QUECTEL

FC06E Hardware Design

Wi-Fi&Bluetooth Module Series

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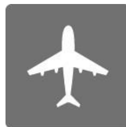
Safety Information

The following safety precautions must be observed during all phases of operation, such as usage, service or repair of any cellular terminal or mobile incorporating the module. Manufacturers of the cellular 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 cellular terminal or mobile before boarding an aircraft. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. If there is an Airplane Mode, it 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.

Cellular terminals or mobiles operating over radio signal and cellular network cannot be guaranteed to connect in certain conditions, such as when the mobile bill is unpaid or the (U)SIM card is invalid. When emergency help is needed in such conditions, use emergency call if the device supports it. In order to make or receive a call, the cellular terminal or mobile must be switched on in a service area with adequate cellular signal strength. In an emergency, the device with emergency call function cannot be used as the only contact method considering network connection cannot be guaranteed under all circumstances.

The cellular terminal or mobile contains a transceiver. When it is ON, it receives and transmits radio frequency signals. RF interference can occur if it is used close to TV sets, radios, computers or other electric equipment.

In locations with explosive or potentially explosive atmospheres, obey all posted signs and turn off wireless devices such as mobile phone or other cellular terminals. Areas with explosive or potentially explosive atmospheres include fuelling areas, below decks on boats, fuel or chemical transfer or storage facilities, and areas where the air contains chemicals or particles such as grain, dust or metal powders.

About the Document

Revision History

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-	2021-11-12	Soni RAO/ Lucas HUANG	Creation of the document
1.0.0	2021-11-12	Soni RAO/Lucas HUANG	Preliminary
1.0.1	2022-5-24	Soni RAO	Preliminary: 1. Updated power consumption data (Chapter 4.5). 2. Updated Wi-Fi RF performance data (Chapter 4.6). 3. Updated ESD data (Table 30). 4. Updated the module's weight (Table 2).
1.0.2	2022-5-25	Soni RAO	Preliminary: 1. Updated the module's height (Table 2, Figure 19). 2. Updated top and side dimension figures and top and bottom views (Figure 19, Figure 22).
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1 Introduction

This document defines the FC06E and describes its air interfaces and hardware interfaces which are connected to your applications.

With this document, you can quickly understand module interface specifications, electrical and mechanical details, as well as other related information of the module. The document, coupled with application notes and user guides, makes it easy to design and set up mobile applications with the module.

1.1. Special Mark

Table 1: Special Mark

Mark	Definition
*	Unless otherwise specified, when an asterisk (*) is used after a function, feature, interface, pin name, AT command, or argument, it indicates that the function, feature, interface, pin, AT command, or argument is under development and currently not supported; and the asterisk (*) after a model indicates that the sample of the model is currently unavailable.

2 Product Overview

2.1. General Description

The module is a Wi-Fi and Bluetooth module with low power consumption. It is a single-die Wi-Fi and Bluetooth* combo solution supporting IEEE 802.11a/b/g/n/ac/ax 2.4 GHz and 5 GHz Wi-Fi standards and Bluetooth 5.2 standard, which enables seamless integration of Wi-Fi and Bluetooth low energy technologies.

FC06E can provide Wi-Fi functions with a low-power PCIe Gen 3 interface and Bluetooth functions with a UART and a PCM interface.

2.2. Key Features

Table 2: Key Features

Feature	Detail
Power Supply	● Core supply voltage: 0.95 V, 1.35 V, 1.95 V ● I/O supply voltage: 1.8 V ● RF supply voltage: 3.3 V or 5.0 V
Operating Frequencies	● 2.4 GHz Wi-Fi: 2.400–2.4835 GHz ● 5 GHz Wi-Fi: 5.150–5.850 GHz
Wi-Fi Features	● Complies with IEEE 802.11a/b/g/n/ac/ax ● Supports 2 × 2 Multi-User Multiple-Input Multiple-Output (MU-MIMO) ● Supported channel bandwidths: − 20/40 MHz at 2.4 GHz − 20/40/80 MHz at 5 GHz ● Dual Band Simultaneous (DBS) with dual MAC, up to 1.77 Gbps data rate (2 × 2 + 2 × 2 802.11ax DBS)
Wi-Fi Transmission Data Rates	● 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)

<table>
<tr><td></td><td>● 802.11ac: VHT20 (MCS 0–8), VHT40 (MCS 0–9), VHT80 (MCS 0–9)
● 802.11ax: HE20 (MCS 0–11), HE40 (MCS 0–11), HE80 (MCS 0–11)</td></tr>
<tr><td>Wi-Fi Transmitting Power</td><td>VDD_FEM = 5 V
● 2.4 GHz:
802.11b @ 11 Mbps: 20 dBm
802.11g @ 54 Mbps: 19 dBm
802.11n, HT20 @ MCS 7: 18.5 dBm
802.11n, HT40 @ MCS 7: 18.5 dBm
802.11ax, HE20 @ MCS 11: 17.5 dBm
802.11ax, HE40 @ MCS 11: 17.5 dBm
● 5 GHz:
802.11a @ 54 Mbps: 19 dBm
802.11n, HT20 @ MCS 7: 18.5 dBm
802.11n, HT40 @ MCS 7: 18.5 dBm
802.11ac, VHT20 @ MCS 8: 17.5 dBm
802.11ac, VHT40 @ MCS 9: 17.5 dBm
802.11ac, VHT80 @ MCS 9: 17 dBm
802.11ax, HE20 @ MCS 11: 17 dBm
802.11ax, HE40 @ MCS 11: 17 dBm
802.11ax, HE80 @ MCS 11: 16.5 dBm

VDD_FEM = 3.3 V
● 2.4 GHz:
802.11b @ 11 Mbps: 19 dBm
802.11g @ 54 Mbps: 15 dBm
802.11n, HT20 @ MCS 7: 15 dBm
802.11n, HT40 @ MCS 7: 15 dBm
802.11ax, HE20 @ MCS 11: 14 dBm
802.11ax, HE40 @ MCS 11: 14 dBm
● 5 GHz:
802.11a @ 54 Mbps: 16.5 dBm
802.11n, HT20 @ MCS 7: 16 dBm
802.11n, HT40 @ MCS 7: 16 dBm
802.11ac, VHT20 @ MCS 8: 15.5 dBm
802.11ac, VHT40 @ MCS 9: 15.5 dBm
802.11ac, VHT80 @ MCS 9: 15 dBm
802.11ax, HE20 @ MCS 11: 15 dBm
802.11ax, HE40 @ MCS 11: 15 dBm
802.11ax, HE80 @ MCS 11: 14 dBm</td></tr>
<tr><td>Wi-Fi Operation Modes</td><td>● AP
● STA</td></tr>
<tr><td>Wi-Fi Modulations</td><td>CCK, DBPSK, BPSK, DQPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM</td></tr>
</table>

Wi-Fi Application Interface	PCIe
Bluetooth Application Interfaces*	● UART ● PCM
RF Antenna Interfaces	● ANT_WIFI0, ANT_WIFI1, ANT_BT ● 50 Ω impedance
Physical Characteristics	● Size: (25.5 ±0.15) mm × (22 ±0.15) mm × (2.25 ±0.2) mm ● Package: LCC ● Weight: approx. 2.27 g
Temperature Ranges	● Operating temperature range: -30 °C to +75 °C [1] ● Storage temperature range: -40 °C to +85 °C
RoHS	All hardware components are fully compliant with EU RoHS directive

2.3. Functional Diagram

TThe following illustrates the main functional components of the module's block diagram

- Power supply
- Wi-Fi application interfaces
- Bluetooth application interfaces*
- Coexistence interfaces
- Other interfaces
- RF antenna interfaces

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

2.4. EVB Kit

To help you develop applications with the module, Quectel supplies an evaluation board ((FC06E-M.2) with accessories to control or test the module. For more details, see ***document [1].***

3 Application Interfaces

3.1. Pin Assignment

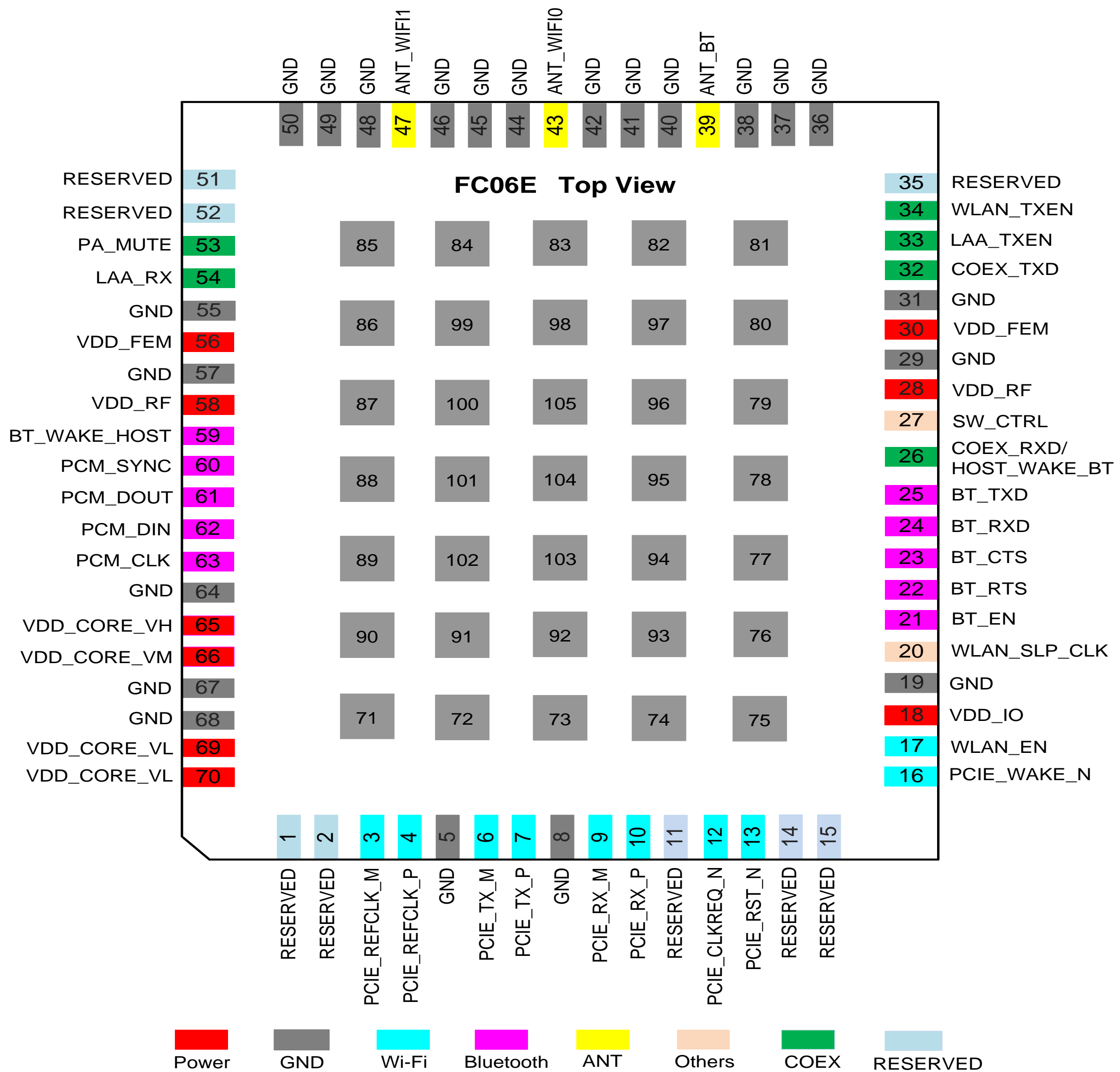


Figure 2: Pin Assignment (Top View)

NOTE

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

3.2. Pin Description

Table 3: I/O Parameters Definition

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

Table 4: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VDD_CORE_VL	69, 70	PI	Provides 0.95 V for the module's main chip	Vmin = 0.9 V Vnom = 0.95 V Vmax = 1.05 V	
VDD_CORE_VM	66	PI	Provides 1.35 V for the module's main chip	Vmin = 1.3 V Vnom = 1.35 V Vmax = 2.1 V	
VDD_CORE_VH	65	PI	Provides 1.95 V for the module's main chip	Vmin = 1.85 V Vnom = 1.95 V Vmax = 2.1 V	
VDD_IO	18	PI	Provides 1.8 V for the module's I/O pins	Vmin = 1.71 V Vnom = 1.8 V Vmax = 1.89 V	

VDD_RF	28, 58	PI	Provides 1.95 V for RF circuit	Vmin = 1.85 V Vnom = 1.95 V Vmax = 2.1 V	
VDD_FEM	30, 56	PI	Provides 3.3V or 5 V for the module's FEM part	Vmin = 3.3 V Vnom = 5.0 V Vmax = 5.5 V	
GND	5, 8, 19, 29, 31, 36–38, 40–42, 44–46, 48–50, 55, 57, 64, 67, 68, 71–105				
Wi-Fi Application Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
WLAN_EN	17	DI	Wi-Fi function enable control	VDD_IO	Active high. Keep it connected.
PCIE_REFCLK_M	3	AI	PCIe reference clock (-)		Requires differential impedance of 85 Ω. PCIe Gen 3 compliant.
PCIE_REFCLK_P	4	AI	PCIe reference clock (+)		
PCIE_TX_M	6	AO	PCIe transmit (-)		
PCIE_TX_P	7	AO	PCIe transmit (+)		
PCIE_RX_M	9	AI	PCIe receive (-)		
PCIE_RX_P	10	AI	PCIe receive (+)		
PCIE_CLKREQ_N	12	DO	PCIe clock request	VDD_IO	Active low. Pull each of them up to 1.8 V with external 10 kΩ resistors.
PCIE_WAKE_N	16	DO	PCIe wake up		
PCIE_RST_N	13	DI	PCIe reset		Active low.
Bluetooth Application Interfaces*					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
BT_EN	21	DI	Bluetooth function enable control	VDD_IO	Active high. If unused, pull it down with a 10 KΩ resistor.
PCM_DIN	62	DI	PCM data input		If unused, keep them open.
PCM_SYNC	60	DI	PCM data frame sync		
PCM_CLK	63	DI	PCM clock		

PCM_DOUT	61	DO	PCM data output		
BT_RTS	22	DO	DCE request to send signal to DTE		
BT_CTS	23	DI	DCE clear to send signal from DTE		
BT_RXD	24	DI	Bluetooth UART receive		
BT_TXD	25	DO	Bluetooth UART transmit		
BT_WAKE_HOST	59	DO	Bluetooth wakes up host		
HOST_WAKE_BT/ COEX_RXD	26	DI	Host wakes up Bluetooth		
RF Antenna Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ANT_WIFI0	43	AIO	Wi-Fi 0 antenna interface		
ANT_WIFI1	47	AIO	Wi-Fi 1 antenna interface		50 Ω impedance.
ANT_BT*	39	AIO	Bluetooth antenna interface		
Coexistence Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
COEX_TXD	32	DO	2.4 GHz LTE & Wi-Fi coexistence transmit		
COEX_RXD/ HOST_WAKE_BT	26	DI	2.4 GHz LTE & Wi-Fi coexistence receive		
LAA_TXEN	34	DI	When it goes high, module places the 5 GHz receiver in a protected state.	VDD_IO	If unused, keep them open.
LAA_RX	54	DI	When it goes high, module allows LAA to receive on the Wi-Fi antennas.		

WLAN_TXEN	33	DO	Module asserts it to high state when 5 GHz is set to transmit at power greater than 10 dBm.		
PA_MUTE	53	DI	When it goes high, 2.4 GHz PA is turned off.		
Other Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
WLAN_SLP_CLK	20	DI	32.768 kHz sleep clock	VDD_IO	If unused, keep it open.
SW_CTRL	27	DO	VDD_FEM power switch control		Active high. If unused, keep it open.
RESERVED Pins					
Pin Name	**Pin No.**				**Comment**
RESERVED	1, 2, 11, 14, 15, 35, 51,52				Keep them open.

3.3. Power Supply

The following table shows the power supply pins and ground pins of the module.

Table 5: Definition of Power Supply and GND Pins

Pin Name	Pin No.	Description	Min.	Typ.	Max.	Unit
VDD_CORE_VL	69, 70	Provides 0.95 V for the module's main chip	0.9	0.95	1.05	V
VDD_CORE_VM	66	Provides 1.35 V for the module's main chip	1.3	1.35	2.1	V
VDD_CORE_VH	65	Provides 1.95 V for the module's main chip	1.85	1.95	2.1	V
VDD_IO	18	Provides 1.8 V for the module's I/O pins	1.71	1.8	1.89	V

VDD_RF	28, 58	Provides 1.95 V for RF circuit	1.85	1.95	2.1	V
VDD_FEM	30, 56	Provides 3.3 V or 5 V for the module's FEM part	3.3	3.3, 5.0	5.5	V
GND	5, 8, 19, 29, 31, 36–38, 40–42, 44–46, 48–50, 55, 57, 64, 67, 68, 71–105					

The following figure shows the recommended power-up and power-down timing of the module. All input supplies must be ON and available before WLAN/BT_EN is asserted. There is no requirement for the timing between input power supplies.

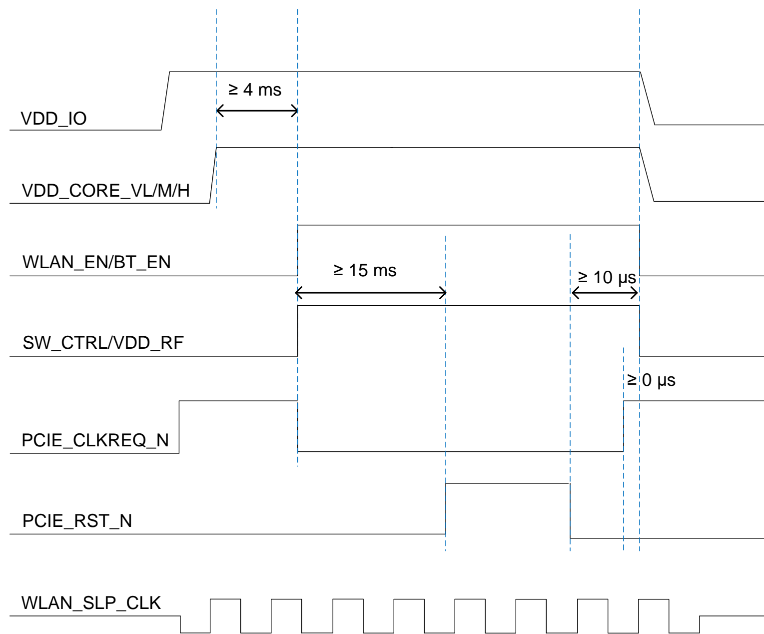


Figure 3: Power-up and Power-down Timing

3.4. Wi-Fi Application Interfaces

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

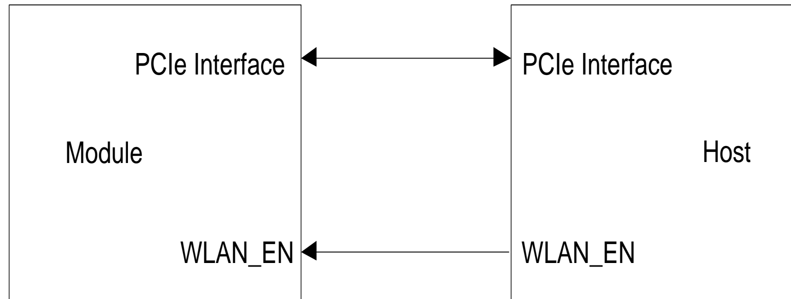


Figure 4: Wi-Fi Application Interface Connection

3.4.1. WLAN_EN

WLAN_EN is used to control the Wi-Fi function of the module which will be enabled when WLAN_EN is at high level.

Table 6: Pin Definition of WLAN_EN

Pin Name	Pin No.	I/O	Description	Comment
WLAN_EN	17	DI	Wi-Fi function enable control	1.8 V power domain. Active high. Keep it connected.

3.4.2. PCIe Interface

The module provides a PCIe interface with key features listed as below:

- *PCI Express Base Specification Revision 3.0* compliant.
- Data rate at 8 Gbps per lane.
- Used as the Wi-Fi application interface connected to the host.

Table 7: Pin Definition of PCIe Interface

Pin Name	Pin No.	I/O	Description	Comment
PCIE_REFCLK_M	3	AI	PCIe reference clock (-)	Requires differential

PCIE_REFCLK_P	4	AI	PCIe reference clock (+)	impedance of 85 Ω. PCIe Gen 3 compliant.
PCIE_TX_M	6	AO	PCIe transmit (-)	
PCIE_TX_P	7	AO	PCIe transmit (+)	
PCIE_RX_M	9	AI	PCIe receive (-)	
PCIE_RX_P	10	AI	PCIe receive (+)	
PCIE_CLKREQ_N	12	DO	PCIe clock request	1.8 V power domain. Active low. Pull each of them up to 1.8 V with external 10 kΩ resistors.
PCIE_WAKE_N	16	DO	PCIe wake up	
PCIE_RST_N	13	DI	PCIe reset	1.8 V power domain. Active low.

The following figure shows the PCIe interface connection between the module and the host.

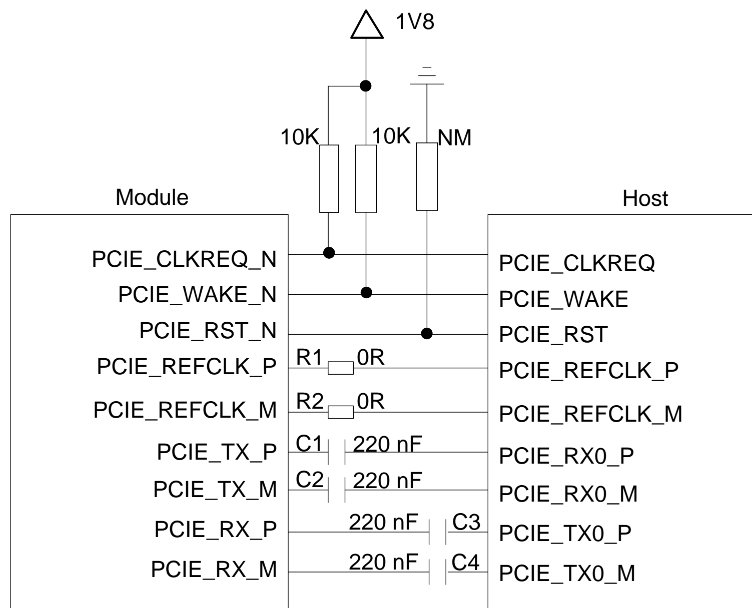


Figure 5: PCIe Interface Connection

To ensure the signal integrity of PCIe interface, C1 and C2 should be placed close to the module, and C3 and C4 should be placed close to the host. The extra stubs of traces must be as short as possible.

The following principles of PCIe interface design should be complied with to meet PCIe Gen 3 specifications.

- It is important to route PCIE_TX_P/M, PCIE_RX_P/M, and PCIE_REFCLK_P/M as differential pairs

with ground surrounded. And the differential impedance should be 85 Ω ±10 %.

- The maximum trace length of each differential pair (PCIE_TX_P/M, PCIE_RX_P/M, and PCIE_REFCLK_P/M) should be less than 200 mm, and trace length matching within each differential pair should be less than 0.5 mm.
- Space between PCIe signals and all other signals should be four times the trace width.
- Do not route signal traces under crystals, oscillators, magnetic devices, or RF signal traces. It is important to route the PCIe differential traces in inner-layer of the PCB and surround the traces with ground on that layer and with ground planes above and below.

3.5. Bluetooth Application Interfaces*

The following figure shows the Bluetooth application interface connection between the module and the host.

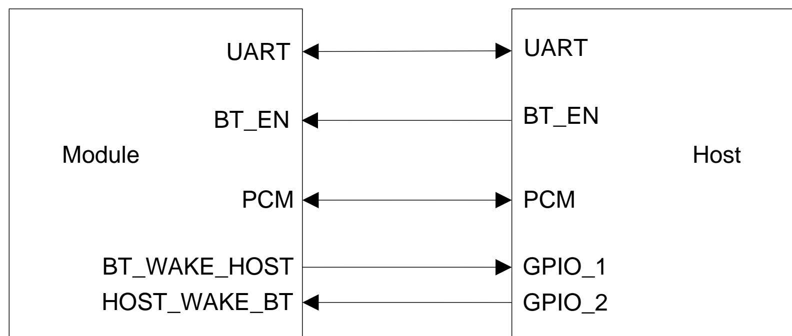


Figure 6: Bluetooth Application Interface Connection

NOTE

GPIO1 of the host connected to BT_WAKE_HOST must be interruptible.

3.5.1. BT_EN

BT_EN is used to control the Bluetooth function of the module. Bluetooth function will be enabled when BT_EN is at high level. If Bluetooth function is not needed, pull BT_EN down with a 10 kΩ resistor.

Table 8: Pin Definition of BT_EN

Pin Name	Pin No.	I/O	Description	Comment
BT_EN	21	DI	Bluetooth function enable control	1.8 V power domain.

	Active high. If unused, pull it down with a 10 KΩ resistor.

3.5.2. UART Interface

The module supports an HCI UART as defined in *Bluetooth Core Specification Version 4.0*. The UART supports hardware flow control, and it is used for data transmission with host. It supports up to 3.2 Mbps baud rates.

The following table shows the pin definition of UART interface.

Table 9: Pin Definition of UART Interface

Pin Name	Pin No.	I/O	Description	Comment
BT_RTS	22	DO	DCE request to send signal to DTE	1.8 V power domain. If unused, keep them open.
BT_CTS	23	DI	DCE clear to send signal from DTE	
BT_RXD	24	DI	Bluetooth UART receive	
BT_TXD	25	DO	Bluetooth UART transmit	

The module provides a 1.8 V UART interface. A voltage-level translator should be used if the application is equipped with a 3.3 V UART interface. A voltage-level translator TXS0104EPWR provided by Texas Instruments is recommended. The following figure shows a reference design.

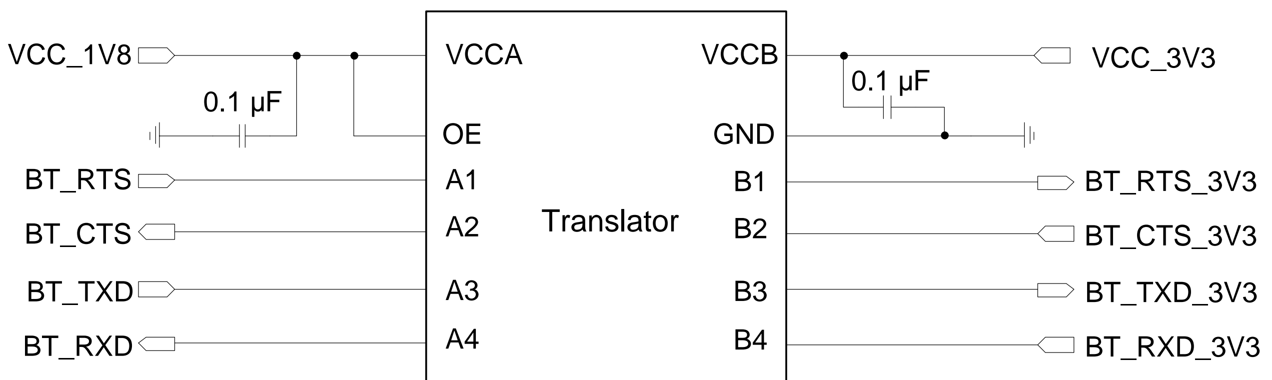


Figure 7: Reference Circuit with Voltage-level Translator

3.5.3. BT_WAKE_HOST and HOST_WAKE_BT

BT_WAKE_HOST and HOST_WAKE_BT are used to wake up the host and the module respectively. If you use Quectel 5G RG520x series as the host, these two pins can be left open because the wakeup function can be achieved through Bluetooth UART.

Table 10: Pin Definition of BT_WAKE_HOST and HOST_WAKE_BT

Pin Name	Pin No.	I/O	Description	Comment
BT_WAKE_HOST	59	DO	Bluetooth wakes up host	1.8 V power domain. If unused, keep them open.
HOST_WAKE_BT	26	DI	Host wakes up Bluetooth	

3.5.4. PCM Interface

The PCM interface is used for Bluetooth audio. The following table shows the pin definition of PCM interface.

Table 11: Pin Definition of PCM Interface

Pin Name	Pin No.	I/O	Description	Comment
PCM_DIN	62	DI	PCM data input	1.8 V power domain. If unused, keep them open.
PCM_SYNC	60	DI	PCM data frame sync	
PCM_CLK	63	DI	PCM clock	
PCM_DOUT	61	DO	PCM data output	

The following figure shows the PCM interface connection between the module and the host.

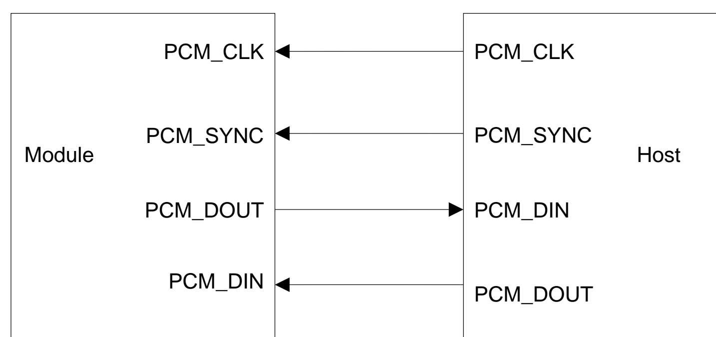


Figure 8: PCM Interface Connection

3.6. Coexistence Interfaces

The module supports 2.4 GHz LTE & Wi-Fi coexistence and 5 GHz LTE & Wi-Fi coexistence.

The following table shows the pin definition of coexistence interfaces.

Table 12: Pin Definition of Coexistence Interfaces

Pin Name	Pin No.	I/O	Description	Comment
COEX_TXD	32	DO	2.4 GHz LTE & Wi-Fi coexistence transmit	1.8 V power domain. If unused, keep them open.
COEX_RXD	26	DI	2.4 GHz LTE & Wi-Fi coexistence receive	
LAA_TXEN	34	DI	When it goes high, module places the 5 GHz receiver in a protected state.	
LAA_RX	54	DI	When it goes high, module allows LAA to receive on the Wi-Fi antennas.	
WLAN_TXEN	33	DO	Module asserts it to high state when 5 GHz is set to transmit at power greater than 10 dBm.	
PA_MUTE	53	DI	When it goes high, 2.4 GHz PA is turned off.	

3.7. Other Interfaces

3.7.1. WLAN_SLP_CLK

The WLAN_SLP_CLK is 32.768 kHz sleep clock which is used in low power modes, such as power saving mode and sleep mode. It serves as a timer in various power saving schemes, and can maintain basic logic operations when the module is in sleep mode.

Table 13: Pin Definition of WLAN_SLP_CLK

Pin Name	Pin No.	I/O	Description	Comment
WLAN_SLP_CLK	20	DI	32.768 kHz sleep clock	1.8 V power domain. If unused, keep it open.

Figure and table below show the reference input clock requirements of WLAN_SLP_CLK.

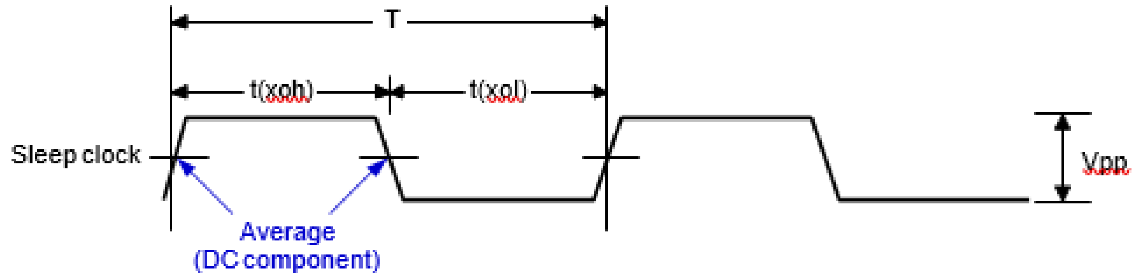


Figure 9: Requirements of WLAN_SLP_CLK

Table 14: Parameters of WLAN_SLP_CLK

Parameter	Description	Min	Typ	Max	Unit
T (xoh)	Sleep-clock logic high	4.58	4.58	25.94	μs
T (xol)	Sleep-clock logic low	4.58	4.58	25.94	μs
T	Sleep-clock period	-	30.5208	-	μs
F	Sleep-clock frequency (F = 1/T)	-	32.7645	-	kHz
Vpp	Peak-to-peak voltage	-	1.8	-	V

3.7.2. SW_CTRL

SW_CTRL can be used to control external RF power supply chip.

The following table shows the pin definition of SW_CTRL.

Table 15: Pin Definition of SW_CTRL

Pin Name	Pin No.	I/O	Description	Comment
SW_CTRL	27	DO	VDD_FEM power switch control	1.8 V power domain. Active high. If unused, keep it open.

3.8. RF Antenna Interfaces

Table 16: Pin Definition of RF Antenna Interfaces

Pin Name	Pin No.	I/O	Description	Comment
ANT_WIFI0	43	AIO	Wi-Fi 0 antenna interface	50 Ω impedance
ANT_WIFI1	47	AIO	Wi-Fi 1 antenna interface	
ANT_BT*	39	AIO	Bluetooth antenna interface	

3.8.1. Operating Frequencies

Table 17: Operating Frequencies (Unit: GHz)

Feature	Frequency
2.4 GHz Wi-Fi	2.400–2.4835
5 GHz Wi-Fi	5.150–5.850

3.8.2. RF Antenna Reference Design

FC06E provides three RF antenna interfaces for antenna connection. The following reference design shows an example with ANT_WIFI0. For other RF antenna interfaces, the reference design is the same.

It is recommended to reserve a π-type matching circuit for better RF performance, and the π-type matching components (C1, C2, R1) should be placed as close to the antenna as possible. C1 and C2 are not mounted by default.

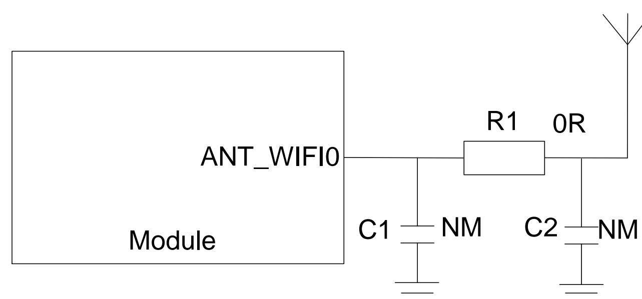


Figure 10: RF Antenna Reference Design

3.8.3. 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.

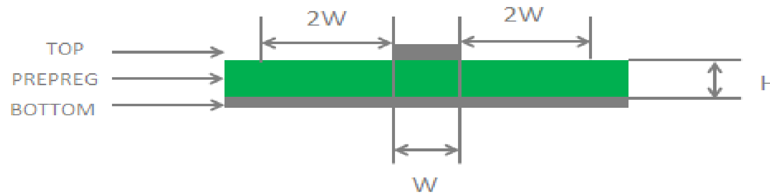


Figure 11: Microstrip Design on a 2-layer PCB

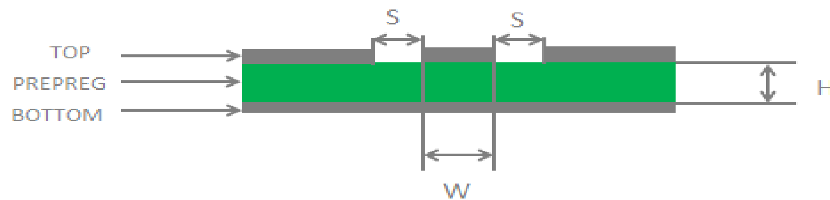


Figure 12: Coplanar Waveguide Design on a 2-layer PCB

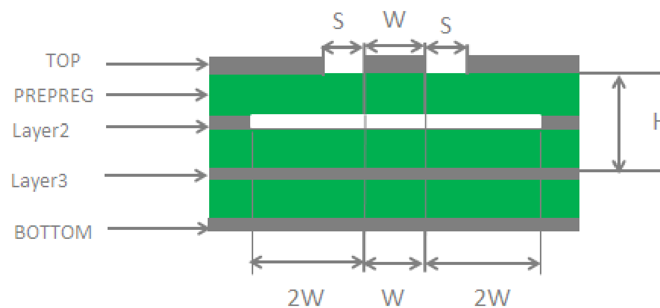


Figure 13: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

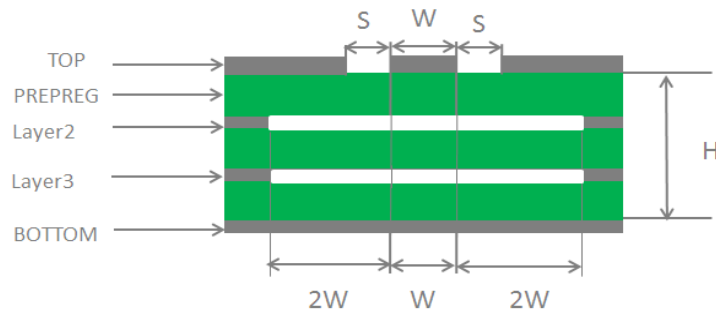


Figure 14: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

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].***

3.8.4. Antenna Design Requirements

The following table shows the requirements for antennas.

Table 18: Antenna Requirements

Parameter	Requirement
Frequency Ranges (GHz)	● 2.400–2.4835 ● 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

3.8.5. RF Connector Recommendation

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

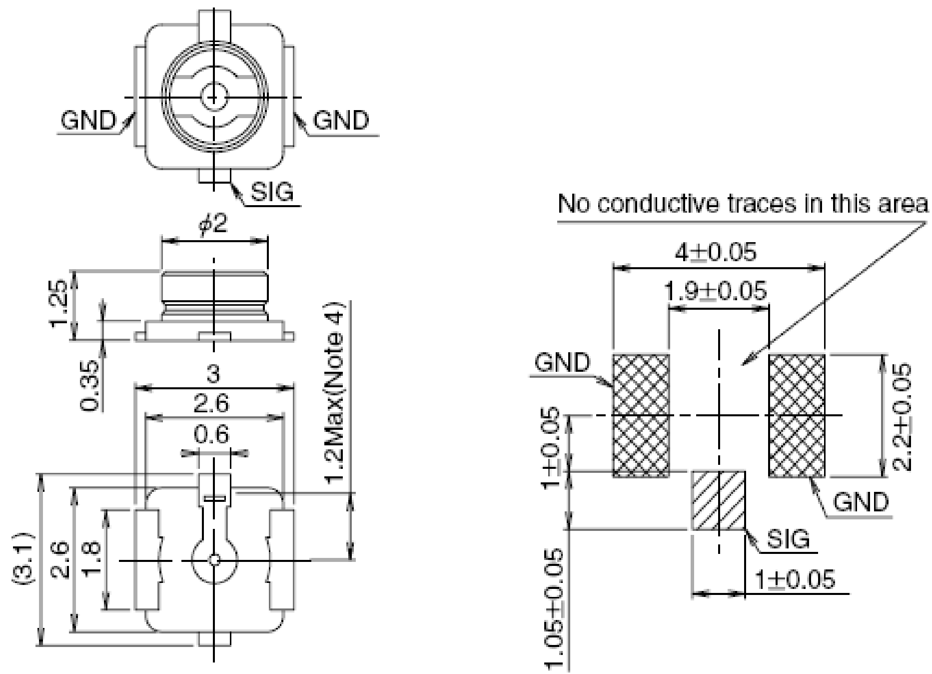


Figure 15: Dimensions of the Receptacle (Unit: mm)

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 16: Specifications of Mated Plugs

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

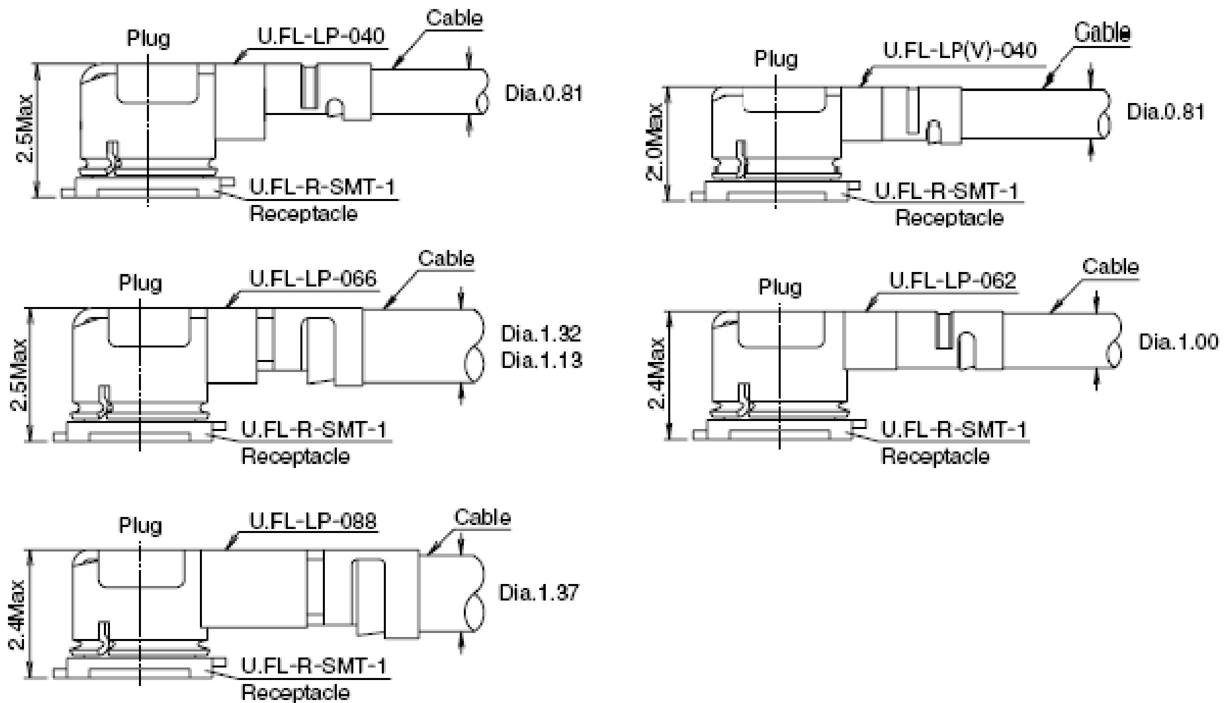


Figure 17: Space Factor of the Mated Connectors (Unit: mm)

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

4 Electrical Characteristics & Reliability

4.1. Absolute Maximum Ratings

The following table shows the absolute maximum ratings.

Table 19: Absolute Maximum Ratings (Unit: V)

Parameter	Min.	Max.
VDD_CORE_VL	-0.3	V_{DDX} + 0.2
VDD_CORE_VM	-0.3	V_{DDX} + 0.2
VDD_CORE_VH	-0.3	V_{DDX} + 0.2
VDD_IO	-0.3	V_{DDX} + 0.2
VDD_RF	-0.3	V_{DDX} + 0.2
VDD_FEM	-0.3	6.0
I/O input pins voltage	-0.3	VDD_IO + 0.2

NOTE

V_{DDX} is the external supply voltage for the corresponding power input pins.

4.2. Power Supply Ratings

Table 20: Module Power Supply Ratings (Unit: V)

Parameter	Min.	Typ.	Max.
VDD_CORE_VL	0.9	0.95	1.05
VDD_CORE_VM	1.3	1.35	2.1
VDD_CORE_VH	1.85	1.95	2.1
VDD_IO	1.71	1.8	1.89
VDD_RF	1.85	1.95	2.1
VDD_FEM	3.3	5.0	5.5

4.3. Digital I/O Characteristics

Table 21:Digital I/O Characteristics (Unit: V)

Parameter	Description	Min.	Max.
V_{IH}	High-level Input Voltage	0.65 × VDD_IO	VDD_IO + 0.3
V_{IL}	Low-level Input Voltage	-0.3	0.35 × VDD_IO
V_{OH}	High-level Output Voltage	VDD_IO - 0.45	VDD_IO
V_{OL}	Low-level Output Voltage	0	0.45

4.4. Operating and Storage Temperatures

Table 22: Operating and Storage Temperatures (Unit: °C)

Parameter	Min.	Typ.	Max.
Operating Temperature Range [2]	-30	25	+75
Storage Temperature Range	-40	-	+85

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

4.5. Power Consumption

The following tables show the power consumption of the module in different modes.

4.5.1. Power Consumption in Low Power Modes

Table 23: Power Consumption of the Module (Low Power Modes, Unit: mA)

Module State	Wi-Fi State	VDD_CORE_VL	VDD_CORE_VM	VDD_CORE_VH	VDD_IO	VDD_RF	VDD_FEM
OFF [3]	Wi-Fi function disabled	0.12	0.08	0.07	2.1	0.03	0.02

4.5.2. Power Consumption

Table 24: Power Consumption (Unit: mA)

Mode	Condition	VDD_CORE_VL	VDD_CORE_VM	VDD_CORE_VH	VDD_IO	VDD_RF	VDD_FEM
2 × 2 + 2 × 2 (DBS)	802.11n HT20 @ MCS 0	413.99	282.85	143.89	7.52	0.03	1287
	802.11n HT40 @ MCS 7	426.17	300.12	141.51	7.57	0.03	1148
	802.11n HT20 @ MCS 0 + 802.11ac VHT20 MCS 0	385.44	284.79	143.28	7.53	0.03	1316
	802.11n MCS 7 HT40 + 802.11ac MCS 9 VHT80	430.46	302.49	140.11	7.55	0.02	1158

[3] In OFF state, the Wi-Fi driver is uninstalled and WLAN_EN is pulled down.

	802.11ax MCS 0 HE20	402.1	295.64	152.93	7.53	0.03	1289
	802.11ax MCS 11 2.4 GHz HE40 + 5 GHz HE80	488.97	311.17	150.23	7.56	0.03	1142

4.6. RF Performances

The following tables summarize the Wi-Fi transmitting and receiving performances of the module.

4.6.1. Wi-Fi RF Performances

Table 25: Wi-Fi Tx Power at 2.4 GHz (Unit: dBm)

Description VDD_FEM = 5 V	Typ.	Tolerance
802.11b @ 1 Mbps	20	±2 dB
802.11b @ 11 Mbps	20	±2 dB
802.11g @ 6 Mbps	20	±2 dB
802.11g @ 54 Mbps	19	±2 dB
802.11n, HT20 @ MCS 0	20	±2 dB
802.11n, HT20 @ MCS 7	18.5	±2 dB
802.11n, HT40 @ MCS 0	20	±2 dB
802.11n, HT40 @ MCS 7	18.5	±2 dB
802.11ax, HE20 @ MCS 0	20	±2 dB
802.11ax, HE20 @ MCS 11	17.5	±2 dB
802.11ax, HE40 @ MCS 0	20	±2 dB
802.11ax, HE40 @ MCS 11	17.5	±2 dB
Description VDD_FEM = 3.3 V	**Typ.**	**Tolerance**
802.11b @ 1 Mbps	19	±2 dB
802.11b @ 11 Mbps	19	±2 dB
802.11g @ 6 Mbps	17	±2 dB
802.11g @ 54 Mbps	15	±2 dB
802.11n, HT20 @ MCS 0	17	±2 dB

802.11n, HT20 @ MCS 7	15	±2 dB
802.11n, HT40 @ MCS 0	17	±2 dB
802.11n, HT40 @ MCS 7	15	±2 dB
802.11ax, HE20 @ MCS 0	17	±2 dB
802.11ax, HE20 @ MCS 11	14	±2 dB
802.11ax, HE40 @ MCS 0	17	±2 dB
802.11ax, HE40 @ MCS 11	14	±2 dB

Table 26: Wi-Fi Tx Power at 5 GHz (Unit: dBm)

Description VDD_FEM = 5 V	Typ.	Tolerance
802.11a @ 6 Mbps	20	±2 dB
802.11a @ 54 Mbps	19	±2 dB
802.11n, HT20 @ MCS 0	20	±2 dB
802.11n, HT20 @ MCS 7	18.5	±2 dB
802.11n, HT40 @ MCS 0	20	±2 dB
802.11n, HT40 @ MCS 7	18.5	±2 dB
802.11ac, VHT20 @ MCS 0	20	±2 dB
802.11ac, VHT20 @ MCS 8	17.5	±2 dB
802.11ac, VHT40 @ MCS 0	20	±2 dB
802.11ac, VHT40 @ MCS 9	17.5	±2 dB
802.11ac, VHT80 @ MCS 0	20	±2 dB
802.11ac, VHT80 @ MCS 9	17	±2 dB
802.11ax, HE20 @ MCS 0	20	±2 dB
802.11ax, HE20 @ MCS 11	17	±2 dB
802.11ax, HE40 @ MCS 0	20	±2 dB

802.11ax, HE40 @ MCS 11	17	±2 dB
802.11ax, HE80 @ MCS 0	20	±2 dB
802.11ax, HE80 @ MCS 11	16.5	±2 dB
Description VDD_FEM = 3.3 V	**Typ.**	**Tolerance**
802.11a @ 6 Mbps	18	±2 dB
802.11a @ 54 Mbps	16.5	±2 dB
802.11n, HT20 @ MCS 0	18	±2 dB
802.11n, HT20 @ MCS 7	16	±2 dB
802.11n, HT40 @ MCS 0	18	±2 dB
802.11n, HT40 @ MCS 7	16	±2 dB
802.11ac, VHT20 @ MCS 0	18	±2 dB
802.11ac, VHT20 @ MCS 8	15.5	±2 dB
802.11ac, VHT40 @ MCS 0	18	±2 dB
802.11ac, VHT40 @ MCS 9	15.5	±2 dB
802.11ac, VHT80 @ MCS 0	17.5	±2 dB
802.11ac, VHT80 @ MCS 9	15	±2 dB
802.11ax, HE20 @ MCS 0	18	±2 dB
802.11ax, HE20 @ MCS 11	15	±2 dB
802.11ax, HE40 @ MCS 0	18	±2 dB
802.11ax, HE40 @ MCS 11	15	±2 dB
802.11ax, HE80 @ MCS 0	17.5	±2 dB
802.11ax, HE80 @ MCS 11	14	±2 dB

Table 27: Wi-Fi Rx Sensitivity at 2.4 GHz (Unit: dBm)

Description VDD_FEM = 5 V or 3.3V	Typ.	Tolerance

802.11b @ 1 Mbps	-95	±2 dB
802.11b @ 11 Mbps	-89	±2 dB
802.11g @ 6 Mbps	-93	±2 dB
802.11g @ 54 Mbps	-75	±2 dB
802.11n, HT20 @ MCS 0	-91	±2 dB
802.11n, HT20 @ MCS 7	-72	±2 dB
802.11n, HT40 @ MCS 0	-89	±2 dB
802.11n, HT40 @ MCS 7	-70	±2 dB
802.11ax, HE20 @ MCS 0	-91	±2 dB
802.11ax, HE20 @ MCS 11	-63	±2 dB
802.11ax, HE40 @ MCS 0	-90	±2 dB
802.11ax, HE40 @ MCS 11	-61	±2 dB

Table 28: Wi-Fi Rx Sensitivity at 5 GHz (Unit: dBm)

Description VDD_FEM = 5 V or 3.3V	Typ.	Tolerance
802.11a @ 6 Mbps	-92	±2 dB
802.11a @ 54 Mbps	-74	±2 dB
802.11n, HT20 @ MCS 0	-91	±2 dB
802.11n, HT20 @ MCS 7	-72	±2 dB
802.11n, HT40 @ MCS 0	-88	±2 dB
802.11n, HT40 @ MCS 7	-70	±2 dB
802.11ac, VHT20 @ MCS 0	-91	±2 dB
802.11ac, VHT20 @ MCS 8	-70	±2 dB
802.11ac, VHT40 @ MCS 0	-90	±2 dB
802.11ac, VHT40 @ MCS 9	-65	±2 dB

802.11ac, VHT80 @ MCS 0	-86	±2 dB
802.11ac, VHT80 @ MCS 9	-61	±2 dB
802.11ax, HE20 @ MCS 0	-91	±2 dB
802.11ax, HE20 @ MCS 11	-63	±2 dB
802.11ax, HE40 @ MCS 0	-90	±2 dB
802.11ax, HE40 @ MCS 11	-60	±2 dB
802.11ax, HE80 @ MCS 0	-86	±2 dB
802.11ax, HE80 @ MCS 11	-58	±2 dB

4.6.2. Bluetooth RF Performances*

Table 29: Bluetooth Tx Power and Rx Sensitivity (Unit: dBm)

Mode	Transmitting Power (Typ.)	Receiving Sensitivity (Typ.)
GFSK	8	-91
π/4-DQPSK	6.5	-91
8-DQPSK	6.5	-88
BLE (1 Mbps)	8	-98
BLE (2 Mbps)	8	-95

4.7. 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 30: Electrostatic Discharge Characteristics (Temperature: 25–30 °C, Humidity: 40 ±5 %)

Tested Interfaces	Contact Discharge	Air Discharge	Unit

Antenna Interfaces	±3	±6	kV
Other Interfaces	±0.5	±1	kV

4.8. Thermal Dissipation

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

The following principles for thermal consideration are provided for reference:

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

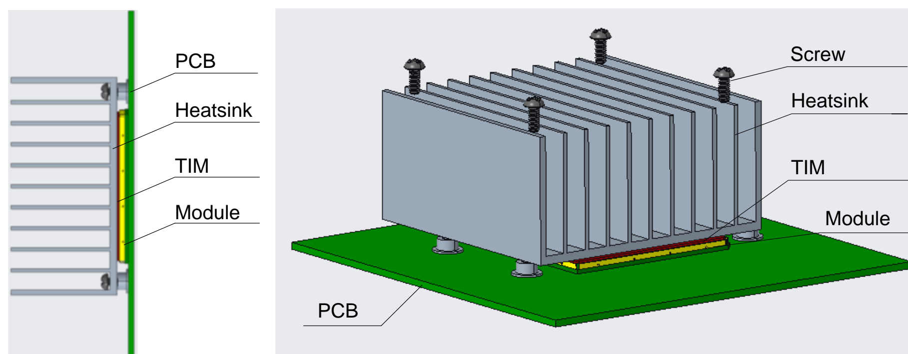


Figure 18: Placement and Fixing of the Heatsink

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

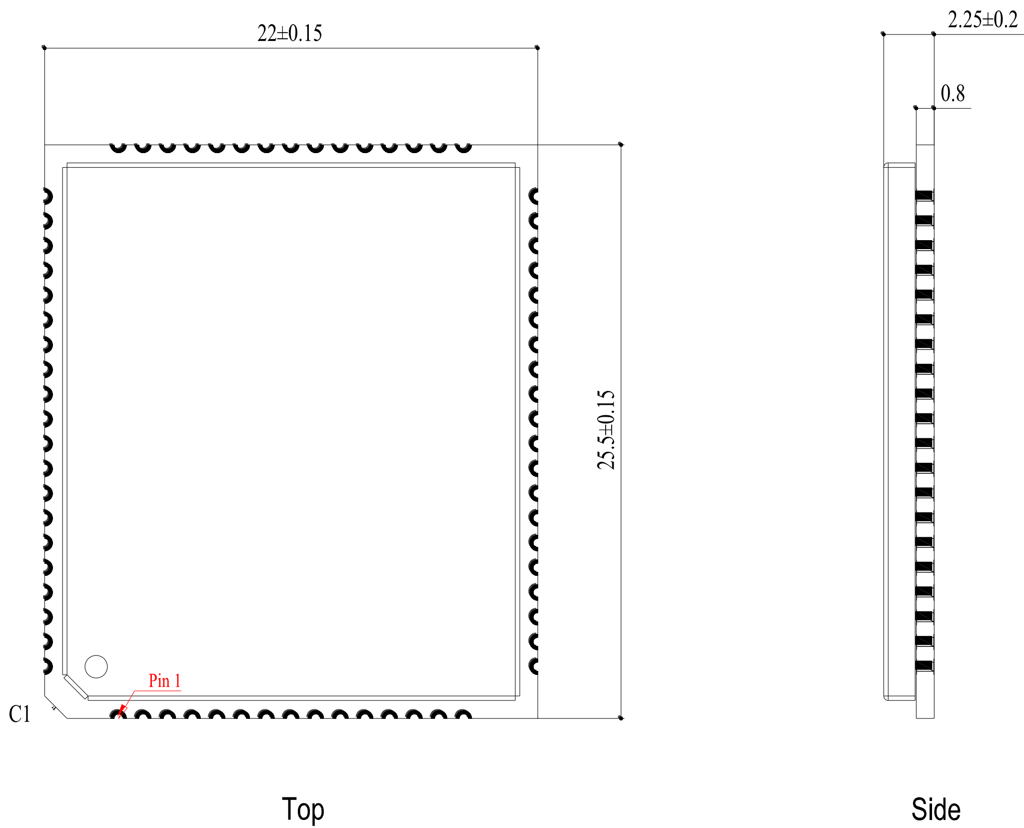


Figure 19: Module Top and Side Dimensions

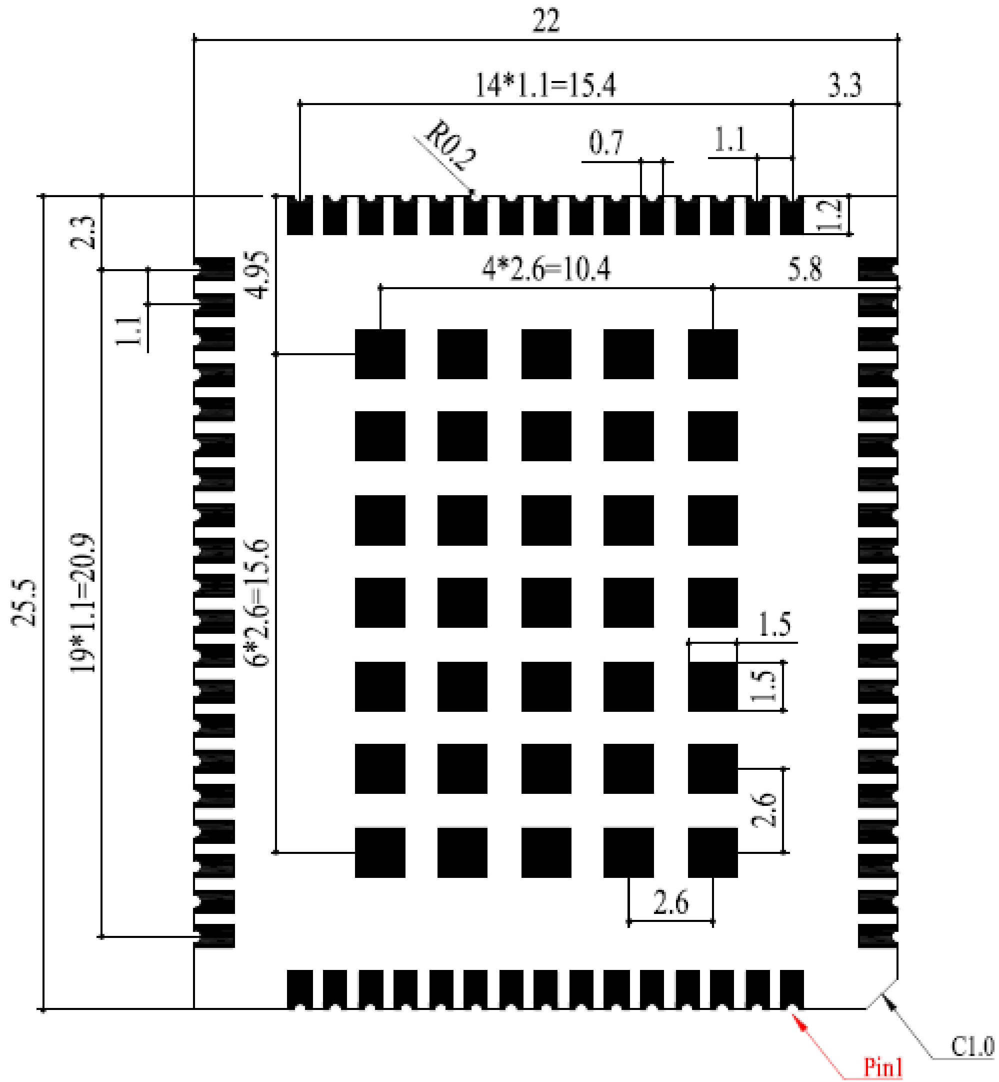


Figure 20: Module Bottom Dimension (Bottom View)

NOTE

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

5.2. Recommended Footprint

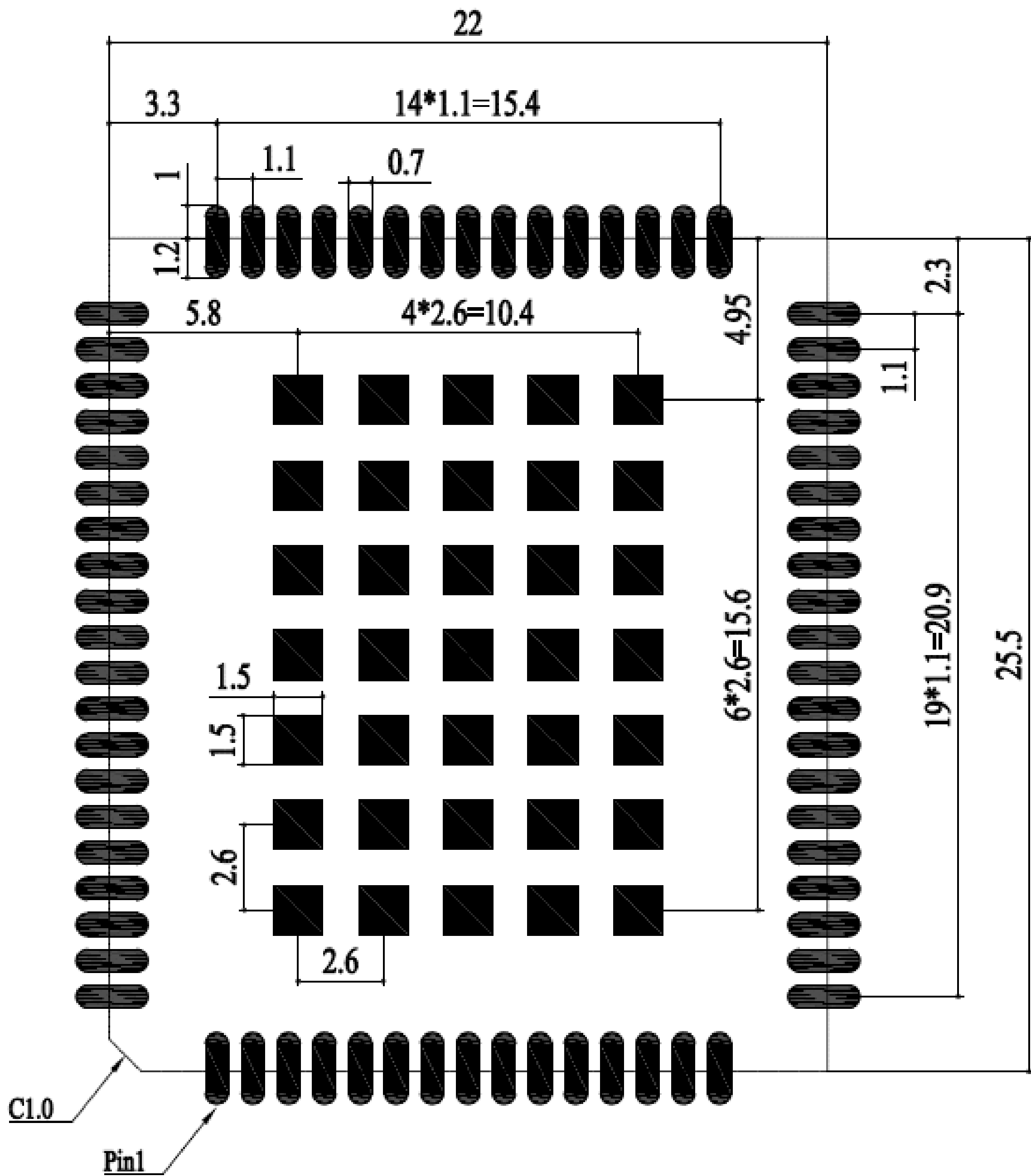


Figure 21: Recommended Footprint (Top View)

NOTE

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

5.3. Top and Bottom Views

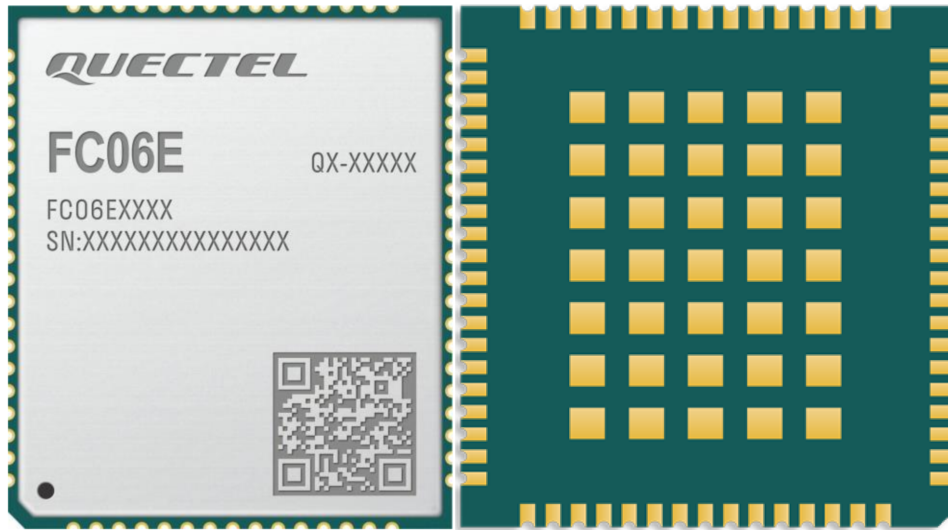


Figure 22: Top and Bottom Views of the Module

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 and 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 [4] 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.

[4] 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 remove the packages of tremendous modules if they are not 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 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.

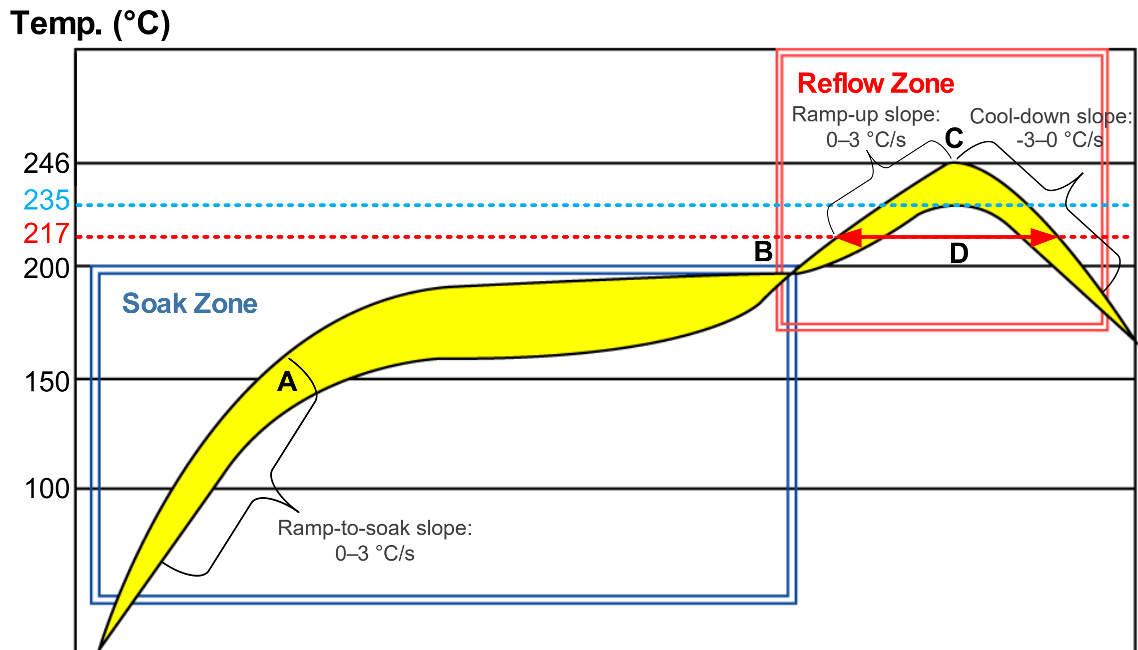


Figure 23: Recommended Reflow Soldering Thermal Profile

Table 31: 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. 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].***

6.3. Packaging Specifications

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

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

6.3.1. Carrier Tape

Dimension details are as follow:

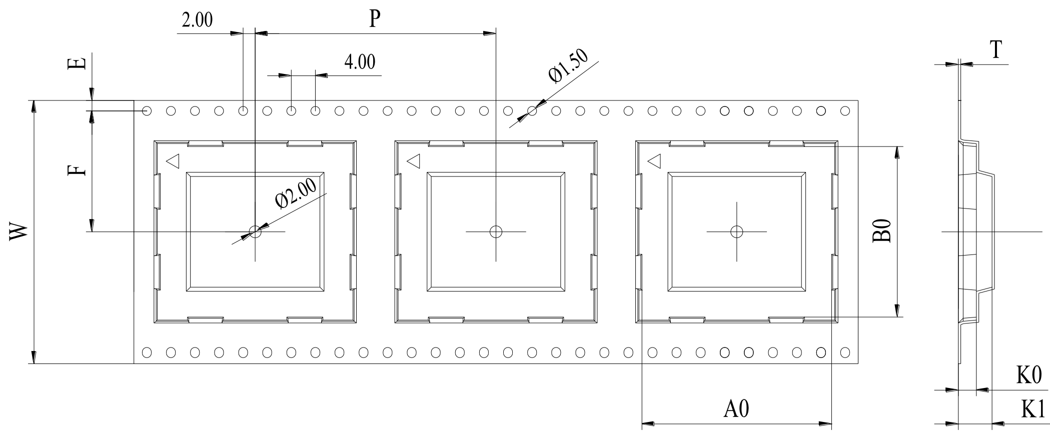


Figure 24: Carrier Tape Dimension Drawing

Table 32: Carrier Tape Dimension Table (Unit: mm)

W	P	T	A0	B0	K0	K1	F	E
44	32	0.4	18.5	20.5	3	6.8	20.2	1.75

6.3.2. Plastic Reel

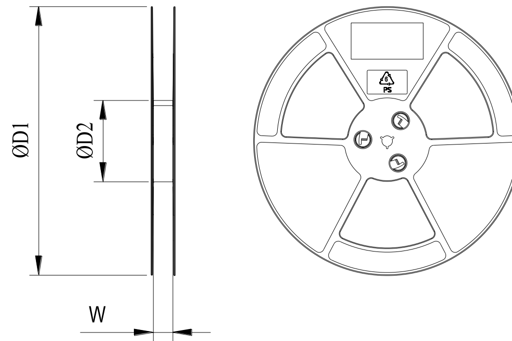
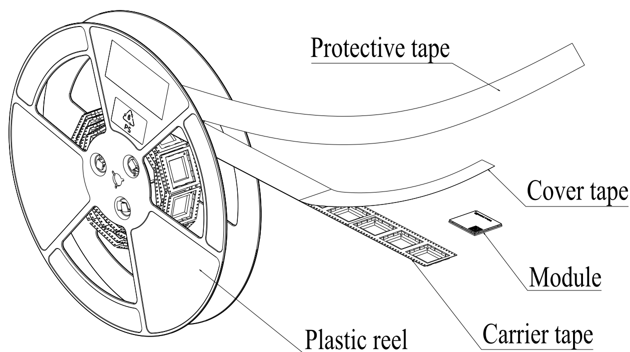


Figure 25: Plastic Reel Dimension Drawing

Table 33: Plastic Reel Dimension Table (Unit: mm)

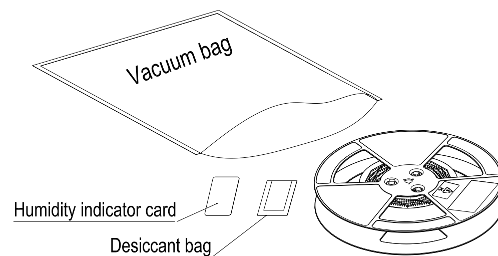
øD1	øD2	W
330	100	44.5

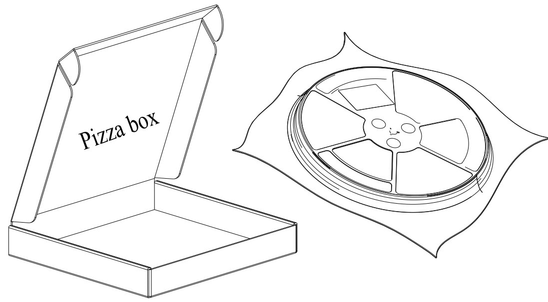
6.3.3. Packaging Process



Place the module into the carrier tape and use the cover tape to cover it; then wind the heat-sealed carrier tape to the plastic reel and use the protective tape for protection. 1 plastic reel can load 250 modules.

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





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

Put 4 packaged pizza boxes into 1 carton box and seal it. 1 carton box can pack 1000 modules.

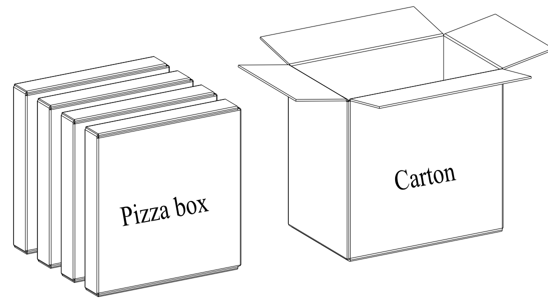


Figure 26: Packaging Process

7 Appendix References

Table 34: Related Documents

Document Name
[1] Quectel_Wi-Fi-M.2_EVB_User_Guide
[2] Quectel_RF_Layout_Application_Note
[3] Quectel_Module_SMT_Application_Note

Table 35: Terms and Abbreviations

Abbreviation	Description
AP	Access Point
BLE	Bluetooth Low Energy
BPSK	Binary Phase Shift Keying
CCK	Complementary Code Keying
CTS	Clear To Send
DBS	Dual Band Simultaneous
DCE	Data Communications Equipment
DPSK	Differential Phase Shift Keying
DQPSK	Differential Quadrature Phase Shift Keying
DTE	Data Terminal Equipment
ESD	Electrostatic Discharge
EVB	Evaluation Board

FEM	Front-End Module
GFSK	Gauss frequency Shift Keying
GND	Ground
HCI	Host Controller Interface
HE	High Efficiency
HT	High Throughput
IEEE	Institute of Electrical and Electronics Engineers
I/O	Input/Output
LAA	License Assisted Access
LCC	Leadless chip carrier
LGA	Land Grid Array
LTE	Long Term Evolution
MAC	Medium Access Control
Mbps	Megabits per second
MCS	Modulation and Coding Scheme
MSL	Moisture Sensitivity Levels
MU-MIMO	Multi-User Multiple-Input Multiple-Output
PA	Power Amplifier
PCB	Printed Circuit Board
PCIe	Peripheral Component Interconnect Express
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
SMT	Surface Mount Technology
STA	Station
TBD	To Be Determined
Tx	Transmit
UART	Universal Asynchronous Receiver/Transmitter
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
Vpp	Peak-to-peak Voltage
VSWR	Voltage Standing Wave Ratio
Wi-Fi	Wireless-Fidelity

8 Worning

8.1. Important Notice to OEM integrators

Product Marketing Name： Quectel FC06E

1.This module is limited to OEM installation ONLY.

2.This module is limited to installation in fixed applications, according to Part 2.1091(b).

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

Important Note Important Note notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify to Quectel Wireless Solutions Co., Ltd.. that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the USI, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application. End Product LabelingWhen the module is installed in the host device, the FCC/IC ID label must be visible through a window on the final device or it must be visible when an access panel, door or cover is easily re-moved. If not, a second label must be placed on the outside of the final device that contains the following text: “Contains FCC ID: XMR2023FC06E” The FCC ID can be used only when all FCC mpliance requirements are met.

Antenna Installation

(1)The antenna must be installed such that 20 cm is maintained between the antenna and users,

(2)The transmitter module may not be co-located with any other transmitter or antenna.

(3)Only antennas of the same type and with equal or less gains as shown below may be used with thismodule. Other types of antennas and/or higher gain antennas may require additional authorization for operation.

(4)The max allowed antenna gain is 1 dBi for external monopole antenna.

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID/IC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC/IC authorization.

Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user’s manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

7.2. FCC Statement

Federal Communication Commission Interference Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1)This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:
-Reorient or relocate the receiving antenna.
-Increase the separation between the equipment and receiver.
-Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
-Consult the dealer or an experienced radio/TV technician for help.
Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

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

(For module device use)
1)The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2)The transmitter module may not be co-located with any other transmitter or antenna. As long as 2conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Radiation Exposure Statement

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

8.3. IC Statement

IRSS-GEN
"This device complies with Industry Canada’s licence-exempt RSSs. Operation is subject to the following two conditions: (1) This device may not cause interference; and (2) This device must accept any interference, including interference that may cause undesired operation of the device." or "Le présent appareil est conforme aux CNR d’Industrie Canada applicables aux appareils radio exempts de licence. L’exploitation est autorisée aux deux conditions suivantes :
1) l’appareil ne doit pas produire de brouillage; 2) l’utilisateur de l’appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d’en compromettre le fonctionnement."
Déclaration sur l'exposition aux rayonnements RF
L'autre utilisé pour l'émetteur doit être installé pour fournir une distance de séparation d'au moins 20 cm de toutes les personnes et ne doit pas être colocalisé ou fonctionner conjointement avec une autre antenne ou un autre émetteur.
The host product shall be properly labeled to identify the modules within the host product.
The Innovation, Science and Economic Development Canada certification label of a module shall be clearly visible at all times when installed in the host product; otherwise, the host product must be labeled to display the Innovation, Science and Economic Development Canada certification number for the module, preceded by the word “Contains” or similar wording expressing the same meaning, as follows:
“Contains IC: 10224A-2023FC06E” or “where: 10224A-2023FC06E is the module’s certification number”.

Le produit hôte doit être correctement étiqueté pour identifier les modules dans le produit hôte. L'étiquette de certification d'Innovation, Sciences et Développement économique Canada d'un module doit être clairement visible en tout temps lorsqu'il est installédans le produit hôte; sinon, le produit hôte doit porter une étiquette indiquant le numéro de certification d'Innovation, Sciences et Développement économique Canada pour le module, précédé du mot «Contient» ou d'un libellé semblable exprimant la même signification, comme suit:
"Contient IC: 10224A-2023FC06E" ou "où: 10224A-2023FC06E est le numéro de certification du module".
i. the device for operation in the band 5150–5250 MHz is only for indoor use to reduce the potential for harmful interference to co-channel mobile satellite systems;
ii. for devices with detachable antenna(s), the maximum antenna gain permitted for devices in the bands 5250-5350 MHz and 5470-5725 MHz shall be such that the equipment still complies with the e.i.r.p. limit;
iii. for devices with detachable antenna(s), the maximum antenna gain permitted for devices in the band 5725-5850 MHz shall be such that the equipment still complies with the e.i.r.p. limits as appropriate;
iv. Omnidirectional antenna is recommended