Ai-BS21-32S Specification

Version   V1.0.0

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Document resume

Version	Date	Develop/revise content	Edition	Approve
V1.0.0	2024.02.22	First Edition	Nannan Yuan	NingGuan

Content

1. Product Overview

Ai-BS21-32S is a Bluetooth star flash module developed by Shenzhen Ai-Thinker Technology Co., Ltd. The core processor chip Hi2821 of this module is a highly integrated 2.4GHz SoC BLE & SLE chip, which supports BLE5.4/SLE1.0 and integrated RF circuits. RF includes power amplifier PA, low noise amplifier, TX/RX Switch, integrated power management and other modules, supports 3 Bandwidths of 1M/2M/4M, and supports a maximum speed of 12Mbit/s.

Hi2821 chip integrates high-performance 32-bit microprocessor (MCU), hardware security engine and rich peripheral interfaces. Peripheral interfaces include SPI, UART, I2S, PMW, GPIO, USB2.0, NFC Tag, PDM, I2S/PCM, QDEC, KEYSCAN keyboard scanning circuits, and supports 8 channels of 13-bit resolution ADC. ADC supports docking audio equipments, built-in SRAM and sealed Flash, and supports running.

Hi2821 supports LiteOS and provides an open and easy-to-use development and debugging environment.

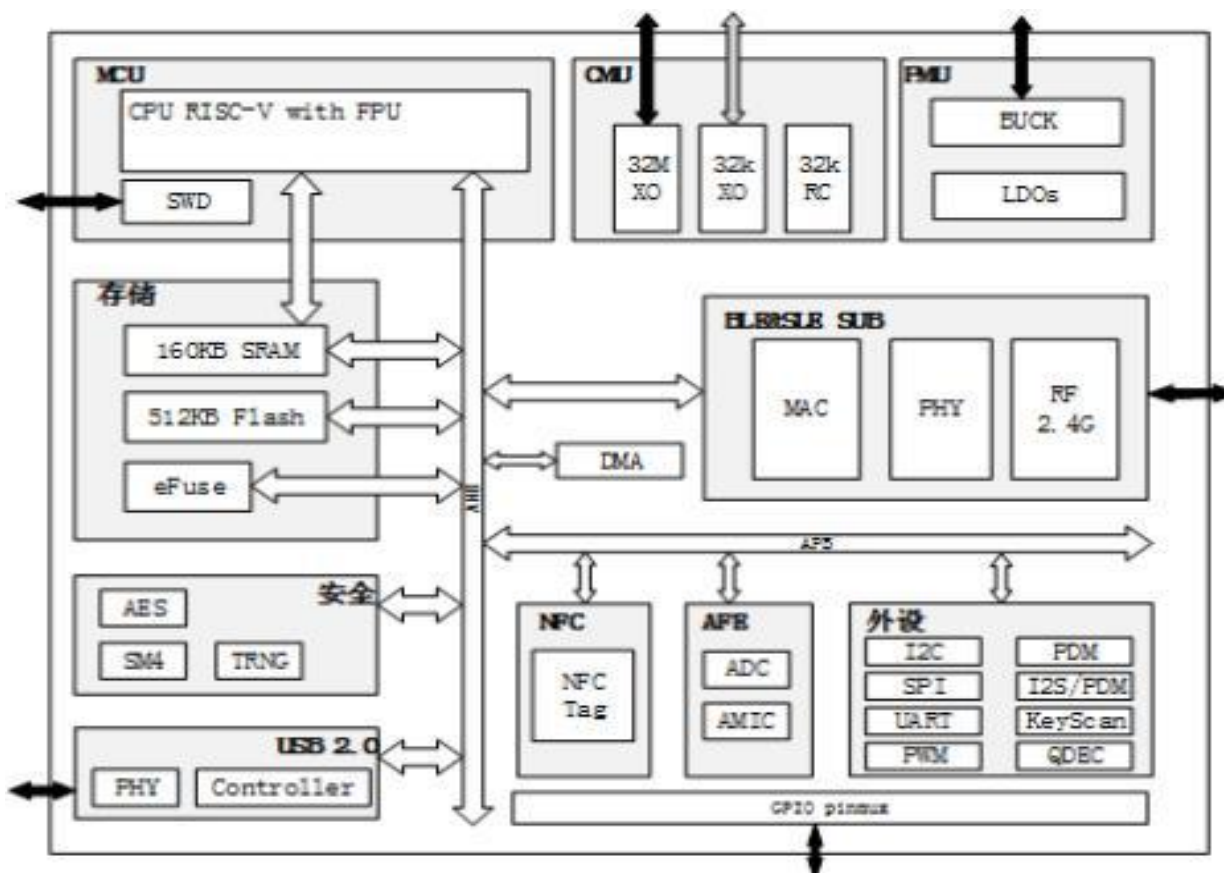Hi2821 is suitable for PC accessories, IoT and other IoT smart terminal fields.

Figure 1 Architecture diagram of main chip

1.1. Characteristic

■ Dual-mode coexistence of BLE and SLE is supported

■ BLE5.4

■ Supports LE 1M,LE 2M, and Long Range

■ RISC-V high-performance 32-bit CPU with a maximum clock frequency of 64MHz, floating point and SWD

■ Supports SRAM 160kB and built-in 512KB Flash

■ Supported Encryption methods: AES(Advanced Encryption Standard), SM4, and TRNG(True Random Number Generator)

■ Supported peripheral interfaces include: SPI, UART, I2C, PMW, GPIO, USB2.0, NFC Tag, PDM, I2S/PCM, QDEC, KEYSCAN, etc

■ Supports the BLE whitelist and can be resolved

■ HID man-machine interface

■ Supports the BLE service gap sweep function

■ Support for BLEAFH frequency modulation

■ Supports SLE1.0 protocol, wireless frame type 1(GFSK frame) and wireless frame type 2 (low latency frame),G frame and T frame, broadcast, discovery and access function, Unicast function, multicast function, high precision ranging

■ Supports B/SLE and WLAN,3/4 lines of off-chip coexistence (high real-time)

■ Supports B/SLE and WLAN, and coexists through UART (low real-time)

2. Main parameters

Table 1 Description of main parameters

Model	Ai-BS21-32S
Package	SMD-38
Size	25.5*18*3.1 (± 0. 2) mm
Antenna	On-board antenna/IPEX
Frequency	2400~2483.5MHz
Operating temperature	-40℃ ~ 85℃
Storage temperature	-40 ℃ ~ 125 ℃, <90% RH
Power supply	Power supply voltage 1.8V ~ 3.6V, power supply current> 500mA
Interface	SPI/UART/I2C/PMW/GPIO/USB2.0/NFCTag/PDM/I2S/PCM/ QDEC/KEYSCAN
IO	29
UART rate	Default 115200 bps
Bluetooth	BLE 5.4
Security	AES(Advanced Encryption Standard), SM4 and TRNG(True Random Number Generator).
SPI Flash	Built-in 512KB Flash

2.1. Electrostatic requirements

Ai-BS21-32S are electrostatic sensitive equipment, special preventive measures should be taken during handling.

Figure 2 ESD anti-static diagram

2.2. Electrical characteristics

Table 2 Electrical Characteristics Table

Parameter		Condition	Min.	Typical value	Max.	Unit
Supply voltage		VDD	1.8	3.3	3.6	V
I/O	V_{IL}/V_{IH}	-	-0.3/0.75VD	-	0.25VDD/VDD	V
	V_{OL}/V_{OH}	-	N/0.8VIO	-	0.1VIO/N	V
	I_{MAX}	-	-	-	12	mA

2.3. Bluetooth RF performance

Table 3 Bluetooth RF performance table

Description	Typical value			Unit
Operating frequency	2400~2483.5			MHz
Output power				
Mode	Min.	Typical value	Max.	Unit
BLE 2Mbps	-	6	-	dBm
BLE 1Mbps	-	6	-	dBm
Long Range	-	6	-	dBm
Receiving sensitivity				
Mode	Min.	Typical value	Max.	Unit
BLE 2Mbps	-	-94	-	dBm
BLE 1Mbps	-	-97	-	dBm
BLE 125Kbps	-	-103	-	dBm

2.4. RF performance of SLE

Table 4 SLE RF performance table

Description	Typical value			Unit
Operating frequency	2400~2483.5			MHz
Output power				
Mode	**Min.**	**Typical value**	**Max.**	**Unit**
SLE Tx Power (wireless frame type 1) normal	-	6	-	dBm
SLE Tx Power (wireless frame type 2) normal	-	2	-	dBm
SLE Tx Power (wireless frame type 1) high power	-	8	-	dBm
SLE Tx Power (wireless frame type 2) high power	-	4	-	dBm
Receiving sensitivity				
Mode	**Min.**	**Typical value**	**Max.**	**Unit**
SLE 2MGFSK rate1	-	-93	-	dBm
SLE 2MQPSK rate3/4	-	-95	-	dBm
SLE 2M8PSK rate3/4	-	-90	-	dBm
SLE 4MGFSK rate1	-	-90	-	dBm
SLE 4MQPSK rate3/4	-	-92	-	dBm

3. Appearance size

Front   Front   Back
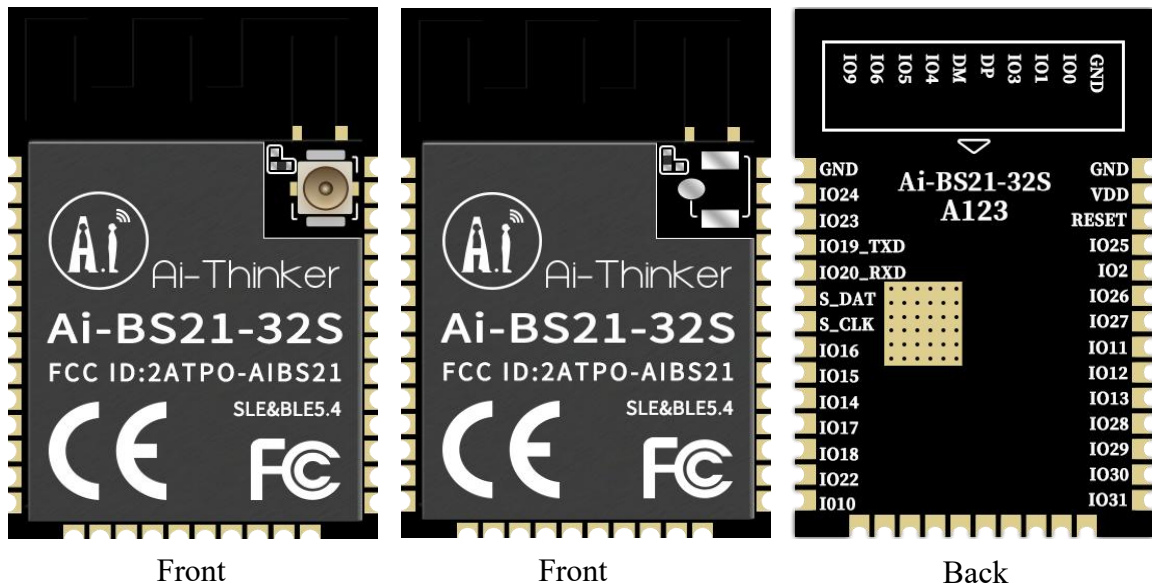
Figure 3 External view of the module (for reference only, subject to the actual object)

Front   Back
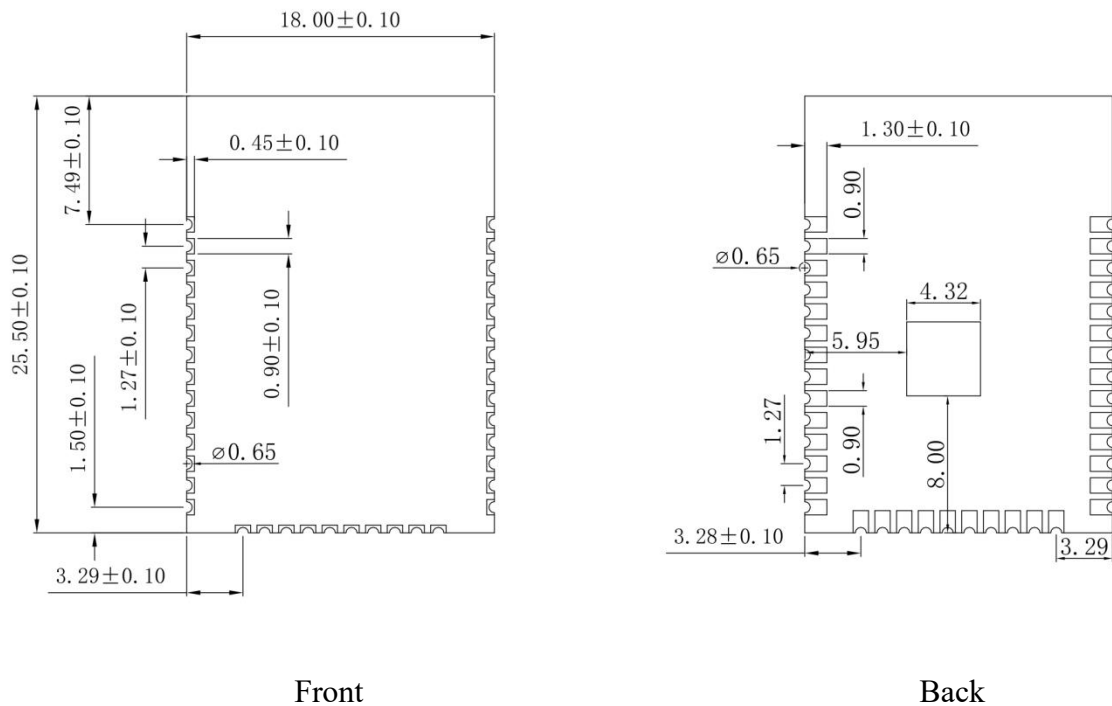
Figure 4 Module size diagram

4. Pin definition

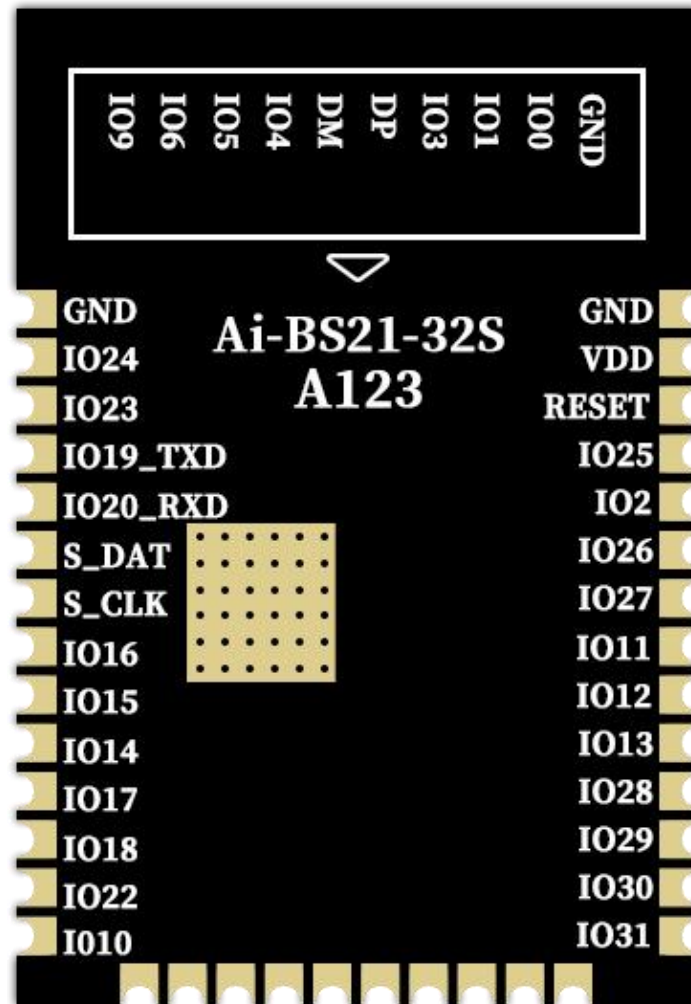Ai-BS21-32S module connects 38 pins, for example, the pin function definition table is the interface definition.


Figure 5 Schematic diagram of module pin (bottom view)

Table 5 Definition table of pin functions

No.	Name	Description
1,15,38	GND	Negative pole of grounding power supply
2	VDD	Power supply, positive pole of power supply
3	RESET	RESET/GPIO21/UART_H0_CTS/EXTLNA_RX_EN
4	IO25	GPIO25/O32M/I2C0_CLK/RESERVED
5	IO2	GPIO2/AIN0/SPI0_TXD/DMIC_CLK/RESERVED
6	IO26	GPIO26/I2C0_DATA/BT_WIFI_SW
7	IO27	GPIO27/I2C1_CLK/BT_WIFI_SW

8	IO11	GPIO11/high speed SPI_TXD/SPI2_TXD/PWM4
9	IO12	GPIO12/high speed SPI_RXD/SPI2_CS0/PWM5
10	IO13	GPIO13/high speed SPI_CS/SPI2_CS1/PWM6
11	IO28	GPIO28/AIN4/I2C1_DATA/RESERVED
12	IO29	GPIO29/AIN5/QDEC_A/BT_STATUS
13	IO30	GPIO30/AIN6/QDEC_ B /RESERVED
14	IO31	GPIO31/AIN7/LED_OUT/RESERVED
16	IO0	GPIO0/XL1/SPI0_RXD/DMIC_DIN/EXTLNA_CTRL
17	IO1	GPIO1/XL2/SPI0_TXD/DMIC_CLK/RESERVED
18	IO3	GPIO3/AIN1/SPI0_CS0/I2S_SCLK/RESERVED
19	DP	USB_DP
20	DM	USB_DM
21	IO4	GPIO4/AIN2/SPI0_CS1/I2S_DOUT/BT_FEM_TX_EN
22	IO5	GPIO5/AIN3/SPI1_RXD/I2S_DIN/RESERVED
23	IO6	GPIO6/SPI1_TXD/I2S_MCLK
24	IO9	GPIO9/NFC1/SPI1_CLK/PWM2
25	IO10	GPIO10/NFC2/SPI2_RXD/PWM3
26	IO22	GPIO22/UART_H0_RX_D/BT_FREQ
27	IO18	GPIO18/UART_L1_TXD/PWM11
28	IO17	GPIO17/UART_L1_RTS/PWM10
29	IO14	GPIO14/high speed SPI_CLK/SPI2_CLK/PWM7
30	IO15	GPIO15/UART_L0_RXD/PWM8
31	IO16	GPIO16/UART_L0_TXD/PWM9
32	S_CLK	SWD_CLK
33	S_DAT	SWD_DAT
34	RXD	GPIO20/UART_L1_RXD/PLUSE_CAPTURE
35	TXD	GPIO19/UART_L1_CTS/KEY_SCAN_BIR[0:31]
36	IO23	GPIO23/UART_H0_RXD/BT_FREQ
37	IO24	GPIO24/UART_H0_TXD/WLAN_ACTIVE

5. Schematic diagram
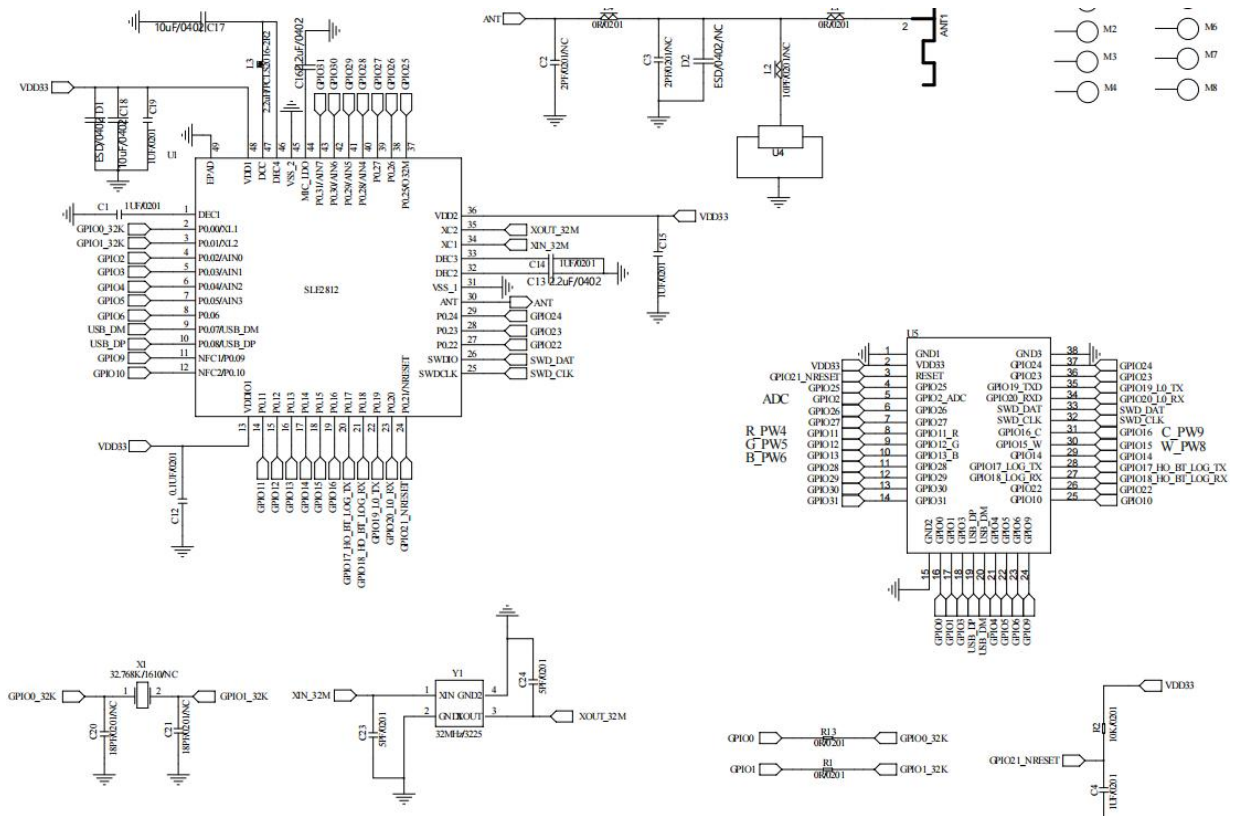
Figure 6 Schematic diagram of the module

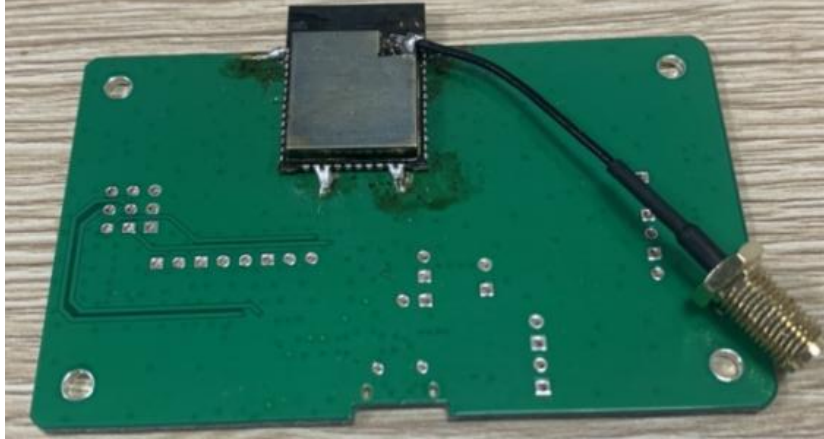# 6. Antenna parameters

6.1. Antenna Test conditions

Figure 7 Antenna test conditions
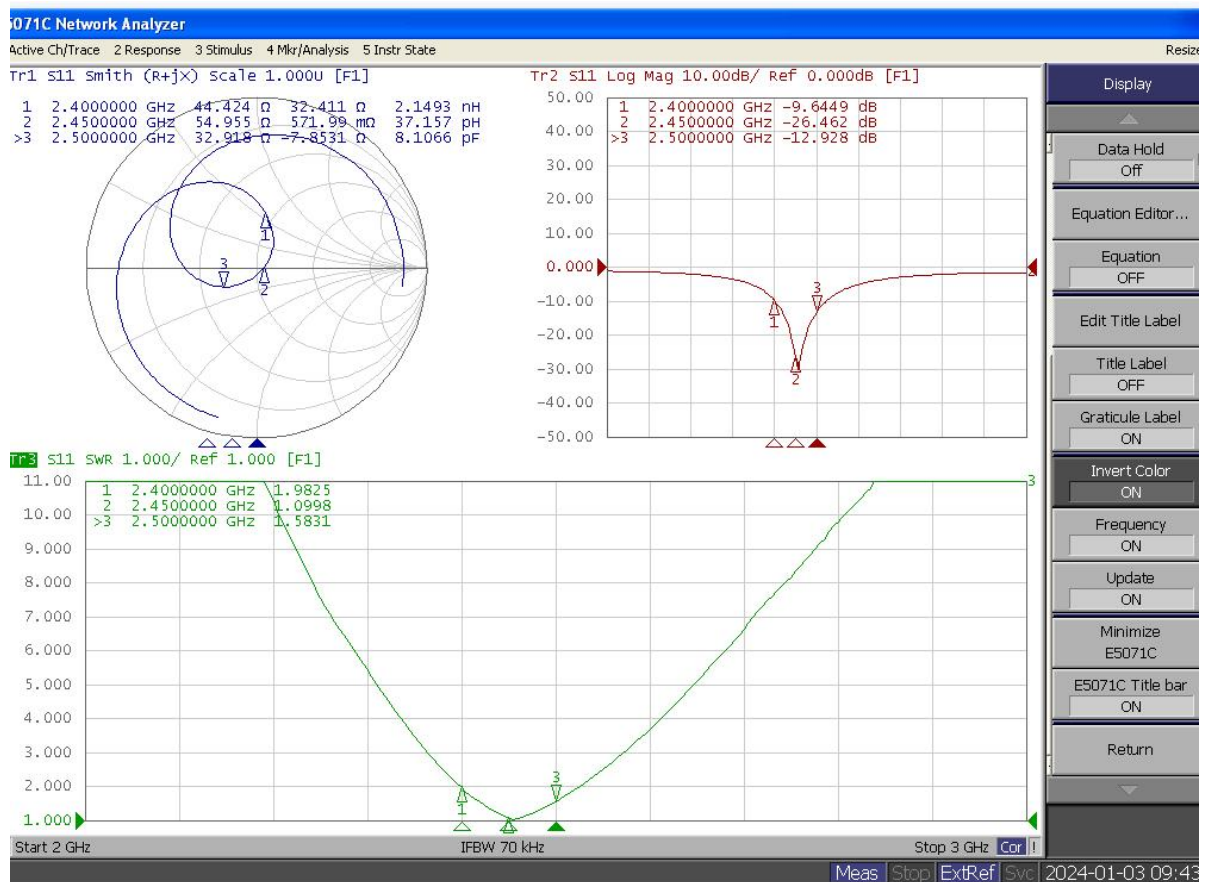
## 6.2. Antenna S parameters

Figure 8 Antenna S parameters

6.3. Antenna gain and efficiency

Table 6 Antenna gain and efficiency

Frequency ID	1	2	3	4	5	6	7	8	9	10	11
Frequency (MHz)	2400.0	2410.0	2420.0	2430.0	2440.0	2450.0	2460.0	2470.0	2480.0	2490.0	2500.0
Gain (dBi)	0.64	0.60	0.71	0.85	1.04	1.15	1.21	1.29	1.38	1.22	1.10
Efficiency (%)	52.96	54.45	56.50	58.94	60.49	61.96	62.80	62.55	61.61	58.48	57.67

6.4. Antenna Field pattern diagram
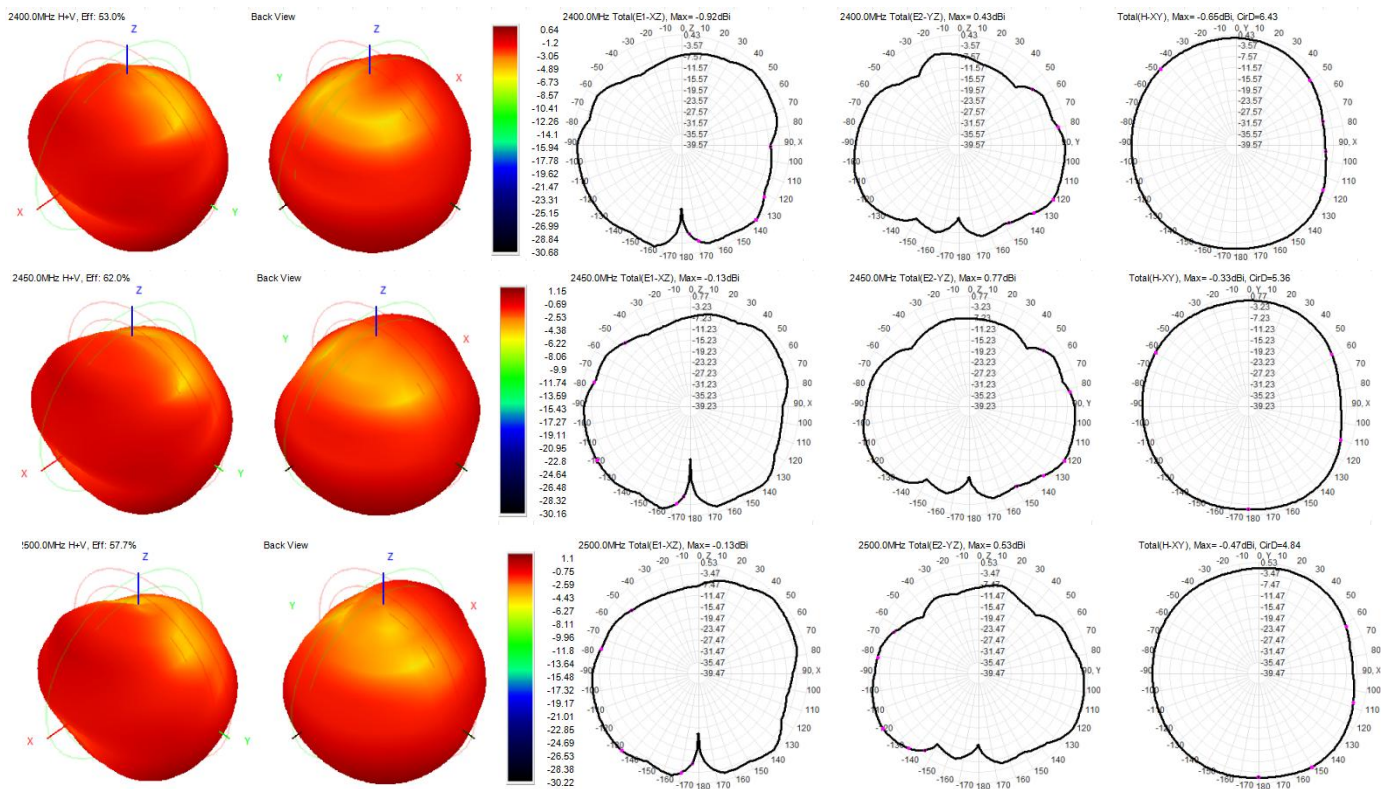
Figure 9 Antenna field type diagram

7. Design Guide

7.1. Module application guide circuit

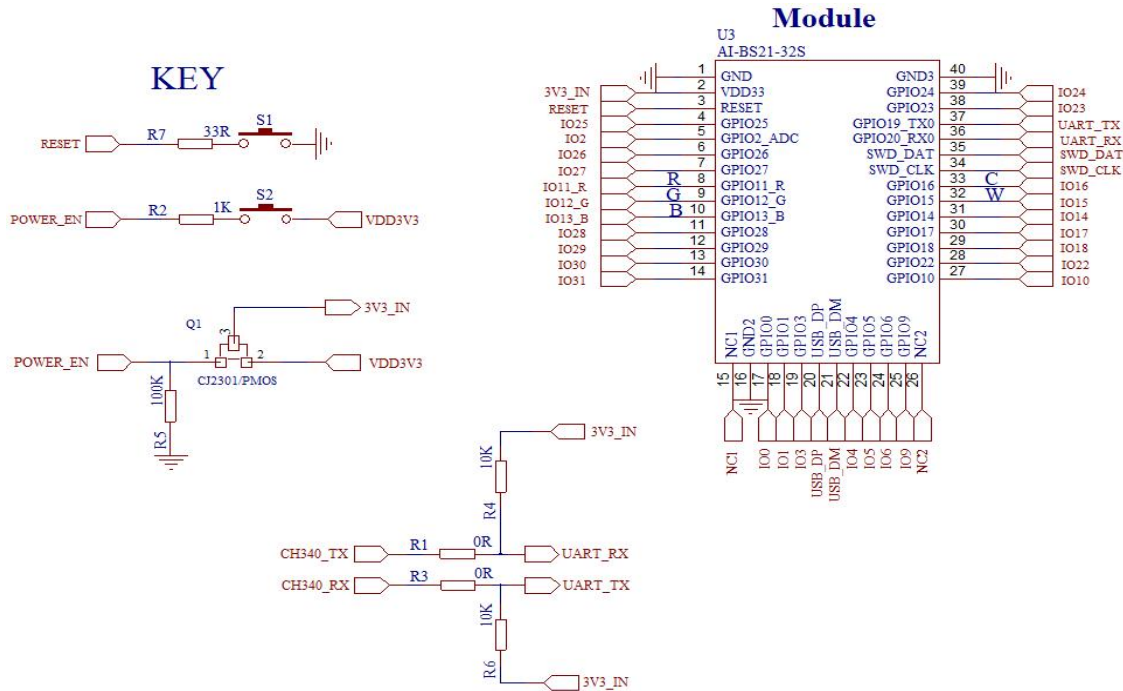(>= 200mA, it is recommended to use DC-DC or LDO for independent power supply)

Figure 10 Application circuit diagram

Note:

- The Ai-BS21-32S can be reset through the RESET pin, and can also be reset by power-off. A PMOS can be used at the power input to realize the power-off action to reset the module.

- On the TX & RX serial line, two resistances are reserved and connected in series. It is used to prevent the 3.3V voltage of the serial port from affecting the reset of the module.

7.2. Recommend PCB package size
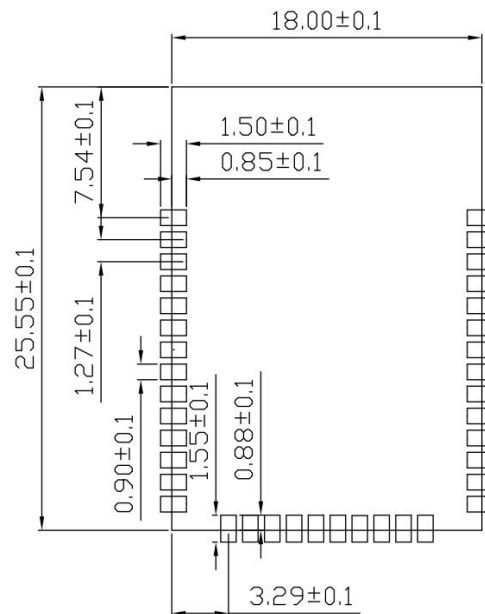

Figure 11 Recommend PCB package size

7.3. Antenna layout requirements

■   The installation position on the motherboard is recommended in the following two ways:

Solution 1: place the module on the edge of the motherboard and extend the antenna area to the edge of the motherboard.

Solution 2: Place the module on the edge of the main board, and the edge of the main board will empty an area 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.
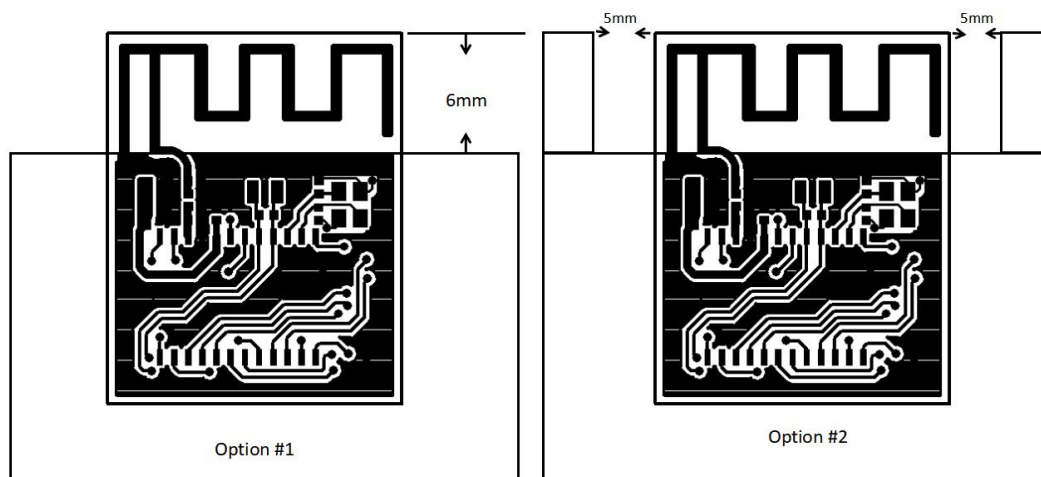
Figure 12 Schematic diagram of Antenna layout

7.4. Power supply

■ Recommend a voltage of 3.3V with a peak current of over 500mA.

■ We recommend that you use LDO for power supply. If you use DC-DC, we recommend that you control the ripple within 30mV.

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

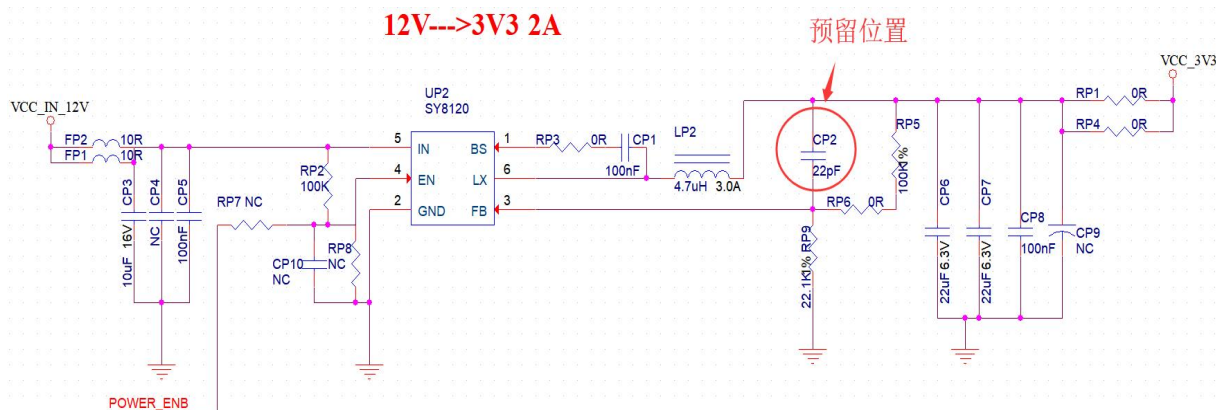■ We recommend that you add ESD devices to the 3.3V power interface.

Figure 13 DC-DC step-down circuit diagram

7.5. GPIO

■ Some IO ports are introduced outside the module. If you need to use them, we recommend that you connect 10-100 ohms of resistance to the IO ports in series. In this way, overshoot can be suppressed and the levels on both sides can be more stable. It is helpful for both EMI and ESD.

■ For the pull-down of special I/O ports, please refer to the instructions in the specification, which will affect the startup configuration of the module.

■ The I/O port of the module is 3.3V. If the main control does not match the I/O port level of the module, a level conversion circuit needs to be added.

■ If the IO port is directly connected to the peripheral interface, or the terminal such as the pin, it is recommended to reserve ESD devices near the terminal of the IO port.
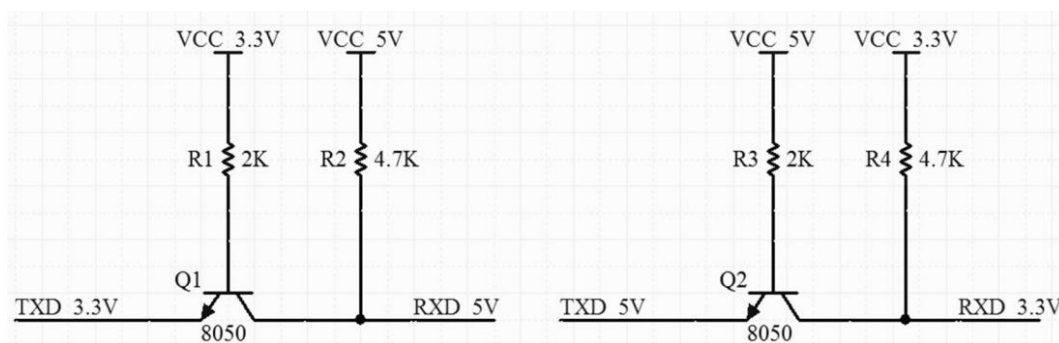

**Figure 14 Level conversion circuit**

8. Storage Conditions

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

The humidity sensitivity level MSL of the module is Level 3.

After the vacuum bag is unpacked, it must be used up within 168 hours at 25±5℃/60%RH, otherwise it can be put on line again after baking.

9. Reflow soldering curve
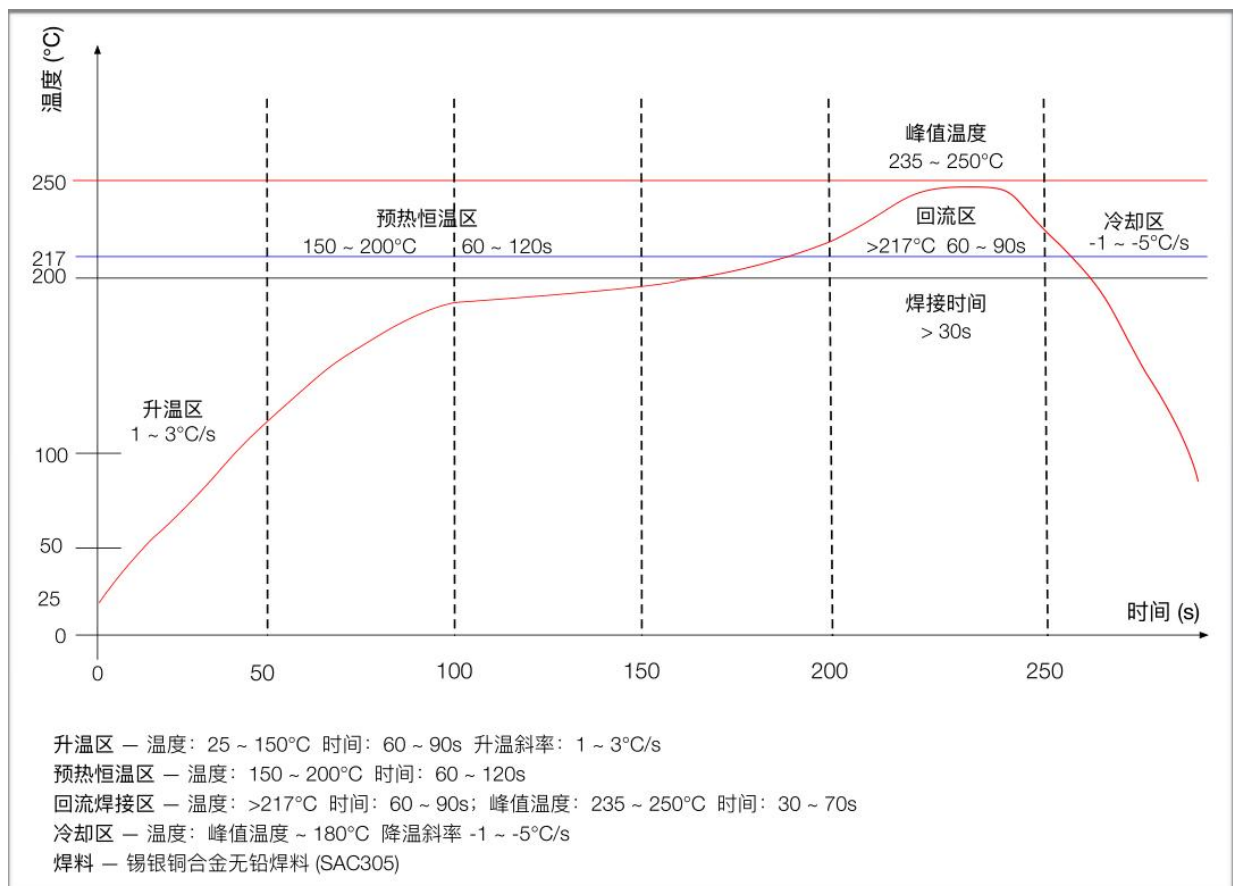
Figure 15 Reflow soldering curve

10. Product packaging information

Ai-BS21-32S module adopts braided packaging, 800pcs/disk. As shown in the following figure:

Figure 16 Packing ribbon diagram

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