EM061K-GL
Hardware Design

LTE-A 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 explosive or potentially explosive atmospheres, obey all posted signs and turn off wireless devices such as mobile phone or other cellular 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
-	2023-02-24	Fung ZHU/ Eysen WANG	Creation of the document
1.0.0	2023-02-24	Fung ZHU/ Eysen WANG	Preliminary

Contents

Table Index

Figure Index

1 Introduction

The hardware design defines the air and hardware interfaces of EM061K-GL which connect to your applications.

This document can help you quickly understand the interface specifications, electrical and mechanical details as well as other related information of EM061K-GL. Besides, reference designs will be offered to exemplify diverse applications of the modules. With this hardware design coupled with application notes and user guides, you can use the modules to design and set up mobile applications easily.

CE Statement

Regulatory Conformance

Hereby, [Quectel Wireless Solutions Co., Ltd.] declares that the radio equipment type [EM061K-GL] is in compliance with Directive 2014/53/EU.

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

The device could be used with a separation distance of 20cm to the human body.

UK Statement

Regulations 2017 (SI 2017/1206)

Declaration of Conformity

Hereby, [Quectel Wireless Solutions Co., Ltd.] declares that [EM061K-GL] is in compliance with the essential requirements and other relevant provisions of the UK Radio Equipment Regulations 2017 (SI 2017/1206).

Product Marketing Name：QUECTEL EM061K-GL

FCC Certification Requirements

According to the definition of mobile and fixed device is described in Part 2.1091(b), this device is a mobile device.

And the following conditions must be met:

1. This Modular Approval is limited to OEM installation for mobile and fixed applications only. The antenna installation and operating configurations of this transmitter, including any applicable source-based timeaveraging duty factor, antenna gain and cable loss must satisfy MPE categorical Exclusion

Requirements of 2.1091.

2. The EUT is a mobile device; maintain at least a 20 cm separation between the EUT and the user's body and must not transmit simultaneously with any other antenna or transmitter.

3. A label with the following statements must be attached to the host end product: This device contains FCC ID: XMR2023EM061KGL

4. To comply with FCC regulations limiting both maximum RF output power and human exposure to RF radiation, maximum antenna gain (including cable loss) must not exceed:

radiation, maximum antenna gain (including cable loss) must not exceed: Operating Band	FCC Max Antenna Gain （dBi)	IC Max Antenna Gain （dBi)
WCDMA B2	8.00	6.22
WCDMA B4	5.00	5.00
WCDMA B5	9.43	6.13
LTE B2	8.50	8.50
LTE B4	5.50	5.50
LTE B5	9.91	6.62
LTE B7	9.00	9.00
LTE B12	9.20	6.14
LTE B13	9.66	6.46
LTE B14	9.73	6.50
LTE B17	9.24	6.16
LTE B25	8.50	8.50
LTE B26(814-824)	9.86	NA
LTE B26(824-849)	9.91	6.62
LTE B30	0.98	0.98
LTE B38	9.00	9.00
LTE B41	9.00	9.00
LTE B66	5.50	5.50
LTE B71	8.98	5.99

5. This module must not transmit simultaneously with any other antenna or transmitter

6. The host end product must include a user manual that clearly defines operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.

For portable devices, in addition to the conditions 3 through 6 described above, a separate approval is required to satisfy the SAR requirements of FCC Part 2.1093

If the device is used for other equipment that separate approval is required for all other operating configurations, including portable configurations with respect to 2.1093 and different antenna configurations.

For this device, OEM integrators must be provided with labeling instructions of finished products.

Please refer to KDB784748 D01 v07, section 8. Page 6/7 last two paragraphs:

A certified modular has the option to use a permanently affixed label, or an electronic label. For a permanently affixed label, the module must be labeled with an FCC ID - Section 2.926 (see 2.2 Certification (labeling requirements) above). The OEM manual must provide clear instructions explaining

to the OEM the labeling requirements, options and OEM user manual instructions that are required (see next paragraph).

For a host using a certified modular with a standard fixed label, if (1) the module's FCC ID is not visible when installed in the host, or (2) if the host is marketed so that end users do not have straightforward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module: "Contains Transmitter Module FCC ID: XMR2023EM061KGL" or "Contains FCC ID: XMR2023EM061KGL" must be used. The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.

The final host / module combination may also need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.

The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. In cases where the manual is provided only in a form other than paper, such as on a computer disk or over the Internet, the information required by this section may be included in the manual in that alternative form, provided the user can reasonably be expected to have the capability to access information in that form.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

To ensure compliance with all non-transmitter functions the host manufacturer is responsible for ensuring compliance with the module(s) installed and fully operational. For example, if a host was previously authorized as an unintentional radiator under the Supplier's Declaration of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that the after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements.

Manual Information To the End User

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

IC Statement

IRSS-GEN

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

The transmitter module may not be co-located with any other transmitter or antenna.

or "Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

1) l'appareil ne doit pas produire de brouillage; 2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement."

Déclaration sur l'exposition aux rayonnements RF

L'autre utilisé pour l'émetteur doit être installé pour fournir une distance de séparation d'au moins 20 cm

de toutes les personnes et ne doit pas être colocalisé ou fonctionner conjointement avec une autre antenne ou un autre émetteur.

The host product shall be properly labeled to identify the modules within the host product.

The Innovation, Science and Economic Development Canada certification label of a module shall be clearly visible at all times when installed in the host product; otherwise, the host product must be labeled to display the Innovation, Science and Economic Development Canada certification number for the module, preceded by the word "Contains" or similar wording expressing the same meaning, as follows: "Contains IC: 10224A-23EM061KGL" or "where: 10224A-23EM061KGL is the module's certification number".

Le produit hôte doit être correctement étiqueté pour identifier les modules dans le produit hôte.

L'étiquette de certification d'Innovation, Sciences et Développement économique Canada d'un module doit être clairement visible en tout temps lorsqu'il est installédans le produit hôte; sinon, le produit hôte doit porter une étiquette indiquant le numéro de certification d'Innovation, Sciences et Développement économique Canada pour le module, précédé du mot «Contient» ou d'un libellé semblable exprimant la même signification, comme suit:

"Contient IC: 10224A-23EM061KGL " ou "où: 10224A-23EM061KGL est le numéro de certification du module".

1.1. Reference Standards

The module complies with the following standards:

- *PCI Express M.2 Specification Revision 4.0, Version 1.1*
- *Universal Serial Bus Specification, Revision 4.0*
- *ISO/IEC 7816-3*
- *MIPI Alliance Specification for RF Front-End Control Interface Version 2.0*
- *3GPP TS 27.007* and *3GPP 27.005*
- *3GPP TS 34.121-1* and *3GPP TS 36.521-1*

1.2. Special Marks

Table 1: Special Marks

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

	after a model indicates that the sample of the model is currently unavailable.
[…]	Brackets ([…]) used after a pin enclosing a range of numbers indicate all pins of the same type. For example, SDIO_DATA [0:3] refers to all four SDIO pins: SDIO_DATA0, SDIO_DATA1, SDIO_DATA2, and SDIO_DATA3.

2 Product Overview

2.1. Frequency Bands and Functions

EM061K-GL are LTE-A/UMTS/HSPA+ wireless communication modules with diversity receiver. They provide data connectivity on LTE-FDD, LTE-TDD, DC-HSDPA, HSPA+, HSDPA, HSUPA and WCDMA networks. They are standard WWAN M.2 Key-B modules. For more details, see *PCI Express M.2 Specification Revision 4.0, Version 1.1*.

They support embedded operating systems such as Windows, Linux and Android, and also provide GNSS and voice functionality [1] to meet specific application demands.

The following table shows the frequency bands and GNSS functions of the module. For details about CA combinations, you can see *document [1]*.

Table 2: Frequency Bands and GNSS Functions of EM061K-GL

Mode	Frequency Band
LTE-FDD (with Rx-diversity)	B1/B2/B3/B4/B5/B7/B8/B12/B13/B14/B17 [2]/B18/B19/B20/B25/B26 /B28/B29 [3]/B30/B32 [3]/B66/B71
LTE-TDD (with Rx-diversity)	B34/B38/B39/B40/B41
WCDMA (with Rx-diversity)	B1/B2/B3/B4/B5/B6/B8/B19
GNSS	GPS/GLONASS/BDS/Galileo

The module can be applied to a wide range of applications such as industrial routers, home gateways, set-top boxes, industrial laptops, consumer laptops, industrial PDAs, rugged tablet PCs and digital signage, etc.

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1 The module contains **Data＋Voice*** and **Data-only** version. **Data＋Voice*** version supports voice and data functions, while **Data-only** version only supports data function.
2 B17 is supported through MFBI + B12.
3 LTE-FDD B29/B32 and support Rx only and are only for secondary component carrier.

2.2. Key Features

Table 3: Key Features

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* and ETSI and IMT-2000 • Supports (U)SIM card: 1.8/3.0 V • Supports Dual SIM Single Standby
eSIM	Optional eSIM function
USB Interface	• Compliant with USB 2.0 specifications, with maximum transmission rates up to 480 Mbps. • Used for AT command communication, data transmission, firmware upgrade (USB 2.0 only), software debugging, GNSS NMEA sentence output, and voice over USB*. • Supports USB serial drivers: – Windows 7/8/8.1/10/11 – Linux 2.6–5.18 – Android 4.x–12.x
PCM Interface*	• Used for audio function through external codecs • Supports 16-bit linear data format • Supports long and short frame synchronization • Supports master and slave modes, but must be the master in long frame synchronization
Rx-diversity	LTE/WCDMA
Antenna Interfaces	• Main antenna connector and RX-diversity/GNSS antenna connector • 50 Ω impedance
Transmitting Power	• WCDMA: Class 3 (23 dBm ±2 dB) • LTE B7/B38/B40/B41: Class 3 (23 dBm ±1 dB) • LTE B30: Class 3 (22 dBm ±1 dB) • Other bands: Class 3 (23.5 dBm ±1 dB)
LTE Features	• Supports 3GPP Rel-12 LTE-FDD and LTE-TDD • Supports CA category: up to UL CA Cat 6/DL CA Cat 6 • Supports modulations: – UL: QPSK and 16QAM modulations – DL: QPSK, 16QAM and 64QAM modulations • Supports 1.4/3/5/10/15/20 MHz RF bandwidths

	● Max. transmission data rates:
	   – LTE-FDD: 300 Mbps (DL)/50 Mbps (UL)
	   – LTE-TDD: 226 Mbps (DL)/28 Mbps (UL)

UMTS Features	● Supports 3GPP Rel-9 DC-HSDPA, HSPA+, HSDPA, HSUPA and WCDMA ● Supports DL BPSK, QPSK, 16QAM and 64QAM modulations ● Supports UL BPSK, QPSK ● DC-HSDPA: Max. 42 Mbps (DL) ● HSUPA: Max. 5.76 Mbps (UL) ● WCDMA: Max. 384 kbps (DL)/384 kbps (UL)
GNSS Features	● Supports GPS, GLONASS, BDS and Galileo ● Data update rate: 1 Hz by default
AT Commands	● Compliant with *3GPP TS 27.007* and *3GPP TS 27.005* ● Quectel enhanced AT commands
Internet Protocol Features	● QMI/MBIM/NITZ/HTTP/HTTPS/FTP/LwM2M*/PING* ● Supports PAP and CHAP for PPP connections
Firmware Upgrade	Via USB 2.0 or DFOTA
SMS	● Point-to-point MO and MT ● Text and PDU modes ● SMS cell broadcast ● SMS storage: ME by default ● Windows OS SMS push feature
Physical Characteristics	● M.2 Key-B ● Size: 30.0 mm × 42.0 mm × 2.3 mm ● Weight: approx. 6.2 g
Temperature Range	● Operating temperature range: -25 to +75 °C [4] ● Extended temperature range: -40 to +85 °C [5] ● Storage temperature range: -40 to +90 °C
RoHS	● All hardware components are fully compliant with EU RoHS directive

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[4] 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 the temperature range of -10 °C to +55 °C，the mentioned RF performance margins higher than 3GPP specifications can be guaranteed. When temperature goes beyond temperature range of -10 °C to 55 °C, a few RF performances of module may be slightly off 3GPP specifications.

[5] 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 Pout, 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. Functional Diagram

The following figure shows a functional diagram of EM061K-GL.

- Power management
- Baseband
- LPDDR2 SDRAM+NAND flash
- Radio frequency
- M.2 Key-B interface

Figure 1: Functional Diagram

2.4. Pin Assignment

The following figure shows the pin assignment of the module. It is recommended to keep RESERVED pins unconnected. Please contact Quectel for more details if required.

No.	Pin Name
74	VCC
72	VCC
70	VCC
68	NC
66	USIM1_DET
64	RESERVED
62	RESERVED
60	WLAN_PA_EN
58	RFFE_DATA
56	RFFE_CLK
54	RESERVED
52	RESERVED
50	RESERVED
48	USIM2_VDD
46	USIM2_RST
44	USIM2_CLK
42	USIM2_DATA
40	USIM2_DET
38	NC
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
ANTCTL3	65
ANTCTL2	63
ANTCTL1	61
ANTCTL0	59
GND	57
RESERVED	55
RESERVED	53
GND	51
RESERVED	49
RESERVED	47
GND	45
RESERVED	43
RESERVED	41
GND	39
RESERVED	37
RESERVED	35
GND	33
RESERVED	31
RESERVED	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

PIN74 PIN75

BOT TOP

PIN10 PIN11

PIN2 PIN1

Figure 2: Pin Assignment

2.5. 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

DC characteristics include power domain and rate current, etc.

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 for the module	Vmin = 3.135 V Vnom = 3.7 V Vmax = 4.4 V	
3	GND		Ground		
4	VCC	PI	Power supply for the module	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 differential data (+)		Test point must be reserved.
8	W_DISABLE1#	DI, PU	Airplane mode control Active low	$V_{IH}min = 1.8\ V$ $V_{IL}max = 0.4\ V$ $V_{IL}min = -0.4\ V$	
9	USB_DM	AIO	USB differential data (-)		Test point must be reserved.
10	WWAN_LED#	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*	DIO, PD	PCM clock	$V_{IH}min = 1.8\ V$ $V_{IL}max = 0.4\ V$ $V_{OH}min = 1.8\ V$ $V_{OL}max = 0.4\ V$	
21	CONFIG_0	DO	Connected to GND internally		
22	PCM_DIN*	DI, PD	PCM data input	$V_{IH}min = 3.3\ V$ $V_{IL}max = 0.4\ V$	
23	WAKE_ON_ WAN#*	OD	Wake up the host Active low	**High-Voltage:** Vmin = 3.5 V Vnom = 3.3 V Vmax = 3.0 V	Externally pull up to 1.8 V or 3.3 V.

				Low-Voltage: Vmin = 1.95 V Vnom = 1.8 V Vmax = 1.65 V	
24	PCM_DOUT*	DO, PD	PCM data output	V_{OH}min = 1.8 V V_{OL}max = 0.4 V	
25	DPR	DI, PU	Dynamic power reduction Active low	V_{IH}min = 1.8 V V_{IL}max = 0.4 V	High level by default.
26	W_DISABLE2#*	DI, PU	GNSS control Active low	V_{IH}min = 1.8 V V_{IL}max = 0.4 V V_{IL}min = -0.4 V	
27	GND		Ground		
28	PCM_SYNC*	DIO, PD	PCM data frame sync	V_{IH}min = 1.8 V V_{IL}max = 0.4 V V_{OH}min = 1.8 V V_{OL}max = 0.4 V	
29	RESERVED				
30	USIM1_RST	DO, PD	(U)SIM1 card reset	USIM1_VDD	
31	RESERVED				
32	USIM1_CLK	DO, PD	(U)SIM1 card clock	USIM1_VDD	
33	GND		Ground		
34	USIM1_DATA	DIO, PD	(U)SIM1 card data	USIM1_VDD	
35	RESERVED				
36	USIM1_VDD	PO	(U)SIM1 card power supply	High-Voltage: Vmin = 3.05 V Vnom = 2.85 V Vmax = 2.7 V Low-Voltage: Vmin = 1.95 V Vnom = 1.8 V Vmax = 1.65 V	
37	RESERVED				
38	NC		Not connected		
39	GND		Ground		

40	USIM2_DET [6]	DI, PD	(U)SIM2 card hot-swap detect	$V_{IH}min = 1.8$ V $V_{IL}max = 0.4$ V	Internally pulled up to 1.8 V.
41	RESERVED	AO			
42	USIM2_DATA	DIO, PD	(U)SIM2 card data	USIM2_VDD	
43	RESERVED				
44	USIM2_CLK	DO, PD	(U)SIM2 card clock	USIM2_VDD	
45	GND		Ground		
46	USIM2_RST	DO, PD	(U)SIM2 card reset	USIM2_VDD	
47	RESERVED				
48	USIM2_VDD	PO	(U)SIM2 card power supply	**High-Voltage:** Vmin = 3.05 V Vnom = 2.85 V Vmax = 2.7 V **Low-Voltage:** Vmin = 1.95 V Vnom = 1.8 V Vmax = 1.65 V	
49	RESERVED				
50	RESERVED				
51	GND		Ground		
52	RESERVED				
53	RESERVED				
54	RESERVED				
55	RESERVED				
56	RFFE_CLK* [7]	DO, PD	Used for external MIPI IC control	$V_{OH}min = 1.8$ V $V_{OL}max = 0.4$ V	
57	GND		Ground		
58	RFFE_DATA* [7]	DIO, PD	Used for external MIPI IC control	$V_{IH}min = 1.8$ V $V_{IL}max = 0.4$ V	

6 This pin is pulled low by default, and will be internally pulled up to 1.8 V by software configuration only when (U)SIM hot-swap is enabled by **AT+QSIMDET.** For more details, see *document [3]*.
7 If RFFE_CLK and RFFE_DATA are required, please contact Quectel for more details.

				$V_{OH}min = 1.8\ V$ $V_{OL}max = 0.4\ V$	
59	ANTCTL0*	DO, PD	Antenna GPIO control	$V_{OH}min = 1.8\ V$ $V_{OL}max = 0.4\ V$	
60	WLAN_PA_EN*	DI, PD	Self-protection of QLN control	$V_{IH}min = 1.8\ V$ $V_{IL}max = 0.4\ V$	
61	ANTCTL1*	DO, PD	Antenna GPIO control	$V_{OH}min = 1.8\ V$ $V_{OL}max = 0.4\ V$	
62	RESERVED				
63	ANTCTL2*	DO, PD	Antenna GPIO control	$V_{OH}min = 1.8\ V$ $V_{OL}max = 0.4\ V$	
64	RESERVED				
65	ANTCTL3*	DO, PD	Antenna GPIO control	$V_{OH}min = 1.8\ V$ $V_{OL}max = 0.4\ V$	
66	USIM1_DET [6]	DI, PD	(U)SIM1 card hot-swap detect	$V_{IH}min = 1.8\ V$ $V_{IL}max = 0.4\ V$	Internally pulled up to 1.8 V.
67	RESET#	DI, PU	Reset the module Active low	$V_{IH}max = 2.1\ V$ $V_{IH}min = 1.3\ V$ $V_{IL}max = 0.5\ V$	Internally pulled up to 1.8 V with a 10 kΩ resistor.
68	NC		Not connected		
69	CONFIG_1	DO	Connected to GND internally		
70	VCC	PI	Power supply for the module	Vmin = 3.135 V Vnom = 3.7 V Vmax = 4.4 V	
71	GND		Ground		
72	VCC	PI	Power supply for the module	Vmin = 3.135 V Vnom = 3.7 V Vmax = 4.4 V	
73	GND		Ground		
74	VCC	PI	Power supply for the module	Vmin = 3.135 V Vnom = 3.7 V Vmax = 4.4 V	
75	CONFIG_2	DO	Not connected internally		

NOTE

Keep all NC and unused pins unconnected.

2.6. EVB Kit

To help you develop applications conveniently with EM061K-GL, Quectel supplies an evaluation board (5G-M2 EVB). For more details, see *document [2]*.

3 Operating Characteristics

3.1. Operating Modes

The table below summarizes different operating modes of the module.

Table 6: Overview of Operating Modes

Mode	Details	
Full Functionality Mode	Idle	Software is active. The module has registered on the network, and it is ready to send and receive data.
	Voice*/Data	Network is connected. In this mode, the power consumption is decided by network setting and data transfer rate.
Minimum Functionality Mode	**AT+CFUN=0** 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** or driving W_DISABLE1# pin low will set the module to airplane mode. In this mode, the RF function is invalid.	
Sleep Mode	The module keeps receiving paging messages, SMS, voice call* and TCP/UDP data from the network with its power consumption reduced to the minimal level.	
Power Down Mode	In this mode, the power management unit shuts down the power supply. Software is inactive, while all interfaces are inaccessible and the operating voltage (connected to VCC) remains applied.	

NOTE

For more details about the AT command, see *document [3]*.

3.2. Sleep Mode

In sleep mode, DRX (Discontinuous Reception) of the module is able to reduce the power consumption to a minimum level, and DRX cycle index values are broadcasted by the wireless network. The figure below shows the relationship between the DRX run time and the power consumption in sleep mode. The longer the DRX cycle is, the lower the power consumption will be.
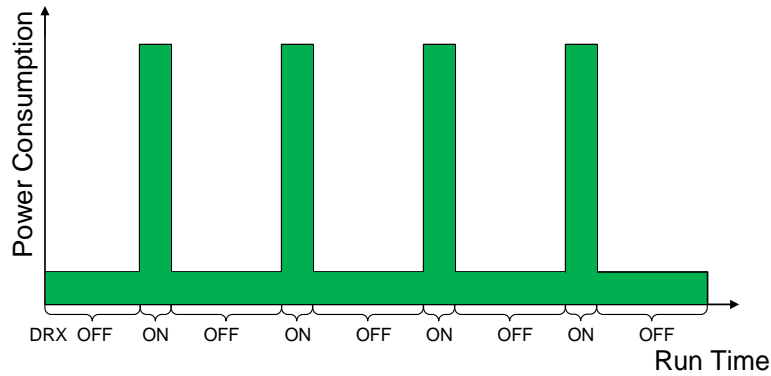
Figure 3: DRX Run Time and Power Consumption in Sleep Mode

The following part of this chapter describes the power saving procedure and sleep mode entrance of the module.

If the host supports USB suspend/resume and remote wakeup function, the following two conditions must be met simultaneously to bring the module into sleep mode.

● Execute **AT+QSCLK=1**.
● The host's USB bus, which is connected to the module's USB interface, enters suspend state.

The following figure shows the connection between the module and the host.
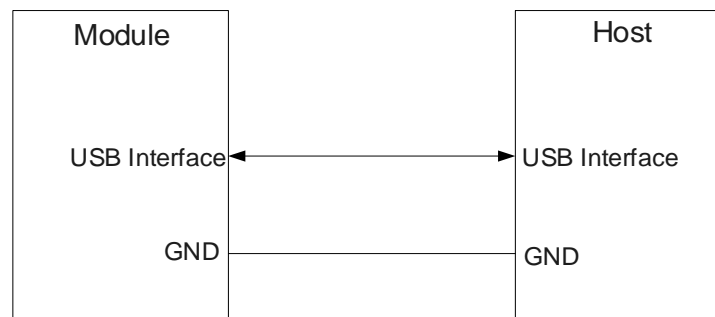
Figure 4: Sleep Mode Application with USB Remote Wakeup Function

The module will wake up when the host sends data to the module through USB interface.

3.3. Airplane Mode

Execution of **AT+CFUN=4** or driving W_DISABLE1# pin low will set the module to airplane mode. For more details, see *Chapter 4.4.1*.

3.4. Communication Interface with Host

The module supports communication with the host through USB interface. USB 2.0 should be reserved for firmware upgrade. See the USB mode features as below:

USB Mode:

● Supports all USB 2.0 features.
● Supports MBIM/QMI/QRTR/AT.

3.5. Power Supply

3.5.1. Power Supply Pins

Table 7: Definition of VCC and GND Pins

Pin No.	Pin Name	I/O	Description	Comment
2, 4, 70, 72, 74	VCC	PI	Power supply for the module	Vmin = 3.135 V Vnom = 3.7 V Vmax = 4.4 V
3, 5, 11, 27, 33, 39, 45, 51, 57, 71, 73	GND		Ground	

3.5.2. Reference Design for Power Supply

The performance of the module largely depends on the power supply design. The continuous current of the power supply should be 3 A at least and the peak current should be 4 A at least. In case of a slight difference between input and output voltages, use an LDO when supplying power to the module. In case of a large difference between input and desired output (typically 3.7 V) voltages, using a buck DC-DC converter is preferred.

The following figure shows a reference design for +5 V input power supply based on DC-DC converter.

The typical output of the power supply is about 3.7 V.
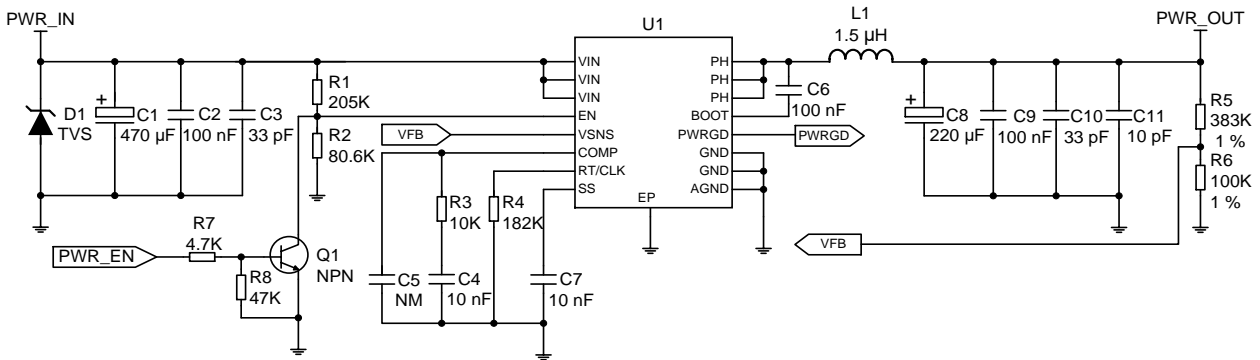
Figure 5: Reference Circuit for Power Supply

> **NOTE**
>
> To avoid corrupting the data in the internal flash, do not cut off the power supply before the module is completely turned off, and do not cut off power supply directly when the module is working.

3.5.3. Voltage Stability Requirements

The power supply of the module ranges from 3.135 V to 4.4 V. Please ensure that the input voltage never drops below 3.135 V, otherwise the module will be powered off automatically. The following figure shows the maximum voltage drop during burst transmission in 3G/4G networks.
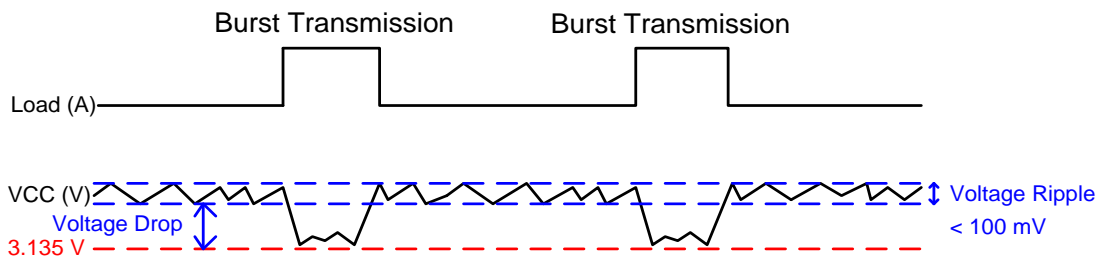
Figure 6: Power Supply Limits During Burst Transmission

To decrease the voltage drop, two bypass capacitors of about 220 µF with low ESR (ESR = 0.7 Ω) should be used. To avoid disturbing the power supply, two multi-layer ceramic chip capacitor (MLCC) arrays also should be used due to their ultra-low ESR. It is recommended to use eight ceramic capacitors (1 µF, 100 nF, 33 pF, 10 pF) to compose the MLCC arrays, and to place these capacitors close to VCC pins. The width of VCC trace should be not less than 2.5 mm. In principle, the longer the VCC trace is, the wider it should be.

In addition, to guarantee the stability of the power supply, please use a TVS component with a reverse TVS voltage of 5.1 V and a dissipation power higher than 0.5 W. The following figure shows a reference circuit of the VCC.
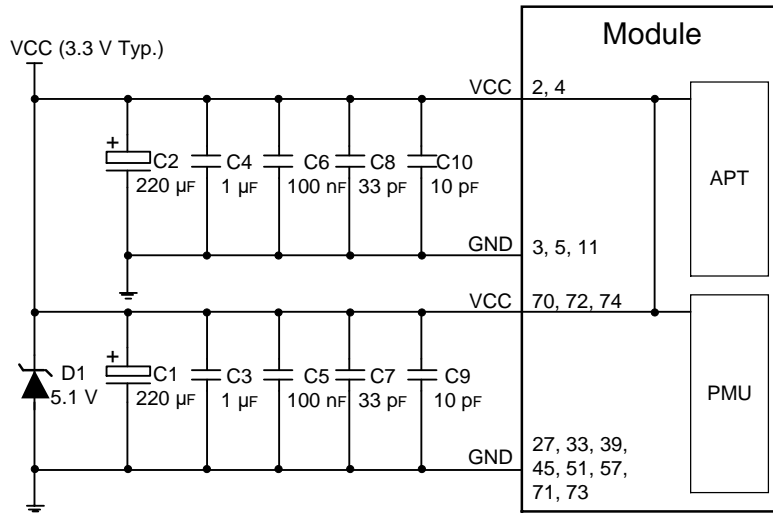
Figure 7: Reference Circuit for VCC Pins

3.5.4. Power Supply Voltage Monitoring

You can use **AT+CBC** to monitor the voltage value of VCC. For more details, see *document [3]*.

3.6. Turn On

FULL_CARD_POWER_OFF# serves to turn on/off the module. 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 been internally pulled down with a 100 kΩ resistor.

When FULL_CARD_POWER_OFF# is de-asserted (driven high, ≥ 1.19 V), the module will be turned on.

Table 8: Pin Definition of FULL_CARD_POWER_OFF#

Pin No.	Pin Name	I/O	Description	Comment
6	FULL_CARD_ POWER_OFF#	DI, PD	Turn on/off the module High level: turn on Low level: turn off	Internally pulled 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.
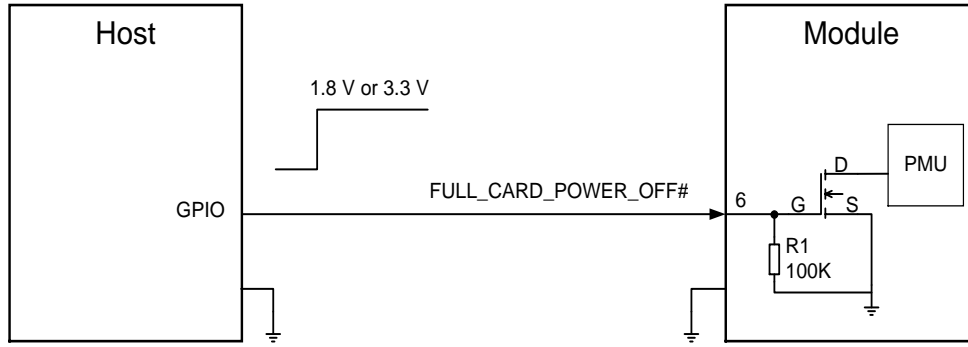
NOTE: The voltage of pin 6 should be not less than 1.19 V when it is at high level.

Figure 8: Turn on the Module Using Host GPIO

The turn-on timing is illustrated in the following figure.
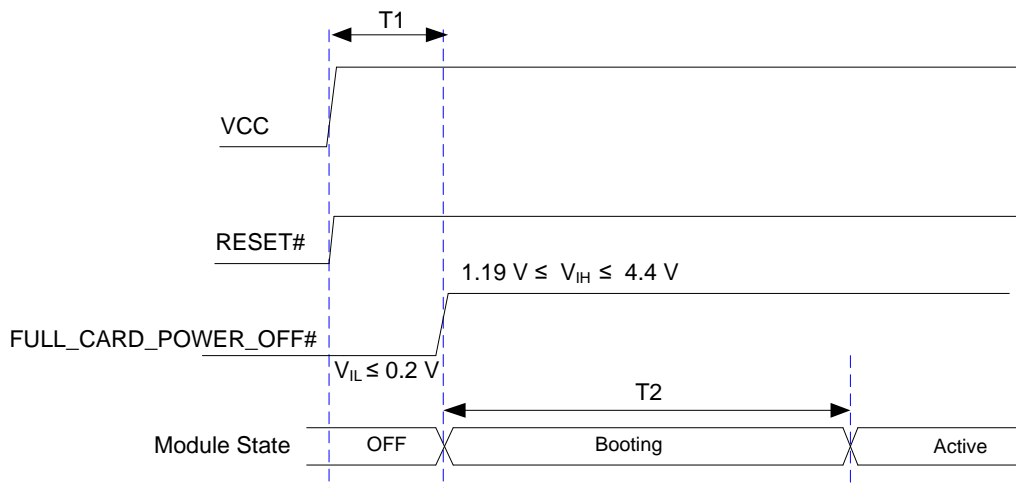
Figure 9: Turn-on Timing of the Module

Table 9: Turn-on Timing of the Module

Symbol	Min.	Typ.	Max.	Comment
T1	30 ms	-	-	The turn-on time of the module.
T2	-	TBD	-	The system booting time of the module.

3.7. Turn Off

If the module is turned off using a host GPIO, when VCC is supplied with power, pulling down FULL_CARD_POWER_OFF# pin (≤ 0.2 V) will turn off the module normally. The turn-off timing is illustrated in the following figure.

NOTE: As shown by the dotted line, it is suggested to disconnect VCC after the module shuts down.
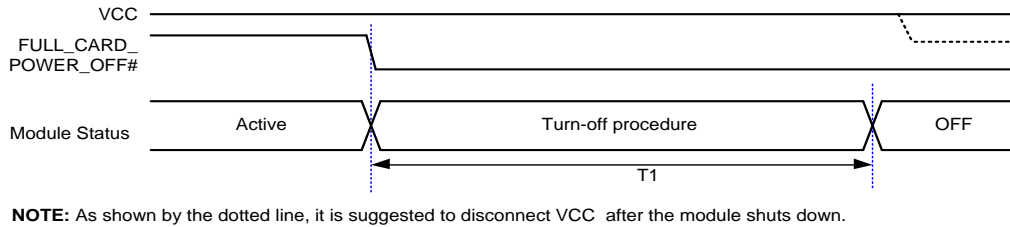
Figure 10: Turn-off Timing of the Module

Table 10: Turn-off Timing of the Module

Symbol	Min.	Typ.	Max.	Comment
T1	TBD	-	-	The turn-off time of the module

3.8. Reset

The RESET# pin serves to reset the module. Triggering the RESET# signal will lead to loss of all data from the modem and removal of system drivers. It will also lead to disconnection of the modem from the network.

Table 11: Pin Definition of RESET#

Pin No.	Pin Name	I/O	Description	Comment
67	RESET#	DI, PU	Reset the module Active LOW	Internally pulled up to 1.8 V with a 10 kΩ resistor.

The module can be reset by pulling down the RESET# pin for 250–600 ms. An open collector (OC)/drain driver or a button can be used to control the RESET# pin.
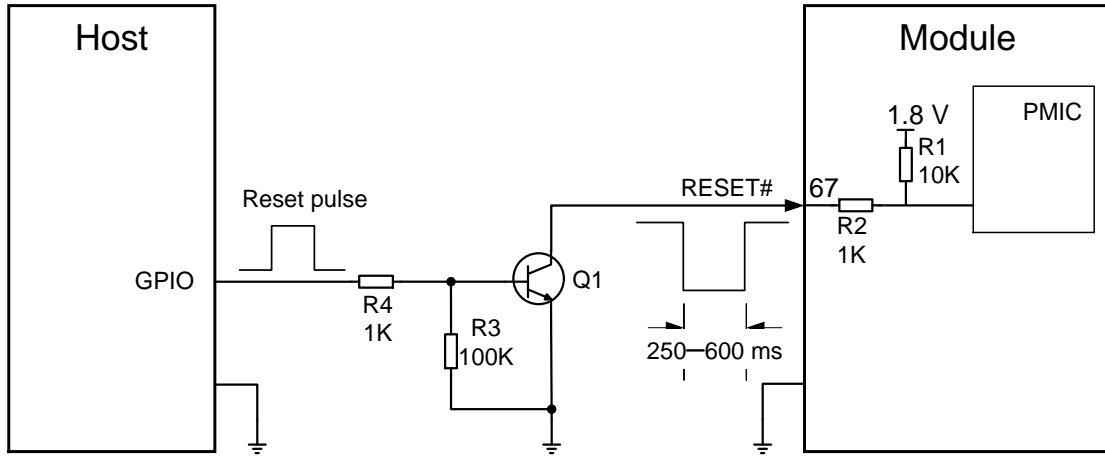
Figure 11: Reference Circuit for RESET# with Open Collector Driving Circuit

The reset timing is illustrated in the following figure.
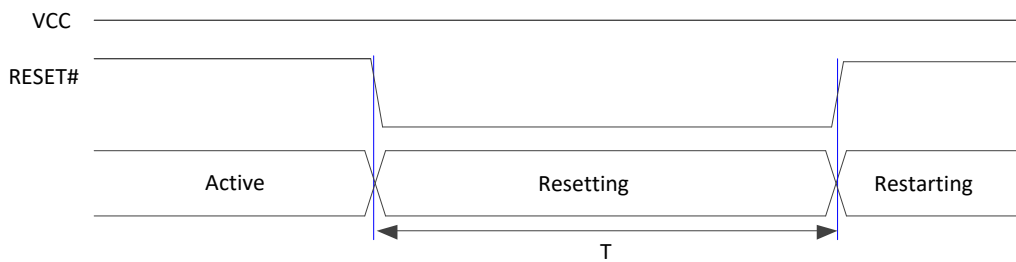
Figure 12: Reset Timing of the Module

Table 12: Reset Timing of the Module

Symbol	Min.	Typ.	Max.	Comment
T	250 ms	400 ms	500 ms	RESET# should be pulled down for 250–500 ms. Asserting time of less than 250 ms is unreliable and asserting time higher than 500 ms will cause repeated reset.

4 Application Interfaces

The physical connections and signal levels of the module comply with the 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
- PCM interface*
- Control and indication interfaces
- Antenna Tuner Control Interface*
- Configuration pins

4.1. (U)SIM Interfaces

The (U)SIM interface circuitry meets ETSI and IMT-2000 requirements and *ISO/IEC 7816-3*. Both Class B (3.0 V) and Class C (1.8 V) (U)SIM cards are supported, and dual SIM single standby function is supported.

4.1.1. Pin definition of (U)SIM

Table 13: Pin Definition of (U)SIM Interfaces

Pin No.	Pin Name	I/O	Description	Comments
36	USIM1_VDD	PO	(U)SIM1 card power supply	
34	USIM1_DATA	DIO, PD	(U)SIM1 card data	
32	USIM1_CLK	DO, PD	(U)SIM1 card clock	
30	USIM1_RST	DO, PD	(U)SIM1 card reset	
66	USIM1_DET	DI, PD	(U)SIM1 card hot-swap detect	Internally pulled up to 1.8 V.
40	USIM2_DET	DI, PD	(U)SIM2 card hot-swap detect	Internally pulled up to 1.8 V.
42	USIM2_DATA	DIO, PD	(U)SIM2 card data	

44	USIM2_CLK	DO, PD	(U)SIM2 card clock
46	USIM2_RST	DO, PD	(U)SIM2 card reset
48	USIM2_VDD	PO	(U)SIM2 card power supply

4.1.2.   (U)SIM Hot-Swap

The module supports (U)SIM card hot-swap via (U)SIM card hot-swap detect pins USIM1_DET and USIM2_DET. (U)SIM card insertion can be detected by high/low level. (U)SIM card hot-swap function is disabled by default.

The following command configures (U)SIM card hot-swap detection.

AT+QSIMDET Configure (U)SIM Card Hot-swap 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** If there is any error: **ERROR**
Maximum Response Time	300 ms
Characteristics	The command takes effect after the module is rebooted. 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

1. Hot-swap function is invalid if the configured value of **<insert_level>** is inconsistent with hardware design.
2. The underlined value represents the default configuration.
3. USIM1_DET and USIM2_DET are pulled low by default, and will be internally pulled up to 1.8 V by software configuration only when (U)SIM hot-swap is enabled by **AT+QSIMDET**. For more details, see *document [3]*.

4.1.3. Normally Closed (U)SIM Card Connector

With a normally closed (U)SIM card connector, USIM_DET pin is normally shorted to ground when there is no (U)SIM card inserted. (U)SIM card detection by high level is applicable to this type of connector. Once (U)SIM hot-swap is enabled by executing **AT+QSIMDET=1,1**, insertion of a (U)SIM card will drive USIM_DET from low to high level, and the removal of it will drive USIM_DET from high to low level.

● When the (U)SIM is absent, CD is shorted to ground and USIM_DET is at low level.
● When the (U)SIM is present, CD is open from ground and USIM_DET is at high level.

The following figure shows a reference design of (U)SIM interface with a normally closed (U)SIM card connector.
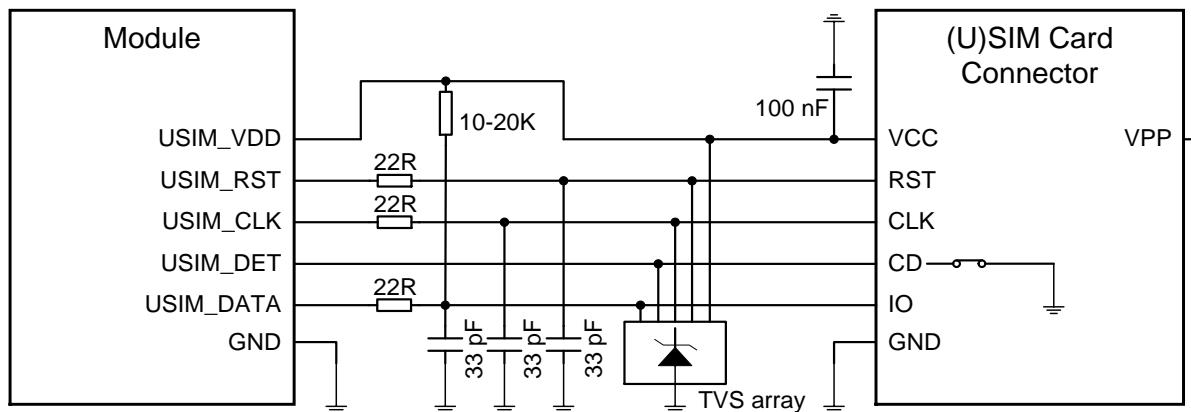
NOTE: All these resistors, capacitors and TVS array should be close to (U)SIM card connector in PCB layout.

Figure 13: 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, CD1 and CD2 of the connector are disconnected when there is no (U)SIM card inserted. (U)SIM card detection by low level is applicable to this type of connector. Once (U)SIM hot-swap is enabled by executing **AT+QSIMDET=1,0**, insertion of a (U)SIM card will drive

USIM_DET from high to low level, and the removal of it will drive USIM_DET from low to high level.

● When the (U)SIM is absent, CD1 is open from CD2 and USIM_DET is at high level.
● When the (U)SIM is inserted, CD1 is shorted to ground and USIM_DET is at low level.

The following figure shows a reference design of (U)SIM interface with a normally open (U)SIM card connector.
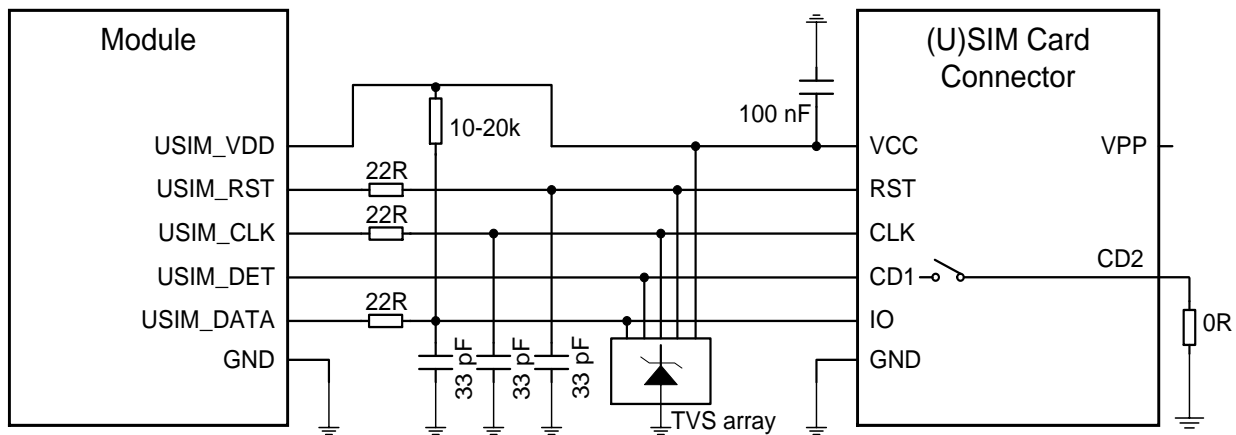
NOTE: All these resistors, capacitors and TVS array should be close to (U)SIM card connector in PCB layout.

Figure 14: Reference Circuit for Normally Open (U)SIM Card Connector

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

If the (U)SIM card detection function is not needed, please keep USIM_DET unconnected. A reference circuit for the (U)SIM card interface with a 6-pin (U)SIM card connector is illustrated by the following figure.
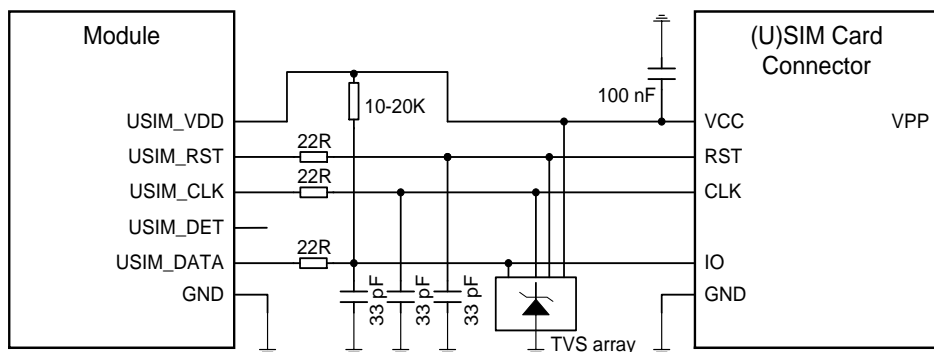
NOTE: All these resistors, capacitors and TVS array should be close to (U)SIM card connector in PCB layout.

Figure 15: Reference Circuit for 6-Pin (U)SIM Card Connector

4.1.6. (U)SIM2 Card Compatible Design

It should be noted that if the (U)SIM2 interface is used for an external (U)SIM card, the circuits are the same as those of (U)SIM1 interface. if the (U)SIM2 interface is used for an internal eSIM card, pins 40, 42, 44, 46 and 48 of the module must be kept open.

A recommended compatible design for the (U)SIM2 interface is shown below.
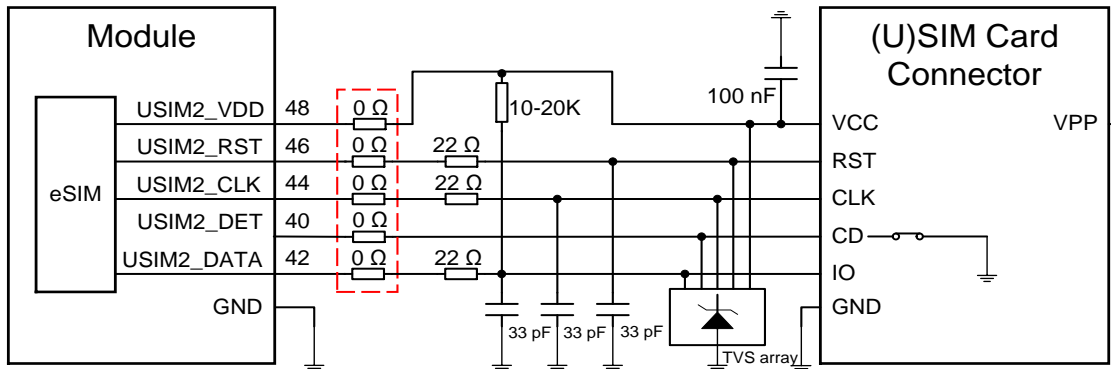
NOTE: The five 0 Ω resistors must be close to the module, and all other components should be close to (U)SIM card connector in PCB layout.

Figure 16: Recommended Compatible Design for (U)SIM2 Interface

4.1.7. (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.
- Ensure the ground between the module and the (U)SIM card connector is short and wide. Keep the trace width of ground and USIM_VDD not 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 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. The 33 pF capacitors are used to filter out RF interference. Additionally, keep the (U)SIM peripheral circuit close to the (U)SIM card connector.
- For USIM_DATA, a 10–20 kΩ pull-up resistor must be added near the (U)SIM card connector.
- The (U)SIM card connector should be placed near the M.2 socket, because a long trace may lead to waveform distortion, which affects the signal quality.

4.2. USB Interface

The module provides one integrated Universal Serial Bus (USB) interface which complies with USB 2.0 specifications and supports 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, firmware upgrade (USB 2.0 only), software debugging, GNSS NMEA sentence output, and voice over USB*.

Table 14: Pin Definition of USB Interface

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

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

The following figure presents a reference circuit for the USB interface.
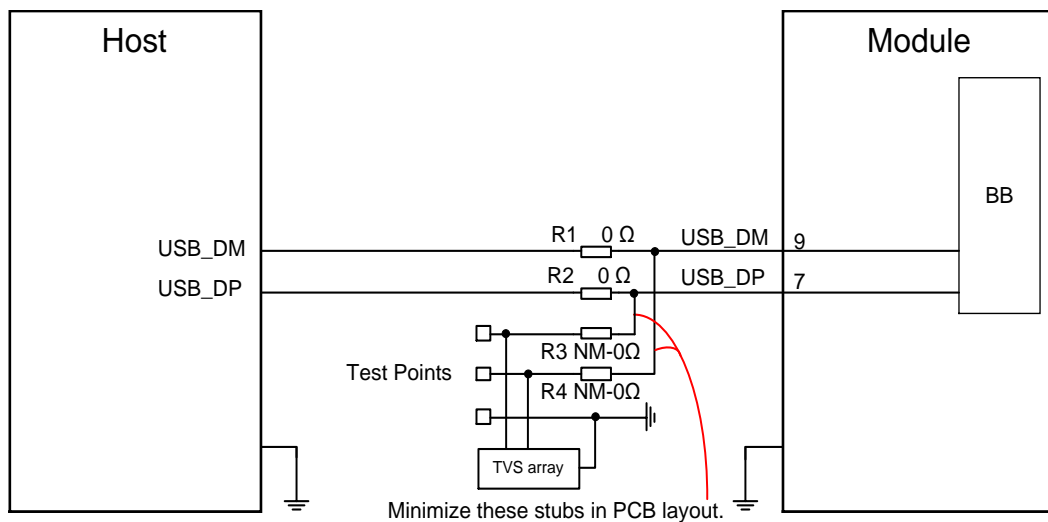
Figure 17: Reference Circuit for USB Interface

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.

Please follow the principles below when designing the USB interface to meet 2.0 specifications:

● Route the USB signal traces as differential pairs with ground surrounded. The impedance of differential trace of USB 2.0 is 90 Ω.

- For USB 2.0, the trace length should be less than 120 mm, and the differential data pair matching should be less than 2 mm.
- Do not route signal traces under crystals, oscillators, magnetic devices, PCIE, other high-speed 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 components might cause influences on USB data traces, so you should pay attention to the selection of the components. Typically, the stray capacitance should be less than 1.0 pF for USB 2.0.
- Keep the ESD protection components as close to the USB connector as possible.
- If possible, reserve 0 Ω resistor on USB_DP and USB_DM traces respectively.

4.3. PCM Interface*

The module supports audio communication through external codecs 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 only with a 256 kHz PCM_CLK and an 8 kHz, 50 % duty cycle PCM_SYNC.

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.
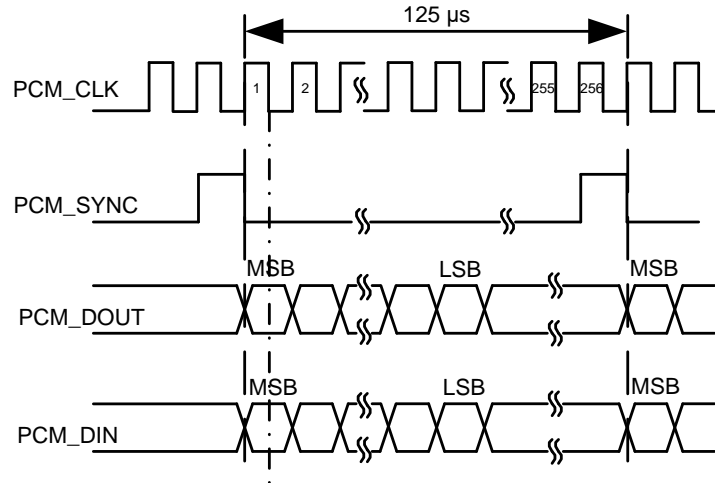
Figure 18: Primary Mode Timing
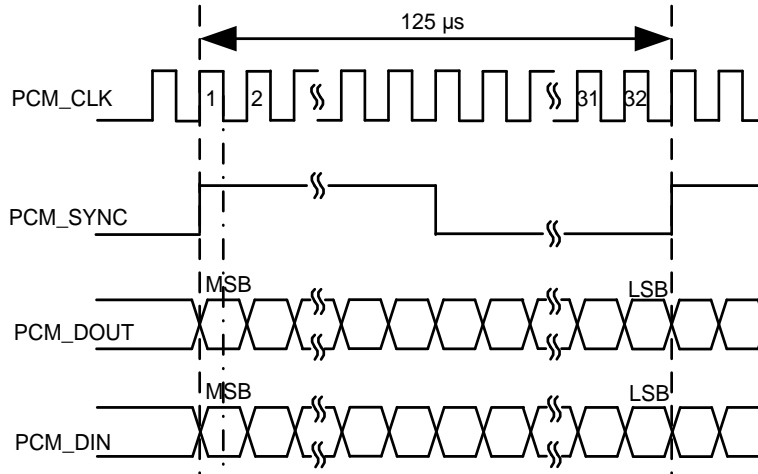
Figure 19: Auxiliary Mode Timing

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

Table 15: Pin Definition of PCM Interface

Pin No.	Pin Name	I/O	Description	Comment
20	PCM_CLK	DIO, PD	PCM clock	
22	PCM_DIN	DI, PD	PCM data input	
24	PCM_DOUT	DO, PD	PCM data output	
28	PCM_SYNC	DIO, PD	PCM data frame sync	

The clock and mode can be configured by AT command. The default configuration is master mode using short frame synchronization format with 2048 kHz PCM_CLK and 8 kHz PCM_SYNC. For more details, see *document [3]*.

4.4. Control and Indication Interfaces

Table 16: Pin Definition of Control and Indication Interfaces

Pin No.	Pin Name	I/O	Description	Comment
8	W_DISABLE1#	DI, PU	Airplane mode control Active low	
10	WWAN_LED#	OD	RF status indication LED Active low	
23	WAKE_ON_WAN#*	OD	Wake up the host Active low	
25	DPR	DI, PU	Dynamic power reduction Active low	High level by default.
26	W_DISABLE2#*	DI, PU	GNSS control Active low	
60	WLAN_PA_EN*	DI	Self-protection of QLN control	

4.4.1. 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 configure the module into 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 AT command and corresponding RF function status of the module.

Table 17: RF Function Status

Logic Level	AT Command	RF Function Status	Operating Mode
High Level	**AT+CFUN=1**	Enabled	Full functionality mode
	AT+CFUN=0	Disabled	Minimum functionality mode
	AT+CFUN=4		Airplane mode

| Low Level | AT+CFUN=0
AT+CFUN=1
AT+CFUN=4 | Disabled | Airplane mode |

4.4.2. 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 GNSS function can also be controlled through software AT commands. The combination of W_DISABLE2# pin and AT commands controls the GNSS function.

Table 18: GNSS Function Status

Logic Level	AT Command	GNSS Function Status
High Level	AT+QGPS=1	Enabled
	AT+QGPSEND	Disabled
Low Level	AT+QGPS=1	Disabled
	AT+QGPSEND	

For details about AT commands mentioned above, see *document [4]*.

A simple voltage-level translator 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. 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. A reference circuit of the two pins is shown below.
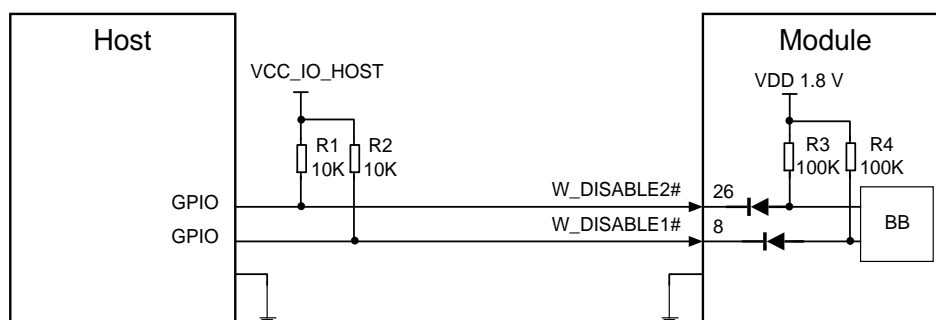
NOTE: The voltage level of VCC_IO_HOST could be 1.8 V or 3.3 V typically.

Figure 20: Reference Circuit of W_DISABLE1# and W_DISABLE2#

4.4.3. 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 power 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.
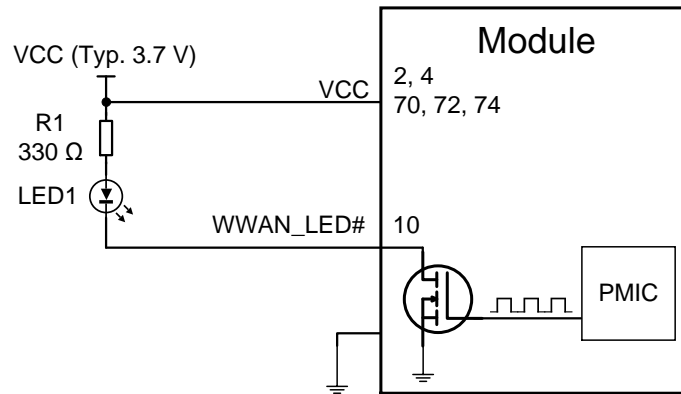
Figure 21: WWAN_LED# Reference Circuit

Table 19: Network Status Indications of WWAN_LED#

Logic 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** and **AT+CFUN=0** (RF function disabled).

4.4.4. 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 one-second low level pulse signal will be outputted to wake up the host.

Table 20: State of the WAKE_ON_WAN#

WAKE_ON_WAN# State	Module Operation Status
Outputs a one-second pulse signal at low level	Call/SMS/Data is incoming (to wake up the host)
Always at high level	Idle/Sleep
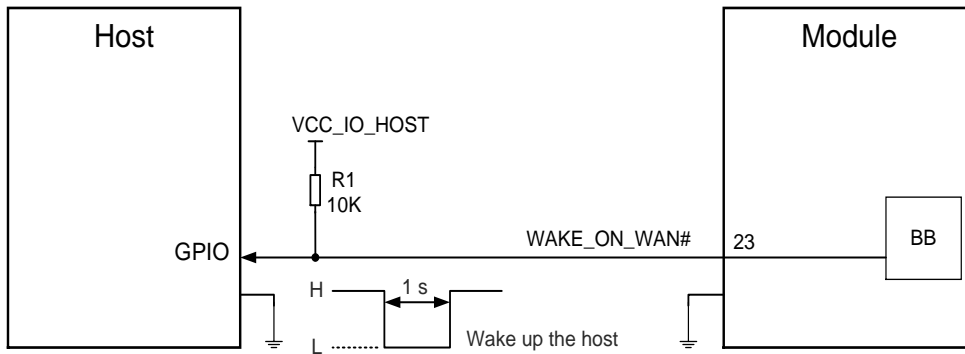
NOTE: The voltage level on VCC_IO_HOST depends on the host side due to the open drain in pin 23.

Figure 22: Reference Circuit of WAKE_ON_WAN#

4.4.5. DPR

The module provides a 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 burst transmission.

Table 21: Pin definition of DPR

Pin No.	Pin Name	I/O	Description	Comment
25	DPR	DI, PU	Dynamic power reduction Active low	High level by default.

Table 22: Function of the DPR Signal

Logic Level	Function
High/Floating	No backoff of max transmitting power occurred
Low	Backoff of max transmitting power occurred according to configuration in SAR efs file

4.4.6. WLAN_PA_EN

QLN enables self-protection circuit (integrated inside QLN) when WLAN_PA_EN is at high level.

- In LTE mode, WLAN_PA_EN is set to 0 (low level) by default.
- When WLAN_PA_EN is set to 1 (high level), the LNA will be in self-protection mode.

Table 23: Pin definition of WLAN_PA_EN

Pin No.	Pin Name	I/O	Description	Comment
60	WLAN_PA_EN	DI, PD	Self-protection of QLN control	

4.5. Antenna Tuner Control Interface*

ANTCTL [0:3] and RFFE interfaces are used for antenna tuner control and should be routed to an appropriate antenna control circuit.

4.5.1.1. Antenna Tuner Control Interface through GPIOs

Table 24: Pin Definition of Antenna Tuner Control Interface through GPIOs

Pin No.	Pin Name	I/O	Description	Comment
59	ANTCTL0	DO, PD		
61	ANTCTL1	DO, PD	Antenna tuner GPIO control	
63	ANTCTL2	DO, PD		
65	ANTCTL3	DO, PD		

4.5.1.2. Antenna Tuner Control Interface through RFFE

Table 25: Pin Definition of Antenna Tuner Control Interface through RFFE

Pin No.	Pin Name	I/O	Description	Comment
56	RFFE_CLK	DO, PD	Used for external MIPI IC control	
58	RFFE_DATA	DIO, PD	Used for external MIPI IC control	

> **NOTE**
>
> If RFFE_CLK and RFFE_DATA are required, please contact Quectel for more details.

4.6. Configuration Pins

Table 26: List of Configuration Pins

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	GND	GND	Quectel defined	-

Table 27: Pin Definition of Configuration Pins

Pin No.	Pin Name	I/O	Description
21	CONFIG_0	DO	Not connected internally
69	CONFIG_1	DO	Connected to GND internally
75	CONFIG_2	DO	Connected to GND internally
1	CONFIG_3	DO	Connected to GND internally

The following figure shows a reference circuit for these four pins.
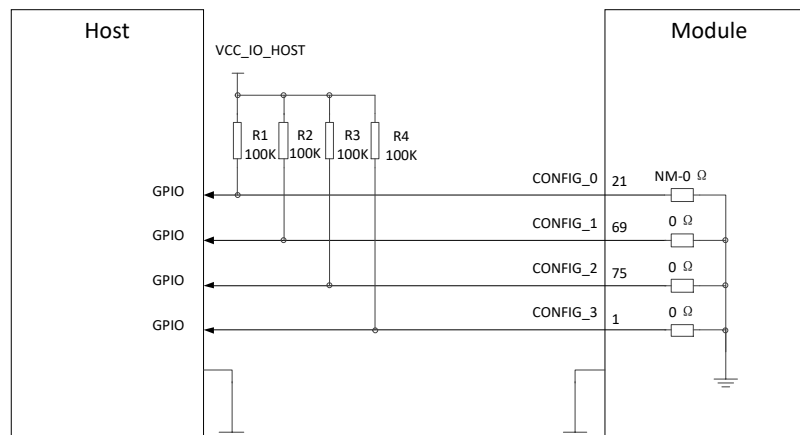
NOTE: The voltage level VCC_IO_HOST depends on the host side, and could be a 1.8 V or 3.3 V voltage level.

Figure 23: Recommended Circuit of Configuration Pins

5 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.

5.1. Cellular Network

5.1.1. Antenna Interfaces & Frequency Bands

The module provides a main antenna connector and a diversity/GNSS antenna connector, which are used to resist the fall of signals caused by high-speed movement and multipath effect. The impedance of antenna ports is 50 Ω.

Table 28: Antenna Connectors Definition

Antenna Connector	I/O	Description	Comment
ANT_MAIN	AIO	Main antenna interface: • LTE: TRx • WCDMA: TRx	50 Ω impedance
ANT_DRx/GNSS	AI	Diversity/GNSS antenna interface: • LTE: DRx • WCDMA: DRx • GNSS: GPS/GLONASS/Galileo/BDS	

Table 29: Frequency Bands

3GPP Band	Transmit	Receive	Unit
WCDMA B1	1920–1980	2110–2170	MHz
WCDMA B2	1850–1910	1930–1990	MHz
WCDMA B3	1710–1785	1805–1880	MHz
WCDMA B4	1710–1755	2110–2155	MHz
WCDMA B5	824–849	869–894	MHz

WCDMA B6	830–840	875–885	MHz
WCDMA B8	880–915	925–960	MHz
WCDAM B19	830–845	875–890	MHz
LTE-FDD B1	1920–1980	2110–2170	MHz
LTE-FDD B2	1850–1910	1930–1990	MHz
LTE-FDD B3	1710–1785	1805–1880	MHz
LTE-FDD B4	1710–1755	2110–2155	MHz
LTE-FDD B5	824–849	869–894	MHz
LTE-FDD B7	2500–2570	2620–2690	MHz
LTE-FDD B8	880–915	925–960	MHz
LTE-FDD B12	699–716	729–746	MHz
LTE-FDD B13	777–787	746–756	MHz
LTE-FDD B14	788–798	758–768	MHz
LTE-FDD B17	704–716	734–746	MHz
LTE-FDD B18	815–830	860–875	MHz
LTE-FDD B19	830–845	875–890	MHz
LTE-FDD B20	832–862	791–821	MHz
LTE-FDD B25	1850–1915	1930–1995	MHz
LTE-FDD B26	814–849	859–894	MHz
LTE-FDD B28	703–748	758–803	MHz
LTE-FDD B29 [8]	-	717–728	MHz
LTE-FDD B30	2305–2315	2350–2360	MHz
LTE-FDD B32 [8]	-	1452–1496	MHz
LTE-FDD B66	1710–1780	2110–2200	MHz

8 LTE-FDD B29/B32 support Rx only and are only for secondary component carrier.

LTE-FDD B71	663-698	617-652	MHZ
LTE-TDD B34	2010-2025	2010-2025	MHZ
LTE-TDD B38	2570–2620	2570–2620	MHz
LTE-TDD B39	1880–1920	1880–1920	MHz
LTE-TDD B40	2300–2400	2300–2400	MHz
LTE-TDD B41	2496–2690	2496–2690	MHz

5.1.2. Tx Power

Table 30: EM061K-GL Conducted RF Output Power

Frequency Bands	Modulation	Max.	Min.	Comment
WCDMA B1	BPSK	23 dBm ±2 dB	< -50 dBm	-
WCDMA B2	BPSK	23 dBm ±2 dB	< -50 dBm	-
WCDMA B3	BPSK	23 dBm ±2 dB	< -50 dBm	-
WCDMA B4	BPSK	23 dBm ±2 dB	< -50 dBm	-
WCDMA B5	BPSK	23 dBm ±2 dB	< -50 dBm	-
WCDMA B6	BPSK	23 dBm ±2 dB	< -50 dBm	-
WCDMA B8	BPSK	23 dBm ±2 dB	< -50 dBm	-
WCDMA B19	BPSK	23 dBm ±2 dB	< -50 dBm	-
LTE-FDD B1	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-FDD B2	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-FDD B3	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-FDD B4	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-FDD B5	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-FDD B7	QPSK	23 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-FDD B8	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-FDD B12	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-FDD B13	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB

LTE-FDD B14	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-FDD B17	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-FDD B18	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-FDD B19	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-FDD B20	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-FDD B25	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-FDD B26	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-FDD B28	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-FDD B30	QPSK	22 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-FDD B66	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-FDD B71	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-TDD B34	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-TDD B38	QPSK	23 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-TDD B39	QPSK	23.5 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-TDD B40	QPSK	23 dBm ±1 dB	< -40 dBm	10 MHz, 1RB
LTE-TDD B41	QPSK	23 dBm ±1 dB	< -40 dBm	10 MHz, 1RB

5.1.3. Rx Sensitivity

Table 31: EM061K-GL Rx Sensitivity

Frequency Bands	Primary	Diversity	SIMO [9]	3GPP (SIMO) (dBm)	Comment [10]
WCDMA B1	TBD	TBD	TBD	-106.7	
WCDMA B2	TBD	TBD	TBD	-104.7	
WCDMA B3	TBD	TBD	TBD	-103.7	
WCDMA B4	TBD	TBD	TBD	-106.7	
WCDMA B5	TBD	TBD	TBD	-104.7	
WCDMA B6	TBD	TBD	TBD	-106.7	

9 SIMO is a smart antenna technology that uses a single antenna at the transmitter side and multiple antennas at the receiver side, which can improve Rx performance.
10 The RB configuration follows 3GPP specification.

WCDMA B8	TBD	TBD	TBD	-103.7	
WCDMA B19	TBD	TBD	TBD	-106.7	
LTE-FDD B1	TBD	TBD	TBD	-96.3	10 MHz
LTE-FDD B2	TBD	TBD	TBD	-94.3	10 MHz
LTE-FDD B3	TBD	TBD	TBD	-93.3	10 MHz
LTE-FDD B4	TBD	TBD	TBD	-96.3	10 MHz
LTE-FDD B5	TBD	TBD	TBD	-94.3	10 MHz
LTE-FDD B7	TBD	TBD	TBD	-94.3	10 MHz
LTE-FDD B8	TBD	TBD	TBD	-93.3	10 MHz
LTE-FDD B12	TBD	TBD	TBD	-93.3	5 MHz
LTE-FDD B13	TBD	TBD	TBD	-93.3	10 MHz
LTE-FDD B14	TBD	TBD	TBD	-93.3	10 MHz
LTE-FDD B17	TBD	TBD	TBD	-93.3	10 MHz
LTE-FDD B18	TBD	TBD	TBD	-96.3	10 MHz
LTE-FDD B19	TBD	TBD	TBD	-96.3	10 MHz
LTE-FDD B20	TBD	TBD	TBD	-93.3	10 MHz
LTE-FDD B25	TBD	TBD	TBD	-92.8	5 MHz
LTE-FDD B26	TBD	TBD	TBD	-93.8	5 MHz
LTE-FDD B28	TBD	TBD	TBD	-94.8	10 MHz
LTE-FDD B29 [11]	TBD	TBD	TBD	-93.3	10 MHz
LTE-FDD B30	TBD	TBD	TBD	-95.3	10 MHz
LTE-FDD B32 [11]	TBD	TBD	TBD	-96.3	10 MHz
LTE-FDD B66	TBD	TBD	TBD	-95.8	10 MHz
LTE-FDD B71	TBD	TBD	TBD	-94.3	10 MHz
LTE-TDD B34	TBD	TBD	TBD	-96.3	10 MHz
LTE-TDD B38	TBD	TBD	TBD	-96.3	10 MHz
LTE-TDD B39	TBD	TBD	TBD	-96.3	10 MHz

11 The test results are based on CA_2A-29A, and CA_20A-32A. LTE-FDD B29/B32 support Rx only and are only for secondary component carrier.

LTE-TDD B40	TBD	TBD	TBD	-96.3	10 MHz
LTE-TDD B41	TBD	TBD	TBD	-94.3	20 MHz

5.2. GNSS

5.2.1. Antenna Interface & Frequency Bands

The module includes a fully integrated global navigation satellite system solution.

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, see *document [4]*.

Table 32: GNSS Frequency

Type	Frequency	Unit
GPS/Galileo	1575.42 ±1.023	MHz
GLONASS	1601.65 ±4.15	MHz
BDS	1561.098 ±2.046	MHz

5.2.2. GNSS Performance

Table 33: GNSS Performance

Parameter	Description	Condition	Typ.	Unit
Sensitivity	Acquisition	Autonomous	TBD	dBm
	Reacquisition	Autonomous	TBD	dBm
	Tracking	Autonomous	TBD	dBm
TTFF	Cold start @ open sky	Autonomous	TBD	s
		XTRA enabled	TBD	s

		Autonomous	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. 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 loss of lock.
3. Acquisition sensitivity: the minimum GNSS signal power at which the module can fix position successfully within 3 minutes after executing cold start command.

5.3. Antenna Design Requirements

Table 34: Antenna Requirements

Type	Requirements
Main Antenna (WCDMA/LTE Tx/Rx)	• VSWR: ≤ 2 • Efficiency: >30 % • Max Input Power: 50 W • Input Impedance: 50 Ω
Diversity/GNSS Antenna (WCDMA/LTE/GNSS RX)	• Cable Insertion Loss: – **< 1 dB:** LB (<1 GHz) – **< 1.5 dB:** MB (1–2.3 GHz) – **< 2 dB:** LB (> 2.3 GHz)

NOTE

It is recommended to use a passive GNSS antenna when LTE B13 or B14 is supported, as the use of active antenna may generate harmonics which will affect the GNSS performance.

5.4. Antenna Connectors

5.4.1. Antenna Connector Location

The antenna connector locations are shown below.

Figure 24: Antenna Connectors on EM061K-GL

5.4.2. Antenna Connector Specifications

The module is mounted with standard 2 mm × 2 mm receptacle antenna connectors for convenient antenna connection. The antenna connector's PN is IPEX 20449-001E, and the connector dimensions are illustrated as below:
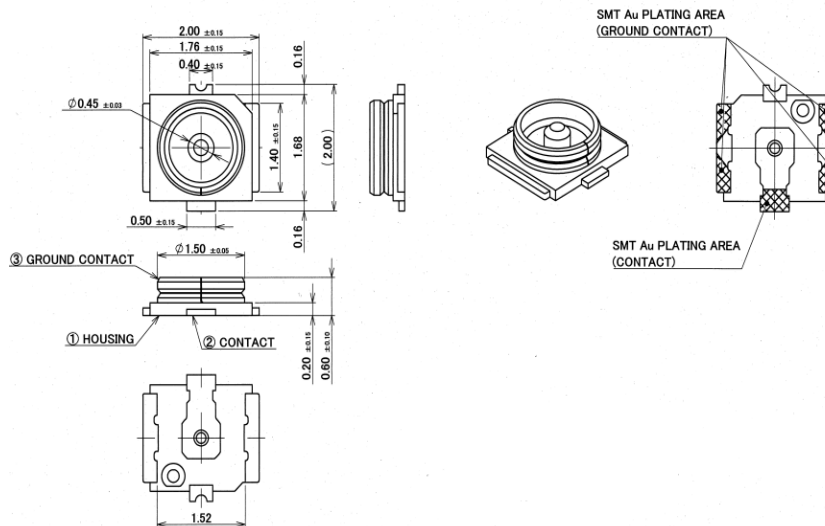
Figure 25: Dimensions of the Receptacle (Unit: mm)

Table 35: Major Specifications of the RF Connectors

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. 1.45 (3–6 GHz)

5.4.3. Antenna Connector Installation

The receptacle RF connector used in conjunction with the modules will accept two types of mated plugs that will meet a maximum height of 1.2 mm using a Ø 0.81 mm coaxial cable or a maximum height of 1.45 mm utilizing a Ø 1.13 mm coaxial cable.

The following figure shows the dimensions of mated plugs using Ø 0.81 mm coaxial cables:
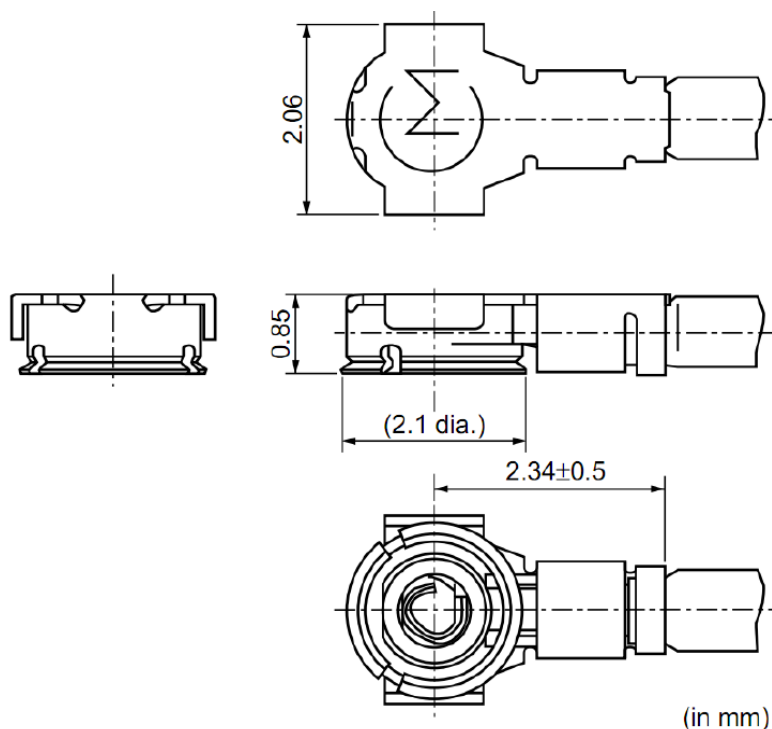
Figure 26: Dimensions of Mated Plugs (Ø0.81/Ø1.13 mm Coaxial Cables) (Unit: mm)

The following figure illustrates the connection between the receptacle RF connector on the modules and the mated plugs using a Ø 0.81 mm coaxial cable.
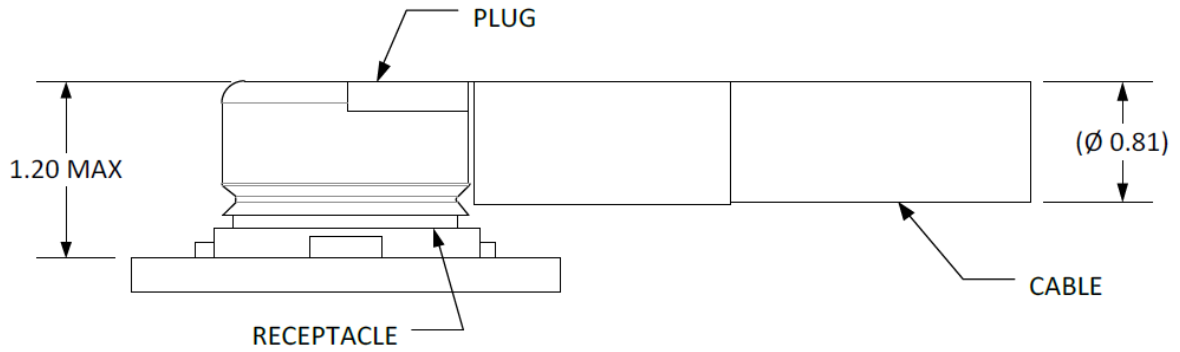
Figure 27: Space Factor of Mated Connectors (Ø0.81 mm Coaxial Cables) (Unit: mm)

The following figure illustrates the connection between the receptacle RF connector on EM061K-GL and the mated plugs using a Ø 1.13 mm coaxial cable.
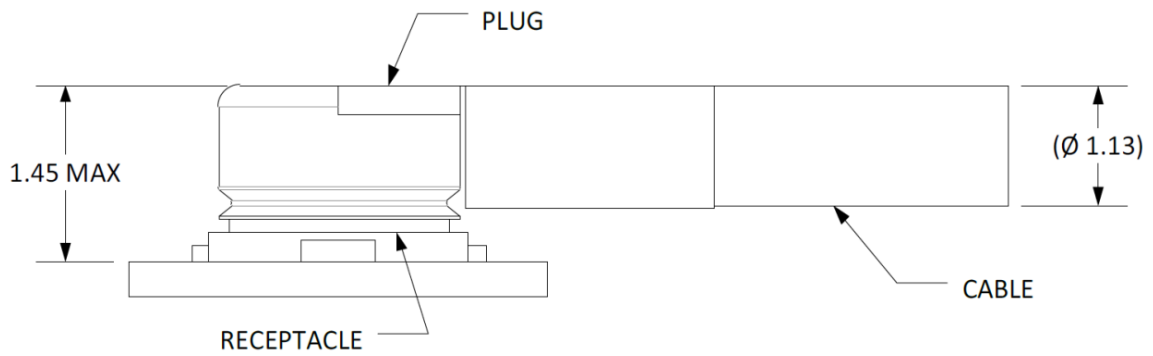
Figure 28: Space Factor of Mated Connectors (Ø 1.13 mm Coaxial Cables) (Unit: mm)

6 Electrical Characteristics and Reliability

6.1. Absolute Maximum Ratings

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

Table 36: Absolute Maximum Ratings

Parameter	Min.	Typ.	Max.	Unit
VCC	-0.3	3.7	4.7	V

6.2. Power Supply Ratings

The typical input voltage of the module is 3.7 V.

Table 37: Power Supply Requirements

Parameter	Description	Condition	Min.	Typ.	Max.	Unit
VCC	Power supply for the module	The actual input voltages must be kept between the minimum and maximum values.	3.135	3.7	4.4	V
Voltage Ripple	-		-	30	100	mV

6.3. Power consumption

Table 38: Averaged Power Consumption

Description	Condition	Typ.	Unit
OFF state	Power down	TBD	µA
Sleep State	**AT+CFUN=0** @ USB2.0 Suspend	TBD	mA
	AT+CFUN=4 @ USB2.0 Suspend	TBD	mA
	WCDMA PF = 64 @ USB2.0 Suspend	TBD	mA
	LTE-FDD PF = 64 @ USB2.0 Suspend	TBD	mA
	LTE-TDD PF = 64 @ USB2.0 Suspend	TBD	mA
Idle State	WCDMA PF = 64 (B1 CH10700 USB Disconnect)	TBD	mA
	WCDMA PF = 64 (B1 CH10700 USB2.0 Connect)	TBD	mA
	LTE-FDD PF = 64 (B1 CH300 USB Disconnect)	TBD	mA
	LTE-FDD PF = 64 (B1 CH300 USB2.0 Connect)	TBD	mA
	LTE-TDD PF = 64 (B38 CH38000 USB Disconnect)	TBD	mA
	LTE-TDD PF = 64 (B38 CH38000 USB2.0 Connect)	TBD	mA
WCDMA Data Transfer (GNSS Off)	WCDMA B1 HSDPA CH10700 @ TBD dBm	TBD	mA
	WCDMA B1 HSUPA CH10700 @ TBD dBm	TBD	mA
	WCDMA B2 HSDPA CH9800 @ TBD dBm	TBD	mA
	WCDMA B2 HSUPA CH9800 @ TBD dBm	TBD	mA
	WCDMA B3 HSDPA CH1338 @ TBD dBm	TBD	mA
	WCDMA B3 HSUPA CH1338 @ TBD dBm	TBD	mA
	WCDMA B4 HSDPA CH1638 @ TBD dBm	TBD	mA
	WCDMA B4 HSUPA CH1638 @ TBD dBm	TBD	mA
	WCDMA B5 HSDPA CH4407 @ TBD dBm	TBD	mA

	WCDMA B5 HSUPA CH4407 @ TBD dBm	TBD	mA
	WCDMA B6 HSDPA CH4400 @ TBD dBm	TBD	mA
	WCDMA B6 HSUPA CH4400 @ TBD dBm	TBD	mA
	WCDMA B8 HSDPA CH3012 @ TBD dBm	TBD	mA
	WCDMA B8 HSUPA CH3012 @ TBD dBm	TBD	mA
	WCDMA B19 HSDPA CH738 @ TBD dBm	TBD	mA
	WCDMA B19 HSUPA CH738 @ TBD dBm	TBD	mA
LTE Data Transfer (GNSS Off)	LTE-FDD B1 CH300 @ TBD dBm	TBD	mA
	LTE-FDD B2 CH900 @ TBD dBm	TBD	mA
	LTE-FDD B3 CH1575 @ TBD dBm	TBD	mA
	LTE-FDD B4 CH2175 @ TBD dBm	TBD	mA
	LTE-FDD B5 CH2525 @ TBD dBm	TBD	mA
	LTE-FDD B7 CH3100 @ TBD dBm	TBD	mA
	LTE-FDD B8 CH3625 @ TBD dBm	TBD	mA
	LTE-FDD B12 CH5095 @ TBD dBm	TBD	mA
	LTE-FDD B13 CH5230 @ TBD dBm	TBD	mA
	LTE-FDD B14 CH5330 @ TBD dBm	TBD	mA
	LTE-FDD B17 CH5790 @ TBD dBm	TBD	mA
	LTE-FDD B18 CH5925 @ TBD dBm	TBD	mA
	LTE-FDD B19 CH6075 @ TBD dBm	TBD	mA
	LTE-FDD B20 CH6300 @ TBD dBm	TBD	mA
	LTE-FDD B25 CH8365 @ TBD dBm	TBD	mA
	LTE-FDD B26 CH8865@ TBD dBm	TBD	mA
	LTE-FDD B28 CH9360 @ TBD dBm	TBD	mA
	LTE-FDD B30 CH9820 @ TBD dBm	TBD	mA

	LTE-FDD B66 CH66886 @ TBD dBm	TBD	mA
	LTE-FDD B71 CH68786 @ TBD dBm	TBD	mA
	LTE-TDD B34 CH36275@ TBD dBm	TBD	mA
	LTE-TDD B38 CH38000 @ TBD dBm	TBD	mA
	LTE-TDD B39 CH38450 @ TBD dBm	TBD	mA
	LTE-TDD B40 CH39150 @ TBD dBm	TBD	mA
	LTE-TDD B41 CH40740 @ TBD dBm	TBD	mA
WCDMA Voice Call*	WCDMA B1 CH10700 @ TBD dBm	TBD	mA
	WCDMA B2 CH9800 @ TBD dBm	TBD	mA
	WCDMA B3 CH1338 @ TBD dBm	TBD	mA
	WCDMA B4 CH1638 @ TBD dBm	TBD	mA
	WCDMA B5 CH4407 @ TBD dBm	TBD	mA
	WCDMA B6 CH4400 @ TBD dBm	TBD	mA
	WCDMA B8 CH3012 @ TBD dBm	TBD	mA
	WCDMA B19 CH738 @ TBD dBm	TBD	mA

NOTE

1. Power consumption test is carried out under 3.7 V, 25 °C with 5G-M2 EVB, and with thermal dissipation measures.
2. For more details about current consumption, please contact Quectel Technical Support to obtain the power consumption test report of the modules.

6.4. Digital I/O Characteristics

Table 39: (U)SIM Low-voltage I/O Requirements

Parameter	Description	Min.	Max.	Unit
V_{IH}	High-level input voltage	0.7 × USIM_VDD	USIM_VDD + 0.3	V
V_{IL}	Low-level input voltage	-0.3	0.2 × USIM_VDD	V
V_{OH}	High-level output voltage	0.8 × USIM_VDD	USIM_VDD	V
V_{OL}	Low-level output voltage	0	0.4	V

Table 40: (U)SIM High-voltage I/O Requirements

Parameter	Description	Min.	Max.	Unit
V_{IH}	High-level input voltage	0.7 × USIM_VDD	USIM_VDD + 0.3	V
V_{IL}	Low-level input voltage	-0.3	0.2 × USIM_VDD	V
V_{OH}	High-level output voltage	0.8 × USIM_VDD	USIM_VDD	V
V_{OL}	Low-level output voltage	0	0.4	V

Table 41: 1.8 V Digital I/O Requirements

Parameter	Description	Min.	Max.	Unit
V_{IH}	High-level input voltage	1.65	2.1	V
V_{IL}	Low-level input voltage	-0.3	0.54	V
V_{OH}	High-level output voltage	1.3	1.8	V
V_{OL}	Low-level output voltage	0	0.4	V

Table 42: 3.3 V Digital I/O Requirements

Parameter	Description	Min.	Max.	Unit
3.3 V	Power domain	3.135	3.464	V
V_{IH}	High-level input voltage	2.0	3.6	V
V_{IL}	Low-level input voltage	-0.5	0.8	V

6.5. ESD Protection

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

Table 43: Electrostatic Discharge Characteristics (Temperature: 25–30 ⁰C, Humidity: 40 ±5 %)

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

6.6. Operating and Storage Temperatures

Table 44: Operating and Storage Temperatures

Parameter	Min.	Typ.	Max.	Unit
Operating Temperature Range [12]	-25	+25	+75	⁰C
Extended Temperature Range [13]	-40	-	+85	⁰C
Storage temperature Range	-40	-	+90	⁰C

6.7. Thermal Dissipation

Figure 29: 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, etc.) will be affected to a certain extent. Therefore, the thermal design should be maximally optimized to ensure all internal IC chips

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[12] 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 the temperature range of -10 °C to +55 °C，the mentioned RF performance margins higher than 3GPP specifications can be guaranteed. When temperature goes beyond temperature range of -10 °C to 55 °C, a few RF performances of module may be slightly off 3GPP specifications.

[13] 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 Pout, 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.

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.
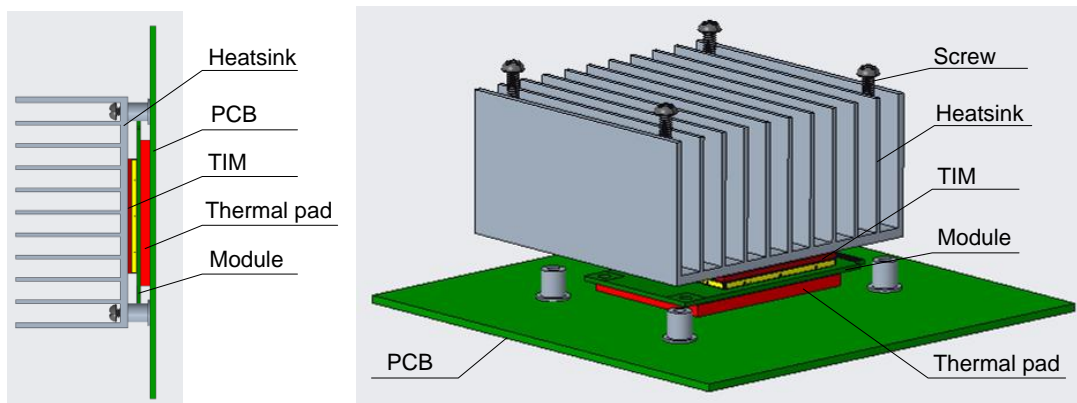

Figure 30: Placement and Fixing of the Heatsink

Table 45: Maximum Operating Temperature for Main Chips (Unit: °C)

BASEBAND	MCP	PMU	WTR	MMPA	PA	APT
85	85	85	85	100	85	85

6.8. Notification

Please follow the principles below in the module application.

6.8.1. 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.

6.8.2. Cleaning

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

6.8.3. Installing

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

7 Mechanical Information and Packaging

This chapter mainly describes mechanical dimensions and packaging specifications of EM061K-GL. All dimensions are measured in mm, and the dimensional tolerances are ±0.15 mm unless otherwise specified.
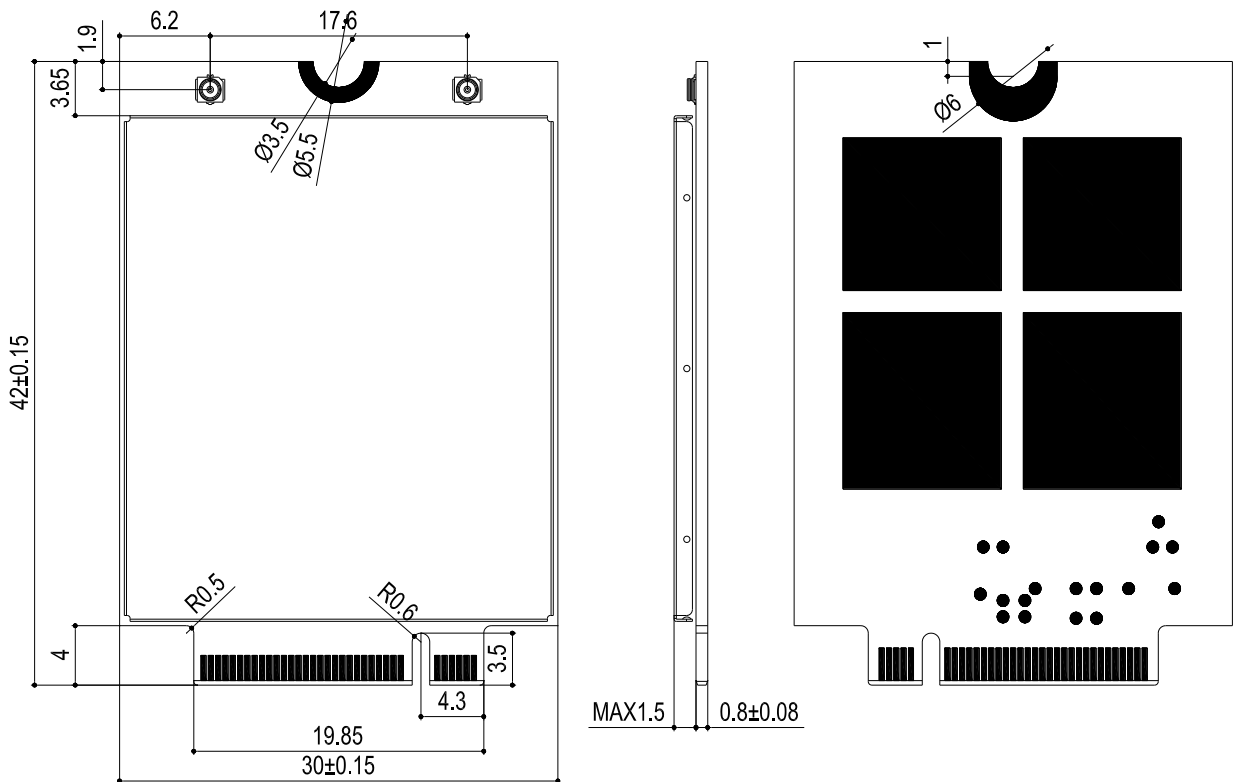
7.1. Mechanical Dimensions

Figure 31: Module Top and Side Dimensions

7.2. Top and Bottom Views

Figure 32: Top and Bottom Views of the Module

7.3. M.2 Connector

EM061K-GL adopts a standard PCI Express M.2 connector which compiles with the directives and standards listed in *PCI Express M.2 Specification*.

7.4. Packaging

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 modules adopt blister tray packaging and details are as follow:

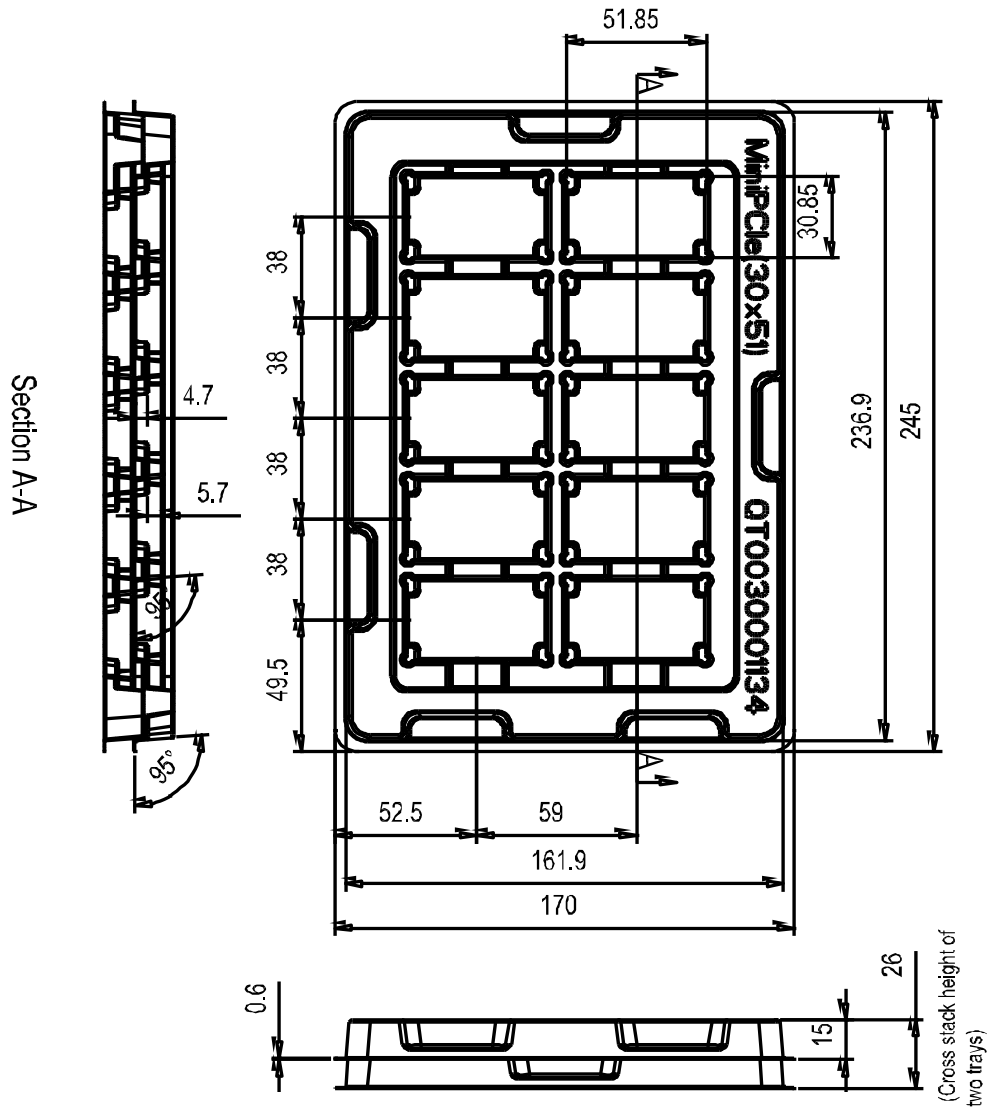### 7.4.1. Blister Tray

Dimension details are as follow:

Figure 33: Blister Tray Dimension Drawing

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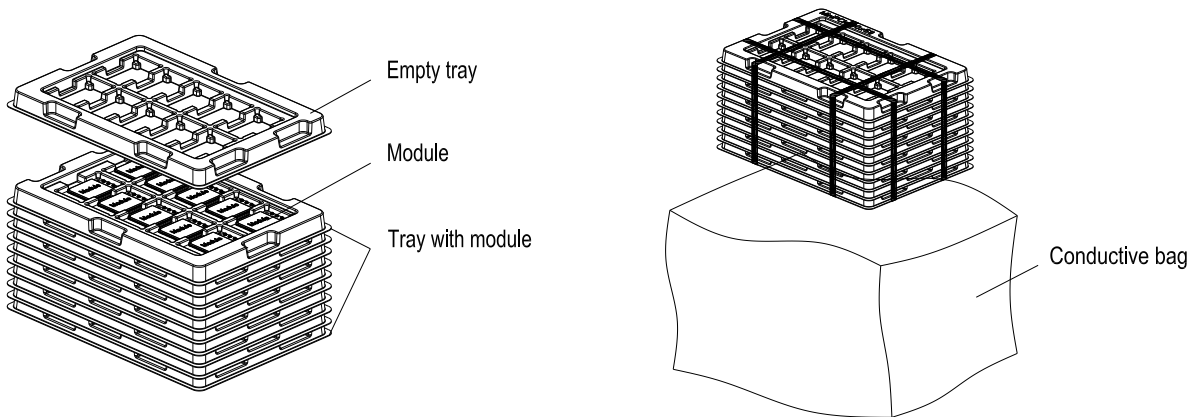
Each blister tray packs 10 modules. Stack 10 blister trays with modules together, and put 1 empty blister tray on the top.

Packing 11 blister trays together and then put blister trays into a conductive bag, seal and pack the conductive bag.
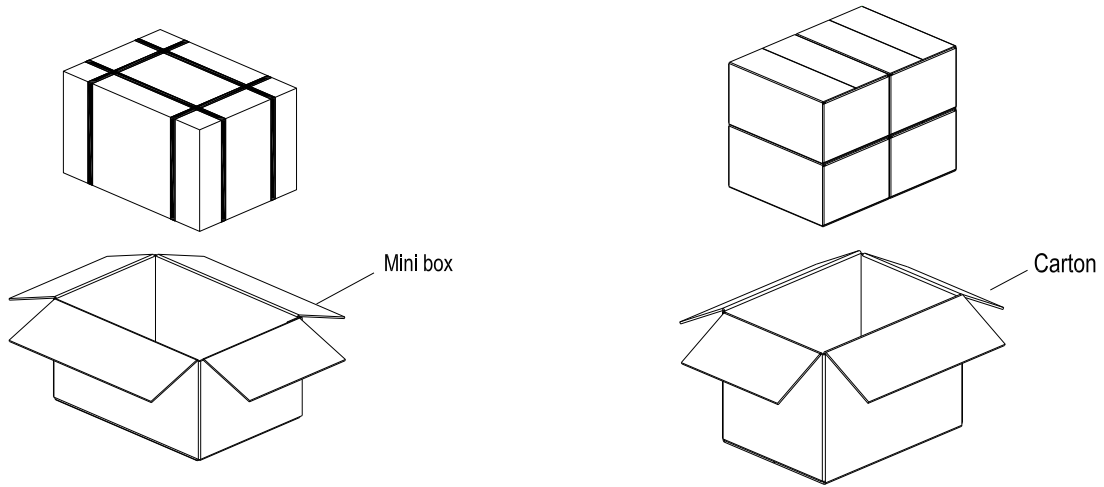
Put seal-packed blister trays into a mini box. One mini box can pack 100 modules.

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

Figure 34: Packaging Process

8 Appendix References

Table 46: Related Documents

Document Name
[1]　Quectel_EM061K-GL_CA_Feature
[2]　Quectel_5G-M2_EVB_User_Guide
[3]　Quectel_EG06xK&Ex120K&EM060K_Series_AT_Commands_Manual
[4]　Quectel_LTE-A(Q)_Series_GNSS_Application_Note

Table 47: Terms and Abbreviations

Abbreviation	Description
APT	Average Power Tracking
AT	ATtention
BB	Baseband
BDS	BeiDou Navigation Satellite System
BIOS	Basic Input/Output System
bps	Bit(s) per second
BPSK	Binary Phase Shift Keying
CBRS	Citizen Broadband Radio Service
CPE	Customer-Premise Equipment
COEX	Coexistence
DC-HSDPA	Dual-carrier High Speed Downlink Package Access
DFOTA	Delta Firmware Upgrade Over-The-Air

DL	Downlink
DPR	Dynamic Power Reduction
DRX	Discontinuous Reception
DRx	Diversity Receive
EBI	External Bus Interface
EIRP	Equipment Isotropic Radiated Power
ESD	Electrostatic Discharge
ESR	Equivalent Series Resistance
FDD	Frequency Division Duplex
GLONASS	Global Navigation Satellite System (Russia)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSM	Global System for Mobile Communications
HSDPA	High Speed Downlink Packet Access
HSPA	High Speed Packet Access
HSUPA	High Speed Uplink Packet Access
IC	Integrated Circuit
kbps	Kilobits per second
LAA	License Assisted Access
LDO	Low-dropout Regulator
LED	Light Emitting Diode
LPDDR2	Low Power Double Data Rate 2
LSB	Least Significant Bit
LTE	Long Term Evolution
MBIM	Mobile Broadband Interface Model

Mbps	Megabits per second
MCP	Multiple Chip Package
ME	Mobile Equipment
MFBI	Multi-Frequency Band Indicator
MIPI	Mobile Industry Processor Interface
MIMO	Multiple-Input Multiple-Output
MLCC	Multi-layer Ceramic Capacitor
MMPA	Multimode Multiband Power Amplifier
MO	Mobile Originated
MSB	Most Significant Bit
MT	Mobile Terminated
NAND	NON-AND
NC	Not Connected
NPN	Negative-Positive-Negative
PA	Power Amplifier
PAP	Password Authentication Protocol
PC	Personal Computer
PCB	Printed Circuit Board
PCIe	Peripheral Component Interconnect Express
PCM	Pulse Code Modulation
PDU	Protocol Data Unit
PME	Power Management Event
PMIC	Power Management IC
PMU	Power Management Unit
POS	Point of Sale

PPP	Point-to-Point Protocol
PRx	Primary Receive
QLN	Qualcomm Low-noise Amplifer
QMI	Qualcomm MSM (Mobile Station Modems) Interface
QPSK	Quadrature Phase Shift Keying
RB	Resource Block
RF	Radio Frequency
RFFE	RF Front-End
RH	Relative Humility
Rx	Receive
SAR	Specific Absorption Rate
SDRAM	Synchronous Dynamic Random-Access Memory
SMS	Short Message Service
SPMI	System Power Management Interface
TCP	Transmission Control Protocol
TDD	Time Division Duplex
TRx	Transmit & Receive
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
VFB	Voltage Feedback

V_{IH}	High-level Input Voltage
V_{IL}	Low-level Input Voltage
V_{OH}	High-level Output Voltage
V_{OL}	Low-level Output Voltage
WCDMA	Wideband Code Division Multiple Access
WTR	Wafer-scale RF transceiver
XO	Crystal Oscillator