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FIBOCOM N510-GL Hardware User Manual

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Applicability type

No.	Product model	Description
1	N510-GL	The manual is suitable for N510-GL series products.

Copyright

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Trademark

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Versions

Version	Author	Assessor	Approver	Update Date	Description
V1.0.0	Wang yuanguang	Liuke	Chenguojiang	2019-06-13	Initial Version

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1 Foreword

This paper describes the electrical characteristics, RF performance, structure size and application environment of N510-GL module. With the help of this document and other related documents, developers can quickly understand the hardware functions of N510-GL module and develop products.

1.1 Introduction

This product is designed with reference to the following criteria:

- 3GPP TS 36.521-1 R13: User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: Conformance testing
- 3GPP TS 36.521-1 V14.5.0 *R14: User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: Conformance testing
- 3GPP TS 21.111 V10.0.0: USIM and IC card requirements
- 3GPP TS 51.011 V4.15.0: Specification of the Subscriber Identity Module -Mobile Equipment (SIM-ME) interface
- 3GPP TS 31.102 V10.11.0: Characteristics of the Universal Subscriber Identity Module (USIM) application
- 3GPP TS102.223 V07.06.0: Universal Subscriber Identity Module (USIM) Application Toolkit(USAT)

Cooperating with the following documents will help us to better understand and use this product:

- N510-GL Family AT Command Manual
- Fibocom N510-GL LCC+LGA SMT Application Design Description
- ADP-N510 Instruction Manual

1.2 Safety Instructions

By following the following safety principles, personal safety can be ensured and products and work environments can be protected from potential damage. The product manufacturer needs to communicate the following safety instructions to the end user. If these safety rules are not complied with, Fibocom will not bear any responsibility for the consequences of user misuse.

Road safety first! When you drive, do not use handheld mobile devices, even if they have hands-free functions.
Please stop before you call!

Please close the mobile terminal before boarding. The wireless function of the mobile terminal is prohibited from opening on the aircraft to prevent interference to the aircraft communication system. Ignorance of this prompt may lead to flight safety and even violation of the law.

When in hospitals or health care settings, please pay attention to whether there are restrictions on the use of mobile devices. Radio frequency interference may cause malfunction of medical equipment, so it may be necessary to turn off mobile terminal equipment.

Mobile terminal devices do not guarantee effective connection under any circumstances, such as when mobile terminal devices are not charged or (U) SIM is invalid. When you encounter these situations in an emergency, remember to use emergency calls, while ensuring that your device is on and in an area with sufficient signal strength.

Your mobile terminal device receives and transmits radio frequency signals at boot time. Radio Frequency Interference (RFI) occurs when it is close to TV, radio, computer or other electronic devices.

Please keep mobile terminal equipment away from flammable gas. Close the mobile terminal when you are near the gas station, oil depot, chemical plant or explosion workplace. Operating electronic equipment in any potentially explosive dangerous place has potential safety hazards.

2 Product Overview

2.1 Product Introduction

N510-GL is a highly integrated NB-IoT wireless communication module, which supports the R13 standard of NB-IoT specification. The product specifications of N510-GL are as follows:

Table2-1 Product Specifications

Specifications		
Operating Band	Band 1,2,3,4,5,8,12,13,17,18,19,20,25,26*,28,66,71,85	
Data Transmission	R13	Single-tone UL：15.6kbps
		Multi-tone UL：62.5kbps，DL：26.15kbps
	R14*	Single-tone UL：18.1kbps
		Multi-tone UL:158.5Kbps DL/126.8Kbps UL
Power	DC:3.3V~5V (3.8V DC power supply is recommended)	
Temperature	Operating temperature：-30°C~+75°C①	
	Extended temperature：-40°C~+85°C②	
	Storage: -40°C~+90°C	
Physical Characteristics	Package: LCC 42pin+LGA 28pin	
	Dimension: 22.2 x 20.2 x 2.1 mm	
	Weight:1.6g	
Interface		
Antenna	Antenna x 1	
Functional Interface	USIM 1.8V/3.0V	
	2 wire UART x 2，4 wire UART x 1	
	EINT、I2C、GPIO、System Indicator、ADC	
Software		
Protocol Stack	Embedded TCP/IP and UDP/IP protocol stack	
AT Command	3GPP TS 27.007 and 27.005, and proprietary FIBOCOM AT	
Firmware update	UART	

Remarks:

1.①It represents that the module can work normally in this temperature range, and the related performance meets the requirements of 3GPP standard.

2.②It indicates that the module can work normally in this temperature range and the baseband RF function is normal, but individual RF indicators may exceed the standard range of 3GPP. When the temperature returns to the normal working range of the module, the indicators of the

module will still meet the standard of 3GPP.

3.* B26 software is closed

NB1 Band: 1/2/3/4/5/8/12/13/17/18/19/20/25/26*/28/66/71/85 Max power 23dBm

Restriction of Hazardous Substances Directive (RoHS)

European Union

FIBOCOM products sold in the European Union, on or after 3 January 2013 meet the requirements of Directive 2011/65/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment ("RoHS recast" or "RoHS 2").

uropean Union compliance statement

CE European Union conformity

The following information is applicable to mobile devices that carry a CE mark.

EU Regulatory Conformance

Hereby, We, Manufacturer (Fibocom Wireless Inc.) declares that the radio equipment type N510-GL is in compliance with

the Directive 2014/53/EU.

In all cases assessment of the final product must be mass against the Essential requirements of the Directive 2014/53/EU Articles 3.1(a) and (b), safety and EMC respectively, as well as any relevant Article

RF exposure

This product meets the applicable national or international RF exposure guidance (EN62133) At normal use, the device is at least 20cm away from the human body. The RF exposure guidance includes a considerable safety margin designed to assure the safety of all persons, regardless of age and health.

FCC Certification Requirements.

According to the definition of mobile and fixed device is described in Part 2.1091(b), this device is a mobile device.

And the following conditions must be met:

1. This Modular Approval is limited to OEM installation for mobile and fixed applications only. The antenna installation and operating configurations of this transmitter, including any applicable source-based timeaveraging

duty factor, antenna gain and cable loss must satisfy MPE categorical Exclusion Requirements

of 2.1091.

2. The EUT is a mobile device; maintain at least a 20 cm separation between the EUT and the user's body and must not transmit simultaneously with any other antenna or transmitter.

3.A label with the following statements must be attached to the host end product: This device contains

FCC ID: ZMON510GL

4.To comply with FCC regulations limiting both maximum RF output power and human exposure to RF radiation, maximum antenna gain (including cable loss) must not exceed:

Operating Band	FCC Max Antenna Gain（dBi）
LTE NB1 BAND 2	9.00
LTE NB1 BAND 4	6.00
LTE NB1 BAND 5	10.41
LTE NB1 BAND 12	9.69
LTE NB1 BAND 13	10.15
LTE NB1 BAND 17	9.72
LTE NB1 BAND 25	9.00
LTE NB1 BAND 66	6
LTE NB1 BAND 71	9.46
LTE NB1 BAND 85	9.69

5. This module must not transmit simultaneously with any other antenna or transmitter

6. The host end product must include a user manual that clearly defines operating requirements and conditions that must be observed to ensure compliance with current FCC RF exposure guidelines.

For portable devices, in addition to the conditions 3 through 6 described above, a separate approval is required to satisfy the SAR requirements of FCC Part 2.1093

If the device is used for other equipment that separate approval is required for all other operating configurations, including portable configurations with respect to 2.1093 and different antenna configurations.

For this device, OEM integrators must be provided with labeling instructions of finished products.

Please refer to KDB784748 D01 v07, section 8. Page 6/7 last two paragraphs:

A certified modular has the option to use a permanently affixed label, or an electronic label. For a

permanently affixed label, the module must be labeled with an FCC ID - Section 2.926 (see 2.2 Certification (labeling requirements) above). The OEM manual must provide clear instructions explaining to the OEM the labeling requirements, options and OEM user manual instructions that are required (see next paragraph).

For a host using a certified modular with a standard fixed label, if (1) the module's FCC ID is not visible when installed in the host, or (2) if the host is marketed so that end users do not have straightforward commonly used methods for access to remove the module so that the FCC ID of the module is visible; then an additional permanent label referring to the enclosed module:"Contains Transmitter Module FCC ID: ZMON510GL" or "Contains FCC ID: ZMON510GL" must be used. The host OEM user manual must also contain clear instructions on how end users can find and/or access the module and the FCC ID.

The final host / module combination may also need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.

The user's manual or instruction manual for an intentional or unintentional radiator shall caution the user that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. In cases where the manual is provided only in a form other than paper, such as on a computer disk or over the Internet, the information required by this section may be included in the manual in that alternative form, provided the user can reasonably be expected to have the capability to access information in that form.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

To ensure compliance with all non-transmitter functions the host manufacturer is responsible for ensuring compliance with the module(s) installed and fully operational. For example, if a host was previously authorized as an unintentional radiator under the Supplier's Declaration of Conformity procedure without a transmitter certified module and a module is added, the host manufacturer is responsible for ensuring that the after the module is installed and operational the host continues to be compliant with the Part 15B unintentional radiator requirements.

Manual Information To the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

2.2 Application Diagram

Figure2-2 Hardware block diagram

2.3 Development Board

ADP-N510 is a development board for debugging of N510-GL module. With this development board, we can quickly master module functions and complete basic function testing. Refer to ADP-N510 Instructions for the Specific Use of Development Board.

3 Pin Distribution

3.1 Pin Distribution Chart

3.2 Pin Function Description

The pin definitions of the N510-GL module are as follows:

Table3-1 N510-GL Pin Definitions

PIN	PIN Name	I/O	PIN Description	DC Characteristics	Note
1	GND	--	GND	-	
2	GND	--	GND	-	
3	RF_ANT	I/O	Antenna	-	
4	GND	-	GND	-	
5	GND	-	GND	-	
6	NC	-	-	-	keep it open
7	GND	-	GND	-	
8	GND	-	GND	-	
9	VBAT	PI	Power supply for module	3.8V(3.3V-5V)	
10	VBAT	PI	Power supply for module	3.8V(3.3V-5V)	
11-12	NC	-	-	-	keep it open
13	VDD	PO	Power supply for external GPIO’ s pull up circuits	2.8V	If the pin is unused, keep it open
14	POWER_ON_N	I	POWER_ON	3.3V	

PIN	PIN Name	I/O	PIN Description	DC Characteristics	Note
15	UART1_DTR*	I	UART1 Terminal Ready, Can Reusable for GPIO	2.8V	If the pin is unused, keep it open
16	UART1_DSR*	O	UART1 Data Set Ready, Can Reusable for GPIO	2.8V	If the pin is unused, keep it open
17	UART1_DCD*	O	UART1 Data Carrier Detect, Can Reusable for GPIO	2.8V	If the pin is unused, keep it open
18	UART1_RXD	I	UART1_RXD	2.8V	If the pin is unused, keep
19	UART1_TXD	O	UART1_TXD	2.8V	If the pin is unused, keep it open
20	UART1_RTS	O	UART1_RTS	2.8V	If the pin is unused, keep it open
21	UART1_CTS	I	UART1_CTS	2.8V	If the pin is unused, keep it open
22	UART1_RING*	I/O	UART1 Ring indicator ,Can Reusable for GPIO	2.8V	If the pin is unused, keep it open
23	SIM_SIO	I/O	SIM_DATA	1.8/3V	
24	SIM_SCLK	O	SIM_SCL	1.8/3V	
25	SIM_SRST	O	SIM_RST	1.8/3V	
26	VSIM	PO	VSIM	1.8/3V	
27	SIM_DET	I	SIM_DET	2.8V	If the pin is unused, keep it open
28-31	NC	-	-	-	keep it open
32	GND	-	GND	-	-
33-36	NC	-	-	-	keep it open

PIN	PIN Name	I/O	PIN Description	DC Characteristics	Note
37	RESET	I	RESET	3.3V	If the pin is unused, keep it open
38	LPG	O	LPG	2.8V	If the pin is unused, keep it open
39	UART2_RXD	I	UART2_RXD	2.8V	If the pin is unused, keep it open
40	UART2_TXD	O	UART2_TXD	2.8V	If the pin is unused, keep
41	WAKEUP_IN	I	WAKEUP_IN	2.8V	If the pin is unused, keep it open
42-51	GND	-	GND	-	
52	I2C_SDA	I/O		2.8V	If the pin is unused, keep it open
53	NC	--	-	-	keep it open
54	GPIO1	-	-	-	If the pin is unused, keep it open
55	GND	-	GND	-	
56	I2C_SCL	O		2.8V	If the pin is unused, keep it open
57	GND	-	GND	-	
58	GPIO2	-	-	-	If the pin is unused, keep it open

PIN	PIN Name	I/O	PIN Description	DC Characteristics	Note
59	ADC1	I	General purpose analog to digital	-	If the pin is unused, keep it open
60	GND	-	GND	-	
61	WAKEUP_OUT	O	Wakeup HOST	2.8V	If the pin is unused, keep it open
62	GPIO3	-	-	-	If the pin is unused, keep it open
63	GND	-	GND	-	
64	ADC0	I	General purpose analog to digital converter.	1.4V	If the pin is unused, keep it open
65	GND	-	GND	-	
66	GND	-	GND	-	
67	GND	-	GND	-	
68	GND	-	GND	-	
69	GPIO4	-	-	-	If the pin is unused, keep it open
70	GND	-	GND	-	

I/O parameter description:

Table3-2 I/O parameter description

I/O Parameter	Description
IO	Bidirectional interface
PI	Power input
PO	Power output
I	Input
O	Output
*	TBD

Remarks:

The I/O interface power domain of the module defaults to 2.8V, and the power domain of ADC is

1.4V.

4 Work Mode

N510-GL provides the following four working modes.

Table4-1 N510-GL Mode of Work

Working mode	Describe	Characteristic
Off Mode	the power supply of Vbat is on, but the module is power off.	The module is shut down.
Standby Mode	The module is powered on and the VDD outputs 2.8V voltage. The LPG signal lamp pin state is slow flash (70ms low level/3000ms high level).	The module is fully started, and has been registered on the network, ready to communicate at any time. This is the default mode of operation after the module is booted.
Data Service	Module boot-up and successful network injection and data communication. The LPG signal lamp operates as a flash (70ms low level/70ms high level).	The module is transmitting data. When the transmission is over, the module returns to standby or low power mode.
Low Power Mode	The AT command enables the module to enter a low power mode.	The module serial communication in DRX mode is normal, while the serial communication in PSM and eDRX mode is closed. In low power mode, the module is still registered on the network and does not need to be re-attached after waking up.

4.1 Off Mode

The module needs to provide 3.3V-5V DC power supply through the VBAT pin. The module can turn on power by control POWER_ON pin.

4.2 Standby Mode

The module is powered on and the VDD outputs 2.8V voltage, which can be operated by AT command through serial port. Has registered on the network, no business processing, can communicate at any time, this is the default mode of operation after the module boots.

4.3 Data Service

The module boots up and successfully injects the network for business transmission. The LPG signal lamp indicates the working state. The AT instruction can be operated through the serial port, and the module carries out data transmission. When the transmission is over, the module returns to standby or low power mode.

4.4 Low power mode

The module is powered on and successfully injected into the network for business transmission. After that, the AT command operation control module enters the low power mode, or the module is in standby state for a long time, the module will enter the low power mode.

5 Electrical Characteristics

5.1 Power Supply

5.1.1 Description of Power Pin

The power interface of the N510-GL module is shown in the following table:

Table5-1 Definition of External Power Supply Interface Pin for Module

Pin	Pin Name	I/O	Pin Description	DC Parameter（V）		
				Minimum Value	Typical Value	Maximum Value
9,10	VBAT	PI	Power input	3.3V	3.8V	5V
13	VDD	PO	2.8V power output	2.6V	2.8V	3-
26	VSIM	PO	SIM power supply	-	1.8V/3.0V	-

5.1.2 Power Supply Design Requirements

N510-GL module needs to supply power through VBAT pin. In order to ensure the stability of power supply, it needs to use capacitance to filter DC power supply. The specific design is shown in Fig. 5-1.

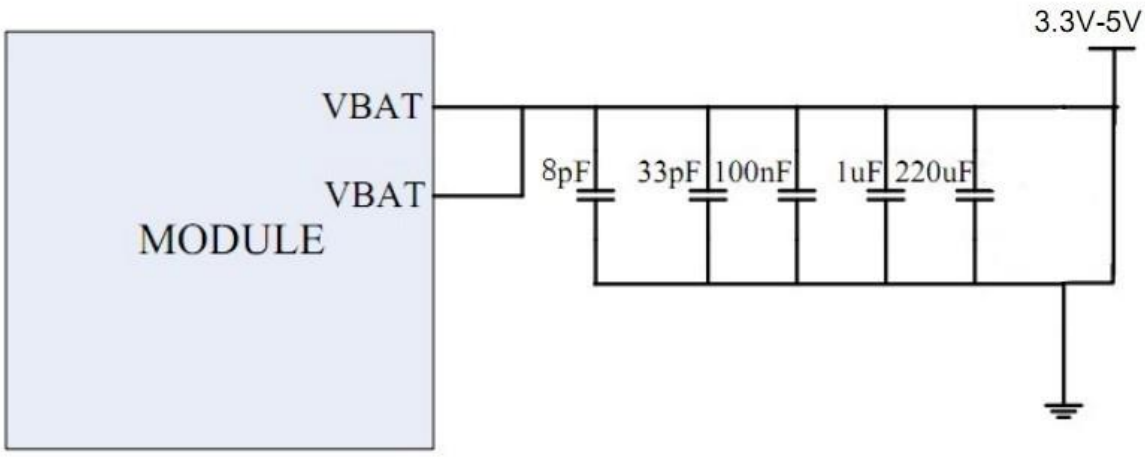

Figure5-1 Capacitance Combination Design of Power Supply Input

Capacitance combination design for power supply is described in the following table:

Table5-2 Capacitance Design Description of External Power Supply Circuit

Recommended Capacitor	Function	Instruction
220uF x 2	Voltage stabilizing capacitor	Low ESR capacitance is required to reduce power fluctuation when the module is working. No less than 440uF capacitor is required.
1uF、100nF	Digital Signal Noise	Eliminate interference from clocks and digital signals
33pF、8pF	900,1800 MHz Frequency Band	Elimination of Low and Medium Frequency Radio Frequency Interference

The stability of the power supply can ensure the normal operation of the N510-GL module. Special attention should be paid to the ripple of the power supply less than 300 mV in the design. When the module works, it is necessary to ensure that the DC power supply voltage is not less than 3.3V and not higher than 3.8V. The power supply limitation is shown in Figure 5-2.

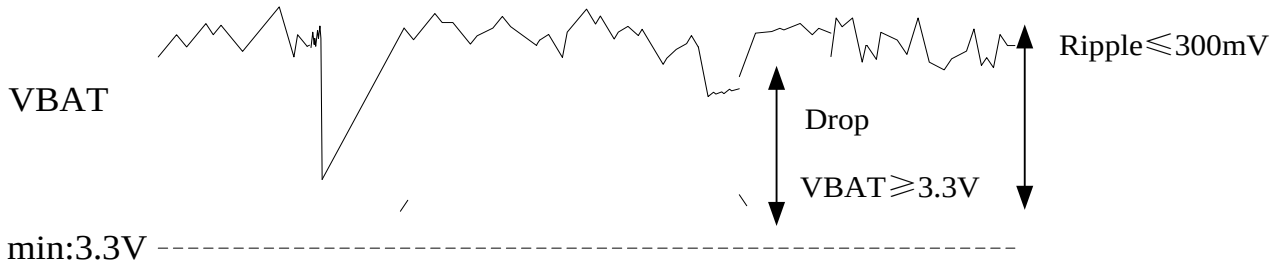

Figure5-2 Power Supply Limitation

Schematic design: it is necessary to stabilize and filter the power supply to ensure the power supply stability of the module.

PCB design: Ensure that the external power supply to VBAT is wide enough. It is suggested that the width of VBAT should be more than 1 mm and the small capacitance should be placed close to the module.

5.2 Electrostatic Protection Capability

ESD protection should be considered in the design of N510-GL module. The anti-static capability of the module pin is limited. The key input/output signal interface must be anti-static. The anti-static capability of the equipment can be improved by reasonable structure design and PCB layout design to ensure that the metal shield shell is completely grounded. The ESD voltage withstanding of the module pin is as follows:

Table5-3 Explanation of electrostatic protection capability of module pins (temperature: 25℃, humidity: 45%)

Test Location	Test Method	Contact Discharge	Air Discharge	Unit
Other interfaces	Contact and non-contact testing with an electrostatic gun	±1	±2	KV
Antenna core and antenna ground	Contact and non-contact testing with an electrostatic gun	±8	±15	KV

5.3 Mode Power Consumption

In the case of 3.8V power supply, the power consumption of the N510-GL module is shown in the following table:

Table5-4 Module Power Statistics Table

Parameter	Pattern	Describe		Typical Value
I_{sleep}	DRX	2.56s		2.1mA
	eDRX	20.48s		154uA
	PSM	Sleep mode		2.7uA
I_{active}	Active	BAND 1	RF Transmit mode, NB-LTE 15KHz,23dBm	117 mA
			RF Transmit mode, NB-LTE 3.75KHz,23dBm	184 mA
			RF Receive mode	19.4 mA
		BAND 2	RF Transmit mode, NB-LTE 15KHz,23dBm	115 mA
			RF Transmit mode, NB-LTE 3.75KHz,23dBm	180 mA
			RF Receive mode	19.4 mA
		BAND 3	RF Transmit mode, NB-LTE 15KHz,23dBm	115 mA

Parameter	Pattern	Describe		Typical Value
			RF Transmit mode, NB-LTE 3.75KHz,23dBm	183 mA
			RF Receive mode	19.4 mA
		BAND 4	RF Transmit mode, NB-LTE 15KHz,23dBm	113 mA
			RF Transmit mode, NB-LTE 3.75KHz,23dBm	174 mA
			RF Receive mode	19.4 mA
		BAND 5	RF Transmit mode, NB-LTE 15KHz,23dBm	135 mA
			RF Transmit mode, NB-LTE 3.75KHz,23dBm	201 mA
			RF Receive mode	19.4 mA
I_{active}	Active	BAND 8	RF Transmit mode, NB-LTE 15KHz,23dBm	120 mA
			RF Transmit mode, NB-LTE 3.75KHz,23dBm	190 mA
			RF Receive mode	19.4 mA
		BAND 12	RF Transmit mode, NB-LTE 15KHz,23dBm	130 mA
			RF Transmit mode, NB-LTE 3.75KHz,23dBm	198 mA
			RF Receive mode	19.4 mA
		BAND 13	RF Transmit mode, NB-LTE 15KHz,23dBm	146 mA
			RF Transmit mode, NB-LTE 3.75KHz,23dBm	226 mA
			RF Receive mode	19.4 mA
		Band 17	RF Transmit mode, NB-LTE 15KHz,23dBm	130 mA

Parameter	Pattern	Describe		Typical Value
	Active		RF Transmit mode, NB-LTE 3.75KHz,23dBm	191 mA
			RF Receive mode	19.4 mA
		Band 18	RF Transmit mode, NB-LTE 15KHz,23dBm	140 mA
			RF Transmit mode, NB-LTE 3.75KHz,23dBm	215 mA
			RF Receive mode	19.4 mA
		Band 19	RF Transmit mode, NB-LTE 15KHz,23dBm	134 mA
			RF Transmit mode, NB-LTE 3.75KHz,23dBm	208 mA
			RF Receive mode	19.4 mA
		Band 20	RF Transmit mode, NB-LTE 15KHz,23dBm	132 mA
			RF Transmit mode, NB-LTE 3.75KHz,23dBm	202 mA
			RF Receive mode	19.4 mA
I_{active}	Active	Band 25	RF Transmit mode, NB-LTE 15KHz,23dBm	112 mA
			RF Transmit mode, NB-LTE 3.75KHz,23dBm	173 mA
			RF Receive mode	19.4 mA
		Band 28	RF Transmit mode, NB-LTE 15KHz,23dBm	130 mA
			RF Transmit mode, NB-LTE 3.75KHz,23dBm	200 mA
			RF Receive mode	19.4 mA
		Band 66	RF Transmit mode, NB-LTE 15KHz,23dBm	113 mA

Parameter	Pattern	Describe		Typical Value
I_{active}	Active		RF Transmit mode, NB-LTE 3.75KHz,23dBm	176 mA
			RF Receive mode	19.4 mA
		Band 71	RF Transmit mode, NB-LTE 15KHz,23dBm	121 mA
			RF Transmit mode, NB-LTE 3.75KHz,23dBm	191 mA
			RF Receive mode	19.4 mA
		Band 85	RF Transmit mode, NB-LTE 15KHz,23dBm	120 mA
			RF Transmit mode, NB-LTE 3.75KHz,23dBm	190 mA
			RF Receive mode	19.4 mA

6 Functional Interface

6.1 Control Interface

6.1.1 Module Startup

6.1.1.1Explanation of switch pin

N510-GL module switch pins are defined as follows:

Table6-1 Definition of Switch Interface Pin

PIN	Pin Name	I/O	Pin Description	Power Domain （TYP）
14	POWER_ON	I	Power ON	3.3V

6.1.1.2 Startup Operation Requirements

When the N510-GL module is in shutdown mode, the module can be turned on by lowering POWER_ON (800 ms < lowering time < 2.5s). It is recommended that OC/OD drive circuit be used to control POWER_ON pin, and the low-level voltage must be less than or equal to 0.5V when POWER_ON is turned on. The reference circuit is shown in the following figure:

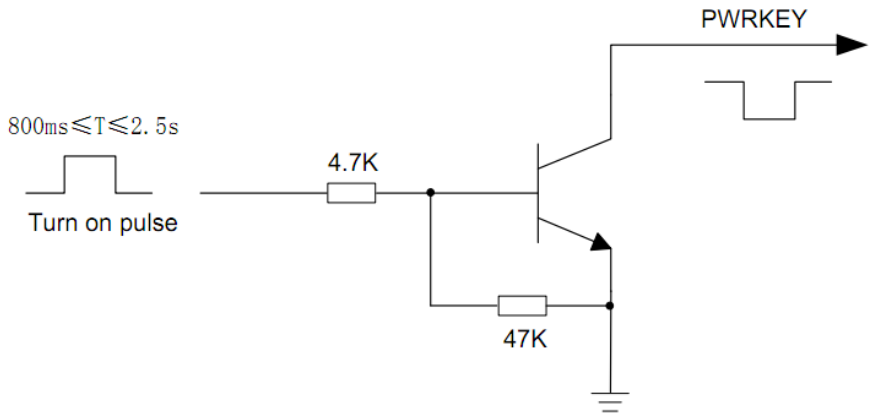

Figure6-1 OC/OD Driver Reference Switch-on Circuit

Another way to control the POWER_ON pin is to use a button switch directly. A TVS (recommended ESD9X5VL-2/TR) is placed near the button for ESD protection. The reference circuit is shown in the following figure:

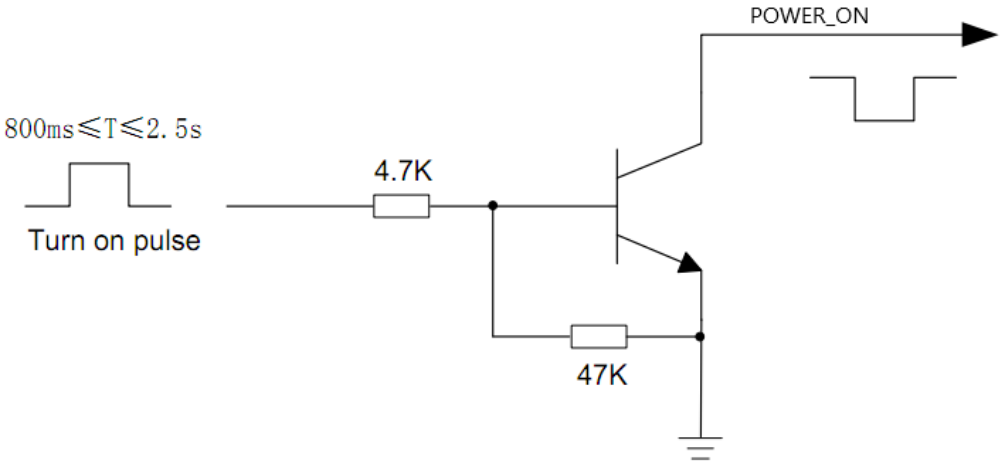

Figure6-2 Key Boot Reference Circuit

6.1.1.3 Boot Time Sequence

After the module is powered on, pull down POWER_ON greater than 800 ms less than 2.5s, and the module will start. At this time, the module VDD outputs 2.8V voltage, and the module starts the initialization process.

The start-up sequence is shown in the following figure:

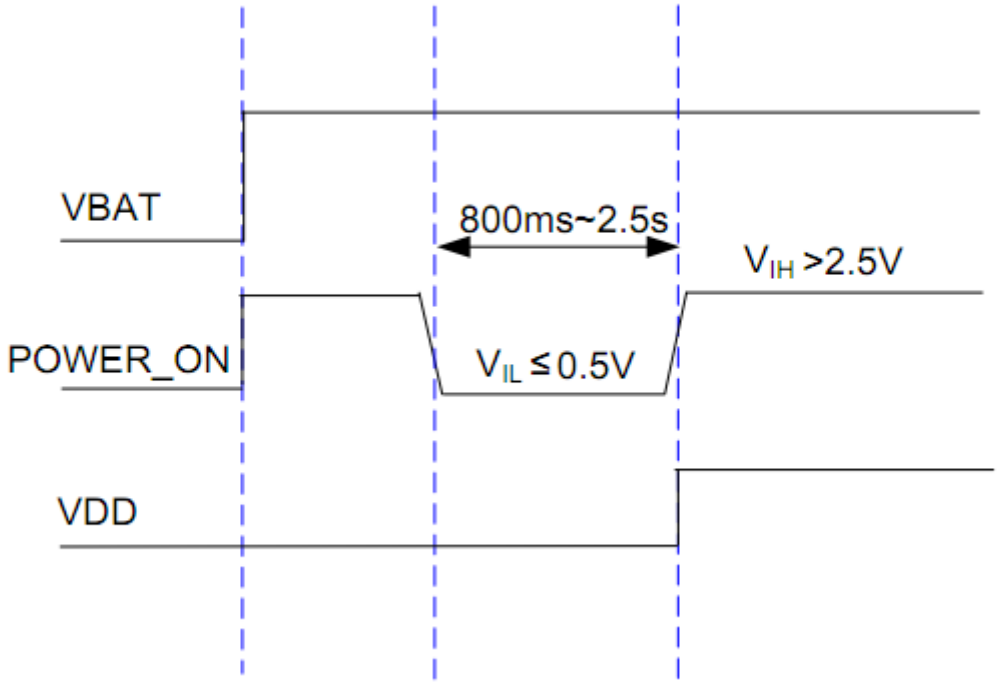

Figure 6-3 Bootup Sequence Diagram

6.1.2 Module Shutdown

6.1.2.1 Shutdown Operation Requirements

When the N510-GL module is in boot mode, the module can be shut down by pulling down

POWER_ON (2.1s < pull down time < 6s). It is recommended to use OC/OD driver circuit to control POWER_ON pin, and to lower the low-level voltage when POWER_ON is turned off must be less than 0.5V.

6.1.2.2 Shutdown Mode

The module supports the following shutdown modes:

Table6-2 Shutdown Mode

Shutdown Mode	Shutdown Method	Applicable Scenario
Hardware shutdown	Pull down PWRKEY (2.1s≤Pull down time <6s) and release it.	Normal shutdown
Software shutdown	AT+CPWROFF	Shutdown needs to be achieved through software control
Low Voltage Shutdown	When VBAT voltage is too low (less than3.3V) or power off, the module will shut down.	Module exceptions

6.1.2.3 Shutdown Time

By lowering the VBAT, the power management unit (PMU) of the module will power off, and the module will realize hardware shutdown. The timing of hardware shutdown control is shown in the following figure:

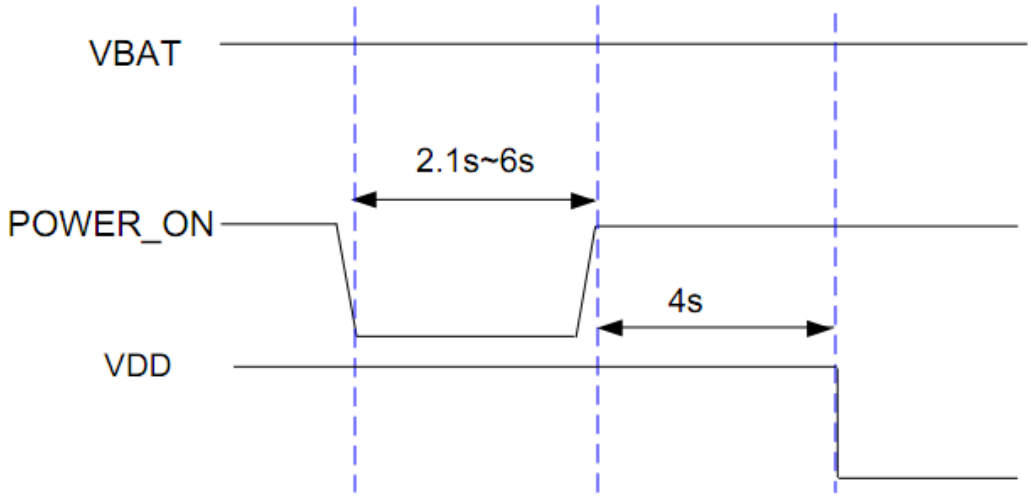

Figure6-4 Hardware shutdown control sequence

Remarks:

After the first POWER_ON power off, 4s is needed between the second POWER_ON power on

6.1.3 Reset

6.1.3.1 Reposition Pin Description

Table6-3 Reposition pin description

PIN	Pin Name	I/O	Pin Description	Power Domain （TYP）
37	RESET	I	Reset signal	3.3V

6.1.3.2 Instructions for the Use of Reset

The module supports reset function. By pulling down the RESET signal more than 40 ms (recommended value is 50 ms), over 60ms, the module will RESET again ,the module can be reset to the initial state. After releasing the RESET, the module will restart. RESET can be suspended when not in use. The low level voltage when pulling down RESET to start must be less than or equal to 0.5V.

RESET control sequence is shown in the following figure:

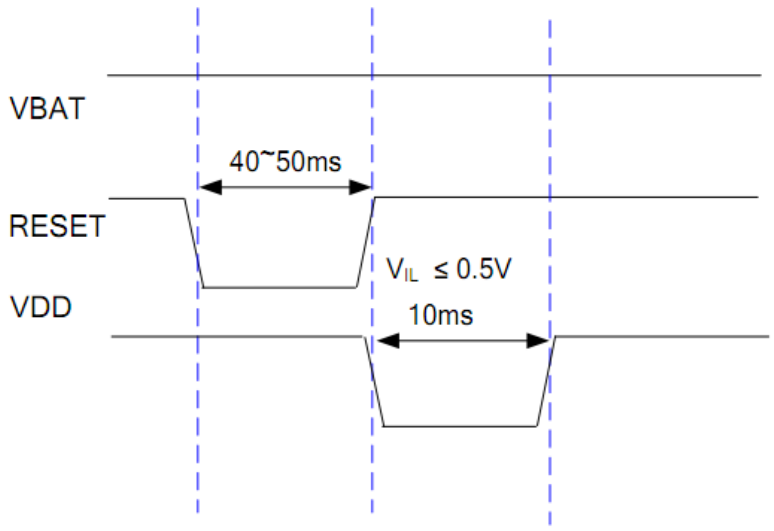

Figure6-5 Reset control timing

Remarks:

RESET is a sensitive signal. It is recommended to add a de-jitter capacitor near the module end. PCB layouts should be far away from radio frequency interference and do a good job of packet processing, while avoiding the edge and surface alignment of PCB (to avoid ESD causing module reset).

6.1.4 Flight Mode

The module supports software-controlled flight mode switches and sends AT instructions to the module through serial port 1 (AT serial port):

AT+CFUN=4

The module can enter the flight mode.

The module exits the flight mode by sending the following AT instructions to the module through the serial port 1 (AT serial port):

AT+CFUN=1

The module can exit the flight mode and enter the normal working mode.

6.2 Indicator Interface

6.2.1 Pin Description

The N510-GL module provides a signal to display the working status of the module. The status indicator pin is shown in the following table:

Table6-4 Instructions for Interface Pins of Indicators

PIN	Pin Name	I/O	Pin Description	Power Domain （TYP）
38	LPG	O	Indicate the work and network status of the module	2.8V

6.2.2 Working State Indication

N510-GL module network indicator LPG status description.

Table6-5 Description of the Working State of Indicator Lamp

Mode	NET_MODE	Describe
1	Flash(600ms High /600ms Low)	No SIM card Registration Network(T<15S) Net failure
2	Slow flash(70ms Low /3000ms High)	Successful standby of network injection
3	Fast flash(70ms Low /70ms High)	Data Link Establishment
4	Low	Shutdown Sleep PSM/eDRX

6.3 SIM Card Interface

The N510-GL module supports 1.8V and 3V SIM cards.

6.3.1 SIM Pin Description

The SIM pin is shown in the following table:

Table6-6 Module SIM Card Pin Description

PIN	Pin Name	I/O	Pin Description	Power Domain （TYP）
23	SIM_SIO	IO	USIM card data pin	1.8V/3.0V
24	SIM_SCLK	O	USIM card clock pin	1.8V/3.0V
25	SIM_SRST	O	USIM card reset pin	1.8V/3.0V
26	VSIM	PO	USIM card power supply	1.8V/3.0V
27	SIM_DET	I	USIM card in-place detection pin, high level effective, high level means SIM card insertion, low level means SIM card pullout.	2.8V

6.3.2 SIM Interface Circuit

The reference circuit of SIM card holder with detection signal is designed as follows:

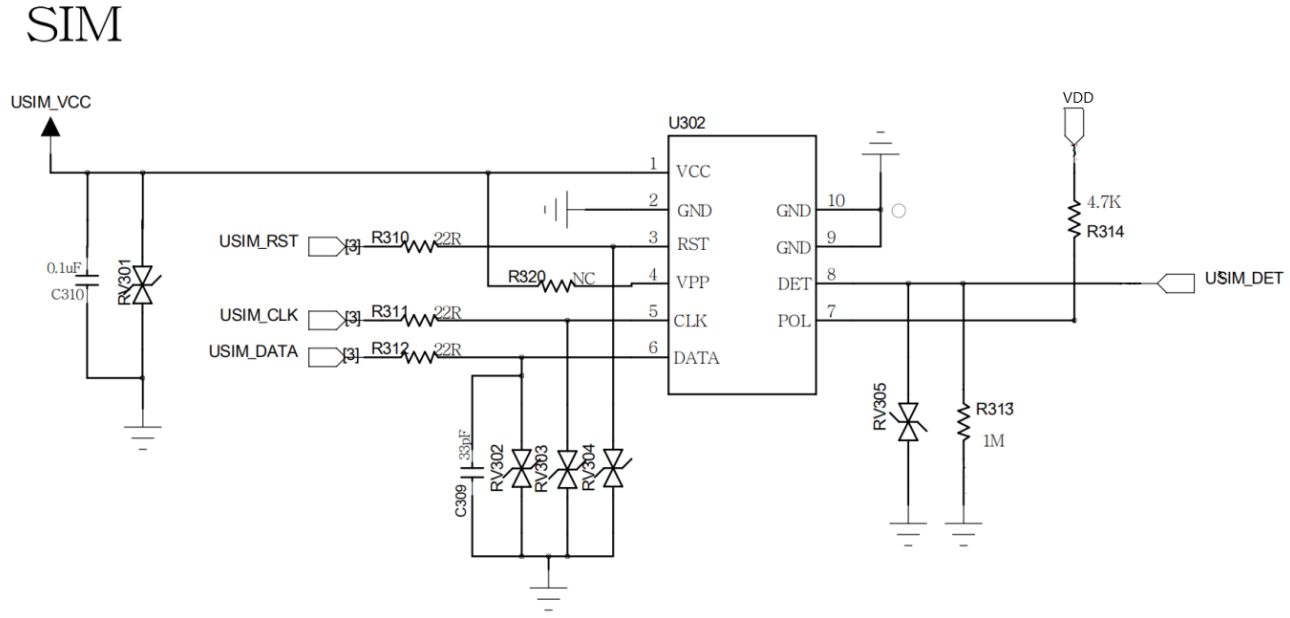

Figure6-8 SIM Card Reference Circuit with Detection Signal

The principle of SIM card holder with detection signal is explained as follows:

- SIM card insertion, SIM_DET and SIM card socket pin 7 short circuit, SIM_DET is high level.

- SIM card pull out, SIM_DET and SIM card socket pin 7 open circuit, SIM_DET is low level.
- SIM plug-in check function is turned off by default, and this function should be turned on through software settings.

6.3.3 SIM Card Circuit Design Requirements

The circuit design of SIM card needs to meet the requirements of EMC standard and ESD. At the same time, it needs to improve the anti-interference ability to ensure that the SIM card can work steadily. The following points should be strictly observed in the design:

- The layout of SIM card holder is as close as possible to the module and away from strong interference sources such as RF antenna, DCDC power supply and clock signal line.
- The SIM card with metal shielding case is adopted to improve the anti-interference ability.
- The line length from module to SIM card holder should not exceed 100 mm, too long line will reduce the signal quality.
- SIM_CLK and SIM_DATA signals are packaged and isolated to avoid mutual interference. If it is difficult to do so, at least SIM signals need to be protected as a group of packets.
- The filter capacitor of SIM card signal line and ESD device are placed near the SIM card holder. The equivalent capacitance of ESD device should be 22-33 pF capacitor.

6.4 UART

6.4.1 UART Pin Description

The N510-GL module provides two UART interfaces for asynchronous serial communication with a default baud rate of 115200. UART1 and UART2 interface supports AT command, but cannot be used at the same time, The UART interface definition is shown in the following table:

Table6-8 Module UART Pin Description

PIN	Pin Name	I/O	Pin Description	Power Domain（TYP）
15	UART1_DTR*	I/O	UART1 Terminal Ready	2.8V
16	UART1_DSR*	I/O	UART1 Data Set Ready	2.8V
17	UART1_DCD*	I/O	UART1 Data Carrier Detect	2.8V
18	UART1_RXD	I	UART1 Receive Data	2.8V
19	UART1_TXD	O	UART1 Transmit Data	2.8V
20	UART1_RTS	O	UART1 Clear To Send	2.8V
21	UART1_CTS	I	UART1 Request To Send	2.8V

PIN	Pin Name	I/O	Pin Description	Power Domain（TYP）
22	UART1_RING*	I/O	UART1 Ring indicator	2.8V
39	UART2_RXD	I	UART2 Receive Data	2.8V
40	UART2_TXD	O	UART2 Transmit Data	2.8V

6.4.2UART Interface Application

The connection between the N510-GL module (DCE) UART interface and the MCU (DTE) signal is shown in the following figure:

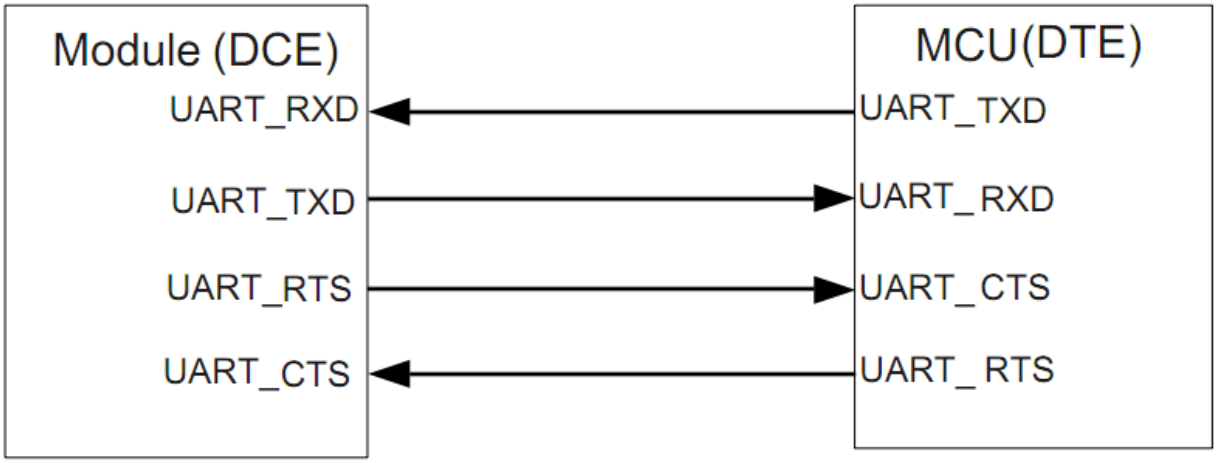

Figure6-9 Diagram of UART Signal Connection between Module and MCU

The UART interface level of N510-GL module is 2.8V. If the serial level of the system used by the customer is not 2.8V, we need to add a level conversion circuit in the serial connection between the module and the customer system. We can choose the serial level conversion chip directly according to our own needs. Customers can also use the level conversion circuit shown below. Module_VDD is 2.8V output level of 20 pins of N510-GL module, and MCU_VDD is the system serial port level for customers.

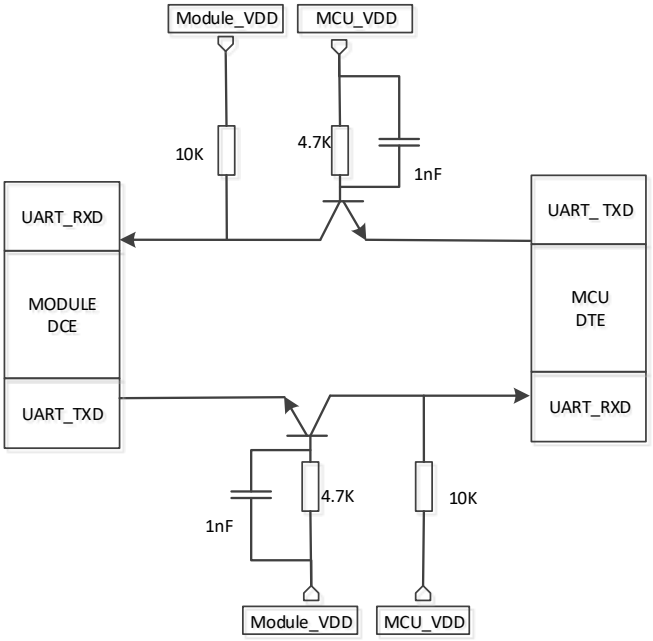

Figure6-10 Module and MCU UART Level Conversion Circuit

For more information on the application of UART serial port, please refer to “FIBOCOM UART Application Design Instructions”.

6.5 I2C

N510-GL provides a set of I2C interfaces, which are defined as follows:

Table6-9 I2C pin definition description

PIN	Pin Name	I/O	Pin Description	Power Domain （TYP）
56	I2C_SCL	I/O	I2C Serial Clock Signal (The pin can be suspended when not in use.)	2.8V
52	I2C_SDA	O	I2C Serial Port Data Signal(The pin can be suspended when not in use.)	2.8V

Because the N510-GL module has pulled up the I2C signal to 2.8V through 4.7K resistance, it is not necessary to pull up the I2C signal in the actual use process.

6.6 ADC

6.6.1 ADC Pin Description

The definition of ADC pin is as follows:

Table6-10 Module A/D Conversion Pin Description

PIN	Pin Name	I/O	Pin Description	Power Domain （TYP）
64	ADC0	I	Input pin of analog-to-digital conversion	1.4V
59	ADC1	I	Input pin of analog-to-digital conversion	1.4V

6.6.2 ADC Instructions for Use

The N510-GL module provides a 10-bit analog-to-digital conversion input pin with an accuracy of about 1.4 mV. Users can use the pin to measure the input voltage, ranging from 0 to 1.4 V. The analog-to-digital conversion function can not work properly in the PSM/eDRX mode.

7 Low Power Design

7.1.1 DRX

N510-GL supports DRX mode. Modules access the network normally. Without applying for PSM and eDRX, if there is no data service interaction, the module will automatically enter the lower power DRX mode (sending configuration messages automatically from the network side). In this mode, the bottom current of the module entering low power consumption is about 200 uA, and the average power consumption is reduced to 3.7 mA. UART and GPIO work normally in DRX mode.

7.1.2 eDRX

N510-GL can enter eDRX low-power mode, which can greatly reduce power consumption to 140uA.When the module needs to enter eDRX, it sends the request in the request message. The network configures the request value of the module in the reply message, and the module enters the eDRX mode. In this mode, UART and GPIO can work properly when the internal part of the module is powered off; moreover, the module has been registered on the network and can quickly enter standby state after waking up.

Entering eDRX requires sending the following AT instructions:

Send commands: AT + CEDRXS =1 or AT + CEDRXS = 2,5, "0011"

Description: The module will save the eDRX configuration. Once the eDRX is set successfully, if the instruction to exit the eDRX is not sent, the module will enter the eDRX mode. Even if the module is powered on and off again, the module can automatically enter the eDRX mode after reboot. Users can enter eDRX mode by sending the following AT instructions and request the period of eDRX on the network side. When the period of eDRX downward from the network side is more than 81.92 s, the module goes into deep sleep mode, otherwise it is shallow sleep mode. 0011 represents the period of eDRX requests from users to the network, which is 40.96 seconds. Users can set their own eDRX according to the protocol.

Users can use AT + CEDRXRDP command to query the period value of eDRX and PTW window time issued on the network side.

To exit eDRX, you need to send the following AT instructions:

Send command: AT + CEDRXS = 0

Description: The module will save the eDRX configuration. Once the instructions are successfully sent out of the eDRX mode, the module will not enter the eDRX mode unless the instructions are re-sent into the eDRX mode. Even if the module is powered on and off again, the module will not automatically enter the eDRX mode after restart.

7.1.3 PSM

N510-GL can enter the power saving mode, which has lower power consumption and a typical value of 2.8uA. In this mode, the module is basically powered off, only the clock circuit is powered on, and the wake-up function is supported.

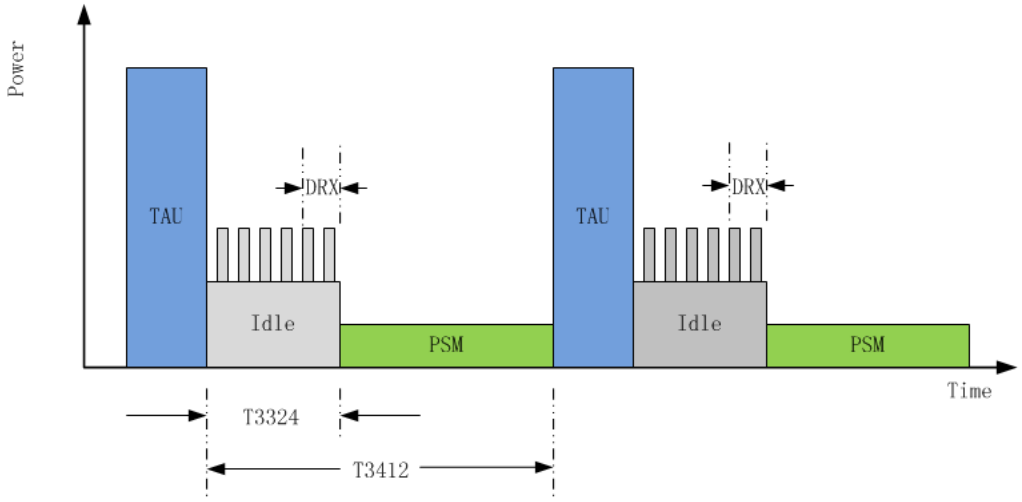

Figure 7-1 Current Diagram of PSM Working Time

When the module needs to enter the PSM, it will send the application to enter the PSM in the request message, and the network will send the agreed entry message in the reply message, and configure the T3324 and T3412 timers. The timer T3324 enters the PSM after timeout; after entering the PSM, the timer T3412 timeout, the module will automatically wake up and start paging.

PSM Entry:

1.Send commands: AT+CPSMS=1 or AT+CPSMS=1,,,"01000111","00100100"

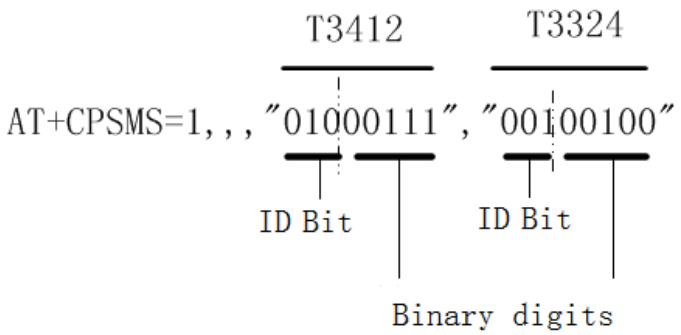

Figure 7-2AT instruction description entering PSM mode

The parameters can be customized, as shown in the table below. Actually, the network download configuration is used.

Table6-7 PSM Timer Configuration Correspondence Table

T3324 ID Bit		**T3412 ID Bit**	
Code	Time	Code	Time
000	2s	000	10min
001	1min	001	1h
010	6min	010	10h
011	1min	011	2s
100	1min	100	30s
101	1min	101	1min
110	1min	110	320h
111	Timer Close	111	Timer Close

After T3324 timeout, the module automatically enters the PSM; after T3412 timeout, the module automatically exits the PSM.

2. The module is rebooted, powered on and off, saved and configured. After booting, there is no data transmission service in the time of T3324 timer configuration, and it can automatically enter the PSM.

PSM Exit:

1. Pull down the WAKEUP_IN pin to wake up and automatically try to access the network, the descent edge is valid.

2. Pull down the POWER_ON module (700-800ms) to wake up and automatically try to access the network.

3. T3412 clock timeout module will automatically wake up and automatically access the network.

If any of the above three conditions are satisfied, the module can exit the PSM mode.

8 RF Specifications

8.1 operating Frequency Band

The N510-GL module provides a main antenna interface for receive and transmit radio frequency signals. The operating frequency band of the module is shown in the following table:

Table8-1 Description of operating frequency band of module

Band	Description	Mode	Tx (MHz)	Rx (MHz)
Band 1	2100MHz	NB-IOT	1920-1980	2110-2170
Band 2	1900MHz	NB-IOT	1850-1910	1930-1990
Band 3	1800MHz	NB-IOT	1710-1785	1805-1880
Band 4	2100MHz	NB-IOT	1710-1755	2110-2155
Band 5	850MHz	NB-IOT	824-849	869-894
Band 8	900 MHz	NB-IOT	880-915	925-960
Band 12	700 MHz	NB-IOT	699-716	729-746
Band 13	700 MHz	NB-IOT	777–787	746-756
Band 17	700 MHz	NB-IOT	704–716	734-746
Band 18	800 MHz	NB-IOT	815–830	860-875
Band 19	800 MHz	NB-IOT	830-845	875-890
Band 20	800 MHz	NB-IOT	832-862	791-821
Band 25	1900 MHz	NB-IOT	1850-1915	1930-1995
Band 28	700MHz	NB-IOT	703-748	758-803
Band 66	2100 MHz	NB-IOT	1710-1780	2110-2180
Band 71	600 MHz	NB-IOT	663-698	617-652
Band 85	700 MHz	NB-IOT	698-716	728-746

8.2 Transmission Power

The transmission power of each band of the N510-GL module is shown in the following table:

Table8-2 Explanation of Transmitting Power of Modules in Each Frequency Band

Mode	Band	Tx Power(dBm)
NB-IOT	Band 1	23±1
NB-IOT	Band 2	23±1
NB-IOT	Band 3	23±1
NB-IOT	Band 4	23±1
NB-IOT	Band 5	23±1

Mode	Band	Tx Power(dBm)
NB-IOT	Band 8	23±1
NB-IOT	Band 12	23±1
NB-IOT	Band 13	23±1
NB-IOT	Band 17	23±1
NB-IOT	Band 18	23±1
NB-IOT	Band 19	23±1
NB-IOT	Band 20	23±1
NB-IOT	Band 25	23±1
NB-IOT	Band 28	23±1
NB-IOT	Band 66	23±1
NB-IOT	Band 71	23±1
NB-IOT	Band 85	23±1

8.3 Reception Sensitivity

The receiving sensitivity of N510-GL module with and without retransmit is as follows:

Table 8-3 Module Frequency Band Sensitivity Description

Mode	Band	Rx Sensitivity Level with Retransmit (dBm)	Rx Sensitivity Level without Retransmit (dBm)
NB-IOT	Band 1	-129±1	-115
NB-IOT	Band 2	-129±1	-115
NB-IOT	Band 3	-129±1	-115
NB-IOT	Band 4	-129±1	-115
NB-IOT	Band 5	-129±1	-115
NB-IOT	Band 8	-129±1	-115
NB-IOT	Band 12	-129±1	-115
NB-IOT	Band 13	-129±1	-115
NB-IOT	Band 17	-129±1	-115
NB-IOT	Band 18	-129±1	-115
NB-IOT	Band 19	-129±1	-115
NB-IOT	Band 20	-129±1	-115
NB-IOT	Band 25	-129±1	-115
NB-IOT	Band 28	-129±1	-115
NB-IOT	Band 66	-129±1	-115
NB-IOT	Band 71	-129±1	-115
NB-IOT	Band 85	-129±1	-115

NB-IoT supports more retransmissions than traditional methods. Every time the number of retransmissions doubled, the rate would be halved and the gain would be 3 dB.

8.4 Communication Antenna

8.4.1 Antenna Interface

The N510-GL module provides an antenna interface as shown in the following table:

Table8-3 Description of Line Interface Pins

PIN	Pin Name	I/O	Pin Description	Power Domain （TYP）
3	RF_ANT	I	Antenna	-

8.4.2 Antenna Design Requirements

The antenna design requirements are shown in the following table:

Table8-4 Modular Antenna Design Requirements

N510-GL Module Main Antenna Requirements	
Frequency Range	The most suitable antenna must be used to adapt the relevant frequency band.
Bandwidth (NB-IOT)	NB-IOT Band1:250MHz NB-IOT Band2:140MHz NB-IOT Band3:170MHz NB-IOT Band4:445MHz NB-IOT Band5:70MHz NB-IOT Band8:80MHz NB-IOT Band12:47MHz NB-IOT Band13:41MHz NB-IOT Band17:42MHz NB-IOT Band18:60MHz NB-IOT Band19:60MHz NB-IOT Band20:71MHz NB-IOT Band25:145MHz NB-IOT Band28:100MHz NB-IOT Band66:470MHz

N510-GL Module Main Antenna Requirements	
	NB-IOT Band71:81MHz NB-IOT Band85:48MHz
Impedance	50 ohms
Input Power	23dBm
Standing wave ratio recommended	≤ 2:1

The N510-GL module is not protected by ESD. Therefore, ESD treatment is needed for all sensitive components in the module. In the whole processing, processing and operation, the module should have proper anti-static treatment.

8.5 RF PCB Design

8.5.1 Route Principle

The N510-GL module is designed with a single antenna for transmitting and receiving RF signals. RF line is recommended to take microstrip line, the route is as short as possible, and do a good job of 50_impedance control.

A PI-type circuit is reserved between the N510-GL module and the antenna connector for antenna debugging. The two parallel devices are directly connected to the RF line without pulling out the branch. When the distance between the antenna and the module is more than 1 cm, matching is needed at both ends of the module and the antenna.

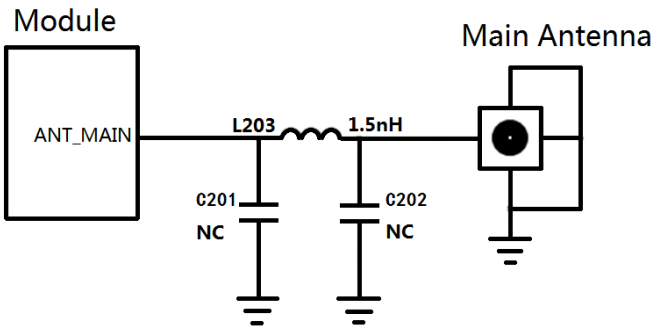

Figure8-1 Modular Antenna Pi Circuit

8.5.2 Impedance Design

The RF signal cable impedance of the antenna interface must be controlled at 50Ω.

For more information, please refer to “FIBOCOM_RF Antenna Application Design Instructions”.

9 Reliability

9.1 Ambient Temperature Range

Normal operation of the module needs to be within a certain temperature range. The specific ambient temperature range of N510-GL is shown in the table below.

Table8-1 Ambient Temperature Range for Module Operation

Parameter	minimum value	Typical value	Maximum value	Unit
Working environment temperature	-30	25	75	°C
Extended Working temperature	-40	25	85	°C
Storage temperature	-40	-	90	°C

9.2 Environmental Reliability Requirements

In order to improve the reliability and stability of the product, the module has carried out a series of reliability tests. The specific test contents are shown in the table below.

Table8-2 Environmental Reliability Requirements for Module Work

Item	Testing Conditions
Cryogenic storage test	Temperature:-40℃±3℃.Module test lasts 24 hours in shutdown state.
High Temperature Storage Testing	Temperature:+85℃±3℃.Module test lasts 24 hours in shutdown state.
Temperature impact test	Under shutdown condition, 24 cycles were carried out under the conditions of temperature-40 and + 85 respectively for 0.5 h and temperature conversion time less than 3 min.
High Temperature and Humidity Test	Temperature:+85℃±3℃. Humidity:90~95%RH. Module test lasts 24 hours in shutdown state.

<table>
<tr><th>Item</th><th>Testing Conditions</th></tr>
<tr><td>Low temperature operation test</td><td>Temperature:-30℃±3℃. Module test lasts 24 hours in work state.</td></tr>
<tr><td>High temperature operation test</td><td>Temperature:+75℃±3℃. Module test lasts 24 hours in work state.</td></tr>
<tr><td>Vibration test</td><td>Vibration tests are carried out according to the requirements shown in the table below.
<table>
<tr><td>Frequency</td><td>Random Vibration ASD (Acceleration Spectrum Density)</td></tr>
<tr><td>5~20Hz</td><td>0.96m2/s3</td></tr>
<tr><td>20~500Hz</td><td>0.96m2/s3(20Hz),Other-3dB/octave</td></tr>
</table></td></tr>
<tr><td>Life Test of Connector</td><td>RF antenna interface cables need 30 plug-in tests</td></tr>
</table>

All the above tests have passed.

9.3 ESD Design Requirements

In module application, ESD protection should be paid attention to because of the static electricity generated by human body electrostatic and charged friction between microelectronics, which may cause certain damage to the module by discharging it in various ways. ESD protection measures should be adopted in production, assembly and testing, especially in product design. For example, anti-static protection should be added at the interface of circuit design and the point vulnerable to electrostatic discharge damage or influence, and anti-static gloves should be worn in production.

Because the module is embedded in the system board, ESD protection should be considered in the design. Key input/output signal interfaces, such as SIM card signal interface, antenna interface, UART should be placed near the interface. In addition, the system board should have reasonable structure design and PCB layout design to ensure that the metal shield shell is completely grounded, so as to achieve good ESD protection.

10 Structural Specifications

10.1 Product Appearance

The product appearance of the N510-GL module is shown as follows:

Figure10-1 Module Appearance Diagram

10.2 Structure Size

The detailed structure size of the N510-GL module is shown in the following figure:

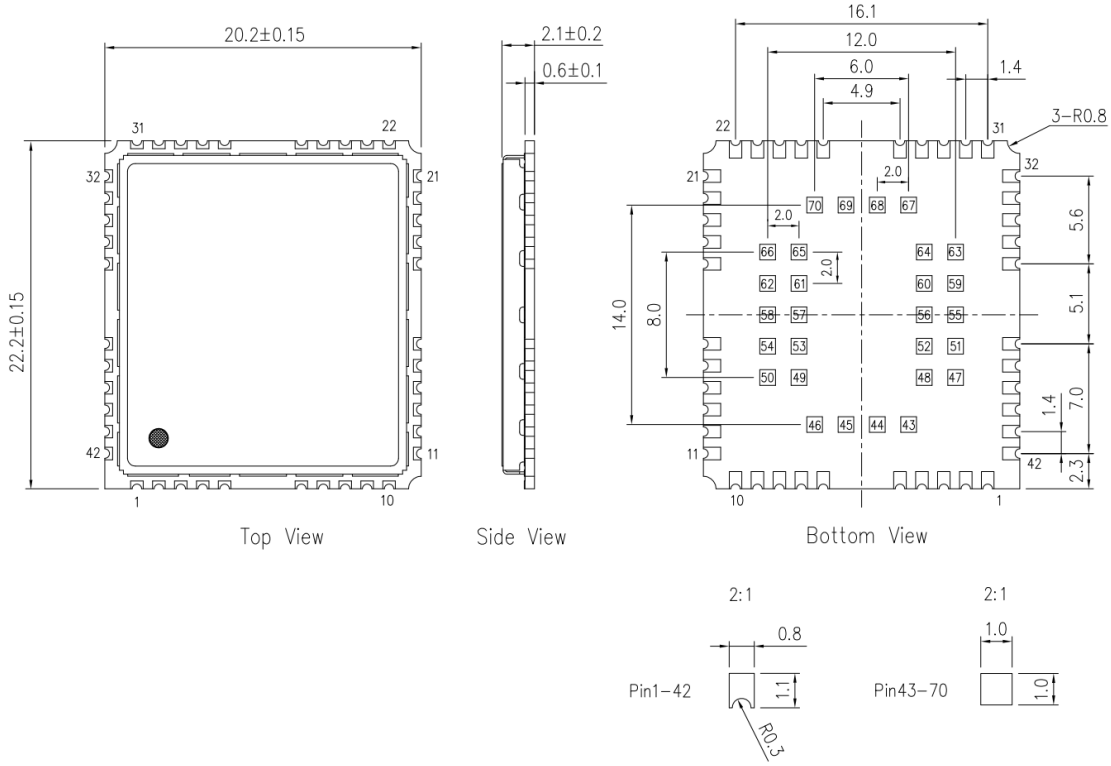

Figure10-2 N510-GL structural dimensions

10.3 Packing

Please refer to FIBOCOM_N510 LCC SMT Application Design Instructions for packaging.

11 Certification

N510-GL series module authentication supports CCC, SRRC, RoHS, NAL, CE, GCF, China Mobile standards.

12 Default Setting

12.1 Default Settings of UART

UART1 defaults to four-wire AT serial port, which can send AT instructions. The default baud rate is 115200.

UART2 is a two-wire serial port with a default baud rate of 115200.

12.2 Default Settings for Low Power Mode

EDRX and PSM mode are turned off by default. When used, it is necessary to open and close the setting mode through AT instruction, and set the specific working mode of the module.

12.3 Inspection Function Default Setting of Plug-In SIM Card

N510-GL module provides plug-in SIM card check function, which is turned off by default and can be set by software when needed.

12.4 USB Default Settings

The N510-GL module provides a USB port, which is used to capture the log when the module works.

13 Order Information

The order information for N510-GL products is shown in the table below.

Table13-1 Order Information Table for N510-GL Products

Model	Product Description
N510-GL	NB-IOT MT2625, LCC 42+LGA 28 Packaging NB-IoT：1,2,3,4,5,8,12,13,17,18,19,20,25,28,66,71,85 Size: 22.2 x 20.2 x 2.1 mm Weight:1.6 g

14 Appendix

14.1 Terminology

The technical terms involved in the document are shown in the following table:

Table13-1 Documents on Terminology

Abbreviation	Full name
AFC	Automatic Frequency Control
ETS	European Telecommunication Standard
ESD	Electronic Static Discharge
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
FEM	Front end module
GSM	Global Standard for Mobile Communications
LNA	Low Noise Amplifier
PCB	Printed Circuit Board
PCL	Power Control Level
PLL	Phase-Locked Loop
PMU	Power manager unit
RTC	Real Time Clock
RFPA	Radio frequency power amplifier
SIM	Subscriber Identification Module
SMS	Short Message Service
SMD	Surface Mounted Devices
UART	Universal Asynchronous Receiver Transmitter, asynchronous serial port
VSWR	Voltage Standing Wave Ratio
VCO	Voltage Controlled Oscillator

14.2 Relevant Documents

- AT Commands User Manual
- FIBOCOM ADP-N510 Development Board Instructions

- FIBOCOM_N 700 LCC SMT Application Design Description

14.3 Reference Standard

- ETSI ETS 300 916 (GSM 07.07 version 5.9.1 Release 1996).
- ETSI TS 100 585 (GSM 07.05 version 7.0.1 Release 1998).
- ETSI ETS 300 901 (GSM 03.40 version 5.8.1 Release 1996).
- ETSI TS 100 900 (GSM 03.38 version 7.2.0 Release 1998).
- ETSI EN 300 607-1 (GSM 11.10-1 version 8.1.1 Release 1999).
- ETSI TS 100 907 (GSM 02.30 version 6.1.0 Release 1997).
- ETSI TS 100 549 (GSM 03.90 version 7.0.0 Release 1998).
- ETSI TS 101 267 (GSM 11.14 version 6.3.0 Release 1997).
- ETSI TS 100 977 (GSM 11.11 version 6.3.0 Release 1997).
- ETSI EN 300 908 (GSM 05.02 version 8.5.1 Release 1999).
- ETSI TS 101 356 (3GPP TS 07.60 version 7.2.0 Release 1998).
- 3GPP TS 36.521-1 R13: User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: Conformance testing
- 3GPP TS 21.111 V10.0.0: USIM and IC card requirements
- 3GPP TS 51.011 V4.15.0: Specification of the Subscriber Identity Module -Mobile Equipment (SIM-ME) interface
- 3GPP TS 31.102 V10.11.0: Characteristics of the Universal Subscriber Identity Module (USIM) application
- 3GPP TS102.223 V07.06.0: Universal Subscriber Identity Module (USIM) Application Toolkit(USAT)

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