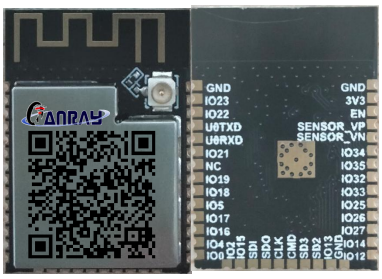
1. General description

1.1 Introduction



Module name: AM201108
P/N: Anray211810191GB02
(Size: 25.5*18*3mm)

AM201108 is a general-purpose WiFi-BT-BLE MCU module with powerful functions and a wide range of uses. It can be used for low-power sensor networks and demanding tasks, such as voice encoding, audio streaming, and MP3 decoding.

The core of this module is the ESP32 chip, which is scalable and adaptive. The two CPU cores can be individually controlled or powered on. The user can cut off the power of the CPU and use the low-power coprocessor to continuously monitor the status changes of the peripherals or whether certain analog quantities exceed the threshold. AM201108 also integrates a wealth of peripherals, including capacitive touch sensors, Hall sensors, low-noise sensor amplifiers, SD card interface, Ethernet interface, high-speed SDIO/SPI, UART, I2S and I2C.

The AM201108 module was developed by Ai-Thinker Technology. The core processor ESP32 of this module has two built-in low-power Xtensa®32-bit LX6 MCUS. The main frequency supports 80 MHz, 160 MHz and 240 MHz. This manual is only used as a guide.

1.2 Features

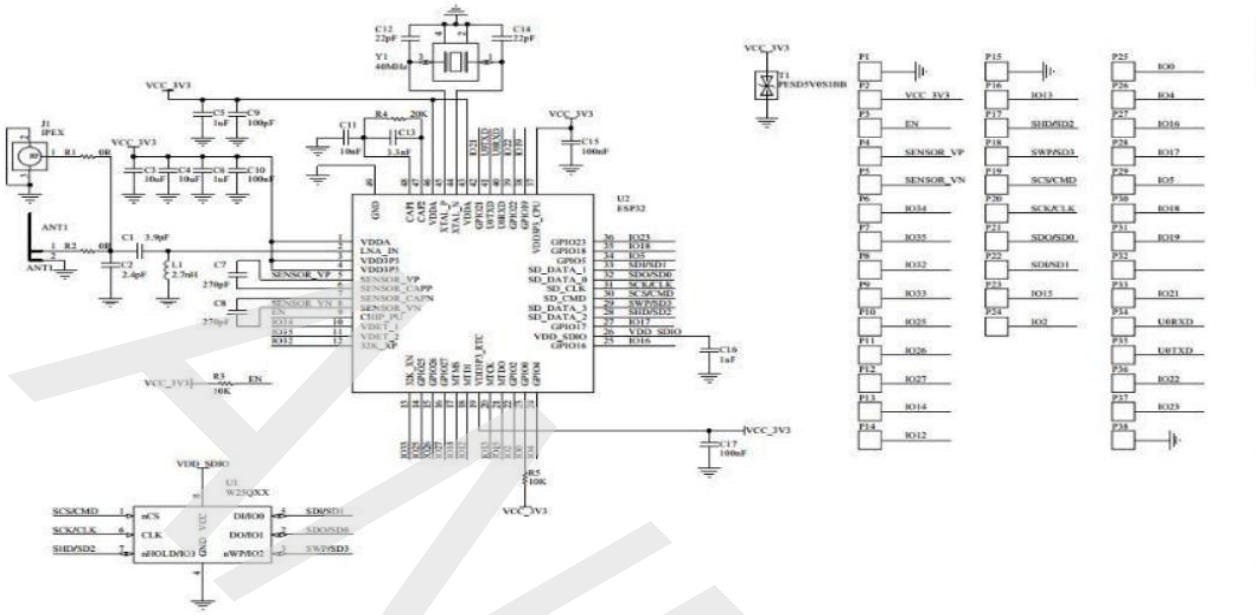
- Ultra-small 802.11b/g/n Wi-Fi + BT SOC module
- Adopt low-power dual-core 32-bit CPU, can be used as an application processor
- The main frequency is up to 240MHz, and the computing power is up to 600DMIPS
- Build-in 520KB SRAM
- Support interface of UART/SPI/I2C/PWM/ADC/DAC
- Support Open OCD debugging interface
- Support multiple sleep modes, the minimum deep sleep current can reach 6.5 μ A
- Support STA/AP/STA+AP working mode
- Support Smart Config/AirKiss one-click network configuration
- General AT commands can be used quickly
- Support serial port local upgrade and remote firmware upgrade (FOTA) embedded Lwip and Free RTOS

1.3 Application

Wireless terminal,industrial remote sensing,security monitoring,medical equipment,electronic station board,intelligent transportation,etc.

2. Electrical Properties

2.1 Schematic diagram



2.2 General Specification

Model Name	AM201108
Product Description	2.4GHz WIFI &BT Module(1T1R),Support Wi-Fi 2.4G /Bluetooth function
Frequency range	2412~2484MHz
Antenna	Printed PCB or IPEX antenna
SPI Flash	Default 32Mbit,maximum support 128Mbit
Interface	UART、SPI、SDIO、I2C、PWM、I2S、IR、ADC、DAC
IO	22
UART rate	Support 300~4608000bps,default 115200bps
Bluetooth	Bluetooth 4.2 BR/EDR and BLE stander
WIFI	802.11 b/g/n/e/i
On-chip sensors	Hall sensor\Temperature sensor\Capacitive touch sensor
Transmit power	802.11b:17±2dBm(@11Mbps) 802.11g:14±2dBm(@54Mbps) 802.11n:13±2dBm(@MCS7)
Receiving sensitivity	CKK,1Mbps: -90dBm CKK,11Mbps: -85dBm 6Mbps(1/2 BPSK): -88dBm

	54Mbps(3/4 64-QAM):-70dBm MCS7(65Mbps,72.2Mbps):-67dBm Active (RF work) Wi-Fi Tx packet 13dBm~21dBm 160~260mA Wi-Fi/BT Tx packet 0dBm 120mA Wi-Fi/BT Rx and listening 80~90mA Associated sleep patterns 0.9mA@DTIM3， (Associated with Light-sleep mode) 1.2mA@DTIM1 Modem-sleep CPU is working status Maximum speed：20mA Normal speed： 5~10mA slow： 3mA Light-sleep - 0.8mA Deep-sleep ULP coprocessor is working 0.5mA Ultra-low power sensor monitoring method25uA@1% duty RTC timer + RTC memory 20uA Hibernation Only the RTC timer is working 2.5uA
Operating temperature	-20°C to +85°C
Storage temperature	-40°C to +85°C，＜90%RH
Size:L* W * T(mm)	25.5*18*3 (typical)
Power supply range	Supply voltage 3.0V ~ 3.6V，Supply current >500mA
ROHS	All hardware components are fully compliant with EU ROHS directive

3. Function description

3.1 CPU and RAM

AM201108 contains two low-power Xtensa®32-bit LX6 MCUS. On-chip storage includes:

- 448KBytes ROM for program startup and kernel function call
- 520 KB on-chip SRAM for data and instruction storage
- 8KBytes of SRAM in RTC (RTC slow memory) can be accessed by the coprocessor in Deep-sleep mode
- The 8KBytes of SRAM in RTC, that is, RTC fast memory, can be used for data storage and accessed by the main CPU during RTC startup in Deep-sleep mode
- 1kbit EFUSE, of which 256 bits are dedicated to the system (MAC address and chip settings); the remaining 768 bits are reserved for user applications, which include Flash encryption and chip ID

3.2 External Flash and SRAM

AM201108 supports up to four 16 MBytes external QSPI Flash and static random access memory (SRAM), and has a hardware encryption function based on AES to protect developers' programs and data.

Module accesses external QSPI Flash and SRAM through cache. Up to 16 MBytes of external Flash is mapped to the CPU code space, supporting 8-bit, 16-bit and 32-bit access, and executable code.

Up to 8M Bytes of external Flash and SRAM are mapped to the CPU data space, supporting 8-bit, 16-bit and 32-bit access. Flash only supports read operations, SRAM can support read and write operations.

3.3 Crystal oscillator

AM201108 supports crystal oscillators with frequencies of 40 MHz, 26 MHz and 24 MHz. The accuracy of the crystal oscillator is between ±10 PPM, and the operating temperature range is between -40°C and 5°C. Please select the correct crystal type when using the download tool. In the circuit design, the ground adjustment capacitors C1 and C2 are added to the input and output terminals of the crystal oscillator, respectively. The value of the two capacitors can be flexibly set, ranging from 6 pF to 22 pF. However, the specific capacitance value can only be determined after matching the overall performance of the entire circuit.

Generally speaking, if the frequency of the crystal oscillator is 26 MHz, the capacitance values of C1 and C2 are within 10 pF; if the frequency of the crystal oscillator is 40 MHz, the capacitance values of C1 and C2 are 10 pF<C1, C2<22 pF. The frequency of the RTC crystal oscillator is usually 32 kHz or 32.768 kHz. Due to the internal calibration used to correct the frequency offset, the frequency of the crystal oscillator may exceed the range of ±20 PPM. When the chip is working in low-power mode, the device should select an external low-speed 32 kHz crystal oscillator clock instead of the internal RC oscillator to obtain an accurate wake-up time.

3.4 Power consumption

Module has advanced power management technology that can switch between various power saving modes.
Active mode: The chip's radio frequency is in working state. The chip can receive, transmit and listen to signals.
Modem-sleep mode: The CPU keeps running and the clock can be configured. Wi-Fi/Bluetooth baseband and radio frequency are turned off.
Light-sleep mode: The CPU is suspended. RTC and ULP coprocessors run. Any wake-up event (MAC, host, RTC timer or external interrupt) will wake up the chip.
Deep-sleep mode: Only RTC is working. Wi-Fi and Bluetooth connection data are stored in RTC. The ULP coprocessor keeps running.
Hibernation mode: The built-in 8 MHz oscillator and ULP coprocessor are both disabled. RTC memory recovery power is cut off. Only one RTC clock timer on the slow clock and certain RTC GPIOs are active. RTC timer or RTC GPIO can wake up the chip from Hibernation mode.
Associated sleep mode: The power saving mode can be switched between Active mode and Modem-sleep mode/Light-sleep mode. CPU, Wi-Fi, Bluetooth, and radio frequency are periodically woken up as preset to ensure Wi-Fi/Bluetooth connection.
Ultra-low-power sensor monitoring mode: The main system is in Deep-sleep mode, and the ULP coprocessor is turned on or off periodically to measure sensor data. According to the data measured by the sensor, the ULP coprocessor decides whether to wake up the main system. The power consumption changes with the power saving mode/sleep mode and the working status of the functional module.

4. Electrical parameters

Unless otherwise specified, the test environment for the specifications listed in this chapter is：VBAT= 3.3V,TA= 27℃。

Limit parameters：

Rated value	Condition	Value	Unit
Storage temperature	-	-40~85	℃
Maximum welding temperature	-	260	℃
Supply voltage	IPC/JEDEC J-STD-020	+3.0~+3.6	V

Recommended working conditions：

Working environment	Name	Min	Typical value	Max	Unit
Operating	-	-40	20	85	℃
temperature					
Supply voltage	VDD	3.0	3.3	3.6	V

Digital port characteristics:

Port	Name	Min	Typical value	Max	Unit
Input logic level is low	VIL	-0.3	-	0.25VDD	V
Input logic level is high		0.75VDD	-	VDD+0.3	V
Out put logic level is low	VOL	N	-	0.1VDD	V
Output logic level is high		0.8VDD	-	N	V

Wi-Fi RF characteristics:

Description	Min	Typical value	Max	Unit
General features				
Input frequency	2412	-	2484	MHz
Input resistance	-	50	-	Ω
Input launch	-	-	-10	dB
PA output power	15.5	16.5	21.5	dBm
Sensitivity				
DSSS,1Mbps	-	-98	-	dBm
CCK, 11 Mbps	-	-90	-	dBm
OFDM, 6 Mbps	-	-93	-	dBm
OFDM, 54 Mbps	-	-75	-	dBm
HT20, MCSO	-	-93	-	dBm
HT20, MCS7	-	-73	-	dBm
HT40, MCSO	-	-90	-	dBm
HT40, MCS7	-	-70	-	dBm
MCS32	-	-91	-	dBm
Adjacent Channel Suppression				
OFDM, 6 Mbps	-	37	-	dB
OFDM, 54 Mbps	-	21	-	dB
HT20, MCS0	-	37	-	dB
HT20, MCS7	-	20	-	dB

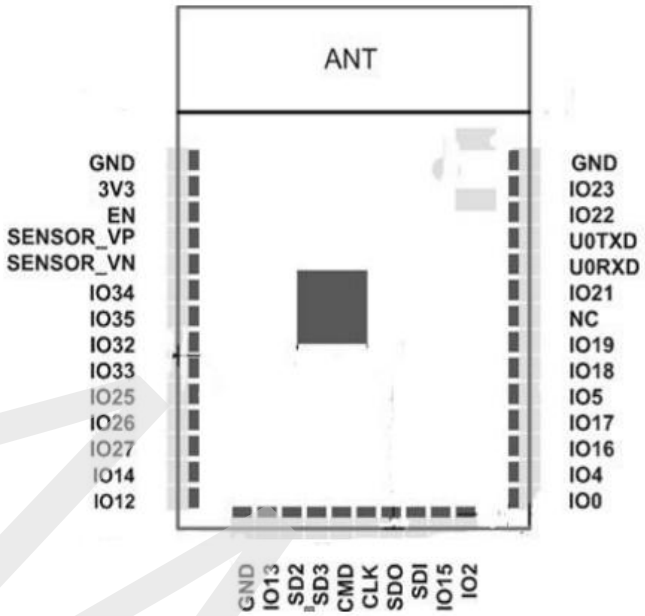
BLE receiver features:

Parameter	Condition	Min	Typical value	Max	Unit
Sensitivity@ 0.1% BER	-	-	-98	-	dBm
Max received signal@0.1% BER	-	0	-	-	dBm
Co-channel C/I	-	-	+10	-	dB
Adjacent channel selectivity C/I	F = F0 + 1 MHz	-	-5	-	dB
	F = F0 - 1 MHz	-	-5	-	dB
	F = F0 + 2 MHz	-	-25	-	dB
	F = F0 - 2 MHz	-	-35	-	dB
	F = F0 + 3 MHz	-	-25	-	dB
	F = F0 - 3 MHz	-	-45	-	dB
Out-of-band blocking performance	30MHz-2000MHz	-10	-	-	dBm
	2000MHz-2400MHz	-27	-	-	dBm
	2500MHz-3000MHz	-27	-	-	dBm
	3000MHz-12.5GHz	-10	-	-	dBm
Intermodulation performance	-	-36	-	-	dBm

BLE transmitter characteristics:

Parameter	Condition	Min	Typical value	Max	Unit
RF transmit frequency	-	-	+7.5	+10	dBm
RF power control range	-	-	25	-	dB
Adjacent channel transmit power	F = F0 + 1 MHz	-	-14.6	-	dBm
	F = F0 - 1 MHz	-	-12.7	-	dBm
	F = F0 + 2 MHz	-	-44.3	-	dBm
	F = F0 - 2 MHz	-	-38.7	-	dBm
	F = F0 + 3 MHz	-	-49.2	-	dBm
	F = F0 - 3 MHz	-	-44.7	-	dBm
	F = F0 + > 3 MHz	-	-50	-	dBm
	F = F0 - > 3 MHz	-	-50	-	dBm
Δf1avg	-	-	-	265	kHz
Δf2max	-	247	-	-	kHz
Δf2avg/Δf1avg	-	-	-0.92	-	-
ICFT	-	-	-10	-	kHz
Frequency drift rate	-	-	0.7	-	kHz/50us
Frequency drift	-	-	2	-	kHz

5. Pin Definition



Pin distribution

No.	Pin	Function Description
1	GND	Ground
2	3V3	3.3V power supply(VDD); The output current of the external power supply is recommended to be above 500mA
3	EN	Chip enable terminal, active at high level
4	SENSOR_VP	GPI36,SENSOR_VP,ADC_H,ADC1_CH0,RTC_GPIO0
5	SENSOR_VN	GPI39,SENSOR_VN,ADC1_CH3,ADC_H,RTC_GPIO3
6	IO34	GPI34,ADC1_CH6,RTC_GPIO4
7	IO35	GPI35,ADC1_CH7,RTC_GPIO5
8	IO32	GPIO32,XTAL_32K_P(32.768kHz crystal oscillator input ADC1_CH4, TOUCH9,RTC_GPIO9
9	IO33	GPIO33,XTAL_32K_N(32.768kHz crystal oscillator output ADC1_CH5, TOUCH8,RTC_GPIO8
10	IO25	GPIO25,DAC_1,ADC2_CH8,RTC_GPIO6,EMAC_RXD0
11	IO26	GPIO26,DAC_2,ADC2_CH9,RTC_GPIO7,EMAC_RXD1
12	IO27	GPIO27,ADC2_CH7,TOUCH7,RTC_GPIO17,EMAC_RX_DV

13	IO14	GPIO14,ADC2_CH6,TOUCH6,RTC_GPIO16,MTMS,
		HSPICLK,HS2_CLK,SD_CLK,EMAC_TXD2
14	IO12	GPIO12,ADC2_CH5,TOUCH5,RTC_GPIO15,MTDI,HSPIQ,HS2_DAT A2,SD_DAT A2,EMAC_TXD3
15	GND	Ground
16	IO13	GPIO13,ADC2_CH4,TOUCH4,RTC_GPIO14,MTCK,HSPID,HS2_DA TA3,SD_DAT A3,EMAC_RX_ER
17	SHD/SD2	GPIO9,SD_DATA2,SPIHD,HS1_DATA2,U1RXD
18	SWP/SD3	GPIO10,SD_DATA3,SPIWP,HS1_DATA3,U1TXD
19	SCS/CMD	GPIO11,SD_CMD,SPICS0,HS1_CMD,U1RTS
20	SCK/CLK	GPIO6,SD_CLK,SPICLK,HS1_CLK,U1CTS
21	SDO/SD0	GPIO7,SD_DATA0,SPIQ,HS1_DATA0,U2RTS
22	SDI/SD1	GPIO8,SD_DATA1,SPID,HS1_DATA1,U2CTS
23	IO15	GPIO15,ADC2_CH3,TOUCH3,MTDO,HSPICS0,RTC_GPIO13,HS2_C MD,SD_CMD , EMAC_RXD3
24	IO2	GPIO2,ADC2_CH2,TOUCH2,RTC_GPIO12,HSPIWP,HS2_DATA0,SD _DATA0
25	IO0	GPIO0,ADC2_CH1,TOUCH1,RTC_GPIO11,CLK_OUT1,EMAC_TX_C LK
26	IO4	GPIO4,ADC2_CH0,TOUCH0,RTC_GPIO10,HSPIHD,HS2_DATA1, SD_DATA1, EMAC_TX_ER
27	IO16	GPIO16,HS1_DATA4,U2RXD,EMAC_CLK_OUT
28	IO17	GPIO17,HS1_DATA5,U2TXD,EMAC_CLK_OUT_180
29	IO5	GPIO5,VSPICS0,HS1_DATA6,EMAC_RX_CLK
30	IO18	GPIO18,VSPICLK,HS1_DATA7
31	IO19	GPIO19,VSPIQ,U0CTS,EMAC_TXD0
32	NC	-
33	IO21	GPIO21,VSPIHD,EMAC_TX_EN
34	RXD0	GPIO3,U0RXD,CLK_OUT2
35	TXD0	GPIO1,U0TXD,CLK_OUT3,EMAC_RXD2
36	IO22	GPIO22,VSPIWP,U0RTS,EMAC_TXD1
37	IO23	GPIO23,VSPID,HS1_STROBE
38	GND	Ground

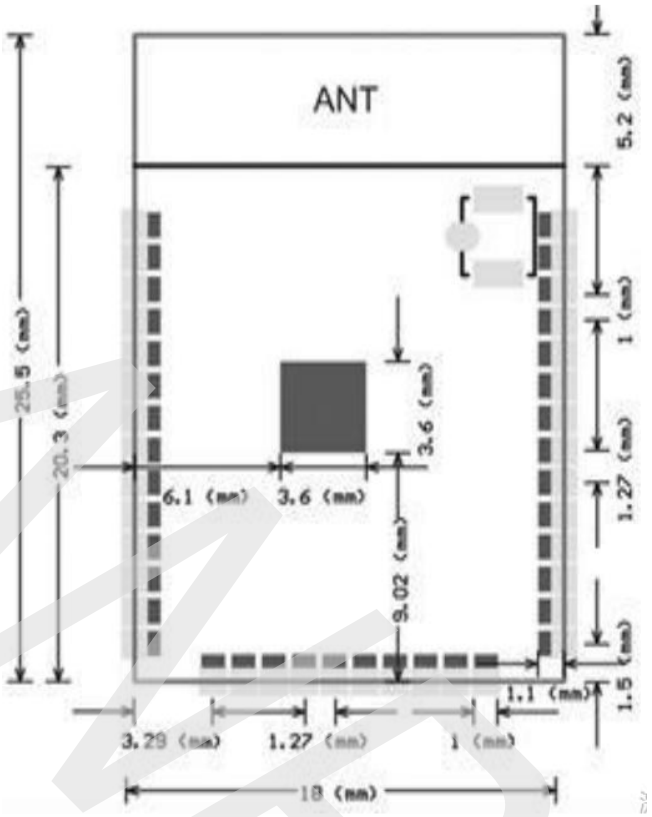
Strapping Pin

Build-in LDO (VDD_SDIO)voltage					
Pin	Default	3.3V		1.8V	
MTDI/GPIO12	Pull down	0		1	
System startup method					
Pin	Default	SPI Flash startup method		Download startup method	
GPIO0	Pull up	1		0	
GPIO2	Pull down	/		0	
During system startup, U0TXD outputs log print information					
Pin	Default	U0TXD flip		U0TXD static	
MTDO/GPIO15	Pull up	1		0	
SDIO slave signal input and output timing					
Pin	Default	Falling edge input Falling edge output	Falling edge input Rising edge output	Rising edge input Falling edge output	Rising edge input Rising edge output
MTDO/GPIO15	Pull up	0	0	1	1
GPIO5	Pull up	0	1	0	1

Note: Module has a total of 6 strapping pins, software can read the value of these 6 bits in the register "GPIO_STRAPPING". During the chip power-on reset process, the strapping pin samples the level and stores it in the latch, which is latched as "0" or "1", and remains until the chip is powered down or turned off. Each strapping pin is connected to internal pull-up/pull-down. If a strapping pin is not connected or the connected external circuit is in a high impedance state, the internal weak pull-up/pull-down will determine the default value of the input level of the strapping pin. To change the value of the strapping bit, the user can apply an external pull-down/pull-up resistor, or use the GPIO of the host MCU to control the level of the strapping pin when the Module is powered on and reset.
After reset, the strapping pin has the same function as the normal pin.

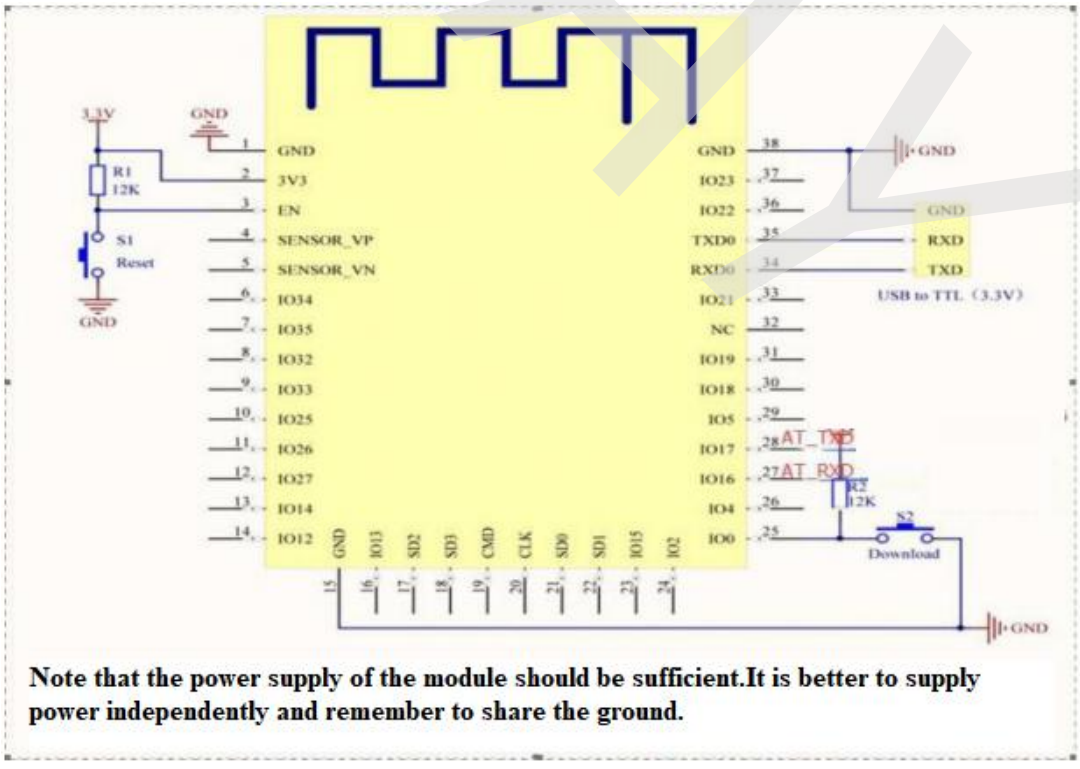
6. Physical Dimension

(Unit: mm)



7. Design Guideline

7.1 Application circuit



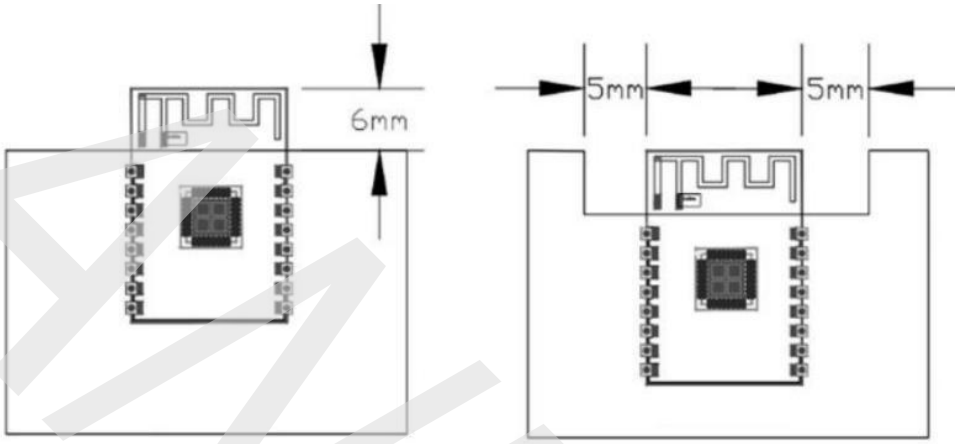
7.2 Antenna layout requirements

1）Installation position on the main board，advise for following two ways：

Option 1#：The module is placed on the edge of the main board, and the antenna area is extended out of the edge of the main board.

Option 2#：Put the module on the edge of the motherboard, and the edge of the motherboard is hollowed out in the antenna position.

2）In order to meet the performance of the on-board antenna, metal parts are prohibited from being placed around the antenna.

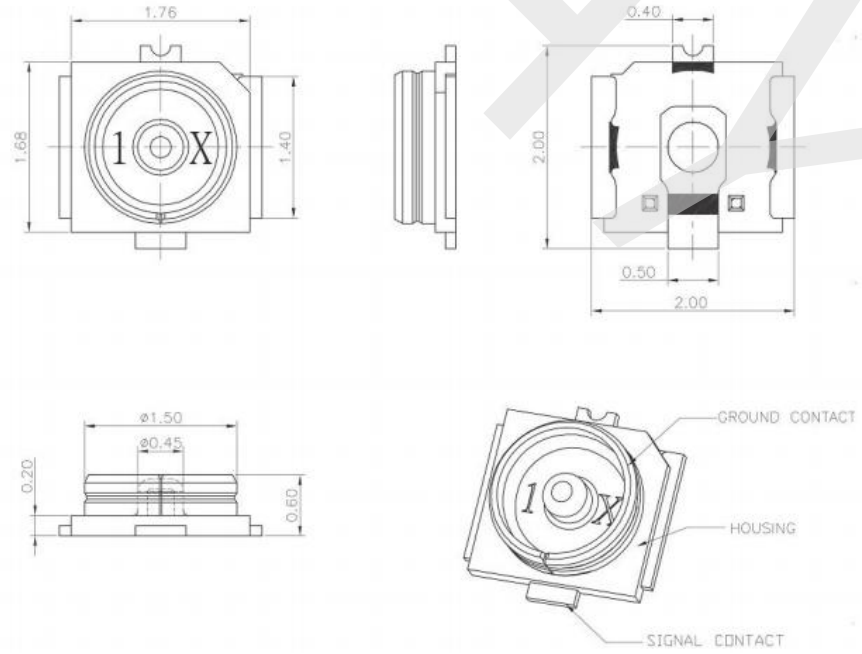


Option 1# Option 2#

7.3 RF connector of module

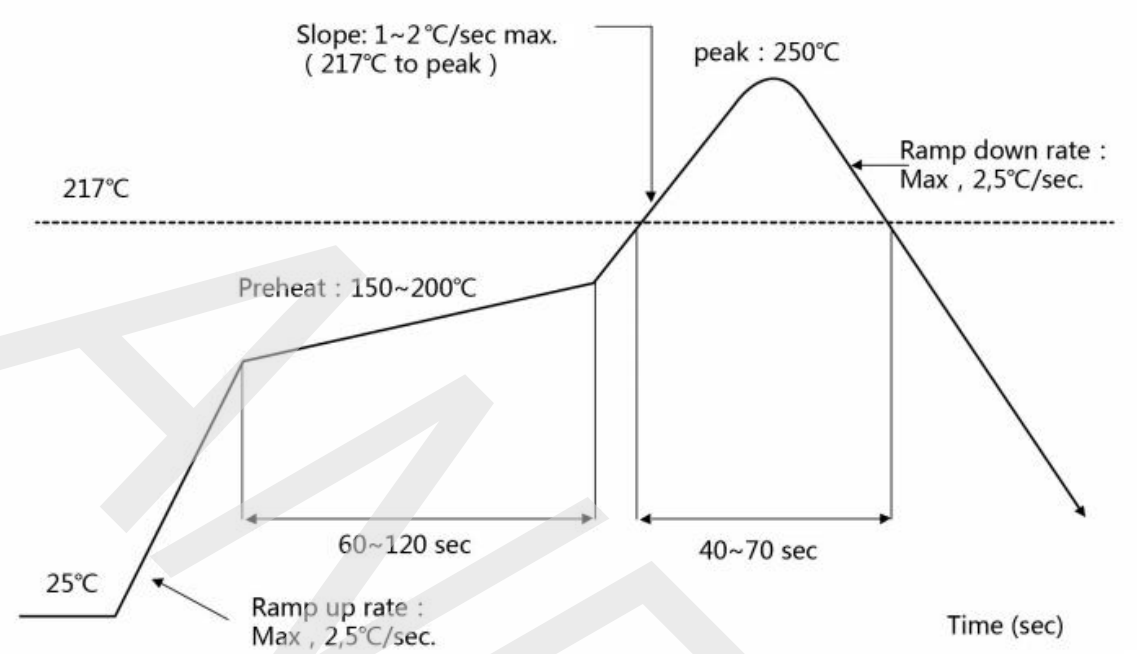
(Unit: mm)

There are RF-I receptacle connectors on the module, for external dual band antenna. The RF receptacle connectors are complied with RF-I standard.



8. Recommended SMT temperature

Referred to IPC/JEDEC standard.
Peak Temperature : <250°C
Number of Times : ≤2 times



9. Notice

AM201108 module is an electrostatic sensitive device, which needs special ESD precautions.When used ESD protective devices should be added. The correct ESD processing and packaging must be adopted in the transportation, operation and use of AM201108 modules. Do not touch the module by hand or weld with a non-antistatic soldering iron to avoid damage to the module.

10. Package