Ai-M61-01 Specification

Version V1.1.1

Document resume

Version	Date	Develop/revise content	Edition	Approve
V1.1.0	2023.03.16	First Edition	Shengxin Zou	Ning Guan
V1.1.1	2023.11.17	1、Update the chip block diagram and the supported peripheral interfaces; 2、Add important statements	Ning Guan	Hong Xu

Content

1. Product Overview

Ai-M61-01 is a Wi-Fi 6+BLE5.3 module developed by Shenzhen Ai-Thinker Technology Co., Ltd. The module is equipped with a BL618 chip as the core processor and supports Wi-Fi 802.11b/g/n/ax Protocol and BLE protocol, support Thread protocol. The BL618 system includes a low-power 32-bit RISC-V CPU with a floating point unit, DSP unit, cache and memory, and the highest frequency can reach 320M.

The Ai-M61-01 module has rich peripheral interfaces, including Camera, MJPEG, Dispaly, Audio Codec, USB2.0, SDU, Ethernet (EMAC), SD/MMC (SDH), SPI, UART, I2C, I2S, PWM, GPDAC, GPADC, ACOMP, GPIO, etc. It can be widely used in audio and video multimedia, Internet of Things (IoT), mobile devices, wearable electronic devices, smart home and other fields.

Ai-M61-01 module Sec Eng module supports AES/SHA/PKA/TRNG and other functions, supports image encryption and signature startup, and meets various security application requirements in the Internet of Things field.

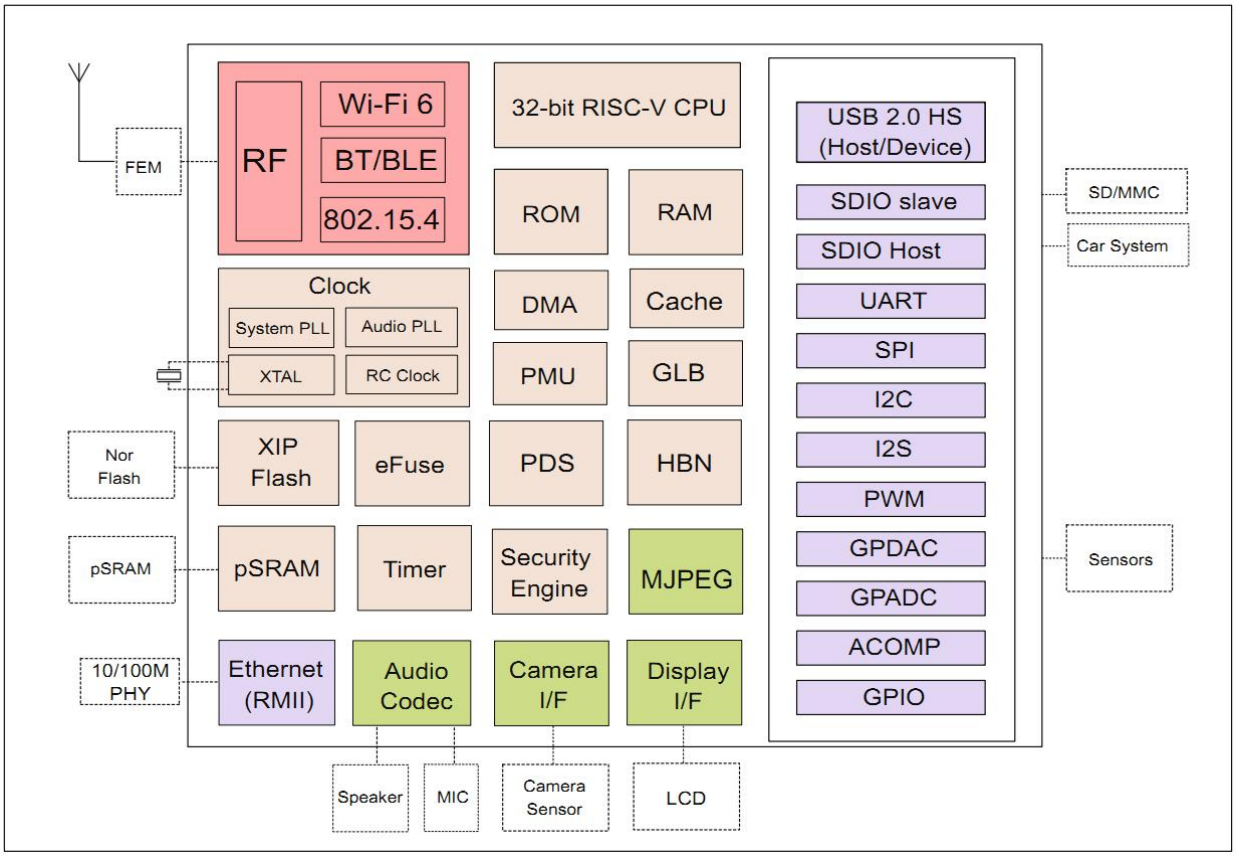


Figure 1 Main chip architecture diagram

1.1. Characteristic

- The package is SMD-48
- Support 2.4GHz working frequency band
- Support IEEE 802.11 b/g/n/ax
- Support BLE5.3
- Support Thread
- Support Wi-Fi/BLE/Thread coexistence
- Wi-Fi security supports WPS/WEP/WPA/WPA2/WPA3
- Support 20/40MHz bandwidth，1T1R，maximum rate 229.4 Mbps
- Support ST, SoftAP、STA+SoftAP and sniffer mode
- 32-bit RISC-V CPU with FPU and DSP, the highest frequency can reach 320M
- 4MB pSRAM，532KB SRAM，128KB ROM，4Kb eFuse
- Support Camera, MJPEG, Dispaly, Audio Codec, USB2.0, SDU, Ethernet (EMAC), SD/MMC (SDH), SPI, UART, I2C, I2S, PWM, GPDAC, GPADC, ACOMP and GPIO, etc
- Support Camera Sensor DVP interface
- Support Video Codec MJPEG encoding
- Support LCD display (QSPI, DBI and RGB)
- Integrated RF Balun, PA/LNA
- Support secure boot; secure debugging
- Support XIP QSPI On-The-Fly AES Decryption (OTFAD)
- Support TrustZone
- Support AES-CBC/CCM/GCM/XTS mode
- Support MD5, SHA-1/224/256/384/512
- Support TRNG（True Random Number Generator）
- Support PKA (Public Key Accelerator) for RSA/ECC
- BLE Fast Wi-Fi connection is supported
- 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-M61-01
Package	SMD-48
Size	31.0*25.0*3.1(±0.2)mm
Antenna	on-board PCB antenna/IPEX connector
Frequency	2400 ~ 2483.5MHz
Operating temperature	-40℃ ~ 85℃
Storage temperature	-40℃ ~ 125℃, < 90%RH
Power supply	Support voltage 2.97V ~ 3.6V， supply current ≥500mA
Interface	Support Camera, MJPEG, Dispaly, Audio Codec, USB2.0, SDU, Ethernet (EMAC), SD/MMC (SDH), SPI, UART, I2C, I2S, PWM, GPDAC, GPADC, ACOMP and GPIO, etc.
IO	29
UART rate	Default 115200 bps
Security	WPS/WEP/WPA/WPA2/WPA3
Flash	Default 8MByte,maximum support 16MByte

2.1. Static electricity requirement

Ai-M61-01is 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	2.97	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**
11ax Mode HE40，PA output power	-	16	-	dBm
11ax Mode HE20，PA output power	-	17	-	dBm
11n Mode HT40， PA output power	-	19	-	dBm
11n Mode HT20， PA output power	-	19	-	dBm
11g Mode, PA output power	-	19	-	dBm
11b Mode, PA output power	-	22	-	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
11ax， HE20 (MCS9)	-	-70	-	dBm
11ax， HE40 (MCS9)	-	-67	-	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	-	10	15	dBm
2Mbps	-	10	15	dBm
Receive Sensitivity				
Rate Mode	**Min.**	**Typical value**	**Max.**	**Unit**
1Mbps sensitivity@30.8%PER	-	-99	-	dBm
2Mbps sensitivity@30.8%PER	-	-97	-	dBm

2.5. Power

The following power consumption data is based on a 3.3V power supply and an ambient temperature of 25°C.

- POUT power for all transmit modes is measured at the antenna interface.
- All emission data is based on 100% duty cycle, measured in continuous emission mode.

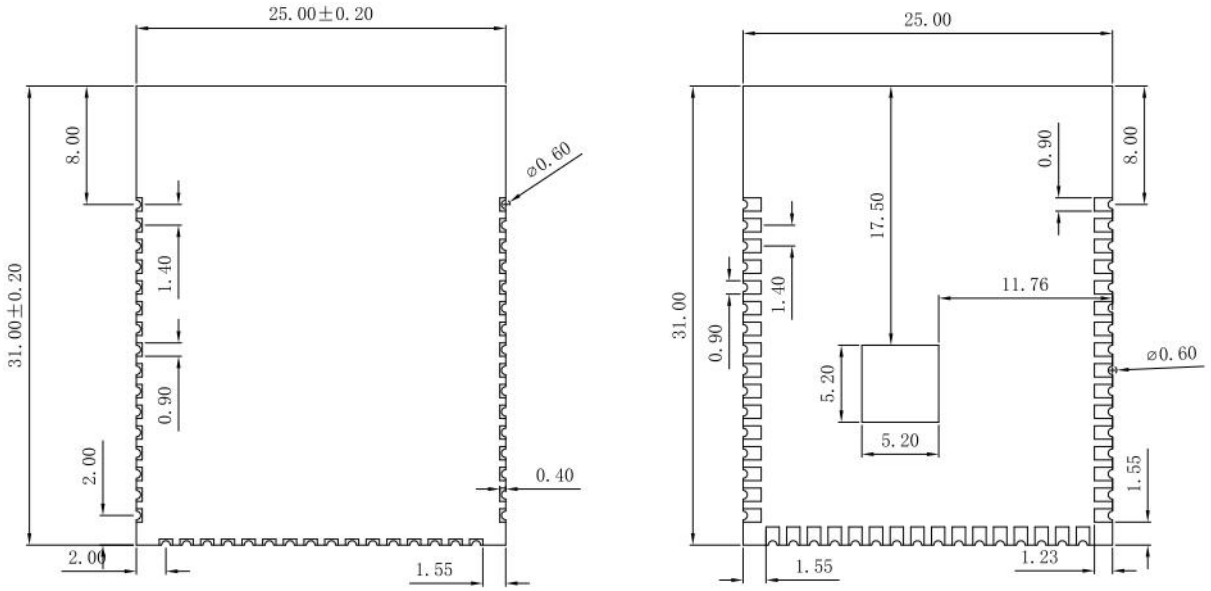
Table 5 Power consumption

Mode	Min.	AVG	Max.	Unit
Tx 802.11b，11Mbps，POUT=+22dBm	-	374	-	mA
Tx 802.11g，54Mbps，POUT =+19dBm	-	331	-	mA
Tx 802.11n，MCS7，POUT =+19dBm	-	328	-	mA
Tx 802.11ax，MCS7，POUT =+19dBm	-	293	-	mA
Rx 802.11b，packet length 1024 byte	-	64	-	mA
Rx 802.11g，packet length 1024 byte	-	64	-	mA
Rx 802.11n，packet length 1024 byte	-	64	-	mA
Rx 802.11ax，packet length 1024 byte	-	64	-	mA

3. Appearance Dimensions

Front Front Back

Figure 3 Appearance (the rendering is for reference only, the actual object shall prevail)



Front Back

Figure 4 Dimension diagram

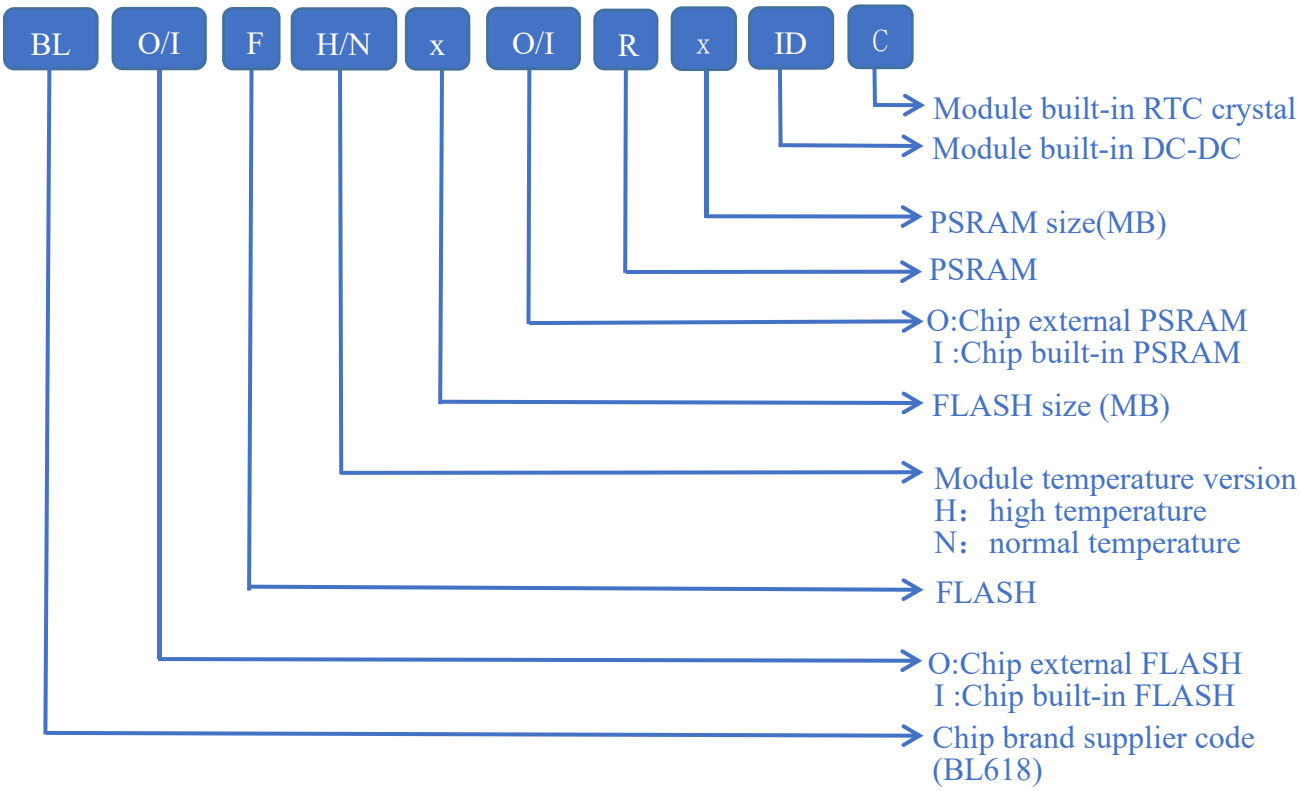
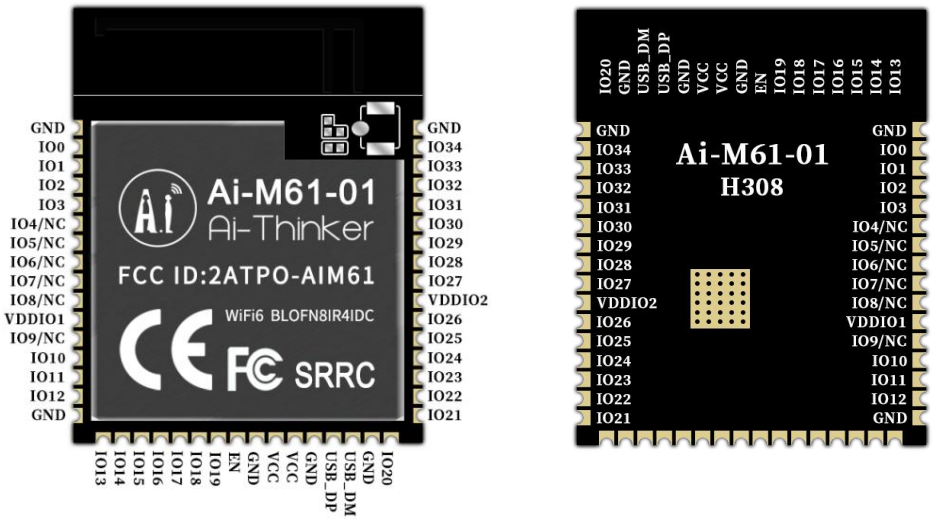


Figure 5 Shield printing information

4. Pin Definition

The Ai-M61-01 module has a total of 48 pins, as shown in the schematic diagram of the pins, and the pin function definition table is the interface definition.



Front Back

Figure 6 Schematic diagram of module pins

Table 6 Pin function definition table

No.	Name	Function
1,15,25,28, 31,48	GND	Ground
2	IO0	GPIO0/SPI_SS/I2S_BCLK/I2C_SCL/PWM0/ADC_CH9
3	IO1	GPIO1/SPI_SCLK/I2S_FS/I2C_SDA/PWM0/ADC_CH8
4	IO2	GPIO2/SPI_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM0/ADC_CH2
5	IO3	GPIO3/SPI_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM0/ADC_CH3
6-10,12	IO4-IO9	The default is NC, which cannot be used. This IO port is shared with the module's Flash pin, and cannot be used in the state of external FLASH.
11	VDDIO1	3.3V power supply, the output current of the external power supply is recommended to be above 500mA.
13	IO10	GPIO10/SPI_MISO/SDH_DAT1/SF2_D3/I2S_DI/I2S_RCLK_O/I2C_SCLPWM0/ADC_CH7
14	IO11	GPIO11/SPI_MOSI/SDH_DAT0/SF3_CLK/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM0
15	IO12	GPIO12/SPI_SS/SDH_CLK/SF3_D0/I2S_BCLK/I2C_SCL/PWM0/ADC_CH6
17	IO13	GPIO13/SPI_SCLK/SDH_CMD/SF3_D2/I2S_FS/I2C_SDA/PWM0/ADC_CH5
18	IO14	GPIO14/SPI_MOSI/SPI_MISO/SDH_DAT3/SF3_D1/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM0/ADC_CH4
19	IO15	GPIO15/SPI_MOSI/SDH_DAT2/SF3_CS/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM0
20	IO16	It is not available by default, and this IO port is shared with the internal 32.768KHz crystal oscillator input PIN of the module. GPIO16/SPI_SS/I2S_BCLK/I2C_SCL/XTAL_32K_IN/PWM0
21	IO17	It is not available by default, and this IO port is shared with the internal 32.768KHz crystal oscillator output PIN of the module. GPIO17/SPI_SCLK/I2S_FS/I2C_SDA/XTAL_32K_OUT/PWM0
22	IO18	GPIO18/SPI_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM0
23	IO19	GPIO19/SPI_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM0/ADC_CH1
24	EN	Default as chip enable, active high
26-27	VCC	3.3V power supply, the output current of the external power supply is recommended to be above 500mA

29	USB_DP	USB_DP
30	USB_DM	USB_DM
32	IO20	GPIO20/SPI_SS/I2S_BCLK/I2C_SCL/PWM0/ADC_CH0
33	IO21	TXD/GPIO21TXD//SPI_SCLK/I2S_FS/I2C_SDA/PWM0
34	IO22	RXD/GPIO22/SPI_MOSI/SPI_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM0
35	IO23	GPIO23/SPI_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM0
36	IO24	GPIO24/SPI_SS/I2S_BCLK/I2C_SCL/PWM0
37	IO25	GPIO25/SPI_SCLK/I2S_FS/I2C_SDA/PWM0
38	IO26	GPIO26/SPI_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM0
39	VDDIO2	3.3V power supply, the output current of the external power supply is recommended to be above 500mA
40	IO27	GPIO27/SPI_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM0/ADC_CH10
41	IO28	GPIO28/SPI_SS/I2S_BCLK/I2C_SCL/PWM0/ADC_CH11
42	IO29	GPIO29/SPI_SCLK/I2S_FS/I2C_SDA/PWM0
43	IO30	GPIO30/SPI_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM0
44	IO31	GPIO31/SPI_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM0
45	IO32	GPIO32/SPI_SS/I2S_BCLK/I2C_SCL/PWM0
46	IO33	GPIO33/SPI_SCLK/I2S_FS/I2C_SDA/PWM0
47	IO34	GPIO34/SPI_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM0
Note: 1. GPIO2 is used as Bootstrap. When the power level is high at the moment of power-on, the module enters the programming mode; when the power is low at the moment of power-on, the module starts normally.		

5. Schematic

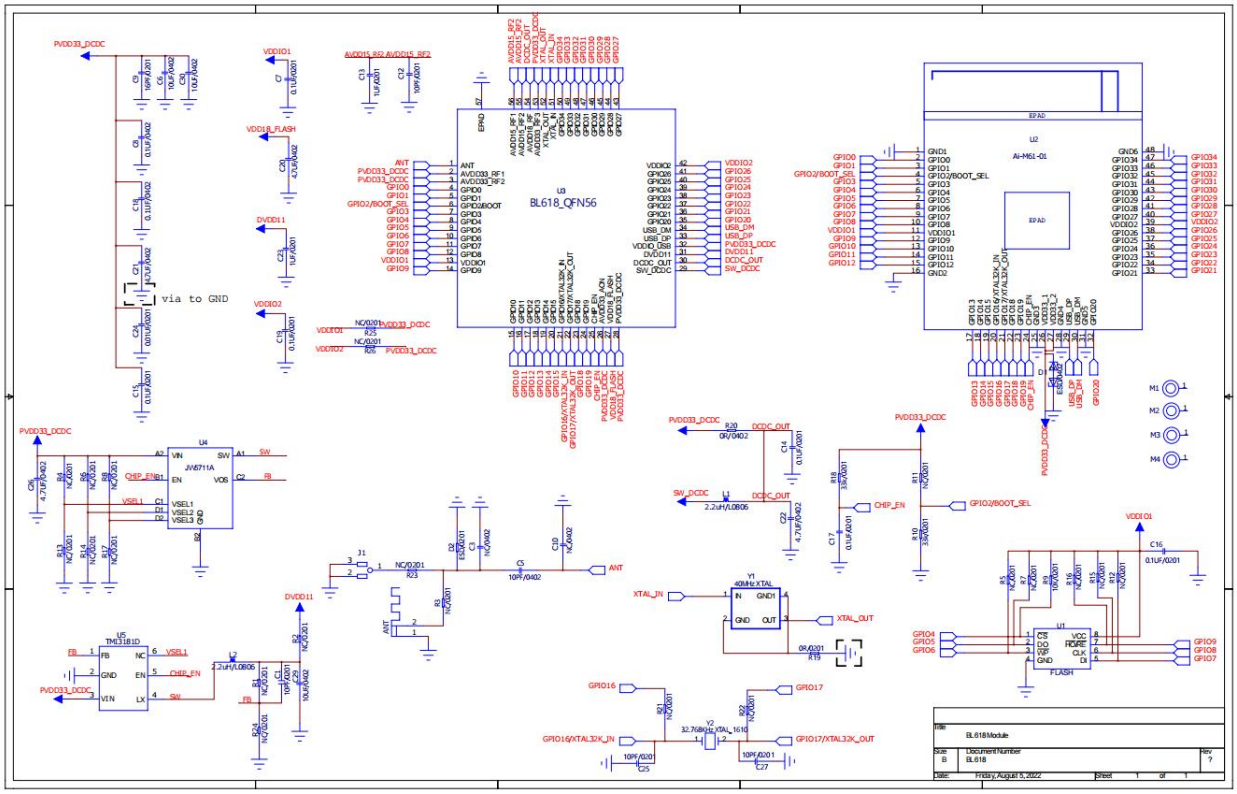


Figure 7 Module schematic

6. Antenna parameters

6.1. Antenna test prototype

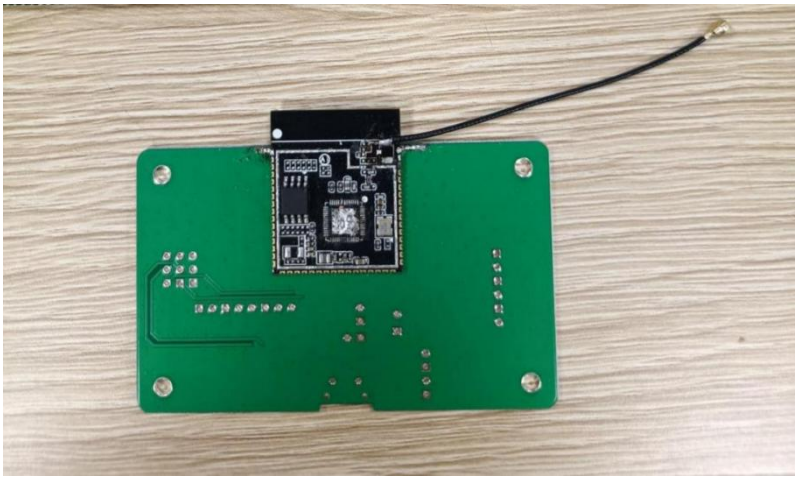


Figure 8 Antenna schematic diagram of antenna test prototype

6.2. Antenna S parameter

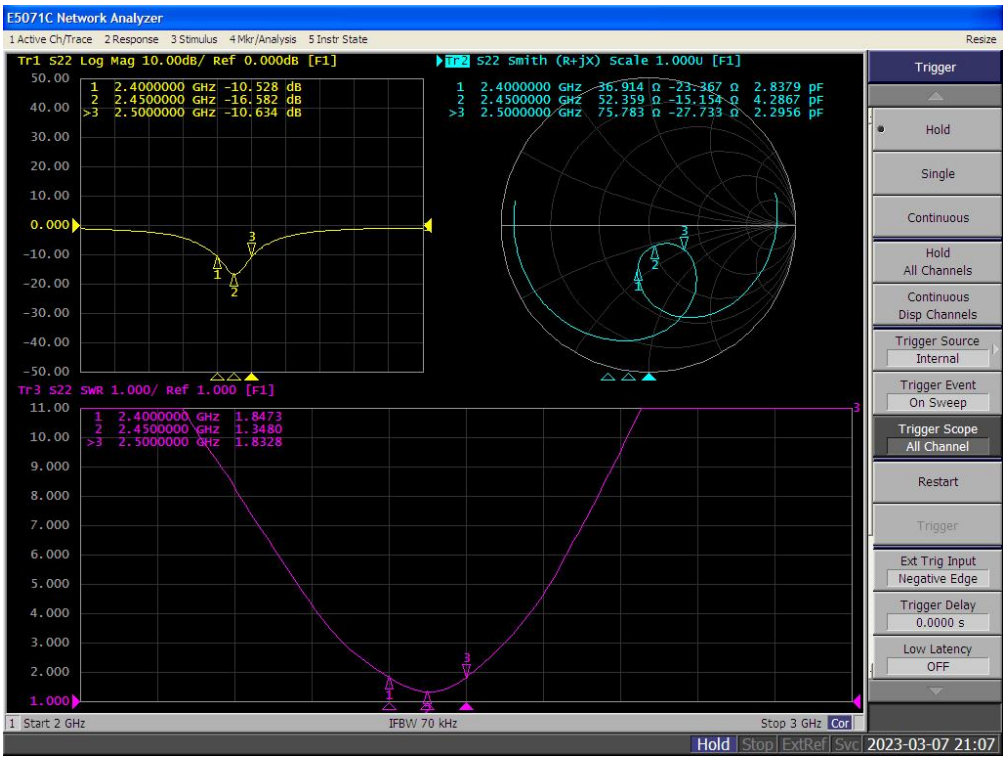


Figure 9 Antenna S parameters

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)	2.84	2.83	2.65	2.70	2.88	2.89	2.99	3.12	3.04	2.85	2.77
Efficiency (%)	60.77	62.29	61.85	64.01	65.91	66.37	67.29	67.11	66.12	64.72	62.52

6.4. Antenna pattern

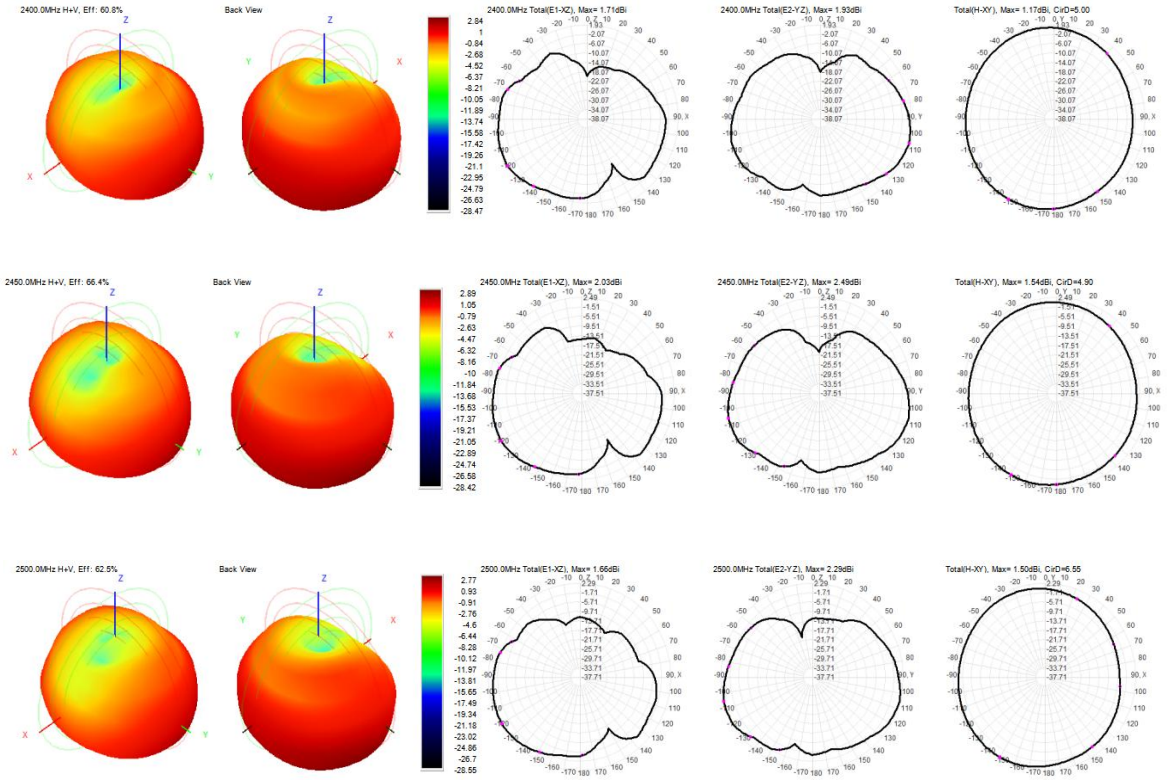


Figure 10 Antenna pattern

7. Design Guidance

7.1. Module application circuit

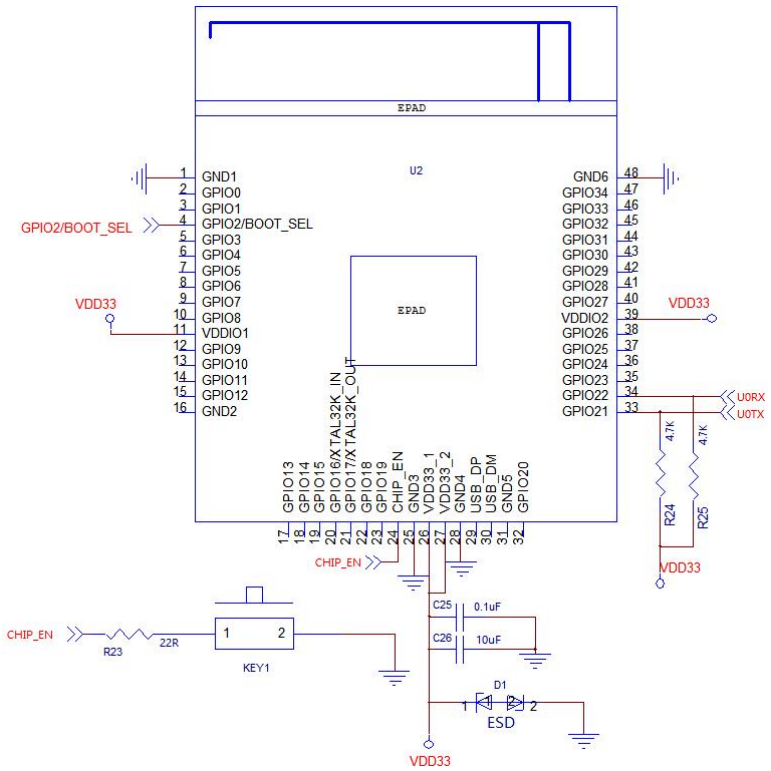


Figure 11 Application circuit diagram

- GPIO2 is the module startup control pin. It is in the normal working mode when it is low level, and it is in the firmware burning mode when it is high level. The default low level inside the chip.
- GPIO16/GPIO17, disabled by default. These IO ports are shared with the internal 32.768KHz crystal oscillator pins of the module. The IO is in NC state.
- GPIO4/GPIO5/GPIO6/GPIO7/GPIO8/GPIO9 are NC by default and cannot be used. This IO port is shared with the module's Flash pin, and cannot be used when the external FLASH is connected.

7.2. Recommended PCB package size

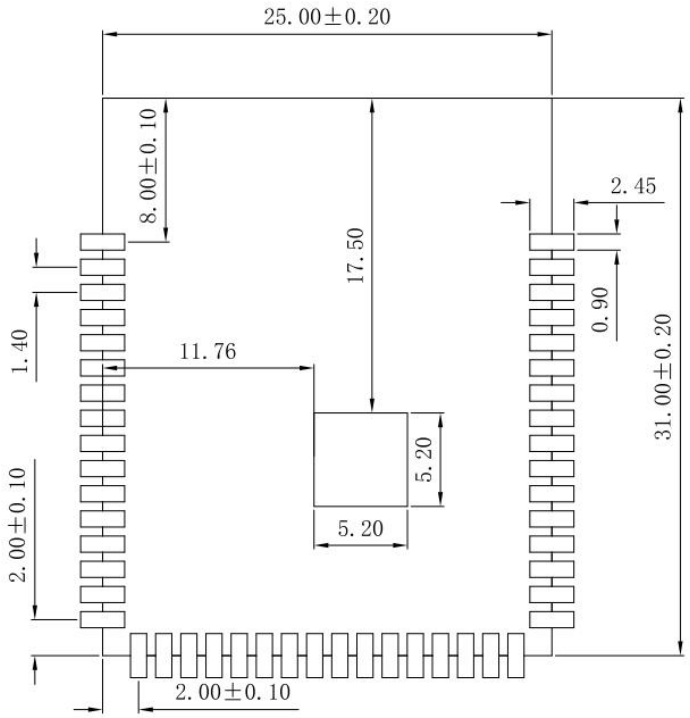


Figure 12 Recommended PCB Package Dimensions

7.3. Antenna layout requirements

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

Solution 1: Put the module on the edge of the motherboard, and the antenna area extends out of the edge of the motherboard.

Solution 2: Put the module on the edge of the motherboard, and hollow out an area on the edge of the motherboard where the antenna is.

- 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.

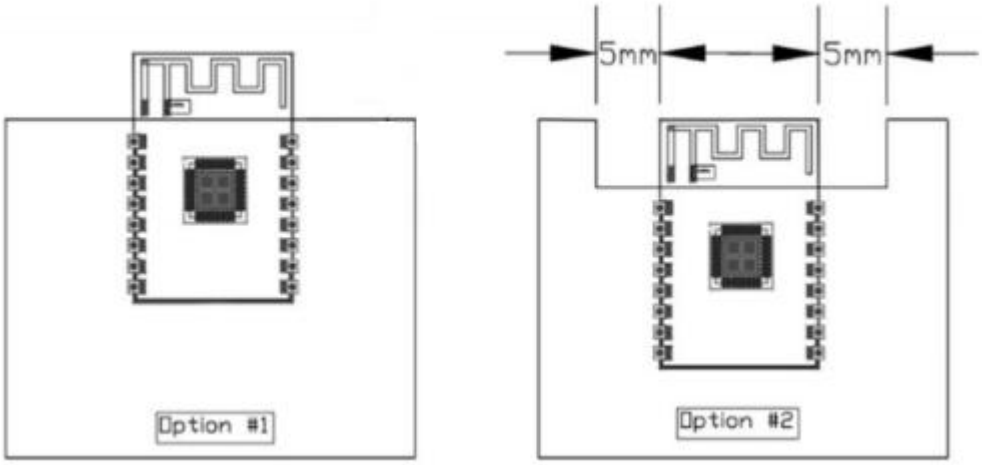


Figure 13 Antenna layout diagram

7.4. Power supply

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

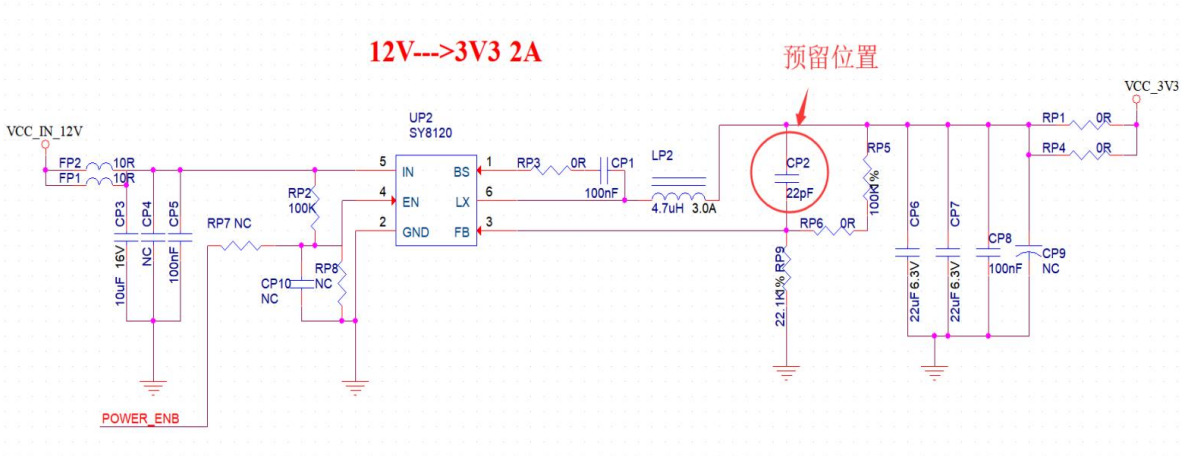


Figure 14 DC-DC step-down circuit diagram

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 ports. This can suppress overshoot and make the levels on both sides more stable. Helpful for both EMI and ESD.
- For the pull-up and pull-down of the special IO port, please refer to the instructions in 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 do not match, a level conversion circuit needs to be added.
- If the IO port is directly connected to the peripheral interface, or terminals such as pin headers, it is recommended to reserve an ESD device near the IO port wiring near the terminal.

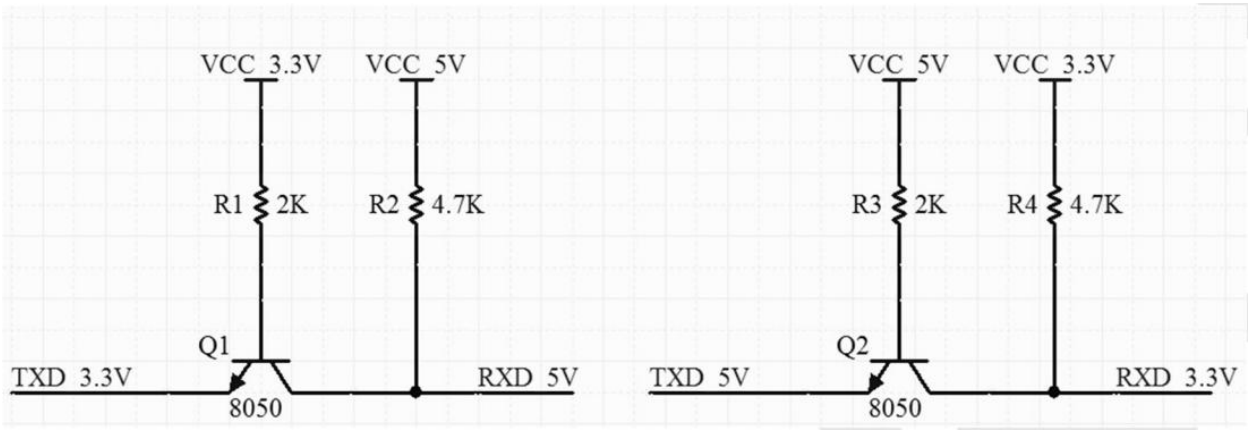


Figure 15 Level convert circuit

8. Storage conditions

Products sealed in moisture-proof bags should be stored in a non-condensing atmosphere at <40°C/90%RH.

The moisture sensitivity level MSL of the module is 3.

After the vacuum bag is unpacked, it must be used within 168 hours at 25±5°C/60%RH, otherwise it needs to be baked before it can be put online again.

9. Reflow welding curve diagram

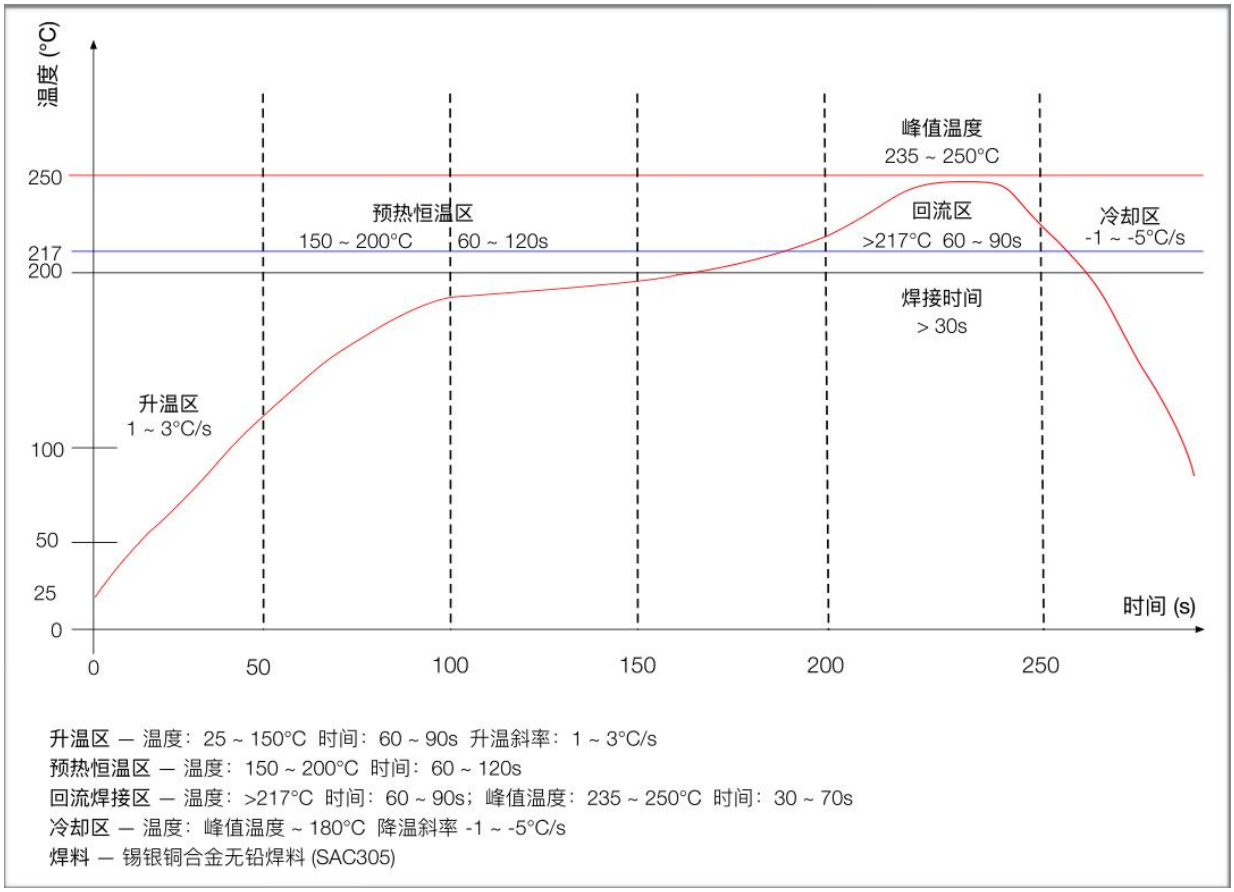


Figure 16 Reflow welding diagram

10.Product Packaging Information

Ai-M61-01module is packaged in a tape, 450pcs/reel.As shown in the below image:

Figure 17 Package and packing diagram

11.Contact us

Ai-Thinker official website　Office forum　Develop DOCS

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WeChat mini program　WeChat official account

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