FCM360W

Hardware Design

Wi-Fi&Bluetooth Module Series

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Status: Preliminary

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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

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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 or mobile terminal incorporating the module. Manufacturers of the cellular terminal should notify users and operating personnel of the following safety precautions by incorporating them into all product manuals. Otherwise, Quectel assumes no liability for customers' failure to comply with these precautions.

	Full attention must be paid to driving at all times to reduce the risk of an accident. Using a mobile phone 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 or mobile terminal 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. If emergency assistance is needed, use emergency call if the device supports it. To make or receive a call, the cellular or mobile terminal 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 since network connection cannot be guaranteed under all circumstances.
	The cellular or mobile terminal contains a transceiver. When it is ON, it receives and transmits radio 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 phones or other cellular terminals. Areas with explosive or potentially explosive atmospheres include fueling areas, below decks on boats, fuel or chemical transfer or storage facilities, and areas where the air contains chemicals or particles such as grain, dust or metal powders.

About the Document

Revision History

Version	Date	Author	Description
-	2023-03-08	Mark WU	Creation of the document
1.0.0	2023-03-08	Mark WU	Preliminary

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1 Introduction

QuecOpen® is a solution where the module acts as the main processor. Constant transition and evolution of both the communication technology and the market highlight its merits. It can help you to:

- Realize embedded applications' quick development and shorten product R&D cycle
- Simplify circuit and hardware structure design to reduce engineering costs
- Miniaturize products
- Reduce product power consumption
- Apply OTA technology
- Enhance product competitiveness and price-performance ratio
- Apply anti-copy encryption technology to enhance product safety

This document defines FCM360W in QuecOpen® solution and describes its air interfaces and hardware interfaces, which are connected with 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 Marks

Table 1: Special Marks

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

2 Product Overview

FCM360W is a high-performance Wi-Fi and Bluetooth module for smart-home IoT terminals supporting IEEE 802.11b/g/n/ax and Bluetooth 5.1 standards. The module, featuring built-in PMU, PA, LNA and T/R switch, provides multiple interfaces including UART, SPI, I2C*, I2S*, SDIO*, ADC* and PWM* for various applications.

FCM360W is an SMD module with compact packaging. It includes:

- 240 MHz RICS processor
- 48 KB ROM, 512 KB SRAM and a built-in 4 MB flash
- Support secondary development

Table 2: Basic Information

FCM360W	
Packaging type	LCC
Pin counts	39
Dimensions	(25.5 ±0.15) mm × (18 ±0.15) mm × (3.2 ±0.2) mm
Weight	Approx. 1.65 g

2.1. Key Features

Table 3: Key Features

Basic Information	
Protocols and Standards	● Wi-Fi Protocols: IEEE 802.11b/g/n/ax ● Bluetooth protocol: Bluetooth 5.1 ● All hardware components are fully compliant with EU RoHS directive
Power Supply	**VBAT Power Supply:** ● 3.0–3.6 V ● Typ.: 3.3 V
Temperature Ranges	● Operating temperature [1]: -40 to +85 °C ● Storage temperature: -45 to +95 °C
EVB Kit	FCM360W TE-B [2]
RF Antenna Interface	
Antenna Interfaces	● ANT_WIFI/BT (optional) ● PCB antenna (optional) ● Coaxial RF connector (optional) ● 50 Ω impedance
Application Interface [3]	
Application Interfaces	UART, SPI, I2C*, I2S*, SDIO*, PWM*, ADC*

[1] Within the operating temperature range, the module's related performance meets IEEE and Bluetooth specifications.
[2] For more details about the EVB, see ***document [1]***.
[3] For more details about the interfaces, see ***Chapter 3.3*** and ***Chapter 3.4***.

2.2. Functional Diagram

The following figure shows a block diagram of the module and illustrates the major functional parts.

- Main chip
- Radio frequency
- Peripheral interfaces

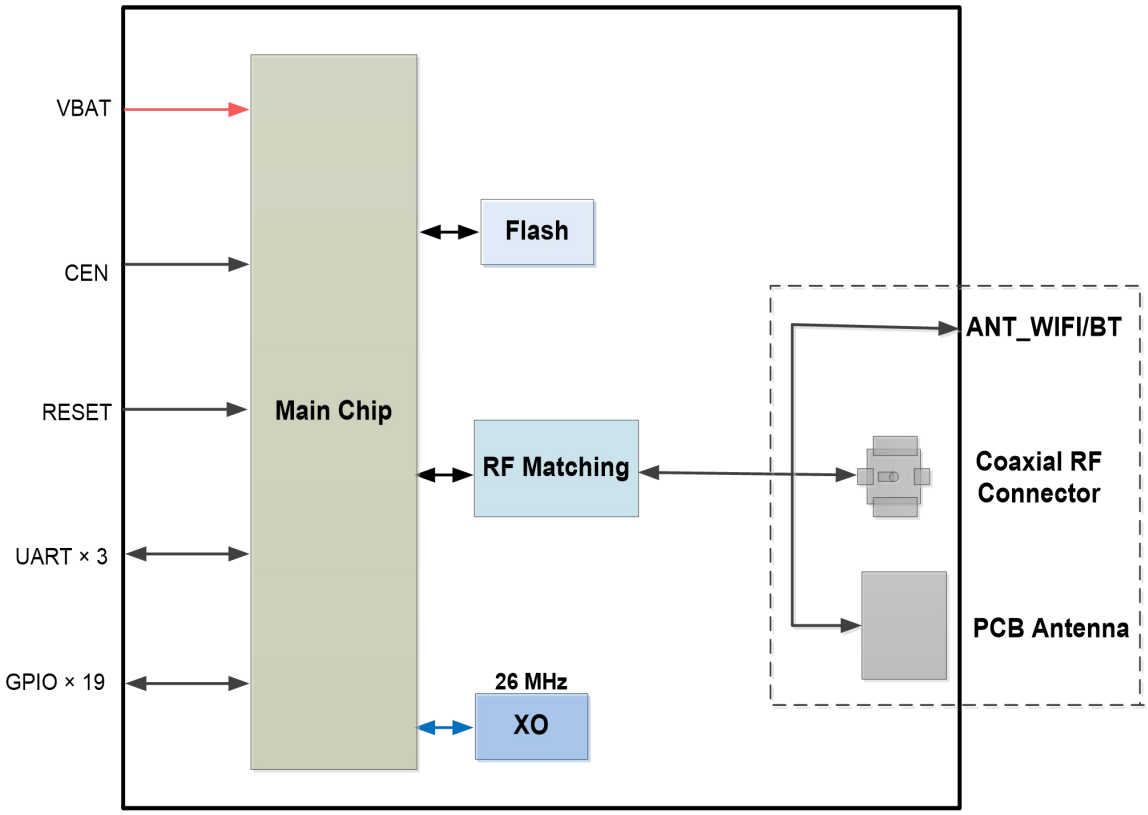


Figure 1: Functional Diagram

NOTE

The module supports pin antenna (ANT_WIFI/BT), PCB antenna and coaxial RF connector for your selection.

3 Application Interfaces

3.1. Pin Assignment

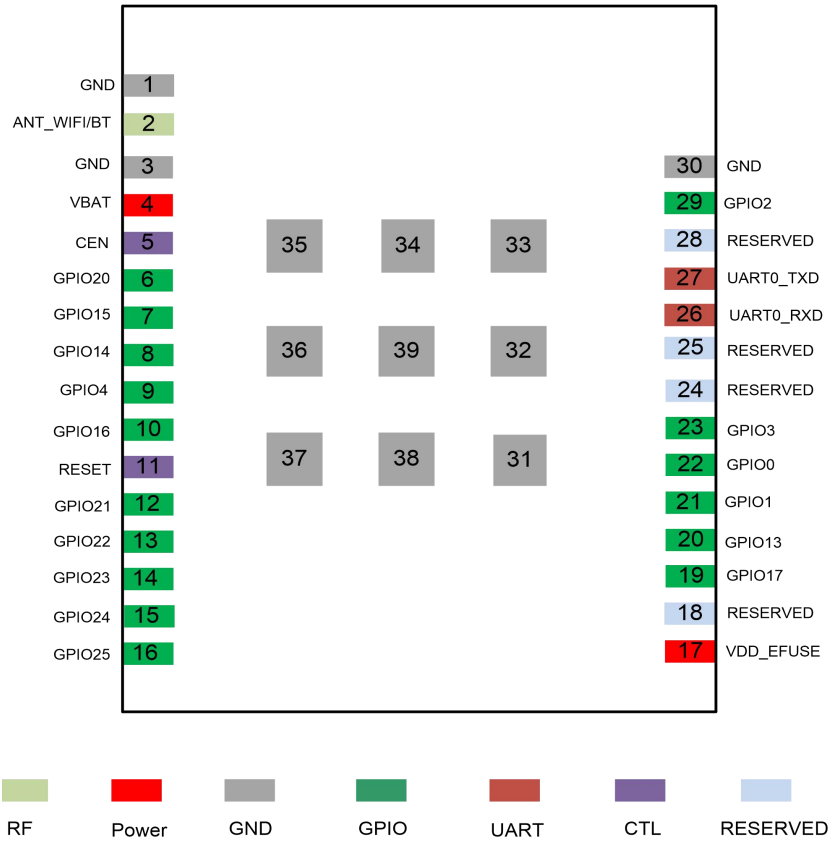


Figure 2: Pin Assignment (Top View)

NOTE

1. Keep all RESERVED and unused pins open.
2. All GND pins should be connected to ground.
3. The module supports UART × 3, SPI × 1, I2C × 1, SDIO × 1, PWM × 6, I2S × 1 and ADC × 3 multiplexed with up to 19 GPIO pins. For more details, see ***Chapter 3.3*** and ***Chapter 3.4***.

3.2. Pin Description

Table 4: I/O Parameter Description

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

DC characteristics include power domain and rated current, etc.

Table 5: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VBAT	4	PI	Power supply for the module	Vmax = 3.6 V Vmin = 3.0 V Vnom = 3.3 V	It must be provided with sufficient current more than 0.6 A.
VDD_EFUSE	17	PI	Power supply for eFuse programming	Vmax = 3.3 V Vmin = 0 V Vnom = 1.8 V	Used to enter safe mode; If unused, keep it open.
GND	1, 3, 30, 31–39				
Control Signals					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESET	11	DI	Resets the module	VBAT	Hardware reset; Internally pulled up to 3.3 V; Active low.
CEN	5	DI	Enable the module		Hardware enable; Internally pulled up to 3.3 V; Active high.
UART0					

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
UART0_TXD	27	DO	UART0 transmit	VBAT	
UART0_RXD	26	DI	UART0 receive		
GPIO Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
GPIO20	6	DIO	General-purpose input/output	VBAT	
GPIO15	7	DIO	General-purpose input/output		
GPIO14	8	DIO	General-purpose input/output		
GPIO4	9	DIO	General-purpose input/output		
GPIO16	10	DIO	General-purpose input/output		
GPIO21	12	DIO	General-purpose input/output		
GPIO22	13	DIO	General-purpose input/output		
GPIO23	14	DIO	General-purpose input/output		
GPIO24	15	DIO	General-purpose input/output		
GPIO25	16	DIO	General-purpose input/output		
GPIO17	19	DIO	General-purpose input/output		Interrupt wakeup.
GPIO13	20	DIO	General-purpose input/output		
GPIO1	21	DIO	General-purpose input/output		Interrupt wakeup.
GPIO0	22	DIO	General-purpose input/output		
GPIO3	23	DIO	General-purpose input/output		
GPIO2	29	DIO	General-purpose input/output		Interrupt wakeup.

RF Antenna Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ANT_WIFI/BT	2	AIO	Wi-Fi/Bluetooth antenna interface (optional)		50 Ω impedance.
RESERVED Pins					
Pin Name	**Pin No.**				**Comment**
RESERVED	18, 24, 25, 28				Keep it unconnected.

3.3. GPIO Multiplexing

The module provides 19 GPIO interfaces by default. Pins are defined as follows:

Table 6: GPIO Multiplexing

Pin Name	Pin No.	Alternate Function 0 (GPIO No.)	Alternate Function 1	Alternate Function 2	Alternate Function 3	Alternate Function 4	Alternate Function 5
GPIO4	9	GPIO4	TRST	UART0_RTS	PWM0	SPI_CS2	-
GPIO16	10	GPIO16	PWM2	UART1_CTS	IR_OUT	-	-
GPIO21	12	GPIO21	SDIO_CMD	UART0_RXD	I2S_TXD	I2C_SDA	-
GPIO22	13	GPIO22	PWM0	SDIO_DATA0	UART0_TXD	I2S_TX_WS	-
GPIO23	14	GPIO23	PWM1	SDIO_DATA1	UART1_RTS	I2S_TX_SCK	-
GPIO24	15	GPIO24	PWM2	SDIO_DATA2	UART1_CTS	I2S_MCLK	-
GPIO25	16	GPIO25	PWM3	SDIO_DATA3	I2C_SDA	-	-
GPIO20	6	GPIO20	ADC2	PWM3	I2S_MCLK	-	-
GPIO15	7	GPIO15	ADC1	BOOTMODE1	VOUT_QN	PWM5	I2S_TX_WS
GPIO14	8	GPIO14	ADC0	BOOTMODE0	VOUT_QP	PWM4	I2S_TXD

RESET	11	GPIO18	TESTMODE	UART1_RTS	SPI_HOLD	I2S_TXD	I2C_SCL
GPIO17	19	GPIO17	UART2_RXD	WAKEUP	SPI_WP	PWM5	I2S_TX_WS
GPIO13	20	GPIO13	UART2_TXD	SDIO_CLK	I2C_SCL	I2S_RXD	-
GPIO1	21	GPIO1	SPI_CS0	TMS	UART1_RXD	PWM1	I2S_RXD
GPIO0	22	GPIO0	SPI_CLK	TCK	UART2_TXD	PWM0	I2S_TX_SCK
GPIO3	23	GPIO3	SPI_MISO	TDI	UART0_CTS	PWM3	I2C_SDA
GPIO2	29	GPIO2	SPI_MOSI	TDO	UART1_TXD	PWM2	I2C_SCL
UART0_RXD	26	GPIO5	40M_CLK_OUT	IR_OUT	I2S_RX_WS	XTAL_I_32K	-
UART0_TXD	27	GPIO6	COLD_RESET	32K_CLK_OUT	I2S_RX_SCK	XTAL_O_32K	-

NOTE

The GPIO0, GPIO1, GPIO2, GPIO17 and GPIO18 (RESET) can be used as sleep interrupt to wake up the module which will immediately enter the operating state after being awakened.

3.4. Application Interfaces

3.4.1. UARTs

The module supports 3 UARTs: UART0, UART1 and UART2. The module serves as DCE (Data Communication Equipment), which is connected in the traditional DCE-DTE (Data Terminal Equipment) mode.

Table 7: Pin Definition of UARTs

Pin Name	Pin No.	Multiplexing Function	I/O	Description	Comment
UART0_TXD	27	-	DO	UART0 transmit	Pin 13 (alternative)
UART0_RXD	26	-	DI	UART0 receive	Pin 12 (alternative)
GPIO3	23	UART0_CTS	DO	UART0 clear to send	
GPIO4	9	UART0_RTS	DI	UART0 request to send	
GPIO2	29	UART1_TXD	DO	UART1 transmit	
GPIO1	21	UART1_RXD	DI	UART1 receive	
GPIO16	10	UART1_CTS	DO	UART1 clear to send	Pin 15 (alternative)
GPIO23	14	UART1_RTS	DI	UART1 request to send	Pin 11 (alternative)
GPIO13	20	UART2_TXD	DO	UART2 transmit	Pin 22 (alternative)
GPIO17	19	UART2_RXD	DI	UART2 receive	

The UART0 can be used as main UART for AT command communication and data transmission. The default baud rate is 115200 bps, and the maximum baud rate can reach 6 Mbps. It's also available for firmware upgrade and supports a default baud rate of 921600 bps. The pins 26 and 27 (default pins) can be used as communication, download and debugging ports, while the pins 12 and 13 (alternative pins) can only be used as communication and debugging ports.

The main UART connection between DCE and DTE is illustrated below.

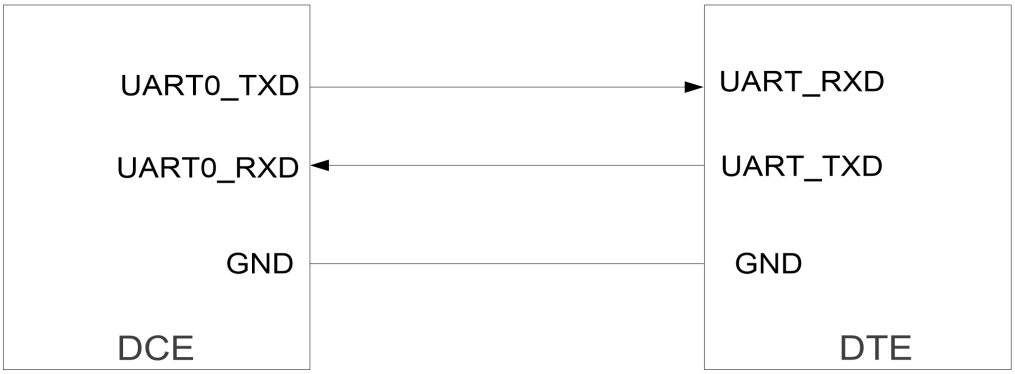


Figure 3: Main UART Connection

The UART1 and UART2 can all be used as debug UART. They support 115200 bps baud rate by default, and are used for outputting partial logs with debugging tools. The UART1 and UART2 can be used as communication and debugging ports but are not recommended to be used as download ports.

The following is a reference design of debug UART.

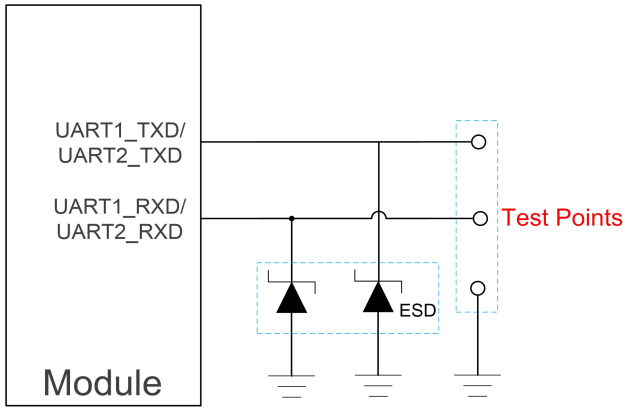


Figure 4: Debug UART Reference Design

NOTE

Test points must be reserved for UART1_TXD, UART2_TXD, UART1_RXD and UART2_RXD.

3.4.2. SPI

The module provides one SPI that supports both master and slave modes. The maximum clock frequency of the interface can reach 20 MHz in slave mode, and 40 MHz in master mode.

The following figure shows the connection between the host and the slave:

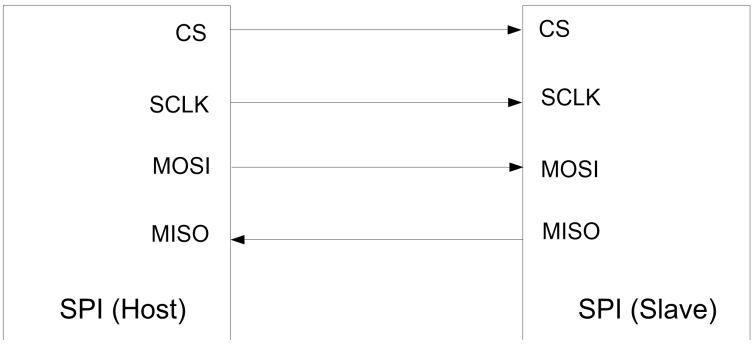


Figure 5: SPI Connection

Table 8: Pin Definition of SPI

Pin Name	Pin No.	Multiplexing Function	I/O	Description	Comment
GPIO1	21	SPI_CS0	DIO	SPI chip select	In master mode, it is an input signal; In slave mode, it is an output signal.
GPIO0	22	SPI_CLK	DIO	SPI clock	In master mode, it is an output signal; In slave mode, it is an input signal.
GPIO3	23	SPI_MISO	DIO	SPI master-in slave-out	
GPIO2	29	SPI_MOSI	DIO	SPI master-out slave-in	

3.4.3. I2C Interface*

The module provides one I2C interface that supports master mode only. It supports:

- AMBA 2.0 APB bus
- Standard-mode (100 Kbps) and fast-mode (400 Kbps) protocols
- Programmable master and slave modes
- 7-bit and 10-bit addressing modes
- Automatic clock stretching
- Programmable clock and data timing
- DMA
- Universal call address

Table 9: Pin Definition of I2C Interface

Pin Name	Pin No.	Multiplexing Function	I/O	Description	Comment
GPIO2	29	I2C_SCL	OD	I2C serial clock	Pin 11, Pin 20 (alternative)
GPIO3	23	I2C_SDA	OD	I2C serial data	Pin 12, Pin 16 (alternative)

3.4.4. SDIO Interface*

Table 10: Pin Definition of SDIO Interface

Pin Name	Pin No.	Multiplexing Function	I/O	Description
GPIO21	12	SDIO_CMD	DIO	SDIO command
GPIO13	20	SDIO_CLK	DI	SDIO clock
GPIO25	16	SDIO_DATA3	DIO	SDIO data bit 3
GPIO24	15	SDIO_DATA2	DIO	SDIO data bit 2
GPIO22	13	SDIO_DATA0	DIO	SDIO data bit 0
GPIO23	14	SDIO_DATA1	DIO	SDIO data bit 1

The SDIO interface connection between the module and the host is illustrated in the following figure

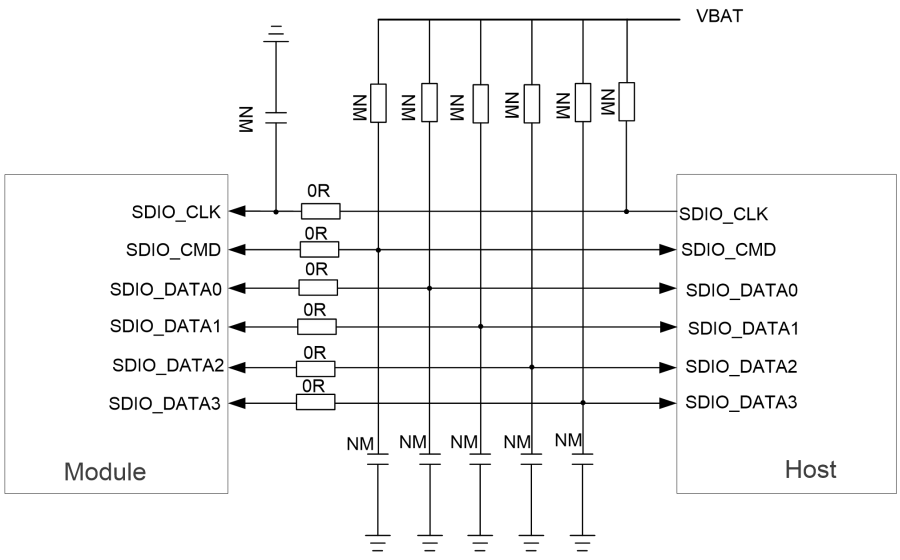


Figure 6：SDIO Interface Connection

To ensure compliance of interface design with the SDIO 3.0 specification, please comply with the following principles for SDIO interface design.

- Route the SDIO traces in inner layer of the PCB, and surround the traces with ground on that layer and with ground planes above and below. The impedance of SDIO signal trace is 50 Ω ±10 %.
- Keep SDIO signals far away from other sensitive circuits/signals, such as RF circuits and analog signals, as well as noisy signals such as clock signals and DC-DC signals.
- The distance between SDIO signals and other signals must be greater than twice the trace width, and the bus load capacitance must be less than 15 pF.
- SDIO signal traces need to be equal length (the distance between the traces should be less than 0.5 mm).

3.4.5. PWM Interfaces*

The module supports six PWM channels by default. Pin description of PWM interfaces are as follows.

Table 11: Pin Definition of PWM Interfaces

Pin Name	Pin No.	Multiplexing Function	I/O	Description	Comment
GPIO16	10	PWM2	DO	PWM2 out	Pin 15, Pin 29 (alternative).
GPIO23	14	PWM1	DO	PWM1 out	Pin 21 (alternative).
GPIO25	16	PWM3	DO	PWM3 out	Pin 6, Pin 23 (alternative).
GPIO15	7	PWM5	DO	PWM5 out	Pin 19 (alternative).
GPIO14	8	PWM4	DO	PWM4 out	
GPIO4	9	PWM0	DO	PWM0 out	Pin 13, Pin 22 (alternative).

3.4.6. I2S Interface*

The module supports one I2S interface for transmission of digital audio data between internal components of the system, such as Codec, DSP, digital input/output interface, ADC, DAC and digital filter, etc.

Table 12: Pin Definition of I2S Interface

Pin Name	Pin No.	Multiplexing Function	I/O	Description	Comment
GPIO1	21	I2S_RXD	DI	I2S receive data	Pin 20 (alternative).
GPIO14	8	I2S_TXD	DO	I2S transmit data	Pin 11, Pin 12 (alternative).
GPIO20	6	I2S_MCLK	OD	I2S master clock	Pin 15 (alternative).
GPIO0	22	I2S_TX_SCK	DIO	I2S transmit serial clock	Pin 14 (alternative).
GPIO15	7	I2S_TX_WS	DIO	I2S transmit word select	Pin 13, Pin 19 (alternative).

3.4.7. ADC Interfaces*

The module supports three ADC interfaces by default, whose voltage range is 0–3.3 V. To improve ADC accuracy, surround ADC trace with ground.

Table 13: Pin Definition of ADC Interfaces

Pin Name	Pin No.	Multiplexing Function	I/O	Description
GPIO20	6	ADC2	AI	General-purpose ADC interface
GPIO15	7	ADC1	AI	General-purpose ADC interface
GPIO14	8	ADC0	AI	General-purpose ADC interface

Table 14: ADC Features

Parameter	Min.	Typ.	Max.	Unit
ADC Voltage Range	0	-	3.3	V

ADC Resolution Rate	-	TBD	-	bit

3.5. RF Antenna Interfaces

Appropriate antenna type and design should be used with matched antenna parameters according to specific application. It is required to perform a comprehensive functional test for the RF design before mass production of terminal products. The entire content of this chapter is provided for illustration only. Analysis, evaluation and determination are still necessary when designing target products.
The module supports PCB antenna, coaxial RF connector and ANT_WIFI/BT antenna pin (stamp hole). The coaxial RF connector is not mounted on the module when using PCB antenna or ANT_WIFI/BT antenna.

3.5.1. Operating Frequencies

The operating frequencies of the module are listed below:

Table 15: Operating Frequencies (Unit: GHz)

Feature	Frequency
2.4 GHz Wi-Fi	2.400–2.4835
Bluetooth	2.400–2.4835

3.5.2. ANT_WIFI/BT Antenna (Optional)

Table 16: ANT_WIFI/BT Pin Definition

Pin Name	Pin No.	I/O	Description	Comment
ANT_WIFI/BT	2	AIO	Wi-Fi/Bluetooth antenna interface	50 Ω impedance.

3.5.2.1. Reference Design

The circuit of RF antenna interface is shown below. For better RF performance, it is necessary to reserve a π matching circuit and add ESD protection components. Reserved matching components such as R1, C1, C2, and D1 should be placed as close to the antenna as possible. C1, C2, and D1 are not mounted by

default. The parasitic capacitance of TVS should be less than 0.05 pF and R1 is recommended to be 0 Ω.

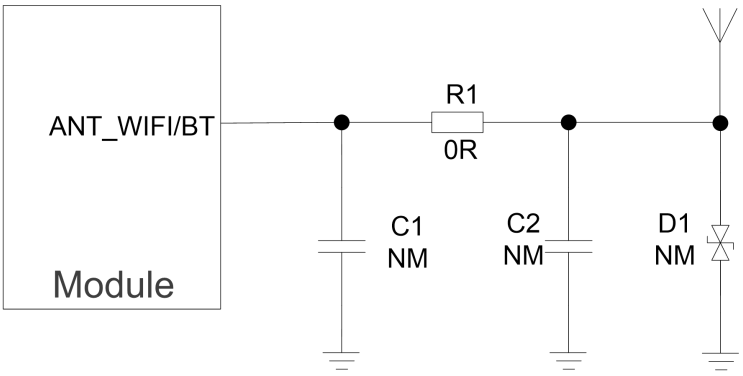


Figure 7: RF Antenna Reference Design

3.5.2.2. Antenna Design Requirements

Table 17: Antenna Design Requirements

Parameter	Requirement
Frequency Range (GHz)	2.400–2.4835
Cable Insertion Loss (dB)	< 1
VSWR	≤ 2
Gain (dBi)	1 (Typ.)
Max. input power (W)	50
Input impedance (Ω)	50
Polarization type	Vertical

3.5.2.3. 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.

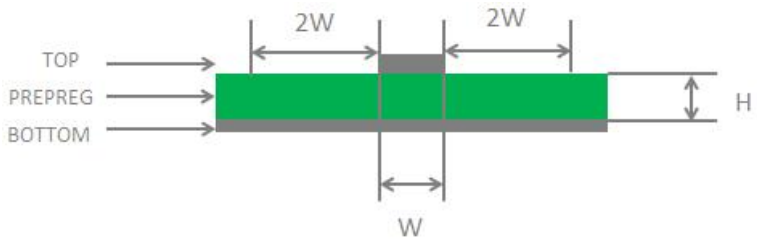


Figure 8: Microstrip Design on a 2-layer PCB

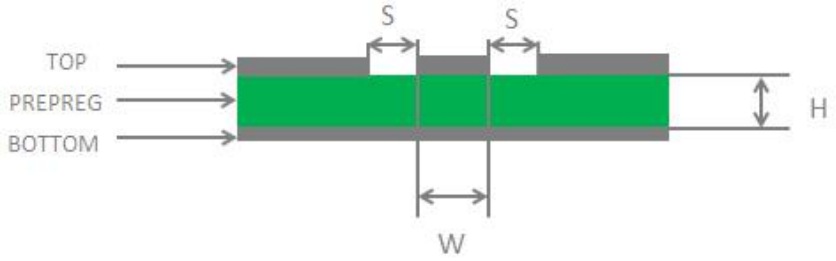


Figure 9: Coplanar Waveguide Design on a 2-layer PCB

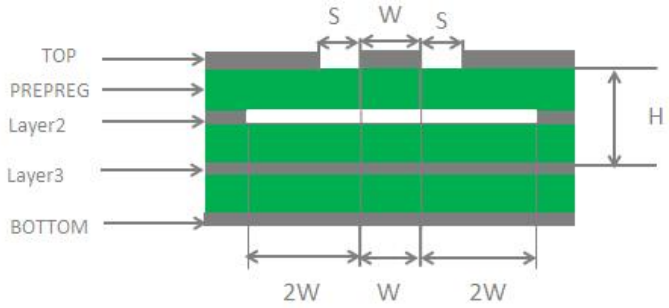


Figure 10: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

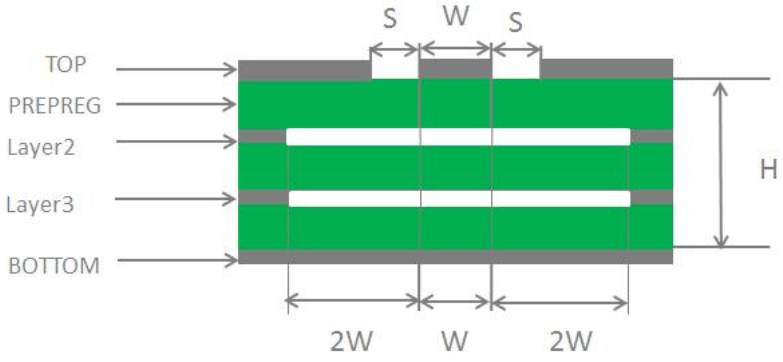


Figure 11: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

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

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

3.5.3. PCB Antenna (Optional)

Table 18: PCB Antenna Specifications

Parameter	Requirement
Frequency Range (GHz)	2.400–2.500
Input Impedance (Ω)	50
VSWR	≤ 3
Gain (dBi)	-0.38 (Typ.)
Efficiency	26 %

When using the PCB antenna on the module, the module should be placed at the side of the motherboard. The distance between the PCB antenna and connectors, vias, traces, ethernet port and any other metal components on the motherboard should be at least 16 mm. All layers in the PCB of the motherboard under the PCB antenna should be designed as a keepout area.

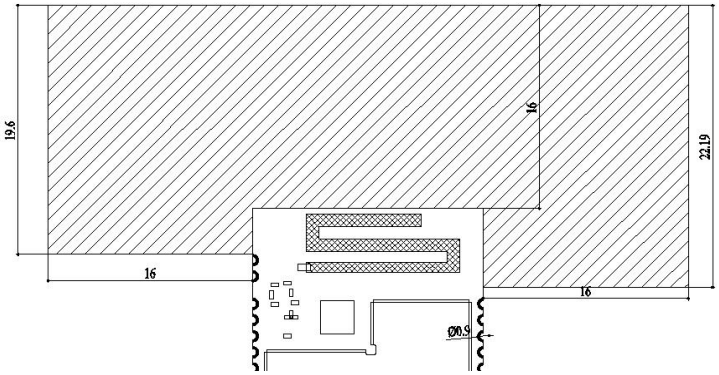


Figure 12: Keepout Area on Motherboard

Do not routing at the RF test point at the bottom of the module to ensure its performances during PCB design.

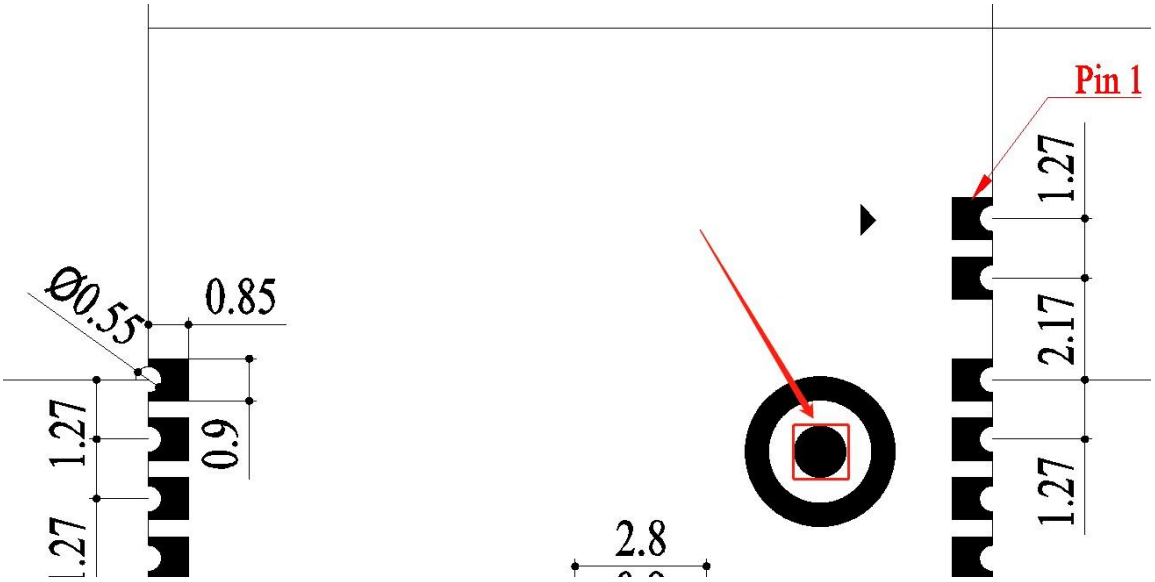


Figure 13: Prohibited Area for Routing

3.5.4. Coaxial RF Connector (Optional)

3.5.4.1. Receptacle Specifications

The mechanical dimensions of the receptacle supported by the module are as follows.

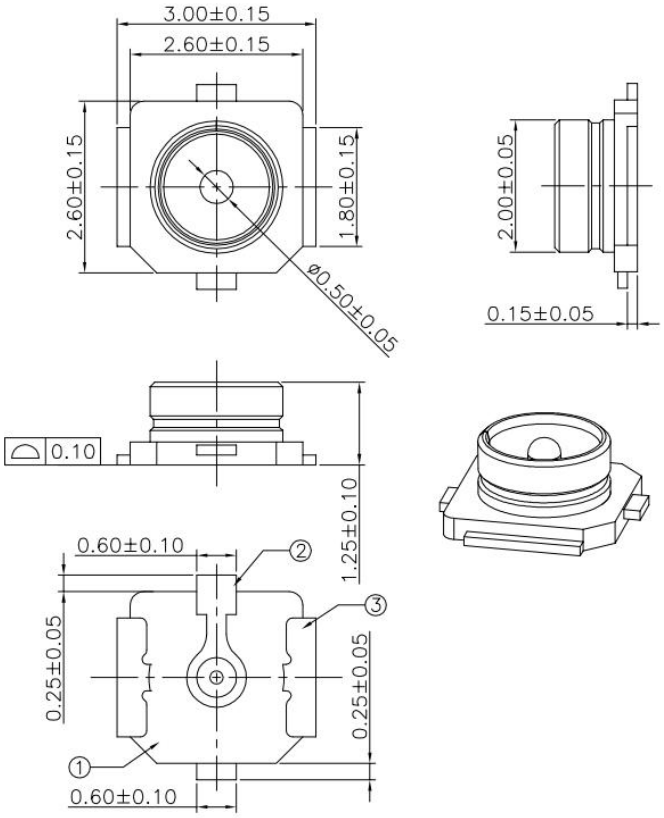


Figure 14: Dimensions of the Receptacle (Unit: mm)

Table 19: Major Specifications of the RF Connector

Item	Specification
Nominal Frequency Range	DC to 6 GHz
Nominal Impedance	50 Ω
Temperature Rating	-40 °C to +85 °C
Voltage Standing Wave Ratio (VSWR)	Meet the requirements of: Max. 1.3 (DC–3 GHz) Max. 1.45 (3–6 GHz)

The mated plug listed in the following figure can be used to match the connector.

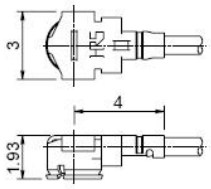
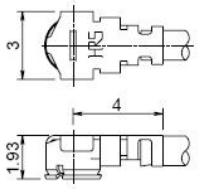
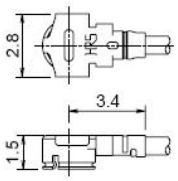
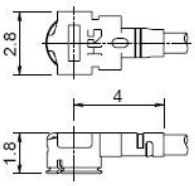
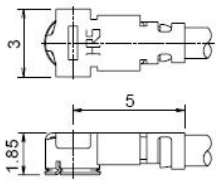
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 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 15: Specifications of Mated Plugs (Unit: mm)

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

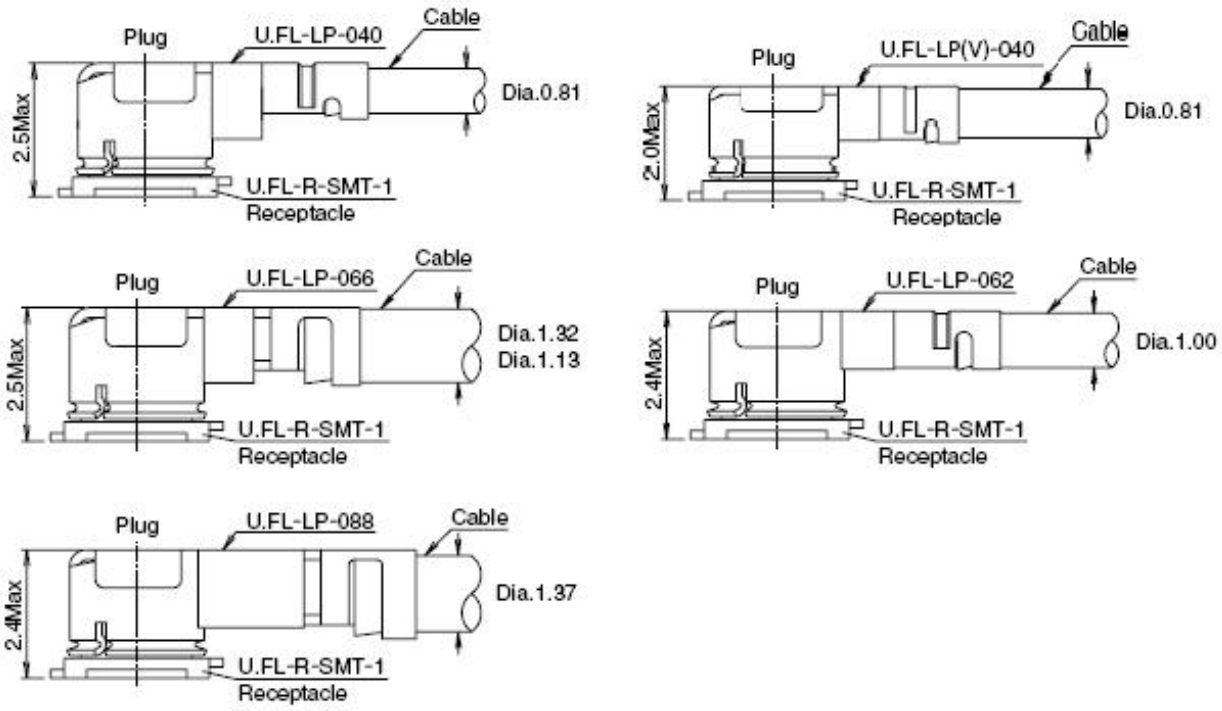


Figure 16: Space Factor of the Mated Connectors (Unit: mm)

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

3.5.4.2. Assemble Coaxial Cable Plug Manually

The pictures for plugging in a coaxial cable plug is shown below, θ = 90° is acceptable, while θ ≠ 90° is not.

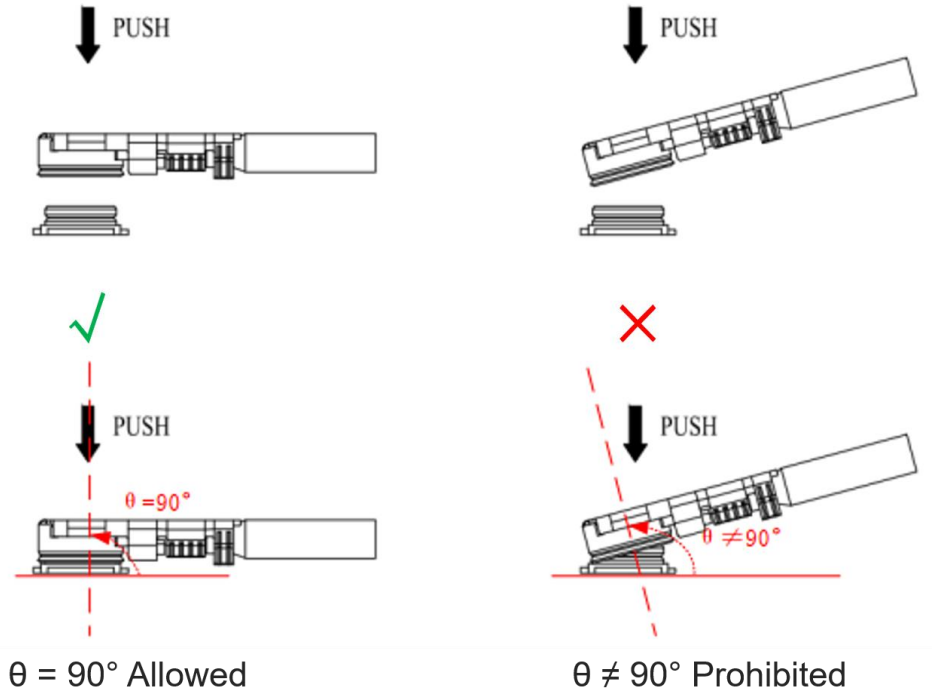


Figure 17: Plug in a Coaxial Cable Plug

The pictures of pulling out the coaxial cable plug is shown below, θ = 90° is acceptable, while θ ≠ 90° is not.

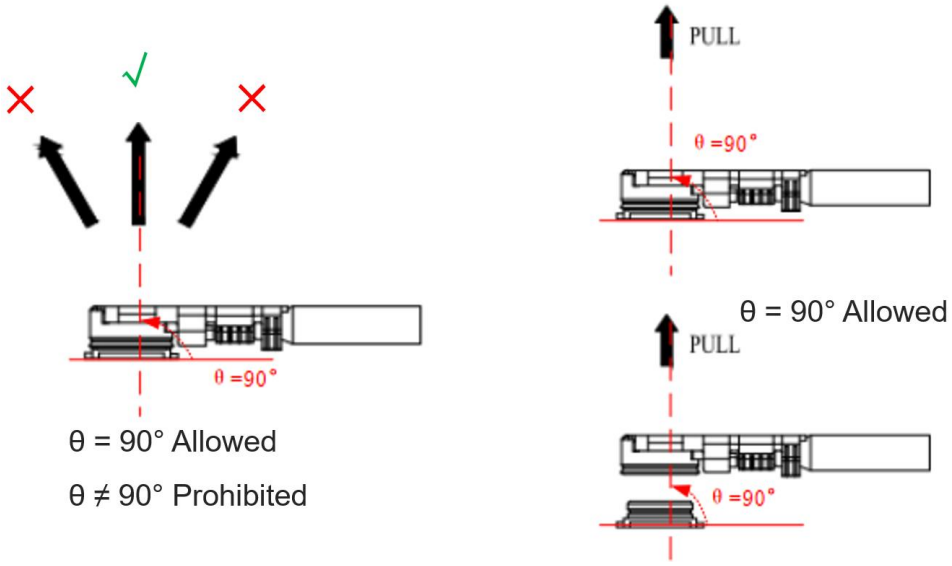


Figure 18: Pull out a Coaxial Cable Plug

3.5.4.3. Assemble Coaxial Cable Plug with Jig

The pictures of installing the coaxial cable plug with a jig is shown below, θ = 90° is acceptable, while θ ≠ 90° is not.

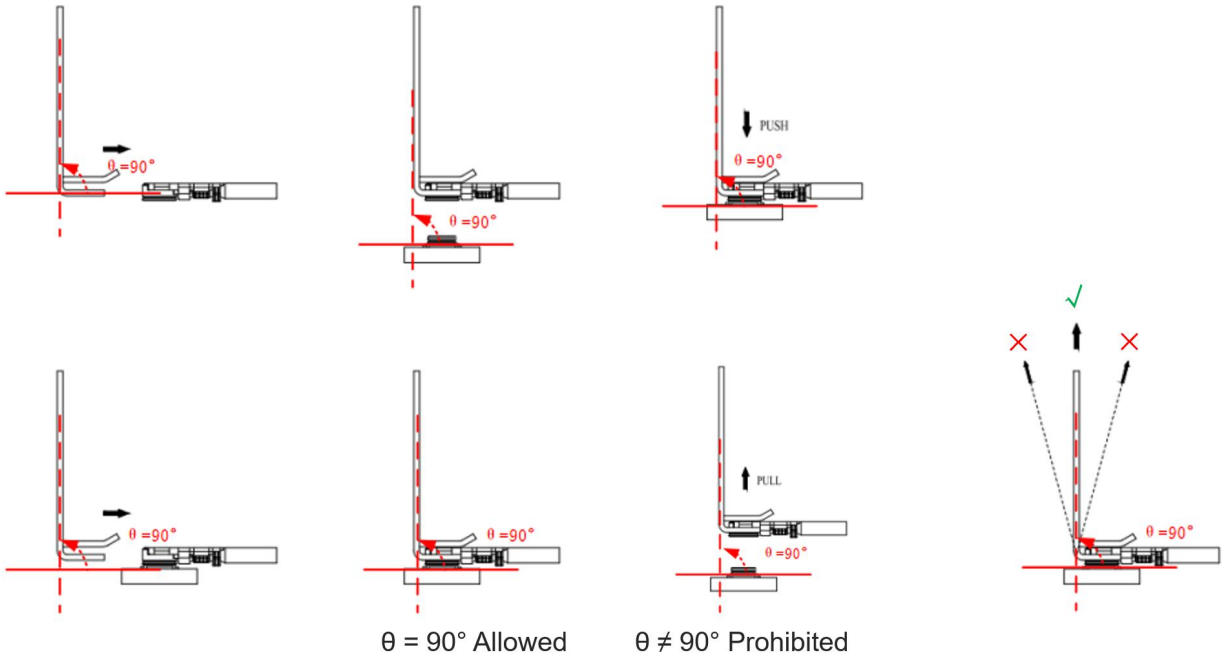


Figure 19: Install the Coaxial Cable Plug with Jig

3.5.4.4. 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 Operating Characteristics

4.1. Power Supply

Power supply pin and ground pins of the module are defined in the following table.

Table 20: Pin Definition of Power Supply and GND Pins

Pin Name	Pin No.	I/O	Description	Min.	Typ.	Max.	Unit
VBAT	4	PI	Power supply for the module	3.0	3.3	3.6	V
GND	1, 3, 30, 31–39						

4.1.1. Reference Design for Power Supply

The module is powered by VBAT, and it is recommended to use a power supply chip that can provide more than 0.6 A output current. For better power supply performance, it is recommended to parallel a 22 µF decoupling capacitor, and two filter capacitors (1 µF and 100 nF) near the module's VBAT pin. In addition, it is recommended to add a TVS near the VBAT to improve the surge voltage bearing capacity of the module. In principle, the longer the VBAT trace is, the wider it should be.

VBAT reference circuit is shown below:

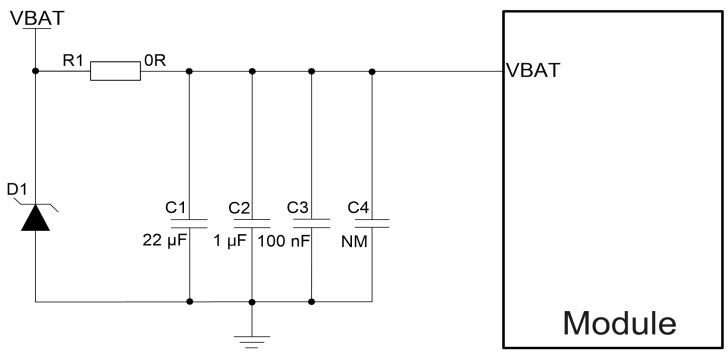


Figure 20: VBAT Reference Circuit

4.2. Turn On

After the module VBAT is powered on, keep the CEN pin at high level to realize the automatic startup of the module.

Table 21: Pin Definition of CEN

Pin Name	Pin No.	I/O	Description	Comment
CEN	5	DI	Enable the module	Hardware enable; Internally pulled up to 3.3 V; Active high.

The turn-on timing is shown below:

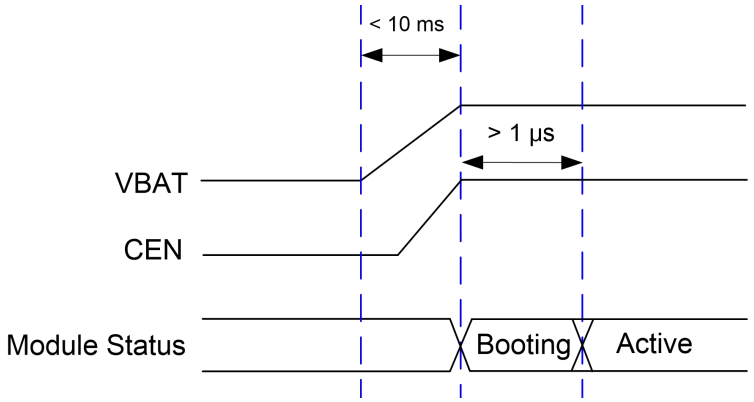


Figure 21: Turn-on Timing

4.3. Reset

Drive RESET low for at least 100 ms and then release it to reset the module.

Table 22: Pin Definition of RESET

Pin Name	Pin No.	I/O	Description	Comment
RESET	11	DI	Resets the module	Hardware reset; Internally pulled up to 3.3 V; Active low.

The reference design for resetting the module are shown below. An open collector driving circuit can be used to control the RESET pin.

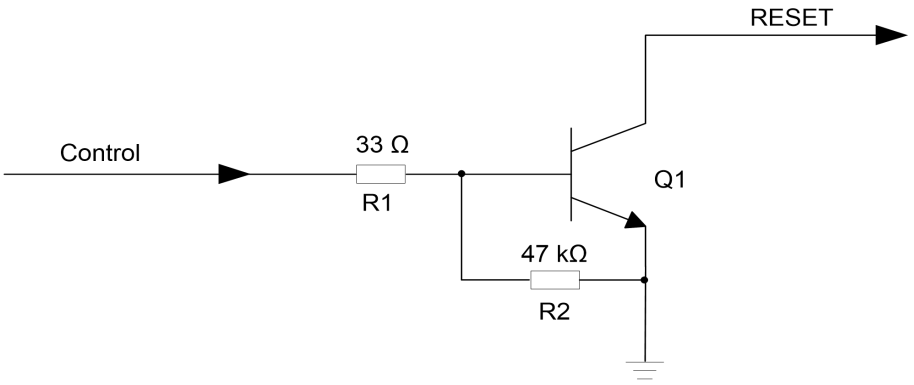


Figure 22: Reference Circuit of RESET by A Using Driving Circuit

Another way to control the RESET is by using a button directly. When pressing the button, an electrostatic strike may generate from finger. Therefore, a TVS component shall be placed near the button for ESD protection.

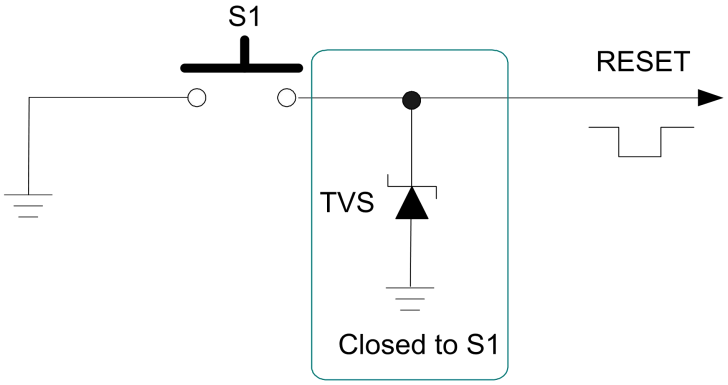


Figure 23: Reference Circuit of RESET with A Button

The module reset timing is illustrated in the following figure.

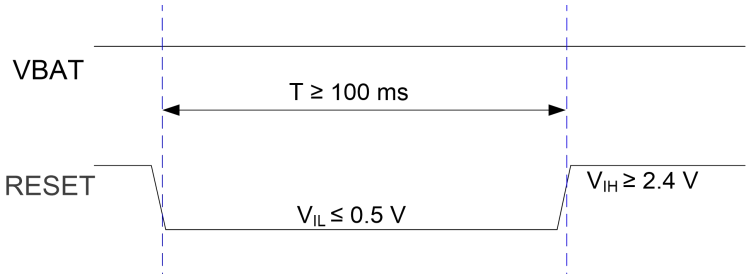


Figure 24: Reset Timing

4.4. Download Mode

Keep the input signal of RESET at low level during resetting or power-up and the module will enter download mode. In the download mode, the firmware can be download through the main UART. During the hardware design, the RESET pin of the module is connected to the RTS of the serial port chip, or the GPIO is controlled according to the following waveform, otherwise the download will fail.

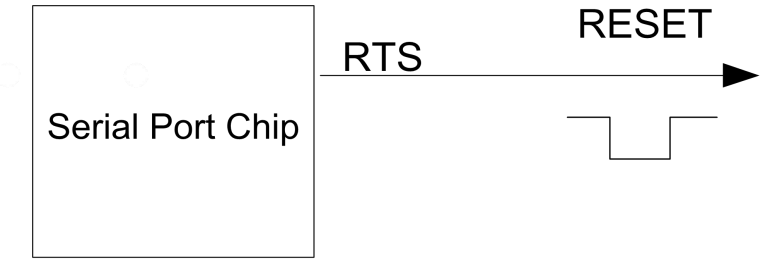


Figure 25: Reference Design for Download Mode

5 RF Performances

5.1. Wi-Fi Performances

Table 23: Wi-Fi Performances

Operating Frequency				
2.4 GHz: 2.400–2.4835 GHz				
Modulation				
BPSK, QPSK, CCK, 16QAM, 64QAM				
Operating Mode				
● AP ● STA				
Transmission Data Rate				
● 802.11b: 1 Mbps, 2 Mbps, 5.5 Mbps, 11 Mbps ● 802.11g: 6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps, 24 Mbps, 36 Mbps, 48 Mbps, 54 Mbps ● 802.11n: HT20 (MCS 0–7), HT40 (MCS 0–7) ● 802.11ax: HE20（MCS 0–7）				
Condition		**EVM**	**Unit: dBm, Tolerance: ±2 dB**	
			Transmitting Power @ Typ.	**Receiving Sensitivity @ Typ.**
2.4 GHz	802.11b @ 1 Mbps	≤ 35 %	17	-92
	802.11b @ 11 Mbps		17	-86
	802.11g @ 6 Mbps	≤ -5 dB	14	-89
	802.11g @ 54 Mbps	≤ -25 dB	14	-73
	802.11n, HT20 @ MCS 0	≤ -5 dB	14	-89
	802.11n, HT20 @ MCS 7	≤ -27 dB	14	-70

802.11n, HT40 @ MCS 0	≤ -5 dB	13	-87
802.11n, HT40 @ MCS 7	≤ -27 dB	13	-67
802.11ax, HE20 @ MCS 0	≤ -5 dB	14	-89
802.11ax, HE20 @ MCS 7	≤ -27 dB	14	-69

5.2. Bluetooth Performances

Table 24: Bluetooth Performances

Operating Frequency		
2.400~2.4835 GHz		
Modulation		
GFSK		
Operating Mode		
BLE		
Condition	**Unit: dBm, Tolerance: ±2 dB [4]**	
	Transmitting Power @ Typ.	**Receiving Sensitivity @ Typ.**
BLE (1 Mbps)	6 dBm	-90 dBm
BLE (2 Mbps)	6 dBm	-89 dBm

[4] The tolerance for Bluetooth receiving sensitivity is ±4 dB in high channel (CH39).

6 Electrical Characteristics & Reliability

6.1. Absolute Maximum Ratings

Absolute maximum ratings for power supply and voltage on digital and analog pins of the module are listed in the following table.

Table 25: Absolute Maximum Ratings (Unit: V)

Parameter	Min.	Max.
VBAT	-0.3	3.6
Voltage at Digital Pins	-0.3	3.6
Voltage at ADC[0:2]	0	3.3

6.2. Power Supply Ratings

Table 26: Module Power Supply Ratings (Unit: V)

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

6.3. Power Consumption

Table 27: Power Consumption in Low Power Modes

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

Table 28: Power Consumption in Non-signaling Modes (Unit: mA)

Condition	Typ.
802.11b, Tx 1 Mbps @ 17 dBm	285
802.11b, Tx 11 Mbps @ 17 dBm	277
802.11g, Tx 6 Mbps @ 14 dBm	182
802.11g, Tx 54 Mbps @ 14 dBm	167
802.11n HT20, Tx MCS 0 @ 14 dBm	184
802.11n HT20, Tx MCS 7 @ 14 dBm	179
802.11n HT40, Tx MCS 0 @ 13 dBm	183
802.11n HT40, Tx MCS 7 @ 13 dBm	172
802.11ax HE20, Tx MCS 0 @14 dBm	184
802.11ax HE20, Tx MCS 7 @ 14 dBm	180

6.4. Digital I/O Characteristics

Table 29: VBAT I/O Characteristics (Unit: V)

Parameter	Description	Min.	Max.
V_{IH}	High-level Input Voltage	0.7 × VBAT	VBAT
V_{IL}	Low-level Input Voltage	0	0.3 × VBAT
V_{OH}	High-level Output Voltage	0.9 × VBAT	-
V_{OL}	Low-level Output Voltage	-	0.1 × VBAT

6.5. ESD Protection

Static electricity occurs naturally and 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: ESD Characteristics (Unit: kV)

Model	Test Result	Standard
Human Body Model (HBM)	±4	ANSI/ESDA/JEDEC JS-001-2017
Charged Device Model (CDM)	±0.5	ANSI/ESDA/JEDEC JS-002-2018

7 Mechanical Information

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

7.1. Mechanical Dimensions

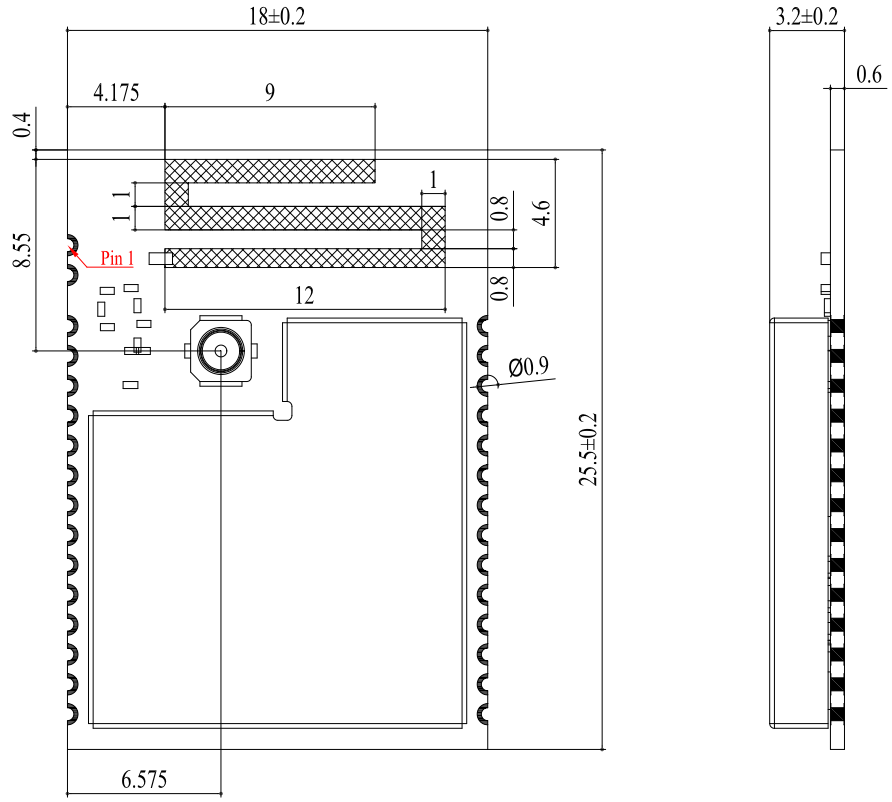


Figure 26: Top and Side Dimensions

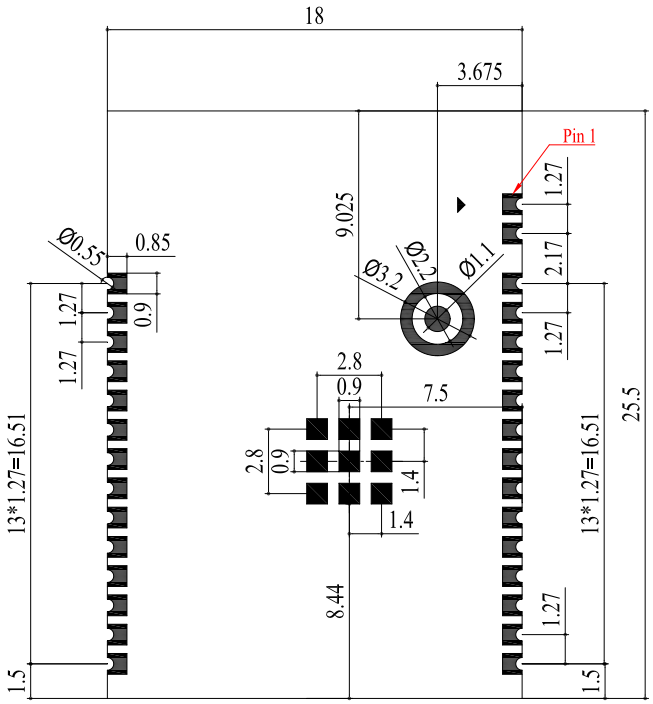


Figure 27: Bottom Dimensions (Bottom View)

NOTE

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

7.2. Recommended Footprint

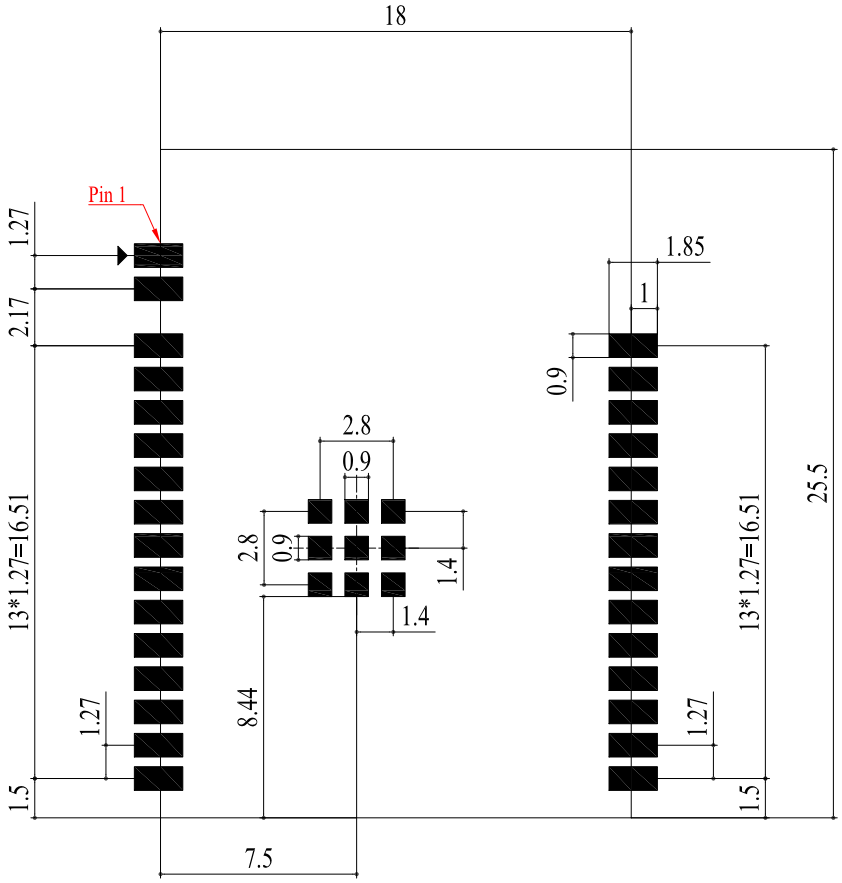


Figure 28: Recommended Footprint

NOTE

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

7.3. Top and Bottom Views

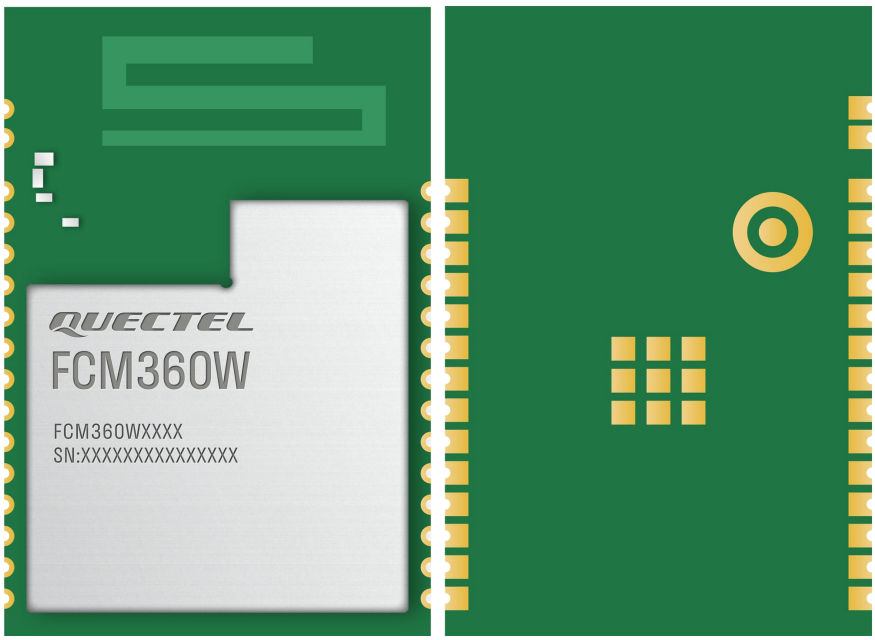


Figure 29: Top and Bottom Views (Pin Antenna)

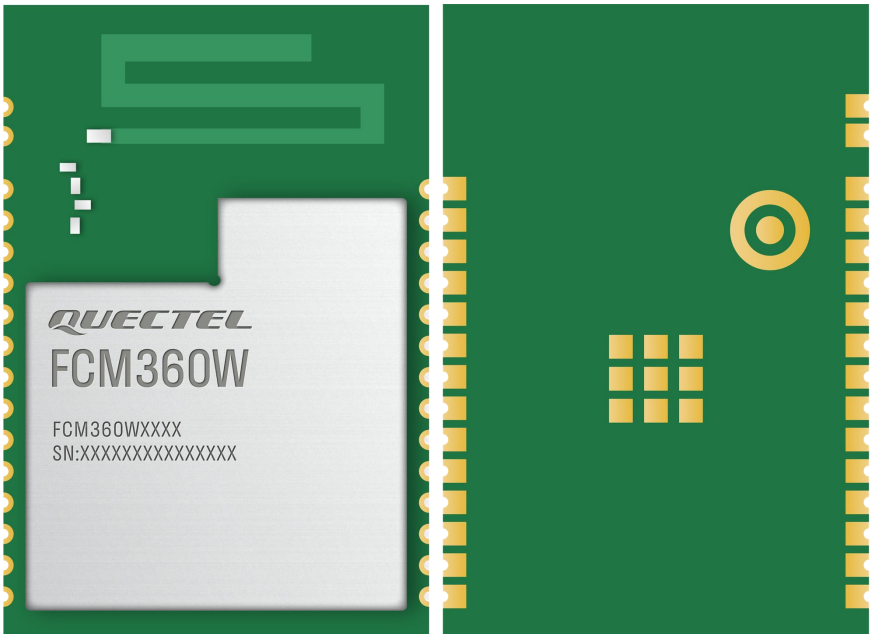


Figure 30: Top and Bottom Views (PCB Antenna)

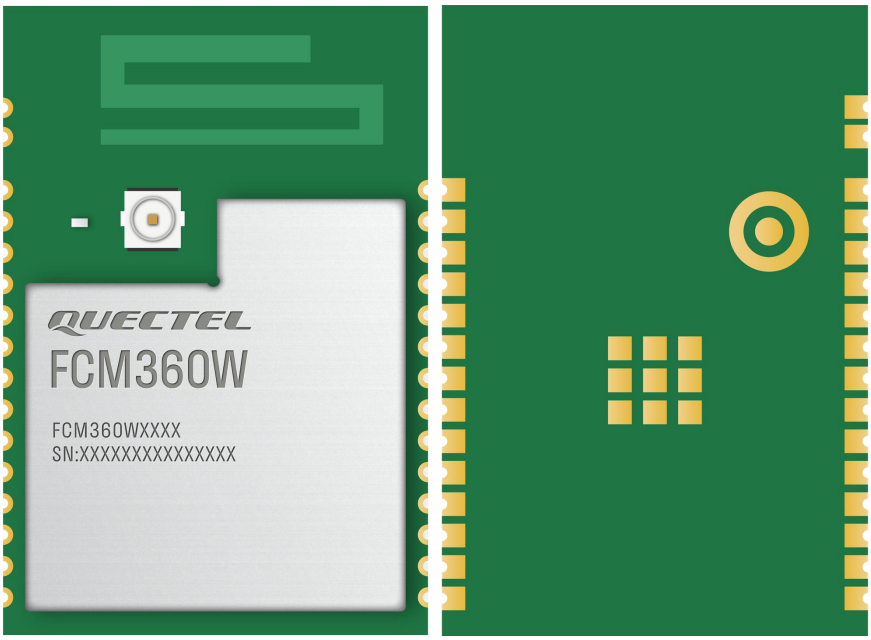


Figure 31: Top and Bottom Views (Coaxial RF Connector)

NOTE

1. Images above are for illustrative purposes only and may differ from the actual module. For authentic appearance and label, please refer to the module received from Quectel.
2. The coaxial RF connector is not mounted on the module when using PCB antenna or ANT_WIFI/BT antenna.

8 Storage, Manufacturing & Packaging

8.1. Storage Conditions

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

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

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

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

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

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

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

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

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

NOTE

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

8.2. 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.

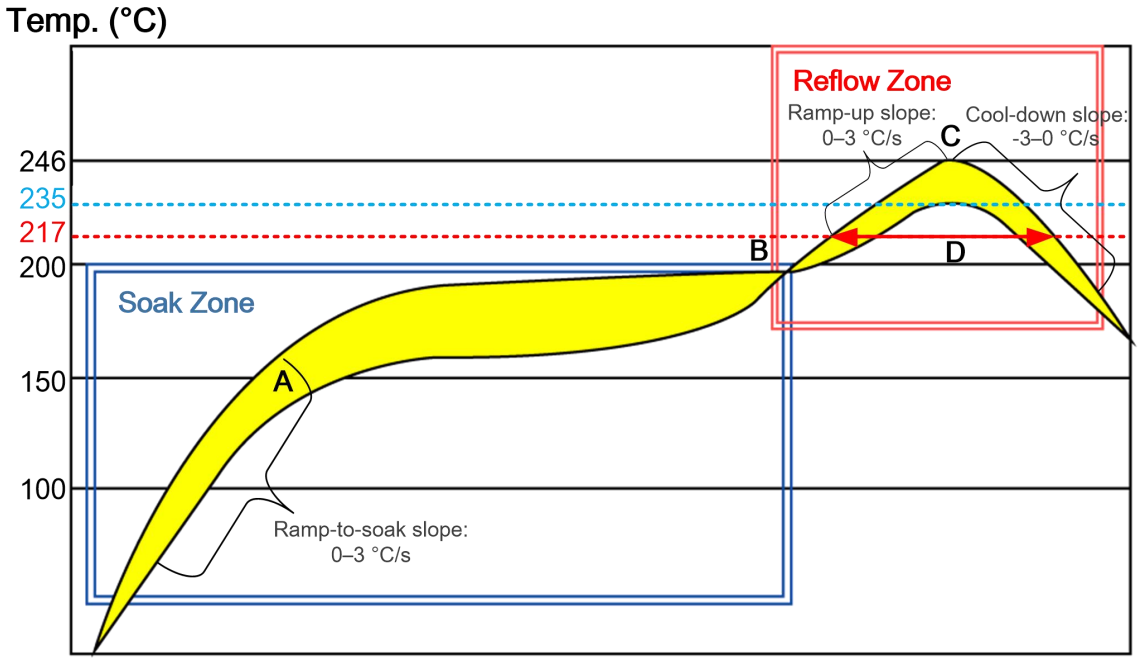


Figure 32: Recommended Reflow Soldering Thermal Profile

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 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]***.

8.3. 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:

8.3.1. Carrier Tape

Carrier tape dimensions are detailed below:

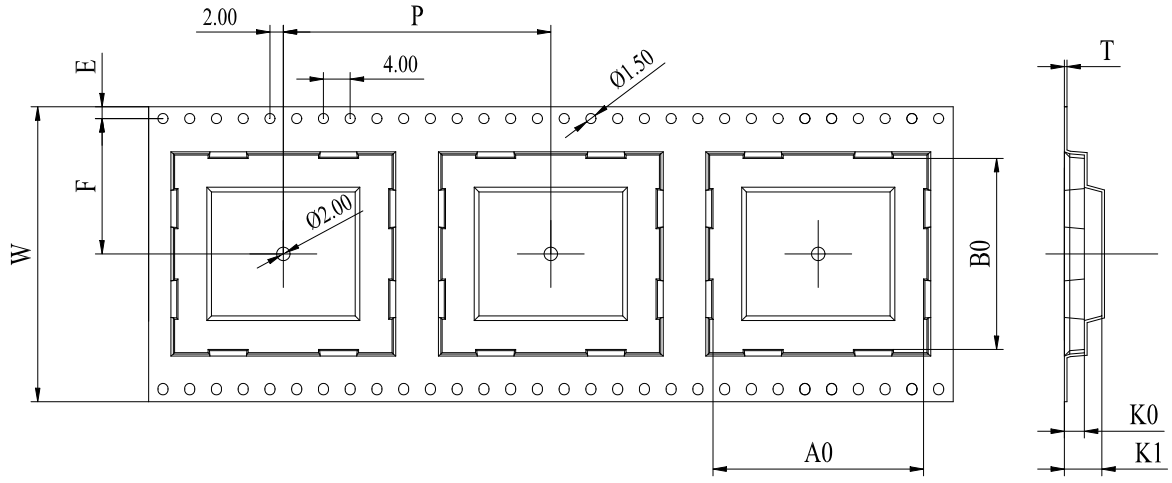


Figure 33: Tape Specifications

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

W	P	T	A0	B0	K0	K1	F	E
44	32	0.4	18.4	25.9	3.7	6.8	20.2	1.75

8.3.2. Plastic Reel

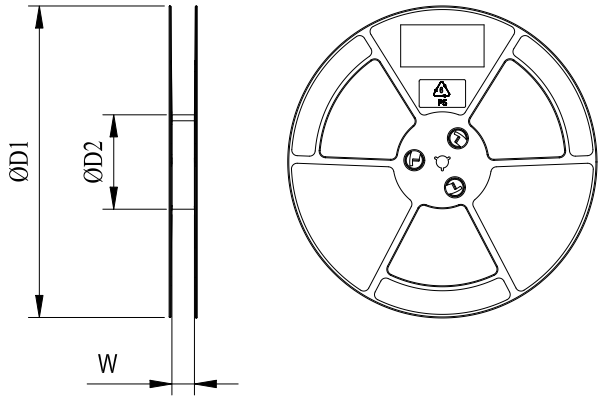


Figure 34: Plastic Reel Dimension Drawing

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

øD1	øD2	W
330	100	44.5

8.3.3. Mounting Direction

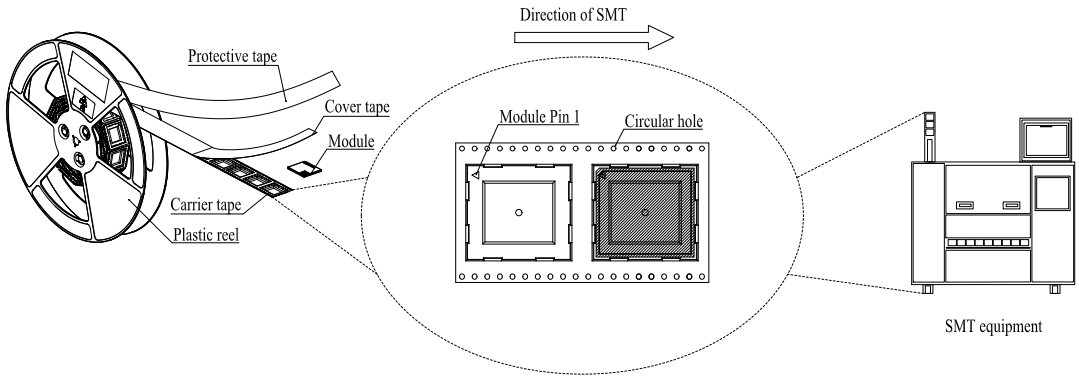
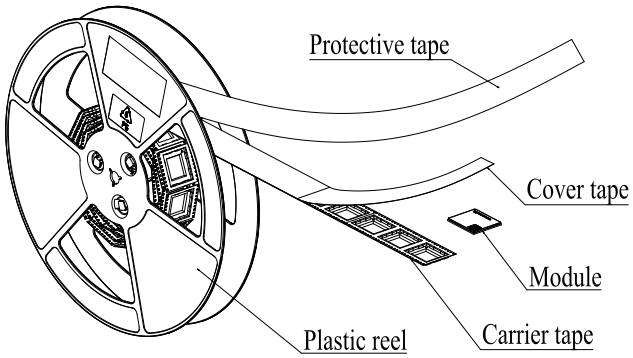


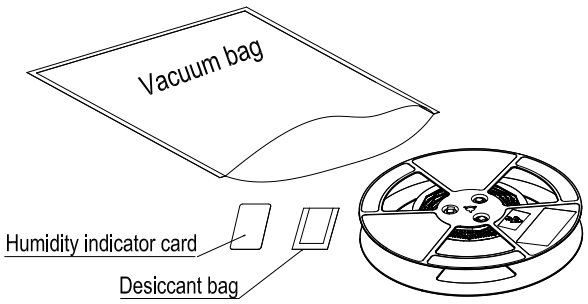
Figure 35: Mounting Direction

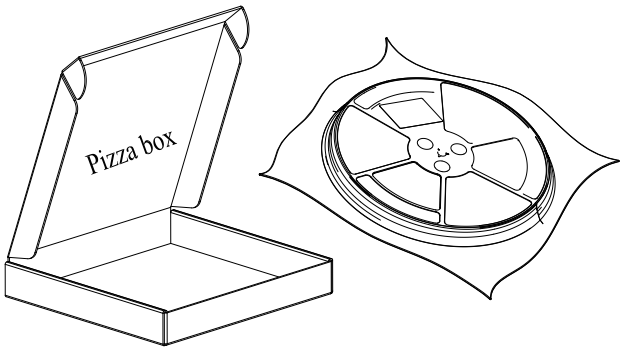
8.3.4. Packaging Process



Place the modules into the carrier tape and use the cover tape to cover them; then wind the heat-sealed carrier tape on 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, then vacuumize it.





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

Place 4 packaged pizza boxes inside 1 carton box and seal it. 1 carton box can pack 1000 modules.

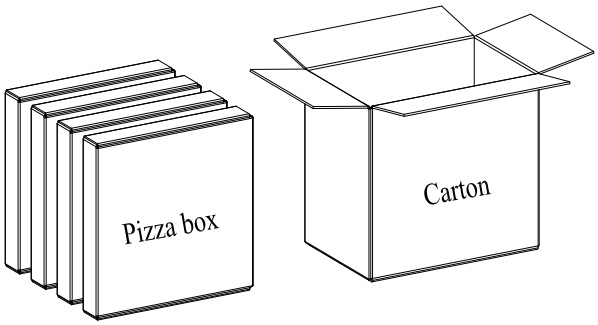


Figure 36: Packaging Process

9 Appendix References

Table 34: Reference Documents

Document Name
[1] Quectel_FCM360W_TE-B_User_Guide
[2] Quectel_RF_Layout_Application_Note
[3] Quectel_Module_SMT_Application_Note

Table 35: Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
AMBA	Advanced Microcontroller Bus Architecture
AP	Access Point
APB	Advanced Peripheral Bus
BLE	Bluetooth Low Energy
BPSK	Binary Phase Shift Keying
CCK	Complementary Code Keying
CDM	Charged Device Model
CS	Chip Select
DAC	Digital-to-Analog Converter
DCE	Data Communications Equipment
DMA	Direct Memory Access
DSP	Digital Signal Processor

DTE	Data Terminal Equipment
DTIM	Delivery Traffic Indication Message
ESD	Electrostatic Discharge
GFSK	Gauss frequency Shift Keying
GND	Ground
GPIO	General-Purpose Input/Output
HE	High Efficiency
HT	High Throughput
I/O	Input/Output
I2C	Inter-Integrated Circuit
I2S	Inter-IC Sound
IEEE	Institute of Electrical and Electronics Engineers
IoT	Internet of Things
LNA	Low Noise Amplifier
LCC	Leadless Chip Carrier (package)
Mbps	Million Bits Per Second
MISO	Master In Slave Out
MOSI	Master Out Slave In
NC	Not Connected
OTA	Over-the-Air
PA	Power Amplifier
PCB	Printed Circuit Board
PMU	Power Management Unit
PWM	Pulse Width Modulation
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency

RISC	Reduced Instruction-Set Computer
RoHS	Restriction of Hazardous Substances
ROM	Read Only Memory
SCLK	Serial Clock
SDIO	Secure Digital Input/Output
SPI	Serial Peripheral Interface
SRAM	Static Random Access Memory
STA	Station
TBD	To Be Determined
UART	Universal Asynchronous Receiver/Transmitter
V_{IH}	High-level Input Voltage
V_{IL}	Low-level Input Voltage
Vmax	Maximum Voltage
Vmin	Minimum Voltage
Vnom	Normal Voltage Value
V_{OH}	High-level Output Voltage
V_{OL}	Low-level Output Voltage
VSWR	Voltage Standing Wave Ratio
Wi-Fi	Wireless Fidelity

FCC Certification Requirements.

According to the definition of mobile and fixed device is described in Part 2.1091(b), this device is a mobile device.

And the following conditions must be met:

1. This Modular Approval is limited to OEM installation for mobile and fixed applications only. The antenna installation and operating configurations of this transmitter, including any applicable source-based time-averaging duty factor, antenna gain and cable loss must satisfy MPE categorical Exclusion Requirements of 2.1091.

2. The EUT is a mobile device; maintain at least a 20 cm separation between the EUT and the user's body and must not transmit simultaneously with any other antenna or transmitter.

3.A label with the following statements must be attached to the host end product: This device contains **FCC ID: XMR2023FCM360W.**

4.To comply with FCC regulations limiting both maximum RF output power and human exposure to RF radiation, maximum antenna gain (including cable loss) must not exceed:

- ❒ Bluetooth LE:≤0.1dBi
- ❒ Wi-Fi 2.4G:≤0.1dBi

5. This module must not transmit simultaneously with any other antenna or transmitter

6. The host end product must include a user manual that clearly defines operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.

For portable devices, in addition to the conditions 3 through 6 described above, a separate approval is required to satisfy the SAR requirements of FCC Part 2.1093

If the device is used for other equipment that separate approval is required for all other operating configurations, including portable configurations with respect to 2.1093 and different antenna configurations.

For this device, OEM integrators must be provided with labeling instructions of finished products. Please refer to KDB784748 D01 v07, section 8. Page 6/7 last two paragraphs:

A certified modular has the option to use a permanently affixed label, or an electronic label. For a permanently affixed label, the module must be labeled with an FCC ID - Section 2.926 (see 2.2 Certification (labeling requirements) above). The OEM manual must provide clear instructions explaining to the OEM the labeling requirements, options and OEM user manual instructions that are required (see next paragraph).

For a host using a certified modular with a standard fixed label, if (1) the module's FCC ID is not visible when installed in the host, or (2) if the host is marketed so that end users do not have straightforward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module:"Contains Transmitter Module FCC ID: **XMR2023FCM360W**" or "Contains FCC ID: **XMR2023FCM360W**" must be used. The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.

The final host / module combination may also need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.

The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. In cases where the manual is provided only in a form other than paper, such as on a computer disk or over the Internet, the information required by this section may be included in the manual in that alternative form, provided the user can reasonably be expected to have the capability to access information in that form.

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.

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

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

The EUT is a mobile device; maintain at least a 20 cm separation between the EUT and the user's body and must not transmit simultaneously with any other antenna or transmitter.

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.

To comply with IC regulations limiting both maximum RF output power and human exposure to RF radiation, maximum antenna gain (including cable loss) must not exceed:

- Bluetooth LE:≤0.1dBi
- Wi-Fi 2.4G:≤0.1dBi

The host product shall be properly labelled 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-2023FCM360W**” or “where: **10224A-2023FCM360W** 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-2023FCM360W "** ou "où: **10224A-2023FCM360W** est le numéro de certification du module.