



# Ai-WB2-12F Specification

Version V1.1.0

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## Document resume

| Version | Date      | Develop/revise content | Edition     | Approve  |
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## 1. Product Overview

Ai-WB2-12F is a Wi-Fi&BT module developed by Shenzhen Ai-Thinker Technology Co., LTD. The module is equipped with BL602 chip as the core processor and supports Wi-Fi 802.11b/g/n protocol and BLE 5.0 protocol. The BL602 chip has a low-power 32-bit RISC CPU, 276KB RAM, and a wealth of peripheral interfaces, including SDIO, SPI, UART, I2C, IR Remote, PWM, ADC, DAC, PIR and GPIO etc. It can be widely used in Internet of Things (IoT), mobile devices, wearable electronic devices, smart home and other fields.

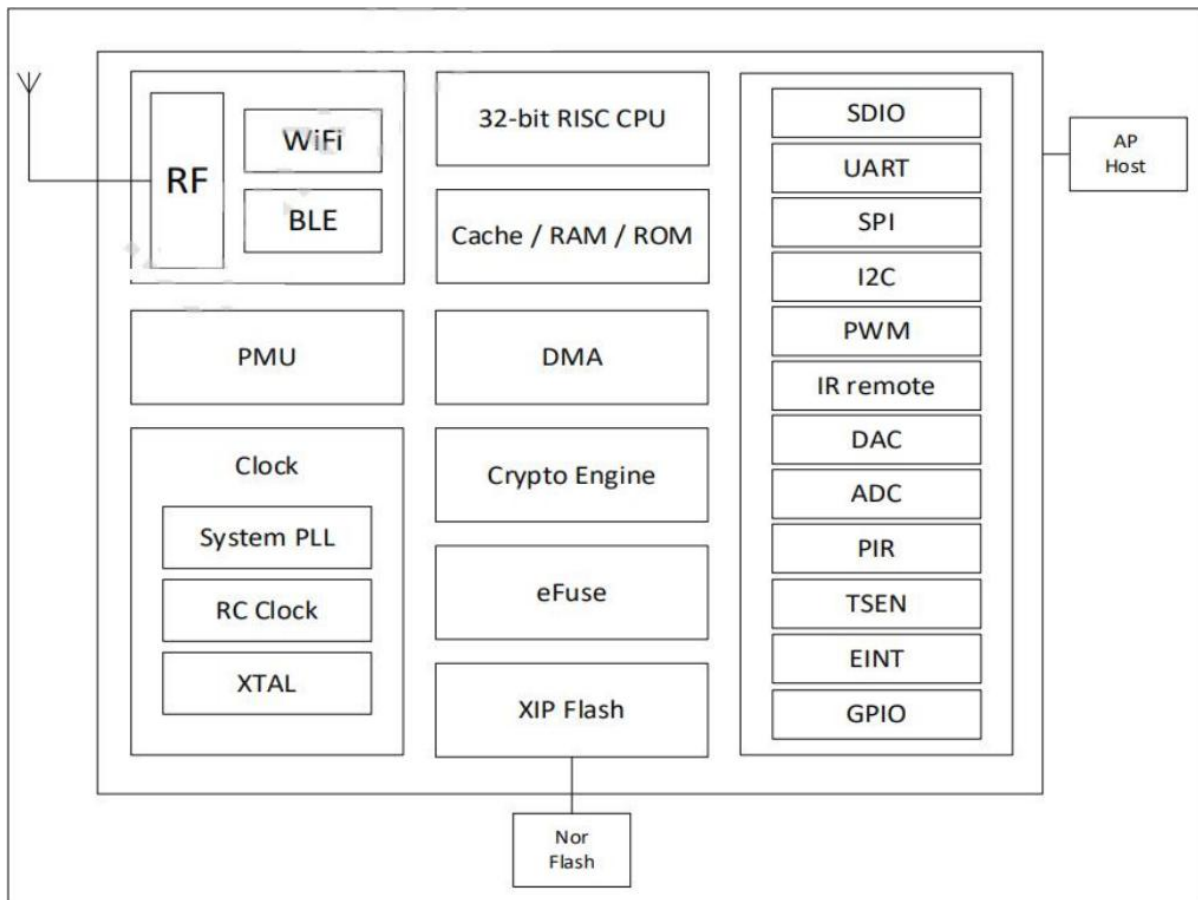


Figure 1 Main chip block diagram

## 1.1. Characteristic

- The package is SMD-22
- Support IEEE 802.11 b/g/n protocol
- Wi-Fi Security Support WPS/WEP/WPA/WPA2 Personal/WPA2 Enterprise/WPA3
- Support 20MHz bandwidth and Max rate is 72.2 Mbps
- Bluetooth BLE 5.0, Bluetooth Mesh
- Support Station + BLE mode、 Station + SoftAP + BLE mode
- Support 32-bit RISC CPU, 276KB RAM
- Secure start-up, supports mirroring with ECC-256 signature
- Support QSPI/SPI Flash On-The-Fly AES Decryption, support AES 128 CTR mode
- Support AES 128/192/256-bit encryption engine
- Support SHA-1/224/256
- Support true Random number generator (TRNG)
- Public key Accelerator (PKA), support large number basic operations, software provides signature, verification and other application program interface
- Support SDIO, SPI, UART, I2C, IR remote, PWM, ADC, DAC, PIR, GPIO etc
- Integrated Wi-Fi MAC/BB/RF/PA/LNA/BT
- Support a variety of sleep modes, deep sleep current 12 $\mu$ A
- Universal AT instruction for quick start
- Support secondary development, integrated Windows, Linux development environment

## 2. Main parameters

**Table 1 Description of the main parameters**

|                              |  |
|------------------------------|--|
| <b>Model</b>                 | Ai-WB2-12F   |
| <b>Package</b>               | SMD-22   |
| <b>Size</b>                  | 24.0*16.0*3.1(±0.2)mm                              |
| <b>Antenna</b>               | on-board PCB antenna                               |
| <b>Frequency</b>             | 2400 ~ 2483.5MHz                                   |
| <b>Operating temperature</b> | -40°C ~ 85°C                                       |
| <b>Storage temperature</b>   | -40°C ~ 125°C, < 90%RH                             |
| <b>Power supply</b>          | Support voltage 2.7V ~ 3.6V, supply current ≥500mA |
| <b>Interface</b>             | UART/GPIO/ADC/PWM/I2C/SPI                          |
| <b>IO</b>                    | 15   |
| <b>UART rate</b>             | Default 115200 bps                                 |
| <b>Security</b>              | WPS/WEP/WPA/WPA2 Personal/WPA2 Enterprise/WPA3     |
| <b>Flash</b>                 | Default 4MByte, MAX support 16MByte                |

### 2.1. Static electricity requirement

Ai-WB2-12F is an electrostatic sensitive device. Therefore, you need to take special precautions when carrying it.



**Figure 2 ESD preventive measures**

## 2.2. Electrical characteristics

**Table 2 Electrical characteristics table**

| Parameters     | Condition | Min. | Typical value | Max.      | Unit |
|----------------|-----------|------|---------------|-----------|------|
| Voltage Supply | VDD       | 2.7  | 3.3           | 3.6       | V    |
| I/O            | VIL       | -    | -             | 0.3*VDDIO | V    |
|                | VIH       | -    | 0.7*VDDI      | -         | V    |
|                | VOL       | -    | -             | 0.1*VDDIO | V    |
|                | VOH       | -    | -             | 0.9*VDDIO | V    |
|                | IMAX      | -    | -             | -         | 15   |

## 2.3. Wi-Fi RF Performance

**Table 3 Wi-Fi RF performance table**

| Description                    | Typical value    |               |      | Unit |
|--------------------------------|------------------|---------------|------|------|
| Frequency range                | 2400 ~ 2483.5MHz |               |      | MHz  |
| <b>Output Power</b>            |                  |               |      |      |
| Mode                           | Min.             | Typical value | Max. | Unit |
| 11n Mode HT20, PA output power | -                | 16            | -    | dBm  |
| 11g Mode, PA output power      | -                | 17            | -    | dBm  |
| 11b Mode, PA output power      | -                | 19            | -    | dBm  |
| <b>Receive Sensitivity</b>     |                  |               |      |      |
| Mode                           | Min.             | Typical value | Max. | Unit |
| 11b, 1 Mbps                    | -                | -98           | -    | dBm  |
| 11b, 11 Mbps                   | -                | -90           | -    | dBm  |
| 11g, 6 Mbps                    | -                | -93           | -    | dBm  |
| 11g, 54 Mbps                   | -                | -76           | -    | dBm  |
| 11n, HT20 (MCS7)               | -                | -73           | -    | dBm  |

## 2.4. BLE RF Performance

**Table 4 BLE RF performance table**

| Description                | Typical value    |               |      | Unit |
|----------------------------|------------------|---------------|------|------|
| Frequency range            | 2400 ~ 2483.5MHz |               |      | MHz  |
| <b>Output Power</b>        |                  |               |      |      |
| Rate Mode                  | Min.             | Typical value | Max. | Unit |
| 1Mbps                      | -                | 9             | 15   | dBm  |
| <b>Receive Sensitivity</b> |                  |               |      |      |
| Rate Mode                  | Min.             | Typical value | Max. | Unit |
| 1Mbps sensitivity@30.8%PER | -                | -96           | -    | dBm  |

## 2.5. Power

The following power consumption data are based on a 3.3V power supply, 25°C ambient temperature, and measured using an internal voltage regulator.

- All measurements are made at the antenna interface with a filter.
- All transmission data are based on 100% duty cycle in continuous transmission mode.

**Table 5 Power consumption table**

| Mode                               | Min. | AVG | Max. | Unit |
|------------------------------------|------|-----|------|------|
| Tx 802.11b, 11Mbps, POUT=+21dBm    | -    | 260 | -    | mA   |
| Tx 802.11g, 54Mbps, POUT =+18dBm   | -    | 245 | -    | mA   |
| Tx 802.11n, MCS7, POUT =+17dBm     | -    | 230 | -    | mA   |
| Rx 802.11b,packet length 1024 byte | -    | 65  | -    | mA   |
| Rx 802.11g,packet length 1024 byte | -    | 65  | -    | mA   |
| Rx 802.11n,Packet length 1024 byte | -    | 65  | -    | mA   |
| Deep-Sleep                         | -    | 12  | -    | μA   |



### 3. Appearance Dimensions

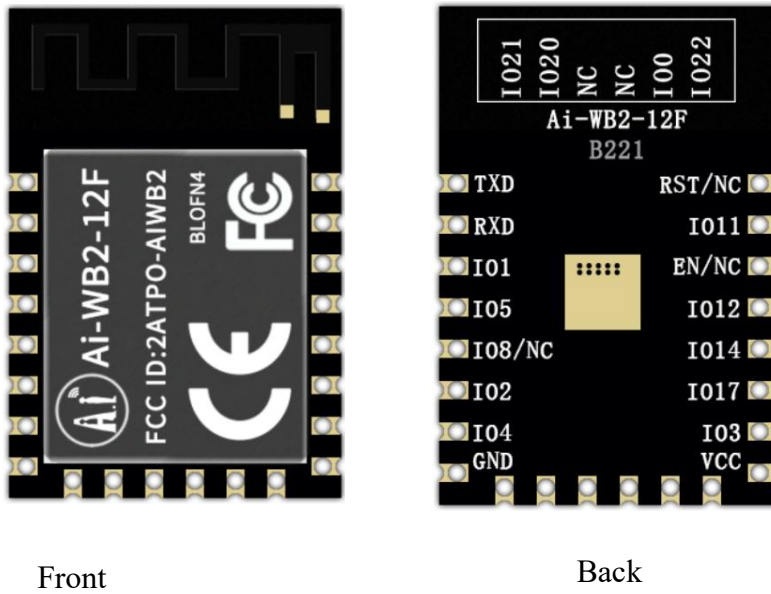


Figure 3 Appearance diagram (pictures is for reference only,subject to physical objects)

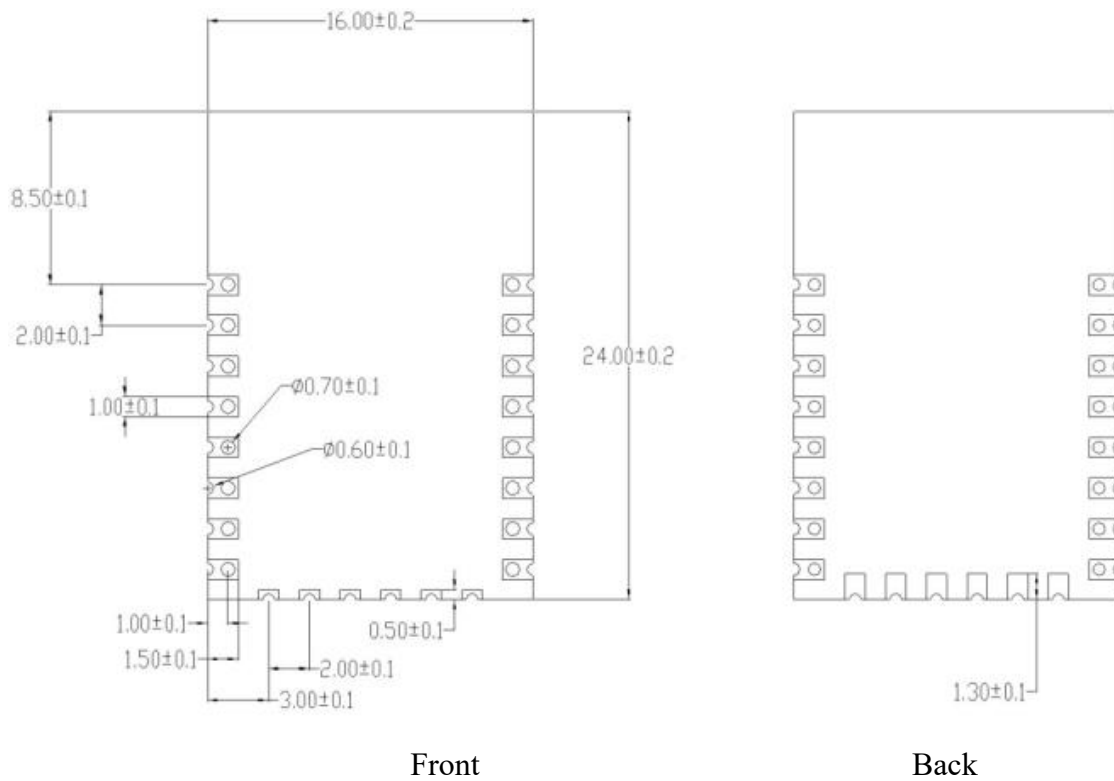
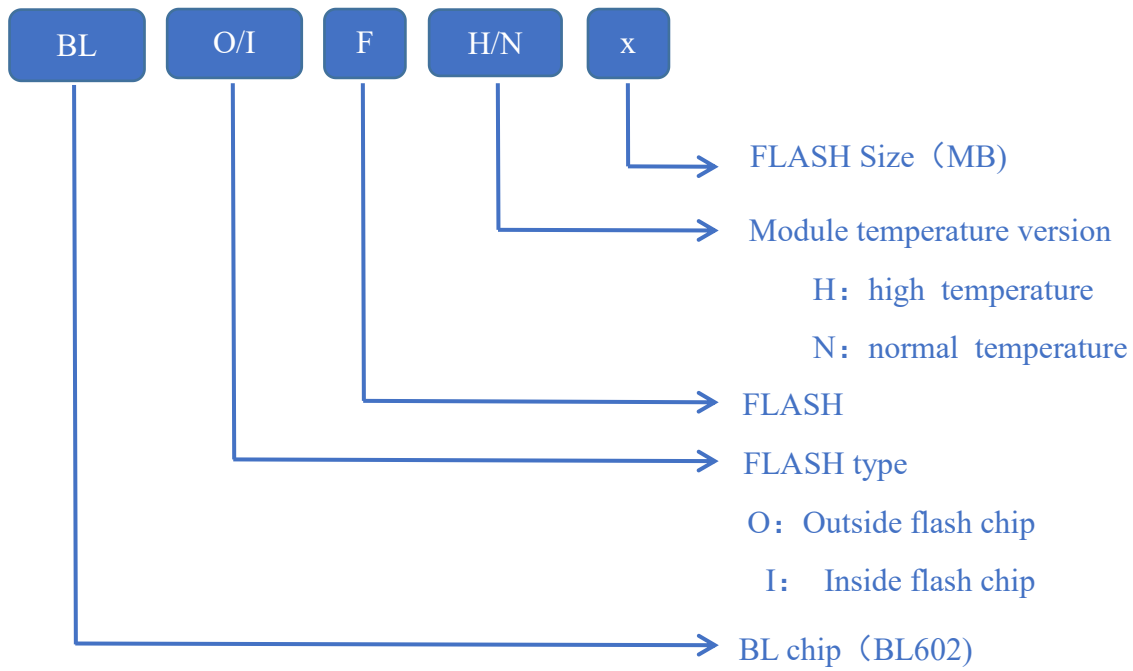


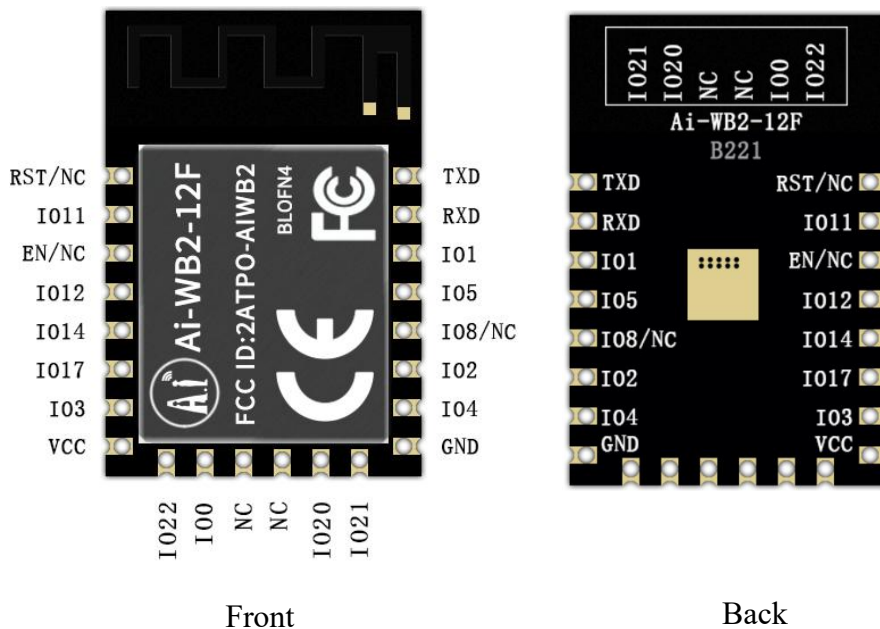
Figure 4 Dimension diagram



**Figure 5. Naming of module information**

## 4. Pin Definition

Ai-WB2-12F module is connected with a total of 22 pins, as shown in the pin schematic diagram, pin function definition table is the interface definition.

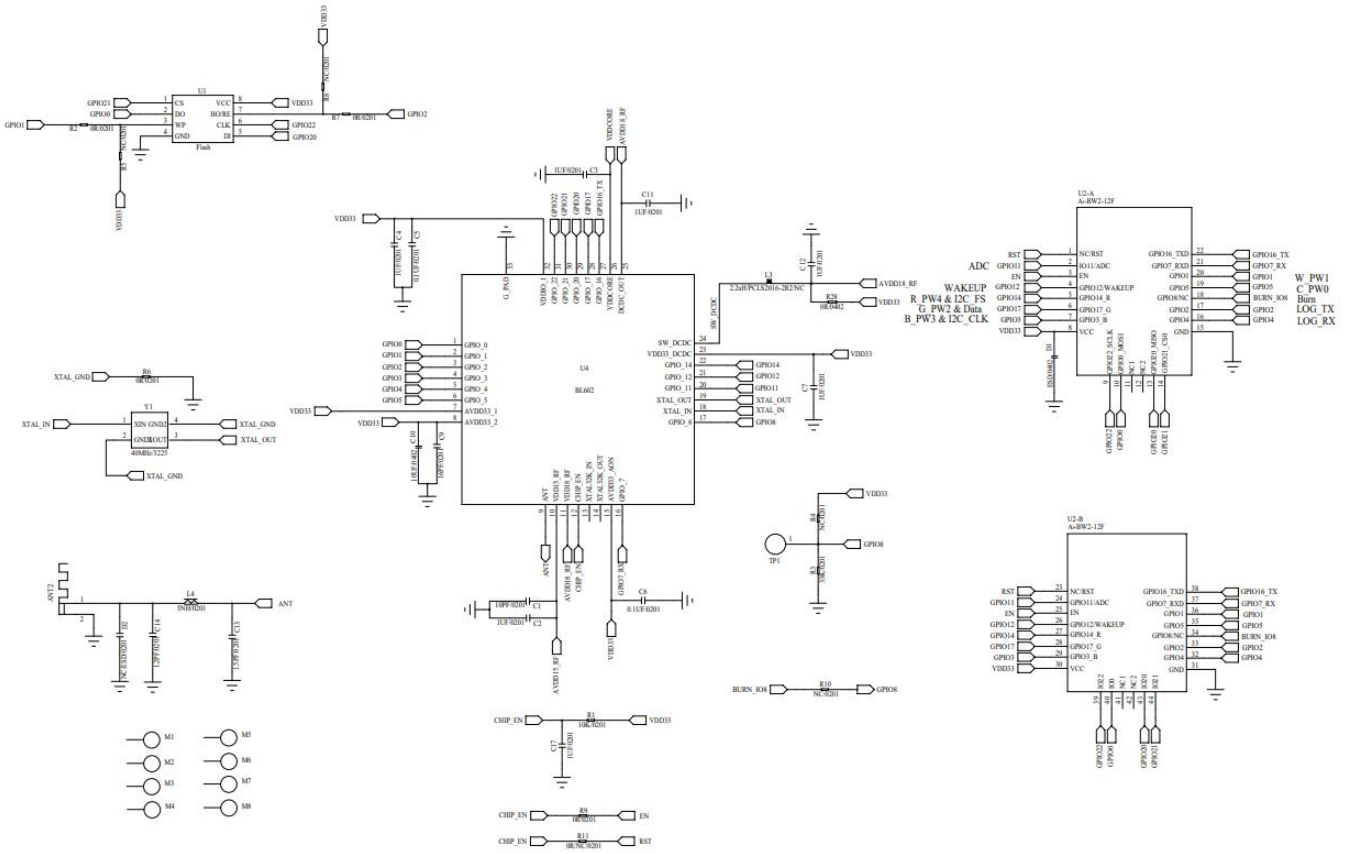


**Figure 6 Schematic diagram of module pins**

**Table 6 Pin function definition table**

| No. | Name   | Function   |
|-----|--------|--|
| 1   | RST/NC | Default not connect, can be customized to reset pin, active-low, if you need to use it, please contact Ai-Thinker  |
| 2   | IO11   | GPIO11/SPI_SCLK/IIC_SDA/ADC_CH10   |
| 3   | EN/NC  | Default chip enable pin, active-high, cannot be used with RST at the same time   |
| 4   | IO12   | GPIO12/SPI_MOSI/MISO/IIC_SCL/PWM_CH2/ADC_CH0   |
| 5   | IO14   | GPIO14/SPI_SS/IIC_SCL/PWM_CH4/ADC_CH2  |
| 6   | IO17   | GPIO17/SPI_MOSI/MISO/IIC_SDA/PWM_CH2   |
| 7   | IO3    | GPIO3/SPI_SCLK/IIC_SDA/PWM_CH3   |
| 8   | VCC    | 3.3V power supply; It is recommended that the output current of the external power supply be higher than 500mA   |
| 9   | IO22   | It is not recommended to use. It is shared with the Flash in the module. If you need to use it, please contact Ai-Thinker. GPIO22/SPI_SS/IIC_SCL/PWM_CH2/JTAG_TCK/TMS                    |
| 10  | IO0    | It is not recommended to use. It is shared with the Flash in the module. If you need to use it, please contact Ai-Thinker.<br>GPIO0/SDIO_CLK//SPI_MOSI/MISO/IIC_SCL/PWM_CH0/JTAG_TMS/TCK |
| 11  | NC     | NC, unavailable  |
| 12  | NC     | NC, unavailable  |
| 13  | IO20   | It is not recommended to use. It is shared with the Flash in the module. If you need to use it, please contact Ai-Thinker.<br>GPIO20/SPI_MOSI/MISO/IIC_SCL/PWM_CH0/JTAG_TMS/TCK          |
| 14  | IO21   | It is not recommended to use. It is shared with the Flash in the module. If you need to use it, please contact Ai-Thinker.<br>GPIO21/SPI_MOSI/MISO/IIC_SDA/PWM_CH1/JTAG_TDI/TDO          |
| 15  | GND    | Ground   |
| 16  | IO4    | GPIO4/SPI_MOSI/MISO/IIC_SCL/PWM_CH4/ADC_CH4  |
| 17  | IO2    | It is not recommended to use. It is shared with the Flash in the module. If you need to use it, please contact Ai-Thinker. GPIO2/SPI_SS/IIC_SCL/PWM_CH2                                  |
| 18  | IO8/NC | Default NC, unavailable  |
| 19  | IO5    | GPIO5/SPI_MOSI/MISO/IIC_SDA/PWM_CH0/ADC_CH4  |
| 20  | IO1    | It is not recommended to use. It is shared with the Flash in the module. If you need to use it, please contact Ai-Thinker. GPIO1/SPI_MOSI/MISO/IIC_SDA/PWM_CH1                           |
| 21  | RXD    | RXD/GPIO7/SPI_SCLK/IIC_SDA/PWM_CH2   |
| 22  | TXD    | TXD/GPIO16/SPI_MOSI/MISO/IIC_SCL/PWM_CH1   |

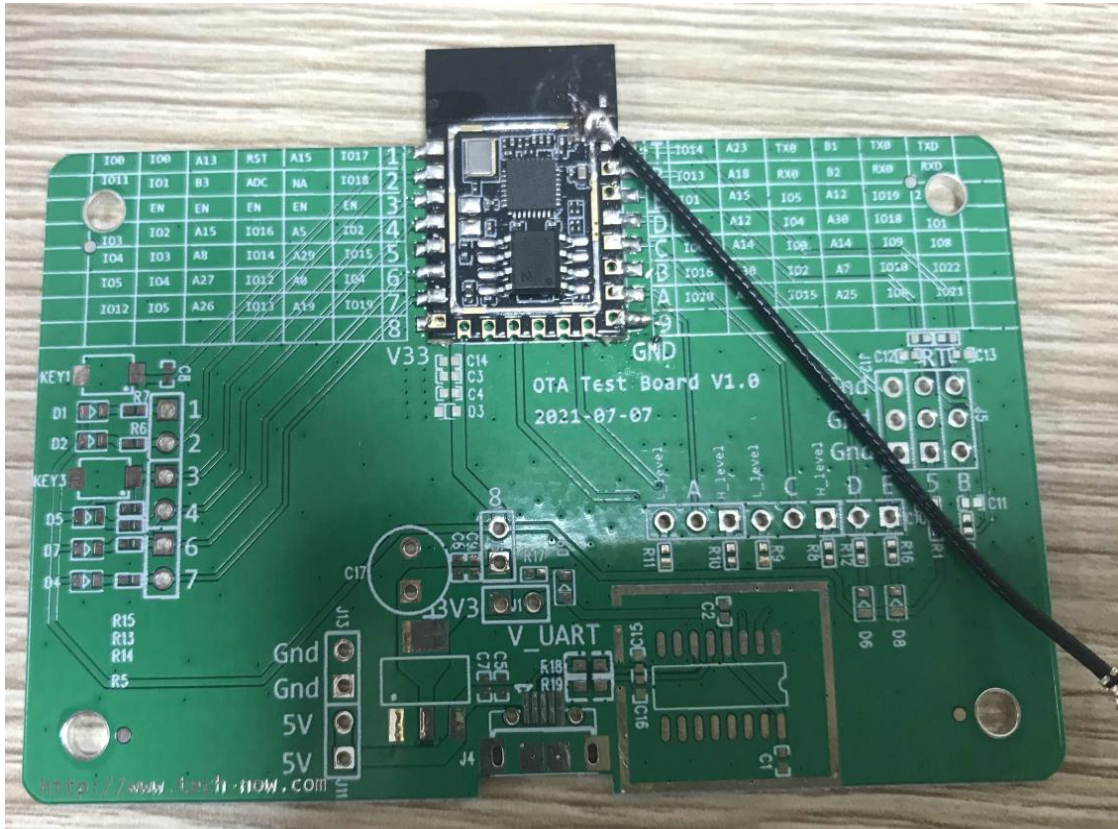
## 5. Schematic



**Figure 7 Module schematic**

## 6. Antenna parameters

### 6.1. Schematic diagram of the antenna test prototype



**Figure 8 Schematic diagram of the antenna test prototype**

## 6.2. Antenna S parameter

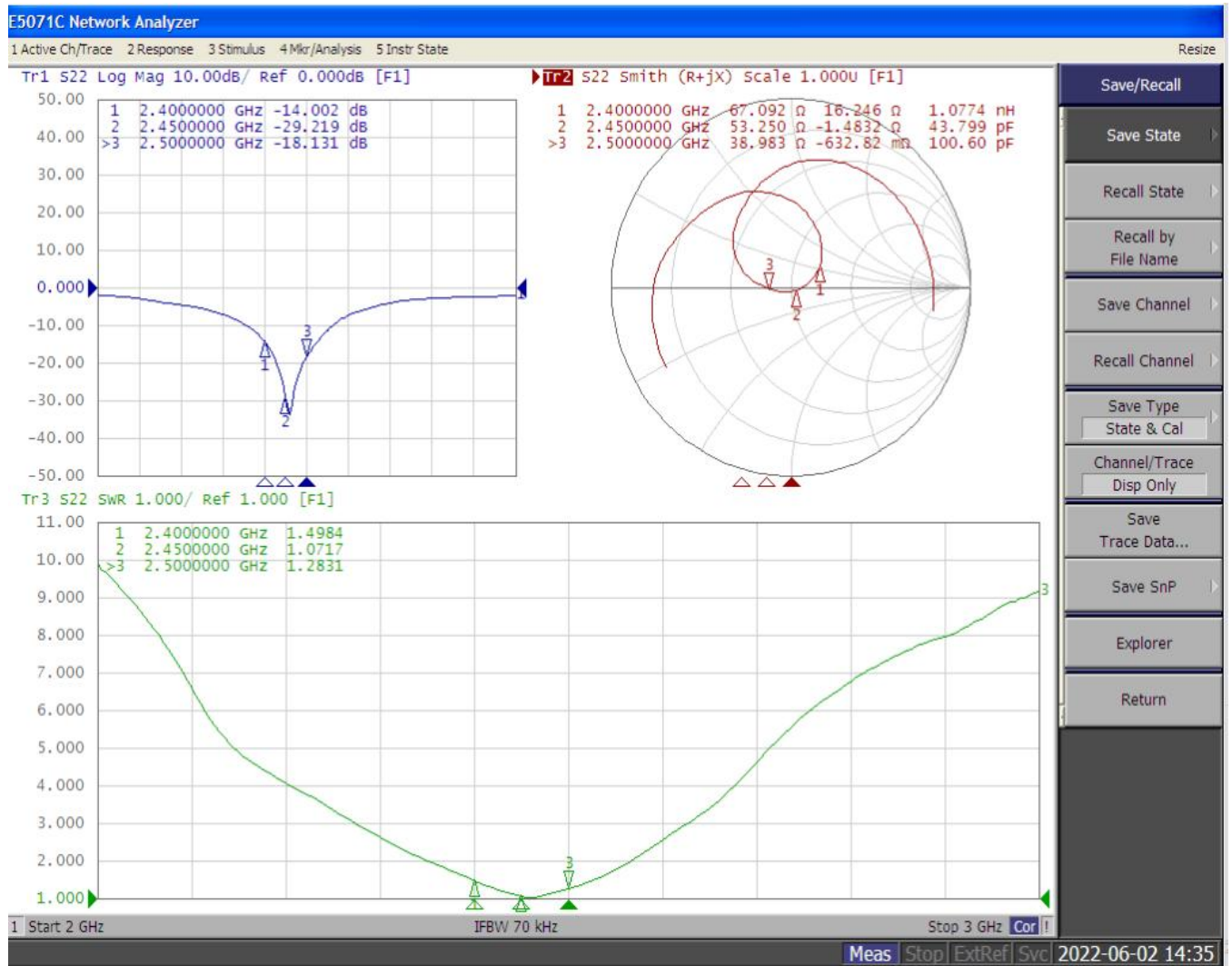


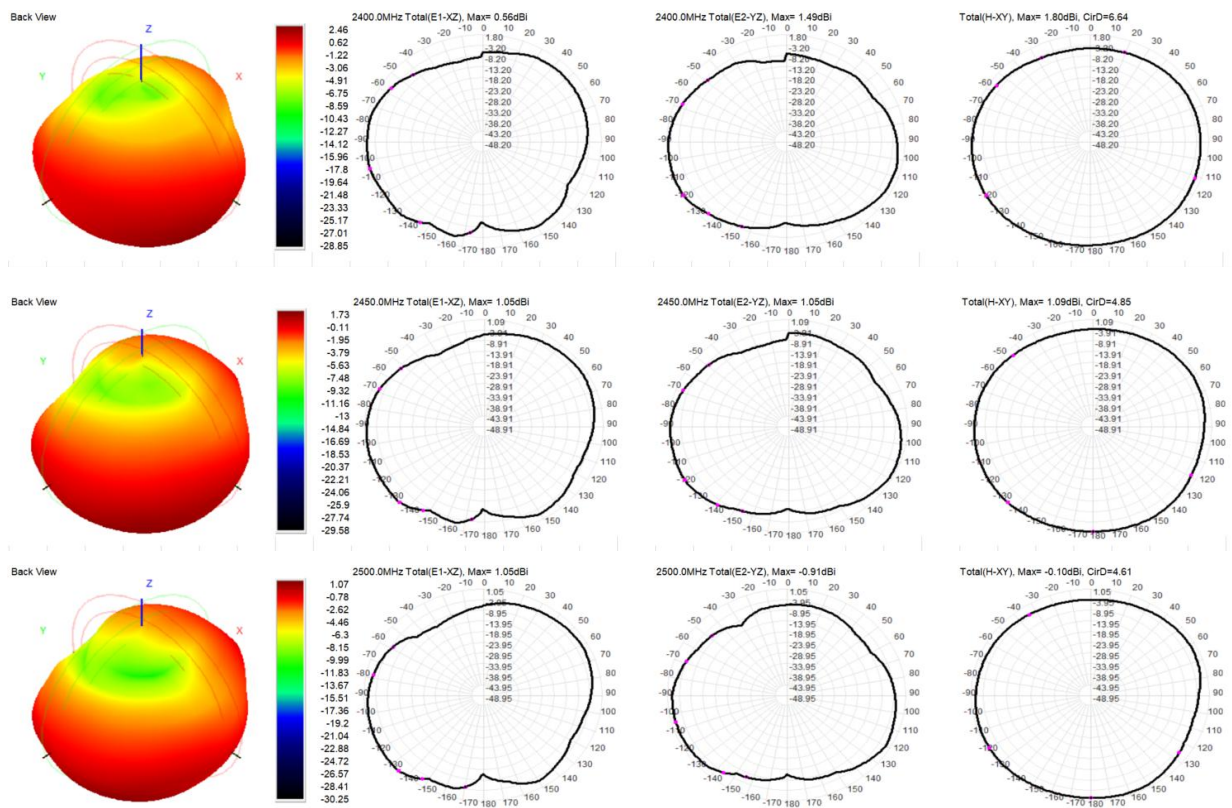
Figure 9 Antenna S parameters

## 6.3. Antenna Gain and Efficiency

Table 7 Antenna Gain and efficiency

| Frequency ID   | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     | 9     | 10    | 11    |
|----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Frequency(MHz) | 2400  | 2410  | 2420  | 2430  | 2440  | 2450  | 2460  | 2470  | 2480  | 2490  | 2500  |
| Gain (dBi)     | 2.46  | 2.41  | 2.03  | 1.88  | 1.46  | 1.73  | 1.79  | 1.76  | 1.66  | 1.22  | 1.07  |
| Efficiency (%) | 61.00 | 62.04 | 60.03 | 62.22 | 58.96 | 64.17 | 63.83 | 62.07 | 60.04 | 54.27 | 52.93 |

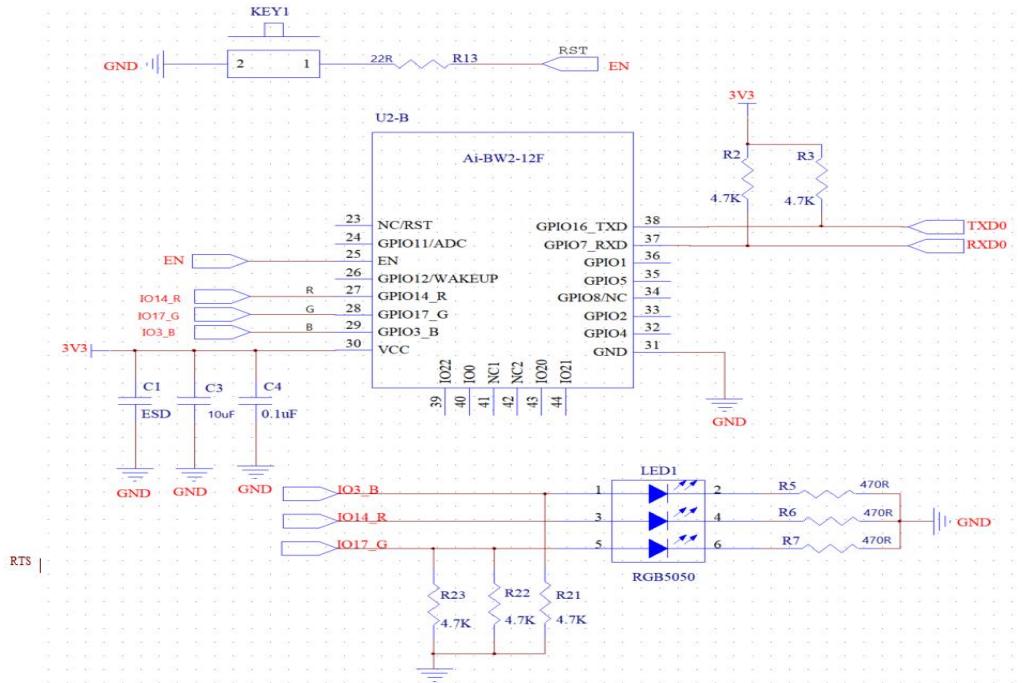
## 6.4. Antenna pattern



**Figure 10 Antenna pattern**

## 7. Design Guidance

### 7.1. Application circuit



**Figure 11 Application circuit diagram**

- If the IO port is used as PWM, it is recommended to reserve a 4.7K pull-down resistor around the module. Especially in the application of light control, it can prevent the flashing light phenomenon at the moment of power-on start.
- The GPIO0 / GPIO1 / GPIO2 / GPIO8 / GPIO20 / GPIO21 / GPIO22 / RST pins, which are not available by default. If you need to use it, please contact Ai-Thinker.

### 7.2. Antenna layout requirements

- The following two methods are recommended for the installation position on the mainboard:

Option 1: put the module on the edge of the motherboard, and the antenna area extends out of the edge of the motherboard.

Option : put the module on the edge of the motherboard, the edge of the motherboard at the antenna position hollowed out an area.

- In order to meet the performance of onboard antenna, it is forbidden to place metal parts around the antenna and keep away from high frequency devices.



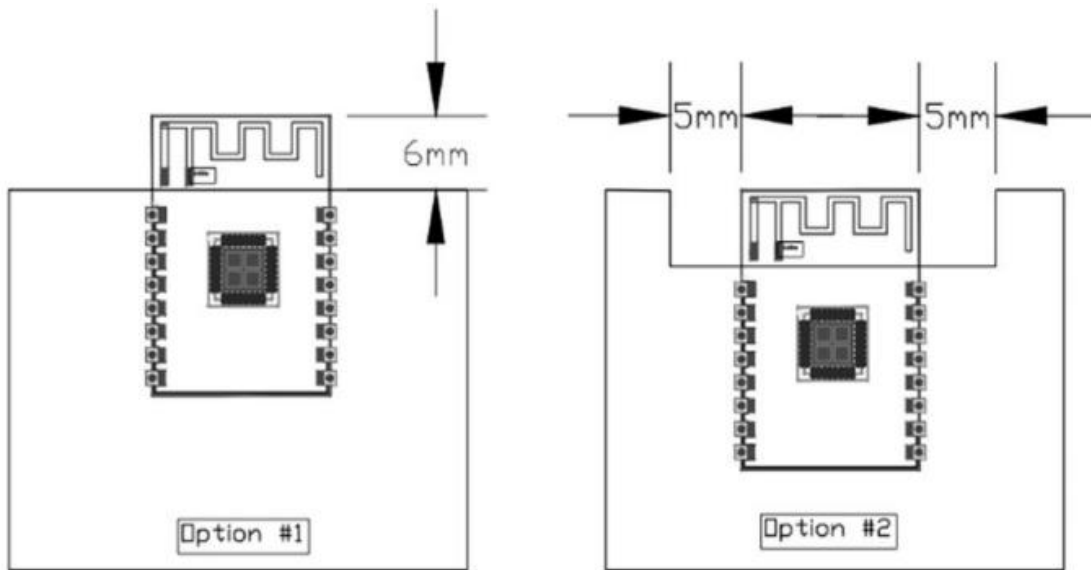


Figure 12 Antenna layout diagram

### 7.3. Power supply

- Recommended 3.3V voltage, peak current over 500mA.
- Power supply is recommend to use LDO; if the DC-DC is used, the ripple is recommended to be controlled within 30mV
- DC-DC power supply circuit proposes to reserve the dynamic response capacitance to optimize the output ripple with large load changes.
- It is recommended to add ESD devices to the 3.3V power interface.

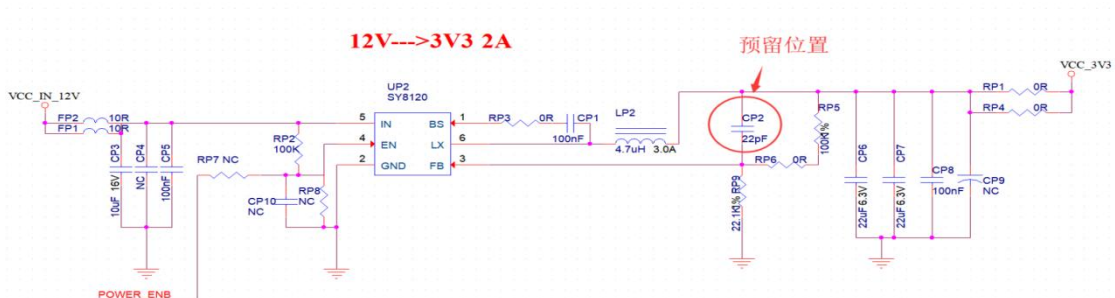


Figure 13 DC-DC step-down circuit diagram

## 7.4. GPIO

- There are some IO ports on the periphery of the module. If you need to use it, it is recommended to connect a 10-100 ohm resistor in series with the IO port. This inhibits overshoot and makes both sides level more stable. It is helpful for EMI and ESD.
- For special I/O ports to be pulled up and down, refer to the direction for use in the specifications, which may affect the module start-up configuration.
- The IO port of the module is 3.3V. If the IO level of the main control and the module do not match, a level convert circuit needs to be added.
- If the I/O port is directly connected to a peripheral port or terminals, for example, a pin row, reserve an ESD device near the terminal of the I/O cable.

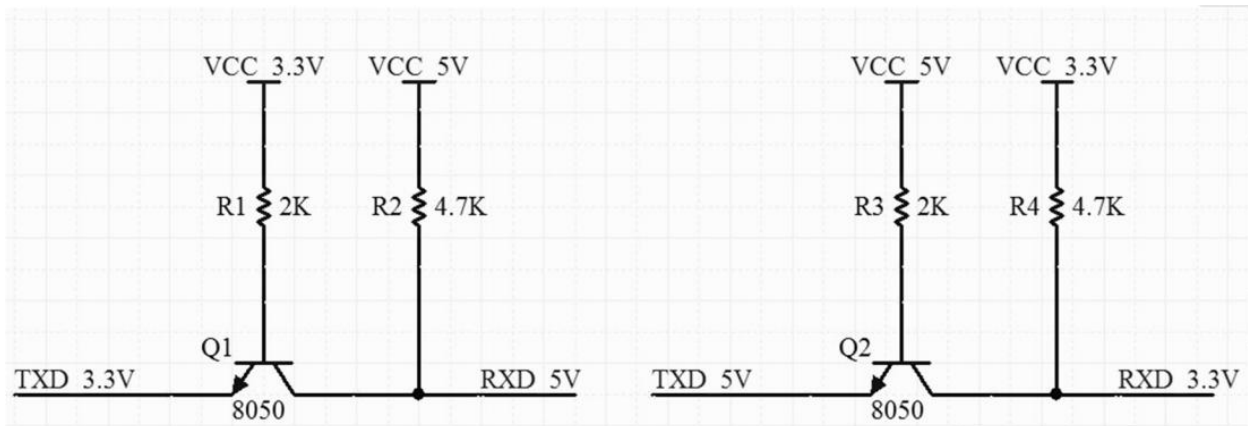


Figure 14 Level convert circuit

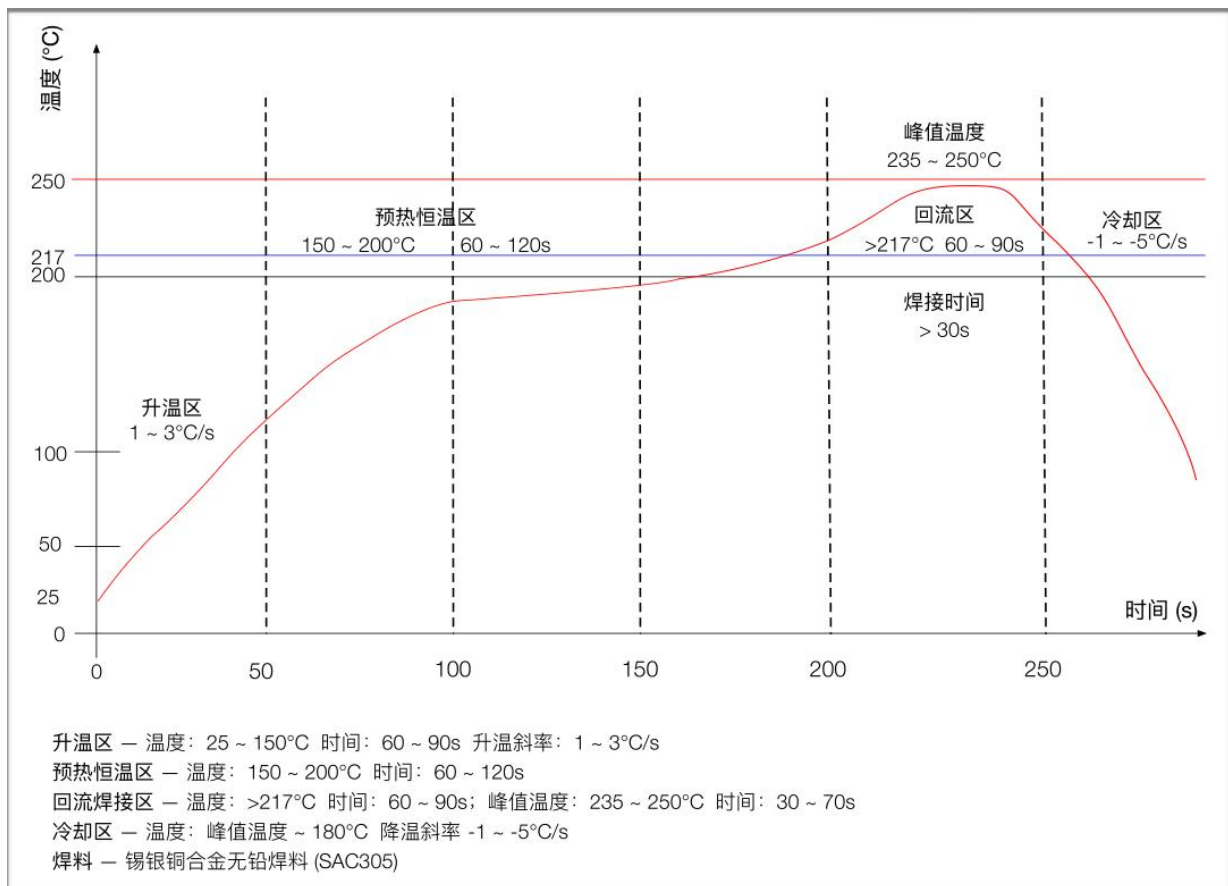
## 8. Storage conditions

Products sealed in moisture-proof bags should be stored in a non-condensing atmosphere of  $<40^{\circ}\text{C} / 90\% \text{RH}$ .

The module has a moisture sensitivity rating of MSL 3.

After the vacuum bag is opened, it must be used within 168 hours at  $25 \pm 5^{\circ}\text{C} / 60\% \text{RH}$ , otherwise it needs to be baked before it can be put on line again.

## 9. Reflow welding curve diagram



**Figure 15 Reflow welding diagram**

## 10. Product related models

**Table 8 Product related model list**

| Model   | Power Supply                         | Package | Size                 | Antenna   |
|---|--------------------------------------|---------|----------------------|---|
| Ai-WB2-12S  | 2.7V ~ 3.6V,<br>I <sub>≥</sub> 500mA | SMD-16  | 24.0*16.0*3.1±0.2)mm | on-board PCB antenna                                  |
| Ai-WB2-12F  | 2.7V ~ 3.6V,<br>I <sub>≥</sub> 500mA | SMD-22  | 24.0*16.0*3.1±0.2)mm | on-board PCB antenna                                  |
| Ai-WB2-07S  | 2.7V ~ 3.6V,<br>I <sub>≥</sub> 500mA | SMD-22  | 17.0*16.0*3.1±0.2)mm | IPEX interface  |
| Ai-WB2-13   | 2.7V ~ 3.6V,<br>I <sub>≥</sub> 500mA | SMD-18  | 20.0*18.0*3.1±0.2)mm | on-board PCB antenna                                  |
| Ai-WB2-13U  | 2.7V ~ 3.6V,<br>I <sub>≥</sub> 500mA | SMD-18  | 14.0*18.0*3.1±0.2)mm | IPEX interface  |
| Ai-WB2-32S  | 2.7V ~ 3.6V,<br>I <sub>≥</sub> 500mA | SMD-38  | 25.5*18.0*3.1±0.2)mm | Default onboard PCB antenna/compatible IPEX interface |
| Ai-WB2-01M  | 2.7V ~ 3.6V,<br>I <sub>≥</sub> 500mA | DIP-18  | 18.0*18.0*2.8±0.2)mm | on-board PCB antenna                                  |
| Ai-WB2-12F-Kit  | 3.3V or 5V,<br>I <sub>≥</sub> 500mA  | DIP-30  | 49.66*25.4(±0.2)mm   | on-board PCB antenna                                  |
| Ai-WB2-13-Kit   | 3.3V or 5V,<br>I <sub>≥</sub> 500mA  | DIP-30  | 49.66*25.4(±0.2)mm   | on-board PCB antenna                                  |
| Ai-WB2-32S-Kit  | 3.3V or 5V,<br>I <sub>≥</sub> 500mA  | DIP-38  | 55.05*25.4(±0.2)mm   | on-board PCB antenna                                  |
| Product related information : <a href="https://docs.ai-thinker.com">https://docs.ai-thinker.com</a> |                                      |         |                      |   |

## 11.Product Packaging Information

Ai-WB2-12F module was packaged in a tape, 800pcs/reel. As shown in the below image:



Figure 15 Package and packing diagram

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WeChat mini program



WeChat official account

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