

Lierda UB6L series

Hardware design manual

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Revision History

Document version	Change date	Reviser	Reviewer	Change content
Rev1.0	23-06-25	LHL	YB	Initial Version
Rev1.1	23-08-25	LHL	YB	Modify the LE transmission power. Modify the power consumption parameters of the module.



Safety Instructions

Users are responsible for complying with the relevant regulations on wireless communication modules and devices in other countries and specific regulations on the use environment. 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! Do not use handheld mobile devices while driving 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 in the aircraft to prevent interference with the aircraft communication system. Ignoring this reminder may endanger 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 under such circumstances, please 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 powered on, which may cause radio frequency interference when it is 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 hazardous area poses a safety risk.

Module selection for application

Serial Number	Module model	Support frequency bands	Dimensions	Module introduction
1	L-WFMUB6L-G5NI4	2.4 GHz ISM Band	13x12.2x2.1 mm	



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1 Introduction

The UB6L series module supports 802.11b/g/n/ax@2.4G and BLE5.2 functions, is a Wi-Fi 6 module with a USB interface, and can be widely used in areas such as high-definition network cameras, OTT/IPTV/DVB/set-top boxes, smart TVs, etc.

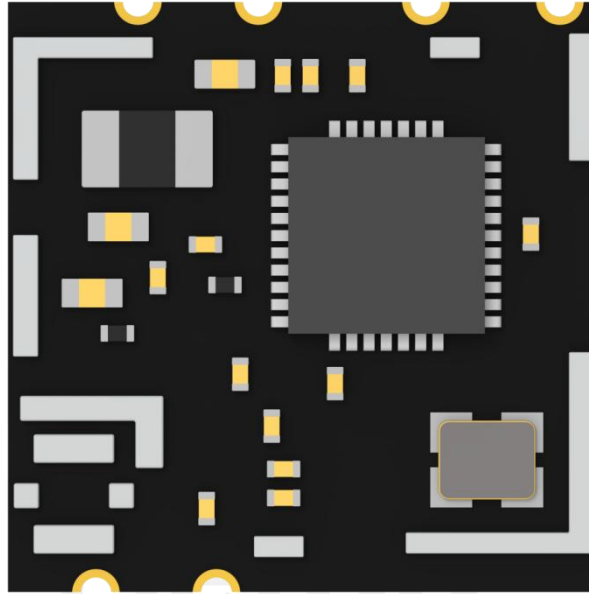


Figure 1.1 Module Schematic

2 Product Overview

2.1 Key Features

Interface	LCC+ stamp hole
Wireless standard	IEEE 802.11b/g/n/ax+BLE5.2
Module packaging	13 mm × 12.2 mm × 2.1 mm
Operating voltage	3.0V~3.6V, typical value 3.3V
Working frequency band	2400~2483.5MHZ(2.4GHz ISM Band)
Operating temperature	-20 ~ +80℃
Storage temperature	-40 ~ +85℃
Communication Interface	USB 2.0
Bandwidth	Support standard 20/40MHz bandwidth.
MAC	IEEE 802.11d/e/i/k/v/w

2.2 Product advantages

- 1) Support IEEE 802.11b/g/n/ax@2.4G
- 2) Support BLE 5.2
- 3) Support STA, AP, and Wi-Fi Direct modes.
- 4) Support WEP/WPA/WPA2/WPA3-SAE Personal, MFP frequency band
- 5) Support Wi-Fi/BLE time division multiplexing.
- 6) Support USB 2.0 interface
- 7) Support MU-MIMO, OFDMA
- 8) Support Wi-Fi 6 TWT

2.3 Application Scenarios

- High-definition network camera, surveillance PTZ
- OTT/IPTV/DVB set-top box
- Smart home, smart home appliances.

2.4 Function Block Diagram

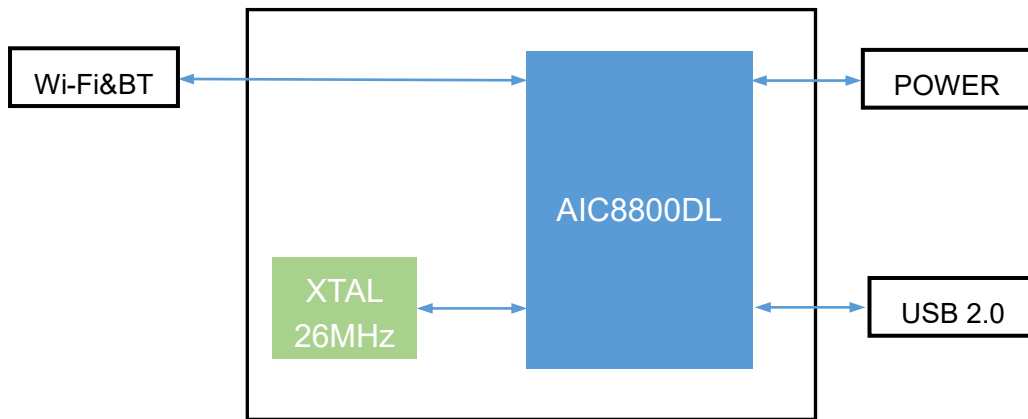


Figure 2.1 Functional Diagram

2.5 Pinout diagram

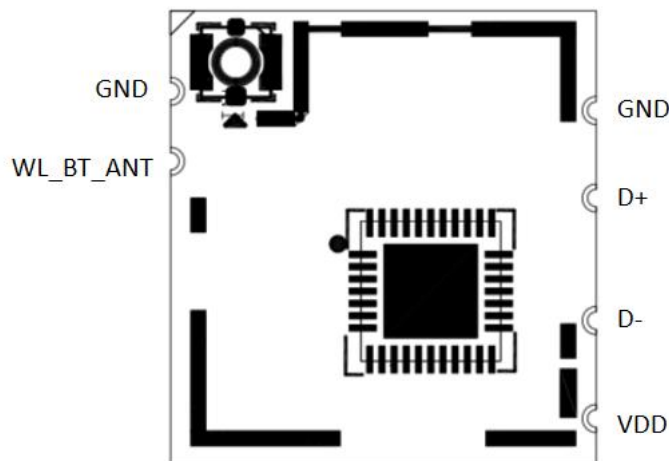


Figure 2.2 Pinout Diagram

2.6 Pin Description Table

Pins	Pin definition	I/O Type	Function Description
1	GND	G	Grounding
2	WL_BT_ANT	RF	2.4G Wi-Fi & BT Antenna
3	VDD	P	Power supply (DC 3.3V, TYP)
4	D-	I/O	USB DATA -
5	D+	I/O	USB DATA +
6	GND	G	Grounding

“P”:POWER “I”:INPUT “O”:OUTPUT “G”:GND

3 Job characteristics

3.1 Power supply design

3.1.1 Power interface

VDD pin is used to connect external power supply, the interface description is as follows table:

Table 3-1 Power Supply Pin Definitions

Pin number	Pin definition	Description	Minimum value V	Typical value V	Maximum value V
3	VDD	Module power	3.0	3.3	3.6

The module power supply range is 3.0~3.6V, ensuring that the operating voltage is not lower than 3.0V. The power supply current requirement is not less than 500mA.

3.1.2 Power supply design

The UB6L module power supply pins are recommended to use 22uF and 0.1uF decoupling capacitors. The capacitors should be placed as close as possible to the VDD power supply pin. The power supply voltage range requirement is 3.0~3.6V. When using a 3.3V power supply, it is necessary to ensure that the supply voltage is not lower than 3.0V. The VDD pin is directly connected to the internal chip VDD33_PA pin of the module, which is used to power the Wi-Fi PA module circuit. When transmitting at maximum power, VDD33_PA needs to have a power supply capability of peak current 300mA, and the power supply ripple is recommended to be within 10mV to avoid excessive ripple causing degradation in RF performance. The recommended power supply circuit is as follows:

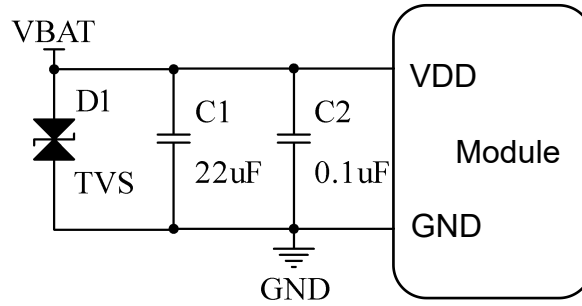


Figure 3.1 Power Supply Recommended Design

Note: D1 TVS is used for electrostatic protection, it is recommended to place TVS diodes for electrostatic protection.

3.1.3 Power-on sequence

When the VDD pin of the UB6L module is powered up to reach a stable state inside the module chip, the duration is 208ms. The power-up sequence of the module is as shown in the following figure:

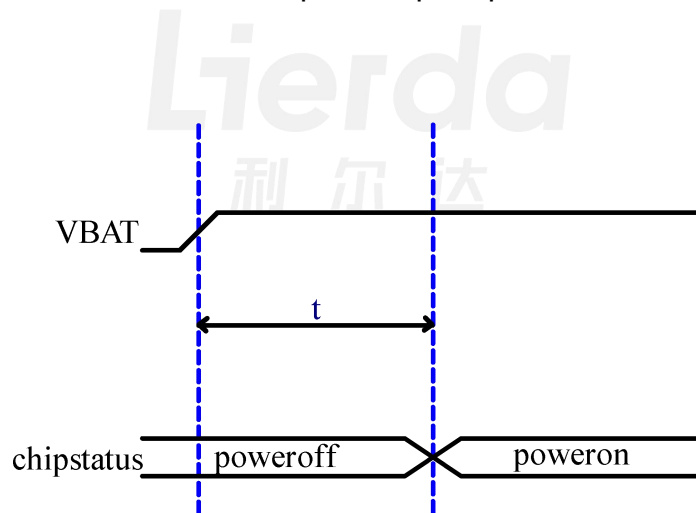


Figure 3.2 Power-on Sequence of the UB6L Module

t: chip status stable \geq VDD power on +208ms

The module reaches a stable state 208ms after power-on, so it is required to operate the module after power-on for \geq 208ms.

4 Application Interface

4.1 USB interface

The UB6L module supports the USB 2.0 interface, which is used for communication data transmission and firmware upgrades. The interface description is as follows:

Table 4-1 USB Interface Pin Definition

Pin number	Pin Definition	Description	Note
4	D-	USB differential data (-)	Differential impedance control is required during design.
5	D+	USB differential data (+)	

4.2 USB circuit reference design

USB signals are differential high-speed signals. When designing, it is necessary to pay attention to controlling the differential impedance and ensuring equal length. Please refer to the design below:

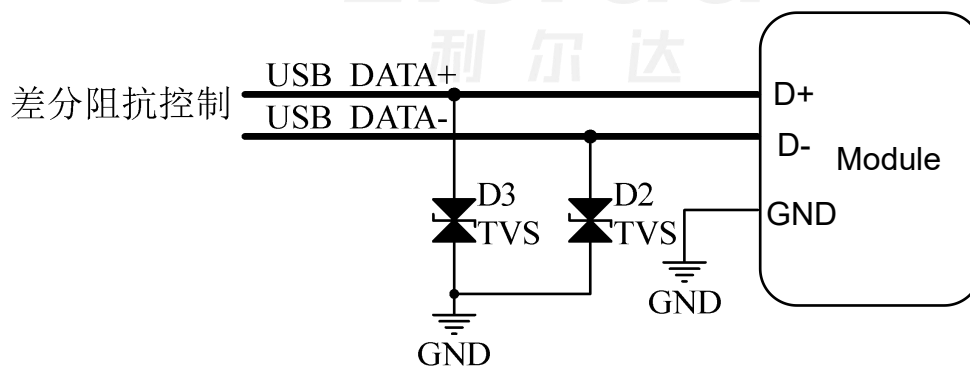


Figure 4.1 USB Reference Design

D2 and D3 are TVS diodes used to prevent interference caused by hot-plugging of the USB interface, which may lead to abnormal operation of the internal circuit. When connected to an external USB connector, TVS diodes need to be added and placed near the USB interface. It is recommended to choose protective devices with a junction capacitance less than 0.6pF.

USB differential line routing precautions:

- Differential impedance control at 90 Ohm $\pm 15\%$;

- Common mode impedance control at 30 Ohm $\pm 30\%$, and ensure equal length;

- Cable Skew is less than 100ps, Cable Delay is less than 26ns;

- The area around the wiring needs to be treated with grounding, away from areas with crystal oscillators, crystals, magnetic devices or equipment, radio frequency signals, etc.

5 Radio Frequency Characteristics

5.1 Antenna interface

Table 5-1 Antenna Interface Definition

Pin number	Pin definition	I/O Type	Description	Note
2	WL_BT_ANT	RF	2.4G Wi-Fi & BT antenna interface	50 ohm characteristic impedance

5.2 Wi-Fi performance

Table 5-2 Wi-Fi Performance Parameters

Performance	Description	
Wireless standard	IEEE 802.11b/g/n/ax(@2.4GHz),Wi-Fi compliant	
Working frequency	2.400GHz ~ 2.4835GHz (2.4GHz ISM Band)	
Channel	2.4GHz: Ch1 ~ Ch13	
Modulation method	802.11b	DQPSK,DBPSK,CCK
	802.11g/n: OFDM	64-QAM,16-QAM,QPSK,BPSK

	802.11ax: OFDMA	1024-QAM,256-QAM,64-QAM, 16-QAM,QPSK,BPSK
Transmit power	802.11b/1Mbps	20dBm ± 2dB@EVM ≤ -10.5dB
	802.11b/11Mbps	20dBm ± 2dB@EVM ≤ -15.5dB
	802.11g/6Mbps	20dBm ± 2dB@EVM ≤ -5dB
	802.11g/54Mbps	16dBm ± 2dB@EVM ≤ -25dB
	802.11n/MCS0(20/40M)	20dBm ± 2dB@EVM ≤ -5dB
	802.11n/MCS7(20/40M)	16dBm ± 2dB@EVM ≤ -27dB
	802.11ax/MCS0(20/40M)	20dBm ± 2dB@EVM ≤ -5dB
	802.11ax/MCS9(20/40M)	16dBm ± 2dB@EVM ≤ -32dB
	802.11ax/MCS11(20/40M)	15dBm ± 2dB@EVM ≤ -35dB
Frequency Tolerance	±20ppm	
Receive Sensitivity (11b,20MHz) @8% PER	1Mbps	PER@-98.5dBm,typical
	11Mbps	PER@-91dBm,typical
Receive Sensitivity (11g,20MHz) @10% PER	6Mbps	PER@-94dBm,typical
	54Mbps	PER@-77.5dBm,typical
Receive Sensitivity (11n,20MHz) @10% PER	MCS=0	PER@-94dBm,typical
	MCS=7	PER@-75.5dBm,typical
Receive Sensitivity (11n,40MHz) @10% PER	MCS=0	PER@-91dBm,typical
	MCS=7	PER@-72.5dBm,typical
Receive Sensitivity (11ax,20MHz) @10% PER	MCS=0	PER@-93.5dBm,typical
	MCS=9	PER@-68.5dBm,typical
Receive Sensitivity (11ax,40MHz) @10% PER	MCS=0	PER@-89.5dBm,typical
	MCS=9	PER@-65.5dBm,typical

5.3 BT performance

The UB6L module supports BLE mode.

5.3.1 LE mode

Table 5-3 BT performance parameters

Performance	Description
Bluetooth standard	BLE5.2
Working frequency	2.402GHz ~ 2.480GHz
Channel	LE: Ch0 ~ Ch39
Modulation method	GFSK
Transmit power	3~10dBm
Sensitivity @ PER=30.8% for LE(1Mbps)	-101.5dBm
Sensitivity @ PER=30.8% for LE(2Mbps)	-98.5dBm
sensitivity, @ PER=30.8% for LE Coded (S=2)	-106.5dBm
sensitivity, @ PER=30.8% for LE Coded (S=8)	-111dBm
Maximum input level	0dBm

5.4 Reference design

When using the UB6L module, a π -type matching circuit needs to be reserved between the WL_BT_ANT antenna interface of the module and the antenna interface of the baseboard. It is recommended to use the antenna matching circuit with the initial parameters as shown in the figure below:

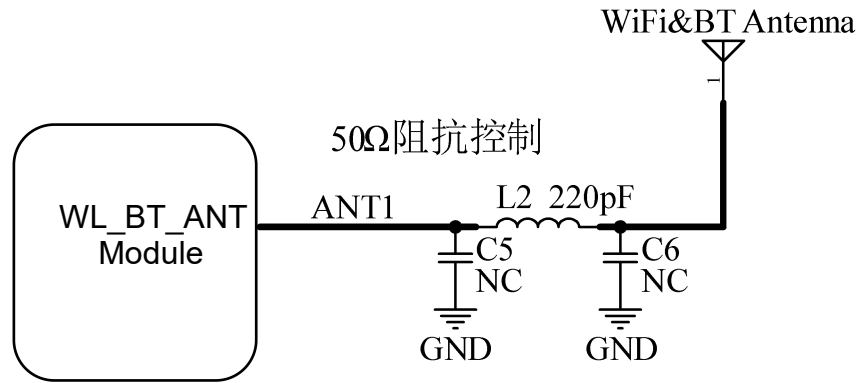


Figure 5.1 Antenna Reference Design Circuit

L2 defaults to using a 220pF capacitor or a 0 ohm resistor, with C5 and C6 missing for matching reservation, and their final values will be determined based on actual debugging results.

The routing of the antenna interface to the mainboard antenna must ensure 50 Ω impedance control, the routing should be as short as possible, without vias, and without sharp angle turns. Ground vias should be added around the RF routing. As shown in Figure 5.2 below:

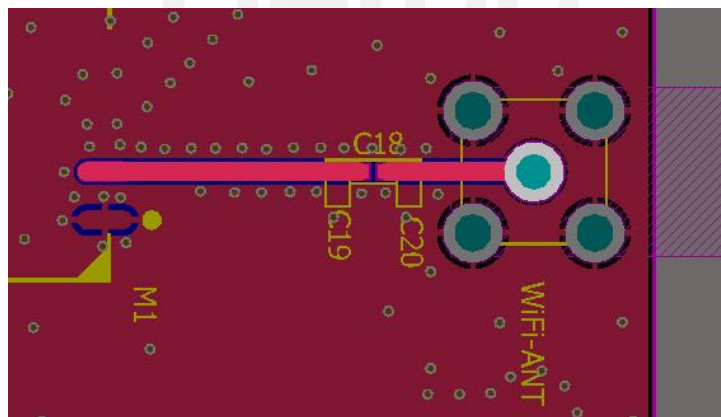


Figure 5.2 Impedance line of the bottom plate

The relationship between board thickness and line width and spacing can be referred to:

Recommended values for FR4 double-sided board (H=board thickness, W=trace width, D=trace to copper distance)

- H=1.0mm, W=0.8mm, D=0.2mm
- H=1.0mm, W=1.0mm, D=0.254mm (recommended)

- H=1.2mm, W=1.0mm, D=0.2mm (recommended)
- H=1.6mm, W=1.0mm, D=0.2mm (recommended)

For π -type matching circuits, to avoid introducing additional parasitic parameters that could increase the difficulty of debugging, it is recommended to place them as shown in the following figure:

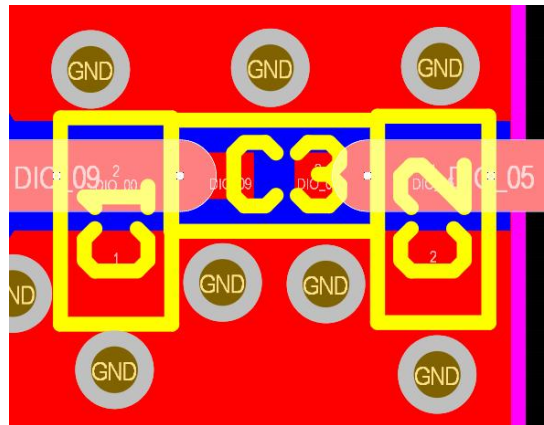


Figure 5.3 Matching circuit LC placement

6 Electrical performance and reliability

6.1 Rated power value

Parameters	Description	Minimum value	Typical value	Maximum value	Unit
V _{DD}	Power Supply	3.0	3.3	3.6	V

6.2 Power consumption

Description	Test conditions	Maximum value	
		@TX(mA)	@RX(mA)
Wi-Fi data transmission	802.11b,11Mbps@20dBm	247	32
	802.11g,54Mbps@16dBm	130	32
	802.11n,HT20,MCS7@16dBm	127	32
	802.11n,HT40,MCS7@16dBm	98	33
	802.11ax,HE20,MCS11@15dBm	104	33
	802.11ax,HE40,MCS11@15dBm	92	33
BT data transmission	BLE @1M default power	120	65
	BLE @2M default power	80	65
	BLE @S=8 default power	145	65
	BLE @S=2 default power	110	66

6.3 Digital logic voltage characteristics

Parameters	Description	Minimum value	Typical value	Maximum value	Unit
V _{IL}	CMOS Low Level Input Voltage	0	/	0.3*VDD	V
V _{IH}	CMOS High Level Input Voltage	0.7*VDD	/	VDD	V
V _{TH}	CMOS Threshold Voltage	/	0.5*VDD	/	V

6.4 Electrostatic protection

Parameters	Description	Minimum value	Typical value	Maximum value	Unit
V _{ESD}	VDD&ANT PIN ESD performance	/	1	/	KV

6.5 Working and storage temperature

Parameters	Description	Minimum value	Typical value	Maximum value	Unit
T _A	Operating temperature	-20	/	+80	°C
T _{Storage}	Storage temperature	-40	/	+85	°C

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7 Reference design

7.1 Schematic diagram

The UB6L series module interface consists of three parts: power supply, USB interface, and RF antenna port. For specific detailed design content of each part, please refer to Chapters 3, 4, and 5.

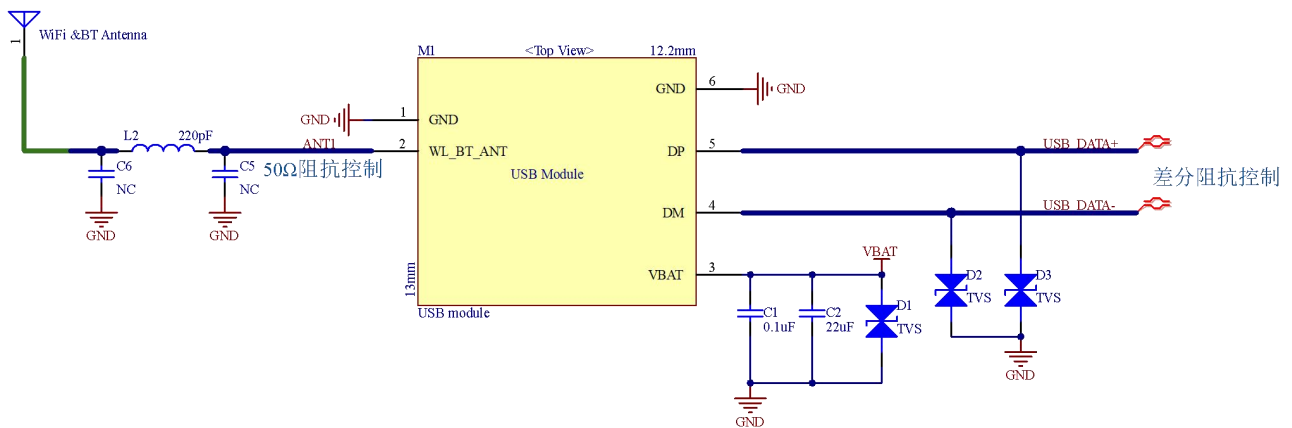


Figure 7.1 Reference Design Schematic

7.2 Layout considerations for the motherboard

The UB6L module's BOTTOM layer has no high-speed or sensitive signal traces, but it is recommended to route the traces on the top layer of the baseboard away from the module to avoid unexpected influences.

The test pad and version information window on the BOTTOM layer of the module are exposed with copper, and avoidance treatment needs to be done. Over holes or exposed copper cannot be placed at the corresponding positions on the bottom plate to prevent short circuits. The window opening on the Bottom layer of the module is as shown in the diagram below:

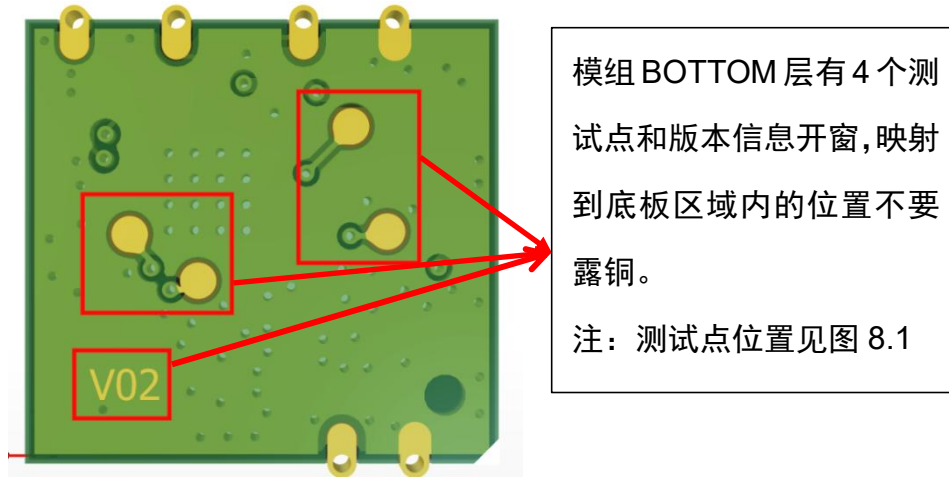


Figure 7.2 UB6L module bottom window position

7.3 Precautions for placing peripheral components of the module

The safety distance that needs to be controlled for components of 0402 and below in the outermost Mechanical 1 layer of the module package. If there are components of 0402 and below on the substrate, they need to be placed outside the outer Mechanical 1 layer to avoid interference during product placement, causing product abnormalities.

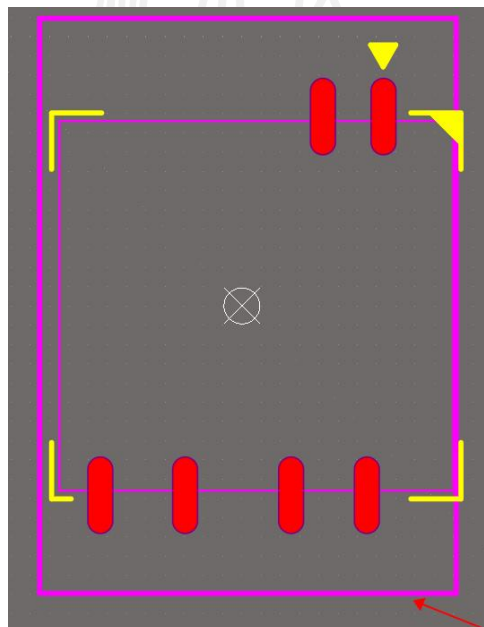


Figure 7.3 UB6L Module Recommended Package

8 Mechanical dimensions

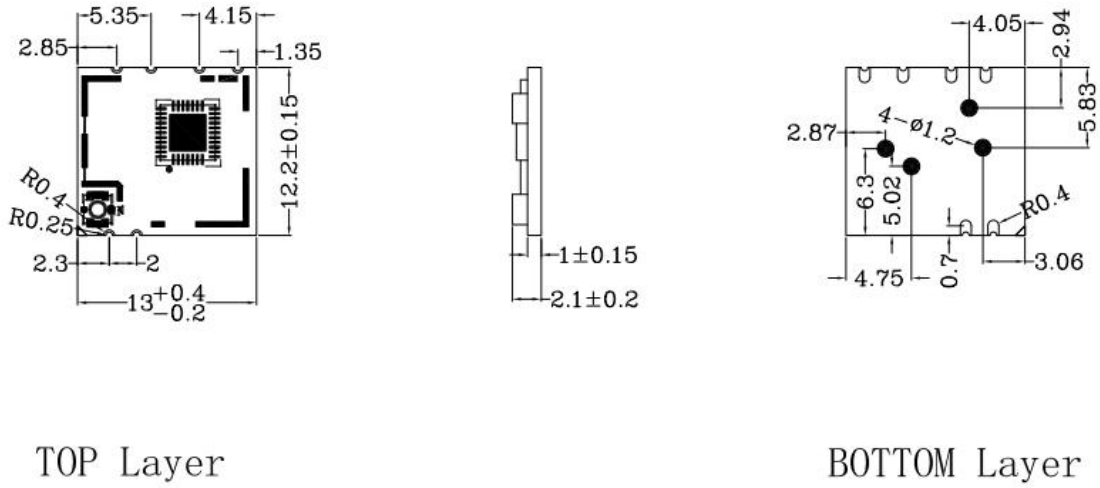


Figure 8.1 Module Outline Dimension Diagram

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9 Production and packaging information

9.1 Production welding

9.1.1 Production Guide

It is recommended to use SMT machine for patching in the stamp mouth sealing module, and the patching should be completed within 24 hours after unpacking. Otherwise, the vacuum packaging needs to be re-drawn to avoid moisture causing poor patching.

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: $125^{\circ}\text{C}\pm 5^{\circ}\text{C}$;

The alarm temperature is set to 130°C ;

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

If the unpacking time exceeds 3 months, special attention should be paid to whether the product is damp, because the PCB immersion gold process may cause oxidation of the solder joints after more than 3 months, which may lead to problems such as false soldering and soldering leakage during SMT.

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 placement, to ensure the reasonableness of oven temperature control, component adsorption method, and placement method.

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

9.1.2 Module positioning requirements on the baseplate

It is suggested that the green oil thickness at the bottom 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. Additionally, it is necessary to ensure that no other components are arranged within 2mm around the interface board module position to facilitate module maintenance.

9.1.3 Steel mesh opening design

The selection of the thickness of the steel mesh on the substrate 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 positions can be locally thickened to 0.15-0.20mm to avoid voids.

9.1.4 Production precautions

- During the production process, all operators must wear antistatic gloves.
- Baking should not exceed the specified baking time;
- No explosive, flammable, or corrosive substances are allowed to be added 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 time the door is open as much as possible.
- After baking, wait for the module to cool naturally to below 36°C before wearing electrostatic gloves to prevent scalding.
- When operating, be sure to prevent the bottom of the module from getting wet or dirty;

9.1.5 Reflow soldering operation guide

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

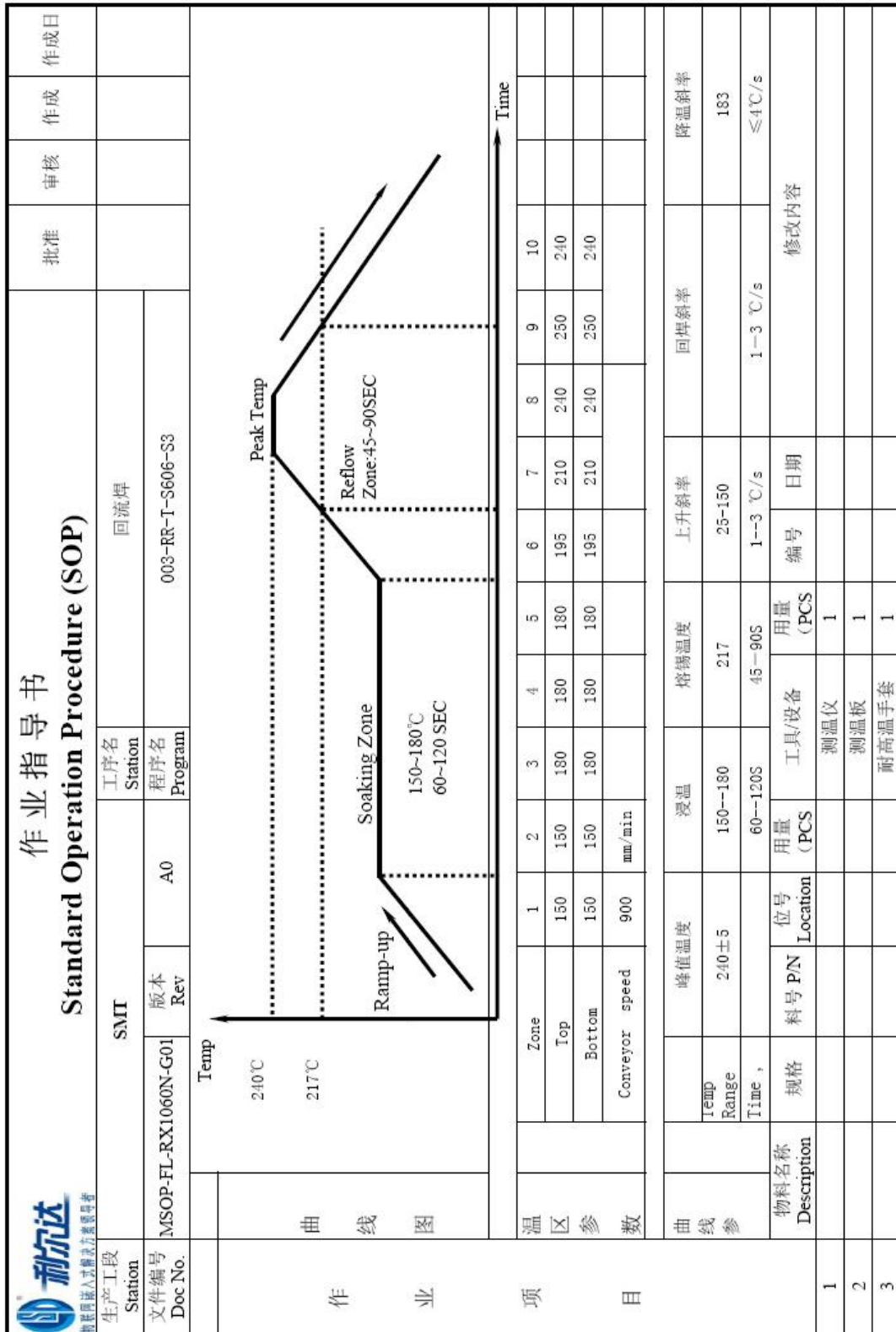


Figure 9.1 Reflow Soldering Operation Manual

9.2 Packaging specifications

9.2.1 Packaging method

Model	Packaging method	Carton (PCS)	Minimum packaging quantity (PCS)	Number of reels per carton
L-WFMUB6L-G5NI4	Roller belt	6500	1300	5

9.2.2 Dimensions of the tape and product orientation.

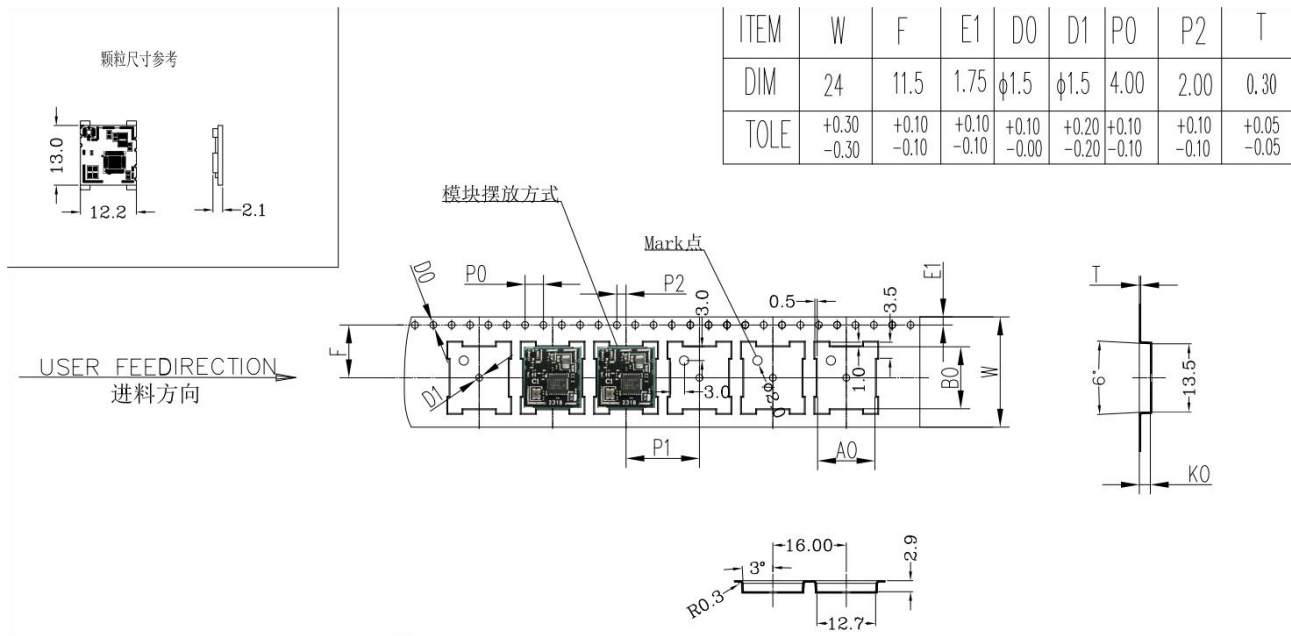


Figure 9.2 Tape Dimensions and Product Orientation