RM510Q-GL

Hardware Design

5G Module Series

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Safety Information

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

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

About the Document

Revision History

Version	Date	Author	Description
-	2020-10-22	Kingson ZHANG /Jumping HE	Creation of the document
1.0	2021-02-07	Kingson ZHANG /Jumping HE	First official release

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1 Introduction

1.1. Introduction

The hardware design defines RM510Q-GL and describes the air and hardware interfaces which are connected with customers' applications.

This document helps you quickly understand the interface specifications, electrical and mechanical details, as well as other related information of RM510Q-GL. To facilitate its application in different fields, reference design is also provided for reference. Associated with application notes and user guides, customers can use the module to design and set up mobile applications easily.

1.2. Reference Standard

The module complies with the following standards:

- PCI Express M.2 Specification Revision 3.0, Version 1.2
- PCI Express Base Specification Revision 3.0
- Universal Serial Bus Specification, Revision 3.1
- ISO/IEC 7816-3
- MIPI Alliance Specification for RF Front-End Control Interface Version 2.0
- 3GPP TS 27.007 and 27.005

1.3. Special Mark

Table 1: Special Mark

Mark	Definition
*	When an asterisk (*) is used after a function, feature, interface, pin name, AT command, or argument, it indicates that the function, feature, interface, pin name, AT command, or argument is under development and currently not supported, unless otherwise specified.
[…]	Brackets ([…]) used after a pin enclosing a range of numbers indicate all pin of the same type. For example, ANTCTL [0:3] refers to all four ANTCTL pins, ANTCTL0, ANTCTL1, ANTCTL2, and ANTCTL3.

2 Product Concept

2.1. General Description

RM510Q-GL is a 5G NR/LTE-FDD/LTE-TDD/WCDMA wireless communication module with receive diversity. It provides data connectivity on 5G NR SA and NSA, LTE-FDD, LTE-TDD, DC-HSDPA, HSPA+, HSDPA, HSUPA and WCDMA networks. It is a standard M.2 Key-B WWAN module. For more details, see *PCI Express M.2 Specification Revision 3.0, Version 1.2.*

RM510Q-GL is an industrial-grade module for industrial and commercial applications only.

It supports embedded operating systems such as Windows, Linux and Android, and also provide GNSS and voice functionality to meet specific application demands.

The following table shows the frequency bands and GNSS type of the module.

Table 2: Frequency Bands and GNSS Type of RM510Q-GL Module

Mode	RM510Q-GL
5G NR SA	n1/n2/n3/n5/n7/n8/n12/n20/n25/n28/n38/n40/n41/n48*/n66/n71/n77/n78/n79/ n257 [1]/n258 [1]/n260 [1]/n261 [1]
5G NR NSA	n1/n2/n3/n5/n7/n8/n12/n20/n25/n28/n38/n40/n41/n48*/n66/n71/n77/n78/n79
LTE-FDD	B1/B2/B3/B4/B5/B7/B8/B12(B17)/B13/B14/B18/B19/B20/B25/B26/B28/B29 [2]/B30/ B32 [2]/B66/B71
LTE-TDD	B34/B38/B39/B40/B41/B42/B43/B48
LAA	B46 [2]
WCDMA	B1/B2/B3/B4/B5/B6/B8/B19
GNSS	GPS/GLONASS/QZSS/BeiDou(Campass)/Galileo

NOTES

1. [1)] These bands work with mmWave antennas, and they support NSA only.
2. [2)] These bands support receiving only.

3: This module supports mmWave Bands, and marketing without active mmWave antenna.
We will provide software to host manufacturers when they use an active mmWave antenna with this module, this software will control the module work with active mmWave antenna. The host manufacturer can't use the active mmWave antenna directly.
The Host Manufacturer will execute the mmWave bands' certification.

The module can be applied to the following fields:

- Rugged tablet PC and laptop computer
- Remote monitor system
- Smart metering system
- Wireless CPE
- Smart TV
- Outdoor live devices
- Wireless router and switch
- Other wireless terminal devices

2.2. Key Features

The following table describes key features of RM510Q-GL.

Table 3: Key Features of RM510Q-GL

Feature	Details
Function Interface	PCI Express M.2 Interface
Power Supply	● Supply voltage: 3.135–4.4 V ● Typical supply voltage: 3.7 V
(U)SIM Interface	● Compliant with ISO/IEC 7816-3 ● Support (U)SIM card: Class B (3.0 V) and Class C(1.8 V) ● Support single (U)SIM slot
USB Interface	● Compliant with USB 3.1 and 2.0 specifications, with maximum transmission rates up to 10 Gbps on USB 3.1 and 480 Mbps on USB 2.0. ● Used for AT command communication, data transmission, firmware upgrade, software debugging, GNSS NMEA sentence output and voice over USB. ● Supports USB serial drivers for: Windows 7/8/8.1/10, Linux 2.6–5.4, Android 4.x/5.x/6.x/7.x/8.x/9.x/10
PCIe Interface	● Complaint with PCIe Gen 3, support 8 Gbps per lane, PCIe × 1. ● Used for AT command communication, data transmission, firmware upgrade, software debugging, GNSS NMEA sentence output

PCM	● Used for audio function with external codec ● Support 16-bit linear data format ● Support long and short frame synchronization ● Support master and slave modes, but must be the master in long frame synchronization
Transmitting Power	● Class 3 (24 dBm +1/-3 dB) for WCDMA bands ● Class 3 (23 dBm ±2 dB) for LTE bands ● Class 3 (23 dBm ±2 dB) for 5G NR bands ● Class 2 (26 dBm ±2 dB) for LTE B38/B40/B41/B42/B43 bands HPUE [1)] ● Class 2 (26 dBm +2/-3 dB) for 5G NR n41/n77/n78/n79 bands HPUE ● Class 1 for 5G NR FR2 n257/n258/n260/n261 with QTM527 ● Class 3 for 5G NR FR2 n257/n258/n260/n261 with QTM525
5G NR Features	● Supports 3GPP Rel-15 ● Supports Modulations: Uplink: π/2-BPSK, QPSK, 16QAM, 64QAM and 256QAM Downlink: QPSK, 16QAM, 64QAM and 256QAM ● Supports MIMO: Uplink: 2 × 2 MIMO[2)] on n41 Downlink: 4 × 4 MIMO on n1/n2/n3/n7/25/n38/n40/n41/n48*/n66/n77/n78/n79 Uplink and downlink support 2 x 2 MIMO on FR2(mmWave) bands. ● Supports SCS 15 kHz [3)] and 30 kHz [3)] on sub6 bands. ● Supports SCS 120kHz on FR2(mmWave) bands. ● Supports QTM525(power class 3) and QTM527(power class 1). ● Supports SA[4)] and NSA[4)] operation modes on all the 5G band ● Supports Option 3x, 3a, 3 and Option 2 ● Max. transmission data rates [5)]:NSA: Max 5 Gbps(DL)/ 650 Mbps (UL) SA: Max 4.2 Gbps(DL)/ 450 Mbps (UL) Sub-6 NSA: Max 5 Gbps(DL)/ 650 Mbps (UL) mmWave NSA: Max 7.5 Gbps(DL)/ 2.9 Gbps (UL)
LTE Features	● Supports 3GPP Rel-15 ● Supports up to CA Cat 20 ● Supports modulations: Uplink: QPSK, 16QAM and 64QAM and 256QAM* Downlink: QPSK, 16QAM and 64QAM and 256QAM ● Supports 1.4/3/5/10/15/20 MHz RF bandwidth ● Supports downlink 4 × 4 MIMO on: B1/B2/B3/B4/B7/B25/B30/B38/B39/B40/B41/B42/B43/B48/B66 ● Max. transmission data rates [5)]: LTE: Max 2.0 Gbps (DL)/200 Mbps (UL)
UMTS Features	● Supports 3GPP Rel-9 DC-HSDPA, HSPA +, HSDPA, HSUPA and WCDMA ● Supports QPSK, 16QAM and 64QAM modulation ● Max. transmission data rates [5)]: DC-HSDPA: Max 42 Mbps (DL)

	HSUPA: Max 5.76 Mbps (UL) WCDMA: Max 384 kbps (DL)/384 kbps (UL)
Rx-diversity	● Supports 5G NR/LTE/WCDMA Rx-diversity
GNSS Features	● Protocol: NMEA 0183 ● Data Update Rate: 1 Hz
Antenna Interfaces	● ANT0, ANT1, ANT2, and ANT3_GNSSL1
AT Commands	● Compliant with *3GPP TS 27.007* and *3GPP TS 27.005* ● Quectel enhanced AT commands
Internet Protocol Features	● Supports QMI/NTP* protocols ● Supports the protocols PAP and EIRP usually used for PPP connections
Firmware Upgrade	● USB 2.0 interface, PCIe interface and DFOTA
SMS	● Text and PDU modes ● Point-to-point MO and MT ● SMS cell broadcast ● SMS storage: ME by default
Physical Characteristics	● M.2 Key-B ● Size: (30.0 ±0.15) mm × (52.0 ±0.15) mm × (2.3 ±0.2) mm ● Weight: approx. 9.1 g
Temperature Range	● Operating temperature range: -30 ~ +70 °C [6)] ● Extended temperature range: -40 ~ +85 °C [7)] ● Storage temperature range: -40 to +90°C
RoHS	All hardware components are fully compliant with EU RoHS directive

NOTES

1. [1)] HPUE is only for single carrier.
2. [2)] Uplink 2 × 2 MIMO is only supported in 5G SA mode.
3. [3)] 5G NR FDD bands only support 15 kHz SCS, and NR TDD bands only support 30 kHz SCS.
4. [4)] See ***document [1]*** for bandwidth supported by each frequency band in the NSA and SA modes.
5. [5)] The maximum rates are theoretical and the actual values refer to the network configuration.
6. [6)] To meet this operating temperature range, you need to ensure effective thermal dissipation, for example, by adding passive or active heatsinks, heat pipes, vapor chambers, etc. Within this range, the module can meet 3GPP specifications.
7. [7)] To meet this extended temperature range, you need to ensure effective thermal dissipation, for example, by adding passive or active heatsinks, heat pipes, vapor chambers, etc. Within this range, the module remains the ability to establish and maintain functions such as voice, SMS, emergency call, etc., without any unrecoverable malfunction. Radio spectrum and radio network are not influenced, while one or more specifications, such as P_{out}, may undergo a reduction in value, exceeding the specified tolerances of 3GPP. When the temperature returns to the normal operating temperature level, the module will meet 3GPP specifications again.

2.3. Evaluation Board

To help you develop applications conveniently with the module, Quectel supplies an evaluation board (5G-mmWave-EVB), a USB micro-B cable, a USB type-C cable, antennas and other peripherals to control or test the module. For more details, see ***document [2] & document [3]***.

2.4. Functional Diagram

The following figure shows a block diagram of RM510Q-GL.

- Power management
- Baseband
- LPDDR4X SDRAM + NAND Flash
- Radio frequency
- M.2 Key-B interface

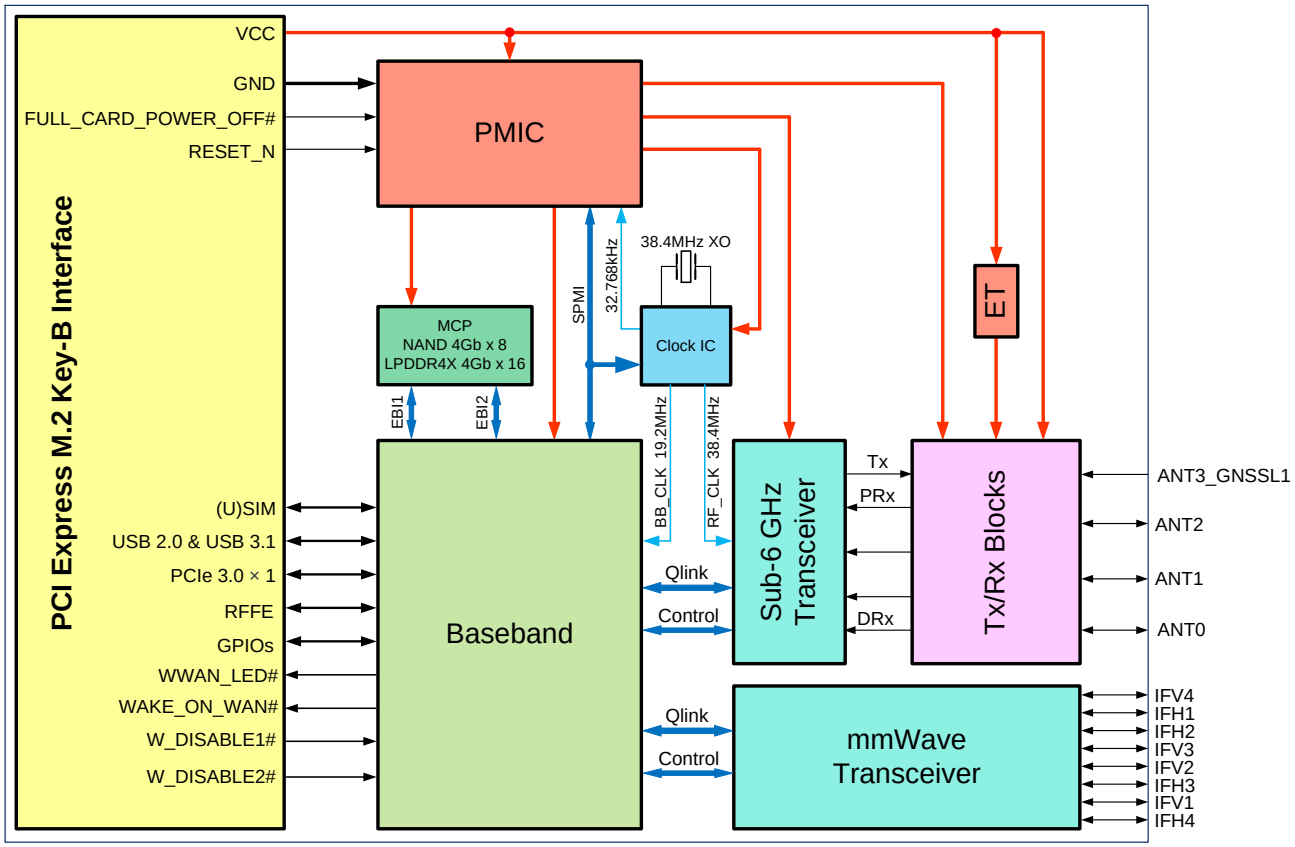
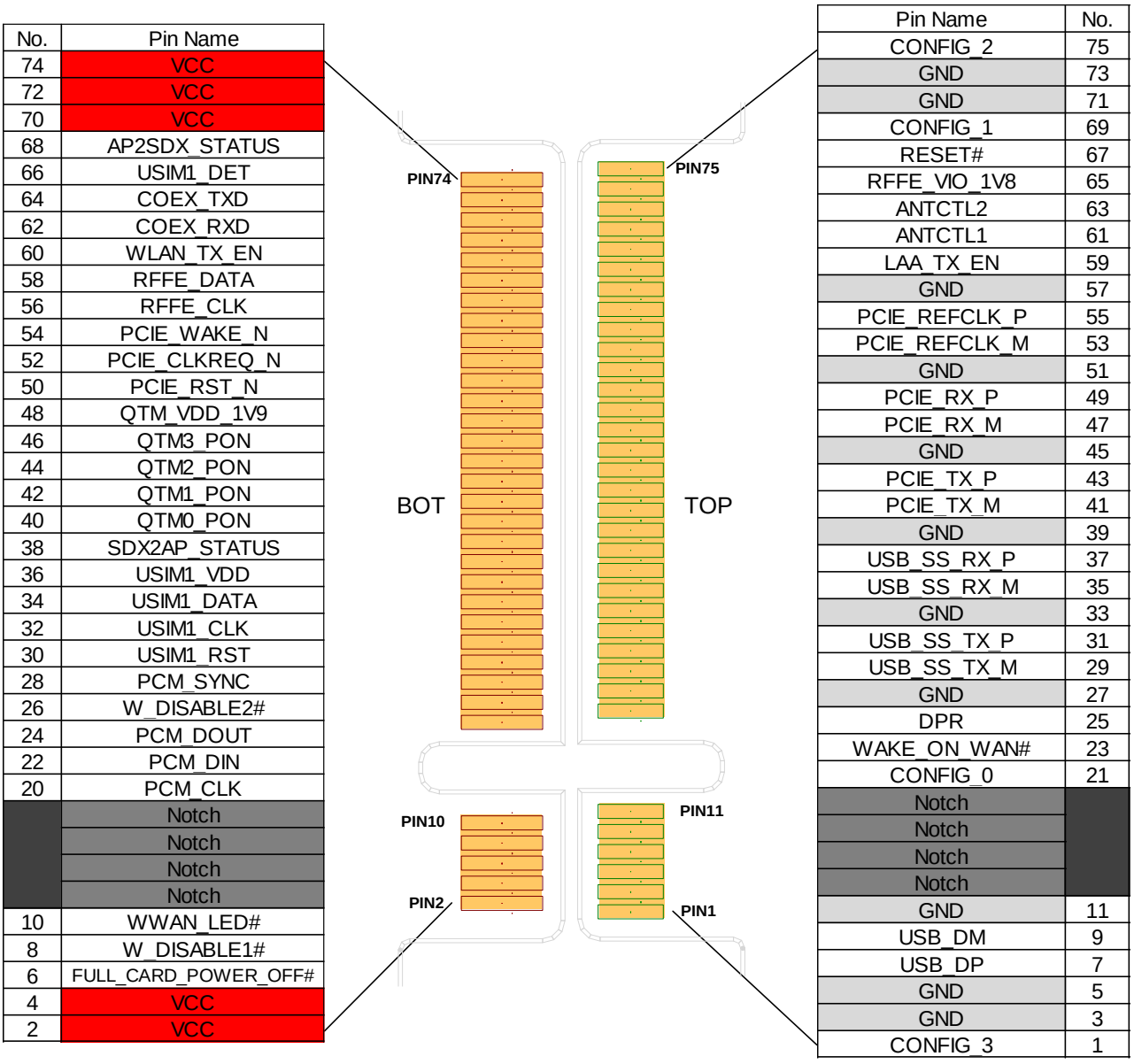


Figure 1: Functional Diagram

2.5. Pin Assignment

The following figure shows the pin assignment of the module. The top side contains module and antenna connectors.



No.	Pin Name
74	VCC
72	VCC
70	VCC
68	AP2SDX_STATUS
66	USIM1_DET
64	COEX_TXD
62	COEX_RXD
60	WLAN_TX_EN
58	RFFE_DATA
56	RFFE_CLK
54	PCIE_WAKE_N
52	PCIE_CLKREQ_N
50	PCIE_RST_N
48	QTM_VDD_1V9
46	QTM3_PON
44	QTM2_PON
42	QTM1_PON
40	QTM0_PON
38	SDX2AP_STATUS
36	USIM1_VDD
34	USIM1_DATA
32	USIM1_CLK
30	USIM1_RST
28	PCM_SYNC
26	W_DISABLE2#
24	PCM_DOUT
22	PCM_DIN
20	PCM_CLK
	Notch
	Notch
	Notch
	Notch
10	WWAN_LED#
8	W_DISABLE1#
6	FULL_CARD_POWER_OFF#
4	VCC
2	VCC

Pin Name	No.
CONFIG_2	75
GND	73
GND	71
CONFIG_1	69
RESET#	67
RFFE_VIO_1V8	65
ANTCTL2	63
ANTCTL1	61
LAA_TX_EN	59
GND	57
PCIE_REFCLK_P	55
PCIE_REFCLK_M	53
GND	51
PCIE_RX_P	49
PCIE_RX_M	47
GND	45
PCIE_TX_P	43
PCIE_TX_M	41
GND	39
USB_SS_RX_P	37
USB_SS_RX_M	35
GND	33
USB_SS_TX_P	31
USB_SS_TX_M	29
GND	27
DPR	25
WAKE_ON_WAN#	23
CONFIG_0	21
Notch	
Notch	
Notch	
Notch	
GND	11
USB_DM	9
USB_DP	7
GND	5
GND	3
CONFIG_3	1

Figure 2: Pin Assignment

2.6. Pin Description

Table 4: Definition of I/O Parameters

Type	Description
AI	Analog Input
AO	Analog Output
AIO	Analog Input/Output
DI	Digital Input
DO	Digital Output
DIO	Digital Input/Output
OD	Open Drain
PI	Power Input
PO	Power Output
PU	Pull Up
PD	Pull Down

The following table shows the pin definition and description of the module.

Table 5: Pin Description

Pin No.	Pin Name	I/O	Description	DC Characteristic	Comment
1	CONFIG_3	DO	Not connected internally		
2	VCC	PI	Power supply	Vmin = 3.135 V Vnom = 3.7 V Vmax = 4.4 V	
3	GND		Ground		
4	VCC	PI	Power supply	Vmin = 3.135 V Vnom = 3.7 V Vmax = 4.4 V	

5	GND		Ground		
6	FULL_CARD_POWER_OFF#	DI, PD	Turn on/off the module. High level: Turn on Low level: Turn off	V_{IH}max = 4.4 V V_{IH}min = 1.19 V V_{IL}max = 0.2 V	Internally pulled down with a 100 kΩ resistor.
7	USB_DP	AIO	USB 2.0 differential data (+)		
8	W_DISABLE1#	DI, OD	Airplane mode control. Active LOW.	1.8/3.3 V	
9	USB_DM	AIO	USB 2.0 differential data (-)		
10	WWAN_LED#	DO, OD	RF status indication LED Active LOW.	VCC	
11	GND		Ground		
12	Notch		Notch		
13	Notch		Notch		
14	Notch		Notch		
15	Notch		Notch		
16	Notch		Notch		
17	Notch		Notch		
18	Notch		Notch		
19	Notch		Notch		
20	PCM_CLK	DI, PD	PCM data bit clock	1.8 V	
21	CONFIG_0	DO	Not connected internally		
22	PCM_DIN	DI, PD	PCM data input	1.8 V	
23	WAKE_ON_WAN#	DO, OD	Wake up the host. Active LOW		
24	PCM_DOUT	DO, PD	PCM data output	1.8 V	
25	DPR*	DI, PU	Dynamic power reduction. High level by default.	1.8 V	
26	W_DISABLE2#	DI, OD	GNSS disable control. Active LOW	1.8/3.3 V	

27	GND		Ground	
28	PCM_SYNC	DI, PD	PCM data frame sync	1.8 V
29	USB_SS_TX_M	AO	USB 3.1 super-speed transmit (-)	
30	USIM1_RST	DO, PD	(U)SIM1 card reset	USIM_VDD 1.8/3.0 V
31	USB_SS_TX_P	AO	USB 3.1 super-speed transmit (+)	
32	USIM1_CLK	DO, PD	(U)SIM1 clock	USIM_VDD 1.8/3.0 V
33	GND		Ground	
34	USIM1_DATA	DIO, PU	(U)SIM1 card data	USIM_VDD 1.8/3.0 V
35	USB_SS_RX_M	AI	USB 3.1 super-speed receive (-)	
36	USIM1_VDD	PO	(U)SIM1 card power supply	USIM_VDD 1.8/3.0 V
37	USB_SS_RX_P	AI	USB 3.1 super-speed receive (+)	
38	SDX2AP_STATUS	DO, PD	Status indication to AP	1.8 V
39	GND		Ground	
40	QTM0_PON	DO	mmWave antenna control 0	1.8 V
41	PCIE_TX_M	AO	PCIe transmit (-)	
42	QTM1_PON	DO	mmWave antenna control 1	1.8 V
43	PCIE_TX_P	AO	PCIe transmit (+)	
44	QTM2_PON	DO	mmWave antenna control 2	1.8 V
45	GND		Ground	
46	QTM3_PON	DO	mmWave antenna control 3	1.8 V
47	PCIE_RX_M	AI	PCIe receive (-)	
48	QTM_VDD_1V9	PO	Power supply for mmWave antenna modules	

49	PCIE_RX_P	AI	PCIe receive (+)		
50	PCIE_RST_N	DI, OD	PCIe reset. Active LOW		
51	GND		Ground		
52	PCIE_CLKREQ_N	DO, OD	PCIe clock request. Active LOW		
53	PCIE_REFCLK_M	AI, AO	PCIe reference clock (-)		
54	PCIE_WAKE_N	DO, OD	PCIe wake up Active LOW		
55	PCIE_REFCLK_P	AI, AO	PCIe reference clock (+)		
56	RFFE_CLK* [1)]	DO, PD	Used for external MIPI IC control	1.8 V	
57	GND		Ground		
58	RFFE_DATA* [1)]	DO, PD	Used for external MIPI IC control	1.8 V	
59	LAA_TX_EN*	DO	Notification from transceiver to WLAN when LTE transmitting	1.8 V	
60	WLAN_TX_EN*	DI	Notification from WLAN to SDR while transmitting	1.8 V	
61	ANTCTL1*	DO, PD	Antenna GPIO control	1.8 V	
62	COEX_RXD*	DI, PD	LTE/WLAN coexistence receive data	1.8 V	
63	ANTCTL2*	DO, PD	Antenna GPIO control	1.8 V	
64	COEX_TXD*	DO, PD	LTE/WLAN coexistence transmit data	1.8 V	
65	RFFE_VIO_1V8 [1)]	PO	Power supply for antenna tuner	1.8 V	
66	USIM1_DET	DI; PD	(U)SIM1 card hot-plug detect	1.8 V	
67	RESET#	DI, PU	Reset the module. Active LOW.	V_{IH}max = 1.575 V V_{IH}min = 1.25 V V_{IL}max = 0.45 V	Internally pulled up to 1.5 V with a 100 kΩ resistor
68	AP2SDX_STATUS	DI, PD	Status indication from AP	1.8 V	
69	CONFIG_1	DO	Connected to GND		

			internally	
70	VCC	PI	Power supply	Vmin = 3.135 V Vnom = 3.7 V Vmax = 4.4 V
71	GND		Ground	
72	VCC	PI	Power supply	Vmin = 3.135 V Vnom = 3.7 V Vmax = 4.4 V
73	GND		Ground	
74	VCC	PI	Power supply	Vmin = 3.135 V Vnom = 3.7 V Vmax = 4.4 V
75	CONFIG_2	DO	Not connected internally	

NOTES

1. [1)] If the function is required, please contact us for more details.
2. Keep all NC, reserved and unused pins unconnected.

3 Operating Characteristics

3.1. Operating Modes

The table below briefly summarizes the various operating modes to be mentioned in the following chapters.

Table 6: Overview of Operating Modes

Mode	Details	
Normal Operation	Idle	Software is active. The module has registered on the network, and it is ready to send and receive data.
	Talk/Data	The module is connected to network. In this mode, the power consumption is decided by network setting and data transfer rate.
Minimum Functionality Mode	**AT+CFUN=0** command sets the module to a minimum functionality mode without removing the power supply. In this mode, both RF function and (U)SIM card are invalid.	
Airplane Mode	**AT+CFUN=4** command or driving W_DISABLE1# pin low will set the module to airplane mode. In this mode, the RF function is invalid.	
Sleep Mode	In this mode, the current consumption of the module is reduced to the minimal level, while the module keeps receiving paging messages, SMS, voice calls and TCP/UDP data from the network.	
Power Down Mode	In this mode, the power management unit shuts down the power supply. Software is inactive, the serial interfaces are inaccessible, and the operating voltage (connected to VCC) remains applied.	

3.1.1. Sleep Mode

DRX of module is able to reduce the current consumption to a minimum value during the sleep mode, and DRX cycle index values are broadcasted by the wireless network. The figure below shows the relationship between the DRX run time and the current consumption in sleep mode. The longer the DRX cycle is, the lower the current consumption will be.

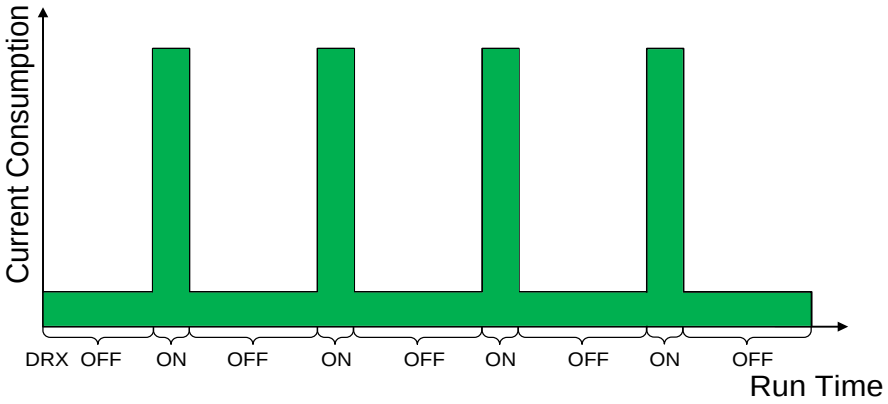


Figure 3: DRX Run Time and Current Consumption in Sleep Mode

The following section describes power saving procedure of module.

If the host supports USB suspend/resume and remote wakeup function, the following two preconditions must be met to enable the module enter sleep mode.

- Execute **AT+QSCLK=1** command to enable the sleep mode.
- The host's USB bus, which is connected with the module's USB interface, has entered into suspend state.

The following figure shows the connection between the module and the host.

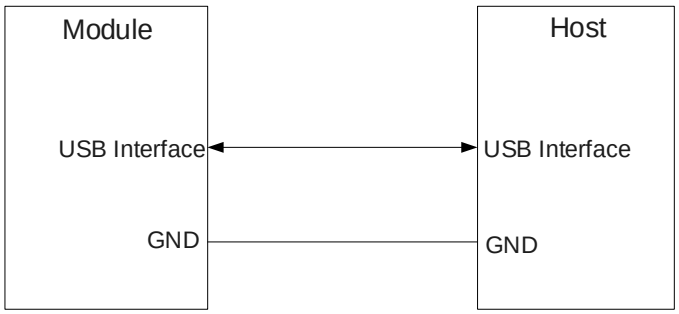


Figure 4: Sleep Mode Application with USB Remote Wakeup

- Sending data to module through USB will wake up the module.
- When module has a URC to report, the module will send remote wake-up signals via USB bus to wake up the host.

3.1.2. Airplane Mode

The module provides a W_DISABLE1# pin to disable or enable airplane mode through hardware operation. See ***Chapter 4.5.1*** for more details

3.2. Communication Interface with Host

The module supports to communicate through both USB and PCIe interfaces, respectively referring to the USB mode and the PCIe mode as described below:

USB Mode

- Supports all USB 2.0/3.1 features
- Supports MBIM/QMI/QRTR/AT
- Communication can be switched to PCIe mode by AT command

USB is the default communication interface between the module and the host. To use PCIe interface for the communication between a host, an AT command under USB mode can be used. For more details about the AT command, see ***document [4]***.

It is suggested that USB 2.0 interface be reserved for firmware upgrade.

USB-AT-based PCIe Mode

- Supports MBIM/QMI/QRTR/AT
- Communication can be switched back to USB mode by AT command

When the module works at the USB-AT-based (switched from USB mode by AT command) PCIe mode, it supports MBIM/QMI/QRTR/AT, and can be switched back to USB mode by AT command. But the firmware upgrade via PCIe interface is not supported, so USB 2.0 interface must be reserved for the firmware upgrade.

eFuse-based PCIe Mode

- Supports MBIM/QMI/QRTR/AT
- Supports Non-X86 systems and X86 system (supports BIOS PCIe early initial)

RM510Q-GL can also be reprogrammed to PCIe mode based on eFuse. If the communication is switched to PCIe mode by burnt eFuse, the communication cannot be switched back to USB mode.

3.3. Power Supply

The following table shows pin definition of VCC pins and ground pins.

Table 7: Definition of VCC and GND Pins

Pin	Pin Name	I/O	Description	DC Characteristics
2, 4, 70, 72, 74	VCC	PI	Power supply	3.135–4.4 V 3.7 V typical DC supply
3, 5, 11, 27, 33, 39, 45, 51, 57, 71, 73	GND		Ground	

3.3.1. Decrease Voltage Drop

The input power supply range of the module is from 3.135 V to 4.4 V. Please ensure that the input voltage will never drop below 3.135 V, otherwise the module will be powered off automatically. The voltage ripple of the input power supply should be less than 100 mV, and the voltage drop should be less than 165 mV.

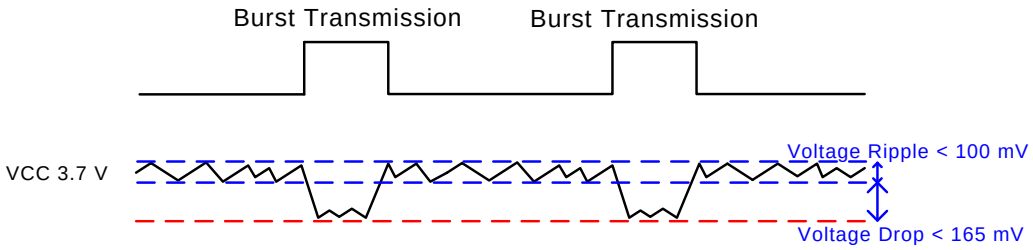


Figure 5: Power Supply Limits during Radio Transmission

To decrease voltage drop, two 100 µF with low ESR should be used, and some multi-layer ceramic chip capacitor (MLCC) array also should be used due to its ultra-low ESR. These capacitors should be close to VCC pins and the width of VCC trace should be no less than 2 mm. In principle, the longer the VCC trace is, the wider width it should be.

In addition, to get a stable power source, it is recommended to use a zener diode with reverse zener voltage of 5.1 V and dissipation power of more than 0.5 W.

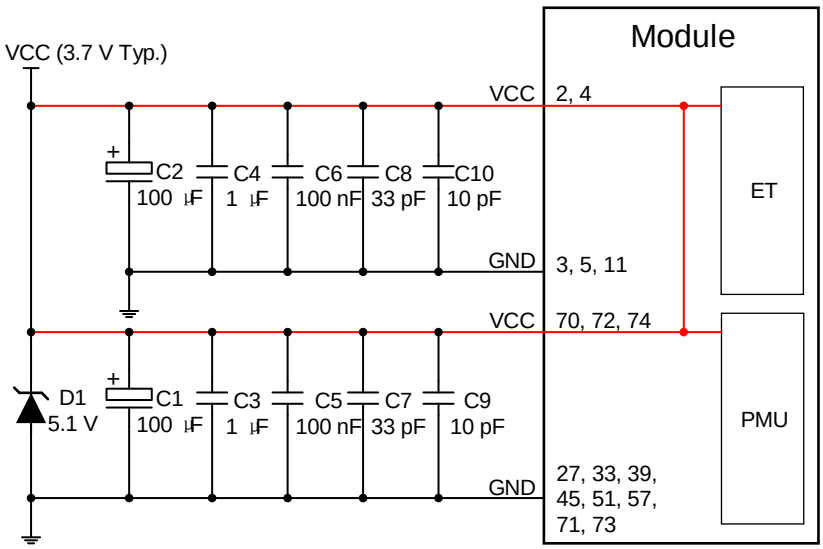


Figure 6: Reference Circuit of VCC

3.3.2. Reference Design for Power Supply

Power design for the module is important, as the performance of the module largely depends on the power source. The power supply is capable of providing a sufficient current of at least 5.0 A. If the voltage drop between the input and output is not too high, it is suggested that an LDO is used to supply power for the module. If there is a big voltage difference between the input source and the desired output (VCC = 3.7 V Typ.), a buck DC-DC converter is preferred as the power supply.

The following figure shows a reference design for +5.0 V input power source based on a DC-DC converter. The typical output of the power supply is about 3.7 V and the maximum load current is 5.0 A.

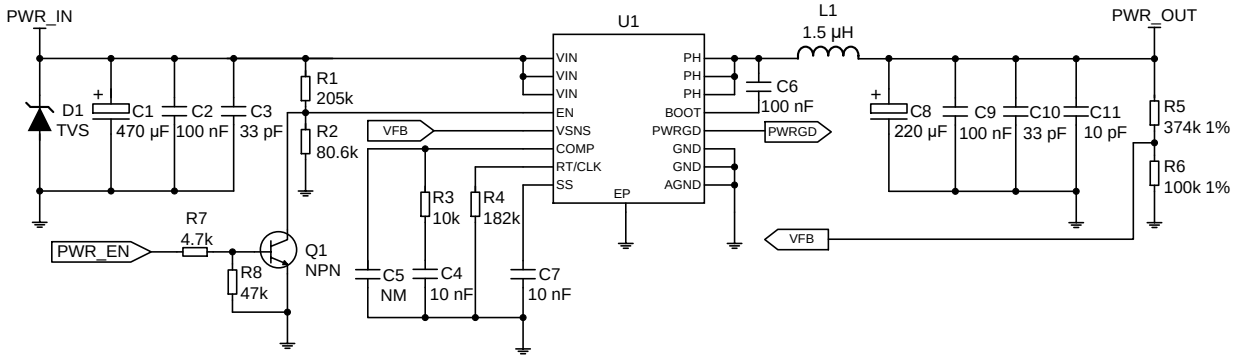


Figure 7: Reference Circuit of Power Supply

NOTE

To avoid damages to the internal flash, please cut off power supply after the module is turned off by pulling down FULL_CARD_POWER_OFF# pin for more than 7 s, and DON'T cut off power supply directly when the module is working.

3.3.3. Monitor the Power Supply

AT+CBC command can be used to monitor the voltage value of VCC. For more details, see ***document [4]***

3.4. Turn on

3.4.1. Turn on the Module

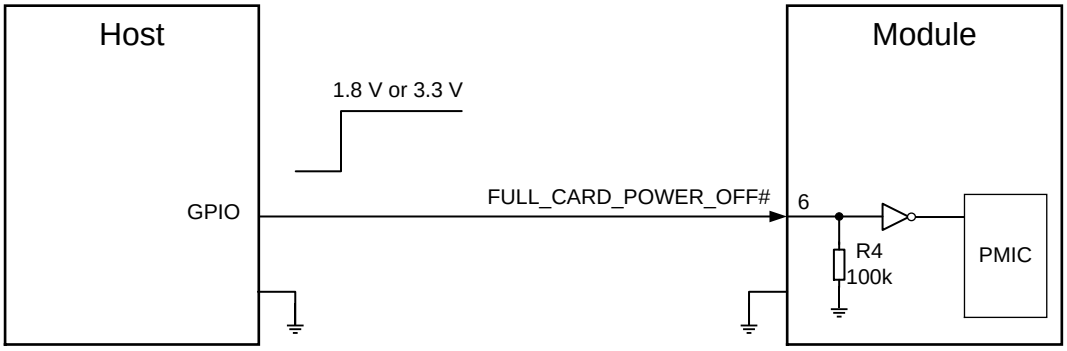
FULL_CARD_POWER_OFF# (FCPO#) is used to turn on/off the module. When the input signal is asserted high (≥ 1.19 V), the module will turn on. When the input signal is driven low signal (≤ 0.2 V) or tri-stated, the module will turn off.

This input signal is 3.3 V tolerant and can be driven by either 1.8 V or 3.3 V GPIO. Also, it has internally pulled down with a 100 kΩ resistor.

Table 8: Definition of FULL_CARD_POWER_OFF#

Pin No.	Pin Name	I/O	Description	DC Characteristics	Comment
6	FULL_CARD_ POWER_OFF#	DI, PD	Turn on/off the module. High level: Turn on Low level: Turn off	V_{IH}max = 4.4 V V_{IH}min = 1.19 V V_{IL}max = 0.2 V	Pull down with a 100 kΩ resistor.

It is recommended to use a host GPIO to control FULL_CARD_POWER_OFF#. A simple reference circuit is illustrated in the following figure.



Note: The voltage of pin 6 should be no less than 1.19V when it is at HIGH level.

Figure 8: Turn on the Module with a Host GPIO

The timing of turn-on scenario is illustrated in the following figure.

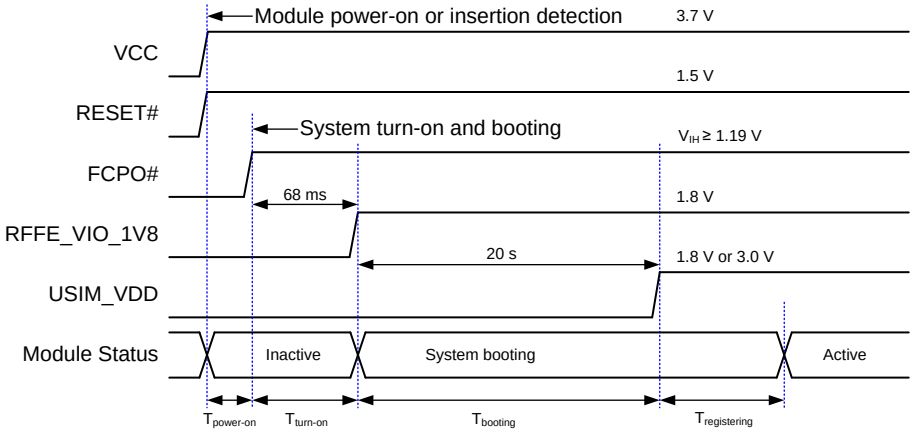


Figure 9: Turn-on Timing through FULL_CARD_POWER_OFF#

Table 9: Turn-on Time of the Module

Symbol	Min.	Typ.	Max.	Comment
$T_{power-on}$	0 ms	20 ms	-	System power-on time. It depends on host device.
$T_{turn-on}$	-	68 ms	-	System turn-on time
$T_{booting}$	20 s	22 s	-	System booting time
$T_{registering}$	-	-	-	Network registering time related to network CSQ.

3.5. Turn off

3.5.1. Turn off the Module through FULL_CARD_POWER_OFF#

For the design that turns on the module with a host GPIO, when the power is supplied to VCC, pulling down FULL_CARD_POWER_OFF# will turn off the module.

The timing of turning-off scenario is illustrated in the following figure.

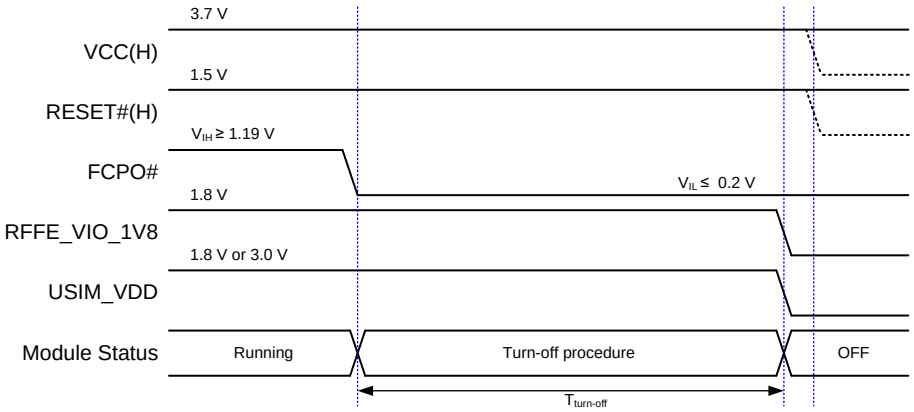


Figure 10: Turn-off Timing through FULL_CARD_POWER_OFF#

Table 10: Turn-off Time through FULL_CARD_POWER_OFF#

Symbol	Min.	Typ.	Max.	Comment
$T_{turn-off}$	6.84 s	-	-	System turn-off time

3.5.2. Turn off the Module through AT Command and FULL_CARD_POWER_OFF#

It is also a safe way to use **AT+QPOWD** command to turn off the module. For more details about the command, see ***document [4]***.

The module is designed to be turned on with a host GPIO. Pull down FULL_CARD_POWER_OFF# pin after the module's USB/PCIe is removed. Otherwise, the module will be powered on again.

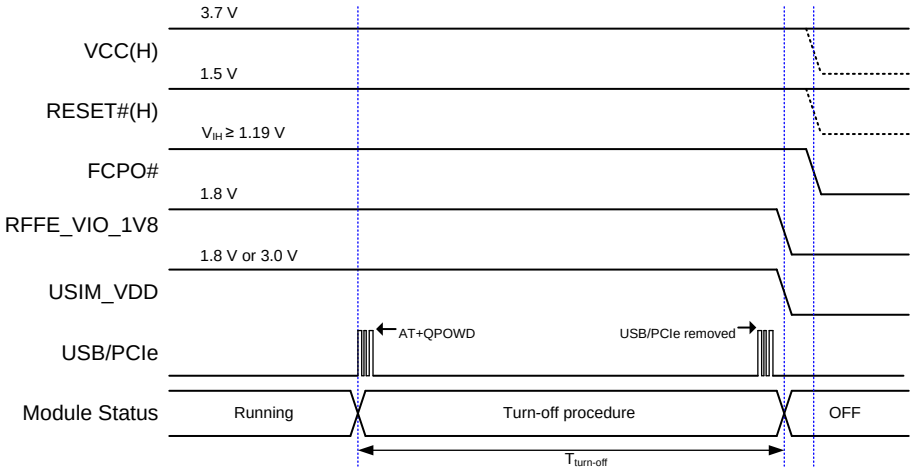


Figure 11: Turn-off Timing through AT Command and FULL_CARD_POWER_OFF#

Table 11: Turn-off Time through AT Command and FULL_CARD_POWER_OFF#

Symbol	Min.	Typ.	Max.	Comment
$T_{turn-off}$	6.84 s	-	-	System turn-off time

NOTES

1. After the host detects that the module USB/PCIe is removed, FCPO# pin must be pulled down.
2. After turning off the module, it is recommended to cut of VCC power supply.

3.6. Reset

RESET# is an asynchronous and active low signal (1.5 V logic level). Whenever this pin is active, the module will immediately enter Power On Reset (POR) condition.

Table 12: Definition of RESET# Pin

Pin No.	Pin Name	I/O	Description	DC Characteristics	Comment
67	RESET#	DI, PU	Reset the module Active LOW.	V_{IH}max = 1.575 V V_{IH}min = 1.25 V V_{IL}max = 0.45 V	Internally pulled up to 1.5 V with a 100 kΩ resistor

NOTE

Triggering the RESET# signal will lead to loss of all data in the modem and removal of system drivers. It will also disconnect the modem from the network.

The module can be reset by pulling down the RESET# pin for 250–600 ms. An open collector/drain driver or a button can be used to control the RESET# pin.

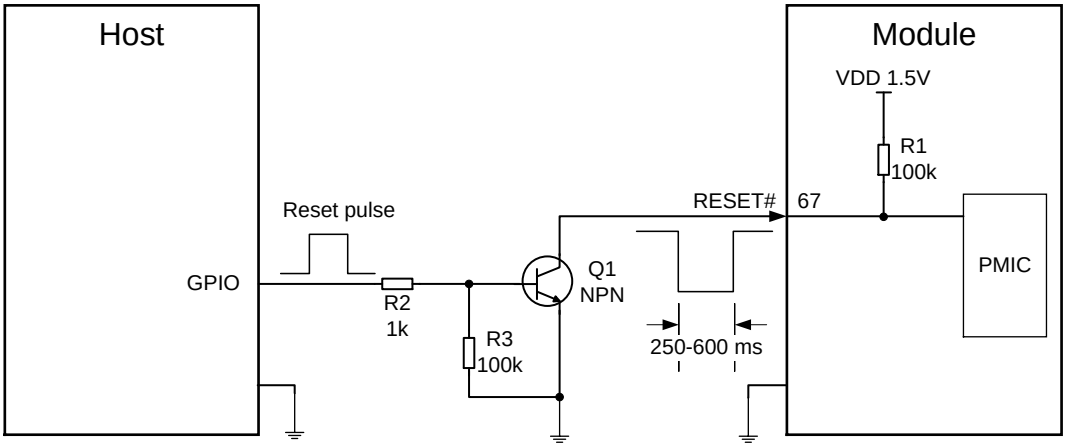
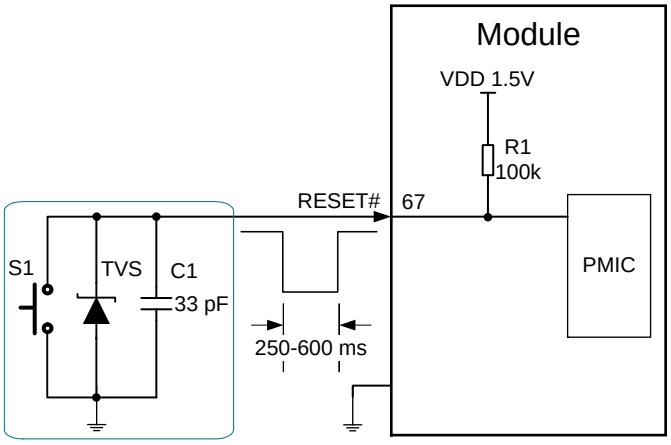


Figure 12: Reference Circuit of RESET# with NPN Driving Circuit



Note: The capacitor C1 is recommended to be less than 47 pF.

Figure 13: Reference Circuit of RESET# with a Button

The reset scenario is illustrated in the following figure.

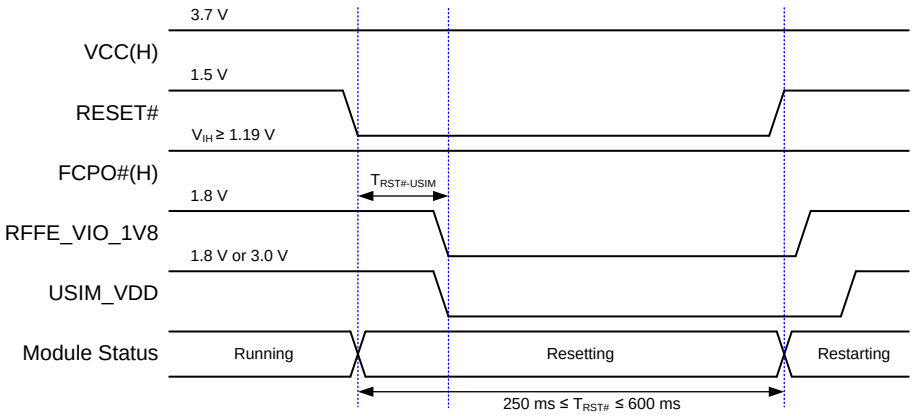


Figure 14: Resetting Timing through RESET#

Table 13: Resetting Time through RESET#

Symbol	Min.	Typ.	Max.	Comment
$T_{RST\#-USIM}$	200 ms	-	-	(U)SIM card turn-off time
$T_{RST\#}$	250 ms	400 ms	600 ms	More than 600 ms will cause reset repeatedly

4 Application Interfaces

The physical connections and signal levels of RM510Q-GL comply with *PCI Express M.2 specification*. This chapter mainly describes the definition and application of the following interfaces/pins of the module:

- (U)SIM interfaces
- USB interface
- PCIe interface
- PCM interface
- Control and indication interfaces
- Cellular/WLAN COEX interface*
- Antenna tuner control interface*
- Configuration pins

4.1. (U)SIM Interface

The (U)SIM interface circuitry meets ETSI and IMT-2000 requirements. Both Class B (3.0 V) and Class C (1.8 V) (U)SIM cards are supported. RM510Q-GL only supports single (U)SIM slot.

4.1.1. Pin Definition of (U)SIM

Table 14: Pin Definition of (U)SIM Interface

Pin No.	Pin Name	I/O	Description	DC Characteristics
36	USIM1_VDD	PO	Power supply for (U)SIM1 card	1.8/3.0 V
34	USIM1_DATA	DIO, PU	(U)SIM1 card data	USIM_VDD 1.8/3.0 V
32	USIM1_CLK	DO, PD	(U)SIM1 card clock	USIM_VDD 1.8/3.0 V
30	USIM1_RST	DO, PD	(U)SIM1 card reset	USIM_VDD 1.8/3.0 V
66	USIM1_DET	DI, PU	(U)SIM1 card hot-plug detect	1.8 V

4.1.2. Hot-plug of (U)SIM

The module supports (U)SIM card hot-plug via the USIM_DET pin. (U)SIM card is detected by USIM_DET interrupt. (U)SIM card hot-plug is disabled by default.

This is command enables (U)SIM card hot-plug function. The level of (U)SIM card detection pin should also be set when the (U)SIM card is inserted.

AT+QSIMDET (U)SIM Card Detection	
Test Command **AT+QSIMDET=?**	Response **+QSIMDET: (**list of supported **<enable>**s**),(**list of supported **<insert_level>**s**)** **OK**
Read Command **AT+QSIMDET?**	Response **+QSIMDET: <enable>,<insert_level>** **OK**
Write Command **AT+QSIMDET=<enable>,<insert_level>**	Response **OK** Or **ERROR**
Maximum Response Time	300 ms
Characteristics	The command takes effect after rebooting. The configuration will be saved automatically.

Parameter

<enable>	Integer type. Enable or disable (U)SIM card detection. 0 Disable 1 Enable
<insert_level>	Integer type. The level of (U)SIM detection pin when a (U)SIM card is inserted. 0 Low level 1 High level

NOTES

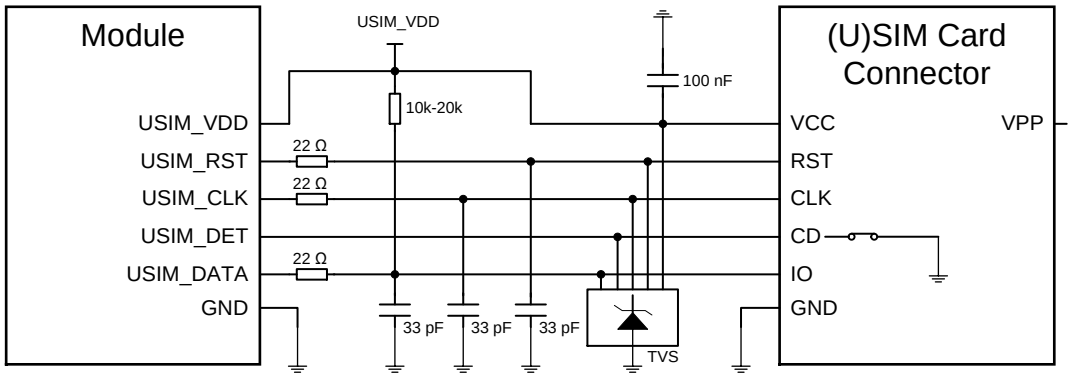
1. Hot-plug function is invalid if the configured value of **<insert_level>** is inconsistent with hardware design.
2. Hot-plug function takes effect after the module is restarted.
3. USIM_DET is internally pulled up to 1.8 V by software configuration when (U)SIM hot-plug is enabled by **AT+QSIMDET**.

4.1.3. Normally Closed (U)SIM Card Connector

With a normally closed (U)SIM card connector, the USIM_DET is normally short-circuited to ground when a (U)SIM card is not inserted, and the USIM_DET will change from low to high voltage level when a (U)SIM card is inserted. The rising edge indicates an insertion of the (U)SIM card. When the (U)SIM card is removed, USIM_DET will change from high to low voltage level. The falling edge indicates a removal of the (U)SIM card.

- When the (U)SIM is absent, CD is short-circuited to ground and USIM_DET is at low voltage level.
- When the (U)SIM is inserted, CD is open from ground and USIM_DET is at high voltage level.

The following figure shows a reference design of (U)SIM interface with a normally closed (U)SIM card connector.



Note: All these resistors, capacitors and TVS should be close to (U)SIM card connector in PCB layout.

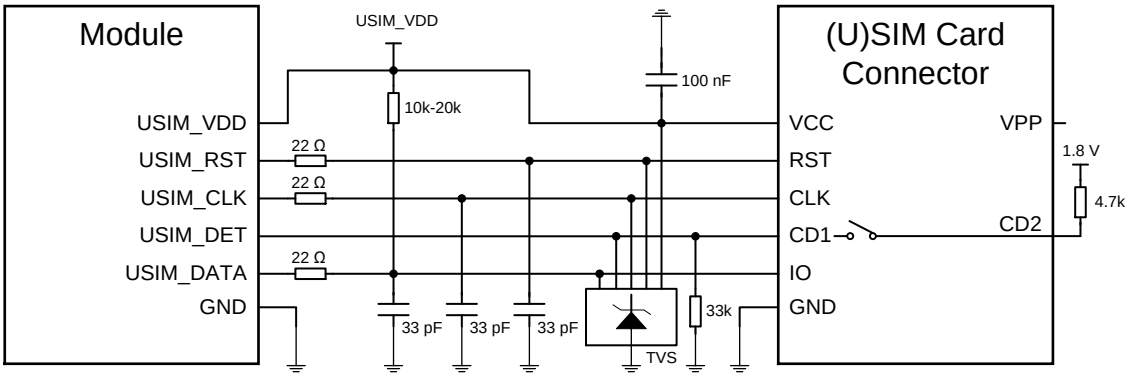
Figure 15: Reference Circuit for Normally Closed (U)SIM Card Connector

4.1.4. Normally Open (U)SIM Card Connector

With a normally open (U)SIM card connector, the USIM_DET is normally pulled down to ground through an external resistance when a (U)SIM card is not inserted, and the USIM_DET will change from low to high voltage level when a (U)SIM card is inserted. The rising edge indicates an insertion of the (U)SIM card. When the (U)SIM card is removed, USIM_DET will change from high to low voltage level. The falling edge indicates a removal of the (U)SIM card.

- When the (U)SIM is absent, CD1 is open from CD2 and USIM_DET is at low voltage level.
- When the (U)SIM is inserted, CD1 is pulled up to 1.8 V and USIM_DET is at high voltage level.

The following figure shows a reference design of (U)SIM interface with a normally open (NO) (U)SIM card connector.

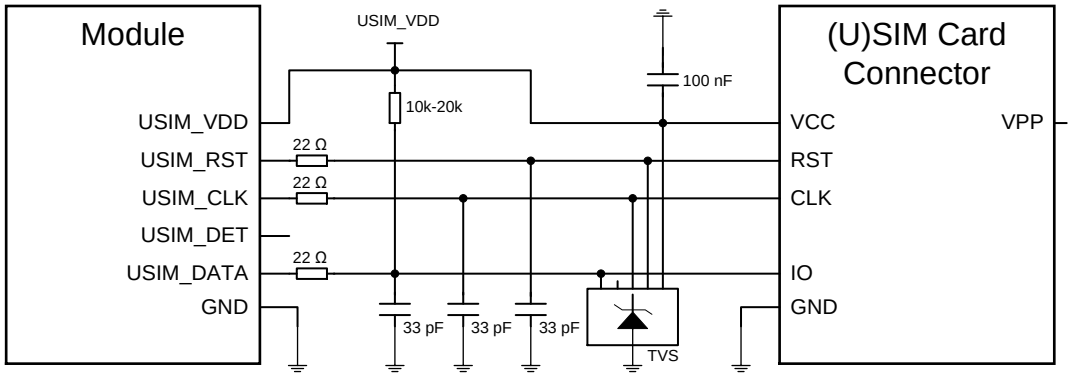


Note: All these resistors, capacitors and TVS should be close to (U)SIM card connector in PCB layout.

Figure 16: Reference Circuit for Normally Open (U)SIM Card Connector

4.1.5. Without Hot-plug (U)SIM Card Connector

If (U)SIM card detection function is not needed, please keep USIM_DET disconnected. A reference circuit for (U)SIM card interface with a 6-pin (U)SIM card connector is illustrated by the following figure.



Note: All these resistors, capacitors and TVS should be close to (U)SIM card connector in PCB layout.

Figure 17: Reference Circuit for a 6-Pin (U)SIM Card Connector

4.1.6. (U)SIM Design Notices

To enhance the reliability and availability of the (U)SIM card in applications, please follow the criteria below in (U)SIM circuit design.

- Place the (U)SIM card connector as close to the module as possible. Keep the trace length less than 200 mm.

- Keep (U)SIM card signals away from RF and VCC traces.
- Make sure the ground between the module and the (U)SIM card connector is short and wide. Keep the trace width of ground and USIM_VDD no less than 0.5 mm to maintain the same electric potential.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them away from each other and shield them with surrounded ground.
- To offer better ESD protection, add a TVS diode array of which the parasitic capacitance should be not higher than 10 pF. Add 22 Ω resistors in series between the module and the (U)SIM card connector to suppress EMI such as spurious transmission, and to enhance ESD protection. The 33 pF capacitors are used to filter out RF interference.
- For USIM_DATA, a 10–20 kΩ pull-up resistor must be added near the (U)SIM card connector.

4.2. USB Interface

The module provides one integrated Universal Serial Bus (USB) interface which complies with the USB 3.1 & 2.0 specifications and supports super speed (10 Gbps) on USB 3.1 and high speed (480 Mbps) and full speed (12 Mbps) modes on USB 2.0. The USB interface is used for AT command communication, data transmission, GNSS NMEA sentence output, software debugging, firmware upgrade.

For more details about the USB 3.1 & 2.0 specifications, please visit http://www.usb.org/home.

Table 15: Pin Definition of USB Interface

Pin No.	Pin Name	I/O	Description	Comment
7	USB_DP	AIO	USB differential data bus (+)	Require differential impedance of 90 Ω
9	USB_DM	AIO	USB differential data bus (-)	
29	USB_SS_TX_M	AO	USB 3.1 super-speed transmit (-)	
31	USB_SS_TX_P	AO	USB 3.1 super-speed transmit (+)	
35	USB_SS_RX_M	AI	USB 3.1 super-speed receive (-)	
37	USB_SS_RX_P	AI	USB 3.1 super-speed receive (+)	

The USB 2.0 interface is recommended to be reserved for firmware upgrade in designs. The following figure shows a reference circuit of USB 3.1 & 2.0 interface.

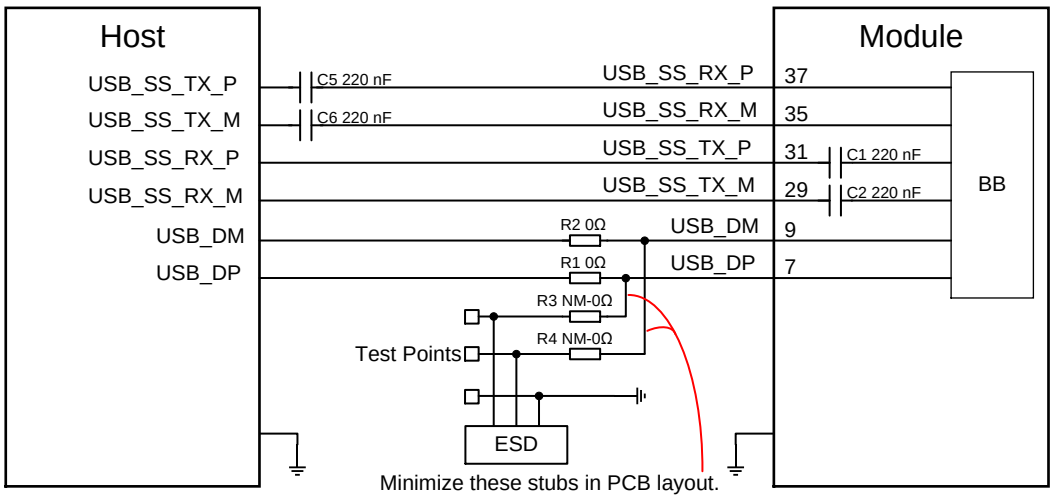


Figure 18: Reference Circuit of USB 3.1 & 2.0 Interface

AC coupling capacitors C5 and C6 must be placed close to the host and close to each other. C1 and C2 have been integrated inside the module, so do not place these two capacitors on design. To ensure the signal integrity of USB 2.0 data traces, R1, R2, R3 and R4 must be placed close to the module, and the stubs must be minimized in PCB layout.

You should follow the principles below when designing for the USB interface to meet USB 3.1 and 2.0 specifications:

- Route the USB signal traces as differential pairs with ground surrounded. The impedance of differential trace of USB 2.0 and 3.1 is 90 Ω.
- For USB 2.0 signal traces, the trace length should be less than 120 mm, and the differential data pair matching should be less than 2 mm. For USB 3.1 signal traces, length matching of each differential data pair (Tx/Rx) should be less than 0.7 mm, while the matching between Tx and Rx should be less than 10 mm.
- Do not route signal traces under crystals, oscillators, magnetic devices, PCIe and RF signal traces. Route the USB differential traces in inner-layer of the PCB, and surround the traces with ground on that layer and with ground planes above and below.
- Junction capacitance of the ESD protection device might cause influences on USB data lines, so you should pay attention to the selection of the device. Typically, the stray capacitance should be less than 1.0 pF for USB 2.0, and less than 0.15 pF for USB 3.1.
- Keep the ESD protection devices as close to the USB connector as possible.
- If possible, reserve 0 Ω resistors on USB_DP and USB_DM lines respectively.

NOTES

1. Only USB 2.0 can be used for firmware upgrade currently.
2. If no USB interface is designed, make sure AT and DM port OK.

4.3. PCIe Interface

The module provides one integrated PCIe (Peripheral Component Interconnect Express) interface.

- *PCI Express Base Specification Revision 3.0* compliant
- Data rate up to 8 Gbps per lane

4.3.1. PCIe Operating Mode

The module supports endpoint (EP) mode and root complex (RC) mode. In EP mode, the module is configured as a PCIe EP device. In RC mode, the module is configured as a PCIe root complex.

AT+QCFG="pcie/mode" is used to set PCIe RC/EP mode.

AT+QCFG="pcie/mode"	**Set PCIe RC/EP Mode**
Write Command **AT+QCFG="pcie/mode"[,<mode>]**	Response If the optional parameter is omitted, query the current setting: **+QCFG: "pcie/mode",<mode>** **OK** If the optional parameter is specified, set PCIe RC/EP mode: **OK** Or **ERROR**
Maximum Response Time	300 ms
Characteristics	This command will take effect after rebooting. The configuration will be saved automatically.

Parameter

<mode>	Integer type. Set PCIe RC or EP mode. 0 PCIe EP mode. 1 PCIe RC mode.

For more details about the command, see ***document [4]***.

4.3.2. Pin Definition of PCIe

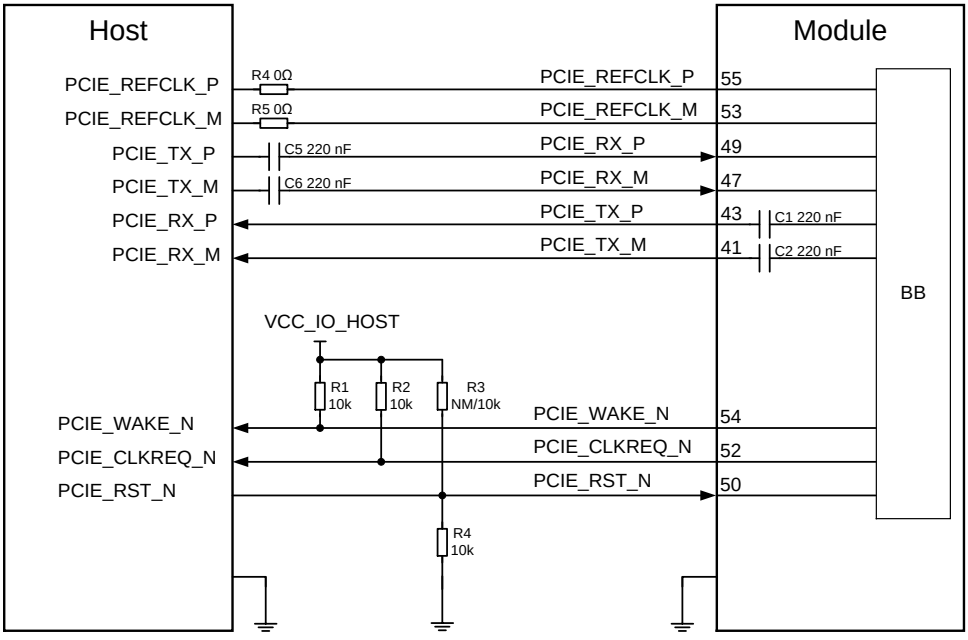
The following table shows the pin definition of PCIe interface.

Table 16: Pin Definition of PCIe Interface

Pin No.	Pin Name	I/O	Description	Comment
55	PCIE_REFCLK_P	AIO	PCIe reference clock (+)	100 MHz. Require differential impedance of 85 Ω
53	PCIE_REFCLK_M	AIO	PCIe reference clock (-)	
49	PCIE_RX_P	AI	PCIe receive (+)	Require differential impedance of 85 Ω
47	PCIE_RX_M	AI	PCIe receive (-)	
43	PCIE_TX_P	AO	PCIe transmit (+)	Require differential impedance of 85 Ω
41	PCIE_TX_M	AO	PCIe transmit (-)	
50	PCIE_RST_N	DI, OD	PCIe reset. Active LOW.	Open drain
52	PCIE_CLKREQ_N	DO, OD	PCIe clock request. Active LOW.	Open drain
54	PCIE_WAKE_N	DO, OD	PCIe wake up. Active LOW.	Open drain

4.3.3. Reference Design of PCIe

The following figure shows a reference circuit for the PCIe interface.



Note. The voltage level VCC_IO_HOST of these three signals depend on the host side due to open drain.

Figure 19: PCIe Interface Reference Circuit

To ensure the signal integrity of PCIe interface, AC coupling capacitors C5 and C6 should be placed close to the host on PCB. C1 and C2 have been embedded into the module, so do not place these two capacitors on your schematic and PCB.

The following principles of PCIe interface design should be complied with, so as to meet PCIe specification.

- Keep the PCIe data and control signals away from sensitive circuits and signals, such as RF, audio, crystal and oscillator signals.
- Add a capacitor in series on Tx/Rx traces to prevent any DC bias.
- Keep the maximum trace length less than 300 mm.
- Keep the length matching of each differential data pair (Tx/Rx) less than 0.7 mm for PCIe routing traces.
- Keep the differential impedance of PCIe data trace as 85 Ω ±10 %.
- You must not route PCIe data traces under components or cross them with other traces.

4.3.4. PCIe Timing

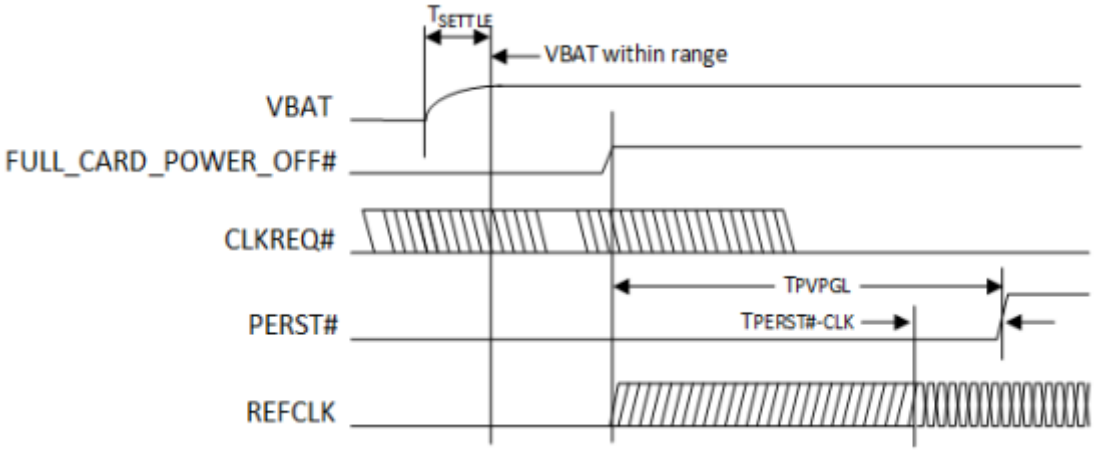


Figure 20: PCIe Power-up Timing of M.2 Specification

Table 17: PCIe Power-up Timing of M.2 Specification

Symbol	Min.	Typ.	Max.	Comment
T_{PVPGL}	50 ms	-	-	Power Valid to PERST# Input inactive
$T_{PERST\#-CLK}$	100 µs	-	-	REFCLK stable before PERST# inactive

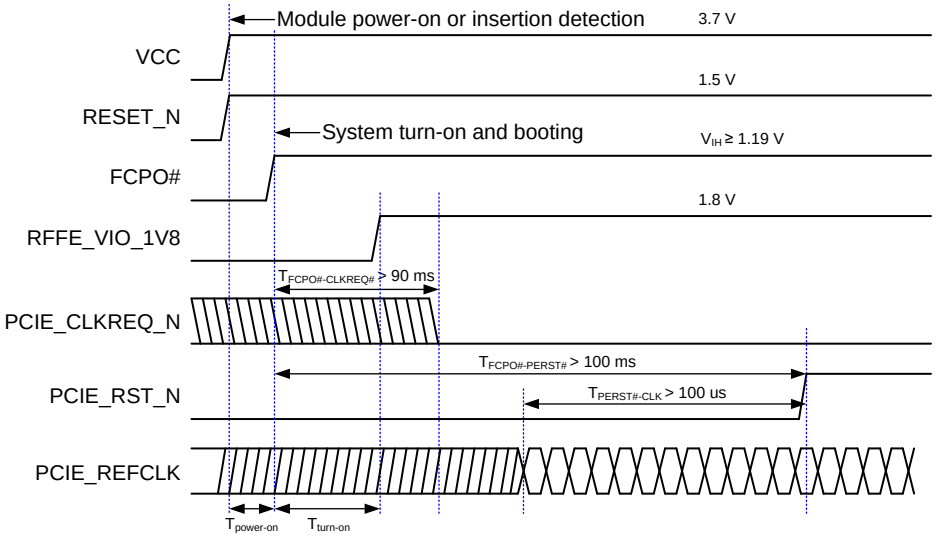


Figure 21: PCIe Power-up Timing of the Module

Table 18: PCIe Power-up Timing of Module

Symbol	Min.	Typ.	Max.	Comment
$T_{power-on}$	0m s	20 ms	-	System power-on time. It is depend on host device.
$T_{turn-on}$	-	68 ms	-	System turn-on time
$T_{FCPO\#-CLKREQ\#}$	90 ms	100 ms	-	Power valid to CLKREQ# output active
$T_{FCPO\#-PERST\#}$	100 ms	-	-	Power valid to PERST# input inactive
$T_{PERST\#-CLK}$	100 µs	-	-	REFCLK stable before PERST# inactive

4.4. PCM Interface

The following table shows the pin definition of PCM interface which can be applied to audio codec design.

Table 19: Pin Definition of PCM Interface

Pin No.	Pin Name	I/O	Description	DC Characteristics
20	PCM_CLK	DI, PD	PCM data bit clock	1.8 V
22	PCM_DIN	DI, PD	PCM data input	1.8 V
24	PCM_DOUT	DO, PD	PCM data output	1.8 V
28	PCM_SYNC	DI,PD	PCM data frame sync	1.8 V

The module supports audio communication via Pulse Code Modulation (PCM) digital interface. The PCM interface supports the following modes:

- Primary mode (short frame synchronization): the module works as both master and slave
- Auxiliary mode (long frame synchronization): the module works as master only

In primary mode, the data is sampled on the falling edge of the PCM_CLK and transmitted on the rising edge. The PCM_SYNC falling edge represents the MSB. In this mode, the PCM interface supports 256 kHz, 512 kHz, 1024 kHz or 2048 kHz PCM_CLK at 8 kHz PCM_SYNC, and also supports 4096 kHz PCM_CLK at 16 kHz PCM_SYNC.

In auxiliary mode, the data is sampled on the falling edge of the PCM_CLK and transmitted on the rising edge. The PCM_SYNC rising edge represents the MSB. In this mode, PCM interface operates with a 256 kHz PCM_CLK and an 8 kHz, 50 % duty cycle PCM_SYNC only.

The module supports 16-bit linear data format. The following figures show the primary mode's timing relationship with 8 kHz PCM_SYNC and 2048 kHz PCM_CLK, as well as the auxiliary mode's timing relationship with 8 kHz PCM_SYNC and 256 kHz PCM_CLK.

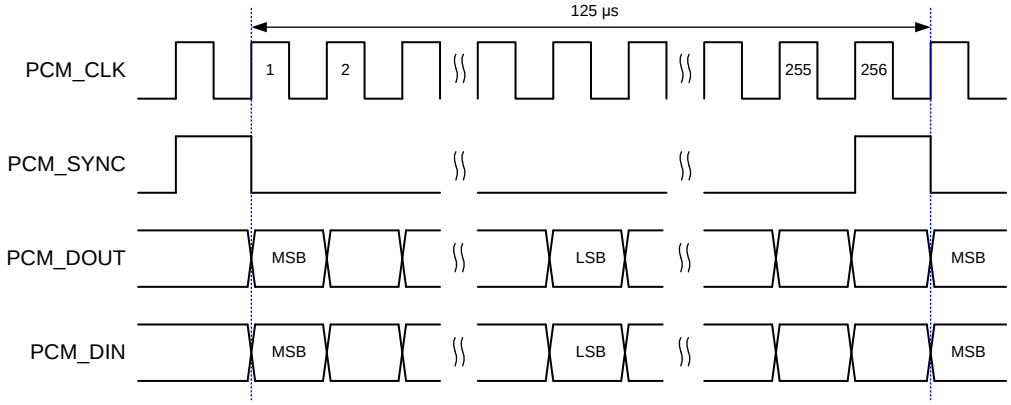


Figure 22: Primary Mode Timing

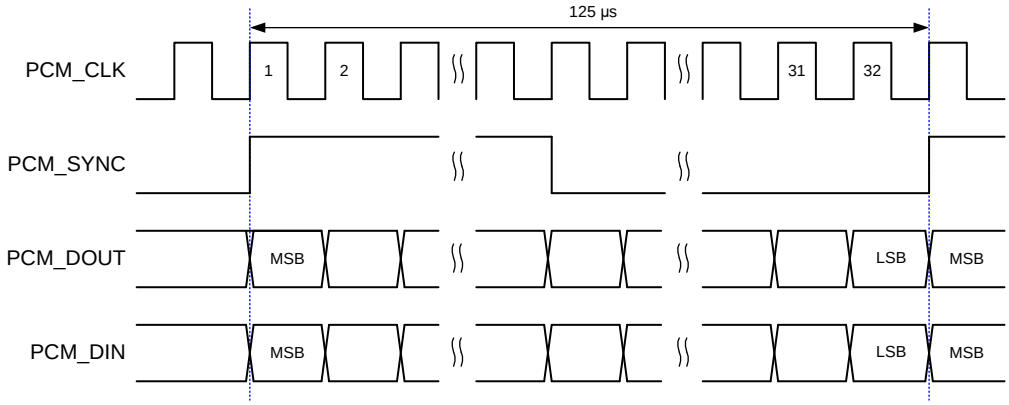


Figure 23: Auxiliary Mode Timing

The clock and mode can be configured by AT command, and the default configuration is master mode using short frame synchronization format with 2048 kHz PCM_CLK and 8 kHz PCM_SYNC. See ***document [4]*** for details about **AT+QDAI** command.

4.5. Control and Indication Interfaces

The following table shows the pin definition of control and indication pins.

Table 20: Pin Definition of Control and Indication Interfaces

Pin No.	Pin Name	I/O	Description	DC Characteristics
8	W_DISABLE1#	DI, OD	Airplane mode control. Pulled up by default. Active LOW.	1.8/3.3 V
26	W_DISABLE2#	DI, OD	GNSS disable control. Pulled up by default. Active LOW.	1.8/3.3 V
10	WWAN_LED#	DO,OD	Indicate RF status of the module. Open drain.	VCC
23	WAKE_ON_WAN#	DO,OD	Wake up the host. Open drain.	
25	DPR*	DI, PU	Dynamic power reduction. High level by default.	1.8 V
38	SDX2AP_STATUS	DO, PD	Status indication to AP	1.8 V
68	AP2SDX_STATUS	DI, PD	Status indication from AP	1.8 V

4.5.1. W_DISABLE1#

The module provides a W_DISABLE1# pin to disable or enable airplane mode through hardware operation. W_DISABLE1# is pulled up by default. Driving it low will set the module to airplane mode. In airplane mode, the RF function will be disabled.

The RF function can also be enabled or disabled through software AT commands. The following table shows the RF function status of the module.

Table 21: RF Function Status

W_DISABLE1# Level	AT Commands	RF Function Status
High Level	**AT+CFUN=1**	Enabled (RF operation allowed)
High Level	**AT+CFUN=0** **AT+CFUN=4**	Disabled (no RF operation allowed)
Low Level	**AT+CFUN=1**	
Low Level	**AT+CFUN=0** **AT+CFUN=4**	

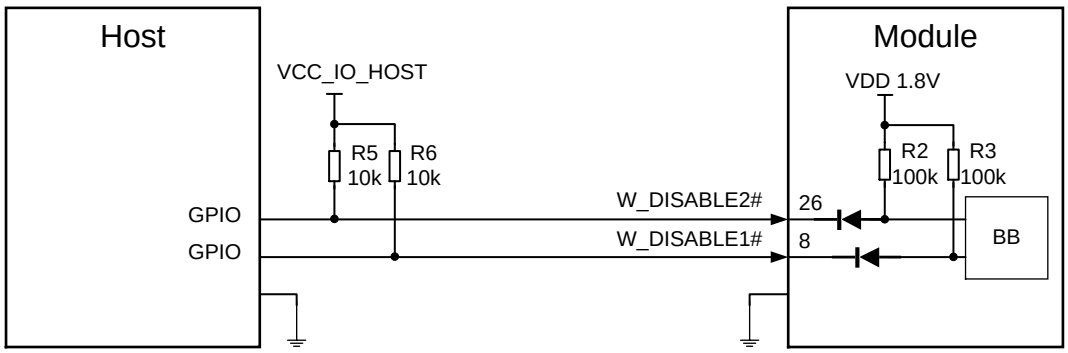
4.5.2. W_DISABLE2#

The module provides a W_DISABLE2# pin to disable or enable the GNSS function. The W_DISABLE2# pin is pulled up by default. Driving it low will disable the GNSS function. The combination of W_DISABLE2# pin and AT commands can control the GNSS function.

Table 22: GNSS Function Status

W_DISABLE2# Level	AT Commands	GNSS Function Status
High Level	**AT+QGPS=1**	Enabled (GNSS function allowed)
High Level	**AT+QGPSEND**	Disabled (no GNSS function allowed)
Low Level	**AT+QGPS=1**	
Low Level	**AT+QGPSEND**	

A simple level shifter based on diodes is used on W_DISABLE1# pin and W_DISABLE2# pin which are pulled up to a 1.8 V voltage in the module, as shown in the following figure, so the control signals (GPIO) of the host device could be at 1.8 V or 3.3 V voltage level. W_DISABLE1# and W_DISABLE2# are active low signals, and a reference circuit is shown as below.



Notes: The voltage level of VCC_IO_HOST could be 1.8 V or 3.3 V typically.

Figure 24: W_DISABLE1# and W_DISABLE2# Reference Circuit

4.5.3. WWAN_LED#

The WWAN_LED# signal is used to indicate RF status of the module, and its sink current is up to 10 mA.

To reduce current consumption of the LED, a current-limited resistor must be placed in series with the LED, as illustrated in the figure below. The LED is ON when the WWAN_LED# signal is at low level.

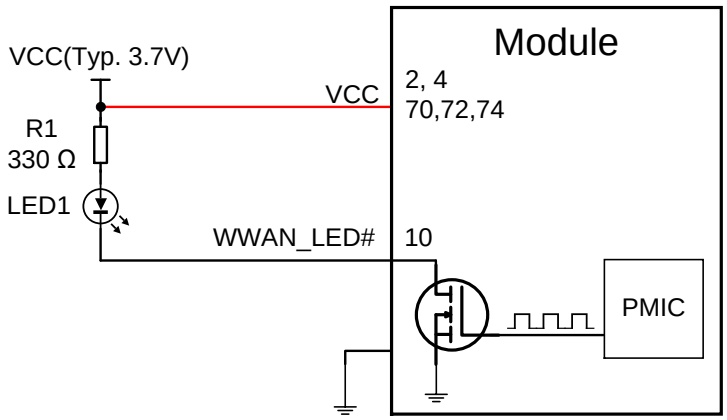


Figure 25: WWAN_LED# Reference Circuit

The following table shows the RF status indicated by WWAN_LED# .

Table 23: Network Status Indications of WWAN_LED#

WWAN_LED# Level	Description
Low Level (LED ON)	RF function is turned on

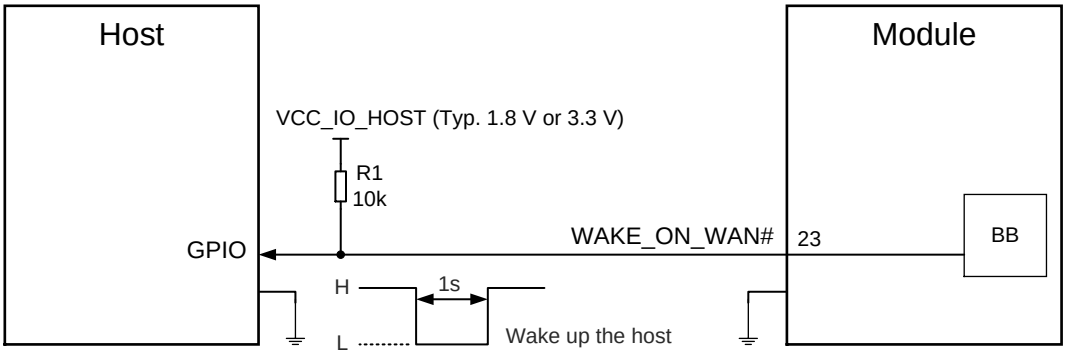
High Level (LED OFF)	RF function is turned off if any of the following occurs: ● The (U)SIM card is not powered. ● W_DISABLE1# is at low level (airplane mode enabled). ● **AT+CFUN=4** (RF function disabled).

4.5.4. WAKE_ON_WAN#

The WAKE_ON_WAN# is an open drain pin, which requires a pull-up resistor on the host. When a URC returns, a 1 s low level pulse signal will be outputted to wake up the host. The module operation status indicated by WAKE_ON_WAN# is shown as below.

Table 24: State of the WAKE_ON_WAN#

WAKE_ON_WAN# State	Module Operation Status
Output a 1 s low level pulse signal	Call/SMS/Data is incoming (to wake up the host)
Always at high level	Idle/Sleep



Note. The voltage level VCC_IO_HOST depends on the host side due to open drain in pin23.

Figure 26: WAKE_ON_WAN# Signal Reference Circuit

4.5.5. DPR*

The module provides the DPR (Dynamic Power Reduction) pin for body SAR (Specific Absorption Rate) detection. The signal is sent from a host system proximity sensor to the module to provide an input trigger, which will reduce the output power in radio transmission.

Table 25: Function of the DPR Signal

DPR Level	Function
High/Floating	NO max. transmitting power backoff
Low	Max. transmitting power backoff by **AT+QCFG="sarcfg"**

NOTE

See ***document [4]*** for more details about **AT+QCFG="sarcfg"** command.

4.5.6. STATUS

The module provides two status indication pins for communication with IPQ807x device. Pin 38 (SDX2AP_STATUS) outputs the status indication signal to IPQ807x device, and pin 68 (AP2SDX_STATUS) inputs the status indication signal from IPQ807x device.

4.6. Cellular/WLAN Coexistence Interface*

The module provides the cellular/WLAN Coexistence interface, the following table shows the pin definition of this interface.

Table 26: Pin Definition of Coexistence Interface

Pin No.	Pin Name	I/O	Description	DC Characteristics
59	LAA_TX_EN	DO	Notification from SDR to WLAN when LTE transmitting	1.8 V
60	WLAN_TX_EN	DI	Notification from WLAN to SDR while transmitting	1.8 V
62	COEX_RXD	DI, PD	LTE/WLAN coexistence receive data	1.8 V
64	COEX_TXD	DO, PD	LTE/WLAN coexistence transmit data	1.8 V

4.7. Antenna Tuner Control Interface

ANTCTL[1:2] and RFFE interface are used for antenna tuner control and should be routed to an appropriate antenna control circuit. More details about the interface will be added in the future version of this document.

Table 27: Pin Definition of Antenna Tuner Control Interface

Pin No.	Pin Name	I/O	Description	DC Characteristics
56	RFFE_CLK* [1)]	DO	Used for external MIPI IC control	1.8 V
58	RFFE_DATA* [1)]	IO	Used for external MIPI IC control	1.8 V
65	RFFE_VIO_1V8 [1)]	PO	Power supply for antenna tuner	1.8 V
61	ANTCTL1*	DO, PD	Antenna Control GPIO	1.8 V
63	ANTCTL2*	DO, PD	Antenna Control GPIO	1.8 V

NOTE

[1)] If customers have this function requirement, please contact us for more details.

4.8. Configuration Pins

The module provides four configuration pins, which are defined as below.

Table 28: Configuration Pins List of M.2 Specification

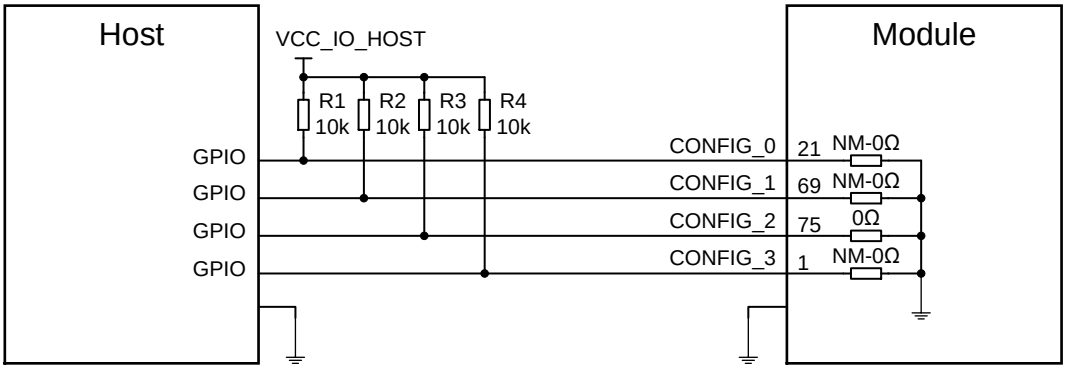
Config_0 (Pin 21)	Config_1 (Pin 69)	Config_2 (Pin 75)	Config_3 (Pin 1)	Module Type and Main Host Interface	Port Configuration
NC	GND	NC	NC	Quectel defined	2

Table 29: Definition of Configuration Pins

Pin No.	Pin Name	I/O	Description	DC Characteristics
21	CONFIG_0	DO	Not connected internally	-

69	CONFIG_1	DO	Connected to GND internally	-
75	CONFIG_2	DO	Not connected internally	-
1	CONFIG_3	DO	Not connected internally	-

The following figure shows a reference circuit of these four pins.



Notes: The voltage level of VCC_IO_HOST could be 1.8 V or 3.3 V typically.

Figure 27: Recommended Circuit of Configuration Pins

5 RF Characteristics

This chapter mainly describes RF characteristics of the module.

5.1. mmWave IF Interfaces

5.1.1. Assignment and Definition of mmWave IF Interfaces

The following figure and table show the assignment and definition of RM510Q-GL mmWave IF interfaces respectively.

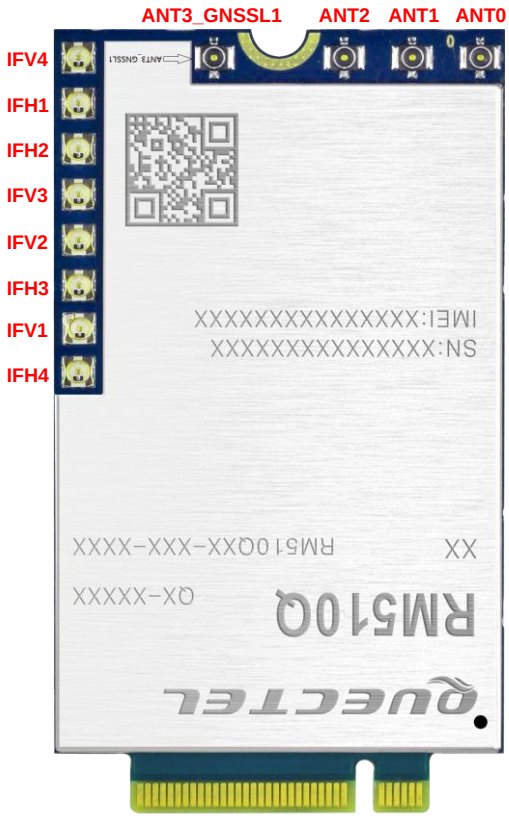


Figure 28: Assignment of mmWave IF Interfaces

Table 30: Definition of mmWave IF Interfaces

mmWave IF Interface	I/O	Functional Description
IFH1	AIO	Horizontal polarization IF output signal and control signal for mmWave RFIC device 1
IFH2	AIO	Horizontal polarization IF output signal and control signal for mmWave RFIC device 2
IFH3	AIO	Horizontal polarization IF output signal and control signal for mmWave RFIC device 3
IFH4	AIO	Horizontal polarization IF output signal and control signal for mmWave RFIC device 4
IFV1	AIO	Vertical polarization IF output signal and local oscillator (LO) signal for mmWave RFIC device 4
IFV2	AIO	Vertical polarization IF output signal and LO signal for mmWave RFIC device 3
IFV3	AIO	Vertical polarization IF output signal and LO signal for mmWave RFIC device 2
IFV4	AIO	Vertical polarization IF output signal and LO signal for mmWave RFIC device 1

5.1.2. Characteristics of mmWave IF Interfaces

5.1.2.1. VSWR Requirements of mmWave IF Interfaces

Table 31: VSWR Requirements of mmWave IF Interfaces

Range	VSWR Requirement
10 MHz to 1.2 GHz	Better than 2:1
1.2–3.6 GHz	Better than 2:1
6–10 GHz	Better than 2:1; variation over 1.4 GHz < 0.5

5.1.2.2. Insertion Loss Requirements of mmWave IF Interfaces

Table 32: Insertion Loss Requirements of mmWave IF Interfaces

Range	Insertion Loss Requirement
10 MHz to 1.2 GHz	< 2 dB

1.2–3.6 GHz	< 4 dB
6–10 GHz	< 7 dB (from the IFIC to the RFIC) < 5 dB (from the RM510-GL to QTM525)

5.1.2.3. IF Isolation

IF isolation requirements for proper operation at 6–10 GHz operating frequency are as follows:

Total system isolation between an IF path (combined PCB, cables, connectors, and so on) and the connected antenna module should be more than 35 dB, and the isolation between an IF path and other antenna modules should be more than 25 dB.

5.1.2.4. mmWave and Sub-6 GHz Antennas Coexistence

Isolation between mmWave and sub-6 GHz antennas: > 20 dB

The following table shows the isolation requirements between IF cable and Sub-6 GHz antennas.

Table 33: Isolation Requirements between IF cable to Sub-6 GHz Antennas

Range	Isolation Requirement
100 MHz – 1 GHz	75 dB
1–6 GHz	70 dB
6–10 GHz	65 dB

5.1.3. mmWave IF Port Mapping

RM510Q-GL supports QTM525(power class 3) and QTM527(power class 1). IF port mapping as shown below.

Table 34: mmWave IF Port Mapping

Group	QTM_Pon	RM510Q-GL	QTM527	QTM525
1	QTM0_PON	IFV4	QTM527-1_IF2 (V)	IF2 (V)
		IFH1	QTM527-1_IF1 (H)	IF1 (H)

2	QTM2_PON	IFH2	QTM527-2_IF1 (H)	IF1 (H)
		IFV3	QTM527-2_IF2 (V)	IF2 (V)
3	QTM3_PON	IFV2	QTM527-3_IF2 (V)	IF2 (V)
		IFH3	QTM527-3_IF1 (H)	IF1 (H)
4	QTM1_PON	IFV1	QTM527-4_IF2 (V)	IF2 (V)
		IFH4	QTM527-4_IF1 (H)	IF1 (H)

5.1.4. IF Connector

The dimensions of antenna receptacle (IPEX: 20981-001E-02) on the RM510Q-GL and plug (IPEX: 20980-001R-13) are illustrated as below.

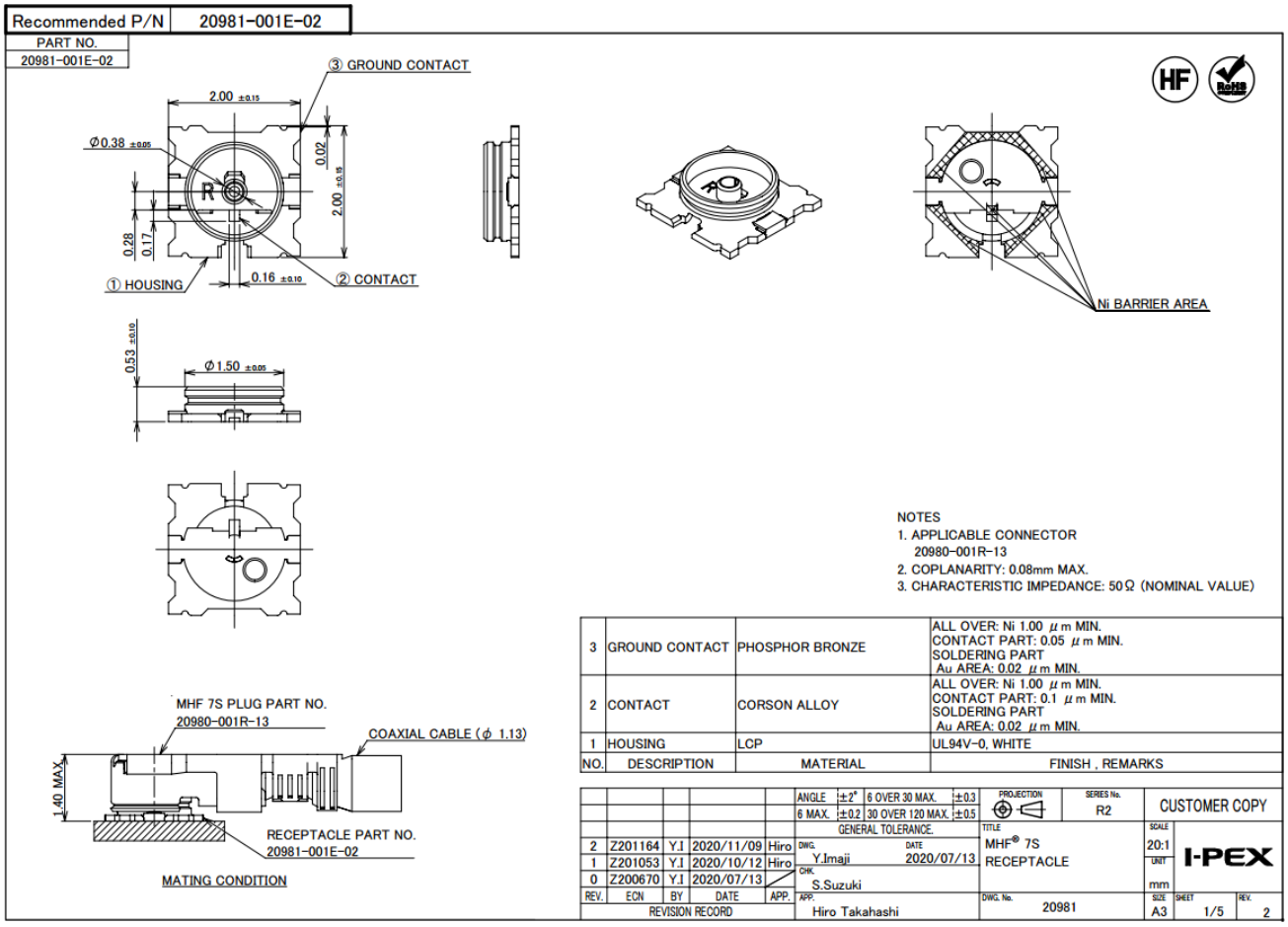


Figure 29: Dimensions of IF Connectors

5.2. Cellular Antenna Interfaces

5.2.1. Pin Definition

The pin definition of antenna interfaces is shown below.

Table 35: RM510Q-GL Pin Definition of Antenna Interfaces

Pin Name	I/O	Description	Comment
ANT0	AIO	Antenna0 interface: 5G NR: MHB_TRX & n41 TRX1[1)] & n77/n78/n79_PRX MIMO; LTE: MHB_TRX & UHB[2)]_PRX MIMO WCDMA: MHB_TRX	50 Ω impedance
ANT1	AIO	Antenna1 interface: 5G NR: LB_TRX & MHB_DRX MIMO & n41_DRX1[1)] & n77/n78/n79_DRx MIMO LTE: LB_TRX & MHB_DRX MIMO & UHB[2)]_DRX MIMO & LAA PRX WCDMA: LB_TRX	50 Ω impedance
ANT2	AIO	Antenna2 interface: 5G NR: LB_DRX & MHB_PRX MIMO & n41 TRX0 [1)] & n77/n78/n79_TRX LTE: LB_DRX & MHB_PRX MIMO & UHB [2)] _TRX WCDMA: LB_DRX	50 Ω impedance
ANT3_ GNSSL1	AI	Antenna3 interface: 5G NR: MHB_DRX MIMO & n41 DRX0 [1)] & n77/n78/n79_DRX LTE: MHB_DRX & UHB [2)]_DRX & LAA DRX WCDMA: MHB_DRX GNSS: L1	50 Ω impedance

NOTES

1.[1)] NR TRX1 = TX MIMO + PRX MIMO; NR DRX1 = DRX MIMO
2.[2)] UHB frequency range: 3400–3800 MHz

5.2.2. Port Mapping

Table 36: Antenna Mapping

Antenna	WCDMA	4G	Refarmed	5G NR n41	n77/n78/ n79	LB (MHz)	MHB (MHz)	n77/ n78 (MHz)	n79 (MHz)
ANT0	MHB_TRX	MHB_TRX UHB[1)] _PRX MIMO	MHB_TRX UHB [1)] _PRX MIMO	TRX1 [2)] TRX1 [2)]	PRX MIMO	–	1452 to 2690	3300 to 4200	4400 to 5000
ANT1	LB_TRX	LB_TRX MHB_DRX MIMO, UHB[1)]_DRX MIMO, LAA PRX	LB_TRX MHB_DRX MIMO UHB [1)]_DRX MIMO,	DRX1 [2)]	DRX MIMO	617 to 960	1452 to 2690	3300 to 4200	4400 to 6000
ANT2	LB_DRX	LB_DRX, MHB_PRX MIMO, UHB [1)] _TRX	LB_DRX, MHB_PRX MIMO, UHB [1)] _ TRX	TRX0 [2)]	TRX	617 to 960	1452 to 2690	3300 to 4200	4400 to 5000
ANT3_ GNSSL1	MHB_DRX	MHB_DRX, UHB [1)] _DRX, LAA_DRX	MHB_DRX, UHB [1)] _DRX,	DRX0 [2)]	DRX	-	1452 to 2690	3300 to 4200	4400 to 6000

NOTES

1. [1)] UHB frequency range: 3400–3800 MHz
2. [2)] NR TRX1 = TX MIMO + PRX MIMO; NR DRX1 = DRX MIMO

5.2.3. Operating Frequency

Table 37: RM510Q-GL Module Operating Frequency

Band Name	Transmit (MHz)	Receive (MHz)	LTE-FDD	LTE-TDD	UMTS	5G NR
IMT (2100)	1920–1980	2110–2170	B1	–	B1	n1
PCS (1900)	1850–1910	1930–1990	B2	–	B2	n2
DCS (1800)	1710–1785	1805–1880	B3	–	B3	n3
AWS	1710–1755	2110–2155	B4	–	B4	–
Cell (850)	824–849	869–894	B5	–	B5	n5
JCELL (800)	830–840	875–885	–	–	B6	–
IMT-E (2600)	2500–2570	2620–2690	B7	–	–	n7

EGSM (950)	880–915	925–960	B8	–	B8	n8
700 lower A–C	699–716	729–746	B12(B17)	–	–	n12
700 upper C	777–787	746–756	B13	–	–	–
700 D	788–798	758–768	B14	–	–	–
B18	815–830	860–875	B18	–	–	–
B19	830–845	875–890	B19	–	B19	–
EU800	832–862	791–821	B20	–	–	n20
PCS + G	1850–1915	1930–1995	B25	–	–	n25
B26	814–849	859–894	B26	–	–	–
700 APAC	703–748	758–803	B28	–	–	n28
FLO	–	717–728	B29	–	–	–
WCS	2305–2315	2350–2360	B30	–	–	–
L-band	–	1452–1496	B32	–	–	–
B34	2010–2025	2010–2025	–	B34	–	–
B38	2570–2620	2570–2620	–	B38	–	n38
B39	1880–1920	1880–1920	–	B39	–	–
B40	2300–2400	2300–2400	–	B40	–	n40
B41/B41-XGP	2496–2690	2496–2690	–	B41	–	n41
B42	3400–3600	3400–3600	–	B42	–	–
B43	3600–3800	3600–3800	–	B43	–	–
B46	5150–5925	5150–5925	–	B46	–	–
B48	3550–3700	3550–3700	–	B48	–	n48*
B66	1710–1780	2110–2200	B66	–	–	n66
B71	663–698	617–652	B71	–	–	n71
n77	3300–4200	3300–4200	–	–	–	n77
n78	3300–3800	3300–3800	–	–	–	n78
n79	4400–5000	4400–5000	–	–	–	n79

5.2.4. Sensitivity

The following tables show conducted receiving sensitivity of RM510Q-GL.

Table 38: RM510Q-GL Conducted Receiving Sensitivity

Mode	Frequency	Primary	Diversity	SIMO [1)]	3GPP (SIMO)
WCDMA	WCDMA B1	-109.5	-110.3	-110.5	-106.7 dBm
	WCDMA B2	-109.5	-110.6	-110.5	-104.7 dBm
	WCDMA B3	-109.5	-110.4	-110.5	-103.7 dBm
	WCDMA B4	-109	-110.1	-110	-106.7 dBm
	WCDMA B5	-110.5	-112	-112	-104.7 dBm
	WCDMA B8	-109.5	-112	-111.5	-103.7 dBm
	WCDMA B19	-111	-112	-112	-104.7 dBm
LTE	LTE-FDD B1 (10 MHz)	-98.0	-99.2	-101.0	-96.3 dBm
	LTE-FDD B2 (10 MHz)	-97.0	-99.2	-101.5	-94.3 dBm
	LTE-FDD B3 (10 MHz)	-97.0	-98.7	-101.2	-93.3 dBm
	LTE-FDD B4 (10 MHz)	-97.5	-98.7	-101.0	-96.3 dBm
	LTE-FDD B5 (10 MHz)	-99.0	-101.0	-102.5	-94.3 dBm
	LTE-FDD B7 (10 MHz)	-97.0	-98.5	-100.5	-94.3 dBm
	LTE-FDD B8 (10 MHz)	-98.5	-100.5	-102.2	-93.3 dBm
	LTE-FDD B12(B17) (10 MHz)	-99.5	-101.5	-102.5	-93.3 dBm
	LTE-FDD B13 (10 MHz)	-100.0	-101.5	-102.5	-93.3 dBm
	LTE-FDD B14 (10 MHz)	-100.0	-101.2	-102.5	-93.3 dBm
	LTE-FDD B18 (10 MHz)	-99.5	-101.5	-102.5	-96.3 dBm
	LTE-FDD B19 (10 MHz)	-98.7	-101.0	-102.0	-96.3 dBm
	LTE-FDD B20 (10 MHz)	-99.0	-101.2	-102.1	-93.3 dBm

	LTE-FDD B25 (10 MHz)	-100.0	-101.5	-102.5	-92.8 dBm
	LTE-FDD B26 (10 MHz)	-97.0	-99.3	-101.0	-93.8 dBm
	LTE-FDD B28 (10 MHz)	-99.0	-101.3	-102.2	-94.8 dBm
	LTE-FDD B30 (10 MHz)	-100.0	-101.5	-102.5	-95.3 dBm
	LTE-FDD B32 (10 MHz)	TBD	TBD	TBD	-95.3 dBm
	LTE-TDD B34 (10 MHz)	-97.0	-98.5	-100.5	-96.3 dBm
	LTE-TDD B38 (10 MHz)	-97.0	-98.3	-100.5	-96.3 dBm
	LTE-TDD B39 (10 MHz)	-97.0	-97.0	-100.0	-96.3 dBm
	LTE-TDD B40 (10 MHz)	-96.0	-97.0	-100.0	-96.3 dBm
	LTE-TDD B41 (10 MHz)	-96.8	-98.3	-100.5	-94.3 dBm
	LTE-TDD B42 (10 MHz)	-96.8	-99.0	-100.5	-95 dBm
	LTE-TDD B43 (10 MHz)	-96.8	-99.0	-100.5	-95 dBm
	LTE-TDD B48 (10 MHz)	-96.8	-96.8	-99.0	-95 dBm
	LTE-FDD B66 (10 MHz)	-96.8	-98.3	-100.2	-96.5 dBm
	LTE-FDD B71 (10 MHz)	-100.0	-101.0	-102.5	-94.2 dBm
5G NR	5G NR-FDD n1 (20 MHz) (SCS: 15 kHz)	-94.5	-95.5	-97.5	-94.0 dBm
	5G NR-FDD n2 (20 MHz) (SCS: 15 kHz)	-94.5	-95.5	-97.5	-92.0 dBm
	5G NR-FDD n3 (20 MHz) (SCS: 15 kHz)	-93.5	-95.5	-97.0	-91.0 dBm
	5G NR-FDD n5 (10 MHz) (SCS: 15 kHz)	-95.5	-97.0	-99.5	-95.0 dBm
	5G NR-FDD n7 (20 MHz) (SCS: 15 kHz)	-93.5	-94	-96.5	-92.0 dBm
	5G NR-FDD n8 (10 MHz) (SCS: 15 kHz)	-95.0	-97.0	-98.5	-94.0 dBm
	5G NR-FDD n12 (10 MHz) (SCS: 15 kHz)	-95.0	-98.0	-99.5	-94.0 dBm
	5G NR-FDD n20 (10 MHz) (SCS: 15 kHz)	-95.0	-97.0	-99.0	-94.0 dBm
	5G NR-FDD n25 (20 MHz)	-94.5	-95.0	-97.5	-90.5 dBm

	(SCS: 15 kHz)				
	5G NR-FDD n28 (10 MHz) (SCS: 15 kHz)	-95.0	-97.0	-99.0	-96.0 dBm
	5G NR-TDD n38 (20 MHz) (SCS: 30 kHz)	-94.0	-95.0	-97.0	-94.0 dBm
	5G NR-TDD n40 (20 MHz) (SCS: 30 kHz)	-93.5	-93.5	-95.5	-94.0 dBm
	5G NR-TDD n41 (20 MHz) (SCS: 30 kHz)	-85.0	-87.0	-88.5	-92.0 dBm
	5G NR-FDD n48 (20 MHz) (SCS: 30 kHz)	-94.0	-95.5	-97	-93.5 dBm
	5G NR-FDD n66 (20 MHz) (SCS: 15 kHz)	-91.5	-92.0	-94.5	-93.5 dBm
	5G NR-FDD n71 (10 MHz) (SCS: 15 kHz)	-95.0	-97.5	-99.5	-94.0 dBm
	5G NR-TDD n77 (20 MHz) (SCS: 30 kHz)	-86.0	-87.0	-89.0	-92.9 dBm
	5G NR-TDD n78 (20 MHz) (SCS: 30 kHz)	-86.0	-87.5	-89.0	-92.9 dBm
	5G NR-TDD n79 (40 MHz) (SCS: 30 kHz)	-86.0	-86.5	-89.5	-89.7 dBm

NOTE

[1] SIMO is a smart antenna technology that uses a single antenna at the transmitter side and two antennas at the receiver side, which improves Rx performance.

5.2.5. Output Power

The following table shows the RF output power of the module.

Table 39: Cellular Output Power

Mode	Frequency	Max.	Min.
WCDMA	WCDMA bands	24 dBm +1/-3 dB (Class 3)	< -50 dBm
LTE	LTE bands	23 dBm ±2 dB (Class 3)	< -40 dBm
	LTE HPUE bands (B38/B40/B41/B42/B43)	26 dBm ±2 dB (Class 2)	< -40 dBm

5G NR	5G NR bands	23 dBm ±2 dB (Class 3)	< -40 dBm (BW: 5–20 MHz) 1)
	5G NR HPUE bands (n41/n77/n78/n79)	26 dBm +2/-3 dB (Class 2)	< -40 dBm (BW: 5–20 MHz) 1)

NOTE

1) For 5G NR TDD bands, the normative reference for this requirement is *TS 38.101-1 [2] clause 6.3.1*

5.3. GNSS Antenna Interface

The following table shows frequency specification of GNSS antenna connector.

5.3.1. General Description

The module includes a fully integrated global navigation satellite system solution (GPS, GLONASS, BeiDou/Compass, and Galileo).

The module supports standard NMEA-0183 protocol, and outputs NMEA sentences at 1 Hz data update rate via USB interface by default.

By default, the module GNSS engine is switched off. It has to be switched on via AT command. For more details about GNSS engine technology and configurations, see ***document [5]***.

5.3.2. GNSS Frequency

Table 40: GNSS Frequency

Type	Frequency	Unit
GPS/Galileo/QZSS	1575.42 ±1.023 (L1)	MHz
Galileo	1575.42 ±2.046 (E1)	MHz
QZSS	1575.42 (L1)	MHz
GLONASS	1597.5–1605.8	MHz
BeiDou	1561.098 ±2.046	MHz

NOTES

1. Keep the characteristic impedance for the trace of GNSS antenna (ANT3_GNSSL1) to 50 Ω.
2. Place the π-type matching components as close to the antenna as possible.
3. Keep the digital circuits, such as that of (U)SIM card, USB interface, camera module, display connector and SD card, away from the antenna traces.
4. Keep 75 dB isolation between each two antenna traces.
5. Keep 15 dB isolation between each two antennas to improve the receiving sensitivity. and 20 dB isolation between 5G NR UL MIMO TRX0 and TRX1 antennas.

5.3.3. GNSS Performance

The following table shows GNSS performance of RM510Q-GL.

Table 41: GNSS Performance

Parameter	Description	Conditions	Typ.	Unit
Sensitivity (GNSS)	Cold start	Autonomous	-148	dBm
	Reacquisition	Autonomous	-159	dBm
	Tracking	Autonomous	-159	dBm
TTFF (GNSS)	Cold start @ open sky	Autonomous	33.99	s
		XTRA enabled	13.56	s
	Warm start @ open sky	Autonomous	22.55	s
		XTRA enabled	2.02	s
	Hot start @ open sky	Autonomous	1.33	s
		XTRA enabled	1.47	s
Accuracy (GNSS)	CEP-50	Autonomous @ open sky	1.8	m

NOTES

1. Tracking sensitivity: the minimum GNSS signal power at which the module can maintain lock (keep positioning for at least 3 minutes continuously).
2. Reacquisition sensitivity: the minimum GNSS signal power required for the module to maintain lock within 3 minutes after the loss of lock.
3. Cold start sensitivity: the minimum GNSS signal power at which the module can fix position successfully within 3 minutes after executing cold start command.

5.4. Antenna Connectors

5.4.1. Antenna Connector Location

RM510Q-GL have four antenna connectors each: ANT0, ANT1, ANT2 and ANT3_GNSSL1, which are shown as below.

Figure 30: RM510Q-GL Antenna Connectors

5.4.2. Antenna Connector Size

RM510Q-GL are mounted with standard 2 mm × 2 mm receptacle antenna connectors for convenient antenna connection. The antenna connector's PN is IPEX 20579-001E, and the connector dimensions are illustrated as below:

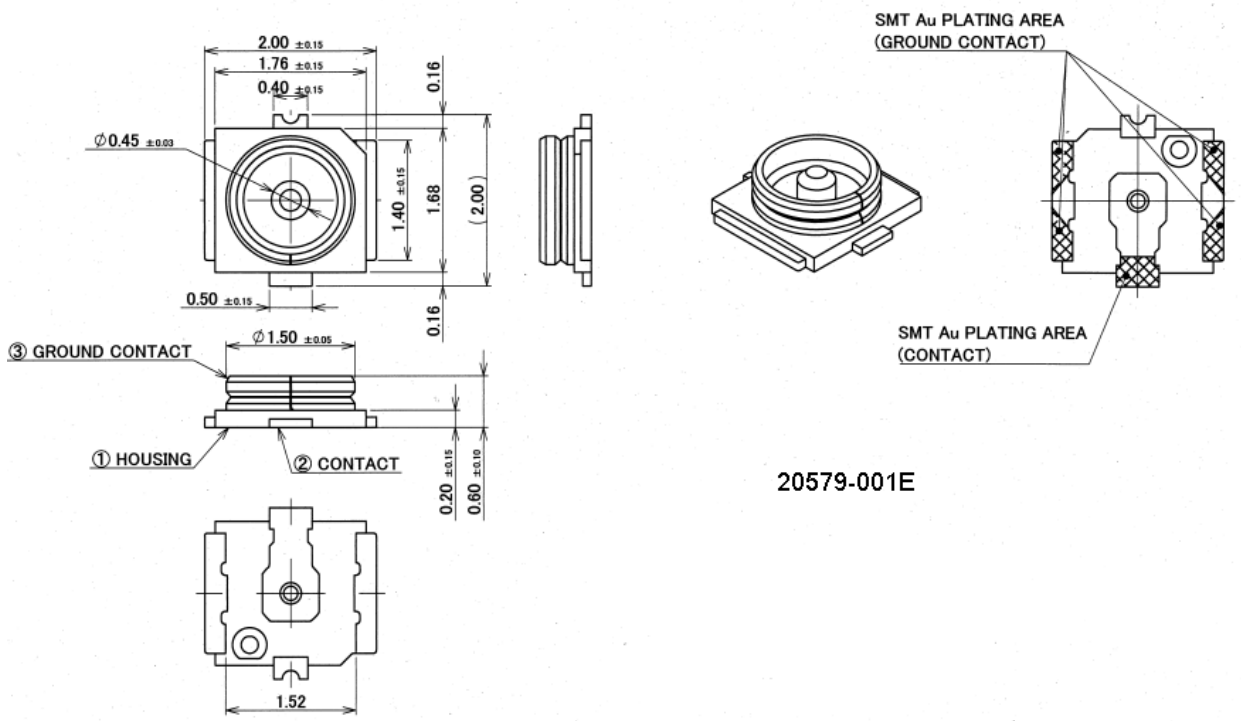


Figure 31: RF Connector Dimensions (Unit: mm)

Table 42: Major Specifications of the RF Connector

Item	Specification
Nominal Frequency Range	DC to 6 GHz
Nominal Impedance	50 Ω
Temperature Rating	-40 to +85 °C
Voltage Standing Wave Ratio (VSWR)	Meet the requirements of: Max 1.3 (DC–3 GHz) Max 1.4 (3–6 GHz)

5.4.3. Antenna Connector Installation

The receptacle RF connector used in conjunction with the module will accept two types of mating plugs that will meet a maximum height of 1.2 mm using a Ø0.81 mm coaxial cable or a maximum height of 1.45 mm utilizing a Ø1.13 mm coaxial cable.

The following figure shows the specifications of mating plugs using Ø0.81 mm coaxial cables.

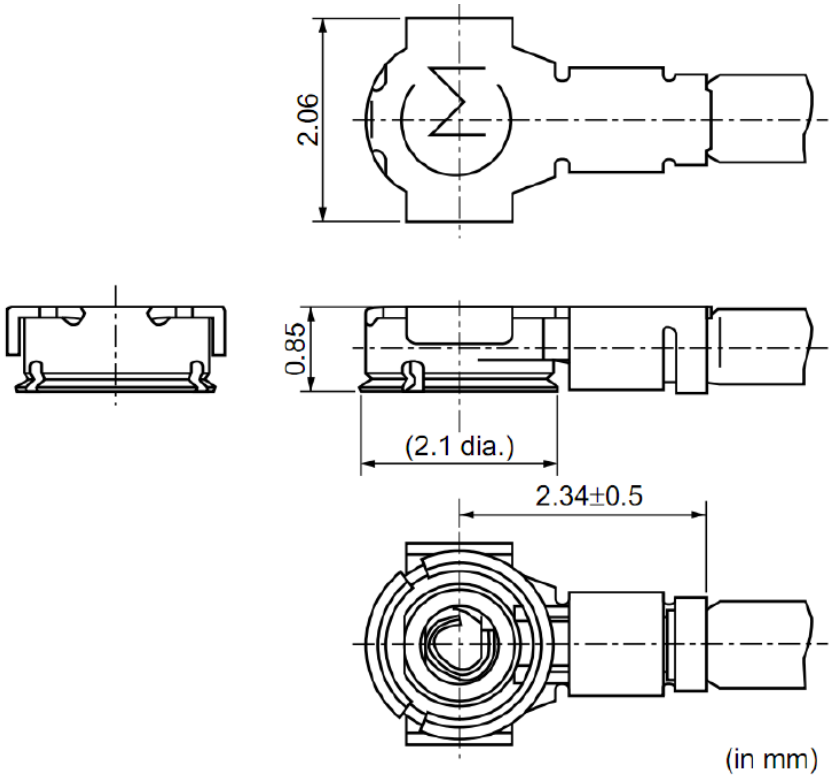


Figure 32: Specifications of Mating Plugs Using Ø0.81 mm Coaxial Cables

The following figure illustrates the connection between the receptacle RF connector on the module and the mating plug using a Ø0.81 mm coaxial cable.

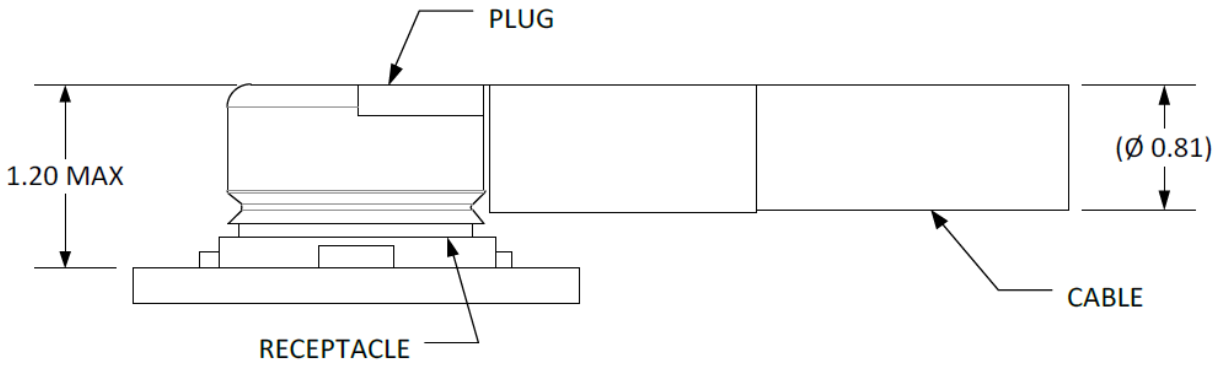


Figure 33: Connection between RF Connector and Mating Plug Using Ø0.81 mm Coaxial Cable

The following figure illustrates the connection between the receptacle RF connector on the module and the mating plug using a Ø1.13 mm coaxial cable.

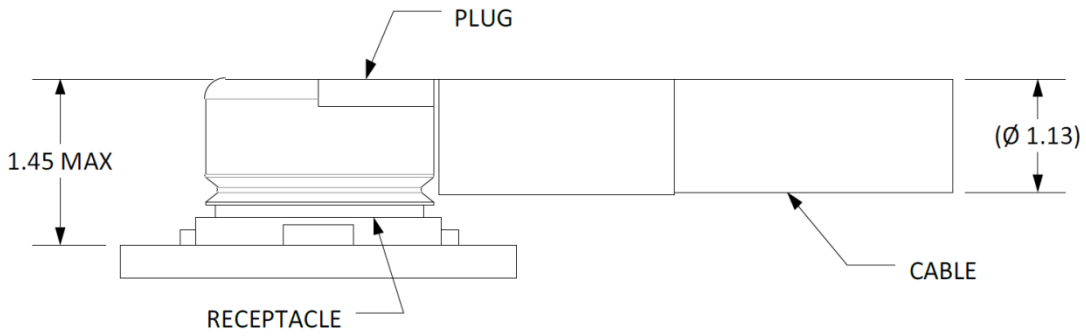


Figure 34: Connection between RF Connector and Mating Plug Using Ø1.13 mm Coaxial Cable

5.4.4. Recommended RF Connector for Installation

5.4.4.1. Assemble Coaxial Cable Plug Manually

The pictures for plugging in a coaxial cable plug is shown below, θ = 90° OK, θ ≠ 90° NG.

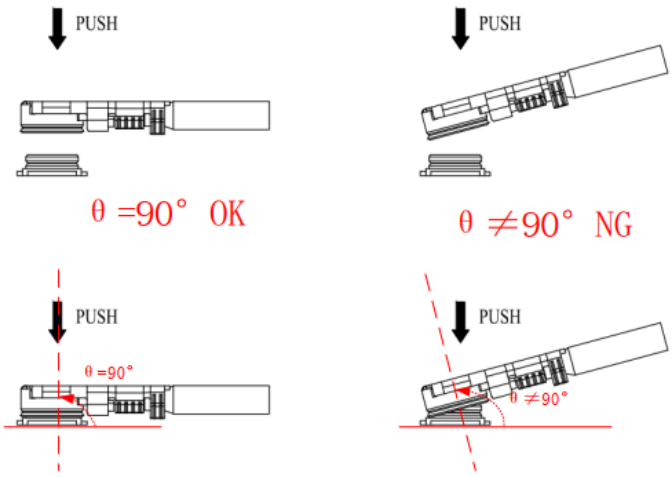


Figure 35：Plug in A Coaxial Cable Plug

The pictures of pulling out the coaxial cable plug is shown below, θ = 90° OK, θ ≠ 90° NG.

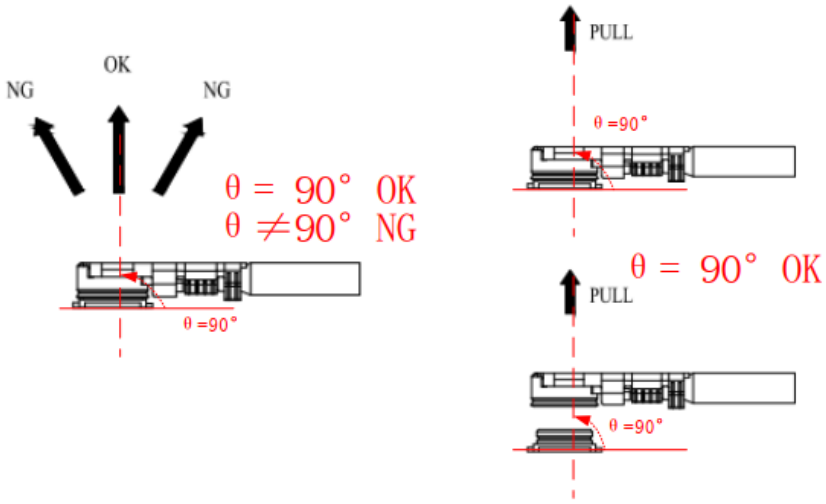


Figure 36：Pull out Coaxial Cable Plug

5.4.4.2. Assemble Coaxial Cable Plug with Jig

The pictures of installing the coaxial cable plug with a jig is shown below, θ = 90° OK, θ ≠ 90° NG.

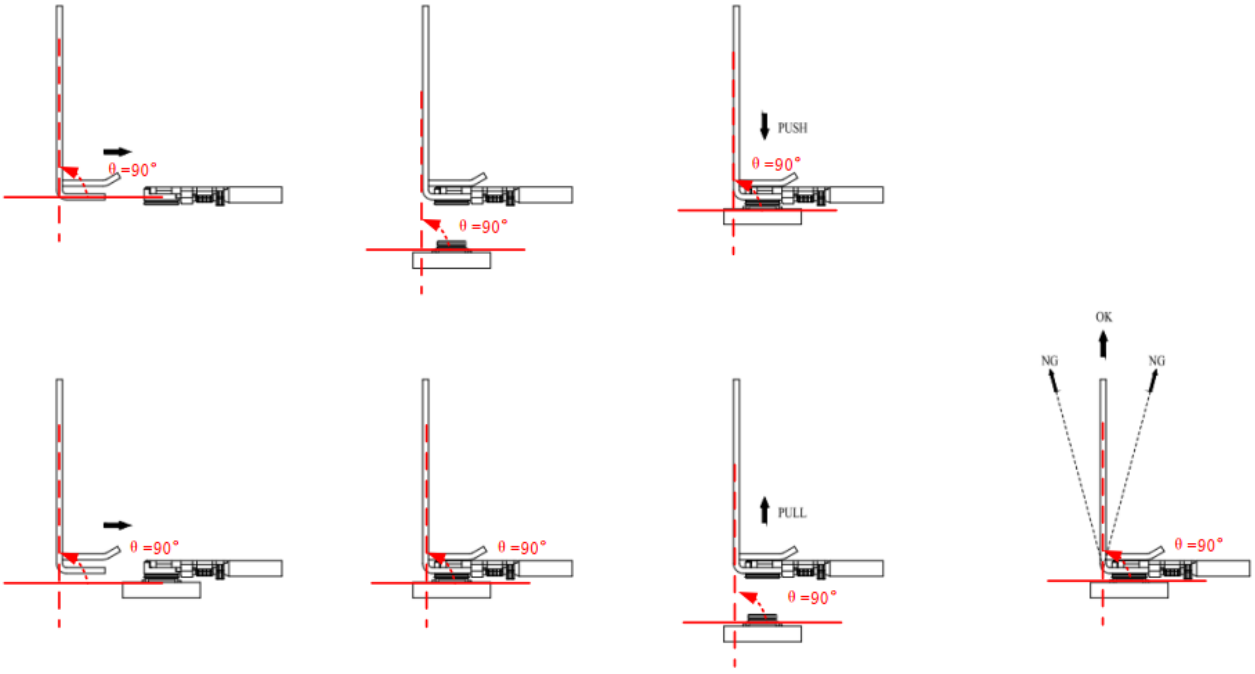


Figure 37：Install the Coaxial Cable Plug with Jig

5.4.5. Recommended Manufacturers of RF Connector and Cable

For more details, visit https://www.i-pex.com.

5.5. Antenna Requirements

Table 43: Cellular Bands Supported by RM510Q-GL Antenna Connectors

Antenna	Description	Frequency
ANT0	Antenna0 interface: 5G NR: MHB_TRX & n41 TRX1 & n77/n78/n79_PRx MIMO; LTE: MHB_TRX & UHB_PRX MIMO WCDMA: MHB_TRX	1400–5000 MHz
ANT1	Antenna1 interface: 5G NR: LB_TRX & MHB_DRX MIMO & n41_DRx1 & n77/n78/n79_DRx MIMO LTE: LB_TRX & MHB_DRX MIMO & UHB_DRX MIMO & LAA_PRX WCDMA: LB_TRX	600–6000 MHz
ANT2	Antenna2 interface: 5G NR: LB_DRX & MHB_PRX MIMO & n41 TRX0 & n77/n78/n79 TRX LTE: LB_DRX & MHB_PRX MIMO & UHB_TRX WCDMA: LB_DRX	600–5000 MHz
ANT3_ GNSSL1	Antenna3 interface: 5GNR: MHB_DRX & n41 DRX0 & n77/n78/n79_DRX LTE: MHB_DRX & UHB_DRX & LAA_DRX WCDMA: MHB_DRX GNSS: L1	1400–6000 MHz

The following table shows the requirements on WCDMA, LTE, 5G NR antenna and GNSS antenna.

Table 44: Antenna Requirements

Type	Requirements
WCDMA/LTE/5G NR	VSWR: ≤ 3 Efficiency: > 30 % Input Impedance: 50 Ω Cable insertion loss: < 1 dB WCDMA B5/B6/B8/B19 LTE B5/B8/B12(B17)/B13/B14/B18/B19/B20/B26/B28/B29/B71 5G NR n5/n8/n12/n20/n28/n71 Cable insertion loss: < 1.5 dB

	WCDMA B1/B2/B3/B4 LTE B1/B2/B3/B4/B25/B32/B34/B39/B66 5G NR n1/n2/n3/n25/n66 Cable insertion loss: < 2 dB LTE B7/B30/B38/B40/B41/B42/B43/B46/B48 5G NR n7/n38/n40/n41/n48/n77/n78/n79
GNSS	Frequency range: 1559–1606 MHz Polarization: RHCP or linear VSWR: < 2 (Typ.) Passive antenna gain: >0 dBi

6 Electrical Characteristics and Reliability

6.1. Power Supply Requirements

The typical input voltage of the module is 3.7 V,-The following table shows the power supply requirements of the module.

Table 45: Power Supply Requirements

Parameter	Description	Min.	Typ.	Max.	Unit
VCC	Power Supply	3.135	3.7	4.4	V
Voltage Ripple		–	30	100	mV
Voltage Drop		–	–	165	mV

6.2. Current Consumption

Table 46: RM510Q-GL Current Consumption

Description	Conditions	Typ.	Unit
OFF state	**Power off**	82	μA
Sleep state	**AT+CFUN=0** (USB Suspend)	5.11	mA
	WCDMA @DRX =0. 64s, USB Suspend	5.389	mA
	LTE-FDD @DRX = 0.64s, USB Suspend	5.689	mA
	LTE-TDD @DRX = 0.64s, USB Suspend	5.803	mA

Idle state	WCDMA @Paging Frame=64	31.06	mA
	WCDMA @Paging Frame=64, USB Active	52.42	mA
	LTE-FDD @DRX=0.64s	32.93	mA
	LTE-FDD @DRX=0.64s, USB Active	54.77	mA
	LTE-TDD @DRX=0.64s	32.85	mA
	LTE-TDD @DRX=0.64s, USB Active	54.56	mA
WCDMA (GNSS OFF)	WCDMA B1 HSDPA CH10700 @ 23 dBm	595	mA
	WCDMA B1 HSUPA CH10700 @ 23 dBm	540	mA
	WCDMA B2 HSDPA CH9800 @ 23 dBm	650	mA
	WCDMA B2 HSUPA CH9800 @ 23 dBm	615	mA
	WCDMA B3 HSDPA CH1338 @ 23 dBm	570	mA
	WCDMA B3 HSUPA CH1338 @ 23 dBm	545	mA
	WCDMA B4 HSDPA CH1638 @ 23 dBm	520	mA
	WCDMA B4 HSUPA CH1638 @ 23 dBm	505	mA
	WCDMA B5 HSDPA CH4407 @ 23 dBm	430	mA
	WCDMA B5 HSUPA CH4407 @ 23 dBm	405	mA
	WCDMA B6 HSDPA CH4400 @ 23 dBm	420	mA
	WCDMA B6 HSUPA CH4400 @ 23 dBm	415	mA
	WCDMA B8 HSDPA CH3012 @ 23 dBm	430	mA
	WCDMA B8 HSUPA CH3012 @ 23 dBm	420	mA
	WCDMA B19 HSDPA CH738 @ 23 dBm	420	mA
	WCDMA B19 HSUPA CH738 @ 23 dBm	420	mA
LTE (GNSS OFF)	LTE-FDD B1 CH300 @ 23 dBm	795	mA
	LTE-FDD B2 CH900 @ 23 dBm	715	mA
	LTE-FDD B3 CH1575 @ 23 dBm	770	mA
	LTE-FDD B4 CH2175 @ 23 dBm	680	mA

	LTE-FDD B5 CH2525 @ 23 dBm	485	mA
	LTE-FDD B7 CH3100 @ 23 dBm	745	mA
	LTE-FDD B8 CH3625 @ 23 dBm	495	mA
	LTE-FDD B12(B17) CH5095 @ 23 dBm	485	mA
	LTE-FDD B13 CH5230 @ 23 dBm	560	mA
	LTE-FDD B14 CH5330 @ 23 dBm	480	mA
	LTE-FDD B18 CH5925 @ 23 dBm	515	mA
	LTE-FDD B19 CH6075 @ 23 dBm	490	mA
	LTE-FDD B20 CH6300 @ 23 dBm	480	mA
	LTE-FDD B25 CH8365 @ 23 dBm	695	mA
	LTE-FDD B26 CH8865 @ 23 dBm	470	mA
	LTE-FDD B28 CH9435 @ 23 dBm	490	mA
	LTE-FDD B30 CH9820 @ 23 dBm	860	mA
	LTE-TDD B34 CH36275 @ 23 dBm	440	mA
	LTE-TDD B38 CH38000 @ 23 dBm	420	mA
	LTE-TDD B39 CH38450 @ 23 dBm	380	mA
	LTE-TDD B40 CH39150 @ 23 dBm	345	mA
	LTE-TDD B41 CH40620 @ 23 dBm	440	mA
	LTE-TDD B42 CH42590 @ 23 dBm	460	mA
	LTE-TDD B43 CH44590 @ 23 dBm	500	mA
	LTE-TDD B48 CH55990 @ 23 dBm	480	mA
	LTE-FDD B66 CH66886 @ 23 dBm	765	mA
	LTE-FDD B71 CH68761 @ 23 dBm	460	mA
5G NR (GNSS OFF)	5G NR-TDD n41 CH501204 @ 26 dBm	500	mA
	5G NR-TDD n41 CH518598 @ 26 dBm	500	mA
	5G NR-TDD n41 CH535998 @ 26 dBm	515	mA

	5G NR-TDD n77 CH620668 @ 26 dBm	500	mA
	5G NR-TDD n77 CH650000 @ 26 dBm	500	mA
	5G NR-TDD n77 CH679332 @ 26 dBm	520	mA
	5G NR-TDD n78 CH620668 @ 26 dBm	500	mA
	5G NR-TDD n78 CH636666 @ 26 dBm	530	mA
	5G NR-TDD n78 CH652666 @ 26 dBm	500	mA
	5G NR-TDD n79 CH695090 @ 26 dBm	550	mA
	5G NR-TDD n79 CH713522 @ 26 dBm	550	mA
	5G NR-TDD n79 CH731976 @ 26 dBm	530	mA
	5G NR-FDD n1 CH423000 @ 23 dBm	950	mA
	5G NR-FDD n1 CH428000 @ 23 dBm	880	mA
	5G NR-FDD n1 CH433000 @ 23 dBm	930	mA
	5G NR-FDD n2 CH387000 @ 23 dBm	610	mA
	5G NR-FDD n2 CH392000 @ 23 dBm	740	mA
	5G NR-FDD n2 CH397000 @ 23 dBm	610	mA
	5G NR-FDD n3 CH362000 @ 23 dBm	780	mA
	5G NR-FDD n3 CH368500 @ 23 dBm	780	mA
	5G NR-FDD n3 CH375000 @ 23 dBm	870	mA
	5G NR-FDD n5 CH174800 @ 23 dBm	515	mA
	5G NR-FDD n5 CH176300 @ 23 dBm	510	mA
	5G NR-FDD n5 CH177800 @ 23 dBm	510	mA
	5G NR-FDD n7 CH525000 @ 23 dBm	690	mA
	5G NR-FDD n7 CH531000 @ 23 dBm	690	mA
	5G NR-FDD n7 CH537000 @ 23 dBm	670	mA
	5G NR-FDD n8 CH186000 @ 23 dBm	550	mA
	5G NR-FDD n8 CH188500 @ 23 dBm	520	mA

	5G NR-FDD n8 CH191000 @ 23 dBm	520	mA
	5G NR-FDD n12 CH146800 @ 23 dBm	480	mA
	5G NR-FDD n12 CH147500 @ 23 dBm	480	mA
	5G NR-FDD n12 CH148200 @ 23 dBm	480	mA
	5G NR-FDD n20 CH159200 @ 23 dBm	480	mA
	5G NR-FDD n20 CH161200 @ 23 dBm	480	mA
	5G NR-FDD n20 CH163200 @ 23 dBm	490	mA
	5G NR-FDD n25 CH387000 @ 23 dBm	640	mA
	5G NR-FDD n25 CH392500 @ 23 dBm	750	mA
	5G NR-FDD n25 CH398000 @ 23 dBm	680	mA
	5G NR-FDD n28 CH152600 @ 23 dBm	550	mA
	5G NR-FDD n28 CH156100 @ 23 dBm	560	mA
	5G NR-FDD n28 CH159600 @ 23 dBm	530	mA
	5G NR-TDD n38 CH515000 @ 23 dBm	310	mA
	5G NR-TDD n38 CH519000 @ 23 dBm	310	mA
	5G NR-TDD n38 CH523000 @ 23 dBm	310	mA
	5G NR-TDD n40 CH461000 @ 23 dBm	580	mA
	5G NR-TDD n40 CH470000 @ 23 dBm	580	mA
	5G NR-TDD n40 CH479000 @ 23 dBm	580	mA
	5G NR-TDD n48 CH637000 @ 23 dBm	420	mA
	5G NR-TDD n48 CH641667 @ 23 dBm	420	mA
	5G NR-TDD n48 CH646333@ 23 dBm	410	mA
	5G NR-FDD n66 CH423000 @ 23 dBm	790	mA
	5G NR-FDD n66 CH429000 @ 23 dBm	880	mA
	5G NR-FDD n66 CH435000 @ 23 dBm	850	mA
	5G NR-FDD n71 CH124400 @ 23 dBm	500	mA

	5G NR-FDD n71 CH126900 @ 23 dBm	480	mA
	5G NR-FDD n71 CH129400 @ 23 dBm	490	mA
WCDMA voice call*	WCDMA B1 CH10700 @ 23 dBm	670	mA
	WCDMA B2 CH9800 @ 23 dBm	730	mA
	WCDMA B3 CH1338 @ 23 dBm	650	mA
	WCDMA B4 CH1638 @ 23 dBm	600	mA
	WCDMA B5 CH4408 @ 23 dBm	460	mA
	WCDMA B6 CH4175 @ 23 dBm	460	mA
	WCDMA B8 CH3012 @ 23 dBm	475	mA
	WCDMA B19 CH338 @ 23 dBm	460	mA

6.3. Digital I/O Characteristic

Table 47: Logic Levels of Digital I/O (1.8 V)

Parameter	Description	Min.	Max.	Unit
V_{IH}	Input high voltage	1.65	2.1	V
V_{IL}	Input low voltage	-0.3	0.54	V
V_{OH}	Output high voltage	1.3	1.8	V
V_{OL}	Output low voltage	0	0.4	V

Table 48: (U)SIM 1.8 V I/O Requirements

Parameter	Description	Min.	Max.	Unit
USIM_VDD	Power supply	1.65	1.95	V
V_{IH}	Input high voltage	0.7 × USIM_VDD	USIM_VDD + 0.3	V

V_{IL}	Input low voltage	-0.3	0.2 × USIM_VDD	V
V_{OH}	Output high voltage	0.8 × USIM_VDD	USIM_VDD	V
V_{OL}	Output low voltage	0	0.4	V

Table 49: (U)SIM 3.0 V I/O Requirements

Parameter	Description	Min.	Max.	Unit
USIM_VDD	Power supply	2.7	3.05	V
V_{IH}	Input high voltage	0.7 × USIM_VDD	USIM_VDD + 0.3	V
V_{IL}	Input low voltage	-0.3	0.2 × USIM_VDD	V
V_{OH}	Output high voltage	0.8 × USIM_VDD	USIM_VDD	V
V_{OL}	Output low voltage	0	0.4	V

6.4. Electrostatic Discharge

The module is not protected against electrostatic discharge (ESD) in general. Consequently, it is subject to ESD handling precautions that typically apply to ESD sensitive components. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates the module.

Table 50: Electrostatic Discharge Characteristics (Temperature: 25 ºC, Humidity: 40 %)

Tested Interfaces	Contact Discharge	Air Discharge	Unit
VCC, GND	±5	±10	kV
Antenna Interfaces	±4	±8	kV
Other Interfaces	±0.5	±1	kV

6.5. Thermal Dissipation

RM510Q-GL are designed to work over an extended temperature range. To achieve a maximum

performance while working under extended temperatures or extreme conditions (such as with maximum power or data rate) for a long time, it is strongly recommended to add a thermal pad or other thermally conductive compounds between the module and the main PCB for thermal dissipation.

The thermal dissipation area on the bottom (i.e. the area for adding thermal pad) is shown as below, and conductive compounds are also added on the BB, MCP, PMU, WTR, PA-1, PA-2 chips inside the module. The dimensions are measured in mm.

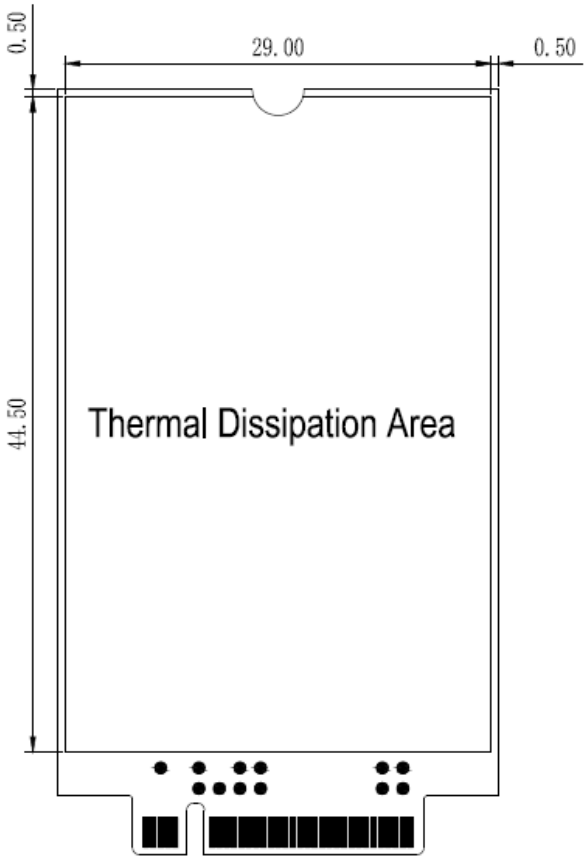


Figure 38: Thermal Dissipation Area on Bottom Side of Module

There are other measures to enhance heat dissipation performance:

- Add ground vias as many as possible on PCB.
- Maximize airflow over/around the module.
- Place the module away from other heating sources.
- Module mounting holes must be used to attach (ground) the device to the main PCB ground.
- It is NOT recommended to apply solder mask on the main PCB where the module's thermal dissipation area is located.
- Select appropriate material, thickness and surface for the outer housing of the application device that integrates the module (i.e. the mechanical enclosure) to enhance thermal dissipation ability. Customers may also need active cooling to dissipate heat of the module.
- If possible, add a heatsink on the top of the module. A thermal pad should be used between the

heatsink and the module, and the heatsink should be designed with as many fins as possible to increase heat dissipation area.

NOTE

If a conformal coating is necessary for the module, do NOT use any coating material that may chemically react with the PCB or shielding cover, and prevent the coating material from flowing into the module.

6.6. 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 51: Absolute Maximum Ratings

Parameter	Min.	Typ.	Max.	Unit
VCC	-0.3		4.7	V
Voltage at Digital Pins	-0.3		2.3	V

6.7. Operating and Storage Temperatures

Table 52: Operating and Storage Temperatures

Parameter	Min.	Typ.	Max.	Unit
Operating Temperature Range[1)]	-30	+25	+70	ºC
Extended Temperature Range[2)]	-40	-	+85	ºC
Storage temperature Range	-40	-	+90	ºC

NOTES

1. [1)] To meet this operating temperature range, you need to ensure effective thermal dissipation, for example, by adding passive or active heatsinks, heat pipes, vapor chambers, etc. Within this range,

the module meets 3GPP specifications.

2. [2)] To meet this extended temperature range, you need to ensure effective thermal dissipation, for example, by adding passive or active heatsinks, heat pipes, vapor chambers, etc. Within this range, the module remains the ability to establish and maintain functions such as voice, SMS, etc., without any unrecoverable malfunction. Radio spectrum and radio network are not influenced, while one or more specifications, such as P_{out}, may undergo a reduction in value, exceeding the specified tolerances of 3GPP. When the temperature returns to the normal operating temperature level, the module will meet 3GPP specifications again.

7 Mechanical Dimensions and Packaging

This chapter mainly describes mechanical dimensions and packaging specifications of RM510Q-GL. All dimensions are measured in mm, and the tolerances are ±0.05 mm unless otherwise specified.

7.1. Mechanical Dimensions of the Module

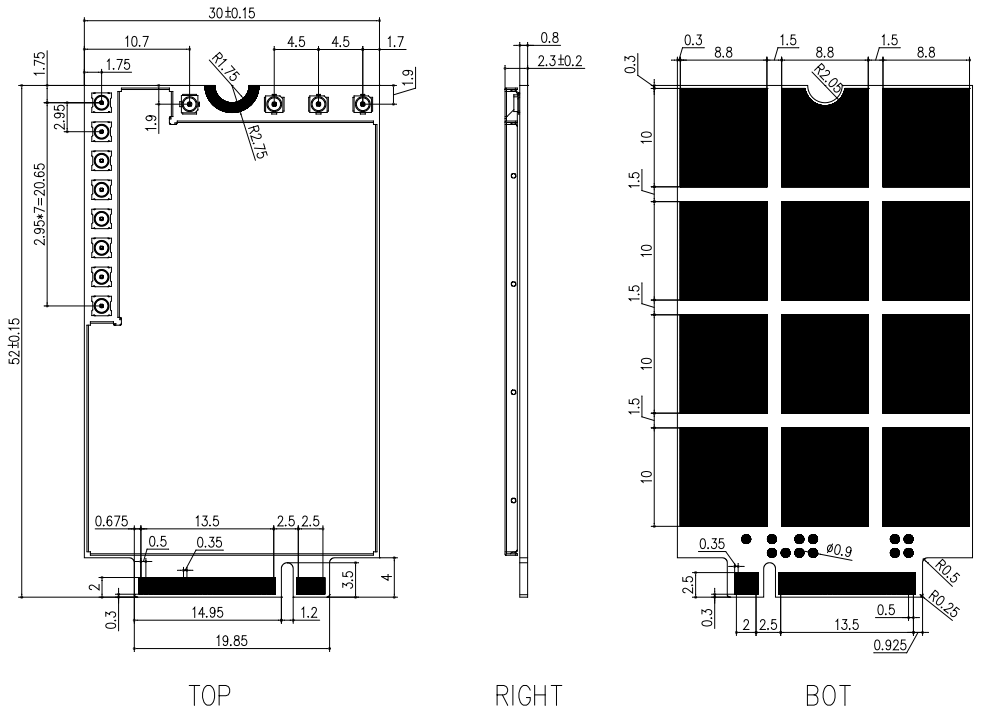


Figure 39: Mechanical Dimensions of the Module (Unit: mm)

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.

7.2. Top and Bottom Views of the Module

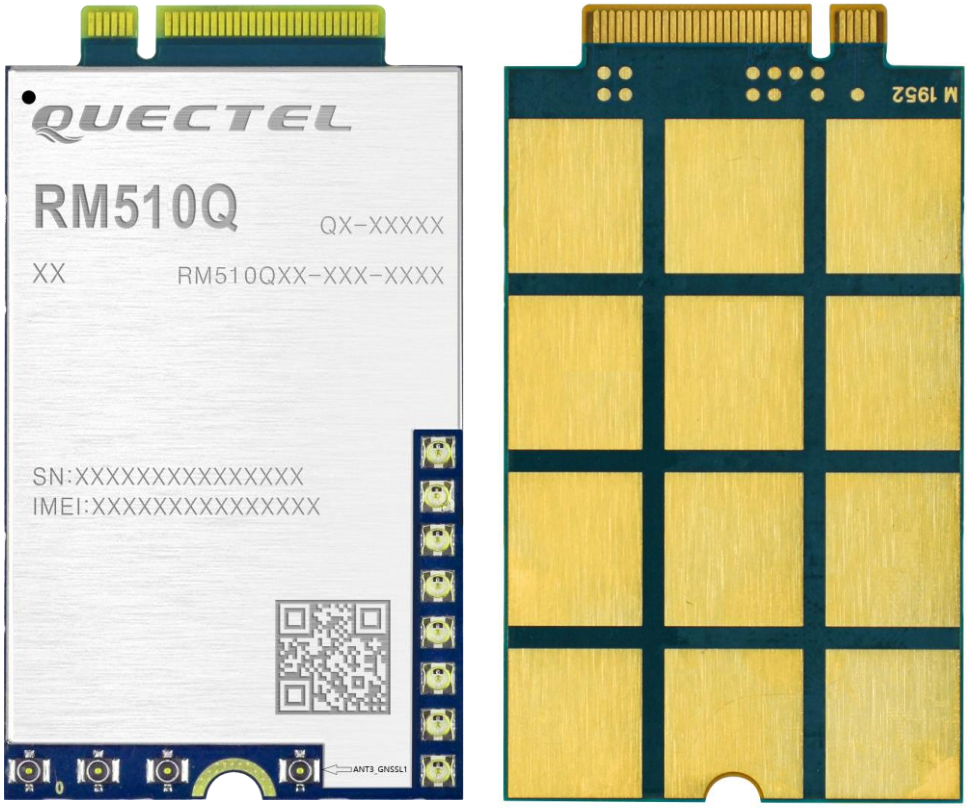


Figure 40: RM510Q-GL Top View and Bottom View

7.3. M.2 Connector

The module adopts a standard PCI Express M.2 connector which compiles with the directives and standards listed in *PCI Express M.2 Specification Rev3.0*.

7.4. Packaging

The modules are packaged in trays. The following figure shows the tray size.

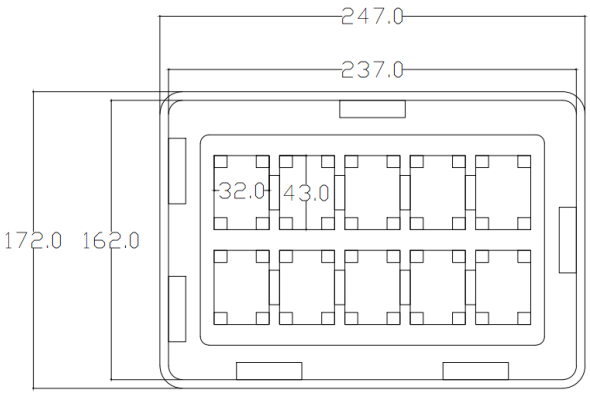


Figure 41: Tray Size (Unit: mm)

Each tray contains 10 modules. The smallest package contains 100 modules. Tray packaging procedures are as below.

1. Use 10 trays to package 100 modules at a time (tray size: 247 mm × 172 mm).
2. Place an empty tray on the top of the 10-tray stack.
3. Fix the stack with masking tape in "#" shape as shown in the following figure.
4. Pack the stack with conductive bag, and then fix the bag with masking tape.
5. Place the list of IMEI No. into a small carton.
6. Seal the carton and then label the seal with sealing sticker (small carton size: 250 mm × 175 mm × 128 mm).

Figure 42: Tray Packaging Procedure

8 Appendix References

Table 53: Related Documents

SN.	Document Name	Description
[1]	Quectel_RM510Q-GL_CA&EN-DC_Features	CA&EN-DC combinations of RM510Q-GL
[2]	Quectel_5G-mmWave_EVB_LP(525)_User_Guide	RM510Q-GL EVB user guide (QTM525)
[3]	Quectel_5G-mmWave_EVB_HP(527)_User_Guide	RM510Q-GL EVB user guide (QTM527)
[4]	Quectel_RG50xQ&RM5xxQ_Series_AT_Commands_Manual	AT commands manual for RG50xQ, RM5xxQ series
[5]	Quectel_RG50xQ&RM5xxQ_Series_GNSS_Application_Note	The GNSS application note for RG50xQ and RM5xxQ series

Table 54: Terms and Abbreviations

Abbreviation	Description
BIOS	Basic Input Output System
bps	Bit Per Second
CPE	Customer Premise Equipment
CSQ	Cellular Signal Quality
DFOTA	Delta Firmware Upgrade Over-The-Air
DL	Downlink
DPR	Dynamic Power Reduction
EIRP	Equivalent Isotropically Radiated Power
ESD	Electrostatic Discharge

ET	Envelope tracking
FDD	Frequency Division Duplexing
FR2	Frequency Range 2
GLONASS	Global Navigation Satellite System (Russia)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HSPA	High Speed Packet Access
HSUPA	High Speed Uplink Packet Access
IF	Intermediate Frequency
kbps	Kilo Bits Per Second
LAA	License Assisted Access
LED	Light Emitting Diode
LO	Local Oscillator
LTE	Long Term Evolution
Mbps	Mega Bits Per Second
ME	Mobile Equipment
MIMO	Multiple-Input Multiple-Output
MLCC	Multilayer Ceramic Chip Capacitor
MMS	Multimedia Messaging Service
mmWave	Millimeter wave
MO	Mobile Originated
MSB	Most Significant Bit
MT	Mobile Terminated
PAP	Password Authentication Protocol

PCB	Printed Circuit Board
PCIe	Peripheral Component Interconnect Express
PCM	Pulse Code Modulation
PDU	Protocol Data Unit
PPP	Point-to-Point Protocol
RF	Radio Frequency
RFFE	RF Front-End
RFIC	Radio-frequency Integrated Circuit
Rx	Receive
SAR	Specific Absorption Rate
SCS	Sub-carrier Spacing
SMS	Short Message Service
TCP	Transmission Control Protocol
Tx	Transmit
UART	Universal Asynchronous Receiver & Transmitter
UDP	User Datagram Protocol
UL	Uplink
URC	Unsolicited Result Code
USB	Universal Serial Bus
(U)SIM	(Universal) Subscriber Identity Module
V_{IH}	Input High Voltage Level
V_{IL}	Input Low Voltage Level
V_{OH}	Output High Voltage Level
V_{OL}	Output Low Voltage Level
VSWR	Voltage Standing Wave Ratio

WCDMA	Wideband Code Division Multiple Access

OEM/Integrators Installation Manual

Important Notice to OEM integrators 1. This module is limited to OEM installation ONLY. 2. This module is limited to installation in mobile or fixed applications, according to Part 2.1091(b). 3. The separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and different antenna configurations 4. For FCC Part 15.31 (h) and (k): The host manufacturer is responsible for additional testing to verify compliance as a composite system. When testing the host device for compliance with Part 15 Subpart B, the host manufacturer is required to show compliance with Part 15 Subpart B while the transmitter module(s) are installed and operating. The modules should be transmitting and the evaluation should confirm that the module's intentional emissions are compliant (i.e. fundamental and out of band emissions). The host manufacturer must verify that there are no additional unintentional emissions other than what is permitted in Part 15 Subpart B or emissions are complaint with the transmitter(s) rule(s). The Grantee will provide guidance to the host manufacturer for Part 15 B requirements if needed.

Important Note

notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify to Quectel that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the USI, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application

End Product Labeling

When the module is installed in the host device, the FCC/IC ID label must be visible through a window on the final device or it must be visible when an access panel, door or cover is easily re-moved. If not, a second label must be placed on the outside of the final device that contains the following text: “Contains FCC ID: XMR2020RM510QGL” “Contains IC: XMR2020RM510QGL”. The FCC ID/IC ID can be used only when all FCC/IC compliance requirements are met.

Antenna

(1) The antenna must be installed such that 20 cm is maintained between the antenna and users,
(2) The transmitter module may not be co-located with any other transmitter or antenna.

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC/IC authorization is no longer considered valid and the FCC ID/IC ID 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/IC authorization.

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

Test Mode	Antenna Gain (dBi)	Test Mode	Antenna Gain (dBi)
WCDMA B2	8.00	LTE B38	2.00
WCDMA B4	5.00	LTE B41	2.00
WCDMA B5	5.00	LTE B48	-2.00*
LTE B2	8.00	LTE B66	5.00
LTE B4	5.00	LTE B71	5.00
LTE B5	5.00	n2	8.00
LTE B7	8.00	n5	5.00
LTE B12	5.00	n7	8.00
LTE B13	5.00	n12	5.00
LTE B14	5.00	n25	8.00
LTE B17	5.00	n41	5.00
LTE B25	8.00	n66	5.00
LTE B26	5.00	n71	5.00
LTE B30	-1.02*	n77	5.00

Note: “*” means when using higher gain antenna, the host manufacturer should reduce the conducted power to meet the FCC maximum RF output power limit.

Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user’s manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual

Federal Communication Commission Interference Statement

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.

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.

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

List of applicable FCC rules

This module has been tested and found to comply with part 22, part 24, part 27, part 90 requirements for Modular Approval.

The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, 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.

This device is intended only for OEM integrators under the following conditions: (For module device use)

1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2) The transmitter module may not be co-located with any other transmitter or antenna.

As long as 2 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.

Radiation Exposure Statement

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

Industry Canada Statement

This device complies with Industry Canada’s licence-exempt RSSs. Operation is subject to the following two conditions:
(1) This device may not cause interference; and
(2) This device must accept any interference, including interference that may cause undesired operation of the device.

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."

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 20 cm between the radiator & your body

Déclaration d'exposition aux radiations:
Cet équipement est conforme aux limites d'exposition aux rayonnements ISED 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.

This device is intended only for OEM integrators under the following conditions: (For module device use)

1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2) The transmitter module may not be co-located with any other transmitter or antenna. As long as 2 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.

Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes: (Pour utilisation de dispositif module)

1) L'antenne doit être installée de telle sorte qu'une distance de 20 cm est respectée entre l'antenne et les utilisateurs, et
2) Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

Tant que les 2 conditions ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

IMPORTANT NOTE:

In the event that these conditions cannot be met (for example certain laptop configurations or colocation with another transmitter), then the Canada authorization is no longer considered valid and the IC ID 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 Canada authorization.

NOTE IMPORTANTE:

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: “Contains IC: 10224A-2021AG521R”.

Plaque signalétique du produit final

Ce module émetteur est autorisé uniquement pour une utilisation dans un dispositif où l'antenne peut être installée de telle sorte qu'une distance de 20cm peut être maintenue entre l'antenne et les utilisateurs. Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: 10224A-2021RM510GL".

Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user’s manual of the end product which integrates this module.
The end user manual shall include all required regulatory information/warning as show in this manual.

Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module.
Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.