BC66-NA

Hardware Design

NB-IoT Module Series

Version: 1.1

Date: 2021-12-15

Status: Released

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Quectel Wireless Solutions Co., Ltd.
Building 5, Shanghai Business Park Phase III (Area B), No.1016 Tianlin Road, Minhang District, Shanghai 200233, China
Tel: +86 21 5108 6236
Email: info@quectel.com

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Safety Information

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

	Full attention must be paid to driving at all times in order to reduce the risk of an accident. Using a mobile while driving (even with a handsfree kit) causes distraction and can lead to an accident. Please comply with laws and regulations restricting the use of wireless devices while driving.
	Switch off the cellular terminal or mobile before boarding an aircraft. The operation of wireless appliances in an aircraft is forbidden to prevent interference with communication systems. If there is an Airplane Mode, it should be enabled prior to boarding an aircraft. Please consult the airline staff for more restrictions on the use of wireless devices on an aircraft.
	Wireless devices may cause interference on sensitive medical equipment, so please be aware of the restrictions on the use of wireless devices when in hospitals, clinics or other healthcare facilities.
	Cellular terminals or mobiles operating over radio signal and cellular network cannot be guaranteed to connect in certain conditions, such as when the mobile bill is unpaid or the (U)SIM card is invalid. When emergency help is needed in such conditions, use emergency call if the device supports it. In order to make or receive a call, the cellular terminal or mobile must be switched on in a service area with adequate cellular signal strength. In an emergency, the device with emergency call function cannot be used as the only contact method considering network connection cannot be guaranteed under all circumstances.
	The cellular terminal or mobile contains a transceiver. When it is ON, it receives and transmits radio frequency signals. RF interference can occur if it is used close to TV sets, radios, computers or other electric equipment.
	In locations with explosive or potentially explosive atmospheres, obey all posted signs and turn off wireless devices such as mobile phone or other cellular terminals. Areas with explosive or potentially explosive atmospheres include fuelling areas, below decks on boats, fuel or chemical transfer or storage facilities, and areas where the air contains chemicals or particles such as grain, dust or metal powders.

About the Document

Revision History

Version	Date	Author	Description
-	2019-11-05	Speed SUN/ Lewis SHEN/ Allan LIANG	Creation of the document
1.0	2019-11-05	Speed SUN/ Lewis SHEN/ Allan LIANG	First official release
1.1	2021-12-15	Clifton HE/ Henry Qi/ Randy LI	1. Optimized the overall chapter structure of this document. 2. Updated the application protocols and added the eSIM feature (Chapter 2.2). 3. Optimized the description of the module operating modes (Chapter 3.3). 4. Added the way of waking up from deep sleep mode and updated the wake-up sequence diagram (Chapter 3.4). 5. Added the way of module reset by software (Chapter 3.7). 6. Optimized the USB interface related description and updated the circuit diagram (Chapter 3.13). 7. Added the absolute maximum ratings table (Table 25). 8. Optimized the module current consumption table and updated some relevant values therein (Table 27). 9. Added digital logic level characteristics tables (Chapter 5.4). 10. Added a corner mark of the module (Figure 32, Figure 33). 11. Updated the information of the module mechanical dimension and dimensional tolerances. (Chapter 6). 12. Updated the storage conditions of the module (Chapter 7.1). 13. Updated the recommended control requirements of the

	furnace temperature test (Chapter 7.2). 14. Updated the packaging information (Chapter 7.3).

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1 Introduction

This document defines BC66-NA module and describes its air interface and hardware interfaces which are connected with your applications.

With this document, you can quickly understand module interface specifications, electrical and mechanical details, as well as other related information of the module. The document, coupled with application notes and user guides, makes it easy to design and set up mobile applications with the module.

1.1. Special Mark

Table 1: Special Mark

Mark	Definition
*	Unless otherwise specified, when an asterisk (*) is used after a function, feature, interface, pin name, command, or argument, it indicates that the function, feature, interface, pin, AT command, or argument is under development and currently not supported; and the asterisk (*) after a model indicates that the sample of such model is currently unavailable.

2 Product Overview

2.1. General Description

BC66-NA 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-NA supports a broad range of frequency bands as listed below.

Table 2: Frequency Bands of BC66-NA Module

Mode	Frequency Bands
LTE HD-FDD	B1/B2/B3/B4/B5/B8/B12/B13/B17/B18/B19/B20/B25/B26*/B28/B66/B71/B85

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

BC66-NA 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-NA 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.

2.2. Key Features

The following table describes the detailed features of BC66-NA module.

Table 3: Key Features

Feature	Details
Power Supply	● Supply voltage: 2.1–3.63 V ● Typical supply voltage: 3.3 V
Power Saving	Typical power consumption: 3.5 μA
Frequency Bands	**LTE Cat NB2:** B1/B2/B3/B4/B5/B8/B12/B13/B17/B18/B19/B20/B25/B26*/B28/B66/B71/B85
Transmitting Power	23 dBm ±2 dB
USIM Interface	Supports 1.8 V USIM card
USB Interface	● Conforms to *USB 1.1* specifications, with maximum data transfer rate up to 12 Mbps ● Used for debugging and upgrading ● Supports 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 115200 bps. When powering on the module, the MCU has to send **AT** commands consecutively to synchronize the 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 deep sleep mode, the baud rate synchronized during start-up will be used directly. ● Used for firmware upgrade, and in such case, the baud rate is 921600 bps by default. **Debug UART Port:** ● Used for debugging ● Default baud rate: 115200 bps **Auxiliary UART Port:** ● Used for debugging ● Default baud rate: 115200 bps
Network Protocols	UDP/TCP/LwM2M/MQTT(S)/SNTP/TLS/DTLS*/PPP*/CoAP(S)*/HTTP(S)*
SMS*	Text/PDU Mode

Data Transmission Features	● Single-tone: Max. 103 kbps (DL)/18 kbps (UL) ● Multi-tone: Max. 103 kbps (DL)/151 kbps (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	● Main UART ● USB ● DFOTA
Real Time Clock	Supported
Physical Characteristics	● Size: (17.7 ±0.15) mm × (15.8 ±0.15) mm × (2.0 ±0.2) mm ● Weight: 1.2 ±0.2 g
Temperature Range	● Operating temperature range: -35 °C to +75 °C [1] ● Extended temperature range: -40 °C to +85 °C [2] ● Storage temperature range: -40 °C to +90 °C
Antenna Interface	50 Ω impedance control
eSIM	Reserves eSIM chip location [3]
RoHS	All hardware components are fully compliant with EU RoHS directive

[1] Within operating temperature range, the module is 3GPP compliant.
[2] Within extended temperature range, the module maintains functions such as SMS* and data transmission, without any unrecoverable malfunction. Radio spectrum and radio network will not be influenced, while one or more specifications, such as Pout, may exceed the specified tolerances of 3GPP. When the temperature returns to the normal operating temperature levels, the module will meet 3GPP specifications again.
[3] The built-in eSIM is not included by default; if there are related requirements, a different purchase code will be provided.

2.3. Functional Diagram

The following figure shows a block diagram of BC66-NA and illustrates the major functional parts.

- Radio frequency
- Baseband
- Power management
- Peripheral interfaces

Figure 1: Functional Diagram

2.4. EVB

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

3 Application Interfaces

BC66-NA module 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:

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

3.1. Pin Assignment

Figure 2: Pin Assignment

NOTE

Keep all reserved and unused pins unconnected.

3.2. Pin Description

Table 4: I/O Parameters Definition

Type	Description
AI	Analog Input
AIO	Analog Input/Output
DI	Digital Input
DO	Digital Output
DIO	Digital Input/Output
PI	Power Input
PO	Power Output

Table 5: 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 = 3.63 V Vmin = 2.1 V Vnom = 3.3 V	-
VBAT_RF	43	PI	Power supply for the module's RF part	Vmax = 3.63 V Vmin = 2.1 V Vnom = 3.3 V	-
VDD_EXT	24	PO	1.8 V output power supply	Vnom = 1.8 V	No voltage output in deep sleep mode. It is intended to power 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				
Power Key Interface					

Pin Name	Pin No.	I/O	Description	DC Characteristics	Comment
PWRKEY	7	DI	Turn on the module	V_{IL}max = 0.3 × VBAT V_{IH}min = 0.7 × VBAT	Active low.
Reset Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RESET	15	DI	Reset the module	V_{IL}max = 0.25 × VBAT V_{IH}min = 0.75 × VBAT	Reset pull-down time ≥ 50 ms. 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 deep sleep mode.	V_{IL}max = 0.3 × VBAT V_{IH}min = 0.7 × VBAT	Active on falling edge.
Network Status Indication					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
NETLIGHT	16	DO	Indicate the module's network activity status	-	-
ADC Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
ADC0	9	AI	General-purpose analog to digital converter interface	-	Voltage range: 0–1.4 V. If unused, keep this pin unconnected.
Main UART Port					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
TXD	17	DO	Main UART transmit	-	1.8 V power domain.
RXD	18	DI	Main UART receive	-	
Auxiliary UART Port					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**

RXD_AUX	28	DI	Auxiliary UART receive	-	1.8 V power domain.
TXD_AUX	29	DO	Auxiliary UART transmit	-	
Debug UART Port					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RXD_DBG	38	DI	Debug UART receive	-	1.8 V power domain.
TXD_DBG	39	DO	Debug UART transmit	-	
RI Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RI	20	DO	Ring indication signal	-	1.8 V power domain.
USIM Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
SIM_GND	10	-	Dedicated ground for USIM card	-	-
SIM_DATA	11	DIO	USIM card data	-	-
SIM_RST	12	DO	USIM card reset	-	-
SIM_CLK	13	DO	USIM card clock	-	-
SIM_VDD	14	PO	USIM card power supply	Vnom = 1.8 V	Voltage accuracy: 1.8 V ±5%. Max. supply current: about 60 mA.
Antenna Interface					
Pin Name	**Pin No.**	**I/O**	**Description**	**DC Characteristics**	**Comment**
RF_ANT	35	AIO	RF antenna interface	-	50 Ω 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	Vnom = 3.3 V	-
USB_DP	50	DIO	USB differential data (+)	-	Conform to *USB 1.1* specifications. Request 90 Ω differential impedance.
USB_DM	51	DIO	USB differential data (-)	-	
Reserved Pins					
Pin Name	**Pin No.**				**Comment**
RESERVED	2–6, 8, 21–23, 25, 26, 30–33, 44–46, 48, 52–58				Keep these pins unconnected.

NOTE

Keep all reserved and unused pins unconnected.

3.3. Operating Modes

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

Table 6: Application Processor (AP) Operating Modes

Mode	Description
Normal	In normal mode, the AP tasks are running (AT command communication, etc.).
Idle	When all AP tasks are suspended, the AP enters idle mode.

Table 7: Modem Operating Modes

Mode	Description
Connected	When the network is connected, the module supports data transmission. In such a case, the modem can switch to DRX/eDRX mode.
DRX/eDRX	The modem is in idle mode, and downlink data can be received during PTW only. In

	such a case, the modem can switch to PSM or connected mode.
PSM	In power saving mode, the modem is disconnected from the network and cannot receive any downlink data. In such a case, the modem can switch to connected mode.

Table 8: Module Operating Modes

Mode	Description
Active	When the AP is in normal mode or the modem is in connected mode, the module is active and supports all services and functions. The current consumption in active mode is higher than in sleep modes.
Light Sleep	Generally, when the AP is in idle mode and the modem is in DRX/eDRX mode, the module enters light sleep mode. In such a case, the AP tasks is suspended and the modem receives downlink data only during PTW. In light sleep mode, the current consumption of module is reduced greatly.
Deep Sleep	When the AP is in idle mode and the modem is in PSM mode, the module enters deep sleep mode in which the CPU is powered off and only the 32 kHz RTC clock is working. In deep sleep mode, the current consumption is reduced to the minimum (typically 3.5 μA).

3.4. Deep Sleep

The module consumes extremely low current in deep sleep mode (typical value: 3.5 μA). The main purpose of deep sleep is to reduce the power consumption of the module and prolong the power supply duration of the battery. In this mode, the serial port does not work.

The following figure shows the power consumption of the module in different modes.

Figure 3: Module Power Consumption in Different Modes (Modem)

When the modem remains in PSM or remains out of PTW during DRX/eDRX mode and the AP is in idle mode, the module will enter deep sleep mode.

The procedure of the modem entering PSM is as follows:

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

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

- After the T3412 timer expires, the module will exit from deep sleep mode automatically.
- The user can define an RTC timer. When the RTC timer expires, the module will exit deep sleep mode.
- Lifetime timeout for LwM2M session.
- Pulling down PSM_EINT (falling edge) will wake up the module from deep sleep mode.

The timing of waking up the module from deep sleep mode is illustrated below.

Figure 4: Timing of Waking Up the Module from Deep Sleep

NOTE

1. Among all GPIO interrupts, only the dedicated external interrupt pin PSM_EINT can successfully wake up the module from deep sleep mode. Other general-purpose GPIO interrupts cannot wake up the module from deep sleep mode.
2. When the eDRX cycle exceeds 82 s, the module enters deep sleep mode after PTW while the AP remains in idle mode.

3. When **AT+CFUN=0**, the module enters deep sleep mode while the AP remains in idle mode.
4. In OOS stage (default searching intervals: 5 s/10 s/10 s/1 s/120 s/7200 s/7200 s/…), the module enters sleep mode initially and then enters deep sleep mode after an interval of 1 s if there is no network or high-priority EARFCN found.

3.5. Power Supply

3.5.1. Power Supply Pins

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

Table 9: Power Supply Pins

Pin Name	Pin No.	I/O	Description	Min.	Typ.	Max.	Unit
VBAT_BB	42	PI	Power supply for the module's baseband part	2.1	3.3	3.63	V
VBAT_RF	43	PI	Power supply for the module's RF part	2.1	3.3	3.63	V
GND	1, 27, 34, 36, 37, 40, 41		GND	-	0	-	V

3.5.2. Reference Design for Power Supply

Power design for a module is critical to its performance. It is recommended to use a low quiescent current power management chip with output current capacity of 0.8 A as the power supply for BC66-NA. Lithium-thionyl chloride (Li-SOCl2) batteries and Lithium manganese oxide (LiMn2O4) batteries can be used as the power supply. The supply voltage of the module ranges from 2.1 V to 3.63 V. When the module is working, ensure its input voltage never drops below 2.1 V; otherwise, the module cannot work normally.

For better power performance, it is recommended to place a 100 μF tantalum capacitor with low ESR (ESR = 0.7 Ω) and three ceramic capacitors (100 nF, 100 pF and 22 pF) near the VBAT pins. Also, it is recommended to add a TVS diode on the VBAT trace (near VBAT pins) to improve surge voltage withstanding 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 5: Reference Circuit for Power Supply

3.6. Turn On

BC66-NA can be turned on by driving PWRKEY low for at least 500 ms.

Table 10: PWRKEY Pin

Pin Name	Pin No.	I/O	Description	Comment
PWRKEY	7	DI	Turn on the module	PWRKEY pull-down time ≥ 500 ms Active low.

The reference designs for resetting the module are shown below. An open drain/collector driving circuit or a button can be used to control the PWRKEY pin.

Figure 6: Reference Design for PWRKEY Controlled with an OC/OD Driving Circuit

Figure 7: Reference Design for PWRKEY Controlled with a Button

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

Figure 8: Turn-On Timing

NOTE

PWRKEY cannot be pulled down all the time, otherwise the module will not be able to enter deep sleep mode.

3.7. Turn Off

The module can be turned off though any of the following methods:

- The module is turned off automatically when VBAT drops below 2.1 V.
- The module is turned off by **AT+QPOWD=0**.

Figure 9: Turn-Off Timing by Disconnecting VBAT

Figure 10: Turn-Off Timing by AT Command

3.8. Reset

The module can be reset though any of the following methods:

- By driving the RESET pin low for at least 50 ms.
- By **AT+QRST=1**. For detailed information about the command, see ***document [2]***.

Table 11: Reset Pin Definition

Pin Name	Pin No.	I/O	Description	Comment
RESET	15	DI	Reset the module	Reset pull-down time ≥ 50 m. Active low.

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 11: Reference Circuit of RESET Controlled with an OC/OD Driving Circuit

Figure 12: Reference Circuit of RESET Controlled with a Button

The reset timing is illustrated in the following figure.

Figure 13: Reset Timing

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 12: Pin Definition of UART Interfaces

Interface	Pin Name	Pin No.	I/O	Description	Comment
Main UART Port	TXD	17	DO	Main UART transmit	1.8 V power domain
	RXD	18	DI	Main UART receive	
Auxiliary UART Port	RXD_AUX	28	DI	Auxiliary UART receive	
	TXD_AUX	29	DO	Auxiliary UART transmit	
Debug UART Port	RXD_DBG	38	DI	Debug UART receive	
	TXD_DBG	39	DO	Debug UART transmit	
Ring Indication	RI	20	DO	Ring indication	

NOTE

When the module enters light sleep mode with a fixed baud rate, please send the command **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 115200 bps. When powering on the module, the MCU has to send **AT** commands 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 deep sleep 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 921600 bps by default.

The figure below shows the connection between DCE and DTE.

Figure 14: 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 debugging. Its baud rate is 115200 bps by default. The following is a reference design of debug UART port.

Figure 15: 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 debugging. Its baud rate is 115200 bps by default. The following is a reference design of auxiliary UART port.

Figure 16: Reference Design of Auxiliary UART Port

3.9.4. UART Application

The module provides 1.8 V UART interfaces. A level translator should be used if the application is equipped with a 3.3 V UART interface. The following figure shows a reference design.

Figure 17: 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 modules input and output circuit designs, but please pay attention to the direction of connection.

Figure 18: 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 1.8 V.

Figure 19: 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.

NOTE

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

3.10. USIM Interface

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

Table 13: Pin Definition of USIM Interface

Pin Name	Pin No.	I/O	Description	Comment
SIM_GND	10	-	Dedicated ground for USIM card	-
SIM_DATA	11	DIO	USIM card data	-
SIM_RST	12	DO	USIM card reset	-
SIM_CLK	13	DO	USIM card clock	-
SIM_VDD	14	PO	USIM card power supply	Voltage accuracy: 1.8 V ±5 %. Max. supply current: about 60 mA.

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

Figure 20: Reference Circuit for USIM Interface with a 6-pin USIM Card Connector

To enhance the reliability and availability of the USIM card in applications, follow the criteria below in USIM circuit design:

- Place the USIM card connector as close to the module as possible and keep the trace length as less than 200 mm as possible.
- Keep USIM card signal lines away from RF and VBAT traces.
- Make the trace between the ground of the module and the USIM card connector short and wide. Ensure the trace width no less than 0.5 mm to avoid any decrease in electric potential. The decoupling capacitor between SIM_VDD and GND should be not more than 1 μF 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 surrounding ground.

- To offer good ESD protection, it is recommended to add a TVS diode array whose parasitic capacitance should be not more than 50 pF. Place the ESD protection device as close to the USIM card connector as possible, and ensure the USIM card signal lines from the USIM card connector go through the ESD protection device before reaching the module. The 22 Ω resistors should be connected in series between the module and the USIM card connector to suppress EMI spurious transmission and enhance ESD protection. Note that the module's USIM peripheral devices should be placed close to the USIM card connector.
- Place the RF bypass capacitors (33 pF) close to the USIM card connector on all signal traces to improve EMI suppression.

3.11. ADC Interface

The module provides one Analog-to-Digital Converter (ADC) interface. The interface is available in active mode only. In deep sleep mode, the module has to be woken up first to ensure the availability of the interface.

Table 14: Pin Definition of ADC Interface

Pin Name	Pin No.	I/O	Description	Comment
ADC0	9	AI	Analog to digital converter interface	Voltage range: 0–1.4 V

NOTE

Please refer to **AT+QADC** command for detailed usage of the interface function.

3.12. RI

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

Table 15: RI Signal Status

Module Status	RI Signal Level
Idle	RI keeps at a high level.
SMS*	When an SMS* is received, RI outputs for 120 ms at a low level and starts data output.

URC	When a URC is incoming, RI outputs for 120 ms at a low level and starts data output.

Figure 21: RI Behaviour When a URC or an SMS* Message is Received

NOTE

The default RI pin state can be configured with **AT+QCFG="ripin",<value>** command. See ***document [2]*** for more details.

3.13. Network Status Indication

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

Table 16: Pin Definition of NETLIGHT Interface

Pin Name	Pin No.	I/O	Description	Comment
NETLIGHT	16	DO	Indicate the module's network activity status	-

Table 17: Module Status Indicated by NETLIGHT

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

A reference circuit is shown as below.

Figure 22: Reference Design of NETLIGHT

NOTE

By default, NETLIGHT function is disabled (**AT+QLEDMODE=0**), and it can be enabled with **AT+QLEDMODE=1**.

3.14. USB Interface

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

Table 18: Pin Definition of USB Interface

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

The following is a reference design of USB interface:

Figure 23: 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 ground surrounded. The impedance of USB differential trace is 90 Ω.
- 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 of the PCB, and surround the traces with ground on that layer and ground planes above and below.
- Junction capacitance of the ESD protection device might cause influences on USB data lines, so please pay attention to the selection of the device. Typically, the stray capacitance should be less than 3 pF.
- Keep the ESD protection devices as close to the USB connector as possible.

NOTE

1. Pull down the USB_MODE to GND through a 10 kΩ resistor before turning on the module, and the module will enter the USB download function immediately; during the download process, the PWRKEY must be pulled down continuously. If the USB_MODE is suspended, the module will enter the normal boot mode after turning on.
2. When the USB interface is used for log capturing, the module will not be able to enter deep sleep mode.
3. When using USB function of the module, an external 3.3 V power supply should be provided.

4 Antenna Interface

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

4.1. Pin Definition

Table 19: Pin Definition of NB-IoT Antenna Interface

Pin Name	Pin No.	I/O	Description	Comment
RF_ANT	35	AIO	RF antenna interface	50 Ω characteristic impedance
GND	34, 36, 37		Ground	-

4.2. Operating Frequencies

Table 20: Module Operating Frequencies

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

B13	746–756 MHz	777–787 MHz
B17	734–746 MHz	704–716 MHz
B18	860–875 MHz	815–830 MHz
B19	875–890 MHz	830–845 MHz
B20	791–821 MHz	832–862 MHz
B25	1930–1995 MHz	1850–1915 MHz
B26*	859–894MHz	814–849MHz
B28	758–803 MHz	703–748 MHz
B66	2110–2180 MHz	1710–1780 MHz
B71	617–652 MHz	663–698 MHz
B85	728–746 MHz	698–716 MHz

4.3. RF Antenna Reference Design

BC66-NA 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 50 Ω.
- BC66-NA 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 0 Ω resistor is mounted on R1.

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

Figure 24: Reference Design of NB-IoT Antenna Interface

4.4. RF Routing Guidelines

For user's PCB, the characteristic impedance of all RF traces should be controlled to 50 Ω. The impedance of the RF traces is usually determined by the trace width (W), the materials' dielectric constant, the height from the reference ground to the signal layer (H), and the spacing between RF traces and grounds (S). Microstrip or coplanar waveguide is typically used in RF layout to control characteristic impedance. The following are reference designs of microstrip or coplanar waveguide with different PCB structures.

Figure 25: Microstrip Design on a 2-layer PCB

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

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

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

To ensure RF performance and reliability, follow the principles below in RF layout design:

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

For more details, see ***document [3]***.

4.5. Antenna Design Requirements

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

Table 21: Antenna Cable Insertion Loss Requirements

Band	Requirements
LTE B5/B8/B12/B13/B17/B18/B19/B20/B26*/B28/B71/B85	Cable insertion loss: <1 dB
LTE B1/B2/B3/B4/B25/B66	Cable insertion loss: <1.5 dB

Table 22: Required Antenna Parameters

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

4.6. RF Output Power

Table 23: RF Conducted Output Power

Frequency Band	Max.	Min.
B1/B2/B3/B4/B5/B8/B12/B13/B17/B18/B19/B20/B25/B28/B66/B71/B85	23 dBm ±2 dB	< -39 dBm
B26*	TBD	TBD

NOTE

The design conforms to the NB-IoT radio protocols in *3GPP Rel-13/Rel-14*.

4.7. RF Receiving Sensitivity

Table 24: Receiving Sensitivity (with RF Retransmissions)

Frequency Band	Receiving Sensitivity
B1/B2/B3/B4/B5/B8/B12/B13/B17/B18/B19/B20/B25/B28/B66/B71/B85	-129 dBm
B26*	TBD

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

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

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

Figure 30: Mechanicals of U.FL-LP Connectors

The following figure describes the space factor of mated connector.

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

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

5 Electrical Characteristics and Reliability

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 25: Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VBAT	-0.3	3.63	V
Voltage at Digital Pins	-0.3	3.63	V
Voltage at Analog Pins	-0.3	3.63	V

5.2. Operating and Storage Temperatures

The following table lists the operating and storage temperatures of BC66-NA.

Table 26: Operating and Storage Temperatures

Parameter	Min.	Typ.	Max.	Unit
Operating Temperature Range [4]	-35	+25	+75	ºC

[4] Within operating temperature range, the module is 3GPP compliant.

Extended Temperature Range [5]	-40	-	+85	ºC
Storage Temperature Range	-40	-	+90	ºC

5.3. Power Consumption

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

Table 27: Module Current Consumption (3.3 V VBAT Power Supply)

Power OFF (AT+QPOWD=0)					
AP Mode	**Modem Mode**	**Min.**	**Typ.**	**Max.**	**Unit**
-	-	-	2.7	-	µA
Deep Sleep					
AP Mode	**Modem Mode**	**Min.**	**Typ.**	**Max.**	**Unit**
Idle	PSM	-	3.5	-	µA
Light Sleep					
AP Mode	**Modem Mode**	**Min.**	**Typ.**	**Max.**	**Unit**
Idle	eDRX = 81.92 s, PTW = 40.96 s	-	130	-	µA
	DRX = 1.28 s	-	520	-	µA
	DRX = 2.56 s	-	250	-	µA
Active					
AP Mode	**Modem Mode**	**Min.**	**Typ.**	**Max.** [6]	**Unit**
Normal	Connected @Single-tone (15 kHz B1 @ 23 dBm	-	95	265	mA
	Connected @Single-tone (15 kHz B2 @ 23 dBm	-	95	265	mA

[5] Within extended temperature range, the module maintains functions such as SMS* and data transmission, without any unrecoverable malfunction. Radio spectrum and radio network will not be influenced, while one or more specifications, such as Pout, may exceed the specified tolerances of 3GPP. When the temperature returns to the normal operating temperature levels, the module will meet 3GPP specifications again.

[6] The “maximum value” in “Active” mode refers to the maximum pulse current during RF emission.

	subcarrier spacing)	B3 @ 23 dBm	-	100	280	mA
		B4 @ 23 dBm	-	100	280	mA
		B5 @ 23 dBm	-	95	270	mA
		B8 @ 23 dBm	-	100	290	mA
		B12 @ 23 dBm	-	85	240	mA
		B13 @ 23 dBm	-	90	250	mA
		B17 @ 23 dBm	-	85	240	mA
		B18 @ 23 dBm	-	95	270	mA
		B19 @ 23 dBm	-	95	270	mA
		B20 @ 23 dBm	-	95	270	mA
		B25 @ 23 dBm	-	95	270	mA
		B26* @ 23 dBm	-	TBD	TBD	mA
		B28 @ 23 dBm	-	85	240	mA
		B66 @ 23 dBm	-	100	280	mA
		B71 @ 23 dBm	-	85	240	mA
		B85 @ 23 dBm	-	85	235	mA
Normal	Connected @Single-tone (3.75 kHz subcarrier spacing)	B1 @ 23 dBm	-	210	270	mA
		B2 @ 23 dBm	-	205	270	mA
		B3 @ 23 dBm	-	210	280	mA
		B4 @ 23 dBm	-	215	280	mA
		B5 @ 23 dBm	-	200	280	mA
		B8 @ 23 dBm	-	220	290	mA
		B12 @ 23 dBm	-	180	230	mA
		B13 @ 23 dBm	-	190	250	mA
		B17 @ 23 dBm	-	180	240	mA

	B18 @ 23 dBm	-	195	260	mA
	B19 @ 23 dBm	-	205	270	mA
	B20 @ 23 dBm	-	205	270	mA
	B25 @ 23 dBm	-	205	270	mA
	B26* @ 23 dBm	-	TBD	TBD	mA
	B28 @ 23 dBm	-	185	240	mA
	B66 @ 23 dBm	-	215	280	mA
	B71 @ 23 dBm	-	180	240	mA
	B85 @ 23 dBm	-	180	240	mA

NOTE

The data in the above table are the actual test results under Quectel's laboratory instrument test conditions.

5.4. Digital I/O Characteristic

Table 28: USIM 1.8 V I/O Requirements

Parameter	Description	Min.	Max.	Unit
V_{IH}	Input high voltage	0.75 × SIM_VDD	-	V
V_{IL}	Input low voltage	-	0.25 × SIM_VDD	V
V_{OH}	Output high voltage	0.85 × SIM_VDD	-	V
V_{OL}	Output low voltage	-	0.15 × SIM_VDD	V

Table 29: Other I/O Requirements

Parameter	Description	Min.	Max.	Unit
V_{IH}	Input high voltage	0.75 × VDD_EXT	-	V
V_{IL}	Input low voltage	-	0.25 × VDD_EXT	V
V_{OH}	Output high voltage	0.85 × VDD_EXT	-	V
V_{OL}	Output low voltage	-	0.15 × VDD_EXT	V

5.5. ESD

If the static electricity generated by various ways discharges to the module, the module maybe damaged to a certain extent. Thus, please take proper ESD countermeasures and handling methods. For example, wearing anti-static gloves during the development, production, assembly and testing of the module; adding ESD protective components to the ESD sensitive interfaces and points in the product design.

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

Table 30: Electrostatic Discharge Characteristics (25 ºC, 45 % Relative Humidity)

Tested Interfaces	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 millimeter (mm), and the dimensional tolerances are ±0.2 mm unless otherwise specified.

6.1. Mechanical Dimensions of the Module

Figure 32: Top and Side Dimensions (Unit: mm)

Figure 33: Bottom Dimensions (Bottom View)

NOTE

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

6.2. Recommended Footprint

Figure 34: Recommended Footprint (Unit: mm)

NOTE

1. Keep at least 3 mm between the module and other components on the motherboard to improve soldering quality and maintenance convenience.
2. To keep the reliability of the mounting and soldering, keep the motherboard thickness as at least 1.2 mm.

6.3. Top and Bottom Views

Figure 35: Top and Bottom Views of the Module

NOTE

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

7 Storage, Manufacturing & Packaging

7.1. Storage Conditions

The module is provided with vacuum-sealed package. MSL of the module is rated as 3, and its storage restrictions are shown as below.

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

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

3. The floor life of the module is 168 hours [7] in a plant where the temperature is 23 ±5 °C and relative humidity is below 60 %. After the vacuum-sealed packaging is removed, the module must be processed in reflow soldering or other high-temperature operations within 24 hours. Otherwise, the module should be stored in an environment where the relative humidity is less than 10 % (e.g. a drying cabinet).

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

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

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

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

[7] This floor life is only applicable when the environment conforms to *IPC/JEDEC J-STD-033*. It is recommended to start the solder reflow process within 24 hours after the package is removed if the temperature and moisture do not conform to, or are not sure to conform to *IPC/JEDEC J-STD-033*. And do not remove the packages of tremendous modules if they are not ready for soldering.

NOTE

1. To avoid blistering, layer separation and other soldering issues, extended exposure of the module to the air is forbidden.
2. Take out the module from the package and put it on high-temperature-resistant fixtures before baking. All modules must be soldered to PCB within 24 hours after the baking, otherwise put them in the drying oven. If shorter baking time is desired, see *IPC/JEDEC J-STD-033* for the baking procedure.
3. Pay attention to ESD protection, such as wearing anti-static gloves, when touching the modules.

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. Apply proper force on the squeegee to produce a clean stencil surface on a single pass. To guarantee module soldering quality, the thickness of stencil for the module is recommended to be 0.18–0.20 mm. For more details, see ***document [4]***.

The peak reflow temperature should be 235–246 ºC, with 246 ºC as the absolute maximum reflow temperature. To avoid damage to the module caused by repeated heating, it is strongly recommended that the module should be mounted only 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 31: Recommended Thermal Profile Parameters

Factor	Recommendation
Soak Zone	
Max. slope	1–3 °C/s
Soak time (between A and B: 150 °C and 200 °C)	70–120 s
Reflow Zone	
Max. slope	2–3 °C/s
Reflow time (D: over 217 °C)	40–70 s
Max. temperature	235–246 °C
Cooling down slope	-1.5 °C/s to -3 °C/s
Reflow Cycle	
Max. reflow cycle	1

NOTE

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.
3. If a conformal coating is necessary for the module, do NOT use any coating material that may chemically react with the PCB or shielding cover, and prevent the coating material from flowing into the module.
4. Avoid using ultrasonic technology for module cleaning since it can damage crystals inside the module.
5. Due to the complexity of the SMT process, please contact Quectel Technical Supports in advance for any situation that you are not sure about, or any process (e.g. selective soldering, ultrasonic soldering) that is not mentioned in ***document [4]***.

7.3. Packaging Specification

The module adopts carrier tape packaging and details are as follow:

7.3.1. Carrier Tape

Dimension details are as follow:

Figure 37: Carrier Tape Dimension Drawing

Table 32: Carrier Tape Dimension Table (Unit: mm)

W	P	T	A0	B0	K0	K1	F	E
32	24	0.4	16.2	18.1	2.8	7.6	14.2	1.75

7.3.2. Plastic Reel

Figure 38: Plastic Reel Dimension Drawing

Table 33: Plastic Reel Dimension Table (Unit: mm)

øD1	øD2	W
330	100	32.5

7.3.3. Packaging Process

Place the module into the carrier tape and use the cover tape to cover them; then wind the heat-sealed carrier tape to the plastic reel and use the protective tape for protection. One plastic reel can load 250 modules.

Place the packaged plastic reel, humidity indicator card and desiccant bag into a vacuum bag, then vacuumize it.

Place the vacuum-packed plastic reel into a pizza box.

Put 4 pizza boxes into 1 carton and seal it. One carton can pack 1000 modules.

Figure 39: Packaging Process

8 Appendix References

Table 34: Related Documents

Document Name	
[1]	Quectel_BC66-NA-TE-B_User_Guide_V1.0
[2]	Quectel_BC66&BC66-NA_AT_Commands_Manual
[3]	Quectel_RF_Layout_Application_Note
[4]	Quectel_Module_Secondary_SMT_Application_Note

Table 35: Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
AP	Application Processor
ASM	Antenna Switch Module
CoAP	Constrained Application Protocol
DCE	Data Communications Equipment (typically module)
DFOTA	Delta Firmware Upgrade Over-The-Air
DRX	Discontinuous Reception
DTE	Data Terminal Equipment (typically computer, external controller)
DTLS	Datagram Transport Layer Security
eDRX	extended Discontinuous Reception
EMI	Electromagnetic Interference
ESD	Electrostatic Discharge
ESR	Equivalent Series Resistance

H-FDD	Half Frequency Division Duplexing
HTTP	Hypertext Transfer Protocol
HTTPS	Hypertext Transfer Protocol Secure
I/O	Input/Output
kbps	kilobits per second
LCC	Leadless Chip Carrier (package)
LDO	Low-dropout Regulator
LED	Light Emitting Diode
LGA	Land Grid Array
LTE	Long-Term Evolution
LwM2M	Lightweight M2M
MCU	Microcontroller Unit/Microprogrammed Control Unit
MQTT	Message Queuing Telemetry Transport
MQTTS	Message Queuing Telemetry Transport Secure
MSL	Moisture Sensitivity Levels
NB-IoT	Narrow Band-Internet of Things
OOS	Out of Service
PA	Power Amplifier
PCB	Printed Circuit Board
PDN	Public Data Network
PDU	Protocol Data Unit
PMU	Power Management Unit
PPP	Point-to-Point Protocol
PSM	Power Save Mode
PTW	Paging Time Window

RF	Radio Frequency
RTC	Real Time Clock
RX	Receive
SMS	Short Message Service
SMT	Surface Mount Technology
SNTP	Simple Network Time Protocol
SRAM	Static Random Access Memory
TAU	Tracking Area Update
TCP	Transmission Control Protocol
TLS	Transport Layer Security
TX	Transmit
TVS	Transient Voltage Suppressor
UART	Universal Asynchronous Receiver & Transmitter
UDP	User Datagram Protocol
URC	Unsolicited Result Code
USB	Universal Serial Bus
USIM	Universal Subscriber Identification Module
Vmax	Maximum Voltage Value
Vmin	Minimum Voltage Value
Vnom	Nominal Voltage Value
V_{IH}min	Minimum Input High Level Voltage Value
V_{IL}max	Maximum Input Low Level Voltage Value
VSWR	Voltage Standing Wave Ratio
XO	Crystal Oscillator
XTAL	External Crystal Oscillator