

# CAVLI C31QM LTE-M/NB-IoT Module Hardware Manual

Version: 1.2

## **Cavalier Wireless Inc. DBA Cavli Wireless**

177 Park Avenue, San Jose, California, USA 95113

Website: www.cavliwireless.com

Contact: +1-650-334-3414

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# Chapter 1. Introduction

This document is the wireless solution product Cavli C31-QM module hardware interface manual. It is intended to describe the hardware composition and functional characteristics of the module solution product, application interface definition and usage, electrical and mechanical characteristics. Combined with this document and other application documents, users can quickly use the module to design wireless products.



# Chapter 2. Product Overview

#### 2.1 Product Overview

The Cavli C31-QM module is an eMTC/NB-IOT based wireless communication module for the Internet of things. It is encapsulated for LGA with 102 pins, and the structure size of the module is 22.5mm\*26.5mm\*2.4mm. Support the following frequency bands:

NB-IoT: B1/B3/B5/B8/B20/B26/B28

LTE-M: B1/B2/B4/B5/B7/B8/B12/B13/B17/B20/B26/B28/B66/B71

C31-QM Integrated multi constellation GNSS receiver support GPS/GLONASS/BeiDou/Galileo/QZSS positioning system.

GNSS supports at least 44 channels, tracking sensitivity can reach -153dBm;

The C31-QM module uses low power technology, and the current power consumption can be as low as 5uA at deep sleep.

The C31-QM module can be used in the following applications:

- Vehicle equipment
- Smart city (intelligent parking, water / gas meter, street lamp, smoke alarm, garbage bin, etc.)
- Intelligent medical treatment
- Industrial and agricultural intelligent monitoring (machine alarm, gas detection, irrigation, soil pH value, etc.)
- Smart home



#### • Other wireless terminals

## 2.2 Module Features

Table 2-1 Module specifications

Features	Description
Physical properties	22.5mm*26.5mm*2.4mm
Application processor	Single-core ARM Cortex-A7 processor, clocked at 1.2GHZ, 256kB, L2 cache
Working voltage	3.3V - 4.2V Typical voltage 3.7V
Power saving	PSM mode power < 5uA
Power saving	Dormant mode current < 1mA
Application interface	standard SIM interface, support 3.0V / 1.8V, support hot-swapping function  USB2.0 (High-Speed)  Hardware reset interface  UART serial interface  PCM interface  power interface  Network status indication interface  GPIO interface
Operating frequency band	NB-IoT: B1/B3/B5/B8/B20/B26/B28 LTE-M: B1/B2/B4/B5/B7/B8/B12/B13/B17/B20/B26/B28/B66/ B71



Emissive power	LTE Power grade 3 (0.25W)
Linissive power	E1 (0.4W)
	LTE CatM1 support 1.4MHz
	LTE CatNB1 support 200KHz
Data	LTE CatM1: 375Kbps (DL)
Data service	LTE CatM1: 375Kbps (UL)
	LTE CatNB1: 32Kbps (DL)
	LTE CatNB1: 72Kbps (UL)
Satellite positioning	GPS/BeiDou/GLONASS
Satellite positioning	Protocol: NMEA
GNSS Interface GNSS Antenna interface	
	Support Text and PDU patterns
SMS	Support point - to - point MO and MT
	SMS storage: USIM card /ME (default)
	normal working temperature –30°C to +75°C
Operating temperature	Extreme working temperature –40°C to +80°C
	Storage temperature: -45°C to +85°C
AT command	Supports standard AT Command (3GPP TS 27.007.27.005)

The C31-QM module recommends working at - 30degree C to +75degree C environment. It is suggested that the application terminal adopt temperature control measures under harsh conditions. At the same time, some RF indexes may exceed the limit. At the same time, it is suggested to be stored under a certain temperature.

The C31-QM module can further reduce its power consumption by way of entering PSM. PSM is similar to shut down, but modules are still registered on the network. After waking



from the PSM mode, the module does not need to re attach or re-establish the PDN connection. So the module cannot respond to user request immediately after entering PSM. The PSM function can be used by AT+CPSMS=1. In the PSM state, the module can be wake-up by pulling the PWRKEY pin to a low level.

#### 2.3 Module Function

C31-QM module contains the following circuit elements:

- Baseband processing unit
- Power management unit
- Memory unit
- RF transceiver unit
- RF front-end unit
- GPS RF receiving unit

C31-QM module function block diagram is as follows:



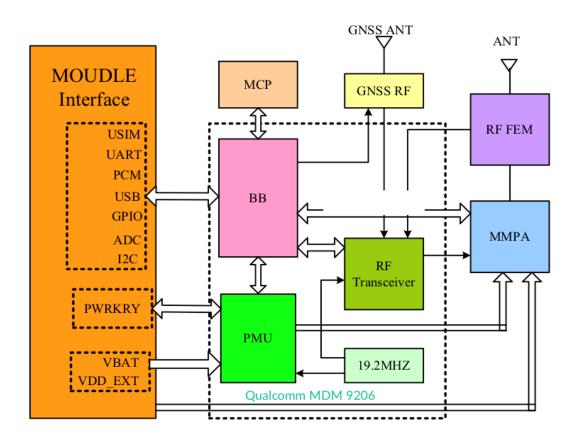


Figure 2-1 C31-QM module functional block diagram

## 2.4 Module working mode

Table 2-2. Mode of Operation

Working Mode	Description
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	Open 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.
	After entering PSM mode, the module can achieve the minimum power consumption, each power supply inside the module is closed, the software except RTC is stopped
PSM mode	running, and the serial port and USB cannot be used.

# Chapter 3. Interface application description

# 3.1 Overview of this chapter

There are 102 patch pins in C31-QM. The following sections will explain the functions of each unit interface in detail.



- Modular foot distribution diagram
- Modular foot description
- Power interface
- USB interface
- USIM interface
- UART interface
- Network status indicator interface
- PCM interface
- RF antenna interface

#### 3.2 Module Interface

## 3.2.1 C31-QM tube foot distribution diagram

#### C31-QM pins are assigned as follows:

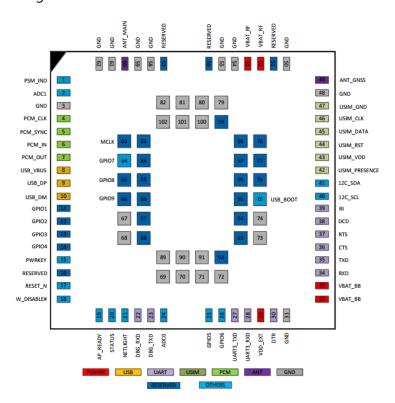


Figure 3-1 C31-QM pin distribution diagram



Table 3-1 module pin definition list

	Table 3-1 module pin definition list				
Pin	Pin definition	Pin	Pin definition		
1	DCM IND	2	ADC1		
1	PSM_IND	2	ADC1		
3	GND	4	PCM_CLK		
5	PCM_SYNC	6	PCM_IN		
7	PCM_OUT	8	USB_VBUS		
<b>'</b>	FCW_OOT		036_4803		
9	USB_DP	10	USB_DM		
11	GPIO_1	12	GPIO_2		
13	GPIO_3	14	GPIO_4		
13	GFIO_3	14	GPIO_4		
15	PWRKEY	16	RESERVED		
17	RESET_N	18	W_DISABLE		
19	AD DEADV	20	STATUS		
19	AP_READY	20	STATUS		
21	NETLIGHT	22	DBG_RXD		
23	DBG_TXD	24	ADC0		
25	GPIO_5	26	GPIO_6		
23	GFIO_3	20	GPIO_0		
27	UART3_TXD	28	UART3_RXD		
29	VDD_EXT	30	DTR		
31	GND	32	VBAT_BB		
31	GIND	32	VDAT_DD		
33	VBAT_BB	34	RXD		
35	TXD	36	CTS		
37	DTC	38	DCD		
31	RTS	30	וטכט		
39	RI	40	I2C_SCL		



41	I2C_SDA	42	USIM_PRESENCE
43	USIM_VDD	44	USIM_RST
45	USIM_DATA	46	USIM_CLK
47	USIM_GND	48	GND
49	ANT_GNSS	50	GND
51	RESERVED	52	VBAT_RF
53	VBAT_RF	54	GND
55	GND	56	RESERVED
57	RESERVED	58	GND
59	GND	60	ANT_MAIN
61	GND	62	GND
63	I2S_MCLK	64	GPIO_7
65	GPIO_8	66	GPIO_9
67	GND	68	GND
69	GND	70	GND
71	GND	72	GND
73	GND	74	GND
75	USB_BOOT	76	RESERVED
77	RESERVED	78	RESERVED
79	GND	80	GND
81	GND	82	GND
83	RESERVED	84	RESERVED



85	RESERVED	86	RESERVED
87	RESERVED	88	RESERVED
89	GND	90	GND
91	GND	92	RESERVED
93	RESERVED	94	RESERVED
95	RESERVED	96	RESERVED
97	RESERVED	98	RESERVED
99	RESERVED	100	GND
101	GND	102	GND

# ■ NOTE

- ① The general IO port level is 1.8V (in addition to SIM, the SIM card port level support 1.8V and 3.0V).
- ② The definition RESERVED and NC pins floating, shall not be used.

## 3.2.2. Module pin description

The definition of the module interface pipe foot is described as follows:

Table 3-2 pin parameter abbreviations

Sign indicator	Description
IO	Input or output
PI	Power input
PO	Power output
Al	Analog input
AO	Analog output



DI	Digital input
DO	Digital output
PU	Pull up
PD	Drop-down

Table 3-3 interface definition

Pin	definition	Ю	Functional description	Remarks		
Power s	Power supply					
32,33	VBAT_BB	PI	Baseband power supply	Input voltage3.3~4.2V		
52,53	VBAT_RF	PI	Radio frequency power supply	Input voltage3.3~4.2V		
29	VDD_EXT	РО	Internal 1.8V power output	Maximum current 50mA		
System	control					
15	PWRKEY	DI	Switch control input, low level effective	Default high level 0.8V		
17	RESET_N	DI	Hardware reset control, low level effective	Far away from the source of interference		
USB int	erface					
8	USB_VBUS	PI	USB insertion detection, high level effective			
9	USB_DP	Ю	USB differential signal +			
10	USB_DM	Ю	USB differential signal-			
SIM into	SIM interface					



42	USIM_PRESE NCE	DI	SIM card hot plug detection	External demand for 10K pullup resistance	
43	USIM_VDD	РО	Output power supply to SIM card		
44	USIM_RST	DO	SIM card reset output		
45	USIM_DATA	Ю	SIM card bus data	Internal 100K resistance pull up	
46	USIM_CLK	DO	SIM card clock output		
47	USIM_GND				
State in	dication				
20	STATUS	DO	Module status indication (in development)	1.8V voltage domain	
21	NETLIGHT	DO	Network status indication (in development)	1.8V voltage domain	
UART1 interface					
34	RXD	DI	Data reception	1.8V voltage domain	
35	TXD	DO	Data transmission	1.8V voltage domain	
36	CTS	DO	Scavenging sending	1.8V voltage domain	
37	RTS	DI	Request to send	1.8V voltage domain	
38	DCD	DOH	Output carrier detection	Unused, suspension treatment	
39	RI	DOH	Ringing indication	Unused, suspension treatment	



30	DTR	DI	Data terminal preparation	Unused, suspension treatment		
UART2	interface					
22	DBG_RXD	DI	Data reception	Debug UART		
23	DBG_TXD	DO	Data transmission	Debug UART		
UART3	serial port					
27	UART3_TXD	DO	Data transmission	1.8V voltage domain		
28	UART3_RXD	DI	Data reception	1.8V voltage domain		
I2C inte	erface					
40	I2C_SCL	OD	I2C bus clock output	Internal 10K resistance pull up		
41	I2C_SDA	Ю	I2C bus data input and output	Internal 10K resistance pull up		
PCM in	PCM interface					
4	PCM_CLK	DO	PCM bus data output	1.8V voltage domain		
5	PCM_SYNC	DO	PCM bus synchronous output	1.8V voltage domain		
6	PCM_IN	DI	PCM bus data input	1.8V voltage domain		
7	PCM_OUT	DO	PCM bus data output	1.8V voltage domain		
Other f	Other functional feet					
1	PSM_IND	DO	PSM status indication	1.8V voltage domain		
18	W_DISABLE	DI	Flight mode control	1.8V voltage domain		
19	AP_READY	DI	Detection of AP dormancy state	1.8V voltage domain		



2	ADC1	AI	General analog digital converter interface	Range 0.1V~1.7V				
24	ADC0	Al	General analog digital converter interface	Range 0.1V~1.7V				
Univer	Universal input-output interface							
11	GPIO_1	Ю	General input / output port	Reusable SPI_MOSI				
12	GPIO_2	Ю	General input / output port	Reusable SPI_MISO				
13	GPIO_3	Ю	General input / output port	Reusable SPI_CS_N				
14	GPIO_4	Ю	General input / output port	Reusable SPI_CLK				
25	GPIO_5	Ю	General input / output port	Reusable I2C_SDA				
26	GPIO_6	Ю	General input / output port	Reusable I2C_SCL				
64	GPIO_7	Ю	General input / output port					
65	GPIO_8	Ю	General input / output port					
66	GPIO_9	Ю	General input / output port					
Anteni	Antenna interface							
49	ANT_GNSS	Al	GNSS antenna interface					
60	ANT_MAIN	Ю	Main antenna interface					

## 3.3 Power Interface

C31-QM module power interface consists of three parts:

- VBAT\_BB/RF for the module power supply; VBAT\_BB pins are used for baseband power supply, and VBAT\_RF is used for RF power supply.
- USIM\_VDD power supply for SIM card operation;



• VDD\_EXT for internal 1.8V output power, the maximum supply of 50mA current;

#### 3.3.1 Power supply design

#### C31-QM module power interface is as follows:

Table 3-4 definition of power pipe feet

Pins	Name	1/0	Description	Min	Typical	Max
32,33	VBAT_BB	PI	Baseband power supply	3.3V	3.7V	4.2V
52,53	VBAT_RF	PI	Radio frequency power supply	3.3V	3.7V	4.2V
43	USIM_VDD	РО	SIM power Supply	0	1.8V/ 2.85V	1.98/ 3.3V
29	VDD_EXT	РО	Output power supply		1.8V	
3,31,48,50,54,5 5,58,59,61,62,6 7-74,79-82,89- 91,100-102	GND		Ground	-	0	-

The C31-QM module can be powered by a single power supply mode. The module has 4 channels of power supply, two VBAT\_BB pins supply the baseband of the module, two VBAT\_RF pins give the module radio frequency power supply, the module power supply range is between 3.3V - 4.2V, and the power supply current is not less than 2A. Because in the EGPRS network, when the instantaneous high power transmission is instantaneous, the maximum 2A current peak will be generated, which leads to a larger ripple in the power supply. If the instantaneous voltage drop causes the VBAT power supply voltage to be too low or the power supply current is insufficient, the module may turn off or restart. Therefore, the module power supply needs to provide enough current to ensure the normal operation of the module.

When the external power supply is connected to the module, the VBAT\_BB and VBAT\_RF need to use the star line. The VBAT\_BB line width should not be less than 1mm, and the



VBAT\_RF line width should not be less than 2mm. In principle, the longer the VBAT is walking, the wider the line is.

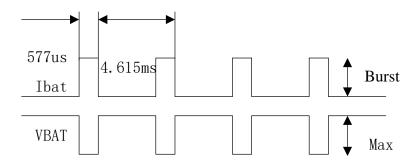


Figure 3-2 voltage drop of burst current power supply for TDMA network

In order to ensure that the power supply is sufficient, 2 470uF/6.3V tantalum capacitors can be connected in close proximity to the power input, and then a 10pF, 33pF, 0.1uF, 1uF ceramic capacitor can be added to improve the performance and stability of the system.

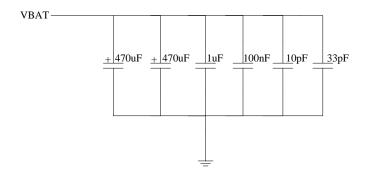


Figure 3-3 VBAT power supply power supply

#### 3.3.2 Power reference circuit

The actual design of power supply circuit can use switched DC power supply or linear LDO power supply to design VBAT power supply, both design circuits need to provide sufficient current. Specific reference to the following circuit design:



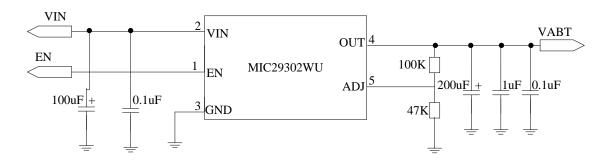


Figure 3-4 LDO linear power reference circuit

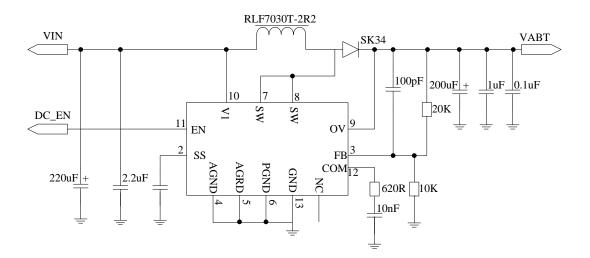


Figure 3-5 reference circuit for switching power supply

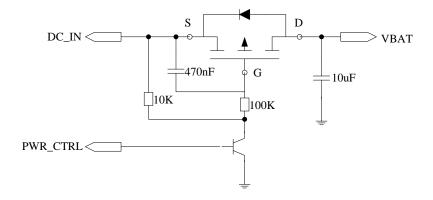


Figure 3-6 reference circuit for PMOS tube control power switch

# ■ NOTE



- In order to prevent the module from being damaged by surge and overvoltage, a 5.1V/500mW Zener diode is suggested to be connected in parallel at 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.

#### 3.3.3 VDD\_EXT 1V8 voltage output

After the C31-QM module is opened normally, the twenty-ninth pins will output the voltage 1.8V, the current load is maximum 50mA. VDD\_EXT can also be used as an external power supply, such as level conversion chips.

#### 3.4 Turn on / turn off / reset

Table 3-- 5 definition of reset pin

Pin	Signal name	I/O	High value	Description
15	PWRKEY	PI	VBAT-0.3V	Low level open
17	RESET_N	DI	1.8V	Module reset control foot, low efficiency

#### 3.4.1. Module opening

In the case of power supply, there are three kinds of modules: 1: button. A switch key 2: grounding can be linked at PWRKEY. Control the PWRKEY directly to the ground 3:AP. The user can pull up the PWRKEY pin by at least 500mS and then pull it up to enable the module to turn on. It is suggested to use open set drive circuit to control PWRKEY pins. The AP control reference circuit is illustrated as follows:



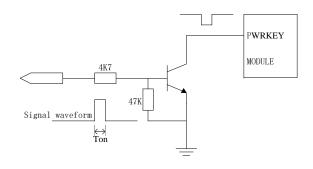


Figure 3-7 open reference circuit

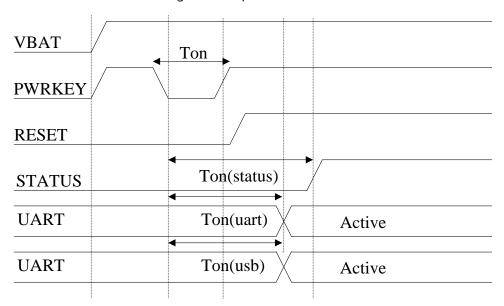


Figure 3-8 opening sequence diagram

Table 3-6 opening timing parameters

Symbol	Description	MIN	Typical	max	unit
Ton	Open low level width	100	500	-	ms
Ton(status)	Start time (according to status state)	4.5	-	-	S
Ton(usb)	Start time (according to USB state)	3.5		-	S
Ton(uart)	Start time (according to UART state)	3.5		-	S
VIH	PWRKEY input high level	0.6	0.8	1.8	V



VIL	PWRKEY input low level	-0.3	0	0.5	V

#### 3.4.2 Module shutdown

The shutdown of C31-QM module can be shut down by PWRKEY and AT commands. The command is AT\$QCPWRDN

When the module is in the boot state, the PWRKEY pin is pulled down at least 1.2S, and the module will execute the shutdown process. The shutdown sequence diagram is as follows:

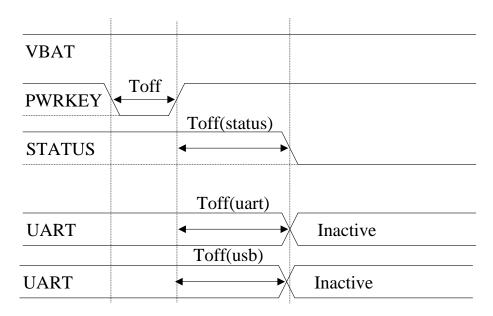


Figure 3-9 shutdown sequence diagram

Table 3-7 shutdown timing parameters

Symbol	Description	MIN	Typical	max	unit
Toff	Low level pulse width of shutdown	1.2		-	S
Toff(status)	Start time (according to status state)	2	-	-	S
Toff(usb)	Start time (according to USB state)	2		-	S
Toff(uart)	Start time (according to uart state)	2		-	S



#### 3.4.3 Reset control

PM2100 module PIN17 signal is the RESET\_N reset pin. When the application end needs to reset the module, the pin can be lowered by 100ms < T-Reset < 600ms and the module can be reset. The external resistance of the pin is 10K to VDD\_EXT. The RESET\_N pin is sensitive to interference and needs to stay away from the RF interference signal.

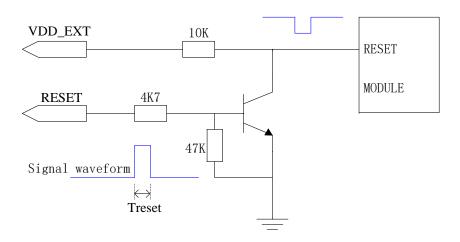


Figure 3-10 reset reference circuit

Table 3-8 RESET pin parameters

Symbol	Description	MIN	Typical	max	unit
T-Reset	Low level pulse width	100		600	ms
VIH	RESET input high level voltage	1.3	1.8	2.1	V
VIL	RESET input low level voltage	-0.3	0	0.5	V

C31-QM module supports the AT command reset, and the AT instruction is AT+CFUN=1,1 to restart the module. Detailed instructions can be used to view the C31-QM AT instruction set manual.



#### 3.5 USB interface

C31-QM module USB interface supports USB2.0 high-speed protocol. It can be used for software debugging, software upgrading, data transmission and AT command. Interface supports slave device mode and does not support USB charging mode. The USB interface pin is defined as follows:

Table 3-9 USB interface pipe definition

PIN	Signal name	Ю	Description
8	USB_VBUS	PI	USB insertion detection, high level effective
9	USB_DP	Ю	USB differential signal +
10	USB_DM	Ю	USB differential signal -

Module as USB slave device, supporting USB dormancy and wakeup mechanism. The USB interface application reference circuit is as follows:

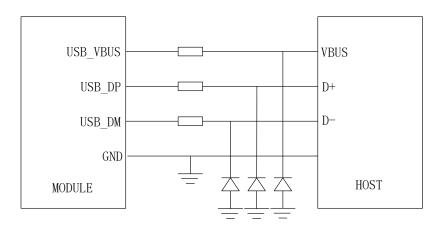


Figure 3-11 USB connection design circuit diagram





- 1. The USB interface supports the high speed (480Mbps) and the full speed (12Mbps) mode, so the line design needs to strictly follow the requirements of the USB2.0 protocol, pay attention to the protection of the data line, the differential walk line, and the control impedance of 90 Omega.
- 2. In order to improve the antistatic performance of USB interface, it is suggested to add ESD protection device to the data line, and the equivalent capacitance of protection device is less than 1pF.
- 3. The power supply voltage of the USB interface bus is provided by the module without external supply. At the same time, because the module's USB interface does not provide USB bus power, modules can only be used as slave devices of USB bus devices. The USB interface supports the following functions:
- Software download and upgrade
- Data communication
- AT Command
- GNSS NMEA Output

#### 3.6 UART Interface

C31-QM module provides a full function serial port for communication. The serial level is 1.8V.

The module supports three serial ports at the same time.

PIN	NAME	Ю	Functional description	Remarks
34	RXD	DI	Data reception	1.8 voltage domain
35	TXD	D0	Data transmission	1.8 voltage domain
30	DTR	DI	Data terminal preparation	Unused, suspension treatment
38	DCD	DOH	Output carrier detection	Unused, suspension treatment



39	RI	DOH	Ringing indication	Unused, suspension treatment
22	DBG_RXD	DI	Data reception	1.8 voltage domain
23	DBG_TXD	DO	Data transmission	1.8 voltage domain
27	UART3_TXD	DO	Data transmission	1.8 voltage domain
28	UART3_RXD	DI	Data reception	1.8 voltage domain

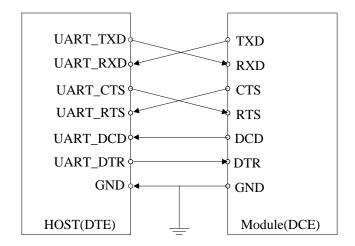


Figure 3-12 full function UART serial port design diagram

If you need to use the two-wire serial port, you need to refer to the following serial port design.



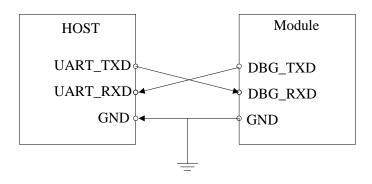


Figure 3-13 two-wire UART serial port design diagram

C31-QM module is a TTL 1.8V level. If the serial port needs to be connected to the MCU of the 3.3V level, a level conversion chip needs to be added to achieve the level matching. The reference circuit is recommended as follows:

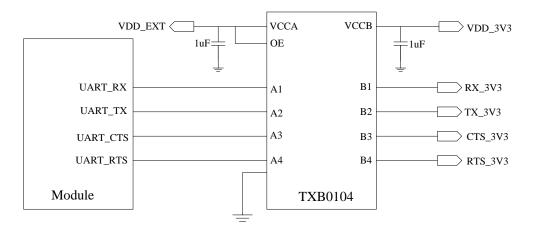


Figure 3-14 level conversion chip circuit

#### 3.7 USIM interface

C31-QM 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 3-10 USIM card signal definition

PIN	Signal name	IO properties	High value	Description
42	USIM_PRESENCE	DI	1.8V	SIM hot-plug detection



43	USIM_VDD	РО	1.8V/2.95V	USIM card power supply
44	USIM_RST	DO	1.8V/2.95V	SIM card reset output
45	USIM_DATA	Ю	1.8V/2.95V	USIM card data signal
46	USIM_CLK	DO	1.8V/2.95V	SIM card clock signal
47	USIM_GND			

#### 3.7.1 USIM card reference circuit

C31-QM module does not contain USIM card slot. Users need to design USIM card slot on their own interface board.

The USIM card interface reference circuit is as follows:

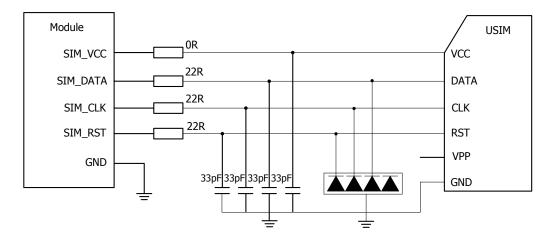


Figure 3-15 USIM design circuit diagram

# MOTE

- 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.
- 2. 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 signal line is far away from the radio frequency, power and high-speed signal line.

- 3. The internal USIM\_DATA signal has been pulled to VDD\_EXT through 47K resistor, and no external pull is required.
- 4. USIM\_PRESENCE is USIM card insert or not insert detection foot, External pull up 100K, default high level, hot-plug application can be through this pin to detect SIM card status.
- 5. To avoid transient voltage overload, USIM interface is recommended to connect 22R resistor in series on signal path.
- 6. The ground and module of USIM card holder should maintain good connectivity.

### 3.7.2 USIM\_PRESENCE Reference design of hot plug

C31-QM module supports the hot plug detection function of USIM card.

USIM\_PRESENCE pin is used as an input detection pin to determine whether the USIM card is inserted or not. Pin is defaults to the high level.

Table 3-11 SIM card hot plug detection foot definition

NO	Tube foot detection state	Functional description	
1	high	SIM card is inserted, UIM_DET is high	
2	low	SIM card is pulled out, UIM_DET is low	



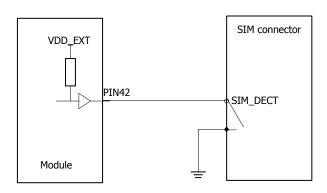


Figure 3-16 USIM card Hot pluggable detection

## M NOTE

- 1. When using normally closed SIM or normally open SIM card, the detection function can be set by AT command. If AT + HOSCFG = 1.1 SIM card in place when the state is high, set AT + HOSCFG = 1,0 SIM card in place when the state is low
- 2. The internal UIM\_DATA has been pulled to VDD\_EXT through 15K resistor, and no external pull is required.

## 3.8 PCM digital voice interface

C31-QM module provides a set of PCM audio interface for external codec audio decoder chip. It supports 8bit A rate, U rate and 16bit linear short frame coding format, PCM\_SYNC is 8kHZ and PCM\_CLK is 2048kHZ.

Table 3-12 PCM pin definition

PIN	Signal name	IO properties	Description
4	PCM_CLK	D0	PCM clock pulse
5	PCM_SYNC	D0	PCM frame synchronization signal
6	PCM_IN	DI	PCM data input
7	PCM_OUT	DO	PCM data output



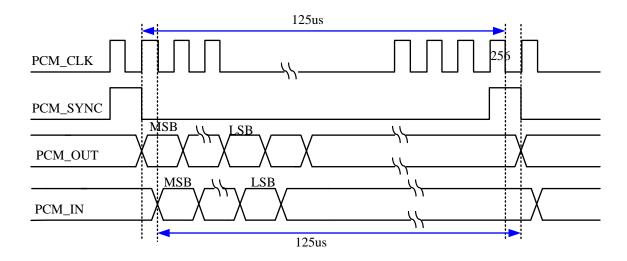


Figure 3-17 PCM short frame pattern sequence diagram

#### 3.9 Network indicator interface

C31-QM module provides a NENLIGHT pin indicating the status of network communication, which can be used to drive the LED lamp indicating the network state.

Table 3-13 definition of network indicator lamp

Pin name	Pin	I/O properties	Description
NETLIGHT	21	DO	Network status indication

Table 3-14 network indicator state

State	LED display status



No service	Always on
Successful registration network	Double flash
Data transmission	Flash

LED network indicator reference design is as follows:

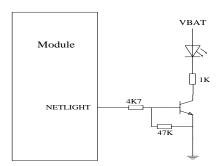


Figure 3-18network indicator circuit diagram

## M NOTE

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

## 3.10 General purpose GPIO interface

C31-QM module provides multiple GPIO. Some of these GPIO can be reused as a variety of functions. The specific usage can be consulted by the module provider.



Table 3-15General Purpose GPIO Pin Definitions

Pin	Pin name	Ю	Functional description	Remarks
11	GPIO_1	Ю	General input / output port	Reusable SPI_MOSI
12	GPIO_2	Ю	General input / output port	Reusable SPI_MOSI
13	GPIO_3	Ю	General input / output port	Reusable SPI_CS_N
14	GPIO_4	Ю	General input / output port	Reusable SPI_CLK
25	GPIO_5	Ю	General input / output port	Reusable I2C_SDA
26	GPIO_6	Ю	General input / output port	Reusable I2C_SCL
64	GPIO_7	Ю	General input / output port	
65	GPIO_8	Ю	General input / output port	
66	GPIO_9	Ю	General input / output port	



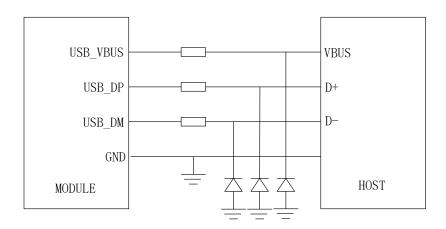


Figure 3-11 USB connection design circuit diagram

## M NOTE

- 1. The USB interface supports the high speed (480Mbps) and the full speed (12Mbps) mode, so the line design needs to strictly follow the requirements of the USB2.0 protocol, pay attention to the protection of the data line, the differential walk line, and the control impedance of 90 Omega.
- 2. In order to improve the antistatic performance of USB interface, it is suggested to add ESD protection device to the data line, and the equivalent capacitance of protection device is less than 1pF.
- 3. the power supply voltage of the USB interface bus is provided by the module without external supply. At the same time, because the module's USB interface does not provide USB bus power, modules can only be used as slave devices of USB bus devices. The USB interface supports the following functions:
- Software download and upgrade
- Data communication
- AT Command
- GNSS NMEA Output

#### 3.6 UART Interface

C31-QM module provides a full function serial port for communication. The serial level is 1.8V.



The module supports three serial ports at the same time.

PIN	NAME	10	Functional description	Remarks
34	RXD	DI	Data reception	1.8 voltage domain
35	TXD	D0	Data transmission	1.8 voltage domain
30	DTR	DI	Data terminal preparation	Unused, suspension treatment
38	DCD	DOH	Output carrier detection	Unused, suspension treatment
39	RI	DOH	Ringing indication	Unused, suspension treatment
22	DBG_RXD	DI	Data reception	1.8 voltage domain
23	DBG_TXD	DO	Data transmission	1.8 voltage domain
27	UART3_TXD	DO	Data transmission	1.8 voltage domain
28	UART3_RXD	DI	Data reception	1.8 voltage domain

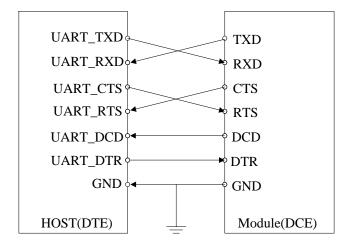




Figure 3-12 full function UART serial port design diagram

If you need to use the two-wire serial port, you need to refer to the following serial port design.

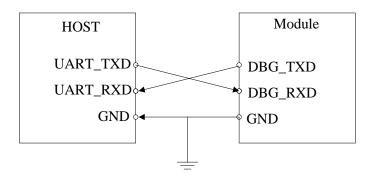


Figure 3-13 two-wire UART serial port design diagram

C31-QM module is a TTL 1.8V level. If the serial port needs to be connected to the MCU of the 3.3V level, a level conversion chip needs to be added to achieve the level matching. The reference circuit is recommended as follows:

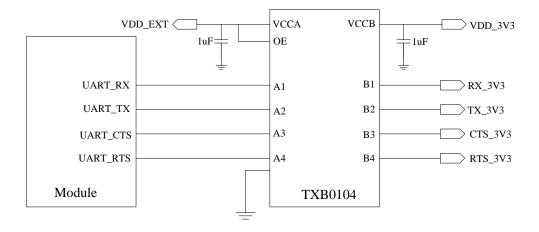


Figure 3-14 level conversion chip circuit

#### 3.7 USIM interface

C31-QM 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 3-10 USIM card signal definition

PIN	Signal name	IO properties	High value	Description
42	USIM_PRESENCE	DI	1.8V	SIM hot-plug detection
43	USIM_VDD	PO	1.8V/2.95V	USIM card power supply
44	USIM_RST	DO	1.8V/2.95V	SIM card reset output
45	USIM_DATA	Ю	1.8V/2.95V	USIM card data signal
46	USIM_CLK	DO	1.8V/2.95V	SIM card clock signal
47	USIM_GND			

#### 3.7.1 USIM card reference circuit

C31-QM module does not contain USIM card slot. Users need to design USIM card slot on their own interface board.

The USIM card interface reference circuit is as follows:

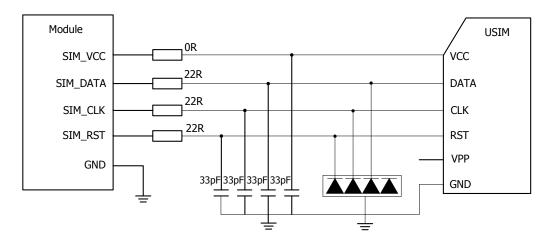


Figure 3-15 USIM design circuit diagram

# MOTE

1. 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.

- 2. 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 signal line is far away from the radio frequency, power and high-speed signal line.
- 3. The internal USIM\_DATA signal has been pulled to VDD\_EXT through 47K resistor, and no external pull is required.
- 4. USIM\_PRESENCE is USIM card insert or not insert detection foot, External pull up 100K, default high level, hot-plug application can be through this pin to detect SIM card status.
- 5. To avoid transient voltage overload, USIM interface is recommended to connect 22R resistor in series on signal path.
- 6. The ground and module of USIM card holder should maintain good connectivity.

#### 3.7.2 USIM\_PRESENCE Reference design of hot plug

C31-QM module supports the hot plug detection function of USIM card.

USIM\_PRESENCE pin is used as an input detection pin to determine whether the USIM card is inserted or not. Pin is defaults to the high level.

Table 3-11 SIM card hot plug detection foot definition

NO	Tube foot detection state	Functional description
1	high	SIM card is inserted, UIM_DET is high
2	low	SIM card is pulled out, UIM_DET is low



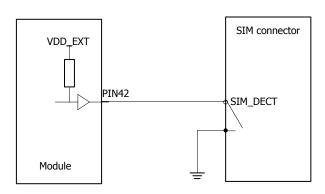


Figure 3-16 USIM card Hot pluggable detection

# ■ NOTE

- 1. When using normally closed SIM or normally open SIM card, the detection function can be set by AT command. If AT + HOSCFG = 1.1 SIM card in place when the state is high, set AT + HOSCFG = 1,0 SIM card in place when the state is low
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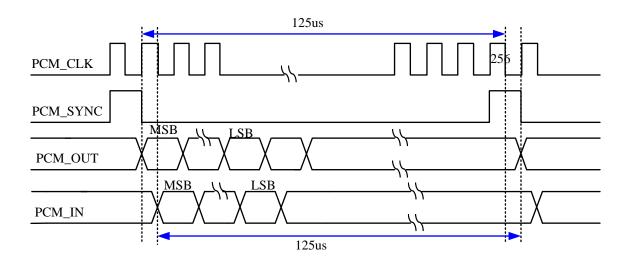


Figure 3-17 PCM short frame pattern sequence diagram

### 3.9 Network indicator interface

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Successful registration network	Double flash
Data transmission	Flash



LED network indicator reference design is as follows:

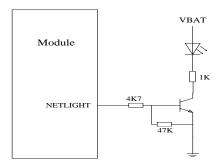


Figure 3-18network indicator circuit diagram



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

### 3.10 General purpose GPIO interface

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13	GPIO_3	Ю	General input / output port	Reusable SPI_CS_N
14	GPIO_4	Ю	General input / output port	Reusable SPI_CLK
25	GPIO_5	Ю	General input / output port	Reusable I2C_SDA
26	GPIO_6	Ю	General input / output port	Reusable I2C_SCL



64	GPIO_7	Ю	General input / output port	
65	GPIO_8	Ю	General input / output port	
66	GPIO_9	Ю	General input / output port	

# Chapter 4. Overall technical indicators

## 4.1 Overview of this chapter

C31-QM module radio contains the following sections:

- Operating frequency.
- Conducted RF measurements.
- Conducted receiver sensitivity and transmit power.

# 4.2 Operating frequency

Table 4-1 radiofrequency frequency meter

Frequency band	Uplink frequency	Downlink frequency	Duplex mode
LTE B1	1920MHz - 1980MHz	2110MHz - 2170MHz	FDD
LTE B3	1710MHz - 1785MHz	1805MHz - 1880MHz	FDD
LTE B4	1710MHz - 1755MHz	2110MHz - 2155MHz	FDD
LTE B5	824MHz – 849MHz	869MHz – 894MHz	FDD
LTE B8	880 MHz–915 MHz	925 MHz-960 MHz	FDD
LTE B18	815MHz - 830MHz	860MHz - 875MHz	FDD
LTE B19	830MHz - 845MHz	875MHz - 890MHz	FDD
LTE B20	832MHz - 862MHz	791MHz - 821MHz	FDD
LTE B26	814MHz - 849MHz	859MHz - 894MHz	FDD



LTE B28 7	703MHz - 748MHz	758MHz - 803MHz	FDD
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# 4.3 Conducted RF Measurements radio frequency.

#### 4.3.1 Test environment

Table 4-2 Test Instruments

Test instrument	Power supply	Murata coaxial RF cable
CMW500	Agilent 66319	MXHP32HP1000

### 4.3.2 Test standards

C31-QM module passes the 3GPP TS 51.010-1, 3GPP TS 34.121-1, 3GPP TS 36.521-1, 3GPP2 C.S0011 and 3GPP2 C.S0033 test standards. Each module in the factory through rigorous testing to ensure reliable quality.

# 4.4 Conducted receive sensitivity and transmit power

The test indicators of the transmission power of the C31-QM module are as follows:

Table 4-3 radiofrequency indicators for conduction emission

Directories	3GPP protocol requirements (dBm)	Min
NB-IOT		
LTE B1	21 to 25	<-44dBm
LTE B3	21 to 25	<-44dBm
LTE B4	21 to 25	<-44dBm



LTE B5	21 to 25	<-44dBm
LTE B8	21 to 25	<-44dBm
LTE B18	21 to 25	<-44dBm
LTE B20	21 to 25	<-44dBm
LTE B26	21 to 25	<-44dBm
LTE B28	21 to 25	<-44dBm
eMTC		
LTE B39	21 to 25	<-44dBm
LTE B8	21 to 25	<-44dBm
LTE B5	21 to 25	<-44dBm

Table 4-4 radiofrequency sensitivity index

Directory (sensitivity)	3GPP protocol requirements	Min	Typical	max
NB-IOT				
LTE B1	-107.5	<-107.5		
LTE B3	-107.5	<-107.5		
LTE B4	-107.5	<-107.5		
LTE B5	-107.5	<-107.5		
LTE B8	-107.5	<-107.5		
LTE B18	-107.5	<-107.5		
LTE B20	-107.5	<-107.5		
LTE B26	-107.5	<-107.5		



LTE B28	-107.5	<-107.5	
еМТС			
LTE B5	-100.8	<-100.8	
LTE B8	-99.8	<-99.8	
LTE B39	-103	TBD	

### 4.5 Antenna requirements

C31-QM module supports one main antenna and one GNSS antenna. In the design of antenna circuits, the 50 ohmic impedance is required for the alignment between modules and antennas. The RF antenna pin is defined as follows:

Table 4-5 RF pin definition

Pin	Pin name	Ю	Functional description	Remarks
49	ANT_GNSS	Al		GNSS antenna interface
60	ANT_MAIN	Ю		Main antenna interface

To minimize losses on the RF line or RF cable, it is recommended that insertion loss meet the following requirements:

- 880--960MHZ < 0.7dB
- 1710-1920MHZ < 1.2dB</li>

When the circuit board is designed, the parameters of the matching device parameters are optimized according to the user's circuit board. Propose a reserved matching circuit. The main board R1/R2 acquiesces 0 ohms and C1/C2 default. In order to prevent the internal static damage module, it is suggested to select a bidirectional TVS tube at the D1/D2 of the antenna connection.



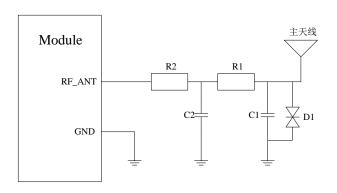


Figure 4-1 antenna connection circuit diagram

Table 4-6 GNSS antenna requirements

Frequency band	Standing wave ratio	Active antenna noise coefficient	Active antenna gain	LNA gain embedded in active antenna
GPS L1 1575.41+/1.023MHZ	<2:1	<1.5DB	>-2DBi	20DB
GLONASS 1597.5- 1605.8MHZ	<2:1	<1.5DB	>-2DBi	20DB
BeiDou 1559.05- 1563.14MHZ	<2:1	<1.5DB	>-2DBi	20DB

If RF connector is used for antenna connection, Murata's MM9329-2700 connector is recommended.



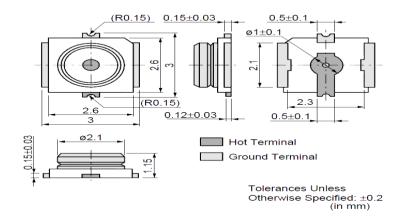


Figure 4-2 recommends a RF connector size diagram

Table 4-7 RF connector main parameters

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

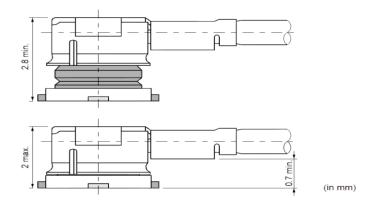


Figure 4-3 matching coaxial radio frequency line size diagram

# 4.6 Power consumption characteristics

Table 4-8 NB-IOT and eMTC power consumption



Туре	Test bandwidth	modulation mode	Call Cur	rent (mA)
		QPSK	Avg Current	23dB
				Current
eMTC B5		5M		197
еМТС В8		5M		200
eMTC B39		TBD		TBD
NB-IOT B1		-		215
NB-IOT B3		-		216
NB-IOT B4		-		207
NB-IOT B5		-		210
NB-IOT B8	-		212	
NB-IOT B18	-		210	
NB-IOT B20	-		219	
NB-IOT B26	-		215	
NB-IOT B28	-		TBD	



# Chapter 5. Interface electrical characteristics

# 5.1 Limit condition

Table 5-1 C31-QM module working storage temperature

Parameter	Min	Мах
normal working temperature	-30°C	80°C
Extreme working temperature	-40°C	85°C
Storage temperature:	-45°C	90°C

Table 5-2 limit operating voltage range of C31-QM module

Parameter	Description	Min	Typical	Max
	Module power supply voltage	3.3V	3.7V	4.2V
VBAT_BB	RMS average current			0.9V
VBAT_RF	GSM TDMA Instantaneous pressure drop			300mV



### 5.2 Module IO electrical level

#### C31-QM module IO electrical level is as follows:

Which corresponds to 1.8V USIM application, USIM\_VDD is 1.8V, corresponds to 3V USIM application, USIM\_VDD is 2.85V. Other digital IO levels are unified to 1.8V.

Table 5-3 electrical characteristics of C31-QM module

Parameter	Description	Min	Мах
VIH	High level input voltage	0.65* VDD_EXT	VDD_EXT+0.3V
VIL	Low level input voltage	-	0.35*VDD_EXT
VOH	High level output voltage	VDD_EXT-0.45V	VDD_EXT
VOL	Low-level output voltage	0	0.45V

## 5.3 Electrostatic characteristics

C31-QM module needs to protect ESD when it is used to ensure product quality.

Table 5-4 C31-QM ESD characteristics

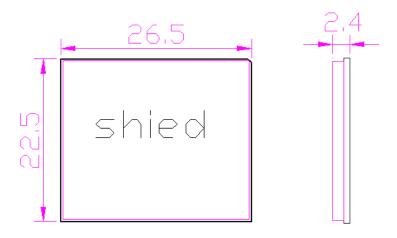
Test port	Contact discharge	Air discharge	Unit
USB interface	±4	±8	KV
USIM interface	±4	±8	KV
VBAT power supply	±4	±8	KV



# Chapter 6. Mechanical Size

This section describes the mechanical dimensions of the module.

## 6.1 Modular mechanical size





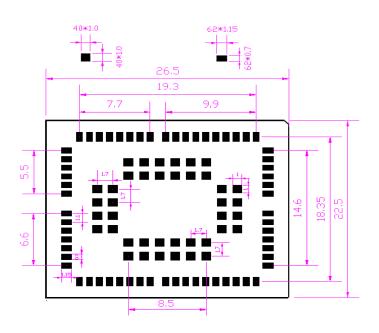


Figure 6-1 C31-QM mechanical size diagram (unit mm)

Figure 6-2 C31-QM bottom dimension diagram (unit mm)

### 6.2 Module overlook and bottom view

The printing scraper is used to print the solder paste on the net plate, so that the solder paste is imprinted on the PCB through the opening of the net plate. The strength of the printing scraper needs to be suitable. In order to ensure the quality of the block printing paste, the thickness of the steel net corresponding to the part of the module welding plate should be 0.18mm.





Figure 6-3 C31-QM overlook view

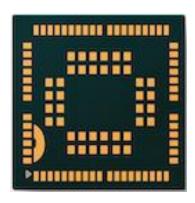


Figure 6-4 C31-QM bottom view

# Chapter 7. Patch production

# 7.1 Summary

- Packaging and storage of module
- Production welding

## 7.2 Module packaging and storage

C31-QM NB 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 C31-QM NB 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 put to 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

C31-QM NB 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 C31-QM NB 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.



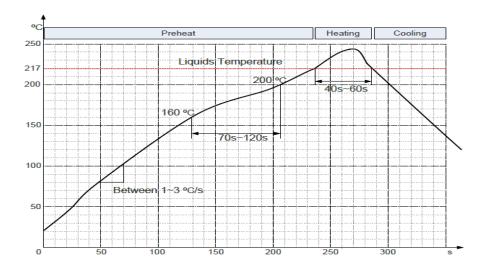


Figure 7-1 reflow soldering temperature curve

# Chapter 8. Terminology abbreviation

Table 8-1 terminology abbreviations

Abbreviation	Full name
3GPP	Third Generation Partnership Project



AMR	Adaptive Multi-rate
СТЅ	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
РСВ	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
UART	Universal Asynchronous Receiver-Transmitter
USIM	Universal Subscriber Identity Module

PIN	Signal name	Ю	Description
8	USB_VBUS	PI	USB insertion detection, high level effective



9	USB_DP	Ю	USB differential signal +
10	USB_DM	Ю	USB differential signal -