FCS950U

Hardware Design

Wi-Fi&Bluetooth Module Series

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Safety Information

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

	Full attention must be 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 cellular terminal or mobile before boarding an aircraft. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. If there is an Airplane Mode, it should be enabled prior to boarding an aircraft. Please consult the airline staff for more restrictions on the use of wireless devices on an aircraft.
	Wireless devices may cause interference on sensitive medical equipment, so please be aware of the restrictions on the use of wireless devices when in hospitals, clinics or other healthcare facilities.
	Cellular terminals or mobiles operating over radio signal and cellular network cannot be guaranteed to connect in certain conditions, such as when the mobile bill is unpaid or the (U)SIM card is invalid. When emergency help is needed in such conditions, use emergency call if the device supports it. In order to make or receive a call, the cellular terminal or mobile must be switched on in a service area with adequate cellular signal strength. In an emergency, the device with emergency call function cannot be used as the only contact method considering network connection cannot be guaranteed under all circumstances.
	The cellular terminal or mobile contains a transceiver. When it is ON, it receives and transmits radio frequency signals. RF interference can occur if it is used close to TV sets, radios, computers or other electric equipment.
	In locations with explosive or potentially explosive atmospheres, obey all posted signs and turn off wireless devices such as mobile phone or other cellular terminals. Areas with explosive or potentially explosive atmospheres include fuelling areas, below decks on boats, fuel or chemical transfer or storage facilities, and areas where the air contains chemicals or particles such as grain, dust or metal powders.

About the Document

Revision History

Version	Date	Author	Description
-	2022-09-30	Arrow HUANG	Creation of the document
0.1	2022-09-30	Arrow HUANG	Draft
0.2	2022-11-15	Arrow Huang	Update
0.3	2022-11-29	Arrow Huang	Update

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1 Introduction

This document defines the FCS950U and describes its air interface 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 designFCS950U 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 such 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

2.1 General Description

The FCS950U is a low-power and cost-effective Wi-Fi & Bluetooth module that supports the 1 × 1 IEEE 802.11a/b/g/n/ac WLAN standard and Bluetooth 5.0 standard protocols, and it provides a low-power SDIO 3.0 interface for Wi-Fi, UART and PCM interfaces for Bluetooth.

FCS950U is a patch module with 44 LCC pins. The module package is compact in only 12.0 mm × 12.0 mm × 2.45 mm.

2.2 Key Features

The following table describes the key features of FCS950U.

Table 2: Key Features

Features	Description
Power Supply	• **VBAT power supply:** Supply voltage range: 3.2–3.4 V Typical supply voltage: 3.3 V • **VIO power supply:** Supply voltage range: 1.7–1.98 V Typical supply voltage: 1.8 V
Wi-Fi Transmission Data Rates	**2.4 GHz:** • 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) **5 GHz:** • 802.11a: 6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps, 24 Mbps, 36 Mbps, 48 Mbps, 54 Mbps • 802.11n: HT20 (MCS 0–7), HT40 (MCS 0–7)

	● 802.11ac: VHT20 (MCS 0–8), VHT40 (MCS 0–9), VHT80 (MCS 0–9)
Wi-Fi Protocol	IEEE 802.11a/b/g/n/ac
Wi-Fi Modulation Modes	DBPSK, DQPSK, CCK, BPSK, QPSK, 16QAM, 64QAM, 256QAM
Wi-Fi Operating Modes	● STA
Bluetooth Operating Modes	● BR + EDR ● BLE
Bluetooth Modulation Modes	GFSK, π/4-DQPSK, 8-DPSK
Wi-Fi Application Interface	SDIO 3.0
Bluetooth Application Interface	UART and PCM
RF Antenna Interface	● ANT_WIFI0/BT ● 50 Ω impedance
Physical Characteristics	● Size: (12.0 ±0.15) mm × (12.0 ±0.15) mm × (2.45 ±0.2) mm ● Package: LCC ● Weight: TBD
Temperature Range	● Operating temperature range: -40°C to +85 °C [1] ● Storage temperature range: -40 °C to +95 °C
RoHS	All hardware components are fully compliant with EU RoHS directive

2.3. EVB Kit

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

To help you develop applications with the module, Quectel supplies an evaluation board (FCS950U-M.2) with accessories to control or test the module FCS950U

3 Application Interfaces

3.1. General Description

FCS950U is equipped with 44 LCC pins. The following interfaces are described in detail in subsequent chapters:

- Power supply
- Wi-Fi application interface
  - SDIO interface
  - WLAN_WAKE
- Bluetooth application interfaces
  - Bluetooth UART
  - BT_WAKE_HOST
  - PCM interface
- RF antenna interface
  - ANT_WIFI0/BT
- Other interfaces
  - CHIP_EN
  - COEX_RXD
  - COEX_TXD

3.2. Pin Assignment

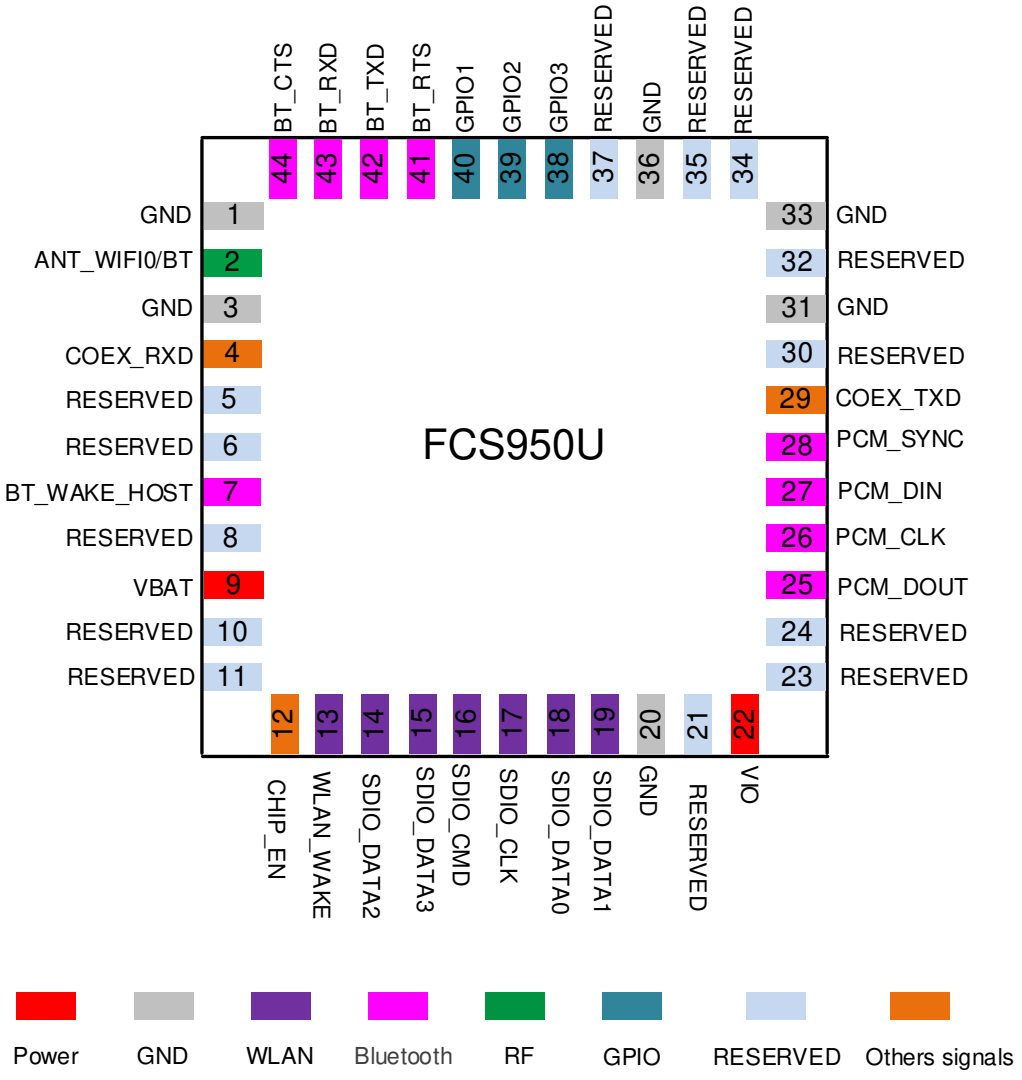


Figure 1: Pin Assignment (Top View)

NOTE

Keep all RESERVED pins open.

3.3. Pin Description

The following tables show the pin description of FCS950U.

Table 3: I/O Parameters Definition

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 rate current.

Table 4: Pin Description

Power Supply				
Pin Name	**Pin No.**	**I/O**	**Description**	**Comment**
VBAT	9	PI	Power supply for the module	It must be provided with sufficient current up to 1.0 A.
VIO	22	PI	Power supply for module's I/O pins	VIO only supports 1.8 V.
GND	1, 3, 20, 31, 33, 36			
Wi-Fi Application Interface				
Pin Name	**Pin No.**	**I/O**	**Description**	**Comment**
WLAN_WAKE	13	DO	Wake up the host by an external Wi-Fi module	VIO power domain. Active high.
SDIO_DATA2	14	DIO	SDIO data bit 2/NC	VIO power domain. Need to be pulled up to 1.8 V via external 10 kΩ resistors.
SDIO_DATA3	15	DIO	SDIO data bit 3/NC	VIO power domain.

SDIO_CMD	16	DIO	SDIO command	
SDIO_CLK	17	DI	SDIO clock	
SDIO_DATA0	18	DIO	SDIO data bit 0	
SDIO_DATA1	19	DIO	SDIO data bit 1/IRQ	
Bluetooth Application Interface				
Pin Name	**Pin No.**	**I/O**	**Description**	**Comment**
BT_WAKE_HOST	7	DO	Bluetooth wake up the host	VIO power domain. If unused, keep them open.
PCM_DOUT	25	DO	PCM data output	
PCM_CLK	26	DI	PCM clock	
PCM_DIN	27	DI	PCM data input	
PCM_SYNC	28	DI	PCM data frame sync	
BT_RTS	41	DO	Bluetooth UART request to send	
BT_TXD	42	DO	Bluetooth UART transmit	
BT_RXD	43	DI	Bluetooth UART receive	
BT_CTS	44	DI	Bluetooth UART clear to send	
RF Antenna Interfaces				
Pin Name	**Pin No.**	**I/O**	**Description**	**Comment**
ANT_WIFI0/BT	2	AIO	Wi-Fi0/Bluetooth antenna interface	50 Ω impedance.
Other Interface				
Pin Name	**Pin No.**	**I/O**	**Description**	**Comment**
CHIP_EN	12	DI	Module enable pin	VIO power domain. High level by default.
COEX_RXD*	4	DI	LTE & Wi-Fi/Bluetooth coexistence receive	VIO power domain.
COEX_TXD*	29	DO	LTE & Wi-Fi/Bluetooth coexistence transmit	VIO power domain.
RESERVED				

Pin Name	Pin No.			Comment
RESERVED	5, 6, 8, 10, 11, 21, 23, 24, 30, 32, 34, 35, 37			Keep them open.
GPIO				
Pin Name	**Pin No.**	**I/O**	**Description**	**Comment**
GPIO3	38	DIO	RFCTL, Boot mode selection	Keep them open.
GPIO2	39	DIO		
GPIO1	40	DIO		

3.4. Power Supply

3.4.1. Power Supply Pins Introduction

The following table shows the power supply pins and ground pins of FCS950U.

Table 5: Definition of Power Supply and GND Pins

Pin Name	Pin No.	Description	Min.	Typ.	Max.	Unit
VBAT	9	Power supply for the module	3.2	3.3	3.4	V
VIO	22	Power supply for module's I/O pins	1.7	1.8	1.98	V
GND	1, 3, 20, 31, 33, 36	Ground				

The FCS950U is powered by VBAT. It is recommended to use a power chip with a maximum output current of more than 1.0 A.

The reference circuit of VBAT input terminal is as shown in the figure below:

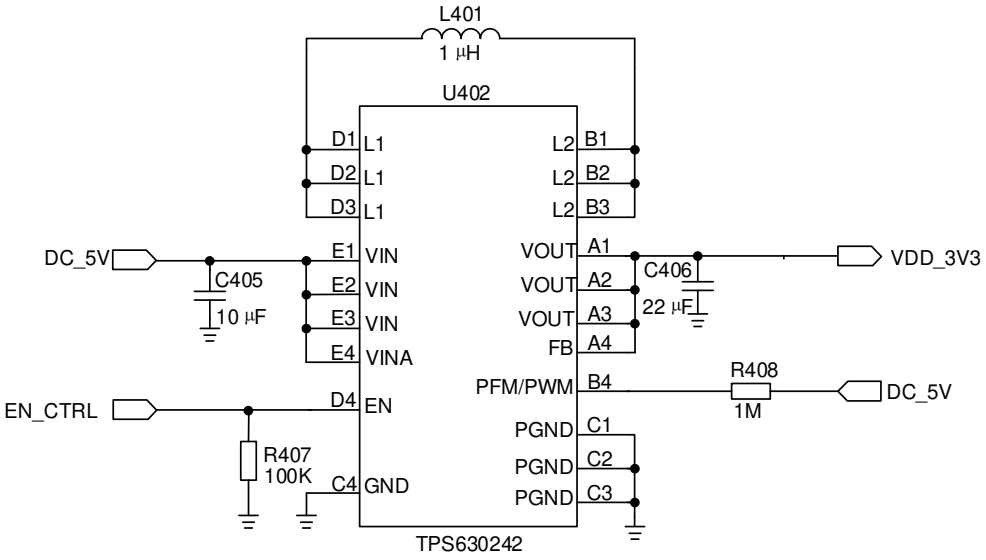


Figure 2: Reference Circuit for VBAT

The time sequences of FCS950U power up and down is shown in the below:

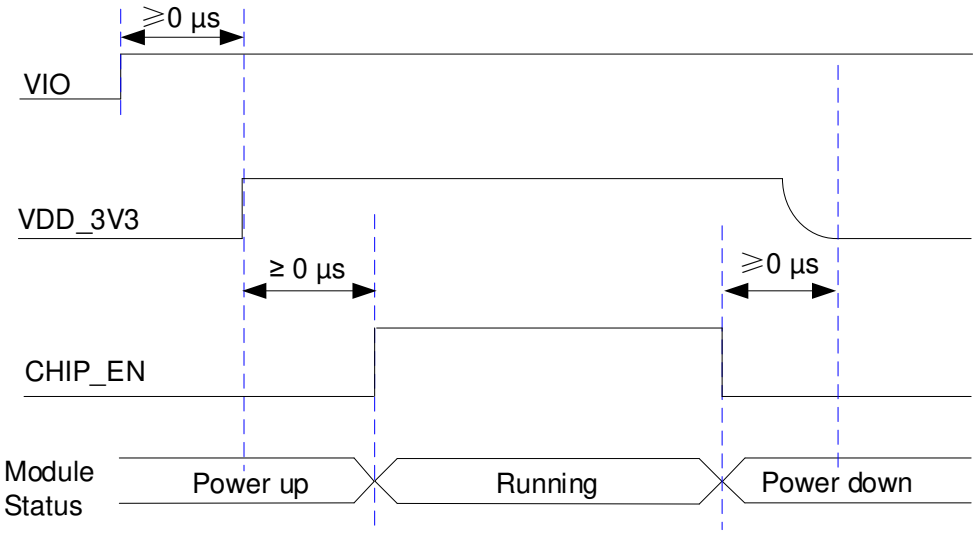


Figure 3: Timing of Power up/down

3.5. Wi-Fi Application Interface

The following figure shows the Wi-Fi application interface connection between FCS950U and the host.

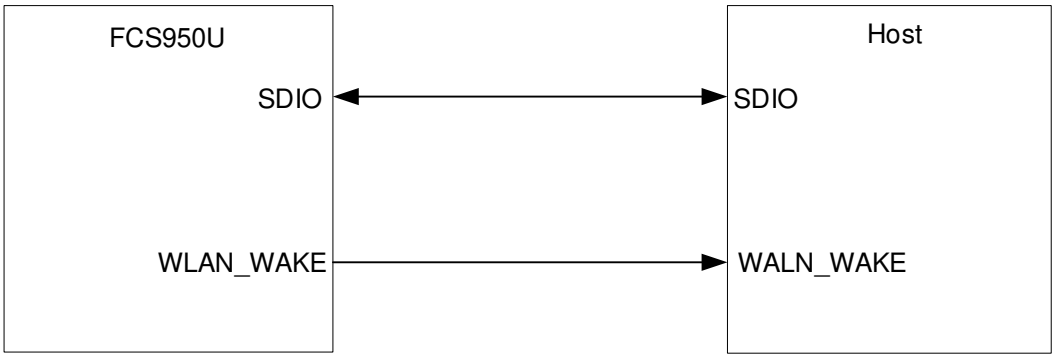


Figure 4: Wi-Fi Application Interface Connection

3.5.1. SDIO Interface

FCS950U SDIO interface definition is as follows:

Table 6: Pin Definition of SDIO Interface

Pin Name	Pin No.	I/O	Description	Comment
SDIO_DATA3	15	DIO	SDIO data bit 3/NC	VIO power domain.
SDIO_DATA2	14	DIO	SDIO data bit 2/NC	VIO power domain. Need to pull up to 1.8 V via external 10 kΩ resistors.
SDIO_DATA1	19	DIO	SDIO data bit 1/IRQ	VIO power domain.
SDIO_DATA0	18	DIO	SDIO data bit 0	
SDIO_CLK	17	DI	SDIO clock	
SDIO_CMD	16	DIO	SDIO command	

The following figure shows the SDIO interface connection between FCS950U and the host.

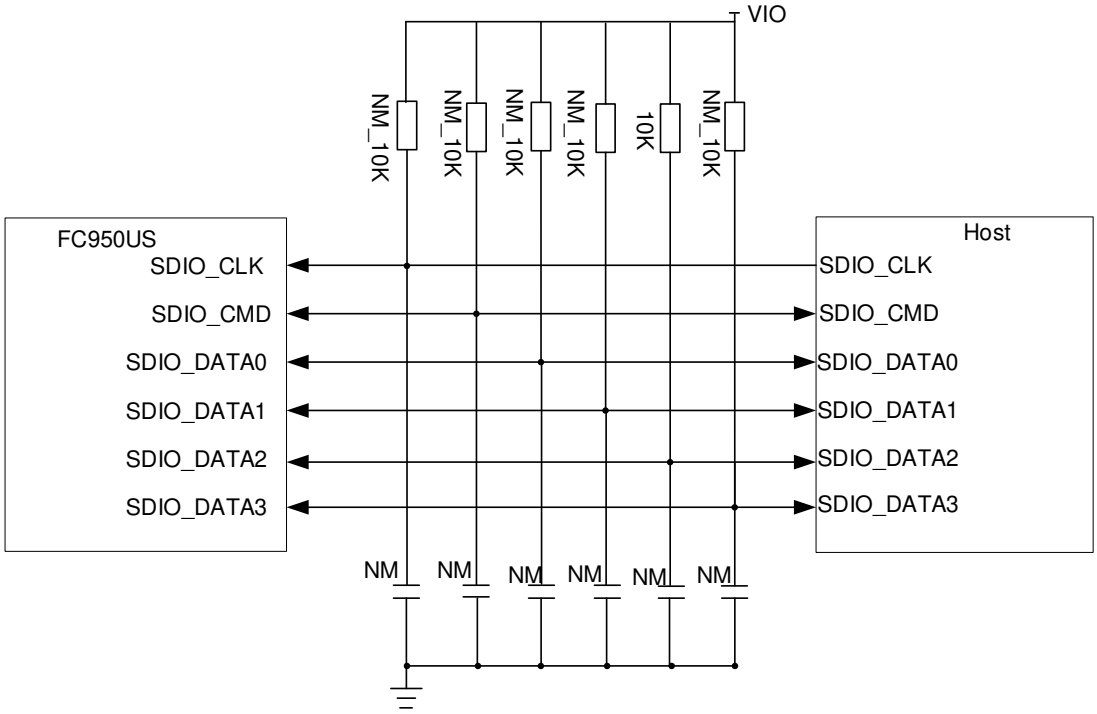


Figure 5: SDIO Interface Connection

To ensure that the interface design complies with the SDIO 3.0 specification, the following principles are recommended to be adopted:

- Route the SDIO traces in inner-layer of the PCB and the impedance is controlled at 50 Ω ±10 %.
- SDIO signals need to be keep away from sensitive signals, such as radio frequency, analog signals, clocks, and DC-DC noise signals.
- SDIO signal traces (SDIO_CLK and SDIO_DATA[0:3]/SDIO_CMD) need to be treated with equal length (the distance between the traces is less than 1 mm).
- The distance between SDIO signals and other signals must be greater than twice the line width, and the bus load capacitance must be less than 15 pF.
- The maximum length of the internal wiring of the SDIO module is 7.99 mm.

3.5.2. WLAN_WAKE

WLAN_WAKE is used to wake up the host.

Table 7: Pin Definition of WLAN_WAKE

Pin Name	Pin No.	I/O	Description	Comment
WLAN_WAKE	13	DO	Wake up the host by an external Wi-Fi module	VIO power domain. Active high.

3.6. Bluetooth Application Interfaces

The following figure shows the block diagram of Bluetooth application interface connection between FCS950U and the host.

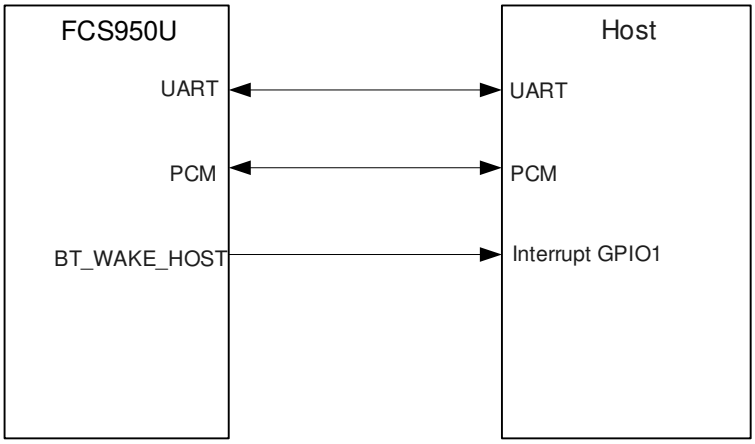


Figure 6: Bluetooth Application Interfaces Connection

3.6.1. Bluetooth UART

The FCS950U supports Host Controller Interface (HCI) UART defined by Bluetooth. The UART supports hardware flow control, and it is used for data transmission with host. It supports up to 4 Mbps baud rates.

Table 8: Pin Definition of Bluetooth UART

Pin Name	Pin No.	I/O	Description	Comment
BT_RTS	41	DO	Bluetooth UART request to send	VIO power domain. If unused, keep them open.
BT_TXD	42	DO	Bluetooth UART transmit	
BT_RXD	43	DI	Bluetooth UART receive	
BT_CTS	44	DI	Bluetooth UART clear to send	

The following figure shows a reference design for UART interface connection between FCS950U and the host.

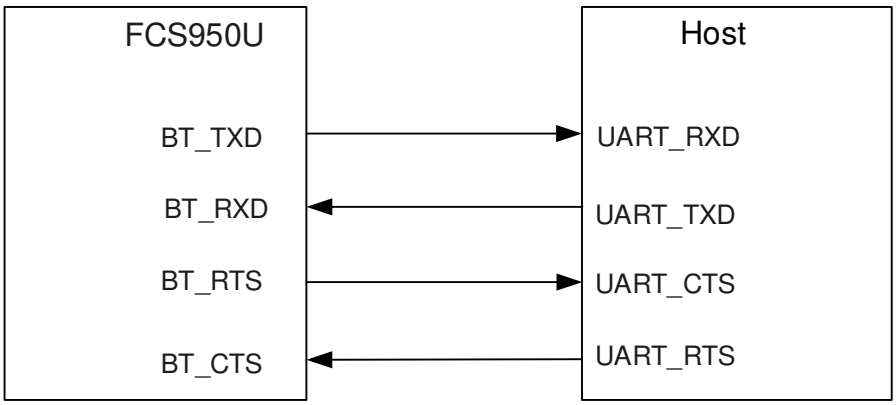


Figure 7: Reference Design for UART Interface Connection

NOTE

Please note that the module CTS is connected to the host CTS, and the module RTS is connected to the host RTS.

3.6.2. BT_WAKE_HOST

BT_WAKE_HOST are used to wake up Bluetooth function.

Table 9: Pin Definition of BT_WAKEUP_HOST

Pin Name	Pin No.	I/O	Description	Comment
BT_WAKE_HOST	7	DO	Bluetooth wake up the host	VIO power domain. If unused, keep them open.

3.6.3. PCM Interface

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

Table 10: Pin Definition of PCM Interface

Pin Name	Pin No.	I/O	Description	Comment
PCM_DOUT	25	DO	PCM data output	VIO power domain. If unused, keep them open.
PCM_CLK	26	DI	PCM clock	

PCM_DIN	27	DI	PCM data input
PCM_SYNC	28	DI	PCM data frame sync

The following figure shows the PCM interface connection between FCS950U and the host.

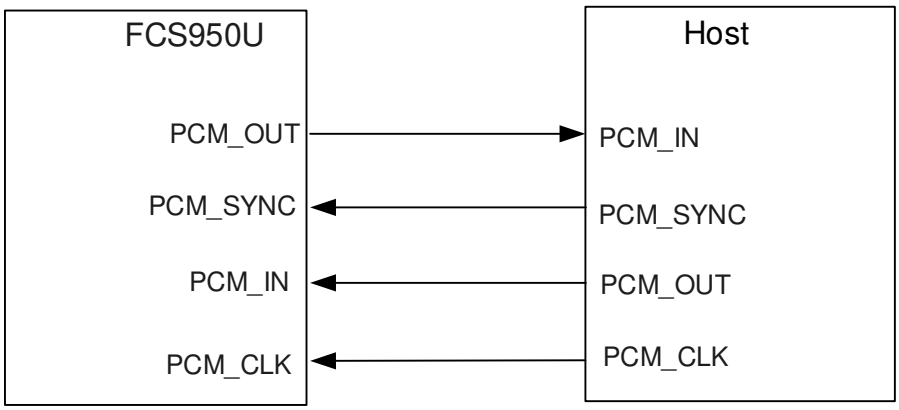


Figure 8: PCM Interface Connection

3.7. Other Interfaces

3.7.1. CHIP_EN

The module is enabled by CHIP_EN.

Table 11: Pin Definition of CHIP_EN

Pin Name	Pin No.	I/O	Description	Comment
CHIP_EN	12	DI	Module enable pin	VIO power domain. High level by default.

3.7.2. Coexistence UART*

The following table shows the pin definition of FCS950U's coexistence UART.

Table 1: Pin Definition of Coexistence UART

Pin Name	Pin No.	I/O	Description	Comment

COEX_RXD	4	DO	LTE & Wi-Fi/Bluetooth coexistence receive	VIO power domain.
COEX_TXD	29	DI	LTE & Wi-Fi/Bluetooth coexistence transmit	

3.8. RF Antenna Interface

ANT_WIFI0/BT is the RF antenna pin, and the RF port requires 50 Ω impedance.

3.8.1. Operating Frequency

The operating frequency of FCS950U is shown in the following.

Table 12: FCS950U Operating Frequency (Unit: GHz)

Feature	Frequency
2.4 GHz Wi-Fi	2.400–2.4835
5 GHz Wi-Fi	5.150–5.850
BLE 5.0	2.402–2.480

3.8.2. Pin Definition of RF Antenna Interface

Pin definitions of the antenna interface are shown in the following table:

Table 13: Pin Definition of RF Antenna Interfaces

Pin Name	Pin No.	I/O	Description	Comment
ANT_WIFI0/BT	2	AIO	Wi-Fi0/Bluetooth antenna interface	50 Ω impedance.

3.8.3. Reference Design

FCS950U module provides an RF antenna pin for Wi-Fi/Bluetooth antenna connection. The RF trace in host PCB connected to the module's RF antenna pin should be microstrip line or other types of RF trace, with characteristic impendence close to 50 Ω. FCS950U module comes with grounding pins which are next to the antenna pin to give a better grounding.

A reference circuit for the RF antenna interface is shown below. It is recommended to reserve a π-type matching circuit for better RF performance. R1/C1/C2 shall be placed as close to the antenna as possible. Capacitors (C1/C2) are not mounted by default.

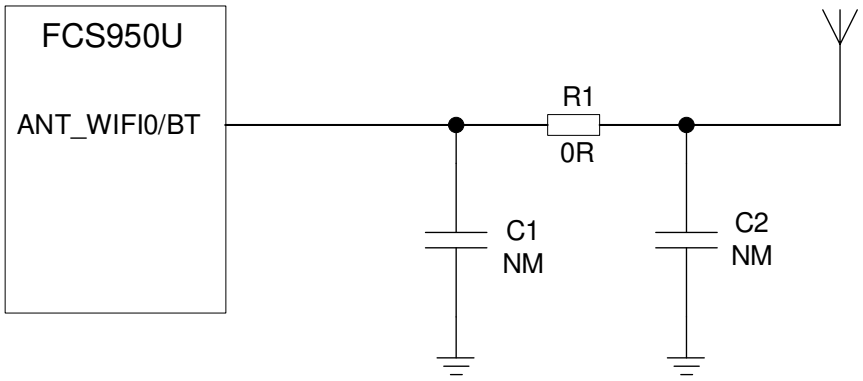


Figure 9: Reference Circuit for RF Antenna Interface

When using the PCB antenna on the module, place the module near the PCB of the mainboard. Ensure that the distance between the PCB of the mainboard and other metal components, connectors, PCB via holes, cabling, and copper coating is at least 16 mm. Ensure that all layers of the PCB area of the mainboard under the PCB antenna are cleared.

3.8.4. 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.

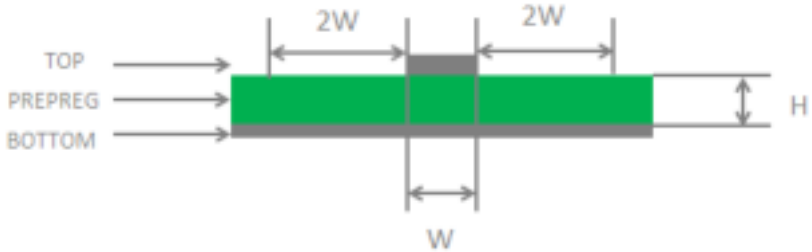


Figure 10: Microstrip Design on a 2-layer PCB

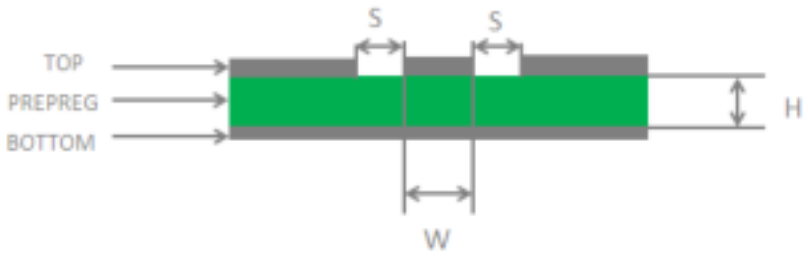


Figure 11: Coplanar Waveguide Design on a 2-layer PCB

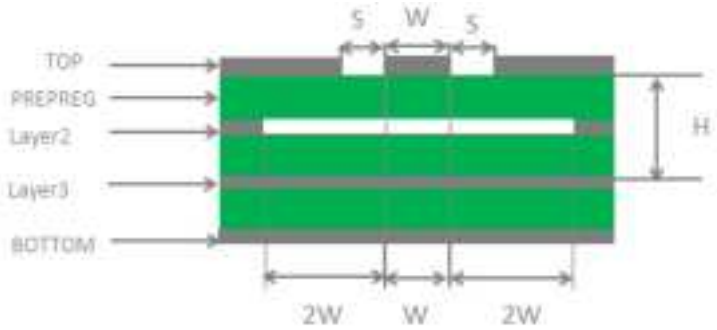


Figure 12: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

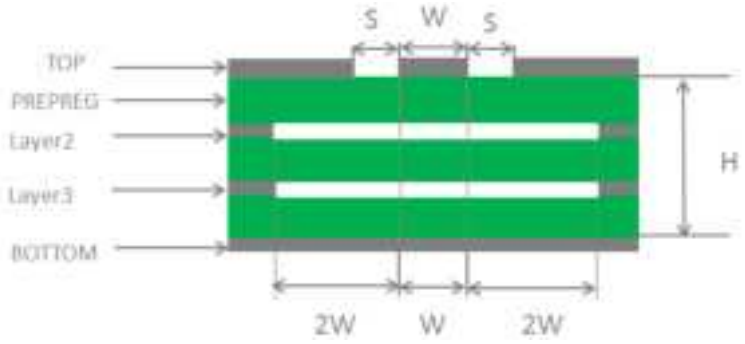


Figure 13: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

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 no less than two times 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 [1]***.

3.8.5. Antenna Design Requirements

The antenna design requirements are as follows:

Table 14: Antenna Requirements

Type	Requirements
Frequency Range	● 2.400–2.4835 GHz (cable insertion loss < 1 dB) ● 5.150–5.850 GHz (cable insertion loss < 1 dB)
VSWR	≤ 2 (recommended)
Gain (dBi)	1 (Typ)
Max Input Power (W)	50
Input Impedance (Ω)	50
Polarization Type	Vertical

3.8.6. 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.

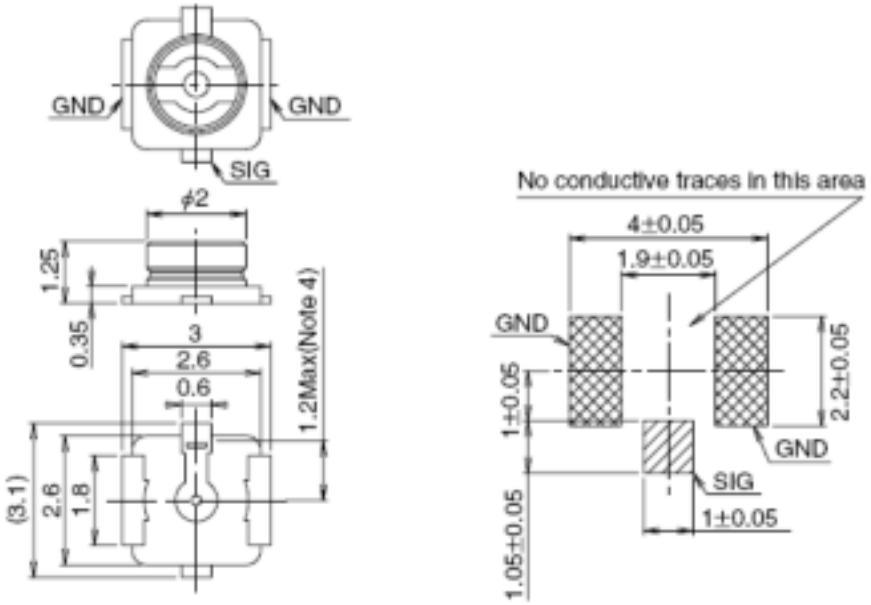


Figure 14: Dimensions of the Receptacle (Unit: mm)

U.FL-LP serial connectors listed in the following figure can be used to match the U.FL-R-SMT.

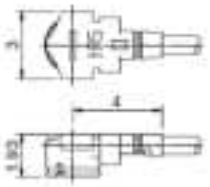
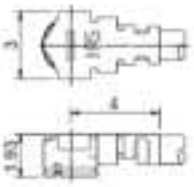
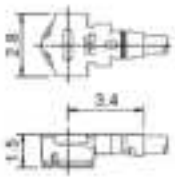
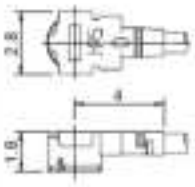
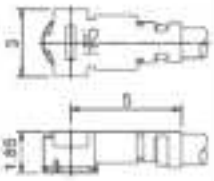
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia.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

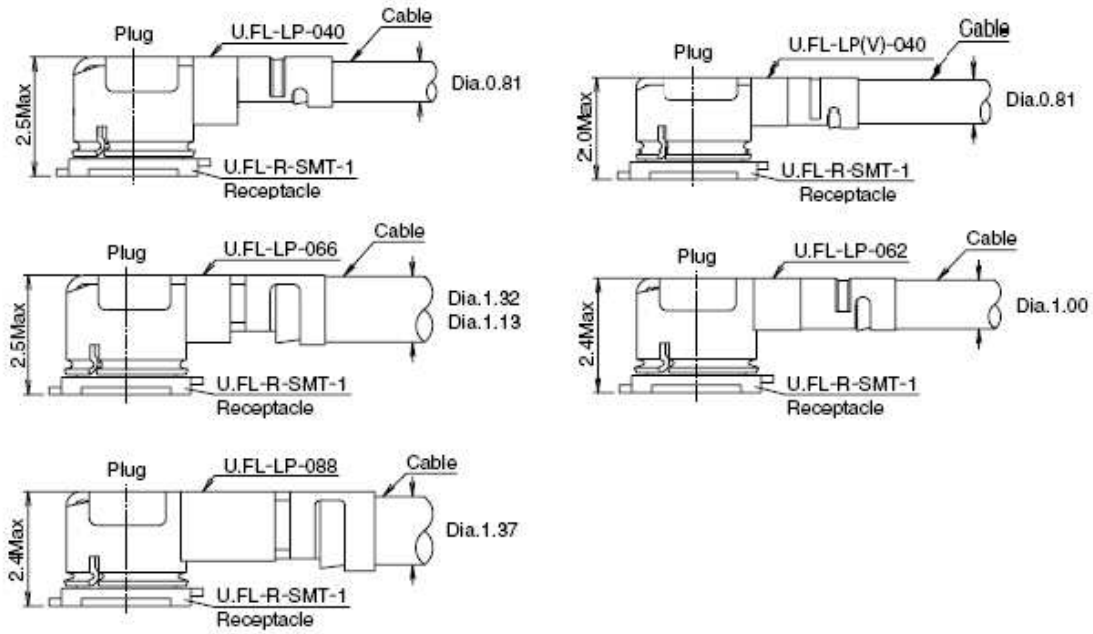


Figure 16: Space Factor of Mated Connectors (Unit: mm)

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

4 Electrical Characteristics & Reliability

FCS950U

4.1 Absolute Maximum Ratings

Table 15: Absolute Maximum Ratings (Unit: V)

Parameter	Min.	Max.
VBAT	-0.3	3.6
Digital I/O Input Voltage	-0.3	1.98

The following table shows the recommended operating conditions of the module.

Table 16: Recommended Operating Conditions (Unit: V)

Parameter	Min.	Typ.	Max.
VBAT	3.2	3.3	3.4
VIO	1.7	1.8	1.98

4.2 Digital I/O Characteristics

Table 17: Digital I/O Characteristics

Symbol	Parameter	Min.	Max.	Unit
V_{IH}	High-level input voltage	0.7 × VIO	VIO + 0.2	V
V_{IL}	Low-level input voltage	-0.3	0.3 × VIO	V
V_{OH}	High-level output voltage	0.9 × VIO	VIO	V
V_{OL}	Low-level output voltage	0	0.1 × VIO	V
I_{iL}	Input leakage current	-5	5	μA

4.3 RF Performances

4.3.1. Wi-Fi Performance

Table 18: Conducted RF Output Power at 2.4 GHz

Standard	Data Rate	Typ. (dBm)
802.11b	1 Mbps	19
802.11b	11 Mbps	17
802.11g	6 Mbps	18.5
802.11g	54 Mbps	15
802.11n, HT20	MCS 0	18.5
802.11n, HT20	MCS 7	14.5
802.11n, HT40	MCS 0	18.5
802.11n, HT40	MCS 7	14.5

Table 19: Conducted RF Output Power at 5 GHz

Standard	Data Rate	Typ. (dBm)
802.11a	6 Mbps	18.5
802.11a	54 Mbps	15
802.11n, HT20	MCS 0	17.5
802.11n, HT20	MCS 7	14
802.11n, HT40	MCS 0	17.5
802.11n, HT40	MCS 7	14
802.11ac, VHT20	MCS 0	17.5
802.11ac, VHT20	MCS 8	14
802.11ac, VHT40	MCS 0	17.5
802.11ac, VHT40	MCS 9	13

802.11ac, VHT80	MCS 0	17.5
802.11ac, VHT80	MCS 9	13

4.3.2. BLE Performance

The following table shows the BLE transmitting of FCS950U module.

Table 20: BLE Transmitting Power

Channel	Transmitting Power
0	8 dBm
19	8 dBm
39	8 dBm

4.4 Operating and Storage Temperatures

Table 21: Operating and Storage Temperatures (Unit: °C)

Parameter	Min.	Typ.	Max.
Operating temperature range [2]	-40	+25	+85
Storage temperature range	-40	-	+95

[2] Within this temperature range, the module's related indicators can meet IEEE and Bluetooth specifications.

5 Mechanical Information

This chapter describes the mechanical dimensions of FCS950U. All dimensions are measured in millimeter (mm), and the dimensional tolerances are ±0.2 mm unless otherwise specified.

5.1. Mechanical Dimensions

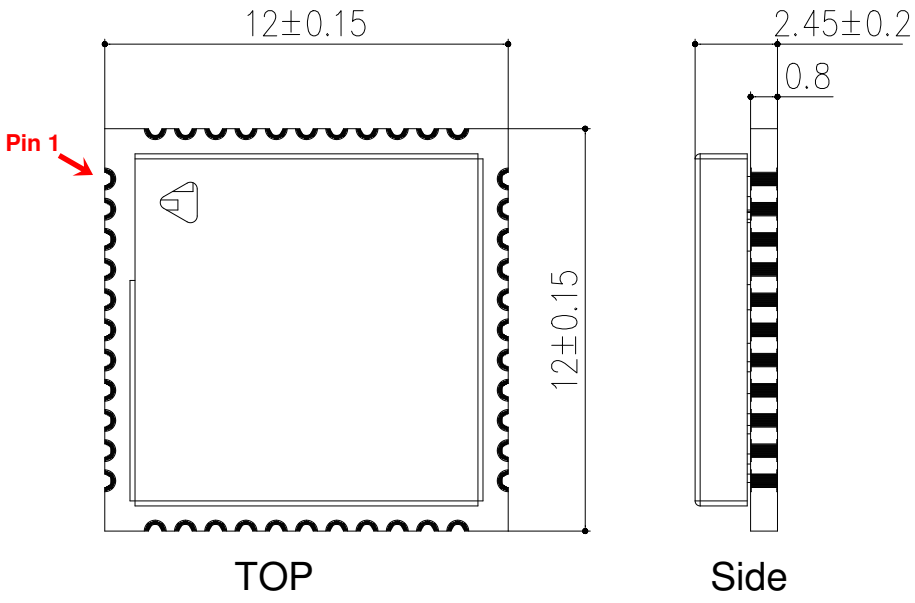


Figure 17: Top and Side Dimensions

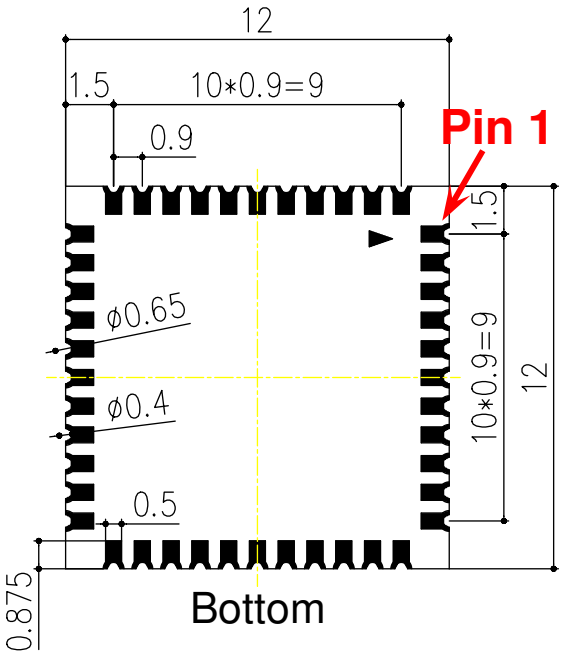


Figure 18: Bottom Dimension (Top View)

NOTE

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

5.2. Recommended Footprint

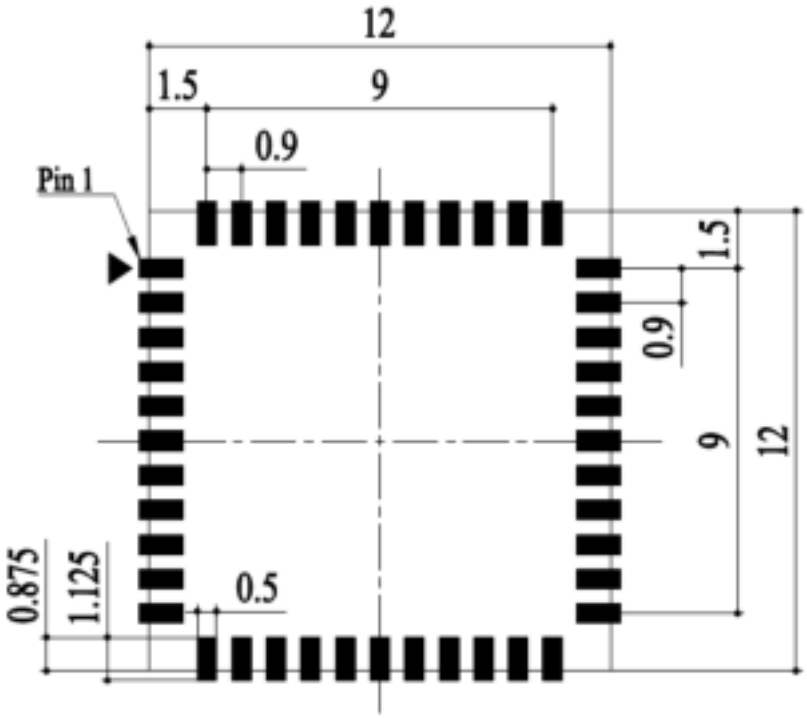


Figure 19: Recommended Footprint (Top View)

NOTE

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

6 Storage, Manufacturing & Packaging

6.1. Storage Conditions

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

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

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

3. Floor life: 168 hours [3] 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.

[3] This floor life is only applicable when the environment conforms to IPC/JEDEC J-STD-033. It is recommended to start the solder reflow process within 24 hours after the package is removed if the temperature and moisture do not conform to, or are not sure to conform to *IPC/JEDEC J-STD-033*. And do not remove the packages of tremendous modules if they are not ready for soldering.

NOTE

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

6.2. Manufacturing and Soldering

Push the squeegee to apply the solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate to the PCB. Apply proper force on the squeegee to produce a clean stencil surface on a single pass. To guarantee module soldering quality, the thickness of stencil for the module is recommended to be 0.15–0.18 mm. For more details, see ***document [2]***.

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.

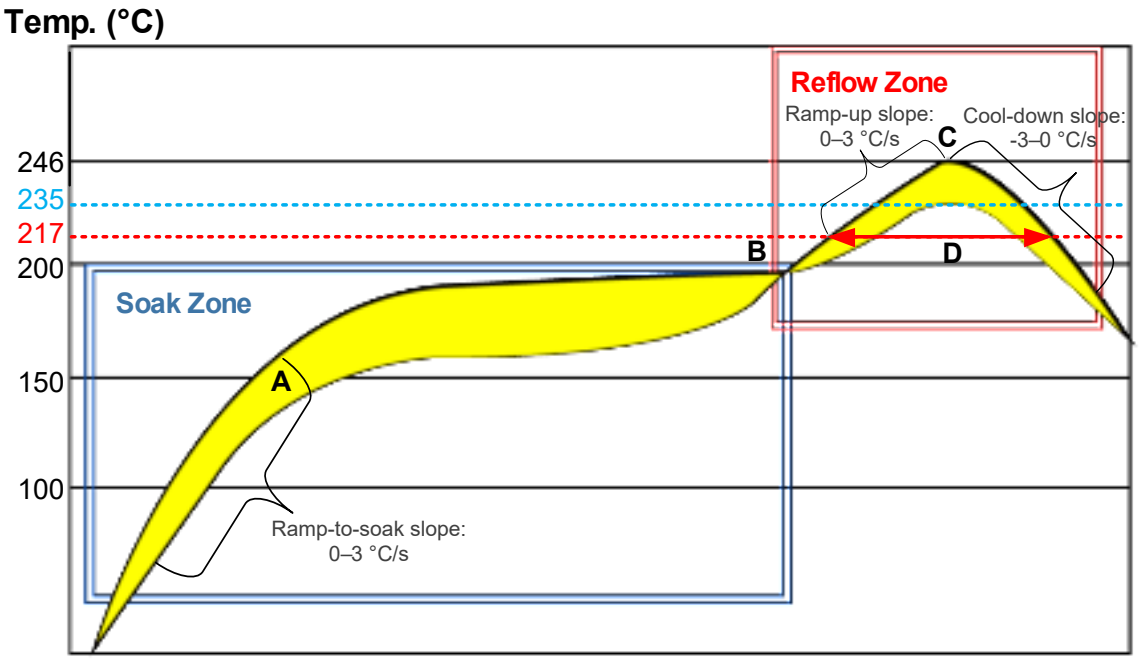


Figure 20: Recommended Reflow Soldering Thermal Profile

Table 22: 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. 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.
2. 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.
3. 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.

6.3. Notification

Please follow the principles below in the module application.

6.3.1. Coating

If a conformal coating is necessary for the module, do NOT use any coating material that may chemically react with the PCB or shielding cover, and prevent the coating material from flowing into the module.

6.3.2. Cleaning

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

6.4. Packaging Specifications

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

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

6.4.1. Carrier Tape

Dimension details are as follow:

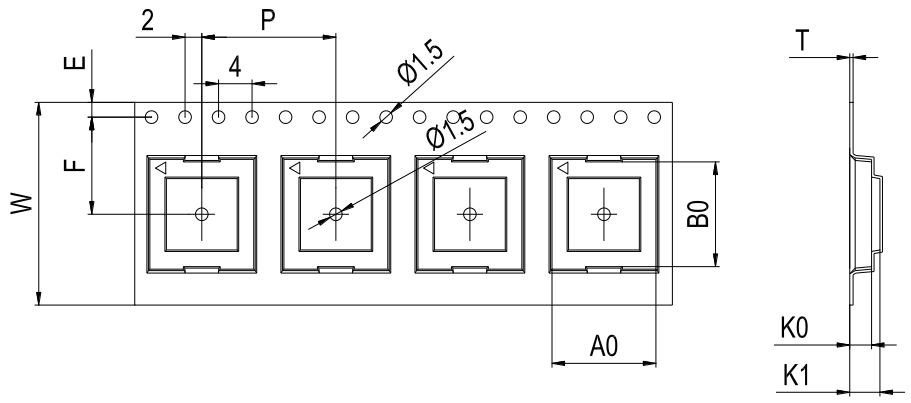


Figure 21: Carrier Tape Dimension Drawing

Table 23: Carrier Tape Dimension Table (Unit: mm)

W	P	T	A0	B0	K0	K1	F	E
24	16	0.35	12.4	12.4	2.6	3.6	11.5	1.75

6.4.2. Plastic Reel

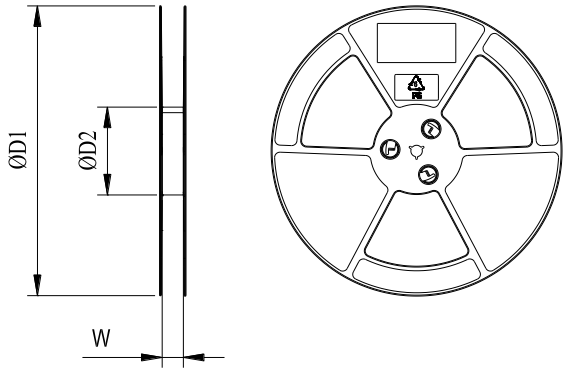
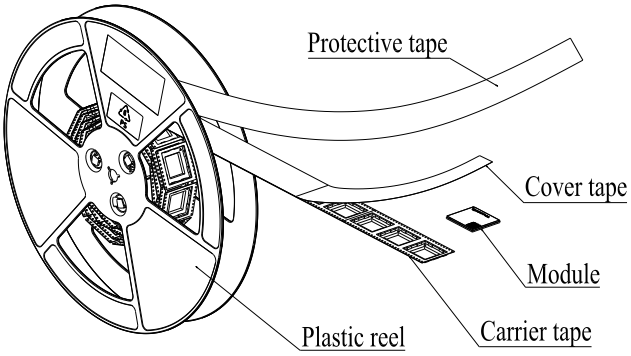


Figure 22: Plastic Reel Dimension Drawing

Table 24: Plastic Reel Dimension Table (Unit: mm)

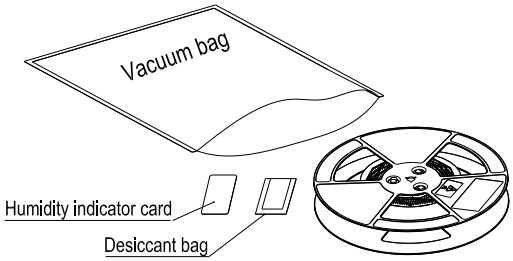
øD1	øD2	W
330	100	24.5

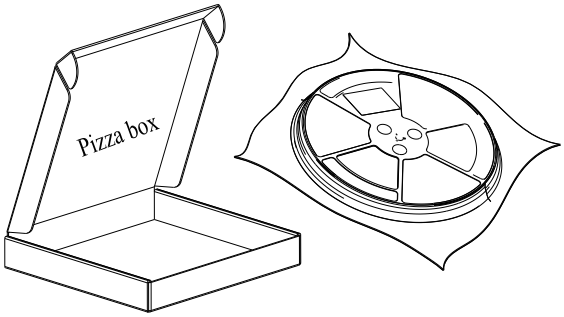
6.4.3. Packaging Process



Place the module into the carrier tape and use the cover tape to cover it; then wind the heat-sealed carrier tape to the plastic reel and use the protective tape for protection. 1 plastic reel can load 500 modules.

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





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

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

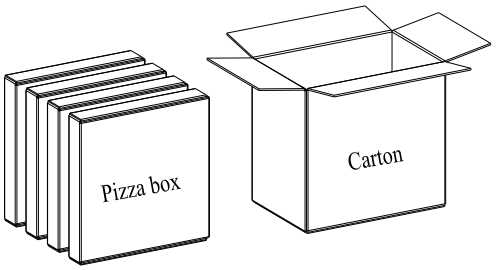


Figure 23: Packaging Process

7 Appendix References

Table 25: Related Documents

Document Name
[1] Quectel_RF_Layout_Application_Note
[2] Quectel_Module_Secondary_SMT_Application_Note

Table 26: Terms and Abbreviations

Abbreviation	Description
AP	Access Point
BLE	Bluetooth Low Energy
BPSK	Binary Phase Shift Keying
BT	Bluetooth
CCK	Complementary Code Keying
CTS	Clear To Send
DQPSK	Differential Quadrature Reference Phase Shift Keying
GATT	Generic Attribute Profile
GND	Ground
HT	High Throughput
IEEE	Institute of Electrical and Electronics Engineers
I_{iL}	Input Leakage Current
I/O	Input/Output

Mbps	Million Bits Per Second
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RoHS	Restriction of Hazardous Substances
STA	Station
RTS	Request to Send
RXD	Receive Data
TBD	To Be Determined
TXD	Transmit Data
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
V_{IH}	High-level Input Voltage
V_{IL}	Low-level Input Voltage
Vmax	Maximum Voltage
Vmin	Minimum Voltage
V_{OH}	Minimum High-level Output Voltage
V_{OL}	Low-level Output Voltage
Vnom	Normal Voltage
VSWR	Voltage Standing Wave Ratio

FCC

OEM/Integrators Installation Manual

Important Notice to OEM integrators

1. This module is limited to OEM installation ONLY.
2. This module is limited to installation in mobile or fixed applications, according to Part 2.1091(b).
3. The separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and different antenna configurations
4. For FCC Part 15.31 (h) and (k): The host manufacturer is responsible for additional testing to verify compliance as a composite system. When testing the host device for compliance with Part 15 Subpart B, the host manufacturer is required to show compliance with Part 15 Subpart B while the transmitter module(s) are installed and operating. The modules should be transmitting and the evaluation should confirm that the module's intentional emissions are compliant (i.e. fundamental and out of band emissions). The host manufacturer must verify that there are no additional unintentional emissions other than what is permitted in Part 15 Subpart B or emissions are complaint with the transmitter(s) rule(s).
The Grantee will provide guidance to the host manufacturer for Part 15 B requirements if needed.

Important Note

notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify to Quectel that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the Quectel, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.

End Product Labeling

When the module is installed in the host device, the FCC/IC ID label must be visible through a window on the final device or it must be visible when an access panel, door or cover is easily re-moved. If not, a second label must be placed on the outside of the final device that contains the following text: “Contains FCC ID: XMR2023FCS950U”
“Contains IC: 10224A-2023FCS950U “
The FCC ID/IC ID can be used only when all FCC/IC compliance requirements are met.

Antenna Installation

(1) The antenna must be installed such that 20 cm is maintained between the antenna and users,
(2) The transmitter module may not be co-located with any other transmitter or antenna.
(3) Only antennas of the same type and with equal or less gains as shown below may be used with this module. Other types of antennas and/or higher gain antennas may require additional authorization for

operation.

Antenna type	2.4GHz band Peak Gain (dBi)	5.2GHz band Peak Gain (dBi)	5.3GHz band Peak Gain (dBi)	5.5GHz band Peak Gain (dBi)	5.8GHz band Peak Gain (dBi)
Dipole	0.73	1.14	1.00	0.60	0.95

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

Manual Information to the End User

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

Federal Communication Commission Interference Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:
- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

List of applicable FCC rules

This module has been tested and found to comply with part 15.247 and 15.407 requirements for Modular Approval.
The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed

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

This device is intended only for OEM integrators under the following conditions: (For module device use)

1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2) The transmitter module may not be co-located with any other transmitter or antenna.
As long as 2 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.

Radiation Exposure Statement

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

IC

Industry Canada Statement

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.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:
(1) l'appareil ne doit pas produire de brouillage, et
(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement."

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 20 cm between the radiator & your body.

Déclaration d'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux rayonnements ISED 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.

RSS-247 Section 6.4 (5) (6) (for local area network devices, 5GHz)

The device could automatically discontinue transmission in case of absence of information to transmit, or operational failure. Note that this is not intended to prohibit transmission of control or signaling information or the use of repetitive codes where required by the technology.

The device for operation in the band 5150–5250 MHz is only for indoor use to reduce the potential for harmful interference to co-channel mobile satellite systems;
The maximum antenna gain permitted for devices in the bands 5250–5350 MHz and 5470–5725 MHz shall comply with the e.i.r.p. limit; and
The maximum antenna gain permitted for devices in the band 5725–5825 MHz shall comply with the e.i.r.p. limits specified for point-to-point and non point-to-point operation as appropriate.

L'appareil peut interrompre automatiquement la transmission en cas d'absence d'informations à transmettre ou de panne opérationnelle. Notez que ceci n'est pas destiné à interdire la transmission d'informations de contrôle ou de signalisation ou l'utilisation de codes répétitifs lorsque cela est requis par

la technologie.

Le dispositif utilisé dans la bande 5150-5250 MHz est réservé à une utilisation en intérieur afin de réduire le risque de brouillage préjudiciable aux systèmes mobiles par satellite dans le même canal;
Le gain d'antenne maximal autorisé pour les dispositifs dans les bandes 5250-5350 MHz et 5470-5725 MHz doit être conforme à la norme e.r.p. limite; et
Le gain d'antenne maximal autorisé pour les appareils de la bande 5725-5825 MHz doit être conforme à la norme e.i.r.p. les limites spécifiées pour un fonctionnement point à point et non point à point, selon le cas.

This device is intended only for OEM integrators under the following conditions: (For module device use)

1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2) The transmitter module may not be co-located with any other transmitter or antenna.
As long as 2 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.

Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes: (Pour utilisation de dispositif module)

1) L'antenne doit être installée de telle sorte qu'une distance de 20 cm est respectée entre l'antenne et les utilisateurs, et
2) Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

Tant que les 2 conditions ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

IMPORTANT NOTE:

In the event that these conditions can not be met (for example certain laptop configurations or colocation with another transmitter), then the Canada authorization is no longer considered valid and the IC ID can not 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 Canada authorization.

NOTE IMPORTANTE:

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada

n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

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-2023FCS950U”.

Plaque signalétique du produit final

Ce module émetteur est autorisé uniquement pour une utilisation dans un dispositif où l'antenne peut être installée de telle sorte qu'une distance de 20cm peut être maintenue entre l'antenne et les utilisateurs. Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: 10224A-2023FCS950U".

Manual Information To the End User

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

Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module.
Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

CE

Hereby, [Quectel Wireless Solutions Co., Ltd.] declares that the radio equipment type [FCS950U] is in compliance with Directive 2014/53/EU. The full text of the EU declaration of conformity is available at the following internet address: http://www.quectel.com/support/technical.htm
The device could be used with a separation distance of 20cm to the human body.
The device is restricted to indoor use only when operating in the 5250-5350 MHz frequency range.

CE

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