# FC64E-B

# Hardware Design

**Wi-Fi&Bluetooth Module Series**

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

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

# About the Document

## Revision History

| Version | Date | Author | Description |
|---|---|---|---|
| - | 2021-01-19 | Soni RAO/ Lucas HUANG | Creation of the document |
| 1.0 | 2023-01-18 | Soni RAO | First official release |
| 1.1 | 2023-07-31 | Soni RAO/ Amy HAN | 1. Added the relevant information for FC62E.<br>2. Reserved pin 26 (VDD_3V3) and pin 55 (PA_MUTE).<br>3. Added the thermal dissipation for the module (Chapter 4.8). |

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# 1 Introduction

This document defines the FC64E-B module and describes its air interfaces and hardware interfaces, which are connected with your application.

This document provides a quick insight into module interface specifications, electrical and mechanical details, as well as other module-related information. Coupled with application notes and user guides, the document makes it easy for you to use the module to design and set up mobile applications.

**NOTE**

For conciseness purposes, FC64E-B will hereinafter be referred to collectively as "the module/modules" in parts hereof applicable to both models, and individually as "FC64E-B" in parts hereof referring to the differences between them.

# 2 Product Overview

## 2.1. General Description

The module is a low-power single-die Wi-Fi and Bluetooth combo solution supporting IEEE 802.11a/b/g/n/ac/ax 2.4 GHz and 5 GHz Wi-Fi standards and Bluetooth 5.2 standard, which enables seamless integration of Wi-Fi and Bluetooth low energy technologies.

It supports Wi-Fi and Bluetooth functions with the low-power PCIe Gen 3, UART, and PCM interfaces.

The built-in 2.4 GHz Wi-Fi & LTE coexistence filter is optional.

## 2.2. Key Features

**Table 1: Key Features**

| Feature | Detail |
|---|---|
| Power Supply | ● Core supply voltage: 0.95 V, 1.35 V, 1.95 V<br>● I/O supply voltage: 1.8 V<br>● RF supply voltage: 2.2 V |
| Operating Frequencies | ● 2.4 GHz Wi-Fi: 2.400–2.4835 GHz<br>● 5 GHz Wi-Fi: 5.150–5.850 GHz<br>● Bluetooth: 2.400–2.4835 GHz |
| Wi-Fi Features | ● Compliant with IEEE 802.11a/b/g/n/ac/ax<br>● Supported channel bandwidth:<br>20/40 MHz at 2.4 GHz<br>20/40/80 MHz at 5 GHz<br>● 2 × 2 Multi-User Multiple-Input Multiple-Output (MU-MIMO)<br>**FC64E-B:**<br>● Dual Band Simultaneous (DBS) with dual MAC, up to 1.8 Gbps data rate (2 × 2 + 2 × 2 802.11ax DBS) |
| Bluetooth Features | ● Adaptive frequency hopping (AFH) for reducing radio frequency interference |

| | |
|---|---|
| | ● Compliance with *Bluetooth Core Specification Version 5.2* with provisions for supporting future specifications.<br>● 2 Mbps Bluetooth Low Energy (BLE), BLE Long Range |
| Wi-Fi Data Transmission Rates | ● 802.11b: 1 Mbps, 2 Mbps, 5.5 Mbps, 11 Mbps<br>● 802.11a/g: 6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps, 24 Mbps, 36 Mbps, 48 Mbps, 54 Mbps<br>● 802.11n: HT20 (MCS 0–7), HT40 (MCS 0–7)<br>● 802.11ac: VHT20 (MCS 0–8), VHT40 (MCS 0–9), VHT80 (MCS 0–9)<br>● 802.11ax: HE20 (MCS 0–11), HE40 (MCS 0–11), HE80 (MCS 0–11) |
| Wi-Fi Transmitting Power | ● **Without 2.4 GHz Wi-Fi & LTE Coexistence Filter**<br>802.11b @ 11 Mbps: 17 dBm ±2 dB<br>802.11g @ 54 Mbps: 14.5 dBm ±2 dB<br>802.11n, HT20 @ MCS 7: 13.5 dBm ±2 dB<br>802.11n, HT40 @ MCS 7: 13 dBm ±2 dB<br>802.11ax, HE20 @ M FC64E-B CS 11: 11 dBm ±2 dB<br>802.11ax, HE40 @ MCS 11: 10 dBm ±2 dB<br>● **With 2.4 GHz Wi-Fi & LTE Coexistence Filter**<br>802.11b @ 11 Mbps: 16 dBm ±2 dB<br>802.11g @ 54 Mbps: 13 dBm ±2 dB<br>802.11n, HT20 @ MCS 7: 12.5 dBm ±2 dB<br>802.11n, HT40 @ MCS 7: 11.5 dBm ±2 dB<br>802.11ax, HE20 @ MCS 11: 11 dBm ±2 dB<br>802.11ax, HE40 @ MCS 11: 10 dBm ±2 dB<br>● **5 GHz**<br>802.11a @ 54 Mbps: 13 dBm ±2 dB<br>802.11n, HT20 @ MCS 7: 12 dBm ±2 dB<br>802.11n, HT40 @ MCS 7: 11.5 dBm ±2 dB<br>802.11ac, VHT20 @ MCS 8: 11.5 dBm ±2 dB<br>802.11ac, VHT40 @ MCS 9: 10.5 dBm ±2 dB<br>802.11ac, VHT80 @ MCS 9: 10 dBm ±2 dB<br>802.11ax, HE20 @ MCS 11: 9.5 dBm ±2 dB<br>802.11ax, HE40 @ MCS 11: 9.5 dBm ±2 dB<br>802.11ax, HE80 @ MCS 11: 8.5 dBm ±2 dB |
| Wi-Fi Operating Modes | ● AP<br>● STA |
| Wi-Fi Modulations | DBPSK, DQPSK, CCK, BPSK, QPSK, 16QAM, 64QAM, 256QAM, 1024QAM |
| Wi-Fi Application Interface | PCIe |
| Bluetooth Application Interfaces | ● UART<br>● PCM |
| RF Antenna Interfaces | ● Wi-Fi antenna interface (ANT_WIFI0) × 1<br>● Dedicated Wi-Fi antenna interface (ANT_WIFI1) × 1<br>● Dedicated Bluetooth antenna interface (ANT_BT) × 1 |

| | |
|---|---|
| | ● 50 Ω characteristic impedance |
| Physical Characteristics | ● Size: (18 ±0.15) mm × (19.9 ±0.15) mm × (2.1 ±0.2) mm<br>● Package: LCC<br>● Weight: approx. 1.6 g |
| Temperature Ranges | ● Operating temperature range [1]: -30 °C to +75 °C<br>● Storage temperature range: -40 °C to +85 °C |
| RoHS | All hardware components are fully compliant with EU RoHS directive |

## 2.3. EVB Kit

To help you develop applications with the module, Quectel supplies an evaluation board (FC6xE M.2 EVB) with accessories to develop and test the module. For more details, see ***document [1]***.

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

# 3 Application Interfaces

## 3.1. General Description

The module has 52 LCC pins and 28 LGA pins. The following interfaces are described in detail in subsequent chapters:

- Power supply
- Wi-Fi application interfaces
- Bluetooth application interfaces
- Coexistence interfaces
- Other interfaces
- RF antenna interfaces

## 3.2. Pin Assignment

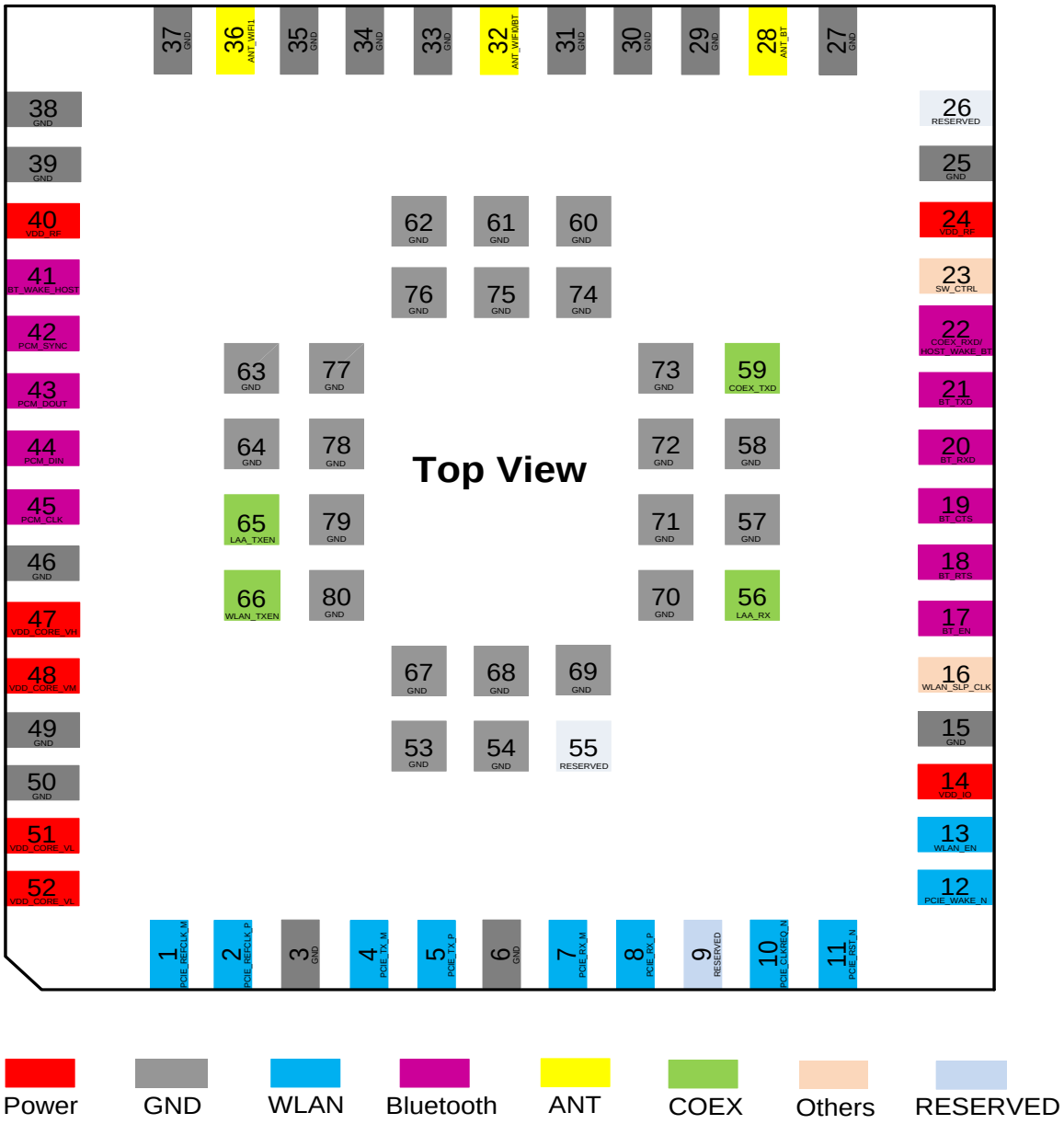



**Figure 1: Pin Assignment (Top View)**

**NOTE**

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

## 3.3. Pin Description

**Table 2: I/O Parameter Definition**

| Type | Description |
|---|---|
| AI | Analog Input |
| AIO | Analog Input/Output |
| AO | Analog /Output |
| DI | Digital Input |
| DO | Digital Output |
| PI | Power Input |

**Table 3: Pin Description**

| **Power Supply** | | | | | |
|---|---|---|---|---|---|
| **Pin Name** | **Pin No.** | **I/O** | **Description** | **DC Characteristics** | **Comment** |
| VDD_CORE_VL | 51, 52 | PI | Provides 0.95 V for the module's main chip | Vmin = 0.9 V<br>Vnom = 0.95 V<br>Vmax = 1.05 V | It must be provided with sufficient current up to 1 A. |
| VDD_CORE_VM | 48 | PI | Provides 1.35 V for the module's main chip | Vmin = 1.3 V<br>Vnom = 1.35 V<br>Vmax = 2.1 V | It must be provided with sufficient current up to 0.4 A. |
| VDD_CORE_VH | 47 | PI | Provides 1.95 V for the module's main chip | Vmin = 1.85 V<br>Vnom = 1.95 V<br>Vmax = 2.1 V | It must be provided with sufficient current up to 0.4 A. |
| VDD_IO | 14 | PI | Provides 1.8 V for the module's I/O pins | Vmin = 1.71 V<br>Vnom = 1.8 V<br>Vmax = 1.89 V | It must be provided with sufficient current up to 0.05 A. |
| VDD_RF | 24, 40 | PI | Provides 2.2 V for RF circuit | Vmin = 1.9 V<br>Vnom = 2.2 V<br>Vmax = 2.4 V | It must be provided with sufficient current up to 2.0 A. |
| GND | 3, 6, 15, 25, 27, 29–31, 33–35, 37–39, 46, 49, 50, 53, 54, 57, 58, 60–64, 67–80 | | | | |
| **Wi-Fi Application Interfaces** | | | | | |

| Pin Name | Pin No. | I/O | Description | DC Characteristics | Comment |
|---|---|---|---|---|---|
| WLAN_EN | 13 | DI | Power up/down internal regulators used by WLAN section | VDD_IO | Active high.<br>Keep it connected. |
| PCIE_REFCLK_M | 1 | AI | PCIe reference clock (-) | | Require differential impedance of 85 Ω. |
| PCIE_REFCLK_P | 2 | AI | PCIe reference clock (+) | | |
| PCIE_TX_M | 4 | AO | PCIe transmit (-) | | |
| PCIE_TX_P | 5 | AO | PCIe transmit (+) | | |
| PCIE_RX_M | 7 | AI | PCIe receive (-) | | |
| PCIE_RX_P | 8 | AI | PCIe receive (+) | | |
| PCIE_CLKREQ_N | 10 | DO | PCIe clock request | VDD_IO | Active low. |
| PCIE_RST_N | 11 | DI | PCIe reset | | |
| PCIE_WAKE_N | 12 | DO | PCIe wake up | | |
| **Bluetooth Application Interfaces** | | | | | |
| **Pin Name** | **Pin No.** | **I/O** | **Description** | **DC Characteristics** | **Comment** |
| BT_EN | 17 | DI | Power up/down internal regulators used by Bluetooth section | VDD_IO | Active high.<br>Pull it down with a 10 kΩ resistor when Bluetooth function is not used. |
| PCM_DIN | 44 | DI | PCM data input | | If unused, keep them open. |
| PCM_SYNC | 42 | DI | PCM data frame sync | | |
| PCM_CLK | 45 | DI | PCM clock | | |
| PCM_DOUT | 43 | DO | PCM data output | | Do not pull it down when Bluetooth is booting. |
| BT_RTS | 18 | DO | Request to send signal from the module | | If unused, keep them open. |

| | | | | | |
|---|---|---|---|---|---|
| BT_CTS | 19 | DI | Clear to send signal to the module | | |
| BT_RXD | 20 | DI | Bluetooth UART receive | | |
| BT_TXD | 21 | DO | Bluetooth UART transmit | | |
| BT_WAKE_HOST | 41 | DO | Bluetooth wakes up host | | |
| COEX_RXD/ HOST_WAKE_BT | 22 | DI | Host wakes up Bluetooth | | |
| **RF Antenna Interfaces** | | | | | |
| **Pin Name** | **Pin No.** | **I/O** | **Description** | **DC Characteristics** | **Comment** |
| ANT_WIFI0 | 32 | AIO | Wi-Fi 0 antenna interface | | 50 Ω characteristic impedance. |
| ANT_WIFI1 | 36 | AIO | Wi-Fi 1 antenna interface | | |
| ANT_BT [2] | 28 | AIO | Bluetooth antenna interface | | |
| **Other Interfaces** | | | | | |
| **Pin Name** | **Pin No.** | **I/O** | **Description** | **DC Characteristics** | **Comment** |
| WLAN_SLP_CLK | 16 | DI | WLAN sleep clock | VDD_IO | Pull it down with a 10 kΩ resistor when it is not used. |
| SW_CTRL | 23 | DO | VDD_RF switch control | | Active high. If unused, keep it open. |
| **Coexistence Interfaces** | | | | | |
| **Pin Name** | **Pin No.** | **I/O** | **Description** | **DC Characteristics** | **Comment** |
| COEX_RXD/ HOST_WAKE_BT | 22 | DI | LTE & Wi-Fi/ Bluetooth coexistence receive | VDD_IO | If unused, keep them open. |

| | | | |
|---|---|---|---|
| COEX_TXD | 59 | DO | LTE & Wi-Fi/ Bluetooth coexistence transmit |
| LAA_TXEN | 65 | DI | If it is at high level, the module puts the 5 GHz receiver in a protected state. |
| WLAN_TXEN | 66 | DO | Module pulls it high when 5 GHz is set to transmit at power greater than 10 dBm. |
| LAA_RX | 56 | DI | If it is at high level, module allows LAA to receive through the Wi-Fi antennas. |

| **RESERVED Pin** | | |
|---|---|---|
| **Pin Name** | **Pin No.** | **Comment** |
| RESERVED | 9, 26, 55 | Keep them open. |

## 3.4. Power Supply

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

**Table 4: Definition of Power Supply and GND Pins**

| Pin Name | Pin No. | Description | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| VDD_CORE_VL | 51, 52 | Provides 0.95 V for the module's main chip | 0.9 | 0.95 | 1.05 | V |
| VDD_CORE_VM | 48 | Provides 1.35 V for the module's main chip | 1.3 | 1.35 | 2.1 | V |
| VDD_CORE_VH | 47 | Provides 1.95 V for the module's main chip | 1.85 | 1.95 | 2.1 | V |
| VDD_IO | 14 | Provides 1.8 V for the module's I/O pins | 1.71 | 1.8 | 1.89 | V |

| | | | | | | |
|---|---|---|---|---|---|---|
| VDD_RF | 24, 40 | Provides 2.2 V for RF circuit | 1.9 | 2.2 | 2.4 | V |
| GND | 3, 6, 15, 25, 27, 29–31, 33–35, 37–39, 46, 49, 50, 53, 54, 57, 58, 60–64, 67–80 | | | | | |

The power-on and power-off timings are illustrated in the following figure.

All input power supplies must be ON and available no later than that the WLAN_EN/BT_EN is asserted. There is no requirement for the timings between input power supplies. For more details about reference design of power supply, see ***document [2]***.

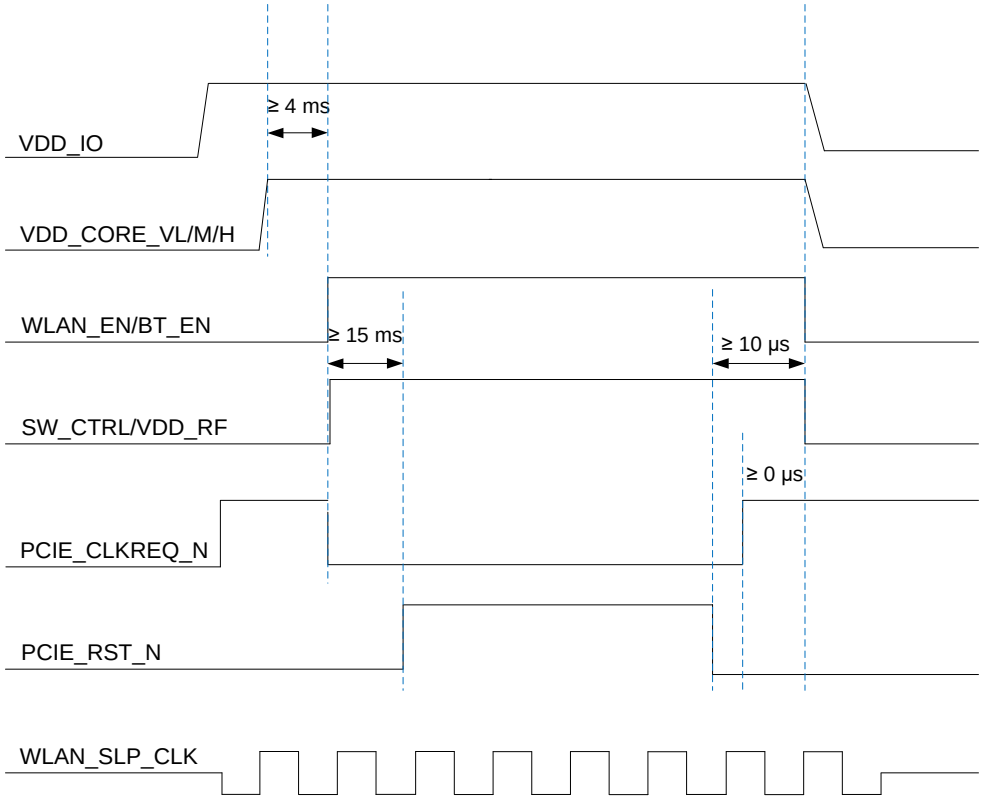



**Figure 2: Power-on and Power-off Timings**

## 3.5. Wi-Fi Application Interfaces

Wi-Fi application interface connection between the module and the host is illustrated in the figure below.

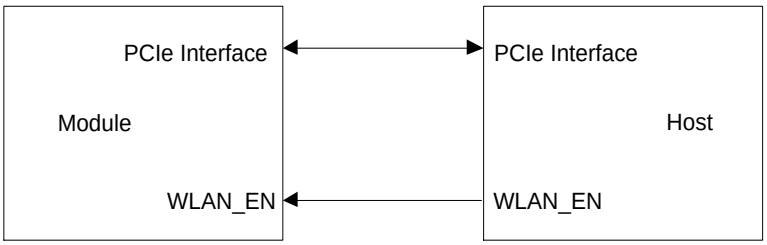



**Figure 3: Block Diagram of Wi-Fi Application Interfaces**

### 3.5.1. WLAN_EN

Used to power up or power down the internal regulators used by the WLAN section. When this pin is high, the regulators are enabled and the WLAN section is out of reset. When this pin is low the WLAN section is in reset.

**Table 5: Pin Definition of WLAN_EN**

| Pin Name | Pin No. | I/O | Description | Comment |
|---|---|---|---|---|
| WLAN_EN | 13 | DI | Power up/down internal regulators used by WLAN section | Active high.<br>Keep it connected. |

### 3.5.2. PCIe Interface

The module supports a PCIe interface with key features listed below:

- *PCI Express Base Specification Revision 3.0* compliant.
- Date rate up to 8 Gbps/lane.
- Can be used to connect to a host as a Wi-Fi function interface.

**Table 6: Pin Definition of PCIe Interface**

| Pin Name | Pin No. | I/O | Description | Comment |
|---|---|---|---|---|
| PCIE_REFCLK_M | 1 | AI | PCIe reference clock (-) | Require differential |

| | | | | |
|---|---|---|---|---|
| PCIE_REFCLK_P | 2 | AI | PCIe reference clock (+) | impedance of 85 Ω. |
| PCIE_TX_M | 4 | AO | PCIe transmit (-) | |
| PCIE_TX_P | 5 | AO | PCIe transmit (+) | |
| PCIE_RX_M | 7 | AI | PCIe receive (-) | |
| PCIE_RX_P | 8 | AI | PCIe receive (+) | |
| PCIE_CLKREQ_N | 10 | DO | PCIe clock request | |
| PCIE_RST_N | 11 | DI | PCIe reset | Active low. |
| PCIE_WAKE_N | 12 | DO | PCIe wake up | |

PCIe interface connection between the module and the host is illustrated in the figure below.

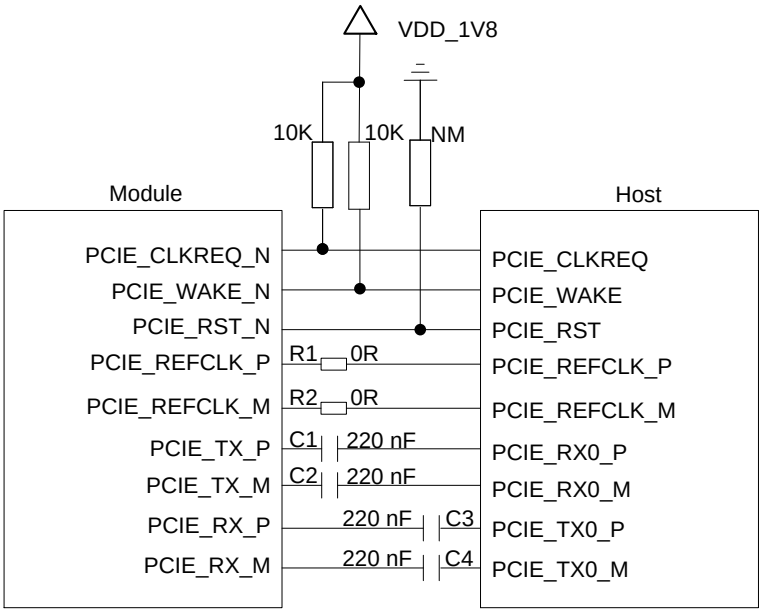



**Figure 4: Reference Design of PCIe Interface**

To ensure signal integrity of PCIe interface, C1 and C2 should be placed close to the module, and C3 and C4 should be placed close to the host. Extra stubs must be as short as possible.

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

- It is important to route PCIE_TX_P/M, PCIE_RX_P/M, and PCIE_REFCLK_P/M as differential pairs surrounded with ground. Differential impedance should be 85 Ω ±10 %.
- Maximum trace length of each differential pair (PCIE_TX_P/M, PCIE_RX_P/M, and

PCIE_REFCLK_P/M) should not exceed 200 mm, and length mismatch of each differential pair should not exceed 0.5 mm.

- Space between PCIe signals and all other signals should be four times the trace width.
- Do not route signal traces under crystals, oscillators, magnetic devices, or RF signal traces. It is important to route the PCIe differential traces in the inner layer of the PCB and surround the traces with ground on that layer and with ground planes above and below.

## 3.6. Bluetooth Application Interfaces

Bluetooth application interface connection between the module and the host is illustrated in the figure below.

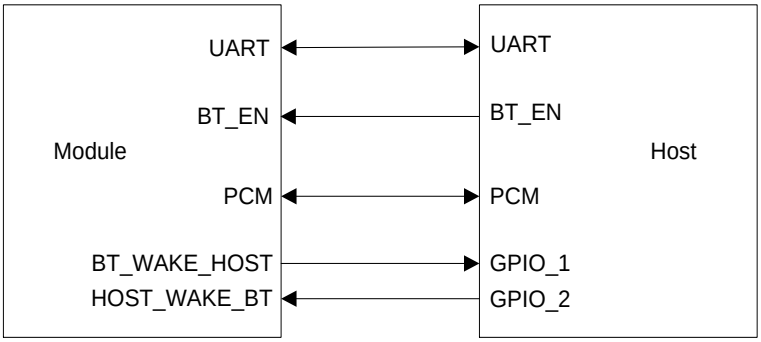



**Figure 5: Block Diagram of Bluetooth Application Interfaces**

**NOTE**

The GPIO_1 connected to BT_WAKE_HOST must be interruptible.

### 3.6.1. BT_EN

Used to power up or power down the internal regulators used by the BT section. Low asserting reset for Bluetooth. This pin has no effect on WLAN and must be driven high or low (not left floating). If Bluetooth function is not needed, pull BT_EN down with a 10 kΩ resistor.

**Table 7: Pin Definition of BT_EN**

| Pin Name | Pin No. | I/O | Description | Comment |
|---|---|---|---|---|
| BT_EN | 17 | DI | Power up/down internal regulators | Active high.<br>Pull it down with a 10 kΩ resistor when |

| | | |
|---|---|---|
| | used by Bluetooth section | Bluetooth function is not used. |

### 3.6.2. UART

The module supports an HCI UART as defined in *Bluetooth Core Specification Version 4.0*. The UART supports hardware flow control, and it is used for data transmission with the host. It supports baud rates up to 3.2 Mbps.

**Table 8: Pin Definition of UART**

| Pin Name | Pin No. | I/O | Description | Comment |
|---|---|---|---|---|
| BT_RTS | 18 | DO | Request to send signal from the module | If unused, keep them open. |
| BT_CTS | 19 | DI | Clear to send signal to the module | |
| BT_TXD | 21 | DO | Bluetooth UART transmit | |
| BT_RXD | 20 | DI | Bluetooth UART receive | |

### 3.6.3. BT_WAKE_HOST and HOST_WAKE_BT

BT_WAKE_HOST wakes up the host and HOST_WAKE_BT wakes up the module.

**Table 9: Pin Definition of BT_WAKE_HOST and HOST_WAKE_BT**

| Pin Name | Pin No. | I/O | Description | Comment |
|---|---|---|---|---|
| BT_WAKE_HOST | 41 | DO | Bluetooth wakes up host | If unused, keep them open. |
| HOST_WAKE_BT | 22 | DI | Host wakes up Bluetooth | |

### 3.6.4. PCM Interface

The PCM interface is used for Bluetooth audio. Pin definition of PCM interface is provided in the table below.

**Table 10: Pin Definition of PCM Interface**

| Pin Name | Pin No. | I/O | Description | Comment |
|---|---|---|---|---|
| PCM_DIN | 44 | DI | PCM data input | If unused, keep them open. |
| PCM_SYNC | 42 | DI | PCM data frame sync | |
| PCM_CLK | 45 | DI | PCM clock | |
| PCM_DOUT | 43 | DO | PCM data output | Do not pull it down when Bluetooth is booting. |

PCM interface connection between the module and the host is illustrated in the figure below.

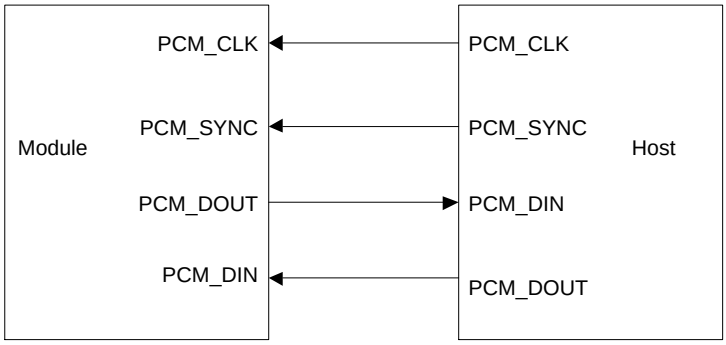



**Figure 6: Block Diagram of PCM Interface**

## 3.7. Coexistence Interfaces

The module supports 2.4 GHz and 5 GHz LTE/Wi-Fi & Bluetooth coexistence.

Pin definition of coexistence interfaces is provided in the following table.

**Table 11: Pin Definition of Coexistence Interfaces**

| Pin Name | Pin No. | I/O | Description | Comment |
|---|---|---|---|---|
| COEX_RXD/ HOST_WAKE_BT | 22 | DI | LTE & Wi-Fi/Bluetooth coexistence receive | If unused, keep them open. |
| COEX_TXD | 59 | DO | LTE & Wi-Fi/Bluetooth coexistence transmit | |
| LAA_TXEN | 65 | DI | If it is at high level, the module | |

| | | | |
|---|---|---|---|
| | | | puts the 5 GHz receiver in a protected state. |
| WLAN_TXEN | 66 | DO | Module pulls it high when 5 GHz is set to transmit at power greater than 10 dBm. |
| LAA_RX | 56 | DI | If it is at high level, module allows LAA to receive through the Wi-Fi antennas. |

## 3.8. Other Interfaces

### 3.8.1. WLAN_SLP_CLK

The WLAN_SLP_CLK (32.768 kHz clock) is used in low-power modes, such as IEEE power saving mode and sleep mode. It serves as a timer in various power saving schemes, and can maintain basic logic operations when the module is in sleep mode.

**Table 12: Pin Definition of WLAN_SLP_CLK**

| Pin Name | Pin No. | I/O | Description | Comment |
|---|---|---|---|---|
| WLAN_SLP_CLK | 16 | DI | WLAN sleep clock | Pull it down with a 10 kΩ resistor when it is not used. |

Figure and table below show the sleep clock requirements.

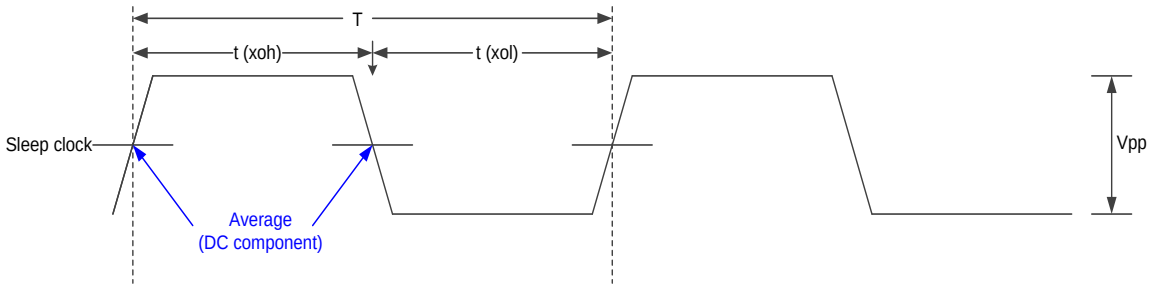



**Figure 7: Requirements of WLAN_SLP_CLK**

**Table 13: Parameters of WLAN_SLP_CLK**

| Parameter | Description | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| t (xoh) | Sleep-clock logic high | 4.58 | 4.58 | 25.94 | μs |
| t (xol) | Sleep-clock logic low | 4.58 | 4.58 | 25.94 | μs |
| T | Sleep-clock period | - | 30.5208 | - | μs |
| F | Sleep-clock frequency (F = 1/T) | - | 32.7645 | - | kHz |
| Vpp | Peak-to-peak voltage | - | 1.8 | - | V |

### 3.8.2. SW_CTRL

SW_CTRL can be used to control external VDD_RF power supply chip. Pin definition of SW_CTRL is presented in the following table.

**Table 14: Pin Definition of SW_CTRL**

| Pin Name | Pin No. | I/O | Description | Comment |
|---|---|---|---|---|
| SW_CTRL | 23 | DO | VDD_RF switch control | Active high.<br>If unused, keep it open. |

## 3.9. RF Antenna Interfaces

**Table 15: Pin Definition of RF Antenna Interfaces**

| Pin Name | Pin No. | I/O | Description | Comment |
|---|---|---|---|---|
| ANT_WIFI0 | 32 | AIO | Wi-Fi 0 antenna interface | 50 Ω characteristic impedance. |
| ANT_WIFI1 | 36 | AIO | Wi-Fi 1 antenna interface | |
| ANT_BT [3] | 28 | AIO | Bluetooth antenna interface | |

### 3.9.1. Operating Frequencies

**Table 16: Operating Frequencies of the Module (Unit: GHz)**

| Mode | Frequency |
|---|---|
| 2.4 GHz Wi-Fi | 2.400–2.4835 |
| 5 GHz Wi-Fi | 5.150–5.850 |
| Bluetooth | 2.400–2.4835 |

### 3.9.2. RF Antenna Reference Design

The module supports maximally three RF antenna interfaces for antenna connection. An example reference design with ANT_WIFI0, which applies to other RF antenna interfaces as well, is illustrated in the following figure.

It is recommended to reserve a π-type matching circuit for better RF performance. π-type matching components (C1, C2, R1) should be placed as close to the antenna as possible. C1 and C2 are not mounted by default.

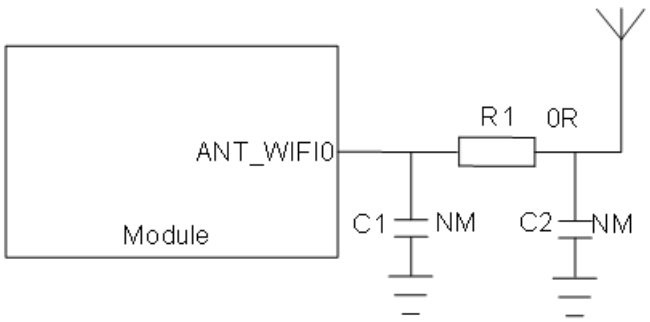



**Figure 8: RF Antenna Reference Design**

### 3.9.3. RF Routing Guidelines

For user's PCB, The characteristic impedance of all RF traces should be controlled to 50 Ω. The impedance of the RF traces is usually determined by the trace width (W), the materials' dielectric constant, the height from the reference ground to the signal layer (H), and the spacing between RF traces and ground (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.

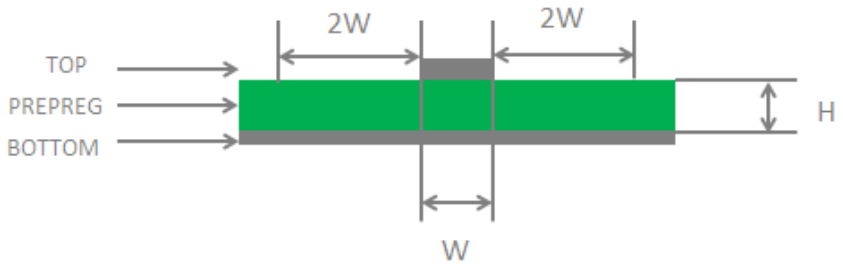



**Figure 9: Microstrip Design on a 2-layer PCB**

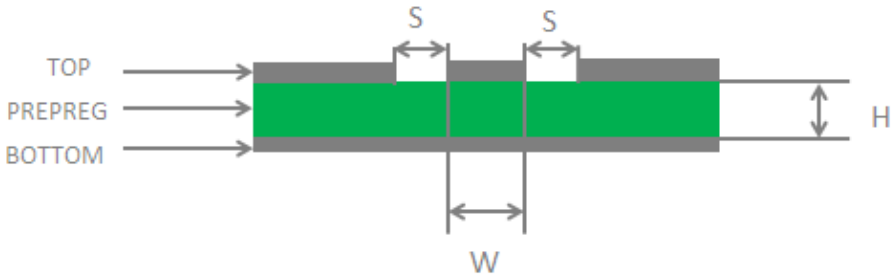



**Figure 10: Coplanar Waveguide Design on a 2-layer PCB**

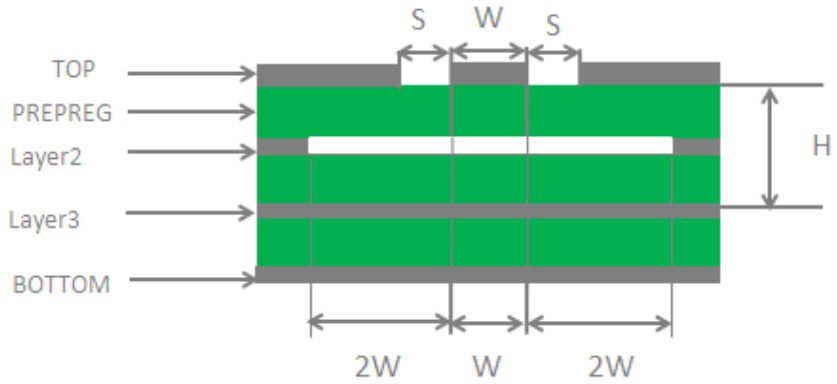



**Figure 11: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)**

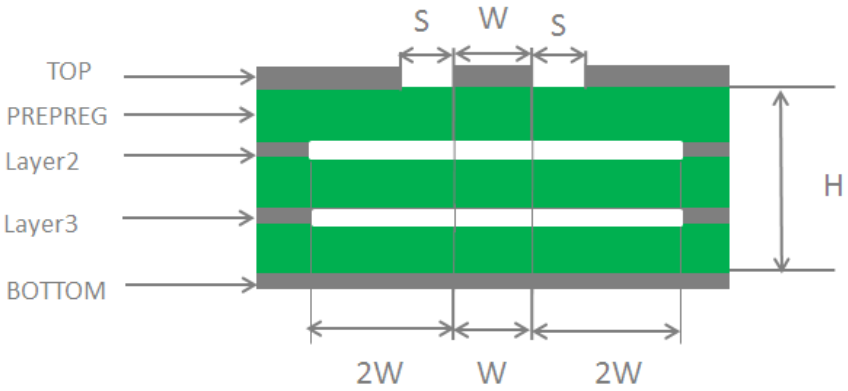



**Figure 12: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)**

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 twice the width of RF signal traces (2 × W).
- Keep RF traces away from interference sources, and avoid intersection and paralleling between traces on adjacent layers.

For more details about RF layout, see ***document [3]***.

### 3.9.4. Antenna Design Requirements

Antenna design requirements are provided in the following table.

**Table 17: Antenna Design Requirements**

| Parameter | Requirement |
|---|---|
| Frequency Ranges (GHz) | • 2.400–2.4835<br>• 5.150–5.850 |
| Cable insertion loss (dB) | < 1 |

| | |
|---|---|
| VSWR | ≤ 2 |
| Gain (dBi) | WIFI 2.4G:≤0.73,WIFI 5G:≤1.14 |
| Max. Input Power (W) | 50 |
| Input Impedance (Ω) | 50 |
| Polarization Type | Vertical |

- Note: The antenna connector will be fixed in the actual use of the finished product and cannot be replaced.

### 3.9.5. 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.

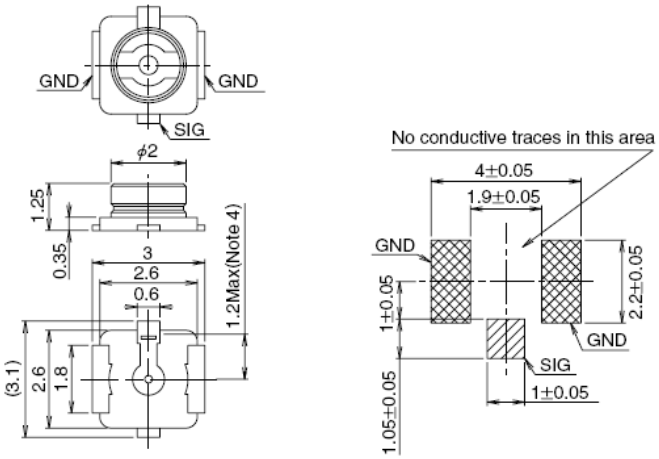



**Figure 13: Receptacle Dimensions (Unit: mm)**

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

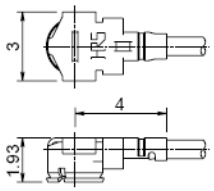
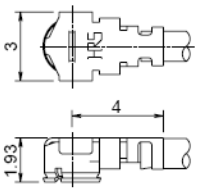
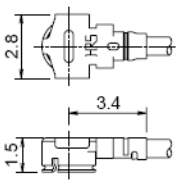
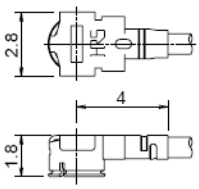
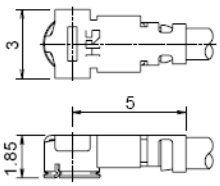
| Part No. | U.FL-LP-040 | U.FL-LP-066 | U.FL-LP(V)-040 | U.FL-LP-062 | U.FL-LP-088 |
|---|---|---|---|---|---|
| |  |  |  |  |  |
| Mated Height | 2.5mm Max.<br>(2.4mm Nom.) | 2.5mm Max.<br>(2.4mm Nom.) | 2.0mm Max.<br>(1.9mm Nom.) | 2.4mm Max.<br>(2.3mm Nom.) | 2.4mm Max.<br>(2.3mm Nom.) |
| Applicable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

**Figure 14: Specifications of Mated Plugs**

The following figure describes the space factor of mated connectors.

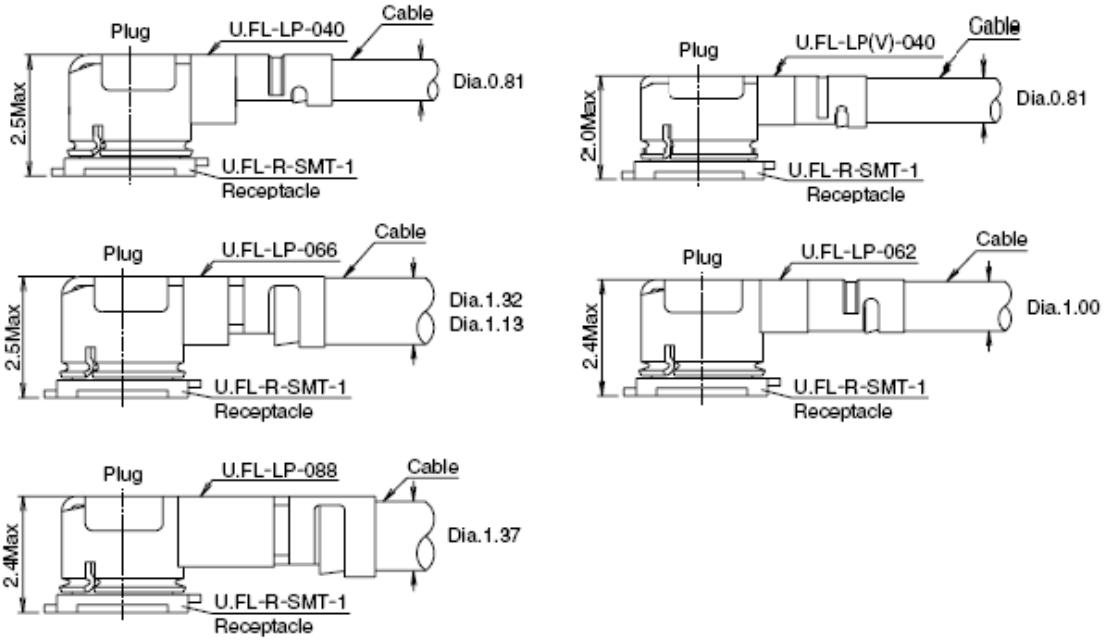



**Figure 15: Space Factor of Mated Connectors (Unit: mm)**

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

# 4 Electrical Characteristics & Reliability

## 4.1. Absolute Maximum Ratings

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

**Table 18: Absolute Maximum Ratings (Unit: V)**

| Parameter | Min. | Max. |
|---|---|---|
| VDD_CORE_VL | -0.3 | $V_{DDX}$ + 0.2 |
| VDD_CORE_VM | -0.3 | $V_{DDX}$ + 0.2 |
| VDD_CORE_VH | -0.3 | $V_{DDX}$ + 0.2 |
| VDD_IO | -0.3 | $V_{DDX}$ + 0.2 |
| VDD_RF | -0.3 | $V_{DDX}$ + 0.2 |
| I/O pins input voltage | -0.3 | VDD_IO + 0.2 |

**NOTE**

$V_{DDX}$ is the external supply voltage for the corresponding power input pins.

## 4.2. Power Supply Ratings

**Table 19: Module Power Supply Ratings (Unit: V)**

| Parameter | Min. | Typ. | Max. |
|---|---|---|---|
| VDD_CORE_VL | 0.9 | 0.95 | 1.05 |
| VDD_CORE_VM | 1.3 | 1.35 | 2.1 |
| VDD_CORE_VH | 1.85 | 1.95 | 2.1 |
| VDD_IO | 1.71 | 1.8 | 1.89 |
| VDD_RF | 1.9 | 2.2 | 2.4 |

## 4.3. Digital I/O Characteristics

**Table 20: VDD_IO I/O Requirements (Unit: V)**

| Symbol | Parameter | Min. | Max. |
|---|---|---|---|
| $V_{IH}$ | High-level input voltage | 0.65 × VDD_IO | VDD_IO + 0.3 |
| $V_{IL}$ | Low-level input voltage | -0.3 | 0.35 × VDD_IO |
| $V_{OH}$ | High-level output voltage | VDD_IO - 0.45 | VDD_IO |
| $V_{OL}$ | Low-level output voltage | 0 | 0.45 |

## 4.4. Operating and Storage Temperatures

**Table 21: Operating and Storage Temperatures (Unit: ºC)**

| Parameter | Min. | Typ. | Max. |
|---|---|---|---|
| Operating Temperature Range [4] | -30 | 25 | +75 |
| Storage Temperature Range | -40 | - | +85 |

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

## 4.5. Power Consumption

**Table 22: Power Consumption in Non-signaling Mode (Unit: mA)**

| Description | Condition | VDD_CORE_VL (0.95 V) | VDD_CORE_VM (1.35 V) | VDD_CORE_VH (1.95 V) | VDD_IO (1.8 V) | VDD_RF (2.2 V) |
|---|---|---|---|---|---|---|
| 2 × 2 | 2.4 GHz 802.11n HT20 @ MCS 0 | 386.73 | 173.39 | 123.84 | 2.92 | 717.42 |
| | 2.4 GHz 802.11n HT40 @ MCS 7 | 394.78 | 179.08 | 118.99 | 2.83 | 606.19 |
| | 2.4 GHz 802.11ax HE40 @ MCS 11 | 390.55 | 185.37 | 117.55 | 2.9 | 554.28 |
| | 5 GHz 802.11n HT20 @ MCS 0 | 402.2 | 260.99 | 143.97 | 2.84 | 663.39 |
| | 5 GHz 802.11ac VHT40 @ MCS 9 | 439.5 | 264.94 | 141.83 | 2.91 | 552.6 |
| | 5 GHz 802.11ax HE80 @ MCS 11 | 583.84 | 268.09 | 151.57 | 2.95 | 540.68 |
| | 5 GHz 802.11ax HE80 @ MCS 0 | 563.83 | 273.32 | 153.62 | 2.91 | 630.2 |
| 2 × 2 + 2 × 2 | 802.11n HT20 @ MCS 0 | 417.56 | 303.69 | 222.21 | 2.92 | 1336 |
| | 802.11n HT40 @ MCS 0 | 526.4 | 316.91 | 218.83 | 2.91 | 1087 |
| | 802.11n HT20 @ MCS 0 + 802.11ac VHT20 @ MCS 0 | 424.04 | 306.3 | 223.24 | 2.91 | 1342 |
| | 802.11n HT40 @ MCS 7 + 802.11ac VHT80 MCS 9 | 672.59 | 319.42 | 218.2 | 2.9 | 1127 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 802.11ax HE20 @ MCS 0 | 429.49 | 311.57 | 232.78 | 2.91 | 1355 |
| | 802.11ax 2.4 GHz HE40 @ MCS 11 + 5 GHz HE80 @ MCS 11 | 674.75 | 324.69 | 228.4 | 2.92 | 1111 |

## 4.6. RF Performances

### 4.6.1. Wi-Fi Performances

**Table 23: Tx Power at 2.4 GHz (Without 2.4 GHz Wi-Fi & LTE Coexistence Filter)**

| Standard | Typ. (dBm) | Tolerance (dB) |
|---|---|---|
| 802.11b @ 1 Mbps | 17 | ±2 |
| 802.11b @ 11 Mbps | 17 | ±2 |
| 802.11g @ 6 Mbps | 16 | ±2 |
| 802.11g @ 54 Mbps | 14.5 | ±2 |
| 802.11n, HT20 @ MCS 0 | 16 | ±2 |
| 802.11n, HT20 @ MCS 7 | 13.5 | ±2 |
| 802.11n, HT40 @ MCS 0 | 15.5 | ±2 |
| 802.11n, HT40 @ MCS 7 | 13 | ±2 |
| 802.11ax, HE20 @ MCS 0 | 16 | ±2 |
| 802.11ax, HE20 @ MCS 11 | 11 | ±2 |
| 802.11ax, HE40 @ MCS 0 | 15.5 | ±2 |
| 802.11ax, HE40 @ MCS 11 | 10 | ±2 |

**Table 24: Tx Power at 2.4 GHz (With 2.4 GHz Wi-Fi/LTE Coexistence Filter)**

| Standard | Typ. (dBm) | Tolerance (dB) |
|---|---|---|
| 802.11b @ 1 Mbps | 16 | ±2 |
| 802.11b @ 11 Mbps | 16 | ±2 |
| 802.11g @ 6 Mbps | 15 | ±2 |
| 802.11g @ 54 Mbps | 13 | ±2 |
| 802.11n, HT20 @ MCS 0 | 15 | ±2 |

| | | |
|---|---|---|
| 802.11n, HT20 @ MCS 7 | 12.5 | ±2 |
| 802.11n, HT40 @ MCS 0 | 14.5 | ±2 |
| 802.11n, HT40 @ MCS 7 | 11.5 | ±2 |
| 802.11ax, HE20 @ MCS 0 | 15 | ±2 |
| 802.11ax, HE20 @ MCS 11 | 11 | ±2 |
| 802.11ax, HE40 @ MCS 0 | 14 | ±2 |
| 802.11ax, HE40 @ MCS 11 | 10 | ±2 |

**Table 25: Tx Power at 5 GHz**

| Standard | Typ. (dBm) | Tolerance (dB) |
|---|---|---|
| 802.11a @ 6 Mbps | 15 | ±2 |
| 802.11a @ 54 Mbps | 13 | ±2 |
| 802.11n, HT20 @ MCS 0 | 15 | ±2 |
| 802.11n, HT20 @ MCS 7 | 12 | ±2 |
| 802.11n, HT40 @ MCS 0 | 14.5 | ±2 |
| 802.11n, HT40 @ MCS 7 | 11.5 | ±2 |
| 802.11ac, VHT20 @ MCS 0 | 15 | ±2 |
| 802.11ac, VHT20 @ MCS 8 | 11.5 | ±2 |
| 802.11ac, VHT40 @ MCS 0 | 14.5 | ±2 |
| 802.11ac, VHT40 @ MCS 9 | 10.5 | ±2 |
| 802.11ac, VHT80 @ MCS 0 | 14 | ±2 |
| 802.11ac, VHT80 @ MCS 9 | 10 | ±2 |
| 802.11ax, HE20 @ MCS 0 | 15 | ±2 |
| 802.11ax, HE20 @ MCS 11 | 9.5 | ±2 |
| 802.11ax, HE40 @ MCS 0 | 14 | ±2 |

| | | |
|---|---|---|
| 802.11ax, HE40 @ MCS 11 | 9.5 | ±2 |
| 802.11ax, HE80 @ MCS 0 | 14 | ±2 |
| 802.11ax, HE80 @ MCS 11 | 8.5 | ±2 |

**Table 26: Rx Sensitivity at 2.4 GHz (Without 2.4 GHz Wi-Fi/LTE Coexistence Filter)**

| Standard | Typ. (dBm) | Tolerance (dB) |
|---|---|---|
| 802.11b @ 1 Mbps | -96 | ±2 |
| 802.11b @ 11 Mbps | -87 | ±2 |
| 802.11g @ 6 Mbps | -92 | ±2 |
| 802.11g @ 54 Mbps | -74 | ±2 |
| 802.11n, HT20 @ MCS 0 | -91 | ±2 |
| 802.11n, HT20 @ MCS 7 | -72 | ±2 |
| 802.11n, HT40 @ MCS 0 | -89 | ±2 |
| 802.11n, HT40 @ MCS 7 | -67 | ±2 |
| 802.11ax, HE20 @ MCS 0 | -92 | ±2 |
| 802.11ax, HE20 @ MCS 11 | -62 | ±2 |
| 802.11ax, HE40 @ MCS 0 | -89 | ±2 |
| 802.11ax, HE40 @ MCS 11 | -59 | ±2 |

**Table 27: Rx Sensitivity at 2.4 GHz (With 2.4 GHz Wi-Fi/LTE Coexistence Filter)**

| Standard | Typ. (dBm) | Tolerance (dB) |
|---|---|---|
| 802.11b @ 1 Mbps | -96 | ±2 |
| 802.11b @ 11 Mbps | -87 | ±2 |
| 802.11g @ 6 Mbps | -90 | ±2 |
| 802.11g @ 54 Mbps | -72 | ±2 |

| | | |
|---|---|---|
| 802.11n, HT20 @ MCS 0 | -88 | ±2 |
| 802.11n, HT20 @ MCS 7 | -70 | ±2 |
| 802.11n, HT40 @ MCS 0 | -86 | ±2 |
| 802.11n, HT40 @ MCS 7 | -67 | ±2 |
| 802.11ax, HE20 @ MCS 0 | -90 | ±2 |
| 802.11ax, HE20 @ MCS 11 | -60 | ±2 |
| 802.11ax, HE40 @ MCS 0 | -86 | ±2 |
| 802.11ax, HE40 @ MCS 11 | -58 | ±2 |

**Table 28: Rx Sensitivity at 5 GHz (Unit: dBm)**

| Standard | Typ. (dBm) | Tolerance (dB) |
|---|---|---|
| 802.11a @ 6 Mbps | -90 | ±2 |
| 802.11a @ 54 Mbps | -72 | ±2 |
| 802.11n, HT20 @ MCS 0 | -89 | ±2 |
| 802.11n, HT20 @ MCS 7 | -70 | ±2 |
| 802.11n, HT40 @ MCS 0 | -87 | ±2 |
| 802.11n, HT40 @ MCS 7 | -68 | ±2 |
| 802.11ac, VHT20 @ MCS 0 | -89 | ±2 |
| 802.11ac, VHT20 @ MCS 8 | -66 | ±2 |
| 802.11ac, VHT40 @ MCS 0 | -87 | ±2 |
| 802.11ac, VHT40 @ MCS 9 | -63 | ±2 |
| 802.11ac, VHT80 @ MCS 0 | -84 | ±2 |
| 802.11ac, VHT80 @ MCS 9 | -57 | ±2 |
| 802.11ax, HE20 @ MCS 0 | -90 | ±2 |
| 802.11ax, HE20 @ MCS 11 | -60 | ±2 |

| | | |
|---|---|---|
| 802.11ax, HE40 @ MCS 0 | -87 | ±2 |
| 802.11ax, HE40 @ MCS 11 | -58 | ±2 |
| 802.11ax, HE80 @ MCS 0 | -84 | ±2 |
| 802.11ax, HE80 @ MCS 11 | -55 | ±2 |

### 4.6.2. Bluetooth Performances

**Table 29: Tx Power**

| Description | Typ. (dBm) | Tolerance (dB) |
|---|---|---|
| GFSK | 7 | ±2 |
| π/4-DQPSK | 4 | ±2 |
| 8-DQPSK | 4 | ±2 |
| BLE (1 Mbps) | 7 | ±2 |
| BLE (2 Mbps) | 7 | ±2 |

**Table 30: Rx Sensitivity**

| Description | Typ. (dBm) | Tolerance (dB) |
|---|---|---|
| GFSK | -92 | ±2 |
| π/4-DQPSK | -90 | ±2 |
| 8-DQPSK | -85 | ±2 |
| BLE (1 Mbps) | -95 | ±2 |
| BLE (2 Mbps) | -93 | ±2 |

## 4.7. ESD Protection

Static electricity occurs naturally and may damage the module. Therefore, applying proper ESD countermeasures and handling methods is imperative. For example, wear anti-static gloves during the

development, production, assembly and testing of the module; add ESD protection components to the ESD sensitive interfaces and points in the product design.

**Table 31: ESD Characteristics (Temperature: 25–30 ºC, Humidity: 40 ±5 %, Unit: kV)**

| Tested Interfaces | Contact Discharge | Air Discharge |
|---|---|---|
| Antenna Interfaces | ±4 | ±6 |
| Other Interfaces | ±0.5 | ±1 |

## 4.8. Thermal Dissipation [5]

The module offers the best performance when all internal IC chips are working within their operating temperatures. When the IC chip reaches or exceeds the maximum junction temperature, the module may still work but the performance and functions (such as RF output power, data rate, etc.) will be affected to a certain extent. Therefore, the thermal design should be maximally optimized to ensure all internal IC chips always work within the recommended operating temperature range. For applications that use the AP mode, it is recommended to take heat dissipation structure.

The following principles for thermal consideration are provided for reference:

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

[5] Thermal dissipation is necessary for module in AP mode.

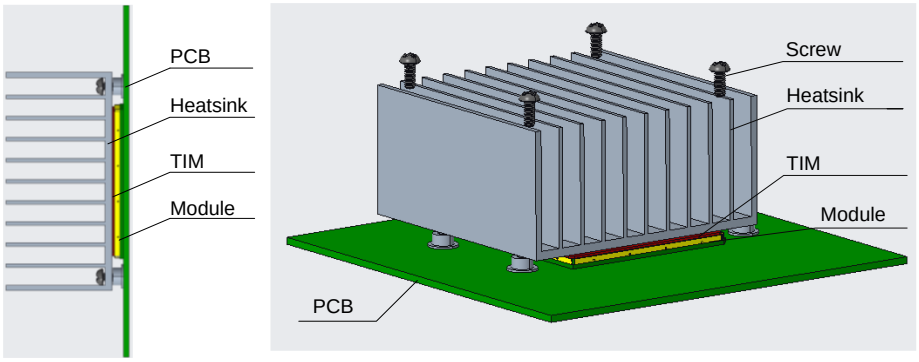



**Figure 16: Placement and Fixing of the Heatsink**

# 5 Mechanical Information

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

## 5.1. Mechanical Dimensions

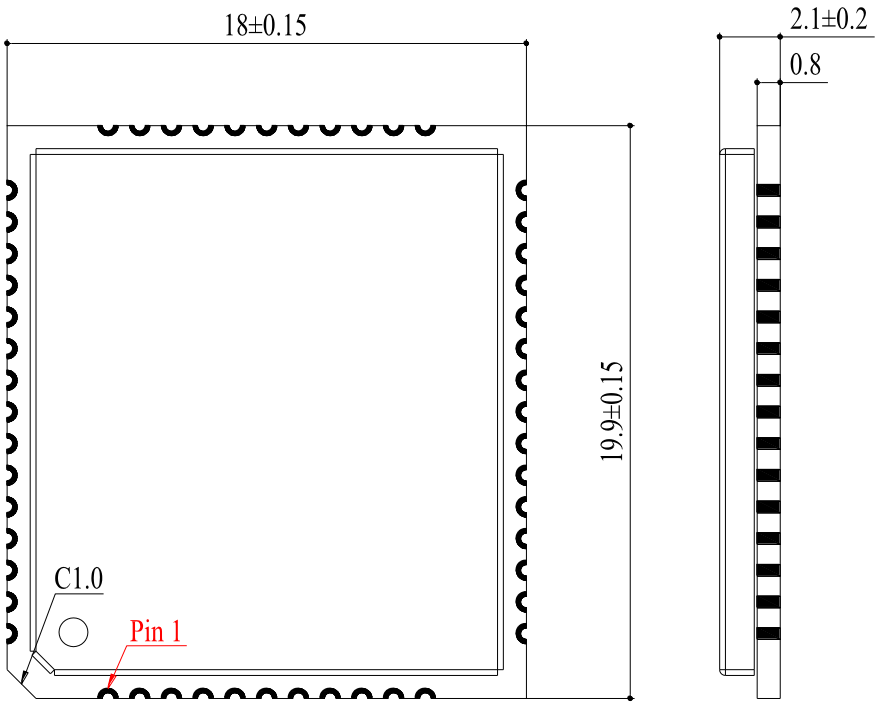



**Figure 17: Top and Side Dimensions**

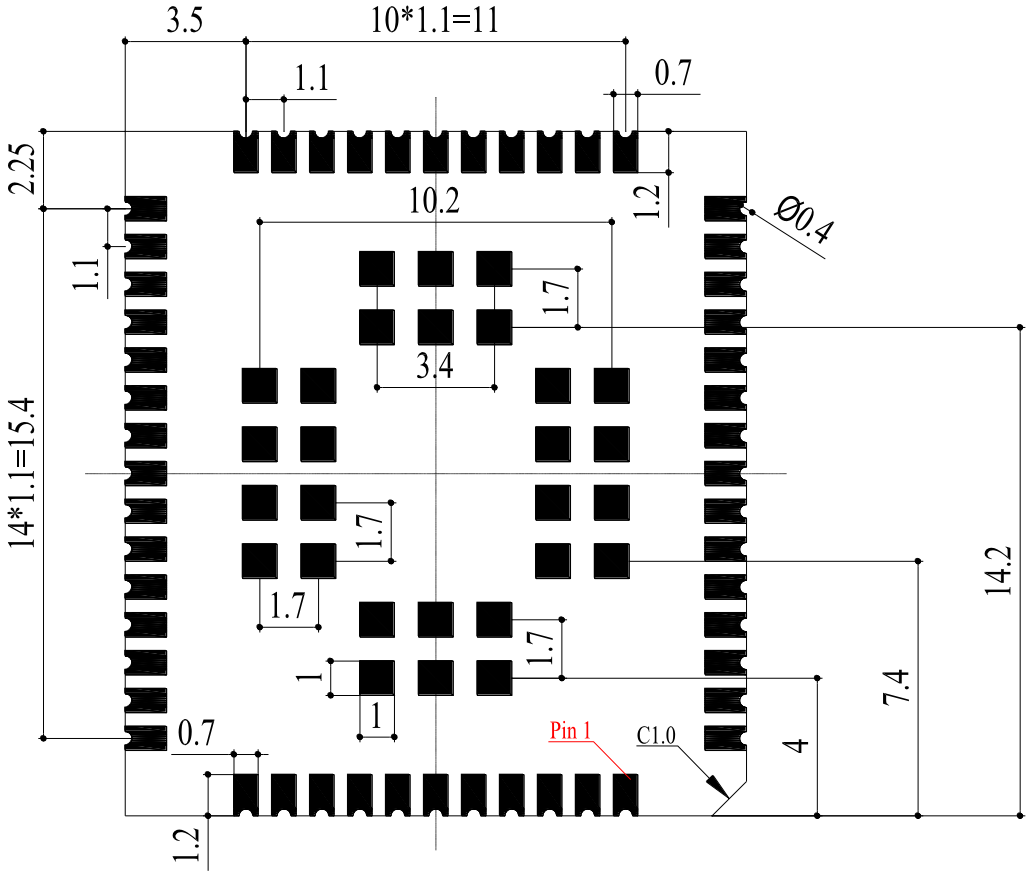



**Figure 18: Bottom Dimensions (Bottom View)**

**NOTE**

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

## 5.2. Recommended Footprint

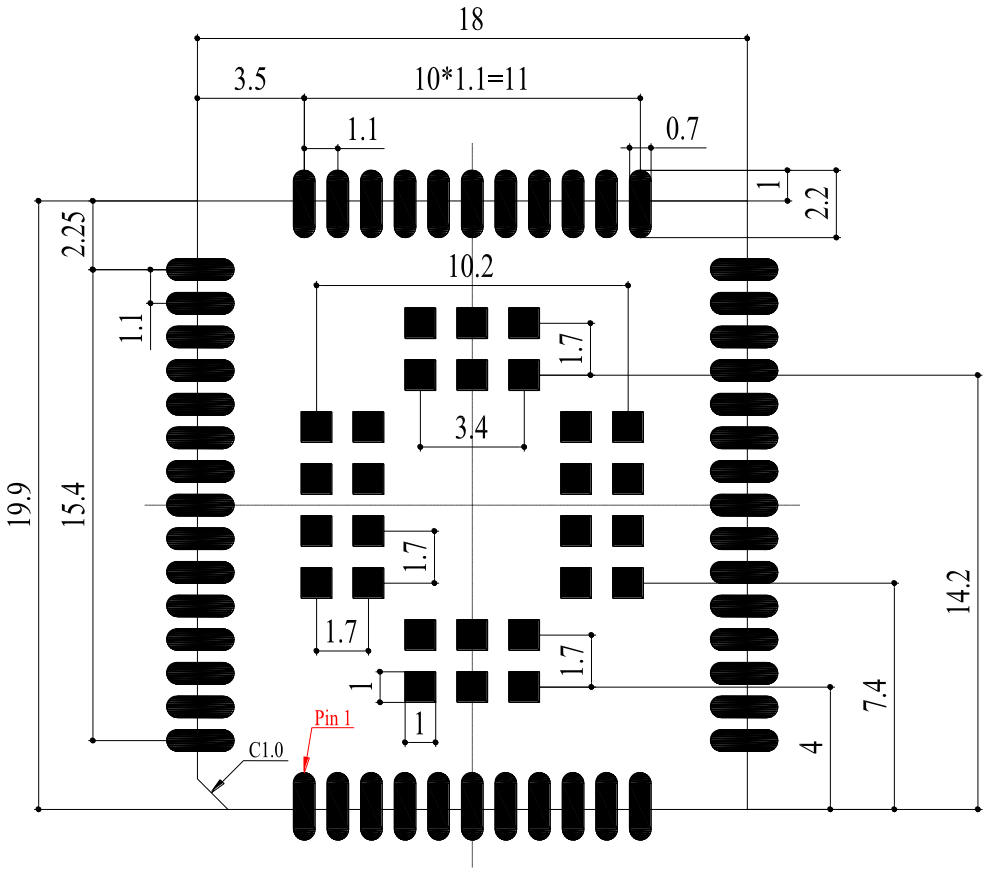



**Figure 19: Recommended Footprint**

**NOTE**

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

## 5.3. Top and Bottom Views

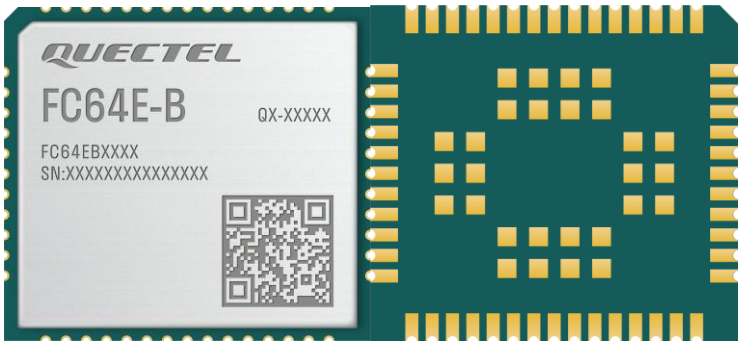



**Figure 20: FC64E-B Top and Bottom Views**

**NOTE**

Images above are for illustrative purposes only and may differ from the actual module. For authentic appearance and label, please refer to the module received from Quectel.

# 6 Storage, Manufacturing and 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 [6] 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 drying 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.

**NOTE**

[6] 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.

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 [4]***.

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.

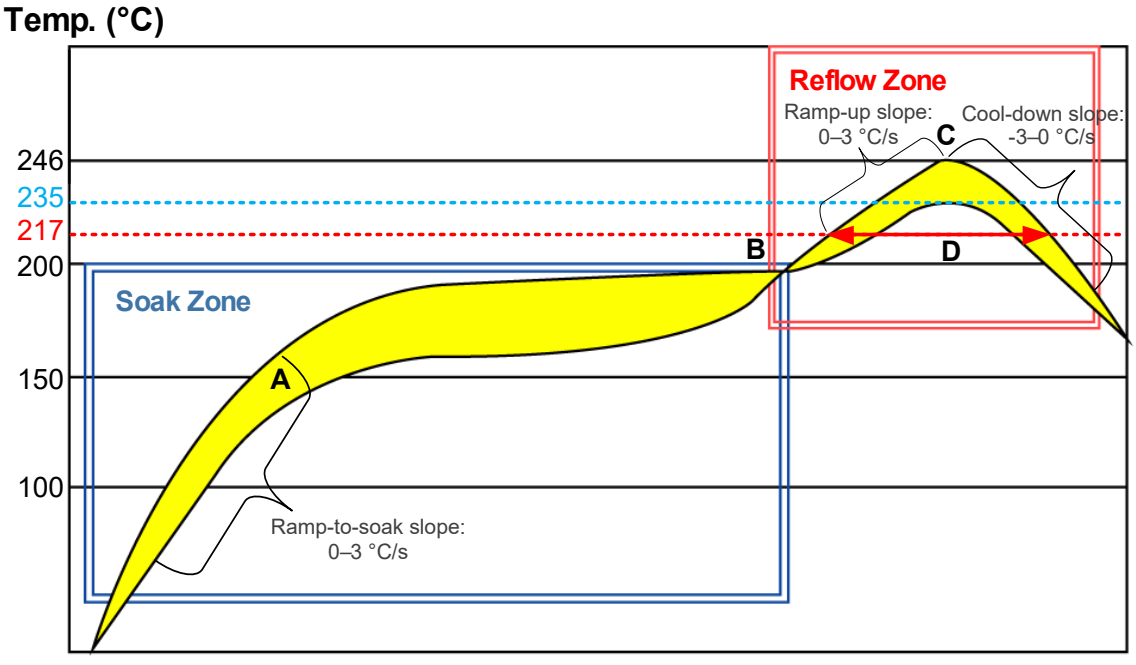



**Figure 21: Recommended Reflow Soldering Thermal Profile**

**Table 32: Recommended Thermal Profile Parameters**

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

**NOTE**

1. The above profile parameter requirements are for the measured temperature of the solder joints. Both the hottest and coldest spots of solder joints on the PCB should meet the above requirements.
2. During manufacturing and soldering, or any other processes that may contact the module directly, NEVER wipe the module's shielding can with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol, trichloroethylene, etc., Otherwise, the shielding canmay become rusted.
3. The shielding can for the module is made of Cupro-Nickel base material. It is tested that after 12 hours' Neutral Salt Spray test, the laser engraved label information on the shielding can is still clearly identifiable and the QR code is still readable, although white rust may be found.
4. If a conformal coating is necessary for the module, do NOT use any coating material that may chemically react with the PCB or shielding cover, and prevent the coating material from flowing into the module.
5. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.
6. Due to the complexity of the SMT process, please contact Quectel Technical Support in advance for any situation that you are not sure about, or any process (e.g. selective soldering, ultrasonic soldering) that is not mentioned in ***document [4]***.

## 6.3. Packaging Specifications

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

### 6.3.1. Carrier Tape

Carrier tape dimensions are detailed below:

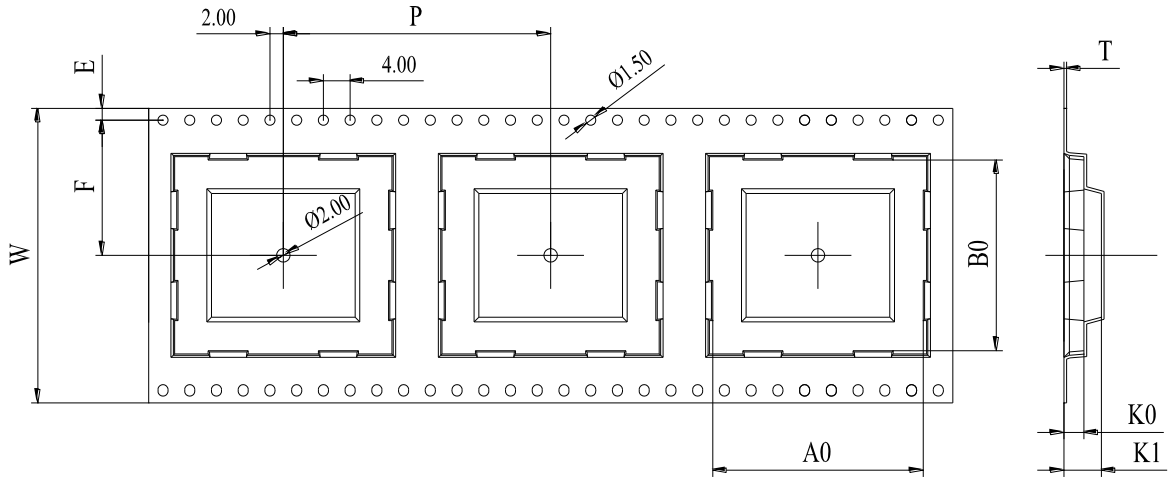



**Figure 22: Carrier Tape Specifications**

**Table 33: Carrier Tape Dimension Table (Unit: mm)**

| W | P | T | A0 | B0 | K0 | K1 | F | E |
|---|---|---|---|---|---|---|---|---|
| 44 | 32 | 0.4 | 20.4 | 18.5 | 2.6 | 6.8 | 20.2 | 1.75 |

### 6.3.2. Plastic Reel

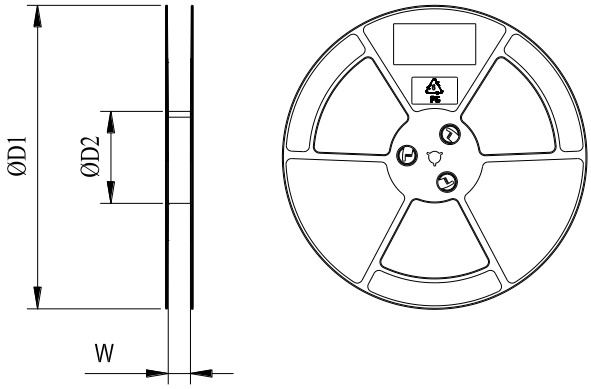



**Figure 23: Plastic Reel Specifications**

**Table 34: Plastic Reel Dimension Table (Unit: mm)**

| øD1 | øD2 | W |
|---|---|---|
| 330 | 100 | 44.5 |

### 6.3.3. Mounting Direction

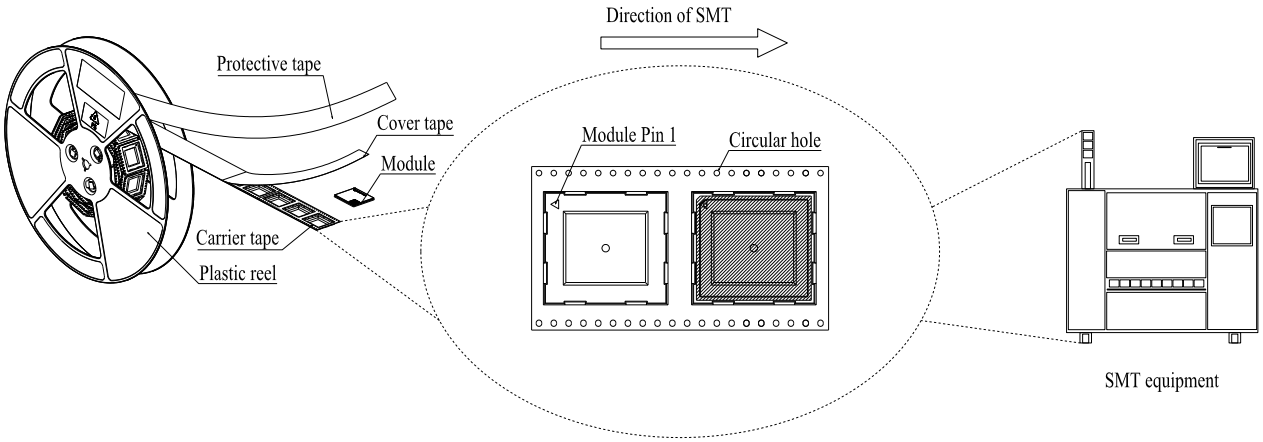
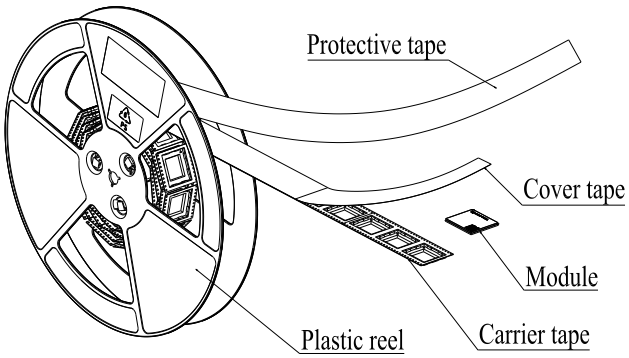


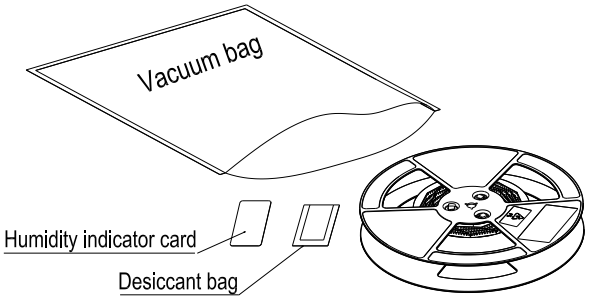

**Figure 24: Mounting Direction**

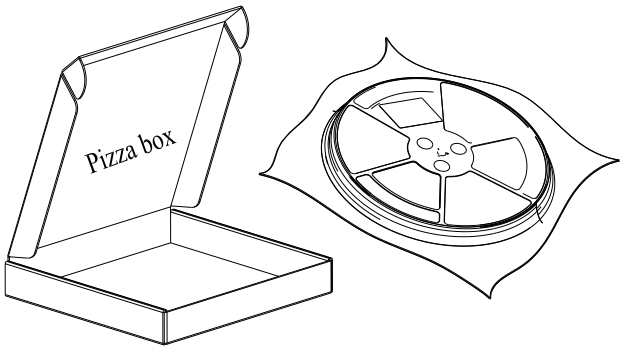
### 6.3.4. Packaging Process




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 250 modules.

Place the packaged plastic reel, 1 humidity indicator card and 1 desiccant bag into a vacuum bag, vacuumize it.




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

Put 4 pizza boxes into 1 carton and seal it. 1 carton can pack 1000 modules.

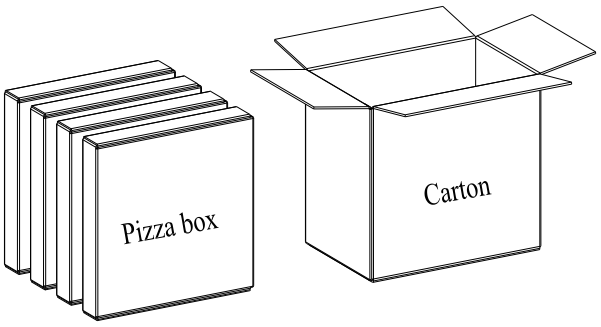



**Figure 25: Packaging Process**

# 7 Appendix References

**Table 35: Related Documents**

| Document Name |
|---|
| [1] Quectel_FC6xE_M.2_EVB_User_Guide |
| [2] Quectel_FC6xE_Reference_Design |
| [3] Quectel_RF_Layout_Application_Note |
| [4] Quectel_Module_SMT_Application_Note |

**Table 36: Terms and Abbreviations**

| Abbreviation | Description |
|---|---|
| AFH | Adaptive Frequency Hopping |
| AP | Access Point |
| BPSK | Binary Phase Shift Keying |
| BLE | Bluetooth Low Energy |
| CCK | Complementary Code Keying |
| DBPSK | Differential Binary Phase Shift Keying |
| DBS | Dual Band Simultaneous |
| DQPSK | Differential Quadrature Phase Shift Keying |
| ESD | Electrostatic Discharge |
| EVB | Evaluation Board |
| GFSK | Gauss frequency Shift Keying |

| | |
|---|---|
| GND | Ground |
| HCI | Host Controller Interface |
| HE | High Efficiency |
| HT | High Throughput |
| IEEE | Institute of Electrical and Electronics Engineers |
| I/O | Input/Output |
| LAA | License Assisted Access |
| LCC | Leadless chip carrier |
| LGA | Land Grid Array |
| LTE | Long Term Evolution |
| MAC | Medium Access Control |
| Mbps | Megabits per second |
| MCS | Modulation and Coding Scheme |
| MSL | Moisture Sensitivity Levels |
| MU-MIMO | Multi-User Multiple-Input Multiple-Output |
| PA | Power Amplifier |
| PCB | Printed Circuit Board |
| PCIe | Peripheral Component Interconnect Express |
| PCM | Pulse Code Modulation |
| QAM | Quadrature Amplitude Modulation |
| QPSK | Quadrature Phase Shift Keying |
| RF | Radio Frequency |
| RoHS | Restriction of Hazardous Substances |
| Rx | Receive |
| SMT | Surface Mount Technology |

| | |
|---|---|
| STA | Station |
| Tx | Transmit |
| UART | Universal Asynchronous Receiver/Transmitter |
| VHT | Very High Throughput |
| $V_{IH}$ | High-level Input Voltage |
| $V_{IL}$ | Low-level Input Voltage |
| Vmax | Maximum Voltage |
| Vmin | Minimum Voltage |
| Vnom | Nominal Voltage |
| $V_{OH}$ | High-level Output Voltage |
| $V_{OL}$ | Low-level Output 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 time-averaging duty factor, antenna gain and cable loss must satisfy MPE categorical Exclusion Requirements of 2.1091.
2. The EUT is a mobile device; maintain at least a 20 cm separation between the EUT and the user's body and must not transmit simultaneously with any other antenna or transmitter.
3.A label with the following statements must be attached to the host end product: This device contains FCC ID: XMR2023FC64EB.
4.To comply with FCC regulations limiting both maximum RF output power and human exposure to RF radiation, maximum antenna gain (including cable loss) must not exceed:

- Bluetooth/Bluetooth LE/Wi-Fi 2.4G:≤0.73dBi
- Wi-Fi 5G:≤1.14 dBi

5. This module must not transmit simultaneously with any other antenna or transmitter
6. The host end product must include a user manual that clearly defines operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.
For portable devices, in addition to the conditions 3 through 6 described above, a separate approval is required to satisfy the SAR requirements of FCC Part 2.1093
If the device is used for other equipment that separate approval is required for all other operating configurations, including portable configurations with respect to 2.1093 and different antenna configurations.
For this device, OEM integrators must be provided with labeling instructions of finished products. Please refer to KDB784748 D01 v07, section 8. Page 6/7 last two paragraphs:
A certified modular has the option to use a permanently affixed label, or an electronic label. For a permanently affixed label, the module must be labeled with an FCC ID - Section 2.926 (see 2.2 Certification (labeling requirements) above). The OEM manual must provide clear instructions explaining to the OEM the labeling requirements, options and OEM user manual instructions that are required (see next paragraph).
For a host using a certified modular with a standard fixed label, if (1) the module's FCC ID is not visible when installed in the host, or (2) if the host is marketed so that end users do not have straightforward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module: "Contains Transmitter Module FCC ID: XMR2023FC64EB." or "Contains FCC ID: XMR2023FC64EB." must be used. The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.
The final host / module combination may also need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.
The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user

that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. In cases where the manual is provided only in a form other than paper, such as on a computer disk or over the Internet, the information required by this section may be included in the manual in that alternative form, provided the user can reasonably be expected to have the capability to access information in that form.
This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.
Changes or modifications not expressly approved by the manufacturer could void the user’s authority to operate the equipment.
IC Certification Requirements.

This device contains licence-exempt transmitteris)/receivers) that comply with Innovation, Science and EconomicDevelopment Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:
1. This device may not cause interference.
2. This device must accept any interference, including interference that may cause undesired operation of the device.

To comply with IC regulations limiting both maximum RF output power and human exposure to RF radiation, maximum antenna gain (including cable loss) must not exceed:
❒ Bluetooth/Bluetooth LE/Wi-Fi 2.4G:≤0.73 dBi
❒ Wi-Fi 5G:≤1.14 dBi

L'appareil contient un émetteur / récepteur exempté de licence conforme au CNR exempté de licence d'innovation, sciences et développement économique Canada. Les opérations sont soumises aux deux conditions suivantes:

1. Cet appareil peut ne pas causer d'interférence.

L'appareil doit accepter toute interférence, y compris celles qui peuvent entraîner un fonctionnement indésirable de l'appareil.

This equipment complies with ISED radiation exposure limits set forth for an uncontrolled environment. To comply with RSS-102 RF Exposure compliance requirements, this grant is applicable to only Mobile Configurations. The antennas used for the transmitter must be installed to provide a separation distance of at least 20cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

The user manual for LE-LAN devices shall contain instructions related to the restrictions mentioned in the abovesections, namely that:
i. the device for operation in the band 5150-5250 MHz is only for indoor use to reduce the potential for harmfulinterference 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 antennals), the maximum antenna gain permitted for devices in the band5725-5850 MHz shall be such that the equipment still complies with the e.i.r.p. limits as appropriate;
iv. where applicable, antenna type(s), antenna models(s), and worst-case tilt angle(s) necessary to remain compliantwith the e.iro. elevation mask reauirement set forth in section 6.2.2.3 shall be clearly indicated.

The host product shall be properly labelled to identify the modules within the host product.
The Innovation, Science and Economic Development Canada certification label of a module shall be clearly visible at all times when installed in the host product; otherwise, the host product must be labeled to display the Innovation, Science and Economic Development Canada certification number for the module, preceded by the word “Contains” or similar wording expressing the same meaning, as follows: “Contains IC: 10224A-2023FC64EB” or “where: 10224A-2023FC64EB is the module’s certification number”.