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FIBOCOM L610-LA Hardware Guide

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Applicability type

No.	Product model	Description
1	L610-LA	MAIN_ANT, FDD/TDD/GSM, WiFi-Scan, BT

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Versions

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V1.0.1	Wang Yuanguang	Wang Bo	Liu Ke	2019-12-06	Added OPEN pin multiplexing
V1.0.2	Wang Yuanguang	Wang Bo	Liu Ke	2019-12-12	Modified some issues and added pin support for I/O power domain
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V1.1.1	Wang Yuanguang	Wang Bo	Liu Ke	2020-05-29	Add ADC accuracy

Contents

1 Foreword

1.1 Introduction

The document describes the electrical characteristics, RF performance, dimensions and application environment, etc. of L610 wireless modules. With the assistance of the document and other instructions, the developers can quickly understand the hardware functions of L610 modules and develop product hardware.

1.2 Safety Instruction

By following the safety guidelines below, you can ensure your personal safety and help protect the product and work environment from potential damage. Product manufacturers need to communicate the following safety instructions to end users. In case of failure to comply with these safety rules, Fibocom will not be responsible for the consequences caused by the user's misuse.

Road safety first! When you drive, do not use the handheld devices even if it has a hand-free feature. Please stop and call.

Please turn off the mobile device before boarding. The wireless feature of the mobile device is not allowed on the aircraft to prevent interference with the aircraft communication system. Ignoring this note may result in flight safety issue or even violate the law.

When in a hospital or health care facility, please be aware of restrictions on the use of mobile devices. Radio frequency interference may cause medical equipment to malfunction, so it may be necessary to turn off the mobile device.

The mobile device does not guarantee that an effective connection can be made under any circumstances, for example, when there is no prepayment for the mobile device or the (U)SIM is invalid. When you encounter the above situation in an emergency, remember to use an emergency call, while keeping your device turned on and in areas where signal is strong.

Your mobile device receives and transmits RF signals when it is powered on. Radio interference occurs when it is near televisions, radios, computers, or other

electronic devices.

Keep the mobile device away from flammable gases. Turn off the mobile device when you get near to gas stations, oil depots, chemical plants or explosive workplaces. There are potential safety hazards when operating electronic equipment in any potentially explosive area.

1.3 Reference Standard

This design of the product complies with the following standards:

- *3GPP TS 51.010-1 V10.5.0: Mobile Station (MS) conformance specification; Part 1: Conformance specification*
- *3GPP TS 34.121-1 V10.8.0: User Equipment (UE) conformance specification; Radio transmission and reception (FDD); Part 1: Conformance specification*
- *3GPP TS 34.122 V10.1.0: Technical Specification Group Radio Access Network; Radio transmission and reception (TDD)*
- *3GPP TS 36.521-1 V10.6.0: User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: Conformance testing*
- *3GPP TS 21.111 V10.0.0: USIM and IC card requirements*
- *3GPP TS 51.011 V4.15.0: Specification of the Subscriber Identity Module -Mobile Equipment (SIM-ME) interface*
- *3GPP TS 31.102 V10.11.0: Characteristics of the Universal Subscriber Identity Module (USIM) application*
- *3GPP TS 31.11 V10.16.0: Universal Subscriber Identity Module (USIM) Application Toolkit (USAT)*
- *3GPP TS 36.124 V10.3.0: Electro Magnetic Compatibility (EMC) requirements for mobile terminals and ancillary equipment*
- *3GPP TS 27.007 V10.0.8: AT command set for User Equipment (UE)*
- *3GPP TS 27.005 V10.0.1: Use of Data Terminal Equipment - Data Circuit terminating Equipment (DTE - DCE) interface for Short Message Service (SMS) and Cell Broadcast Service (CBS)*

1.4 Related Documents

- FIBOCOM EVK-GT8230-NL User Guide
- FIBOCOM ADP-L610 User Guide
- FIBOCOM L610 SMT Design Guide
- FIBOCOM Design Guide_RF Antenna
- FIBOCOM L610 AT Commands

2 Product Overview

2.1 Product Introduction

L610 modules are wideband wireless terminal products applicable to various network formats and multi-bands including FDD-LTE/GSM.

The frequency band division of L610 series products is as follows:

Band	L610-LA
LTE FDD	Band 1,2,3,4,5,7,8,28,66
LTE TDD	NO Support
GSM	850/900/1800/1900
ANT	Main+WIFI
Built-in ESIM	NO Support

2.2 Product Specifications

Specifications		
Operating band	LTE FDD: Band 1,2,3,4,5,7,8,28,66	
	GSM/GPRS: 850/900/1800/1900	
Data transmission	LTE FDD Rel.13	10Mbps DL/5Mbps UL
	GPRS	GPRS:85.6kbps DL/85.6kbps UL (multi-slot class 12)
Power supply	3.4V~4.3V (3.8V recommended)	
Temperature	Normal operation: -30°C~+75°C	
	Extended operation: -40°C ~+85°C	
	Storage: -40°C ~+90°C	
Power consumption	Sleep mode: 3mA	
	Idle mode: 15mA	
Physical characteristics	Package: LCC 80PIN+LGA 64PIN	
	Size: 31.0×28.0×2.35 mm	
	Weight: About 5.5g	

Interface	
Antenna	Antenna: main x 1, WIFI x 1
Function interface	USIM 3.0V/1.8V
	USB 2.0 x 1
	System status indication
	ADC*3
Software	
Protocol stack	Embedded TCP/IP and UDP/IP protocol stack
AT command	3GPP TS 27.007 and 27.005, and proprietary FIBOCOM AT
Firmware update	USB
Voice service	AMR, caller ID, call forwarding, call hold, call waiting and multi-party call, etc.
SMS service	Point-to-point MO, MT, cell broadcast, Text and PDU modes

Note:

When the normal operating temperature range of -30°C ~+75°C is exceeded, the RF performance of the module may slightly exceed the requirements of 3GPP Specification.

2.3 Hardware Diagram

Figure 2-2 hardware diagram shows the main hardware features of L610 module, including baseband and RF features.

Baseband includes:

- GSM/LTE TDD/LTE FDD controller
- PMIC
- UART, SIM, PCM, I2C, SPI, SDIO, ADC, KEY

RF includes:

- RF Transceiver
- RF PA
- RF filter
- Antenna

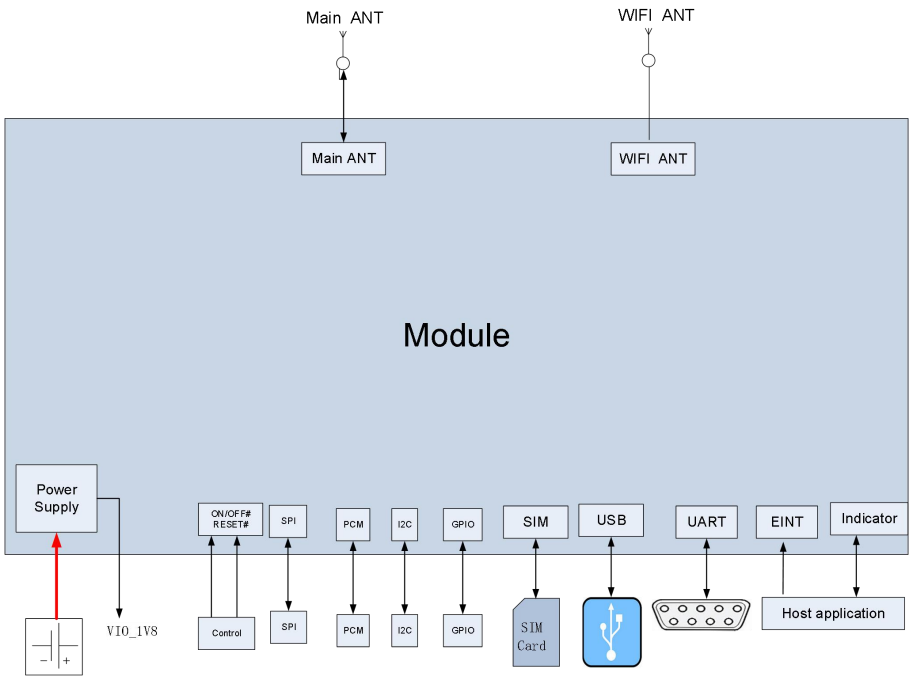

Figure 2-2 Hardware diagram

3 Application Interface

3.1 LCC+LGA Interface

L610 modules adopt LCC 80PIN+LGA 64PIN packaging, with a total of 144 pins.

3.1.1 Pin Distribution

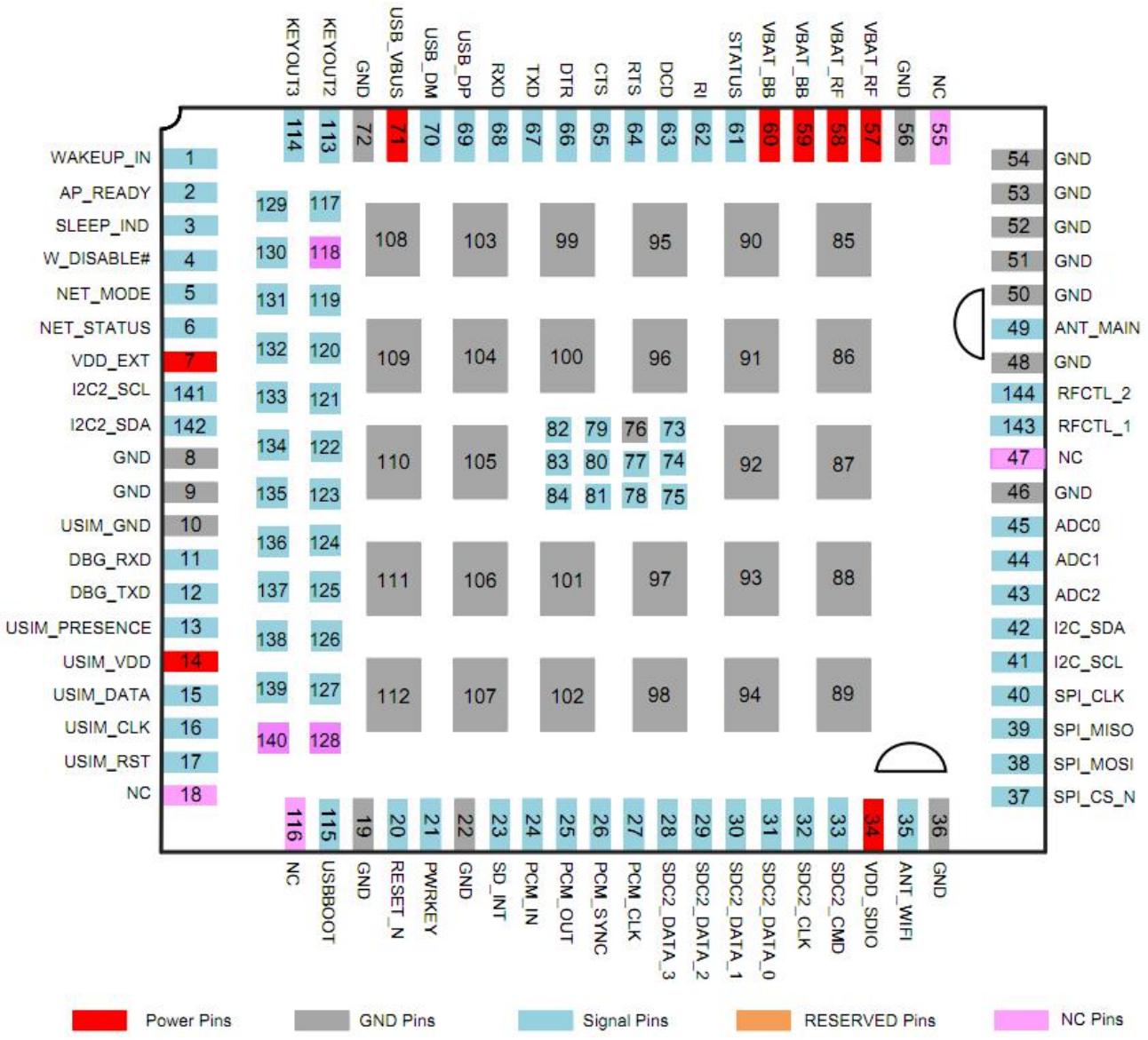

Figure 3-1 Pin Distribution Diagram (TOP plan perspective view)

Note:

"85-->112" is the thermal pin, and the module is grounded internally. It is recommended that the

heat sink pad is reserved for PCB packaging and welded.

3.1.2 Pin Definition

The pins are defined as follows:

Pin	Pin Name	I/O	Level	Reset Value	Description
1	WAKEUP_IN	I	V_{IL}min=-0.3V V_{IL}max=0.63V V_{IH}min=1.2/2.2V V_{IH}max=2.0/2.8V*	L	External device wake-up module Left floating when not in use
2	AP_READY	I	V_{IL}min=-0.3V V_{IL}max=0.63V V_{IH}min=1.2/2.2V V_{IH}max=2.0/2.8V*	H	The module detects whether the host is sleeping Left floating when not in use
3	SLEEP_IND	O	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	SLEEP_IND Left floating when not in use
4	W_DISABLE#	I	V_{IL}min=-0.3V V_{IL}max=0.63V V_{IH}min=1.2/2.2V V_{IH}max=2.0/2.8V*	L	Module flight mode control Left floating when not in use
5	NET_MODE	O	V_{OH}min=1.35V V_{OL}max=0.45V	L	Module state indication Left floating when not in use
6	NET_STATUS	O	V_{OH}min=1.35V V_{OL}max=0.45V	L	
7	VDD_EXT	PO	1.8V		Module digital level, 1.8V output Left floating when not in use
8	GND	G	-		Ground
9	GND	G	-		Ground
10	USIM_GND	G	-		Ground
11	DBG_RXD	I	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V		DEBUG serial port Receive Left floating when not in use
12	DBG_TXD	O	V_{OL}max=0.45V V_{OH}min=1.35V		DEBUG serial port Transmit Left floating when not in use
13	USIM_PRESENCE	I	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	USIM hot plug detection; no need to connect 10k to Ground in series;

Pin	Pin Name	I/O	Level	Reset Value	Description
					software shutdown detection function
14	USIM_VDD	PO	For 1.8V USIM: Vmax=1.9V Vmin=1.7V For 3.0V USIM: Vmax=3.05V Vmin=2.7V I/Omax=50mA		USIM power supply
15	USIM_DATA	I/O	For 1.8V USIM: V_{IL}max=0.6V V_{IH}min=1.2V V_{OL}max=0.45V V_{OH}min=1.35V For 3.0V USIM: V_{IL}max=1.0V V_{IH}min=1.95V V_{OL}max=0.45V V_{OH}min=2.55V		USIM data signal cable
16	USIM_CLK	O	For 1.8V USIM: V_{OL}max=0.45V V_{OH}min=1.35V For3.0V USIM: V_{OL}max=0.45V V_{OH}min=2.55V		USIM clock signal cable
17	USIM_RST	O	For 1.8V USIM: V_{OL}max=0.45V V_{OH}min=1.35V For 3.0V USIM: V_{OL}max=0.45V V_{OH}min=2.55V		USIM reset signal cable
18	NC	-	-		NC
19	GND	G	-		Ground
20	RESET_N	I	V_{IH}max=VBAT V_{IL}max=0.5V		Module reset signal, active low
21	PWRKEY	I	V_{IH}max=VBAT V_{IL}max=0.5V		Module power-on/power-off, active low
22	GND	G	-		Ground
23	SD_DET	I	-		SD detection Left floating when not in use
24	PCM_IN	I	V_{IL}min=-0.3V V_{IL}max=0.6V	L	PCM data input

Pin	Pin Name	I/O	Level	Reset Value	Description
			V_{IH}min=1.2V V_{IH}max=2.0V		Left floating when not in use
25	PCM_OUT	O	V_{OL}max=0.45V V_{OH}min=1.35V	L	PCM data output Left floating when not in use
26	PCM_SYNC	I/O	V_{OL}max=0.45V V_{OH}min=1.35V V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	PCM data synchronization signal Left floating when not in use
27	PCM_CLK	I/O	V_{OL}max=0.45V V_{OH}min=1.35V V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	PCM clock Left floating when not in use
28	SDC2_DATA_3	I/O	V_{IL}min=-0.3V V_{IL}max=0.63V V_{IH}min=1.2/2.2V V_{IH}max=2.0/2.8V*	H	SDC2_DATA_3 Left floating when not in use
29	SDC2_DATA_2	I/O	V_{IL}min=-0.3V V_{IL}max=0.63V V_{IH}min=1.2/2.2V V_{IH}max=2.0/2.8V*	H	SDC2_DATA_2 Left floating when not in use
30	SDC2_DATA_1	I/O	V_{IL}min=-0.3V V_{IL}max=0.63V V_{IH}min=1.2/2.2V V_{IH}max=2.0/2.8V*	H	SDC2_DATA_1 Left floating when not in use
31	SDC2_DATA_0	I/O	V_{IL}min=-0.3V V_{IL}max=0.63V V_{IH}min=1.2/2.2V V_{IH}max=2.0/2.8V*	H	SDC2_DATA_0 Left floating when not in use
32	SDC2_CLK	O	V_{IL}min=-0.3V V_{IL}max=0.63V V_{IH}min=1.2/2.2V V_{IH}max=2.0/2.8V*		SDC2_CLK Left floating when not in use
33	SDC2_CMD	O	V_{IL}min=-0.3V V_{IL}max=0.63V V_{IH}min=1.2/2.2V V_{IH}max=2.0/2.8V*	H	SDC2_CMD Left floating when not in use
34	VDD_SDIO	PO	-		VDD_SDIO
35	WIFI_ANT	I	-		WIFI antenna Left floating when not in use

Pin	Pin Name	I/O	Level	Reset Value	Description
36	GND	G	-		Ground
37	SPI_CS_N	I	V_{OL}max=0.45V V_{OH}min=1.35V V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V		SPI_CS_N Left floating when not in use
38	SPI_MOSI	I	V_{OL}max=0.45V V_{OH}min=1.35V V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	SPI_MOSI Left floating when not in use
39	SPI_MISO	O	V_{OL}max=0.45V V_{OH}min=1.35V V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	SPI_MISO Left floating when not in use
40	SPI_CLK	O	V_{OL}max=0.45V V_{OH}min=1.35V V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	SPI_CLK Left floating when not in use
41	I2C_SCL	OD	V_{OL}max=0.45V V_{OH}min=1.35V V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	H	I2C interface clock signal Left floating when not in use
42	I2C_SDA	OD	V_{OL}max=0.45V V_{OH}min=1.35V V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	H	I2C interface data signal Left floating when not in use
43	ADC2	I	-		Analog to digital converter interface 2 Connect 1k in series when in use; left floating when not in use
44	ADC1	I	-		Analog to digital converter interface 1 Connect 1k in series when in use; left

Pin	Pin Name	I/O	Level	Reset Value	Description
					floating when not in use
45	ADC0	I	-		Analog to digital converter interface 0 Connect 1k in series when in use; left floating when not in use
46	GND	G	-		Ground
47	NC	-	-		NC
48	GND	G	-		Ground
49	ANT_MAIN	I/O	-		Main antenna
50	GND	G	-		Ground
51	GND	G	-		Ground
52	GND	G	-		Ground
53	GND	G	-		Ground
54	GND	G	-		Ground
55	NC	-	-		NC
56	GND	G	-		Ground
57	VBAT_RF	PI	Vmax=4.2V Vmin=3.4V Vnorm=3.8V		RF power input (3.4V-4.2V)
58	VBAT_RF	PI	Vmax=4.2V Vmin=3.4V Vnorm=3.8V		RF power input (3.4V-4.2V)
59	VBAT_BB	PI	Vmax=4.2 Vmin=3.4V Vnorm=3.8V		Baseband power input (3.4V-4.2V)
60	VBAT_BB	PI	Vmax=4.2 Vmin=3.4V Vnorm=3.8V		Baseband power input (3.4V-4.2V)
61	STATUS	O	V_{OH}min=1.35V V_{OL}max=0.45V	L	Reserved Left floating when not in use
62	RI*	O	V_{OL}max=0.45V V_{OH}min=1.35V	L	Module output ring indicator Left floating when not in use
63	DCD*	O	V_{OL}max=0.45V V_{OH}min=1.35V	L	Module output carrier detection Left floating when not in use
64	RTS	O	V_{OL}max=0.45V V_{OH}min=1.35V	L	DTE request to send data Left floating when not in use

Pin	Pin Name	I/O	Level	Reset Value	Description
65	CTS	I	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	Module clear to send Left floating when not in use
66	DTR*	I	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	DTE ready Left floating when not in use
67	TXD	O	V_{OL}max=0.45V V_{OH}min=1.35V		Module Transmit data Left floating when not in use
68	RXD	I	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V		Module Receive data Left floating when not in use
69	USB_DP	I/O			USB signal DP Left floating when not in use
70	USB_DM	I/O			USB signal DM
71	USB_VBUS	PI	Vmax=5.25V Vnorm=5.0V		USB plug detection Left floating when not in use
72	GND	G	-		Ground
73	SPK_P	O			SPK_P Left floating when not in use
74	SPK_N	O			SPK_N Left floating when not in use
75	MIC_P	I			MIC_P Left floating when not in use
76	GND	G			Ground
77	MIC_N	I			MIC_N Left floating when not in use
78	KEYIN1	I			KEYIN1 Left floating when not in use
79	KEYIN2	I			KEYIN2 Left floating when not in use
80	KEYIN3	I			KEYIN3 Left floating when not in use

Pin	Pin Name	I/O	Level	Reset Value	Description
81	KEYIN4	I			KEYIN4 Left floating when not in use
82	KEYIN5	I			KEYIN5 Left floating when not in use
83	KEYOUT0	I			KEYOUT0 Left floating when not in use
84	KEYOUT1	I			KEYOUT1 Left floating when not in use
85-112	GND	G	-		Ground
113	KEYOUT2	I			KEYOUT2 Left floating when not in use
114	KEYOUT3	I			KEYOUT3 Left floating when not in use
115	USB_BOOT	I	-		USB_BOOT Enter DL mode before upgrading
116	NC	-			NC
117	CLK26M_OUT	O			CLK26M_OUT Left floating when not in use
118	NC	-			NC
119	LCD_FMARK	O	V_{IL}min=-0.3V V_{IL}max=0.63V V_{IH}min=1.2/2.2V V_{IH}max=2.0/2.8V*	L	LCD_FMARK Left floating when not in use
120	LCD_RSTB	O		H	LCD_RSTB Left floating when not in use
121	SPILCD_SEL	O	V_{IL}min=-0.3V V_{IL}max=0.63V V_{IH}min=1.2/2.2V V_{IH}max=2.0/2.8V*	L	SPILCD_SEL Left floating when not in use
122	SPILCD_CS	O	V_{IL}min=-0.3V V_{IL}max=0.63V V_{IH}min=1.2/2.2V V_{IH}max=2.0/2.8V*	L	SPILCD_CS Left floating when not in use
123	SPILCD_CLK	O	V_{IL}min=-0.3V V_{IL}max=0.63V V_{IH}min=1.2/2.2V	L	SPILCD_CLK Left floating when not in use

Pin	Pin Name	I/O	Level	Reset Value	Description
			V_{IH}max=2.0/2.8V*		
124	SPILCD_SDC	O	V_{IL}min=-0.3V V_{IL}max=0.63V V_{IH}min=1.2/2.2V V_{IH}max=2.0/2.8V*	L	SPILCD_SDC Left floating when not in use
125	SPILCD_SI/O	I/O	V_{IL}min=-0.3V V_{IL}max=0.63V V_{IH}min=1.2/2.2V V_{IH}max=2.0/2.8V*	L	SPILCD_SI/O Left floating when not in use
126	GPIO1	I/O	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	GPIO1 Left floating when not in use
127	PM_EN_WLAN	O	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	PM_EN_WLAN Left floating when not in use
128	NC	-			NC
129	SD1_DATA3	I/O	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	SD1_DATA3 Left floating when not in use
130	SD1_DATA2	I/O	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	SD1_DATA2 Left floating when not in use
131	SD1_DATA1	I/O	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	SD1_DATA1 Left floating when not in use
132	SD1_DATA0	I/O	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	SD1_DATA0 Left floating when not in use
133	SD1_CLK	O	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	SD1_CLK Left floating when not in use
134	SD1_CMD	I/O	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	SD1_CMD Left floating when not in use
135	WAKE_WLAN	O	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V	L	WAKE_WLAN Left floating when not in use

Pin	Pin Name	I/O	Level	Reset Value	Description
			V_{IH}max=2.0V		
136	WLAN_EN	O	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	WLAN_EN Left floating when not in use
137	UART3_RXD	I	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V		UART3_RXD Left floating when not in use
138	UART3_TXD	O	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V		UART3_TXD Left floating when not in use
139	BT_EN	O	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	BT_EN Left floating when not in use
140	NC	-			NC
141	I2C2_SCL	I/O	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	I2C2_SCL Left floating when not in use
142	I2C2_SDA	I/O	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V	L	I2C2_SDA Left floating when not in use
143	RFCTL_1	I/O	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0V		RFCTL_1 Left floating when not in use
144	RFCTL_2	I/O	V_{IL}min=-0.3V V_{IL}max=0.6V V_{IH}min=1.2V V_{IH}max=2.0VS		RFCTL_2 Left floating when not in use

Note:

Keep the unused pins floating, "*" indicates in development.

Pin 85-112 is the module thermal pad, and the corresponding ground pad is reserved for PCB packaging and welded.

3.1.3 Pin Multiplexing

For L610 pin multiplexing, see *FIBOCOM L610-CN-00-00 GPIO Function Multiplexing*.

3.2 Power Supply

The power interfaces of L610 modules are shown in the following table:

Pin Name	I/O	Pin	Description
VBAT_RF	I	57,58	Module power supply, 3.4~4.2V, nominal value 3.8V
VBAT_BB	I	59,60	Module power supply, 3.4~4.2V, nominal value 3.8V
VDD_EXT	O	7	Voltage output, 1.8V
GND	-	8,9,19,22,36,46,48,50-54,56,85-112	Ground

3.2.1 Power Supply

L610 modules need to be powered by the VBAT pin. The recommended power design is shown in Figure 3-2:

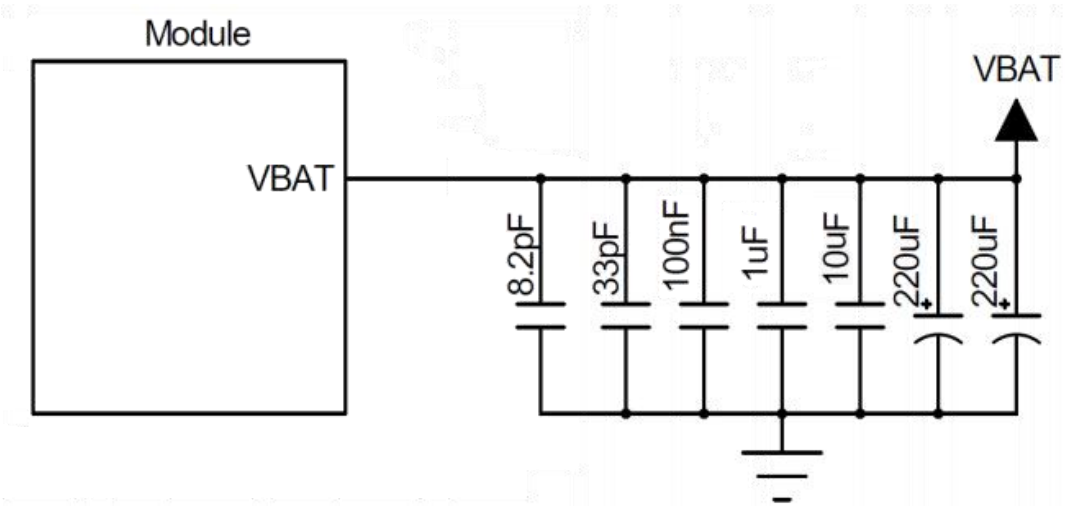

Figure 3-2 Recommended Power Design

Note:

VBAT_RF and VBAT_BB are included in the subsequent documents.

Power filter capacitor design is shown in the following table:

Recommended Capacitor	Application	Description
220uF x 2,10uf	Regulating capacitor	Reduce power fluctuations during module operation, requiring low ESR capacitor ● LDO or DCDC power requires not less than 440uF capacitor

Recommended Capacitor	Application	Description
		● Battery power can be properly reduced to 100~220uF capacitor
1uF,100nF	Digital signal noise	Filter clock and digital signal interference
33pF	700, 850/900 MHz band	Filter low band RF interference
8.2pF	1700/1800/1900,2100/2300,2500/2600MHz band	Filter middle/high band RF interference

The power stability ensures the normal operation of L610 modules. The design requires special attention to the power ripple below 300mV (the circuit ESR < 150mohm). When the module is operating in GSM mode (Burst transmit), the maximum operating current can reach 2A, and the power voltage needs to be at least 3.3V. Otherwise, the module may power off or restart. The power limit is shown in Figure 3-3:

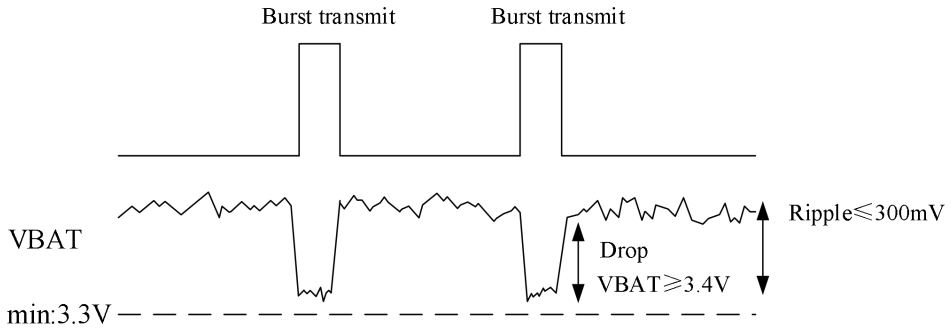

Figure 3- 3 Power Limit

Note:

Clients are recommended to add a TVS (recommended model: SMBJ15A) to the VBAT input, so as to improve the anti-surge capability of the product.

3.2.2 1.8V Output

L610 modules output 1.8V voltage through the VDD_EXT for use of the internal digital circuits of the modules. The voltage is the logic level voltage of the module and can be used to indicate that the module is on or off, or for external low current (< 80mA) circuit. If it is not in use, keep it in floating status. The logic level of VDD_EXT is defined as follows:

Parameter	Minimum	Typical	Maximum	Unit
VDD_EXT	1.71	1.8	1.89	V

3.2.3 Power Consumption

The power consumption of L610 module in the case of 3.8V power supply is shown in the following table:

Parameter	Mode	Condition	Average Typ.Current(mA)
I_{off}	Power off	Module power off	0.013
I_{idle}	Idle	Idle(AT+cfun=0)	12
I_{sleep}	GSM	MFRMS=5	2.3
	LTE FDD	Paging cycle #128 frames	2.5
$I_{GSM-RMS}$	GSM	GSM850 PCL5	260
		EGSM900 PCL5	260
		DCS1800 PCL0	200
		PCS1900 PCL0	200
$I_{GPRS-RMS\ CS4}$	GPRS	GPRS Data transfer GSM850; PCL=5; 1Rx/4Tx	480
		GPRS Data transfer GSM900; PCL=5; 1Rx/4Tx	480
		GPRS Data transfer DCS1800; PCL=0; 1Rx/4Tx	400
		GPRS Data transfer PCS1900; PCL=0; 1Rx/4Tx	400
$I_{LTE-RMS}$	LTE FDD	LTE FDD Data transfer Band 1 @+23dBm	730
		LTE FDD Data transfer Band 2 @+23dBm	780
		LTE FDD Data transfer Band 3 @+23dBm	730
		LTE FDD Data transfer Band 4 @+23dBm	730
		LTE FDD Data transfer Band 5 @+23dBm	600
		LTE FDD Data transfer Band 7 @+23dBm	730
		LTE FDD Data transfer Band 8 @+23dBm	600
		LTE FDD Data transfer Band 28 @+23dBm	600
		LTE FDD Data transfer Band 66 @+23dBm	730

3.3 Control Signal

L610 modules provide two control signals for power on/off and reset operations. The pin definitions are as follows:

Pin Name	I/O	Pin	Description
RESET_N	I	20	When the module is in work, pull down RESET for Tst (100ms), and then

Pin Name	I/O	Pin	Description
			pull it high, the module is reset
PWRKEY	I	21	When pulling down for power on, the minimum duration of low level is 2s; when pulling down for power off, the minimum duration of low level is 3.1s

3.3.1 Module Power-on

3.3.1.1 Power-on Circuit Reference

When L610 module is in powered-off mode, the module will power on by pulling down PWRKEY for at least 2s. It is recommended to use OC/OD drive circuit to control PWRKEY pin. The reference circuit is shown in Figure 3-4:

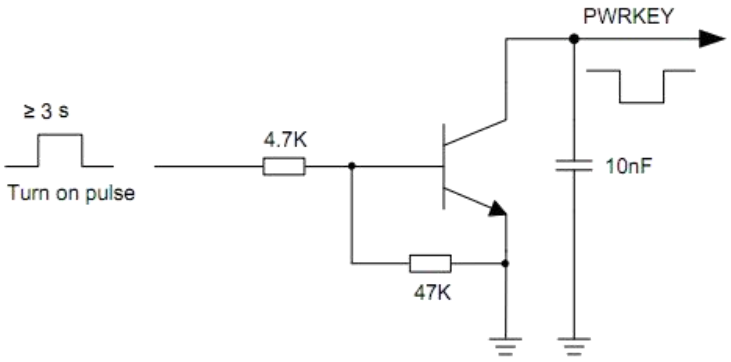

Figure 3-4 OC/OD Drive Power-on Reference Circuit

Another method to control PWRKEY pin is to directly control through a button, and place a TVS (ESD9X5VL-2/TR recommended) near the button for ESD protection. The reference circuit is shown in Figure 3-5:

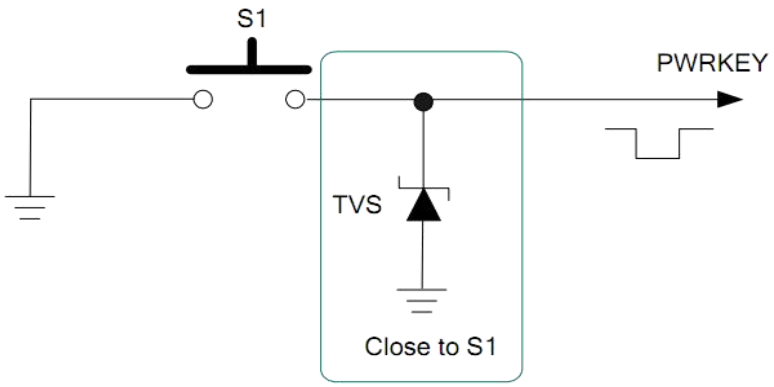

Figure 3-5 Button Power-on Reference Circuit

3.3.1.2 Power-on Timing

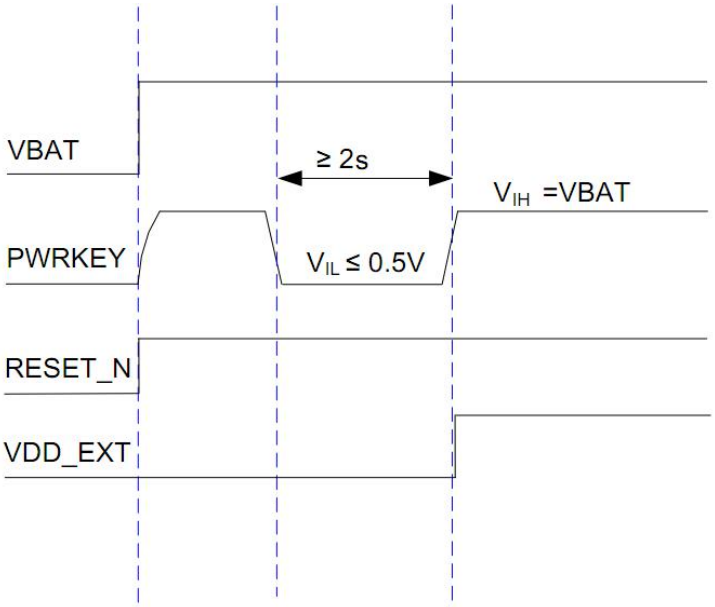

Figure 3-6 Power-on Timing Control Diagram

Note:

Before pulling down the PWRKEY pin, make sure that the VBAT voltage is stable. It is recommended that the interval between power up VBAT and pull down PWRKEY pin should not be less than 30ms.

3.3.1.3 Auto Power-on

If the module is required to power on automatically, the PWRKEY pin can be directly connected to the ground. The module can only be shut down if it is powered off in this mode.

3.3.2 Module Shutdown

The module supports the following three shutdown modes:

Shutdown Mode	Shutdown Method	Applicable Scenario
Low voltage shutdown	When VBAT voltage is too low or powers down, the module will shut down	The module does not shut down through normal process, i.e., does not log out from the base station
Hardware shutdown	Pull down PWRKEY (for at least 3.1s) and then release	Normal shutdown
AT shutdown	AT+ CPWROFF	Software shutdown

1. When the module is working properly, do not cut off the power of the module immediately to avoid damaging the internal Flash. It is strongly recommended to shut down the module by PWRKEY or AT command before cutting off the power supply.
2. The AT command to shut down, not suit for auto power-on.

3.3.2.1 Shutdown Timing

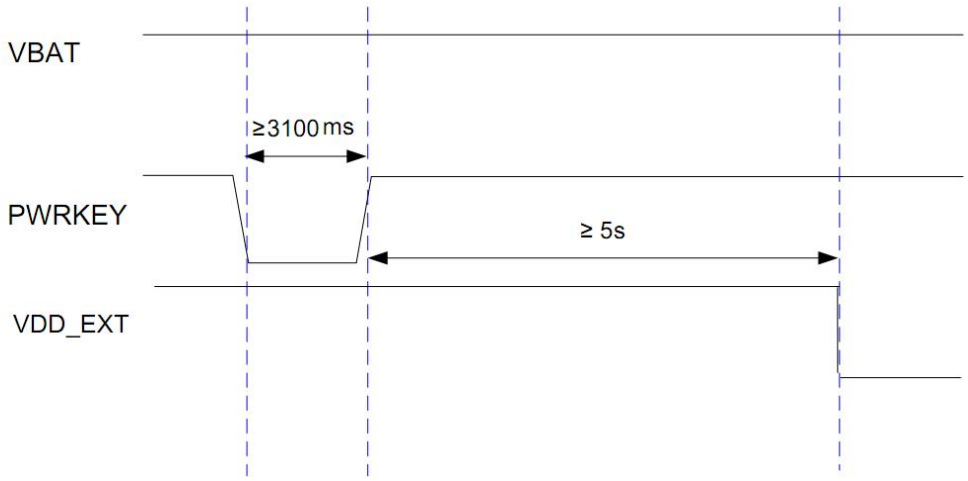

Figure 3-7 Shutdown Timing Control Diagram

3.3.3 Module Reset

L610 modules can be reset by hardware and AT command.

Reset Mode	Reset Method
Hardware	Pull down RESET_N for Tst (100ms) and then pull up the level
AT command	AT+CFUN=15

3.3.3.1 Reset Circuit

The reset reference circuit is shown in Figure 3-6. It is similar to the PWRKEY control circuit. The client can control the RESET_N pin using an OC/OD drive circuit or button.

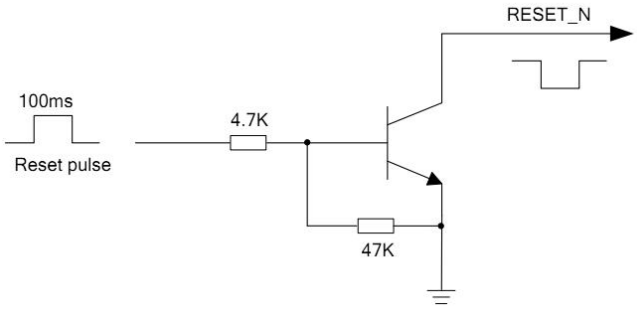

Figure 3-6 RESET_N OC/OD Reference Circuit

Another reset control is shown in Figure 3-7:

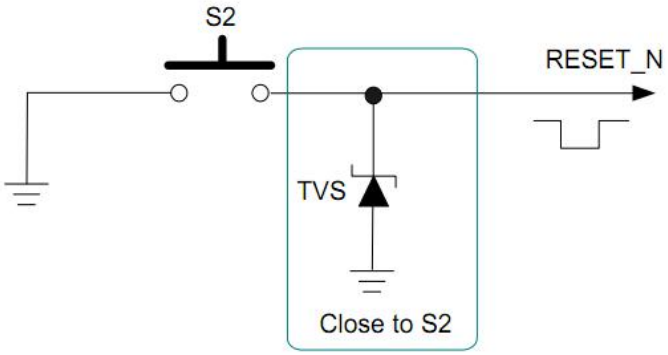

Figure 3-7 RESET_N Button Reference Circuit

3.3.3.2 RESET_N Control Timing

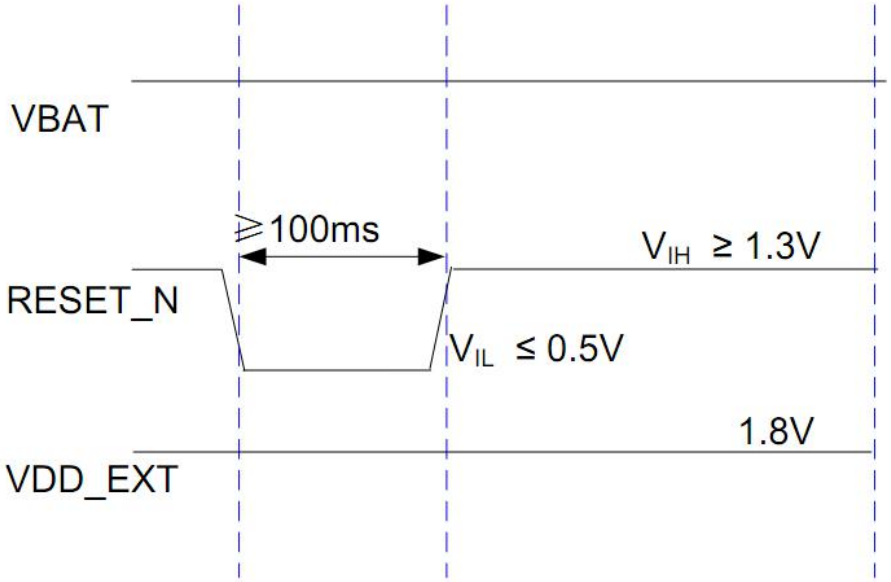

Figure 3- 8 Reset Control Timing

Note:

RESET_N is a sensitive signal, so it is recommended to add a debouncing capacitor close to the module. PCB layout should be far away from the RF interference and grounded, and avoid routing on the edge and surface of PCB (to avoid module reset caused by ESD).

3.4 USB Interface

L610 modules support USB 2.0 and are compatible with USB High-Speed (480Mbits/s) and USB Full-Speed (12Mbits/s). Refer to “Universal Serial Bus Specification 2.0” for the timing and electrical characteristics of L610 module USB bus.

3.4.1 USB Interface Definition

Pin Name	I/O	Pin	Description
USB_DM	I/O	70	USB differential data bus
USB_DP	I/O	69	USB differential data bus
USB_VBUS	PI	71	USB_DET

For more information about USB 2.0 specification, please visit http://www.usb.org/home

Note:

Since the module supports USB 2.0 High-Speed, TVS tube equivalent capacitance on the

USB_DM/DP differential signal cable is required to be less than 1pF, and a 0.5pF TVS is recommended.

It is recommended to connect a 0ohm resistor to USB_DM/DP differential line in series.

USB_DM and USB_DP are high-speed differential signal lines, which can achieve the maximum transmission rate of 480Mbits/s and must follow the rules below in PCB Layout:

- USB_DM and USB_DP signal lines control the differential impedance of 90ohm;
- USB_DM and USB_DP signal lines shall be parallel and equal in length, and shall avoid right-angle wiring;
- USB_DM and USB_DP signal cables are routed on the signal layer closest to the ground layer, and the lines shall be wrapped with GND.

3.5 USIM Interface

L610 modules provide USIM interface and support 1.8V and 3.0V SIM.

3.5.1 USIM Pin

USIM pins are shown in the following table:

Pin Name	I/O	Pin	Description
USIM_DATA	I/O	15	USIM/SIM DATA
USIM_CLK	O	16	USIM/SIM Clock Signal
USIM_RESET	O	17	USIM/SIM RESET Signal
USIM_VDD	O	14	USIM/SIM Power
USIM_PRESENCE	I	13	Detect USIM/SIM card for Hot-swap

3.5.2 USIM Interface Circuit

3.5.2.1 SIM Card Slot with Detection Signal

USIM/SIM design requires the use of SIM card slot (recommended model: SIM016-8P-220P). It is recommended to use hot plug slot with SIM detection function.

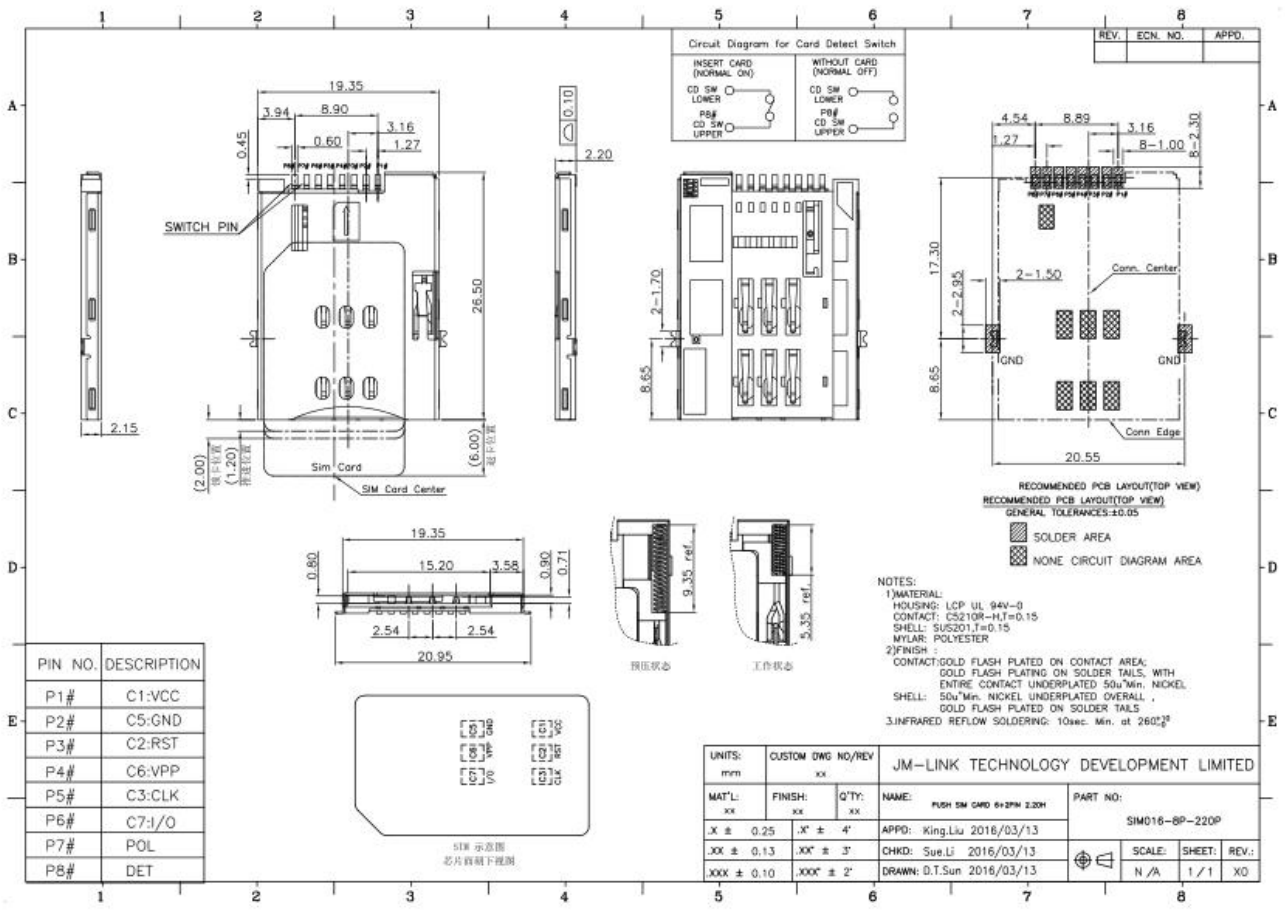

Figure 3-9 SIM Card Slot Diagram SIM016-8P-220P

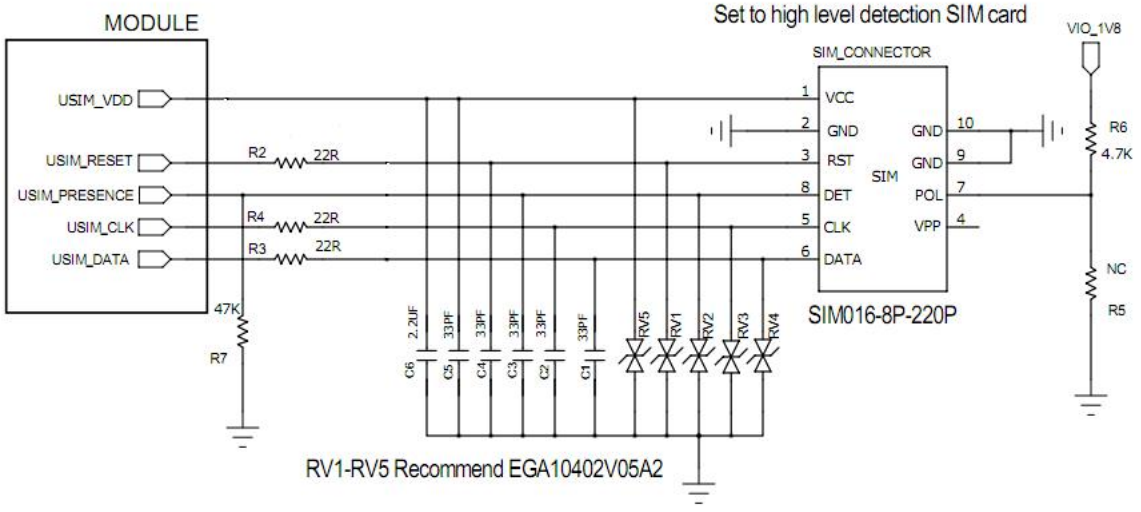

Figure 3-10 Reference Design of L610 USIM/SIM Interface with Detection Signal

Principles of SIM card slot with detection signal are as follows:

When SIM is inserted, USIM_PRESENCE pin is high level;

When SIM is not inserted, USIM_PRESENCE pin is low level.

3.5.2.2 SIM Card Slot without Detection Signal

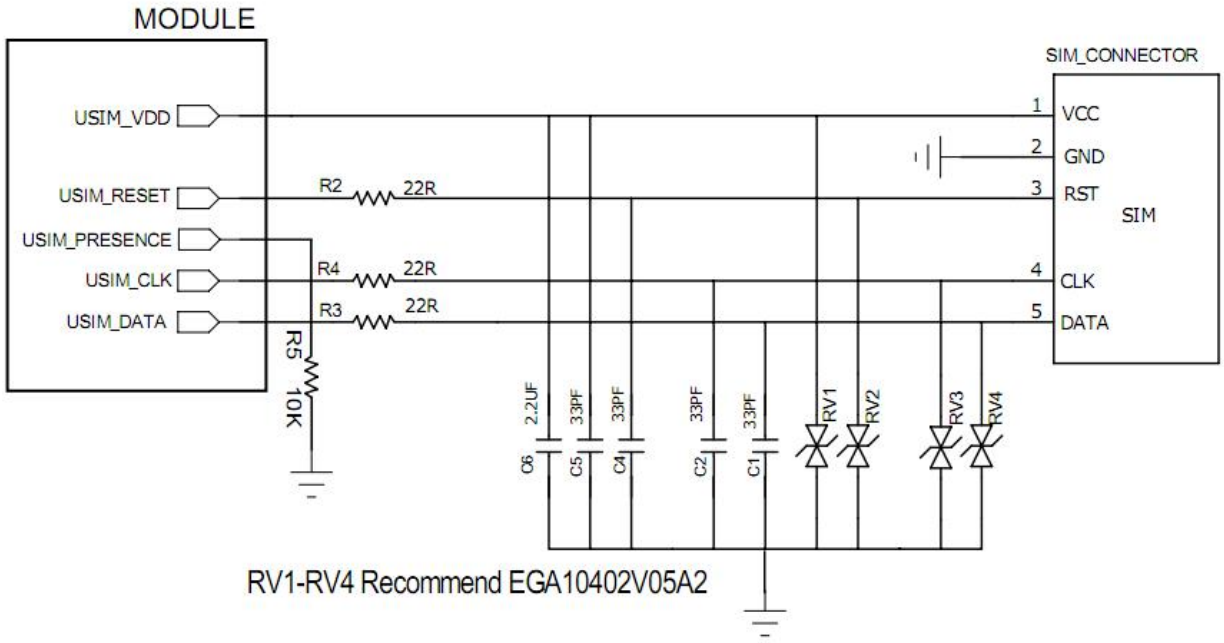

Figure 3-11 Reference Design of L610 USIM/SIM Interface without Detection Signal

Note:

SIM card slot has no detection signal, and the module USIM_ PRESENCE pin connects 10K to ground in series. In addition, disable SIM hot plug detection function through AT command.

3.5.3 USIM Hot Plug

L610 modules support SIM hot plug function. It determines the insertion and removal of SIM on the slot by detecting the USIM_ PRESENCE pin state of SIM card slot to support SIM hot plug function.

SIM hot plug function can be configured by “AT+MSMPD” command, and the AT commands are shown in the following table:

AT Command	SIM Hot Plug Detection	Function Description
AT+MSMPD=1	Enabled	Default value, SIM hot plug detection function is enabled. The module detects whether the SIM is inserted through the USIM_PRESENCE pin state
AT+MSMPD=0	Disabled	SIM hot plug detection function is disabled. The module reads the SIM when the device starts, and does not detect the USIM_PRESENCE state

After the SIM hot plug detection function is enabled, when USIM_PRESENCE is in high level, the module will detect the SIM insertion and then execute the SIM initialization program. After reading the SIM

information, the module will register on the network. When the USIM_PRESENCE is in low level, the module judges that the SIM is removed, then it will not read the SIM.

Note:

The USIM_PRESENCE is in active high by default, and can be switched to active low by AT command.

AT Command	Function Description
AT+GTSET="SIMPHASE",1	Default, high level detection
AT+GTSET="SIMPHASE",0	Low level detection

3.5.4 USIM Design Requirements

SIM circuit design shall meet EMC standards and ESD requirements, and at the same time, shall improve anti-interference ability to ensure that the SIM can work stably. The design needs to strictly observe the following rules:

- SIM card slot is placed as close to the module as possible, away from the RF antenna, DCDC power, clock signal cables and other strong interference sources;
- Adopt the SIM card slot with metal shield shell to improve anti-interference ability;
- The length of cable from the module to the SIM card slot shall not exceed 100mm. Longer cable will reduce signal quality;
- USIM_CLK and USIM_DATA signals are ground isolated to avoid mutual interference. If it is difficult to do so, SIM signal needs to be ground protected as a set;
- The filter capacitor and ESD device of SIM signal cable are placed close to the SIM card slot. Select 22~33pF capacitor for ESD device equivalent capacitor.

3.6 UART Interface

3.6.1 UART Interface Definition

L610 module has three serial ports: Main serial port, UART3 and Debug serial ports. The following describes the main features of these two serial ports:

The Main serial port and UART3 support 0,2400,4800,9600,14400,19200,28800, 33600,38400,57600,115200, 230400,460800,921600,1000000 baud rates.

The default baud rate is 115200bps, used for data transmission and AT command transmission.

The Debug serial port supports 115200bps baud rate for FIBOCOM internal debugging.

The following table describes the main serial port pin.

Pin Name	I/O	Pin	Description
RI	O	62	Module output ring indicator
DCD	O	63	Module output carrier detection
RTS	O	64	DTE request to send
CTS	I	65	Module clear to send
DTR	I	66	DTE ready
TXD	O	67	Module Transmit data
RXD	I	68	Module Receive data

The following table describes UART3 pin.

Pin Name	I/O	Pin	Description
UART3_RXD	I	137	Module Receive data
UART3_TXD	O	138	Module Transmit data

The following table describes the debug serial port pin.

Pin Name	I/O	Pin	Description
DBG_RXD	I	11	Module Receive data
DBG_TXD	O	12	Module Transmit data

3.6.2 UART Interface Application

The serial port level of L610 module is 1.8V. If the level of the client host system is 3.3V or other, a level translator shall be added to the serial port connection between the module and the host. The following figure shows the reference circuit design using level switching chip:

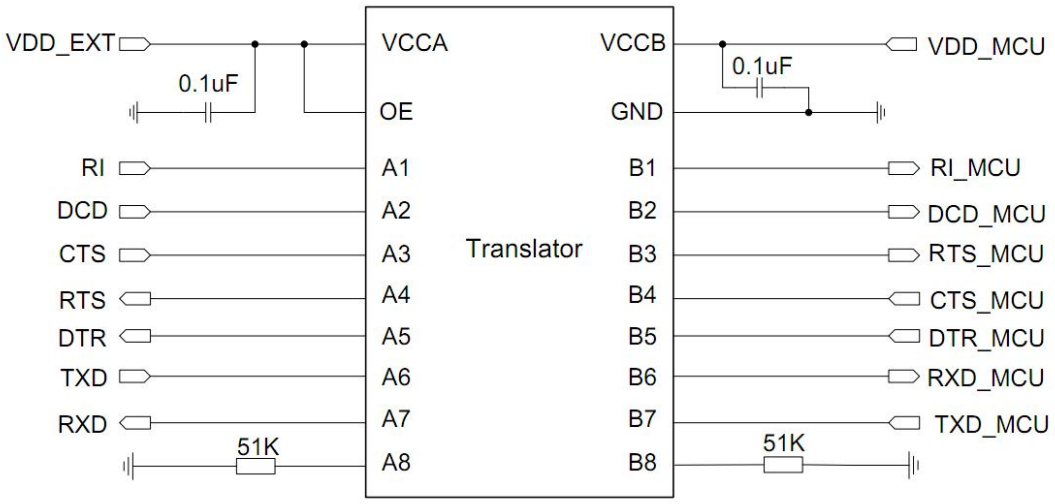

Figure 3-17 UART Signal Connection 1

Another level switching circuit is shown in the figure below. The input and output circuit design in the following dashed part can refer to that in the solid line part, but pay attention to the connection direction.

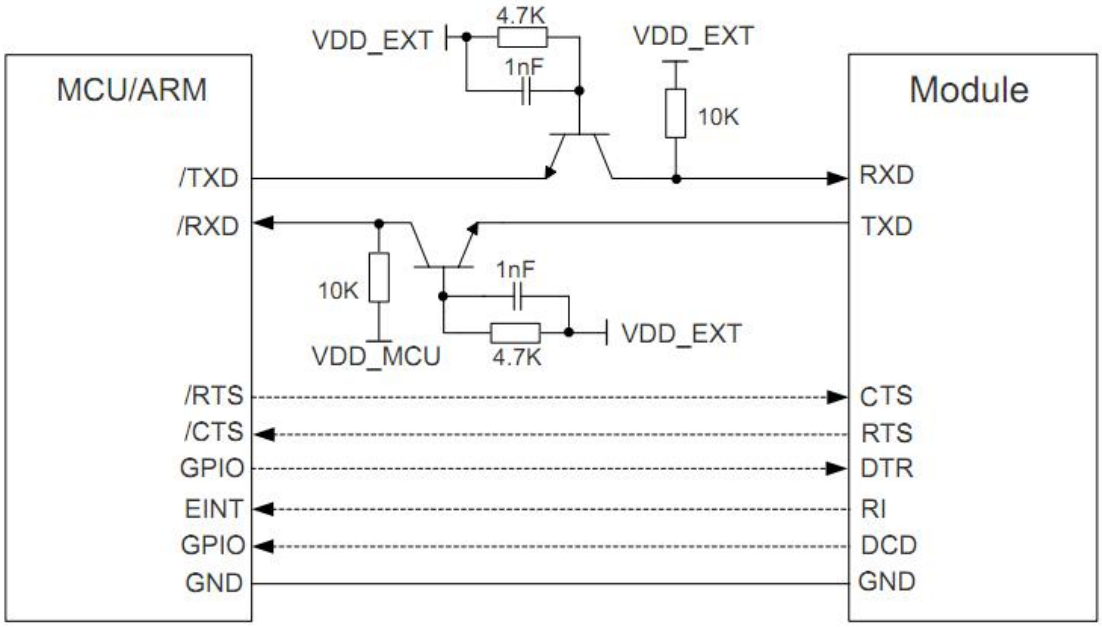

Figure 3-18 UART Signal Connection 2

Note:

This level switching circuit is not suitable for applications with baud rates above 460Kbps.

3.7 Status Indicator

3.7.1 NET_MODE Signal

L610 modules provide three network indicator output signal interfaces.

Pin Name	I/O	Pin	Description
NET_MODE	O	5	Module status indicator
NET_STATUS	O	6	Reserved
STATUS	O	61	Reserved

L610 module network indicator NET_MODE status description.

Mode	NET_MODE	Description
1	Flash (600ms High/600ms Low)	No SIM SIM PIN Registering network (T < 15S) Network registration failed
2	Slow flash (75ms Low /3000ms High)	Standby
3	Speed flash (75ms Low /75ms High)	Data link established
4	High	Sleep
5	Low	Voice call

L610 module network indicator interface reference circuit is shown in Figure 3-19:

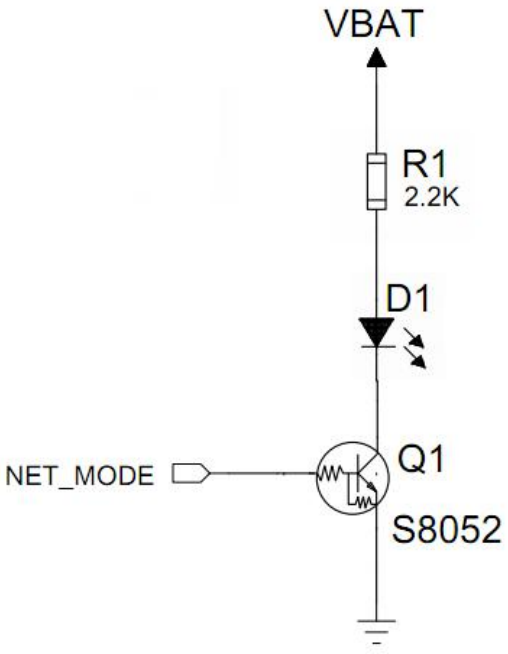

Figure 3-19 L610 Module Network Indicator Reference Design

3.8 Low Power Consumption Mode

3.8.1 Flight Mode

W_DISABLE# pin description:

Pin Name	I/O	Pin	Description
W_DISABLE#	I	4	Module flight mode control

L610 module supports two ways to enter the flight mode:

1	Hardware I/O interface button control	Pull up or float (pull high by default) the W_DISABLE# signal to enter the normal mode, pull it down to enter the flight mode
2	AT command control	AT+CFUN=4--enter the flight mode AT+CFUN=1--enter the normal mode

3.8.2 Sleep Mode

For details of sleep mode, refer to *FIBOCOM L610 AT Commands*.

3.9 ADC Function

L610 provides three ADC interfaces. Use AT+MMAD= < index>, < index>=0, 1, 2 to read the voltage value on the each ADC. The ADC range is 0-VBAT.

Pin Name	I/O	Pin	Description
ADC0	I	45	Analog to digital converter interface 0
ADC1	I	44	Analog to digital converter interface 1
ADC2	I	43	Analog to digital converter interface 2

Note:

Ground isolation is recommended for ADC layout to improve ADC voltage measurement accuracy;

When using the ADC function, a 1K resistor is required to be connected in series.

4 RF Interface

4.1 L610 Operating Band

Operating Band	Descriptl/On	Mode	Tx (MHz)	Rx (MHz)
Band 1	IMT 2100MHz	LTE FDD	1920 - 1980	2110 - 2170
Band 2	PCS 1900 MHz	LTE FDD	1850 - 1910	1930 - 1990
Band 3	DCS 1800MHz	LTE FDD/GSM	1710 - 1785	1805 - 1880
Band 4	AWS-1 1700	LTE FDD	1710 - 1755	2110 - 2155
Band 5	CLR 850MHz	LTE FDD	824 - 849	869 - 894
Band 7	IMT-E 2600MHz	LTE FDD	2500 - 2570	2620 - 2690
Band 8	E-GSM 900MHz	LTE FDD/GSM	880 - 915	925 - 960
Band 28	APAC 700MHz	LTE FDD	703 - 748	758 - 803
Band 66	AWS-1 1700	LTE FDD	1710 - 1780	2110 - 2180

4.2 L610 RF Output Power

L610 RF output power is shown in the following table.

Mode	Band	Tx Power(dBm)	Note
	GSM 850	32.5+1/-1	
	GSM 900	32.5+1/-1	
	GSM 1800	29.5+1/-1	
	GSM 1900	29.5+1/-1	
LTE FDD	Band 1	23+1/-3	10MHz Bandwidth, 1 RB
	Band 2	23+1/-3	10MHz Bandwidth, 1 RB
	Band 3	23+1/-3	10MHz Bandwidth, 1 RB
	Band 4	23+1/-3	10MHz Bandwidth, 1 RB
	Band 5	23+1/-3	10MHz Bandwidth, 1 RB
	Band 7	23+1/-3	10MHz Bandwidth, 1 RB
	Band 8	23+1/-3	10MHz Bandwidth, 1 RB
	Band 28	23+1/-3	10MHz Bandwidth, 1 RB

Mode	Band	Tx Power(dBm)	Note
	Band 66	23+1/-3	10MHz Bandwidth, 1 RB

4.3 L610 RF Receiving sensitivity

Mode	Band	Rx Sensitivity(dBm) Typical	Note
	GSM 900	-109.5	BER < 2.43%
	DCS 1800	-108.0	BER < 2.43%
LTE FDD	Band 1	-98.0	10MHz Band width
	Band 2	-97.0	10MHz Band width
	Band 3	-98.0	10MHz Band width
	Band 4	-97.0	10MHz Band width
	Band 5	-98.5	10MHz Band width
	Band 7	-97.0	10MHz Band width
	Band 8	-98.5	10MHz Band width
	Band 28	-98.5	10MHz Band width
	Band 66	-97.0	10MHz Band width

4.4 RF PCB Design

4.4.1 Antenna RF Connector

The two-way antenna of L610 module adopts the pad-out way. It is recommended that clients use the U.FL-R-SMT-1 antenna connector and the matching RF adapter cable.

The antenna is a sensitive device and is easily affected by the external environment. For example, the position of the antenna, the space it occupies, and the surrounding ground all may affect antenna performance. In addition, the RF cable connecting the antenna, and the position of the fixed antenna also may affect antenna performance.

Figure 4-1 is the reference circuit design for the main and diversity antenna. These matches need to be placed close to the antenna:

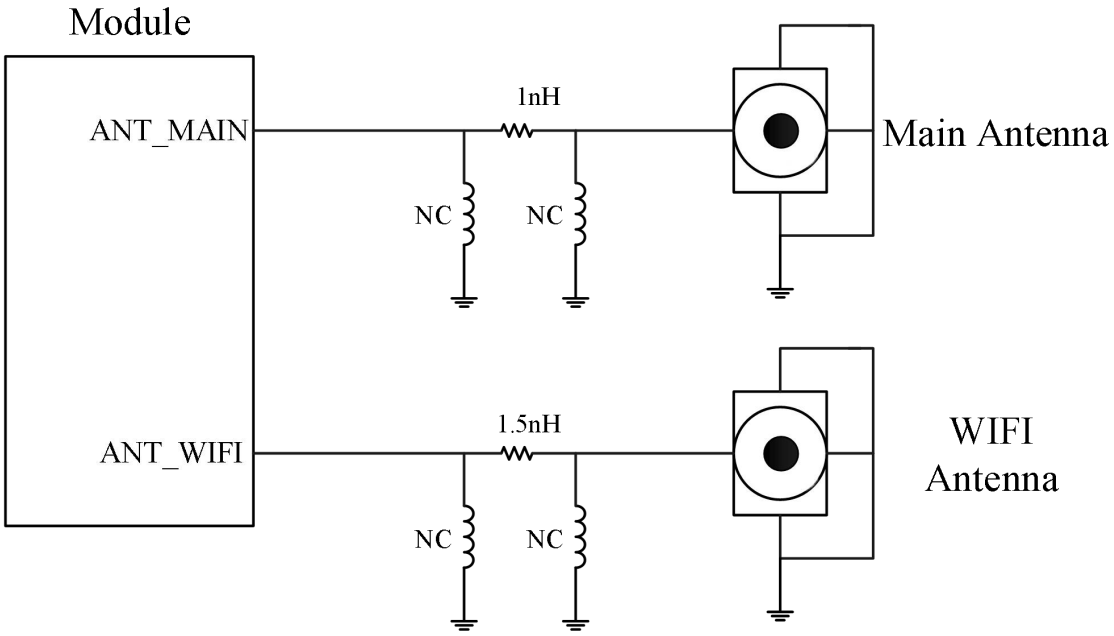

Figure 4-1 RF Reference Circuit Design

- Make sure the characteristic impedance of the transmission cable is 50 ohms.
- Since the antenna cable loss is less than 0.3dB, keep the PCB routing as short as possible.
- PCB LAYOUT should be as straight as possible to avoid vias and layers, and avoid right-angle and acute-angle routing.
- PCB routing should have a good reference ground to avoid other signal line from approaching the antenna.
- A complete ground level is recommended as a reference ground.
- Strengthen the connection between the ground around the antenna and the main ground.

Note:

Refer to *FIBOCOM Design Guide_RF Antenna* for specific design details.

4.5 Antenna Design

1) Antenna Efficiency

Antenna efficiency is the ratio of antenna input power to radiated power. Due to the antenna's return loss, material loss, and coupling loss, the radiated power is always lower than the input power. Antenna efficiency > 40% (-4dB) is recommended.

2) S11 or VSWR

S11 indicates the matching degree of the antenna's 50-ohm impedance, which affects the antenna efficiency to a certain extent. This indicator can be measured using VSWR test. S11 < -10dB is

recommended.

3) Polarization

Polarization is the rotation direction of the electric field in the maximum radiation direction of the antenna. Linear polarization is recommended.

4) Radiation Pattern

Radiation pattern refers to the antenna's electromagnetic field strength in the far field in all directions. Half-wave dipole antenna is the most suitable terminal antenna. For built-in antenna, PIFA antennas or IFA antennas are recommended:

Antenna area: 6mm high x 10mm wide x 100mm long.

Antenna radiation direction: Omni_directl/Onal (omnidirectional).

5) Gain and Directivity

Antenna directivity refers to the electromagnetic field strength of electromagnetic wave in all directions. Gain is a collection of antenna benefits and antenna directivity.

Recommended antenna gain ≤ 2.5dBi.

6) Interference

In addition to the antenna performance, other interferences on the PCB also may affect the performance of the module. In order to ensure the high performance of the module, interference must be controlled. Suggestions: For example, LCD, CP, FPC routing, audio circuit, power supply should be as far from the antenna as possible, and make the appropriate isolation and shielding, or filtering on the path.

7) Antenna Index Requirements

L610 Module Main Antenna Requirements	
Frequency range	It must use the most suitable antenna to adapt to the relevant frequency band
Bandwidth (GSM/GPRS)	GSM850: 70 MHz GSM900: 80 MHz GSM1800(DCS): 170 MHz GSM1900(PCS): 140 MHz
Bandwidth (LTE)	LTE band 1 (2100): 250 MHz LTE Band 2(1900): 140 MHz LTE Band 3 (1800): 170 MHz LTE Band 4(2100): 145 MHz LTE Band 5 (850): 70 MHz LTE Band 7(2500): 190 MHz LTE Band 8 (900): 80 MHz

L610 Module Main Antenna Requirements	
	LTE Band 28(2100): 100 MHz LTE Band 66(2100): 100 MHz
Impedance	50 ohms
Input power	> 33dBm (2 W) peak power GSM > 23dBm average power LTE
Standing wave ratio recommended	≤ 2:1

5 Electrical Characteristics

5.1 Limiting Voltage Range

The limiting voltage range refers to the power voltage of the module and the maximum voltage range that the digital and analog I/O interfaces can withstand.

The voltage range of L610 module is shown in the following table.

Parameter	Description	Min	Typ	Max	Unit
VBAT	Power supply	-0.3	-	4.6	V
GPI/O	Level power supply voltage of digital I/O	-0.3	-	2.0/2.8	V

5.2 Ambient Temperature Range

L610 modules are recommended to operate at -30~+75℃ ambient temperature. It is recommended that the application considers temperature control measures in harsh environmental conditions. At the same time, the limited operating temperature range of the module should be provided. Under these temperature conditions, some RF indicators may exceed the limit. At the same time, it is recommended that the module application terminal be stored in certain temperature conditions. Modules may not operate or may be damaged outside this range.

Temperature	Min	Typ	Max	Unit
Operating temperature	-30	25	75	℃
Limited operating temperature	-40	-	85	℃
Storage temperature	-40	-	90	℃

5.3 Electrical Characteristics of the Interface in Operating Status

V_L: Logic low level;

V_H: Logic high level;

Signal	VL		VH		Unit
	Min	Max	Min	Max	
Digital input	-0.3	0.6	1.2	2.0	V
Digital output	-	0.45	1.35	-	V

Parameter	I/O	Min	Typ	Max	Unit
VBAT	I	3.4	3.8	4.3	V
USIM_VDD	O	1.7/2.75	1.8/2.85	1.9/2.95	V

5.4 Environmental Reliability Requirements

Test Item	Test Condition
Low temperature storage test	Temperature -45℃±3℃, 24 hours in shutdown state
High temperature storage test	Temperature +90℃±3℃, 24 hours in shutdown state
Temperature shock test	In shutdown state, 0.5 hour at -40℃ and +85℃ ambient temperatures respectively, the temperature conversion time < 3min, for 24 cycles
High temperature and humidity test	Temperature +65℃±3℃, humidity 90~95%RH, 88 hours in shutdown state
Low temperature operating test	Temperature -30℃±3℃, 24 hours in operating state
High temperature operating test	Temperature +75℃±3℃, 24 hours in operating state
Vibration test	Conduct vibration test according to the requirements shown in the following table:

Frequency	Random Vibration ASD (Acceleration Spectral Density)
5~20Hz	0.96m^2/s^3
20~500Hz	0.96m^2/s^3 (20Hz), other -3dB/octave

5.5 ESD Characteristics

Although the design of L610 module has considered the ESD issues and provided ESD protection, the ESD issue may occur in the transport and secondary development, so developers should consider ESD protection for the final product. In addition to considering anti-static treatment for packaging, please refer to recommended circuit for interface design in the document for client's application.

Refer to the following table for the ESD allowable discharge range of L610 module.

Part	Air Discharge	Contact Discharge
GND	±15KV	±8KV
Antenna interface	±15KV	±8KV
Other interface	-	±0.5KV

Note:

The above data is tested on ADP-L610-00.

6 Structure Specification

6.1 Product Appearance

The product appearance of L610 module is shown in the figure below:

Figure 6-1 Module Product Appearance (Top)

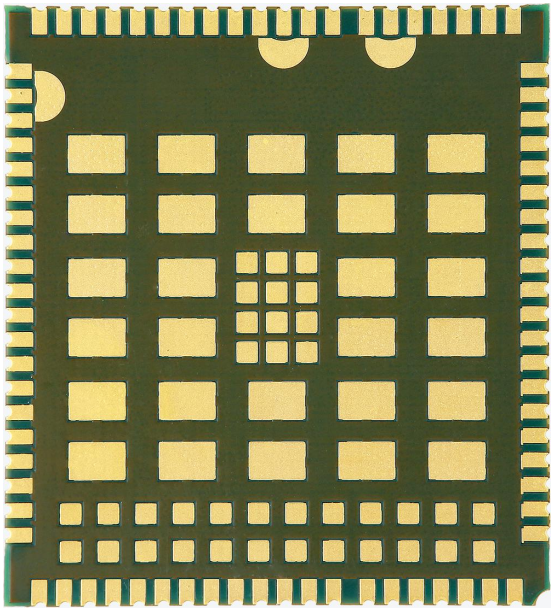

Figure 6-2 Module Product Appearance (Bottom)

6.2 Structural Dimension

The structural dimension of L610 module is shown in Figure 6-3:

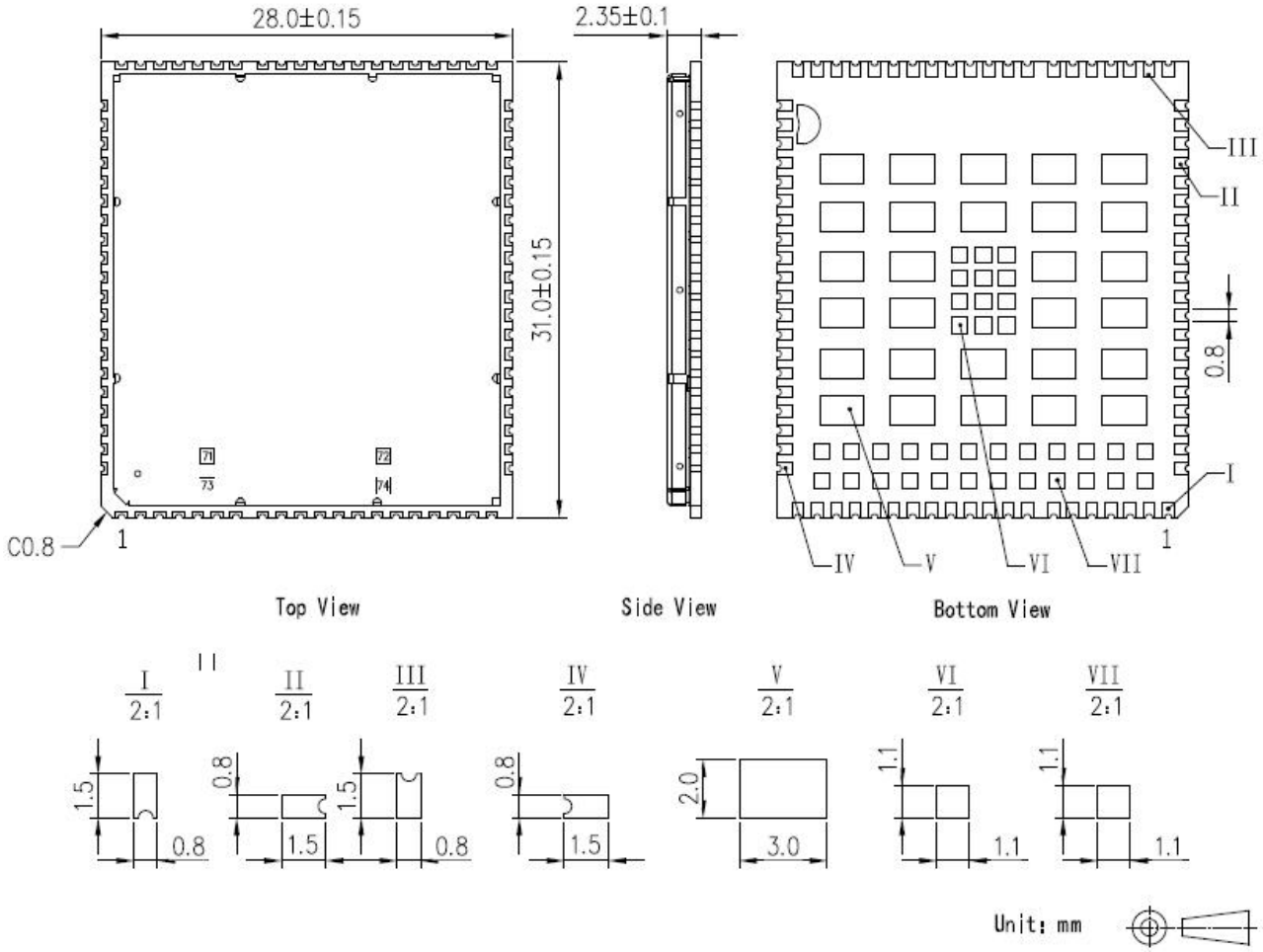

Figure 6-3 Structural Dimension (in mm)

6.3 SMT Patch

For module stencil design, solder paste and furnace temperature control, please refer to *FIBOCOM L610 SMT Design Guide*.

7 Warnning

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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.

Note: This equipment 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. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
-Reorient or relocate the receiving antenna.
-Increase the separation between the equipment and receiver.
-Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
-Consult the dealer or an experienced radio/TV technician for help.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

FCC Caution:

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.
This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.
This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.
This device is intended only for OEM integrators under the following conditions:
1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and the maximum antenna gain allowed as below table.
2) The transmitter module may not be co-located with any other transmitter or antenna.
As long as 2 conditions above are met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements

required with this module installed.

IMPORTANT NOTE: In the event that these conditions can not be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID can not be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: “Contains FCC ID: ZMOL610LA”. The grantee's FCC ID can be used only when all FCC compliance requirements are met.

Manual Information To the End User

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

This device is intended only for OEM integrators under the following conditions:

The antenna must be installed such that 20 cm is maintained between the antenna and users, and the Max allowed antenna gain as following table showed:

Operating Band	Antenna Gain （dBi）
GSM850	10.10
GSM1900	11.69
LTE B2	9.00
LTE B4	6.00
LTE B5	10.41
LTE B7	9.00
LTE B66	6.00