RG255C-GL Mini PCIe

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 terminal or mobile incorporating the module. Manufacturers of the terminal should notify users and operating personnel of the following safety information by incorporating these guidelines into all manuals of the product. Otherwise, Quectel assumes no liability for customers' failure to comply with these precautions.

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

About the Document

Revision History

Version	Date	Author	Description
-	2023-08-25	Mike CHEN/ Ethan FANG/ Sherlock ZHAO	Creation of the document
1.0.0	2023-08-25	Mike CHEN/ Ethan FANG/ Sherlock ZHAO	Preliminary

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1 Introduction

This document defines RG255C-GL Mini PCIe module, and describes its air interfaces and hardware interfaces which are connected with your applications.

With this document, you can quickly understand module interface specifications, electrical and mechanical details, as well as other related information of the module. The document, coupled with application notes and user guides, makes it easy to design and set up wireless applications with the module.

1.1. Special Mark

Table 1: Special Mark

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

2 Product Overview

2.1. Frequency Bands and Functions

RG255C-GL Mini PCIe module provides data connectivity on 5G NR SA, LTE-FDD, LTE-TDD networks with PCI Express Mini Card 1.2 standard interface. It supports embedded operating systems, such as Linux and Android, and provides audio, high-speed data transmission, and GNSS functionalities (optional) to meet your specific application demands.

RG255C-GL Mini PCIe module can be applied in the following fields:

- PDA and laptop computer
- Remote monitor system
- Wireless POS system
- Intelligent meter reading system
- Wireless router and switch
- Other wireless terminal devices

Table 2: Frequency Bands and Functions

Mode	Frequency Bands
LTE-FDD	B1/B2/B3/B4/B5/B7/B8/B12/B13/B14/B17/B18/B19/B20/B25/B26/B28/B30/B66/B71/B70*
LTE-TDD	B34/B38/B39/B40/B41/B42/B43/B48
5G NR SA	n1/n2/n3/n5/n7/n8/n12/n13/n14/n18/n20/n25/n26/n28/n30/n38/n40/n41/n48/ /n66/n71/n77/n78/n79/n70*
GNSS (optional)	GPS/GLONASS/BDS/Galileo

2.2. Key Features

The following table describes the detailed features of the module.

Table 3: Key Features

Features	Details
Function Interface	PCI Express Mini Card 1.2 Standard Interface
Power Supply	● Supply voltage: 3.0–3.6 V ● Typical supply voltage: 3.3 V
Transmitting Power	● 5G NR bands: Class 3 (23 dBm ±2 dB) ● 5G NR n38/n40/n41/n77/n78/n79 HPUE [1]: Class 2 (26 dBm +2/-3 dB) ● LTE bands: Class 3 (23 dBm ±2 dB) ● LTE B38/B40/B41/B42/B43 HPUE [1]: Class 2 (26 dBm ±2 dB)
5G NR Features	● Supports 3GPP Rel-17 Red. Cap. 5G NR sub-6 ● Supported modulations: - Uplink: QPSK, 16QAM, 64QAM and 256QAM - Downlink: QPSK, 16QAM, 64QAM and 256QAM ● Supports SCS 15 kHz [2] and 30 kHz [2] ● Supports SA on operation mode ● Supports Option 2 ● Max. transmission data rates [3]: - SA: 220 Mbps (DL), 100 Mbps (UL)
LTE Features	● Supports 3GPP Rel-15 ● Supported modulations: - Uplink: QPSK, 16QAM and 64QAM - Downlink: QPSK, 16QAM and 64QAM and 256QAM ● Supports 1.4/3/5/10/15/20 MHz RF bandwidth ● Max. transmission data rates [3]: - 150 Mbps (DL), 50 Mbps (UL)
Rx-diversity	Supports 5G NR/LTE Rx-diversity
GNSS Features [4]	● Supports L1/L2/L5 ● Protocol: NMEA 0183 ● Data Update Rate: 1 Hz
Antenna Connectors	ANT_MAIN, ANT_DRX, ANT_GNSS

[1] HPUE is only for single carrier.
[2] 5G NR FDD bands only support 15 kHz SCS, and NR TDD bands only support 30 kHz SCS.
[3] The maximum rates are theoretical and the actual values depend on the network configuration.
[4] If you need the function of L2, contact Quectel Technical Support.

AT Commands	● Compliant with *3GPP TS 27.007*, *3GPP TS 27.005* ● Quectel enhanced AT commands
Internet Protocol Features	Supports TCP/UDP/SSL*/TLS*/FTP(S)*/HTTP(S)*/MQTT(S)*/SMTP(S)*/ NTP*/PING/NITZ*/LwM2M* protocols
USB Tethering	RmNet, RNDIS, ECM, DUN, MBIM
SMS	● Only Support SGS, IMS and NAS SMS ● Text and PDU modes ● Point-to-point MO and MT ● SMS cell broadcast ● SMS storage: ME by default
(U)SIM Interface	Supports (U)SIM card: 1.8/3.0 V
UART	**Main UART:** ● Supports RTS and CTS hardware flow control ● Baud rate: 115200 bps by default ● Used for AT command communication and data transmission
Audio Features*	● Supports one digital audio interface: PCM interface ● LTE: AMR/AMR-WB ● Supports echo cancellation and noise suppression
PCM Interface*	● Supports 16-bit linear data format ● Supports long frame synchronization and short frame synchronization ● Supports master and slave modes, but must be the master for long frame synchronization
USB Interface	● Compliant with USB 2.0 specification (slave mode only), with transmission rates up to 480 Mbps ● Used for AT command communication, data transmission, firmware upgrade, software debugging and GNSS NMEA output ● Supports USB serial drivers: Windows 7/8/8.1/10/11, Linux 2.6–6.5, Android 4.x–13.x
Physical Characteristics	● Size: 50.95 mm × 30.0 mm × 4.95 mm ● Weight: TBD
Temperature Range	● Operating temperature range: -35 to +75 °C [5] ● Extended temperature range: -40 to +80 °C [6] ● Storage temperature range: -40 to +90 °C
Firmware Upgrade	USB 2.0 interface or DFOTA*

[5] To meet the normal operating temperature range requirements, it is necessary to ensure effective thermal dissipation, e.g., by adding passive or active heat sinks, heat pipes, vapor chambers. Within this range, the module's indicators comply with 3GPP specification requirements.

[6] To meet the extended operating temperature range requirements, it is necessary to ensure effective thermal dissipation, e.g., by adding passive or active heat sinks, heat pipes, vapor chambers. Within the extended temperature range, the module remains the ability to establish and maintain functions such as voice, SMS, and data transmission, without any unrecoverable malfunction. Radio spectrum and radio network are not influenced, while one or more specifications, such as P_{out}, may exceed the specified tolerances of 3GPP. When the temperature returns to the operating temperature range, the module meets 3GPP specifications again.

RoHS	All hardware components are fully compliant with EU RoHS directive

2.3. Functional Diagram

The following figure shows the block diagram of the module.

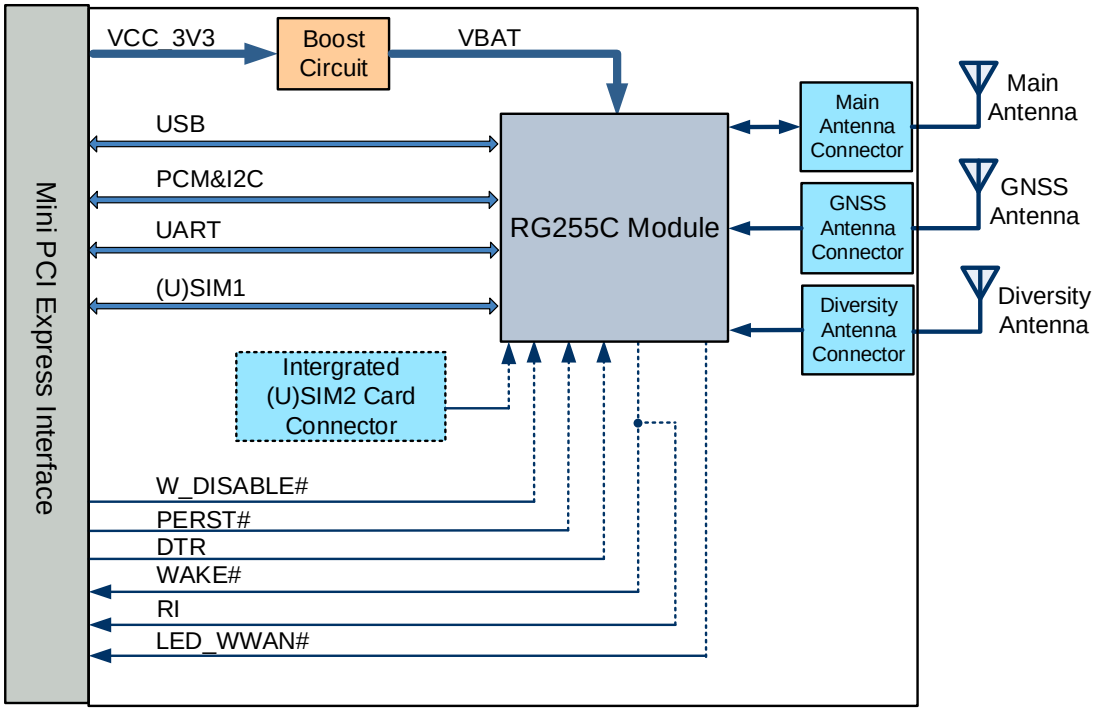
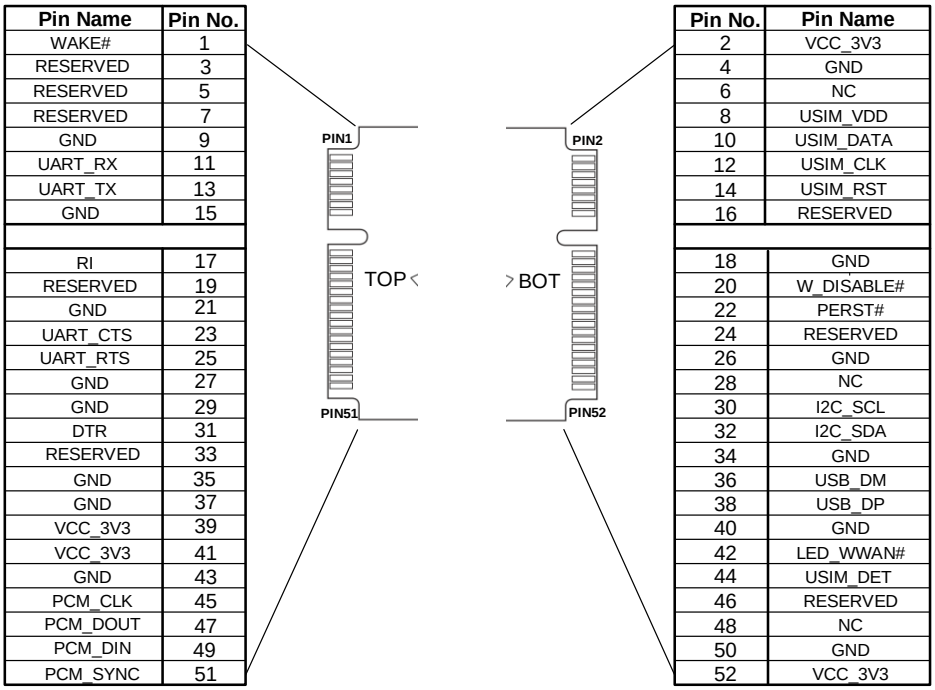


Figure 1: Functional Diagram

2.4. Pin Assignment

The following figure shows the pin assignment of the module. The top side contains RG255C-GL module and antenna connectors.



Pin Name	Pin No.
WAKE#	1
RESERVED	3
RESERVED	5
RESERVED	7
GND	9
UART_RX	11
UART_TX	13
GND	15
RI	17
RESERVED	19
GND	21
UART_CTS	23
UART_RTS	25
GND	27
GND	29
DTR	31
RESERVED	33
GND	35
GND	37
VCC_3V3	39
VCC_3V3	41
GND	43
PCM_CLK	45
PCM_DOUT	47
PCM_DIN	49
PCM_SYNC	51

Pin No.	Pin Name
2	VCC_3V3
4	GND
6	NC
8	USIM_VDD
10	USIM_DATA
12	USIM_CLK
14	USIM_RST
16	RESERVED
18	GND
20	W_DISABLE#
22	PERST#
24	RESERVED
26	GND
28	NC
30	I2C_SCL
32	I2C_SDA
34	GND
36	USB_DM
38	USB_DP
40	GND
42	LED_WWAN#
44	USIM_DET
46	RESERVED
48	NC
50	GND
52	VCC_3V3

Figure 2: Pin Assignment

2.5. Pin Description

The following tables show the definition and description of the 52 pins on RG255C-GL Mini PCIe.

Table 4: Parameter Definition

Parameter	Description
AIO	Analog Input/Output
DI	Digital Input
DO	Digital Output
DIO	Digital Input/Output

OC	Open Collector
PI	Power Input
PO	Power Output

DC characteristics include power domain and rate current.

Table 5: Pin Description

Pin No.	Pin Name	I/O	Description	DC Characteristics	Comment
1	WAKE#	OC	Wake up the host		
2	VCC_3V3	PI	Power supply for the module	Vmin = 3.0 V Vnom = 3.3 V Vmax = 3.6 V	
3	RESERVED		Reserved		
4	GND		Ground		
5	RESERVED		Reserved		
6	NC		Not connected		
7	RESERVED		Reserved		
8	USIM_VDD	PO	(U)SIM card power supply	High-voltage: Vmax = 3.1 V Vnom = 3.0 V Vmin = 2.6 V Low-voltage: Vmax = 1.9 V Vnom = 1.8 V Vmin = 1.4 V	
9	GND		Ground		
10	USIM_DATA	DIO	(U)SIM card data	USIM_VDD	
11	RXD	DI	Receive	3.3 V	
12	USIM_CLK	DO	(U)SIM card clock	USIM_VDD	
13	TXD	DO	Transmit	3.3 V	

14	USIM_RST	DO	(U)SIM card reset	USIM_VDD	
15	GND		Ground		
16	RESERVED		Reserved		
17	RI	DO	Ring indication	3.3 V	
18	GND		Ground		
19	RESERVED		Reserved		
20	W_DISABLE#	DI	Airplane mode control	3.3 V	Pulled up by default. Active low.
21	GND		Ground		
22	PERST#	DI	Fundamental reset	3.3 V	Pulled up by default. Active low.
23	CTS	DI	Clear to send signal to the module	3.3 V	
24	RESERVED		Reserved		
25	RTS	DO	Request to send signal from the module	3.3 V	
26	GND		Ground		
27	GND		Ground		
28	NC		Not connected		
29	GND		Ground		
30	I2C_SCL	DO	I2C serial clock (for external codec)	1.8 V	Requires external pull-up to 1.8 V.
31	DTR	DI	Sleep mode control	3.3 V	
32	I2C_SDA	DIO	I2C serial data (for external codec)	1.8 V	Requires external pull-up to 1.8 V.
33	RESERVED		Reserved		
34	GND		Ground		
35	GND		Ground		

36	USB_DM	AIO	USB 2.0 differential data (-)		Requires differential impedance of 90 Ω. A Test point must be reserved.
37	GND		Ground		
38	USB_DP	AIO	USB 2.0 differential data (+)		Requires differential impedance of 90 Ω. A Test point must be reserved.
39	VCC_3V3	PI	Power supply for the module	Vmin = 3.0 V Vnom = 3.3 V Vmax = 3.6 V	
40	GND		Ground		
41	VCC_3V3	PI	Power supply for the module	Vmin = 3.0 V Vnom = 3.3 V Vmax = 3.6 V	
42	LED_WWAN#	OC	LED signal for indicating the network status of the module		Active low.
43	GND		Ground		
44	USIM_DET	DI	(U)SIM card hot-plug detect	1.8 V	
45	PCM_CLK*	DIO	PCM clock	1.8 V	
46	RESERVED		Reserved		
47	PCM_DOUT*	DO	PCM data output	1.8 V	
48	NC		Not connected		
49	PCM_DIN*	DI	PCM data input	1.8 V	
50	GND		Ground		
51	PCM_SYNC*	DIO	PCM data frame sync	1.8 V	

52	VCC_3V3	PI	Power supply for the module	Vmin = 3.0 V Vnom = 3.3 V Vmax = 3.6 V

NOTE

Keep all NC, RESERVED and unused pins unconnected.

2.6. EVB Kit

Quectel supplies an evaluation board (Mini PCIe EVB) with accessories to develop and test the module. For more details, see ***documents [2]***.

3 Operating Characteristics

3.1. Operating Modes

The following table briefly outlines the operating modes to be mentioned in the following chapters.

Table 6: Overview of Operating Modes

Mode	Details	
Full Functionality Mode	Idle	The module remains registered on the network, and is ready to send and receive data. In this mode, the software is active.
	Voice/Data	The module is connected to network. Its current consumption varies with the network setting and data transmission rate.
Airplane Mode	**AT+CFUN=4** or W_DISABLE# pin can set the module to airplane mode where the RF function is invalid and all AT commands related to it will be inaccessible.	
Minimum Functionality Mode	**AT+CFUN=0** can set the module to a minimum functionality mode without removing the power supply. In this mode, both RF function and (U)SIM card are invalid.	
Sleep Mode	The module remains the ability to receive paging message, SMS, voice call and TCP/UDP data from the network normally. In this mode, the power consumption is reduced to an ultra-low level.	

NOTE

For more details about **AT+CFUN**, see ***document [3]***.

3.2. Sleep Mode

RG255C-GL Mini PCIe is able to reduce its power consumption to an ultra-low level in sleep mode. There are three preconditions must be met to make the module enter sleep mode.

- Execute **AT+QSCLK=1** to enable sleep mode.
- Ensure the DTR is kept at high level or be kept open.
- Ensure the host's USB bus, which is connected with the module's USB interface, enters suspend state.

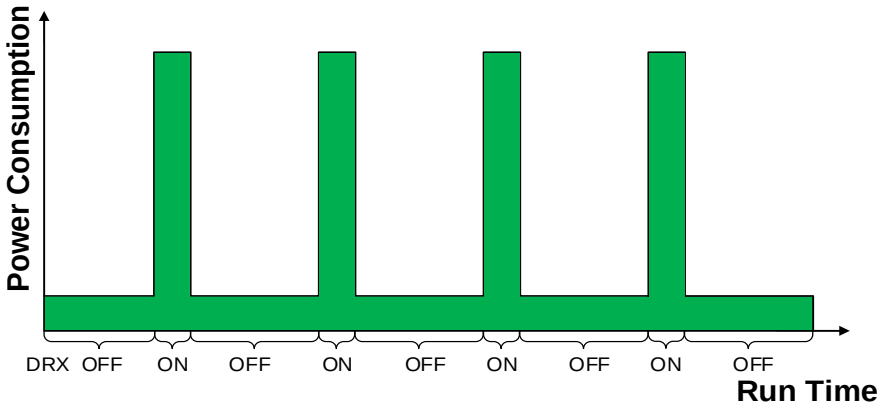


Figure 3: Module Power Consumption in Sleep Mode

NOTE

DRX cycle values are transmitted over the wireless network.

3.3. Airplane Mode

When the module enters airplane mode, the RF function will be disabled, and all AT commands related to it will be inaccessible. For more details, see ***Chapter 4.5.2***.

3.4. Power Supply

The following table shows the definition of VCC_3V3 pins and GND pins.

Table 7: Definition of VCC_3V3 and GND Pins

Pin Name	Pin No.	I/O	Description
VCC_3V3	2, 39, 41, 52	PI	Power supply for the module
GND	4, 9, 15, 18, 21, 26, 27, 29, 34, 35, 37, 40, 43, 50		

The typical supply voltage of RG255C-GL Mini PCIe is 3.3 V. The power supply must be able to provide a rated output current of 3.5 A at least, and a bypass capacitor of not less than 470 µF with low ESR should be used to prevent the voltage from dropping. If a switching power supply is used to power the module, the power device and the routing traces of the switching power supply should avoid the antennas as much as possible to prevent EMI interference.

The following figure shows a reference design of power supply where R2 and R3 are 1% tolerance resistors and C3 is a low ESR capacitor.

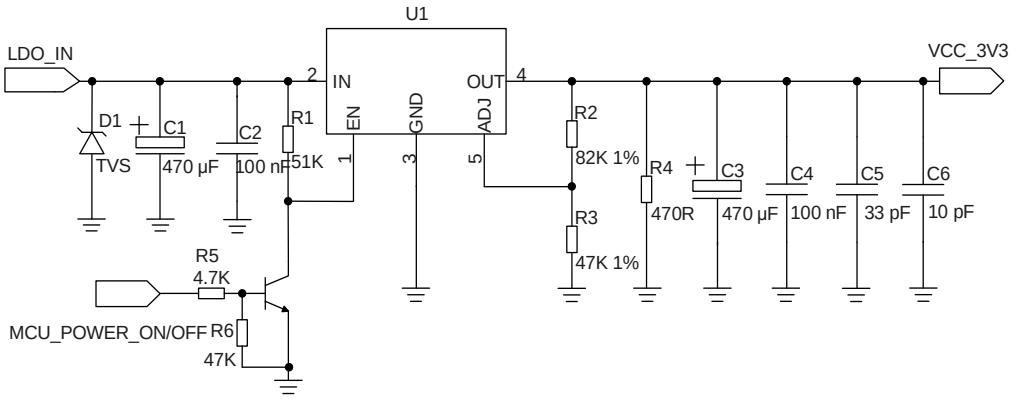


Figure 4: Reference Circuit of Power Supply

4 Application Interfaces

The physical connections and signal levels of RG255C-GL Mini PCIe comply with *PCI Express Mini Card Electromechanical Specification*. This chapter mainly describes the definition and application of the following interfaces and pins of RG255C-GL Mini PCIe:

- (U)SIM interface
- USB interface
- UART
- PCM* and I2C interfaces
- Control and indication signals

4.1. (U)SIM Interface

The (U)SIM interface circuitry meets ETSI and IMT-2000 requirements. Either 1.8 V or 3.0 V (U)SIM card is supported. The following table shows the pin definition of (U)SIM interface.

Table 8: Pin Definition of (U)SIM Interface

Pin Name	Pin No.	I/O	Description	Comment
USIM_VDD	8	PO	(U)SIM card power supply	1.8/3.0 V power domain.
USIM_DATA	10	DIO	(U)SIM card data	1.8/3.0 V power domain.
USIM_CLK	12	DO	(U)SIM card clock	1.8/3.0 V power domain.
USIM_RST	14	DO	(U)SIM card reset	1.8/3.0 V power domain.
USIM_DET	44	DI	(U)SIM card hot-plug detect	1.8 V power domain.

RG255C-GL Mini PCIe supports (U)SIM card hot-plug via the USIM_DET pin. The function supports low-level and high-level detections. Disabled by default, it can be configured via **AT+QSIMDET**. See ***document [3]*** for details about the command.

The following figure shows a reference design for (U)SIM interface with an 8-pin (U)SIM card connector.

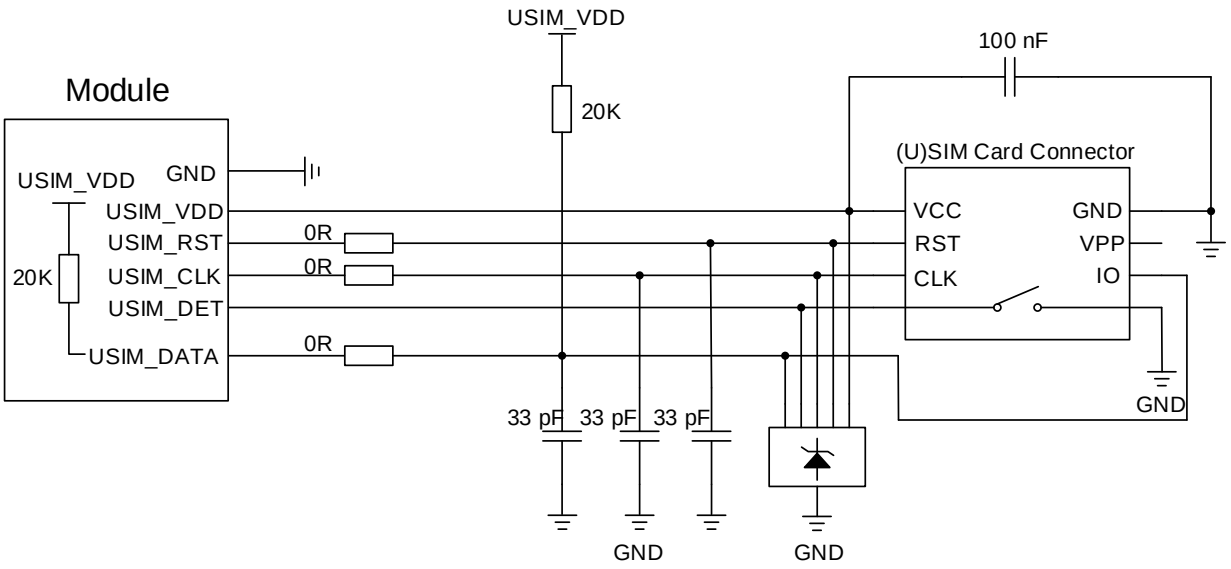


Figure 5: Reference Circuit of (U)SIM Interface with an 8-pin (U)SIM Card Connector

If (U)SIM card hot-plug detect is not needed, keep USIM_DET unconnected. A reference circuit for (U)SIM interface with a 6-pin (U)SIM card connector is illustrated in the following figure.

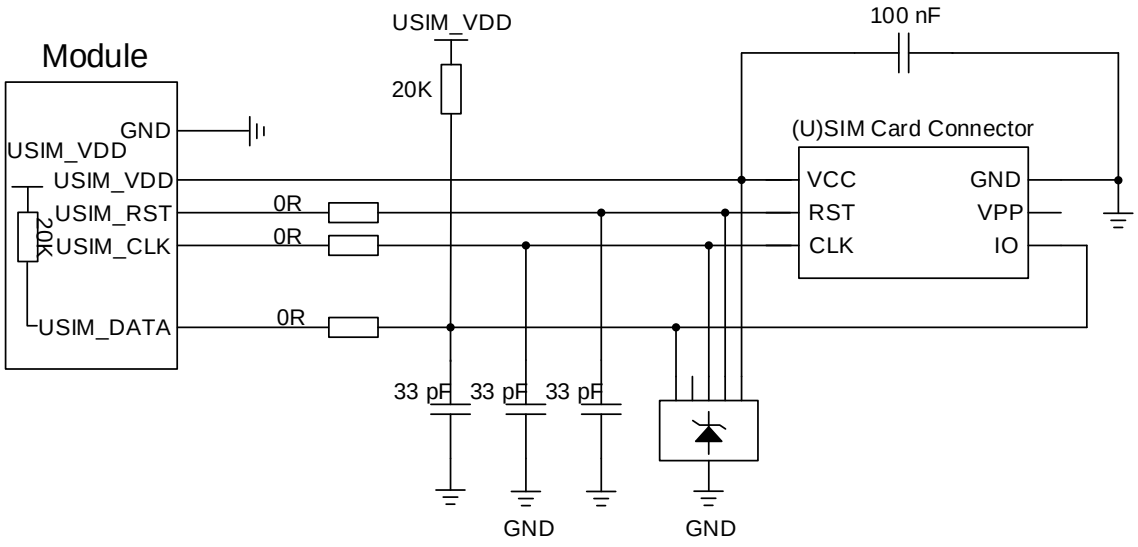


Figure 6: Reference Circuit of (U)SIM Interface with a 6-pin (U)SIM Card Connector

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

- Place the (U)SIM card connector as close to the module as possible. Keep the trace length as less than 200 mm as possible.
- Keep (U)SIM card signals away from RF and power supply traces.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them away from each other and shield them with surrounded ground.
- For better ESD protection, it is recommended to add a TVS array with parasitic capacitance not exceeding 15 pF.
- The 0 Ω resistors should be added in series between the module and the (U)SIM card connector to facilitate debugging. Additionally, add 33 pF capacitors in parallel among USIM_DATA, USIM_CLK and USIM_RST signal traces to filter out RF interference. Note that the (U)SIM peripheral circuit should be close to the (U)SIM card connector.
- The pull-up resistor on USIM_DATA trace can improve anti-jamming capability when long layout trace and sensitive occasion are applied, and it must be placed close to the (U)SIM card connector.

4.2. USB Interface

RG255C-GL Mini PCIe provides one integrated Universal Serial Bus (USB) interface which complies with USB 2.0 specification. It can only be used as a slave device. Meanwhile, it supports high-speed (480 Mbps) mode and full-speed (12 Mbps) mode.

The USB interface is used for AT command communication, data transmission, GNSS NMEA output, software debugging and firmware upgrade.

The following table shows the pin definition of USB interface.

Table 9: Pin Definition of USB Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_DM	36	AIO	USB 2.0 differential data (-)	Requires differential impedance of 90 Ω. Test points must be reserved.
USB_DP	38	AIO	USB 2.0 differential data (+)	

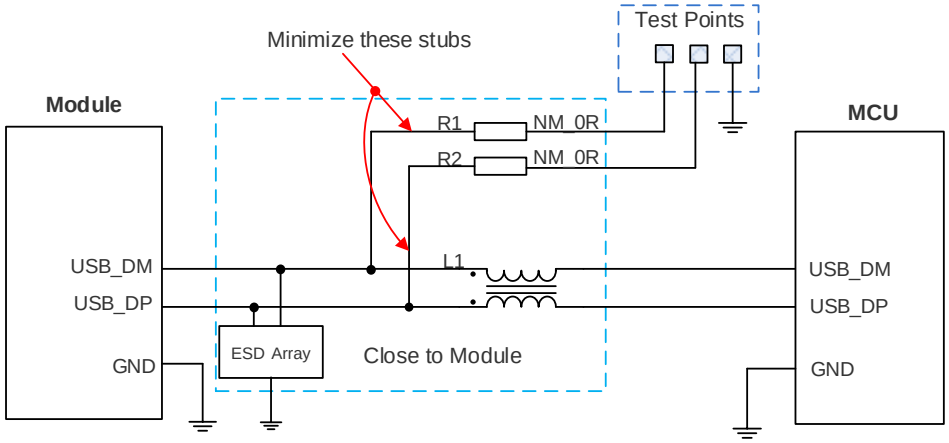


Figure 7: Reference Circuit of USB Interface

A common mode choke L1 is recommended to be added in series between the module and your MCU to suppress EMI spurious transmission. Meanwhile, the 0 Ω resistors (R1 and R2) should be added in series between the module and the test points to facilitate debugging, and the resistors are not mounted by default. In order to ensure the integrity of USB data line signal, L1, R1, and R2 components must be placed close to the module, and also these resistors should be placed close to each other. The extra stubs of trace must be as short as possible.

To meet USB 2.0 specification, the following principles should be complied with when design the USB interface.

- Route the USB signal traces as differential pairs with ground surrounded. The impedance of USB differential trace is 90 Ω.
- Do not route signal traces under crystals, oscillators, magnetic devices 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 traces, so you should pay attention to the selection of the device. Typically, the capacitance value should be less than 2 pF.
- Keep the ESD protection components as close to the USB connector as possible.

4.3. UART

RG255C-GL Mini PCIe provides one main UART that supports 115200 bps, 9600 bps, 19200 bps, 38400 bps, 57600 bps, and 230400 bps baud rates, and the default is 115200 bps. It supports RTS and CTS hardware flow control, and can be used for AT command communication and data transmission.

The following table shows the pin definition of the interface.

Table 10: Pin Definition of Main UART

Pin Name	Pin No.	I/O	Description	Comment
RXD	11	DI	Receive	3.3 V power domain.
TXD	13	DO	Transmit	3.3 V power domain.
CTS	23	DI	Clear to send signal to the module	3.3 V power domain.
RTS	25	DO	Request to send signal from the module	3.3 V power domain.

The signal level of main UART is 3.3 V. When connecting to MCU, you need to pay attention to the signal direction. The reference circuit is shown as below:

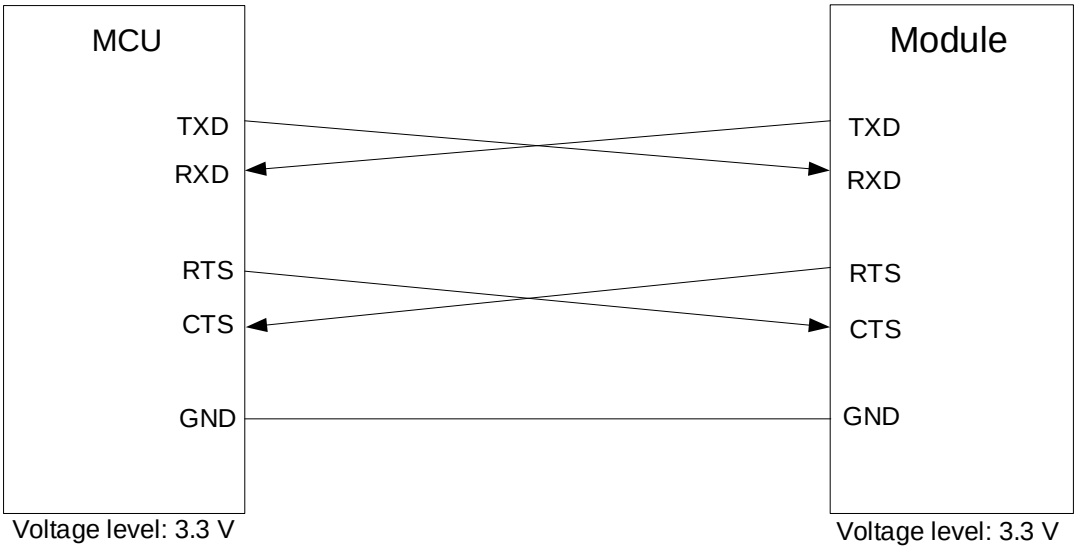


Figure 8: Reference Circuit of Power Supply

NOTE

AT+IPR can be used to set the baud rate of the main UART, and **AT+IFC** can be used to set the hardware flow control (hardware flow control is disabled by default). See ***document [3]*** for details.

4.4. PCM* and I2C Interfaces

RG255C-GL Mini PCIe provides one Pulse Code Modulation (PCM) digital interface and one I2C interface.

The following table shows the pin definition of PCM and I2C interfaces that can be applied in audio codec design.

Table 11: Pin Definition of PCM and I2C Interfaces

Pin Name	Pin No.	I/O	Description	Comment
PCM_CLK	45	DIO	PCM clock	1.8 V power domain.
PCM_DOUT	47	DO	PCM data output	
PCM_DIN	49	DI	PCM data input	
PCM_SYNC	51	DIO	PCM data frame sync	
I2C_SCL	30	DO	I2C serial clock (for external codec)	Requires external pull-up to 1.8 V.
I2C_SDA	32	DIO	I2C serial data (for external codec)	

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

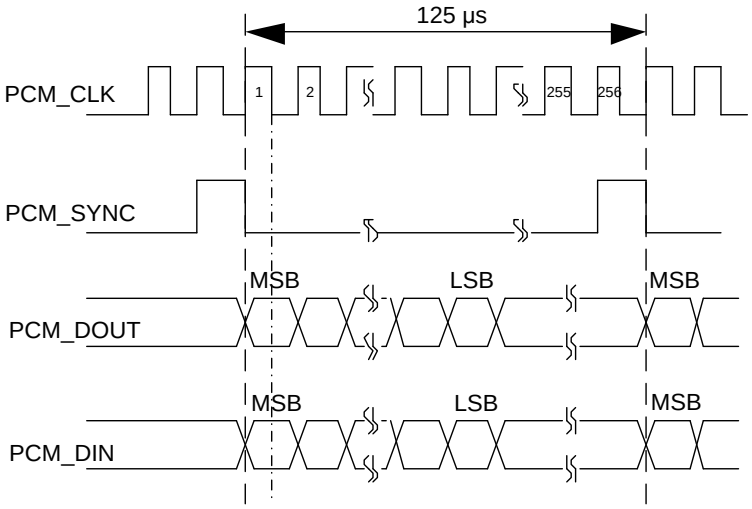


Figure 9: Timing in Primary Mode

In auxiliary mode, data is also sampled on the falling edge of the PCM_CLK and transmitted on the rising edge. But in this mode, the PCM_SYNC rising edge represents the MSB. PCM_CLK supports 256 kHz, 512 kHz, 1024 kHz and 2048 kHz when PCM_SYNC reaches 8 kHz with a 50 % duty cycle.

The following figure shows the timing relationship in auxiliary mode with 8 kHz PCM_SYNC and 256 kHz PCM_CLK.

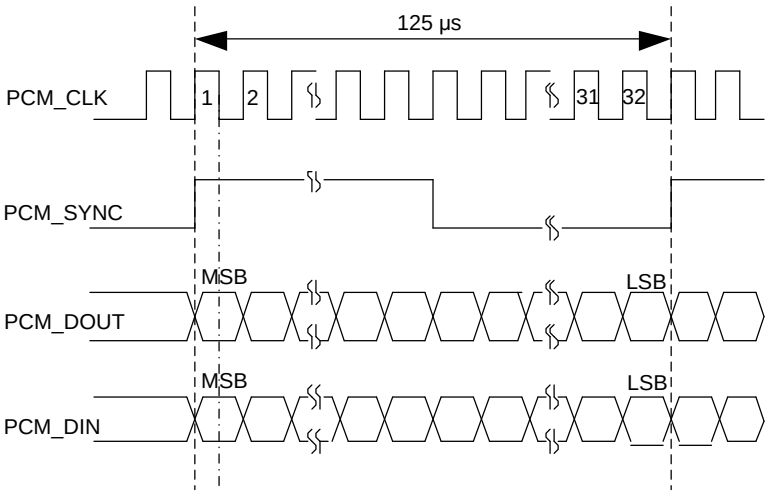


Figure 10: Timing in Auxiliary Mode

The clock and mode of PCM can be configured by **AT+QDAI**, and the default configuration is short frame mode (master mode, PCM_CLK = 2048 kHz, PCM_SYNC = 8 kHz, 16-bit linear data format). In addition, RG255C-GL Mini PCIe's firmware has integrated the configuration on some PCM codec's application with I2C interface. See ***document [3]*** for details about **AT+QDAI**.

The following figure shows a reference design of PCM and I2C interfaces with an external codec IC.

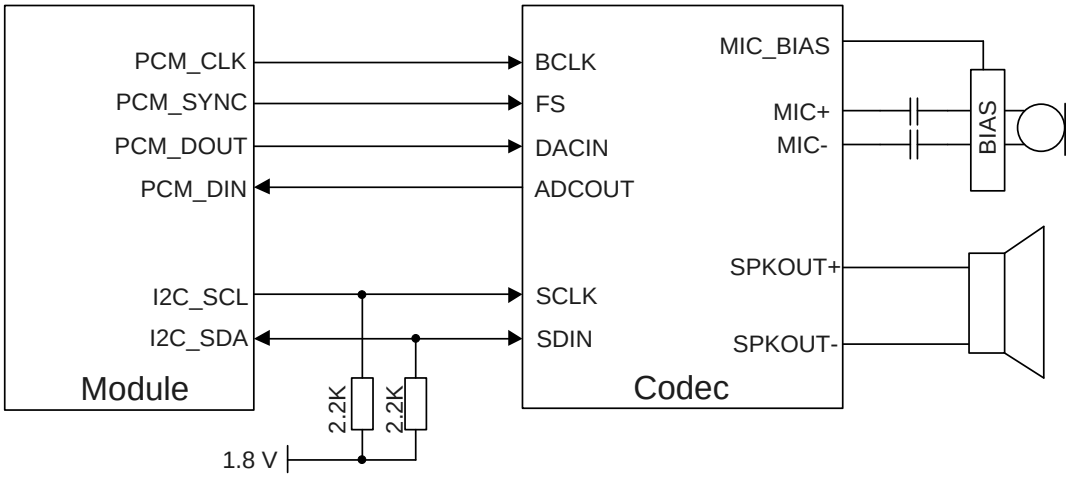


Figure 11: Reference Circuit of PCM and I2C Application with Audio Codec

NOTE

1. It is recommended to reserve an RC (R = 0 Ω, C = 33 pF) circuit on the PCM lines, especially for PCM_CLK.
2. The module can only be used as a master device in applications related to PCM and I2C interfaces

4.5. Control and Indication Signals

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

Table 12: Pin Definition of Control and Indication Signals

Pin Name	Pin No.	I/O	Description	Comment
RI	17	DO	Ring indication	3.3 V power domain.
DTR	31	DI	Sleep mode control	3.3 V power domain.
W_DISABLE#	20	DI	Airplane mode control	3.3 V power domain. Pulled up by default; Active low.
PERST#	22	DI	Fundamental reset	3.3 V power domain. Pulled up by default; Active low.
LED_WWAN#	42	OC	LED signal for indicating the network status of the module	Active low.
WAKE#	1	OC	Wake up the host	

4.5.1. RI

The RI signal can be used to wake up the host. When a URC returns, there will be the following behaviors on the RI pin after executing **AT+QCFG="risignaltype","physical"**.

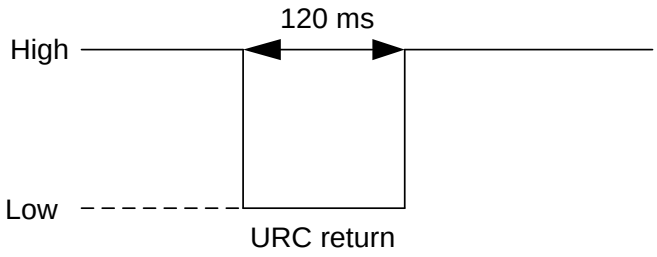


Figure 12: RI Behaviors

4.5.2. W_DISABLE#

The module provides a W_DISABLE# signal to disable or enable the RF function (excluding GNSS). The W_DISABLE# pin is pulled up by default. Its control function for airplane mode is disabled by default, and **AT+QCFG="airplanecontrol",1** can be used to enable the function. Driving the pin low after its control function for airplane mode is enabled by AT command, which can make the module enter the airplane mode.

Table 13: Airplane Mode Controlled by Hardware Method

W_DISABLE#	RF Function Status	Module Operating Mode
High level	RF enabled	Normal operation
Low level	RF disabled	Airplane mode

The RF function can also be enabled or disabled through **AT+CFUN**, and the details are as follows.

Table 14: Airplane Mode Controlled by Software Method

AT+CFUN=?	RF Function Status	Module Operating Mode
0	RF and (U)SIM disabled	Minimum functionality mode
1	RF enabled	Normal operation
4	RF disabled	Airplane mode

NOTE

The execution of **AT+CFUN** does not affect GNSS function.

4.5.3. DTR

The DTR signal is used for sleep mode control. It is pulled up by default. When the module is in sleep mode, driving DTR low can wake up the module. For more details about the preconditions for the module to enter sleep mode, see ***Chapter 3.2***.

4.5.4. PERST#

The PERST# signal can be used to force a hardware reset. The module can be reset by driving the PERST# signal low for 150–460 ms and then releasing it. The PERST# signal is sensitive to interference. The traces should be as short as possible and be surrounded with ground.

The reset scenario is illustrated in the following figure.

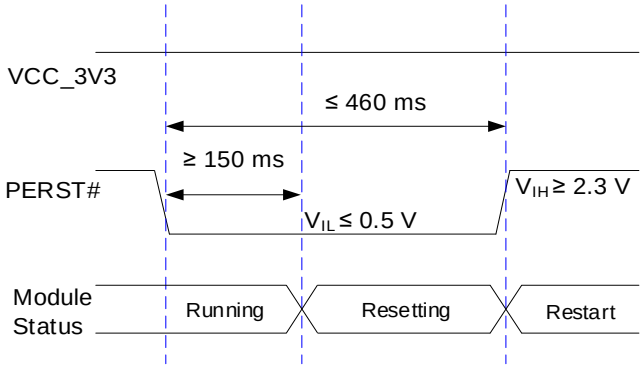


Figure 13: Reset Timing

4.5.5. LED_WWAN#

LED_WWAN# is an open collector output signal, it is used to indicate the network status of the module, and its maximum input current can be up to 40 mA. According to the following circuit, to reduce the current of the LED, a resistor must be placed in series with the LED. The LED emits light when the LED_WWAN# output signal is active low.

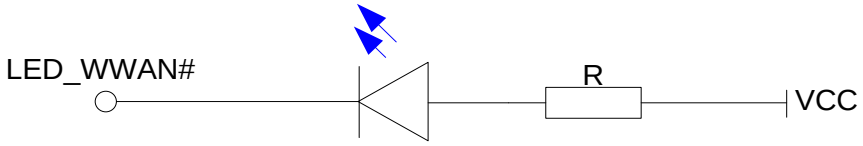


Figure 14: LED_WWAN# Signal Reference Circuit Diagram

There are two indication modes for LED_WWAN# signal to indicate network status, which can be switched through following AT commands:

- **AT+QCFG="ledmode",0** (default setting)
- **AT+QCFG="ledmode",2**

The following tables show the detailed network status indications of the LED_WWAN# signal.

Table 15: Indications of Network Status (AT+QCFG="ledmode",0, Default Setting)

Pin Status	Description
Flicker slowly (200 ms Low/1800 ms High)	Network searching
Flicker slowly (1800 ms Low/200 ms High)	Idle
Flicker quickly (125 ms Low/125 ms High)	Data transmission is ongoing
Always Low	Voice calling

Table 16: Indications of Network Status (AT+QCFG="ledmode",2)

Pin Status	Description
Low Level (Light ON)	Registered on network successfully
High-Impedance (Light OFF)	• No network coverage or not registered • W_DISABLE# signal is at low level. (RF disabled.) • **AT+CFUN=0**, **AT+CFUN=4** input

4.5.6. WAKE#

The WAKE# signal is an open collector signal, which is similar to RI signal, but a pull-up resistor and **AT+QCFG="risignaltype","physical"** are required to wake up the host. When a URC returns, a 120 ms low level pulse will be outputted. The state of WAKE# signal is shown as below.

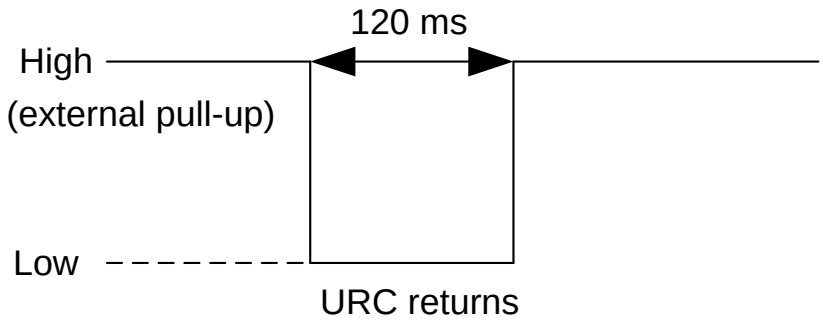


Figure 15: WAKE# Behaviors

5 Antenna Connection

5.1. Antenna Connectors

RG255C-GL Mini PCIe is mounted with three antenna connectors for external antenna connection: a main antenna connector, an Rx-diversity antenna connector, and a GNSS antenna connector. And Rx-diversity function is enabled by default. The impedance of the antenna connectors is 50 Ω.

5.2. Antenna Interfaces

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

5.2.1. Pin Definition of Antenna Interfaces

Table 17: Pin Definition of Antenna Interfaces

Pin Name	I/O	Description	Comment
ANT_MAIN	AIO	**Antenna 0 interface:** - **5G NR:** LB/MHB/5GLM_UHB/5GH TRX - **LTE:** LB/MHB/UHB TRX	**LB:** 617–960 MHz **MHB:** 1695–2690 MHz **5GLM_UHB:** 3300–3800 MHz **5GH:** 4400–5000 MHz
ANT_DRX	AI	**Antenna 2 interface:** - **5G NR:** LB/MHB/5GLM_UHB/5GH DRX - **LTE:** LB/MHB/UHB DRX	
ANT_GNSS	AI	**Antenna 1 interface:** - **GNSS:** L1/L2/L5	

5.2.2. Cellular Network

5.2.2.1. Rx Sensitivity

Table 18: Conducted RF Receiving Sensitivity (Unit: dBm)

Mode	Frequency Bands	Receiving Sensitivity (Typ.)			3GPP (SIMO)
		Primary	Diversity	SIMO [7]	
LTE	LTE-FDD B1 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B2 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B3 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B4 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B5 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B7 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B8 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B12 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B13 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B14 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B17 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B18 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B19 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B20 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B25 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B26 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B28 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B30 (10 MHz)	TBD	TBD	TBD	TBD

[7] 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.

	LTE-TDD B34 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-TDD B38 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-TDD B39 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-TDD B40 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-TDD B41 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-TDD B42 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-TDD B43 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-TDD B48 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B66 (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B70* (10 MHz)	TBD	TBD	TBD	TBD
	LTE-FDD B71 (10 MHz)	TBD	TBD	TBD	TBD
5G NR	5G NR FDD n1 (20 MHz)	TBD	TBD	TBD	TBD
	5G NR FDD n2 (20 MHz)	TBD	TBD	TBD	TBD
	5G NR FDD n3 (20 MHz)	TBD	TBD	TBD	TBD
	5G NR FDD n5 (20 MHz)	TBD	TBD	TBD	TBD
	5G NR FDD n7 (20 MHz)	TBD	TBD	TBD	TBD
	5G NR FDD n8 (20 MHz)	TBD	TBD	TBD	TBD
	5G NR FDD n12 (15 MHz)	TBD	TBD	TBD	TBD
	5G NR FDD n13 (10MHz)	TBD	TBD	TBD	TBD
	5G NR FDD n14 (10 MHz)	TBD	TBD	TBD	TBD
	5G NR FDD n18 (15 MHz)	TBD	TBD	TBD	TBD
	5G NR FDD n20 (20 MHz)	TBD	TBD	TBD	TBD
	5G NR FDD n25 (20 MHz)	TBD	TBD	TBD	TBD
	5G NR FDD n26 (20 MHz)	TBD	TBD	TBD	TBD
	5G NR FDD n28 (20 MHz)	TBD	TBD	TBD	TBD

	5G NR FDD n30 (10 MHz)	TBD	TBD	TBD	TBD
	5G NR TDD n38 (20 MHz)	TBD	TBD	TBD	TBD
	5G NR TDD n40 (20 MHz)	TBD	TBD	TBD	TBD
	5G NR TDD n41 (20 MHz)	TBD	TBD	TBD	TBD
	5G NR FDD n48 (20 MHz)	TBD	TBD	TBD	TBD
	5G NR FDD n66 (20 MHz)	TBD	TBD	TBD	TBD
	5G NR FDD n70* (20 MHz)	TBD	TBD	TBD	TBD
	5G NR FDD n71 (20 MHz)	TBD	TBD	TBD	TBD
	5G NR TDD n77 (20 MHz)	TBD	TBD	TBD	TBD
	5G NR TDD n78 (20 MHz)	TBD	TBD	TBD	TBD
	5G NR TDD n79 (20 MHz)	TBD	TBD	TBD	TBD

5.2.2.2. Tx Power

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

Table 19: Tx Power

Mode	Frequency Bands	Max. Tx Power	Min. Tx Power
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 [8]
	5G NR HPUE bands (n38/n40/n41/n77/n78/n79)	26 dBm +2/-3 dB (Class 2)	< -40 dBm

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

5.2.3. GNSS (Optional)

The module includes a fully integrated global navigation satellite system solution (GPS, GLONASS, BDS, Galileo).

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

The GNSS engine is switched off by default. It has to be switched on via AT command. For more details about GNSS engine technology and configurations, see ***document [3]***.

5.2.3.1. GNSS Frequency

Table 20: GNSS Frequency (Unit: MHz)

Antenna Type	Frequency
GPS	1575.42 ±1.023 (L1) 1227.60 ±1.023 (L2) [9] 1176.45 ±10.23 (L5)
GLONASS	1597.5–1605.8
BDS	1561.098 ±2.046 (B1I)
Galileo	1575.42 ±2.046 (E1) 1176.45 ±10.23 (E5a)

5.2.3.2. GNSS Performance

The following table shows GNSS performance of the module.

Table 21: GNSS Performance

Parameter	Description	Conditions	Typ.	Unit
Sensitivity	Acquisition	Autonomous	TBD	dBm
	Reacquisition		TBD	dBm
	Tracking		TBD	dBm

[9] If you need this function, contact Quectel Technical Support.

TTFF	Cold start @ open sky	Autonomous	TBD	s
		XTRA enabled	TBD	s
	Warm start @ open sky	Autonomous	TBD	s
		XTRA enabled	TBD	s
	Hot start @ open sky	Autonomous	TBD	s
		XTRA enabled	TBD	s
Accuracy	CEP-50	Autonomous @ open sky	TBD	m

NOTE

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

5.3. Recommended Mating Plugs for Antenna Connection

RG255C-GL Mini PCIe is mounted with RF connectors (receptacles) for convenient antenna connection. The dimensions of the antenna connectors are shown as below.

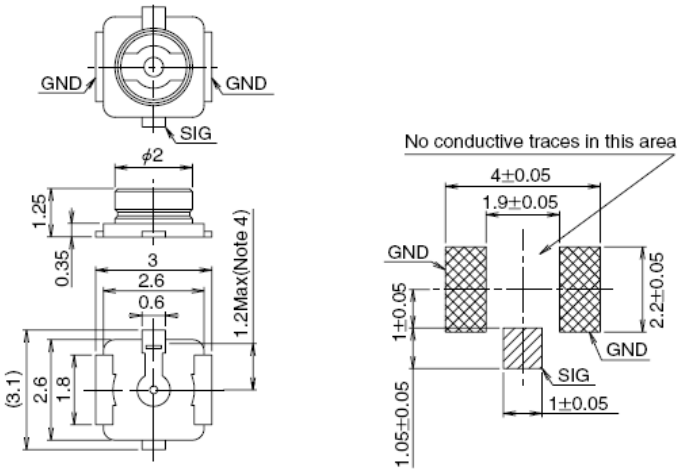


Figure 16: Dimensions of the Receptacle RF Connectors (Unit: mm)

U.FL-LP mating plugs listed in the following figure can be used to match the receptacles.

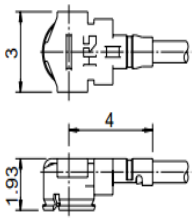
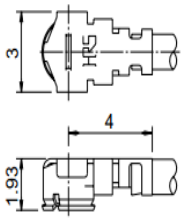
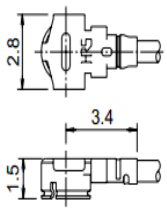
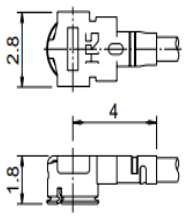
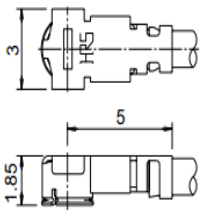
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia.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

Figure 17: Mechanicals of U.FL-LP Mating Plugs

The following figure describes the space factor of mating plugs.

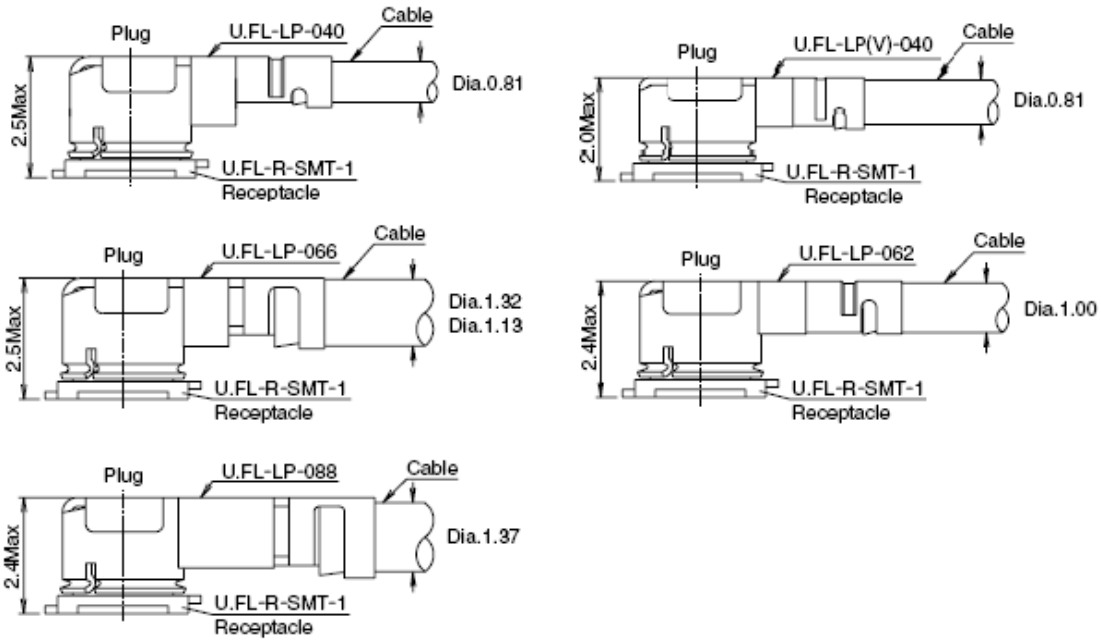


Figure 18: Space Factor of Mating Plugs (Unit: mm)

5.3.1. Recommended RF Connector for Installation

5.3.1.1. Assemble Coaxial Cable Plug Manually

The illustration for plugging in a coaxial cable plug is shown below, θ = 90° is acceptable, while θ ≠ 90° is not.

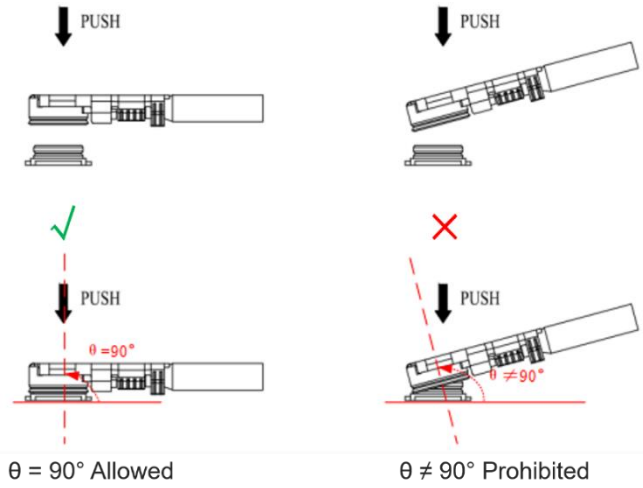


Figure 41: Plug in a Coaxial Cable Plug

The illustration of pulling out the coaxial cable plug is shown below, θ = 90° is acceptable, while θ ≠ 90° is not.

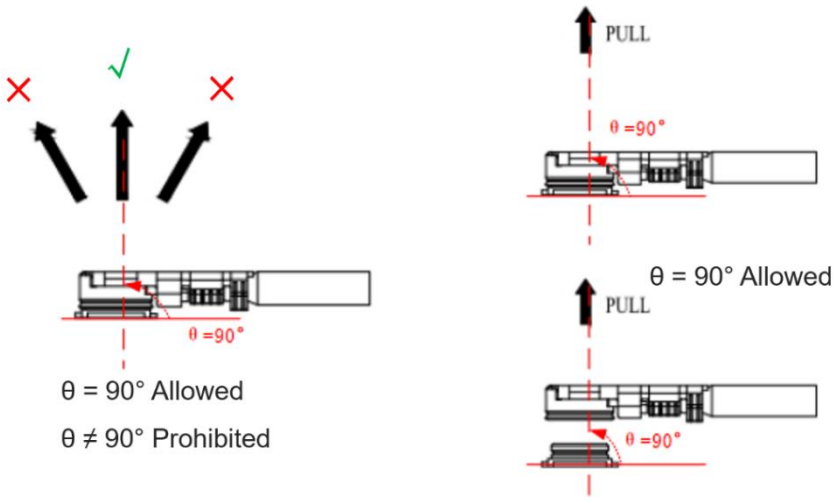


Figure 42: Pull out a Coaxial Cable Plug

5.3.1.2. Assemble Coaxial Cable Plug with Jig

The pictures of installing the coaxial cable plug with a jig is shown below, θ = 90° is acceptable, while θ ≠ 90° is not.

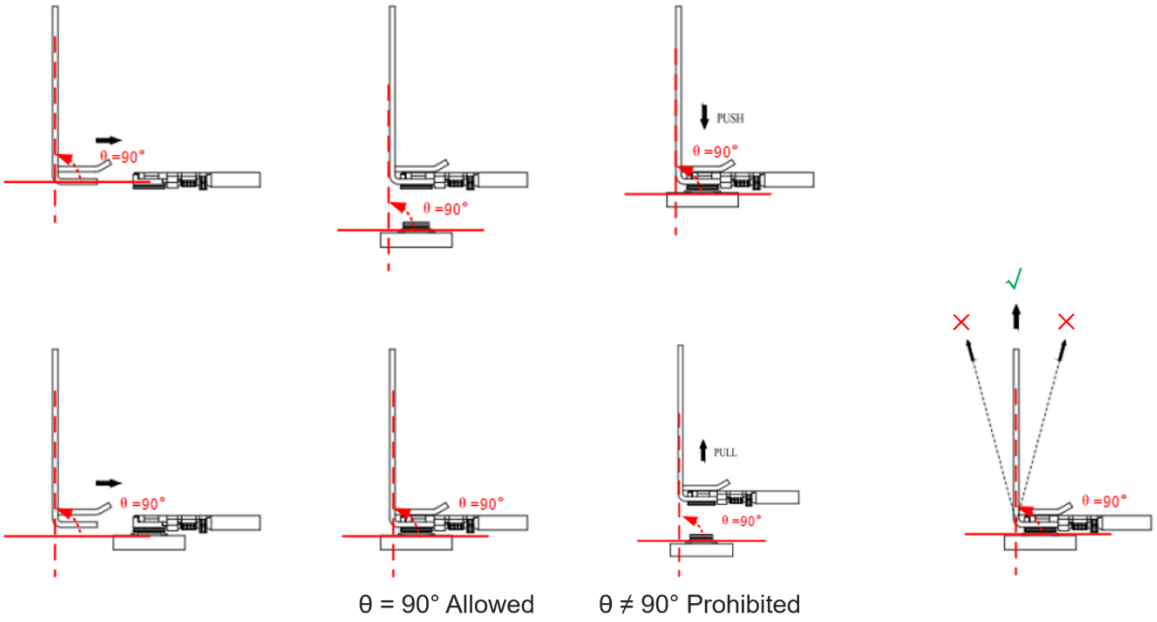


Figure 43: Install the Coaxial Cable Plug with Jig

5.3.2. Recommended Manufacturers of RF Connector and Cable

RF connectors and cables by I-PEX2 are recommended. For more details, visit https://www.i-pex.com.

6 Electrical Characteristics and Reliability

This chapter mainly describes the following electrical characteristics and reliability of RG255C-GL Mini PCIe:

- Power supply requirements
- Digital I/O characteristics
- ESD protection
- Power consumption
- Thermal dissipation

6.1. Power Supply Requirements

The input voltage of RG255C-GL Mini PCIe is 3.0–3.6 V, as specified by *PCI Express Mini Card Electromechanical Specification Revision 1.2*. The following table shows the power supply requirements of RG255C-GL Mini PCIe.

Table 22: Power Supply Requirements

Parameter	Description	Min.	Typ.	Max.	Unit
VCC_3V3	Power supply for the module	3.0	3.3	3.6	V

6.2. Digital I/O Characteristic

The following table shows the I/O requirements of RG255C-GL Mini PCIe.

Table 23: I/O Requirements

Parameter	Description	Min.	Max.	Unit
V_{IH}	High-level input voltage	0.7 × VCC_3V3	VCC_3V3 + 0.3	V
V_{IL}	Low-level input voltage	-0.3	0.3 × VCC_3V3	V
V_{OH}	High-level output voltage	VCC_3V3 - 0.5	VCC_3V3	V
V_{OL}	Low-level output voltage	0	0.4	V

Table 24: (U)SIM High/Low-voltage I/O Requirements (Unit: V)

Parameter	Description	Min.	Max.
V_{IH}	High-level input voltage	0.7 × USIM_VDD	USIM_VDD + 0.3
V_{IL}	Low-level input voltage	-0.3	0.2 × USIM_VDD
V_{OH}	High-level output voltage	0.8 × USIM_VDD	-
V_{OL}	Low-level output voltage	-	0.4

NOTE

1. The PCM* and I2C interfaces are 1.8 V power domain.
2. The maximum voltage value of V_{IL} for PERST# and W_DISABLE# is 0.5 V.

6.3. ESD Protection

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

Table 25: Electrostatic Discharge Characteristics (Temperature: 25–30 °C, Humidity: 40 ±5 %)

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

6.4. Power Consumption

Table 26: Averaged Power Consumption

Mode	Condition	Band/Combination	Typ.	Unit
Turn off	Power off	-	TBD	μA
RF Disabled	**AT+CFUN=0** (USB 2.0 suspend)	-	TBD	mA
	AT+CFUN=4 (USB 2.0 suspend)	-	TBD	mA
Idle mode	SA PF = 64 (USB 2.0 active)	-	TBD	mA
	SA PF = 64 (USB 2.0 active)	-	TBD	mA
LTE data transmission (GNSS OFF)	LTE LB @ 24 dBm	B5	TBD	mA
	LTE MB @ 24 dBm	B1	TBD	mA
	LTE HB @ 24 dBm	B7	TBD	mA
	LTE HPUE @ 24 dBm	B41	TBD	mA
5G SA data transmission (GNSS OFF)	5G NR LB @ 23 dBm	n5	TBD	mA
	5G NR MB @ 23 dBm	n1	TBD	mA
	5G NR HB @ 23 dBm	n7	TBD	mA
	5G NR 5GLM_UHB @ 26 dBm	n78	TBD	mA
	5G NR 5GH @ 26 dBm	n79	TBD	mA

Table 27: GNSS Power Consumption

Description	Condition	Typ.	Unit
Searching (**AT+CFUN=0**)	Cold start @ Passive antenna	TBD	mA
	Lost state @ Passive antenna	TBD	mA
Tracking (**AT+CFUN=0**)	Instrument environment	TBD	mA

6.5. Thermal Dissipation

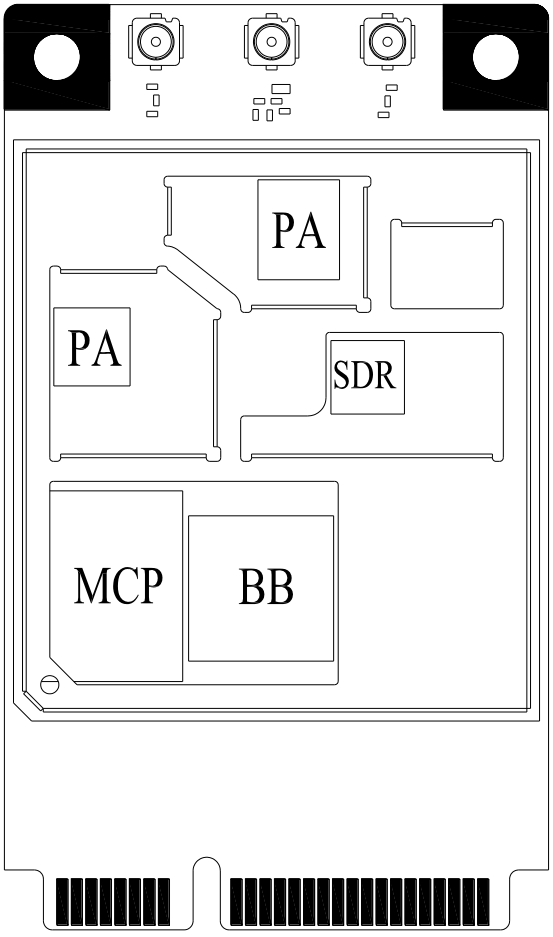


Figure 19: Distribution of Heat Source Chips Inside the Module

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

still work but the performance and function (such as RF output power, data rate) will be affected to a certain extent. Therefore, the thermal design should be maximally optimized to ensure all internal IC chips always work within the recommended operating temperature range.

The following principles for thermal consideration are provided for reference:

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

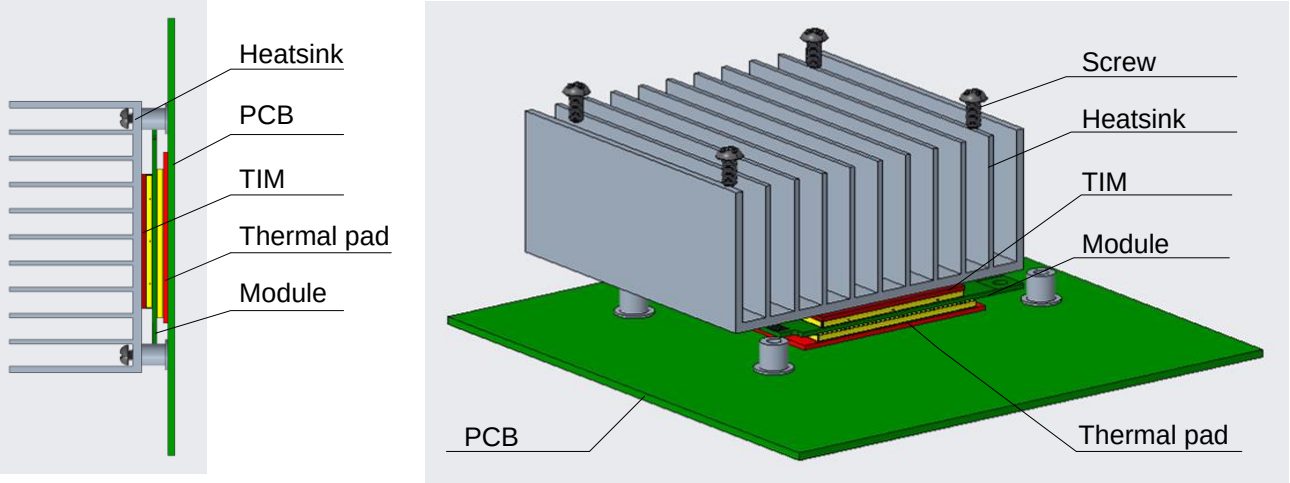


Figure 20: Placement and Fixing of the Heatsink

NOTE

The module offers the best performance when the internal BB chip stays below 95 °C. When the maximum temperature of the BB chip reaches or exceeds 95 °C, the module works normal but provides

reduced performance (such as RF output power, data rate). When the maximum BB chip temperature reaches or exceeds 105 °C, the module will disconnect from the network, and it will recover to network connected state after the maximum temperature falls below 105 °C. Therefore, the thermal design should be maximally optimized to make sure the maximum BB chip temperature always maintains below 95 °C. You can execute **AT+QTEMP** and get the maximum BB chip temperature from the first returned value. For more details of the command, see ***document [3]***.

6.6. Notification

Please follow the principles below in the module application.

6.6.1. Coating

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.

6.6.2. Cleaning

Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.

6.6.3. Cleaning

It is recommended to fix the module firmly when the module is inserted into a socket.

7 Mechanical Information

This chapter mainly describes mechanical dimensions as well as packaging specification of RG255C-GL Mini PCIe module. All dimensions are measured in millimeter (mm), and the dimensional tolerances are ±0.15 mm unless otherwise specified.

7.1. Mechanical Dimensions

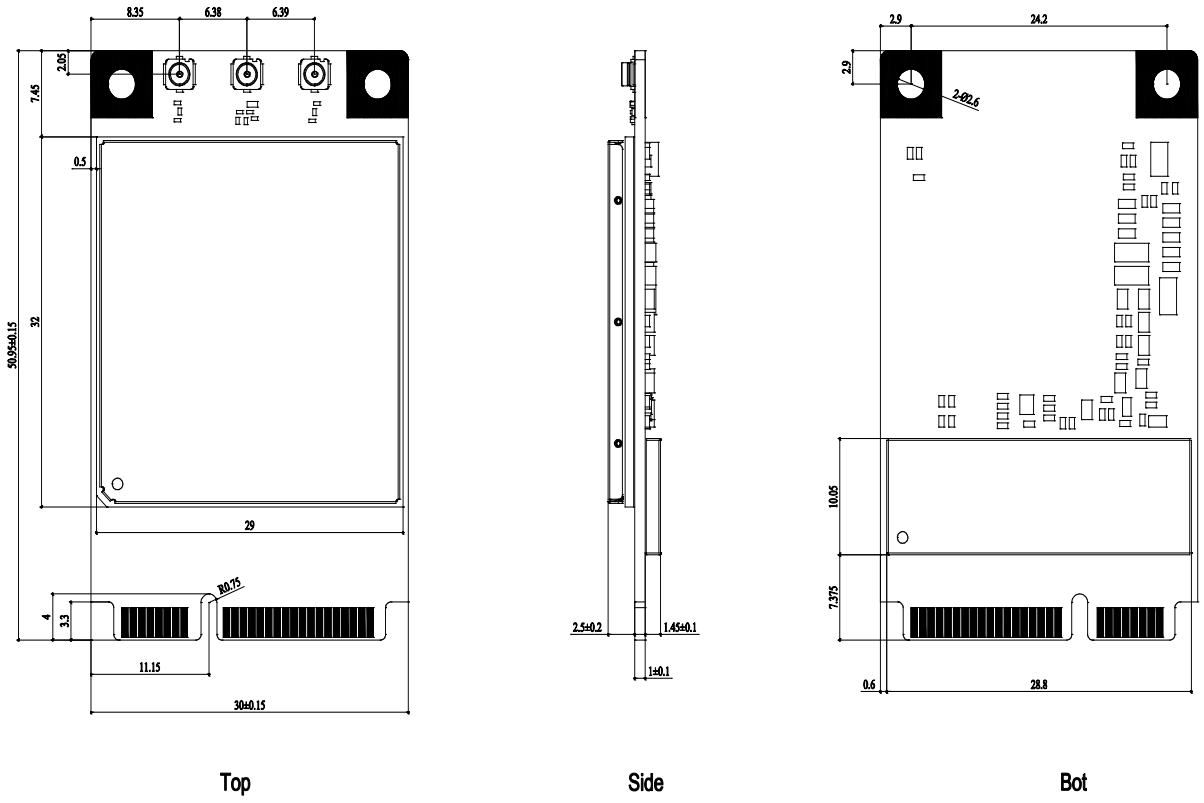


Figure 21: Mechanical Dimensions

NOTE

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

7.2. Standard Dimensions of Mini PCI Express

RG255C-GL Mini PCIe adopts a standard Mini PCI Express connector which compiles with the directives and standards listed in the *PCI Express Mini Card Electromechanical Specification Revision 1.2*. The following figure takes the Molex 679105700 as an example.

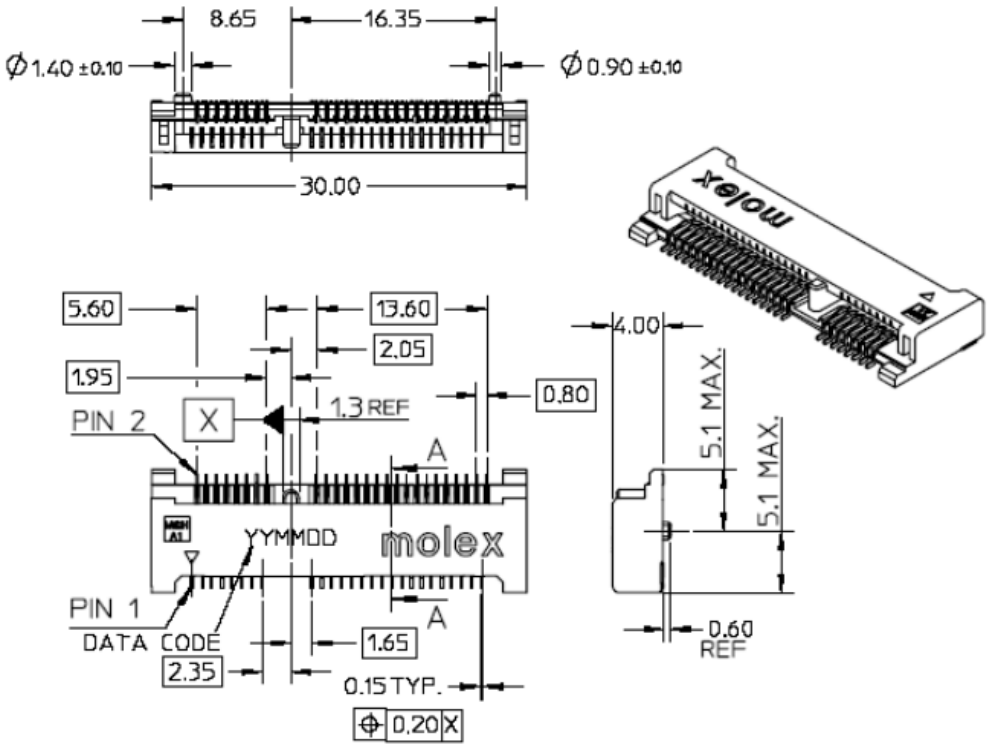


Figure 22: Standard Dimensions of Mini PCI Express Connector (Molex 679105700)

7.2. Top and Bottom Views

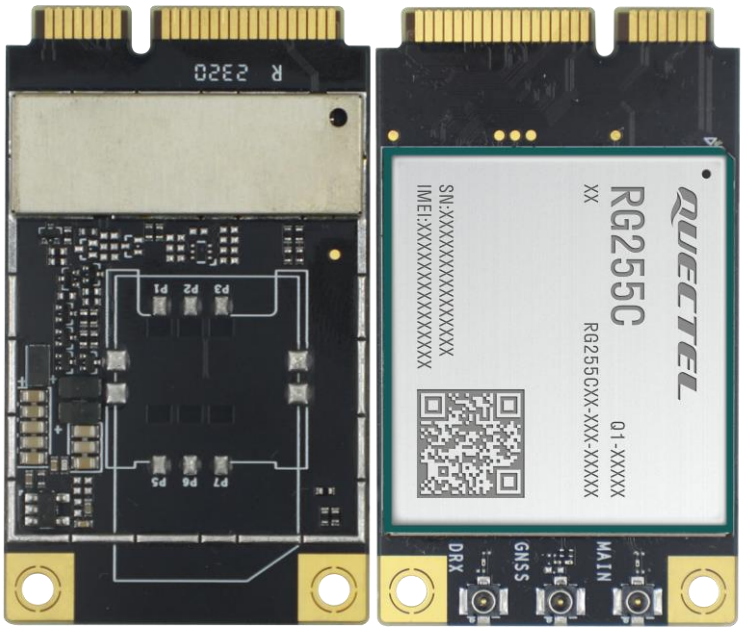


Figure 23: Top and Bottom Views of the Module

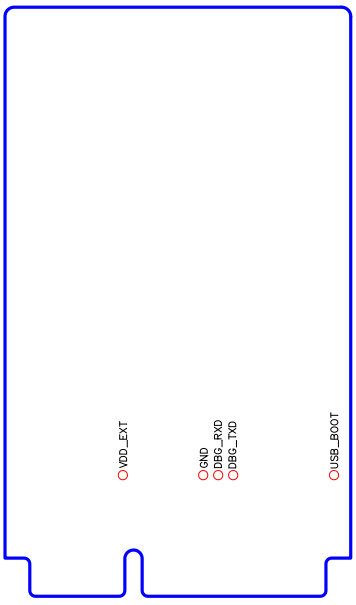


Figure 24: Test Points of the Module

7.3. Packaging Specifications

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

The module adopts blister tray packaging and details are as follow:

7.3.1. Blister Tray

Dimension details are as follow:

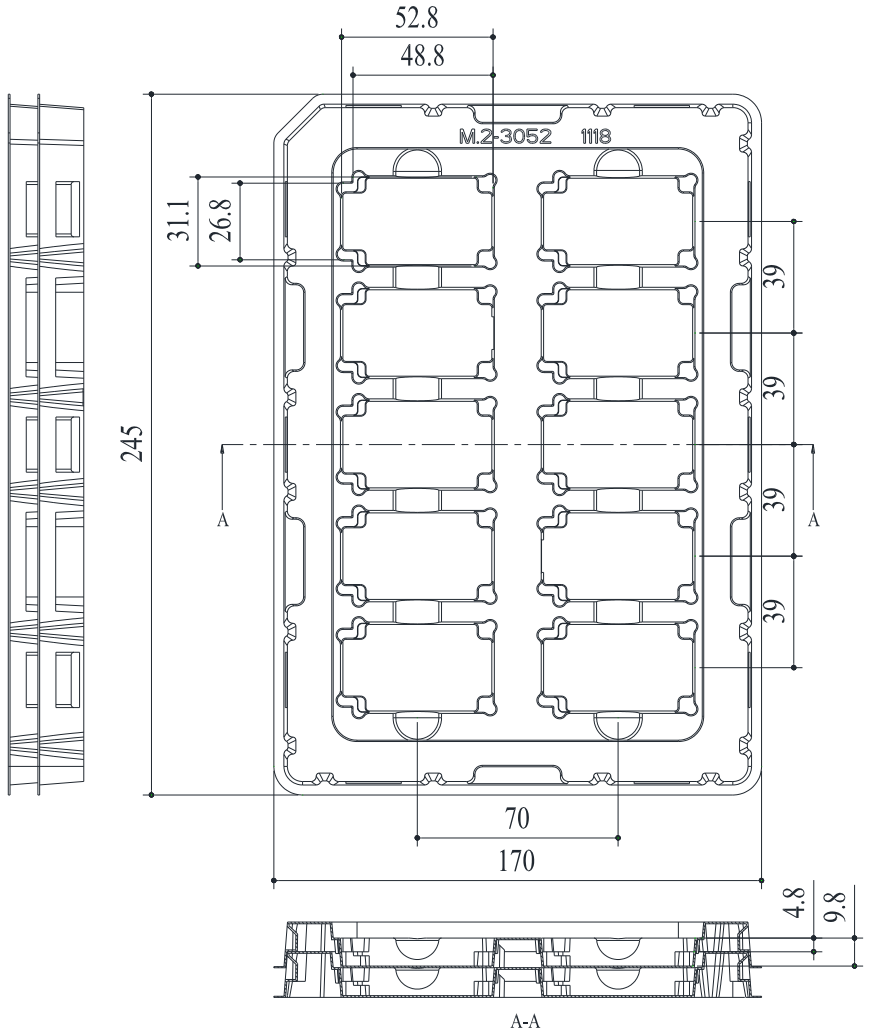
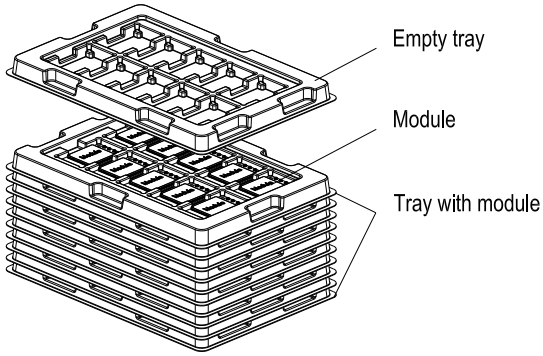
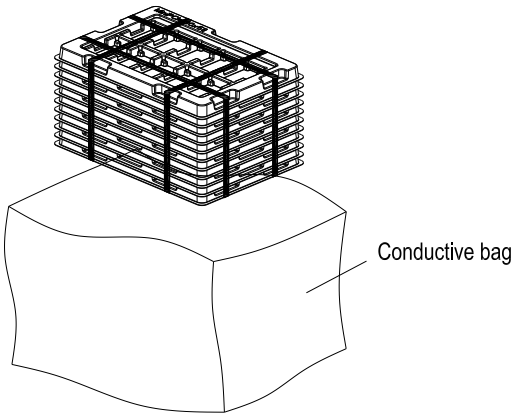


Figure 25: Blister Tray Dimension Drawing

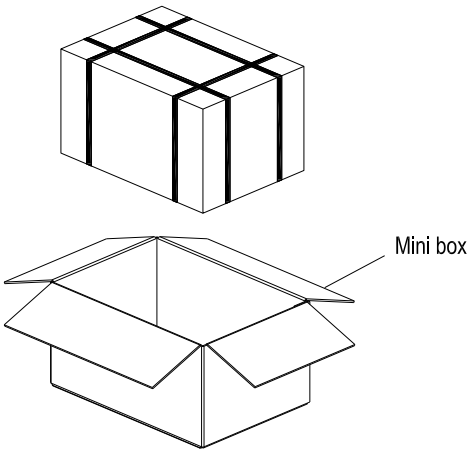
7.3.2. Packaging Process



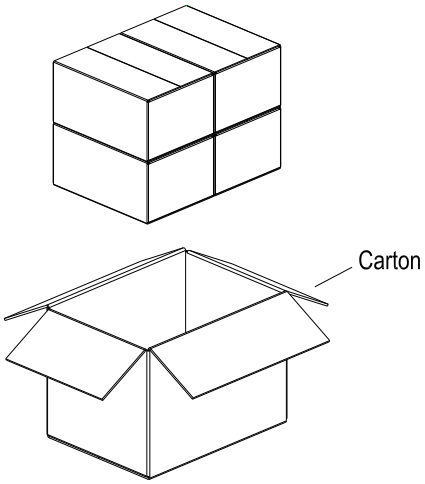
Each blister tray packs 10 modules. Stack 10 blister trays with modules together, and put 1 empty blister tray on the top.



Packing 11 blister trays together and then put blister trays into conductive bag, seal and pack the conductive bag.



Put the seal-packed blister trays into the mini box. 1 mini box can pack 100 modules.



Put 4 packaged mini boxes into 1 carton box and then seal it. 1 carton box can pack 400 modules.

Figure 26: Packaging Process

8 Appendix References

Table 28: Related Documents

Document Name
[1] Quectel_RG255C-GL_Hardware_Design
[2] Quectel_Mini_PCIe_EVB_User_Guide
[3] Quectel_RG255C_Series&RM255C-GL_AT_Commands_Manual

Table 29: Terms and Abbreviations

Abbreviation	Description
AMR	Adaptive Multi-rate
BDS	BeiDou Navigation Satellite System
bps	Bits Per Second
CMUX	Connection Multiplexing
CS	Coding Scheme
CTS	Clear to Send
DFOTA	Delta Firmware Upgrade Over-The-Air
DL	Downlink
DTR	Data Terminal Ready
DUN	Dail-up Networking
ECM	Ethernet Networking Control Model
EFR	Enhanced Full Rate
EMI	Electro Magnetic Interference

ESD	Electrostatic Discharge
ESR	Equivalent Series Resistance
FDD	Frequency Division Duplexing
FR	Full Rate
FTP	File Transfer Protocol
FTPS	FTP over SSL
GLONASS	Russian Global Navigation Satellite System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HR	Half Rate
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
IMS	IP Multimedia Subsystem
kbps	Kilo Bits Per Second
LED	Light Emitting Diode
LTE	Long-Term Evolution
MBIM	Mobile Broadband Interface Model
Mbps	Million Bits Per Second
MCU	Micro Control Unit
ME	Mobile Equipment
MIMO	Multiple-Input Multiple-Output
MO	Mobile Originated
MQTT	Message Queuing Telemetry Transport
MT	Mobile Terminated
NAS	Non-access Stratum

NDIS	Network Driver Interface Specification
NMEA	National Marine Electronics Association
NTP	Network Time Protocol
PA	Power amplifier
PCM	Pulse Code Modulation
PDA	Personal Digital Assistant
PDU	Protocol Data Unit
PING	Packet Internet Groper
POS	Point of Sale
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RmNet	Remote Network
RNDIS	Remote Network Driver Interface Specification
RoHS	Restriction of Hazardous Substances
RTS	Ready To Send
Rx	Receive
SAW	Surface Acoustic Wave
SIMO	Single Input Multiple Output
SMS	Short Message Service
SMTP	Simple Mail Transfer Protocol
SMTPS	Simple Mail Transfer Protocol Secure
SSL	Secure Sockets Layer
TCP	Transmission Control Protocol
TDD	Time Division Duplexing

TX	Transmitting Direction
TVS	Transient Voltage Suppressor
UART	Universal Asynchronous Receiver & Transmitter
UDP	User Datagram Protocol
UL	Uplink
URC	Unsolicited Result Code
USB	Universal Serial Bus
(U)SIM	(Universal) Subscriber Identification Module
WLAN	Wireless Local Area Network