# Ai-WB2-M1 Specification

Version V1.0.1

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# Document resume

| Version | Date | Develop/revise content | Edition | Approve |
|---------|------|------------------------|---------|---------|
| V1.0.0 | 2022.9.1 | First Edition | NanNan Yuan | Ning Guan |
| V1.0.1 | 2022.10.31 | Add RF OTA parameters | NanNan Yuan | Ning Guan |
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# Content

# 1. Product overview

Ai-WB2-M1 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.
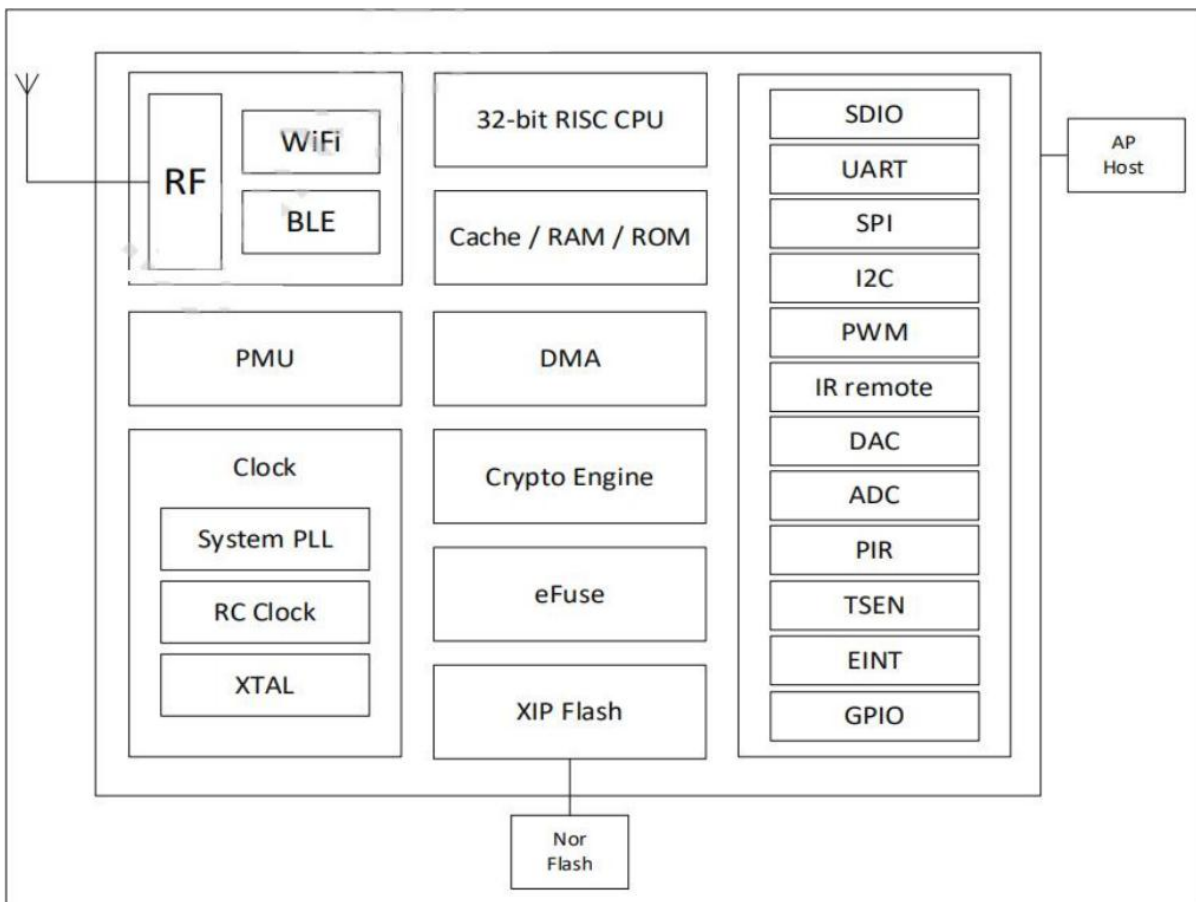


**Figure 1 Main chip block diagram**

## 1.1. Characteristic

- The package is SMD-61

- 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 12μA

- Universal AT instruction for quick start

- Support secondary development, integrated Windows, Linux development environment

## 2.  Main parameters

**Table 1 Description of the main parameters**

| Model | Ai-WB2-M1 |
|---|---|
| **Package** | SMD-61 |
| **Size** | 16.6*13.2*2.4(±0.2)mm |
| **Antenna** | On-board PCB antenna |
| **Frequency** | 2400~2483.5MHz |
| **Operating temperature** | -40°C~85°C |
| **Storage temperature** | -40°C~125°C,<90%RH |
| **Power supply** | Support voltage 2.7V~3.6V，supply current≥500mA |
| **Interface** | UART/GPIO/ADC/PWM/I2C/SPI |
| **IO** | 15 |
| **UART rate** | Default 115200 bps |
| **Security** | WPS/WEP/WPA/WPA2 Personal/WPA2 Enterprise/WPA3 |
| **Flash** | Default 4MByte |

## 2.1.  Static electricity requirement

Ai-WB2-M1 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 | | Conditio | 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*VDDIO | - | - | V |
| | VOL | - | - | 0.1*VDDIO | - | V |
| | VOH | - | - | 0.9*VDDIO | - | V |
| | IMAX | - | - | - | 15 | mA |

## 2.3. Wi-Fi RF Performance

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

| Description | Typical value | Unit |
|---|---|---|
| Frequency range | 2400～2483.5MHz | MHz |
| **Output Power** | | |
| **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 |
| **Receive Sensitivity** | | |
| **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 |
| **Output Power** | | | | |
| **Rate Mode** | **Min.** | **Typical value** | **Max.** | **Unit** |
| 1Mbps | - | 9 | 15 | dBm |
| **Receive Sensitivity** | | | | |
| **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



Front                                                Back
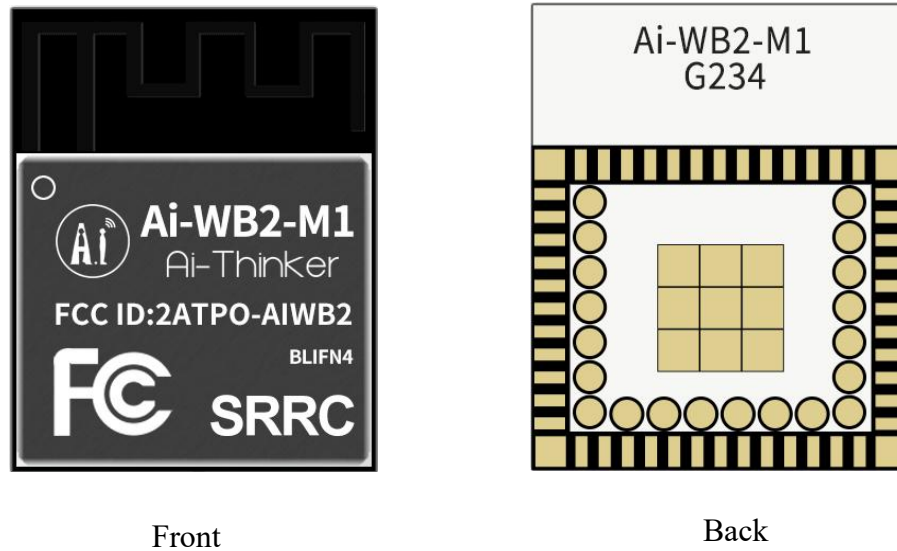
**Figure 3 Appearance diagram (Rendering figure is for reference only,subject to physical objects)**
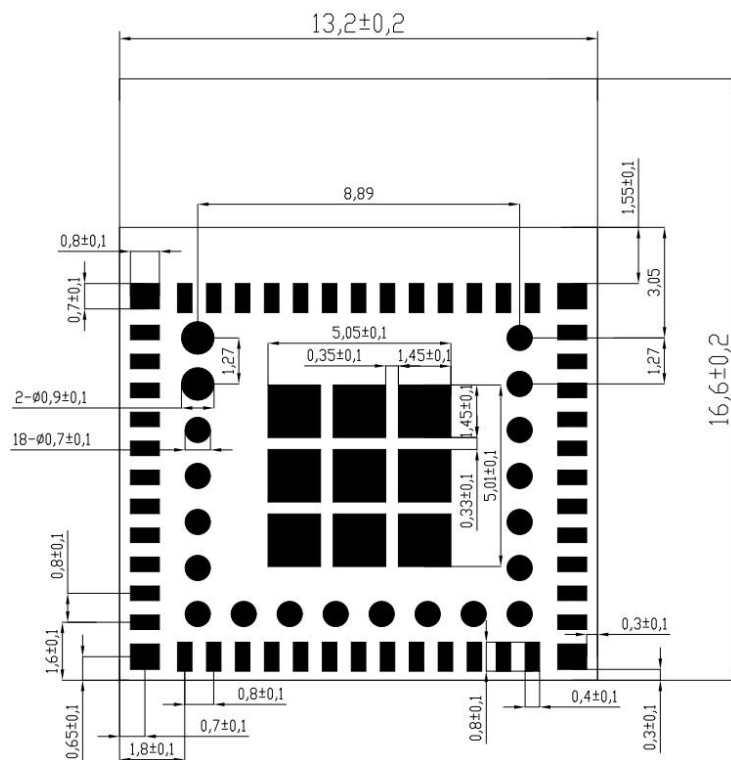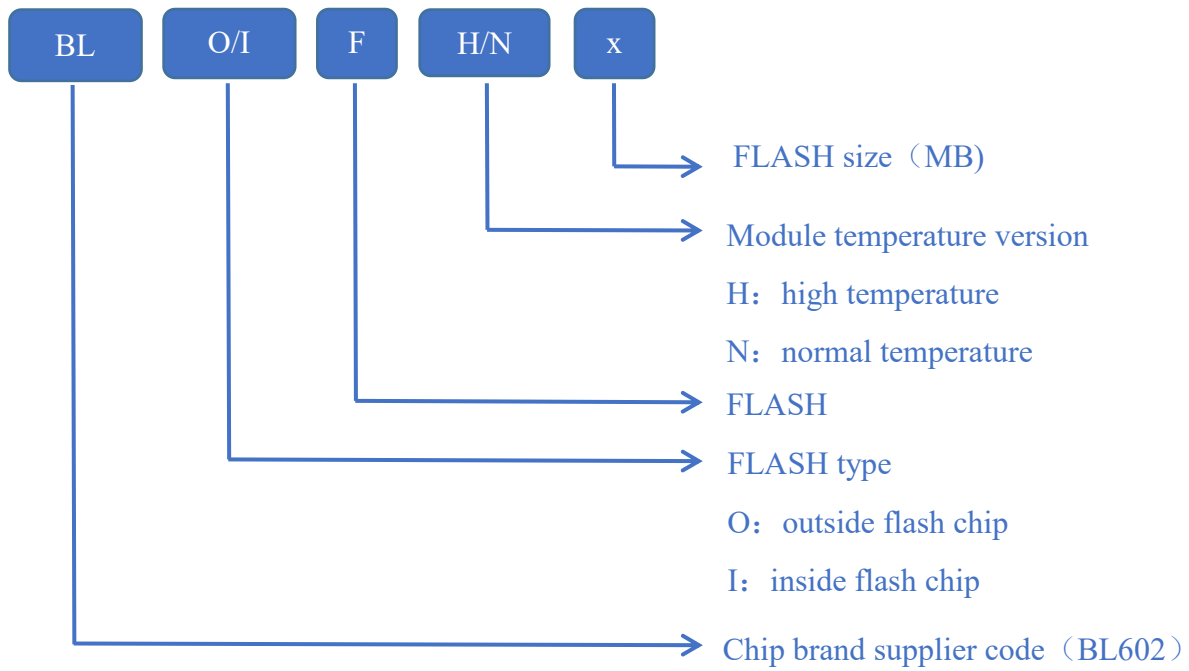


Figure 4 Dimension diagram

**Figure 5 Shield printing information**

# 4. Pin definition

Ai-WB2-M1 module is connected with a total of 61 pins, as shown in the pin schematic diagram, pin function definition table is the interface definition.
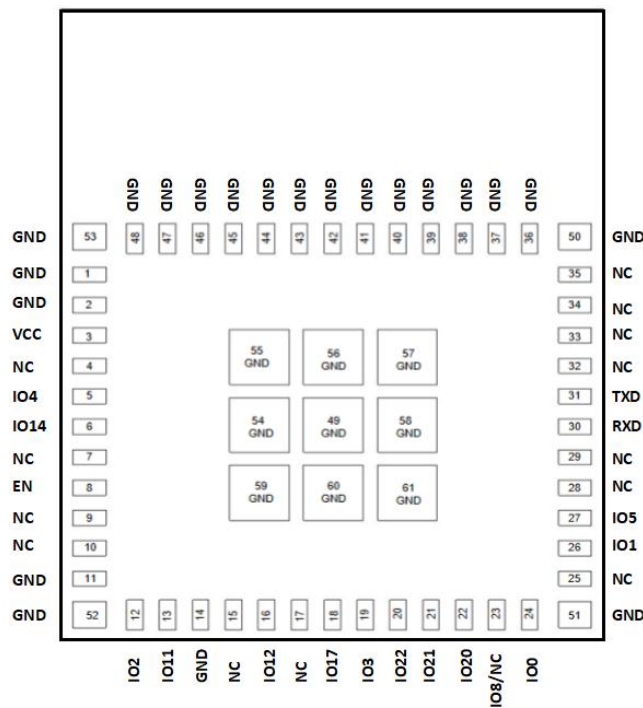


Figure 6 Schematic diagram of module pins

**Table 6 pin function definition table**

| No. | Name | Function |
|---|---|---|
| 1,2,11,14, 36-61 | GND | Ground |
| 3 | VCC | 3.3V power supply; It is recommended that the output current of the external power supply be higher than 500mA |
| 4,7,9,10,15 ,17,25,28, 29,32-35 | NC | NC, not available to use |
| 5 | IO4 | GPIO4/SPI_MOSI/MISO/IIC_SCL/PWM_CH4/ADC_CH4 |
| 6 | IO14 | GPIO14/SPI_SS/IIC_SCL/PWM_CH4/ADC_CH2 |
| 8 | EN | Default chip enable pin, active-high, high level effective. |
| 12 | IO2 | GPIO2/SPI_SS/IIC_SCL/PWM_CH2 |
| 13 | IO11 | GPIO11/SPI_SCLK/IIC_SDA/ADC_CH10 |
| 16 | IO12 | GPIO12/SPI_MOSI/MISO/IIC_SCL/PWM_CH2/ADC_CH0 |
| 18 | IO17 | GPIO17/SPI_MOSI/MISO/IIC_SDA/PWM_CH2 |
| 19 | IO3 | GPIO3/SPI_SCLK/IIC_SDA/PWM_CH3 |
| 20 | IO22 | GPIO22/SPI_SS/IIC_SCL/PWM_CH2/JTAG_TCK/TMS |
| 21 | IO21 | GPIO21/SPI_MOSI/MISO/IIC_SDA/PWM_CH1/JTAG_TDI/TDO |
| 22 | IO20 | GPIO20/SPI_MOSI/MISO/IIC_SCL/PWM_CH0/JTAG_TMS/TCK |
| 23 | IO8/NC | NC, unavailable. If you need to use it, please contact Ai-Thinker. Bootstrap/GPIO8/SPI_MOSI/MISO/IIC_SCL/PWM_CH3 |
| 24 | IO0 | GPIO0/SDIO_CLK//SPI_MOSI/MISO/IIC_SCL/PWM_CH0/JTAG_TMS/TCK |
| 26 | IO1 | GPIO1/SPI_MOSI/MISO/IIC_SDA/PWM_CH1 |
| 27 | IO5 | GPIO5/SPI_MOSI/MISO/IIC_SDA/PWM_CH0/ADC_CH4 |
| 30 | RXD | RXD/GPIO7/SPI_SCLK/IIC_SDA/PWM_CH2 |
| 31 | TXD | TXD/GPIO16/SPI_MOSI/MISO/IIC_SCL/PWM_CH1 |

Note:
  1.At the moment of power-on,if Bootstrap GPIO8 is high, the module enters the programming mode;if Bootstrap GPIO8 is low, the module starts normally.
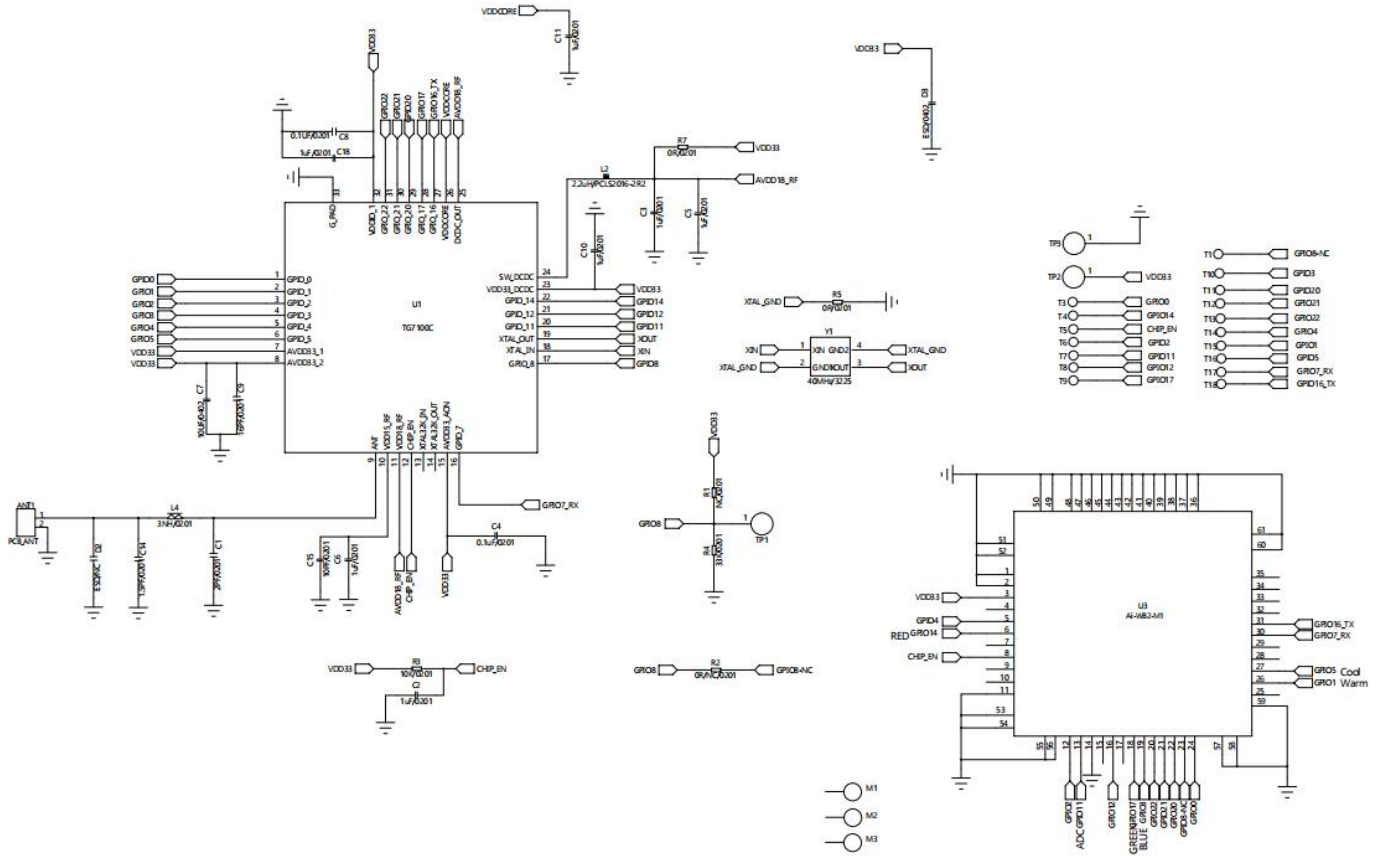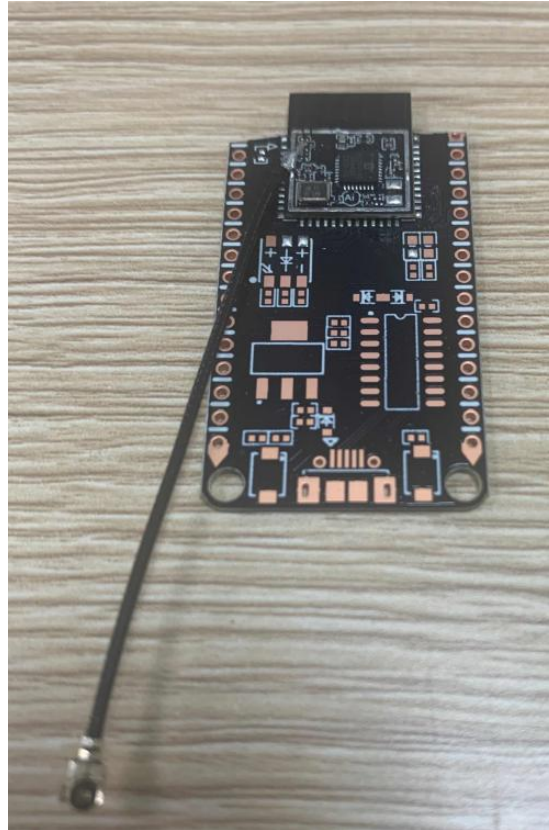
# 5. Schematic



**Figure 7 Module schematic**

# 6. Antenna parameters

## 6.1. Antenna test prototype signal



**Figure 8 Schematic diagram of the antenna test prototype**
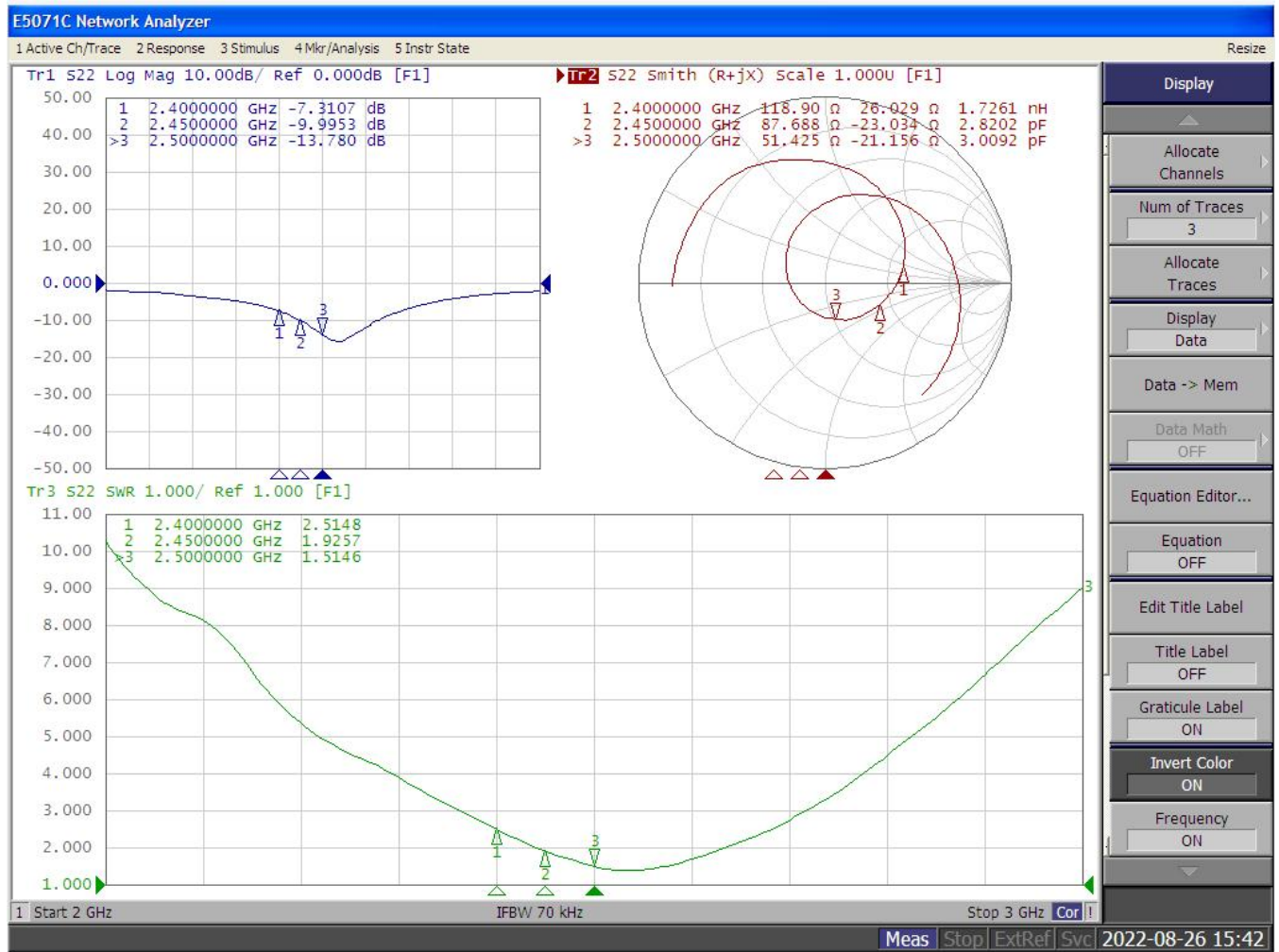
## 6.2.  Antenna S parameters



**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) | 0.92 | 0.97 | 0.99 | 1.17 | 1.45 | 1.59 | 1.62 | 1.51 | 1.34 | 1.49 | 1.45 |
| Efficiency(%) | 62.58 | 62.89 | 61.99 | 63.61 | 66.06 | 67.52 | 68.91 | 69.57 | 69.48 | 70.15 | 69.18 |

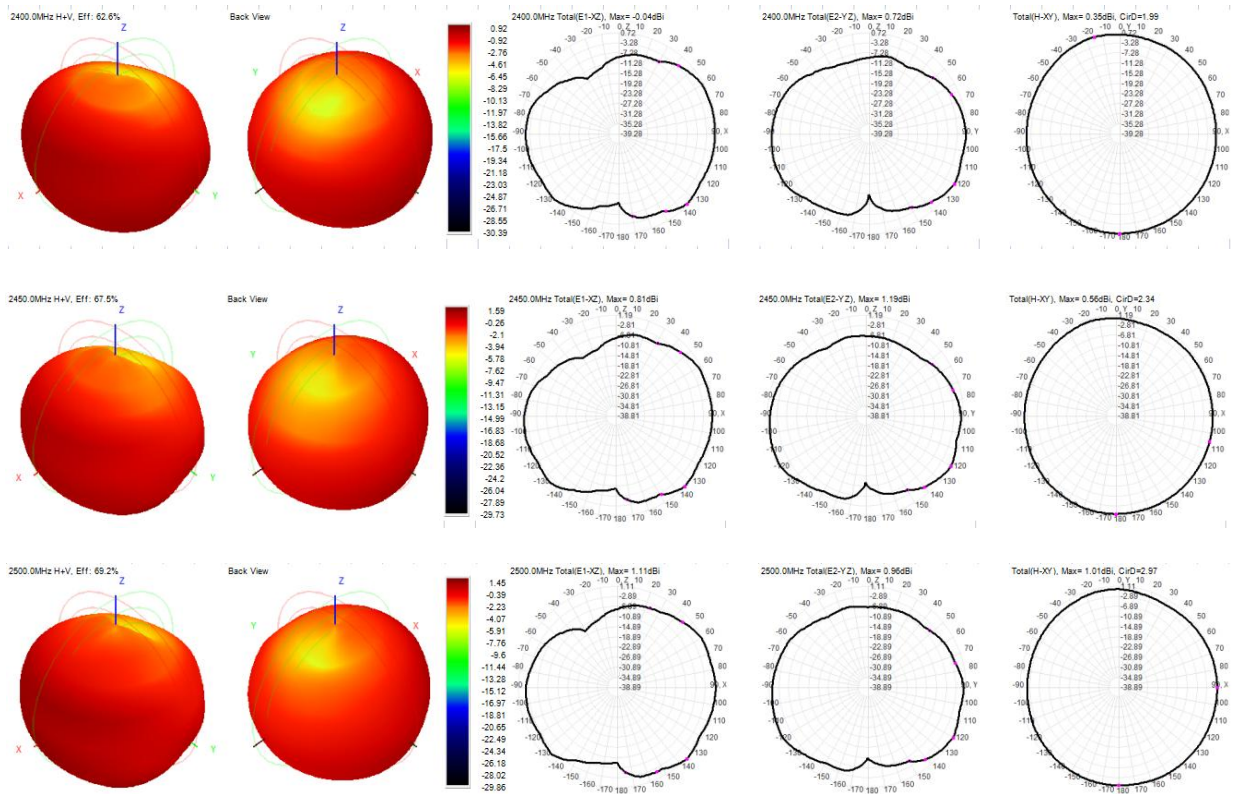## 6.4.  Antenna field diagram



**Figure 10 Antenna field type diagram**

## 6.5. RF OTA parameters

**Table 8 RF OTA parameters**

| Item | Mode | Rate(Mbps) | Channel | Fre.(MHz) | Data(dBm) |
|------|------|-----------|---------|-----------|-----------|
| TRP  | 11b  | 11  | 1  | 2412 | 16.47 |
|      |      |     | 6  | 2437 | 15.76 |
|      |      |     | 13 | 2472 | 15.36 |
|      | 11g  | 54  | 1  | 2412 | 14.25 |
|      |      |     | 6  | 2437 | 13.66 |
|      |      |     | 13 | 2472 | 12.93 |
|      | HT20 | MCS7 | 1 | 2412 | 13.65 |
|      |      |     | 6  | 2437 | 12.59 |
|      |      |     | 13 | 2472 | 12.09 |
| TIS  | 11b  | 11  | 1  | 2412 | -86.02 |
|      |      |     | 6  | 2437 | -85.4 |
|      |      |     | 13 | 2472 | -85.9 |
|      | 11g  | 54  | 1  | 2412 | -71.39 |
|      |      |     | 6  | 2437 | -72.22 |
|      |      |     | 13 | 2472 | -71.04 |
|      | HT20 | MCS7 | 1 | 2412 | -64.12 |
|      |      |     | 6  | 2437 | -64.79 |
|      |      |     | 13 | 2472 | -65.34 |

# 7. Design guidance

## 7.1. Application circuit
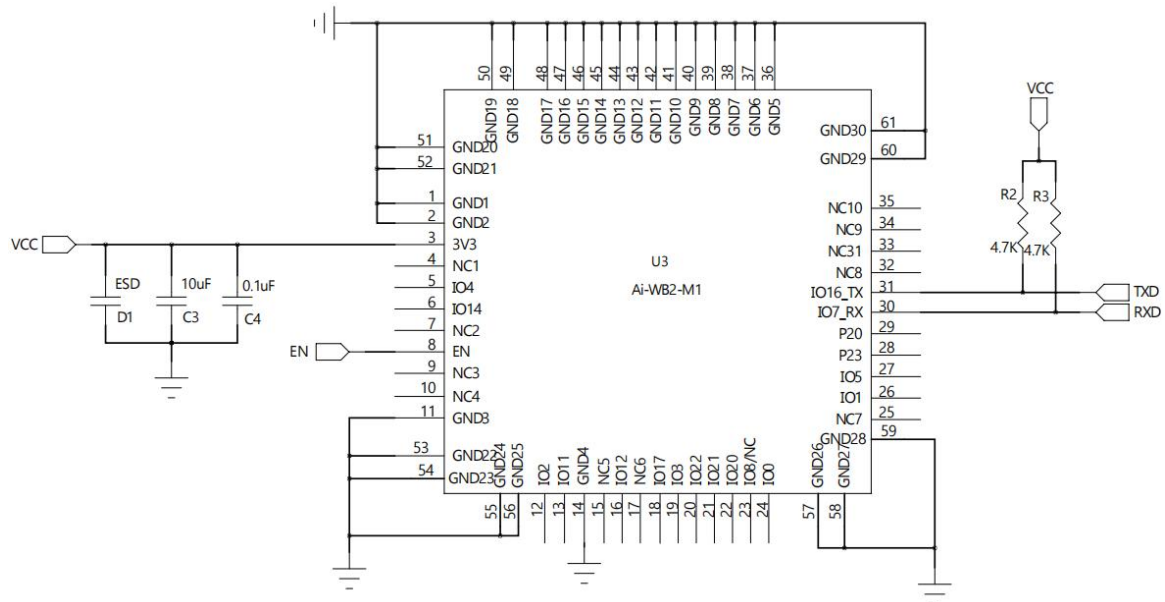


**Figure 11 Application guidance circuit**

■ 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.

■ IO8/NC pin, which are not available by default.If you need to use it, please contact Ai-Thinker.

## 7.2. Recommend PCB footprint size
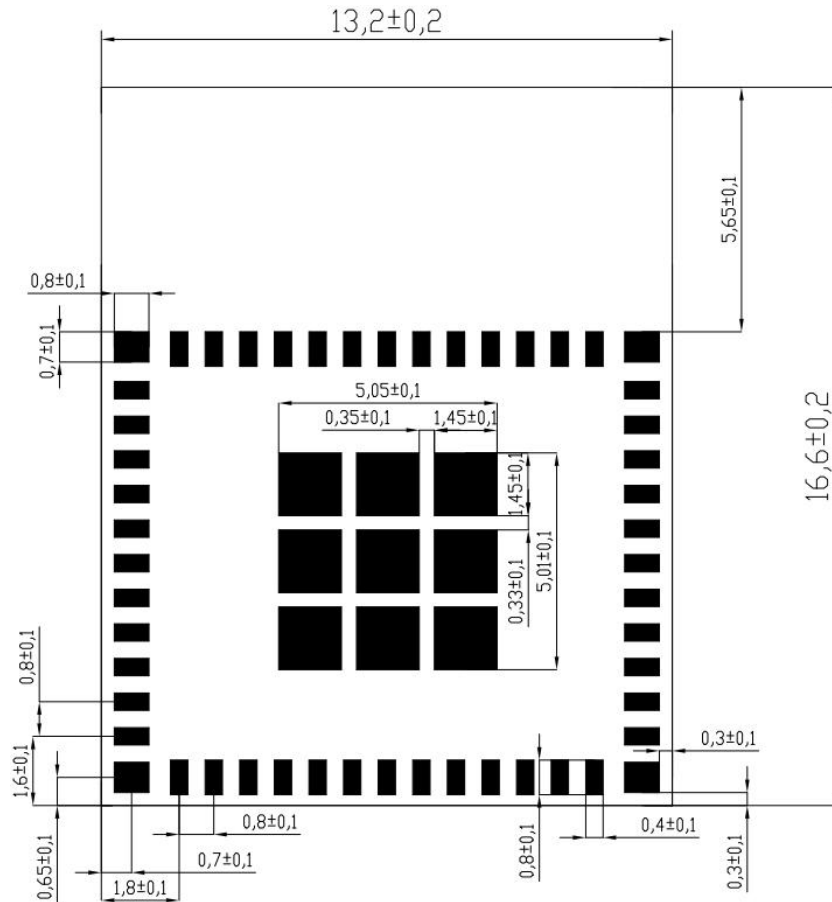


**Figure 12 Recommend PCB footprint size**

■ When making the PCB patch package, please pay attention to the welding pad does not shrink into the module inside, to prevent a short circuit to the back test point and leading to poor patch.

## 7.3. 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 2: 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.
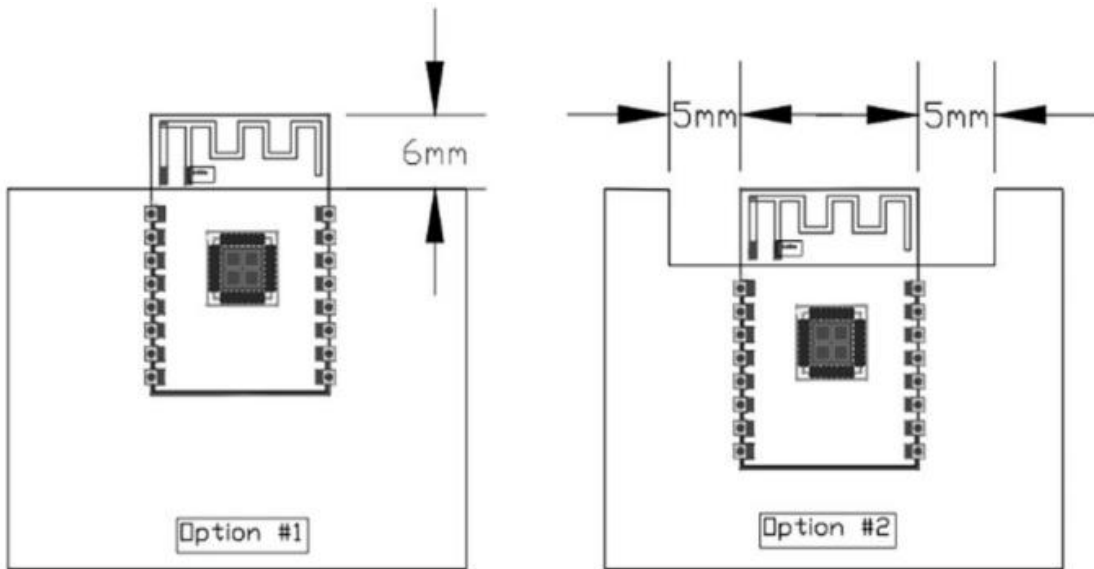
**Figure 13 Antenna layout diagram**

## 7.4.  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.
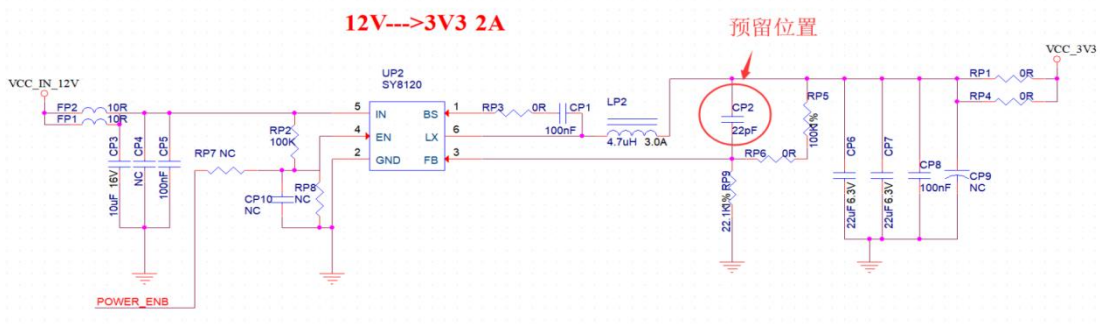


**Figure 14 DC-DC step-down circuit diagram**

## 7.5. 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 usage instructions in the specifications, which may affect the module startup 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 conversion 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.
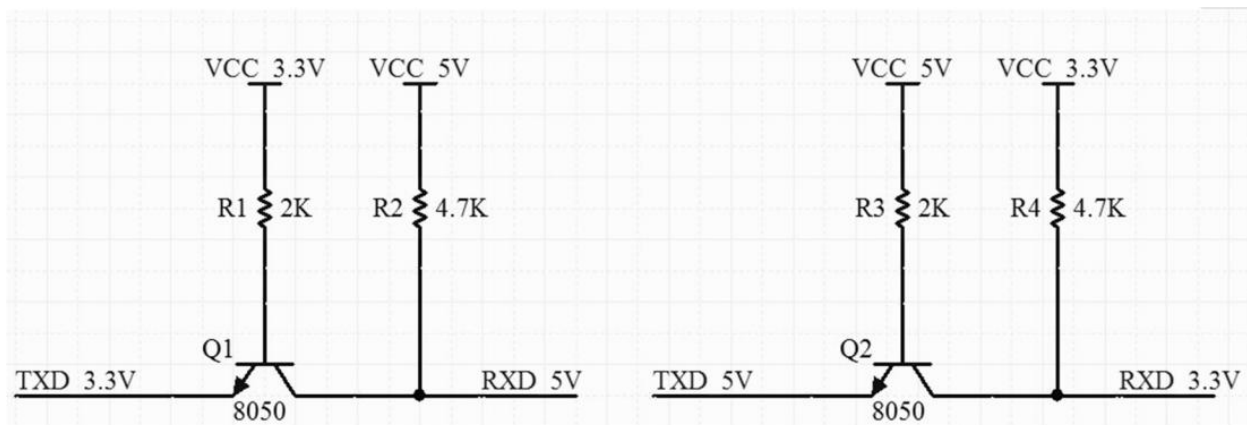


**Figure 15 Level convert circuit**

# 8. Storage conditions

Products sealed in moisture-proof bags should be stored in a non-condensing atmosphere of <40 ° C /90%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±5℃/60%RH, otherwise it needs to be baked before it can be put on line again.

# 9. Reflow welding curve diagram
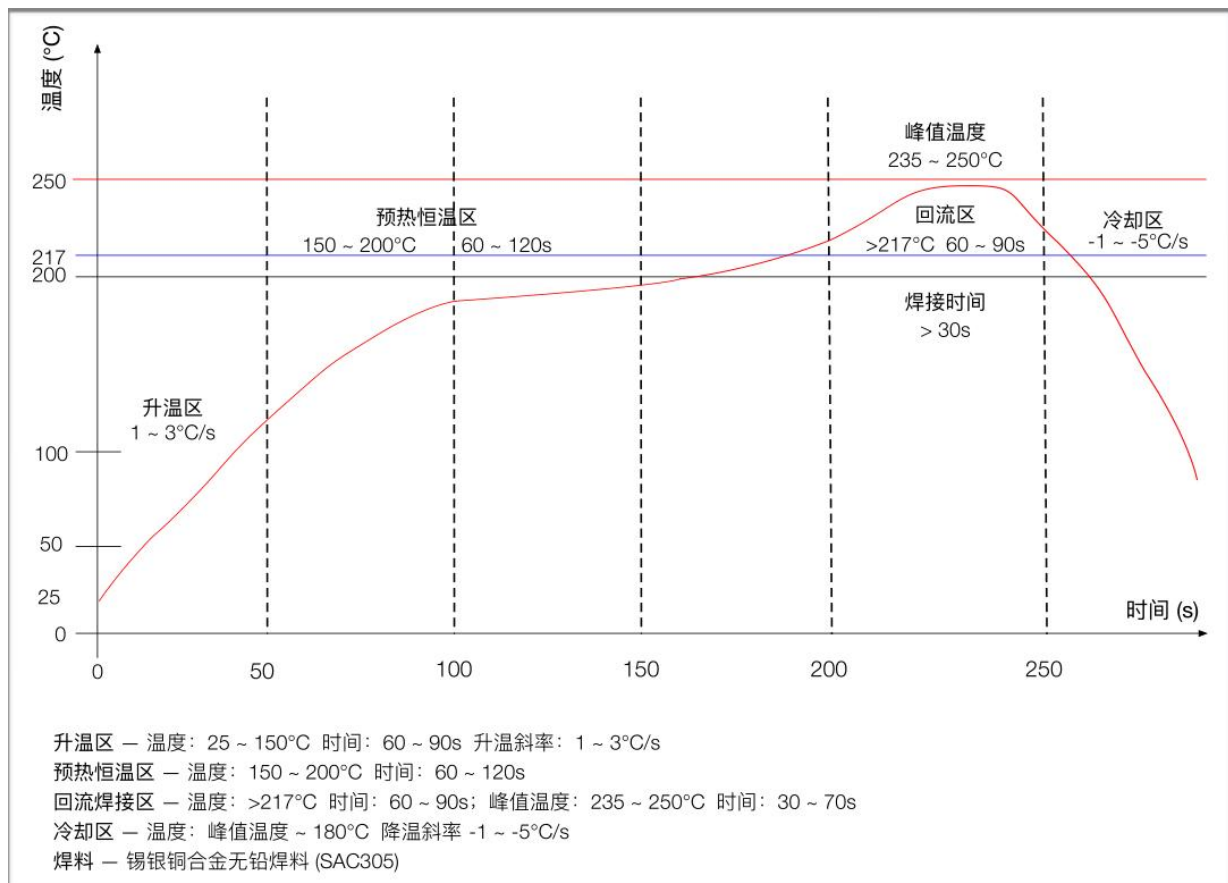


**Figure 16 Reflow welding diagram**

# 10. Product packaging information

Ai-WB2-M1 module was packaged in a tape，900pcs/reel. As shown in the below image：



**Figure 17 Package and packing diagram**

# 11. Contact us

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WeChat official account

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