Lierda WB81 Series Hardware Design Manual

Version：Rev1.0

Date：23/03/13

State：Controlled Version

Company Address: Lierda Internet of Things Technology Park, No. 1326 Wenyi West Road, Hangzhou

Tel：0571-88800000

Legal Notices

If you receive this document from Lierda Technology Group Co., Ltd. (hereinafter referred to as "Lierda"), you have agreed to the following terms. If you do not agree to the following terms, please stop using this document.

This product complies with the design requirements for environmental protection and personal safety. The storage, use and disposal of the product should be carried out in accordance with the requirements of the product manual, relevant contracts or relevant laws and regulations.

The company reserves the right to modify and improve the products described in this manual without prior notice; at the same time, it reserves the right to revise or withdraw this manual at any time.

Company Address: Lierda Internet of Things Technology Park, No. 1326 Wenyi West Road, Hangzhou

Tel：0571-88800000

Revision History

Version	Date	Draft	Approved	Revision Content
Rev 1.0	2023-01-13	TYY	YB	Initial Version

Company Address: Lierda Internet of Things Technology Park, No. 1326 Wenyi West Road, Hangzhou

Tel：0571-88800000

Safety Instructions

It is the user's responsibility to follow the relevant regulations of other countries on wireless communication modules and equipment, as well as their specific operating environment regulations. By following the safety principles below, you can ensure personal safety and help protect the product and work environment from potential damage. Our company is not responsible for related losses caused by customers' failure to follow these regulations.

	Road safety first! Do not use a handheld mobile terminal while driving unless it has a hands-free function. Please stop and call again!
	Please turn off the mobile terminal device before boarding the plane. The wireless function of the mobile terminal is prohibited on the aircraft to prevent interference with the aircraft communication system. Ignoring this prompt may affect flight safety or even violate the law.
	When in a hospital or health care facility, pay attention to whether there are restrictions on the use of mobile terminal equipment. RF interference can cause medical equipment to malfunction and it may be necessary to switch off the mobile terminal equipment.
	The mobile terminal device does not guarantee a valid connection in all cases, eg no call charges or SIM invalidation on the mobile terminal device. When you encounter the above situations in an emergency, please remember to use the emergency call, and at the same time make sure that your device is powered on and in an area with sufficient signal strength.
	Your mobile terminal equipment will receive and transmit radio frequency signals when it is turned on, and radio frequency interference will be generated when it is close to a TV, radio, computer or other electronic equipment.
	Please keep the mobile terminal away from flammable gas. When you are close to gas stations, oil depots, chemical plants or explosive workplaces, please turn off the mobile terminal device. Operating electronic equipment in any potentially explosive atmosphere is a safety hazard.

Applicable Module Selection

No.	Model Name	Support Frequency Band	Dimension(mm)	Description
1	L-WFIWB81-G5PP4	2.4GHz ISM Band	31.4×18×3.35	IoT Wi-Fi Module

Contents

1 Introduction

WB81 series is a high-performance universal IoT Wi-Fi4 module that supports 802.11b/g/n @ 2.4 GHz and Bluetooth 4.2 (BR/EDR/BLE) functions (currently only the onboard antenna version is optional). The module is scalable and self-adaptive, powerful and versatile. The built-in chip contains an Xtensa® 32-bit LX6 single/dual-core CPU that can be individually controlled, and the main clock frequency supports adjustment within the range of 80 MHz to 240 MHz; the module has rich internal development resources and provides optional PSRAM and FLASH with different capacities (default 2 MB PSRAM and 8 MB FLASH); supports TCP/IP protocol, fully complies with 802.11 Wi-Fi MAC protocol stack, data transmission rate up to 150 Mbps, antenna output power up to 20 dBm, can achieve a wide range of wireless communication. At the same time, WB81 supports optimizing the effective working time and realizing power consumption management by minimizing host interaction; it also integrates a wealth of peripherals, including Hall sensors, SD card interface, Ethernet interface, high-speed SPI, UART, I2S and I2C, etc., can be widely used in mobile devices, low-power IoT sensor hubs, photovoltaic communication sticks/collectors, smart homes and other fields.

Figure 1.1 WB81 Series Module

2 Overview

2.1 Product Information

Table 2-1 Product Information

Module	Description
L-WFIWB81-G5PP4	ESP32, b/g/n Wi-Fi, 1T1R, 31.4mm*18mm*3.35mm, with shield, TVS and 40MHz Crystal.

2.2 General Specification

Table 2-2 General Specification

Feature	Description
Interface	Stamp hole
Wireless Standard	IEEE 802.11 b/g/n + BT 4.2 (BR/EDR+BLE)
Dimension	18.0 mm × 31.4 mm × 3.35 (Max) mm
Operating Voltage	3.0 V ~ 3.6 V ， Typ 3.3 V
Frequency Range	2400 ~ 2483.5 MHz (2.4 GHz ISM Band)
Operating Temperature	-40 ~ +85 ℃
Storage Temperature	-40 ~ +105 ℃
Communication Interface	SD card, UART, SPI, SDIO, I2C, LED PWM, I2S, IR, Capacitive TOUCH, pulse counter, GPIO, ADC, DAC, TWAI® and Ethernet interface, etc.
Bandwidth	Support 20/40MHz bandwidth
Storage Characteristics	Initial model supports 2 MB PSRAM (QSPI) and 8 MB FLASH (QSPI)

2.3 Features

Figure 2.1 Schematic diagram of module structure

● Shielding frame + shielding cover combination structure is adopted, the shielding cover is flexible to install and disassemble, and it is convenient for visual inspection and maintenance. The module structure is shown in Figure 2.1; and heat-dissipating silica gel is added to the chip, and the heat dissipation performance can be optimized up to 5°C in a 25°C working environment. ℃, optimized up to 10℃ under 85℃ working environment.

● Support IEEE 802.11b/g/n @ 2.4G (802.11n, transmission speed up to 150 Mbps).

● Support Bluetooth 4.2, including traditional Bluetooth (BR/EDR) and low-power Bluetooth (Bluetooth LE).

● Support infrastructure network (Infrastructure BSS) Station/Soft AP/hybrid mode.

● Supports CCMP (CBC-MAC, counter mode), TKIP (MIC, RC4), WAPI (SMS4), WEP (RC4) and CRC.

● Standard HCI based on SDIO/SPI/UART interface.

● High-speed UART HCI, up to 4 Mbps.

● Support CVSD and SBC audio codec algorithms.

● Ethernet MAC interface with dedicated DMA supporting IEEE 1588.

- Supports the two-wire automotive interface TWAI®, compliant with ISO 11898-1 (CAN specification 2.0).
- Cryptographic hardware accelerators such as AES, Hash (SHA-2), RSA, ECC, and Random Number Generator (RNG) are supported.

2.4 Applications

- Photovoltaic communication stick/collector
- Smart Gateway Device
- Smart Home Appliances
- Health/Medical/Nursing Equipment

2.5 Block Diagram

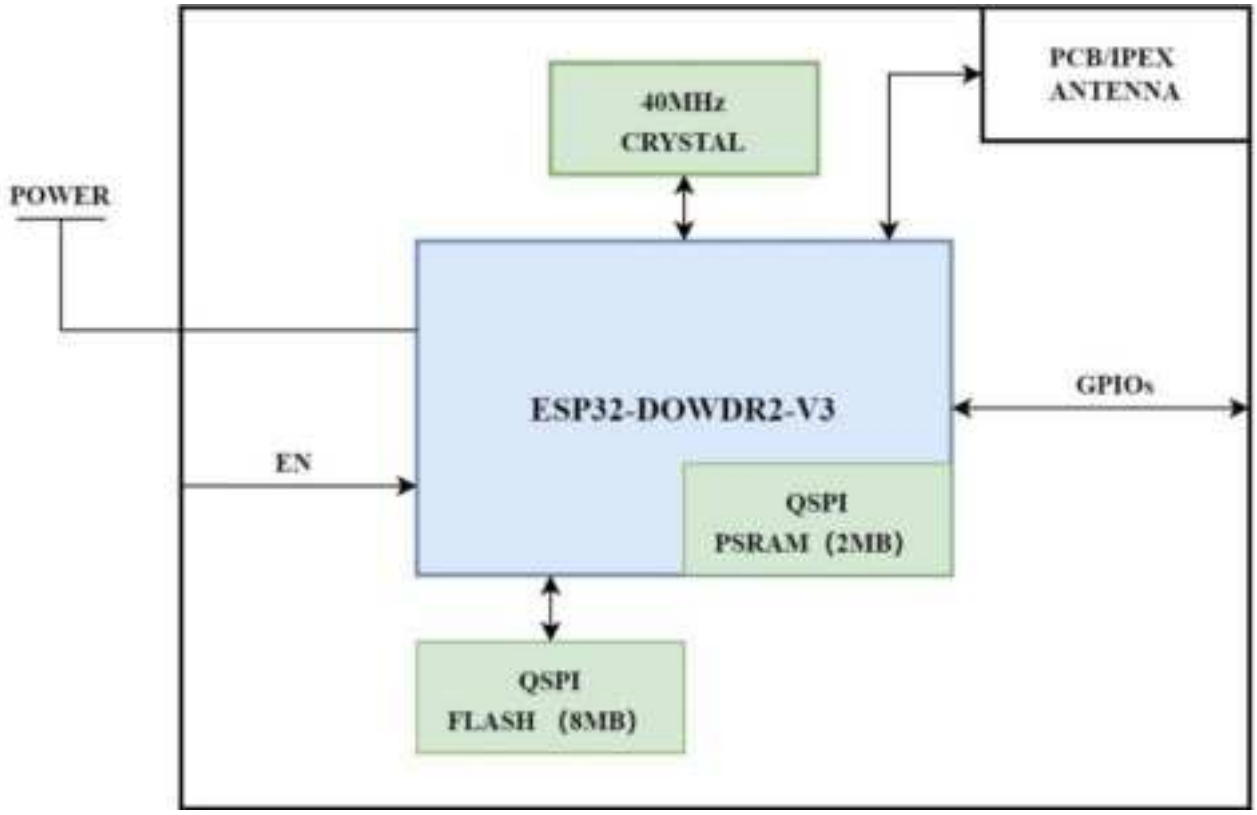

Figure 2.2 WB81 Block Diagram

2.6 Pin Assignments

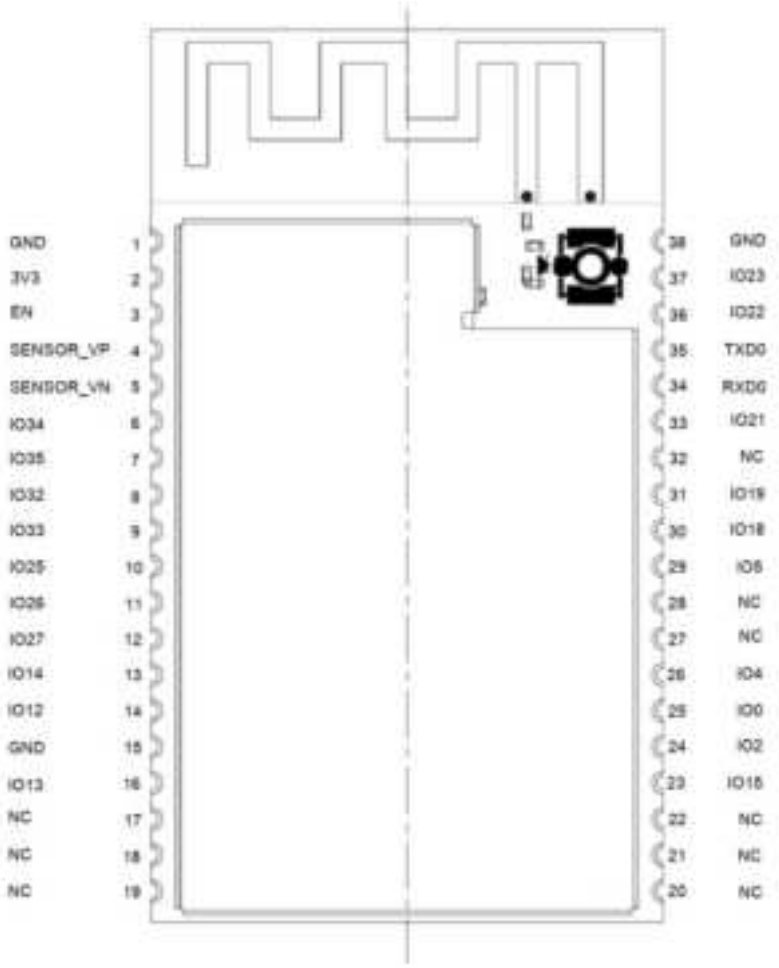

Figure 2.2 Pin Outline

2.7 Pin Definition

Table 2-3 Pin Definition

No.	Name	Type	Description
1	GND	P	Ground
2	3V3	P	Power supply
3	EN	I	Module-enable signal, Active high, which is connected to pin CHIP_PU on the IC
4	SENSOR_VP	I	GPIO36, ADC1_CH0, RTC_GPIO0

5	SENSOR_VN	I	GPIO39, ADC1_CH3, RTC_GPIO3
6	IO34	I	GPIO34, ADC1_CH6, RTC_GPIO4
7	IO35	I	GPIO35, ADC1_CH7, RTC_GPIO5
8	IO32	I/O	GPIO32,XTAL_32K_P(32.768 kHz crystal oscillator input), ADC1_CH4, TOUCH9, RTC_GPIO9
9	IO33	I/O	GPIO33, XTAL_32K_N (32.768 kHz crystal oscillator output), ADC1_CH5, TOUCH8, RTC_GPIO8
10	IO25	I/O	GPIO25, DAC_1, ADC2_CH8, RTC_GPIO6, EMAC_RXD0
11	IO26	I/O	GPIO26, DAC_2, ADC2_CH9, RTC_GPIO7, EMAC_RXD1
12	IO27	I/O	GPIO27, ADC2_CH7, TOUCH7, RTC_GPIO17, EMAC_RX_DV
13	IO14	I/O	GPIO14, ADC2_CH6, TOUCH6, RTC_GPIO16, MTMS, HSPICLK, HS2_CLK, SD_CLK, EMAC_TXD2
14	IO12	I/O	GPIO12, ADC2_CH5, TOUCH5, RTC_GPIO15, MTDI, HSPIQ, HS2_DATA2, SD_DATA2, EMAC_TXD3
15	GND	P	Ground
16	IO13	I/O	GPIO13, ADC2_CH4, TOUCH4, RTC_GPIO14, MTCK, HSPID, HS2_DATA3, SD_DATA3, EMAC_RX_ER
17	NC	-	Pulled up and not connected
18	NC	-	Pulled up and not connected
19	NC	-	Pulled up and not connected
20	NC	-	Pulled up and not connected
21	NC	-	Pulled up and not connected
22	NC	-	Pulled up and not connected
23	IO15	I/O	GPIO15, ADC2_CH3, TOUCH3, MTDO, HSPICS0, RTC_GPIO13, HS2_CMD, SD_CMD, EMAC_RXD3
24	IO2	I/O	GPIO2, ADC2_CH2, TOUCH2, RTC_GPIO12, HSPIWP, HS2_DATA0, SD_DATA0
25	IO0	I/O	GPIO0, ADC2_CH1, TOUCH1, RTC_GPIO11, CLK_OUT1, EMAC_TX_CLK
26	IO4	I/O	GPIO4, ADC2_CH0, TOUCH0, RTC_GPIO10, HSPIHD, HS2_DATA1, SD_DATA1, EMAC_TX_ER
27	NC	-	Pulled up and not connected

28	NC	-	Pulled up and not connected
29	IO5	I/O	GPIO5, VSPICS0, HS1_DATA6, EMAC_RX_CLK
30	IO18	I/O	GPIO18, VSPICLK, HS1_DATA7
31	IO19	I/O	GPIO19, VSPIQ, U0CTS, EMAC_TXD0
32	NC	-	Pulled up and not connected
33	IO21	I/O	GPIO21, VSPIHD, EMAC_TX_EN
34	RXD0	I/O	GPIO3, U0RXD, CLK_OUT2
35	TXD0	I/O	GPIO1, U0TXD, CLK_OUT3, EMAC_RXD2
36	IO22	I/O	GPIO22, VSPIWP, U0RTS, EMAC_TXD1
37	IO23	I/O	GPIO23, VSPID, HS1_STROBE
38	GND	-	Ground

NOTE

Note:P indicates a power supply pin and I/O indicates an input/output pin.

2.8 Strapping pin

The WB81 module has 5 strapping pins: MTDI (GPIO12), GPIO0, GPIO2, MTDO (GPIO15) and GPIO5. Software can read the strapping values of these 5 pins in the register "GPIO_STRAPPING".

In the process of releasing the system reset (power-on reset, RTC watchdog reset, brown-out reset) of the module chip, the Strapping pin will sample the level and store it in the latch, and the latch is "0". or "1" and remain until the chip is powered down or turned off. And each Strapping pin will be connected to internal pull-up/pull-down. If a Strapping pin has no external connection or the connected external line is in a high-impedance state, the internal weak pull-up/pull-down will determine the default value of the Strapping pin input level. To change the value of Strapping, users can use an external pull-down/pull-up resistor, or use the GPIO of the host MCU to control the Strapping pin level when the

module is powered on and released. After the reset is released, the Strapping pin has the same function as the normal pin.

Please refer to Table 2-4 for the detailed startup mode of configuring the Strapping pin:

Table 2-4 Strapping Pin Description

Voltage of Internal LDO (VDD_SDIO)					
PIN	Default	3.3V		1.8V	
MTDI	Pull-down	0		1	
Booting Mode					
PIN	Default	SPI Boot		Download Boot	
GPIO0	Pull-up	1		0	
GPIO2	Pull-down	Do not care		0	
Enabling/Disabling Debugging Log Print over U0TXD During Booting					
PIN	Default	U0TXD Active		U0TXD Silent	
MTDO	Pull-up	1		0	
Timing of SDIO Slave					
PIN	Default	FE Sampling FE Output	FE Sampling RE Output	RE Sampling FE Output	RE Sampling RE Output
MTDO	Pull-up	0	0	1	1
GPIO5	Pull-up	0	1	0	1

NOTE

(1)FE: falling-edge, RE: rising-edge.

(2)Firmware can configure register bits to change the settings of “Voltage of Internal LDO (VDD_SDIO)” and “Timing of SDIO Slave” after booting.

(3)Internal pull-up resistor (R9) for MTDI is not populated in the module, as the flash and SRAM in the module only support a power voltage of 3.3 V (output by VDD_SDIO).

Figure 2.4 shows the setup time and hold time of the Strapping pin of the module EN (corresponding to the CHIP_PU pin of the IC) before and after power-on. The description of each parameter is shown in Table 2-5.

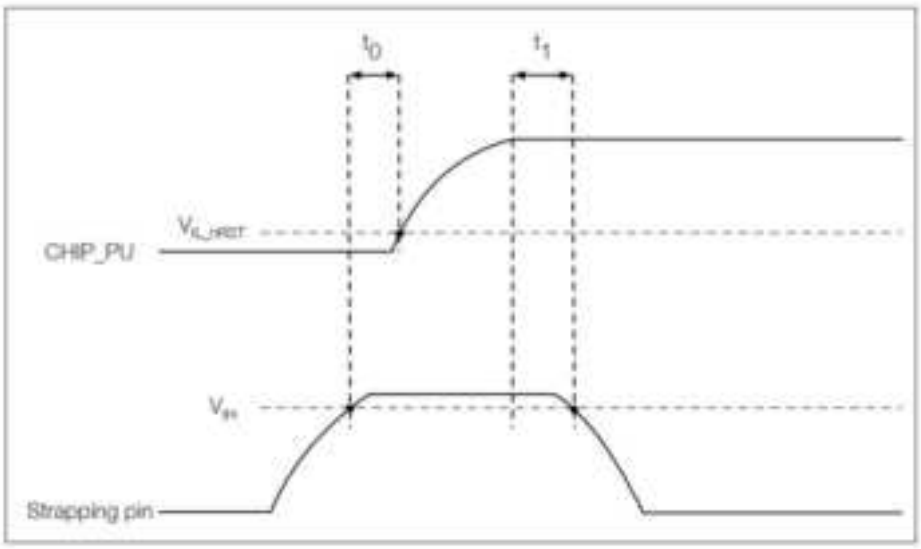

Figure 2.4 The setup time and hold time of the strapping pin

Table 2-5 Parameter description of the setup time and hold time of the Strapping pin

Parameter	Description	Min	Unit
t_0	Setup time before CHIP_PU goes from low to high	0	ms
t_1	Pull-down	1	ms

2.9 Physical Dimensions

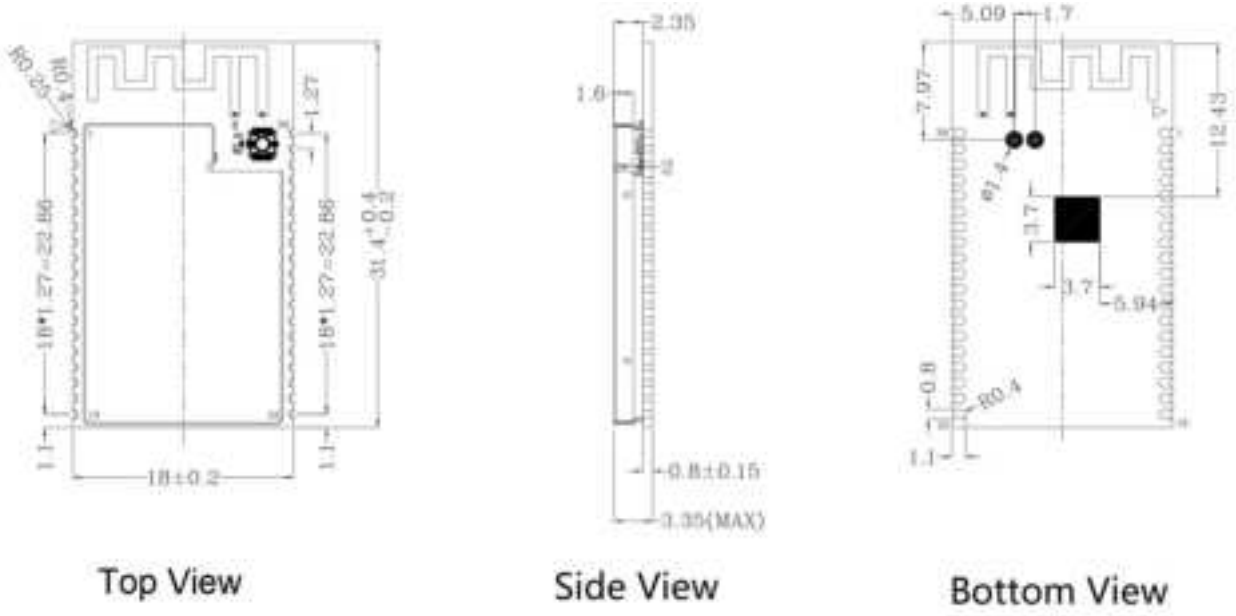

Figure 2.5 Dimensions of the module

2.10 Recommended schematic symbol and PCB package graphics

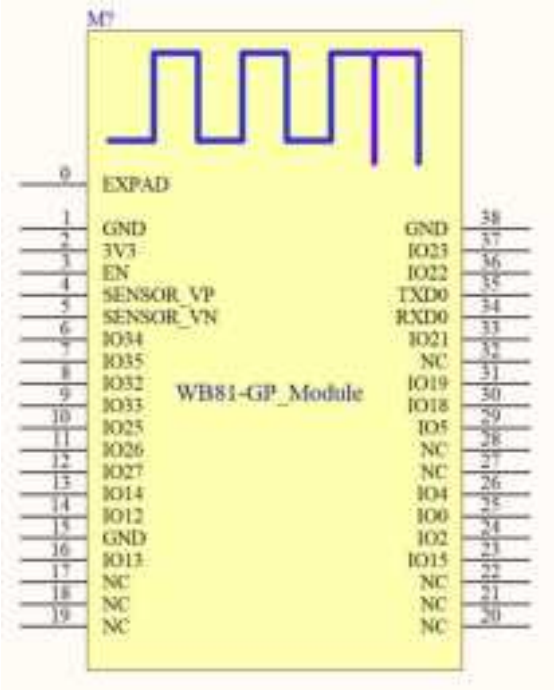

Figure 2.6 Schematic Symbol

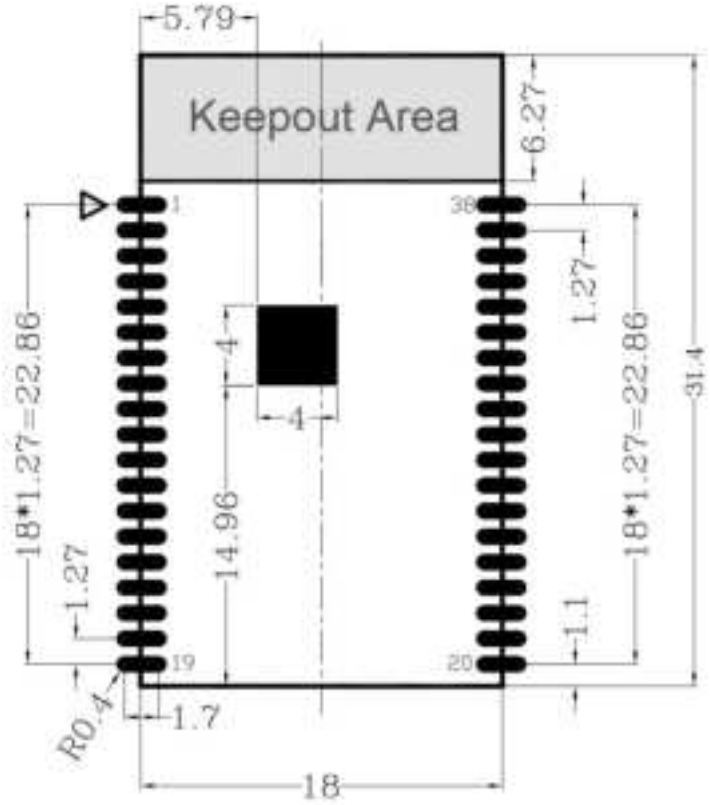

Figure 2.7 PCB Package Graphics

3 RF Characteristics

3.1 Wi-Fi RF Characteristics

Table 3-1 Module Wi-Fi RF Performance

Parameter	Content	
Frequency Range	2400 MHz ~ 2483.5 MHz (2.4 GHz ISM Band)	
Number of Channels	2.4 GHz：Ch1 ~ Ch13	
Modulation	802.11b	DQPSK, DBPSK, CCK
	802.11g/n (OFDM)	64-QAM, 16-QAM, QPSK, BPSK
Output Power	802.11b @ 1 Mbps	19.5 dBm ± 2 dB @ EVM ≤ -10.5 dB
	802.11b @11 Mbps	19.5 dBm ± 2 dB @ EVM ≤ -15.5 dB
	802.11g @ 6 Mbps	17 dBm ± 2 dB @ EVM ≤ -5 dB
	802.11g @ 54 Mbps	13 dBm ± 2 dB @ EVM ≤ -25dB
	802.11n @ MCS0 (20/40 M)	17 dBm ± 2 dB @ EVM ≤ -5dB
	802.11n @ MCS7 (20/40 M)	13 dBm ± 2 dB @ EVM ≤ -27dB
Freq. Tolerance	± 20 ppm	
Receive Sensitivity (11b, 20 MHz) @8% PER	1 Mbps	PER @ -97 dBm, typical
	11 Mbps	PER @ -88 dBm, typical
Receive Sensitivity (11g, 20 MHz) @10% PER	6 Mbps	PER @ -92 dBm, typical
	54 Mbps	PER @ -75 dBm, typical
Receive Sensitivity (11n, 20 MHz) @10% PER	MCS0	PER @ -92 dBm, typical
	MCS7	PER @ -72 dBm, typical
Receive Sensitivity (11n, 40 MHz) @10% PER	MCS0	PER @ -89 dBm, typical
	MCS7	PER @ -69 dBm, typical
Adjacent channel rejection	802.11g @ 6 Mbps	27 dB, typical
	802.11g @ 54 Mbps	13 dB, typical
	802.11n @ HT20, MCS0	27 dB, typical
	802.11n @ HT20, MCS7	12 dB, typical

Note: The module is powered by 3.3V and tested at 25℃.

3.2 BT RF Characteristics

3.2.1 BR+EDR Mode

Table 3-2 Module BR/EDR RF Performance

Parameter	Content	
Bluetooth Standard	BR+EDR	
Frequency Range	2402 MHz ~ 2480 MHz	
Channels	BR/EDR：Ch0 ~ Ch78	
Modulation	BR (1M)	GFSK
	EDR (2M)	π/4-DQPSK
	EDR (3M)	8DPSK
RF transmit power	0 dBm, typical	
Gain control step	3 dB, typical	
RF power control range	-12 ~ +9 dBm	
Sensitivity @ BER=0.1% for GFSK (1 Mbps)	-90 dBm, typical	
Sensitivity @ BER=0.01% for π/4-DQPSK (2 Mbps)	-89 dBm, typical	
Sensitivity @ BER=0.01% for 8DPSK (3 Mbps)	-82 dBm, typical	
Maximum received signal @ 0.1%/0.01% BER	GFSK (1 Mbps)	0 dBm, typical
	π/4-DQPSK (2 Mbps)	0 dBm, typical
	8DPSK (3 Mbps)	-15 dBm, typical

NOTE

The module is powered by 3.3V and tested at 25℃.

3.2.2 Bluetooth LE Mode

Parameter	Content
Bluetooth Standard	BT4.2
Frequency Range	2402 MHz ~ 2480 MHz
Channels	LE：Ch0 ~ Ch39
Modulation	GFSK
RF transmit power	0 dBm, typical
Gain control step	3 dB, typical
RF power control range	-12 ~ +9 dBm
Sensitivity @ PER = 30.8% for LE(1Mbps)	-96 dBm，typical
Maximum received signal@ 30.8% PER	0 dBm

NOTE

The module is powered by 3.3V and tested at 25℃.

3.3 Antenna area clearance design

When designing the upper board of the module, attention must be paid to the layout of the module on the bottom board, and the influence of the bottom board on the performance of the module PCB antenna should be minimized as much as possible. It is strongly recommended to place the module as close to the edge of the bottom board as possible. If conditions permit, the PCB antenna area should preferably extend out of the bottom board frame, and make the antenna feed point the closest to the half side. If there is a bottom plate under the antenna area, be sure to cut it off to minimize the impact of the bottom plate; ensure that interfering signals (such as USB, LCD, camera, power inductors, crystals, etc.) traces and vias are at least 10 mm away;If there are components with metal shells and high device heights near the module antenna area, a distance of more than 10 mm should be kept from the antenna area; when it comes to the design of the whole machine, the equipment shell (especially the material around the antenna) should be made of non-metallic materials Made, and keep at least 3 mm distance between the antenna and the housing, and please pay attention to the influence of the housing on the antenna.In Figure 3.1, positions (3) and (4) of the WB81-GP module on the backplane are strongly recommended, positions (1), (2), (5) and (6) are not recommended, especially position (5) , the bottom plate will greatly attenuate the radiation capability of the antenna if the area of the module antenna is not cleared.

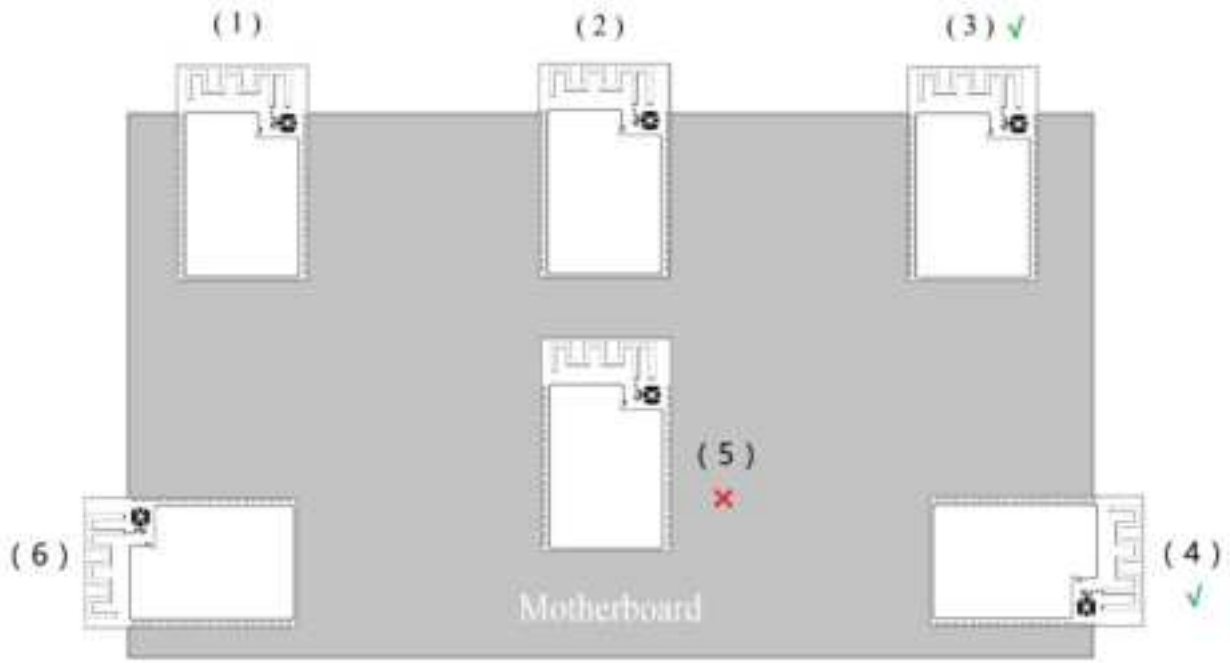

Figure 3.1 Schematic diagram of the position of the WB81-GP module on the bottom plate

If the above method is limited and cannot be implemented in an ideal situation, please ensure that the module is not wrapped by any metal casing, and the PCB antenna area of the module and the 15 mm extended area must be strictly clear, as shown in Figure 3.2:

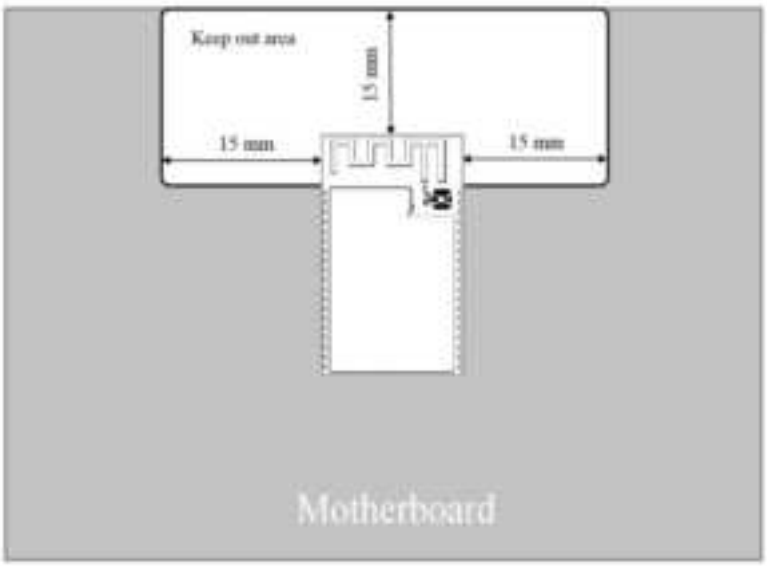

Figure 3.2 Schematic diagram of the clearance of the antenna area

4 Reference Design

4.1 Peripheral schematic design reference

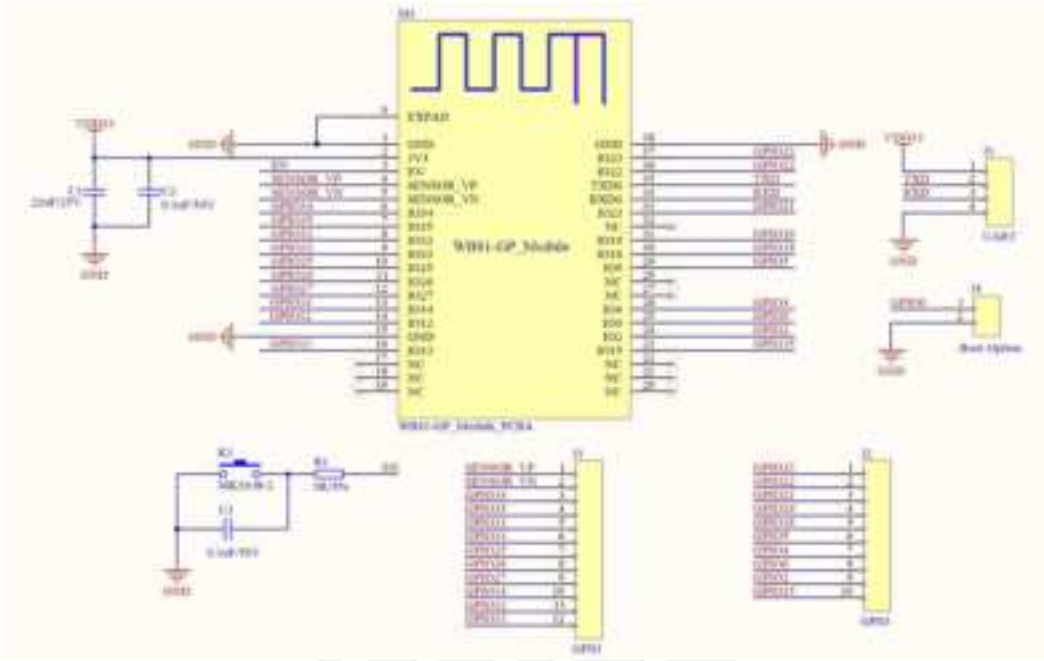

Figure 4.1 WB81-GP module hardware reference design

When the WB81-GP module works in TX mode, the instantaneous current will increase, and the poor quality of the external power supply will cause the power rail to collapse, so the following points must be paid attention to when designing the circuit:The current capacity of the power supply is preferably above 500mA, and it is recommended to place a 22 μ F capacitor on the module power supply trace near the pin, which can be used with a 0.1 μ F capacitor.The power supply ripple can greatly affect the TX performance of the radio frequency. When measuring the power supply ripple, it should be noted that the power supply ripple must be tested under WB81-GP’ s normal packet sending, and as the power changes in different modes, the power supply ripple will also change accordingly. Changes, the higher the packet sending power, the greater the ripple; generally, when sending MCS7 @ 11n data packets, the peak-to-peak power ripple must be <80mV; when sending 11M @ 11b, the peak-to-peak power ripple must be <120mV.

4.2 Peripheral Pinout

Table 4-1 Module Peripheral Pinout Recommendations

Interface	Signal	Pin	Description
ADC	ADC2_CH0	GPIO4	12-bit SAR ADC
	ADC2_CH1	GPIO0	
	ADC2_CH2	GPIO2	
	ADC2_CH3	MTDO	
	ADC2_CH4	MTCK	
	ADC2_CH5	MTDI	
	ADC2_CH6	MTMS	
	ADC2_CH7	GPIO27	
	ADC2_CH8	GPIO25	
	ADC2_CH9	GPIO26	
DAC	DAC_1	GPIO25	Two 8-bit DACs
	DAC_2	GPIO26	
TOUCH Sensor	TOUCH0	GPIO4	Capacitive touch sensors
	TOUCH1	GPIO0	
	TOUCH2	GPIO2	
	TOUCH3	MTDO	
	TOUCH4	MTCK	
	TOUCH5	MTDI	
	TOUCH6	MTMS	
	TOUCH7	GPIO27	
	TOUCH8	32K_XN	
	TOUCH9	32K_XP	
JTAG	MTDI	MTDI	JTAG for software debugging
	MTCK	MTCK	

	MTMS	MTMS	
	MTDO	MTDO	
SD/SDIO/MMC Host Controller	HS2_CLK	MTMS	Supports SD memory card V3.01 standard
	HS2_CMD	MTDO	
	HS2_DATA0	GPIO2	
	HS2_DATA1	GPIO4	
	HS2_DATA2	MTDI	
	HS2_DATA3	MTCK	
SDIO/SPI Slave Controller	SD_CLK	MTMS	SDIO interface that conforms to the industry standard SDIO 2.0 card specification
	SD_CMD	MTDO	
	SD_DATA0	GPIO2	
	SD_DATA1	GPIO4	
	SD_DATA2	MTDI	
	SD_DATA3	MTCK	
UART	U0RXD_in	Any GPIO Pins	Three UART devices with hardware flow-control and DMA
	U0CTS_in		
	U0SDR_in		
	U0TXD_out		
	U0RTS_out		
	U0DTR_out		
	U1RXD_in		
	U1CTS_in		
	U1TXD_out		
	U1RTS_out		
	U2RXD_in		
	U2CTS_in		
	U2TXD_out		
	U2RTS_out		

I2C	I2CEXT0_SCL_in	Any GPIO Pins	Two I2C devices in slave or master mode
	I2CEXT0_SDA_in		
	I2CEXT1_SCL_in		
	I2CEXT1_SDA_in		
	I2CEXT0_SCL_out		
	I2CEXT0_SDA_out		
	I2CEXT1_SCL_out		
	I2CEXT1_SDA_out		
LED PWM	Ledc_hs_sig_out0~7	Any GPIO Pins	16 independent channels @ 80 MHz clock/RTC CLK. Duty accuracy: 16 bits
	Ledc_ls_sig_out0~7		
General Purpose SPI	HSPIQ_in/_out	Any GPIO Pins	Standard SPI consists of clock, chip-select, MOSI and MISO. These SPIs can be connected to LCD and other external devices. They support the following features: ●Both master and slave modes; ●Four sub-modes of the SPI transferformat; ●Configurable SPI frequency; ●Up to 64 bytes of FIFO and DMA.
	HSPID_in/_out		
	HSPICLK_in/_out		
	HSPI_CS0_in/_out		
	HSPI_CS1_out		
	HSPI_CS2_out		
	VSPIQ_in/_out		
	VSPID_in/_out		
	VSPICLK_in/_out		
	VSPI_CS0_in/_out		
	VSPI_CS1_out		
	VSPI_CS2_out		
Parallel QSPI	HSPICLK	MTMS	Supports Standard SPI, Dual SPI, and Quad SPI that can be connected to the external flash and SRAM
	HSPICS0	MTDO	
	HSPIQ	MTDI	
	HSPID	MTCK	
	HSPIHD	GPIO4	
	HSPIWP	GPIO2	

	VSPICLK	GPIO18	
	VSPICS0	GPIO5	
	VSPIQ	GPIO19	
	VSPID	GPIO23	
	VSPIHD	GPIO21	
	VSPIWP	GPIO22	
EMAC	EMAC_TX_EN	GPIO21	Ethernet MAC with RMII Interface
	EMAC_TXD0	GPIO19	
	EMAC_TXD1	GPIO22	
	EMAC_RXD0	GPIO25	
	EMAC_RXD1	GPIO26	
	CRS_DV	GPIO27	
	REF_CLK	GPIO0	
	EMAC_MDC	GPIO23	
	EMAC_MDIO	GPIO18	
	EMAC_RST	GPIO5	
TWAI	Twai_rx	Any GPIO Pins	Compatible with ISO 11898-1 protocol (CAN Specification 2.0)
	Twai_tx		
	Twai_bus_off_on		
	Twai_clkout		

4.3 Backplane Layout Considerations

There is no high-speed signal or sensitive signal routing on the BOTTOM layer of the WB81-GP module, but it is recommended to design the routing on the TOP layer of the bottom board to avoid the module to avoid unexpected factors.

There are not too many hollowing-out processing requirements in the design of the bottom board. In addition to the clearance requirements for the antenna area mentioned above, the bottom board can be used for almost the entire board copper laying, but it must be noted that the test point pads of the module BOTTOM layer need to be exposed due to the window opening. For avoidance treatment, no via holes or exposed copper should be placed in the corresponding position of the bottom plate, and it should be covered with solder resist oil to prevent short-circuiting. WB81-GP module BOTTOM layer window exposed copper area is shown in Figure 4.2:

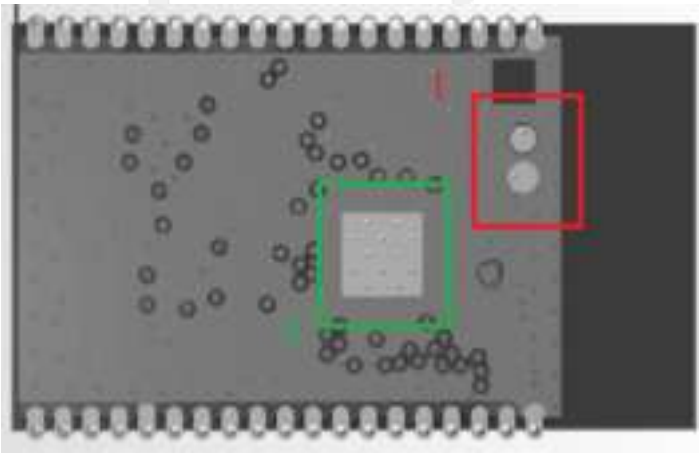

Figure 4.2 WB81-GP module BOTTOM layer open window schematic diagram of exposed copper area

The exposed copper points in the area 1 marked by the red box are RF test points, and the positions mapped to the backplane area must not have any traces or exposed copper.

Area 2 marked by the green box is the heat dissipation pad EXPAD (connected to GND) under the chip on the back of the module. The area is fully connected to the ground plane of other layers to improve thermal conductivity; when connecting to the ground plane of the

same layer, the cross connection method (Direct Connect should be selected) cannot be selected for copper plating. The effect of the cross connection is shown in Figure 4.3, and the heat will pass through Conduction accumulates on the copper-clad block in the middle, resulting in excessive local temperature; in addition, it should be noted that the exposed copper area is generally not tinned, but an appropriate amount of tin can optimize the heat conduction effect of the bottom plate (excessive tin may lead to mold Floating height and false soldering when soldering and pasting, and tin leakage through holes, etc.): If EXPAD is a whole piece of rectangular window opening method, the via holes must be half-plugged to avoid tin leakage; a more recommended optimization method is Make the EXPAD on the bottom plate into a nine-square pattern, as shown in Figure 4.4, cover the gap with ink, and drill the ground hole in the gap, which can effectively improve the problem of tin leakage.。

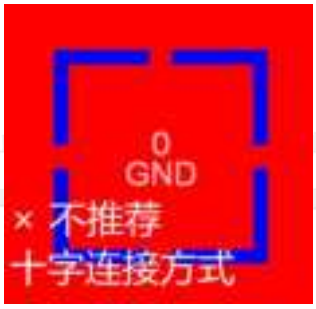

Figure 4.3 Copper connection not recommended

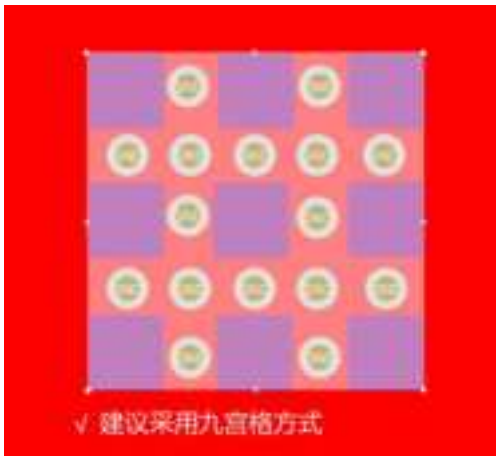

Figure 4.4 The nine-square grid method of the floor EXPAD

5 Electrical Performance and Reliability

5.1 Electrical Characteristics

Table 5-1 Module Electrical Characteristics

SYMBOL	DESCRIPTION	MIN	TYP.	Max	Unit
V_{DD}	Absolute Maximum power supply voltage	-0.3	-	3.6	V
	Recommended Power Supply	3.0	3.3	3.6	V
I_{VDD}	Current delivered by external power supply	0.5	-	-	A
I_{output}	Cumulative IO output current	-	-	1100	mA
V_{IL}	Low Level Input Voltage	-0.3	-	0.25×VDD	V
V_{IH}	High Level Input Voltage	0.75×VDD	-	VDD+0.3	V
I_{IL}	Low-level input current	-	-	50	nA
I_{IH}	High-level input current	-	-	50	nA
V_{OL}	Low-level output voltage	0.8×VDD	-	-	V
V_{OH}	High-level output voltage	-	-	0.1×VDD	V
R_{PU}	Resistance of internal pull-up resistor	-	45	-	KΩ
R_{PD}	Resistance of internal pull-down resistor	-	45	-	KΩ
V_{IL_nRST}	Low-level input voltage of EN (Chip_PU) to power off the chip	-	-	0.6	V
T_A	Operating temperature	-40	-	+85	℃
T_{Store}	Storage temperature	-40	-	+105	℃
V_{ESD}	VDD & ANT PIN ESD performance	-	4	-	KV

5.2 Power Consumption

Table 5-2 Module RF Power Consumption Description

Description		Max Current @ TX	Max Current @ RX
WIFI	802.11b, 11 Mbps @ 19.5 dBm,50% duty cycle	250 mA	120 mA
	802.11b, 11 Mbps @ 19.5 dBm,10% duty cycle	145 mA	

	802.11g, 54 Mbps @ 14 dBm,50% duty cycle	195 mA	
	802.11g, 54Mbps @ 14 dBm,10% duty cycle	135 mA	
	802.11n, HT20, MCS0 @ 17 dBm,50% duty cycle	225 mA	
	802.11n, HT20, MCS0 @ 17 dBm,10% duty cycle	145 mA	
	802.11n, HT20, MCS7 @ 14 dBm,50% duty cycle	190 mA	
	802.11n, HT20, MCS7 @ 14 dBm,10% duty cycle	135 mA	
	802.11n, HT40, MCS0 @ 16 dBm,10% duty cycle	145 mA	
	802.11n, HT40, MCS7 @ 14 dBm,10% duty cycle	140 mA	
BT	BR @ DH5, default power (0 dBm)	145 mA	120 mA
	BR @ DH5, max power (9 dBm)	190 mA	
	EDR @ 2-DH5, default power (0 dBm)	145 mA	
	EDR @ 2-DH, max power (9 dBm)	190 mA	
	EDR @ 3-DH5 default power (0 dBm)	145 mA	
	EDR @ 3-DH5 max power (9 dBm)	190 mA	
	BLE @ 1M, default power (0 dBm)	150 mA	
	BLE @ 1M, max power (9 dBm)	195 mA	

NOTE

(1)Test conditions: VDD: 3.3V, Temp: 25° C, Product: L-WFIWB81-G5PP4.

(2)The power consumption data may vary under different firmware versions, and the actual test shall prevail.

Table 5-3 Module low power consumption performance

Mode		Typ.	Unit	Test instruction
Deep sleep		5.47	μA	AT+GSLP=10000
System sleep	Dtim 1	8.02	mA	AT+CWMODE=1 AT+CWJAP="wifi_ax_test","12345678",,,,1 AT+SLEEP=2
	Dtim 3	4.48		AT+CWMODE=1 AT+CWJAP="wifi_ax_test","12345678",,,,3

				AT+SLEEP=2
	Dtim 5	3.87		AT+CWMODE=1 AT+CWJAP="wifi_ax_test","12345678",,,,5 AT+SLEEP=2
	Dtim 10	3.31		AT+CWMODE=1 AT+CWJAP="wifi_ax_test","12345678",,,,10 AT+SLEEP=2
	Dtim 30	2.90		AT+CWMODE=1 AT+CWJAP="wifi_ax_test","12345678",,,,30 AT+SLEEP=2

NOTE

(1)Test conditions: VDD: 3.3V, Temp: 25° C, product: L-WFIWB81-G5PP4.

(2)The power consumption data may vary under different firmware versions, and the actual test shall prevail.

6 Production and Packaging Information

6.1 Production Welding

6.1.1 Production Instructions

It is recommended to use SMT machine to mount the stamp mouth packaging module, and the mounting should be completed within 24 hours after unpacking, otherwise, it should be vacuum-packed again to avoid moisture and poor mounting.

If the package contains a humidity indicator card, it is recommended to judge whether the module needs to be baked according to the humidity card. The conditions for baking are as follows:

Baking temperature: 125℃±5℃;

The alarm temperature is set to 130°C;

After cooling <36° C under natural conditions, SMT patching can be carried out;

If the unpacking time exceeds 3 months, you need to pay special attention to whether the product is damp. Because of the PCB immersion gold process, more than 3 months may cause oxidation of the pads, which may cause problems such as virtual soldering and missing soldering during placement.

In order to ensure the qualified rate of reflow soldering, it is recommended to select 10% of the products for visual inspection and AOI inspection for the first placement, so as to ensure the rationality of furnace temperature control, device adsorption method and placement method.

Operators at each station must wear electrostatic gloves during the whole production process.

6.1.2 Module location requirements on the backplane

It is recommended that the thickness of the green oil at the position of the module on the bottom plate be less than 0.02mm to avoid excessive thickness, and the raised module cannot effectively contact the solder paste and affect the soldering quality. In addition, it is necessary to consider that other devices cannot be placed within 2mm around the interface board module to ensure the maintenance of the module.

6.1.3 Stencil Opening Design

In principle, the thickness of the stencil on the bottom plate is selected based on the comprehensive consideration of the package type of the device on the board. The following requirements need to be focused on:

The pad position of the module can be partially thickened to 0.15~0.20mm to avoid empty soldering.

6.1.4 Production Notes

- During the production process, each operator must wear electrostatic gloves;
- Do not exceed the specified baking time when baking;
- It is strictly forbidden to add explosive, flammable and corrosive substances during baking;
- When baking, the modules should be placed in a high-temperature tray to keep the air circulation between the modules;
- When baking, the oven door must be closed to ensure that the oven is closed to prevent temperature leakage;
- Try not to open the door when the oven is running. If it must be opened, try to shorten the time for opening the door;
- After baking, wait for the module to cool naturally below 36° C before taking it out with electrostatic gloves to avoid burns;

- During operation, strictly prevent the bottom surface of the module from getting water or dirt;

6.1.5 Recommended Reflow Profile

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

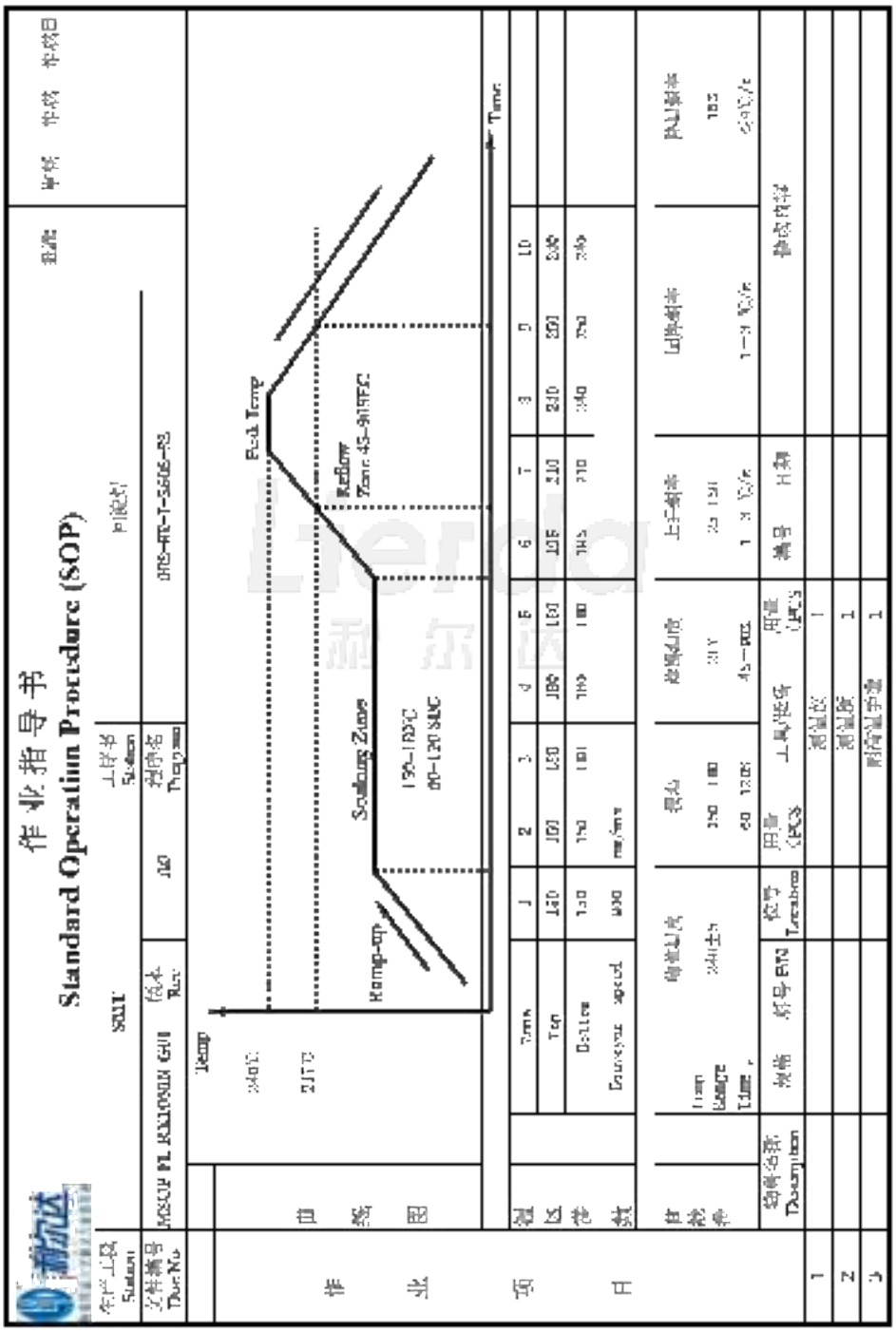

Figure 6-1 Reflow Soldering Operation Instructions

6.2 Package Information

6.2.1 Packaging Method

Model Name	Packing Method	Packing Case (pcs)	MPQ(pcs)	Reels per Case
L-WFIWB81-G5PP4	Tape and Reel	4000	800	5

6.2.2 Carrier Size Detail

Schematic diagram of the placement direction of the tape and reel packaging module：

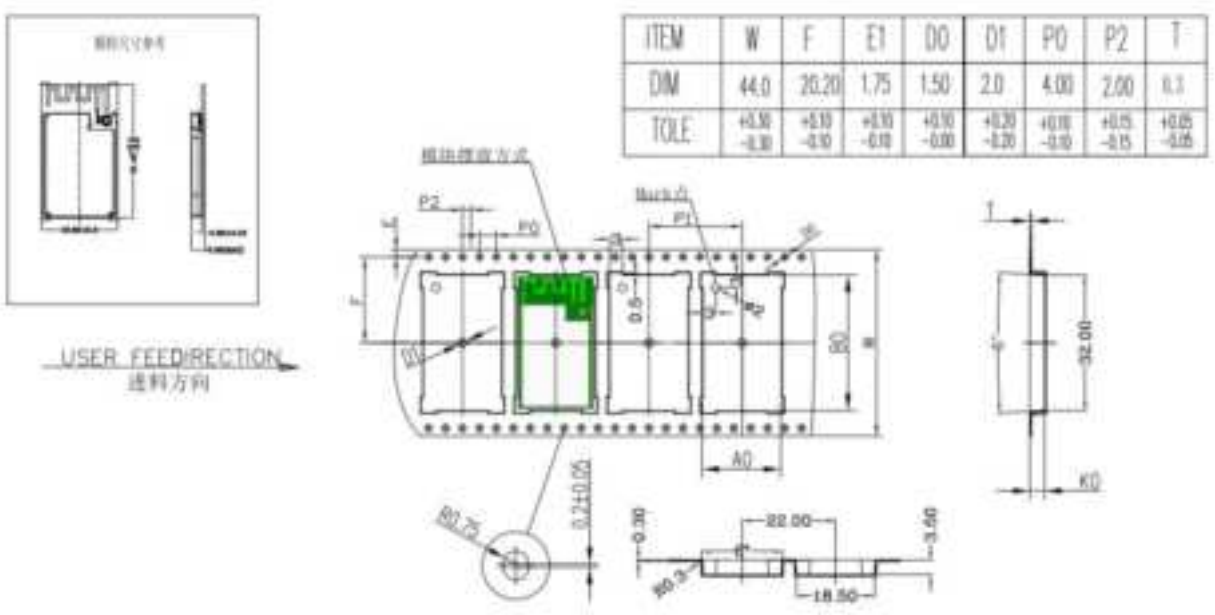

Figure 6.2 Carrier size and product orientation

Conformity

FCC regulatory conformance：
This device complies with Part 15 of the FCC Rules. Operation is subject to the following two
conditions:
(1) This device may not cause harmful interference.
(2) This device must accept any interference received, including interference that may cause
undesired operation.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.
This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
-Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
-Consult the dealer or an experienced radio/TV technician for help

NOTE: The manufacturer is not responsible for any radio or TV interference caused by unauthorized modifications to this equipment. Such modifications could void the user's authority to operate the equipment.

FCC Radiation Exposure Statement:
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

ORIGINAL EQUIPMENT MANUFACTURER (OEM) NOTES

The OEM must certify the final end product to comply with unintentional radiators (FCC Sections 15.107 and 15.109) before declaring compliance of the final product to Part 15 of the FCC rules and regulations. Integration into devices that are directly or indirectly connected to AC lines must add with Class II Permissive Change.

The OEM must comply with the FCC labeling requirements. If the module's label is not visible when installed, then an additional permanent label must be applied on the outside of the finished product which states: "Contains transmitter module FCC ID: **2AOFDL-WFIWB81**". Additionally, the following statement should be included on the label and in the final product's user manual: "This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:
(1) This device may not cause harmful interferences, and
(2) this device must accept any interference received, including interference that may cause undesired operation."

The module is limited to installation in mobile or fixed applications. Separate approval is required for all other operating configurations, including portable configuration with respect to Part 2.1093 and different antenna configurations.

A module or modules can only be used without additional authorizations if they have been tested and granted under the same intended end‐use operational conditions, including simultaneous transmission operations. When they have not been tested and granted in this manner, additional testing and/or FCC application filing may be required. The most straightforward approach to address additional testing conditions is to have the grantee responsible for the certification of at least one of the modules submit a permissive change application. When having a module grantee file a permissive change is not practical or feasible, the following guidance provides some additional options for host manufacturers. Integrations using modules where additional testing and/or FCC application filing(s) may be required are: (A) a module used in devices requiring additional RF exposure compliance information (e.g., MPE evaluation or SAR testing); (B) limited and/or split modules not meeting all of the module requirements; and (C) simultaneous transmissions for independent collocated transmitters not previously granted together.

This Module is full modular approval, it is limited to OEM installation ONLY.
Integration into devices that are directly or indirectly connected to AC lines must add with Class II Permissive Change. (OEM) Integrator has to assure compliance of the entire end product include the integrated Module. Additional measurements (15B) and/or equipment authorizations (e.g. Verification) may need to be addressed depending on co-location or simultaneous transmission issues if applicable. (OEM) Integrator is reminded to assure that these installation instructions will not be made available to the end user

Requirement per KDB996369 D03

2.2 List of applicable FCC rules

List the FCC rules that are applicable to the modular transmitter. These are the rules that specifically establish the bands of operation, the power, spurious emissions, and operating fundamental frequencies. DO NOT list compliance to unintentional-radiator rules (Part 15 Subpart B) since that is not a condition of a module grant that is extended to a host manufacturer. See also Section 2.10 below concerning the need to notify host manufacturers that further testing is required.3

Explanation: This module meets the requirements of FCC part 15C(15.247).

2.3 Summarize the specific operational use conditions

Describe use conditions that are applicable to the modular transmitter, including for example any limits on antennas, etc. For example, if point-to-point antennas are used that require reduction in power or compensation for cable loss, then this information must be in the instructions. If the use condition limitations extend to professional users, then instructions must state that this information also extends to the host manufacturer's instruction manual. In addition, certain information may also be needed, such as peak gain per frequency band and minimum gain, specifically for master devices in 5 GHz DFS bands.

Explanation: The EUT has a PCB Antenna, and the antenna use a permanently attached antenna which is not replaceable.

2.4 Limited module procedures

If a modular transmitter is approved as a "limited module," then the module manufacturer is responsible for approving the host environment that the limited module is used with. The manufacturer of a limited module must describe, both in the filing and in the installation instructions, the alternative means that the limited module manufacturer uses to verify that the host meets the necessary requirements to satisfy the module limiting conditions.

A limited module manufacturer has the flexibility to define its alternative method to address the conditions that limit the initial approval, such as: shielding, minimum signaling amplitude, buffered modulation/data inputs, or power supply regulation. The alternative method could include that the limited module manufacturer reviews detailed test data or host designs prior to giving the host manufacturer approval.

This limited module procedure is also applicable for RF exposure evaluation when it is necessary to demonstrate compliance in a specific host. The module manufacturer must state how control of the product into which the modular transmitter will be installed will be maintained such that full compliance of the product is always ensured. For additional hosts other than the specific host originally granted with a limited module, a Class II permissive change is required on the module grant to register the additional host as a specific host also approved with the module.

Explanation: The module is not a limited module.

2.5 Trace antenna designs

For a modular transmitter with trace antenna designs, see the guidance in Question 11 of KDB Publication 996369 D02 FAQ – Modules for Micro-Strip Antennas and traces. The integration information shall include for the TCB review the integration instructions for the following aspects:
layout of trace design, parts list (BOM), antenna, connectors, and isolation requirements.
a) Information that includes permitted variances (e.g., trace boundary limits, thickness, length, width, shape(s), dielectric constant, and impedance as applicable for each type of antenna);
b) Each design shall be considered a different type (e.g., antenna length in multiple(s) of frequency, the wavelength, and antenna shape (traces in phase) can affect antenna gain and must be considered);
c) The parameters shall be provided in a manner permitting host manufacturers to design the printed circuit (PC) board layout;
d) Appropriate parts by manufacturer and specifications;
e) Test procedures for design verification; and
f) Production test procedures for ensuring compliance.
The module grantee shall provide a notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify the module grantee that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the grantee, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.
Explanation: Yes, The module with trace antenna designs, and This manual has been shown the layout of trace design, antenna, connectors, and isolation requirements.

2.6 RF exposure considerations

It is essential for module grantees to clearly and explicitly state the RF exposure conditions that permit a host product manufacturer to use the module. Two types of instructions are required for RF exposure information: (1) to the host product manufacturer, to define the application conditions (mobile, portable – xx cm from a person’s body); and (2) additional text needed for the host product manufacturer to provide to end users in their end-product manuals. If RF exposure statements and use conditions are not provided, then the host product manufacturer is required to take responsibility of the module through a change in FCC ID (new application).
Explanation: This module complies with FCC RF radiation exposure limits set forth for an uncontrolled environment, This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body." This module is designed to comply with the FCC statement, FCC ID is: 2AOFDL-WFIWB81.

2.7 Antennas

A list of antennas included in the application for certification must be provided in the instructions. For modular transmitters approved as limited modules, all applicable professional installer instructions must be included as part of the information to the host product manufacturer. The antenna list shall also identify the antenna types (monopole, PIFA, dipole, etc. (note that for example an “omni-directional antenna” is not considered to be a specific “antenna type”)).

For situations where the host product manufacturer is responsible for an external connector, for example with an RF pin and antenna trace design, the integration instructions shall inform the installer that unique antenna connector must be used on the Part 15 authorized transmitters used in the host product. The module manufacturers shall provide a list of acceptable unique connectors.

Explanation: The EUT has a PCB Antenna, and the antenna use a permanently attached antenna which is unique.

2.8 Label and compliance information

Grantees are responsible for the continued compliance of their modules to the FCC rules. This includes advising host product manufacturers that they need to provide a physical or e-label stating “Contains FCC ID” with their finished product. See Guidelines for Labeling and User Information for RF Devices – KDB Publication 784748.

Explanation: The host system using this module, should have label in a visible area indicated the following texts: “Contains FCC ID:2AOFDL-WFIWB81”

2.9 Information on test modes and additional testing requirements5

Additional guidance for testing host products is given in KDB Publication 996369 D04 Module Integration Guide. Test modes should take into consideration different operational conditions for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product.

The grantee should provide information on how to configure test modes for host product evaluation for different operational conditions for a stand-alone modular transmitter in a host, versus with multiple, simultaneously transmitting modules or other transmitters in a host.

Grantees can increase the utility of their modular transmitters by providing special means, modes, or instructions that simulates or characterizes a connection by enabling a transmitter. This can greatly simplify a host manufacturer’s determination that a module as installed in a host complies with FCC requirements.

Explanation: Top band can increase the utility of our modular transmitters by providing instructions that simulates or characterizes a connection by enabling a transmitter.

2.10 Additional testing, Part 15 Subpart B disclaimer

The grantee should include a statement that the modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuity), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

Explanation: The module without unintentional-radiator digital circuity, so the module does not require an evaluation by FCC Part 15 Subpart B. The host shoule be evaluated by the FCC Subpart B.