Lierda YB86 Series Module Hardware Design Manual

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Revision History of the Document

Document version	Change date	Reviser	Reviewer	Change content
Rev1.0	24-08-09	ZXY	YB	Initial Version

Safety Instructions

Users are responsible for complying with relevant regulations on wireless communication modules and devices in other countries and specific regulations on the use environment. By following the safety principles below, personal safety can be ensured and potential damage to products and work environments can be prevented. Our company is not responsible for any losses related to customers' failure to comply with these regulations.

	Road safety comes first! When driving, please do not use handheld mobile devices unless they have hands-free functionality. Please pull over before making a call!
	Please turn off your mobile devices before boarding. The wireless function of mobile devices is prohibited from being turned on during the flight to prevent interference with the aircraft communication system. Ignoring this prompt may compromise flight safety and even violate the law.
	When in a hospital or healthcare facility, pay attention to whether there are 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. In case of emergency situations with the above conditions, remember to use emergency calls, ensuring that your device is powered on and in an area with sufficient signal strength.
	Your mobile terminal device will receive and emit radio frequency signals when it is turned on, which may cause radio frequency interference when it is close to 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 your mobile terminal device. 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-WFIYB86-G5PP4	2.4GHz ISM Band	22.9×13.3×2.6	PCB antenna, 2MB FLASH

Content

Legal Statement 1
Revision History of the Document 2
Safety Instructions 3
Module selection for application 4
Content 5
1 Introduction 7
2 Product Overview 8
2.1 Basic Features 8
2.2 Application Scenarios 8
2.3 Function Block Diagram 9
2.4 Pin distribution 10
2.5 Pin Description Table 11
2.6 Safety mechanism 12
3 Characteristics of work 14
3.1 Power supply design 14
3.2 Reset design 14
3.2.1 Key reset reference circuit 15
4 Application Interface 16
4.1 UART communication 16
4.1.1 Main serial port 16
4.1.2 Debugging serial port 16
5 Radio Frequency Characteristics 17
5.1 Wi-Fi performance 17
5.2 BLE radio performance 18
5.3 Key points of clear space design in antenna area 19

5.4 Layout considerations for the motherboard 21
6 Electrical performance and reliability 24
6.1 Absolute maximum rating 24
6.2 Power consumption 24
6.3 Rated power value 26
6.4 Direct current electrical characteristics 26
6.5 Static electricity protection 27
7 Mechanical dimensions 28
7.1 Mechanical dimensions 28
8 Production information packaging information 29
8.1 Packaging specifications 29
8.1.1 Packaging method 29
8.1.2 Dimensions of the tape and product orientation 29
8.2 Storage conditions 30
8.3 Manufacturing welding 31
8.3.1 Furnace passing method 31
8.3.2 Module placement requirements on the baseboard. 31
8.3.3 Steel mesh opening design 31
8.3.4 Production Notes 32
8.3.5 Production process 33
8.3.6 Repair 34
8.3.7 Reflow soldering operation guidance 34

1 Introduction

The YB86 series module is a cost-effective IoT Wi-Fi 6 module that supports 802.11b/g/n/ax @ 2.4 GHz and BLE 5.0 protocols; the module adopts RISC processor architecture with a high operating frequency of up to 240MHz; it has built-in 512KB SRAM and 2MB FLASH, supports comprehensive encryption mechanisms, and can meet strict security requirements.

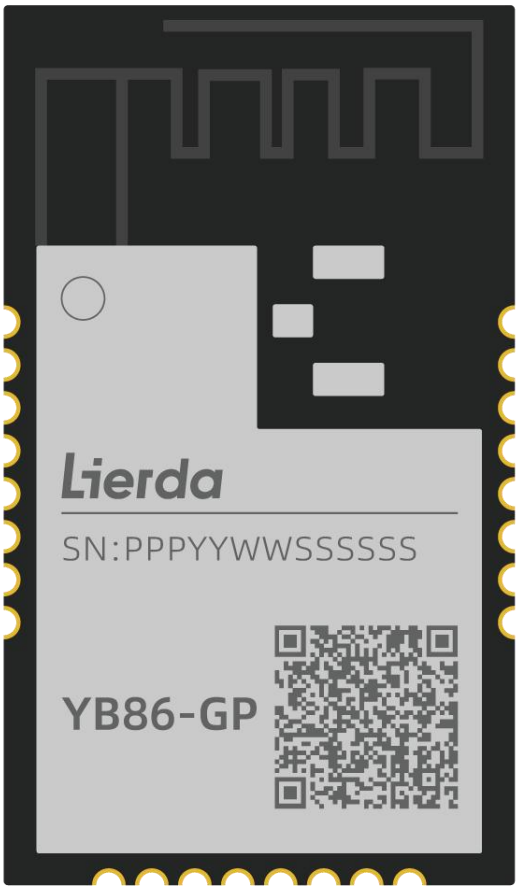

Figure 1.1 Module Schematic

2 Product Overview

2.1 Basic Features

Table 2-1 Module Basic Characteristics

Characteristics	Description
Encapsulation of interfaces	LCC + postage interface
Wireless standards	IEEE 802.11b/g/n/ax + BLE5.0
Module size	22.9mm × 13.3mm × 2.6mm
Operating voltage	3.0V ~ 3.6V, typical value 3.3V
Working frequency band	2400 ~ 2483.5MHz (2.4 GHz ISM Band)
Operating temperature	-40 ~ +85℃
Storage temperature	-40 ~ +105℃
Module interface	UART
Serial port configuration	Main serial port UART2: ◆ Used for data transmission, default baud rate is 115200bps Debugging serial port UART1: ◆ Used for firmware upgrade, default baud rate is 115200bps
Wi-Fi bandwidth	Support standard 20/40 MHz bandwidth.
Storage features	Support 2MB FLASH

2.2 Application Scenarios

- Photovoltaic communication stick / data collector
- Intelligent gateway device
- Smart home, smart home appliances.
- Health/Medical/Care Equipment

2.3 Function Block Diagram

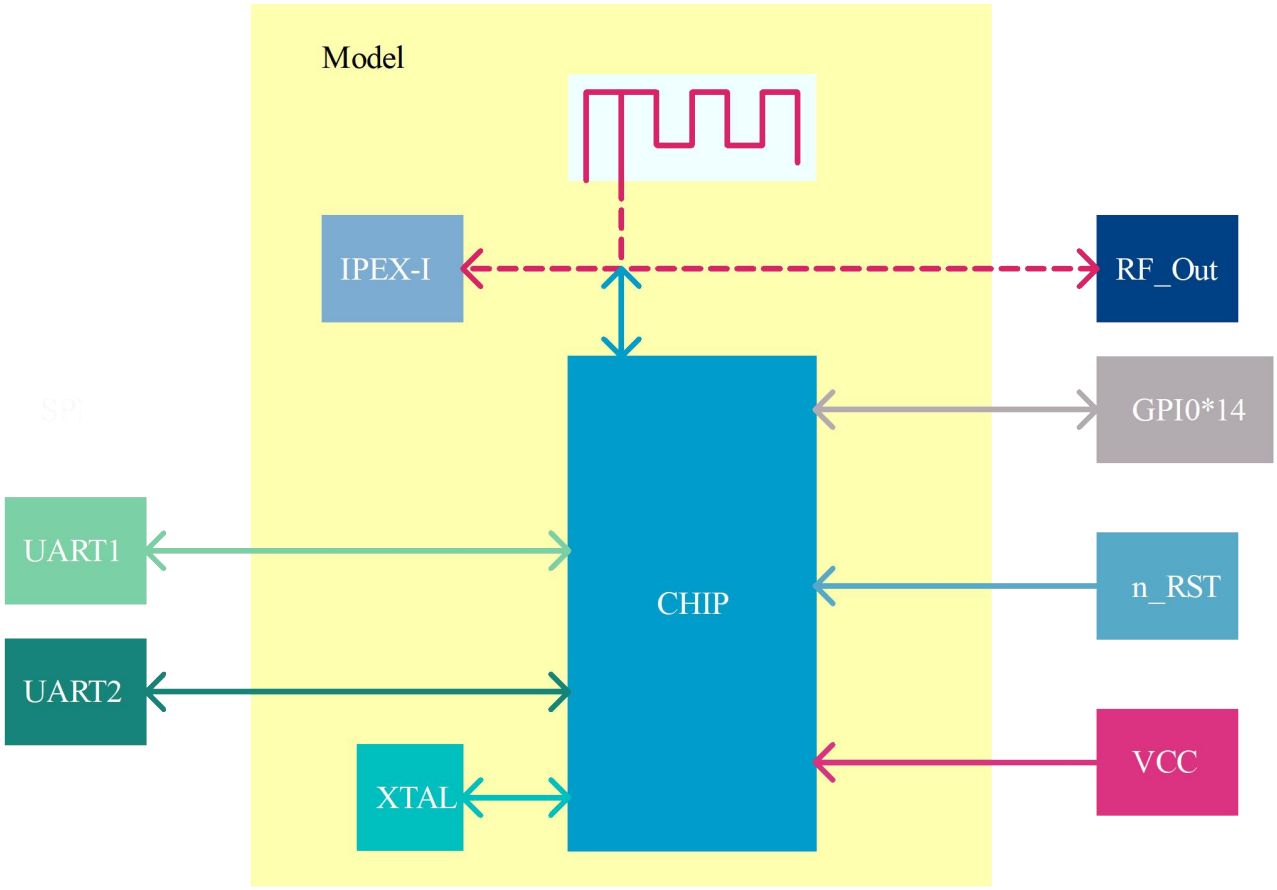

Figure 2.1 Module Structure Diagram

2.4 Pin distribution

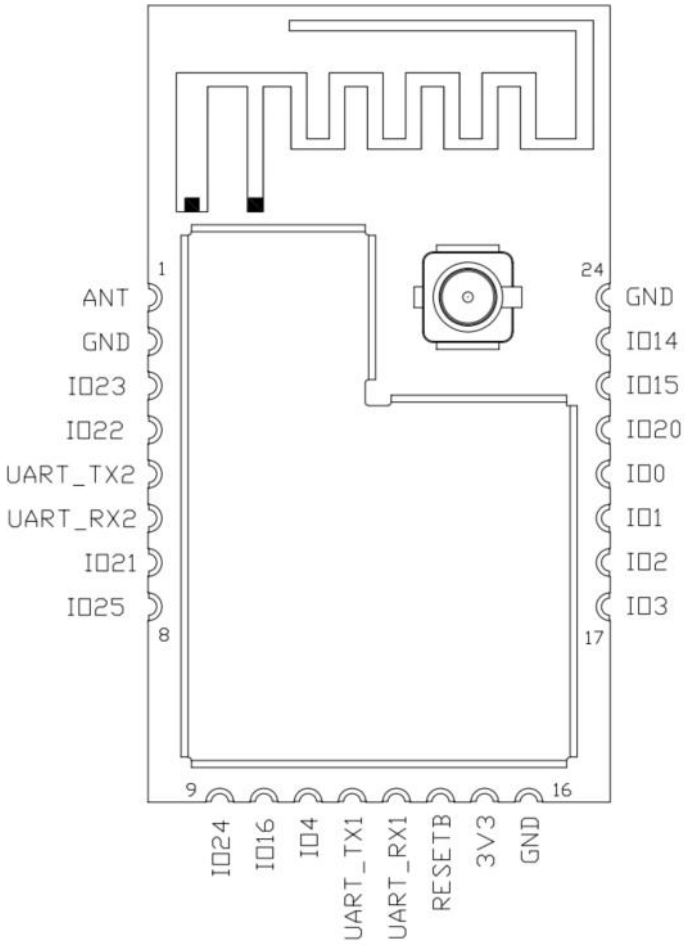

Figure 2.2 Pinout Diagram

2.5 Pin Description Table

For a better understanding of the application, the following table explains the type definitions of I/O parameters:

Table 2-2 Explanation of I/O Parameter Type Definitions

I/O parameter types	Explanation
IO	Input Output
DI	Numeric input
DO	Number output
P	Power pin
G	GND
RFI/O	RF input and output

Table 2-3 Module Pin Function Description

Pin number	Pin names	I/O Type	Description	Note
1	ANT	RFI/O	RF input and output	Default to PCB antenna
2	GND	G	GND	/
3	IO23	IO	General-purpose IO port	Corresponding GPIO23 of the IC.
4	IO22	IO	General-purpose IO port	Corresponding GPIO22 of the IC.
5	UART_TX2	DO	Main serial port: Module sends data	Corresponding IC's UART2
6	UART_RX2	DI	Main serial port: Module receives data	Corresponding IC's UART2
7	IO21	IO	General-purpose IO port	GPIO21 of the corresponding IC
8	IO25	IO	General-purpose IO port	Corresponding to IC's GPIO25
9	IO24	IO	General-purpose IO port	Corresponding IC's GPIO24
10	IO16	IO	General-purpose IO port	Corresponding IC's GPIO16
11	IO4	IO	General-purpose IO port	Corresponding IC's GPIO4

12	UART_TX1	DO	Debug serial port: Module sends data	Corresponding IC's UART0
13	UART_RX1	DI	Debugging serial port: Module receiving data	Corresponding IC's UART0
14	RESETB	DI	Reset pin	Corresponding to IC's GPIO18, there is a 4.7K pull-up resistor.
15	3V3	P	Power supply	The power supply range is 3.0~3.6V, typically 3.3V.
16	GND	G	GND	/
17	IO3	IO	General-purpose IO port	Corresponding IC's GPIO3
18	IO2	IO	General-purpose IO port	Corresponding IC's GPIO2
19	IO1	IO	General-purpose IO port	Corresponding IC's GPIO1
20	IO0	IO	General-purpose IO port	Corresponding GPIO0 of the IC
21	IO20	IO	General purpose IO port	Corresponding GPIO20 of the IC
22	IO15	IO	General purpose IO port	Corresponding IC's GPIO15
23	IO14	IO	General purpose IO port	Corresponding IC's GPIO14
24	GND	G	GND	/

2.6 Safety mechanism

The YB86 series modules are equipped with hardware accelerators such as AES, SHA, ECC, and True Random Number Generator (TRNG), supporting some common algorithms. Among them, SHA, ECC, and TRNG provide security guarantees for secure boot. By operating TRNG with Flash addresses, AES keys for Flash encryption/decryption can be generated. The YB86 series modules support the following security features:

- Hardware encryption accelerator
  - Support AES128
  - Support HASH
  - Support ECC
  - Support TRNG

- Flash encryption
- Secure Boot

3 Characteristics of work

3.1 Power supply design

Pin number	Pin name	I/O	Description	Note
15	VCC	P	Power supply	The power supply must be able to provide a current of up to 500mA.
16	GND	G	GND	

When designing the power circuit for the YB86 series modules, the following points should be noted:

●When the module is operating in TX mode, the instantaneous current increases, so it is required that the power supply has a supply capacity of over 500mA, and a 22 μ F capacitor and a 0.1 μ F capacitor should be placed near the pins on the module power supply line, as shown in Figure 3.1.

●Power ripple greatly affects the RF TX performance. When the module is in TX state and sending MCS7@11n data packets, the peak-to-peak value of power ripple must be <80mV; when sending 11M@11b, the peak-to-peak value of power ripple must be <120mV.

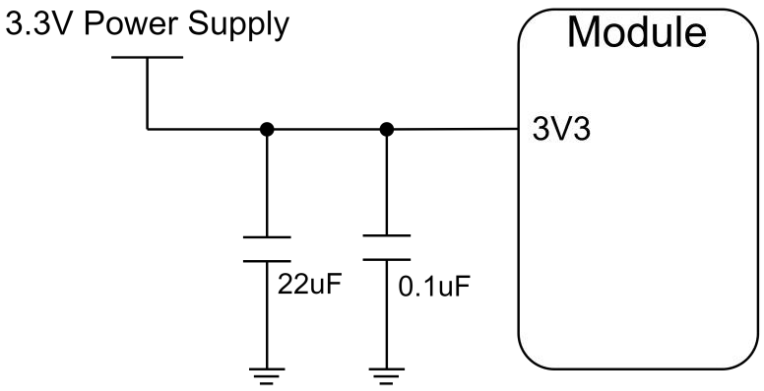

Figure 3.1 Module Power Supply Reference Circuit

3.2 Reset design

Pin 3 of the module is the RESETB pin, which is the enable pin. A low level can put the

module into a reset state. Users can directly connect it to other MCU's IO for control.

Pin number	Pin name	I/O	Description	Note
14	RESETB	I	Reset pin	Low level effective

3.2.1 Key reset reference circuit

The key reset reference circuit shown in Figure 3.1 holds the chip in a low level for 5ms to reset. To prevent the button from being affected by ESD, it is usually recommended to place a TVS tube near the button, and a capacitor position of 100nF~1 μ F can also be reserved near the module's EN pin, which is not soldered by default.

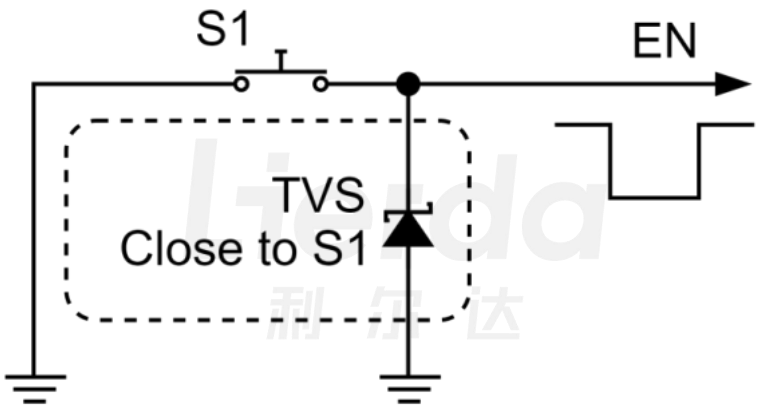

Figure 3.1 Key Reset Reference Circuit

4 Application Interface

4.1 UART communication

This module provides two UART communication interfaces, main serial port UART2, and debug serial port UART1.

4.1.1 Main serial port

Main serial port UART2, used for AT command configuration and data transmission, with a default baud rate of 115200bps, the serial port connection diagram is as follows:

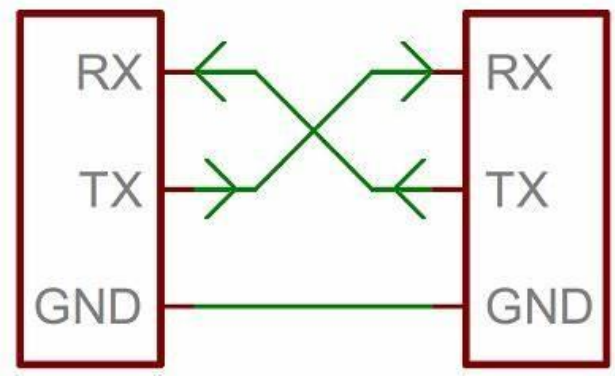

Figure 4.1 UART Serial Port Connection Diagram

4.1.2 Debugging serial port

Debugging the UART1 serial port is mainly used for firmware upgrading and debugging, with a default baud rate of 115200bps; When burning, pay attention to connecting the module to the burner with 3.3V, GND, TX (module TX connected to burner RX), RX, RESETB (connected to RST). If the burner does not have an RST interface, the module's RESETB needs to be short-circuited to GND for 1 second.

5 Radio Frequency Characteristics

5.1 Wi-Fi performance

Table 5-1 Module Wi-Fi RF Parameters 1

Parameter	Content	
Frequency range	2400MHz ~ 2483.5MHz (2.4GHz ISM Band)	
Work channel	2.4GHz：Ch1 ~ Ch13	
Modulation method	802.11b	DQPSK, DBPSK, CCK
	802.11g/n (OFDM)	64-QAM, 16-QAM, QPSK, BPSK
Output power	802.11b @ 1Mbps	17dBm ± 2dB @ EVM≤ -10.5dB
	802.11b @ 11Mbps	17dBm ± 2dB @ EVM ≤ -15.5dB
	802.11g @ 6Mbps	17dBm ± 2dB @ EVM ≤ -5dB
	802.11g @ 54Mbps	15dBm ± 2dB @ EVM ≤ -25dB
	802.11n @ MCS0 (20MHz)	17dBm ± 2dB @ EVM ≤ -5dB
	802.11n @ MCS7 (20MHz)	14dBm ± 2dB @ EVM ≤ -27dB
	802.11n @ MCS0 (40MHz)	15dBm ± 2dB @ EVM ≤ -5dB
	802.11n @ MCS7 (40MHz)	13dBm ± 2dB @ EVM ≤ -27dB
	802.11ax @ MCS0 (20MHz)	17dBm ± 2dB @ EVM ≤ -5dB
	802.11ax @ MCS7 (20MHz)	14dBm ± 2dB @ EVM ≤ -27dB
Sensitivity reception	802.11b @ 1Mbps	PER @ -94dBm, typical
	802.11b @ 11Mbps	PER @ -87dBm, typical
	802.11g @ 6Mbps	PER @ -90dBm, typical
	802.11g @ 54Mbps	PER @ -74dBm, typical
	802.11n @ MCS0 (20MHz)	PER @ -90dBm, typical
	802.11n @ MCS7 (20MHz)	PER @ -71dBm, typical
	802.11n @ MCS0 (40MHz)	PER @ -87dBm, typical
	802.11n @ MCS7 (40MHz)	PER @ -68dBm, typical

	802.11ax @ MCS0 (20MHz)	PER @ -90dBm, typical
	802.11ax @ MCS7 (20MHz)	PER @ -70dBm, typical
Adjacent channel suppression	802.11g @ 6Mbps	27dB, typical
	802.11g @ 54Mbps	13dB, typical
	802.11n @ HT20, MCS0	27dB, typical
	802.11n @ HT20, MCS7	12dB, typical

Note

Module under test is powered by 3.3V, tested at 25℃ environment.

5.2 BLE radio performance

Table 5-2 BLE Module RF Performance

Parameters	Content
Bluetooth standard	BLE 5.0
Frequency Range	2402MHz ~ 2480MHz
Work channel	LE：Ch0 ~ Ch39
Modulation method	GFSK
Radio frequency transmission power	0dBm, typical
Gain control step size	3dB, typical
RF power control range	0 ~ +9 dBm
Sensitivity @ PER=30.8%, LE (1Mbps) (CH0, CH19)	-91dBm，typical
Sensitivity @ PER=30.8%, LE(1Mbps)(CH39)	-90dBm，typical
Maximum receive signal @ PER=30.8%, LE(1Mbps)	-10dBm
Sensitivity @ PER=30.8%, LE (2Mbps) (CH0, CH19)	-90dBm，typical
Sensitivity: PER=30.8%, LE(2Mbps)(CH39)	-89dBm，typical
Maximum receive signal @ PER=30.8%, LE(2Mbps)	-10dBm

Note

The test module is powered by 3.3V and tested at 25° C ambient temperature.

5.3 Key points of clear space design in antenna area

When designing a module with an onboard antenna on the board, attention should be paid to the layout of the module on the baseboard to minimize the impact of the baseboard on the antenna performance of the module PCB as much as possible. It is recommended to place the module as close to the edge of the baseboard as possible. If conditions allow, the PCB antenna area should preferably extend beyond the baseboard frame, and the feed point of the antenna should be closest to the edge. If there is a baseboard below the antenna area, it must be cut off to minimize the impact of the baseboard. Ensure that interfering signal traces (such as USB, LCD, camera, power inductors, and crystals) and vias are at least 10 mm away from the antenna; if there are metal-shielded components with a high height near the module antenna area, maintain a distance of at least 10 mm from the antenna area; when it comes to the design of the whole device, the device's casing (especially the material around the antenna) should be made of non-metallic materials, and there should be at least 3 mm spacing between the antenna and the casing, while also considering the impact of the casing on the antenna. In Figure 5.1, it is strongly recommended to position the module on the baseboard at locations (3) and (4), locations (1), (2), and (6) are not recommended, and position (5) is prohibited. If there is no clearance in the baseboard in the module antenna area, it will greatly attenuate the antenna's radiation capability.

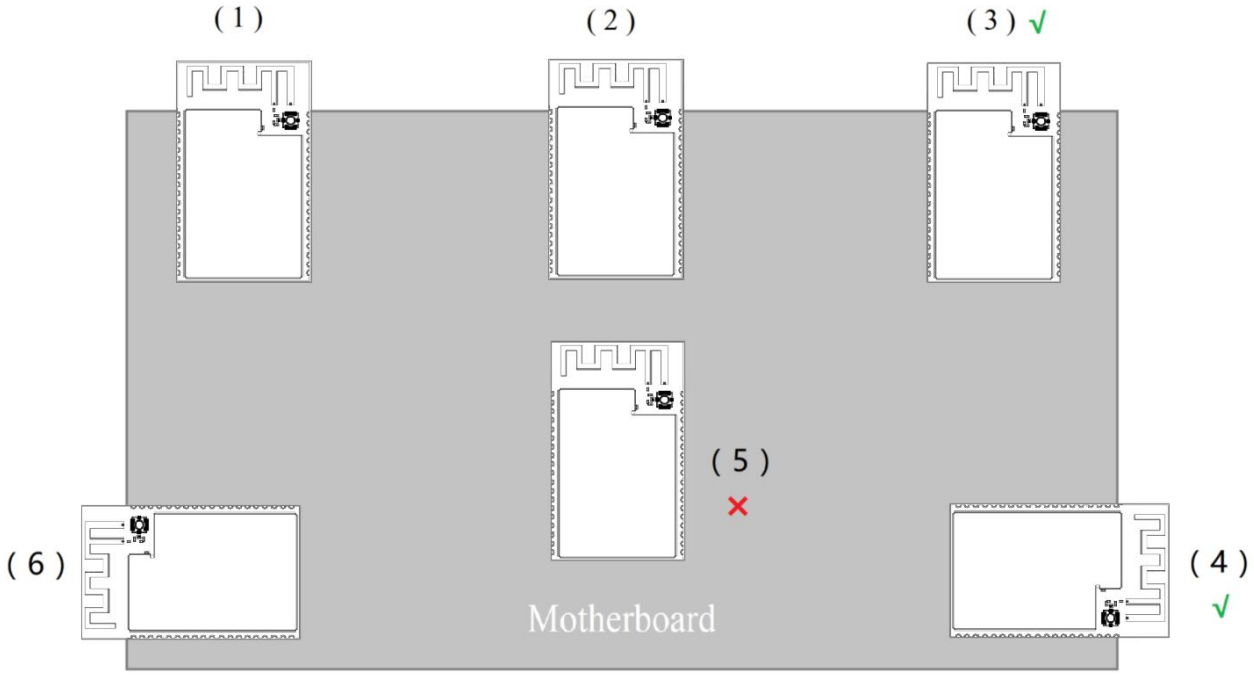

Figure 5.1 Schematic diagram of the module with on-board antenna on the bottom plate.

If the above method is limited and cannot be implemented as ideally planned, please ensure that the module is not enclosed by any metal casing, and the module's PCB antenna area and the area extending 15mm outside must be strictly clear, as shown in Figure 5.2:

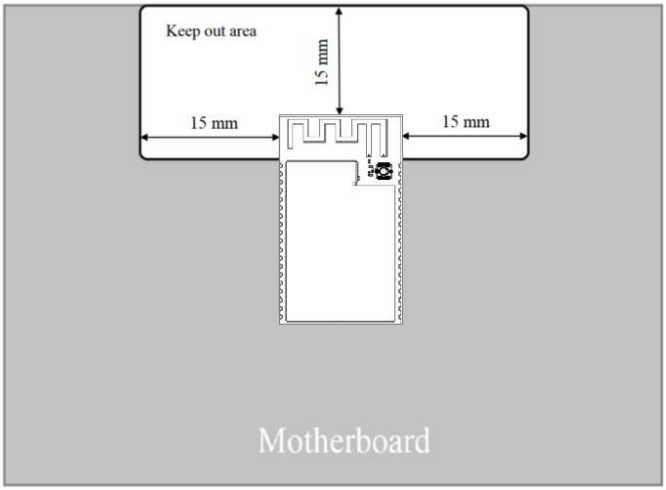

Figure 5.2 Schematic Diagram of Antenna Zone Clearance

5.4 Layout considerations for the motherboard

The BOTTOM layer of the module has no high-speed 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 excessive requirement for hollowing out in the bottom plate design, except for the clear space requirement mentioned in section 5.3 above. The bottom plate can be fully covered with copper, but attention should be paid to avoiding the test point solder pads on the BOTTOM layer of the module due to exposed copper caused by window openings. No vias or exposed copper should be placed at the corresponding positions on the bottom plate, and solder mask should be applied to prevent short circuits. The exposed copper area of the BOTTOM layer of the module is shown in Figure 5.3.

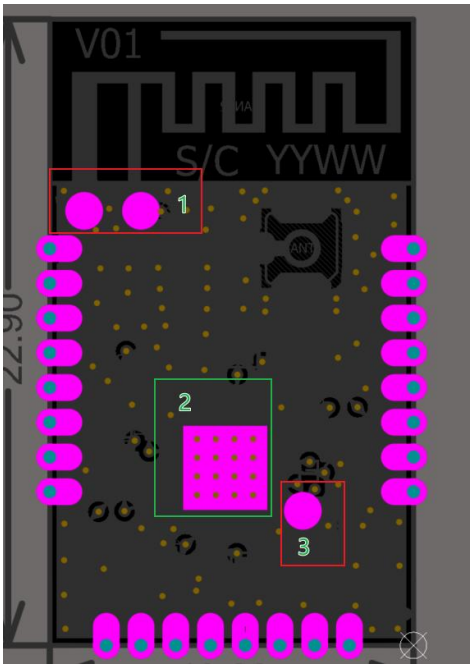

Figure 5.3 Schematic Diagram of the Copper Exposed Area in the Window Opening of the BOTTOM Layer Module

The RF test points with exposed copper dots in the areas labeled 1 and 3 in the red box are mapped to the bottom plate area, where there must be no traces or exposed copper.

Area 2 marked by the green box is the heat dissipation pad EXPAD under the chip on the back of the module (connected to GND). It is recommended to perform similar copper revealing treatment at the corresponding position on the bottom plate, and to make as many ground holes as possible to connect the copper revealing area with other ground planes on different layers to enhance the heat conduction performance. When connecting to the same layer ground plane, the copper should not be connected in a cross pattern (Direct Connect should be selected), as the cross connection will cause heat to accumulate on the copper block in the middle, leading to local overheating as shown in Figure 5.4. Additionally, it is important to note that the copper revealing area generally should not be tinned, but a moderate amount of tinning can optimize the heat conduction effect of the bottom plate (excessive tinning may lead to floating, virtual soldering, and solder leakage during module soldering): if EXPAD is in the form of a whole rectangular window, the through holes must be treated as half-plugged holes to prevent solder leakage; a more recommended optimization method is to make the EXPAD on the bottom plate in a nine-grid pattern, as shown in Figure 5.5, cover the ink in the gaps, and place the ground holes in the gaps, which can effectively improve the solder leakage issue.

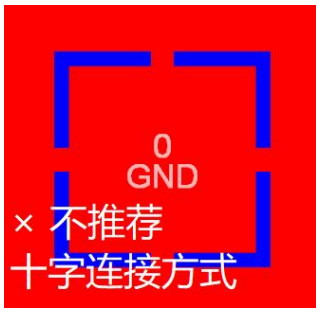

Figure 5.4 Non-recommended copper laying method

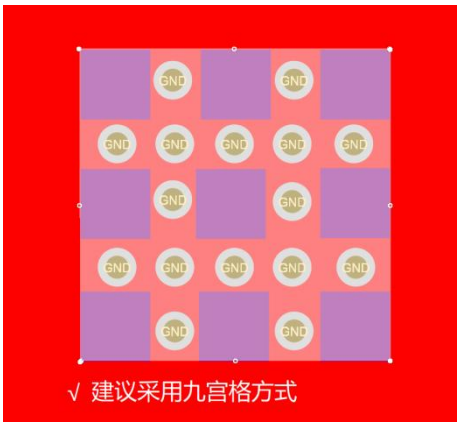

Figure 5.5 Nine-grid method of the bottom plate EXPAD.

6 Electrical performance and reliability

6.1 Absolute maximum rating

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

Table 6-1 Maximum Rated Voltage of Pins

Parameters	Description	Minimum value	Typical value	Maximum value	Unit
VCC	Power Supply	3.0	3.3	3.6	V
T_A	Operating temperature	-40	/	+85	℃
T_S	Storage temperature	-40	/	+105	℃
MSL	Wet sensitivity level	MSL3			

6.2 Power consumption

Table 6-2 Module Power Consumption Data

Describe	Test conditions	I_{AVE}@TX (duty 100%)	I_{PEAK}@TX	I_{AVE}@RX	Unit
Wi-Fi data transmission	802.11b,1Mbps@17dBm	340	440	100	mA
	802.11b,11Mbps@17dBm	340	440		
	802.11g,6Mbps@17dBm	340	420	100	
	802.11g,54Mbps@15dBm	270	340		
	802.11n,HT20,MCS0@17dBm	310	420	100	
	802.11n,HT20,MCS7@14dBm	270	340		
	802.11n,HE40,MCS0@15dBm	330	400	110	
	802.11n,HE40,MCS7@13dBm	270	340		
	802.11ax,HT20,MCS0@17dBm	330	360	100	

	802.11ax,HT20,MCS7@14dBm	230	330		
BLE data transmission	BLE,@9dBm	130	160	95	

6.3 Rated power value

Table 6-3 Working Voltage Range

Parameters	Minimum value	Typical value	Maximum value	Unit	Note
V_{DD}	+3.0	+3.3	+3.6	V	Supply voltage (1)
I_{VDD}	0.5	-	-	A	The supply current of the external power source (2)
T_A	-40	+25	+85	℃	Normal working environment (3)

Note

(1) When the module operates within this voltage range, the module's relevant performance meets the requirements of the IEEE 802.11 standard.

(2) The power supply is required to have a current capacity of 500mA or above, otherwise certain parameters such as transmission power, EVM rate, and other values may exceed the range of the IEEE 802.11 standard.

(3) When the module operates within this temperature range, the module's relevant performance meets the requirements of the IEEE 802.11 standard.

6.4 Direct current electrical characteristics

Table 6-4 Module DC Electrical Characteristics

Symbol	Description	Minimum	Typical	Maximum	Unit
CIN	Pin capacitance	-	2	-	pF
VIH	High-level input voltage	0.7*VDD	-	VDD	V
VIL	Low-level input voltage	0	-	0.3*VDD	V
IIH	High-level input current	-10	-	10	uA
IIL	Low-level input current	-10	-	10	uA
VOH	High-level output voltage	0.9*VDD	-	-	V

VOL	Low-level output voltage	-	-	0.1*VDD	V
IOH	High-level source current(4mA)	2	3.2	5	mA
IOL	Low-level sink current(4mA)	4	5.2	7	mA
RPU	Pull-up resistor	66K	-81.1K	110K	Ω
RPD	Pull-down resistor	55K	62.7K	82.5K	Ω

6.5 Static electricity protection

In module applications, static electricity generated by human static electricity, electrostatic friction between microelectronics, etc., discharged to the module through various ways may cause certain damage to the module. Therefore, ESD protection should be emphasized. In the processes of research and development, production assembly, testing, etc., especially in product design, ESD protection measures should be taken. For example, anti-static protection should be added at interfaces in circuit design and points susceptible to static discharge damage or interference; testing equipment should ensure good grounding; anti-static gloves should be worn during production.

Table 6-5 Pin Electrostatic Protection Level

Test mouth type	Description	Discharge phenomenon	Unit	Test standard
Power supply pin	Power port and GND.	±4	KV	IEC61000-4-2
RF port	Antenna Port	±4	KV	

7 Mechanical dimensions

7.1 Mechanical dimensions

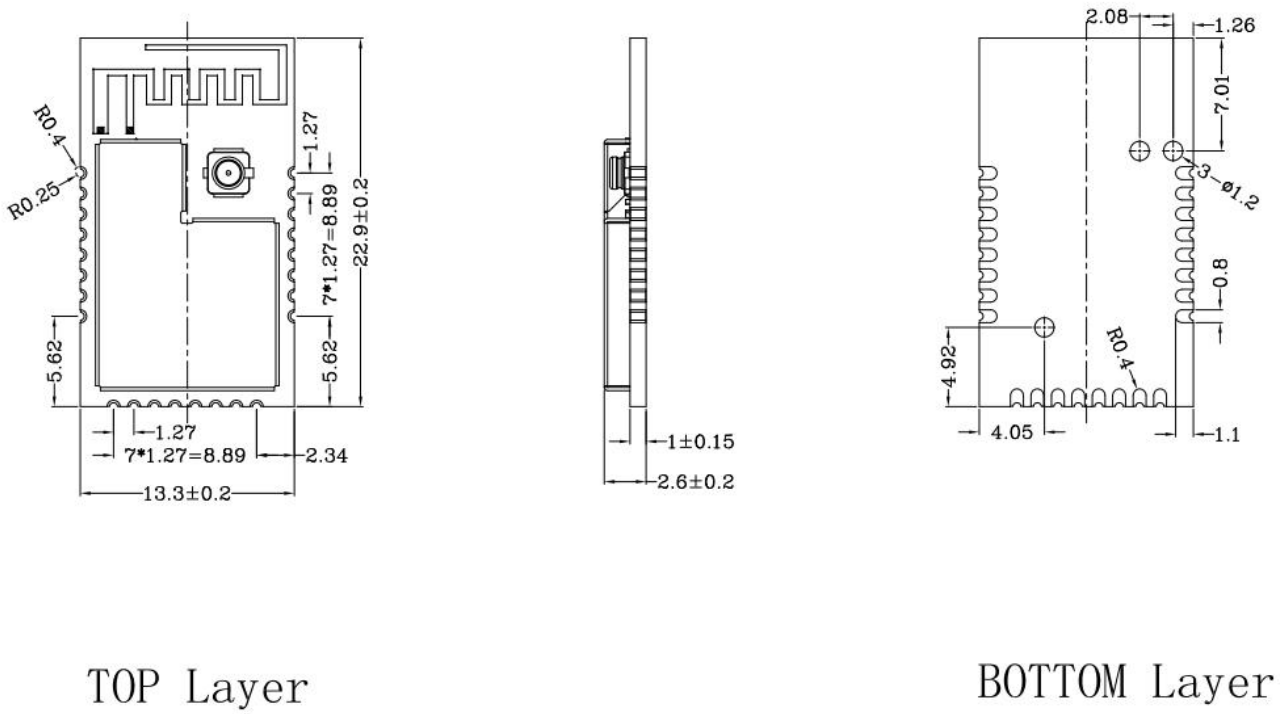

Figure 7.1 Module Dimension Diagram

8 Production information packaging information

This chapter describes guidance information on the packaging, storage, production, maintenance, etc. of modules, which is applicable to the assembly process guidance of modules.

8.1 Packaging specifications

8.1.1 Packaging method

Table 8-1 Module Reel Packaging Information

Model	Packaging method	Carton (PCS)	Maximum packaging quantity (PCS)	Number of rolls per box
L-WFIYB86-G5PP4	Roller belt	5000	1000	5

8.1.2 Dimensions of the tape and product orientation

Roller tape packaging module placement orientation diagram: (Refer to the diagram, the actual label content shall prevail, pay attention to the module PIN1 position)

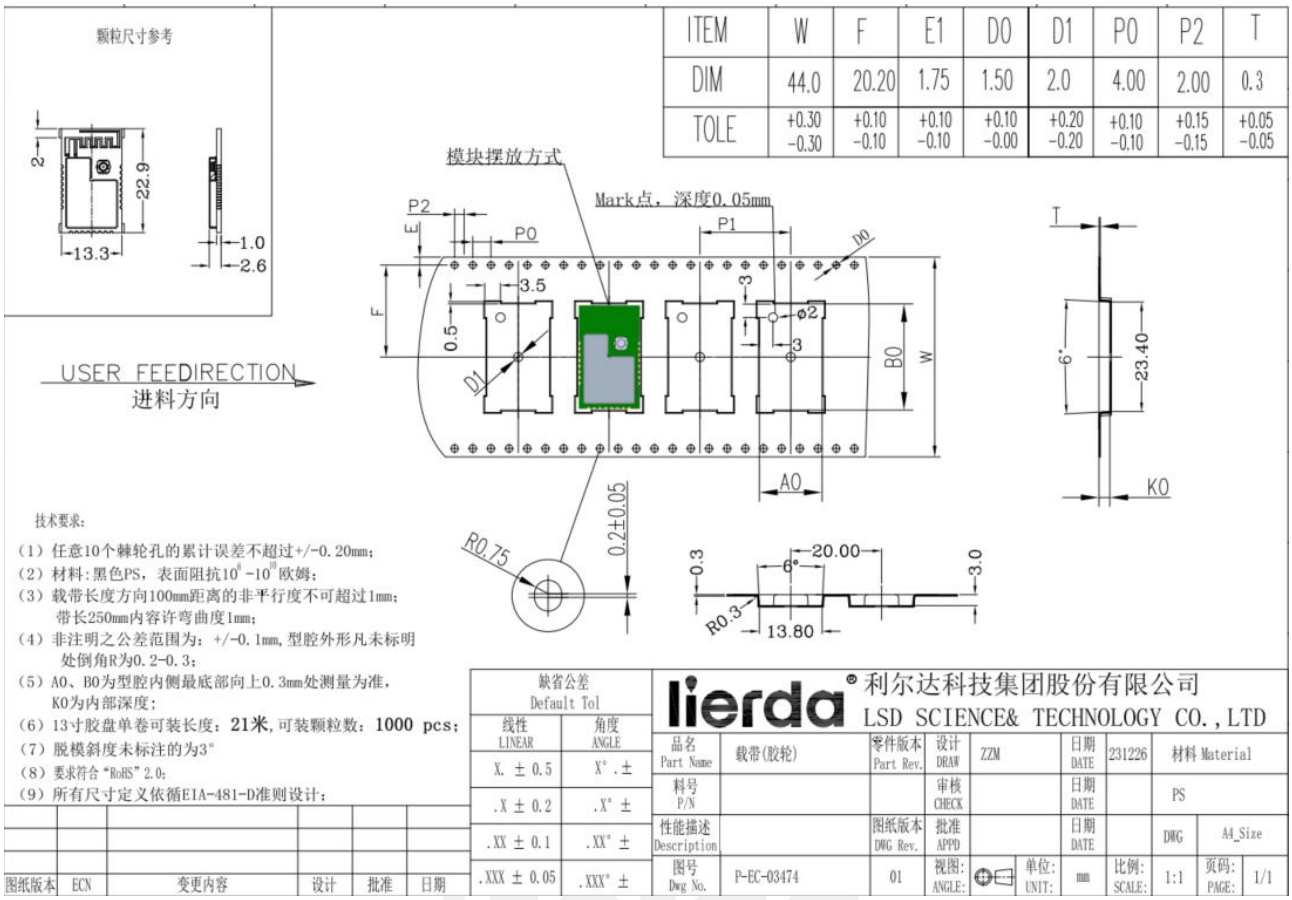

Figure 8.1 Packaging Specifications and Dimensions

8.2 Storage conditions

The module is shipped in the form of vacuum reel sealed bags, with a moisture sensitivity level of MSL 3.

Storage conditions:

1) Temperature below 40°C, humidity below 90% (RH), can ensure 12 months of solderability in well-sealed packaging.

2) After unpacking, make sure to carry out SMT assembly within 168 hours under the condition that the ambient temperature is below 30°C and the relative humidity is below 60% (RH).

If the above conditions are not met, baking is required:

1) Roll packaging, bake at 60°C ± 5°C for 24-48 hours,

2) If accelerated baking is needed, the module should be taken out from the tape and

placed on a high-temperature resistant container (e.g. tray) for baking (ESD protection should be observed during the removal process), baked at 125℃±5℃ for 8 hours.

3) The cumulative baking time should not exceed 96 hours.

Please refer to the IPC/JEDEC J-STD-033 standard for more detailed guidance.

8.3 Manufacturing welding

8.3.1 Furnace passing method

If the customer is using a double-sided board for the module's base, it is recommended to place the module in the second reflow. It is best for the customer's board to go through the oven on the carrier tape during the first reflow, and also try to put it on the carrier tape during the second reflow. If for special reasons it cannot go through the oven on the carrier tape, consider using a fixture to go through the oven on the track or place a flat heat-resistant straight board under the PCBA to support it during the reflow process to prevent PCB deformation leading to virtual soldering of the module during reflow.

8.3.2 Module placement requirements on the baseboard.

It is recommended that the green oil thickness of the bottom board 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.

8.3.3 Steel mesh opening design

The selection principle of the thickness of the steel mesh on the bottom plate is generally based on the comprehensive consideration of the packaging type of the components inside the board, and the following requirements need to be focused on:

The module solder pad position can be locally thickened to 0.15-0.20mm to avoid

solder voids.

8.3.4 Production Notes

- During the production process, all operators must wear anti-static gloves.
- Baking must not exceed the specified baking time;
- Do not add explosive, flammable, or corrosive substances during baking;
- During baking, the modules should be placed in a high-temperature tray to ensure air circulation between the modules;
- When 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 door-opening time as much as possible.
- After baking, wait for the module to cool naturally to below 36° C before wearing electrostatic gloves to avoid scalding.
- During operation, be sure to prevent the module's bottom from getting wet or dirty.

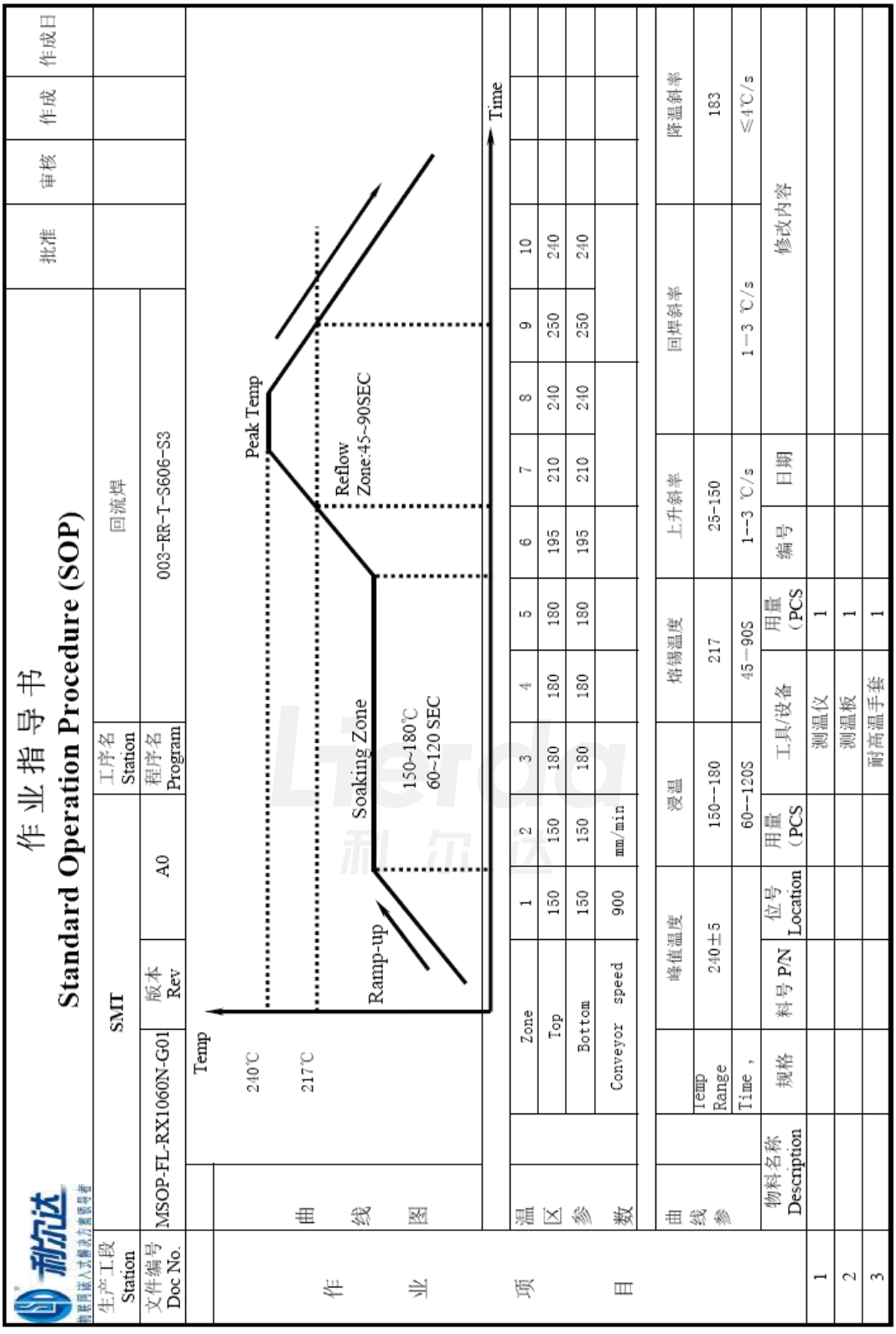

Figure 8.2 Reflow Soldering Operation Manual

8.3.5 Production process

During the production of welding or other processes that may directly contact the

module, no organic solvents (such as alcohol, isopropanol, acetone, trichloroethylene, etc.) should be used to wipe the module shield; otherwise, it may cause rust on the shield.

If spraying or potting is needed for the module, please ensure that the spraying or potting materials used will not chemically react with the module shield or PCB, and also make sure that the spraying or potting materials will not flow into the interior of the module.

8.3.6 Repair

If the module has defects such as virtual soldering and short circuits that require maintenance, please follow the parameters below:

Lead-free process: Soldering iron temperature 380±10℃, soldering iron contact time ≤5S;

Lead process: soldering iron temperature 350±10°C, soldering iron contact time ≤5S;

Modules are not recommended to be blown with a hot air gun to avoid affecting the performance of the modules.

8.3.7 Reflow soldering operation guidance

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