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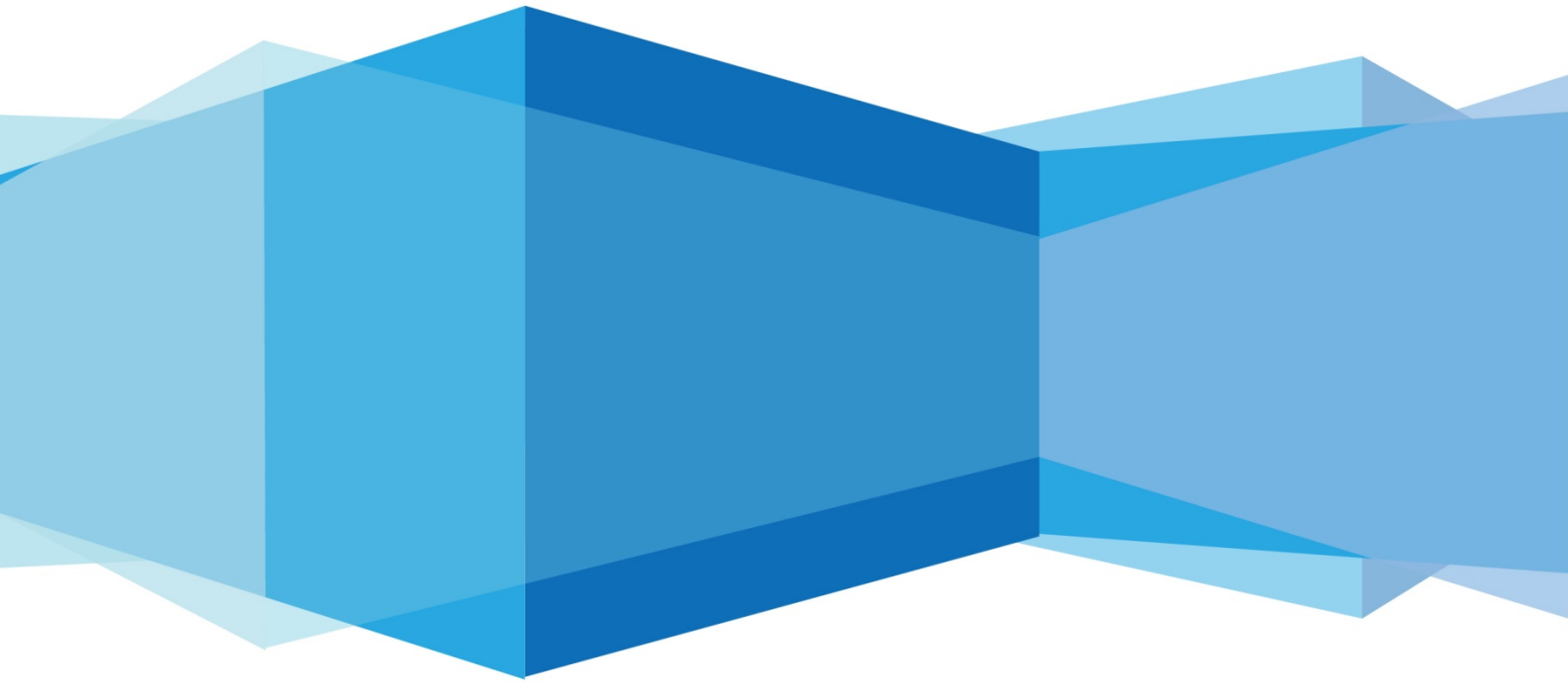
832149

NB05-01Module Manual



利尔达科技集团股份有限公司
LIERDA SCIENCE & TECHNOLOGY GROUP CO.,LTD

Record of Revision

Product name	NB-IoT Module(LTE)	Product Model		NB05-01	
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Contents

1. Overview

This article defines the Lierda NB-IoT module, and describes its hardware interface, application methods, etc.

This article can help you quickly understand the standard of module interface, as well as the electrical and mechanical characteristics. Combined with other relevant documents, you can quickly learn how to use the NB-IoT module.

This document NBXX-01 on behalf of NB05-01, NB08-01 collectively referred to these two models.

2. The introduction of the Module

The purpose of the NBXX-01 module is to use the NB-IoT broadcast protocol (3GPP NB-IoT Rel-13) with mobile network operator communications infrastructure equipment. The band used by the NB-IoT module below.

NBXX-01 series modules used in the band:

Mode	NB05-01	NB08-01
H-FDD	B5(850MHZ)	B8(900MHZ)

The NBXX-01 module dimensions of 20mm × 16mm × 2.2mm, the module can meet almost all the requirements of the Internet of Things applications, including vehicles and personal tracking, security systems, wireless POS, industrial PDA, smart metering, remote maintenance and control, Smart city and more.

NBXX-01 module is LCC package, is a SMD type module, it can be easily embedded in the application circuit.

NBXX-01 module is designed with energy-saving technology, ultra-low power consumption in sleep mode.

This module is fully in line with the EU RoHS directive.

3. The Main Features

The following describes the detailed function and the key features of the Lierda NBXX-01 module：

Feature	Implementation
Power Supply	Supply voltage:3.1 V ~ 4.2 V　Typical Supply voltage :3.6 V
Power Saving	Sleep Current:＜5uA
Transmitting Power	23dBm±2dBm
Sensitivity	-128dBm±1dBm
Temperature Range	Operation temperature range：-30°C ~ + 85°C
USIM/ESIM Interfaces	USIM，3.0V
UART Interfaces	Main Port：Used for command communication and data transfer, currently supports a 9600 baud rate
Physical Characteristics	Size:20±0.15×16±0.15×2.2±0.3mm
Fimware　upgrade	Fimware upgrade via UART Port
Antenna Interface	50 Ohm Impedance Control

4. Functional Diagram

The block diagram below shows the main features of the NBXX-01: radio frequency, power management, peripheral interface.

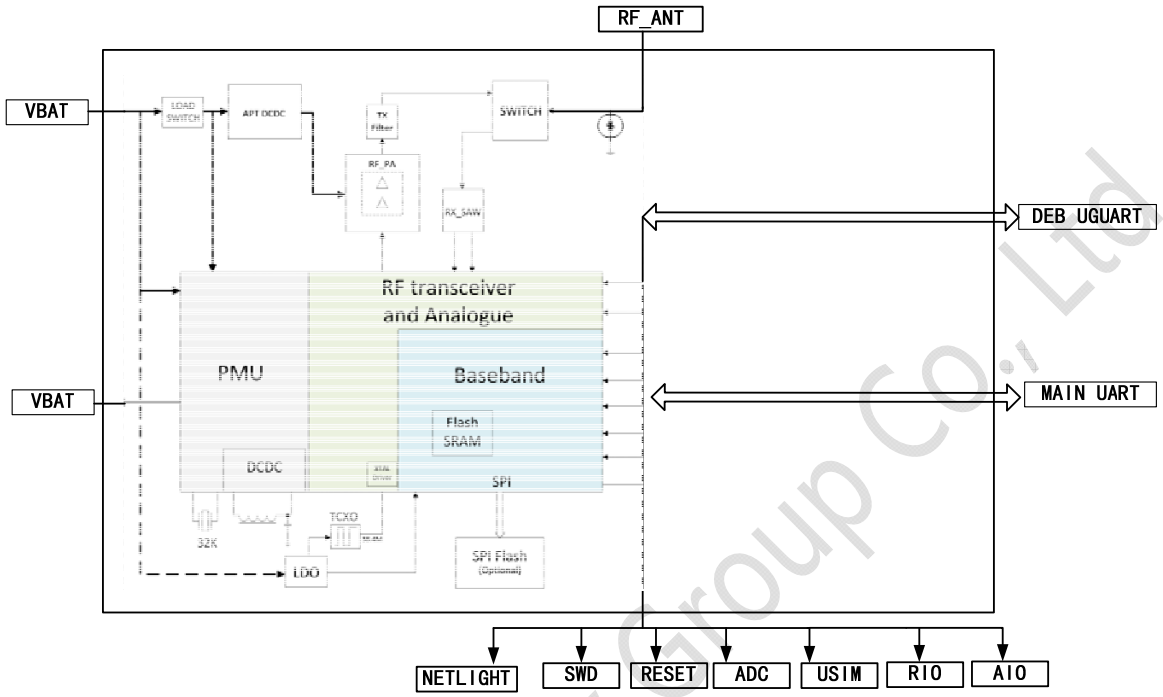


Figure 1 Module feature Illustration

5. Functions

5.1 Overview

The NB-IoT Module has 42 SMT pins in total, this chapter below will give more information:

- Power Supply
- Gate-Limit Interface
- UART Interface
- USIM Interface
- ADC Interface
- RFID Interface
- NETLIGHT

6. Pin definition

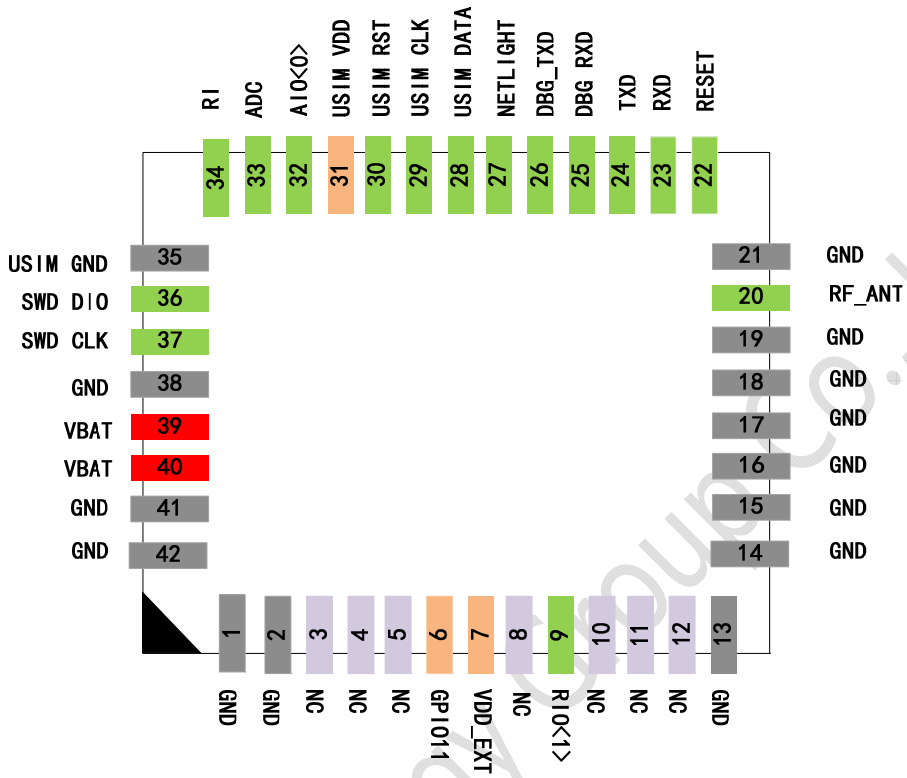


Figure 2 NBXX-01 Module Pins Illustration

6.1 Description of pins

The definition and description of Module NBXX-01`s pins is below:

Pin description：

Power Supply pins：					
Name	Number	Attribute	Description	DC characteristics	Remarks
VBAT	39,40	PI	Main Power Module VBAT=3.1V~4.2V	Vmax=4.2V Vmin=3.1V Vnorm=3.6V	
VDD_EXT	7	PO	Provide 3 Voltage for external circuit	Vnorm=3.0V IOmax=20mA	If this will never be needed, keep open. If this will be used, we recommend adding a 2.2 ~ 4.7 uF bypass capacitor
GND	1,2,13~19, 21,38,41~42		Ground		

SWD Interface					
SWD_IO	36	IO	Serial line data signal	VOLmax=0.4V VOHmin=2.4V VILmin=-0.3V VILmax=0.6V VIHmin=2.1V VIHmax=3.3V	This interface is designed to firmware programming. Using this interface to program firmware will reset the IEMI No. It requires UART Update Program to protect IMEI No. during program/ Update.
SWD_CLK	37	DI	Serial line clock signal	VOLmax=0.4V VOHmin=2.4V	
Reset Pin					
RESET	22	DI	Reset the module	RPU≈78kΩ VIHmax=3.3V VIHmin=2.1V VILmax=0.6V	Internal Up-adjust，low voltage when active.
Simulate I/O Interface					
RIO<1>	9	AIO	Simulation		Not Active yet. Keep clear.
AIO<0>	32	AIO	Simulation		Not Active yet. Keep clear.
Network status indicate port					
NETLIGHT	27	DO	Network status indicator	VOLmax=0.4V VOHmin=2.4V	Not Active yet. Keep clear.
ADC Interface					
ADC	33	AI	General Simulation-Digital Signal transform		Not Active yet. Keep clear.
Main UART Communication Interface					
RXD	23	DI	Receive data.	VILmax=0.6V VIHmin=2.1V VIHmax=3.3V	Keep Voltage under 3.0V, If not Active yet. Keep clear.
TXD	24	DO	Send data.	VOLmax=0.4V VOHmin=2.4V	Keep Voltage under 3.0V, If not Active yet. Keep clear.
RI	34	DO	Signal Indicate	VOLmax=0.4V VOHmin=2.4V	Keep Voltage under 3.0V, If not Active yet. Keep clear.
Emulation Port					
DBG_RXD	25	DI	Receive data.	VILmax=0.6V VIHmin=2.1V	If not Active yet. Keep clear.

				VIHmax=3.3V	
DBG_TXD	26	DO	Send data.	VOLmax=0.4V VOHmin=2.4V	If not Active yet. Keep clear.
USIM Interface					
USIM_VDD	31	DO	Provide power supply for USIM Card	Vnorm=3.0V	All signals go through USIM Interface should be ESD protected by TSD diode.
USIM_RST	30	DO	USIM Reset terminal	VOLmax=0.4V VOHmin=2.4V	
USIM_DATA	28	IO	USIM Data terminal	VOLmax=0.4V VOHmin=2.4V VILmin=-0.3V VILmax=0.6V VIHmin=2.1V VIHmax=3.3V	
USIM_CLK	29	DO	USIM clock terminal	VOLmax=0.4V VOHmin=2.4V	
USIM_GND	35		USIM ground	Share ground	
RF Interface					
RF_ANT	20	IO	RF antenna interface	Impedance is 50Ω	
Reserved pins					
GPIO11	6	IO			If not Active yet. Keep clear.
NC	3~5,8，10~12	Reserved			Not connect to any other pins (Temp)

6.2 Operating mode

The NBXX-01 module has three modes of operation to determine the different levels of low power consumption based on usage scenarios. Under normal operating conditions are divided into:

Active mode	The module is active; all functions are normally available for data transmission and reception; the module can switch to Idle mode or PSM mode in this mode.
Idle	The module is in a light sleep state, the module is in a network connection state and can accept paging messages. In this mode, the module can be switched to active mode or PSM mode.
PSM	Module only RTC work, the module is in the network is not connected, no longer accept paging messages. When DTE (Data Terminal Equipment) actively send data or timer T3412 (periodic update) timeout, the module will be awakened.

6.3 Power supply & power saving technology

The NBXX-01 module's power supply range is 3.1 V to 4.2 V, making sure that the input voltage does not drop below 3.1V. If the supply voltage is lower than 3.1 V, the module will be abnormal. The performance of the module depends largely on the power supply, so the design of the power supply module is very important, in which the power supply current of at least 0.5A.

For better performance, it is recommended to place a 100uF tantalum capacitor and three ceramic capacitors 100nf, 100pf and 22pf near VBAT. The reference circuit is shown below。

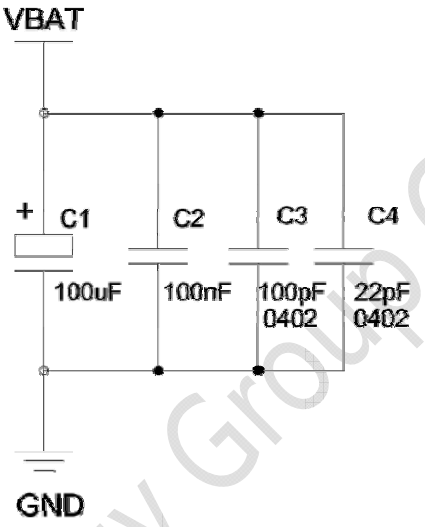
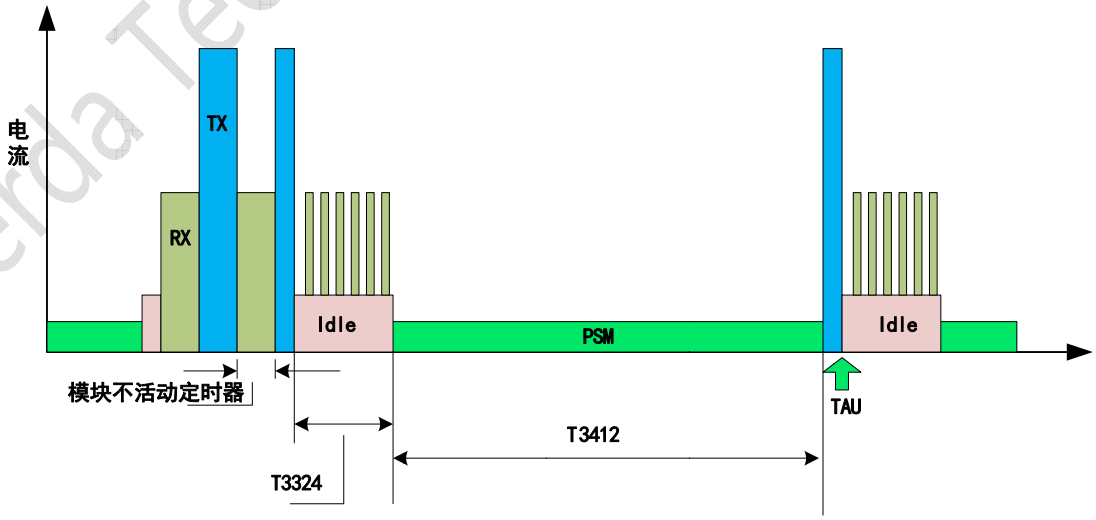


Figure 3 Reference design for power supply

The maximum consumption of modules under PSM is 5uA.PSM, the main purpose is to reduce module power consumption and extend battery power supply time. The following figure shows the power consumption diagram of modules in different modes.



The process of module into the PSM as follows: to make a connection or tracking area update and network (TAU), module will apply to the request message, the network terminal

response message back to the configuration of the T3324 numerical timer module, and start up timer. When the T3324 timer expires, module will enter the PSM. module for emergency service for networking or public data network initialization, cannot apply for entry into the PSM.
When the module is in the PSM mode, the network activities will be closed, including the search for the cell message, the cell reelection, etc. But the T3412 timer will (associated with periodic TAU updates) continue to work.
There are two ways for modules to quit PSM mode: one way is DTE sends the data actively, the other is when the T3412 timer goes out, the TAU starts, the module exits PSM.
Power supply mode: This module can automatically start working by power supply to the VBAT pin, and the sequence diagram is as follows:

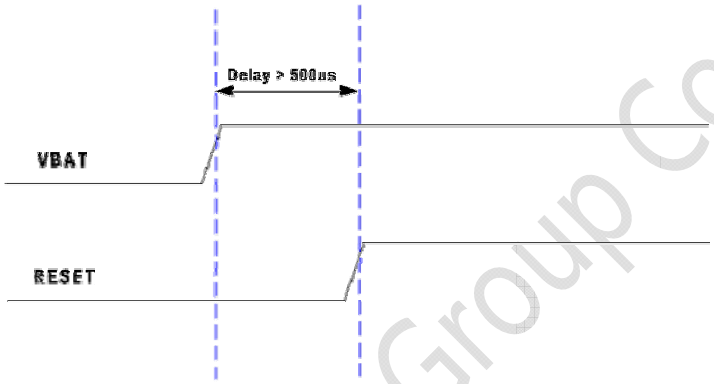


Figure 4 power on sequence

Power off mode: This module can automatically stop working by disconnecting the power supply of the VBAT pin. These sequence diagram is as follows:

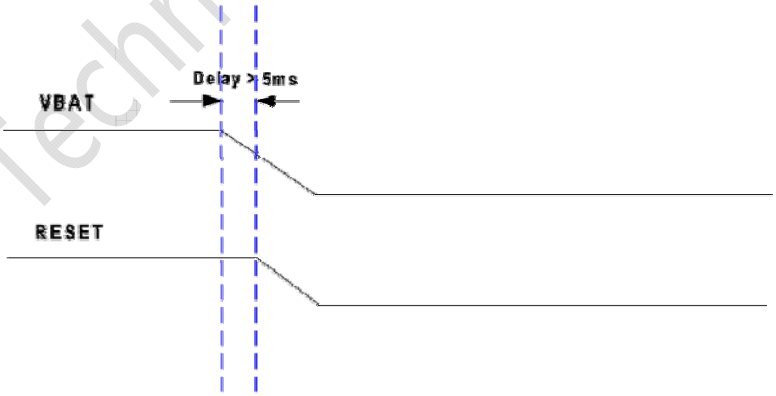


Figure 5 Turn off the power supply sequence

NBXX-01 module reset: the module can reset to a low level of reset pin for a certain time. The recommended circuit can output a low level through registers or mechanical switches.

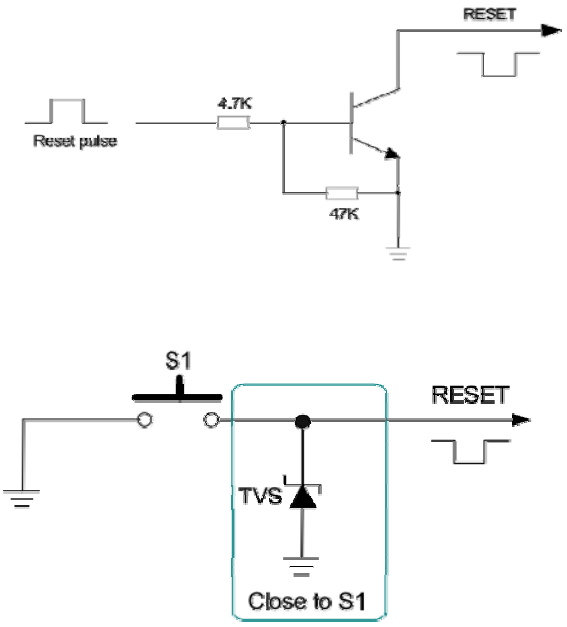


Figure 6 Reset circuit (left MCU IO driver, right button driver)

6.4 UART Joggle

The NBXX-01 module has two UART ports: main port and debug port.

Main communication port:

TXD: send the data and link to the bottom MCU

RXD: accept the the data, link with the bottom MCU

RI: indicate the signal side, link to the bottom MCU

The main communication port is transmitted through the AT command, and the baud rate is 9600bps.

Debug port:

DBG_TXD: send data to the COM port of the host computer

DBG_RXD: receive data from the COM port of the upper computer

The debug port can be used to view the system log through the PC software UE Log View software, and the baud rate is 921600bps.

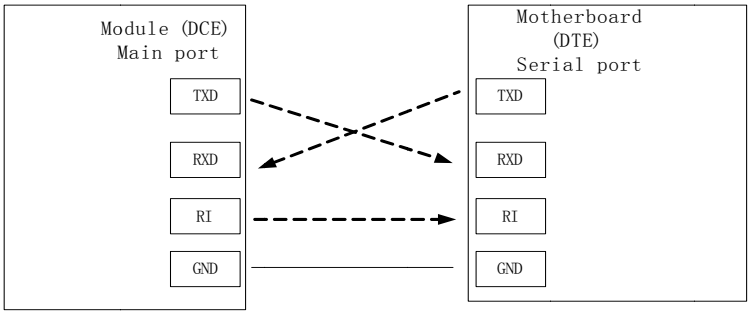


Figure7 Serial circuit reference design

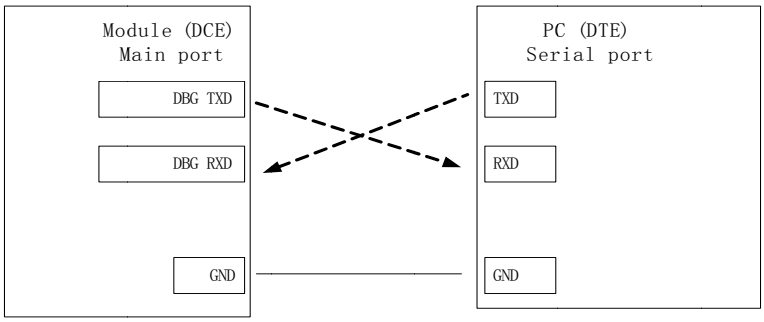


Figure 8 Debugging serial circuit reference design

Serial port application design: the design of 3.3V system is as follows:

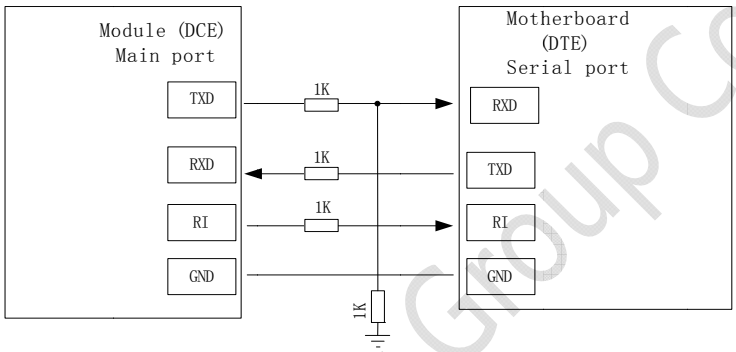


Figure9 Reference design of serial voltage matching circuit

6.5 USIM card interface

NBXX-01's ESIM and USIM interface supports 3 GPP specification, which is suitable for routine application tools. On the module, there is a USIM interface monitoring circuit, which only supports 3 V USIM card. 6 pin USIM card circuit is designed as follows,

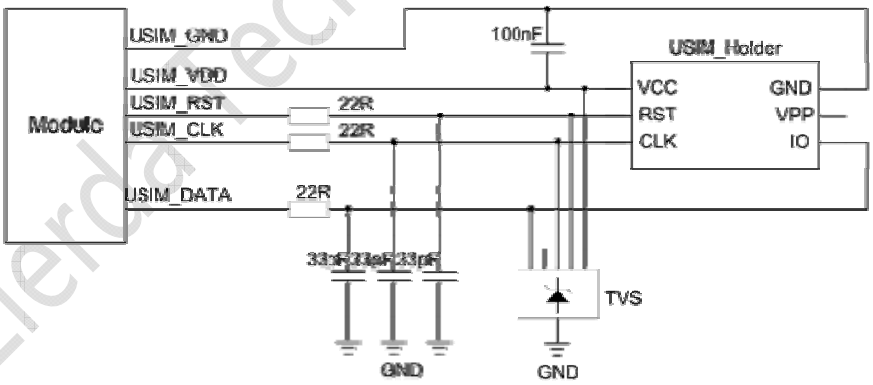


Figure 10 USIM card circuit design reference

(1) In order to improve the reliability and availability of the USIM card in the application. Please follow the standard design in the USIM circuit design.

(2) The USIM slot is as close to the module as possible, and the length of the walk line is as much less than 200mm as possible.

(3) The USIM signal is far away from the RF and VBAT circuits.

(4) Ensure that the ground connection between the module and USIM card slot is short and wide. The width of the ground wire is no less than 0.5mm, so as to maintain the same potential. USIM_VDD is added near the USIM slot to add a less than 1uF decoupling capacitor.Avoid crosstalk between USIM_DATA and USIM_CLK. Keep them away from each other and shield them from the encircling ground.
(5) In order to offer good ESD protection, add a TVS diode array. The TVS pipe is close to the USIM card slot, ensure the USIM interface module is not damaged by ESD. In the module and USIM card slot between 22 series resistor to restrain stray EMI transmission and enhanced ESD protection. Attention, the USIM peripheral circuit should close to the USIM card connector.
(6) The RF bypass capacitor (33pF) is placed near the USIM slot to improve the EMI suppression.

6.6 RI time series state (under development)

status	RI response
Standby	HIGH
SMS	When a SMS signal is received, RI becomes LOW, and the state of LOW becomes HIGH state after about 120ms
URC	Some URC signals can start RI to keep the 120ms low level

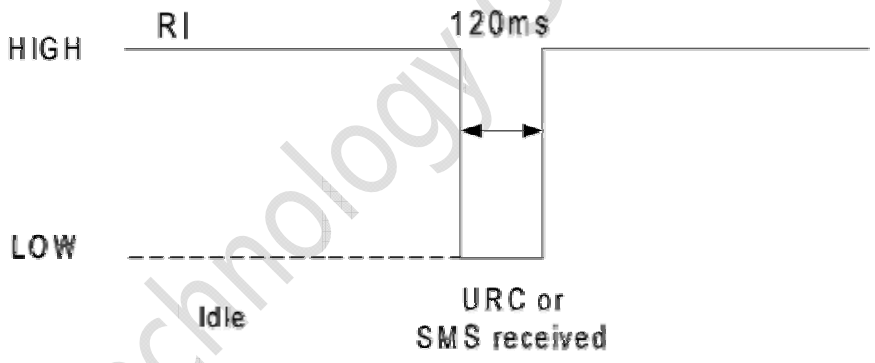


Figure 11 RI status when receiving URC or SMS

6.7 Network Status Indication(under development)

The network status indication signal can be indicated by the LED lamp, and the pin working state is listed in the lower table.

Status	Module Function
LOW	The module does not work or synchronize with the network
HIGH	The module synchronize with the network

The reference circuit is designed as follows:

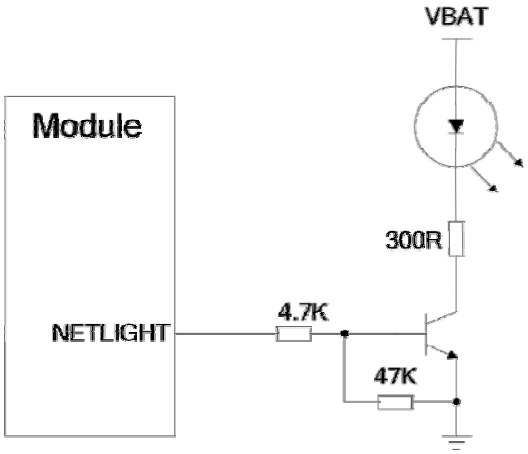


Figure 12 Reference design of network indicator lamp

6.8 RF Circuit Design

RF circuit design reference is as follows:

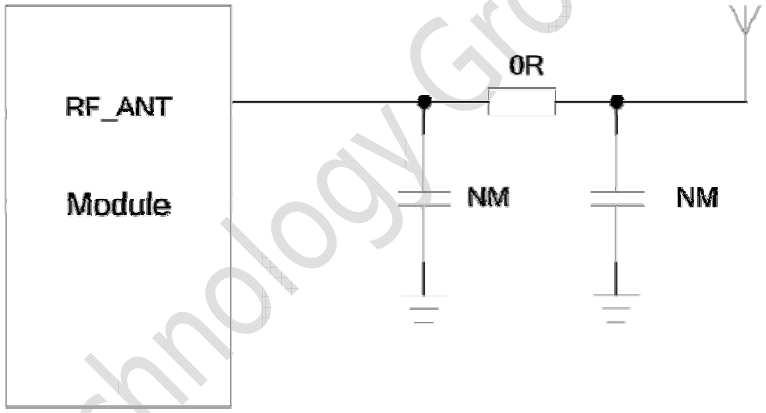


Figure 13 RF Circuit Design

The NBXX-01 module provides an antenna connected with the RF pads in the antenna pads on both sides of some ground, and the purpose is to provide a better ground connection for the RF part. In addition, there is a π capacitor that matches the circuit used to regulate the performance of the radio frequency, it is better to put the capacitor close to RF_ANT pin of the module. Pay attention to the module RF pin and characteristic impedance of RF antenna pin should be set at 50 ohms in the design of RF PCB.

6.9 RF Output Power

RT Output Power

Frequency	Max
900MHz	23dBm±2dB
850MHz	23dBm±2dB

RF Sensitivity

Frequency	Sensitivity
900MHz	-128dBm
850MHz	-128dBm

Service Frequency

Frequency	Receiving Frequency	Transmitting Frequency
900MHz	925~960MHz	880~915MHz
850MHz	869~894MHz	824~849MHz

6.10 Antenna Requirements

NB-IoT antenna requirements shows in the following table:

Parameter Type	Requirement
Frequency Range	824-960MHz
VSWR	≤2
Gain（dBi）	≥1
Maximum Input Power（W）	5
Input matching impedance（Ω）	50
RHCP	linear

7. Electrical Characteristics, Reliability and Wireless Characteristics

The NBXX-01 module simulates the rated voltage parameters of the voltage and the digital voltage as shown in the following table:

Parameter	Min.	Max.	Unit
VBAT	3.1	+4.2	V
Maximum current of power supply	0	0.3	A
RMS Current	0	0.25	A
Digital pin voltage	-0.3	+3.0	V
Analog pin voltage	-0.3	+4.2	V
The voltage of analog / digital pins in the state of power loss	-0.25	+0.25	V

Working Temperature:

Parameter	Min.	Typ.	Max.	Unit
Operating Temperature Range (OTR)	-30	+25	+85	℃
Storage Temperature Range	-40		+125	℃

8. Appearance and Structure

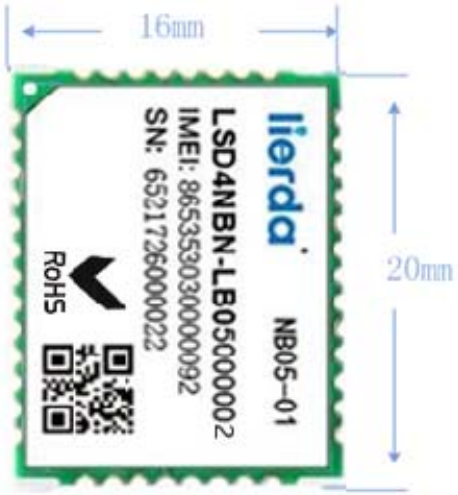


Figure 14 Appearance Size

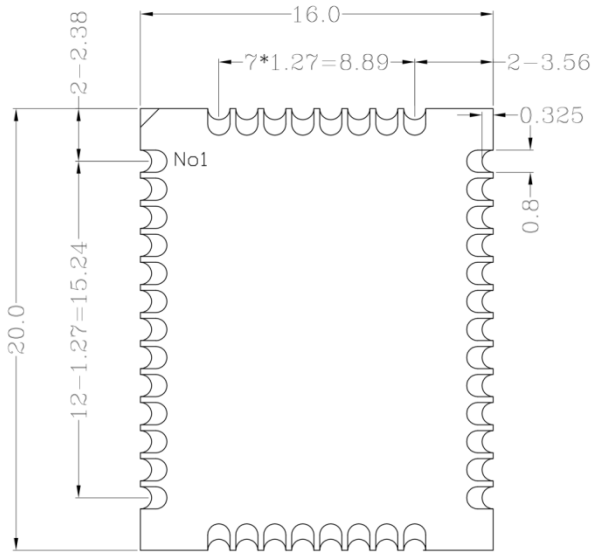


Figure 15 Encapsulation Dimension Figure and Unit (mm)

9. Contact Us

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Contact Number:0571-88800000;
Contact Email:NBIoT_support@lierda.com
Official Website:Http://www.lierda.com

The NB05-01 module is designed to comply with FCC statement.FCC ID is 2AOFDNB05-01.

FCC RF Exposure Requirements

This device complies with FCC RF radiation exposure limits set forth for an uncontrolled environment.

The antenna(s) used for this transmitter must not be co-located or operating in conjunction with any other antenna or transmitter and must be installed to provide a separation distance of at least 20cm from all persons.

FCC Regulations

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.

This device has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules.

These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.