AF67E

Hardware Design

Automotive Wi-Fi&Bluetooth Module Series

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	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
-	2023-09-01	Barret XIONG/ Starry CHEN/ Morris XIAO	Creation of the document
1.0.0	2023-09-01	Barret XIONG/ Starry CHEN/ Morris XIAO	Preliminary

Contents

Table Index

Figure Index

1 Introduction

This document describes the AF67E features, performance, and air interfaces and hardware interfaces connected to your applications. The document provides a quick insight into interface specifications, RF performance, electrical and mechanical specifications, and other module information, ae well.

2 Product Overview

AF67E is an automotive grade Wi-Fi and Bluetooth module with low power consumption. It is compliant with IEEE 802.11a/b/g/n/ac/ax and Bluetooth 5.3 standard, which enables seamless integration of Wi-Fi and Bluetooth Low Energy technologies. It supports 2.4 GHz and 5 GHz Wi-Fi and 2T2R with maximum data transmission rate up to 2.1 Gbps. It supports a low-power PCIe Gen 3 interface for Wi-Fi functions, a UART and a PCM interface for Bluetooth functions, and it also supports LTE & Wi-Fi/Bluetooth coexistence interface.

It is an SMD module with compact packaging. Related information is listed in the table below:

Table 1: Basic Information

AF67E	
Packaging type	LGA
Pin counts	112
Dimensions	(23.0 ±0.2) mm × (23.0 ±0.2) mm × (3.0 ±0.2) mm
Weight	TBD

2.1. Key Features

Table 2: Key Features

Category	Description
Supply Voltages	**VDD_CORE_VL:** ● 0.9–1.2 V ● Typ.: 0.95 V **VDD_CORE_VM:** ● 1.30–1.42 V ● Typ.: 1.35 V **VDD_CORE_VH:** ● 1.85–2.0 V ● Typ.: 1.9 V **VDD_PA:** ● 1.71–2.1 V ● Typ.: 1.8 V **VDD_IO:** ● 1.71–1.89 V ● Typ.: 1.8 V
Operating Frequencies	**Wi-Fi:** ● 2.4 GHz: 2.400–2.484 GHz ● 5 GHz: 5.150–5.850 GHz **Bluetooth:** ● 2.400–2.484 GHz
Wi-Fi Data Rates	● 802.11b: 1 Mbps, 2 Mbps, 5.5 Mbps, 11 Mbps ● 802.11a/g: 6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps, 24 Mbps, 36 Mbps, 48 Mbps, 54 Mbps ● 802.11n: HT20 (MCS 0–7), HT40 (MCS 0–7) ● 802.11ac: VHT20 (MCS 0–8), VHT40 (MCS 0–9), VHT80 (MCS 0–9) ● 802.11ax: HE20 (MCS 0–13), HE40 (MCS 0–13), HE80 (MCS 0–13)
Wi-Fi Transmitting Power	**2.4 GHz：** ● 802.11b @ 11 Mbps: TBD ±3.5 dBm ● 802.11g @ 54 Mbps: TBD ±3.5 dBm ● 802.11n @ HT20 MCS 7: TBD ±3.5 dBm ● 802.11n @ HT40 MCS 7: TBD ±3.5 dBm ● 802.11ax @ HE20 MCS 11: TBD ±3.5 dBm ● 802.11ax @ HE20 MCS 13: TBD ±3.5 dBm ● 802.11ax @ HE40 MCS 11: TBD ±3.5 dBm ● 802.11ax @ HE40 MCS 13: TBD ±3.5 dBm

	5 GHz： ● 802.11a @ 54 Mbps: TBD ±3.5 dBm ● 802.11n @ HT20 MCS 7: TBD ±3.5 dBm ● 802.11n @ HT40 MCS 7: TBD ±3.5 dBm ● 802.11ac @ VHT20 MCS 8: TBD ±3.5 dBm ● 802.11ac @ VHT40 MCS 9: TBD ±3.5 dBm ● 802.11ac @ VHT80 MCS 9: TBD ±3.5 dBm ● 802.11ax @ HE20 MCS 11: TBD ±3.5 dBm ● 802.11ax @ HE20 MCS 13: TBD ±3.5 dBm ● 802.11ax @ HE40 MCS 11: TBD ±3.5 dBm ● 802.11ax @ HE40 MCS 13: TBD ±3.5 dBm ● 802.11ax @ HE80 MCS 11: TBD ±3.5 dBm ● 802.11ax @ HE80 MCS 13: TBD ±3.5 dBm
Wi-Fi Protocol Features	The module complies with IEEE 802.11a/b/g/n/ac/ax protocol
Wi-Fi Modulations	BPSK, QPSK, CCK, 16QAM, 64QAM, 256QAM,1024QAM,4096QAM
Wi-Fi Operating Modes	AP and STA
Bluetooth Protocol Features	The module complies with GATT, SPP, and HFP-AG protocols
Bluetooth Modulations	GFSK, 8-DPSK and π/4-DQPSK
Bluetooth Operating Modes	● Bluetooth Classic (BR + EDR) ● Bluetooth Low Energy (BLE)
Wireless Application Interfaces	● PCIe Gen 3 interface: for Wi-Fi applications ● UART and PCM interfaces: for Bluetooth applications
WLAN_SLP_CLK	32.768 kHz clock interface: for low power consumption mode
Antenna Interfaces	● Wi-Fi & Bluetooth antenna interfaces ● 50 Ω characteristic impedance
Temperature Ranges	● Operating Temperature Range [1]: -40 °C to +85 °C ● Storage Temperature Range: -40 °C to +90 °C
RoHS	All hardware components are fully compliant with EU RoHS directive

[1] Within this range, the module's indicators comply with IEEE and Bluetooth specification requirements.

2.2. Functional Diagram

The functional diagram illustrates the following major functional parts:

- Power management
- Baseband part
- Radio frequency part
- Peripheral interfaces

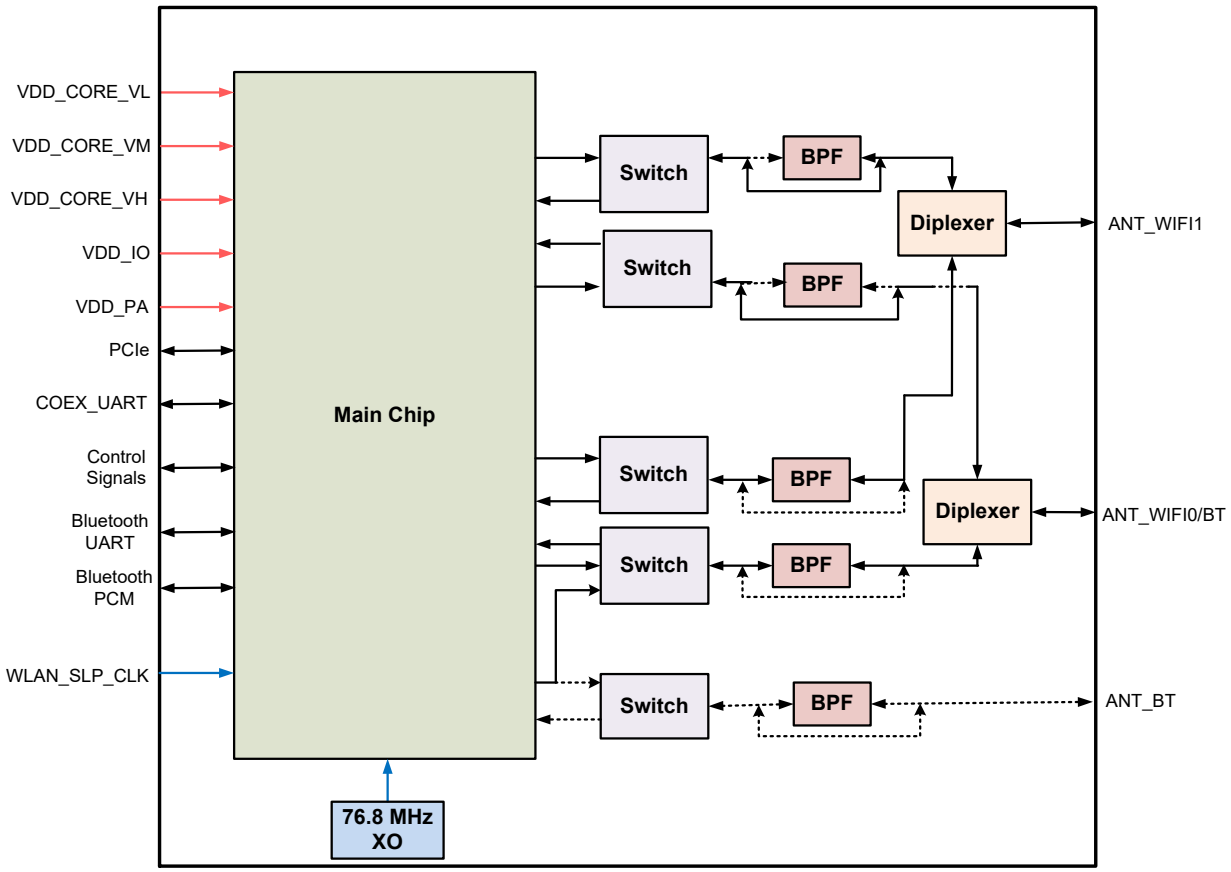


Figure 1: Functional Diagram

2.3. Pin Assignment

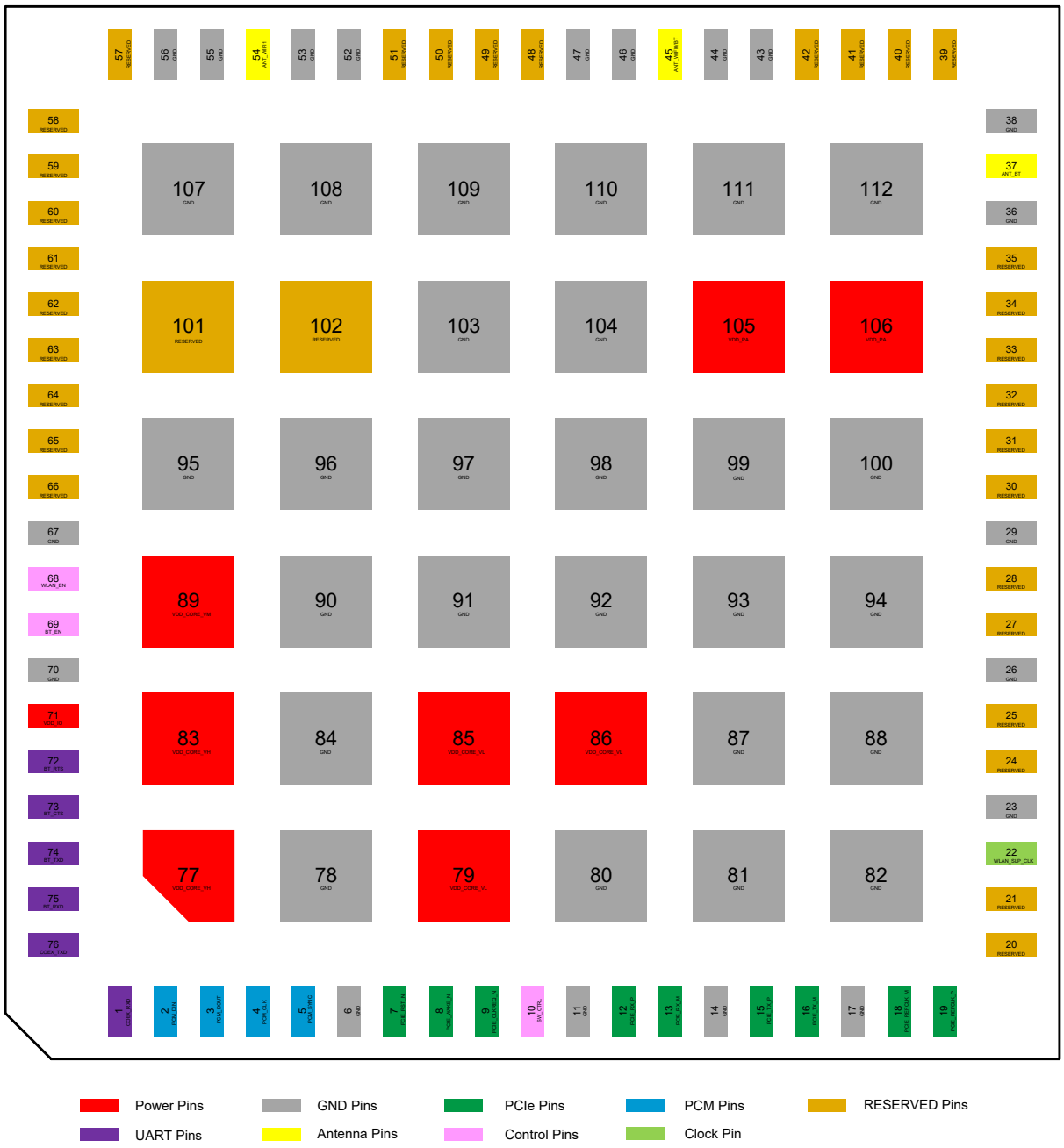


Figure 2: Pin Assignment (Top View)

NOTE

Keep all RESERVED pins and unused pins unconnected.

2.4. Pin Description

Table 3: Parameter Definition

Parameter	Description
AI	Analog Input
AO	Analog Output
AIO	Analog Input/Output
DI	Digital Input
DO	Digital Output
PI	Power Input

DC characteristics include power domain and rate current in the table below.

Table 4: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VDD_CORE_VL	79, 85, 86	PI	Voltage for core, low voltage	Vmin = 0.9 V Vnom = 0.95 V Vmax = 1.2 V	It must be provided with sufficient current up to 1175 mA.
VDD_CORE_VM	89	PI	Voltage for core, medium voltage	Vmin = 1.30 V Vnom = 1.35 V Vmax = 1.42 V	It must be provided with sufficient current up to 440 mA.
VDD_CORE_VH	77, 83	PI	Voltage for core, high voltage	Vmin = 1.85 V Vnom = 1.9 V Vmax = 2.0 V	It must be provided with sufficient current up to 245 mA.
VDD_IO	71	PI	Power supply for the module's I/O pins	Vmin = 1.71 V Vnom = 1.8 V	It must be provided with

				Vmax = 1.89 V	sufficient current up to 50 mA.
VDD_PA	105, 106	PI	Power supply for the module's RF part	Vmin = 1.71 V Vnom = 1.8 V Vmax = 2.1 V	It must be provided with sufficient current up to 2400 mA.
GND	6, 11, 14, 17, 23, 26, 29, 36, 38, 43, 44, 46, 47, 52, 53, 55, 56, 67, 70, 78, 80–82, 84, 87, 88, 90–100, 103, 104, 107–112				
Bluetooth Application Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PCM_DIN	2	DI	PCM data input	VDD_IO	
PCM_SYNC	5	DI	PCM data frame sync		
PCM_CLK	4	DI	PCM clock		
PCM_DOUT	3	DO	PCM data output		
BT_TXD	74	DO	Bluetooth UART transmit		
BT_RXD	75	DI	Bluetooth UART receive		
BT_RTS	72	DO	Request to send signal from the module		
BT_CTS	73	DI	Clear to send signal to the module		
Wi-Fi Application Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PCIE_REFCLK_P	19	AI	PCIe reference clock (+)		Require differential impedance of 85 Ω.
PCIE_REFCLK_M	18	AI	PCIe reference clock (-)		
PCIE_TX_P	15	AO	PCIe transmit (+)		
PCIE_TX_M	16	AO	PCIe transmit (-)		
PCIE_RX_P	12	AI	PCIe receive (+)		
PCIE_RX_M	13	AI	PCIe receive (-)		
PCIE_CLKREQ_N	9	OD	PCIe clock request	VDD_IO	

PCIE_WAKE_N	8	OD	PCIe wake up		
PCIE_RST_N	7	DI	PCIe reset		
Control Signals					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
WLAN_EN	68	DI	Wi-Fi function enable control	VDD_IO	Reserve a 100 kΩ external weak pull-down resistor. Active high.
BT_EN	69	DI	Bluetooth enable control	VDD_IO	Reserve a 100 kΩ external weak pull-down resistor. Active high.
SW_CTRL	10	DO	Switch control	VDD_IO	Control PMIC output. If unused, keep it open.
Coexistence Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
COEX_TXD	76	DO	LTE & Wi-Fi/Bluetooth coexistence transmit	VDD_IO	If unused, keep them open.
COEX_RXD	1	DI	LTE & Wi-Fi/Bluetooth coexistence receive		
WLAN_SLP_CLK Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
WLAN_SLP_CLK	22	DI	WLAN sleep clock	VDD_IO	The module is unable to boot up and work without sleep clock.
RF Antenna Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**

ANT_WIFI0/BT	45	AIO	Wi-Fi 0/Bluetooth antenna interface	50 Ω characteristic impedance.
ANT_WIFI1	54	AIO	Wi-Fi 1 antenna interface	
ANT_BT	37	AIO	Reserved dedicated Bluetooth antenna interface	
RESERVED Pins				
Pin Name	**Pin No.**			**Comment**
RESERVED	20, 21, 24, 25, 27, 28, 30–35, 39–42, 48–51, 57–66, 101, 102			Keep them open.

3 Operating Characteristics

3.1. Power Supply

3.1.1. Power Supply Interfaces

The following table shows the power supply pins and ground pins of the module. It is recommended to power the VDD_IO by VDD_EXT of the host.

Table 5: Power Supply and GND Pins

Pin Name	Pin No.	I/O	Description	Comment
VDD_CORE_VL	79, 85, 86	PI	Voltage for core, low voltage	It must be provided with sufficient current up to 1175 mA.
VDD_CORE_VM	89	PI	Voltage for core, medium voltage	It must be provided with sufficient current up to 440 mA.
VDD_CORE_VH	77, 83	PI	Voltage for core, high voltage	It must be provided with sufficient current up to 245 mA.
VDD_IO	71	PI	Power supply for the module's I/O pins	It must be provided with sufficient current up to 50 mA.
VDD_PA	105, 106	PI	Power supply for the module's RF part	It must be provided with sufficient current up to 2400 mA.
GND	6, 11, 14, 17, 23, 26, 29, 36, 38, 43, 44, 46, 47, 52, 53, 55, 56, 67, 70, 78, 80–82, 84, 87, 88, 90–100, 103, 104, 107–112			

3.1.2. Reference Design for Power Supply

AF67E is powered by VDD_CORE_VL, VDD_CORE_VM, VDD_CORE_VH and VDD_IO. These power supplies of the module can be powered by AG5xx Series modules. The following figure shows the reference design for these power pins which are powered by AG5xx Series modules.

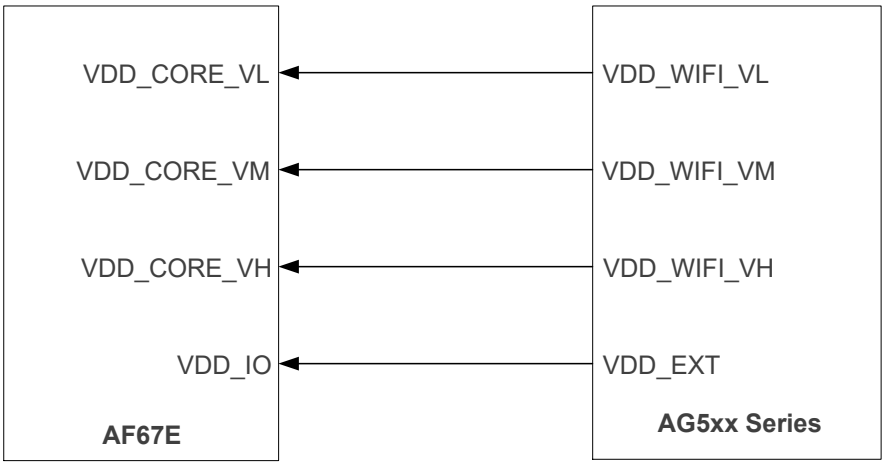


Figure 3: Reference Circuit for VDD_CORE_VL, VDD_CORE_VM, VDD_CORE_VH and VDD_IO

VDD_CORE_VL, VDD_CORE_VM, VDD_CORE_VH and VDD_IO can also be powered by independent power chips. VDD_CORE_VL is recommended to use a power supply chip with the maximum output current exceeding 1175 mA. VDD_CORE_VM is recommended to use a power supply chip with the maximum output current exceeding 440 mA. VDD_CORE_VH is recommended to use a power supply chip with the maximum output current exceeding 245 mA. VDD_IO is recommended to use a power supply chip with maximum output current exceeding 50 mA.

The RF part of the module is powered by VDD_PA. VDD_PA is recommended to use a power supply chip with maximum output current exceeding 2400 mA. The following figure shows a reference design for VDD_PA which are controlled by WLAN_PWR_EN1 of the host.

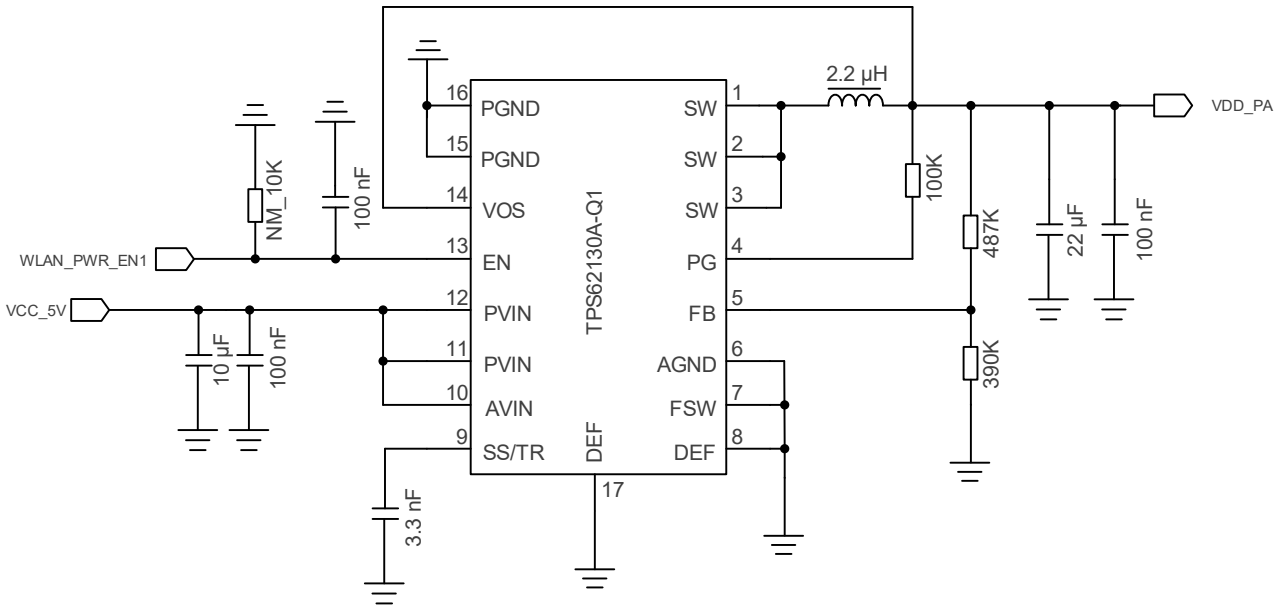


Figure 4: Reference Circuit for VDD_PA

3.1.3. Timing of Turn On and Turn Off

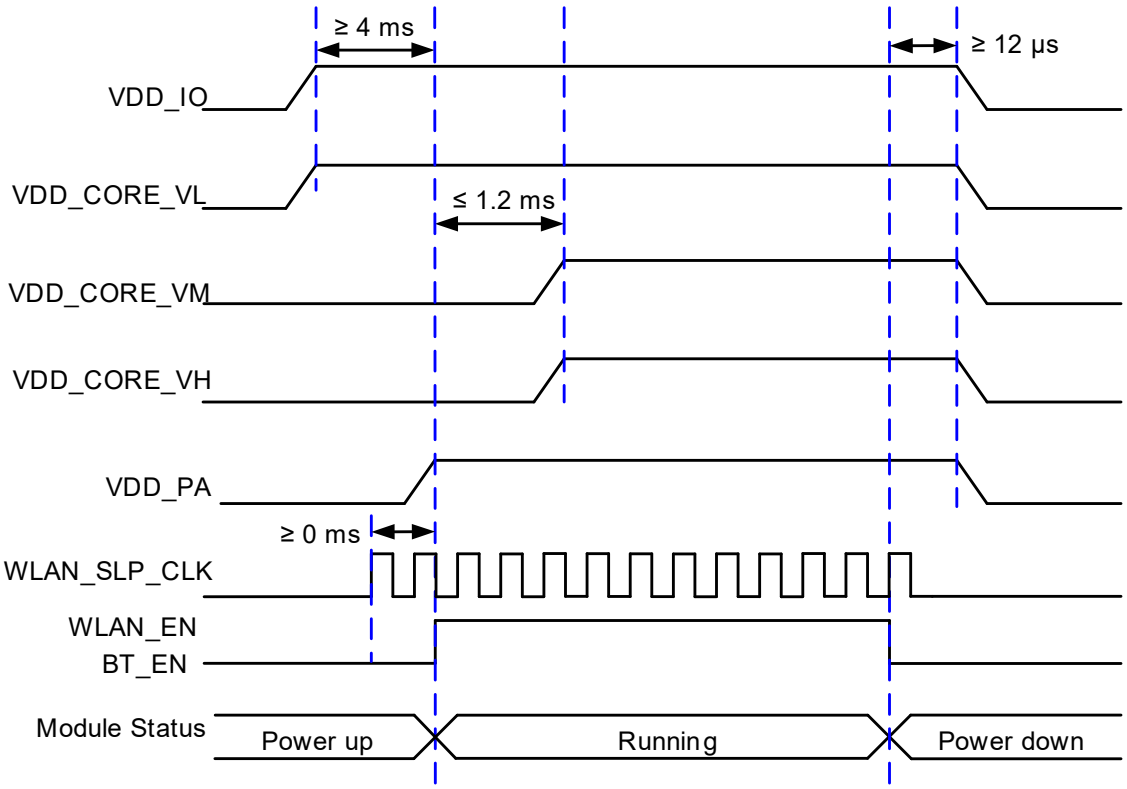


Figure 5: Timing of Turn On and Turn Off

4 Application Interfaces

4.1. Wi-Fi Application Interfaces

The following figure shows the Wi-Fi application interface connection between AF67E and the host.

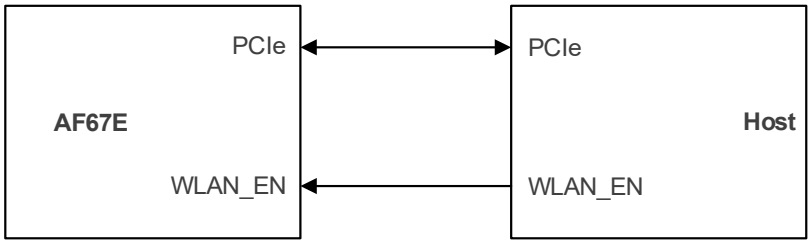


Figure 6: Block Diagram of Wi-Fi Application Interface Connection

4.1.1. WLAN_EN

Wi-Fi function of the module is controlled by WLAN_EN. When WLAN_EN is at a high level, Wi-Fi function will be enabled.

Table 6: Pin Description of WLAN_EN

Pin Name	Pin No.	I/O	Description	Comment
WLAN_EN	68	DI	Wi-Fi function enable control	Reserve a 100 kΩ external weak pull-down resistor. Active high.

NOTE

WLAN_EN is the Wi-Fi function enable signal. When routing, keep it far away from power supply traces, crystal-oscillators, magnetic devices, sensitive signals and signals, such as RF signals, analog signals, and noise signals generated by clock and DC-DC.

4.1.2. PCIe Interface

Table 7: Pin Definition of PCIe Interface

Pin Name	Pin No.	I/O	Description	Comment
PCIE_REFCLK_P	19	AI	PCIe reference clock (+)	Require differential impedance of 85 Ω.
PCIE_REFCLK_M	18	AI	PCIe reference clock (-)	
PCIE_TX_P	15	AO	PCIe transmit (+)	
PCIE_TX_M	16	AO	PCIe transmit (-)	
PCIE_RX_P	12	AI	PCIe receive (+)	
PCIE_RX_M	13	AI	PCIe receive (-)	
PCIE_CLKREQ_N	9	DO	PCIe clock request	
PCIE_WAKE_N	8	DO	PCIe wakes up	
PCIE_RST_N	7	DI	PCIe reset	

The following figure shows the PCIe interface connection between AF67E and the host.

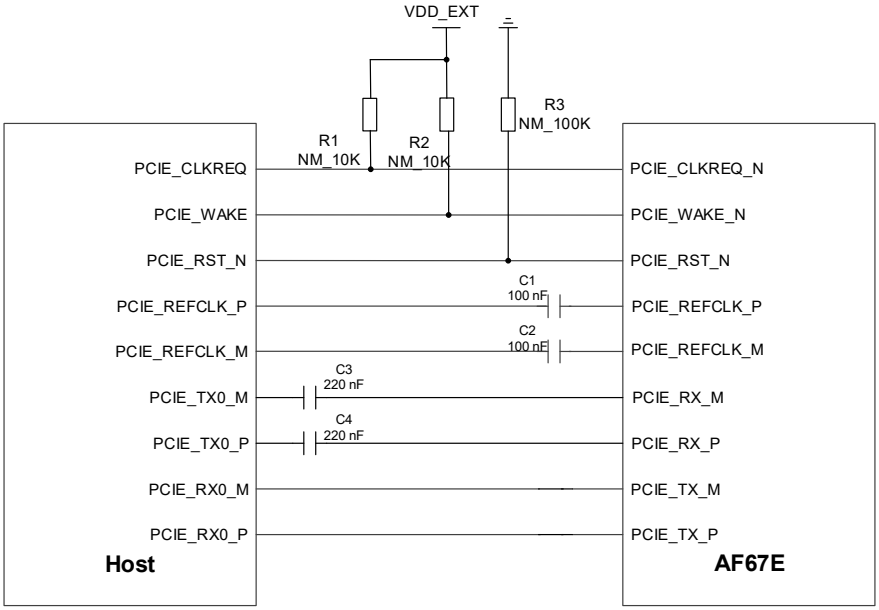


Figure 7: PCIe Interface Connection

To ensure the signal integrity of PCIe interface, C3 and C4 should be placed close to the host module. The extra stubs of traces must be as short as possible. A couple of 100 nF capacitors (C1/C2) must be added when the host is i.MX serial, because the differential clock of i.MX serial does not meet PCIe compliance standard.

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

- It is important to route the PCIe signal traces as differential pairs with ground on that layer and with ground planes above and below. And the differential impedance is 85 Ω ±10 %.
- For PCIe signal traces, the maximum length of each differential data pair (PCIE_TX/PCIE_RX/PCIE_REFCLK) is recommended to be less than 300 mm, and each differential data pair matching should be less than 0.7 mm (5 ps).
- Spacing between Tx differential data pair and Rx differential data pair should be three times of trace width.
- Spacing to all other signals (inter-interface) is four times of 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 inner-layer of the PCB and surround the traces with ground on that layer and with ground planes above and below.

4.2. Bluetooth Application Interfaces

The following figure shows the Bluetooth application interface connection between AF67E and the host.

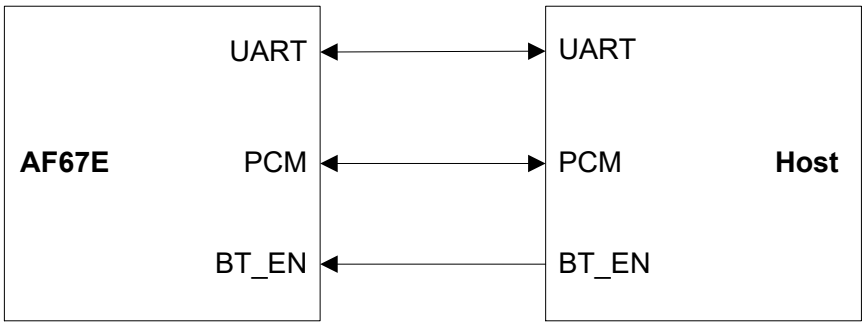


Figure 8: Block Diagram of Bluetooth Application Interface Connection

4.2.1. BT_EN

Bluetooth function of AF67E is controlled by BT_EN. When BT_EN is at a high level, Bluetooth function will be enabled.

Table 8: Pins Description of BT_EN

Pin Name	Pin No.	I/O	Description	Comment
BT_EN	69	DI	Bluetooth enable control	Reserve a 100 kΩ external weak pull-down resistor. Active high

4.2.2. Bluetooth UART

AF67E supports an HCI UART as defined in *Bluetooth Core Specification Version 4.0*. The UART supports hardware flow control, and it can be used for data transmission with up to 3.2 Mbps baud rates.

Table 9: Pin Description of Bluetooth UART

Pin Name	Pin No.	I/O	Description
BT_TXD	74	DO	Bluetooth UART transmit
BT_RXD	75	DI	Bluetooth UART receive
BT_RTS	72	DO	Request to send signal from the module
BT_CTS	73	DI	Clear to send signal to the module

The following figure shows a reference design for Bluetooth UART connection between AF67E and the host.

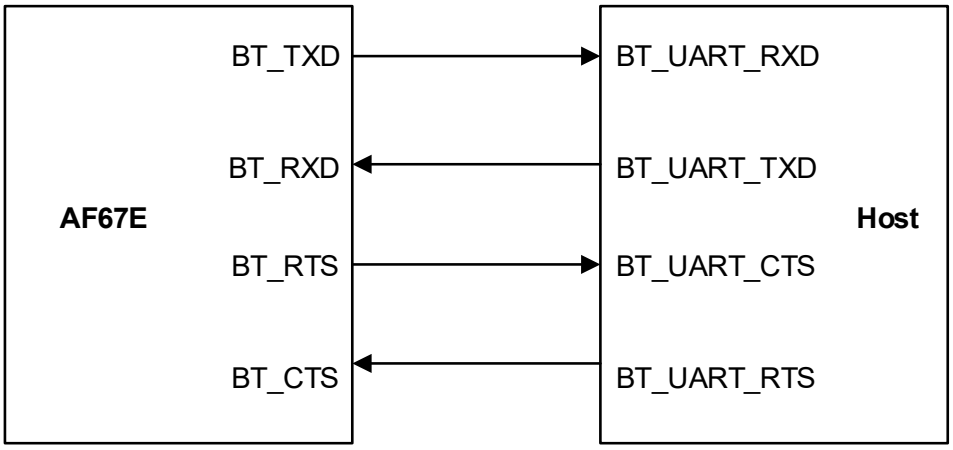


Figure 9: Block Diagram of Bluetooth UART Connection

NOTE

When paired with Quectel's AG5xx Series modules, it may be their own CTS connected to CTS and RTS connected to RTS. This depends on the input and output directions, so in principle, when connected, the input corresponds to the output.

4.2.3. PCM Interface

The module provides PCM interface for Bluetooth audio application.

Table 10: Pin Description of PCM Interface

Pin Name	Pin No.	I/O	Description
PCM_DIN	2	DI	PCM data input
PCM_SYNC	5	DI	PCM data frame sync
PCM_CLK	4	DI	PCM clock
PCM_DOUT	3	DO	PCM data output

The following figure shows a reference design for PCM interface connection between AF67E and the host.

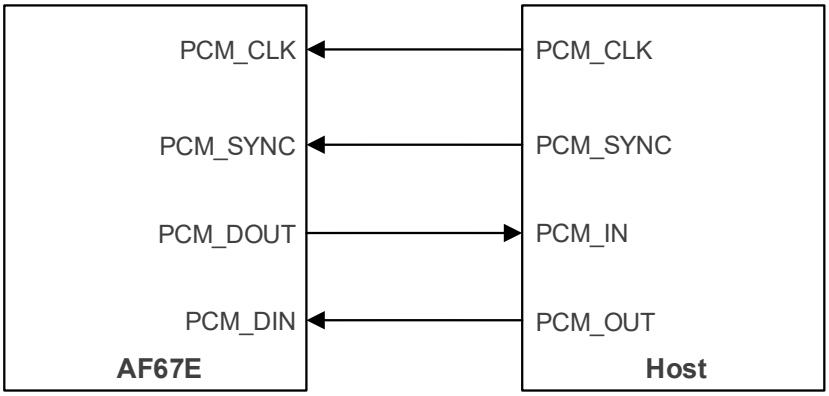


Figure 10: Block Diagram of PCM Interface Connection

4.3. Other Interfaces

4.3.1. Coexistence Interface

Table 11: Pin Description of Coexistence Interfaces

Pin Name	Pin No.	I/O	Description	Comment
COEX_TXD	76	DO	LTE & WLAN/Bluetooth coexistence transmit	If unused, keep them open.
COEX_RXD	1	DI	LTE & WLAN/Bluetooth coexistence receive	

The following figure shows the coexistence interface connection between AF67E and the host.

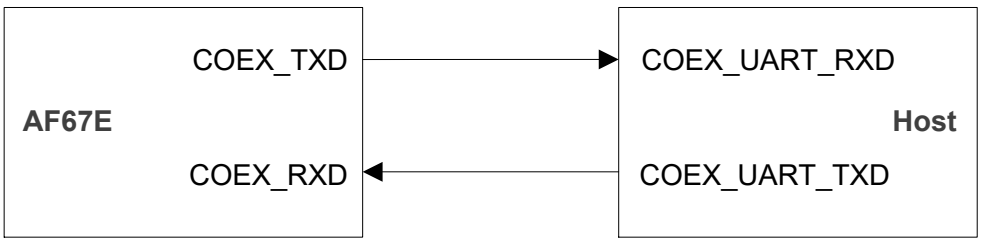


Figure 11: Block Diagram of Coexistence Interface Connection

4.3.2. WLAN_SLP_CLK

The 32.768 kHz sleep clock is used in low power consumption modes, such as power saving mode and sleep mode. It serves as a timer to determine when to wake up the module to receive signals in various power saving schemes, and to maintain basic logic operations when the module is in sleep mode. The module is unable to boot up and work without the sleep clock.

Table 12: Pin Description of WLAN_SLP_CLK

Pin Name	Pin No.	I/O	Description	Comment
WLAN_SLP_CLK	22	DI	WLAN sleep clock	The module is unable to boot up and work without sleep clock.

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

Table 13: Parameter Recommendation

Parameter	Recommended Value	Unit
Frequency	32.768	kHz
Frequency accuracy	±200	ppm
Duty cycle	30–70 %	-
Peak-to-peak voltage	1.8	V
Signal type	Square wave	-
Clock Logic High	5–25	μs

4.3.3. SW_CTRL

Table 1: Pin Definition of SW_CTRL

Pin Name	Pin No.	I/O	Description	Comments
SW_CTRL	10	DO	Switch control	Control PMIC output. If unused, keep it open.

The following figure shows the SW_CTRL connection between AF67E and the host. The SW_CTRL only can be used with AG5xx Series modules.

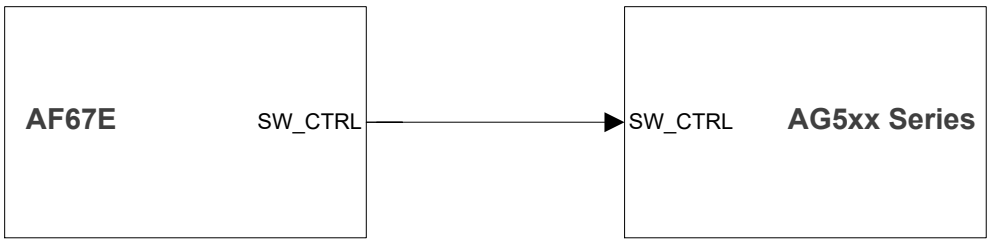


Figure 12: SW_CTRL Connection

5 RF Specifications

Appropriate antenna type and design should be used with matched antenna parameters according to specific application. It is required to perform a comprehensive functional test for the RF design before mass production of terminal products. The entire content of this chapter is provided for illustration only. Analysis, evaluation and determination are still necessary when designing target products.

5.1. RF Antenna

5.1.1. Antenna Interfaces & Frequency Bands

Table 14: Pin Description of RF Antenna Interfaces

Pin Name	Pin No.	I/O	Description	Comment
ANT_BT	37	AIO	Reserved dedicated Bluetooth antenna interface	50 Ω characteristic impedance.
ANT_WIFI1	54	AIO	Wi-Fi 1 antenna interface	
ANT_WIFI0/BT	45	AIO	Wi-Fi 0/Bluetooth antenna interface	

Table 15: Operating Frequency of AF67E (Unit: GHz)

Parameter	Frequency
2.4 GHz Wi-Fi	2.400–2.484
5 GHz Wi-Fi	5.150–5.850
Bluetooth	2.400–2.484

5.1.2. Reference Design

The module provides 3 RF antenna pins for Wi-Fi and 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 the characteristic impedance close to 50 Ω.

It is recommended to reserve a π-type matching circuit for better RF performance. Place the matching components (C1, C2, R1, D1, C3, C4, R2, D2, C5, C6, R3, D3) to antennas as close as possible. Capacitors (C1–C6) are not mounted by default, and R1–R3 are only mounted with 0 Ω resistor. ESD protection devices (D1–D3) should be added on all antenna interfaces, and the parasitic capacitance should be less than 0.05 pF.

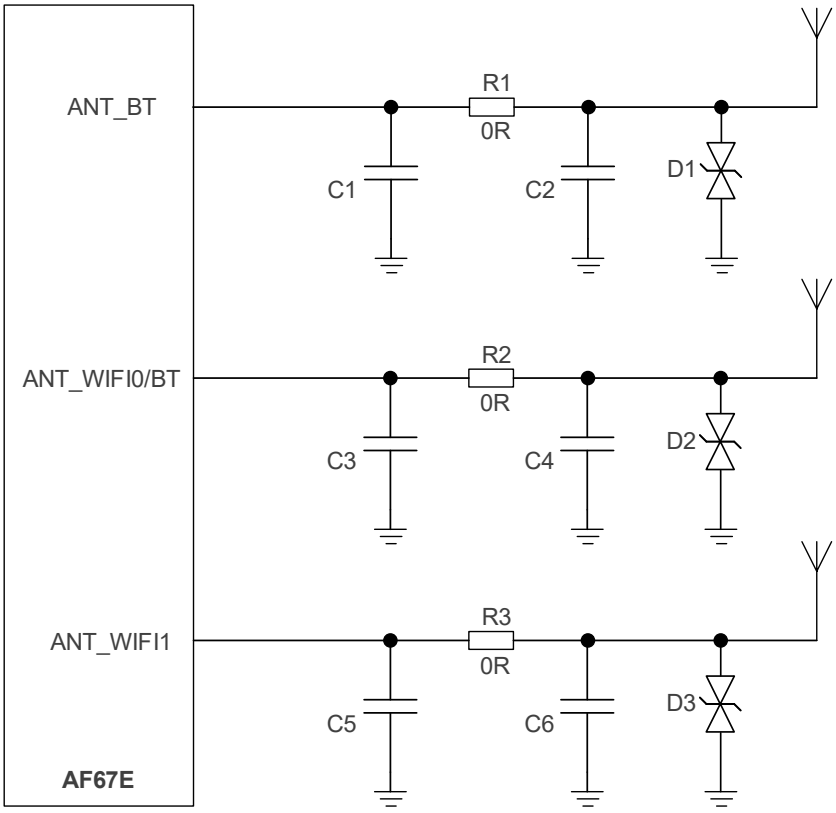


Figure 13: Reference Design of RF Antenna Interface

Another type of reference circuit for the RF antenna interface is shown below. It is designed for vehicle applications. It is recommended to reserve two notch filter circuits and a π-type matching circuit for better RF performance. L1–L6, C2, C3, C6, C7, C10, C11 comprise notch filter circuits for filtering out interference caused by a particular frequency. When L1, L2, C2, C3 are not mounted, R1, C1, C4 comprise a π-type matching circuit. When L3, L4, C6, C7 are not mounted, R2, C5, C8 comprise a π-type matching circuit. When L5, L6, C10, C11 are not mounted, R3, C9, C12 comprise a π-type matching circuit. Capacitors (C1–C12) and inductors (L1–L6) are not mounted by default, and R1–R3 are only mounted with 0 Ω resistor. ESD protection devices (D1–D3) should be added on all antenna interfaces, and the parasitic capacitance should be less than 0.05 pF.

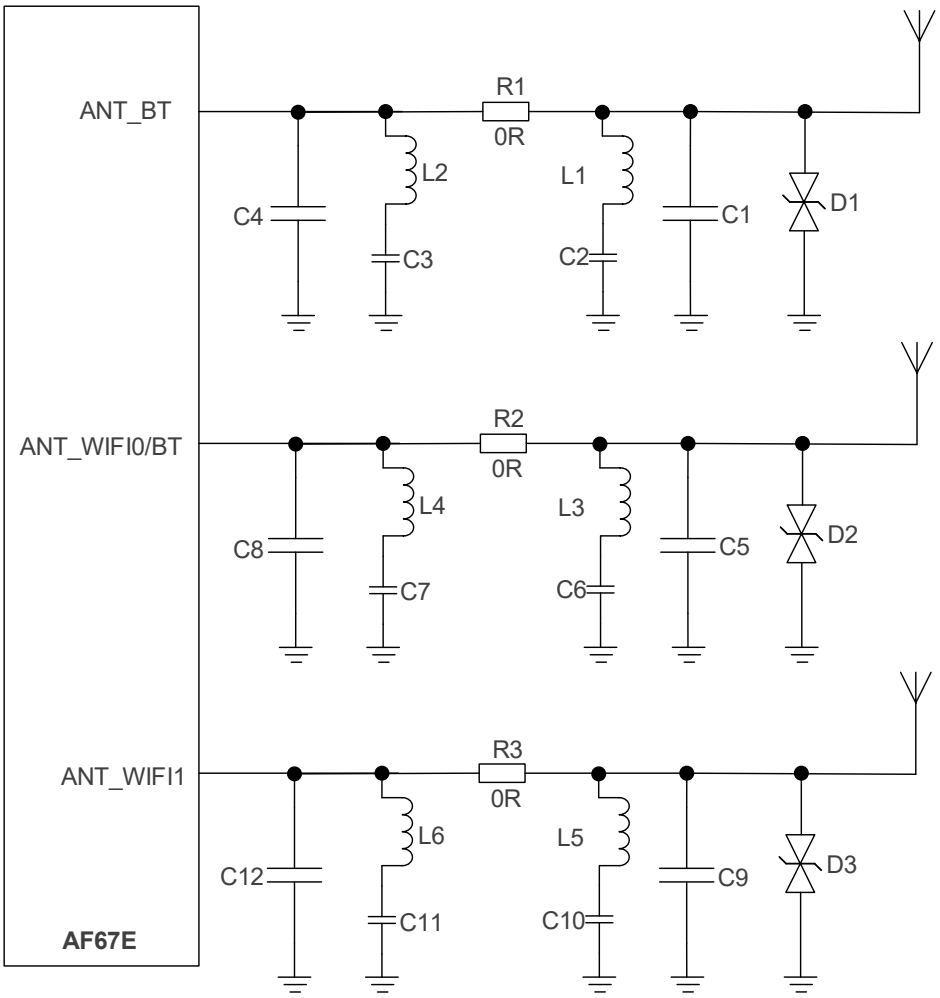


Figure 14: Reference Design of RF Antenna Interface (Vehicle Applications)

5.2. RF Performances

5.2.1. Wi-Fi Performances

5.2.1.1. Transmitting Power

Table 16: Conducted RF Transmitting Power at 2.4 GHz (Unit: dBm)

Standard	Data Rate	Typ.
802.11b	1 Mbps	TBD
802.11b	11 Mbps	TBD
802.11g	6 Mbps	TBD
802.11g	54 Mbps	TBD
802.11n (HT20)	MCS 0	TBD
802.11n (HT20)	MCS 7	TBD
802.11n (HT40)	MCS 0	TBD
802.11n (HT40)	MCS 7	TBD
802.11ax (HE20)	MCS 0	TBD
802.11ax (HE20)	MCS 11	TBD
802.11ax (HE20)	MCS 13	TBD
802.11ax (HE40)	MCS 0	TBD
802.11ax (HE40)	MCS 11	TBD
802.11ax (HE40)	MCS 13	TBD

Table 17: Conducted RF Transmitting Power at 5 GHz (Unit: dBm)

Standard	Data Rate	Typ.
802.11a	6 Mbps	TBD
802.11a	54 Mbps	TBD

802.11n (HT20)	MCS 0	TBD
802.11n (HT20)	MCS 7	TBD
802.11n (HT40)	MCS 0	TBD
802.11n (HT40)	MCS 7	TBD
802.11ac (VHT20)	MCS 0	TBD
802.11ac (VHT20)	MCS 8	TBD
802.11ac (VHT40)	MCS 0	TBD
802.11ac (VHT40)	MCS 9	TBD
802.11ac (VHT80)	MCS 0	TBD
802.11ac (VHT80)	MCS 9	TBD
802.11ax (HE20)	MCS 0	TBD
802.11ax (HE20)	MCS 11	TBD
802.11ax (HE20)	MCS 13	TBD
802.11ax (HE40)	MCS 0	TBD
802.11ax (HE40)	MCS 11	TBD
802.11ax (HE40)	MCS 13	TBD
802.11ax (HE80)	MCS 0	TBD
802.11ax (HE80)	MCS 11	TBD
802.11ax (HE80)	MCS 13	TBD

5.2.1.2. Receiver Sensitivity

Table 18: Conducted RF Receiver Sensitivity at 2.4 GHz (Unit: dBm)

Standard	Data Rate	Typ.
802.11b	1 Mbps	TBD
802.11b	11 Mbps	TBD

802.11g	6 Mbps	TBD
802.11g	54 Mbps	TBD
802.11n (HT20)	MCS 0	TBD
802.11n (HT20)	MCS 7	TBD
802.11n (HT40)	MCS 0	TBD
802.11n (HT40)	MCS 7	TBD
802.11ax (HE20)	MCS 0	TBD
802.11ax (HE20)	MCS 11	TBD
802.11ax (HE20)	MCS 13	TBD
802.11ax (HE40)	MCS 0	TBD
802.11ax (HE40)	MCS 11	TBD
802.11ax (HE40)	MCS 13	TBD

Table 19: Conducted RF Receiver Sensitivity at 5 GHz (Unit: dBm)

Standard	Data Rate	Typ.
802.11a	6 Mbps	TBD
802.11a	54 Mbps	TBD
802.11n (HT20)	MCS 0	TBD
802.11n (HT20)	MCS 7	TBD
802.11n (HT40)	MCS 0	TBD
802.11n (HT40)	MCS 7	TBD
802.11ac (VHT20)	MCS 0	TBD
802.11ac (VHT20)	MCS 8	TBD
802.11ac (VHT40)	MCS 0	TBD
802.11ac (VHT40)	MCS 9	TBD

802.11ac (VHT80)	MCS 0	TBD
802.11ac (VHT80)	MCS 9	TBD
802.11ax (HE20)	MCS 0	TBD
802.11ax (HE20)	MCS 11	TBD
802.11ax (HE20)	MCS 13	TBD
802.11ax (HE40)	MCS 0	TBD
802.11ax (HE40)	MCS 11	TBD
802.11ax (HE40)	MCS 13	TBD
802.11ax (HE80)	MCS 0	TBD
802.11ax (HE80)	MCS 11	TBD
802.11ax (HE80)	MCS 13	TBD

5.2.2. Bluetooth Performances

Table 20: Bluetooth Transmitting and Receiving Performances

Channel	Transmitting Power	Receiver Sensitivity
0	TBD	TBD
19	TBD	TBD
39	TBD	TBD

5.3. RF Routing Guidelines

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

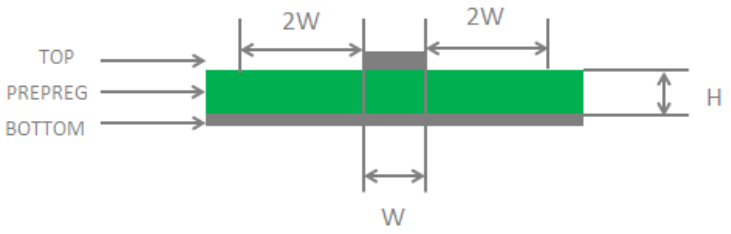


Figure 15: Microstrip Design on a 2-layer PCB

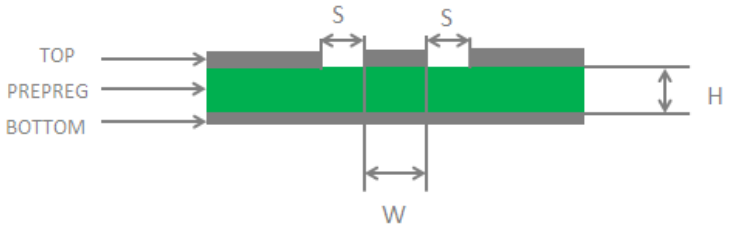


Figure 16: Coplanar Waveguide Design on a 2-layer PCB

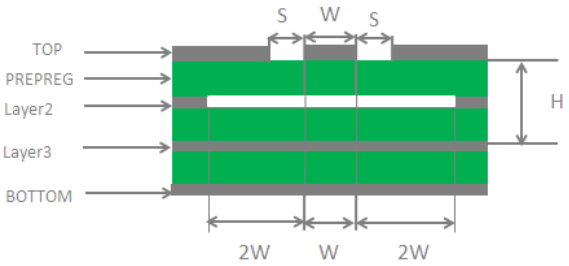


Figure 17: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

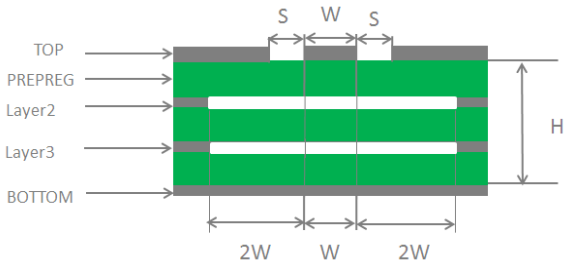


Figure 18: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

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 not 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 [1]***.

5.4. Antenna Design Requirements

Table 21: Antenna Requirements

Parameter	Requirements
Frequency Range (GHz)	**Wi-Fi:** ● 2.4 GHz: 2.400–2.484 ● 5 GHz: 5.150–5.850 **Bluetooth:** ● 2.400–2.484
Cable Insertion Loss (dB)	< 1
VSWR	≤ 2 (Typ.)
Gain (dBi)	≥ 1
Max Input Power (W)	50
Input Impedance (Ω)	50
Polarization Type	Vertical

5.5. RF Connector Recommendation

If RF connector is used for antenna connection, it is recommended to use the HFM connector provided by Rosenberger.

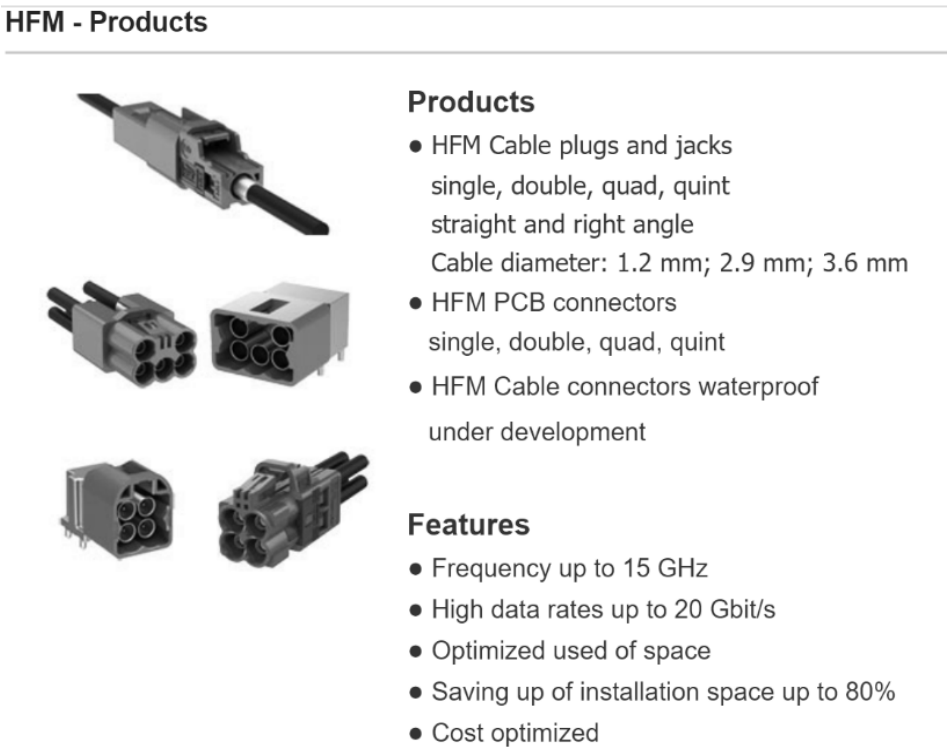


Figure 19: Description of the HFM Connector

For more details, visit https://www.rosenbergerap.com.

6 Electrical Characteristics&Reliability

6.1. Absolute Maximum Ratings

Table 22: Power Supply Ratings (Unit: V)

Parameter	Min.	Max.
VDD_CORE_VL	-0.3	2.1
VDD_CORE_VM	-0.3	2.1
VDD_CORE_VH	-0.3	2.1
VDD_IO	-0.3	VDD_IO + 0.2
VDD_PA	-0.3	VDD_PA + 0.4
Digital I/O Input Voltage	-0.3	VDD_IO + 0.2

Table 23: Recommended Operating Conditions (Unit: V)

Parameter	Min.	Typ.	Max.
VDD_CORE_VL	0.9	0.95	1.2
VDD_CORE_VM	1.30	1.35	1.42
VDD_CORE_VH	1.85	1.9	2.0
VDD_IO	1.71	1.8	1.89
VDD_PA	1.71	1.8	2.1

6.2. Power Consumption

6.2.1. Wi-Fi Power Consumption

6.2.1.1. Normal Operation Mode

Table 24: Wi-Fi Power Consumption of the Module (Normal Operation Mode; Unit: mA)

Frequency	Description	Condition	$I_{VDD\_CORE\_VL}$	$I_{VDD\_CORE\_VM}$	$I_{VDD\_CORE\_VH}$	I_{VDD_IO}	I_{VDD_PA}
2.4 GHz	802.11b	Tx 1 Mbps	TBD	TBD	TBD	TBD	TBD
		Tx 11 Mbps	TBD	TBD	TBD	TBD	TBD
	802.11g	Tx 6 Mbps	TBD	TBD	TBD	TBD	TBD
		Tx 54 Mbps	TBD	TBD	TBD	TBD	TBD
	802.11n	Tx HT20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HT20 @ MCS 7	TBD	TBD	TBD	TBD	TBD
		Tx HT40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HT40 @ MCS 7	TBD	TBD	TBD	TBD	TBD
	802.11ax	Tx HE20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HE20 @ MCS 11	TBD	TBD	TBD	TBD	TBD
		Tx HE20 @ MCS 13	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 11	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 13	TBD	TBD	TBD	TBD	TBD
5 GHz	802.11a	Tx 6 Mbps	TBD	TBD	TBD	TBD	TBD
		Tx 54 Mbps	TBD	TBD	TBD	TBD	TBD
	802.11n	Tx HT20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HT20 @ MCS 7	TBD	TBD	TBD	TBD	TBD

		Tx HT40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HT40 @ MCS 7	TBD	TBD	TBD	TBD	TBD
	802.11ac	Tx VHT20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx VHT20 @ MCS 8	TBD	TBD	TBD	TBD	TBD
		Tx VHT40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx VHT40 @ MCS 9	TBD	TBD	TBD	TBD	TBD
		Tx VHT80 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx VHT80 @ MCS 9	TBD	TBD	TBD	TBD	TBD
	802.11ax	Tx HE20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HE20 @ MCS 11	TBD	TBD	TBD	TBD	TBD
		Tx HE20 @ MCS 13	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 11	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 13	TBD	TBD	TBD	TBD	TBD
		Tx HE80 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HE80 @ MCS 11	TBD	TBD	TBD	TBD	TBD
		Tx HE80 @ MCS 13	TBD	TBD	TBD	TBD	TBD

6.2.1.2. Low Power Mode

Table 25: Wi-Fi Power Consumption of the Module (Low Power Mode; Unit: mA)

Frequency	Description	Condition	$I_{VDD\_CORE\_VL}$	$I_{VDD\_CORE\_VM}$	$I_{VDD\_CORE\_VH}$	I_{VDD_IO}	I_{VDD_PA}
2.4 GHz	802.11b	Tx 1 Mbps	TBD	TBD	TBD	TBD	TBD
		Tx 11 Mbps	TBD	TBD	TBD	TBD	TBD
	802.11g	Tx 6 Mbps	TBD	TBD	TBD	TBD	TBD

		Tx 54 Mbps	TBD	TBD	TBD	TBD	TBD
	802.11n	Tx HT20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HT20 @ MCS 7	TBD	TBD	TBD	TBD	TBD
		Tx HT40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HT40 @ MCS 7	TBD	TBD	TBD	TBD	TBD
	802.11ax	Tx HE20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HE20 @ MCS 11	TBD	TBD	TBD	TBD	TBD
		Tx HE20 @ MCS 13	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HE20 @ MCS 11	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 13	TBD	TBD	TBD	TBD	TBD
5 GHz	802.11a	Tx 6 Mbps	TBD	TBD	TBD	TBD	TBD
		Tx 54 Mbps	TBD	TBD	TBD	TBD	TBD
	802.11n	Tx HT20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HT20 @ MCS 7	TBD	TBD	TBD	TBD	TBD
		Tx HT40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HT40 @ MCS 7	TBD	TBD	TBD	TBD	TBD
	802.11ac	Tx VHT20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx VHT20 @ MCS 8	TBD	TBD	TBD	TBD	TBD
		Tx VHT40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx VHT40 @ MCS 9	TBD	TBD	TBD	TBD	TBD
		Tx VHT80 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx VHT80 @ MCS 9	TBD	TBD	TBD	TBD	TBD
	802.11ax	Tx HE20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HE20 @ MCS 11	TBD	TBD	TBD	TBD	TBD

	Tx HE20 @ MCS 13	TBD	TBD	TBD	TBD	TBD
	Tx HE40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
	Tx HE40 @ MCS 11	TBD	TBD	TBD	TBD	TBD
	Tx HE40 @ MCS 13	TBD	TBD	TBD	TBD	TBD
	Tx HE80 @ MCS 0	TBD	TBD	TBD	TBD	TBD
	Tx HE80 @ MCS 11	TBD	TBD	TBD	TBD	TBD
	Tx HE80 @ MCS 13	TBD	TBD	TBD	TBD	TBD

6.2.1.3. Other Modes

Table 26: Wi-Fi Power Consumption of the Module (SISO Mode; Unit: mA)

Frequency	Description	Condition	$I_{VDD\_CORE\_VL}$	$I_{VDD\_CORE\_VM}$	$I_{VDD\_CORE\_VH}$	I_{VDD_IO}	I_{VDD_PA}
2.4 GHz	802.11b	Tx 1 Mbps	TBD	TBD	TBD	TBD	TBD
		Tx 11 Mbps	TBD	TBD	TBD	TBD	TBD
	802.11g	Tx 6 Mbps	TBD	TBD	TBD	TBD	TBD
		Tx 54 Mbps	TBD	TBD	TBD	TBD	TBD
	802.11n	Tx HT20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HT20 @ MCS 7	TBD	TBD	TBD	TBD	TBD
		Tx HT40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HT40 @ MCS 7	TBD	TBD	TBD	TBD	TBD
	802.11ax	Tx HE20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HE20 @ MCS 11	TBD	TBD	TBD	TBD	TBD
		Tx HE20 @ MCS 13	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 11	TBD	TBD	TBD	TBD	TBD

		Tx HE40 @ MCS 13	TBD	TBD	TBD	TBD	TBD
5 GHz	802.11a	Tx 6 Mbps	TBD	TBD	TBD	TBD	TBD
		Tx 54 Mbps	TBD	TBD	TBD	TBD	TBD
	802.11n	Tx HT20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HT20 @ MCS 7	TBD	TBD	TBD	TBD	TBD
		Tx HT40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HT40 @ MCS 7	TBD	TBD	TBD	TBD	TBD
	802.11ac	Tx VHT20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx VHT20 @ MCS 8	TBD	TBD	TBD	TBD	TBD
		Tx VHT40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx VHT40 @ MCS 9	TBD	TBD	TBD	TBD	TBD
		Tx VHT80 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx VHT80 @ MCS 9	TBD	TBD	TBD	TBD	TBD
	802.11ax	Tx HE20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HE20 @ MCS 11	TBD	TBD	TBD	TBD	TBD
		Tx HE20 @ MCS 13	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 11	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 13	TBD	TBD	TBD	TBD	TBD
		Tx HE80 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HE80 @ MCS 11	TBD	TBD	TBD	TBD	TBD
		Tx HE80 @ MCS 13	TBD	TBD	TBD	TBD	TBD

Table 27: Wi-Fi Power Consumption of the Module (MIMO Mode; Unit: mA)

Frequencies	Description	Condition	$I_{VDD\_CORE\_VL}$	$I_{VDD\_CORE\_VM}$	$I_{VDD\_CORE\_VH}$	I_{VDD_IO}	I_{VDD_PA}
2.4 GHz	802.11b	Tx 1 Mbps	TBD	TBD	TBD	TBD	TBD
		Tx 11 Mbps	TBD	TBD	TBD	TBD	TBD
	802.11g	Tx 6 Mbps	TBD	TBD	TBD	TBD	TBD
		Tx 54 Mbps	TBD	TBD	TBD	TBD	TBD
	802.11n	Tx HT20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HT20 @ MCS 7	TBD	TBD	TBD	TBD	TBD
		Tx HT40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HT40 @ MCS 7	TBD	TBD	TBD	TBD	TBD
	802.11ax	Tx HE20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HE20 @ MCS 11	TBD	TBD	TBD	TBD	TBD
		Tx HE20 @ MCS 13	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 11	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 13	TBD	TBD	TBD	TBD	TBD
5 GHz	802.11a	Tx 6 Mbps	TBD	TBD	TBD	TBD	TBD
		Tx 54 Mbps	TBD	TBD	TBD	TBD	TBD
	802.11n	Tx HT20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HT20 @ MCS 7	TBD	TBD	TBD	TBD	TBD
		Tx HT40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HT40 @ MCS 7	TBD	TBD	TBD	TBD	TBD
	802.11ac	Tx VHT20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx VHT20 @ MCS 8	TBD	TBD	TBD	TBD	TBD

		Tx VHT40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx VHT40 @ MCS 9	TBD	TBD	TBD	TBD	TBD
		Tx VHT80 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx VHT80 @ MCS 9	TBD	TBD	TBD	TBD	TBD
	802.11ax	Tx HE20 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HE20 @ MCS 11	TBD	TBD	TBD	TBD	TBD
		Tx HE20 @ MCS 13	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 11	TBD	TBD	TBD	TBD	TBD
		Tx HE40 @ MCS 13	TBD	TBD	TBD	TBD	TBD
		Tx HE80 @ MCS 0	TBD	TBD	TBD	TBD	TBD
		Tx HE80 @ MCS 11	TBD	TBD	TBD	TBD	TBD
		Tx HE80 @ MCS 13	TBD	TBD	TBD	TBD	TBD

6.2.2. Bluetooth Power Consumption

Table 28: Bluetooth Power Consumption During Non-signalling

Mode	Power Rate	Supply Voltage	Power Consumption
Non-signaling	TBD	VDD_CORE_VL	TBD
		VDD_CORE_VM	TBD
		VDD_CORE_VH	TBD
		VDD_IO	TBD
		VDD_PA	TBD

NOTE

The power consumption data above is for reference only, which may vary among different modules. For detailed information, contact Quectel Technical Support for the power consumption test report of the specific module.

6.3. Digital I/O Characteristics

Table 29: Suggested Digital I/O Characteristics

Parameter	Description	Min.	Max.	Units
V_{IH}	High-level input voltage	0.7 × VDD_IO	VDD_IO + 0.2	V
V_{IL}	Low-level input voltage	0.3	0.3 × VDD_IO	V
V_{OH}	High-level output voltage	VDD_IO - 0.45	VDD_IO	V
V_{OL}	Low-level output voltage	0	0.45	V
I_{iH}	High-level input leakage current	-	1	μA
I_{iL}	Low-level input leakage current	-1	-	μA

6.4. 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 30: ESD Characteristics (Temperature: 25-30 °C, Humidity: 40 ±5 %; Unit: kV)

Test Interfaces	Contact Discharge	Air Discharge
VDD_CORE_VL	TBD	TBD
VDD_CORE_VM	TBD	TBD

VDD_CORE_VH	TBD	TBD
VDD_PA	TBD	TBD
VDD_IO	TBD	TBD
GND	TBD	TBD
All antenna interfaces	TBD	TBD

6.5. Operating and Storage Temperatures

Table 31: Operating and Storage Temperatures (Unit: °C)

Parameter	Min.	Typ.	Max.
Operating Temperature [2]	-40	+25	+85
Storage Temperature	-40	-	+90

6.6. Thermal Dissipation

The module offers the best performance when all internal IC chips are working within their operating temperatures. When the IC chip reaches or exceeds the maximum junction temperature, the module may still work but the performance and 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. 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;

[2] Within this range, the module's indicators comply with IEEE and Bluetooth specification requirements.

- Choose a TIM (Thermal Interface Material) with high thermal conductivity, good softness and good wettability and place it between the heatsink and the module;
- Fasten the heatsink with four screws to ensure that it is in close contact with the module to prevent the heatsink from falling off during the drop, vibration test, or transportation.

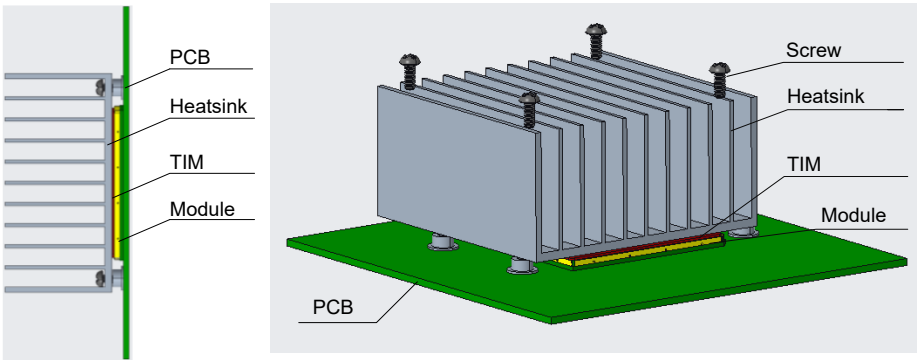


Figure 20: Placement and Fixing of the Heatsink

Table 32: Maximum Junction Temperature for Main Chips (Unit: °C)

BB
115

7 Mechanical Information

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

7.1. Mechanical Dimensions

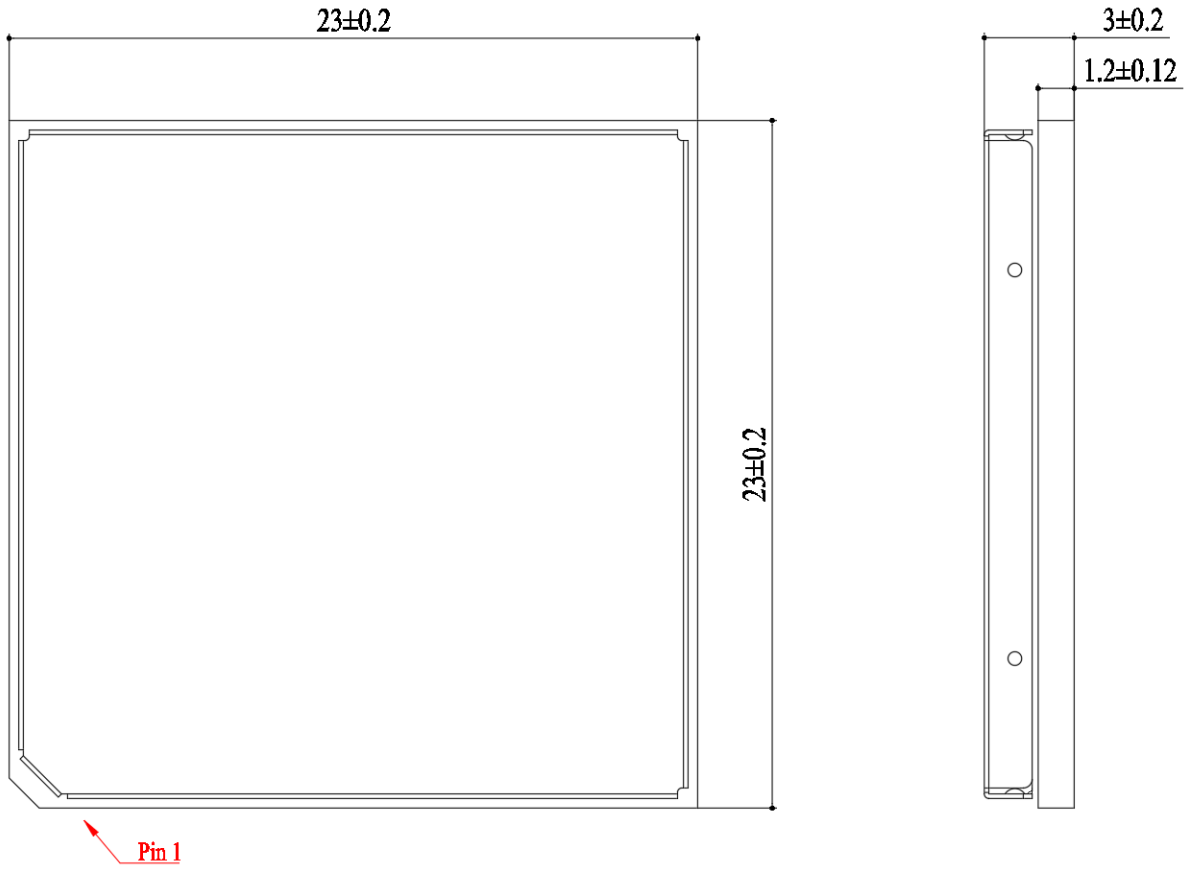


Figure 21: Top and Side Dimensions

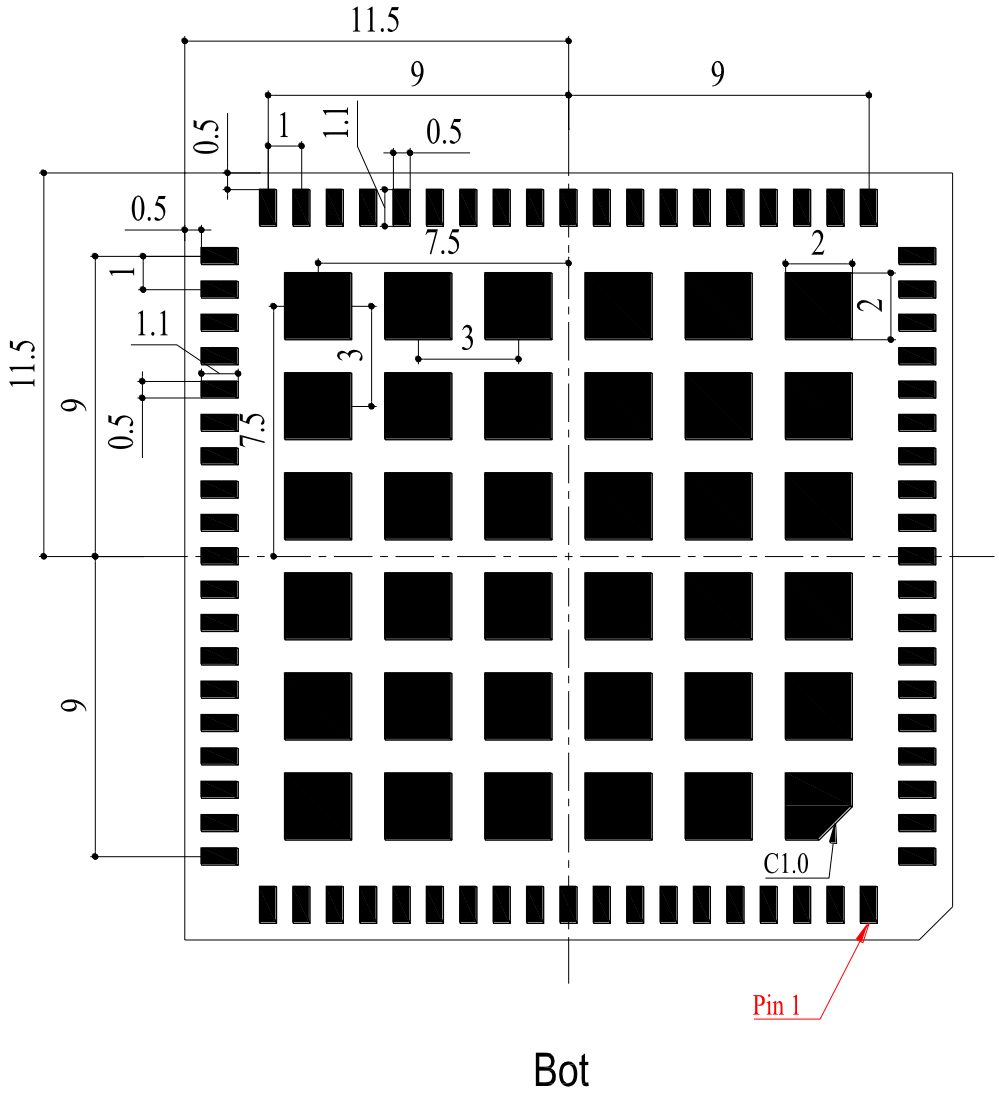


Figure 22: Bottom Dimensions

NOTE

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

7.2. Recommended Footprint

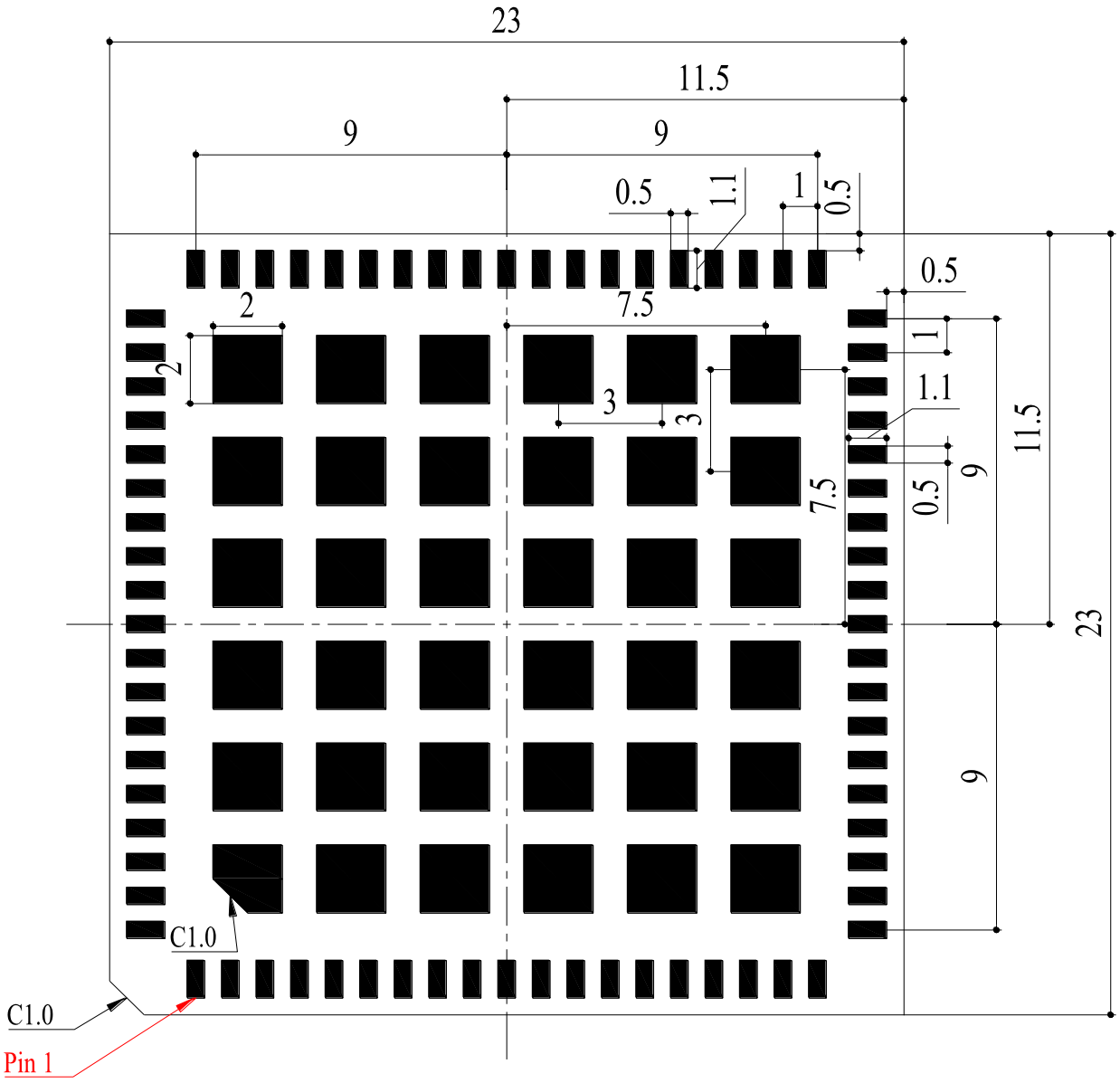


Figure 23: Recommended Footprint

NOTE

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

7.3. Top and Bottom Views

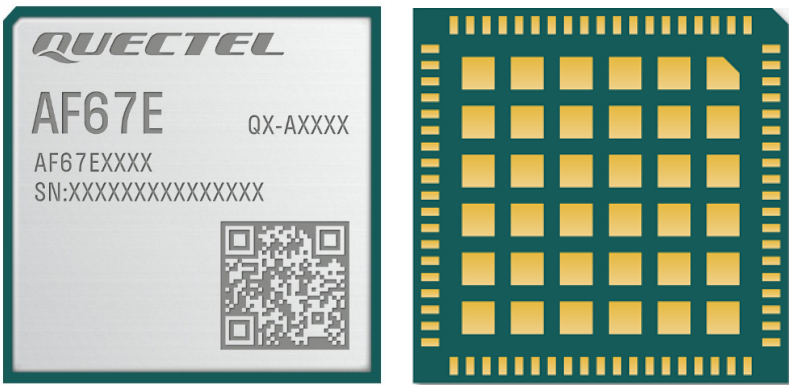


Figure 24: Top & Bottom Views of the Module

NOTE

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

8 Storage, Manufacturing & Packaging

8.1. Storage Conditions

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

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

2. Shelf life (in a vacuum-sealed packaging): 12 months in recommended storage condition.

3. Floor life: 168 hours [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;

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*. Do not unpack the modules in large quantities until they are ready for soldering.

NOTE

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

8.2. Manufacturing and Soldering

Push the squeegee to apply the solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate to the PCB. Apply proper force on the squeegee to produce a clean stencil surface on a single pass. To guarantee module soldering quality, the thickness of stencil for the module is recommended to be 0.13–0.15 mm. For more details, see ***document [1]***.

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:

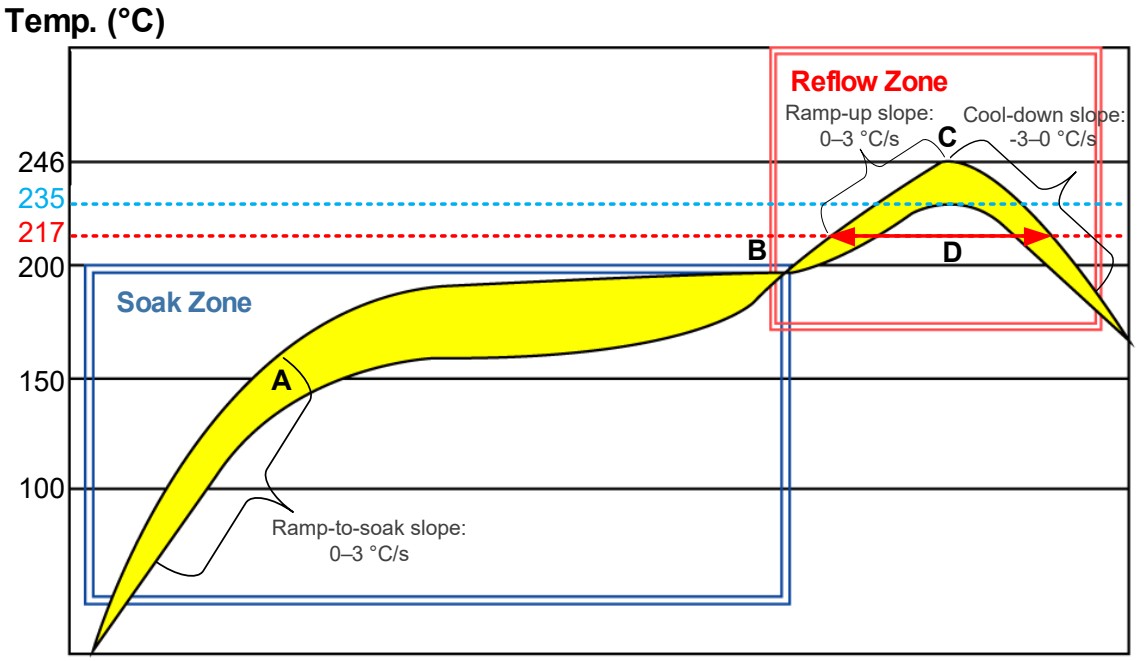


Figure 25: Recommended Reflow Soldering Thermal Profile

Table 33: 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. Due to the large-size form factor, to avoid excessive temperature change, which may cause excessive thermal deformation of the metal shielding frame and cover, it is recommended to reduce the ramp-up and cool-down slopes in the liquid phase of the solder paste. If possible, please choose a reflow oven with more than 10 temperature zones during production so that there are more temperature zones to set up to meet the optimal temperature curve.
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.
4. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.
5. 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 [2].***

8.3. Packaging Specification

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

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

8.3.1. Carrier Tape

Dimension details are as follow:

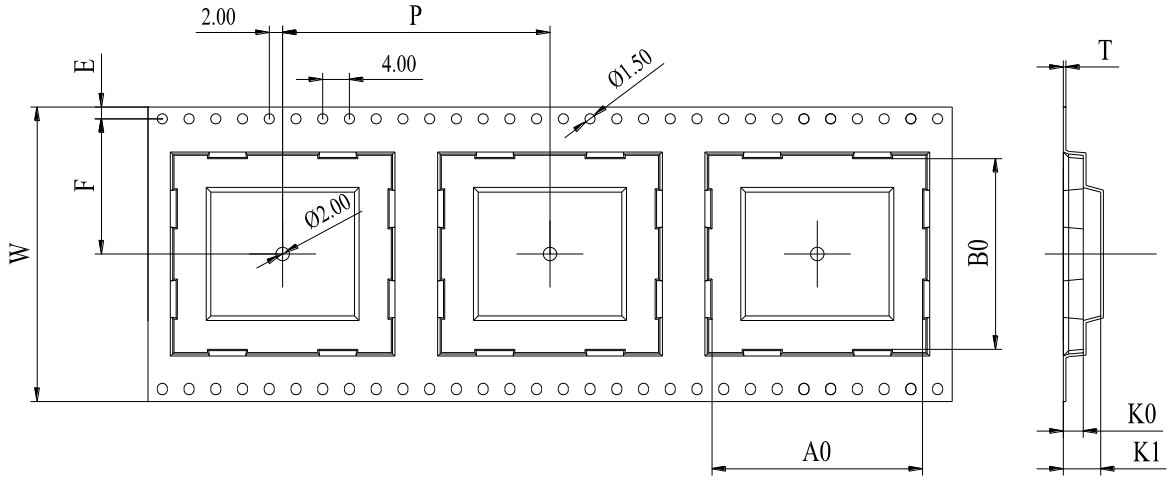


Figure 26: Carrier Tape Dimension Drawing

Table 34: Carrier Tape Dimension Table (Unit: mm)

W	P	T	A0	B0	K0	K1	F	E
44	32	0.4	23.5	23.5	3.5	6.8	20.2	1.75

8.3.2. Plastic Reel

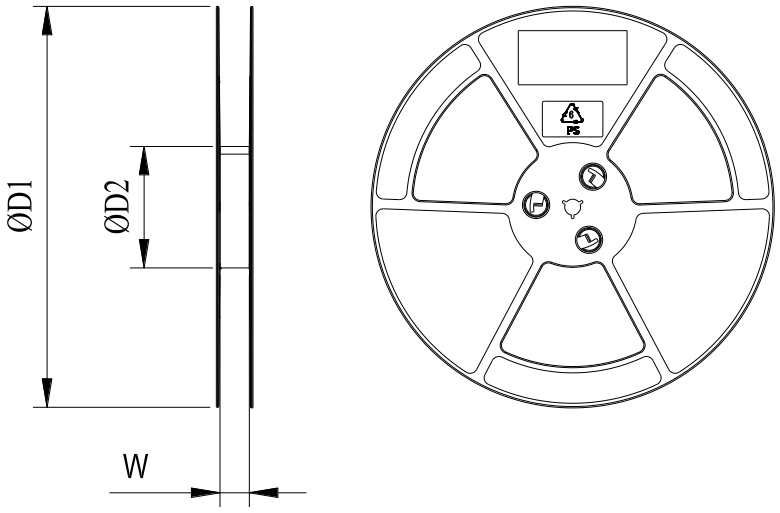


Figure 27: Plastic Reel Dimension Drawing

Table 35: Plastic Reel Dimension Table (Unit: mm)

øD1	øD2	W
330	100	44.5

8.3.3. Mounting Direction

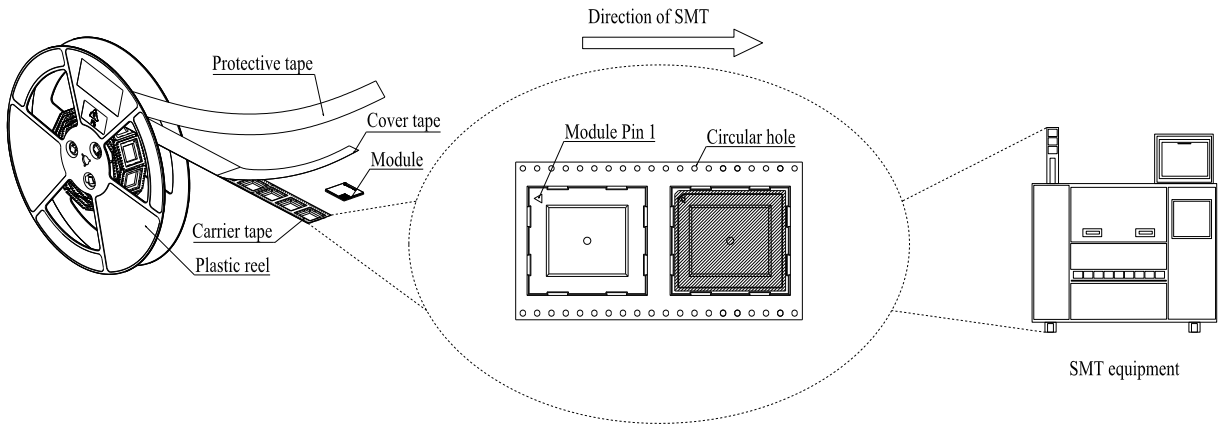
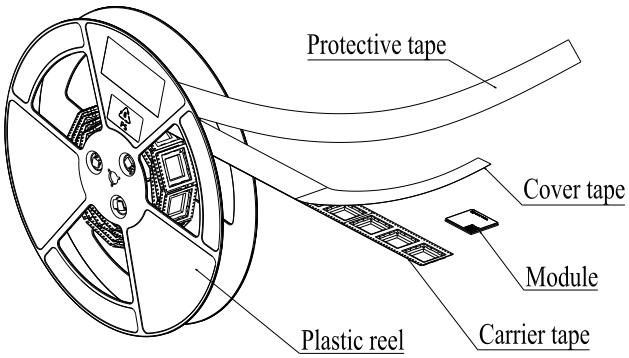


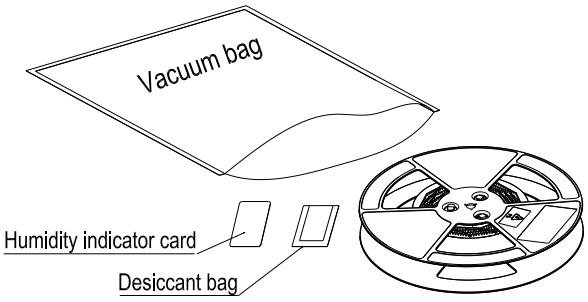
Figure 28: Mounting Direction

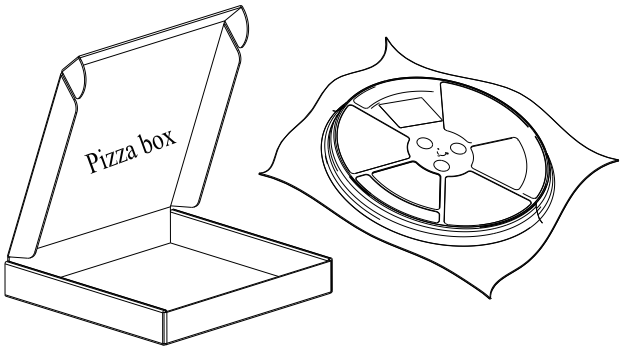
8.3.4. Packaging Process



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 packaged pizza boxes into 1 carton box and seal it. 1 carton box can pack 1000 modules.

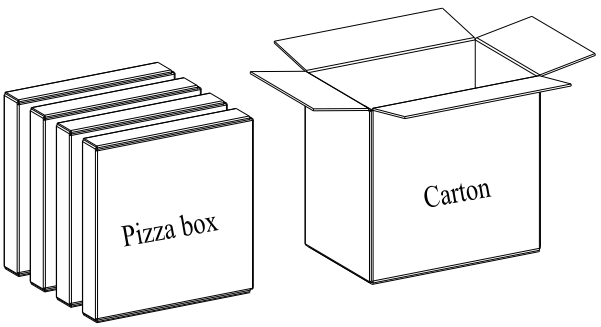


Figure 29: Packaging Process

9 Appendix References

Table 36: Related Documents

Document Name
[1] Quectel_RF_Layout_Application_Note
[2] Quectel_Module_SMT_Application_Note

Table 37: Terms and Abbreviations

Abbreviation	Description
AP	Application Processor
BLE	Bluetooth Low Energy
bps	Bits Per Second
BPSK	Binary Phase Shift Keying
BR	Basic Rate
CCK	Complementary Code Keying
CTS	Clear To Send
DPSK	Differential Phase Shift Keying
EDR	Enhanced Data Rate
GATT	Generic Attribute Profile
GFSK	Gauss frequency Shift Keying
HE	High Efficiency
HFP	Hands-free Profile
HT	Hardware Test/High Throughput

I/O	Input/Output
LGA	Land Grid Array
LTE	Long Term Evolution
MCS	Modulation and Coding Scheme
MIMO	Multiple Input Multiple Output
PA	Power Amplifier
PCB	Printed Circuit Board
PCIe	Peripheral Component Interconnect Express
PCM	Pulse Code Modulation
PMIC	Power Management Integrated Circuit
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
Rx	Receive
SPP	Serial Port Profile/Standard Parallel Port
STA	Station
TBD	To Be Determined
TRx	Transmit & Receive
Tx	Transmit
UART	Universal Asynchronous Receiver/Transmitter
VHT	Very High Throughput
Vmax	Maximum Voltage
Vnom	Nominal Voltage
Vmin	Minimum Voltage
WLAN	Wireless Local Area Network

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: XMR202406AF67E
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: XMR202406AF67E" or "Contains FCC ID:XMR202406AF67E" 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."

Statement on RF radiation exposure
The other used for the transmitter shall be installed to provide a separation distance of at least 20 cm from all persons and shall not be co-located or operate in conjunction with another antenna or transmitter.

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-202406AF67E" or "where: 10224A-202406AF67E 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-202406AF67E " ou "où: 10224A-202406AF67E 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;