

L651_Hardware Design

NB-IoT+GSM/GPRS+(GNSS) Module Series

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Version History

Date	Version	Modify records	Author
2018-11-23	V1.0	First Release	Tp.Lin
2019-06-05	V1.1	UART part of the description; Review modify; Data transmission update; Module system block diagram, pin distribution diagram, package information diagram update; Power consumption data update; Increase sensitive data and consumption data;	Tp.Lin Rb.li

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1. Introduction

L651 is a small NB-IoT+GSM/GPRS+(GNSS) module for LCC package, with low power consumption, high performance, stable performance, small size, light weight, high reliability, high cost-effective, it can be applied to a variety of compact products.

L651G supports NB-IoT+GSM/GPRS+GNSS, L651C supports NB-IoT+GSM/GPRS.

1.1 Hardware Diagram

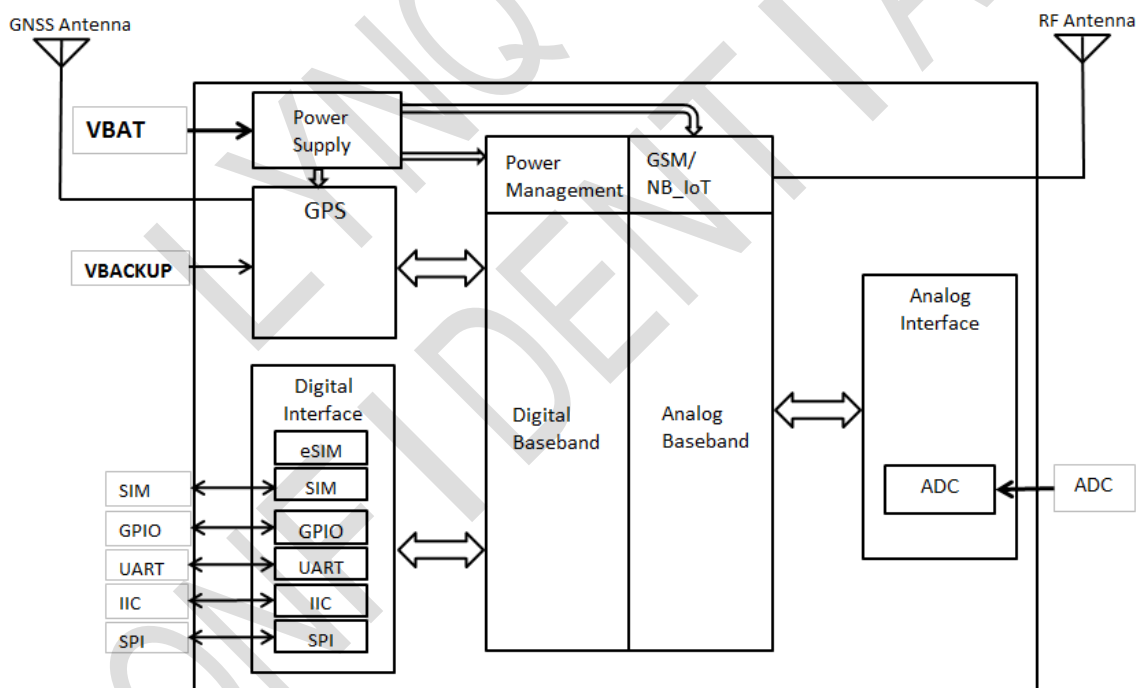


Figure 1-1 L651G Functional architecture

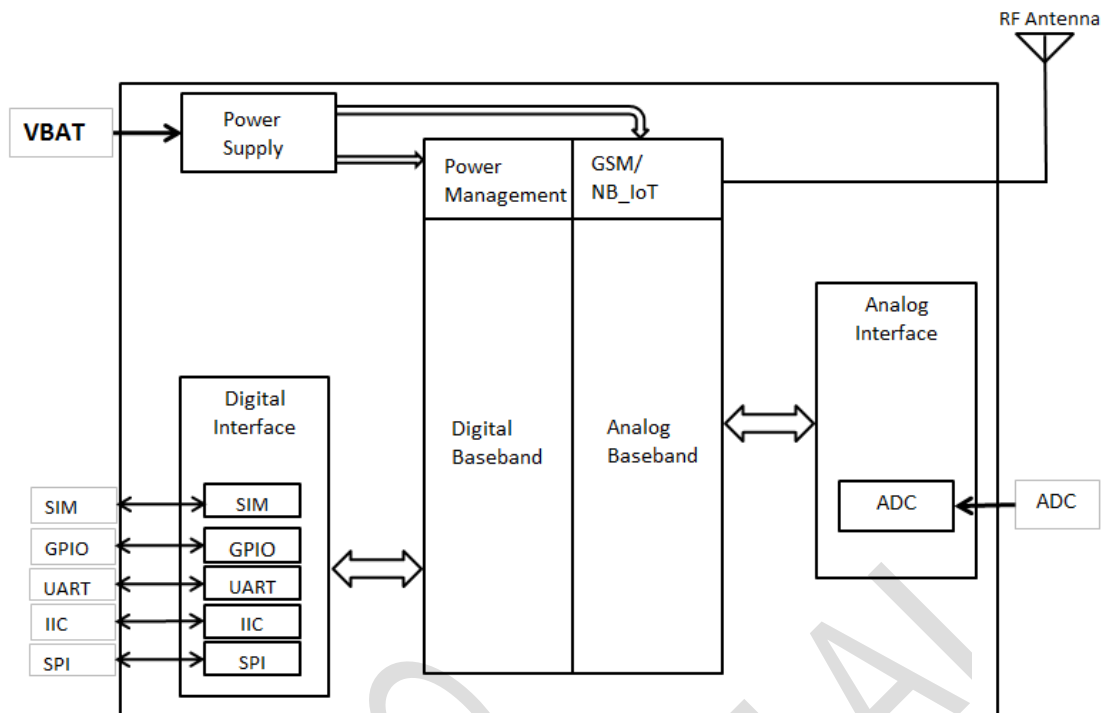


Figure 1-2 L651C Functional architecture

1.2 Main features

- **CPU**

MIPS processor@192MHz

- **Flash**

PSRAM: 32Mb

Flash: 64Mb

- **Frequency bands**

GSM:

GSM900

DCS1800

NB-IoT:

Band3
Band5
Band8
Band20
Band28

- **Output Power**

GSM:

GSM900 33dBm \pm 2dB

DCS1800 30dBm \pm 2dB

NB-IoT:

Band3 23dBm \pm 2dB

Band5 23dBm \pm 2dB

Band8 23dBm \pm 2dB

Band20 23dBm \pm 2dB

Band28 23dBm \pm 2dB

- **Sensitivity**

GSM:

GSM900 \leq -109dBm

DCS1800 \leq -108dBm

NB-IoT:

Band3 \leq -114.3dBm

Band5 \leq -114.5dBm

Band8 \leq -114.8dBm

Band20 \leq -114.5dBm

Band28 \leq -114.4dBm

- **Ultra-low power consumption**

PSM: 4uA@3.8V

GSM standby mode: 1.9mA@3.8V

- **Data transmission**

NB-IoT:

UL: 15.6Kbps@15k ST 0dBm

UL: 32.8Kbps@15k MT 0dBm

UL: 4.68Kbps@3.75k 0dBm

DL: 20.2Kbps@MCL120

GPRS:

UL: MAX 80Kbps

DL: MAX 80Kbps

- **Product series**

L651C: NB-IoT+GSM/GPRS

L651G: NB-IoT+GSM/GPRS+GNSS

1.3 Specifications

- Supply Voltage Range: 3.4~4.2V (type3.8V)
- Dimensions: 24mm * 20mm * 2.4mm
- Package: 52-pin LCC
- Support GSM and NB-IoT (NB-IoT support PSM and eDRX mode)
- GNSS: GPS+BEIDOU/Glonass
- Operation Temperature Range: -40°C~+85°C
- Storage Temperature Range: -45°C~+90°C
- Two antenna interface: GSM/NB-IoT antenna and GNSS antenna

1.4 Interfaces

- ADC
- IIC
- GPIO
- SPI
- SIM: Support 1.8V/3V or eSIM
- UART

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2. Package Information

2.1 Pin Configuration

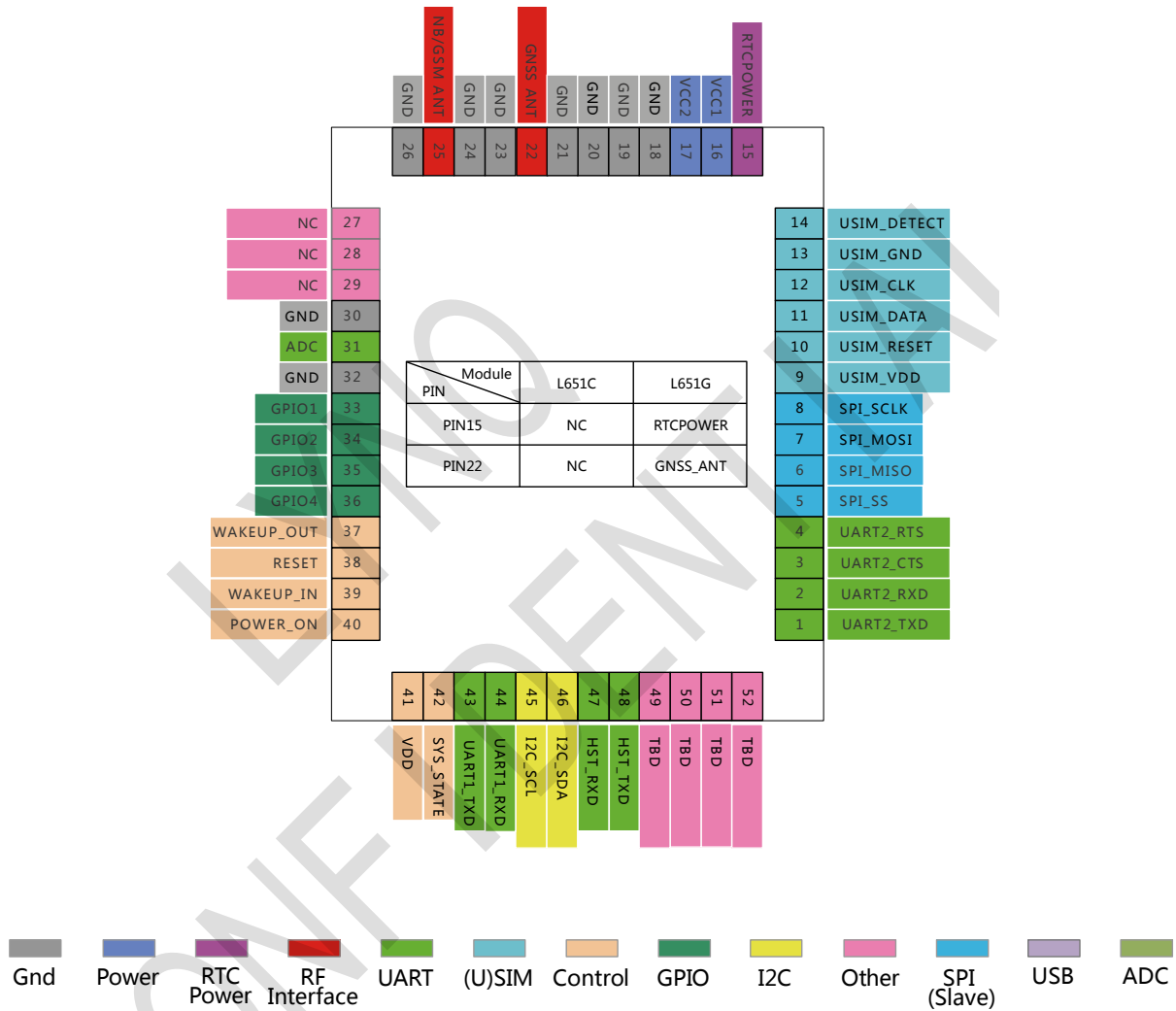


Figure 2-1 L651 Pin View

2.2 Pin definition

Table 2-1 L651 Pin description

Pin NO.	Pin name	Type	Function Description	Power domain	State (1)
1.	UART2_TXD	O	UART2 transmit data output	VIO28	Open
2.	UART2_RXD	I	UART2 receive data input	VIO28	Open
3.	UART2_CTS	DO	UART2 clear to send	VIO28	Open
4.	UART2_RTS	DI	UART2 ready to receive	VIO28	Open
5.	SPI_SS*	O	SPI chip-select	VIO28	Open
6.	SPI_MISO*	I	SPI master in slave out	VIO28	Open
7.	SPI_MOSI*	O	SPI master out slave in	VIO28	Open
8.	SPI_SCLK*	O	SPI clock	VIO28	Open
9.	USIM_VDD	P	SIM output voltage	1.8V/3V	Open
10.	USIM_RESET	O	SIM reset	1.8V/3V	Open
11.	USIM_DATA	I/O	SIM data	1.8V/3V	Open
12.	USIM_CLK	O	SIM clock	1.8V/3V	Open
13.	USIM_GND	G	Ground		GND
14.	USIM_DETEC T	I	SIM detect pin	VIO28	Open
15.	RTCPOWER	P	GPS backup power,L651C is NC	1.4V-2.5V	
16.	VCC1	P	Power supply	3.4V-4.2V	VCC
17.	VCC2				
18.	GND	G	Ground		GND
19.	GND	G	Ground		GND
20.	GND	G	Ground		GND
21.	GND	G	Ground		GND

22.	GNSS_ANT	ANT	GNSS Antenna		
23.	GND	G	Ground		GND
24.	GND	G	Ground		GND
25.	NB/GSM ANT	ANT	GSM/NB-IoT Antenna		
26.	GND	G	Ground		GND
27.	NC		NC		
28.	NC		NC		
29.	NC		NC		
30.	GND	G	Ground		GND
31.	ADC*	I	ADC external input channel	0V-1.8V	Open
32.	GND	G	Ground		GND
33.	GPIO1	I/O	General input/output PIN	VIO28	Open
34.	GPIO2	I/O	General input/output PIN	VIO28	Open
35.	GPIO3	I/O	General input/output PIN	VIO28	Open
36.	GPIO4	I/O	General input/output PIN	VIO28	Open
37.	WAKEUP_OUT	O	General input/output PIN. It can be used as wake signal to host from module	VIO28	Open
38.	RESET	I	System reset signal	0.7V-1.4V	Open
39.	WAKEUP_IN	I	Wake up module for exiting PSM	0V-1.4V	Open
40.	POWER_ON	I	Power key	0V-1.4V	Open
41.	VDD	P	80mA@2.8V output voltage	2.8V	Open
42.	SYS_STATE	O	Output PIN as LED control for network status	VIO28	Open
43.	UART1_TXD	O	UART1 transmit data output	VIO28	Open
44.	UART1_RXD	I	UART1 receive data input	VIO28	Open
45.	I2C_SCL*	I/O	IIC clock	VIO28	Open

46.	I2C_SDA*	I/O	IIC data	VIO28	Open
47.	HST_RXD	I	Download/debug UART receive data input	VIO28	Open
48.	HST_TXD	O	Download/debug UART transmit data output	VIO28	Open
49.	TBD				
50.	TBD				
51.	TBD				
52.	TBD				

(1) Suggested status when not in use. "*" indicates that software functions are being developed.

Table 2-2 Pin type description

P: Power	G: Ground
I: Input	DI: Digital input
O: Output	DO: Digital output
ANT: Antenna	DIO: Digital input output
NC: Not connect	AI: Analog input
TBD: To Be Determined	

Note: Because RESET, WAKEUP_IN and POWER_ON have the highest voltage range of 1.4V, when the voltage of CPU control pin is inconsistent with it, please use logic control circuit.

2.3 Package Information

2.3.1 Dimensions

The L651 mechanical dimensions are described as following figure (Top view, Back view, Side view).

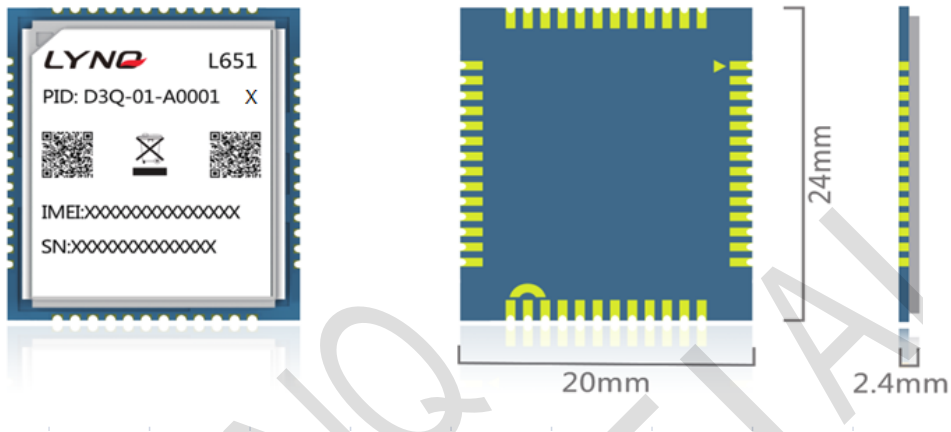


Figure 2-2 Mechanical Dimensions

2.3.2 Product labeling

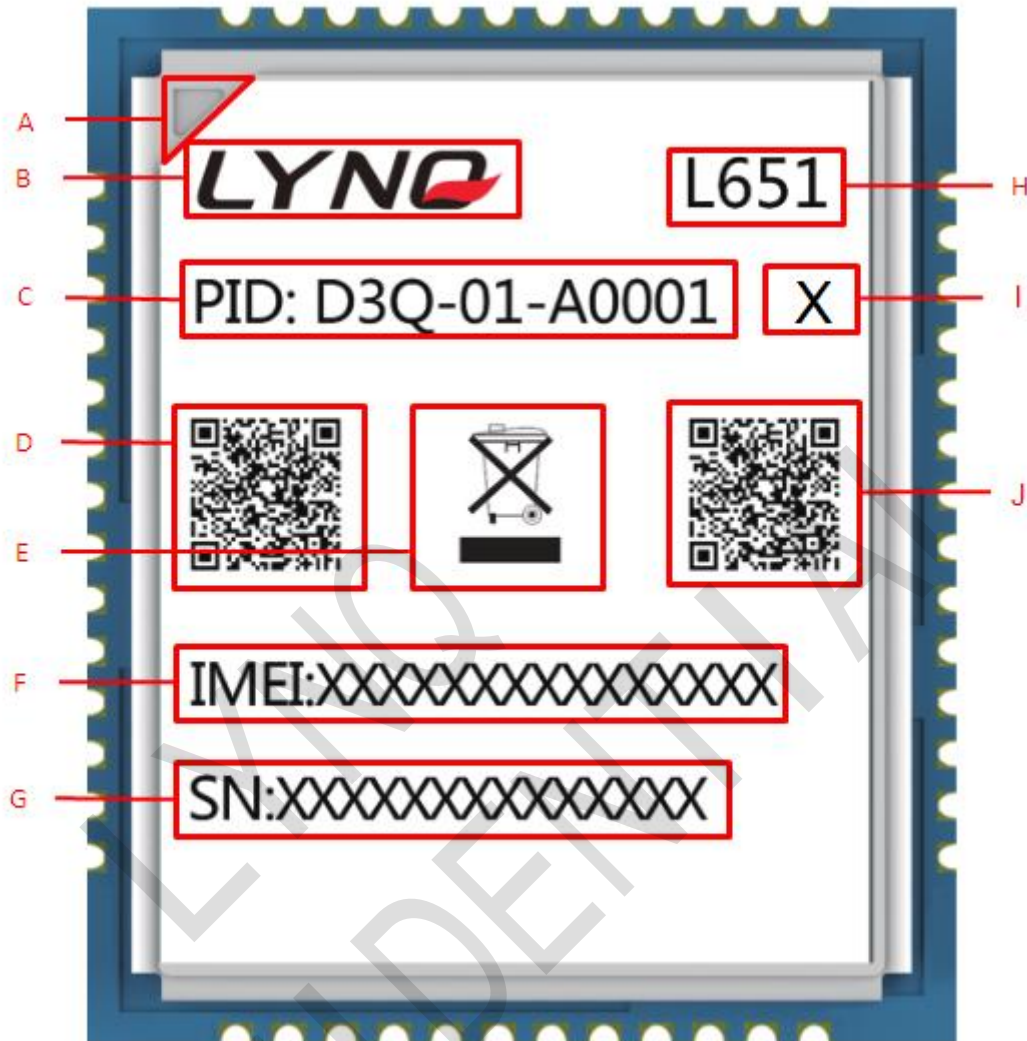


Figure 2-3 Label of L651

Table 2-3 Description of label

Item	Description
A	Pin1 mark
B	Logo of company
C	PIN number
D	QR code--include IMEI number
E	WEEE

F	IMEI number
G	SN number
H	SOM name
I	Configuration--C: NB-IoT+GSM/GPRS; G: NB-IoT+GSM/GPRS+GNSS
J	QR code--include SN number

2.3.3 Module size

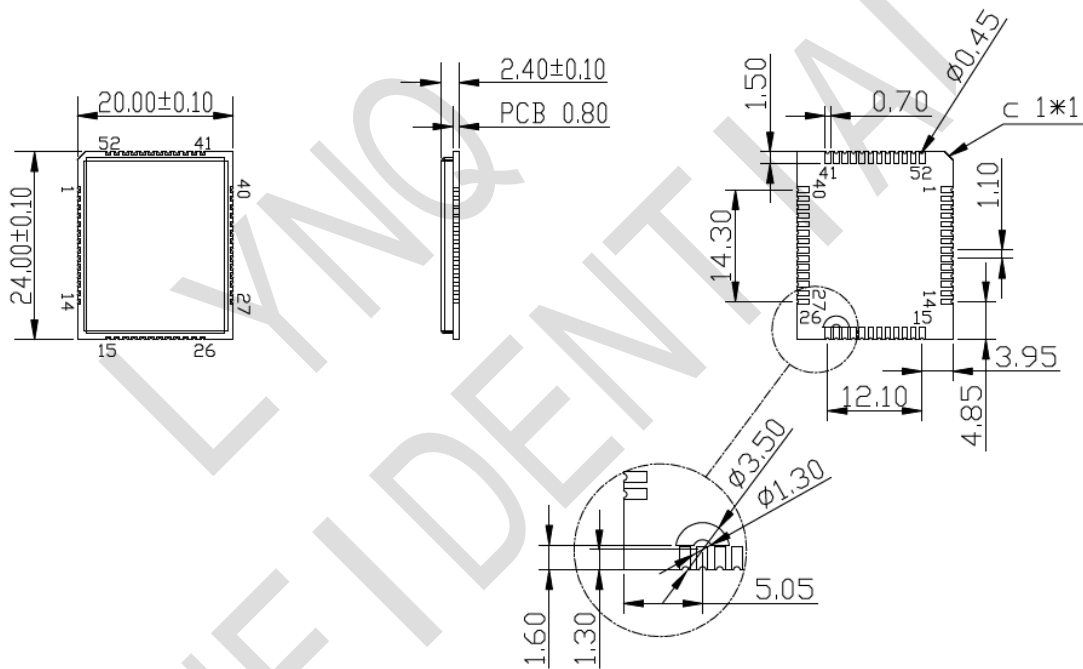


Figure 2-3 Module Size (Unit: mm)

2.3.4 Recommend Pad

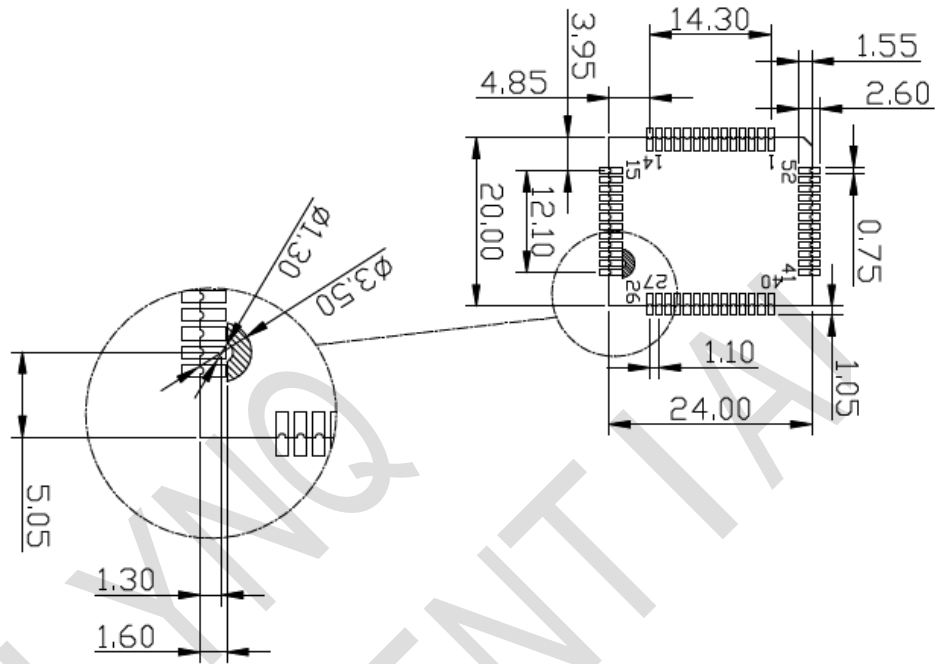


Figure 2-4 Recommend pad(Top view, Unit: mm)

3. Interface Circuit Design

3.1 Power Section

3.1.1 Power Supply interface

VCC is the main power supply of the module, and the input voltage range is 3.4V to 4.2V. The recommended voltage is 3.8V. Because the module transmit burst may cause voltage drops, the highest peak will reach 2.0A of 2G mode. In NB-IoT mode, the module transient peak current may reach 400mA. In 2G mode, the peak current of power supply capacity should be above 2.0A and the average current should be above 1A. A large capacitor voltage is recommended to be used near VCC 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 470uF or larger. During layout, the capacitors are close to the VCC pins.

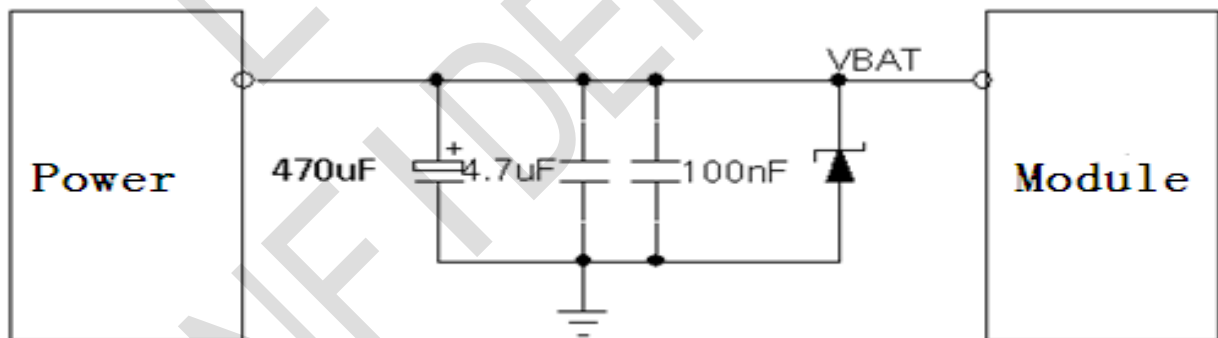


Figure 3-1 Power Supply circuit

Notes: When using 2G mode, please select capacitor as large value as possible; and add 100pF, 33pF capacitors if requiring.

Add Zener close to our module. The Zener should be 5.1V/500mW, $I_r < 100\mu\text{A}$ @ $V_r = 4.2\text{V}$. $T_a = 25^\circ\text{C}$.

3.1.2 Hardware Power On/Off

Module 40-pin is the Power on/off key. Pulling down the POWER_ON at least 460ms~1s and then releasing, the module will boot. There is internally pulled-up resistor.

Module 40-pin can also be used for hardware shutdown. When this pin has been pulled down over 6~8 seconds, the module will shutdown.

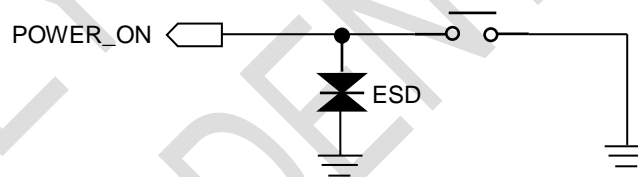


Figure 3-2 Turn on circuit

3.1.3 Hardware reset

Module 38-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 V_{RTC} , and does not need to pull up externally.

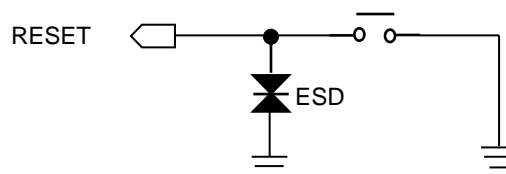


Figure 3-3 System Reset

3.1.4 WAKEUP_IN

Module 39-pin is the WAKEUP_IN input. The module will exit the PSM mode when it receives a 160ms low level signal.

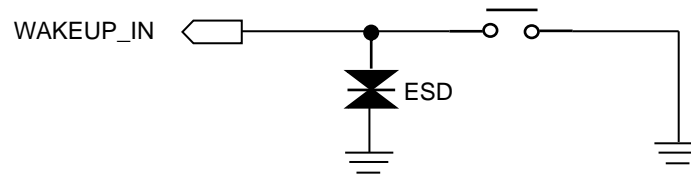


Figure 3-4 WAKEUP_IN circuit

3.2 SIM Interface

3.2.1 Pin Description

L651 supports and is able to automatically detect 3.0V and 1.8V SIM card. SIM card interface signal is shown in table 3-1.

Table 3-1 SIM Pin Description

Pin NO.	Pin Name	Signal definition	Function Description
9	USIM_VDD	VSIM output voltage	VSIM card power supply, output by the module
10	USIM_RESET	SIM card reset pin	SIM card reset signal, output by the module
11	USIM_DATA	SIM card data pin	SIM card DATA signal, I/O signal
12	USIM_CLK	SIM card clock pin	SIM card clock signal, output by the module
13	USIM_GND	Ground	Ground
14	USIM_DETECT	SIM detect pin	SIM detect pin, input signal

3.2.2 SIM application

Please note to increase the ESD components on SIM card signal group (PIN number: 9, 10, 11, 12,

13), 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. SIM_SCLK and SIM_SIO signals are recommended to be protected. Paralleling a 1uF capacitor between GND and VSIM, that can filter out the interference of radio frequency signals.

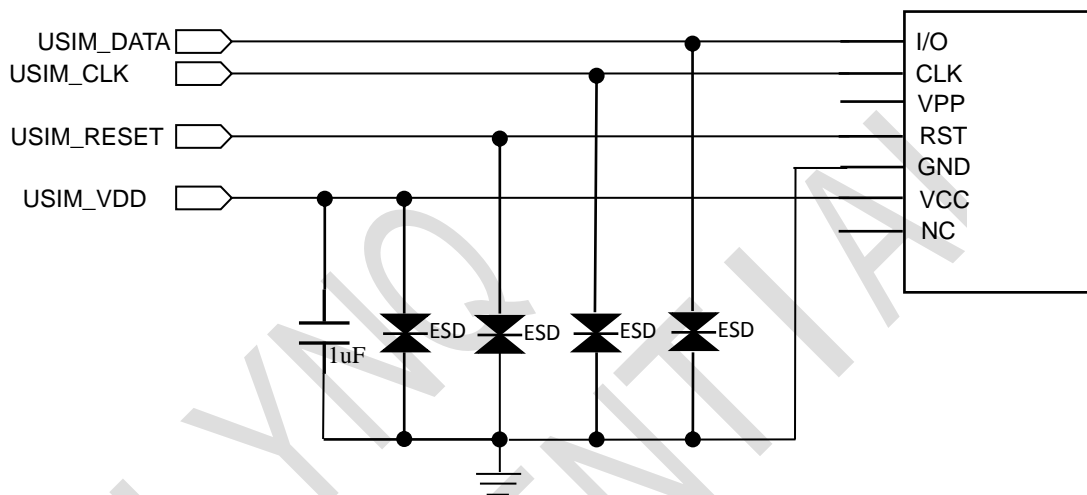


Figure 3-5 SIM Circuit

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

3.2.3 eSIM

The eSIM card is reserved inside the module. The eSIM card and external SIM card can only be selected one by one.

3.3 IIC Interface

L651 module can support a group of IIC interface. You can connect peripherals that need to

communicate using the IIC interface.

3.4 UART Interface

3.4.1 Pin Description

L651 module provides three serial communication interface UART: HST_UART is the download and debug port of L651 module, and the default baud rate is 921600 bps. For grabbing logs in the process of software debug, we suggest that users retain this interface and reserve test points when designing. UART1 can be used as the port for serial communication and AT command, and the default port baud rate is up to 57600 bps. UART2 is the open port for customers to choose independently.

The pin signal is defined as shown in table 3-1.

Table 3-2 UART Pin Description

Pin NO.	Pin Name	I/O	Function Description
1	UART2_TXD	DO	UART2 transmit data output
2	UART2_RXD	DI	UART2 receive data input
3	UART2_CTS	DO	UART2 Clear to Send
4	UART2_RTS	DI	UART2 require to send
43	UART1_TXD	DO	UART1 transmit data output
44	UART1_RXD	DI	UART1 receive data input
47	HST_RXD	DI	Download/debug UART receive data input
48	HST_TXD	DO	Download/debug UART transmit data output

3.4.2 UART application

If used UART in communication between the module and application processor, and the level is 2.8V, the connection mode is shown in Figure 3-6. You can use 4 wires or 2 wires mode connection.

Module interface level is 2.8V. If the AP interface level does not match, you must increase the level conversion circuit.

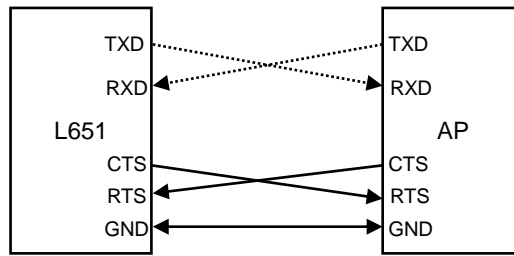


Figure 3-6 Connect to AP method(4lines)

3.5 LED Interface

SYS_STATE (PIN42) is used as the enable pin. Table 3-3 lists the LED status.

Table 3-3 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

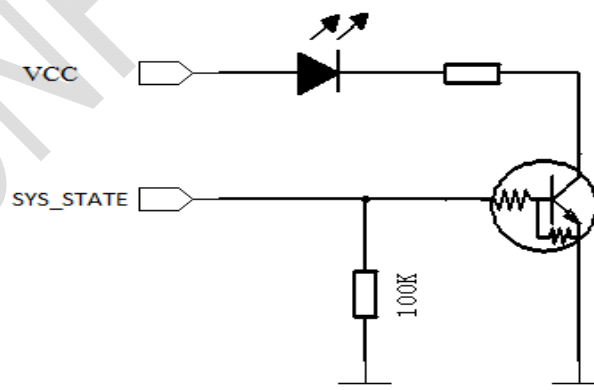


Figure 3-7 LED Circuit

3.6 ADC

The module provides an ADC for detecting light-sensitive resistors or other devices that require ADC detection. The Max voltage of ADC is 1.8V with 10-bit accuracy.

Table 3-4 ADC value

Parameter	Min.	Typ.	Max.	Unit
Input range	0.05		1.8	V

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4. Electrical characteristics

4.1 Electrical characteristic

Table 4-1 Electrical characteristic

Power	Min.	Nom.	Max	Unit
VCC	3.4	3.8	4.2	V
Peak current	-0.3	-	2	A

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

4.2 Temperature characteristic

Table 4-2 Temperature characteristic

State	Min.	Nom.	Max	Unit
Working	-40	+25	+85	°C
Storage	-45	+25	+90	°C

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 Absolute maximum power rating

PIN Name	Description	Min.	Typ.	Max.	Unit
VCC	Power supply			5	V

4.4 Recommended operating conditions

Table 4-4 Recommended operating range

PIN Name	Description	Min.	Typ.	Max.	Unit
VCC	Power supply	3.4	3.8	4.2	V

4.5 Power consumption

Table 4-5 Power Consumption

Mode	Parameter	Conditions	Min.	Average	Max.	Unit
NB-IoT	Power off mode	VCC=3.8V	-	7		uA
	PSM	VCC=3.8V	-	4		uA
	eDRX	VCC=3.8V, Value=20.48s,	-	810		uA

		PTW=5.12s, Paging cycle: 1.28s				
	DRX	VCC=3.8V, Paging cycle: 1.28s		1.31		mA
	Wake mode	VCC=3.8V		22		mA
	Band3	VCC=3.8V@TX: 22dBm		74	360	mA
	Band5	VCC=3.8V@TX: 21.9dBm		60	350	mA
	Band8	VCC=3.8V@TX: 22dBm		72	321	mA
	Band20	VCC=3.8V@TX: 22dBm		72	355	mA
	Band28	VCC=3.8V@TX: 22dBm		70	335	mA
GSM	Standby mode	VCC=3.8V		1.9		mA
	1D4U	VCC=3.8V		466	2000	mA
	3D2U	VCC=3.8V		312	2000	mA

Notes: The test value of power consumption is the value tested in laboratory condition. As shown in the above table, it is the current consumption data of L651C, and the current consumption data index of L651G are to be updated with subsequent versions.

4.6 Power Sequence

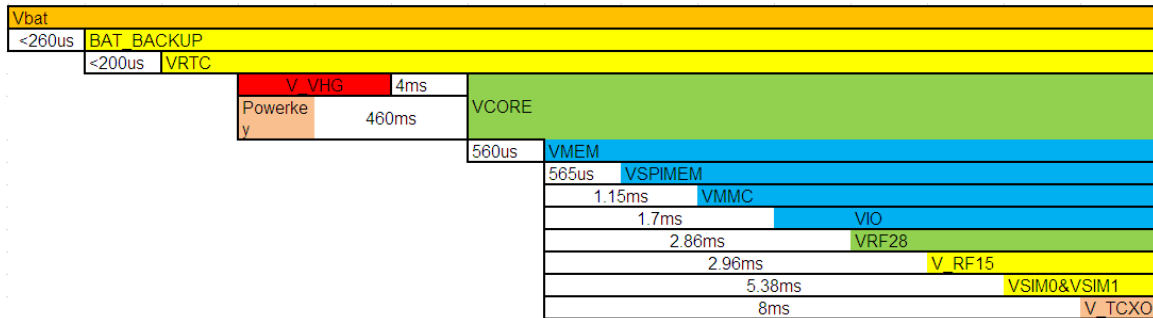


Figure 4-1 Power up time sequence diagram

4.7 Digital Interface Characteristics

Table 4-6 Digital IO Voltage

Parameter	Description	Min.	Typical	Max.	Unit
VIH	High level input voltage	2.6	2.8	3	V
VIL	Low level input voltage	0	-	0.7	V
VOH	High level output voltage	2.6	2.8	3	V
VOL	Low level output voltage	0	-	0.3	V

Notes: Suit to all GPIOs, IIC, UART interfaces. All the GPIOs of module are 2.8V.

4.8 ESD Protection

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 4-7 ESD Performance

PIN Name	Contact discharge	Air discharge
VCC	±4KV	±8KV
GND	±4KV	±8KV
RF_ANT	±4KV	±8KV
GNSS_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_ON and reset key) need to add ESD device. POWER_ON and reset key line 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 $C_{pr} < 0.5\text{pF}$.

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

The L651 module supports GSM and NB-IoT.

Table 5-1 GSM Frequency Band

Frequency	Uplink	Downlink
E-GSM900	880 MHz — 915 MHz	925 MHz — 960 MHz
DCS1800	1710 MHz — 1785 MHz	1805 MHz — 1880 MHz

Table 5-2 GSM Output Power

Frequency	Max output power	Min output power
E-GSM900	33dBm \pm 2dB	5dBm \pm 5dB
DCS1800	30dBm \pm 2dB	0dBm \pm 5dB

Table 5-3 GSM Receive Sensitivity

Frequency	Receive sensitivity
E-GSM900	-109dBm
DCS1800	-108dBm

Table 5-4 NB-IoT Frequency Band

Frequency	Uplink	Downlink
-----------	--------	----------

Band 3	1710 MHz—1785MHz	1805MHz —1880MHz
Band 5	824 MHz —849MHz	869MHz —894MHz
Band 8	880MHz —915MHz	925MHz —960MHz
Band20	832Mhz —862MHz	791MHz —821MHz
Band28	703MHz —748MHz	758MHz —803MHz

Table 5-5 NB-IoT Output Power

Frequency	Max output power	Min output power
Band 3	23dBm \pm 2dB	< -45dBm
Band 5	23dBm \pm 2dB	< -45dBm
Band 8	23dBm \pm 2dB	< -45dBm
Band 20	23dBm \pm 2dB	< -45dBm
Band 28	23dBm \pm 2dB	< -45dBm

Table 5-6 NB-IoT Receive Sensitivity

Frequency	200 KHz (CAT NB1) REF SENS (Total)	200 KHz(CAT NB1) REF SENS (EPRE @15KHz)	200 KHz(CAT NB1) NB-PDSCH repetitions (Total)	200 KHz(CAT NB1) NB-PDSCH repetitions (EPRE @15KHz)
Band3	-114.3dBm	-125.1dBm	TBD	TBD
Band5	-114.5dBm	-125.3dBm	TBD	TBD
Band8	-114.8dBm	-125.6dBm	TBD	TBD
Band20	-114.5dBm	-125.3dBm	TBD	TBD
Band28	-114.4dBm	-125.2dBm	TBD	TBD

Note: “TBD” means that in the subsequent update.

5.2 Data link

GSM:

L651 support GPRS CLASS12

DL: MAX 80Kbps

UL: MAX 80Kbps

NB-IoT:

Supports both single-tone and multi-tone transmission modes in uplink

Supports 200KHz bandwidth in downlink and uplink

UL: 15.6Kbps@15k ST 0dBm

UL: 32.8Kbps@15k MT 0dBm

UL: 4.68Kbps@3.75k 0dBm

DL: 20.2Kbps@MCL120

5.3 GSM/NB-IoT Antenna Circuit Design

The design of the peripheral circuit of the antenna interface is shown in the figure below. In order to better regulate the RF performance, it is recommended to reserve a matching circuit. The antenna connection reference circuit is shown below. C101 and C102 are not pasted by default, only 0 ohm R101 resistance is pasted, and 50 ohm is needed to control the wiring.

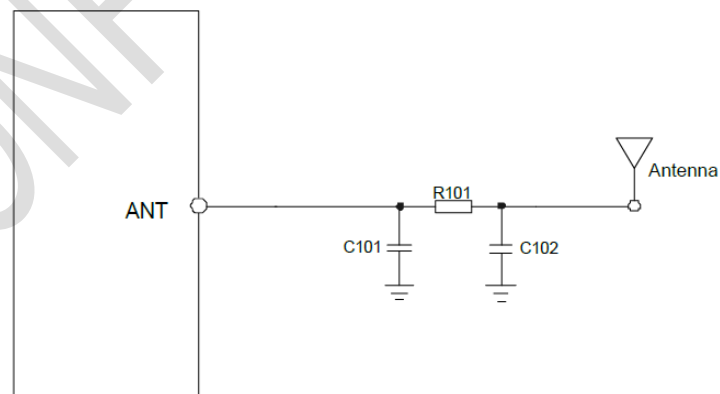


Figure 5-1 Main Antenna Design

Attention should be paid to component placement and RF routing:

- The antenna and matching circuit are placed close to the module pin;
- The RF line from the ANT pin of the module to the antenna must be controlled by 50 ohm impedance.
- To the antenna RF module ANT foot line must be far away from the high speed signal lines and strong interference sources, Avoid crossing or leveling any signal lines with adjacent layers Line.

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6. GNSS

6.1 GNSS Features

- Support GPS+Glonass/GPS+BD2
- 64 channel tracking at the same time, with built-in LNA
- NMEA maximum update rate 10Hz
- Type of Antenna: Active antenna / Passive antenna
- Position precision: 2.0m CEP

6.2 GNSS Performance

Table 6-1 GNSS Performance

Project	Describe	Performance			
		Min.	Typ.	Max.	Unit
Horizontal Position Accuracy ⁽¹⁾	Autonomous		TBD		m
Velocity Accuracy ⁽²⁾	Without Aid		TBD		m/s
	DGPS		TBD		m/s
Acceleration Accuracy	Without Aid		TBD		m/s ²
	DGPS		TBD		m/s ²
Timing Accuracy			TBD		ns
Dynamic Performance	Maximum Altitude			TBD	m
	Maximum Velocity			TBD	m/s
	Maximum Acceleration			TBD	G
GPS Time To First Fix ⁽³⁾	Hot start		TBD		s
	Warm start		TBD		s

	Cold start		TBD		s
BD2 Time To First Fix ⁽³⁾	Hot start		TBD		s
	Warm start		TBD		s
	Cold start		TBD		s
GPS Sensitivity ⁽³⁾	Autonomous acquisition(cold start)		TBD		dBm
	Re-acquisition		TBD		dBm
	Tracking		TBD		dBm
BD2 Sensitivity ⁽³⁾	Autonomous acquisition(cold start)		TBD		dBm
	Re-acquisition		TBD		dBm
	Tracking		TBD		dBm
Receiver	Channels		TBD		
	Update rate		TBD	TBD	Hz
	Tracking L1, CA Code				
	Protocol support NMEA,PMTK				
GPS Power consumption ⁽⁴⁾	Acquisition		TBD		mA
	Continuous tracking		TBD		mA
	Sleep current		TBD		uA
	Backup current		TBD		uA
BD2 Power consumption ⁽⁴⁾	Acquisition		TBD		mA
	Continuous tracking		TBD		mA
	Sleep current		TBD		uA
	Backup current		TBD		uA
GPS+BD2 Power consumption ⁽⁴⁾	Acquisition		TBD		mA
	Continuous tracking		TBD		mA
	Sleep current		TBD		uA
	Backup current		TBD		uA

GPS+GLONASS Power consumption ⁽⁴⁾	Acquisition		TBD		mA
	Continuous tracking		TBD		mA
	Sleep current		TBD		uA
	Backup current		TBD		uA

- (1) 50% 24hr static, -130dBm
- (2) 50% at 30m/s
- (3) GNSS signal level: -130dBm
- (4) Single Power supply 1.8V@-130dBm

6.3 Antenna selection

Table 6-2 Antenna selection

TYPE	Specifications	
Passive Antenna	Frequency Range	TBD
	Polarization mode	TBD
	Gain	TBD
Active Antenna	Frequency Range	TBD
	Polarization mode	TBD
	Noise Factor	TBD
	Gain	TBD

7. Storage and Production

7.1 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 7-1 Humidity level

Rank	Factory Environment \cong +30°C /60%RH
1	No controlled < 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.

7.2 Production

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

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.

7.2.1 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 7-2 Baking conditions

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

Notes: The original packaging of the module cannot bear the high temperature of baking. The packaging needs to be removed before baking, otherwise the packaging will be damaged.

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.

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.

7.2.2 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 reflow 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) 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.

7.2.3 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.

7.2.4 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.

- 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.

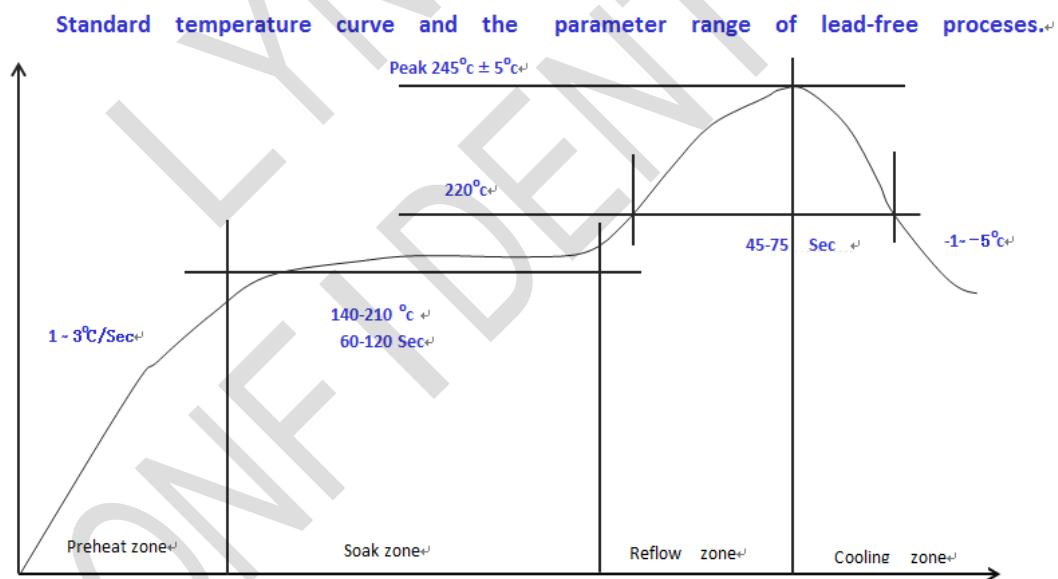


Figure 7-1 Temperature Curve

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.

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8. 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.