# Ai-M61-CBM Specification

Version   V1.0.0

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# Document resume

| Version | Date | Develop/revise content | Edition | Approve |
|---------|------|------------------------|---------|---------|
| V1.0.0 | 2023.10.30 | First Edition | Pengfei Dong | Ning Guan |
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# Content

# 1.  Product Overview

Ai-M61-CBM is a Wi-Fi 6+BLE5.3 module developed by Shenzhen Ai-Thinker Technology Co., Ltd. The module is equipped with the 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, with a maximum frequency of up to 320M.

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

Ai-M61-CBM 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 field of Internet of Things.
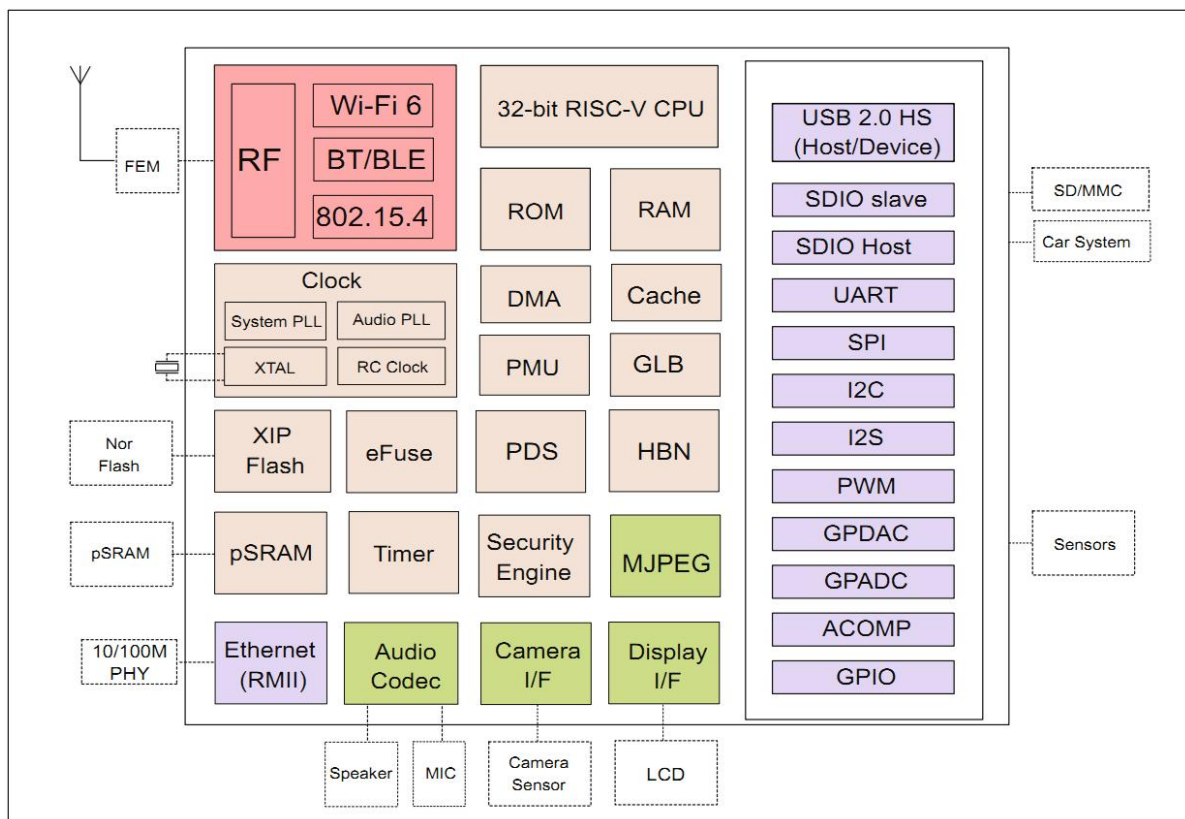


**Figure 1 Main chip architecture diagram**

## 1.1.  Characteristic

- The package is SMD-44

- 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 STA, 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, ect

- Support Camera Sensor DVP interface

- Support Video Codec MJPEG encoding

- Support LCD display (QSPI, DBI and RGB)

- Integrated RF Balum, PA/LNA

- Support secure boot; secure debugging

- Supports 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

- Supports TRNG (True Random Number Generator)

- Supports PKA (Public Key Accelerator) for RSA/ECC

- Wi-Fi fast connection with BLE support

- 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-CBM |
|---|---|
| **Package** | SMD-44 |
| **Size** | 15.0*15.0*2.4($\pm$0.2)mm |
| **Antenna** | Stamp hole |
| **Frequency** | 2400～2483.5MHz |
| **Operating temperature** | -40℃～85℃ |
| **Storage temperature** | -40℃～125℃，＜90%RH |
| **Power supply** | Power supply voltage 2.97V～3.6V, power 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** | 35 |
| **UART rate** | Default 115200 bps |
| **Security** | WPS/WEP/WPA/WPA2/WPA3 |
| **Flash** | Default 8MByte |

## 2.1.  Static electricity requirement

Ai-M61-CBM 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 | 2.97 | 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**

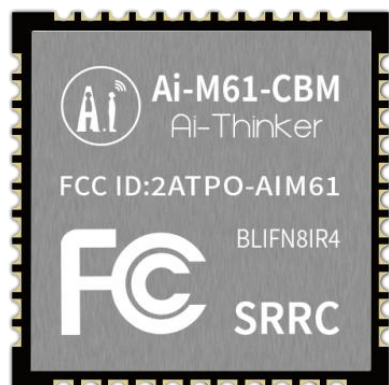| Description | Typical value | | | Unit |
|---|---|---|---|---|
| Frequency range | 2400 ~ 2483.5MHz | | | MHz |
| **Output Power** | | | | |
| **Rate Mode** | **Min.** | **Typical value** | **Max.** | **Unit** |
| 1Mbps | - | 10 | 15 | dBm |
| 2Mbps | - | 10 | 15 | dBm |
| **Receive Sensitivity** | | | | |
| **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 are measured in continuous emission mode based on 100% duty cycle.

**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



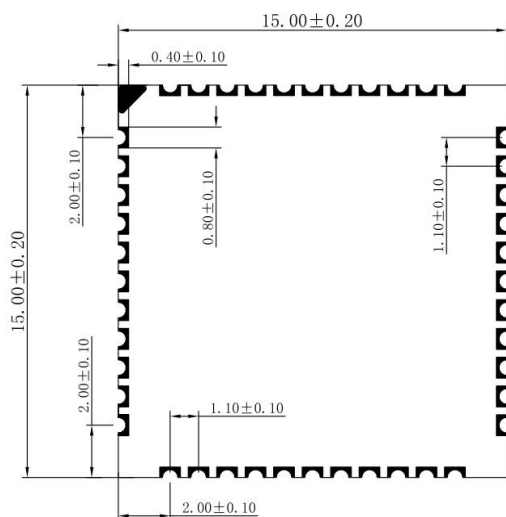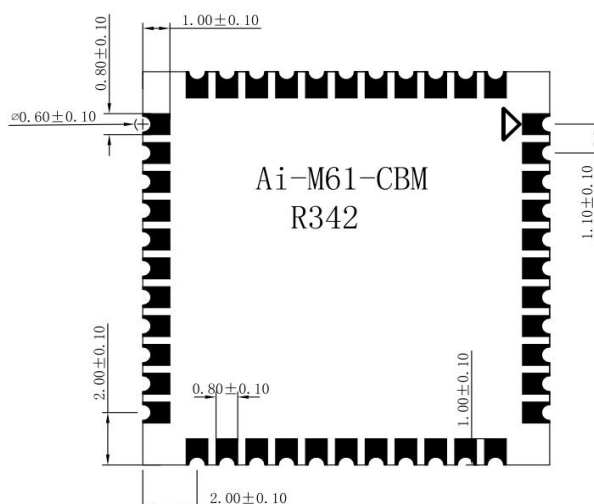Front                                        Back

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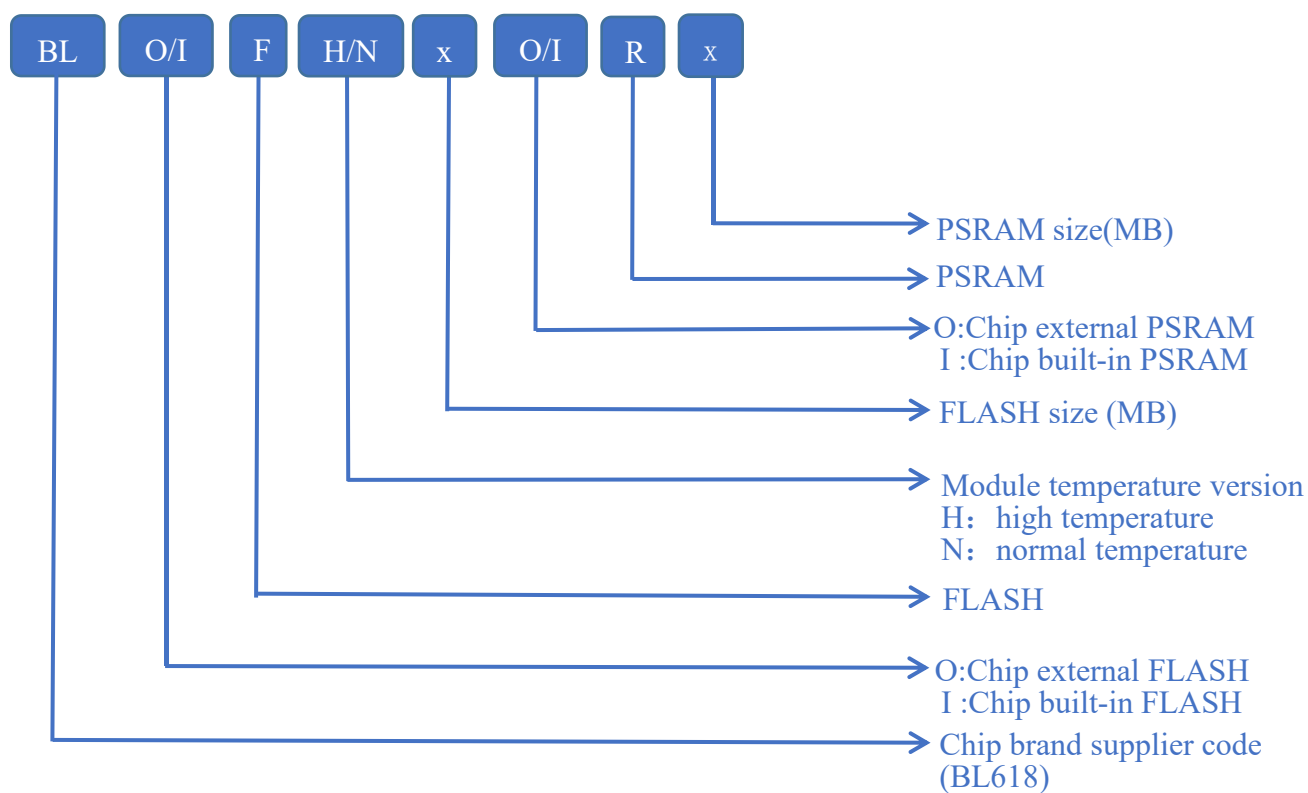


Front                                        Back

**Figure 4 Dimension diagram**

| BL | O/I | F | H/N | x | O/I | R | x |

- → PSRAM size(MB)
- → PSRAM
- → O:Chip external PSRAM
  I :Chip built-in PSRAM
- → FLASH size (MB)
- → Module temperature version
  H：high temperature
  N：normal temperature
- → FLASH
- → O:Chip external FLASH
  I :Chip built-in FLASH
- → Chip brand supplier code
  (BL618)

**Figure 5 Shield printing information**

# 4. Pin definition

The Ai-M61-CBM module has a total of 44 pins. As shown in the pin diagram, the pin function definition table is the interface definition.
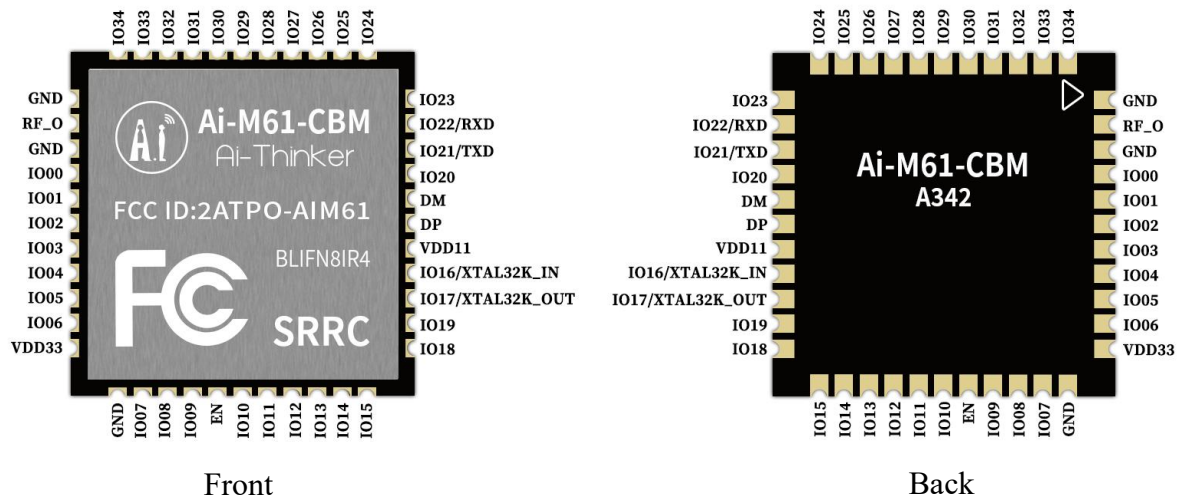


**Figure 6 Schematic diagram of module pins**

**Table 6 Pin function definition table**

| No. | Name | Function |
|-----|------|----------|
| 1 | GND | Ground |
| 2 | RF_O | RF output pin |
| 3 | GND | Ground |
| 4 | IO00 | GPIO00/SPI_SS/I2S_BCLK/I2C_SCL/PWM0/ADC_CH9 |
| 5 | IO01 | GPIO01/SPI_SCLK/I2S_FS/I2C_SDA/PWM1/ADC_CH8 |
| 6 | IO02 | GPIO02/SPI_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM2/ADC_CH2 |
| 7 | IO03 | GPIO03/SPI_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM3/ADC_CH3 |
| 8 | IO04 | GPIO04/SPI_SS/SF2_CS/I2S_BCLK/I2C_SCL/PWM0 |
| 9 | IO05 | GPIO05/SPI_SCLK/SF2_D1/I2S_FS/I2C_SDA/PWM1 |
| 10 | IO06 | GPIO06/SPI_MOSI/SF2_D2/I2S_DI/I2S_DI//I2S_RCLK_O/I2C_SCL/PWM2 |
| 11 | VDD33 | 3.3V power supply; the output current of the external power supply is recommended to be above 500mA. |

| 12 | GND | Ground |
|---|---|---|
| 13 | IO07 | GPIO07/SPI_MISO/SF2_D0/I2S_DO//I2S_RCLK_O/I2C_SDA/PWM3 |
| 14 | IO08 | GPIO08/SPI_SS/SF2_CLK/I2S_BCLK/I2C_SCL/PWM0 |
| 15 | IO09 | GPIO09/SPI_SCLK/SF2_D3/I2S_FS//I2C_SDA/PWM1 |
| 16 | EN | Default is as chip enable, high level is effective |
| 17 | IO10 | GPIO10/SPI_MISO/SDH_DAT1/SF2_D3/I2S_DI/I2S_RCLK_O/I2C_SCLPWM2/ADC_CH7 |
| 18 | IO11 | GPIO11/SPI_MOSI/SDH_DAT0/SF3_CLK/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM3 |
| 19 | IO12 | GPIO12/SPI_SS/SDH_CLK/SF3_D0/I2S_BCLK/I2C_SCL/PWM0/ADC_CH6 |
| 20 | IO13 | GPIO13/SPI_SCLK/SDH_CMD/SF3_D2/I2S_FS/I2C_SDA/PWM1/ADC_CH5 |
| 21 | IO14 | GPIO14/SPI_MOSI/SPI_MISO/SDH_DAT3/SF3_D1/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM2/ADC_CH4 |
| 22 | IO15 | GPIO15/SPI_MOSI/SDH_DAT2/SF3_CS/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM3 |
| 23 | IO18 | GPIO18/SPI_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM2 |
| 24 | IO19 | GPIO19/SPI_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM3/ADC_ CH1 |
| 25 | IO17 | Not available by default, this IO port is shared with the module's internal 32.768KHz crystal oscillator output PIN. GPIO17/SPI_SCLK/I2S_FS/I2C_SDA/XTAL_32K_OUT/PWM1 |
| 26 | IO16 | Not available by default, this IO port is shared with the module's internal 32.768KHz crystal oscillator input PIN pin. GPIO16/SPI_SS/I2S_BCLK/I2C_SCL/XTAL_32K_IN/PWM0 |
| 27 | VDD11 | VDD11 power supply; for ultra-low power usage scenarios, an external power supply of 1.1V is required; for non-ultra-low power usage scenarios, leave it floating. |
| 28 | USB_DP | USB_DP |
| 29 | USB_DM | USB_DM |
| 30 | IO20 | GPIO20/SPI_SS/I2S_BCLK/I2C_SCL/PWM0/ADC_CH0 |
| 31 | IO21/TXD | TXD/GPIO21/SPI_SCLK/I2S_FS/I2C_SDA/PWM1 |
| 32 | IO22/RXD | RXD/GPIO22/SPI_MOSI/SPI_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM3 |
| 33 | IO23 | GPIO23/SPI_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM3 |
| 34 | IO24 | GPIO24/SPI_SS/I2S_BCLK/I2C_SCL/PWM0 |

| 35 | IO25 | GPIO25/SPI_SCLK/I2S_FS/I2C_SDA/PWM1 |
|----|------|-------------------------------------|
| 36 | IO26 | GPIO26/SPI_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM2 |
| 37 | IO27 | GPIO27/SPI_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM3/ADC_CH10 |
| 38 | IO28 | GPIO28/SPI_SS/I2S_BCLK/I2C_SCL/PWM0/ADC_CH11 |
| 39 | IO29 | GPIO29/SPI_SCLK/I2S_FS/I2C_SDA/PWM1 |
| 40 | IO30 | GPIO30/SPI_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM2 |
| 41 | IO31 | GPIO31/SPI_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM3 |
| 42 | IO32 | GPIO32/SPI_SS/I2S_BCLK/I2C_SCL/PWM0 |
| 43 | IO33 | GPIO33/SPI_SCLK/I2S_FS/I2C_SDA/PWM1 |
| 44 | IO34 | GPIO34/SPI_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM2 |

Note: 1. GPIO2 serves as Bootstrap. When the power 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.
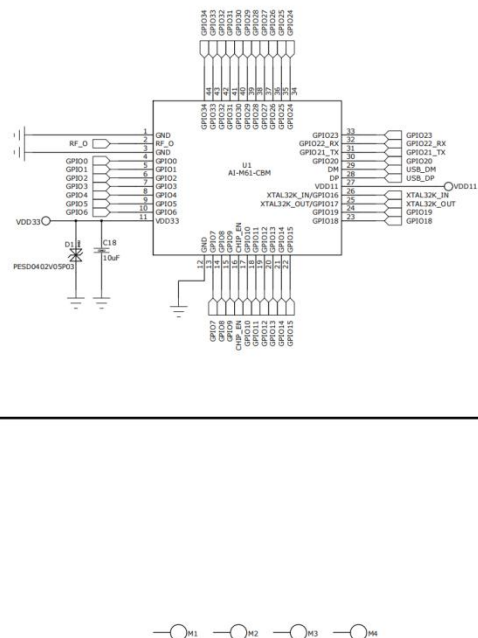
# 5. Schematic



**Figure 7 Module schematic**

# 6. Design Guidance

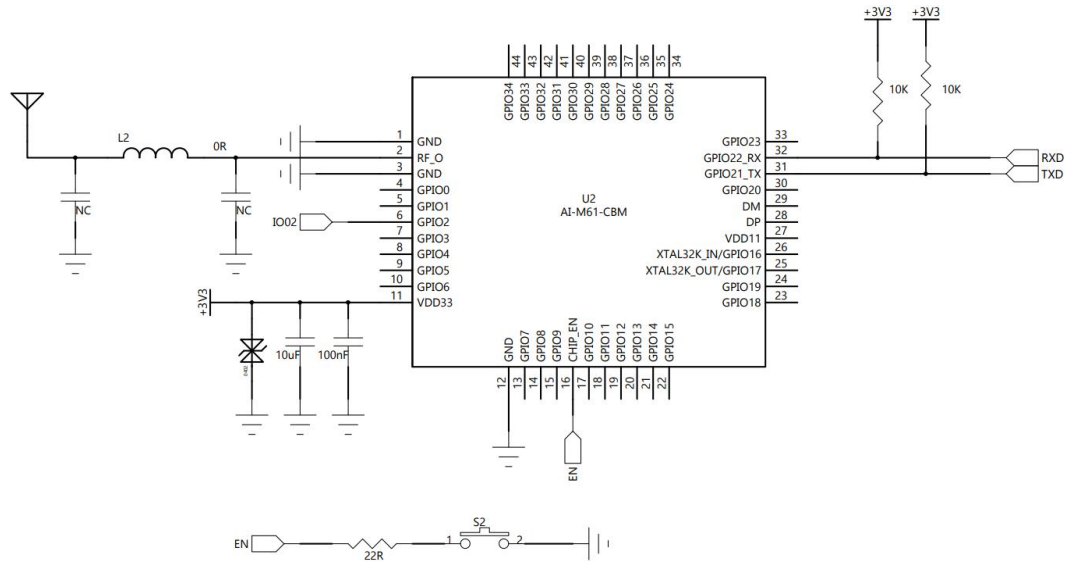## 6.1. Module application circuit

**Figure 8 Application circuit diagram**

■ GPIO2 is the module startup control pin. When it is low, it is in normal working mode, and when it is high, it is in firmware burning mode. The chip internal default low level.

■ GPIO16/GPIO17, available by default. These IO ports are shared with the 32.768KHz crystal oscillator PIN pin.
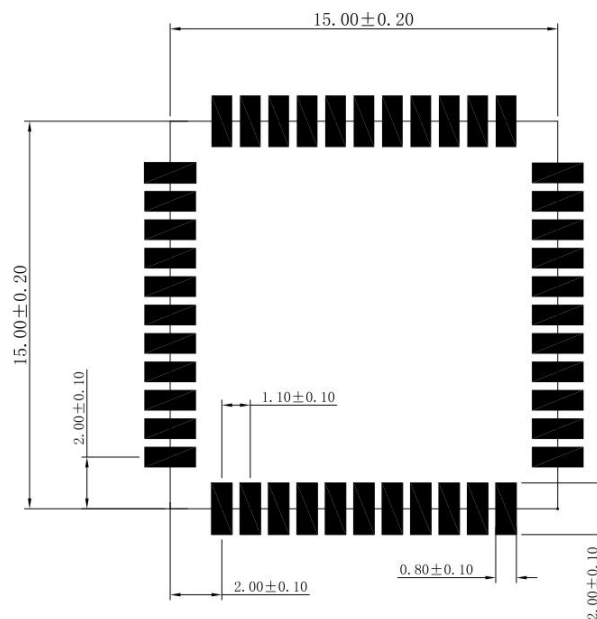
## 6.2. Recommended PCB package size

**Figure 9 Recommended PCB Package Dimensions**

## 6.3. Power Supply

■ Recommended voltage is 3.3V, peak current is 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 100mV.

■ It is recommended to reserve the position of dynamic response capacitor in DC-DC power supply circuit, which can optimize the output ripple when the load changes greatly.

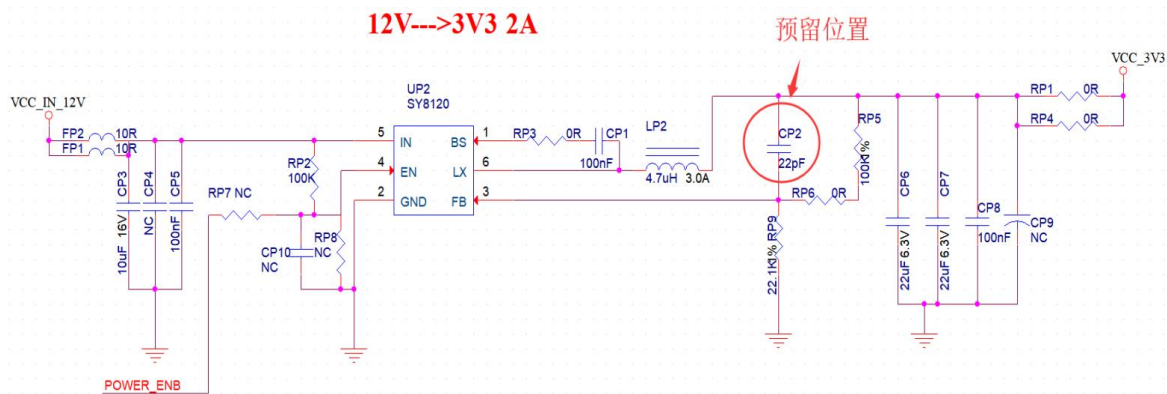■ It is recommended to add ESD devices to the 3.3V power interface.



**Figure 10 DC-DC step-down circuit diagram**

## 6.4. 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 to the IO port. This can suppress overshoot and make the levels on both sides more stable. Helps with both EMI and ESD.

■ For the pull-up and pull-down of the special IO port, please refer to the instructions in the specification sheet, 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 a peripheral interface or a terminal such as a pin header, it is recommended to reserve ESD devices near the terminals in the IO port wiring.
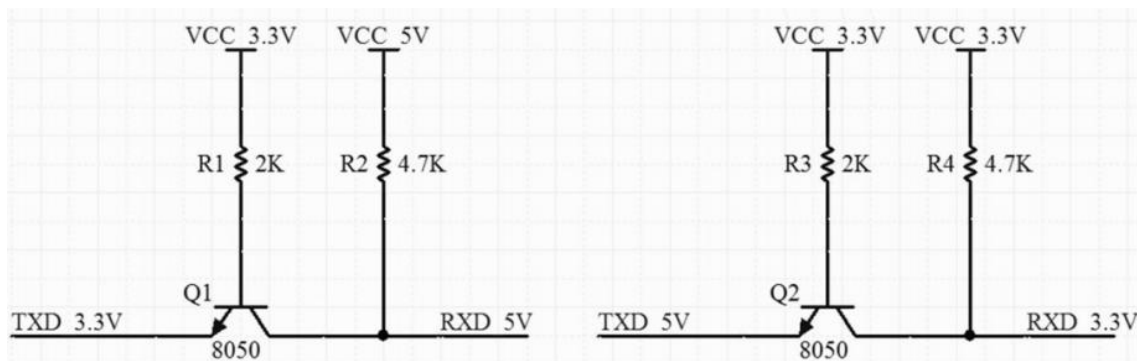


**Figure 11 Level convert circuit**

# 7. Storage conditions

Products sealed in moisture-proof bags should be stored in a non-condensing atmospheric environment <40℃/90%RH.

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

After the vacuum bag is unsealed, it must be used within 168 hours at 25±5℃/60%RH, otherwise it will need to be baked before it can be put online again.

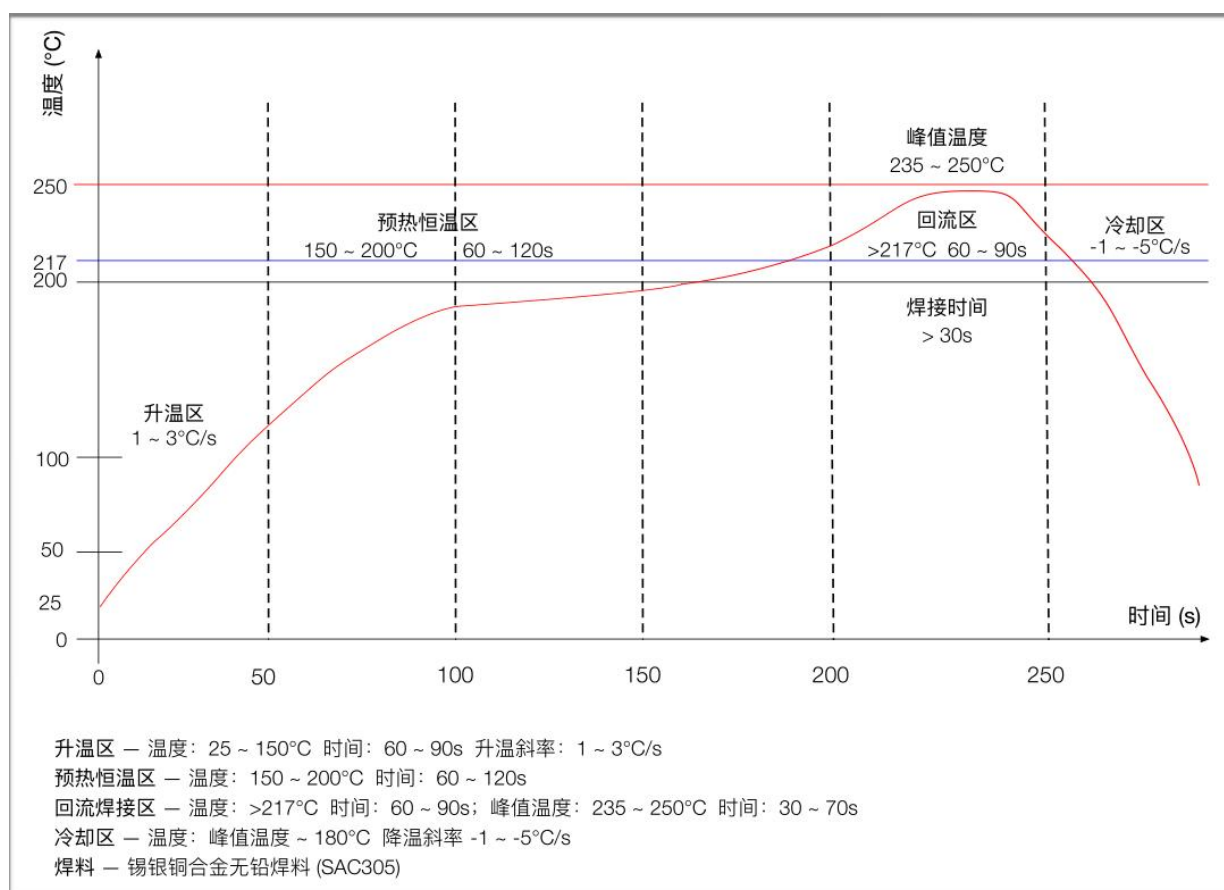# 8. Reflow welding curve diagram



**Figure 12 Reflow welding diagram**

# 9. Product Packaging Information

Ai-M61-CBM module is packaged in a tape, 1100pcs/reel.As shown in the below image:



**Figure 13 Package and packing diagram**

# 10. Contact us

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