Lierda UB64 Series Hardware Design Manual

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Revision History

Document Version	Change Date	Reviser	Reviewer	Change content
Rev1.0	23-07-25	WZJ	YB	Initial Version
Rev1.0	23-11-8	WZJ	YB	Add test conditions

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 following safety principles, personal safety can be ensured and potential damage to products and work environments can be prevented. Our company is not responsible for any losses resulting from customers' failure to comply with these regulations.

	Road safety comes first! Do not use handheld mobile devices while driving unless they have a hands-free function. 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 airplane to prevent interference with the aircraft communication system. Ignoring this prompt may jeopardize 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 bill or the SIM card is invalid in the mobile terminal device. When you encounter the above situation in an emergency, please remember to use emergency calls, and ensure that 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 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 location with potential explosion hazards poses a safety risk.

Module selection for application

Serial number	Module model	Support frequency bands	Dimensions (mm)	Module introduction
1	L-WFMUB64-D5NN4	2.4 GHz ISM Band / 5GHz Band	13×12.2×2.6	

Content

1 Introduction

The UB64 series is a dual-band USB interface Wi-Fi 6 module that supports 802.11b/a/g/n/ac/ax 2.4GHz & 5GHz and BR/EDR/BLE5.4 functions. Its WLAN function supports USB 2.0 interface, while the Bluetooth function supports UART interface and USB 2.0 interface. The module supports 5/10MHz narrowband & 20MHz/40MHz bandwidth to ensure backward and network compatibility, and can be widely used in areas such as high-definition network cameras, OTT/IPTV/DVB/set-top boxes, medical devices, and more.

Figure 1.1 Product Appearance Diagram

2 Product Overview

2.1 Key Features

Interface	Postage interface
Wireless standard	IEEE 802.11 b/a/g/n/ac/ax+BR/EDR/BLE5.4
Module packaging	13 mm × 12.2 mm × 2.6 mm
Operating voltage	3.0V~3.6V, typical value is 3.3V
Working frequency band	2400~2483.5MHZ(2.4 GHz ISM Band) 5180~5825MHz(5GHz Band)
Operating temperature	-20 ~ +80℃
Storage temperature	-40 ~ +85℃
Communication Interface	USB 2.0
Bandwidth	Support 5/10MHz narrowband & standard 20/40MHz bandwidth.
MAC	IEEE802.11 d/e/i/k/v/w

2.2 Product advantages

(1) Supports IEEE 802.11 b/a/g/n/ac/ax@2.4GHz&5GHz

(2) Built-in BR/EDR/BLE5.4

(3) Support STA, AP, and Wi-Fi Direct modes.

(4) Support WEP/WPA/WPA2/WPA3-SAE Personal, MFP frequency band

(5) Support USB 2.0 interface

(6) Support MU-MIMO, OFDMA

(7) Support Wi-Fi 6 TWT

(8) Support Wi-Fi 5G AUX

2.3 Application Scenarios

- High-definition network camera, surveillance PTZ
- OTT/IPTV/DVB set-top box
- Smart medical devices

2.4 Function Block Diagram

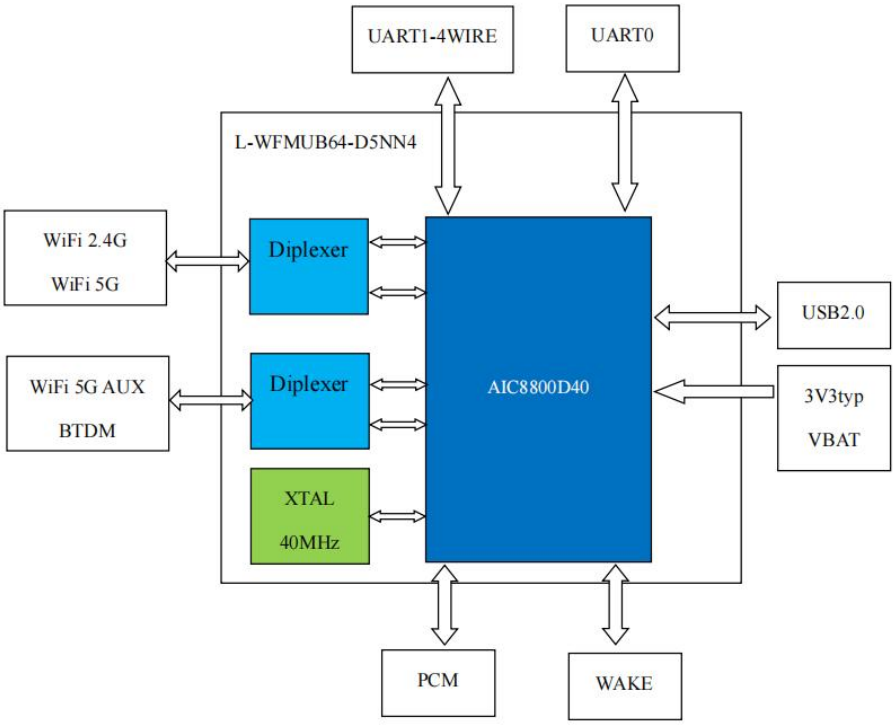

Figure 2.1 Functional Diagram

2.5 Pinout diagram

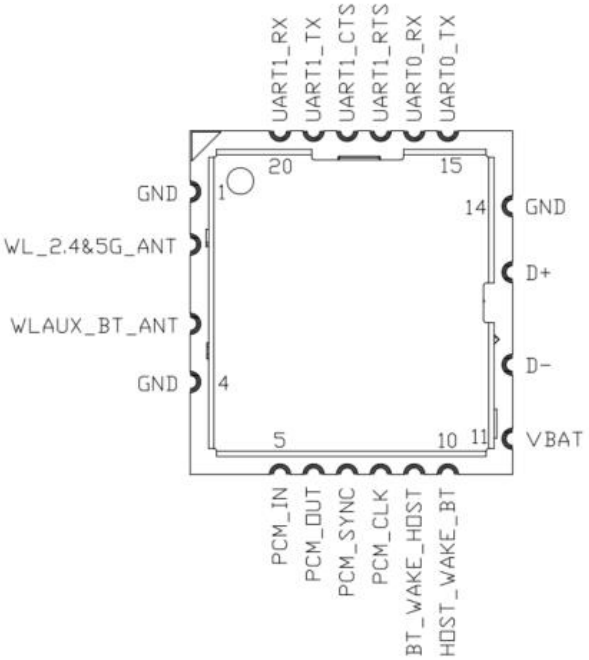

Figure 2.2 Pinout Diagram

2.6 Pin Description Table

Pins	Pin definition	I/O type	Function Description
1	GND	G	Grounding pin
2	WL_2.4&5G_ANT	RF	Wi-Fi 2.4G & 5G antenna pins
3	WLAUX_BT_ANT	RF	WIFI 5G AUX&BT antenna pins
4	GND	G	Grounding pin
5	PCM_IN	I/O	PCM input pin
6	PCM_OUT	I/O	PCM output pin
7	PCM_SYNC	I/O	PCM frame sync signal pin
8	PCM_CLK	I/O	PCM clock pin
9	BT_WAKE_HOST	I/O	Bluetooth wake-up host pin (High level effective by default, low level)
10	HOST_WAKE_BT	I/O	Host wake-up Bluetooth pin (High-level active)
11	VBAT	P	Power supply pin (typical value 3.3V)
12	D-	I/O	USB DATA Pin
13	D+	I/O	USB DATA+ pin
14	GND	G	Grounding pin
15	UART0_TX	I/O	Debug the serial port TX pin (921600bps).
16	UART0_RX	I/O	Debug the serial port RX pin (921600bps).
17	UART1_RTS	I/O	Bluetooth flow control pin
18	UART1_CTS	I/O	Bluetooth flow control pin
19	UART1_TX	I/O	Bluetooth serial port TX pin
20	UART1_RX	I/O	Bluetooth serial port RX pin

Note

"P":POWER "I":INPUT "O":OUTPUT "G":GND

BT function usage instructions can be found in the driver user manual, and the

wake-up function is only available when using Bluetooth UART1 communication.

For PCM function adaptation customization, please consult separately.

3 Characteristics of work

3.1 Power supply design

3.1.1 Power interface

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

Table 3-1 Power Supply Pin Definitions

Pin number	Pin definition	Describe	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 preferably not less than 700mA.

3.1.2 Power supply design

The UB64 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, make sure the supply voltage is not lower than 3.0V. The VDD pin needs to provide a power capability of 700mA peak current, and the power ripple is recommended to be within 10mV to avoid excessive ripple causing degradation in RF performance. The recommended power supply circuit is as follows:

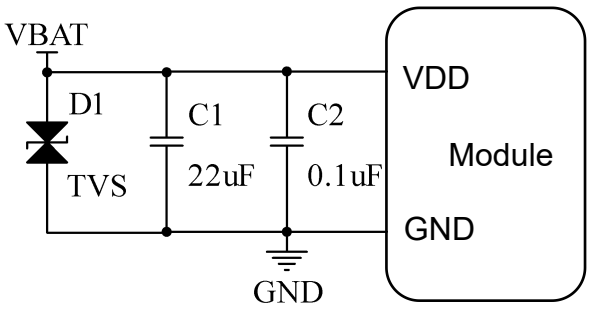

Figure 3.1 Power Supply Recommended Design

Note

For D1 TVS electrostatic protection, it is recommended to place TVS diodes for electrostatic protection.

4 Application Interface

4.1 USB interface

The UB64 module supports USB 2.0 interface, which is used for communication data transfer. The interface description is as follows:

Table 4-1 USB Interface Pin Definitions

Pin number	Pin definition	Description	Note
4	D-	USB differential data (-)	Designing requires controlling the differential impedance.
5	D+	USB differential data (+)	

4.2 USB circuit reference design

USB signals are differential high-speed signals. When designing, it is important to control the differential impedance and ensure equal length. Please refer to the design below:

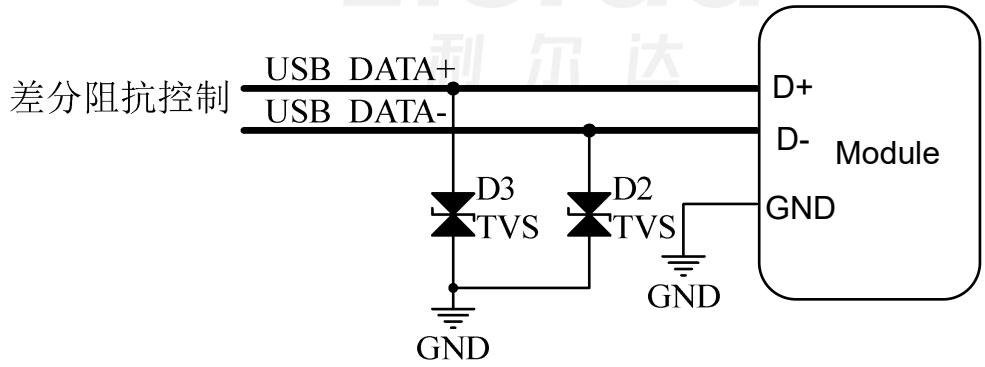

Figure 4.1 USB Reference Design

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 circuits. When connected to an external USB connector, it is recommended to add TVS diodes placed near the USB interface. It is suggested to choose protective devices with a junction capacitance less than 0.6pF.

USB differential line routing considerations:

- Differential impedance control at 90Ohm ±15%;
- Common mode impedance is controlled at 30 Ohm ±30%, and ensure they are of equal length;
- Cable Skew is less than 100ps, Cable Delay is less than 26ns;
- Wiring around needs to be treated with ground insulation, away from areas with crystal oscillators, crystals, magnetic devices or equipment, RF 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_2.4&5G_ANT	RF	2.4G Wi-Fi & BT antenna interface	50Ω characteristic impedance
3	WLAUX_BT_ANT	RF	WIFI AUX & BT antenna pins	50Ω characteristic impedance

5.2 Wi-Fi performance

Table 5-2 Wi-Fi Performance Parameters (Test Environment: 25℃/3.3V)

Performance	Description	
Wireless standard	IEEE 802.11b/a/g/n/ac/ax(@2.4GHz&5GHz), Wi-Fi compliant	
Working frequency	2.400 GHz ~ 2.4835 GHz (2.4 GHz ISM Band) 5180 ~ 5825MHz(5GHz Band)	
Channel	2.4GHz：CH1 ~ CH13 5GHz: CH36 ~ CH165	
Modulation method	802.11b	DQPSK,DBPSK,CCK
	802.11 a/g/n/ac: OFDM	64-QAM,16-QAM,QPSK,BPSK，256-QAM,
	802.11ax：OFDMA	1024-QAM,256-QAM,64-QAM, 16-QAM,QPSK,BPSK
Transmit power @2.4G	802.11b/1Mbps	18dBm@EVM ≤ -10.5dB,Typical
	802.11b/11Mbps	18dBm@EVM ≤ -15.5dB,Typical
	802.11g/6Mbps	18dBm,Typical@EVM ≤ -5dB,Typical
	802.11g/54Mbps	15dBm@EVM ≤ -25dB,Typical
	802.11n/MCS0(20/40M)	18dBm@EVM ≤ -5dB,Typical
	802.11n/MCS7(20/40M)	15dBm@EVM ≤ -27dB,Typical
	802.11ax/MCS0(20/40M)	18dBm@EVM ≤ -5dB,Typical

	802.11ax/MCS9(20/40M)	14dBm@EVM ≤ -32dB,Typical
	802.11ax/MCS11(20/40M)	13dBm@EVM ≤ -35dB,Typical
Transmit power @5G	802.11a / 6Mbps	18dBm@EVM ≤ -5dB,Typical
	802.11a /54Mbps	15dBm@EVM ≤ -25dB,Typical
	802.11n /MCS0 (20/40M)	18dBm@EVM ≤ -5dB,Typical
	802.11n /MCS7 (20/40M)	15dBm@EVM ≤ -27dB,Typical
	802.11ac /MCS0 (20/40M)	18dBm@EVM ≤ -5dB,Typical
	802.11ac /MCS9 (20/40M)	14dBm@EVM ≤ -32dB,Typical
	802.11ax /MCS0 (20/40M)	18dBm@EVM ≤ -5dB,Typical
	802.11ax /MCS9 (20/40M)	13dBm@EVM ≤ -32dB,Typical
	802.11ax MCS11 (20/40M)	12dBm@EVM ≤ -35dB,Typical
Frequency tolerance	±20ppm	
Receive Sensitivity (11b,20MHz) @8% PER	1Mbps	-97.5dBm@2.4G,Typical
	11Mbps	-89.5dBm@2.4G,Typical
Receive Sensitivity (11g,20MHz) @10% PER	6Mbps	-94dBm@2.4G,Typical
	54Mbps	-78dBm@2.4G,Typical
Receive Sensitivity (11n,20MHz) @10% PER	MCS=0	-94dBm@2.4G,Typical
	MCS=7	-75dBm@2.4G,Typical
Receive Sensitivity (11n,40MHz) @10% PER	MCS=0	-91dBm@2.4G,Typical
	MCS=7	-73dBm@2.4G,Typical
Receive Sensitivity (11ax,20MHz) @10% PER	MCS=0	-93.5dBm@2.4G,Typical
	MCS=7	-74dBm@2.4G,Typical
	MCS=9	-68dBm@2.4G,Typical

	MCS=11	-67dBm@2.4G,Typical
Receive Sensitivity (11ax,40MHz) @10% PER	MCS=0	-90dBm@2.4G,Typical
	MCS=7	-72dBm@2.4G,Typical
	MCS=9	-67dBm@2.4G,Typical
	MCS=11	-64dBm@2.4G,Typical
Receive Sensitivity (11a,20MHz) @10% PER	6Mbps	-94dBm@5G,Typical
	54Mbps	-77.5dBm@5G,Typical
Receive Sensitivity (11n,20MHz) @10% PER	MCS=0	-94dBm@5G,Typical
	MCS=7	-75dBm@5G,Typical
Receive Sensitivity (11n,40MHz) @10% PER	MCS=0	-91dBm@5G,Typical
	MCS=7	-72dBm@5G,Typical
Receive Sensitivity (11ac,20MHz) @10% PER	MCS=0	-94dBm@5G,Typical
	MCS=8	-71dBm@5G,Typical
Receive Sensitivity (11ac,40MHz) @10% PER	MCS=0	-91dBm@5G,Typical
	MCS=7	-72dBm@5G,Typical
	MCS=9	-66dBm@5G,Typical
Receive Sensitivity (11ax,20MHz) @10% PER	MCS=0	-92dBm@5G,Typical
	MCS=7	-73dBm@5G,Typical
	MCS=9	-70dBm@5G,Typical
	MCS=11	-65dBm@5G,Typical
Receive Sensitivity (11ax,40MHz) @10% PER	MCS=0	-89.5dBm@5G,Typical
	MCS=7	-72.5dBm@5G,Typical
	MCS=9	-67dBm@5G,Typical
	MCS=11	-62dBm@5G,Typical
AUX Sensitivity	6Mbps	-94dBm@5G,Typical

(11a，20MHz) @10% PER	54Mbps	-77.5dBm@5G,Typical
AUX Sensitivity (11n，20MHz) @10% PER	MCS=0	-94dBm@5G,Typical
	MCS=7	-75dBm@5G,Typical
AUX Sensitivity (11n，40MHz) @10% PER	MCS=0	-91dBm@5G,Typical
	MCS=7	-72dBm@5G,Typical
AUX Sensitivity (11ac，20MHz) @10% PER	MCS=0	-94dBm@5G,Typical
	MCS=8	-71dBm@5G,Typical
AUX Sensitivity (11ac，40MHz) @10% PER	MCS=0	-90.5dBm@5G,Typical
	MCS=9	-65.5dBm@5G,Typical
AUX Sensitivity (11ax，20MHz) @10% PER	MCS=0	-93dBm@5G,Typical
	MCS=11	-64.5dBm@5G,Typical
AUX Sensitivity (11ax，40MHz) @10% PER	MCS=0	-89.5dBm@5G,Typical
	MCS=11	-61.5dBm@5G,Typical

5.3 BT performance

The UB64 module has BR/EDR/BLE modes.

5.3.1 LE mode

Table 5-3 BLE Performance Parameters (Test Environment: 25℃/3.3V)

Performance	Description
Bluetooth standard	BLE5.4
Working frequency	2.402GHz ~ 2.480GHz
Channel	LE：Ch0 ~ Ch39
Modulation method	GFSK
Carrier transmission power	9dBm,Typical
Modulated Wave Power (DTM)	10dBm,Typical
Sensitivity @ PER=30.8% for LE(1Mbps)	-95dBm,Typical
Sensitivity @ PER=30.8% for LE(2Mbps)	-92dBm,Typical

Sensitivity, @ PER=30.8% for LE Coded (S=2)	-100dBm,Typical
Sensitivity, @ PER=30.8% for LE Coded (S=8)	-102dBm,Typical
Maximum input level	0dBm,Typical

5.3.2 BR+EDR mode

Table 5-4 BR+EDR Performance Parameters (Test Environment: 25℃/3.3V)

Performance	Description	
Bluetooth standard	BR+EDR	
Working frequency	2.402GHz ~ 2.480GHz	
Channel	BR/EDR：Ch0 ~ Ch78	
Modulation method	BR (1M)	GFSK
	EDR (2M)	π/4-DQPSK
	EDR (3M)	8DPSK
Transmit Power	BR (1M)	9dBm,Typical
	EDR (2M)	6dBm,Typical
	EDR (3M)	6dBm,Typical
Sensitivity @BER=0.1% for GFSK(1Mbps)	-94dBm，Typical	
Sensitivity @BER=0.01% for π/4-DQPSK(2Mbps)	-92dBm，Typical	
Sensitivity @ BER=0.01% for 8DPSK(3Mbps)	-86dBm，Typical	
Maximum input level	GFSK(1Mbps)	0dBm
	π/4-DQPSK(2Mbps)	0dBm
	8DPSK(3Mbps)	0dBm

5.4 Reference design

The UB64 module has two RF interfaces, namely WL_2.4&5G_ANT and WLAUX_BT_ANT. The WL_2.4&5G_ANT interface is the main Wi-Fi antenna interface for 2.4G and 5G, while the WLAUX_BT_ANT interface is for Wi-Fi 5G auxiliary reception + Bluetooth 2.4G antenna interface. The two interfaces use two Diplexers internally in the

module to share one antenna for 2.4G and 5G.

The π-type matching circuit needs to be reserved between the antenna interface of the module and the antenna interface of the baseboard. The following circuits should be reserved for both RF ports. It is recommended to use the antenna matching circuit with the initial parameters as shown in the figure below:

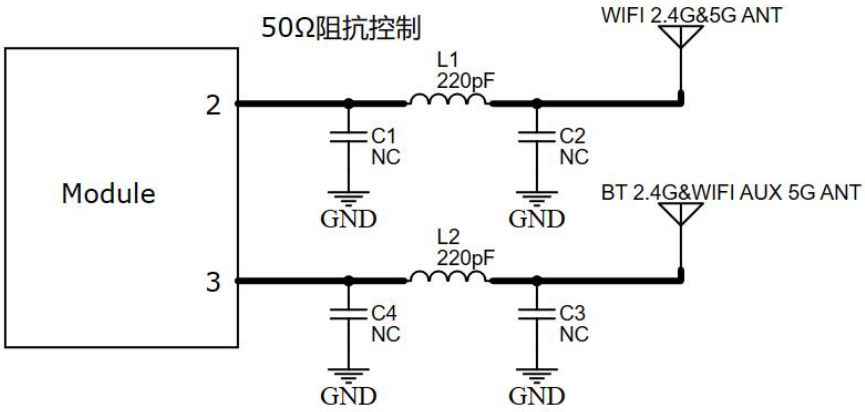

Figure 5.1 Antenna reference design circuit

L2 defaults to using a 220pF capacitor or a 0 ohm resistor, C5 and C6 are not populated, reserved for matching, their final values will be determined based on actual tuning results.

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

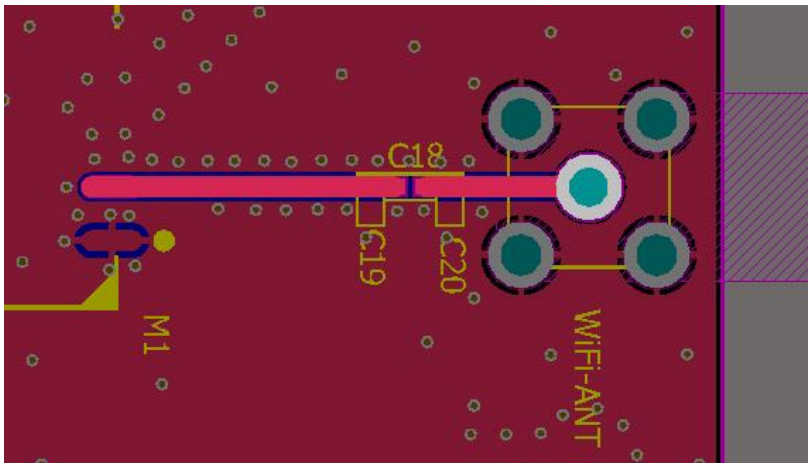

Figure 5.2 Impedance line of the bottom plate

The relationship between copper thickness and line width/space can be referenced:

Recommended values for FR4 double-sided boards (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 the π-type matching circuit, to avoid introducing additional parasitic parameters that may affect the difficulty of debugging, it is recommended to place it as shown in the following figure:

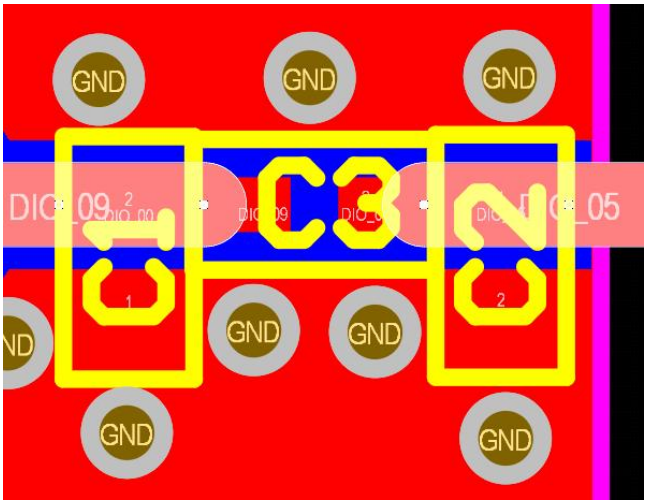

Figure 5.3 Matching circuit LC placement method

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 (test environment: 25℃/3.3V)	Current (mA)		
		I_{Ave} @TX	I_{Peak} @TX	I_{Ave}@RX
Wi-Fi data transmission	802.11b,11Mbps@20dBm	190(Duty 50%)	360	65
	802.11ax,HE20,MCS11@13dBm	85(Duty 20%)	300	65
	802.11ax,HE40,MCS11@12dBm	80(Duty 20%)	300	65
BT data transmission	BLE@1M default power	90	110	58
	BR@DH5 default power	78	125	58
	EDR@3DH5 default power	68	100	58

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 Static electricity protection

Parameters	Describe	Minimum value	Typical value	Maximum value	Unit
V_{ESD} VDD&ANT PIN ESD	HBM:JS - 001 - 2017	/	3	/	KV
	CDM:JS - 001 - 2018	/	0.8	/	KV

performance	IEC61000-4-2 contact discharge	/	2	/	KV

6.5 Work and storage temperature

Parameters	Description	Minimum value	Typical value	Maximum value	Unit
T_A	Operating temperature	-20	/	+80	℃
$T_{Storage}$	Storage temperature	-40	/	+85	℃

7 Reference design

7.1 Schematic diagram

The UB64 series module interface consists of three parts: power supply, USB interface, and RF antenna port. Specific detailed design content for each part can be found in Chapters 3, 4, and 5.

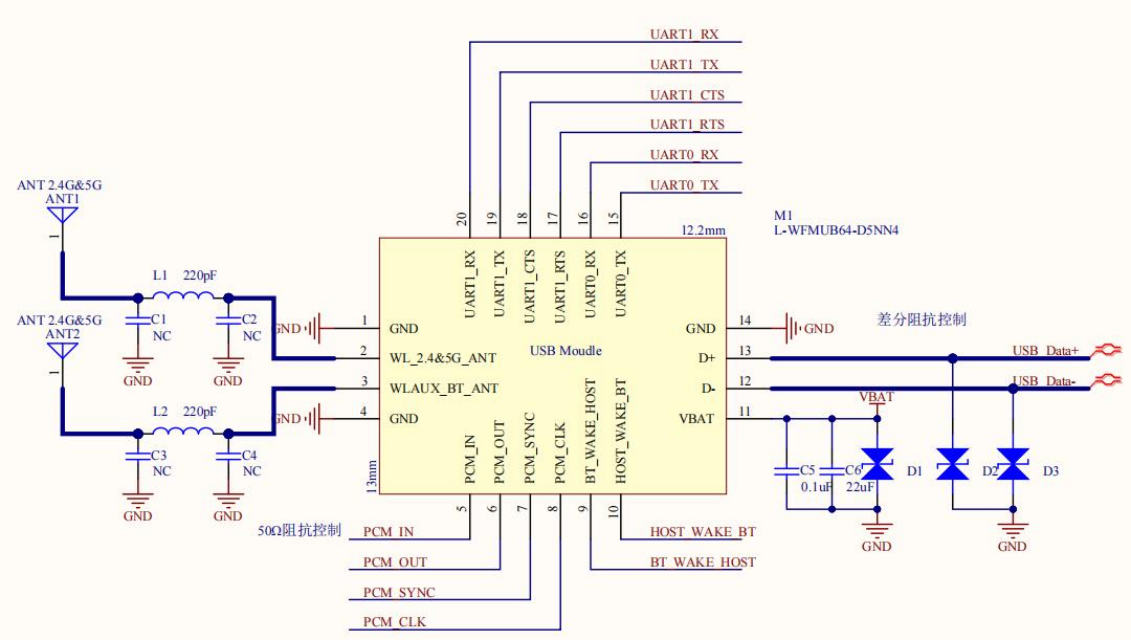

Figure 7.1 Reference Design Schematic

7.2 Layout considerations for the motherboard

The UB64 module BOTTOM layer has no high-speed signals or sensitive signal traces, but it is still recommended to route traces on the top layer of the baseboard away from the module to avoid unexpected influencing factors.

There are no excessive requirements for 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. There are two GND pads on the bottom, do not route traces below to avoid short circuits.

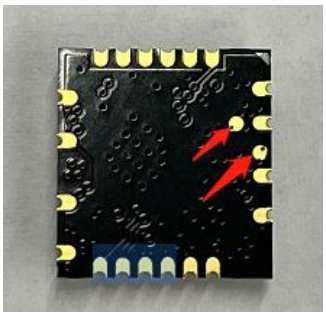

Figure 7.2 Physical Image of the Module Bottom

8 Mechanical dimensions

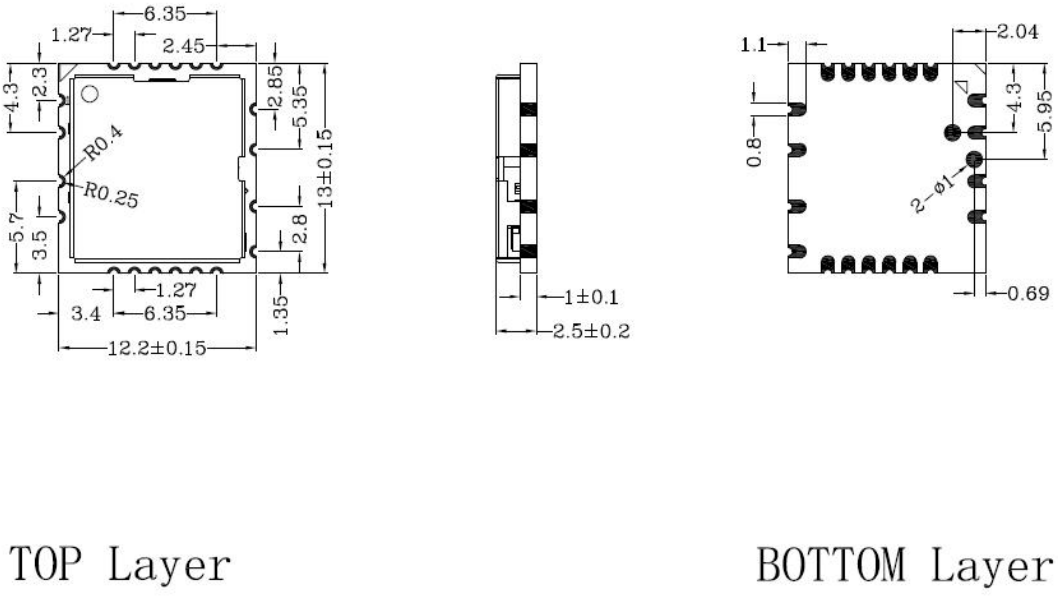

Figure 8.1 Module Outline Dimensions

9 Production and packaging information

9.1 Production welding

9.1.1 Production Guide

It is recommended to use SMT machines for the stamping of the seal module, and the stamping should be completed within 24 hours after unpacking. Otherwise, the vacuum packaging needs to be resealed to avoid moisture causing poor stamping.

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°C ± 5°C;

The alarm temperature is set to 130℃.

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

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

To ensure the qualification 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 furnace 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 location requirements on the baseboard

It is recommended that the green oil thickness of the bottom plate module position be less than 0.02mm to avoid excessive thickness, which may cause the pad module to not

effectively contact the solder paste, affecting the welding quality. In addition, please note that within 2mm around the interface board module position, no other components should be arranged to ensure the maintenance of the module.

9.1.3 Steel mesh opening design

The thickness of the steel mesh on the bottom plate is selected 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 pad position of the module can be locally thickened to 0.15-0.20mm to avoid solder voids.

9.1.4 Production precautions

- During the production process, all operators must wear antistatic 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.
- 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 it is necessary to 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 avoid scalding.
- When operating, be sure to prevent the bottom of the module from getting wet or dirty.

9.1.5 Reflow soldering operation guide

This assignment guide is only suitable for lead-free operations and is for reference only.

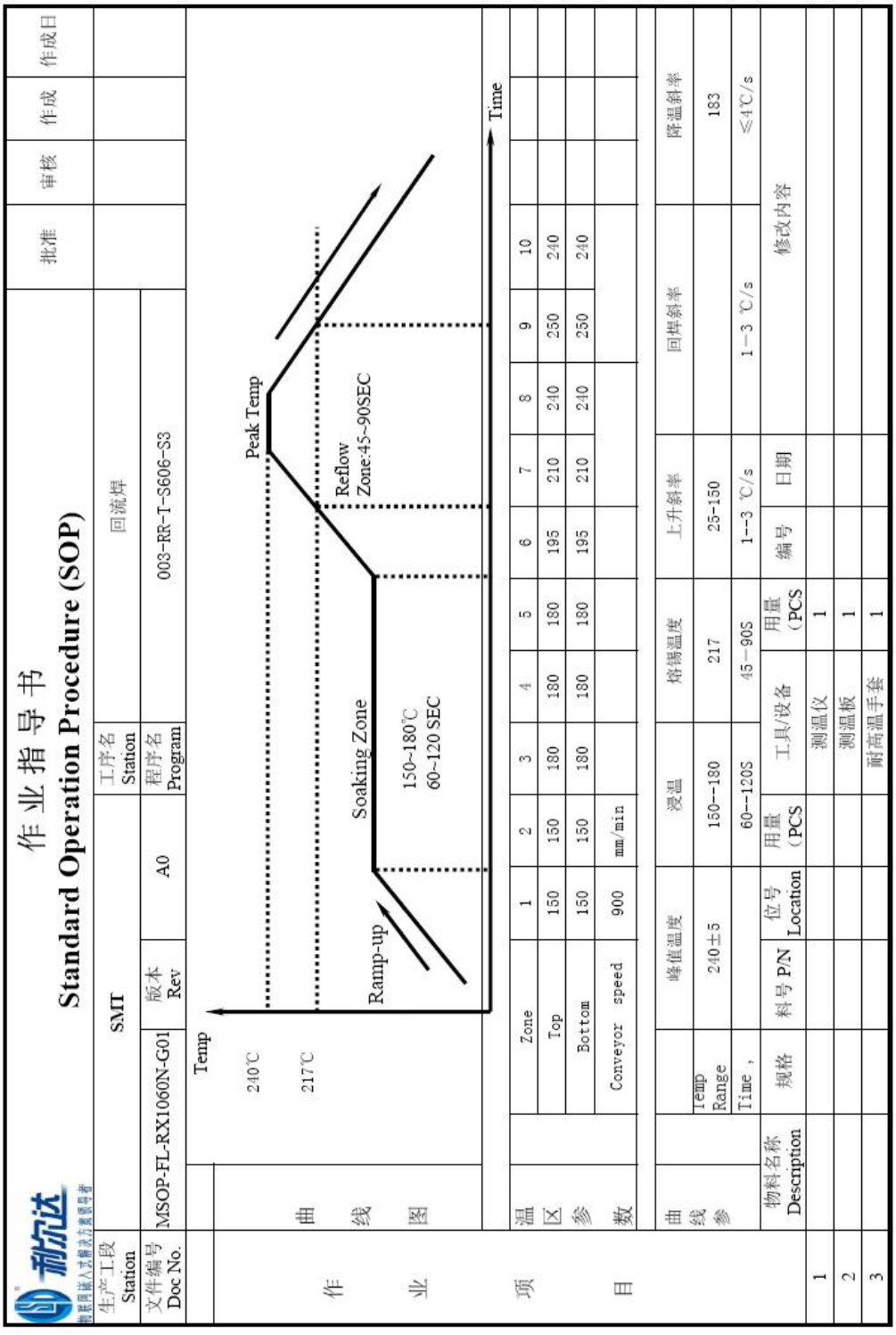

Figure 9.1 Reflow Soldering Operation Manual

9.2 Packaging specifications

9.2.1 Packaging method

Model	Packaging method	Carton (PCS)	Minimum packaging quantity (PCS)	Number of rolls per box.
L-WFMUB64-D5NN4	Roller belt	6500	1300	5

9.2.2 Size of the tape and product orientation

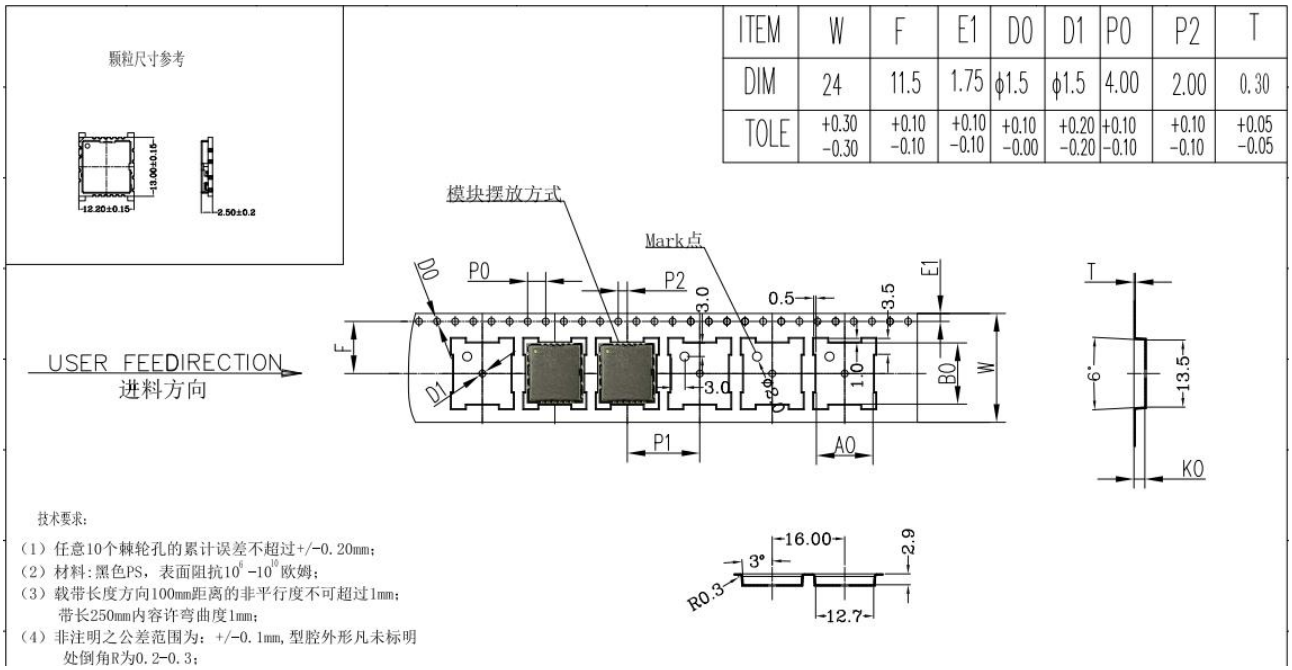

Figure 9.2 Tape Dimensions and Product Orientation