BG96-NA

Hardware Design

LTEModule Series

Rev. BG96-NA_Hardware_Design_V1.0

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About the Document

History

Revision	Date	Author	Description
1.0	2017-04-28	Allen WANG/ Daryl DU	Initial

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1 Introduction

This document defines the BG96-NAmodule and describes its air interface and hardware interface which are connected with your application.

This document can help you quickly understand module interface specifications, electrical andmechanical details, etc. Associated with application note and user guide, you can use BG96-NA module to design and set up mobile applications easily.

1.1. Safety Information

The following safety precautions must be observed during all phases of the operation, such as usage, service or repair of any cellular terminal or mobile incorporating BG96-NA module. Manufacturers of the cellular terminal should send the following safety information to users and operating personnel, and incorporate these guidelines into all manuals supplied with the product. If not so, Quectel assumes no liability for the customer's failure to comply with these precautions.

	Full attention must be given 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. You must comply with laws and regulations restricting the use of wireless devices while driving.
	Switch off the cellular terminal or mobile before boarding an aircraft. Make sure it is switched off. The operation of wireless appliances in an aircraft is forbidden, so as to prevent interference with communication systems. Consult the airline staff about the use of wireless devices on boarding the aircraft, if your device offers an Airplane Mode which must be enabled prior to boarding an aircraft.
	Switch off your wireless device when in hospitals,clinics or other health care facilities. These requests are desinged to prevent possible interference with sensitive medical equipment.
	Cellular terminals or mobiles operatingover radio frequency signal and cellular network cannot be guaranteed to connect in all conditions, for example no mobile fee or with an invalid (U)SIM card. While you are in this condition and need emergent help, please remember using emergency call. In order to make or receive a call, the cellular terminal or mobile must be switched on and in a service area with adequate cellular signal strength.
	Your cellular terminal or mobile contains a transmitter and receiver. When it is ON, it receives and transmits radio frequency energy. RF interference can occur if it is used close to TV set, radio, computer or other electric equipment.
	In locations with potentially explosive atmospheres, obey all posted signs to turn off wireless devices such as your phone or other cellular terminals. Areas with potentially explosive atmospheres includefuelling areas, below decks on boats, fuel or chemical transfer or storage facilities, areas where the air contains chemicals or particles such as grain, dust or metal powders, etc.

1.2 FCC Certification Requirements.

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

And the following conditions must be met:

1. This Modular Approval is limited to OEM installation for mobile and fixed applications only. The antenna installation and operating configurations of this transmitter, including any applicable source-based time-averaging duty factor, antenna gain and cable loss must satisfy MPE categorical Exclusion Requirements of 2.1091.

2. The EUT is a mobile device; maintain at least a 20 cm separation between the EUT and the user's body and must not transmit simultaneously with any other antenna or transmitter.

3.A label with the following statements must be attached to the host end product: This device contains FCC ID: XMR201705BG96NA

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

- ❒ LTE Band2:≤8.00dBi
- ❒ LTE Band4:≤5.00dBi
- ❒ LTE Band12:≤8.734dBi
- ❒ LTE Band13:≤9.173dBi

5. This module must not transmit simultaneously with any other antenna or transmitter

6. The host end product must include a user manual that clearly defines operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.

For portable devices, in addition to the conditions 3 through 6 described above, a separate approval is required to satisfy the SAR requirements of FCC Part 2.1093

If the device is used for other equipment that separate approval is required for all other operating configurations, including portable configurations with respect to 2.1093 and different antenna configurations.

For this device, OEM integrators must be provided with labeling instructions of finished products. Please refer to KDB784748 D01 v07, section 8. Page 6/7 last two paragraphs:

A certified modular has the option to use a permanently affixed label, or an electronic label. For a permanently affixed label, the module must be labeled with an FCC ID - Section 2.926 (see 2.2 Certification (labeling requirements) above). The OEM manual must provide clear instructions explaining to the OEM the labeling requirements, options and OEM user manual instructions that are required (see next paragraph).

For a host using a certified modular with a standard fixed label, if (1) the module's FCC ID is not visible when installed in the host, or (2) if the host is marketed so that end users do not have straightforward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module:"Contains Transmitter Module FCC ID: XMR201705BG96NA" or "Contains FCC ID: XMR201705BG96NA" must be used. The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.

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

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

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

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

To ensure compliance with all non-transmitter functions the host manufacturer is responsible for ensuring compliance with the module(s) installed and fully operational. For example, if a host was previously authorized as an unintentional radiator under the Declaration of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that the after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements

2 Product Concept

2.1. General Description

BG96-NAmodule is anembeddedIoT(LTE CatM1) wireless communication modulewithout receive diversity. It supportsHalf-duplex LTE-FDD wireless communication, whichprovides data connectivity on LTE-FDDnetworks. The following table shows the frequency bands of BG96-NA module.

Table 1: Frequency Bands of BG96-NA Module

Module	LTE Bands	GSM	Rx-diversity	GNSS (Optional)
BG96-NA	FDD: B2/B4/B12/B13	Not Supported	Not Supported	GPS, GLONASS,BeiDou/Compass, Galileo, QZSS

With a compact profile of 22.5mm ×26.5mm ×2.3mm, BG96-NA can meet almost all requirements for M2M applications such as automotive, metering, tracking system, security, router, wireless POS, mobile computing device, PDA phone, tablet PC, etc.

BG96-NA is an SMD type module which can be embedded into application through its 102 LGA pads.

BG96-NAsupports internet service protocols like TCP, UDP and PPP. Extended AT commands have been developed for customers to use these internet service protocols easily.

2.2. Key Features

The following table describes the detailed features of BG96-NA module.

Table 2: Key Features of BG96-NA

Features	Details
Power Supply	Supply voltage: 3.3V~4.3V Typical supply voltage: 3.8V
Transmitting Power	Class 3 (23dBm±2.7dB) for LTE-FDD bands
LTE Features	Support up to LTE Cat M1 Support 1.08MHz RF bandwidth Support SISO in DL direction Cat M1: Max. 375kbps (DL)/375kbps (UL)
Internet Protocol Features*	Support TCP/UDP/PPP protocols Support PAP (Password Authentication Protocol) and CHAP (Challenge Handshake Authentication Protocol) protocols which are usually used 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 (U)SIM card: 1.8V, 3.0V
USB Interface	Compliant with USB 2.0 specification (slave only); the data transfer rate can reach up to 480Mbps Used for AT command communication, data transmission, GNSS NMEA output, software debugging and firmware upgrade SupportUSB drivers forWindows XP, Windows Vista, Windows 7, Windows 8/8.1, Windows 10, Windows CE 5.0/6.0/7.0*,Linux 2.6/3.x/4.1,Android 4.x/5.x/6.0
UART Interface	**UART1:** Used for AT command communication and data transmission Baud rate reach up to 3000000bps; 115200bps by default Support RTS and CTS hardware flow control **UART2:** Used for module debugging and log output 115200bps baud rate
AT Commands	3GPP TS 27.007 and 3GPP TS 27.005 AT commands, as well as Quectel enhanced AT commands
Network Indication	OneNETLIGHT pin for network connectivity status indication

Antenna Interfaces	Including main antenna (ANT_MAIN) and GNSS antenna (ANT_GNSS) interfaces
Physical Characteristics	Size: 22.5mm ×26.5mm×2.3mm Weight: 3.1g
Temperature Range	Operation temperature range: -35°C ~ +75°C[1)] Extended temperature range: -40°C ~ +85°C[2)]
Firmware Upgrade	USB interface and DFOTA*
RoHS	All hardware components are fully compliant with EU RoHS directive

NOTES

1. [1)] Within operation temperature range, the module is 3GPP compliant.
2. [2)] Within extended temperature range, the module remains the ability to establish and maintain SMS, data transmission, etc. There is no unrecoverable malfunction. Only one or more parameters like P_{out} might reduce in their value and exceed the specified tolerances. When the temperature returns to the normal operating temperature levels, the module will meet 3GPP compliant again.
3. "*" means under development.

2.3. Functional Diagram

The following figure shows a block diagram of BG96-NA and illustrates the major functional parts.

- Power management
- Baseband
- DDR+NAND flash
- Radio frequency
- Peripheral interfaces

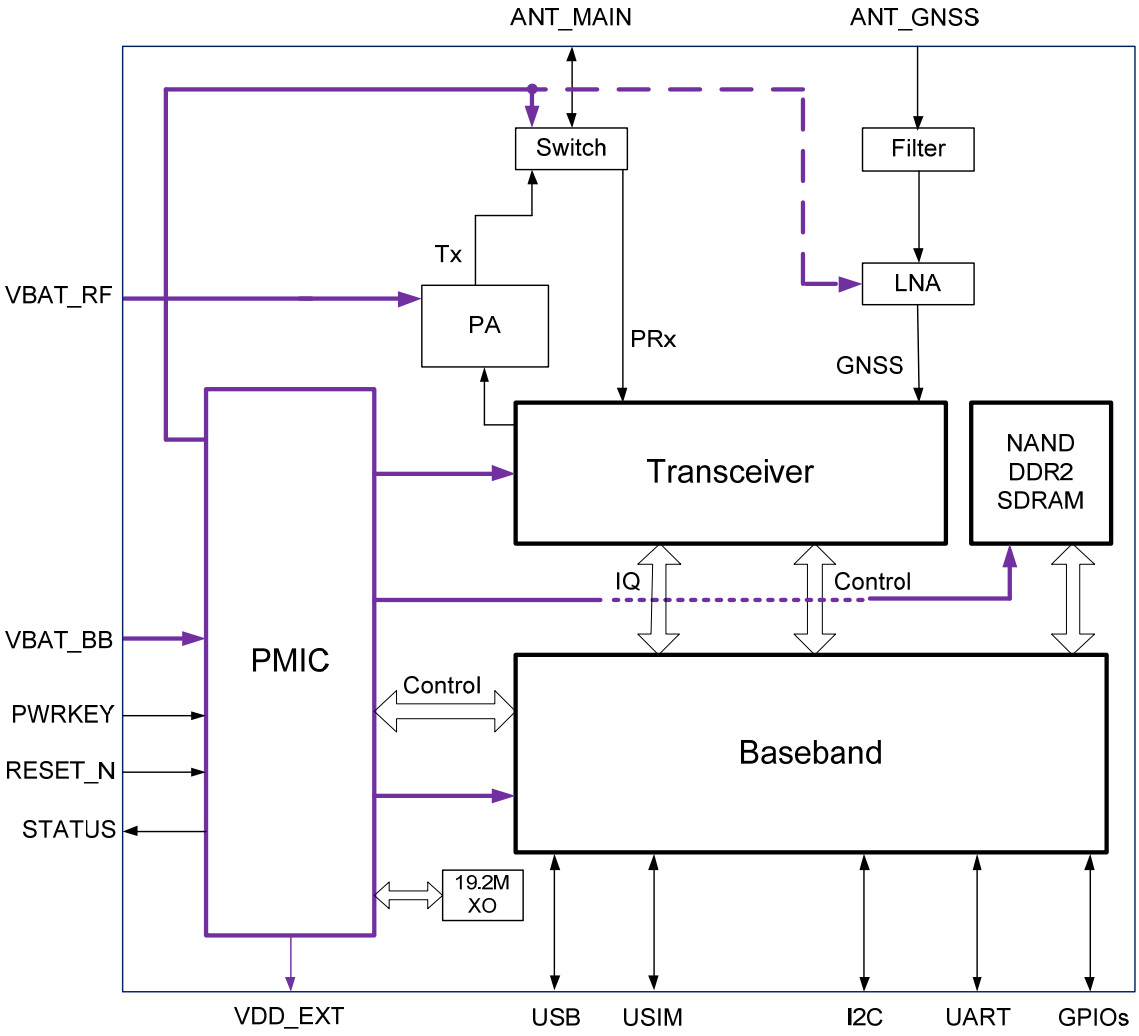


Figure 1: Functional Diagram

NOTE

"*" means under development.

2.4. Evaluation Board

In order to help customers develop applications conveniently with BG96-NA, Quectel supplies theevaluation board (EVB), USB data cable, earphone, antenna and other peripherals to control or test the module.

3 Application Interfaces

3.1. General Description

BG96-NAis equipped with 62-pin 1.1mm pitch SMT pads plus 40-pin ground pads and reserved pads that can be connected to customers' cellular application platform. The subsequent chapters will provide detailed description of interfaces listed below:

- Power supply
- (U)SIM card interfaces
- USB interface
- UART interfaces
- Network status indication
- USB_BOOT interface

3.2. Pin Assignment

The following figure shows the pin assignment of the BG96-NA module.

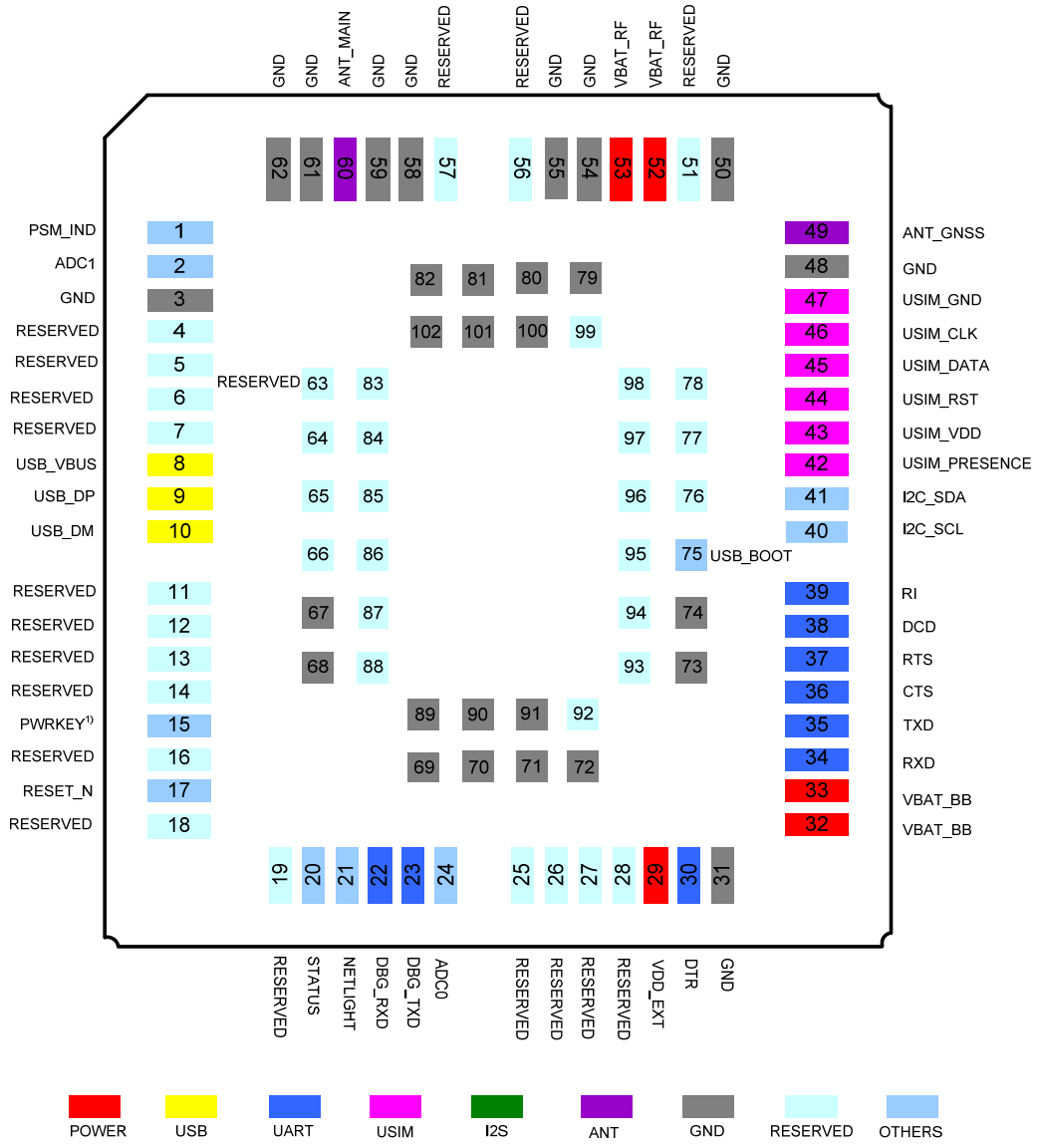


Figure 2: Pin Assignment (Top View)

NOTES

1. Keep all RESERVEDpins and unused pins unconnected.
2. GND pads should be connected to ground in the design.
3. 1)PWRKEY output voltage is 0.8V because of the diode drop in the Qualcomm chipset.
4. "*" means under development.

3.3. Pin Description

The following tables show the pin definition and description of BG96-NA.

Table 3: I/O Parameters Definition

Type	Description
IO	Bidirectional
DI	Digital input
DO	Digital output
PI	Power input
PO	Power output
AI	Analog input
AO	Analog output
OD	Open drain

Table 4: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VBAT_BB	32, 33	PI	Power supply for module baseband part.	Vmax=4.3V Vmin=3.3V Vnorm=3.8V	
VBAT_RF	52,53	PI	Power supply for module RF part.	Vmax=4.3V Vmin=3.3V Vnorm=3.8V	
VDD_EXT	29	PO	Provide 1.8V for external circuit.	Vnorm=1.8V $I_O$max=50mA	Power supply for external GPIO's pull up circuits.
GND	3, 31, 48, 50, 54, 55, 58, 59, 61, 62, 67~74, 79~82, 89~91, 100~102		Ground		

Turn on/off					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PWRKEY	15	DI	Turnon/off the module	V_{IH}max=2.1V V_{IH}min=1.3V V_{IL}max=0.5V	The output voltage is0.8V because of thediode drop in theQualcomm chipset.
RESET_N	17	DI	Reset the module	V_{IH}max=2.1V V_{IH}min=1.3V V_{IL}max=0.5V	If unused, keep this pin open.
Status Indication					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
STATUS	20	OD	Indicate the module's operating status.	V_{OH}min=1.35V V_{OL}max=0.45V	1.8V power domain. If unused, keep this pin open.
NETLIGHT	21	DO	Indicate the module'snetwork activity status.	V_{OH}min=1.35V V_{OL}max=0.45V	1.8V power domain. If unused, keep it open.
USB Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
USB_VBUS	8	PI	USB detection	Vmax=5.25V Vmin=3.0V Vnorm=5.0V	
USB_DP	9	IO	USB differential data bus (+)	Compliant with USB 2.0 standard specification.	Require differential impedance of 90ohm.
USB_DM	10	IO	USB differential data bus (-)	Compliant with USB 2.0 standard specification.	Require differential impedance of 90ohm.
(U)SIM Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
USIM_GND	47		Specified ground for (U)SIM card		
USIM_VDD	43	PO	Power supply for (U)SIM card	**For 1.8V(U)SIM:** Vmax=1.9V Vmin=1.7V	Either 1.8V or 3.0V is supported by the module automatically.

				For 3.0V(U)SIM: Vmax=3.05V Vmin=2.7V $I_O$max=50mA	
USIM_DATA	45	IO	Data signal of (U)SIM card	**For 1.8V (U)SIM:** V_{IL}max=0.6V V_{IH}min=1.2V V_{OL}max=0.45V V_{OH}min=1.35V **For 3.0V (U)SIM:** V_{IL}max=1.0V V_{IH}min=1.95V V_{OL}max=0.45V V_{OH}min=2.55V	
USIM_CLK	46	DO	Clock signal of (U)SIM card	**For 1.8V (U)SIM:** V_{OL}max=0.45V V_{OH}min=1.35V **For 3.0V (U)SIM:** V_{OL}max=0.45V V_{OH}min=2.55V	
USIM_RST	44	DO	Reset signal of (U)SIM card	**For 1.8V (U)SIM:** V_{OL}max=0.45V V_{OH}min=1.35V **For 3.0V (U)SIM:** V_{OL}max=0.45V V_{OH}min=2.55V	
USIM_ PRESENCE	42	DI	(U)SIM card insertion detection	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	1.8V power domain. If unused, keep it open.
UART1 Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RI	39	DO	Ring indicator	V_{OL}max=0.45V V_{OH}min=1.35V	1.8V power domain. If unused, keep it open.
DCD	38	DO	Data carrier detection	V_{OL}max=0.45V V_{OH}min=1.35V	1.8V power domain. If unused, keep it open.
RTS	37	DI	Request to send	V_{IL}min=-0.3V V_{IL}max=0.6V	1.8V power domain. If unused, keep it open.

				V_{IH}min=1.2V V_{IH}max=2.0V	
CTS	36	DO	Clear to send	V_{OL}max=0.45V V_{OH}min=1.35V	1.8V power domain. If unused, keep it open.
TXD	35	DO	Transmit data	V_{OL}max=0.45V V_{OH}min=1.35V	1.8V power domain. If unused, keep it open.
RXD	34	DI	Receive data	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	1.8V power domain. If unused, keep it open.
DTR	30	DI	Data terminal ready, sleep mode control.	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	1.8V power domain. Pull-up by default. Low level wakes up the module. If unused, keep it open.
UART2 Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
DBG_TXD	23	DO	Transmit data	V_{OL}max=0.45V V_{OH}min=1.35V	1.8V power domain. If unused, keep it open.
DBG_RXD	22	DI	Receive data	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	1.8V power domain. If unused, keep it open.
I2C Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
I2C_SCL	40	OD	I2C serial clock. Used for external codec.		External pull-up resistor is required. 1.8V only. If unused, keep it open.
I2C_SDA	41	OD	I2C serial data. Used for external codec.		External pull-up resistor is required. 1.8V only. If unused, keep it open.
RF Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ANT_MAIN	60	IO	Main antenna interface	50Ωimpedance	

ANT_GNSS	49	AI	GNSS antenna interface	50Ωimpedance	If unused, keep it open.
Other Pins					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PSM_IND*	1	DO	Power saving mode indicator	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	1.8V power domain. If unused, keep it open.
USB_BOOT	75	DI	Force the module to boot from USB port.	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	1.8V power domain. If unused, keep it open.
ADC Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ADC1	2	AI	General purpose analog to digital converter	Voltage range: 0.3V to VBAT_BB	If unused, keep it open.
ADC0	24	AI	General purpose analog to digital converter	Voltage range: 0.3V to VBAT_BB	If unused, keep it open.
RESERVED Pins					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESERVED	4~7,11~14,16,18,19, 25~28,51,56,57, 63~66,76~78, 83~88, 92~99		Reserved		Keep these pins unconnected.

NOTES

1. Keep all RESERVED pins and unused pins unconnected.
2. “*” meansunder development.

3.4. Operating Modes

The table below briefly summarizes the various operating modes referred in the following chapters.

Table 5: Overview of Operating Modes

Mode	Details	
Normal Operation	Idle	Software is active. The module hasregistered on network, and it is ready to send and receive data.
	Data	Network connection is ongoing. In this mode, the power consumption is decided by network settingand data transfer rate.
Minimum Functionality Mode	**AT+CFUN** command can set the module to a minimum functionality mode without removing the power supply. In this case, both RF function and (U)SIM card will be invalid.	
Airplane Mode	**AT+CFUN** command or W_DISABLE# pin can set the module to airplane mode. In this case, RF function will be invalid.	
Sleep Mode	In this mode, the current consumption of the module will be reduced to the minimal level. During this mode, the module can still receive paging message, SMSand TCP/UDP data from the network normally.	
PSM*	A UE may adopt the PSM (Power Saving Mode) for reducing its power consumption. PSM is similar to power-off, but the UE remains registered on the network and there is no need to re-attach or re-establish PDN connections. When the module is successfully entered into the PSM, PSM_IND* outputs a low level.	
Power Down Mode	In this mode, the power management unit shuts down the power supply. Software is not active. The serial interface is not accessible. Operating voltage (connected to VBAT_RF and VBAT_BB) remains applied.	

NOTES

1. In PSM or sleep mode, it is recommended to use UART interface for module connection. USB connection is NOT recommended as it will cause increase in power consumption.
2. "*" means under development.

3.5. Power Saving

3.5.1. Sleep Mode

BG96-NA is able to reduce its current consumption to a minimum value during the sleep mode. The following section describes power saving procedure of BG96-NA module.

3.5.1.1. UART Application

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

- Execute **AT+QSCLK=1**commandto enable sleep mode.
- Drive DTR to high level.

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

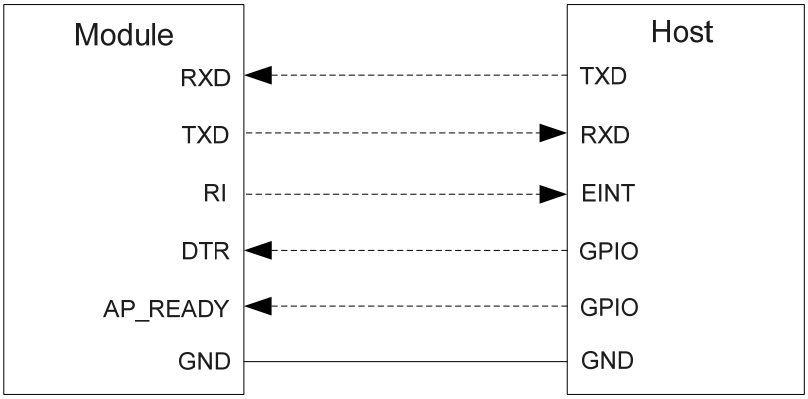


Figure 3: Sleep Mode Application via UART

- Driving the host DTR to low level will wake up the module.
- When BG96-NA has URC to report, RI signal will wake up the host. Refer to ***Chapter 3.15***for details about RI behavior.
- AP_READY* will detect the sleep state of the host (can be configured to high level or low level detection). Please refer to **AT+QCFG="apready"**command for details.

3.5.1.2. USB Application with USB Remote Wakeup Function

If the host supports USB suspend/resume and remote wakeup functions, the following three preconditions must be met to let the module enter into sleep mode.

- Execute **AT+QSCLK=1**commandto enable the sleep mode.
- Ensure the DTR is held in high level or keep it open.
- The host's USB bus, which is connected with the module's USB interface, enters into suspended state.

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

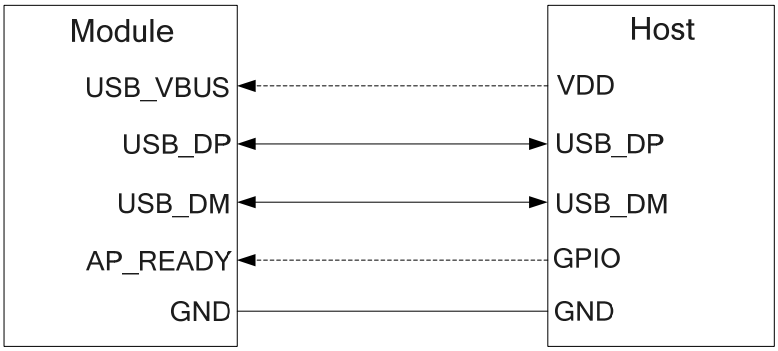


Figure 4: Sleep Mode Application with USB Remote Wakeup

- Sending data to BG96-NAthrough USB will wake up the module.
- When BG96-NAhas URC to report, the module will send remote wake-up signals viaUSB bus so as to wake up the host.

3.5.1.3. USB Application with USB Suspend/Resume and RI Function

If the host supports USB suspend/resume, but does not support remote wake-up function, the RI signal is needed to wake up the host. There are threepreconditions to let the module enter into the sleep mode.

- Execute **AT+QSCLK=1**commandto enable sleep mode.
- Ensure the DTR is held in high level or keep it open.
- The host's USB bus, which is connected with the module's USB interface, enters into suspended state.

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

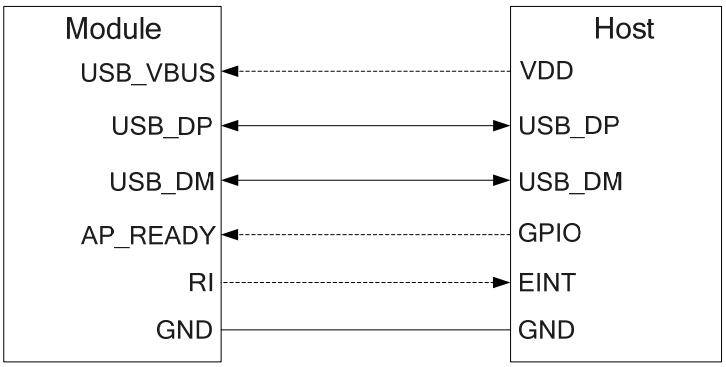


Figure 5: Sleep Mode Application with RI

- Sending data to BG96-NAthrough USB will wake up the module.
- When BG96-NAhas URC to report, RI signal will wake up the host.

3.5.1.4. USB Application without USB Suspend Function

If the host does not support USB suspend function, you should disconnect USB_VBUS with additional control circuit to let the module enter into sleep mode.

- Execute **AT+QSCLK=1**commandto enable the sleep mode.
- Ensure the DTR is held in high level or keep it open.
- Disconnect USB_VBUS.

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

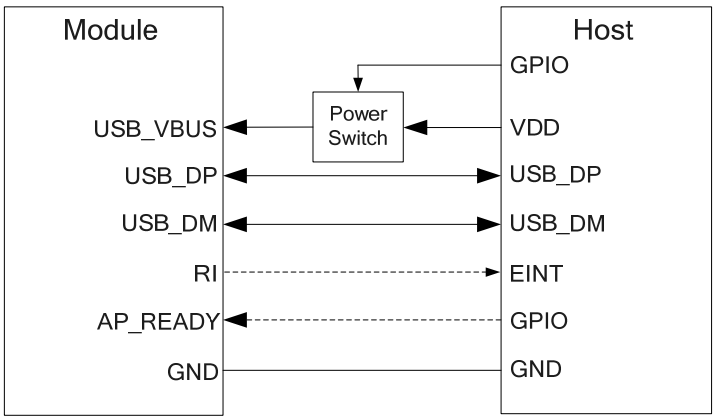


Figure 6: Sleep Mode Application without Suspend Function

Switching onthe power switch to supply power to USB_VBUS will wake up the module.

NOTE

1. Please pay attention to the level match shown in dotted line between the module and the host. Refer to ***document [1]*** for more details about BG96-NA power management application.
2. "*" means under development.

3.5.2. Airplane Mode

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

Hardware:

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

Software:

AT+CFUNcommand provides choice of the functionality level.

- **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. The W_DISABLE# control function is disabled in firmware by default. It can be enabled by **AT+QCFG="airplanecontrol"** command. The command is still under development.
2. The execution of **AT+CFUN** command will not affect GNSS function.

3.6. Power Supply

3.6.1. Power Supply Pins

BG96-NA provides four VBAT pins for connection with anexternal power supply. There are two separate voltage domains for VBAT.

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

The following table shows the details of VBAT pins and ground pins.

Table 6: VBAT and GND Pins

Pin Name	Pin No.	Description	Min.	Typ.	Max.	Unit
VBAT_RF	52,53	Power supply for module RF part.	3.3	3.8	4.3	V
VBAT_BB	32,33	Power supply for module baseband part.	3.3	3.8	4.3	V
GND	3, 31, 48,50, 54, 55,58, 59, 61,62, 67~74, 79~82,89~91, 100~102	Ground	-	-	-	-

3.6.2. Decrease Voltage Drop

The power supply range of the module is from 3.3Vto4.3V. Please make sure that the input voltage will never drop below 3.3V.

To decrease voltage drop, a bypass capacitor of about 100μF with low ESR should be used, and a multi-layer ceramic chip (MLCC) capacitor array should also be used to provide the low ESR. 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 1mm, andthe width of VBAT_RF trace should be no less than 2mm.In principle, the longerthe VBAT trace is, the wider it will be.

Three ceramic capacitors (100nF, 33pF, 10pF) are recommended to be applied to the VBAT pins. These capacitors should be placed close to the VBAT pins. In addition, in order to get a stable power source, it is suggested that you should use a zener diode of which reverse zener voltage is 5.1V and dissipation power is more than 0.5W. The following figure shows the star structure of the power supply.

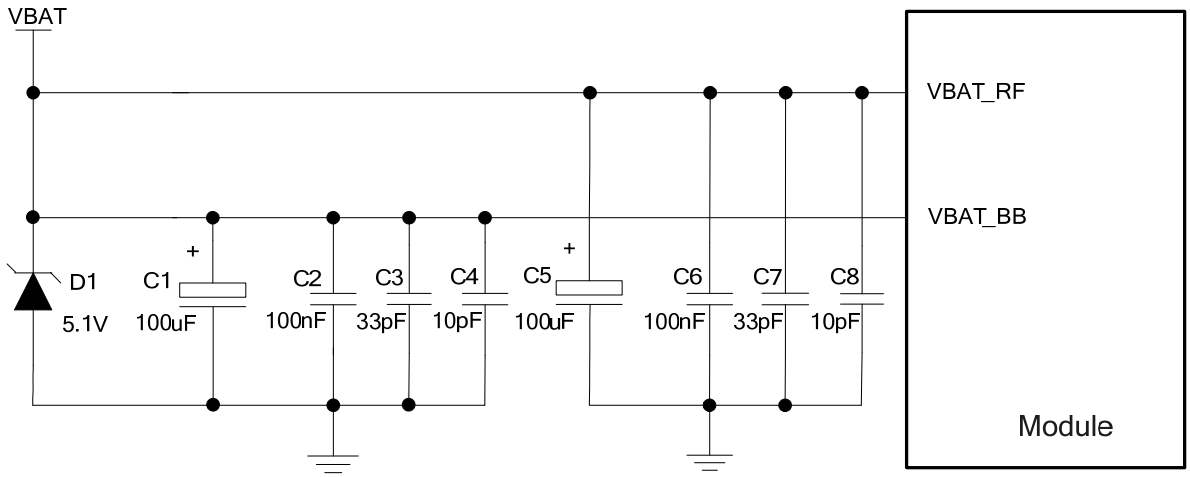


Figure 7: Star Structure of the Power Supply

3.6.3. Monitor the Power Supply

AT+CBC command can be usedto monitor the VBAT_BB voltage value. For more details, please refer to ***document [2]***.

3.7. Turn on and off Scenarios

3.7.1. Turn on Module Using the PWRKEY

The following table shows the pin definition of PWRKEY.

Table 7: PWRKEY Pin Description

Pin Name	Pin No.	Description	DC Characteristics	Comment
PWRKEY	15	Turn on/off the module	V_{IH}max=2.1V V_{IH}min=1.3V V_{IL}max=0.5V	The output voltage is0.8V because of thediode drop in theQualcomm chipset.

When BG96-NA is in power down mode, it can be turned on to normal mode by driving the PWRKEY pin to a low level for at least 100ms. It is recommended to use an open drain/collector driver to control the PWRKEY.After STATUS pin outputting a high level, PWRKEY pin can be released. A simple reference circuit is illustrated in the following figure.

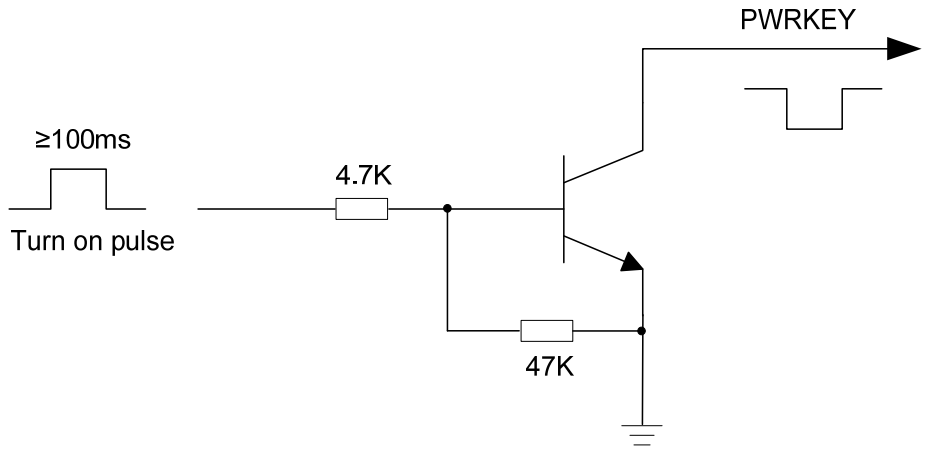


Figure 8: Turn on the Module Using Driving Circuit

The other way to control the PWRKEY is using a button directly. When pressing the key, electrostatic strike may generate from finger. Therefore, aTVS component is indispensable to be placed nearby the button for ESD protection. A reference circuit is shownin the following figure.

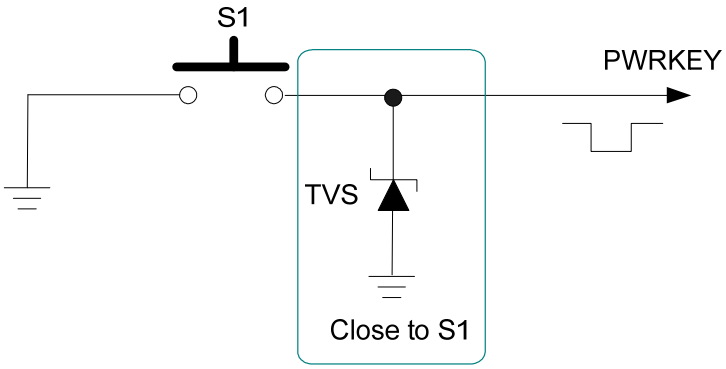


Figure 9: Turn on the Module Using Keystroke

The turn on scenario is illustrated in the following figure.

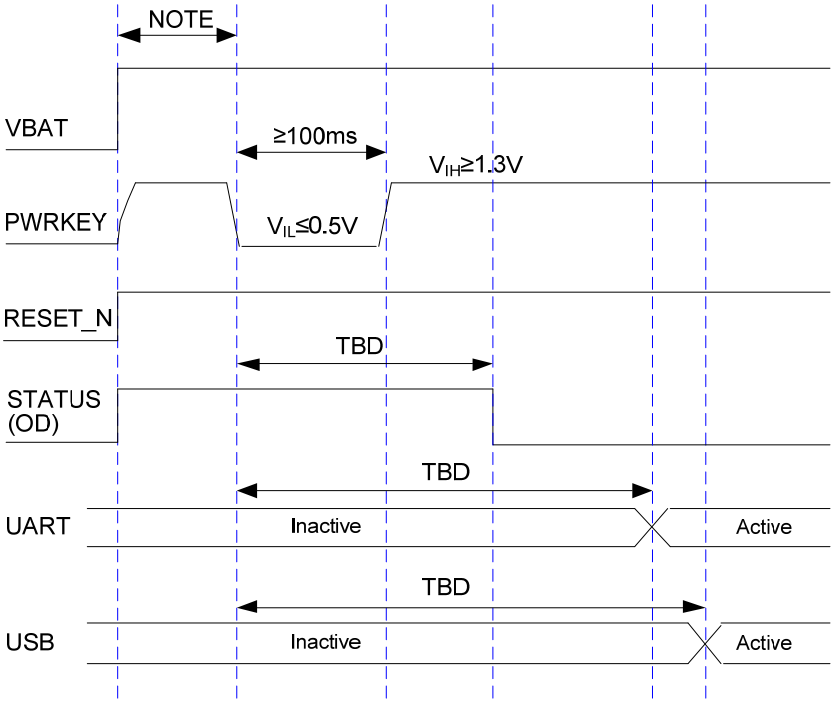


Figure 10: Timing of Turning on Module

NOTE

Make sure that VBAT is stable before pulling down PWRKEY pin. The time between them is no less than 30ms.

3.7.2. Turn off Module

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

- Normal power down procedure: Turn off the module using the PWRKEY pin.
- Normal power down procedure: Turn off the module using **AT+QPOWD**command.

3.7.2.1. Turn off Module Using the PWRKEY Pin

Driving the PWRKEY pin to a low level voltage(the specific time is TBD), the module will execute power-down procedure after the PWRKEY is released. The power-down scenario is illustrated inthe following figure.

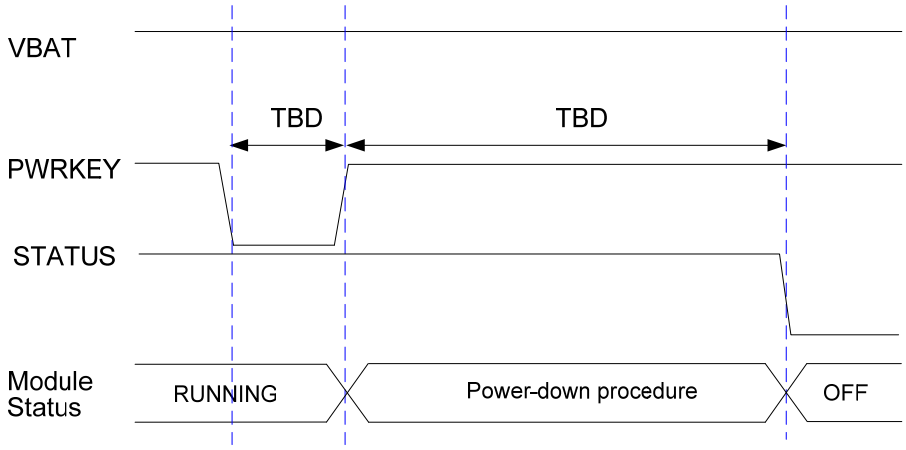


Figure 11: Timing of Turning off Module

3.7.2.2. Turn off Module Using AT Command

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

Please refer to***document [2]*** for details about **AT+QPOWD**command.

3.8. Reset the Module

The RESET_N pin can be used to reset the module.The module can be reset by driving RESET_N to a low level voltage for time between Treset_min and Treset_max.

Table 8: RESET_N Pin Description

Pin Name	Pin No.	Description	DC Characteristics	Comment
RESET_N	17	Reset the module	V_{IH}max=2.1V V_{IH}min=1.3V V_{IL}max=0.5V	

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.

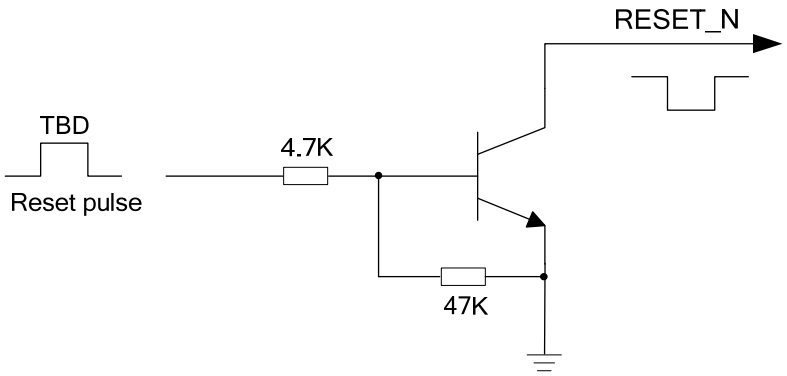


Figure 12: Reference Circuit of RESET_N by Using Driving Circuit

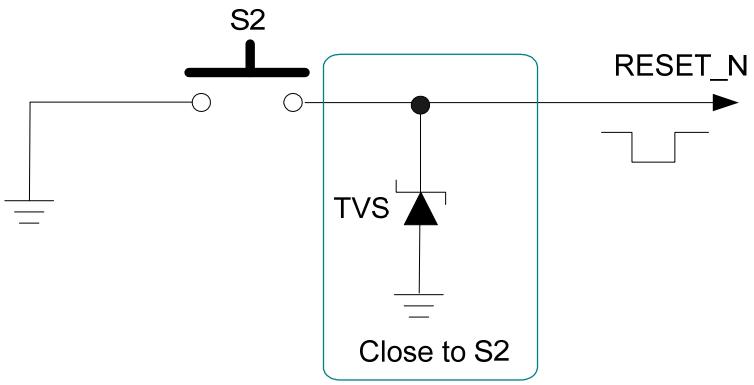


Figure 13: Reference Circuit of RESET_N by Using Button

The reset scenario is illustrated inthe following figure.

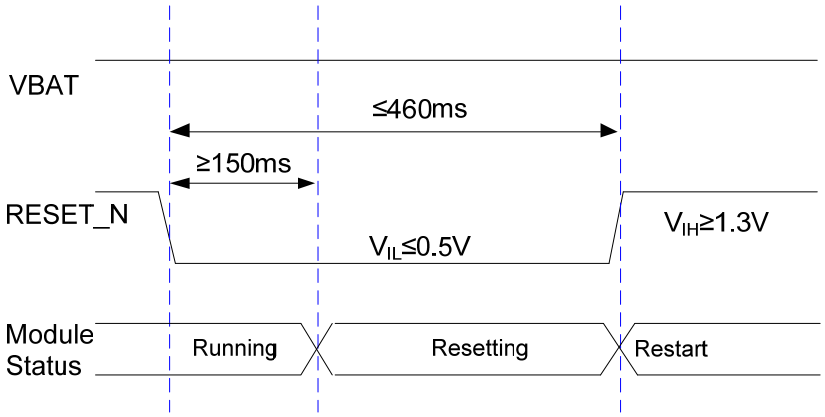


Figure 14: Timing of Resetting Module

NOTES

1. Use RESET_N only when turning off the module by **AT+QPOWD**command and PWRKEY pin failed.
2. Ensure that there is no large capacitance on PWRKEY and RESET_N pins.

3.9. (U)SIM Card Interfaces

The(U)SIM card interface circuitrymeets ETSI and IMT-2000 SIM interface requirements. Both 1.8V and 3.0V (U)SIM cards are supported.

Table 9: Pin Definition of the (U)SIMCard Interfaces

Pin Name	Pin No.	I/O	Description	Comment
USIM_VDD	43	PO	Power supply for (U)SIM card	Either 1.8V or 3.0V is supported by the module automatically.
USIM_DATA	45	IO	Data signal of (U)SIM card	
USIM_CLK	46	DO	Clock signal of (U)SIM card	
USIM_RST	44	DO	Reset signal of (U)SIM card	
USIM_ PRESENCE	42	DI	(U)SIM card insertion detection	
USIM_GND	47		Specified ground for (U)SIM card	

BG96-NA supports (U)SIM card hot-plug via the USIM_PRESENCEpins. The function supports low level and high level detections andisdisabled by default. Please refer to ***document [2]*** about **AT+QSIMDET**command for details.

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

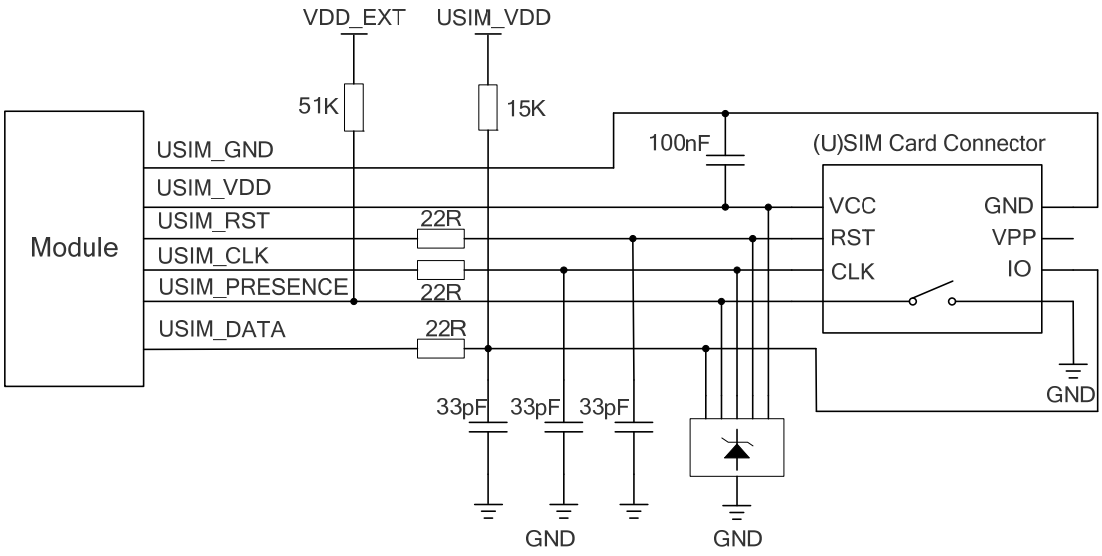


Figure 15: Reference Circuit of (U)SIM Card Interface withan 8-Pin (U)SIM Card Connector

If (U)SIM card detection function is not needed, please keep USIM_PRESENCE unconnected. Areference circuit for (U)SIM card interface with a 6-pin (U)SIM card connector is illustrated inthe following figure.

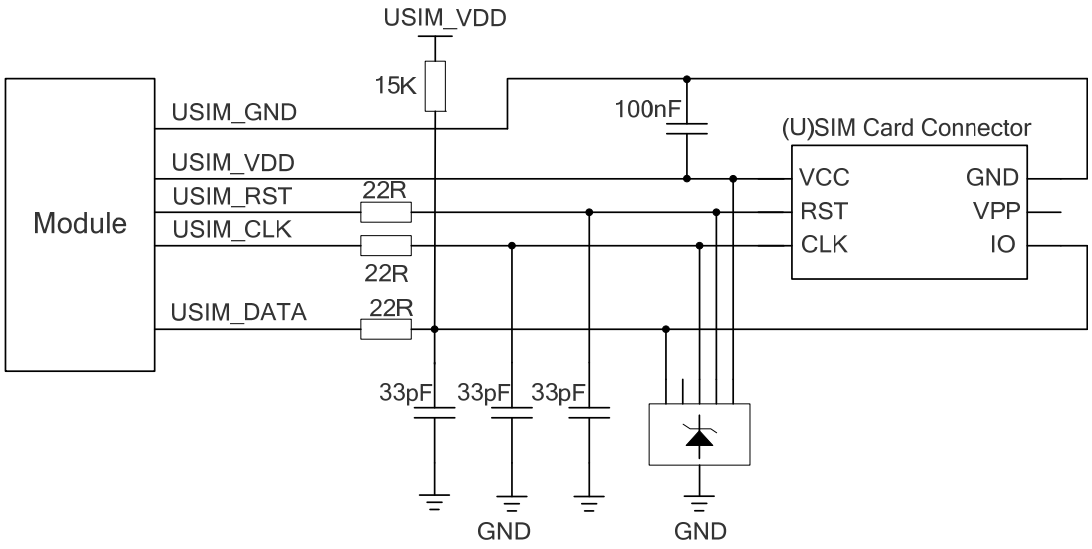


Figure 16: Reference Circuit of (U)SIM Card Interface with a 6-Pin (U)SIM Card Connector

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

- Keep layout of (U)SIM card as close to the module as possible. Keep the trace length as less than 200mm as possible.
- Keep (U)SIM card signals away from RF and VBAT traces.
- Assure the ground between the module and the (U)SIM card connector short and wide. Keep the trace width of ground and USIM_VDD no less than 0.5mm to maintain the same electric potential.
- To avoid cross-talk between USIM_DATA and USIM_CLK, keep them awayfromeach other and shield them with surrounded ground.
- In order to offer good ESD protection, it is recommended to add a TVSdiode array which parasitic capacitance should be not more than 50pF. The 22ohmresistors should be added in series between the module and the (U)SIM card so as to suppress EMI spurious transmission and enhanceESD protection. The 33pFcapacitors are used for filtering interference of GSM900.Please note that the (U)SIM peripheral circuit should be close to the (U)SIM card connector.
- The pull-up resistor on USIM_DATA line can improve anti-jamming capability when long layout trace and sensitive occasion areapplied, and should be placed close to the (U)SIMcard connector.

3.10. USB Interface

BG96-NA contains one integrated Universal Serial Bus (USB) transceiver which complies with the USB 2.0 specification and supports high-speed (480Mbps) and full-speed (12Mbps)modes. The USB interface is used for AT command communication, data transmission, software debugging and firmware upgrade. The following table shows the pin definition of USB interface.

Table 10: Pin Description of USB Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_VBUS	8	PI	Used for detecting the USB connection.	Typical 5.0V
USB_DP	9	IO	USB differential data bus (+)	Require differential impedance of 90Ω.
USB_DM	10	IO	USB differential data bus (-)	Require differential impedance of 90Ω.
GND	3		Ground	

More details about the USB 2.0 specifications, please visithttp://www.usb.org/home.

The USB interface is recommended to be reserved for firmware upgrade in your design. The following figure shows areference circuit of USB interface.

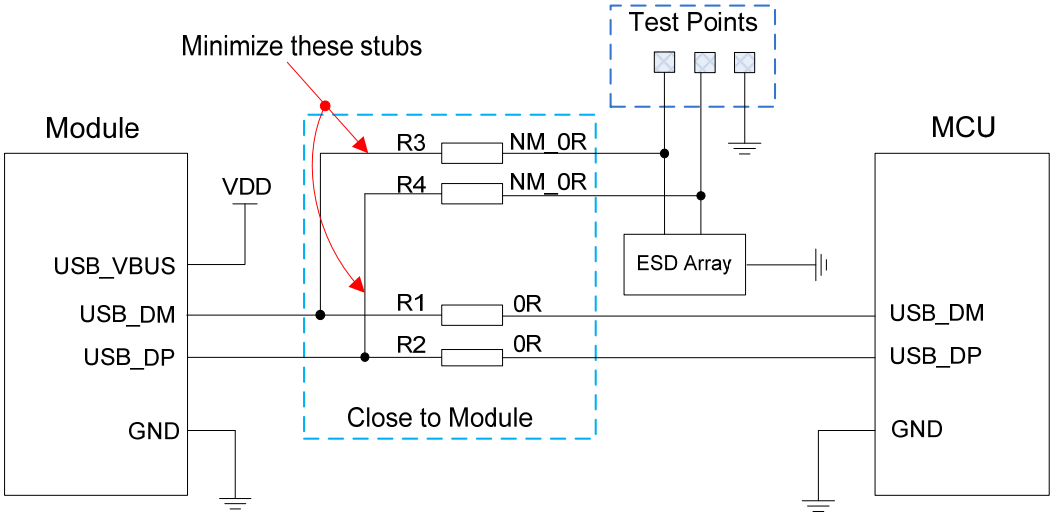


Figure 17: Reference Circuit of USB Application

In order to meet ensurethe integrity of USB data line signal, components R1, R2, R3 and R4 must 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.

In order to ensure the USB interface design corresponding with the USB 2.0 specification, please comply with the following principles.

- It is important to route the USB signal traces as differential pairs with total grounding. The impedance of USB differential trace is 90ohm.
- 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 with ground shielding onnot only upper and lower layers but also right and left sides.
- Pay attention to the influence of junction capacitance of ESD protection components on USB data lines. Typically, the capacitance value should be less than 2pF.
- Keep the ESD protection components to the USB connector as close as possible.

NOTE

BG96-NA module can only be used as a slave device.

3.11. UART Interfaces

The module provides two UART interfaces: the UART1interface andUART2interface. The following are theirfeatures.

- The UART1 interface supports 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600 and 3000000bpsbaud rates, and the default is 115200bps. This interface is used for data transmission and AT command communication.
- The UART2interface supports 115200bps baud rate. It is used for module debugging and log output.

The following tables show the pin definition of the main and debug UART interfaces.

Table 11: Pin Definition of UART1Interface

Pin Name	Pin No.	I/O	Description	Comment
DTR	30	DI	Sleep mode control	1.8V power domain
RXD	34	DI	Receive data	1.8V power domain
TXD	35	DO	Transmit data	1.8V power domain
CTS	36	DO	Clear to send	1.8V power domain
RTS	37	DI	Request to send	1.8V power domain
DCD	38	DO	Data carrier detection	1.8V power domain
RI	39	DO	Ring indicator	1.8V power domain

Table 12: Pin Definition of UART2Interface

Pin Name	Pin No.	I/O	Description	Comment
DBG_TXD	23	DO	Transmit data	1.8V power domain
DBG_RXD	22	DI	Receive data	1.8V power domain

The logic levels are described in the following table.

Table 13:Logic Levels of Digital I/O

Parameter	Min.	Max.	Unit
V_{IL}	-0.3	0.6	V
V_{IH}	1.2	2.0	V
V_{OL}	0	0.45	V
V_{OH}	1.35	1.8	V

The module provides 1.8V UART interface. A level translator should be used if your application is equipped with a 3.3V UART interface. A level translator TXS0108EPWR provided by Texas Instrument is recommended. The following figure shows a reference design.

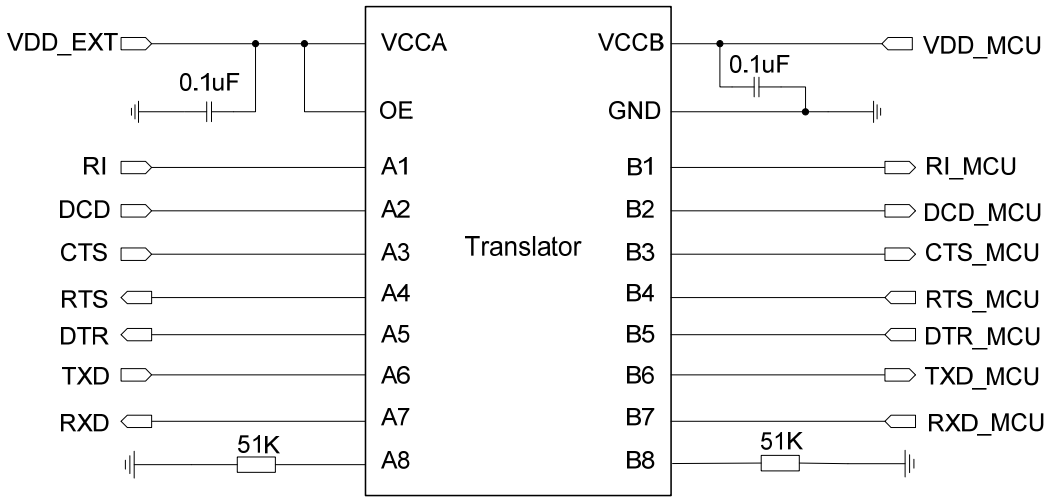


Figure 18: Reference Circuit with Translator Chip

Please visit http://www.ti.comformore information.

Another example with transistor translation circuit is shown as below. Thecircuitdesign of dotted line section can refer to the circuitdesign of solid line section, in terms of both module input and output circuit designs, but please pay attention to the direction of connection.

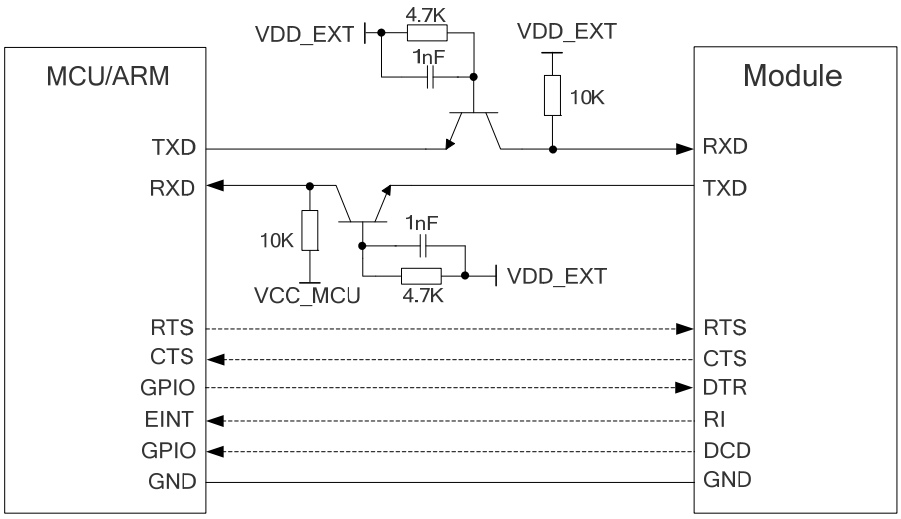


Figure 19: Reference Circuit with Transistor Circuit

NOTE

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

3.12. I2C Interfaces

BG96-NA provides one I2C interface.

The following table shows the pin definition of I2C interfaces which can be applied on audio codec design.

Table 14: Pin Definition of I2C Interfaces

Pin Name	Pin No.	I/O	Description	Comment
I2C_SCL	40	OD	I2C serial clock	Require external pull-up to 1.8V
I2C_SDA	41	OD	I2C serial data	Require external pull-up to 1.8V

3.13. Network Status Indication

BG96-NA provides one network indication pin:NETLIGHT. The pin is used to drive a network status indicationLED.

The following tables describe the pin definition and logic level changes ofNETLIGHT in different network status.

Table 15: Pin Definition of Network Status Indicator

Pin Name	Pin No.	I/O	Description	Comment
NETLIGHT	21	DO	Indicate the module'snetwork activity status.	1.8V power domain

Table 16: Working State of the Network Status Indicator

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

A reference circuit is shown in the following figure.

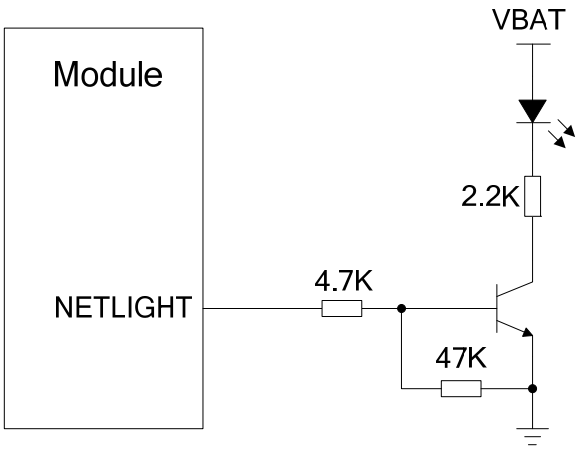


Figure 20: Reference Circuit of the Network Indicator

3.14. STATUS

The STATUS pin is an open drain output for indicating the module's operation status. It can be connected to a GPIO of DTE with a pulled up resistor, or an LED indication circuit as below. When the module is turned on normally, the STATUS will present a low state. Otherwise, the STATUS will present high-impedance state.

Table 17: Pin Definition of STATUS

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

The following figure shows different circuit designs of STATUS, and you can choose either one according to your application demands.

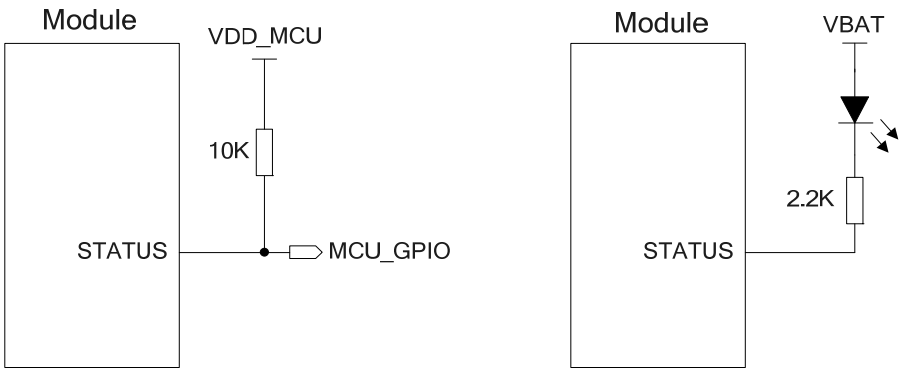


Figure 21: Reference Circuit of the STATUS

3.15. Behavior of the RI

AT+QCFG="risignaltype","physical" command can be used to configure RI behavior.

No matter on which port URC is presented, URC will trigger the behavior of RI pin.

NOTE

URC can be output from UART port, USB AT port and USB modem port by **AT+QURCCFG**command. The default port is USB AT port.

The default behaviors of RI are shown as below.

Table 18:Default Behavior of RI

State	Response
Idle	RI keeps athigh level.
URC	RI outputs 120ms low pulse when new URC returns.

The RI behavior can be changed by **AT+QCFG="urc/ri/ring"**command.Please refer to ***document [2]*** for details.

3.16. USB_BOOT Interface

BG96-NA provides a USB_BOOT pin. During development or factory production, USB_BOOT pin can force the module to boot from USB port for firmware upgrade.

Table 19: Pin Definition of USB_BOOT Interface

Pin Name	Pin No.	I/O	Description	Comment
USB_BOOT	75	DI	Force the module to boot from USB port	1.8V power domain. Active high. If unused, keep it open.

The following figure shows a reference circuit of USB_BOOT interface.

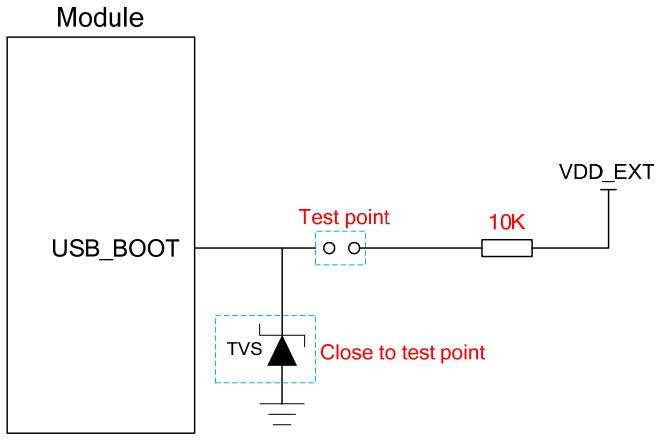


Figure 22: Reference Circuit of USB_BOOT Interface

4 GNSS Receiver

4.1. General Description

BG96-NA includes a fully integrated global navigation satellite system solution that supports Gen8C-Lite of Qualcomm (GPS, GLONASS, BeiDou/Compass, Galileo and QZSS).

BG96-NA supports standard NMEA-0183 protocol, and outputs NMEA sentences at 1Hz data update rate via USB interface by default.

By default, BG96-NA GNSS engine is switched off. It has to be switched on via AT command. For more details about GNSS engine technology and configurations, please refer to ***document [3]***.

4.2. GNSS Performance

The following table shows the GNSS performance of BG96-NA.

Table 20: GNSS Performance

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

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

NOTES

1. Tracking sensitivity: the lowest GNSS signal value at the antenna port on which the module can keep on positioning for 3 minutes.
2. Reacquisition sensitivity: the lowest GNSS signal value at the antenna port on which the module can fix position again within 3 minutes after loss of lock.
3. Cold start sensitivity: the lowest GNSS signal value at the antenna port on which the module fixes position within 3 minutes after executing cold start command.
4. "*" means under development.

4.3. Layout Guidelines

The following layout guidelines should be taken into account in your design.

- 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 ohm characteristic impedance for the ANT_GNSS trace.

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

5 Antenna Interfaces

BG96-NA antenna interfaces include a main antenna interface andaGNSS antennainterface. The antenna interfaceshave an impedance of 50ohm.

5.1. MainAntenna Interface

5.1.1. Pin Definition

The pin definition of main antenna interface is shown below.

Table 21: Pin Definition of the RF Antenna Interface

Pin Name	Pin No.	I/O	Description	Comment
ANT_MAIN	60	IO	Main antennainterface	50ohmimpedance

5.1.2. Operating Frequency

Table 22: Module Operating Frequencies

3GPP Band	Transmit	Receive	Unit
B2	1850~1910	1930~1990	MHz
B4	1710~1755	2110~2155	MHz
B12	699~716	728~746	MHz
B13	777~787	746~757	MHz

5.1.3. Reference Design of RF Antenna Interface

Areference design of ANT_MAIN antenna padis shown as below. It should reserve a π-type matching circuit for better RF performance. The capacitors are not mounted by default.

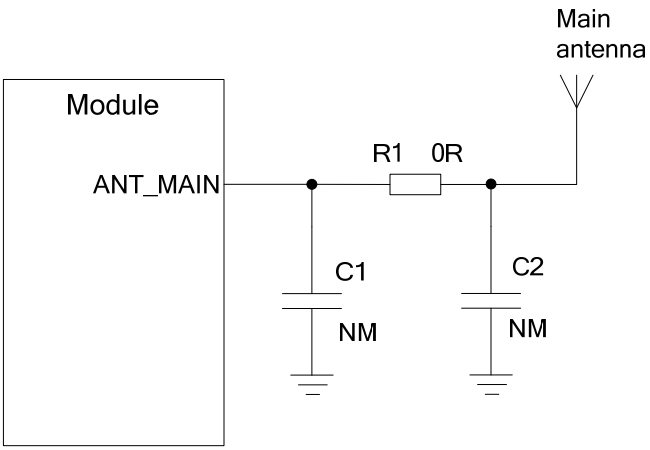


Figure 23: Reference Circuit of RF Antenna Interface

NOTE

Place theπ-type matching components (R1, C1, C2) as close to the antenna as possible.

5.1.4. Reference Design of RF Layout

For user's PCB, the characteristic impedance of all RF traces should be controlled as 50 ohm. The impedance of the RF traces is usually determined by the trace width (W), the materials' dielectric constant, the distance between signal layer and reference ground(H), and the clearance between RF trace and ground(S). Microstrip line or coplanar waveguideline is typically used in RF layout for characteristic impedance control. The following are reference designs of microstrip line or coplanar waveguidelinewithdifferent PCB structures.

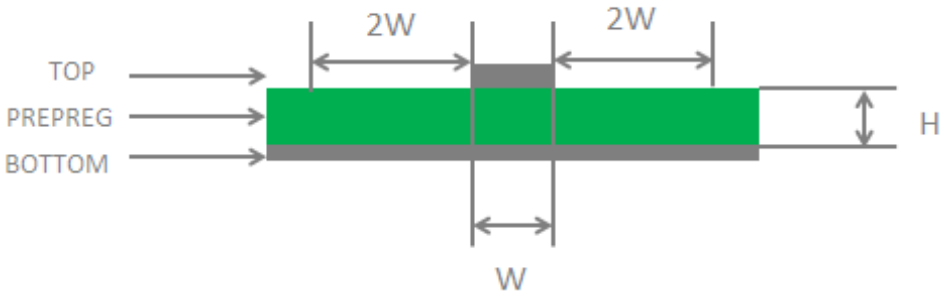


Figure 24: Microstrip Line Designon a 2-layer PCB

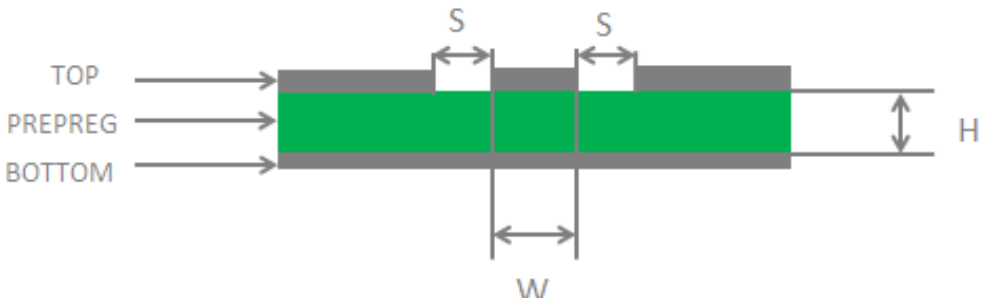


Figure 25: Coplanar Waveguide Line Design on a 2-layer PCB

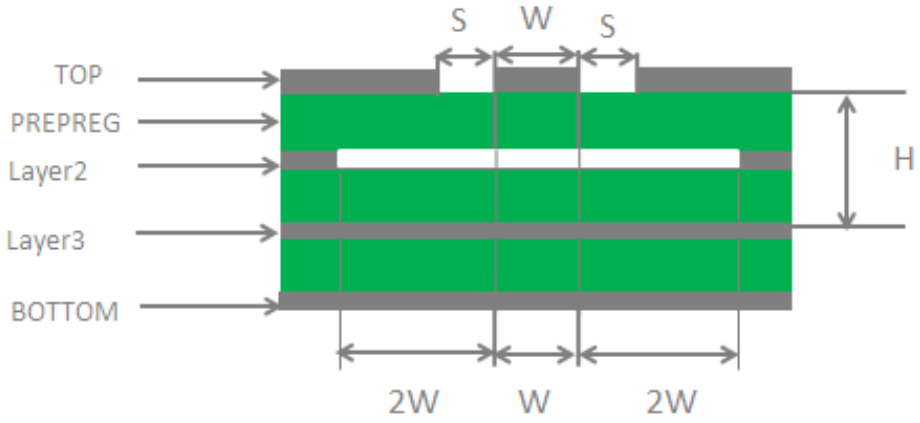


Figure 26: Coplanar Waveguide Line Design on a 4-layer PCB (Layer 3 as Reference Ground)

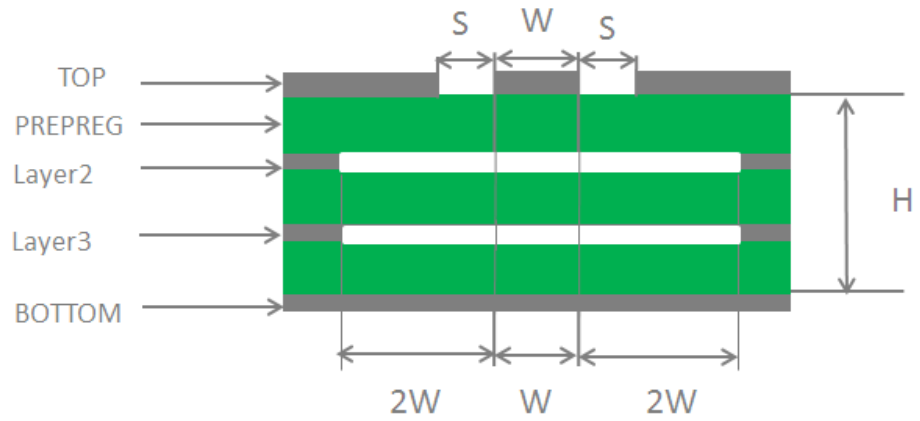


Figure 27: Coplanar Waveguide Line Designon a4-layer PCB (Layer 4 as Reference Ground)

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

- Use impedance simulation tool to control the characteristic impedanceof RF tracesas 50ohm.
- The GND pins adjacent to RF pins should not be hot welded, and should be fully connected to ground.
- The distance between the RF pinsand the RFconnectorshould be as short as possible, and all the right angle tracesshould be changed to curved ones.
- There should be clearance area under the signal pin of the antenna connector or solder joint.
- The reference ground of RF traces should be complete. Meanwhile, adding some ground viasaround RF traces and the reference ground could help to improve RF performance. The distance between theground viasand RF traces should be no less than two times the width of RF signal traces (2*W).

For more details about RFlayout, please refer to ***document [4]***.

5.2. GNSS Antenna Interface

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

Table 23: Pin Definition of GNSS Antenna Interface

Pin Name	Pin No.	I/O	Description	Comment
ANT_GNSS	49	AI	GNSS antennainterface	50 ohm impedance

Table 24: GNSS Frequency

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

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

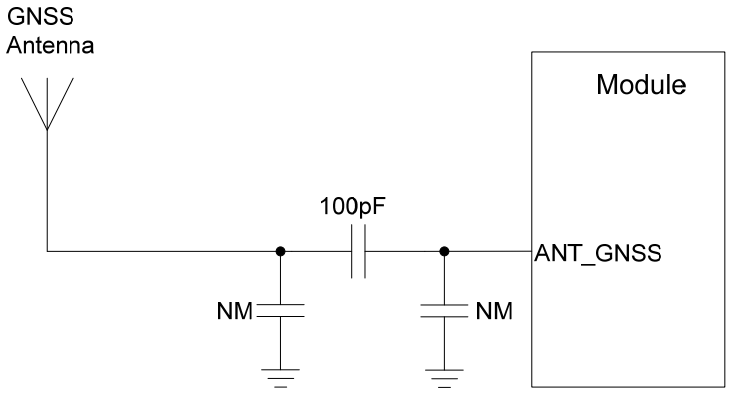


Figure 28: Reference Circuit of GNSS Antenna Interface

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. Antenna Installation

5.3.1. Antenna Requirements

The following table shows the requirements on main antenna.

Table 25: Main Antenna Requirements

Type	Requirements
LTE	VSWR: ≤2 Gain (dBi): 1 Max Input Power (W): 50 Input Impedance (ohm): 50 Polarization Type: Vertical Cable Insertion Loss: <1.5dB (LTE B1/B2/B3/B4)

5.3.2. Recommended RF Connector for Antenna Installation

If RF connector is used for antenna connection, it is recommended to use the UF.L-R-SMTconnector provided by HIROSE.

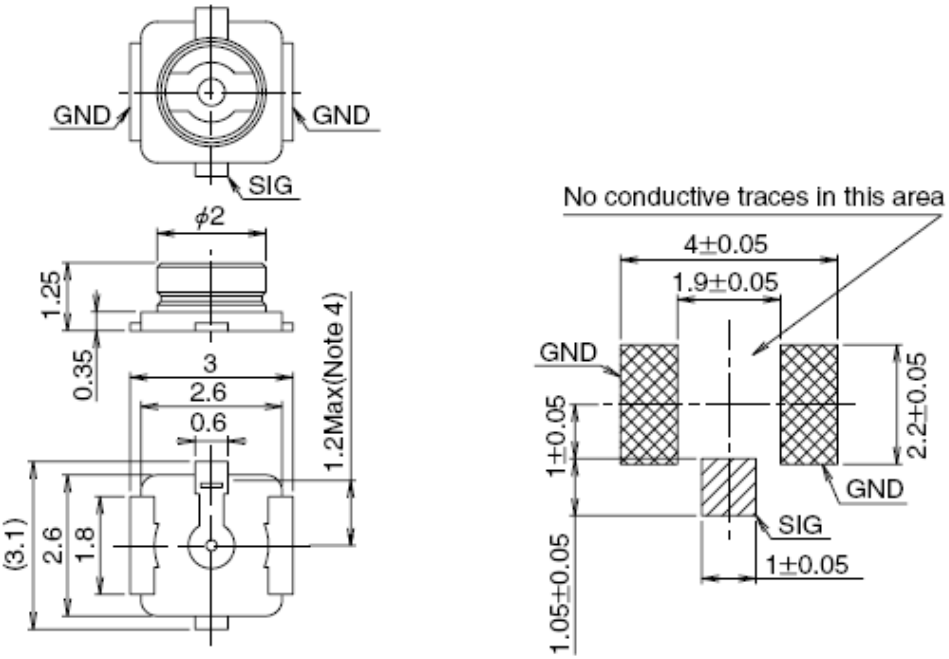


Figure 29: Dimensions of the UF.L-R-SMT Connector (Unit: mm)

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

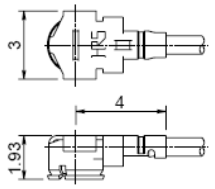
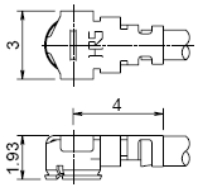
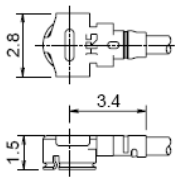
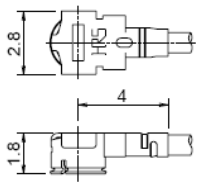
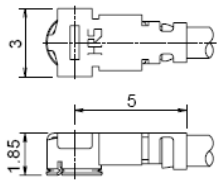
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 0.81mm Coaxial cable	Dia. 1mm Coaxial cable	Dia. 1.37mm Coaxial cable
Weight (mg)	53.7	59.1	34.8	45.5	71.7
RoHS	YES				

Figure 30:Mechanicals of UF.L-LP Connectors

The following figure describes the space factor of mated connector.

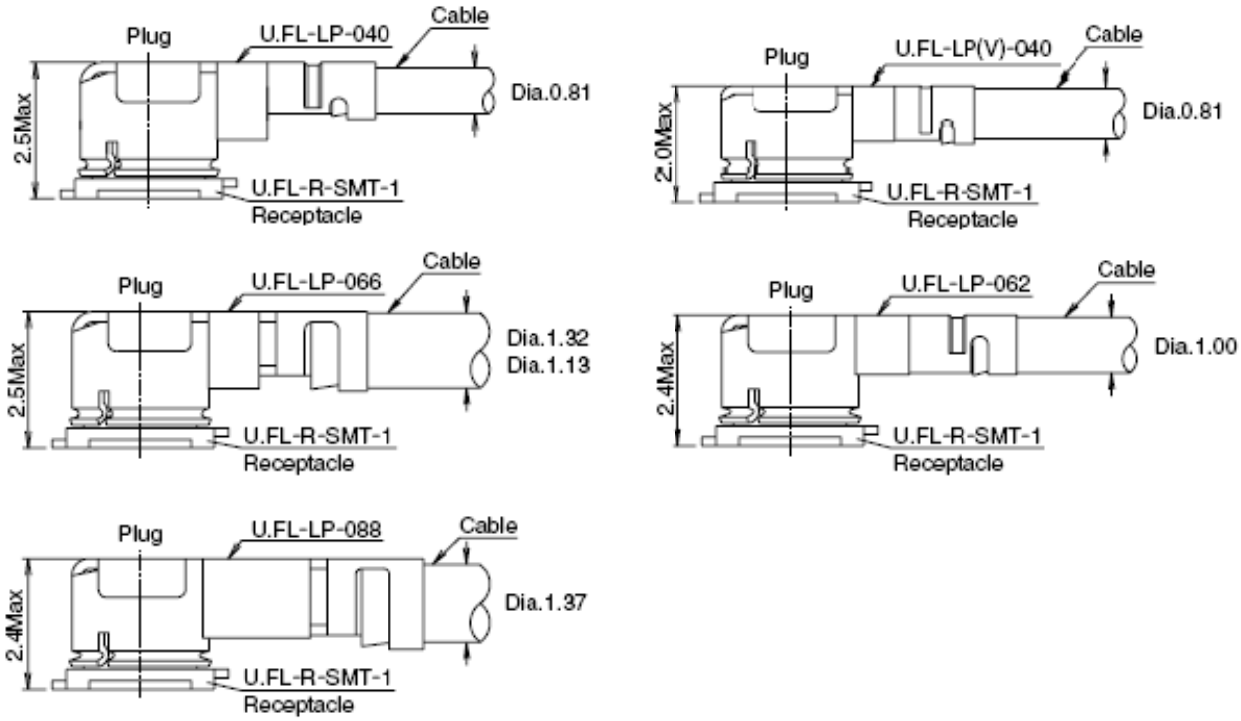


Figure 31:Space Factor of Mated Connector (Unit: mm)

For more details, please visithttp://www.hirose.com.

6 Electrical, Reliability and RadioCharacteristics

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 26: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VBAT_RF/VBAT_BB	-0.3	4.7	V
USB_VBUS	-0.3	5.5	V
Peak Current of VBAT_BB	0	TBD	A
Peak Current of VBAT_RF	0	TBD	A
Voltage at Digital Pins	-0.3	2.3	V

6.2. Power Supply Ratings

Table 27: Power Supply Ratings

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
VBAT	VBAT_BB and VBAT_RF	Voltage must stay within the min/max values, including voltage drop, ripple and spikes.	3.3	3.8	4.3	V

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
I_{VBAT}	Peak supply current (during transmissionslot)			TBD	TBD	A
USB_VBUS	USB detection		3.0	5.0	5.25	V

6.3. Operating Temperature

The operating temperature is listed in the following table.

Table 28: Operating Temperature

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

NOTES

1. [1)]Within operation temperature range, the module is 3GPP compliant.
2. [2)] Within extended temperature range, the module remains the ability to establish and maintain SMS, data transmission, etc. There is no unrecoverable malfunction. Only one or more parameters like P_{out} might reduce in their value and exceed the specified tolerances. When the temperature returns to the normal operating temperature levels, the module will meet 3GPP compliant again.

6.4. Current Consumption

Theinformation will be added in the future version of this document.

6.5. RF Output Power

The following table shows the RF output power of BG96-NA module.

Table 29: Conducted RF Output Power

Frequency	Max.	Min.
LTE-FDD B2/B4B12/B13	23dBm±2.7dB	TBD

6.6. RF Receiving Sensitivity

The following table shows the conducted RF receiving sensitivity of BG96-NA module.

Table 30: BG96-NA Conducted RF Receiving Sensitivity

Frequency	Primary	Diversity	SISO	3GPP
LTE-FDD B2	TBD	Not Supported	TBD	-100.3dBm
LTE-FDD B4	TBD	Not Supported	TBD	-102.3dBm
LTE-FDD B12	TBD	Not Supported	TBD	-99.3dBm
LTE-FDD B13	TBD	Not Supported	TBD	-93.3dBm

6.7. Electrostatic Discharge

Theinformation will be added in the future version of this document.

7 Mechanical Dimensions

This chapter describes the mechanical dimensions of the module.All dimensions are measured in mm.

7.1. Mechanical Dimensions of the Module

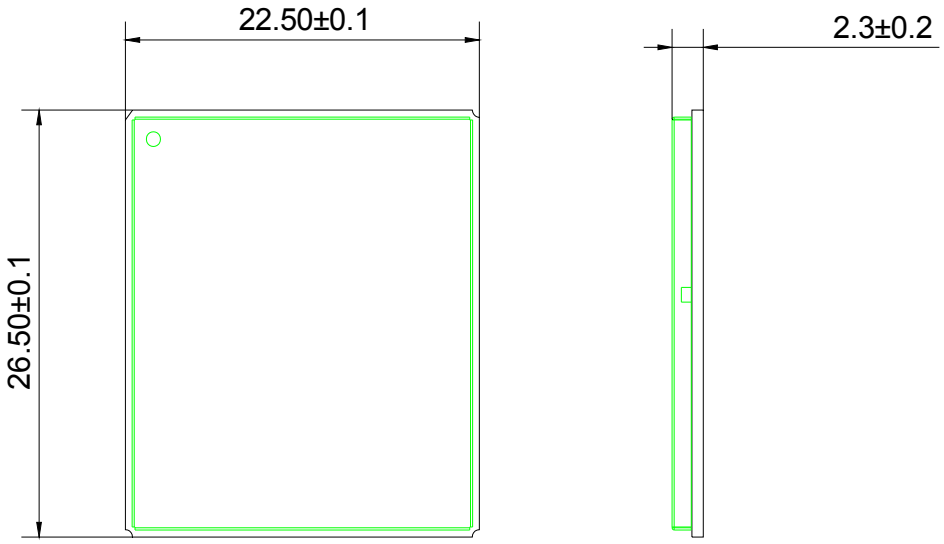


Figure 32: Module Top and Side Dimensions

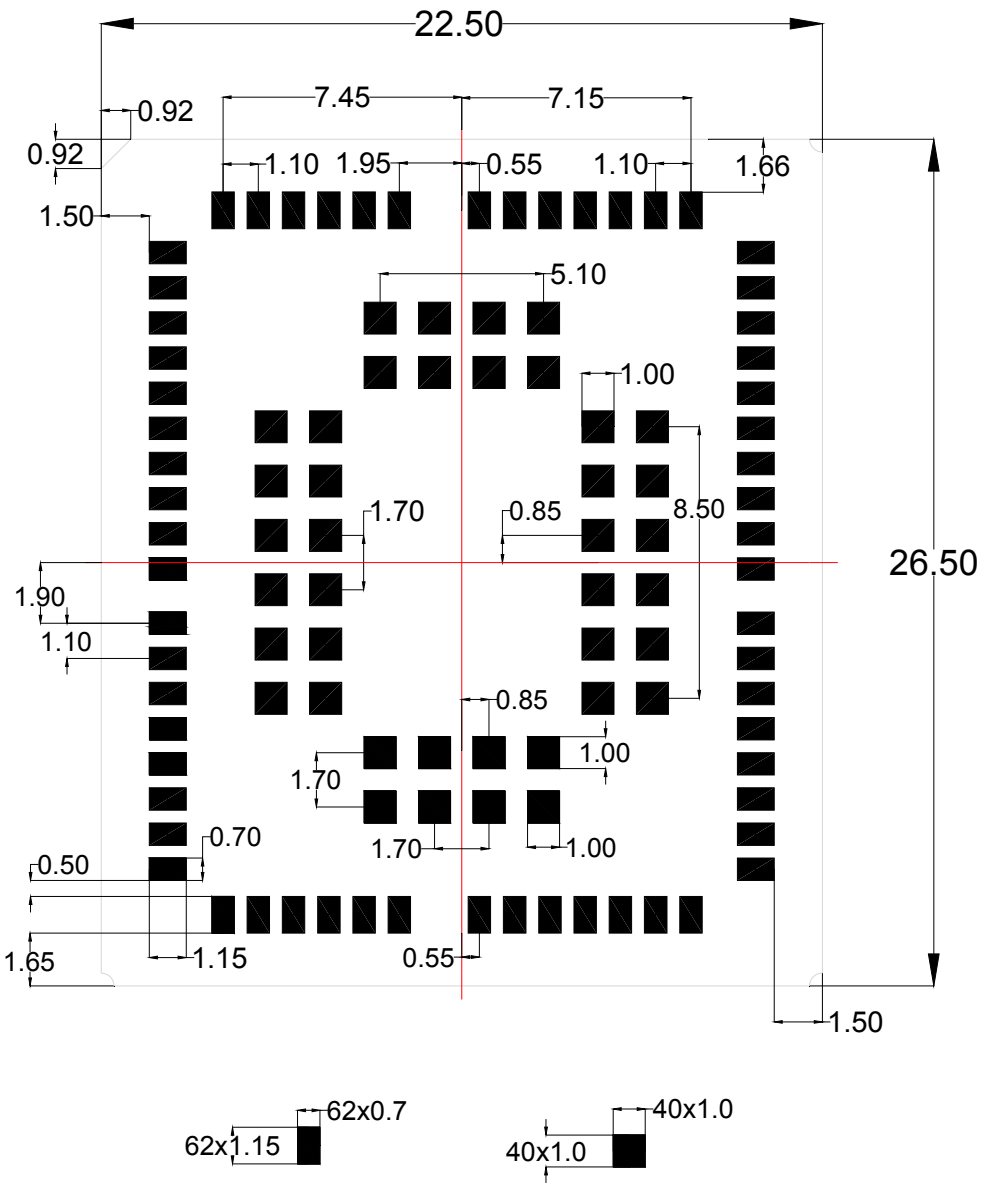


Figure 33: Module Bottom Dimensions (Bottom View)

7.2. Recommended Footprint

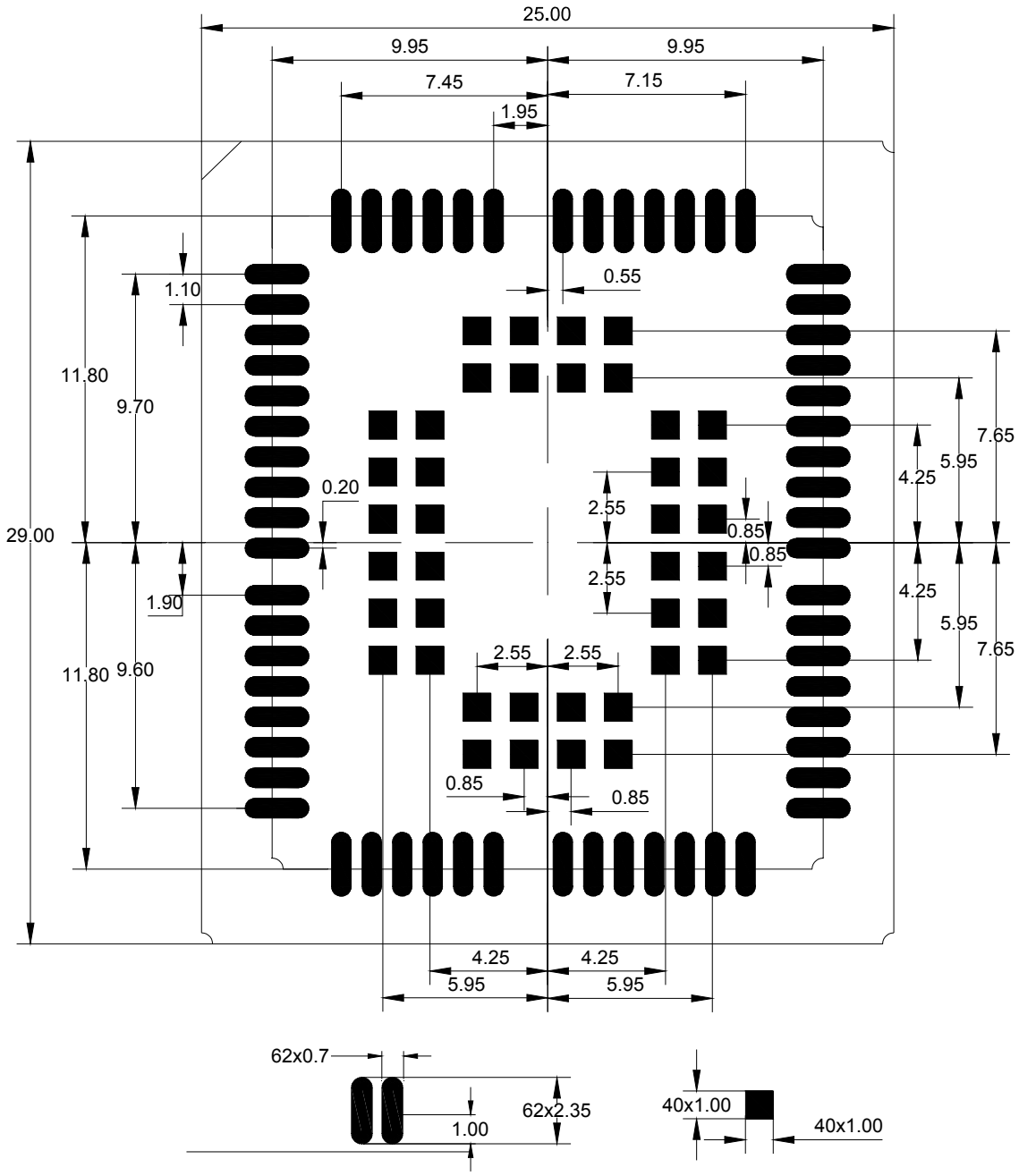


Figure 34: Recommended Footprint (Top View)

NOTE

For easymaintenance of the module, please keep about 3mm between the module and other components in thehost PCB.

7.3. Design Effect Drawings of the Module

Figure 35: Top View of the Module

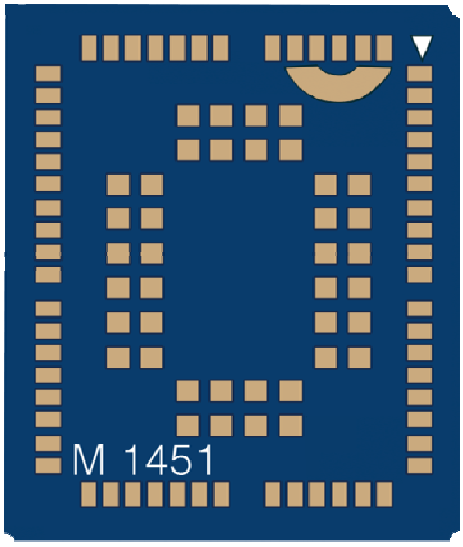


Figure 36: Bottom View of the Module

NOTE

These are design effect drawings of BG96-NA module. For more accurate pictures, please refer to the module that you get from Quectel.

8 Storage, Manufacturing and Packaging

8.1. Storage

BG96-NA is stored in avacuum-sealed bag. The storage restrictionsareshown as below.

1. Shelf life in the vacuum-sealed bag: 12 months at <40ºC/90%RH.
2. After the vacuum-sealed bag is opened, devices that will be subjected to reflow soldering or other high temperature processes must be:

- Mounted within 72 hours at the factory environment of ≤30ºC/60%RH.
- Stored at <10%RH.

3. Devices require baking before mounting, if any circumstance below occurs.

- When the ambient temperature is 23ºC±5ºCand the humidity indication card shows the humidity is >10% before opening the vacuum-sealed bag.
- Device mounting cannot be finished within 72 hours at factory conditions of ≤30ºC/60%

4. If baking is required, devices may be baked for 48 hours at 125ºC±5ºC.

NOTE

As the plastic package cannot be subjected to high temperature, it should be removed from devices before high temperature (125ºC) baking. If shorter baking time is desired, please refer to *IPC/JEDECJ-STD-033* for baking procedure.

8.2. Manufacturing and Welding

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 properlyso as to produce a clean stencil surface on a single pass. To ensure the module soldering quality, thethickness of stencil for the module is recommended to be 0.18mm. For more details, please refer to***document [5]***.

It is suggested that the peak reflow temperature is 235~245ºC (for SnAg3.0Cu0.5 alloy). The absolute max reflow temperature is 260ºC. To avoid damage to the module caused byrepeated heating, it is suggested that the module should be mounted after reflow soldering for the other side of PCB has been completed. Recommended reflow soldering thermal profile is shown below.

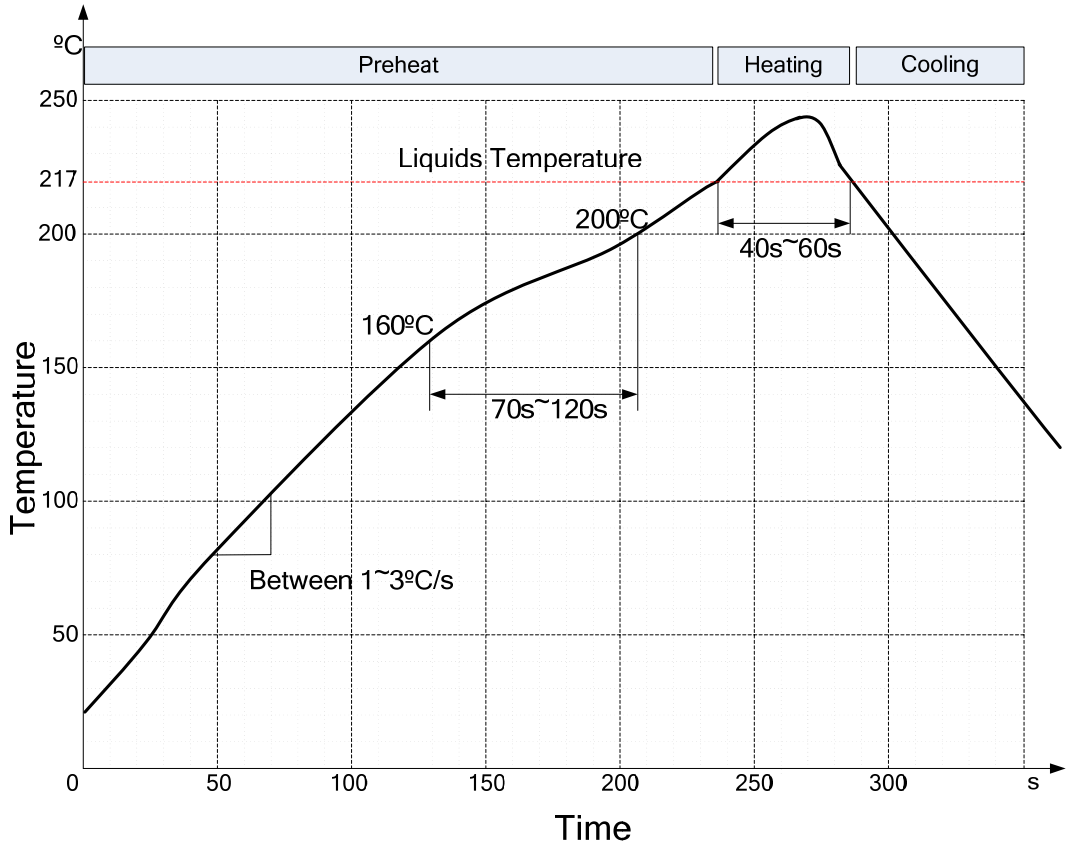


Figure 37: Reflow Soldering Thermal Profile

8.3. Packaging

The information will be added in the future version of this document.

9 Appendix A References

Table 31: Related Documents

SN	Document Name	Remark
[1]	Quectel_BG96_Power_Management_Application_Note	BG96 Power Management Application Note
[2]	Quectel_BG96_AT_Commands_Manual	BG96 AT Commands Manual
[3]	Quectel_BG96_GNSS_AT_Commands_Manual	BG96 GNSS AT Commands Manual
[4]	Quectel_RF_Layout_Application_Note	RF Layout Application Note
[5]	Quectel_Module_Secondary_SMT_User_Guide	Module Secondary SMT User Guide

Table 32: Terms and Abbreviations

Abbreviation	Description
AMR	Adaptive Multi-rate
bps	Bits Per Second
CHAP	Challenge Handshake Authentication Protocol
CS	Coding Scheme
CSD	Circuit Switched Data
CTS	Clear To Send
DC-HSPA+	Dual-carrier High Speed Packet Access
DFOTA	Delta Firmware Upgrade Over The Air
DL	Downlink
DTR	Data Terminal Ready

DTX	Discontinuous Transmission
EFR	Enhanced Full Rate
ESD	Electrostatic Discharge
FDD	Frequency Division Duplex
FR	Full Rate
GMSK	Gaussian Minimum Shift Keying
GSM	Global System for Mobile Communications
HR	Half Rate
HSPA	High Speed Packet Access
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
I/O	Input/Output
Inorm	Normal Current
LED	Light Emitting Diode
LNA	Low Noise Amplifier
LTE	Long Term Evolution
MIMO	Multiple Input Multiple Output
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
QAM	Quadrature Amplitude Modulation

QPSK	Quadrature Phase Shift Keying
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
UMTS	Universal Mobile Telecommunications System
URC	Unsolicited Result Code
(U)SIM	(Universal) Subscriber Identity Module
Vmax	Maximum Voltage Value
Vnorm	Normal 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
WCDMA	Wideband Code Division Multiple Access

10 Appendix B GPRS Coding Schemes

Table 33: 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 34: 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

12 Appendix D EDGE Modulationand Coding Schemes

Table 35: EDGE Modulation and Coding Schemes

Coding Schemes	Modulation	Coding Family	1 Timeslot	2 Timeslot	4 Timeslot
CS-1:	GMSK	/	9.05kbps	18.1kbps	36.2kbps
CS-2:	GMSK	/	13.4kbps	26.8kbps	53.6kbps
CS-3:	GMSK	/	15.6kbps	31.2kbps	62.4kbps
CS-4:	GMSK	/	21.4kbps	42.8kbps	85.6kbps
MCS-1	GMSK	C	8.80kbps	17.60kbps	35.20kbps
MCS-2	GMSK	B	11.2kbps	22.4kbps	44.8kbps
MCS-3	GMSK	A	14.8kbps	29.6kbps	59.2kbps
MCS-4	GMSK	C	17.6kbps	35.2kbps	70.4kbps
MCS-5	8-PSK	B	22.4kbps	44.8kbps	89.6kbps
MCS-6	8-PSK	A	29.6kbps	59.2kbps	118.4kbps
MCS-7	8-PSK	B	44.8kbps	89.6kbps	179.2kbps
MCS-8	8-PSK	A	54.4kbps	108.8kbps	217.6kbps
MCS-9	8-PSK	A	59.2kbps	118.4kbps	236.8kbps