

FC20 Series

Hardware Design

Short-Range Module Series

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Safety Information

The following safety precautions must be observed during all phases of operation, such as usage, service or repair of any terminal or mobile incorporating the module. Manufacturers of the terminal should 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 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 should 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.



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 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 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 terminals. Areas with explosive or potentially explosive atmospheres include fueling 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
-	2016-11-02	Power JIN	Creation of the document
1.0	2016-11-02	Power JIN	First official release
1.1	2017-12-14	Power JIN/ Kane ZHU	- Updated the chip model into QCA1023. - Added LTE coexistence function for FC20-N. - Updated current consumption values (Table 23). - Updated RF output power values (Table 24&25). - Updated RF receiving sensitivity (Table 26&27). - Added EC20 R2.1 in the modules that can use in combination with FC20 series module.
2.0	2018-05-17	Power JIN/ Kane ZHU	- Removed all descriptions relating to BT function. - Removed UART, PCM and BT_EN from Figure 1. - Changed pins 7, 8, 10, 13~18 into reserved ones. - Updated bottom dimensions, recommended footprint and recommended stencil. - Updated the peak reflow temperature and recommended reflow soldering thermal profile (Chapter 6.2).
2.1	2018-07-06	Power JIN/ Kane ZHU	- Added a reference design for RF antenna interface (Chapter 3.8.3). - Updated the recommended thermal profile parameters (Chapter 6.2). - Updated the frequency range of the modules.
2.2	2019-05-22	Power JIN	- Modified the maximum output current of VDD_3V3 (Table 4&Chapter 3.4). - Added the timing between VIO and VDD_3V3 (Figure 4). - Changed NM_10nF of SDIO interface connection to NM_10pF (Figure 6).

			- Added two pull-down resistors (Figure 7). - Added electrostatic discharge characteristics (Table 26). - Updated the peak reflow temperature and recommended reflow soldering thermal profile (Chapter 6.2).
2.3	2019--08-16	Soni RAO/ Finley ZHANG	- Added Bluetooth related contents (Table 1&2&4&17&Chapter 3.6). - Operation mode STA and pin WAKE_ON_WIRELESS are fully developed. - Updated data rates of FC20 series module (Table 2). - Updated functional diagram of FC20 series module (Figure 1). - Updated pin 7, 8, 10, 13~18 and 46 from RESERVED to BT function pins in Figure 2 and Table 4. - Updated pin descriptions of VDD_3V3 and DBG_TXD in Table 4. - Added note for pin SDIO_D2 in Chapter 3.3. - Updated reference circuit for RF antenna interface (vehicle applications) in Figure 12.
2.4	2020-01-07	Power JIN/ Downey YANG/ Jun WU	- Added BLE information (Table 1). - Added Bluetooth profile and related description (Table 2). - Added association between PCM interface and BLE function in notes specific (Figure 1). - Updated block diagram of Bluetooth interface connection (Figure 7). - Added association between PCM interface and BLE function (Chapter 3.5.2.3). - Added Table 30 to illustrate BLE transmitting and receiving performance.
2.5	2020-01-21	Fanny CHEN	Added Table 26 to illustrate BLE power consumption in the non-signaling mode.
2.6	2020-11-24	Elinor WANG/ Downey YANG	- Added Bluetooth 4.2 function applicable to the module FC20 and FC20-N. - Removed the module EC20 R2.0 which was used in combination with FC20 series module due to the module's EOL. - Added BT_UART & PCM interfaces for BT function applicable to the module FC20-N. - Removed DBG_TXD interface. - Updated WLAN data rates of the module FC20 and FC20-N (Table 2);

			Updated Bluetooth protocol features, package mode and temperature ranges and added Bluetooth modulation and 32KHZ_IN Interface (Table 2). - Updated the DC characteristics of VIO pin (Table 4). - Added RF antenna layout reference guide (Chapter 3.7.4). - Updated the power consumption of the module in low power mode (Table 23). - Removed Wi-Fi power consumption of the module. - Updated conducted RF output power at 5 GHz (Table 26). - Updated conducted RF receiving sensitivity at 5 GHz (Table 28). - Added the top view of FC20-N module (Chapter 5.4).
2.7	2022-01-27	Otto LI/ Julian XIA	- Updated from Bluetooth 4.2 to Bluetooth 5.0. - Updated the thickness of the module to 2.05 mm and updated the 2D structure picture. - Updated the voltage domain of VIO to 1.8/3.3 V. - Updated Pin 4 from RESERVED to DBG_RXD. - Updated the applicability of Bluetooth function of FC20-N. - Updated the SDIO interface connection design and routing requirements (Chapter 3.5.1.3). - Updated the tolerances of mechanical dimension to ± 0.2 mm (Chapter 5.1). - Updated the thickness of stencil to 0.15–0.18 mm; updated the peak reflow temperature; updated the max. slope of reflow zone; added relevant notes for coating, ultrasonic cleaning and SMT process (Chapter 6.2). - Updated the packaging (Chapter 6.3).
2.8	2023-01-04	Shinnie Xu/ Julian XIA	- Updated RF parameters and indicators (Table 28). - Updated the ramp-to-soak slope of soak zone, ramp-up slope and cool-down slope of reflow zone, and note (Chapter 6.2). - Added the chapter of module mounting direction (Chapter 6.3.3).
2.9	2023-09-04	James XIONG	Added the Wi-Fi encryption modes (Table 3).
3.0	2024-01-08	James XIONG	- Updated the note for module manufacturing and Soldering (Chapter 6.2). - Updated the module packing specification (Tables 33 & 34, Figure 29).

3.1	2024-07-24	Shinnie XU	1. Added Wi-Fi modulation DSSS, DBPSK and DQPSK (Table 3). 2. Updated the comments of pin 10 (BT_EN) and pin 32 (WAKE_ON_WIRELESS) (Tables 5 & 9 & 12). 3. Updated power supply (Figure 3 & Chapter 3.3). 4. Updated power up and down timing of the module (Chapter 3.3). 5. Updated SDIO design principles (Chapter 3.4.1.3). 6. Updated reference circuit for RF antenna interface and added relevant notes (Chapter 3.6.3). 7. Updated Bluetooth power consumption in non-signaling mode (Table 26). 8. Updated Bluetooth transmitting and receiving performance (Table 31). 9. Updated the reference document for recommended thickness of stencil (Chapter 6.2 & Table 37). 10. Added the note specifying that corrosive gases should be avoided for module processing (Chapter 6.2).
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1 Introduction

This document defines the FC20 series module and describes its air interface and hardware interfaces which are connected to your applications. The document can help you quickly understand module interface specifications, electrical and mechanical details, as well as other related information of the module. The modules can be used in combination with LTE Standard modules (EC21 series and EC25 series, etc.) or other application processors (IMX6, IMX8, etc.). You can use FC20 series module to design and set up LTE + Wi-Fi/Bluetooth applications easily. FC20 series module contains two variants: FC20 and FC20-N, which are shown in the following table. You can choose specific types based on actual needs.

Hereby, Quectel Wireless Solutions Co., Ltd. declares that the radio equipment type FC20 is in compliance with Directive 2014/53/EU.

The full text of the EU declaration of conformity is available at the following internet address:
<http://www.quectel.com/support/technical.htm>

Disposal of old electrical appliances



The European directive 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE), requires that old household electrical appliances must not be disposed of in the normal unsorted municipal waste stream. Old appliances must be collected separately in order to optimize the recovery and recycling of the materials they contain, and reduce the impact on human health and the environment.

The crossed out “wheeled bin” symbol on the product reminds you of your obligation, that when you dispose of the appliance, it must be separately collected.

Consumers should contact their local authority or retailer for information concerning the correct disposal of their old appliance.

	AT	BE	BG	HR	CY	CZ	DK
	EE	FI	FR	DE	EL	HU	IE
	IT	LV	LT	LU	MT	NL	PL
	PT	RO	SK	SI	ES	SE	UK(NI)

This equipment should be installed and operated with minimum distance 20cm between the radiator and your body. The device is restricted to indoor use only when operating in the 5150 to 5350 MHz frequency range.

Table 1: FC20 Series Products

Module	Wi-Fi	Bluetooth
FC20	2.4 GHz and 5 GHz	Bluetooth 5.0
FC20-N ¹	2.4 GHz	-

1.1. Special Mark

Table 2: 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.

¹ FC20-N module does not support Bluetooth function.

2 Product Overview

FC20 series is a low-power and cost-effective Wi-Fi & Bluetooth module.

FC20:

- Supports IEEE 802.11a/b/g/n/ac and Bluetooth 5.0 (BLE and SPP) standard protocols.
- Provides a low-power SDIO 3.0 interface for Wi-Fi, UART and PCM interfaces for Bluetooth function and also supports LTE & Wi-Fi/Bluetooth coexistence.

FC20-N:

- Supports IEEE 802.11b/g/n (2.4 GHz) standard protocol.
- Provides a low-power SDIO 3.0 interface for Wi-Fi and supports LTE & Wi-Fi coexistence.

FC20 series module is SMD module with 38 LCC pins and 14 LGA pins in total. The module package is compact in only 16.6 mm × 13.0 mm × 2.05 mm.

2.1 Key Features

Table 3: Key Features

Features	Description
Power Supplies	● VDD_3V3 power supply: Supply voltage range: 3.14–3.46 V Typical supply voltage: 3.3 V ● I/O interface power supply: Supply voltage range: 1.71–3.46 V Typical supply voltage: 1.8/3.3 V
Wi-Fi Data Rates	FC20: ● 802.11b: 1 Mbps, 2 Mbps, 5.5 Mbps, 11 Mbps ● 802.11g: 6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps, 24 Mbps, 36 Mbps, 48 Mbps, 54 Mbps ● 802.11a: 6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps, 24 Mbps, 36 Mbps, 48 Mbps, 54 Mbps ● 802.11n: HT20 (MCS 0–MCS 7), HT40 (MCS 0–MCS 7)

	802.11ac: VHT20 (MCS 0–MCS 8), VHT40 (MCS 0–MCS 9), VHT80 (MCS 0–MCS 9) FC20-N: 802.11b: 1 Mbps, 2 Mbps, 5.5 Mbps, 11 Mbps 802.11g: 6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps, 24 Mbps, 36 Mbps, 48 Mbps, 54 Mbps 802.11n: HT20 (MCS 0–MCS 7), HT40 (MCS 0–MCS 7)
Wi-Fi Transmitting Power	FC20: 2.4 GHz 802.11b/11 Mbps: 17.0 dBm $\pm$2.5 dB 802.11g/54 Mbps: 15.0 dBm $\pm$2.5 dB 802.11n/HT20 MCS 7: 14.5 dBm $\pm$2.5 dB 802.11n/HT40 MCS 7: 13 dBm $\pm$2.5 dB 5 GHz 802.11a/54 Mbps: 12.5 dBm $\pm$2.5 dB 802.11n/HT20 MCS 7: 11.5 dBm $\pm$2.5 dB 802.11n/HT40 MCS 7: 10.5 dBm $\pm$2.5 dB 802.11ac/VHT20 MCS 8: 11.5 dB $\pm$2.5 dB 802.11ac/VHT40 MCS 9: 10.5 dBm $\pm$2.5 dB 802.11ac/VHT80 MCS 9: 10.5 dBm $\pm$2.5 dB FC20-N: 2.4 GHz 802.11b/11 Mbps: 17.0 dBm $\pm$2.5 dB 802.11g/54 Mbps: 15.0 dBm $\pm$2.5 dB 802.11n/HT20 MCS 7: 14.5 dBm $\pm$2.5 dB 802.11n/HT40 MCS 7: 13 dBm $\pm$2.5 dB
Wi-Fi Protocol	FC20: - IEEE 802.11a/b/g/n/ac FC20-N: - IEEE 802.11b/g/n (2.4 GHz)
Wi-Fi Modulation Modes	FC20: - DSSS, DBPSK, DQPSK, CCK, BPSK, QPSK, 16QAM, 64QAM, 256QAM FC20-N: - DSSS, DBPSK, DQPSK, CCK, BPSK, QPSK, 16QAM, 64QAM
Wi-Fi Operating Modes	- AP - STA
Wi-Fi Security Types	WPA3
Bluetooth Protocol	FC20: - GATT - SPP - HFP-AG

Bluetooth Modulation	FC20: GFSK, 8-DPSK, $\pi/4$ -DQPSK
Bluetooth Operation Modes	FC20: ● Bluetooth Classic (BR + EDR) ● BLE
Wireless Connectivity Interfaces	FC20: ● Wi-Fi: SDIO 3.0 ● Bluetooth: UART and PCM FC20-N: ● Wi-Fi: SDIO 3.0
32KHZ_IN Interface	32 kHz clock interface for low power consumption of Wi-Fi
Antenna Interface	● Wi-Fi/Bluetooth antenna interface ● 50 Ω characteristic impedance
Physical Characteristics	● Dimensions: (16.6 $\pm$ 0.15) mm $\times$ (13.0 $\pm$ 0.15) mm $\times$ (2.05 $\pm$ 0.2) mm ● Package: LCC + LGA ● Weight: approx. 0.81 g
Temperature Ranges	● Operating temperature range ²: -40 °C to +85 °C ● Storage temperature range: -40 °C to +95 °C
RoHS	All hardware components are fully compliant with EU RoHS directive

2.2 EVB Kit

Quectel supplies an evaluation board (UMTS<E EVB) with accessories to develop and test the module.

² Within the operating temperature range, the module's related performance meets IEEE and Bluetooth specifications.

3 Application Interfaces

3.1. Pin Assignment

The following figure shows the pin assignment of FC20 series module:

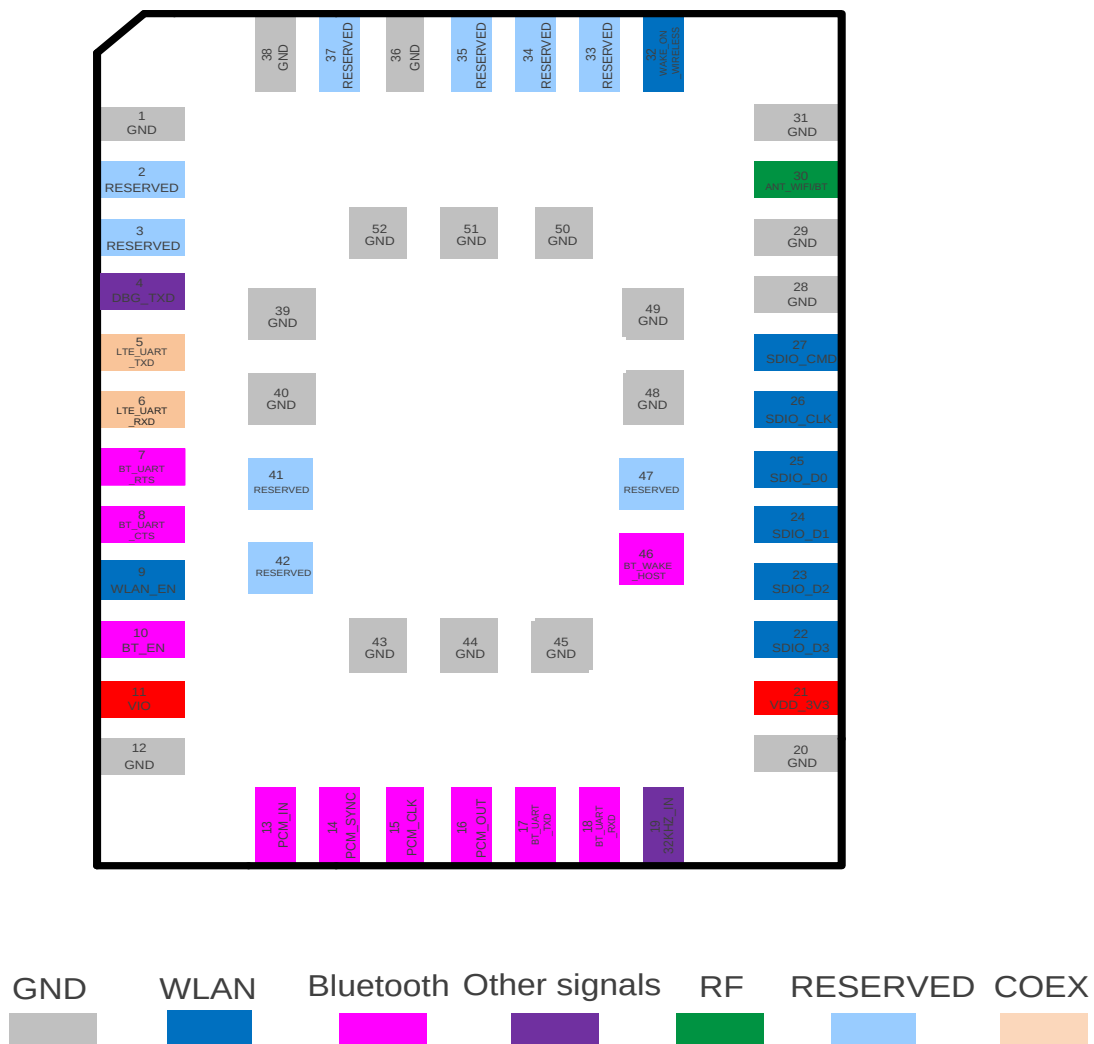


Figure 1: Pin Assignment (Top View)

NOTE

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

3.2. Pin Description

The pin definition of FC20 series module is as below.

Table 4: Parameters Definition

Parameter	Description
AIO	Analog Input/Output
DI	Digital Input
DIO	Digital Input/Output
DO	Digital Output
OD	Open Drain
PI	Power Input

Table 5: Pin Description of FC20 Series Module

Power Supplies				
Pin Name	Pin No.	I/O	Description	Comment
VDD_3V3	21	PI	Main power supply for module	It must be provided with sufficient current up to 0.9 A. 1.8/3.3 V power domain.
VIO	11	PI	Power supply for module's I/O pins	It should be provided with sufficient current up to 10 mA. It is powered by VDD_EXT of matching LTE Standard module (such as EC21 series and EC25 series) by default.
GND	1, 12, 20, 28, 29,31, 36, 38–40, 43–45, 48–52			

Wi-Fi Application Interface

Pin Name	Pin No.	I/O	Description	Comment
WAKE_ON_WIRELESS	32	OD	Wi-Fi wake up the host	VIO power domain. Active high. Require external 10 kΩ pull-up to VIO. If unused, keep it open.
WLAN_EN	9	DI	Wi-Fi function enable control	VIO power domain. Active high.
SDIO_D3	22	DIO	SDIO data bit 3	VIO power domain.
SDIO_D2	23	DIO	SDIO data bit 2	VIO power domain. Require external 10 kΩ pull-up to VIO. SDIO_D2 is the boot strap signal, which should be kept at high level for normal operation during power-up.
SDIO_D1	24	DIO	SDIO data bit 1	VIO power domain.
SDIO_D0	25	DIO	SDIO data bit 0	
SDIO_CLK	26	DI	SDIO clock	VIO power domain. Internally pulled up to VIO by default.
SDIO_CMD	27	DIO	SDIO command	VIO power domain.

Bluetooth Application Interfaces ³

Pin Name	Pin No.	I/O	Description	Comment
BT_EN	10	DI	Bluetooth function enable control	VIO power domain. Active high. If unused, pull it down.
BT_WAKE_HOST	46	OD	Bluetooth wake up the host	VIO power domain. Pull up to VIO internally through a 10 kΩ resistor. If unused, keep it open.
PCM_IN	13	OD	PCM data input	VIO power domain. If unused, keep these pins open.
PCM_SYNC	14	DI	PCM data frame sync	

³ FC20-N has Bluetooth application pins, but they are not used and kept open.

PCM_CLK	15	DI	PCM clock	
PCM_OUT	16	DO	PCM data output	
BT_UART_RTS	7	DO	Request to send signal from the module	
BT_UART_CTS	8	DI	Clear to send signal to the module	
BT_UART_TXD	17	DO	Bluetooth UART transmit	
BT_UART_RXD	18	DI	Bluetooth UART receive	
Coexistence UART ⁴				
Pin Name	Pin No.	I/O	Description	Comment
LTE_UART_TXD	5	DO	LTE & Wi-Fi/Bluetooth coexistence transmit	VIO power domain. If unused, keep these pins open.
LTE_UART_RXD	6	DI	LTE & Wi-Fi/Bluetooth coexistence receive	
RF Antenna Interface				
Pin Name	Pin No.	I/O	Description	Comment
ANT_WIFI/BT	30	AIO	Wi-Fi/Bluetooth antenna interface	50 Ω characteristic impedance.
Other Interfaces				
Pin Name	Pin No.	I/O	Description	Comment
DBG_TXD	4	OD	Used for software debugging	VIO power domain. Require external 10 kΩ resistor pull-up to VIO. If unused, keep it open.
32KHZ_IN	19	DI	Low power. External 32.768 kHz clock input.	VIO power domain. If unused, keep it open. Sleep clock.
RESERVED Pins				
Pin Name	Pin No.			Comment
RESERVED	2, 3, 33–35, 37, 41, 42, 47			Keep these pins open.

⁴ The coexistence UART supports LTE and Wi-Fi coexistence, as well as LTE and Bluetooth coexistence.

3.3. Power Supply

The following table shows the definition of power supply and GND pins of FC20 series module.

Table 6: Power Supply Pins and GND Pins

Pin Name	Pin No.	Description	Min.	Typ.	Max.	Unit
VDD_3V3	21	Main power supply for the module	3.14	3.3	3.46	V
VIO	11	Power supply for the module's I/O pins	1.71	1.8/3.3	3.46	V
GND	1, 12, 20, 28, 29, 31, 36, 38–40, 43–45, 48–52					

The module is powered by VDD_3V3, and it is recommended to use a power supply chip with sufficient current of 0.9 A at least. For better power supply performance, it is recommended to parallel a 22 μ F decoupling capacitor, and 100 nF, 33 pF and 10 pF filter capacitors near the module's VDD_3V3 pin. Meanwhile, it is recommended to add a TVS near the VDD_3V3 pin to improve the surge voltage bearing capacity of the module. In principle, the longer the VDD_3V3 trace, the wider it should be.

The reference circuit of VDD_3V3 input terminal is as shown in the figure below:

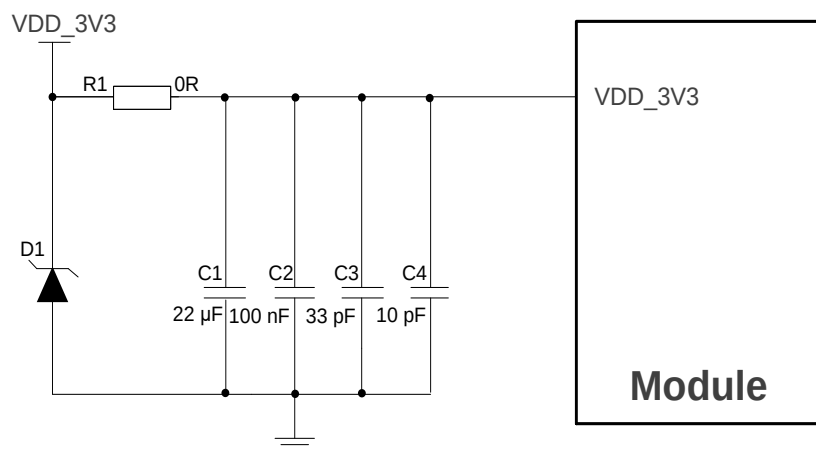


Figure 2: Reference Circuit for VDD_3V3

The following figure shows the recommended power up/down sequences for FC20 series module.

Case 1: VIO voltage domain is 1.8 V.

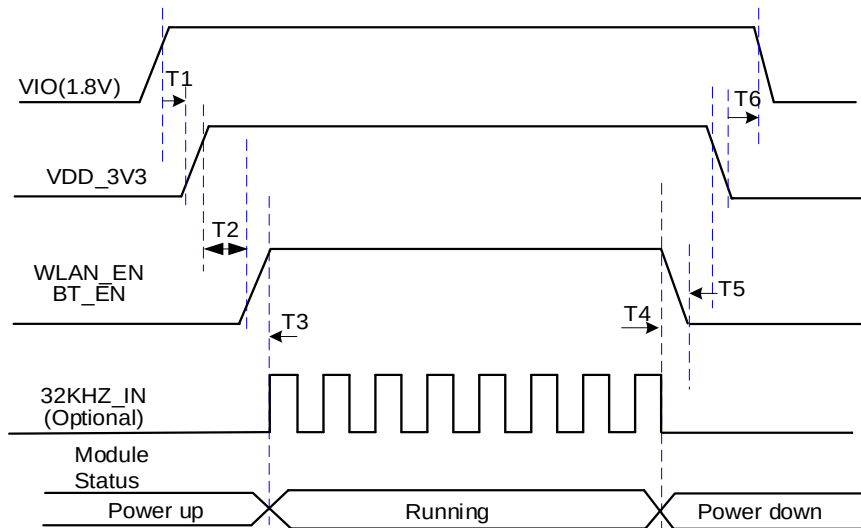


Figure 3: Power Up and Down Timing (Case 1)

Table 7: Power Sequence Timing (Case 1; Unit: μ s)

Symbol	Parameter	Min.	Max.
T1	Time from VIO rising to 90 % to VDD_3V3 rising to 10 %.	0	-
T2	Time from VDD_3V3 rising to 90 % to WLAN_EN and BT_EN both rising to 0.7 V.	10	-
T3	Time from WLAN_EN being pulled up to high level to 32KHZ_IN starting to input.	0	-
T4	Time from when WLAN_EN starts to be pulled down to a low level to when 32KHZ_IN is pulled down to a low level or is in a high impedance state.	0	-
T5	Time from WLAN_EN and BT_EN being pulled down to low level to VDD_3V3 dropping to 90 %.	10	-
T6	Time from VDD_3V3 dropping to 10 % to VIO dropping to 90 %.	0	-

Case 2: Both VIO and VDD_3V3 voltage domains are 3.3 V.

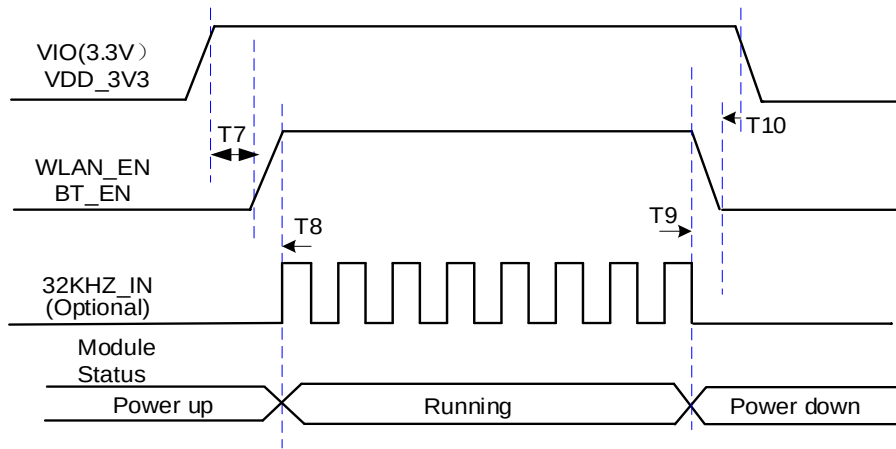


Figure 4: Power Up and Down Timing (Case 2)

Table 8: Power Sequence Timing (Case 2; Unit: μ s)

Symbol	Parameter	Min.	Max.
T7	Time from both VIO and VDD_3V3 rising to 90 % to WLAN_EN and BT_EN both rising to 0.7 V.	10	-
T8	Time from WLAN_EN being pulled up to high level to 32KHZ_IN starting to input.	0	-
T9	Time from when WLAN_EN starts to be pulled down to a low level to when 32KHZ_IN is pulled down to a low level or is in a high impedance state.	0	-
T10	Time from WLAN_EN and BT_EN being pulled down to low level to both VIO and VDD_3V3 dropping to 90 %.	10	-

NOTE

1. The module's WLAN_EN and BT_EN are both 1.8 V. If the VIO voltage on the host side is also 1.8 V, it can be directly connected to the host interface without level-shifting.
2. Before pulling WLAN_EN/BT_EN up and after pulling WLAN_EN/BT_EN down, all host interface signals (including signals SDIO/UART/PCM connected to the host, etc.) must remain floating or low level.

3.4. WLAN & Bluetooth Application Interfaces

FC20 series module supports a low-power SDIO 3.0 interface for Wi-Fi, and UART and PCM interfaces for Bluetooth function.

3.4.1. Wi-Fi Application Interfaces

The following figure shows the Wi-Fi application interface connection between FC20 series module and host.

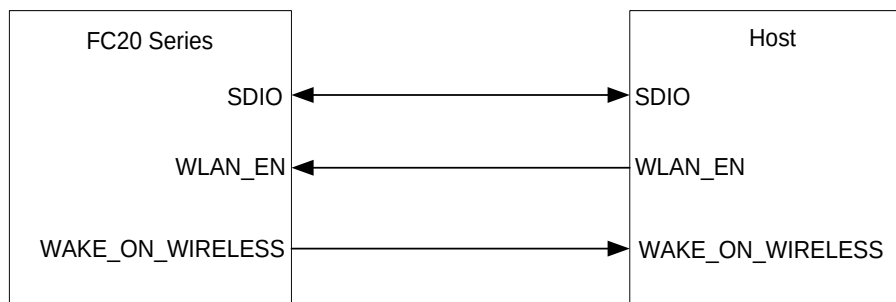


Figure 5: Wi-Fi Application Interface Connection

3.4.1.1. WAKE_ON_WIRELESS

WAKE_ON_WIRELESS is used to wake up the host. When the pin is pulled up, the host can be woken up.

Table 9: Pin Definition of WAKE_ON_WIRELESS

Pin Name	Pin No.	I/O	Description	Comment
WAKE_ON_WIRELESS	32	OD	Wi-Fi wake up the host	VIO power domain. Active high. Require external 10 kΩ pull-up to VIO. If unused, keep it open.

3.4.1.2. WLAN_EN

WLAN_EN is used to control the Wi-Fi function of FC20 series module. When WLAN_EN is at high level, Wi-Fi function will be enabled.

Table 10: Pin Definition of WLAN_EN

Pin Name	Pin No.	I/O	Description	Comment
WLAN_EN	9	DI	Wi-Fi function enable control	VIO power domain. Active high.

NOTE

The input of WLAN_EN is a sensitive signal, so pay attention to shielding and protecting it with ground when routing it, and route it as close as possible to the FC20 series module.

3.4.1.3. SDIO Interface

The SDIO interface pin definition is as below.

Table 11: Pin Definition of SDIO Interface

Pin Name	Pin No.	I/O	Description	Comment
SDIO_D3	22	DIO	SDIO data bit 3	VIO power domain.
SDIO_D2	23	DIO	SDIO data bit 2	VIO power domain. Require external 10 kΩ pull-up to VIO. SDIO_D2 is the boot strap signal, which should be kept at high level for normal operation during power-up.
SDIO_D1	24	DIO	SDIO data bit 1	VIO power domain.
SDIO_D0	25	DIO	SDIO data bit 0	
SDIO_CLK	26	DI	SDIO clock	VIO power domain. Internally pulled up to VIO by default.
SDIO_CMD	27	DIO	SDIO command	VIO power domain.

The following figure shows the SDIO interface connection between FC20 series module and host.

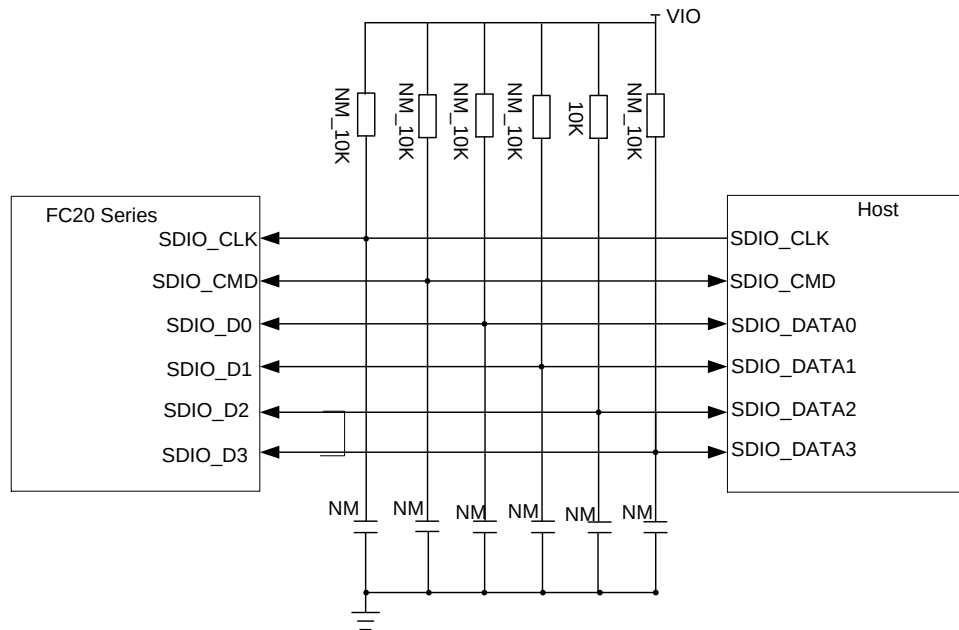


Figure 6: SDIO Interface Connection

To ensure that the interface design complies with the SDIO 3.0 specification, please comply with the following principles:

- Route SDIO signals with ground shielded, and control the impedance at $50\ \Omega \pm 10\%$. 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, analog signals, as well as noisy signals such as clock signals, DC-DC signals.
- SDIO_D2 requires an external 10 k Ω resistor to be pulled up to VIO, and can maintain at a high level when the module is powered on reset.
- The distance between SDIO signals and other signals must be greater than twice the line width, and the bus load capacitance must be less than 15 pF.
- SDIO_CLK and SDIO_D[0:3]/SDIO_CMD need to be equal in length (the difference is less than 1 mm).
- Route SDIO traces in parallel on the same layer whenever possible, ensuring that there are enough ground vias around the SDIO traces and connecting them to a ground plane.
- The internal SDIO trace length of the module is 11.24 mm, the trace length has the following requirements according to the transmission mode:
 - a) In SDR104 mode, the recommended trace routing length should be less than 50 mm in total;
 - b) In other modes, such as DDR50, SDR50, the recommended trace routing length should be less than 150 mm in total.

3.4.2. Bluetooth Application Interfaces ⁵

The following figure shows the block diagram of Bluetooth application interfaces connection between FC20 and host.

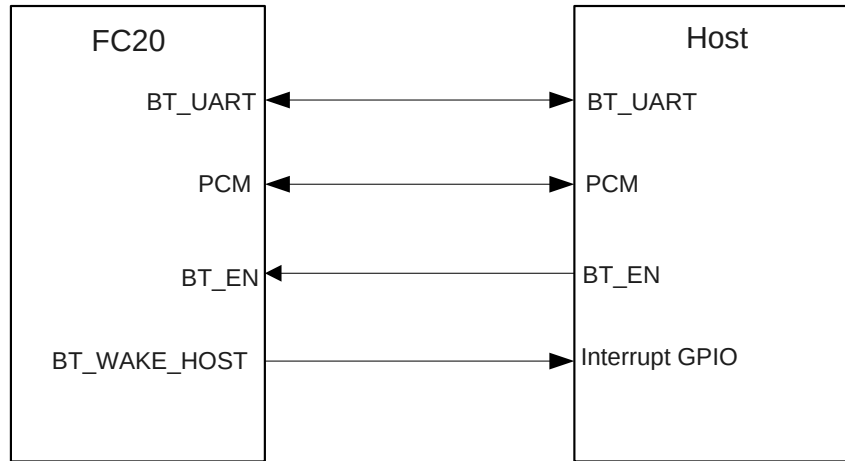


Figure 7: Bluetooth Application Interfaces Connection

3.4.2.1. BT_EN

BT_EN is used to control the Bluetooth function of FC20. When BT_EN is at a high-level, Bluetooth function will be enabled.

Table 12: Pin Definition of BT_EN

Pin Name	Pin No.	I/O	Description	Comment
BT_EN	10	DI	Bluetooth function enable control	VIO power domain. Active high. If unused, pull it down.

3.4.2.2. BT_WAKE_HOST

BT_WAKE_HOST is used to wake up the host. Active Low. When the pin is pulled down, the host can be woken up.

⁵ FC20-N module has pins for Bluetooth application which are not used and should be kept open.

Table 13: Pin Definition of BT_WAKE_HOST

Pin Name	Pin No.	I/O	Description	Comment
BT_WAKE_HOST	46	OD	Bluetooth wake up the host	VIO power domain. Pull up to VIO internally through a 10 kΩ resistor. If unused, keep it open.

3.4.2.3. PCM Interface

FC20 provides a PCM interface specialized for Bluetooth audio application. The following table shows the pin definition of PCM interface. The PCM interface is not applicable in BLE function.

Table 14: Pin Definition of PCM Interface

Pin Name	Pin No.	I/O	Description	Comment
PCM_IN	13	OD	PCM data input	VIO power domain. If unused, keep these pins open.
PCM_SYNC	14	DI	PCM data frame sync	
PCM_CLK	15	DI	PCM clock	
PCM_OUT	16	DO	PCM data output	

The following figure shows a reference design for PCM interface connection between FC20 and host.

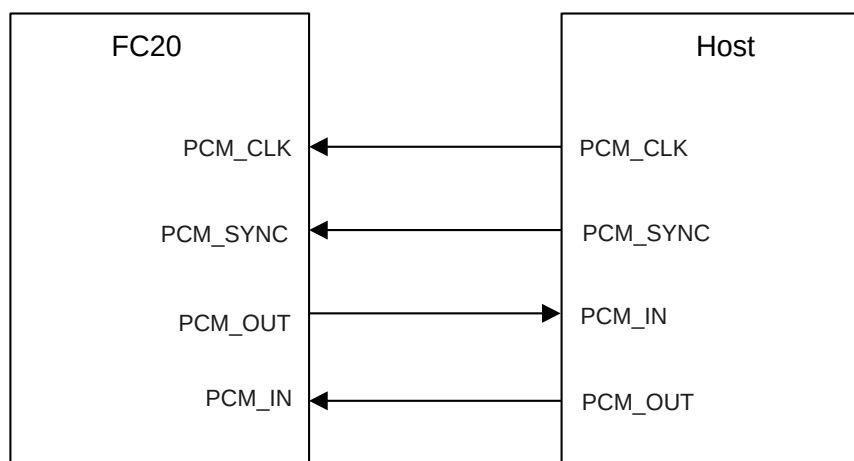


Figure 8: PCM Interface Connection

3.4.2.4. Bluetooth UART

The pin definition of Bluetooth UART is as below.

Table 15: Pin Definition of Bluetooth UART

Pin Name	Pin No.	I/O	Description	Comment
BT_UART_RTS	7	DO	Request to send signal from the module	VIO power domain. If unused, keep these pins open.
BT_UART_CTS	8	DI	Clear to send signal to the module	
BT_UART_TXD	17	DO	Bluetooth UART transmit	
BT_UART_RXD	18	DI	Bluetooth UART receive	

The following figure shows a reference design for UART connection between FC20 and host.

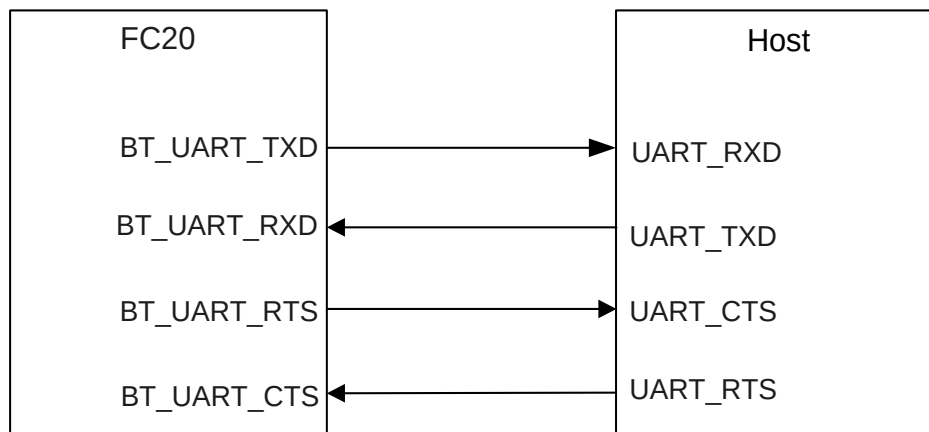


Figure 9: UART Interface Connection

NOTE

1. To increase the stability of UART communication, it is necessary to add UART hardware flow control design.
2. When combining with Quectel LTE Standard module (such as EC21 series and EC25 series), pay attention to the direction of CTS and RTS.

3.4.3. Coexistence UART ⁶

The pin definition of the coexistence UART is as below.

Table 16: Pin Definition of Coexistence UART

Pin Name	Pin No.	I/O	Description	Comment
LTE_UART_TXD	5	DO	LTE & Wi-Fi/Bluetooth coexistence transmit	VIO power domain. If unused, keep these pins open.
LTE_UART_RXD	6	DI	LTE & Wi-Fi/Bluetooth coexistence receive	

The following figure shows the coexistence UART connection between FC20 series module and host.

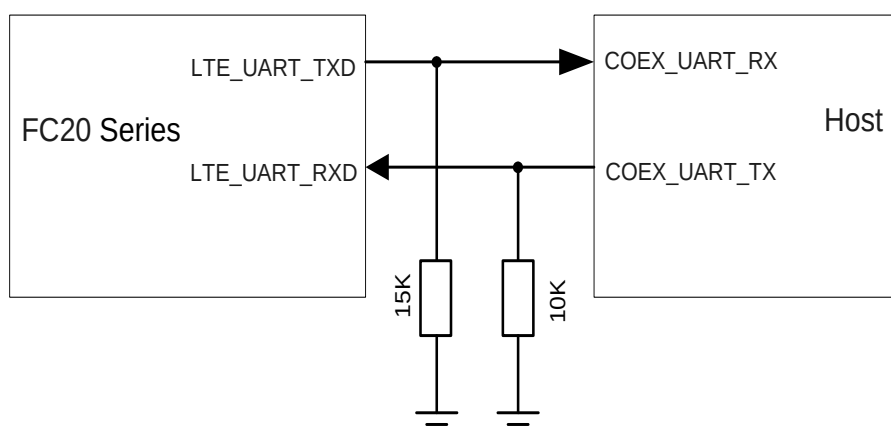


Figure 10: Coexistence UART Connection

NOTE

In combination with Quectel LTE Standard module (such as EC21 series and EC25 series), the pull-down resistor should be reserved.

⁶ The coexistence UART supports LTE and Wi-Fi coexistence, as well as LTE and Bluetooth coexistence.

3.5. 32KHZ_IN

The 32 kHz clock can be used in low power mode, such as IEEE power saving mode and sleep mode, in which basic logic operations can be maintained. In low power mode, it supports FC20 series to receive wake-up interrupt.

The pin definition of the 32KHZ_IN is as below.

Table 17: Pin Definition of 32KHZ_IN

Pin Name	Pin No.	I/O	Description	Comment
32KHZ_IN	19	DI	Low power. External 32.768 kHz clock input.	VIO power domain. If unused, keep it open. Sleep clock.

3.6. 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.

ANT_WIFI/BT is the RF antenna pin. And the RF port has an impedance of 50 Ω .

3.6.1. Pin Definition

The pin definition of the antenna interface is as below.

Table 18: Pin Definition of RF Antenna Interface

Pin Name	Pin No.	I/O	Description	Comment
ANT_WIFI/BT	30	AIO	Wi-Fi/Bluetooth antenna interface	50 Ω characteristic impedance.

3.6.2. Operating Frequency

The operating frequency of FC20 series module is as bellow.

Table 19: Operating Frequency of FC20 (Unit: GHz)

Feature	Frequency
2.4 GHz Wi-Fi	2.412–2.462
5 GHz Wi-Fi	5.180–5.825
Bluetooth	2.402–2.480

Table 20: Operating Frequency of FC20-N (Unit: GHz)

Feature	Frequency
2.4 GHz Wi-Fi	2.412–2.472

3.6.3. Reference Designs

FC20 series module provides an RF antenna pin for Wi-Fi & Bluetooth antenna connection.

A reference circuit for the RF antenna interface is shown below. It is recommended to reserve a dual L-type matching circuit and add an ESD protection component for better RF performance. Matching components such as R1, C1, C2, C3 and D1 should be placed as close to the antenna as possible. The C1 and C2 capacitors are not mounted by default, and only a 0 Ω resistor is mounted at R1. The parasitic capacitance of ESD protection component should be less than 0.05 pF.

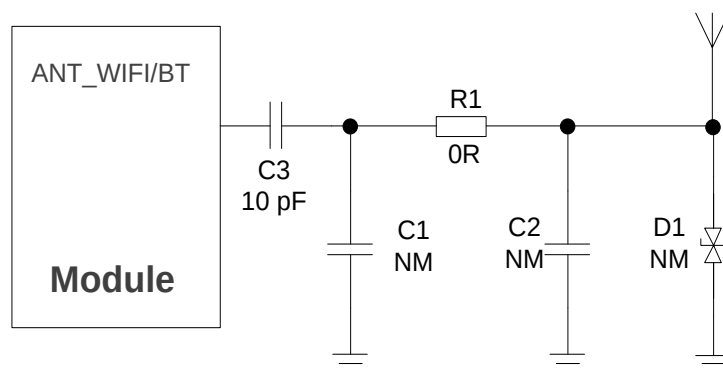


Figure 11: Reference Circuit for RF Antenna Interface

NOTE

If there is DC power at the antenna ports, C3 must be used for DC-blocking to prevent short circuit to ground. The capacitance value is recommended to be 10 pF, which can be adjusted according to actual requirements. If there is no DC power in the peripheral design, C3 should not be reserved.

Another type of reference circuit for the RF antenna interface is shown below. It is designed for vehicle applications. It is recommended to reserve two notch filter circuits and a dual L-type matching circuit for better RF performance. C2/L1 and L3/C3 comprise two notch filter circuits for filtering out interference caused by a particular frequency. When L3/C2/L1/C3 is not mounted, C1/R2/C4/C5 comprise a dual L-type matching circuit. Capacitors C1/C2/C3/C4 and inductors L1/L3 are not mounted by default, and R2 is 0 Ω by default.

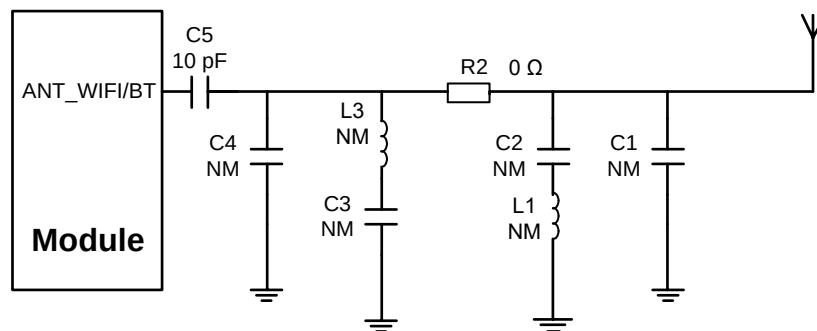


Figure 12: Reference Circuit for RF Antenna Interface (Vehicle Applications)

NOTE

If there is DC power at the antenna ports, C5 must be used for DC-blocking to prevent short circuit to ground. The capacitance value is recommended to be 10 pF, which can be adjusted according to actual requirements. If there is no DC power in the peripheral design, C5 should not be reserved.

3.6.4. 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.

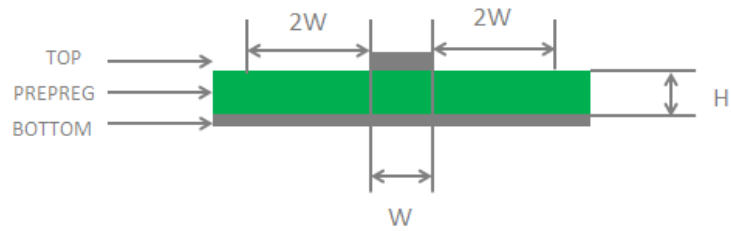


Figure 13: Microstrip Design on a 2-layer PCB

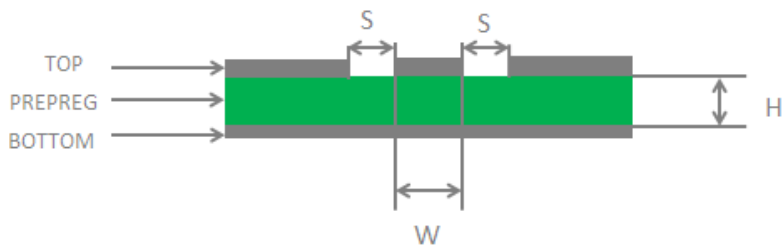


Figure 14: Coplanar Waveguide Design on a 2-layer PCB

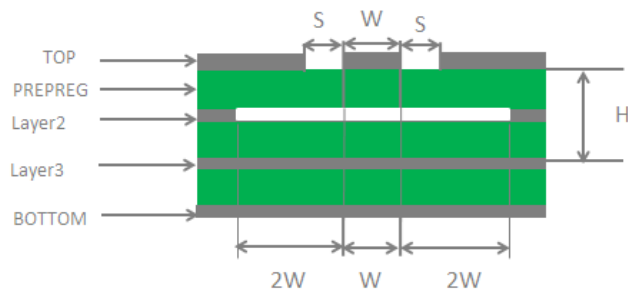


Figure 15: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

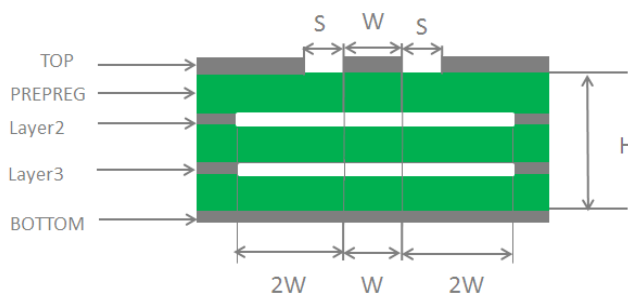


Figure 16: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

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

- Use an impedance simulation tool to accurately 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 RF 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 ($2 \times W$).
- Keep RF traces away from interference sources (such as DC-DC, (U)SIM/USB/SDIO high frequency digital signals, display signals, and clock signals), and avoid intersection and paralleling between traces on adjacent layers.

For more details about RF layout, see **document [2]**.

3.6.5. Requirements for Antenna Design

Table 21: Requirements for Antenna Design

Parameters	Requirements
Frequency Ranges (GHz)	● 2.412–2.462 ● 5.180–5.825
Cable Insertion Loss (dB)	< 1
VSWR	≤ 2 (recommended)
Gain (dBi)	1 (Typ.)
Max. Input Power (W)	50
Input Impedance (Ω)	50
Polarization Type	Vertical

Note: The antenna connector will be fixed in the actual use of the finished product and cannot be replaced.

3.6.6. 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.

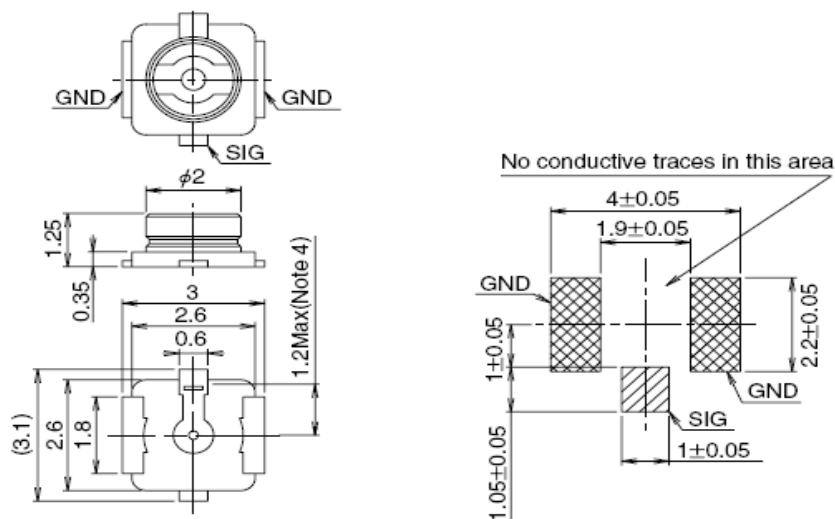


Figure 17: Dimensions of the Receptacle (Unit: mm)

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

Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
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 18: Specifications of Mated Plugs

The following figure describes the space factor of the mated connectors.

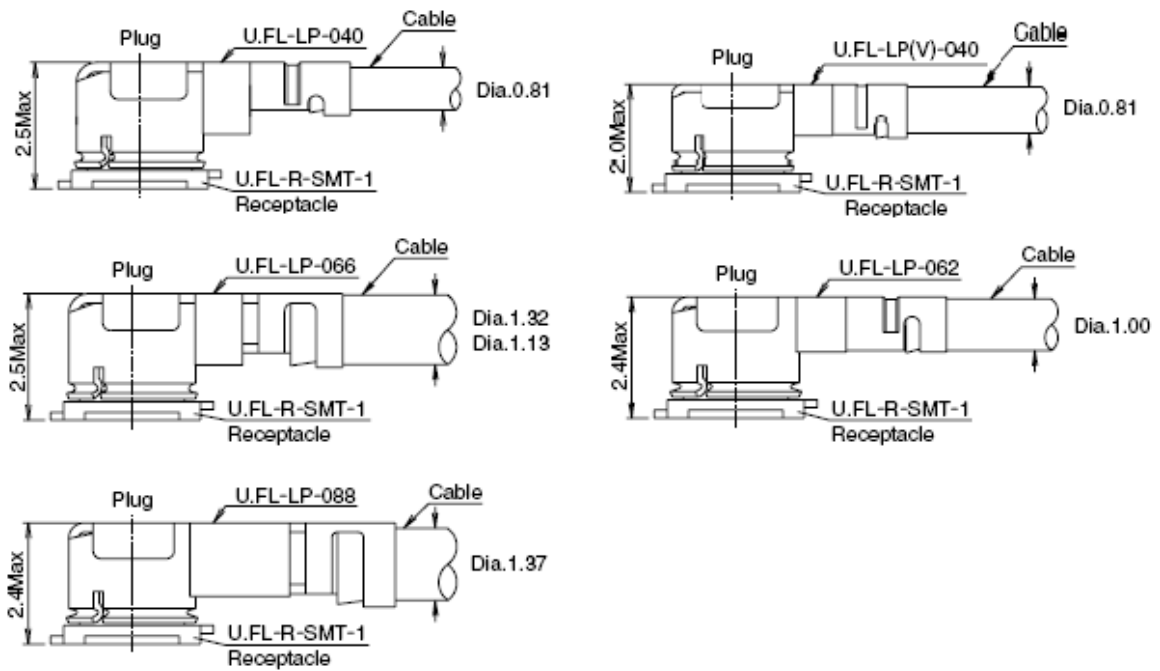


Figure 19: Space Factor of Mated Connectors (Unit: mm)

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

4 Electrical Characteristics & Reliability

4.1. Absolute Maximum Ratings

Table 22: Absolute Maximum Ratings (Unit: V)

Parameter	Min.	Max.
VDD_3V3	-0.3	3.46
VIO	-0.3	3.46
Voltage at digital pins	-0.3	VIO + 0.2

Table 23: Recommended Operating Conditions (Unit: V)

Parameter	Min.	Typ.	Max.
VDD_3V3	3.14	3.3	3.46
VIO	1.71	1.8/3.3	3.46

4.2. Digital I/O Characteristics

Table 24: Digital I/O Characteristics

Symbol	Parameter	Min.	Max.	Unit
V _{IH}	High-level input voltage	0.7 × VIO	VIO + 0.2	V
V _{IL}	Low-level input voltage	-0.3	0.3 × VIO	V

V_{OH}	High-level output voltage	$0.9 \times V_{IO}$	-	V
V_{OL}	Low-level output voltage	-	$0.1 \times V_{IO}$	V
I_{IL}	Input leakage current	-5	5	μA

4.3. Power Consumption

Table 25: Wi-Fi Power Consumption

Description	Conditions	I_{VDD_3V3}	I_{VIO}	Unit
OFF State ⁷	AT+QWIFI=0	2	554	μA
Idle ⁸	AT+QWIFI=1	66	6.5	mA
802.11b	Tx 1 Mbps @ 17.5 dBm	370	6.5	
	Tx 11 Mbps @ 17.2 dBm	357	6.5	
	Rx 1 Mbps	48	6.5	
	Rx 11 Mbps	49	6.5	
802.11g	Tx 6 Mbps @ 16 dBm	328	6.5	
	Tx 54 Mbps @ 14.8 dBm	245	6.5	
	Rx 6 Mbps	49	6.5	
	Rx 54 Mbps	50	6.5	
802.11n (2.4 GHz)	Tx HT20 MCS 0 @ 15.8 dBm	322	6.5	
	Tx HT20 MCS 7 @ 13.5 dBm	234	6.5	
	Tx HT40 MCS 0 @ 14.5 dBm	291	6.5	
	Tx HT40 MCS 7 @ 12.5 dBm	194	6.5	
	Rx HT20 MCS 0	49	6.5	

⁷ OFF State: Disable Wi-Fi function through **AT+QWIFI=0** or other methods.

⁸ Idle: Turn on the Wi-Fi function through **AT+QWIFI=1** or other methods, and no device is connected to the Wi-Fi hotspot.

802.11n (5 GHz)	Rx HT20 MCS 7	50	6.5
	Rx HT40 MCS 0	54	6.5
	Rx HT40 MCS 7	52	6.5
	Tx HT20 MCS 0 @ 13.3 dBm	395	6.5
	Tx HT20 MCS 7 @ 10.6 dBm	307	6.5
	Tx HT40 MCS 0 @ 12.9dBm	342	6.5
	Tx HT40 MCS 7 @ 9.4 dBm	235	6.5
	Rx HT20 MCS 0	78	6.5
	Rx HT20 MCS 7	78	6.5
	Rx HT40 MCS 0	77	6.5
	Rx HT40 MCS 7	77	6.5
	Tx VHT20 MCS 0 @ 13.2 dBm	378	6.5
	TX VHT20 MCS 8 @ 12.5 dBm	289	6.5
	Tx VHT40 MCS 0 @ 13.5 dBm	372	6.5
802.11ac	Tx VHT40 MCS 9 @ 10.5 dBm	244	6.5
	Tx VHT80 MCS 0 @ 13 dBm	355	6.5
	Tx VHT80 MCS 9 @ 10 dBm	220	6.5
	Rx VHT20 MCS 0	78	6.5
	Rx VHT20 MCS 8	78	6.5
	Rx VHT40 MCS 0	85	6.5
	Rx VHT40 MCS 9	84	6.5
	Rx VHT80 MCS 0	92	6.5
	Rx VHT80 MCS 9	91	6.5

NOTE

Only FC20 module supports Wi-Fi at 5 GHz.

Table 26: Bluetooth Power Consumption in Non-signaling Mode (Unit: mA)

Condition	I _{VDD_3V3}	I _{VDD_IO}
BR @ 8 dBm	52.46	4.60
EDR (π/4-DQPSK) @ 5 dBm	46.54	4.60
EDR (8-DPSK) @ 5 dBm	46.54	4.60
BLE (1 Mbps) @ -3 dBm	19.61	4.60

NOTE

Only FC20 module supports Bluetooth Power Consumption in Non-signaling Mode , FC20-N does not support Bluetooth function.

4.4. RF Performance

4.4.1. Wi-Fi Performance

The following four tables summarize the transmission and reception characteristics of the FC20 series at 2.4 GHz and 5 GHz.

Table 27: Conducted RF Output Power at 2.4 GHz

Standard	Data Rate	Typ.
802.11b	1 Mbps	17.5 dBm ±2.5 dB
802.11b	11 Mbps	17.0 dBm ±2.5 dB
802.11g	6 Mbps	16.5 dBm ±2.5 dB
802.11g	54 Mbps	15.0 dBm ±2.5 dB

802.11n (HT20)	MCS 0	15.5 dBm $\pm$ 2.5 dB
802.11n (HT20)	MCS 7	14.5 dBm $\pm$ 2.5 dB
802.11n (HT40)	MCS 0	15.0 dBm $\pm$ 2.5 dB
802.11n (HT40)	MCS 7	13.0 dBm $\pm$ 2.5 dB

Table 28: Conducted RF Output Power at 5 GHz

Standard	Data Rate	Typ.
802.11a	6 Mbps	14.5 dBm $\pm$ 2.5 dB
802.11a	54 Mbps	12.5 dBm $\pm$ 2.5 dB
802.11n (HT20)	MCS 0	13.5 dBm $\pm$ 2.5 dB
802.11n (HT20)	MCS 7	11.5 dBm $\pm$ 2.5 dB
802.11n (HT40)	MCS 0	12.0 dBm $\pm$ 2.5 dB
802.11n (HT40)	MCS 7	10.5 dBm $\pm$ 2.5 dB
802.11ac (VHT20)	MCS 0	13.5 dBm $\pm$ 2.5 dB
802.11ac (VHT20)	MCS 8	11.5 dBm $\pm$ 2.5 dB
802.11ac (VHT40)	MCS 0	12.0 dBm $\pm$ 2.5 dB
802.11ac (VHT40)	MCS 9	10.5 dBm $\pm$ 2.5 dB
802.11ac (VHT80)	MCS 0	11.5 dBm $\pm$ 2.5 dB
802.11ac (VHT80)	MCS 9	10.5 dBm $\pm$ 2.5 dB

Table 29: Conducted RF Receiving Sensitivity at 2.4 GHz (Unit: dBm)

Standard	Data Rate	Typ.
802.11b	1 Mbps	-92
802.11b	11 Mbps	-85
802.11g	6 Mbps	-88

802.11g	54 Mbps	-72
802.11n (HT20)	MCS 0	-88.5
802.11n (HT20)	MCS 7	-70
802.11n (HT40)	MCS 0	-85
802.11n (HT40)	MCS 7	-67

Table 30: Conducted RF Receiving Sensitivity at 5 GHz (Unit: dBm)

Standard	Data Rate	Typ.
802.11a	6 Mbps	-91
802.11a	54 Mbps	-75
802.11n (HT20)	MCS 0	-90
802.11n (HT20)	MCS 7	-71
802.11n (HT40)	MCS 0	-88
802.11n (HT40)	MCS 7	-69
802.11ac (VHT20)	MCS 0	-91
802.11ac (VHT20)	MCS 8	-67
802.11ac (VHT40)	MCS 0	-88
802.11ac (VHT40)	MCS 9	-62
802.11ac (VHT80)	MCS 0	-85
802.11ac (VHT80)	MCS 9	-59

NOTE

Only FC20 module supports conducted RF output power and receiving sensitivity at 5 GHz.

4.4.2. Bluetooth Performance

The following table shows the Bluetooth transmitting and receiving performance of FC20 module.

Table 31: Bluetooth Transmitting and Receiving Performance (tolerance: ± 2.5 dB)

Mode	Transmitting Power	Receiver Sensitivity
BR	8 dBm	-92 dBm
EDR	5 dBm	-86 dBm
BLE	-3 dBm	-94 dBm

4.5. 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.

Table 32: Electrostatic Discharge Characteristics (Temperature: 25–30 °C, Humidity: 40 $\pm$ 5 %)

Tested Interfaces	Contact Discharge	Air Discharge
VDD_3V3	± 3 kV	± 12 kV
VIO	± 3 kV	± 8 kV
GND	± 3 kV	± 12 kV
Antenna Interfaces	± 4 kV	± 12 kV

4.6. Operating and Storage Temperatures

Table 33: Operating and Storage Temperatures (Unit: °C)

Parameters	Min.	Typ.	Max.
Normal Operating Temperature ⁹	-40	+25	+85
Storage Temperature	-45	-	+95

⁹ Within the operating temperature range, the module's related performance meets IEEE and Bluetooth specifications.

5 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.

5.1. Mechanical Dimensions

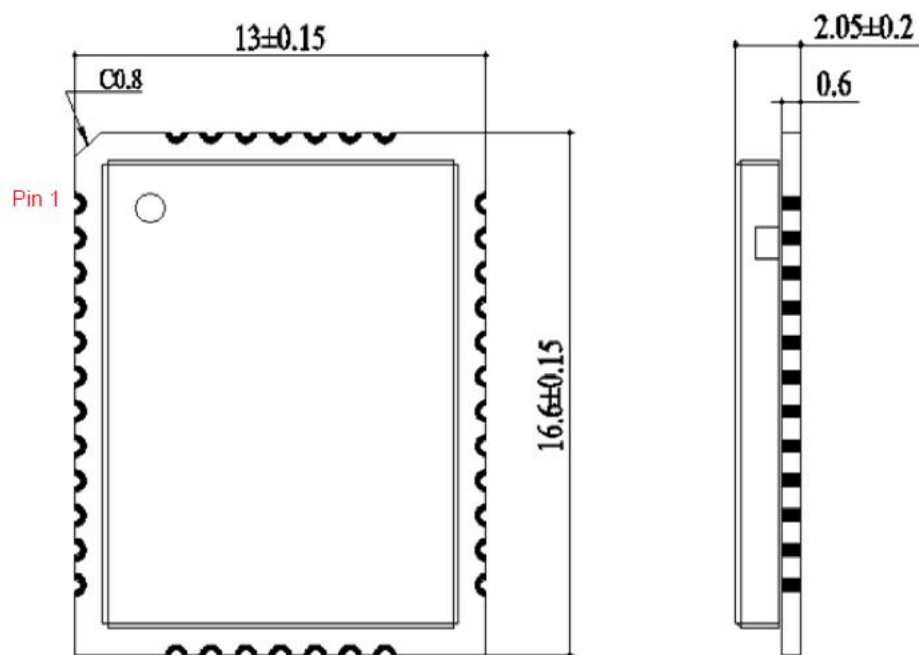


Figure 20: Top and Side Dimensions

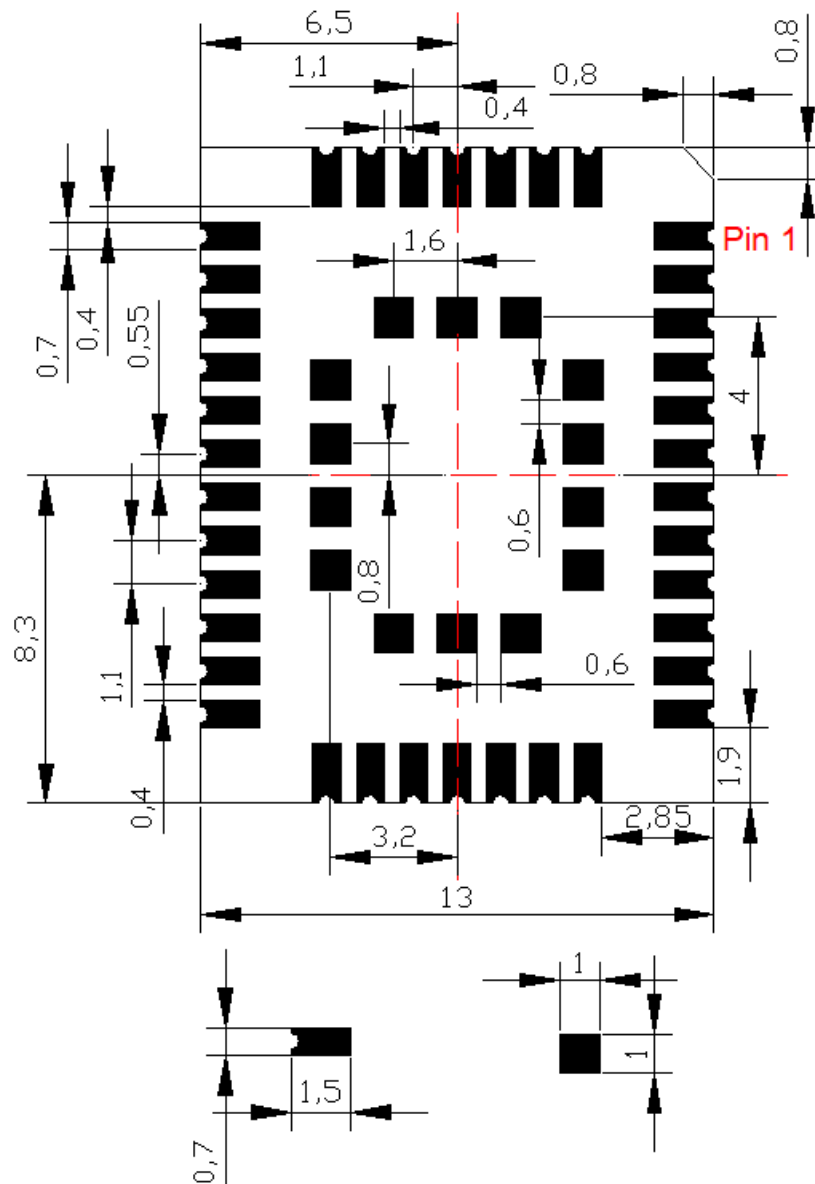


Figure 21: Bottom Dimensions (Bottom View)

NOTE

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

5.2. Recommended Footprint

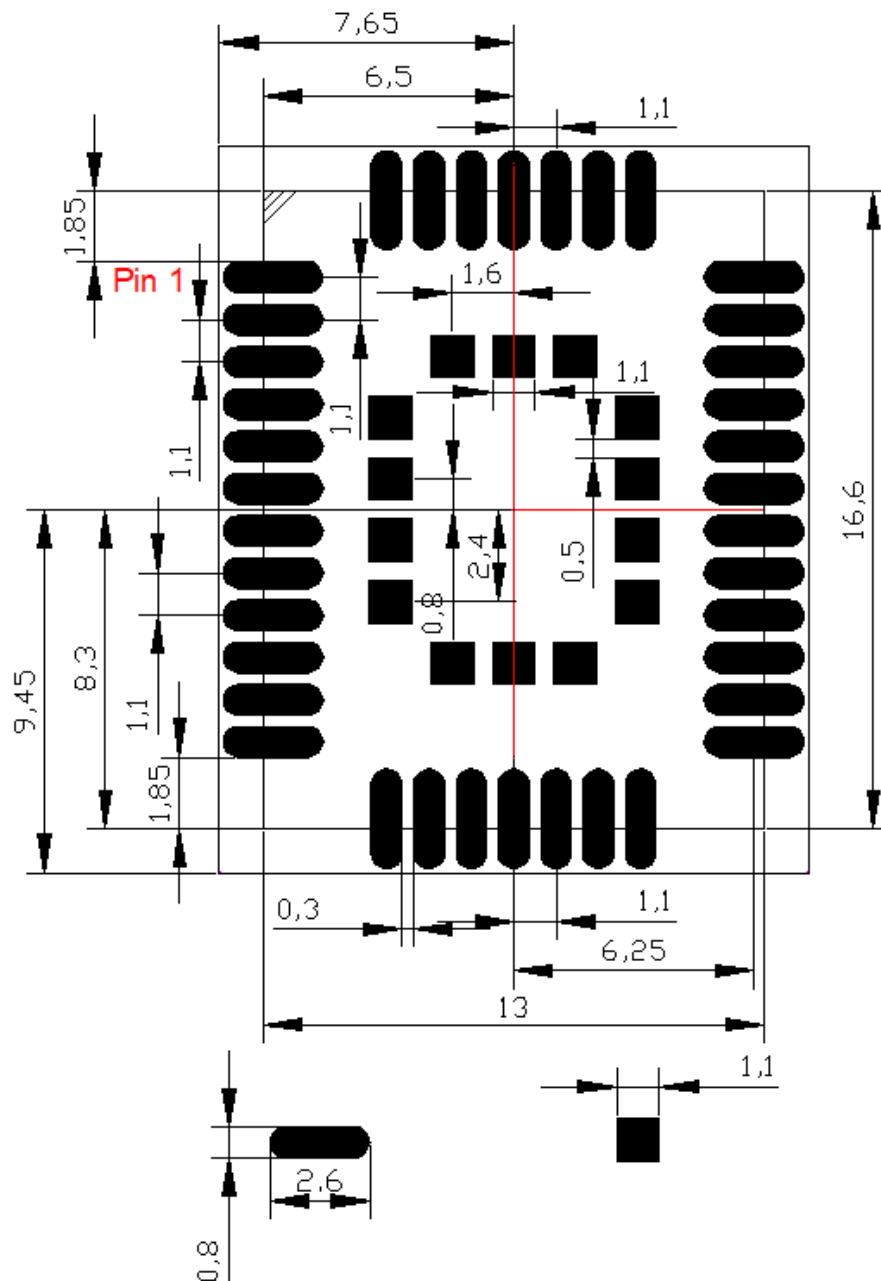


Figure 22: Recommended Footprint

NOTE

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

5.4. Top and Bottom Views

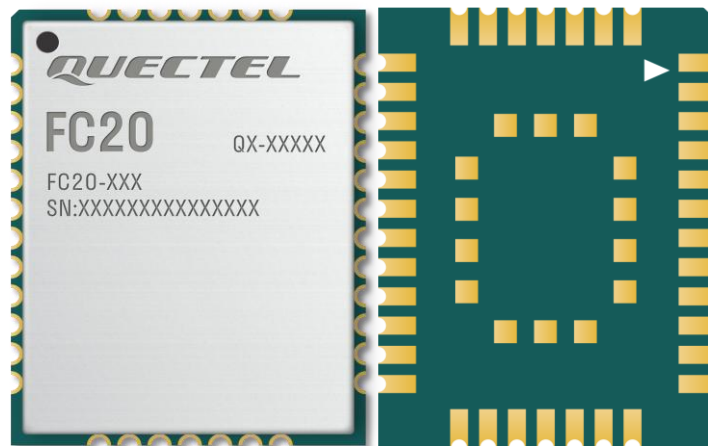


Figure 24: Top & Bottom Views of the Module

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.

6 Storage, Manufacturing & Packaging

6.1. 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 ¹⁰ 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.

¹⁰ 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*. And 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.

6.2. 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 [3]**.

The recommended peak reflow temperature should be 235–246 °C, with 246 °C 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.

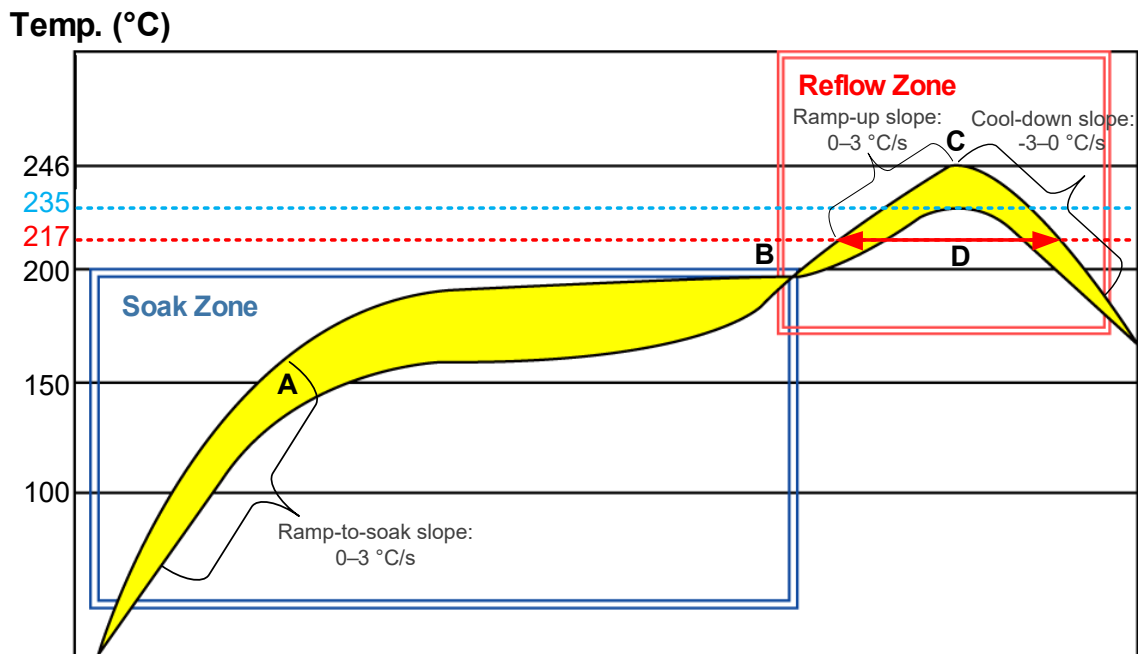


Figure 25: Recommended Reflow Soldering Thermal Profile

Table 34: Recommended Thermal Profile Parameters

Factor	Recommended 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. Avoid using materials that contain mercury (Hg), such as adhesives, for module processing, even if the materials are RoHS compliant and their mercury content is below 1000 ppm (0.1 %).
7. Corrosive gases may corrode the electronic components inside the module, affecting their reliability and performance, and potentially leading to a shortened service life that fails to meet the designed lifespan. Therefore, do not store or use unprotected modules in environments containing corrosive gases such as hydrogen sulfide, sulfur dioxide, chlorine, and ammonia.
8. 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 [4]**.

6.3. Packaging Specification

This chapter outlines the key packaging parameters and processes. All figures below are for reference purposes only, as the actual appearance and structure of packaging materials may vary in delivery.

The modules are packed in a tape and reel packaging as specified in the sub-chapters below.

6.3.1. Carrier Tape

Carrier tape dimensions are illustrated in the following figure and table:

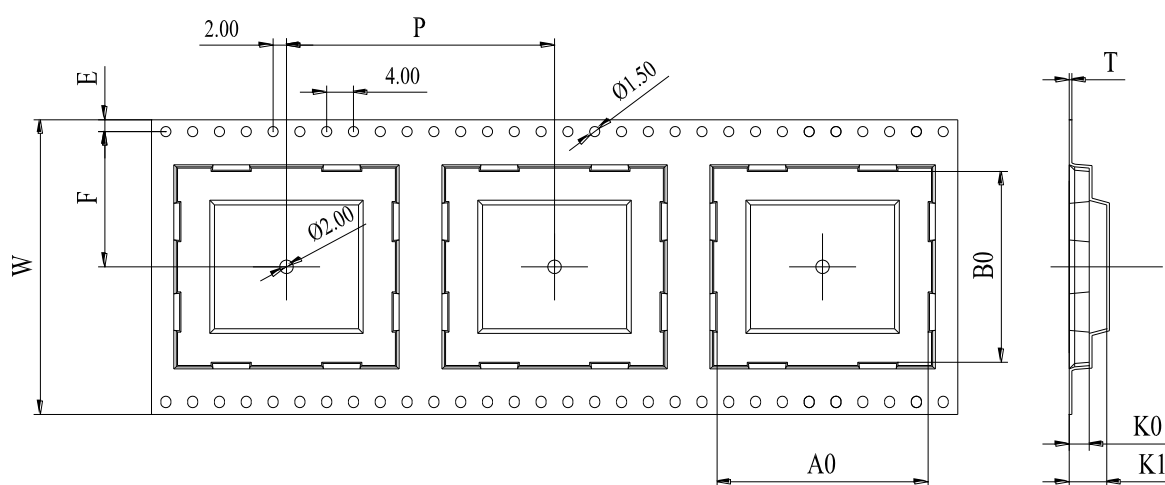


Figure 26: Carrier Tape Dimension Drawing (Unit: mm)

Table 35: Carrier Tape Dimension Table (Unit: mm)

W	P	T	A0	B0	K0	K1	F	E
32	20	0.4	13.4	17	2.6	3.8	14.2	1.75

6.3.2. Plastic Reel

Plastic reel dimensions are illustrated in the following figure and table:

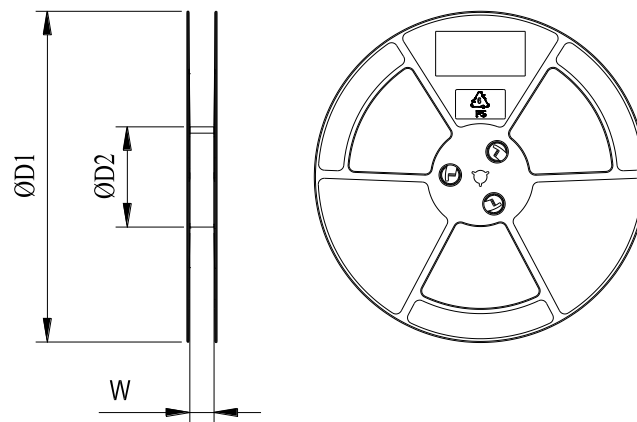


Figure 27: Plastic Reel Dimension Drawing

Table 36: Plastic Reel Dimension Table (Unit: mm)

ØD1	ØD2	W
380	100	32.5

6.3.3. Mounting Direction

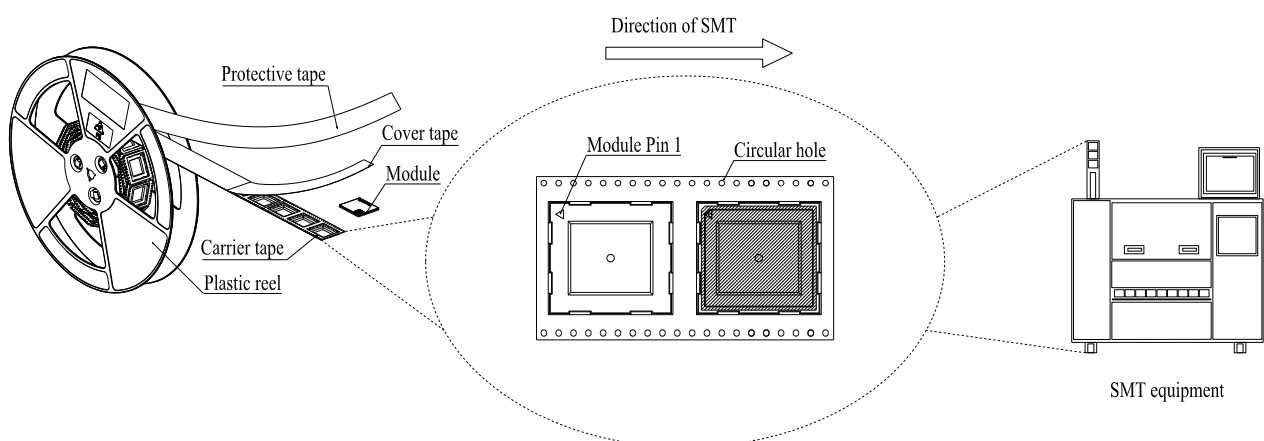
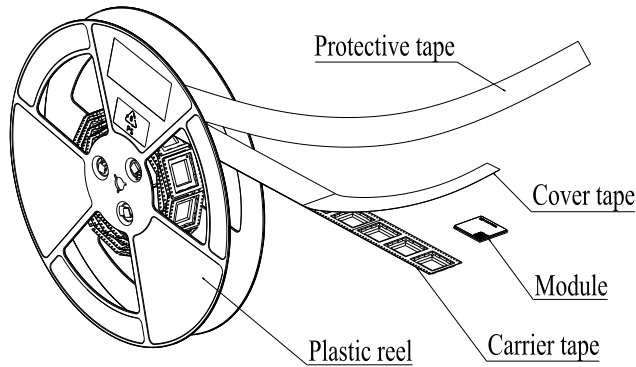


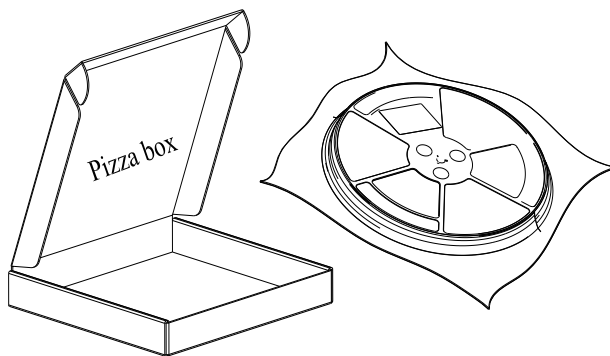
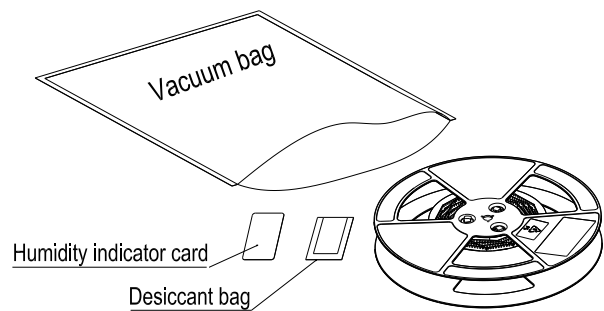
Figure 28: Mounting Direction

6.3.4. Packaging Process



Place the modules onto the carrier tape cavity and cover them securely with cover tape. Wind the heat-sealed carrier tape onto a plastic reel and apply a protective tape for additional protection. 1 plastic reel can pack 1000 modules.

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



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

Place the 4 packaged pizza boxes into 1 carton and seal it. 1 carton can pack 4000 modules.

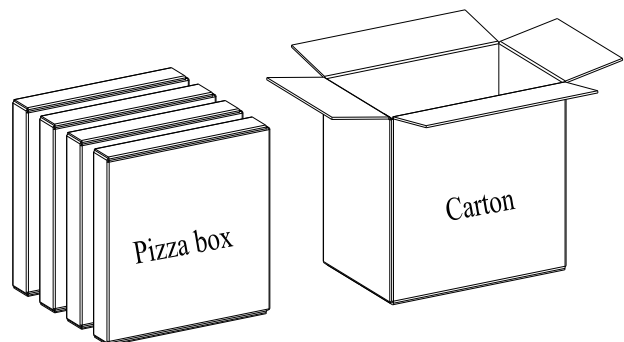


Figure 29: Packaging Process

7 Appendix References

Table 37: Related Documents

Document Name
[1] Quectel_UMTS<E_EVB_User_Guide
[2] Quectel_RF_Layout_Application_Note
[3] Quectel_Module_Stencil_Design_Requirements
[4] Quectel_Module_SMT_Application_Note

Table 38: Terms and Abbreviations

Abbreviation	Description
AP	Access Point
BLE	Bluetooth Low Energy
BPSK	Binary Phase Shift Keying
BR	Basic Rate
CCK	Complementary Code Keying
CTS	Clear To Send
DPSK	Differential Phase Shift Keying
DQPSK	Differential Quadrature Reference Phase Shift Keying
EDR	Enhanced Data Rate
ESD	Electrostatic Discharge
EVB	Evaluation Board
GATT	Generic Attribute Profile

GFSK	Gauss frequency Shift Keying
GND	Ground
HFP-AG	Hands-free Profile-Audio Gateway
HT	High Throughput
IEEE	Institute of Electrical and Electronics Engineers
I_{IL}	Input Leakage Current
I/O	Input/Output
LCC	Leadless Chip Carrier (package)
LGA	Land Grid Array
LTE	Long Term Evolution
Mbps	Million Bits Per Second
MCS	Modulation and Coding Scheme
MPQ	Minimum Packing Quantity
MSL	Moisture Sensitivity Levels
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
SDIO	Secure Digital Input/Output
SMT	Surface Mount Technology

STA	Station
SPP	Serial Port Profile
Tx	Transmit
TXD	Transmit Data
UMTS	Universal Mobile Telecommunications System
UART	Universal Asynchronous Receiver/Transmitter
(U)SIM	(Universal) Subscriber Identity Module
VHT	Very High Throughput
V _{IH}	High-level Input Voltage
V _{IL}	Low-level Input Voltage
V _{OH}	High-level Output Voltage
V _{OL}	Low-level Output Voltage
VSWR	Voltage Standing Wave Ratio
WPA	Wi-Fi Protected Access

FCC Statement

Warning: Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: 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 or more 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

The device must not be co-located or operating in conjunction with any other antenna or transmitter. 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 Radiation Exposure Statement

This equipment should be installed and operated with minimum distance 20cm between the radiator and your body.

Does not comply with the use restrictions of the product:

Portable devices used close with human's body (within 20cm), Like Cell phone, Notebook etc.

Integration instructions for host product manufacturers according to KDB 996369 D03 OEM Manual v01

2.2 List of applicable FCC rules

FCC Part 15 Subpart C 15.247 & 15.209 & 15.407.

2.3 Specific operational use conditions

The module can be used for mobile applications with a maximum 1.28dBi antenna. The host manufacturer installing this module into their product must ensure that the final product complies with the FCC requirements by a technical assessment or evaluation to the FCC rules,

including the transmitter operation. The host manufacturer 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.

2.4 Limited module procedures

Not applicable. The module is a Single module and complies with the requirement of FCC Part 15 212.

2.5 Trace antenna designs

Not applicable. The module has its own antenna, and doesn't need a host's printed board micro strip trace antenna etc.

2.6 RF exposure considerations

The module must be installed in the host equipment such that at least 20cm is maintained between the antenna and user's body; and if RF exposure statement or module layout is changed, then the host product manufacturer is required to take responsibility of the module through a change in FCC ID or new application. The FCC ID of the module cannot be used on the final product. In these circumstances, the host manufacturer will be responsible for reevaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

2.7 Antennas

Antenna Specification are as follows:

Type: External Antenna

Frequency(MHz)	Gain(dBi)
2412-2480	0.47
5150-5250	-0.76
5250-5350	-0.19
5470-5725	1.28
5725-5850	1.1

This device is intended only for host manufacturers under the following conditions: The transmitter module may not be co-located with any other transmitter or antenna; The module shall be only used with the internal antenna(s) that has been originally tested and certified with this module. The antenna must be either permanently attached or employ a "unique" antenna coupler.

As long as the conditions above are met, further transmitter test will not be required. However, the host manufacturer 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, etc).

2.8 Label and compliance information

Host product manufacturers need to provide a physical or e-label stating "Contains FCC ID: XMR202507FC20" with their finished product.

2.9 Information on test modes and additional testing requirements

Host manufacturer must perform test of radiated & conducted emission and spurious emission, e.t.c according to the actual test modes for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product. Only when all the test results of test modes comply with FCC requirements, then the end product can be sold legally.

2.10 Additional testing, Part 15 Subpart B disclaimer

The modular transmitter is only FCC authorized for FCC Part 15 Subpart C 15.247 & 15.209 & 15.407 and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuitry), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

Federal Communication Commission Statement (FCC, U S)

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

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 Caution:

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

IMPORTANT NOTES

Co-location warning:

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

OEM integration instructions:

This device is intended only for OEM integrators under the following conditions:

The transmitter module may not be co-located with any other transmitter or antenna. The module shall be only used with the external antenna(s) that has been originally tested and certified with this module.

As long as the conditions 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 (for example, digital device emissions, PC peripheral requirements, etc.).

Validity of using the module certification:

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization for this module in combination with the host equipment is no longer considered valid and the FCC ID of the module 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 authorization.

End product labeling:

The final end product must be labeled in a visible area with the following: "Contains Transmitter Module **FCC ID: XMR202507FC20**"

Information that must be placed in the end user manual:

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 shown in this manual.

ISED Statement

This device complies with ISED license-exempt RSS standard(s). 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.

Le présent appareil est conforme aux CNR d'ISED applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

The device is compliance with RF field strength limits, users can obtain Canadian information on RF exposure and compliance.

ISED Radiation Exposure Statement

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

Déclaration d' exposition aux radiations:

Cet équipement est conforme aux limites d' exposition aux rayonnements ISED établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.

The user manual for local area network devices shall contain instructions related to the restrictions mentioned in the above sections, namely that:

- (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) the maximum antenna gain permitted for devices in the bands 5250-5350 MHz and 5470-5725 MHz shall comply with the e.i.r.p. limit; and
- (iii) the maximum antenna gain permitted for devices in the band 5725-5825 MHz shall comply with the e.i.r.p. limits specified for point-to-point and non point-to-point operation as appropriate.

(i) Les dispositifs fonctionnant dans la bande 5150-5250 MHz sont réservés uniquement pour une utilisation à l'intérieur afin de réduire les risques de brouillage préjudiciable aux systèmes de satellites mobiles utilisant les mêmes canaux.

(ii) le gain d'antenne maximal autorisé pour les appareils dans les bandes 5250-5350 MHz et 5470-5725 MHz doivent respecter le pire limiter; et

(iii) le gain d'antenne maximal autorisé pour les appareils dans la bande 5725-5825 MHz doivent respecter le pire limites spécifiées pour le point-à-point et l'exploitation non point à point, le cas échéant.

Users should also be advised that high-power radars are allocated as primary users (i.e. priority users) of the bands 5250-5350 MHz and 5650-5850 MHz and that these radars could cause interference and/or damage to LE-LAN devices.

Les utilisateurs de radars de haute puissance sont désignés utilisateurs principaux (c.-à-d., qu'ils ont la priorité) pour les bandes 5250-5350 MHz et 5650-5850 MHz et que ces radars pourraient causer du brouillage et/ou des dommages aux dispositifs LAN-EL.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains IC:10224A-202507FC20".

Étiquetage du produit final

Ce module émetteur n'est autorisé que pour une utilisation dans un dispositif où l'antenne peut être installée de telle sorte que 20 cm puissent être maintenus entre l'antenne et les utilisateurs. Le produit final doit être étiqueté dans une zone visible avec la mention suivante: "contient IC:10224A-

202507FC20".