BC66 Hardware Design

LPWA Module Series

Rev. BC66_Hardware_Design_V1.2

Date: 2019-06-04

Status: Released

Our aim is to provide customers with timely and comprehensive service. For any assistance, please contact our company headquarters:

Quectel Wireless Solutions Co., Ltd.
7th Floor, Hongye Building, No.1801 Hongmei Road, Xuhui District, Shanghai 200233, China
Tel: +86 21 5108 6236
Email: info@quectel.com

Or our local office. For more information, please visit:
http://www.quectel.com/support/sales.htm

For technical support, or to report documentation errors, please visit:
http://www.quectel.com/support/technical.htm
Or email to: support@quectel.com

GENERAL NOTES

QUECTEL OFFERS THE INFORMATION AS A SERVICE TO ITS CUSTOMERS. THE INFORMATION PROVIDED IS BASED UPON CUSTOMERS' REQUIREMENTS. QUECTEL MAKES EVERY EFFORT TO ENSURE THE QUALITY OF THE INFORMATION IT MAKES AVAILABLE. QUECTEL DOES NOT MAKE ANY WARRANTY AS TO THE INFORMATION CONTAINED HEREIN, AND DOES NOT ACCEPT ANY LIABILITY FOR ANY INJURY, LOSS OR DAMAGE OF ANY KIND INCURRED BY USE OF OR RELIANCE UPON THE INFORMATION. ALL INFORMATION SUPPLIED HEREIN IS SUBJECT TO CHANGE WITHOUT PRIOR NOTICE.

COPYRIGHT

About the Document

History

Revision	Date	Author	Description
1.0	2018-08-24	Speed SUN/ Newgate HUA	Initial
1.1	2018-11-14	Newgate HUA	Updated supported bands and involved RF parameters of BC66.
1.2	2019-06-04	Speed SUN	1. Reserved pins 3~6 and deleted the description of SPI interface. 2. Optimized the description of the module's operating modes (Chapter 3.4). 3. Enabled USB interface and added its related description (Chapters 2.3, 3.2, 3.3 & 3.7). 4. Added a note for the reference design of power supply (Chapter 3.6.2). 5. Added RI signal status description (Table 13). 6. Added NETLIGHT working status description (Table 14). 7. Added the current consumption values for band 4 and the testing conditions (Chapter 5.2). 8. Updated the module's recommended stencil thickness and peak reflow temperatures (Chapter 7.2).

Contents

Table Index

Figure Index

1 Introduction

This document defines the BC66 module and describes its air interface and hardware interface which are connected with the customers' applications.

This document can help customers quickly understand 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 BC66 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 BC66 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 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. 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 prior to 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 network 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. In order to make or receive a call, the cellular terminal or mobile must be switched on in a service area with adequate cellular signal strength.
	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 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

BC66 is a high-performance NB-IoT module with extremely low power consumption. It is designed to communicate with infrastructures of mobile network operators through NB-IoT radio protocols (3GPP Rel.13 and 3GPP Rel.14*). BC66 supports a broad range of frequency bands as listed below.

Table 1: Frequency Bands of BC66 Module

Mode	BC66
H-FDD	B1/B2/B3/B4/B5/B8/B12/B13/B17/B18/B19/B20/B25/B26*/B28/B66

BC66 is an SMD type module with LCC package, and has an ultra-compact profile of 17.7mm × 15.8mm × 2.0mm. These make it can be easily embedded into size-constrained applications and provide reliable connectivity with the applications.

BC66 provides abundant external interfaces (UART, USB, ADC*, NETLIGHT, etc.) and protocol stacks (UDP/TCP, LwM2M, MQTT, etc.), which provide great convenience for customers' applications.

Due to compact form factor, ultra-low power consumption and extended temperature range, BC66 is a best choice for a wide range of IoT applications, such as smart metering, bike sharing, smart wearables, smart parking, smart city, home appliances, security and asset tracking, agricultural and environmental monitoring, etc. It is able to provide a complete range of SMS* and data transmission services to meet customers' demands.

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 BC66 module.

Table 2: BC66 Key Features

Feature	Details
Power Supply	● Supply voltage: 2.1V ~ 3.63V ● Typical supply voltage: 3.3V
Power Saving	● Typical power consumption: 3.5μA
Frequency Bands	**LTE Cat NB1:** ● B1/B2/B3/B4/B5/B8/B12/B13/B17/B18/B19/B20/B25/B26*/B28/B66
Transmitting Power	● 23dBm±2dB
USIM Interface	● Support 1.8V USIM card
USB Interface	● Conform to USB 1.1 specifications, with maximum data transfer rate up to 12Mbps ● Used for software debugging and upgrading ● Support USB serial driver under Windows/Linux operating systems
UART Interfaces	**Main UART Port:** ● Used for AT command communication and data transmission. ● By default, the module is in auto-baud mode, and it supports automatic baud rates not exceeding 115200bps. When powering on the module, the MCU has to send **AT** command consecutively to synchronize baud rate with the module. When **OK** is returned, it indicates the baud rate has been synchronized successfully. When the module is woken up from PSM or idle mode, the baud rate synchronized during start-up will be used directly. ● Also can be used for firmware upgrade, and in such case, the baud rate is 921600bps by default. **Debug UART Port:** ● Used for firmware debugging ● Default baud rate: 115200bps **Auxiliary UART Port:** ● Used for firmware debugging ● Default baud rate: 115200bps
Network Protocols	● UDP/TCP/LwM2M/MQTT/DTLS/SNTP/CoAP*/PPP*/TLS*/HTTP*/HTTPS*
SMS*	● Text/PDU Mode
Data Transmission Features	● Single-tone: 25.5kbps (DL)/16.7kbps (UL) ● Multi-tone: 25.5kbps (DL)/62.5kbps (UL)

AT Commands	●	3GPP TS 27.005/3GPP TS 27.007 AT commands (3GPP Rel. 13/Rel.14*) and Quectel Enhanced AT commands
Firmware Update	●	Upgrade firmware via DFOTA, USB or main UART port
Real Time Clock	●	Supported
Physical Characteristics	●	Size: (17.7±0.15)mm × (15.8±0.15)mm × (2.0±0.2)mm
	●	Weight: 1.2g±0.2g
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
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 normal operation 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 BC66 and illustrates the major functional parts.

- Radio frequency
- Baseband
- Power management
- Peripheral interfaces

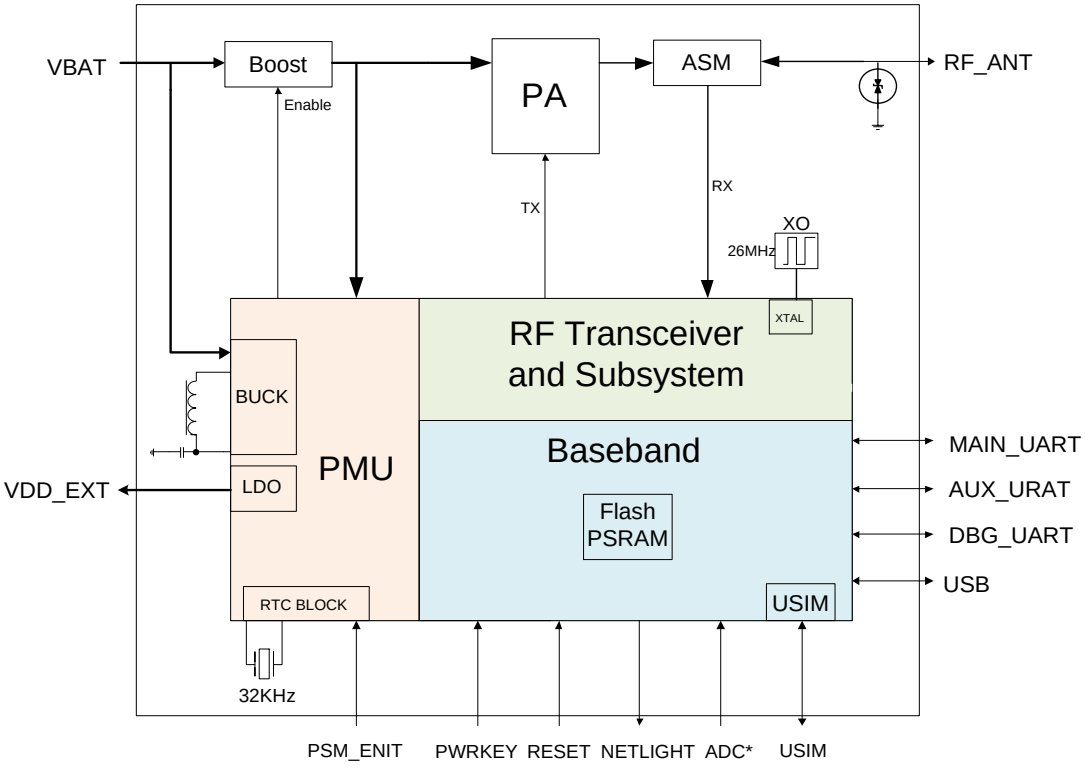


Figure 1: Functional Diagram

NOTE

"*" means under development.

2.4. Development Board

Quectel provides a complete set of development tools to facilitate the use and testing of BC66 module. The development tool kit includes the TE-B board, USB cable, antenna and other peripherals. For more details, please refer to ***document [1]***.

3 Application Interfaces

3.1. General Description

BC66 is equipped with a total of 58 pins, including 44 LCC pins and 14 LGA pins. The subsequent chapters will provide detailed descriptions of the following functions/pins/interfaces:

- PSM
- Power Supply
- PWRKEY
- RESET
- USB Interface
- UART Interfaces
- USIM Interface
- ADC Interface*
- RI Behaviors
- Network Status Indication

NOTE

"*" means under development.

3.2. Pin Assignment

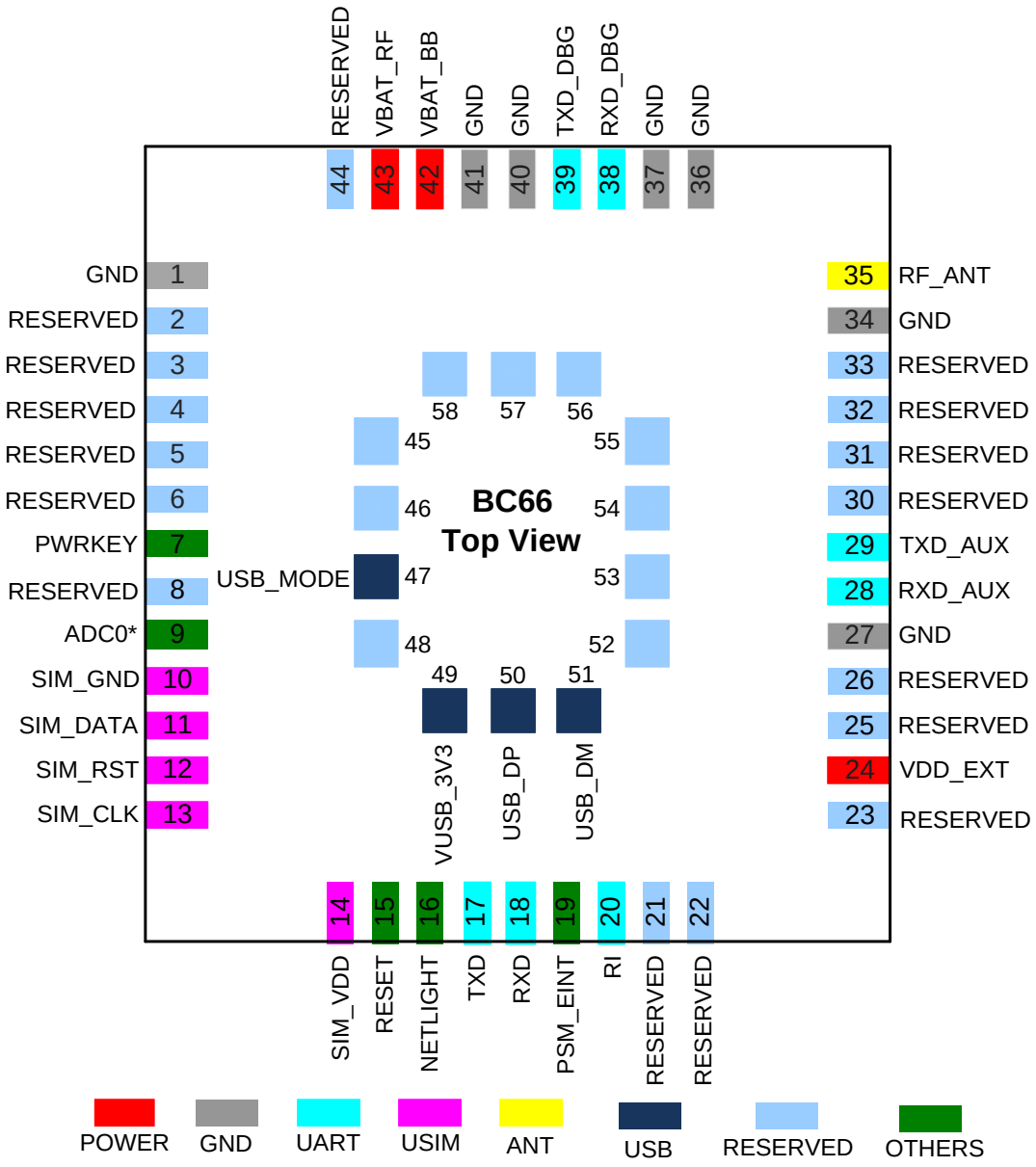


Figure 2: Pin Assignment

NOTES

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

3.3. Pin Description

Table 3: I/O Parameters Definition

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

Table 4: Pin Description

Power Supply					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
VBAT_BB	42	PI	Power supply for the module's baseband part	Vmax=3.63V Vmin=2.1V Vnorm=3.3V	
VBAT_RF	43	PI	Power supply for the module's RF part	Vmax=3.63V Vmin=2.1V Vnorm=3.3V	
VDD_EXT	24	PO	1.8V output power supply	Vnorm=1.8V	No voltage output in PSM mode. It is intended to supply power for the module's pull-up circuits, and is thus not recommended to be used as the power supply for external circuits.
GND	1, 27, 34, 36, 37, 40, 41		GND		

Power Key Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PWRKEY	7	DI	Pull down PWRKEY to turn on the module	V_{IL}max=0.3*VBAT V_{IH}min=0.7*VBAT	
Reset Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESET	15	DI	Reset the module		Active low.
PSM_EINT Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
PSM_EINT	19	DI	Dedicated external interrupt pin. Used to wake up the module from PSM.		
Network Status Indication					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
NETLIGHT	16	DO	Network status indication		
ADC Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ADC0*	9	AI	General purpose analog to digital converter interface	Voltage range: 0V~1.4V	
Main UART Port					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RXD	18	DI	Receive data from TXD of DTE		1.8V power domain.
TXD	17	DO	Transmit data to RXD of DTE		
Auxiliary UART Port					

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
RXD_AUX	28	DI	Receive data from TXD of DTE		1.8V power domain.
TXD_AUX	29	DO	Transmit data to RXD of DTE		
Debug UART Port					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RXD_DBG	38	DI	Receive data from TXD of DTE		1.8V power domain.
TXD_DBG	39	DO	Transmit data to RXD of DTE		
Ringing Signal					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RI	20	DO	Ring indication signal		1.8V power domain.
USIM Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
SIM_VDD	14	DO	USIM card power supply	Vnorm=1.8V	
SIM_RST	12	DO	USIM card reset signal	V_{OL}max=0.15×SIM_VDD V_{OH}min=0.85×SIM_VDD	
SIM_DATA	11	IO	USIM card data signal	V_{IL}max=0.25×SIM_VDD V_{IH}min=0.75×SIM_VDD V_{OL}max=0.15×SIM_VDD V_{OH}min=0.85×SIM_VDD	
SIM_CLK	13	DO	USIM card clock signal	V_{OL}max=0.15×SIM_VDD V_{OH}min=0.85×SIM_VDD	
SIM_GND	10	GND	Specified ground for USIM card		
Antenna Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RF_ANT	35	IO	RF antenna interface		50Ω characteristic impedance
USB Interface					

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
USB_MODE	47	DI	Pull down the pin to achieve USB download function		
VUSB_3V3	49	PI	USB power supply	Vnorm=3.3V	
USB_DP	50	IO	USB differential data (+)		Conform to USB 1.1 specifications. Request 90 Ω differential impedance.
USB_DM	51	IO	USB differential data (-)		
Reserved Pins					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESERVED	2~6, 8, 21~23, 25, 26, 30~33, 44~46, 48, 52~58				Keep these pins unconnected.

NOTES

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

3.4. Operating Modes

The following table briefly describes the three operating modes of the module.

Table 5: Overview of Operating Modes

Mode	Description of Operating Modes	
Normal Operation	Connected	In connected mode, the module is in "Active" status. 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 connected mode.
	Idle	In idle mode, the module is in “Light Sleep” status and network connection is maintained in DRX/eDRX state; paging messages can be received. Transitions to connected mode or PSM can be initiated in idle mode.
	PSM	In PSM, the module is in “Deep Sleep” status and only the 32kHz RTC is working. CPU is powered off; the network is disconnected and thus cannot receive downlink data. Transitions to connected mode can be initiated in PSM.

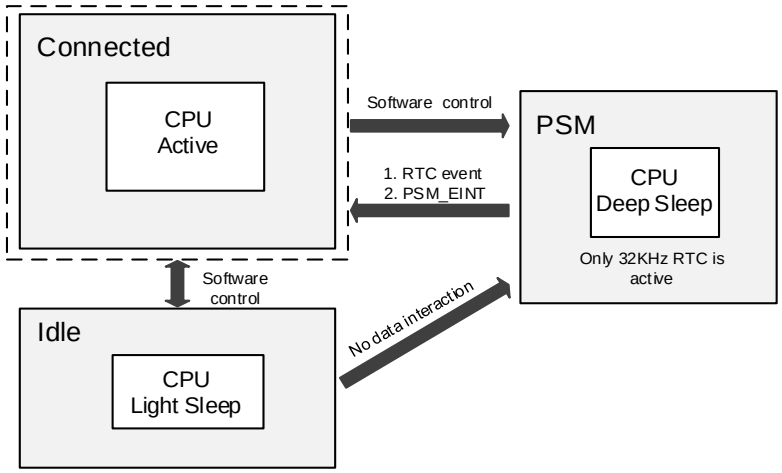


Figure 3: Module Operating Modes

3.5. Power Saving Mode (PSM)

Based on system performance, the module consumes an ultra-low current (typically 3.5μA power consumption) 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.

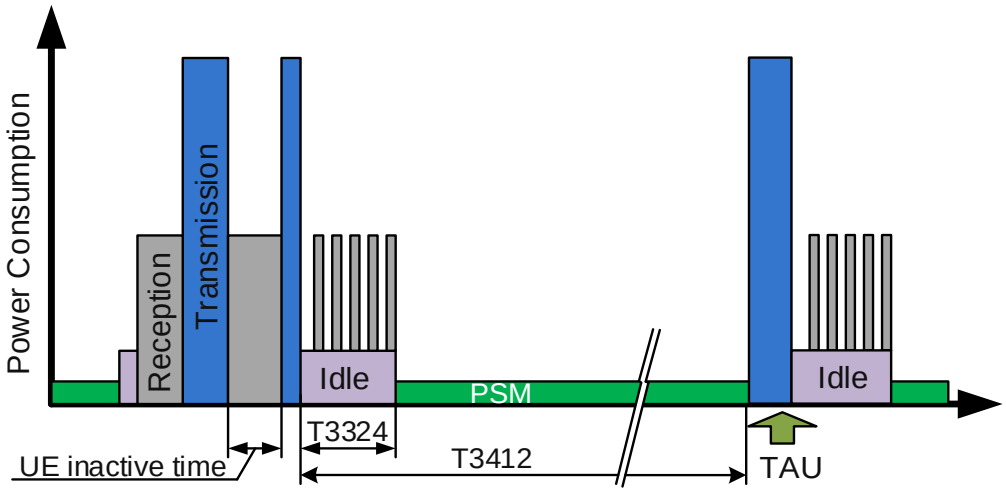


Figure 4: Module Power Consumption in Different Modes

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, but T3412 is still active.

Either of the following methods can make the module exit from PSM:

- After the T3412 timer expires, the module will exit PSM automatically.
- Pulling down PSM_EINT (falling edge) will wake the module up from PSM. The timing of waking up the module from PSM is illustrated below.

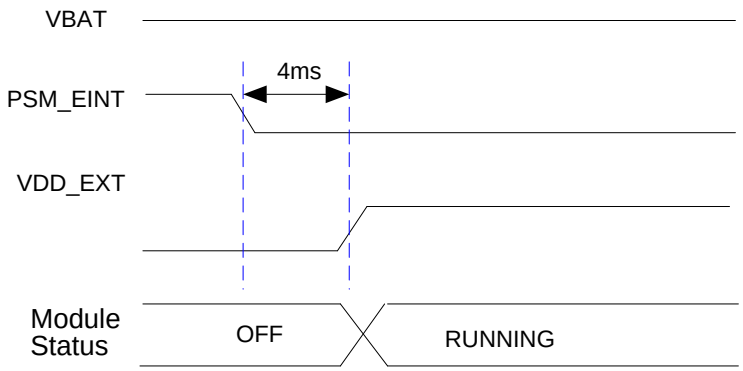


Figure 5: Timing of Waking up Module from PSM

NOTE

Among all GPIO interrupts, only the dedicated external interrupt pin PSM_EINT can successfully wake up the module from PSM. The module cannot be woken up by any other general purpose GPIO interrupts.

3.6. Power Supply

3.6.1. Power Supply Pins

BC66 provides two VBAT pins for connection with an external power supply. The table below describes the module's VBAT and ground pins.

Table 6: Power Supply Pins

Pin Name	Pin No.	Description	Min.	Typ.	Max.	Unit
VBAT_BB	42	Power supply for the module's baseband part	2.1	3.3	3.63	V
VBAT_RF	43	Power supply for the module's RF part	2.1	3.3	3.63	V
GND	1, 27, 34, 36, 37, 40, 41	GND				

3.6.2. Reference Design for Power Supply

Power design for a module is critical to its performance. It is recommended to use a low quiescent current LDO with output current capacity of 0.5A as the power supply for BC66. A Li-MnO2/2S alkaline battery can also be used as the power supply. The supply voltage of the module ranges from 2.1V to 3.63V. When the module is working, please make sure its input voltage will never drop below 2.1V; otherwise 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 pins. Also, it is recommended to add a TVS diode on the VBAT trace (near VBAT pins) to improve surge voltage withstand capability. In principle, the longer the VBAT trace is, the wider it should be. A reference circuit for power supply is illustrated in the following figure.

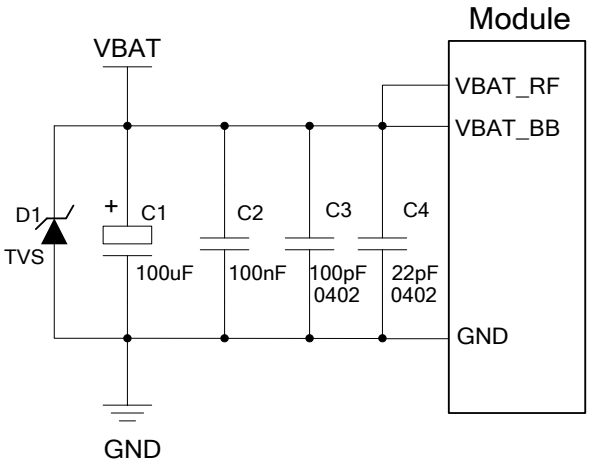


Figure 6: Reference Circuit for Power Supply

NOTE

During the module's power-on or reset, an instantaneous current of 700mA will be generated for a period of 200us. To decrease the current, it is recommended to connect a large-capacitance capacitor to VBAT. If the load capacity of power supply is insufficient, then a 100uF tantalum capacitor is recommended.

3.7. Power up/Power down Scenarios

3.7.1. Turn on

BC66 will be powered up after driving the PWRKEY pin to a low level voltage for at least 500ms.

Table 7: PWRKEY Pin

Pin Name	Pin No.	Description	PWRKEY Pull-down Time
PWRKEY	7	Pull down PWRKEY to power up the module	≥500ms

It is recommended use an open drain/collector driver to control the PWRKEY. A simple reference circuit is illustrated in the following figure.

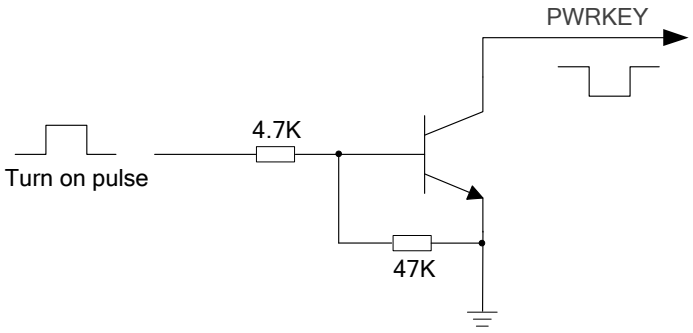


Figure 7: Turn on the Module Using Driving Circuit

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

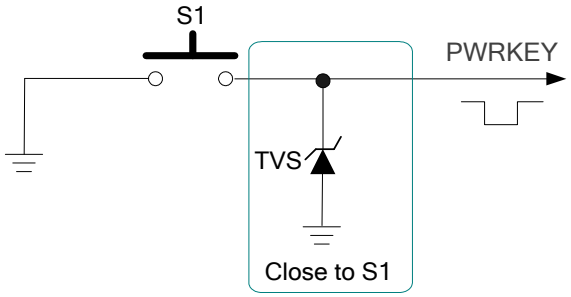


Figure 8: Turn on the Module Using Keystroke

The power up timing is illustrated in the following figure.

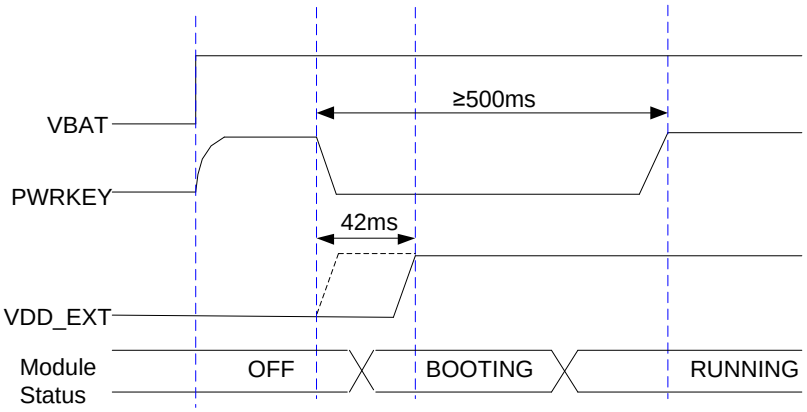


Figure 9: Power up Timing

NOTE

PWRKEY cannot be pulled down all the time, otherwise the module will not be able to enter into PSM.

3.7.2. Turn off

BC66 can be powered off though any of the following methods:

- Power off by **AT+QPOWD=0**.
- In emergent conditions, the module can be powered off through disconnecting VBAT power supply.
- The module will be powered off automatically when VBAT drops below 2.1V.

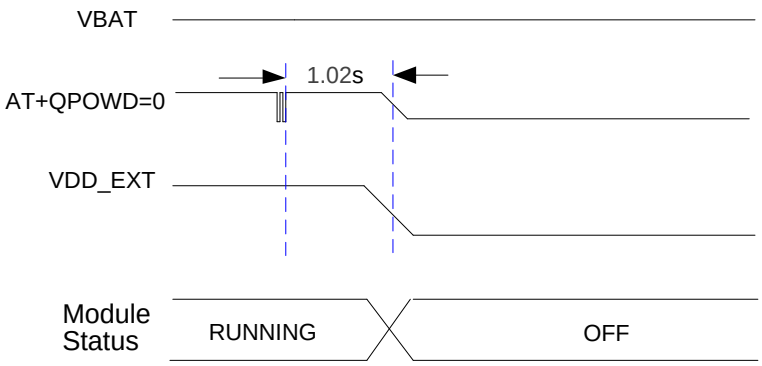


Figure 10: Power down Timing (Power off by AT Command)

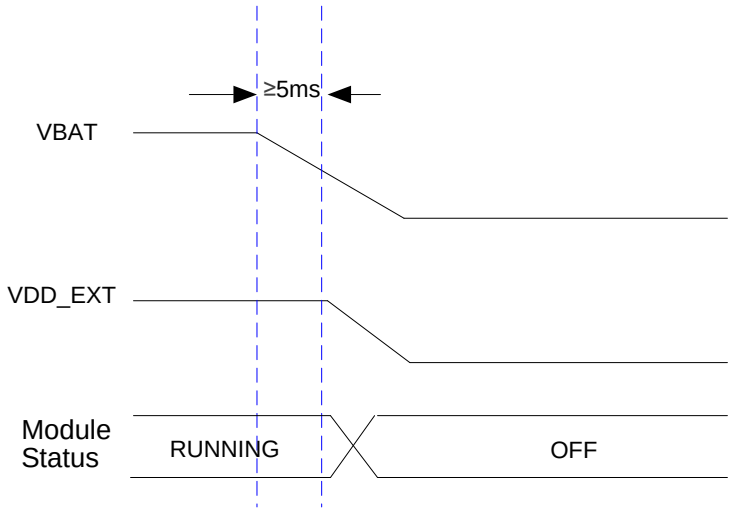


Figure 11: Power down Timing (Power off by Disconnecting VBAT)

3.7.3. Reset the Module

Driving the RESET pin to a low level voltage for at least 50ms will reset the module.

Table 8: Reset Pin

Pin Name	Pin No.	Description	Reset Pull-down Time
RESET	15	Reset the module. Active low.	≥50ms

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

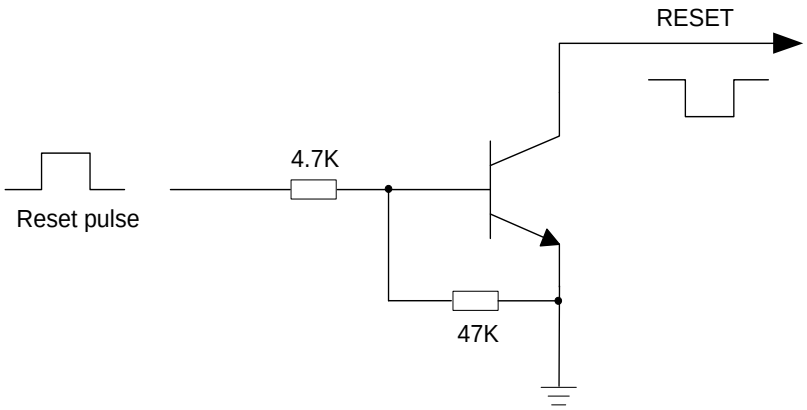


Figure 12: Reference Circuit of RESET by Using Driving Circuit

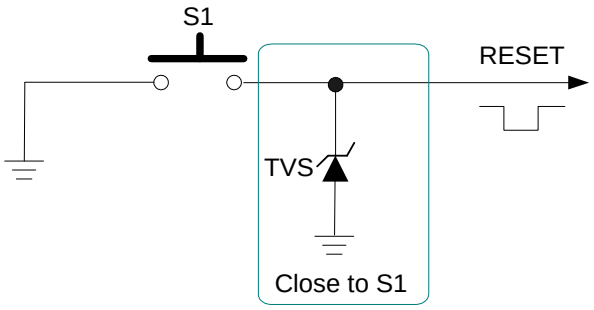


Figure 13: Reference Circuit of RESET by Using Button

The reset scenario is illustrated in the following figure.

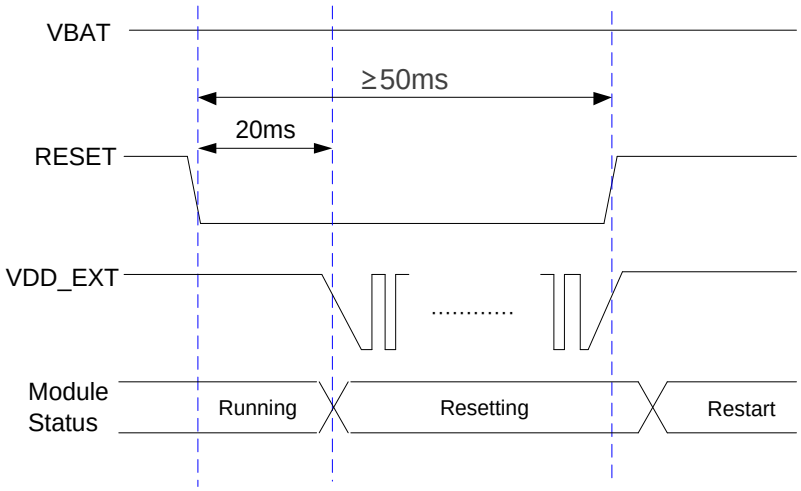


Figure 14: Reset Timing

3.8. USB Interface

The USB interface of BC66 module conforms to USB 1.1 specifications and supports full speed (12Mbps) mode. The interface can be used for software debugging and software upgrading, and supports USB serial driver under Windows/Linux operating systems.

The following table is the pin definition of USB interface:

Table 9: Pin Definition of USB Interface

Pin Name	Pin No.	I/O	Description	Note
USB_MODE	47	DI	Pull down the pin to achieve USB download function	
VUSB_3V3	49	PI	USB power supply	Vnorm=3.3V
USB_DP	50	IO	USB differential data (+)	Conform to USB 1.1 specifications. Require 90Ω differential impedance.
USB_DM	51	IO	USB differential data (-)	

The following is a reference design of USB interface:

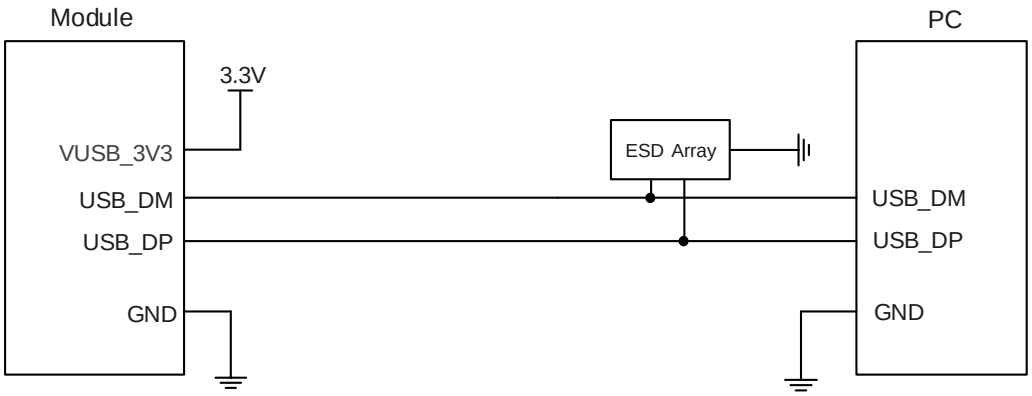


Figure 15: USB Interface Reference Design

In the circuit design of USB interface, in order to ensure the performance of USB, the following principles are suggested in the circuit design:

- It is important to route the USB signal traces as differential pairs with total grounding. The impedance of USB differential trace is 90Ω.
- Do not route signal traces under power supply, RF signal traces and other sensitive signal traces. It is important to route the USB differential traces in inner-layer with ground shielding on not only upper and lower layers but also right and left sides.
- Pay attention to the influence of junction capacitance of ESD protection components on USB data lines. Typically, the capacitance value should be less than 3pF.
- Keep the ESD protection components as close to the USB connector as possible.

NOTES

1. USB_MODE must be pulled down so as to realize USB download function.
2. When the USB interface is used for log capturing, the module will not be able to enter PSM.
3. When using USB function of the module, an external 3.3V power supply should be provided.

3.9. UART Interfaces

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

Table 10: Pin Definition of UART Interfaces

Interface	Pin Name	Pin No.	Description	Comment
Main UART Port	TXD	17	Transmit data to RXD of DTE	1.8V power domain
	RXD	18	Receive data from TXD of DTE	
Debug UART Port	RXD_DBG	38	Receive data from TXD of DTE	
	TXD_DBG	39	Transmit data to RXD of DTE	
Auxiliary UART Port	RXD_AUX	28	Receive data from TXD of DTE	
	TXD_AUX	29	Transmit data to RXD of DTE	
Ring Indication Signal	RI	20	Ring indication signal (when there is a SMS or URC output, the module will inform DTE with the RI pin)	

NOTE

When the module enters idle mode with a fixed baud rate, please send **AT** via UART to wake up the module first before sending other AT commands.

3.9.1. Main UART Port

The main UART port supports AT command communication, data transmission and firmware upgrade.

- By default, the module is in auto-baud mode and it supports automatic baud rates not exceeding 115200bps. When powering on the module, the MCU has to send **AT** command consecutively to synchronize baud rate with the module. When **OK** is returned, it indicates the baud rate has been synchronized successfully. When the module is woken up from PSM or idle mode, the baud rate synchronized during start-up will be used directly.
- When the port is used for firmware upgrade, the baud rate is 921600bps by default.

The figure below shows the connection between DCE and DTE.

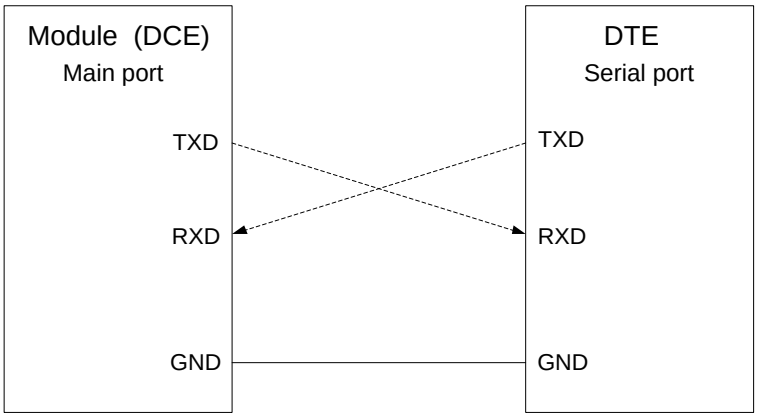


Figure 16: Reference Design for Main UART Port

3.9.2. Debug UART Port

Through debug tools, the debug UART port can be used to output logs for firmware debugging. Its baud rate is 115200bps by default. The following is a reference design of debug UART port.

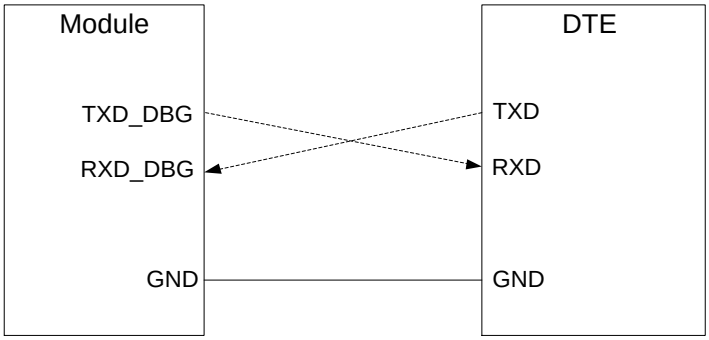


Figure 17: Reference Design of Debug UART Port

3.9.3. Auxiliary UART Port

The auxiliary UART port is designed as a general purpose UART for communication with DTE. It also supports log output for firmware debugging, and hardware flow control*. Its baud rate is 115200bps by

default. The following is a reference design of auxiliary UART port.

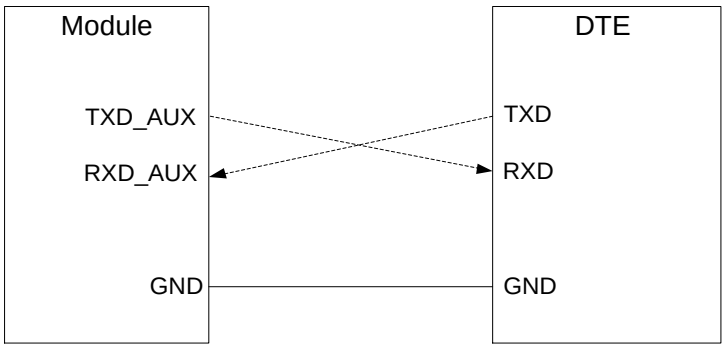


Figure 18: Reference Design of Auxiliary UART Port

3.9.4. UART Application

The module provides 1.8V UART interfaces. A level translator should be used if the application is equipped with a 3.3V UART interface. A level translator TXS0108EPWR provided by *Texas Instruments* (please visit http://www.ti.com for more information) is recommended. The following figure shows a reference design.

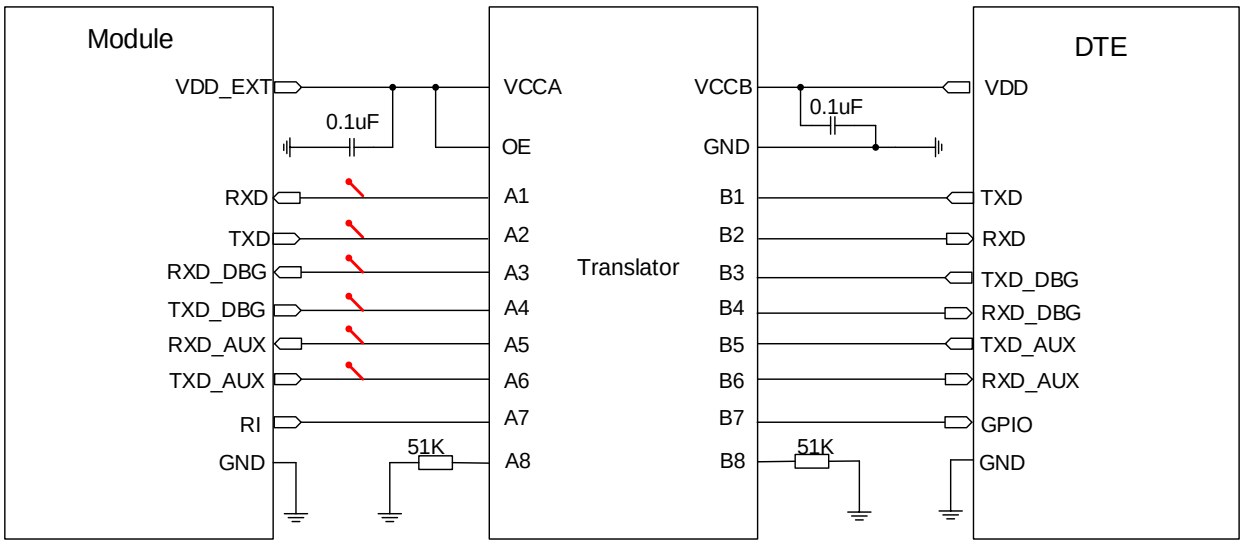


Figure 19: Reference Circuit with Voltage Level Translator Chip

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

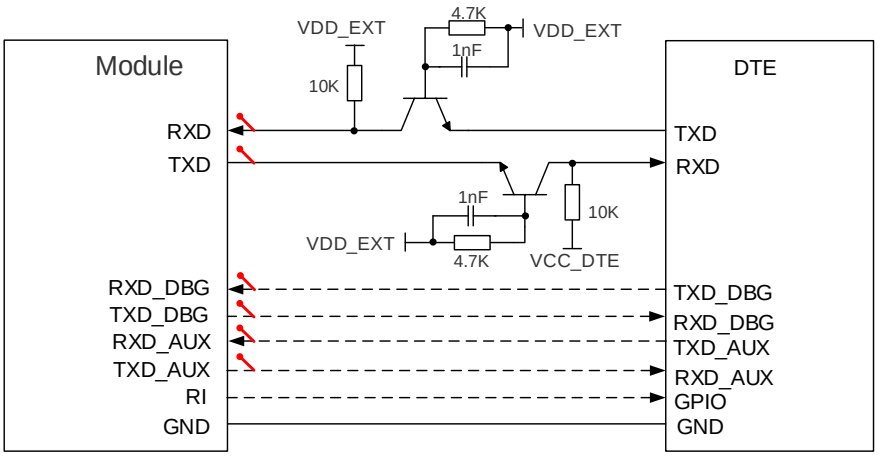


Figure 20: Reference Circuit with Transistor Circuit

The following circuit shows a reference design for the communication between the module and a PC with standard RS-232 interface. Please make sure the I/O voltage of level shifter which connects to module is 1.8V.

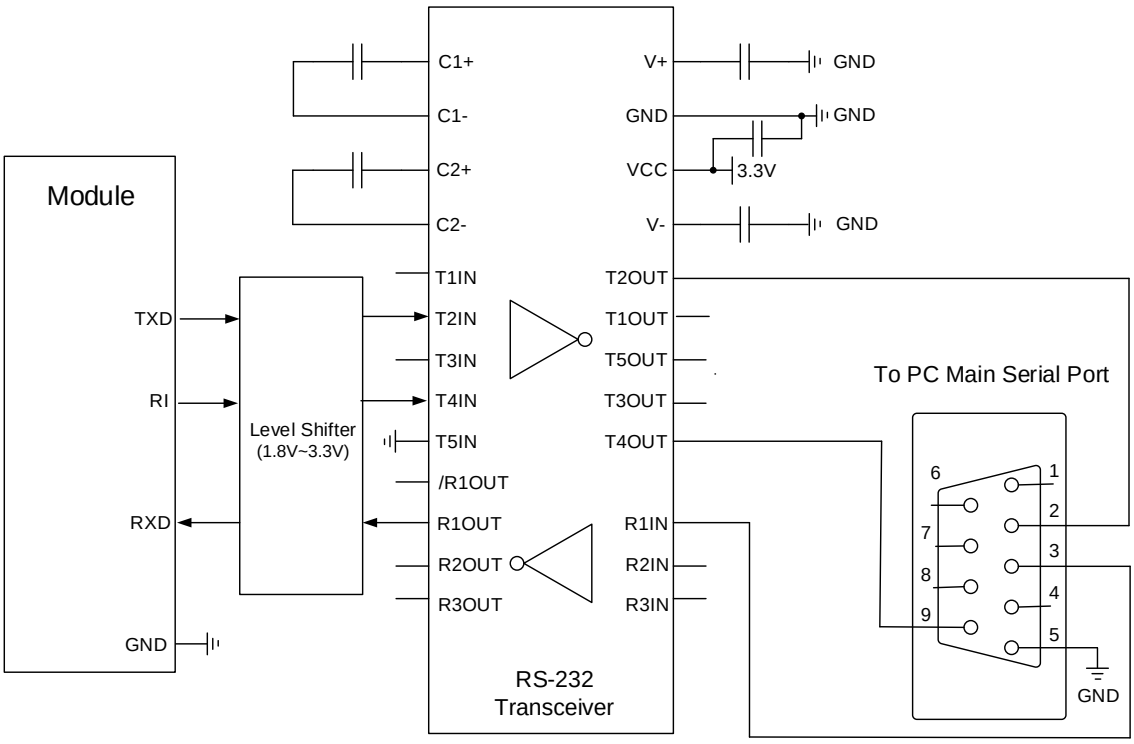


Figure 21: Sketch Map for RS-232 Interface Match

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

NOTES

1. Transistor circuit solution is not suitable for applications with high baud rates exceeding 460Kbps.
2. "" represents the test point of UART interfaces. It is also recommended to reserve the test points of VBAT and PWRKEY, for convenient firmware upgrade and debugging when necessary.
3. "*" means under development.

3.10. USIM Interface

The module provides a USIM interface compliant to ISO/IEC 7816-3, enabling the module to access to an external 1.8V USIM card.

The external USIM card is powered by an internal regulator in the module and supports 1.8V power supply.

Table 11: Pin Definition of USIM Interface

Pin Name	Pin No.	Description	Comment
SIM_VDD	14	Power supply for USIM card	Voltage accuracy: 1.8V±5%. Maximum supply current: about 60mA.
SIM_CLK	13	Clock signal of USIM card	
SIM_DATA	11	Data signal of USIM card	
SIM_RST	12	Reset signal of USIM card	
SIM_GND	10	Specified ground for USIM card	

A reference circuit design for USIM interface with a 6-pin USIM card connector is illustrated below.

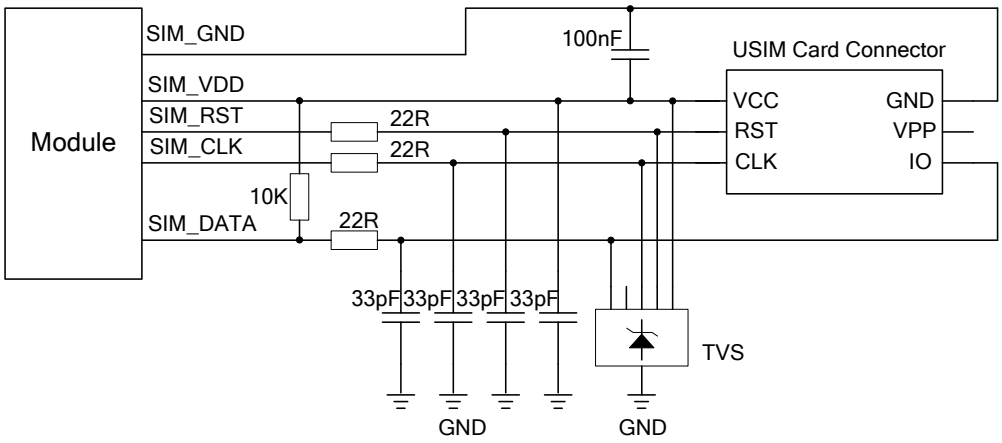


Figure 22: Reference Circuit for USIM Interface with a 6-pin USIM Card Connector

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

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

- Keep the placement of USIM card connector as close as possible to the module. Keep the trace length as less than 200mm as possible.
- Keep USIM card signals away from RF and VBAT traces.
- Assure the trace between the ground of module and that of USIM card connector is short and wide. Keep the trace width of ground no less than 0.5mm to maintain the same electric potential. The decouple capacitor between SIM_VDD and GND should be not more than 1μF and be placed close to the USIM card connector.
- To avoid cross talk between SIM_DATA and SIM_CLK, keep them away from each other and shield them separately with surrounded ground.
- 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 ESD protection device should be placed as close to USIM card connector as possible, and make sure the USIM card signal lines go through the ESD protection device first and then 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 signal traces to improve EMI suppression.

3.11. ADC Interface*

The module provides a 10-bit ADC input channel to read the voltage value. The interface is available in active mode, and has to be woken up first to ensure availability in sleep modes.

Table 12: Pin Definition of ADC Interface

Pin Name	Pin No.	Description	Sample Range
ADC0*	9	Analog to digital converter interface	0V ~ 1.4V

NOTE

"*" means under development.

3.12. RI Behaviors

When there is a message received or URC output, the module will notify DTE through RI pin.

Table 13: RI Signal Status

Module Status	RI Signal Level
Idle	RI keeps in high level
SMS	When an SMS is received, RI outputs 120ms low pulse first and then changes to high level and starts data output.
URC	When URC is incoming, RI outputs 120ms low pulse first and then changes to high level and starts data output.

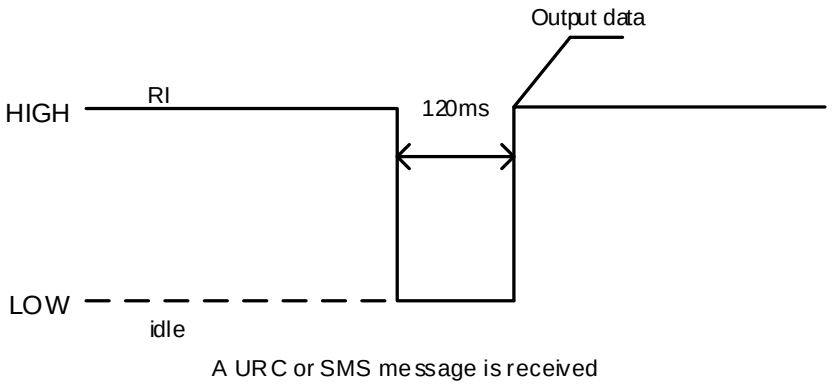


Figure 23: Behaviors of RI When a URC or SMS Message is Received

3.13. Network Status Indication

The NETLIGHT signal can be used to indicate the network status of the module. The following table illustrates the module status indicated by NETLIGHT.

Table 14: Module Status Indicated by NETLIGHT

NETLIGHT Level	Module Status
Always Low (LED OFF)	The module is not working or in idle/PSM mode
64ms High (LED ON)/800ms Low (LED OFF)	Network searching
64ms High (LED ON)/2000ms Low (LED OFF)	Network connected

A reference circuit is shown as below.

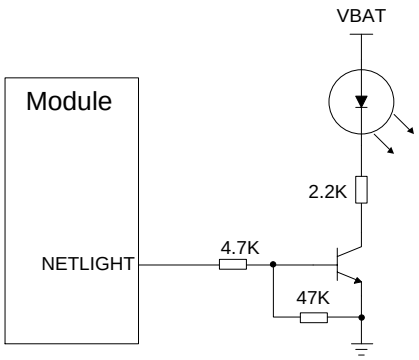


Figure 24: Reference Design of NETLIGHT

4 Antenna Interface

The pin 35 is the RF antenna pad. The antenna port has an impedance of 50Ω.

4.1. Pin Definition

Table 15: Pin Definition of NB-IoT Antenna Interface

Pin Name	Pin No.	Description
RF_ANT	35	RF antenna interface
GND	34, 36, 37	Ground

4.2. Operating Frequencies

Table 16: Module Operating Frequencies

Frequency Band	Receiving Frequency	Transmitting Frequency
B1	2110MHz~2170MHz	1920MHz~1980MHz
B2	1930MHz~1990MHz	1850MHz~1910MHz
B3	1805MHz~1880MHz	1710MHz~1785MHz
B4	2110MHz~2155MHz	1710MHz~1755MHz
B5	869MHz~894MHz	824MHz~849MHz
B8	925MHz~960MHz	880MHz~915 MHz
B12	729MHz~746MHz	699MHz~716MHz
B13	746MHz~756MHz	777MHz~787MHz

B17	734MHz~746MHz	704MHz~716MHz
B18	860MHz~875MHz	815MHz~830MHz
B19	875MHz~890MHz	830MHz~845MHz
B20	791MHz~821MHz	832MHz~862MHz
B25	1930MHz~1995MHz	1850MHz~1915MHz
B26*	859MHz~894MHz	814MHz~849MHz
B28	758MHz~803MHz	703MHz~748MHz
B66	2110MHz~2200MHz	1710MHz~1780MHz

NOTE

"*" means under development.

4.3. RF Antenna Reference Design

BC66 provides an RF antenna pad for external NB-IoT antenna connection.

- The RF trace on host PCB connected to the module's RF antenna pad should be coplanar waveguide or microstrip, whose characteristic impedance should be close to 50Ω.
- BC66 comes with ground pads which are next to the antenna pad in order to give a better grounding.
- In order to achieve better RF performance, 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 0Ω resistor is mounted on R1.

A reference design of the RF interface is shown as below.

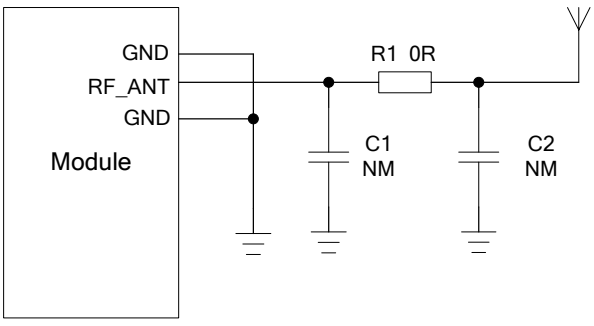


Figure 25: Reference Design of NB-IoT Antenna Interface

4.4. 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 height 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.

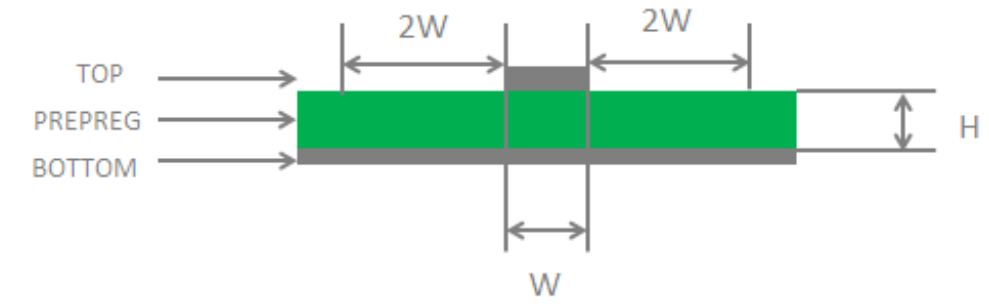


Figure 26: Microstrip Line Design on a 2-layer PCB

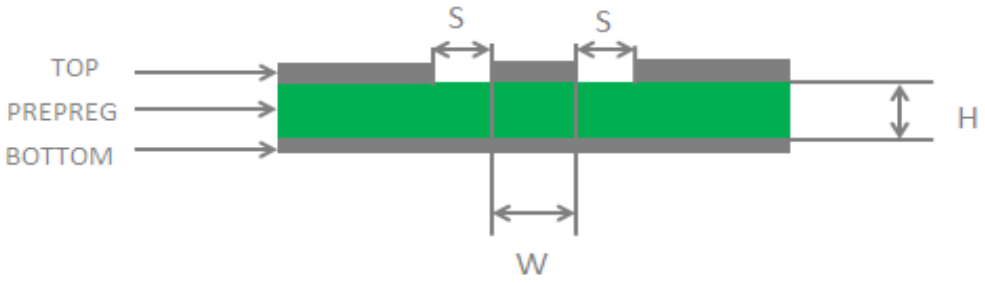


Figure 27: Coplanar Waveguide Line Design on a 2-layer PCB

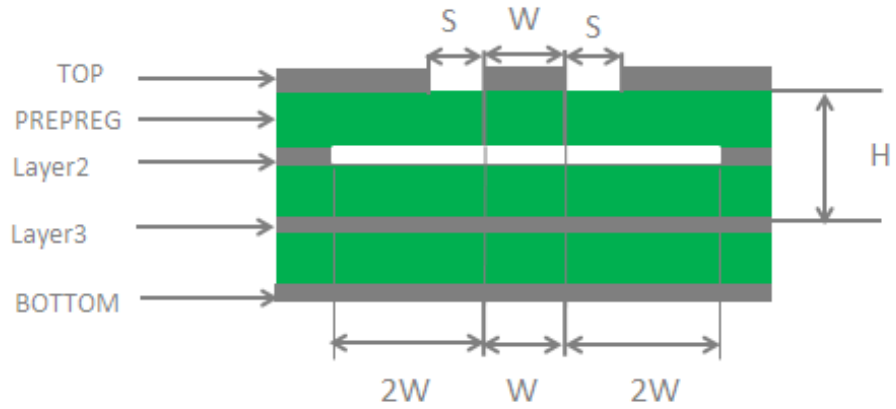


Figure 28: Coplanar Waveguide Line Design on a 4-layer PCB (Layer 3 as Reference Ground)

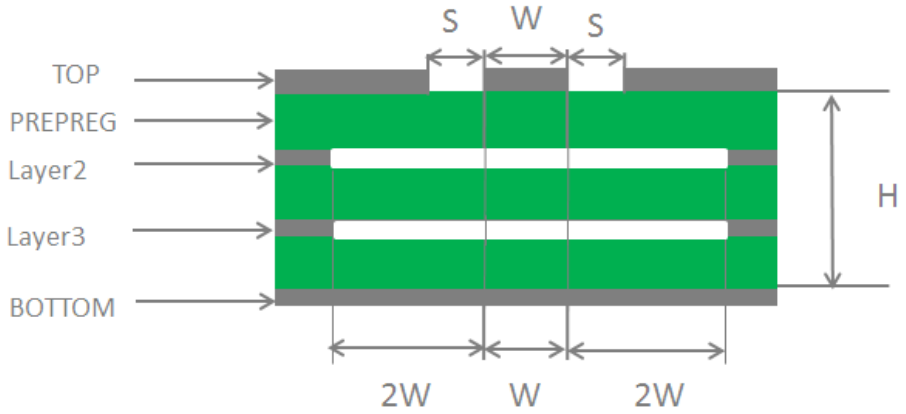


Figure 29: Coplanar Waveguide Line Design on a 4-layer PCB (Layer 4 as Reference Ground)

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, please refer to ***document [2]***.

4.5. 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 NB-IoT antenna.

Table 17: Antenna Cable Insertion Loss Requirements

Band	Requirements
LTE B5/B8/B12/B13/B17/B18/B19/B20/B26*/B28	Cable Insertion loss: <1dB
LTE B1/B2/B3/B4/B25/B66	Cable Insertion loss: <1.5dB

NOTE

"*" means under development.

Table 18: Required Antenna Parameters

Parameters	Requirements
Frequency Range	699MHz~2200MHz
VSWR	≤2
Efficiency	> 30%
Max Input Power (W)	50
Input Impedance (Ω)	50

4.6. RF Output Power

Table 19: RF Conducted Output Power

Frequency Band	Max.	Min.
B1	23dBm±2dB	<-39dBm
B2	23dBm±2dB	<-39dBm
B3	23dBm±2dB	<-39dBm
B4	23dBm±2dB	<-39dBm
B5	23dBm±2dB	<-39dBm
B8	23dBm±2dB	<-39dBm
B12	23dBm±2dB	<-39dBm
B13	23dBm±2dB	<-39dBm
B17	23dBm±2dB	<-39dBm
B18	23dBm±2dB	<-39dBm
B19	23dBm±2dB	<-39dBm
B20	23dBm±2dB	<-39dBm
B25	23dBm±2dB	<-39dBm
B26*	TBD	TBD
B28	23dBm±2dB	<-39dBm
B66	23dBm±2dB	<-39dBm

NOTES

1. The design conforms to the NB-IoT radio protocols in *3GPP Rel.13* and *3GPP Rel.14*.
2. "*" means under development.

4.7. RF Receiving Sensitivity

Table 20: Receiving Sensitivity (with RF Retransmissions)

Frequency Band	Receiving Sensitivity
B1	-129dBm
B2	-129dBm
B3	-129dBm
B4	-129dBm
B5	-129dBm
B8	-129dBm
B12	-129dBm
B13	-129dBm
B17	-129dBm
B18	-129dBm
B19	-129dBm
B20	-129dBm
B25	-129dBm
B26*	TBD
B28	-129dBm
B66	-129dBm

NOTE

"*" means under development.

4.8. Recommended RF Connector for Antenna Installation

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

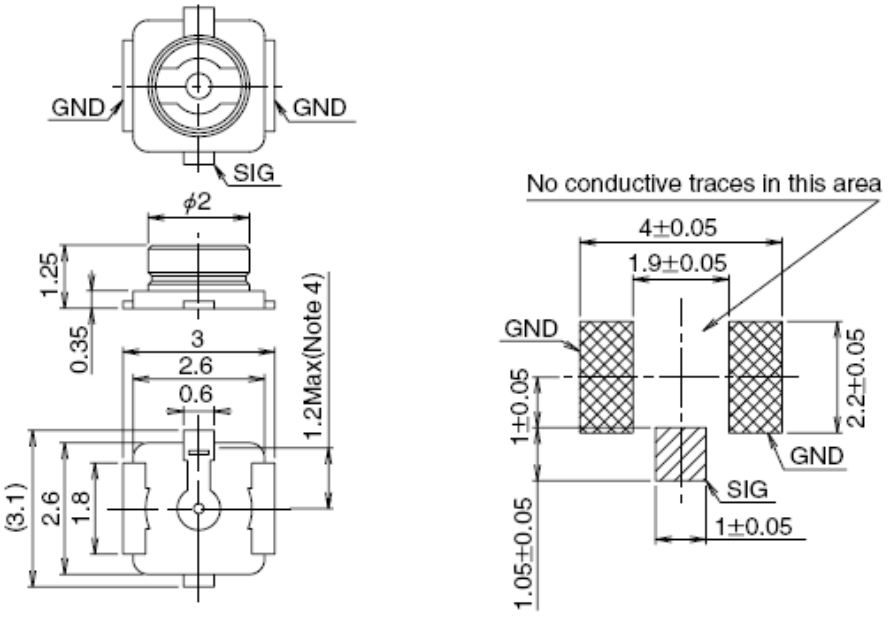


Figure 30: Dimensions of the U.FL-R-SMT Connector (Unit: mm)

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

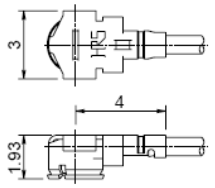
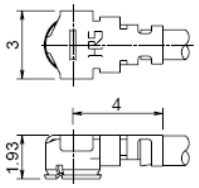
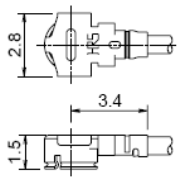
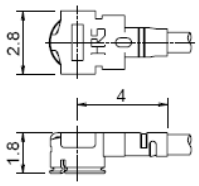
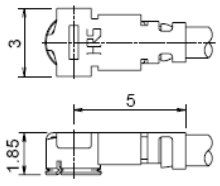
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia. 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 31: Mechanicals of U.FL-LP Connectors

The following figure describes the space factor of mated connector.

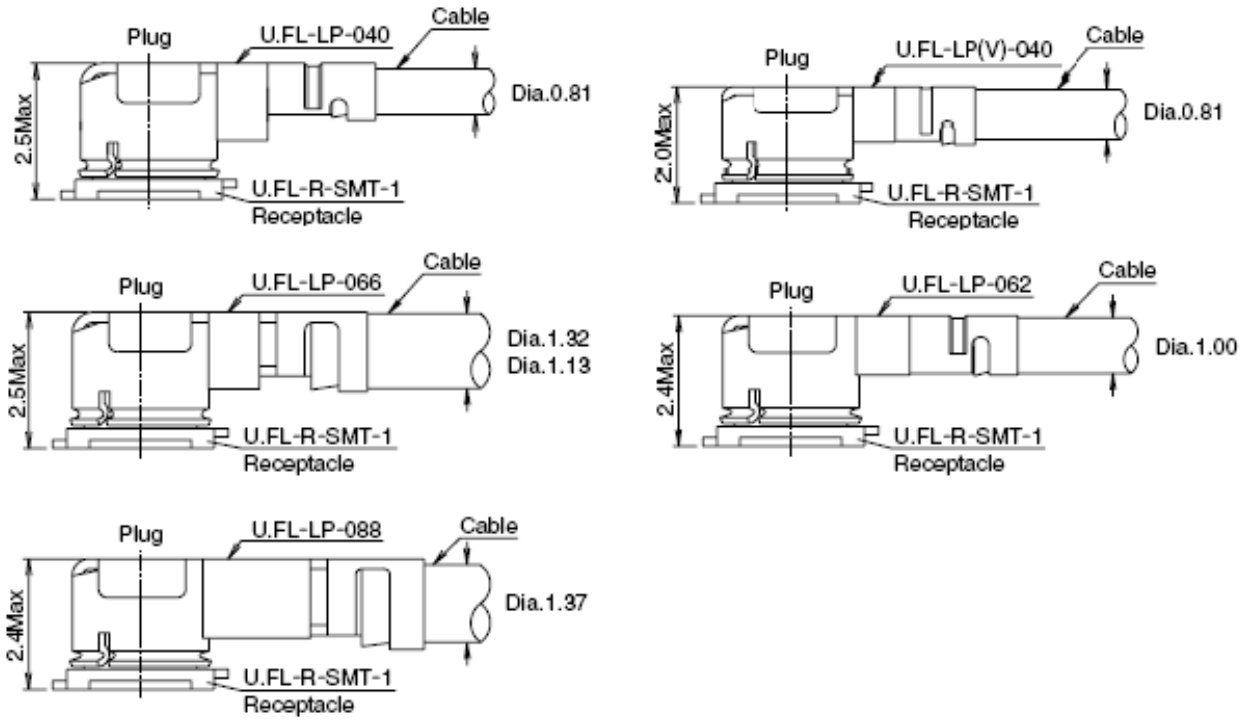


Figure 32: Space Factor of Mated Connector (Unit: mm)

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

5 Electrical and Reliability Characteristics

5.1. Operation and Storage Temperatures

The following table lists the operation and storage temperatures of BC66.

Table 21: Operation and Storage Temperatures

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 normal operation temperature levels, the module will meet 3GPP specifications again.

5.2. Current Consumption

The table below lists the current consumption of BC66 under different states.

Table 22: Module Current Consumption (3.3V VBAT Power Supply)

Parameter	Mode	Description		Min.	Typ.	Max. [2]	Unit
I_{VBAT}	PSM	Sleep mode			3.5		μA
	Idle	eDRX=81.92s, PTW=40.96s			288		μA
		@DRX=1.28s			541		μA
		@DRX=2.56s			434		μA
	Connected [1]	Single-tone (15kHz subcarrier spacing)	B1 @23dBm		100	285	mA
			B2 @23dBm		103	294	mA
			B3 @23dBm		107	308	mA
			B4 @23dBm		107	307	mA
			B5 @23dBm		107	303	mA
			B8 @23dBm		113	325	mA
			B12 @23dBm		134	393	mA
			B13 @23dBm		111	319	mA
			B17 @23dBm		133	392	mA
			B18 @23dBm		110	316	mA
			B19 @23dBm		109	311	mA
			B20 @23dBm		109	301	mA
			B25 @23dBm		103	293	mA
			B26* @23dBm		TBD	TBD	mA
			B28 @23dBm		128	375	mA
			B66 @23dBm		109	312	mA
		Single-tone (3.75kHz subcarrier spacing)	B1 @23dBm		193	302	mA
			B2 @23dBm		187	296	mA
			B3 @23dBm		215	335	mA

	B4 @23dBm	237	311	mA
	B5 @23dBm	215	330	mA
	B8 @23dBm	224	344	mA
	B12 @23dBm	250	395	mA
	B13 @23dBm	203	316	mA
	B17 @23dBm	258	409	mA
	B18 @23dBm	198	313	mA
	B19 @23dBm	198	314	mA
	B20 @23dBm	215	329	mA
	B25 @23dBm	187	297	mA
	B26* @23dBm	TBD	TBD	mA
	B28 @23dBm	250	398	mA
	B66 @23dBm	200	316	mA

NOTES

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

5.3. Electrostatic Discharge

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

The following table shows the module’s electrostatic discharge characteristics.

Table 23: Electrostatic Discharge Characteristics (25ºC, 45% Relative Humidity)

Test	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 millimetre (mm), and the tolerances for dimensions without tolerance values are ±0.05mm.

6.1. Mechanical Dimensions of the Module

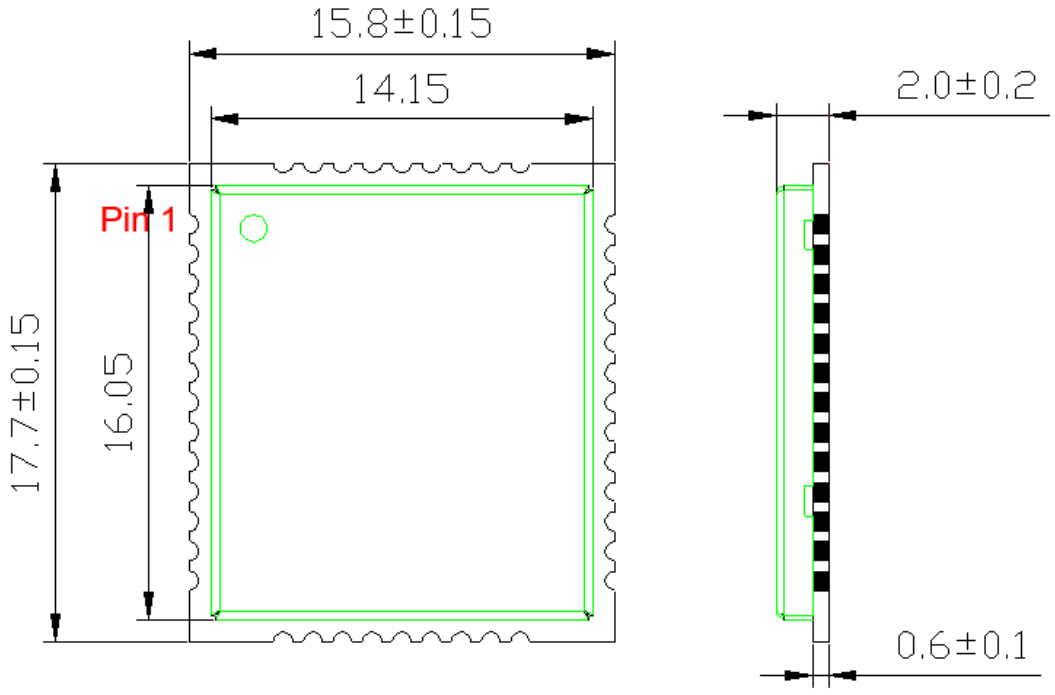


Figure 31: BC66 Top and Side Dimensions (Unit: mm)

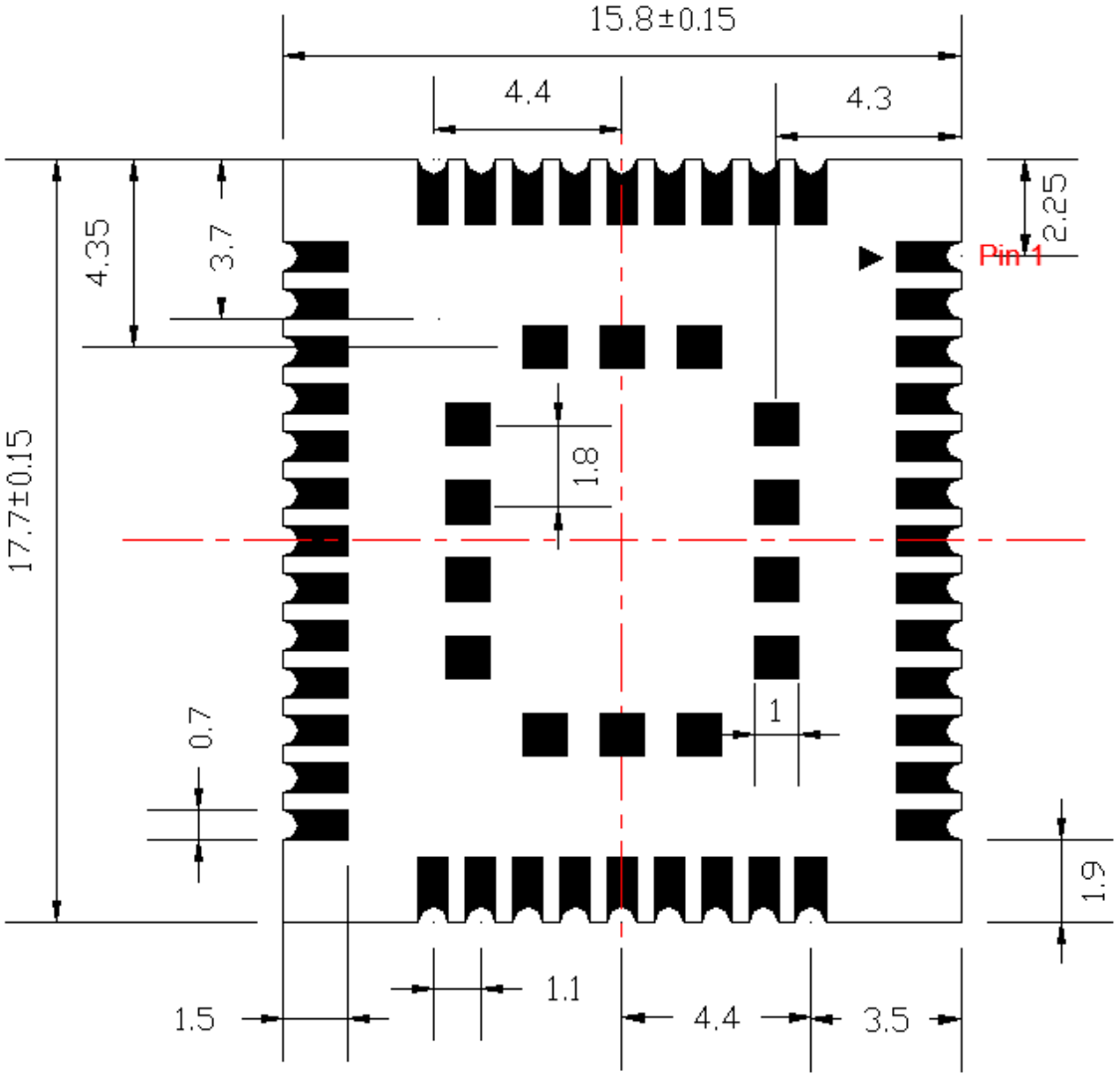


Figure 32: Module Bottom Dimension (Bottom View)

6.2. Recommended Footprint

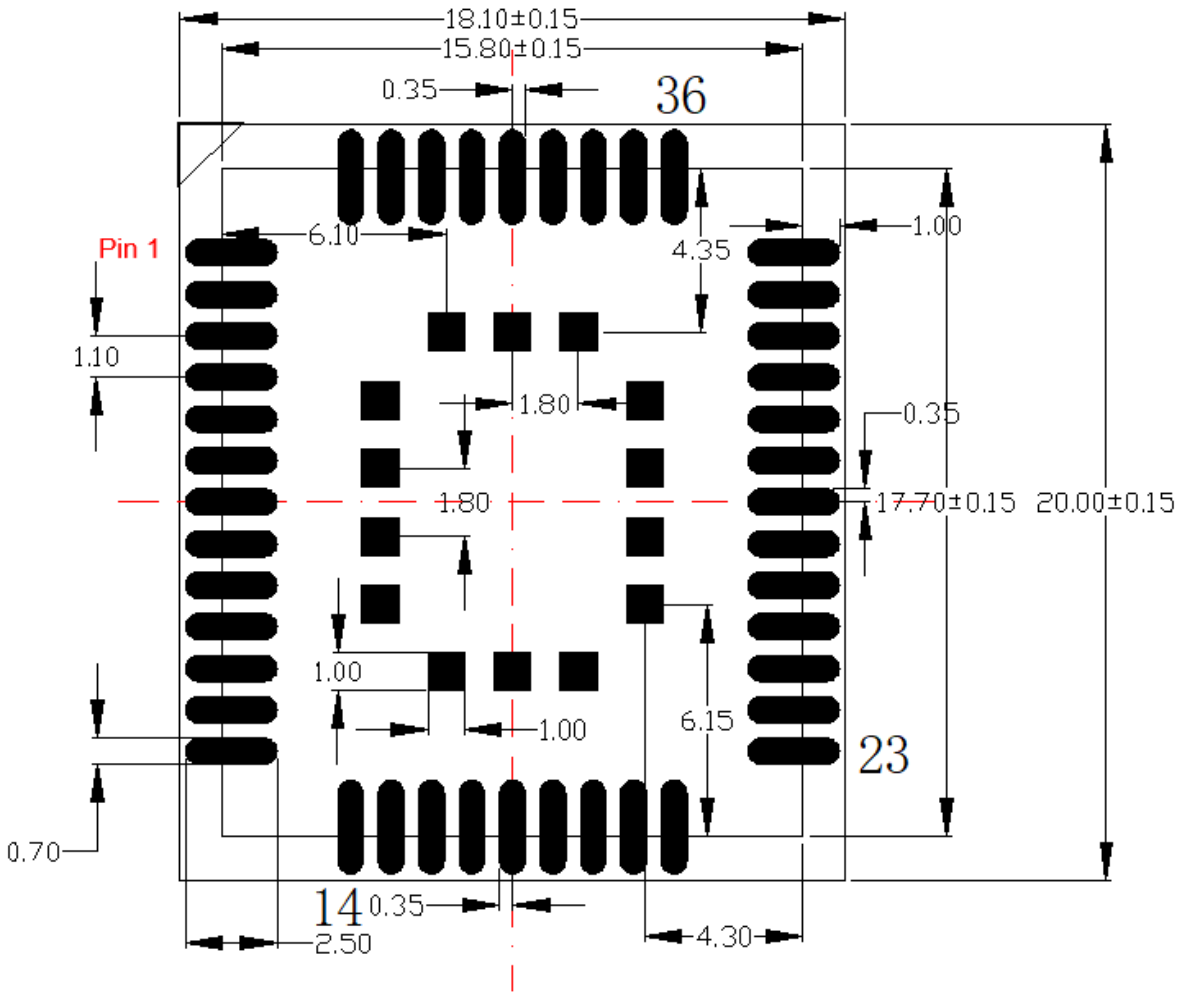


Figure 33: Recommended Footprint (Unit: mm)

NOTE

The module should be kept about 3mm away from other components on the host PCB.

6.3. Top and Bottom Views of the Module

Figure 33: Top View of the Module

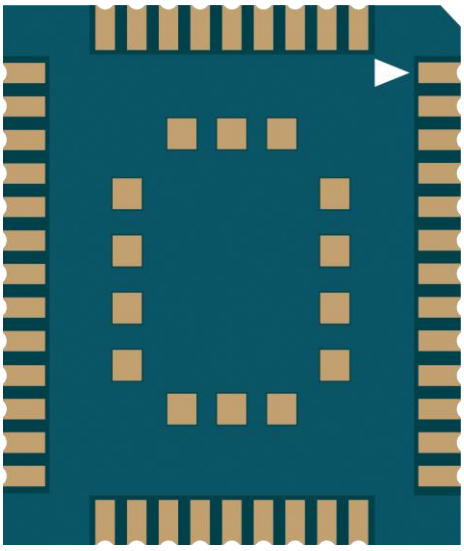


Figure 34: Bottom View of the Module

NOTE

These are renderings of BC66 module. For authentic appearance, please refer to the module that you receive from Quectel.

7 Storage, Manufacturing and Packaging

7.1. Storage

BC66 module is stored in a vacuum-sealed bag. It is rated at MSL 3, and 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%.

4. If baking is required, devices may be baked for 8 hours at 120ºC±5ºC.

NOTE

As the plastic package cannot be subjected to high temperature, it should be removed from devices before high temperature (120ºC) baking. If shorter baking time is desired, please refer to *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 0.18mm~0.20mm. For more details, please refer to ***document [4]***.

It is suggested that the peak reflow temperature is 238~245ºC, and the absolute maximum reflow temperature is 245ºC. 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.

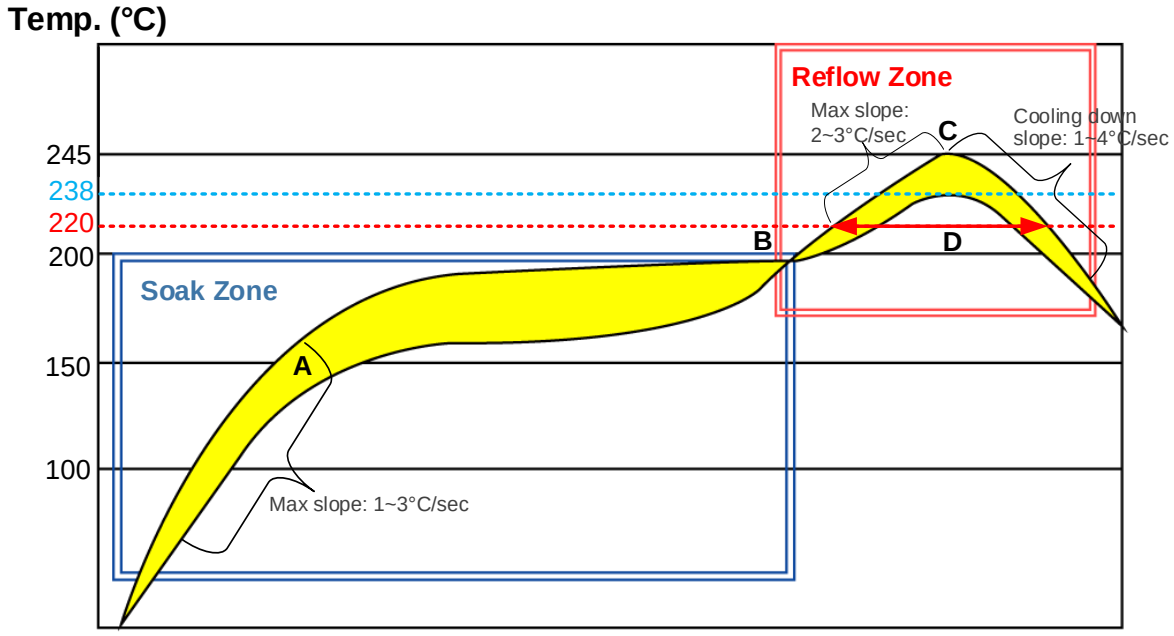


Figure 36: Recommended Reflow Soldering Thermal Profile

Table 24: Recommended Thermal Profile Parameters

Factor	Recommendation
Soak Zone	
Max slope	1 to 3°C/sec
Soak time (between A and B: 150°C and 200°C)	60 to 120 sec

Reflow Zone	
Max slope	2 to 3°C/sec
Reflow time (D: over 220°C)	40 to 60 sec
Max temperature	238°C ~ 245°C
Cooling down slope	1 to 4°C/sec
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 can 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

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

7.3.1. Tape and Reel Packaging

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

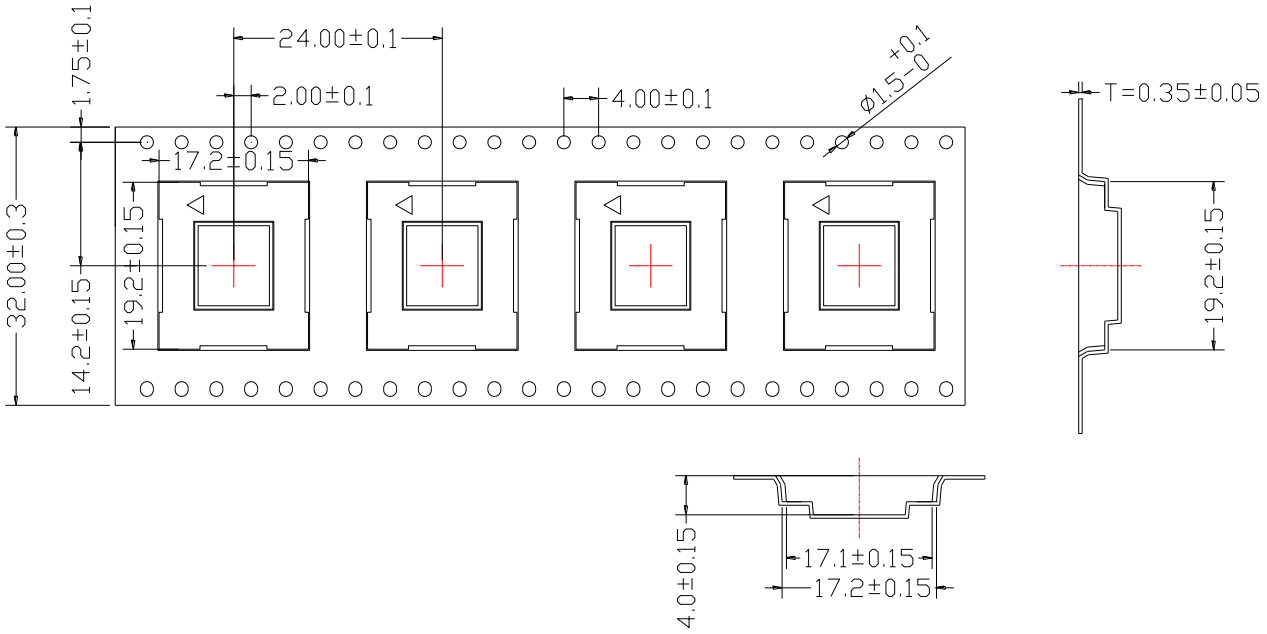


Figure 35: Tape Dimensions (Unit: mm)

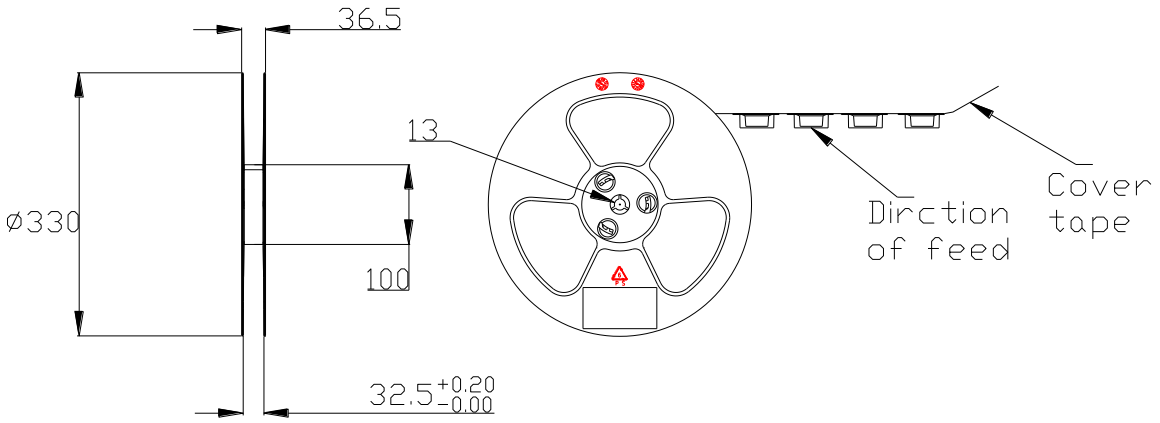


Figure 36: Reel Dimensions (Unit: mm)

8 Appendix A References

Table 25: Related Documents

SN	Document Name	Remark
[1]	Quectel_BC66-TE-B_User_Guide	BC66-TE-B User Guide
[2]	Quectel_RF_Layout_Application_Note	RF Layout Application Note
[3]	Quectel_BC66_AT_Commands_Manual	BC66 AT Commands Manual
[4]	Quectel_Module_Secondary_SMT_User_Guide	Module Secondary SMT User Guide

Table 26: Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
CoAP	Constrained Application Protocol
DCE	Data Communications Equipment (typically module)
DTE	Data Terminal Equipment (typically computer, external controller)
DTLS	Datagram Transport Layer Security
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
FTP	File Transfer Protocol
H-FDD	Half Frequency Division Duplexing
HTTP	Hyper Text Transfer Protocol
HTTPS	Hyper Text Transfer Protocol over Secure Socket Layer
I/O	Input/Output

kbps	Kilo Bits Per Second
LED	Light Emitting Diode
Li-MnO2	Lithium-manganese Dioxide
Li-2S	Lithium Sulfur
LTE	Long Term Evolution
LwM2M	Lightweight M2M
MQTT	Message Queuing Telemetry Transport
NB-IoT	Narrow Band- Internet of Things
PCB	Printed Circuit Board
PDU	Protocol Data Unit
PPP	Point-to-Point Protocol
PSM	Power Save Mode
RF	Radio Frequency
RTC	Real Time Clock
RXD	Receive Data
SMS	Short Message Service
SSL	Secure Sockets Layer
TCP	Transmission Control Protocol
TE	Terminal Equipment
TXD	Transmitting Data
UART	Universal Asynchronous Receiver & Transmitter
UDP	User Datagram Protocol
URC	Unsolicited Result Code
USIM	Universal Subscriber Identification Module
VSWR	Voltage Standing Wave Ratio

Vmax	Maximum Voltage Value
Vnorm	Normal Voltage Value
Vmin	Minimum Voltage Value
V_{IH}max	Maximum Input High Level Voltage Value
V_{IH}min	Minimum Input High Level Voltage Value
V_{IL}max	Maximum Input Low Level Voltage Value
V_{IL}min	Minimum Input Low Level Voltage Value
$V_I$max	Absolute Maximum Input Voltage Value
$V_I$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