FC900E

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
-	2022-05-27	Lisa LI	Creation of the document
1.0.0	2022-05-27	Lisa LI	Preliminary
1.0.1	2022-09-19	Lisa LI	Updated RF specifications、Power Consumption; Update module size

Contents

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1 Introduction

This document defines the FC900E and describes its air interfaces and hardware interfaces which are connected with your application.

This document can help you quickly understand module interface specifications, electrical and mechanical details, as well as other related information of the module. Associated with application notes and user guides, you can use FC900E to design and set up applications easily.

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, ANTCTL[0:3] refers to all four ANTCTL pins, ANTCTL0, ANTCTL1, ANTCTL2 and ANTCTL3.

2 Product Overview

2.1. General Description

The FC900E is a low-power, 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 supports the Wi-Fi low-power SDIO 3.0 interface. UART & PCM interface for Bluetooth.

The FC900E module is a patch module with 44 LCC pins. The module is compact in package and the size is only 12.0 mm × 12.0 mm × 2.05 mm.

2.2. Key Features

The following table describes the key features of FC900E.

Table 2: Key Features

Features	Details
Power Supply	● **VBAT power supply:** Supply voltage range: 3.14–3.46 V Typical supply voltage: 3.3 V ● **VIO power supply:** Supply voltage range: 1.71–3.46 V Typical supply voltage: 1.8/3.3 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 (MCS0–MCS7) **5 GHz:** ● 802.11a: 6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps, 24 Mbps, ● 36 Mbps, 48 Mbps, 54 Mbps ● 802.11n: HT20 (MCS0–MCS7), HT40 (MCS0–MCS7)

	● 802.11ac: VHT20 (MCS0–MCS8), VHT40 (MCS0–MCS9), VHT80 (MCS0–MCS9)
Wi-Fi Transmitting Power	● **2.4 GHz** 802.11b (11 Mbps): 16 dBm 802.11g (54 Mbps): 14 dBm 802.11n (HT20 MCS7): 14 dBm 802.11n (HT40 MCS7): 13 dBm ● **5 GHz** 802.11a (54 Mbps): 11 dBm 802.11n (HT20 MCS7): 9 dBm 802.11n (HT40 MCS7): 12.5 dBm 802.11ac (VHT20 MCS8): 9 dBm 802.11ac (VHT40 MCS9): 7.5 dBm 802.11ac (VHT80 MCS9): 8 dBm
Wi-Fi Protocol Feature	IEEE 802.11a/b/g/n/ac
Wi-Fi Modulation	CCK, BPSK, QBPSK, 16QAM, 64QAM, 256QAM
Wi-Fi Operation Mode	● AP ● STA
Bluetooth Operation Mode	● BR + EDR ● BLE
Bluetooth Modulation	GFSK, π/4-DQPSK, 8-DPSK
Wi-Fi Application Interface	SDIO 3.0
Bluetooth Application Interface	UART and PCM
RF Antenna Interfaces	● ANT_WIFI0/BT ● 50 Ω characteristic impedance
Physical Characteristics	● Size: (12.0 ±0.15) mm × (12.0 ±0.15) mm × (2.05 ±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

[1] To meet this operating temperature range, you need to ensure effective thermal dissipation, for example, by adding passive or active heatsinks, heat pipes, vapor chambers, etc. Within this range, the module's related performance can meet IEEE specifications.

2.3. EVB

Quectel supplies an evaluation board (FC900E-M.2) with accessories to control or test the module.

3 Application Interfaces

3.1. General Description

FC900E is equipped with 44 LCC pins. The subsequent chapters will provide a detailed introduction to the following interfaces and pins of the module:

- Power supply
- Wi-Fi application interface
  - SDIO interface
  - WLAN_EN
  - WLAN_WAKE
- Bluetooth application interface
  - Bluetooth UART
  - BT_EN
  - BT_WAKE_HOST & HOST_WAKE_BT
  - PCM interface
- RF antenna interfaces
  - ANT_WIFI0/BT
- Another interface
  -WLAN_SLP_CLK

3.2. Pin Assignment

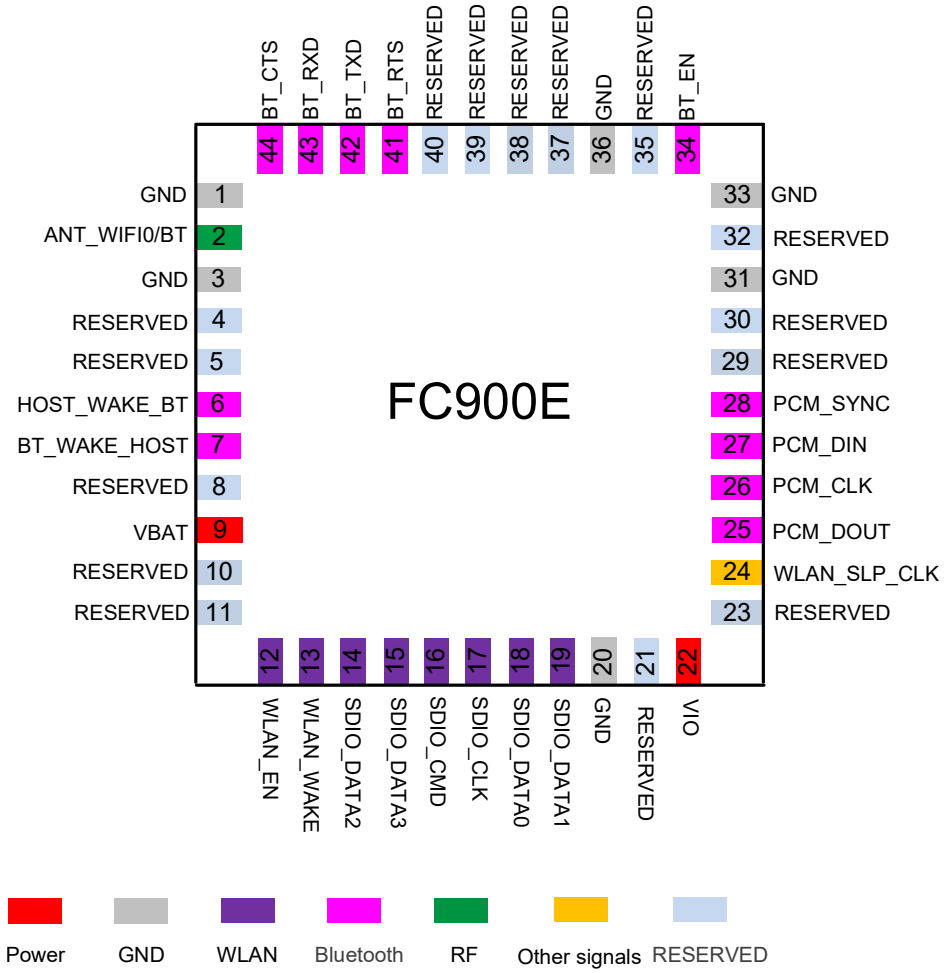


Figure 2: Pin Assignment (Top View)

NOTE

Keep all RESERVED pins open.

3.3. Pin Description

The following tables show the pin description of FC900E.

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
PO	Power Output

Table 4: Pin Description

Power Supply				
Pin Name	**Pin No.**	**I/O**	**Description**	**Comment**
VBAT	9	PI	Power supply for the module	
VIO	22	PI	Power supply for module's I/O pins	
GND	1, 3, 20, 31, 33, 36			
Wi-Fi Application Interface				
Pin Name	**Pin No.**	**I/O**	**Description**	**Comment**
WLAN_EN	12	DI	Wi-Fi function enable control	VIO power domain. Active high.
WLAN_WAKE	13	DO	Wake up the host by Wi-Fi	
SDIO_DATA2	14	DIO	SDIO data bit 2/NC	VIO power domain. Need to be pulled up.
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_EN	34	DI	Bluetooth enable control	VIO power domain. Active high. If unused, pull it down.
HOST_WAKE_BT	6	DI	Host wakes up Bluetooth	VIO power domain. If unused, keep them open.
BT_WAKE_HOST	7	DO	Bluetooth wakes up host	
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**
WLAN_SLP_CLK	24	DI	External 32.768 kHz low power clock input	
RESERVED				

Pin Name	Pin No.	Comment
RESERVED	4, 5, 8, 10, 11, 21, 23, 29, 30, 32, 35, 37, 38, 39, 40	Keep them open.

3.4. Power Supply

3.4.1. Power Supply Pins Introduction

The following table shows the power supply pins and ground pins of FC900E.

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	3.14	3.3	3.46	V
VIO	22	Power supply for module's I/O pins	1.71	1.8/3.3	3.46	V
GND	1, 3, 20, 31, 33, 36	Ground				

The FC900E is powered by VBAT. It is recommended to use a power chip with a maximum output current of more than 0.6.

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

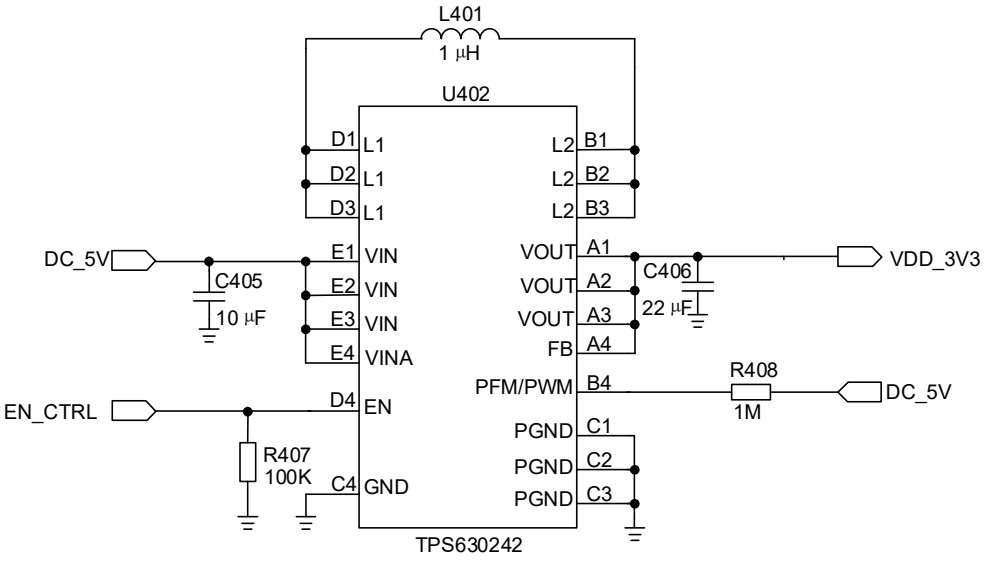


Figure 3: VBAT Circuit

The time sequence of FC900E power on and off is shown in the below:

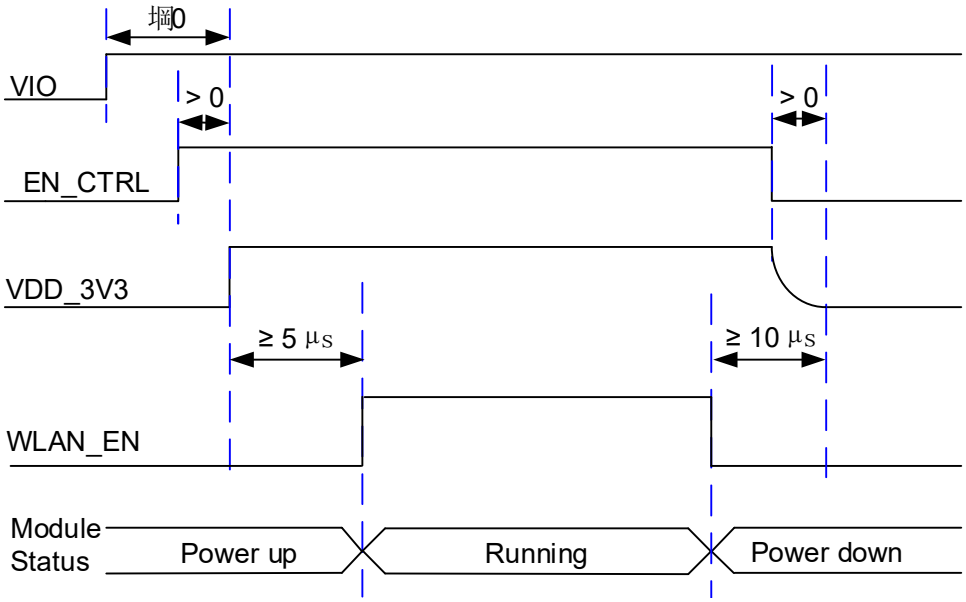


Figure 4: Power-up Timing

3.5. Wi-Fi Application Interface

The following figure shows the Wi-Fi application interface connection between FC900E and the host.

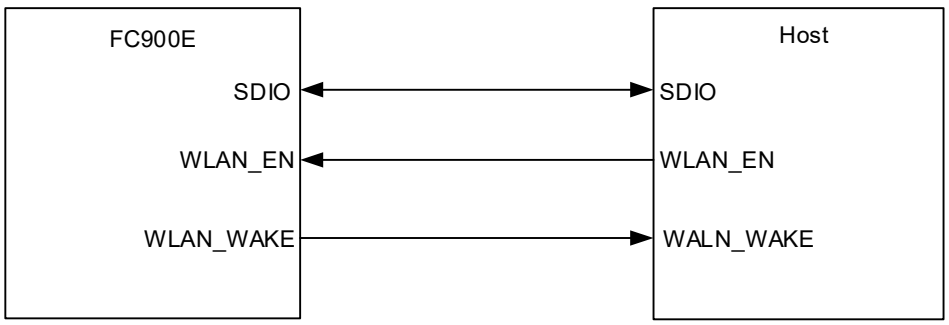


Figure 5: Wi-Fi Application Interface Connection

3.5.1. SDIO Interface

FC900E 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	VIO power domain
SDIO_DATA2	14	DIO	SDIO data bit 2	VIO power domain; Need to pull up to 1.8 V via external 10 kΩ resistors.
SDIO_DATA1	19	DIO	SDIO data bit 1	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 FC900E and host.

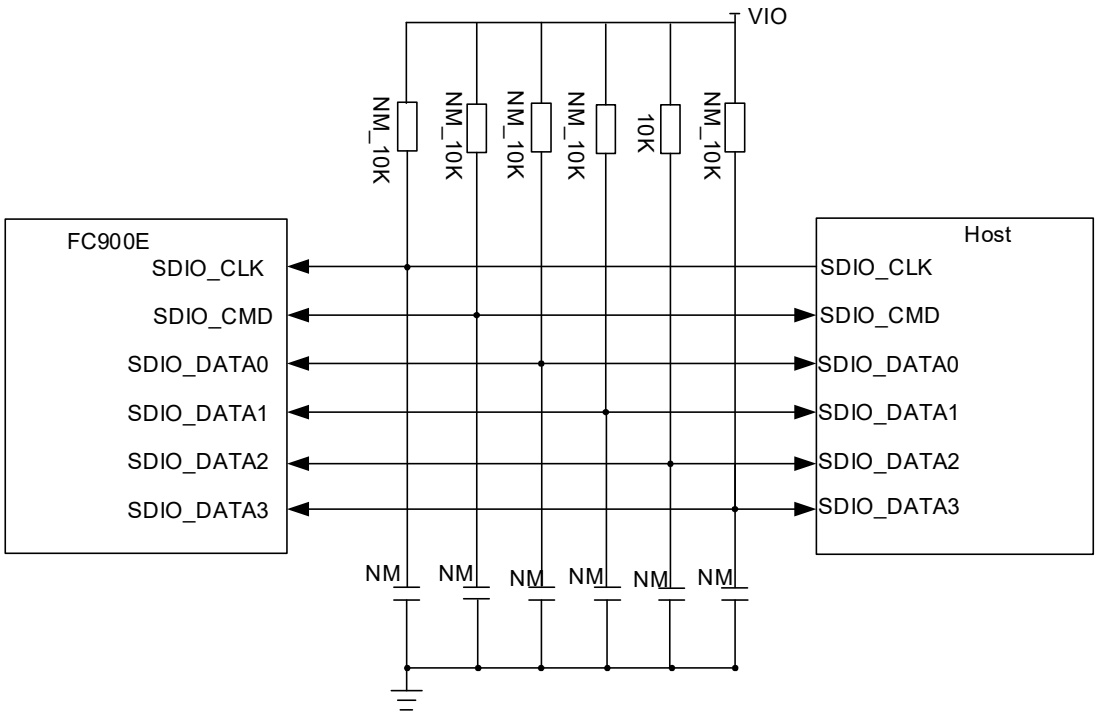


Figure 6: SDIO Interface Connection

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 2 times the trace width, and the busload 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_EN

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

Table 7: Pin Definition of WLAN_EN

Pin Name	Pin No.	I/O	Description	Comment
WLAN_EN	12	DI	Wi-Fi function enable control	VIO power domain. Active high.

NOTE

WLAN_EN is the Wi-Fi function enable signal. When wiring, keep it away from sensitive signals such as radio frequency, analog signal, clock, and DC-DC noise signals.

3.5.3. WLAN_WAKE

WLAN_WAKE is used to wake up the host.

Table 8: Pin Definition of WLAN_WAKE

Pin Name	Pin No.	I/O	Description	Comment
WLAN_WAKE	13	DO	Wake up the host by Wi-Fi	VIO power domain. If unused, keep it open.

3.6. Bluetooth Application Interface

The following figure shows the block diagram of Bluetooth application interface connection between FC900E and a host.

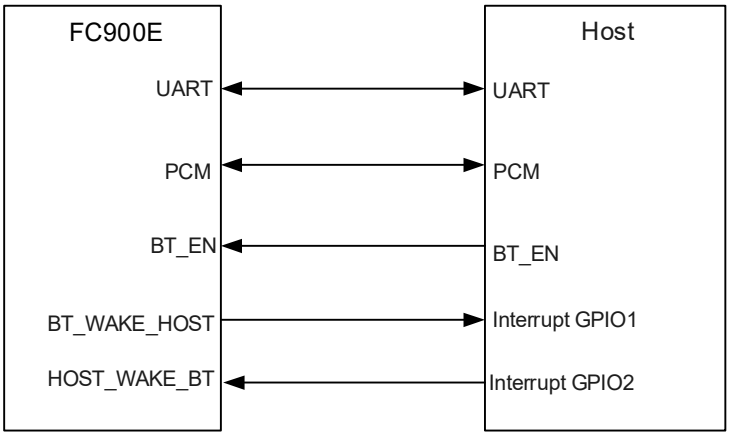


Figure 7: Module and Host Connection Diagram

3.6.1. Bluetooth UART

The FC900E 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 9: 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 FC900E and host.

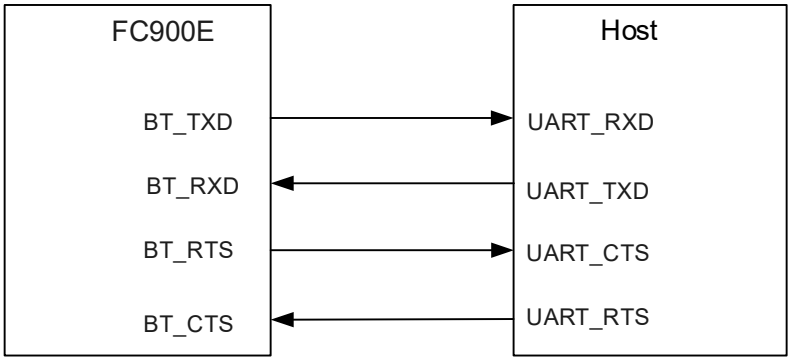


Figure 8: Reference Design for UART Interface Connection

3.6.2. BT_EN

BT_EN is used to control the Bluetooth function of FC900E. Bluetooth function will be enabled when BT_EN is at high level.

Table 10: Pin Definition of BT_EN

Pin Name	Pin No.	I/O	Description	Comment
BT_EN	34	DI	Bluetooth enable control	Active high. If unused, please pull it down. VIO power domain.

3.6.3. BT_WAKE_HOST & HOST_WAKE_BT

BT_WAKE_HOST and HOST_WAKE_BT are used to wake up Bluetooth function.

Table 11: Pin Definition of BT_WAKEUP_HOST and HOST_WAKEUP_BT

Pin Name	Pin No.	I/O	Description	Comment
HOST_WAKE_BT	6	DI	Host wakes up Bluetooth function	VIO power domain. If unused, keep them open.
BT_WAKE_HOST	7	DO	Bluetooth function wakes up host	

3.6.4. PCM Interface

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

Table 12: 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 FC900E and the host.

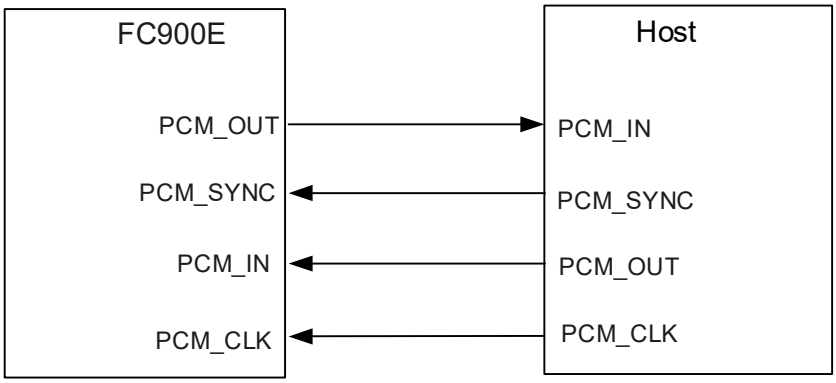


Figure 9: PCM Interface Connection

3.7. Other Interfaces

3.7.1. WLAN_SLP_CLK

The 32.768 kHz sleep clock is used in low power modes, such as IEEE power saving mode and sleep mode. It serves as a timer to determine when to wake up the FC900E to receive signals in various power saving schemes, and to maintain basic logic operations when the module is in sleep mode.

Table 13: Pin Definition of WLAN_SLP_CLK

Pin Name	Pin No.	I/O	Description
WLAN_SLP_CLK	24	DI	External 32.768 kHz low power clock input.

The following are the recommended selection parameters for the recommended 32.768 kHz crystal:

Table 14: WLAN_SLP_CLK Parameter Recommendation

Parameter	Value	Unit
Frequency	32.768	kHz
Frequency accuracy	±200	ppm
Duty cycle	30–70	%
Input signal amplitude	200–3300	mV, p-p
Signal type	Square wave or sine wave	-
Input impedance	> 100	kΩ
Crystal load capacitance	< 5	pF
Clock jitter	< 10000	ppm

3.8. RF Antenna Interfaces

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

3.8.1. Operating Frequency

The operating frequency of FC900E is shown in the following.

Table 15: FC900E Operating Frequency

Feature	Frequency	Unit
2.4 GHz Wi-Fi	2.412–2.484	GHz
5 GHz Wi-Fi	5.180–5.825	GHz
BLE 5.0	2.402–2.480	GHz

3.8.2. Pin Definition of RF Antenna Interface

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

Table 16: 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

FC900E 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. FC900E 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.

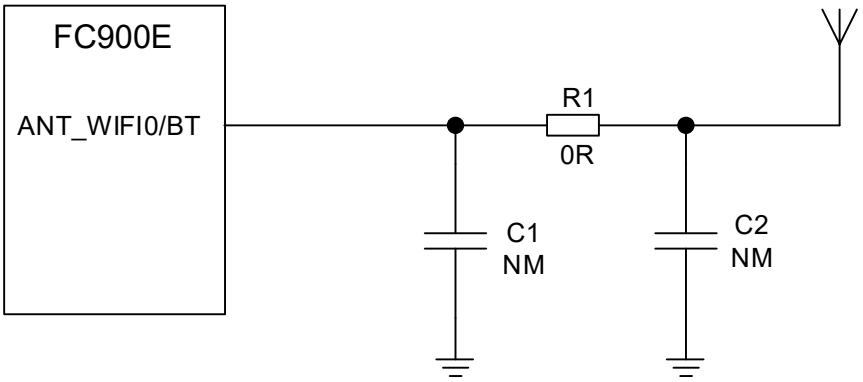


Figure 10: Reference Design

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. Reference Design of RF Routing

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

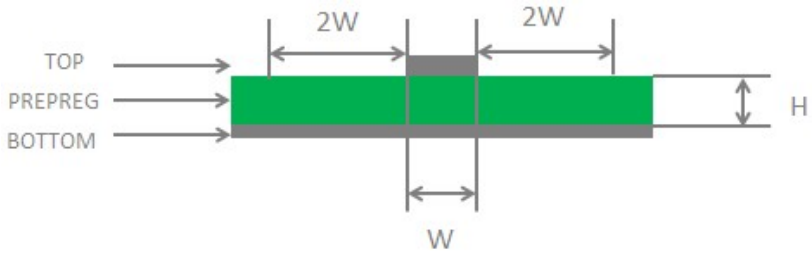


Figure 11: Microstrip Design on a 2-layer PCB

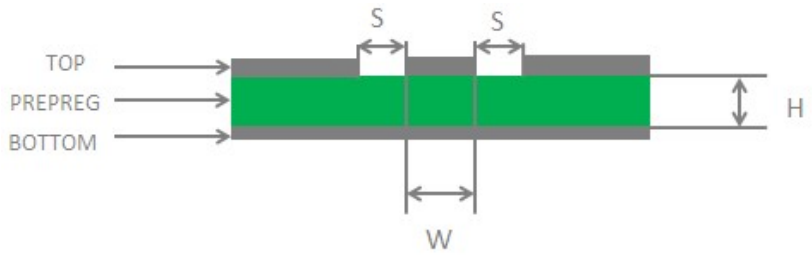


Figure 12: Coplanar Waveguide Design on a 2-layer PCB

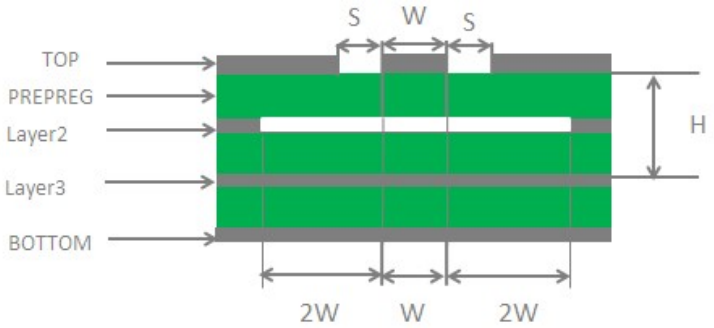


Figure 13: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

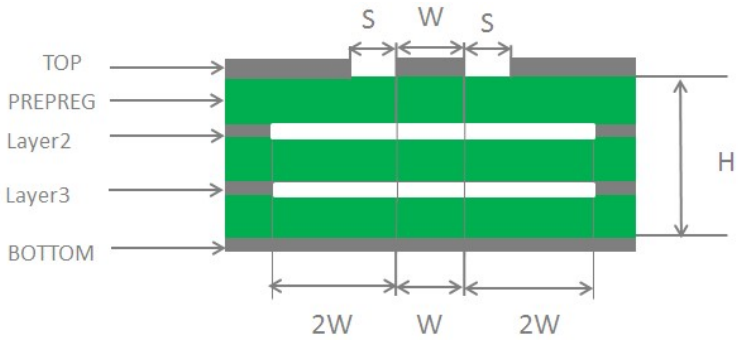


Figure 14: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

To ensure RF performance and reliability, the following principles should be complied with RF layout design:

- Use impedance simulation tool to control the characteristic impedance of RF traces to 50 Ω.
- The GND pins adjacent to RF pins should not be designed as thermal relief pins, 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 area 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. Requirements for Antenna Design

The antenna design requirements are as follows:

Table 17: Antenna Requirements

Type	Requirements
Frequency Range	● 2.412–2.484 GHz (cable insertion loss < 1 dB) ● 5.150–5.875 GHz (cable insertion loss < 1 dB)
VSWR	< 2
Gain (dBi)	Typ. 1
Max Input Power (W)	50
Input Impedance (Ω)	50
Polarization Type	Vertical

3.8.6. RF Connector Recommendation

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

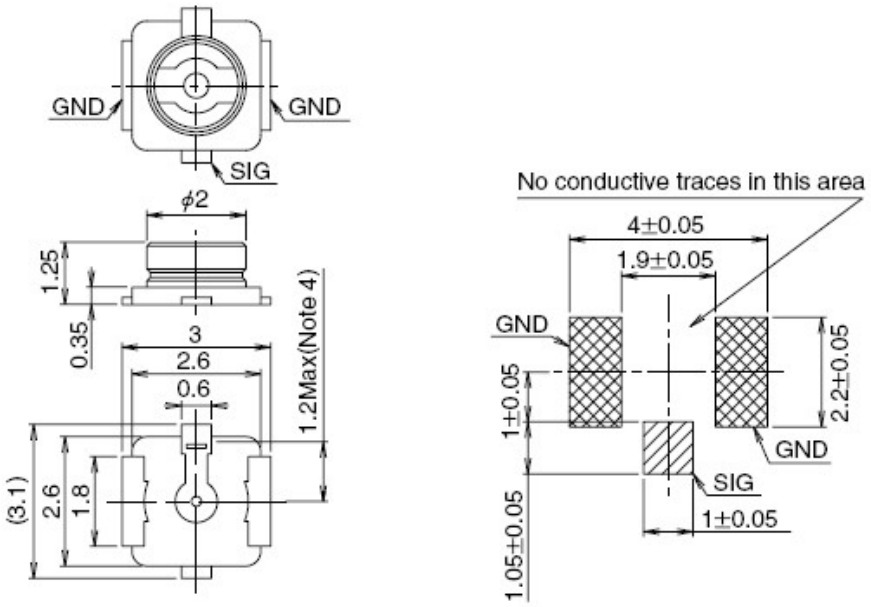


Figure 15: Dimensions of the Receptacle (Unit: mm)

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

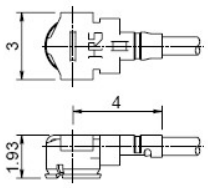
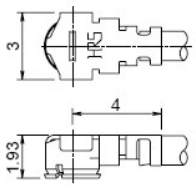
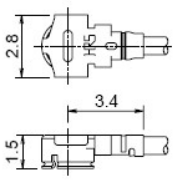
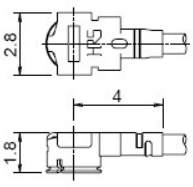
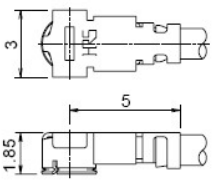
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 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 16: Specifications of Mated Plugs

The following figure describes the space factor of mated connectors.

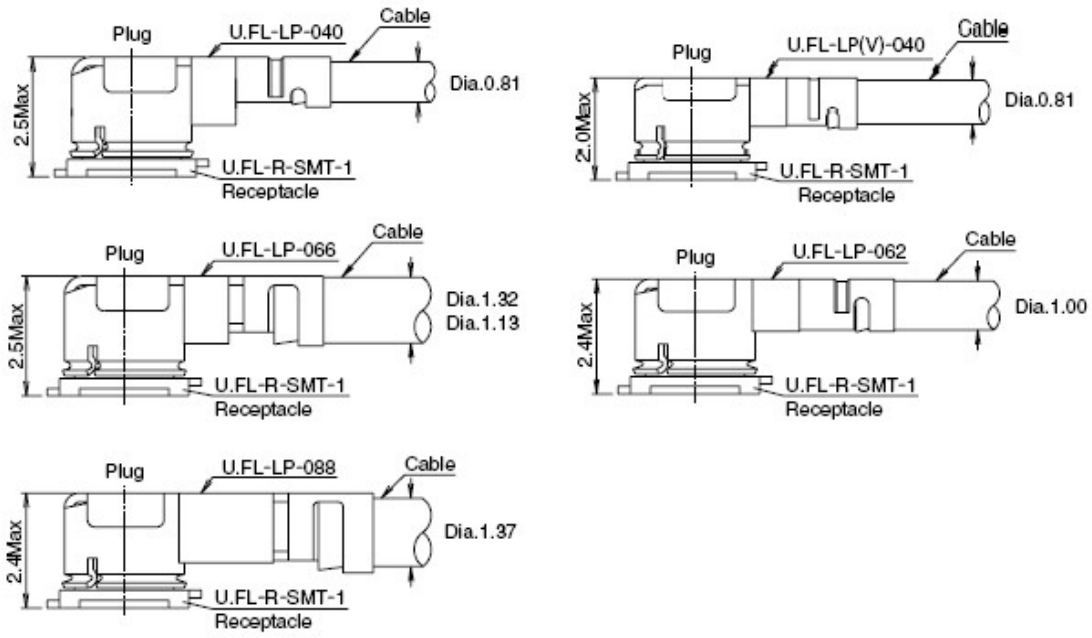


Figure 17: Space Factor of Mated Connectors (Unit: mm)

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

4 Electrical Characteristics & Reliability

4.1. General Description

This chapter mainly introduces the electrical characteristics and radio frequency characteristics of FC900E, the specific content is as follows:

- Absolute maximum ratings
- I/O interface characteristics
- Power consumption
- RF performance
- ESD protection
- Operating and storage temperature

4.2. Absolute Maximum Ratings

Table 18: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VBAT	-0.3	3.46	V
Digital I/O Input Voltage	-0.3	3.46	V

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

Table 19: Recommended Operating Conditions

Parameter	Min.	Typ.	Max.	Unit
VBAT	3.13	3.3	3.46	V
VIO	1.71	1.8/3.3	3.46	V

4.3. I/O Interface Characteristics

The following table shows the general DC electrical characteristics over recommended operating conditions (unless otherwise specified).

Table 20: General DC Electrical 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

4.4. Power Consumption

Table 21: Power Consumption of the Module

Description	Condition	$I_{WLAN3V3}$	I_{VIO}	Unit
OFF state	**AT+QWIFI=0**	0.35	178.40	μA
Idle state	**AT+QWIFI=1**	36.28	2.96	mA
802.11b	TX 1 Mbps	343.48	6.08	mA
	TX 11 Mbps	313.83	6.07	mA
	RX 1 Mbps	49.82	6.04	mA
	RX 11 Mbps	49.38	6.03	mA
802.11g	TX 6 Mbps	301.60	6.61	mA
	TX 54 Mbps	193.76	6.05	mA
	RX 6 Mbps	49.19	6.03	mA

	RX 54 Mbps	49.71	6.04	mA
802.11n (2.4 GHz)	TX HT20-MCS0	300.01	6.06	mA
	TX HT20-MCS7	198.75	6.09	mA
	TX HT40-MCS0	261.61	6.06	mA
	TX HT40-MCS7	159.06	6.05	mA
	RX HT20-MCS0	49.24	6.03	mA
	RX HT20-MCS7	50.06	6.03	mA
	RX HT40-MCS0	53.41	6.05	mA
	RX HT40-MCS7	54.66	6.05	mA
802.11a	TX 6 Mbps	404.76	6.06	mA
	TX 54 Mbps	264.71	6.08	mA
	RX 6 Mbps	70.87	6.05	mA
	RX 54 Mbps	75.38	6.05	mA
802.11n (5 GHz)	TX HT20-MCS0	394.21	6.09	mA
	TX HT20-MCS7	252.31	6.08	mA
	TX HT40-MCS0	372.55	6.09	mA
	TX HT40-MCS7	215.34	6.07	mA
	RX HT20-MCS0	71.17	6.05	mA
	RX HT20-MCS7	71.79	6.05	mA
	RX HT40-MCS0	75.83	6.06	mA
	RX HT40-MCS7	75.73	6.06	mA
802.11ac	TX VHT20 MCS0	393.99	6.10	mA
	TX VHT20 MCS8	245.02	6.07	mA
	TX VHT40 MCS0	358.76	6.09	mA
	TX VHT40 MCS9	197.73	6.07	mA

	TX VHT80 MCS0	324.33	6.08	mA
	TX VHT80 MCS9	182.54	6.07	mA
	RX VHT20 MCS0	71.11	6.05	mA
	RX VHT20 MCS8	71.84	6.05	mA
	RX VHT40 MCS0	75.67	6.06	mA
	RX VHT40 MCS9	75.84	6.06	mA
	RX VHT80 MCS0	84.70	6.07	mA
	RX VHT80 MCS9	82.86	6.07	mA

4.5. RF Performances

4.5.1. Wi-Fi Performance

Table 22: Conducted RF Output Power at 2.4 GHz

Standard	Data Rate	Typ.
802.11b	1 Mbps	19 dBm
802.11b	11 Mbps	19 dBm
802.11g	6 Mbps	18 dBm
802.11g	54 Mbps	17 dBm
802.11n, HT20	MCS0	18 dBm
802.11n, HT20	MCS7	16 dBm
802.11n, HT40	MCS0	17 dBm
802.11n, HT40	MCS7	16 dBm

Table 23: Conducted RF Output Power at 5 GHz

Standard	Data Rate	Typ.

802.11a	6 Mbps	15 dBm
802.11a	54 Mbps	12 dBm
802.11n, HT20	MCS0	13.5 dBm
802.11n, HT20	MCS7	10 dBm
802.11n, HT40	MCS0	13.5 dBm
802.11n, HT40	MCS7	10 dBm
802.11ac, VHT20	MCS0	12.5 dBm
802.11ac, VHT20	MCS8	10 dBm
802.11ac, VHT40	MCS0	12 dBm
802.11ac, VHT40	MCS9	8.5 dBm
802.11ac, VHT80	MCS0	12 dBm
802.11ac, VHT80	MCS9	9 dBm

Table 24: Conducted RF Receiving Sensitivity at 2.4 GHz

Standard	Data Rate	Typ.
802.11b	1 Mbps	-94 dBm
802.11b	11 Mbps	-87 dBm
802.11g	6 Mbps	-89 dBm
802.11g	54 Mbps	-73 dBm
802.11n, HT20	MCS0	-89 dBm
802.11n, HT20	MCS7	-70 dBm
802.11n, HT40	MCS0	-86 dBm
802.11n, HT40	MCS7	-67.5 dBm

Table 25: Conducted RF Receiving Sensitivity at 5 GHz

Standard	Data Rate	Typ.

802.11a	6 Mbps	-89.5 dBm
802.11a	54 Mbps	-73 dBm
802.11n, HT20	MCS0	-89 dBm
802.11n, HT20	MCS7	-70 dBm
802.11n, HT40	MCS0	-86.5 dBm
802.11n, HT40	MCS7	-67.5 dBm
802.11ac, VHT20	MCS0	-89 dBm
802.11ac, VHT20	MCS8	-66 dBm
802.11ac, VHT40	MCS0	-86 dBm
802.11ac, VHT40	MCS9	-61.5 dBm
802.11ac, VHT80	MCS0	-83.5 dBm
802.11ac, VHT80	MCS9	-58.5 dBm

4.5.2. BLE Performance

The following table shows the BLE transmitting and receiving performance of FC900E module.

Table 26: BLE Transmitting and Receiving Performance

Channel	Transmitting Power	Receiving Sensitivity
0	(-3 ±2.5) dBm	-96 dBm
19	(-2 ±2.5) dBm	-95 dBm
39	(-3 ±2.5) dBm	-94 dBm

4.6. 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 27: Electrostatics Discharge Characteristics (25 °C, 45 % Relative Humidity; Unit: kV)

Tested Interfaces	Contact Discharge	Air Discharge
VDD	7	12
GND	8	12
Antenna Interfaces	7	12

4.7. Operating and Storage Temperatures

Table 28: Operating and Storage Temperatures (Unit: °C)

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

[2] To meet this operating temperature range, you need to ensure effective thermal dissipation, for example, by adding passive or active heatsinks, heat pipes, vapor chambers, etc. Within this range, the module's related performance can meet IEEE specifications.

5 Mechanical Information

This chapter describes the mechanical dimensions of FC900E. All dimensions are measured in millimeter (mm), and the dimensional tolerances are ±0.2 mm unless otherwise specified.

5.1. Mechanical Dimensions

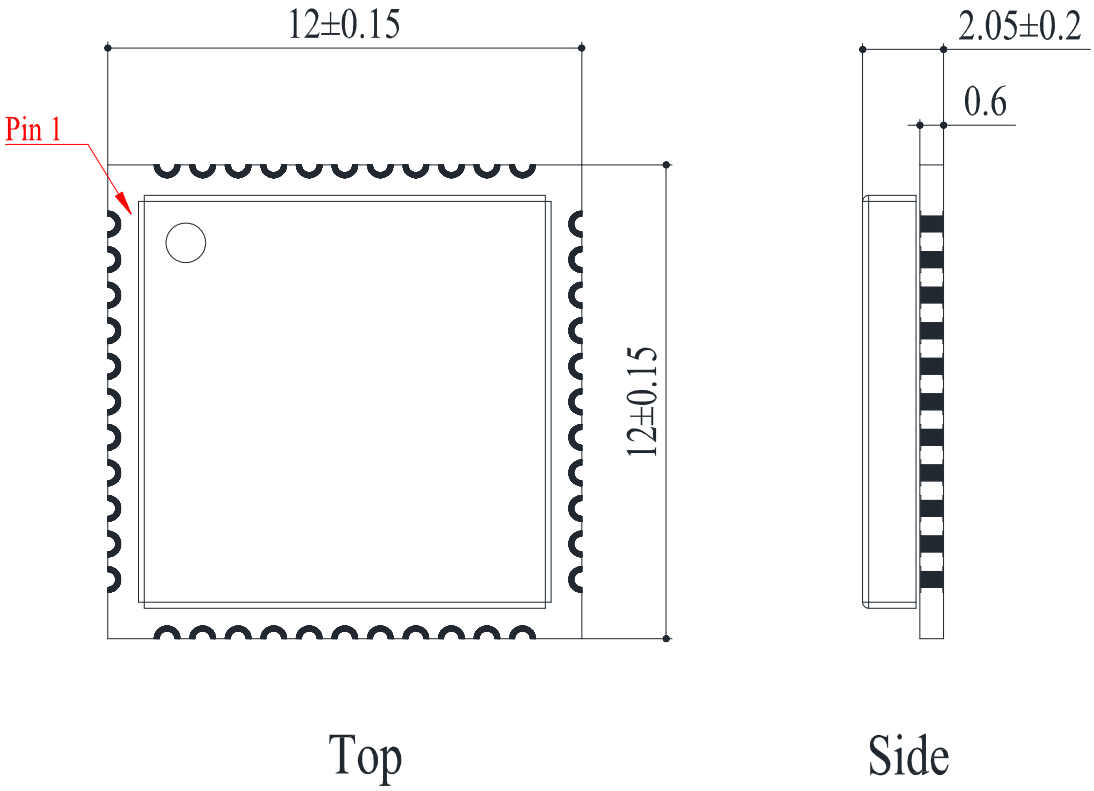


Figure 18: Top and Side Dimensions (Top and Side View)

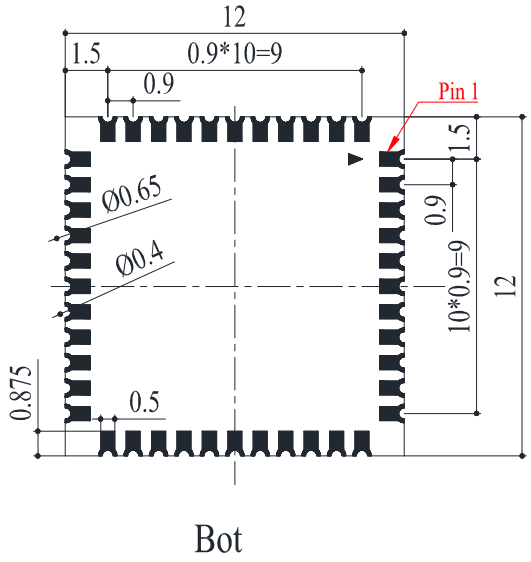


Figure 19: Bottom Dimension (Top View)

NOTE

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

5.2. Recommended Footprint

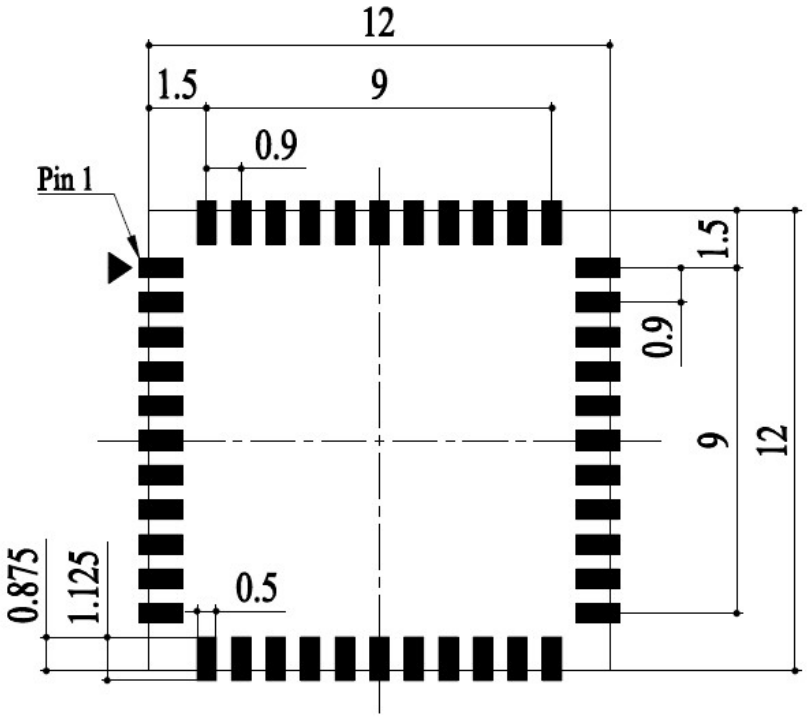


Figure 20: Recommended Footprint (Top View)

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. All modules must be soldered to PCB within 24 hours after the baking, otherwise put them in the drying oven. 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. The force on the squeegee should be adjusted properly to produce a clean stencil surface on a single pass. To ensure the module soldering quality, the thickness of stencil for the module is recommended to be 0.15–0.18mm. For more details, see ***document [2]***.

The 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 strongly 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.

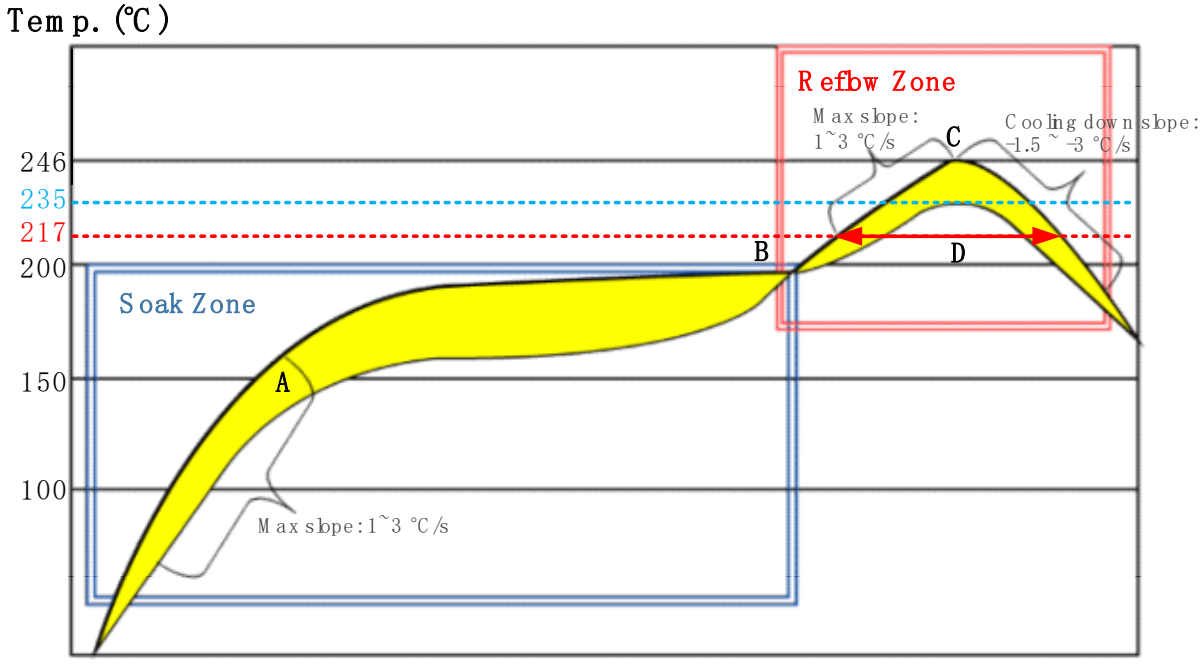


Figure 21: Recommended Reflow Soldering Thermal Profile

Table 29: Recommended Thermal Profile Parameters

Factor	Recommendation
Soak Zone	
Max slope	1–3 °C/s
Soak time (between A and B: 150 °C and 200 °C)	70–120 s
Reflow Zone	
Max slope	1–3 °C/s
Reflow time (D: over 217 °C)	40–70 s
Max temperature	235 °C to 246 °C
Cooling down slope	-1.5 to -3 °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

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

6.4.1. Carrier Tape

Dimension details are as follow:

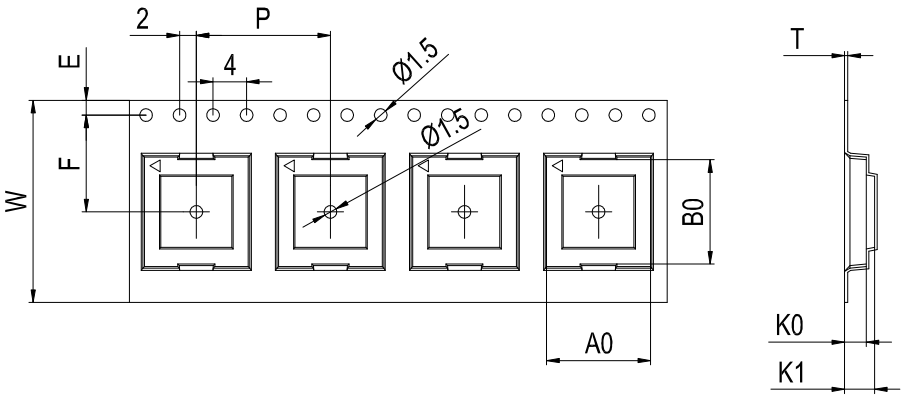


Figure 22: Carrier Tape Dimension Drawing

Table 30: 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

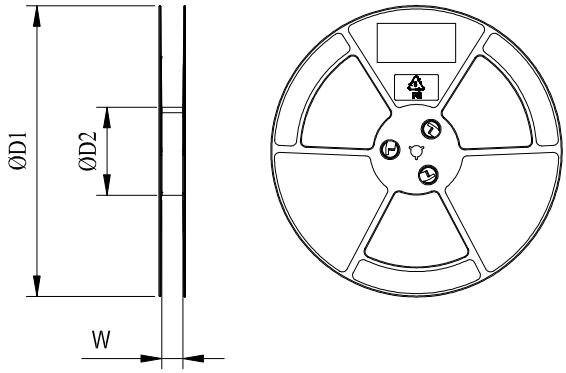
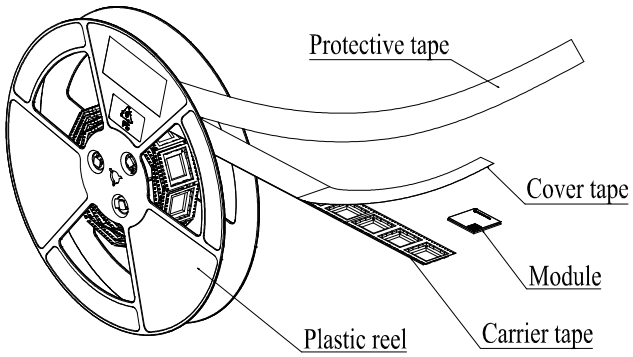


Figure 23: Plastic Reel Dimension Drawing

Table 31: Plastic Reel Dimension Table (Unit: mm)

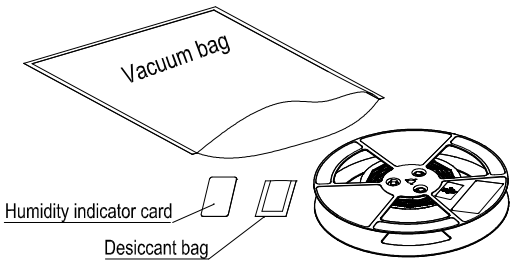
øD1	øD2	W
330	100	24.5

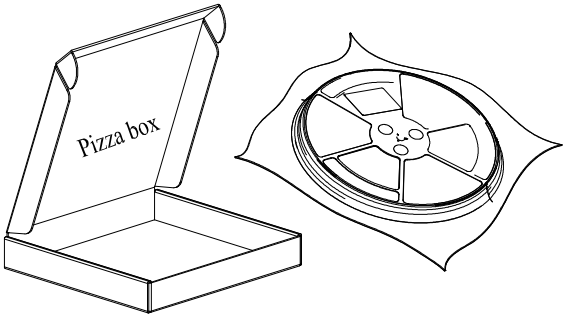
6.4.3. Packaging Process



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.

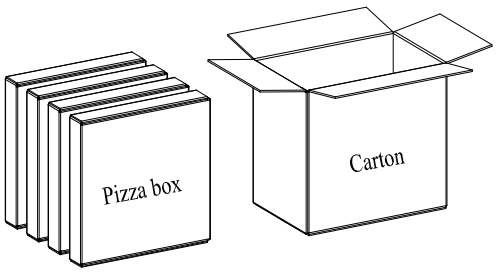


Figure 24: Packaging Process

7 Appendix References

Table 32: Related Documents

Document Name
[1] Quectel_RF_Layout_Application_Note
[2] Quectel_Module_SMT_Application_Note

Table 33: 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/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	Spike-triggered average
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}max	Maximum High-level Input Voltage
V_{IH}min	Minimum High-level Input Voltage
V_{IL}max	Maximum Low-level Input Voltage
V_{IL}min	Minimum Low-level Input Voltage
V_{OL}max	Maximum Low-level Output Voltage
V_{OH}min	Minimum High-level Output Voltage
Vnom	Normal Voltage
VSWR	Voltage Standing Wave Ratio

FCC Certification Requirements.
According to the definition of mobile and fixed device is described in Part 2.1091(b), this device is a mobile device. And the following conditions must be met:

1. This Modular Approval is limited to OEM installation for mobile and fixed applications only. The antenna installation and operating configurations of this transmitter, including any applicable source-based timeaveraging duty factor, antenna gain, and cable loss must satisfy MPE categorical Exclusion Requirements of 2.1091.
2. The EUT is a mobile device; maintain at least a 20 cm separation between the EUT and the user's body and must not transmit simultaneously with any other antenna or transmitter.
3. A label with the following statements must be attached to the host end product: This device contains FCC ID: XMR202210FC900E

4. This module must not transmit simultaneously with any other antenna or transmitter
5. The host end product must include a user manual that clearly defines operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.

For portable devices, in addition to the conditions 3 through 6 described above, a separate approval is required to satisfy the SAR requirements of FCC Part 2.1093
If the device is used for other equipment that separate approval is required for all other operating configurations, including portable configurations with respect to 2.1093 and different antenna configurations.
For this device, OEM integrators must be provided with labeling instructions of finished products.
Please refer to KDB784748 D01 v07, section 8. Page 6/7 last two paragraphs:
A certified modular has the option to use a permanently affixed label, or an electronic label. For a permanently affixed label, the module must be labeled with an FCC ID - Section 2.926 (see 2.2 Certification (labeling requirements) above). The OEM manual must provide clear instructions explaining to the OEM the labeling requirements, options and OEM user manual instructions that are required (see next paragraph).
For a host using a certified modular with a standard fixed label, if (1) the module's FCC ID is not visible when installed in the host, or (2) if the host is marketed so that end users do not have straightforward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module: "Contains Transmitter Module FCC ID: XMR202210FC900E" or "Contains FCC ID: XMR202210FC900E" must be used. The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.

The final host / module combination may also need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.
The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes, or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. In cases where the manual is provided only in a form other than paper, such as on a computer disk or over the Internet, the information required by this section may be included in the manual in that alternative form, provided the user can reasonably be expected to have the capability to access information in that form.
This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.
To ensure compliance with all non-transmitter functions the host manufacturer is responsible for ensuring compliance with the module(s) installed and fully operational. For example, if a host was previously authorized as an unintentional radiator under the Supplier's Declaration of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that the after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements.

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.

IC Statement

IRSS-GEN

"This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions: (1) This device may not cause interference; and (2) This device must accept any interference, including interference that may cause undesired operation of the device." or "Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1) l'appareil ne doit pas produire de brouillage; 2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement."

Déclaration sur l'exposition aux rayonnements RF

L'autre utilisé pour l'émetteur doit être installé pour fournir une distance de séparation d'au moins 20 cm de toutes les personnes et ne doit pas être colocalisé ou fonctionner conjointement avec une autre antenne ou un autre émetteur.

The host product shall be properly labeled to identify the modules within the host product.

The Innovation, Science and Economic Development Canada certification label of a module shall be clearly visible at all times when installed in the host product; otherwise, the host product must be labeled to display the Innovation, Science and Economic Development Canada certification number for the module, preceded by the word "Contains" or similar wording expressing the same meaning, as follows:

"Contains IC: 10224A-2022FC900E" or "where: 10224A-2022FC900E is the module's certification number".

Le produit hôte doit être correctement étiqueté pour identifier les modules dans le produit hôte.

L'étiquette de certification d'Innovation, Sciences et Développement économique Canada d'un module doit être clairement visible en tout temps lorsqu'il est installédans le produit hôte; sinon, le produit hôte doit porter une étiquette indiquant le numéro de certification d'Innovation, Sciences et Développement économique Canada pour le module, précédé du mot «Contient» ou d'un libellé semblable exprimant la même signification, comme suit:

"Contient IC: 10224A-2022FC900E " ou "où: 10224A-2022FC900E est le numéro de certification du module".

i.the device for operation in the band 5150–5250 MHz is only for indoor use to reduce the potential for harmful interference to co-channel mobile satellite systems;

ii. for devices with detachable antenna(s), the maximum antenna gain permitted for devices in the bands 5250-5350 MHz and 5470-5725 MHz shall be such that the equipment still complies with the e.i.r.p. limit;

iii. for devices with detachable antenna(s), the maximum antenna gain permitted for devices in the band 5725-5850 MHz shall be such that the equipment still complies with the e.i.r.p. limits as appropriate;

iv. Omnidirectional antenna is recommended

CE Statement

Regulatory Conformance

Hereby, we (Quectel Wireless Solutions Co., Ltd.) declares that the radio equipment type FC900E series are in compliance with Directive 2014/53/EU.

RF exposure

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

This device may be operated in all member states of the EU.

Observe national and local regulations where the device is used.

This device is restricted to indoor use only when operating in the 5150 to 5350 MHz,frequency range in the following countries:

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	

UK Regulations

Regulations 2017 (SI 2017/1206)

Declaration of Conformity

Quectel Wireless Solutions Co., Ltd. hereby declares that this Bluetooth and Wi-Fi functions, FC900E series are in compliance with the essential requirements and other relevant provisions of the UK Radio Equipment Regulations 2017 (SI 2017/1206).