



Ai-WB1-12F Specification

Version V1.1.0

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Document resume

| Version | Date | Develop/revise content | Edition | Approve |
|---------|-----------|------------------------|--------------|-----------|
| V1.1.0 | 2022.6.20 | First Edition | ChaoMei Deng | Ning Guan |
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1. Product Overview

Ai-WB1-12F is a Wi-Fi&Bluetooth module developed by Shenzhen Ai-Thinker Technology Co., Ltd. The module is equipped with W800 chip as the core processor, supports Wi-Fi 802.11b/g/n protocol, and supports BT/BLE Dual-mode working mode, support BT/BLE4.2 protocol. W800 chip has built-in low-power 32-bit XT804 CPU, operating frequency 240MHz, built-in 2MB Flash, 288KB RAM and rich peripheral interfaces, including SDIO, PSRAM, SPI, UART, I2C, PWM, ADC, Touch sensor, Duplex I2S and GPIO Wait. It can be widely used in the Internet of Things (IoT), mobile devices, wearable electronic devices, smart home and other fields.

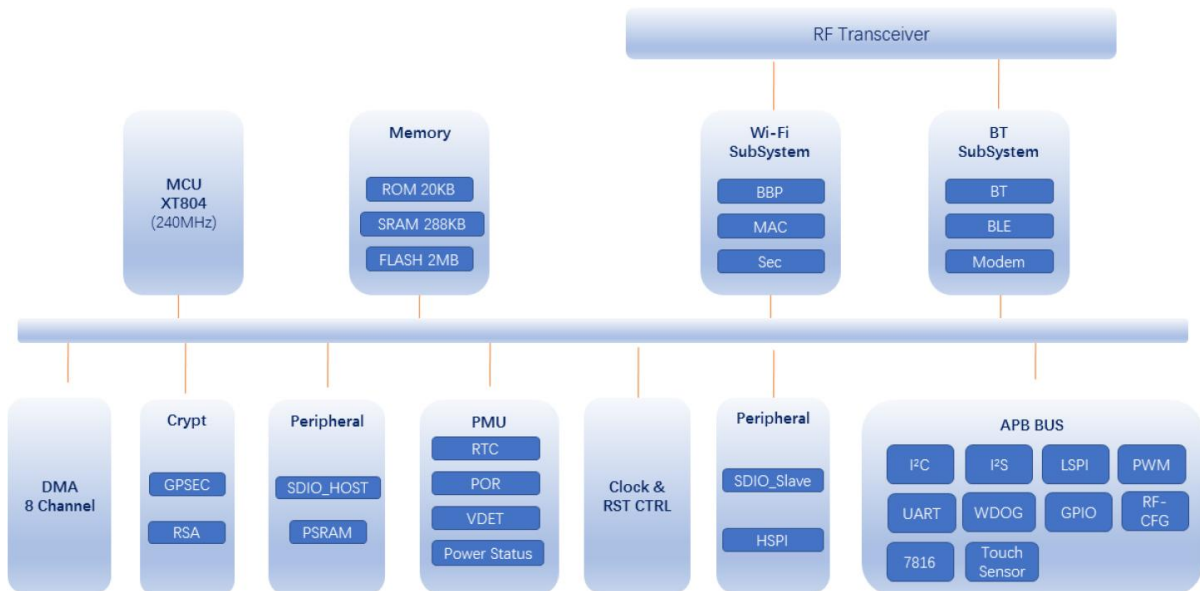


Figure 1 Main chip architecture diagram

1.1. Characteristic

- The package is SMD-22
- Support IEEE 802.11 b/g/n protocol
- Wi-Fi Security Support Wi-Fi WMM/WMM-PS/WPA/WPA2 /WPS
- Support 20/40MHz bandwidth, the highest rate is 150 Mbps
- Support BT/BLE dual-mode working mode, support BT/BLE4.2 protocol
- Support Station 、 Station + SoftAP 、 SoftAP mode
- Support 32-bit XT804 CPU, 288KB RAM
- The MCU has a built-in Tee security engine, and the code can distinguish between security events and non-security events
- Integrated SASC/TIPC, memory and internal modules/interfaces can be configured with security attributes to prevent non-secure code access
- Enable firmware signature mechanism for secure boot/upgrade
- With firmware encryption function to enhance code security
- Firmware encryption keys are distributed using asymmetric algorithms for enhanced key security
- Hardware encryption module: RC4256, AES128, DES/3DES, SHA1/MD5, CRC32, 2048RSA, true random number generator
- Support SDIO, PSRAM, SPI, UART, I2C, PWM, ADC, Touch sensor, Duplex I2S and GPIO
- Integrated Wi-Fi MAC/BB/RF/PA/LNA/Bluetooth
- Support a variety of sleep modes, standby power consumption current 10 μ 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

| | |
|------------------------------|---|
| Model | Ai-WB1-12F |
| Package | SMD-22 |
| Size | 24.0*16.0*3.1(±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 3.0V ~ 3.6V, supply current $\geq 500\text{mA}$ |
| Interface | UART/GPIO/ADC/PWM/I2C/SPI/Touch sensor/PSRAM/SDIO/Duplex I2S |
| IO | 18 |
| UART rate | Default 115200 bps |
| Security | Wi-Fi WMM/WMM-PS/WPA/WPA2 /WPS |
| Flash | Default 2MByte |

2.1. Static electricity requirement

Ai-WB1-12F 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 | 3.0 | 3.3 | 3.6 | V |
| I/O | VIL | - | 0.3 | 0.8 | V |
| | VIH | - | 2.0 | VDD+0.3 | V |
| | VOL | - | - | 0.4 | V |
| | VOH | - | 2.4 | - | V |
| | IMAX | - | - | - | 24 |

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 | Max. | Unit |
| 11n Mode HT20, PA output power | - | 12 | - | dBm |
| 11g Mode, PA output power | - | 13 | - | dBm |
| 11b Mode, PA output power | - | 18 | - | dBm |
| Receive Sensitivity | | | | |
| Mode | Min. | Typical | Max. | Unit |
| 11b, 1 Mbps | - | -95 | - | dBm |
| 11b, 11 Mbps | - | -85 | - | dBm |
| 11g, 6 Mbps | - | -89 | - | dBm |
| 11g, 54 Mbps | - | -72 | - | dBm |
| 11n, HT20 (MCS7) | - | -69 | - | 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 | Max. | Unit |
| 1Mbps | - | 4 | 6 | dBm |
| Receive Sensitivity | | | | |
| Rate Mode | Min. | Typical | Max. | Unit |
| 1Mbps sensitivity@30.8%PER | - | -92 | - | dBm |

2.5. Power

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

- All measurements are made at the antenna interface with filters
- All transmit data is based on 100% duty cycle, measured in continuous transmit mode.

Table 5 Power consumption

| Mode | Min. | AVG | Max. | Unit |
|-------------------------------------|------|-----|------|------|
| Tx 802.11b, 11Mbps, POUT=+19dBm | - | 348 | - | mA |
| Tx 802.11g, 54Mbps, POUT =+15dBm | - | 190 | - | mA |
| Tx 802.11n, MCS7, POUT =+12dBm | - | 190 | - | mA |
| Rx 802.11b, packet length 1024 byte | - | 96 | - | mA |
| Rx 802.11g, packet length 1024 byte | - | 96 | - | mA |
| Rx 802.11n, packet length 1024 byte | - | 96 | - | mA |
| SRAM retention | - | - | - | - |
| Deep-Sleep | - | 10 | - | μA |

3. Appearance Dimensions

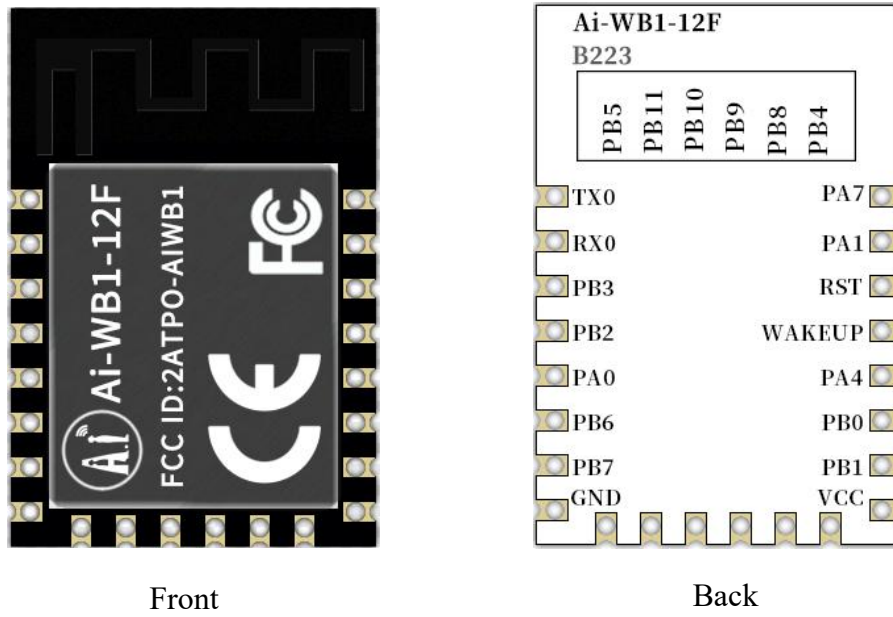


Figure 3 Appearance diagram (pictures is for reference only,subject to physical objects)

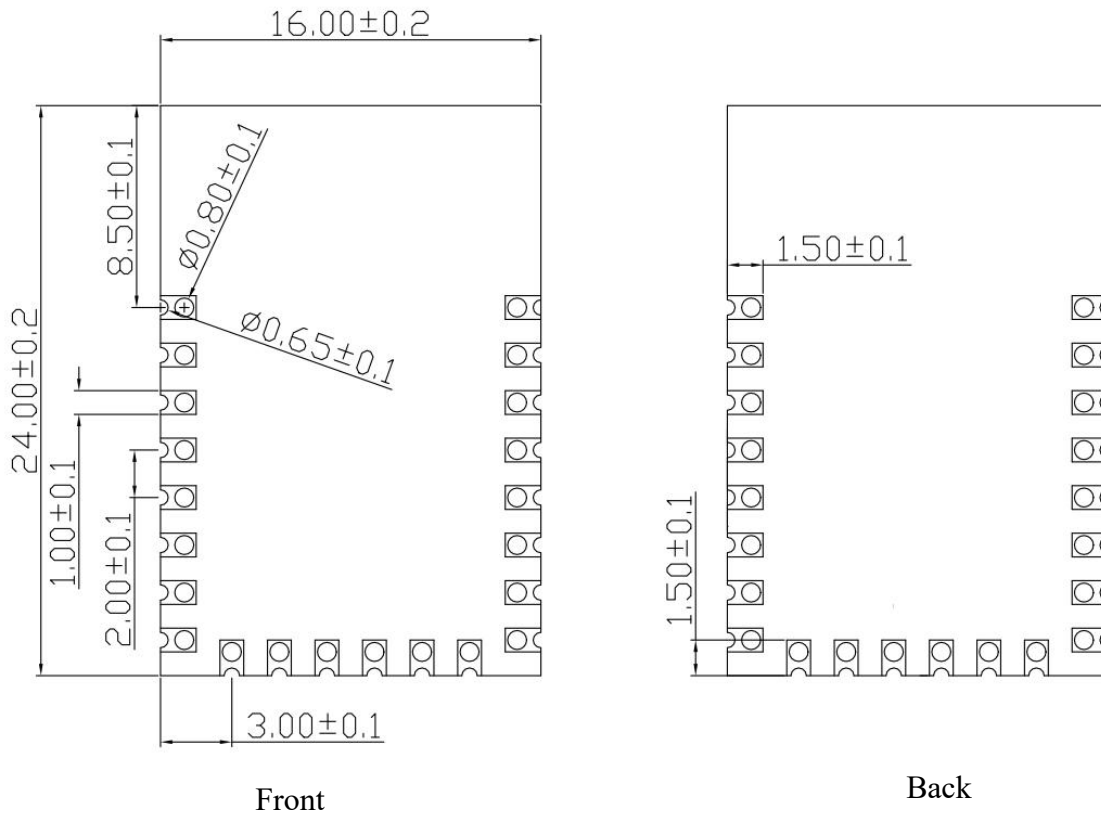


Figure 4 Dimension diagram

4. Pin Definition

Ai-WB1-12F module has a total of 22 pins, as shown in the pin diagram, the pin function definition table is the interface definition.

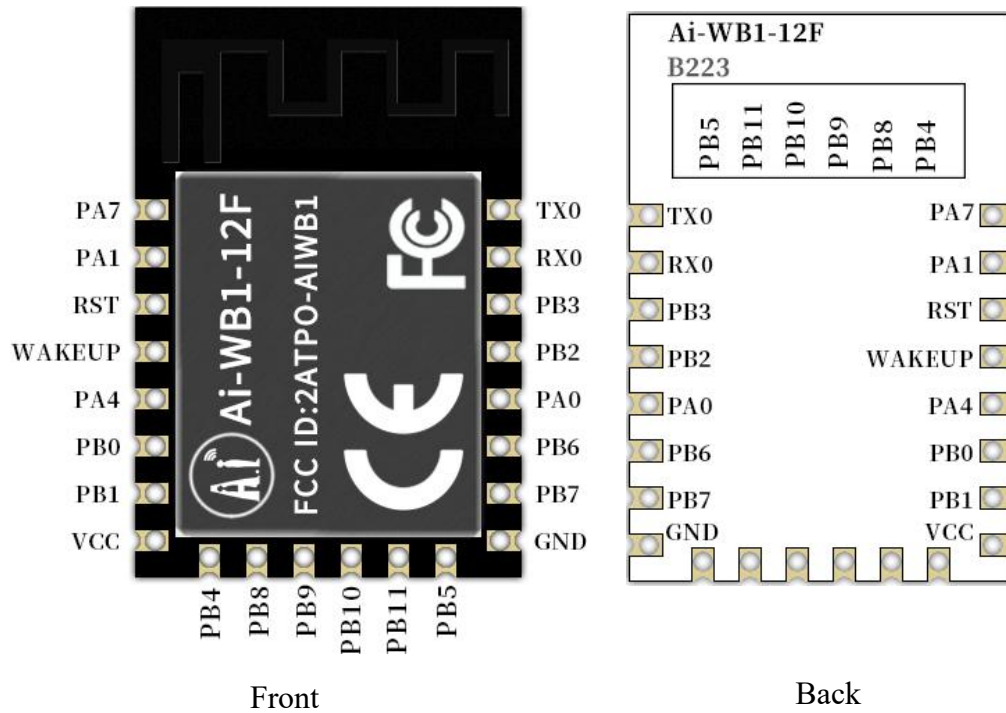


Figure 5 Schematic diagram of module pins

Table 6 Pin function definition table

| No. | Name | Function |
|-----|------|---|
| 1 | PA7 | PWM4/LSPI_MOSI/I2S_MCK/I2S_DI/Touch0/GPIO |
| 2 | PA1 | JTAG_CK/I2C_SCL/PWM3/I2S_LRCK/ADC0 |
| 3 | RST | As a chip enable, active low |
| 4 | WAKE | Wakeup function |
| 5 | PA4 | JTAG_SWO/I2C_SDA/PWM4/I2S_BCK/ADC1 |
| 6 | PB0 | PWM0/LSPI_MISO/UART3_TX/PSRAM_CK/Touch3/GPIO |
| 7 | PB1 | PWM1/LSPI_CLK/UART3_RX/PSRAM_CS/Touch4/GPIO |
| 8 | VCC | 3.3V power supply; the output current of the external power supply is recommended to be above 500mA |
| 9 | PB4 | LSPI_CS/UART2_RTS/UART4_TX/PSRAM_D2/Touch7/GPIO |
| 10 | PB8 | I2S_BCK/MMC_D0/PWM_BREAK/SDIO_D0/Touch11/GPIO |
| 11 | PB9 | I2S_LRCK/MMC_D1/HSPI_CS/SDIO_D1/Touch12/GPIO |
| 12 | PB10 | I2S_DI/MMC_D2/HSPI_DI/SDIO_D2/GPIO |
| 13 | PB11 | I2S_DO/MMC_D3/HSPI_DO/SDIO_D3/GPIO |
| 14 | PB5 | LSPI_MOSI/UART2_CTS/UART4_RX/PSARM_D3/Touch8/GPIO |
| 15 | GND | Ground |
| 16 | PB7 | UART1_RX/MMC_CMD/HSPI_INT/SDIO_CMD/Touch10/GPIO |
| 17 | PB6 | UART1_TX/MMC_CLK/HSPI_CK/SDIO_CK/Touch9/GPIO |
| 18 | PA0 | I2S_MCLK/LSPI_CS/PWM2/I2S_DO/BOOTMODE |
| 19 | PB2 | PWM2/LSPI_CK/UART2_TX/PSRAM_D0/Touch5/GPIO |
| 20 | PB3 | PWM3/LSPI_MISO/UART2_RX/PSRAM_D1/Touch6/GPIO |
| 21 | RX0 | UART0_RX/PWM1/UART1_CTS/I2C_SCL |
| 22 | TX0 | UART0_TX/PWM0/UART1_RTS/I2C_SDA |

5. Schematic

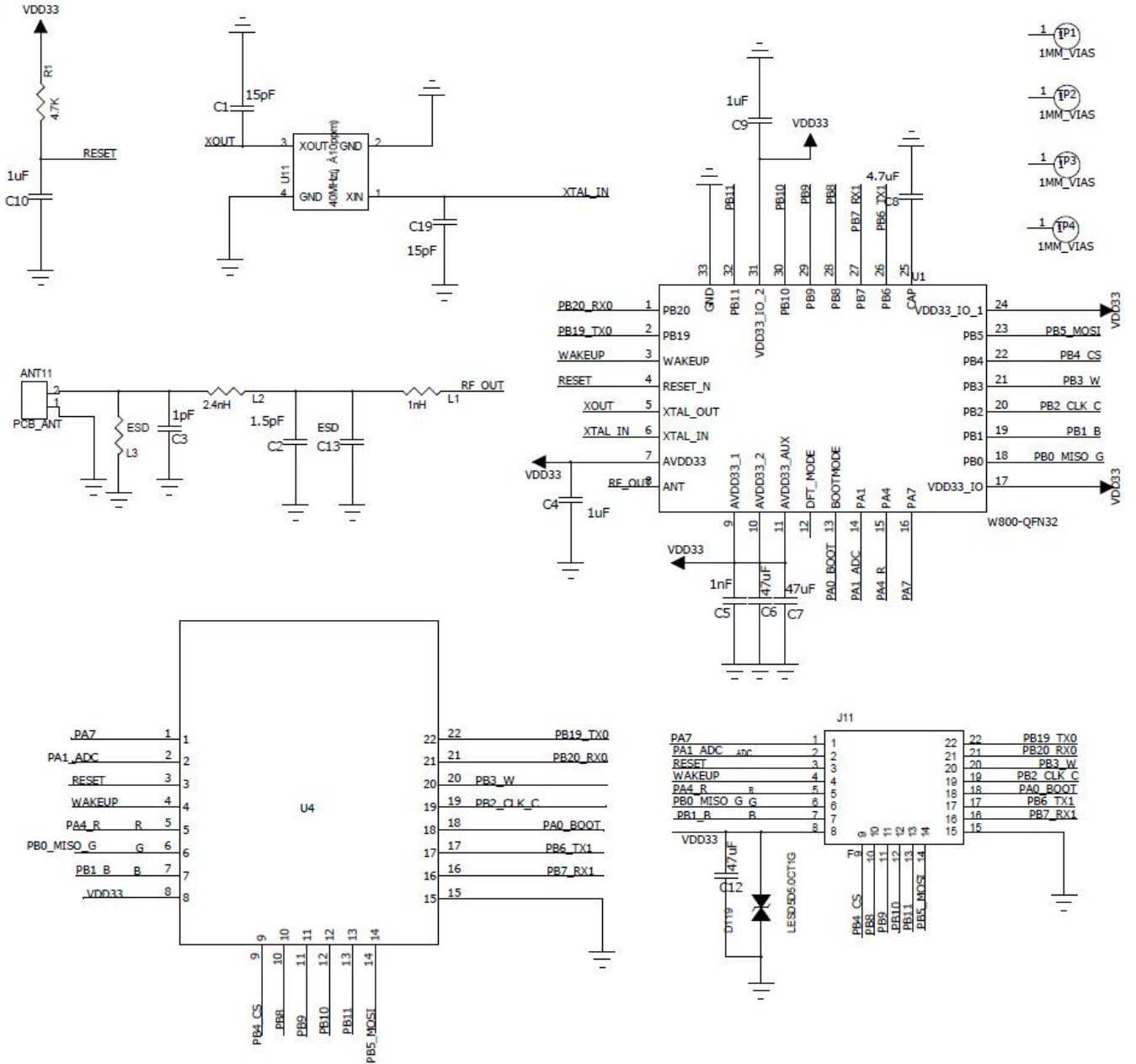


Figure 6 Schematic

6. Antenna parameters

6.1. Schematic diagram of the antenna test prototype

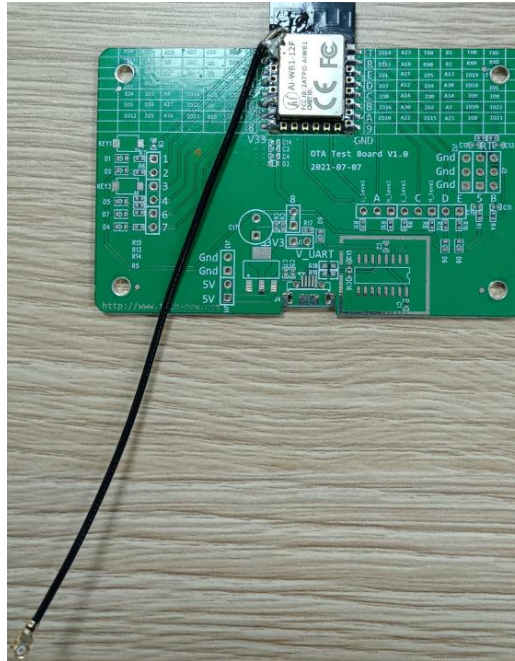


Figure 7 Schematic diagram of the antenna test prototype

6.2. Antenna S parameter

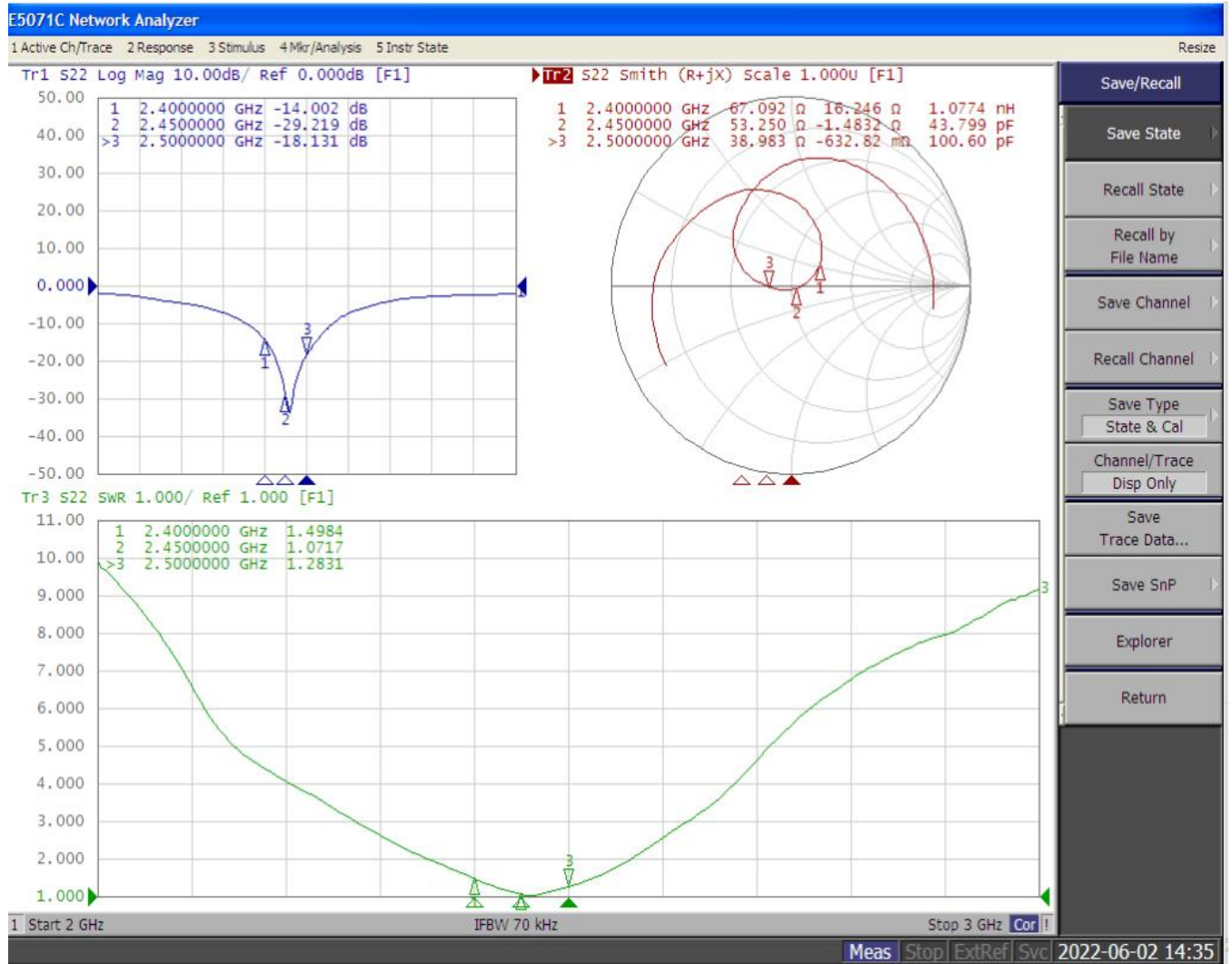


Figure 8 Antenna S parameters

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) | 1.63 | 1.49 | 1.61 | 1.90 | 2.09 | 2.22 | 2.15 | 2.04 | 1.80 | 1.78 | 1.60 |
| Efficiency (%) | 54.1 | 54.57 | 56.92 | 58.90 | 61.35 | 63.54 | 63.64 | 62.99 | 61.33 | 60.62 | 59.16 |

6.4. Antenna pattern

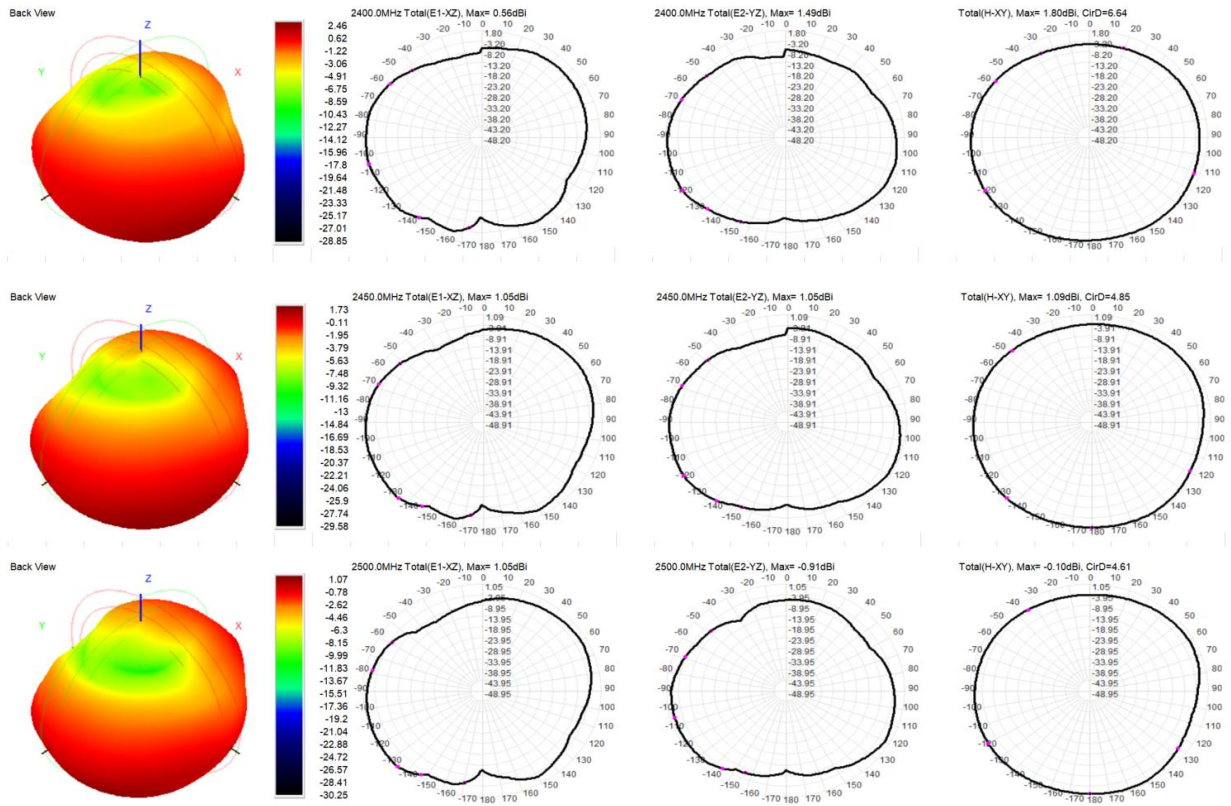


Figure 9 Antenna pattern

7. Design Guidance

7.1. Application Guidance Circuit

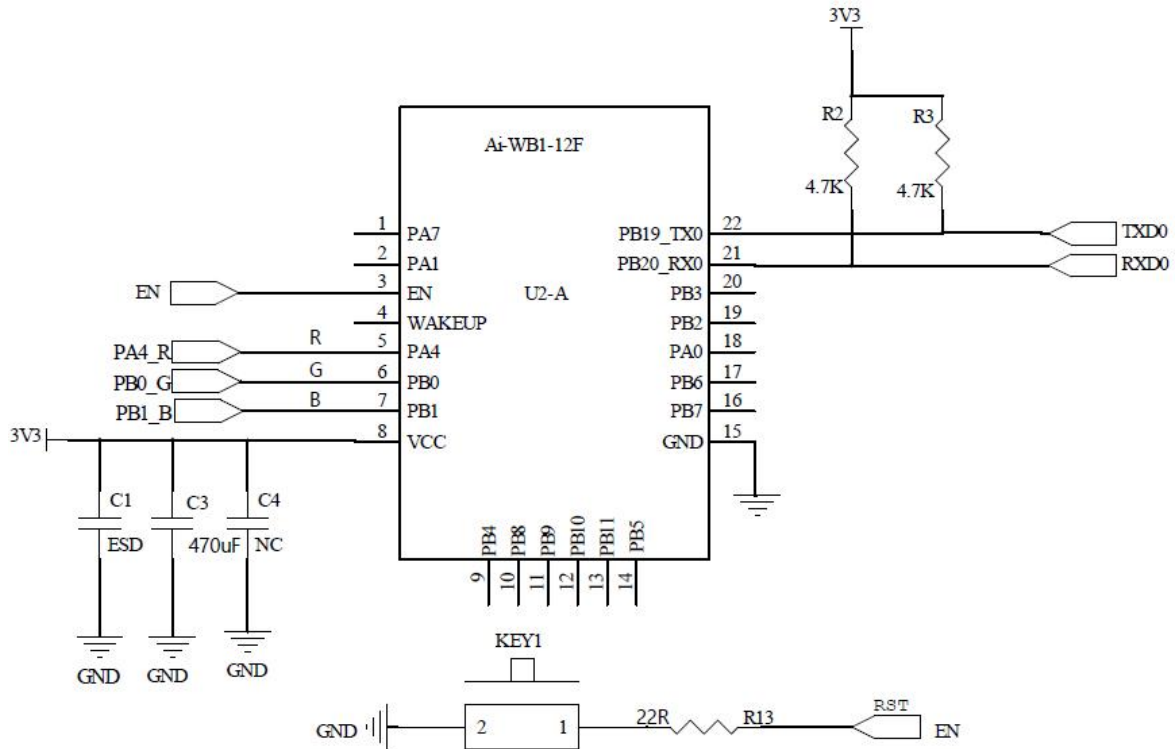


Figure 10 Application circuit diagram

- If the IO port is used as PWM, it is recommended to reserve a 4.7K pull-down resistor on the periphery of the module. Especially in the application of light control, it can prevent the flashing light phenomenon at the moment of power-on start.
- For power input, a 470uF capacitor needs to be added next to the VCC pin and placed close to the VCC pin, otherwise it will affect the RF EVM and other performance.

7.2. Recommended PCB package size

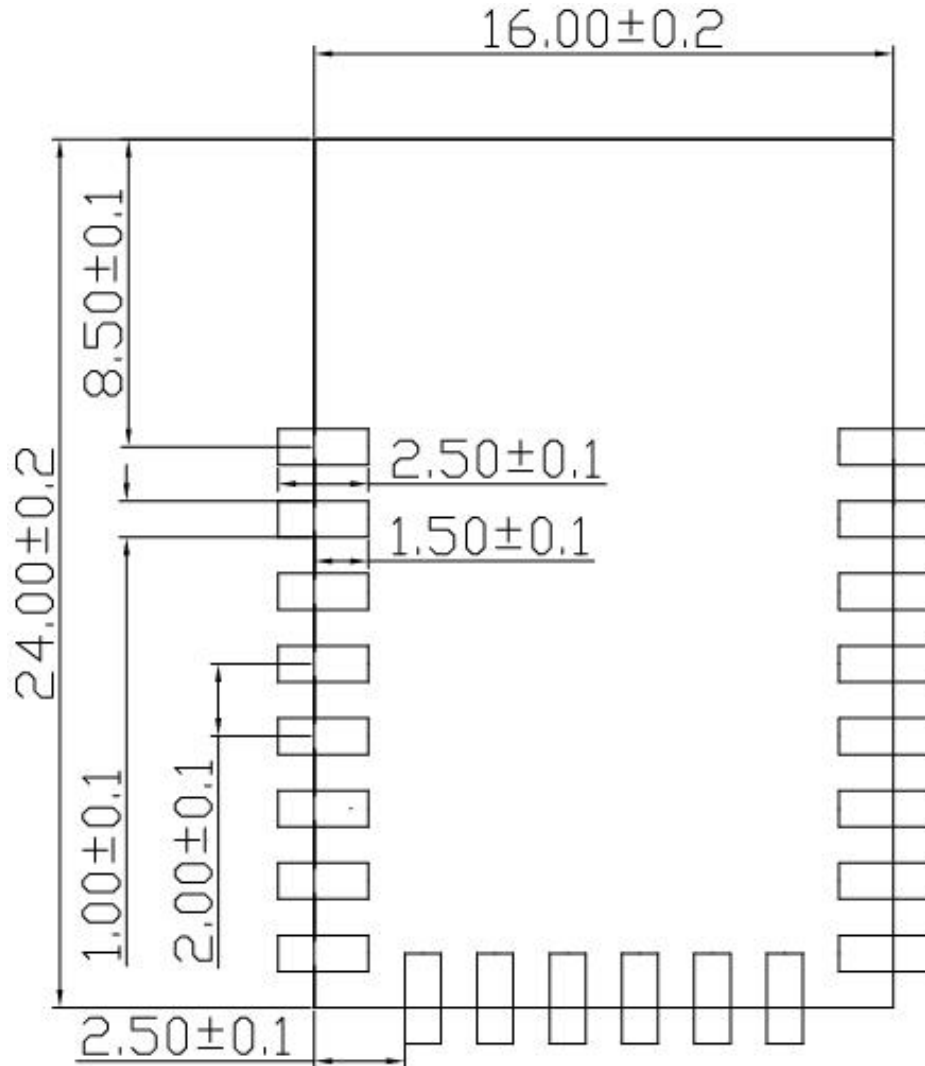


Figure 11 Recommended PCB package size (top view)

7.3. Antenna Layout Requirements

- In the installation position on the motherboard, the following two methods are recommended:

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, and hollow out an area on the edge of the motherboard at the antenna position.

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

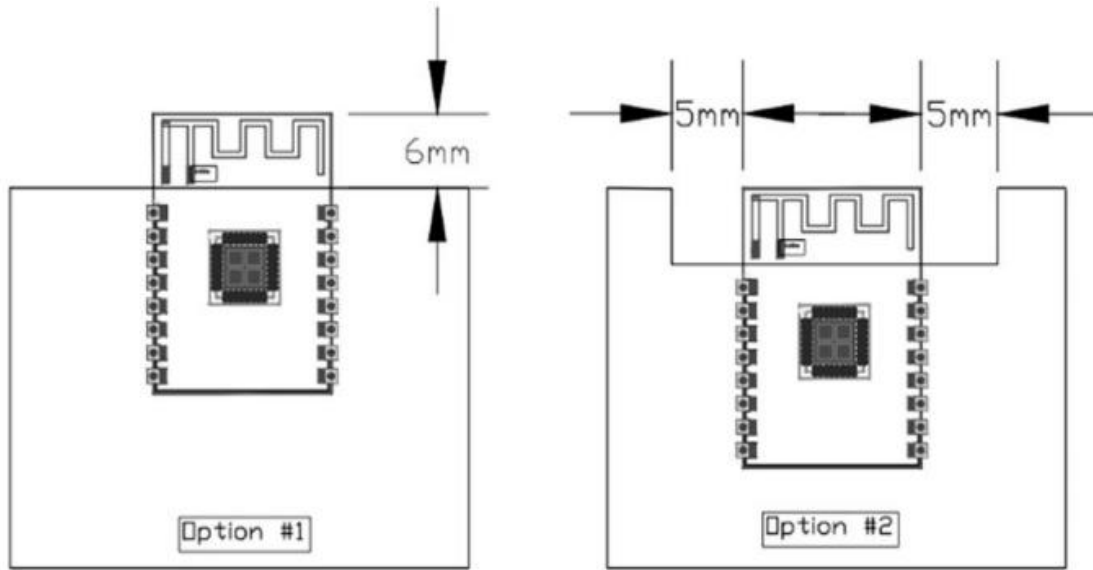


Figure 12 Schematic diagram of antenna layout

7.4. Power supply

- Recommended 3.3V voltage, peak current above 500mA.
- It is recommended to use LDO for power supply; if DC-DC is used, it is recommended that the ripple be controlled within 30mV.
- It is recommended to reserve the position of the dynamic response capacitor for the DC-DC power supply circuit, which can optimize the output ripple when the load changes greatly.
- It is recommended to add ESD devices to the 3.3V power interface.

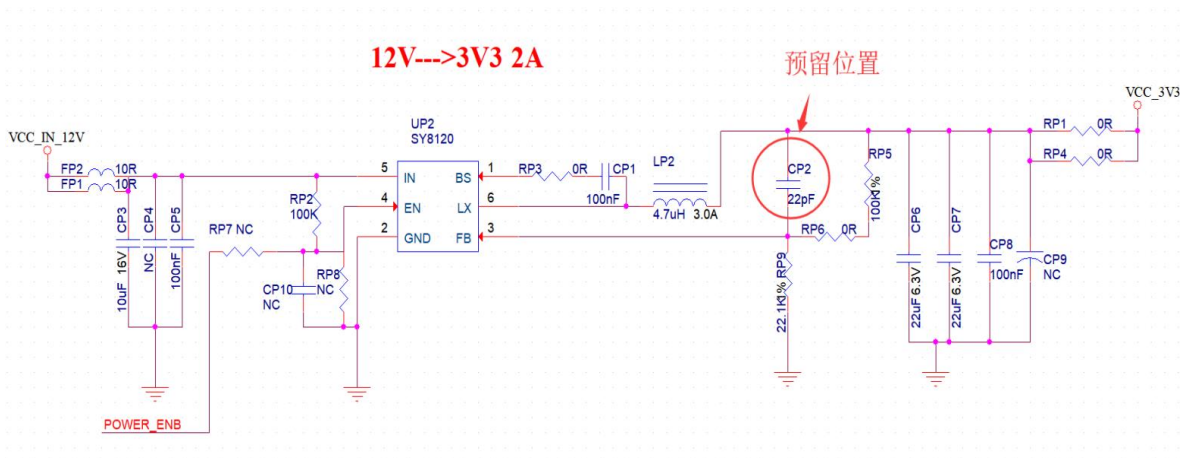


Figure 13 DC-DC step-down circuit diagram

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 suppresses overshoot and makes the level on both sides smoother. Helps with both EMI and ESD.
- For the up-down and down-down of the special IO port, please refer to the instruction manual of the specification, which will affect the startup configuration of the module.
- The IO port of the module is 3.3V. If the level of the main control and the IO port of the module does not match, a level conversion circuit needs to be added.
- If the IO port is directly connected to a peripheral interface, or a terminal such as a pin header, it is recommended to reserve an ESD device near the terminal of the IO port trace.

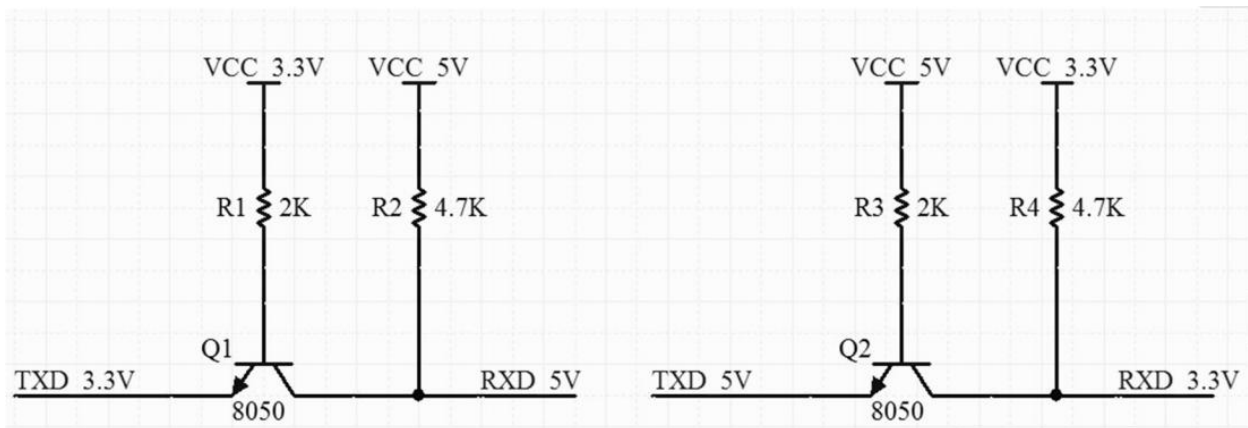


Figure 14 Level convert circuit

8. Storage conditions

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

The module's moisture sensitivity level MSL is level 3.

the vacuum bag is unpacked, it must be used within 168 hours at $25 \pm 5^{\circ}\text{C}/60\% \text{RH}$, otherwise it will need to be baked before going online again.

9. Reflow welding curve diagram

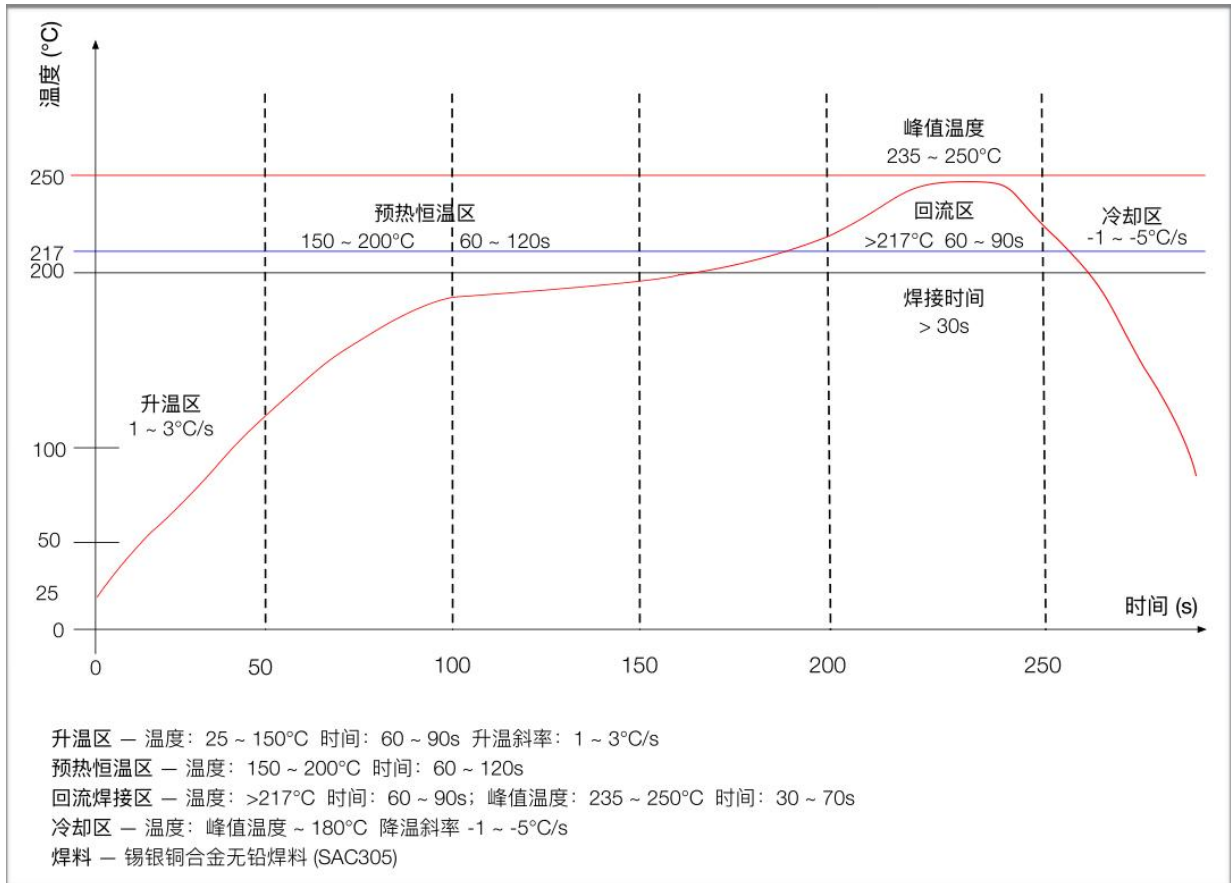


Figure 15 Reflow welding diagram

10. Product related models

Table 8 Product related model list

| Model | Power Supply | Package | Size | Antenna |
|--|---------------------------------------|---------|------------------------------|---|
| Ai-WB1-12F | 3.0V ~ 3.6V, $I \geq 500\text{mA}$ | SMD-22 | 24.0*16.0*3.1(± 0.2)mm | on-board PCB antenna |
| Ai-WB1-32S | 3.0V ~ 3.6V, $I \geq 500\text{mA}$ | SMD-38 | 25.5*18.0*3.1(± 0.2)mm | Default onboard PCB antenna/compatible IPEX interface |
| Ai-WB1-12F-Kit | 3.3V or 5V, $I > 500\text{mA}$ | DIP-30 | 25.41*55.19(± 0.2)mm | on-board PCB antenna |
| Ai-WB1-32S-Kit | 3.3V or 5V, $I > 500\text{mA}$ | DIP-38 | 25.4*55.78(± 0.2)mm | on-board PCB antenna |
| Product related information: https://docs.ai-thinker.com | | | | |

11.Product Packaging Information

Ai-WB1-12F module is packaged in a tape, 800pcs/reel.As shown in the below image:



Figure 16 Package and packing diagram

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