

FCS961K-L

Hardware Design

Short-Range Module Series

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Safety Information

The following safety precautions must be observed during all phases of operation, such as usage, service or repair of any terminal or mobile incorporating the module. Manufacturers of the terminal should notify users and operating personnel of the following safety information by incorporating these guidelines into all manuals of the product. Otherwise, Quectel assumes no liability for customers' failure to comply with these precautions.



Full attention must be given to driving at all times in order to reduce the risk of an accident. Using a mobile while driving (even with a handsfree kit) causes distraction and can lead to an accident. Please comply with laws and regulations restricting the use of wireless devices while driving.



Switch off the terminal or mobile before boarding an aircraft. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. If there is an Airplane Mode, it should be enabled prior to boarding an aircraft. Please consult the airline staff for more restrictions on the use of wireless devices on an aircraft.



Wireless devices may cause interference on sensitive medical equipment, so please be aware of the restrictions on the use of wireless devices when in hospitals, clinics or other healthcare facilities.



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



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



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

About the Document

Revision History

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-	2024-03-08	Arrow HUANG	Creation of the document
1.0	2024-10-29	Amy HAN	First official release

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1 Introduction

This document defines the FCS961K-L 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.

Due to the module being too small to accommodate the IC ID, it was placed in the user manual.
IC:10224A-025FCS961KL

1.1. Special Marks

Table 1: Special Marks

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.
[...]	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

FCS961K-L is a low-power, cost-effective Wi-Fi 6 and Bluetooth module supporting IEEE 802.11b/g/n/ax and BLE 5.2 protocols. It supports 2.4 GHz and 1T1R with maximum data transmission rate up to 286.8 Mbps. It provides an SDIO 2.0/USB 2.0* interface for Wi-Fi functions, and an UART interface for Bluetooth functions.

The module is an SMD module with compact packaging.

Table 2: Basic Information

FCS961K-L	
Packaging type	LCC
Pin counts	44
Dimensions	(12.0 ±0.15) mm × (12.0 ±0.15) mm × (2.2 ±0.2) mm
Weight	Approx. 0.54 g

2.1. Key Features

Table 3: Key Features

Basic Information	
Protocols and Standard	● Wi-Fi protocols: IEEE 802.11b/g/n/ax ● Bluetooth protocol: BLE 5.2 ● All hardware components are fully compliant with EU RoHS directive
Power Supplies	VBAT Power Supply: ● 2.97–3.6 V ● Typ.: 3.3 V VDD_IO Power Supply: ● 1.71–3.6 V ● Typ.: 1.8/3.3 V
Temperature Ranges	● Operating temperature ¹: -20 °C to +80 °C ● Storage temperature: -25 °C to +90 °C
EVB Kit	FCS961K-L-M.2, RK3568-WF EVB ²
RF Antenna Interface	
Wi-Fi/Bluetooth Antenna Interface	● ANT_WIFI/BT ● 50 Ω characteristic impedance
Application Interface	
Wi-Fi Application Interfaces	SDIO 2.0/USB 2.0*
Bluetooth Application Interface	UART

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.

3 RF Performances

3.1. Wi-Fi Performances

Table 4: Wi-Fi Performances

Operating Frequency			
2.4 GHz: 2.400–2.4835 GHz			
Modulation			
DSSS, DBPSK, DQPSK, CCK, BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM			
Encryption Mode			
WEP, WPA, WPA2, WPA3-SAE			
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–MCS 7), HT40 (MCS 0–MCS 7) 802.11ax³: HE20 (MCS 0–MCS 11), HE 40 (MCS 0–MCS 11)			
Condition (VBAT = 3.3 V; Temp.: 25 °C)		Typ.; Unit: dBm; Tolerance: ±2.5 dB	
		Transmitting Power	Receiver Sensitivity
2.4 GHz	802.11b @ 1 Mbps	18	-96
	802.11b @ 11 Mbps	18	-88
	802.11g @ 6 Mbps	18	-94

³ In Rx mode, the maximum data rate can reach up to MCS 9 only. In Tx mode, the maximum data rate can reach up to MCS 11.

802.11g @ 54 Mbps	≤ -25 dB	16	-76
802.11n, HT20 @ MCS 0	≤ -5 dB	18	-93
802.11n, HT20 @ MCS 7	≤ -27 dB	16	-74
802.11n, HT40 @ MCS 0	≤ -5 dB	18	-88
802.11n, HT40 @ MCS 7	≤ -27 dB	16	-71
802.11ax, HE20 @ MCS 0	≤ -5 dB	18	-92
802.11ax, HE20 @ MCS 9 ⁴	≤ -35 dB	16	-71
802.11ax, HE20 @ MCS 11 ⁴	≤ -35 dB	14	-
802.11ax, HE40 @ MCS 0	≤ -5 dB	18	-88
802.11ax, HE40 @ MCS 9 ⁵	≤ -35 dB	16	-67
802.11ax, HE40 @ MCS 11 ⁵	≤ -35 dB	14	-

3.2. Bluetooth Performances

Table 5: Bluetooth Performances

Operating Frequency		
2.400–2.4835 GHz		
Modulation		
GFSK, $\pi/4$ -DQPSK, 8-DPSK		
Operating Mode		
Bluetooth Low Energy (BLE)		
Condition (VBAT = 3.3 V; Temp.: 25 °C)	Typ.; Unit: dBm; Tolerance: ±5 dB	
	Transmitting Power	Receiver Sensitivity
BLE (1 Mbps)	5	-98

⁴ 802.11ax HE20 supports the maximum data rate up to MCS 11 in Tx mode and MCS 9 in Rx mode.

⁵ 802.11ax HE40 supports the maximum data rate up to MCS 11 in Tx mode and MCS 9 in Rx mode.

BLE (2 Mbps)	5	-95
BLE (S = 8)	5	-108
BLE (S = 2)	5	-103

4 Application Interfaces

4.1. Pin Assignment

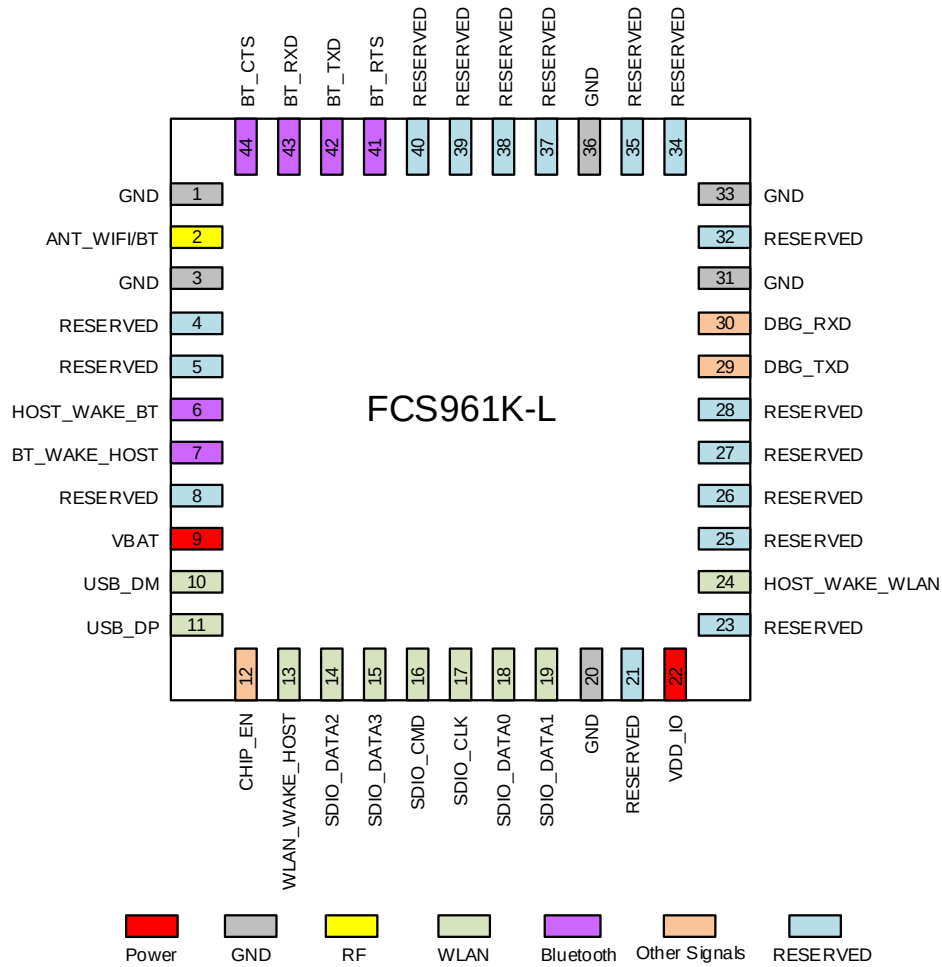


Figure 1: Pin Assignment (Top View)

NOTE

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

4.2. Pin Definitions

Table 6: Parameter Definition

Parameter	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.

Table 7: Pin Description

Power Supply and GND Pins					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
VBAT	9	PI	Power supply for the module	Vmin = 2.97 V Vnom = 3.3 V Vmax = 3.6 V	It is recommended to provide a current of 0.6 A at least.
VDD_IO	22	PI	Power supply for the module's I/O pins	Vmin = 1.71 V Vnom = 1.8/3.3 V Vmax = 3.6 V	It is recommended to provide a current of 0.2 A at least.
GND	1, 3, 20, 31, 33, 36				
Wi-Fi Application Interfaces					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
HOST_WAKE_WLAN	24	DI	Host wakes up WLAN	VDD_IO	Currently, the host wakes up the WLAN via SDIO interface.
WLAN_WAKE_HOST	13	DO	WLAN wakes up host		Active high.
SDIO_CMD	16	DIO	SDIO command		The module provides

SDIO_CLK	17	DI	SDIO clock	an SDIO/USB* interface for Wi-Fi applications. Require single-ended impedance of 50 Ω. SDIO 2.0 compliant. Reserve 10–100 kΩ resistors to pull each of them up to VDD_IO.
SDIO_DATA0	18	DIO	SDIO data bit 0	
SDIO_DATA1	19	DIO	SDIO data bit 1	
SDIO_DATA2	14	DIO	SDIO data bit 2	
SDIO_DATA3	15	DIO	SDIO data bit 3	
USB_DM*	10	AIO	USB 2.0 differential data (-)	Require differential impedance of 90 Ω. Test points must be reserved. If unused, keep them open.
USB_DP*	11	AIO	USB 2.0 differential data (+)	

Bluetooth Application Interfaces

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
BT_RTS	41	DO	Request to send signal from the module	VDD_IO	It is recommended to add a 0 Ω series resistor.
BT_CTS	44	DI	Clear to send signal to the module		
BT_TXD	42	DO	Bluetooth UART transmit		
BT_RXD	43	DI	Bluetooth UART receive		
HOST_WAKE_BT	6	DI	Host wakes up Bluetooth		Active high.
BT_WAKE_HOST	7	DO	Bluetooth wakes up host		

RF Antenna Interface

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

Other Interfaces

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
CHIP_EN	12	DI	Module enable	VDD_IO	Active high.

DBG_TXD	29	DO	Debug UART transmit	Test points must be reserved.
DBG_RXD	30	DI	Debug UART receive	
RESERVED Pins				
Pin Name	Pin No.		Comment	
RESERVED	4, 5, 8, 21, 23, 25–28, 32, 34, 35, 37–40		Keep them open.	

4.3. Reference Design for Power Supply

The module is powered by VBAT. It is recommended to use a power supply chip that provides at least 0.6 A to ensure sufficient current. For better power supply performance, it is recommended to parallel a 22 μ F decoupling capacitor, and 100 nF, 33 pF and 10 pF filter capacitors near the module's 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:

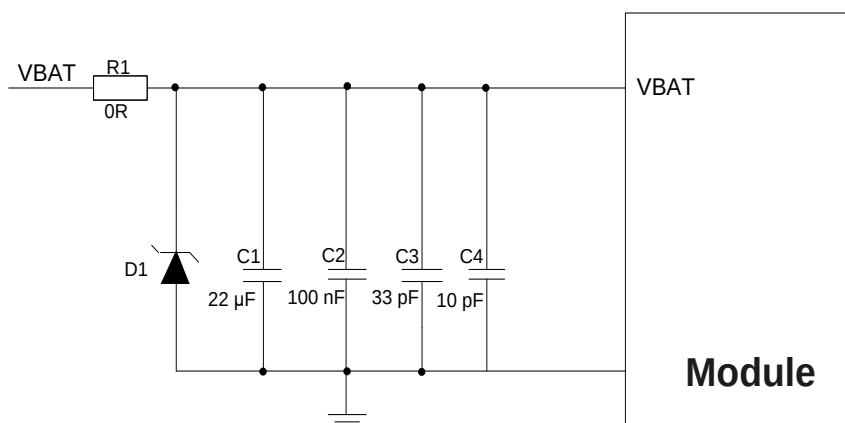


Figure 2: Reference Design of Power Supply

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

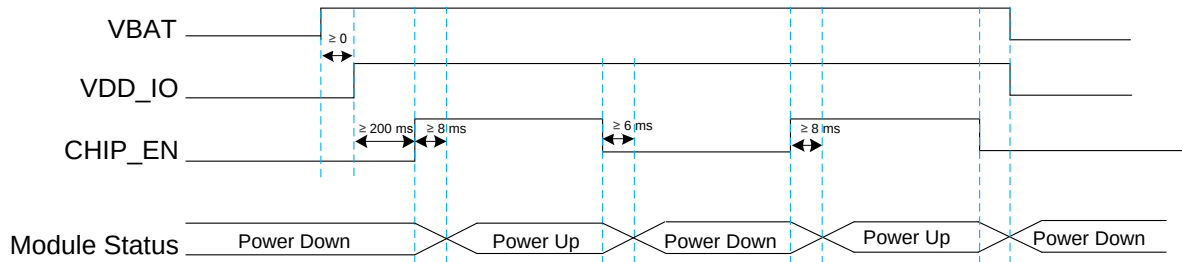


Figure 3: Power-up Timing

NOTE

1. VBAT should be powered up earlier than VDD_IO.
2. CHIP_EN reaches a high level at least 200 ms after VDD_IO is powered up.
3. The module will be turned on at least 8 ms later after CHIP_EN reaches a high level.
4. The module will be turned off at least 6 ms later after CHIP_EN reaches a low level.

4.4. Wi-Fi Application Interfaces

The module provides an SDIO/USB* interface for Wi-Fi functions. The Wi-Fi application interface connection between the module and the host is illustrated in the following figure.

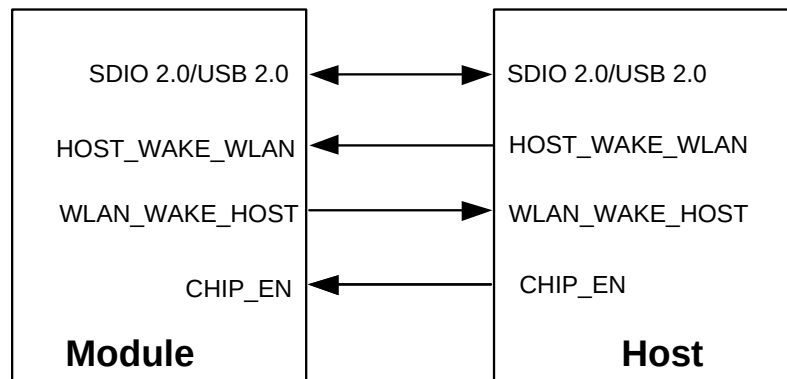


Figure 4 Wi-Fi Application Interface Connection

4.4.1. SDIO Interface

The module provides SDIO 2.0 interface communicating with the host for Wi-Fi functions. SDIO interface connection between the module and the host is illustrated in the following figure:

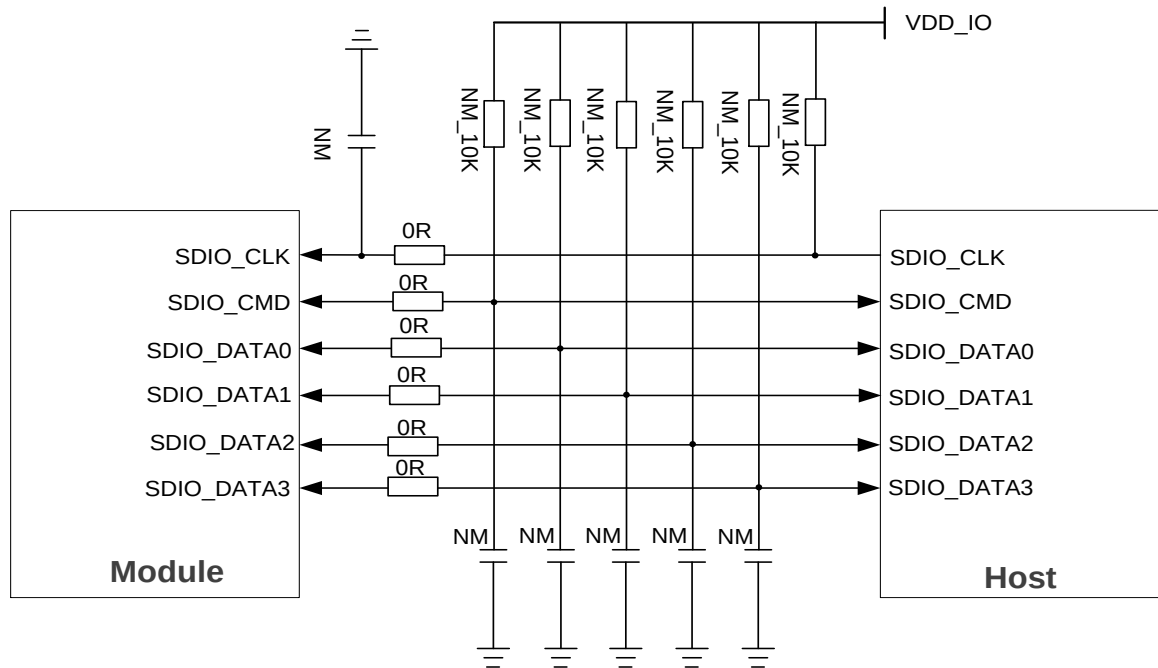


Figure 5: Reference Design of SDIO Interface

To ensure compliance of interface design with the SDIO 2.0 specification, it is recommended to adopt the following principles:

- To minimize bus jitter, reserve 10–100 kΩ pull-up resistors (with a recommended value of 10 kΩ) on the SDIO_CMD, SDIO_DATA[0:3], and SDIO_CLK signal traces and pull them up to VDD_IO of the module.
- The impedance of SDIO signal trace is $50\ \Omega \pm 10\%$. 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. And the SDIO_CLK signal trace should be routed with ground surrounded separately.
- Keep SDIO signals far away from power supply traces, crystal-oscillators, magnetic devices, sensitive signals such as RF signals, analog signals, as well as noise signals generated by clock, DC-DC.
- 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.
- Route SDIO traces in parallel on the same layer whenever possible, ensuring that there are enough ground vias around the SDIO traces and connecting them to a ground plane.

4.4.2. USB Interface*

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

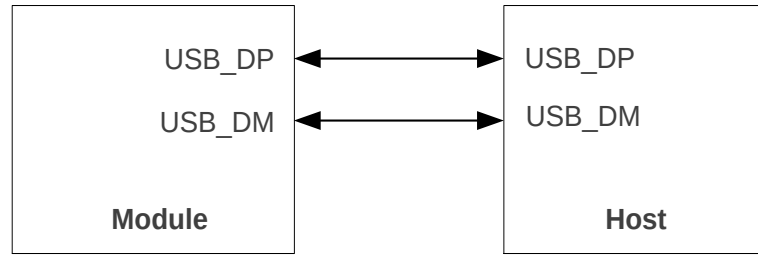


Figure 6: USB Interface Connection

To ensure compliance of interface design with the USB 2.0 specification, it is recommended to adopt the following principles:

- The impedance of USB signal trace is $90\ \Omega \pm 10\%$. Route the USB traces in inner layer of the PCB, and surround the traces with ground on that layer and with ground planes above and below.
- Keep USB signals far away from power supply traces, crystal-oscillators, magnetic devices, sensitive signals such as RF signals, analog signals, as well as noise signals generated by clock and DC-DC.
- USB signal traces (USB_DP and USB_DM) need to be equal in length, width and distance (the distance between the traces should be less than 1 mm).
- The distance between USB signal traces and other signals must be greater than twice the trace width, and the bus load capacitance must be less than 15 pF.

4.5. Bluetooth Application Interfaces

The Bluetooth application interface connection between the module and the host is illustrated in the following figure:

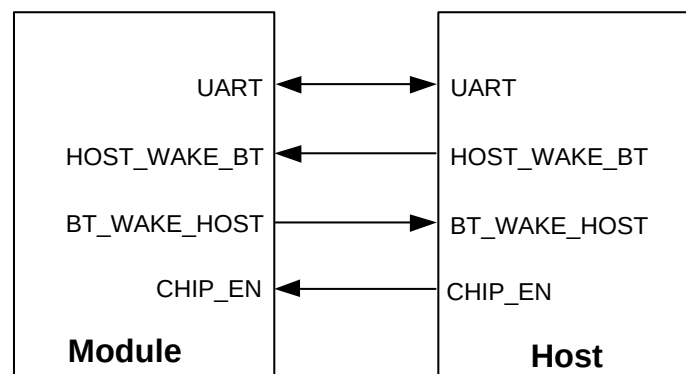


Figure 7: Bluetooth Application Interface Connection

NOTE

The host's BT_WAKE_HOST must be interruptible.

4.5.1. UART Interface

The module supports Bluetooth HCI (Host Controller Interface) UART which supports hardware flow control (RTS/CTS) and can be used for data transmission with the host. The baud rate can be up to 3.25 Mbps.

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

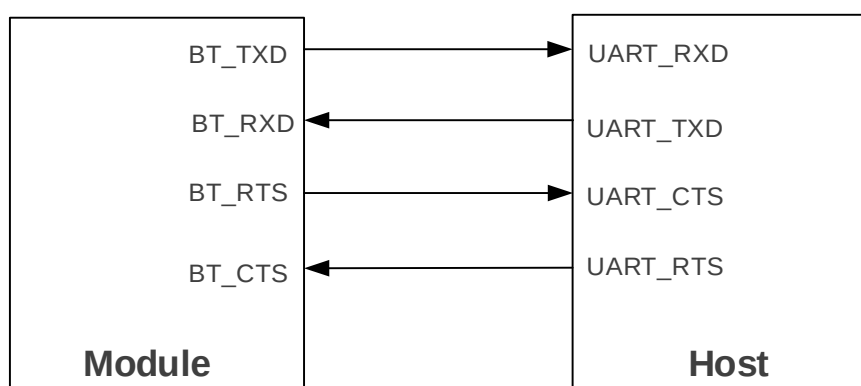


Figure 8: UART Interface Connection

NOTE

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

Table 8: UART Parameters

Parameter	Description
Data Bits Per Frame	8 bits
Parity	None
Number of Stop Bits	1 bit
Hardware Flow Control	RTS/CTS

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.

The module provides a pin antenna interface (ANT_WIFI/BT). And the RF port of the module requires 50 Ω characteristic impedance.

4.6.1. Reference Design

A reference circuit for the RF antenna interface is shown below. It is recommended to reserve a dual L-type circuit and add ESD protection components for better RF performance. Reserved matching components (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 .

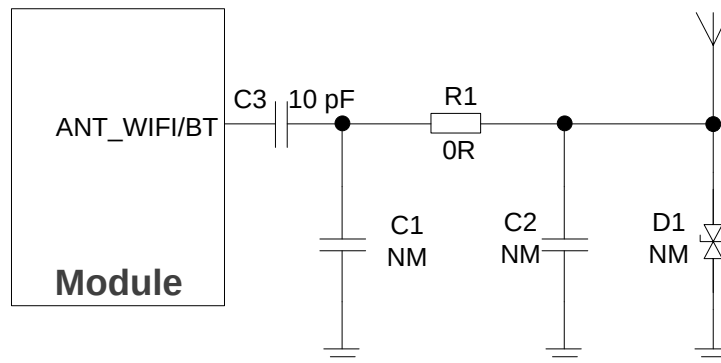


Figure 9: Reference Circuit for RF Antenna Interface

NOTE

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

4.6.2. Requirements for Antenna Design

Table 9: Requirements for Antenna Design

Parameter	Requirement ⁶
Frequency Ranges (GHz)	2.4 GHz: 2.400–2.4835
Cable Insertion Loss (dB)	< 1
VSWR	≤ 2 (Typ.)
Gain (dBi)	1 (Typ.)
Max. Input Power (W)	50
Input Impedance (Ω)	50
Polarization Type	Vertical

4.6.3. RF Routing Guidelines

For user's PCB, the characteristic impedance of all RF traces should be controlled to 50 Ω . The impedance of the RF traces is usually determined by the trace width (W), the materials' dielectric constant, the height from the reference ground to the signal layer (H), and the spacing between RF traces and grounds (S). Microstrip or coplanar waveguide is typically used in RF layout to control characteristic impedance. The following are reference designs of microstrip or coplanar waveguide with different PCB structures.

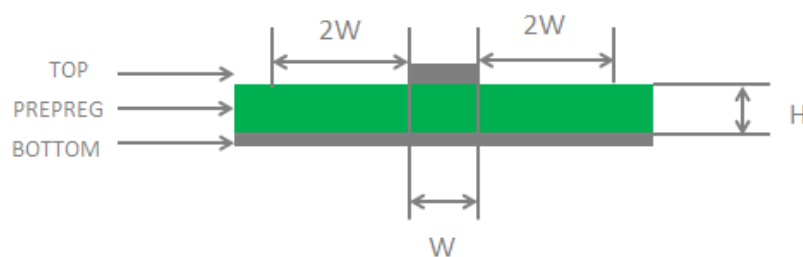


Figure 10: Microstrip Design on a 2-layer PCB

⁶ For more details about the RF performances, see **Chapter 3**.

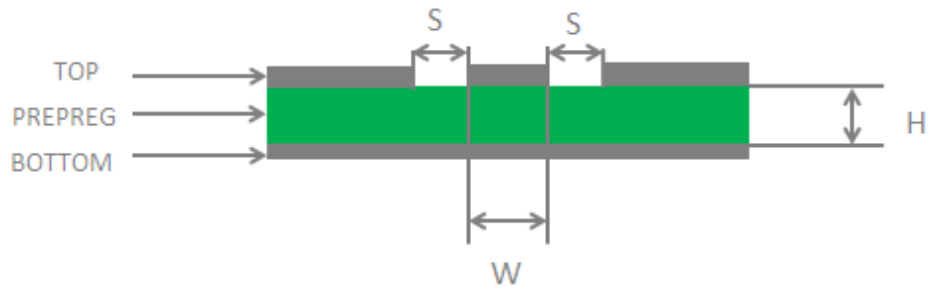


Figure 11: Coplanar Waveguide Design on a 2-layer PCB

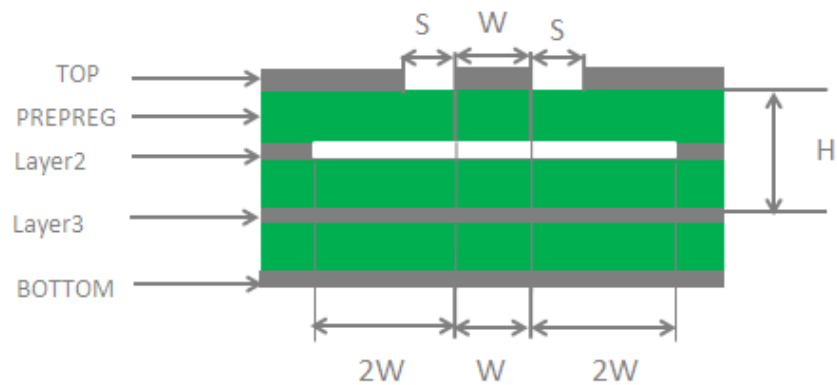


Figure 12: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

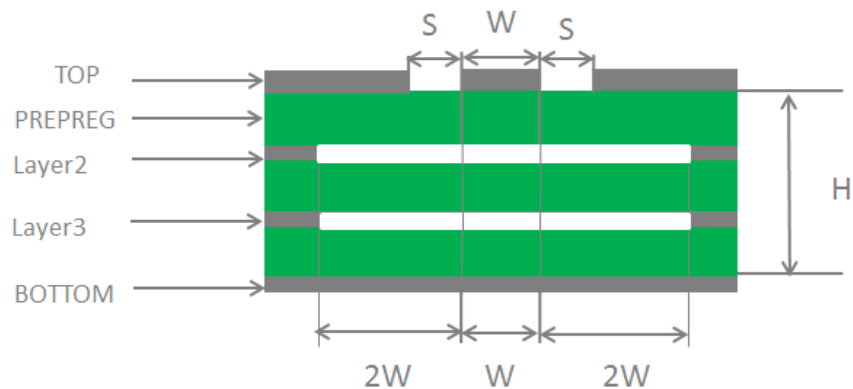


Figure 13: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

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

- Use an impedance simulation tool to accurately control the characteristic impedance of RF traces to 50 Ω .
- The GND pins adjacent to RF pins should not be designed as thermal relief pads, and should be fully connected to ground.
- The distance between the RF pins and the RF connector should be as short as possible and all the right-angle traces should be changed to curved ones. The recommended trace angle is 135°.
- There should be clearance under the signal pin of the antenna connector or solder joint.
- The reference ground of RF traces should be complete. Meanwhile, adding some ground vias around RF traces and the reference ground could help to improve RF performance. The distance between the ground vias and RF traces should be at least twice the width of RF signal traces ($2 \times W$).
- Keep RF traces away from interference sources (such as DC-DC, (U)SIM/USB/SDIO high frequency digital signals, display signals, and clock signals), and avoid intersection and paralleling between traces on adjacent layers.

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

4.6.4. RF Connector Recommendation

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

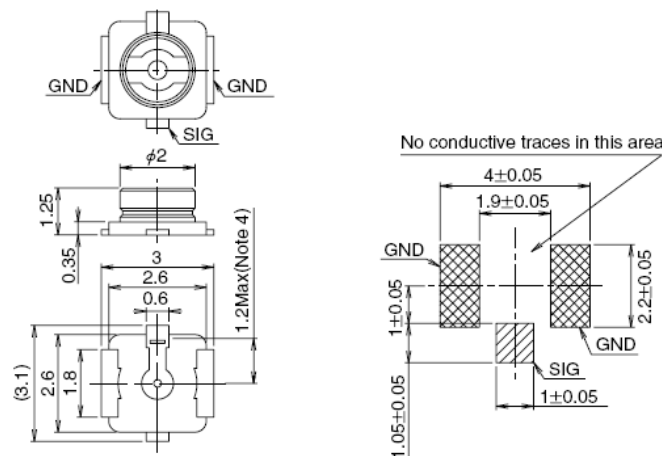


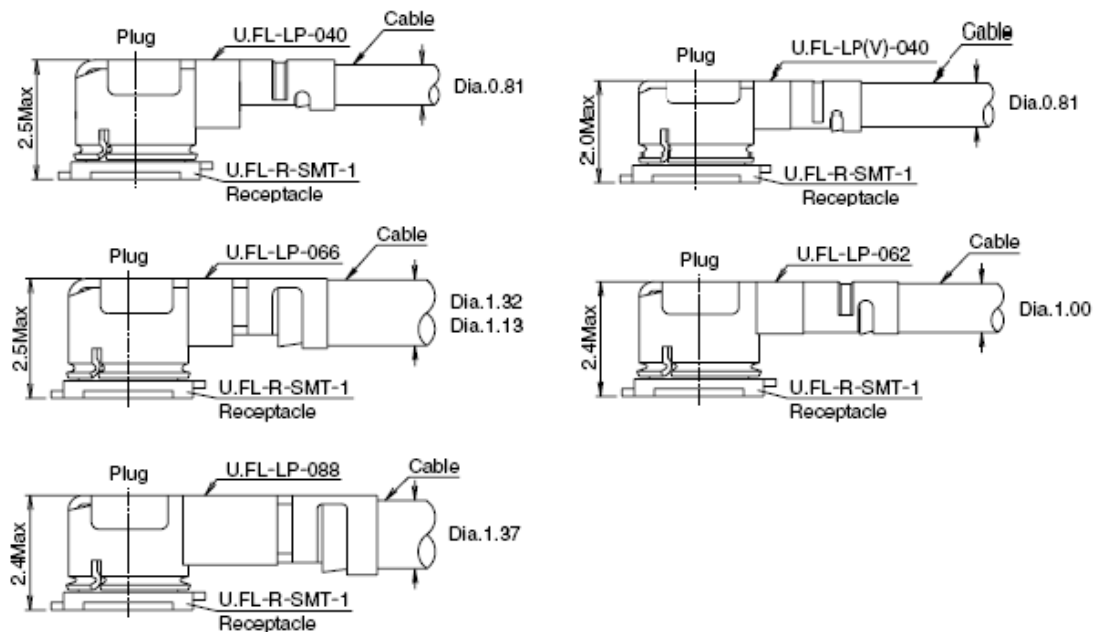
Figure 14: Dimensions of the Receptacle (Unit: mm)

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

Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 0.81mm Coaxial cable	Dia. 1mm Coaxial cable	Dia. 1.37mm Coaxial cable
Weight (mg)	53.7	59.1	34.8	45.5	71.7
RoHS	YES				

Figure 15: Specifications of Mated Plugs

The following figure describes the space factor of mated connectors.


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

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

5 Electrical Characteristics and Reliability

5.1. Absolute Maximum Ratings

Table 10: Absolute Maximum Ratings (Unit: V)

Parameter	Min.	Max.
VBAT	-0.3	3.6
VDD_IO	-0.3	3.6
Voltage at Digital Pins	-0.3	3.6

5.2. Power Supply Ratings

Table 11: Module's 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.	2.97	3.3	3.6
VDD_IO	Power supply for the module's I/O pins	-	1.71	1.8/3.3	3.6

5.3. Power Consumption

5.3.1. Wi-Fi Power Consumption

Table 12: Wi-Fi Power Consumption in Non-signaling Mode

Condition			I _{VDD_IO} (μA)	I _{VBAT} (mA)
2.4 GHz	802.11b	Tx @ 1 Mbps	122.54	192.17
		Tx @ 11 Mbps	120.92	99.66
	802.11g	Tx @ 6 Mbps	120.97	115.15
		Tx @ 54 Mbps	120.49	84.62
	802.11n	Tx HT20 @ MCS 0	121.84	175.48
		Tx HT20 @ MCS 7	121.17	93.78
		Tx HT40 @ MCS 0	122.63	171.83
		Tx HT40 @ MCS 7	121.43	95.43
	802.11ax	Tx HE20 @ MCS 0	122.46	159.16
		Tx HE20 @ MCS 11	121.26	87.22
		Tx HE40 @ MCS 0	122.33	159.79
		Tx HE40 @ MCS 11	121.18	89.82

5.3.2. Bluetooth Power Consumption

Table 13: Bluetooth Power Consumption in Non-signalling Mode

Condition	I _{VDD_IO} (μA)	I _{VBAT} (mA)
BLE (1 Mbps) @ 7.5 dBm	124.09	148.9
BLE (2 Mbps) @ 7.5 dBm	123.44	101.1
BLE (S = 8) @ 7.5 dBm	124.99	172.43
BLE (S = 2) @ 7.5 dBm	124.39	131.32

5.4. Digital I/O Characteristics

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

Parameter	Description	Min.	Max.
V _{IH}	High-level input voltage	0.7 × VDD_IO	VDD_IO
V _{IL}	Low-level input voltage	0	0.3 × VDD_IO
V _{OH}	High-level output voltage	0.7 × VDD_IO	-
V _{OL}	Low-level output voltage	-	0.3 × VDD_IO

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 15: Electrostatics Discharge Characteristics (Unit: kV)

Model	Test Result	Standard
Human Body Model (HBM)	±3	ESDA/JEDEC JS-001-2017
Charged Device Model (CDM)	±0.8	ESDA/JEDEC JS-002-2018

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, etc.) will be affected to a certain extent. Therefore, the thermal design should be maximally optimized to ensure all internal IC chips always work within the recommended operating temperature range.

The following principles for thermal consideration are provided for reference:

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

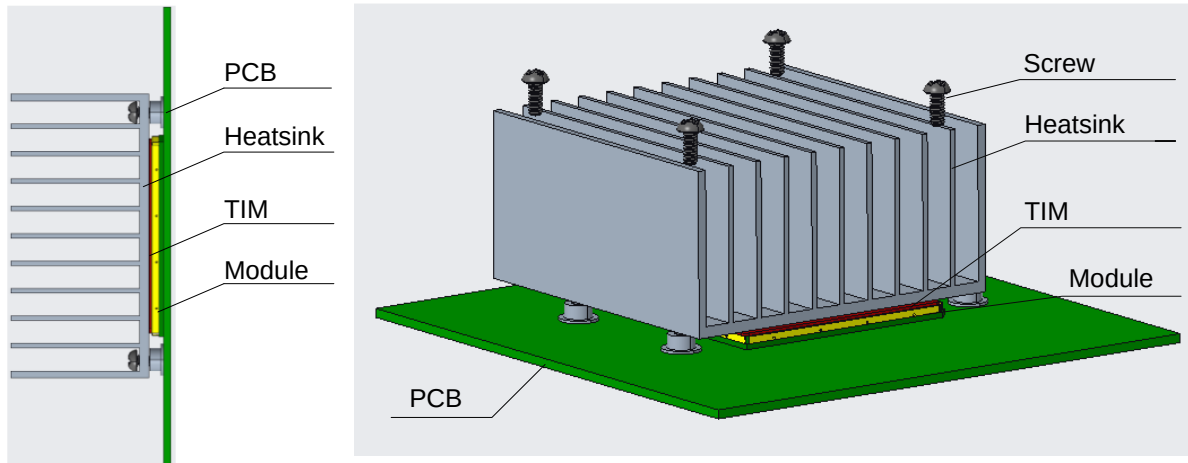


Figure 17: Placement and Fixing of the Heatsink

6 Mechanical Information

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

6.1. Mechanical Dimensions

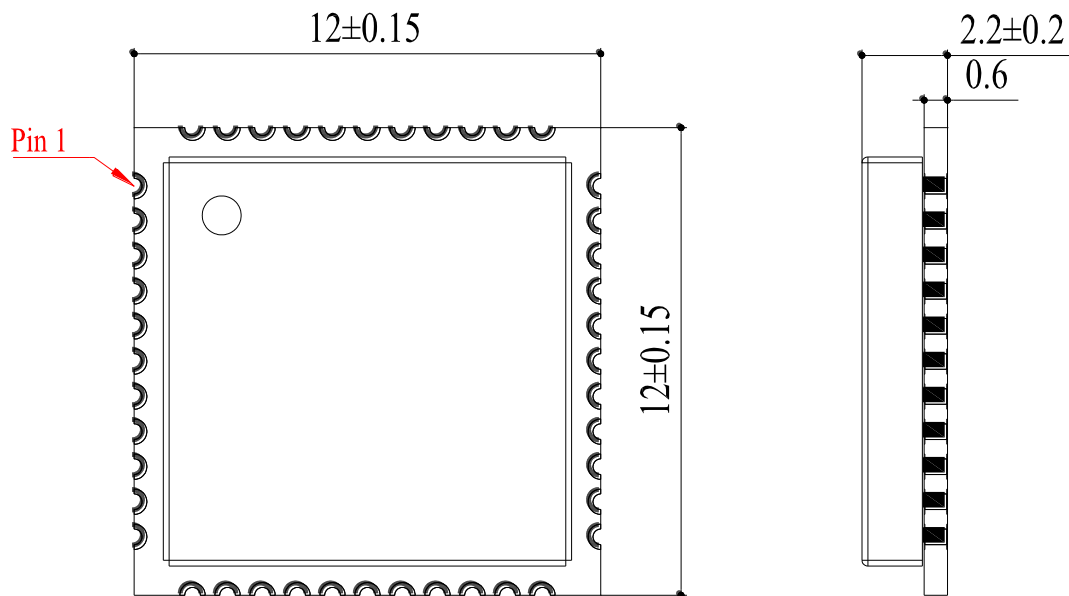


Figure 18: Top and Side Dimensions

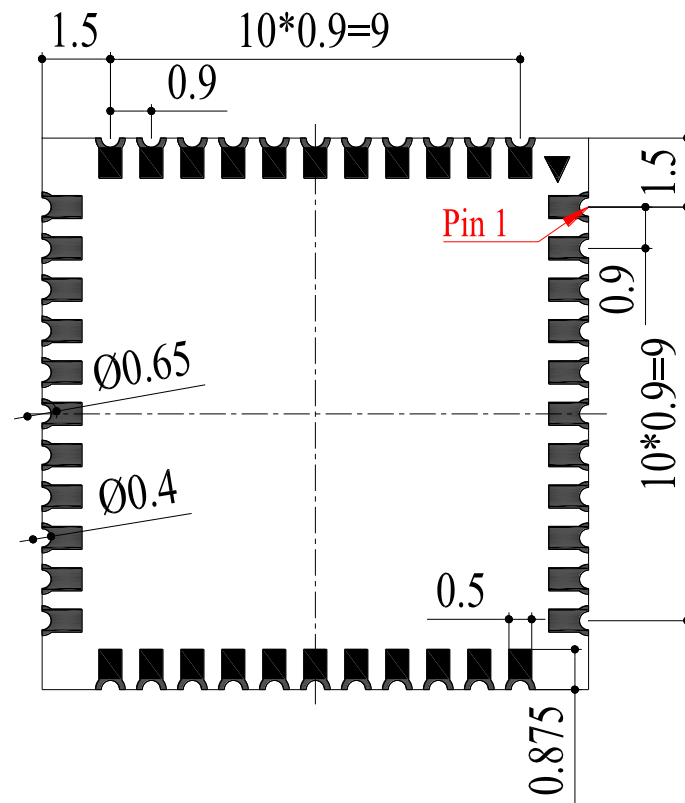


Figure 19: Bottom Dimensions (Bottom View)

NOTE

The module's coplanarity standard: ≤ 0.13 mm.

6.2. Recommended Footprint

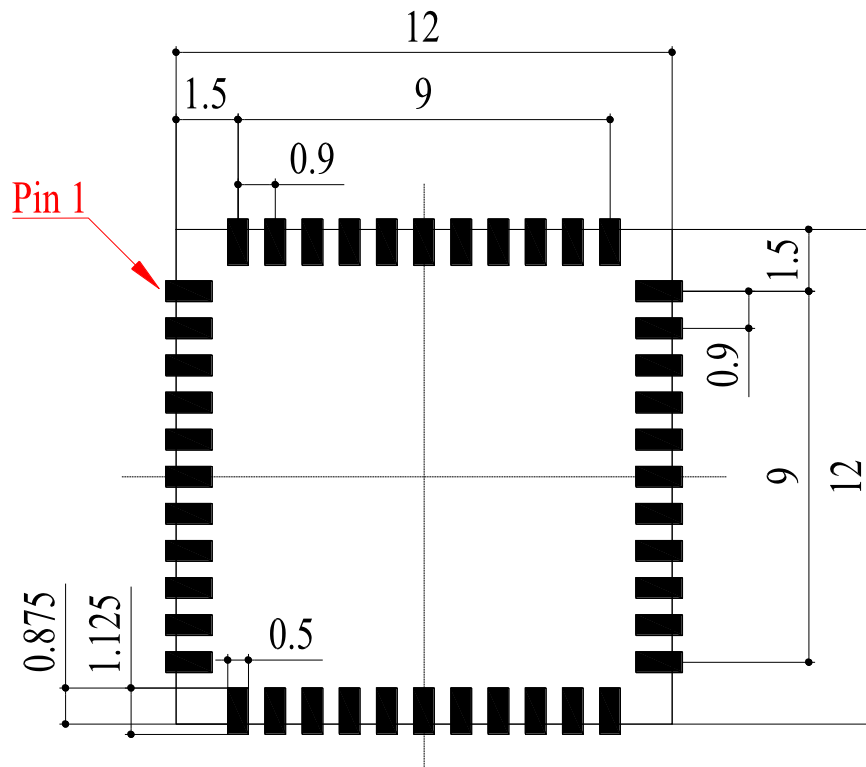


Figure 20: Recommended Footprint

NOTE

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

6.3. Top and Bottom Views

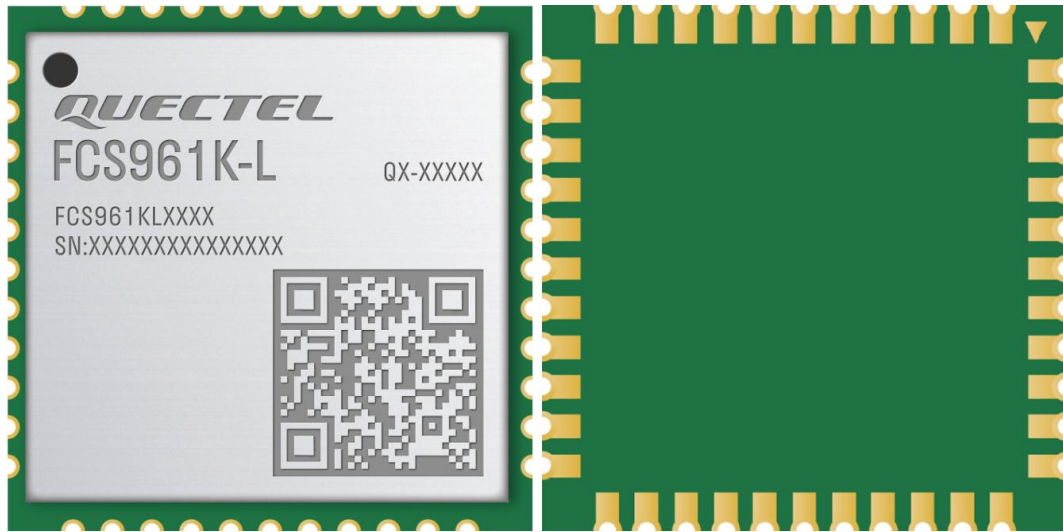


Figure 21: Top and Bottom Views

NOTE

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.

7 Storage, Manufacturing and Packaging

7.1. Storage Conditions

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

1. Recommended Storage Condition: the temperature should be 23 ± 5 °C and the relative humidity should be 35–60 %.
2. Shelf life (in a vacuum-sealed packaging): 12 months in Recommended Storage Condition.
3. Floor life: 168 hours ⁷ 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.

⁷ 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.

7.2. Manufacturing and Soldering

Push the squeegee to apply the solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate to the PCB. Apply proper force on the squeegee to produce a clean stencil surface on a single pass. To guarantee module soldering quality, the thickness of stencil for the module is recommended to be 0.15–0.18 mm. For more details, see **document [3]**.

The recommended peak reflow temperature should be 235–246 °C, with 246 °C as the absolute maximum reflow temperature. To avoid damage to the module caused by repeated heating, it is recommended that the module should be mounted only after reflow soldering for the other side of PCB has been completed. The recommended reflow soldering thermal profile (lead-free reflow soldering) and related parameters are shown below.

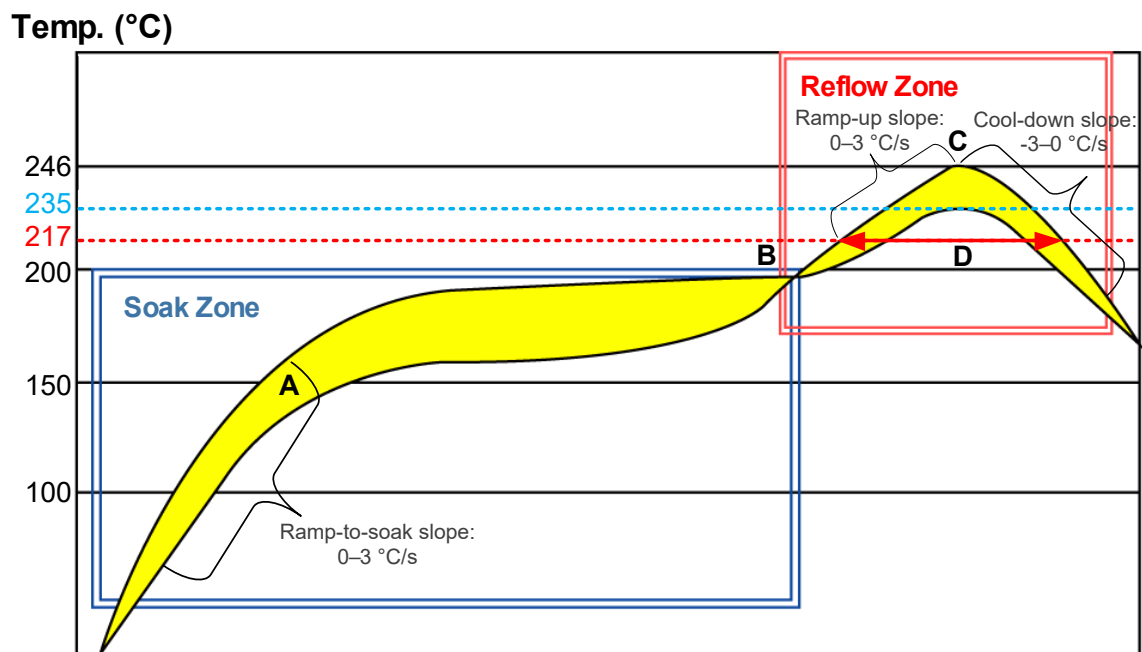


Figure 22: Recommended Reflow Soldering Thermal Profile

Table 16: Recommended Thermal Profile Parameters

Factor	Recommended Value
Soak Zone	
Ramp-to-soak slope	0–3 °C/s
Soak time (between A and B: 150 °C and 200 °C)	70–120 s
Reflow Zone	
Ramp-up slope	0–3 °C/s
Reflow time (D: over 217 °C)	40–70 s
Max. temperature	235–246 °C
Cool-down slope	-3–0 °C/s
Reflow Cycle	
Max. reflow cycle	1

NOTE

1. The above profile parameter requirements are for the measured temperature of the solder joints. Both the hottest and coldest spots of solder joints on the PCB should meet the above requirements.
2. During manufacturing and soldering, or any other processes that may contact the module directly, NEVER wipe the module's shielding can with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol, trichloroethylene, etc. Otherwise, the shielding can may become rusted.
3. The shielding can for the module is made of Cupro-Nickel base material. It is tested that after 12 hours' Neutral Salt Spray test, the laser engraved label information on the shielding can is still clearly identifiable and the QR code is still readable, although white rust may be found.
4. If a conformal coating is necessary for the module, do NOT use any coating material that may chemically react with the PCB or shielding cover, and prevent the coating material from flowing into the module.
5. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.
6. Avoid using materials that contain mercury (Hg), such as adhesives, for module processing, even if the materials are RoHS compliant and their mercury content is below 1000 ppm (0.1 %).
7. Corrosive gases may corrode the electronic components inside the module, affecting their reliability and performance, and potentially leading to a shortened service life that fails to meet the designed lifespan. Therefore, do not store or use unprotected modules in environments containing corrosive gases such as hydrogen sulfide, sulfur dioxide, chlorine, and ammonia.
8. Due to the complexity of the SMT process, please contact Quectel Technical Support in advance for

any situation that you are not sure about, or any process (e.g. selective soldering, ultrasonic soldering) that is not mentioned in **document [4]**.

7.3. Packaging Specification

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

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

7.3.1. Carrier Tape

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

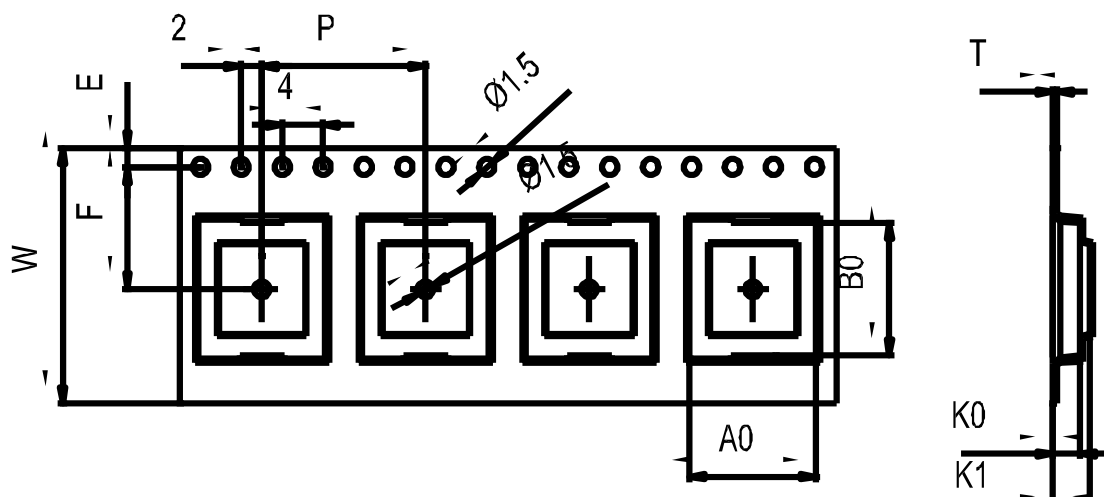


Figure 23: Carrier Tape Dimension Drawing (Unit: mm)

Table 17: Carrier Tape Dimension Table (Unit: mm)

W	P	T	A0	B0	K0	K1	F	E
24	20	0.4	12.4	12.4	2.95	5.6	11.5	1.75

7.3.2. Plastic Reel

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

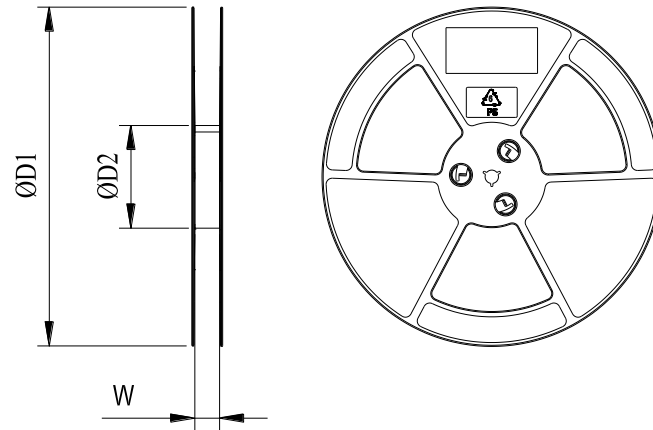


Figure 24: Plastic Reel Dimension Drawing

Table 18: Plastic Reel Dimension Table (Unit: mm)

ØD1	ØD2	W
330	100	24.5

7.3.3. Mounting Direction

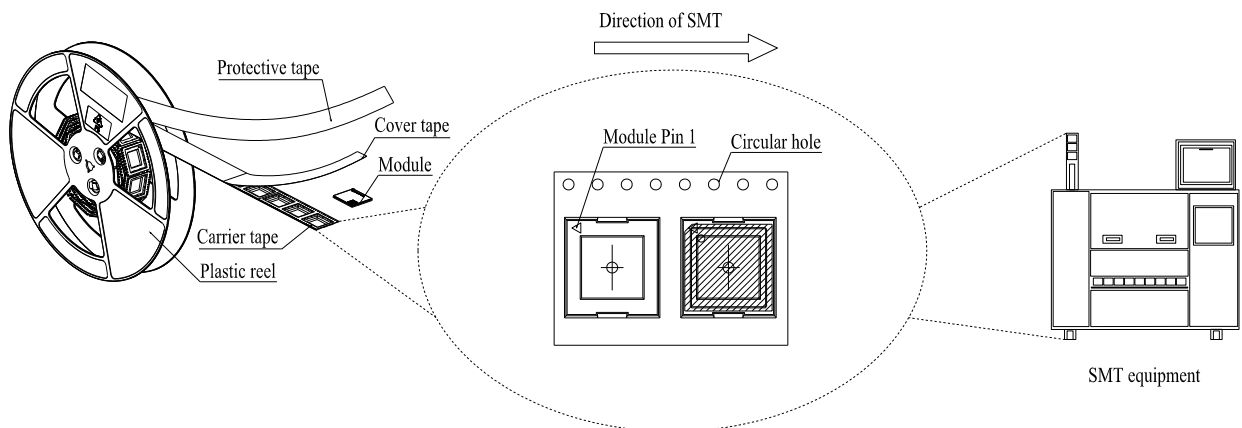
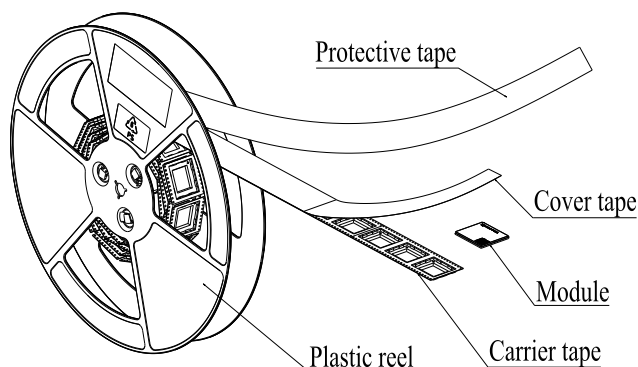


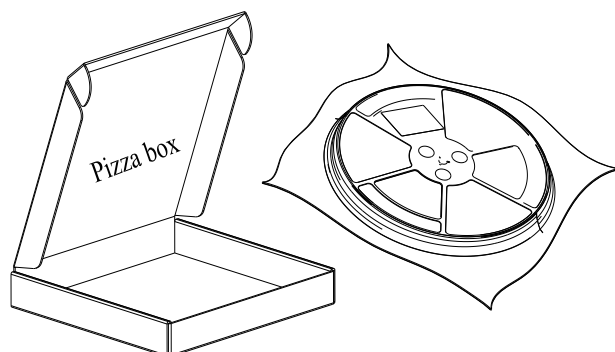
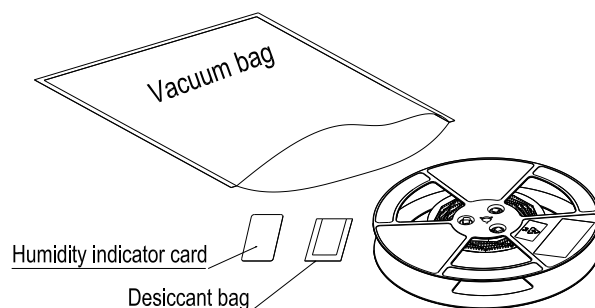
Figure 25: Mounting Direction

7.3.4. Packaging Process



Place the modules onto the carrier tape cavity and cover them securely with cover tape. Wind the heat-sealed carrier tape onto a plastic reel and apply a protective tape for additional protection. 1 plastic reel can pack 500 modules.

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



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

Place the 4 packaged pizza boxes into 1 carton and seal it. 1 carton can pack 2000 modules.

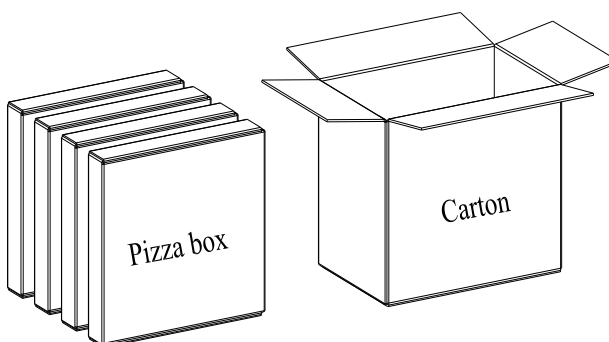


Figure 26: Packaging Process

8 Appendix References

Table 19: Related Documents

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

Table 20: Terms and Abbreviations

Abbreviation	Description
1T1R	One Transmit One Receive
AP	Access Point
BLE	Bluetooth Low Energy
BPSK	Binary Phase Shift Keying
CCK	Complementary Code Keying
CDM	Charged Device Model
CTS	Clear To Send
DBPSK	Differential Binary Phase Shift Keying
DPSK	Differential Phase Shift Keying
DQPSK	Differential Quadrature Phase Shift Keying
DSSS	Direct Sequence Spread Spectrum

eSCO	Extended Synchronous Connection-Oriented
ESD	Electrostatic Discharge
EVB	Evaluation Board
EVM	Error Vector Magnitude
GFSK	Gauss Frequency Shift Keying
GND	Ground
HBM	Human Body Model
HCI	Host Controller Interface
HE	High Efficiency
HT	High Throughput
I/O	Input/Output
IC	Integrated Circuit
IEEE	Institute of Electrical and Electronics Engineers
kbps	Kilobits Per Second
LCC	Leadless Chip Carrier (package)
Mbps	Million Bits Per Second
MCS	Modulation and Coding Scheme
MSL	Moisture Sensitivity Levels
PCB	Printed Circuit Board
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RoHS	Restriction of Hazardous Substances
RTS	Request to Send
Rx	Receive

SAE	Simultaneous Authentication of Equals
SCO	Synchronous Connection-Oriented
SDIO	Secure Digital Input/Output
SMD	Surface Mount Device
SMT	Surface Mount Technology
STA	Station
TVS	Transient Voltage Suppressor
Tx	Transmit
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
(U)SIM	(Universal) Subscriber Identity Module
VHT	Very High Throughput
V_{IH}	High-level Input Voltage
V_{IL}	Low-level Input Voltage
V_{max}	Maximum Voltage
V_{min}	Minimum Voltage
V_{nom}	Nominal Voltage
V_{OH}	High-level Output Voltage
V_{OL}	Low-level Output Voltage
VSWR	Voltage Standing Wave Ratio
WEP	Wired Equivalent Privacy
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

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

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: XMR2025FCS961KL" 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 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: XMR2025FCS961KL**"

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 Innovation, Science and Economic Development Canada's 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'Innovation, Science and Economic Development Canada's 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.

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-025FCS961KL".

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-025FCS961KL".