BG772A-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 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 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 fuelling 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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-	2021-01-28	Besson RONG/ Ben JIANG	Creation of the document
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1 Introduction

This document defines BG772A-GL module and describes its air interface and hardware interfaces which are connected with customers' applications.

This document helps customers quickly understand the interface specifications, electrical and mechanical details, as well as other related information of the module. To facilitate application designs, it also includes some reference designs for customers' reference. The document, coupled with application notes and user guides, makes it easy to design and to set up mobile applications with BG772A-GL.

Hereby, [Quectel Wireless Solutions Co., Ltd.] declares that the radio equipment type [BG772A-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: XMR2022BG772AGL
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)	FCC Max Antenna Gain（dBi）	IC Max Antenna Gain（dBi）

must not exceed: Operating Band		
LTE BAND 2	7.300	7.30
LTE BAND 4	4.300	4.30
LTE BAND 5	8.841	5.40
LTE BAND 12	8.098	4.91
LTE BAND 13	8.514	5.23
LTE BAND 25	7.300	7.30
LTE BAND 26(814-824)	8.841	5.36
LTE BAND 26(824-849)	8.841	5.36
LTE BAND 66	4.300	4.30
NB-IOT Band 2	7.300	7.30
NB-IOT Band 4	4.300	4.30
NB-IOT Band 5	8.841	5.40
NB-IOT Band 12	8.098	4.91
NB-IOT Band 13	8.514	5.23
NB-IOT Band 25	7.300	4.93
NB-IOT Band 26	8.841	7.30
NB-IOT Band 66	4.300	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: XMR2022BG772AGL" or "Contains FCC ID: XMR2022BG772AGL" 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." 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-2022BG772A" or "where: 10224A-2022BG772A 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-2022BG772A " ou "où: 10224A-2022BG772A est le numéro de certification du module".

1.1. Special Mark

Table 1: Special Mark

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

2 Product Concept

2.1. General Description

BG772A-GL is an embedded IoT (LTE Cat M1, LTE Cat NB1/Cat NB2*) wireless communication module. It provides data connectivity on LTE-FDD network, and supports half-duplex operation in LTE network. It also provides optional GNSS* and voice* [1)] functionality to meet customers' specific application demands.

The module is based on an architecture in which WWAN (LTE) and GNSS Rx chains share certain hardware blocks. However, the module does not support concurrent operation of WWAN and GNSS. The solution adopted in the module is a form of coarse time-division multiplexing (TDM) between WWAN and GNSS Rx chains. Given the relaxed latency requirements of most LPWA applications, time-division sharing of resources can be made largely transparent to applications. For more details, see ***document [1]***.

Table 2: Frequency Bands and GNSS Types of BG772A-GL Module

Module	Supported Bands	Power Class	GNSS*
BG772A-GL	**Cat M1** [1)]**:** LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B25/B26/B27/B28/B66 **Cat NB2** [2)]**:** 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

NOTES

1. [1)] BG772A-GL supports VoLTE* (Voice over LTE) under LTE Cat M1.
2. [2)] LTE Cat NB2* is backward compatible with LTE Cat NB1.

With a compact profile of 14.9 mm × 12.9 mm × 1.9 mm, BG772A-GL can meet almost all requirements for M2M applications such as smart metering, tracking system, security, wireless POS, etc. It is especially suitable for size and weight sensitive applications such as smart watch and other wearable devices.

BG772A-GL is an SMD type module which can be embedded into applications through its 94 LGA pads. It supports internet service protocols like TCP, UDP and PPP. Extended AT commands have been developed for customers to use these internet service protocols easily.

2.2. Key Features

Table 3: Key Features of BG772A-GL

Features	Details
Power Supply [1)]	● VBAT_BB: 2.2–4.35 V, typical 3.3 V ● VBAT_RF: 3.1–4.2 V, typical 3.3 V
Transmitting Power	Class 3 (23 dBm ± 2.7 dB) for LTE-FDD bands
LTE Features	● Supports 3GPP Rel-14* ● Supports LTE Cat M1 and LTE Cat NB2* ● Supports 1.4 MHz RF bandwidth for LTE Cat M1 ● Supports 200 kHz RF bandwidth for LTE Cat NB2 ● Cat M1: Max. 600 kbps (DL)/1000 kbps (UL) ● Cat NB2*: Max. 120 kbps (DL)/140 kbps (UL)
Internet Protocol Features	● Supports PPP/TCP/UDP/SSL/TLS/FTP(S)/HTTP(S)/NITZ*/PING/ MQTT/LwM2M*/CoAP* protocols ● Support PAP and CHAP for PPP connections
SMS	● Text and PDU modes ● Point-to-point MO and MT ● SMS cell broadcast ● SMS storage: ME by default
(U)SIM Interface	Supports 1.8 V USIM/SIM card only
PCM Interface*	Supports one digital audio interface: PCM interface for VoLTE only
USB Interface*	● Compliant with USB 2.0 specification ● Supports operation at full-speed (12 Mbps) only
UART Interfaces	**Main UART:** ● Used for data transmission and AT command communication ● 115200 bps baud rate 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 **AUX UART:** ● Used for RF calibration debugging and log output ● 921600 bps baud rate by default ● The default frame format is 8N1 (8 data bits, no parity, 1 stop bit) ● Supports RTS and CTS hardware flow control
GNSS*	● GPS, GLONASS
AT Commands	● 3GPP TS 27.007 and 3GPP TS 27.005 AT commands ● Quectel enhanced AT commands
Network Indication	One NET_STATUS pin for network connectivity status indication
Antenna Interfaces	Main antenna (ANT_MAIN) and GNSS antenna (ANT_GNSS) interfaces
Physical Characteristics	● Dimensions: (14.9 ±0.2) mm × (12.9 ±0.2) mm × (1.9 ±0.2) mm ● Package: LGA ● Weight: TBD
Temperature Range	● Operating temperature range: -35 °C to +75 °C [2)] ● Extended temperature range: -40 °C to +85 °C [3)] ● Storage temperature range: -40 °C to +90 °C
Firmware Upgrade	● Debug UART ● DFOTA*
RoHS	All hardware components are fully compliant with EU RoHS directive.

NOTES

1. [1)] When the module starts up normally, to ensure full-function mode, the minimum power supply voltage should be higher than 3.1 V.
2. [2)] Within the operating temperature range, the module meets 3GPP specifications.
3. [3)] Within the extended temperature range, the module remains the ability to establish and maintain functions such as voice*, SMS and data transmission, without any unrecoverable malfunction. Radio spectrum and radio network are not influenced, while one or more specifications, such as P_{out}, may exceed the specified tolerances of 3GPP. When the temperature returns to the operating temperature range, the module meets 3GPP specifications again.

2.3. Functional Diagram

The following figure shows a block diagram of BG772A-GL and illustrates the major functional parts.

- Power management
- Baseband
- Radio frequency
- Peripheral interfaces

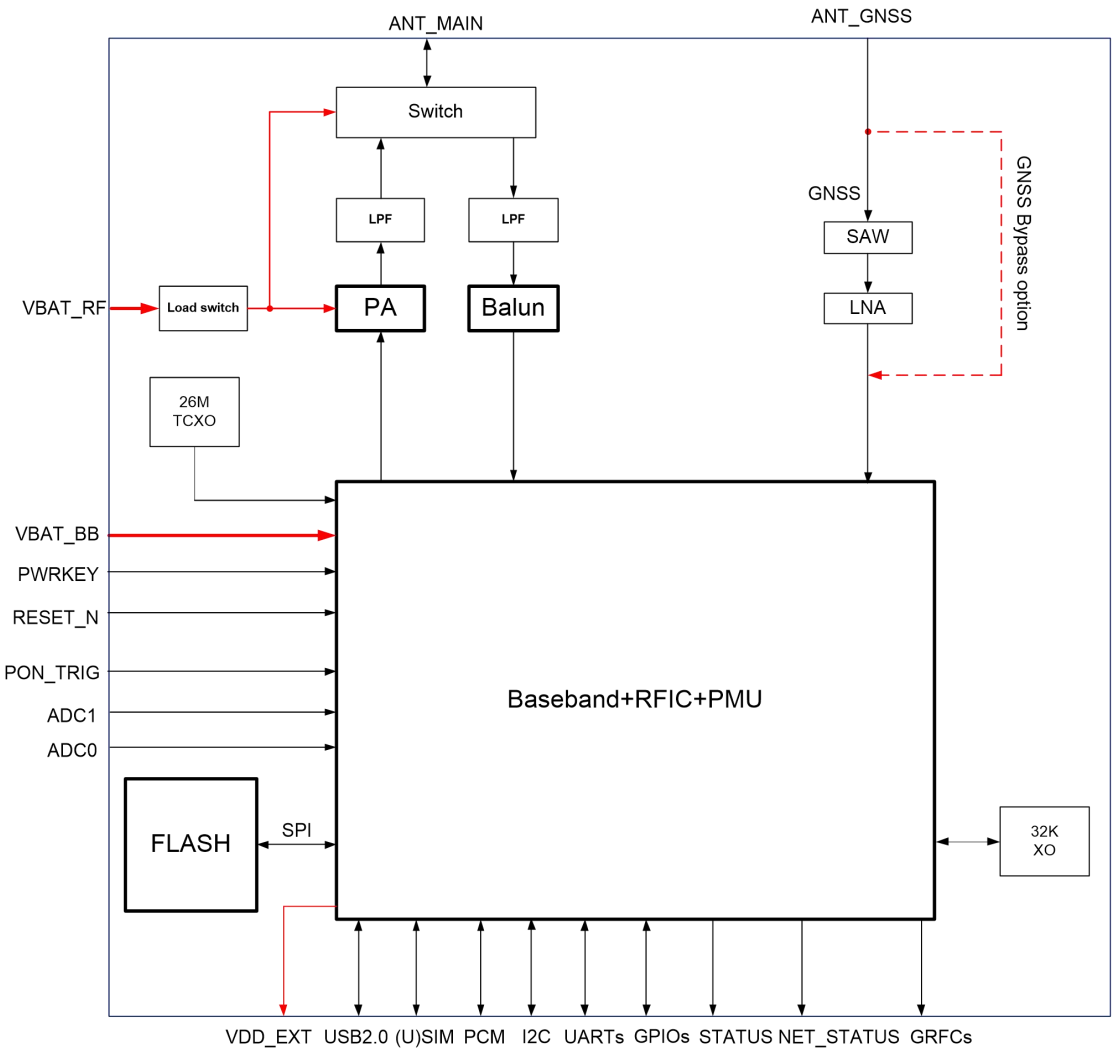


Figure 1: Functional Diagram

NOTE

PCM and I2C interfaces are for VoLTE* only.

2.4. Evaluation Board

To facilitate application development with BG772A-GL conveniently, Quectel supplies the evaluation board (EVB), USB to RS-232 converter cables, USB data cables, earphone, antennas and other peripherals to control or test the module. For more details, see ***document [2]***.

3 Application Interfaces

BG772A-GL is equipped with 94 LGA pads that can be connected to customers' cellular application platforms. The subsequent chapters will provide detailed description of interfaces listed below:

- Power supply
- PON_TRIG interface*
- (U)SIM interface
- USB interface*
- UART interfaces
- PCM and I2C interfaces*
- Status indication interfaces
- ADC interfaces*
- GPIO interfaces*

3.1. Pin Assignment

The following figure shows the pin assignment of BG772A-GL.

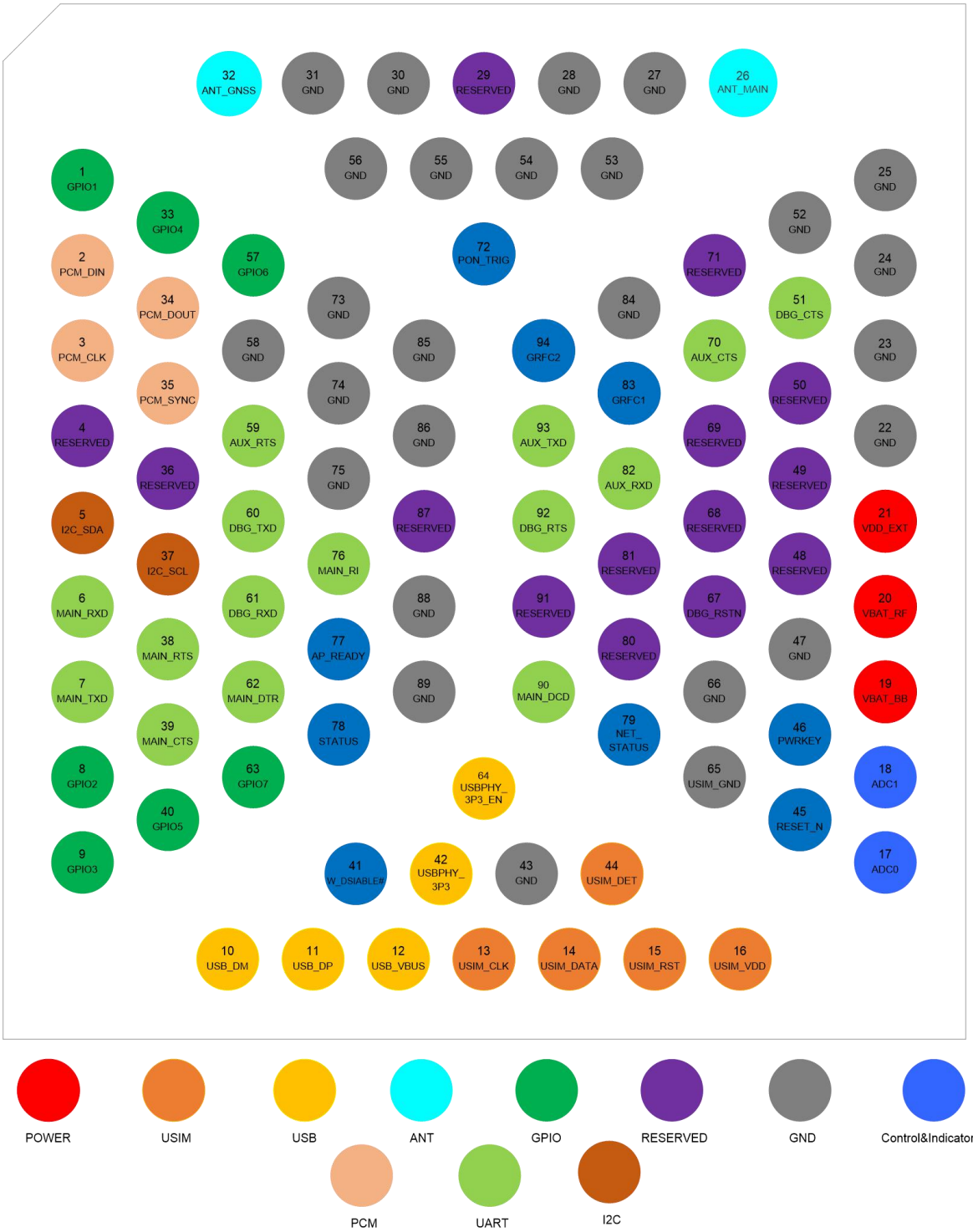


Figure 2: Pin Assignment (Top View)

NOTES

1. ADC input voltage must not exceed 1.8 V.
2. The input voltage range of USB_VBUS is 1.19–2.0 V.
3. Keep all RESERVED pins and unused pins unconnected.
4. GND pins should be connected to ground in the design.
5. PCM and I2C interfaces are for VoLTE* only.

3.2. Pin Description

The following tables show the pin definition of BG772A-GL.

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
NP	No Pull
OD	Open Drain
PI	Power Input
PO	Power Output
PU	Pull Up
PD	Pull Down

Table 5: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VBAT_BB	19	PI	Power supply for the module's baseband part	Vmax = 4.35 V Vmin = 2.2 V Vnom = 3.3 V	Refer to NOTE 1
VBAT_RF	20	PI	Power supply for the module's RF part	Vmax = 4.2 V Vmin = 3.1 V Vnom = 3.3 V	Refer to NOTE 1
VDD_EXT	21	PO	Provide 1.8 V for external circuit	Vnom = 1.8 V $I_O$max = 50 mA	If this pin is unused, keep it open.
GND	22–25, 27, 28, 30, 31, 43, 47, 52–56, 58, 66, 73–75, 84–86, 88, 89				
Turn on/off					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PWRKEY*	46	DI/PU	Turn on/off the module	V_{IL}max = 0.3 V V_{IH}min = 1.0 V	
Reset					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESET_N	45	DI/PU	Reset the module	V_{IL}max = 0.3 V V_{IH}min = 1.3 V	
Status Indication					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
STATUS	78	DO/PD	Indicate the module's operation status	1.8 V	If this pin is unused, keep it open.
NET_STATUS*	79	DO/PU	Indicate the module's network activity status	1.8 V	
USB Interface*					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
USB_VBUS	12	AI	USB connection detect	V_{IH}max = 2.0 V V_{IH}min = 1.19 V	

USB_DP	11	DIO	USB differential data (+)		Compliant with USB 2.0 standard specification. Require differential impedance of 90 Ω.
USB_DM	10	DIO	USB differential data (-)		
USBPHY_3P3	42	PI	Power supply for USB PHY circuit	Vnom = 3.3 V	
USBPHY_3P3_EN	64	DO/PU	External LDO enable control for USB	1.8 V	
(U)SIM Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
USIM_DET*	44	DI/PD	(U)SIM card hot-plug detect	1.8 V	If this pin is unused, keep it open.
USIM_VDD	16	PO	(U)SIM card power supply	Vmax = 1.9 V Vmin = 1.7 V	Only 1.8 V (U)SIM card is supported.
USIM_RST	15	DO/PD	(U)SIM card reset	1.8 V	
USIM_DATA	14	DIO/PU	(U)SIM card data	1.8 V	
USIM_CLK	13	DO/PD	(U)SIM card clock	1.8 V	
USIM_GND	65		Specified ground for (U)SIM card		
Main UART Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
MAIN_DTR	62	DI/PU	Main UART data terminal ready	1.8 V	If this pin is unused, keep it open.
MAIN_RXD	6	DI/PU	Main UART receive	1.8 V	
MAIN_TXD	7	DO/PU	Main UART transmit	1.8 V	
MAIN_CTS	39	DO/PU	Main UART clear to send	1.8 V	
MAIN_RTS	38	DI/PU	Main UART request to send	1.8 V	
MAIN_DCD	90	DO/PU	Main UART data carrier detect	1.8 V	
MAIN_RI*	76	DO/PU	Main UART ring indication	1.8 V	

Debug UART Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
DBG_RXD	61	DI/PU	Debug UART receive	1.8 V	If this pin is unused, keep it open.
DBG_TXD	60	DO/PU	Debug UART transmit	1.8 V	
DBG_CTS	51	DO/PU	Debug UART clear to send	1.8 V	
DBG_RTS	92	DI/PD	Debug UART request to send	1.8 V	
Auxiliary UART Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
AUX_TXD	93	DO/PU	Auxiliary UART transmit	1.8 V	If this pin is unused, keep it open.
AUX_RXD	82	DI/PU	Auxiliary UART receive	1.8 V	
AUX_CTS	70	DO/PU	Auxiliary UART clear to send	1.8 V	
AUX_RTS	59	DI/PU	Auxiliary UART request to send	1.8 V	
PCM Interface*					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PCM_CLK	3	DO/PD	PCM clock	1.8 V	If this pin is unused, keep it open.
PCM_SYNC	35	DO/PU	PCM data frame sync	1.8 V	
PCM_DIN	2	DI/PU	PCM data input	1.8 V	
PCM_DOUT	34	DO/PU	PCM data output	1.8 V	
I2C Interface*					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
I2C_SCL	37	OD	I2C serial clock (for external codec)		External pull-up resistor is required. 1.8 V only. If this pin is unused, keep it open.

I2C_SDA	5	OD	I2C serial data (for external codec)		External pull-up resistor is required. 1.8 V only. If this pin is unused, keep it open.
Antenna Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ANT_MAIN	26	AIO	Main antenna interface		50 Ω impedance.
ANT_GNSS	32	AI	GNSS antenna interface		50 Ω impedance. If this pin is unused, keep it open.
GPIO Interfaces*					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
GPIO1	1	DIO/PU	General-purpose input/output	1.8 V	If this pin is unused, keep it open.
GPIO2	8	DIO/PD	General-purpose input/output	1.8 V	
GPIO3	9	DIO/PD	General-purpose input/output	1.8 V	
GPIO4	33	DIO/PD	General-purpose input/output	1.8 V	
GPIO5	40	DIO/PD	General-purpose input/output	1.8 V	BOOT_CONFIG. Do not pull it up before startup. If this pin is unused, keep it open.
GPIO6	57	DIO/PU	General-purpose input/output	1.8 V	If this pin is unused, keep it open.
GPIO7	63	DIO/PU	General-purpose input/output	1.8 V	
ADC Interfaces*					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ADC0	17	AI	General-purpose ADC interface	Voltage range: 0–1.8 V	If this pin is unused, keep it open.
ADC1	18	AI	General-purpose ADC interface	Voltage range: 0–1.8 V	

Other Interface Pins					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
W_DISABLE#*	41	DI/PU	Airplane mode control	1.8 V	Pulled up by default. When it is at low voltage level, the module can enter airplane mode. If this pin is unused, keep it open.
AP_READY*	77	DI/PU	Application processor ready	1.8 V	If this pin is unused, keep it open.
PON_TRIG*	72	DI/NP	Wake up the module from PSM	1.8 V	Wakeup active high for minimum assertion time 100 μs. No pulled by default. If this pin is unused, keep it open.
GRFC Interfaces*					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
GRFC1	83	DO/PD	Generic RF controller	1.8 V	If this pin is unused, keep it open.
GRFC2	94	DO/PD	Generic RF controller	1.8 V	
RESERVED Pins					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESERVED	4, 29, 36, 48–50, 67–69, 71, 80–81, 87,91				Keep these pins open.

NOTES

1. When the module starts up normally, to ensure full-function mode, the minimum power supply voltage should be higher than 3.1 V.
2. The input voltage range of USB_VBUS is 1.19–2.0 V.
3. USBPHY_3P3 and USBPHY_3P3_EN pins are used for USB PHY circuits.
4. ADC input voltage must not exceed 1.8 V.
5. Keep all RESERVED pins and unused pins unconnected.
6. PCM and I2C interfaces are for VoLTE* only.

3.3. Operating Modes

The table below briefly summarizes the various operating modes of BG772A-GL.

Table 6: Overview of Operating Modes

Mode	Details	
Normal Operation	Connected	The module is connected to network. Its current consumption varies with the network setting and data transfer rate.
	Idle	The module remains registered on network, and is ready to send and receive data. In this mode, the software is active.
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) 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.

3.4. Power Saving

3.4.1. Airplane Mode

When the module enters airplane mode, the RF function does not work, and all AT commands correlative with RF function will be inaccessible. This mode can be set via the following ways.

Hardware:

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

Software:

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

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

NOTES

1. Airplane mode control via W_DISABLE#* is disabled in firmware by default. It can be enabled by **AT+QCFG="airplanecontrol"**. For details of the command, see ***document [3]***.
2. The execution of **AT+CFUN** command will not affect GNSS function.

3.4.2. Power Saving Mode (PSM)*

BG772A-GL module minimizes its power consumption through entering PSM. 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 BG772A-GL 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, the network confirms 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 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:

- PON_TRIG active high for minimum assertion time 100 μs will wake up the module from PSM. (recommended)
- When RTC expiration will wake up the module.

NOTE

See ***document [4]*** for details about **AT+CPSMS**.

3.4.3. 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 [4]*** for details about **AT+CEDRXS**.

3.4.4. Sleep Mode

BG772A-GL can reduce its current consumption to a lower value during the sleep mode. The following sub-chapters describe the power saving procedure of BG772A-GL.

3.4.4.1.UART Application

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

- Execute **AT+QSCLK=1** command to enable sleep mode.
- Drive MAIN_DTR high.

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

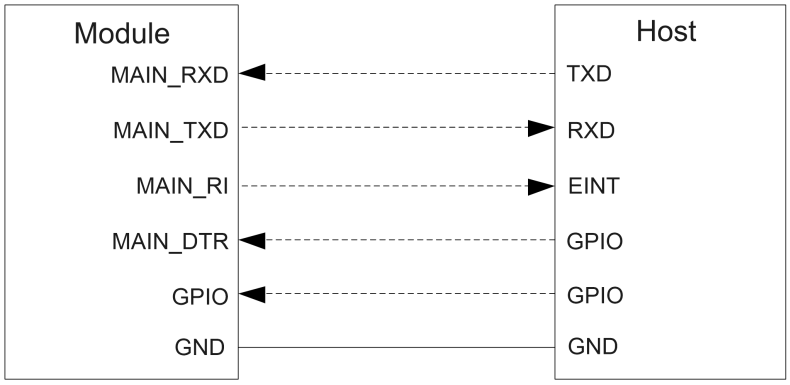


Figure 3: Sleep Mode Application via UART

- When BG772A-GL has a URC to report, MAIN_RI signal will wake up the host. See ***Chapter 3.14*** for details about MAIN_RI behavior.
- Driving the MAIN_DTR low will wake up the module.
- 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 [3]*** for details.

3.5. Power Supply

3.5.1. Power Supply Pins

BG772A-GL provides VBAT_BB and VBAT_RF two pins for connection with an external power supply.

The following table shows the details of VBAT_BB and VBAT_RF pins and ground pins.

Table 7: VBAT and GND Pins

Pin Name	Pin No.	Description	Min.	Typ.	Max.	Unit
VBAT_BB [1)]	19	Power supply for the module's baseband part	2.2	3.3	4.35	V
VBAT_RF [1)]	20	Power supply for the module's RF part	3.1	3.3	4.2	V
GND	22–25, 27, 28, 30, 31, 47, 52–56, 58, 66, 73–75, 84–86, 88, 89		-	-	-	-

NOTE

1) When the module starts up normally, to ensure full-function mode, the minimum power supply voltage should be higher than 3.1 V.

3.5.2. Decrease Voltage Drop

The power supply VBAT_BB range of BG772A-GL is from 2.2 V to 4.35 V, the power supply VBAT_RF range of BG772A-GL is from 3.1 V to 4.2 V. When the module starts up normally, to ensure full-function mode, the minimum power supply voltage should be higher than 3.1 V.

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

In addition, to get a stable power source, it is suggested to use a TVS with low leakage current and suitable reverse stand-off voltage, and also it is recommended to place it as close to the VBAT pins as possible. The following figure shows the star structure of the power supply.

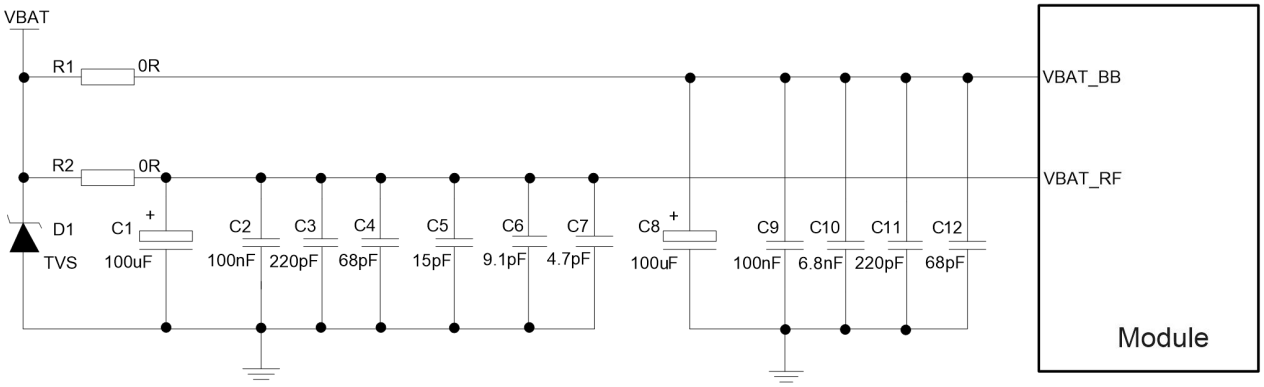


Figure 4: Star Structure of the Power Supply

3.6. Turn on and off Scenarios

3.6.1. Pin Definition of PWRKEY

The following table shows the pin definition of PWRKEY.

Table 8: Pin Definition of PWRKEY

Pin Name	Pin No.	Description	DC Characteristics	Comment
PWRKEY*	46	Turn on/off the module	V_{IL}max = 0.3 V V_{IH}min = 1.0 V	Internally pulled up resistor is 470 kΩ.

3.6.2. Turn on Module Using PWRKEY

When the module is in power off mode, it can be turned on by driving PWRKEY low for at least 500 ms. It is recommended to use an open drain/collector driver to control the PWRKEY. A simple reference circuit is illustrated in the following figure.

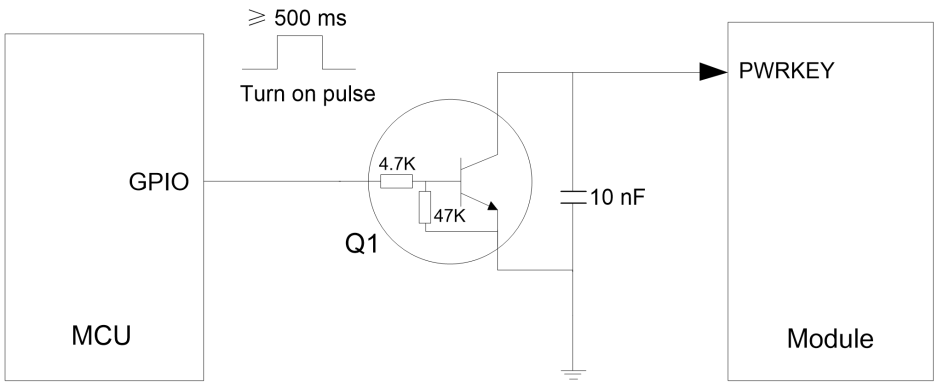


Figure 5: Turn on the Module by Using Driving Circuit

Another way to control the PWRKEY is by using a button directly. When pressing the button, electrostatic strike may generate from the finger. Therefore, a TVS component is indispensable to be placed near the button for ESD protection. A reference circuit is shown in the following figure.

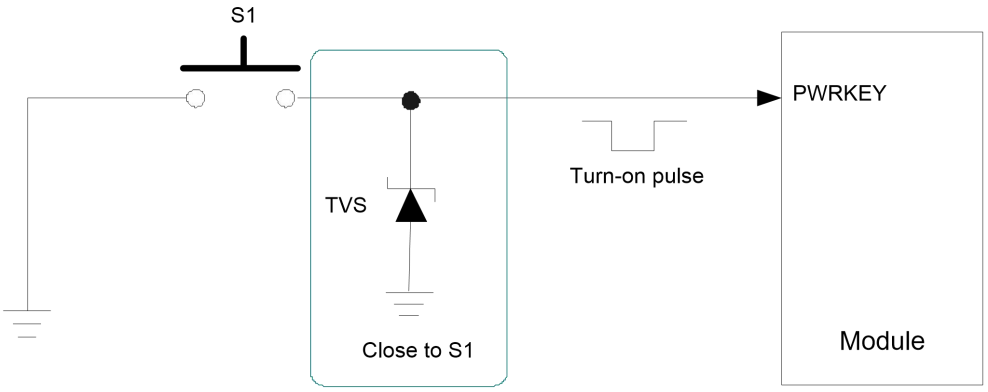


Figure 6: Turn on the Module by Using Keystroke

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

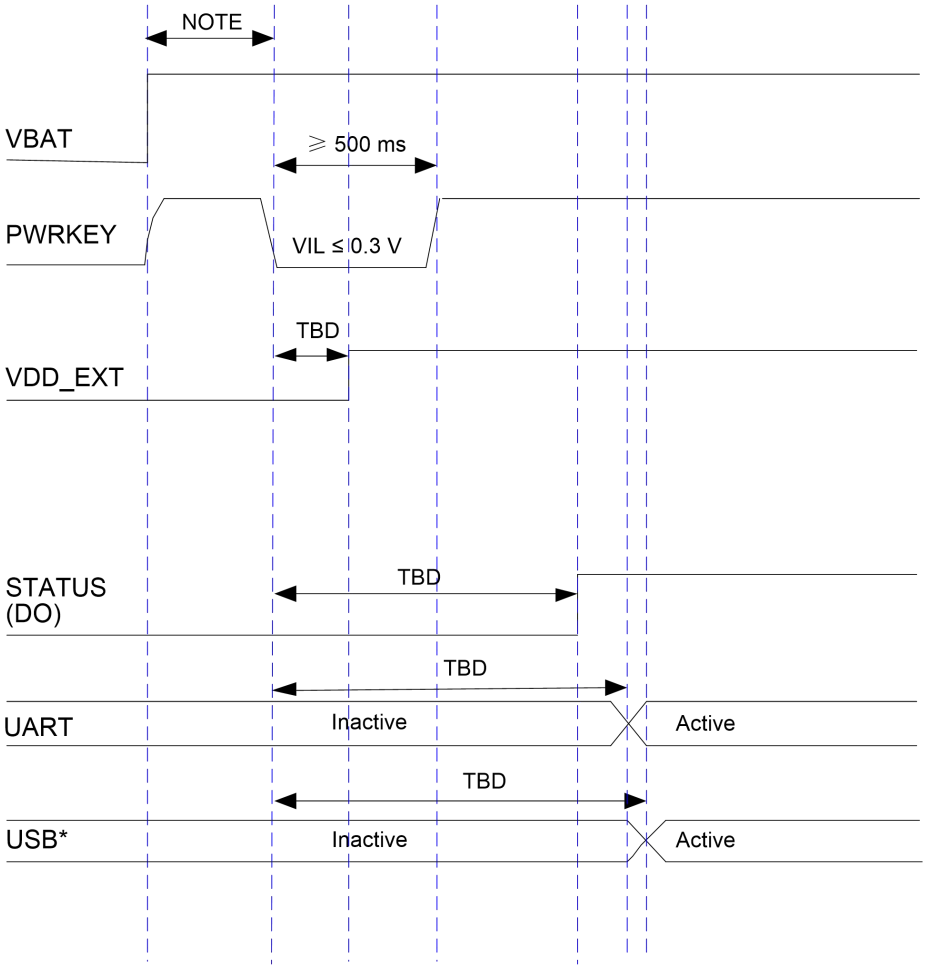


Figure 7: Power-up Timing

NOTE

Ensure that VBAT is stable before pulling down PWRKEY pin and keep the interval no less than 30 ms.

3.6.3. Turn off Module

Either of the following methods can be used to turn off the module normally:

- Turn off the module through PWRKEY.
- Turn off the module through **AT+QPOWD**.

3.6.3.1. Turn off Module through PWRKEY

Drive the PWRKEY pin low for 650–1500 ms and then releasing it, the module will execute power-down procedure.

The power-down timing is illustrated in the following figure.

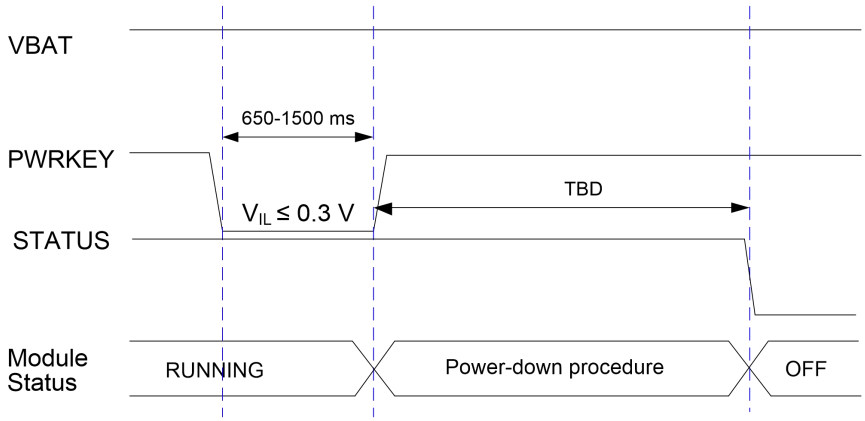


Figure 8: Power-down Timing

3.6.3.2. Turn off Module through AT Command

It is also a safe way to use **AT+QPOWD** to turn off the module, which is similar to turning off the module with PWRKEY.

See ***document [4]*** for details about **AT+QPOWD**.

3.7. Reset the Module

RESET_N is used to reset the module. The module can be reset by driving RESET_N low for minimum assertion time 100 ms.

Table 9: Pin Definition of RESET_N

Pin Name	Pin No.	Description	DC Characteristics	Comment
RESET_N	45	Reset the module	V_{IL}max = 0.3 V V_{IH}min = 1.3 V	

The reset timing is illustrated in the following figure.

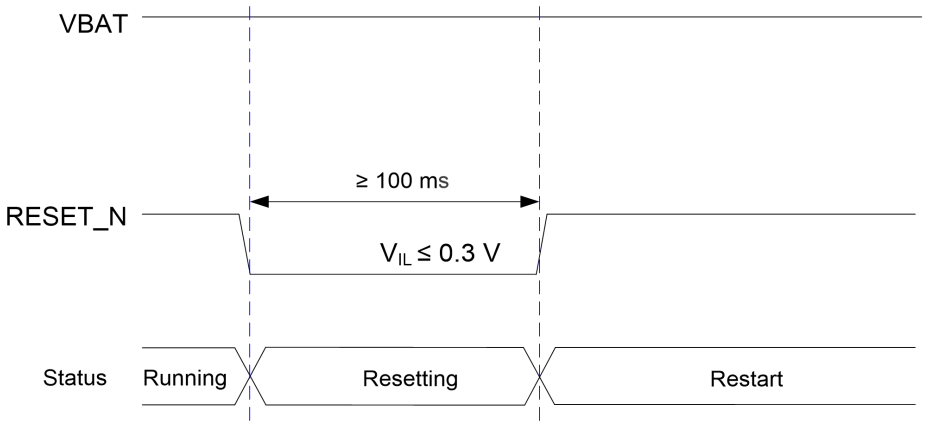


Figure 9: Reset Timing

The recommended circuit is similar to the PWRKEY control circuit. An open drain/collector driver or button can be used to control the RESET_N pin.

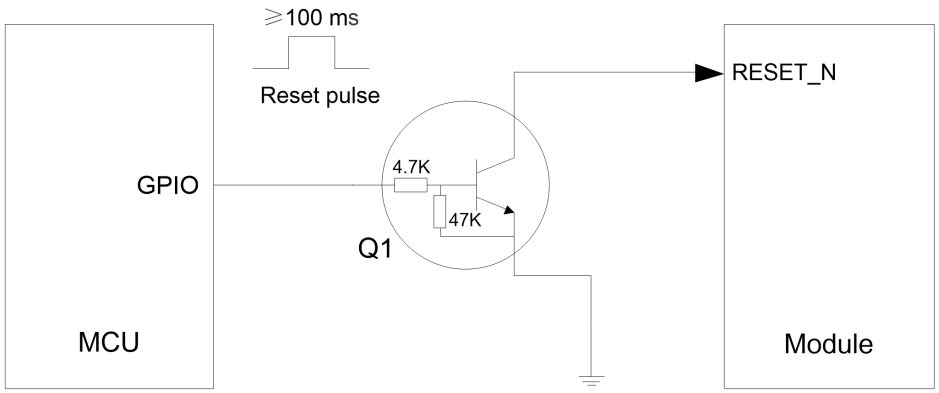


Figure 10: Reference Circuit of RESET_N by Using Driving Circuit

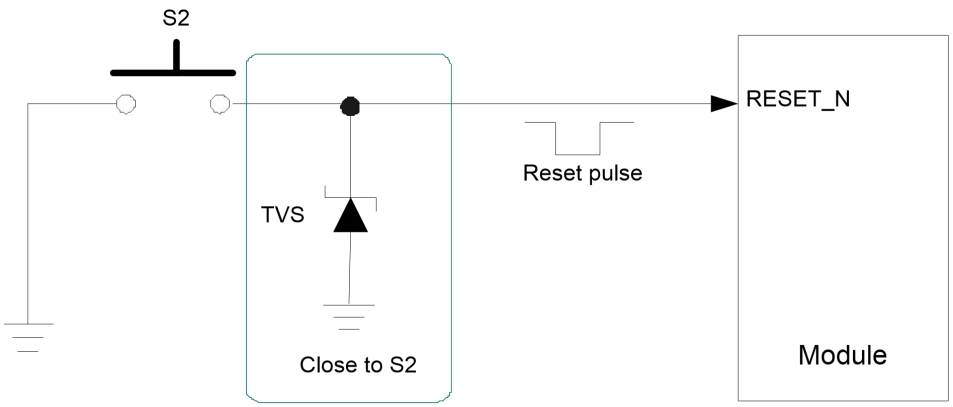


Figure 11: Reference Circuit of RESET_N by Using Button

NOTE

Ensure that there is no large capacitance on RESET_N pin.

3.8. PON_TRIG*

BG772A-GL provides one PON_TRIG pin which is used to wake up the module from PSM. When the pin detects high level for minimum assertion time 100 μs, the module will wake up from PSM.

Table 10: Pin Definition of PON_TRIG

Pin Name	Pin No.	I/O	Description	Comment
PON_TRIG	72	DI/NP	Wake up the module from PSM	1.8 V power domain. Wakeup active high for minimum assertion time 100 μs . No pulled by default.

A reference circuit is shown in the following figure.

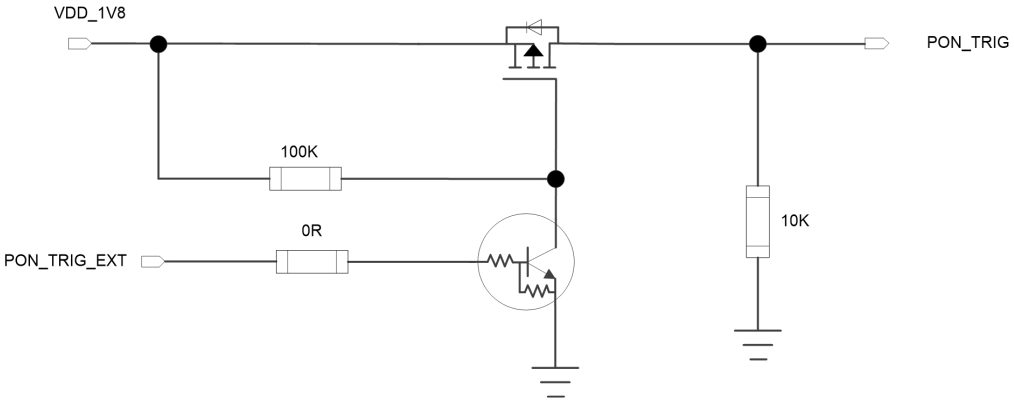


Figure 12: Reference Circuit of PON_TRIG

NOTE

VDD_1V8 is provided by an external LDO.

3.9. (U)SIM Interface

BG772A-GL supports 1.8 V (U)SIM card only. The (U)SIM interface circuitry meets ETSI and IMT-2000 requirements.

Table 11: Pin Definition of (U)SIM Interface

Pin Name	Pin No.	I/O	Description	Comment
USIM_DET*	44	DI/PD	(U)SIM card hot-plug detect	1.8 V power domain.
USIM_VDD	16	PO	(U)SIM card power supply	Only 1.8 V (U)SIM card is supported.
USIM_RST	15	DO/PD	(U)SIM card reset	1.8 V power domain.
USIM_DATA	14	DIO/PU	(U)SIM card data	1.8 V power domain.
USIM_CLK	13	DO/PD	(U)SIM card clock	1.8 V power domain.
USIM_GND	65		Specified ground for (U)SIM card	

BG772A-GL supports (U)SIM card hot-plug via USIM_DET, and both high- and low- level detections are supported. The function is disabled by default, and see **AT+QSIMDET** in ***document [4]*** for more details.

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

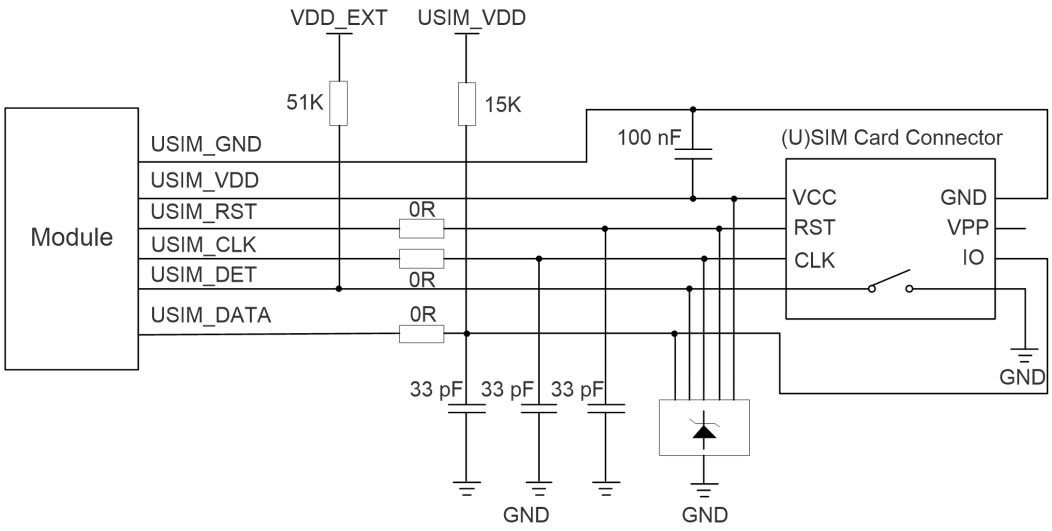


Figure 13: Reference Circuit of (U)SIM Interface with an 8-Pin (U)SIM Card Connector

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

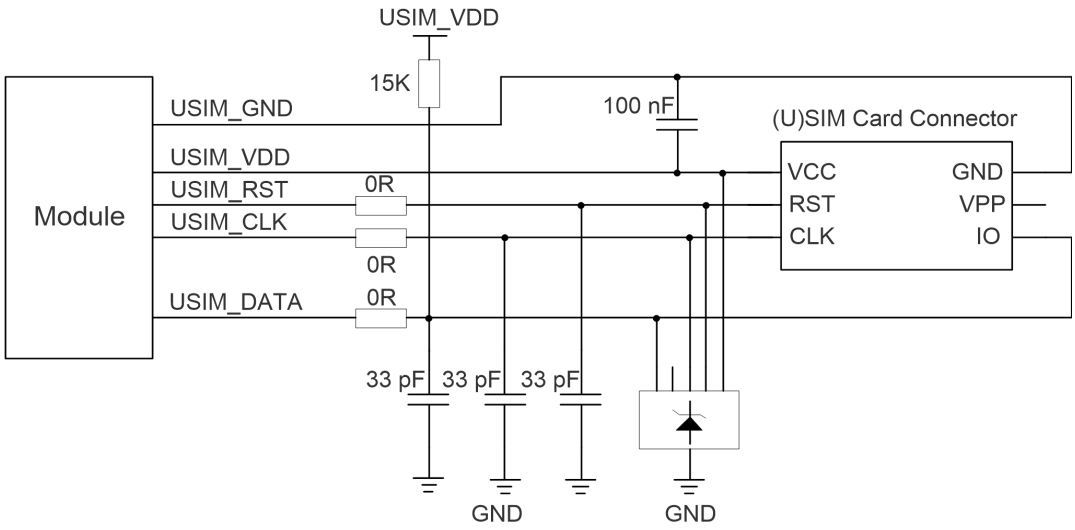


Figure 14: Reference Circuit of (U)SIM Interface with a 6-Pin (U)SIM Card Connector

To enhance the reliability and availability of the (U)SIM card in applications, follow the criteria below in (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. Make sure the bypass capacitor between USIM_VDD and USIM_GND less than 1 μF, and place it as close to (U)SIM card connector as possible. If the system ground plane is complete, USIM_GND can be connected to the system ground directly.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them away from each other and shield them with surrounded ground. USIM_RST should also be ground shielded.
- To offer good ESD protection, it is recommended to add a TVS diode array with parasitic capacitance not exceeding 15 pF. In order to facilitate debugging, it is recommended to reserve series resistors for the (U)SIM signals of the module. The 33 pF capacitors are used for filtering interference of EGSM900. Note that the (U)SIM peripheral circuit should be close to the (U)SIM card connector.
- The pull-up resistor on USIM_DATA line can improve anti-jamming capability when long layout trace and sensitive occasion are applied, and should be placed close to the (U)SIM card connector.

3.10. USB Interface*

BG772A-GL contains one integrated Universal Serial Bus (USB) interface which complies with the USB 2.0 specification and supports operation at full-speed (12 Mbps) mode only. The USB interface is under development, it is not recommended to use at present. The following table shows the pin definition of USB interface.

Table 12: Pin Definition of USB Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_VBUS	12	AI	USB connection detect	Input range: 1.19–2.0 V
USB_DP	11	DIO	USB differential data (+)	Require differential impedance of 90 Ω
USB_DM	10	DIO	USB differential data (-)	
USBPHY_3P3	42	PI	Power supply for USB PHY circuit	Vnom = 3.3 V
USBPHY_3P3_EN	64	DO/PU	External LDO enable control for USB	1.8 V power domain
GND	43		Ground	

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

The following figures illustrate reference designs of USB PHY and USB interface.

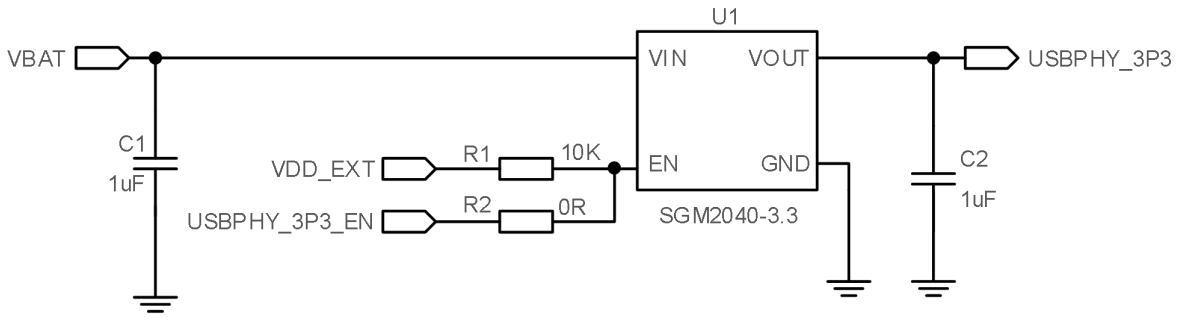


Figure 15: Reference Design of USB PHY

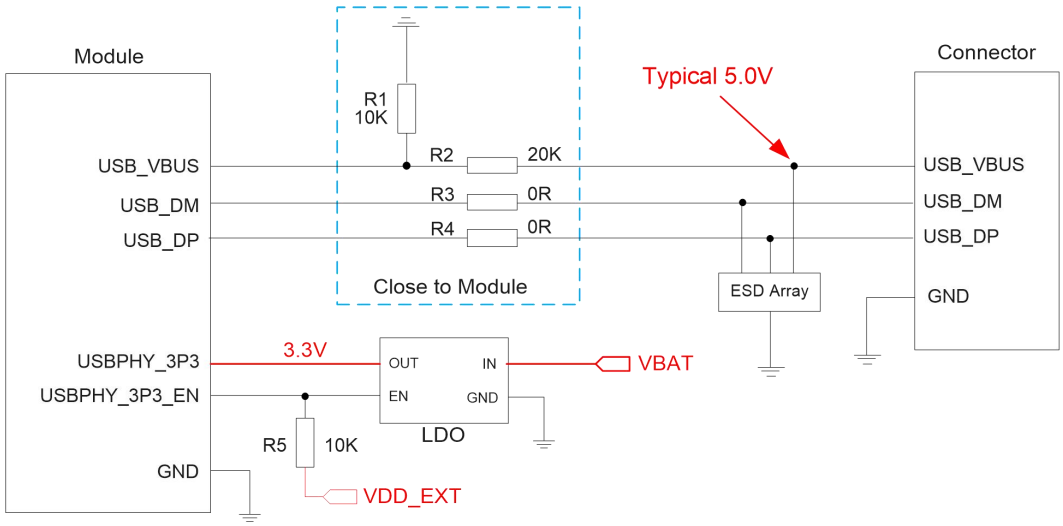


Figure 16: Reference Design of USB Interface

To ensure the integrity of USB data trace signal, components R3 and R4 should be placed close to the module, and also these resistors should be placed close to each other. The extra stubs of trace must be as short as possible.

To meet USB 2.0 specification, 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 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 lines, 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.

NOTES

1. The USB interface is under development, it is not recommended to use at present.
2. The input voltage range of USB_VBUS is 1.19–2.0 V.

3.11. UART Interfaces

The module provides three UART interfaces: the main UART interface, the debug UART interface and the auxiliary UART interface. Features of them are illustrated below:

- The main UART interface supports 9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps, 230400 bps, 460800 bps, 921600 bps and 3000000 bps baud rates, and the default is 115200 bps. It is used for data transmission and AT command communication, and supports RTS and CTS hardware flow control. The default frame format is 8N1 (8 data bits, no parity, 1 stop bit).
- The debug UART interface supports 9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps, 230400 bps, 460800 bps, 921600 bps and 3000000 bps baud rates, and the default is 115200 bps. It is used for firmware upgrade, software debugging and log output, and supports RTS and CTS hardware flow control. The default frame format is 8N1 (8 data bits, no parity, 1 stop bit).
- The auxiliary UART interface supports 921600 bps baud rate by default, and is used for RF calibration and log output, and supports RTS and CTS hardware flow control. The default frame format is 8N1 (8 data bits, no parity, 1 stop bit).

The following tables show the pin definition of three UART interfaces.

Table 13: Pin Definition of Main UART Interface

Pin Name	Pin No.	I/O	Description	Comment
MAIN_DTR	62	DI/PU	Main UART data terminal ready	1.8 V power domain
MAIN_RXD	6	DI/PU	Main UART receive	
MAIN_TXD	7	DO/PU	Main UART transmit	
MAIN_CTS	39	DO/PU	Main UART clear to send	
MAIN_RTS	38	DI/PU	Main UART request to send	
MAIN_DCD	90	DO/PU	Main UART data carrier detect	

MAIN_RI*	76	DO/PU	Main UART ring indication

NOTE

AT+IPR command can be used to set the baud rate of the main UART interface, and **AT+IFC** command can be used to set the hardware flow control (the function is disabled by default). See ***document [4]*** for more details about these AT commands.

Table 14: Pin Definition of Debug UART Interface

Pin Name	Pin No.	I/O	Description	Comment
DBG_TXD	60	DO/PU	Debug UART transmit	1.8 V power domain
DBG_RXD	61	DI/PU	Debug UART receive	
DBG_CTS	51	DO/PU	Debug UART clear to send	
DBG_RTS	92	DI/PD	Debug UART request to send	

Table 15: Pin Definition of Auxiliary UART Interface

Pin Name	Pin No.	I/O	Description	Comment
AUX_TXD	93	DO/PU	Auxiliary UART transmit	1.8 V power domain
AUX_RXD	82	DI/PU	Auxiliary UART receive	
AUX_CTS	70	DO/PU	Auxiliary UART clear to send	
AUX_RTS	59	DI/PU	Auxiliary UART request to send	

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

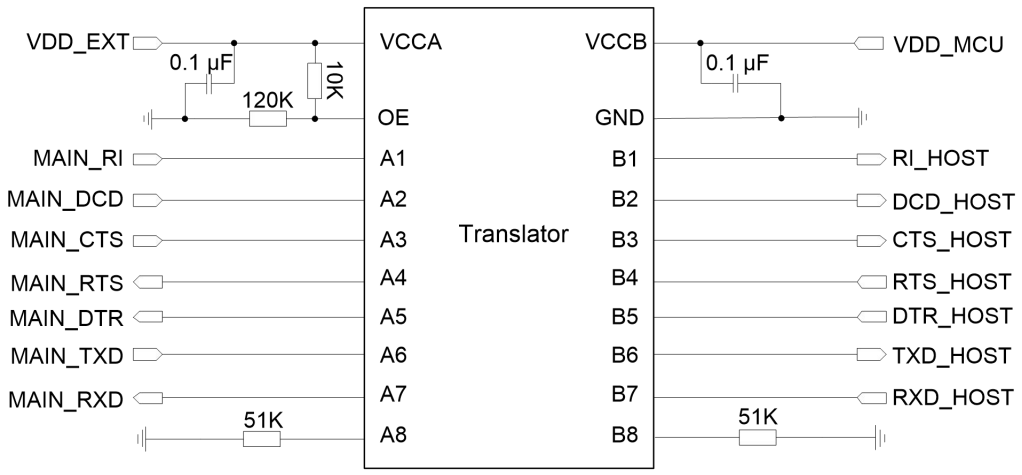


Figure 17: Main UART Reference Design (Translator Chip)

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

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

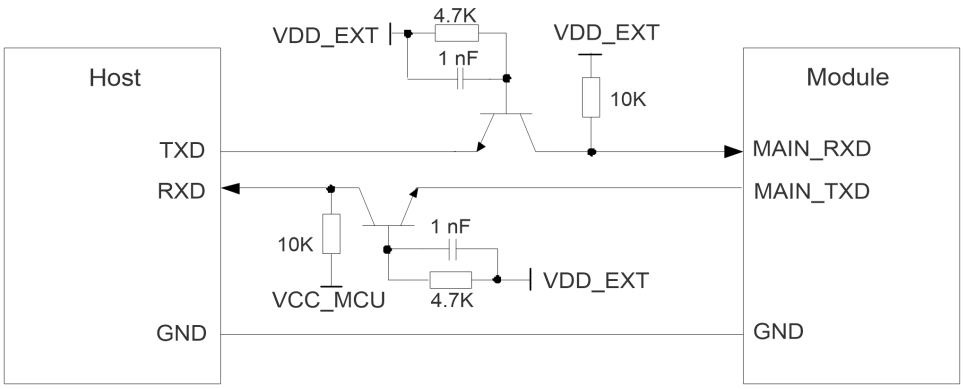


Figure 18: Main UART Reference Design (Transistor Circuit)

NOTES

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 PSM, otherwise, it will damage the chip.

3.12. PCM and I2C Interfaces*

BG772A-GL provides one Pulse Code Modulation (PCM) digital interface and one I2C interface for VoLTE only. The following table shows the pin definition of the two interfaces which can be applied on audio codec design.

Table 16: Pin Definition of PCM and I2C Interfaces

Pin Name	Pin No.	I/O	Description	Comment
PCM_CLK	3	DO/PD	PCM clock	1.8 V power domain
PCM_SYNC	35	DO/PU	PCM data frame sync	
PCM_DIN	2	DI/PU	PCM data input	
PCM_DOUT	34	DO/PU	PCM data output	
I2C_SCL	37	OD	I2C serial clock (for external codec)	Require external pull-up to 1.8 V
I2C_SDA	5	OD	I2C serial data (for external codec)	Require external pull-up to 1.8 V

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

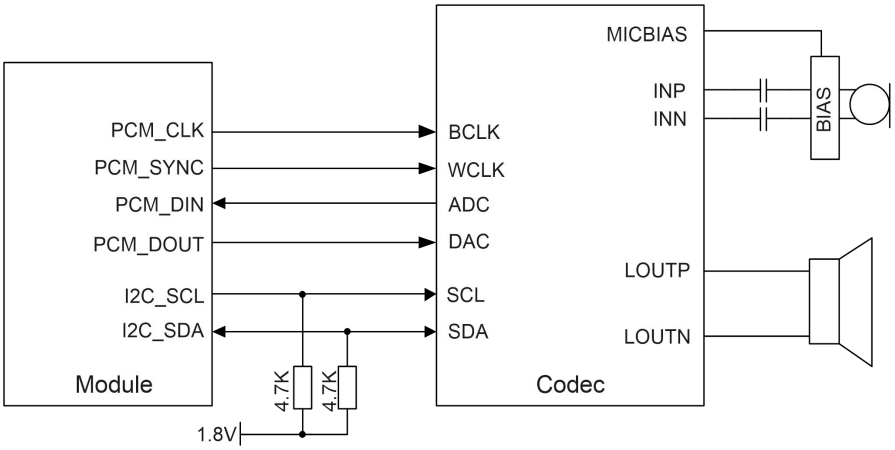


Figure 19: Reference Circuit of PCM Application with Audio Codec

NOTE

PCM and I2C interfaces support VoLTE only.

3.13. Network Status Indication*

BG772A-GL provides one network status indication pin: NET_STATUS. The pin is used to drive a network status indication LED. The following tables describe the pin definition and logic level changes of NET_STATUS in different network activity status.

Table 17: Pin Definition of NET_STATUS

Pin Name	Pin No.	I/O	Description	Comment
NET_STATUS	79	DO/PU	Indicate the module's network activity status	1.8 V power domain.

Table 18: Working State of NET_STATUS

Pin Name	Logic Level Changes	Network Status
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.

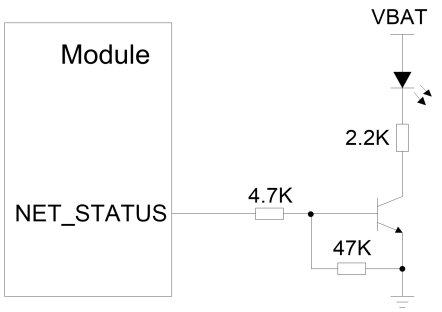


Figure 20: Reference Design of NET_STATUS

3.14. STATUS

The STATUS pin is used to indicate the operation status of BG772A-GL. It outputs high level when the module powers on.

The following table describes the pin definition of STATUS.

Table 19: Pin Definition of STATUS

Pin Name	Pin No.	I/O	Description	Comment
STATUS	78	DO/PD	Indicate the module's operation status	1.8 V power domain

The following figure shows a reference circuit of STATUS.

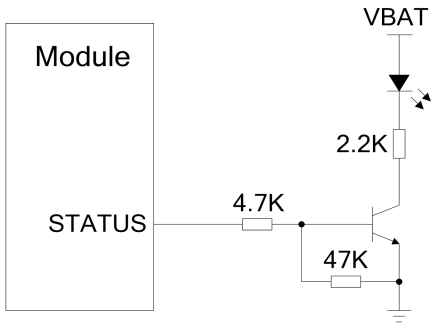


Figure 21: Reference Design of STATUS

3.15. Behaviors of MAIN_RI*

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

The default behaviors of MAIN_RI are shown as below.

Table 20: Default Behaviors of MAIN_RI

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

The default MAIN_RI behaviors can be configured flexibly by **AT+QCFG="urc/ri/ring"*** command. For more details about **AT+QCFG**, see ***document [3]***.

NOTE

A URC can be outputted from UART port, through configuration via **AT+QURCCFG**.

3.16. ADC Interfaces*

The module provides two analog-to-digital converter (ADC) interfaces. **AT+QADC=0** can be used to read the voltage value on ADC0 pin. **AT+QADC=1** be used to read the voltage value on ADC1 pin. For more details about the AT command, see ***document [4]***.

To improve the accuracy of ADC voltage values, the trace of ADC should be surrounded with ground.

Table 21: Pin Definition of ADC Interfaces

Pin Name	Pin No.	I/O	Description
ADC0	17	AI	General-purpose ADC interface
ADC1	18	AI	General-purpose ADC interface

The following table describes the characteristics of ADC interfaces.

Table 22: Characteristics of ADC Interfaces

Parameter	Min.	Typ.	Max.	Unit
Voltage Range	0		1.8	V
Resolution	6		12	bit
Input Resistance			0.5	kΩ

NOTES

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 %.

3.17. GPIO Interfaces*

The module provides seven general-purpose input and output (GPIO) interfaces. **AT+QCFG="gpio"** can be used to configure the status of GPIO pins. For more details about the AT command, see ***document [3]***.

Table 23: Pin Definition of GPIO Interfaces

Pin Name	Pin No.	Description
GPIO1	1	General-purpose input/output
GPIO2	8	General-purpose input/output
GPIO3	9	General-purpose input/output
GPIO4	33	General-purpose input/output
GPIO5	40	General-purpose input/output
GPIO6	57	General-purpose input/output
GPIO7	63	General-purpose input/output

3.18. GRFC Interfaces*

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

Table 24: Pin Definition of GRFC Interfaces

Pin Name	Pin No.	Description	Comments
GRFC1	83	Generic RF controller	1.8 V power domain.
GRFC2	94	Generic RF controller	1.8 V power domain.

Table 25: Truth Table of GRFC Interfaces

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 GNSS Receiver*

4.1. General Description

BG772A-GL supports GPS and GLONASS satellite systems using dedicated hardware accelerators in a power and cost-efficient manner.

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

By default, BG772A-GL GNSS engine is switched off. It has to be switched on via AT command. The module does not support concurrent operation of WWAN and GNSS. For more details about GNSS engine technology and configurations, see ***document [1]***.

4.2. GNSS Performance

The following table shows the GNSS performance of BG772A-GL.

Table 26: GNSS Performance

Parameter	Description	Conditions	Typ.	Unit
Sensitivity (GNSS)	Cold start	Autonomous	-145	dBm
	Reacquisition	Autonomous	-153	dBm
	Tracking	Autonomous	-158	dBm
TTFF (GNSS)	Cold start @ open sky	Autonomous	TBD	s
		XTRA enabled	TBD	s
	Warm start @ open sky	Autonomous	TBD	s
		XTRA enabled	TBD	s
	Hot start	Autonomous	TBD	s

	@ open sky	XTRA enabled	TBD	s
Accuracy (GNSS)	CEP-50	Autonomous @ open sky	1.41	m

NOTES

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

4.3. Layout Guidelines

The following layout guidelines should be taken into account in application designs.

- Maximize the distance between GNSS antenna and main antenna.
- Digital circuits such as (U)SIM card, USB interface, camera module, display connector and SD card should be kept away from antennas.
- Use ground vias around the GNSS trace and sensitive analog signal traces to provide coplanar isolation and protection.
- Keep 50 Ω characteristic impedance for ANT_GNSS trace.

Refer to ***Chapter 5*** for GNSS antenna reference design and antenna installation information.

5 Antenna Interfaces

BG772A-GL includes a main antenna interface and a GNSS antenna interface. The impedance of antenna port is 50 Ω.

5.1. Main Antenna Interface

5.1.1. Pin Definition

The pin definition of the main antenna interface is shown below.

Table 27: Pin Definition of Main Antenna Interface

Pin Name	Pin No.	I/O	Description	Comment
ANT_MAIN	26	AIO	Main antenna interface	50 Ω impedance

5.1.2. Operating Frequency

Table 28: BG772A-GL Operating Frequency

3GPP Band	Transmit	Receive	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 [1)]	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 [2)]	814–849	859–894	MHz
LTE-FDD B27 [2)]	807–824	852–869	MHz
LTE-FDD B28	703–748	758–803	MHz
LTE-FDD B66	1710–1780	2110–2180	MHz

NOTES

1. [1)] LTE-FDD B17 is supported by Cat NB2 only.
2. [2)] LTE-FDD B26 and B27 are supported by Cat M1 only.

5.1.3. Reference Design of Main Antenna Interface

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

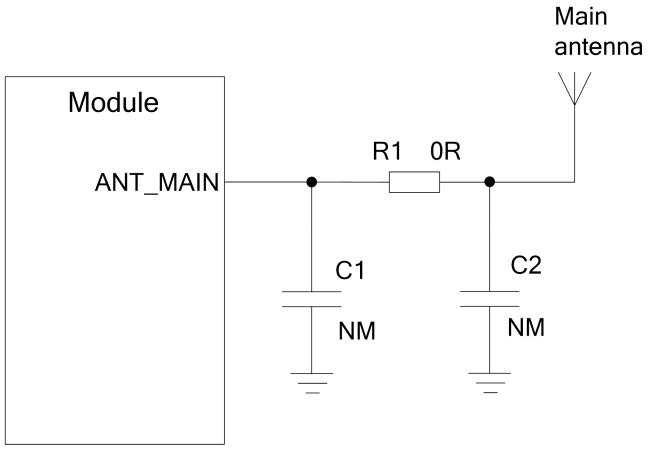


Figure 22: Reference Design of Main Antenna Interface

5.2. GNSS Antenna Interface

The following tables show the pin definition and frequency specification of GNSS antenna interface.

5.2.1. Pin Definition

Table 29: Pin Definition of GNSS Antenna Interface

Pin Name	Pin No.	I/O	Description	Comment
ANT_GNSS	32	AI	GNSS antenna interface	50 Ω impedance

5.2.2. GNSS Operating Frequency

Table 30: GNSS Operating Frequency

Type	Frequency	Unit
GPS	1575.42 ±1.023	MHz
GLONASS	1597.5–1605.8	MHz

5.2.3. Reference Design of GNSS Antenna Interface

A reference design of GNSS antenna interface is shown as below.

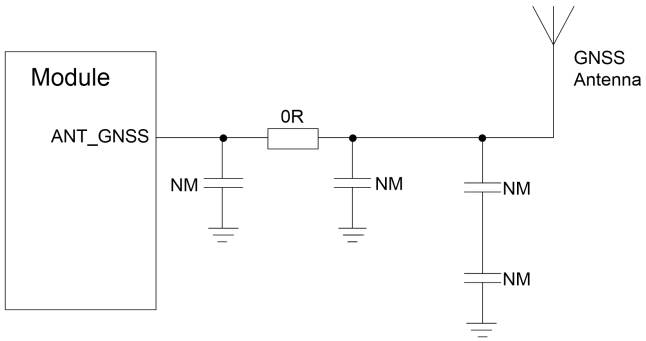


Figure 23: Reference Circuit of GNSS Antenna Interface

NOTE

The module of BG772A-GL is designed with a passive antenna.

5.3. Antenna Installation

5.3.1. Reference Design of RF Layout

For users' PCB, the characteristic impedance of all RF traces should be controlled to 50 Ω. The impedance of RF traces is usually determined by the trace width (W), the materials' dielectric constant, height from the reference ground to the signal layer (H), and the clearance 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.

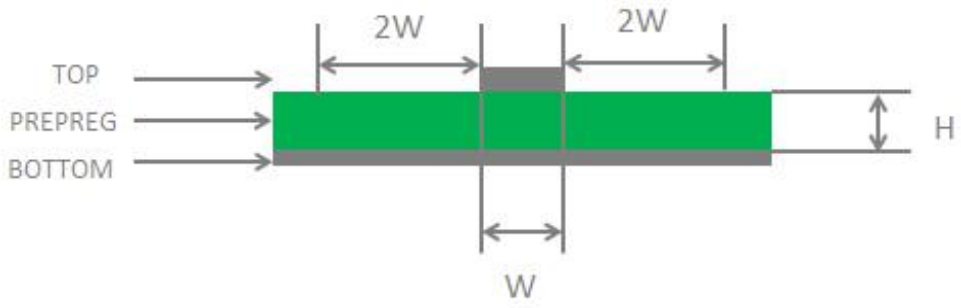


Figure 24: Microstrip Design on a 2-layer PCB

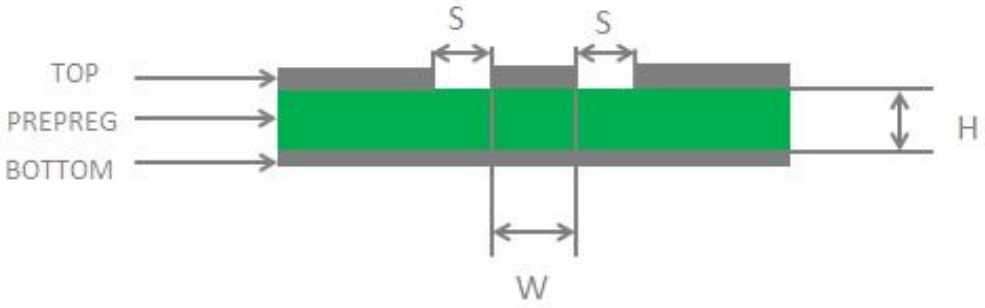


Figure 25: Coplanar Waveguide Design on a 2-layer PCB

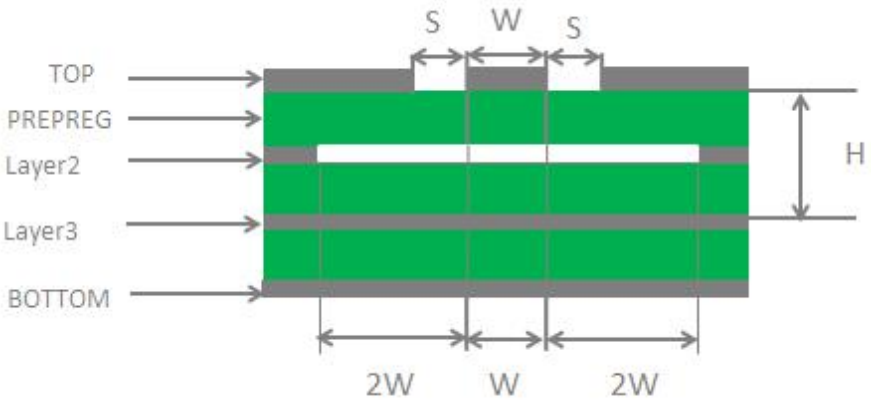


Figure 26: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

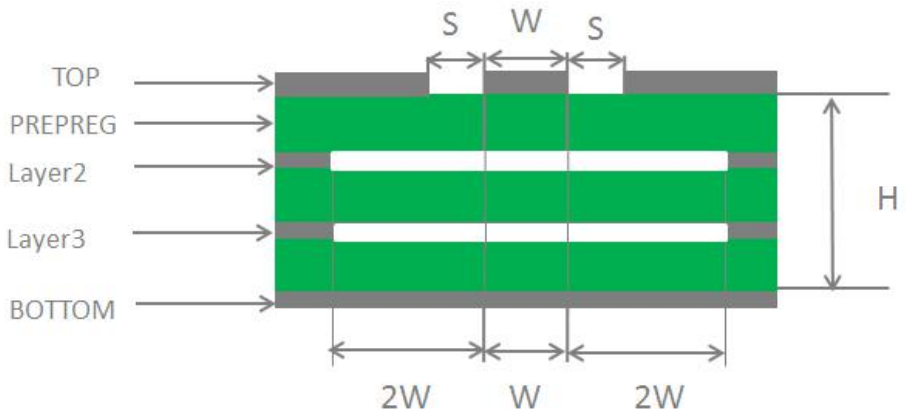


Figure 27: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

To ensure RF performance and reliability, the following principles should be complied with 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.
- 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 × 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]***.

5.3.2. Antenna Requirements

The following table shows the requirements on main antenna and GNSS antenna.

Table 31: Antenna Requirements

Antenna Type	Requirements
GNSS [1)]	Frequency range: 1559–1609 MHz 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 % Max Input Power (W): 50 Input Impedance (Ω): 50 Cable Insertion Loss: < 1 dB (LTE B5/B8/B12/B13/B17/B18/B19/B20/B26/B27/B28) Cable Insertion Loss: < 1.5 dB (LTE B1/B2/B3/B4/B25/B66)

NOTE

[1)] 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.

5.3.3. Recommended RF Connector for Antenna Installation

If RF connector is used for antenna connection, it is recommended to use U.FL-R-SMT connectors provided by *HIROSE*.

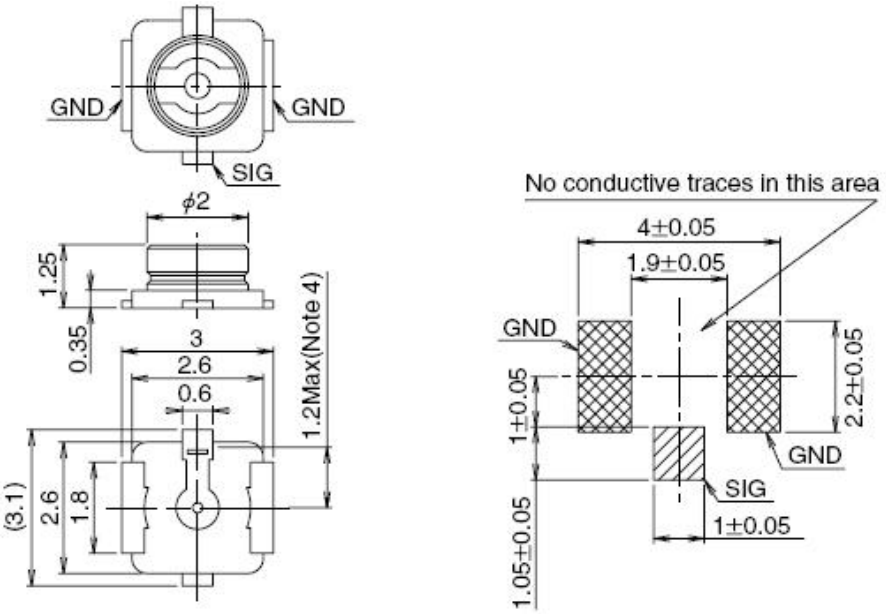


Figure 28: Dimensions of the U.FL-R-SMT Connector (Unit: mm)

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

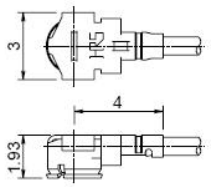
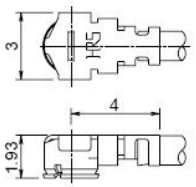
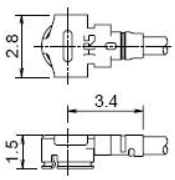
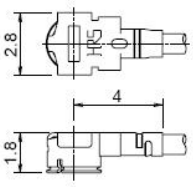
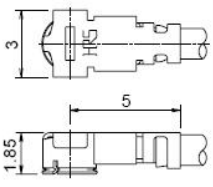
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 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 29: Mechanicals of U.FL-LP Connectors

The following figure describes the space factor of mated connector.

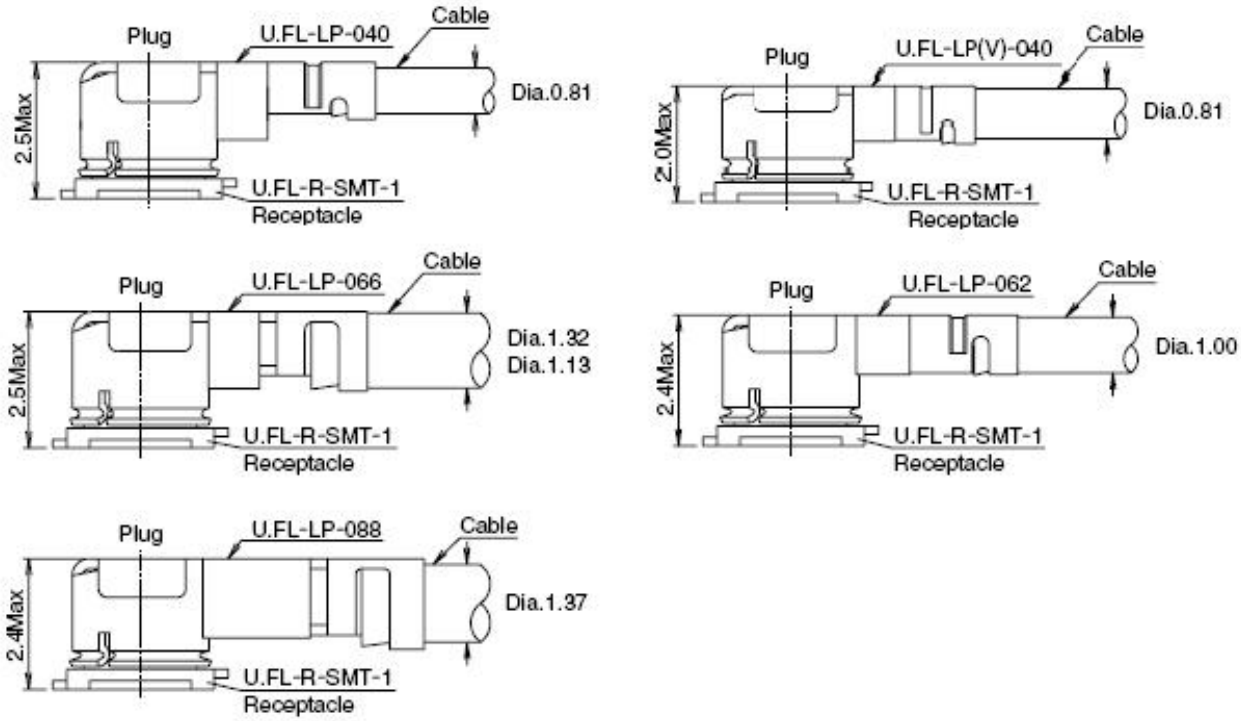


Figure 30: Space Factor of Mated Connector (Unit: mm)

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

6 Electrical, Reliability and Radio Characteristics

6.1. Absolute Maximum Ratings

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

Table 32: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VBAT_BB	-0.2	4.5	V
VBAT_RF	/	4.6	V
USB_VBUS	1.19	2.0	V
Voltage at Digital Pins	-0.3	2.0	V

6.2. Power Supply Ratings

Table 33: Power Supply Ratings

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
VBAT_BB [1)]	Power supply for the module's baseband part	The actual input voltages must be kept between the minimum and maximum values.	2.2	3.3	4.35	V
VBAT_RF [1)]	Power supply for the module's RF part	The actual input voltages must be kept between	3.1	3.3	4.2	V

		the minimum and maximum values.			
USBPHY_3P3	Power supply for USB PHY circuit		3.3		V
USB_VBUS	USB connection detect		1.19	2.0	V

NOTE

[1] When the module starts up normally, in order to ensure full-function mode, the minimum power supply voltage should be higher than 3.1 V.

6.3. Operating and Storage Temperatures

The operating and storage temperatures of the module are listed in the following table.

Table 34: Operating and Storage Temperatures

Parameter	Min.	Typ.	Max.	Unit
Operating Temperature Range [1]	-35	+25	+75	ºC
Extended Temperature Range [2]	-40		+85	ºC
Storage Temperature Range	-40		+90	ºC

NOTES

1. [1] Within the operating temperature range, the module meets 3GPP specifications.
2. [2] Within the extended temperature range, the module remains the ability to establish and maintain functions such as voice*, SMS and data transmission, without any unrecoverable malfunction. Radio spectrum and radio network are not influenced, while one or more specifications, such as P_{out}, may exceed the specified tolerances of 3GPP. When the temperature returns to the operating temperature range, the module meets 3GPP specifications again.

6.4. Current Consumption

The following table shows current consumption of BG772A-GL.

Table 35: BG772A-GL Current Consumption (Power Supply: 3.3 V, Room Temperature)

Description	Conditions	Avg.	Max.	Unit
Leakage	Power-off @ USB/UART disconnected	TBD	-	μA
PSM	PSM @ USB/UART disconnected	TBD	-	μA
Rock Bottom	**AT+CFUN=0** @ Sleep mode	TBD	-	mA
Sleep Mode (USB/UART 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
Idle State (USB/UART 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 data transfer (GNSS OFF)	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 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 B28A @ dBm	TBD	TBD	mA
	LTE-FDD B28B @ dBm	TBD	TBD	mA
	LTE-FDD B66 @ dBm	TBD	TBD	mA
LTE Cat NB2 data transfer (GNSS OFF)	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 36: GNSS Current Consumption (Power Supply: 3.3 V, Room Temperature)

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

6.5. Digital I/O Characteristic

Table 37: 1.8 V I/O Requirements

Parameter	Description	Min.	Max.	Unit
V_{IH}	Input high voltage	1.2	2.0	V
V_{IL}	Input low voltage	-0.2	0.57	V
V_{OH}	Output high voltage	1.36	2.0	V
V_{OL}	Output low voltage	0	0.38	V

Table 38: (U)SIM 1.8 V I/O Requirements

Parameter	Description	Min.	Max.	Unit
USIM_VDD	Power supply	1.7	1.9	V
V_{IH}	Input high voltage	1.2	2.0	V
V_{IL}	Input low voltage	-0.2	0.57	V
V_{OH}	Output high voltage	1.36	2.0	V

V_{OL}	Output low voltage	0	0.38	V

6.6. RF Output Power

The following table shows the RF output power of BG772A-GL.

Table 39: BG772A-GL RF Output Power

Frequency Bands	Max. RF Output Power	Min. RF Output Power
LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/B17[1)]/B18/B19/B20/B25/B26 [2)]/B27 [2)] /B28/B66	23 dBm ±2.7 dB	< -39 dBm

NOTES

1. [1)] LTE-FDD B17 is supported by Cat NB2 only.
2. [2)] LTE-FDD B26 and B27 are supported by Cat M1 only.

6.7. RF Receiving Sensitivity

The following table shows the conducted RF receiving sensitivity of BG772A-GL.

Table 40: BG772A-GL Conducted RF Receiving Sensitivity

Network	Frequency Band	Primary	Diversity	Receiving Sensitivity (dBm)	
				Cat M1/3GPP	Cat NB2 [1)]/3GPP
LTE	LTE-FDD B1	Supported	Not 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 [2]	Not Supported	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 [3]	TBD/-100.3	Not Supported
LTE-FDD B27 [3]	TBD/-100.8	Not Supported
LTE-FDD B28	TBD/-100.8	TBD/-107.5
LTE-FDD B66	TBD/-101.8	TBD/-107.5

NOTES

1. [1] LTE Cat NB2 receiving sensitivity without repetitions.
2. [2] LTE-FDD B17 is supported by Cat NB2 only.
3. [3] LTE-FDD B26 and B27 are supported by Cat M1 only.

6.8. Electrostatic Discharge

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.

The following table shows the electrostatic discharge characteristics of BG772A-GL module.

Table 41: Electrostatic Discharge Characteristics (Temperature: 25 ºC, Relative Humidity: 45 %)

Tested Interfaces	Contact Discharge	Air Discharge	Unit
VBAT, GND	TBD	TBD	kV
Main/GNSS Antenna Interfaces	TBD	TBD	kV

7 Mechanical Dimensions

This chapter describes the mechanical dimensions of the module. All dimensions are measured in millimeter (mm), and the dimensional tolerances are ±0.05 mm unless otherwise specified.

7.1. Top and Side Dimensions

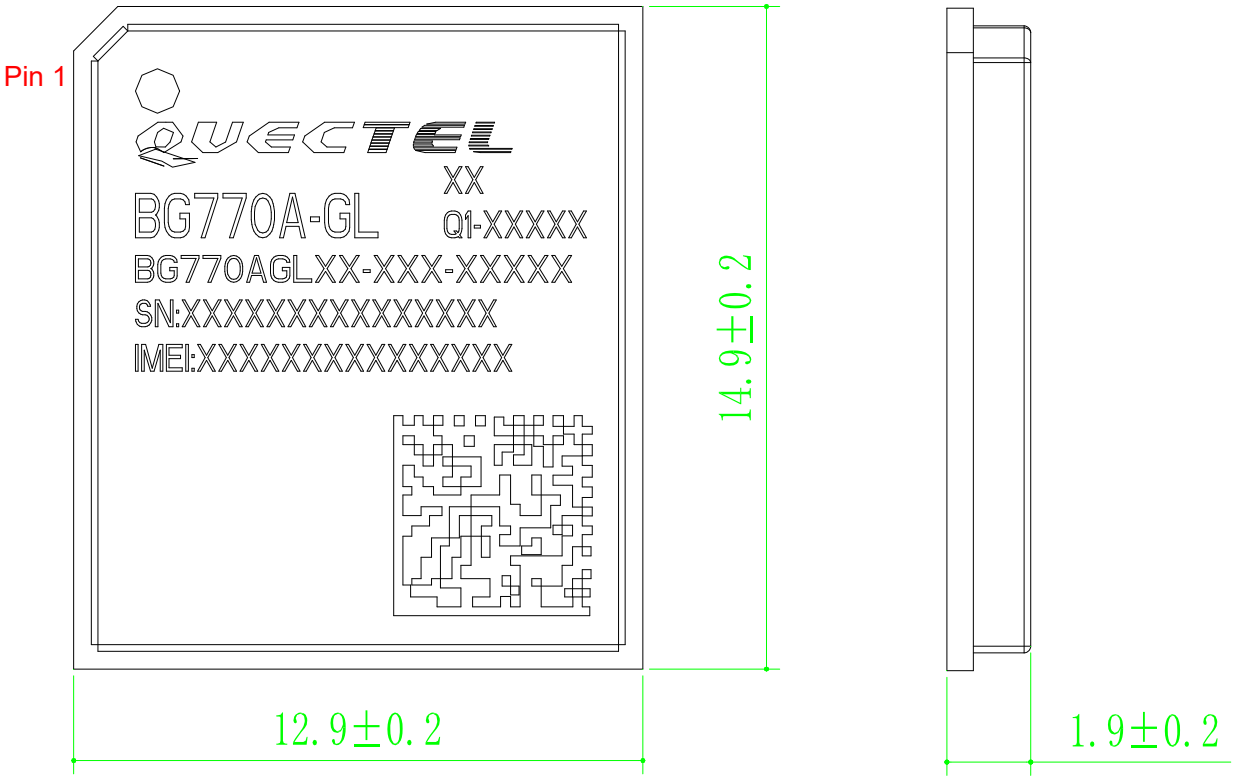


Figure 31: Module Top and Side Dimensions

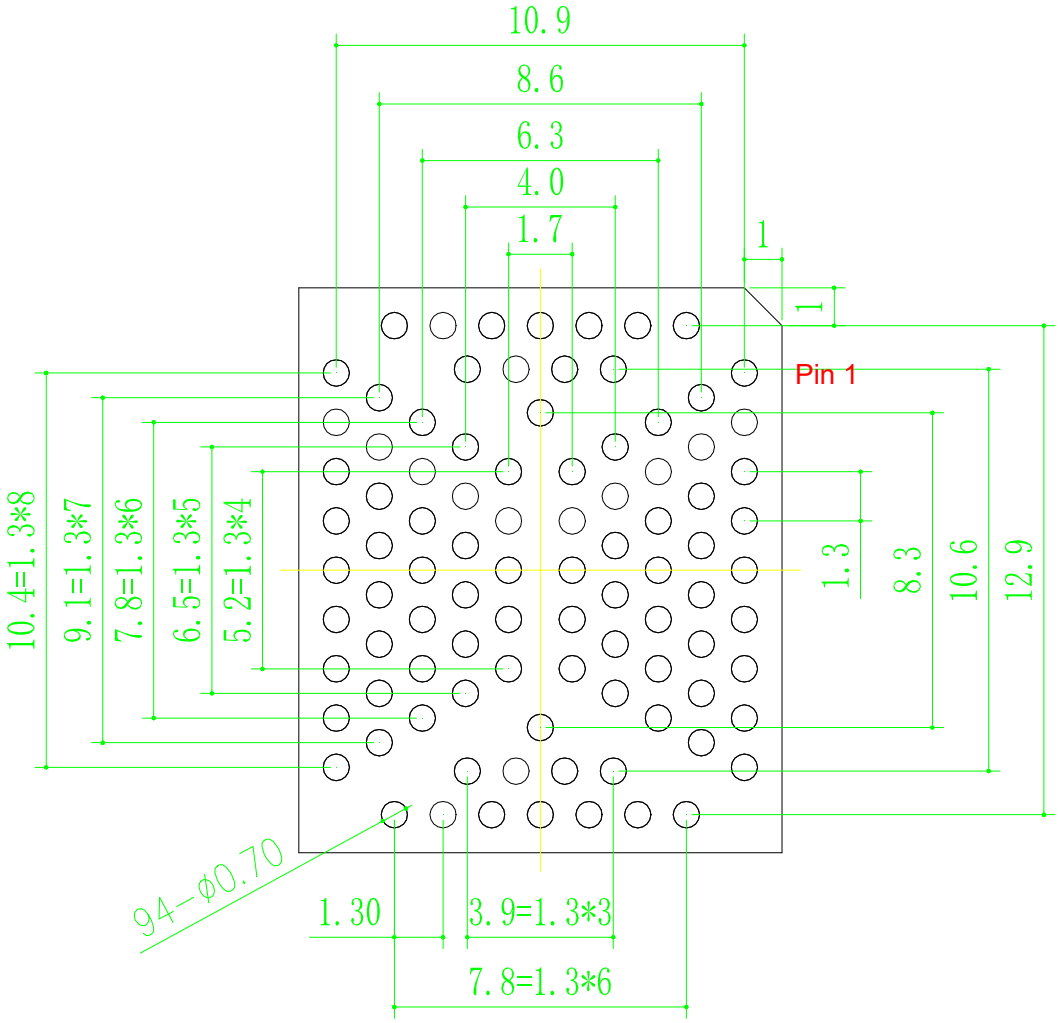


Figure 32: Bottom Dimensions (Bottom View)

NOTE

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

7.2. Recommended Footprint

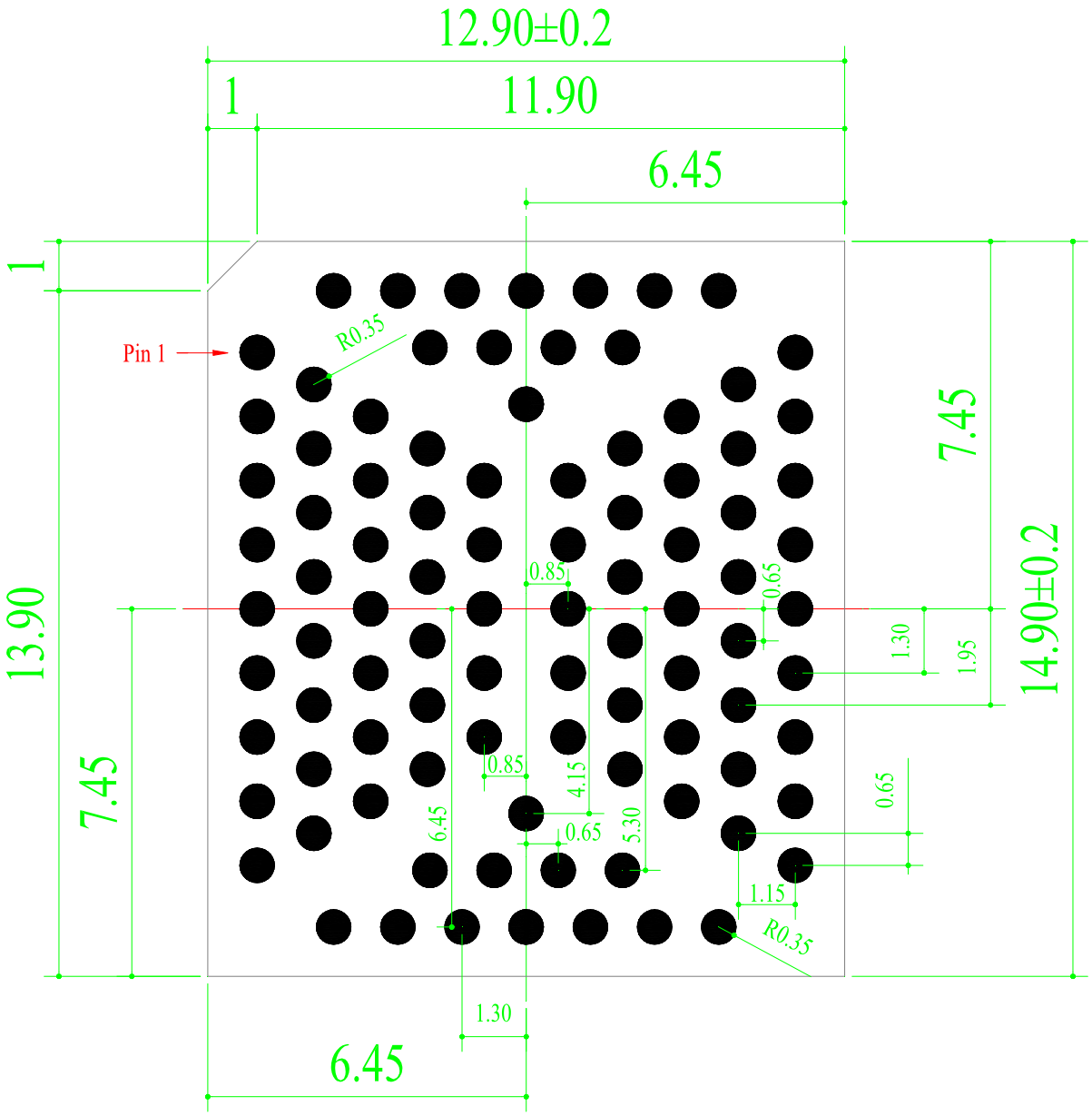


Figure 33: Recommended Footprint (Top View)

NOTES

1. For easy maintenance of the module, keep a distance of 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]***.

7.3. Top and Bottom Views

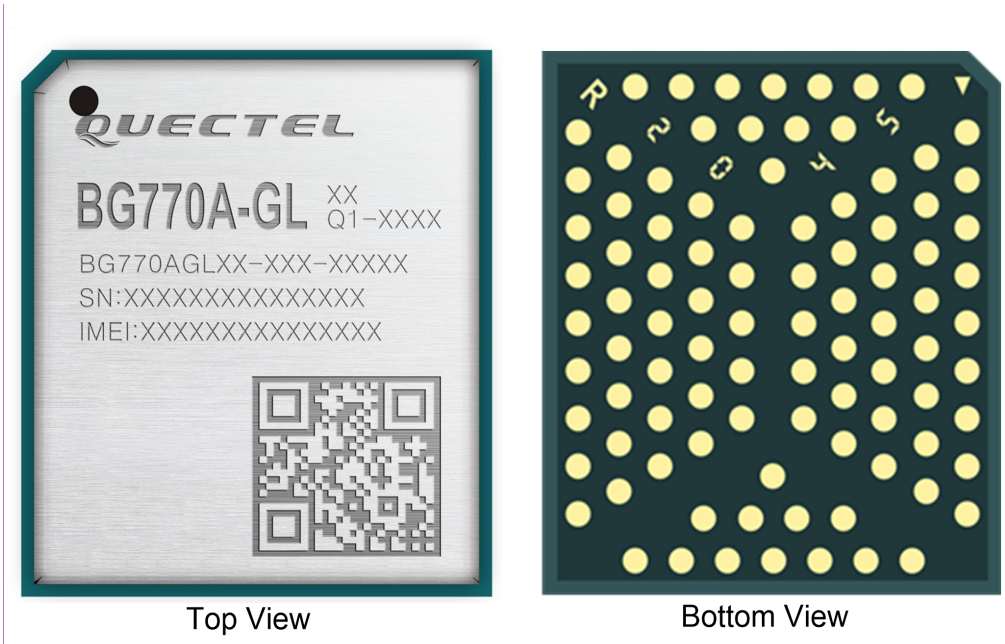


Figure 34: Top and Bottom View of the Module

NOTE

Images above are for illustration purpose only and may differ from the actual module. For authentic appearance and label, refer to the module received from Quectel.

8 Storage, Manufacturing and Packaging

8.1. Storage

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

1. Recommended Storage Condition: The temperature should be 23 ±5 °C and the relative humidity should be 35–60 %.

2. The storage life (in vacuum-sealed packaging) is 12 months in Recommended Storage Condition.

3. The floor life of the module is 168 hours [1)] in a plant where the temperature is 23 ±5 °C and relative humidity is below 60 %. After the vacuum-sealed packaging is removed, the module must be processed in reflow soldering or other high-temperature operations within 168 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10 % (e.g. a 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 ±5 °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.

NOTES

1. [1)]This floor life is only applicable when the environment conforms to *IPC/JEDEC J-STD-033*.
2. To avoid blistering, layer separation and other soldering issues, it is forbidden to expose the modules to the air for a long time. If the temperature and moisture do not conform to IPC/JEDEC J-STD-033 or the relative moisture is over 60 %, it is recommended to start the solder reflow process within 24 hours after the package is removed. And do not remove the packages of tremendous modules if they are not ready for soldering.
3. Take the module out of the packaging and put it on high-temperature resistant fixtures before the baking. If shorter baking time is desired, refer to *IPC/JEDEC J-STD-033* for baking procedure.

8.2. Manufacturing and Soldering

Push the squeegee to apply the solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate to the PCB. The force on the squeegee should be adjusted properly so as to produce a clean stencil surface on a single pass. To ensure the module soldering quality, the thickness of stencil for the module is recommended to be 0.10–0.12 mm. For more details, see ***document [6]***.

It is suggested that the peak reflow temperature is 238–246 ºC, and the absolute maximum reflow temperature is 246 ºC. To avoid damage to the module caused by repeated heating, it is strongly recommended that the module should be mounted 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.

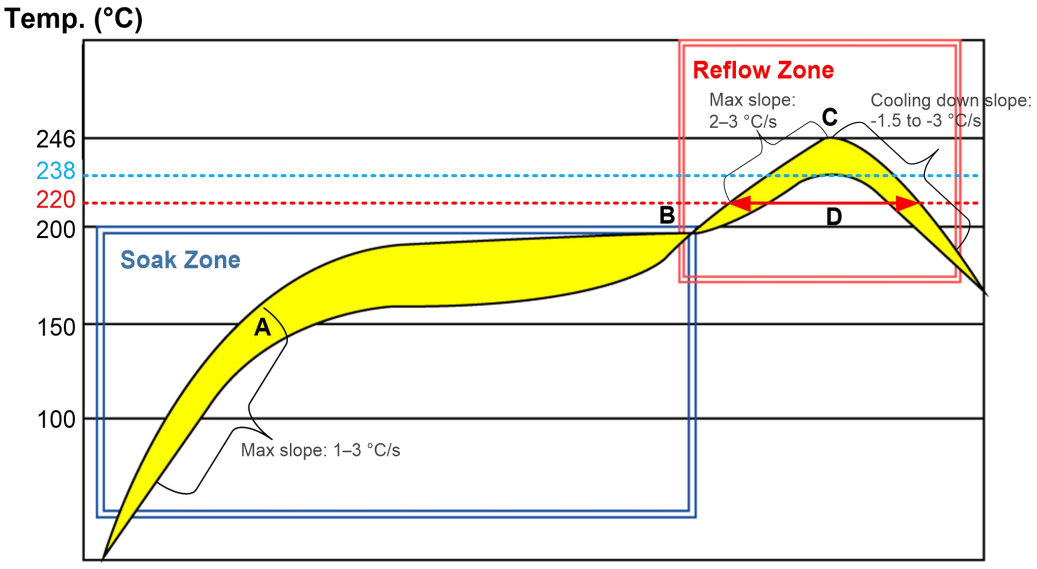


Figure 35: Recommended Reflow Soldering Thermal Profile

Table 42: Recommended Thermal Profile Parameters

Factor	Recommendation
Soak Zone	
Max slope	1 to 3 °C/s
Soak time (between A and B: 150 °C and 200 °C)	70 to 120 s
Reflow Zone	
Max slope	2 to 3 °C/s
Reflow time (D: over 220 °C)	45 to 70 s
Max temperature	238 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.

8.3. Packaging

BG772A-GL is packaged in a vacuum-sealed bag which is ESD protected. The bag should not be opened until the devices are ready to be soldered onto the application.

The following figures show the packaging details, measured in millimetre (mm).

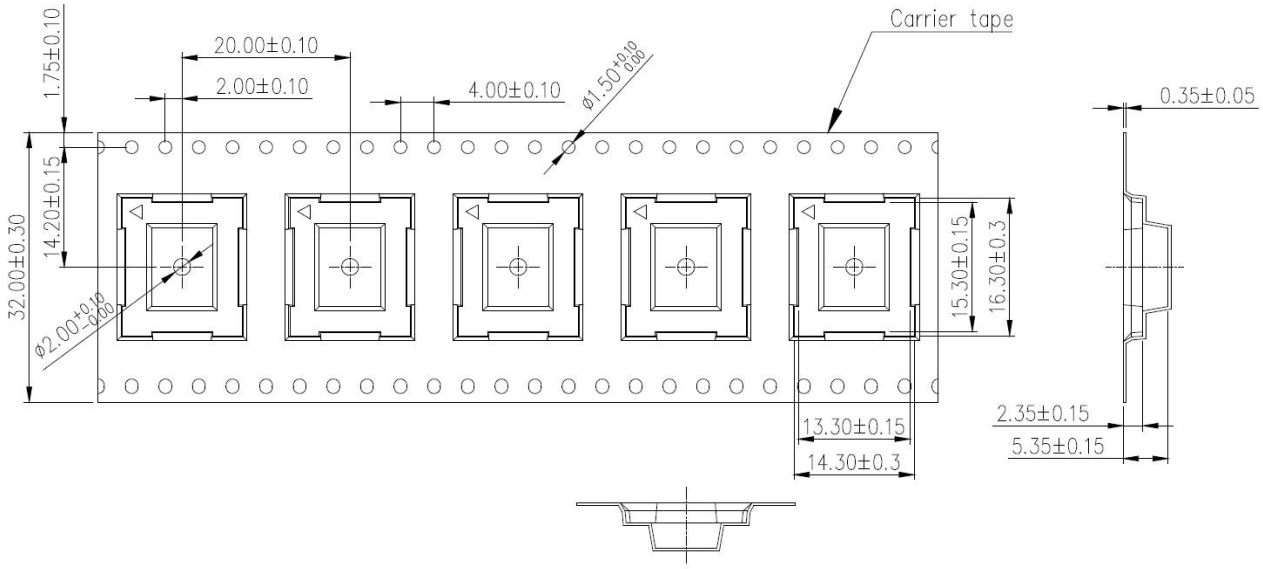


Figure 36: Tape Dimensions

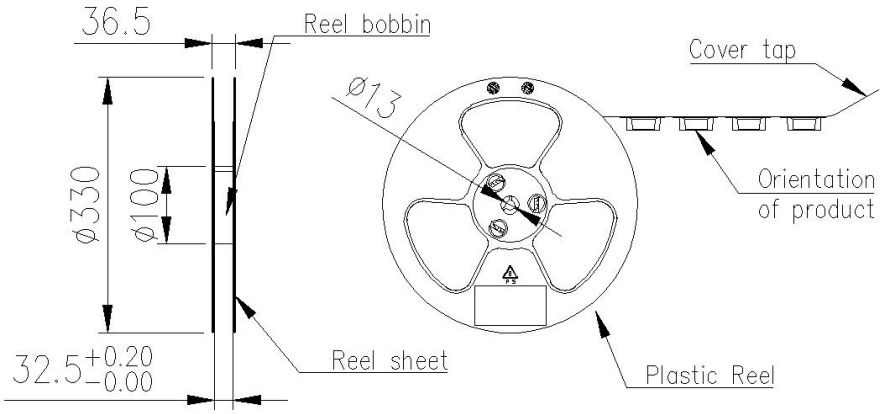


Figure 37: Reel Dimensions

Table 43: BG772A-GL Packaging Specifications

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

9 Appendix A References

Table 44: Related Documents

SN	Document Name	Description
[1]	Quectel_BG772A-GL_GNSS_Application_Note	BG772A-GL GNSS Application Note
[2]	Quectel_UMTS&LTE_EVB_User_Guide	UMTS&LTE EVB User Guide
[3]	Quectel_BG772A-GL_QCFG_AT_Commands_Manual	AT+QCFG Commands Manual for BG772A-GL Module
[4]	Quectel_BG772A-GL_AT_Commands_Manual	AT Commands Manual of BG772A-GL Module
[5]	Quectel_RF_Layout_Application_Note	RF Layout Application Note
[6]	Quectel_Module_Secondary_SMT_Application_Note	Module Secondary SMT User Guide

Table 45: 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
I2C	Inter-Integrated Circuit
LNA	Low Noise Amplifier
LPF	Low Pass Filter
LTE	Long Term Evolution
MO	Mobile Originated
MT	Mobile Terminated
PAP	Password Authentication Protocol
PCB	Printed Circuit Board
PDU	Protocol Data Unit
PPP	Point-to-Point Protocol
PSM	Power Saving Mode
RF	Radio Frequency
RHCP	Right Hand Circularly Polarized
RTS	Request to Send
SAW	Surface Acoustic Wave
SMS	Short Message Service
UL	Uplink
UE	User Equipment
URC	Unsolicited Result Code
(U)SIM	(Universal) Subscriber Identity Module

Vmax	Maximum Voltage Value
Vnom	Nominal Voltage Value
Vmin	Minimum Voltage Value
VIHmax	Maximum Input High Level Voltage Value
VIHmin	Minimum Input High Level Voltage Value
VILmax	Maximum Input Low Level Voltage Value
VSWR	Voltage Standing Wave Ratio
WWAN	Wireless Wide Area Network