BC66&BC660K-GL

Compatible Design

NB-IoT Module Series

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About the Document

Revision History

Version	Date	Author	Description
-	2020-11-26	Clifton HE	Creation of the document
1.0	2021-02-18	Clifton HE	First official release

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1 Introduction

Quectel NB-IoT module BC66 is compatible with Quectel NB-IoT module BC660K-GL. This document outlines the compatible design for the two modules.

1.1. Special Mark

Table 1: Special Mark

Mark	Definition
*	When an asterisk (*) is used after a function, feature, interface, pin name, AT command, or argument, it indicates that the function, feature, interface, pin name, AT command, or argument is under development and currently not supported, unless otherwise specified.

2 General Descriptions

2.1. Product Description

BC66 and BC660K-GL are high-performance, low power consumption, multi-band NB-IoT modules designed as compatible products to meet different user requirements. This compatible design manual helps to ensure smooth migrations between the two modules in your products.

Table 2: Module General Information

Module	Appearance	Packaging	Dimensions (mm)	Description
BC66		44 LCC pins 14 LGA pins	17.7 × 15.8 × 2.0	Multi-band NB-IoT module
BC660K-GL		44 LCC pins 14 LGA pins	17.7 × 15.8 × 2.0	Multi-band NB-IoT module

2.2. Features Overview

The following table compares the general properties and features of BC66 and BC660K-GL modules.

Table 3: Features Overview

Feature	BC66	BC660K-GL
Power Supply	2.1–3.63 V Typ. 3.3 V	2.2–4.3 V Typ. 3.3 V
Peak Current	VBAT: Max. 0.5 A	VBAT: Max. 0.5 A
Sleep Current	3.5 μA @ Deep Sleep (Typ.)	800 nA @ Deep Sleep (Typ.)
Frequency Bands	H-FDD: B1/B2/B3/B4/B5/B8/B12/B13/B17/B18/B19/B20/B25/B26*/B28/B66	H-FDD: B1/B2/B3/B4/B5/B8/B12/B13/B14/B17/B18/B19/B20/B25/B28/B66/B70/B85
Temperature Range	Operating temperature range: -35 to +75 °C 1) Extended temperature range: -40 to +85 °C 2) Storage temperature range: -40 to +90 °C	Operating temperature range: -35 to +75 °C 1) Extended temperature range: -40 to +85 °C 2) Storage temperature range: -40 to +90 °C
UART Interface	**Main UART Interface:** ● When used for AT command communication and data transmission, the module is in auto-baud mode by default, where the UART port automatically synchronizes within 115200 bps its baud rate with that of the MCU, which has to keep sending AT commands to the module during the baud rate synchronization process until **OK** is returned indicating a successful synchronization. After the module is woken up from Deep Sleep mode, its UART automatically uses the previously synchronized baud rate. ● When used for firmware upgrade,	**Main UART interface:** ● When used for AT command communication and data transmission, support baud rates 2400 bps, 4800 bps, 9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps (default), 230400 bps, and 460800 bps. ● When used for firmware upgrade, support baud rate 921600 bps (default). **Debug UART interface:** Used for debugging and the baud rate is 6 Mbps. **Signal level:** 1.8/3.3 V

	support baud rate of 921600 bps (default) **Debug UART interface:** Used for debugging and the default baud rate is 115200 bps **Auxiliary UART interface:** Used for debugging and the default baud rate is 115200 bps **Signal level:** 1.8 V	
USIM	1.8 V USIM card	1.8/3.0 V USIM card
ADC	ADC0	ADC0
RTC Backup	Not supported	Not supported
Firmware Upgrade	Main UART interface, DFOTA or USB	Main UART interface or DFOTA

NOTES

1. [1] Within operating temperature range, the module is 3GPP compliant.
2. [2] Within extended temperature range, the module maintains functions such as voice, SMS, data transmission, etc. There is no unrecoverable malfunction, nor effect on radio spectrum or harm to radio network. Only one or more parameters like P_{out} might reduce in value and exceed the specified tolerance. When the temperature returns to normal operating temperature levels, the module will meet 3GPP specifications again.

2.3. Pin Assignment

The following figure shows the pin assignment of BC66 and BC660K-GL.

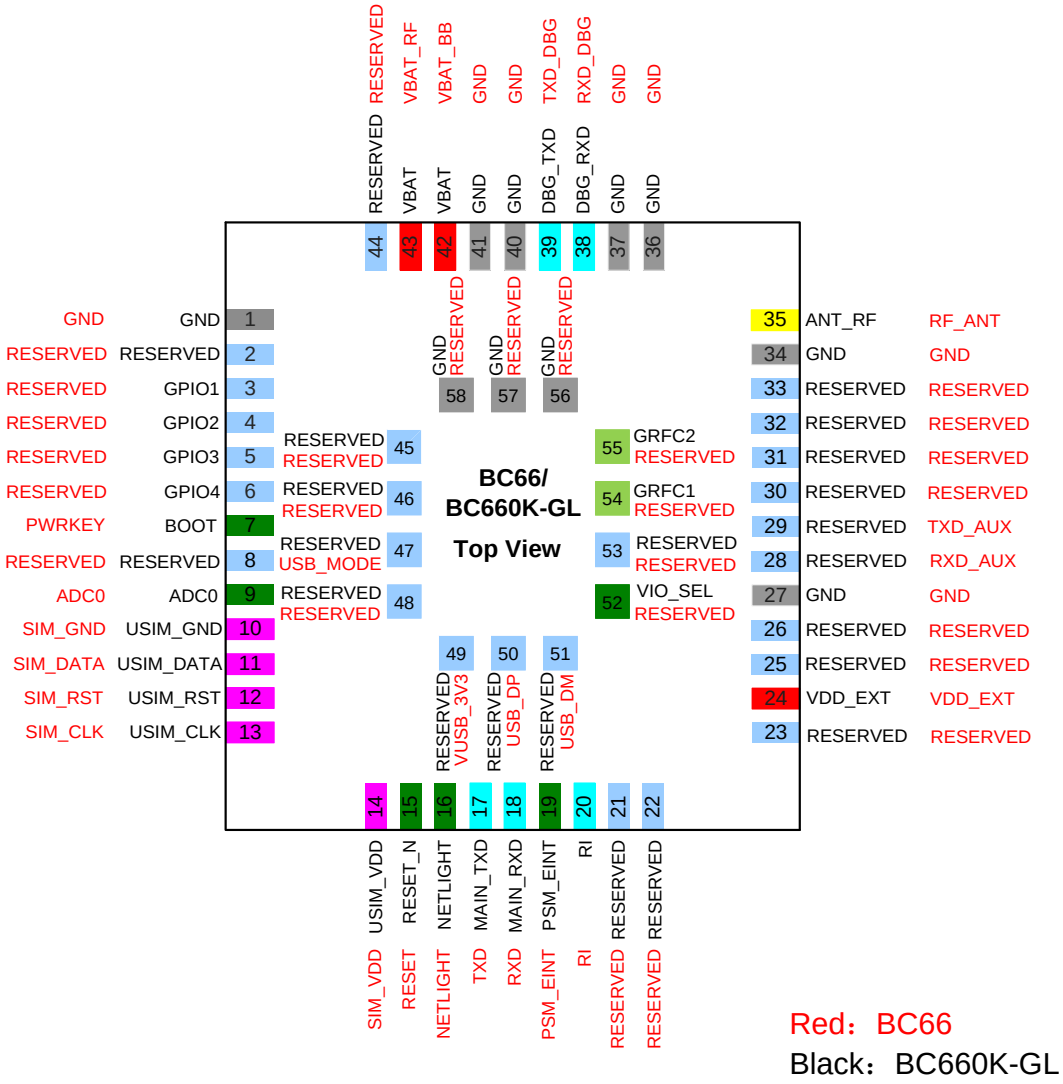

Figure 1: BC66 & BC660K-GL Pin Assignment (Top View)

NOTES

1. The pin names marked in **red** are defined for the BC66 module.
2. The pin names marked in **black** are defined for the BC660K-GL module.
3. Keep all reserved and unused pins disconnected.

3 Pin Description

This chapter describes and compares the pins of BC66 and BC660K-GL.

Table 4: I/O Parameters Definition

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

Table 5: Pin Comparison between BC66 and BC660K-GL

Pin No.	BC66			BC660K-GL		
	Pin Name	I/O	Description	Pin Name	I/O	Description
3	RESERVED	-	-	GPIO1	DIO	General-purpose input/output
4	RESERVED	-	-	GPIO2	DIO	General-purpose input/output
5	RESERVED	-	-	GPIO3	DIO	General-purpose input/output
6	RESERVED	-	-	GPIO4	DIO	General-purpose input/output
7	PWRKEY	DI	Turn on/off the module	BOOT	DI	Makes module enter download mode
9	ADC0	AI	General-purpose ADC interface	ADC0	AI	General-purpose ADC interface

10	SIM_GND		Dedicated ground for USIM card	USIM_GND		Dedicated Ground for USIM card
11	SIM_DATA	DIO	USIM card data	USIM_DATA	DIO	USIM card data
12	SIM_RST	DO	USIM card reset	USIM_RST	DO	USIM card reset
13	SIM_CLK	DO	USIM card clock	USIM_CLK	DO	USIM card clock
14	SIM_VDD	PO	USIM card power supply	USIM_VDD	PO	USIM card power supply
15	RESET	DI	Reset the module	RESET_N	DI	Reset the module
16	NETLIGHT	DO	Indicate the module's network activity status	NETLIGHT*	DO	Indicate the module's network activity status
17	TXD	DO	Main UART transmit	MAIN_TXD	DO	Main UART transmit
18	RXD	DI	Main UART receive	MAIN_RXD	DI	Main UART receive
19	PSM_EINT	DI	External interrupt pin dedicated to waking up the module from Deep Sleep mode.	PSM_EINT	DI	External interrupt pin dedicated to waking up the module from Deep Sleep/Light Sleep mode.
20	RI	DO	Ring indication	RI	DO	Ring indication
24	VDD_EXT	PO	Provide 1.8 V voltage for external circuits. No voltage output in Deep Sleep mode.	VDD_EXT	PO	Provide 1.8/3.3 V voltage for external circuits. No voltage output in Deep Sleep/Light Sleep mode.
28	RXD_AUX	DI	Auxiliary UART receive	RESERVED	-	-
29	TXD_AUX	DO	Auxiliary UART transmit	RESERVED	-	-
35	RF_ANT	DIO	Antenna interface	ANT_RF	DIO	Antenna interface
38	RXD_DBG	DI	Debug UART receive	DBG_RXD	DI	Debug UART receive
39	TXD_DBG	DO	Debug UART transmit	DBG_TXD	DO	Debug UART transmit
42	VBAT_BB	PI	Power supply for the module's baseband part	VBAT	PI	Power supply for the module

43	VBAT_RF	PI	Power supply for the module's RF part	VBAT	PI	Power supply for the module
47	USB_MODE	DI	Pull down the pin to enable USB download function	RESERVED	-	-
49	VUSB_3V3	PI	USB power supply	RESERVED	-	-
50	USB_DP	DIO	USB differential data (+)	RESERVED	-	-
51	USB_DM	DIO	USB differential data (-)	RESERVED	-	-
52	RESERVED	-	-	VIO_SEL	DI	IO Voltage selection [1)]
54	RESERVED	-	-	GRFC1*	DO	Generic RF controller
55	RESERVED	-	-	GRFC2*	DO	Generic RF controller
56	RESERVED	-	-	GND	-	Ground
57	RESERVED	-	-	GND	-	Ground
58	RESERVED	-	-	GND	-	Ground
1, 27, 34, 36, 37, 40, 41	GND	-	Ground	GND	-	Ground
2, 8, 21–23, 25–26, 30–33, 44–46, 48, 53	RESERVED	-	-	RESERVED	-	-

NOTES

1. The pins in **red** are compatible pins of different functions.
2. The pins in **black** are compatible pins of the same functions.
3. Keep all reserved and unused pins disconnected.
4. [1)] When VIO_SEL is grounded and VBAT < 3.3 V, VDD_EXT = VBAT;
   When VIO_SEL is grounded and VBAT ≥ 3.3 V, VDD_EXT = 3.3 V;
   When VIO_SEL is floating, VDD_EXT = 1.8 V.

4 Hardware Reference Design

The following chapters describe the compatible design of BC66 and BC660K-GL in terms of their main application functions and interfaces.

4.1. Power Supply

4.1.1. Operating Voltage

The power supply ranges of BC66/BC660K-GL are listed below:

Table 6: Module Operating Voltage Range

Module	Power Supply Pins	Min.	Typ.	Max.	Unit	Conditions
BC66	VBAT_BB & VBAT_RF	2.1	3.3	3.63	V	The actual input voltages must stay between the minimum and maximum values.
BC660K-GL	VBAT	2.2	3.3	4.3	V	

When considering the compatible design of the modules, make sure the input voltage is 2.2–3.63 V. Ensure the module's input voltage never drops below 2.2 V during operation.

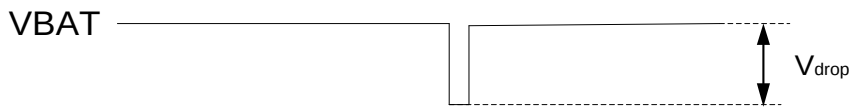

Figure 2: VBAT Voltage Waveform Diagram

4.1.2. Power Supply Reference Design

Power design for a module is critical to its performance. It is recommended to use a low quiescent current LDO with an output capacity of 0.5 A to regulate the power supply for both BC66 and BC660K-GL.

To ensure better power supply performance and compatibility, the recommended input voltage is 3.3 V. Also, it is recommended to add 100 μF, 100 nF, 100 pF and 22 pF capacitors near the VBAT pins of BC66

or BC660K-GL. Additionally, it is recommended to add a TVS diode on the VBAT traces (near the VBAT pins) to improve surge voltage withstand capability.

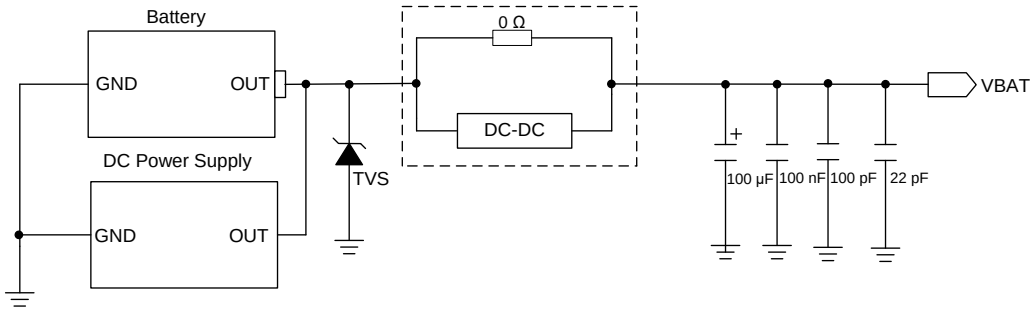

Figure 3: Compatible Reference Design for Power Supply

Depending on the type of power supply (battery or DC power supply), the reference design for power switching circuit in the above dashed box will be different. The details are illustrated in the table below.

Table 7: Power Switching Circuit Design Based on Power Supply Type

Power Supply Type	Component Used for the Power Switching Circuit	
	BC66 (VBAT = 2.1–3.63 V)	BC660K-GL (VBAT = 2.2–4.3 V)
Li-SOCl2 Battery	0 Ω Resistor	0 Ω Resistor
Li-MnO2 Battery	0 Ω Resistor	0 Ω Resistor
DC Power Supply	DC-DC Converter	DC-DC Converter

4.2. Turn on

The methods of turning on BC66 and BC660K-GL are different:

- BC66: It can be turned on by driving its PWRKEY pin low for at least 500 ms. It is recommended to use an open drain/collector driver or a button to control the PWRKEY.
- BC660K-GL: After the module VBAT is powered on, keep RESET_N and BOOT high (default), and the module will turn on automatically.

For BC660K-GL, drive and keep the BOOT pin low during module reset or powering on, and the module will enter the download mode. In the download mode, firmware can be downloaded through the main UART interface. After the download is completed, the module needs to be reset to exit from this mode.

An open drain/collector driver or a button can be used to control the BOOT pin for BC660K-GL and the PWRKEY pin for BC66.

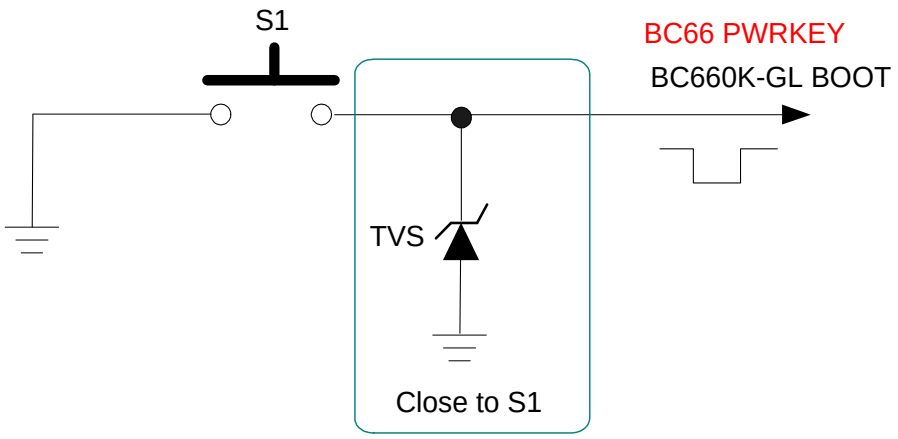

Figure 4: Compatible Reference Design for BOOT/PWRKEY Controlled with a Button

The turn-on timing of BC66 and BC660K-GL is illustrated below.

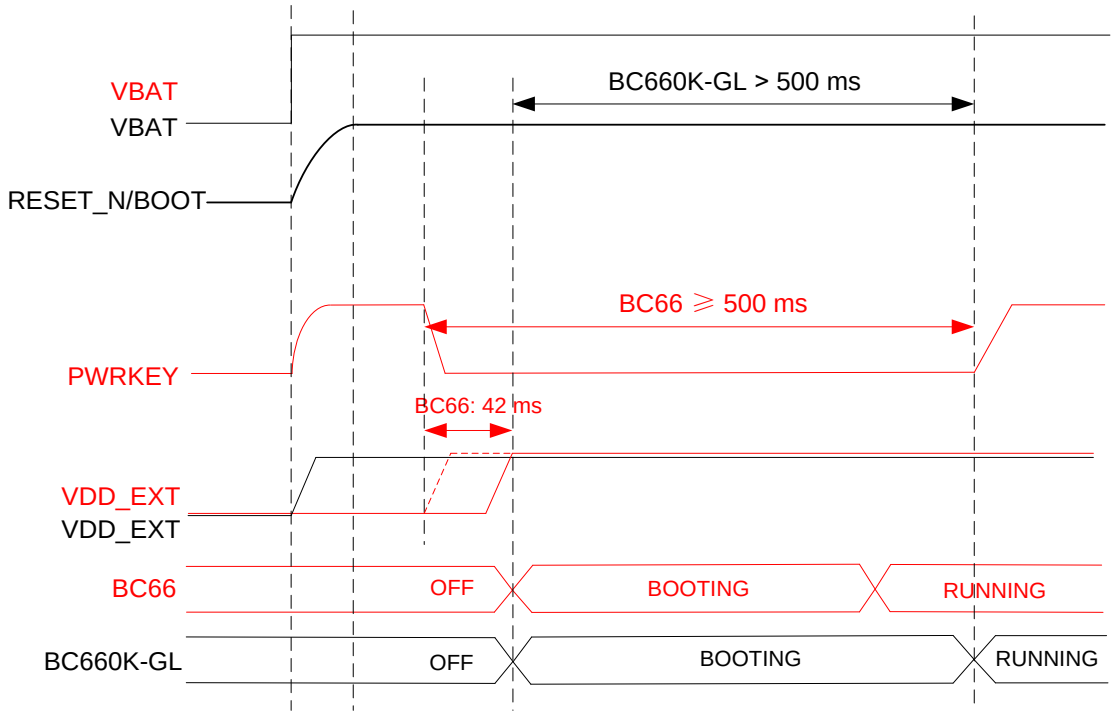

Figure 5: BC66 & BC660K-GL Turn-on Timing

NOTES

1. For BC66: Ensure that VBAT_ BB and VBAT_RF are stable before driving low PWRKEY to turn on

BC66 and that PWRKEY is not kept low all the time as otherwise the module cannot enter Deep Sleep mode.

2. For BC660K-GL: After the module is powered off, it can be turned on again only after its VBAT voltage drops below 0.7 V. The actual discharging time of VBAT needs to be determined based on circuit tests and enough time margin should be left to avoid abnormal module startup. After VBAT is powered on, RESET_N and BOOT automatically rise to high level due to internal pull-ups.
3. The **red** part in the above figure is for BC66.
4. The **black** part in the above figure is for BC660K-GL.

4.3. Turn off

The methods of turning off BC66 and BC660K-GL are also different:

- BC66 can be turned off by executing **AT+QPOWD=0** or by cutting off the VBAT power supply;
- BC660K-GL can only be turned off by cutting off the VBAT power supply.

The turn-off timing is illustrated in the figure below.

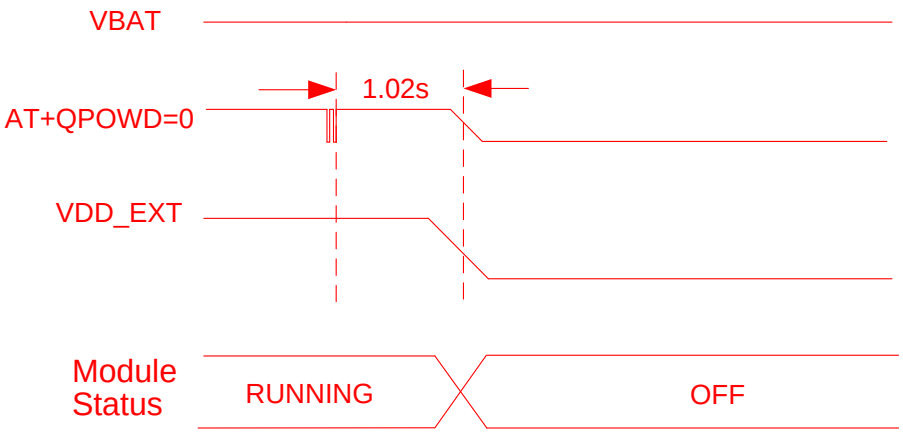

Figure 6: Turning Off BC66 with AT Command

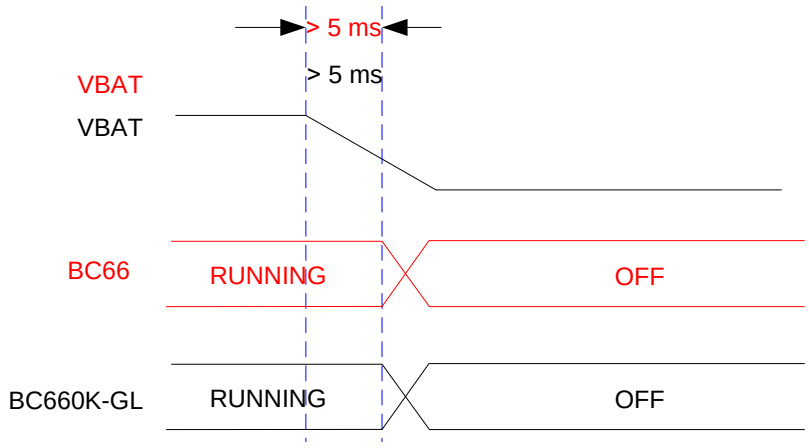

Figure 7: Turning off BC66/BC660K-GL by Disconnecting VBAT

NOTES

1. The **red** part in the above figure is for BC66.
2. The **black** part in the above figure is for BC660K-GL.

4.4. Reset

BC66 and BC660K-GL can be reset with hardware and software methods, which are illustrated below.

4.4.1. Reset BC66/BC660K-GL with Hardware Method

Driving the RESET/RESET_N low for at least 50 ms resets BC66/BC660K-GL. The reference design for resetting the module is shown below. An open drain/collector driving circuit or button can be used to control the RESET/RESET_N pin.

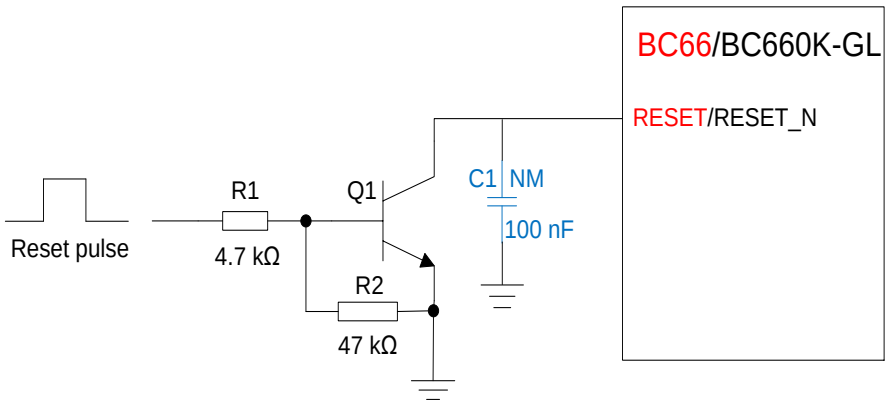

Figure 8: Compatible Reference Design for Reset controlled with an OC/OD driver

NOTE

It is recommended to reserve a 100 nF capacitor (C1 marked in **blue**) not mounted by default for BC660K-GL.

The reset timing of BC66/BC660K-GL is illustrated in the figure below.

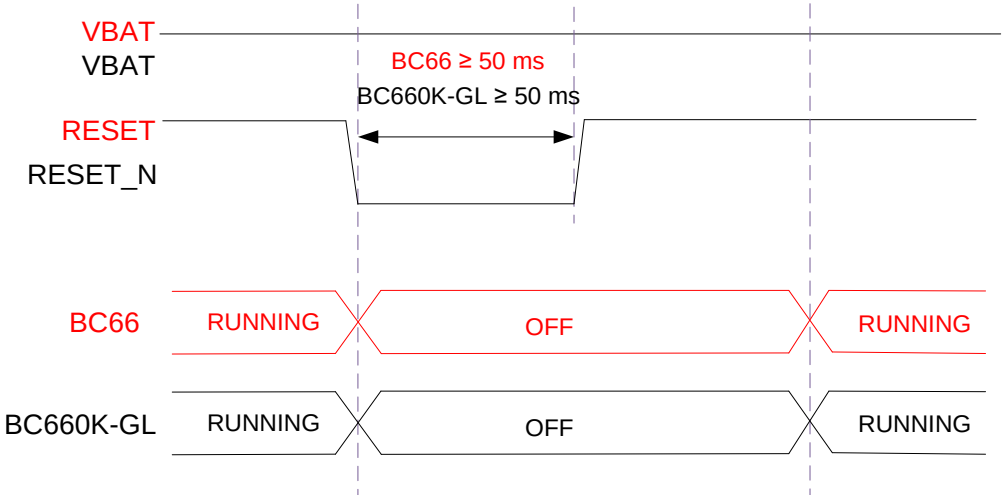

Figure 9: Timing of Module Reset

NOTES

1. The **red** part in the above figure is for BC66.
2. The **black** part in the above figure is for BC660K-GL.

4.4.2. Reset BC66/BC660K-GL with Software Method

AT+QRST=1 command can be used to reset BC66/BC660K-GL. For more details about the command, see ***document [2]*** and ***document [4]***.

4.5. Network Status Indication

The NETLIGHT signal can drive a network status indication LED to indicate the network status of BC66/BC660K-GL. A reference design is shown below.

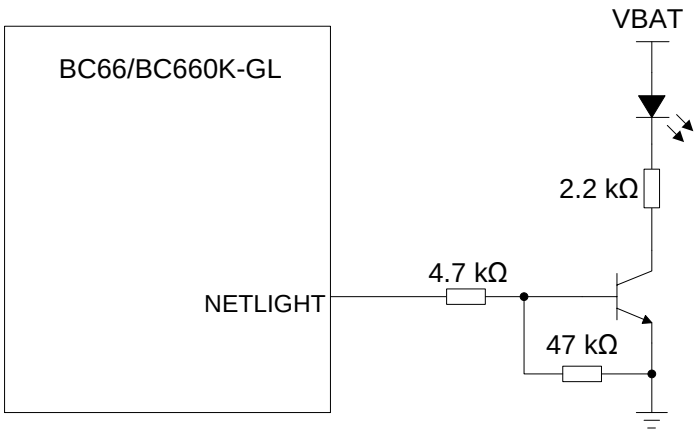

Figure 10: Compatible Reference Design for NETLIGHT

NOTE

The NETLIGHT function of BC660K-GL is under development.

4.6. USB Interface

BC66 has a USB interface which conforms to USB 1.1 specifications and supports full speed (12 Mbps) mode. Supporting USB serial drivers for Windows/Linux operating systems, the interface can be used for software debugging and software upgrade. For more details, see ***document [1]***.

BC660K-GL does not support USB function.

The following is a reference design for the USB interface of BC66:

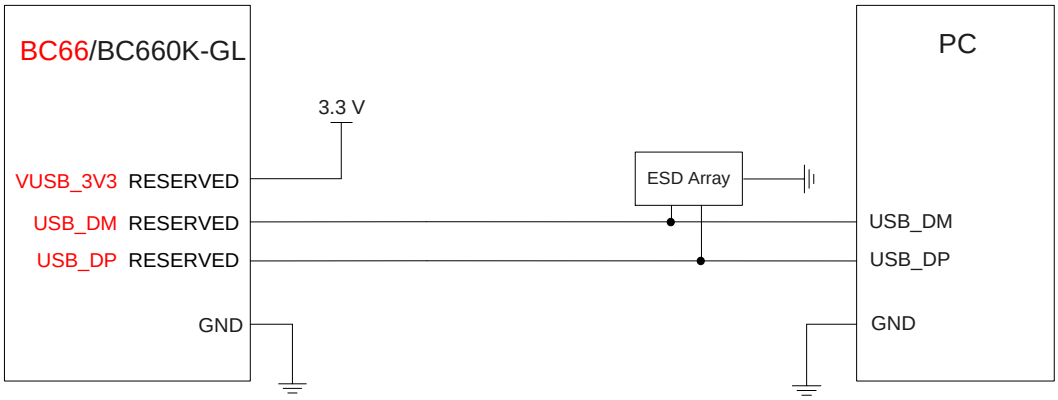

Figure 11: Compatible Reference Design for USB Interface

NOTES

1. For BC66, its USB_MODE must be pulled down to realize the USB download function.
2. For BC66, when its USB interface is used for log capturing, the module cannot enter Deep Sleep mode.
3. For BC66, to use its USB function, an external 3.3 V power supply should be provided.

4.7. USIM Interface

- BC66 supports 1.8 V USIM cards.
- BC660K-GL supports 1.8/3.0 V USIM cards.

The USIM interfaces of BC66/BC660K-GL are compatible with each other. A compatible reference design for the USIM interfaces connected with a 6-pin USIM card connector is shown in the figure below:

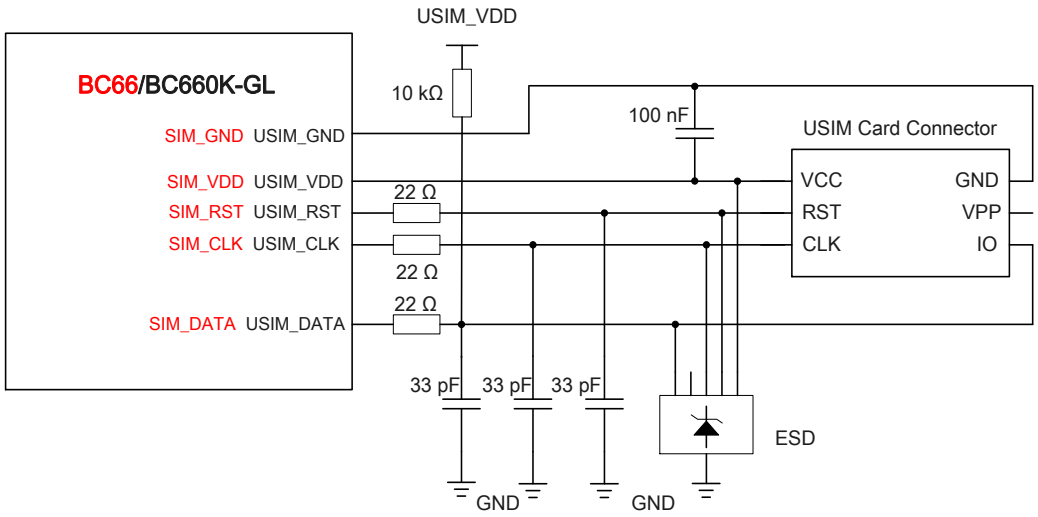

Figure 12: Compatible Reference Design for USIM Interface

NOTES

1. It is necessary to add a 10 kΩ pull-up resistor between USIM_DATA and USIM_VDD to improve the anti-interference ability.
2. The **red** part in the above figure is for BC66.
3. The **black** part in the above figure is for BC660K-GL.

4.8. UART Interfaces

The UART interfaces of BC66/BC660K-GL have different voltage domains, as listed below.

Table 8: UART Interface Voltage Domain

Module	UART Interface	Voltage Domain
BC66	Main UART	1.8 V
	Debug UART	
	AUX UART	
BC660K-GL	Main UART	1.8/3.3 V
	Debug UART	

A compatible voltage level translation reference design for BC66/BC660K-GL's UART interfaces is shown below. For designs of the circuits in dotted lines, refer to those in solid lines, and pay attention to the direction of connection.

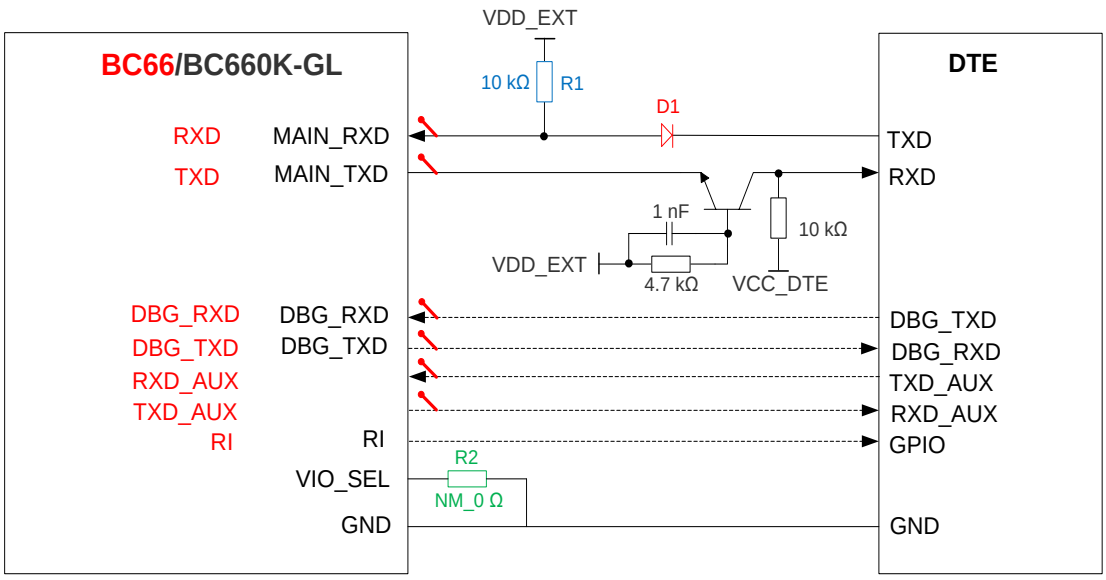

Figure 13: Compatible Reference Design for Level Conversion Circuits

NOTES

1. The level conversion circuit solution shown above is not suitable for applications with high baud rates exceeding 460 kbps.
2. "" represents the test points of UART interfaces. It is recommended to reserve the test points of VBAT_BB, VBAT_RF and PWRKEY for BC66, and the test points of VBAT, BOOT and RESET_N for BC660K-GL, for convenient firmware upgrade and debugging when necessary.
3. While using BC66, mount R1 in **blue** and do not mount R2 in **green**.
4. While using BC660K-GL, do not pull up MAIN_RXD to VDD_EXT directly, do not mount R1 in **blue**, and substitute D1 in **red** with a 1 kΩ resistor.
5. While using BC660K-GL, do not mount R2 in **green**.
6. For BC660K-GL, pay attention to the following notes about VIO_SEL:
   When VIO_SEL is grounded and VBAT < 3.3 V, VDD_EXT = VBAT;
   When VIO_SEL is grounded and VBAT ≥ 3.3 V, VDD_EXT = 3.3 V;
   When VIO_SEL is floating, VDD_EXT = 1.8 V.

4.9. ADC Interface

BC66 modules provide a 10-bit ADC input channel to read the voltage value of ADC0, while BC660K-GL provides a 12-bit ADC input channel of the same use.

- The maximum voltage value applicable to BC66's ADC0 is 1.4 V.
- The maximum voltage value applicable to BC660K-GL's ADC0 is 1.2 V.

Table 9: ADC Interface Information

Module	Pin Name	Pin No.	Description
BC66	ADC0	9	General-purpose ADC interface
BC660K-GL	ADC0	9	General-purpose ADC interface

NOTE

For BC660K-GL, a 320 kΩ pull-down resistor is integrated inside its BB chip, to which the ADC pin is connected. This resistor needs to be considered when you apply the voltage division rule (voltage divider) to relevant calculations.

4.10. RF Antenna Interface

BC660K-GL's antenna interface ANT_RF is compatible with BC66's antenna interface RF_ANT. The impedance of the antenna interfaces is 50 Ω.

For better RF performance, it is recommended to reserve a π-type matching circuit (R1/C1/C2) close to the antenna. By default, the capacitors (C1/C2) are not mounted while the 0 Ω resistor R1 is mounted. A reference design for RF antenna interface is shown as below.

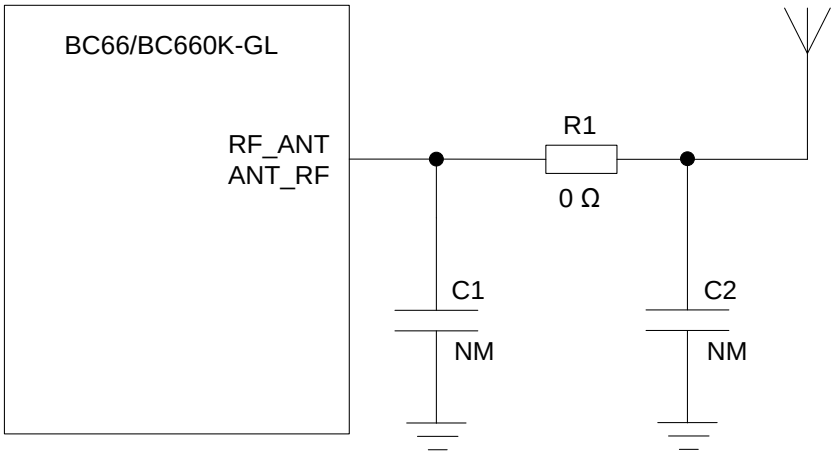

Figure 14: Reference Design for RF Antenna Interface

5 Recommended Footprint and Stencil Design

This chapter introduces the recommended compatible footprint and stencil design of BC66 and BC660K-GL. All dimensions are measured in millimeter (mm), and the tolerance for dimensions is ±0.05 mm unless otherwise specified.

5.1. Recommended Compatible Footprint

The following figure shows the bottom views of BC66 and BC660K-GL.

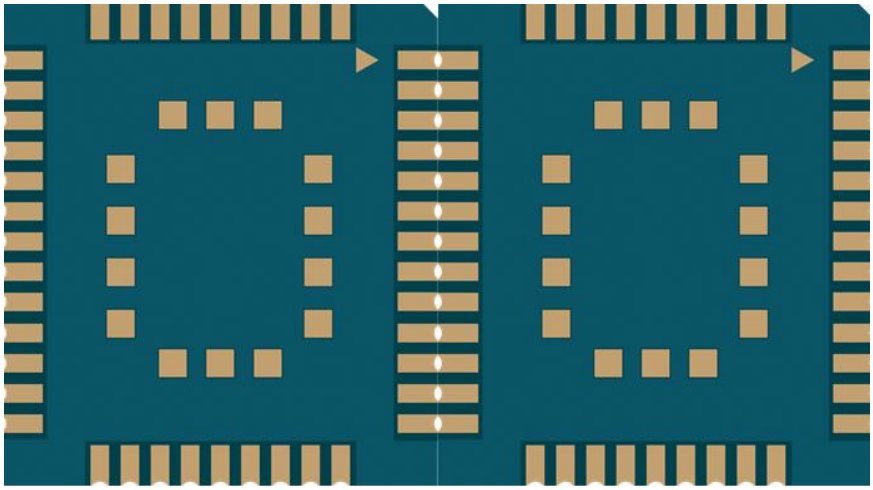

Figure 15: Bottom Views of BC66/BC660K-GL

The following figure shows the recommended compatible footprint of BC66 and BC660K-GL.

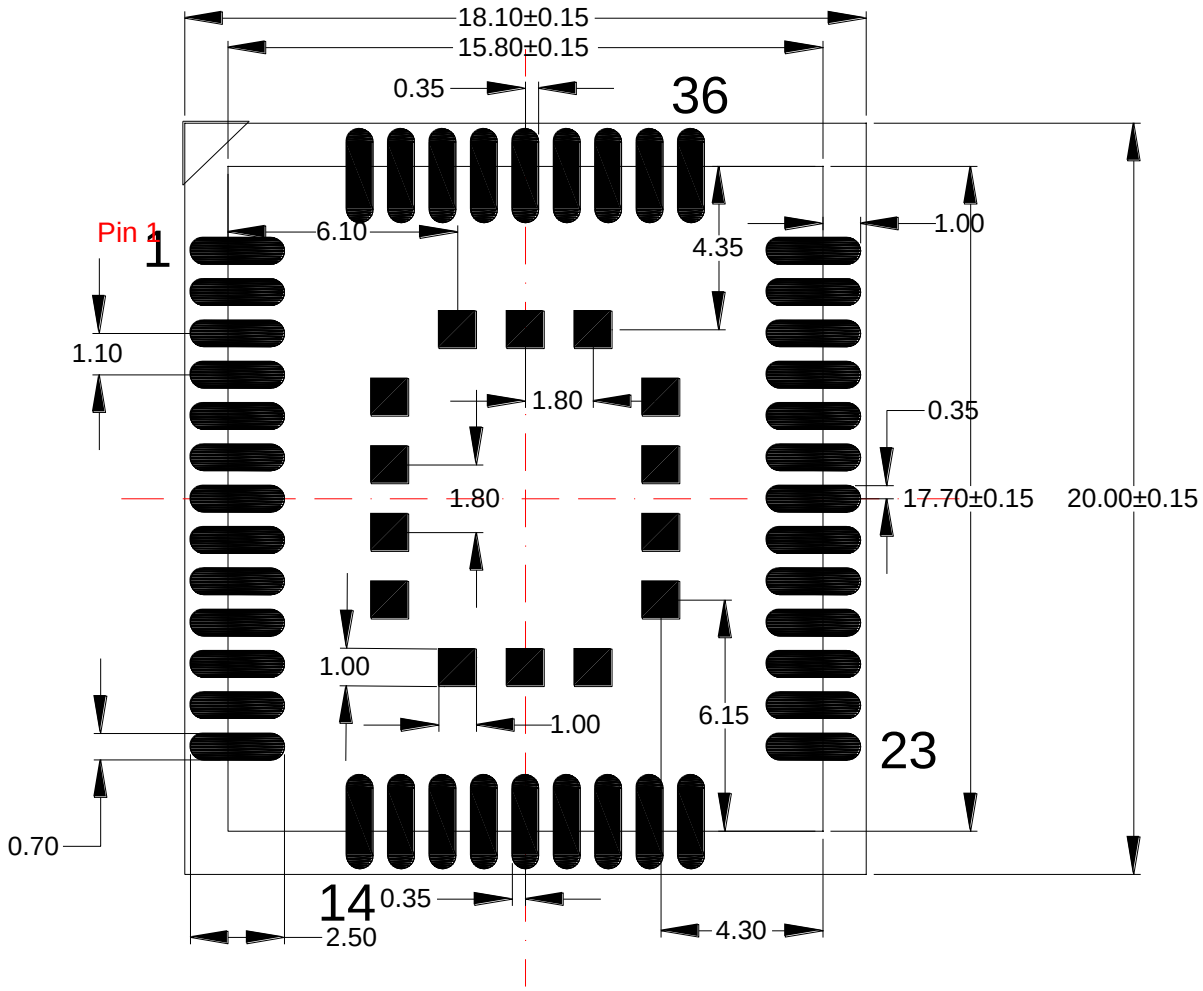

Figure 16: Recommended Footprint of BC66/BC660K-GL (Unit: mm)

NOTE

For easy maintenance of the module, it is recommended to keep a distance of about 3 mm between the module and other components on the motherboard.

The following is an installation sketch for the two modules:

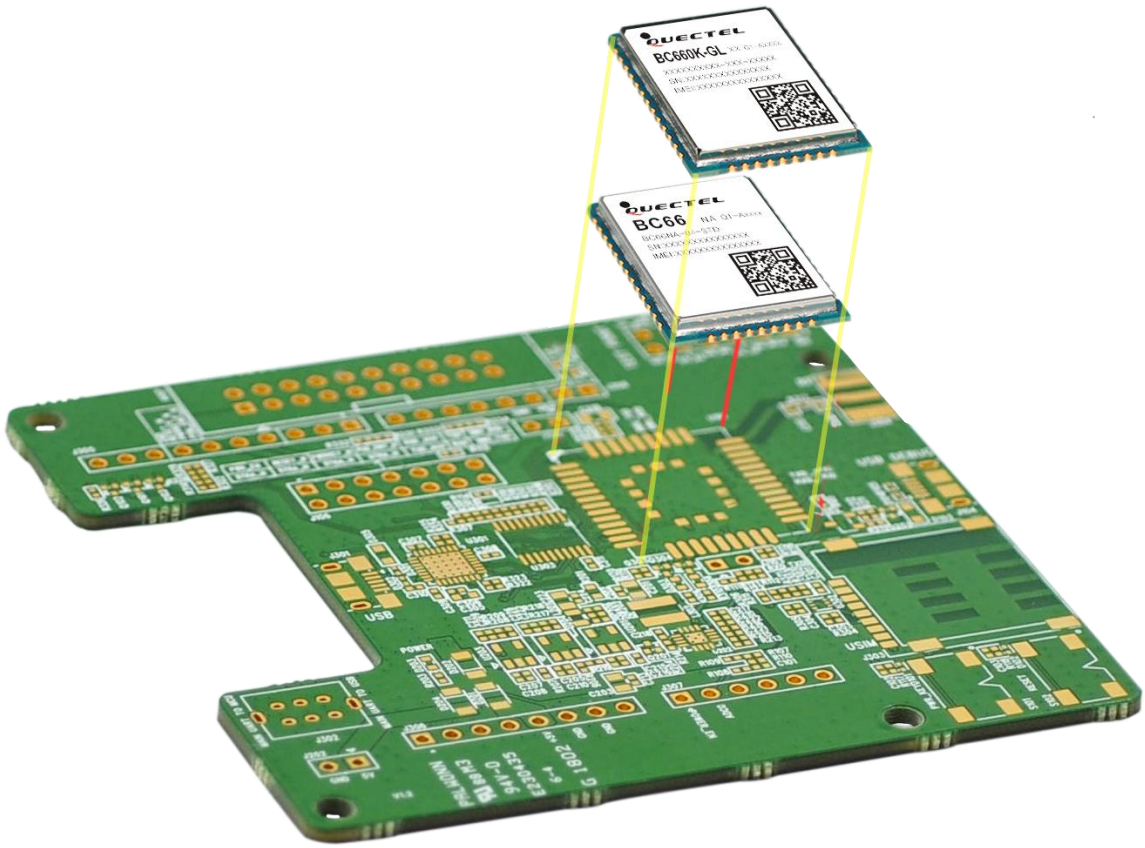

Figure 17: Installation Sketch for BC66&BC660K-GL

5.2. Recommended Stencil Design

BC66 and BC660K-GL have the same PCB thickness. To ensure soldering quality of the two modules, the thickness of stencil is recommended to be 0.15–0.18 mm. For more details, see ***document [1]*** and ***document [3]***.

6 Appendix References

Table 10: Related Documents

SN	Document Name	Description
[1]	Quectel_BC66_Hardware_Design	BC66 Hardware Design
[2]	Quectel_BC66_AT_Commands_Manual	BC66 AT Commands Manual
[3]	Quectel_BC660K-GL_Hardware_Design	BC660K-GL Hardware Design
[4]	Quectel_BC660K-GL_AT_Commands_Manual	BC660K-GL AT Commands Manual

Table 11: Terms and Abbreviations

Abbreviation	Description
ADC	Analog-to-Digital Converter
LCC	Leadless Chip Carriers
LGA	Land Grid Array
H-FDD	Half Frequency Division Duplexing
kbps	Kilo Bits Per Second
LED	Light Emitting Diode
NB-IoT	Narrow Band- Internet of Things
PCB	Printed Circuit Board
RF	Radio Frequency
RXD	Receive Data
SMS	Short Message Service
TXD	Transmitting Data

UART	Universal Asynchronous Receiver & Transmitter
USIM	Universal Subscriber Identification Module
Li-MnO2	Lithium Manganese Dioxide
Li-SOCl2	Lithium Thionyl Chloride