BG95-M3 Mini PCIe

Hardware Design

LPWA Module Series

Version: 1.1

Date: 2021-08-31

Status: Released

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

	Full attention must be paid to driving at all times in order to reduce the risk of an accident. Using a mobile while driving (even with a handsfree kit) causes distraction and can lead to an accident. Please comply with laws and regulations restricting the use of wireless devices while driving.
	Switch off the cellular terminal or mobile before boarding an aircraft. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. If there is an Airplane Mode, it should be enabled prior to boarding an aircraft. Please consult the airline staff for more restrictions on the use of wireless devices on an aircraft.
	Wireless devices may cause interference on sensitive medical equipment, so please be aware of the restrictions on the use of wireless devices when in hospitals, clinics or other healthcare facilities.
	Cellular terminals or mobiles operating over radio signal and cellular network cannot be guaranteed to connect in certain conditions, such as when the mobile bill is unpaid or the (U)SIM card is invalid. When emergency help is needed in such conditions, use emergency call if the device supports it. In order to make or receive a call, the cellular terminal or mobile must be switched on in a service area with adequate cellular signal strength. In an emergency, the device with emergency call function cannot be used as the only contact method considering network connection cannot be guaranteed under all circumstances.
	The cellular terminal or mobile contains a transceiver. When it is ON, it receives and transmits radio frequency signals. RF interference can occur if it is used close to TV sets, radios, computers or other electric equipment.
	In locations with explosive or potentially explosive atmospheres, obey all posted signs and turn off wireless devices such as mobile phone or other cellular terminals. Areas with explosive or potentially explosive atmospheres include 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
1.0	2020-05-15	Speed SUN/ Watt ZHU/ Hyman DING	Initial
1.1	2022-08-31	Lex LI/ Pearl Guo/ Matt YE	1. Added the description of the share of hardware blocks between WWAN and GNSS Rx chains (Chapter 2.1). 2. Updated the USB serial drivers (Table 2). 3. Updated the description of USB_VBUS (Footnote 2 and Chapter 3.7). 4. Added the description of Sleep Mode (Table 5). 5. Added the Power Saving chapter (Chapter 3.4). 6. Added high-speed mode supported by USB interface (Chapter 3.7). 7. Added description of DTR signal (Chapter 3.10.2). 8. Updated GNSS performance data (Table 16). 9. Added a note about the choice of GNSS antenna when LTE B13 is supported (Chapter 5.3). 10. Updated the contact discharge and air discharge data (Table 27). 11. Added the operating and storage temperatures information (Chapter 6.7). 12. Updated power consumption in PSM, Sleep and Idle modes and GNSS power consumption (Table 29 and 30). 13. Updated the packaging specification (Chapter 7.3).

Contents

Table Index

Figure Index

1 Introduction

This document defines Quectel BG95-M3 Mini PCIe module, and describes its air interfaces and hardware interfaces that are connected with your applications.

This document can help you quickly understand the interface specifications, electrical characteristics, mechanical specifications and other related information of the module. To facilitate application designs, it also includes some reference designs for your reference. The document, coupled with application notes and user guides, makes it easy to design and set up mobile applications with BG95-M3 Mini PCIe.

2 Product Overview

2.1. Frequency Bands and Functions

BG95-M3 Mini PCIe is an embedded IoT (LTE Cat M1, LTE Cat NB2 and EGPRS) wireless communication module with PCI Express Mini Card 1.2 standard interface. It provides data connectivity on LTE HD-FDD and GPRS/EGPRS networks. It also provides GNSS and voice [1] functionality to meet your specific application demands.

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

BG95-M3 Mini PCIe is an industrial-grade module for industrial and commercial applications only.

The module can be applied to the following fields:

- Wireless POS systems
- Tracking systems
- Intelligent meter reading systems
- Security systems

Table 1: Frequency Bands and Functions

Frequency Bands/ Functions	BG95-M3 Mini-PCIe
LTE Cat M1	LTE HD-FDD: B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B25/B26/B27/B28/B66/B85
LTE Cat NB2	LTE HD-FDD: B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/B25/B28/B66/B71/B85

1 BG95-M3 Mini PCIe supports VoLTE (Voice over LTE) under LTE Cat M1 network and CS voice under GSM network.

EGPRS	GSM850/EGSM900/DCS1800/PCS1900
Power Class	Power Class 5 (21 dBm) @ LTE HD-FDD bands
GNSS	GPS, GLONASS, BDS, Galileo, QZSS
Digital Audio	Supports PCM for VoLTE and GSM CS voice

2.2. Key Features

The following table describes the detailed features of BG95-M3 Mini PCIe module.

Table 2: Key Features

Features	Details
Function Interface	PCI Express Mini Card 1.2 Standard Interface
Power Supply	● Supply voltage: 3.0–3.6 V ● Typical supply voltage: 3.3 V
Transmitting Power	● Class 5 (21 dBm +1.7/-3 dB) for LTE HD-FDD bands ● Class 4 (33 dBm ±2 dB) for GSM850 ● Class 4 (33 dBm ±2 dB) for EGSM900 ● Class 1 (30 dBm ±2 dB) for DCS1800 ● Class 1 (30 dBm ±2 dB) for PCS1900 ● Class E2 (27 dBm ±3 dB) for GSM850 8-PSK ● Class E2 (27 dBm ±3 dB) for EGSM900 8-PSK ● Class E2 (26 dBm ±3 dB) for DCS1800 8-PSK ● Class E2 (26 dBm ±3 dB) for PCS1900 8-PSK
LTE Features	● Supports 3GPP Rel-14 ● Supports LTE Cat M1 and LTE Cat NB2 ● Supports 1.4 MHz RF bandwidth for LTE Cat M1 ● Supports 200 kHz RF bandwidth for LTE Cat NB2 ● Cat M1: Max. 588 kbps (DL)/1119 kbps (UL) ● Cat NB2: Max.127 kbps (DL)/158.5 kbps (UL)
GSM Features	**GPRS:** ● Supports GPRS multi-slot class 33 (33 by default) ● Coding scheme: CS-1, CS-2, CS-3 and CS-4 ● Max. 107 kbps (DL)/85.6 kbps (UL) **EDGE:** ● Supports EDGE multi-slot class 33 (33 by default) ● Supports GMSK and 8-PSK for different MCS (Modulation and Coding

	Scheme) ● Downlink coding schemes: MCS 1–9 ● Uplink coding schemes: MCS 1–9 ● Max. 296 kbps (DL)/236.8 kbps (UL)
Internet Protocol Features	● Supports PPP/TCP/UDP/SSL/TLS/FTP(S)/HTTP(S)/NITZ/PING/ MQTT/LwM2M/CoAP/IPv6 protocols ● Supports PAP (Password Authentication Protocol) and CHAP (Challenge Handshake Authentication Protocol) protocols which are usually used for PPP (Point-to-Point Protocol) connections
SMS	● Text and PDU mode ● Point-to-point MO and MT ● SMS cell broadcast ● SMS storage: ME by default
(U)SIM Interface	Supports 1.8 V USIM/SIM card only
UART Interfaces	● Baud rate can reach up to 230400 bps, 115200 bps by default ● Used for AT command communication and data transmission
Audio Feature	● Supports one digital audio interface: PCM interface for VoLTE and GSM CS voice only
USB Interface [2]	● Compliant with USB 2.0 specification (slave only) ● Used for AT command communication, data transmission, GNSS NMEA sentence output, software debugging and firmware upgrade ● Supports USB serial drivers for Windows 7/8/8.1/10/11, Linux 2.6–5.18, Android 4.x–12.x
Antenna Connectors	● Main antenna connector ● GNSS antenna connector
GNSS Features	● Protocol: NMEA 0183 ● Data update rate: 1 Hz by default
AT Commands	● *3GPP TS 27.007* and *3GPP TS 27.005* AT commands ● Quectel enhanced AT commands
Physical Characteristics	● Size: 51.0 mm × 30.0 mm × 4.9 mm ● Weight: approx. 7.2 g
Temperature Range	● Operating temperature range: -35 to +75 °C [3] ● Extended temperature range: -40 to +80 °C [4] ● Storage temperature range: -40 to +90 °C
Firmware Upgrade	● USB interface

2 The USB interface remains powered after BG95-M3 Mini PCIe is turned on, since USB_VBUS on BG95-M3 has been internally connected to BG95-M3's VBAT pins.

3 Within the operating temperature range, the module meets 3GPP specifications.

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

	● DFOTA
RoHS	All hardware components are fully compliant with EU RoHS directive

2.3. Functional Diagram

The following figure shows the block diagram of BG95-M3 Mini PCIe.

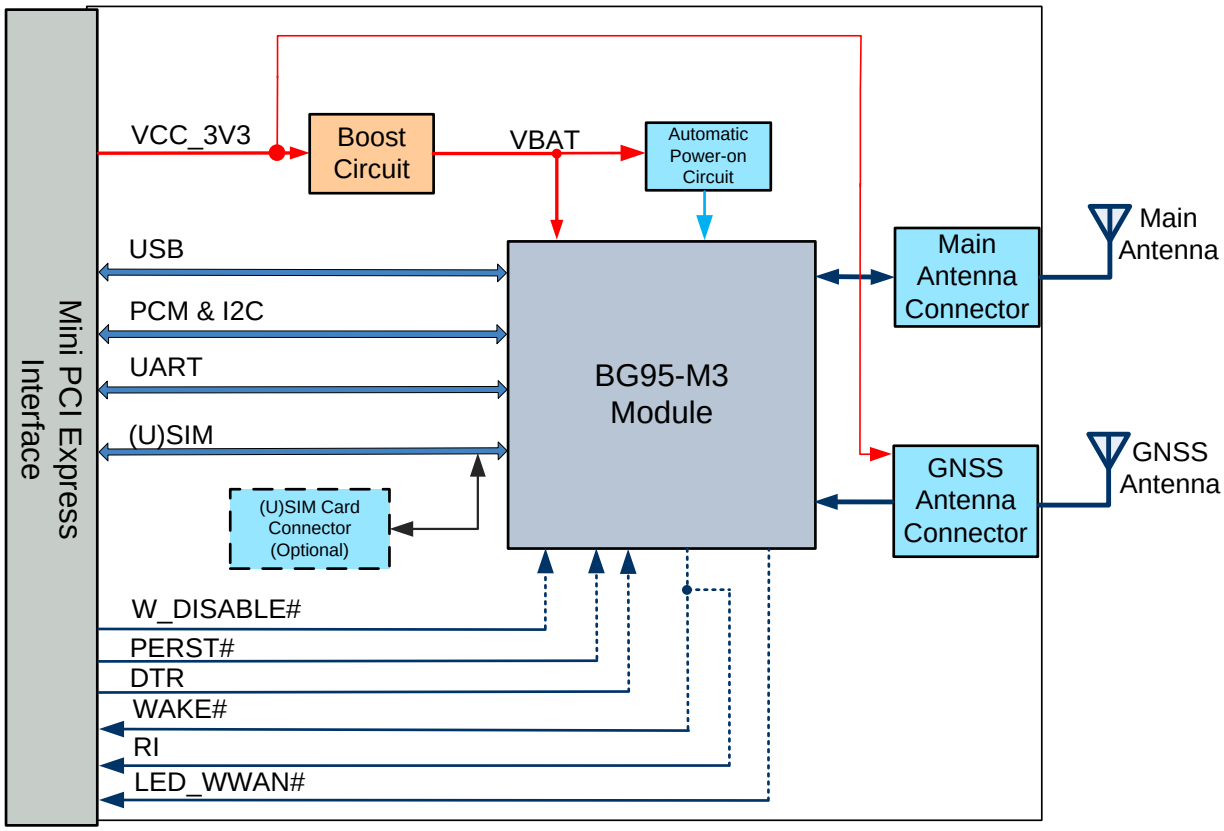


Figure 1: Functional Diagram

NOTE

The integrated (U)SIM card connector shares the same (U)SIM bus with the external (U)SIM card connector that is connected to Mini PCI Express (U)SIM interface. It does not support (U)SIM card detection function, and cannot be used simultaneously with the external (U)SIM card connector. When unused, it has no effect on the external (U)SIM card connector.

2.4. EVB Kit

To help you develop applications with the module, Quectel supplies an evaluation board (Mini PCIe EVB User Guide) with accessories to control or test the module. For more details, see ***document [2]***.

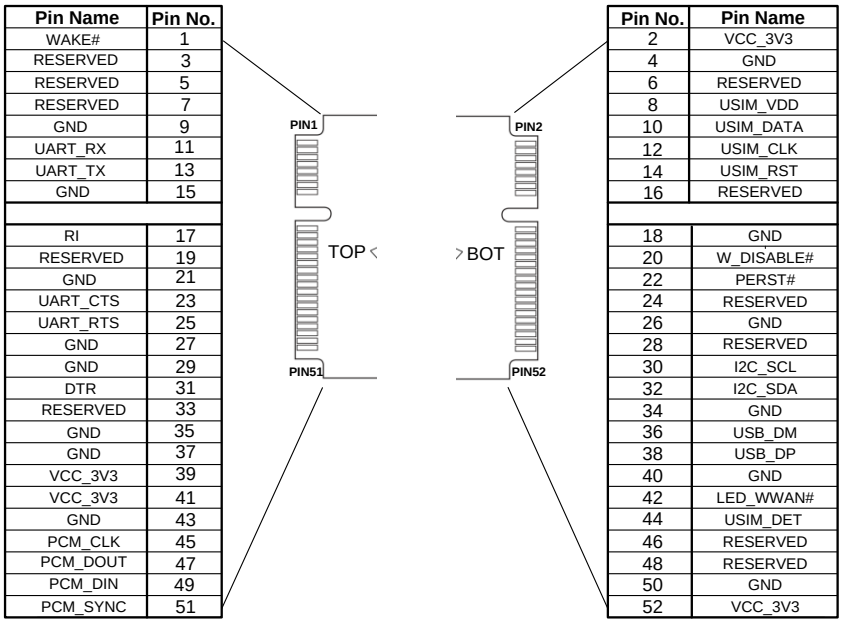
3 Application Interfaces

The physical connections and signal levels of BG95-M3 Mini PCIe comply with *PCI Express Mini Card Electromechanical Specification Revision 1.2*. This chapter mainly describes the definition and application of the following interfaces of BG95-M3 Mini PCIe:

- Power supply
- (U)SIM interface
- USB interface
- UART interface
- PCM and I2C interfaces
- Control and indication Signals

3.1. Pin Assignment

The following figure shows the pin assignment of BG95-M3 Mini PCIe module. The top side contains BG95-M3 module and antenna connectors.



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

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

Figure 2: Pin Assignment

3.2. Pin Description

The following tables show the pin definition and description of BG95-M3 Mini PCIe.

Table 3: Definition of I/O Parameters

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

Table 4: Pin Description

Pin No.	Pin Name	I/O	Description	Comment
1	WAKE#	OC	Wake up the host	Active low
2	VCC_3V3	PI	3.0–3.6 V DC power supply, typically 3.3 V	
3	RESERVED		Reserved	
4	GND		Ground	
5	RESERVED		Reserved	
6	RESERVED		Reserved	
7	RESERVED		Reserved	
8	USIM_VDD	PO	(U)SIM card power supply	1.8 V only
9	GND		Ground	

10	USIM_DATA	DIO	(U)SIM card data	1.8 V only
11	UART_RX	DI	UART receive	
12	USIM_CLK	DO	(U)SIM card clock	1.8 V only
13	UART_TX	DO	UART transmit	
14	USIM_RST	DO	(U)SIM card reset	1.8 V only
15	GND		Ground	
16	RESERVED		Reserved	
17	RI	DO	Ring indication	Active low
18	GND		Ground	
19	RESERVED		Reserved	
20	W_DISABLE#	DI	Airplane mode control	Pulled up by default. Active low.
21	GND		Ground	
22	PERST#	DI	Fundamental reset	Pulled up by default. Active low.
23	UART_CTS	DI	DCE clear to send signal from DTE	
24	RESERVED		Reserved	
25	UART_RTS	DO	DCE request to send signal to DTE	
26	GND		Ground	
27	GND		Ground	
28	RESERVED		Reserved	
29	GND		Ground	
30	I2C_SCL [5]	OD	I2C serial clock (for external codec)	Require external pull-up to 1.8 V. For VoLTE and GSM CS voice only.
31	DTR	DI	Data terminal ready	

5 PCM and I2C interfaces support VoLTE and GSM CS voice.

32	I2C_SDA [5]	OD	I2C serial data (for external codec)	Require external pull-up to 1.8 V. For VoLTE and GSM CS voice only.
33	RESERVED		Reserved	
34	GND		Ground	
35	GND		Ground	
36	USB_DM	AIO	USB differential data (-)	
37	GND		Ground	
38	USB_DP	AIO	USB differential data (+)	
39	VCC_3V3	PI	3.0–3.6 V DC power supply, typically 3.3 V	
40	GND		Ground	
41	VCC_3V3	PI	3.0–3.6 V DC power supply, typically 3.3 V	
42	LED_WWAN#	OC	LED signal for indicating the network status of the module	Active low
43	GND		Ground	
44	USIM_DET	DI	(U)SIM card detect	
45	PCM_CLK [5]	DO	PCM clock	1.8 V power domain. For VoLTE and GSM CS voice only.
46	RESERVED		Reserved	
47	PCM_DOUT [5]	DO	PCM data output	1.8 V power domain. For VoLTE and GSM CS voice only.
48	RESERVED		Reserved	
49	PCM_DIN [5]	DI	PCM data input	1.8 V power domain. For VoLTE and GSM CS voice only.
50	GND		Ground	
51	PCM_SYNC [5]	DO	PCM frame sync	1.8 V power domain. For VoLTE and GSM CS voice only.

52	VCC_3V3	PI	3.0–3.6 V DC power supply, typically 3.3 V

NOTE

1. The module can be reset by driving PERST# low for 2–3.8 s.
2. Keep all reserved and unused pins unconnected.

3.3. Operating Modes

The following table briefly outlines the operating modes in the undermentioned chapters.

Table 5: Overview of Operating Modes

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

See details about **AT+CFUN=4** and **AT+CFUN=0** in ***document [4]***.

3.4. Power Saving

3.4.1. Sleep Mode

BG95-M3 Mini PCIe is able to minimize the power consumption in sleep mode. The following three conditions should be met to make the module enter sleep mode. See the AT command below in ***document [4]***.

- Execute **AT+QSCLK=1** to enable sleep mode.

- Drive the DTR pin high or leave it open.
- The host's USB, which connects to the module's USB interface, enters suspend mode.

Adopt either way below to wake up the module from sleep mode:

- Pull down DTR and keep it low
- exit the host's USB suspend mode

3.4.2. Airplane Mode

When the module enters airplane mode, its RF function will be disabled, and all related AT commands will be inaccessible. For more details, see ***chapter 3.10.3***.

3.5. Power Supply

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

Table 6: Definition of VCC_3V3 and GND Pins

Pin Name	Pin No.	I/O	Description	Comment
VCC_3V3	2, 39, 41, 52	PI	Power supply for the module	3.0–3.6 V DC power supply, typically 3.3 V
GND	4, 9, 15, 18, 21, 26, 27, 29, 34, 35, 37, 40, 43, 50			

The typical supply voltage of BG95-M3 Mini PCIe is 3.3 V. In 2G network, the input peak current may reach 2.7 A during the transmitting time. Therefore, the power supply should be able to provide a rated current of 2.7 A at least, and a low-ESR bypass capacitor not less than 470 µF should be used to prevent the voltage from dropping. If the switching power supply is used to supply power to the module, the power device and power supply routing traces of the switching power supply should avoid the antennas as much as possible to prevent EMI interference.

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

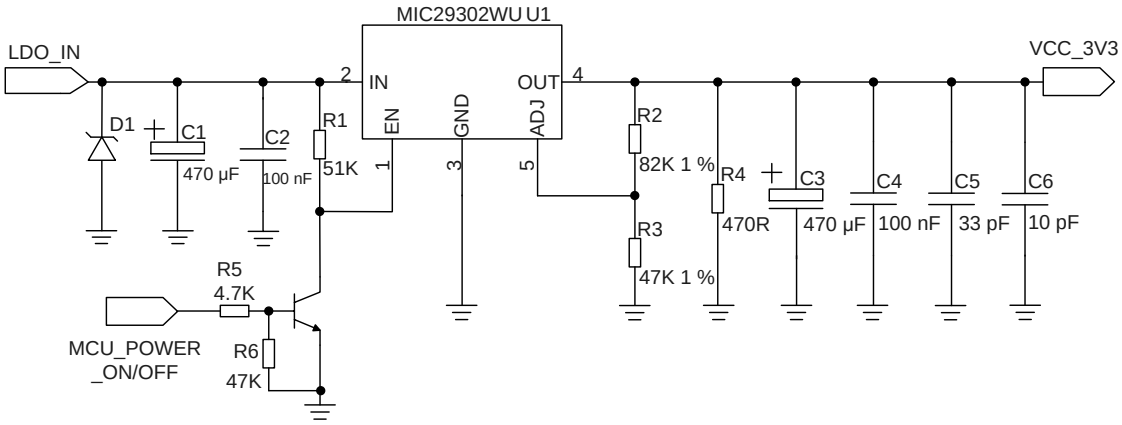


Figure 3: Reference Design of Power Supply

3.6. (U)SIM Interface

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

Table 7: Pin Definition of (U)SIM Interface

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

The module supports (U)SIM card hot-plug via USIM_DET, and support both high-level and low-level detections. The function is disabled by default. See **AT+QSIMDET** in ***document [4]*** for details. The following figure shows a reference design of (U)SIM interface with an 8-pin (U)SIM card connector.

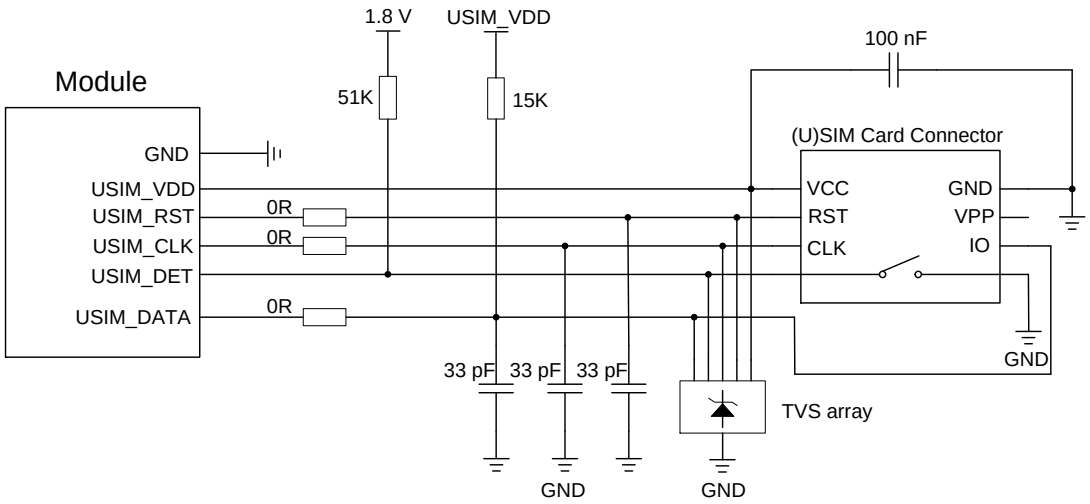


Figure 4: Reference Design of (U)SIM Interface with 8-Pin (U)SIM Card Connector

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

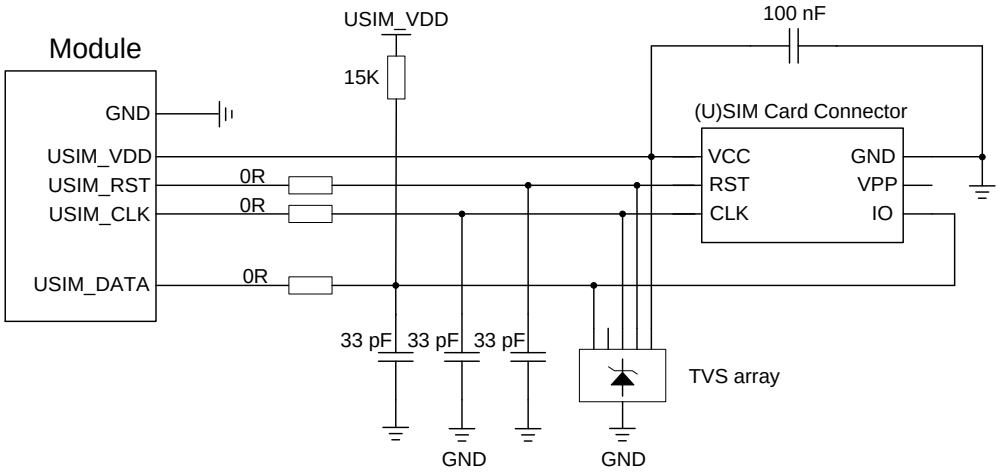


Figure 5: Reference Design of (U)SIM Interface with 6-Pin (U)SIM Card Connector

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

- Keep the placement of (U)SIM card connector to the module as close as possible. The trace length should not be more than 200mm, and the shorter, the better.
- Keep (U)SIM card signals away from RF and power supply traces.
- Assure the ground between the module and the (U)SIM card connector short and wide. Keep the trace width of ground not less than 0.5 mm to maintain the same electric potential. The decouple capacitor between USIM_VDD and GND should be not more than 1 μF and be placed close to the (U)SIM card connector.

- To avoid crosstalk between USIM_DATA and USIM_CLK, keep them away from each other and shield them with surrounded ground.
- In order to offer good ESD protection, it is recommended to add a TVS array with parasitic capacitance not exceeding 15 pF. The 0 Ω resistors should be added in series between the module and the (U)SIM card connector so as to facilitate debugging. The 33 pF capacitors are used for filtering interference of EGSM900. Please note that the (U)SIM peripheral circuit should be close to the (U)SIM card connector.
- The pull-up resistor on USIM_DATA line can improve anti-jamming capability when long layout trace and sensitive occasion are applied, and should be placed close to the (U)SIM card connector.

3.7. USB Interface

The module provides one integrated Universal Serial Bus (USB) interface which complies with the USB 2.0 specification and supports operation at low-speed (1.5 Mbps) full-speed (12 Mbps) and high-speed (480 Mbps) modes. The USB interface is used for AT command communication, data transmission, GNSS NMEA sentence output, software debugging, and firmware upgrade.

The following table shows the pin definition of USB interface.

Table 8: Pin Definition of USB Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_DM	36	AIO	USB differential data (-)	Require differential impedance of 90 Ω
USB_DP	38	AIO	USB differential data (+)	

The following figure shows a reference design of USB interface.

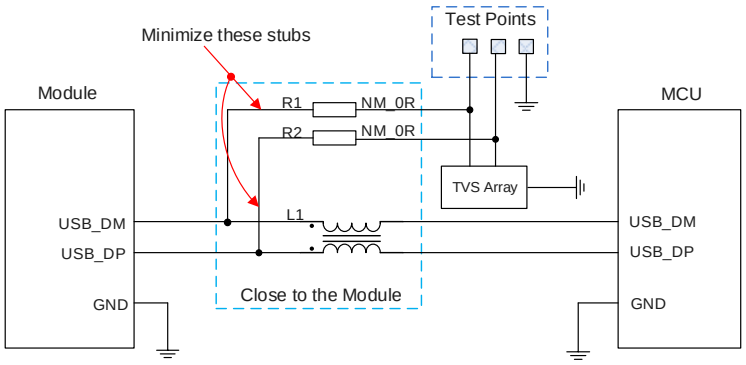


Figure 6: Reference Design of USB Interface

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

Comply with the following rules to design the USB interface, so as to meet USB 2.0 specification.

- It is important to route the USB signal traces as differential pairs with ground surrounded. The impedance of USB differential trace is 90 Ω.
- Do not route signal traces under crystals, oscillators, magnetic devices and RF signal traces. It is important to route the USB differential traces in inner-layer of the PCB, and surround the traces with ground on that layer and with ground planes above and below.
- Junction capacitance of the ESD protection component might cause influences on USB data lines, so please pay attention to the selection of the components. The junction capacitance should be less than 2 pF.
- Keep the ESD protection components as close to the USB connector as possible.

NOTE

1. The module can only be used as a slave device.
2. The USB interface remains powered after BG95-M3 Mini PCIe is turned on, since USB_VBUS on BG95-M3 has been internally connected to BG95-M3's VBAT pins.

3.8. UART Interface

The UART interface supports 9600, 19200, 38400, 57600, 115200 and 230400 bps baud rates. The default baud rate is 115200 bps. This interface can be used for AT command communication and data transmission.

Table 9: Pin Definition of UART Interface

Pin Name	Pin No.	I/O	Description	Comment
UART_RX	11	DI	UART receive	3.3 V
UART_TX	13	DO	UART transmit	
UART_CTS	23	DI	DCE clear to send signal from DTE	
UART_RTS	25	DO	DCE request to send signal to DTE	

The power domain of UART interface is 3.3 V. Pay attention to the signal direction while connecting the UART interface to a peripheral MCU/RAM. A reference design of UART interface is provided below:

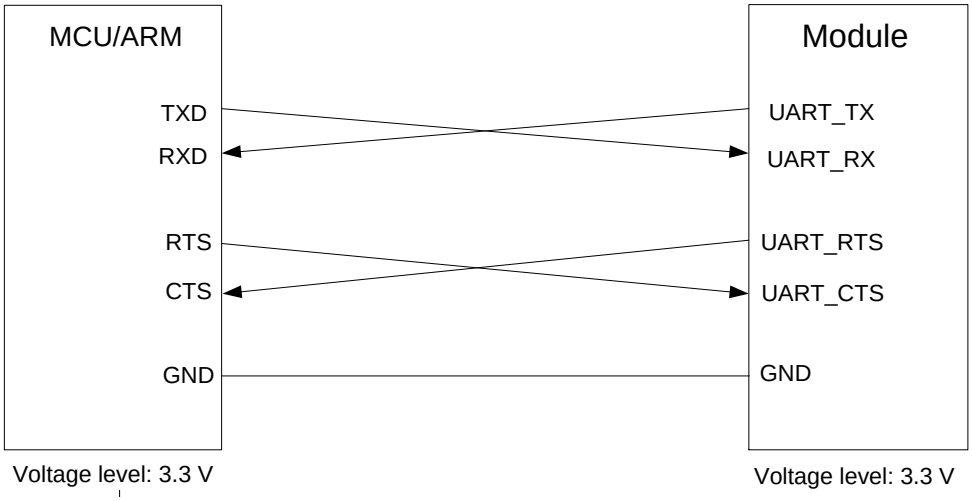


Figure 7: Reference Design of UART Interface

NOTE

AT+IPR can be used to set the baud rate of UART interface, and **AT+IFC** can be used to set the hardware flow control disabled by default. See ***document [4]*** for details.

3.9. PCM and I2C Interfaces

BG95-M3 Mini PCIe provides one Pulse Code Modulation (PCM) digital interface and one I2C interface for VoLTE and GSM CS voice.

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

Table 10: Pin Definition of PCM and I2C Interfaces

Pin Name	Pin No.	I/O	Description	Comment
PCM_CLK	45	DO	PCM clock	1.8 V
PCM_DOUT	47	DO	PCM data output	1.8 V
PCM_DIN	49	DI	PCM data input	1.8 V

PCM_SYNC	51	DO	PCM frame sync	1.8 V
I2C_SCL	30	OD	I2C serial clock (for external codec)	Require external pull-up to 1.8 V.
I2C_SDA	32	OD	I2C serial data (for external codec)	

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

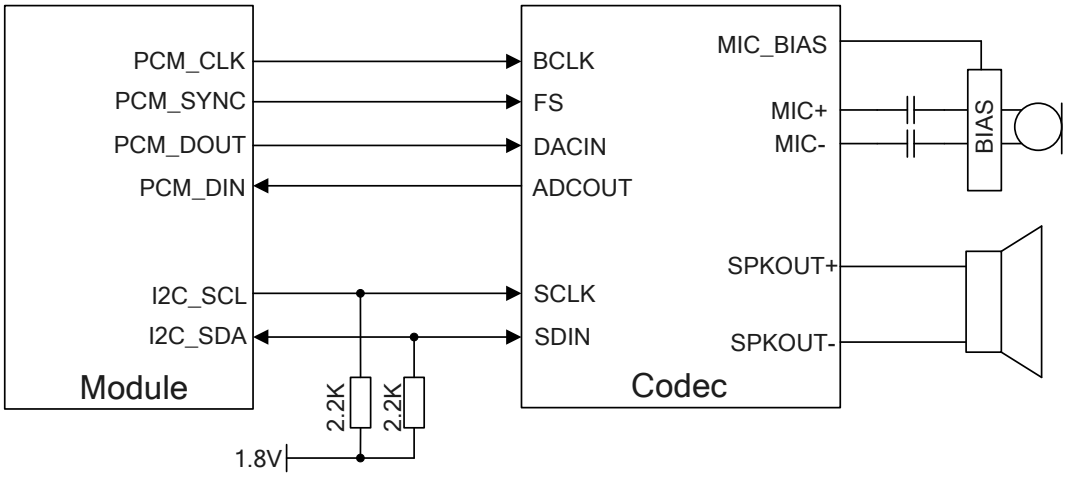


Figure 8: Reference Design of PCM and I2C Application with Audio Codec

NOTE

PCM and I2C interfaces support VoLTE and GSM CS voice.

3.10. Control and Indication Signals

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

Table 11: Pin Definition of Control and Indication Signals

Pin Name	Pin No.	I/O	Description	Comment
RI	17	DO	Ring indication	3.3 V
DTR	31	DI	Data terminal ready	3.3 V
W_DISABLE#	20	DI	Airplane mode control	Pulled up by default. Active low. 3.3 V

PERST#	22	DI	Fundamental reset	Pulled up by default. Active low.
LED_WWAN#	42	OC	LED signal for indicating the network status of the module	Active low.
WAKE#	1	OC	Wake up the host	

NOTE

The module can be reset by driving PERST# low for 2–3.8 s.

3.10.1. RI

RI is used to wake up the host. When a URC returns, there will be the following behaviors on the RI pin after executing **AT+QCFG="risignaltype","physical"**, see ***document [3]*** for details.

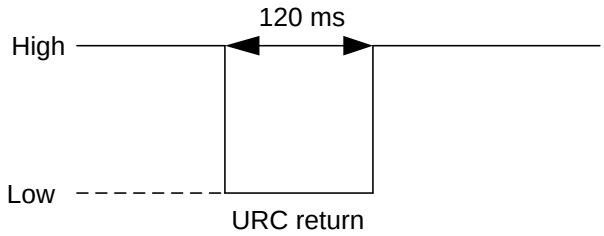


Figure 9: RI Behavior

3.10.2. DTR

DTR signal is for sleep mode control and is pulled up by default. Driving it low wakes up the module from sleep mode. For more details about how to make the module enter sleep mode, see ***Chapter 3.4.1***.

3.10.3. W_DISABLE#

W_DISABLE# enables/disables the RF function (excluding GNSS). It is pulled up by default, and driving it low makes the module enter airplane mode.

The pin function is disabled by default, and **AT+QCFG="airplanecontrol",1** can be used to enable this function. See ***document [3]*** for details about the AT command.

Table 12: Airplane Mode Control (Hardware Method)

W_DISABLE#	RF Function Status	Module Operation Mode
High level (default)	RF enabled	Full Functionality Mode
Low level	RF disabled	Airplane Mode

The RF function can also be enabled/disabled with **AT+CFUN=<fun>**, and details are listed below.

Table 13: Airplane Mode Control (Software Method)

AT+CFUN=<fun>	RF Function Status	Module Operation Mode
<fun>=0	RF and (U)SIM disabled	Minimum Functionality Mode
<fun>=1	RF enabled	Full Functionality Mode
<fun>=4	RF disabled	Airplane Mode

3.10.4. PERST#

PERST# forces a hardware reset on the module. The module is reset by driving PERST# low for 2–3.8 s and then releasing it. The reset timing is illustrated in the following figure.

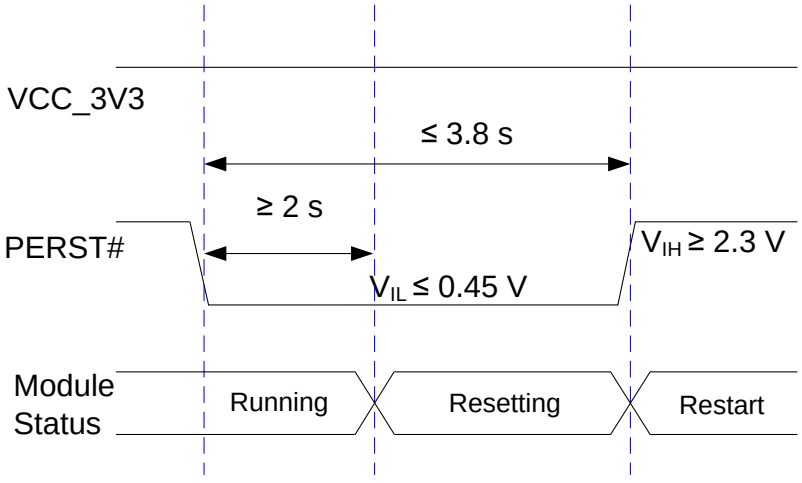


Figure 10: Reset Timing

3.10.5. LED_WWAN#

LED_WWAN# indicates the network status of the module, and it absorbs a current up to 40 mA.

According to the following circuit, in order to reduce the current of the LED, a resistor should be placed in series with the LED. The LED is powered on when LED_WWAN# is pulled low.

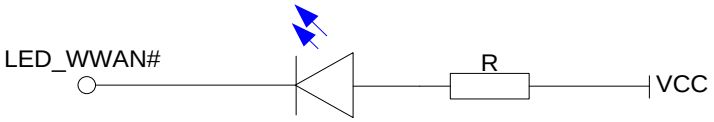


Figure 11: Reference Design of LED_WWAN#

LED_WWAN# supports two indication modes which can be switched through **AT+QCFG="ledmode"**:

- **AT+QCFG="ledmode",0** (Default setting)
- **AT+QCFG="ledmode",1**

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

Table 14: Indications of Network Status (AT+QCFG="ledmode",0, Default Setting)

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

Table 15: Indications of Network Status (AT+QCFG="ledmode",1)

Pin Status	Description
Low Level (Light on)	Registered on network successfully
High-impedance (Light off)	• No network coverage or not registered • W_DISABLE# is at low level (airplane mode) • **AT+CFUN=0** or **AT+CFUN=4**

See ***document [4]*** for details about the AT commands mentioned above.

3.10.6. WAKE#

WAKE# is an open collector signal which is similar to RI, but you need to add an external pull-up resistor in the design of this pin. When a URC returns, a 120 ms low level pulse will be output. The state of WAKE# is shown as below. See ***document [3]*** for details about the AT command mentioned above.

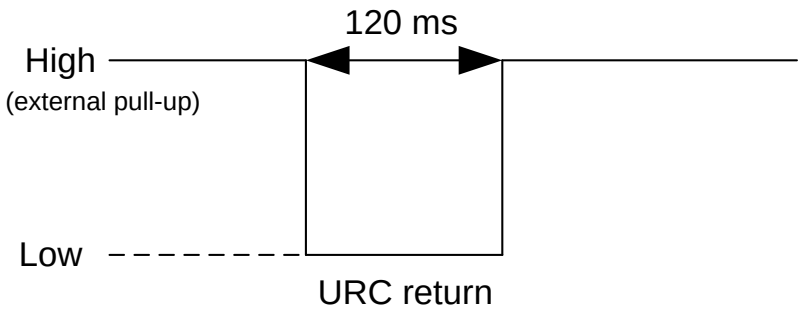


Figure 12: WAKE# Behaviors

4 GNSS

4.1. General Description

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

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

By default, the GNSS engine is switched off. It has to be switched on via AT command. See ***document [1]*** for more details about GNSS engine technology and configurations.

4.2. GNSS Performance

The following table shows the GNSS performance of BG95-M3 Mini PCIe.

Table 16: GNSS Performance

Parameter	Description	Conditions	Typ.	Unit
Sensitivity	Acquisition	Autonomous	-146	dBm
	Reacquisition	Autonomous	-157	dBm
	Tracking	Autonomous	-157	dBm
TTFF	Cold start @ open sky	Autonomous	31.01	s
		XTRA enabled	10.4	s
	Warm start @ open sky	Autonomous	30.58	s
		XTRA enabled	1.53	s
	Hot start	Autonomous	1.6	s

	@ open sky	XTRA enabled	1.5	s
Accuracy	CEP-50	Autonomous @ open sky	2.5	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 Antenna Connector

BG95-M3 Mini PCIe is mounted with two antenna connectors for external antenna connection: a main antenna connector and a GNSS antenna connector. The impedance of the antenna ports is 50 Ω.

Figure 13: Main and GNSS Antenna Connectors

5.1. Main Antenna Connector

5.1.1. Description of Main Antenna Connector

The details of main antenna connector are shown below.

Table 17: Description of Main Antenna Connector

Connector	I/O	Description	Comment
Main Antenna	AIO	Main antenna connector	50 Ω impedance

5.1.2. Operating Frequency

Table 18: Operating Frequency

3GPP Band	Transmit	Receive	Unit
LTE HD-FDD B1	1920–1980	2110–2170	MHz
LTE HD-FDD B2, PCS1900	1850–1910	1930–1990	MHz
LTE HD-FDD B3, DCS1800	1710–1785	1805–1880	MHz
LTE HD-FDD B4	1710–1755	2110–2155	MHz
LTE HD-FDD B5, GSM850	824–849	869–894	MHz
LTE HD-FDD B8, EGSM900	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 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 [6]	814–849	859–894	MHz
LTE HD-FDD B27 [6]	807–824	852–869	MHz
LTE HD-FDD B28	703–748	758–803	MHz
LTE HD-FDD B66	1710–1780	2110–2180	MHz

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

LTE HD-FDD B71 [7]	663–698	617–652	MHz
LTE HD-FDD B85	698–716	728–746	MHz

5.2. GNSS Antenna Connector

5.2.1. Description of GNSS Antenna Connector

The following tables show details of GNSS antenna connector.

By default, the GNSS antenna connector supports active antennas with 3.3 V power supply design. It also supports passive antennas.

Table 19: Description of GNSS Antenna Connector

Connector	I/O	Description	Comment
GNSS Antenna	AI	GNSS antenna connector	50 Ω impedance

5.2.2. GNSS Frequency

Table 20: GNSS Frequency

Type	Frequency	Unit
GPS	1575.42 ±1.023	MHz
GLONASS	1597.5–1605.8	MHz
Galileo	1575.42 ±2.046	MHz
BDS	1561.098 ±2.046	MHz
QZSS	1575.42 ±1.023	MHz

5.3. Antenna Design Requirements

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

7 LTE HD-FDD B71 is supported by Cat NB2 only.

Table 21: Antenna Design Requirements

Type	Requirements
GNSS	● Frequency range 1: 1559–1609 MHz ● Polarization: RHCP or linear ● VSWR: < 2 (Typ.) ● Passive antenna gain: > 0 dBi ● Active antenna noise figure: < 1.5 dB ● Active antenna gain: > 0 dBi ● Active antenna embedded LNA gain: < 17 dB ● Active antenna power supply: 3.3 V
LTE/GSM	● VSWR: ≤ 2 ● Efficiency: > 30% ● Max Input Power: 50 W ● Input Impedance: 50 Ω ● Cable Insertion Loss: < 1 dB: LB (<1 GHz) ● Cable Insertion Loss: < 1.5 dB**:** MB (1–2.3 GHz)

NOTE

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

5.4. RF Connector Recommendation

The module is mounted with antenna connectors (receptacles) for convenient antenna connection. The dimensions of receptacles are shown as below.

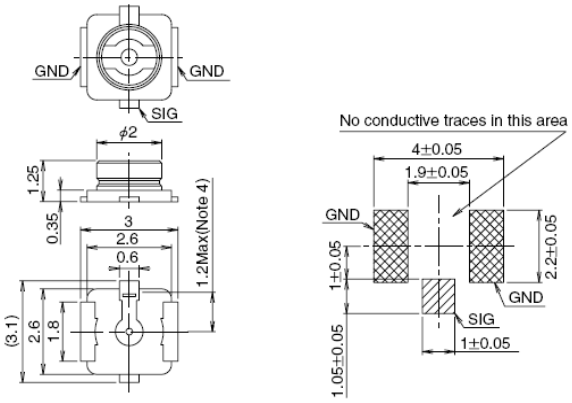


Figure 14: Dimensions of the Receptacle (Unit: mm)

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

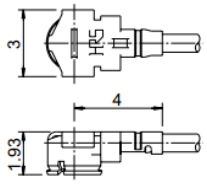
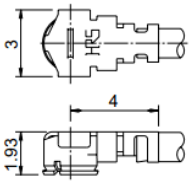
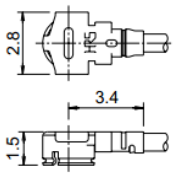
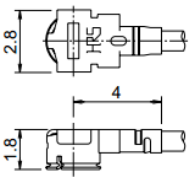
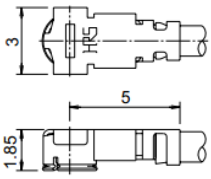
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 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 15: Specifications of Mated Plugs

The following figure describes the space factor of mated connectors.

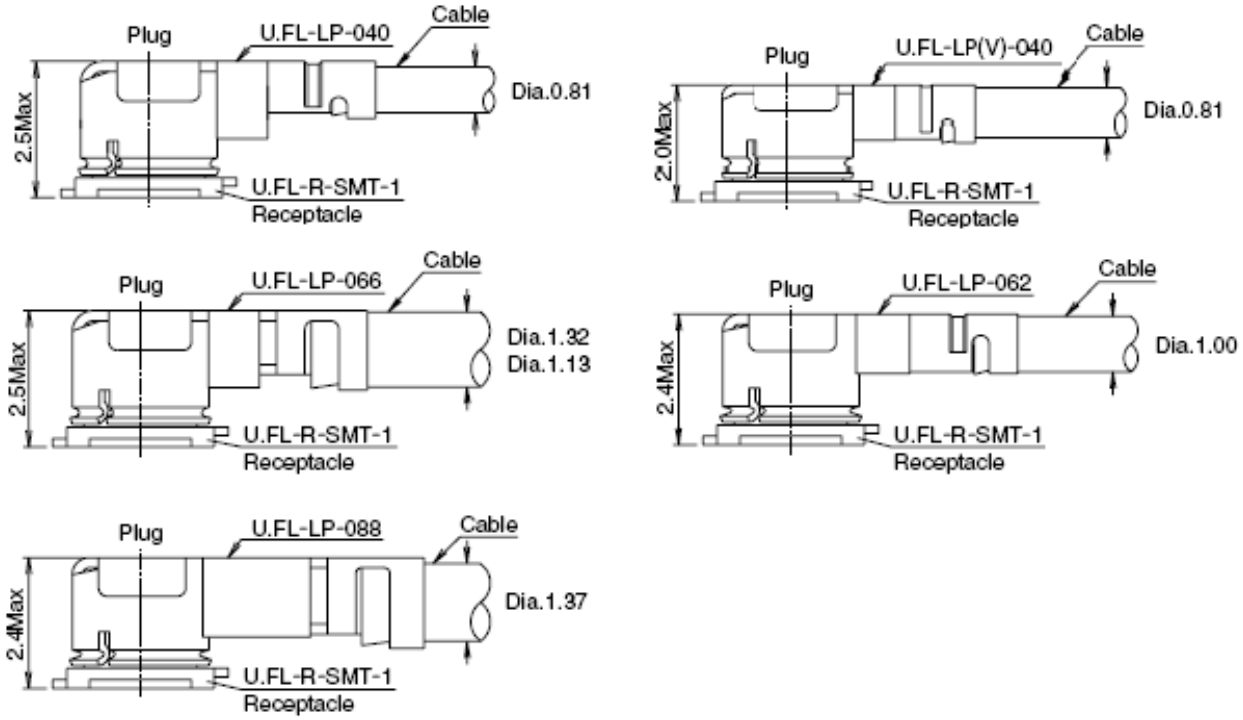


Figure 16: Space Factor of Mated Connectors (Unit: mm)

For more details of the recommended mating plugs, please visit http://www.hirose.com.

6 Electrical Characteristics and Reliability

6.1. General Description

The following subchapters mainly describe the following electrical and radio characteristics of BG95-M3 Mini PCIe:

- Power supply ratings
- Digital I/O characteristics
- Tx power
- Rx sensitivity
- ESD characteristics
- Power consumption

6.2. Power Supply Ratings

The input voltage of the module is 3.3 V ±9 % (3.0–3.6 V), as specified by *PCI Express Mini Card Electromechanical Specification Revision 1.2*. The following table shows the power supply ratings of the module.

Table 22: Power Supply Ratings

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
VCC_3V3	Power Supply	The actual input voltages should be kept between the minimum and maximum values.	3.0	3.3	3.6	V

6.3. Digital I/O Characteristics

The following table shows the digital I/O characteristics of the module.

Table 23: 3.3 V Digital I/O Characteristics

Parameter	Description	Min.	Max.	Unit
V_{IH}	Input high voltage	0.7 × VCC_3V3	VCC_3V3 + 0.3	V
V_{IL}	Input low voltage	-0.3	0.3 × VCC_3V3	V
V_{OH}	Output high voltage	VCC_3V3 - 0.5	VCC_3V3	V
V_{OL}	Output low voltage	0	0.4	V

Table 24: 1.8 V Digital I/O Characteristics

Parameter	Description	Min.	Max.	Unit
V_{IH}	Input high voltage	1.2	2.0	V
V_{IL}	Input low voltage	-0.3	0.6	V
V_{OH}	Output high voltage	1.35	1.8	V
V_{OL}	Output low voltage	0	0.45	V

NOTE

1. The PCM and I2C interfaces belong to 1.8 V power domain and other I/O interfaces belong to VCC_3V3 power domain.
2. The maximum voltage value of V_{IL} for PERST# and W_DISABLE# is 0.5 V.

6.4. Tx Power

The following tables show the Tx power of the module.

Table 25: Tx Power

Frequency	Max.	Min.

LTE HD-FDD: B1/B2/B3/B4/B5/B8/B12/B13/B18/B19/B20/ B25/B26 [8]/B27 [8]/B28/B66/B71 [9]/B85	21 dBm + 1.7/-3 dB	< -39 dBm
GSM850/EGSM900	33 dBm ± 2 dB	5 dBm ± 5 dB
DCS1800/PCS1900	30 dBm ± 2 dB	0 dBm ± 5 dB
GSM850/EGSM900 (8-PSK)	27 dBm ± 3 dB	5 dBm ± 5 dB
DCS1800/PCS1900 (8-PSK)	26 dBm ± 3 dB	0 dBm ± 5 dB

6.5. Rx Sensitivity

Table 26: Rx Sensitivity

Band	Primary	Diversity	Sensitivity (dBm)	
			Cat M1/3GPP	Cat NB2 [10]/3GPP
LTE HD-FDD B1	√	-	-106/-102.3	-115/-107.5
LTE HD-FDD B2			-104.9/-100.3	-115/-107.5
LTE HD-FDD B3			-102.9/-99.3	-115/-107.5
LTE HD-FDD B4			-104.4/-102.3	-114/-107.5
LTE HD-FDD B5			-104.4/-100.8	-116/-107.5
LTE HD-FDD B8			-104.1/-99.8	-113/-107.5
LTE HD-FDD B12			-104.4/-99.3	-116/-107.5
LTE HD-FDD B13			-104.4/-99.3	-115.5/-107.5
LTE HD-FDD B18			-104.4/-102.3	-116/-107.5
LTE HD-FDD B19			-104.4/-102.3	-115.5/-107.5
LTE HD-FDD B20			-104.1/-99.8	-115.5/-107.5
LTE HD-FDD B25			-104.5/-100.3	-115.5/-107.5

8 LTE HD-FDD B26 and B27 are supported by Cat M1 only.
9 LTE HD-FDD B71 is supported by Cat NB2 only.
10 3GPP has no requirements for LTE Cat NB Rx sensitivity level with repetitions.

LTE HD-FDD B26 [8]		-104.5/-100.3	-
LTE HD-FDD B27 [8]		-104.5/-100.8	-
LTE HD-FDD B28		-104/-100.8	-116/-107.5
LTE HD-FDD B66		-103.9/-101.8	-115.5/-107.5
LTE HD-FDD B71 [9]		-	-115/-107.5
LTE HD-FDD B85		-104.3/-99.3	-116/-107.5

Band	Primary	Diversity	Sensitivity (dBm)
			GSM/3GPP
GSM850/EGSM900	√	-	-107/-102
DCS1800/PCS1900			-107/-102

NOTE

"√" means supported and "-" means not supported or not applicable.

6.6. ESD Protection

Static electricity occurs naturally and it may damage the module. Therefore, it is imperative to adopt proper ESD countermeasures and handling methods. 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 27: ESD Discharge Characteristics

Tested Interfaces	Contact Discharge	Air Discharge	Unit
GND	±6	±8	kV
VCC_3V3	±6	±8	kV
Main antenna connector	±5	±6	kV
GNSS antenna connector	±5	±6	kV

6.7. Operating and Storage Temperatures

Table 28: Operating and Storage Temperatures

Parameter	Temperature Range
Operating Temperature Range [11]	-30 to +75 °C
Extended Temperature Range [12]	-40 to +80 °C
Storage Temperature Range	-40 to +90 °C

6.8. Power Consumption

The following tables describe the current consumption of the module.

Table 29: Power Consumption

Description	Conditions	Average	Unit
PSM	Power Saving Mode (USB Suspend)	2.47	mA
Sleep Mode (USB Suspend)	**AT+CFUN=0** @ Sleep Mode	2.55	mA
	LTE Cat M1 DRX = 1.28 s	3.84	mA
	LTE Cat NB1 DRX = 1.28 s	3.68	mA
	LTE Cat M1 e-I-DRX = 81.92 s, PTW = 2.56 s, DRX = 1.28 s	2.74	mA
	LTE Cat NB1 e-I-DRX = 81.92 s, PTW = 2.56 s, DRX = 1.28 s	2.72	mA
	EGSM900 DRX = 5	3.26	mA
	DCS1800 DRX = 5	3.33	mA

11 Within the operating temperature range, the module meets 3GPP specifications.

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

Idle (USB Suspend)	LTE Cat M1 DRX = 1.28 s	24.80	mA
	LTE Cat NB1 DRX = 1.28 s	20.65	mA
	LTE Cat M1 e-I-DRX = 81.92 s, PTW = 2.56 s, DRX = 1.28 s	24.15	mA
	LTE Cat NB1 e-I-DRX = 81.92 s, PTW = 2.56 s, DRX = 1.28 s	20.27	mA
	EGSM900 DRX = 5	18.23	mA
	DCS1800 DRX = 5	18.31	mA
Idle (USB Active)	LTE Cat M1 DRX = 1.28 s	29.49	mA
	LTE Cat NB1 DRX = 1.28 s	29.43	mA
	LTE Cat M1 e-I-DRX = 81.92 s, PTW = 2.56 s, DRX = 1.28 s	28.41	mA
	LTE Cat NB1 e-I-DRX = 81.92 s, PTW = 2.56 s, DRX = 1.28 s	28.55	mA
	EGSM900 DRX = 5	28.90	mA
	DCS1800 DRX = 5	29.04	mA
LTE Cat M1 data transfer (GNSS OFF)	Band 1 @ 21.35 dBm	250	mA
	Band 2 @ 21.53 dBm	240	mA
	Band 3 @ 21.18 dBm	242	mA
	Band 4 @ 21.48 dBm	260	mA
	Band 5 @ 21.38 dBm	260	mA
	Band 8 @ 22.46 dBm	259	mA
	Band 12 @ 21.45 dBm	235	mA
	Band 13 @ 21.46 dBm	254	mA
	Band 18 @ 22.29 dBm	254	mA
	Band 19 @ 21.39 dBm	244	mA
	Band 20 @ 22.27 dBm	259	mA
	Band 25 @ 21.46 dBm	256	mA

	Band 26 @ 22.16 dBm	256	mA
	Band 27 @ 21.8 dBm	250	mA
	Band 28A @ 21.3 dBm	253	mA
	Band 28B @ 21.2 dBm	244	mA
	Band 66 @ 22.82 dBm	249	mA
	Band 85 @ 21.27 dBm	237	mA
LTE Cat NB1 data transfer (GNSS OFF)	Band 1 @ 21.14 dBm	204	mA
	Band 2 @ 21.11 dBm	371	mA
	Band 3 @ 21.65 dBm	206	mA
	Band 4 @ 21.51 dBm	203	mA
	Band 5 @ 21.33 dBm	400	mA
	Band 8 @ 21.13dBm	393	mA
	Band 12 @ 21.09 dBm	203	mA
	Band 13 @ 21.21 dBm	412	mA
	Band 18 @ 21.38 dBm	215	mA
	Band 19 @ 20.78 dBm	390	mA
	Band 20 @ 21.13 dBm	395	mA
	Band 25 @ 21.57 dBm	206	mA
	Band 28 @ 21.06dBm	378	mA
	Band 66 @ 21.62 dBm	370	mA
	Band 71 @ 20.78 dBm	148	mA
	Band 85 @ 20.07 dBm	357	mA
GPRS data transfer (GNSS OFF)	GPRS GSM850 4UL/1DL @ 29.58 dBm	862	mA
	GPRS EGSM900 4UL/1DL @ 29.65 dBm	857	mA
	GPRS DCS1800 4UL/1DL @ 26.16 dBm	565	mA

	GPRS PCS1900 4UL/1DL @ 25.88 dBm	587	mA
EDGE data transfer (GNSS OFF)	EDGE GSM850 4UL/1DL @ 22.58 dBm	523	mA
	EDGE EGSM900 4UL/1DL @ 22.66 dBm	521	mA
	EDGE DCS1800 4UL/1DL @ 21.7 dBm	470	mA
	EDGE PCS1900 4UL/1DL @ 22.23 dBm	486	mA

Table 30: GNSS Power Consumption

Parameter	Description	Conditions	Typ.	Unit
I_{VBAT}	Searching (**AT+CFUN=0**)	Cold start @ Passive Antenna	100.67	mA
		Lost state @ Passive Antenna	101.87	mA
	Tracking (**AT+CFUN=0**)	Instrument environment	59.37	mA
		Open Sky @ Passive Antenna	TBD	mA
		Open Sky @ Active Antenna	TBD	mA

6.9. Notification

Please follow the rules below in the module application.

6.9.1. Coating

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

6.9.2. Cleaning

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

6.9.3. Assembly Requirement

It is recommended to fix the module on the plane when the module is inserted to a socket.

7 Mechanical Information

7.1. General Description

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

7.2. Mechanical Dimensions

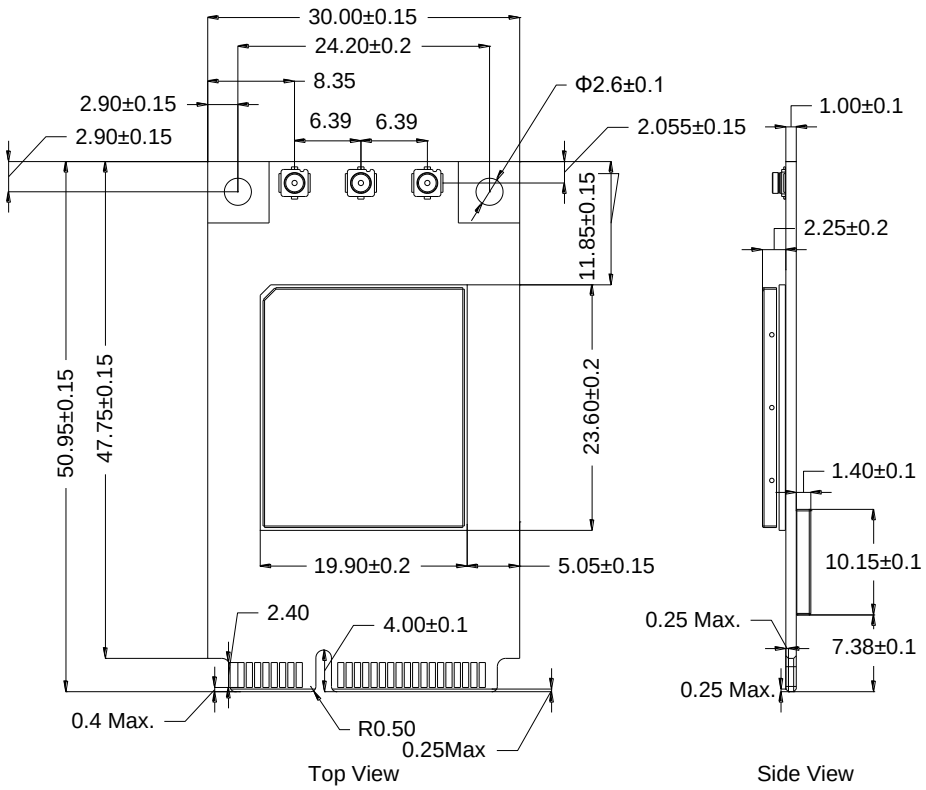


Figure 17: Mechanical Dimensions of BG95-M3 Mini PCIe

7.3. Packaging Specification

This chapter describes only the key parameters and process of packaging. All figures below are for reference only. The appearance and structure of the packaging materials are subject to the actual delivery. The module adopts carrier tape packaging and details are as follow:

7.3.1. Blister Tray

Dimension details are as follow:

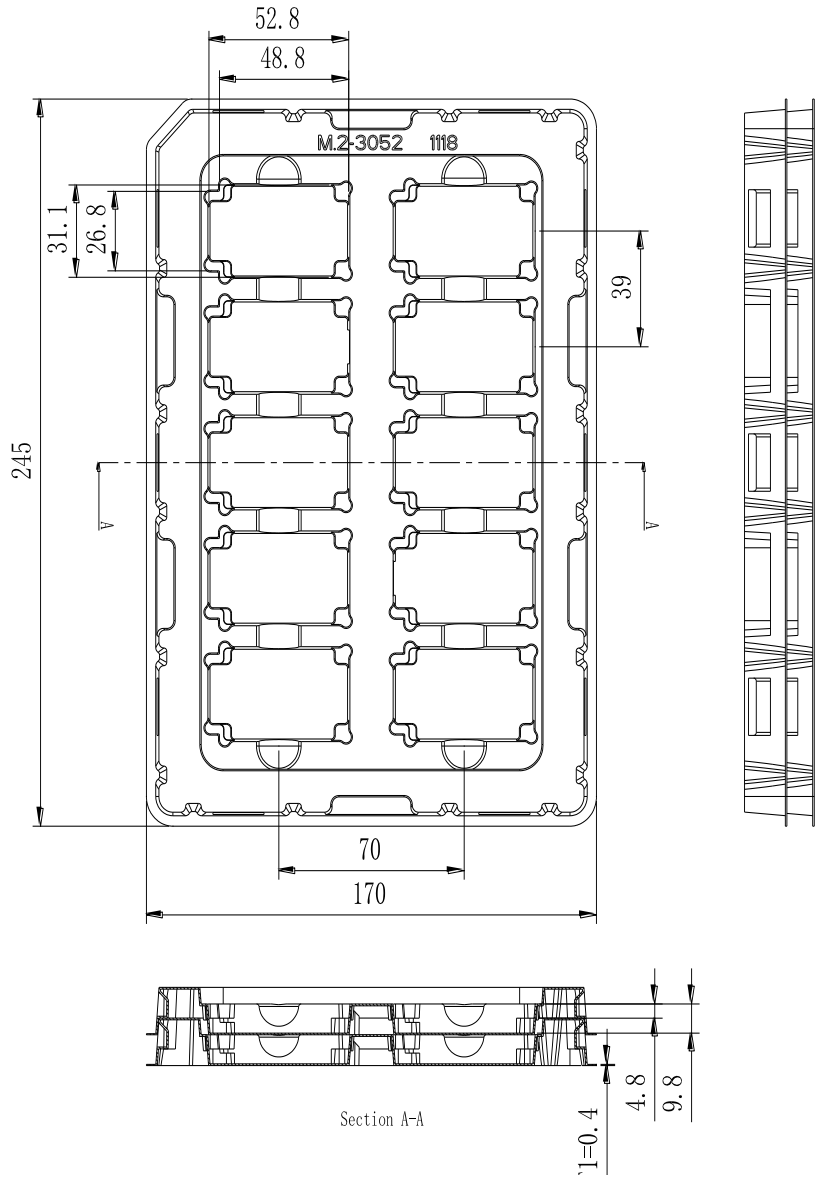
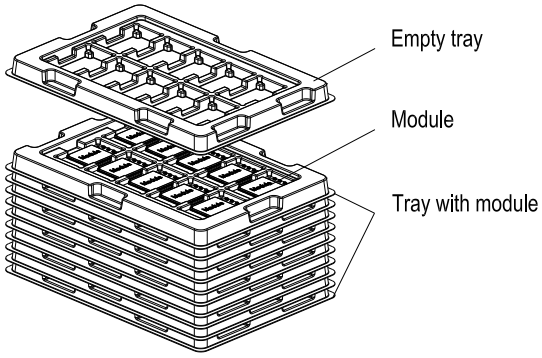
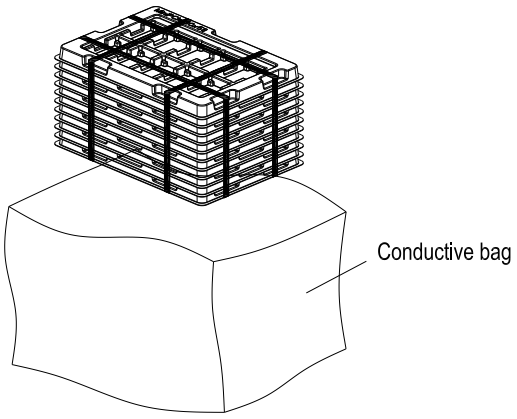


Figure 18: Blister Tray Dimension Drawing

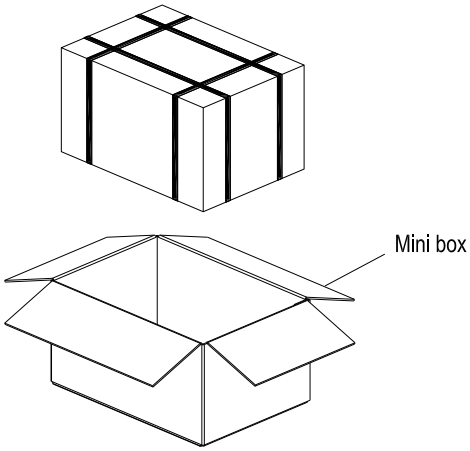
7.3.2. Packaging Process



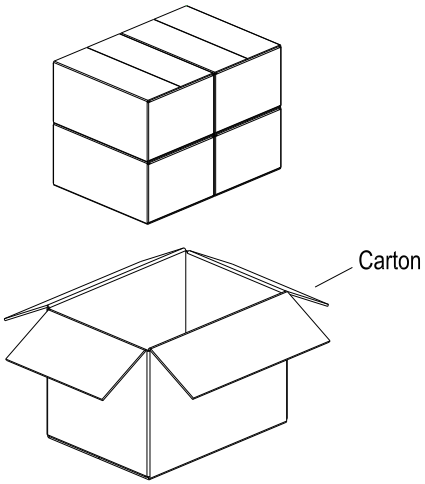
Pack 10 modules in each blister tray. Stack 10 blister trays with modules together, and put 1 empty blister tray on the top.



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



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



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

Figure 19: Packaging Process

8 Appendix References

Table 31: Related Documents

Document Name
[1] Quectel_BG95&BG77&BG600L_Series_GNSS_Application_Note
[2] Quectel_Mini_PCIe_EVB_User_Guide
[3] Quectel_BG95&BG77&BG600L_Series_QCFG_AT_Commands_Manual
[4] Quectel_BG95&BG77&BG600L_Series_AT_Commands_Manual

Table 32: Terms and Abbreviations

Abbreviation	Description
bps	Bits Per Second
CHAP	Challenge Handshake Authentication Protocol
CS	Coding Scheme
CTS	Clear to Send
DFOTA	Delta Firmware upgrade Over-The-Air
DL	Downlink
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
EDGE	Enhanced Data Rates for GSM Evolution
EGPRS	Enhanced General Packet Radio Service
EMI	Electromagnetic Interference

ESD	Electrostatic Discharge
ESR	Equivalent Series Resistance
FDD	Frequency Division Duplexing
GLONASS	GLobalnaya Navigazionnaya Sputnikovaya Sistema, the Russian Global Navigation Satellite System
GMSK	Gaussian Minimum Shift Keying
GNSS	Global Navigation Satellite System
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System for Mobile Communications
kbps	kilobits per second
LED	Light Emitting Diode
LTE	Long Term Evolution
Mbps	Million Bits Per Second
MCS	Modulation and Coding Scheme
MCU	Micro Control Unit
ME	Mobile Equipment
NMEA	National Marine Electronics Association
PAP	Password Authentication Protocol
PCI	Peripheral Component Interconnect
PCIe	Peripheral Component Interconnect Express
PCM	Pulse Code Modulation
PDA	Personal Digital Assistant
PDU	Protocol Data Unit
POS	Point of Sale
PPP	Point-to-Point Protocol

RF	Radio Frequency
RTS	Ready To Send
RX	Receive Direction
SMS	Short Message Service
TX	Transmitting Direction
TVS	Transient Voltage Suppressor
UART	Universal Asynchronous Receiver & Transmitter
UL	Uplink
URC	Unsolicited Result Code
USB	Universal Serial Bus
(U)SIM	(Universal) Subscriber Identification Module