

FME164Q Hardware Design

Short-Range Module Series

Version: 1.0

Date: 2024-11-19

Status: Released



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Quectel Wireless Solutions Co., Ltd.

Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai 200233, China

Tel: +86 21 5108 6236

Email: info@quectel.com

Or our local offices. For more information, please visit:

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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
-	2024-05-11	Soni RAO	Creation of the document
1.0	2024-11-19	Soni RAO	First official release

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1 Introduction

This document defines the FME164Q features, performances, and air interfaces and hardware interfaces connected to your applications. The document provides a quick insight into 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 FLM164Q is in compliance with Directive 2014/53/EU.

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

Disposal of old electrical appliances



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

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

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



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

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

1.1. Special Mark

Table 1: Special Mark

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

2 Product Overview

FME164Q is a low-power, cost-effective Wi-Fi 6 and Bluetooth module supporting IEEE 802.11a/b/g/n/ac/ax and Bluetooth 5.3 protocols. It provides a PCIe Gen 3 interface for Wi-Fi application and a UART and a PCM interface for Bluetooth application.

FME164Q is a module developed by Quectel FC64E module using MOB technology, and complies with *PCI Express M.2 Specification Revision 4.0* and *PCI Express Base Specification Revision 4.0*.

2.1. Key Features

Table 2: Key Features

Basic Information	
Protocols and Standard	● Wi-Fi protocols: IEEE 802.11a/b/g/n/ac/ax ● Bluetooth protocol: Bluetooth 5.3 ● All hardware components are fully compliant with EU RoHS directive
Functional Interface	PCI Express M.2
Power Supply	VCC Power Supply: ● 3.0–3.6 V ● Typ.: 3.3 V
Physical Characteristics	● Packaging type: M.2 Key-E ● Dimensions: 22.0 mm × 30.0 mm × 4.0 mm ● Weight: approx. 3.22 g
Temperature Ranges	● Operating temperature ¹: -10 °C to +65 °C ● Storage temperature: -40 °C to +85 °C
RF Antenna Interface	
Wi-Fi Antenna Interfaces	● RF Coaxial Connector: ANT_WIFI0/BT, ANT_WIFI1 ● 50 Ω characteristic impedance
Bluetooth Antenna Interface	● RF Coaxial Connector: ANT_WIFI0/BT ● 50 Ω characteristic impedance

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

Application Interface

Wi-Fi Application Interface	PCIe 3.0
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Bluetooth Application Interfaces	● PCM ● UART
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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			
DBPSK, DQPSK, CCK, BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM			
Operating Mode			
● AP ● STA			
Encryption Mode			
WPA3			
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–MCS 7), HT40 (MCS 0–MCS 7) ● 802.11ac: VHT20 (MCS 0–MCS 8), VHT40 (MCS 0–MCS 9), VHT80 (MCS 0–MCS 9) ● 802.11ax: HE20 (MCS 0–MCS 11), HE40 (MCS 0–MCS 11), HE80 (MCS 0–MCS 11)			
Condition (VCC = 3.3 V; Temp. 25 °C)	EVM	Typ.; Unit: dBm; Tolerance: ±2 dB	
		Transmitting Power	Receiver Sensitivity
2.4 GHz	802.11b @ 1 Mbps	17	-96
		≤ -9 dB	
	802.11b @ 11 Mbps	17	-88
	802.11g @ 6 Mbps	16	-93
		≤ -5 dB	

5 GHz	802.11g @ 54 Mbps	≤ -25 dB	14.5	-74
	802.11n, HT20 @ MCS 0	≤ -5 dB	16	-93
	802.11n, HT20 @ MCS 7	≤ -27 dB	13.5	-73
	802.11n, HT40 @ MCS 0	≤ -5 dB	15.5	-90
	802.11n, HT40 @ MCS 7	≤ -27 dB	13	-71
	802.11ax, HE20 @ MCS 0	≤ -5 dB	16	-93
	802.11ax, HE20 @ MCS 11	≤ -35 dB	11	-63
	802.11ax, HE40 @ MCS 0	≤ -5 dB	15.5	-90
	802.11ax, HE40 @ MCS 11	≤ -35 dB	10	-60
	802.11a @ 6 Mbps	≤ -5 dB	15	-91
	802.11a @ 54 Mbps	≤ -25 dB	13	-72
	802.11n, HT20 @ MCS 0	≤ -5 dB	15	-92
	802.11n, HT20 @ MCS 7	≤ -27 dB	12	-72
	802.11n, HT40 @ MCS 0	≤ -5 dB	14.5	-89
	802.11n, HT40 @ MCS 7	≤ -27 dB	11.5	-70
	802.11ac, VHT20 MCS 0	≤ -5 dB	15	-92
	802.11ac, VHT20 MCS 8	≤ -30 dB	11.5	-69
	802.11ac, VHT40 @ MCS 0	≤ -5 dB	14.5	-89
	802.11ac, VHT40 @ MCS 9	≤ -32 dB	10.5	-65
	802.11ac, VHT80 @ MCS 0	≤ -5 dB	14	-86
	802.11ac, VHT80 @ MCS 9	≤ -32 dB	10	-61
	802.11ax, HE20 @ MCS 0	≤ -5 dB	15	-92
	802.11ax, HE20 @ MCS 11	≤ -35 dB	9.5	-62
	802.11ax, HE40 @ MCS 0	≤ -5 dB	14.5	-89
	802.11ax, HE40 @ MCS 11	≤ -35 dB	9.5	-60
	802.11ax, HE80 @ MCS 0	≤ -5 dB	14	-86

802.11ax, HE80 @ MCS 11	≤ -35 dB	8.5	-57
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NOTE

1. The built-in 2 GHz SAW device of the module is optional. **Table 3** shows the Wi-Fi transmitting power and receiver sensitivity data of the module without built-in SAW device. Due to the impact of the SAW device, these data are reduced by 1 dB when the module is equipped with the SAW device.
2. The receiver sensitivity test requires that LDPC be set to ON.

3.2. Bluetooth Performances

Table 4: Bluetooth Performances

Operating Frequency		
2.400–2.4835 GHz		
Modulation		
GFSK, 8-DPSK, $\pi/4$ -DQPSK		
Operating Mode		
• Classic Bluetooth (BR + EDR) • Bluetooth Low Energy (BLE), supporting 2 Mbps and BLE Long Range		
Condition (VCC = 3.3 V; Temp. 25 °C)	Typ.; Unit: dBm; Tolerance: ± 2 dB	
	Transmitting Power	Receiver Sensitivity
BR (GFSK)	7	-94
EDR ($\pi/4$ -DQPSK)	3.5	-92
EDR (8-DPSK)	3.5	-87
BLE (1 Mbps)	6.5	-97
BLE (2 Mbps)	6.5	-95
BLE (125 kbps)	6.5	-104
BLE (500 kbps)	6.5	-99

NOTE

The built-in 2 GHz SAW device of the module is optional. **Table 4** shows the Bluetooth transmitting power and receiver sensitivity data of the module without built-in SAW device. Due to the impact of the SAW device, these data are reduced by 1 dB when the module is equipped with the SAW device.

4 Application Interfaces

4.1. Pin Assignment

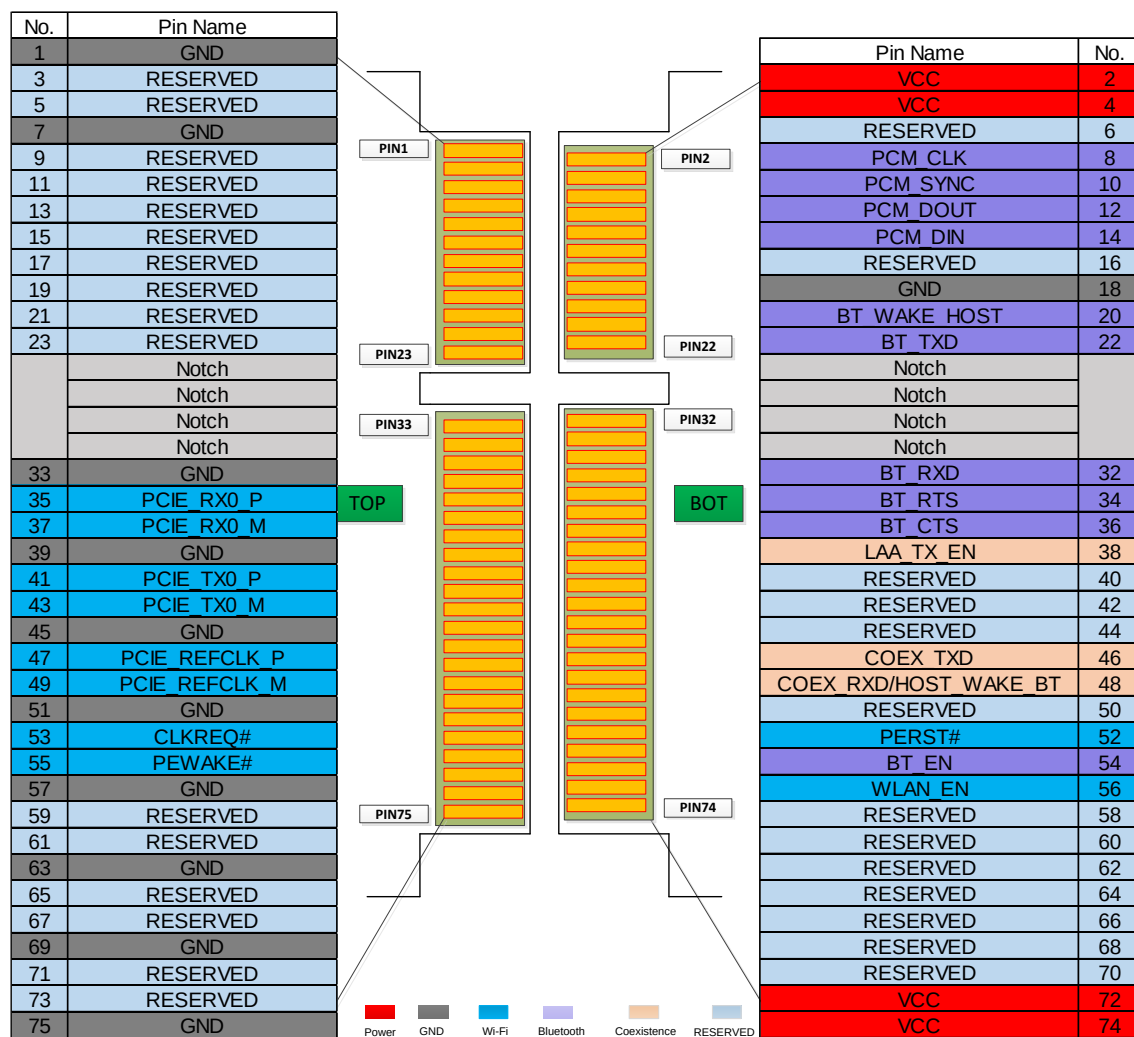


Figure 1: Pin Assignment

NOTE

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

4.2. Pin Definitions

Table 5: Parameter Definition

Parameter	Description
AI	Analog Input
AO	Analog Output
DI	Digital Input
DO	Digital Output
PI	Power Input

DC characteristics include power domain and rated current.

Table 6: Pin Description

Power Supply and GND Pins					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
VCC	2, 4, 72, 74	PI	Power supply for the module	Vmin = 3.0 V Vnom = 3.3 V Vmax = 3.6 V	It is recommended to provide at least 3 A to ensure sufficient current.
GND	1, 7, 18, 33, 39, 45, 51, 57, 63, 69, 75				
Wi-Fi Application Interfaces					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
WLAN_EN	56	DI	WLAN function enable control	1.8/3.3 V power domain	Active high.

PCIE_RX0_P	35	AI	PCle receive 0 (+)		
PCIE_RX0_M	37	AI	PCle receive 0 (-)		Require differential impedance of 85 Ω. Only EP mode is supported. PCIe Gen 3 compliant.
PCIE_TX0_P	41	AO	PCle transmit 0 (+)		
PCIE_TX0_M	43	AO	PCle transmit 0 (-)		
PCIE_REFCLK_P	47	AI	PCle reference clock (-)		
PCIE_REFCLK_M	49	AI	PCle reference clock (+)		
PERST#	52	DI	PCle reset		Active low.
CLKREQ#	53	DO	PCle clock request	1.8/3.3 V power domain	Pull each of them up to 1.8/3.3 V with an external 10 kΩ resistor respectively close to the host.
PEWAKE#	55	DO	PCle wake up		

Bluetooth Application Interfaces

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
BT_TXD	22	DO	Bluetooth UART transmit		
BT_RXD	32	DI	Bluetooth UART receive		
BT_RTS	34	DO	Request to send signal from the module		PCM interface only supports slave mode. If unused, keep them open.
BT_CTS	36	DI	Clear to send signal to the module	1.8 V power domain	
PCM_CLK	8	DI	PCM clock		
PCM_SYNC	10	DI	PCM data frame sync		
PCM_DOUT	12	DO	PCM data output		
PCM_DIN	14	DI	PCM data input		
BT_EN	54	DI	Bluetooth enablement control	1.8/3.3 V power domain	Active high. If Bluetooth function is unused, pull it down.
BT_WAKE_HOST	20	DO	Bluetooth wake up	1.8/3.3 V power	Pull up to 1.8/3.3 V

			host	domain	with an external 10 kΩ resistor close to the host.
COEX_RXD/ HOST_WAKE_BT ²	48	DI	Host wake up Bluetooth	1.8 V power domain	Do not pull it up when Wi-Fi driver is installed. If unused, keep it open.
Coexistence Interfaces					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
LAA_TX_EN	38	DI	SDR input into the module		
COEX_TXD	46	DO	2.4 GHz LTE & Wi-Fi/Bluetooth coexistence transmit	1.8 V power domain	If unused, keep them open.
COEX_RXD/ HOST_WAKE_BT ²	48	DI	2.4 GHz LTE & Wi-Fi/Bluetooth coexistence receive		
RESERVED Pins					
Pin Name	Pin No.				Comment
RESERVED	3, 5, 6, 9, 11, 13, 15–17, 19, 21, 23, 40, 42, 44, 50, 58–62, 64–68, 70, 71, 73				Keep them open.

4.3. Reference Design for Power Supply

The module is powered by VCC, and it is recommended to use a power supply chip with sufficient current of 3 A at least. For better power supply performance, it is recommended to parallel a 47 μF decoupling capacitor and 100 nF, 33 pF and 10 pF filter capacitors near the module's VCC pins. At the same time, it is suggested to add a TVS near the VCC pins to improve the surge voltage bearing capacity of the module. In principle, the longer the power supply trace is, the wider it should be.

VCC reference circuit is shown below:

² When the Bluetooth driver is loaded, the pin is used for the host to wake up Bluetooth. When no Bluetooth driver is loaded, the pin is used for 2.4 GHz Wi-Fi/Bluetooth & LTE coexistence reception.

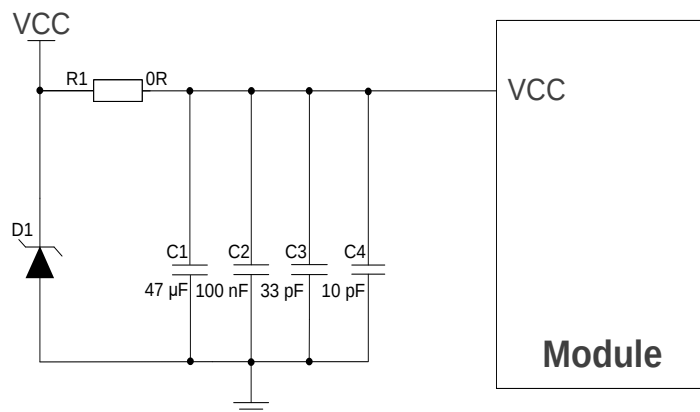


Figure 2: Reference Design of Power Supply

The power-up and power-down timing of the module is shown in the figure below.

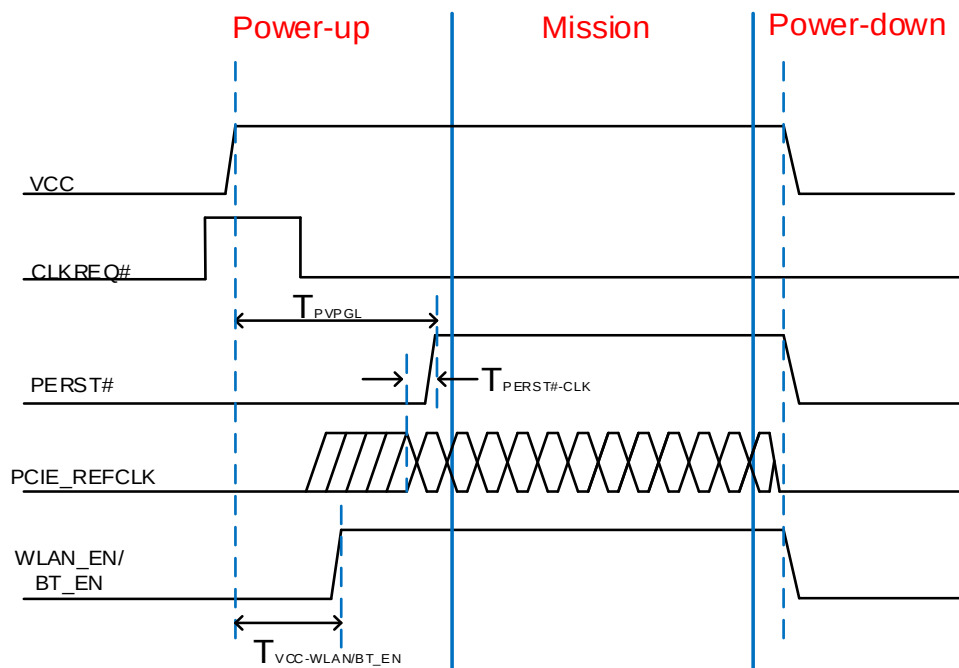


Figure 3: Power-up and Power-down Timing

Table 7: Power-up and Power-down Timing Parameters (Unit: ms)

Parameter	Description	Min.	Typ.	Max.
T_{PVPGL}	VCC stable to PERST# drive high	50	-	-
$T_{PERST\#-CLK}$	PCIE_REFCLK stable before PERST# drive high	0.1	-	-

$T_{VCC-WLAN/BT_EN}$	VCC stable to WLAN_EN/BT_EN drive high	30	-	-
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4.4. Wi-Fi Application Interfaces

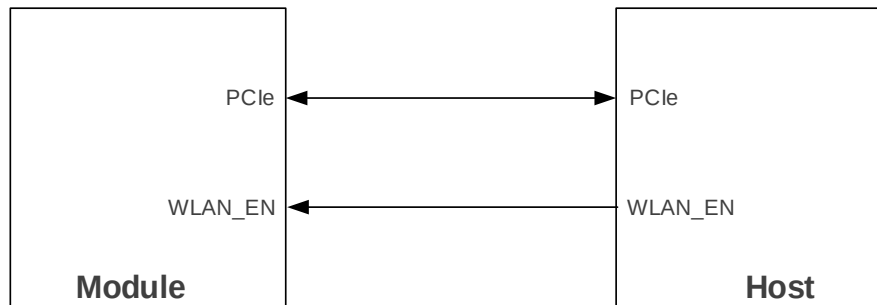


Figure 4: Wi-Fi Application Interface Connection

4.4.1. PCIe Interface

The module provides a PCIe 3.0 interface for Wi-Fi functions. The PCIe interface connection between the module and the host is shown below:

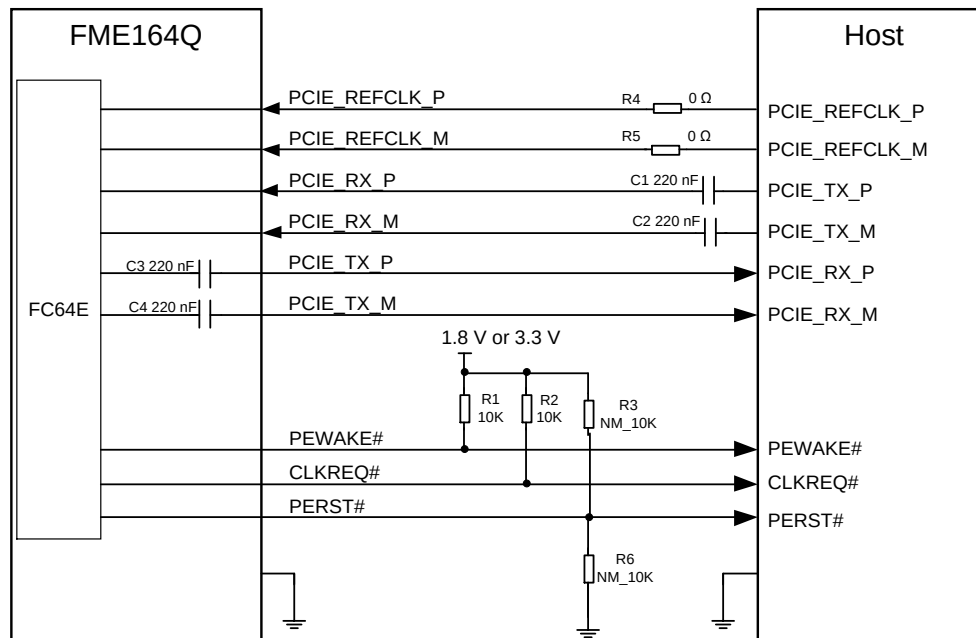


Figure 5: PCIe Interface Connection

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

- It is important to route PCIe Tx/Rx/REFCLK as differential pairs with ground surrounded. And the differential impedance should be $85\ \Omega \pm 10\%$.
- The maximum trace length of each differential pair (PCIe Tx/Rx/REFCLK) should be less than 180 mm, and trace length matching within each differential pair should be less than 0.5 mm.
- The trace space between Tx and Rx signal traces should be greater than 3 times the trace width. And the trace space between Tx/Rx signal traces and all other signal traces should be greater than four times the trace width.
- Connect 220 nF capacitors in series on the Tx and Rx traces to ensure the signal integrity of PCIe interface. C3 and C4 have been respectively connected in series on the module's Tx traces and placed inside of the module. C1 and C2 should be respectively connected in series on the module's Rx traces and placed close to the host. The extra stubs of traces must be as short as possible.
- 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.

4.5. Bluetooth Application Interfaces

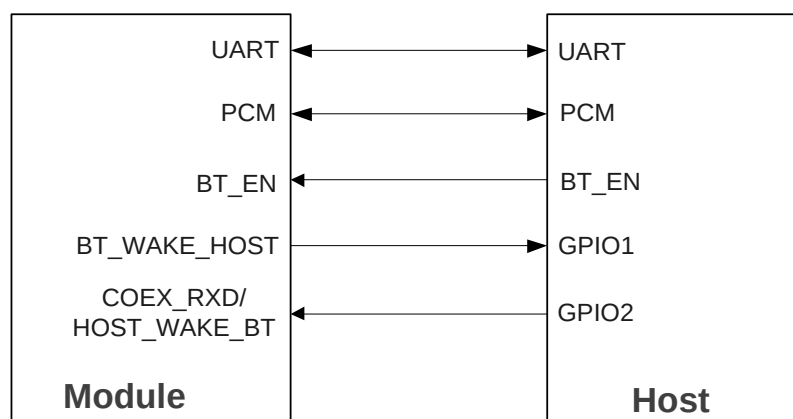


Figure 6: Bluetooth Application Interface Connection

NOTE

The host's GPIO1 connected to the module's BT_WAKE_HOST must be interruptible.

4.5.1. PCM Interface

The module provides a PCM interface for Bluetooth voice. The PCM connection between the module and the host is as follow:

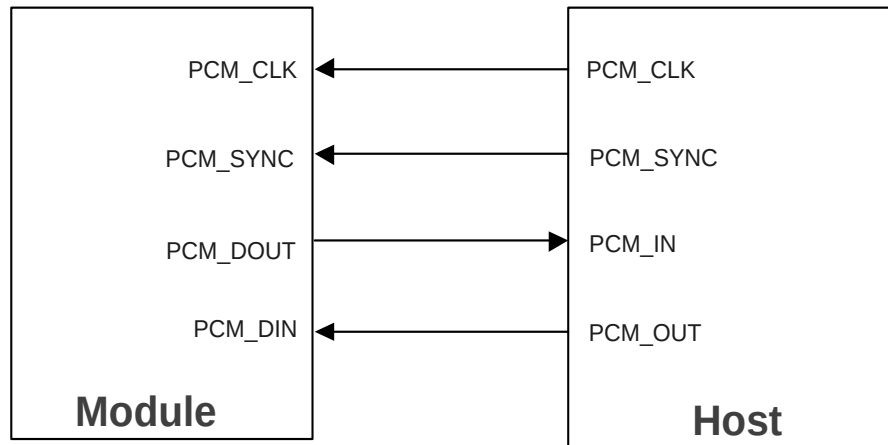


Figure 7: PCM Interface Connection (Slave Mode)

The PCM interface timing and relevant parameters are shown below:

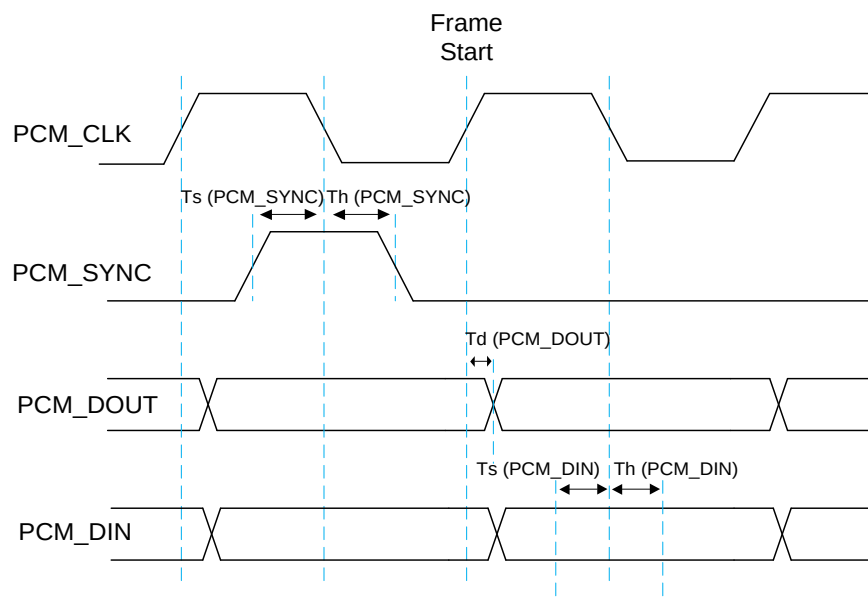


Figure 8: PCM Interface Timing

Table 8: PCM Interface Timing Parameters

Parameter	Description	Min.	Typ.	Max.	Unit
-	PCM_CLK frequency	64	-	2048	kHz
Ts (PCM_SYNC)	Setup time from PCM_SYNC to PCM_CLK falling edge	0	-	-	ns
Th (PCM_SYNC)	Hold time from PCM_CLK falling edge to PCM_SYNC falling edge	150	-	-	ns
Td (PCM_DOUT)	Delay from PCM_CLK rising edge to PCM_DOUT	0	-	150	ns
Ts (PCM_DIN)	Setup time from PCM_DIN to PCM_CLK falling edge	0	-	-	ns
Th (PCM_DIN)	Hold time of PCM_DIN after PCM_CLK fall	150	-	-	ns

4.5.2. UART Interface

The module supports Bluetooth Host Controller Interface (HCI) UART interface. The UART interface complies with the *Bluetooth Core Specification Version 5.3* and supports hardware flow control. It can be used for data transmission with a host and supports baud rates up to 3.2 Mbps.

The UART interface connection between the module and the host is shown below:

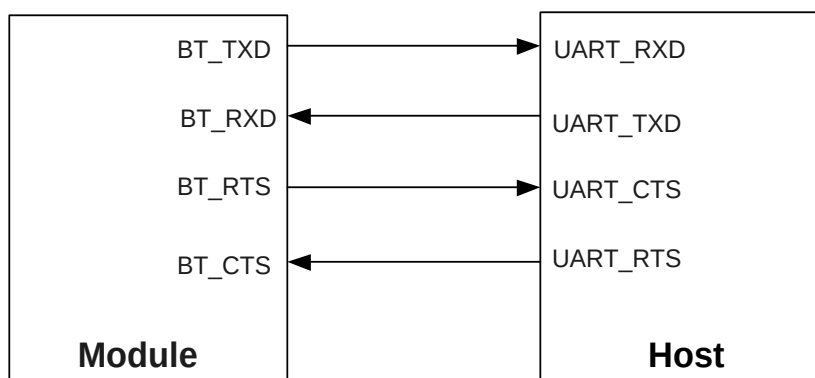


Figure 9: UART Interface Connection

NOTE

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

The HCI UART transmitting timing and relevant parameters are shown below:

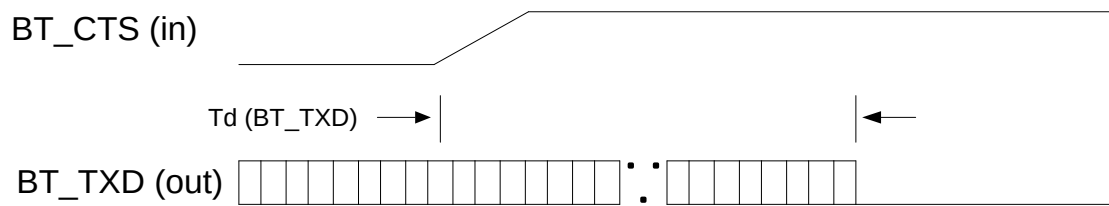


Figure 10: HCI UART Transmitting Control Timing

Table 9: HCI UART Transmitting Control Timing Parameters

Parameter	Description	Min.	Typ.	Max.	Unit
Td (BT_TXD)	Delay time from BT_CTS to BT_TXD stop bit	-	-	8	Byte

The HCI UART receiving timing and relevant parameters are shown below:

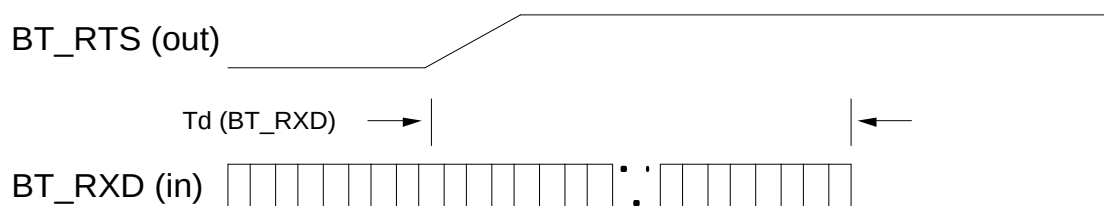


Figure 11: HCI UART Receiving Control Timing

Table 10: HCI UART Receiving Control Timing Parameters

Parameter	Description	Min.	Typ.	Max.	Unit
Td (BT_RXD)	Delay time from BT_RTS to BT_RXD stop bit	-	-	8	Byte

4.6. RF Antenna Interface

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

4.6.1. RF Coaxial Connector

4.6.1.1. Receptacle Specifications

The mechanical dimensions of the receptacle provided by the module are as follows:

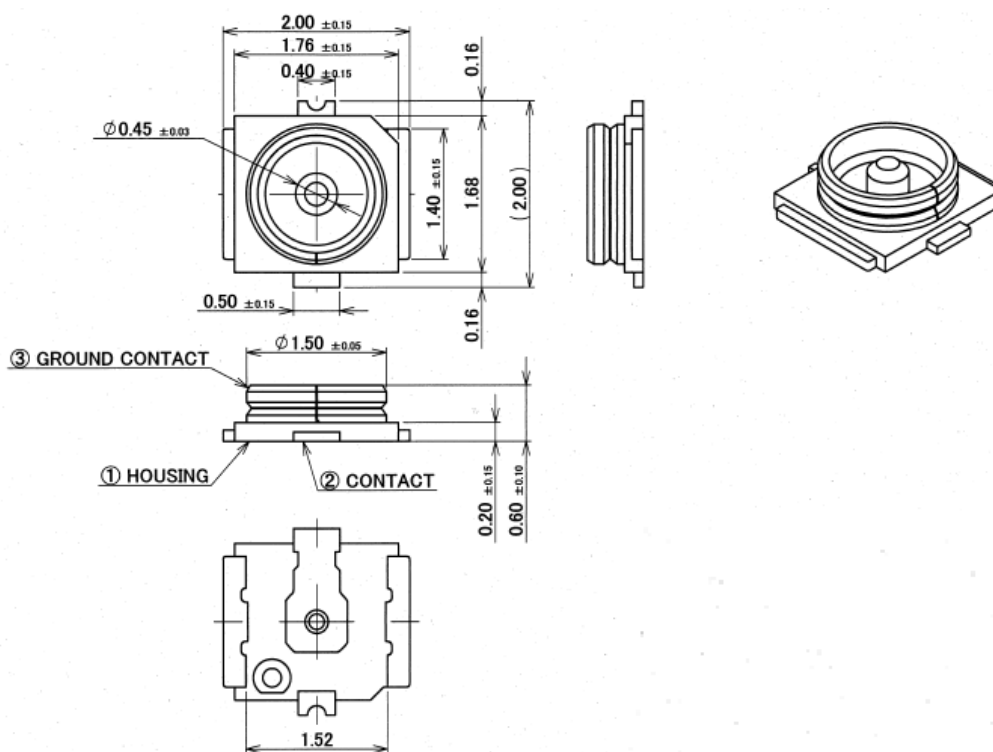


Figure 12: Dimensions of the Receptacle (Unit: mm)

Table 11: Major Specifications of the Receptacle

Item	Specification
Nominal Frequency Range	DC to 6 GHz
Nominal Impedance	50 Ω
Temperature Range	-40 °C to +85 °C
Voltage Standing Wave Ratio (VSWR)	Meet the requirements of: ● Max. 1.3 (DC–3 GHz) ● Max. 1.4 (3–6 GHz)

4.6.1.2. RF Connector Location

The module has two antenna connectors: ANT_WIFI0/BT and ANT_WIFI1, which are shown as below.



Figure 13: Antenna Connectors

4.6.1.3. Antenna Connector Installation

The receptacle mounted on the module accepts two types of mated plugs that will meet a maximum height of 1.2 mm when using a Ø 0.81 mm coaxial cable or a maximum height of 1.45 mm when utilizing a Ø 1.13 mm coaxial cable.

The following figure shows the dimensions of mated plugs using Ø 0.81 mm coaxial cables.

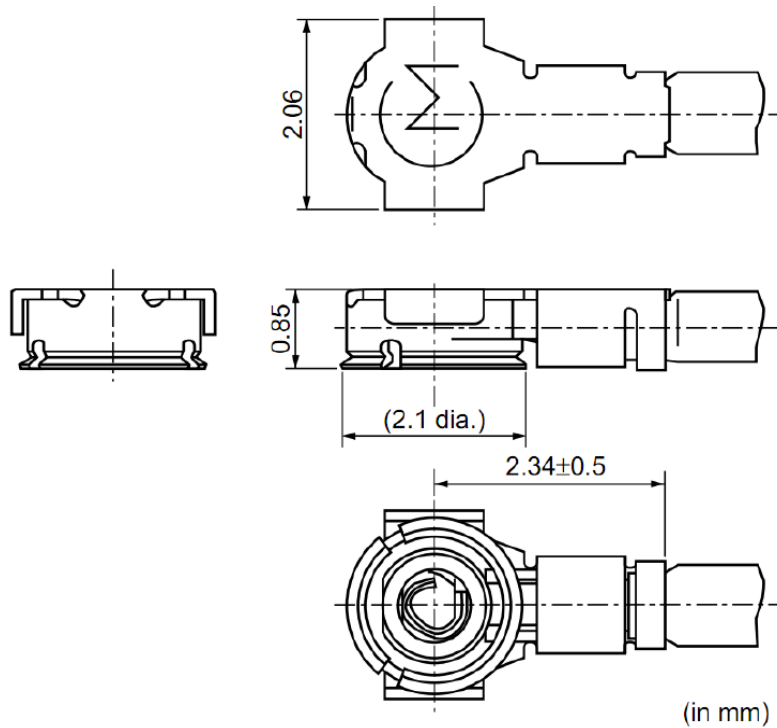


Figure 14: Dimensions of Mated Plugs (Ø 0.81 mm Coaxial Cables) (Unit: mm)

The following figure illustrates the connection between the receptacle on the module and the mated plug using a Ø 0.81 mm coaxial cable.

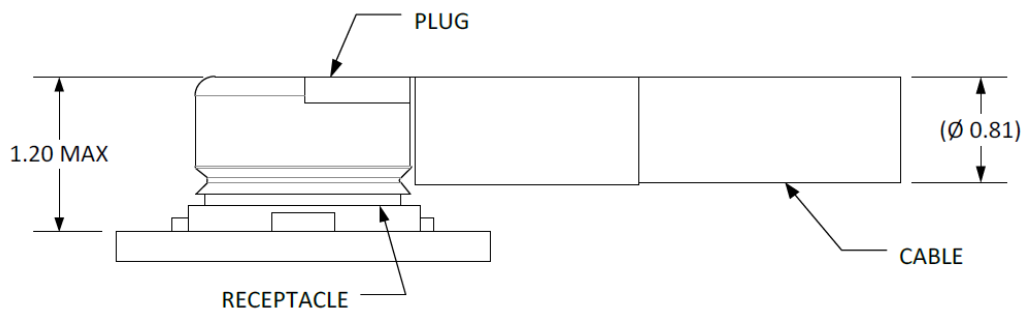


Figure 15: Space Factor of Mated Connectors (Ø 0.81 mm Coaxial Cables) (Unit: mm)

The following figure illustrates the connection between the receptacle on the module and the mated plug using a Ø 1.13 mm coaxial cable.

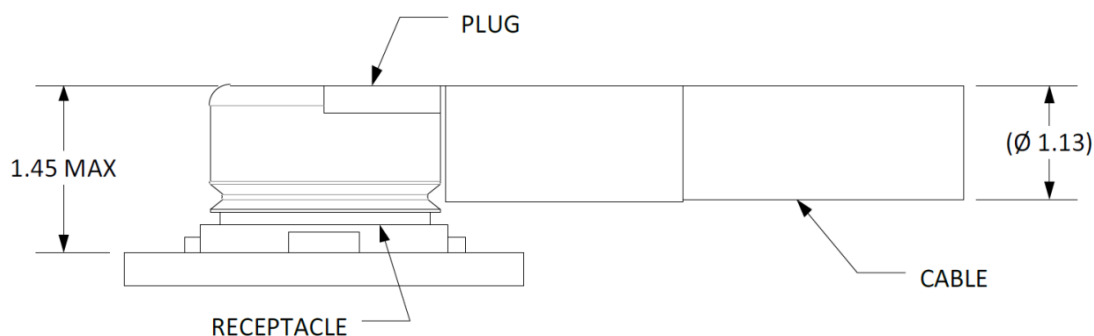


Figure 16: Space Factor of Mated Connectors (Ø 1.13 mm Coaxial Cables) (Unit: mm)

4.6.1.4. Recommended RF Connector Installation

The pictures for plugging in a coaxial cable plug is shown below, $\theta = 90^\circ$ is acceptable, while $\theta \neq 90^\circ$ is not.

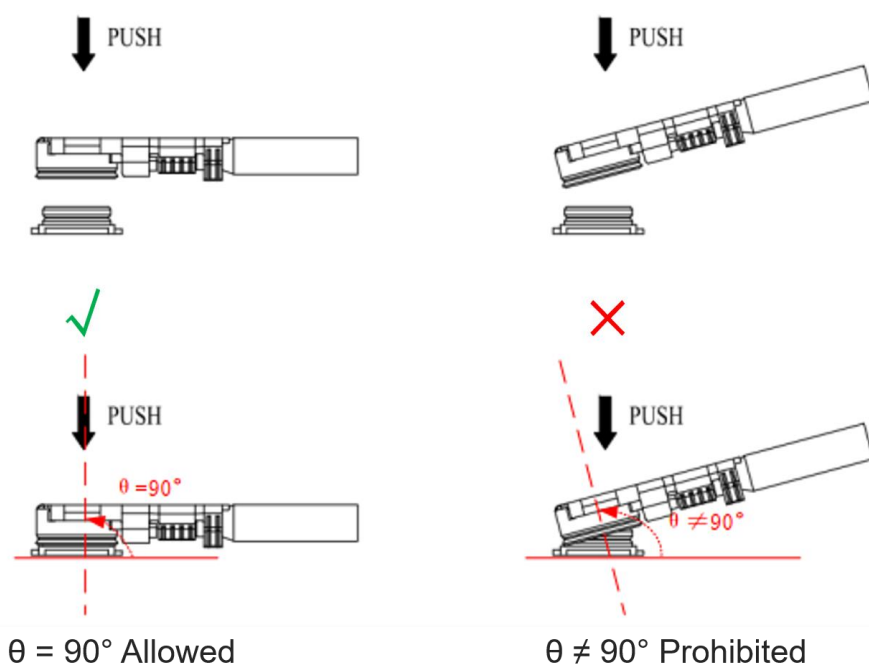


Figure 17: Plug in a Coaxial Cable Plug

The pictures of pulling out the coaxial cable plug is shown below, $\theta = 90^\circ$ is acceptable, while $\theta \neq 90^\circ$ is not.

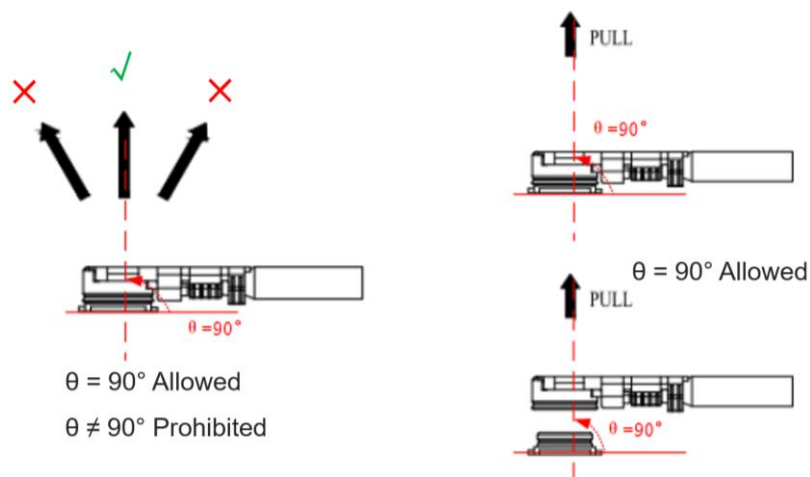


Figure 18: Pull out a Coaxial Cable Plug

The pictures of installing the coaxial cable plug with a jig is shown below, $\theta = 90^\circ$ is acceptable, while $\theta \neq 90^\circ$ is not.

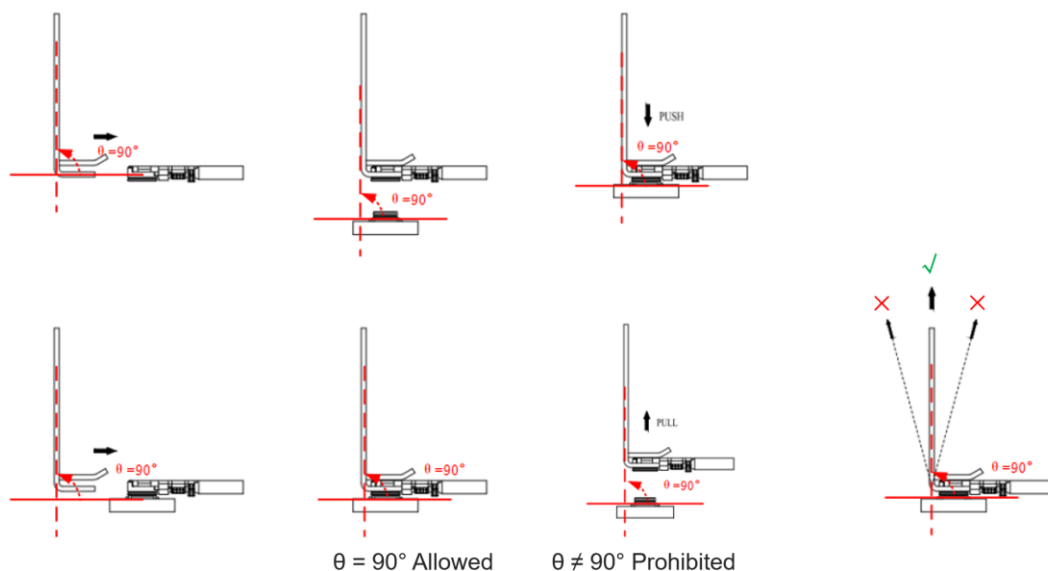


Figure 19: Install the Coaxial Cable Plug with Jig

4.6.1.5. Recommended Manufacturers of RF Connector and Cable

RF connectors and cables by I-PEX are recommended. For more details, visit <https://www.i-pex.com>.

4.6.2. Requirements for Antenna Design

Table 12: Requirements for Antenna Design

Parameter	Requirement ³
Frequency Ranges (GHz)	● 2.4 GHz: 2.400–2.4835 ● 5 GHz: 5.150–5.850
Cable Insertion Loss (dB)	< 1
VSWR	≤ 2 (Typ.)
Gain (dBi)	1 (Typ.)
Max. Input Power (W)	50
Input Impedance (Ω)	50
Polarization Type	Vertical

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

5 Electrical Characteristics and Reliability

5.1. Absolute Maximum Ratings

Table 13: Absolute Maximum Ratings (Unit: V)

Parameter	Min.	Max.
VCC	-0.3	3.6
Voltage at 1.8 V Digital Pins	-0.3	1.9
Voltage at 3.3 V Digital Pins	-0.3	3.6

5.2. Power Supply Ratings

Table 14: Module Power Supply Ratings (Unit: V)

Parameter	Description	Conditions	Min.	Typ.	Max.
VCC	Power supply for the module	The actual input voltages must be kept between the minimum and maximum values.	3.0	3.3	3.6

5.3. Power Consumption

5.3.1. Wi-Fi Power Consumption

Table 15: Power Consumption in Non-signaling Mode (Typ.; Unit: mA)

Condition			I _{vcc}
2.4 GHz	802.11n	HT20 @ MCS 0	759
		HT40 @ MCS 7	732
	802.11ax	HE40 @ MCS 11	720
5 GHz	802.11n	HT20 @ MCS 0	898
		HT40 @ MCS 7	869
	802.11ax	HE80 @ MCS 11	914
2.4 GHz + 5 GHz	802.11n	HT20 @ MCS 0	1463
		HT40 @ MCS 7	1536
	802.11ax	HE20 @ MCS 0	1415
		HE20 @ MCS 11	1475
		HE40 @ MCS 11	1507

NOTE

In the above test cases, 2.4 GHz/5 GHz are in two antennas transmission mode.

5.3.2. Bluetooth Power Consumption

Table 16: Bluetooth Power Consumption in Non-signalling Mode (Typ.; Unit: mA)

Condition	I _{VCC}
	ANT_WIFI0/BT
BR (GFSK)	172
EDR ($\pi/4$ -DQPSK)	170
EDR (8-DPSK)	170
BLE (1 Mbps)	163
BLE (2 Mbps)	142

5.4. Digital I/O Characteristics

Table 17: 1.8 V I/O Requirements (Unit: V)

Parameter	Description	Min.	Max.
V _{IH}	High-level input voltage	$0.7 \times V_{DDX}$	$V_{DDX} + 0.3$
V _{IL}	Low-level input voltage	-0.3	$0.3 \times V_{DDX}$
V _{OH}	High-level output voltage	$V_{DDX} - 0.45$	V_{DDX}
V _{OL}	Low-level output voltage	0	0.45

Table 18: 3.3 V I/O Requirements (Unit: V)

Parameter	Description	Min.	Max.
V _{IH}	High-level input voltage	3.0	3.6
V _{IL}	Low-level input voltage	-0.3	0.45
V _{OH}	High-level output voltage	3.0	3.6
V _{OL}	Low-level output voltage	0	0.45

NOTE

V_{DDX} represents the actual input voltage value from the external input pin for the I/O port.

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

Tested Interfaces	Contact Discharge	Air Discharge	Unit
Antenna Interfaces	0.8	6	kV

5.6. Thermal Dissipation

The module offers the best performance when all internal IC chips are working within their operating temperatures. When the IC chip reaches or exceeds the maximum junction temperature, the module may still work but the performance and function (such as RF output power, data rate) 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.
- Expose the copper in the PCB area where module is mounted.
- Apply a soft thermal pad with appropriate thickness and high thermal conductivity between the module and the PCB to conduct heat.
- 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.

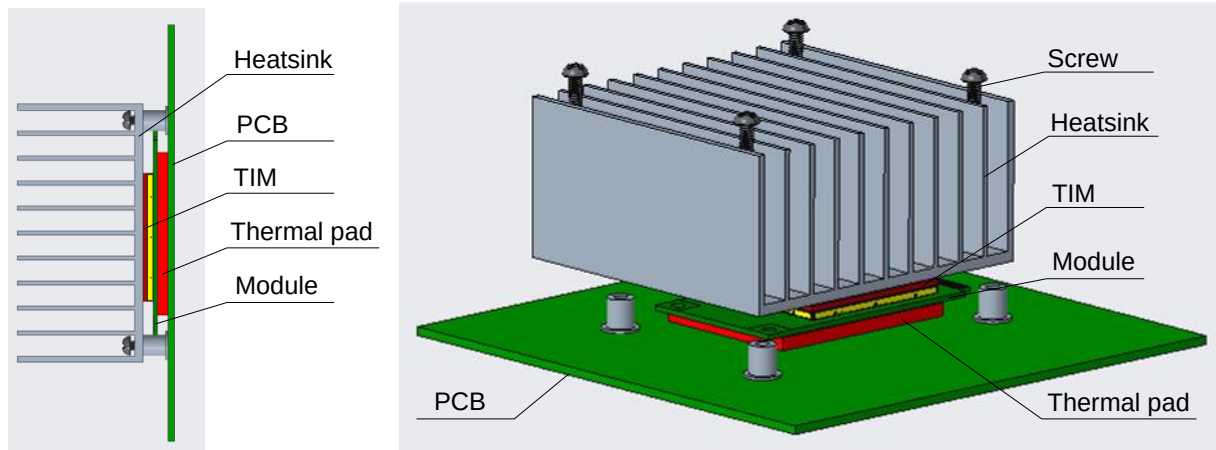


Figure 20: Placement and Fixing of the Heatsink

5.7. Notification

Please follow the principles below in the module application.

5.7.1. Coating

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.

5.7.2. Cleaning

Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.

5.7.3. Installing

Fix the module firmly to avoid poor contact caused by shaking. It is recommended to install the module on the socket with a screw as shown below.

It is recommended to use a screw with a head diameter of 5–5.5 mm.

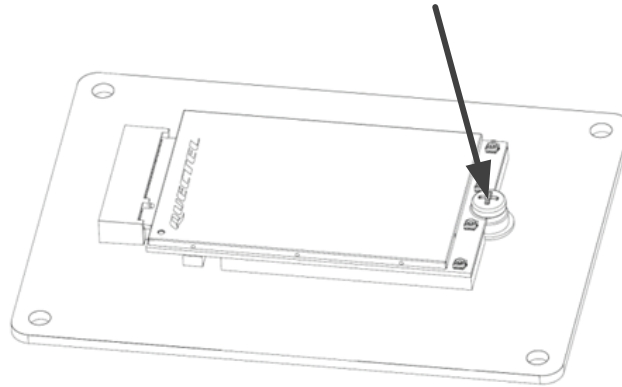


Figure 21: Installation Schematic

6 Mechanical Information

This chapter describes the mechanical dimensions of the module. All dimensions are measured in millimeter (mm), and the dimensional tolerances are ± 0.15 mm unless otherwise specified.

6.1. Mechanical Dimensions

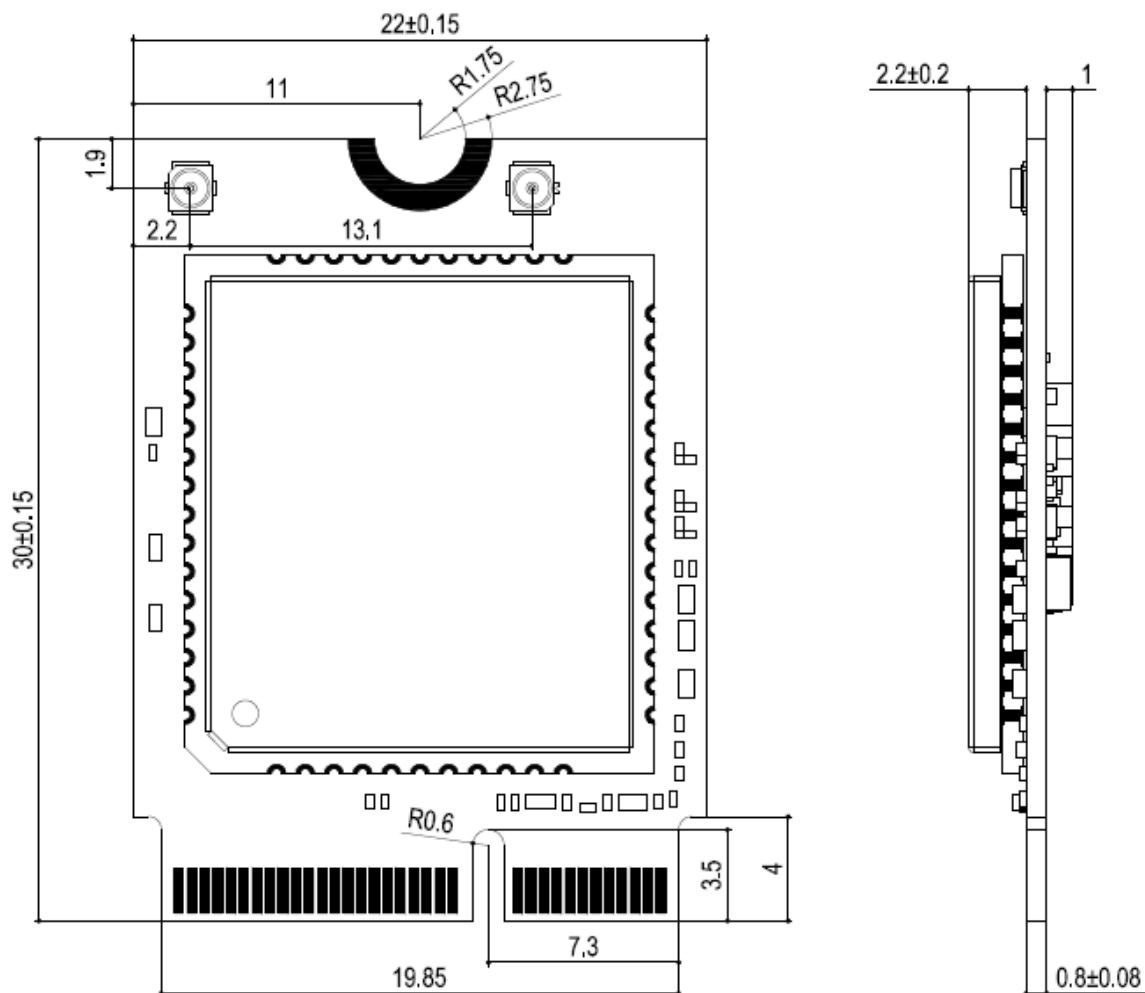


Figure 22: Top and Side Dimensions

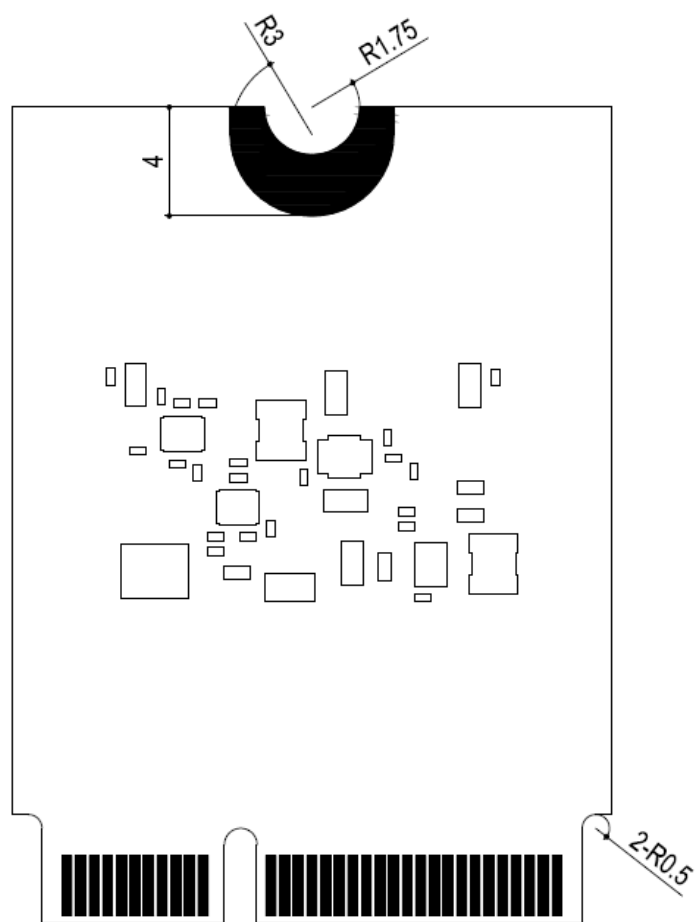


Figure 23: Bottom Dimensions (Bottom View)

6.2. Top and Bottom Views

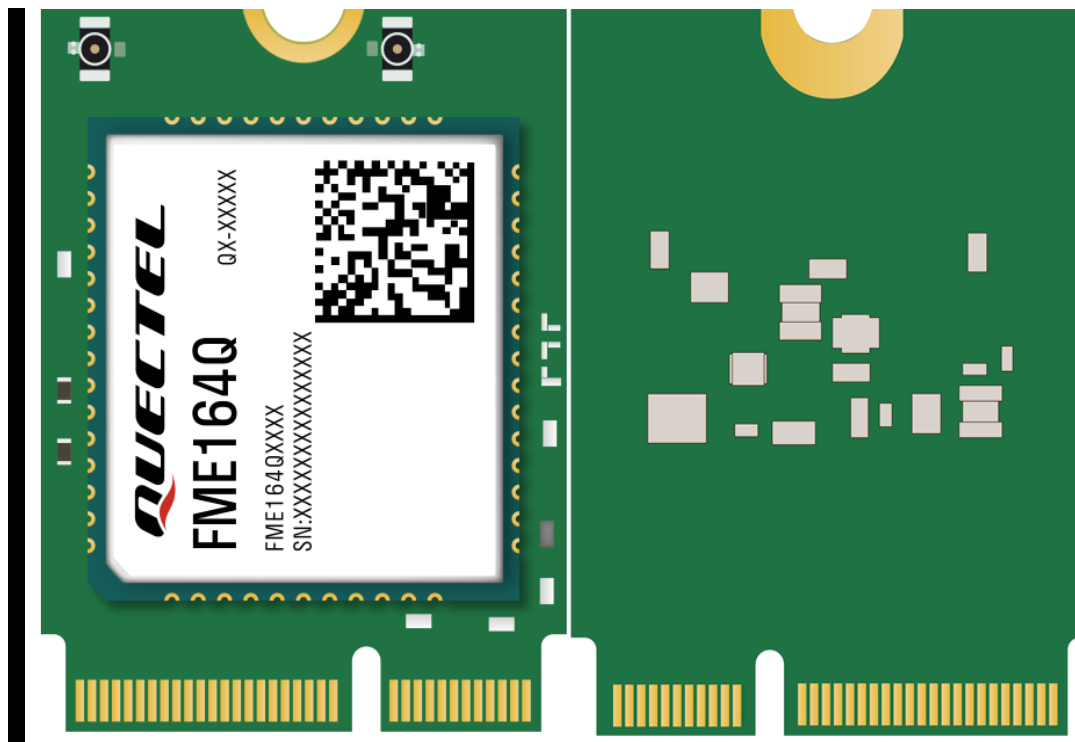


Figure 24: Top and Bottom Views

NOTE

Images above are applicable to FME164Q for illustration purpose only and may differ from the actual module. For authentic appearance and label, please refer to the module received from Quectel.

6.3. M.2 Connector

The module features a standard PCI Express M.2 Key-E interface, using a standard M.2 Key-E connector. For more information, please refer to the PCI Express M.2 specification.

7 Storage, Manufacturing and Packaging

7.1. Storage Conditions

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: 12 months in Recommended Storage Condition.

NOTE

Pay attention to ESD protection, such as wearing anti-static gloves, when touching the modules.

7.2. 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 blister tray packaging as specified in the sub-chapters below.

7.2.1. Blister Tray

Blister tray dimensions are illustrated in the following figure:

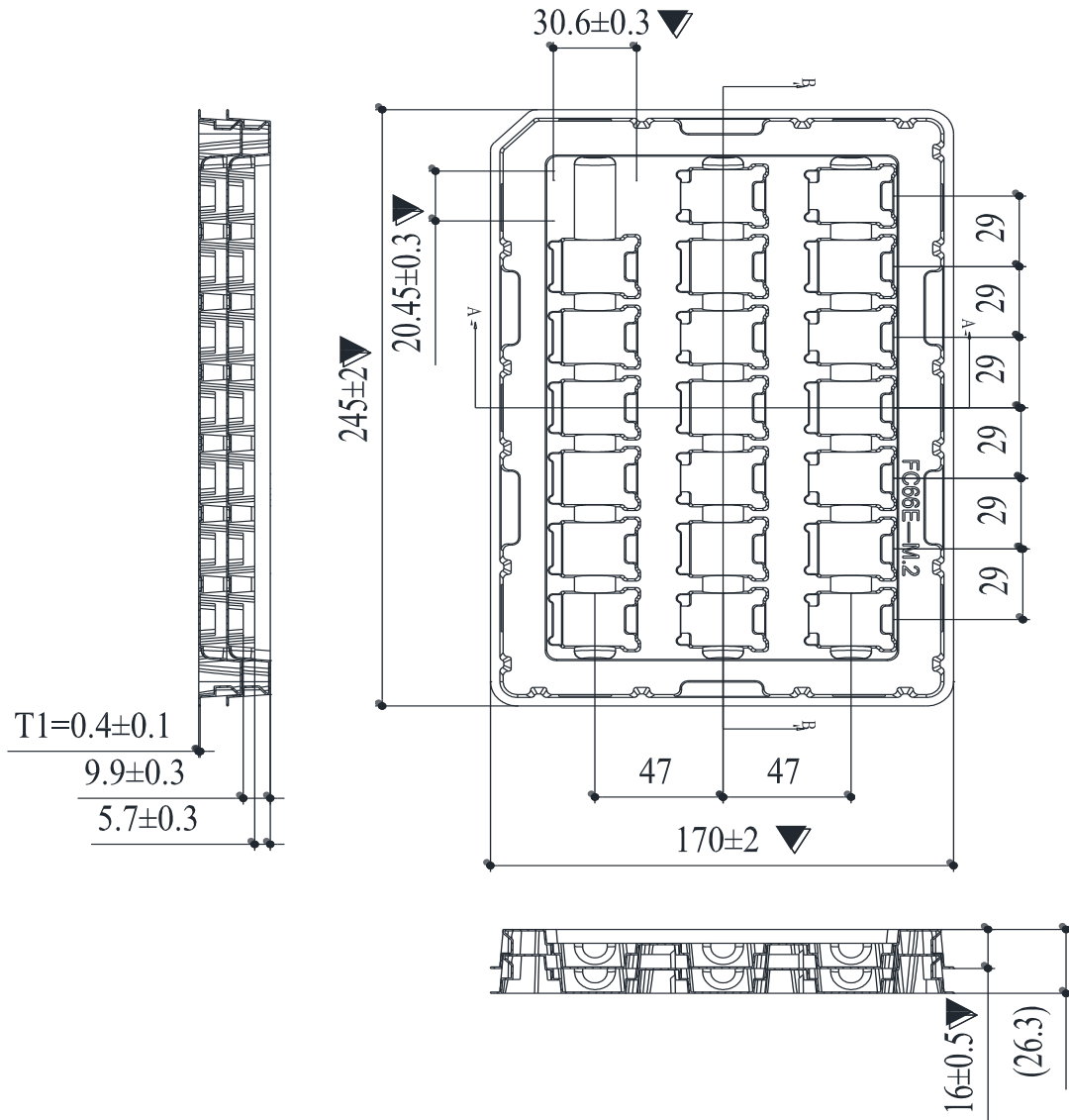
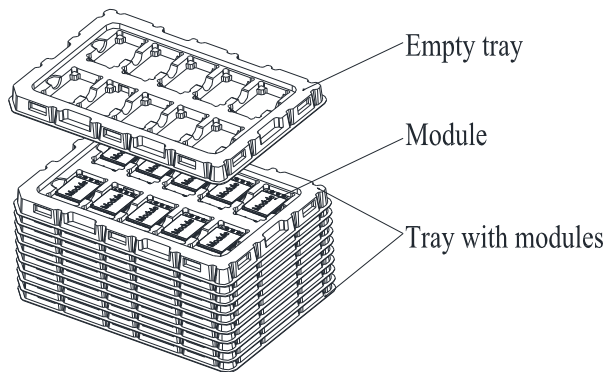


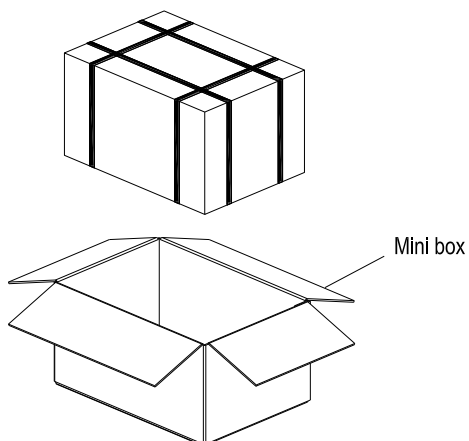
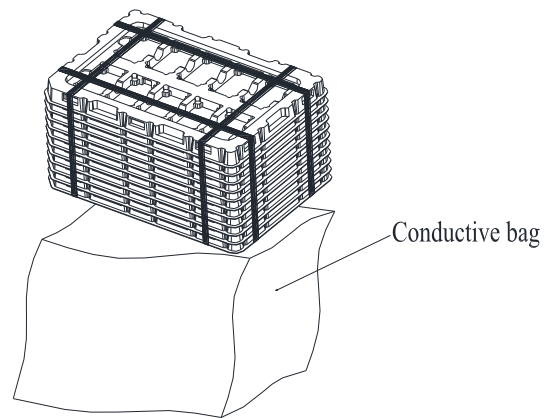
Figure 25: Blister Tray Dimension Drawing (Unit: mm)

7.2.2. Packaging Process



Each blister tray packs 20 modules. Stack 10 trays with modules, and place 1 empty tray on top.

Fasten the 11 trays and place them into a conductive bag and fasten it.



Pack the conductive bag with blister trays into a mini box. 1 mini box can pack 200 modules.

Place the 4 packaged mini boxes into 1 carton and seal it. 1 carton can pack 800 modules.

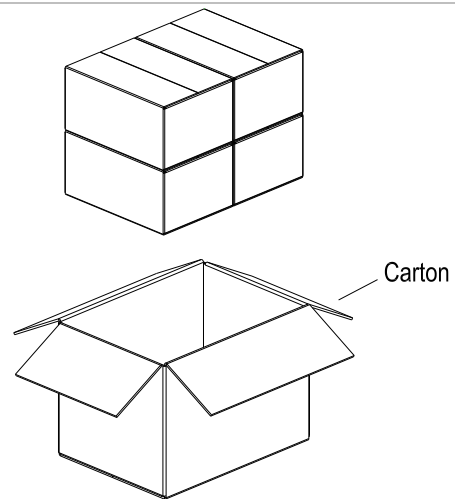


Figure 26: Packaging Process

8 Appendix References

Table 20: Terms and Abbreviations

Abbreviation	Description
AP	Access Point
BLE	Bluetooth Low Energy
BPSK	Binary Phase Shift Keying
BR	Basic Rate
CCK	Complementary Code Keying
CTS	Clear To Send
DBPSK	Differential Binary Phase Shift Keying
DPSK	Differential Phase Shift Keying
DQPSK	Differential Quadrature Phase Shift Keying
EDR	Enhanced Data Rate
EHT	Extremely High Throughput
ESD	Electrostatic Discharge
EVM	Error Vector Magnitude
GFSK	Gauss frequency Shift Keying
GND	Ground
HCI	Host Controller Interface
HE	High Efficiency
HT	High Throughput
I/O	Input/Output

IC	Integrated Circuit
IEEE	Institute of Electrical and Electronics Engineers
LDPC	Low Density Parity Check Code
LTE	Long Term Evolution
Mbps	Megabits per second
MCS	Modulation and Coding Scheme
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
RXD	Receive Data
SAW	Surface Acoustic Wave
SDR	Software-Defined Radio
STA	Station
TVS	Transient Voltage Suppressor
Tx	Transmit
TXD	Transmit Data
UART	Universal Asynchronous Receiver/Transmitter
(U)SIM	(Universal) Subscriber Identity Module
VHT	Very High Throughput

Vmax	Maximum Voltage
Vmin	Minimum Voltage
Vnom	Nominal 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 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 shown in this manual.

2.4 Limited module procedures

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

2.5 Trace antenna designs

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

2.6 RF exposure considerations

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

2.7 Antennas

Antenna Specification are as follows:

Type: External Antenna

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: XMR2025FME164Q" 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, etc. according to the actual test modes for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product. Only when all the test results of test modes comply with FCC requirements, then the end product can be sold legally.

2.10 Additional testing, Part 15 Subpart B disclaimer

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

Federal Communication Commission Statement (FCC, U S)

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

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

FCC Caution:

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

IMPORTANT NOTES**Co-location warning:**

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

OEM integration instructions:

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

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

As long as the conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance.

requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

Validity of using the module certification:

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

End product labeling:

The final end product must be labeled in a visible area with the following: "Contains Transmitter Module **FCC ID: XMR2025FME164Q**"

Information that must be placed in the end user manual:

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

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.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains IC:10224A-2025FME164Q".

Étiquetage du produit final

Ce module émetteur n'est autorisé que pour une utilisation dans un dispositif où l'antenne peut être installée de telle sorte que 20 cm puissent être maintenus entre l'antenne et les utilisateurs. Le produit final doit être étiqueté dans une zone visible avec la mention suivante: "contient IC:10224A-2025FME164Q".