

BG950A-GL&BG951A-GL

Hardware Design

LPWA 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 emergent 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 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 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

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-	2021-07-07	Lex LI/Ben JIANG	Creation of the document
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1 Introduction

This document defines BG950A-GL & BG951A-GL modules and describes their air interfaces and hardware interfaces which relate to customers' applications.

It can help customers quickly understand interface specifications, electrical and mechanical details, as well as other related information of the module. Associated with application notes and user guides, customers can use this module to design and to set up mobile applications easily.

Hereby, [Quectel Wireless Solutions Co., Ltd.] declares that the radio equipment type [BG950A-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>



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

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: XMR2021BG950AGL
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)
LTE Band 2	7.30	7.30
LTE Band 4	4.30	4.30
LTE Band 5	8.84	5.40
LTE Band 12	8.10	4.91
LTE Band 13	8.51	5.23
LTE Band 25	7.30	7.30
LTE Band 26	8.84	5.36
LTE Band 66	4.30	4.30
NB-IOT Band 2	7.30	7.30
NB-IOT Band 4	4.30	4.30
NB-IOT Band 5	8.84	5.40
NB-IOT Band 12	8.10	4.91
NB-IOT Band 13	8.51	5.23
NB-IOT Band 17	8.02	4.93
NB-IOT Band 25	7.30	7.30
NB-IOT Band 66	4.30	4.30

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: XMR2021BG950AGL" or "Contains FCC ID: XMR2021BG950AGL" 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 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 shown 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." 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-2021BG950A" or "where: 10224A-2021BG950A 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 installé dans 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-2021BG950A " ou "où: 10224A-2021BG950A est le numéro de certification du 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, 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 such model is currently unavailable.

2 Product Overview

The module is an embedded IoT (LTE Cat M1, LTE Cat NB1/NB2^{*}) wireless communication module. It provides data connectivity on LTE-FDD network, and supports half-duplex operation in LTE network. It also provides GNSS and voice^{* 1} functionality to meet your specific application demands.

The module is an SMD type module which is engineered to meet the demanding requirements in M2M applications such as smart metering, tracking system, security, wireless POS, etc. Related information and details are listed in the table below:

BG950A-GL & BG951A-GL modules are industrial-grade modules for industrial and commercial applications only.

Table 2: Brief Introduction of BG950A-GL & BG951A-GL Modules

Categories	
Packaging and pins number	LGA;102 pieces
Dimensions	(23.6 ±0.2) mm × (19.9 ±0.2) mm × (2.2 ±0.2) mm
Weight	TBD
Wireless functions	LTE and GNSS
Variants	BG950A-GL/BG951A-GL

¹ BG950A-GL & BG951A-GL supports VoLTE^{*} (Voice over LTE) under LTE Cat M1.

2.1. Frequency Bands and Functions

Table 3: Wireless Network Type

Module	Supported Bands ²	LTE Bands Power Class	GNSS
BG950A-GL	Cat M1 ³ : LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/B18/ B19/B20/B25/B26/B27/B28/B66 Cat NB1/NB2* ⁴ : LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/B17/ B18/B19/B20/B25/B28/B66	Power Class 3 (23 dBm ± 2.7 dB)	GPS, GLONASS
BG951A-GL	Cat M1 : LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/B18/ B19/B20/B25/B26/B27/B28/B66 Cat NB1/NB2* : LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/B17/ B18/B19/B20/B25/B28/B66	Power Class 3 (23 dBm ± 2.7 dB)	TBD

² LTE-FDD B26 and B27 are supported by LTE Cat M1 only.

³ BG950A-GL & BG951A-GL support VoLTE* (Voice over LTE) under LTE Cat M1.

⁴ LTE Cat NB2* is backward compatible with LTE Cat NB1.

2.2. Key Features

Table 4: Key Features

Features	Details
Power Supply	● Supply voltage: 2.2–4.5 V ● Typical supply voltage: 3.3 V
SMS*	● Text and PDU mode ● Point-to-point MO and MT ● SMS cell broadcast ● SMS storage: ME by default
(U)SIM Interface	Supports USIM/SIM card: 1.8 V only
Audio Features	● Supports one digital audio interfaces: PCM and I2C ● LTE: VoLTE* under LTE Cat M1
PCM Interface*	● Support one digital audio interface: PCM interface for VoLTE* only ● Used for audio function with external codec
I2C Interface*	● One I2C interface ● Multi-master mode is not supported
USB Interface*	● Compliant with USB 2.0 specifications, with transmission rates up to 12 MHz on USB Full-speed ● Used AT command communication, data transmission, software debugging and firmware upgrade ● USB serial driver: – Windows 7/8/8.1/10 – Linux 2.6–5.4 – Android 4.x/5.x/6.x/7.x/8.x/9.x system
UART Interfaces	Main UART: ● Used for AT command communication and data transmission ● Baud rate: 115200 bps baud by default ● The default frame format is 8N1 (8 data bits, no parity, 1 stop bit) ● Supports RTS and CTS hardware flow control Debug UART: ● Used for firmware upgrade, software debugging and log output ● 115200 bps baud rate by default ● The default frame format is 8N1 (8 data bits, no parity, 1 stop bit) ● Support RTS and CTS hardware flow control Auxiliary UART: ● Used for RF calibration debugging and log output ● 961200 bps baud rate by default ● The default frame format is 8N1 (8 data bits, no parity, 1 stop bit) ● Support RTS and CTS hardware flow control

Network Indication*	NET_STATUS to indicate network connectivity status.
AT Commands	● 3GPP TS 27.007 and 3GPP TS 27.005 AT commands ● Quectel enhanced AT commands
Antenna Interface	● ANT_MAIN ● ANT_GNSS ● 50 Ω impedance.
Transmitting Power	LTE-FDD: Class 3 (23 dBm $\pm$ 2.7 dB)
LTE Features	● Support 3GPP Rel-14* ● Supports LTE Cat M1 and LTE Cat NB1/NB2* ● Supports 1.4 MHz RF bandwidth for LTE Cat M1 ● Support 200 kHz RF bandwidth for LTE Cat NB1/NB2* ● Cat M1: 588 kbps (DL)/1119 kbps (UL) ● Cat NB1: 27.2 kbps (DL)/62.5 kbps (UL) ● Cat NB2*: 127 kbps (DL)/158 kbps (UL)
Internet Protocol Features	● Support IPv4/IPv6/PPP/TCP/UDP/SSL/TLS/DTLS/FTP(S)/HTTP(S)/MQTT/LwM2M/CoAP protocols ● Supports PAP and CHAP protocols for PPP connections
GNSS Features	● BG950A-GL: supports GPS, GLONASS ● BG951A-GL: TBD
Temperature Range	● Operating temperature range: -35 to +75 °C ⁵ ● Extended temperature range: -40 to +85 °C ⁶ ● Storage temperature range: -40 to +90 °C
Firmware Upgrade	● Debug UART interface ● USB 2.0 interface* ● DFOTA
RoHS	All hardware components are fully compliant with EU RoHS directive.

⁵ Within operating temperature range, the module is 3GPP compliant.

⁶ Within extended operating temperature range, proper mounting, heating sinks and active cooling may be required to make certain functions of the module such as voice*, SMS*, data transmission to be realized. Only one or more parameters like P_{out} might reduce in their value and exceed the specified tolerances. When the temperature returns to normal operating temperature levels, the module will meet 3GPP specifications again.

2.3. Functional Diagram

The following figure shows a block diagram of the module and illustrates the major functional parts.

- Power management
- Baseband
- Radio frequency
- Peripheral interface

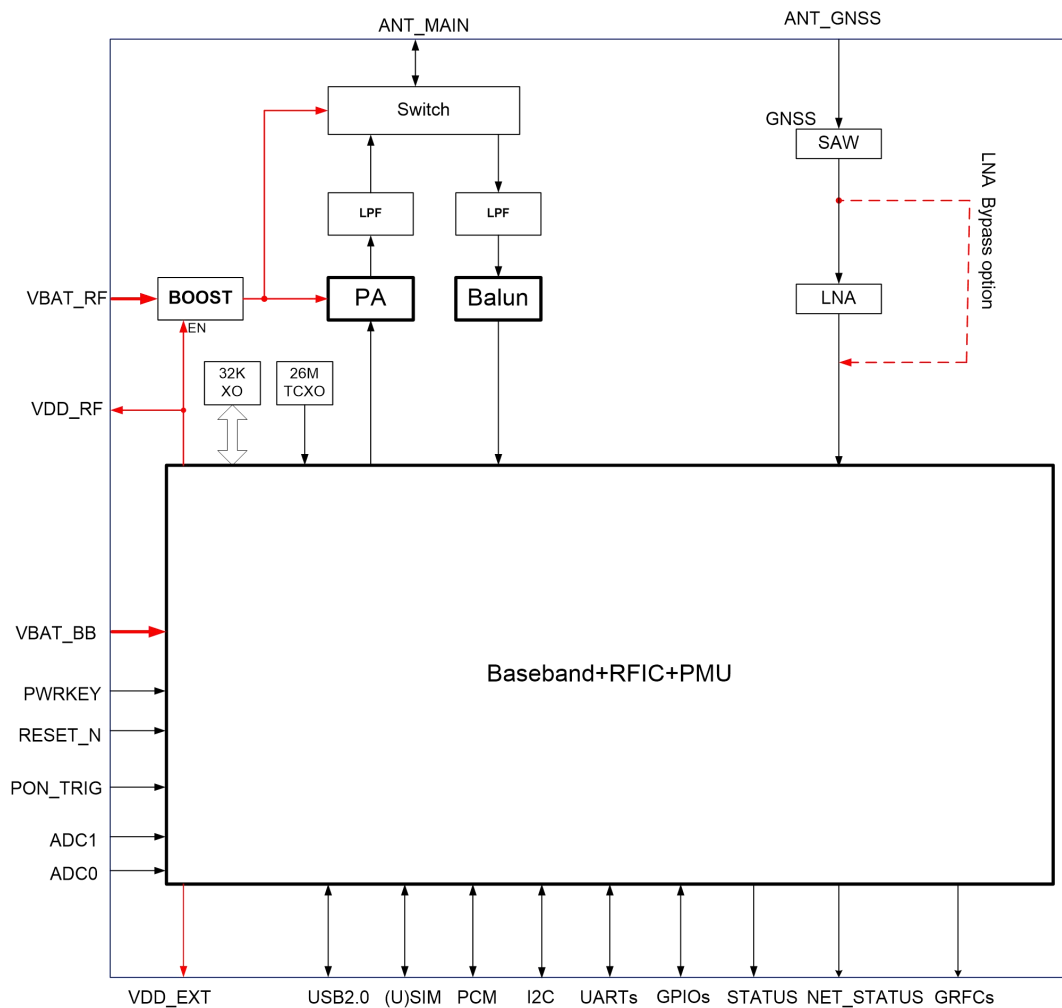


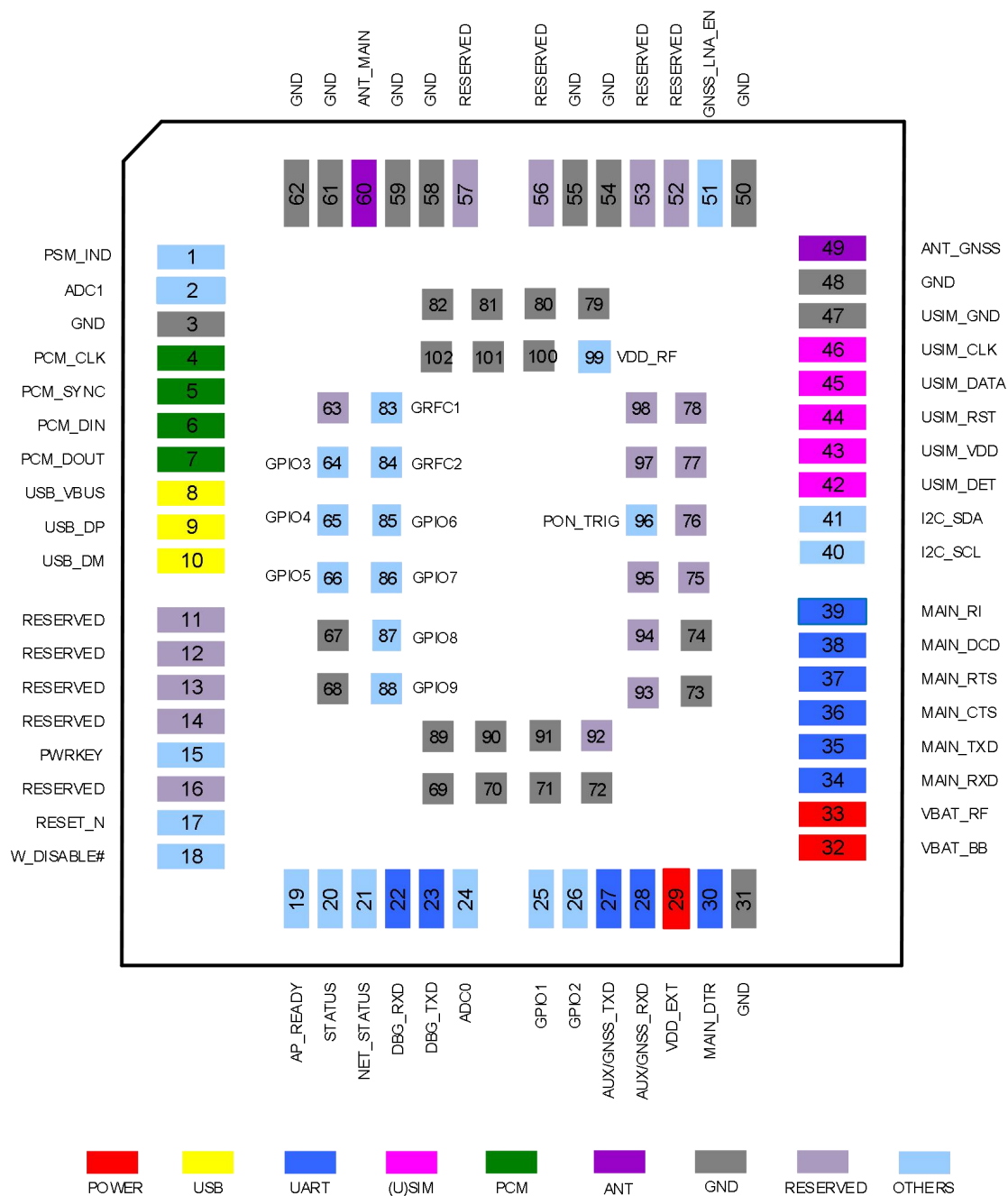
Figure 1: Functional Diagram of BG950A-GL

NOTE

1. PCM and I2C interfaces are for VoLTE* only.
2. The related information of BG951A-GL will be added in the future version.

2.4. Pin Assignment

The following figure illustrates the pin assignment of BG950A-GL.



NOTE

1. ADC input voltage must not exceed 1.8 V.
2. Keep all RESERVED pins and unused pins unconnected.
3. GND pins should be connected to ground in the design.
4. PCM and I2C interfaces are for VoLTE* only.
5. Only BG950A-GL supports GNSS_LNA_EN (pin 51) and VDD_RF (pin 99).
6. For BG950A-GL, pin27 and pin28 can only be used as AUX_TXD and AUX_RXD.
7. The pin assignment of BG951A-GL will be added in the future version.

2.5. Pin Description

The following table shows the DC characteristics and pin descriptions.

Table 5: I/O Parameters Definition

Type	Description
AI	Analog Input
AIO	Analog Input/Output
DI	Digital Input
DO	Digital Output
DIO	Digital Input/Output
OD	Open Drain
PI	Power Input
PO	Power Output

Table 6: Pin Description

Power Supply					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
VBAT_BB	32	PI	Power supply for the module's baseband part	Vmax = 4.5 V Vmin = 2.2 V	See NOTE 1
VBAT_RF	33	PI	Power supply for the module's RF part	Vnom = 3.3 V	See NOTE 1
VDD_EXT	29	PO	Provide 1.8 V for external circuits	Vnom = 1.8 V Iomax = 50 mA	If unused, keep this pin open.
GND	3, 31, 48, 50, 54, 55, 58, 59, 61, 62, 67–74, 79–82, 89–91, 100–102				
Turn on/off					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
PWRKEY*	15	DI	Turn on/off the module	VILmax = 0.3 V VIHmin = 1.0 V	
Reset					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
RESET_N	17	DI	Reset the module	VILmax = 0.3 V VIHmin = 1.3 V	
Status Indication					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
PSM_IND*	1	DO	Indicate the module's power saving mode	VOLmax = 0.38 V VOHmin = 1.36 V	1.8 V power domain. If unused, keep this pin open.
STATUS	20	DO	Indicate the module's operation status		
NET_STATUS*	21	DO	Indicate the module's network activity status		
USB Interface*					
Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
USB_VBUS	8	AI	USB connection detect	Vnom = 5.0 V	Typical 5.0 V
USB_DP	9	AIO	USB differential data (+)		Compliant with USB 2.0 standard specification. Require
USB_DM	10	AIO	USB differential data		

(-)

 differential
impedance of
90 Ω.

(U)SIM Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
USIM_DET*	42	DI	(U)SIM card hot-plug detect	$V_{ILmin} = -0.2\text{ V}$ $V_{ILmax} = 0.57\text{ V}$ $V_{IHmin} = 1.19\text{ V}$ $V_{IHmax} = 2.0\text{ V}$	1.8 V power domain. If unused, keep this pin open.
USIM_VDD	43	PO	(U)SIM card power supply	$V_{max} = 1.9\text{ V}$ $V_{min} = 1.7\text{ V}$	Only 1.8 V (U)SIM card is supported.
USIM_RST	44	DO	(U)SIM card reset	$V_{OLmax} = 0.38\text{ V}$ $V_{OHmin} = 1.36\text{ V}$	
USIM_DATA	45	DIO	(U)SIM card data	$V_{ILmin} = -0.2\text{ V}$ $V_{ILmax} = 0.57\text{ V}$ $V_{IHmin} = 1.19\text{ V}$ $V_{IHmax} = 2.0\text{ V}$ $V_{OLmax} = 0.38\text{ V}$ $V_{OHmin} = 1.36\text{ V}$	1.8 V power domain.
USIM_CLK	46	DO	(U)SIM card clock	$V_{OLmax} = 0.38\text{ V}$ $V_{OHmin} = 1.36\text{ V}$	
USIM_GND	47		Specified ground for (U)SIM card		

Main UART Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
MAIN_DTR	30	DI	Main UART data terminal ready	$V_{ILmin} = -0.2\text{ V}$ $V_{ILmax} = 0.57\text{ V}$	
MAIN_RXD	34	DI	Main UART receive	$V_{IHmin} = 1.19\text{ V}$ $V_{IHmax} = 2.0\text{ V}$	
MAIN_TXD	35	DO	Main UART transmit	$V_{OLmax} = 0.38\text{ V}$ $V_{OHmin} = 1.36\text{ V}$	
MAIN_CTS	36	DO	Main UART clear to send	$V_{OLmax} = 0.38\text{ V}$ $V_{OHmin} = 1.36\text{ V}$	1.8 V power domain. If unused, keep this pin open.
MAIN_RTS	37	DI	Main UART request to send	$V_{ILmin} = -0.2\text{ V}$ $V_{ILmax} = 0.57\text{ V}$ $V_{IHmin} = 1.19\text{ V}$ $V_{IHmax} = 2.0\text{ V}$	
MAIN_DCD	38	DO	Main UART data carrier detect	$V_{OLmax} = 0.38\text{ V}$ $V_{OHmin} = 1.36\text{ V}$	
MAIN_RI*	39	DO	Main UART ring indication		

Debug UART Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
DBG_RXD	22	DI	Debug UART receive	$V_{ILmin} = -0.2\text{ V}$ $V_{ILmax} = 0.57\text{ V}$ $V_{IHmin} = 1.19\text{ V}$ $V_{IHmax} = 2.0\text{ V}$	1.8 V power domain. If unused, keep this pin open.
DBG_TXD	23	DO	Debug UART transmit	$V_{OLmax} = 0.38\text{ V}$ $V_{OHmin} = 1.36\text{ V}$	

Auxiliary/GNSS UART Interface ⁷

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
AUX/GNSS_TXD	27	DO	Auxiliary/GNSS UART transmit	$V_{OLmax} = 0.38\text{ V}$ $V_{OHmin} = 1.36\text{ V}$	1.8 V power domain. If unused, keep this pin open.
AUX/GNSS_RXD	28	DI	Auxiliary/GNSS UART receive	$V_{ILmin} = -0.2\text{ V}$ $V_{ILmax} = 0.57\text{ V}$ $V_{IHmin} = 1.19\text{ V}$ $V_{IHmax} = 2.0\text{ V}$	

PCM Interface*

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
PCM_CLK	4	DO	PCM clock	$V_{OLmax} = 0.38\text{ V}$ $V_{OHmin} = 1.36\text{ V}$	1.8 V power domain. If unused, keep this pin open.
PCM_SYNC	5	DO	PCM data frame sync		
PCM_DIN	6	DI	PCM data input	$V_{ILmin} = -0.2\text{ V}$ $V_{ILmax} = 0.57\text{ V}$ $V_{IHmin} = 1.19\text{ V}$ $V_{IHmax} = 2.0\text{ V}$	
PCM_DOUT	7	DO	PCM data output	$V_{OLmax} = 0.38\text{ V}$ $V_{OHmin} = 1.36\text{ V}$	

I2C Interface*

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
I2C_SCL	40	OD	I2C serial clock (for external codec)		External pull-up resistor is required. 1.8 V only. If unused, keep this pin open.
I2C_SDA	41	OD	I2C serial data (for external codec)		

⁷ For BG950A-GL module, pin 27 and pin 28 can only be used as auxiliary UART interface.

Antenna Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
ANT_MAIN	60	AIO	Main antenna interface		50 Ω impedance
ANT_GNSS	49	AI	GNSS antenna interface		50 Ω impedance. If unused, keep this pin open.

GPIO Interface*

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
GPIO1	25	DIO	General-purpose input/output	$V_{OLmax} = 0.38\text{ V}$ $V_{OHmin} = 1.36\text{ V}$ $V_{ILmin} = -0.2\text{ V}$ $V_{ILmax} = 0.57\text{ V}$ $V_{IHmin} = 1.19\text{ V}$ $V_{IHmax} = 2.0\text{ V}$	1.8 V power domain. If unused, keep this pin open.
GPIO2	26	DIO			
GPIO3	64	DIO			
GPIO4	65	DIO			
GPIO5	66	DIO			
GPIO6	85	DIO			
GPIO7	86	DIO			
GPIO8	87	DIO			
GPIO9	88	DIO			

ADC Interface

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
ADC0	24	AI	General-purpose ADC interface	Voltage range: 0–1.8 V	If unused, keep this pin open.
ADC1	2	AI	General-purpose ADC interface	Voltage range: 0–1.8 V	

Other Interfaces*

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
W_DISABLE#	18	DI	Airplane mode control	$V_{ILmin} = -0.2\text{ V}$ $V_{ILmax} = 0.57\text{ V}$ $V_{IHmin} = 1.19\text{ V}$ $V_{IHmax} = 2.0\text{ V}$	1.8 V power domain. Pulled up by default. When it is at low

					level, the module can enter airplane mode. If unused, keep this pin open.
AP_READY	19	DI	Application processor sleep state detect	$V_{ILmin} = -0.2\text{ V}$ $V_{ILmax} = 0.57\text{ V}$ $V_{IHmin} = 1.19\text{ V}$ $V_{IHmax} = 2.0\text{ V}$	1.8 V power domain. If unused, keep this pin open.
PON_TRIG	96	DI	Wake up the module from PSM	$V_{ILmin} = -0.2\text{ V}$ $V_{ILmax} = 0.3\text{ V}$ $V_{IHmin} = 1.2\text{ V}$ $V_{IHmax} = 2.0\text{ V}$	1.8 V power domain.

GRFC Interface*

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
GRFC1	83	DO	Generic RF controller	$V_{OLmax} = 0.38\text{ V}$ $V_{OHmin} = 1.36\text{ V}$ $V_{OHmax} = 2.0\text{ V}$	1.8 V power domain. If unused, keep this pin open.
GRFC2	84	DO	Generic RF controller		

External GNSS LNA Interface ⁸

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
GNSS_LNA_EN	51	DO	External GNSS LNA enable	$V_{OLmax} = 0.38\text{ V}$ $V_{OHmin} = 1.36\text{ V}$	1.8 V power domain. If unused, keep this pin open.
VDD_RF ⁹	99	PO	Can be used for external GNSS LNA power supply	$V_{nom} = 1.9\text{ V}$ $I_{Omax} = 50\text{ mA}$	If unused, keep this pin open.

RESERVED Pins

Pin Name	Pin No.	Comment
RESERVED	11–14, 16, 52, 53, 56, 57, 63, 75, 76, 77, 78, 92–94, 95, 97, 98	Keep these pins open.

1. For every VBAT transition/re-insertion from 0 V, VBAT slew rate < 25 mV/μs. After the module starts

NOTE

⁸ Only BG950A-GL supports GNSS_LNA_EN (pin 51) and VDD_RF (pin 99).

⁹ It is forbidden to connect high-power loads to VDD_RF, which will cause the system to crash.

up normally, in order to ensure full-function mode, the minimum power supply voltage should be higher than 2.2 V.

2. ADC input voltage must not exceed 1.8 V.
3. Keep all RESERVED pins and unused pins unconnected.
4. PCM and I2C interfaces are for VoLTE* only.

2.6. Evaluation Board

To help customers to develop applications with the module conveniently, Quectel supplies an evaluation board (EVB), USB to RS-232 converter cables, USB data cables, earphone, antennas, and other peripherals to control or to test the module. For more details, refer to **document [1]**.

3 Operating Characteristics

3.1. Operating Modes

The table below outlines operating modes of the module.

Table 7: Overview of Operating Modes

Mode	Details	
Normal Operation	Idle	Software is active. The module has registered on network, and it is ready to send and receive data.
	Talk/Data	Network is connected. In this mode, the power consumption is decided by network setting and data transfer rate.
Extended Idle Mode DRX (e-I-DRX)	The module and the network may negotiate over non-access stratum signaling the use of e-I-DRX for reducing power consumption, while being available for mobile terminating data and/or network originated procedures within a certain delay dependent on the DRX cycle value.	
Airplane Mode	AT+CFUN=4 or W_DISABLE#* pin can set the module into airplane mode where the RF function is invalid.	
Minimum Functionality Mode	AT+CFUN=0 can set the module into 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* and TCP/UDP data from the network normally. In this mode, the current consumption is reduced to a low level.	
Power OFF Mode	The module's power supply is shut down by its power management unit. In this mode, the software is inactive, the serial interfaces are inaccessible, while the operating voltage (connected to VBAT_BB and VBAT_RF) remains applied.	
Power Saving Mode (PSM)*	PSM is similar to power-off, but the module remains registered on the network and there is no need to re-attach or re-establish PDN connections. The current consumption is reduced to a minimized level.	

NOTE

During e-I-DRX, it is recommended to use UART interface for data communication, as the use of USB interface will increase power consumption.

3.2. Sleep Mode*

BG950A-GL & BG951A-GL can reduce their current consumption to a lower value during the sleep mode. The following sub-chapters describe the power saving procedure of BG950A-GL & BG951A-GL.

3.2.1. UART Application Scenario

If the host communicates with the module via UART interface, the following preconditions can let the module enter sleep mode:

- Execute **AT+QSCLK=2** to enable sleep mode.
- Drive MAIN_DTR high.
- Pull the PON_TRIG pin low.

The figure illustrates the connection between the module and the host.

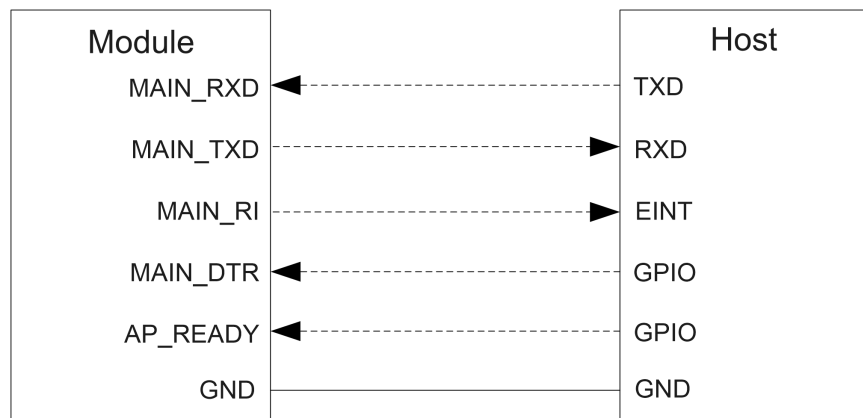


Figure 3: Sleep Mode Application via UART Interface

- Driving the module's MAIN_DTR low will wake up the module.
- When the module has a URC to report, MAIN_RI* signal will wake up the host. See **Chapter 4.6.4** for details about MAIN_RI* behavior.
- AP_READY* will detect the sleep state of the host (can be configured to high voltage level or low voltage level detection). See **AT+QCFG="apready"** in **document [2]** for details.

3.3. Power Saving Mode (PSM)*

BG950A-GL & BG951A-GL module can enter PSM for reducing its power consumption. The mode is similar to power-off, but the module remains registered on the network and there is no need to re-attach or re-establish PDN connections. So BG950A-GL & BG951A-GL module in PSM cannot immediately respond users' requests.

When the module wants to use the PSM, it shall request an Active Time value during every Attach and TAU procedures. If the network supports PSM and accepts that the module uses PSM, it will confirm the usage of PSM by allocating an Active Time value to the module. If the module wants to change the Active Time value, e.g. when the conditions are changed in the module, the module consequently requests the value it wants in the TAU procedure.

If PSM is supported by the network, then it can be enabled via **AT+CPSMS***.

Either of the following methods will wake up the module from PSM:

- Drive PWRKEY low will wake up the module.
- When the T3412_EXT timer expires, the module will be automatically woken up.
- When PON_TRIG is pulled high and maintains its level statue, the module will wake up from PSM (Power Saving Mode). PON_TRIG is pulled down by default.

NOTE

See **document [3]** for details about **AT+CPSMS***.

3.4. Extended Idle Mode DRX (e-I-DRX)

The module (UE) and the network may negotiate over non-access stratum signalling the use of e-I-DRX for reducing its power consumption, while being available for mobile terminating data and/or network originated procedures within a certain delay dependent on the DRX cycle value.

Applications that want to use e-I-DRX need to consider specific handling of mobile terminating services or data transfers, and in particular, they need to consider the delay tolerance of mobile terminated data.

In order to negotiate the use of e-I-DRX, the UE requests e-I-DRX parameters during attach procedure and RAU/TAU procedure. The EPC may reject or accept the UE request for enabling e-I-DRX. In case the EPC accepts e-I-DRX, the EPC based on operator policies and, if available, the e-I-DRX cycle length value in the subscription data from the HSS, may also provide different values of the e-I-DRX parameters than what was requested by the UE. If the EPC accepts the use of e-I-DRX, the UE applies e-I-DRX based on the received e-I-DRX parameters. If the UE does not receive e-I-DRX parameters in the

relevant accept message because the EPC rejected its request or because the request was received by EPC not supporting e-I-DRX, the UE shall apply its regular discontinuous reception.

If e-I-DRX is supported by the network, then it can be enabled by **AT+CEDRXS=1**.

NOTE

See **document [3]** for details about **AT+CEDRXS**.

3.5. Airplane Mode

When the module enters airplane mode, the RF function will be disabled, and all AT commands correlative with RF function will be inaccessible. This mode can be set via the following ways.

Hardware:

W_DISABLE#* pin is pulled up by default. Driving it low will let the module enter airplane mode.

Software:

AT+CFUN=<fun> provides choices of the functionality level through setting **<fun>** into 0, 1 or 4.

- **AT+CFUN=0**: Minimum functionality (Both RF function and (U)SIM function are disabled).
- **AT+CFUN=1**: Full functionality (by default).
- **AT+CFUN=4**: Airplane mode (RF function is disabled).

NOTE

1. Airplane mode control via W_DISABLE#* is disabled in firmware by default. It can be enabled by **AT+QCFG="airplanecontrol"***. More details about the command will be provided in **document [2]**.
2. The execution of **AT+CFUN** will not affect GNSS function.

For every VBAT transition/re-insertion from 0 V, VBAT slew rate < 25 mV/μs. After the module starts up normally, in order to ensure full-function mode, the minimum power supply voltage should be higher than 2.2 V.

3.6. Power Supply

3.6.1. Power Supply Pins

The module provides two VBAT pins dedicated to the connection with the external power supply.

Pin Name	Pin No.	Description	Min.	Typ.	Max.	Unit
VBAT_BB	32	Power supply for the module's baseband part	2.2	3.3	4.5	V
VBAT_RF	33	Power supply for the module's RF part	2.2	3.3	4.5	V
GND	3, 31, 48, 50, 54, 55, 58, 59, 61, 62, 67–74, 79–82, 89–91, 100–102		-	-	-	-

- One VBAT_RF pin for RF part.
- One VBAT_BB pin for baseband part.

Table 8: Pin Definition of Power Supply



3.6.2. Power Supply Monitoring

AT+CBC* can monitor the VBAT_BB voltage value. For more details, see **document [3]**.

3.6.3. Requirements for Voltage Stability

The power supply range of the module is from 2.2 V to 4.5 V. Make sure the input voltage will never drop below 2.2 V.

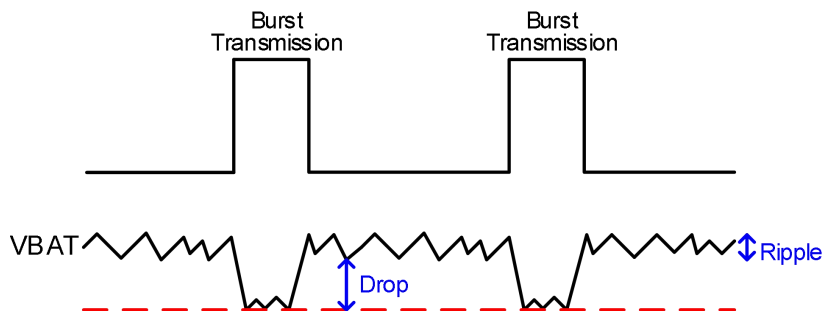


Figure 4: Power Supply Limits During Burst Transmission

To decrease voltage 's drop, a bypass capacitor of about 100 μF with low ESR should be used, and a multi-layer ceramic chip (MLCC) capacitor array should also be reserved due to its ultra-low ESR. It is recommended to use three ceramic capacitors for composing the MLCC array (100 nF, 33 pF, 10 pF), and place these capacitors close to VBAT pins. The main power supply from an external application must be a single voltage source and can be expanded to two sub paths with the star structure. The width of VBAT_BB trace should be no less than 1 mm. The width of VBAT_RF trace should be no less than 1 mm. In principle, the longer the VBAT trace is, the wider it will be.

In addition, to ensure the stability of the power supply, it is necessary to add two high-power TVSs at the front end of each power supply. Reference circuit of power supply is shown as below:

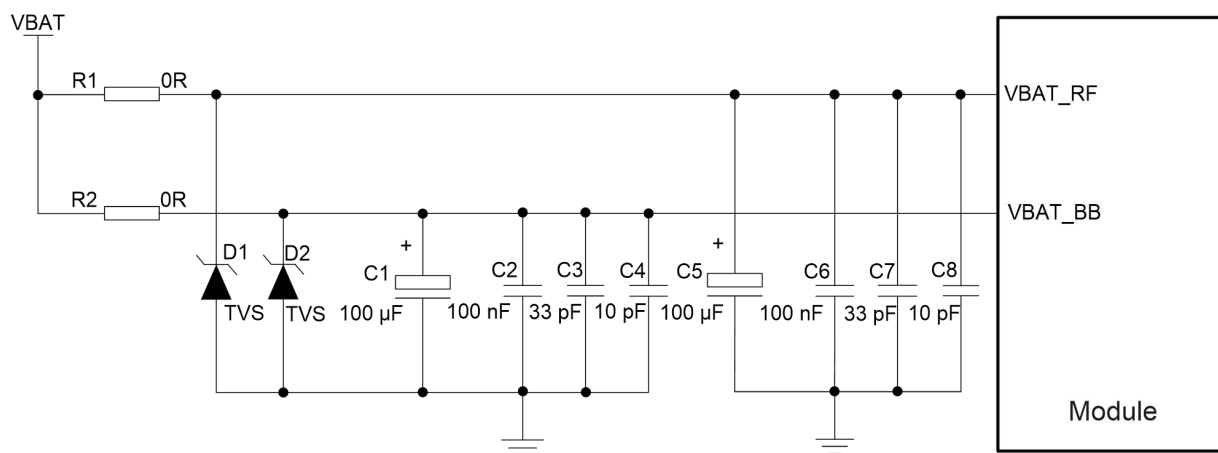


Figure 5: Star Structure of the Power Supply

3.7. Turn On

3.7.1. Turn on the Module with PWRKEY*

Table 9: Pin Definition of PWRKEY

Pin Name	Pin No.	I/O	Description	Comment
PWRKEY	15	DI	Turn on/off the module	Internally pulled up resistor is 470 kΩ.

When the module is in power off mode, it can be turned on and enter normal operation mode by driving the PWRKEY low for 500–1000 ms. It is recommended to use an open drain/collector driver to control the PWRKEY.

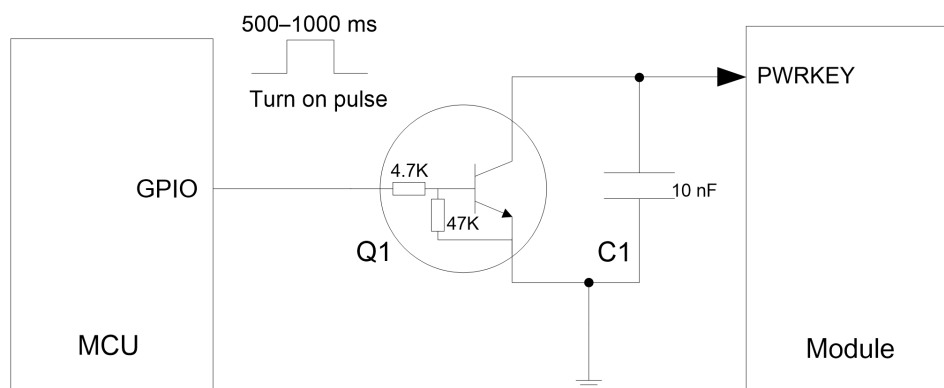


Figure 6: Turn on the Module by Using Driving Circuit

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

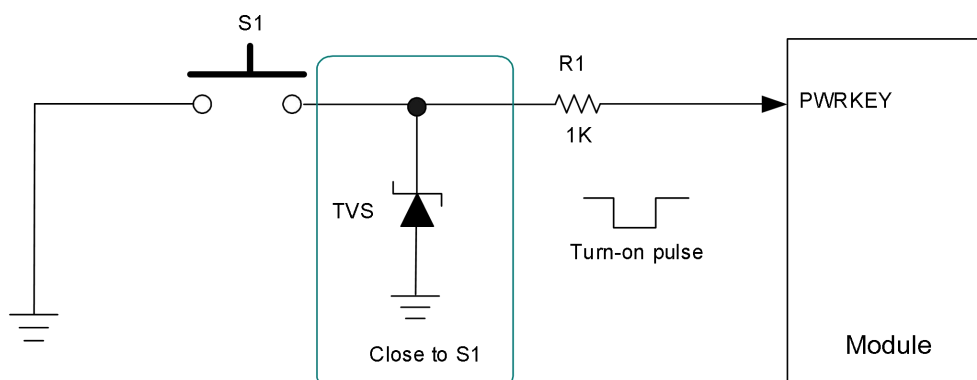


Figure 7: Turn on the Module by Using Keystroke

The power-up scenario is illustrated in the following figure.

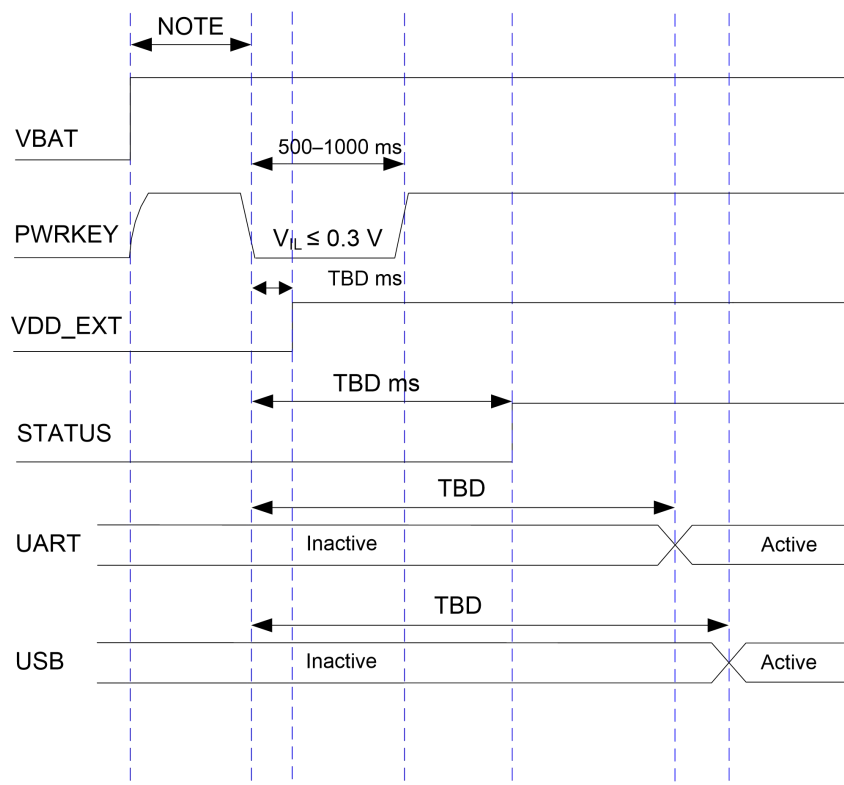


Figure 8: Power-up Timing

NOTE

Ensure that VBAT is stable for at least 30 ms before pulling down the PWRKEY.

3.8. Turn Off

The following procedures can be used to turn off the module:

3.8.1. Turn off the Module with PWRKEY*

When the module is in power on mode, driving the PWRKEY low for at least 650–1500 ms, then the module will execute power-down procedure after the PWRKEY is released.

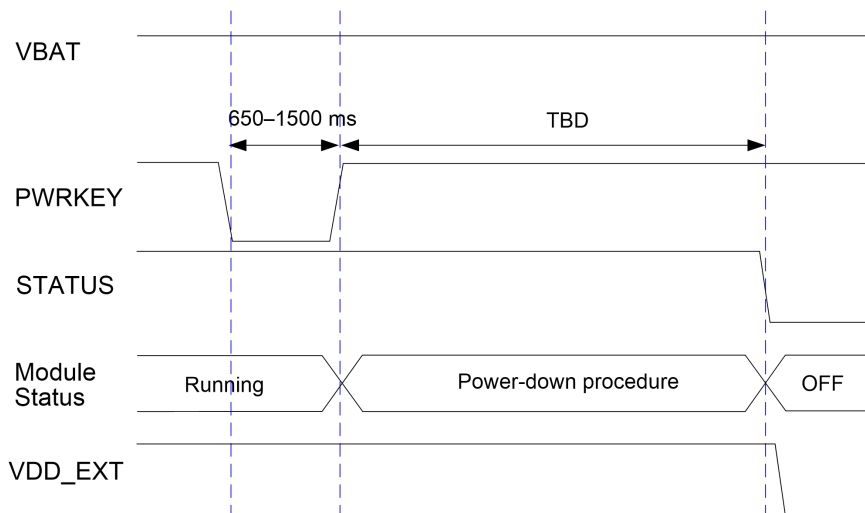


Figure 9: Power-down Timing

3.8.2. Turn off the Module with AT Command

It is safe to use **AT+QPOWD*** to turn off the module, which is equal to turn off the module via PWRKEY pin.

Refer to **document [3]** for details about **AT+QPOWD***.

NOTE

1. To avoid damaging the internal flash, do not switch off the power supply when the module works normally. Only after the module is turned off by PWRKEY or AT command, the power supply can be cut off.
2. When turning off module with AT command, keep PWRKEY at a high level after the execution of power-off command. Otherwise, the module will be turned on again after turned off.

3.9. Reset

The module can be reset by driving the RESET_N low for a certain time (TBD) and then releasing it. The RESET_N signal is sensitive to interference, so it is recommended to route the trace as short as possible and surround it with ground.

Table 10: Pin Definition of RESET_N

Pin Name	Pin No.	I/O	Description
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RESET_N	17	DI	Reset the module
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The recommended circuit is similar to the PWRKEY control circuit. An open drain/collector driver or button can be used to control RESET_N.

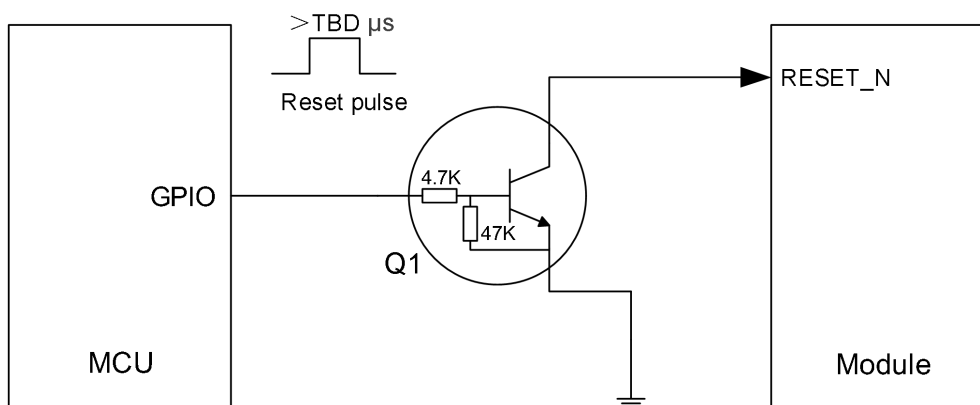


Figure 10: Reference Circuit of RESET_N with Driving Circuit

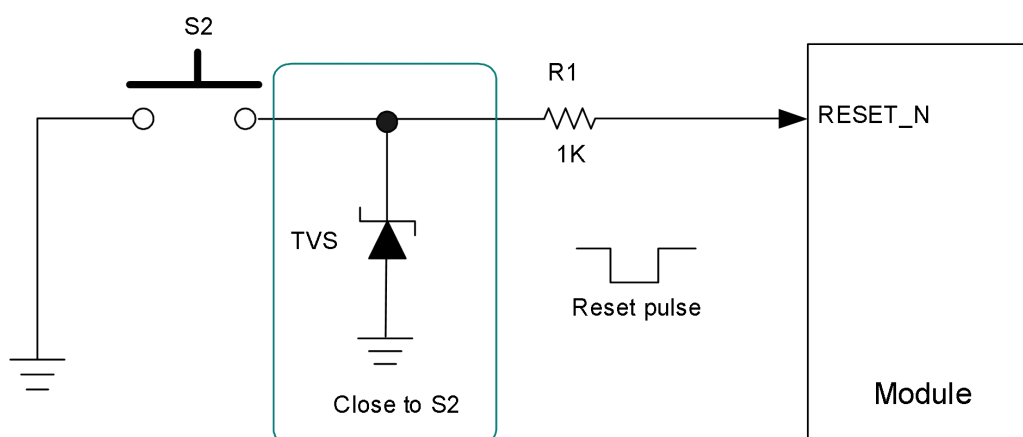


Figure 11: Reference Circuit of RESET_N with A Button

The reset timing is illustrated in the following figure.

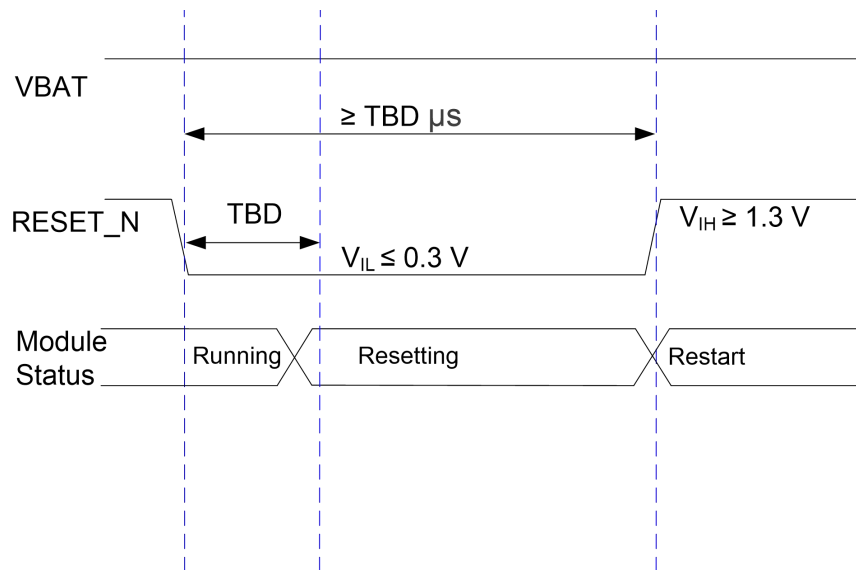


Figure 12: Reset Timing

3.10. PON_TRIG*

BG950A-GL & BG951A-GL modules provide one PON_TRIG pin which is used to wake up the module from PSM*.

Table 11: Pin Definition of PON_TRIG

Pin Name	Pin No.	I/O	Description	Comment
PON_TRIG	96	DI	Wake up the module from PSM	1.8 V power domain.

A reference circuit is shown in the following figure.

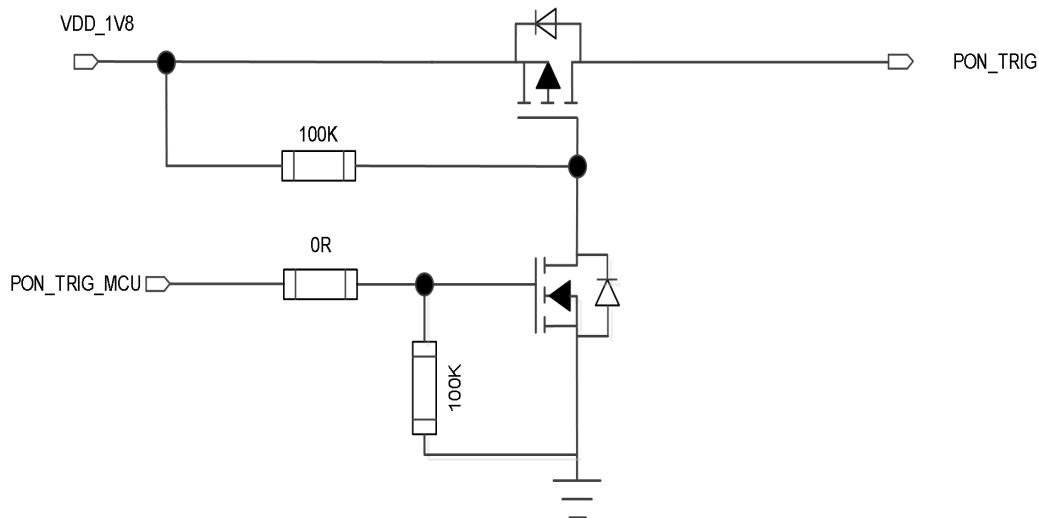


Figure 13: Reference Circuit of PON_TRIG

NOTE

1. VDD_1V8 is provided by an external LDO.
2. The PON_TRIG pin is pulled down by default. After the module starts up, the PON_TRIG pin must be pulled up so that the main UART interface can communicate. In normal operation mode, the PON_TRIG pin is recommended to be pulled up all the time.
3. After sending the AT command that makes the module enter PSM mode, drive PON_TRIG low can let the module enter PSM mode. When you need to wake up the module from PSM mode, PON_TRIG should be pulled up all the time, otherwise the module will re-enter PSM mode.
4. Send **AT+QSClk** first, and then drive PON_TRIG low after pulling down MAIN_DTR can make the module enter sleep mode, otherwise the module cannot enter sleep mode normally. When you need to wake up the module from sleep mode, PON_TRIG pin also should be pulled up all the time before pulling up MAIN_DTR, otherwise the main UART interface cannot communicate.

4 Application Interfaces

4.1. (U)SIM Interface

The circuitry of (U)SIM interfaces meet *ETSI* and *IMT-2000* requirements. BG950A-GL & BG951A-GL support 1.8 V (U)SIM card only.

Table 12: Pin Definition of (U)SIM Interface

Pin Name	Pin No.	I/O	Description	Comment
USIM_DET*	42	DI	(U)SIM card hot-plug detection	1.8 V power domain. If unused, keep this pin open.
USIM_VDD	43	PO	(U)SIM card power supply	Only 1.8 V (U)SIM card is supported.
USIM_RST	44	DO	(U)SIM card reset	
USIM_DATA	45	DIO	(U)SIM card data	1.8 V power domain.
USIM_CLK	46	DO	(U)SIM card clock	
USIM_GND	47		Specified ground for (U)SIM card	

The module supports (U)SIM card hot-plug via the USIM_DET* pin, and both high-level and low-level detections are supported. The function is disabled by default, and refer to **AT+QSIMDET** in **document [3]** for more details.

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

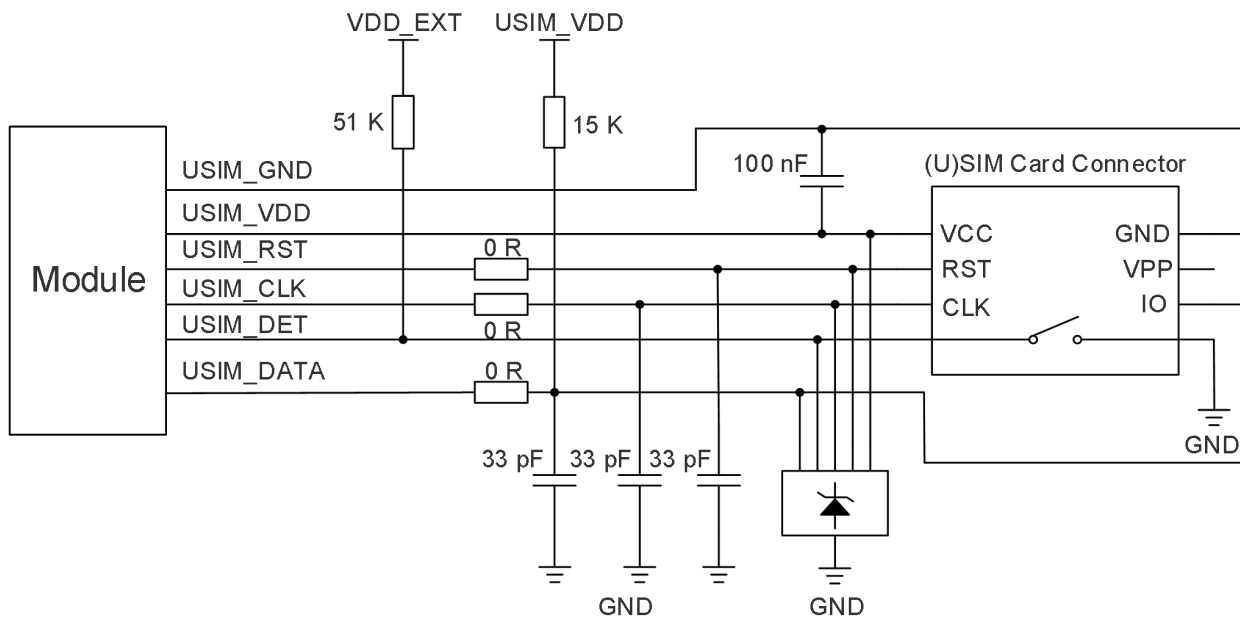


Figure 14: Reference Circuit of (U)SIM Interface with an 8-Pin (U)SIM Card Connector

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

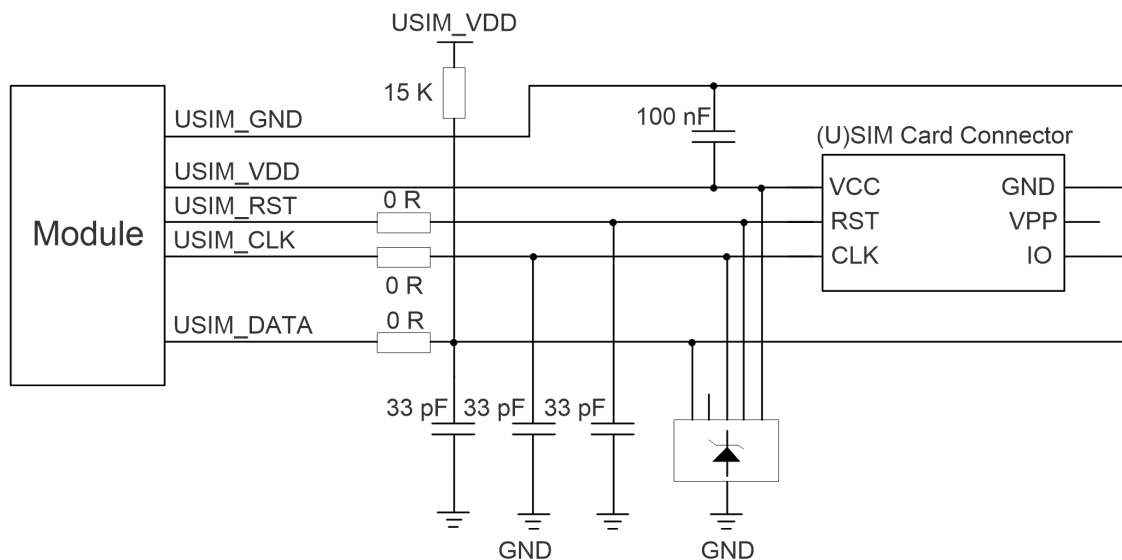


Figure 15: Reference Circuit of (U)SIM Interface with a 6-Pin (U)SIM Card Connector

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

- Keep the placement of (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 VBAT traces.
- Assure the ground between the module and the (U)SIM card connector short and wide. Keep the trace width of ground and USIM_VDD no less than 0.5 mm to maintain the same electric potential. If the ground is complete on customers' PCB, USIM_GND can be connected to PCB ground directly.
- Make sure the bypass capacitor between USIM_VDD and USIM_GND less than 1 μ F, and place it as close to (U)SIM card connector as possible.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them away from each other and shield them with surrounded ground.
- To offer good ESD protection, it is recommended to add a TVS diode array of which parasitic capacitance should not be more than 15 pF. The 0 Ω resistors should be added in series between the module and the (U)SIM card to facilitate debugging. The 33 pF capacitors are used for filtering interference of EGSM900. Please 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 occasions are applied, and should be placed close to the (U)SIM card connector.

4.2. USB Interface*

The module provides one USB interface. The USB interface complies with the USB 2.0 specifications, and supports Full-speed (12 Mbps) and Low-speed (1.5 Mbps) for USB 2.0.

USB interface is used AT command communication, data transmission, software debugging and firmware upgrade.

Table 13: Pin Definition of USB Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_VBUS	8	AI	USB connection detect	Typ. 5.0 V
USB_DP	9	AIO	USB differential data (+)	Compliant with USB 2.0 standard specification. Require differential impedance of 90 Ω .
USB_DM	10	AIO	USB differential data (-)	

It is recommended to reserve test points for debugging and firmware upgrading in customers' designs.

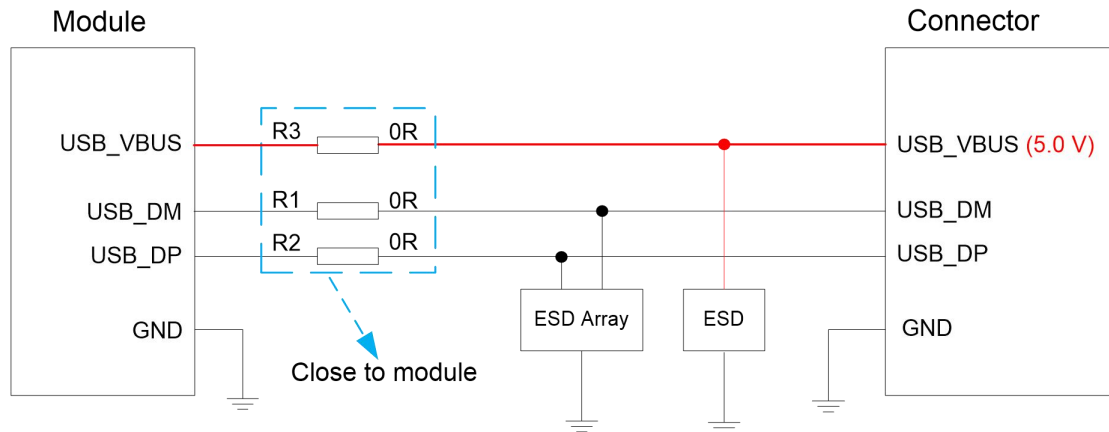


Figure 16: Reference Circuit of USB Application

To ensure the integrity of USB data trace signal, resistors R1 and R2 should be placed close to the module, and 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, comply with the following principles while designing the USB interface.

- It is important to 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, PCIe and RF signal traces. It is important to 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 pay attention to the selection of the device. Typically, the stray capacitance should be less than 2 pF.
- Keep the ESD protection devices as close to the USB connector as possible.
- If possible, reserve a 0 Ω resistor on USB_DP and USB_DM traces respectively.

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

4.3. PCM and I2C Interfaces*

The module provides one Pulse Code Modulation (PCM) digital interface and one I2C interface for VoLTE* only. The PCM interface supports the following modes:

Table 14: Pin Definition of PCM Interface

Pin Name	Pin No.	I/O	Description	Comment
PCM_CLK	4	DO	PCM clock	
PCM_SYNC	5	DO	PCM data frame sync	1.8 V power domain.
PCM_DIN	6	DI	PCM data input	If unused, keep this pin open.
PCM_DOUT	7	DO	PCM data output	

Table 15: Pin Definition of I2C Interface

Pin Name	Pin No.	I/O	Description	Comment
I2C_SCL	40	OD	I2C serial clock (for external codec)	External pull-up resistor is required.
I2C_SDA	41	OD	I2C serial data (for external codec)	1.8 V only. If unused, keep this pin open.

The reference design is illustrated as follows:

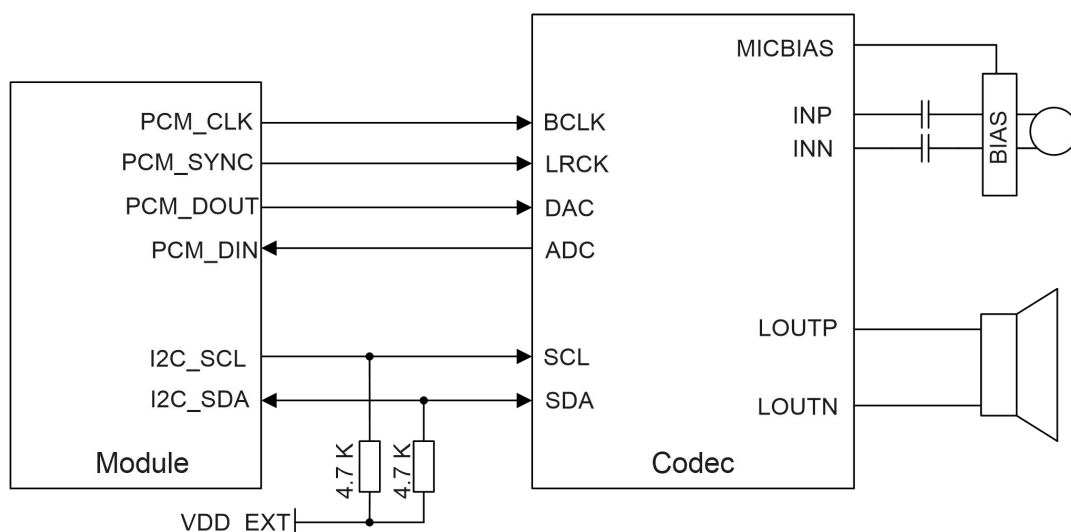


Figure 17: Reference Circuit of PCM Interface

4.4. UART Interfaces

Pin definition of the UART interface is shown as follows:

Table 16: Pin Definition of Main UART Interface

Pin Name	Pin No.	I/O	Description	Comment
MAIN_DTR	30	DI	Main UART data terminal ready	
MAIN_RXD	34	DI	Main UART receive	
MAIN_TXD	35	DO	Main UART transmit	
MAIN_CTS	36	DO	Main UART clear to send	1.8 V power domain If unused, keep this pin open.
MAIN_RTS	37	DI	Main UART request to send	
MAIN_DCD	38	DO	Main UART data carrier detect	
MAIN_RI	39	DO	Main UART ring indication	

The module provides three UART interfaces and the following shows their features:

Table 17: UART Information

Parameters	Main UART Interface	Debug UART Interface	Auxiliary UART Interface
Supported Baud Rate	9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps, 230400 bps, 460800 bps, 921600 bps and 3000000 bps	9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps, 230400 bps, 460800 bps, 921600 bps and 3000000 bps	-
Default Baud Rate	115200 bps	115200 bps	921600 bps
Default frame format	8N1 (8 data bits, no parity, 1 stop bit)	8N1 (8 data bits, no parity, 1 stop bit).	8N1 (8 data bits, no parity, 1 stop bit).
Functions	• Data transmission • AT command communication • RTS and CTS hardware flow control	• Firmware upgrade • Software debugging • Log output	• RF calibration • Log output

NOTE

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

Table 18: Pin Definition of Debug UART Interface

Pin Name	Pin No.	I/O	Description	Comment
DBG_TXD	23	DO	Debug UART transmit	1.8 V power domain If unused, keep this pin open.
DBG_RXD	22	DI	Debug UART receive	

Table 19: Pin Definition of Auxiliary UART Interface

Pin Name	Pin No.	I/O	Description	Comment
AUX/GNSS_TXD	27	DO	Auxiliary/GNSS UART transmit	1.8 V power domain If unused, keep this pin open.
AUX/GNSS_RXD	28	DI	Auxiliary/GNSS UART receive	

The module provides 1.8 V UART interfaces. A voltage-level translator should be used if the application is equipped with a 3.3 V UART interface. The following figure shows a reference design of the main UART interface:

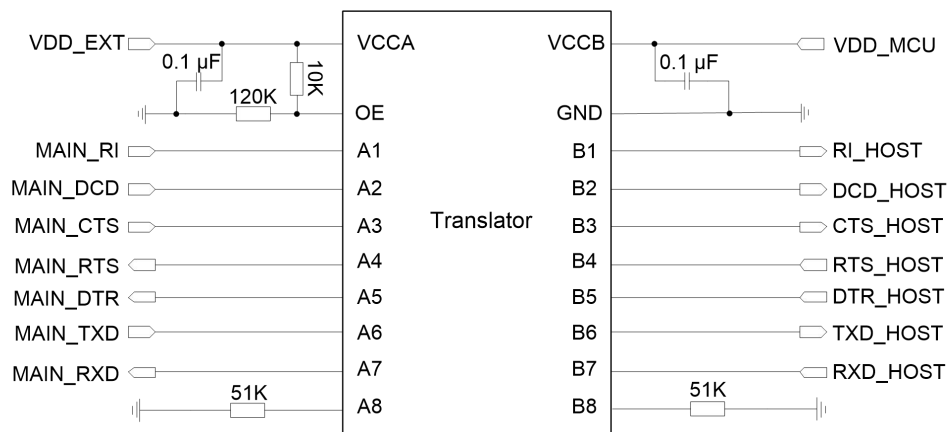


Figure 18: Reference Circuit with Translator Chip

Visit <http://www.ti.com> for more information.

Another example with transistor circuit is shown as below. For the design of circuits shown in dotted lines, refer to that shown in solid lines, but pay attention to the direction of connection.

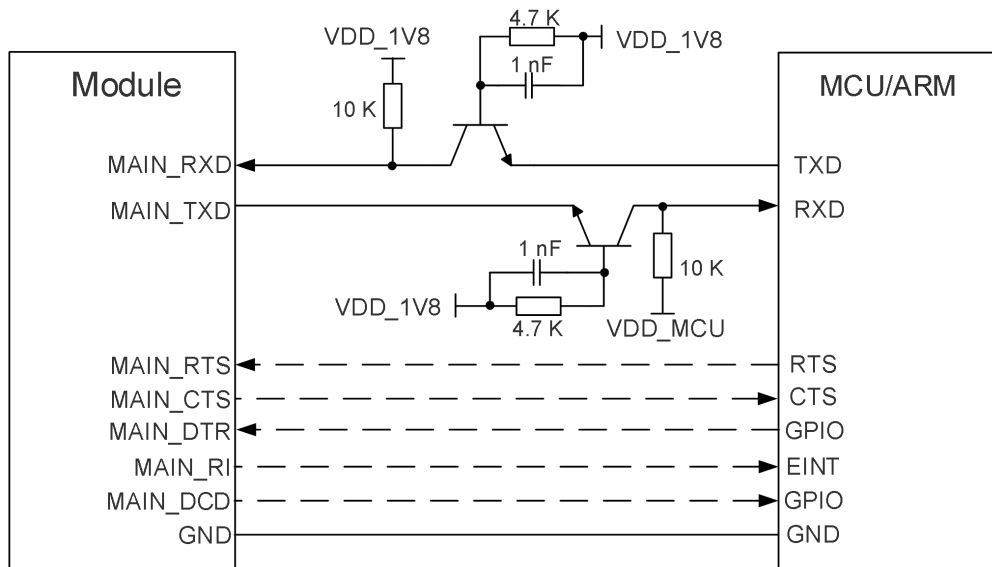


Figure 19: Reference Circuit with Transistor Circuit

NOTE

1. Transistor circuit solution is not suitable for applications with high baud rates exceeding 460 kbps.
2. The main UART of the module shouldn't be asserted high during BG950A-GL & BG951A-GL enter PSM.
3. Please note that the module CTS is connected to the host CTS, and the module RTS is connected to the host RTS.

4.5. ADC Interface

The module provides two Analog-to-Digital Converter (ADC) interfaces. To improve the accuracy of ADC, the trace of ADC interfaces should be surrounded by ground.

Table 20: Pin Definition of ADC Interface

Pin Name	Pin No.	I/O	Description	Comment
ADC0	24	AI	General-purpose ADC interface	Voltage range: 0–1.8 V
ADC1	2	AI	General-purpose ADC interface	

The voltage value on ADC pins can be read via **AT+QADC=<port>**:

- **AT+QADC=0**: read the voltage value on ADC0
- **AT+QADC=1**: read the voltage value on ADC1

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

The resolution of the ADC is up to 12 bits. The following table describes the characteristic of the ADC interface.

Table 21: Characteristics of ADC Interface

Name	Min.	Typ.	Max.	Unit
Voltage Range	0	-	1.8	V
Resolution	6	-	12	bit
Input Resistance	-	-	TBD	KΩ

NOTE

1. ADC input voltage must not exceed 1.8 V.
2. It is prohibited to supply any voltage to ADC pin when VBAT is removed.
3. It is recommended to use resistor divider circuit for ADC application, and the divider's resistor accuracy should be no less than 1 %.

4.6. Indication Signal

4.6.1. PSM Status Indication*

Table 22: Pin Definition of PSM_IND

Pin Name	Pin No.	I/O	Description	Comment
PSM_IND	1	DO	Indicate the module's power saving mode	1.8 V power domain. If unused, keep this pin open.

When PSM is enabled, the function of PSM_IND pin will be activated after the module is rebooted. When PSM_IND is in high voltage level, the module is in normal operation state. When it is in low level, the module is in PSM.

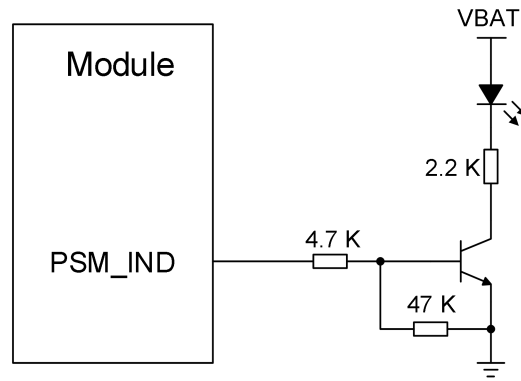


Figure 20: Reference Circuit of the PSM Status Indication

4.6.2. Network Status Indication*

Table 23: Pin Definition of NET_STATUS

Pin Name	Pin No.	I/O	Description	Comment
NET_STATUS	21	DO	Module network activity status indication	1.8 V power domain. If unused, keep this pin open.

The network indication pins can be used to drive network status indication LEDs. The module provides two network indication pins: NET_MODE and NET_STATUS. The following tables describe pin definition and logic level changes in different network status.

Table 24: Working State of Network Connection Status Indication

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

A reference circuit is shown in the following figure.

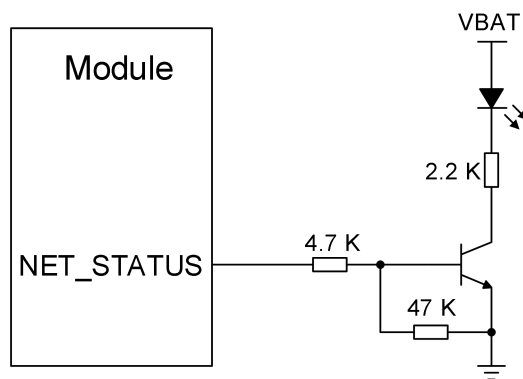


Figure 21: Reference Circuit of Network Status Indication

4.6.3. STATUS

The STATUS pin is an open drain output for indicating the module's operation status. It will output high level when module is powered on successfully.

Table 25: Pin Definition of STATUS

Pin Name	Pin No.	I/O	Description	Comment
STATUS	20	DO	Indicate the module's operation status	1.8 V power domain

A reference circuit is shown as below.

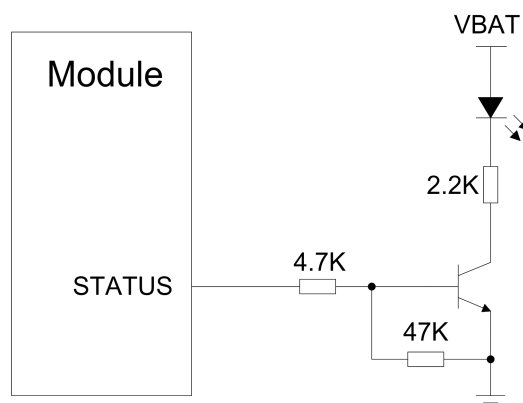


Figure 22: Reference Circuits of STATUS

4.6.4. Behaviors of MAIN_RI*

AT+QCFG= "risignalttype", "physical" can be used to configure MAIN_RI behavior. No matter on which port a URC is presented, the URC will trigger the behavior of MAIN_RI pin.

Table 26: Pin Definition of MAIN_RI

Pin Name	Pin No.	I/O	Description	Comment
MAIN_RI	39	DO	Main UART ring indication	1.8 V power domain. If unused, keep this pin open.

NOTE

The URC can be outputted via UART port, USB AT port and USB modem port, which can be set by **AT+QURCCFG**. The default port is USB AT port.

In addition, MAIN_RI behaviors can be configured flexibly. The default behavior of the MAIN_RI is shown as below.

Table 27: Default Behaviors of MAIN_RI

State	Response
Idle	MAIN_RI keeps at high level.
URC	MAIN_RI outputs 120 ms low pulse when new URC returns.

The MAIN_RI behavior can be changed via **AT+QCFG="urc/ri/ring"***. See **document [2]** for details.

NOTE

URC can be outputted from UART port, USB AT port and USB modem port, through configuration via **AT+QURCCFG**. The default port is USB AT port.

4.7. GRFC Interface*

The module provides two generic RF control interfaces for the control of external antenna tuners.

Table 28: Pin Definition of GRFC Interface

Pin Name	Pin No.	I/O	Description	Comment
GRFC1	83	DO	Generic RF controller	1.8 V power domain.
GRFC2	84	DO	Generic RF controller	

Table 29: Truth Table of GRFC Interface

GRFC1 Level	GRFC2 Level	Frequency Range (MHz)	Band
Low	Low	TBD	TBD
Low	High	TBD	TBD
High	Low	TBD	TBD
High	High	TBD	TBD

4.8. GPIO Interface*

The module provides nine general-purpose input and output (GPIO) interfaces. **AT+QCFG="gpio"** command can be used to configure the status of GPIO pins. For more details about the AT command, see [document \[2\]](#).

Table 30: Pin Definition of GPIO Interface

Pin Name	Pin No.	I/O	Description	Comment
GPIO1	25	DIO	General-purpose input/output	1.8 V power domain.
GPIO2	26	DIO	General-purpose input/output	
GPIO3	64	DIO	General-purpose input/output	
GPIO4	65	DIO	General-purpose input/output	

GPIO5	66	DIO	General-purpose input/output
GPIO6	85	DIO	General-purpose input/output
GPIO7	86	DIO	General-purpose input/output
GPIO8	87	DIO	General-purpose input/output
GPIO9	88	DIO	General-purpose input/output

5 RF Specifications

5.1. Cellular Network

5.1.1. Antenna Interface & Frequency Bands

The pin definition is shown as below:

Table 31: Pin Definition of Cellular Network Interface

Pin Name	Pin No.	I/O	Description	Comment
ANT_MAIN	60	AIO	Main antenna interface	50 Ω impedance

NOTE

Only passive antennas are supported.

Table 32: Operating Frequency of BG950A-GL & BG951A-GL

Operating Frequency	Transmit (MHz)	Receive (MHz)	Unit
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 B8	880–915	925–960	MHz
LTE-FDD B12	699–716	729–746	MHz

LTE-FDD B13	777–787	746–756	MHz
LTE-FDD B17 ¹⁰	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 B27	807–824	852–869	MHz
LTE-FDD B28	703–748	758–803	MHz
LTE-FDD B66	1710–1780	2110–2180	MHz

5.1.2. RF Output Power

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

Table 33: RF Output Power

Frequency Bands	Max. RF Output Power	Min. RF Output Power
LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/B17/B18/B19/B20/ B25/B26/B27/B28/B66	23 dBm $\pm$ 2.7 dB	< -39 dBm

¹⁰ LTE-FDD B17 is supported by Cat NB2* only.

5.1.3. Receiving Sensitivity

The following table shows conducted RF receiving sensitivity of the module.

Table 34: Conducted RF Receiving Sensitivity of BG950A-GL

Network	Frequency Band	Primary	Diversity	Sensitivity (dBm)	
				Cat M1/3GPP	Cat NB2 ¹¹ /3GPP
LTE	LTE-FDD B1	Supported	-	TBD/-102.3	TBD/-107.5
	LTE-FDD B2			TBD/-100.3	TBD/-107.5
	LTE-FDD B3			TBD/-99.3	TBD/-107.5
	LTE-FDD B4			TBD/-102.3	TBD/-107.5
	LTE-FDD B5			TBD/-100.8	TBD/-107.5
	LTE-FDD B8			TBD/-99.8	TBD/-107.5
	LTE-FDD B12			TBD/-99.3	TBD/-107.5
	LTE-FDD B13			TBD/-99.3	TBD/-107.5
	LTE-FDD B17 ¹²			-	TBD/-107.5
	LTE-FDD B18			TBD/-102.3	TBD/-107.5
	LTE-FDD B19			TBD/-102.3	TBD/-107.5
	LTE-FDD B20			TBD/-99.8	TBD/-107.5
	LTE-FDD B25			TBD/-100.3	TBD/-107.5
	LTE-FDD B26 ¹³			TBD/-100.3	-
	LTE-FDD B27 ¹⁶			TBD/-100.8	-
	LTE-FDD B28			TBD/-100.8	TBD/-107.5
	LTE-FDD B66			TBD/-101.8	TBD/-107.5

¹¹ LTE Cat NB2* receiving sensitivity without repetitions.

¹² LTE-FDD B17 is supported by Cat NB2* only.

¹³ LTE-FDD B26 and B27 are supported by Cat M1 only.

Table 35: Conducted RF Receiving Sensitivity of BG951A-GL

Network	Frequency Band	Primary	Diversity	Sensitivity (dBm)	
				Cat M1/3GPP	Cat NB2 ¹⁴ /3GPP
LTE	LTE-FDD B1	Supported	-	TBD/-102.3	TBD/-107.5
	LTE-FDD B2			TBD/-100.3	TBD/-107.5
	LTE-FDD B3			TBD/-99.3	TBD/-107.5
	LTE-FDD B4			TBD/-102.3	TBD/-107.5
	LTE-FDD B5			TBD/-100.8	TBD/-107.5
	LTE-FDD B8			TBD/-99.8	TBD/-107.5
	LTE-FDD B12			TBD/-99.3	TBD/-107.5
	LTE-FDD B13			TBD/-99.3	TBD/-107.5
	LTE-FDD B17 ¹⁵			-	TBD/-107.5
	LTE-FDD B18			TBD/-102.3	TBD/-107.5
	LTE-FDD B19			TBD/-102.3	TBD/-107.5
	LTE-FDD B20			TBD/-99.8	TBD/-107.5
	LTE-FDD B25			TBD/-100.3	TBD/-107.5
	LTE-FDD B26 ¹⁶			TBD/-100.3	-
	LTE-FDD B27 ²⁰			TBD/-100.8	-
	LTE-FDD B28			TBD/-100.8	TBD/-107.5
	LTE-FDD B66			TBD/-101.8	TBD/-107.5

5.1.4. Reference Design

¹⁴ LTE Cat NB2* receiving sensitivity without repetitions.

¹⁵ LTE-FDD B17 is supported by Cat NB2* only.

¹⁶ LTE-FDD B26 and B27 are supported by Cat M1 only.

The module provides one RF antenna interface for antenna connection.

It is recommended to reserve a π -type matching circuit for better RF performance, and the π -type matching components (R1, C1 and C2) should be placed as close to the antenna as possible. The capacitors are not mounted by default.

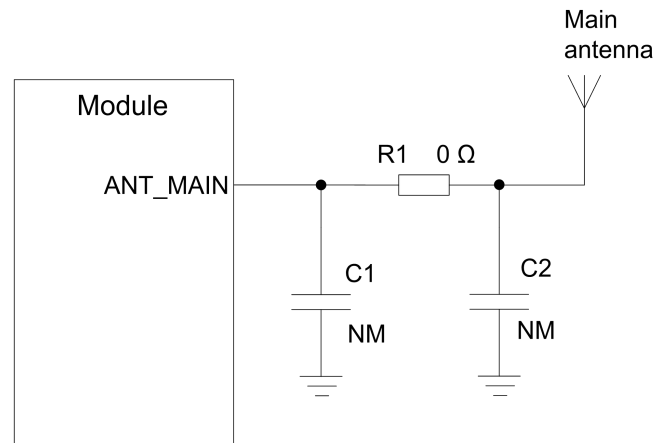


Figure 23: Reference Circuit for Main Antenna Interface

5.2. GNSS Network

The module includes a fully integrated global navigation satellite system solution that supports GPS, GLONASS.

The module supports standard *NMEA-0183* protocol, and outputs NMEA sentences via debug UART interface (data update rate: 1–10 Hz, 1 Hz by default).

By default, the module's GNSS function is switched off. It must be switched on via AT command. For more details about GNSS function's technology and configurations, see **document [4]**.

5.2.1. Antenna Interface & Frequency Bands

The following table shows the pin definition, frequency bands, and performance of GNSS antenna interface.

Table 36: Pin Definition of GNSS Antenna Interface

Pin Name	Pin No.	I/O	Description	Comment
----------	---------	-----	-------------	---------

ANT_GNSS	49	AI	GNSS antenna interface	50 Ω impedance
----------	----	----	------------------------	-----------------------

Table 37: GNSS Frequency

Type	Frequency	Unit
GPS	1575.42 $\pm$ 1.023	MHz
GLONASS	1597.5–1605.8	MHz

5.2.2. GNSS Performance

Table 38: GNSS Performance

Parameter	Description	Conditions	Typ.	Unit
Sensitivity (GNSS)	Cold start	Autonomous	TBD	dBm
	Reacquisition	Autonomous	TBD	
	Tracking	Autonomous	TBD	
TTFF (GNSS)	Cold start @ open sky	Autonomous	TBD	s
		XTRA enabled	TBD	
	Warm start @ open sky	Autonomous	TBD	
		XTRA enabled	TBD	
	Hot start @ open sky	Autonomous	TBD	
		XTRA enabled	TBD	
Accuracy (GNSS)	CEP-50	Autonomous @ open sky	TBD	M

NOTE

1. Tracking sensitivity: the lowest GNSS signal value at the antenna port on which the module can keep on positioning for 3 minutes.
2. Re-acquisition sensitivity: the lowest GNSS signal value at the antenna port on which the module can fix position again within 3 minutes after loss of lock.
3. Cold start sensitivity: the lowest GNSS signal value at the antenna port on which the module fixes position within 3 minutes after executing cold start commands.

5.2.3. Reference Design

The following is the reference circuit of GNSS antenna.

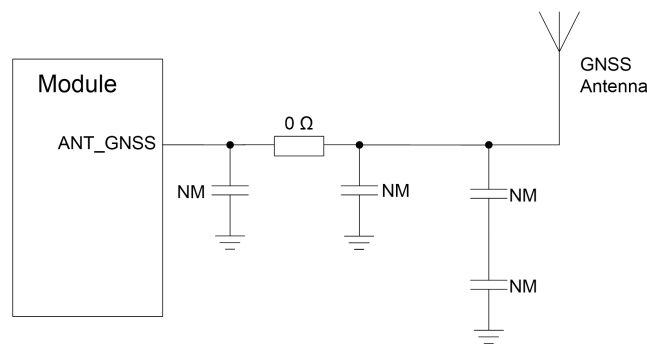


Figure 24: Reference Circuit of GNSS Antenna

NOTE

The module of BG950A-GL & BG951A-GL are designed with a passive antenna.

5.3. Reference Design of RF Routing

For user's PCB, the characteristic impedance of all RF traces should be controlled to $50\ \Omega$. The impedance of the RF traces is usually determined by the trace width (W), the materials' dielectric constant, the height from the reference ground to the signal layer (H), and the spacing between RF traces and grounds (S). Microstrip or coplanar waveguide is typically used in RF layout to control characteristic impedance. The following are reference designs of microstrip or coplanar waveguide with different PCB structures.

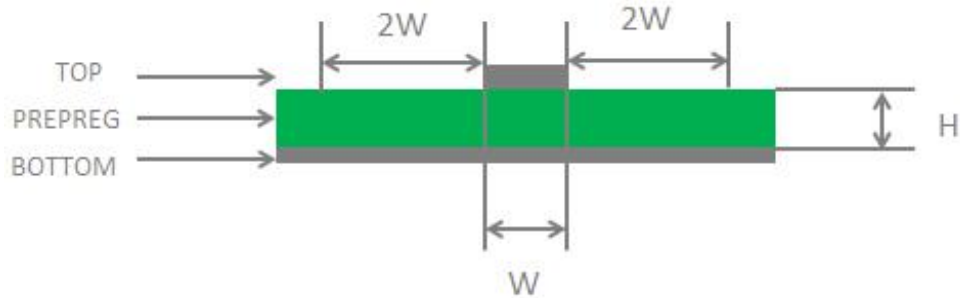


Figure 25: Microstrip Design on a 2-layer PCB

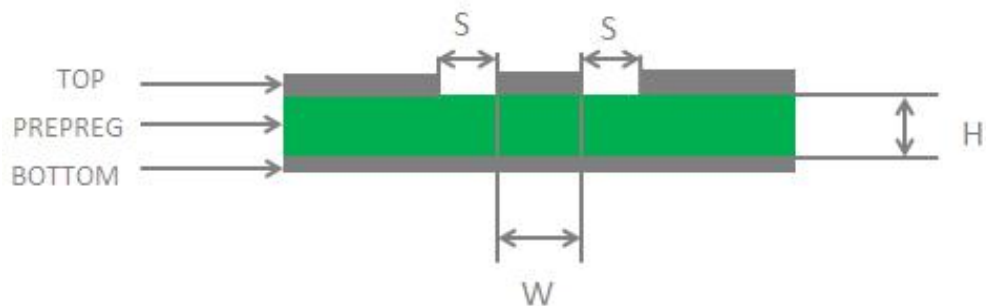


Figure 26: Coplanar Waveguide Design on a 2-layer PCB

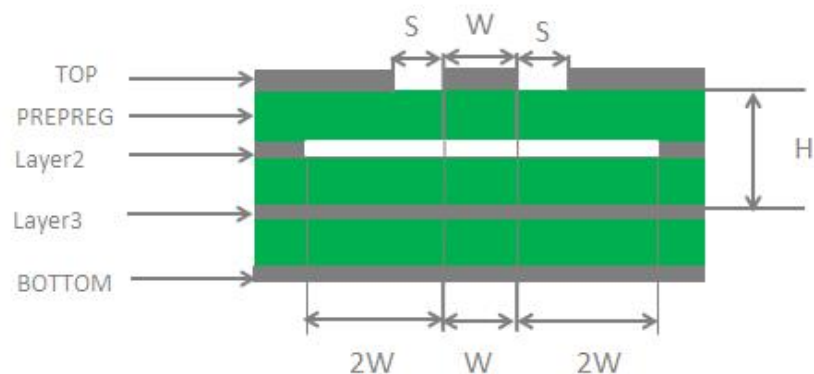


Figure 27: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

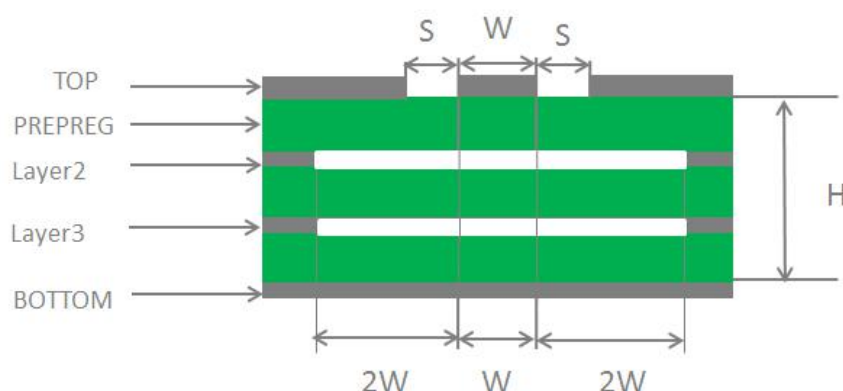


Figure 28: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

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

- Use an impedance simulation tool to accurately control the characteristic impedance of RF traces to 50 Ω .
- The GND pins adjacent to RF pins should not be designed as thermal relief pads, and should be fully connected to ground.
- The distance between the RF pins and the RF connector should be as short as possible and all the right-angle traces should be changed to curved ones. The recommended trace angle is 135°.
- There should be clearance under the signal pin of the antenna connector or solder joint.
- The reference ground of RF traces should be complete. Meanwhile, adding some ground vias around RF traces and the reference ground could help to improve RF performance. The distance between the ground vias and RF traces should be no less than two times the width of RF signal traces ($2 \times W$).
- Keep RF traces away from interference sources, and avoid intersection and paralleling between traces on adjacent layers.

For more details about RF layout, see **document [5]**.

5.4. Requirements for Antenna Design

Table 39: Requirements for Antenna Design

Antenna Type	Requirements
GNSS ¹⁷	Frequency range: 1559–1609 MHz

¹⁷ It is recommended to use a passive GNSS antenna when LTE B13 is supported, as the use of active antenna may generate harmonics which will affect the GNSS performance.

	Polarization: RHCP or linear VSWR: < 2 (Typ.) Passive antenna gain: > 0 dBi Active antenna noise figure: < 1.5 dB Active antenna gain: > 0 dBi Active antenna embedded LNA gain: 17 dB
LTE	VSWR: ≤ 2 Efficiency: > 30 % Gain: 1 dBi Max input power: 50 W Input impedance: 50 Ω Polarization: vertical Cable insertion loss: < 1 dB: LB (<1 GHz) < 1.5 dB: MB (1–2.3 GHz)

5.5. RF Connector Recommendation

The receptacle dimensions are illustrated as below.

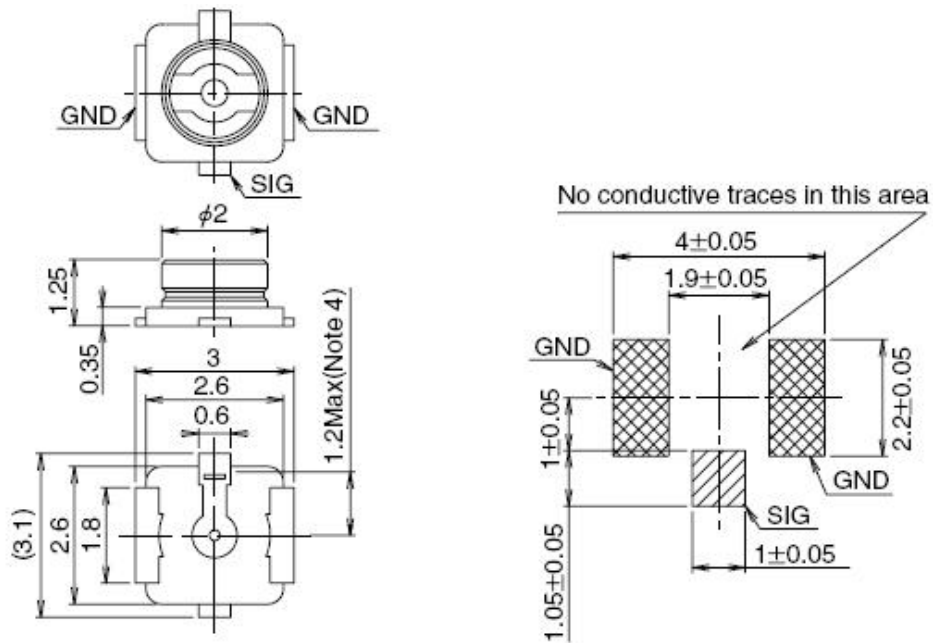


Figure 29: Dimensions of the U.FL-R-SMT Connector (Unit: mm)

U.FL-LP serial connectors listed in the following figure can be used to match the U.FL-R-SMT.

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 30: Mechanicals of U.FL-LP Connectors

The following figure describes the space factor of mated connector.

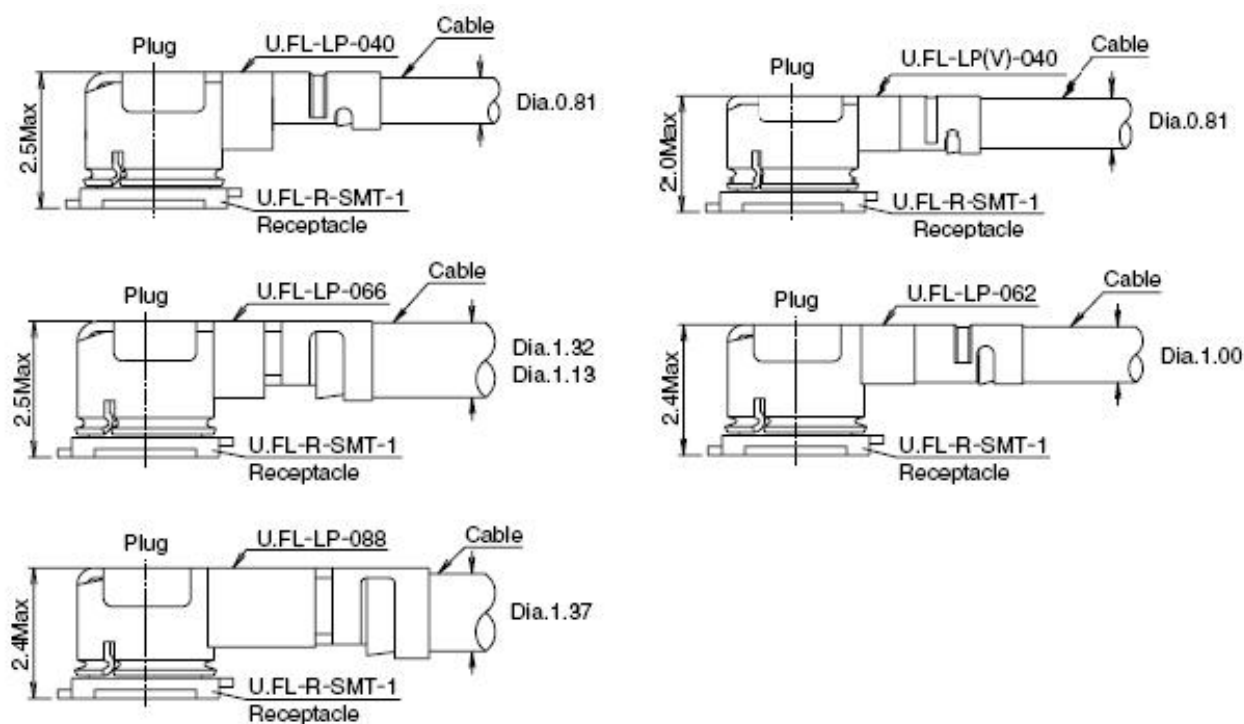


Figure 31: Space Factor of Mated Connector (Unit: mm)

For more details, visit <http://www.hirose.com>.

6 Reliability and Electrical

7 Characteristics

7.1. Absolute Maximum Ratings

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

Table 40: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VBAT_RF/VBAT_BB	-0.2	4.5	V
USB_VBUS	-0.3	6.0	V
Voltage on Digital Pins	-0.3	2.0	V

7.2. Power Supply Ratings

Table 41: The Module's Power Supply Ratings

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
VBAT_BB/ VBAT_RF	Power supply for the module's baseband part/Power supply for the module's RF part	The actual input voltages must stay between the minimum and maximum values.	2.2	3.3	4.5	V
USB_VBUS	USB connection		-	5.0	-	V

detect

7.3. Power Consumption

Table 42: BG950A-GL Power Consumption

BG950A-GL (Power Supply: 3.3 V, Room Temperature)				
Description	Conditions	Avg.	Max.	Unit
Leakage	Power-off @ USB/UART disconnected	2.1	-	μA
PSM	PSM @ USB/UART disconnected	TBD	-	μA
Rock bottom	AT+CFUN=0 @ Sleep mode	TBD	-	mA
Sleep mode (USB disconnected)	LTE Cat M1 DRX = 1.28 s	TBD	-	mA
	LTE Cat NB1 DRX = 1.28 s	TBD	-	mA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	TBD	-	mA
	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	TBD	-	mA
	LTE Cat M1 DRX = 1.28 s	TBD	-	mA
	LTE Cat NB1 DRX = 1.28 s	TBD	-	mA
Idle state	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	TBD	-	mA
	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	TBD	-	mA
	LTE-FDD B1 @ dBm	TBD	TBD	mA
	LTE-FDD B2 @ dBm	TBD	TBD	mA
LTE Cat M1 data transfer (GNSS OFF)	LTE-FDD B3 @ dBm	TBD	TBD	mA

	LTE-FDD B4 @ dBm	TBD	TBD	mA
	LTE-FDD B5 @ dBm	TBD	TBD	mA
	LTE-FDD B8 @ dBm	TBD	TBD	mA
	LTE-FDD B12 @ dBm	TBD	TBD	mA
	LTE-FDD B13 @ dBm	TBD	TBD	mA
	LTE-FDD B18 @ dBm	TBD	TBD	mA
	LTE-FDD B19 @ dBm	TBD	TBD	mA
	LTE-FDD B20 @ dBm	TBD	TBD	mA
	LTE-FDD B25 @ dBm	TBD	TBD	mA
	LTE-FDD B26 @ dBm	TBD	TBD	mA
	LTE-FDD B27 @ dBm	TBD	TBD	mA
	LTE-FDD B28 @ dBm	TBD	TBD	mA
	LTE-FDD B66 @ dBm	TBD	TBD	mA
	LTE-FDD B1 @ dBm	TBD	TBD	mA
	LTE-FDD B2 @ dBm	TBD	TBD	mA
LTE Cat NB1 data transfer (GNSS OFF)	LTE-FDD B3 @ dBm	TBD	TBD	mA
	LTE-FDD B4 @ dBm	TBD	TBD	mA
	LTE-FDD B5 @ dBm	TBD	TBD	mA
	LTE-FDD B8 @ dBm	TBD	TBD	mA
	LTE-FDD B12 @ dBm	TBD	TBD	mA
	LTE-FDD B13 @ dBm	TBD	TBD	mA
	LTE-FDD B17 @ dBm	TBD	TBD	mA
	LTE-FDD B18 @ dBm	TBD	TBD	mA
	LTE-FDD B19 @ dBm	TBD	TBD	mA
	LTE-FDD B20 @ dBm	TBD	TBD	mA
	LTE-FDD B25 @ dBm	TBD	TBD	mA

LTE-FDD B28 @ dBm	TBD	TBD	mA
LTE-FDD B66 @ dBm	TBD	TBD	mA

Table 43: BG951A-GL Power Consumption

BG951A-GL (Power Supply: 3.3 V, Room Temperature)				
Description	Conditions	Avg.	Max.	Unit
Leakage	Power-off @ USB/UART disconnected	2.1	-	μA
PSM	PSM @ USB/UART disconnected	TBD	-	μA
Rock bottom	AT+CFUN=0 @ Sleep mode	TBD	-	mA
Sleep mode (USB disconnected)	LTE Cat M1 DRX = 1.28 s	TBD	-	mA
	LTE Cat NB1 DRX = 1.28 s	TBD	-	mA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	TBD	-	mA
	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	TBD	-	mA
	LTE Cat M1 DRX = 1.28 s	TBD	-	mA
	LTE Cat NB1 DRX = 1.28 s	TBD	-	mA
Idle state	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	TBD	-	mA
	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	TBD	-	mA
	LTE-FDD B1 @ dBm	TBD	TBD	mA
	LTE-FDD B2 @ dBm	TBD	TBD	mA
LTE Cat M1 data transfer (GNSS OFF)	LTE-FDD B3 @ dBm	TBD	TBD	mA
	LTE-FDD B4 @ dBm	TBD	TBD	mA
	LTE-FDD B5 @ dBm	TBD	TBD	mA
	LTE-FDD B8 @ dBm	TBD	TBD	mA

LTE Cat NB1 data transfer (GNSS OFF)	LTE-FDD B12 @ dBm	TBD	TBD	mA
	LTE-FDD B13 @ dBm	TBD	TBD	mA
	LTE-FDD B18 @ dBm	TBD	TBD	mA
	LTE-FDD B19 @ dBm	TBD	TBD	mA
	LTE-FDD B20 @ dBm	TBD	TBD	mA
	LTE-FDD B25 @ dBm	TBD	TBD	mA
	LTE-FDD B26 @ dBm	TBD	TBD	mA
	LTE-FDD B27 @ dBm	TBD	TBD	mA
	LTE-FDD B28 @ dBm	TBD	TBD	mA
	LTE-FDD B66 @ dBm	TBD	TBD	mA
	LTE-FDD B1 @ dBm	TBD	TBD	mA
	LTE-FDD B2 @ dBm	TBD	TBD	mA
	LTE-FDD B3 @ dBm	TBD	TBD	mA
	LTE-FDD B4 @ dBm	TBD	TBD	mA
	LTE-FDD B5 @ dBm	TBD	TBD	mA
	LTE-FDD B8 @ dBm	TBD	TBD	mA
	LTE-FDD B12 @ dBm	TBD	TBD	mA
	LTE-FDD B13 @ dBm	TBD	TBD	mA
	LTE-FDD B17 @ dBm	TBD	TBD	mA
	LTE-FDD B18 @ dBm	TBD	TBD	mA
	LTE-FDD B19 @ dBm	TBD	TBD	mA
	LTE-FDD B20 @ dBm	TBD	TBD	mA
	LTE-FDD B25 @ dBm	TBD	TBD	mA
	LTE-FDD B28 @ dBm	TBD	TBD	mA
	LTE-FDD B66 @ dBm	TBD	TBD	mA

Table 44: BG950A-GL GNSS Current Consumption

BG950A-GL			
Description	Conditions	Typ.	Unit
Searching (AT+CFUN=0)	Cold start @ Passive antenna	TBD	mA
	Hot start @ Passive antenna	TBD	mA
	Lost state @ Passive antenna	TBD	mA
Tracking (AT+CFUN=0)	Instrument environment @ Passive antenna	TBD	mA
	Open sky @ Real network, Passive antenna	TBD	mA
	Open sky @ Real network, Active antenna	TBD	mA

Table 45: BG951A-GL GNSS Current Consumption

BG951A-GL			
Description	Conditions	Typ.	Unit
Searching (AT+CFUN=0)	Cold start @ Passive antenna	TBD	mA
	Hot start @ Passive antenna	TBD	mA
	Lost state @ Passive antenna	TBD	mA
Tracking (AT+CFUN=0)	Instrument environment @ Passive antenna	TBD	mA
	Open sky @ Real network, Passive antenna	TBD	mA
	Open sky @ Real network, Active antenna	TBD	mA

7.4. ESD

The module is not protected against electrostatics discharge (ESD) in general. Consequently, it is subject

to ESD handling precautions that typically apply to ESD sensitive components. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates the module, for example, ESD protection should be added at the interface of circuit design and the points that are vulnerable to electrostatic discharge damage or influence; anti-static gloves should be worn during production, etc.

ESD characteristics of the module's pins are as follows:

Table 46: Electrostatics Discharge Characteristics (Temperature: 25 °C, Humidity: 45 %)

Tested Interfaces	Contact Discharge	Air Discharge	Unit
VBAT, GND	TBD	TBD	kV
All Antenna Interfaces	TBD	TBD	kV

7.5. Operating and Storage Temperatures

Table 47: Operating and Storage Temperatures

Parameter	Min.	Typ.	Max.	Unit
Operating Temperature Range ¹⁸	-35	+25	+75	°C
Extended Operating Temperature Range ¹⁹	-40	-	+85	°C
Storage temperature range	-40	-	+95	°C

¹⁸ Within operating temperature range, the module is 3GPP compliant.

¹⁹ Within extended operating temperature range, proper mounting, heating sinks and active cooling may be required to make certain functions of the module such as voice*, SMS*, data transmission to be realized. Only one or more parameters like P_{out} might reduce in their value and exceed the specified tolerances. When the temperature returns to normal operating temperature levels, the module will meet 3GPP specifications again.

8 Mechanical Information

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

8.1. Mechanical Dimensions

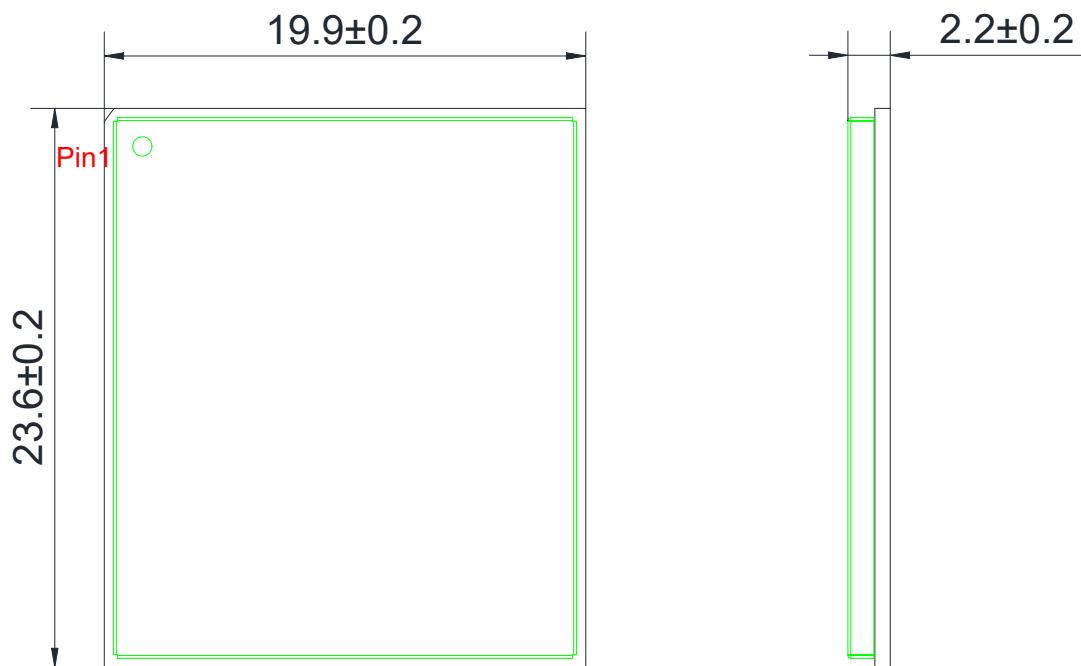


Figure 32: Module Top and Side Dimensions (Unit: mm)

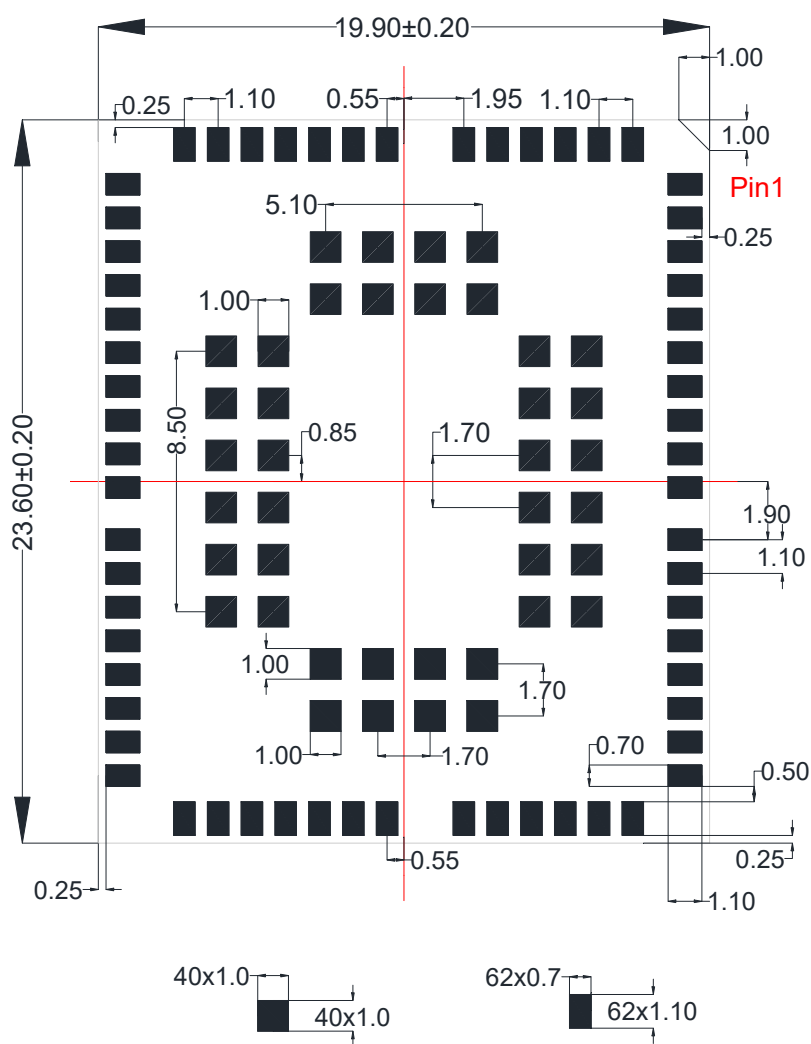


Figure 33: Module Bottom Dimensions (Bottom View, Unit: mm)

NOTE

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

8.2. Recommended Footprint

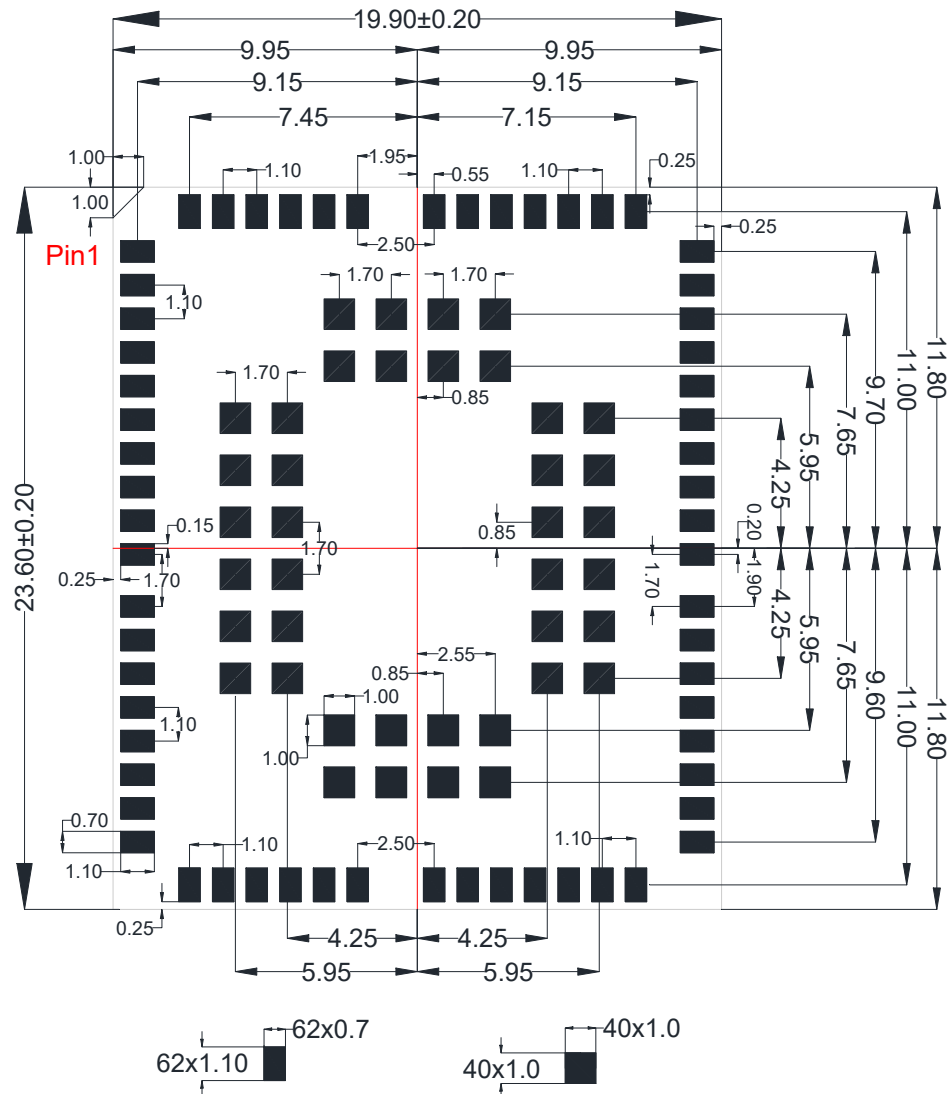


Figure 34: Recommended Footprint (Top View)

NOTE

1. For easy maintenance of the module, keep about 3 mm between the module and other components on the motherboard.
2. All reserved pins must be kept open.
3. For stencil design requirements of the module, see **document [6]**.

8.3. Top and Bottom Views



Figure 35: Top & Bottom Views of the Module

NOTE

1. Images above are for illustration purpose only and may differ from the actual module. For authentic appearance and label, please refer to the module received from Quectel.
2. The top and bottom views of BG951A-GL module will be provided in the future version.

9 Storage, Manufacturing & Packaging

9.1. Storage Conditions

The module is provided with vacuum-sealed packaging. MSL of the module is rated as 3. The storage requirements are shown below.

1. Recommended Storage Condition: The temperature should be $23 \pm 5^{\circ}\text{C}$ and the relative humidity should be 35–60 %.
2. The storage life (in vacuum-sealed packaging) is 12 months in Recommended Storage Condition.
3. The floor life of the module is 168 hours ²⁰ in a plant where the temperature is $23 \pm 5^{\circ}\text{C}$ and relative humidity is below 60 %. After the vacuum-sealed packaging is removed, the module must be processed in reflow soldering or other high-temperature operations within 168 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10 % (e.g. a drying cabinet).
4. The module should be pre-baked to avoid blistering, cracks and inner-layer separation in PCB under the following circumstances:
 - The module is not stored in Recommended Storage Condition;
 - Violation of the third requirement above occurs;
 - Vacuum-sealed packaging is broken, or the packaging has been removed for over 24 hours;
 - Before module repairing.
5. If needed, the pre-baking should follow the requirements below:
 - The module should be baked for 8 hours at $120 \pm 5^{\circ}\text{C}$;
 - All modules must be soldered to PCB within 24 hours after the baking, otherwise they should be put in a dry environment such as in a drying oven.

NOTE

²⁰ This floor life is only applicable when the environment conforms to *IPC/JEDEC J-STD-033*. It is recommended to start the solder reflow process within 24 hours after the package is removed if the temperature and moisture do not conform to, or are not sure to conform to *IPC/JEDEC J-STD-033*. And do not remove the packages of tremendous modules if they are not ready for soldering.

1. To avoid blistering, layer separation and other soldering issues, extended exposure of the module to the air is forbidden.
2. Take out the module from the package and put it on high-temperature-resistant fixtures before baking. All modules must be soldered to PCB within 24 hours after the baking, otherwise put them in the drying oven. If shorter baking time is desired, see *IPC/JEDEC J-STD-033* for the baking procedure.
3. Pay attention to ESD protection, such as wearing anti-static gloves, when touching the modules.

9.2. Manufacturing and Soldering

Push the squeegee to apply the solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate to the PCB. Apply proper force on the squeegee to produce a clean stencil surface on a single pass. To guarantee module soldering quality, the thickness of stencil for the module is recommended to be 0.13–0.15 mm. For more details, see **document [6]**.

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

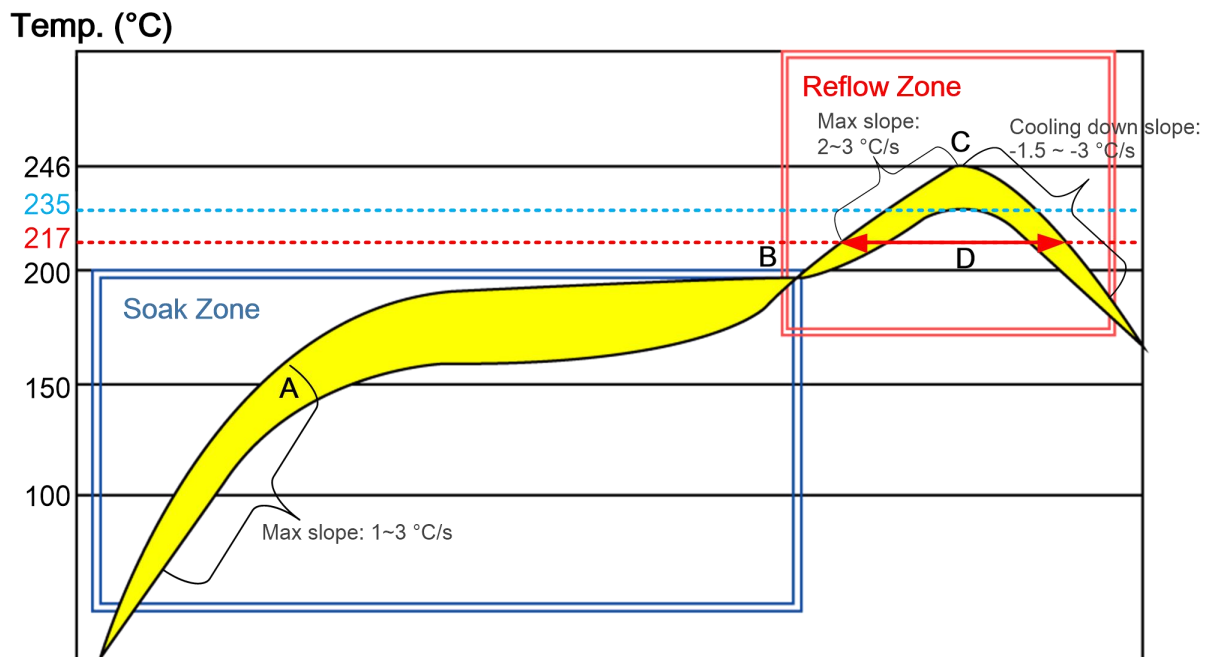


Figure 36: Recommended Reflow Soldering Thermal Profile

Table 48: Recommended Thermal Profile Parameters

Factor	Recommendation
Soak Zone	
Max slope	1–3 °C/s
Soak time (between A and B: 150 °C and 200 °C)	70–120 s
Reflow Zone	
Max slope	2–3 °C/s
Reflow time (D: over 217 °C)	40–70 s
Max temperature	235 °C to 246 °C
Cooling down slope	-1.5 to -3 °C/s
Reflow Cycle	
Max reflow cycle	1

NOTE

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

9.3. Packaging Specifications

The module is packaged in tape and reel carriers. One reel is 330 mm long and contains 500 modules. The figures below show the package details, measured in mm.

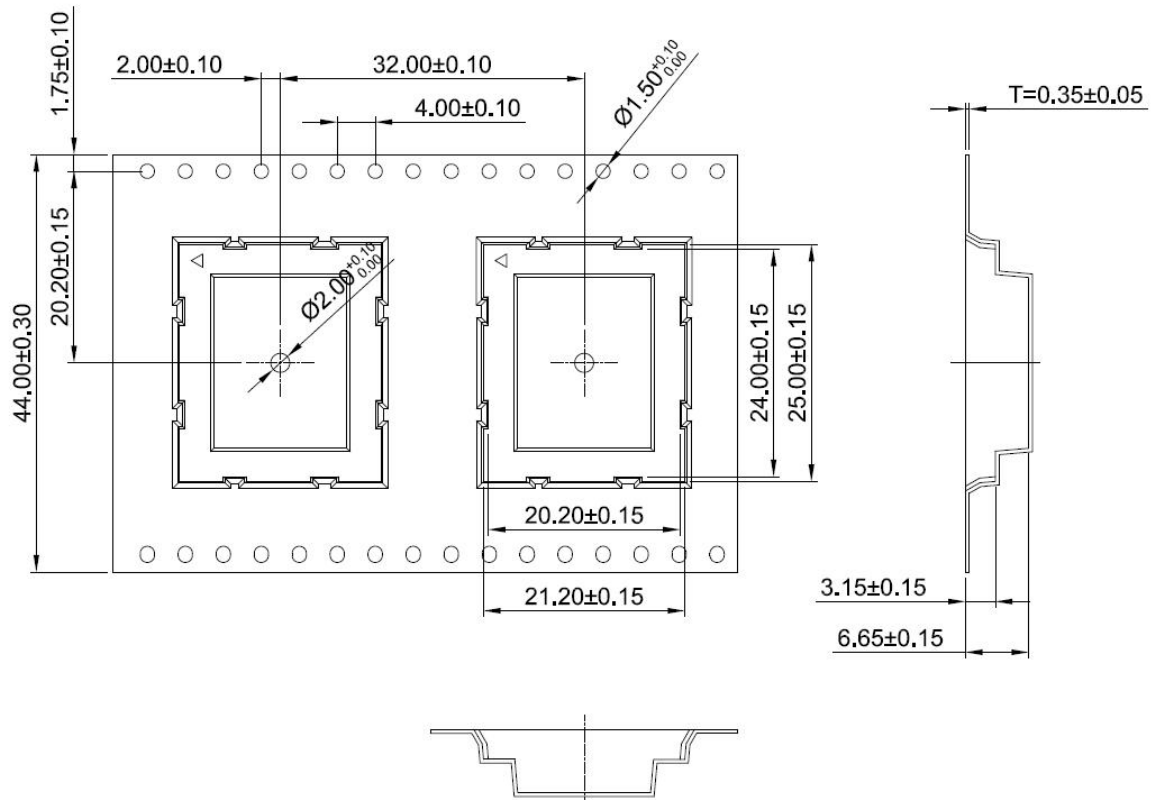


Figure 37: Tape Specifications

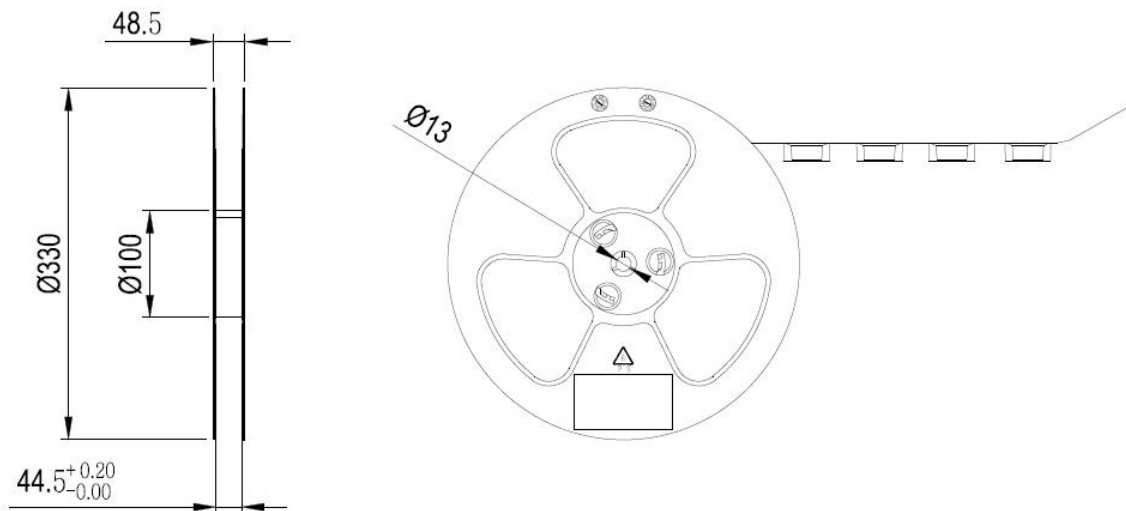


Figure 38: Reel Specifications

Table 49: Packaging Specifications

MOQ for MP	Minimum Package: 500	Minimum Package x 4 = 2000 pcs
500 pieces	Size: 370 mm × 350 mm × 56 mm N.W: TBD kg G.W: TBD kg	Size: 380 mm × 250 mm × 365 mm N.W: TBD kg G.W: TBD kg

10 Appendix References

Table 50: Related Documents

Document Name
[1] Quectel_UMTS<E_EVB_User_Guide
[2] Quectel_BG770A-GL&BG95xA-GL_QCFG_AT_Commands_Manual
[3] Quectel_BG770A-GL&BG95xA-GL_AT_Commands_Manual
[4] Quectel_BG770A-GL&BG95xA-GL_GNSS_Application_Note
[5] Quectel_RF_Layout_Application_Note
[6] Quectel_Module_Secondary_SMT_Application_Note

Table 51: Terms and Abbreviations

Abbreviation	Description
ADC	Analog to Digital Converter
Balun	Balanced to Unbalanced
bps	Bits Per Second
CHAP	Challenge Handshake Authentication Protocol
CTS	Clear to Send
DFOTA	Delta Firmware Upgrade Over the Air
DL	Downlink
DRX	Discontinuous Reception
EGSM	Extended GSM (Global System for Mobile Communications)
e-I-DRX	Extended Idle Mode Discontinuous Reception

EPC	Evolved Packet Core
ESD	Electrostatic Discharge
FDD	Frequency Division Duplex
HSS	Home Subscriber Server
I/O	Input/Output
Inom	Nominal Current
LNA	Low Noise Amplifier
LPF	Low Pass Filter
LTE	Long Term Evolution
MO	Mobile Originated
MT	Mobile Terminated
PA	Power Amplifier
PAP	Password Authentication Protocol
PCB	Printed Circuit Board
PDU	Protocol Data Unit
PPP	Point-to-Point Protocol
PSM	Power Saving Mode
RF	Radio Frequency
RFIC	Radio Frequency Integrated Circuit
RHCP	Right Hand Circularly Polarized
RTS	Request to Send
SAW	Surface Acoustic Wave
SMS	Short Message Service
Tx	Transmit
UL	Uplink

UE	User Equipment
URC	Unsolicited Result Code
(U)SIM	(Universal) Subscriber Identity Module
V _{max}	Maximum Voltage
V _{nom}	Nominal Voltage
V _{min}	Minimum Voltage
V _{IHmax}	Maximum High-level Input Voltage
V _{IHmin}	Minimum High-level Input Voltage
V _{ILmax}	Maximum Low-level Input Voltage
V _{ILmin}	Minimum Low-level Input Voltage
V _{Imax}	Absolute Maximum Input Voltage
V _{Imin}	Absolute Minimum Input Voltage
V _{OHmax}	Maximum High-level Output Voltage
V _{OHmin}	Minimum High-level Output Voltage
V _{OLmax}	Maximum Low-level Output Voltage
V _{OLmin}	Minimum Low-level Output Voltage
VoLTE	Voice over LTE.
VSWR	Voltage Standing Wave Ratio

CE Statement

The minimum distance between the user and/or any bystander and the radiating structure of the transmitter is 20cm.

Hereby, We, Quectel Wireless Solutions Co., Ltd. declares that the radio equipment type BG95-M5 is in compliance with the Directive 2014/53/EU.

The full text of the EU declaration of conformity is available at the following internet address:
Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District,
Shanghai
200233, China

<https://www.quectel.com/support/downloadb/TechnicalDocuments.htm>

The device operates with the following frequency bands and transmitting power:

FCC Certification Requirements.

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

And the following conditions must be met:

1. This Modular Approval is limited to OEM installation for mobile and fixed applications only. The antenna installation and operating configurations of this transmitter, including any applicable source-based time-averaging duty factor, antenna gain and cable loss must satisfy MPE categorical Exclusion Requirements of 2.1091.
2. The EUT is a mobile device; maintain at least a 20 cm separation between the EUT and the user's body and must not transmit simultaneously with any other antenna or transmitter.
3. A label with the following statements must be attached to the host end product: This device contains
FCC ID: XMR2021BG950AGL.
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:

- ☐ GSM850 : $\leq 8.571\text{dBi}$
- ☐ GSM1900 : $\leq 10.03\text{dBi}$
- ☐ Catm LTE Band2/25: $\leq 11.000\text{dBi}$
- ☐ Catm LTE Band4/66: $\leq 8.000\text{dBi}$

- ☐ Catm LTE Band5/26: $\leq 12.541\text{dBi}$
- ☐ Catm LTE Band12: $\leq 11.798\text{dBi}$
- ☐ Catm LTE Band13: $\leq 12.214\text{dBi}$
- ☐ Catm LTE Band85: $\leq 11.798\text{dBi}$
- ☐ NB LTE Band2/25: $\leq 11.000\text{dBi}$
- ☐ NB LTE Band4/66: $\leq 8.000\text{dBi}$
- ☐ NB LTE Band5: $\leq 12.541\text{ dBi}$
- ☐ NB LTE Band12: $\leq 11.798\text{dBi}$
- ☐ NB LTE Band13: $\leq 12.214\text{dBi}$
- ☐ NB LTE Band71: $\leq 11.687\text{dBi}$
- ☐ NB LTE Band85: $\leq 11.798\text{ dBi}$

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: XMR2021BG950AGL" or "Contains FCC ID: XMR2021BG950AGL" must be used. The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.

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

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

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

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

IC 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." 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

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.

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.

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

- ☐ GSM850 : $\leq 8.571\text{dBi}$
- ☐ GSM1900 : $\leq 10.03\text{dBi}$
- ☐ Catm LTE Band2/25: $\leq 11.000\text{dBi}$
- ☐ Catm LTE Band4/66: $\leq 8.000\text{dBi}$
- ☐ Catm LTE Band5/26: $\leq 12.541\text{dBi}$
- ☐ Catm LTE Band12: $\leq 11.798\text{dBi}$
- ☐ Catm LTE Band13: $\leq 12.214\text{dBi}$
- ☐ Catm LTE Band85: $\leq 11.798\text{dBi}$
- ☐ NB LTE Band2/25: $\leq 11.000\text{dBi}$
- ☐ NB LTE Band4/66: $\leq 8.000\text{dBi}$
- ☐ NB LTE Band5: $\leq 12.541\text{ dBi}$
- ☐ NB LTE Band12: $\leq 11.798\text{dBi}$
- ☐ NB LTE Band13: $\leq 12.214\text{dBi}$
- ☐ NB LTE Band71: $\leq 11.687\text{dBi}$
- ☐ NB LTE Band85: $\leq 11.798\text{ dBi}$

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

The Innovation, Science and Economic Development Canada certification label of a module shall be clearly visible at all times when installed in the host product; otherwise, the host product must be labeled to display the Innovation, Science and Economic Development Canada certification number for the module, preceded by the word “Contains” or similar wording expressing the same meaning, as follows:

“Contains IC: 10224A-2021BG950A” or “where: 10224A-2021BG950A 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 installé dans 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-2020BG95M5 " ou "où: 10224A-2020BG95M5 est le numéro de certification du module.

