Lierda L-BTMSB97-G3PC4-01 Module Hardware Design Manual

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Revision History of the Document

Document version	Change Date	Reviser	Reviewer	Change content
Rev1.0	25-06-20	CJH	LSS	Initial Version

Safety Instructions

Users are responsible for complying with relevant regulations and specific environmental laws regarding wireless communication modules and devices in other countries. By following the following safety principles, personal safety can be ensured and help protect products and work environments from potential damage. Our company is not responsible for any losses resulting from customers' failure to comply with these regulations.

	Safety first on the road! Please do not use handheld mobile devices while driving, unless they have hands-free capabilities. Please pull over before making a phone call!
	Please turn off your mobile devices before boarding. The wireless function of mobile devices is prohibited from being turned on in the aircraft to prevent interference with the aircraft communication system. Ignoring this prompt may endanger flight safety or even violate the law.
	When in a hospital or healthcare facility, pay attention to any restrictions on the use of mobile terminal devices. RF interference can cause medical equipment to malfunction, so it may be necessary to turn off mobile terminal devices.
	Mobile terminal devices do not guarantee effective connection in all situations, such as when there is no phone credit or the SIM card is invalid. When you encounter the above situations in an emergency, remember to use emergency calls, and make sure your device is turned on and in an area with sufficient signal strength.
	Your mobile terminal device will receive and emit radio frequency signals when starting up, which may cause radio frequency interference when near a TV, radio, computer, or other electronic devices.
	Please keep mobile terminal devices away from flammable gases. When you are near gas stations, oil depots, chemical plants, or explosive operation sites, please turn off the mobile terminal devices. Operating electronic devices in any potentially explosive environment poses a safety hazard.

Module selection for application

Serial number	Module Model	Support frequency band	Dimensions (mm)	Module introduction
1	L-BTMSB97-G3PC4-01	2.4 GHz ISM Band	9.8×14.4×2.75	Transmitting firmware/ceramic antenna from the machine

Content

1 Introduction

L-BTMSB97-G3PC4-01 Bluetooth module is a high-performance and high-temperature resistant Bluetooth module developed based on low-power Bluetooth chips. The module adopts a metalized semi-hole package and an onboard ceramic antenna design. The product also features low power consumption, small size, rich resources, and strong anti-interference capability.

Figure 1.1 Module Schematic

2 Product Overview

2.1 Key Features

Parameters	Explanation
Wireless standard	BLE 5.2
Frequency range	2400~2483.5MHz(2.4GHz ISM Band)
Antenna	Ceramic antenna
Dimensions	9.8mm × 14.4mm × 2.75 mm
Operating voltage	1.7V to 3.6V, typical value 3.3V
Launch current	6mA@0dBm,Typ
Receive current	5.8mA@1M,Typ
Hibernate current	0.3uA，Typ
Transmit power	-40 ~ +8dBm
Operating temperature	-40 ~ +105℃
Storage temperature	-40 ~ +125℃
Communication interface	UART
Internal storage	256kB Flash +32kB RAM

2.2 Application Scenarios

- 2.4GHz low power Bluetooth system;
- PCs, tablets, smartphones, handheld devices, and other low-power peripheral devices (HID, remote controls, etc.);
- Sports, medical care and other consumer electronics products;
- Smart meters, data collection, and other wireless sensor networks;
- Photovoltaic, charging piles, industrial instruments, and other industries;
- Smart home, LAN, interactive devices, beacon lights.

2.3 Function block diagram

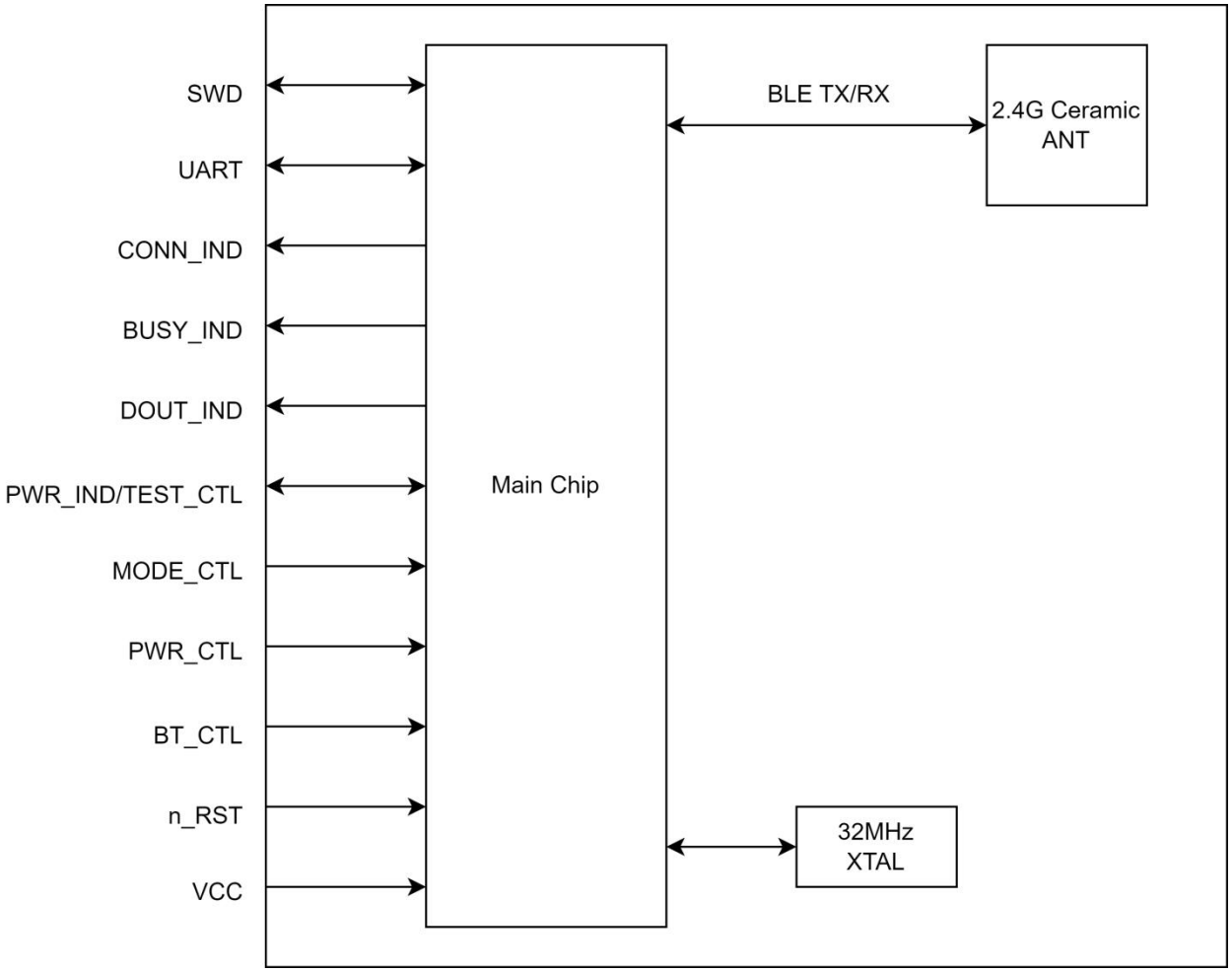


Figure 2.1 Functional Block Diagram

Note

◆ The antenna design of this model module is in the form of a ceramic antenna.

2.4 Pinout diagram

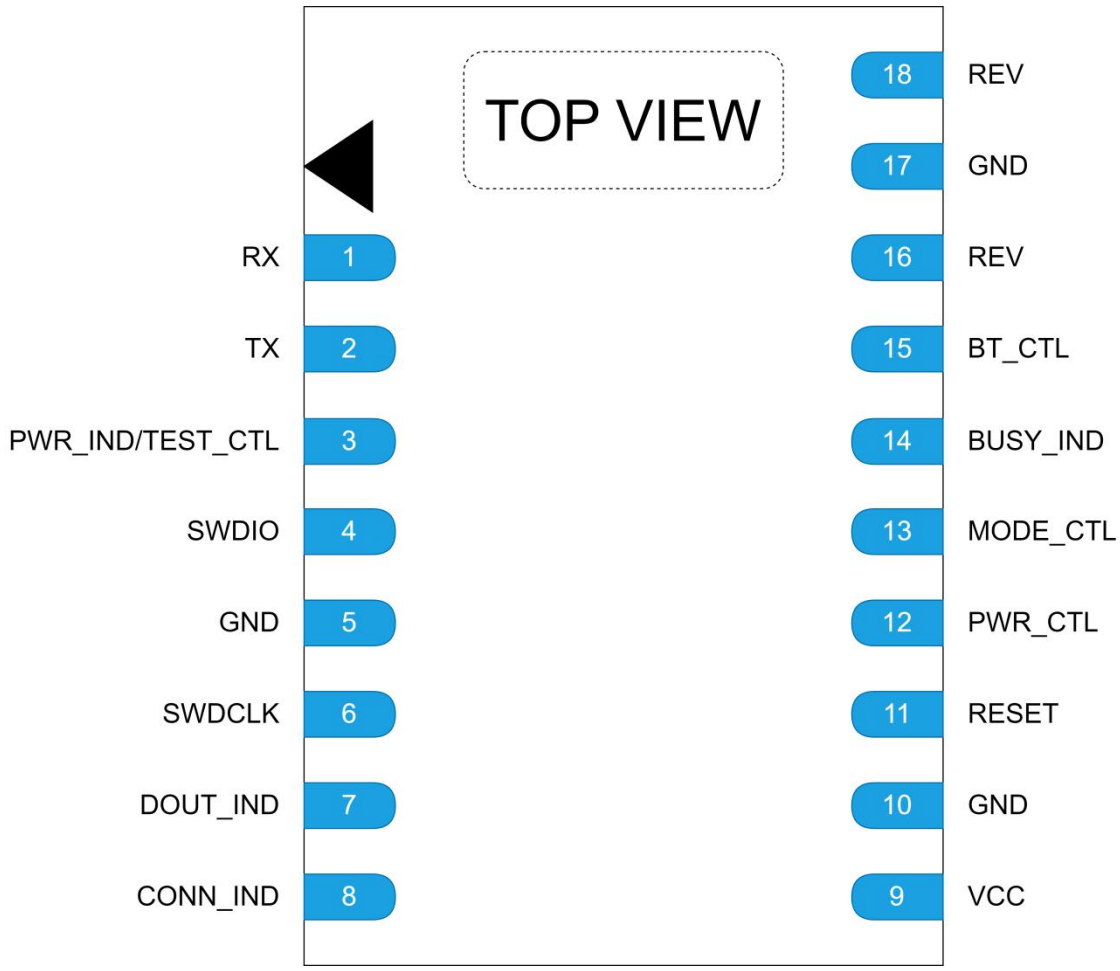


Figure 2.2 Pinout Diagram

2.5 Pin Description Table

Pins	Pin definition	I/O Type	Voltage	Function Description
1	RX	DI	VCC	Serial data input pin
2	TX	DO	VCC	Serial data output pin
3	PWR_IND/TEST_CTL	DI/O	VCC	**Hibernate command pin** High level: The module is in sleep mode, cannot receive serial data at this time Low level: The module is in the keep awake state and can receive serial data at this time. **Test control pin (effective only when powered on)** Set high: User mode Set to: Test mode, user disabled Note: This pin can be left floating or pulled high within 1s after power-up, and must not be pulled low.
4	SWDIO	DI/O	VCC	SWD data signal
5	GND	G	-	GND
6	SWDCLK	DI	VCC	SWD clock signal
7	DOUT_IND	DO	VCC	**Serial data indicator pin** High level: Indicates that the module has no data to send to the MCU at this time. Low level: Indicates that the module is about to or is sending data to the MCU.
8	CONN_IND	DO	VCC	**Connect the status indicator pin.** High level: Indicates that the module is in a disconnected state. Low level: Indicates that the module is in a connected state.
9	VCC	P	1.7 - 3.6V	Main power input
10	GND	G	-	GND

11	RESET	DI	VCC	**Module reset pin** High level: Module is running normally Low level: Module remains in reset. Note: This pin is internally configured with a pull-up resistor and can be left floating when not in use.
12	PWR_CTL	DI	VCC	**Hibernate control pin (cannot be left floating)** Set height: allow the module to enter sleep mode Set to low: wake up the module and do not allow the module to enter sleep mode.
13	MODE_CTL	DI	VCC	**Mode control pin (must not be left floating)** Set: Enter and maintain transparent mode. Set low: enter and maintain command mode.
14	BUSY_IND	DO	VCC	**Data congestion indication pin** (Under transparent transmission mode, it is meaningful, meaningless under command mode) High level: Indicates that the MCU can continue to write up to 200 bytes of data to the module. Low level: Indicates that the MCU should not continue to write data to the module (risk of packet loss)
15	BT_CTL	DI	VCC	**Bluetooth control pin (cannot be left floating)** Set high: turn off Bluetooth, stop broadcasting, or disconnect. Set low: Start Bluetooth broadcasting so that it can be discovered by the host (phone).
16	REV	-	-	Reserved, suspended

17	GND	G	-	GND
18	REV	-	-	Reserved, suspended

“P”:POWER “DI”:INPUT “DO”:OUTPUT “G”:GND

3 Characteristics of work

3.1 Power supply design

3.1.1 Power interface

The VCC pin is used to connect an external power supply, the interface is described in the following table:

Table 3-1 Power Supply Pin Definitions

Pin number	Pin definition	Description	Minimum value V	Typical value V	Maximum value V
9	VCC	Module power	1.7	3.3	3.6

The module operates at a power supply range of 1.7 to 3.6V, ensuring that the voltage does not drop below 1.7V during operation.

3.1.2 Power supply design

L-BTMSB97-G3PC4-01 module power pin recommended using 10uF and 0.1uF decoupling capacitors. The capacitors should be placed as close as possible to the VCC power pin. The power supply voltage range is required to be 1.7~3.6V, typically powered by 3.3V. It is recommended to control the power ripple within 1% of the VCC amplitude to avoid performance degradation due to excessive ripple.

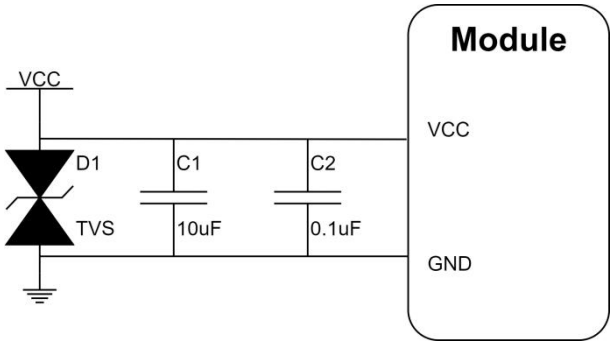


Figure 3.1 Power Supply Recommended Circuit

Note

◆ D1 is used for electrostatic protection. Users need to pay attention to the electrostatic requirements of the product during design, see Table 6-1 for product absolute maximum ratings. If higher protection requirements are needed, it is recommended to externally place TVS diodes for electrostatic protection.

3.2 Reset Interface

Table 3-2 Reset Pin Definition

Pin number	Pin Definition	Function description
11	RESET	Reset pin, low level active

3.2.1 Reset reference design

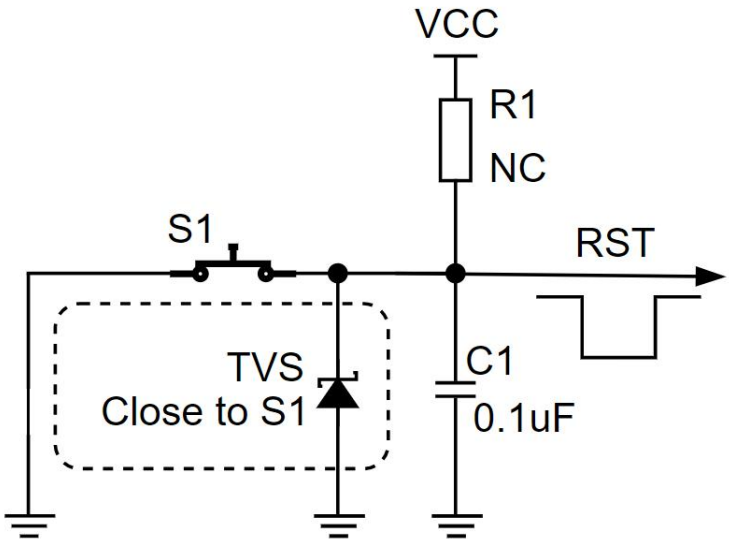


Figure 3.2 Reset Reference Circuit

Note

◆ The reset line should not be too long, pay attention to proper grounding protection, and keep away from RF, VCC power sources, and strong signal interference sources.

◆ It is recommended to reserve a 10K pull-up resistor on the RESET pin of the module by default without soldering it.

◆ The pin is internally configured with a pull-up resistor and can be left floating if not used.

4 Application Interface

The L-BTMSB97-G3PC4-01 module provides the following application interfaces:

- ◆ 4th route control signal interface
- ◆ 4-channel status indicator interface
- ◆ 1-Wire SWD burning interface
- ◆ UART Serial Port 1

4.1 Control signal

Table 4-1 Definition of Control Signal Pins

Serial number	Pin Definition	Direction	Function Description
15	BT_CTL	DI	Bluetooth control pin (not floating)
13	MODE_CTL	DI	Mode control pin (must not float)
12	PWR_CTL	DI	Hibernate control pin (must not be left floating)
3	TEST_CTL	DI	Test control pin (only effective when powered on)

4.1.1 Bluetooth control pin BT_CTL

Table 4-2 Bluetooth Control Pin Definitions

Serial number	Voltage logic	Status indicator
15	0	Start Bluetooth broadcast to make it discoverable by the host (phone).
	1	Turn off Bluetooth, stop broadcasting, or disconnect.

4.1.2 Mode control pin MODE_CTL

Table 4-3 Definition of Mode Control Pins

Serial number	Voltage level logic	Status indicator
13	0	Enter and maintain command mode
	1	Enter and maintain transparent mode.

4.1.3 Hibernate control pin PWR_CTL

Table 4-4 Definition of Sleep Control Pins

Serial number	Voltage logic	Status indicator
12	0	Wake up the module and do not allow the module to enter sleep mode
	1	Allow the module to enter sleep mode.

Note

◆ Do not allow rapid switching of this pin level, the level switch must be confirmed by the PWR_IND pin level.

4.1.4 Test control pin TEST_CTL

Table 4-5 Test Control Pin Definitions

Serial number	Voltage level logic	Status indicator
3	0	Test mode, user disabled
	1	User Mode

Note

◆ The pin can be left floating or pulled high within 1s after power-on, and must not be pulled low.

4.2 Status indicator signal

Table 4-6 Definition of Status Indicator Signal Pins

Serial number	Pin definition	Direction	Function Description
8	CONN_IND	DO	Connect the status indicator pin.
7	DOUT_IND	DO	Serial data indicator pin
14	BUSY_IND	DO	Data congestion indication pin

3	PWR_IND	DO	Hibernate command pin

4.2.1 Connect the status indicator pin CONN_IND.

Table 4-7 Connection of Status Indicator Pin Definitions

Serial number	Voltage logic	Status indicator
8	0	The module is in a connected state.
	1	The module is in a disconnected state.

4.2.2 Serial data indication pin DOUT_IND

Table 4-8 Serial Data Indicator Pin Definitions

Serial number	Level logic	Status indicator
7	0	The module is about to or is currently sending data to the MCU.
	1	The module has no data to send to the MCU at this time.

4.2.3 Data congestion indication pin BUSY_IND

Table 4-9 Data Congestion Indication Pin Definition

Serial number	Voltage level logic	Status indicator
14	0	MCU is instructed not to continue writing data to the module, otherwise there is a risk of packet loss.
	1	Instruct MCU to continue writing up to 200 bytes of data to the module.

Note

◆ Data congestion indication pin is only meaningful in transparent mode, not meaningful in command mode.

4.2.4 Hibernate command pin PWR_IND

Table 4-10 Definition of Sleep Indicator Pin

Serial number	Voltage level logic	Status indicator
3	0	The module is in a keep-awake state (able to receive serial data).
	1	The module is in sleep mode (unable to receive serial port data).

4.3 UART communication

L-BTMSB97-G3PC4-01 module provides 1 UART communication interface for command communication and data transmission, with a default baud rate of 9600bps, configurable up to a maximum baud rate of 921600bps.

In command mode, the main control MCU operates the module through the serial port. The main control MCU sends commands to the module, the module receives and executes the commands, and then returns the results of the command execution to the MCU via the serial port.

Table 4-11 Serial Port Pin Definitions

Pin number	Pin Definition	Function Description
1	RX	Serial data input pin
2	TX	Serial data output pin

Serial port characteristics:

◆ Used for command communication and data transmission, default baud rate is 9600bps;

◆ Support modifying the serial port baud rate (up to 921600bps) and allow setting the serial port output delay.

The schematic diagram of the main serial port connection is as follows:

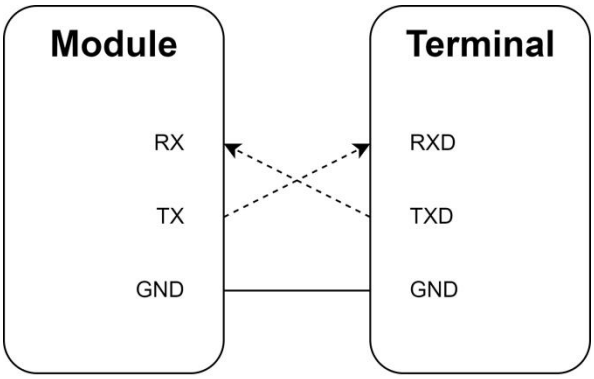


Figure 4.1 Schematic diagram of the main serial port connection

4.4 SWD burning interface

Table 4-12 SWS Pin Definitions

Serial number	Pin definition	Function Description
4	SWDIO	SWD data signal
6	SWDCLK	SWD clock signal

The module can be directly connected to the SWD interface for debugging and firmware flashing using Jlink.

5 Radio frequency characteristics

The module has an on-board ceramic antenna.

5.1 Radio frequency performance

The module supports BLE mode.

Table 5-1 BLE Performance Parameters

Performance	Description
Bluetooth standard	BLE5.2
Frequency range	2.4GHz ~ 2.4835GHz
Physical Layer	LE 1M/2M PHY
Channel	LE：Ch0 ~ Ch39
Modulation method	GFSK
Transmit power	-40dBm ~ 8dBm
Sensitivity @ PER=30.8% for LE(1Mbps)	-95dBm

Note

◆ Test conditions for Table 5-1: Temperature 25° C, Power supply voltage 3.3V.

5.2 On-board antenna application instructions

There should be a large clearance area around the antenna. Clearance refers to the open area in the vertical projection area of the antenna (considering both upper and lower ranges). Within the projected area of the antenna, whether it is patch or through-hole mounting, do not place a ground plane (especially for on-board antennas), no metal components should be present, maintain clearance for the antenna to improve antenna radiation efficiency. The RF part of the module should be avoided from being enclosed by metal shields as much as possible, and the distance between the RF part and interference sources should be at least 10mm (the larger the better if conditions permit). Common

sources of interference include: batteries (including battery connectors), capacitors, inductors, buttons, oscillators, power lines, screws or nuts containing metal, CPUs, LCDs, transformers, speakers, cameras, ribbon cables for internal communication interfaces, power circuits, motors, etc.

Layout requirements for the PCB:

The antenna of the module should be placed at the edge of the PCB of the entire bottom board, with a distance of 10mm around the antenna, and no copper, traces, or components should be placed around the antenna on all layers. If there are multiple antennas, the distance between antennas should be as far apart as possible to avoid interference at the same frequency and intermodulation interference. If the antenna is recommended to be attached to the bottom board, the area around the antenna should be hollowed out. The recommended size of the copper area in the yellow area in the figure below is 4cm×4cm or more.

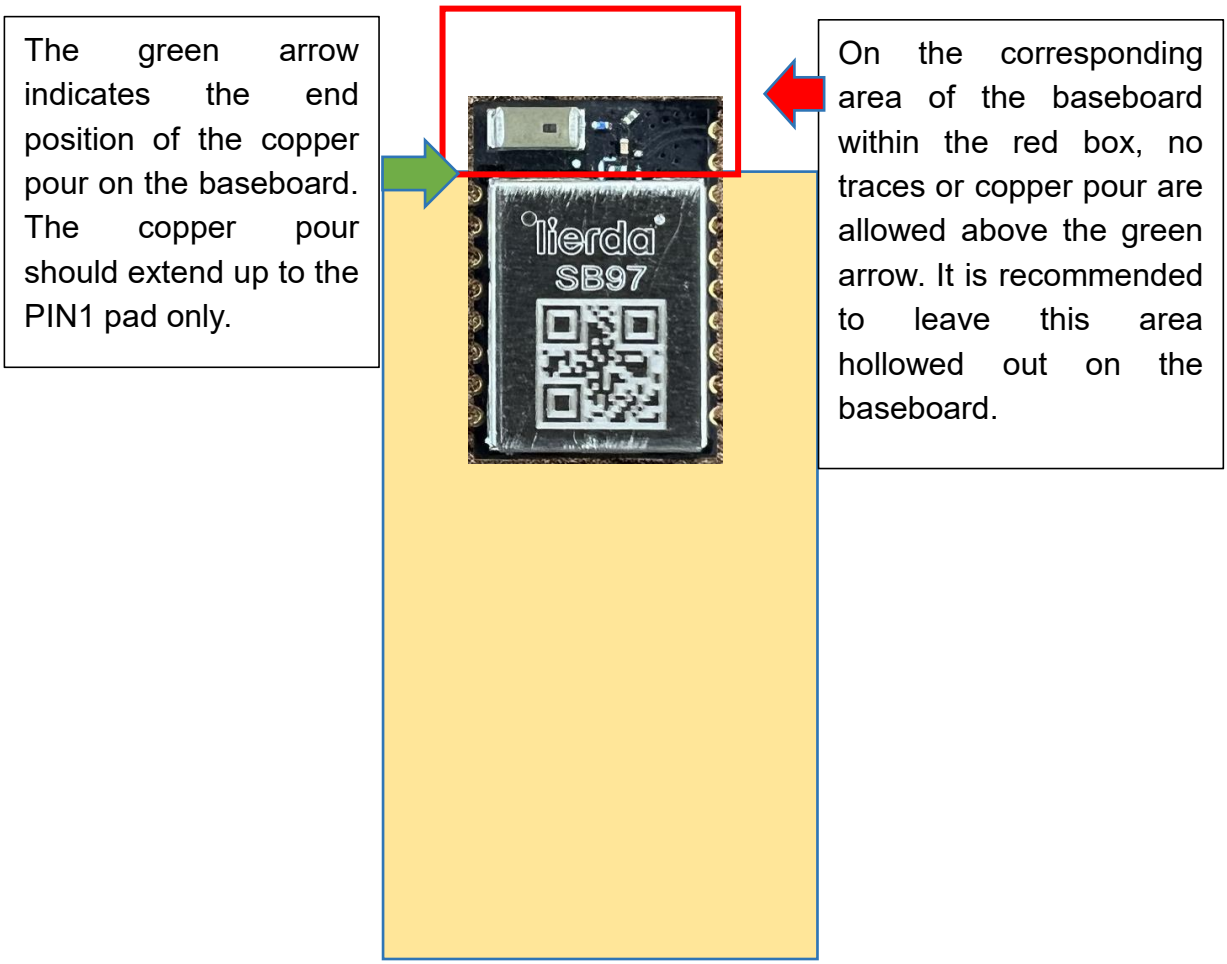


Figure 5.1 Module Placement Suggestion

Test points and interface solder pad description on the bottom layer of the module:

RF performance testing solder pads have windowed areas (exposed copper), and no vias or exposed copper can be placed in the positions mapped by the bottom plate. Test points should be covered with white oil to prevent short circuits. It is recommended that the routing or exposed copper of the bottom plate avoid the red boxed area in the figure below.

There are two exposed copper test point pads in the upper area of the module's BOTTOM layer. On the corresponding area of the baseboard, it is best to avoid routing traces or exposing copper. If routing is necessary, it is recommended to apply solder mask (white oil block) over the traces.

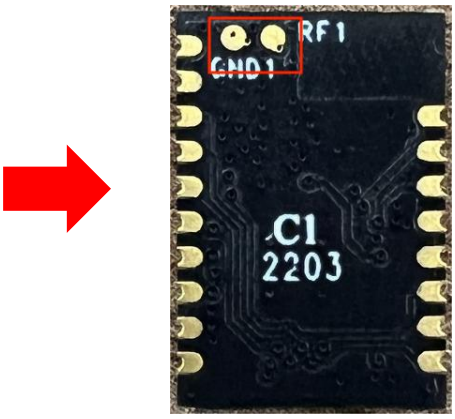


Figure 5.2 Position of test point solder pads on the module bottom

Layout requirements for the motherboard:

The BOTTOM layer of the module does not have high-speed signals or sensitive signal traces, but it is still recommended to route the traces on the TOP layer of the baseboard away from the module to avoid unexpected influencing factors.

There is no need for excessive hollowing out in the bottom plate design, except for the general requirement mentioned earlier to avoid interference sources, the bottom plate can be almost fully covered with copper.

6 Electrical performance and reliability

6.1 Absolute maximum rating

Table 6-1 Product Limit Parameters

Main Parameters	Performance		Note
	Minimum value	Maximum value	
Voltage (V)	1.7	3.9	-
IO voltage (V)	-0.3	VCC+0.3	Not exceeding 3.9V.
Storage temperature (℃)	-40	125	-
Operating temperature (℃)	-40	105	-

Note

Exceeding the absolute maximum ratings may cause permanent damage to the device.

6.2 DC characteristics

Table 6-2 Module Operating Parameters

Main Parameters	Performance			Note
	Minimum value	Typical value	Maximum value	
Operating voltage (mA)	1.7	3.3	3.6	Ripple requirement: peak-to-peak value less than 30mV
Launch current (mA)	/	6	/	@1Mbps,0dbm
Received current (mA)	/	5.8	/	@1Mbps
Standby Current (μA)	/	0.3	/	System off

Note

The data in Table 6-2 is tested under normal temperature at 25℃ with 3.3V power supply conditions.

6.3 Power consumption in work

Table 6-3 Module Power Consumption Parameters

Work mode	Time interval (ms)	Power consumption data (uA)
Broadcast power consumption @1M, 0dBm, broadcast bytes: 7	100	74.16
	200	38.25
	500	16.71
	1000	9.53
	2000	5.94
	5000	3.78
Broadcast power consumption @1M, 0dBm, broadcast bytes: 15	100	81.08
	200	41.71
	500	18.09
	1000	10.22
	2000	6.28
	5000	3.92
Broadcast power consumption @1M, 0dBm, broadcast bytes: 25	100	94.51
	200	48.43
	500	20.78
	1000	11.56
	2000	6.95
	5000	4.19
Power consumption of the connection @1M，0dBm	20	201.08
	50	81.84
	100	42.09

	200	22.22
	500	10.30
	1000	6.32

Note

◆ The data in Table 6-3 are test data under the conditions of room temperature 25° C, 3.3V power supply, and in the sleep state with broadcast enabled (PWR_CTL=1, BT_CTL=0);

◆ Broadcast power consumption is the pure broadcast power consumption. In actual use, scan packets will be generated, and the power consumption will be greater than the typical value here.

◆ The connection power consumption is for handshake packet power consumption, without actual user data. If user data is included, the power consumption will be higher than this typical value.

7 Mechanical dimensions

Dimensions	9.8 mm × 14.4 mm × 2.75 mm

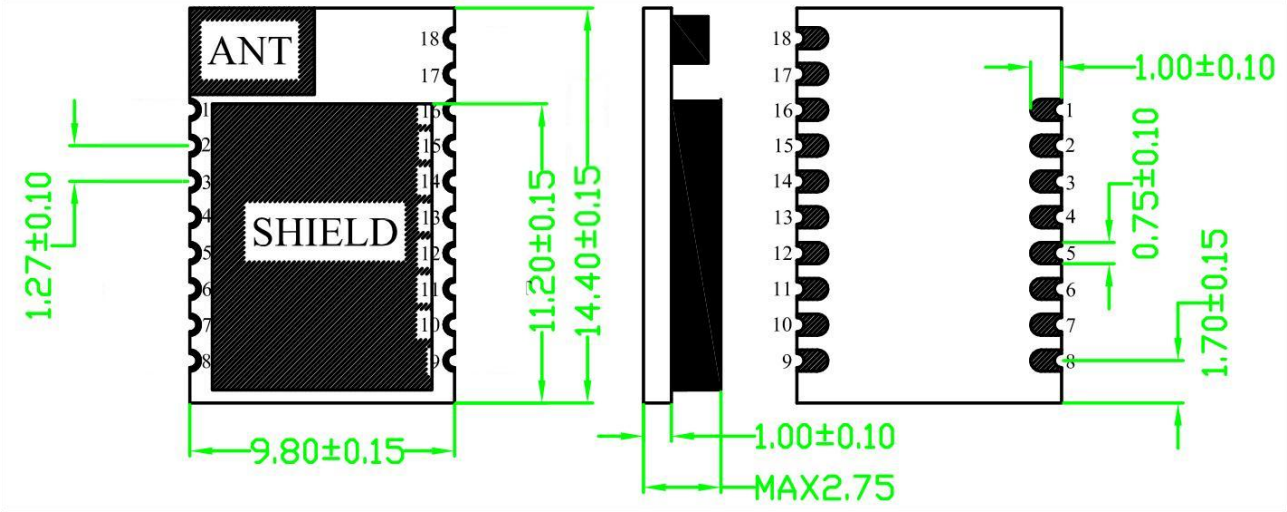


Figure 7.1 Module Outline Dimension Diagram

Note

There is a rib connection cutting tolerance in the length direction of the module, and the module length ranges from 14.2mm to 14.8mm.

8 Production and packaging information

8.1 Manufacturing welding

8.1.1 Production Guide

It is recommended to use SMT machine for the stamp mouth sealing module assembly, and the SMT assembly should be completed within 24 hours after unpacking. Otherwise, vacuum packaging needs to be re-done to avoid moisture affecting the quality of the assembly.

If there is a humidity indicator card inside the package, it is recommended to determine whether the module needs to be baked based on the indication of the humidity card. The conditions for baking are as follows:

Baking temperature: 125℃±5℃;

The alarm temperature is set to 130°C.

After cooling to below 36°C under natural conditions, SMT mounting can be carried out.

If the unpacking time exceeds 3 months, special attention needs to be paid to whether the product has been damp, because of the PCB immersion gold process, which may cause oxidation of the solder joints after more than 3 months, leading to problems such as false soldering and missed soldering during patching.

To ensure the qualified rate of reflow soldering, it is recommended to randomly select 10% of the products for visual inspection and AOI inspection during the first component placement, to ensure the rationality of furnace temperature control, component adhesion method, and placement method.

Operators at each workstation throughout the production process must wear anti-static gloves.

8.1.2 Module placement requirements on the motherboard

It is suggested that the green oil thickness at the bottom plate module position be less than 0.02mm to avoid excessive thickness, which may prevent the spacer module from effectively contacting the solder paste and affecting the welding quality. In addition, it is necessary to ensure that no other components are arranged within 2mm around the interface board module position to facilitate module maintenance.

8.1.3 Steel mesh opening design

The selection principle of the thickness of the steel mesh on the base plate is generally based on the comprehensive consideration of the packaging type of the components inside the board, focusing on the following requirements:

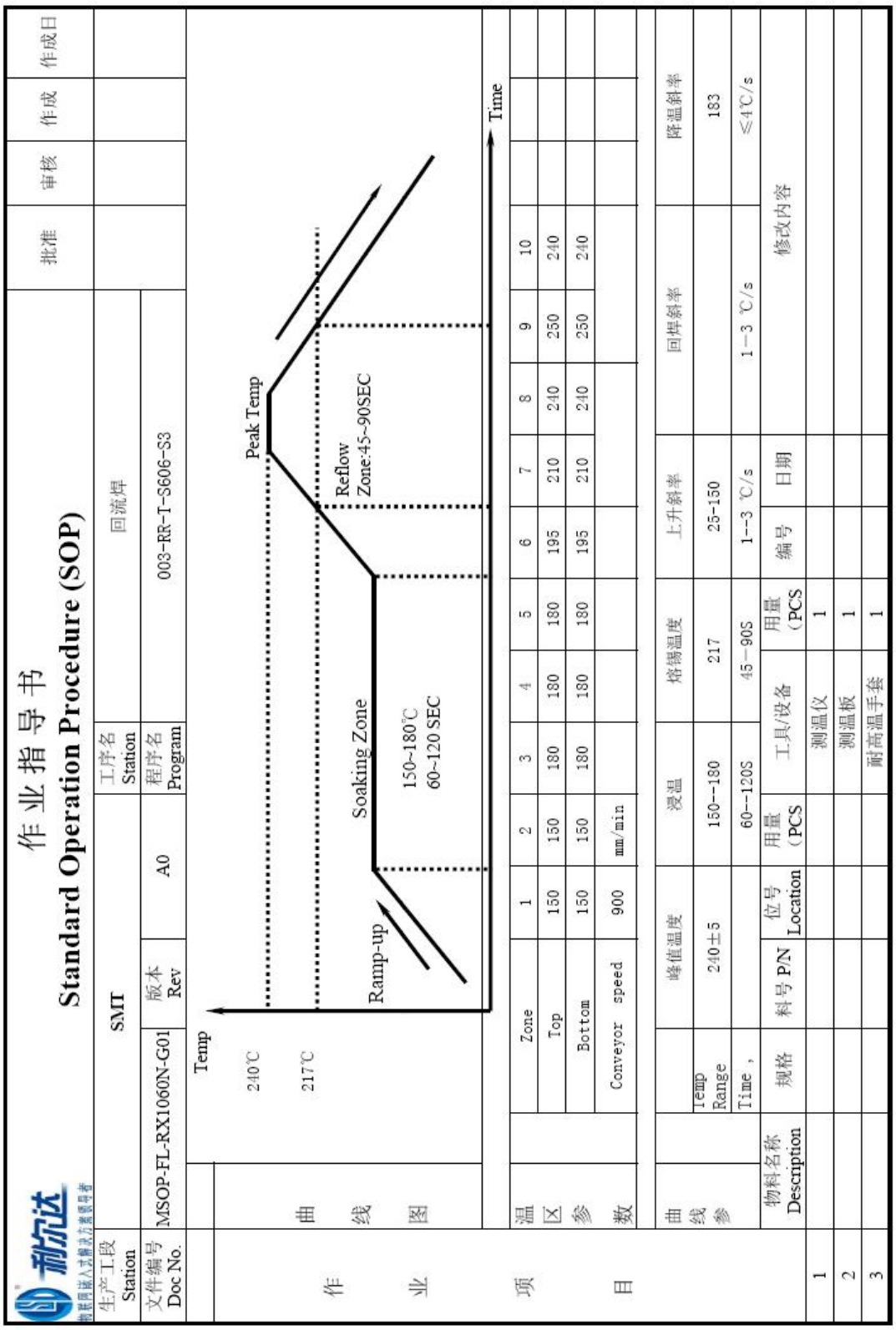
The module solder pad position can be locally thickened to 0.15-0.20mm to avoid voids in soldering.

8.1.4 Production notes

- During the production process, all operators must wear anti-static gloves.
- Baking should not exceed the specified baking time.
- Do not add explosive, flammable, or corrosive substances during baking;
- During baking, the module should be placed in a high-temperature tray to ensure air circulation between the modules.
- During baking, make sure to close the oven door to ensure the oven is sealed and prevent temperature leakage.
- Try not to open the oven door while it is running. If you must open it, try to shorten the time the door is open as much as possible.
- After baking, wait for the module to cool naturally to below 36°C before wearing antistatic gloves to prevent scalding.
- When operating, be sure to prevent the bottom of the module from getting wet or dirty.

8.1.5 Soldering Operation Guidelines

Note: This assignment guide is only suitable for lead-free work and is for reference only.



作业指导书

Standard Operation Procedure (SOP)

生产工段 Station	SMT		工序名 Station	回流焊	批准	审核	作成	作成日
文件编号 Doc No.	MSOP-FL-RX1060N-G01	版本 Rev	A0	程序名 Program	003-RR-T-S606-S3			

作业曲线图

项目

温区参数		1	2	3	4	5	6	7	8	9	10
	Zone										
	Top	150	150	180	180	180	195	210	240	250	240
	Bottom	150	150	180	180	180	195	210	240	250	240
	Conveyor speed	900	mm/min								

曲线参数		峰值温度	浸温	熔锡温度	上升斜率	回焊斜率	降温斜率
	Temp Range	240±5	150--180	217	25-150	183	
	Time ,		60--120S	45--90S	1--3 ℃/s	1--3 ℃/s	≤4℃/s

	物料名称 Description	规格	料号 P/N	位号 Location	用量（PCS	工具/设备	用量（PCS	编号	日期	修改内容
1						测温仪	1			
2						测温板	1			
3						耐高温手套	1			

Figure 8.1 Reflow Soldering Operation Manual

8.2 Packaging specifications

8.2.1 Packaging method

Model	Packaging method	Carton (PCS)	Minimum packaging quantity (PCS)	Number of rolls per box
L-BTMSB97-G3PC4-01	Roller tape	6400	1280	5

8.2.2 Dimensions of the tape and product orientation

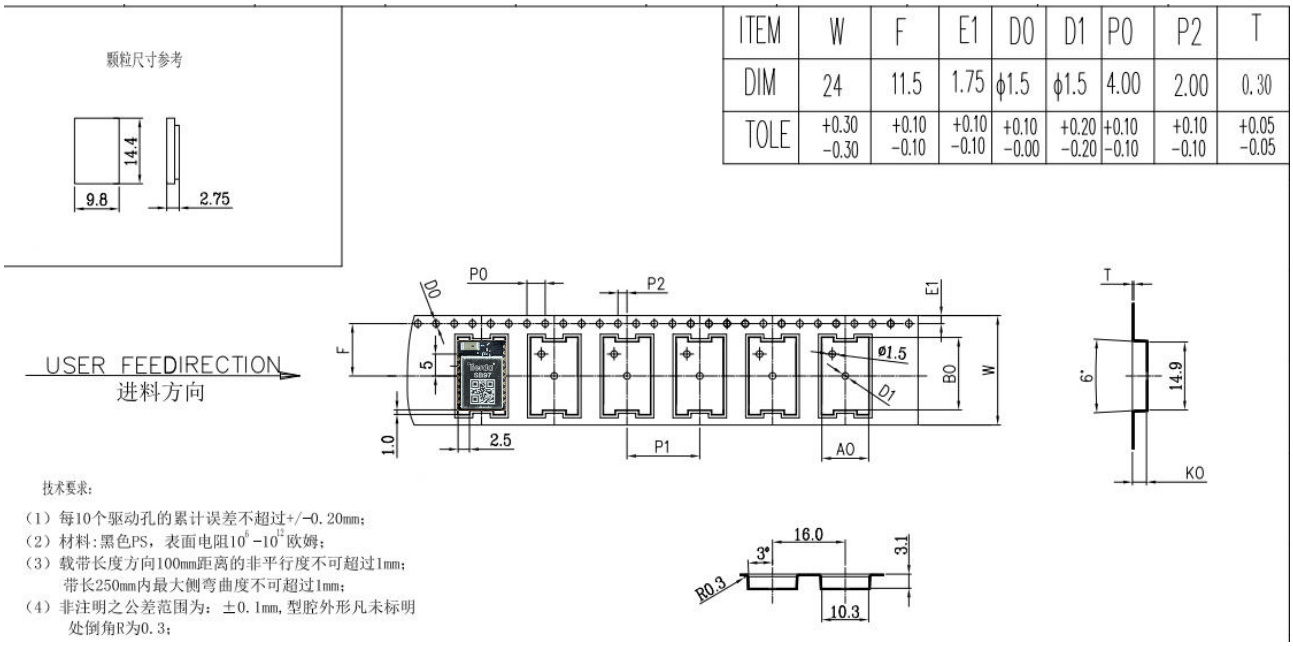


Figure 8.2 Tape Dimensions and Product Orientation