BG950S-GL

Hardware Design

LPWA Module Series

Version: 1.0.0

Date: 2024-07-29

Status: Preliminary

At Quectel, our aim is to provide timely and comprehensive services to our customers. If you require any assistance, please contact our headquarters:

Quectel Wireless Solutions Co., Ltd.
Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai 200233, China
Tel: +86 21 5108 6236
Email: info@quectel.com

Or our local offices. For more information, please visit:
http://www.quectel.com/support/sales.htm.

For technical support, or to report documentation errors, please visit:
http://www.quectel.com/support/technical.htm.
Or email us at: support@quectel.com.

Legal Notices

We offer information as a service to you. The provided information is based on your requirements and we make every effort to ensure its quality. You agree that you are responsible for using independent analysis and evaluation in designing intended products, and we provide reference designs for illustrative purposes only. Before using any hardware, software or service guided by this document, please read this notice carefully. Even though we employ commercially reasonable efforts to provide the best possible experience, you hereby acknowledge and agree that this document and related services hereunder are provided to you on an “as available” basis. We may revise or restate this document from time to time at our sole discretion without any prior notice to you.

Use and Disclosure Restrictions

License Agreements

Documents and information provided by us shall be kept confidential, unless specific permission is granted. They shall not be accessed or used for any purpose except as expressly provided herein.

Copyright

Our and third-party products hereunder may contain copyrighted material. Such copyrighted material shall not be copied, reproduced, distributed, merged, published, translated, or modified without prior written consent. We and the third party have exclusive rights over copyrighted material. No license shall be granted or conveyed under any patents, copyrights, trademarks, or service mark rights. To avoid ambiguities, purchasing in any form cannot be deemed as granting a license other than the normal non-exclusive, royalty-free license to use the material. We reserve the right to take legal action for noncompliance with abovementioned requirements, unauthorized use, or other illegal or malicious use of the material.

Trademarks

Except as otherwise set forth herein, nothing in this document shall be construed as conferring any rights to use any trademark, trade name or name, abbreviation, or counterfeit product thereof owned by Quectel or any third party in advertising, publicity, or other aspects.

Third-Party Rights

This document may refer to hardware, software and/or documentation owned by one or more third parties ("third-party materials"). Use of such third-party materials shall be governed by all restrictions and obligations applicable thereto.

We make no warranty or representation, either express or implied, regarding the third-party materials, including but not limited to any implied or statutory, warranties of merchantability or fitness for a particular purpose, quiet enjoyment, system integration, information accuracy, and non-infringement of any third-party intellectual property rights with regard to the licensed technology or use thereof. Nothing herein constitutes a representation or warranty by us to either develop, enhance, modify, distribute, market, sell, offer for sale, or otherwise maintain production of any our products or any other hardware, software, device, tool, information, or product. We moreover disclaim any and all warranties arising from the course of dealing or usage of trade.

Privacy Policy

To implement module functionality, certain device data are uploaded to Quectel's or third-party's servers, including carriers, chipset suppliers or customer-designated servers. Quectel, strictly abiding by the relevant laws and regulations, shall retain, use, disclose or otherwise process relevant data for the purpose of performing the service only or as permitted by applicable laws. Before data interaction with third parties, please be informed of their privacy and data security policy.

Disclaimer

a) We acknowledge no liability for any injury or damage arising from the reliance upon the information.
b) We shall bear no liability resulting from any inaccuracies or omissions, or from the use of the information contained herein.
c) While we have made every effort to ensure that the functions and features under development are free from errors, it is possible that they could contain errors, inaccuracies, and omissions. Unless otherwise provided by valid agreement, we make no warranties of any kind, either implied or express, and exclude all liability for any loss or damage suffered in connection with the use of features and functions under development, to the maximum extent permitted by law, regardless of whether such loss or damage may have been foreseeable.
d) We are not responsible for the accessibility, safety, accuracy, availability, legality, or completeness of information, advertising, commercial offers, products, services, and materials on third-party websites and third-party resources.

Safety Information

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

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

About the Document

Revision History

Version	Date	Author	Description
-	2023-10-30	ChowHong NG/ Eugene LIM/ Ivan BOSILJCIC	Creation of the document
1.0.0	2024-07-29	Soley ZHANG/ RAJKUMAR A/L MANIAM/ Devin WANG	Preliminary

Contents

Table Index

Figure Index

1 Introduction

This document describes the BG950S-GL features, performance, and air interfaces and hardware interfaces connected to your applications. The document provides a quick insight into interface specifications, RF performance, electrical and mechanical specifications, and other module information, as well.

1.1. Special Mark

Table 1: Special Mark

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

Hereby, Quectel Wireless Solutions Co., Ltd. declares that the radio equipment type BG950S-GL is in compliance with Directive 2014/53/EU.

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

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

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 HD-FDD network. It is an SMD module with compact packaging.

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

Table 2: Brief Information

Categories	
Packaging and pins number	LGA; 102 pins
Dimensions	(23.6 ±0.2) mm × (19.9 ±0.2) mm × (2.2 ±0.2) mm
Weight	Approx. 2.31 g
Wireless technology	LTE and GNSS*

2.1. Frequency Bands and Functions

Table 3: Frequency Bands and Functions

Supported Bands	LTE Bands Power Class	GNSS*
Cat M1: LTE HD-FDD: B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B25/B26/B27 [1]/B28/B66/B85 **Cat NB1/NB2*** [2]: LTE HD-FDD: B1/B2/B3/B4/B5/B8/B12/B13/B17 [3]/B18/B19/B20/B25/B26/B28/B66/B85	Power Class 3 (23 dBm ±2 dB)	GPS, GLONASS

[1] LTE HD-FDD B27 are supported by Cat M1 only.
[2] LTE Cat NB2 is backward compatible with LTE Cat NB1.
[3] LTE HD-FDD B17 are supported by Cat NB1/NB2 only.

2.2. Key Features

Table 4: Key Features

Features	Details
Power Supply	● Supply voltage: 2.2–4.35 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
USIM Interface	● Supports 1.8 V external USIM/eSIM card only ● Supports built-in iSIM*
UARTs	**Main UART:** ● Used for AT command communication and data transmission. ● Baud rate: 115200 bps by default ● Default frame format: 8N1 (8 data bits, no parity, 1 stop bit) ● Supports RTS and CTS hardware flow control **DM UARTs:** ● Used for firmware upgrade, software debugging, RF calibration, log output, GNSS data and NMEA sentence output ● Baud rate: 115200 bps by default ● Default frame format: 8N1 (8 data bits, no parity, 1 stop bit). ● Supports RTS and CTS hardware flow control ● DM1 and DM2 are connected inside the module, so they cannot be used simultaneously
PCM Interface*	Supports one digital audio interface: PCM interface for VoLTE
Network Indication	NET_STATUS for network activity status indication
AT Commands	● *3GPP TS 27.007* and *3GPP TS 27.005* AT commands ● Quectel enhanced AT commands
Antenna Interface	● Main antenna interface (ANT_MAIN), 50 Ω impedance ● GNSS antenna interface (ANT_GNSS*), 50 Ω impedance
Transmitting Power	● Class 3 (23 dBm ±2 dB) for LTE bands
LTE Features	● Supports 3GPP Rel-14* (Cat M1 and Cat NB1/NB2*) ● Supports minimum 1.4 MHz RF bandwidth for LTE Cat M1 ● Supports 200 kHz RF bandwidth for LTE Cat NB1/NB2 ● Rel-14: Cat M1: 588 kbps (DL)/1119 kbps (UL) Cat NB2: 127 kbps (DL)/158 kbps (UL)

Internet Protocol Features	● Supports PPP*/TCP*/UDP/SSL*/MQTT*/FTP(S)*/HTTP(S)*/LwM2M*/ IPv4/IPv6*/TLS*/DTLS*/PING/CoAP/NITZ protocols ● Supports PAP and CHAP for PPP connections
GNSS Features*	GPS, GLONASS
Temperature Range	● Operating temperature range [4]: -35 to +75 °C ● Extended temperature range [5]: -40 to +85 °C ● Storage temperature range: -40 to +90 °C
Firmware Upgrade	● DM UARTs ● DFOTA*
RoHS	All hardware components are fully compliant with EU RoHS directive.

[4] Within this range, the module's indicators comply with 3GPP specification requirements.
[5] Within this range, the module retains the ability to establish and maintain functions such as SMS and data transmission, without any unrecoverable malfunction. Radio spectrum and radio network remain uninfluenced, whereas the value of one or more parameters, such as P_{out}, may decrease and fall below the range of the 3GPP specified tolerances. When the temperature returns to the normal operating temperature range, the module's indicators will comply with 3GPP specification requirements again.

2.3. Functional Diagram

The functional diagram illustrates the following major functional parts:

- Power management
- Baseband
- Radio frequency
- Peripheral interfaces

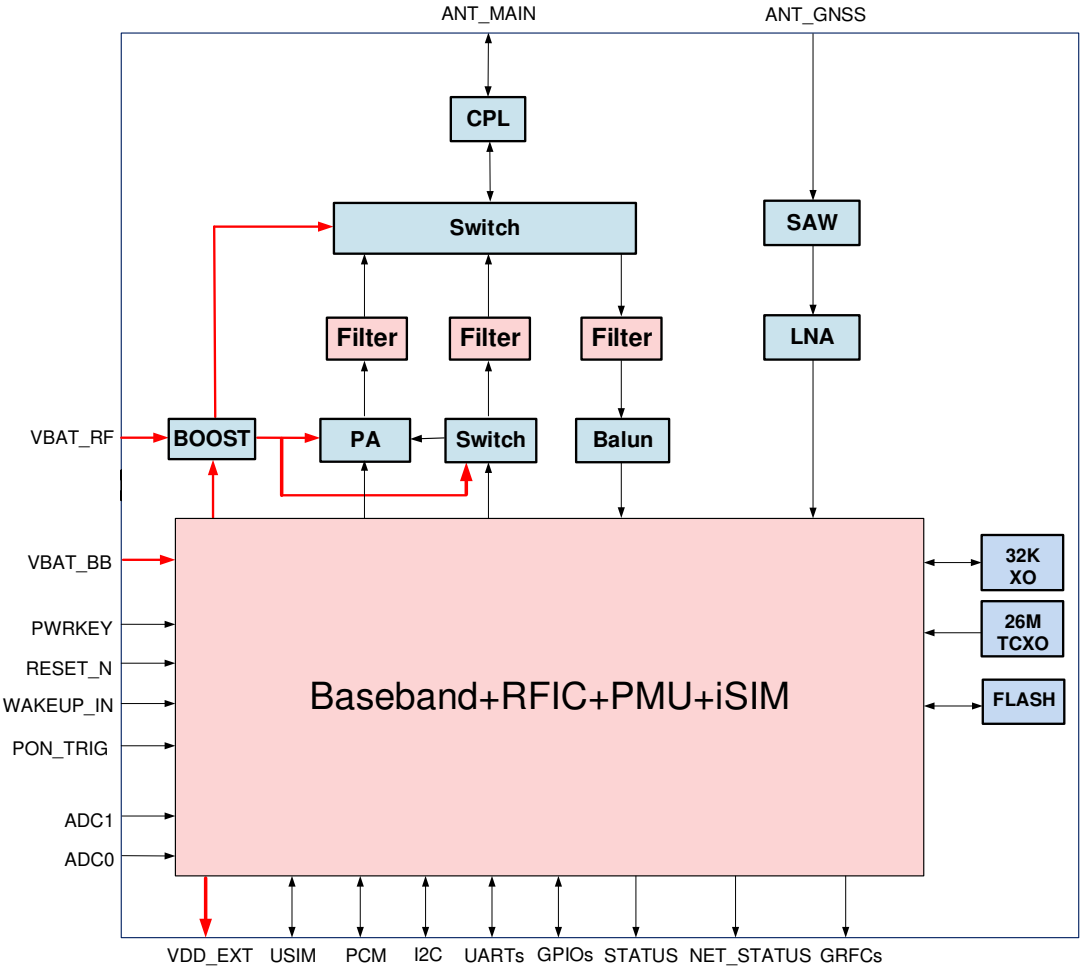


Figure 1: Functional Diagram

2.4. Pin Assignment

The following figure illustrates the pin assignment of the module.

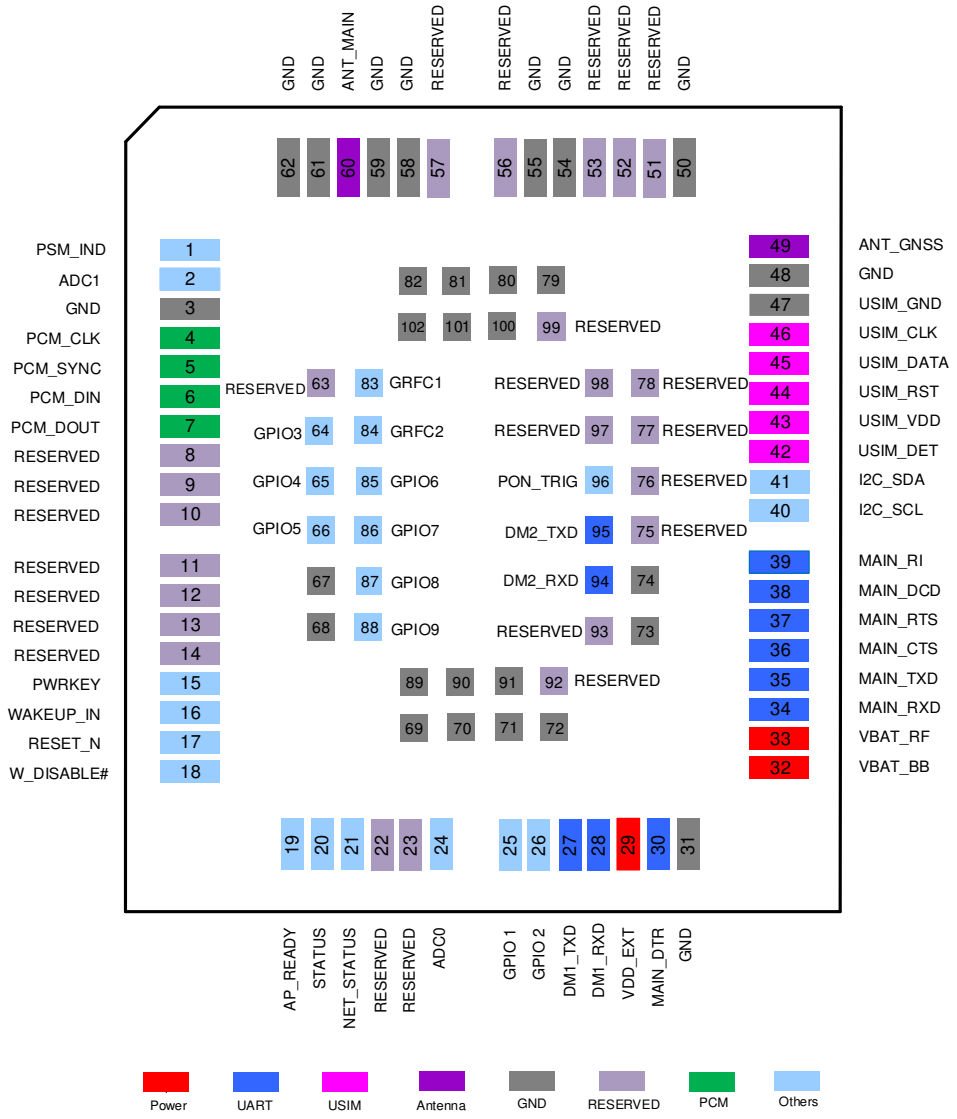


Figure 2: Pin Assignment (Top View)

NOTE

1. ADC* input voltage must not exceed 1.8 V.
2. Keep all RESERVED pins and unused pins unconnected.
3. Connect GND pins to the ground in the design.
4. Pin 27 (DM1_TXD) and pin 28 (DM1_RXD) are connected to pin 95 (DM2_TXD) and pin 94 (DM2_RXD) respectively inside the module.

2.5. Pin Description

Table 5: Parameter Definition

Parameter	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

DC characteristics include power domain and rated current.

Table 6: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristic**	**Comment**
VBAT_BB	32	PI	Power supply for the module's BB part	Vmax = 4.35 V Vmin = 2.2 V Vnom = 3.3 V	
VBAT_RF	33	PI	Power supply for the module's RF part		
VDD_EXT	29	PO	Provides 1.8 V for external circuits	Vnom = 1.8 V $I_O$max = 50 mA	A test point is recommended to be reserved.
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 Characteristic**	**Comment**
PWRKEY*	15	DI	Turn on/off the module	V_{ILMAX} = 0 V V_{IL}max = 0.2 V	Internally pulled up. Active low. A test point

				V_{IH}min = 0.6 V V_{IH}max = 1.98 V	is recommended to be reserved.
Reset					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESET_N	17	DI	Reset the module	V_{IL}max = 0.2 V V_{IH}min = 0.6 V	Internally pulled up. Active low. A test point is recommended to be reserved if unused.
Status Indication Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristic**	**Comment**
STATUS	20	DO	Indicate the module's operation status		If unused, keep these pins open.
NET_STATUS	21	DO	Indicate the module's network activity status		
PSM_IND*	1	DO	Indicate the module's power saving mode		
USIM Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristic**	**Comment**
USIM_VDD	43	PO	USIM card power supply	Vmax = 1.9 V Vmin = 1.7 V	Only 1.8 V USIM card is supported.
USIM_DATA	45	DIO	USIM card data	VDD_EXT	
USIM_CLK	46	DO	USIM card clock		
USIM_RST	44	DO	USIM card reset		
USIM_DET	42	DI	USIM card hot-plug detect		If unused, keep these pins open.
USIM_GND	47	-	Specified ground for USIM card	-	-
Main UART					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristic**	**Comment**
MAIN_CTS	36	DO	Clear to send signal from the module	VDD_EXT	Connect to the MCU's CTS. If unused, keep this pin open.
MAIN_RTS	37	DI	Request to send signal to the module		Connect to the MCU's RTS. If unused, keep

					this pin open.
MAIN_RXD	34	DI	Main UART receive		If unused, keep these pins open.
MAIN_TXD	35	DO	Main UART transmit		
MAIN_DTR	30	DI	Main UART data terminal ready		A test point is recommended to be reserved if unused.
MAIN_DCD	38	DO	Main UART data carrier detect		If unused, keep these pins open.
MAIN_RI	39	DO	Main UART ring indication		
DM UARTs					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristic**	**Comment**
DM1_TXD	27	DO	DM1 UART transmit	VDD_EXT	
DM1_RXD	28	DI	DM1 UART receive		
DM2_RXD	94	DI	DM2 UART receive		Test points must be reserved.
DM2_TXD	95	DO	DM2 UART transmit		
I2C Interface*					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristic**	**Comment**
I2C_SCL	40	OD	I2C serial clock (for external codec)	VDD_EXT	External pull-up resistors are required. 1.8 V only. If unused, keep these pins open.
I2C_SDA	41	OD	I2C serial data (for external codec)		
PCM Interface*					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristic**	**Comment**
PCM_SYNC	5	DIO	PCM data frame sync	VDD_EXT	In master mode, they are output signals. In slave mode, they are input signals.
PCM_CLK	4	DIO	PCM clock		
PCM_DIN	6	DI	PCM data input		If unused, keep these pins open.
PCM_DOUT	7	DO	PCM data output		
Antenna Interfaces					

Pin Name	Pin No.	I/O	Description	DC Characteristic	Comment
ANT_GNSS*	49	AI	GNSS antenna interface	-	50 Ω impedance. If unused, keep this pin open.
ANT_MAIN	60	AIO	Main antenna interface	-	50 Ω impedance.
GRFC Interfaces*					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristic**	**Comment**
GRFC1	83	DO	Generic RF Controller	VDD_EXT	If unused, keep these pins open. Test points are recommended to be reserved.
GRFC2	84	DO	Generic RF Controller		
GPIO Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristic**	**Comment**
GPIO1	25	DIO	General-purpose input/output	VDD_EXT	If unused, keep these pins open. Test points are recommended to be reserved.
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 Interfaces*					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristic**	**Comment**
ADC0	24	AI	General-purpose ADC interface	Input voltage range: 0–1.8 V	If unused, keep these pins open.
ADC1	2	AI	General-purpose ADC interface		
Other Interfaces					

Pin Name	Pin No.	I/O	Description	DC Characteristic	Comment
W_DISABLE#	18	DI	Airplane mode control	VDD_EXT	Pulled up by default. When this pin is at low level, the module can enter airplane mode. If unused, keep this pin open.
WAKEUP_IN*	16	DI	Wake up the module	TBD	A test point is recommended to be reserved.
AP_READY	19	DI	Application processor ready	VDD_EXT	If unused, keep this pin open.
PON_TRIG*	96	DI	Wake up the module from PSM	V_{IL}min = 0 V V_{IL}max = 0.2 V V_{IH}min = 0.6 V V_{IH}max = 1.98 V	Pulled down by default. If unused, keep this pin open. A test point is recommended to be reserved.
RESERVED Pins					
Pin Name	**Pin Number**				**Comment**
RESERVED	8–14, 22, 23, 51, 52, 53, 56, 57, 63, 75–78, 92, 93, 97, 98, 99				

NOTE

1. After entering PSM* or shutdown mode, it is prohibited to provide any external voltage to the module's I/O ports that are not defined as a wake-up source.
2. Keep all RESERVED pins and unused pins unconnected.

2.6. TE-B Kit

Quectel supplies an evaluation board (BG95xA-GL&BG950S-GL TE-B) with accessories to develop and test the module. For more details, see ***document [1]***.

3 Operating Characteristics

3.1. Operating Modes

The table below outlines operating modes of the module.

Table 7: Operating Mode Overview

Mode	Details	
Full Functionality Mode	Idle	The module remains registered on the network and is ready to send and receive data. In this mode, the software is active.
	Connected	The module is connected to the network. Its power consumption varies with the network setting and data transfer rate.
Extended Idle Mode DRX (e-I-DRX)	The module and 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 to airplane mode where the RF function is invalid.	
Minimum Functionality	**AT+CFUN=0** can set the module to minimum functionality without removing the power supply. In this mode, both RF function and USIM card are invalid.	
Sleep Mode	The module retains the ability to receive paging messages, SMS and TCP/UDP data from the network normally. In this mode, the power consumption is reduced to an ultra-low level.	
Shutdown Mode	The module's power supply is shut down by its power management unit. The software is inactive, the serial interfaces are inaccessible, while the operating voltage of VBAT_BB/RF is still maintained.	
Power Saving Mode (PSM)*	PSM is similar to shutdown mode, but the module remains registered on the network and there is no need to re-attach or re-establish PDN connections. The power consumption is minimized.	
Recovery Mode	The module can burn firmware with an empty serial flash, or recover from firmware malfunction. For more details, see ***Chapter 3.6***.	

3.2. 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 as follows:

Hardware:

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

Software:

AT+CFUN=<fun> provides functionality level choices by setting **<fun>** to 0, 1 or 4.

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

NOTE

Airplane mode control via W_DISABLE# is disabled in firmware by default. It can be enabled with **AT+QCFG="airplanecontrol"**. For more details of the command, see ***document [2].***

3.3. Power Saving Mode (PSM)*

The module minimizes its power consumption by entering PSM. The mode is similar to shutdown mode, but the module remains registered on the network and there is no need to re-attach or re-establish PDN connections. Therefore, the module in PSM cannot immediately respond to your requests.

When the module needs to enable PSM, it should request an Active Time value during every attach and TAU procedure. If the network supports PSM and accepts that the module uses PSM, the network 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, then the module will request the value it wants in the TAU procedure.

If PSM is supported by the network, then it can be enabled via **AT+QPSMS**. See ***document [3]*** for details about the AT command. In this case, driving PON_TRIG* low can set the module to PSM.

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

- Driving PON_TRIG high and keeping it high will wake up the module from PSM.
- When the TAU timer expires, the module wakes up from PSM automatically.

NOTE

PON_TRIG is pulled down by default.

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 transmissions, and in particular, they need to consider the delay tolerance of mobile terminated data.

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 were 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.

3.4.1. e-I-DRX Sleep Mode

If e-I-DRX is supported by the network, perform the steps below in sequence to make the module enter e-I-DRX sleep mode, in which case the main UART is inaccessible.

- Send **AT+CEDRXS=1** to enable the use of e-I-DRX.
- Send **AT+QSCLK=2** to enable sleep mode.

To make the module exit e-I-DRX sleep mode, perform the steps below in sequence.

- Send **AT+QSCLK=0** to disable sleep mode.
- Send **AT+CEDRXS=0** to disable the use of e-I-DRX mode.

3.4.2. e-I-DRX Idle Mode

If e-I-DRX is supported by the network, just send **AT+CEDRXS=1** to make the module enter e-I-DRX idle mode, or send **AT+CEDRXS=0** to make the module exit e-I-DRX idle mode.

NOTE

See ***document [3]*** for details about the above AT commands.

3.5. Sleep Mode

The module can reduce its power consumption to an ultra-low level during the sleep mode. Power saving procedures and sleep mode are outlined in the following sub-sections.

3.5.1. UART Application Scenario*

If the MCU communicates with the module via the main UART, perform the steps below in sequence to make the module enter the sleep mode, in which case the data communication pins of the main UART are inaccessible.

1. Send **AT+CFUN=0** to set the module to minimum functionality [6].
2. Drive MAIN_DTR low.
3. Execute **AT+QSCLK=2** to enable sleep mode.
4. Drive MAIN_DTR high to enter sleep mode.

When the module is in sleep mode, perform the steps below in sequence to make the module exit sleep mode.

1. Drive MAIN_DTR low to wake up the module.
2. Execute **AT+QSCLK=0** to disable sleep mode.
3. Send **AT+CFUN=1** to set the module to full functionality [6].

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

[6] After setting the module to minimum functionality with **AT+CFUN=0**, you can test the lowest power consumption of the module after the module enters sleep mode. If you need to keep the RF function on after the module enters sleep mode, there is no need to send any **AT+CFUN**.

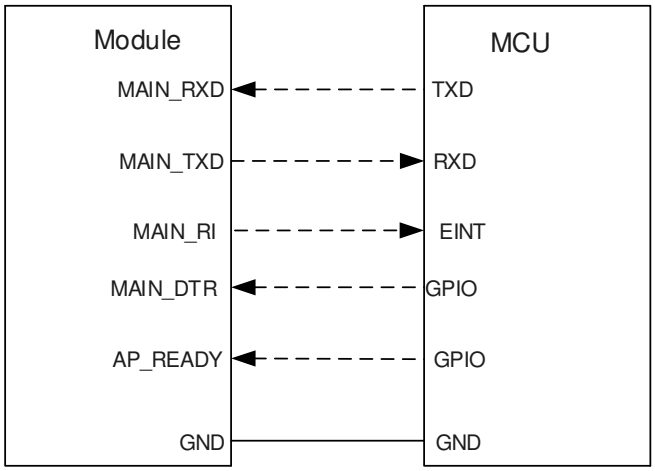


Figure 3: Sleep Mode Application via UART

- When the module has a URC to report, MAIN_RI will wake up the MCU. See ***Chapter 4.6.4*** for details about MAIN_RI behavior.
- After the module is turned on, MAIN_DTR is internally pulled up by default.
- AP_READY detects the sleep state of the MCU (it can be configured to detect high or low voltage level). See **AT+QCFG="apready"** in ***document [2]*** for details.

3.6. Recovery Mode

The module provides the recovery mode for firmware upgrade in emergency cases. This mode can force the baseband chip of the module to upgrade firmware via the DM UARTs. Test points of DM2_RXD (pin 94), DM2_TXD (pin 95), GPIO1 (pin 25) and GPIO2 (pin 26) must be reserved, and keep DM_TXD close to DM_RXD.
The following steps in sequence can set the module to upgrade firmware.

- Short-circuit DM1_TXD & DM1_RXD or DM2_TXD & DM2_RXD.
- Drive PWRKEY* low after VBAT has remained stable for at least 100 ms to turn on the module. In this case, the module will enter recovery mode.
- After the module enters recovery mode successfully, disconnect the connection between DM1_TXD and DM1_RXD, or between DM2_TXD and DM2_RXD.
- Upgrade firmware via the DM UARTs.

NOTE

1. In recovery mode, pin 25 is configured as DM_RTS and pin 26 is configured as DM_CTS. While in other modes, they are GPIO pins.

2. Since the baud rate of the UART required to download firmware to the baseband chip is 3 Mbps, the flow control pins of the DM UART interfaces need to be reserved. Otherwise, you can only download with a 921600 baud rate, which is very slow.

3.7. Power Supply

3.7.1. Power Supply Pins

The module provides two VBAT pins for connection with an external power supply.

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

Table 8: VBAT and GND Pins

Pin Name	Pin No.	I/O	Description	Min.	Typ.	Max.	Unit
VBAT_BB	32	PI	Power supply for the module's BB part	2.2	3.3	4.35	V
VBAT_RF	33	PI	Power supply for the module's RF part	2.2	3.3	4.35	V
GND	3, 31, 48, 50, 54, 55, 58, 59, 61, 62, 67–74, 79–82, 89–91, 100–102						

3.7.2. Voltage Stability Requirements

The power supply range of the module is from 2.2 V to 4.35 V. Ensure the input voltage never drops below 2.2 V.

To decrease voltage drop, one bypass capacitor of about 100 µF with low ESR and one multi-layer ceramic chip (MLCC) capacitor array for its ultra-low ESR should be used for VBAT_BB/RF respectively. 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 should be a single voltage source and can be expanded two sub paths with the star configuration. The width of VBAT_BB trace or VBAT_RF trace should be at least 1 mm. In principle, the longer the VBAT trace is, the wider it should be.

In addition, to ensure power supply stability, it is necessary to add two high-power TVS components near VBAT_BB and VBAT_RF. The reference circuit of the power supply is shown below.

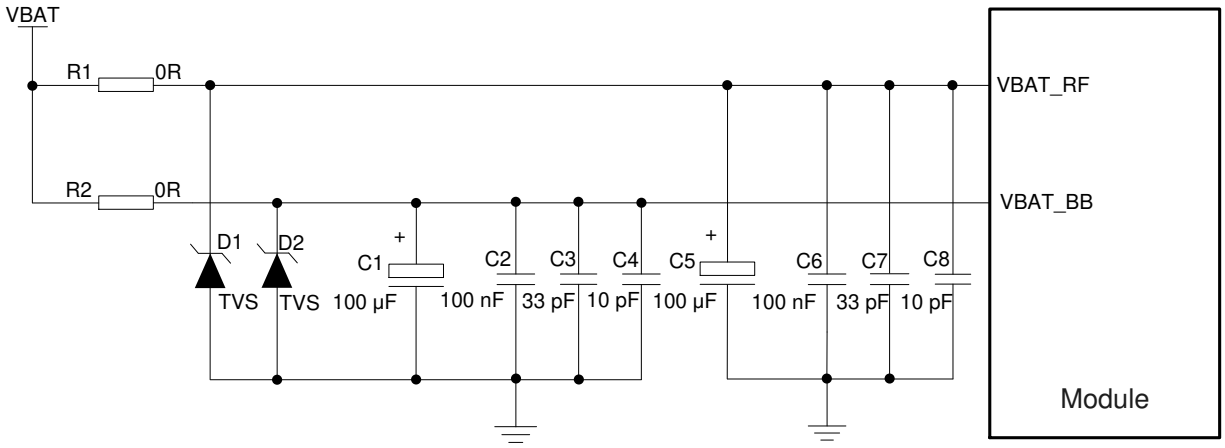


Figure 4: Star Structure of Power Supply

Power design for the module is critical to its performance. The power supply of the module should be able to provide a sufficient current, so it is recommended to select a DC-DC converter chip or an LDO chip with ultra-low leakage current for the power supply design.

3.7.3. Power Supply Monitoring*

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

3.8. Turn On*

3.8.1. Turn On with PWRKEY

Table 9: Pin Description of PWRKEY

Pin Name	Pin No.	I/O	Description	Comment
PWRKEY*	15	DI	Turn on/off the module	Internally pulled up. Active low. A test point is recommended to be reserved.

When the module is in shutdown mode, driving PWRKEY low for 500–1000 ms and then releasing it will turn on the module. It is recommended to use an open drain/collector driver to control PWRKEY.

A simple reference design is illustrated in the following figure.

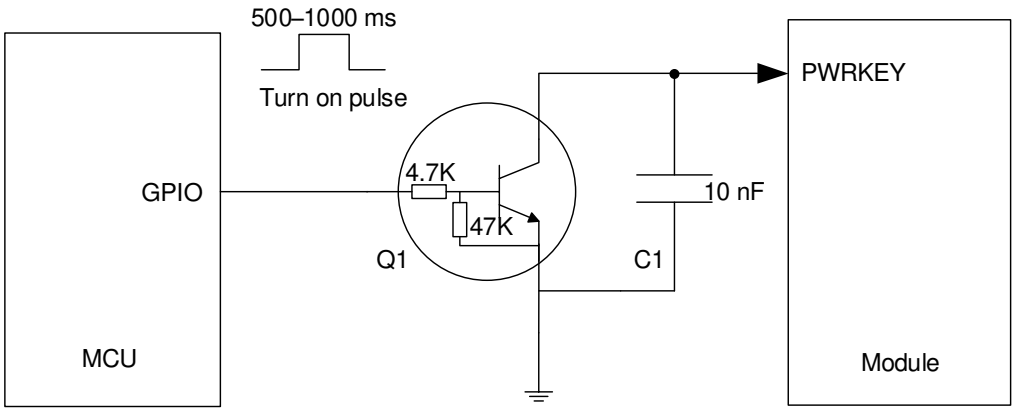


Figure 5: Turn On the Module with a Driver Circuit

Another way to control PWRKEY is with a button. Pressing the button may result in a discharge of static electricity from a finger. Therefore, it is vital to place a TVS component near the button for ESD protection.

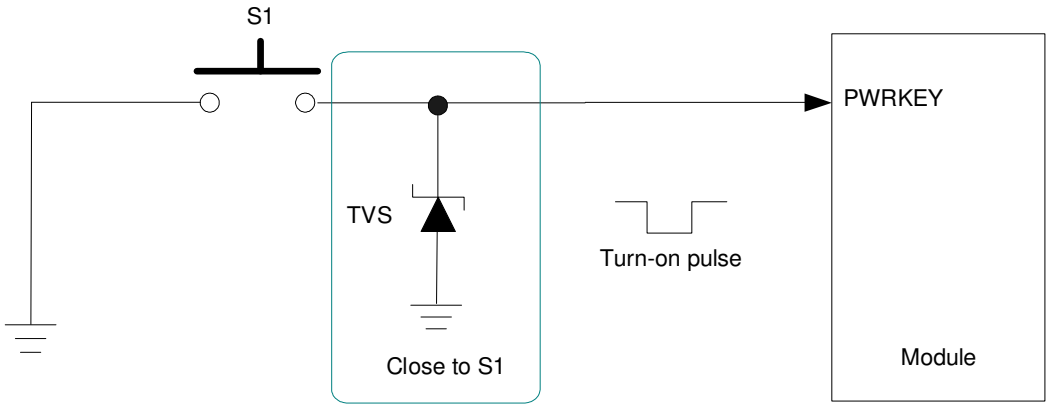


Figure 6: Turn On the Module with a Button

3.9. Turn Off*

After the module is turned off or enters PSM*, do not pull up any I/O pin lest it cause additional power consumption and possibly damage pins on the module.

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

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

NOTE

1. To avoid corrupting the data in the internal flash, do not switch off the power supply while the module is working normally. The power supply can be cut off only after the module is shut down with PWRKEY or AT command.
2. When the module is turned off with AT command, keep PWRKEY at a high level after executing the power-off command. Otherwise, the module will be turned on again after turn-off.

3.10. RESET_N

Drive RESET_N low for at least 100 ms and then releasing it can reset the module. RESET_N signal is sensitive to interference. Consequently, it is recommended to route the trace as short as possible and surround it with ground.

Table 10: Pin Description of RESET_N

Pin Name	Pin No.	I/O	Description
RESET_N	17	DI	Reset the module. Internally pulled up. Active low. A test point is recommended to be reserved if unused.

The recommended circuit for reset function is similar to the PWRKEY control circuit. You can use an open drain/collector driver or a button to control RESET_N.

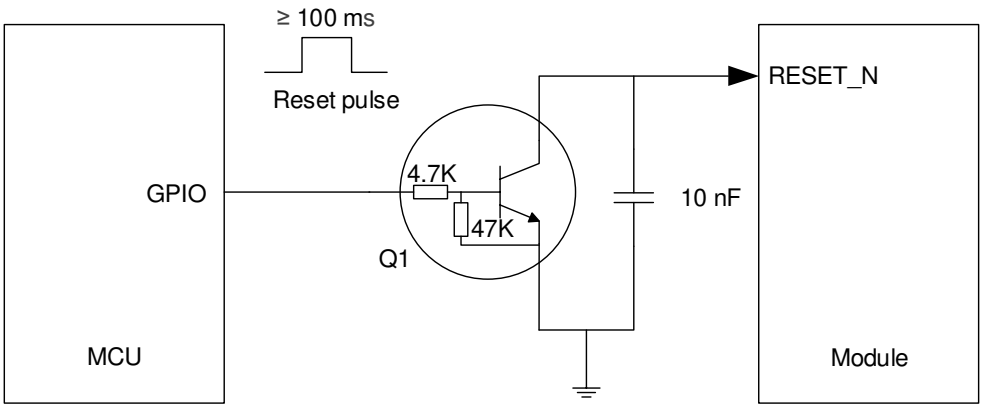


Figure 7: Reference Design of RESET_N with a Driving Circuit

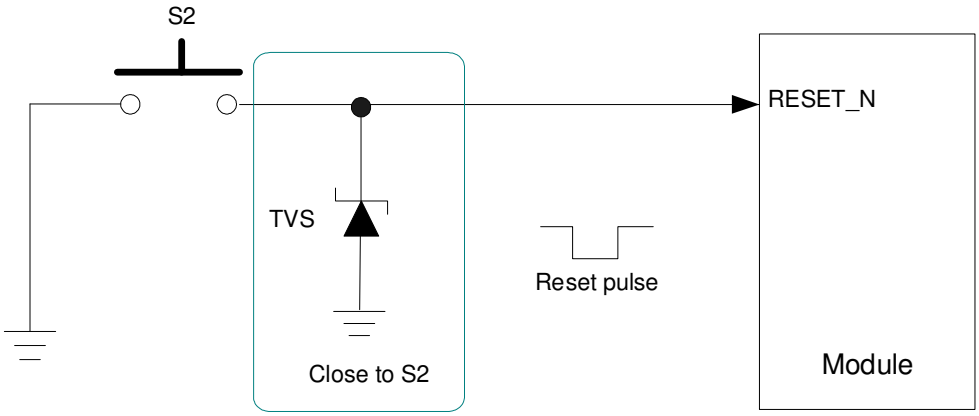


Figure 8: Reference Design of RESET_N with a Button

The reset timing is illustrated in the following figure.

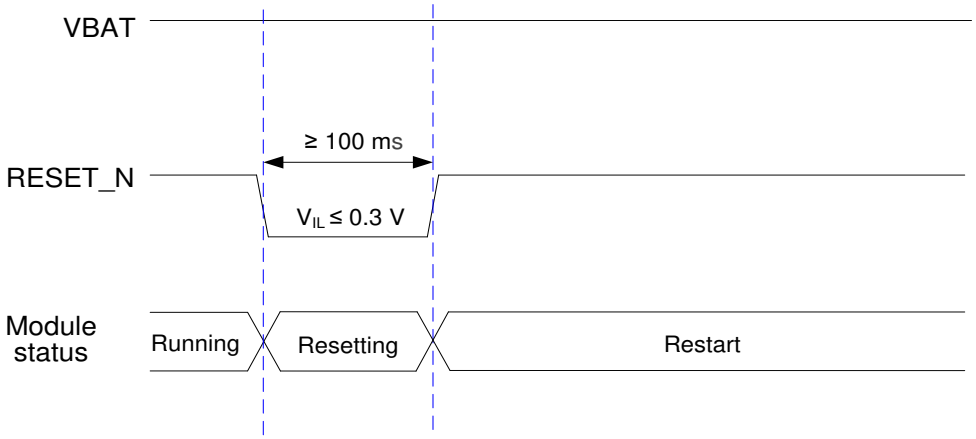


Figure 9: Reset Timing

NOTE

1. Ensure that there is no large capacitance on RESET_N pin.
2. Because PWRKEY and RESET traces are sensitive signal traces, it's necessary to surround the traces with ground on that layer and with ground planes above and below, and keep their traces away from each other, so as to reduce interference.

4 Application Interfaces

4.1. USIM Interface

The module supports 1.8 V USIM card only and supports built-in iSIM*. The USIM interface circuit meets ETSI and IMT-2000 requirements.

Table 11: Pin Description of USIM Interface

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

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

The following figure illustrates a reference design of USIM interface with an 8-pin USIM card connector.

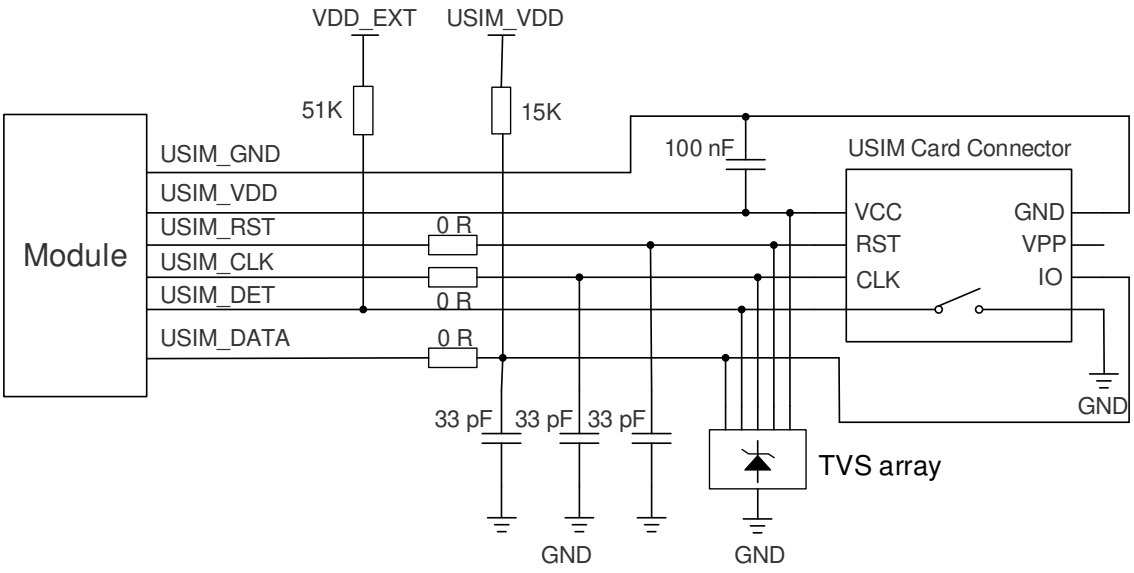


Figure 10: Reference Design of USIM Interface with an 8-pin USIM Card Connector

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

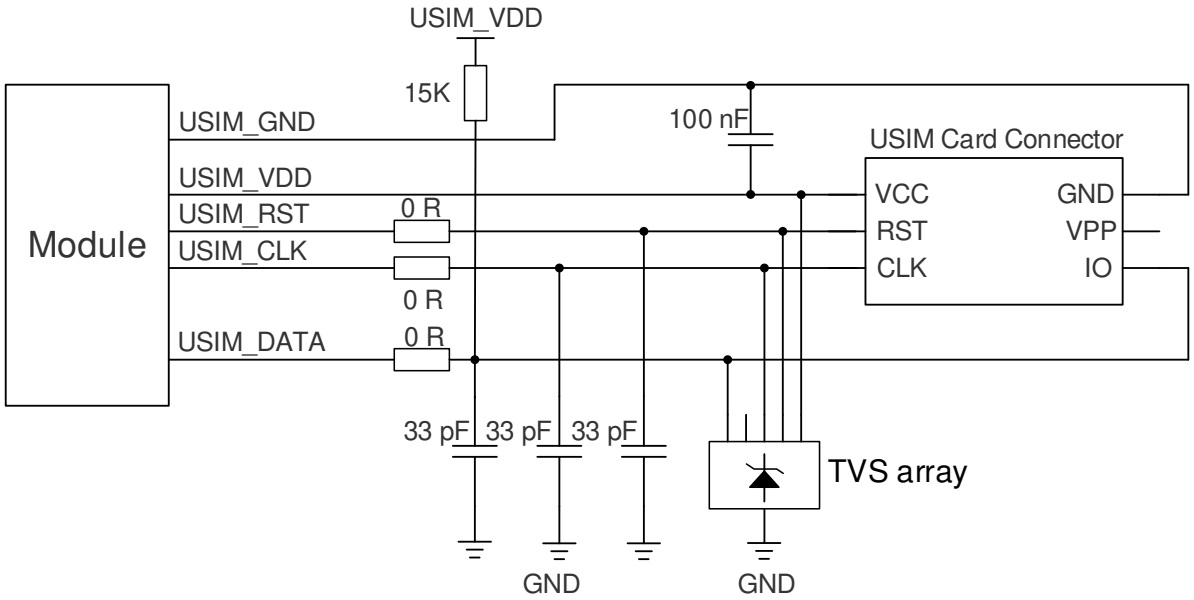


Figure 11: Reference Design of (U)SIM Interface with a 6-pin (U)SIM Card Connector

To enhance the reliability and availability of the USIM card in applications, follow the criteria below in the USIM circuit design:

- Keep the placement of (U)SIM card connector as close to the module as possible. Keep the trace length as short as possible, at most 200 mm.
- Keep USIM card signals away from RF and power supply traces.

- Ensure a short and wide ground trace between the module and the USIM card connector. Keep the ground and USIM_VDD traces at least 0.5 mm wide to maintain the same electric potential. Make sure the bypass capacitor between USIM_VDD and USIM_GND is less than 1 μF, and place it as close to the USIM card connector as possible. If the system ground plane is complete, USIM_GND can be directly connected to the system ground.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep their traces away from each other and shield them with ground. USIM_RST should also be shielded with ground.
- To offer good ESD protection, it is recommended to add a TVS array with parasitic capacitance not exceeding 15 pF. It is recommended to reserve 0 Ω series resistors for the USIM signals of the module to facilitate debugging. The 33 pF capacitors are used for RF filtering interference. Note that the USIM peripheral circuit should be close to the USIM card connector.
- The pull-up resistor on USIM_DATA trace can improve anti-jamming capability, and should be placed close to the USIM card connector.

4.2. UARTs

The module supports main UART and DM UART.

- **Main UART:**
  - It supports 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600 and 3000000 bps baud rates.
  - The default baud rate is 115200 bps.
  - It is used for AT command communication and data transmission, and supports RTS and CTS hardware flow control.
  - The default frame format is 8N1 (8 data bits, no parity, 1 stop bit).

- **DM UART:**
  - It supports 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600 and 3000000 bps baud rates.
  - The default baud rate is 115200 bps.
  - It is used for firmware upgrade, software debugging, RF calibration, log output, GNSS data and NMEA sentence output, and supports RTS and CTS hardware flow control.
  - The default frame format is 8N1 (8 data bits, no parity, 1 stop bit).
  - DM1 and DM2 are connected inside the module, so they cannot be used simultaneously.

The following tables show the pin definition of UARTs.

Table 12: Pin Description of Main UART

Pin Name	Pin No.	I/O	Description	Comment
MAIN_DTR	30	DI	Main UART data terminal ready	A test point is recommended to be reserved if unused.
MAIN_RXD	34	DI	Main UART reception	If unused, keep these pins open.
MAIN_TXD	35	DO	Main UART transmission	
MAIN_CTS	36	DO	Clear to send signal from the module	Connect to the MCU's CTS. If unused, keep this pin open.
MAIN_RTS	37	DI	Request to send signal to the module	Connect to the MCU's RTS. If unused, keep this pin open.
MAIN_DCD	38	DO	Main UART data carrier detection	If unused, keep these pins open.
MAIN_RI	39	DO	Main UART ring indication	

Table 13: Pin Definition of DM UART

Pin Name	Pin No.	I/O	Description	Comment
DM1_RXD	28	DI	DM1 UART receive	
DM1_TXD	27	DO	DM1 UART transmit	
DM2_RXD	94	DI	DM1 UART receive	Test points must be reserved.
DM2_TXD	95	DO	DM1 UART transmit	

NOTE

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

The module features 1.8 V UART. A voltage-level translator should be used if your application has a 3.3 V UART. It is recommended to use a level-shifting chip without internal pull-up. The voltage-level translator TXB0108PWR manufactured by Texas Instruments is recommended.

The following figure shows a reference design of the main UART:

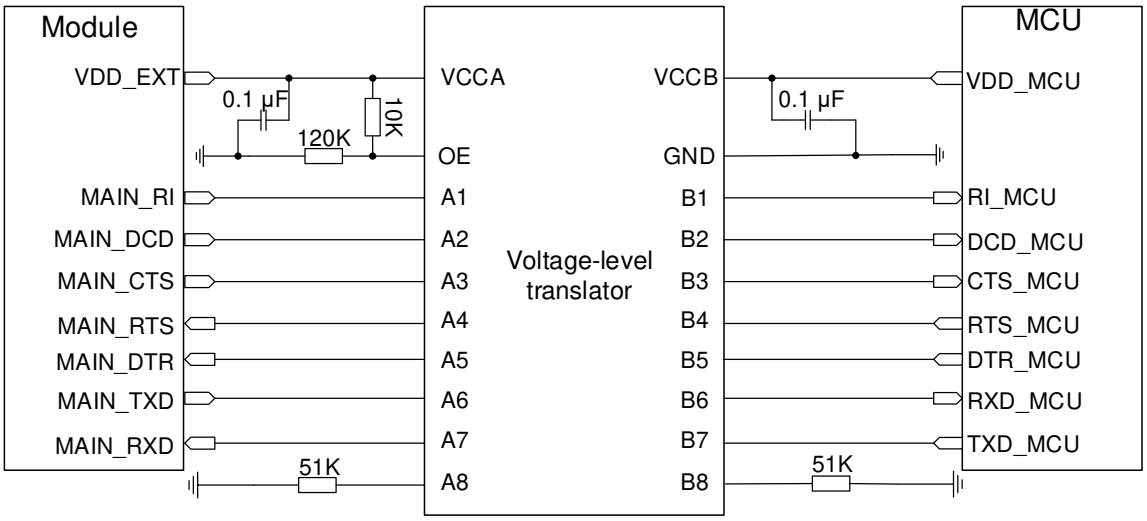


Figure 12: Main UART Reference Design (IC Solution)

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

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

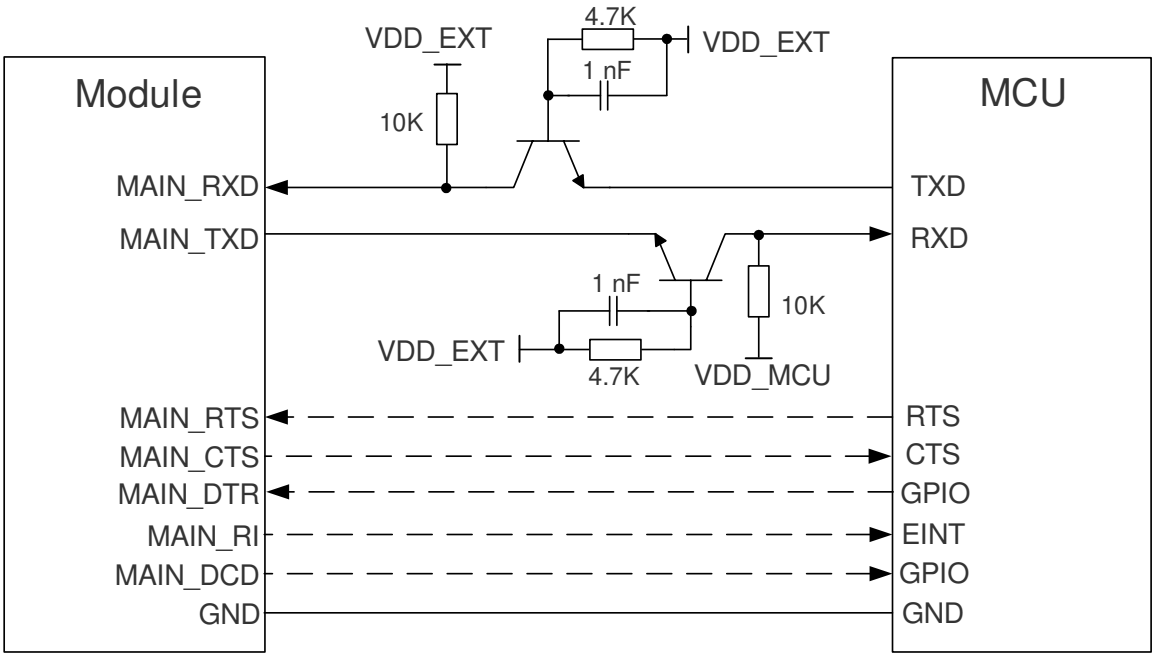


Figure 13: Main UART Reference Design (Transistor Solution)

NOTE

1. Transistor circuit solution is not suitable for applications with high baud rates exceeding 460 kbps.
2. The main UART should be disconnected in PSM* and turn off modes lest it cause additional power consumption and potentially damage to pins of the module.
3. Please note that the module's CTS is connected to the MCU's CTS, and the module's RTS is connected to the MCU's RTS.
4. The level-shifting circuits (***Figure 12*** and ***Figure 13***) take the main UART as an example. The circuits of the DM UARTs are connected in the same way as the main UART.
5. To increase the stability of UART communication, it is recommended to add UART hardware flow control design.

4.3. PCM and I2C Interfaces*

The module provides one Pulse Code Modulation (PCM) digital interface and one inter-integrated circuit (I2C) interface which are used for VoLTE.

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

Table 14: Pin Definition of PCM and I2C Interfaces

Pin Name	Pin No.	I/O	Description	Comment
PCM_CLK	4	DIO	PCM clock	In master mode, they are output signals. In slave mode, they are input signals.
PCM_SYNC	5	DIO	PCM data frame sync	
PCM_DIN	6	DI	PCM data input	If unused, keep these pins open.
PCM_DOUT	7	DO	PCM data output	
I2C_SCL	40	OD	I2C serial clock (for external codec	External pull-up resistors are required. If unused, keep these pins open.
I2C_SDA	41	OD	I2C serial data (for external codec)	

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

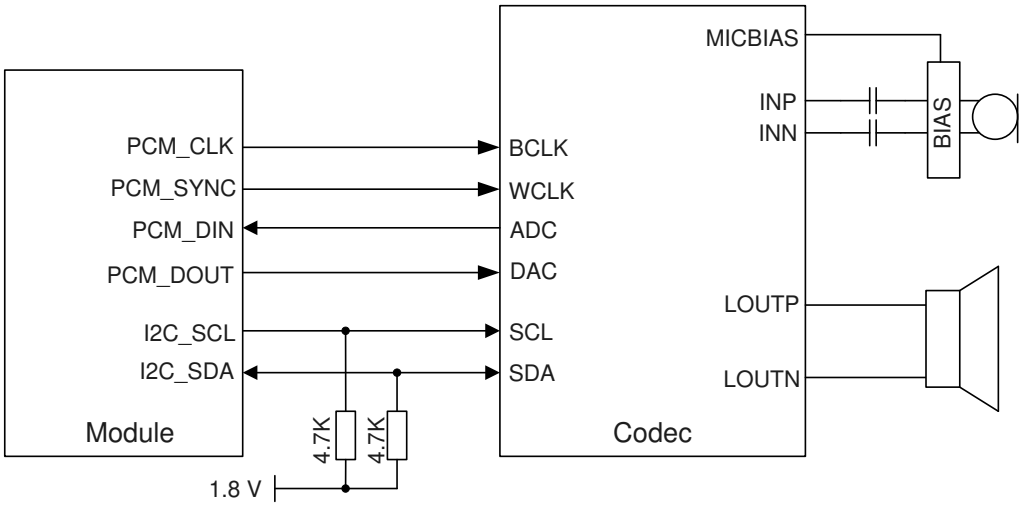


Figure 14: Reference Design of PCM and I2C Application with Audio Codec

4.4. ADC Interfaces*

The module provides two analog-to-digital converter (ADC) interfaces. To improve the accuracy of ADC, the trace of ADC interfaces should be surrounded with ground.

Table 15: Pin Description of ADC Interfaces

Pin Name	Pin No.	I/O	Description	Comment
ADC0	24	AI	General-purpose ADC interface	If unused, keep these pins open.
ADC1	2	AI	General-purpose ADC interface	

With **AT+QADC=<port>**, you can:

- **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 following table describes the characteristic of the ADC interfaces.

Table 16: Characteristics of ADC Interfaces

Name	Min.	Typ.	Max.	Unit
Input voltage Range	0	-	1.8	V
Resolution	6	-	12	bit

NOTE

1. It is prohibited to supply any voltage to the ADC pin when VBAT is removed.
2. It is recommended to use a resistor divider circuit for ADC application, and the divider's resistor accuracy should be not less than 1 %.
3. After the module is turned off or enters PSM*, do not pull up any pin of ADC interfaces lest it cause additional power consumption and potentially damage to pins of the module.

4.5. PON_TRIG Interface*

The module features one PON_TRIG pin. PON_TRIG is pulled down by default.

After sending **AT+QPSMS** to enable PSM*, driving PON_TRIG low will set the module to PSM. Drive PON_TRIG high and keep it high, the module will wake up from PSM.

Table 17: Pin Definition of PON_TRIG

Pin Name	Pin No.	I/O	Description	Comment
PON_TRIG	96	DI	Wake up the module from PSM	If unused, keep this pin open. A test point is recommended to be reserved.

PON_TRIG must be designed to allow for external control. A reference circuit is shown in the following figure.

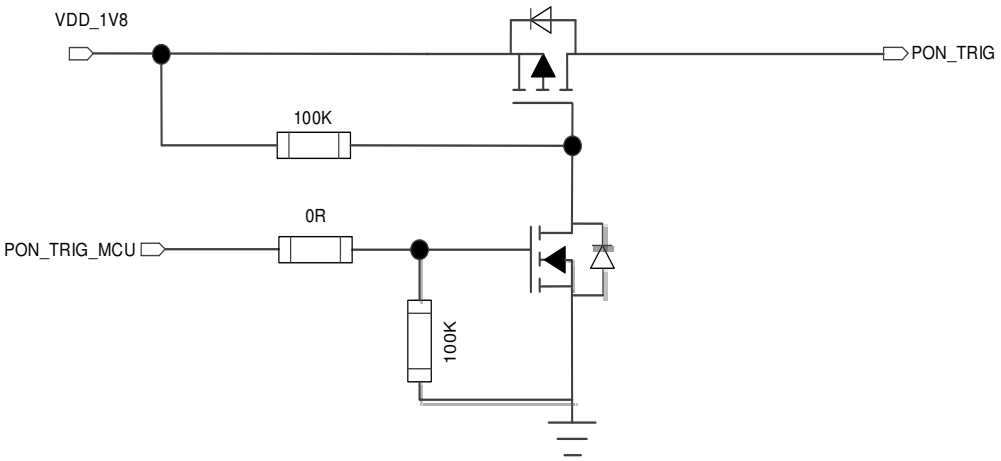


Figure 15: PON_TRIG Reference Circuit 1

In addition, a voltage divider circuit can be used to control PON_TRIG. The voltage domain of the external host and the voltage divider resistor should be selected with care. A voltage divider circuit in the 3.3 V MCU voltage domain is shown in the following figure.

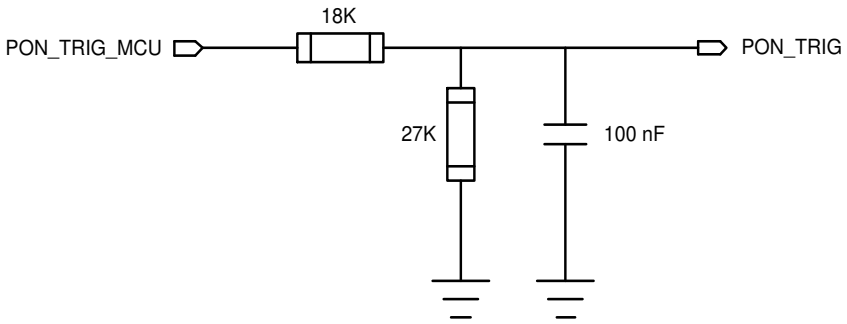


Figure 16: PON_TRIG Reference Circuit 2

NOTE

1. VDD_1V8 is provided by an external LDO.
2. If the MCU's voltage domain is not 3.3 V, the value of the voltage divider resistors should be tested according to your actual application.
3. Inside the module, PON_TRIG is connected in parallel with a 100 kΩ pull-down resistor to the ground.

4.6. Indication Signals

4.6.1. PSM Status Indication*

Table 18: Pin Definition of PSM_IND

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

When PSM is enabled, the function of PSM_IND will be activated after the module is rebooted. When PSM_IND is at a high level, the module is in full functionality mode. When it is at a low level, the module is in PSM.

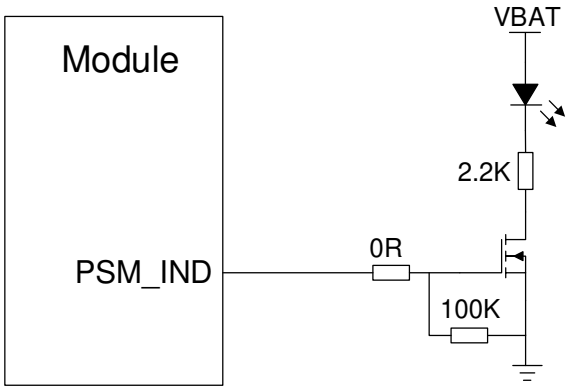


Figure 17: Reference Design of PSM Status Indication

4.6.2. Network Status Indication

Table 19: Pin Definition of NET_STATUS

Pin Name	Pin No.	I/O	Description	Comment
NET_STATUS	21	DO	Indicate the module's network activity status	If unused, keep this pin open.

The network indication pin can be used to drive network status indication LEDs. The module features one network indication pin: NET_STATUS. The pin definition and logic level changes in different network status are outlined in the following table.

Table 20: Working State of Network Connection Status Indication

Pin Name	Status	Description
NET_STATUS	Blink slowly (200 ms High/1800 ms Low)	Network searching
	Blink slowly (1800 ms High/200 ms Low)	Idle
	Blink quickly (125 ms High/125 ms Low)	Data transmission is ongoing

A reference circuit is shown in the following figure.

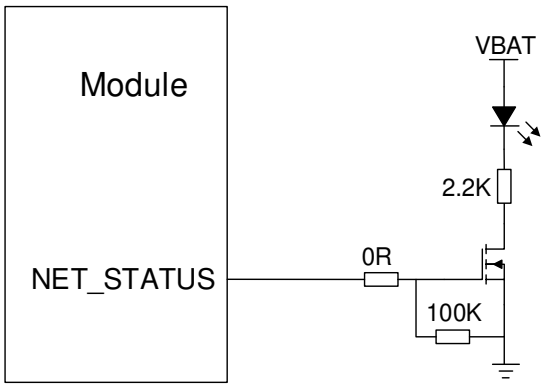


Figure 18: Reference Design of Network Status Indication

4.6.3. STATUS

The STATUS pin indicates the module's operation status. It will output a high level once the module is powered up successfully.

Table 21: Pin Definition of STATUS

Pin Name	Pin No.	I/O	Description	Comment
STATUS	20	DO	Indicate the module's operation status	If unused, keep it open.

A reference design is shown below.

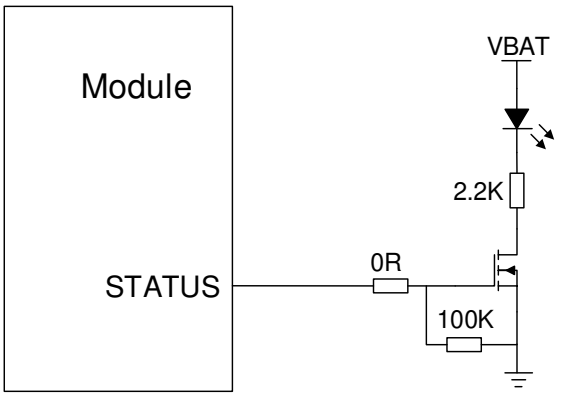


Figure 19: Reference Design of STATUS

4.6.4. MAIN_RI

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

Table 22: Pin Definition of MAIN_RI

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

The default MAIN_RI behaviors can be configured flexibly with **AT+QCFG="urc/ri/ring"**. See ***document [2]*** for details. The default behaviors of the MAIN_RI are shown below.

Table 23: MAIN_RI Default Behaviors

State	Response
Idle	MAIN_RI remains at a high level.
URC	MAIN_RI outputs a 120 ms low pulse when a new URC is returned.

NOTE

A URC can be outputted from the main UART (default), the DM UART or EMUX ports by configuring URC indication option with **AT+QURCCFG**. See ***document [3]*** for details about **AT+QURCCFG**.

4.7. 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.	I/O	Description	Comment
GRFC1	83	DO	Generic RF controller	If unused, keep them open. Test points are recommended to be reserved.
GRFC2	84	DO	Generic RF controller	

Table 25: Truth Table of GRFC Interfaces

GRFC1 Level	GRFC2 Level	Frequency Range (MHz)
Low	Low	880–2180
Low	High	791–879.9
High	Low	698–790.9

4.8. GPIO Interface

The module has nine 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 [2].***

Table 26: Pin Definition of GPIO Interfaces

Pin Name	Pin No.	I/O	Description	Comment
GPIO1	25	DIO	General-purpose input/output	If unused, keep these pins open. Test points are recommended to be reserved.
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

NOTE

In recovery mode, pin 25 is configured as DM_RTS and pin 26 is configured as DM_CTS. While in other modes, they are GPIO pins.

5 RF Specifications

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

5.1. Cellular Network

5.1.1. Antenna Interface & Frequency Bands

Table 27: Pin Description of Cellular Antenna Interface

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

Table 28: Operating Frequency (Unit: MHz)

Operating Frequency	Transmit	Receive	Unit
LTE HD-FDD B1	1920–1980	2110–2170	MHz
LTE HD-FDD B2	1850–1910	1930–1990	MHz
LTE HD-FDD B3	1710–1785	1805–1880	MHz
LTE HD-FDD B4	1710–1755	2110–2155	MHz
LTE HD-FDD B5	824–849	869–894	MHz
LTE HD-FDD B8	880–915	925–960	MHz
LTE HD-FDD B12	699–716	729–746	MHz
LTE HD-FDD B13	777–787	746–756	MHz

LTE HD-FDD B17 [7]	704–716	734–746	MHz
LTE HD-FDD B18	815–830	860–875	MHz
LTE HD-FDD B19	830–845	875–890	MHz
LTE HD-FDD B20	832–862	791–821	MHz
LTE HD-FDD B25	1850–1915	1930–1995	MHz
LTE HD-FDD B26	814–849	859–894	MHz
LTE HD-FDD B27 [8]	807–824	852–869	MHz
LTE HD-FDD B28	703–748	758–803	MHz
LTE HD-FDD B66	1710–1780	2110–2180	MHz
LTE HD-FDD B85	698–716	728–746	MHz

5.1.2. Tx Power

Table 29: Conducted Tx Power

Frequency Bands	Max. Tx Power	Min. Tx Power
LTE HD-FDD bands	23 dBm ±2 dB	< -39 dBm

5.1.3. Rx Sensitivity

Table 30: Conducted RF Receiver Sensitivity

Frequency Band	Receiver Sensitivity (Typ.)		3GPP Requirements (SIMO)	
	Primary (Cat M1)	Primary (Cat NB1/NB2* [9])	Cat M1	Cat NB1/NB2
LTE HD-FDD B1	-106.9	-112.7	-102.3	-107.5
LTE HD-FDD B2	-107.6	-112.7	-100.3	-107.5
LTE HD-FDD B3	-107.7	-112.7	-99.3	-107.5

[7] LTE HD-FDD B17 are supported by Cat NB1/NB2 only.
[8] LTE HD-FDD B27 are supported by Cat M1 only.
[9] LTE Cat NB1 receiving sensitivity without repetitions.

LTE HD-FDD B4	-107	-112.7	-102.3	-107.5
LTE HD-FDD B5	-107.3	-113.7	-100.8	-107.5
LTE HD-FDD B8	-106.7	-113.7	-99.8	-107.5
LTE HD-FDD B12	-107.3	-113.7	-99.3	-107.5
LTE HD-FDD B13	-107.3	-113.7	-99.3	-107.5
LTE HD-FDD B17 [7]	-	-113.7	-	-107.5
LTE HD-FDD B18	-107.3	-113.7	-102.3	-107.5
LTE HD-FDD B19	-107.2	-113.8	-102.3	-107.5
LTE HD-FDD B20	-107.5	-113.7	-99.8	-107.5
LTE HD-FDD B25	-107.6	-113.1	-100.3	-107.5
LTE HD-FDD B26	-107.3	-114.1	-100.3	-107.5
LTE HD-FDD B27 [8]	-107.4	-	-100.8	-
LTE HD-FDD B28	-107.1	-114.1	-100.8	-107.5
LTE HD-FDD B66	-107.1	-113.1	-101.8	-107.5
LTE HD-FDD B85	-107.3	-113.7	-99.3	-107.5

NOTE

-: not supported.

5.1.4. Reference Design

It is recommended to reserve a dual L-type matching circuit for better RF performance, and the dual L-type matching components (C3, R1, C1 and C2) should be placed as close to the antenna as possible. The capacitors C1 and C2 are not mounted by default.

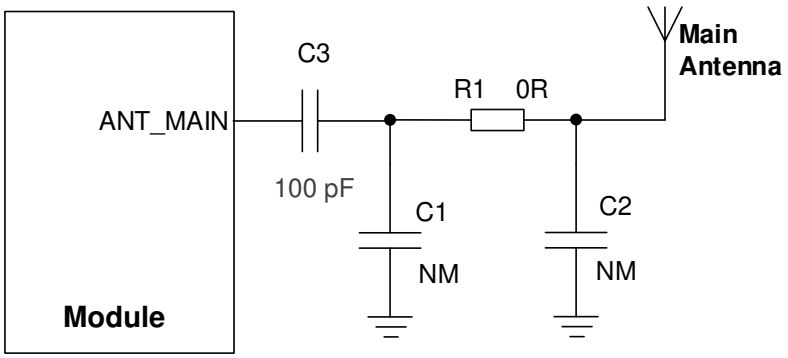


Figure 20: Reference Design of Main Antenna

NOTE

If there is DC power at the antenna ports, C3 must be used for DC-blocking to prevent short circuit to ground. The capacitance value is recommended to be 100 pF, which can be adjusted according to actual requirements. If there is no DC power in the peripheral design, C3 should not be reserved.

5.2. GNSS*

GNSS information of the module is as follows:

- Supports GPS and GLONASS
- Supports NMEA 0183 protocol and outputs NMEA sentences via the CLI UART. Data update rate for both modules: 1 Hz.
- The module's GNSS function is OFF by default. It must be ON via AT commands.

5.2.1. Antenna Interface & Frequency Bands

Table 31: Pin Description of GNSS Antenna Interface

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

Table 32: GNSS Operating Frequency

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

5.2.2. GNSS Performance

Table 33: GNSS Performance

Parameter	Description	Conditions	Typ.	Unit
Sensitivity	Acquisition	Autonomous	TBD	dBm
	Reacquisition	Autonomous	TBD	
	Tracking	Autonomous	TBD	
TTFF	Cold start @ open sky	Autonomous	TBD	s
		AGPS enabled	TBD	
	Warm start @ open sky	Autonomous	TBD	
		AGPS enabled	TBD	
	Hot start @ open sky	Autonomous	TBD	
		AGPS enabled	TBD	
Accuracy	CEP-50	Autonomous @ open sky	TBD	m

NOTE

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

5.2.3. Reference Design

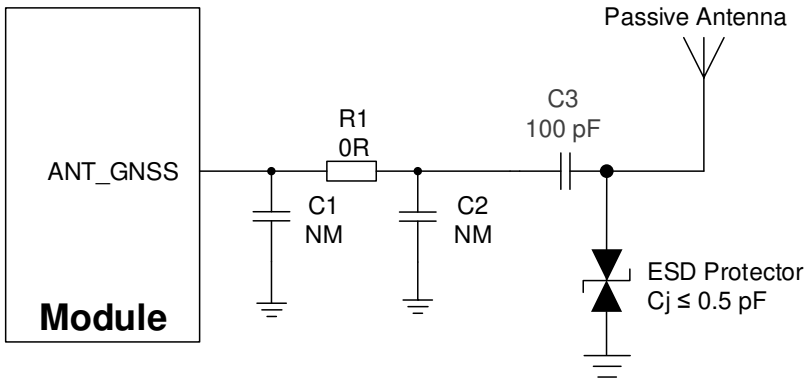


Figure 21: Reference Design of GNSS Antenna

NOTE

1. The module is designed with a built-in LNA, and supports passive antennas only. Active antennas and external LNAs are not supported.
2. If there is DC power at the antenna ports, C3 must be used for DC-blocking to prevent short circuit to ground. The capacitance value is recommended to be 100 pF, which can be adjusted according to actual requirements. If there is no DC power in the peripheral design, C3 should not be reserved.

5.3. RF Routing Guidelines

For user's PCB, the characteristic impedance of all RF traces should be controlled to 50 Ω. 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.

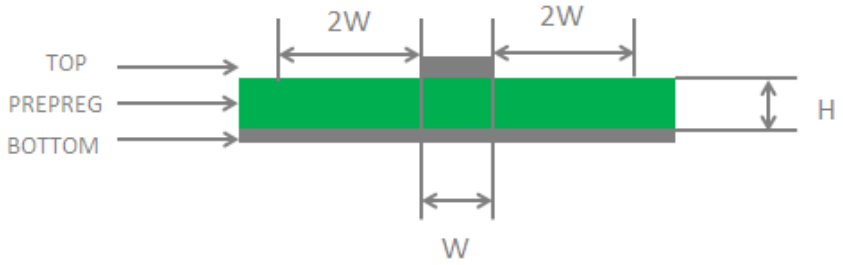


Figure 22: Microstrip Design on a 2-layer PCB

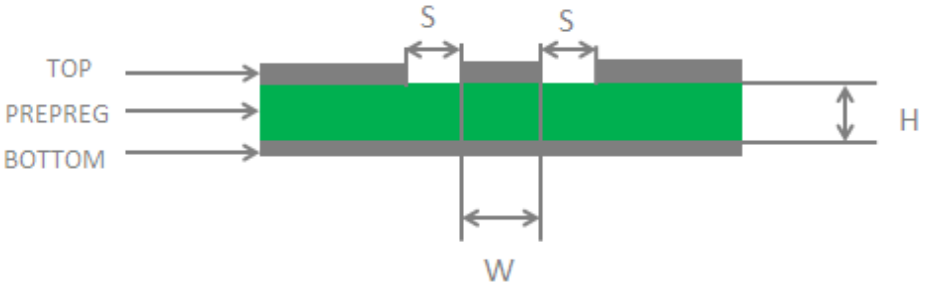


Figure 23: Coplanar Waveguide Design on a 2-layer PCB

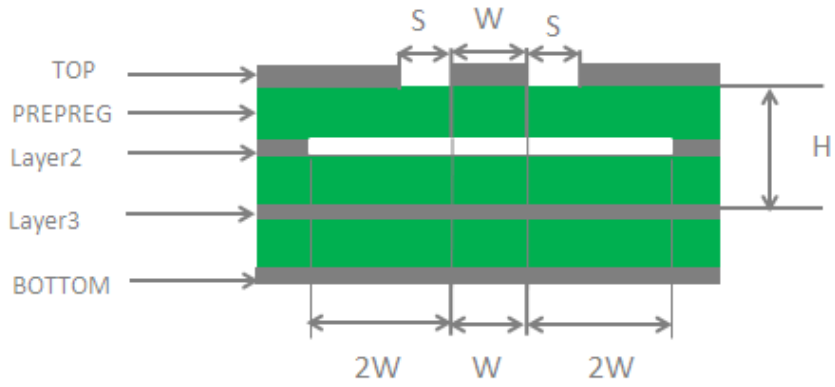


Figure 24: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

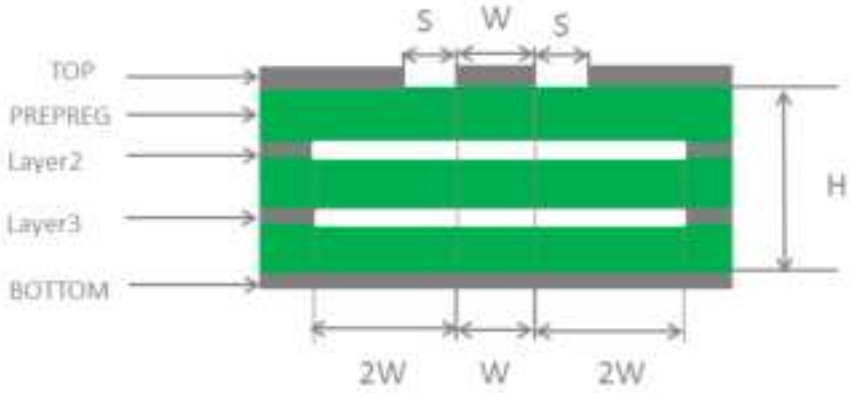


Figure 25: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

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 at least twice the width of RF signal traces (2 × W).
- Keep RF traces away from interference sources (such as DC-DC, (U)SIM/USB/SDIO high frequency digital signals, display signals, and clock signals), and avoid intersection and paralleling between traces on adjacent layers.

For more details about RF layout, see ***document [4]***.

5.4. Antenna Design Requirements

Table 34: Requirements for Antenna Design

Antenna Type	Requirements
GNSS*	Must be a passive antenna Frequency range: 1559–1609 MHz Polarization: RHCP or linear VSWR: ≤ 2 (Typ.)

	Passive antenna gain: > 0 dBi
Cellular	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

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

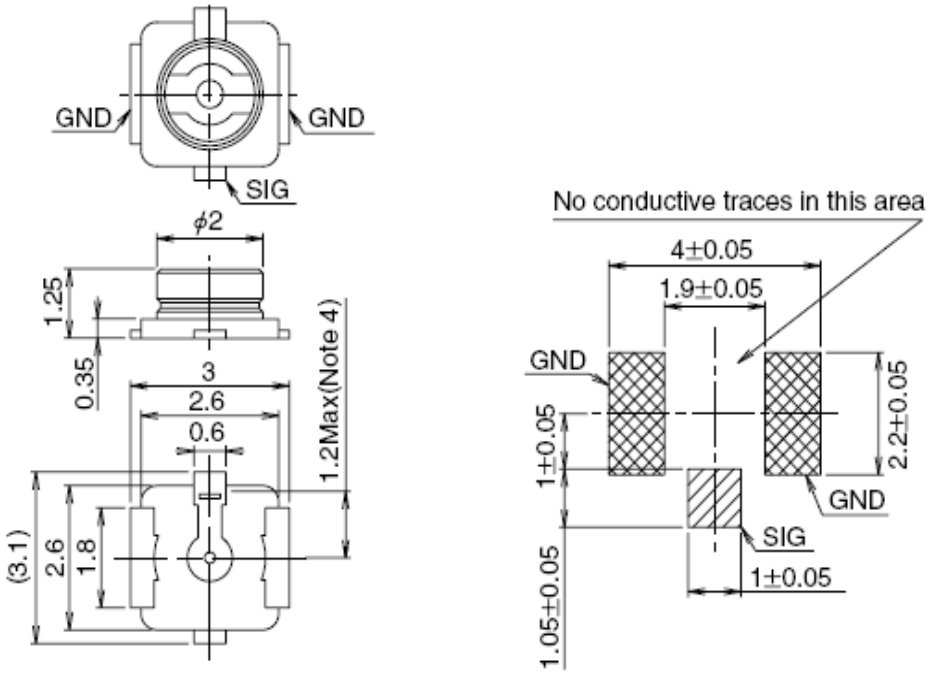


Figure 26: Dimensions of the Receptacle (Unit: mm)

U.FL-LP series mated plugs listed in the following figure can be used to match the U.FL-R-SMT.

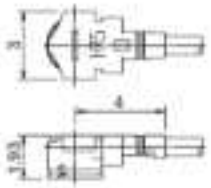
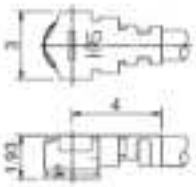
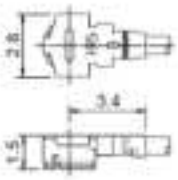
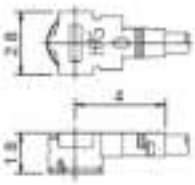
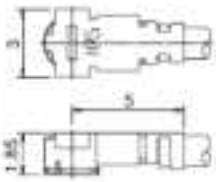
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 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 27: Specifications of Mated Plugs (Unit: mm)

The following figure describes the space factor of the mated connector.

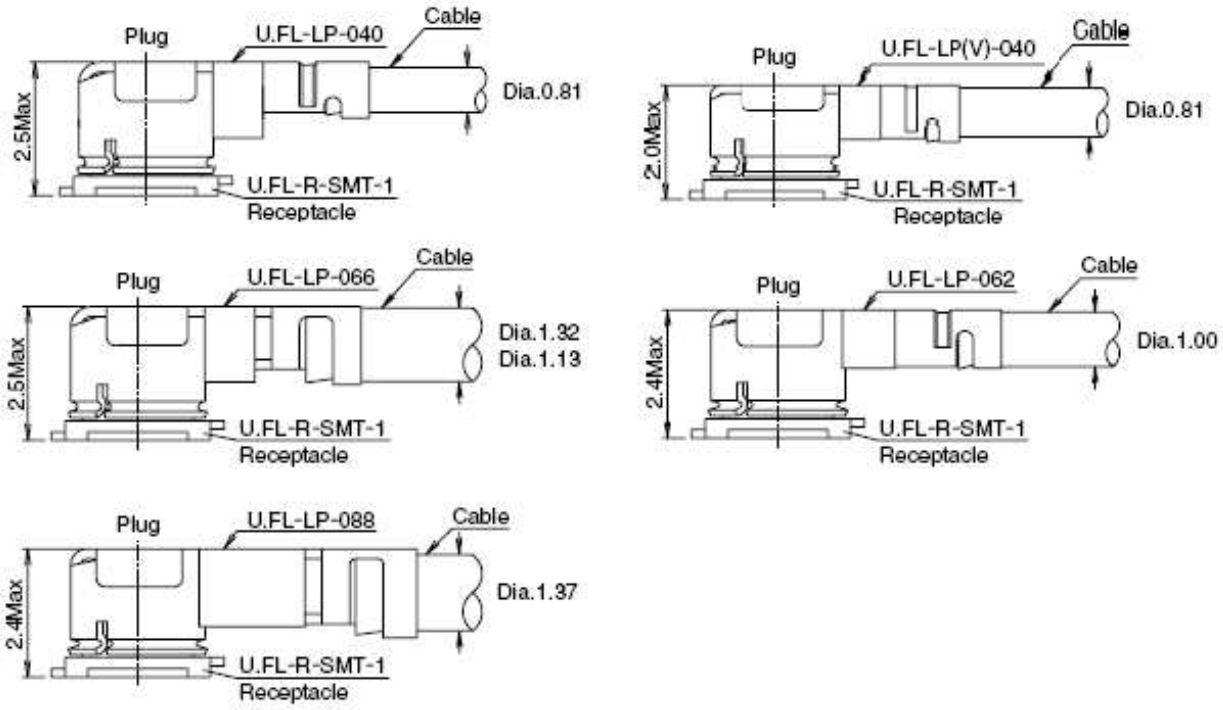


Figure 28: Space Factor of the Mated Connectors (Unit: mm)

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

6 Electrical Characteristics and Reliability

6.1. Absolute Maximum Ratings

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

Table 35: Absolute Maximum Ratings

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

6.2. Power Supply Ratings

Table 36: Module's Power Supply Ratings

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
VBAT_BB/ VBAT_RF	Power supply for the module's BB/RF part	The actual input voltages must stay between the minimum and maximum values.	2.2	3.3	4.35	V

6.3. Power Consumption

6.3.1. Power Consumption

Table 37: Power Consumption (3.3 V Power Supply, Room Temperature)

Description	Conditions	Avg.	Unit
Leakage	Power-off @ USB and UART disconnected	1.49	μA
PSM*	PSM @ USB and UART disconnected	1.44	μA
Rock Bottom	**AT+CFUN=0** @ Sleep mode	5.3	μA
Sleep Mode (USB Disconnected)	LTE Cat M1 DRX = 1.28 s	0.42	mA
	LTE Cat NB1 DRX = 1.28 s	0.74	mA
	LTE Cat M1 e-I-DRX = 40.96 s @ PTW = 1.28 s, DRX = 1.28 s	15.87	μA
	LTE Cat M1 e-I-DRX = 40.96 s @ PTW = 2.56 s, DRX = 1.28 s	27.43	μA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 1.28 s, DRX = 1.28 s	11.37	μA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	16.03	μA
	LTE Cat NB1 e-I-DRX = 40.96 s @ PTW = 2.56 s, DRX = 1.28 s	48.31	μA
	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	27.05	μA
Idle Mode (USB Disconnected)	LTE Cat M1 DRX = 1.28 s	9.85	mA
	LTE Cat NB1 DRX = 1.28 s	9.66	mA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	9.97	mA
	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	TBD	mA

LTE Cat M1 Data Transmission (GNSS OFF)	LTE HD-FDD B1 @ 23.01 dBm	154	mA
	LTE HD-FDD B2 @ 23.04 dBm	147	mA
	LTE HD-FDD B3 @ 23.03 dBm	145	mA
	LTE HD-FDD B4 @ 23.03 dBm	144	mA
	LTE HD-FDD B5 @ 23.08 dBm	182	mA
	LTE HD-FDD B8 @ 23.02 dBm	207	mA
	LTE HD-FDD B12 @ 23.01 dBm	185	mA
	LTE HD-FDD B13 @ 23.03 dBm	172	mA
	LTE HD-FDD B18 @ 23.04 dBm	175	mA
	LTE HD-FDD B19 @ 23.16 dBm	181	mA
	LTE HD-FDD B20 @ 23.02 dBm	185	mA
	LTE HD-FDD B25 @ 23.06 dBm	147	mA
	LTE HD-FDD B26 @ 23.07 dBm	183	mA
	LTE HD-FDD B27 @ 23.09 dBm	176	mA
	LTE HD-FDD B28 @ 22.99 dBm	183	mA
	LTE HD-FDD B66 @ 22.78 dBm	145	mA
	LTE HD-FDD B85 @ 22.78 dBm	189	mA
LTE Cat NB1/NB2 Data Transmission (GNSS OFF)	LTE HD-FDD B1 @ 23.19 dBm	162	mA
	LTE HD-FDD B2 @ 23.01 dBm	155	mA
	LTE HD-FDD B3 @ 23.10 dBm	153	mA
	LTE HD-FDD B4 @ 23.09 dBm	151	mA
	LTE HD-FDD B5 @ 23.03 dBm	193	mA
	LTE HD-FDD B8 @ 23.10 dBm	220	mA
	LTE HD-FDD B12 @ 23.09 dBm	196	mA
	LTE HD-FDD B13 @ 23.20 dBm	182	mA
	LTE HD-FDD B17 @ 23.06 dBm	193	mA

	LTE HD-FDD B18 @ 23.19 dBm	187	mA
	LTE HD-FDD B19 @ 23.20 dBm	194	mA
	LTE HD-FDD B20 @ 23.15 dBm	198	mA
	LTE HD-FDD B25 @ 23.17 dBm	155	mA
	LTE HD-FDD B26 @ 23.17 dBm	197	mA
	LTE HD-FDD B28 @ 23.12 dBm	192	mA
	LTE HD-FDD B66 @ 22.82 dBm	154	mA
	LTE HD-FDD B85 @ 23.17 dBm	197	mA

6.3.2. GNSS* Power Consumption

Table 38: GNSS Power Consumption

Description	Conditions	Typ.	Unit
Acquisition **(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

6.4. Digital I/O Characteristics

Table 39: VDD_EXT Digital I/O Characteristics

Parameter	Description	Min.	Max.	Unit
V_{IH}	High-level input voltage	0.65 × VDD_EXT	-	V
V_{IL}	Low-level input voltage	-	0.35 × VDD_EXT	V
V_{OH}	High-level output voltage	VDD_EXT - 0.4	-	V

V_{OL}	Low-level output voltage	-	0.4	V

6.5. ESD Protection

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

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

Tested Interfaces	Contact Discharge	Air Discharge	Unit
VBAT_BB/RF, GND	TBD	TBD	kV
Main Antenna Interface	TBD	TBD	kV
GNSS Antenna Interface*	TBD	TBD	kV

6.6. Operating and Storage Temperatures

Table 41: Operating and Storage Temperatures

Parameter	Min.	Typ.	Max.	Unit
Operating Temperature Range [10]	-35	+25	+75	℃
Extended Temperature Range [11]	-40	-	+85	℃
Storage Temperature Range	-40	-	+90	℃

[10] Within this range, the module's indicators comply with 3GPP specification requirements.
[11] Within this range, the module retains the ability to establish and maintain functions such as SMS and data transmission, without any unrecoverable malfunction. Radio spectrum and radio network remain uninfluenced, whereas the value of one or more parameters, such as P_{out}, may decrease and fall below the range of the 3GPP specified tolerances. When the temperature returns to the normal operating temperature range, the module's indicators will comply with 3GPP specification requirements again.

7 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.

7.1. Mechanical Dimensions

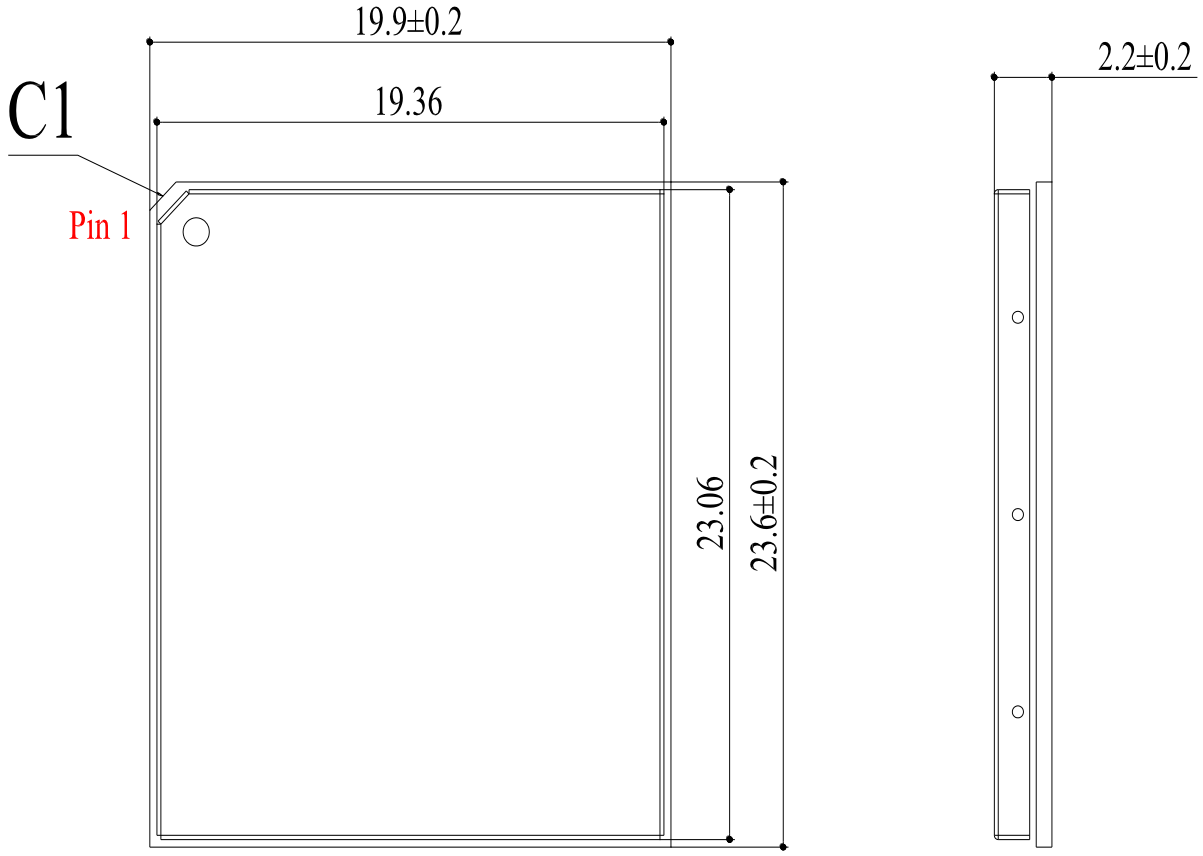


Figure 29: Module Top and Side Dimensions

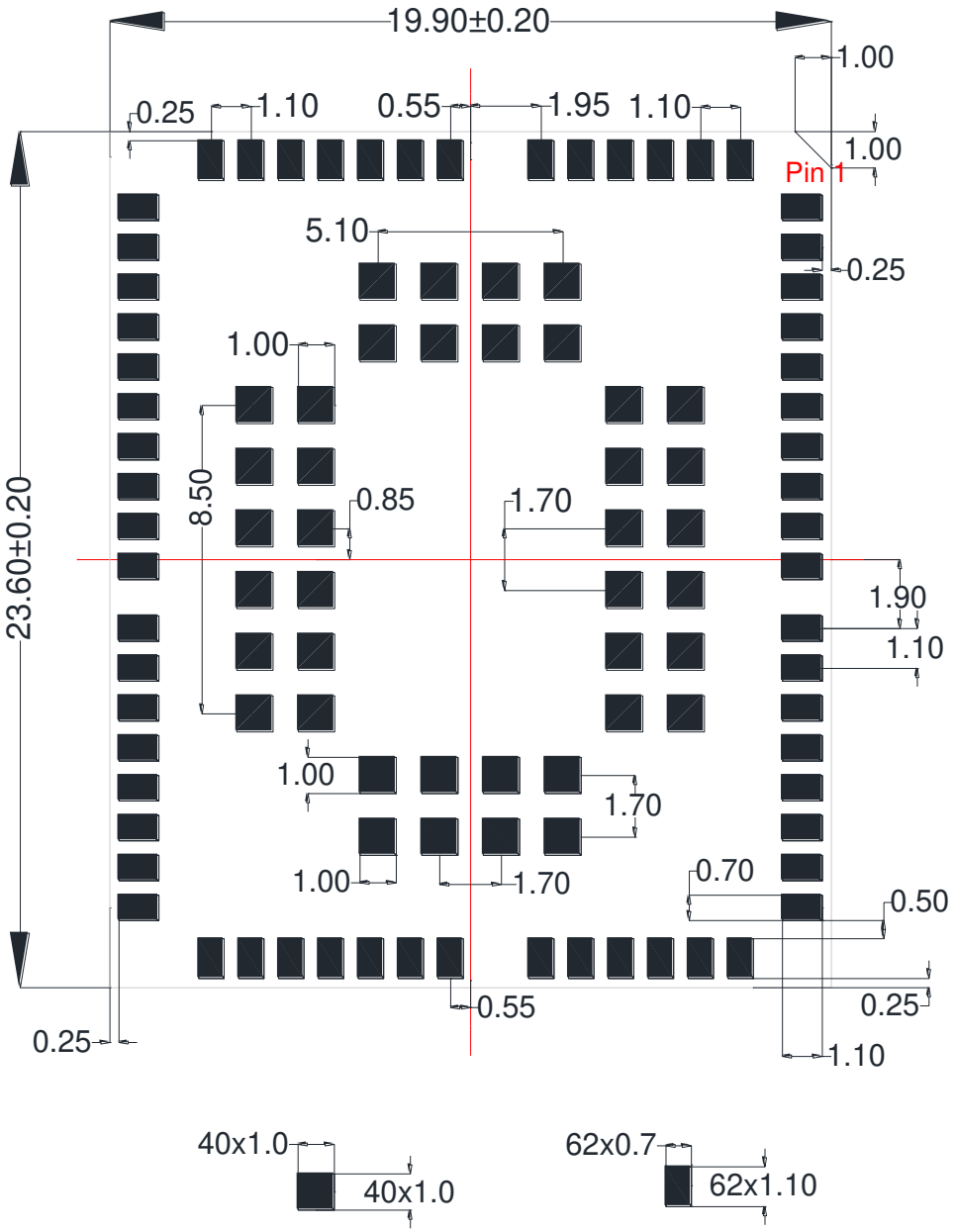


Figure 30: Module Bottom Dimensions (Bottom View)

NOTE

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

7.2. Recommended Footprint

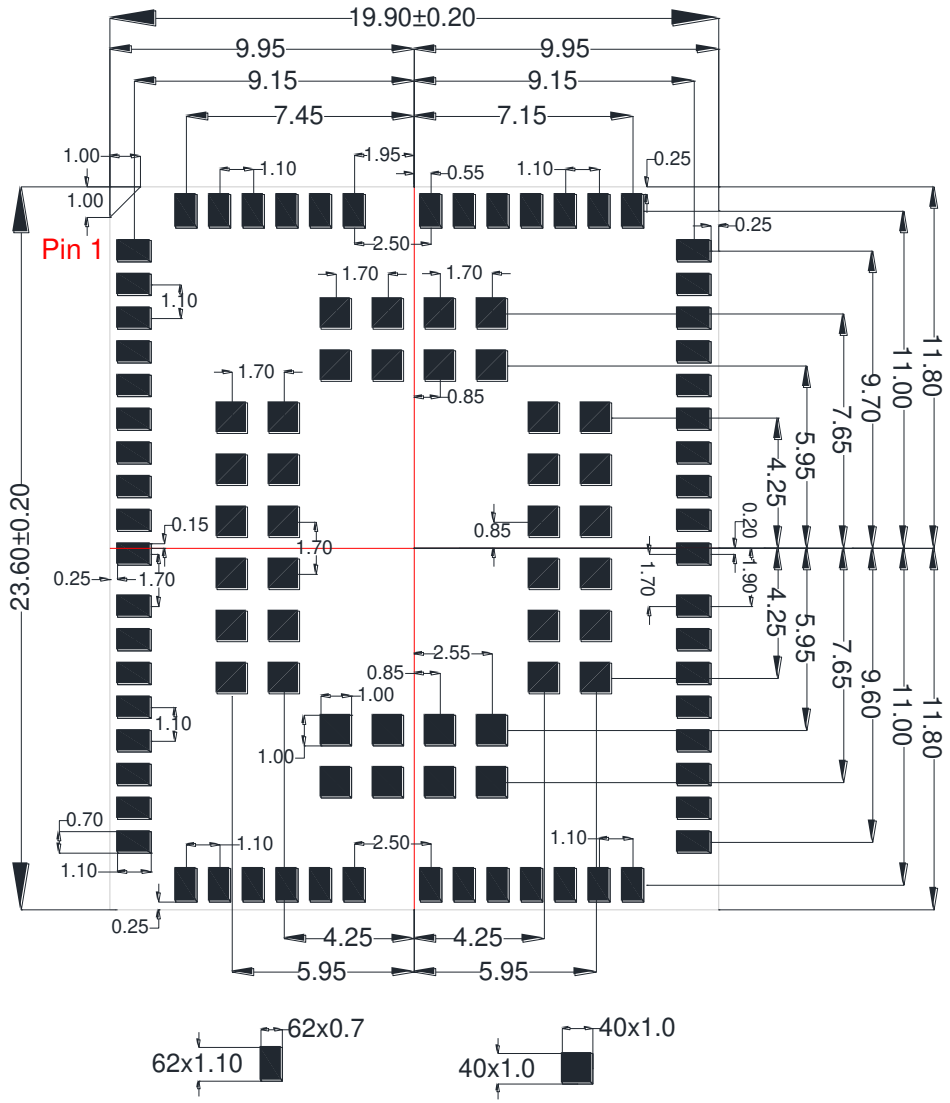


Figure 31: Recommended Footprint

NOTE

1. Keep at least 3 mm between the module and other components on the motherboard to improve soldering quality and maintenance convenience.
2. All reserved pins and unused pins must be kept open.
3. For the stencil design requirements of the module, see ***document [5].***

7.3. Top and Bottom Views

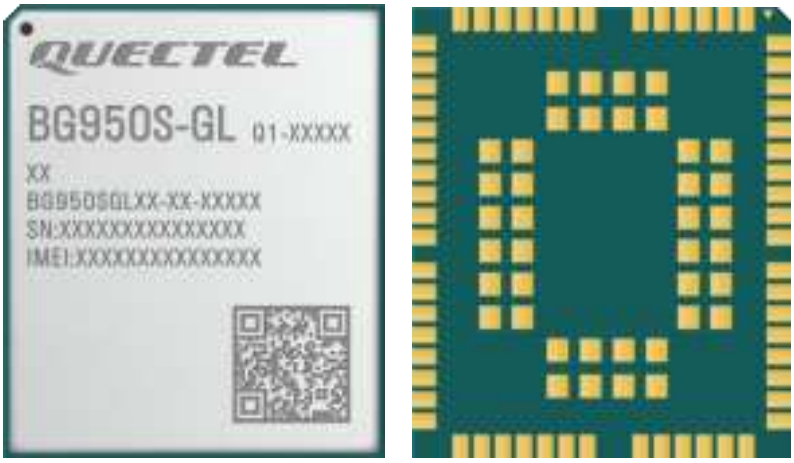


Figure 32: Top & Bottom Views of the Module

NOTE

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

8 Storage, Manufacturing & Packaging

8.1. 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 ±5 °C and the relative humidity should be 35–60 %.

2. Shelf life (in a vacuum-sealed packaging): 12 months in Recommended Storage Condition.

3. Floor life: 168 hours [12] in a factory 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 dry 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 mentioned above;
   - 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;
   - The module must be soldered to PCB within 24 hours after the baking, otherwise it should be put in a dry environment such as in a dry cabinet.

[12] 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 unpack the modules in large quantities until they are ready for soldering.

NOTE

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. 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.

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. 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 [5]***.

The recommended peak reflow temperature should be 235–246 ºC, with 246 ºC as the absolute maximum reflow temperature. To avoid damage to the module caused by repeated heating, it is 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.

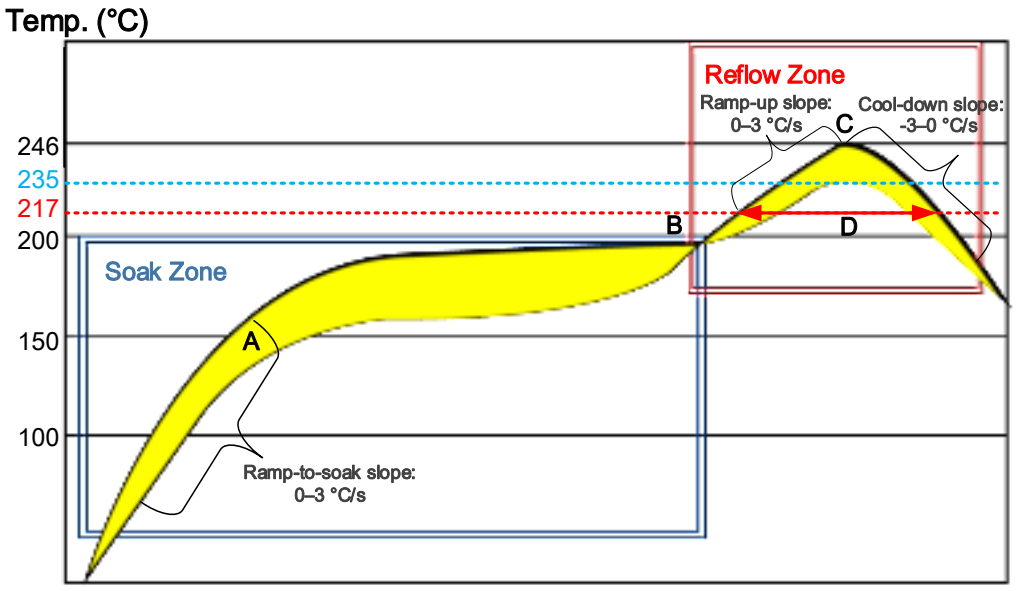


Figure 33: Recommended Reflow Soldering Thermal Profile

Table 42: Recommended Thermal Profile Parameters

Factor	Recommended Value
Soak Zone	
Ramp-to-soak Slope	0–3 °C/s
Soak Time (between A and B: 150 °C and 200 °C)	70–120 s
Reflow Zone	
Ramp-up Slope	0–3 °C/s
Reflow Time (D: over 217 °C)	40–70 s
Max Temperature	235–246 °C
Cool-down Slope	-3–0 °C/s
Reflow Cycle	
Max Reflow Cycle	1

NOTE

1. The above profile parameter requirements are for the measured temperature of the solder joints. Both the hottest and coldest spots of solder joints on the PCB should meet the above requirements.
2. 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.
3. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.
4. Avoid using materials that contain mercury (Hg), such as adhesives, for module processing, even if the materials are RoHS compliant and their mercury content is below 1000 ppm (0.1 %).
5. Corrosive gases may corrode the electronic components inside the module, affecting their reliability and performance, and potentially leading to a shortened service life that fails to meet the designed lifespan. Therefore, do not store or use unprotected modules in environments containing corrosive gases such as hydrogen sulfide, sulfur dioxide, chlorine, and ammonia.
6. Due to the SMT process complexity, please contact Quectel Technical Support in advance regarding any situation that you are not sure about, or any process (e.g., selective soldering, ultrasonic soldering) that is not mentioned in ***document [6].***

8.3. Packaging Specifications

This chapter outlines the key packaging parameters and processes. All figures below are for reference purposes only, as the actual appearance and structure of packaging materials may vary in delivery.

The modules are packed in a tape and reel packaging as specified in the sub-chapters below.

8.3.1. Carrier Tape

Carrier tape dimensions are illustrated in the following figure and table:

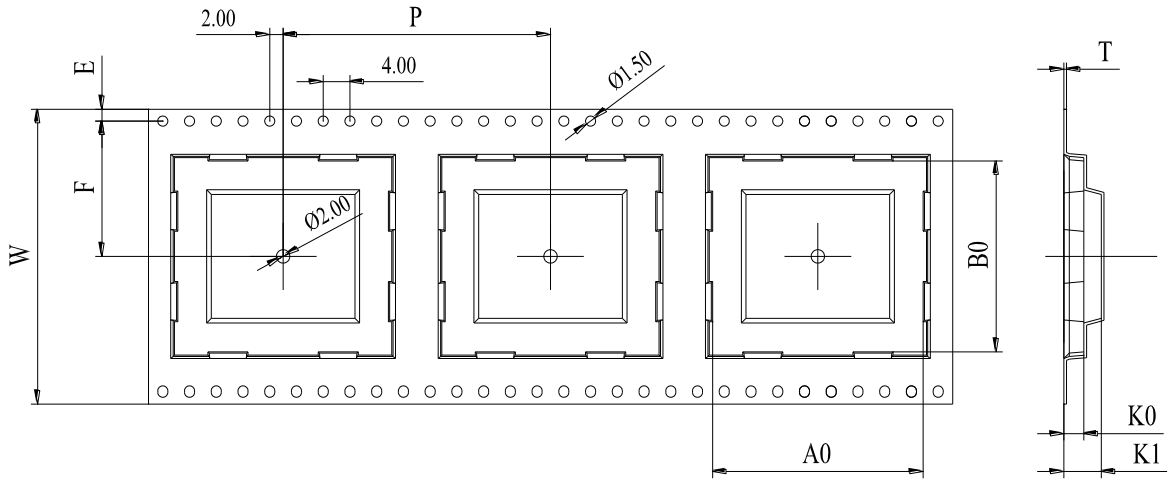


Figure 34: Carrier Tape Dimension Drawing (Unit: mm)

Table 43: Carrier Tape Dimension Table (Unit: mm)

W	P	T	A0	B0	K0	K1	F	E
44	32	0.35	20.2	24	3.15	6.65	20.2	1.75

8.3.2. Plastic Reel

Plastic reel dimensions are illustrated in the following figure and table:

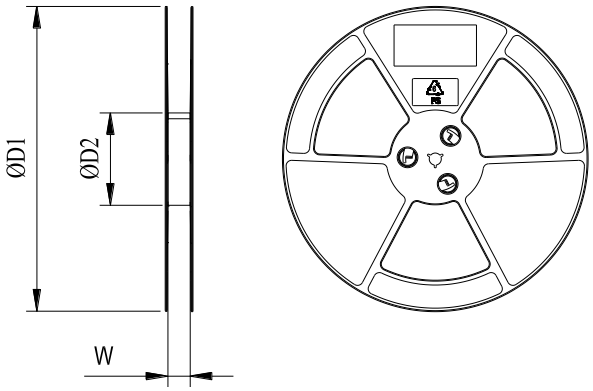


Figure 35: Plastic Reel Dimension Drawing

Table 44: Plastic Reel Dimension Table (Unit: mm)

øD1	øD2	W
330	100	44.5

8.3.3. Mounting Direction

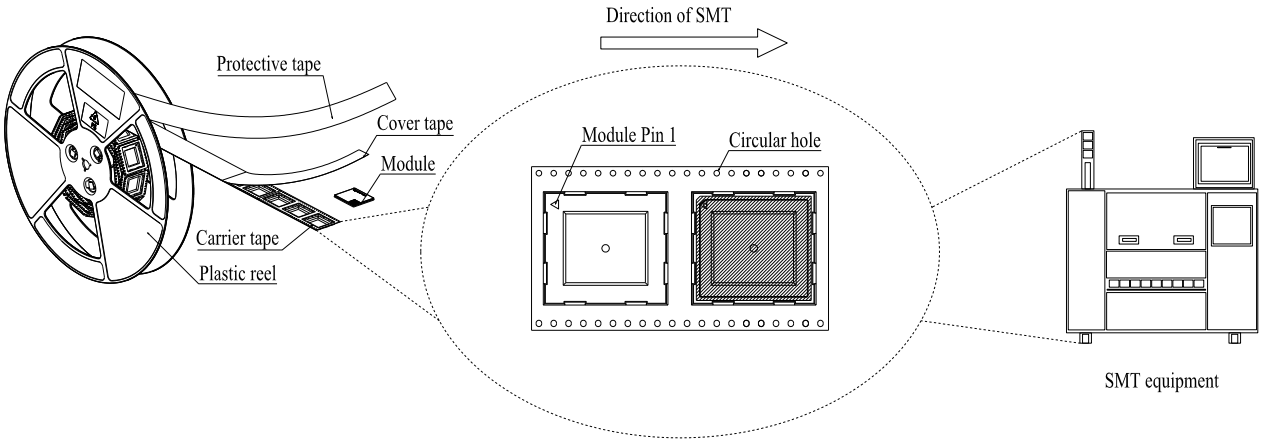
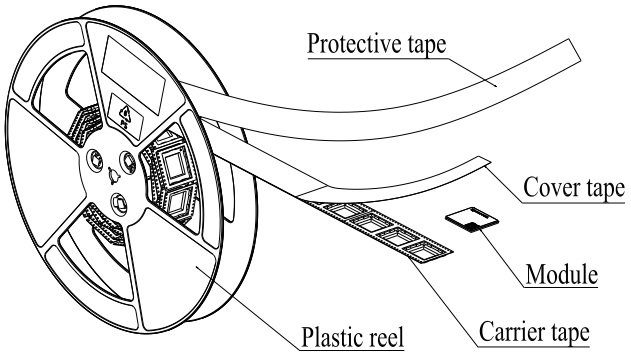


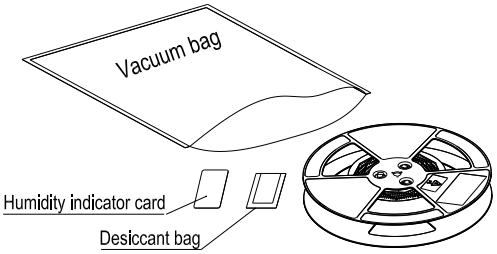
Figure 36: Mounting Direction

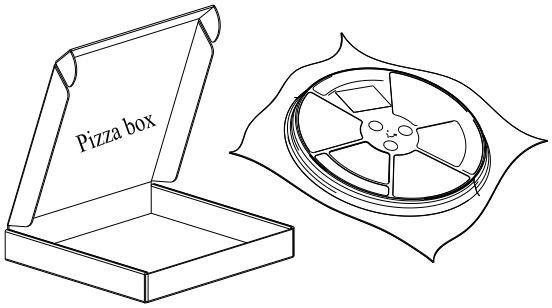
8.3.4. Packing Process



Place the modules onto the carrier tape cavity and cover them securely with cover tape. Wind the heat-sealed carrier tape onto a plastic reel and apply a protective tape for additional protection. 1 plastic reel can pack 250 modules.

Place the packaged plastic reel, humidity indicator card and desiccant bag into a vacuum bag, and vacuumize it.





Place the vacuum-packed plastic reel into a pizza box.

Place the 4 packaged pizza boxes into 1 carton and seal it. 1 carton can pack 1000 modules.

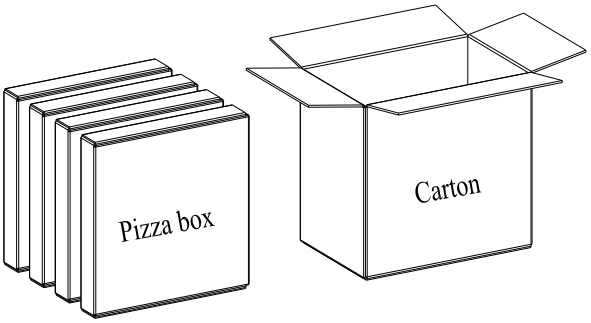


Figure 37: Packaging Process

9 Appendix References

Table 45: Related Documents

Document Name
[1] Quectel_BG95xA-GL&BG950S-GL_TE-B_User_Guide
[2] Quectel_BG77xA-GL&BG95xA-GL&BG950S-GL_QCFG_AT_Commands_Manual
[3] Quectel_BG77xA-GL&BG95xA-GL&BG950S-GL_AT_Commands_Manual
[4] Quectel_RF_Layout_Application_Note
[5] Quectel_Module_Stencil_Design_Requirements
[6] Quectel_Module_SMT_Application_Note

Table 46: Terms and Abbreviations

Abbreviation	Description
ADC	Analog to Digital Converter
Balun	Balanced to Unbalanced
bps	bit(s) per second
CHAP	Challenge Handshake Authentication Protocol
CoAP	Constrained Application Protocol
CHAP	Challenge Handshake Authentication Protocol
CTS	Clear To Send
DFOTA	Delta Firmware Upgrade Over-the-Air
DL	Downlink
DM	Debug Mode

DRX	Discontinuous Reception
DTLS	Datagram Transport Layer Security
e-I-DRX	Extended Idle Mode Discontinuous Reception
EINT	External interrupt
EPC	Evolved Packet Core
ESD	Electrostatic Discharge
ESR	Equivalent Series Resistance
EVB	Evaluation Board
FDD	Frequency Division Duplex
GNSS	Global Navigation Satellite System
GLONASS	Global Navigation Satellite System (Russia)
GPIO	General-Purpose Input/Output
GPS	Global Positioning System
GRFC	Generic RF Controller
HD	Half Duplex
HSS	Home Subscriber Server
HTTP	Hypertext Transfer Protocol
I/O	Input/Output
I2C	Inter-Integrated Circuit
IPv4	Internet Protocol Vrsion 4
IPv6	Internet Protocol Version 6
LDO	Low-Dropout Regulator
LED	Light Emitting Diode
LGA	Land Grid Array
LNA	Low Noise Amplifier

LPF	Low Pass Filter
LPWA	Low-Power Wide-Area (Network)
LTE	Long Term Evolution
LwM2M	Lightweight M2M
ME	Mobile Equipment
MLCC	Multi-layer Ceramic Capacitor
MO	Mobile Originated
MQTT	Message Queuing Telemetry Transport
MSL	Moisture Sensitivity Levels
MT	Mobile Terminated
M2M	Machine to Machine
NITZ	Network Identity and Time Zone
PA	Power Amplifier
PAP	Password Authentication Protocol
PCB	Printed Circuit Board
PDU	Protocol Data Unit
PING	Packet Internet Groper
PMU	Power Management Unit
PPP	Point-to-Point Protocol
PSM	Power Saving Mode
RAU	Routing Area Update
RF	Radio Frequency
RHCP	Right Hand Circular Polarization
RoHS	Restriction of Hazardous Substances
RTS	Request To Send

SAW	Surface Acoustic Wave
SMS	Short Message Service
SMD	Surface Mount Device
SSL	Secure Sockets Layer
TAU	Tracking Area Update.
TCXO	Temperature Compensated Crystal Oscillator
TCP	Transmission Control Protocol
TTFF	Time to First Fix
TLS	Transport Layer Security
TVS	Transient Voltage Suppressor
Tx	Transmit
UART	Universal Asynchronous Receiver/Transmitter
UDP	User Datagram Protocol
UE	User Equipment
URC	Unsolicited Result Code
USIM	Universal Subscriber Identity Module
UL	Uplink
Vmax	Maximum Voltage
Vnom	Nominal Voltage
Vmin	Minimum Voltage
V_{IH}min	Minimum High-level Input Voltage
V_{IL}max	Maximum Low-level Input Voltage
VSWR	Voltage Standing Wave Ratio

FCC ID: XMR2024BG950SGL

Important Notice to OEM integrators

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

Important Note

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

End Product Labeling

When the module is installed in the host device, the FCC/IC ID label must be visible through a window on the final device or it must be visible when an access panel, door or cover is easily re-moved. If not, a second label must be placed on the outside of the final device that contains the following text: “Contains FCC ID: XMR2024BG950SGL”
“Contains IC: 10224A-2024BG950S“
The FCC ID/IC ID can be used only when all FCC/IC compliance requirements are met.

Antenna Installation

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

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC/IC authorization is no longer considered valid and the FCC ID/IC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC/IC authorization.

Antenna Type	Band	Max. Gain
External	LTE Cat M1 Band 2:	1.59dBi
	LTE Cat M1 Band 4:	2dBi
	LTE Cat M1 Band 5:	2.53dBi
	LTE Cat M1 Band 12:	3.95dBi
	LTE Cat M1 Band 13:	4.45dBi
	LTE Cat M1 Band 25:	1.59dBi
	LTE Cat M1 Band 26:	3.19dBi
	LTE Cat M1 Band 66:	2dBi
	LTE Cat M1 Band 85:	3.95dBi
	LTE Cat NB2 Band 2:	1.59dBi
	LTE Cat NB2 Band 4:	2dBi
	LTE Cat NB2 Band 5:	2.53dBi
	LTE Cat NB2 Band 12:	3.95dBi
	LTE Cat NB2 Band 13:	4.45dBi
	LTE Cat NB2 Band 17:	3.95dBi
	LTE Cat NB2 Band 25:	1.59dBi
	LTE Cat NB2 Band 66:	3.19dBi
	LTE Cat NB2 Band 71:	2dBi
	LTE Cat NB2 Band 85:	3.95dBi

Manual Information to the End User

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

Federal Communication Commission Interference Statement

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

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

List of applicable FCC rules

This module has been tested and found to comply with part 2, part 22, part 24, part 27, part 90 requirements for Modular Approval.
The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuity), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

Summarize the specific operational use conditions

This module can be used in IOT devices, the input voltage to the module is nominally 3.3V.

Limited module procedures

This module is a single module.

Trace antenna designs

The antenna is not a trace antenna.

Radiation Exposure Statement

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

IC: 10224A-2024BG950S

Industry Canada Statement

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

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:
(1) l'appareil ne doit pas produire de brouillage, et
(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Radiation Exposure Statement

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

Déclaration d'exposition aux radiations:

Cet équipement est conforme aux limites d'exposition aux rayonnements ISED établies pour un environnement non contrôlé. Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.

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

1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
2) The transmitter module may not be co-located with any other transmitter or antenna.
As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Antenna Type	Band	Max. Gain
External	LTE Cat M1 Band 2:	1.59dBi
	LTE Cat M1 Band 4:	2dBi
	LTE Cat M1 Band 5:	2.53dBi
	LTE Cat M1 Band 12:	3.95dBi
	LTE Cat M1 Band 13:	4.45dBi

	LTE Cat M1 Band 25:	1.59dBi
	LTE Cat M1 Band 26:	3.19dBi
	LTE Cat M1 Band 66:	2dBi
	LTE Cat M1 Band 85:	3.95dBi
	LTE Cat NB2 Band 2:	1.59dBi
	LTE Cat NB2 Band 4:	2dBi
	LTE Cat NB2 Band 5:	2.53dBi
	LTE Cat NB2 Band 12:	3.95dBi
	LTE Cat NB2 Band 13:	4.45dBi
	LTE Cat NB2 Band 17:	3.95dBi
	LTE Cat NB2 Band 25:	1.59dBi
	LTE Cat NB2 Band 66:	3.19dBi
	LTE Cat NB2 Band 71:	2dBi
	LTE Cat NB2 Band 85:	3.95dBi

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

1) L'antenne doit être installée de telle sorte qu'une distance de 20 cm est respectée entre l'antenne et les utilisateurs, et
2) Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.
Tant que les 2 conditions ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

IMPORTANT NOTE:

In the event that these conditions cannot be met (for example certain laptop configurations or colocation with another transmitter), then the Canada authorization is no longer considered valid and the IC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate Canada authorization.

NOTE IMPORTANTE:

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

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that

20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: “Contains IC: 10224A-2024BG950S”.

Plaque signalétique du produit final

Ce module émetteur est autorisé uniquement pour une utilisation dans un dispositif où l'antenne peut être installée de telle sorte qu'une distance de 20cm peut être maintenue entre l'antenne et les utilisateurs. Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "Contient des IC: 10224A-2024BG950S".

Manual Information To the End User

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

Manuel d'information à l'utilisateur final

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