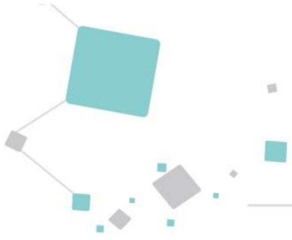

LYNQ

L501_Hardware Design

LTE CAT1 Module Series

Version： V1.0

Date： 2020-03-31

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Version History

Date	Version	Modify records	Author
2020-03-31	V1.0	First Release	Rc.Dong

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1. Introduction

L501 is a Cat1 module for LCC+LGA package, with stable and reliable performance. It can well meet customer's requirements for cost-effective, low-power applications. It suits to IoT areas, such as PoC, Mobile payment, security and alarm systems, on-board vehicle, DTU, asset tracking, sharing economy, etc.

1.1 Hardware Diagram

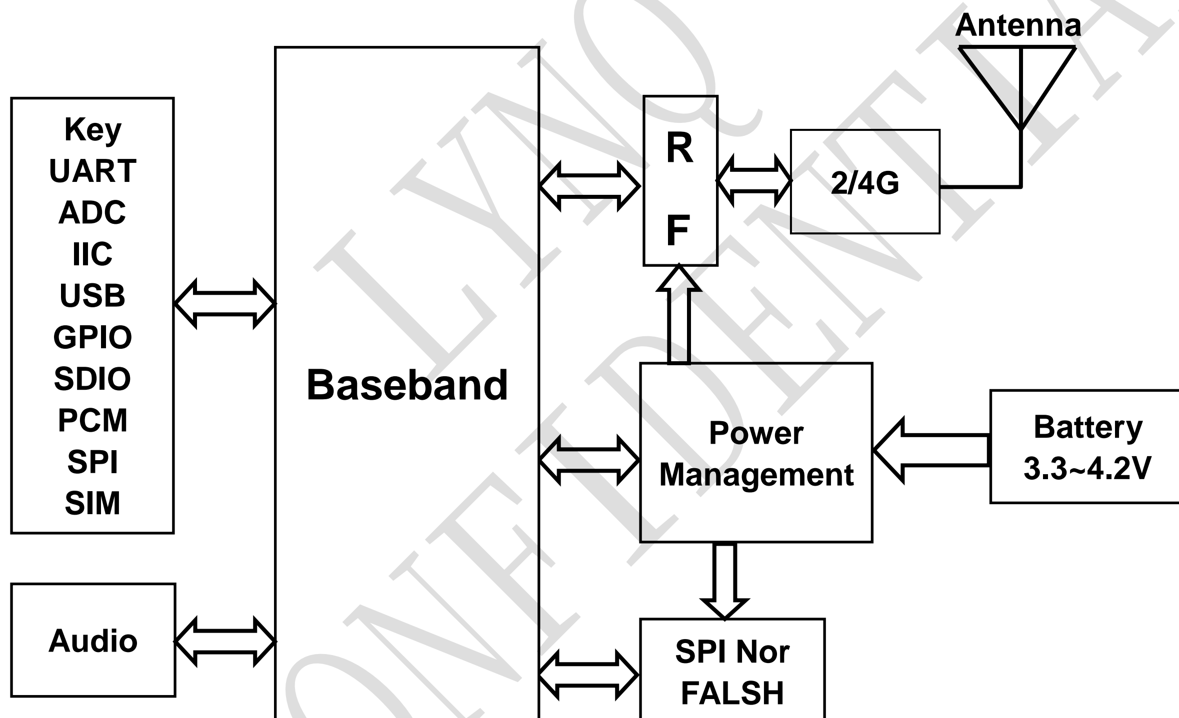

Figure 1.1-1 L501 Functional architecture

1.2 Main features

- **CPU**

  ARM Cortex-R5@624MHz

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- **Flash**

SPI Nor Flash: 128Mb

- **Frequency bands**

TDD-LTE: B34/B38/B39/B40/B41

FDD-LTE: B1/B3/B5/B8

GSM: B3/B8

- **Output Power**

LTE: 23dBm±2dB

GSM: GSM900 33dBm±2dB

DCS1800 30dBm±2dB

- **Sensitivity**

TBD

- **Data transmission**

LTE Cat1 DL: 10Mbps

UL: 5Mbps

- **Power consumption**

Flight mode: 0.7mA @3.8V

LTE Standby: 1.2mA @3.8V

GSM Standby: 1.3mA @3.8V

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1.3 Specifications

- Supply Voltage Range: 3.3～4.2V（typ3.8V）
- Dimensions: 30mm * 30mm * 2.9mm
- Package: 135-pin LCC+LGA
- Operation Temperature Range: -40℃～+85℃
- Storage Temperature Range: -45℃～+90℃
- Support WIFI SCAN
- Weight : Approx 5g

1.4 Interfaces

- IIC
- GPIO
- EINT
- USB2.0
- ADC
- SIM: Support 1.8V/3V
- UART
- SPI
- PCM
- Key
- Analog Audio
- Antenna

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2. Package Information

2.1 Pin Configuration

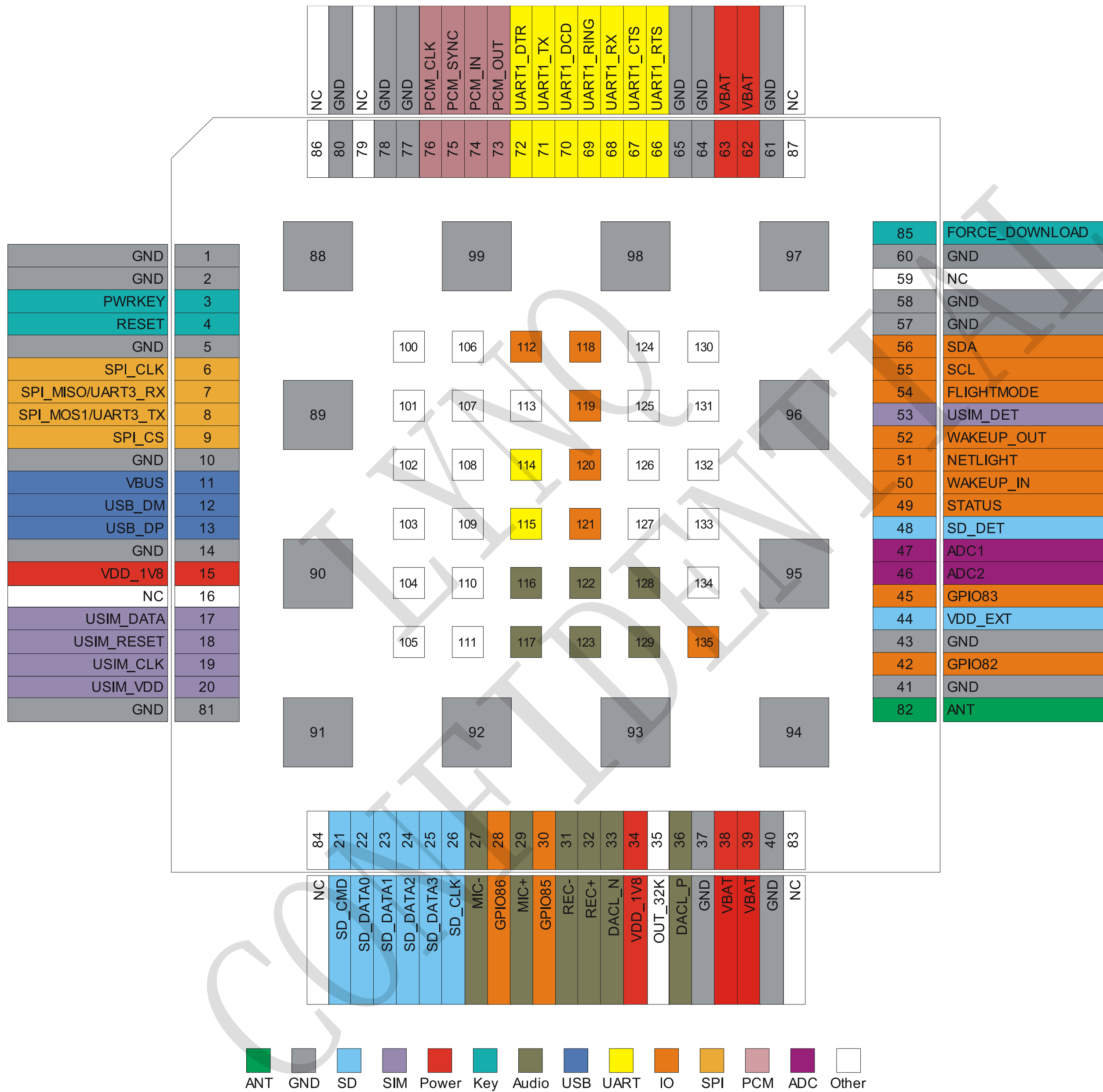

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Figure 2.1-1 L501 Pin View

2.2 Pin definition

Table 2.2-1 L501 Pin description

Pin NO.	Pin name	Type	Function Description	Power domain	State[1]
1.	GND	G	Ground		GND
2.	GND	G	Ground		GND
3.	PWRKEY	I	Power key button	0～4.2V	Open
4.	RESET	I	System reset signal	1.8V	Open
5.	GND	G	Ground		GND
6.	SPI_CLK	O	SPI clock	1.8V	Open
7.	SPI_MISO/ UART3_RX	I	SPI master in slave out	1.8V	Open
8.	SPI_MOS1/ UART3_TX	O	SPI master out slave in	1.8V	Open
9.	SPI_CS	O	SPI chip-select	1.8V	Open
10.	GND	G	Ground		GND
11.	VBUS	P	USB 5V voltage input	5V	Open
12.	USB_DM	DIO	USB port differential data line		Open
13.	USB_DP	DIO			Open
14.	GND	G	Ground		GND
15.	VDD_1V8	P	1.8V output voltage	1.8V	Open
16.	NC		NC		
17.	USIM_DATA	I/O	USIM data	1.8/3.0V	Open
18.	USIM_RESET	O	USIM reset	1.8/3.0V	Open
19.	USIM_CLK	O	USIM clock	1.8/3.0V	Open
20.	USIM_VDD	P	USIM output voltage	1.8/3.0V	Open
21.	SD_CMD	I/O	SD card command pin	3.0V	Open

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22.	SD_DATA0	I/O	SD card data pin	3.0V	Open
23.	SD_DATA1	I/O		3.0V	Open
24.	SD_DATA2	I/O		3.0V	Open
25.	SD_DATA3	I/O		3.0V	Open
26.	SD_CLK	O	SD card clock output	3.0V	Open
27.	MIC-	AI	Microphone Channel	0～1.8V	Open
28.	GPIO86	I/O	General Purpose Input Output 86	1.8V	Open
29.	MIC+	AI	Microphone Channel	0～1.8V	Open
30.	GPIO85	I/O	General Purpose Input Output 85	1.8V	Open
31.	REC-	AO	Receiver output	-1.8～1.8V	Open
32.	REC+	AO	Receiver output	-1.8～1.8V	Open
33.	DACL_N	AO	Audio DAC left channel N	-1.8～1.8V	Open
34.	VDD_1V8	P	1.8V output voltage	1.8V	Open
35.	OUT_32K	O	32k out		Open
36.	DACL_P	AO	Audio DAC left channel P	-1.8～1.8V	Open
37.	GND	G	Ground		GND
38.	VBAT	P	Power supply	3.3～4.2V	VBAT
39.	VBAT	P			VBAT
40.	GND	G	Ground		GND
41.	GND	G	Ground		GND
42.	GPIO82	I/O	General Purpose Input Output 82	1.8V	Open
43.	GND	G	Ground		GND
44.	VDD_EXT	P	VDD_EXT output voltage for SD	3.0V	Open
45.	GPIO83	I/O	General Purpose Input Output 83	1.8V	Open
46.	ADC2	I	ADC external input channel 2	0.1～1.2V	Open
47.	ADC1	I	ADC external input channel 1	0.1～1.2V	Open

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48.	SD_DET	I	SD detect pin	1.8V	Open
49.	STATUS	O	Output PIN as operating status indicating of module	1.8V	Open
50.	WAKEUP_IN	I	Host to set the module into sleep or wake up the module from sleep	1.8V	Open
51.	NETLIGHT	O	Output PIN as LED control for network status	1.8V	Open
52.	WAKEUP_OUT	O	Output PIN can be used as wake signal to host from module	1.8V	Open
53.	USIM_DET	I	USIM detect pin	1.8V	Open
54.	FLIGHTMODE	I	Input PIN as RF operating control	1.8V	Open
55.	SCL	I/O	IIC clock	1.8V	Open
56.	SDA	I/O	IIC data	1.8V	Open
57.	GND	G	Ground		GND
58.	GND	G	Ground		GND
59.	NC		NC		
60.	GND	G	Ground		GND
61.	GND	G	Ground		GND
62.	VBAT	P	Power supply	3.3～4.2V	VBAT
63.	VBAT	P			VBAT
64.	GND	G	Ground		GND
65.	GND	G	Ground		GND
66.	UART1_RTS	DI	UART1 ready to receive	1.8V	Open
67.	UART1_CTS	DO	UART1 clear to send	1.8V	Open
68.	UART1_RX	DI	UART1 receive data input	1.8V	Open
69.	UART1_RING	DO	UART1 ring indicator	1.8V	Open
70.	UART1_DCD	DO	UART1 data carrier detect	1.8V	Open
71.	UART1_TX	DO	UART1 transmit output	1.8V	Open
72.	UART1_DTR	DI	UART1 Data terminal ready	1.8V	Open

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73.	PCM_OUT	O	PCM I/F data out	1.8V	Open
74.	PCM_IN	I	PCM I/F data in	1.8V	Open
75.	PCM_SYNC	I/O	PCM interface sync	1.8V	Open
76.	PCM_CLK	O	PCM interface clock	1.8V	Open
77.	GND	G	Ground		GND
78.	GND	G	Ground		GND
79.	NC		NC		
80.	GND	G	Ground		GND
81.	GND	G	Ground		GND
82.	ANT	ANT	Antenna		Open
83.	NC		NC		
84.	NC		NC		
85.	FORCE_ DOWNLOAD	I	Force software download	1.8V	Open
86.	NC		NC		
87.	NC		NC		
88.	GND	G	Ground		GND
89.	GND	G	Ground		GND
90.	GND	G	Ground		GND
91.	GND	G	Ground		GND
92.	GND	G	Ground		GND
93.	GND	G	Ground		GND
94.	GND	G	Ground		GND
95.	GND	G	Ground		GND
96.	GND	G	Ground		GND
97.	GND	G	Ground		GND
98.	GND	G	Ground		GND

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99.	GND	G	Ground		GND
100.	NC		NC		
101.	NC		NC		
102.	NC		NC		
103.	NC		NC		
104.	NC		NC		
105.	NC		NC		
106.	NC		NC		
107.	NC		NC		
108.	NC		NC		
109.	NC		NC		
110.	NC		NC		
111.	NC		NC		
112.	GPIO8	I/O	General Purpose Input Output 8	1.8V	Open
113.	OUT_26M	O	26M out		Open
114.	UART2_TX	DO	UART2 transmit output	1.8V	Open
115.	UART2_RX	DI	UART2 receive data input	1.8V	Open
116.	NC		NC		
117.	NC		NC		
118.	GPIO10	I/O	General Purpose Input Output 10	1.8V	Open
119.	GPIO11	I/O	General Purpose Input Output 11	1.8V	Open
120.	GPIO32	I/O	General Purpose Input Output 32	1.8V	Open
121.	GPIO31	I/O	General Purpose Input Output 31	1.8V	Open
122.	NC		NC		
123.	NC		NC		
124.	NC		NC		

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125.	NC		NC		
126.	NC		NC		
127.	NC		NC		
128.	NC		NC		
129.	NC		NC		
130.	NC		NC		
131.	NC		NC		
132.	NC		NC		
133.	NC		NC		
134.	NC		NC		
135.	GPIO7	I/O	General Purpose Input Output 7	1.8V	Open

Notes: (1) Suggested status when not in use.

Table 2.2-2 Pin type description

P:POWER	G:GROUND
I:INPUT	DI:DIGITAL INPUT
O:OUTPUT	DO:DIGITAL OUTPUT
DIO:DIGITAL INPUT OUTPUT	AI:ANALOG INPUT
AO:ANALOG OUTPUT	I/O:INPUT or OUTPUT
ANT:ANTENNA	NC:NOT CONNECT

2.3 Package Information

2.3.1 Dimensions

The L501 mechanical dimensions are described as following figure (Top view, Back view, Side view).

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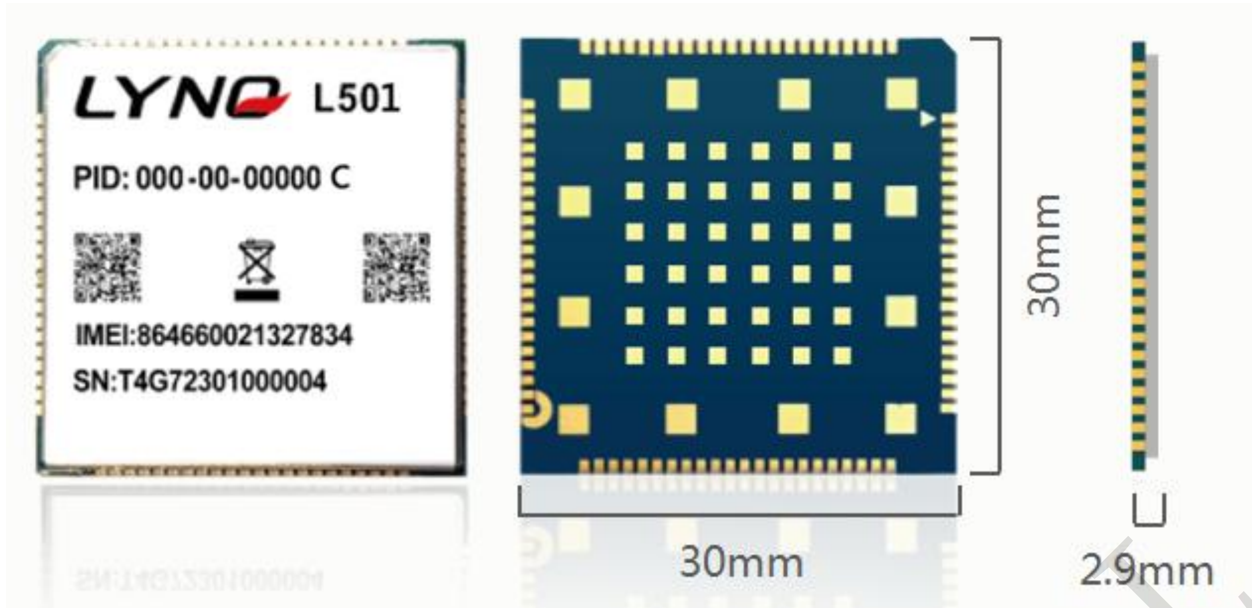

Figure 2.3.1-1 Mechanical Dimensions

2.3.2 Product labeling

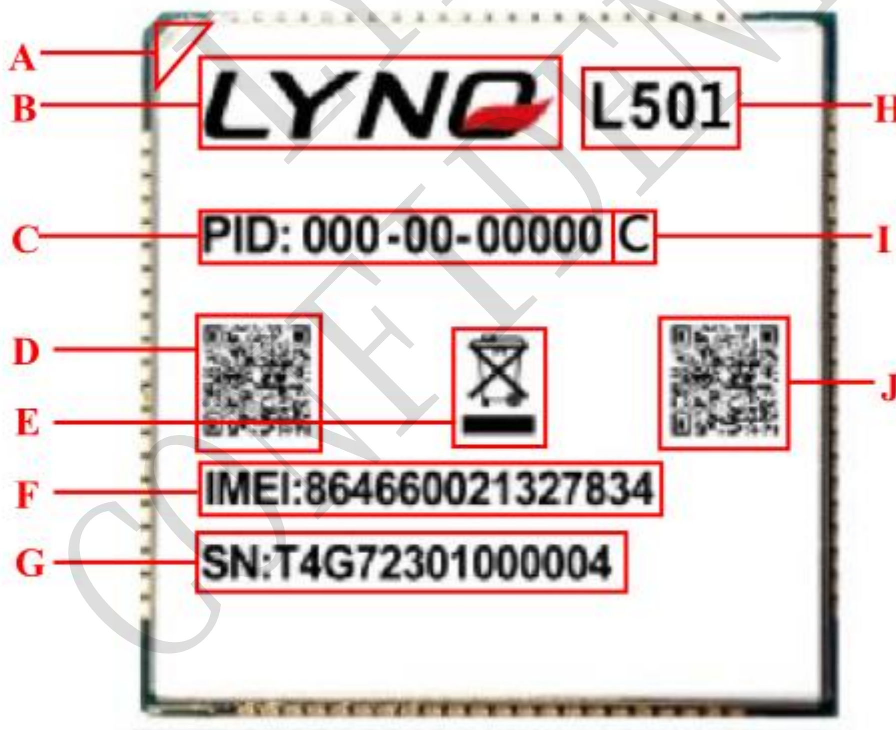

Figure 2.3.2-1 Label of L501

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Table 2.3.2-1 Description of label

Item	Description
A	Pin1 mark
B	Logo of company
C	PID number
D	QR code---include IMEI number
E	WEEE
F	IMEI number
G	SN number
H	Module name
I	Module configuration，C stands for L501C
J	QR code---include SN number

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2.3.3 Module size

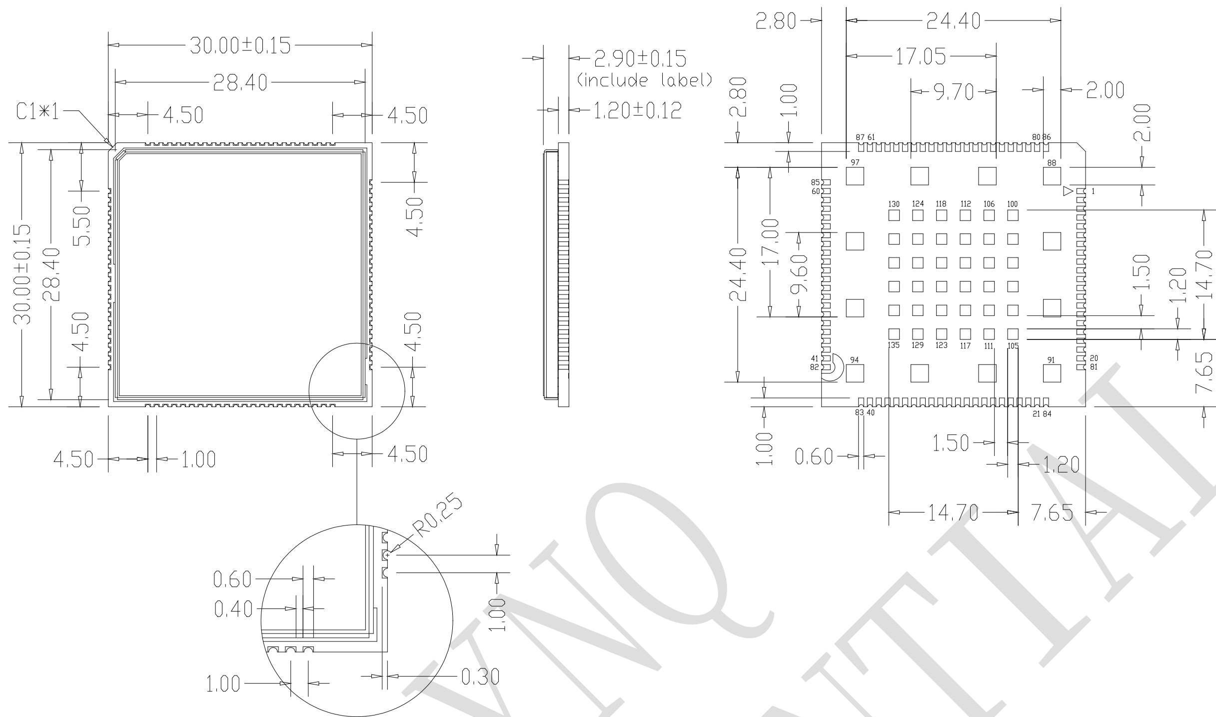

Figure 2.3.3-1 Module Size (Unit: mm)

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2.3.4 Recommend Pad

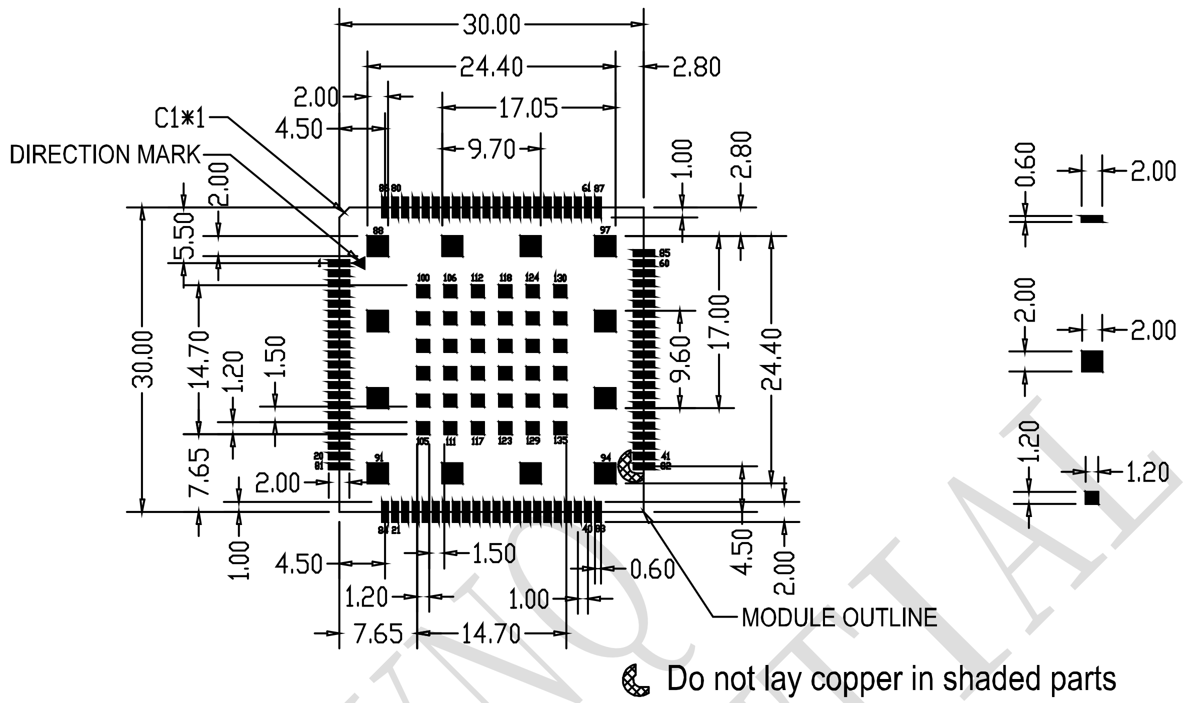

Figure 2.3.4-1 Recommend pad(Top view, Unit: mm)

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3. Interface Circuit Design

3.1 Power Section

3.1.1 Power Supply

VBAT is the main power supply of the smart module, and the input voltage range is 3.3V to 4.2V. The recommended voltage is 3.8V. Because the module transmit burst may cause voltage to drop, the highest current peak will more than 2A (RF max current will be about 2A, and add the current of other parts of system working). A large capacitor is recommended to be used near VBAT pins, and the bigger of the capacitor's value is the better. In order to improve the continued flow of large current, it is recommended to use a low-impedance tantalum capacitor 100uF or larger. During layout, the capacitors are close to the VBAT pins.

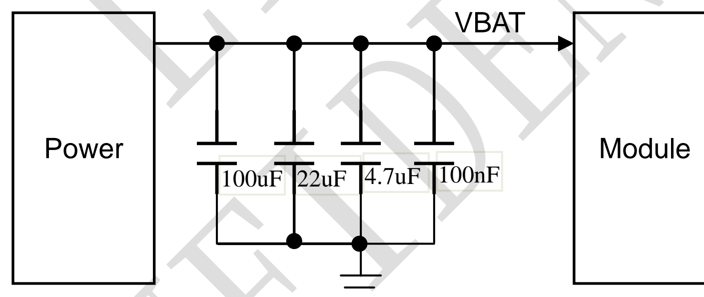

Figure 3.1.1-1 Power Supply circuit

Notes: According to the environment, please select capacitor as large value as possible; and add 100pF, 33pF capacitors if requiring.

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3.1.2 Hardware Power On

Module 3-pin is the Power on key. Pulling down the PWRKEY at least 3s～5s and then releasing, the module will boot. It is internally pull-up to VBAT, and does not need to pull up externally.

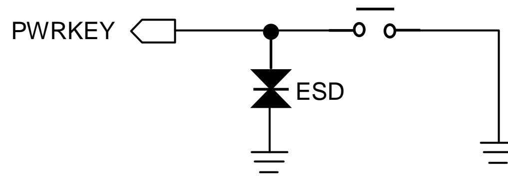

Figure 3.1.2-1 Turn on circuit

3.1.3 Hardware reset

Module 4-pin is the hardware reset input. The module will reset hardware when it receives a 1s low level signal. It is internally pull-up to VDD_1V8, and does not need to pull up externally.

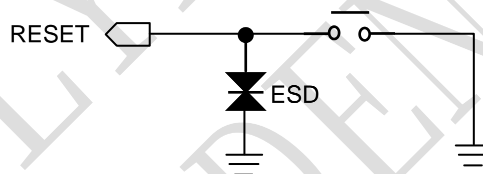

Figure 3.1.3-1 System Reset

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3.2 SIM Interface

3.2.1 Pin Description

L501 supports and is able to automatically detect 3.0V and 1.8V SIM card. SIM card interface signals are shown in table 3.2.1-1.

Table 3.2.1-1 (U)SIM Pin Description

Pin NO.	Pin Name	Signal definition	Function Description

17	USIM_DATA	SIM card data pin	SIM card DATA signal, I/O signal
18	SIM_RESET	SIM card reset pin	SIM card reset signal, output by the module
19	USIM_CLK	SIM card clock pin	SIM card clock signal, output by the module
53	USIM_DET	SIM detect pin	SIM detect pin, input signal
20	VSIM_VDD	VSIM output voltage	VSIM card power supply, output by the module

3.2.2 SIM application

Please note to increase the ESD components on SIM card signal group (PIN number: 17, 18, 19, 20), near the SIM card seat.

In order to meet the requirements of 3GPP TS 27.005 protocol and EMC certification, the proposed SIM card is arranged near the module SIM card interface, and avoid to layout too long resulting in serious waveform distortion, affecting the signal integrity. USIM_CLK and USIM_DATA signals are recommended to be protected. Paralleling a 1uF capacitor between GND and VSIM_VDD, it can filter out the interference of radio frequency signals.

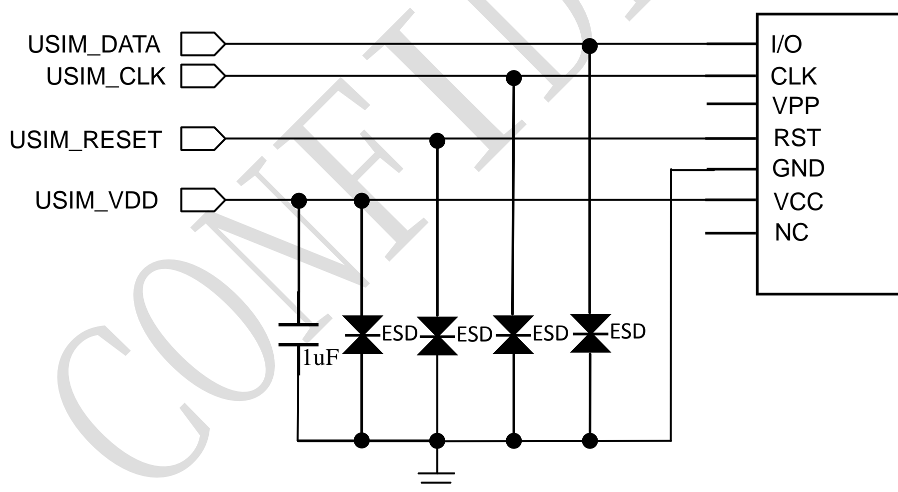

Figure 3.2.2-1 (U)SIM Circuit

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Notes: The capacity value of ESD components should be under 22pF.

3.3 SD Card Interface

The L501 supports 4-bit SD interfaces and SDIO2.0. Each SD signal should be protected by ESD components close to the connector. SD_CLK signal should be protected by GND. The SD card can support up to 32GB, which is mainly used for field test storage log.

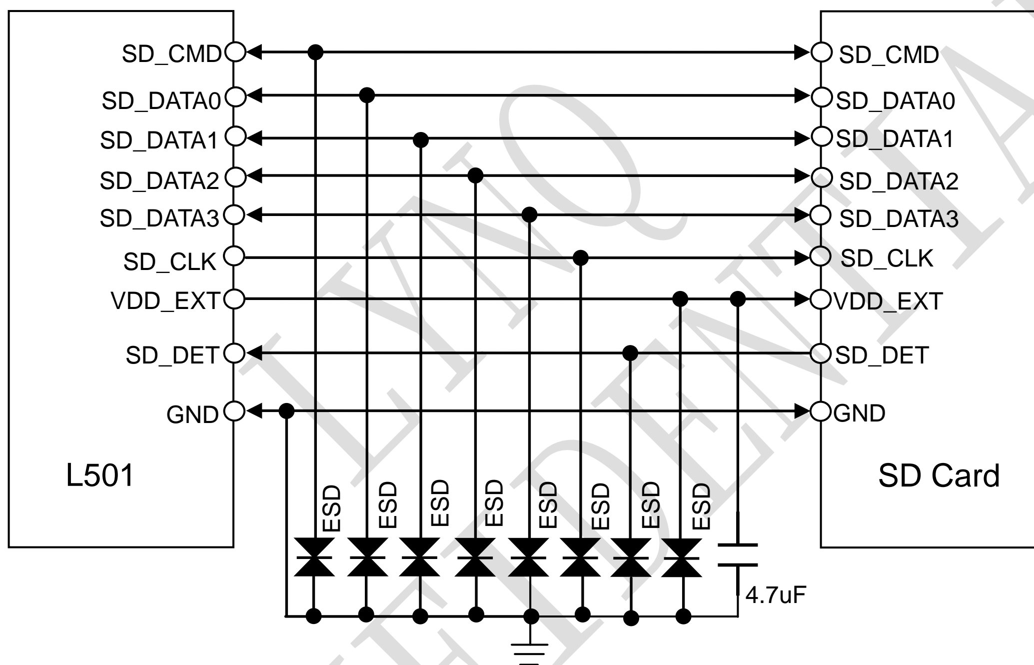

Figure 3.3-1 SD Card Circuit

Notes: The capacity value of ESD should be under 10pF.

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3.4 USB Interface

3.4.1 USB Application

The USB interface conforms to the USB2.0 specification and electrical characteristics. It supports low-speed, full-speed and high-speed modes. The data exchange between the main processor (AP) and the module is mainly completed through the USB interface.

The USB is mainly used for data transmission, firmware update, module program testing and send AT command. The DM/DP differential impedance need to be controlled at 90ohm ±10%, and it should be protected up and down, and can't be crossed with other lines. USB circuit is as follow.

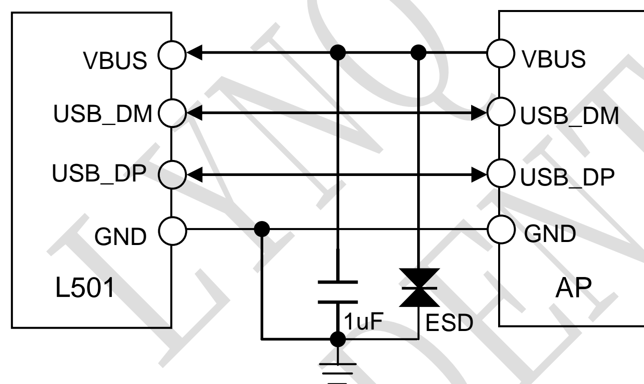

Figure 3.4.1-1 USB Circuit

Notes: If you use the serial port communication, the VBUS and DM/DP reserved test points respectively in order to firmware update. If DM/DP is used to communicate with the MCU, the position of the DM / DP signal near the module needs to reserve a test point and the DM/DP requires a series 0R resistor. The resistor is placed near the module and the test point is placed between module and resistor.

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3.4.2 Firmware Update

The L501 requires the module to enter the forced download mode when updating the firmware through the USB interface. When FORCE_DOWNLOAD (PIN85) is detected to be high during module startup, it enters USB download mode. The circuit of the FORCE_DOWNLOAD interface is as follow.

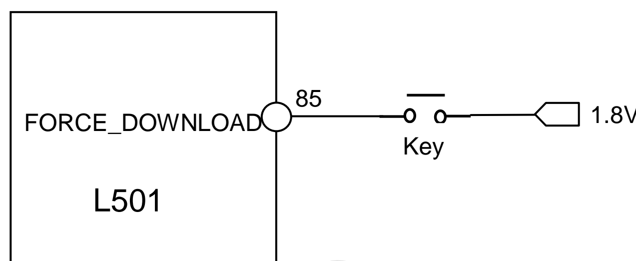

Figure 3.4.1-1 The FORCE_DOWNLOAD Circuit

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3.5 UART Interface

3.5.1 Pin Description

The L501 provides three UART serial communication interfaces: UART1 can be used as complete non-synchronous communication interface, supporting standard modem handshake signal control and in compliance with the RS-232 interface protocol, also supporting 4-wire serial bus interface or 2-wire serial bus interface mode. UART2 is used as a debug port of the L501. UART3 is multiplexed with SPI interface and can be used to connect peripherals.

The three groups of UART port support programmable data width, stop bits, and parity bits, with separate TX and RX FIFOs (512 bytes each). The baud rate of normal application of UART (non-Bluetooth) is 115200bps.

Table 3.5.1-1 UART Pin Description

Pin NO.	Pin Name	I/O	Function Description

66	UART1_RTS	DI	UART1 ready to receive
67	UART1_CTS	DO	UART1 clear to send
68	UART1_RX	I	UART1 receive data input
69	UART1_RING	DO	UART1 ring indicator. It can be used as wake out signal to host from module
70	UART1_DCD	DO	UART1 data carrier detect
71	UART1_TX	O	UART1 transmit data output
72	UART1_DTR	DI	UART1 Data terminal ready(wake up module)
114	UART2_TX	O	UART2 transmit data output
115	UART2_RX	I	UART2 receive data input
8	UART3_TX	O	UART3 transmit data output
7	UART3_RX	I	UART3 receive data input

3.5.2 UART application

If used UART in communication between the module and application processor, and the level is 1.8V, the connection mode is shown in Figure 3.5.2-1 and figure 3.5.2-2. You can use the complete RS232 mode, 4 wires or 2 wires mode connection. Module interface level is 1.8V. If the AP interface level does not match, you must increase the level conversion circuit.

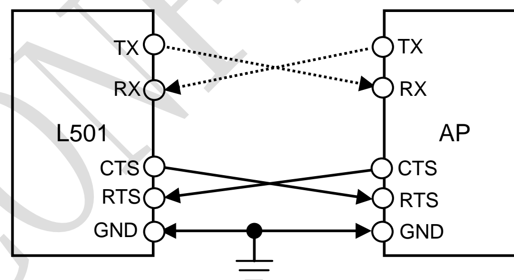

Figure 3.5.2-1 Connect to AP method(4lines)

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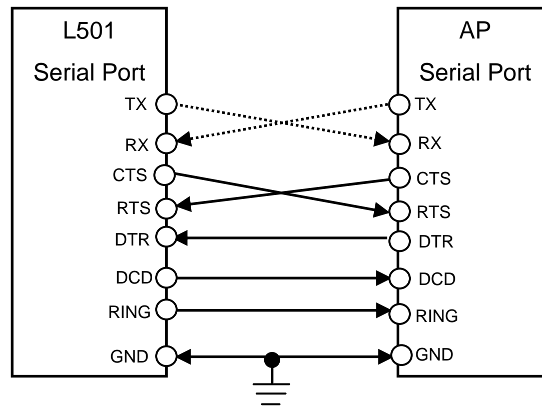

Figure 3.5.2-2 Connect to AP method

3.6 Audio Interface

L501 provides two audio interfaces: digital audio interface and analog audio interface.

3.6.1 Digital Audio Interface

L501 provides a digital audio interface (PCM) that can be used as a PCM master device to transmit digital voice signals. L501 only acts as a master device. PCM sync and PCM CLK are as output pins and PCM sync output 16kHz synchronization signals, the PCM data support 8-bit or 16 bit data format.

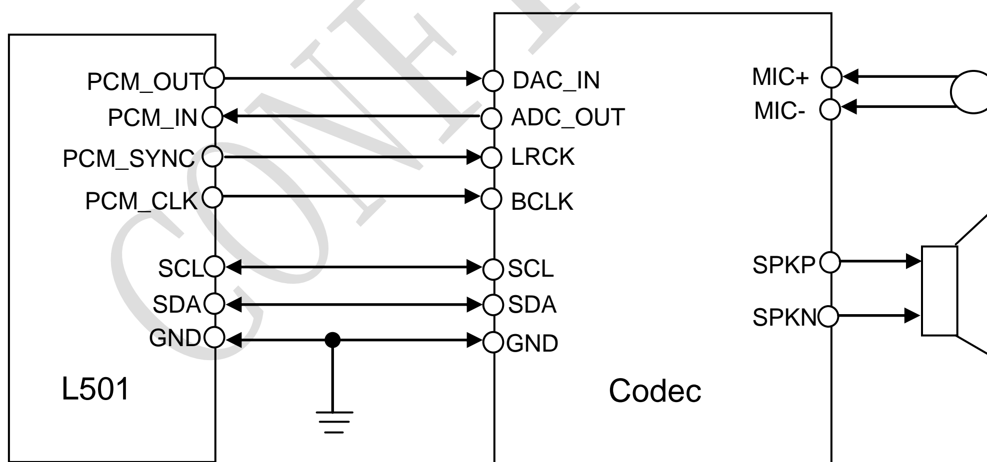

Figure 3.6.1-1 PCM Circuit（L501 as Main device）

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3.6.2 Analog Audio Interface

L501 supports audio input and outputs, which can meet different audio demands. The audio must take the differential layout and must be protected by GND around it. The audio layout should be not parallel to other layout of power or high speed routes.

(1) The MIC input signal (MIC + / MIC-) provided by the module only supports ordinary MIC (ordinary MIC have only two pins). The reference circuit is shown in Figure 3.6.2-1.

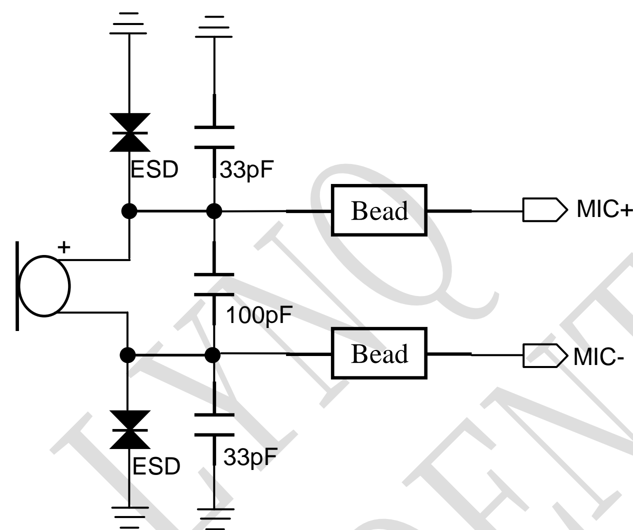

Figure 3.6.2-1 Common MIC Circuit

(2) The module provides normal receiver output, and the receiver signals take the differential layout and connect directly to the device. The reference circuit is shown in Figure 3.6.2-2.

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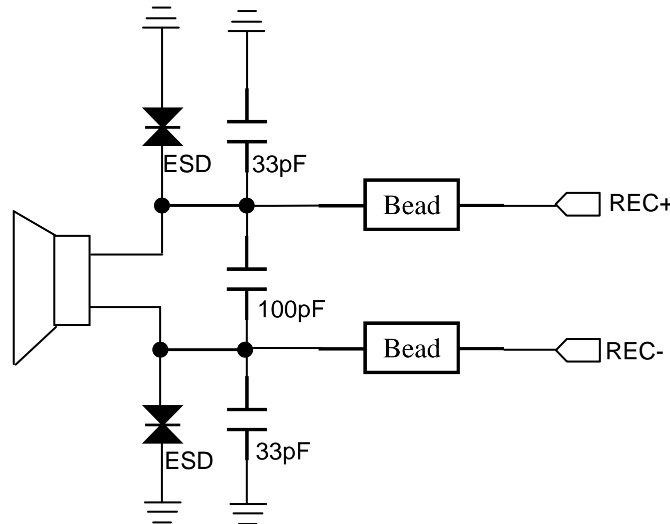

Figure 3.6.2-2 REC Circuit

(3) The module provides a set of DACL_P and DACL_N differential output signals, which can realize the function of the speaker under the amplification of an external PA. The reference circuit is shown in Figure 3.6.2-3.

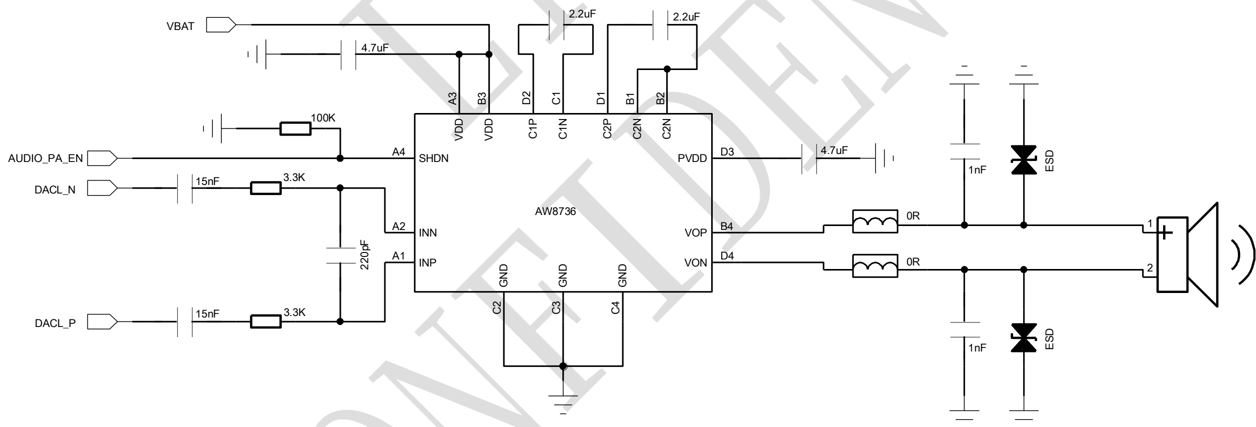

Figure 3.6.2-3 Speaker Amplify Circuit

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3.7 IIC Interface

L501 can support a group of IIC interface. It can communicate with peripherals through the IIC interface. It is internally pulled up to VDD_1V8 through 4.7K resistor. It supports standard mode (100KHz) and fast mode (400KHz).

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3.8 NETLIGHT Interface

3.8.1 NETLIGHT LED Control circuit

NETLIGHT (PIN51) can be used to control the LED status of the network.

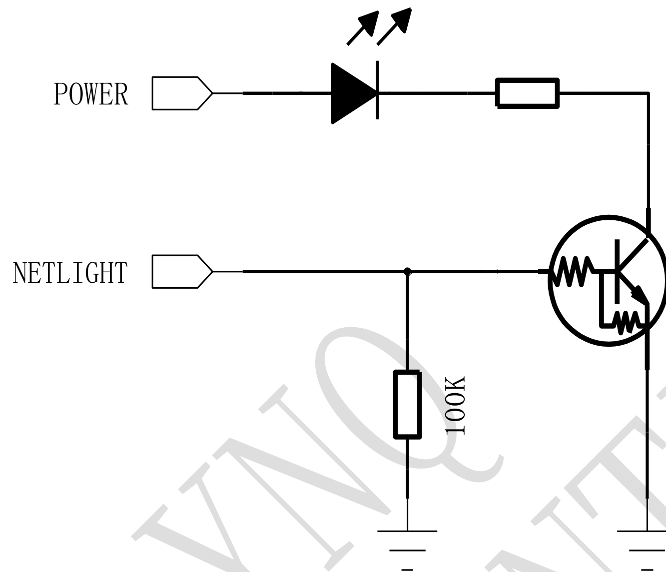

Figure 3.8.1-1 NETLIGHT LED Circuit

3.8.2 NETLIGHT LED Status description

NETLIGHT (PIN13) is used as the enable pin. Table 3.8.2-1 lists the LED status.

Table 3.8.2-1 NETLIGHT LED Status

LED Status	Module Status
OFF	Power off or PSM Mode
64ms ON/800ms OFF	Shut down network
64ms ON/3000ms OFF	Registered network

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3.9 Interactive Application Interface

3.9.1 Pin Description

L501 provides a variety of interfaces for interacting with the application processor, including WAKEUP (WAKEUP includes WAKEUP_IN and WAKEUP_OUT), STATUS and FLIGHTMODE.

Table 3.9.1-1 Interactive Application Interface

Pin NO.	Pin Name	I/O	Function Description
49	STATUS	O	AP query module status
50	WAKEUP_IN	I	AP wakes up module
52	WAKEUP_OUT	O	Module wakes up AP
54	FLIGHTMODE	I	Flight mode

3.9.2 Interface Application

The L501 provides a direct interactive signal to communicate with the AP.

STATUS: Module status query. Low level indicates power-off state or power-on initialization state, and high level indicates power-on state.

WAKEUP_IN: After the module enters sleep, the host can wake up the module by pulling down this signal. After the host pulls the signal high, the module is allowed to enter sleep.

WAKEUP_OUT: When the module has an event and needs to communicate with the AP, the module can wake up the AP by setting this pin to low level (Low level will last 120ms).

FLIGHTMODE: It can be used to control the module to enter or exit flight mode. The module enters flight mode by external input low level.

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3.10 SPI Interface

L501 supports one SPI interface and is master device in default. SPI_MISO and SPI_MOSI signals of SPI interface are multiplexed with UART3

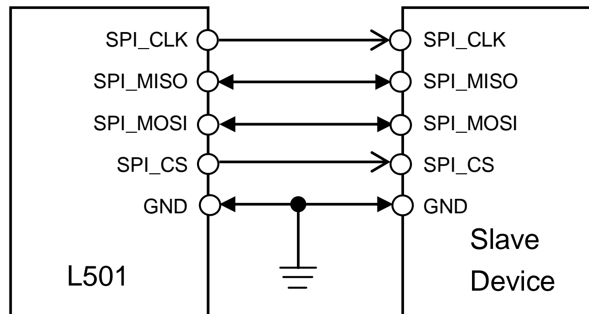

Figure 3.10-1 SPI Connecting

3.11 ADC

L501 provides an ADC for detecting light-sensitive resistors or other devices that require ADC detection. The Max voltage of ADC is 1.2V with 12-bit accuracy.

Table 3.11-1 ADC value

Parameter	Min.	Typ.	Max.	Unit
Input range	0.05		1.2	V

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4. Electrical characteristics

4.1 Electrical characteristic

Table 4.1-1 Electrical characteristic

Power	Min.	Nom.	Max	Unit
VBAT	3.3	3.8	4.2	V
Peak current	-0.3	-	2.0	A

Notes: The over-low voltage can't power on the module. Over-high voltage may be danger to damage the module.

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4.2 Temperature characteristic

Table 4.2-1 Temperature characteristic

State	Min.	Nom.	Max	Unit
Working	-40	25	85	℃
Storage	-45	25	90	℃

Notes: When the temperature is over the range, the RF performance may be dropped. It also may cause power down or restart problem.

4.3 Absolute Maximum Power

Table 4.3-1 Absolute maximum power rating

PIN Name	Description	Min.	Typ.	Max.	Unit
VDD_1V8	Digital power for IO	-0.3		2	V
VBAT	Power supply	-0.3		6	V

4.4 Recommended operating conditions

Table 4.4-1 Recommended operating range

PIN Name	Description	Min.	Typ.	Max.	Unit
VDD_1V8	Digital power for IO	1.7	1.8	1.98	V

Notes: All the GPIOs, UART and IIC of module are 1.8V.

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4.5 Power consumption

Table 4.5-1 Power Consumption

Parameter	Conditions	Min.	Average	Max.	Unit
Power off mode	VBAT=3.8V	-	15		uA
Flight mode	VBAT=3.8V	-	0.7		mA
LTE Standby	VBAT=3.8V		1.2		mA

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GSM Standby	VBAT=3.8V		1.3		mA
Peak current	VBAT=3.8V			2	A

Notes: The test value of power consumption is the value tested in laboratory condition.

4.6 Power Sequence

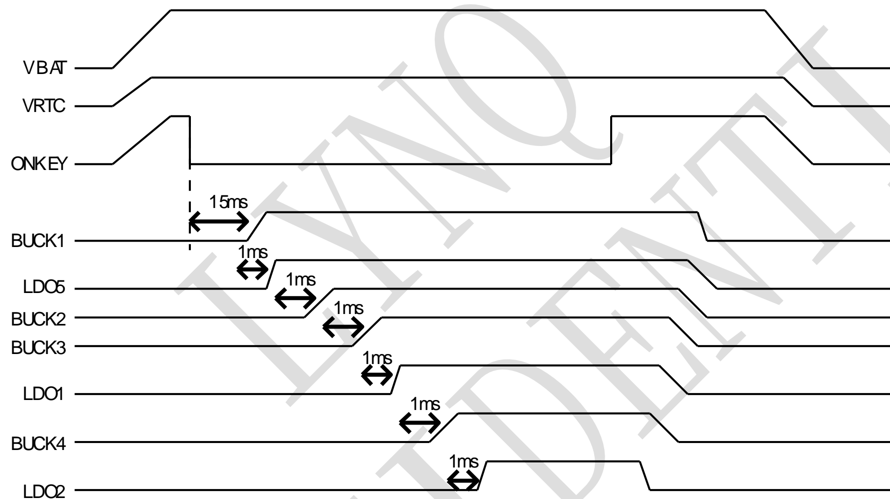

Figure 4.6-1 Power up time sequence diagram

4.7 Digital Interface Characteristics

Table 4.7-1 Digital IO Voltage

Parameter	Description	Min.	Typical	Max.	Unit
VIH	High level input voltage	0.7*VDD_1V8	1.8	1.98	V

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VIL	Low level input voltage	0	-	0.3*VDD_1V8	V
VOH	High level output voltage	0.8*VDD_1V8	1.8	1.98	V
VOL	Low level output voltage	0	-	0.2*VDD_1V8	V

Notes: Suit to all GPIOs, IIC, UART interfaces.

4.8 ESD

The module contains high sensitive electronic and is an electrostatic Sensitive Device. More attentions should be paid to the procedure of handing and packaging. The ESD test results are shown in the following table.

ESD parameter（Tem: 25°C，humidity: 45%）

Table 4.8-1 ESD Performance

PIN Name	Contact discharge	Air discharge
VBAT	±4KV	±8KV
GND	±4KV	±8KV
ANT	±4KV	±8KV

Enhanced ESD performance method:

1、 If a converted board is added, it should have enough GND pins and be equally distributed. And the Layout of GND should be enough wide.

2、 Key (Power key, Force_download key and Reset key) need to add ESD device. Reset key line

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can't be near the edge of the board.

3、 UART and other plug connector need to add ESD devices, and the other control lines from the outside of the machine also need to add ESD devices.

4、 SIM card should be added ESD protect.

5、 External antenna, please add ESD device, ESD C_{pf}<0.5pF.

Notes: For ESD protect, please add ESD methods according to upper ways.

ESD components include varistors and TVS. For better performance, please use TVS.

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5. RF Features

5.1 RF Main Features

a) Support FDD/TDD LTE Rel-8 CAT1;

b) Support GSM/GPRS/EGPRS;

c) Support WIFI SCAN;

d) Support LTE bands include Band 1/3/5/8/34/38/39/40/41;

e) Support GSM bands include GSM900/DCS1800;

The operating frequency range of the product is shown in table 5.1-1.

Table 5.1-1 Frequency Band

Band	Uplink	Downlink	Note
Band1	1920 MHz ～ 1980 MHz	2110 MHz ～ 2170 MHz	
Band3	1710 MHz ～ 1785 MHz	1805 MHz ～ 1880 MHz	
Band5	824 MHz ～ 849 MHz	869 MHz ～ 894 MHz	
Band8	880 MHz ～ 915 MHz	925 MHz ～ 960 MHz	
Band34	2010 MHz ～ 2025 MHz	2010 MHz ～ 2025 MHz	
Band38	2570 MHz ～ 2620 MHz	2570 MHz ～ 2620 MHz	
Band39	1880 MHz ～ 1920 MHz	1880 MHz ～ 1920 MHz	
Band40	2300 MHz ～ 2400 MHz	2300 MHz ～ 2400 MHz	
Band41	2535 MHz ～ 2655 MHz	2535 MHz ～ 2655 MHz	Support 120MHz bandwidth
GSM900	880 MHz ～ 915 MHz	925 MHz ～ 960 MHz	
DCS1800	1710 MHz ～ 1785 MHz	1805 MHz ～ 1880 MHz	

Table 5.1-2 Output power

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Band	Max output power	Min output power
Band1	23dBm±2dB	< -40dBm
Band3	23dBm±2dB	< -40dBm
Band5	23dBm±2dB	< -40dBm
Band8	23dBm±2dB	< -40dBm
Band34	23dBm±2dB	< -40dBm
Band38	23dBm±2dB	< -40dBm
Band39	23dBm±2dB	< -40dBm
Band40	23dBm±2dB	< -40dBm
Band41	23dBm±2dB	< -40dBm
GSM900	33dBm±2dB	5dBm±2dB
DCS1800	30dBm±2dB	0dBm±2dB

Table 5.1-3 Receive sensitivity

Band	REF SENS @10MHz (Total)
Band1	TBD
Band3	TBD
Band5	TBD
Band8	TBD
Band34	TBD
Band38	TBD
Band39	TBD
Band40	TBD
Band41	TBD
GSM900	TBD
DCS1800	TBD

“TBD” Under development.

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5.2 Data link

Table 5.2-1 Data link

Band	Downlink	Uplink
Band1	TBD	TBD
Band3	TBD	TBD
Band5	TBD	TBD
Band8	TBD	TBD
Band34	TBD	TBD
Band38	TBD	TBD
Band39	TBD	TBD
Band40	TBD	TBD
Band41	TBD	TBD

“TBD” Under development.

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5.3 Antenna Circuit Design

The connecting part of the RF antenna supports the PAD form. The connection between the module and the main board antenna interface is required to be welded and connected through a microstrip line or a strip line. The microstrip line or strip line is designed according to the characteristic impedance of 50 ohm, and the length of the wire is less than 10mm. Reserved Π matching network.

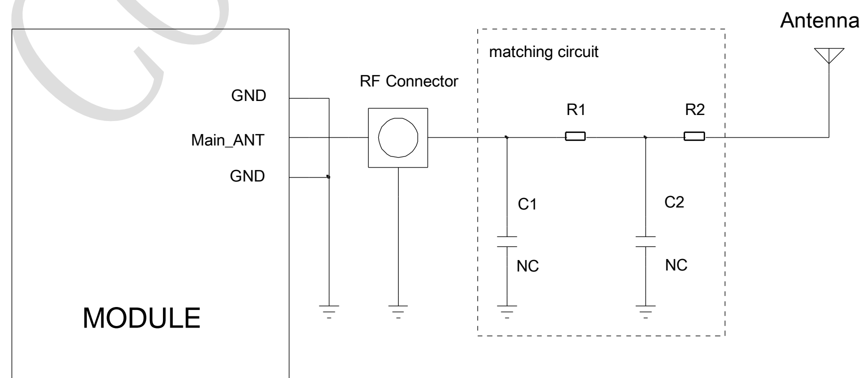

Figure 5.3-1 Main Antenna Design

Figure R1, C1, C2 and R2 composition of the antenna matching network for antenna debugging, the default R1, R2 paste 0 ohm resistor and C2, C1 empty paste.

RF Connector in the figure is used for testing and conducting test (for example, CE, FCC, etc.), which need to be placed as close as possible by the module, the RF path from the module to the antenna feed point should be kept 50 ohm impedance control.

This product antenna peripheral circuit design, the proposed RF circuit Layout program: RF line trances top layer, a reference to the second layer. Users need to pay attention to the design of the PCB line: to ensure the RF has full reference GND layer.

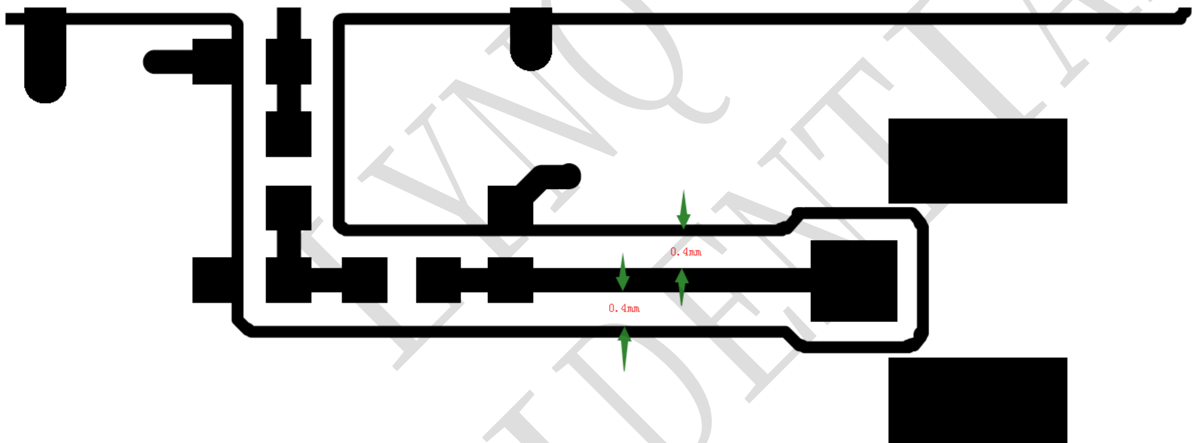

Figure 5.3-2 RF Trace Design

5.4 Antenna Design

PIFA or IFA antenna can be used for inner antenna; Whip antenna can be used for external antenna. The antenna gain must more than 3dBi. The recommend area of inner antenna: 100mm*10mm*6mm (L*W*H), the main board length no less than 90mm. The antenna should be as far as possible from the chip and memory, power interface, data cable interface, camera FPC, screen FPC, connector FPC, and other possible EMI modules and devices.

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Table 5.4-1 Antenna Specifications

Parameter		Specification
Efficiency		>40%
S11/VSWR		<-10dB
Polarization		linear polarization
TRP	Low Band	>18dBm
	Middle Band	>18dBm
	High Band	>18dBm
TIS	Low Band	<-92dBm (@10MHz)
	Middle Band	<-92dBm (@10MHz)
	High Band	<-92dBm (@10MHz)
Low Band		Band 5/8
Middle Band		Band 1/3/34/39
High Band		Band 38/40/41

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6. Storage, Production and Package

6.1 Storage

The rank of moisture proof of the module is level 3. There is an obvious sign on the table of the internal and the external packaging.

In the vacuum sealed bag, the module can be stored for 180 days when the temperature is below 40°C and the humidity is below 90% under good air circulation.

Humidity level is described detail as follows:

Table 6.1-1 Humidity level

Rank	Factory Environment ≦ +30°C /60%RH
1	No control < 30°C /85%RH
2	One year
2a	4 weeks
3	168 hours
4	72 hours
5	48 hours
5a	24 hours
6	Baking before using, SMT during the time table signs

Notes: Moving, storage, production of module must meet the demand of IPC/JEDEC J-STD-033.

6.2 Production

The module is a humidity sensitive device. If the device needs reflow soldering, disassembly and

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maintenance, we must strictly comply with the requirements of humidity sensitive device. If module is damp, a reflow soldering or using a hot-air gun maintenance will lead to internal damage, because the water vapor has the rapid expansion of the burst, causing physical injury to the device, like PCB foaming and BGA component fail. So customers should refer to the following recommendations.

6.2.1 Module confirmation and moisture

The module in the production and packaging process should be strictly accordance with the humidity sensitive device operation. The factory packaging is vacuum bag, desiccant, and humidity indicator card. Please pay attention to the moisture control before SMT and the confirmation of the following aspects.

Demand of Baking confirmation

Smart module uses vacuum sealed bag, which can make it stored for 6 months under the condition of temp 40°C and humidity < 90%. The module should be baked before reflowing soldering if any of the conditions below happen.

1. Storage exceeds the time limit.

2. Package damages and vacuum bags have air leakage.

3. Humidity indicating card change the color at 10%.

4. Module is placed naked in the air over 168 hours.

5. Module is placed naked in the air under 168 hours but not temp 30°C and humidity < 60%.

Baking condition confirmation

The moisture proof level of the smart module is level 3. And the baking conditions are as follows.

Table 6.2.1-1 Baking conditions

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Baking conditions	120°C / 5%RH	40°C / 5%RH
Baking time	4 hours	30 days
Description	not use the original tray	Can use the original tray

Notes: The original anti-ESD tray temperature does not exceed 50°C. Otherwise the tray will be deformed.

The anti-ESD tray of the original packaging is only used for packaging, and can't be used as a SMT tray.

During taking and placing, please take notes of ESD and cannot be placed as overlay.

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Customer product maintenance

If maintenance module after SMT, it is easy for damp module to damage when removing, so the module disassembly and other related maintenance operations should complete within 48 hours after SMT, or need to bake and then maintenance the module.

Because the module return from the field work can't ensure the dry state, it must be baked in accordance with the conditions of baking, then for disassembly and maintenance. If it has been exposed to the humid environment for a long time, please properly extend the baking time, such as 125°C/36 hours.

6.2.2 SMT reflow attentions

The module has the BGA chips, chip resistances and capacitances internally, which will melt at high temperature. If module melt completely encountered a large shock, such as excessive vibration of reflux conveyor belt or hit the board, internal components will easily shift or be false welding. So, using intelligent modules over the furnace need to pay attention to:

- Modules can't be vibrate larger, namely customer requirements as far as possible in orbit (chain)

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furnace, furnace, avoid on the barbed wire furnace, in order to ensure smooth furnace.

- The highest temperature can't too high. In the condition that meet the welding quality of customer motherboard and module, the lower furnace temperature and the shorter maximum temperature time, the better.

Some customer's temperature curve in the line is not suitable, high temperature is too high, and customer motherboard melt good, but non-performing rate is on the high side. Through the analysis of the causes, it found that melt again of BGA components lead device offset and short circuit. After adjusting the temperature curve, it can ensure that the customer's motherboard the welding quality, and also improve the pass through rate. Non-performing rate is controlled below the 2/10000.

6.2.3 SMT stencil design and the problem of less tin soldering

Part of customers found false welding or circuit short when reflowing. The main reason is module tin less, PCB distortion or tins too large. Suggestions are as follows:

- Suggest use ladder stencil, which means the depth of the region of module is thicker than other areas. Please adjust validation according to the measured thickness of solder paste, the actual company conditions and experience value. The products need to strictly test.

- Stencil: Reference module package and the user can adjust according to their company experience; Outside of the module, the stencil extends outside. The GND pads use the net stencil.

6.2.4 SMT attentions

If customer motherboard is thin and slender with a furnace deformation, warping risks, you will be suggested to create "a furnace vehicle" to ensure the welding quality. Other production proposals are as follows:

- The solder pastes use brands like Alfa.

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- The module must use the SMT machine mount (important), and do not recommend manually placed or manual welding.
- For SMT quality, Please ensure the necessary condition according to actual condition of factory before SMT, like SMT pressure, speed (very important), stencil ways.
- We must use the reflow oven more than 8 temperature zones, and strictly control the furnace temperature curve.

Recommended temperature:

B. constant temperature zone: temperature 140-210°C, time: 60s-120s.

E. recirculation zone: PEAK temperature 220-245°C, time: 45s-75s.

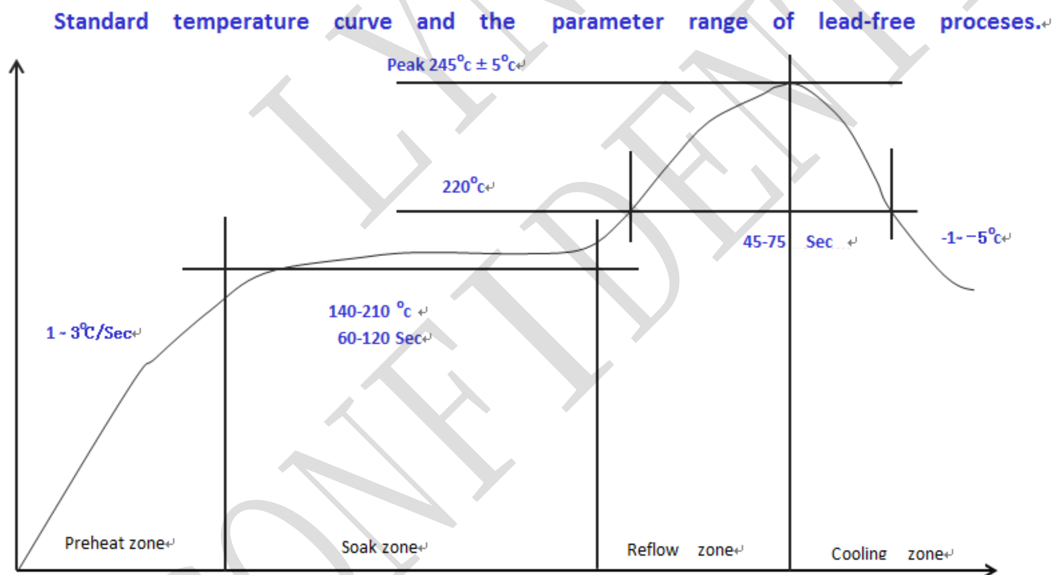

Figure 6.2.4-1 Temperature Curve

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Notes: Customer's board deformation must be controlled well. By reducing the number of imposition or increasing patch clamp to reduce the deformation.

Module thickness of the stencil is recommended to be thickened, and the rest position can be maintained by 0.1mm.

6.3 Packaging Information

The L501 module is packaged with a roll of tape and sealed with a vacuum-sealed antistatic bag.

Coil tape

One coil can hold 250 modules, as shown in the figure.

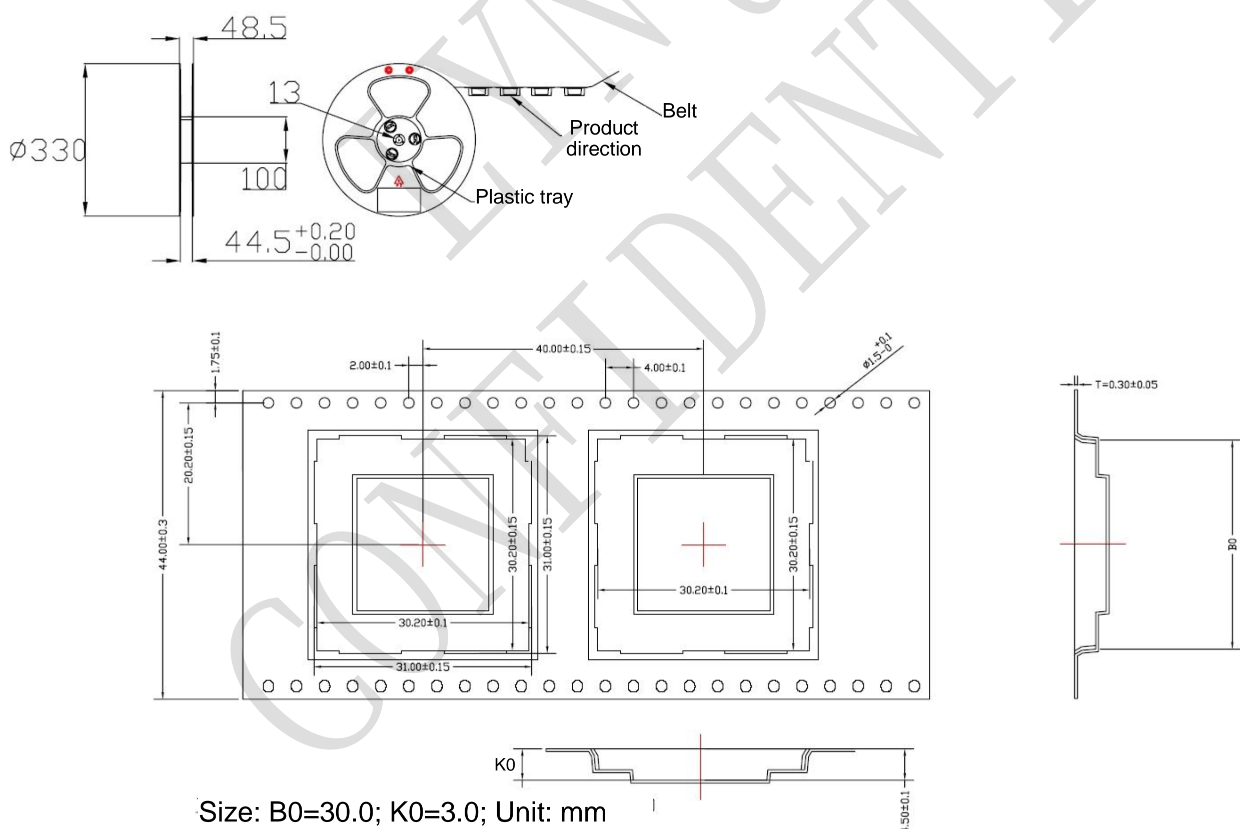

Figure 6.3-1 Coil tape information

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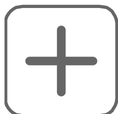
7. Safety Information

For the reasonable usage of the module, please comply with all these safety notices of this page. The product manufacturers should send followed safety information to user, operator or product's spec.

The devices using the module may disturb some electronic equipment. Put the module away from the phone, TV, radio and automation equipment to avoid the module and the equipment to interfere with each other.

Shut down the mobile device or change to flying mode before boarding. The Using of wireless appliances in an aircraft is forbidden to avoid the interference, or else cause to unsafe flying, even violate the law.



In hospital or health care center, switch off the mobile devices. RF interference may damage the medical devices, like hearing-aid, cochlear implant and heart pacemaker etc.

Mobile devices can't guarantee to connect in all conditions, like no fee or with an invalid SIM card. When you need emergent help, please remember using emergency calls and make sure your device power on in an area with well signal.

Put the module away from inflammable gases. Switch off the mobile device when close to gas station, oil depot, chemical plant etc.

The module is not water proof. Please don't use the module in the area with high humidity like bathroom, which will decelerate the physical performance, insulation resistance and mechanical strength.

Non-professionals can't teardown the module which will damage it. Refer to the specification or communicate the related staffs to repair and maintain it.

Please switch on the module before cleaning. The staffs should be equipped with anti-ESD clothing and gloves.

The users and product manufacturers should abide by the national law of wireless modules and devices. If not, Mobiletek will not respond the related damages.

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