



CAVLI C1-RM NB-IoT/EGPRS Hardware Manual

Version: 1.1

Cavalier Wireless Inc. DBA Cavli Wireless

177 Park Avenue, San Jose, California, USA 95113

Website: www.cavliwireless.com

Contact: +1-650-334-3414

All rights reserved 2018

Update records

Version	Date	Author	Description
V1.01	2019/7/5		Initial Document

Contents

Chapter 1. Introduction	7
Chapter 2. Review of modules	7
2.1 A brief introduction to the module.....	7
2.2 Main performance	8
2.3 Module function block diagram.....	9
2.4 Module working mode.....	10
Chapter 3. Interface application description	10
3.1 A summary of this chapter	10
3.2 Module interface	11
3.2.1 C1-RM NB-IOT/EGPRS pins distribution diagram	11
3.2.2 Module pins description	12
3.3 Power interface.....	14
3.4 VDD_EXT 2V8 voltage output.....	15
3.5 Switchgear reset mode	15
3.5.1 Turn on the module	15
3.5.2 Starting time sequence	16
3.5.3 Module shutdown.....	16
3.5.4 Reset control.....	17
3.6 UART interface.....	18
3.6.1 Serial port application circuit.....	19
3.6.2 RI interface	20
3.7 USIM interface	21
3.7.1 USIM card reference circuit.....	21
3.7.2 SIM_DECT hot plug reference design.....	22
3.8 ADC interface.....	23
3.9 SPI interface.....	23
3.10 I2C bus	24
3.11 Network indicator interface.....	25
3.12 General GPIO interface.....	26

Chapter 4. RF overall technical index	27
4.1 Summary.....	27
4.2 Main antenna and Bluetooth antenna.....	27
4.3 Route guidance of radio frequency signal line.....	28
4.4 Radiofrequency connector.....	29
4.5 Working frequency.....	30
4.6 RF conduction emission power and acceptance sensitivity.....	31
4.7 Power consumption characteristics	31
Chapter 5. Electrical characteristics of interface.....	32
5.1 Summary.....	32
5.2 Extreme work	32
5.3 Module IO level.....	32
5.4 Power Supply.....	33
5.5 Electrostatic characteristics.....	33
5.6 Reliability index	34
Chapter 6. Structure and mechanical properties.....	35
6.1 Summary.....	35
6.2 Appearance	35
Chapter 7. Production and packaging.....	36
7.1 Summary.....	36
7.2 Module packaging and storage	36
7.3 Production welding	37
Chapter 8. Terminology abbreviation.....	38

Graph Contents

Figure 2-1 Functional block diagram of C1-RM NB-IoT/EGPRS module.....	9
Figure 3-1 C1-RM NB-IoT/EGPRS pins distribution diagram.....	11
Figure 3-2 VBAT power supply power supply	14
Figure 3-3 VDD_EXT power output sequence diagram.....	15
Figure 3-4 Starting time sequence diagram.....	16
Figure 3-5 shutdown sequence diagram.....	16
Figure 3-6 reset reference circuit.....	17
Figure 3-7 reset sequence diagram	18

Figure 3-8 full function serial port design diagram.....	19
Figure 3-9 UART serial port design diagram	20
Figure 3-10 UART level conversion circuit	20
Figure 3-11 WAKEUP pin signal waveform.....	20
Figure 3-12 SIM circuit design diagram	21
Figure 3-13 SIM card hot plug detection circuit *	22
Figure 3-14 SPI reading sequence diagram	24
Figure 3-15 SPI writing sequence diagram	24
Figure 3-16 I2C interface reference circuit	25
Figure 3-17 circuit diagram of network indicator	26
Figure 4-1 main antenna matching circuit diagram	28
Figure 4-3 complete structure of microstrip line	29
Figure 4-4 complete structure of strip line.....	29
Figure 4-5 RF connector size diagram.....	29
Figure 4-6 antenna connector plug diagram	30
Figure 6-1 C1-RM NB-IoT/EGPRS module appearance.....	35
Figure 6-2 front view and side view of C1-RM NB-IoT/EGPRS module (unit MM)	35
Figure 6-3 C1-RM NB-IoT/EGPRS module bottom view (unit MM)	36
Figure 7-1 reflow soldering temperature curve	38

Table Contents

Table 2-1 key features.....	8
Table 2-2 work mode	10
Table 3-1 pins parameter abbreviations	12
Table 3-2 interface definition	12
Table 3-3 opening timing parameters	16
Table 3-4 shutdown timing parameters.....	17
Table 3-5 RESET pin parameters	17
Table 3-6 definition of serial pin	18
Table 3-7 serial port logic level	19
Table 3-8 USIM card signal definition.....	21
Table 3-9 SIM card hot plug detection foot definition	22
Table 3-10 ADC signal definition.....	23

Table 3-11 SPI signal definition.....	23
Table 3-12 I2C pin definition.....	24
Table 3-13 definition of network indicator lamp.....	25
Table 3-14 network indicator state.....	25
Table 3-15 general GPIO pin definition.....	26
Table 4-1 RF pin definition.....	27
Table 4-2 RF connector main parameters.....	30
Table 4-3 radiofrequency frequency meter.....	30
Table 4-4 C1-RM NB-IOT/EGPRS RF output power.....	31
Table 4-5 radiofrequency sensitivity index.....	31
Table 4-6 NB-IOT power consumption.....	31
Table 5-1 C1-RM NB-IOT/EGPRS module working storage temperature.....	32
Table 5-2 C1-RM NB-IOT/EGPRS module limit operating voltage range.....	32
Table 5-3 electrical characteristics of C1-RM NB-IOT/EGPRS module.....	33
Table 5-4 C1-RM NB-IOT/EGPRS module working voltage.....	33
Table 5-5 C1-RM NB-IOT/EGPRS ESD characteristics.....	33
Table 5-6 reliability test.....	34
Table 7-1 recirculation process parameter table.....	38
Table 8-1 terminology abbreviations.....	38

Chapter 1. Introduction

This document is a wireless solution product C1-RM NB-IoT/EGPRS module hardware interface manual, which is designed to describe the hardware composition and functional features of the module, the definition and usage of the application interface, the electrical performance and mechanical properties. Combined with this document and other application documents, users can quickly use the module to design wireless products.

Chapter 2. Review of modules

2.1 A brief introduction to the module

The C1-RM NB-IoT/EGPRS module is a three band NB-IoT IOT/2G wireless communication module, which supports Band3, Band5 and Band8. It is mainly applied to low power data transmission service. Meet the 3GPP Release 13 standard. The module has 94 pins in all. The ultra-small size with (23.6 ± 0.15) mm \times (19.9 ± 0.15) mm \times (2.2 ± 0.2) mm can meet almost all M2M requirements. The C1-RM NB-IoT/EGPRS module is a patch module. Using LCC package, the module can be embedded in the customer's application by the pin welding disk. It can provide a rich hardware interface between the module and the client's main board. C1-RM NB-IoT/EGPRS module uses low-power technology, standby power consumption is less than 1mA, deep sleep can be as low as 5uA. C1-RM NB-IoT/EGPRS module can be applied to the following situations:

- ✧ Smart city (intelligent parking, water / gas meter, street lamp, smoke alarm, garbage bin, etc.)
- ✧ Consumption and medical care (wearable devices, VIP tracking, life support, remote clinical tracking, etc.)
- ✧ Industrial and agricultural intelligent monitoring (machine alarm, gas detection, irrigation, soil pH value, etc.)
- ✧ Agriculture and environment (agricultural application, environmental monitoring, etc.)
- ✧ Logistics support (industrial assets, container tracking, location and status updates, etc.)

 **NOTE**

"*" indicates that it is being developed.

2.2 Main performance

Table 2-1 key features

Characteristic	Describe
Physical characteristics	23.6mm× 19.9mm× 2.2mm
Application processor	192MHz MIPS processor with 16KB I-Cache and 16KB D Cache
Working voltage	3.4V - 4.2V Typical voltage 3.7V
Power saving	PSM mode power < 5uA
Standby	Dormancy mode current < 1mA
Application interface	Power interface Several general-purpose GPIO interfaces One standard SIM interface, support 3.0V/1.8V, support hot swap function * One Hardware reset interface Three UART serial port interface One SPI interface One Network state indicator interface One PSM_EINT# interface One ADC detection interface
Working band	Working frequency: Band3, Band5, Band8, Band20, Band28, GSM850, EGSM900, DCS1800, PCS1900 The module can automatically search frequency bands, and the band selection can be set by AT command. Need to correspond to a specific version
Network protocol characteristics	UDP/TCP/CoAP/LWM2M PPP/SSL/DTLS/FTP HTTP/MQTT/HTTPS
Data transmission characteristics	Single-tone:25.5kbps(DL),16.7kbps(UP) Multi-tone:25.5kbps(DL),62.5kbps(UP)
Antenna interface	50 Ω interface of the main antenna
Firmware update	Serial port upgrade
Temperature range	Normal working temperature - 20°C to +70°C Limit working temperature - 40°C to +85°C Storage temperature: -45°C to +90°C
AT command	Support standard AT command set (Hayes 3GPP TS 27.007 and 27.005)

2.3 Module function block diagram

The functional block diagram of the C1-RM NBIOT/EGPRS module mainly contains the following units:

- ✧ Baseband processing unit
- ✧ Power management unit
- ✧ RF transceiver unit
- ✧ RF front-end unit
- ✧ Peripheral interface

The functional block diagram of the C1-RM NBIOT/EGPRS module is shown as follows:

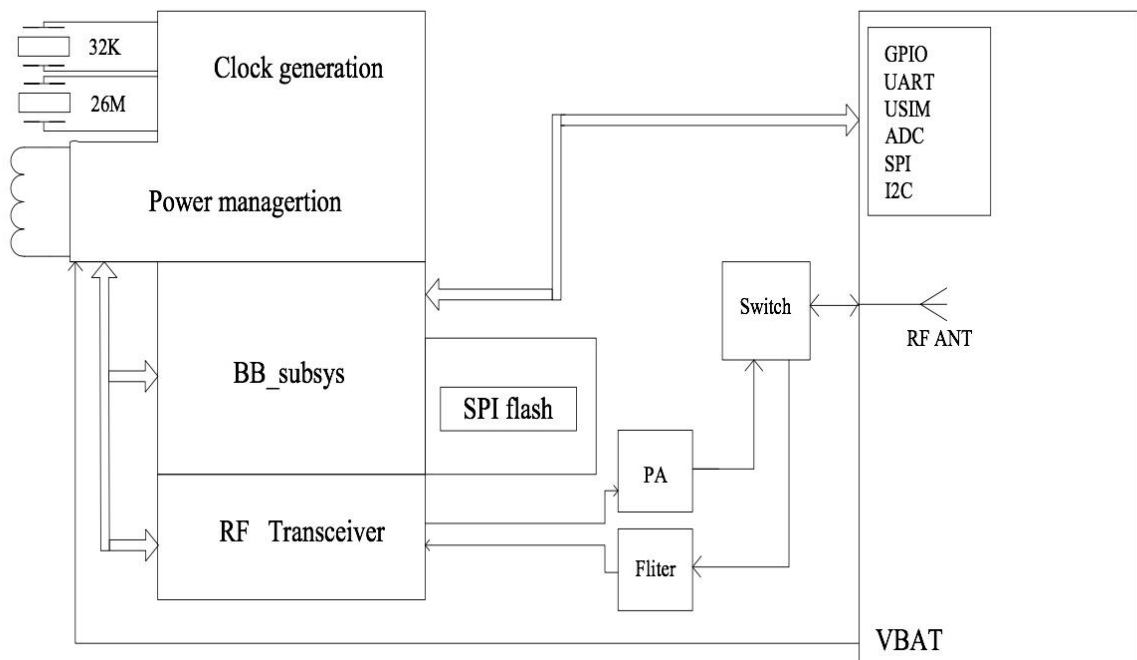


Figure 2-1 Functional block diagram of C1-RM NBIOT/EGPRS module

2.4 Module working mode

Table 2-2 work mode

Working mode	Describe
Turn off the machine	In the case of shutdown, the module can't work
Flight Mode	The module closes the module RF circuit, unable to interact with the network.
Dormancy	The module closes most functions, and it will synchronize with the network.
Free	Turn on the machine and register the network successfully, in the idle state
Data transmission	The module is in working state and has data interaction with the network.
PSM mode	After entering PSM mode, the module can achieve the minimum power consumption, each power supply inside the module is closed, the software except RTC stops running, and the serial port cannot be used.

Chapter 3. Interface application description

3.1 A summary of this chapter

The C1-RM NB-IoT/EGPRS module has 94 pins, including the following unit interface functions. The functions of each unit interface will be explained in detail in the following chapters.

- ✧ Power supply interface
- ✧ USIM interface
- ✧ UART interface
- ✧ Network status indicator interface
- ✧ SPI interface
- ✧ RF antenna interface
- ✧ I2C interface

3.2 Module interface

3.2.1 C1-RM NBIOT/EGPRS pins distribution diagram

C1-RM NBIOT/EGPRS pins are assigned as follows:

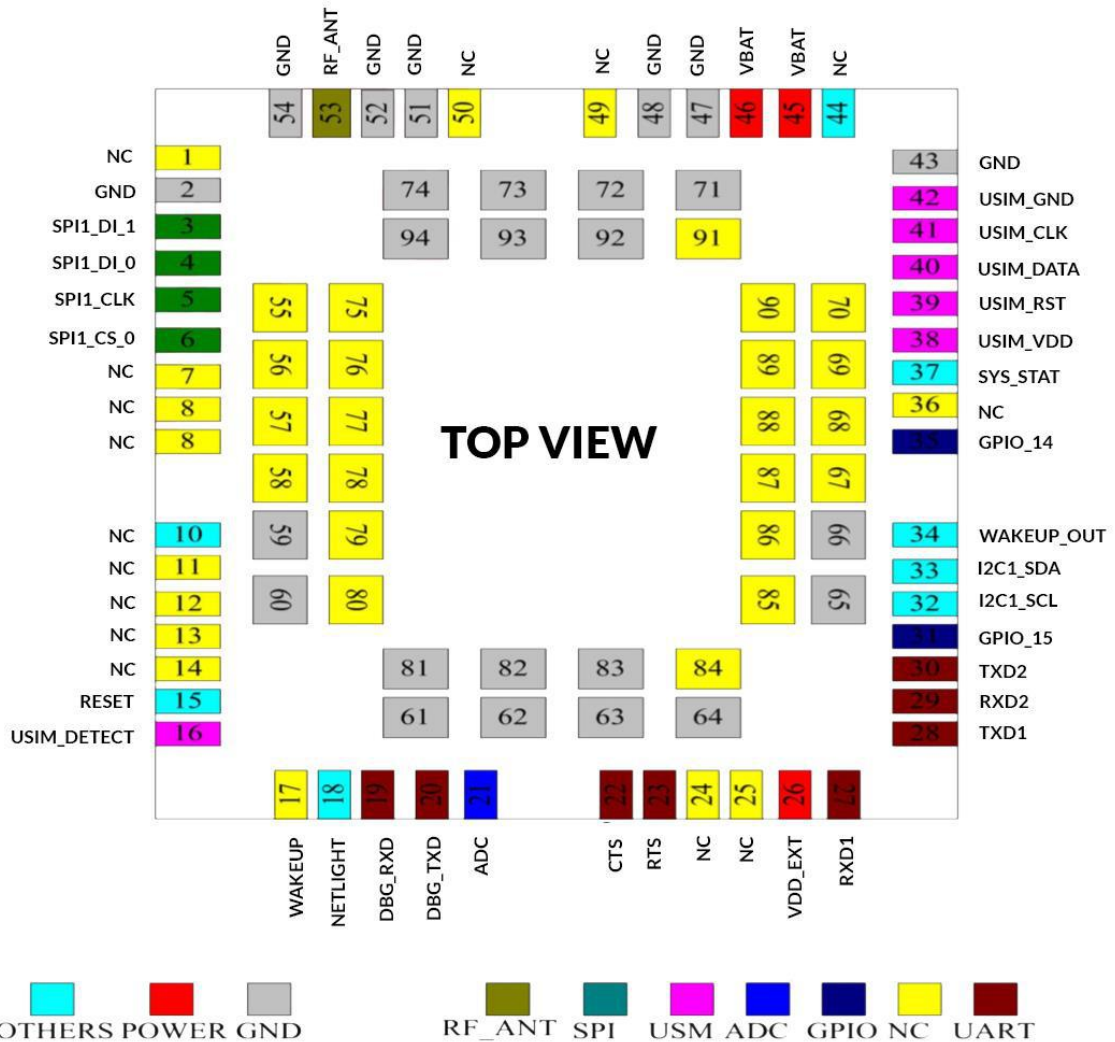


Figure 3-1 C1-RM NBIOT/EGPRS pins distribution diagram

NOTE

- ① The IO port electric level of the module is 2.8V (SIM card port electric level supports 1.8V and 3.0V).
- ② The module defines that the RESERVED pins are suspended and cannot be used.
- ③ The voltage domain of the PSM_EINT tube is 1.1V.

3.2.2 Module pins description

The definition of the module interface pins is described as follows:

Table 3-1 pins parameter abbreviations

Sign indicator	Describe
IO	Input or output
PI	Power input
PO	Power output
AI	Analog input
AO	Analog output
DI	Digital input
DO	Digital output

Table 3-2 interface definition

Pins	Pins name	IO	Functional description	Remarks
Power supply				
45,46	VBAT	PI	Module power supply	Input voltage 3.4~4.2V
26	VDD_EXT	PO	Internal steady voltage power output 2.8V	Hang out when you don't need it
2,43,47,48, 51,52, 54,59,60, 61,62,63, 64,65,66, 71,72,73, 74,81,82, 83,92,93, 94	GND		Ground signal	
Control of system switchgear				
15	RESET	DI	Hardware reset control, low level effective	
SIM interface				
16	SIM_DECT	DI	SIM card hot plug detection	Internal level has been pulled up
42	SIM_GND		SIM card ground	
40	SIM_DATA	IO	SIM card bus data	Internal 10K pull-up resistance

39	SIM_RST	DO	SIM card reset output	Far away from the source of interference
41	SIM_CLK	DO	SIM card clock output	Far away from the source of interference
38	SIM_VDD	PO	Output power supply to SIM card	Far away from the source of interference
State indication				
18	NETLIGHT	DO	Network status indication	2.8V voltage domain
Main serial port interface				
29	RXD2	DI	Master data reception	2.8V voltage domain
30	TXD2	DO	Master data transmission	2.8V voltage domain
34	WAKEUP_OUTPUT	DO	Ringling hints	2.8V voltage domain
22	CTS	DO	Scavenging sending	2.8V voltage domain
23	RTS	DI	Request to send	2.8V voltage domain
Debug serial port interface				
19	RXD_DBG	DI	data	2.8V voltage domain
20	TXD_DBG	DO	Module debug data transmission	2.8V voltage domain
UART1 serial port				
27	UART1_RXD	DI	UART1 data reception	2.8V voltage domain
28	UART1_TXD	DO	UART1 data transmission	2.8V voltage domain
I2C interface				
32	I2C1_SCL	DO	I2C bus clock output	2.8V voltage domain
33	I2C1_SDA	IO	I2C bus data input and output	2.8V voltage domain
SPI interface				
3	SPI1_DI_1	DI	Host input and slave machine output	2.8V voltage domain
4	SPI1_DI_0	DO	Host output slave machine input	2.8V voltage domain
5	SPI1_CLK	DO	Serial clock signal	2.8V voltage domain
6	SPI1_CS_0	DO	Chip Select	2.8V voltage domain
Other functional feet				
17	WAKEUP	DI	External interrupt pin	1.1V voltage domain
21	ADC0	AI	General analog digital converter interface	Range 0.1V~4V
Universal input-output interface				

35	GPIO_14	IO	General input / output port	
31	GPIO_15	IO	General input / output port	
Antenna interface				
53	RF_ANT	IO	RF antenna interface	50Ω characteristic impedance
1,7,8,9,11,12,13,14,24,25,36,44,49,50,55,56,57,58,67,68,69,70,75,76,77,78,79,80,84,85,86,87,88,89,90,91	NC	NC	Hang out when you don't need it	

3.3 Power interface

The C1-RM NB-IOT/EGPRS module power interface consists of two parts:

- ✧ VBAT is the power supply for the module.
- ✧ The VDD_EXT is an internal LDO 2.8V output power for external use.

The voltage input range of the power supply VBAT is 3.4V~4.2V. The module supplies the internal RF and baseband circuits through the two pins of VBAT. On the premise of ensuring that the VBAT power supply is sufficient, one 100uF tantalum capacitors with low equivalent series resistance can be parallel in parallel to the power input, and then parallel connect 10pF, 33pF, 0.1uF, 1uF ceramic capacitors. The PCB line of VBAT is as short and coarse as possible.

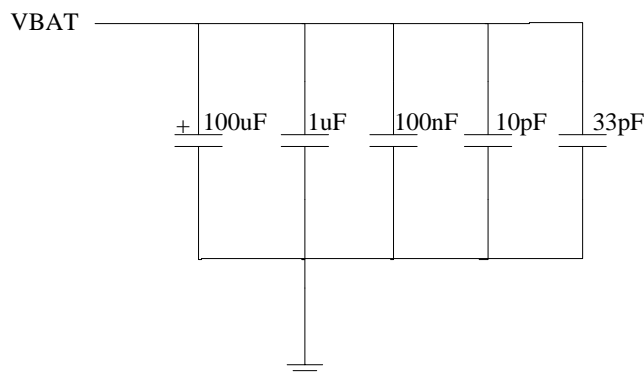


Figure 3-2 VBAT power supply power supply



① In order to prevent the module from being damaged by surge and overvoltage, it is suggested that a 5.1V/500mW Zener diode be connected in parallel with the VBAT pin of the module.

② It is suggested that 3 ceramic capacitors (33pF, 10pF, 100nF) be added to the VBAT pin and placed near the VBAT pin.

3.4 VDD_EXT 2V8 voltage output

After the C1-RM NB-IOT/EGPRS module is opened normally, the twenty-sixth pins will output voltage 2.8V, the current load is maximum 50mA, and the external master control can read the voltage of VDD_EXT to judge whether the module is on the machine. VDD_EXT can also be used as an external power supply, such as level conversion chips.

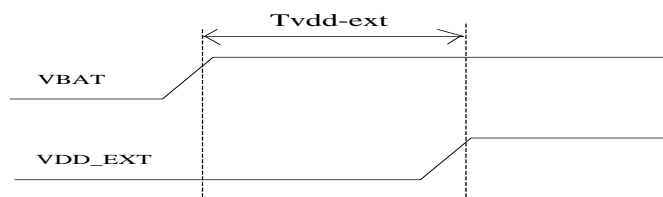


Figure 3-3 VDD_EXT power output sequence diagram.

3.5 Switchgear reset mode

3.5.1 Turn on the module

C1-RM NB-IOT/EGPRS module VBAT power on automatically boot, users can query the level of VDD_EXT pin to determine whether the module boot.

3.5.2 Starting time sequence

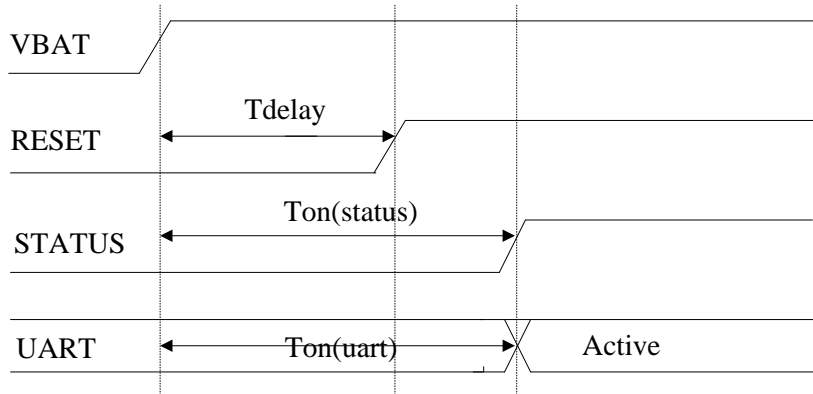


Figure 3-4 Starting time sequence diagram

Table 3-3 opening timing parameters

Symbol	Describe	Min	Typical	Max	Unit
Tdelay			TBD	-	ms
Ton(status)	Start time (according to status state)		TBD	-	s
Ton(uart)	Start time (according to UART state)		TBD	-	s

3.5.3 Module shutdown

The shutdown of the C1-RM NB-IOT/EGPRS module can be powered off by the VBAT pin or shutdown by using the AT "AT+CPOF" command.

When the module is in the boot state, the VBAT pin stops the power supply, the module is to turn off.

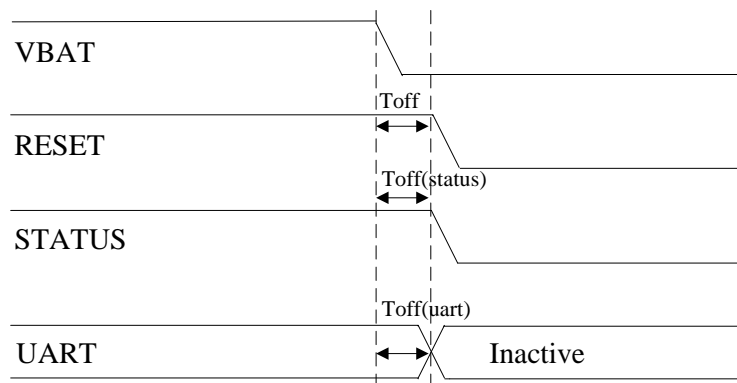


Figure 3-5 shutdown sequence diagram

Table 3-4 shutdown timing parameters

Symbol	Describe	Min	Typical	Max	Unit
Toff			TBD	-	s
Toff(status)	Shutdown time (according to status state)		TBD		
Toff(uart)	Shutdown time (according to UART state)		TBD	-	

3.5.4 Reset control

The C1-RM NBIOT/EGPRS module PIN15 signal is the RESET pin. The application terminal detects the module anomaly, and the software does not respond, the pin can be pulled down by 100-450ms to reset the module, and the external pull 10K resistance to VDD_EXT. RESET pins are sensitive to interference. A capacitor of 10nF to 0.1uF can be installed near the signal, which is used for signal filtering and away from the radio frequency interference signal when wiring.

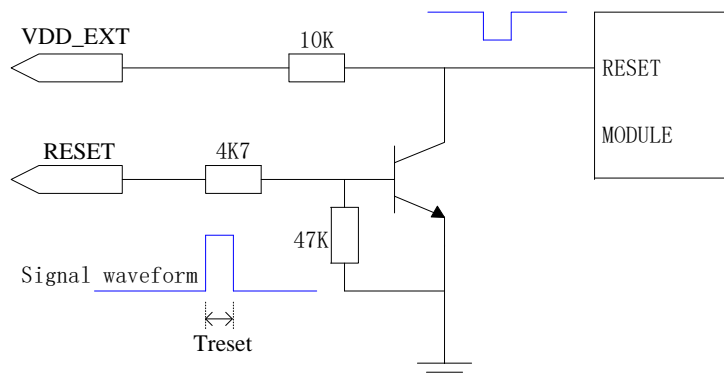


Figure 3-6 reset reference circuit

Table 3-5 RESET pin parameters

Symbol	Describe	Min	Typical	Max	Unit
Treset	Low level pulse width	100		600	ms
VIH	RESET input high level voltage	0.96	1.1	1.2	V
VIL	RESET input low level voltage	-0.3	0	0.84	V

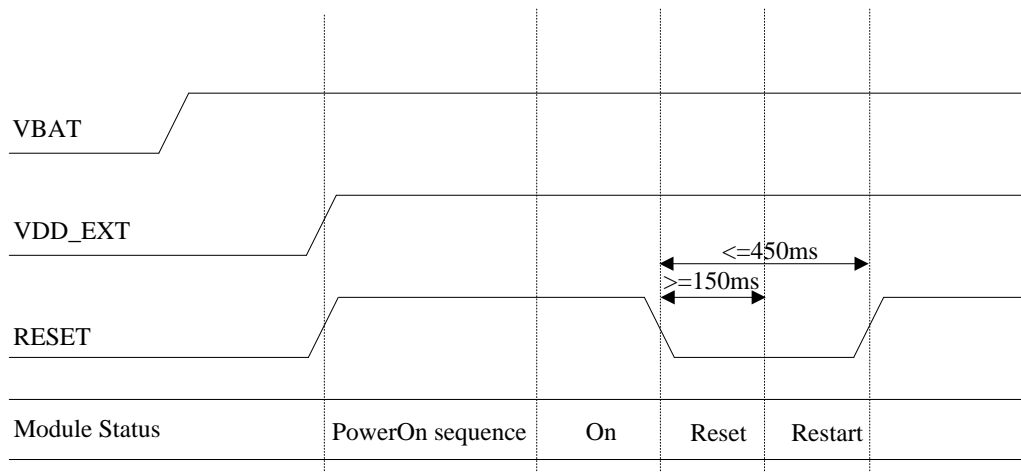


Figure 3-7 reset sequence diagram

The C1-RM NBIOT/EGPRS module supports AT command reset, and the AT command is AT+TRB to restart the module. Detailed command can view the C1-RM NBIOT/EGPRS AT command set manual.

3.6 UART interface

The C1-RM NBIOT/EGPRS module provides three sets of UART interfaces. The main serial port, debugging serial port and auxiliary serial port, serial port level is 2.8V. The module is the DCE (Data Communication Equipment) device

The main serial port can realize AT command interact and peripheral data interaction.

Debug serial port can upgrade firmware, check log information and so on.

Module serial port baud rate can be set 4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800, 921600 BPS baud rate, the default is 57600 bps.

Table 3-6 definition of serial pin

Pin	Pin name	IO	Functional description	Remarks
29	RXD2	DI	Master data reception	2.8V voltage domain
30	TXD2	DO	Master data transmission	2.8V voltage domain
34	WAKEUP_OUT	DO	Ringling hints	2.8V voltage domain
22	CTS	DO	Scavenging sending	2.8V voltage domain

23	RTS	DI	Request to send	2.8V voltage domain
27	UART1_RXD	DI	UART1 data reception	2.8V voltage domain
28	UART1_TXD	DO	UART1 data transmission	2.8V voltage domain
19	RXD_DBG	DI	Module debug data receiving	2.8V voltage domain
20	TXD_DBG	DO	Module debug data transmission	2.8V voltage domain

Table 3-7 serial port logic level

Parameter	Minimum	Maximum	Unit
VIL	0	0.3*VDD_EXT	V
VIH	0.7*VDD_EXT	VDD_EXT	V
VOL	0	0.3*VDD_EXT	V
VOH	0.7*VDD_EXT	VDD_EXT	V

3.6.1 Serial port application circuit

When users want to use the full function serial port, you can refer to the following connection mode.

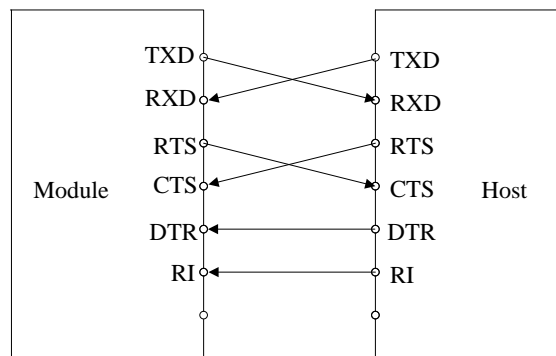


Figure 3-8 full function serial port design diagram

If you need to use 2 wire serial port, you can refer to the following serial port design.

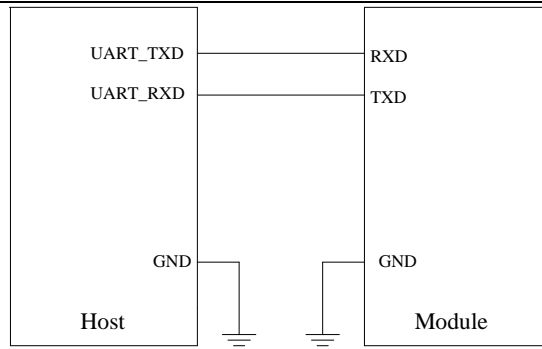


Figure 3-9 UART serial port design diagram

The module serial port is the TTL 2.8V electrical level. If the serial port needs to be connected with the MCU which have 3.3V electrical level, a level conversion chip needs to be added to realize the level matching. The chip connection mode can refer to the following circuit.

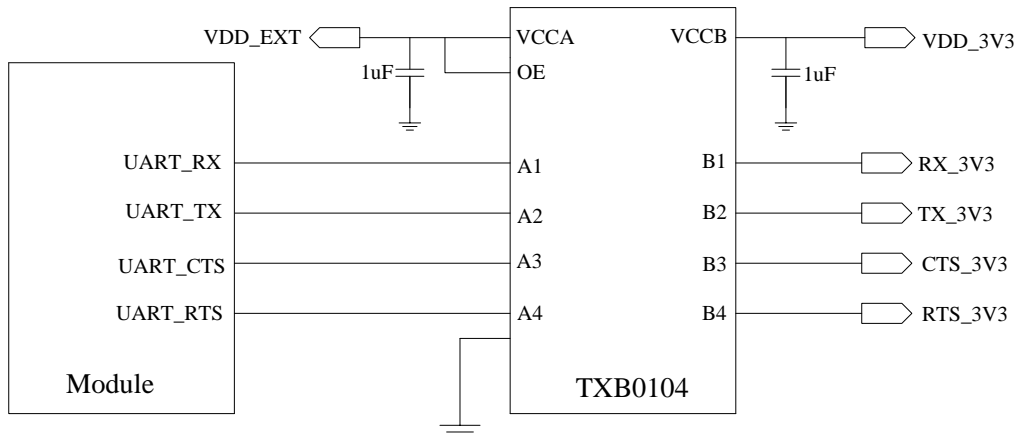


Figure 3-10 UART level conversion circuit

3.6.2 WAKEUP interface

C1-RM NB-IOT/EGPRS module supports serial sleep hiving function, WAKEUP pin can be used as an interrupt to wake up the host.

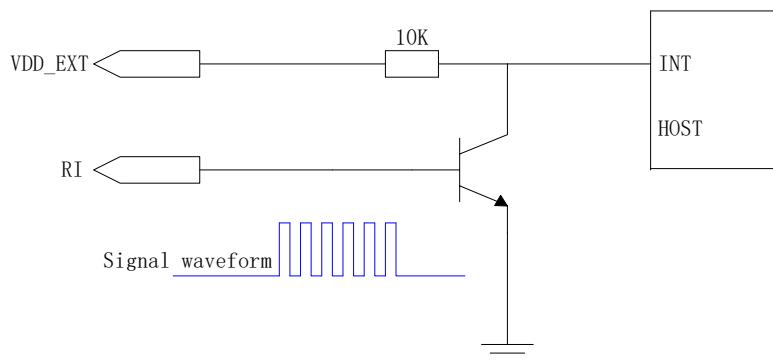


Figure 3-11 WAKEUP pin signal waveform

3.7 USIM interface

The C1-RM NB-IOT/EGPRS module provides a USIM card interface compatible with the ISO 7816-3 standard. The USIM card power supply is provided by the module internal power manager and supports 1.8V/3.0V voltage.

Table 3-8 USIM card signal definition

Pin	Pin name	IO	Functional description	Remarks
16	SIM_DECT	DI	SIM card hot plug detection	Internal level has been pulled up
42	SIM_GND		SIM card ground	
40	SIM_DATA	IO	SIM card bus data	Internal 10K pull-up resistance
39	SIM_RST	DO	SIM card reset output	Far away from the source of interference
41	SIM_CLK	DO	SIM card clock output	Far away from the source of interference
38	SIM_VDD	PO	Output power supply to SIM card	Far away from the source of interference

3.7.1 USIM card reference circuit

The C1-RM NB-IOT/EGPRS module does not own USIM card slot. When users are using it, they need to design USIM card slot on their own interface board.

The USIM card interface reference circuit is as follows:

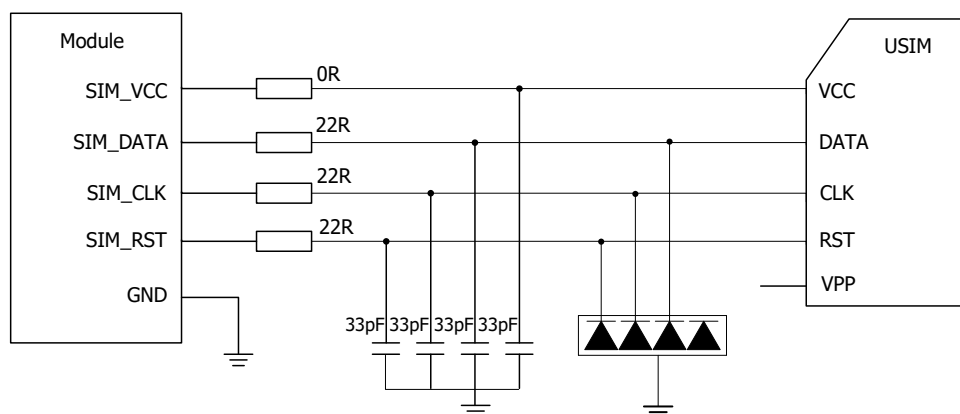


Figure 3-12 SIM circuit design diagram

 **NOTE**

- ✧ The USIM interface line suggests choosing ONSEMI's SMF15C device to do ESD protection, and the peripheral circuit devices should be placed near the card holder. The SIM card seat is close to the module layout.

- ✧ USIM card circuit is easily caused by radio frequency interference to cause non-recognition card or card loss, so the slot should be placed far away from the antenna radiofrequency radiation, the card is far away from the radio frequency, power and high-speed signal line.
- ✧ The internal SIM_DATA has been pulled to VDD_EXT by 47K resistance, and no external pull resistance is required.
- ✧ SIM_DECT is a SIM card insertion or not insertion of the detection foot, the default is high level, hot-plug application can be through this PIN foot SIM card status detection.
- ✧ To avoid transient voltage overload, USIM interface needs to connect 22R resistor in series on signal path.
- ✧ The ground pin of USIM card should maintain good connectivity with the ground pin of module.

3.7.2 SIM_DECT hot plug reference design

The C1-RM NBIOT/EGPRS module supports the hot plug function of the USIM card.

The SIM_DECT pin is used as an input detection pin to determine whether the USIM card is inserted or not. The SIM_DECT pin is defaults to the high level. Hot plug can be turned on or off by AT + HOSCFG, which is turned off by default (see the C1-RM NBIOT/EGPRS AT instruction set for details).

Table 3-9 SIM card hot plug detection foot definition

NO	PIN detection state	Functional description
1	high	SIM card is inserted, SIM_DECT is high
2	low	SIM card is pulled out, SIM_DECT is low

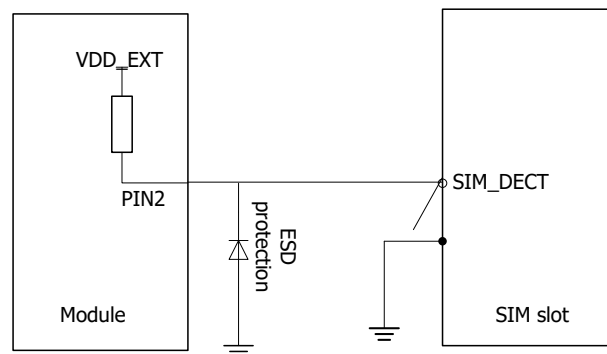


Figure 3-13 SIM card hot plug detection circuit *

 **NOTE**

- ✧ It is suggested that a diode protection be added to the SIM_DECT pin side of the module side.
- ✧ Using the normally closed SIM card holder or the normally open SIM card holder, the detection function can be set through the AT instruction. When AT+HOSCFG=1,1, the SIM card is in a high state. When setting AT+HOSCFG=1,0, the SIM card is in a low state, and when setting AT+HOSCFG=0,0, the SIM card hot plug function is closed.
- ✧ "*" indicates that it is being developed.

3.8 ADC interface

C1-RM NB-IoT/EGPRS module provides a 10-bit analog-to-digital conversion input interface, which can realize external temperature monitoring, and can read ADC pin voltage through AT command.

In order to improve the accuracy of ADC, ADC line should have a good reference.

Table 3-10 ADC signal definition

Pin	Pin name	IO	High level value	Remarks
21	ADC0	AI	General analog digital converter interface	

3.9 SPI interface

The C1-RM NB-IoT/EGPRS module provides a set of SPI interfaces with an interface voltage of 2.8V.

Table 3-11 SPI signal definition

Pin	Pin name	IO	Functional description	Remarks
3	SPI_MISO	DI	Host input slave device output	2.8V voltage domain
4	SPI_MOSI	DO	Host output slave device input	
5	SPI_SCLK	DO	Serial clock signal	
6	SPI_CS	DO	Chip Select	

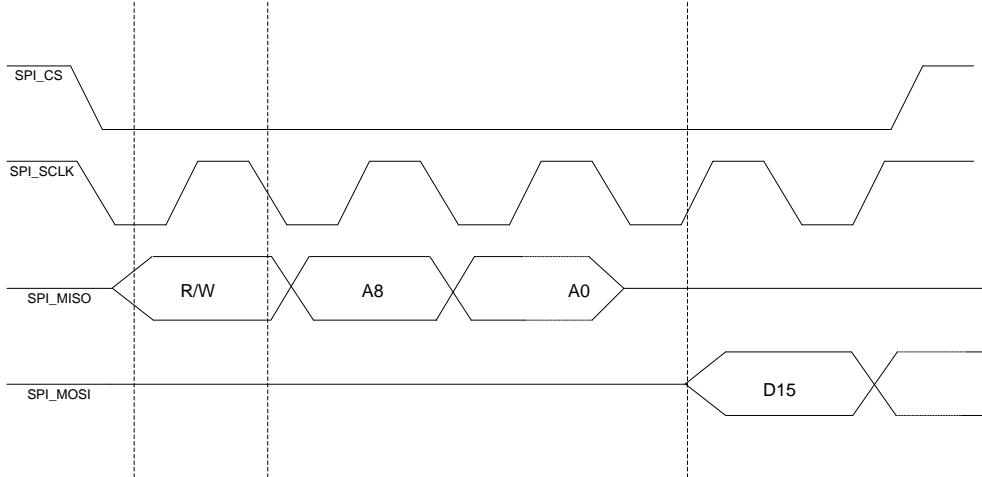


Figure 3-14 SPI reading sequence diagram

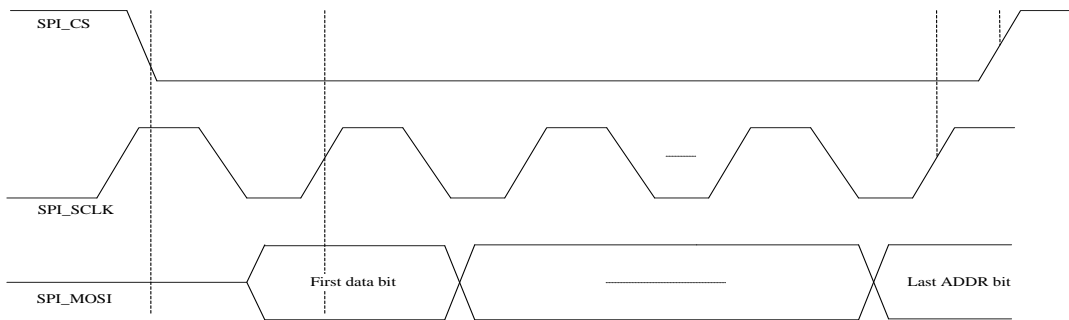


Figure 3-15 SPI writing sequence diagram

3.10 I2C bus

The C1-RM NB-IOT/EGPRS module provides a set of hardware 5.0 protocol bidirectional serial buses with a clock rate of 400 KHZ and an interface voltage of 2.8 V.

Table 3-12 I2C pin definition

Pin	Pin name	IO	Functional description	Remarks
32	SCL	OD	I2C bus clock output	Internal resistance pull up
33	SDA	IO	I2C bus data input and output	Internal resistance pull up

The I2C reference circuit is illustrated as follows:

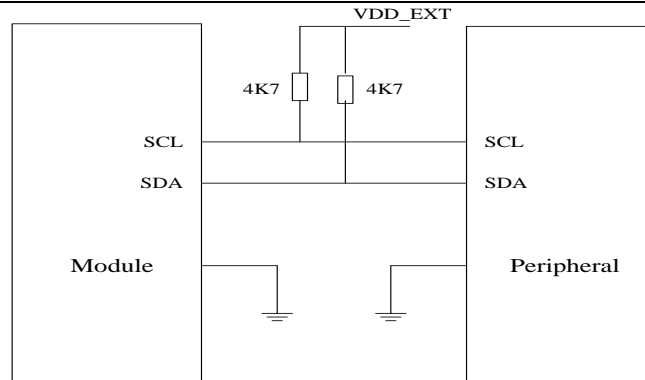


Figure 3-16 I2C interface reference circuit

 **NOTE**

The internal pins of the I2C_SCL and I2C_SDA have been pulled up, so the pull-up resistors can be ignored externally.

3.11 Network indicator interface

The C1-RM NB-IOT/EGPRS module provides a NETLIGHT pin to indicate the status of network communication, which can be used to drive LED lights indicating the network state.

Table 3-13 definition of network indicator lamp

Pin	Pin name	IO	Description
16	NETLIGHT	DO	Network status indication

Table 3-14 network indicator state

State	LED display status
Module is not run or module is not registered	Light OFF
Module successful registration network	Light ON

LED network indicator light reference design chart is as follows:

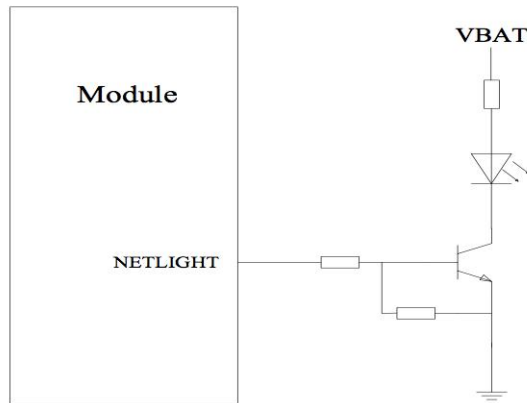


Figure 3-17 circuit diagram of network indicator

NOTE

The resistance value in the circuit diagram of the network indicator can be adjusted according to the LED lamp parameters.

3.12 General GPIO interface

The C1-RM NB-IOT/EGPRS module provides two routes of GPIO. Some of these GPIO can be reused as a variety of functions. The specific usage can be consulted by the module provider.

Table 3-15 general GPIO pin definition

Pin	Pin name	IO	Functional description	Remarks
31	GPIO_15	IO	General input / output port	2.8V level
35	GPIO_14	IO	General input / output port	2.8V level

Chapter 4. RF overall technical index

4.1 Summary

C1-RM NB-IoT/EGPRS module radio frequency overall technical indicators include the following parts:

- ✧ Frequency of work;
- ✧ Conductive radiofrequency measurement;
- ✧ It conducts receiving sensitivity and transmitting power.
- ✧ Antenna requirements
- ✧ Power characteristics of module

4.2 Main antenna and Bluetooth antenna

The C1-RM NB-IoT/EGPRS module provides two antenna interfaces, one is the main antenna interface, the other is the Bluetooth antenna interface. In circuit design, the 50 ohmic impedance is required to connect the module to the antenna.

Antenna is a sensitive device which is easily influenced by external environment. For example, the size of the module, the position of the antenna, the size of the occupied space and the surrounding grounding may affect the performance of the antenna.

The modules of the module antenna are defined as follows:

Table 4-1 RF pin definition

Pin	Pin name	IO	Functional description	Remarks
53	RF_ANT	IO	RF antenna interface	50ohm characteristic impedance

The 53rd pin of the C1-RM NB-IoT/EGPRS module is the main antenna interface. In order to facilitate the antenna debugging, it is necessary to add the π matching circuit on the main board and take the 50 European impedance line. The recommended circuit is as follows:

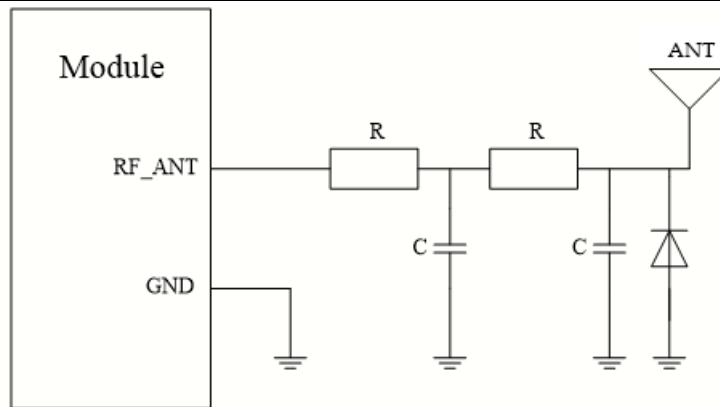


Figure 4-1 main antenna matching circuit diagram

NOTE

The RF antenna of the C1-RM NBIOT/EGPRS module are led by weld plate.

- ✧ The impedance line of antenna needs to be far away from the interference signal such as digital signal line, power supply and so on.
- ✧ The impedance line of the antenna needs to be ground in three dimensions, and more holes are added on both sides of the line.
- ✧ The loss of antenna line should be less than 0.3dB, so PCB line should be kept as short as possible.
- ✧ In the antenna matching, the parasitic capacitance of the TVS pin itself must be small to avoid interference of the signal. At the same time, considering the frequency bands used by the antenna and the minimum parasitic capacitance that can be accepted by different frequency bands, the parasitic capacitance of the ESD protection components usually used on the antenna must be less than 0.5pF or even lower.

4.3 Route guidance of radio frequency signal line

For users, the characteristic impedance of all RF signal lines should be controlled at 50 ohms. The impedance of the RF signal line is determined by the dielectric constant of the material, the widths (W), the ground clearance (S), and the height (H) of the reference ground plane. Please use the impedance simulation tool to calculate the RF line impedance value, PCB characteristic impedance control is usually use two ways of microstrip line and coplanar waveguide.

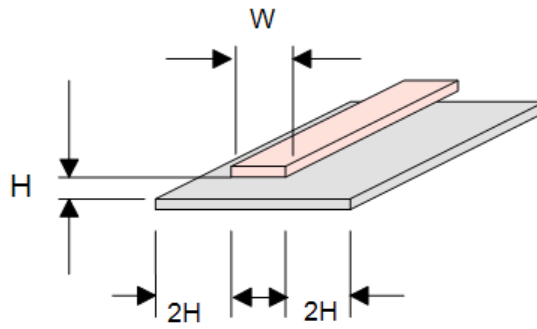


Figure 4-3 complete structure of microstrip line

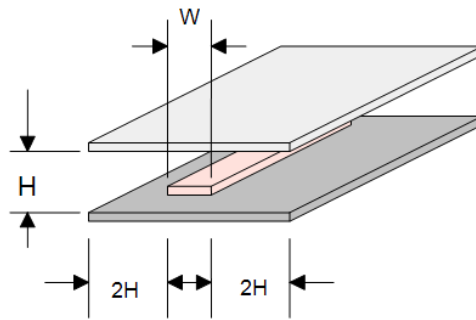


Figure 4-4 complete structure of strip line

4.4 Radiofrequency connector

In the design process, if the RF connector is required, the antenna connector must use a 50 ohm characteristic impedance coaxial connector, and the Hirose U.FL-R-SMT connector is recommended.

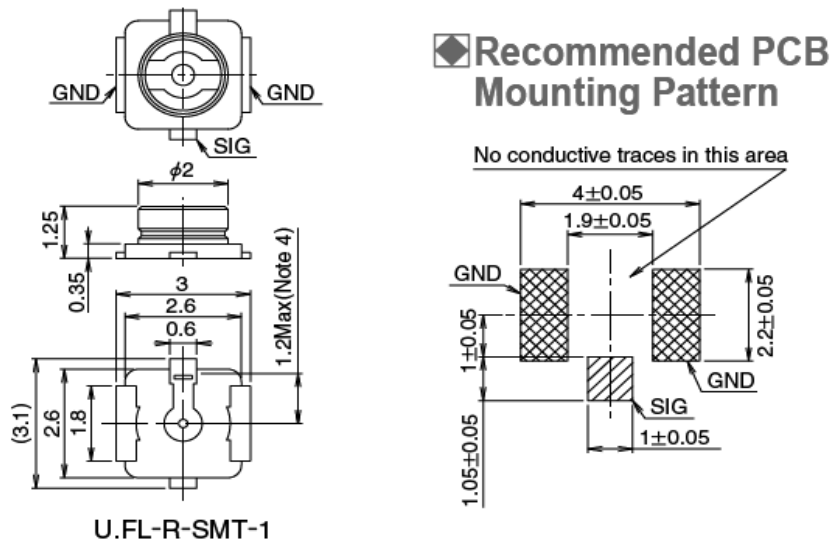


Figure 4-5 RF connector size diagram

The RF connector plug connected with this connector is U.FL-LP series of HRS company.

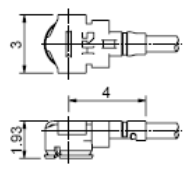
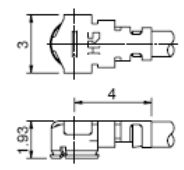
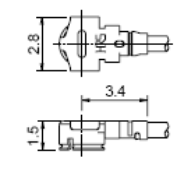
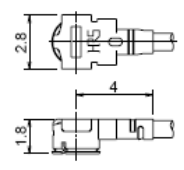
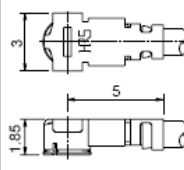
Part No.	U.FL-LP-040	U.FL-LP-066	U.FL-LP(V)-040	U.FL-LP-062	U.FL-LP-088
					
Mated Height	2.5mm Max. (2.4mm Nom.)	2.5mm Max. (2.4mm Nom.)	2.0mm Max. (1.9mm Nom.)	2.4mm Max. (2.3mm Nom.)	2.4mm Max. (2.3mm Nom.)
Applicable cable	Dia. 0.81mm Coaxial cable	Dia. 1.13mm and Dia. 1.32mm Coaxial cable	Dia.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

Figure 4-6 antenna connector plug diagram

Table 4-2 RF connector main parameters

Rated condition	Environment condition	
frequency range	DC to 6GHZ	-40°C to +85°C
characteristic impedance	50 Ω	-40°C to +85°C

4.5 Working frequency

Table 4-3 radiofrequency frequency meter

Band	Uplink frequency	Downlink Frequency	Pattern
B3	1710MHz - 1785MHz	1805MHz - 1880MHz	Half duplex
B5	824MHz - 849MHz	869MHz - 894MHz	Half duplex
B8	880 MHz-915 MHz	925 MHz-960 MHz	Half duplex
B20	832 MHz - 862 MHz	791 MHz - 821 MHz	Half duplex
B28	703 MHz - 748 MHz	758 MHz - 803 MHz	Half duplex
GSM850	824~849MHz	869~894MHz	Half duplex
EGSM900	880~915MHz	925~960MHz	Half duplex
DCS1800	1710~1785MHz	1805~1880MHz	Half duplex
PCS1900	1850~1910MHz	1930~1990MHz	Half duplex

4.6 RF conduction emission power and acceptance sensitivity

The RF output power of the C1-RM NB-IOT/EGPRS module is as follows:

Table 4-4 C1-RM NB-IOT/EGPRS RF output power

Directories	3GPP protocol requirements (dBm)	Minimum value
NB-IOT		
LTE B3	21 to 25	<-40dBm
LTE B5	21 to 25	<-40dBm
LTE B8	21 to 25	<-40dBm
LTE B20	21 to 25	<-40dBm
LTE B28	21 to 25	<-40dBm

Table 4-5 radiofrequency sensitivity index

Directories	3GPP protocol requirements (dBm)	Minimum	Typical	Maximum
NB-IOT				
LTE B3	-107.5	<-107.5	-113	
LTE B5	-107.5	<-107.5	-113	
LTE B8	-107.5	<-107.5	-113	
LTE B20	-107.5	<-107.5	-113	
LTE B28	-107.5	<-107.5	-113	

4.7 Power consumption characteristics

Table 4-6 NB-IOT power consumption

Type	Channel	Power MAX	Call Current (mA)			
			Power	Avg Current	Min Current	Max Current
NB-IOT B3	TBD		Max power	TBD		
	TBD			TBD		
	TBD			TBD		
NB-IOT B5	TBD		Max power	TBD		
	TBD			TBD		
	TBD			TBD		
NB-IOT B8	TBD		Max power	TBD		
	TBD			TBD		

	TBD			TBD		
NB-IOT B20	TBD		Max power	TBD		
NB-IOT B28	TBD		Max power	TBD		

Chapter 5. Electrical characteristics of interface

5.1 Summary

- ✧ Extreme work
- ✧ IO level
- ✧ Power supply
- ✧ Electrostatic characteristics
- ✧ Reliability index

5.2 Extreme work

Table 5-1 C1-RM NB-IOT/EGPRS module working storage temperature

Parameter	Minimum	Maximum
Normal working temperature	-20°C	70°C
Extreme working temperature	-40°C	85°C
Storage temperature	-45°C	90°C

Table 5-2 C1-RM NB-IOT/EGPRS module limit operating voltage range

Parameter	Description	Minimum	Typical	Maximum
VBAT	Module power supply voltage	3.4V	3.7V	4.2V
	RMS average current			0.9V

5.3 Module IO level

The C1-RM NB-IOT/EGPRS module port IO level is as follows:

Which corresponds to 1.8V USIM application, SIM_VDD is 1.8V, corresponds to 3V USIM application, SIM_VDD is 3V.

Other digital IO levels are unified to 2.8V.

Table 5-3 electrical characteristics of C1-RM NB-IoT/EGPRS module

Parameter	Description	Minimum	Maximum
VIH	High level input voltage	0.7* VDD_EXT	VDD_EXT
VIL	Low level input voltage	-	0.3*VDD_EXT
VOH	High level output voltage	0.7*VDD_EXT	VDD_EXT
VOL	Low level output voltage	0	

5.4 Power Supply

The input power requirements of the C1-RM NB-IoT/EGPRS module are as follows:

Table 5-4 C1-RM NB-IoT/EGPRS module working voltage

Parameter	Minimum	Typical	Maximum	Unit
VBAT	3.4	3.7	4.2	V

The power on any interface of the module must not be earlier than the boot time of the module, otherwise it may cause the module to be abnormal or damaged.

5.5 Electrostatic characteristics

C1-RM NB-IoT/EGPRS module without any overvoltage protection measures, the module needs to use static electricity protection, to ensure product quality.

ESD design recommendations:

- ✧ The module's USIM pin needs to be protected by adding TVS.
- ✧ Add TVS at the module input power supply.
- ✧ The PCB wiring of protective devices should take the "V" shape line as far as possible so as to avoid the "T" shape.
- ✧ Ensure the integrity of the module's surrounding ground plane and do not divide it.
- ✧ In the production, assembly and laboratory testing of modules, attention should be paid to the surrounding environment and ESD control of operators.

Table 5-5 C1-RM NB-IoT/EGPRS ESD characteristics

Test port	Contact discharge	Air discharge	Unit
-----------	-------------------	---------------	------

USIM interface	±4	±8	KV
VBAT power supply	±4	±8	KV
RF_ANT	±4	±8	KV
BT_ANT	±4	±8	KV

5.6 Reliability index

Table 5-6 reliability test

Test project	Test conditions	Reference Standard	Experimental result
Low temperature work	Temperature: - 20 C Work mode: normal work Test duration: 24 h	IEC60068-2-1	Appearance check: normal Functional examination: normal RF index check: normal
High temperature work	Temperature: 70 C Work mode: normal work Test duration: 24 h	JESD22-A108-C	Appearance check: normal Functional examination: normal RF index check: normal
Temperature cycle	High temperature: 70 C Low temperature: - 20 C Work mode: normal work Test duration: 30 Cycles; 1 h+1h /cycle	JESD22-A105-B	Appearance check: normal Functional examination: normal RF index check: normal
Drop Test	Height 0.8 m, 6 sides each time, fell to the level marble platform. Work mode: no package, no Power on and off	IEC60068-2-32	Appearance check: normal Functional examination: normal RF index check: normal

Chapter 6. Structure and mechanical properties

6.1 Summary

- ✧ Outward appearance
- ✧ Mechanical dimension of module

6.2 Appearance

The C1-RM NB-IoT/EGPRS module is PCBA with a single layout. The module appearance is as follows:

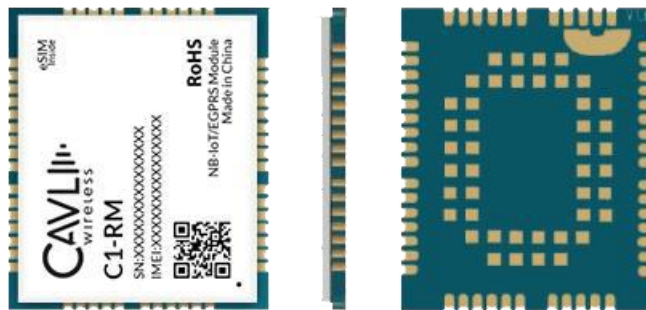


Figure 6-1 C1-RM NB-IoT/EGPRS module appearance

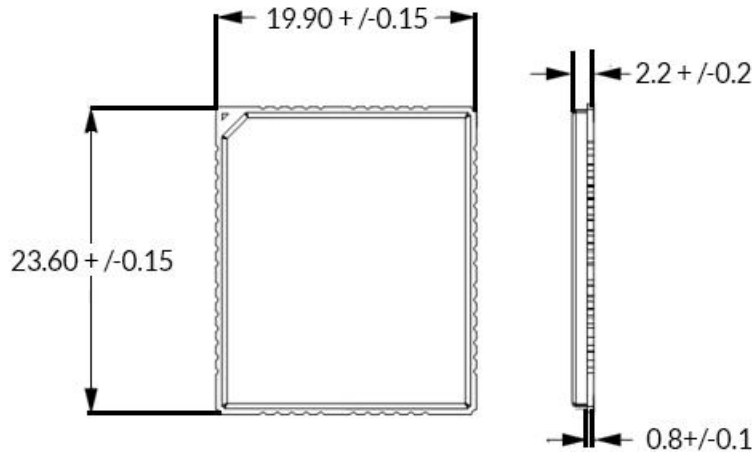


Figure 6-2 front view and side view of C1-RM NB-IoT/EGPRS module (unit MM)

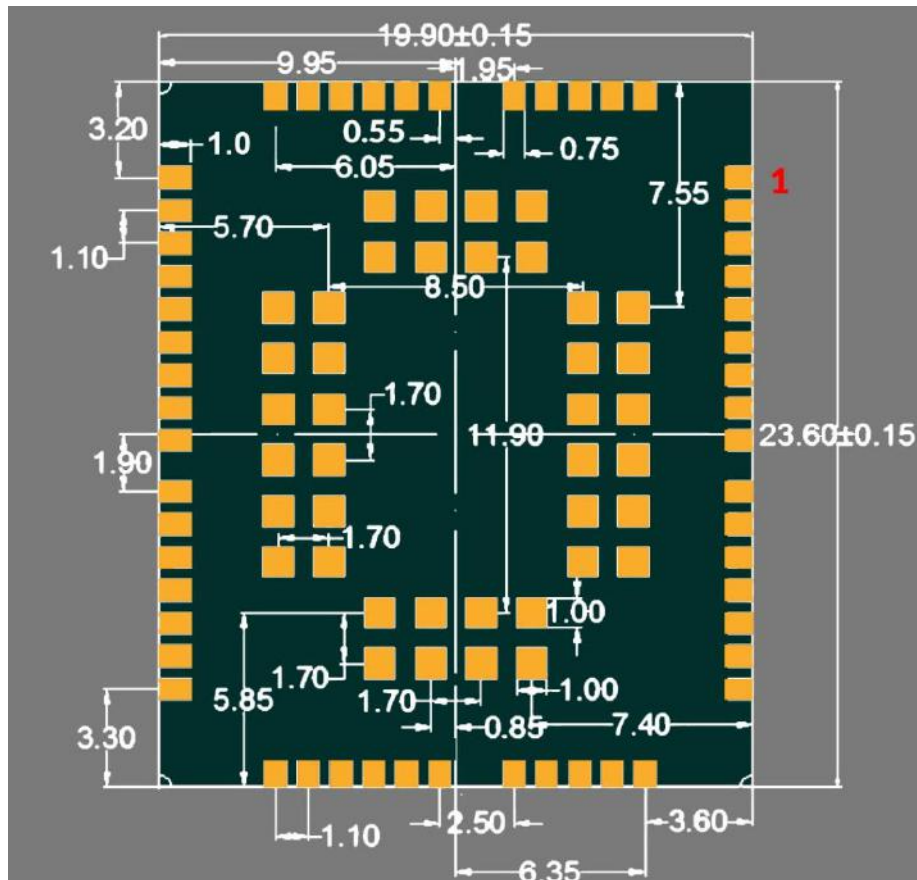


Figure 6-3 C1-RM NBIOT/EGPRS module bottom view (unit MM)

Chapter 7. Production and packaging

7.1 Summary

- ✧ Packaging and storage of module
- ✧ Production welding

7.2 Module packaging and storage

C1-RM NBIOT/EGPRS module is packed in tray and packed in vacuum sealed bag. It is shipped in the form of vacuum sealed bag with 10PCS as a disk and 100PCS as a package.

The storage of C1-RM NBIOT/EGPRS module should follow the following conditions:

- ✧ The humidity sensitive grade of the module is level 3.
- ✧ If the ambient temperature is greater than 40 degrees Celsius and the air humidity is less than 90%, the module can be stored in a vacuum sealed bag for 12 months.
- ✧ When the vacuum sealing bag is opened, if the temperature of the module is less than 30 degrees centigrade, the air humidity is less than 60%, the factory can finish the patch within 72 hours, and the module can be directly reflow welding or other high temperature flow.
- ✧ If the module is in other conditions, it needs baking before the patch.
- ✧ If the module needs to be baked, remove the package and bake at 125 degrees Celsius for 48 hours.

7.3 Production welding

C1-RM NBIOT/EGPRS module is packed by antistatic tray, SMT production line should be equipped with Tray module, reflux furnace above 7 temperature zone is recommended.

- ✧ To ensure the quality of the printing paste, the thickness of the steel mesh corresponding to the pad of the C1-RM NBIOT/EGPRS module is recommended as 0.18mm.
- ✧ It is recommended that the temperature of reflow soldering is 235~245 C, not exceeding 260 C.
- ✧ When PCB double sided layout, LCC module layout must be processed on second sides. Avoid module reversal due to module gravity, resulting in module missing, welding and welding, and poor internal welding of modules.

The recommended temperature curve of the furnace is as shown in the following figure.

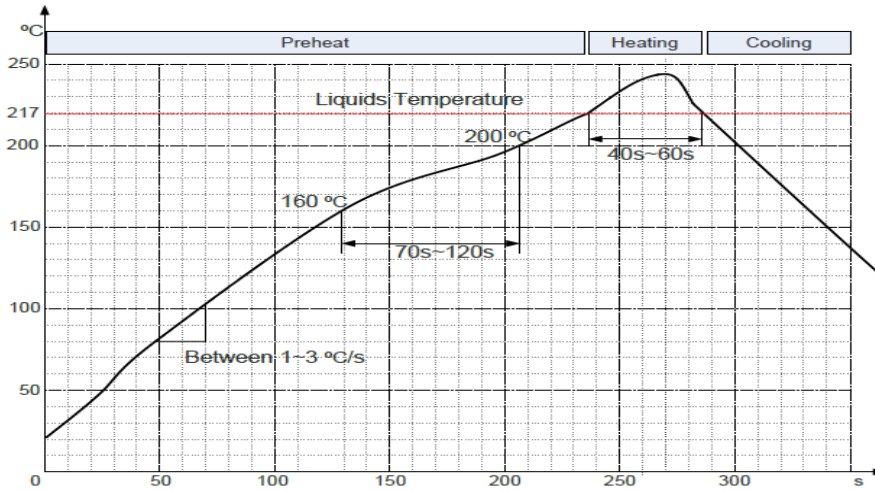


Figure 7-1 reflow soldering temperature curve

Table 7-1 recirculation process parameter table

Temperature zone	Time	Key parameter
Preheating zone (40S°C-165°C)		heating rate: 1°C/s-3°C/s
Isothermal zone (160°C-210°C)	(t1~t2): 70s-120s	
Reflux zone (> 217°C)	(t3~t4): 40s-60s	Peak temperature: 235°C-245°C
Cooling zone	cooling rate: 2°C/s ≤ Slope ≤ 5°C/s	

Chapter 8. Terminology abbreviation

Table 8-1 terminology abbreviations

Abbreviation	Full name
3GPP	Third Generation Partnership Project
AMR	Adaptive Multi-rate
CTS	Clear to Send
DTR	Data Terminal Ready
DL	Down Link

DTE	Data Terminal Equipment
EMC	Electromagnetic Compatibility
ESD	Electrostatic Discharge
LED	Light-Emitting Diode
NC	Not Connected
PCB	Printed Circuit Board
USIM	Universal Subscriber Identity Module
TVS	Transient Voltage Suppressor
TX	Transmitting Direction
UART	Universal Asynchronous Receiver-Transmitter
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency