FC906A 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 paid 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
-	2023-11-16	Shinnie XU	Creation of the document
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1 Introduction

This document defines the FC906A and describes its air interfaces and hardware interfaces which are connected with your applications. With this document, you can quickly understand module interface specifications, RF performance, electrical and mechanical details, as well as other related information of the module.

Hereby, Quectel Wireless Solutions Co., Ltd. declares that the radio equipment type FC906A 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 5250 to 5350 MHz frequency range.

2 Product Overview

FC906A is a low-power and high-performance IEEE 802.11a/b/g/n/ac Wi-Fi 5 and Bluetooth 5.4 module. It supports 2.4 GHz and 5 GHz Wi-Fi bands with maximum data transmission rate up to 433.3 Mbps. It supports Wi-Fi function with an SDIO 3.0 interface, and Bluetooth function with a UART and a PCM interface.

Table 1: Basic Information

FC906A	
Packaging type	LCC
Pin counts	44
Dimensions	(12.0 ±0.15) mm × (12.0 ±0.15) mm × (1.55 ±0.16) mm
Weight	approx. 0.5 g

2.1. Key Features

Table 2: Key Features

Basic Information	
Protocols and Standard	● Wi-Fi protocols: IEEE 802.11a/b/g/n/ac ● Bluetooth protocol: Bluetooth 5.4 ● All hardware components are fully compliant with EU RoHS directive
Power Supply	● **VBAT Power Supply:** – 3.2–4.8 V – Typ.: 3.6 V
Other Powers	● **VDD_IO Power Supply:** – 1.62–3.63 V – Typ.: 1.8/3.3 V ● **Buck Circuit (VIN_LDO_OUT/VIN_LDO) Power Supply:** – 1.3–1.5 V – Typ.: 1.35 V
Temperature Ranges	● Normal operating temperature [1]: -20 °C to +70 °C ● Storage temperature: -40 °C to +85 °C
EVB Kit	FC906A-M.2, RK3568-WF EVB [2]
RF Antenna Interface	
Wi-Fi Antenna Interface	● ANT_WIFI/BT (Wi-Fi/Bluetooth antenna) ● 50 Ω characteristic impedance
Bluetooth Antenna Interfaces	● ANT_WF/BT (Wi-Fi/Bluetooth antenna) ● ANT_BT (reserved exclusive Bluetooth antenna) ● 50 Ω characteristic impedance
Application Interface	
Wi-Fi Application Interface	SDIO 3.0
Bluetooth Application Interfaces	UART, PCM

[1] Within this range, the module's indicators comply with IEEE and Bluetooth specification requirements.
[2] For more details about the EVB, see ***document [1]***.

3 RF Performances

3.1. Wi-Fi Performances

Table 3: Wi-Fi Performances

Operating Frequency				
• **2.4 GHz:** 2.400–2.4835 GHz • **5 GHz:** 5.150–5.850 GHz				
Modulation				
DSSS, CCK, BPSK, QPSK, DBPSK, DQPSK, 16QAM, 64QAM, 256QAM				
Encryption Mode				
WPA3				
Operating Mode				
• AP • STA • AP + STA				
Transmission Data Rate				
• 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)				
Condition (VBAT = 3.6 V; Temp. 25 °C)		**EVM**	**Typ.; Unit: dBm; Tolerance: ±2 dB**	
			Transmitting Power	**Receiver Sensitivity**
2.4 GHz	802.11b @ 1 Mbps	≤ 35 %	17	-97
	802.11b @ 11 Mbps		17	-87
	802.11g @ 6 Mbps	≤ -5 dB	18	-92

	802.11g @ 54 Mbps	≤ -25 dB	16	-73
	802.11n, HT20 @ MCS 0	≤ -5 dB	16	-92
	802.11n, HT20 @ MCS 7	≤ -27 dB	15	-73
	802.11n, HT40 @ MCS 0	≤ -5 dB	16	-90
	802.11n, HT40 @ MCS 7	≤ -27 dB	13.5	-71
5 GHz	802.11a @ 6 Mbps	≤ -5 dB	15.5	-91
	802.11a @ 54 Mbps	≤ -25 dB	15	-73
	802.11n, HT20 @ MCS 0	≤ -5 dB	15.5	-91
	802.11n, HT20 @ MCS 7	≤ -27 dB	14	-72
	802.11n, HT40 @ MCS 0	≤ -5 dB	14	-88
	802.11n, HT40 @ MCS 7	≤ -27 dB	13	-68
	802.11ac, VHT20 MCS 0	≤ -5 dB	15.5	-91
	802.11ac, VHT20 MCS 8	≤ -30 dB	13	-67
	802.11ac, VHT40 @ MCS 0	≤ -5 dB	14	-89
	802.11ac, VHT40 @ MCS 9	≤ -32 dB	11	-62
	802.11ac, VHT80 @ MCS 0	≤ -5 dB	13	-85
	802.11ac, VHT80 @ MCS 9	≤ -32 dB	11	-59

3.2. Bluetooth Performances

Table 4: Bluetooth Performances

Operating Frequency		
2.400–2.4835 GHz		
Modulation		
GFSK, π/4-DQPSK, 8-DPSK		
Operating Mode		
• Classic Bluetooth (BR + EDR) • Bluetooth Low Energy (BLE)		
Condition (VBAT = 3.6 V; Temp. 25 °C)	**Typ.; Unit: dBm; Tolerance: ±2 dB**	
	Transmitting Power	**Receiver Sensitivity**
BR	7	-88
EDR (π/4-DQPSK)	3	-88
EDR (8-DPSK)	3	-86
BLE (1 Mbps)	7	-88

4 Application Interfaces

4.1. Pin Assignment

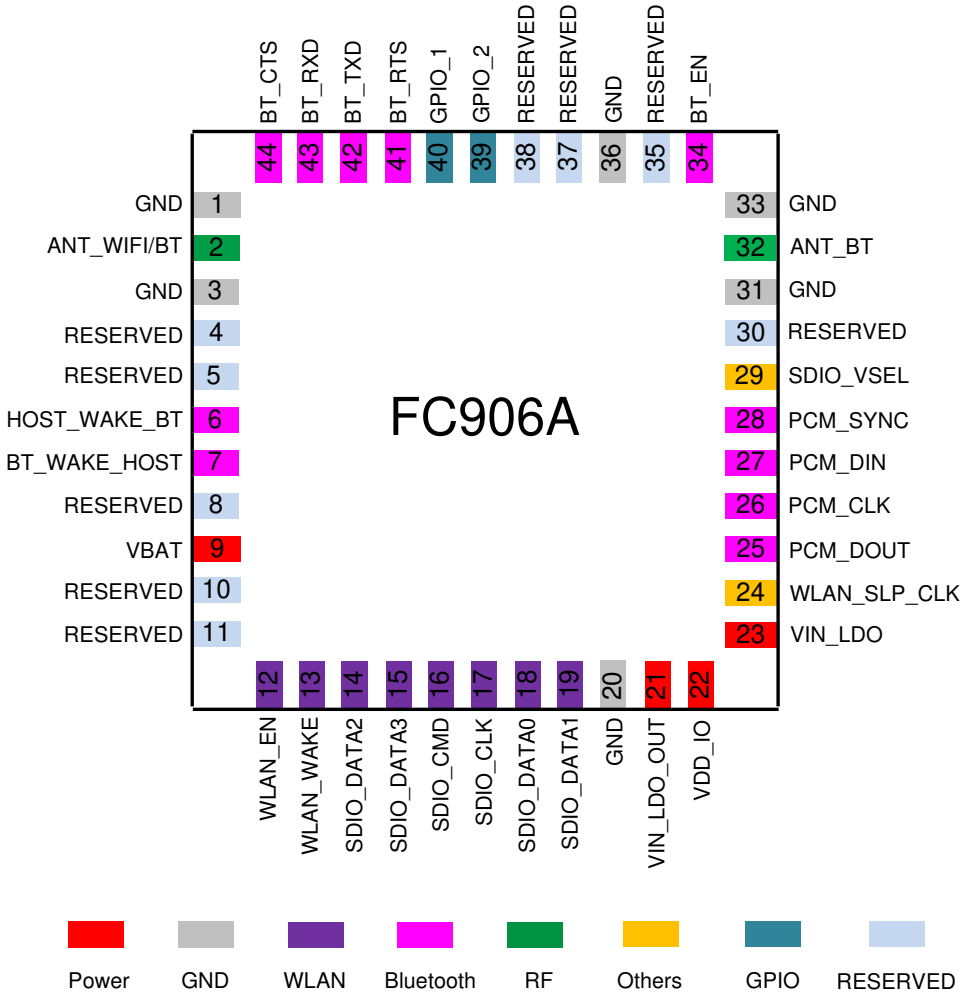


Figure 1: Pin Assignment (Top View)

NOTE

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

4.2. Pin Description

Table 5: Parameter Definition

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

DC characteristics include power domain and rated current.

Table 6: Pin Description

Power Supplies					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VBAT	9	PI	Power supply for the module	Vmin = 3.2 V Vnom = 3.6 V Vmax = 4.8 V	It must be provided with sufficient current of at least 0.5 A.
VDD_IO	22	PI	Power supply for module's I/O pins	Vmin = 1.62 V Vnom = 1.8/3.3 V Vmax = 3.63 V	
VIN_LDO_OUT	21	PO	Buck circuit power output	Vmin = 1.3 V Vnom = 1.35 V Vmax = 1.5 V	
VIN_LDO	23	PI	Buck circuit power input	Vmin = 1.3 V Vnom = 1.35 V Vmax = 1.5 V	
GND [3]	1, 3, 20, 31, 33, 36				
Wi-Fi Application Interfaces					

[3] The pin 20 is the exclusive GND for buck circuit.

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
WLAN_EN	12	DI	Wi-Fi function enable control	VDD_IO	Active high.
WLAN_WAKE	13	DO	Wi-Fi wakes up host		
SDIO_DATA2	14	DI	Read wait (1-bit mode)		Support 1-bit or 4-bit mode. SDIO 3.0 compliant. Require external 10 kΩ resistors to pull each of them up to VDD_IO.
		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 down.
HOST_WAKE_BT	6	DI	Host wakes up Bluetooth		If unused, keep them open.
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 Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ANT_WIFI/BT	2	AIO	Wi-Fi/Bluetooth antenna interface		50 Ω characteristic impedance.
ANT_BT	32	AIO	Reserved exclusive Bluetooth antenna interface		
Other Interfaces					
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 lower power clock input.
SDIO_VSEL	29	DI	SDIO voltage selection		When SDIO interface is 1.8 V power domain, pull it up to VDD_IO; when SDIO interface is 3.3 V power domain, pull it down to GND.
GPIO_1	40	DIO	General-purpose input/output		If unused, keep them open.
GPIO_2	39	DIO	General-purpose input/output		
RESERVED Pins					
Pin Name	**Pin No.**				**Comment**
RESERVED	4, 5, 8, 10, 11, 30, 35, 37, 38				Keep them open.

4.3. Power Supply

The module is powered by VBAT, and it is recommended to use a power supply chip that can provide

sufficient current of at least 0.5 A. For better power supply performance, it is recommended to parallel a 47 µF decoupling capacitor, and two filter capacitors (4.7 µF and 100 nF) near the module's VBAT pin. C4 is reserved for debugging and not mounted by default. In addition, 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:

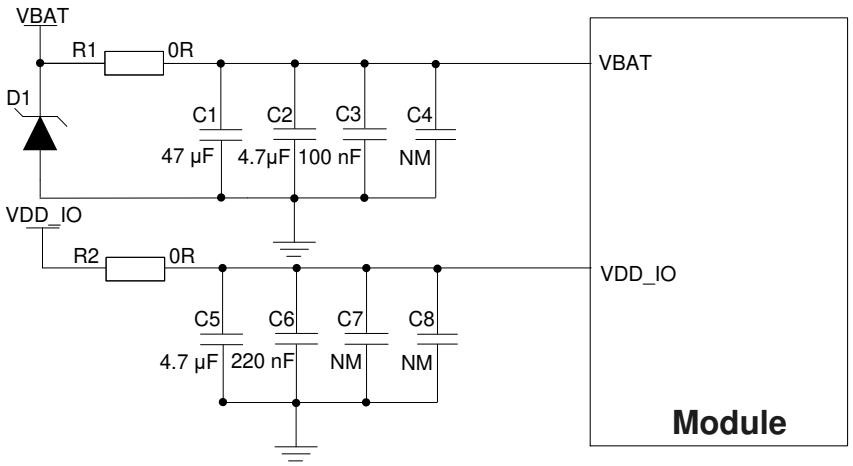


Figure 2: Reference Circuit for Power Supply

The power-up timing of the module is shown below:

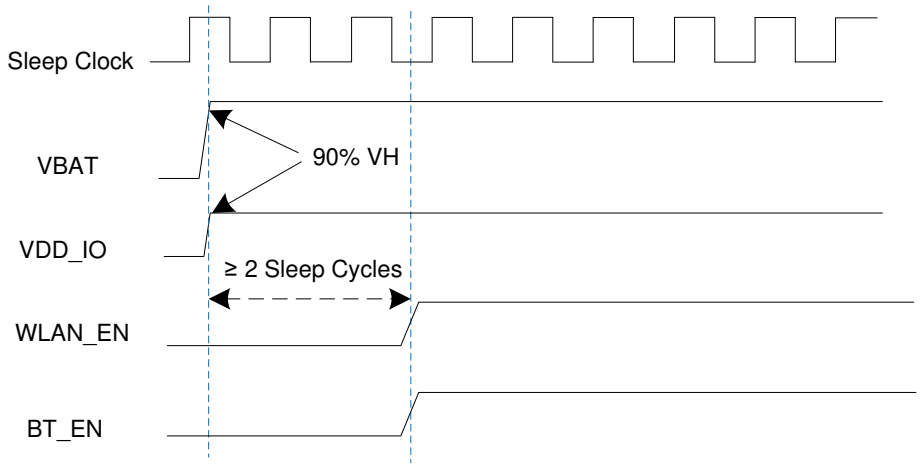


Figure 3: Power-up Timing

NOTE

1. VBAT should not rise 10 %–90 % faster than 40 μs.
2. VBAT should be powered up before or at the same time as VDD_IO. VDD_IO should not be present first or be held high before VBAT is high.

4.3.1. Buck Circuit

The VIN_LDO and VIN_LDO_OUT are the power supply pins for buck circuit. Since the buck circuit is prone to produce high-frequency noise, it warrants special attention. It is recommended to use 2.2 μH inductors such as TFM201610ALM-2R2MTAA (TDK) and 4.7 μF capacitors. Ensure that the traces are as short as possible and the trace width should not be less than 0.4 mm. In addition, it is recommended to route the traces away from sensitive signals.

The buck circuit reference design and recommended inductance parameters are shown below:

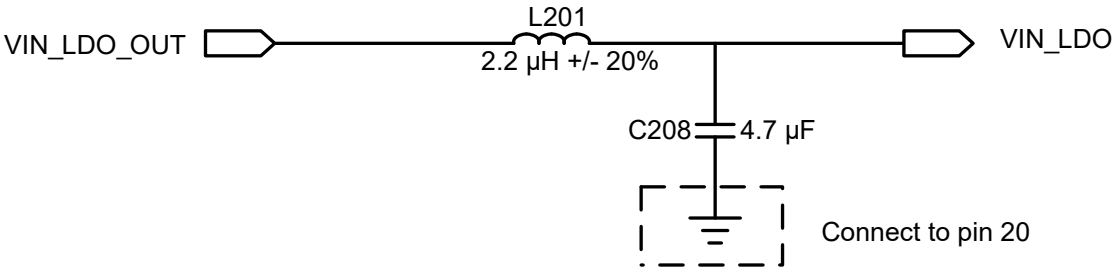


Figure 4: Buck Circuit Reference Design

Table 7: Recommended Inductance Parameters

Parameter	Recommend Value	Unit
Inductance	2.2	μH
Tolerance	±20 %	-
DCR	< 0.2	Ω
Rated current (Rising with temperature)	1.15	A

4.4. Wi-Fi Application Interfaces

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

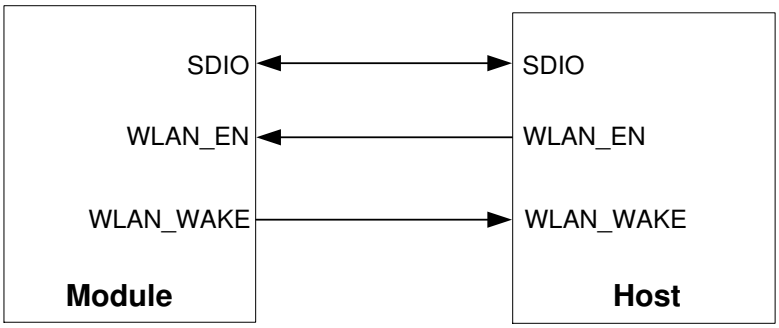


Figure 5: Wi-Fi Application Interface Connection

4.4.1. SDIO Interface

The module supports 1-bit or 4-bit SDIO 3.0 interface (automatic detected when SDIO is connected).

SDIO interface connection between the module and the host is illustrated in the figure below:

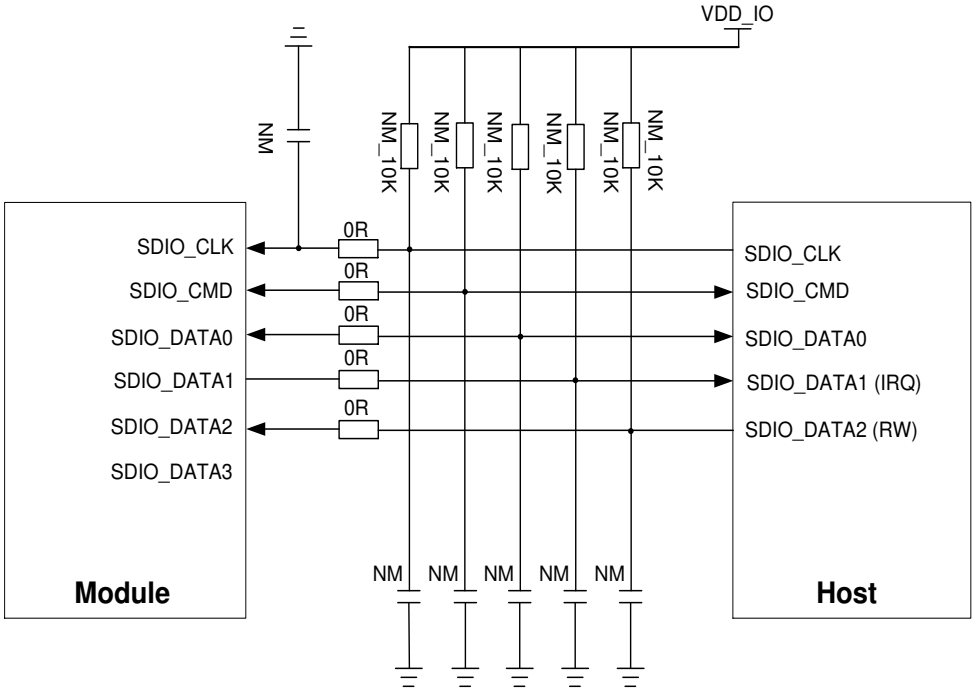


Figure 6: SDIO Interface Connection (1-bit Mode)

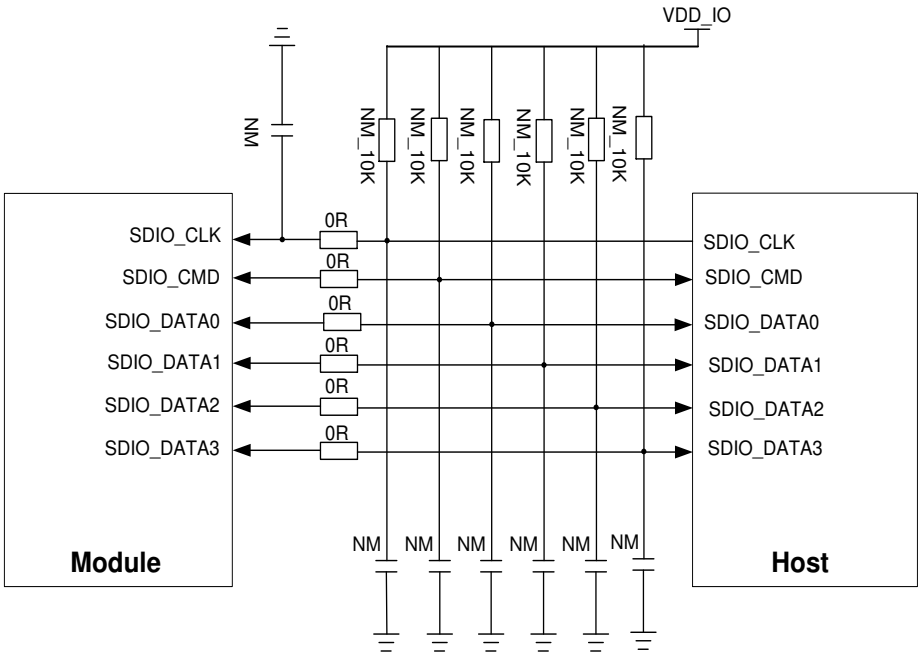


Figure 7: SDIO Interface Connection (4-bit Mode)

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

- To avoid jitter of bus, pull up SDIO_CLK and SDIO_DATA_[0:3]/SDIO_CMD to VDD_IO with resistors respectively. Value range of these resistors should be 10–100 kΩ and the recommended value is 10 kΩ
- 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. The impedance of SDIO signal trace is 50 Ω ±10 %.
- Keep SDIO signals far away from power supply traces, crystal-oscillators, magnetic devices, sensitive signals such as RF signals, analog signals, as well as noise signals generated by clock and DC-DC.
- SDIO signal traces (SDIO_CLK and SDIO_DATA[0:3]/SDIO_CMD) need to be equal in length (less than 0.50 mm distance between the traces).
- The distance between SDIO signals and other signals must be greater than twice the trace width, and the bus load capacitance must be less than 15 pF.

4.5. Bluetooth Application Interfaces

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

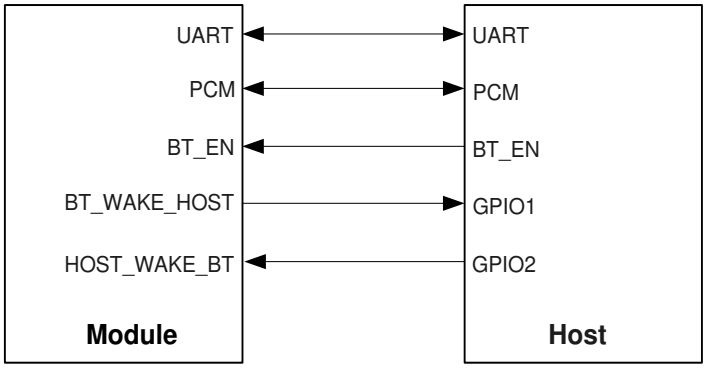


Figure 8: Bluetooth Application Interface Connection

4.5.1. PCM Interface

The module provides a PCM interface for Bluetooth audio application. PCM interface connection between the module and the host is illustrated in the figure below:

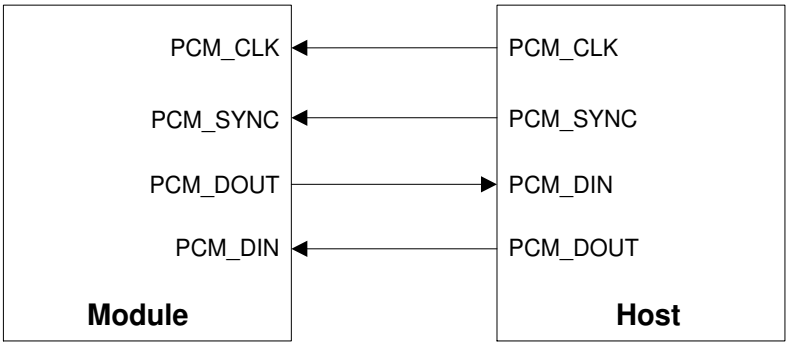


Figure 9: PCM Interface Connection

4.5.2. Bluetooth UART

The module provides an HCI UART defined in *Bluetooth Core Specification Version 5.2*. The UART supports hardware flow control, and can be used for data transmission with the MCU. It supports up to 4.0 Mbps baud rate.

Bluetooth UART connection between the module and the host is illustrated in the figure below:

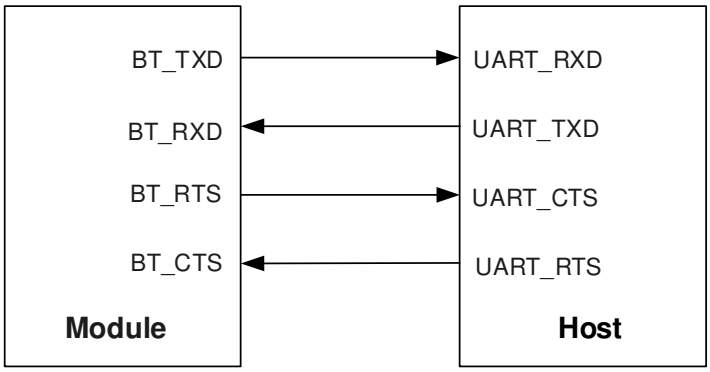


Figure 10: Bluetooth UART Connection

NOTE

To increase the stability of UART communication, it is recommended to add UART hardware flow control design.

The Bluetooth UART timing and relevant parameters are show below:

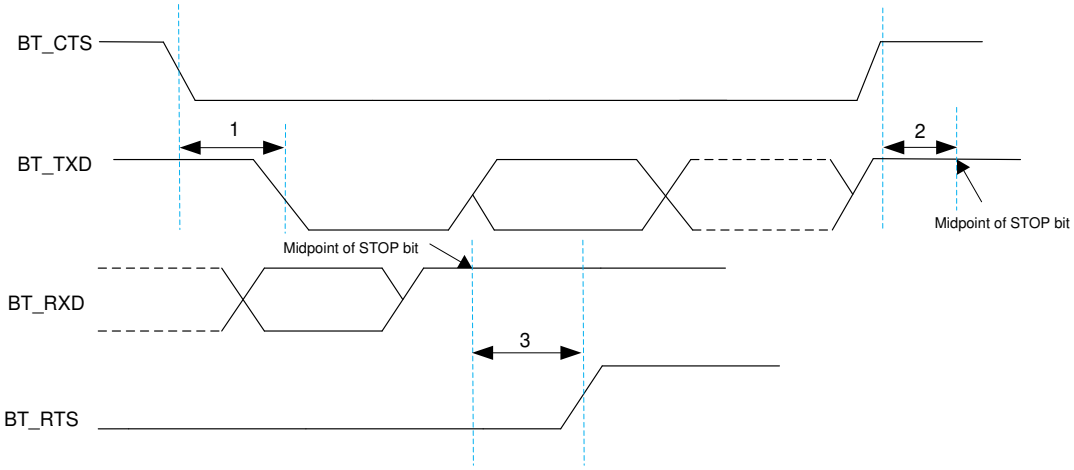


Figure 11: Bluetooth UART Timing

Table 8: Bluetooth UART Timing Parameters

Parameter	Description	Min.	Typ.	Max.	Unit.
1	Delay time, BT_CTS low to BT_TXD low	-	-	1.5	bit periods

2	Setup time, BT_CTS high before midpoint of stop bit	-	-	0.5
3	Delay time, midpoint of stop bit to BT_RTS high	-	-	0.5

4.6. RF Antenna Interfaces

The module provides one Wi-Fi and Bluetooth shared antenna interface (ANT_WIFI/BT) and one reserved exclusive Bluetooth antenna interface (ANT_BT) which is optional. The impedance of antenna port is 50 Ω.

The module supports pin antenna. 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.

4.6.1. Reference Design

A reference circuit for the RF antenna interface is provided below. For better RF performance, it is necessary to reserve a π-type matching circuit and add an ESD protection component (TVS). Matching components such as R1, C1, 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 it is recommended to use a 0 Ω for R1.

The following reference design is based on ANT_WIFI/BT as an example, the reference designs for ANT_BT is the same.

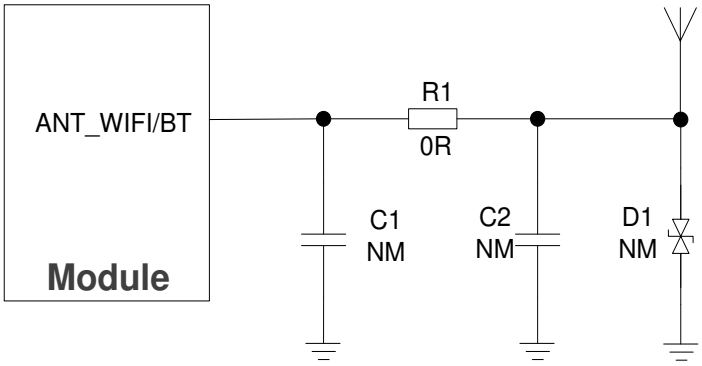


Figure 12: Reference Circuit for Antenna Interface

4.6.2. Requirements for Antenna Design

Table 9: Requirements for Antenna Design

Parameter	Requirement [4]
Frequency Range (GHz)	● 2.4 GHz: 2.400–2.4835 ● 5 GHz: 5.150–5.850
Cable Insertion Loss (dB)	< 1
VSWR	≤ 2
Gain (dBi)	1 (Typ.)
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.

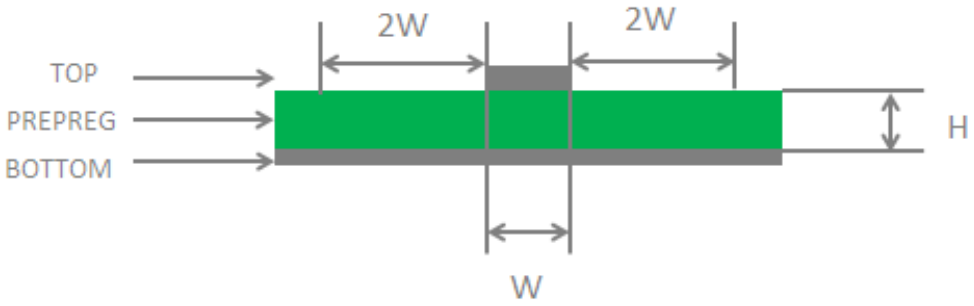


Figure 13: Microstrip Design on a 2-layer PCB

[4] For more details about the RF performances, see ***Chapter 0***.

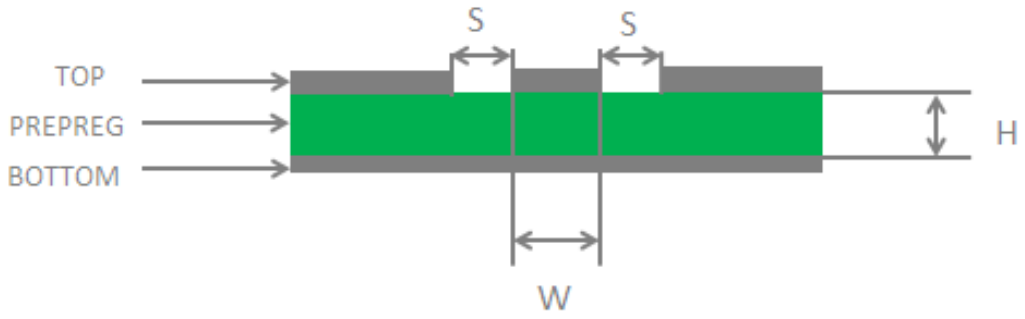


Figure 14: Coplanar Waveguide Design on a 2-layer PCB

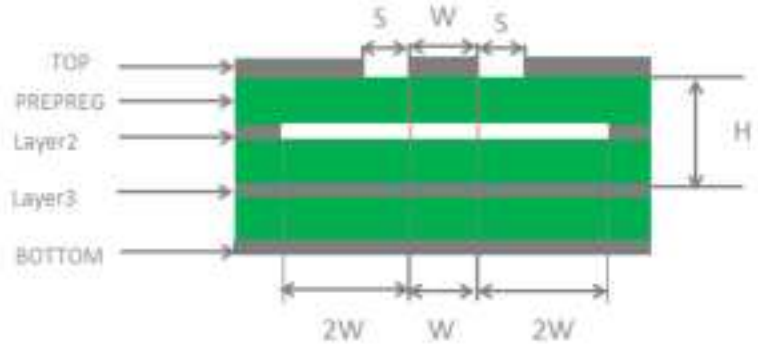


Figure 15: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

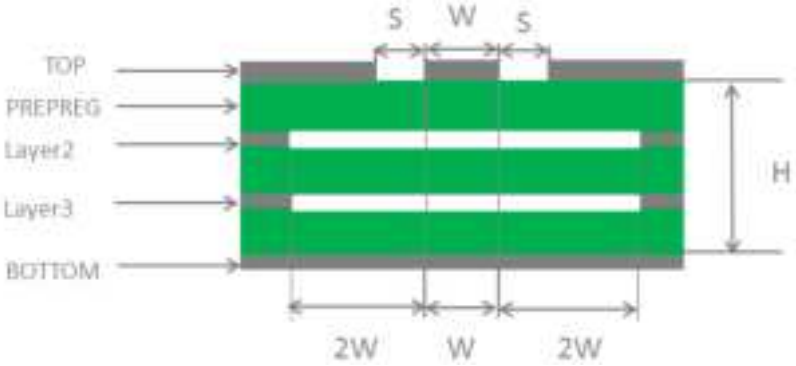


Figure 16: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

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 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 [2]***.

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.

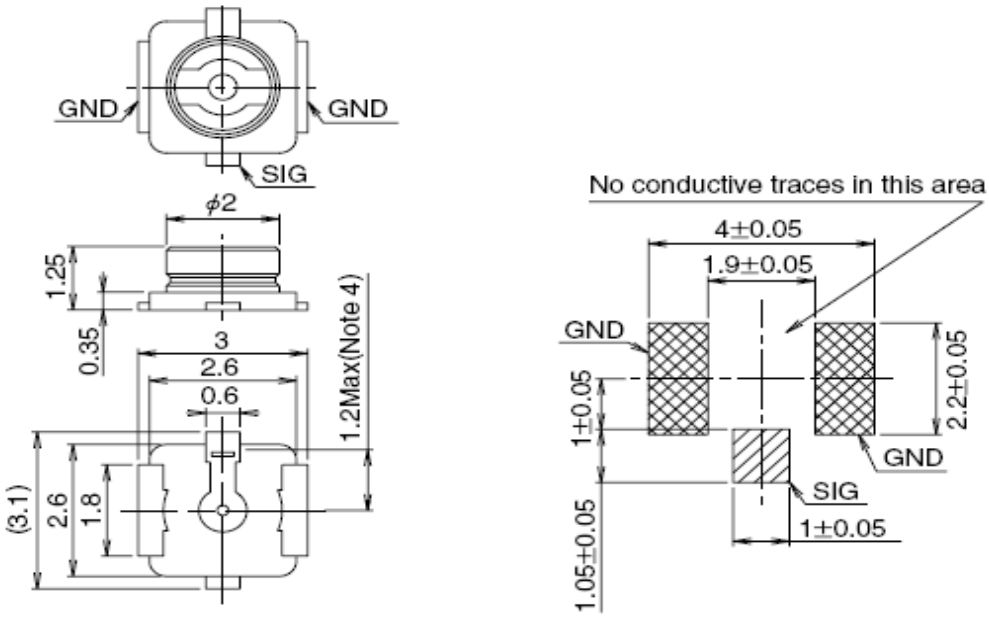


Figure 17: Dimensions of Receptacle (Unit: mm)

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

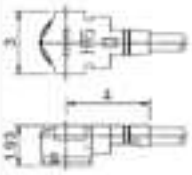
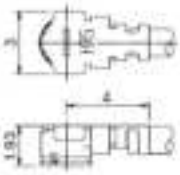
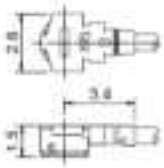
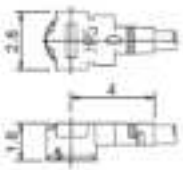
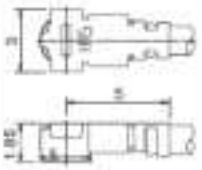
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 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 mated connectors.

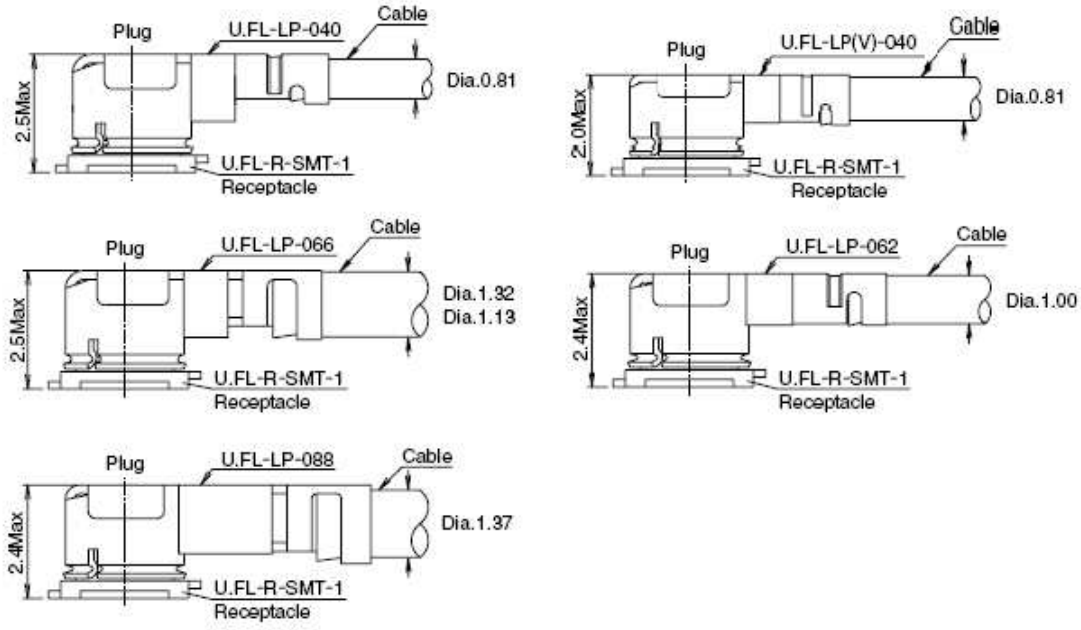


Figure 19: Space Factor of Mated Connectors (Unit: mm)

For more information, please visit http://www.hirose.com.

5 Electrical Characteristics & Reliability

5.1. Absolute Maximum Ratings

Table 10: Absolute Maximum Ratings (Unit: V)

Parameter	Min.	Max.
VBAT	-0.5	5.5
VDD_IO	-0.5	3.9

5.2. Power Supply Ratings

Table 11: Module Power Supply Ratings (Unit: V)

Parameter	Description	Condition	Min.	Typ.	Max.
VBAT	Power supply for the module	The actual input voltages must be kept between the minimum and maximum values.	3.2	3.6	4.8
VDD_IO	Power supply for module's I/O pins	-	1.62	1.8/3.3	3.63

5.3. Power Consumption

5.3.1. Wi-Fi Power Consumption

Table 12: Power Consumption in Non-signalling Mode (Typ.; Unit: mA)

Condition			I_{VBAT}	I_{VDD_IO}
2.4 GHz	802.11b	Tx 1 Mbps @ 17 dBm	315	0.18
		Tx 11 Mbps @ 17 dBm	235	0.18
	802.11g	Tx 6 Mbps @ 18 dBm	276	0.18
		Tx 54 Mbps @ 16 dBm	120	0.18
	802.11n	Tx HT20 MCS 0 @ 16 dBm	246	0.18
		Tx HT20 MCS 7 @ 15 dBm	119	0.18
		Tx HT40 MCS 0 @ 16 dBm	206	0.18
		Tx HT40 MCS 7 @ 13.5 dBm	108	0.18
5 GHz	802.11a	Tx 6 Mbps @ 16 dBm	256	0.18
		Tx 54 Mbps @ 14 dBm	130	0.18
	802.11n	Tx HT20 MCS 0 @ 16 dBm	256	0.18
		Tx HT20 MCS 7 @ 14 dBm	133	0.18
		Tx HT40 MCS 0 @ 14 dBm	233	0.18
		Tx HT40 MCS 7 @ 13 dBm	129	0.18
	802.11ac	Tx VHT20 MCS 0 @ 16 dBm	257	0.18
		Tx VHT20 MCS 8 @ 13 dBm	127	0.18
		Tx VHT40 MCS 0 @ 14 dBm	234	0.18
		Tx VHT40 MCS 9 @ 11 dBm	125	0.18
		Tx VHT80 MCS 0 @ 13 dBm	178	0.18
		Tx VHT80 MCS 9 @ 11 dBm	126	0.18

5.3.2. Bluetooth Power Consumption

Table 13: Bluetooth Power Consumption

Mode	Condition	I_{VBAT} (mA)	I_{VDD_IO} (μA)
Signaling Mode	BR @ 7 dBm	38	18
	EDR (π/4-DQPSK) @ 3 dBm	30	18
	EDR (8-DPSK) @ 3 dBm	30	18
Non-signaling Mode	BLE (1 Mbps) @ 7 dBm	44	18

5.4. Digital I/O Characteristics

Table 14: VDD_IO Low-voltage I/O Requirements (Unit: V)

Parameter	Description	Min.	Max.
V_{IH}	High-level input voltage	0.65 × VDD_IO	-
V_{IL}	Low-level input voltage	-	0.35 × VDD_IO
V_{OH}	High-level output voltage	VDD_IO - 0.45	-
V_{OL}	Low-level output voltage	-	0.45

Table 15: VDD_IO High-voltage I/O Requirements (Unit: V)

Parameter	Description	Min.	Max.
V_{IH}	High-level input voltage	2	-
V_{IL}	Low-level input voltage	-	0.8
V_{OH}	High-level output voltage	VDD_IO - 0.4	-
V_{OL}	Low-level output voltage	-	0.4

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.

Table 16: Electrostatic Discharge Characteristics (Unit: kV)

Model	Test Result	Standard
Human Body Model (HBM)	±2	*ESDA/JEDEC JS-001-2017*
Charged Device Model (CDM)	±0.25	*ESDA/JEDEC JS-002-2018*

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

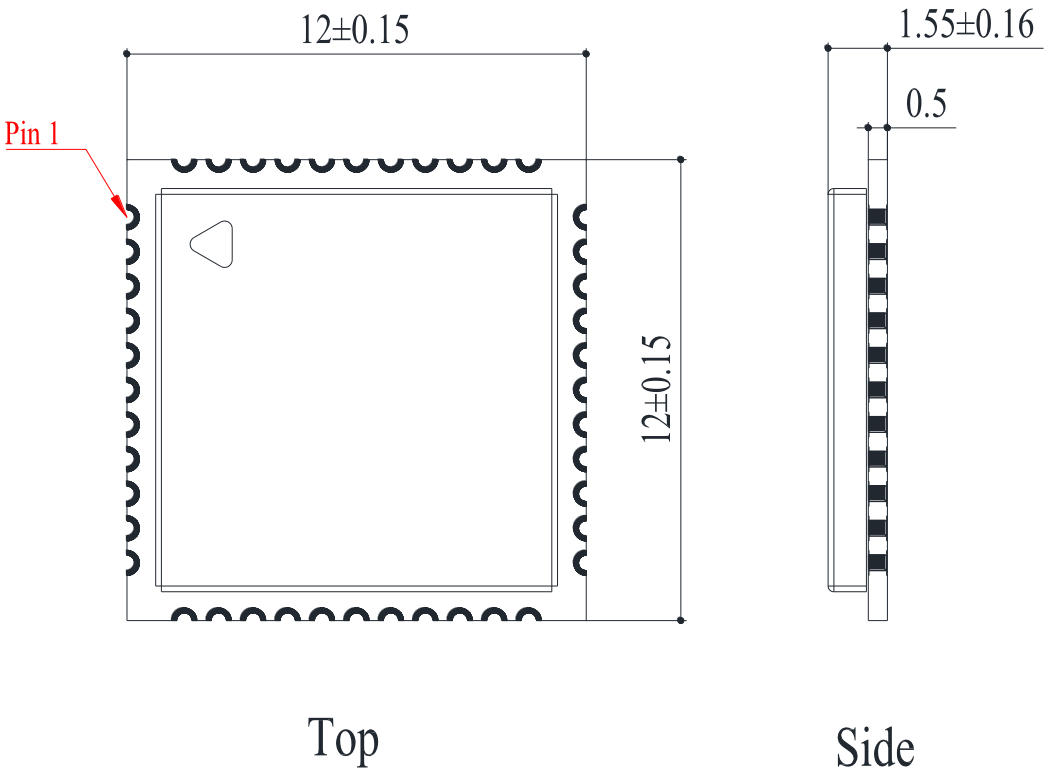


Figure 20: Top and Side Dimensions

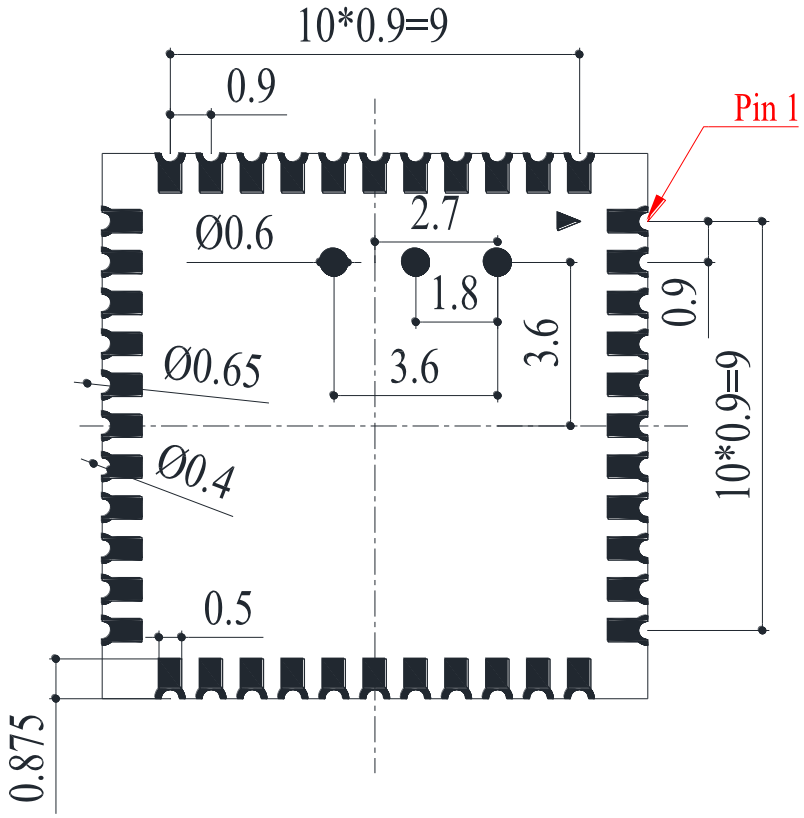


Figure 21: Bottom Dimension (Bottom View)

NOTE

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

6.2 Recommended Footprint

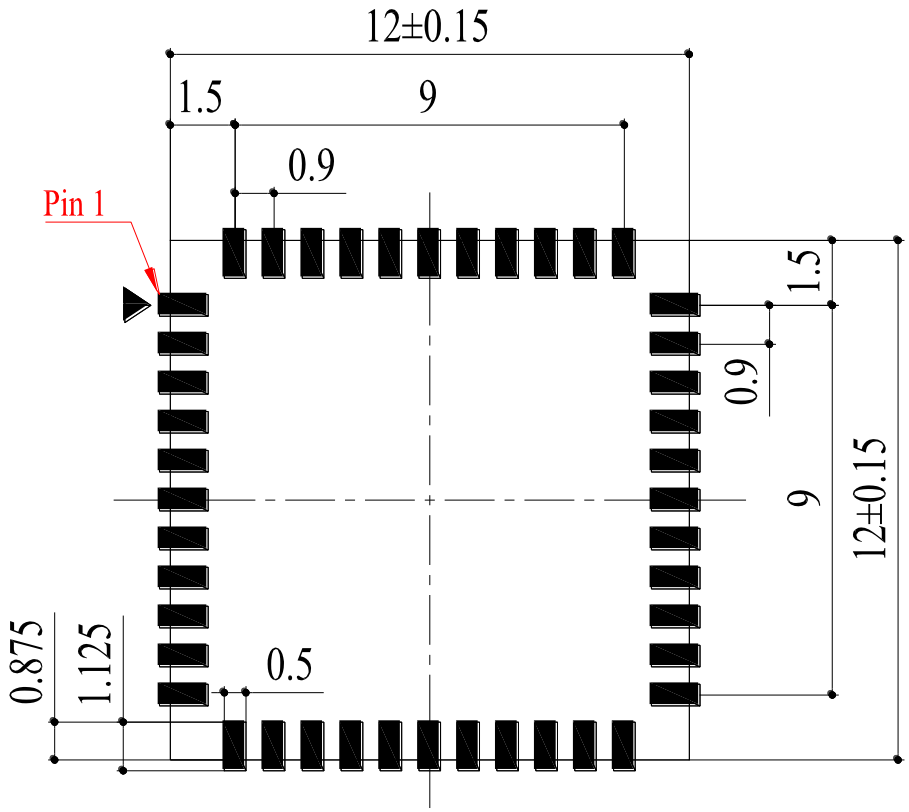


Figure 22: Recommended Footprint

NOTE

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

6.3 Top and Bottom Views

Figure 23: 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 and 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[5] 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.

NOTE

[5] 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.

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 [3]***.

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.

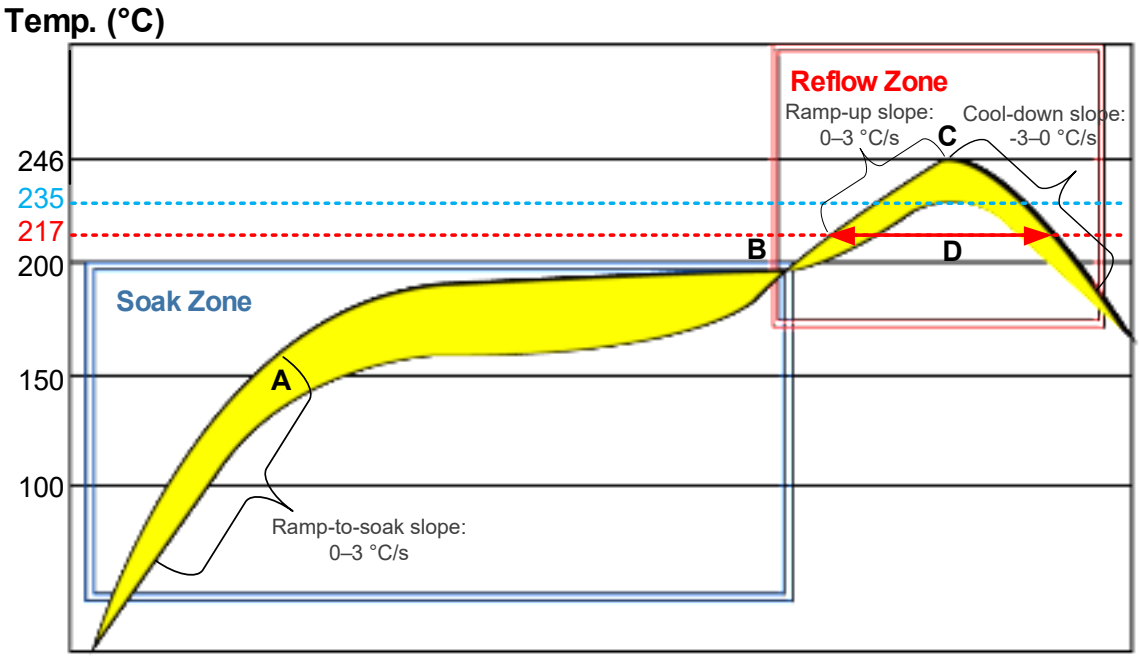


Figure 24: Recommended Reflow Soldering Thermal Profile

Table 17: 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. 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 [3]***.

7.3 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.

7.3.1 Carrier Tape

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

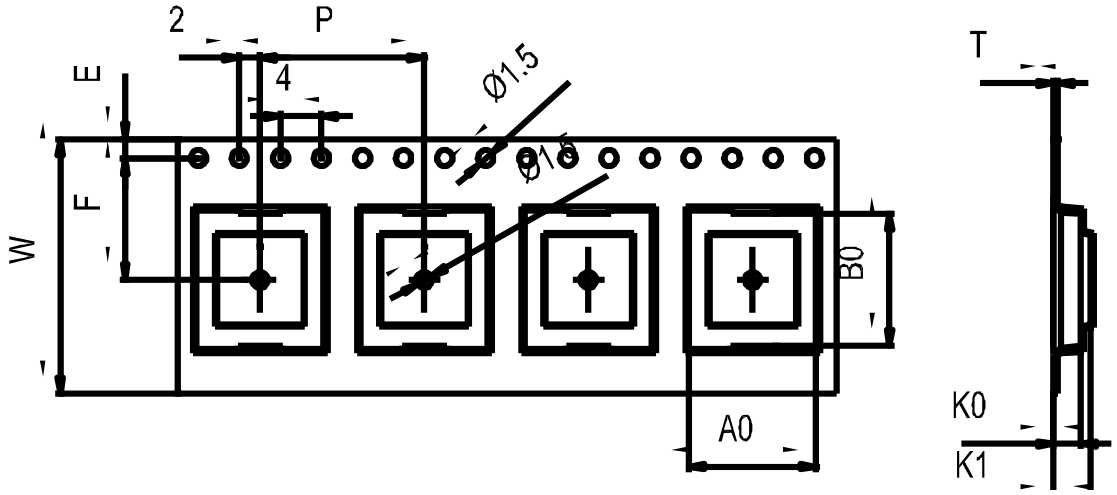


Figure 25: Carrier Tape Dimension Drawing (Unit: mm)

Table 18: 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

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

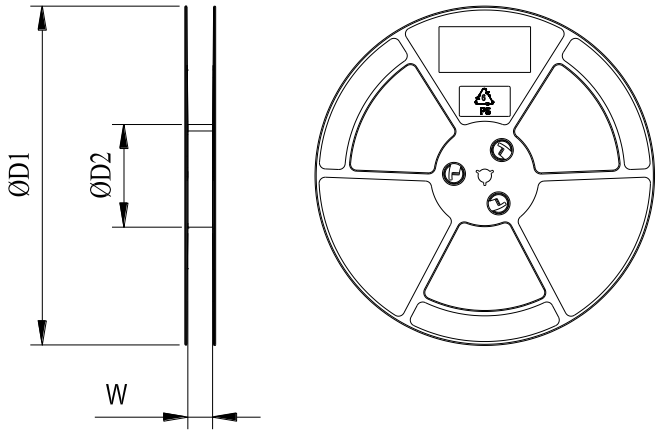


Figure 26: Plastic Reel Dimension Drawing

Table 19: Plastic Reel Dimension Table (Unit: mm)

øD1	øD2	W
330	100	24.5

7.3.3 Mounting Direction

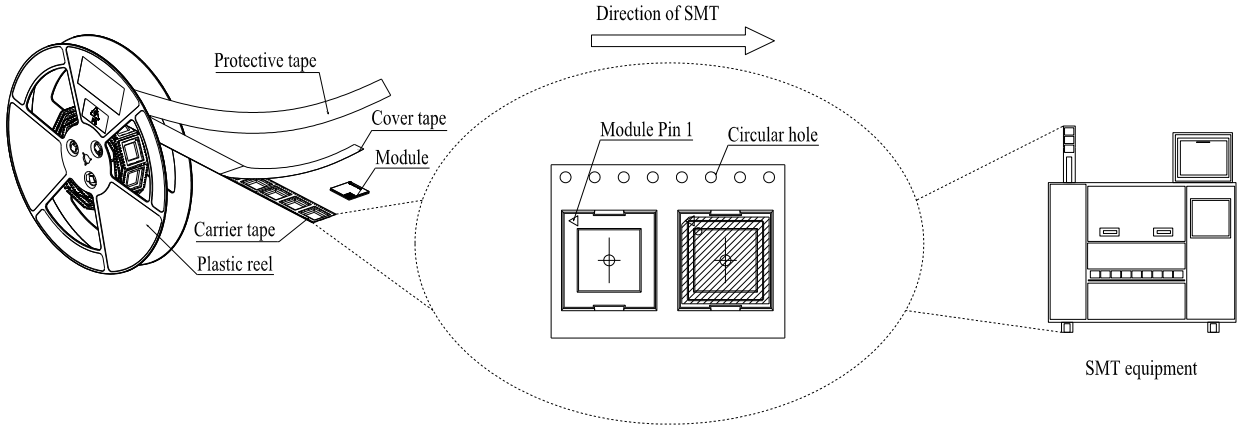
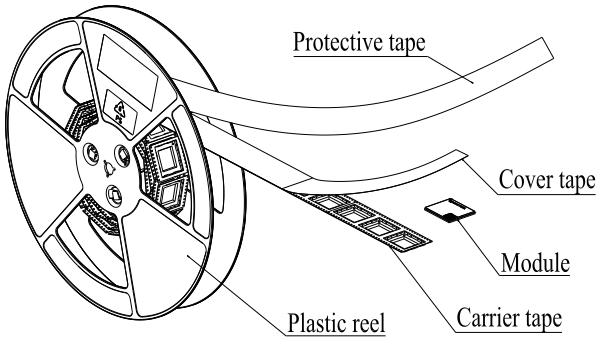


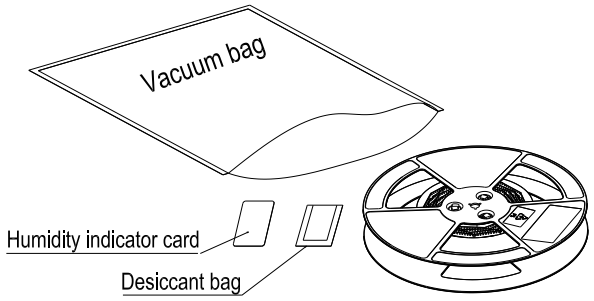
Figure 27: Mounting Direction

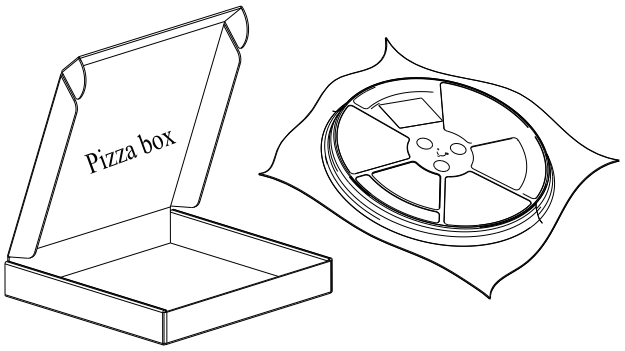
7.3.4 Packaging Process



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 500 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 2000 modules.

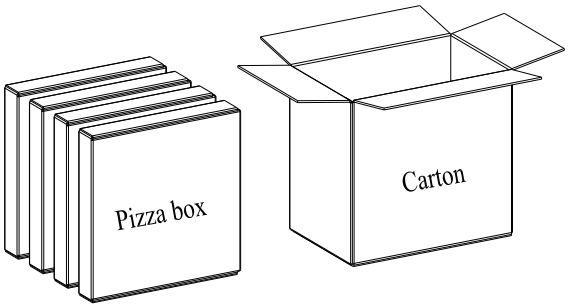


Figure 28: Packaging Process

8 Appendix References

Table 20: Related Documents

Document Name
[1] Quectel_RK3568-WF_EVB_User_Guide
[2] Quectel_RF_Layout_Application_Note
[3] Quectel_Module_SMT_Application_Note

Table 21: Terms and Abbreviations

Abbreviation	Description
AP	Access Point
BLE	Bluetooth Low Energy
BPSK	Binary Phase Shift Keying
BR	Basic Rate
CCK	Complementary Code Keying
CDM	Charged Device Model
CTS	Clear To Send
DBPSK	Differential Binary Phase Shift Keying
DPSK	Differential Phase Shift Keying
DQPSK	Differential Quadrature Phase Shift Keying
DSSS	Direct Sequence Spread Spectrum
EDR	Enhanced Date Rate
ESD	Electrostatic Discharge

EVM	Error Vector Magnitude
GFSK	Gaussian Frequency Shift Keying
GND	Ground
HBM	Human Body Model
HCI	Host Controller Interface
HT	High Throughput
I/O	Input/Output
IEEE	Institute of Electrical and Electronics Engineers
IRQ	Interrupt Request
LCC	Leadless Chip Carrier (package)
Mbps	Million Bits Per Second
MCS	Modulation and Coding Scheme
MCU	Microcontroller Unit
MSL	Moisture Sensitivity Levels
NC	Not Connected
NM	Not Mounted
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
SMD	Surface Mount Device
SMT	Surface Mount Technology
STA	Station
TBD	To Be Determined
Tx	Transmit
TXD	Transmit Data
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
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
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 0.2dBi antenna. The host manufacturer installing this module into their product must ensure that the final compos it 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 hosts 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 users" body; and if RF exposure statement or module layout is changed, then the host product manufacturer 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

Gain: 2.4G:0.2dBi;5G:-0.7dBi;

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: XMR2024FC906A" 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 circuity), 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: XMR2024FC906A**"

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 show in this manual.

IC Statement

This device complies with Industry Canada 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'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, 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.

IC Radiation Exposure Statement

This equipment complies with IC 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 IC 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.