FCM561D-P

Hardware Design

Wi-Fi&Bluetooth Module Series

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Safety Information

The following safety precautions must be observed during all phases of operation, such as usage, service or repair of any 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
-	2023-08-24	Luke FU	Creation of the document
1.0.0	2023-10-27	Roshan WENG/Jay DONG	Preliminary

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1 Introduction

QuecOpen® is a solution where the module acts as the main processor. Constant transition and evolution of both the communication technology and the market highlight its merits. It can help you to:

- Realize embedded applications' quick development and shorten product R&D cycle
- Simplify circuit and hardware structure design to reduce engineering costs
- Miniaturize products
- Reduce product power consumption
- Apply OTA technology
- Enhance product competitiveness and price-performance ratio
- Apply anti-copy encryption technology to enhance product safety

This document defines FCM561D-P in QuecOpen® solution and describes its air interfaces and hardware interfaces, which are connected with your applications. The document provides a quick insight into interface specifications, RF performance, electrical and mechanical specifications, as well as other related information of the module.

Hereby, Quectel Wireless Solutions Co., Ltd. declares that the radio equipment type FCM561D-P is in compliance with Directive 2014/53/EU.

The full text of the EU declaration of conformity is available at the following internet address: http://www.quectel.com/support/technical.htm

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.

1.1. Special Marks

Table 1: Special Marks

Mark	Definition
*	Unless otherwise specified, when an asterisk (*) is used after a function, feature, interface, pin name, AT command, argument, and so on, it indicates that the function, feature, interface, pin, AT command, argument, and so on, is under development and currently not supported; and the asterisk (*) after a model indicates that the sample of the model is currently unavailable.
[…]	Brackets ([…]) used after a pin enclosing a range of numbers indicate all pins of the same type. For example, SDIO_DATA[0:3] refers to all four SDIO pins: SDIO_DATA0, SDIO_DATA1, SDIO_DATA2, and SDIO_DATA3.

2 Product Overview

FCM561D-P series is an MCU Wi-Fi 6 and Bluetooth module for smart-home and industrial IoT compliant with IEEE 802.11b/g/n/ax and BLE 5.2 standards. It provides multiple interfaces including SPI, QSPI, UART, SDIO, I2C, USB, CAN*, LCM, Camera, PWM and I2S for various applications.

FCM561D-P series is an SMD module with compact packaging. It includes:

- 320 MHz RISC-V processor
- Built-in 64 KB ROM and 512 KB SRAM memory, 8 MB PSRAM and 4 MB Flash
- Support secondary development

Table 2: Basic Information

FCM561D	
Packaging type	LCC + LGA
Pin counts	85
Dimensions	● FCM561D-P: (22 ±0.2) mm × (18 ±0.2) mm × (1.9 ±0.2) mm
Weight	● FCM561D-P: Approx 1.24 g

2.1. Key Features

Table 3: Key Features

Basic Information	
Protocols and Standard	● Wi-Fi Protocols: IEEE 802.11b/g/n/ax ● Bluetooth protocol: BLE 5.2 ● All hardware components are fully compliant with EU RoHS directive
Power Supply	**VBAT Power Supply:** ● 3.0–3.6 V ● Typ.: 3.3 V
Temperature Ranges	● Operating temperature [1]: -40 to +85 °C ● Storage temperature: -45 °C to +95 °C
EVB Kit	FCM561D-P-TE-B [2]
Antenna Interface	
Antenna Interfaces [3]	● FCM561D-P: PCB antenna ● 50 Ω characteristic impedance
Application Interface [4]	
Application Interfaces	SPI, QSPI, UART, SDIO, I2C, USB, CAN*, LCM, Camera, PWM, I2S, Analog audio, SAR ADC, Touch sensor

[1] Within the operating temperature range, the module's related performance meets IEEE and Bluetooth specifications.
[2] For more details about the EVB, see ***document*** *错误!未找到引用源。* and ***document*** *错误!未找到引用源。* .
[3] The module is provided with one of the two antenna interface designs. For more details, please contact Quectel Technical Support.
[4] For more details about the interfaces, see ***Chapter 3.3*** and ***Chapter 3.4***

3 Application Interfaces

3.1. Pin Assignment

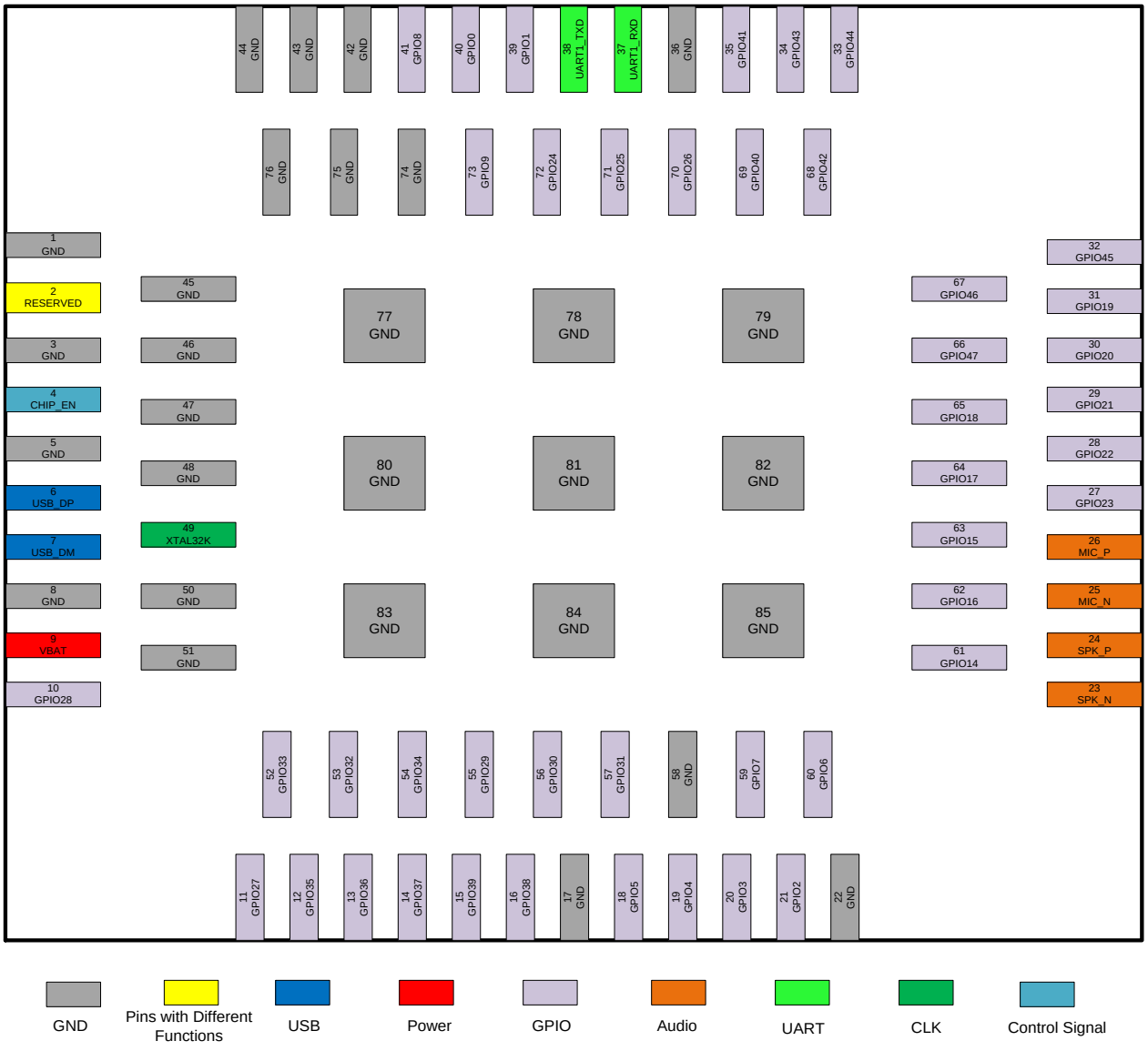


Figure 1: Pin Assignment (Top View)

NOTE

1. The RESERVED pin and unused pins need to be suspended.
2. All GND pins should be connected to ground.
3. The module provides 1 UART, 1 USB interface, 2 analog audio interfaces and 44 GPIO interfaces by default. In the case of multiplexing, it supports up to 48 GPIO interfaces, 2 SPI, 1 QSPI, 3 UARTs, 1 SDIO interface, 2 I2C interfaces, 1 CAN interface*, 1 LCM interface, 12 PWM interfaces, 1 I2S interface, and 8 SAR ADC interfaces. For more details, see ***Chapter 3.3*** and ***Chapter3.4***

3.2. Pin Description

Table 4: Parameter Description

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

DC characteristics include power domain and rated current.

Table 5: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VBAT	9	PI	Power supply for the module	Vmax = 3.6 V Vmin = 3.0 V Vnom = 3.3 V	It must be provided with sufficient current of at least 0.5 A.

GND	1, 3, 5, 8, 17, 22, 36, 42–48, 50, 51, 58, 74–85				
Control Signal					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
CHIP_EN	4	DI	Enable the module	VBAT	Hardware enable. Internally pulled up to 3.3 V. Active high.
UART1					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
UART1_TXD	38	DO	UART1 transmit	VBAT	
UART1_RXD	37	DI	UART1 receive		
USB Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
USB_DP	6	AIO	USB 2.0 differential data (+)		USB 2.0 compliant. Requires 85–100 Ω differential impedance; recommended to be 90 Ω. Test point must be reserved.
USB_DM	7	AIO	USB 2.0 differential data (-)		
RTC					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
XTAL32K	49	DI	32.768 kHz clock input		RTC input. If unused, keep it open.
GPIO Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
GPIO0	40	DIO	General-purpose input/output	VBAT	Interrupt wakeup.
GPIO1	39	DIO	General-purpose input/output		
GPIO2	21	DIO	General-purpose input/output		
GPIO3	20	DIO	General-purpose input/output		

GPIO4	19	DIO	General-purpose input/output
GPIO5	18	DIO	General-purpose input/output
GPIO6	60	DIO	General-purpose input/output
GPIO7	59	DIO	General-purpose input/output
GPIO8	41	DIO	General-purpose input/output
GPIO9	73	DIO	General-purpose input/output
GPIO14	61	DIO	General-purpose input/output
GPIO15	63	DIO	General-purpose input/output
GPIO16	62	DIO	General-purpose input/output
GPIO17	64	DIO	General-purpose input/output
GPIO18	65	DIO	General-purpose input/output
GPIO19	31	DIO	General-purpose input/output
GPIO20	30	DIO	General-purpose input/output
GPIO21	29	DIO	General-purpose input/output
GPIO22	28	DIO	General-purpose input/output
GPIO23	27	DIO	General-purpose input/output
GPIO24	72	DIO	General-purpose input/output
GPIO25	71	DIO	General-purpose input/output
GPIO26	70	DIO	General-purpose input/output
GPIO27	11	DIO	General-purpose input/output
GPIO28	10	DIO	General-purpose input/output

GPIO29	55	DIO	General-purpose input/output
GPIO30	56	DIO	General-purpose input/output
GPIO31	57	DIO	General-purpose input/output
GPIO32	53	DIO	General-purpose input/output
GPIO33	52	DIO	General-purpose input/output
GPIO34	54	DIO	General-purpose input/output
GPIO35	12	DIO	General-purpose input/output
GPIO36	13	DIO	General-purpose input/output
GPIO37	14	DIO	General-purpose input/output
GPIO38	16	DIO	General-purpose input/output
GPIO39	15	DIO	General-purpose input/output
GPIO40	69	DIO	General-purpose input/output
GPIO41	35	DIO	General-purpose input/output
GPIO42	68	DIO	General-purpose input/output
GPIO43	34	DIO	General-purpose input/output
GPIO44	33	DIO	General-purpose input/output
GPIO45	32	DIO	General-purpose input/output
GPIO46	67	DIO	General-purpose input/output
GPIO47	66	DIO	General-purpose input/output

Analog Audio Interfaces

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment

MIC_P	26	AI	Microphone analog input (+)
MIC_N	25	AI	Microphone analog input (-)
SPK_P	24	AO	Analog audio differential output (+)
SPK_N	23	AO	Analog audio differential output (-)

RESERVED PIN		
Pin Name	**Pin No.**	**Comment**
RESERVED	2	Not connected

3.3. GPIO Multiplexing

The module provides 44 GPIOs by default, and has up to 48 GPIOs in the case of multiplexing. Pins are defined as follows:

Table 6: GPIO Multiplexing

Pin Name	Pin No.	Multiplexing Function 0 (GPIO No.)	Multiplexing Function 1	Multiplexing Function 2	Multiplexing Function 3	Multiplexing Function 4	Multiplexing Function 5
GPIO0	40	GPIO0	UART2_TXD	I2C2_SCL	-	-	-
GPIO1	39	GPIO1	UART2_RXD	I2C2_SDA	-	-	-
GPIO2	21	GPIO2	SPI2_CLK	SDIO_CLK	-	-	-
GPIO3	20	GPIO3	SPI2_CS	SDIO_CMD	-	-	-
GPIO4	19	GPIO4	SPI2_MOSI	SDIO_DATA0	-	-	-
GPIO5	18	GPIO5	SPI2_MISO	SDIO_DATA1	-	-	-
GPIO6	60	GPIO6	CLK26M_OUT	PWM0	I2S_CLK	-	-
GPIO7	59	GPIO7	COEX_WIFI_ ACTIVE	PWM1	I2S_SYNC	-	-
GPIO8	41	GPIO8	COEX_BT_ ACTIVE	PWM2	I2S_DIN	-	-

GPIO9	73	GPIO9	COEX_BT_ PRIOPRITY	PWM3	I2S_DOUT	-	-
UART1_RXD	37	GPIO10	-	SDIO_DATA2	-	-	-
UART1_TXD	38	GPIO11	-	SDIO_DATA3	-	-	-
USB_DP	6	GPIO12	UART1_CTS	-	-	TS0	-
USB_DM	7	GPIO13	UART1_RTS	-	-	TS1	-
GPIO14	61	GPIO14	SDIO_CLK	SPI1_CLK	ANT_BT_SEL0	-	LCD_DCLK
GPIO15	63	GPIO15	SDIO_CMD	SPI1_CS	ANT_BT_SEL1	-	LCD_DISP
GPIO16	62	GPIO16	SDIO_DATA0	SPI1_MOSI	ANT_BT_SEL2	-	LCD_DE
GPIO17	64	GPIO17	SDIO_DATA1	SPI1_MISO	ANT_BT_SEL3	-	LCD_HSYNC
GPIO18	65	GPIO18	SDIO_DATA2	-	-	-	LCD_VSYNC
GPIO19	31	GPIO19	SDIO_DATA3	-	-	-	LCD_R4/LCD_CS
GPIO20	30	GPIO20	DL_CS	I2C1_SCL	-	SWD_CLK	LCD_R3/LCD_RST
GPIO21	29	GPIO21	DL_CLK	I2C1_SDA	ADC6	SWD_IO	LCD_R2/LCD_D/CS
GPIO22	28	GPIO22	DL_SI	CLK26M_OUT	ADC5	QSPI_CLK	LCD_R1/LCD_WR
GPIO23	27	GPIO23	DL_SO	-	ADC3	QSPI_CS	LCD_R0/LCD_RD
GPIO24	72	GPIO24	CLK32K_OUT	PWM4	ADC2	QSPI_DATA0	LCD_G5

GPIO25	71	GPIO25	IRDA	PWM5	ADC1	QSPI_DATA1	LCD_G4
GPIO26	70	GPIO26	TXEN	-	-	QSPI_DATA2	LCD_G3
GPIO27	11	GPIO27	DVP_MCLK	-	-	QSPI_DATA3	-
GPIO28	10	GPIO28	RXEN	I2S_MCLK	ADC4	TS2	-
GPIO29	55	GPIO29	DVP_PCLK	-	-	TS3	-
GPIO30	56	GPIO30	DVP_HSYNC	-	-	TS4	-
GPIO31	57	GPIO31	DVP_VSYNC	-	-	TS5	-
GPIO32	53	GPIO32	DVP_DATA0	PWM6	-	TS6	-
GPIO33	52	GPIO33	DVP_DATA1	PWM7	-	TS7	-
GPIO34	54	GPIO34	DVP_DATA2	PWM8	-	TS8	-
GPIO35	12	GPIO35	DVP_DATA3	PWM9	-	TS9	-
GPIO36	13	GPIO36	DVP_DATA4	PWM10	-	TS10	-
GPIO37	14	GPIO37	DVP_DATA5	PWM11	-	TS11	-
GPIO38	16	GPIO38	DVP_DATA6	-	-	TS12	-
GPIO39	15	GPIO39	DVP_DATA7	-	-	TS13	-
GPIO40	69	GPIO40	UART3_RXD	I2S_CLK	-	-	LCD_G2/LCD_DATA7

GPIO41	35	GPIO41	UART3_TXD	I2S_SYNC	-	-	LCD_G1/LCD_DATA6
GPIO42	68	GPIO42	I2C2_SCL	I2S_DIN	-	-	LCD_G0/LCD_DATA5
GPIO43	34	GPIO43	I2C2_SDA	I2S_DOUT	-	-	LCD_B4/LCD_DATA4
GPIO44	33	GPIO44	CAN_TXD	SPI1_CLK	ADC10	-	LCD_B3/LCD_DATA3
GPIO45	32	GPIO45	CAN_RXD	SPI1_CS	ADC11	-	LCD_B2/LCD_DATA2
GPIO46	67	GPIO46	CAN_STB	SPI1_MOSI	-	TS14	LCD_B1/LCD_DATA1
GPIO47	66	GPIO47	-	SPI1_MISO	-	TS15	LCD_B0/LCD_DATA0

NOTE

All GPIOs support interrupting wakeup.

3.4. Application Interfaces

3.4.1. SPIs

In the case of multiplexing, the module integrates 2 SPIs that can operate in master or slave mode with maximum clock frequency of 30 MHz. The SPIs support 8-bit or 16-bit data width and 4-wire or 3-wire (without CS pin) mode.

Table 7: Pin Definition of SPIs

Pin Name	Pin No.	Multiplexing Function	I/O	Description	Comment
GPIO14	61	SPI1_CLK	DIO	SPI1 clock	Other SPI1 configurations, see ***Table 6***.
GPIO16	63	SPI1_CS	DIO	SPI1 chip select	
GPIO15	62	SPI1_MOSI	DIO	SPI1 master-out slave-in	
GPIO17	64	SPI1_MISO	DIO	SPI1 master-in slave-out	
GPIO2	21	SPI2_CLK	DIO	SPI2 clock	
GPIO3	20	SPI2_CS	DIO	SPI2 chip select	
GPIO4	19	SPI2_MOSI	DIO	SPI2 master-out slave-in	
GPIO5	18	SPI2_MISO	DIO	SPI2 master-in slave-out	

The following figure shows the connection between the host and the slave:

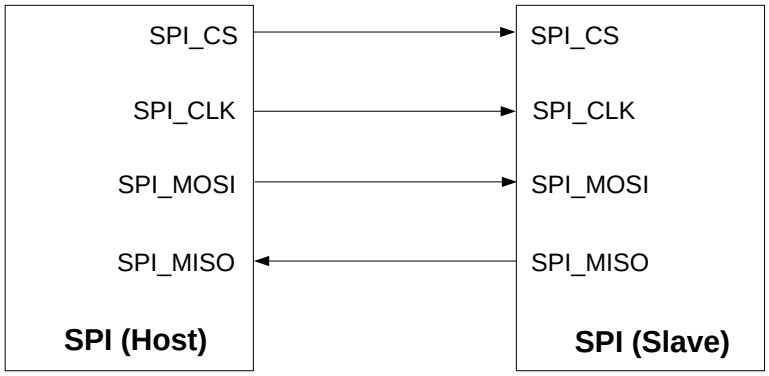


Figure 2: SPI Connection

3.4.2. QSPI

In the case of multiplexing, the module embeds 1 Quad SPI that provides support for communicating with external flash, PSRAM or AMOLED display. The QSPI allows maximum clock frequency up to 80 MHz.

Table 8: Pin Definition of QSPI

Pin Name	Pin No.	Multiplexing Function	I/O	Description
GPIO22	28	QSPI_CLK	DIO	QSPI clock
GPIO23	27	QSPI_CS	DIO	QSPI chip select
GPIO24	72	QSPI_DATA0	DIO	QSPI data bit 0
GPIO25	71	QSPI_DATA1	DIO	QSPI data bit 1
GPIO26	70	QSPI_DATA2	DIO	QSPI data bit 2
GPIO27	11	QSPI_DATA3	DIO	QSPI data bit 3

The following figure shows the QSPI connection between the host and the slave:

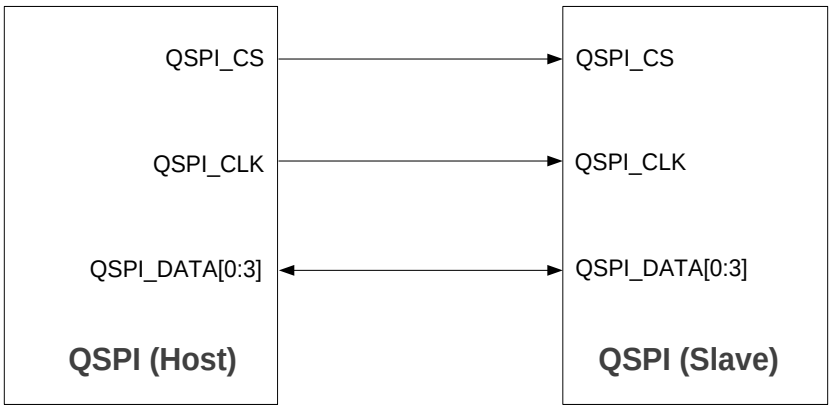


Figure 3: QSPI Connection

3.4.3. UARTs

The module provides 3 UARTs, among which UART1 is default configuration while UART2 and UART3 are multiplexed with GPIOs. The interfaces support full-duplex asynchronous serial communication at a baud rate up to 2 Mbps. UART1 supports hardware flow control with RTS and CTS signals, flash download and debugging information output. Each UART embeds a 128-byte Tx FIFO and a 128-byte Rx FIFO. FIFO mode is disabled by default and can be enabled by software.

Table 9: Pin Definition of UARTs

Pin Name	Pin No.	Multiplexing Function	I/O	Comment
UART1_RXD	37	-	DI	UART1 receive
UART1_TXD	38	-	DO	UART1 transmit
USB_DP	6	UART1_CTS	DI	Clear to send signal to the module
USB_DM	7	UART1_RTS	DO	Request to send signal from the module
GPIO0	40	UART2_TXD	DO	UART2 transmit
GPIO1	39	UART2_RXD	DI	UART2 receive
GPIO40	69	UART3_RXD	DI	UART3 receive
GPIO41	35	UART3_TXD	DO	UART3 transmit

The UART1 can be used for command communication and data transmission. It is recommended to use the CH340 serial port tool and set the communication rate to 2000000 bps during flash download or firmware upgrading. The UART1 connection between the module and the MCU is illustrated below.

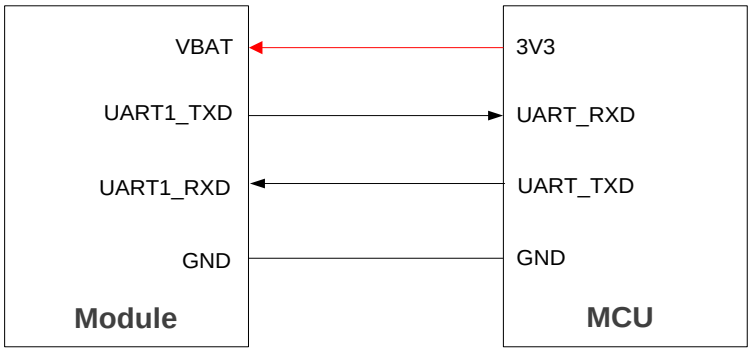


Figure 4: UART1 Connection

3.4.4. SDIO Interface

In the case of multiplexing the module provides 1 SDIO 2.0 interface It can be used as a host to read external SD cards or as a slave communicating with an external host. It allows a maximum 40 MHz clock speed and supports 1 bit (default) or 4 bits data bus mode.

Table 10: Pin Definition of SDIO Interface

Pin Name	Pin No.	Multiplexing Function	I/O	Description	Comment
GPIO2	21	SDIO_CLK	DIO	SDIO clock	Other SDIO configurations, see ***Table 6***.
GPIO3	20	SDIO_CMD	DIO	SDIO command	
GPIO4	19	SDIO_DATA0	DIO	SDIO data bit 0	
GPIO5	18	SDIO_DATA1	DIO	SDIO data bit 1	
GPIO10	37	SDIO_DATA2	DIO	SDIO data bit 2	
GPIO11	38	SDIO_DATA3	DIO	SDIO data bit 3	

The following figure shows the SDIO interface connection between the module and the host:

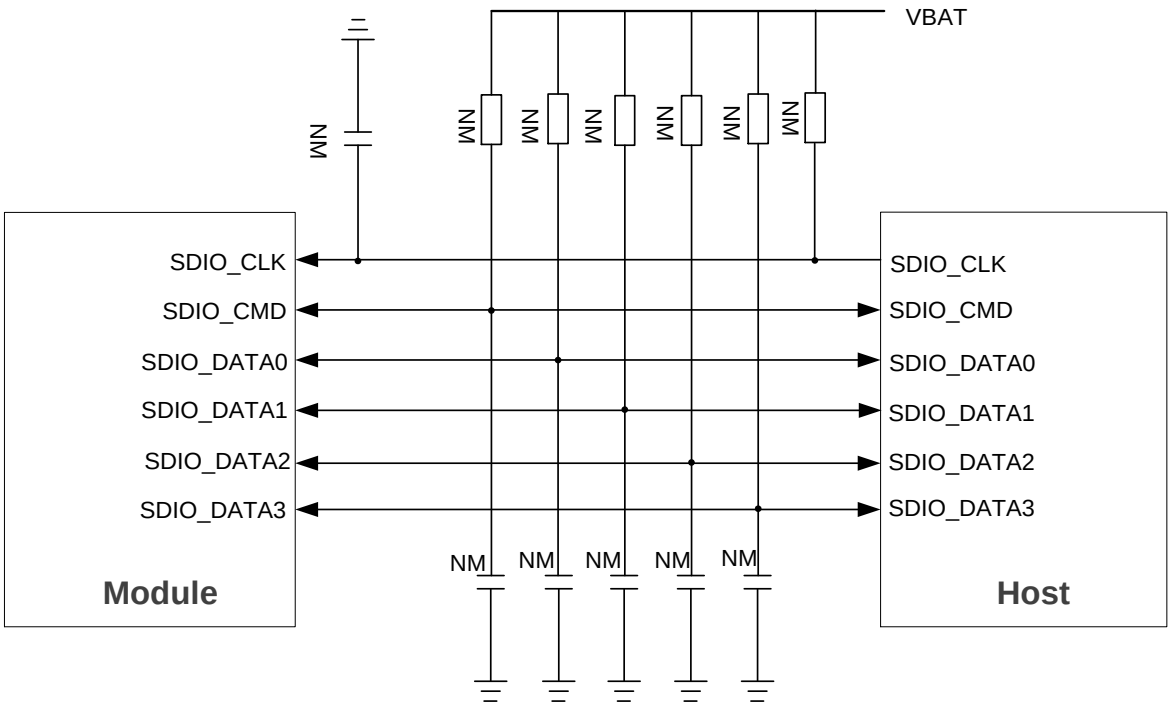


Figure 5: SDIO Interface Connection

To ensure compliance of interface design with the SDIO 2.0 specification, it is recommended to adopt the following principles:

- Route the SDIO traces in inner layer of the PCB, and surround the traces with ground on that layer and with ground planes above and below. The impedance of SDIO signal trace is 50 Ω ±10 %.
- Keep SDIO signals far away from other sensitive circuits/signals such as RF circuits and analog

signals, as well as noise signals such as clock signals and DC-DC signals.

- The distance between SDIO signals and other signals must be greater than twice the trace width, and the bus load capacitance must be less than 15 pF.
- SDIO signal traces (SDIO_CLK and SDIO_DATA[0:3]/SDIO_CMD) need to be equal in length (less than 1 mm distance between the traces).

3.4.5. I2C Interfaces

In the case of multiplexing, the module supports up to 2 I2C interfaces which can operate in master or slave mode. The interfaces support standard (up to 100 Kbps) and fast (up to 400 Kbps) modes with 7-bit and 10-bit addressing. If low level on SCL or bus idle duration is greater than a programmable threshold, it will generate interrupt to MCU.

Table 11: Pin Definition of I2C Interfaces

Pin Name	Pin No.	Multiplexing Function	I/O	Description	Comment
GPIO20	30	I2C1_SCL	DIO	I2C1 serial clock	
GPIO21	29	I2C1_SDA	DIO	I2C1 serial data	
GPIO0	40	I2C2_SCL	DIO	I2C2 serial clock	Other I2C2 configurations, see ***Table 6***.
GPIO1	39	I2C2_SDA	DIO	I2C2 serial data	

NOTE

Reserve 1–10 kΩ pull-up resistors to VBAT when I2C1 and I2C2 interfaces are connected to an external equipment.

3.4.6. USB Interface

The module provides an USB interface compliant with USB 1.1 and 2.0 specifications. It can operate as a host or a device and supports full-speed operation (up to 12 Mbps).

Table 12: Pin Definition of USB Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_DP	6	AIO	USB 2.0 differential data (+)	USB 2.0 compliant. Requires 85–100 Ω differential

USB_DM	7	AIO	USB 2.0 differential data (-)	impedance; recommended to be 90 Ω. Test point must be reserved.

3.4.7. CAN Interface*

In the case of multiplexing, the module provides 1 CAN interface which is compliant with the CAN 2.0B specification. It can be configured to meet the specification of CAN with flexible data rate CAN-FD. CAN 2.0 carries a data payload up to 8 bytes and CAN-FD up to 64 bytes.

Table 13: Pin Definition of CAN Interface

Pin Name	Pin No.	Multiplexing Function	I/O	Description	Comment
GPIO44	33	CAN_TXD	DO	CAN transmit data	3.3 V power domain.
GPIO45	32	CAN_RXD	DI	CAN receive data	
GPIO46	67	CAN_STB	DIO	Transceiver standby	

3.4.8. LCM Interface

In the case of multiplexing, the module supports an LCD-TFT display controller capable of providing a 16-bit parallel digital RGB (Red, Green, Blue) or an 8-bit I8080 interface. The controller supports conversion from YUV420 to RGB565 in RGB display.

Table 14: Pin Definition of LCM_RGB Interface

Pin Name	Pin No.	Multiplexing Function	I/O	Description
GPIO14	61	LCD_DCLK	DO	RGB pixel clock
GPIO15	63	LCD_DISP	DO	RGB display switch
GPIO16	62	LCD_DE	DO	RGB data enable
GPIO17	64	LCD_HSYNC	DO	RGB horizontal sync
GPIO18	65	LCD_VSYNC	DO	RGB vertical sync
GPIO19	31	LCD_R4	DIO	RGB red data 4
GPIO20	30	LCD_R3	DIO	RGB red data 3

GPIO21	29	LCD_R2	DIO	RGB red data 2
GPIO22	28	LCD_R1	DIO	RGB red data 1
GPIO23	27	LCD_R0	DIO	RGB red data 0
GPIO24	72	LCD_G5	DIO	RGB green data 5
GPIO25	71	LCD_G4	DIO	RGB green data 4
GPIO26	70	LCD_G3	DIO	RGB green data 3
GPIO40	69	LCD_G2	DIO	RGB green data 2
GPIO41	35	LCD_G1	DIO	RGB green data 1
GPIO42	68	LCD_G0	DIO	RGB green data 0
GPIO43	34	LCD_B4	DIO	RGB blue data 4
GPIO44	33	LCD_B3	DIO	RGB blue data 3
GPIO45	32	LCD_B2	DIO	RGB blue data 2
GPIO46	67	LCD_B1	DIO	RGB blue data 1
GPIO47	66	LCD_B0	DIO	RGB blue data 0

Table 15: Pin Definition of LCM_I8080 Interface

Pin Name	Pin No.	Multiplexing Function	I/O	Description	Comment
GPIO19	31	LCD_CS	DO	I8080 chip select	Active low.
GPIO20	30	LCD_RST	DO	I8080 reset	
GPIO21	29	LCD_D/CS	DO	I8080 data/command select	
GPIO22	28	LCD_WR	DO	I8080 write data	Active low.
GPIO23	27	LCD_RD	DO	I8080 read data	
GPIO40	69	LCD_DATA7	DIO	I8080 data bit 7	
GPIO41	35	LCD_DATA6	DIO	I8080 data bit 6	
GPIO42	68	LCD_DATA5	DIO	I8080 data bit 5	

GPIO43	34	LCD_DATA4	DIO	I8080 data bit 4
GPIO44	33	LCD_DATA3	DIO	I8080 data bit 3
GPIO45	32	LCD_DATA2	DIO	I8080 data bit 2
GPIO46	67	LCD_DATA1	DIO	I8080 data bit 1
GPIO47	66	LCD_DATA0	DIO	I8080 data bit 0

3.4.9. Camera Interface

In the case of multiplexing, the module supports 1 camera interface. The 8-bit CMOS Image Sensor (CIS) Digital Video Port (DVP) camera interface provides 8-bit parallel port interface to sensors, together with main clock (MCLK), pixel clock (PCLK), horizontal SYNC (HSYNC) and vertical SYNC (VSYNC) signals.

The YUV sensor's input will be directly fed to the hardware JPEG encoder, and the JPEG encoder output is written to data memory directly by a dedicated DMA channel. The YUV signal format could be YUYV, UYVY, YYUV and UVYY. HSYNC and VSYNC level could be set independently.

Table 16: Pin Definition of Camera DVP Interface

Pin Name	Pin No.	Multiplexing Function	I/O	Description
GPIO27	11	DVP_MCLK	DO	DVP master clock
GPIO29	55	DVP_PCLK	DO	DVP pixel clock
GPIO30	56	DVP_HSYNC	DO	DVP horizontal sync
GPIO31	57	DVP_VSYNC	DO	DVP vertical sync
GPIO32	53	DVP_DATA0	DIO	DVP data bit 0
GPIO33	52	DVP_DATA1	DIO	DVP data bit 1
GPIO34	54	DVP_DATA2	DIO	DVP data bit 2
GPIO35	12	DVP_DATA3	DIO	DVP data bit 3
GPIO36	13	DVP_DATA4	DIO	DVP data bit 4
GPIO37	14	DVP_DATA5	DIO	DVP data bit 5
GPIO38	16	DVP_DATA6	DIO	DVP data bit 6

GPIO39	15	DVP_DATA7	DIO	DVP data bit 7

3.4.10. PWM Interfaces

In the case of multiplexing, the module supports up to 12 PWM channels. Each PWM channel has three modes: Timer mode, PWM mode, and Capture mode. Each mode of each channel is multiplexed with 32-bit counting. The PWM running clock can be either high speed clock or low power clock. Each PWM runs independently with its own duty cycle.

Table 17: Pin Definition of PWM Interfaces

Pin Name	Pin No.	Multiplexing Function	I/O	Description
GPIO6	60	PWM0	DIO	PWM0 output
GPIO7	59	PWM1	DIO	PWM1 output
GPIO8	41	PWM2	DIO	PWM2 output
GPIO9	73	PWM3	DIO	PWM3 output
GPIO24	72	PWM4	DIO	PWM4 output
GPIO25	71	PWM5	DIO	PWM5 output
GPIO32	53	PWM6	DIO	PWM6 output
GPIO33	52	PWM7	DIO	PWM7 output
GPIO34	54	PWM8	DIO	PWM8 output
GPIO35	12	PWM9	DIO	PWM9 output
GPIO36	13	PWM10	DIO	PWM10 output
GPIO37	14	PWM11	DIO	PWM11 output

3.4.11. I2S Interface

The module integrates an I2S interface multiplexed with GPIOs. It supports master and slave modes with sample rates from 8 kHz to 384 kHz. The I2S interface supports both PCM mono channel mode and I2S stereo channel mode with programmable data width between 1 and 32 bits.

Table 18：Pin Definition of I2S Interface

Pin Name	Pin No.	Multiplexing Function	I/O	Description	Comment
GPIO9	73	I2S_DOUT	DIO	I2S data out	See ***Table 6*** for other GPIO pins multiplexed as I2S interface.
GPIO8	41	I2S_DIN	DIO	I2S data in	
GPIO7	59	I2S_WS	DIO	I2S word select	
GPIO6	60	I2S_CLK	DIO	I2S serial clock	
GPIO28	10	I2S_MCLK	DIO	I2S master clock	

3.4.12. Analog Audio Interface

In the case of multiplexing, the module comes with a rich set of audio peripherals to enhance the listening experience, including a four-band digital equalizer, two analog-to-digital converters (ADC), two digital-to-analog converters (DAC), two microphone input amplifiers, two audio amplifiers, as well as an SBC decoder accelerator.

It contains two high-fidelity ADCs with sample rates of 8 kHz, 16 kHz, 44.1 kHz, or 48 kHz and also integrates two high-fidelity DACs with sample rates of 8 kHz, 16 kHz, 44.1 kHz, or 48 kHz. The microphone signal can be amplified with gain from 0 to 32 dB with 2 dB/step. The module also provides two high-quality audio amplifiers capable of driving 16 Ω speakers with up to 30 pF of load capacitance.

Table 19: Pin Definition of Analog Audio Interfaces

Pin Name	Pin No.	I/O	Description
MIC_P	26	AI	Microphone analog input (+)
MIC_N	25	AI	Microphone analog input (-)
SPK_P	24	AI	Analog audio differential output (+)
SPK_N	23	AI	Analog audio differential output (-)

3.4.13. SAR ADC Interface

The module embeds 13-bit general-purpose SAR ADC interfaces with programmable sampling rates ranging from 12.5 kHz up to 1.625 MHz. The 13-bit resolution ADC can be configured to 15–17 bits. The ADC interfaces support up to 8 external input channels. It can operate in one-shot mode, software control mode and continuous mode. The ADC supports full scale input range (0 V to 2 × VREF).

Table 20: Pin Definition of SAR ADC Interfaces

Pin Name	Pin No.	Multiplexing Function	I/O	Description	Comment
GPIO25	71	ADC1	AI	General-purpose ADC interface	Channel 1
GPIO24	72	ADC2	AI	General-purpose ADC interface	Channel 2
GPIO23	27	ADC3	AI	General-purpose ADC interface	Channel 3
GPIO28	10	ADC4	AI	General-purpose ADC interface	Channel 4
GPIO22	28	ADC5	AI	General-purpose ADC interface	Channel 5
GPIO21	29	ADC6	AI	General-purpose ADC interface	Channel 6
GPIO44	33	ADC10	AI	General-purpose ADC interface	Channel 7
GPIO45	32	ADC11	AI	General-purpose ADC interface	Channel 8

Table 21: SAR ADC Features

Parameter	Condition	Min.	Typ.	Max.	Unit
Conversion clock				26	MHz
Conversion time		-	16		Cycle
VREF	Internal		1.2		V
	External		1.5		V
Input voltage range		0		VREF × 2	V
Input impedance		10			MΩ
Input capacitance			1		pF

NOTE

The selection of internal or external reference voltage selection can be configured via registers. It is recommended to use internal VREF by default.

3.4.14. Touch Sensor Interfaces

In the case of multiplexing, the module supports up to 16 capacitive-sensing touch sensor interfaces,

labeled TS0–15, which immediately detect capacitance changes induced by touch or proximity of objects.

Table 22: Pin Definition of Touch Sensor Interfaces

Pin Name	Pin No.	Multiplexing Function	I/O	Description
GPIO12	6	TS0	AI	Touch sensor 0
GPIO13	7	TS1	AI	Touch sensor 1
GPIO28	10	TS2	AI	Touch sensor 2
GPIO29	55	TS3	AI	Touch sensor 3
GPIO30	56	TS4	AI	Touch sensor 4
GPIO31	57	TS5	AI	Touch sensor 5
GPIO32	53	TS6	AI	Touch sensor 6
GPIO33	52	TS7	AI	Touch sensor 7
GPIO34	54	TS8	AI	Touch sensor 8
GPIO35	12	TS9	AI	Touch sensor 9
GPIO36	13	TS10	AI	Touch sensor 10
GPIO37	14	TS11	AI	Touch sensor 11
GPIO38	16	TS12	AI	Touch sensor 12
GPIO39	15	TS13	AI	Touch sensor 13
GPIO46	67	TS14	AI	Touch sensor 14
GPIO47	66	TS15	AI	Touch sensor 15

4 Operating Characteristics

4.1. Power Supply

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

Table 23: Pin Definition of Power Supply and GND Pins

Pin Name	Pin No.	I/O	Description	Min.	Typ.	Max.	Unit
VBAT	9	PI	Power supply for the module	3.0	3.3	3.6	V
GND	1, 3, 5, 8, 17, 22, 36, 42–48, 50, 51, 58, 74–85						

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 can provide at least 0.5 A output current. For better power supply performance, it is recommended to parallel a 22 μF decoupling capacitor, and two filter capacitors (1 μF and 100 nF) near the module's VBAT pin. In addition, it is recommended to add a TVS 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.

VBAT reference circuit is shown below:

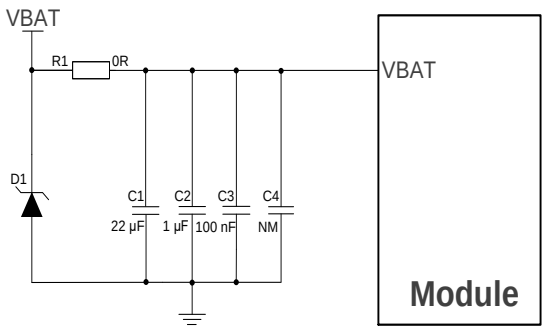


Figure 6: VBAT Reference Circuit

4.2. Turn On

After the module VBAT is powered on, keep the CHIP_EN pin at high level to realize the automatic startup of the module.

Table 24: Pin Definition of CHIP_EN

Pin Name	Pin No.	I/O	Description	Comment
CHIP_EN	4	DI	Enable the module	Hardware enable. Internally pulled up to 3.3 V. Active high.

The turn-on timing is shown below:

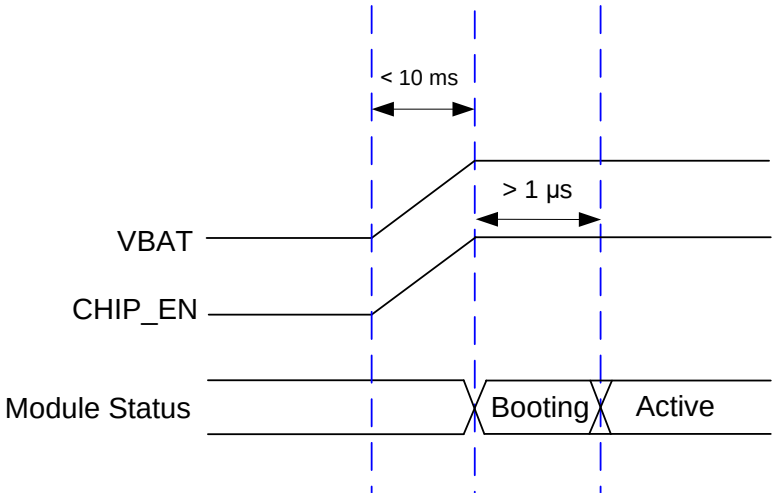


Figure 7: Turn-on Timing

4.3. Reset

When the voltage of CHIP_EN drops below 0.3 V or pull it down for at least 1 ms, the module can be reset. The reference design for hardware resetting of the module are shown below. An open collector driving circuit can be used to control the CHIP_EN pin.

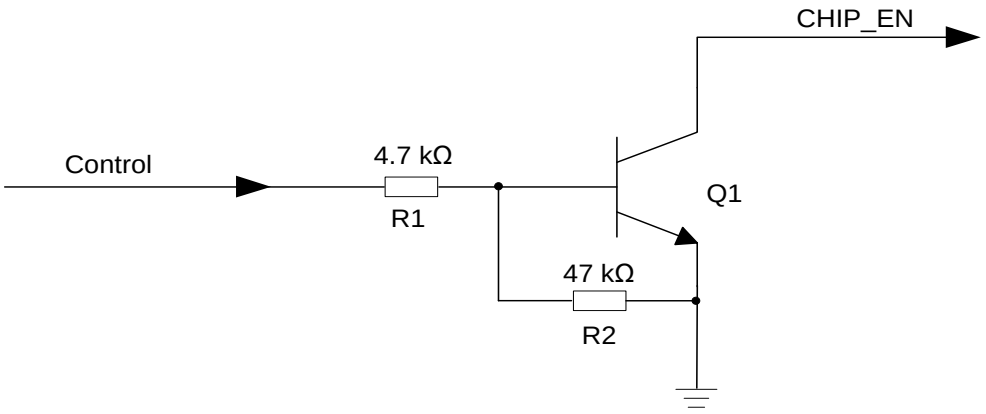


Figure 8: Reference Circuit of CHIP_EN by Using A Driving Circuit

Another way to control the CHIP_EN is by using a button directly. When pressing the button, an electrostatic strike may generate from finger. Therefore, a TVS component shall be placed near the button for ESD protection.

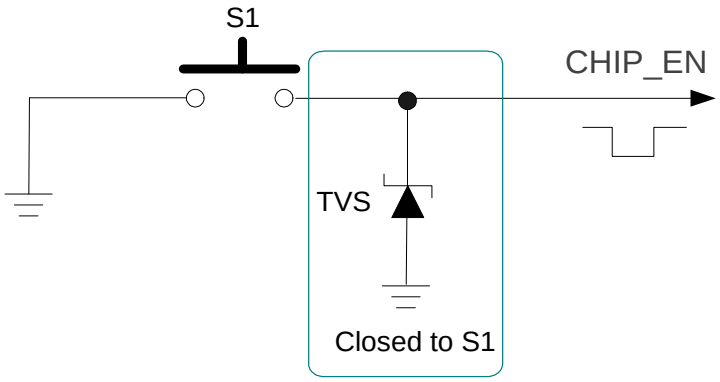


Figure 9: Reference Circuit of RESET with A Button

The module reset timing is illustrated in the following figure.

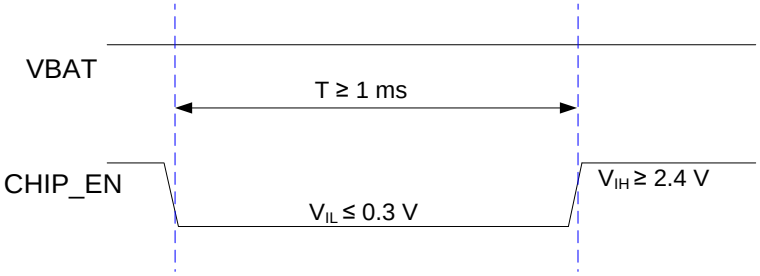


Figure 10: Reset Timing

5 RF Performances

5.1. Wi-Fi Performances

Table 25: Wi-Fi Performances

Operating Frequency				
2.4 GHz: 2.400–2.4835 GHz				
Modulation				
BPSK, QPSK, CCK, 16QAM, 64QAM				
Encryption				
WPA/WPA2/WPA3-Personal				
Operating Mode				
● AP ● STA ● AP+STA				
Transmission Data Rate				
● 802.11b: 1 Mbps, 2 Mbps, 5.5 Mbps, 11 Mbps ● 802.11g: 6 Mbps, 9 Mbps, 12 Mbps, 18 Mbps, 24 Mbps, 36 Mbps, 48 Mbps, 54 Mbps ● 802.11n: HT20 (MCS 0–7), HT40 (MCS 0–7) ● 802.11ax: HE20 (MCS 0–7), HE40 (MCS 0–7)				
Condition		**EVM**	**Typ.; Unit: dBm; Tolerance: ±2 dB**	
			Transmitting Power	**Receiving Sensitivity**
2.4 GHz	802.11b @ 1 Mbps	≤ 35 %	17	-97
	802.11b @ 11 Mbps		17	-87
	802.11g @ 6 Mbps	≤ -5 dB	15	-91
	802.11g @ 54 Mbps	≤ -25 dB	14	-74

	802.11n, HT20 @ MCS 0	≤ -5 dB	14	-90
	802.11n, HT20 @ MCS 7	≤ -27 dB	13	-71
	802.11ax, HE20 @ MCS 0	≤ -5 dB	14	-89
	802.11ax, HE20 @ MCS 7	≤ -27 dB	13	-71

5.2. Bluetooth Performances

Table 26: Bluetooth Performances

Operating Frequency		
2.400–2.4835 GHz		
Modulation		
GFSK		
Operating Mode		
BLE		
Condition	**Typ.; Unit: dBm; Tolerance: ±2 dB**	
	Transmitting Power	**Receiving Sensitivity**
BLE (1 Mbps)	7	-96
BLE (2 Mbps)	7	-92
BLE (125 kbps)	7	-101
BLE (500 kbps)	7	-97

5.3. Antenna Interface

FCM561D is provided with one of the two antenna interface designs: LCC pin antenna interface (ANT_WIFI/BT) and RF coaxial connector. The RF coaxial connector is not available when the module is designed with ANT_BT antenna interface. FCM561D-P supports PCB antennasThe impedance of antenna port is 50 Ω.

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.

5.3.1. Pin Antenna Interface (ANT_WIFI/BT) [7]

Table 27: ANT_WIFI/BT Pin Definition

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

5.3.1.1. Reference Design

A circuit of the RF antenna interface is shown below. For better RF performance, it is necessary to reserve a π matching circuit and add ESD protection components. Reserved matching components such as R1, C1, C2, and D1 should be placed as close to the antenna as possible. C1, C2, and D1 are not mounted by default. The parasitic capacitance of TVS should be less than 0.05 pF and R1 is recommended to be 0 Ω.

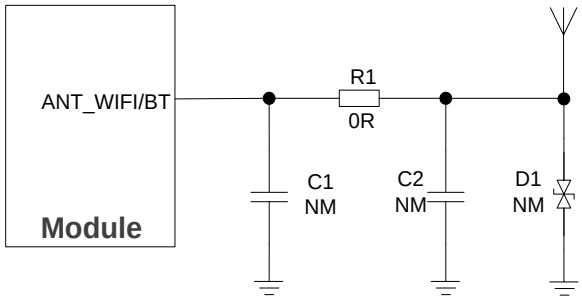


Figure 11: RF Antenna Reference Design

5.3.1.2. Antenna Design Requirements

Table 28: Antenna Design Requirements

Parameter	Requirement

[7] The module is provided with one of the two antenna interface designs. For more details, contact Quectel Technical Support.

Frequency Range (GHz)	2.400–2.4835
Cable Insertion Loss (dB)	< 1
VSWR	≤ 2 (Typ.)
Gain (dBi)	1 (Typ.)
Max. input power (W)	50
Input impedance (Ω)	50
Polarization type	Vertical

5.3.1.3. 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.

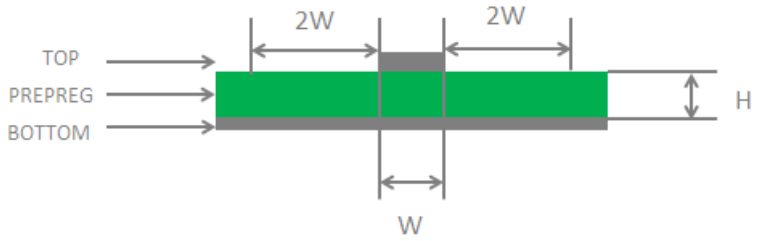


Figure 12: Microstrip Design on a 2-layer PCB

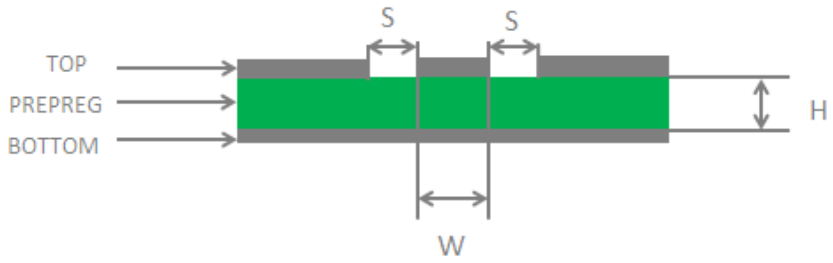


Figure 13: Coplanar Waveguide Design on a 2-layer PCB

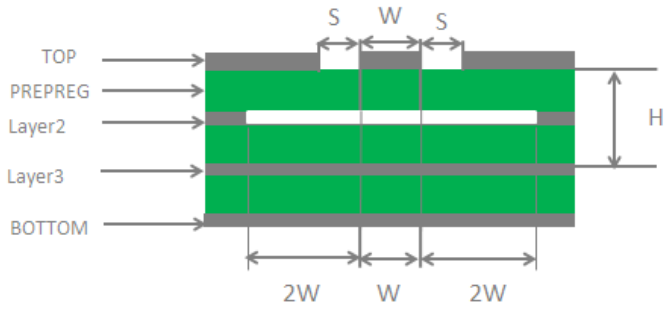


Figure 14: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

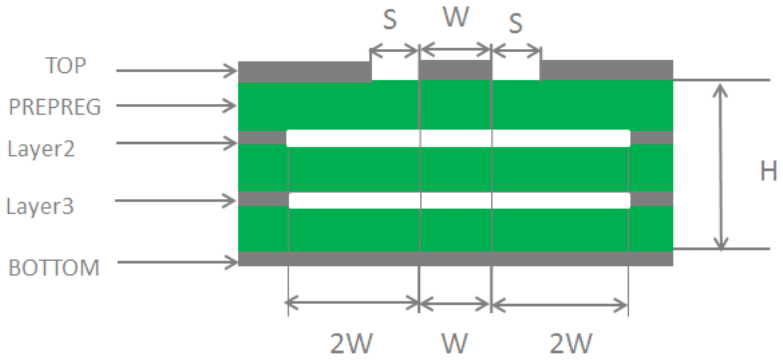


Figure 15: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

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

- Use an impedance simulation tool to control the characteristic impedance of RF traces to 50 Ω.
- GND pins adjacent to RF pins should not be designed as thermal relief pads, and should be fully connected to the ground.
- The distance between the RF pins and the RF connector should be as short as possible and all 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. In addition, 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 × 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 [2]***.

5.3.2. FCM561D-P PCB Antenna [8]

Table 29: PCB Antenna Specifications

Parameter	Requirement
Frequency Range (GHz)	2.400–2.500
Input Impedance (Ω)	50
VSWR	≤ 3 (Typ.)
Gain (dBi)	1 (Typ.)
Efficiency (Avg.)	46.4 %

When using the PCB antenna on the module, the module should be placed at the side of the motherboard. The distance between the PCB antenna and connectors, vias, traces, ethernet port and any other metal components on the motherboard should be at least 16 mm. All layers in the PCB of the motherboard under the PCB antenna should be designed as a keepout area.

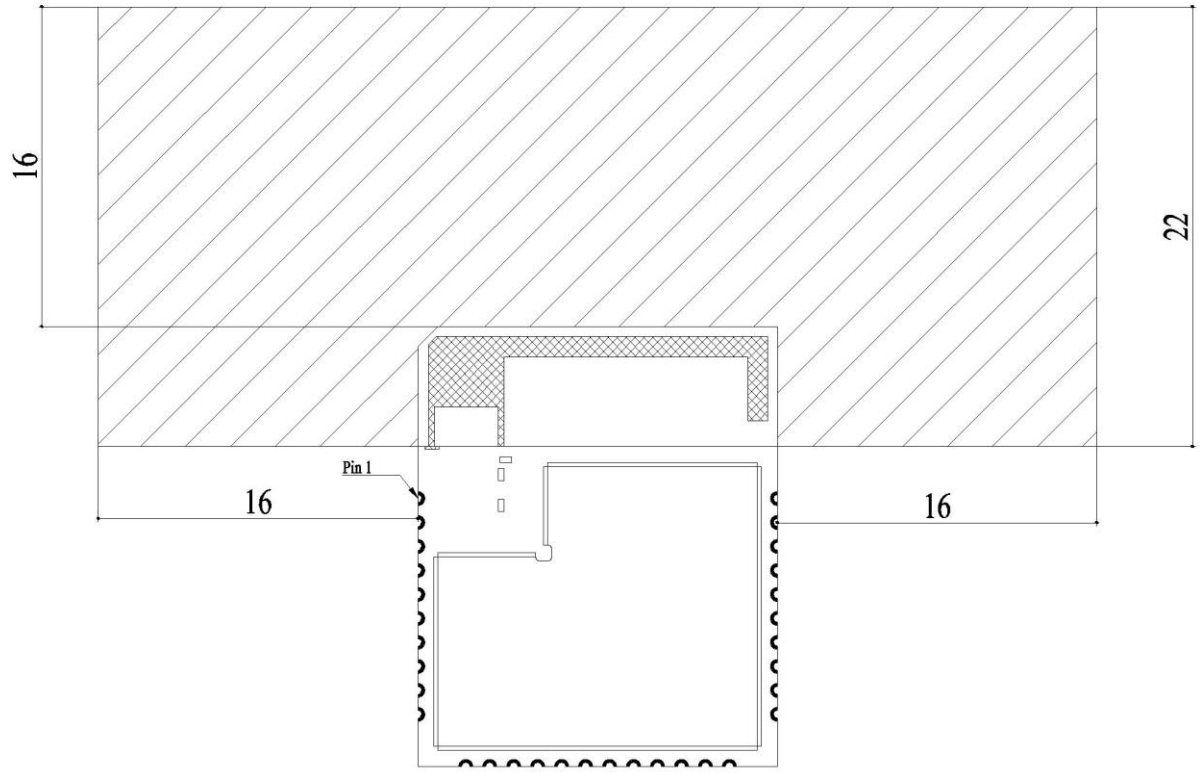


Figure 16: Keepout Area on Motherboard

[8] The module is provided in one of the three antenna/antenna interface designs. For more details, contact Quectel Technical Support.

Do not routing at the RF test point at the bottom of the module to ensure its performances during PCB design.

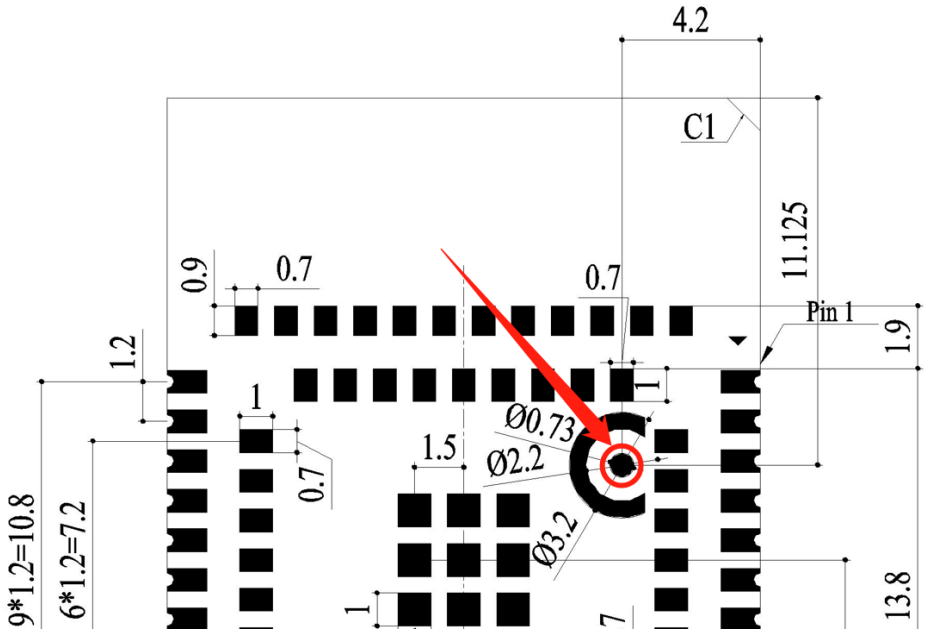


Figure 17: Prohibited Area for Routing

6 Electrical Characteristics & Reliability

6.1. Absolute Maximum Ratings

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

Table 30: Absolute Maximum Ratings (Unit: V)

Parameter	Min.	Max.
VBAT	-0.3	3.6
Voltage at Digital Pins	-0.3	3.6
Voltage at ADC[1:6], ADC[10:11]	0	VREF × 2

6.2. Power Supply Ratings

Table 31: Module Power Supply Ratings (Unit: V)

Parameter	Description	Condition	Min.	Typ.	Max.
VBAT	Power supply for the module	The actual input voltages must be kept between the minimum and maximum values.	3.0	3.3	3.6

6.3. Power Consumption

6.3.1. Wi-Fi Power Consumption

Table 32: Power Consumption in Non-signaling Modes (Unit: mA)

Condition			I_{VBAT} (Typ.)
2.4 GHz	802.11b	Tx 1 Mbps @ 17 dBm	274
		Tx 11 Mbps @ 17 dBm	274
	802.11g	Tx 6 Mbps @ 15 dBm	248
		Tx 54 Mbps @ 14 dBm	248
	802.11n	Tx HT20 MCS 0 @ 14 dBm	241
		Tx HT20 MCS 7 @ 13 dBm	241
	802.11ax	Tx HE20 MCS 0 @14 dBm	238
		Tx HE20 MCS 7 @ 13 dBm	229

6.3.2. Bluetooth Power Consumption

Table 33: Power Consumption in Non-signaling Modes (Unit: mA)

Condition	TX Power (Typ.)	I_{VBAT} (Typ.)
BLE (1 Mbps)	7 dBm	152
BLE (2 Mbps)	7 dBm	108
BLE (125 kbps)	7 dBm	134
BLE (500 kbps)	7 dBm	105

6.4. Digital I/O Characteristics

Table 34: VBAT I/O Characteristics (Unit: V)

Parameter	Description	Min.	Max.
V_{IH}	High-level input voltage	0.7 × VBAT	VBAT + 0.3
V_{IL}	Low-level input voltage	-0.3	0.3 × VBAT
V_{OH}	High-level output voltage	0.9 × VBAT	-
V_{OL}	Low-level output voltage	-	0.1 × VBAT

6.5. ESD Protection

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

Table 35: ESD Characteristics (Unit: kV)

Model	Test Result	Standard
Human Body Model (HBM)	±2	*ANSI/ESDA/JEDEC JS-001-2017*
Charged Device Model (CDM)	±1	*ANSI/ESDA/JEDEC JS-002-2018*

7 Mechanical Information

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

7.1. Mechanical Dimensions

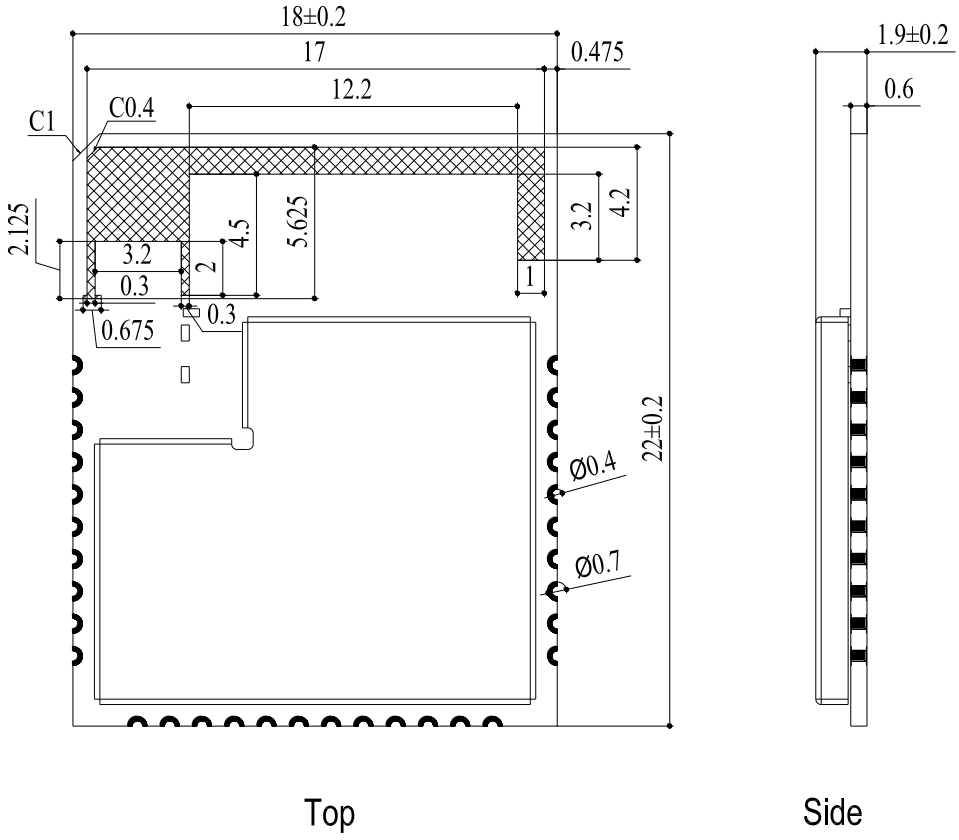


Figure 18: FCM561D-P Top and Side Dimensions

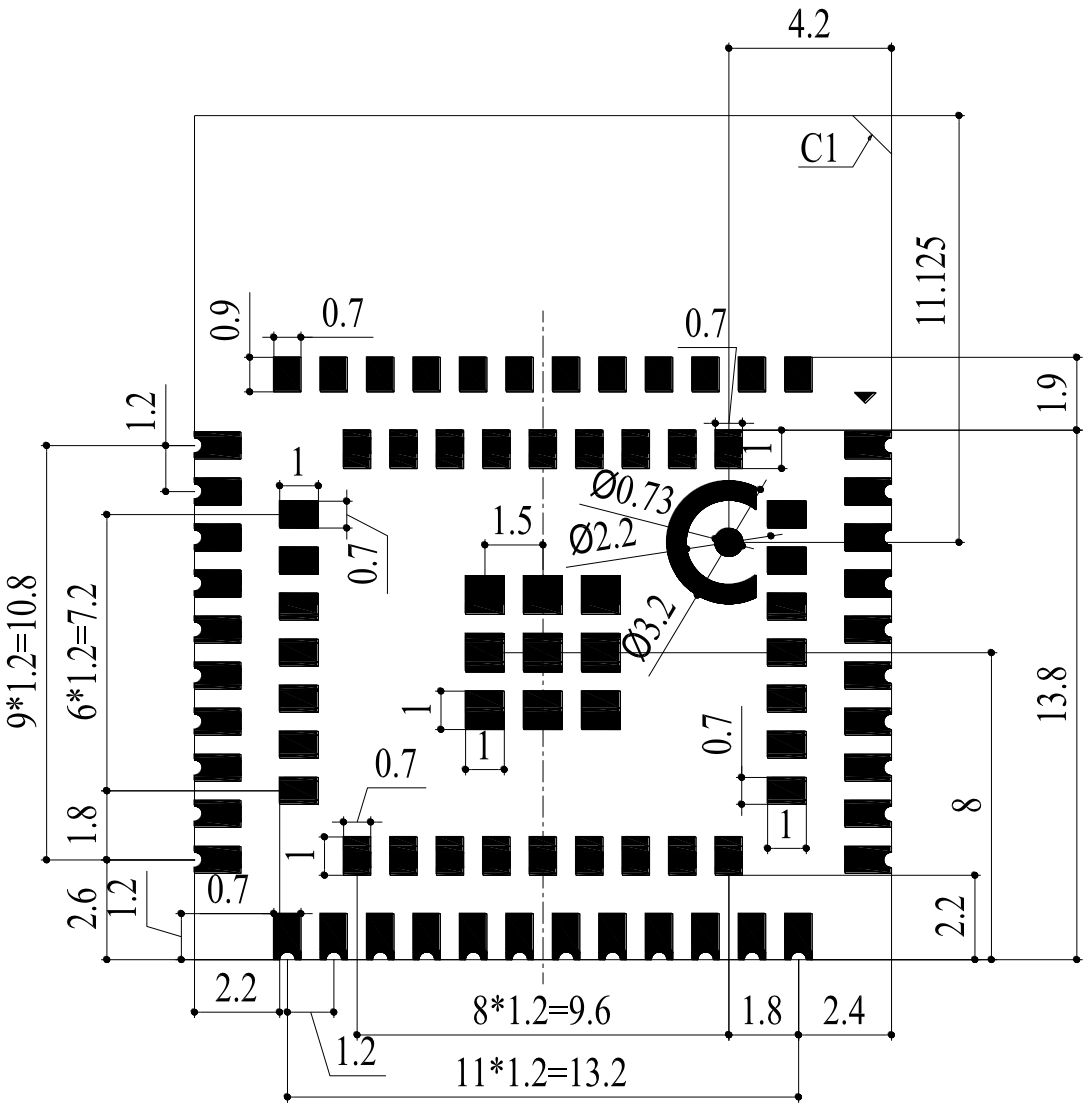


Figure 19: FCM561D-P Bottom Dimensions (Bottom View)

NOTE

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

7.2. Recommended Footprint

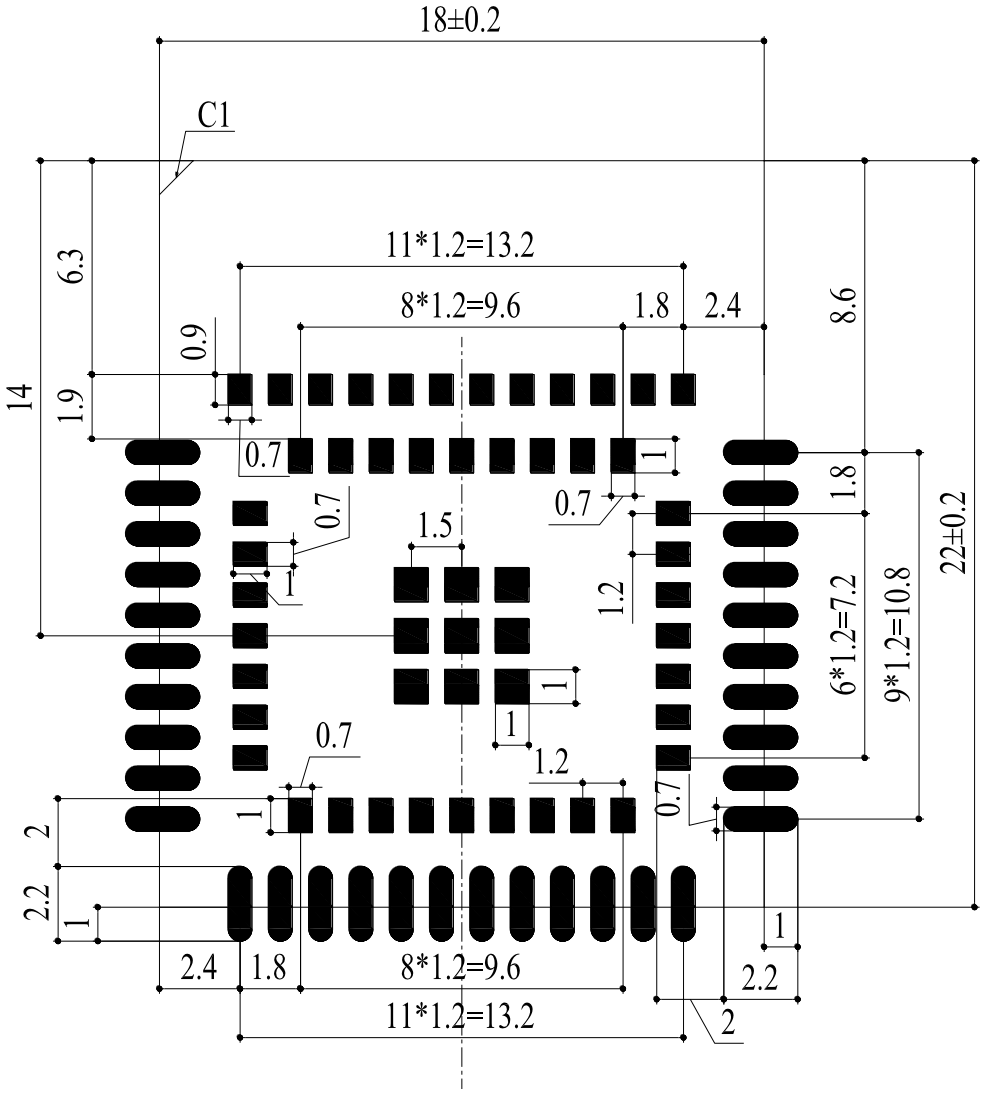


Figure 20: FCM561D-P Recommended Footprint

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

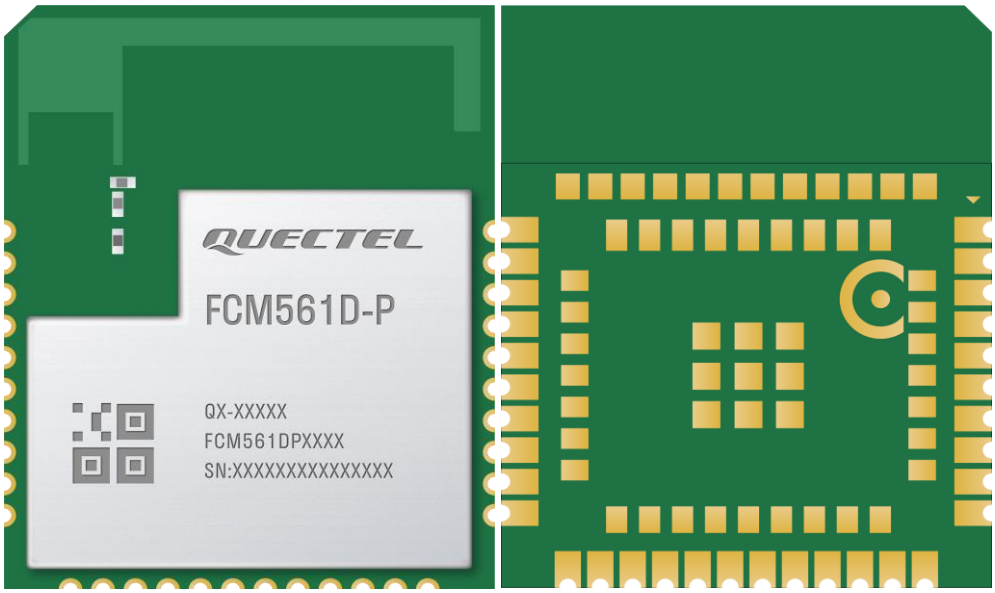


Figure 21: FCM561D-P Top and Bottom Views (PCB Antenna Interface)

NOTE

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

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 [9] in a factory where the temperature is 23 ±5 °C and relative humidity is below 60 %. After the vacuum-sealed packaging is removed, the module must be processed in reflow soldering or other high-temperature operations within 168 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10 % (e.g., a dry cabinet).

4. The module should be pre-baked to avoid blistering, cracks and inner-layer separation in PCB under the following circumstances:

   - The module is not stored in Recommended Storage Condition;
   - Violation of the third requirement mentioned above;
   - Vacuum-sealed packaging is broken, or the packaging has been removed for over 24 hours;
   - Before module repairing.

5. If needed, the pre-baking should follow the requirements below:

   - The module should be baked for 8 hours at 120 ±5 °C;
   - The module must be soldered to PCB within 24 hours after the baking, otherwise it should be put in a dry environment such as in a dry cabinet.

[9] 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 0.15–0.18 mm. For more details, see ***document [3]***.

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.

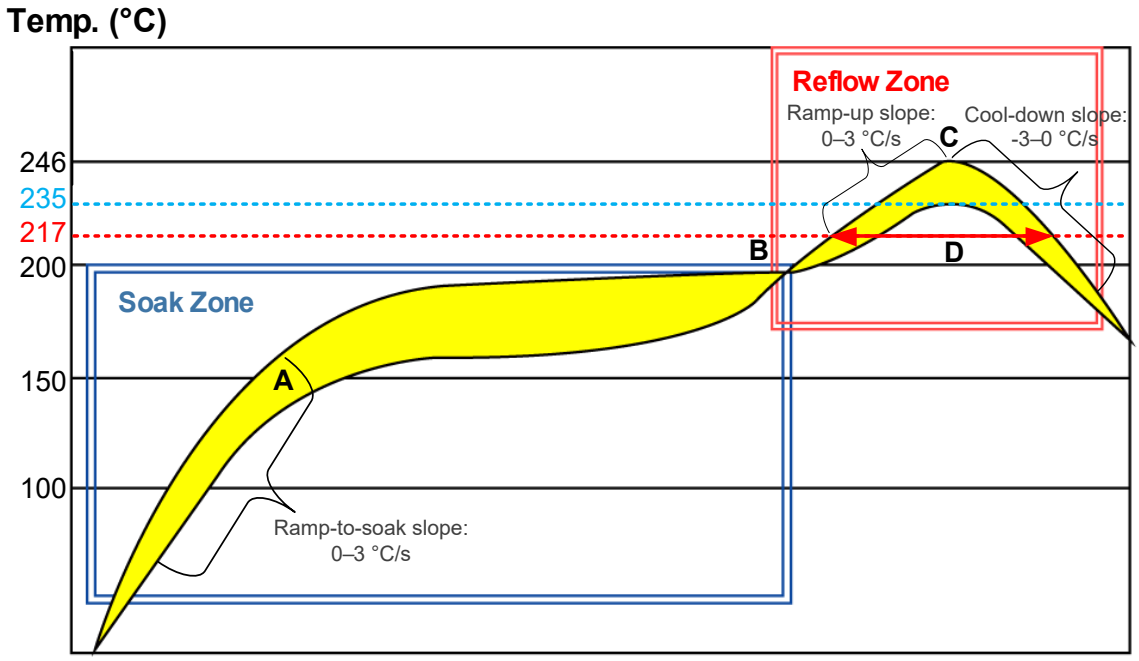


Figure 22: Recommended Reflow Soldering Thermal Profile

Table 36: 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 solder joints. Both the hottest and coldest spots of solder joints on the PCB should meet the above requirements.
2. During manufacturing and soldering, or any other processes that may contact the module directly, NEVER wipe the module's shielding can with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol, trichloroethylene, etc. Otherwise, the shielding can may become rusted.
3. The shielding can for the module is made of Cupro-Nickel base material. It is tested that after 12 hours' Neutral Salt Spray test, the laser engraved label information on the shielding can is still clearly identifiable and the QR code is still readable, although white rust may be found.
4. If a conformal coating is necessary for the module, do NOT use any coating material that may chemically react with the PCB or shielding cover, and prevent the coating material from flowing into the module.
5. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.
6. Due to the complexity of the SMT process, please contact Quectel Technical Support in advance for any situation that you are not sure about, or any process (e.g. selective soldering, ultrasonic soldering) that is not mentioned in ***document [3]***.

8.3. Packaging Specifications

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

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

8.3.1. Carrier Tape

Carrier tape dimensions are detailed below:

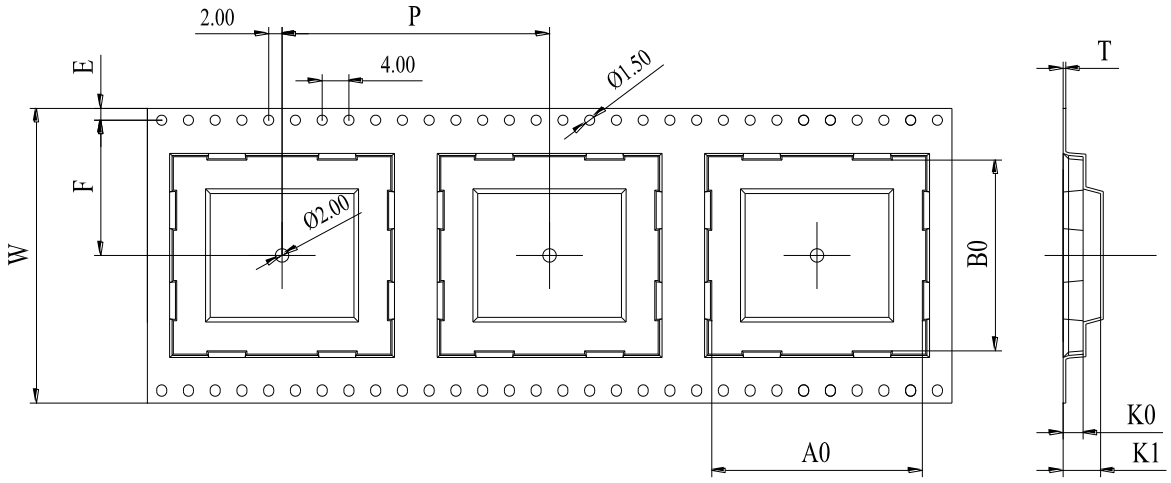


Figure 23: Tape Specifications

Table 37: FCM561D Carrier Tape Dimension Table (Unit: mm)

W	P	T	A0	B0	K0	K1	F	E
44	32	0.4	18.4	25.9	3.7	6.8	20.2	1.75

8.3.2. Plastic Reel

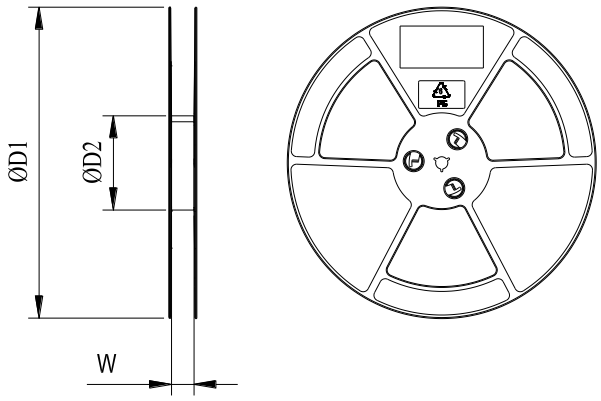


Figure 24: Plastic Reel Dimension Drawing

Table 38: Plastic Reel Dimension Table (Unit: mm)

øD1	øD2	W
330	100	44.5

8.3.3. Mounting Direction

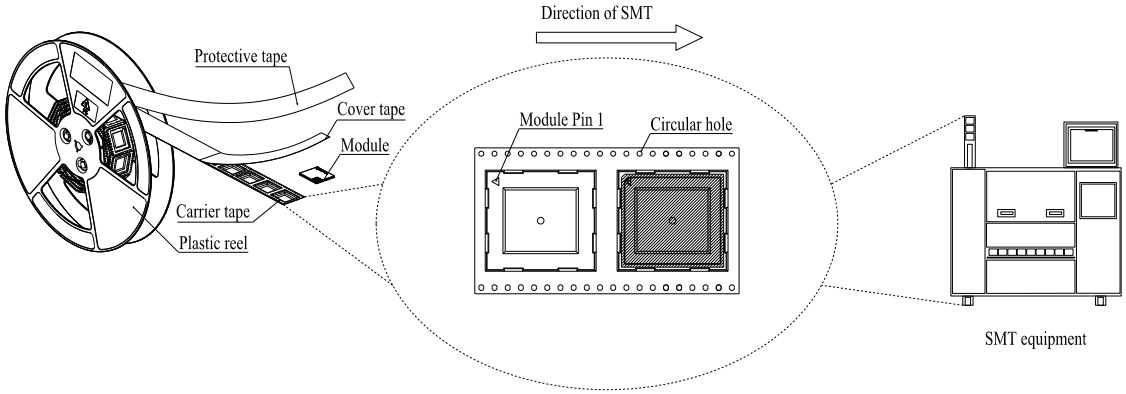
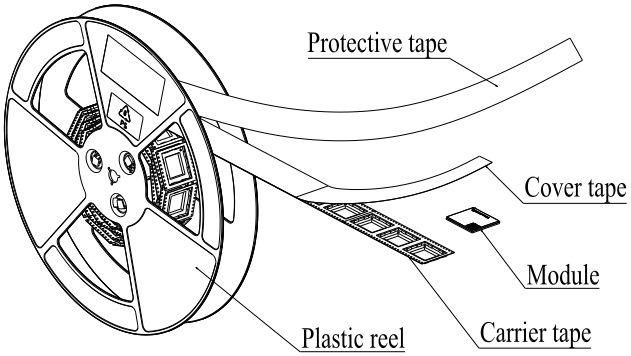


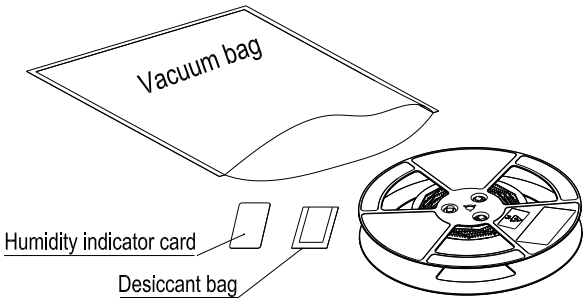
Figure 25: Mounting Direction

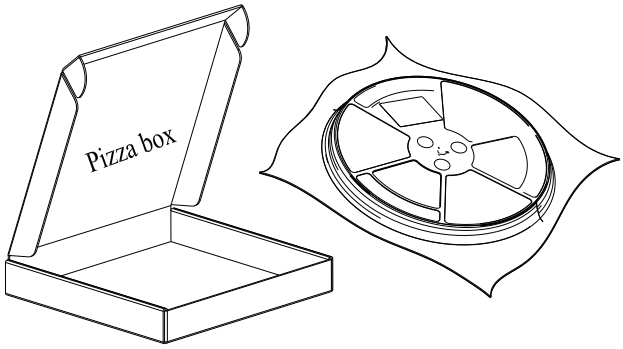
8.3.4. Packaging Process



Place the modules into the carrier tape and use the cover tape to cover them; then wind the heat-sealed carrier tape on 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, then vacuumize it.





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

Place 4 packaged pizza boxes inside 1 carton box and seal it. 1 carton box can pack 1000 modules.

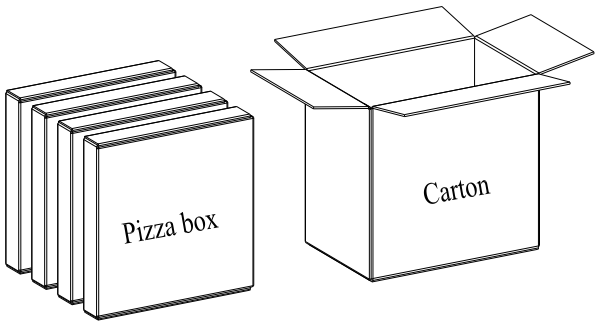


Figure 26: Packaging Process

9 Appendix References

Table 39: Reference Documents

Document Name
[1] Quectel_FCM561D-P_TE-B_User_Guide
[2] Quectel_RF_Layout_Application_Note
[3] Quectel_Module_SMT_Application_Note

Table 40: Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
AMOLED	Active Matrix/Organic Light Emitting Diode
AP	Access Point
BLE	Bluetooth Low Energy
BPSK	Binary Phase Shift Keying
CAN	Controller Area Network
CCK	Complementary Code Keying
CDM	Charged Device Model
CMOS	Complementary Metal Oxide Semiconductor
CIS	CMOS image sensor
CS	Chip Select
DAC	Digital-to-Analog Converter
DMA	Direct Memory Access

DVP	Digital Video Port
ESD	Electrostatic Discharge
FIFO	First Input First Output
EVM	Error Vector Magnitude
GFSK	Gauss frequency Shift Keying
GND	Ground
GPIO	General-Purpose Input/Output
HSYNC	Horizontal Synchronization
HE	High Efficiency
HT	High Throughput
I/O	Input/Output
I2C	Inter-Integrated Circuit
I2S	Inter-IC Sound
IEEE	Institute of Electrical and Electronics Engineers
IoT	Internet of Things
JPEG	Joint Photographic Experts Group
LCC	Leadless Chip Carrier (package)
LCD-TFT	Liquid-crystal Display Thin-film Transistor
LCM	Liquid Crystal Module
Mbps	Million Bits Per Second
MCLK	Master Clock
MCU	Microcontroller Unit
MISO	Master In Slave Out
MOSI	Master Out Slave In
OTA	Over-the-Air
PCB	Printed Circuit Board
PCLK	Pixel Clock

PSRAM	Pseudo Static Random-Access Memory
PWM	Pulse Width Modulation
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
QSPI	Quad Serial Peripheral Interface
RF	Radio Frequency
RISC	Reduced Instruction-Set Computer
RoHS	Restriction of Hazardous Substances
ROM	Read Only Memory
RTC	Real-Time Clock
SAR	Successive Approximation Register
SBC	Sub-band Coding
SCLK	Serial Clock
SD	Secure Digital
SDIO	Secure Digital Input/Output
SMD	Surface Mount Device
SMT	Surface Mount Technology
SPI	Serial Peripheral Interface
SRAM	Static Random-Access Memory
STA	Station
TVS	Transient Voltage Suppressor
Tx	Transmit
UART	Universal Asynchronous Receiver/Transmitter
USB	Universal Serial Bus
V_{IH}	High-level Input Voltage
V_{IL}	Low-level Input Voltage
Vmax	Maximum Voltage

Vmin	Minimum Voltage
Vnom	Nominal Voltage Value
V_{OH}	High-level Output Voltage
V_{OL}	Low-level Output Voltage
VSWR	Voltage Standing Wave Ratio
VSYNC	Vertical Synchronization
Wi-Fi	Wireless Fidelity

FCC Statement

Warning: Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help

The device must not be co-located or operating in conjunction with any other antenna or transmitter. 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.

FCC Radiation Exposure Statement

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

Does not comply with the use restrictions of the product:

Portable devices used close with human's body (within 20cm), Like Cell phone, Notebook etc.

Integration instructions for host product manufacturers according to KDB 996369 D03 OEM Manual v01

2.2 List of applicable FCC rules

FCC Part 15 Subpart C 15.247 & 15.209.

2.3 Specific operational use conditions

The module can be used for mobile applications with a maximum 1 dBi antenna. The host manufacturer installing this module into their product must ensure that the final compos it product complies with the FCC requirements by a technical assessment or evaluation to the FCC rules,

including the transmitter operation. The host manufacturer 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.

2.4 Limited module procedures

Not applicable The module is a Single module and complies with the requirement of FCC Part 15 212.

2.5 Trace antenna designs

Not applicable The module has its own antenna, and doesn’t need a hosts printed board micro strip trace antenna etc.

2.6 RF exposure considerations

The module must be installed in the host equipment such that at least 20cm is maintained between the antenna and users" body; and if RF exposure statement or module layout is changed, then the host product manufacturer required to take responsibility of the module through a change in FCC ID or new application The FCC ID of the module cannot be used on the final product In these circumstances, the host manufacturer will be responsible for reevaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

2.7 Antennas

Antenna Specification are as follows:

Type: PCB Antenna

Gain: 1 dBi Max

This device is intended only for host manufacturers under the following conditions: The transmitter module may not be co-located with any other transmitter or antenna; The module shall be only used with the internal antenna(s) that has been originally tested and certified with this module. The antenna must be either permanently attached or employ a “unique" antenna coupler.

As long as the conditions above are met, further transmitter test will not be required However, the host manufacturer is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc).

2.8 Label and compliance information

Host product manufacturers need to provide a physical or e-label stating "Contains FCC ID: XMR2023FCM561DP" with their finished product.

2.9 Information on test modes and additional testing requirements

Host manufacturer must perform test of radiated & conducted emission and spurious emission, e.t.c according to the actual test modes for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product. Only when all the test results of test modes comply with FCC requirements, then the end product can be sold legally.

2.10 Additional testing, Part 15 Subpart B disclaimer

The modular transmitter is only FCC authorized for FCC Part 15 Subpart C 15.247 & 15 209 and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuity), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

Federal Communication Commission Statement (FCC, U S)

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules These limits are designed to provide reasonable protection against harmful interference in a residential installation This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications However, there is no guarantee that interference will not occur in a particular installation If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

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.

FCC Caution:

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

IMPORTANT NOTES

Co-location warning:

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

OEM integration instructions:

This device is intended only for OEM integrators under the following conditions:

The transmitter module may not be co-located with any other transmitter or antenna The module shall be only used with the external antenna(s) that has been originally tested and certified with this module.

As long as the conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance

requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

Validity of using the module certification:

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

End product labeling:

The final end product must be labeled in a visible area with the following: "Contains Transmitter Module **FCC ID: XMR2023FCM561DP**"

Information that must be placed in the end user manual:

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

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.
Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :(1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.
The device is compliance with RF field strength limits, users can obtain Canadian information on RF exposure and compliance.

IC Radiation Exposure Statement

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

Déclaration d'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.