BG95 Series
Hardware Design

LPWA Module Series

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Safety Information

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

Full attention must be paid to driving at all times in order to reduce the risk of an accident. Using a mobile while driving (even with a handsfree kit) causes distraction and can lead to an accident. Please comply with laws and regulations restricting the use of wireless devices while driving.

Switch off the cellular terminal or mobile before boarding an aircraft. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. If there is an Airplane Mode, it should be enabled prior to boarding an aircraft. Please consult the airline staff for more restrictions on the use of wireless devices on an aircraft.

Wireless devices may cause interference on sensitive medical equipment, so please be aware of the restrictions on the use of wireless devices when in hospitals, clinics or other healthcare facilities.

Cellular terminals or mobiles operating over radio signal and cellular network cannot be guaranteed to connect in certain conditions, such as when the mobile bill is unpaid or the (U)SIM card is invalid. When emergency help is needed in such conditions, use emergency call if the device supports it. In order to make or receive a call, the cellular terminal or mobile must be switched on in a service area with adequate cellular signal strength. In an emergency, the device with emergency call function cannot be used as the only contact method considering network connection cannot be guaranteed under all circumstances.

The cellular terminal or mobile contains a transceiver. When it is ON, it receives and transmits radio frequency signals. RF interference can occur if it is used close to TV sets, radios, computers or other electric equipment.

In locations with explosive or potentially explosive atmospheres, obey all posted signs and turn off wireless devices such as mobile phone or other cellular terminals. Areas with explosive or potentially explosive atmospheres include fuelling areas, below decks on boats, fuel or chemical transfer or storage facilities, and areas where the air contains chemicals or particles such as grain, dust or metal powders.

About the Document

Revision History

Version	Date	Author	Description
1.0	2019-09-30	Lex LI/ Garey XIE	Initial
1.1	2020-02-28	Lex LI/ Garey XIE	1. Updated the GNSS function into an optional feature. 2. Updated the LTE Power Class 5 to 21 dBm. 3. Added the parameters (power supply, operating frequency, output power, etc.) of BG95-M4 and BG95-M5. 4. Updated the transmitting power parameters in Table 3 and Table 40. 5. Updated the pin name of pin 21 from NETLIGHT into NET_STATUS. 6. Updated the block diagram in Figure 1. 7. Updated the power-on timing in Figure 8. 8. Updated the reference design of USB interface in Figure 16. 9. Updated the name of UART interface pins. 10. Added a recommended GNSS UART reference design (Dual-Transistor Solution) in Figure 19. 11. Added the timing of turning on the module with USB_BOOT in Figure 24. 12. Added the truth table of GRFC interfaces in Table 29. 13. Updated the GNSS performance in Table 30. 14. Updated the current consumption parameters in Chapter 6.4. 15. Updated the RF receiving sensitivity in Chapter 6.6.
1.2	2020-07-06	Lex LI/ Ellison WANG	1. Added BG95-M6. 2. Removed B14 for LTE Cat M1 and B26 for LTE Cat NB2. 3. Updated GNSS function into a standard

			configuration. 4. Added the power supply range of BG95-M4, and the typical power supply of BG95-MF. 5. Added the function diagram of BG95-M4, BG95-M5, BG95-M6 and BG95-MF in Chapter 2.3. 6. Enabled pin 56 (ANT_WIFI) for BG95-MF. 7. Updated the GNSS performance in Table 30. 8. Added the current consumption values of BG95-M1, BG95-M2, BG95-M5 and BG95-M6 in Chapter 6.4. 9. Updated the GNSS current consumption values in Chapter 6.4. 10. Added the RF output power values of BG95-M4, BG95-M5 and BG95-M6 in Chapter 6.5. 11. Updated the RF receiving sensitivity of BG95-M3 and added that of BG95-M5 in Chapter 6.6 12. Updated electrostatic discharge characteristics in Chapter 6.7. 13. Updated the description of storage conditions in Chapter 8.1. 14. Updated the recommended reflow soldering thermal profile parameters in Chapter 8.2.
1.3	2021-01-08	Lex LI/ Ben JIANG/ Matt YE	1. Deleted BG95-N1. 2. Added the supply voltage range of BG95-MF. 3. Updated the dimensional tolerance of the module in Table 3 and Chapter 7. 4. Enabled fast shutdown interface (realized through pin 25 GPIO1) and added the description thereof in Chapter 3.6.3. 5. Updated the reference design of PON_TRIG in Figure 19. 6. Updated the GNSS performance in Table 28. 7. Updated the current consumption values of BG95-M1, BG95-M2, BG95-M3, BG95-M5 and BG95-M6, and added that of BG95-M4 and BG95-MF in Chapter 6.4. 8. Added the RF receiving sensitivity of BG95-M4, BG95-M6 and BG95-MF in Chapter 6.6.

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1 Introduction

This document defines BG95 series module and describes its air interface and hardware interfaces which connect to your applications.

This document helps you quickly understand the interface specifications, electrical and mechanical details, as well as other related information of BG95 series. To facilitate application designs, it also includes some reference designs. The document, coupled with application notes and user guides, makes it easy to design and set up mobile applications with the module.

2 Product Concept

2.1. General Description

BG95 is a series of embedded IoT (LTE Cat M1, LTE Cat NB2 and EGPRS) wireless communication modules. It provides data connectivity on LTE-FDD and GPRS/EGPRS networks, and supports half-duplex operation in LTE network. It also provides GNSS and voice* 1) functionality to meet your specific application demands.

The module is 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 [3]***.

Table 1: Version Selection for BG95 Series Modules

Model	Cat M1	Cat NB2 2)	GSM	Wi-Fi Positioning	GNSS
BG95-M1	●	-	-	-	●
BG95-M2	●	●	-	-	●
BG95-M3	●	●	●	-	●
BG95-M4	●	●	-	-	●
BG95-M5	●	●	●	-	●
BG95-M6	●	●	-	-	●
BG95-MF	●	●	-	●	●

Table 2: Frequency Bands and GNSS Types of BG95 Series Modules

Module	Supported Bands	LTE Bands Power Class	GNSS
BG95-M1	**Cat M1 Only:** LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/ B18/B19/B20/B25/B26/B27/B28/ B66/B85	Power Class 5 (21 dBm)	GPS, GLONASS, BeiDou, Galileo, QZSS.
BG95-M2	**Cat M1:** LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/ B18/B19/B20/B25/B26/B27/B28/ B66/B85 **Cat NB2:** LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/ B18/B19/B20/B25/B28/B66/B71/ B85	Power Class 5 (21 dBm)	GPS, GLONASS, BeiDou, Galileo, QZSS.
BG95-M3	**Cat M1:** LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/ B18/B19/B20/B25/B26/B27/ B28/B66/B85 **Cat NB2:** LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/ B18/B19/B20/B25/B28/B66/B71/ B85 **EGPRS:** 850/900/1800/1900 MHz	Power Class 5 (21 dBm)	GPS, GLONASS, BeiDou, Galileo, QZSS.
BG95-M4	**Cat M1:** LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/ B18/B19/B20/B25/B26/B27/B28/ B31/B66/B72/B73/B85 **Cat NB2:** LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/ B18/B19/B20/B25/B28/B31/B66/ B72/B73/B85	Power Class 2* (26 dBm) @ B31/B72/B73 Power Class 3 (23 dBm) @ B31/B72/B73 Power Class 5 (21 dBm) @ other LTE bands	GPS, GLONASS, BeiDou, Galileo, QZSS.
BG95-M5	**Cat M1:** LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/	Power Class 3 (23 dBm)	GPS, GLONASS, BeiDou,

	B18/B19/B20/B25/B26/B27/B28/ B66/B85 **Cat NB2:** LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/ B18/B19/B20/B25/B28/B66/B71/ B85 **EGPRS:** 850/900/1800/1900 MHz		Galileo, QZSS.
BG95-M6	**Cat M1:** LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/ B18/B19/B20/B25/B26/B27/B28/ B66/B85 **Cat NB2:** LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/ B18/B19/B20/B25/B28/B66/B71/ B85	Power Class 3 (23 dBm)	GPS, GLONASS, BeiDou, Galileo, QZSS.
BG95-MF	**Cat M1:** LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/ B18/B19/B20/B25/B26/B27/ B28/B66/B85 **Cat NB2:** LTE-FDD: B1/B2/B3/B4/B5/B8/B12/B13/ B18/B19/B20/B25/B28/B66/B71/ B85 **Wi-Fi (For Positioning Only):** 2.4 GHz	Power Class 5 (21 dBm)	GPS, GLONASS, BeiDou, Galileo, QZSS.

NOTES

1. [1)] BG95 series modules support VoLTE (Voice over LTE) under LTE Cat M1. Additionally, BG95-M3 and BG95-M5 support CS voice under GSM.
2. [2)] LTE Cat NB2 is backward compatible with LTE Cat NB1.
3. "●" means supported.
4. "*" means under development.

With a compact profile of 23.6 mm × 19.9 mm × 2.2 mm, the module can meet almost all requirements for M2M applications such as smart metering, tracking system, security and wireless POS.

BG95 is a series of SMD type modules that can be embedded into applications through the 102 LGA pins. It supports internet service protocols like TCP, UDP and PPP. Based on extended AT commands developed by Quectel, you can use these internet service protocols easily.

2.2. Key Features

The following table describes the detailed features of BG95 series.

Table 3: Key Features of BG95 Series Modules

Features	Details
Power Supply	**BG95-M1/-M2:** ● Supply voltage [1)]: 2.6–4.8 V ● Typical supply voltage: 3.3 V **BG95-M3/-M5/-M6/-MF:** ● Supply voltage: 3.3–4.3 V ● Typical supply voltage: 3.8 V **BG95-M4:** ● Supply voltage: 3.2–4.2 V ● Typical supply voltage: 3.8 V
Transmitting Power	**LTE-FDD bands:** ● Class 5 (21 dBm +1.7/-3 dB) ● Class 3 (23 dBm ±2 dB) ● Class 2* (26 dBm ±2 dB) **GSM 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 See ***Table 2*** for the LTE bands power class level of each specific model.
LTE Features	● Support 3GPP Rel-14 ● Support LTE Cat M1 and LTE Cat NB2 ● Support 1.4 MHz RF bandwidth for LTE Cat M1 ● Support 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:** ● Support GPRS multi-slot class 33 (33 by default) ● Coding scheme: CS-1, CS-2, CS-3 and CS-4 ● Max. 107 kbps (DL), Max. 85.6 kbps (UL) **EDGE:** ● Support EDGE multi-slot class 33 (33 by default) ● Support 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), Max. 236.8 kbps (UL)
Internet Protocol Features	● Support PPP/TCP/UDP/SSL/TLS/FTP(S)/HTTP(S)/NITZ/PING/MQTT/ LwM2M/CoAP/IPv6 protocols ● Support PAP and CHAP for PPP connections
SMS	● Text and PDU mode ● Point to point MO and MT ● SMS cell broadcast ● SMS storage: ME by default
(U)SIM Interface	Support 1.8 V USIM/SIM card only
PCM Interface	Support one digital audio interface: PCM interface for VoLTE or GSM CS voice only
USB Interface	● Compliant with USB 2.0 specification (slave only) ● Support operations at full-speed and low-speed ● Used for AT command communication, data transmission, GNSS NMEA sentences output, software debugging and firmware upgrade ● Support USB serial drivers for Windows 7/8/8.1/10, Linux 2.6–5.10, Android 4.x–10.x
UART Interfaces	**Main UART:** ● Used for data transmission and AT command communication ● 115200 bps baud rate by default ● The default frame format is 8N1 (8 data bits, no parity, 1 stop bit) ● Support RTS and CTS hardware flow control **Debug UART:** ● Used for software debugging and log output ● Support 115200 bps baud rate **GNSS UART:** ● Used for GNSS data and NMEA sentences output ● 115200 bps baud rate by default
GNSS	● Gen9 VT (GPS, GLONASS, BeiDou, Galileo and QZSS) ● 1 Hz data update rate by default
AT Commands	● 3GPP TS 27.007 and 3GPP TS 27.005 AT commands ● Quectel enhanced AT commands

Network Indication	One NET_STATUS pin for network connectivity status indication
Antenna Interfaces	● Main antenna interface (ANT_MAIN) ● GNSS antenna interface (ANT_GNSS) ● Wi-Fi antenna interface (ANT_WIFI, for BG95-MF only)
Physical Characteristics	● Dimensions: (23.6 ±0.2) mm × (19.9 ±0.2) mm × (2.2 ±0.2) mm ● Weight: approx. 2.15 g
Temperature Range	● Operating temperature range: -35 to +75 °C [2)] ● Extended temperature range: -40 to +85 °C [3)] ● Storage temperature range: -40 to +90 °C
Firmware Upgrade	USB interface, DFOTA
RoHS	All hardware components are fully compliant with EU RoHS directive

NOTES

1. [1)] For every VBAT transition/re-insertion from 0 V, the minimum power supply voltage should be higher than 2.7 V. After the module starts up normally, the minimum safety voltage is 2.6 V. In order to ensure full-function mode, the minimum power supply voltage should be higher than 2.8 V.
2. [2)] Within the operating temperature range, the module meets 3GPP specifications.
3. [3)] Within the extended temperature range, the module remains the ability to establish and maintain functions such as voice, SMS and data transmission, without any unrecoverable malfunction. Radio spectrum and radio network are not influenced, while one or more specifications, such as P_{out}, may exceed the specified tolerances of 3GPP. When the temperature returns to the operating temperature range, the module meets 3GPP specifications again.
4. "*" means under development.

2.3. Functional Diagram

The following figures show the block diagram of BG95 series and the major functional parts as listed below.

- Power management
- Baseband
- Radio frequency
- Peripheral interfaces

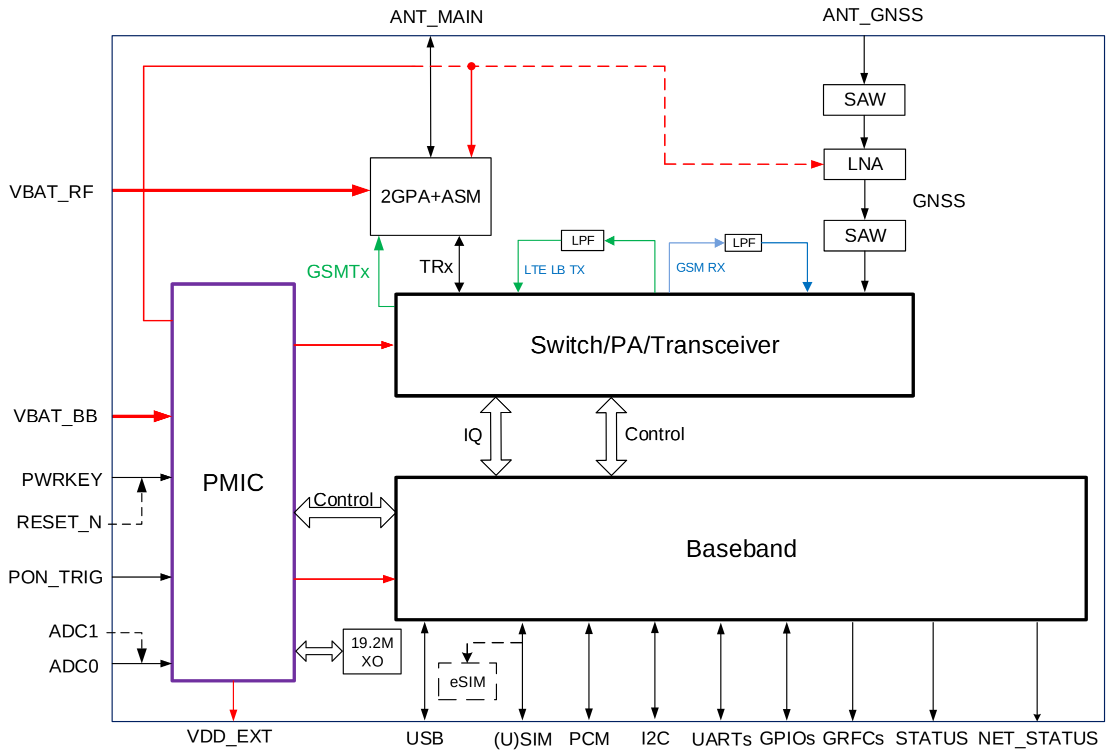


Figure 1: Functional Diagram of BG95-M3

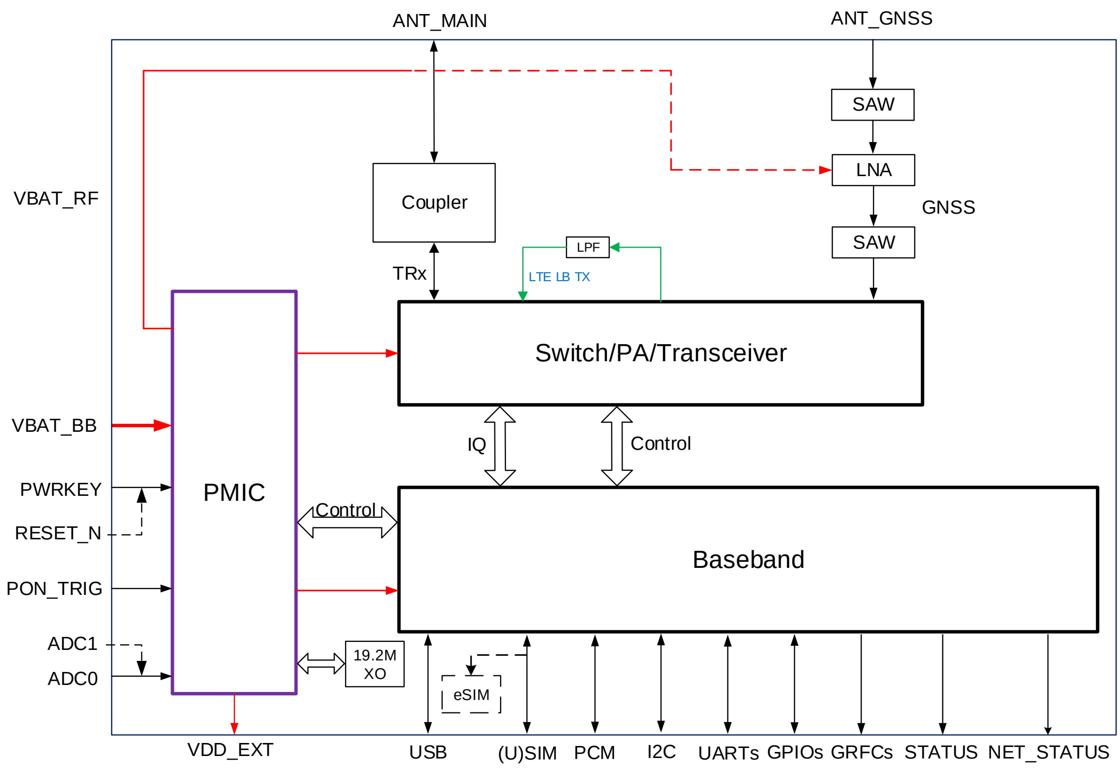


Figure 2: Functional Diagram of BG95-M1/-M2

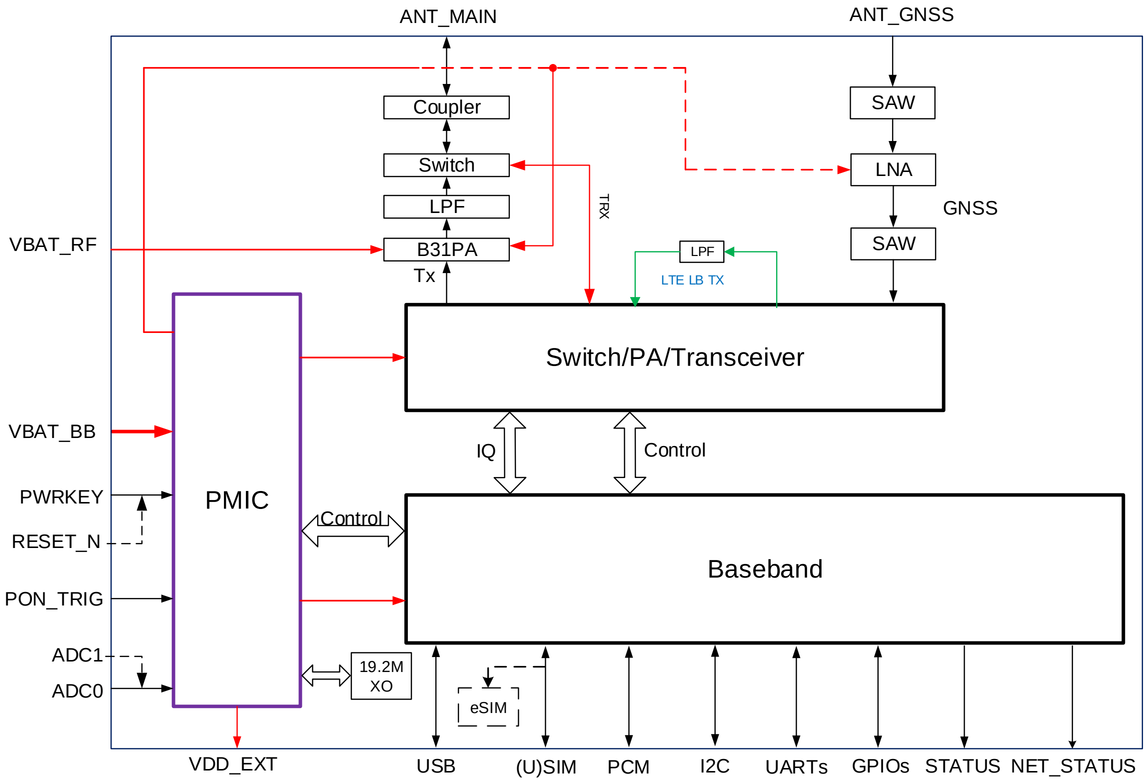


Figure 3: Functional Diagram of BG95-M4

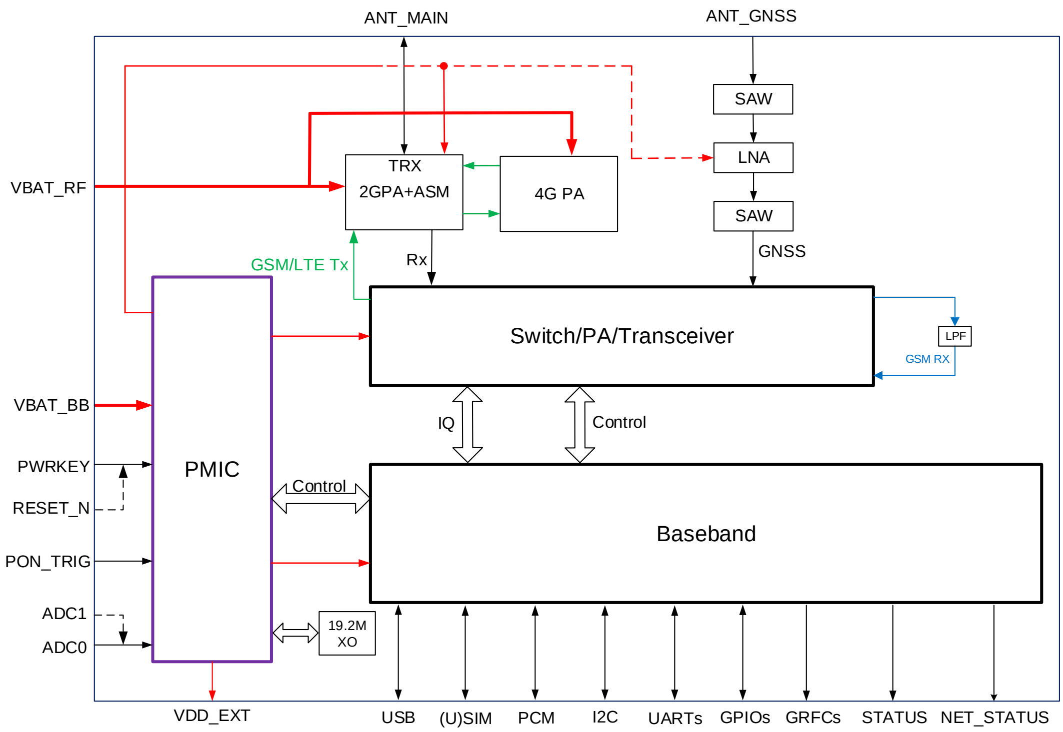


Figure 4: Functional Diagram of BG95-M5

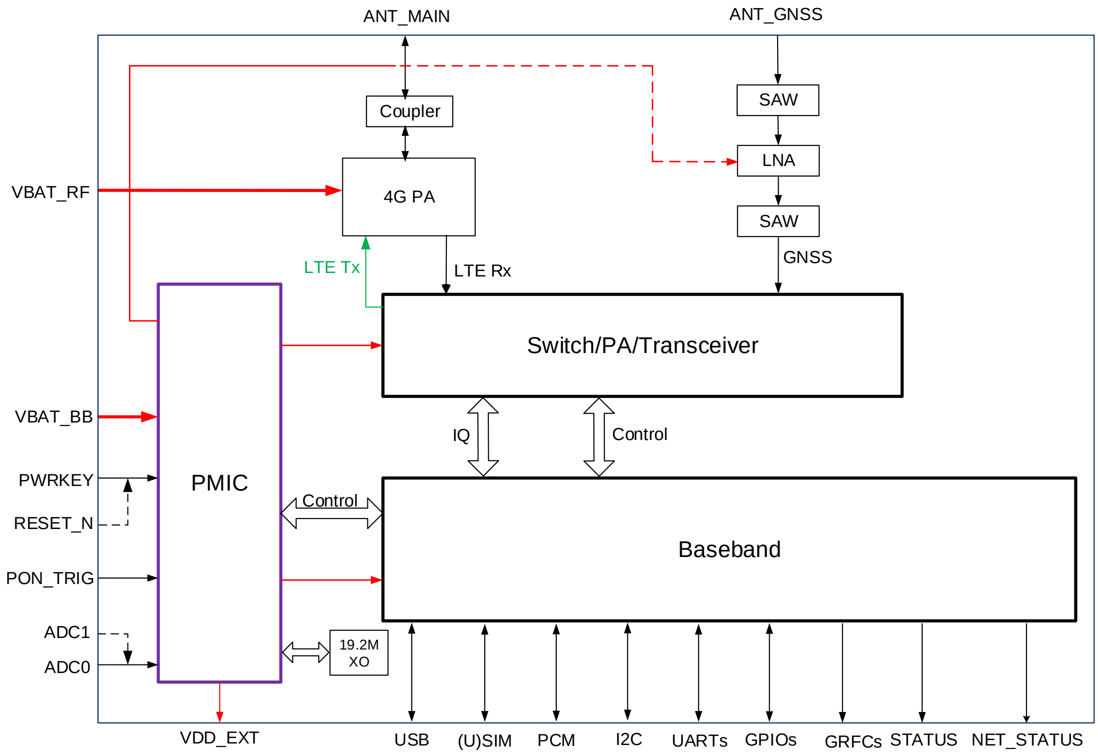


Figure 5: Functional Diagram of BG95-M6

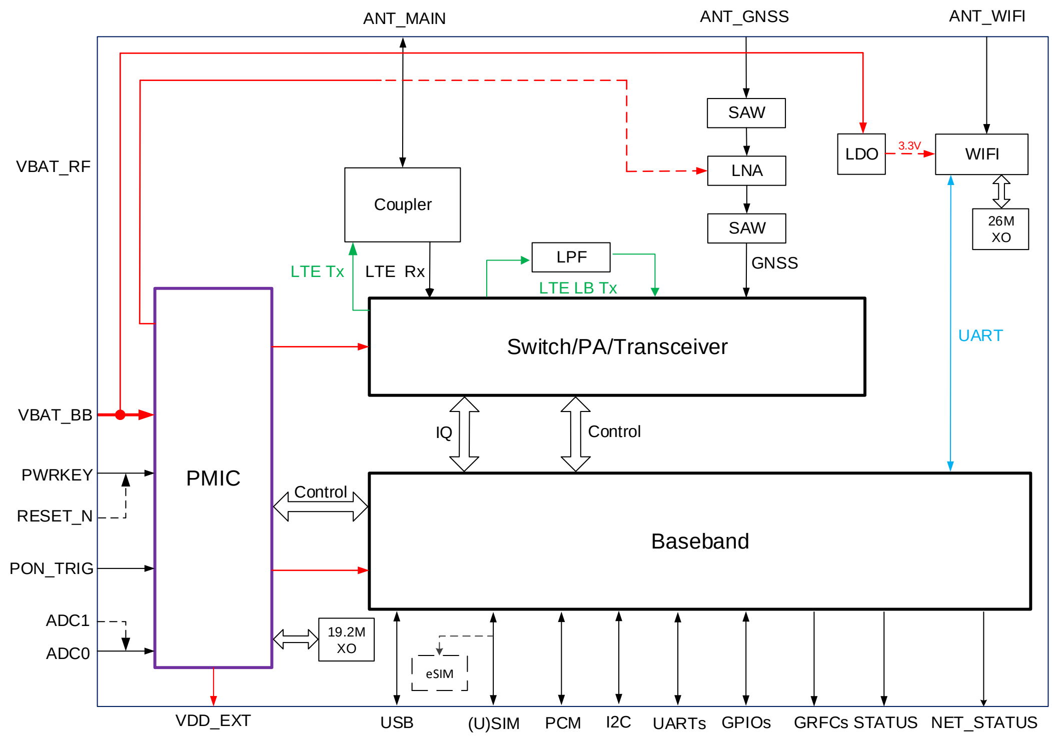


Figure 6: Functional Diagram of BG95-MF

NOTES

1. eSIM function is optional. If eSIM is selected, then any external (U)SIM card cannot be used. BG95-M5 and BG95-M6 do not support eSIM.
2. The output voltage of PWRKEY is 1.5 V because of the voltage drop inside the chipset. Due to platform limitations, the chipset has integrated the reset function into PWRKEY. Therefore, never pull down PWRKEY to GND permanently.
3. RESET_N connects directly to PWRKEY inside the module.
4. Do not use ADC0 and ADC1 simultaneously, as ADC1 connects directly to ADC0 inside the module. BG95 series supports the use of only one ADC interface at a time: either ADC0 or ADC1.

2.4. Evaluation Board

In order to facilitate application development with BG95 conveniently, Quectel supplies the evaluation board (EVB), USB to RS-232 converter cable, USB data cable, earphone, antenna and other peripherals to control or test the module. For more details, see ***document [1]***.

3 Application Interfaces

BG95 series is equipped with 102 LGA pads for connection to various cellular application platforms. The subsequent chapters provide detailed description of interfaces listed below:

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

NOTE

"*" means under development.

3.1. Pin Assignment

The following figure shows the pin assignment of BG95 series.

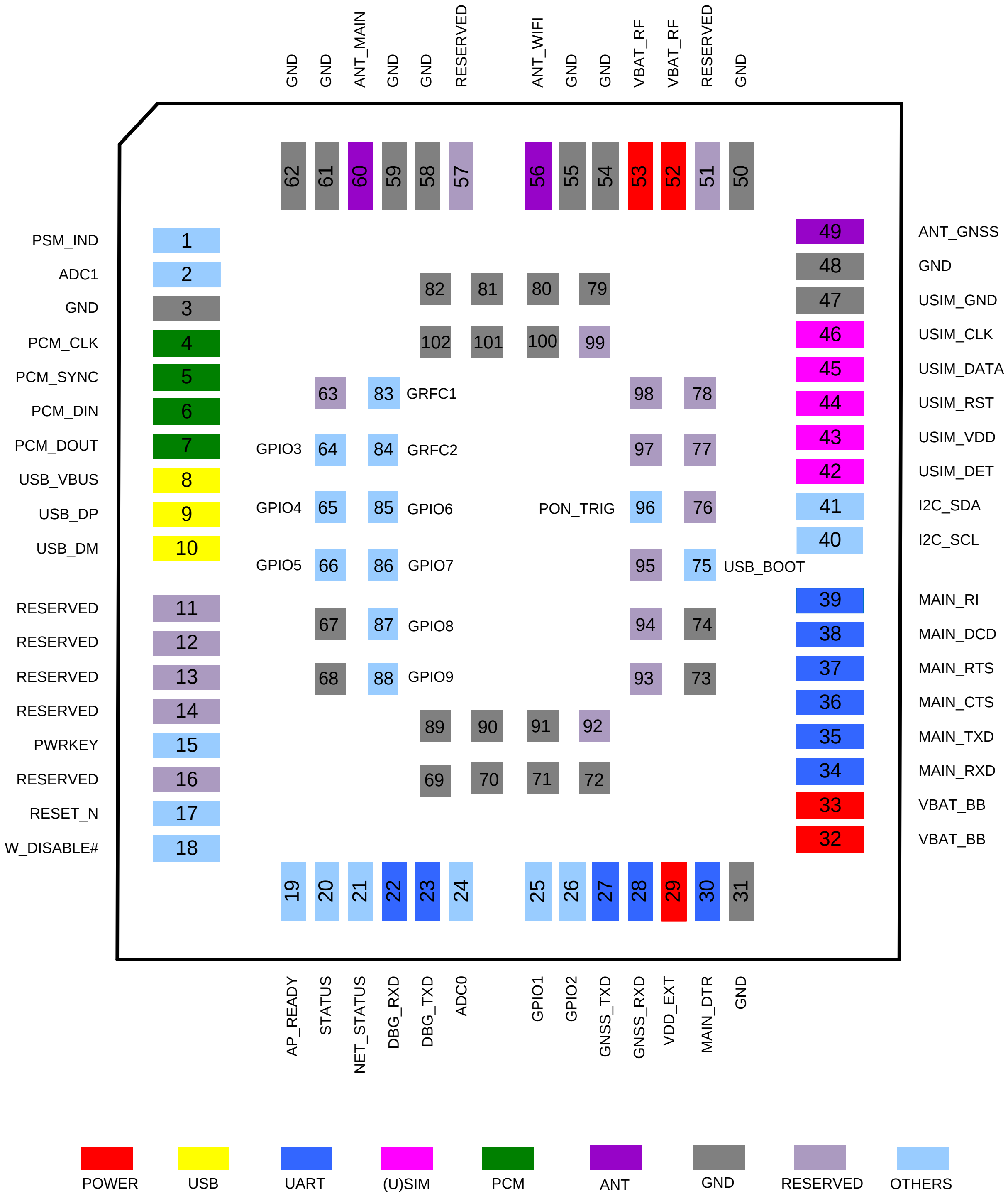


Figure 7: Pin Assignment (Top View)

NOTES

1. Only BG95-MF supports ANT_WIFI (pin 56).
2. BG95-MF does not support GPIO3 and GPIO4 interfaces (pin 64 and pin 65).
3. BG95-M4 does not support GRFC interfaces (pin 83 and pin 84).
4. Do not use ADC0 and ADC1 simultaneously, as ADC1 connects directly to ADC0 inside the module. BG95 series supports the use of only one ADC interface at a time: either ADC0 or ADC1.
5. The output voltage of PWRKEY is 1.5 V because of the voltage drop inside the chipset. Due to platform limitations, the chipset has integrated the reset function into PWRKEY. Therefore, never pull down PWRKEY to GND permanently.
6. RESET_N connects directly to PWRKEY inside the module.
7. GNSS_TXD (pin 27) and GRFC2 (pin 84) are BOOT_CONFIG pins. Never pull them up before startup, otherwise the module cannot power on normally.
8. GPIO1 (pin 25) supports fast shutdown function. This function is disabled by default. See ***Chapter 3.6.3*** for more details.
9. PCM and I2C interfaces are used for VoLTE or GSM CS voice only.
10. Keep all RESERVED pins and unused pins unconnected.
11. Connect GND pins to the ground in the design.

3.2. Pin Description

The following tables show the pin definition and description of BG95 series.

Table 4: Definition of I/O Parameters

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

Table 5: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VBAT_BB	32, 33	PI	Power supply for the module's baseband part	**BG95-M1/-M2:** Vmax = 4.8 V Vmin = 2.6 V Vnom = 3.3 V **BG95-M3/-M5/-M6/-MF** Vmax = 4.3 V Vmin = 3.3 V Vnom = 3.8 V **BG95-M4:** Vmax = 4.2 V Vmin = 3.2 V Vnom = 3.8 V	See NOTE 4
VBAT_RF	52, 53	PI	Power supply for the module's RF part	**BG95-M1/-M2:** Vmax = 4.8 V Vmin = 2.6 V Vnom = 3.3 V **BG95-M3/-M5/-M6/-MF** Vmax = 4.3 V Vmin = 3.3 V Vnom = 3.8 V **BG95-M4:** Vmax = 4.2 V Vmin = 3.2 V Vnom = 3.8 V	See NOTE 4
VDD_EXT	29	PO	Provides 1.8 V for external circuits	Vnom = 1.8 V $I_O$max = 50 mA	If unused, keep this pin open.
GND	3, 31, 48, 50, 54, 55, 58, 59, 61, 62, 67–74, 79–82, 89–91, 100–102				
Turn on/off					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PWRKEY	15	DI	Turn on/off the module	Vnom = 1.5 V V_{IL}max = 0.45 V	Never pull down PWRKEY to GND

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
					permanently.
Reset					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESET_N	17	DI	Reset the module	Vnom = 1.5 V V_{IL}max = 0.45 V	Multiplexed from PWRKEY (connects directly to PWRKEY inside the module).
Status Indication					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PSM_IND	1	DO	Indicate the module's power saving mode	V_{OH}min = 1.35 V V_{OL}max = 0.45 V	1.8 V power domain. If unused, keep this pin open.
STATUS	20	DO	Indicate the module's operation status	V_{OH}min = 1.35 V V_{OL}max = 0.45 V	1.8 V power domain. If unused, keep this pin open.
NET_STATUS	21	DO	Indicate the module's network activity status	V_{OH}min = 1.35 V V_{OL}max = 0.45 V	1.8 V power domain. If unused, keep this pin open.
USB Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
USB_VBUS	8	AI	USB connection detect	Vnom = 5.0 V	Typical 5.0 V
USB_DP	9	AIO	USB differential data (+)		Compliant with USB 2.0 standard specification. Require differential impedance of 90 Ω.
USB_DM	10	AIO	USB differential data (-)		
(U)SIM Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
USIM_DET	42	DI	(U)SIM card hot-plug detect	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep this pin open.
USIM_VDD	43	PO	(U)SIM card power supply	Vmax = 1.9 V Vmin = 1.7 V	Only 1.8 V (U)SIM card is supported.

USIM_RST	44	DO	(U)SIM card reset	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
USIM_DATA	45	DIO	(U)SIM card data	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
USIM_CLK	46	DO	(U)SIM card clock	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	
USIM_GND	47		Specified ground for (U)SIM card		
Main UART Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
MAIN_DTR	30	DI	Main UART data terminal ready	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep this pin open.
MAIN_RXD	34	DI	Main UART receive	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep this pin open.
MAIN_TXD	35	DO	Main UART transmit	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep this pin open.
MAIN_CTS	36	DO	Main UART clear to send	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep this pin open.
MAIN_RTS	37	DI	Main UART request to send	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep this pin open.
MAIN_DCD	38	DO	Main UART data carrier detect	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep this pin open.
MAIN_RI	39	DO	Main UART ring indication	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep this pin open.
Debug UART Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**

DBG_RXD	22	DI	Debug UART receive	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep this pin open.
DBG_TXD	23	DO	Debug UART transmit	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep this pin open.
GNSS UART Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
GNSS_TXD	27	DO	GNSS UART transmit	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	BOOT_CONFIG. Do not pull it up before startup. 1.8 V power domain. If unused, keep this pin open.
GNSS_RXD	28	DI	GNSS UART receive	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep this pin open.
PCM Interface*					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PCM_CLK	4	DO	PCM clock	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep this pin open.
PCM_SYNC	5	DO	PCM data frame sync	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep this pin open.
PCM_DIN	6	DI	PCM data input	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep this pin open.
PCM_DOUT	7	DO	PCM data output	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep this pin open.
I2C Interface*					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
I2C_SCL	40	OD	I2C serial clock (for external codec)		External pull-up resistor is required. 1.8 V only.

					If unused, keep this pin open.
I2C_SDA	41	OD	I2C serial data (for external codec)		External pull-up resistor is required. 1.8 V only. If unused, keep this pin open.
Antenna Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ANT_MAIN	60	AIO	Main antenna interface		50 Ω impedance
ANT_GNSS	49	AI	GNSS antenna interface		50 Ω impedance. If unused, keep this pin open.
ANT_WIFI* [1)]	56	AI	Wi-Fi antenna interface		50 Ω impedance. If unused, keep this pin open. Only BG95-MF supports the interface.
GPIO Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
GPIO1	25	DIO	General-purpose input/output	V_{OL}max = 0.45 V V_{OH}min = 1.35 V V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. GPIO by default, and can be multiplexed into fast shutdown interface (see ***Chapter 3.6.3*** for details). If unused, keep this pin open.
GPIO2	26	DIO	General-purpose input/output	V_{OL}max = 0.45 V V_{OH}min = 1.35 V V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep this pin open.
GPIO3 [2)]	64	DIO	General-purpose input/output	V_{OL}max = 0.45 V V_{OH}min = 1.35 V V_{IL}min = -0.3 V	1.8 V power domain. If unused, keep this pin open.

				V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	
GPIO4 [2)]	65	DIO	General-purpose input/output	V_{OL}max = 0.45 V V_{OH}min = 1.35 V V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep this pin open.
GPIO5	66	DIO	General-purpose input/output	V_{OL}max = 0.45 V V_{OH}min = 1.35 V V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep this pin open.
GPIO6	85	DIO	General-purpose input/output	V_{OL}max = 0.45 V V_{OH}min = 1.35 V V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep this pin open.
GPIO7	86	DIO	General-purpose input/output	V_{OL}max = 0.45 V V_{OH}min = 1.35 V V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep this pin open.
GPIO8	87	DIO	General-purpose input/output	V_{OL}max = 0.45 V V_{OH}min = 1.35 V V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep this pin open.
GPIO9	88	DIO	General-purpose input/output	V_{OL}max = 0.45 V V_{OH}min = 1.35 V V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep this pin open.
ADC Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**

ADC0	24	AI	General-purpose ADC interface	Voltage range: 0.1–1.8 V	Do not use ADC0 and ADC1 simultaneously. If unused, keep these pins open.
ADC1	2	AI	General-purpose ADC interface	Voltage range: 0.1–1.8 V	
Other Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
W_DISABLE#	18	DI	Airplane mode control	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. Pulled up by default. When it is in low voltage level, the module can enter airplane mode. If unused, keep this pin open.
AP_READY	19	DI	Application processor sleep state detect	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep this pin open.
USB_BOOT	75	DI	Force the module into emergency download mode	V_{IL}min = -0.3 V V_{IL}max = 0.6 V V_{IH}min = 1.2 V V_{IH}max = 2.0 V	1.8 V power domain. If unused, keep this pin open.
PON_TRIG	96	DI	Wake up the module from PSM		1.8 V power domain. Rising-edge triggered. Pulled-down by default. If unused, keep this pin open.
GRFC Interfaces					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
GRFC1 [3)]	83	DO	Generic RF controller	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	1.8 V power domain. If unused, keep this pin open.
GRFC2 [3)]	84	DO	Generic RF controller	V_{OL}max = 0.45 V V_{OH}min = 1.35 V	BOOT_CONFIG. Do not pull it up before startup. 1.8 V power domain. If unused, keep this pin open.

RESERVED Pins					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESERVED	11–14, 16, 51, 57, 63, 76–78, 92–95, 97–99				Keep these pins open.

NOTES

1. [1] Only BG95-MF supports ANT_WIFI (pin 56).
2. [2] BG95-MF does not support GPIO3 and GPIO4 interfaces (pin 64 and pin 65).
3. [3] BG95-M4 does not support GRFC interfaces (pin 83 and pin 84).
4. For every VBAT transition/re-insertion from 0 V, the minimum power supply voltage should be higher than 2.7 V. After the module starts up normally, the minimum safety voltage is 2.6 V. In order to ensure full-function mode, the minimum power supply voltage should be higher than 2.8 V.
5. PWRKEY output voltage is 1.5 V because of the voltage drop inside the chipset. Due to platform limitations, the chipset has integrated the reset function into PWRKEY. Therefore, never pull down PWRKEY to GND permanently.
6. RESET_N connects directly to PWRKEY inside the module.
7. Do not use ADC0 and ADC1 simultaneously, as ADC1 connects directly to ADC0 inside the module. BG95 series supports use of only one ADC interface at a time: either ADC0 or ADC1.
8. When PSM is enabled, the function of PSM_IND pin will be activated after the module is rebooted. When PSM_IND is in high voltage level, the module is in normal operation state. When it is in low voltage level, the module is in PSM.
9. GNSS_TXD (pin 27) and GRFC2 (pin 84) are BOOT_CONFIG pins. Never pull them up before startup, otherwise the module cannot power on normally.
10. GPIO1 (pin 25) supports fast shutdown function. This function is disabled by default. See ***Chapter 3.6.3*** for more details.
11. PCM and I2C interfaces are used for VoLTE or GSM CS voice only.
12. Keep all RESERVED pins and unused pins open.
13. “*” means under development.

3.3. Operating Modes

Table 6: Overview of BG95 Series Operating Modes

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

	receive data. In this mode, the software is active.
Extended Idle Mode DRX (e-I-DRX)	The module and the network may negotiate over non-access stratum signaling the use of e-I-DRX for reducing power consumption, while being available for mobile terminating data and/or network originated procedures within a certain delay dependent on the DRX cycle value.
Airplane Mode	**AT+CFUN=4** or W_DISABLE# pin can set the module into airplane mode where the RF function is invalid.
Minimum Functionality Mode	**AT+CFUN=0** can set the module into a minimum functionality mode without removing the power supply. In this mode, both RF function and (U)SIM card are invalid.
Sleep Mode	The module remains the ability to receive paging message, SMS and TCP/UDP data from the network normally. In this mode, the current consumption is reduced to a low level.
Power OFF Mode	The module's power supply is shut down by its power management unit. In this mode, the software is inactive, the serial interfaces are inaccessible, while the operating voltage (connected to VBAT_RF and VBAT_BB) remains applied.
Power Saving Mode (PSM)	PSM is similar to power-off, but the module remains registered on the network and there is no need to re-attach or re-establish PDN connections. The current consumption is reduced to a minimized level.

NOTE

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

3.4. Power Saving

3.4.1. Airplane Mode

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

Hardware:

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

Software:

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

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

- **AT+CFUN=4**: Airplane mode. RF function is disabled.

NOTES

1. Airplane mode control via W_DISABLE# is disabled in firmware by default. It can be enabled by **AT+QCFG="airplanecontrol"**. For details of the command, see ***document [6]***.
2. The execution of **AT+CFUN** will not affect GNSS function.

3.4.2. Power Saving Mode (PSM)

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

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

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

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

- Wake up the module from PSM through a rising edge on PON_TRIG. (Recommended)
- Wake up the module by driving PWRKEY low.
- When the T3412_Ext timer expires, the module wakes up from PSM automatically.

NOTE

See ***document [2]*** for details about **AT+CPSMS**.

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

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

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

In order to negotiate the use of e-I-DRX, the UE requests e-I-DRX parameters during attach procedure and RAU/TAU procedure. The EPC may reject or accept the UE request for enabling e-I-DRX. In case the EPC accepts e-I-DRX, the EPC based on operator policies and, if available, the e-I-DRX cycle length value in the subscription data from the HSS, may also provide different values of the e-I-DRX parameters than what 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.

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

NOTE

See ***document [2]*** for details about **AT+CEDRXS**.

3.4.4. Sleep Mode

The module is able to reduce its current consumption to a lower value during the sleep mode. The following sub-chapters describe the power saving procedure of the module.

3.4.4.1. UART Application

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

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

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

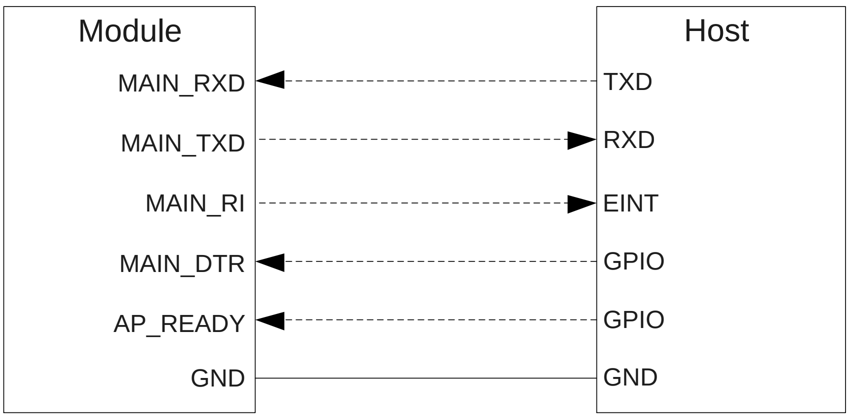


Figure 8: Sleep Mode Application via UART

- When the module has a URC to report, MAIN_RI will wake up the host. See ***Chapter 3.15*** for details about MAIN_RI behavior.
- Driving MAIN_DTR low will wake up the module.
- AP_READY detects the sleep state of the host (can be configured to high level or low level detection). See **AT+QCFG="apready"** in ***document [6]*** for details.

3.5. Power Supply

3.5.1. Power Supply Pins

BG95 series provides the following four VBAT pins for connection with an external power supply. There are two separate voltage domains for VBAT.

- Two VBAT_RF pins for module's RF part.
- Two VBAT_BB pins for module's baseband part.

Table 7: VBAT and GND Pins

Pin Name	Pin No.	Description	Module	Min.	Typ.	Max.	Unit
VBAT_RF	52, 53	Power supply for the module's RF part	BG95-M1/-M2/ 1)	2.6	3.3	4.8	V
			BG95-M3/-M5/-M6/-MF	3.3	3.8	4.3	V
			BG95-M4	3.2	3.8	4.2	V
VBAT_BB	32, 33	Power supply for the module's baseband part	BG95-M1/-M2/ 1)	2.6	3.3	4.8	V
			BG95-M3/-M5/-M6/-MF	3.3	3.8	4.3	V
			BG95-M4	3.2	3.8	4.2	V
GND	3, 31, 48, 50, 54, 55, 58, 59, 61, 62, 67–74, 79–82, 89–91, 100–102						

NOTE

1) For every VBAT transition/re-insertion from 0 V, the minimum power supply voltage should be higher than 2.7 V. After the module starts up normally, the minimum safety voltage is 2.6 V. In order to ensure full-function mode, the minimum power supply voltage should be higher than 2.8 V.

3.5.2. Decrease Voltage Drop

- **BG95-M1/-M2:** The power supply range of BG95-M1/-M2 is 2.6–4.8 V. For every VBAT transition/re-insertion from 0 V, the minimum power supply voltage should be higher than 2.7 V. After the module starts up normally, the minimum safety voltage is 2.6 V. To ensure full-function mode, the minimum power supply voltage should be higher than 2.8 V. Make sure that the input voltage never drop below 2.6 V.

- **BG95-M3/-M5/-M6/-MF:** The power supply range of BG95-M3/-M5/-M6/-MF is from 3.3–4.3 V. Ensure the input voltage never drop below 3.3 V.

- **BG95-M4:** The power supply range of BG95-M4 is from 3.2–4.2 V. Ensure the input voltage never drop below 3.2 V.

The following figure shows the voltage drop during burst transmission in 2G network of BG95-M3/-M5. The voltage drop is less in LTE Cat M1 and/or LTE Cat NB2 networks.

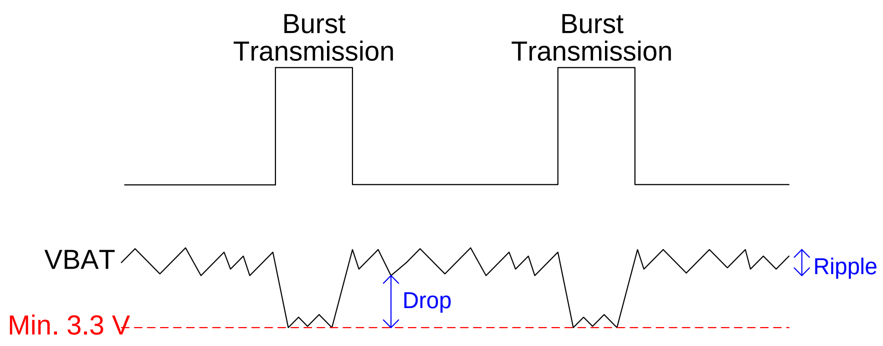


Figure 9: Power Supply Limits during Burst Transmission (BG95-M3/-M5)

To decrease voltage drop, a bypass capacitor of about 100 µF with low ESR should be used, and a multi-layer ceramic chip capacitor (MLCC) array should also be reserved due to its low ESR. It is recommended to use three ceramic capacitors (100 nF, 33 pF, 10 pF) for composing the MLCC array, and place these capacitors close to VBAT pins. The main power supply from an external application has to be a single voltage source and can be expanded to two sub paths with star structure. The width of VBAT_BB trace should be no less than 0.6 mm, and the width of VBAT_RF trace should be no less than 2 mm. In principle, the longer the VBAT trace is, the wider it will be.

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

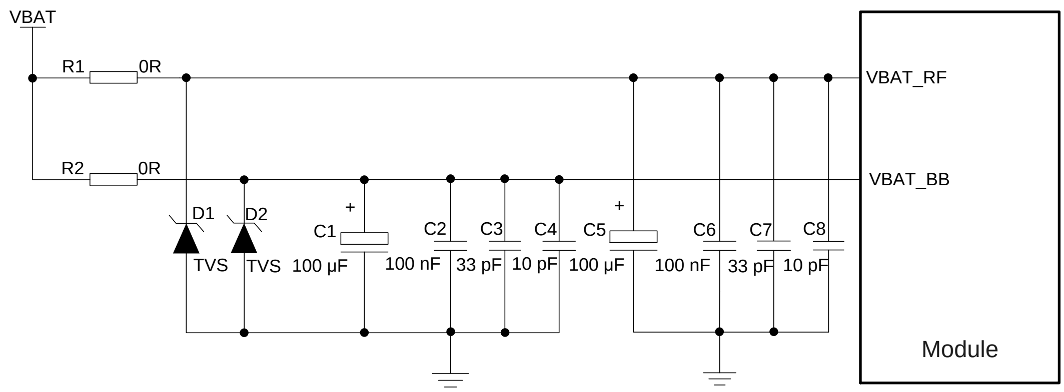


Figure 10: Star Structure of the Power Supply

If only LTE Cat M1 and/or Cat NB2 networks are intended to be used, it is recommended to select a DC-DC converter chip or LDO chip with ultra-low leakage current and current output no less than 1.0 A for the power supply design.

If LTE Cat M1, Cat NB2 and EGPRS networks are all intended to be used, the current output of DC-DC converter chip or LDO chip cannot be lower than 2.0 A and power supply chips with low leakage current should be selected because the module needs higher current when transmitting in GSM network. Only BG95-M3 and BG95-M5 support GSM network. For more details about the supported bands of each module model, see ***Table 1***.

3.5.3. Monitor the Power Supply

AT+CBC can be used to monitor the VBAT_BB voltage value. For more details, see ***document [2]***.

3.6. Turn on and off Scenarios

3.6.1. Turn on Module Using PWRKEY

Table 8: Pin Definition of PWRKEY

Pin Name	Pin No.	Description	DC Characteristics	Comment
PWRKEY	15	Turn on/off the module	Vnom = 1.5 V V_{IL}max = 0.45 V	The output voltage is 1.5 V because of the voltage drop inside the chipset.

When the module is in power-off mode, it can be turned on by driving PWRKEY low for 500–1000 ms. It is recommended to use an open drain/collector driver to control the PWRKEY. A simple reference circuit is illustrated in the following figure.

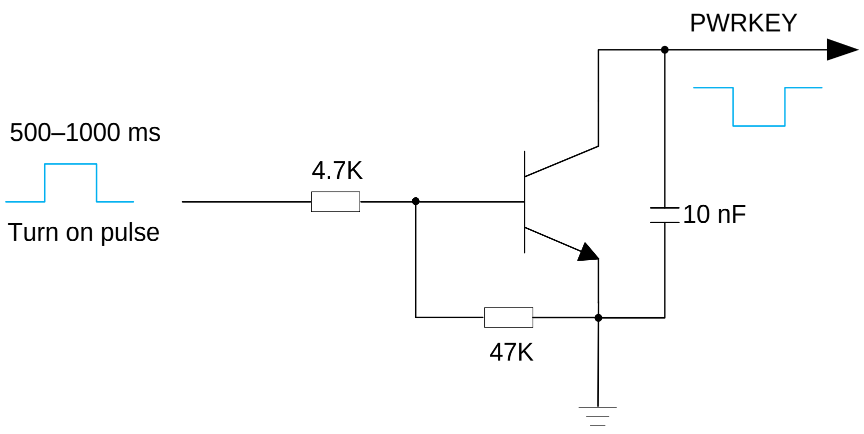


Figure 11: Turn on the Module with a Driving Circuit

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

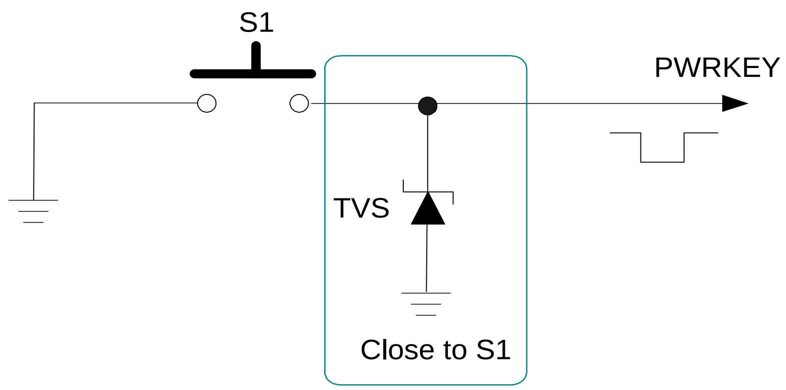


Figure 12: Turn on the Module with a Button

The power up scenario is illustrated in the following figure.

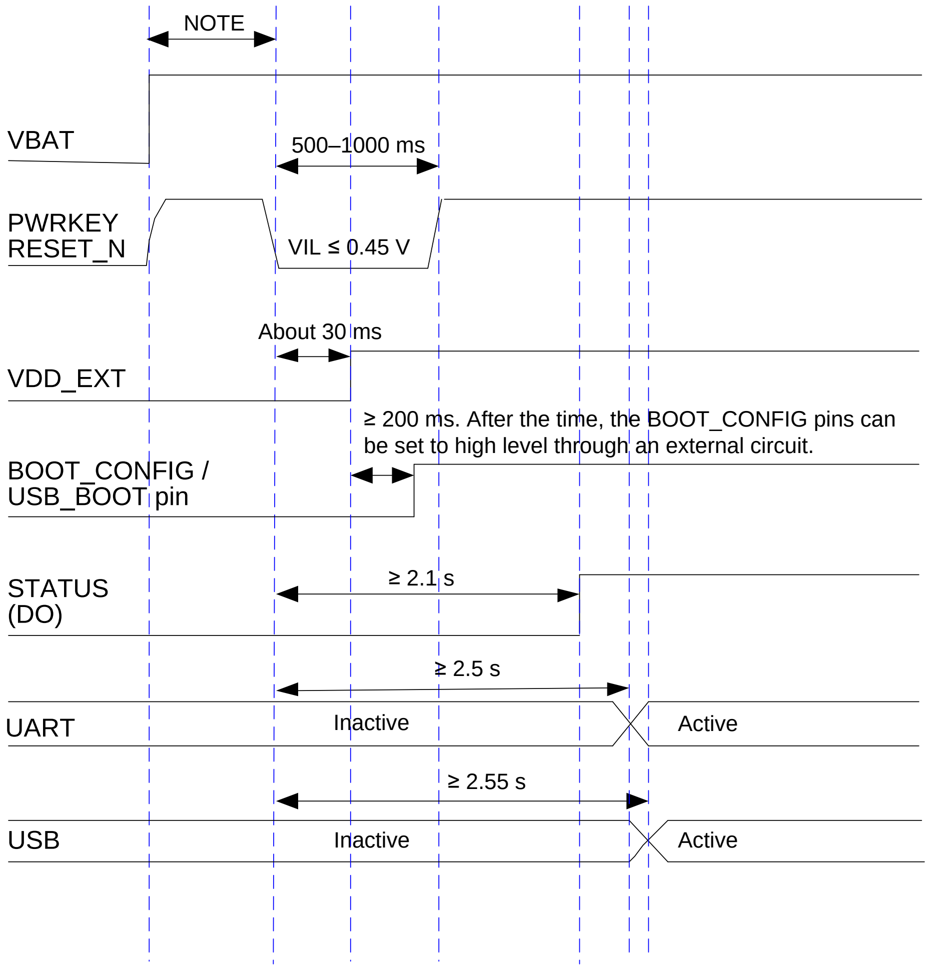


Figure 13: Power-up Timing

NOTES

1. Ensure that VBAT is stable before pulling down PWRKEY and keep the interval no less than 30 ms.
2. The output voltage of PWRKEY is 1.5 V because of the voltage drop inside the chipset. Due to platform limitations, the chipset has integrated the reset function into PWRKEY. Therefore, never pull down PWRKEY to GND permanently.

3.6.2. Turn off Module

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

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

3.6.2.1. Turn off Module Using PWRKEY

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

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

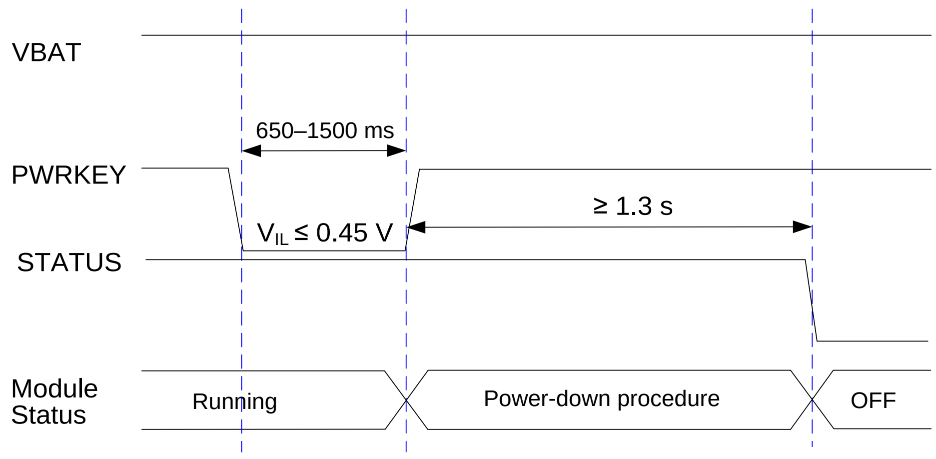


Figure 14: Power-down Timing

3.6.2.2. Turn off Module Using AT Command

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

See ***document [2]*** for details about **AT+QPOWD**.

3.6.3. Fast Shutdown

The module supports fast shutdown function through GPIO1 (pin 25). When the pin detects a falling edge, the module powers off within 100 ms without damaging the filesystem, but the writing data may be lost.

Fast shutdown is disabled by default. For details, see **AT+QCFG="fast/poweroff"** in ***document [6]***.

Table 9: Pin Definition of Fast Shutdown Interface

Pin Name	Pin No.	I/O	Description	Comment
GPIO1 1)	25	DI	When the pin detects a falling edge, the module powers off	Falling-edge triggered. Pulled-up by default.

	within 100 ms.	1.8 V power domain.

The fast shutdown timing is illustrated in the following figure.

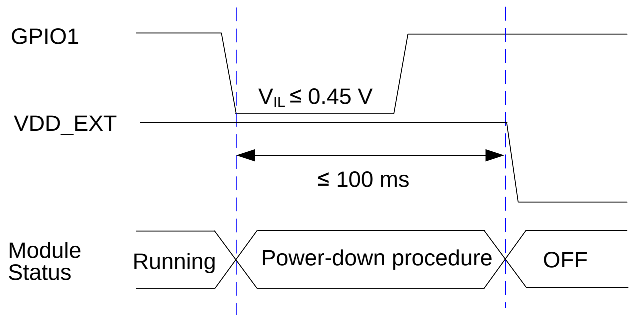


Figure 15: Fast Shutdown Timing

NOTE

[1)] Pin 25 is a general-purpose GPIO by default. It can be multiplexed into fast shutdown interface with **AT+QCFG="fast/poweroff"**.

3.7. Reset the Module

RESET_N is used to reset the module. Due to platform limitations, the chipset has integrated the reset function into PWRKEY, and RESET_N connects directly to PWRKEY inside the module.

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

Table 10: Pin Definition of RESET_N

Pin Name	Pin No.	Description	DC Characteristics	Comment
RESET_N	17	Reset the module	V_{IL}max = 0.45 V	Multiplexed from PWRKEY (connects directly to PWRKEY inside the module).

The reset scenario is illustrated in the following figure.

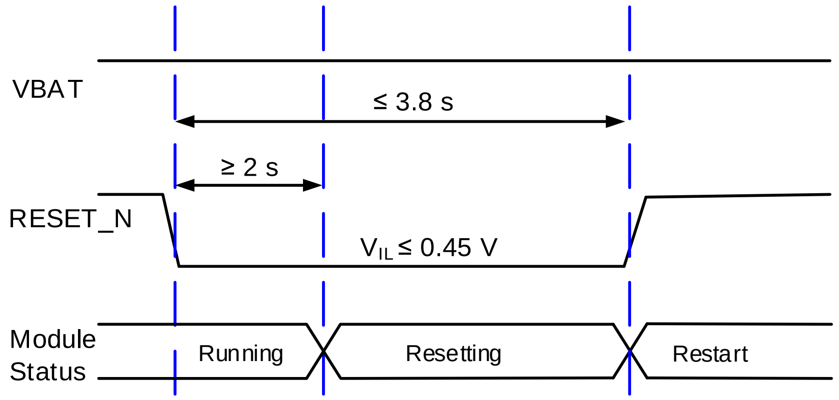


Figure 16: Reset Timing

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

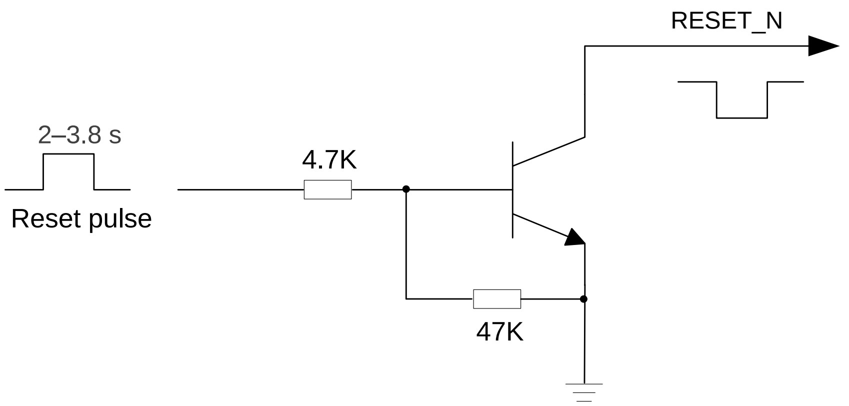


Figure 17: Reference Circuit of RESET_N with a Driving Circuit

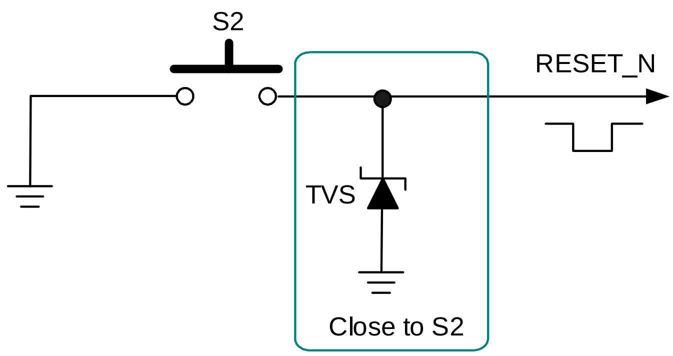


Figure 18: Reference Circuit of RESET_N with a Button

NOTE

Ensure that there is no large capacitance on RESET_N pin.

3.8. PON_TRIG Interface

BG95 series provides one PON_TRIG pin which is used to wake up the module from PSM. When the pin detects a rising edge, the module wakes up from PSM.

Table 11: Pin Definition of PON_TRIG Interface

Pin Name	Pin No.	I/O	Description	Comment
PON_TRIG	96	DI	Wake up the module from PSM	Rising-edge triggered. Pulled-down by default. 1.8 V power domain.

A reference circuit is shown in the following figure.

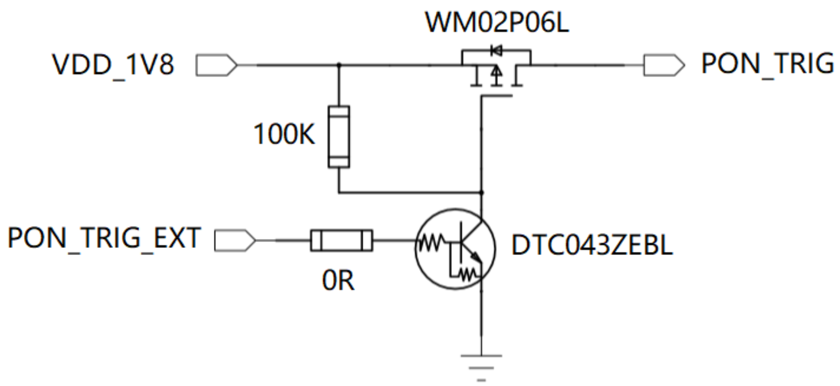


Figure 19: Reference Circuit of PON_TRIG

NOTE

VDD_1V8 is provided by an external LDO.

3.9. (U)SIM Interface

BG95 series supports 1.8 V (U)SIM card only. The (U)SIM interface circuitry meets ETSI and IMT-2000 requirements.

Table 12: Pin Definition of (U)SIM Interface

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

The module supports (U)SIM card hot-plug via the USIM_DET pin, and both high and low level detections are supported. The function is disabled by default, and see **AT+QSIMDET** in ***document [2]*** for more details.

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

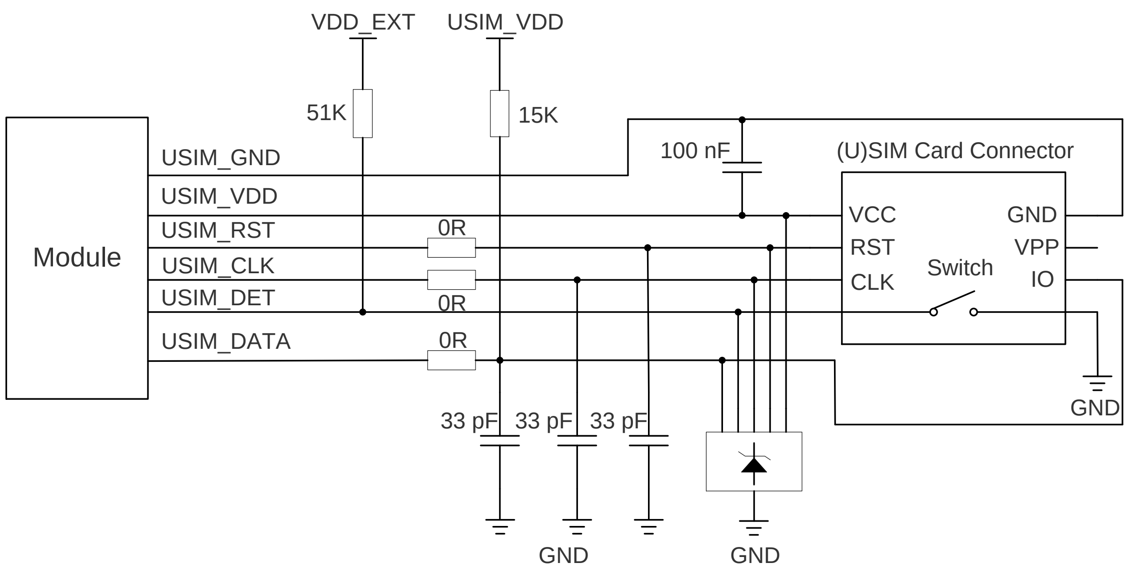


Figure 20: Reference Circuit of (U)SIM Interface with an 8-Pin (U)SIM Card Connector

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

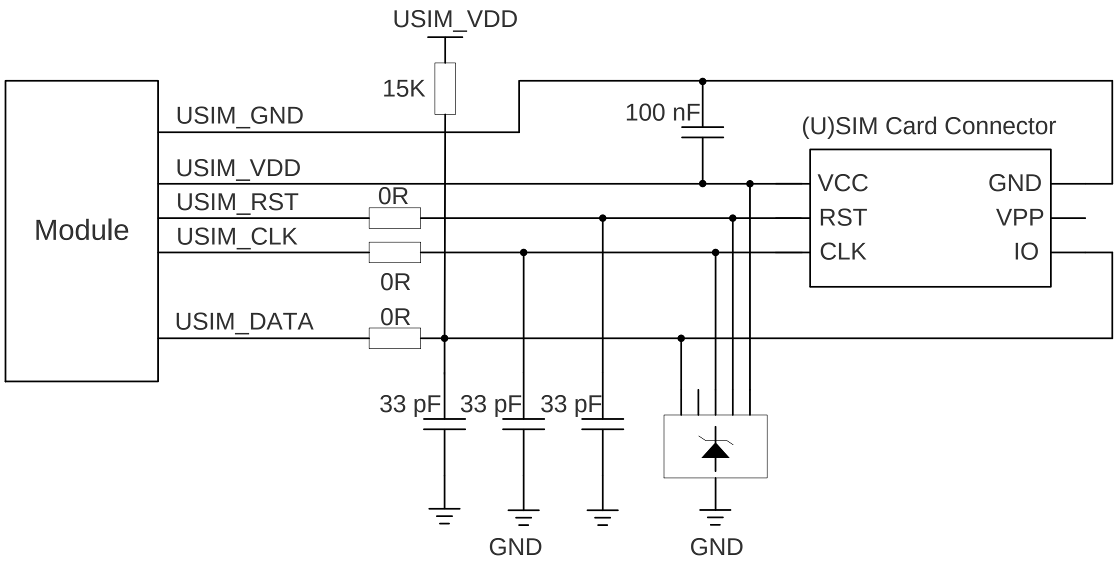


Figure 21: Reference Circuit of (U)SIM Interface with a 6-Pin (U)SIM Card Connector

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

- Keep the placement of (U)SIM card connector as close to the module as possible. Keep the trace length as less than 200 mm as possible.
- Keep (U)SIM card signals away from RF and VBAT traces.
- Assure the ground trace between the module and the (U)SIM card connector short and wide. Keep the trace width of ground and USIM_VDD no less than 0.5 mm to maintain the same electric potential. Make sure the bypass capacitor between USIM_VDD and USIM_GND less than 1 μF, and place it as close to (U)SIM card connector as possible. If the system ground plane is complete, USIM_GND can be connected to the system ground directly.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them away from each other and shield them with surrounded ground. USIM_RST should also be surrounded with ground.
- To offer good ESD protection, it is recommended to add a TVS diode array with parasitic capacitance not exceeding 15 pF. To facilitate debugging, it is recommended to reserve series resistors for the (U)SIM signals of the module. The 33 pF capacitors are used for filtering interference of EGSM900. Note that the (U)SIM peripheral circuit should be close to the (U)SIM card connector.
- The pull-up resistor on USIM_DATA line can improve anti-jamming capability when long layout trace and sensitive occasion are applied, and should be placed close to the (U)SIM card connector.

NOTES

1. eSIM function is optional. If eSIM is selected, then the external (U)SIM card cannot be used simultaneously.
2. BG95-M5 and BG95-M6 do not support eSIM.

3.10. USB Interface

BG95 series 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) and full-speed (12 Mbps) modes. The USB interface is used for AT command communication, data transmission, GNSS NMEA sentences output, software debugging and firmware upgrade. The following table shows the pin definition of USB interface.

Table 13: Pin Definition of USB Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_VBUS	8	AI	USB connection detection	Typical 5.0 V
USB_DP	9	AIO	USB differential data (+)	Require differential impedance of 90 Ω
USB_DM	10	AIO	USB differential data (-)	
GND	3		Ground	

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

The USB interface is recommended to be reserved for firmware upgrade and software debugging in application designs. The following figure shows a reference design of USB interface.

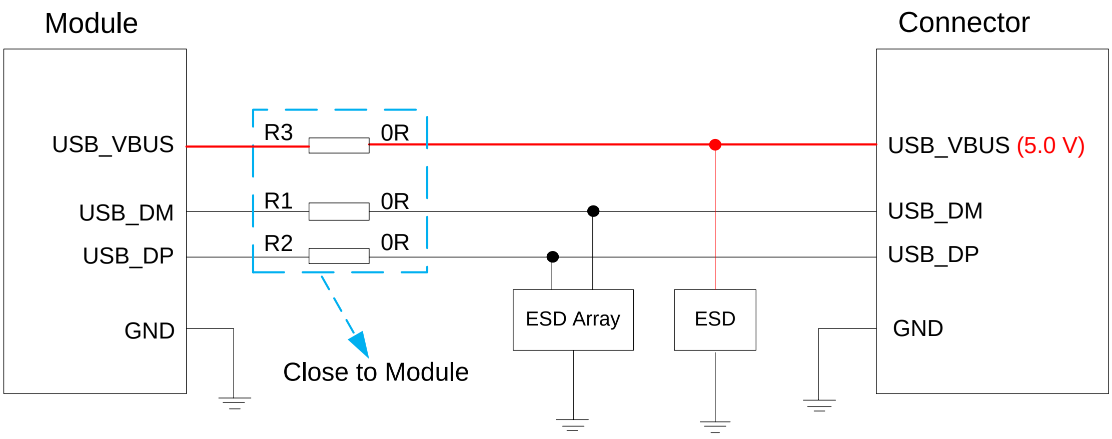


Figure 22: Reference Design of USB Interface

To ensure the integrity of USB data line signal, resistors R1 and R2 should be placed close to the module, and also these resistors should be placed close to each other. The extra stubs of trace must be as short as possible.

To meet USB 2.0 specification, comply with the following principles while designing the USB interface.

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

NOTE

BG95 series can only be used as a slave device.

3.11. UART Interfaces

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

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

Table 14: Pin Definition of Main UART Interface

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

NOTE

AT+IPR can be used to set the baud rate of the main UART interface, and **AT+IFC** can be used to enable/disable the hardware flow control (the function is disabled by default). See ***document [2]*** for more details about these AT commands.

Table 15: Pin Definition of Debug UART Interface

Pin Name	Pin No.	I/O	Description	Comment
DBG_RXD	22	DI	Debug UART receive	1.8 V power domain
DBG_TXD	23	DO	Debug UART transmit	1.8 V power domain

Table 16: Pin Definition of GNSS UART Interface

Pin Name	Pin No.	I/O	Description	Comment
GNSS_TXD	27	DO	GNSS UART transmit	BOOT_CONFIG. Do not pull it up before startup. 1.8 V power domain.
GNSS_RXD	28	DI	GNSS UART receive	1.8 V power domain.

NOTE

GNSS_TXD is a BOOT_CONFIG pin. Never pull it up before startup, otherwise the module cannot power on normally.

The module provides 1.8 V UART interfaces. A voltage-level translator should be used if your application is equipped with a 3.3 V UART interface. The voltage-level translator TXS0108EPWR provided by *Texas Instruments* is recommended. The following figure shows a reference design of the main UART interface.

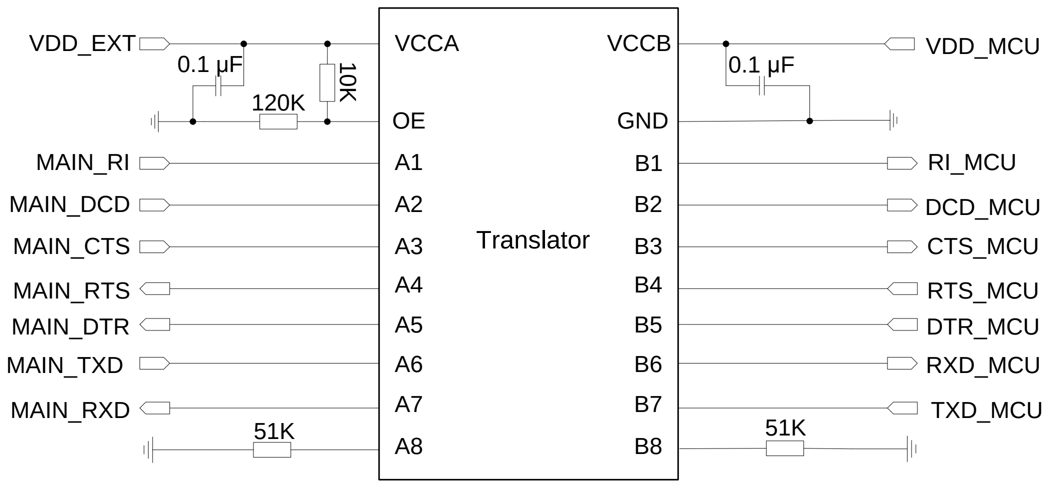


Figure 23: Main UART Reference Design (Translator Chip)

Please visit http://www.ti.com/ for more information.

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

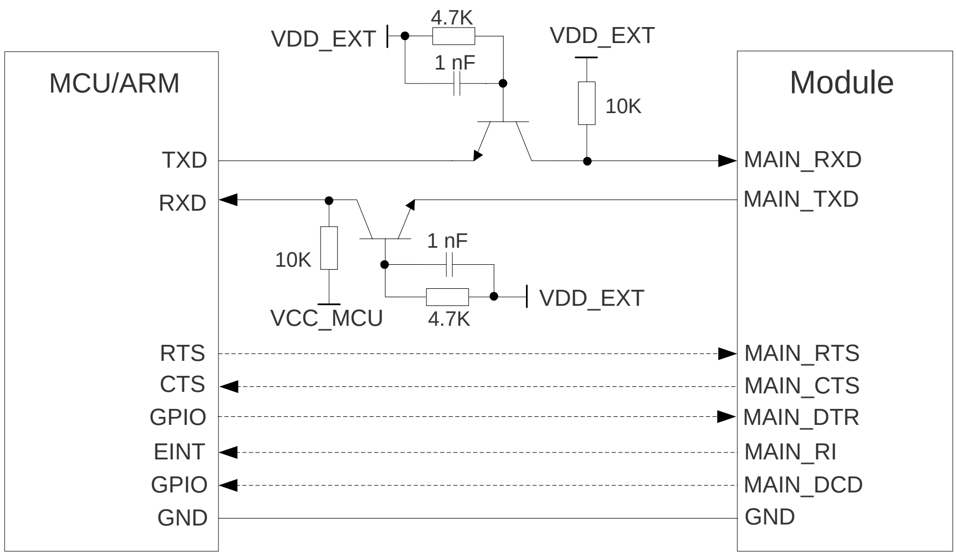


Figure 24: Main UART Reference Design (Transistor Circuit)

NOTE

Transistor circuit solution is not suitable for applications with high baud rates exceeding 460 kbps.

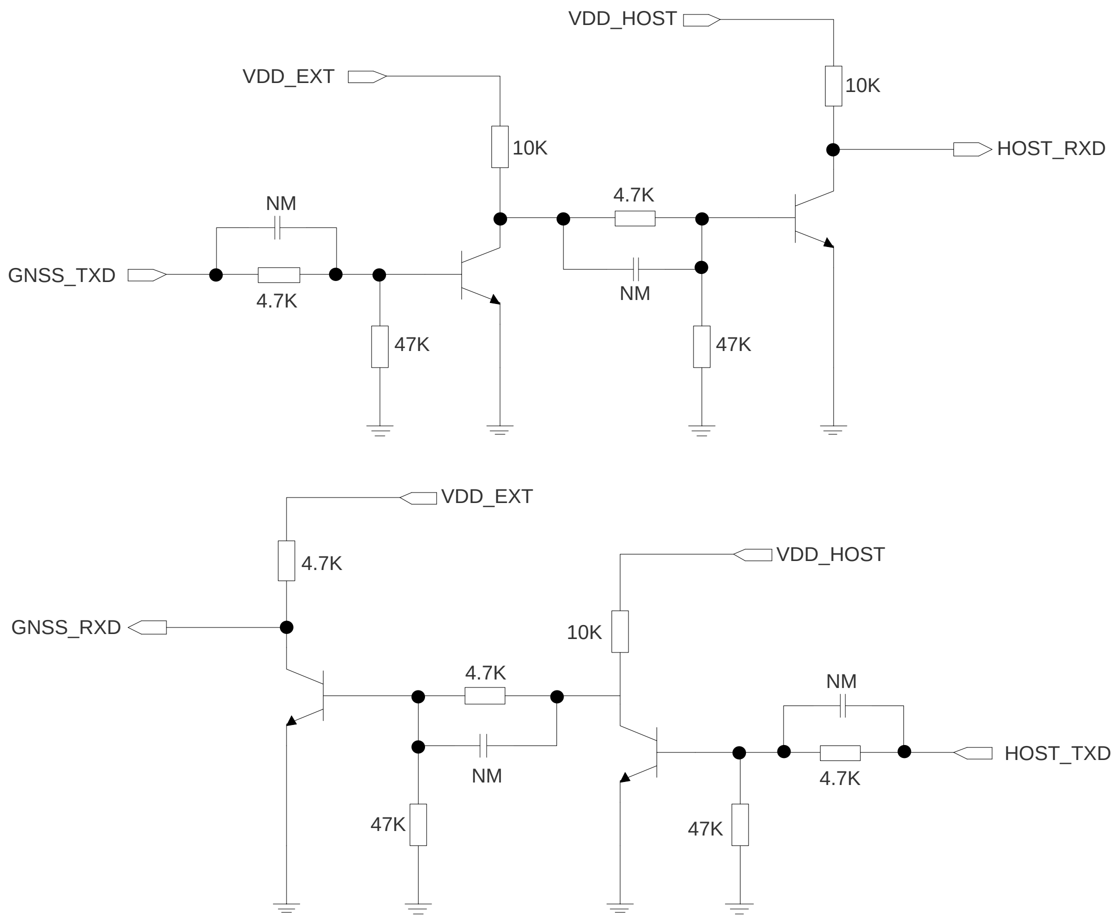


Figure 25: Reference Circuit with Dual-Transistor Circuit (Recommended for GNSS UART)

NOTE

GNSS_TXD is a BOOT_CONFIG pin (pin 27), therefore voltage-level translation IC solution with pull-up circuit or signal transistor/MOSFET circuit is not applicable to it. The dual-transistor circuit solution is recommended for GNSS UART.

3.12. PCM and I2C Interfaces*

BG95 series provides one Pulse Code Modulation (PCM) digital interface and one I2C interface which are used for VoLTE or GSM CS voice only.

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

Table 17: Pin Definition of PCM and I2C Interfaces

Pin Name	Pin No.	I/O	Description	Comment
PCM_CLK	4	DO	PCM clock	1.8 V power domain.
PCM_SYNC	5	DO	PCM data frame sync	1.8 V power domain.
PCM_DIN	6	DI	PCM data input	1.8 V power domain.
PCM_DOUT	7	DO	PCM data output	1.8 V power domain.
I2C_SCL	40	OD	I2C serial clock (for external codec)	Require external pull-up to 1.8 V.
I2C_SDA	41	OD	I2C serial data (for external codec)	Require external pull-up to 1.8 V.

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

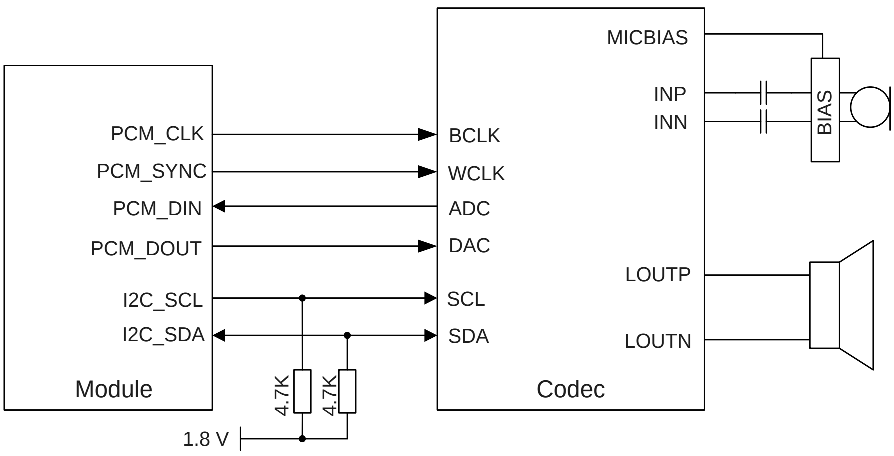


Figure 26: Reference Circuit of PCM Application with Audio Codec

NOTES

1. “*” means under development.
2. PCM and I2C interfaces support VoLTE or GSM CS voice only.

3.13. Network Status Indication

BG95 series provides one network status indication pin (NET_STATUS). The pin is used to drive a network status indication LED. The following tables describe the pin definition and logic level changes of NET_STATUS in different network activity status.

Table 18: Pin Definition of NET_STATUS

Pin Name	Pin No.	I/O	Description	Comment
NET_STATUS	21	DO	Indicates the module's network activity status	1.8 V power domain

Table 19: Working State of NET_STATUS

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

A reference circuit is shown in the following figure.

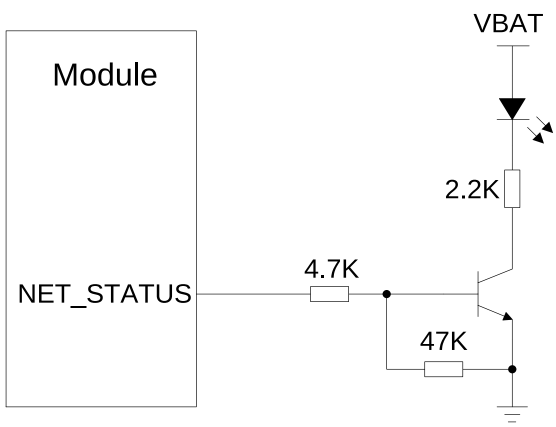


Figure 27: Reference Circuit of the Network Status Indicator

3.14. STATUS

The STATUS pin indicates the operation status of the module. It outputs high level when the module powers on.

Table 20: Pin Definition of STATUS

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

The following figure shows a reference circuit of STATUS.

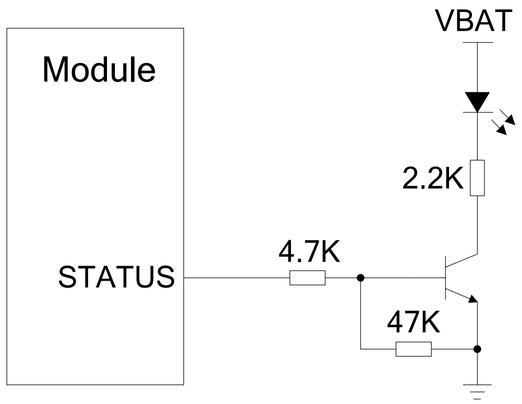


Figure 28: Reference Design of STATUS

3.15. Behaviors of MAIN_RI

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

The default behaviors of MAIN_RI pin are shown as below.

Table 21: Default Behaviors of MAIN_RI Pin

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

The default MAIN_RI pin behaviors can be configured flexibly by **AT+QCFG="urc/ri/ring"**. For more details about **AT+QCFG**, see ***document [6]***.

NOTE

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

3.16. USB_BOOT Interface

BG95 series provides a USB_BOOT pin. During development or factory production, USB_BOOT can force the module to boot from USB port for firmware upgrade.

Table 22: Pin Definition of USB_BOOT Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_BOOT	75	DI	Force the module into emergency download mode	1.8 V power domain. Active high. If unused, keep it open.

The following figure shows a reference circuit of USB_BOOT interface.

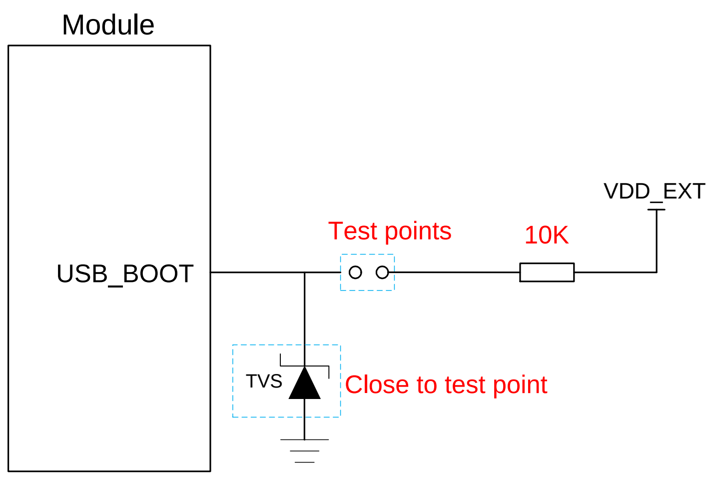


Figure 29: Reference Design of USB_BOOT Interface

The following figure shows the timing of USB_BOOT.

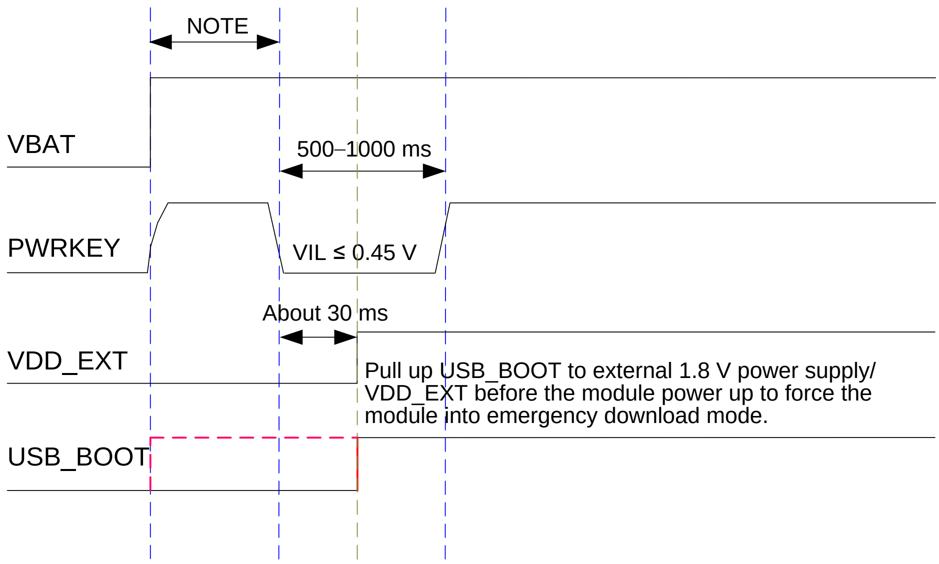


Figure 30: Timing of Turning on Module with USB_BOOT

NOTES

1. It is recommended to reserve the above circuit design during application design.
2. Ensure that VBAT is stable before pulling down PWRKEY. It is recommended that the time difference between powering up VBAT and pulling down PWRKEY is no less than 30 ms.
3. When using MCU to control the module entering emergency download mode, follow the above timing sequence. Connecting the test points as shown in ***Figure 29*** can manually force the module to enter download mode.

3.17. ADC Interfaces

The module provides two analog-to-digital converter (ADC) interfaces but only one ADC interface can be used at a time. ADC1 connects directly to ADC0 inside the module.

AT+QADC=0 can be used to read the voltage value on the ADC being used. For more details about the AT command, see ***document [2]***.

In order to improve the accuracy of ADC voltage values, the traces of ADC should be surrounded with ground.

Table 23: Pin Definition of ADC Interface

Pin Name	Pin No.	I/O	Description	Comment
ADC0	24	AI	General-purpose ADC interface	Do not use ADC0 and ADC1 simultaneously.
ADC1	2	AI	General-purpose ADC interface	

Table 24: Characteristics of ADC Interfaces

Parameter	Min.	Typ.	Max.	Unit
Voltage Range	0.1	-	1.8	V
Resolution (LSB)	-	64.979	-	μV
Analog Bandwidth	-	500	-	kHz
Sample Clock	-	4.8	-	MHz
Input Resistance	10	-	-	MΩ

NOTES

1. ADC input voltage must not exceed 1.8 V.
2. It is prohibited to supply any voltage to ADC pin when VBAT is removed.
3. It is recommended to use resistor divider circuit for ADC application, and the divider resistor accuracy should be no less than 1 %.
4. Do not use ADC0 and ADC1 simultaneously, as ADC1 connects directly to ADC0 inside the module.

3.18. GPIO Interfaces

The module provides 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 [6]***.

Table 25: Pin Definition of GPIO Interfaces

Pin Name	Pin No.	I/O	Description
GPIO1 [1)]	25	DIO	General-purpose input/output
GPIO2	26	DIO	General-purpose input/output
GPIO3 [2)]	64	DIO	General-purpose input/output
GPIO4 [2)]	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

NOTES

1. [1)] GPIO1 (pin 25) is a general-purpose GPIO by default. It can be multiplexed into fast shutdown interface with **AT+QCFG="fast/poweroff"**. See ***Chapter 3.6.3*** for details.
2. [2)] BG95-MF does not support GPIO3 and GPIO4.

3.19. GRFC Interfaces

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

Table 26: Pin Definition of GRFC Interfaces

Pin Name	Pin No.	I/O	Description	Comments
GRFC1	83	DO	Generic RF controller	1.8 V power domain.
GRFC2	84	DO	Generic RF controller	BOOT_CONFIG. Do not pull it up before startup. 1.8 V power domain.

Table 27: Truth Table of GRFC Interfaces

GRFC1 Level	GRFC2 Level	Frequency Range (MHz)	Band
Low	Low	880–2200	B1, B2, B3, B4, B8, B25, B66
Low	High	791–894	B5, B18, B19, B20, B26, B27
High	Low	698–803	B12, B13, B28, B85
High	High	617–698	B71

NOTES

1. GRFC2 (pin 84) is a BOOT_CONFIG pin. Never pull it up before startup, otherwise the module cannot power on normally.
2. BG95-M4 does not support GRFC interfaces.

4 GNSS Receiver

4.1. General Description

BG95 series includes a fully integrated global navigation satellite system solution that supports Gen9 VT (GPS, GLONASS, BeiDou, Galileo and QZSS).

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

By default, BG95 GNSS engine is switched off. It has to be switched on via AT command. The module does not support concurrent operation of WWAN and GNSS. For more details about GNSS engine technology and configurations, see ***document [3]***.

4.2. GNSS Performance

Table 28: GNSS Performance

Parameter	Description	Conditions	Typ.	Unit
Sensitivity (GNSS)	Cold start	Autonomous	-146	dBm
	Reacquisition	Autonomous	-157	dBm
	Tracking	Autonomous	-157	dBm
TTFF (GNSS)	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 (GNSS)	CEP-50	Autonomous @ open sky	< 2.5	m

NOTES

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

4.3. Layout Guidelines

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

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

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

5 Antenna Interfaces

BG95 series includes a main antenna interface and a GNSS antenna interface. Additionally, BG95-MF supports Wi-Fi antenna interface. The impedance of antenna ports is 50 Ω.

5.1. Main Antenna Interface

5.1.1. Pin Definition

Table 29: Pin Definition of Main Antenna Interface

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

5.1.2. Operating Frequency

Table 30: Operating Frequency of BG95 Series Module

3GPP Band	Transmit	Receive	Unit
LTE-FDD B1	1920–1980	2110–2170	MHz
LTE-FDD B2, PCS1900	1850–1910	1930–1990	MHz
LTE-FDD B3, DCS1800	1710–1785	1805–1880	MHz
LTE-FDD B4	1710–1755	2110–2155	MHz
LTE-FDD B5, GSM850	824–849	869–894	MHz
LTE-FDD B8, EGSM900	880–915	925–960	MHz
LTE-FDD B12	699–716	729–746	MHz
LTE-FDD B13	777–787	746–756	MHz

LTE-FDD B18	815–830	860–875	MHz
LTE-FDD B19	830–845	875–890	MHz
LTE-FDD B20	832–862	791–821	MHz
LTE-FDD B25	1850–1915	1930–1995	MHz
LTE-FDD B26 [1)]	814–849	859–894	MHz
LTE-FDD B27 [1)]	807–824	852–869	MHz
LTE-FDD B28	703–748	758–803	MHz
LTE-FDD B31 [3)]	452.5–457.5	462.5–467.5	MHz
LTE-FDD B66	1710–1780	2110–2180	MHz
LTE-FDD B71 [2)]	663–698	617–652	MHz
LTE-FDD B72 [3)]	451–456	461–466	MHz
LTE-FDD B73 [3)]	450–455	460–465	MHz
LTE-FDD B85	698–716	728–746	MHz

NOTES

1. [1)] LTE-FDD B26 and B27 are supported by Cat M1 only.
2. [2)] LTE-FDD B71 is supported by Cat NB2 only.
3. [3)] LTE-FDD B31, B72 and B73 are supported by BG95-M4 only.

5.1.3. Reference Design

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

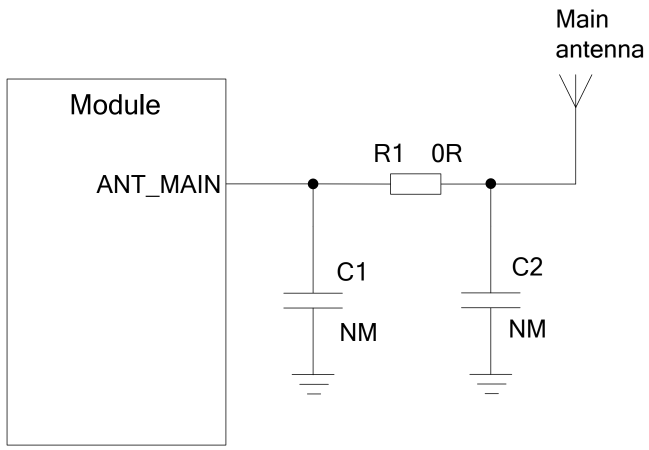


Figure 31: Reference Design of Main Antenna Interface

5.2. GNSS Antenna Interface

5.2.1. Pin Definition

Table 31: Pin Definition of GNSS Antenna Interface

Pin Name	Pin No.	I/O	Description	Comment
ANT_GNSS	49	AI	GNSS antenna interface	50 Ω impedance

5.2.2. GNSS Operating Frequency

Table 32: GNSS Operating Frequency

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

5.2.3. Reference Design

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

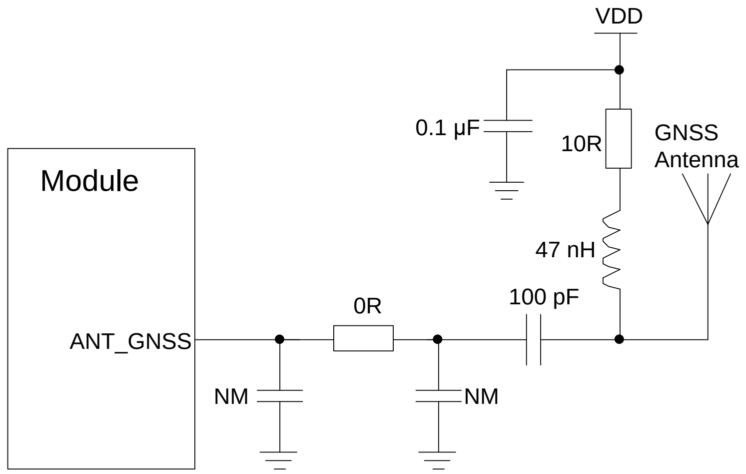


Figure 32: Reference Circuit of GNSS Antenna Interface

NOTES

1. An external LDO can be selected to supply power according to the active antenna requirement.
2. If the module is designed with a passive antenna, then the VDD circuit is not needed.

5.3. Wi-Fi Antenna Interface*

BG95-MF supports Wi-Fi antenna interface through which the module realizes Wi-Fi positioning (receiving only).

Table 33: Pin Definition of Wi-Fi Antenna Interface

Pin Name	Pin No.	I/O	Description	Comment
ANT_WIFI	56	AI	Wi-Fi antenna interface	50 Ω impedance

NOTE

"*" means under development.

5.4. Reference Design of RF Layout

For users' 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.

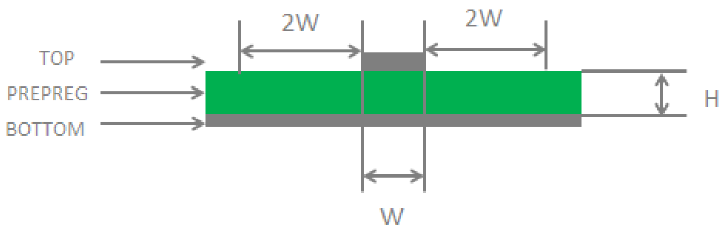


Figure 33: Microstrip Design on a 2-layer PCB

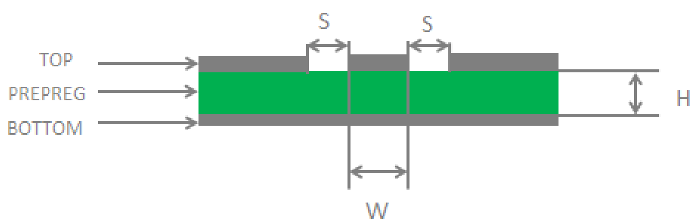


Figure 34: Coplanar Waveguide Design on a 2-layer PCB

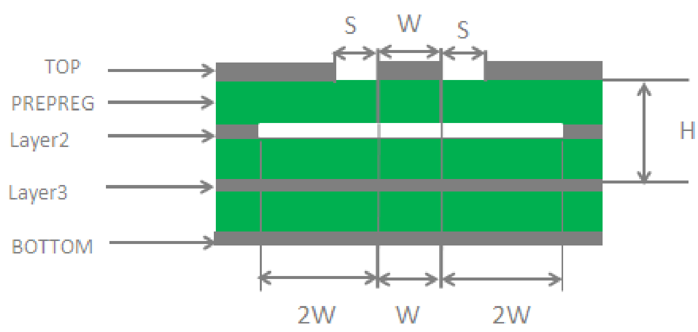


Figure 35: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

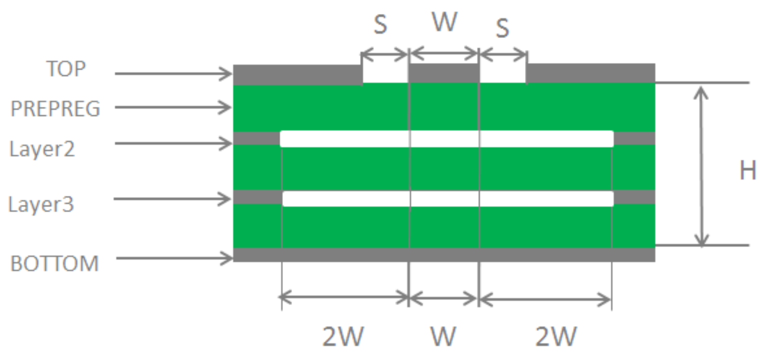


Figure 36: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

To ensure RF performance and reliability, the following principles should be complied with in RF layout design:

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

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

5.5. Antenna Installation

5.5.1. Antenna Requirements

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

Table 34: Antenna Requirements

Antenna Type	Requirements
GNSS [1)]	Frequency range: 1559–1609 MHz Polarization: RHCP or linear

	VSWR: < 2 (Typ.) Passive antenna gain: > 0 dBi Active antenna noise figure: < 1.5 dB Active antenna gain: > 0 dBi Active antenna embedded LNA gain: < 17 dB
LTE/GSM	VSWR: ≤ 2 Efficiency: > 30 % Max Input Power: 50 W Input Impedance: 50 Ω Cable Insertion Loss: < 1 dB (LTE B5/B8/B12/B13/B18/B19/B20/B26/B27/B28/B31/B71/B72/B73/B85, GSM850/EGSM900) Cable Insertion Loss: < 1.5 dB (LTE B1/B2/B3/B4/B25/B66, DCS1800/PCS1900)

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.

5.5.2. Recommended RF Connector for Antenna Installation

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

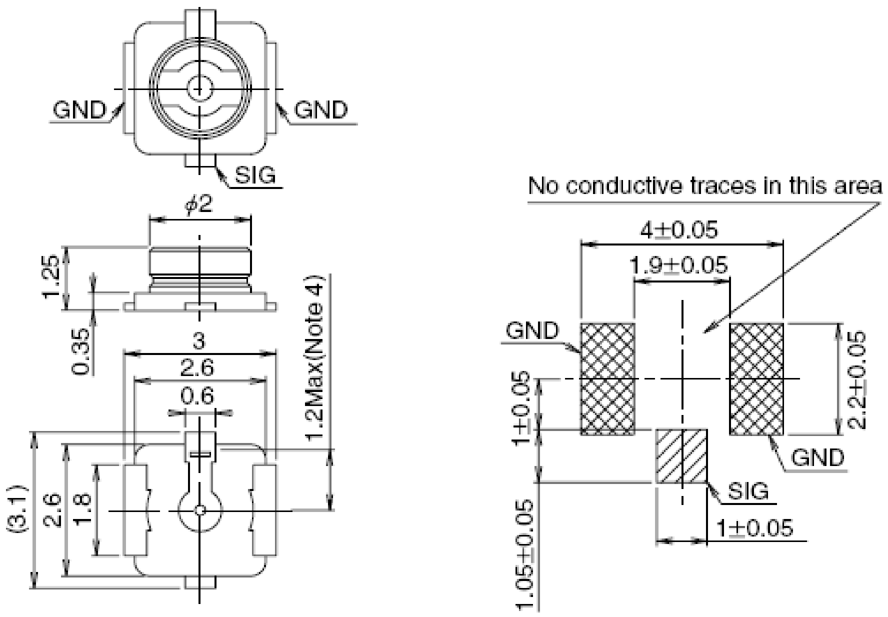


Figure 37: Dimensions of the U.FL-R-SMT Connector (Unit: mm)

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

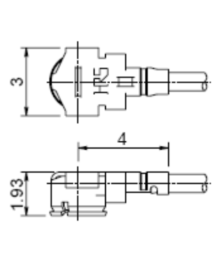
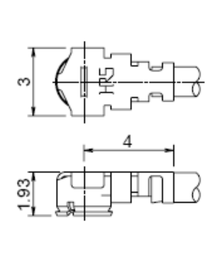
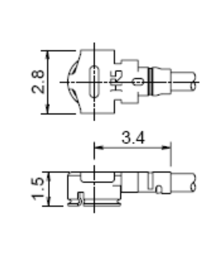
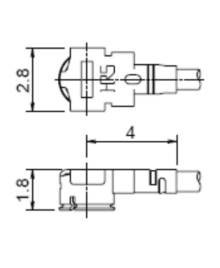
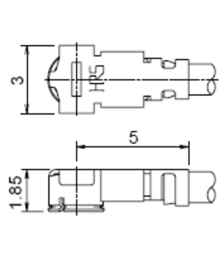
	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
Part No.					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 0.81mm 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 38: Mechanicals of U.FL-LP Connectors

The following figure describes the space factor of mated connectors.

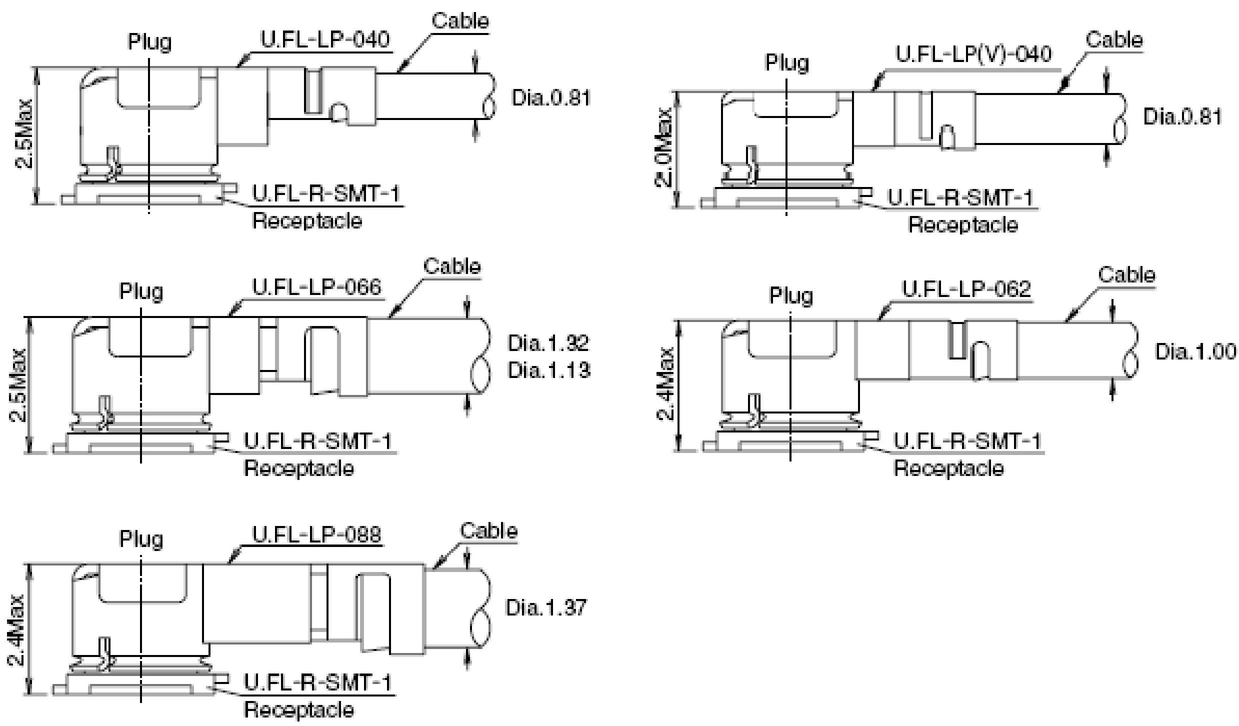


Figure 39: Space Factor of Mated Connectors (Unit: mm)

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

6 Reliability, Radio and Electrical Characteristics

6.1. Absolute Maximum Ratings

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

Table 35: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VBAT_BB	-0.5	6.0	V
VBAT_RF	-0.3	6.0	V
USB_VBUS	-0.3	5.5	V
Voltage at Digital Pins	-0.3	2.09	V

6.2. Power Supply Ratings

Table 36: Power Supply Ratings

Parameter	Description	Conditions	Module	Min.	Typ.	Max.	Unit
VBAT	VBAT_BB/ VBAT_RF	The actual input voltages must be kept between the minimum and the maximum values.	BG95-M1/ BG95-M2	2.6	3.3	4.8	V
			BG95-M3/ BG95-M5/ BG95-M6/ BG95-MF	3.3	3.8	4.3	V
			BG95-M4	3.2	3.8	4.2	V

I_{VBAT}	Peak supply current (during transmission slot)	Maximum power control level on EGSM900	BG95-M3/ BG95-M5	-	1.8	2.0	A
USB_VBUS	USB connection detection		BG95 series	-	5.0	-	V

6.3. Operating and Storage Temperatures

Table 37: Operating and Storage Temperatures

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

NOTES

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

6.4. Current Consumption

Table 38: BG95-M1 Current Consumption (3.3 V Power Supply, Room Temperature)

Description	Conditions	Average	Peak	Unit
Leakage [1)]	Power-off @ USB and UART disconnected	14	-	μA
PSM [2)]	Power Saving Mode	4	-	μA
Rock Bottom	**AT+CFUN=0** @ Sleep mode	0.53	-	mA

Sleep Mode (USB disconnected)	LTE Cat M1 DRX = 1.28 s	1.7	-	mA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	0.577	-	mA
Idle Mode (USB disconnected)	LTE Cat M1 DRX = 1.28 s	20	-	mA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	19.57	-	mA
LTE Cat M1 data transfer (GNSS OFF)	B1 @ 20.66 dBm	200.47	492.01	mA
	B2 @ 20.81 dBm	202.12	495.94	mA
	B3 @ 21.24 dBm	199.57	489.8	mA
	B4 @ 20.82 dBm	197.79	480.87	mA
	B5 @ 21.12 dBm	219.9	559.98	mA
	B8 @ 21.03 dBm	209.96	525.56	mA
	B12 @ 20.67 dBm	202.55	494.76	mA
	B13 @ 20.92 dBm	225.42	571.8	mA
	B18 @ 21.02 dBm	214.87	544.42	mA
	B19 @ 20.95 dBm	216.17	545.96	mA
	B20 @ 20.96 dBm	214.52	544.75	mA
	B25 @ 21.02 dBm	203.86	505.39	mA
	B26 @ 21.06 dBm	218.97	554.38	mA
	B27 @ 20.8 dBm	212.89	536.62	mA
	B28A @ 20.89 dBm	210.15	524.96	mA
	B28B @ 21 dBm	217.13	540.86	mA
	B66 @ 21.03 dBm	198.63	498.38	mA
	B85 @ 21 dBm	203.36	505.76	mA

Table 39: BG95-M2 Current Consumption (3.3 V Power Supply, Room Temperature)

Description	Conditions	Average	Peak	Unit
Leakage [1)]	Power-off @ USB and UART disconnected	12.46	-	μA
PSM [2)]	Power Saving Mode	3.89	-	μA
Rock Bottom	**AT+CFUN=0** @ Sleep mode	0.554	-	mA
Sleep Mode (USB disconnected)	LTE Cat M1 DRX = 1.28 s	1.68	-	mA
	LTE Cat NB1 DRX = 1.28 s	1.55	-	mA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	0.549	-	mA
	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	0.592	-	mA
Idle Mode (USB disconnected)	LTE Cat M1 DRX = 1.28 s	21.2	-	mA
	LTE Cat NB1 DRX = 1.28 s	16.8	-	mA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	20.6	-	mA
	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	16.4	-	mA
LTE Cat M1 data transfer (GNSS OFF)	B1 @ 20.96 dBm	200.76	485.07	mA
	B2 @ 21.16 dBm	204.65	506.97	mA
	B3 @ 21.19 dBm	198.23	480.89	mA
	B4 @ 21.36 dBm	199.07	495.34	mA
	B5 @ 20.97 dBm	218.17	553.18	mA
	B8 @ 20.72 dBm	208.15	528.06	mA
	B12 @ 21.08 dBm	211.45	521.28	mA
	B13 @ 21.01 dBm	223.86	580.66	mA
	B18 @ 21.03 dBm	220.07	559.93	mA

	B19 @ 21.03 dBm	217.55	547.77	mA
	B20 @ 21.03 dBm	220.29	552.3	mA
	B25 @ 20.87 dBm	204.23	501.33	mA
	B26 @ 21.02 dBm	217.94	542.21	mA
	B27 @ 21.2 dBm	222.32	565.29	mA
	B28A @ 20.71 dBm	210.33	521.22	mA
	B28B @ 20.6 dBm	216.98	562.04	mA
	B66 @ 20.98 dBm	197.33	476.57	mA
	B85 @ 21.05 dBm	211.41	541.98	mA
LTE Cat NB1 data transfer (GNSS OFF)	B1 @ 21.06 dBm	158.87	496.92	mA
	B2 @ 21.08 dBm	160.58	500.74	mA
	B3 @ 20.97 dBm	151.47	466.4	mA
	B4 @ 21.05 dBm	151.14	476.36	mA
	B5 @ 20.9 dBm	173.72	564.9	mA
	B8 @ 20.87 dBm	166.6	524.79	mA
	B12 @ 21.05 dBm	161.94	517.55	mA
	B13 @ 20.88 dBm	180.98	573.45	mA
	B18 @ 20.97 dBm	175.49	555.29	mA
	B19 @ 20.99 dBm	174.59	556.395	mA
	B20 @ 20.99 dBm	173.42	542.34	mA
	B25 @ 20.96 dBm	157.75	503.43	mA
	B28 @ 21 dBm	162.61	512.04	mA
	B66 @ 21.19 dBm	152.1	470.05	mA
	B71 @ 21.15 dBm	153.81	487.17	mA
	B85 @ 21.32 dBm	166.88	531.57	mA

Table 40: BG95-M3 Current Consumption (3.8 V Power Supply, Room Temperature)

Description	Conditions	Average	Peak	Unit
Leakage [1)]	Power-off @ USB and UART disconnected	12.99	-	μA
PSM [2)]	Power Saving Mode	3.89	-	μA
Rock Bottom	**AT+CFUN=0** @ Sleep mode	0.575	-	mA
Sleep Mode (USB disconnected)	LTE Cat M1 DRX = 1.28 s	1.89	-	mA
	LTE Cat NB1 DRX = 1.28 s	1.49	-	mA
	EGSM900 DRX = 5	1.21	-	mA
	DCS1800 DRX = 5	1.20	-	mA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	0.63	-	mA
	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	0.67	-	mA
Idle Mode (USB disconnected)	LTE Cat M1 DRX = 1.28 s	18.9	-	mA
	LTE Cat NB1 DRX = 1.28 s	14.8	-	mA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	18.2	-	mA
	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	14.3	-	mA
LTE Cat M1 data transfer (GNSS OFF)	B1 @ 21.29 dBm	193.65	491.42	mA
	B2 @ 20.73 dBm	190.76	477.7	mA
	B3 @ 20.67 dBm	185.89	462.63	mA
	B4 @ 20.85 dBm	185.14	456.71	mA
	B5 @ 21.02 dBm	194.99	487.59	mA
	B8 @ 21.02 dBm	197.31	497.83	mA
	B12 @ 20.96 dBm	189.54	467.22	mA

	B13 @ 20.99 dBm	198.75	510.51	mA
	B18 @ 21 dBm	195.07	490.61	mA
	B19 @ 20.95 dBm	197.63	502.55	mA
	B20 @ 20.92 dBm	197.33	498.89	mA
	B25 @ 21.08 dBm	190.67	481.36	mA
	B26 @ 20.98 dBm	195.96	493.02	mA
	B27 @ 20.69 dBm	192.07	486.82	mA
	B28A @ 20.87 dBm	192.04	482.44	mA
	B28B @ 21.03 dBm	197.39	501.64	mA
	B66 @ 21.11 dBm	188.1	471.7	mA
	B85 @ 20.87 dBm	185.3	453.97	mA
LTE Cat NB1 data transfer (GNSS OFF)	B1 @ 20.86 dBm	153.2	477.37	mA
	B2 @ 21.28 dBm	155.14	478.3	mA
	B3 @ 21.07 dBm	149.14	450.59	mA
	B4 @ 20.91 dBm	147.72	449.24	mA
	B5 @ 20.55 dBm	154.68	476.59	mA
	B8 @ 21.01 dBm	158.82	493.93	mA
	B12 @ 20.88 dBm	148.37	452.51	mA
	B13 @ 21.09 dBm	167.03	520.85	mA
	B18 @ 20.79 dBm	157.12	489.47	mA
	B19 @ 20.68 dBm	156.29	489.16	mA
	B20 @ 21.01 dBm	161.75	503.43	mA
	B25 @ 21.02 dBm	154.16	476.58	mA
	B28 @ 20.82 dBm	147.82	458.52	mA
	B66 @ 21 dBm	148.58	459.72	mA

	B71 @ 20.81 dBm	137.53	428.61	mA
	B85 @ 20.64 dBm	146.51	462.26	mA
GPRS data transfer (GNSS OFF)	GPRS GSM850 4UL/1DL @ 30.5 dBm	670.73	1535	mA
	GPRS GSM900 4UL/1DL @ 29.65 dBm	623.34	1442	mA
	GPRS DCS1800 4UL/1DL @ 26.24 dBm	408.25	836.38	mA
	GPRS PCS1900 4UL/1DL @ 26.43 dBm	423.12	885.95	mA
EDGE data transfer (GNSS OFF)	EDGE GSM850 4UL/1DL @ 22.97 dBm	519	1114	mA
	EDGE GSM900 4UL/1DL @ 22.51 dBm	517.59	1101	mA
	EDGE DCS1800 4UL/1DL @ 22.73 dBm	439.73	919.79	mA
	EDGE PCS1900 4UL/1DL @ 22.27 dBm	443.94	922.29	mA

Table 41: BG95-M4 Current Consumption (3.8 V Power Supply, Room Temperature)

Description	Conditions	Average	Peak	Unit
Leakage 1)	Power-off @ USB and UART disconnected	13.76	-	μA
PSM 2)	Power Saving Mode	3.94	-	μA
Rock Bottom	**AT+CFUN=0** @ Sleep mode	0.556	-	mA
Sleep Mode (USB disconnected)	LTE Cat M1 DRX = 1.28 s	1.53	-	mA
	LTE Cat NB1 DRX = 1.28 s	1.39	-	mA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	0.554	-	mA
	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	0.588	-	mA
Idle Mode (USB disconnected)	LTE Cat M1 DRX = 1.28 s	18.176	-	mA
	LTE Cat NB1 DRX = 1.28 s	14.425	-	mA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	17.604	-	mA

	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	14.061	-	mA
LTE Cat M1 data transfer (GNSS OFF)	B1 @ 20.41 dBm	179.3	447.41	mA
	B2 @ 20.6 dBm	184.18	458.7	mA
	B3 @ 20.67 dBm	180.85	440.88	mA
	B4 @ 20.54 dBm	177.54	431.82	mA
	B5 @ 20.98 dBm	187.2	478.13	mA
	B8 @ 20.28 dBm	185.97	462.04	mA
	B12 @ 20.6 dBm	184.93	462.16	mA
	B13 @ 20.69 dBm	186.61	464.53	mA
	B18 @ 20.29 dBm	179.33	437.18	mA
	B19 @ 20.72 dBm	184.35	457.59	mA
	B20 @ 20.75 dBm	185.44	460.15	mA
	B25 @ 20.73 dBm	185.15	463.16	mA
	B26 @ 20.94 dBm	183.29	454.76	mA
	B27 @ 20.65 dBm	182.74	455.53	mA
	B28A @ 20.36 dBm	184.25	455.64	mA
	B28B @ 20.66 dBm	187.13	466.52	mA
	B31 @ 22.27 dBm	187.01	453.95	mA
	B66 @ 20.98 dBm	182.56	452.13	mA
	B72 @ 22.72 dBm	191.15	463.91	mA
	B73 @ 22.3 dBm	189.37	460.92	mA
	B85 @ 20.71 dBm	184.37	459.05	mA
LTE Cat NB1 data transfer (GNSS OFF)	B1 @ 21.14 dBm	145.63	432.84	mA
	B2 @ 21.02 dBm	145.24	429.63	mA

	B3 @ 21.01 dBm	141.9	407.54	mA
	B4 @ 21.2 dBm	143.23	413.5	mA
	B5 @ 20.79 dBm	143	414.12	mA
	B8 @ 20.86 dBm	156.34	461.8	mA
	B12 @ 21.02 dBm	149.72	433.22	mA
	B13 @ 21.03 dBm	150.06	438.92	mA
	B18 @ 20.79 dBm	142.77	416.53	mA
	B19 @ 21.12 dBm	146.11	430.62	mA
	B20 @ 20.89 dBm	145.87	422.74	mA
	B25 @ 21.09 dBm	147.17	423.53	mA
	B28 @ 20.84 dBm	147.14	430.41	mA
	B31 @ 22.07 dBm	146.57	417.14	mA
	B66 @ 20.94 dBm	140.97	402.6	mA
	B72 @ 22.12 dBm	147.19	420.49	mA
	B73 @ 22.31 dBm	147.55	416.23	mA
	B85 @ 20.94 dBm	147.15	425.59	mA

Table 42: BG95-M5 Current Consumption (3.8 V Power Supply, Room Temperature)

Description	Conditions	Average	Peak	Unit
Leakage 1)	Power-off @ USB and UART disconnected	14.87	-	μA
PSM 2)	Power Saving Mode	5.10	-	μA
Rock Bottom	**AT+CFUN=0** @ Sleep mode	0.587	-	mA
Sleep Mode (USB disconnected)	LTE Cat M1 DRX = 1.28 s	1.56	-	mA
	LTE Cat NB1 DRX = 1.28 s	1.43	-	mA
	EGSM900 DRX = 5	1.21	-	mA

	DCS1800 DRX = 5	1.17	-	mA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	0.72	-	mA
	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	0.68	-	mA
Idle Mode (USB disconnected)	LTE Cat M1 DRX = 1.28 sDRX = 1.28 s	17.3	-	mA
	LTE Cat NB1 DRX = 1.28 s	13.5	-	mA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	16.6	-	mA
	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	13.1	-	mA
LTE Cat M1 data transfer (GNSS OFF)	B1 @ 22.58 dBm	218.72	579.88	mA
	B2 @ 22.99 dBm	216.74	569.73	mA
	B3 @ 22.96 dBm	226.63	602.05	mA
	B4 @ 22.82 dBm	225.59	605.28	mA
	B5 @ 22.83 dBm	233.79	623.5	mA
	B8 @ 22.89 dBm	226.57	599.92	mA
	B12 @ 22.71 dBm	218.31	572.86	mA
	B13 @ 23 dBm	230.49	614.29	mA
	B18 @ 22.75 dBm	227.33	604.2	mA
	B19 @ 22.56 dBm	231.22	618.52	mA
	B20 @ 23.03 dBm	241.04	656.09	mA
	B25 @ 22.74 dBm	212.63	553.65	mA
	B26 @ 23.13 dBm	234.54	627.52	mA
	B27 @ 22.54 dBm	225.16	593.1	mA
	B28A @ 23.01 dBm	224.57	605.41	mA

	B28B @ 23.29 dBm	231.88	627.39	mA
	B66 @ 22.76 dBm	219.52	579.61	mA
	B85 @ 23.02 dBm	220.6	579.15	mA
LTE Cat NB1 data transfer (GNSS OFF)	B1 @ 22.59 dBm	183.76	554.3	mA
	B2 @ 23.15 dBm	188.56	565.97	mA
	B3 @ 23.04 dBm	194.29	565.97	mA
	B4 @ 22.75 dBm	198.68	609.97	mA
	B5 @ 22.87 dBm	197.07	590.36	mA
	B8 @ 22.79 dBm	189.49	585.7	mA
	B12 @ 22.83 dBm	179.76	541.21	mA
	B13 @ 23.07 dBm	196.98	592.24	mA
	B18 @ 22.6 dBm	192.52	586.05	mA
	B19 @ 22.62 dBm	192.24	591.33	mA
	B20 @ 23.15 dBm	200.01	599.16	mA
	B25 @ 22.95 dBm	185.15	599.29	mA
	B28 @ 22.93 dBm	178.48	535.88	mA
	B66 @ 23.07 dBm	198.04	604.5	mA
	B71 @ 23 dBm	178.59	542.54	mA
	B85 @ 23.03 dBm	177.56	538.85	mA
GPRS data transfer (GNSS OFF)	GPRS GSM850 4UL/1DL @ 29.43 dBm	598.33	1279	mA
	GPRS GSM900 4UL/1DL @ 28.76 dBm	564.27	1193	mA
	GPRS DCS1800 4UL/1DL @ 25.83 dBm	440.14	884.67	mA
	GPRS PCS1900 4UL/1DL @ 25.81dBm	451.49	938.21	mA
EDGE data transfer (GNSS OFF)	EDGE GSM850 4UL/1DL @ 23.22 dBm	552.75	1145	mA
	EDGE GSM900 4UL/1DL @ 23.28 dBm	555.95	1148	mA

	EDGE DCS1800 4UL/1DL @ 21.63 dBm	491.43	1010	mA
	EDGE PCS1900 4UL/1DL @ 21.53 dBm	494.98	1033	mA

Table 43: BG95-M6 Current Consumption (3.8 V Power Supply, Room Temperature)

Description	Conditions	Average	Peak	Unit
Leakage 1)	Power-off @ USB and UART disconnected	13.57	-	μA
PSM 2)	Power Saving Mode	4.32	-	μA
Rock Bottom	**AT+CFUN=0** @ Sleep mode	0.473	-	mA
Sleep Mode (USB disconnected)	LTE Cat M1 DRX = 1.28 s	1.42	-	mA
	LTE Cat NB1 DRX = 1.28 s	1.31	-	mA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	0.58	-	mA
	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	0.55	-	mA
Idle Mode (USB disconnected)	LTE Cat M1 DRX = 1.28 s	18.5	-	mA
	LTE Cat NB1 DRX = 1.28 s	14.2	-	mA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	18.2	-	mA
	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	14	-	mA
LTE Cat M1 data transfer (GNSS OFF)	B1 @ 22.91 dBm	199.7	521.07	mA
	B2 @ 22.69 dBm	203.64	529.52	mA
	B3 @ 22.75 dBm	200.94	527.19	mA
	B4 @ 22.94 dBm	205.62	533.94	mA
	B5 @ 23.01 dBm	216.42	584.02	mA
	B8 @ 22.75 dBm	218.12	582.25	mA

	B12 @ 22.72 dBm	192.36	491.34	mA
	B13 @ 23.03 dBm	208.61	544.71	mA
	B18 @ 22.5 dBm	210.15	551.92	mA
	B19 @ 22.74 dBm	215.11	566.58	mA
	B20 @ 22.83 dBm	218.18	576.2	mA
	B25 @ 22.74 dBm	199.24	528.91	mA
	B26 @ 22.84 dBm	212.06	561.52	mA
	B27 @ 22.96 dBm	211.86	559.58	mA
	B28A @ 22.87 dBm	197.23	503.25	mA
	B28B @ 22.9 dBm	201.35	531.84	mA
	B66 @ 22.83 dBm	202.47	529.31	mA
	B85 @ 23.01 dBm	194.48	496.6	mA
LTE Cat NB1 data transfer (GNSS OFF)	B1 @ 22.84 dBm	177.8	539.7	mA
	B2 @ 22.76 dBm	172.31	535.5	mA
	B3 @ 22.68 dBm	167.18	501.91	mA
	B4 @ 22.98 dBm	176.91	542.41	mA
	B5 @ 22.91 dBm	179.95	555.78	mA
	B8 @ 23.09 dBm	193.03	593.4	mA
	B12 @ 23.07 dBm	162.89	492.78	mA
	B13 @ 22.96 dBm	172.4	522.68	mA
	B18 @ 22.73 dBm	175.49	534.71	mA
	B19 @ 22.95 dBm	181.95	558.57	mA
	B20 @ 22.98 dBm	187.71	581.39	mA
	B25 @ 22.87 dBm	172.34	523.64	mA
	B28 @ 22.96 dBm	163.55	496.88	mA

	B66 @ 23.13 dBm	178.54	547.51	mA
	B71 @ 23.1 dBm	160.7	499.26	mA
	B85 @ 23.02 dBm	161.07	501.5	mA

Table 44: BG95-MF Current Consumption (3.8 V Power Supply, Room Temperature)

Description	Conditions	Average	Peak	Unit
Leakage [1)]	Power-off @ USB and UART disconnected	13.79	-	μA
PSM [2)]	Power Saving Mode	4.04	-	μA
Rock Bottom	**AT+CFUN=0** @ Sleep mode	0.511	-	mA
Sleep Mode (USB disconnected)	LTE Cat M1 DRX = 1.28 s	1.59	-	mA
	LTE Cat NB1 DRX = 1.28 s	1.43	-	mA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	0.58	-	mA
	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	0.56	-	mA
Idle Mode (USB disconnected)	LTE Cat M1 DRX = 1.28 s	18.05	-	mA
	LTE Cat NB1 DRX = 1.28 s	14.22	-	mA
	LTE Cat M1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	17.97	-	mA
	LTE Cat NB1 e-I-DRX = 81.92 s @ PTW = 2.56 s, DRX = 1.28 s	14.1	-	mA
LTE Cat M1 data transfer (GNSS OFF)	B1 @ 21.11 dBm	175.75	428.59	mA
	B2 @ 21.31 dBm	174.58	427.47	mA
	B3 @ 20.92 dBm	168.92	406.56	mA
	B4 @ 21.1 dBm	170.65	406.14	mA
	B5 @ 21.07 dBm	188.66	469.44	mA

	B8 @ 21.13 dBm	185.65	456.7	mA
	B12 @ 21.14 dBm	178.63	434.13	mA
	B13 @ 21.37 dBm	192.08	491.1	mA
	B18 @ 21.49 dBm	193.67	506.72	mA
	B19 @ 21.26 dBm	192.39	481.9	mA
	B20 @ 21.28 dBm	191.3	488.73	mA
	B25 @ 21.05 dBm	175.43	433.5	mA
	B26 @ 21.15 dBm	190.49	477.35	mA
	B27 @ 21.54 dBm	194.89	490.41	mA
	B28A @ 21.09 dBm	179.64	438.68	mA
	B28B @ 21.08 dBm	186.91	463.68	mA
	B66 @ 20.93 dBm	169.54	416.36	mA
	B85 @ 21.4 dBm	180.21	441.58	mA
LTE Cat NB1 data transfer (GNSS OFF)	B1 @ 21.01 dBm	135.1	392.86	mA
	B2 @ 20.48 dBm	133.03	400.25	mA
	B3 @ 20.97 dBm	130.75	380.74	mA
	B4 @ 20.98 dBm	131.08	386.66	mA
	B5 @ 20.56 dBm	147.21	434.18	mA
	B8 @ 20.71 dBm	146.28	440.1	mA
	B12 @ 20.83 dBm	139.31	411.59	mA
	B13 @ 20.5 dBm	149.23	456.6	mA
	B18 @ 20.89 dBm	151.5	454.32	mA
	B19 @ 21.12 dBm	153.53	463.48	mA
	B20 @ 21.04 dBm	153.86	466.64	mA
	B25 @ 20.98 dBm	135.14	391.11	mA

	B28 @ 21.4 dBm	142.85	414.98	mA
	B66 @ 20.8 dBm	128.62	377.06	mA
	B71 @ 20.93 dBm	131.08	385.42	mA
	B85 @ 21.04 dBm	136.76	414.4	mA

NOTES

1. [1)] The current consumption of BG95 series in PSM is much lower than that in power-off mode, and this is due to the following two designs:
   - More internal power supplies are powered off in PSM.
   - Also, the internal clock frequency is reduced in PSM.
2. [2)] The module's USB and UART are disconnected and GSM network (if available) does not support PSM.

Table 45: GNSS Current Consumption of BG95-M1 (3.3 V Power Supply, Room Temperature)

Description	Conditions	Typ.	Unit
Searching (**AT+CFUN=0**)	Cold start @ Instrument	76.74	mA
	Host start @ Instrument	74.04	mA
	Warm start @ Instrument	76.19	mA
	Lost start @ Instrument	76.05	mA
Tracking (**AT+CFUN=0**)	Instrument Environment @ Passive Antenna	23.14	mA
	Open Sky @ Real network, Passive Antenna	26.352	mA
	Open Sky @ Real network, Active Antenna	27.463	mA

Table 46: GNSS Current Consumption of BG95-M2 (3.3 V Power Supply, Room Temperature)

Description	Conditions	Typ.	Unit
Searching (**AT+CFUN=0**)	Cold start @ Instrument	76.74	mA
	Host start @ Instrument	74.04	mA
	Warm start @ Instrument	76.19	mA

	Lost start @ Instrument	76.05	mA
Tracking (**AT+CFUN=0**)	Instrument Environment @ Passive Antenna	25.17	mA
	Open Sky @ Real network, Passive Antenna	22.717	mA
	Open Sky @ Real network, Active Antenna	25.698	mA

Table 47: GNSS Current Consumption of BG95-M3 (3.8 V Power Supply, Room Temperature)

Description	Conditions	Typ.	Unit
Searching (**AT+CFUN=0**)	Cold start @ Instrument	70.00	mA
	Host start @ Instrument	73.66	mA
	Warm start @ Instrument	72.54	mA
	Lost start @ Instrument	69.24	mA
Tracking (**AT+CFUN=0**)	Instrument Environment @ Passive Antenna	22.31	mA
	Open Sky @ Real network, Passive Antenna	21.792	mA
	Open Sky @ Real network, Active Antenna	22.357	mA

Table 48: GNSS Current Consumption of BG95-M4 (3.8 V Power Supply, Room Temperature)

Description	Conditions	Typ.	Unit
Searching (**AT+CFUN=0**)	Cold start @ Instrument	64.90	mA
	Host start @ Instrument	63.30	mA
	Warm start @ Instrument	64.47	mA
	Lost start @ Instrument	65.74	mA
Tracking (**AT+CFUN=0**)	Instrument Environment @ Passive Antenna	20.2	mA
	Open Sky @ Real network, Passive Antenna	23.045	mA
	Open Sky @ Real network, Active Antenna	23.173	mA

Table 49: GNSS Current Consumption of BG95-M5 (3.8 V Power Supply, Room Temperature)

Description	Conditions	Typ.	Unit
Searching (**AT+CFUN=0**)	Cold start @ Instrument	67.12	mA
	Host start @ Instrument	65.98	mA
	Warm start @ Instrument	66.46	mA
	Lost start @ Instrument	67.62	mA
Tracking (**AT+CFUN=0**)	Instrument Environment @ Passive Antenna	27.95	mA
	Open Sky @ Real network, Passive Antenna	22.723	mA
	Open Sky @ Real network, Active Antenna	23.529	mA

Table 50: GNSS Current Consumption of BG95-M6 (3.8 V Power Supply, Room Temperature)

Description	Conditions	Typ.	Unit
Searching (**AT+CFUN=0**)	Cold start @ Instrument	65.54	mA
	Host start @ Instrument	64.04	mA
	Warm start @ Instrument	65.37	mA
	Lost start @ Instrument	66.96	mA
Tracking (**AT+CFUN=0**)	Instrument Environment @ Passive Antenna	30.51	mA
	Open Sky @ Real network, Passive Antenna	21.608	mA
	Open Sky @ Real network, Active Antenna	27.773	mA

Table 51: GNSS Current Consumption of BG95-MF (3.8 V Power Supply, Room Temperature)

Description	Conditions	Typ.	Unit
Searching (**AT+CFUN=0**)	Cold start @ Instrument	69.72	mA
	Host start @ Instrument	64.13	mA
	Warm start @ Instrument	70.81	mA

	Lost start @ Instrument	67.14	mA
Tracking (**AT+CFUN=0**)	Instrument Environment @ Passive Antenna	22.33	mA
	Open Sky @ Real network, Passive Antenna	20.065	mA
	Open Sky @ Real network, Active Antenna	21.829	mA

6.5. RF Output Power

Table 52: Conducted RF Output Power of BG95-M1/-M2/-M3/-MF

Frequency Bands	Max. RF Output Power	Min. RF Output Power
LTE-FDD B1/B2/B3/B4/B5/B8/B12/B13/B18/ B19/B20/ B25/B26 1)/B27 1)/B28/B66/B71 2)/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

Table 53: Conducted RF Output Power of BG95-M4

Frequency Bands	Max. RF Output Power	Min. RF Output Power
LTE-FDD B1/B2/B3/B4/B5/B8/B12/B13/B18/ B19/B20/ B25/B26 1)/B27 1)/B28/B66/B85	21 dBm +1.7/-3 dB	< -39 dBm
LTE-FDD B31/B72/B73 3)	23 dBm ±2 dB	< -39 dBm

Table 54: Conducted RF Output Power of BG95-M5/-M6

Frequency Bands	Max. RF Output Power	Min. RF Output Power
LTE-FDD B1/B2/B3/B4/B5/B8/B12/B13/B18/ B19/B20/ B25/B26 1)/B27 1)/B28/B66/B71 2) /B85	23 dBm ±2 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

NOTES

1. [1] LTE-FDD B26 and B27 are supported by Cat M1 only.
2. [2] LTE-FDD B71 is supported by Cat NB2 only.
3. [3] LTE-FDD B31, B72 and B73 for BG95-M4 supports Power Class 2 (26 dBm) and Power Class 3 (23 dBm). Power Class 2 for BG95-M4 is under development.

6.6. RF Receiving Sensitivity

Table 55: Conducted RF Receiving Sensitivity of BG95-M1

Mode	Band	Primary	Diversity	Receiving Sensitivity (dBm)	
				Cat M1/3GPP	Cat NB2
LTE	LTE-FDD B1	Supported	Not Supported	-108/-102.3	Not Supported
	LTE-FDD B2			-108.4/-100.3	
	LTE-FDD B3			-108.4/-99.3	
	LTE-FDD B4			-108/-102.3	
	LTE-FDD B5			-107.6/-100.8	
	LTE-FDD B8			-108/-99.8	
	LTE-FDD B12			-108.6/-99.3	
	LTE-FDD B13			-107/-99.3	
	LTE-FDD B18			-108/-102.3	
	LTE-FDD B19			-108/-102.3	
	LTE-FDD B20			-108/-99.8	

	LTE-FDD B25			-108.2/-100.3	
	LTE-FDD B26			-108.2/-100.3	
	LTE-FDD B27			-108.4-100.8	
	LTE-FDD B28			-106.8/-100.8	
	LTE-FDD B66			-107.8/-101.8	
	LTE-FDD B71			Not Supported	
	LTE-FDD B85			-108.4/-99.3	

Table 56: Conducted RF Receiving Sensitivity of BG95-M2

Mode	Band	Primary	Diversity	Receiving Sensitivity (dBm)	
				Cat M1/3GPP	Cat NB2 1)/3GPP
LTE	LTE-FDD B1	Supported	Not Supported	-107/-102.3	-114/-107.5
	LTE-FDD B2			-107/-100.3	-116/-107.5
	LTE-FDD B3			-107/-99.3	-113/-107.5
	LTE-FDD B4			-107/-102.3	-114/-107.5
	LTE-FDD B5			-107/-100.8	-115/-107.5
	LTE-FDD B8			-107/-99.8	-113/-107.5
	LTE-FDD B12			-107/-99.3	-116/-107.5
	LTE-FDD B13			-107/-99.3	-114/-107.5
	LTE-FDD B18			-107/-102.3	-116/-107.5
	LTE-FDD B19			-107/-102.3	-116/-107.5
	LTE-FDD B20			-107/-99.8	-115/-107.5
	LTE-FDD B25			-107/-100.3	-115/-107.5
	LTE-FDD B26			-107/-100.3	Not Supported
	LTE-FDD B27			-107/-100.8	Not Supported

	LTE-FDD B28			-107/-100.8	-115/-107.5
	LTE-FDD B66			-107/-101.8	-115/-107.5
	LTE-FDD B71			Not Supported	-115/-107.5
	LTE-FDD B85			-107/-99.3	-115/-107.5

Table 57: Conducted RF Receiving Sensitivity of BG95-M3

Mode	Band	Primary	Diversity	Receiving Sensitivity (dBm)	
				Cat M1/3GPP	Cat NB2 1)/3GPP
LTE	LTE-FDD B1	Supported	Not Supported	-106.5/-102.3	-113/-107.5
	LTE-FDD B2			-106/-100.3	-114/-107.5
	LTE-FDD B3			-106/-99.3	-114/-107.5
	LTE-FDD B4			-106.5/-102.3	-114/-107.5
	LTE-FDD B5			-106/-100.8	-115/-107.5
	LTE-FDD B8			-106/-99.8	-114/-107.5
	LTE-FDD B12			-106.5/-99.3	-115/-107.5
	LTE-FDD B13			-106.5-99.3	-115/-107.5
	LTE-FDD B18			-106/-102.3	-115/-107.5
	LTE-FDD B19			-106/-102.3	-115/-107.5
	LTE-FDD B20			-106/-99.8	-114/-107.5
	LTE-FDD B25			-106/-100.3	-114/-107.5
	LTE-FDD B26			-106/-100.3	Not Supported
	LTE-FDD B27			-106.5/-100.8	Not Supported
	LTE-FDD B28			-106/-100.8	-115/-107.5
	LTE-FDD B66			-106.5-101.8	-114/-107.5
	LTE-FDD B71			Not Supported	-115/-107.5

	LTE-FDD B85			-106.5/-99.3	-115/-107.5

Mode	Band	Primary	Diversity	Receiving Sensitivity (dBm)
				GSM/3GPP
GSM	GSM850/EGSM900	Supported	Not Supported	-107/-102
	DCS1800/PCS1900			-107/-102

Table 58: Conducted RF Receiving Sensitivity of BG95-M4

Mode	Band	Primary	Diversity	Receiving Sensitivity (dBm)	
				Cat M1/3GPP	Cat NB2 1)/3GPP
LTE	LTE-FDD B1	Supported	Not Supported	-107/-102.3	-116/-107.5
	LTE-FDD B2			-107/-100.3	-116/-107.5
	LTE-FDD B3			-107/-99.3	-116/-107.5
	LTE-FDD B4			-107/-102.3	-116/-107.5
	LTE-FDD B5			-107/-100.8	-116/-107.5
	LTE-FDD B8			-107/-99.8	-115/-107.5
	LTE-FDD B12			-107/-99.3	-116/-107.5
	LTE-FDD B13			-107/-99.3	-116/-107.5
	LTE-FDD B18			-106/-102.3	-115/-107.5
	LTE-FDD B19			-107/-102.3	-115/-107.5
	LTE-FDD B20			-107/-99.8	-115/-107.5
	LTE-FDD B25			-107/-100.3	-115/-107.5
	LTE-FDD B26			-107/-100.3	Not Supported
	LTE-FDD B27			-107/-100.8	Not Supported
	LTE-FDD B28			-107/-100.8	-115/-107.5
	LTE-FDD B31			-105/-96.6	-114/-107.5

	LTE-FDD B66			-107/-101.8	-114/-107.5
	LTE-FDD B72			-106/-96.6	-114/-107.5
	LTE-FDD B73			-106/-96.6	-114/-107.5
	LTE-FDD B85			-107/-99.3	-115/-107.5

Table 59: Conducted RF Receiving Sensitivity of BG95-M5

Mode	Band	Primary	Diversity	Receiving Sensitivity (dBm)	
				Cat M1/3GPP	Cat NB2 1)/3GPP
LTE	LTE-FDD B1	Supported	Not Supported	-106.5/-102.3	-114/-107.5
	LTE-FDD B2			-107.5/-100.3	-115/-107.5
	LTE-FDD B3			-108.0/-99.3	-114/-107.5
	LTE-FDD B4			-108.0/-102.3	-114/-107.5
	LTE-FDD B5			-107.5/-100.8	-114/-107.5
	LTE-FDD B8			-106.5/-99.8	-114/-107.5
	LTE-FDD B12			-106.5/-99.3	-114/-107.5
	LTE-FDD B13			-107.5/-99.3	-114/-107.5
	LTE-FDD B18			-107.5/-102.3	-115/-107.5
	LTE-FDD B19			-107.5/-102.3	-114/-107.5
	LTE-FDD B20			-107.5/-99.8	-114/-107.5
	LTE-FDD B25			-107.5/-100.3	-114/-107.5
	LTE-FDD B26			-107.5/-100.3	Not Supported
	LTE-FDD B27			-107.5/-100.8	Not Supported
	LTE-FDD B28			-107.5/-100.8	-114/-107.5
	LTE-FDD B66			-107.5/-101.8	-114/-107.5
	LTE-FDD B71			Not Supported	-115/-107.5

	LTE-FDD B85			-107.5/-99.3	-114/-107.5

Mode	Band	Primary	Diversity	Receiving Sensitivity (dBm)
				GSM/3GPP
GSM	GSM850/EGSM900	Supported	Not Supported	-107/-102
	DCS1800/PCS1900			-107/-102

Table 60: Conducted RF Receiving Sensitivity of BG95-M6

Mode	Band	Primary	Diversity	Receiving Sensitivity (dBm)	
				Cat M1/3GPP	Cat NB2 1)/3GPP
LTE	LTE-FDD B1	Supported	Not Supported	-106.5/-102.3	-114/-107.5
	LTE-FDD B2			-107/-100.3	-115/-107.5
	LTE-FDD B3			-107/-99.3	-114/-107.5
	LTE-FDD B4			-106.5/-102.3	-114/-107.5
	LTE-FDD B5			-107.5/-100.8	-115/-107.5
	LTE-FDD B8			-107.5/-99.8	-115/-107.5
	LTE-FDD B12			-107.5/-99.3	-115/-107.5
	LTE-FDD B13			-107.5/-99.3	-115/-107.5
	LTE-FDD B18			-107.5/-102.3	-115/-107.5
	LTE-FDD B19			-107.5/-102.3	-115/-107.5
	LTE-FDD B20			-107.5/-99.8	-114/-107.5
	LTE-FDD B25			-107.5/-100.3	-114/-107.5
	LTE-FDD B26			-107.5/-100.3	Not Supported
	LTE-FDD B27			-107.5/-100.8	Not Supported
	LTE-FDD B28			-107.5/-100.8	-115/-107.5
	LTE-FDD B66			-107.5/-101.8	-114/-107.5
	LTE-FDD B71			Not Supported	-115/-107.5
	LTE-FDD B85			-107.5/-99.3	-115/-107.5

Table 61: Conducted RF Receiving Sensitivity of BG95-MF

Mode	Band	Primary	Diversity	Receiving Sensitivity (dBm)	
				Cat M1/3GPP	Cat NB2 1)/3GPP
LTE	LTE-FDD B1	Supported	Not Supported	-108/-102.3	-115/-107.5
	LTE-FDD B2			-108/-100.3	-115/-107.5
	LTE-FDD B3			-107/-99.3	-115/-107.5
	LTE-FDD B4			-108/-102.3	-115/-107.5
	LTE-FDD B5			-108/-100.8	-115/-107.5
	LTE-FDD B8			-107 /-99.8	-115/-107.5
	LTE-FDD B12			-108/-99.3	-115/-107.5
	LTE-FDD B13			-108/-99.3	-115/-107.5
	LTE-FDD B18			-108/-102.3	-115/-107.5
	LTE-FDD B19			-107/-102.3	-115/-107.5
	LTE-FDD B20			-108/-99.8	-115/-107.5
	LTE-FDD B25			-108/-100.3	-115/-107.5
	LTE-FDD B26			-108/-100.3	Not Supported
	LTE-FDD B27			-108/-100.8	Not Supported
	LTE-FDD B28			-108/-100.8	-115/-107.5
	LTE-FDD B66			-108/-101.8	-115/-107.5
	LTE-FDD B71			Not Supported	-115/-107.5
	LTE-FDD B85			-108/-99.3	-115/-107.5

Table 62: Conducted RF Receiving Sensitivity of BG95-MF Wi-Fi

	Standard	Rate	Receiving Sensitivity
2.4 GHz	802.11b	1 Mbps	-93 dBm
	802.11b	11 Mbps	-88 dBm

	802.11g	6 Mbps	-90 dBm
	802.11g	54 Mbps	-74 dBm
	802.11n HT20	MCS0	-89 dBm
	802.11n HT20	MCS7	-70 dBm

NOTE

[1)] LTE Cat NB2 receiving sensitivity without repetitions.

6.7. Electrostatic Discharge

The module is not protected against electrostatics discharge (ESD) in general. Consequently, it is subject to ESD handling precautions that typically apply to ESD sensitive components. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates the module.

Table 63: Electrostatic Discharge Characteristics (25 ºC, 45 % Relative Humidity)

Tested Interfaces	Contact Discharge	Air Discharge	Unit
VBAT, GND	± 6	± 8	kV
Main/GNSS Antenna Interfaces	± 5	± 6	kV

7 Mechanical Dimensions

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

7.1. Mechanical Dimensions

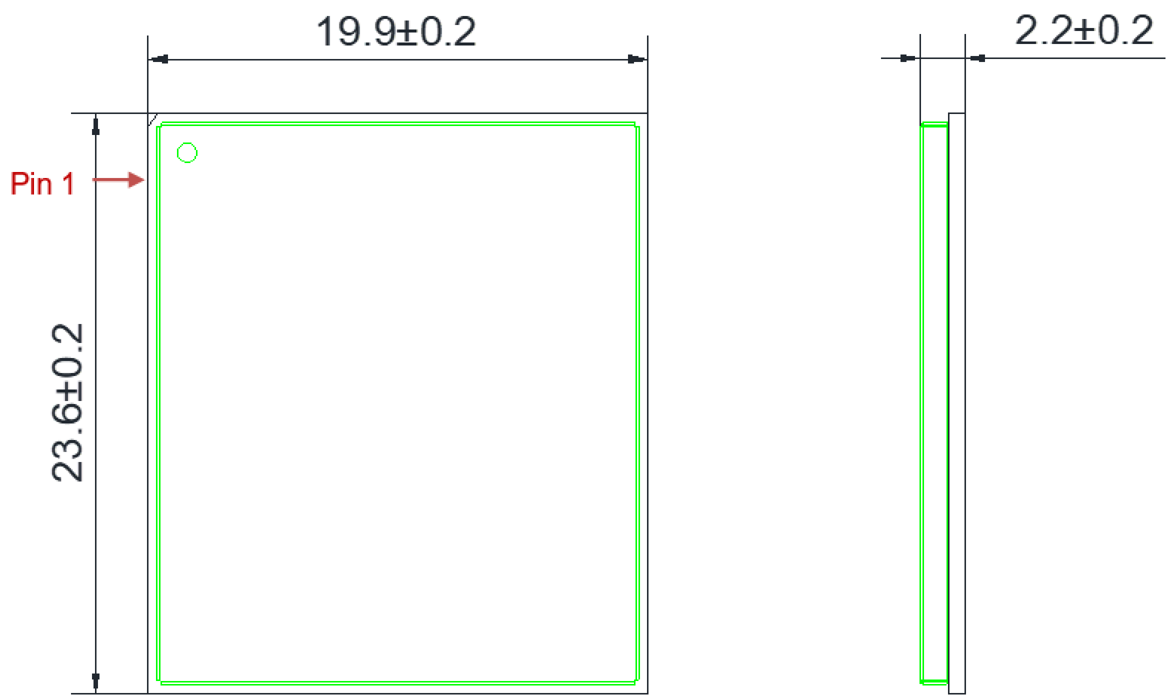


Figure 40: Module Top and Side Dimensions

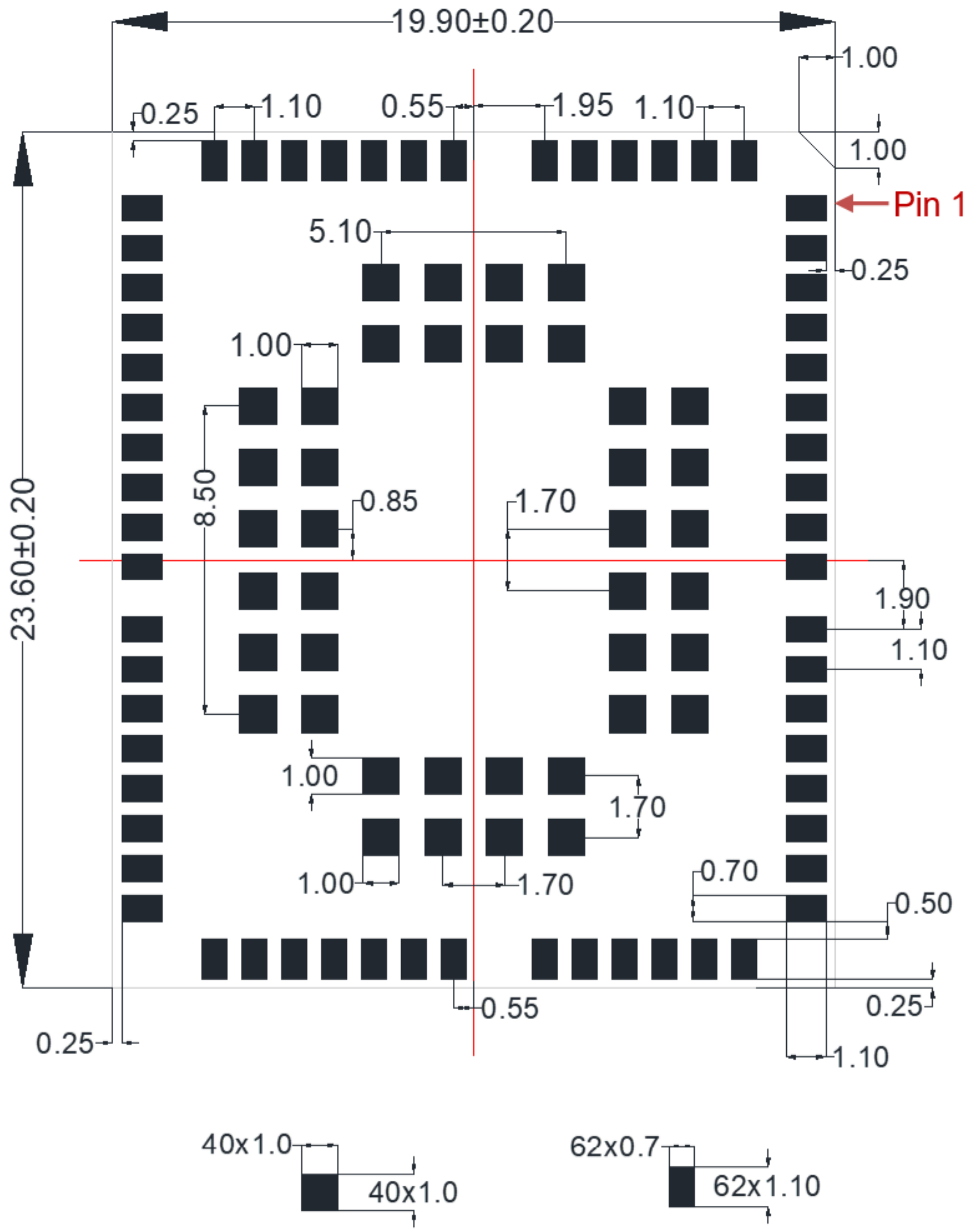


Figure 41: Module Bottom Dimensions (Bottom View)

NOTE

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

7.2. Recommended Footprint

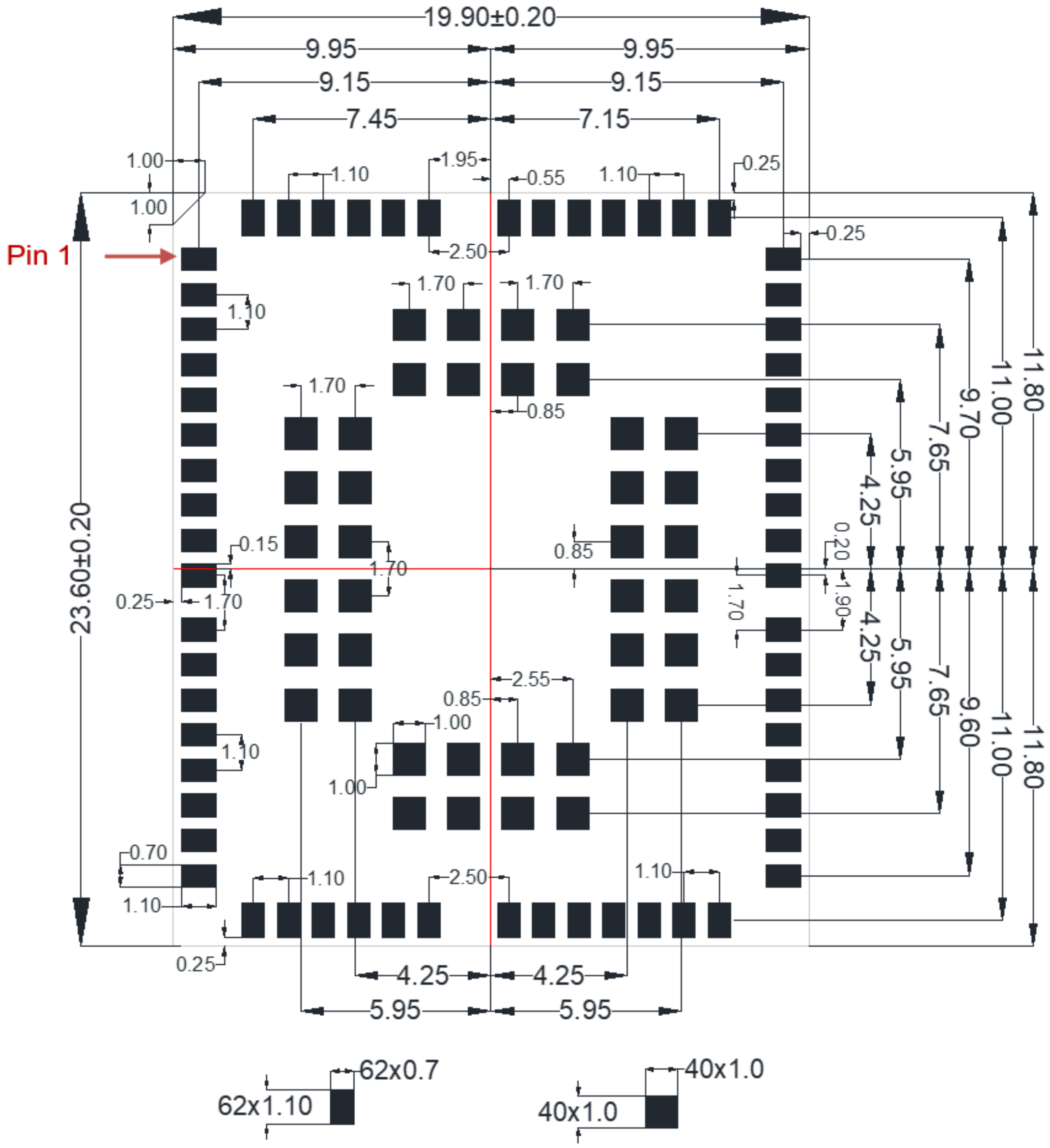


Figure 42: Recommended Footprint (Top View)

NOTES

1. For easy maintenance of the module, keep about 3 mm between the module and other components on the motherboard.
2. All RESERVED pins must be kept open.
3. For stencil design requirements of the module, see ***document [5]***.

7.3. Top and Bottom Views

Figure 43: Top View and Bottom Views

NOTE

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

8 Storage, Manufacturing and Packaging

8.1. Storage

BG95 series is provided with vacuum-sealed packaging. MSL of the module is rated as 3. The storage requirements are shown below.

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

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

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

4. The module should be pre-baked to avoid blistering, cracks and inner-layer separation in PCB under the following circumstances:

   - The module is not stored in Recommended Storage Condition;
   - Violation of the third requirement above occurs;
   - Vacuum-sealed packaging is broken, or the packaging has been removed for over 24 hours;
   - Before module repairing.

5. If needed, the pre-baking should follow the requirements below:

   - The module should be baked for 8 hours at 120 ±5 °C;
   - All modules must be soldered to PCB within 24 hours after the baking, otherwise they should be put in a dry environment such as in a drying oven.

NOTES

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

8.2. Manufacturing and Soldering

Push the squeegee to apply the solder paste on the surface of stencil, thus making the paste fill the stencil openings and then penetrate to the PCB. The force on the squeegee should be adjusted properly so as to produce a clean stencil surface on a single pass. To ensure the module soldering quality, the thickness of stencil for the module is recommended to be 0.13–0.15 mm. For more details, see ***document [5]***.

It is suggested that the peak reflow temperature is 238–246 ºC, and the absolute maximum reflow temperature is 246 ºC. To avoid damage to the module caused by repeated heating, it is strongly recommended that the module should be mounted after reflow soldering for the other side of PCB has been completed. The recommended reflow soldering thermal profile (lead-free reflow soldering) and related parameters are shown below.

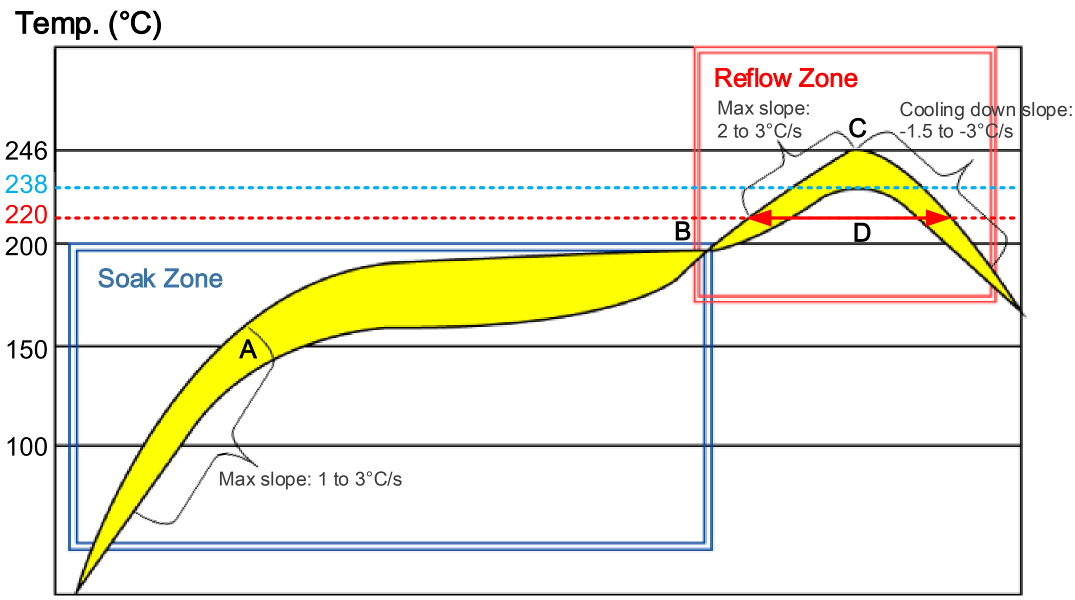


Figure 44: Recommended Reflow Soldering Thermal Profile

Table 64: Recommended Thermal Profile Parameters

Factor	Recommendation
Soak Zone	
Max slope	1–3 °C/s
Soak time (between A and B: 150 °C and 200 °C)	70–120 s
Reflow Zone	
Max slope	2–3 °C/s
Reflow time (D: over 220 °C)	45–70 s
Max temperature	238–246 °C
Cooling down slope	-1.5 to -3 °C/s
Reflow Cycle	
Max reflow cycle	1

NOTE

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

8.3. Packaging

BG95 series is packaged in a vacuum-sealed bag which is ESD protected. The bag should not be opened until the devices are ready to be soldered onto the application.

The reel is 330 mm in diameter and each reel contains 250 modules. The following figures show the packaging details, measured in millimeter (mm).

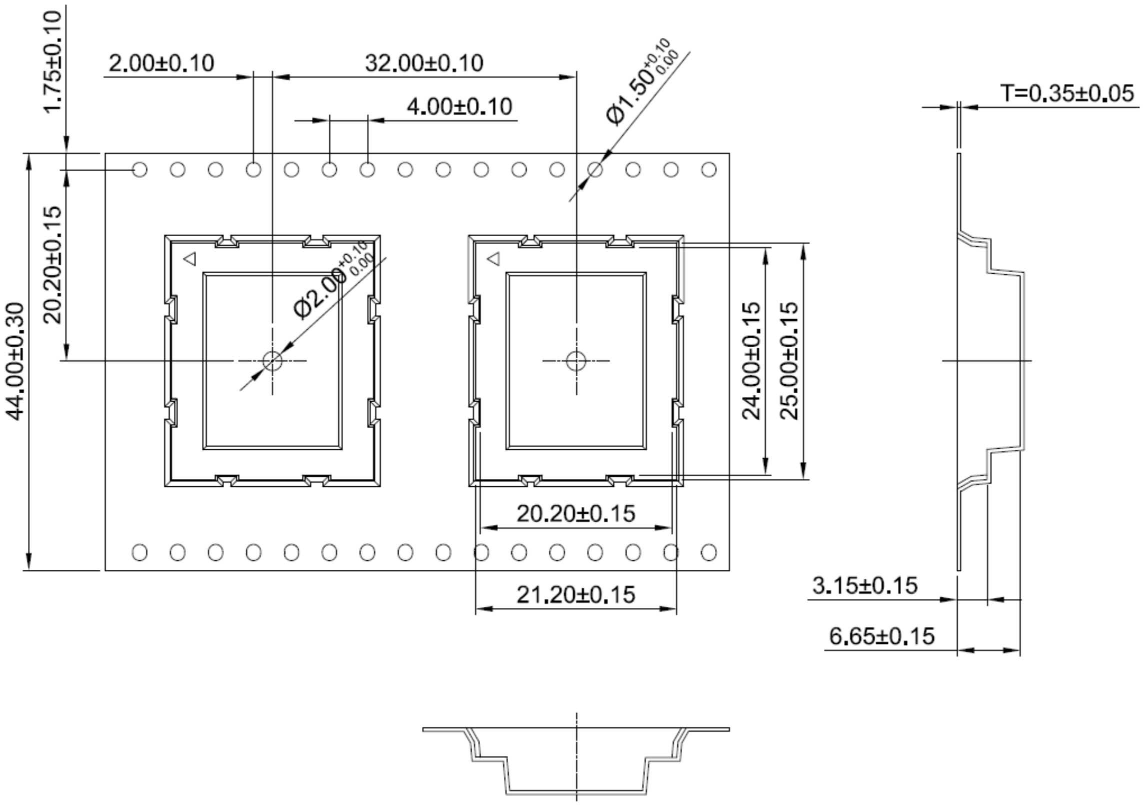


Figure 45: Tape Dimensions

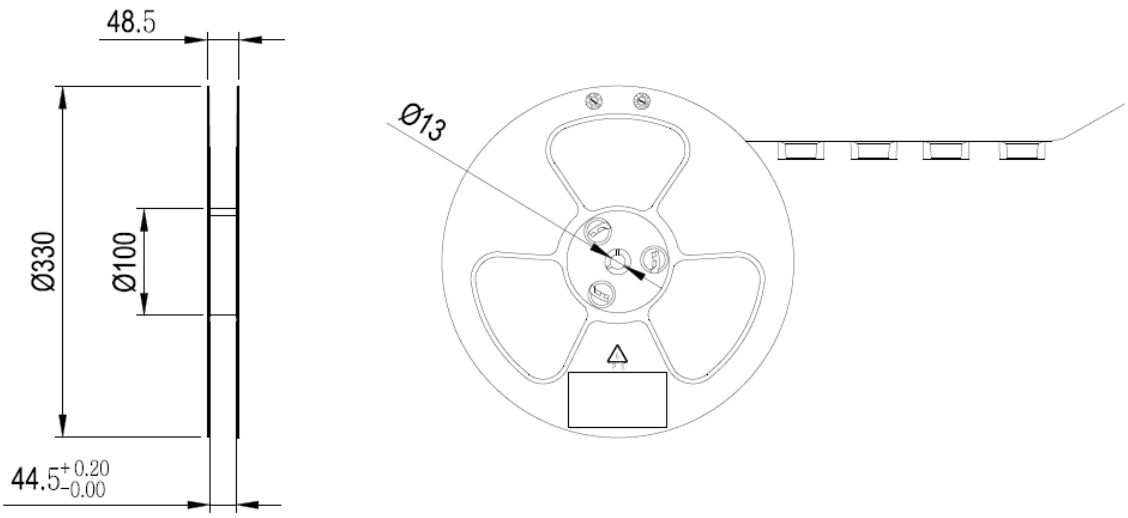


Figure 46: Reel Dimensions

Table 65: Packaging Specifications of BG95

MOQ for MP	Minimum Package: 250	Minimum Package × 4 = 1000
250	Size: 370 mm × 350 mm × 56 mm N.W: 0.61 kg G.W: 1.35 kg	Size: 380 mm × 250 mm × 365 mm N.W: 2.45 kg G.W: 6.28 kg

9 Appendix A References

Table 66: Related Documents

SN	Document Name	Remark
[1]	Quectel_UMTS&LTE_EVB_User_Guide	UMTS&LTE EVB user guide
[2]	Quectel_BG95&BG77&BG600L_Series_ AT_Commands_Manual	AT commands manual of BG95 series and BG77 modules
[3]	Quectel_BG95&BG77&BG600L_Series_ GNSS_Application_Note	GNSS application note of BG95 series, BG77 and BG600L-M3 modules
[4]	Quectel_RF_Layout_Application_Note	RF layout application note
[5]	Quectel_Module_Secondary_SMT_Application_Note	Secondary SMT application note for Quectel modules
[6]	Quectel_BG95&BG77&BG600L_Series_ QCFG_AT_ Commands_Manual	BG95/BG77/BG600L QCFG Commands Manual

Table 67: Terms and Abbreviations

Abbreviation	Description
AMR	Adaptive Multi-rate
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
DTR	Data Terminal Ready

DTX	Discontinuous Transmission
e-I-DRX	Extended Idle Mode Discontinuous Reception
EPC	Evolved Packet Core
ESD	Electrostatic Discharge
FDD	Frequency Division Duplex
FR	Full Rate
GMSK	Gaussian Minimum Shift Keying
GSM	Global System for Mobile Communications
HSS	Home Subscriber Server
I2C	Inter-Integrated Circuit
I/O	Input/Output
LED	Light Emitting Diode
LNA	Low Noise Amplifier
LTE	Long Term Evolution
MO	Mobile Originated
MS	Mobile Station (GSM engine)
MT	Mobile Terminated
PAP	Password Authentication Protocol
PCB	Printed Circuit Board
PDU	Protocol Data Unit
PPP	Point-to-Point Protocol
PSM	Power Saving Mode
RF	Radio Frequency
RHCP	Right Hand Circularly Polarized
Rx	Receive

SISO	Single Input Single Output
SMS	Short Message Service
TDD	Time Division Duplexing
TX	Transmitting Direction
UL	Uplink
UE	User Equipment
URC	Unsolicited Result Code
(U)SIM	(Universal) Subscriber Identity Module
Vmax	Maximum Voltage Value
Vnom	Nominal Voltage Value
Vmin	Minimum Voltage Value
V_{IH}max	Maximum Input High Level Voltage Value
V_{IH}min	Minimum Input High Level Voltage Value
V_{IL}max	Maximum Input Low Level Voltage Value
V_{IL}min	Minimum Input Low Level Voltage Value
V_{I}max	Absolute Maximum Input Voltage Value
V_{I}min	Absolute Minimum Input Voltage Value
V_{OH}max	Maximum Output High Level Voltage Value
V_{OH}min	Minimum Output High Level Voltage Value
V_{OL}max	Maximum Output Low Level Voltage Value
V_{OL}min	Minimum Output Low Level Voltage Value
VSWR	Voltage Standing Wave Ratio
WWAN	Wireless Wide Area Network

10 Appendix B GPRS Coding Schemes

Table 68: Description of Different Coding Schemes

Scheme	CS-1	CS-2	CS-3	CS-4
Code Rate	1/2	2/3	3/4	1
USF	3	3	3	3
Pre-coded USF	3	6	6	12
Radio Block excl.USF and BCS	181	268	312	428
BCS	40	16	16	16
Tail	4	4	4	-
Coded Bits	456	588	676	456
Punctured Bits	0	132	220	-
Data Rate Kb/s	9.05	13.4	15.6	21.4

11 Appendix C GPRS Multi-slot Classes

Twenty-nine classes of GPRS multi-slot modes are defined for MS in GPRS specification. Multi-slot classes are product dependent, and determine the maximum achievable data rates in both the uplink and downlink directions. Written as 3 + 1 or 2 + 2, the first number indicates the amount of downlink timeslots, while the second number indicates the amount of uplink timeslots. The active slots determine the total number of slots the GPRS device can use simultaneously for both uplink and downlink communications.

The description of different multi-slot classes is shown in the following table.

Table 69: GPRS Multi-slot Classes

Multislot Class	Downlink Slots	Uplink Slots	Active Slots
1	1	1	2
2	2	1	3
3	2	2	3
4	3	1	4
5	2	2	4
6	3	2	4
7	3	3	4
8	4	1	5
9	3	2	5
10	4	2	5
11	4	3	5
12	4	4	5
13	3	3	NA
14	4	4	NA

15	5	5	NA
16	6	6	NA
17	7	7	NA
18	8	8	NA
19	6	2	NA
20	6	3	NA
21	6	4	NA
22	6	4	NA
23	6	6	NA
24	8	2	NA
25	8	3	NA
26	8	4	NA
27	8	4	NA
28	8	6	NA
29	8	8	NA
30	5	1	6
31	5	2	6
32	5	3	6
33	5	4	6

12 Appendix D EDGE Modulation and Coding Schemes

Table 70: EDGE Modulation and Coding Schemes

Coding Schemes	Modulation	Coding Family	1 Timeslot	2 Timeslot	4 Timeslot
MCS-1	GMSK	C	8.80 kbps	17.60 kbps	35.20 kbps
MCS-2	GMSK	B	11.2 kbps	22.4 kbps	44.8 kbps
MCS-3	GMSK	A	14.8 kbps	29.6 kbps	59.2 kbps
MCS-4	GMSK	C	17.6 kbps	35.2 kbps	70.4 kbps
MCS-5	8-PSK	B	22.4 kbps	44.8 kbps	89.6 kbps
MCS-6	8-PSK	A	29.6 kbps	59.2 kbps	118.4 kbps
MCS-7	8-PSK	B	44.8 kbps	89.6 kbps	179.2 kbps
MCS-8	8-PSK	A	54.4 kbps	108.8 kbps	217.6 kbps
MCS-9	8-PSK	A	59.2 kbps	118.4 kbps	236.8 kbps

13 Appendix E Compulsory Certifications

By the issue date of the document, BG95-M5 has been certified by JATE and TELEC.

R 003-200108

T D200087003

Figure 47: JATE/TELEC Certification ID of BG95-M5