Guidelines

For user's PCB, the characteristic impedance of all RF traces should be controlled to 50 Ω. The impedance of the RF traces is usually determined by the trace width (W), the materials' dielectric constant, the height from the reference ground to the signal layer (H), and the spacing between RF traces and grounds (S). Microstrip or coplanar waveguide is typically used in RF layout to control characteristic impedance. The following are reference designs of microstrip or coplanar waveguide with different PCB structures.

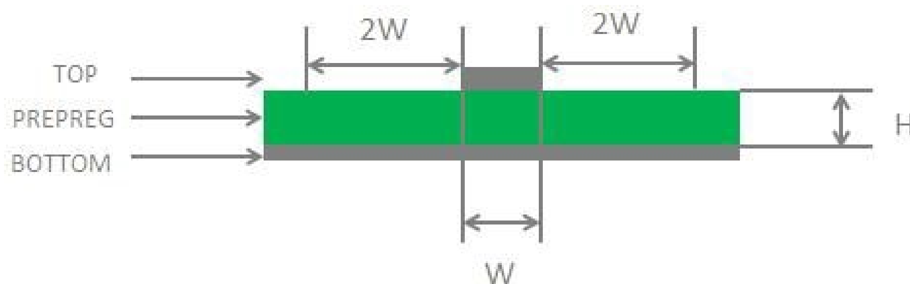


Figure 15: Microstrip Design on a 2-layer PCB

[2] For more details about the RF performances, see ***Chapter 3***.

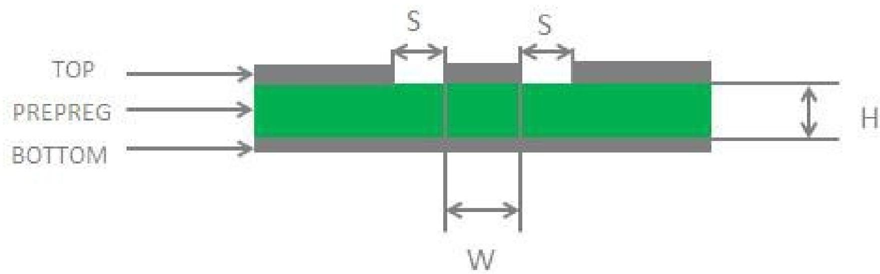


Figure 16: Coplanar Waveguide Design on a 2-layer PCB

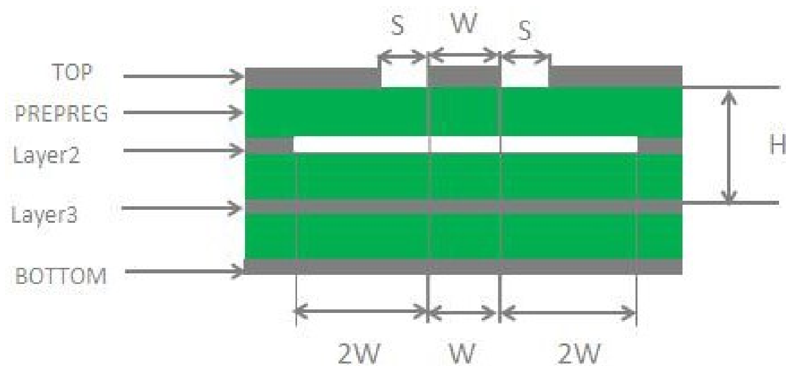


Figure 17: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

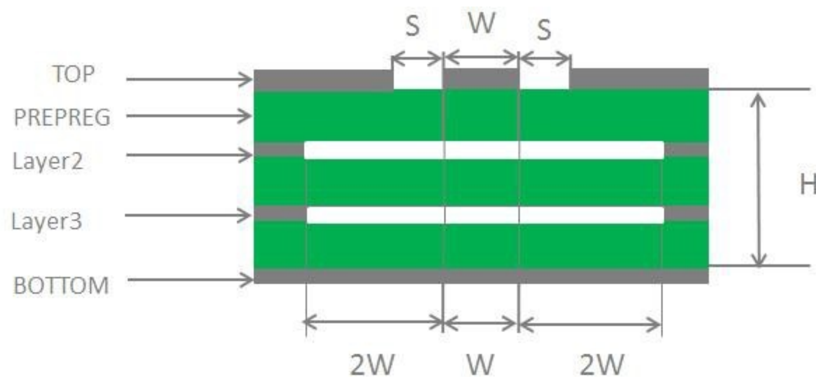


Figure 18: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

To ensure RF performance and reliability, follow the principles below in RF layout design:

- Use an impedance simulation tool to control the characteristic impedance of RF traces to 50 Ω.
- The GND pins adjacent to RF pins should not be designed as thermal relief pads, and should be fully connected to ground.
- The distance between the RF pins and the RF connector should be as short as possible and all the

right-angle traces should be changed to curved ones. The recommended trace angle is 135°.
- There should be clearance under the signal pin of the antenna connector or solder joint.
- The reference ground of RF traces should be complete. Meanwhile, adding some ground vias around RF traces and the reference ground could help to improve RF performance. The distance between the ground vias and RF traces should be not less than twice the width of RF signal traces (2 × W).
- Keep RF traces away from interference sources, and avoid intersection and paralleling between traces on adjacent layers.

For more details about RF layout, see ***document [1]***.

4.6.4. RF Connector Recommendation

If RF connector is used for antenna connection, it is recommended to use the U.FL-R-SMT connector provided by Hirose.

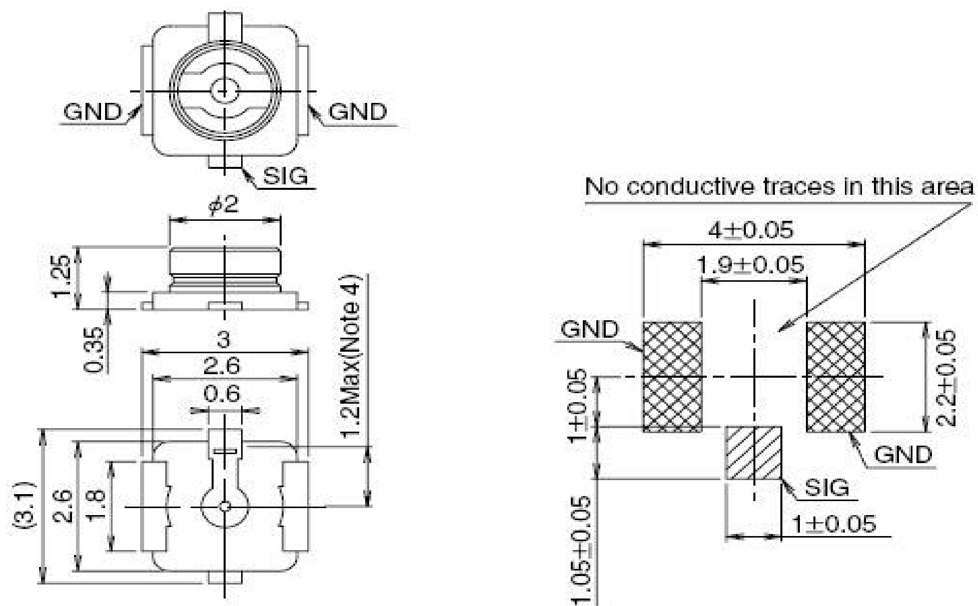


Figure 19: Dimensions of the Receptacle (Unit: mm)

U.FL-LP series mated plugs listed in the following figure can be used to match the U.FL-R-SMT connector.

	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
Part No.					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 0.81mm Coaxial cable	Dia. 1mm Coaxial cable	Dia. 1.37mm Coaxial cable
Weight (mg)	53.7	59.1	34.8	45.5	71.7
RoHS	YES				

Figure 20: Specifications of Mated Plugs

The following figure describes the space factor of mated connectors.

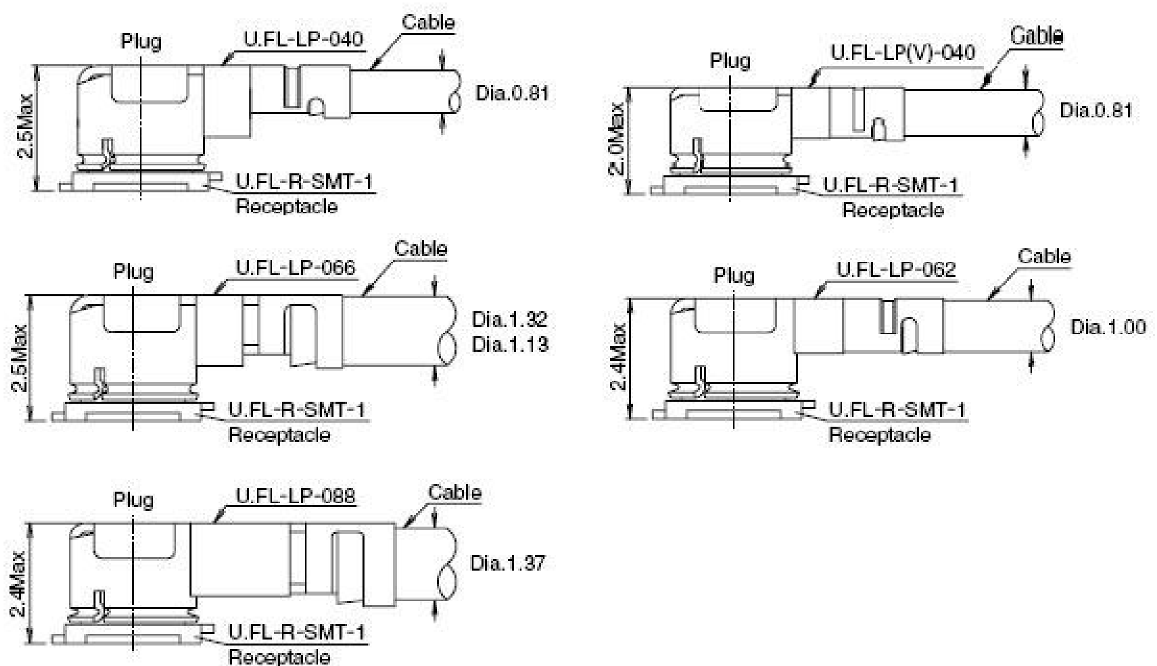


Figure 21: Space Factor of Mated Connectors (Unit: mm)

For more details, please visit https://www.hirose.com.

5 Electrical Characteristics & Reliability

5.1. Absolute Maximum Ratings

Table 12: Absolute Maximum Ratings (Unit: V)

Parameter	Min.	Max.
VBAT	0	3.6
VDD_IO	0	3.6
Voltage at Digital Pins	0	3.6

5.2. Power Supply Ratings

Table 13: Module Power Supply Ratings (Unit: V)

Parameter	Description	Condition	Min.	Typ.	Max.
VBAT	Main power supply for the module	The actual input voltages must be kept between the minimum and maximum values.	3.0	3.3	3.6
VDD_IO	Power supply for module's I/O pins	-	1.62	1.8/3.3	3.6

5.3. Power Consumption

5.3.1. Wi-Fi Power Consumption

Table 14: Power Consumption in Low Power Modes

Mode	Typ.	Unit
Light Sleep	TBD	TBD
Deep Sleep	TBD	TBD
DTIM1	TBD	TBD
DTIM3	TBD	TBD
OFF	TBD	TBD

Table 15: Power Consumption in Non-signalling Mode (Unit: mA)

Condition			I_{VBAT}	I_{VDD_IO}
2.4 GHz	802.11b	Tx @ 1 Mbps	355	0.06
		Tx @ 11 Mbps	340	0.101
	802.11g	Tx @ 6 Mbps	279	0.086
		Tx @ 54 Mbps	212	0.25
	802.11n	Tx HT20 @ MCS 0	270	0.12
		Tx HT20 @ MCS 7	200	0.263
		Tx HT40 @ MCS 0	268	0.12
		Tx HT40 @ MCS 7	177	0.348
5 GHz	802.11a	Tx @ 6 Mbps	375	0.082
		Tx @ 54 Mbps	269	0.244
	802.11n	Tx HT20 @ MCS 0	345	0.85
		Tx HT20 @ MCS 7	244	0.26
		Tx HT40 @ MCS 0	334	0.117

	Tx HT40 @ MCS 7	215	0.34
802.11ac	Tx VHT20 @ MCS 0	345	0.085
	Tx VHT20 @ MCS 8	237	0.272
	Tx VHT40 @ MCS 0	333	0.117
	Tx VHT40 @ MCS 9	203	0.365
	Tx VHT80 @ MCS 0	307	0.17
	Tx VHT80 @ MCS 9	176	0.407

5.3.2. Bluetooth Power Consumption

Table 16: Power Consumption in Non-signalling Mode

Mode	Tx Power (Typ.)	I_{VDD_IO}	I_{VBAT}
BR	4 dBm	112 mA	TBD
EDR (π/4-DQPSK)	4 dBm	110 mA	TBD
EDR (8-DPSK)	4 dBm	110 mA	TBD
BLE (1 Mbps)	4 dBm	115 mA	TBD

5.4. Digital I/O Characteristics

Table 17: VDD_IO High Level I/O Requirements (Unit: V)

Parameter	Description	Min.	Max.
V_{IH}	High-level input voltage	2.0	3.6
V_{IL}	Low-level input voltage	-	0.9
V_{OH}	High-level output voltage	2.97	3.3
V_{OL}	Low-level output voltage	0	0.33

Table 18: VDD_IO Low Level I/O Requirements (Unit: V)

Parameter	Description	Min.	Max.
V_{IH}	High-level input voltage	1.3	2.0
V_{IL}	Low-level input voltage	-	0.8
V_{OH}	High-level output voltage	1.62	1.8
V_{OL}	Low-level output voltage	0	0.18

5.5. ESD Protection

Static electricity occurs naturally and it may damage the module. Therefore, applying proper ESD countermeasures and handling methods is imperative. For example, wear anti-static gloves during the development, production, assembly and testing of the module; add ESD protection components to the ESD sensitive interfaces and points in the product design.

5.6. Thermal Dissipation

The module offers the best performance when all internal IC chips are working within their operating temperatures. When the IC chip reaches or exceeds the maximum junction temperature, the module may still work but the performance and function (such as RF output power, data rate, etc.) will be affected to a certain extent. Therefore, the thermal design should be maximally optimized to ensure all internal IC chips always work within the recommended operating temperature range.

The following principles for thermal consideration are provided for reference:

- Keep the module away from heat sources on your PCB, especially high-power components such as processor, power amplifier, and power supply.
- Maintain the integrity of the PCB copper layer and drill as many thermal vias as possible.
- Follow the principles below when the heatsink is necessary:
  - Do not place large size components in the area where the module is mounted on your PCB to reserve enough place for heatsink installation.
  - Attach the heatsink to the shielding cover of the module; In general, the base plate area of the heatsink should be larger than the module area to cover the module completely;
  - Choose the heatsink with adequate fins to dissipate heat;
  - Choose a TIM (Thermal Interface Material) with high thermal conductivity, good softness and good wettability and place it between the heatsink and the module;

− Fasten the heatsink with four screws to ensure that it is in close contact with the module to prevent the heatsink from falling off during the drop, vibration test, or transportation.

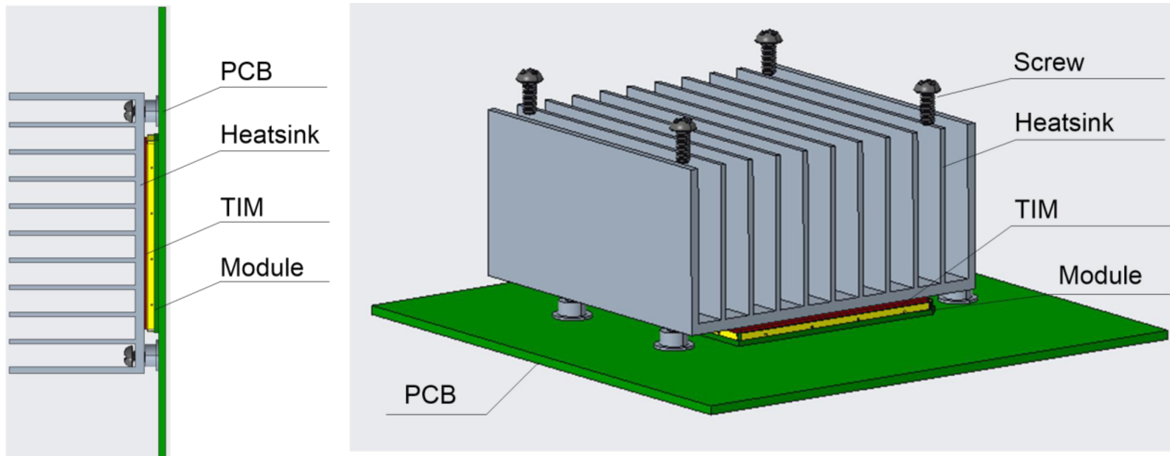


Figure 22: Placement and Fixing of the Heatsink

6 Mechanical Information

This chapter describes the mechanical dimensions of the module. All dimensions are measured in millimeter (mm), and the dimensional tolerances are ±0.2 mm unless otherwise specified.

6.1. Mechanical Dimensions

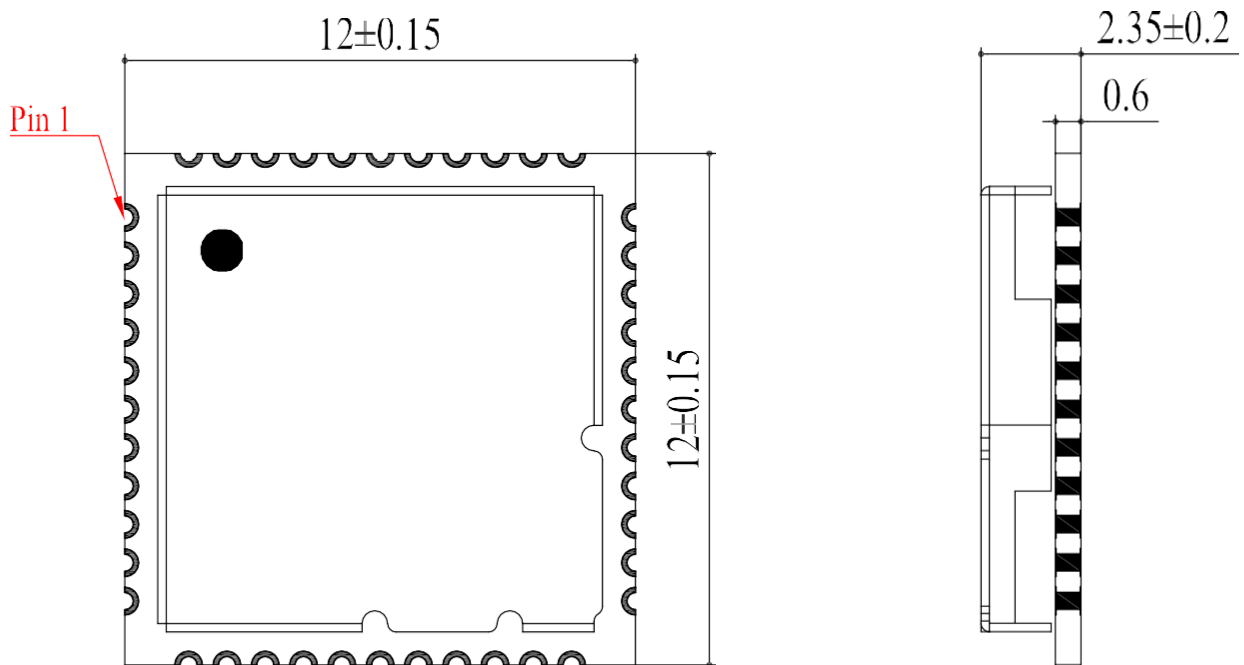


Figure 23: Top and Side Dimensions

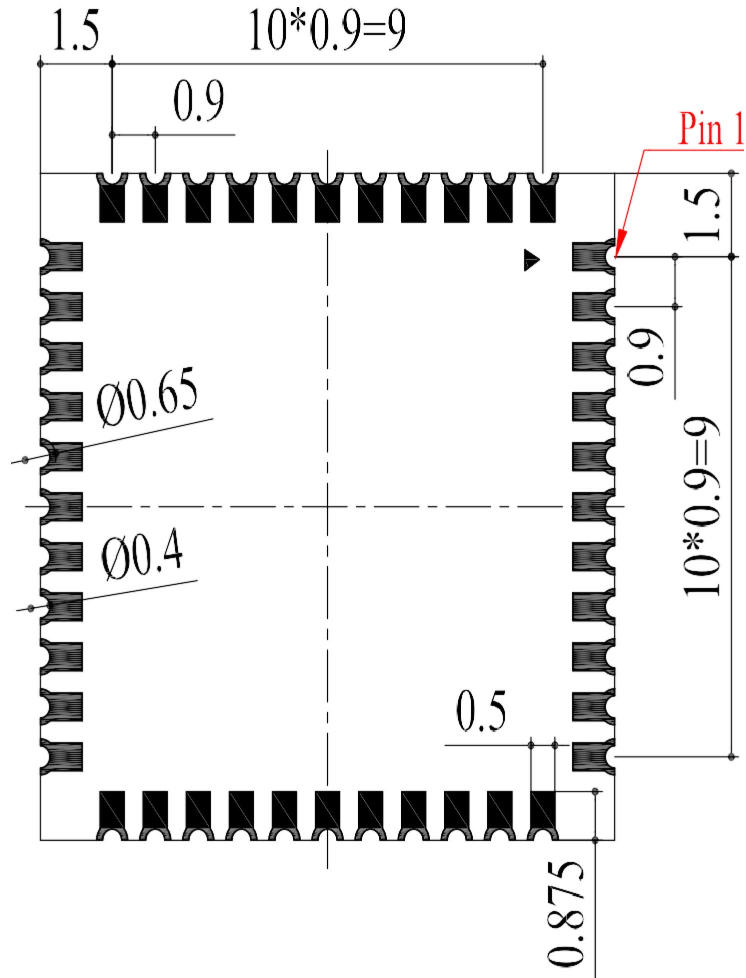


Figure 24: Bottom Dimensions (Bottom View)

NOTE

The package warpage level of the module conforms to the *JEITA ED-7306* standard.

6.2. Recommended Footprint

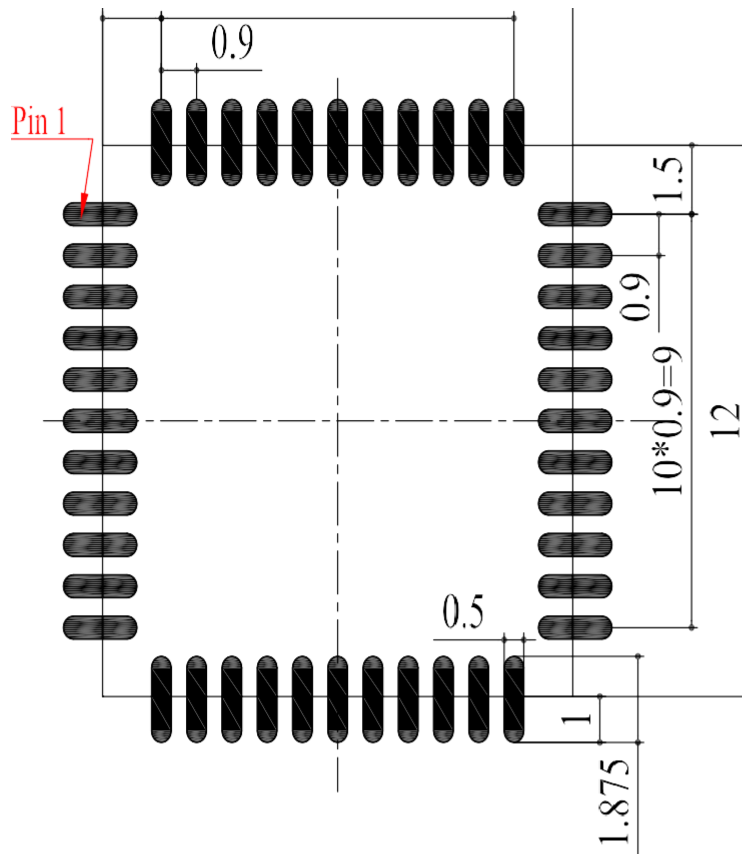


Figure 25: Recommended Footprint

NOTE

Keep at least 3 mm between the module and other components on the motherboard to improve soldering quality and maintenance convenience.

6.3. Top and Bottom Views

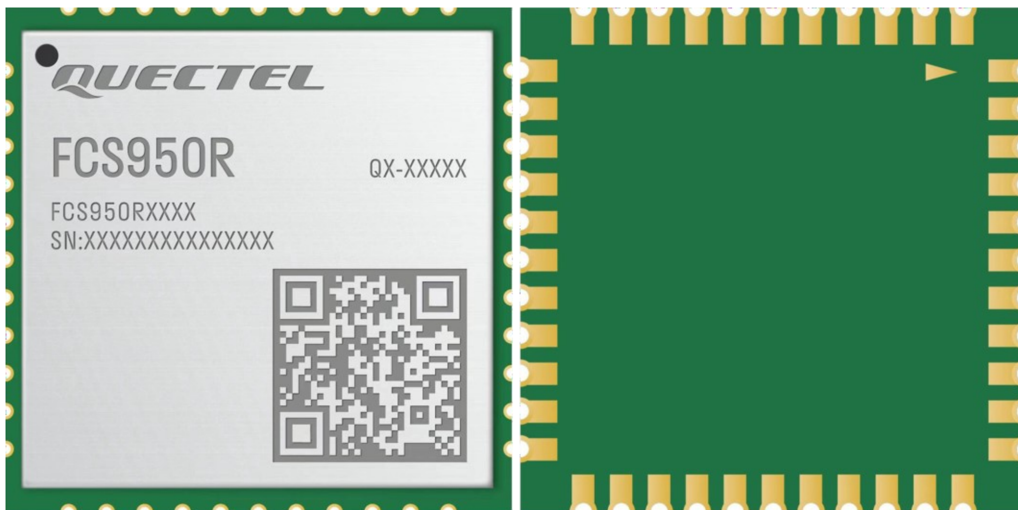


Figure 26: Top and Bottom Views

NOTE

Images above are for illustration purpose only and may differ from the actual module. For authentic appearance and label, please refer to the module received from Quectel.

7 Storage, Manufacturing & Packaging

7.1. Storage Conditions

The module is provided with vacuum-sealed packaging. MSL of the module is rated as 3. The storage requirements are shown below.

1. Recommended Storage Condition: the temperature should be 23 ±5 °C and the relative humidity should be 35–60 %.

2. Shelf life (in a vacuum-sealed packaging): 12 months in Recommended Storage Condition.

3. Floor life: 168 hours [3] in a factory where the temperature is 23 ±5 °C and relative humidity is below 60 %. After the vacuum-sealed packaging is removed, the module must be processed in reflow soldering or other high-temperature operations within 168 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10 % (e.g., a dry cabinet).

4. The module should be pre-baked to avoid blistering, cracks and inner-layer separation in PCB under the following circumstances:

   - The module is not stored in Recommended Storage Condition;
   - Violation of the third requirement mentioned above;
   - Vacuum-sealed packaging is broken, or the packaging has been removed for over 24 hours;
   - Before module repairing.

5. If needed, the pre-baking should follow the requirements below:

   - The module should be baked for 8 hours at 120 ±5 °C;
   - The module must be soldered to PCB within 24 hours after the baking, otherwise it should be put in a dry environment such as in a dry cabinet.

[3] This floor life is only applicable when the environment conforms to *IPC/JEDEC J-STD-033*. It is recommended to start the solder reflow process within 24 hours after the package is removed if the temperature and moisture do not conform to, or are not sure to conform to *IPC/JEDEC J-STD-033*. Do not unpack the modules in large quantities until they are ready for soldering.

NOTE

1. To avoid blistering, layer separation and other soldering issues, extended exposure of the module to the air is forbidden.
2. Take out the module from the package and put it on high-temperature-resistant fixtures before baking. If shorter baking time is desired, see *IPC/JEDEC J-STD-033* for the baking procedure.
3. Pay attention to ESD protection, such as wearing anti-static gloves, when touching the modules.

7.2. Manufacturing and Soldering

Push the squeegee to apply the solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate to the PCB. Apply proper force on the squeegee to produce a clean stencil surface on a single pass. To guarantee module soldering quality, the thickness of stencil for the module is recommended to be 0.15–0.18 mm. For more details, see ***document [2]***.

The recommended peak reflow temperature should be 235–246 ºC, with 246 ºC as the absolute maximum reflow temperature. To avoid damage to the module caused by repeated heating, it is recommended that the module should be mounted only after reflow soldering for the other side of PCB has been completed. The recommended reflow soldering thermal profile (lead-free reflow soldering) and related parameters are shown below.

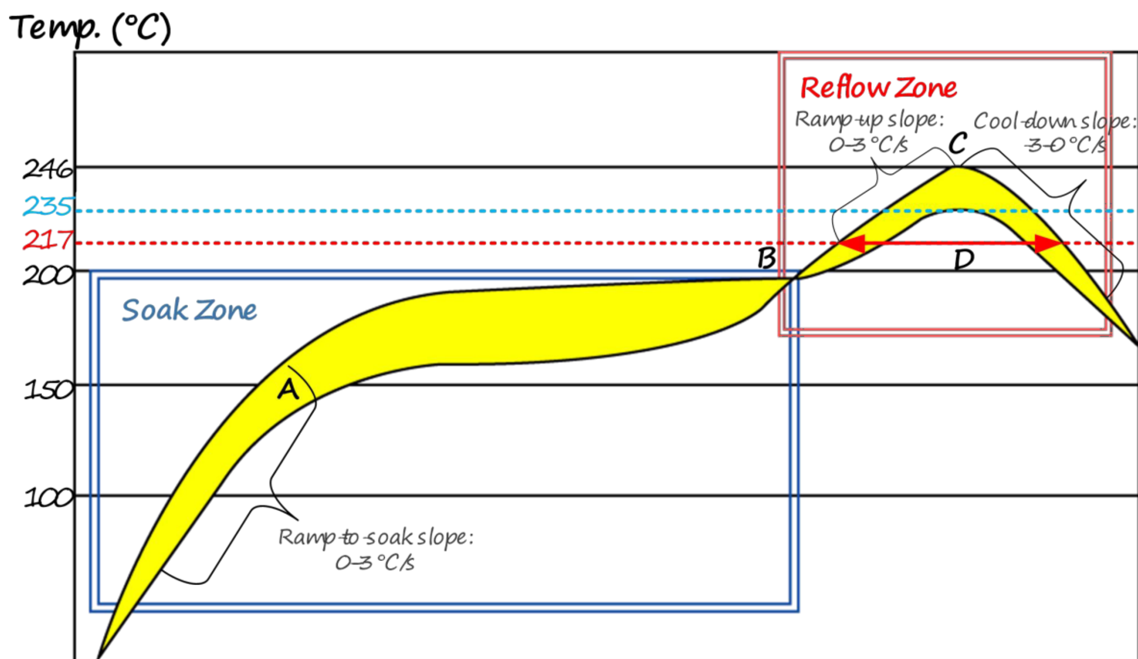


Figure 27: Recommended Reflow Soldering Thermal Profile

Table 19: Recommended Thermal Profile Parameters

Factor	Recommendation Value
Soak Zone	
Ramp-to-soak slope	0–3 °C/s
Soak time (between A and B: 150 °C and 200 °C)	70–120 s
Reflow Zone	
Ramp-up slope	0–3 °C/s
Reflow time (D: over 217 °C)	40–70 s
Max. temperature	235–246 °C
Cool-down slope	-3–0 °C/s
Reflow Cycle	
Max. reflow cycle	1

NOTE

1. The above profile parameter requirements are for the measured temperature of the solder joints. Both the hottest and coldest spots of solder joints on the PCB should meet the above requirements.
2. During manufacturing and soldering, or any other processes that may contact the module directly, NEVER wipe the module's shielding can with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol, trichloroethylene, etc. Otherwise, the shielding can may become rusted.
3. The shielding can for the module is made of Cupro-Nickel base material. It is tested that after 12 hours' Neutral Salt Spray test, the laser engraved label information on the shielding can is still clearly identifiable and the QR code is still readable, although white rust may be found.
4. If a conformal coating is necessary for the module, do NOT use any coating material that may chemically react with the PCB or shielding cover, and prevent the coating material from flowing into the module.
5. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.
6. Due to the complexity of the SMT process, please contact Quectel Technical Support in advance for any situation that you are not sure about, or any process (e.g. selective soldering, ultrasonic soldering) that is not mentioned in ***document [2]***.

7.3. Packaging Specifications

This chapter describes only the key parameters and process of packaging. All figures below are for reference only. The appearance and structure of the packaging materials are subject to the actual delivery.

The module adopts carrier tape packaging and details are as follow:

7.3.1. Carrier Tape

Dimension details are as follow:

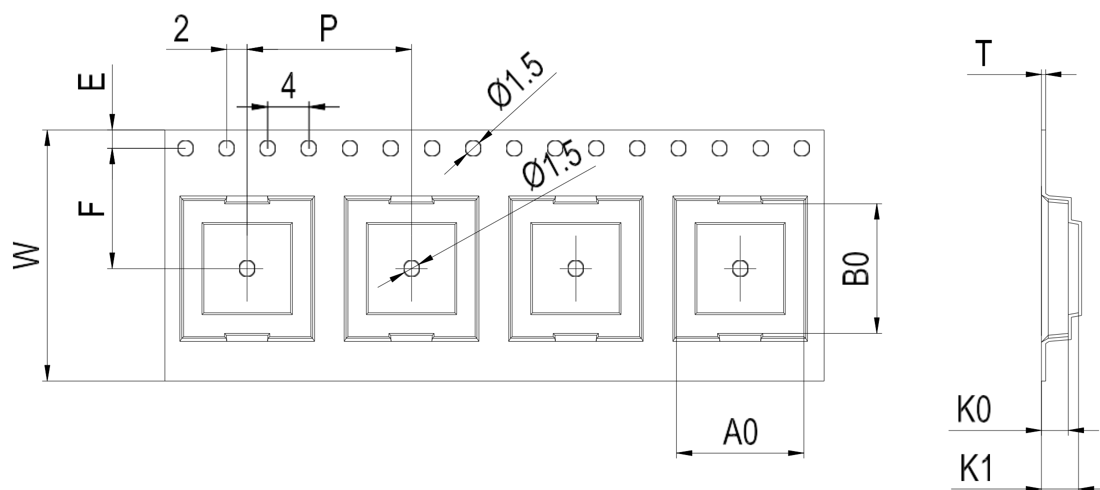


Figure 28: Carrier Tape Dimension Drawing

Table 20: Carrier Tape Dimension Table (Unit: mm)

W	P	T	A0	B0	K0	K1	F	E
24	16	0.35	12.4	12.4	2.6	3.6	11.5	1.75

7.3.2. Plastic Reel

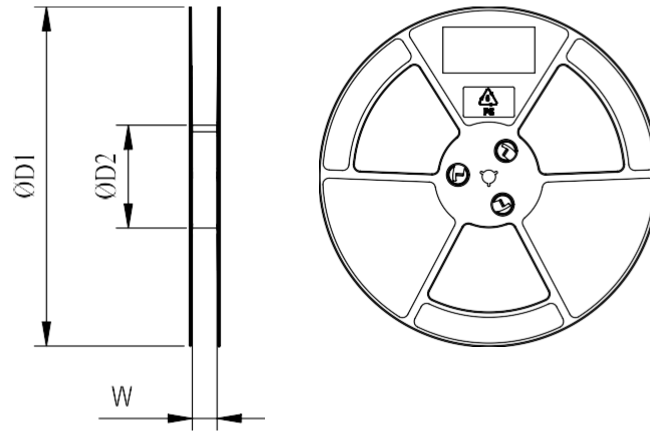


Figure 29: Plastic Reel Dimension Drawing

Table 21: Plastic Reel Dimension Table (Unit: mm)

øD1	øD2	W
330	100	24.5

7.3.3. Mounting Direction

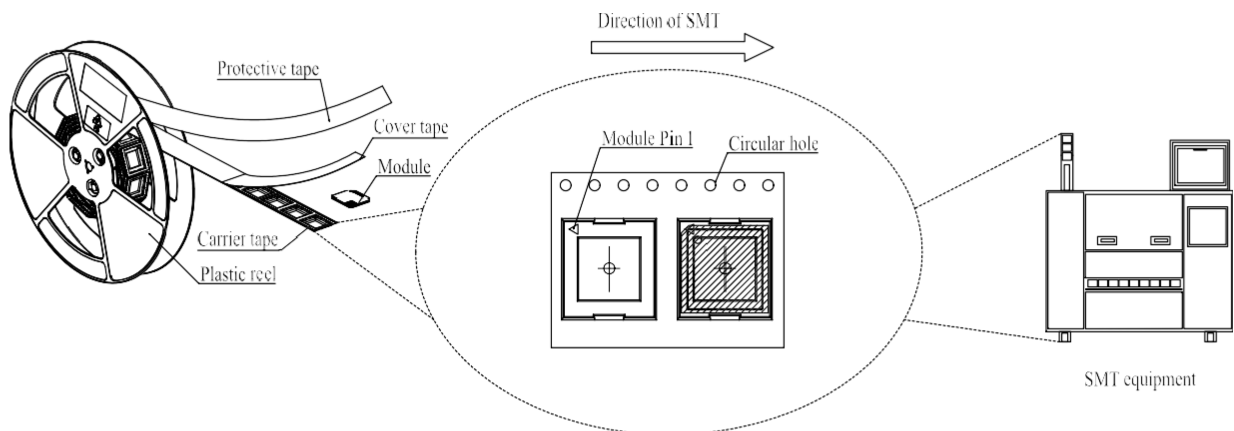
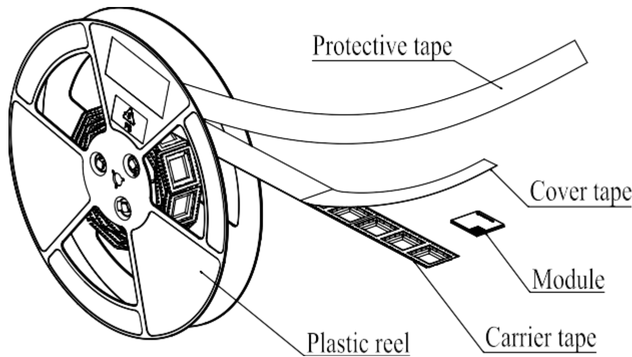


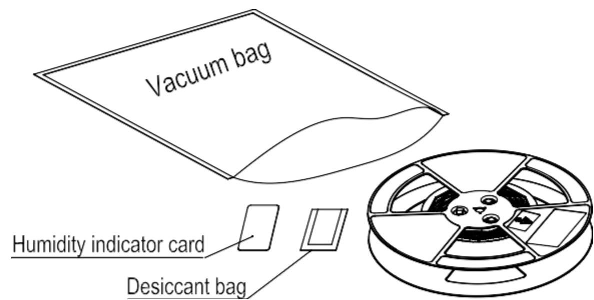
Figure 30: Mounting Direction

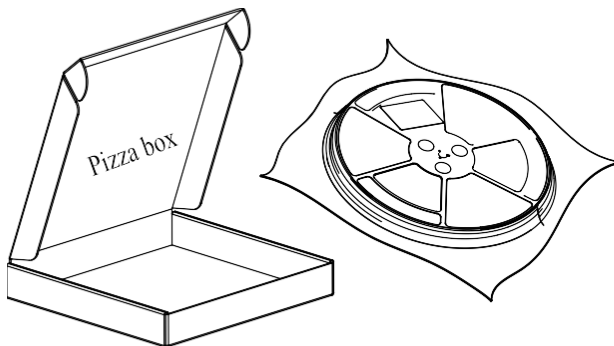
7.3.4. Packaging Process



Place the module into the carrier tape and use the cover tape to cover it; then wind the heat-sealed carrier tape to the plastic reel and use the protective tape for protection. 1 plastic reel can load 500 modules.

Place the packaged plastic reel, 1 humidity indicator card and 1 desiccant bag into a vacuum bag, vacuumize it.





Place the vacuum-packed plastic reel into the pizza box.

Put 4 packaged pizza boxes into 1 carton box and seal it. 1 carton box can pack 2000 modules.

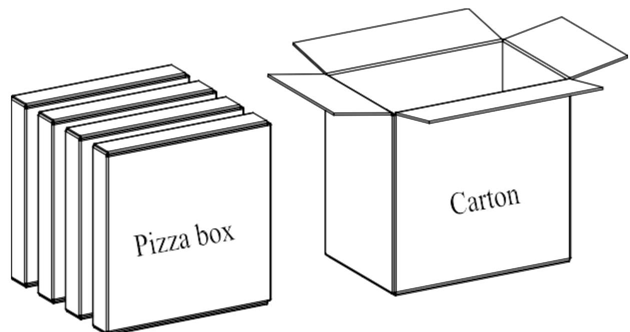


Figure 31: **Packaging Process**

8 Appendix References

Table 22: Related Documents

Document Name
[1] Quectel_RF_Layout_Application_Note
[2] Quectel_Module_SMT_Application_Note

Table 23: Terms and Abbreviations

Abbreviation	Description
1T1R	One Transmit One Receive
AP	Access Point
BLE	Bluetooth Low Energy
BPSK	Binary Phase Shift Keying
BR	Basic Rate
CCK	Complementary Code Keying
CTS	Clear To Send
DBPSK	Differential Binary Phase Shift Keying
DPSK	Differential Phase Shift Keying
DQPSK	Differential Quadrature Phase Shift Keying
DTIM	Delivery Traffic Indication Message
EDR	Enhanced Date Rate
eSCO	Extended Synchronous Connection-Oriented
ESD	Electrostatic Discharge

EVM	Error Vector Magnitude
GFSK	Gaussian Frequency Shift Keying
GND	Ground
GPIO	General-Purpose Input/Output
HCI	Host Controller Interface
HT	High Throughput
IEEE	Institute of Electrical and Electronics Engineers
I/O	Input/Output
IRQ	Interrupt Request
LCC	Leadless Chip Carrier (package)
LSB	Least Significant Bit
LTE	Long-Term Evolution
Mbps	Million Bits Per Second
MCS	Modulation and Coding Scheme
MSB	Most Significant Bit
MSL	Moisture Sensitivity Levels
NC	Not Connected
PCB	Printed Circuit Board
PCM	Pulse Code Modulation
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RoHS	Restriction of Hazardous Substances
RTS	Request to Send
Rx	Receive

RXD	Receive Data
SCO	Synchronous Connection-Oriented
SDIO	Secure Digital Input/Output
SMD	Surface Mount Device
SMT	Surface Mount Technology
STA	Station
TBD	To Be Determined
Tx	Transmit
TXD	Transmit Data
TVS	Transient Voltage Suppressor
UART	Universal Asynchronous Receiver/Transmitter
VBAT	Voltage at Battery (Pin)
VHT	Very High Throughput
V_{IH}	High-level Input Voltage
V_{IL}	Low-level Input Voltage
Vmax	Maximum Voltage
Vmin	Minimum Voltage
Vnom	Nominal Voltage
V_{OH}	High-level Output Voltage
V_{OL}	Low-level Output Voltage
VSWR	Voltage Standing Wave Ratio

9 Worning

9.1. Important Notice to OEM integrators

Product Marketing Name：Quectel FCS950R

1. This module is limited to OEM installation ONLY.
2. This module is limited to installation in fixed applications, according to Part 2.1091(b).
3. This module has been tested and found to comply with the limits for Part 15.247 & 15.407 of the FCC Rules.

4. The separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and different antenna configurations 4. For FCC Part 15.31 (h) and (k): The host manufacturer is responsible for additional testing to verify compliance as a composite system. When testing the host device for compliance with Part 15 Subpart B, the host manufacturer is required to show compliance with Part 15 Subpart B while the transmitter module(s) are installed and operating. The modules should be transmitting and the evaluation should confirm that the module's intentional emissions are compliant (i.e. fundamental and out of band emissions). The host manufacturer must verify that there are no additional unintentional emissions other than what is permitted in Part 15 Subpart B or emissions are complaint with the transmitter(s) rule(s). The Grantee will provide guidance to the host manufacturer for Part 15 B requirements if needed.

Important Note Important Note notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify to Quectel Wireless Solutions Co., Ltd.. that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the USI, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application. End Product LabelingWhen the module is installed in the host device, the FCC/IC 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 re-moved. If not, a second label must be placed on the outside of the final device that contains the following text: “Contains FCC ID: XMR2023FCS950R” The FCC ID can be used only when all FCC mpliance requirements are met.

Antenna Installation

(1) The antenna must be installed such that 20 cm is maintained between the antenna and users,
(2) The transmitter module may not be co-located with any other transmitter or antenna.
(3) Only antennas of the same type and with equal or less gains as shown below may be used with thismodule.

Operating Band	Frequency (MHz)	Antenna Type	Antenna P/N	Antenna Gain (dBi)
Bluetooth	2400~2483.5	Dipole	YE0038AA	0.73 dBi
2.4G WiFi				0.73 dBi
5G WiFi	5150~5850			5150~5250 MHz: 1.14 dBi 5250~5350 MHz: 1.14 dBi 5470~5725 MHz: 1.14 dBi 5725~5850 MHz: 1.14 dBi

Other types of antennas and/or higher gain antennas may require additional authorization for operation.
In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID/IC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC/IC authorization. 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 in the user’s manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

9.2. FCC Statement

Federal Communication Commission Interference Statement
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. This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.
This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:
-Reorient or relocate the receiving antenna.
-Increase the separation between the equipment and receiver.
-Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
-Consult the dealer or an experienced radio/TV technician for help.
Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
This device is intended only for OEM integrators under the following conditions:
(For module device use)

1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2) The transmitter module may not be co-located with any other transmitter or antenna. As long as 2conditions

above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.
Radiation Exposure Statement
This equipment 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.

9.3. IC Statement

IRSS-GEN

"This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions: (1) This device may not cause interference; and (2) This device must accept any interference, including interference that may cause undesired operation of the device." or "Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :
1) l'appareil ne doit pas produire de brouillage; 2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement."
Déclaration sur l'exposition aux rayonnements RF
L'autre utilisé pour l'émetteur doit être installé pour fournir une distance de séparation d'au moins 20 cm de toutes les personnes et ne doit pas être colocalisé ou fonctionner conjointement avec une autre antenne ou un autre émetteur.

Radio frequency radiation exposure statement

The other one used for the transmitter must be installed at a distance of at least 20 cm from all personnel and must not be shared or operated together with any other antenna or transmitter.
The host product shall be properly labeled to identify the modules within the host product.
The Innovation, Science and Economic Development Canada certification label of a module shall be clearly visible at all times when installed in the host product; otherwise, the host product must be labeled to display the Innovation, Science and Economic Development Canada certification number for the module, preceded by the word "Contains" or similar wording expressing the same meaning, as follows:
"Contains IC: 10224A-2023FCS950R" or "where: 10224A-2023FCS950R is the module's certification number". Le produit hôte doit être correctement étiqueté pour identifier les modules dans le produit hôte.
L'étiquette de certification d'Innovation, Sciences et Développement économique Canada d'un module doit être clairement visible en tout temps lorsqu'il est installédans le produit hôte; sinon, le produit hôte doit porter une étiquette indiquant le numéro de certification d'Innovation, Sciences et Développement économique Canada pour le module, précédé du mot «Contient» ou d'un libellé semblable exprimant la même signification, comme suit:
"Contient IC: 10224A-2023FCS950R" ou "où: 10224A-2023FCS950R est le numéro de certification du module".
i.the device for operation in the band 5150–5250 MHz is only for indoor use to reduce the potential for harmful interference to co-channel mobile satellite systems;
ii.for devices with detachable antenna(s), the maximum antenna gain permitted for devices in the bands 5250-5350 MHz and 5470-5725 MHz shall be such that the equipment still complies with the e.i.r.p. limit;
iii.for devices with detachable antenna(s), the maximum antenna gain permitted for devices in the band 5725-5850 MHz shall be such that the equipment still complies with the e.i.r.p. limits as appropriate;
iv.Omnidirectional antenna is recommended