BC95-G Hardware Design

NB-IoT Module Series

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About the Document

History

Revision	Date	Author	Description
1.0	2017-12-01	Ewent LU/ Vick YANG	Initial

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1 Introduction

This document defines the BC95-G module and describes its air interface and hardware interface which are connected with customers' applications.

This document can help customers to quickly understand module interface specifications, electrical and mechanical details, as well as other related information of the module. Associated with application note and user guide, customers can use BC95-G 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 BC95-G 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 customers' 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 designed to prevent possible interference with sensitive medical equipment.
	Cellular terminals or mobiles operating over 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 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

2.1. General Description

BC95-G is a high-performance NB-IoT module with low power consumption. It supports multiple frequency bands as illustrated in the table below. The module is designed to communicate with mobile network operators' infrastructure equipment through the NB-IoT radio protocol (3GPP Rel.14).

Table 1: Frequency Bands of BC95-G Module

Band	Frequency
Band 1	@H-FDD 2100MHz
Band 3	@H-FDD 1800MHz
Band 8	@H-FDD 900MHz
Band 5	@H-FDD 850MHz
Band 20	@H-FDD 800MHz
Band 28*	@H-FDD 700MHz

BC95-G is an SMD type module with LCC package, and comes with an ultra-compact profile of 23.6mm × 19.9mm × 2.2mm, making it can be easily embedded into applications. It can meet almost all the requirements for IoT applications, such as smart metering, bike sharing, smart parking, smart city, security and asset tracking, home appliances, agricultural and environmental monitoring, etc.

Designed with power saving technique, the BC95-G consumes an ultra-low current of 5uA in PSM (Power Saving Mode).

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

NOTE

"*" means under development.

2.2. Key Features

The following table describes the detailed features of BC95-G module.

Table 2: BC95-G Key Features

Feature	Details
Power Supply	● Supply voltage: 3.1V ~ 4.2V ● Typical supply voltage: 3.6V
Power Saving Mode	● Maximum power consumption in PSM: 5uA
Transmitting Power	● 23dBm±2dB
Temperature Range	● Operation temperature range: -35°C ~ +75°C[1)] ● Extended temperature range: -40°C ~ +85°C[2)] ● Storage temperature range: -40°C ~ +90°C
USIM Interface	● Supports Class B USIM card: 1.8V/3.0V
UART Interfaces	**Main port:** ● When used for AT command communication and data transmission, the baud rate is 9600bps ● When used for firmware upgrading, the baud rate is 115200bps **Debug port:** ● Used for firmware debugging ● Only supports 921600bps baud rate
Internet Protocol Features	● Supports IPv4/IPv6*/UDP/CoAP/LwM2M/Non-IP/DTLS*
SMS	● Text and PDU mode ● Point to point MO and MT
Data Transmission Feature	● Single tone with 15kHz/3.75kHz subcarrier: 25.2kbps (DL)/ 15.625kbps(UL) ● Multi tone with 15kHz subcarrier: 25.2kbps (DL)/54kbps (UL)
AT Commands	● Compliant with 3GPP TS 27.007 V14.3.0 (2017-03) and Quectel enhanced AT commands
Physical Characteristics	● Size: (23.6±0.15)mm × (19.9±0.15)mm × (2.2±0.2mm) ● Weight: 1.8g±0.2g

Firmware Upgrade	●	Firmware upgrade via main port or DFOTA*
Antenna Interface	●	50Ω impedance control
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 an SMS, data transmission, etc. There is no unrecoverable malfunction. There are also no effects on radio spectrum and no harm to radio network. 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 specifications again.
3. "*" means under development.

2.3. Functional Diagram

The following figure shows a block diagram of BC95-G and illustrates the major functional parts.

- Radio frequency
- Baseband
- Power management
- Peripheral interfaces

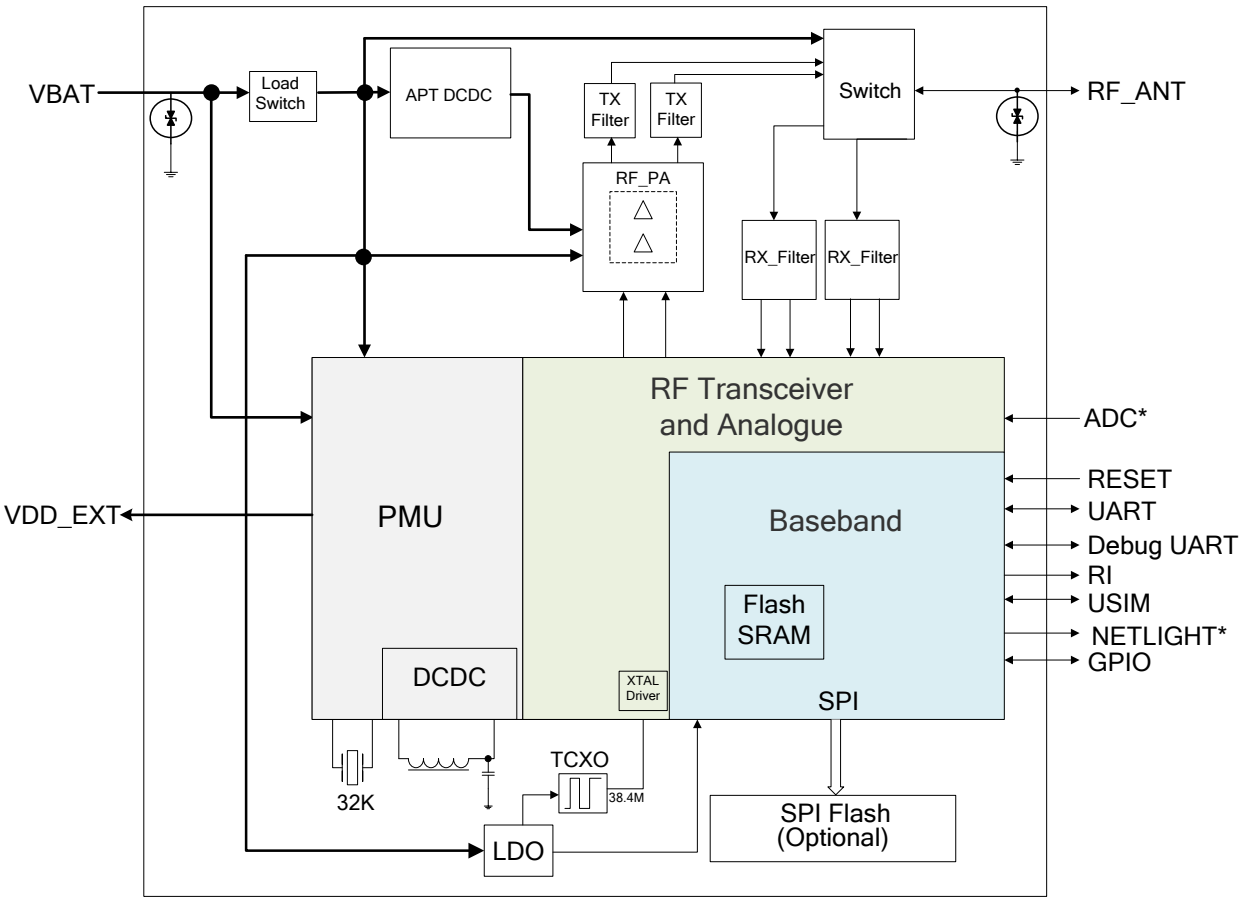


Figure 1: Functional Diagram

NOTE

"*" means under development.

2.4. Evaluation Board

In order to help customers develop applications with BC95-G, Quectel supplies the evaluation board (EVB), USB to RS-232 converter cable, power adapter, antenna and other peripherals to control or test the module.

3 Application Functions

3.1. General Description

BC95-G is equipped with 54-pin 1.1mm pitch SMT pads plus 40-pin ground/reserved pads. The following chapters provide detailed descriptions of these pins:

- Power supply
- UART interfaces
- USIM interface
- ADC interface*
- Network status indication*
- RF interface

NOTE

"*" means under development.

3.2. Pin Assignment

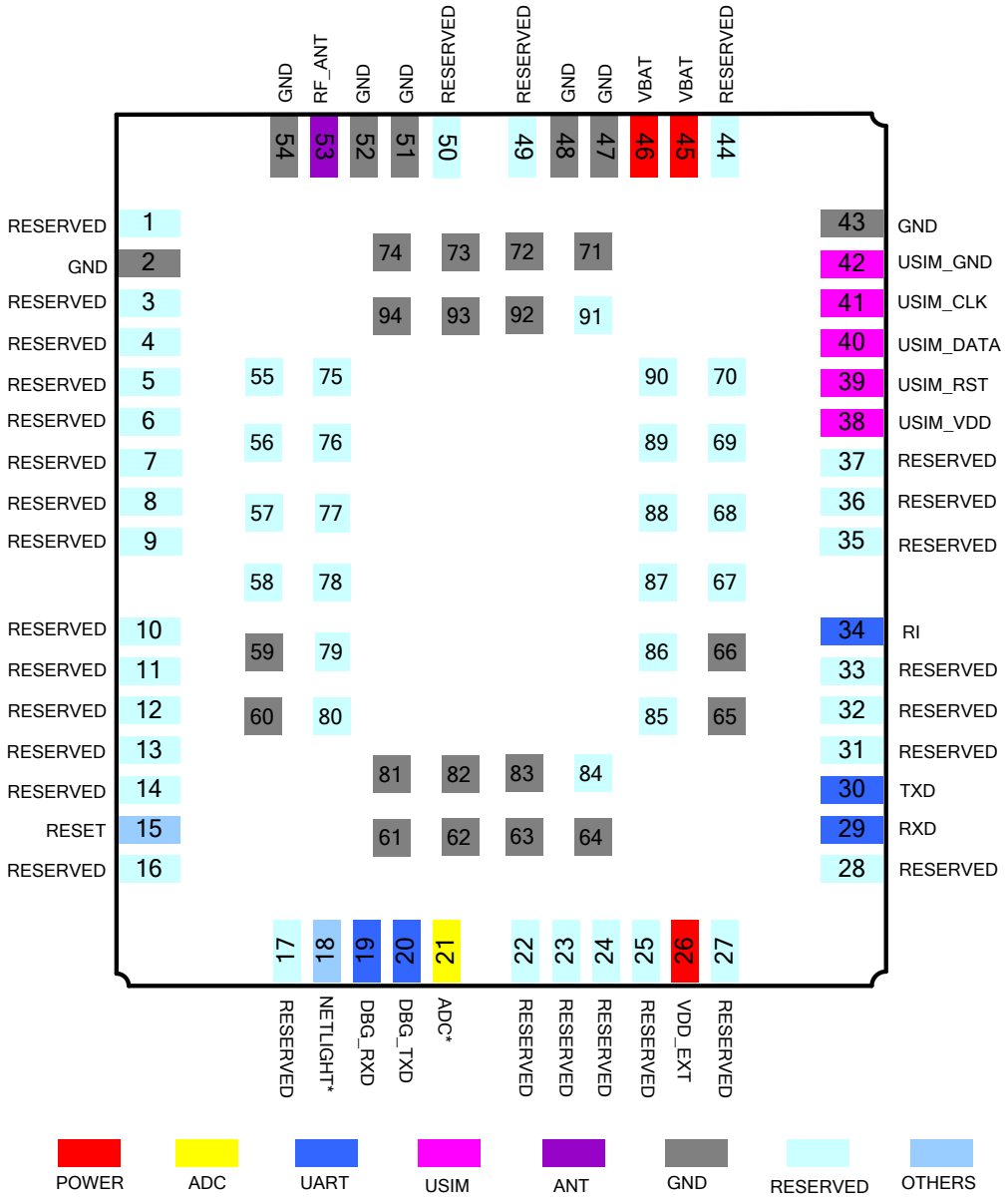


Figure 2: Pin Assignment

NOTES

1. Keep all reserved pins unconnected.
2. "*" means under development.

3.3. Pin Description

The following tables show the pin definition and description of BC95-G.

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	45, 46	PI	Main power supply of the module: VBAT=3.1V~4.2V	Vmax=4.2V Vmin=3.1V Vnorm=3.6V	The power supply must be able to provide sufficient current up to 0.5A.
VDD_EXT	26	PO	Supply 3.0V voltage for external circuits	Vnorm=3.0V $I_O$max=1mA (In PSM)	It is recommended to be used for weak pull-ups of an external I/O port, and in such case a 2.2uF~4.7uF bypass capacitor is also recommended to be added in parallel. If unused, keep this pin open.

GND	2, 43, 47, 48, 51, 52, 54, 59~66, 71~74, 81~83, 92~94		Ground		
Reset Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESET	15	DI	Reset the module	R_{PU}≈78kΩ V_{IH}max=3.3V V_{IH}min=2.1V V_{IL}max=0.6V	Pull up internally. Active low.
Network Status Indicator					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
NETLIGHT*	18	DO	Network status indication	V_{OL}max=0.3V V_{OH}min=2.4V	If unused, keep this pin open.
ADC Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ADC*	21	AI	General purpose analog to digital converter interface	Input voltage range: 0V to 4.0V	The maximum input voltage should be lower than the VBAT voltage. If unused, keep this pin open.
UART Port					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RXD	29	DI	Receive data	V_{IL}max=0.6V V_{IH}min=2.1V V_{IH}max=3.3V	3.0V power domain.
TXD	30	DO	Transmit data	V_{OL}max=0.3V V_{OH}min=2.4V	
RI	34	DO	Ring indicator	V_{OL}max=0.3V V_{OH}min=2.4V	
Debug Port					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**

DBG_RXD	19	DI	Receive data	V_{IL}max=0.6V V_{IH}min=2.1V V_{IH}max=3.3V	If unused, keep this pin open.
DBG_TXD	20	DO	Transmit data	V_{OL}max=0.3V V_{OH}min=2.4V	If unused, keep this pin open.
USIM Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
USIM_VDD	38	DO	Power supply for USIM card	Vnorm=1.8/3.0V	All signals of USIM interface should be protected against ESD with a TVS diode array. Maximum trace length from the module pad to USIM card connector is 200mm.
USIM_RST	39	DO	USIM card reset signal	V_{OL}max=0.1V×USIM_VDD V_{OH}min=0.8V×USIM_VDD	
USIM_DATA	40	IO	USIM card data signal	V_{OL}max=0.1V×USIM_VDD V_{OH}min=0.8V×USIM_VDD V_{IL}min=-0.1V×USIM_VDD V_{IL}max=0.2V×USIM_VDD V_{IH}min=0.7V×USIM_VDD V_{IH}max=1.1V×USIM_VDD	
USIM_CLK	41	DO	USIM card clock signal	V_{OL}max=0.1V×USIM_VDD V_{OH}min=0.8V×USIM_VDD	
USIM_GND	42		Specified ground for USIM card		
RF Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RF_ANT	53	IO	RF antenna pad	Impedance of 50Ω	
RESERVED Pins					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESERVED	1, 3~14, 16, 17, 22~25, 27, 28, 31~33, 35~37, 44, 49, 50, 55~58, 67~70, 75~80, 84~91		Reserved		Keep these pins unconnected.

NOTE

"*" means under development.

3.4. Operating Modes

BC95-G module has three operating modes, which can determine availability of functions for different levels of power-saving.

Table 5: Overview of Operating Modes

Mode	Function	
Normal Operation	Active	In active mode, all functions of the module are available and all processors are active. Radio transmission and reception can be performed. Transitions to idle mode or PSM can be initiated in active mode.
	Idle	In idle mode, the module is in light sleep and network connection is maintained; paging messages can be received; transitions to active mode or PSM can be initiated in idle mode.
	PSM	In PSM, only the 32kHz RTC is working. The network is disconnected, and paging messages cannot be received either. When MO (Mobile Originated) data are sent or the periodic TAU (Tracking Area Update) timer T3412 expires, the module will be woken up.

3.5. Power Supply

3.5.1. Power Supply Pins

BC95-G provides two VBAT pins for connection with an external power supply.

The following table shows the VBAT pins and ground pins.

Table 6: VBAT and GND Pins

Pin Name	Pin No.	Description	Min.	Typ.	Max.	Unit
VBAT	45, 46	Power supply for the module	3.1	3.6	4.2	V

GND	2, 43, 47, 48, 51, 52, 54, 59~66, 71~74, 81~83, 92~94	Ground	-	0	-	V

3.5.2. Reference Design for Power Supply

The power design for the module is very important, as the performance of the module largely depends on the power source. A low quiescent current LDO which can provide sufficient input current up to 0.5A can be used as the power supply. Meanwhile, Li-SOCI2 batteries can also be used to supply power for the module. The power supply range of the module is from 3.1V to 4.2V. Please make sure that the input voltage will never drop below 3.1V even in burst transmission. If the power voltage drops below 3.1V, the module will be abnormal.

For better power performance, it is recommended to place a 100uF tantalum capacitor with low ESR (ESR=0.7Ω) and three ceramic capacitors (100nF, 100pF and 22pF) near the VBAT pin, and a TVS diode also needs to be added on the VBAT trace to increase surge voltage withstand capability. A reference circuit is illustrated in the following figure. In principle, the longer the VBAT trace is, the wider it will be.

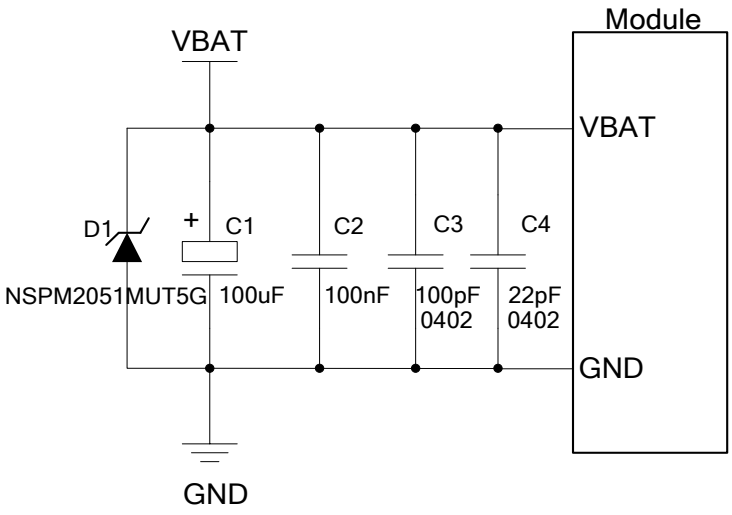


Figure 3: Reference Circuit for Power Supply

3.6. Turn on and off Scenarios

3.6.1. Turn on

The module can be automatically turned on by supplying power source to VBAT pins.

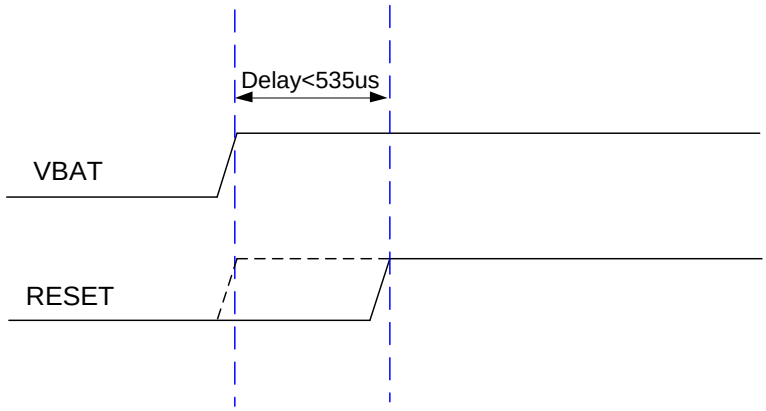


Figure 4: Turn-on Timing

3.6.2. Turn off

The module can be turned off by shutting down the VBAT power supply.

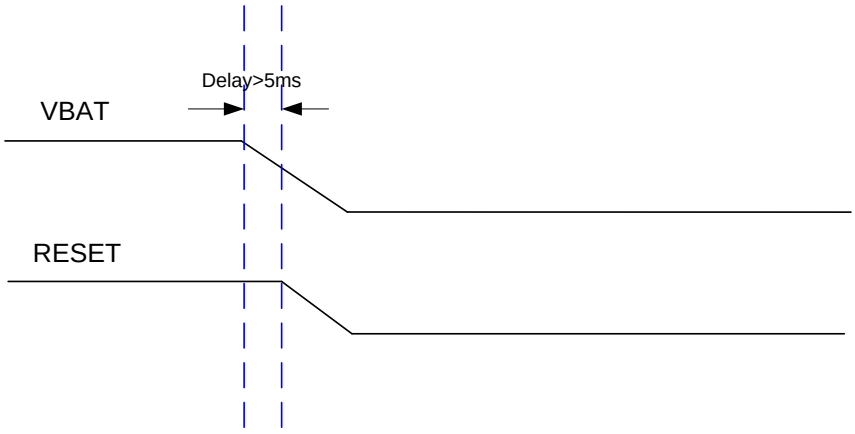


Figure 5: Turn-off Timing

3.6.3. Reset the Module

The module can be reset by following two ways. The reset timing is illustrated as the following table.

- **Hardware**

Reset the module by driving the reset pin to a low level voltage for more than 100ms.

- **Software**

Reset the module using command **AT+NRB**. For more details about the command, please refer to ***document [1]***.

Table 7: Reset Characteristics

Pin Name	Pin No.	Description	Reset Pull-down Time
RESET	15	Reset the module. Active low	>100ms

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

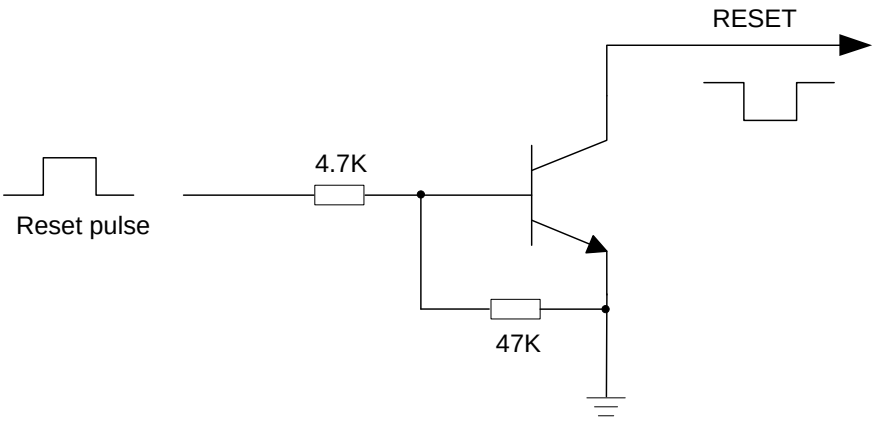


Figure 6: Reference Circuit of RESET by Using Driving Circuit

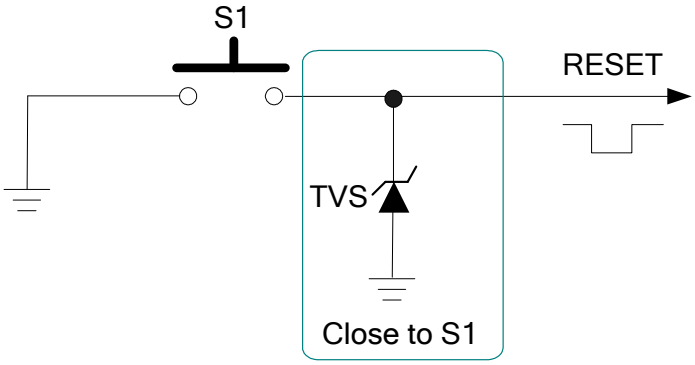


Figure 7: Reference Circuit of RESET by Using Button

3.7. Power Saving Mode (PSM)

Based on system performance, the module consumes a maximum current of 5uA in PSM. PSM is designed to reduce power consumption of the module and improve battery life. The following figure shows the power consumption of the module in different modes.

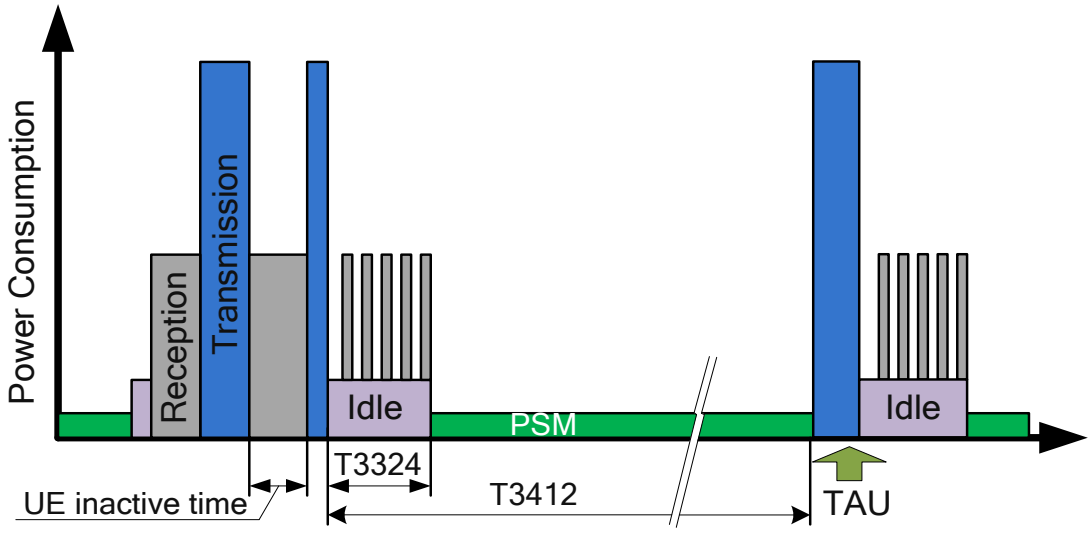


Figure 8: Module Power Consumption in Different Modes

The procedure for entering PSM is as follows: the module 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 module and the mobile reachable timer starts. When the T3324 timer expires, the module enters PSM for 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 PSM, it cannot be paged and stops access stratum activities such as cell reselection, and T3412 is still active.

When MO (Mobile Originated) data are sent or the periodic TAU timer expires, the module will exit from PSM.

3.8. UART Interfaces

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

The main port:

- TXD: Send data to RXD of DTE.
- RXD: Receive data from TXD of DTE.
- RI: Ring indicator (when an SMS message is received or data is transmitted, the module will output signals to inform DTE).

The debug port:

- DBG_TXD: Send data to the COM port of DTE.
- DBG_RXD: Receive data from the COM port of DTE.

The logic levels are described in the following table.

Table 8: Pin Definition of the UART Interfaces

Interfaces	Pin No.	Pin Name	Description	Comment
Debug Port	19	DBG_RXD	Receive data	3.0V power domain
	20	DBG_TXD	Transmit data	
Main Port	29	RXD	Receive data	
	30	TXD	Transmit data	
	34	RI	Ring indicator	

Table 9: Logic Levels of the UART Interfaces

Parameter	Min.	Max.	Unit
V_{IL}	-0.3	0.6	V
V_{IH}	2.1	3.3	V
V_{OL}		0.3	V
V_{OH}	2.4	3.0	V

NOTE

"*" means under development.

3.8.1. Main Port

The main port can be used for AT command communication and data transmission, and in such case the baud rate is 9600bps. It can also be used for firmware upgrading and in such case the baud rate is 115200bps. This main port is available in active mode, idle mode and PSM. For more information about firmware upgrading, please refer to ***document [2]***.

The following figure shows the connection between the DCE and DTE.

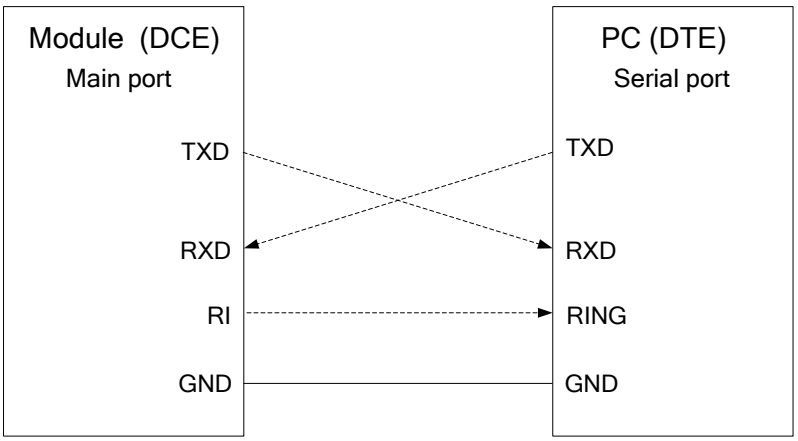


Figure 9: Reference Design for Main Port

3.8.2. Debug Port

The debug port is used to view log information with UEMonitor tool for firmware debugging, and the baud rate is 921600bps. For detailed usage of UEMonitor, please refer to ***document [3]***.

A reference design for debug port is shown as below.

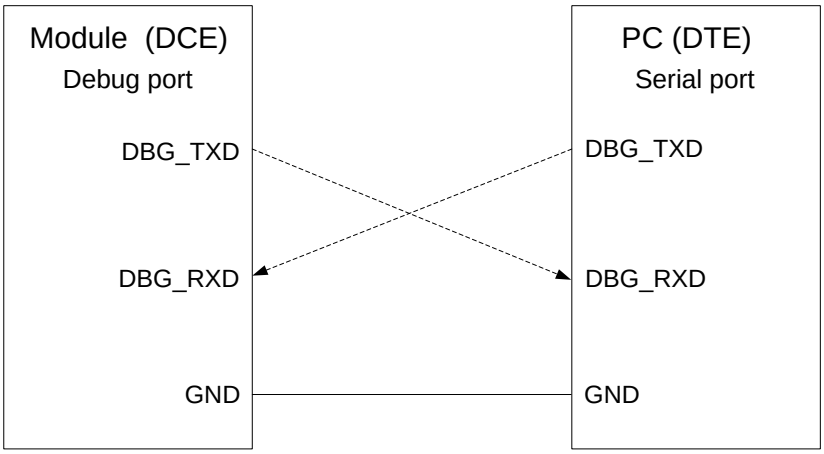


Figure 10: Reference Design for Debug Port

3.8.3. UART Application

A reference design of 3.3V level match is shown as below.

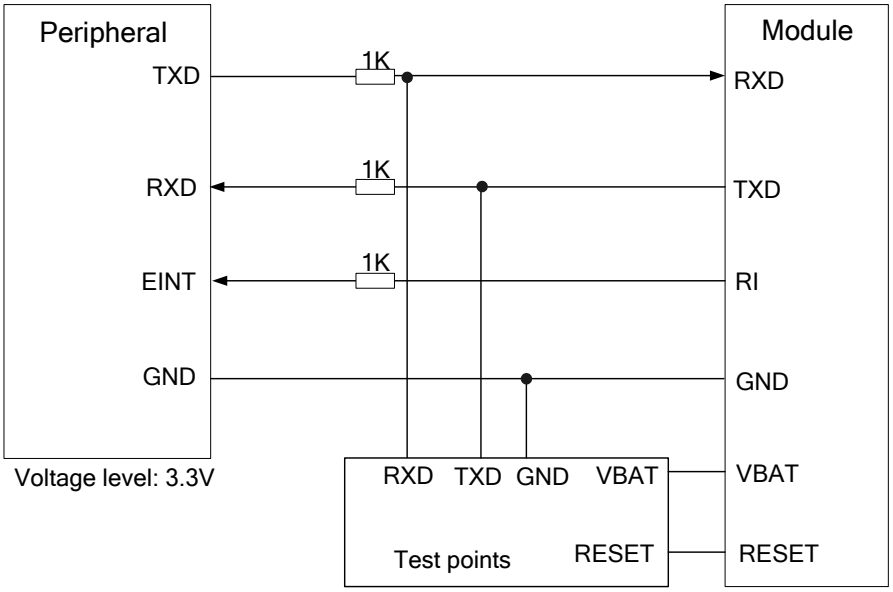


Figure 11: Level Match Design for 3.3V System

NOTES

1. In order to reduce the power consumption of the system, it is highly recommended to add a resistor with resistance greater than 1KΩ on the UART port signal traces when the host's voltage level is 3V or 3.3V.
2. It is recommended to reserve the test points (GND, RXD, TXD, VBAT and RESET) for firmware upgrading.

The following circuit shows a reference design for the communication between the module and PC. As the voltage level of module is 3.0V, a RS-232 transceiver must be used. Please make sure the I/O voltage of transceiver which connects to module is 3.0V.

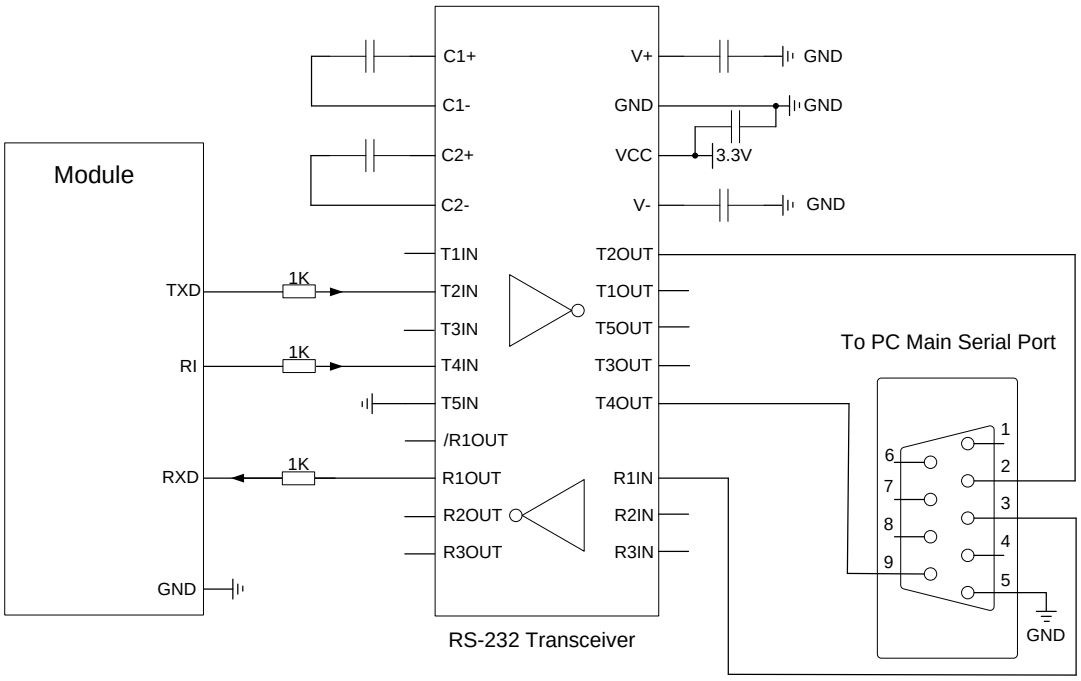


Figure 12: Sketch Map for RS-232 Interface Match

Please visit vendors' web sites to select a suitable RS-232 transceiver IC, such as: http://www.exar.com and http://www.maximintegrated.com.

3.9. USIM Interface

The module provides one USIM interface to allow the module to access external USIM card.

3.9.1. USIM Card Application

The USIM interface supports the functionality of the 3GPP specification, and is intended for use with a USIM application tool-kit.

The USIM card interface is powered by an internal regulator in the module. Both 1.8V and 3.0V USIM cards are supported.

Table 10: Pin Definition of the USIM Interface

Pin No.	Pin Name	Description
38	USIM_VDD	Supply power for USIM card. USIM card voltage domain is1.8V/3.0V±5%.

41	USIM_CLK	USIM card clock signal
40	USIM_DATA	USIM card data signal
39	USIM_RST	USIM card reset signal
42	USIM_GND	Specified ground for USIM card

A reference circuit for 6-pin USIM card connector is illustrated as the following figure.

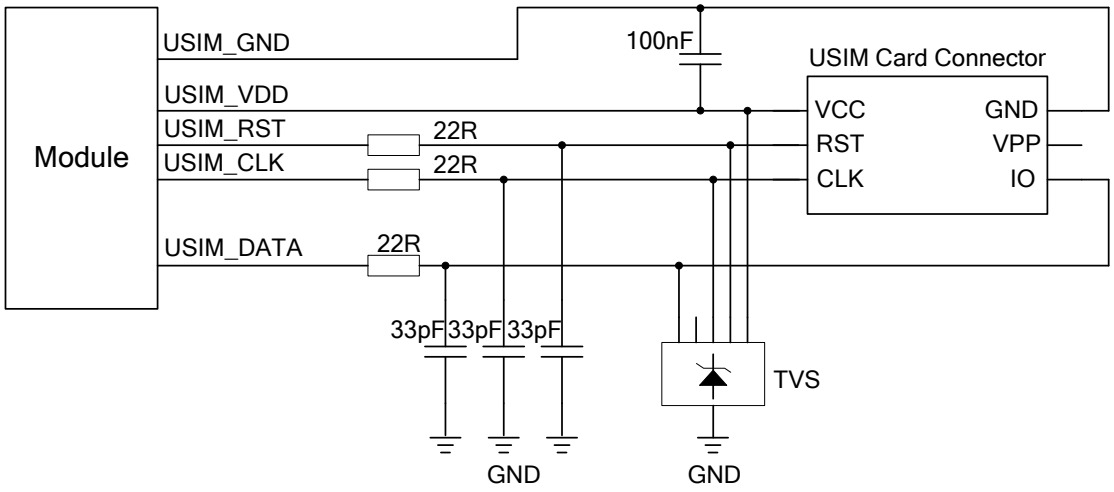


Figure 13: Reference Circuit for USIM Interface with 6-pin USIM Card Connector

For more information of USIM card connector, please visit http://www.amphenol.com and http://www.molex.com.

In order to enhance the reliability and availability of the USIM card in application, please follow the criteria below in USIM circuit design:

- Keep placement of USIM card connector to the module as close as possible. Keep the trace length as less than 200mm as possible.
- Keep USIM card signals away from RF and VBAT traces.
- Assure the ground between the module and USIM card connector short and wide. Keep the trace width of ground no less than 0.5mm to maintain the same electric potential. The decouple capacitor of USIM_VDD is less than 1uF and must be near to USIM card connector.
- To avoid cross talk between USIM_DATA and USIM_CLK, keep them away from each other and shield them with surrounded ground. USIM_RST should also be ground shielded.
- In order to offer good ESD protection, it is recommended to add a TVS diode array. For more information of TVS diode, please visit http://www.onsemi.com. The most important rule is to place the ESD protection device close to the USIM card connector and make sure the USIM card interface signal traces being protected will go through the ESD protection device first and then lead to the

module. The 22Ω resistors should be connected in series between the module and the USIM card connector so as to suppress EMI spurious transmission and enhance ESD protection. Please note that the USIM peripheral circuit should be close to the USIM card connector.

- Place the RF bypass capacitors (33pF) close to the USIM card connector on all signals traces to improve EMI suppression.

3.10. ADC Interface*

The module provides a 10-bit ADC input channel to read the voltage value. This ADC interface is available in both active and idle mode.

Table 11: Pin Definition of the ADC

Pin Name	Pin No.	Description
ADC*	21	Analog to digital converter interface

NOTE

"*" means under development.

3.11. Behaviors of RI

When an SMS message is received or certain URCs are reported, RI pin will be triggered. The behaviors of RI are shown as below.

Table 12: Behaviors of RI

State	RI Response
Idle	HIGH
SMS	When an SMS message is received, the RI is changed to LOW and kept at low level for about 120ms. Then it is changed to HIGH.
URC	Certain URCs can trigger RI to LOW for 120ms. Then it is changed to HIGH.

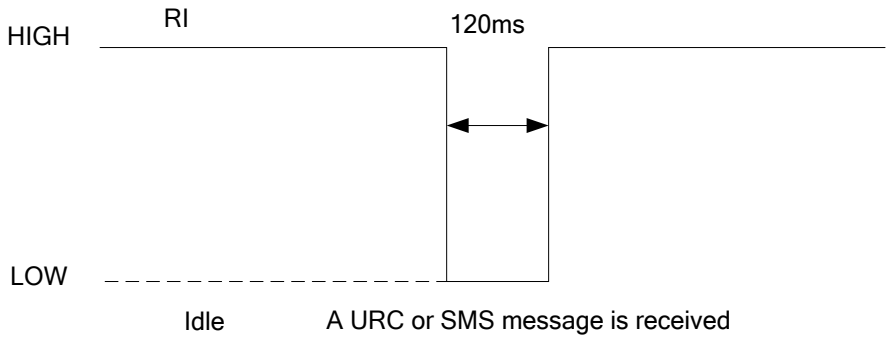


Figure 14: Behaviors of RI When a URC or SMS Message is Received

3.12. Network Status Indication*

The NETLIGHT signal can be used to drive a network status indication LED. The working state of this pin is listed in the following table.

Table 13: Working State of NETLIGHT

State	Module Function
Low (Light off)	The module is not working or not attached to network.
High (Light on)	The module is attached to network.

A reference circuit is shown as below.

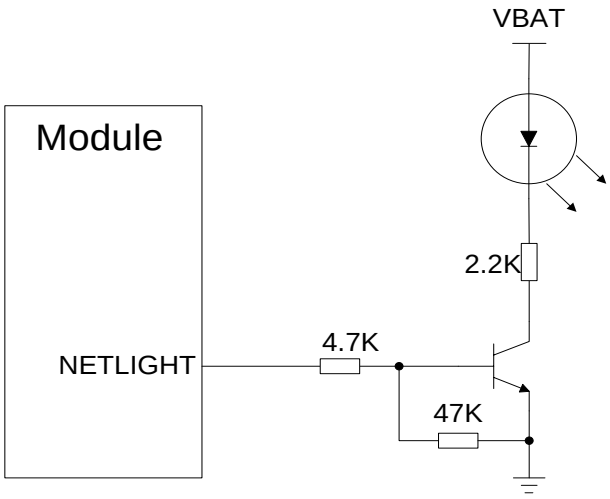


Figure 15: Reference Design for NETLIGHT

NOTE

"*" means under development.

4 Antenna Interface

The pin 53 is the RF antenna pad. The impedance of the antenna port is 50Ω.

Table 14: Pin Definition of the RF Antenna Interface

Pin Name	Pin No.	Description
GND	51	Ground
GND	52	Ground
RF_ANT	53	RF antenna pad
GND	54	Ground

4.1. RF Antenna Reference Design

A reference design for RF antenna is shown as below.

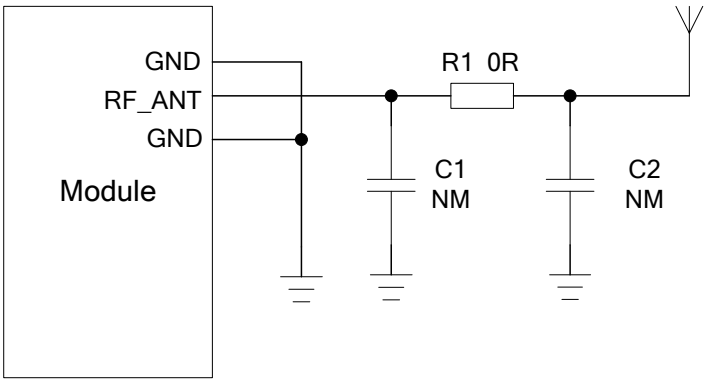


Figure 16: Reference Design for RF Antenna

BC95-G provides an RF antenna pad for antenna connection. There is a ground pad on each side of the antenna pad in order to give a better grounding. Additionally, a π-type matching circuit is recommended to be used to adjust the RF performance. Please place the π-type matching components (R1/C1/C2) as

close to the antenna as possible, and mount them according to actual needs. The capacitors (C1/C2) are not mounted and a 0Ω resistor is mounted on R1 by default.

4.2. Reference Design of RF Layout

For user's PCB, the characteristic impedance of all RF traces should be controlled as 50Ω. 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 waveguide line is typically used in RF layout for characteristic impedance control. The following are reference designs of microstrip line or coplanar waveguide line with different PCB structures.

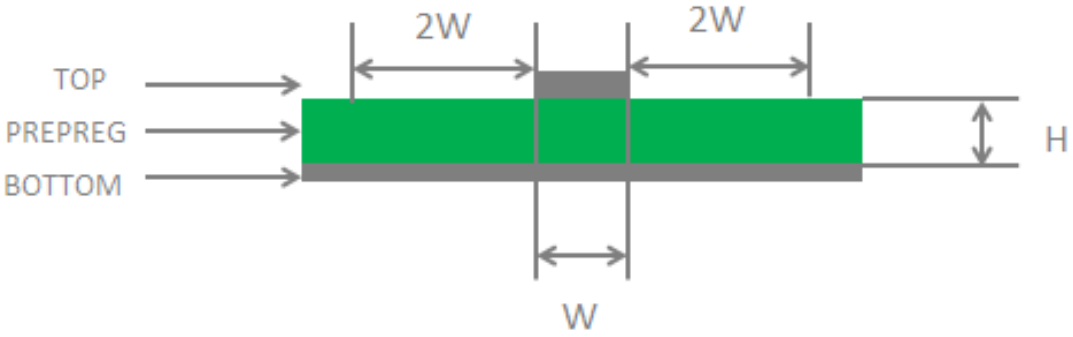


Figure 17: Microstrip Line Design on a 2-layer PCB

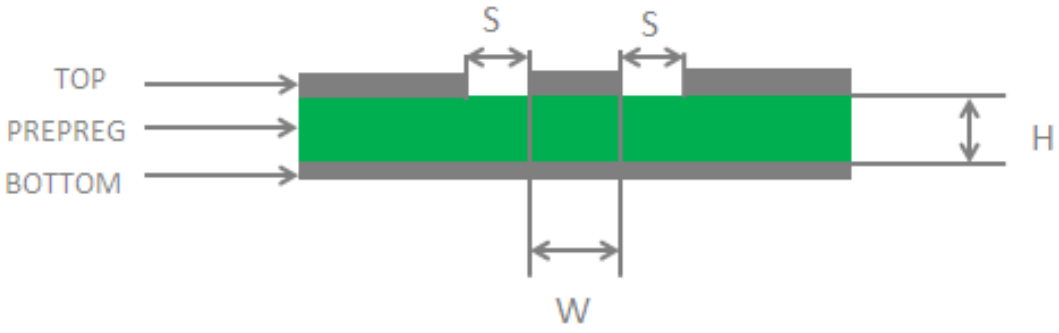


Figure 18: Coplanar Waveguide Line Design on a 2-layer PCB

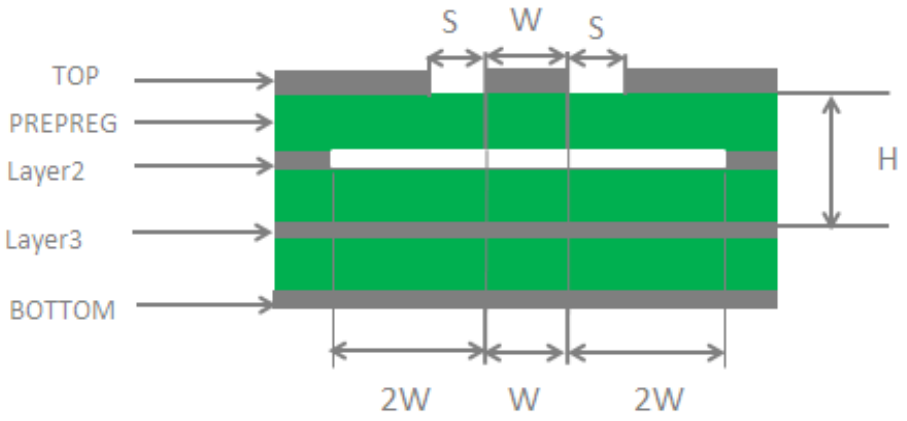


Figure 19: Coplanar Waveguide Line Design on a 4-layer PCB (Layer 3 as Reference Ground)

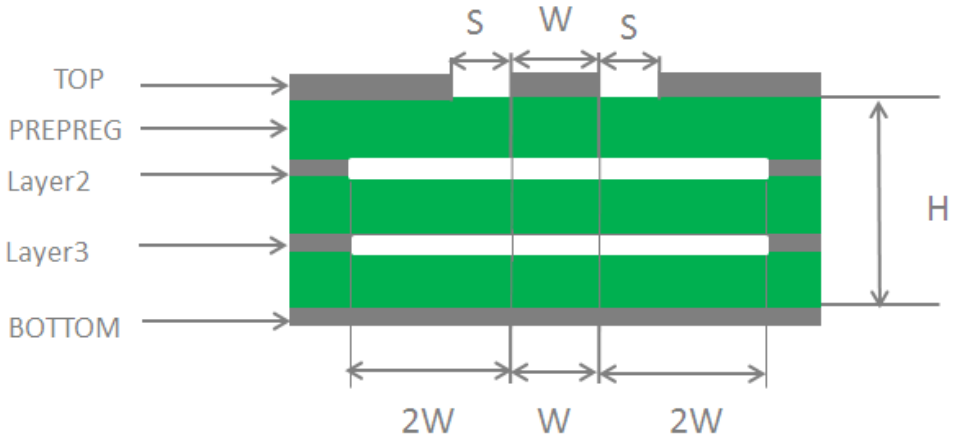


Figure 20: Coplanar Waveguide Line Design on a 4-layer PCB (Layer 4 as Reference Ground)

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 impedance of RF traces as 50Ω.
- 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 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 vias around RF traces and the reference ground could help to improve RF performance. The distance between the ground vias and RF traces should be no less than two times the width of RF signal traces (2*W).

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

4.3. RF Output Power

Table 15: RF Output Power (Uplink QPSK and BPSK Modulation)

Frequency Band	Max.	Min.
Band 1	23dBm±2dB	<-40dBm
Band 3	23dBm±2dB	<-40dBm
Band 8	23dBm±2dB	<-40dBm
Band 5	23dBm±2dB	<-40dBm
Band 20	23dBm±2dB	<-40dBm
Band 28*	23dBm±2dB	<-40dBm

NOTES

1. This design is compliant with the NB-IoT radio protocol *3GPP Rel.14*.
2. "*" means under development.

4.4. RF Receiving Sensitivity

Table 16: RF Receiving Sensitivity (Throughput ≥ 95%)

Frequency Band	Receiving Sensitivity
Band 1	-129dBm±1dB
Band 3	-129dBm±1dB
Band 8	-129dBm±1dB
Band 5	-129dBm±1dB
Band 20	-129dBm±1dB
Band 28*	-129dBm±1dB

NOTE

"*" means under development.

4.5. Operating Frequencies

Table 17: Operating Frequencies

Frequency Band	Receive	Transmit
Band 1	2110MHz~2170MHz	1920MHz~1980MHz
Band 3	1805MHz~1880MHz	1710MHz~1785MHz
Band 8	925MHz~960MHz	880MHz~915MHz
Band 5	869MHz~894MHz	824MHz~849MHz
Band 20	791MHz~821MHz	832MHz~862MHz
Band 28*	758MHz~803MHz	703MHz~748MHz

NOTE

"*" means under development.

4.6. Antenna Requirement

The following table shows the requirement on NB-IoT antenna.

Table 18: Antenna Cable Requirement

Frequency Range	Requirement
703MHz~960MHz	Insertion Loss: <1dB
1710MHz~2200MHz	Insertion Loss: <1dB

Table 19: Antenna Requirements

Type	Requirements
Frequency Range	703MHz~960MHz; 1710MHz~2200MHz
VSWR	≤2
Gain (dBi)	≥1
Max Input Power (W)	50
Input Impedance (Ω)	50
Polarization Type	Linear

4.7. Recommended RF Connector for Antenna Installation

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

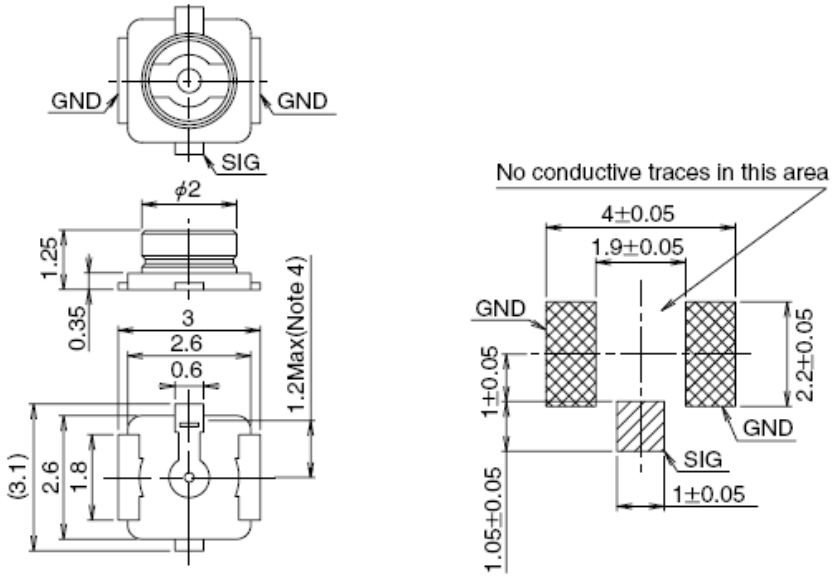


Figure 21: Dimensions of the U.FL-R-SMT Connector (Unit: mm)

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

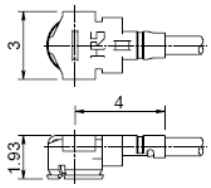
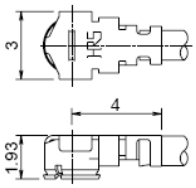
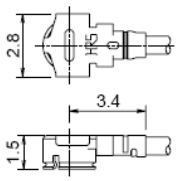
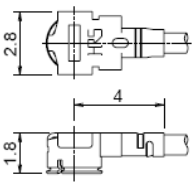
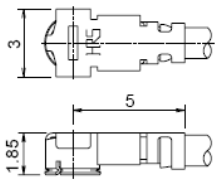
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia.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

Figure 22: Mechanicals of U.FL-LP Connectors

The following figure describes the space factor of mated connector.

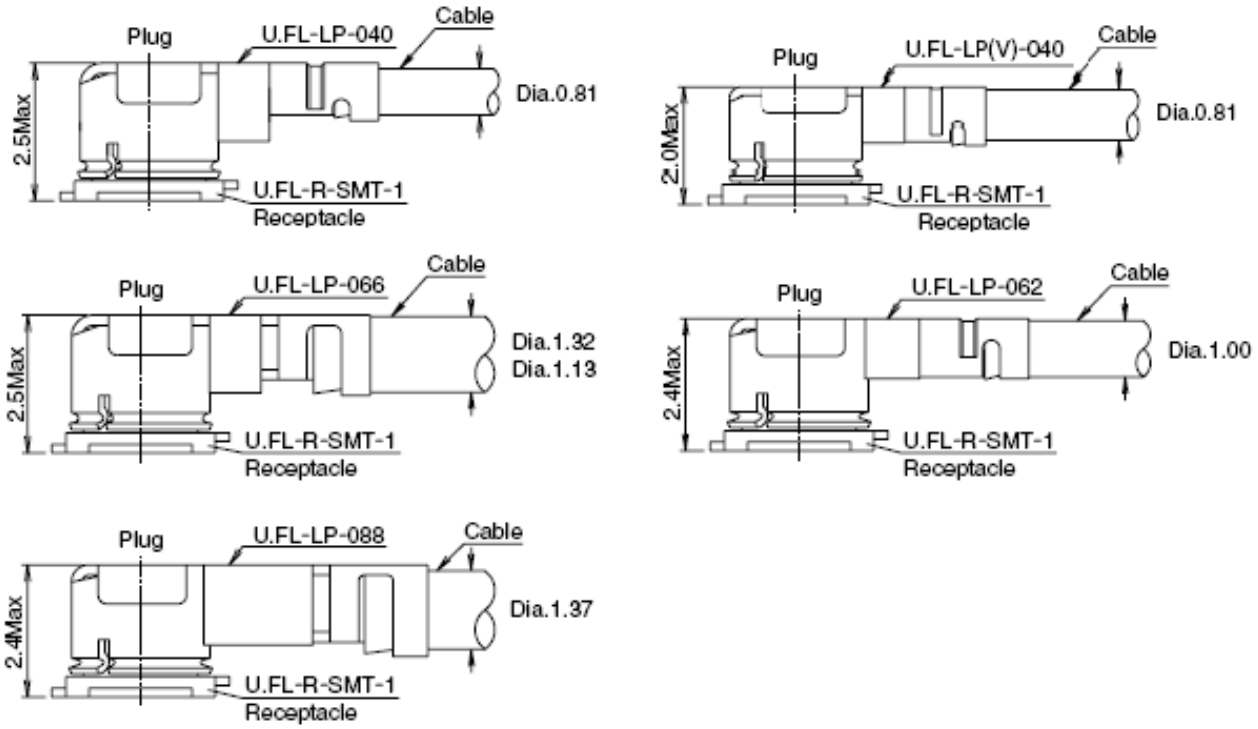


Figure 23: Space Factor of Mated Connector (Unit: mm)

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

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 module are listed in the following table.

Table 20: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VBAT	-0.3	+4.25	V
Current of Power Supply	0	0.3	A
Voltage at Digital Pins	-0.3	+4.25	V
Voltage at Analog Pins	-0.3	+4.25	V
Voltage at Digital/Analog Pins in Power Down Mode	-0.25	+0.25	V

5.2. Operation and Storage Temperature

The operation and storage temperature is listed in the following table.

Table 21: Operation and Storage Temperature

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

Storage Temperature Range	-40	+90	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 an SMS, data transmission, etc. There is no unrecoverable malfunction. There are also no effects on radio spectrum and no harm to radio network. 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 specifications again.

5.3. Current Consumption

The values of current consumption are shown below.

Table 22: Current Consumption

Parameter	Description	Conditions	Min.	Typ.	Max.	Unit
I_{VBAT}	PSM	Deep sleep state		3.6	5	uA
	Idle mode	Standby state @DRX=1.28s		2		mA
	Active mode	Radio transmission (23dBm) (B1/B28*)		250		mA
		Radio transmission (23dBm) (B3/B8/B5/B20)		230		mA
		Radio transmission (12dBm) (B1/B3/B8/B5/B20/B28*)		80		mA
		Radio transmission (0dBm) (B1/B3/B8/B5/B20/B28*)		65		mA
		Radio reception		50		mA

NOTE

"*" means under development.

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 shows the module's electrostatic discharge characteristics.

Table 23: Electrostatic Discharge Characteristics

Test Points	Contact Discharge	Air Discharge	Unit
VBAT, GND	±5	±10	kV
Antenna Interface	±5	±10	kV
Other Interfaces	±0.5	±1	kV

6 Mechanical Dimensions

This chapter describes the mechanical dimensions of the module. All dimensions are measured in mm. The tolerances for dimensions without tolerance values are ±0.05mm.

6.1. Mechanical Dimensions of the Module

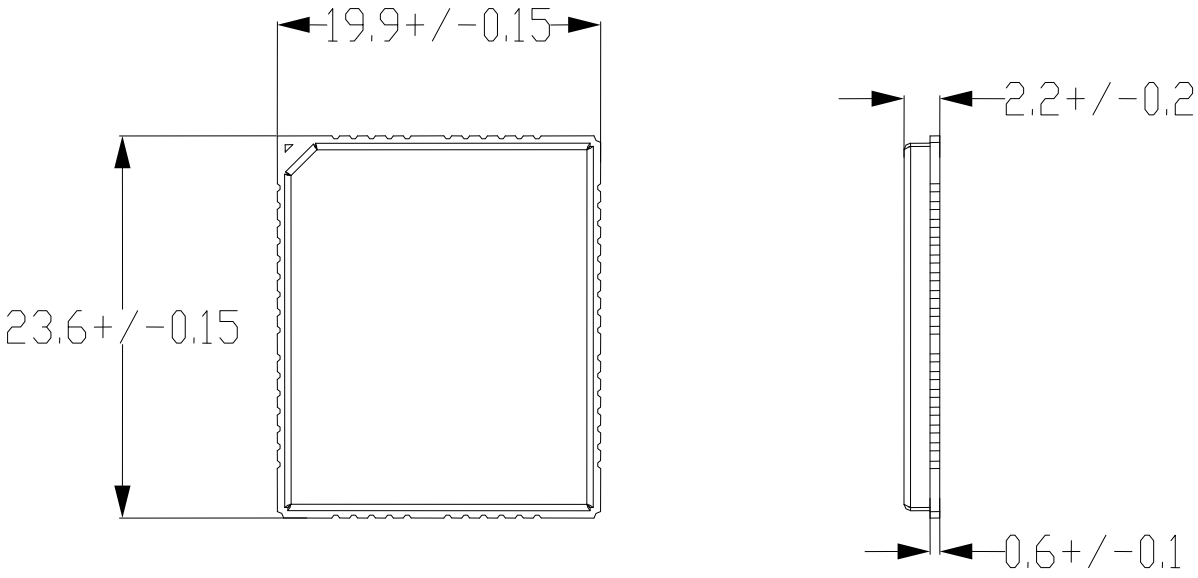


Figure 24: Module Top and Side Dimensions

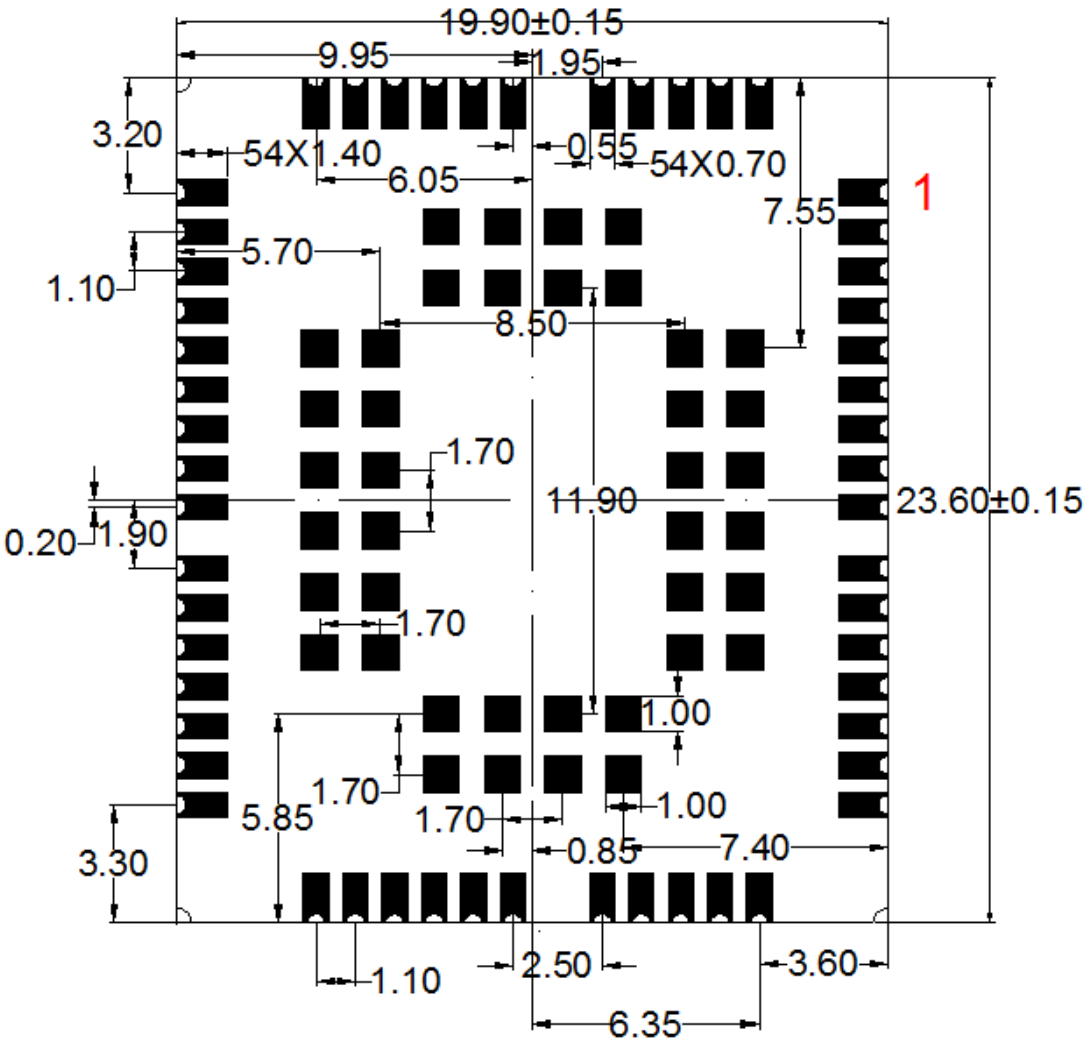


Figure 25: Module Bottom Dimensions (Bottom View)

6.2. Recommended Footprint

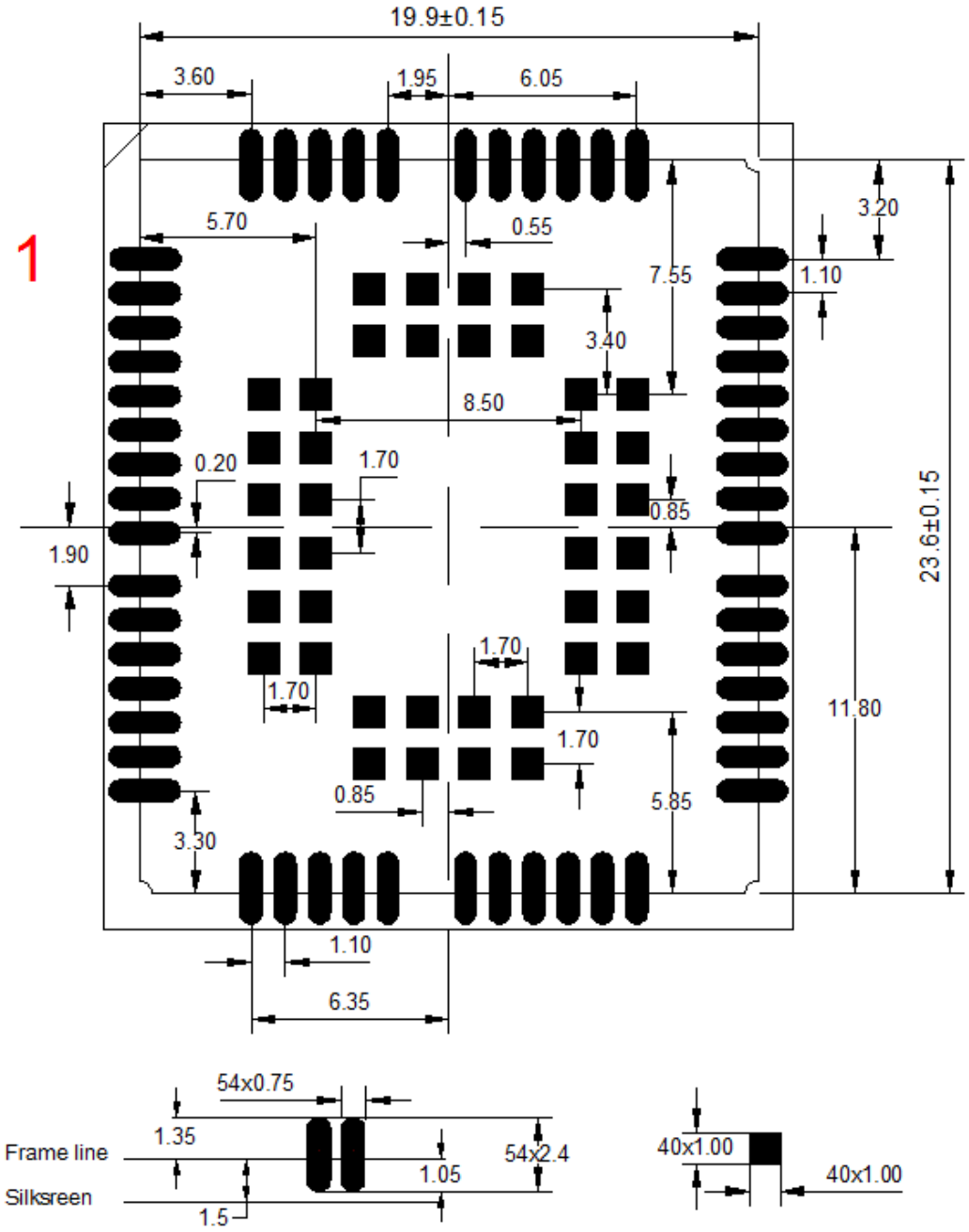


Figure 26: Recommended Footprint (Top View)

NOTES

1. For easy maintenance of the module, please keep about 3mm between the module and other components in the host PCB.
2. All RESERVED pins must not be connected to GND.

6.3. Design Effect Drawings of the Module

Figure 27: Top View of the Module

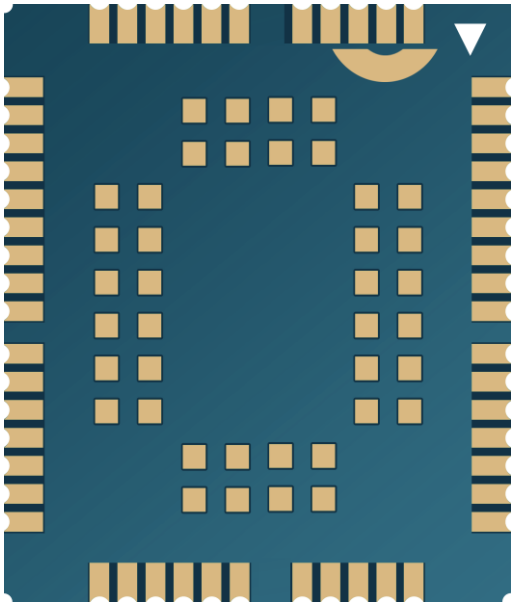


Figure 28: Bottom View of the Module

NOTE

These are design effect drawings of BC95-G module. For more accurate pictures, please refer to the module that you get from Quectel.

7 Storage, Manufacturing and Packaging

7.1. Storage

BC95-G module is stored in a vacuum-sealed bag. The storage restrictions are shown 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 168 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±5ºC and the humidity indication card shows the humidity is >10% before opening the vacuum-sealed bag.
- Device mounting cannot be finished within 168 hours at factory conditions of ≤30ºC/60%
- Stored at >10% RH after the vacuum-sealed bag is opened.

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 the *IPC/JEDECJ-STD-033* for 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 so as to produce a clean stencil surface on a single pass. To ensure the module soldering quality, the thickness of stencil for the module is recommended to be 0.15mm. For more details, please refer to ***document [4]***.

It is suggested that the peak reflow temperature is 235ºC~245ºC (for SnAg3.0Cu0.5 alloy). The absolute max reflow temperature is 260ºC. To avoid damage to the module caused by repeatedly 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.

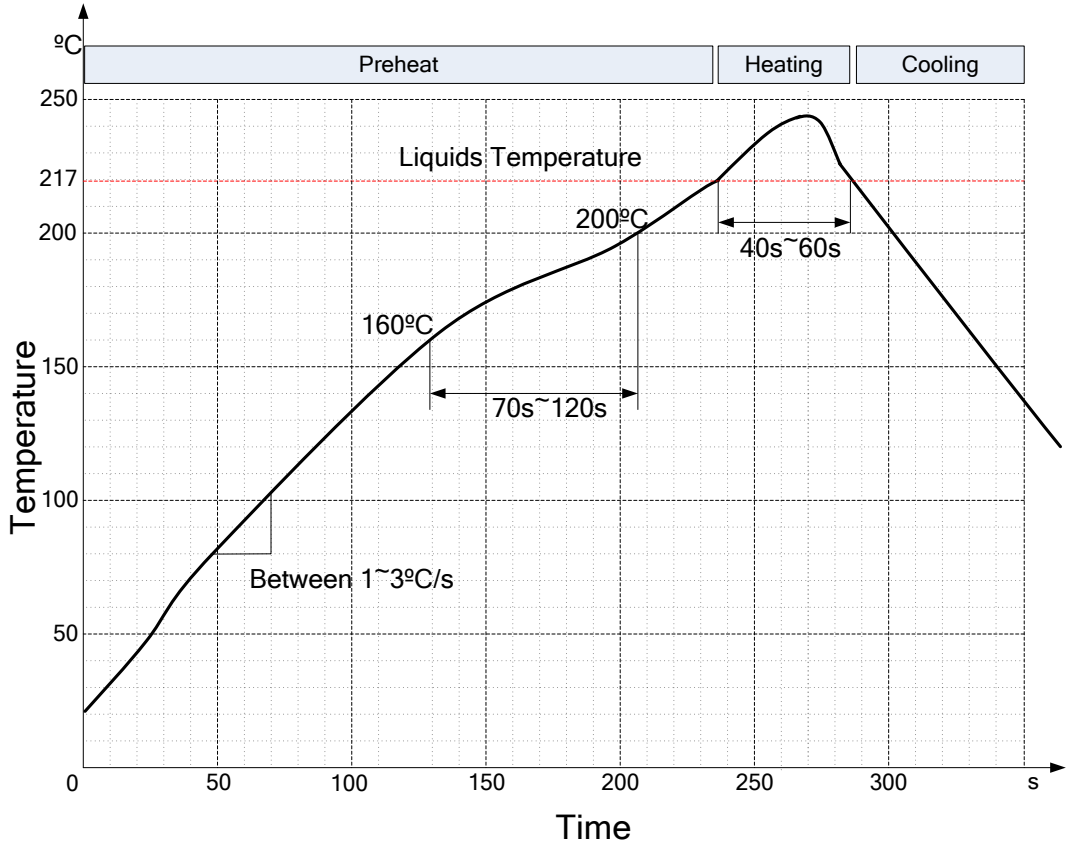


Figure 29: Reflow Soldering Thermal Profile

7.3. Packaging

The modules are stored inside a vacuum-sealed bag which is ESD protected. It should not be opened until the devices are ready to be soldered onto the application.

7.3.1. Tape and Reel Packaging

The reel is 330mm in diameter and each reel contains 250 modules.

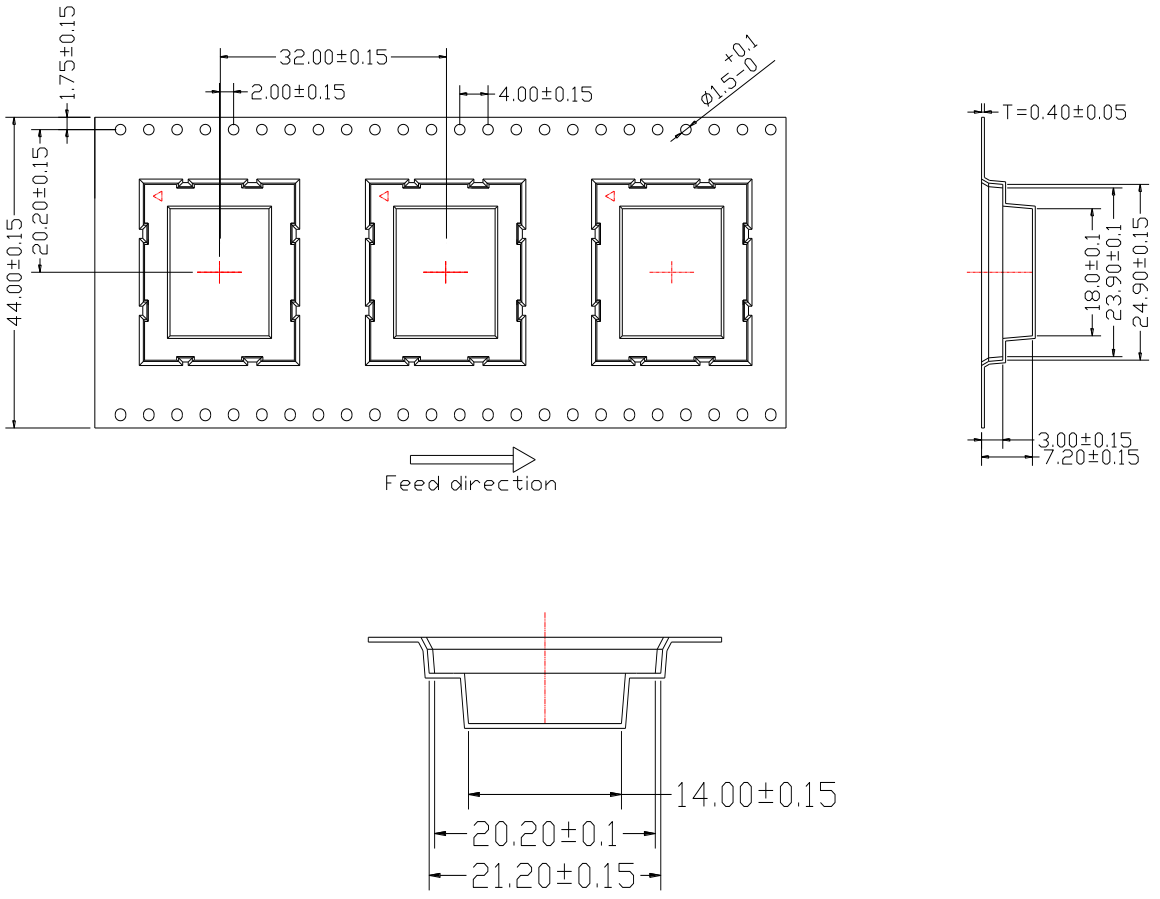


Figure 30: Tape Dimensions

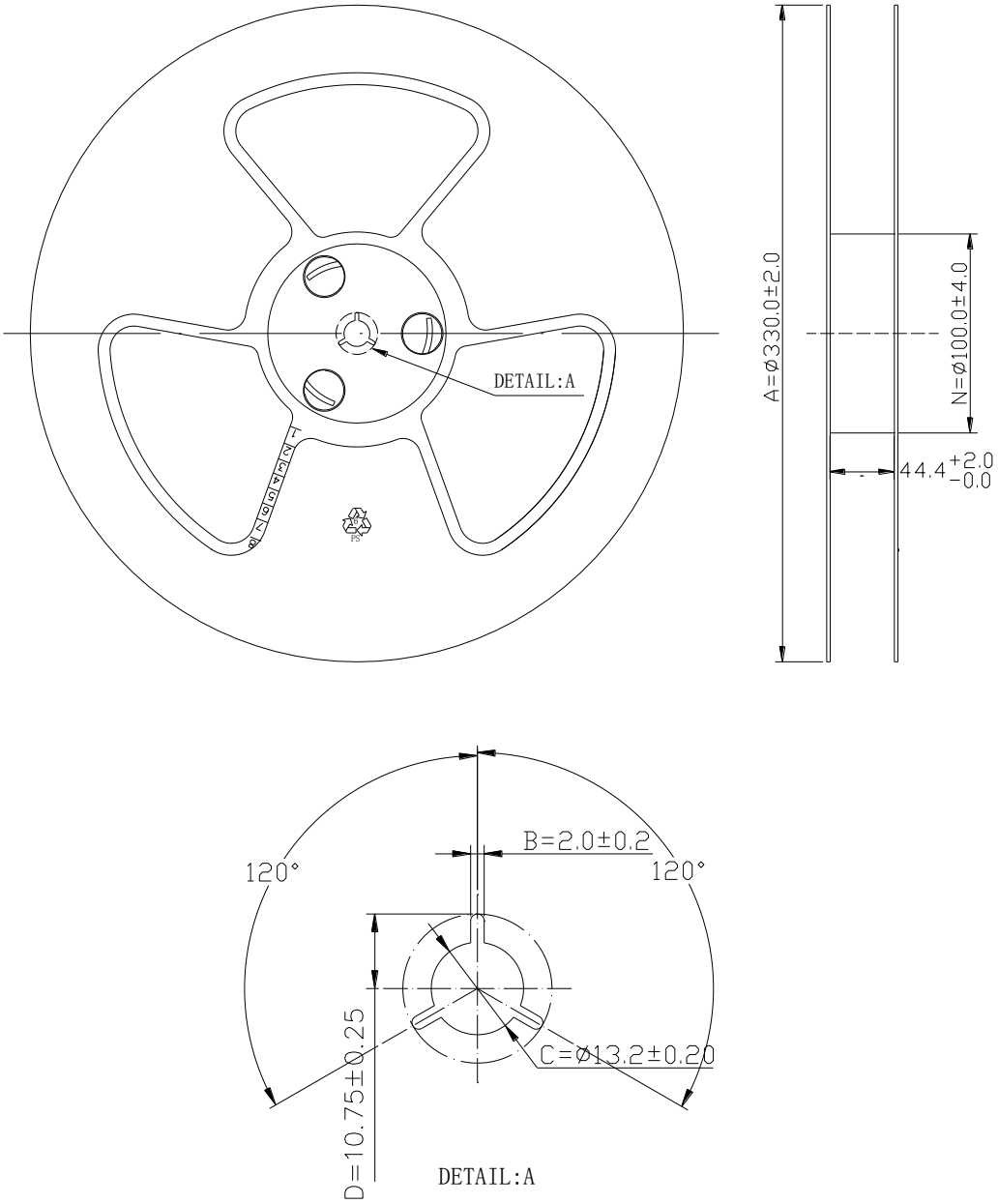


Figure 31: Reel Dimensions

8 Appendix A References

Table 24: Related Documents

SN	Document Name	Remark
[1]	Quectel_BC95-G&BC68_AT_Commands_Manual	BC95-G&BC68 AT Commands Manual
[2]	Quectel_BC95-G&BC68_Firmware_Upgrade_User_Guide	BC95-G&BC68 Firmware Upgrade User Guide
[3]	Quectel_BC95-G&BC68_UEMonitor_User_Guide	BC95-G&BC68 UEMonitor User Guide
[4]	Quectel_Module_Secondary_SMT_User_Guide	Module Secondary SMT User Guide
[5]	Quectel_RF_Layout_Application_Note	RF Layout Application Note

Table 25: Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
AS	Access Stratum
DCE	Data Communications Equipment (typically module)
DTE	Data Terminal Equipment (typically computer, external controller)
DRX	Discontinuous Reception
H-FDD	Half Frequency Division Duplexing
I/O	Input/Output
IC	Integrated Circuit
Imax	Maximum Load Current
Inorm	Normal Current

kbps	Kilo Bits Per Second
LED	Light Emitting Diode
MME	Mobility Management Entity
MO	Mobile Originated
NB-IoT	Narrow Band Internet of Things
PCB	Printed Circuit Board
PDN	Public Data Network
PSM	Power Saving Mode
RF	Radio Frequency
RoHS	Restriction of Hazardous Substances
RTC	Real Time Clock
RX	Receive Direction
USIM	Universal Subscriber Identification Module
SMS	Short Message Service
TAU	Tracking Area Update
TE	Terminal Equipment
TX	Transmitting Direction
UART	Universal Asynchronous Receiver & Transmitter
URC	Unsolicited Result Code
VSWR	Voltage Standing Wave Ratio
Vmax	Maximum Voltage Value
Vnorm	Normal Voltage Value
Vmin	Minimum Voltage Value
VIHmax	Maximum Input High Level Voltage Value
VIHmin	Minimum Input High Level Voltage Value

VILmax	Maximum Input Low Level Voltage Value
VILmin	Minimum Input Low Level Voltage Value
VImax	Absolute Maximum Input Voltage Value
VImin	Absolute Minimum Input Voltage Value
VOHmax	Maximum Output High Level Voltage Value
VOHmin	Minimum Output High Level Voltage Value
VOLmax	Maximum Output Low Level Voltage Value
VOLmin	Minimum Output Low Level Voltage Value