

KCMA32S Hardware Design

Short-Range Module Series

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Safety Information

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



Full attention must be 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
-	2025-02-05	Luke FU/Allen KE/ Riggan XU	Creation of the document
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Contents

Safety Information.....	3
About the Document.....	4
Contents	5
Table Index.....	7
Figure Index	8
1 Introduction	9
1.1. Special Mark	9
2 Product Overview.....	10
2.1. Key Features.....	11
2.2. Functional Diagram	12
3 Application Interfaces	13
3.1. Pin Assignment	13
3.2. Pin Definitions	14
3.3. GPIO Multiplexing	17
3.4. Interface Definition	19
3.4.1. USART Interface	19
3.4.2. SWD Interface	22
3.4.3. I2C Interface.....	23
3.4.4. ADC Interface.....	23
3.4.5. GPIO Interfaces.....	24
4 Operating Characteristics	25
4.1. Power Supply Interface.....	25
4.1.1. Reference Design for Power Supply.....	25
4.2. Reset.....	26
5 RF Specifications	28
5.1. ZigBee Specifications.....	28
5.2. Antenna/Antenna Interfaces	29
5.2.1. Pin Antenna interface (ANT_RF)*	30
5.2.1.1. Reference Design.....	30
5.2.1.2. RF Routing Guidelines	31
5.2.2. PCB Antenna.....	32
5.2.3. RF Coaxial Connector.....	36
5.2.3.1. RF Connector Specifications.....	36
5.2.3.2. Antenna Connector Installation.....	37
5.2.3.3. Recommended Manufacturers of RF Connector and Cable	38
5.2.4. Requirements for Antenna Design.....	38
6 Electrical Characteristics and Reliability	39
6.1. Absolute Maximum Ratings	39

6.2.	Power Supply Ratings.....	39
6.3.	ZigBee Power Consumption	40
6.4.	Digital I/O Characteristics	40
6.5.	ESD Protection.....	41
7	Mechanical Information	42
7.1.	Mechanical Dimensions	42
7.2.	Recommended Footprint	44
7.3.	Top and Bottom Views.....	45
8	Storage, Manufacturing and Packaging	47
8.1.	Storage Conditions.....	47
8.2.	Manufacturing and Soldering.....	48
8.3.	Packaging Specification.....	50
8.3.1.	Carrier Tape	50
8.3.2.	Plastic Reel	51
8.3.3.	Mounting Direction	51
8.3.4.	Packaging Process	52
9	Appendix References	53

Table Index

Table 1: Special Mark.....	9
Table 2: Basic Information	10
Table 3: Key Features.....	11
Table 4: Parameter Definition	14
Table 5: Pin Description	15
Table 6: GPIO Multiplexing (Digital Pins).....	17
Table 7: GPIO Multiplexing (Analog Pins)	18
Table 8: USART Synchronous/Asynchronous Mode.....	20
Table 9: Pin Description of SWD Interface	22
Table 10: Pin Description of Power Supply and GND Pins	25
Table 11: Pin Description of RESET_N	26
Table 12: ZigBee Specifications.....	28
Table 13: Pin Description of ANT_RF	30
Table 14: Requirements for PCB Antenna.....	32
Table 15: Major Specifications of the RF Connector	36
Table 16: Requirements for Antenna Design.....	38
Table 17: Absolute Maximum Ratings (Unit: V).....	39
Table 18: Module Power Supply Ratings (Unit: V)	39
Table 19: ZigBee Power Consumption	40
Table 20: I/O Characteristics (Unit: V; VBAT = 3.3 V)	40
Table 21: Electrostatic Discharge Characteristics (Unit: kV)	41
Table 22: Recommended Thermal Profile Parameters	49
Table 23: Carrier Tape Dimension Table (Unit: mm).....	50
Table 24: Plastic Reel Dimension Table (Unit: mm).....	51
Table 25: Related Documents.....	53
Table 26: Terms and Abbreviations	53

Figure Index

Figure 1: Functional Diagram	12
Figure 2: Pin Assignment (Top View)	13
Figure 3: USART Functional Diagram	19
Figure 4: UART Interface Connection	20
Figure 5: SPI Interface Connection (Master Mode)	20
Figure 6: SPI Interface Connection (Slave Mode)	21
Figure 7: I2S Interface Connection	21
Figure 8: RS-485 Interface Connection	22
Figure 9: SWD Interface Connection	22
Figure 10: Reference Design of Power Supply	25
Figure 11: Reference Circuit for RESET_N with a Button	26
Figure 12: Reset Timing	27
Figure 13: Reference Design of Antenna Interface	30
Figure 14: Microstrip Design on a 2-layer PCB	31
Figure 15: Coplanar Waveguide Design on a 2-layer PCB	31
Figure 16: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground).....	31
Figure 17: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground).....	32
Figure 18: Module Placement	34
Figure 19: Keepout Area on Motherboard	34
Figure 20: Prohibited Area During Routing (Bottom Side).....	35
Figure 21: Dimensions of the Receptacle (Unit: mm).....	36
Figure 22: Dimensions of the Receptacle (Unit: mm).....	37
Figure 23: Space Factor of Mated Connectors (Ø 0.81 mm Coaxial Cables) (Unit: mm).....	37
Figure 24: Space Factor of Mated Connectors (Ø 1.13 mm Coaxial Cables) (Unit: mm).....	38
Figure 25: Top and Side Dimensions.....	42
Figure 26: Bottom Dimension.....	43
Figure 27: Recommended Footprint	44
Figure 28: Top and Bottom Views (Antenna Interface)	45
Figure 29: Top and Bottom Views (PCB Antenna)	45
Figure 30: Top and Bottom Views (RF Coaxial Connector)	46
Figure 31: Recommended Reflow Soldering Thermal Profile	48
Figure 32: Carrier Tape Dimension Drawing (Unit: mm)	50
Figure 33: Plastic Reel Dimension Drawing.....	51
Figure 34: Mounting Direction	51
Figure 35: Packaging Process	52

1 Introduction

The document defines KCMA32S in GSDK solution and describes its hardware interfaces and air interfaces connected to your applications, which can help you quickly understand the hardware interface characteristics, RF characteristics, electrical characteristics, mechanical specifications and other relevant information of the module.

1.1. Special Mark

Table 1: Special Mark

Mark	Definition
*	Unless otherwise specified, an asterisk (*) after a function, feature, interface, pin name, command, argument, and so on indicates that it is under development and currently not supported; and the asterisk (*) after a model indicates that the model sample is currently unavailable.

Hereby, Quectel Wireless Solutions Co., Ltd. declares that the radio equipment type KCMA32S is in compliance with Directive 2014/53/EU. This product can be used across EU member states. The full text of the EU declaration of conformity is available at the following internet address:

<http://www.quectel.com/support/technical.htm>

Disposal of old electrical appliances



The European directive 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE), requires that old household electrical appliances must not be disposed of in the normal unsorted municipal waste stream. Old appliances must be collected separately in order to optimize the recovery and recycling of the materials they contain, and reduce the impact on human health and the environment.

The crossed out “wheeled bin” symbol on the product reminds you of your obligation, that when you dispose of the appliance, it must be separately collected.

Consumers should contact their local authority or retailer for information concerning the correct disposal of their old appliance.

This equipment should be installed and operated with minimum distance 20cm between the radiator and your body

2 Product Overview

KCMA32S is a low-power, cost-effective MCU ZigBee and BLE module, compliant with ZigBee 3.0, BLE 5.4* and BLE mesh* protocols. It integrates a highly configurable wireless transceiver. The module has multiple interfaces including USART, SWD, I2C and ADC for various applications.

The module is an SMD module with compact packaging. The general features of the module are as follow:

- Embedded high-performance 32-bit ARM Cortex-M33 processor with a frequency of up to 80 MHz
- 64/96* KB SRAM, 768/1024* KB Flash ¹
- Flexible and efficient power consumption management
- Bluetooth mesh network low-energy mode
- Support for Peripheral Reflex System (PRS) for autonomous inter-peripheral signaling
- Support for AES256 hardware encryption
- Support for OTA (Over-The-Air Upgrade)
- Support for secondary development

Table 2: Basic Information

KCMA32S	
Packaging type	LCC + LGA
Pin counts	27 pins
Dimensions	(20 +0.3/-0.15) mm × (12 +0.3/-0.15) mm × (2.2 ±0.2) mm
Weight	Approx. 0.7 g

¹ The module supports 64 KB RAM and 768 KB Flash, or 96 KB RAM* and 1024 KB Flash*. For more details, please contact Quectel technical support.

2.1. Key Features

Table 3: Key Features

Basic Information	
Protocols and Standard	● ZigBee protocol: ZigBee 3.0 ● Bluetooth protocol: BLE 5.4[*], BLE mesh[*] ● All hardware components fully comply with EU RoHS directive
Supply Voltage	VBAT Power Supply: ● 1.71–3.8 V ● Typ. 3.3 V
Temperature Ranges	● Normal operating temperature ²: -40 °C to +85 °C ● Storage temperature: -45 °C to +95 °C
TE-B Kit	KCMA32S-TE-B ³
RF Antenna/Antenna Interface ⁴	
Antenna/Antenna Interfaces	● Antenna interface (ANT_RF)[*] ● PCB antenna ● RF coaxial connector (Gen 1) ● 50 Ω characteristic impedance
Application Interfaces ⁵	
Application Interfaces	USART, SWD, I2C, ADC, GPIO

² Within the operating temperature range, the module's related performance meets ZigBee 3.0 and Bluetooth specifications.

³ Quectel supplies an evaluation board (KCMA32S-TE-B) with accessories to develop and test the module. For more details, see **document [1]**.

⁴ The module is provided with one of the three antenna/antenna interface designs. For more details, please contact Quectel Technical Support.

⁵ For more details about the interfaces, see **Chapter 3.3** and **Chapter 3.4**.

2.2. Functional Diagram

The functional diagram illustrates the following major functional parts:

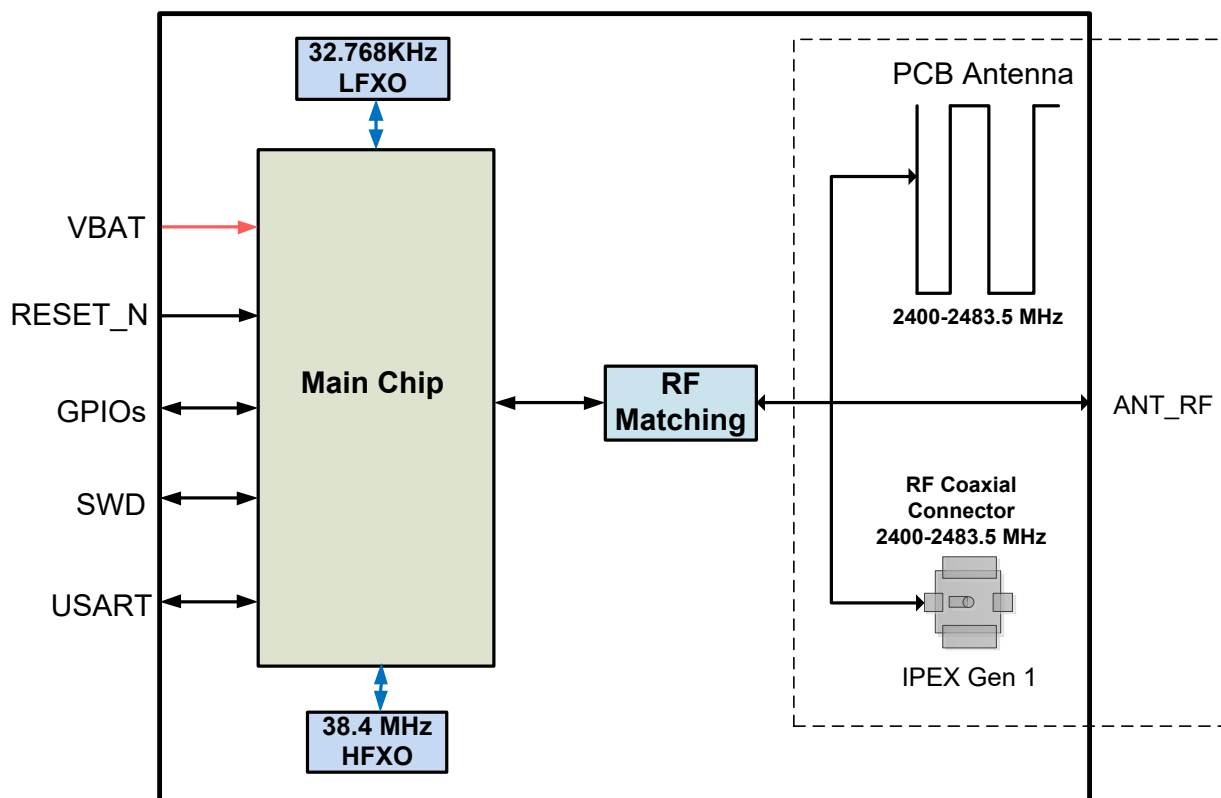


Figure 1: Functional Diagram

NOTE

1. The module is provided with one of the three antenna/antenna interface designs. For more details, please contact Quectel Technical Support.
2. The module supports 1 USART, 1 SWD and 16 GPIO interfaces by default. In the case of multiplexing, it supports interfaces including USART, SWD, I2C and ADC. For more details, see **Chapter 3.3** and **Chapter 3.4**.

3 Application Interfaces

3.1. Pin Assignment

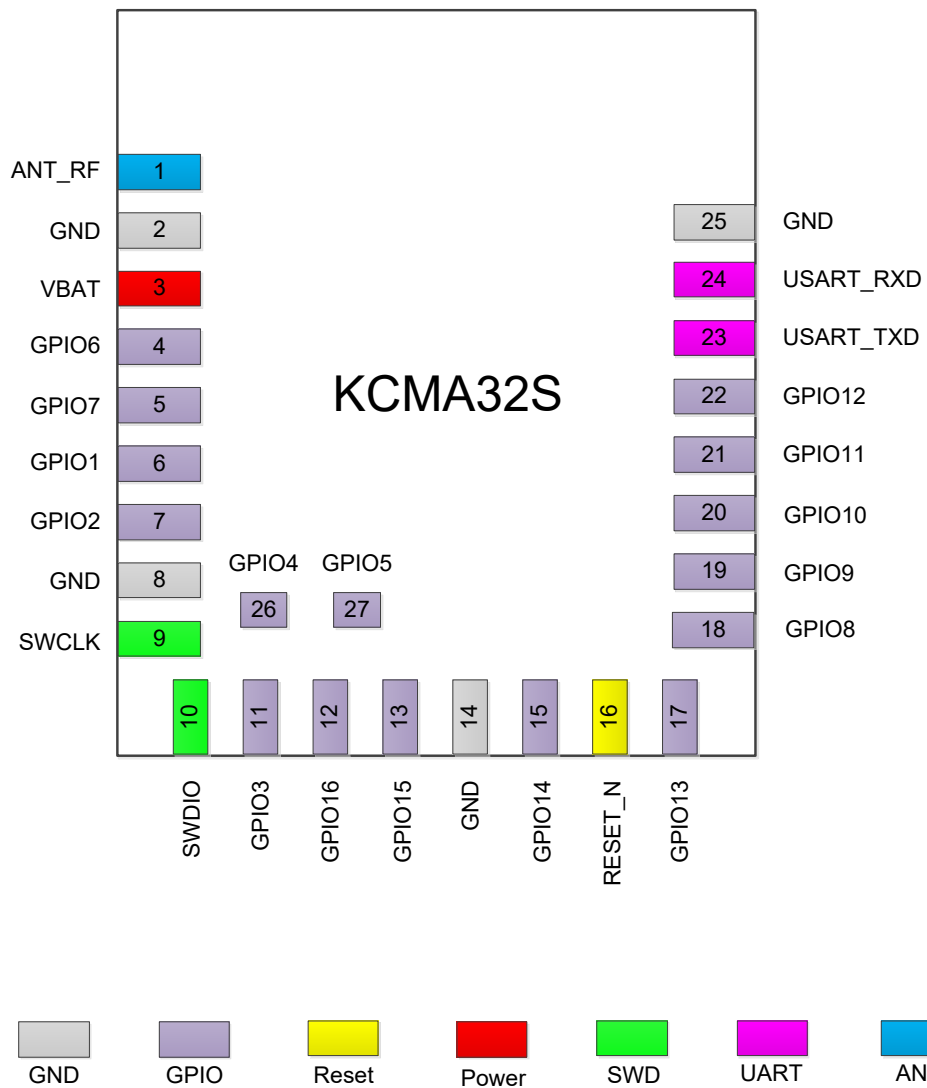


Figure 2: Pin Assignment (Top View)

NOTE

1. Keep all RESERVED and unused pins unconnected.
2. All GND pins should be connected to ground.
3. Ensure that there is no sink current on the pins before turning on the module.
4. For the chip pin names corresponding to the module pin, please contact Quectel Technical Support.
5. The module supports 1 USART, 1 SWD and 16 GPIO interfaces by default. In the case of multiplexing, it supports interfaces including USART, SWD, I2C and ADC. For more details, see **Chapter 3.3** and **Chapter 3.4**.

3.2. Pin Definitions

Table 4: Parameter Definition

Parameter	Description
AIO	Analog Input/Output
DI	Digital Input
DO	Digital Output
DIO	Digital Input/Output
PI	Power Input
PU	Pull Up
PD	Pull Down
Hi-Z	High Impedance

DC characteristics include power domain and rated current.

Table 5: Pin Description

Power Supply and GND Pins						
Pin Name	Pin No.	I/O	Status after Reset	Description	DC Characteristics	Comment
VBAT	3	PI	-	Power supply for the module	Vmin = 1.71 V Vnom = 3.3 V Vmax = 3.8 V	It is recommended to provide a current of more than 0.2 A.
GND	2, 8, 14, 25					Connect them to the ground.
Reset						
Pin Name	Pin No.	I/O	Status after Reset	Description	DC Characteristics	Comment
RESET_N	16	DI	PU	Reset the module	VBAT	Hardware reset. Pull it up to VBAT internally. Active low.
USART Interface						
Pin Name	Pin No.	I/O	Status after Reset	Description	DC Characteristics	Comment
USART_TXD	23	DO	Hi-Z	USART transmit	VBAT	Used for debugging.
USART_RXD	24	DI	Hi-Z	USART receive		
SWD Interface						
Pin Name	Pin No.	I/O	Status after Reset	Description	DC Characteristics	Comment
SWCLK	9	DI	PD	Serial wire debugging clock	VBAT	Used for program downloading. Enabled after power-up. Pull it down to GND internally.
SWDIO	10	DIO	PU	Serial wire debugging input/output		Used for program downloading. Enabled after power-up. Pull it up to VBAT

internally.

GPIO Interfaces

Pin Name	Pin No.	I/O	Status after Reset	Description	DC Characteristics	Comment
GPIO6	4	DIO	Hi-Z	General-purpose input/output	VBAT	Asynchronous external pin interrupts are supported in EM0 and EM1 modes.
GPIO7	5	DIO	Hi-Z	General-purpose input/output		
GPIO1	6	DIO	Hi-Z	General-purpose input/output		
GPIO2	7	DIO	Hi-Z	General-purpose input/output		
GPIO3	11	DIO	Hi-Z	General-purpose input/output		
GPIO16	12	DIO	Hi-Z	General-purpose input/output		
GPIO15	13	DIO	Hi-Z	General-purpose input/output		
GPIO14	15	DIO	Hi-Z	General-purpose input/output		
GPIO13	17	DIO	Hi-Z	General-purpose input/output		
GPIO8	18	DIO	Hi-Z	General-purpose input/output		
GPIO9	19	DIO	Hi-Z	General-purpose input/output		
GPIO10	20	DIO	Hi-Z	General-purpose input/output		
GPIO11	21	DIO	Hi-Z	General-purpose input/output		
GPIO12	22	DIO	Hi-Z	General-purpose input/output		
GPIO4	26	DIO	Hi-Z	General-purpose input/output		
GPIO5	27	DIO	Hi-Z	General-purpose input/output		

RF Antenna Interface*

Pin Name	Pin No.	I/O	Status after Reset	Description	DC Characteristics	Comment
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ANT_RF	1	AIO	-	RF antenna interface	50 Ω characteristic impedance.
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NOTE

1. EM0 mode is the normal operating mode (Active mode); EM1 is the sleep mode.
2. To reduce the probability of module damage and extend module service life, do not power up and down frequently.

3.3. GPIO Multiplexing

The module has 16 GPIO interfaces by default. In the case of multiplexing, it supports up to 20 GPIO interfaces. Pins are defined as follows:

Table 6: GPIO Multiplexing (Digital Pins)

Multiplexing Function	GPIO Interfaces			
	GPIO1–5, SWCLK, SWDIO	GPIO6, GPIO7	GPIO8–12, USART_TXD	GPIO13–16, USART_RXD
I2C0.SCL	√	√	√	√
I2C0.SDA	√	√	√	√
I2C1_SCL	-	-	√	√
I2C1_SDA	-	-	√	√
USART0.CLK	√	√	√	√
USART0.CS	√	√	√	√
USART0.CTS	√	√	√	√
USART0.RTS	√	√	√	√
USART0.RX	√	√	√	√
USART0.TX	√	√	√	√
USART1.CLK	√	√	-	-
USART1.CS	√	√	-	-

USART1.CTS	√	√	-	-
USART1.RTS	√	√	-	-
USART1.RX	√	√	-	-
USART1.TX	√	√	-	-
USART2.CLK	-	-	√	√
USART2.CS	-	-	√	√
USART2.CTS	-	-	√	√
USART2.RTS	-	-	√	√
USART2.RX	-	-	√	√
USART2.TX	-	-	√	√

Table 7: GPIO Multiplexing (Analog Pins)

Multiplexing Function	GPIO1–5, SWCLK, SWDIO	GPIO6, GPIO7	GPIO8–12, USART_TXD	GPIO13–16, USART_RXD
ADC0	√	√	√	√

NOTE

1. All GPIOs can be configured as interrupt signals in EM0 and EM1 modes.
2. SWCLK, SWDIO, GPIO1–7 can be configured as interrupt signals in EM2 and EM3 modes.
3. GPIO4, GPIO7, GPIO8, USART_TXD, GPIO15 have wake-up function in EM4 mode.
4. EM2 is deep sleep mode, EM3 is standby mode, EM4 is turn-off mode.
5. After the module is powered off, all of its GPIOs must be driven low. Otherwise, the current leakage may make the module enter an abnormal state.
6. The maximum number of each application interface multiplexed with GPIOs is not available simultaneously. For more details, see **Chapter 3.4**.

3.4. Interface Definition

3.4.1. USART Interface

The module supports 1 USART interface by default. In the case of multiplexing, it can support up to 3 USART interfaces. See **Table 6** for details. USART supports the following applications:

- UART (supporting full-duplex communication and hardware flow control)
- RS-485
- SPI
- MicroWire
- 3-wire
- ISO 7816 Smart-Cards
- IrDA
- I2S

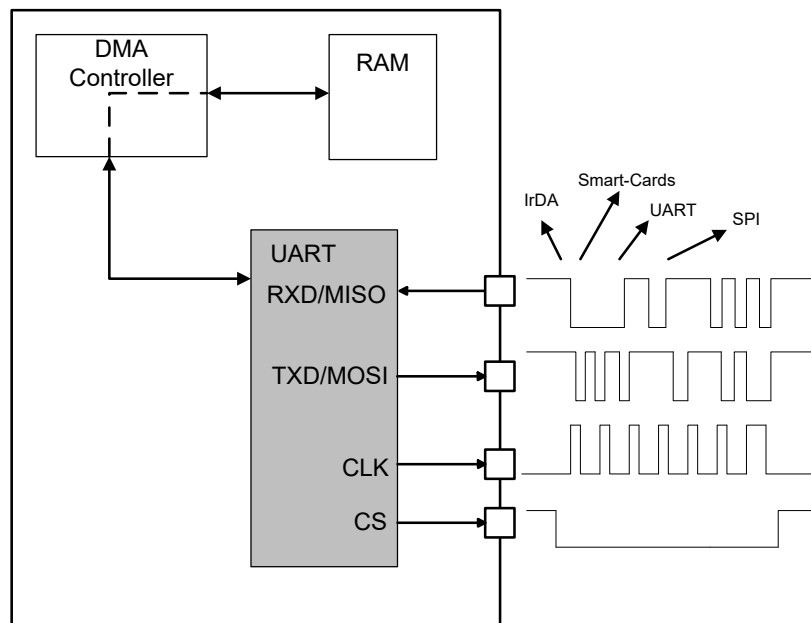


Figure 3: USART Functional Diagram

The USART operates in either asynchronous or synchronous mode:

- In synchronous mode, a separate clock signal generated by the bus master is transmitted with the data. Both the master and slave devices transmit data according to this clock. The synchronous communication mode is compatible with the SPI Bus standard.
- In asynchronous mode, no separate clock signal is transmitted with the data on the bus. The USART receiver thus has to determine where to sample the data on the bus from the actual data. To make it possible, additional synchronization bits are added to the data when operating in asynchronous mode.

Asynchronous or synchronous mode can be selected by configuring SYNC in register (USARTn_CTRL). For specific configuration methods, please consult Quectel Technical Support. The mode options with supported protocols are listed below:

Table 8: USART Synchronous/Asynchronous Mode

SYNC	Communication Mode	Protocol
0	Asynchronous	UART, RS-232, RS-485 (with external driver), IrDA, ISO 7816 Smart-Cards
1	Synchronous	I2S, SPI, MicroWire, 3-wire

USART can be used as a UART application for AT command communication and data transmission. In this case, it supports a self-configurable baud rate with a default baud rate of 115200 bps. UART connection between the module and the MCU is shown below. (The dotted lines are optional if required).

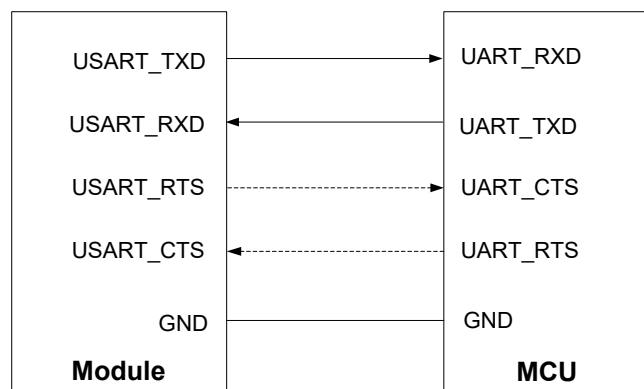


Figure 4: UART Interface Connection

The following figure shows the USART connection between the module and the host when used as SPI application.

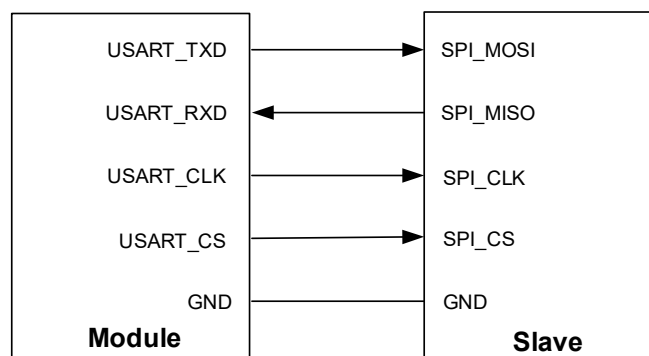


Figure 5: SPI Interface Connection (Master Mode)

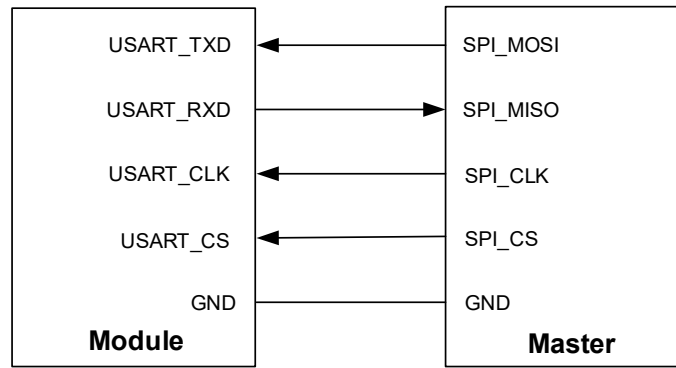


Figure 6: SPI Interface Connection (Slave Mode)

NOTE

When USART is used as an SPI application, the input and output signals must be converted in slave mode: the receiver receives the signal through USART_TXD (SPI_MOSI), and the transmitter drives USART_RXD (SPI_MISO) to send the signal.

The following figure shows the USART connection between the module and the host when used as I2S application.

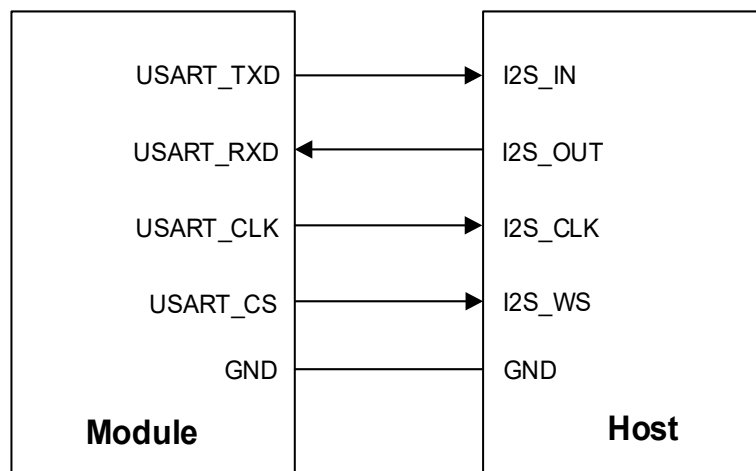


Figure 7: I2S Interface Connection

The following figure shows the USART connection between the module and the host when used as RS-485 application.

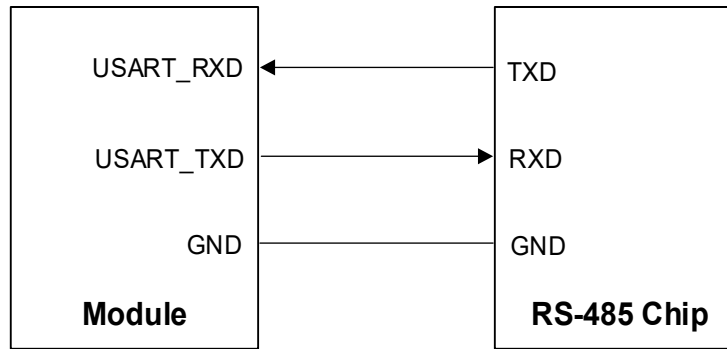


Figure 8: RS-485 Interface Connection

3.4.2. SWD Interface

The module supports a 2-wire SWD interface, the pin descriptions are shown in the table below.

Table 9: Pin Description of SWD Interface

Pin Name	Pin No.	I/O	Description	Comment
SWCLK	9	DI	Serial wire debugging clock	Used for program downloading. Enabled after power-up. Pull it down to GND internally.
SWDIO	10	DIO	Serial wire debugging input/output	Used for program downloading. Enabled after power-up. Pull it up to VBAT internally.

The SWD interface supports on-line program downloading and the common connection is shown below.

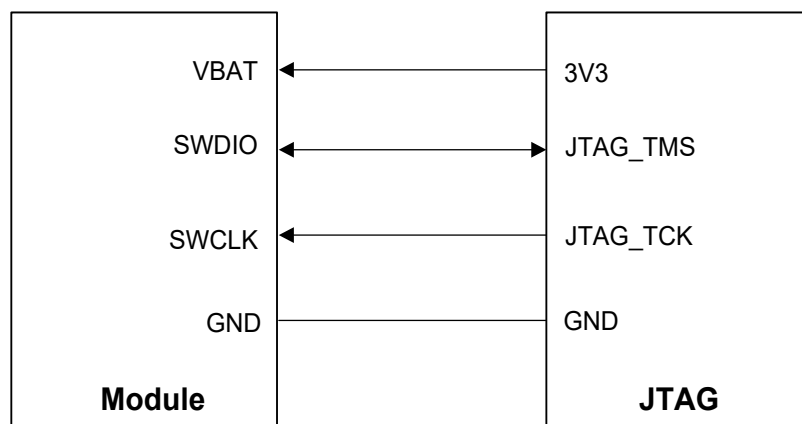


Figure 9: SWD Interface Connection

3.4.3. I2C Interface

In the case of multiplexing, the module can provide 2 I2C interfaces, both supporting master-slave mode and multi-master communication. Details of the interface multiplexing are shown in **Table 6**. The interface supports standard mode (100 kbps), fast mode (400 kbps) and fast+ mode (1 Mbps), and also complies with slave device arbitration and timeout for compatibility with the SMBus system. Automatic identification of slave device addresses is supported in EM0–EM3 power modes.

Both the I2C interfaces are open-drain. The maximum value of the pull-up resistor (R_p) can be calculated by the maximal rise-time (T_r) for the given bus speed and the estimated bus capacitance (C_b) as shown below:

$$R_p = T_r / (0.8473 \times C_b)$$

The maximal rise times for 100 kHz, 400 kHz and 1 MHz rate is 1 μ s, 300 ns and 120 ns respectively.

3.4.4. ADC Interface

In the case of multiplexing, the module support 1 ADC interface, and see **Table 7** for more details. The interface supports up to 12-bit resolution at 1 million samples per second. The flexible incremental architecture uses oversampling, allowing applications to trade speed for higher resolution.

The key features of ADC interface are as below:

- Flexible and configurable oversampling rate architecture, allowing trade-offs between rate and resolution:
 - 1 Msps with oversampling ratio = 2
 - 555 ksps with oversampling ratio = 4
 - 76.9 ksps with oversampling ratio = 32
- Internal and external conversion trigger sources
 - Immediate (software triggered)
 - Local ADC timer
 - External TIMER module (synchronous with output/PWM generation)
 - General PRS hardware signal
- Selectable reference sources
 - 1.21 V internal reference
 - External precision reference
 - Analog power supply
- Support offset and gain calibration
- Programmable input gain: 0.5 x, 1 x, 2 x, 3 x or 4 x
- Flexible output format
- Programmable single-channel conversion
- Independent multi-channel sequential inspection
- Abundant interrupt resources

3.4.5. GPIO Interfaces

In the case of multiplexing, the module supports up to 20 GPIO interfaces, and see **Table 6** and **Table 7** for more details. Each GPIO pin can be independently configured as input or output, as well as open-drain, open-source, glitch filtering, and other functions. Except for the SWD interface pins (SWDIO, SWCLK) and USART interface pins (USART_TXD, USART_RXD), the input and output functions of the other 16 GPIO pins are disabled after reset of the system. External resources such as timers, PWM or USART_RXD/TXD can be customized via the GPIO pins as required. The input value of a single pin can be configured to other peripherals via PRS or used to trigger external interrupts.

4 Operating Characteristics

4.1. Power Supply Interface

Table 10: Pin Description of Power Supply and GND Pins

Pin Name	Pin No.	I/O	Description	Min.	Typ.	Max.	Unit
VBAT	3	PI	Power supply for the module	1.71	3.3	3.8	V
GND	2, 8, 14, 25						

4.1.1. Reference Design for Power Supply

The module is powered by VBAT, and it is recommended to use a power supply chip that provides more than 0.2 A to ensure sufficient current. For better power supply performance, it is recommended to parallel a 22 μ F decoupling capacitor, and 2 filter capacitors (1 μ F and 100 nF) near the module's VBAT pin. C4 is reserved for debugging and not mounted by default. In addition, it is recommended to add a TVS diode near the VBAT to improve the surge voltage bearing capacity of the module. In principle, the longer the VBAT trace is, the wider it should be.

The reference design for the VBAT is shown below:

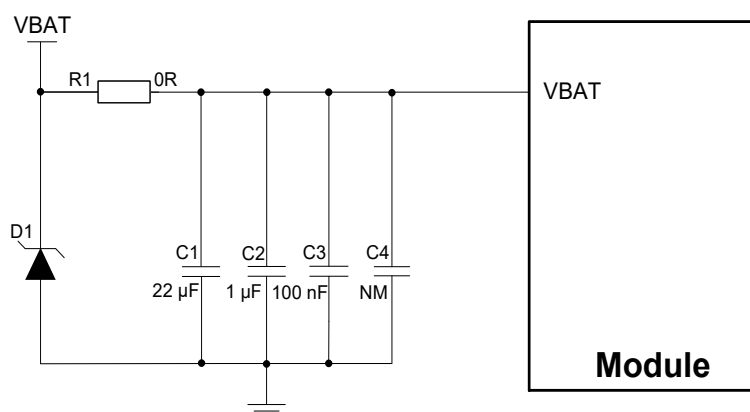


Figure 10: Reference Design of Power Supply

4.2. Reset

Pull RESET_N down for at least 100 ns and then release it to reset the module.

Table 11: Pin Description of RESET_N

Pin Name	Pin No.	I/O	Description	Comment
RESET_N	16	DI	Reset the module	Hardware reset. Pull it up to VBAT internally. Active low.

The reference design for resetting the module is shown below. Press the button directly to realize the resetting of the module. At the same time, it is recommended to place a TVS diode near the button for ESD protection and a 100 nF capacitor to avoid jittering.

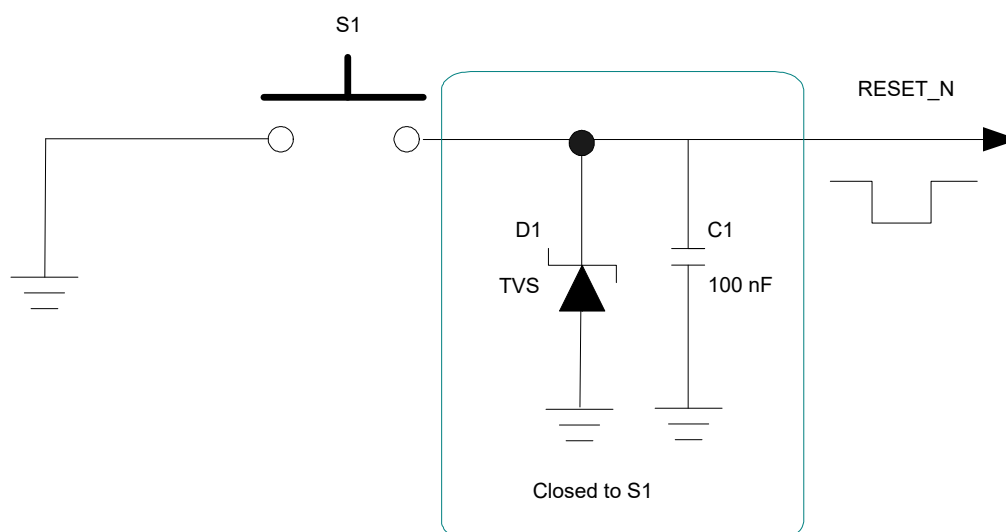


Figure 11: Reference Circuit for RESET_N with a Button

The module reset timing is shown below:

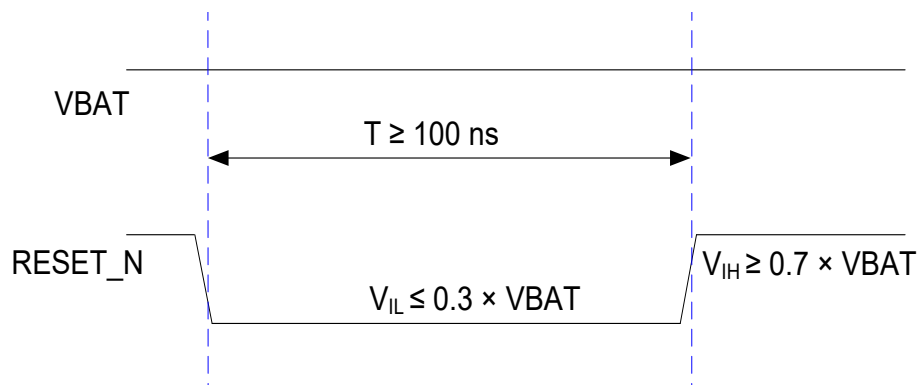


Figure 12: Reset Timing

NOTE

RESET_N is internally integrated with a 44 k Ω (Typ.) resistor.

5 RF Specifications

5.1. ZigBee Specifications

Table 12: ZigBee Specifications

Operating Frequency		
2.400–2.4835 GHz		
Modulation		
O-QPSK		
Operating Mode		
ZigBee 3.0		
Condition (VBAT = 3.3 V; Temp. 25°C)	Transmitting Power	Receiving Sensitivity
CH11 (2405 MHz)	≤ 20 dBm	-104.5 dBm ±2 dB
CH18 (2440 MHz)	≤ 20 dBm	-104.2 dBm ±2 dB
CH26 (2480 MHz)	≤ 20 dBm	-104 dBm ±2 dB

5.2. Bluetooth Specifications

Table13: Bluetooth Specifications

Operating Frequency		
2.400~2.4835 GHz		
Modulation		

GFSK

Operating Mode

BLE

Condition (VBAT = 3.3 V; Temp. 25°C)		
	Transmitting Power	Receiving Sensitivity
BLE (1 Mbps)	≤ 20 dBm	-97.1
BLE (2 Mbps)	≤ 20 dBm	-94.0
BLE (S = 2)	≤ 20 dBm	-100.5
BLE (S = 8)	≤ 20 dBm	-105.0

5.3. Antenna/Antenna Interfaces ⁶

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

The module is provided with one of the three antenna/antenna interface designs: pin antenna interface (ANT_RF)*, PCB antenna and RF coaxial connector. The RF coaxial connector is not soldered when the module is designed with PCB antenna or pin antenna interface. The impedance of antenna port is 50 Ω.

⁶ The module is provided with one of the three antenna/antenna interface designs. For more details, please contact Quectel Technical Support.

5.3.1. Pin Antenna interface (ANT_RF)*

Table 14: Pin Description of ANT_RF

Pin Name	Pin No.	I/O	Description	Comment
ANT_RF	1	AIO	RF antenna interface	50 Ω characteristic impedance.

5.3.1.1. Reference Design

The circuit of pin antenna interface is shown below. For better RF performance, it is recommended to reserve a dual-L type circuit and ESD protection components. The reserved matching components (R1, C1, C2 and D1) should be placed as close to the antenna as possible and should be mounted or not based on the actual situation. By default, C1, C2 and D1 are not mounted, and only a 0 Ω resistor is mounted at R1. The parasitic capacitance of TVS should be less than 0.05 pF.

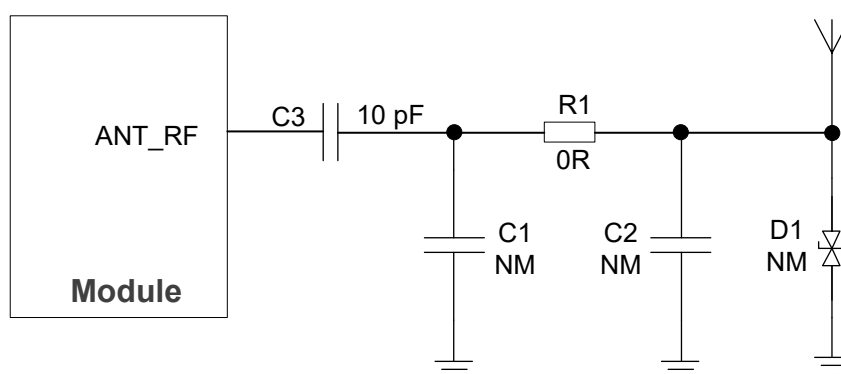


Figure 13: Reference Design of Antenna Interface

NOTE

Notes on C3:

- 1) If there is DC power at the antenna ports, place a capacitor on C3 to prevent short circuit to ground. The capacitance value is recommended to be 10 pF, which can be adjusted according to the debugging results.
- 2) If there is no DC power in the peripheral design:
 - a) Do not reserve C3.
 - b) If C3 has already been reserved, it should be mounted with components, and it is recommended to use 0 Ω resistors. You can also match the components according to the debugging results.

5.3.1.2. RF Routing Guidelines

For user's PCB, the characteristic impedance of all RF traces should be controlled to $50\ \Omega$. 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.

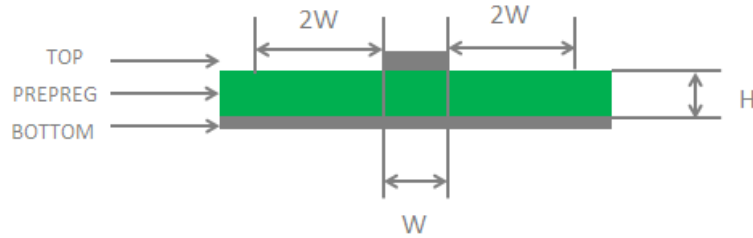


Figure 14: Microstrip Design on a 2-layer PCB

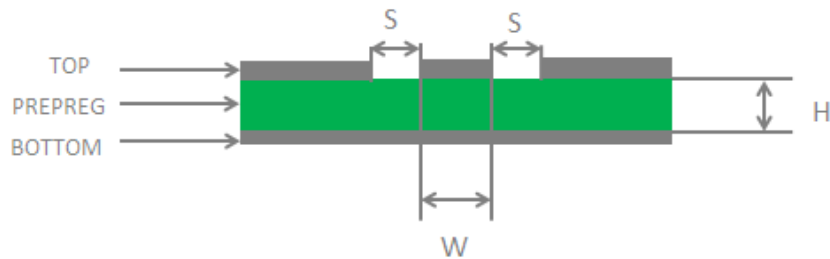


Figure 15: Coplanar Waveguide Design on a 2-layer PCB

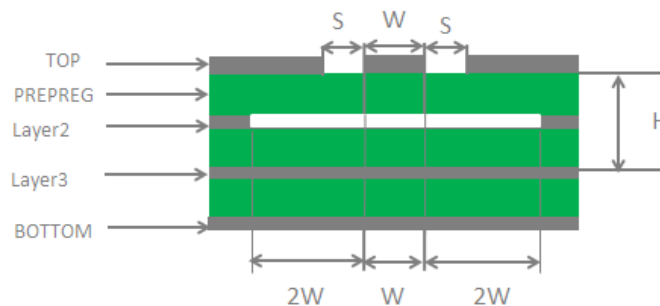


Figure 16: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

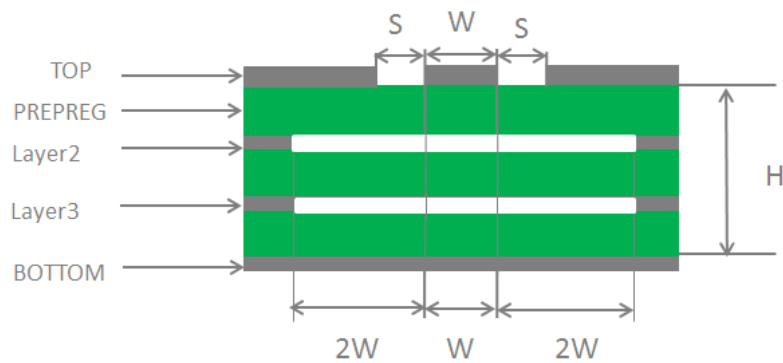


Figure 17: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

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

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

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

5.3.2. PCB Antenna

Table 15: Requirements for PCB Antenna

Parameters	Requirements
Frequency Range (GHz)	2.4 GHz: 2.400–2.4835
Input Impedance (Ω)	50 (Typ.)
VSWR	≤ 4

Gain (dBi)	1.4 (Max.)
Efficiency	30 % (Avg.)

The performance of the PCB antenna depends on the entire product, including the motherboard, case, and other RF signals, and it is recommended to verify it at the early stage of design. To ensure the performance and reliability when designed with PCB antenna, follow the basic principles below for module's placement and layout:

- The module should be placed on the edge of the motherboard.
- On the motherboard, all PCB layers under the PCB antenna should be designed as keepout areas.
- The PCB antenna area extends beyond the motherboard, and keep the antenna feed point close to the edge of the board as much as possible.
- On the motherboard, ensure a minimum clearance of 16 mm between the PCB antenna and vias, traces, copper pour area, and other components, such as connectors, Ethernet ports and any metal components.
- If using a plastic case, ensure a minimum clearance of 10 mm between the PCB antenna and the plastic case. If using a metal case, it is recommended to use an external antenna

NOTE

If any of the above principles cannot be guaranteed, it is advisable to explore alternative antenna solutions for the module or seek assistance from the Quectel Antenna Team, who can offer design assistance and recommend suitable external antennas. Please feel free to contact Quectel Technical Support if necessary.

It is recommended to place the module at areas 1 and 5 as showing in the figure bellow.

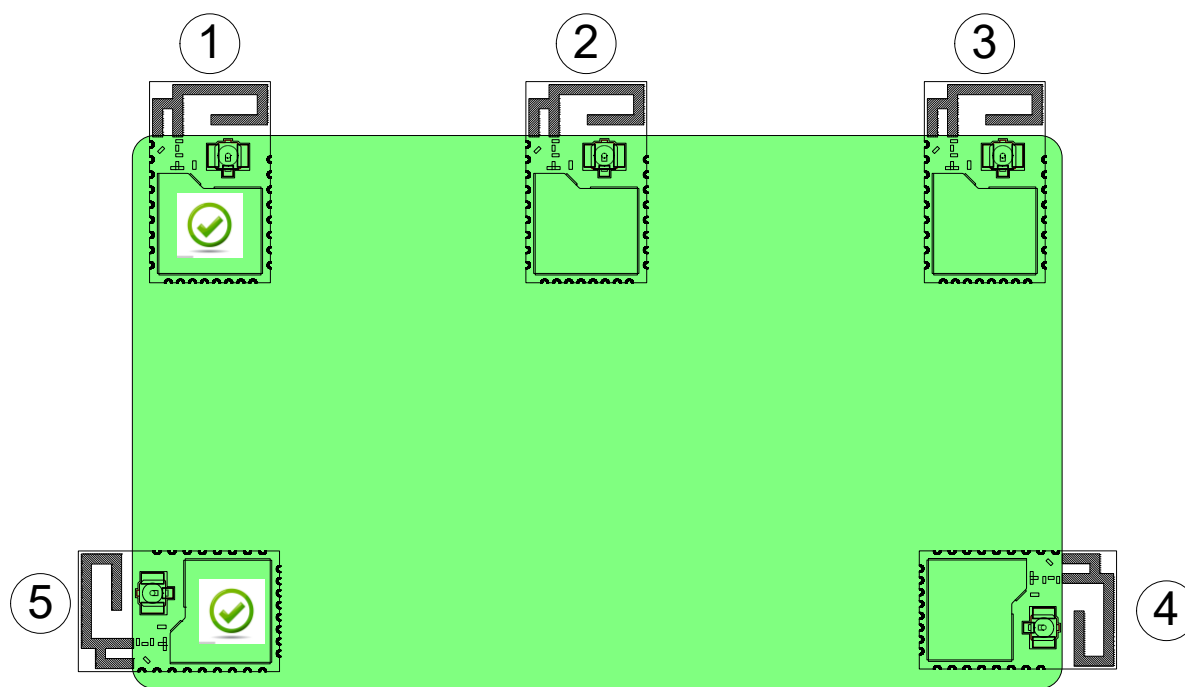


Figure 18: Module Placement

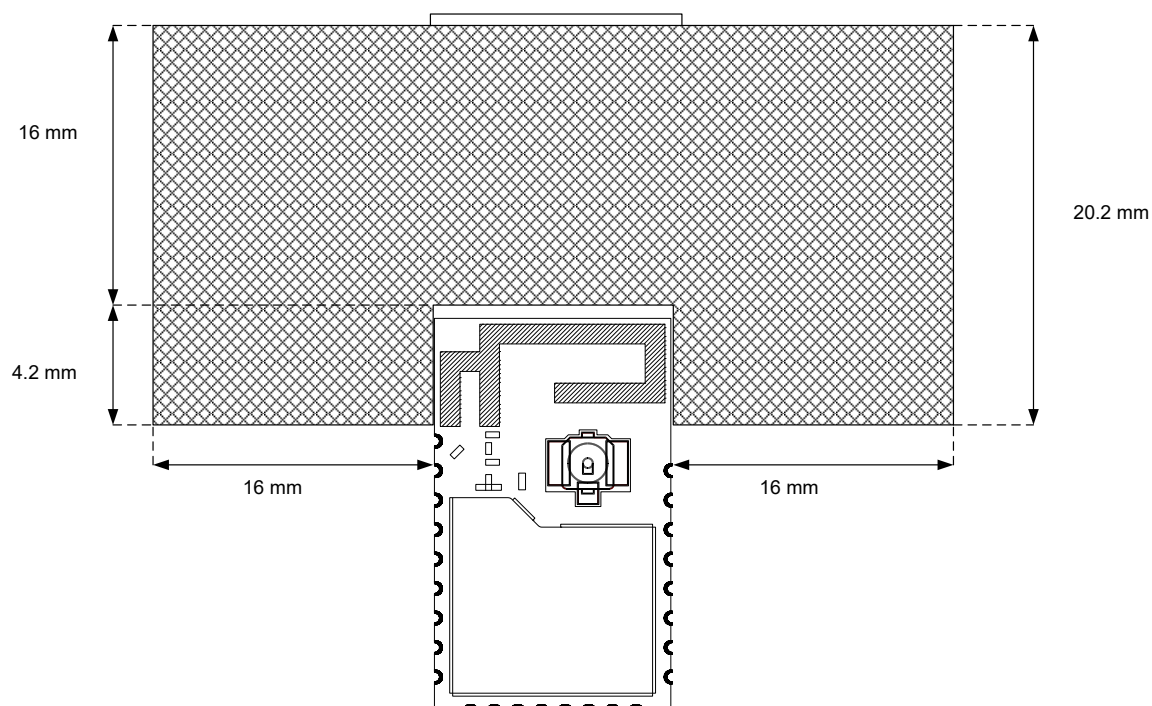


Figure 19: Keepout Area on Motherboard

To ensure module performance, do not route at the RF test point at the bottom of the module during PCB design. The prohibited area during routing is shown in the red box below:

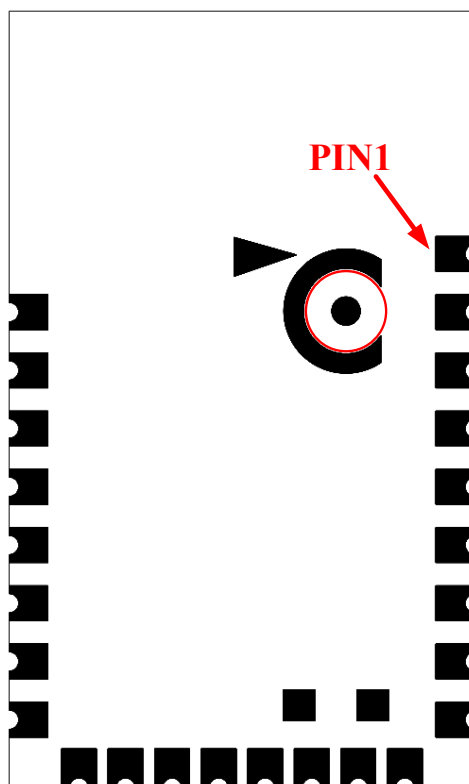


Figure 20: Prohibited Area During Routing (Bottom Side)

5.3.3. RF Coaxial Connector

5.3.3.1. RF Connector Specifications

The mechanical dimensions of the receptacle are as follows.

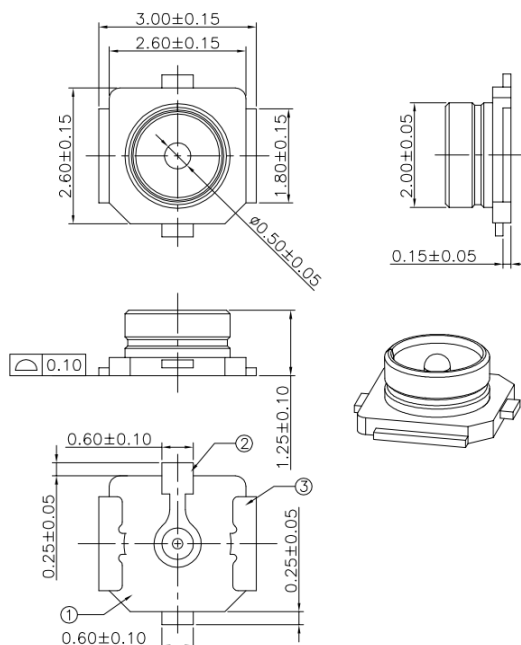


Figure 21: Dimensions of the Receptacle (Unit: mm)

Table 16: Major Specifications of the RF Connector

Parameters	Specification
Nominal Frequency Range	DC to 6 GHz
Nominal Impedance	50 Ω
Temperature Ranges	-40 °C to +85 °C
Voltage Standing Wave Ratio (VSWR)	Meet the requirements of: Max. 1.3 (DC–3 GHz) Max. 1.45 (3–6 GHz)

5.3.3.2. Antenna Connector Installation

The receptacle used in conjunction with the module will accept two types of mated plugs that will meet a maximum height of 2.0 mm using a $\varnothing 0.81$ mm coaxial cable or a maximum height of 2.2 mm utilizing a $\varnothing 1.13$ mm coaxial cable.

The following figure shows the dimensions of mated plugs using a $\varnothing 0.81$ mm coaxial cable.

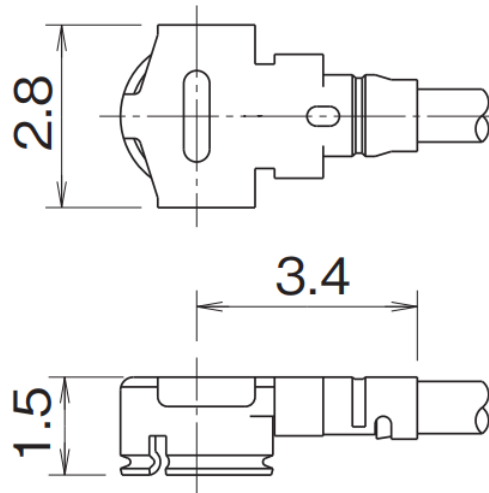


Figure 22: Dimensions of the Receptacle (Unit: mm)

The following figure illustrates the connection between the receptacle on the module and the mated plug using a $\varnothing 0.81$ mm coaxial cable.

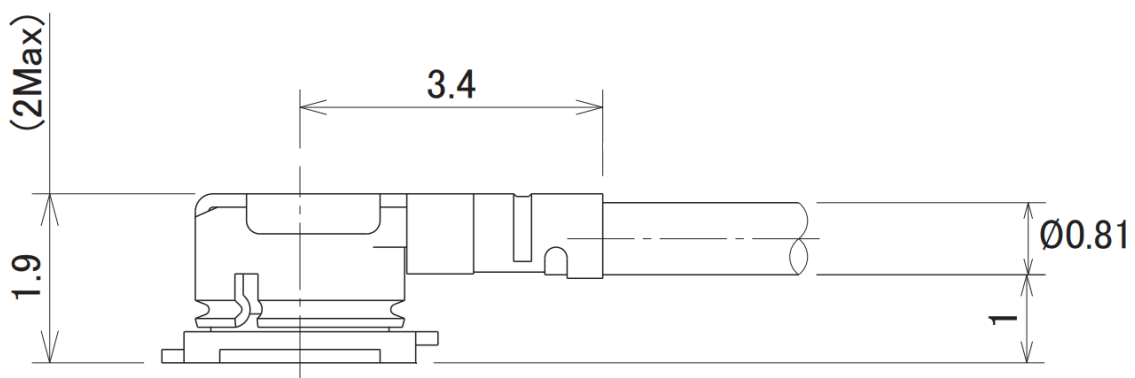


Figure 23: Space Factor of Mated Connectors ($\varnothing 0.81$ mm Coaxial Cables) (Unit: mm)

The following figure illustrates the connection between the receptacle on the module and the mated plug using a $\varnothing 1.13$ mm coaxial cable.

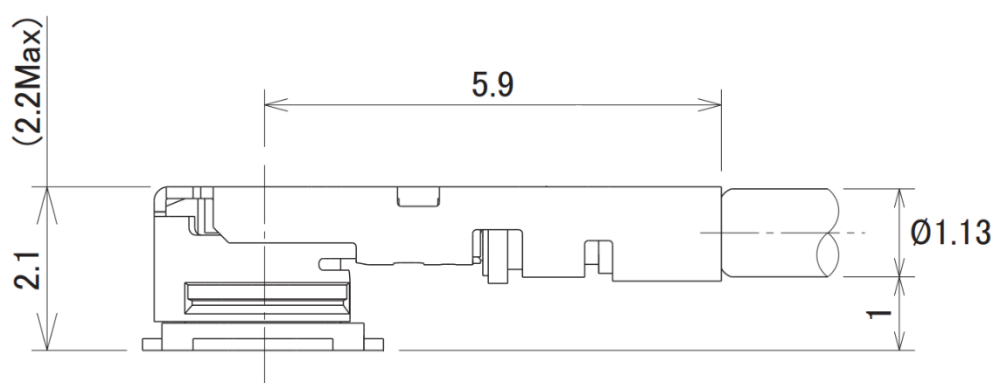


Figure 24: Space Factor of Mated Connectors ($\varnothing 1.13$ mm Coaxial Cables) (Unit: mm)

5.3.3.3. Recommended Manufacturers of RF Connector and Cable

RF connectors and cables by I-PEX are recommended. For more details, visit <https://www.i-pex.com>.

5.3.4. Requirements for Antenna Design

Table 17: Requirements for Antenna Design

Parameters	Requirements
Frequency Range (GHz)	2.4 GHz: 2.400–2.4835
Loss (dB)	< 1
Input Impedance (Ω)	50 (Typ.)
VSWR	≤ 2
Gain (dBi)	1 (Typ.)
Polarization	Vertical

6 Electrical Characteristics and Reliability

6.1. Absolute Maximum Ratings

Table 18: Absolute Maximum Ratings (Unit: V)

Parameters	Min.	Max.
VBAT	-0.3	3.8
Voltage at digital pins	-0.3	4.1
Input voltage at ADC	0	3.8

NOTE

Exceeding the conditions of use as shown above may cause permanent damage to the module.

6.2. Power Supply Ratings

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

Parameters	Description	Condition	Min.	Typ.	Max.
VBAT	Power supply for the module	The actual input voltages must be kept between the minimum and maximum values	1.71	3.3	3.8

6.3. ZigBee Power Consumption

Table 20: ZigBee Power Consumption

Mode	Typ.	Max.	Unit
Sleep	-	TBD	μA
CH11 (2405 MHz) @ Tx 20 dBm	125.391	191.503	mA
CH18 (2440 MHz) @ Tx 20 dBm	126.203	192.761	mA
CH26 (2480 MHz) @ Tx 20 dBm	126.262	192.923	mA

NOTE

1. Test Condition: the power domain of typical values at an ambient temperature of 25 °C.
2. The above power consumption data are tested as typical values, which are for reference only. Due to differences in internal components, software versions and ambient temperature during the test, the power consumption of different modules may vary. For more details, contact Quectel Technical Support.

6.4. Digital I/O Characteristics

Table 21: I/O Characteristics (Unit: V; VBAT = 3.3 V)

Parameters	Description	Min.	Max.
V _{IH}	High-level input voltage	0.7 × VBAT	-
V _{IL}	Low-level input voltage	-	0.3 × VBAT
V _{OH}	High-level output voltage	0.8 × VBAT	-
V _{OL}	Low-level output voltage	-	0.2 × VBAT

6.5. ESD Protection

Static electricity occurs naturally and it may damage the module. Therefore, applying proper ESD countermeasures and handling methods is imperative. For example, wear anti-static gloves during the development, production, assembly and testing of the module; add ESD protection components to the ESD sensitive interfaces and points in the product design.

Table 22: Electrostatic Discharge Characteristics (Unit: kV)

Model	Test Result	Reference Standard
Human Body Model	± 4	ANSI/ESDA/JEDEC JS-001-2017
Charge Device Model	± 1	ANSI/ESDA/JEDEC JS-002-2018

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

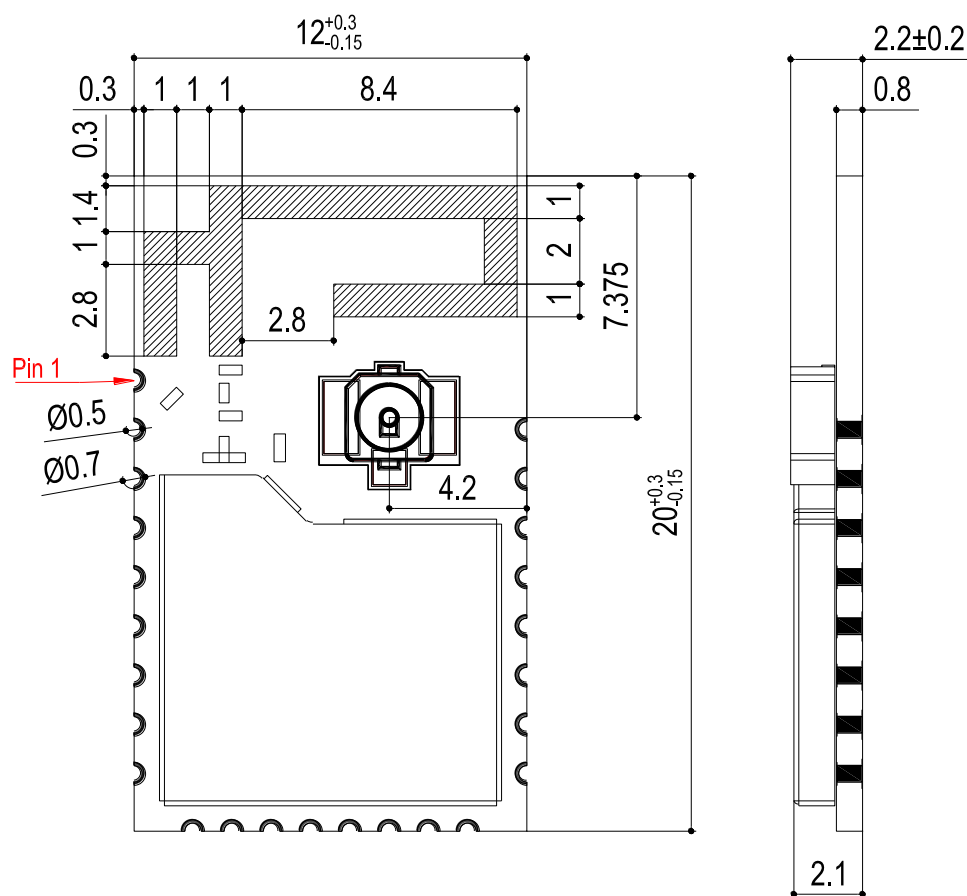


Figure 25: Top and Side Dimensions

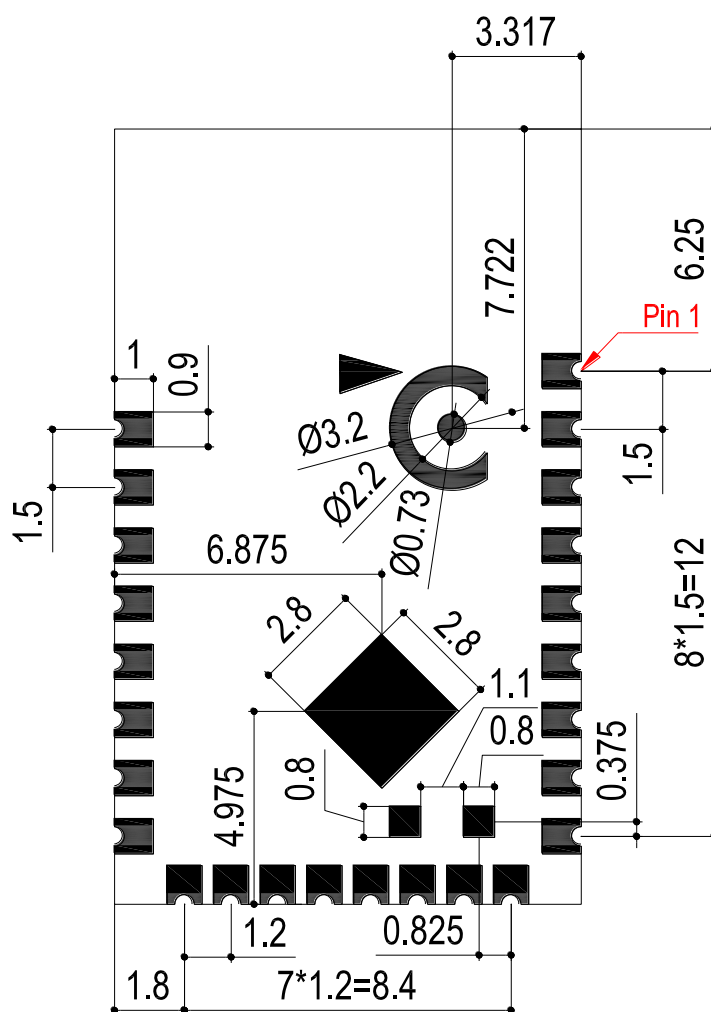


Figure 26: Bottom Dimension

NOTE

The module's coplanarity standard: ≤ 0.13 mm.

7.2. Recommended Footprint

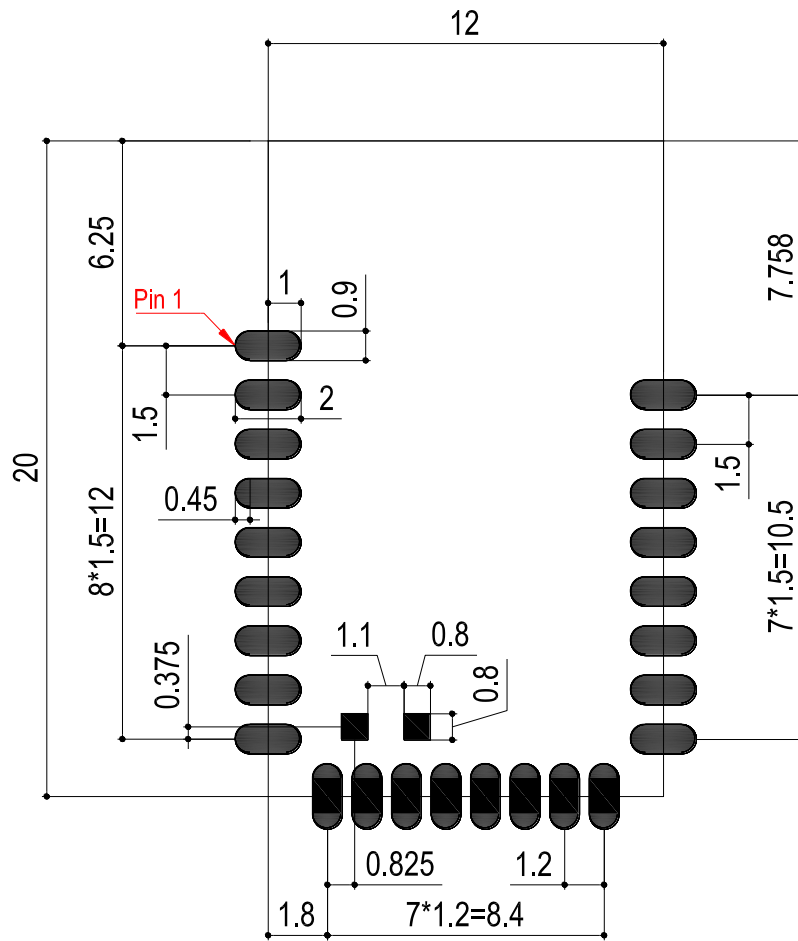


Figure 27: Recommended Footprint

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

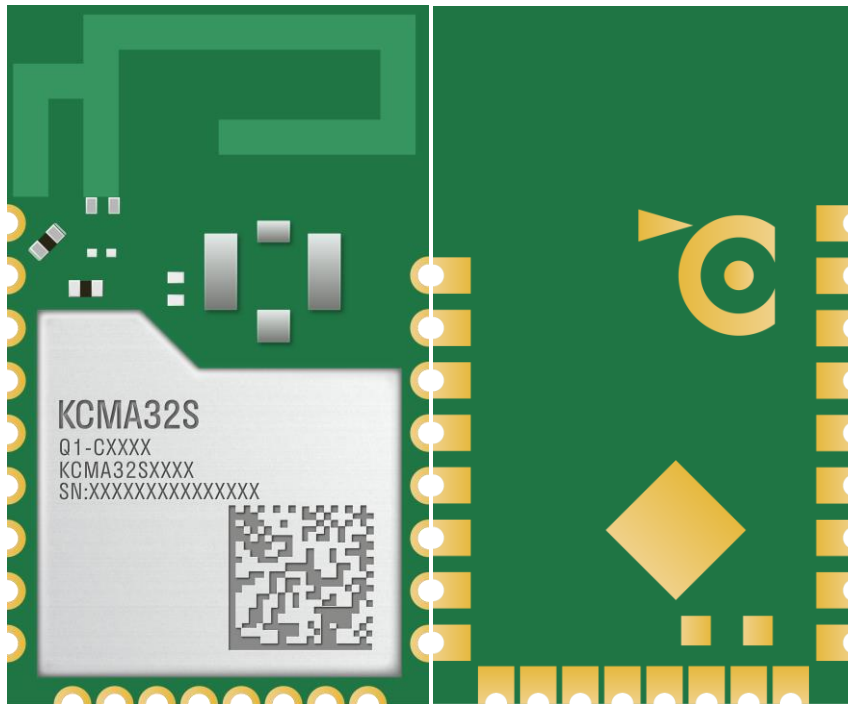


Figure 28: Top and Bottom Views (Antenna Interface)

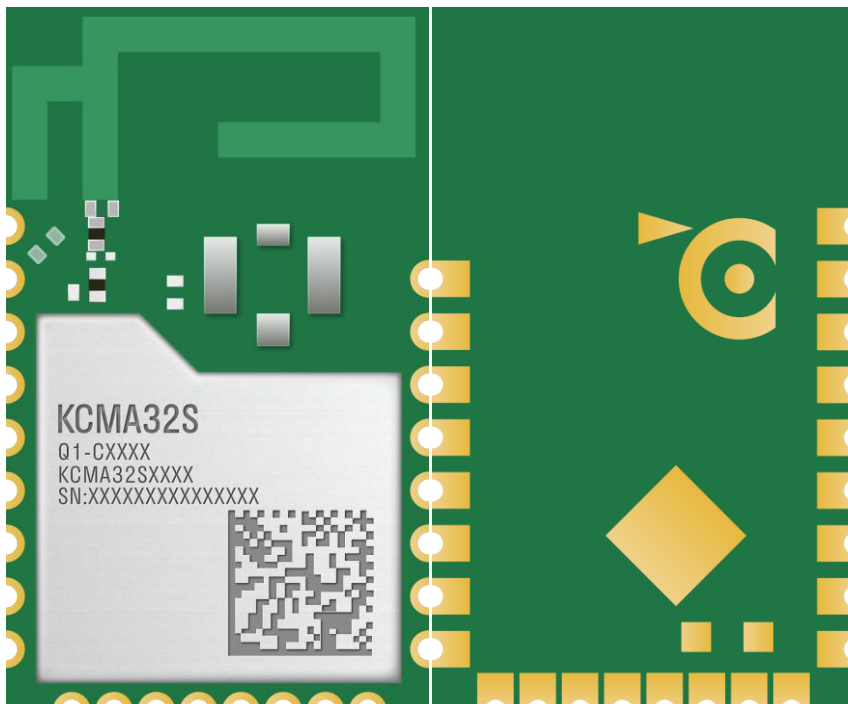


Figure 29: Top and Bottom Views (PCB Antenna)

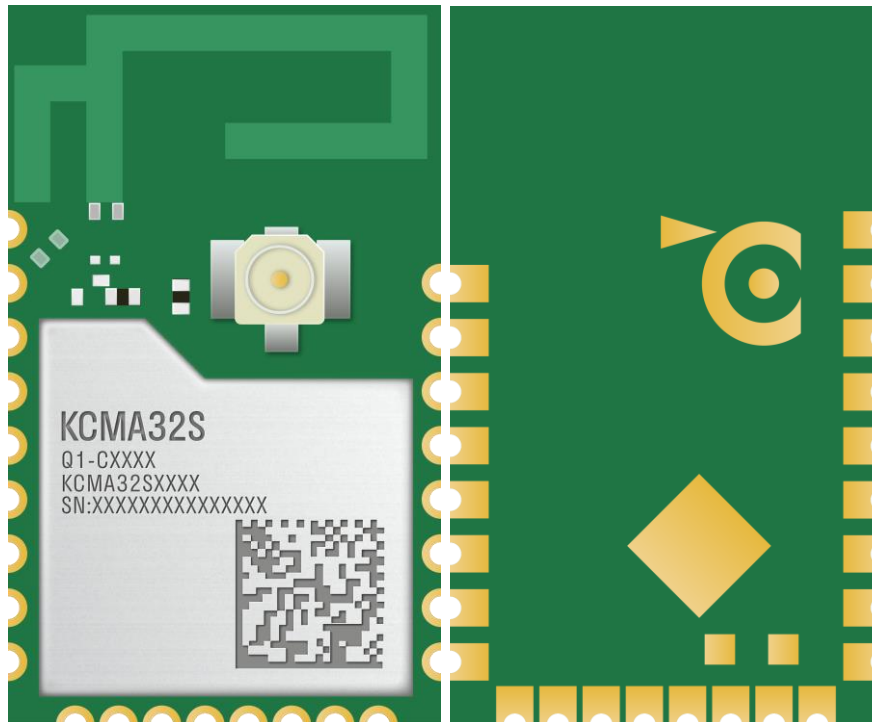


Figure 30: Top and Bottom Views (RF Coaxial Connector)

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 and 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 ⁷ in a factory where the temperature is 23 ± 5 °C and relative humidity is below 60 %. After the vacuum-sealed packaging is removed, the module must be processed in reflow soldering or other high-temperature operations within 168 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10 % (e.g., a dry cabinet).
4. The module should be pre-baked to avoid blistering, cracks and inner-layer separation in PCB under the following circumstances:
 - The module is not stored in Recommended Storage Condition;
 - Violation of the third requirement mentioned above;
 - Vacuum-sealed packaging is broken, or the packaging has been removed for over 24 hours;
 - Before module repairing.
5. If needed, the pre-baking should follow the requirements below:
 - The module should be baked for 24 hours at 120 ± 5 °C;
 - The module must be soldered to PCB within 24 hours after the baking, otherwise it should be put in a dry environment such as in a dry cabinet.

⁷ This floor life is only applicable when the environment conforms to *IPC/JEDEC J-STD-033*. It is recommended to start the solder reflow process within 24 hours after the package is removed if the temperature and moisture do not conform to, or are not sure to conform to *IPC/JEDEC J-STD-033*. And 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 0.12–0.15 mm. For more details, see **document [3]**.

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

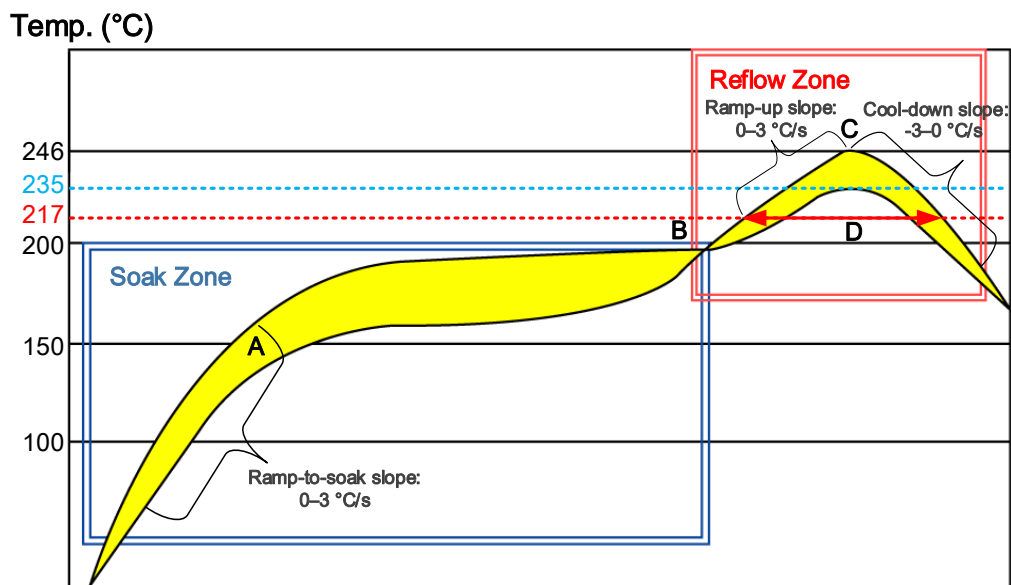


Figure 31: Recommended Reflow Soldering Thermal Profile

Table 23: Recommended Thermal Profile Parameters

Factor	Requirements
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-to-soak 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.
3. The shielding can for the module is made of Cupro-Nickel base material. It is tested that after 12 hours' Neutral Salt Spray test, the laser engraved label information on the shielding can is still clearly identifiable and the QR code is still readable, although white rust may be found.
4. If a conformal coating is necessary for the module, do not use any coating material that may chemically react with the PCB or shielding cover, and prevent the coating material from flowing into the module.
5. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.
6. Avoid using materials that contain mercury (Hg), such as adhesives, for module processing, even if the materials are RoHS compliant and their mercury content is below 1000 ppm (0.1 %).
7. Corrosive gases may corrode the electronic components inside the module, affecting their reliability and performance, and potentially leading to a shortened service life that fails to meet the designed lifespan. Therefore, do not store or use unprotected modules in environments containing corrosive gases such as hydrogen sulfide, sulfur dioxide, chlorine, and ammonia.
8. Due to the complexity of the SMT process, please contact Quectel Technical Support in advance

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

8.3. Packaging Specification

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

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

8.3.1. Carrier Tape

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

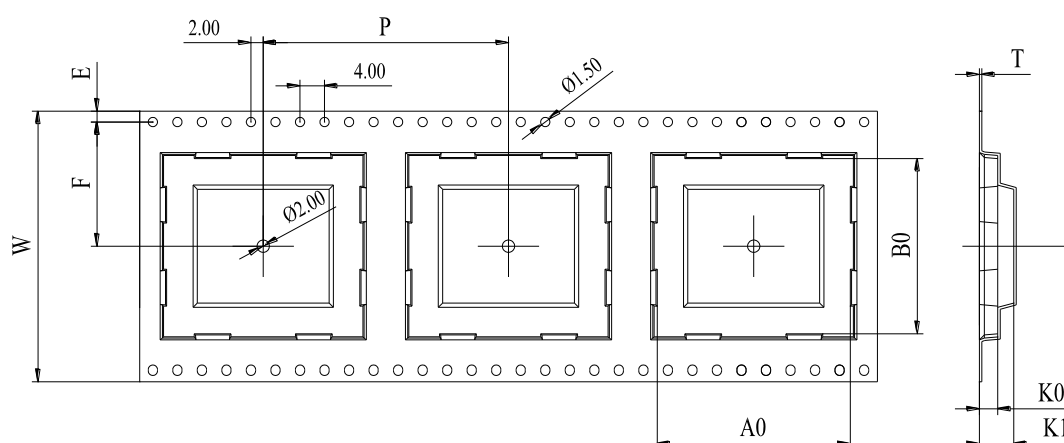


Figure 32: Carrier Tape Dimension Drawing (Unit: mm)

Table 24: Carrier Tape Dimension Table (Unit: mm)

W	P	T	A0	B0	K0	K1	F	E
44	20	0.4	12.5	20.5	2.7	3.9	20.2	1.75

8.3.2. Plastic Reel

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

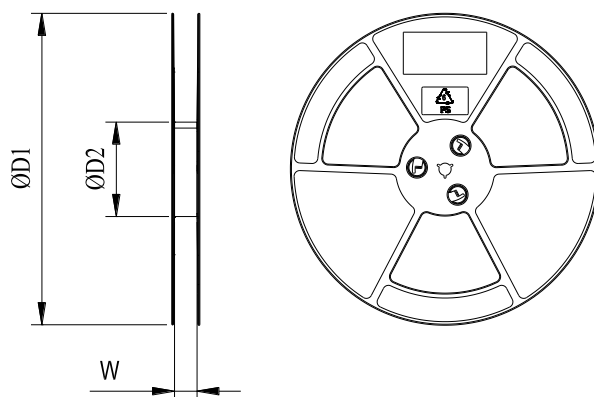


Figure 33: Plastic Reel Dimension Drawing

Table 25: Plastic Reel Dimension Table (Unit: mm)

ØD1	ØD2	W
380	100	44.5

8.3.3. Mounting Direction

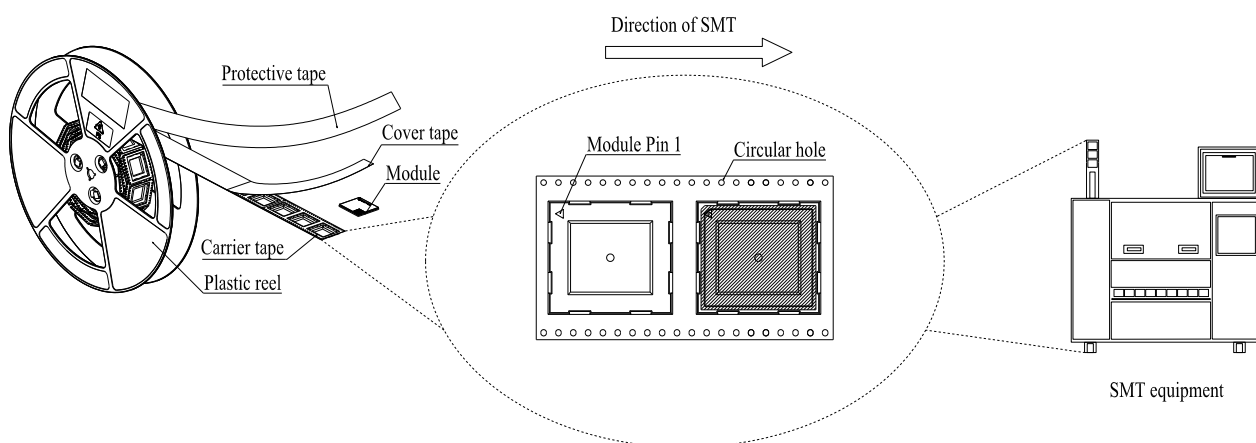
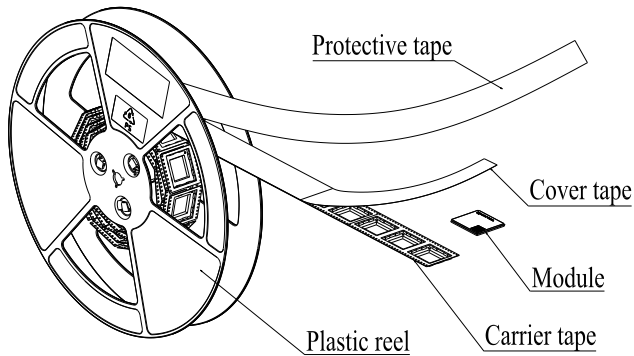


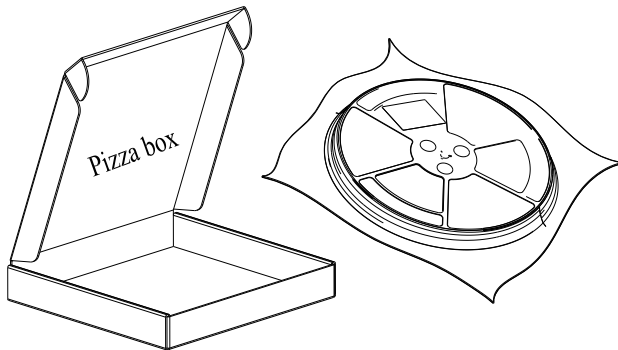
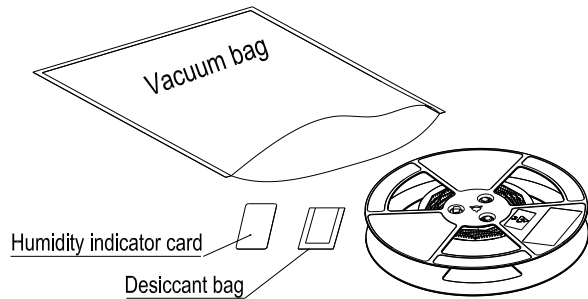
Figure 34: Mounting Direction

8.3.4. Packaging Process



Place the modules onto the carrier tape cavity and cover them securely with cover tape. Wind the heat-sealed carrier tape onto a plastic reel and apply a protective tape for additional protection. 1 plastic reel can pack 1000 modules.

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



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

Place the 4 packaged pizza boxes into 1 carton and seal it. 1 carton can pack 4000 modules.

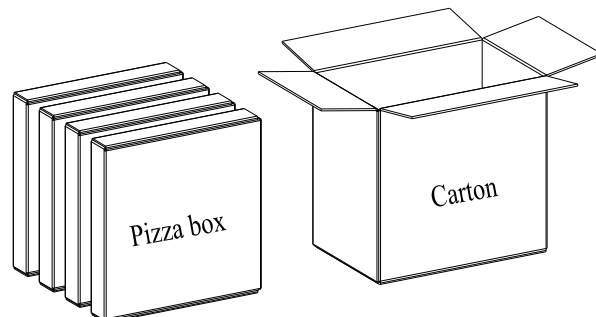


Figure 35: Packaging Process

9 Appendix References

Table 26: Related Documents

Document Name
[1] Quectel_KCMA32S_TE-B_User_Guide
[2] Quectel_RF_Layout_Application_Note
[3] Quectel_Module_Stencil_Design_Requirements
[4] Quectel_Module_SMT_Application_Note

Table 27: Terms and Abbreviations

Abbreviation	Description
ADC	Analog to Digital Converter
AES	Advanced Encryption Standard
ARM	Advanced RISC Machine
BLE	Bluetooth Low Energy
DC	Direct Current
DMA	Direct Memory Access
EM	Energy Mode
ESD	Electrostatic Discharge
GND	Ground
GPIO	General-Purpose Input/Output
HFXO	High Frequency Crystal Oscillator
I/O	Input/Output

I2C	Inter-Integrated Circuit
I2S	Inter-IC Sound
IrDA	Infra-red Data Association
JTAG	Joint Test Action Group
ksps	Kilo Samples Per Second
LCC	Leadless Chip Carrier (package)
LFXO	Low Frequency Crystal Oscillator
LGA	Land Grid Array
MCU	Microcontroller Unit
MISO	Master In Slave Out
MOSI	Master Out Slave In
O-QPSK	Offset Quadrature Phase Shift Keying
OTA	Over-The-Air
PCB	Printed Circuit Board
PRS	Peripheral Reflex System
PWM	Pulse Width Modulation
RF	Radio Frequency
RoHS	Restriction of Hazardous Substances
SPI	Serial Peripheral Interface
SRAM	Static Random-Access Memory
SWD	Serial Wire Debug
TVS	Transient Voltage Suppressor
Tx	Transmit
UART	Universal Asynchronous Receiver/Transmitter
USART	Universal Synchronous/Asynchronous Receiver/Transmitter

(U)SIM	(Universal) Subscriber Identity Module
V_{IH}	High-level Input Voltage
V_{IL}	Low-level Input Voltage
V_{max}	Maximum Voltage
V_{min}	Minimum Voltage
V_{nom}	Nominal Voltage
V_{OH}	High-level Output Voltage
V_{OL}	Low-level Output Voltage
VSWR	Voltage Standing Wave Ratio

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: XMR2025KCMA32S.

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:

☐ Zigbeeh/BLE:1.4dBi

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: XMR2025KCMA32S." or "Contains FCC ID: XMR2025KCMA32S." 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 transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development 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:

☐ Zigbee/BLE:1.4dBi

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 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-2025KCMA32S” or “where: 10224A-2025KCMA32S is the module’s certification number”.