BC92 Hardware Design

NB-IoT Module Series

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About the Document

Revision History

Version	Date	Author	Description
1.0	2020-04-23	Glenn GE/ Miles LI/ Allan LIANG	Initial

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1 Introduction

This document defines the BC92 module and describes its air interface and hardware interfaces that relate to customers' applications.

This document helps customers quickly understand BC92 module interface specifications, electrical and mechanical details, as well as other related information of the module. Associated with application notes and user guides, customers can use BC92 to design and set up mobile applications easily.

1.1. 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 BC92 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 customers' failure to comply with these precautions.

Full attention must always be given to driving 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 the device offers an Airplane Mode, then it should be enabled before boarding an aircraft. Please consult the airline staff for more restrictions on the use of wireless devices on boarding the 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 signals and cellular networks cannot be guaranteed to connect in all possible conditions (for example, with unpaid bills or with an invalid (U)SIM card). When emergent help is needed in such conditions, please remember using emergency call. To make or receive a call, the cellular terminal or mobile must be switched on in a service area with adequate cellular signal strength.
	The cellular terminal or mobile contains a transmitter and receiver. When it is ON, it receives and transmits radio frequency signals. RF interference can occur if it is used close to the 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 include fuelling 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.

2 Product Concept

BC92 is a high-performance, low-power consumption GSM/NB-IoT module. It supports NB-IoT and GSM/GPRS network modes. BC92 supports 3GPP R13 and R14. Its general features are shown below.

- Support GSM850, EGSM900, DCS1800 and PCS1900；
- Support GPRS data transmission and GSM SMS service*；
- Support GPRS multi-slot class 12 (Class 12 by default) and GPRS coding schemes CS-1, CS-2, CS-3 and CS-4；
- Designed with power-saving technology, the current consumption is as low as 4 µA in deep sleep mode；
- Integrate various Internet service protocols (TCP, UDP, PPP, FTP*,HTTP(S)* etc)；
- Support extended AT commands.

The frequency bands supported by BC92 are listed below.

Table 1: BC92 Frequency Bands

Type	Frequency Bands
LTE Cat NB2	B3/B5/B8/B20/B28
GSM	850/900/1800/1900 MHz

BC92 is an SMD type module with 50 LCC pins, which can be embedded into a variety of data transmission applications.

With a compact profile of 23.6 mm × 19.9 mm × 2.2 mm, BC92 can meet almost all requirements for M2M applications, such as smoke detector, wireless meter reading, bike sharing, smart parking, asset tracking, wearables, etc.

The module fully complies with the RoHS directive of the European Union.

NOTE

"*" means under development.

2.1. Key Features

The following table describes the detailed features of BC92.

Table 2: Key Features

Features	Details
Power Supply	Supply voltage range: 3.4~4.2 V. Typical supply voltage: 3.8 V.
Deep Sleep Mode	Typical current consumption in Deep Sleep Mode: 4 μA
NB-IoT Frequency Bands	B3/B5/B8/B20/B28
NB-IoT transmitting power	23 dBm ±2 dB
GSM Frequency Bands	Quad-band: GSM850/EGSM900/DCS1800/PCS1900. Modulation: GMSK. The module searches these frequency bands automatically. The frequency bands can be set via AT commands. Compliant with GSM Phase 2/2+
GSM Transmitting Power	Class 4 (2W) at GSM850 and EGSM900. Class 1 (1W) at DCS1800 and PCS1900.
GPRS Connectivity	GPRS multi-slot class 12 (default). GPRS multi-slot class 1~12 (configurable). GPRS mobile station class B.
GPRS Data features	GPRS data downlink transmission: max 85.6 kbps. GPRS data uplink transmission: max 85.6 kbps. Modulation: GMSK. Coding scheme: CS-1, CS-2, CS-3 and CS-4. Support the protocol PAP (Password Authentication Protocol) usually used for PPP connection. Internet service protocols: UDP/ TCP/ LwM2M/ SNTP/ PPP/ MQTT/ CoAP*/ HTTP*/ HTTPS*/ FTP*.
(U)SIM Interfaces	Support (U)SIM: 1.8 V/3.0 V
SMS*	Text and PDU mode SMS storage: (U)SIM card
UART Interfaces	**Main UART port:** Used for AT command communication and data transmission, the maximum baud rate is 57600 bps and the default baud rate is 9600 bps. **Debug UART port:** Used for software debugging, firmware upgrading and logging. The baud rate

	is 921600 bps
Temperature Range	Operation temperature range: -25 °C ~ +75 °C 1) Extended temperature range: -40 °C ~ +85 °C 2) Storage temperature range: -40 °C ~ +90 °C
Physical Characteristics	Size: （23.6 ±0.15） mm × （19.9 ±0.15） mm × （2.2 ±0.2） mm Package: LCC Weight: 1.8 ±0.1 g
Firmware Upgrade	Firmware upgrade via debug UART port or DFOTA.
Antenna Interface	50 Ω impedance control

NOTES

1. 1) Within the operation temperature range, the module is 3GPP compliant.
2. 2) Within the extended temperature range, the module remains the ability to establish and maintain functions such as SMS* and data transmission, without any unrecoverable malfunction. Radio spectrum and radio networks will not be influenced. While there may be several parameters, such as P_{out} reducing in value, exceeding the specified tolerances of 3GPP. When the temperature returns to the normal operating temperature level, the module will comply with 3GPP specifications again.
3. "*" means under development.

Table 3: Coding Schemes and Maximum Network Data Rates over Air Interface

Coding Scheme	1 Timeslot	2 Timeslot	4 Timeslot
CS-1	9.05 kbps	18.1 kbps	36.2 kbps
CS-2	13.4 kbps	26.8 kbps	53.6 kbps
CS-3	15.6 kbps	31.2 kbps	62.4 kbps
CS-4	21.4 kbps	42.8 kbps	85.6 kbps

2.2. Functional Diagram

The following figure shows a block diagram of BC92 and illustrates the major functional parts:

- Radio frequency
- Baseband
- Power management
- Peripheral interfaces

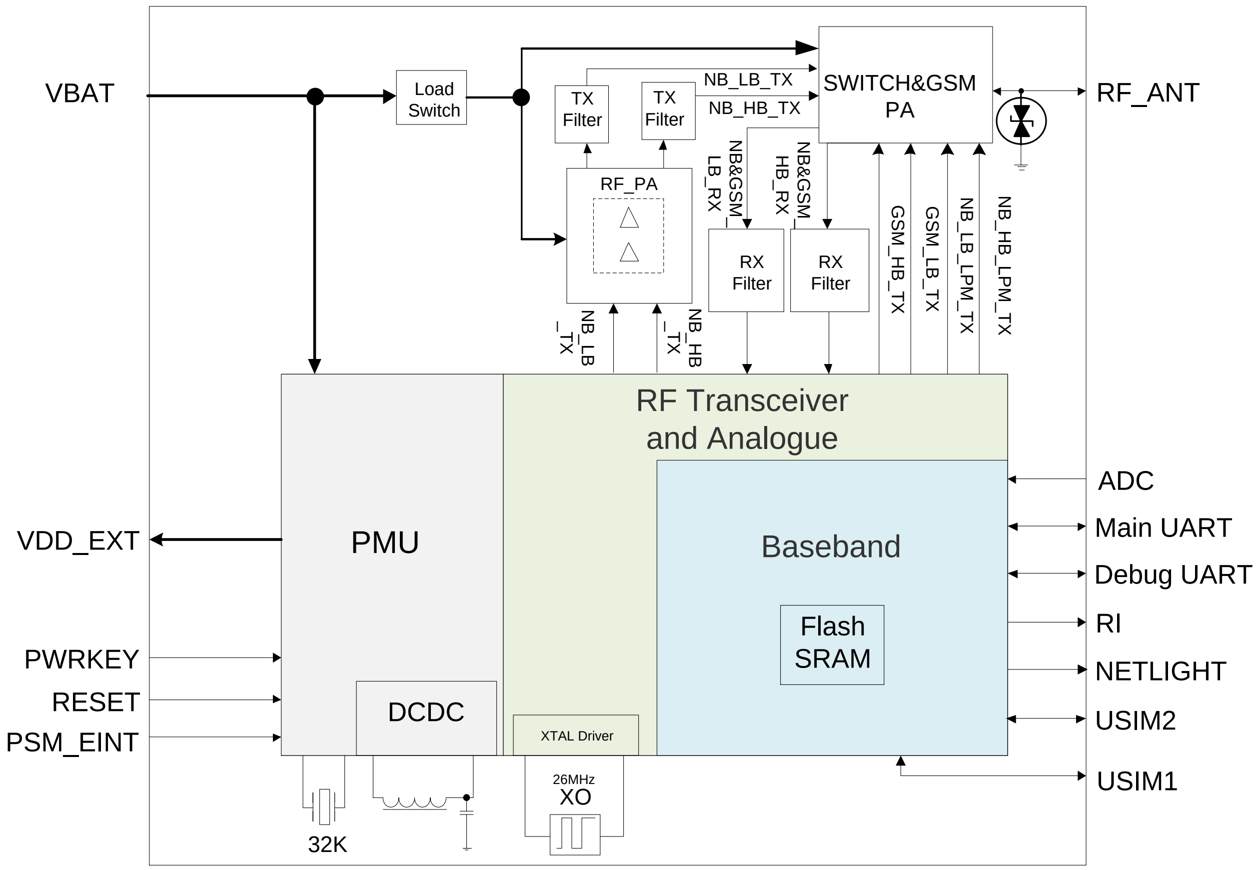

Figure 1: Functional Diagram

2.3. Evaluation Board

Quectel provides a complete set of development tools to help the use and testing of the BC92 module. The development tools include a BC92 TE-B (evaluation board), Micro-USB cable, antenna, and other peripherals. For details, please refer to ***document [2]***.

3 Application Interfaces

3.1. General Description

BC92 is an SMD type module with 50 LCC pins. The later chapters provide detailed descriptions of these interfaces:

- Operating modes
- Power supply
- Turn on/off
- Power saving
- UART interfaces
- (U)SIM interfaces
- RI signal interface
- Network status indication
- ADC interface*

NOTE

"*" means under development.

3.2. Pin Assignment

The following figure shows the pin assignment of BC92.

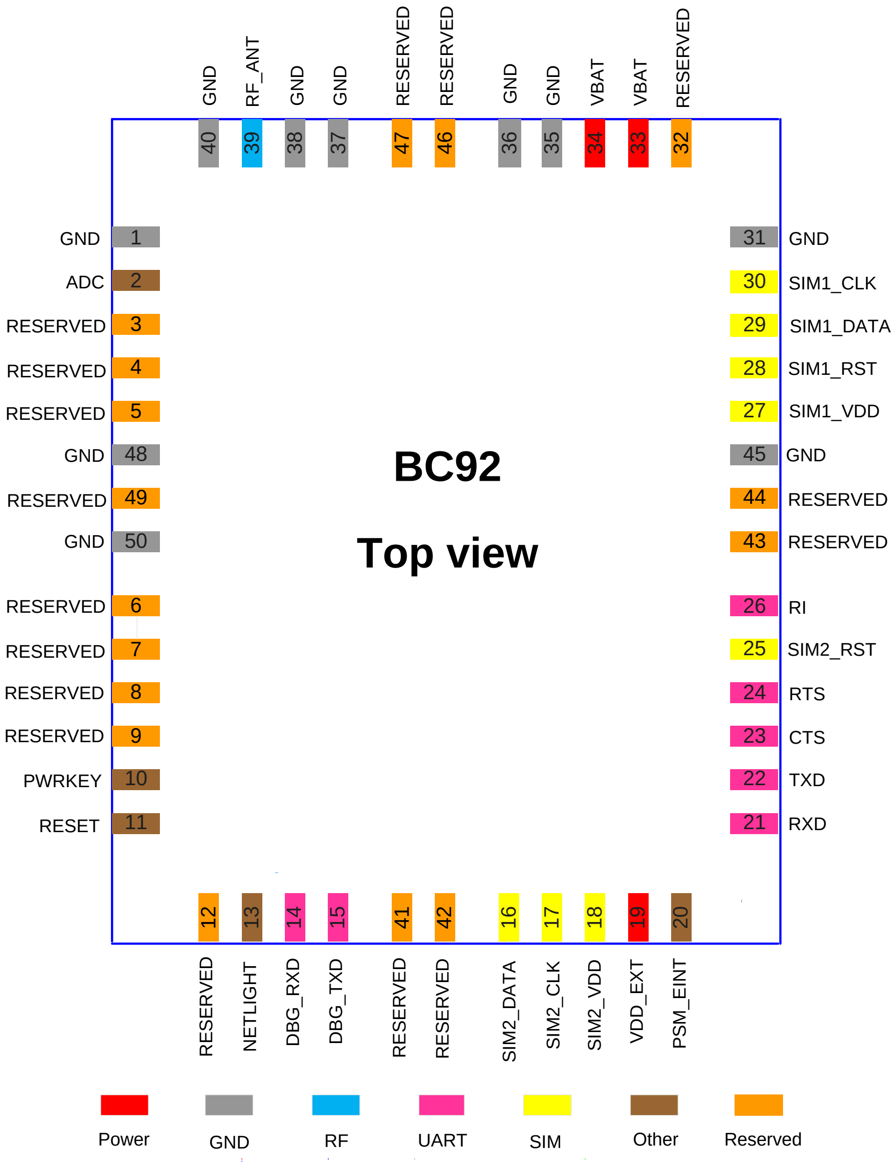

Figure 2: Pin Assignment

NOTE

All reserved pins should be kept open.

3.3. Pin Description

Table 4: I/O Parameters Definition

Type	Description
AI	Analog input
DI	Digital input
DO	Digital output
IO	Bidirectional
PI	Power input
PO	Power output

Table 5: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VBAT	33, 34	PI	The main power supply of the module	Vmax=4.2 V Vmin=3.4 V Vnorm=3.8 V	It must be provided with enough current up to 2.0 A
VDD_EXT	19	PO	Supply 2.8 V voltage	Vnorm=2.8 V	In deep sleep mode, there is no output voltage. It can be used as a pull-up power supply of module I/O port. Do not recommend using it to power an external circuit.
GND	1, 31, 35 36, 37 38, 40, 45, 48, 50		Ground		
PWRKEY					

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
PWRKEY	10	DI	Pull down PWRKEY to turn on the module.	Vnorm=1.07 V	Active low
RESET					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESET	11	DI	Reset the module.	Vnorm=1.07 V	Active low
PSM_EINT					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PSM_EINT	20	DI	Dedicated external interrupt pin. Used to wake up the module from a deep sleep.	Vnorm=1.07 V	Active low
Network Status Indicator					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
NETLIGHT	13	DO	Network status indication	V_{OL}max=0.2 × VDD_EXT V_{OH}min=0.8 × VDD_EXT	Leave open If unused.
Main UART Port					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RXD	21	DI	Receive data	V_{IL}max=0.3 × VDD_EXT V_{IH}min=0.7 × VDD_EXT V_{OL}max=0.2 × VDD_EXT V_{OH}min=0.8 × VDD_EXT	If only TXD, RXD and GND are used for communication, it is recommended to keep the rest pins of main UART port open.
TXD	22	DO	Transmit data		
RI	26	DO	Ring indication		
CTS*	23	DO	Clear to send		
RTS*	24	DI	Request to send		
Debug UART Port					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
DBG_TXD	15	DO	Transmit data	V_{IL}max=0.3 × VDD_EXT V_{IH}min=0.7 × VDD_EXT V_{OL}max=0.2 x VDD_EXT	Leave open If unused.
DBG_RXD	14	DI	Receive data		

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
				V_{OH}min=0.8 x VDD_EXT	
(U)SIM1 Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
SIM1_VDD	27	PO	Power supply for (U)SIM1 card	Either 1.8 V or 3.0 V, selected by the software automatically.	All signals of (U)SIM interface should be protected against ESD with a TVS diode array. The maximum trace length from the module pins to (U)SIM card connector should be 200 mm.
SIM1_DATA	29	IO	Data signal of (U)SIM1 card	V_{IL}max=0.3 × SIM1_VDD V_{IH}min=0.7 × SIM1_VDD V_{OL}max=0.2 × SIM1_VDD V_{OH}min= 0.8 × SIM1_VDD	
SIM1_CLK	30	DO	Clock signal of (U)SIM1 card	V_{OL}max=0.2 × SIM1_VDD V_{OH}min=0.8 × SIM1_VDD	
SIM_RST	28	DO	Reset signal of (U)SIM1 card	V_{OL}max=0.2 × SIM1_VDD V_{OH}min=0.8 × SIM1_VDD	
(U)SIM2 Interface*					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
SIM2_VDD	18	PO	Power supply for (U)SIM2 card	Either 1.8 V or 3.0 V, selected by the software automatically.	Support GSM/GPRS network only. All signals of (U)SIM interfaces should be protected against ESD with a TVS diode array; The maximum trace length from the module pad to (U)SIM card connector should be 200 mm.
SIM2_DATA	16	IO	Data signal of (U)SIM2 card	V_{IL}max=0.3 × SIM1_VDD V_{IH}min=0.7 × SIM1_VDD V_{OL}max=0.2 × SIM1_VDD V_{OH}min= 0.8 × SIM1_VDD	
SIM2_CLK	17	DO	The clock signal of (U)SIM2 card	V_{OL}max=0.2 × SIM1_VDD V_{OH}min=0.8 × SIM1_VDD	
SIM2_RST	25	DO	Reset signal of (U)SIM2 card	V_{OL}max=0.2 × SIM1_VDD V_{OH}min=0.8 × SIM1_VDD	
ADC Interface*					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ADC	2	AI	Analog to digital converter interface	Voltage input range: 0~1.8 V	Leave open If unused.
Antenna Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**

RF_ANT	39	IO	NB-IoT/GSM antenna interface		50 Ω impedance
Reserved Pins					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESERVED	3~9, 12, 32, 41, 42, 43, 44, 46, 47,49				Keep these pins open.

NOTE

"*" means under development.

3.4. Operating Modes

3.4.1. NB-IoT Operating Mode

The module mainly consists of AP and modem, and the tables below describe the NB-IoT operating modes of the AP, modem and the entire module.

Table 6: AP Operating Modes

Mode	Description
Normal	In normal mode, the AP handles tasks, such as AT command communication.
Idle	When all tasks are suspended, the AP will enter idle mode.

Table 7: Modem Operating Modes

Mode	Description
Connected	The network is connected and the module supports data transmission. In such a case, the modem can switch to PSM or DRX/eDRX mode.
DRX/eDRX	The modem is in idle mode, and downlink data can be received during PTW only. In such a case, the modem can switch to PSM or connected mode.
PSM	In power saving mode, the modem is disconnected from the network and cannot receive any downlink data. In such a case, the modem can switch to connected mode.

Table 8: Module Operating Modes

Mode	Description
Active	When the AP is in normal mode or the modem is in connected mode, the module will be active and supports all services and functions. The current consumption in active mode is higher than that in sleep modes.
Light Sleep	When the AP is in idle mode and the modem is in DRX mode, the module will enter light sleep mode. In such a case, the AP tasks will be suspended and the modem will be able to receive downlink data during PTW only. In light sleep mode, the current consumption of the module is reduced greatly.
Deep Sleep	When the AP is in idle mode and the modem is in PSM, the module will enter deep sleep mode in which the CPU is powered off and only the 32 kHz RTC clock is working. In deep sleep mode, the current consumption will be reduced to the minimum (typically 4 μA).

3.4.2. GSM/GPRS Operating Mode

The following table briefly describes the GSM/GPRS operating mode of the module.

Table 9: Operating Modes Overview

Modes	Function	
GSM/GPRS Mode	GSM/GPRS Sleep	It can minimize the current consumption of the module working in GSM / GPRS mode. The module is still able to receive data packages and short messages. It can be woken up through the main UART port.
	GSM Idle	The software is active. The module has registered on the GSM network, and it is ready to send and receive GSM data.

	GPRS Idle	The module is not registered on the GPRS network, so it has no access to the GPRS channel.
	GPRS Standby	The module is registered on the GPRS network, but no GPRS PDP context is active.
	GPRS Ready	The PDP context is active, but no data transfer is ongoing. The module is ready to receive or send GPRS data.
	GPRS DATA	There is GPRS data in transfer. In this mode, the power consumption of the module is decided by the PCL, working frequency of RF and GPRS multi-slot configuration.

NOTE

Whether the module will search NB-IoT or GSM network first is configurable. By default, the NB-IoT network is searched first.

3.5. Power Supply

3.5.1. Power Features of the Module

Power supply design is an important part of the BC92 application design. Due to the 577 μs burst in the GSM part every 4.615 ms, in a burst period, the power supply must be able to deliver high peak current and the supply voltage should not drop below the minimum working voltage of the module.

The maximum current consumption of the module could reach 1.6 A during a burst transmission, which will cause a large voltage drop on VBAT. To ensure the stability of the module's operation, it is recommended that the maximum voltage drop during the burst transmission should not exceed 3.4 V.

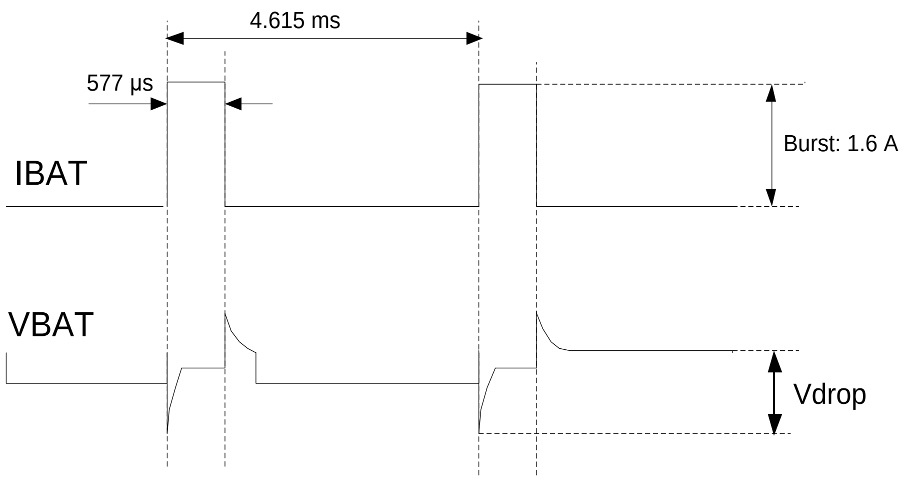

Figure 3: Voltage Ripple during GSM Transmitting

3.5.2. Decrease Supply Voltage Drop

Make sure that the input voltage will never drop below the minimum working voltage even in a burst transmission. It is recommended to place a 100 μF tantalum capacitor with low ESR (ESR=0.7 Ω), ceramic capacitors of 100 nF, 33 pF and 10 pF, and TVS near the VBAT pins. The reference circuit is illustrated in the following figure.

The VBAT trace should be wide enough to ensure that there is not too much voltage drop during burst transmission. The width of the VBAT trace should be no less than 2 mm; and in principle, the longer the trace is, the wider it will be.

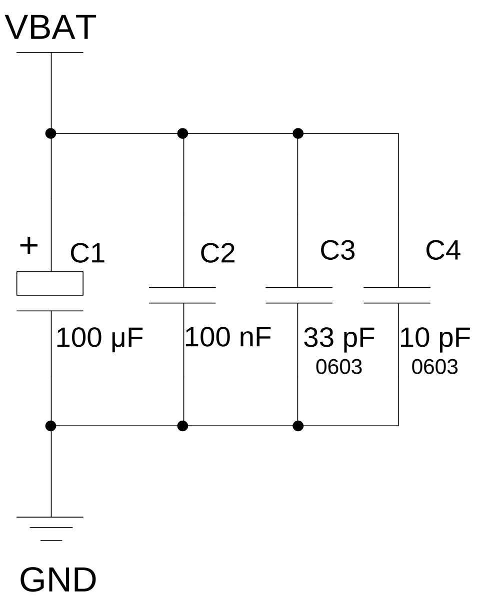

Figure 4: Reference Circuit for VBAT Input

3.5.3. Reference Design for Power Supply

Power design for the module is very important, as the performance of the module largely depends on the power source. The power supply should be provided with enough current up to 2.0 A at least. If the voltage difference between the input and the output voltage is not too big, it is suggested to use an LDO to supply power for the module; if there is a big voltage difference between the input and the output voltage, a switcher power converter is preferred to be used.

The following figure shows a reference design for a +5 V input power supply. The designed output voltage for the power supply is 3.8 V and the maximum load current is 3.0 A. To ensure the stability of the output voltage, a zener diode is suggested to be placed close to the VBAT pins.

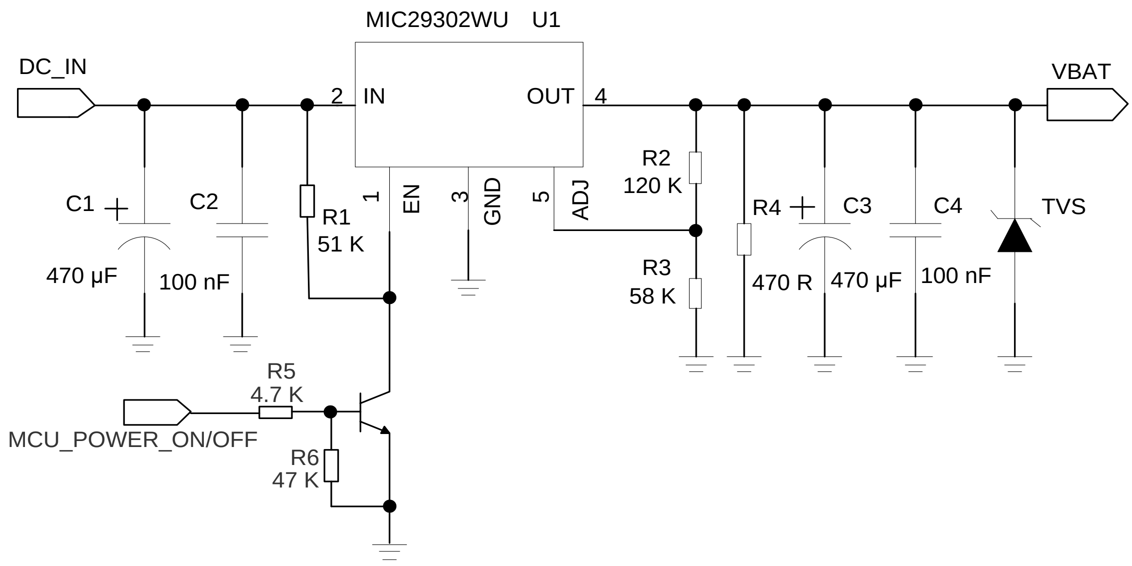

Figure 5: Reference Circuit for Power Supply

NOTES

1. It is recommended to control the module's main power supply (VBAT) via an LDO enabled pin to restart the module when the module becomes abnormal. A power switch circuit like the P-channel MOSFET switch circuit can also be used to control VBAT.
2. This circuit is suitable for power-insensitive scenarios. If there are low power design requirements, please select an appropriate LDO.

3.5.4. Monitor Power Supply

The command **AT+CBC** can be used to monitor the supply voltage. The unit of the displayed voltage is in mV. For details, please refer to ***document [1]***.

3.6. Turn on and off Scenarios

3.6.1. Turn on

The module can be turned on by driving PWRKEY low. An open collector driver circuit is suggested to control the PWRKEY.

A simple reference circuit is illustrated below.

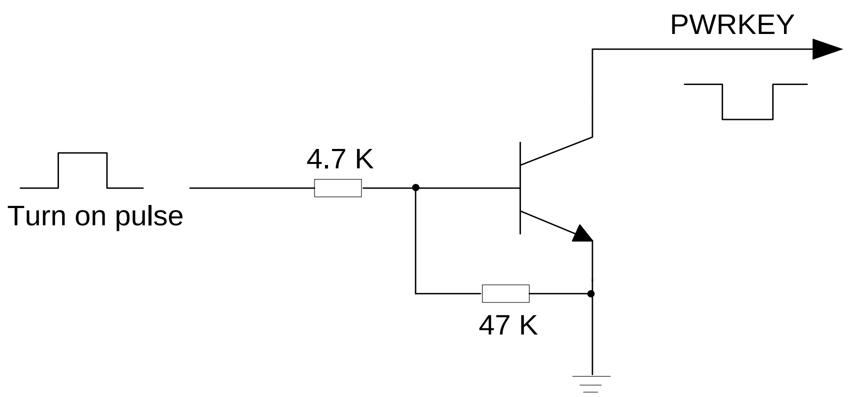

Figure 6: Turn on the Module through an Open-collector Driver

The other way to control the PWRKEY is through a button directly. A TVS component is indispensable to be placed nearby the button for ESD protection. A reference circuit is shown in the following figure.

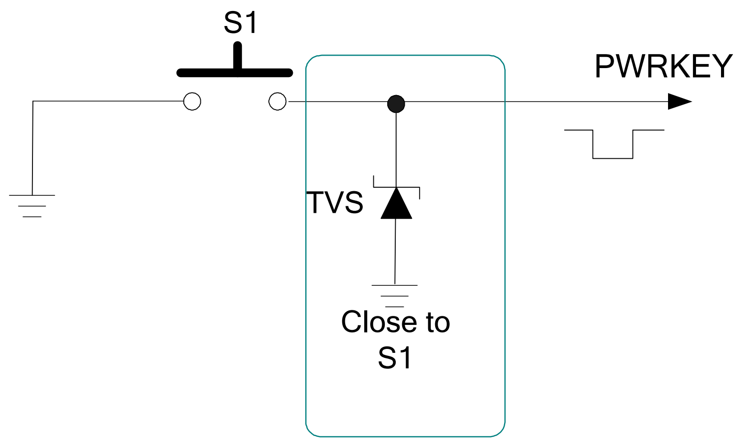

Figure 7: Turn on the Module through a Button

The turn-on scenario is illustrated in the following figure.

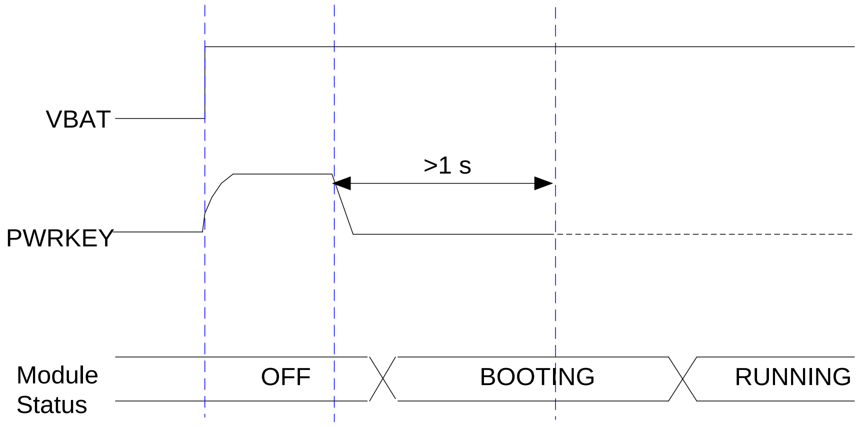

Figure 8: Turn-on Scenario

NOTES

1. PWRKEY is used for the first booting after the module is powered on. If the module is turned off by AT command, it is by pulling down PSM_EINT for at least 100 ms that the module is turned on.
2. The voltage of VBAT should be lower than 1.0 V before being powered on to ensure that PWRKEY is initialized normally after the VBAT being powered on.

3.6.2. Turn off

It is a safe way to turn off the module via command **AT+QPOWD=1**. This command will let the module log off from the network and allow the firmware to save important data before completely disconnecting the power supply.

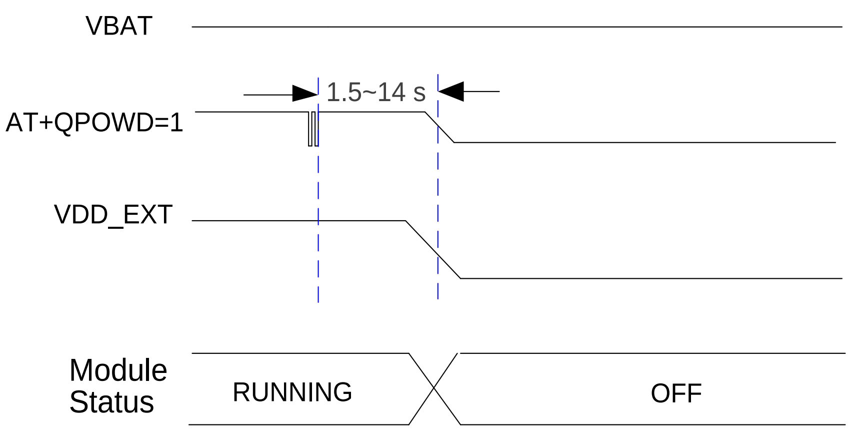

Figure 9: Power down Timing (Power off by AT Command)

Before the completion of the power-off procedure, the module sends out the result code:

NORMAL POWER DOWN

After that moment, no further AT commands can be executed. And then the module enters the power-down mode.

Please refer to ***document [1]*** for details about AT command **AT+QPOWD**.

3.6.3. Reset

Driving RESET low for at least 100 ms will reset the module.

The recommended circuits of resetting the module are shown below. An open-drain/collector driver or the button can be used to control the RESET pin.

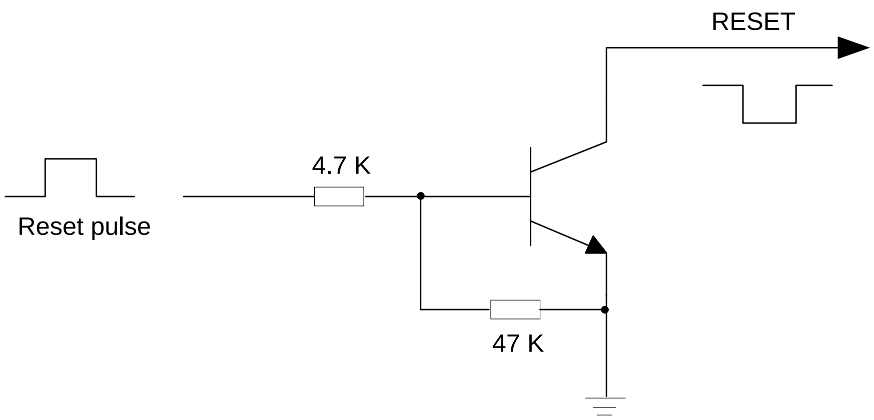

Figure 10: Reference Circuit of RESET with Driver Circuits

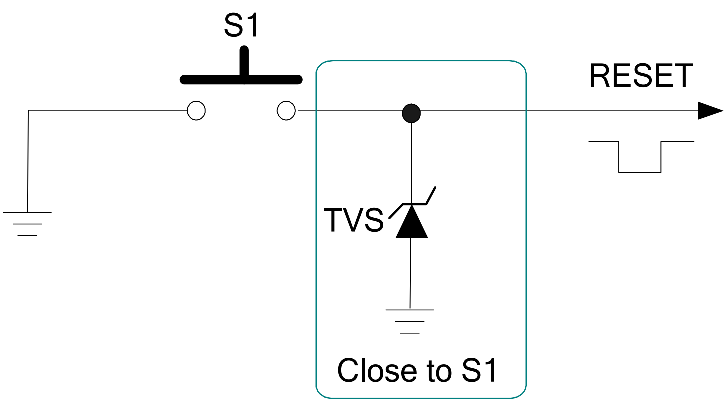

Figure 11: Reference Circuit of RESET with Buttons

The reset timing is illustrated in the following figure.

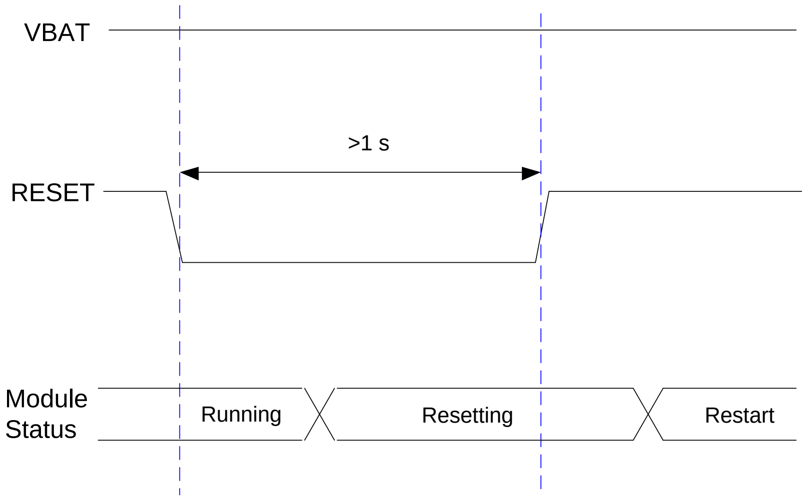

Figure 12: Reset Timing

3.7. Power Saving

Upon system requirement, there are several ways to drive the module to enter low current consumption status.

3.7.1. Light Sleep Mode

In this mode, the UART port is still active and the module can wake up through the main UART port.

3.7.2. Deep Sleep Mode

Based on system performance, the module consumes an ultra-low current (typically 4 μA current consumption) in deep sleep mode. Deep sleep mode is designed to reduce the power consumption of the module and improve battery life. In this mode, the UART port is inactive. The following figure shows the power consumption of the module (modem) in different modes.

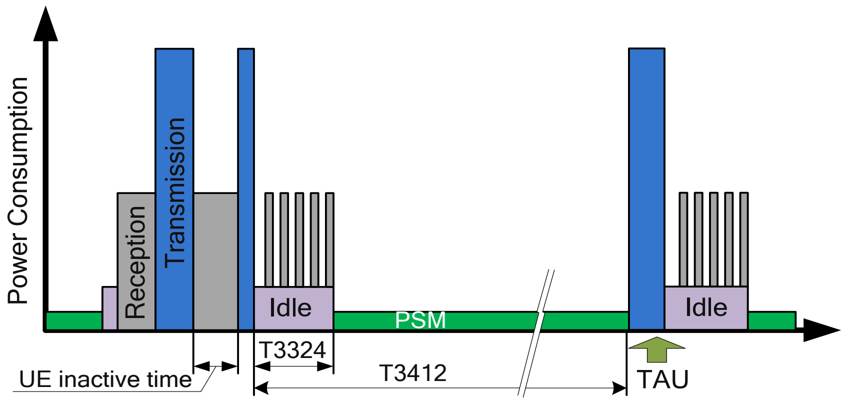

Figure 13: Module Power Consumption in Different Modes(Modem)

When the modem remains in PSM and the AP is in idle mode, the module will enter deep sleep mode.

The procedure of the modem entering PSM is as follows:

The modem requests to enter PSM in **ATTACH REQUEST** message during attach/TAU (Tracking Area Update) procedure. Then the network accepts the request and provides an active time value (T3324) to the modem and the mobile reachable timer starts. When the T3324 timer expires, the modem enters PSM for the duration of T3412 (periodic TAU timer). Please note that the module cannot request PSM when it is establishing an emergency attachment or initializing the PDN (Public Data Network) connection

When the module is in deep sleep mode, it will be woken up in either of the following cases::

- After the T3412 timer expires, the module will exit deep sleep automatically.
- Pulling down PSM_EINT will wake the module up from deep sleep.

The timing of waking up the module from PSM is illustrated below.

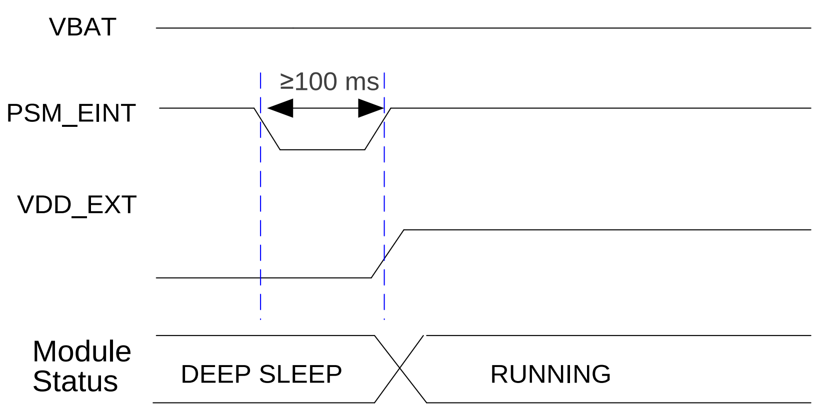

Figure 14: Timing of Waking up Module from PSM

3.8. UART Interfaces

The module provides two UART ports: main UART port and debug UART port. The module is designed as a DCE (Data Communication Equipment), following the traditional DCE-DTE (Data Terminal Equipment) connection.

The logic levels of UART Interfaces are described in the following table.

Table 10: Logic Levels of UART Interfaces

Parameter	Min.	Max.	Unit
V_{IL}	0	0.3 × VDD_EXT	V
V_{IH}	0.7 × VDD_EXT		V
V_{OL}	0	0.2 × VDD_EXT	V
V_{OH}	0.8 × VDD_EXT	VDD_EXT	V

Table 11: Pin Definition of UART Interfaces

Interface	Pin Name	Pin No.	I/O	Description
Main UART port	TXD	22	DO	Send data to RXD of DTE.
	RXD	21	DI	Receive data from TXD of DTE.
	RI	26	DO	Ring indicator (when there is a URC output, the DCE will send a signal to inform the DTE).
	CTS*	23	DO	Clear to send
	RTS*	24	DI	Request to send.
Debug UART port	DBG_RXD	14	DI	Send data to the COM port of peripheral.
	DBG_TXD	15	DO	Receive data from the COM port of peripheral.

NOTE

"*" means under development.

3.8.1. Main UART Port

3.8.1.1. Features of Main UART Port

- Contain data lines TXD and RXD, hardware flow control lines RTS* and CTS*, as well as RI.
- 8 data bits, no parity, one stop bit.
- Baud rates for AT command transfer and GPRS data support are 2400 bps, 4800 bps, 9600 bps (default), 14400 bps, 19200 bps, 28800 bps, 33600 bps, 38400 bps, and 57600 bps.

NOTE

"*" means under development.

3.8.1.2. Reference Design of Main UART Port

The connection between module and host using the main UART port is relatively flexible. The following are two common connection methods

A three-wire connection is shown below.

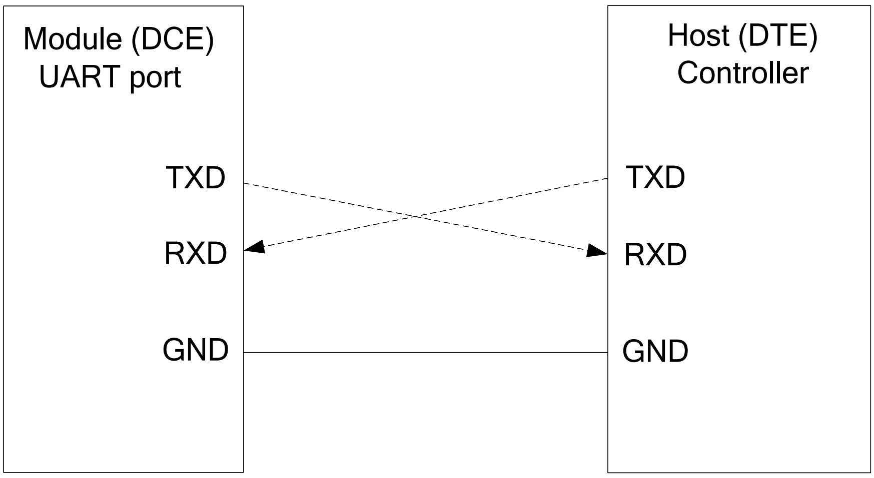

Figure 15: Reference Design for Main UART Port (Three-wire Connection)

A reference design for the main UART port with hardware flow control is shown below. The connection will enhance the reliability of mass data communication.

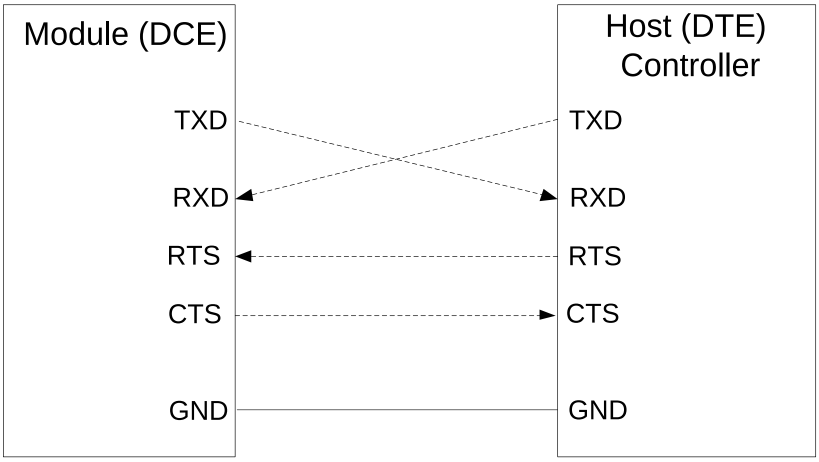

Figure 16: Reference Design for UART Port with Hardware Flow Control

3.8.2. Debug UART Port

- Two lines: DBG_TXD and DBG_RXD.
- For software debugging and firmware upgrade, the baud rate is 921600 bps.

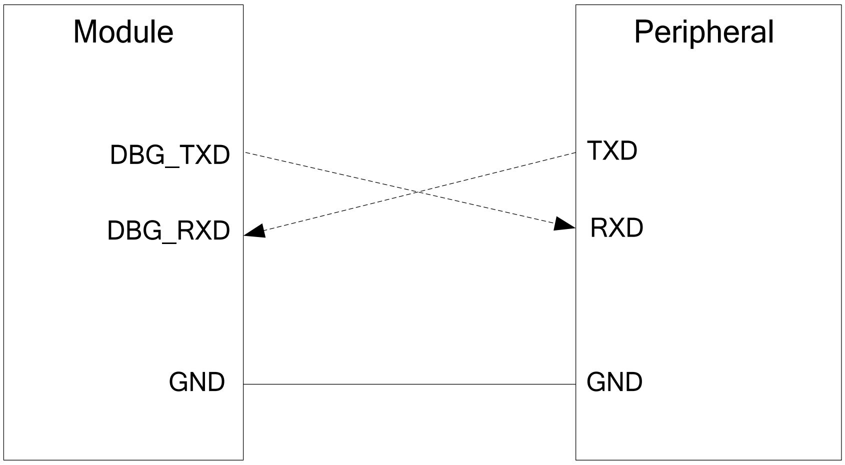

Figure 17: Reference Design for Debug Port

3.8.3. UART Application

A reference design of a 3.3 V level match is shown below. If the host is a 3.0 V system, please change the 5.6 kΩ resistors to 10 kΩ ones.

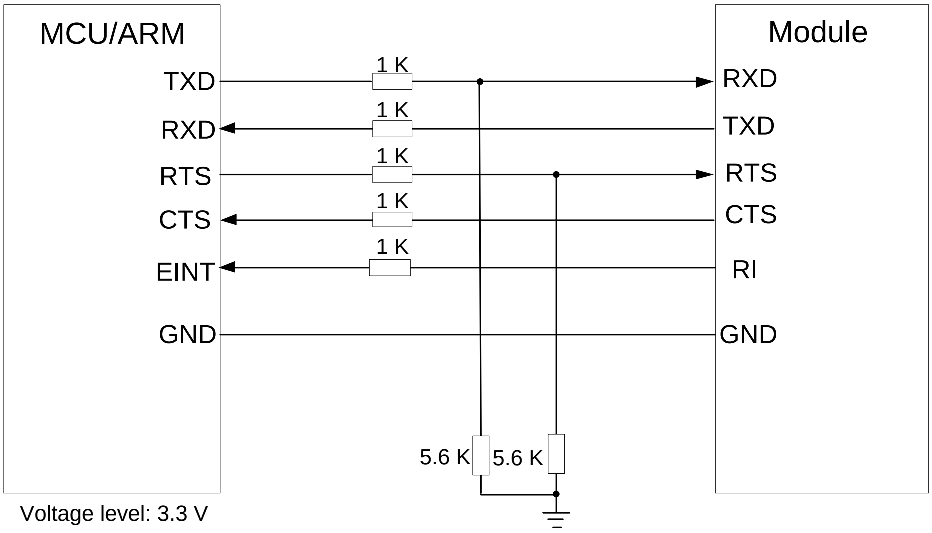

Figure 18: Level Match Design for 3.3 V System

NOTES

1. When the level of the host system is 3 V or 3.3 V, it is recommended to add a voltage divider circuit to the UART port connection between the module and the host to make the level match.
2. For more details on level matching, please refer to the ***document [4]***.

The following figure shows a sketch map between the module and the standard RS-232 interface. As the electrical level of the module is 2.8 V, and RS-232 level shifter must be used. Customers should assure the I/O voltage of level shifter which connects to the module is 2.8 V.

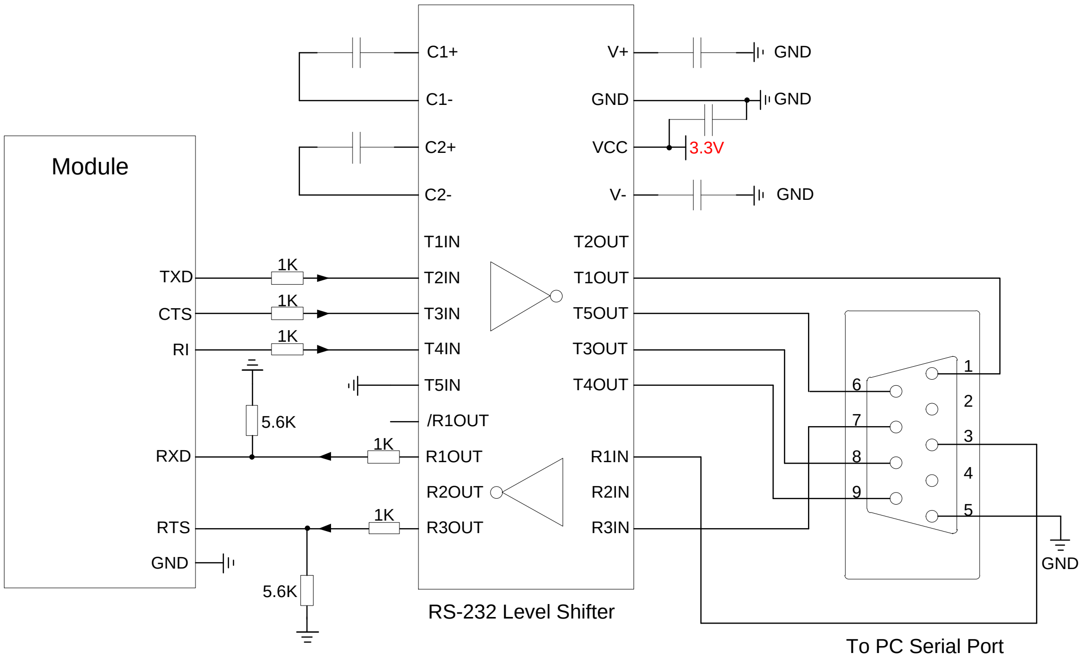

Figure 19: Sketch Map for RS-232 Interface Match

Please visit vendors' websites to select a suitable IC, such as http://www.maximintegrated.com and http://www.exar.com.

3.9. (U)SIM Interfaces

The (U)SIM card is powered by an internal regulator in the module. Both 1.8 V and 3.0 V (U)SIM cards are supported.

Table 12: Pin Definition of (U)SIM Interfaces

Pin Name	Pin No.	Description	Comment
SIM1_VDD	27	Supply power for (U)SIM1 card. Automatic detection of (U)SIM1 card voltage.	(U)SIM1 interface supports both GSM and NB-IoT networks
SIM1_CLK	30	The clock signal of (U)SIM1 card	
SIM1_DATA	29	Data signal of (U)SIM1 card	

SIM1_RST	28	Reset signal of (U)SIM1 card	
SIM2_VDD*	18	Supply power for (U)SIM2 card. Automatic detection of (U)SIM2 card voltage	(U)SIM2 interface supports the GSM network only and it is still under development
SIM2_CLK*	17	The clock signal of (U)SIM2 card	
SIM2_DATA*	16	Data signal of (U)SIM2 card	
SIM2_RST*	25	Reset signal of (U)SIM2 card	

The following figure shows a reference design for (U)SIM1 interface with a 6-pin (U)SIM card connector.

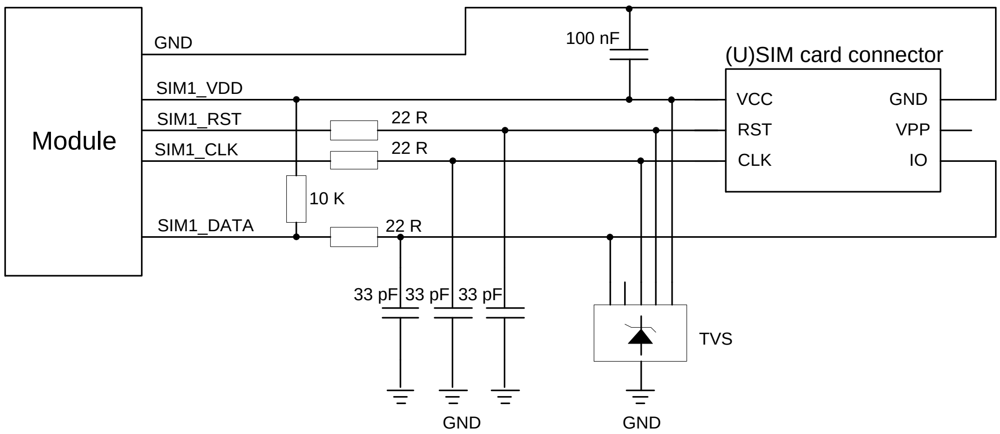

Figure 20: Reference Circuit for (U)SIM1 Interface with a 6-Pin (U)SIM Card Connector

The following figure shows a reference design for (U)SIM2 interface with a 6-pin (U)SIM card connector.

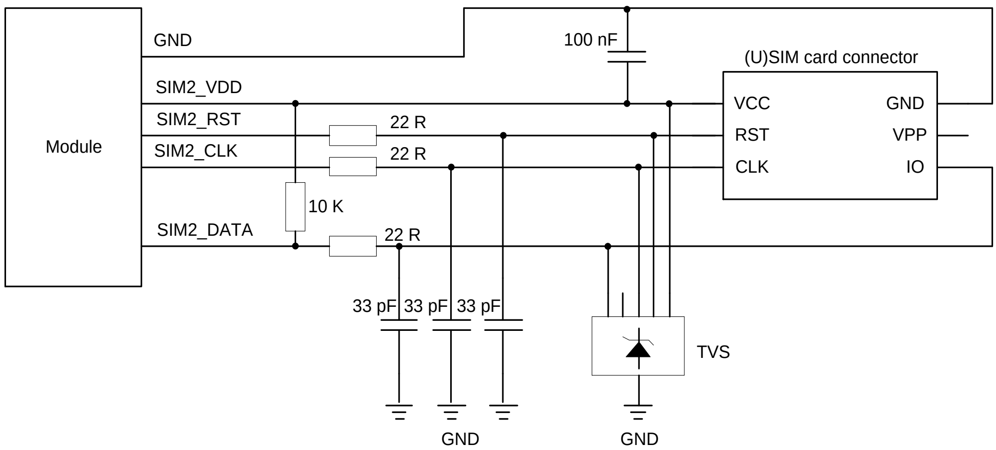

Figure 21: Reference Circuit for (U)SIM2 Interface with a 6-Pin (U)SIM Card Connector

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 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 trace between the ground of the module and that of (U)SIM card connector is short and wide. Keep the trace width of the ground no less than 0.5 mm to maintain the same electric potential. The decoupling capacitor between SIM_VDD and GND should be not more than 1 μF and be placed close to the (U)SIM card connector.
- To avoid cross-talk between SIM_DATA and SIM_CLK, keep them away from each other and shield them separately with the surrounded ground.
- In order to offer good ESD protection, it is recommended to add a TVS diode array whose parasitic capacitance should be not more than 50 pF. The ESD protection device should be placed as close to (U)SIM card connector as possible, and make sure the (U)SIM card signal lines go through the ESD protection device first from (U)SIM card connector and then to the module. The 22 Ω resistors should be connected in series between the module and the (U)SIM card connector to suppress EMI spurious transmission and enhance ESD protection. Please note that the (U)SIM peripheral circuit should be close to the (U)SIM card connector.
- The pull-up resistor on the SIM_DATA line can improve anti-jamming capability and should be placed close to the (U)SIM card connector.

NOTE

"*" means under development.

3.10. RI Signal Interface

When URC reported is received, RI will output a low level and it will last for at least 120 ms.

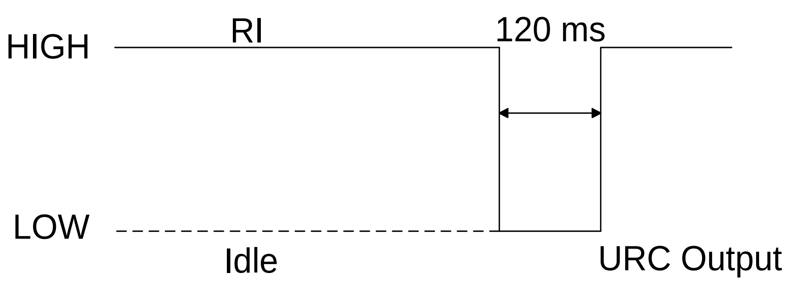

Figure 22: RI Timing When URC Message is Received

3.11. Network Status Indication

NETLIGHT signal can be used to indicate the network status of the module and this function is disabled by default. The NETLIGHT pin outputs a low level. This function can be enabled by **AT+QLEDMODE=1**, after which the NETLIGHT pin will work in states shown in the following table.

Table 13: Working Status of NETLIGHT

Network Modes	Level Status	Module Working Status
NB-IoT Mode	64 ms High (light on) / 800 ms Low (light off)	The module is searching for NB-IoT network.
	64 ms High (light on) / 2000 ms Low (light off)	The module has attached to NB-IoT network and it is connected.
	Low (light off)	The module is in other status.
GSM Mode	64 ms High (light on) / 800 ms Low (light off)	The module has not registerd to a network.
	64 ms High (light on) / 2000 ms Low (light off)	The module has registered to a network
	64 ms High (light on) / 600 ms Low (light off)	GPRS data transmission communication

A reference circuit is shown below.

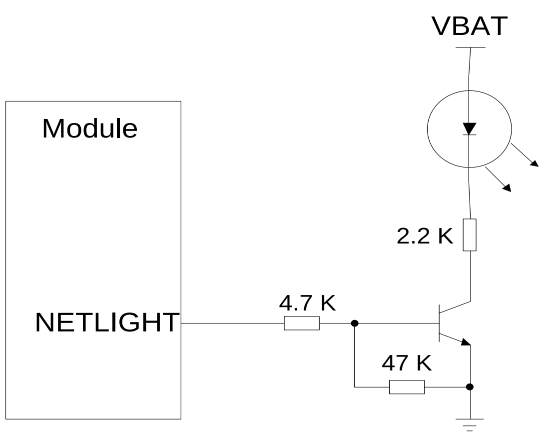

Figure 23: Reference Design for NETLIGHT

3.12. ADC Interface*

The module provides a 10-bit ADC input interface to measure the voltage value.

Table 14: Pin Definition of ADC

Pin Name	Pin No.	Description
ADC	2	General purpose analog to digital converter

NOTE

"*" means under development.

4 Antenna Interface

BC92 has an NB-IoT/GSM antenna interface RF_ANT. NB-IoT/GSM antenna port has 50 Ω characteristic impedance.

4.1. NB-IoT/GSM Antenna Interface

Table 15: Pin Definition of NB-IoT/GSM Antenna

Pin Name	Pin No.	I/O	Description
GND	38		Ground
RF_ANT	39	IO	NB-IoT/GSM antenna interface
GND	40		Ground

4.1.1. RF Antenna Reference Design

The external antenna must be matched properly to obtain the best performance. Therefore, it is recommended to reserve a π type matching circuit and place the π-type matching components (R1/C1/C2) as close to the antenna as possible. By default, the capacitors (C1/C2) are not mounted and a 0 Ω resistor is mounted on R1.

A reference design of the RF interface is shown below.

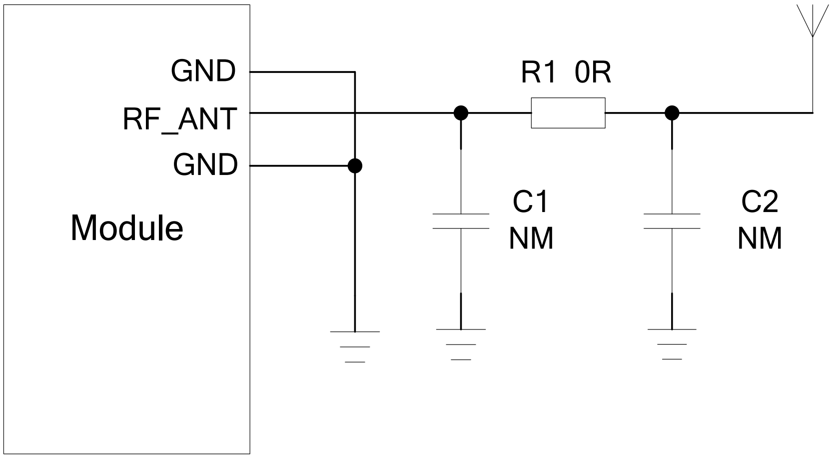

Figure 24: Reference Design for GSM Antenna

4.1.2. 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, height from the reference ground to the signal layer (H), and the clearance between RF traces and grounds (S). Microstrip or coplanar waveguide is typically used in RF layout to control characteristic impedance. The following are reference designs of microstrip or coplanar waveguide with different PCB structures.

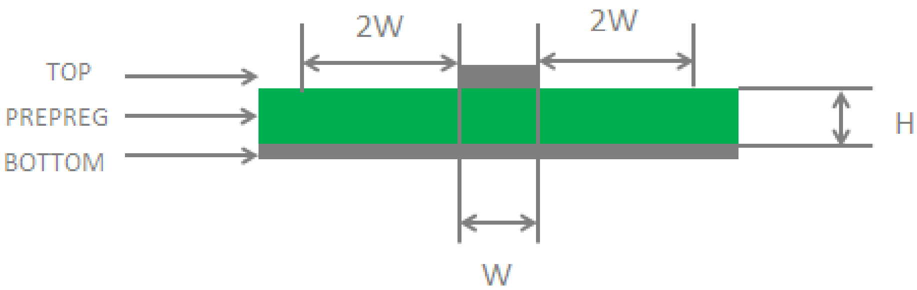

Figure 25: Microstrip Design on a 2-layer PCB

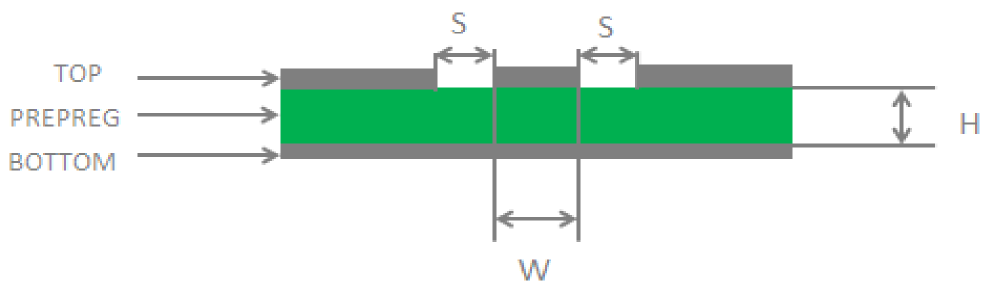

Figure 26: Coplanar Waveguide Design on a 2-layer PCB

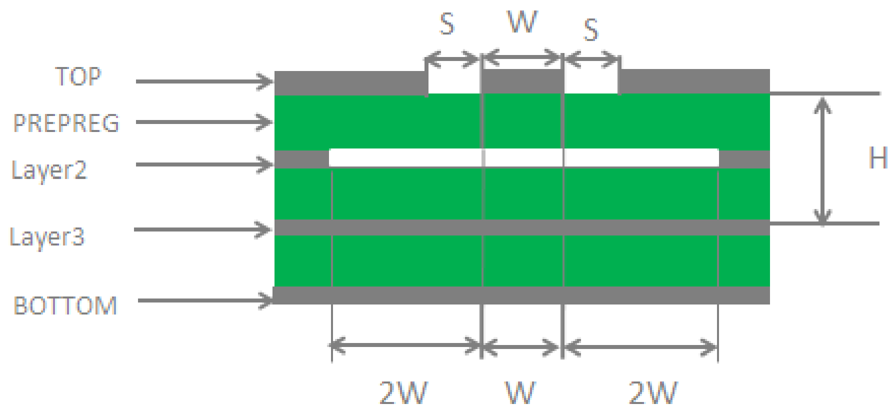

Figure 27: Coplanar Waveguide Design on a 4-layer PCB (Layer 3 as Reference Ground)

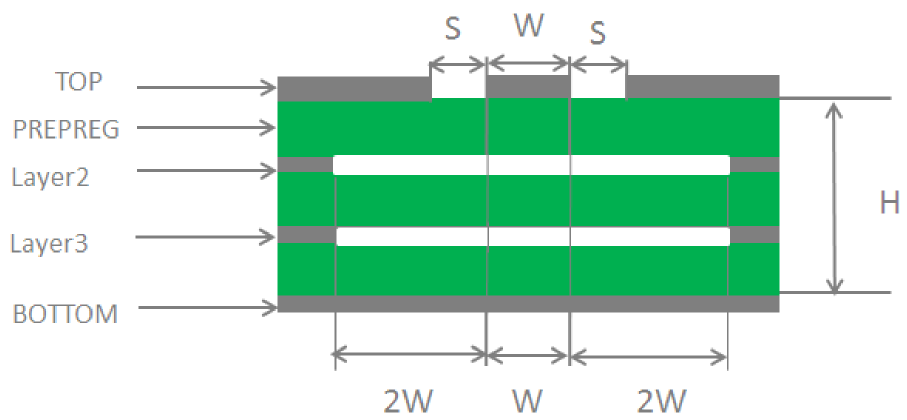

Figure 28: Coplanar Waveguide Design on a 4-layer PCB (Layer 4 as Reference Ground)

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

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

For more details, please refer to ***document [5]***.

4.1.3. Antenna Requirements

To minimize the loss on RF trace and RF cable, please pay attention to the antenna design. The following tables show the requirements on the NB-IoT antenna.

Table 16: GSM Insertion Loss Requirements (GSM)

Type	Requirements
GSM850/EGSM900	Cable insertion loss <1 dB
DCS1800/PCS1900	Cable insertion loss <1.5 dB

Table 17: Cable Insertion Loss Requirements (NB-IoT)

Type	Requirements
B5/B8/B20/B28	Cable insertion loss <1dB
B3	Cable insertion loss <1.5 dB

Table 18: Antenna Requirements

Type	Requirements
Band	GSM frequency band: GSM850/EGSM900/DCS1800/PCS1900 NB frequency band: B3/B5/B8/B20/B28
VSWR	≤2
Gain (dBi)	1
Max. Input Power (W)	50
Input Impedance (Ω)	50
Polarization Type	Linear

4.1.4. RF Output Power

Table 19: RF Output Power

Band	Max.	Min.
GSM850	33 dBm ±2 dB	5 dBm ±5 dB
EGSM900	33 dBm ±2 dB	5 dBm ±5 dB
DCS1800	30 dBm ±2 dB	0 dBm ±5 dB
PCS1900	30 dBm ±2 dB	0 dBm ±5 dB
B3	23 dBm ±2 dB	<-40 dBm
B5	23 dBm ±2 dB	<-40 dBm
B8	23 dBm ±2 dB	<-40 dBm
B20	23 dBm ±2 dB	<-40 dBm
B28	23 dBm ±2 dB	<-40 dBm

NOTE

In GPRS 4 slots TX mode, the maximum output power is reduced by 4 dB. This design conforms to the GSM specification as described in ***Chapter 13.16*** of *3GPP TS 51.010-1*.

4.1.5. RF Receiving Sensitivity

Table 20: GSM RF Receiving Sensitivity

Band	Receiving Sensitivity	3GPP Standard
GSM850	< -109 dBm	<-107.5 dBm
EGSM900	< -109 dBm	<-107.5 dBm
DCS1800	< -109 dBm	<-107.5 dBm
PCS1900	< -109 dBm	<-107.5 dBm

Table 21: NB-IoT Receiving Sensitivity without Repetitions

Band	Receiving Sensitivity	3GPP Standard
B3	<-114 dBm	<-107.5 dBm
B5	<-114 dBm	<-107.5 dBm
B8	<-114 dBm	<-107.5 dBm
B20	<-114 dBm	<-107.5 dBm
B28	<-114 dBm	<-107.5 dBm

Table 22: NB-IoT Receiving Sensitivity in 128 Repetitions

Band	Receiving Sensitivity
B3	-129 dBm
B5	-129 dBm
B8	-129 dBm
B20	-129 dBm
B28	-129 dBm

4.1.6. Operating Frequencies

Table 23: Operating Frequencies

Band	Receiving Frequency	Transmitting Frequency
GSM850	869 MHz~894 MHz	824 MHz~849 MHz
EGSM900	925 MHz~960 MHz	880 MHz~915 MHz
DCS1800	1805 MHz~1880 MHz	1710 MHz~1785 MHz
PCS1900	1930 MHz~1990 MHz	1850 MHz~1910 MHz
B3	1805 MHz~1880 MHz	1710 MHz~1785 MHz
B5	869 MHz~894 MHz	824 MHz~849 MHz
B8	925 MHz~960 MHz	880 MHz~915 MHz
B20	791 MHz~821 MHz	832 MHz~862 MHz
B28	758 MHz~803 MHz	703 MHz~748 MHz

5 Electrical, Reliability and Radio Characteristics

5.1. Absolute Maximum Ratings

Absolute maximum ratings for power supply and voltage on digital and analog pins of the BC92 module are listed in the following table.

Table 24: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VBAT		4.35	V
Voltage on Digital Pins		3	V

5.2. Operation and Storage Temperatures

The following table lists the operation and storage temperatures of BC92.

Table 25: Operation Temperature

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

NOTES

1. 1) Within the operation temperature range, the module is 3GPP compliant.
2. 2) Within the extended temperature range, the module remains the ability to establish and maintain an SMS* and data transmission, etc. There is no unrecoverable malfunction. There are also no effects on the radio spectrum and no harm to the radio network. Only one or more parameters like P_{out} might reduce their value and exceed the specified tolerances. When the temperature returns to normal operation temperature levels, the module will meet 3GPP specifications again.

5.3. Current Consumption

Table 26: Current Consumption of NB-IoT Mode

Module mode	AP mode	Modem mode		Min.	Typ.	Max.	Unit
Deep Sleep	Idle	PSM			4		μA
Light Sleep	Idle	eDRX=40.96s, PTW=10.24 @ECL0			850		μA
		DRX=1.28s @ ECL0			1.8		mA
		DRX=2.56s @ ECL0			1.2		mA
Active 1)	Normal	Connected @Single-tone (15 kHz subcarrier spacing)	B3 @23 dBm			280	mA
			B5 @23 dBm			280	mA
			B8 @23 dBm			300	mA
			B20 @23 dBm			280	mA
			B28 @23 dBm			300	mA
		Connected @Single-tone (3.75 kHz subcarrier spacing)	B3 @23 dBm			280	mA
			B5 @23 dBm			280	mA
			B8 @23 dBm			300	mA
			B20 @23 dBm			280	mA
			B28@23 dBm			300	mA

NOTES

1. [1)] Power consumption under instrument test condition.
2. [2)] The "maximum value" in "Active" mode refers to the maximum pulse current during RF emission.
3. "*" means under development.

Table 27: Current Consumption of GSM/GPRS Mode

Condition	Current Consumption
Low Power Mode	
Sleep mode @DRX=5	1 mA
AT+CFUN=0	0.7 mA
GPRS Data	
DATA Mode, GPRS (3 Rx, 2Tx) CLASS 12	
GSM850	440 mA
EGSM900	440 mA
DCS1800	320 mA
PCS1900	320 mA
DATA Mode, GPRS (2 Rx, 3Tx) CLASS 12	
GSM850	530 mA
EGSM900	530 mA
DCS1800	430 mA
PCS1900	430 mA
DATA Mode, GPRS (4 Rx, 1Tx) CLASS 12	
GSM850	280 mA
EGSM900	280 mA
DCS1800	220 mA
PCS1900	220 mA

DATA Mode, GPRS (1 Rx, 4Tx) CLASS 12	
GSM850	590 mA
EGSM900	590 mA
DCS1800	540 mA
PCS1900	540 mA

NOTE

GPRS Class 12 is the default setting. The GSM module can be configured from GPRS Class 1 to Class 12 via **AT+QGPCLASS**. Setting to lower the GPRS class would make it easier to design the power supply for the GSM module.

5.4. Electrostatic Discharge

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

The following table lists the module's electrostatic discharge characteristics.

Table 28: Electrostatic Discharge Characteristics (25 °C, 45% Relative Humidity)

Test Point	Contact Discharge (KV)	Air Discharge (KV)
VBAT, GND	+/-5	+/-10
RF_ANT	+/-5	+/-10
Others	+/-0.5	+/-1

6 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.

6.1. Mechanical Dimensions

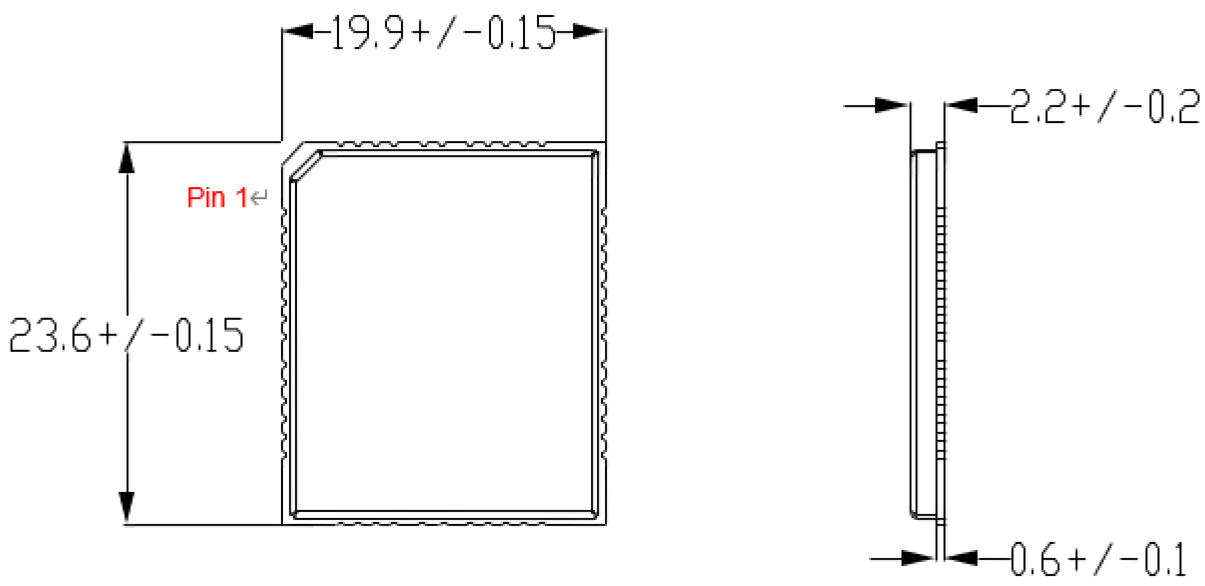

Figure 29: Module Top and Side Dimensions

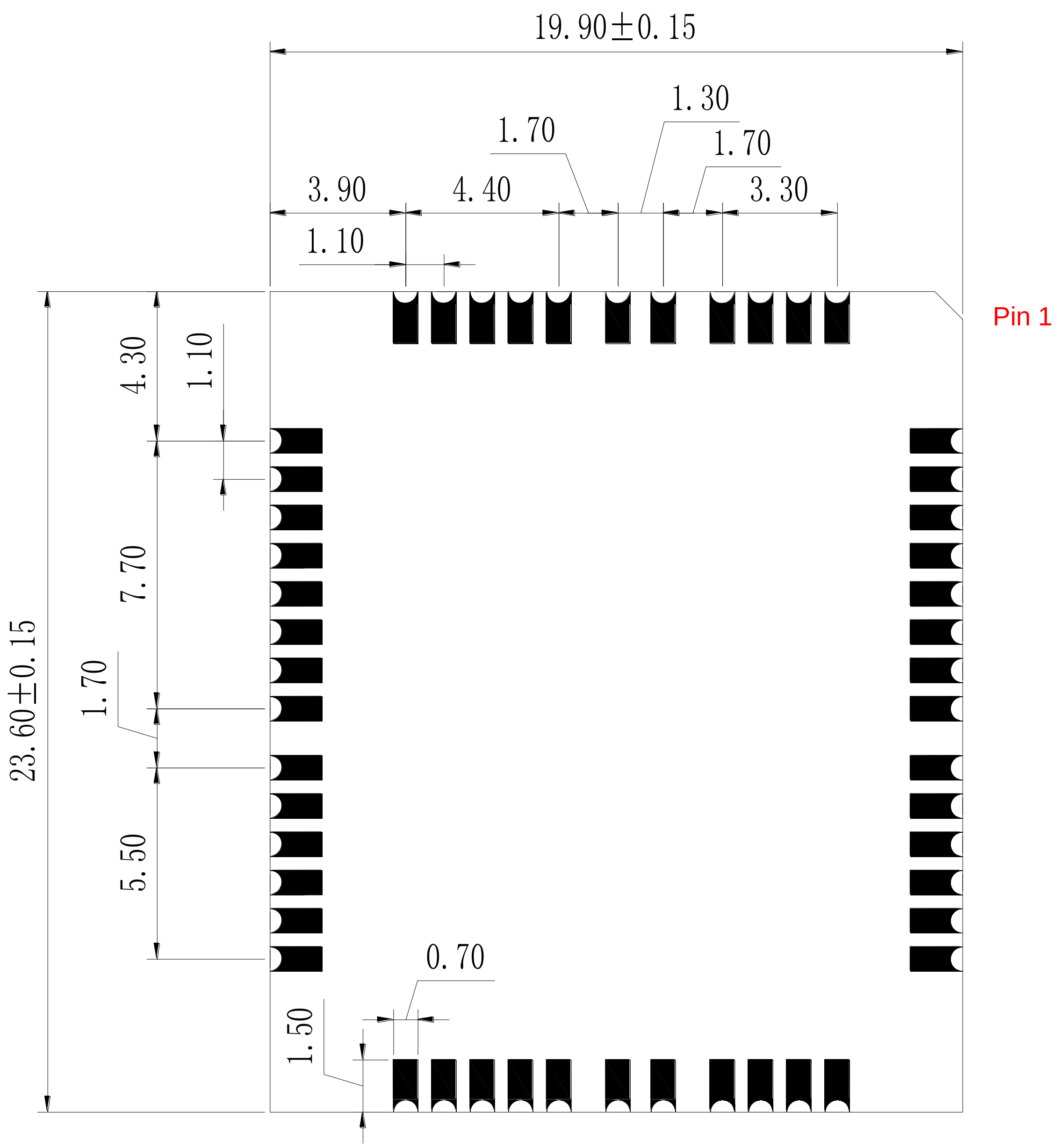

Figure 30: Module Bottom Dimensions

6.2. Recommended Footprint

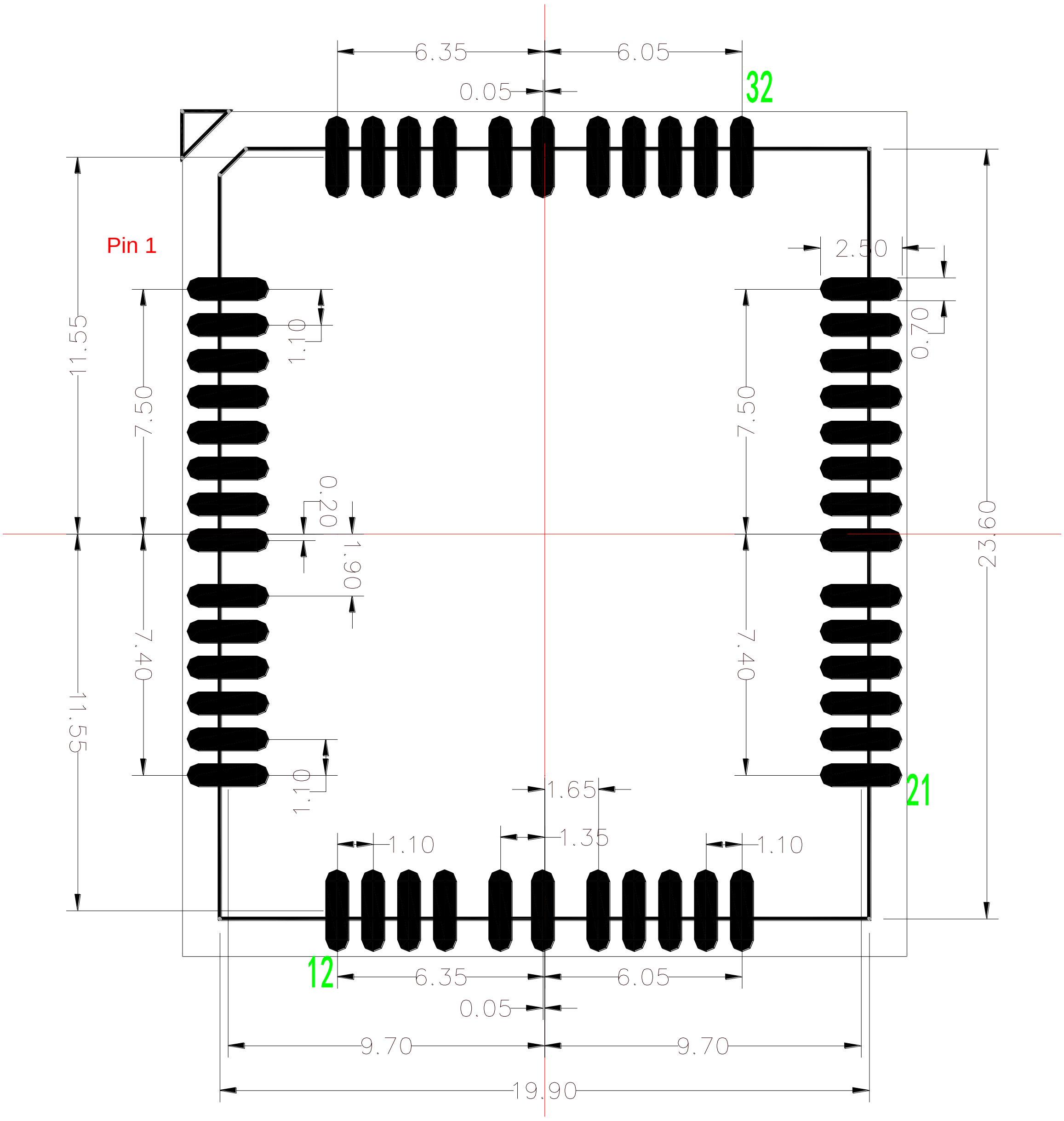

Figure 31: Recommended Footprint (Top View)

NOTE

For easy maintenance of the module, keep about 3 mm between the module and other components on the host PCB.

6.3. Top and Bottom Views

Figure 32: Top View

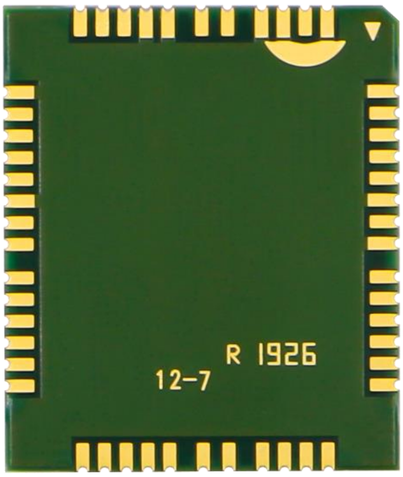

Figure 33: Bottom View

NOTE

These are renderings of BC92 module. For authentic appearance, please refer to the module that you receive from Quectel.

7 Storage, Manufacturing and Packaging

7.1. Storage

BC92 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 24 hours 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 24 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.

NOTE

Please take out the module from the packaging and put it on high-temperature resistant fixtures before the baking. If shorter baking time is desired, please refer to *IPC/JEDEC J-STD-033* for the baking procedure.

7.2. 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 to produce a clean stencil surface on a single pass. To ensure the module soldering quality, the thickness of the stencil for the module is recommended to be 0.15–0.18 mm. For more details, please refer to the ***document [3]***.

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.

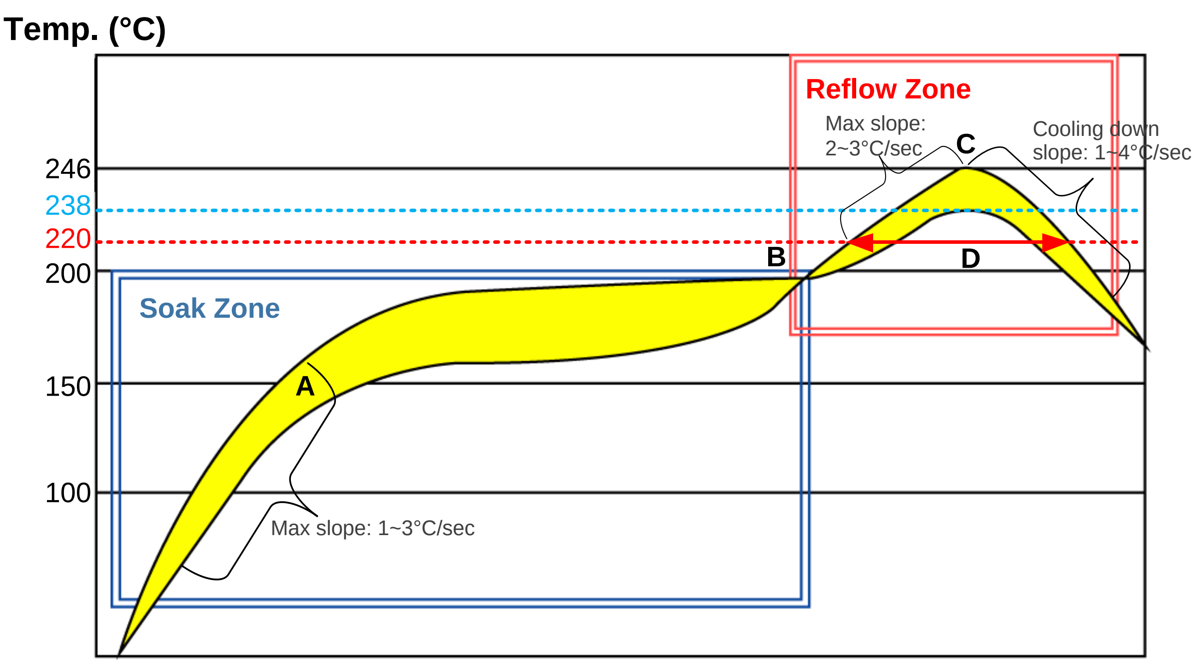

Figure 34: Recommended Reflow Soldering Thermal Profile

Table 29: 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 to -4 °C/s
Reflow Cycle	
Max reflow cycle	1

NOTES

1. During manufacturing and soldering, or any other processes that may contact the module directly, NEVER wipe the module's shielding can with organic solvents, such as acetone, ethyl alcohol, isopropyl alcohol, trichloroethylene, etc. Otherwise, the shielding may become rusted.
2. The shielding can for the module is made of Cupro-Nickel base material. It is tested that after 12 hours' Neutral Salt Spray test, the laser engraved label information on the shielding can is still clearly identifiable and the QR code is still readable, although white rust may be found.

7.3. Packaging

BC92 is packaged in tape and reel carriers. Each reel is 330 mm in diameter and contains 250 modules. The following figures show the package details, measured in mm.

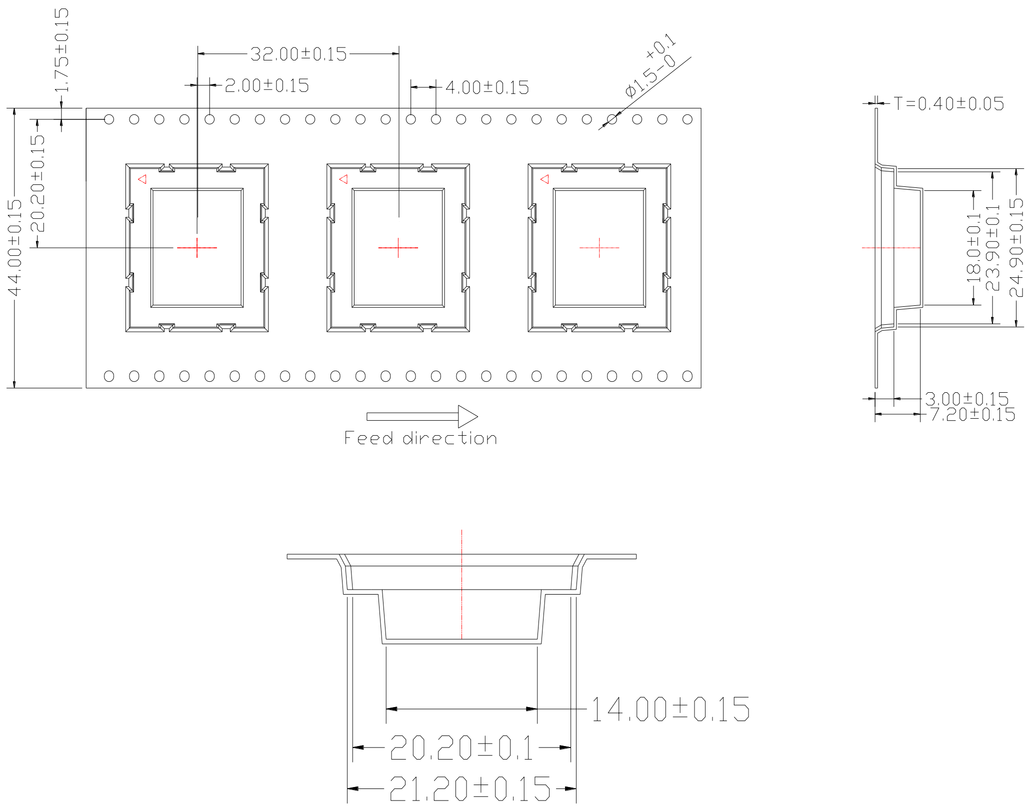

Figure 35: Tape Dimensions

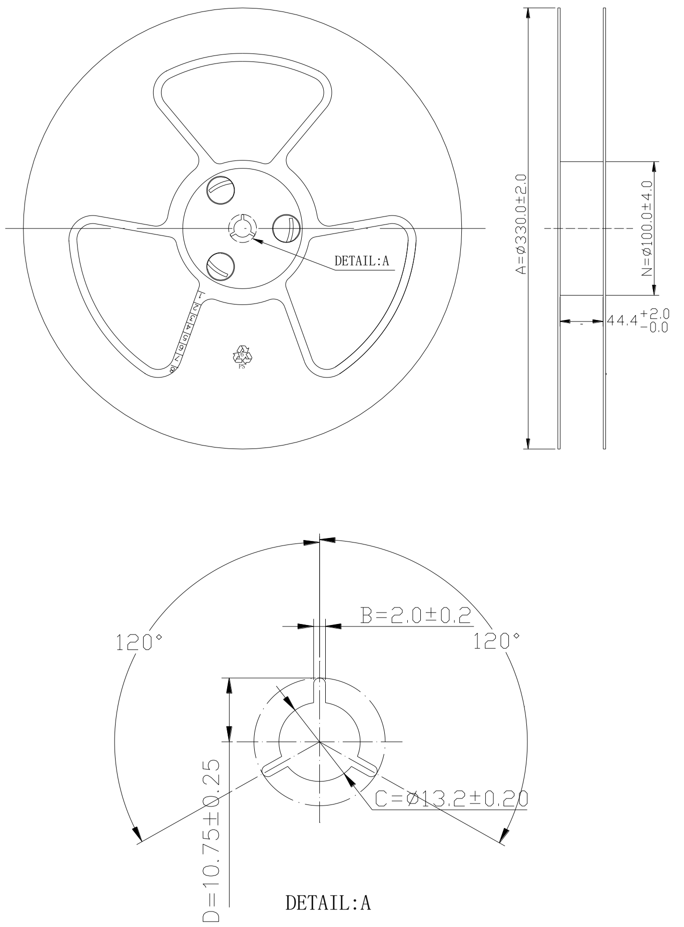

Figure 36: Reel Dimensions

Table 30: BC92 Packaging Specifications

Model Name	MOQ for MP	Minimum Package: 250pcs	Minimum Package x 4=1000pcs
BC92	250 pcs	Size (mm): 370 × 350 × 56 N.W (kg): 0.43 G.W (kg): 1.25	Size (mm): 370 × 250 × 365 N.W (kg): 1.72 G.W (kg): 5.05

8 Appendix A References

Table 31: Related Documents

SN	Document Name	Remarks
[1]	Quectel_BC92_AT_Commands_Manual	BC92 AT commands manual
[2]	Quectel_BC92-TE-B_User_Guide	BC92-TE-B user guide
[3]	Quectel_Module_Secondary_SMT_Application_Note	Quectel Module Secondary SMT Application Note
[4]	Quectel_BC92_Reference_Design	BC92 Reference Design
[5]	Quectel_RF_Layout_Application_Note	RF Layout Application Note
[6]	GSM 07.07	Digital cellular telecommunications (Phase 2+); AT command set for GSM Mobile Equipment (ME)
[7]	GSM 07.10	Support GSM 07.10 multiplexing protocol
[8]	GSM 07.05	Digital cellular telecommunications (Phase 2+); Use of Data Terminal Equipment – Data Circuit terminating Equipment (DTE – DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS)
[9]	GSM 11.14	Digital cellular telecommunications (Phase 2+); Specification of the (U)SIM Application Toolkit for the Subscriber Identity module – Mobile Equipment ((U)SIM – ME) interface
[10]	GSM 11.11	Digital cellular telecommunications (Phase 2+); Specification of the Subscriber Identity module – Mobile Equipment ((U)SIM – ME) interface
[11]	GSM 03.38	Digital cellular telecommunications (Phase 2+); Alphabets and language-specific information

[12]	GSM 11.10	Digital cellular telecommunications (Phase 2); Mobile Station (MS) conformance specification; Part 1: Conformance specification

Table 32: Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
CHAP	Challenge Handshake Authentication Protocol
CS	Coding Scheme
CTS	Clear to Send
DRX	Discontinuous Reception
DSP	Digital Signal Processor
DCE	Data Communications Equipment (typically module)
DTE	Data Terminal Equipment (typically computer, external controller)
DTR	Data Terminal Ready
DTX	Discontinuous Transmission
EGSM	Enhanced GSM
ESD	Electrostatic Discharge
ETS	European Telecommunication Standard
FTP	File Transfer Protocol
GLL	NMEA: Geographic Latitude and Longitude
GLONASS	Global Navigation Satellite System
GLP	GNSS Low Power
GMSK	Gaussian Minimum Shift Keying
GNSS	Global Navigation Satellite System
GPRS	General Packet Radio Service

GPS	Global Positioning System
GSM	Global System for Mobile Communications
G.W	Gross Weight
HR	Half Rate
HTTP(S)	Hypertext Transfer Protocol (Secure)
I/O	Input/Output
IC	Integrated Circuit
IEEE	Institute of Electrical and Electronics Engineers
IMEI	International Mobile Equipment Identity
I_Omax	Maximum Output Load Current
kbps	Kilo Bits Per Second
LCC	Leadless Chip Carriers
LED	Light Emitting Diode
LGA	Land Grid Array
Li-Ion	Lithium-Ion
LO	Low Level Output
MCU	Micro Control Unit
MQTT	Message Queuing Telemetry Transport
MO	Mobile Originated
MOQ	Minimum Order Quantity
MP	Manufacture Product
MS	Mobile Station (GSM engine)
MT	Mobile Terminated
NMEA	National Marine Electronics Association
NTP	Network Time Protocol

N.W	Net Weight
PAP	Password Authentication Protocol
PCB	Printed Circuit Board
PCL	Power Control Level
PDP	Packet Data Protocol
PDU	Protocol Data Unit
PPP	Point-to-Point Protocol
RF	Radio Frequency
RoHS	Restriction of Hazardous Substances
RTC	Real Time Clock
RX	Receive Direction
SIM	Subscriber Identification Module
SMD	Surface Mounted Devices
SMS	Short Message Service
TCP	Transmission Control Protocol
TE	Terminal Equipment
3GPP	3rd Generation Partnership Project
TX	Transmitting Direction
UART	Universal Asynchronous Receiver & Transmitter
UDP	User Datagram Protocol
URC	Unsolicited Result Code
USIM	Universal Mobile Telecommunication System
VSWR	Voltage Standing Wave Ratio
V_Omax	Maximum Output Voltage Value
V_Onorm	Normal Output Voltage Value

V_{O}min	Minimum Output 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}norm	Absolute Normal 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
WAAS	Wide Area Augmentation System
Phonebook Abbreviations	
ON	(U)SIM (or ME) Own Numbers (MSISDNs) list
SM	(U)SIM phonebook

9 Appendix B GPRS Coding Schemes

Four coding schemes are used in GPRS protocol. The differences between them are shown in the following table.

Table 33: Description of Different Coding Schemes

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

Radio block structure of CS-1, CS-2 and CS-3 is shown as the figure below.

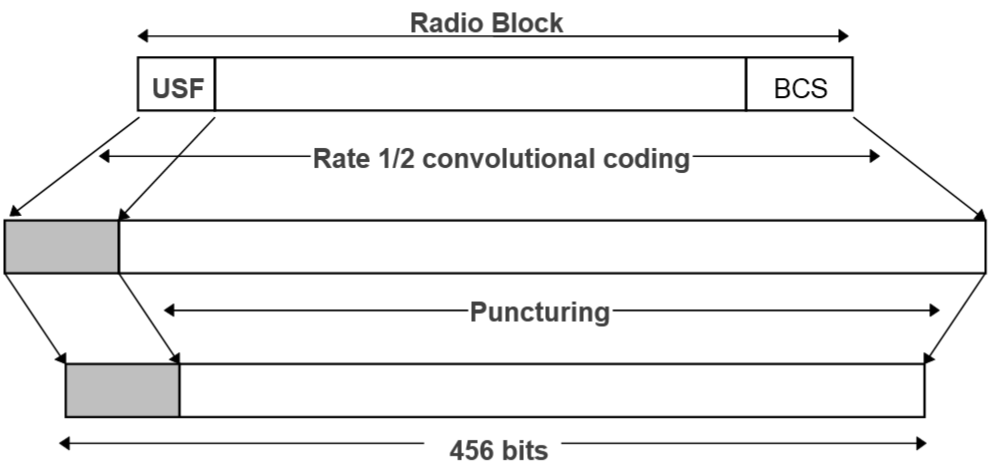

Figure 37: Radio Block Structure of CS-1, CS-2 and CS-3

Radio block structure of CS-4 is shown as the following figure.

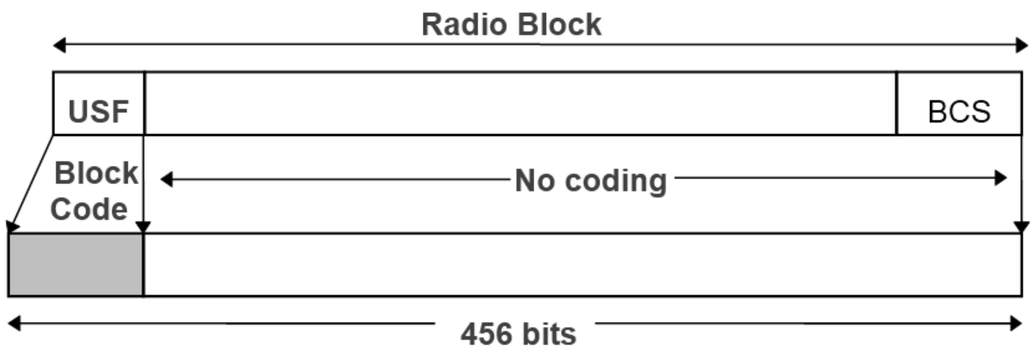

Figure 38: Radio Block Structure of CS-4

10 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

Multi-slot 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