Ai-WV02-32S Specification

Version V1.1.0

Copyright ©2025

Document Resume

Version	Date	Develop/revise content	Formulate	Approved
V1.1.0	2025.09.15	First formulated	Xihuan Lu	Ning Guan

Content

1. Product Overview

Ai-WV02-32S is an artificial intelligence AIoT voice module developed by Shenzhen Ai-Thinker Technology Co., Ltd. This module is equipped with the BL618 chip as the core processor and the VB6824 chip as the voice algorithm processor. BL618 chip supports Wi-Fi 6+BLE5.3, Wi-Fi 802.11b/g/n/ax protocols and BLE protocol, and Thread protocol. The BL618 system features a low-power 32-bit RISC-V CPU with a floating-point unit, DSP unit, cache and memory, with a maximum clock speed of up to 320M.

VB6824 is a high-performance 32-bit RISC core CPU with a main control frequency of up to 240MHz, supporting hardware floating-point computing and featuring an integrated 1MB Flash.

Ai-WV02-32S module features a rich array of peripheral interfaces, specifically including SPI, UART, I2C, I2S, PWM, GPDAC, GPADC, ACOMP and GPIO, etc. It can be widely applied in fields such as audio and video multimedia, Internet of Things (IoT), mobile devices, wearable electronic devices, and smart home.

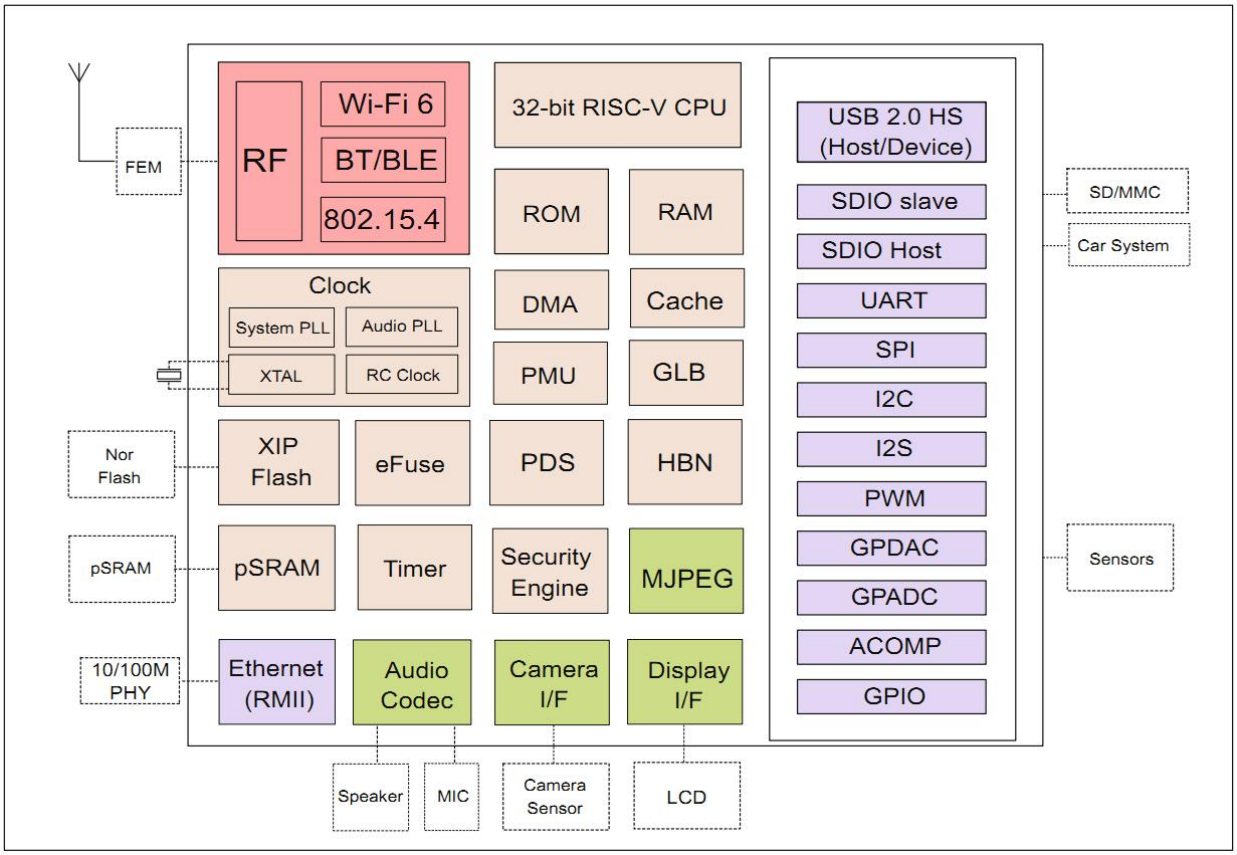


Figure 1 Main chip architecture diagram

1.1. Characteristic

- SMD-40 package
- Supports the 2.4GHz operating frequency band
- Supports IEEE 802.11 b/g/n/ax
- Supports BLE5.3
- Supports Thread
- Supports Wi-Fi/BLE/Thread coexist
- Wi-F i Security Support WPS/WEP/WPA/WPA2/WPA3
- Supports 20/40 MHZ bandwidth, 1T1R, with a maximum rate of 229.4 Mbps
- Supports STA, SoftAP, STA+SoftAP and sniffer modes
- 32-bit RISC-V CPU with FPU and DSP, with a maximum main frequency of up to 320M
- 4MB pSRAM, 532KB SRAM, 128KB ROM, 4Kb eFuse
- Supports USB、SPI、UART、I2C、I2S、PWM、GPDAC、GPADC、ACOMP and GPIO
- Integrated RF Balun、PA/LNA
- Supports safe startup; safe debugging
- Supports XIP QSPI On-The-Fly AES decode (OTFAD)
- Supports TrustZone
- Supports AES-CBC/CCM/GCM/XTS model
- Supports MD5、SHA-1/224/256/384/512
- Supports TRNG (True Random Number Generator)
- Support PKA (Public Key Accelerator) for RSA/ECC
- BLE-enabled Wi-Fi fast connection
- Supports secondary development and integrates Windows and Linux development environments
- Supports offline voice recognition
- Supports voice noise reduction algorithms

2. Main parameters

Table 1 Description of main parameters

Model	Ai-WV02-32S
Package	SMD-40
Size	25.5*18.0*3.1mm
Antenna type	On-board /PAD antenna
Spectrum range	2400 ~ 2483.5MHz
Operating temperature	-40℃~ 85℃
Storage Environment	-40℃~ 125℃, < 90%RH
Power supply	VDD: 2.97V to 3.6V, supply current ≥500mA; DACR/5V:2.5V to 6V, power supply current ≥1A
Supported interfaces	Support USB、SPI、UART、I2C、I2S、PWM、GPDAC、GPADC、ACOMP and GPIO etc.
Available IO	Default 23
Serial port rate	Default 2000000 bps
Security	WPS/WEP/WPA/WPA2/WPA3
Flash	Default 8MByte, Max support 16MByte

2.1. Static electricity requirements

Ai-WV02-32S is an electrostatic sensitive device, and special precautions need to be taken during transportation.

Figure 2 ESD anti-static diagram

2.2. Electrical characteristics

Table 2 Electrical characteristics

Parameter		Pins	Minimum	Typical values	Maximum	Unit
Supply voltage		VDD	2.97	3.3	3.6	V
		DACR/5V	2.5	5	6	V
I/O	VIL	-	-	-	0.3*VDD	V
	VIH	-	0.7*VDD	-	-	V
	VOL	-	-	0.1*VDD	-	V
	VOH	-	-	0.9*VDD	-	V
	IMAX	-	-	-	15	mA

2.3. Wi-Fi RF performance

Table 3 Wi-Fi RF performance

Describe	Typical values			Unit
Spectrum range	2400 ~ 2483.5MHz			MHz
Output power				
Model	**Minimum**	**Typical**	**Maximum**	**unit**
11ax mode HE40, PA output power	-	14	-	dBm
11ax mode HE20, PA output power	-	15	-	dBm
11n mode HT40, PA output power	-	17	-	dBm
11n mode HT20, PA output power	-	17	-	dBm
PA output power in 11g mode	-	17	-	dBm
PA output power in 11b mode	-	21	-	dBm
Receive sensitivity				
Model	**Minimum**	**Typical**	**Maximum**	**Unit**
11b, 1 Mbps	-	-99	-	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 radio frequency performance

Describe	Typical values			Unit
Spectrum range	2400 ~ 2483.5MHz			MHz
Output Power				
Rate Mode	**Minimum**	**Typical**	**Maximum**	**Unit**
1Mbps	-	10	15	dBm
2Mbps	-	10	15	dBm
Receive Sensitivity				
Rate Mode	**Minimum**	**Typical**	**Maximum**	**Unit**
1Mbps Sensitivity@30.8%PER	-	-99	-	dBm
2Mbps Sensitivity@30.8%PER	-	-97	-	dBm

2.5. Power consumption

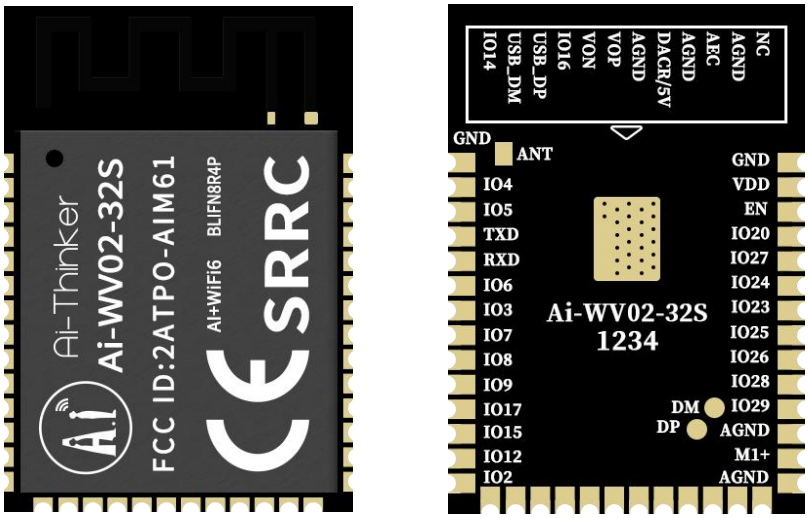
The following power consumption data is measured based on a 3.3V power supply and an ambient temperature of 25° C.

- The POUT power of all transmission modes is the measured value at the antenna interface.
- All emission data were measured in a continuous emission mode based on a 100% duty cycle.

Table 5 Power consumption

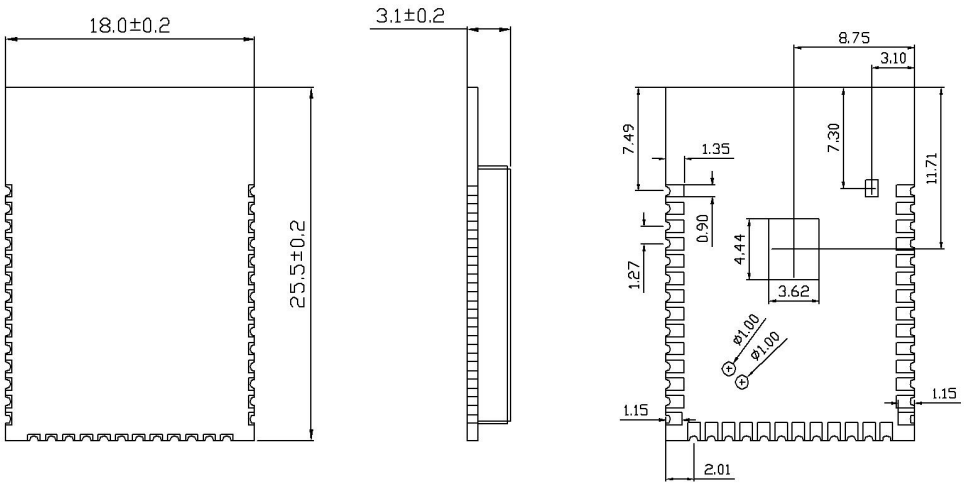
Model	Minimum	Average	Maxim	Unit
Transmit 802.11b, 11Mbps，POUT=+22dBm	-	419	-	mA
Transmit 802.11g, 54Mbps，POUT =+19dBm	-	328	-	mA
Transmit 802.11n, MCS7，POUT =+19dBm	-	326	-	mA
Transmit 802.11ax, MCS9，POUT =+17dBm	-	294	-	mA
Receive 802.11b , packet length 1024 bytes	-	92	-	mA
Receive 802.11g , packet length 1024 bytes	-	92	-	mA
Receive 802.11n , packet length 1024 bytes	-	92	-	mA
Receive 802.11ax , packet length 1024 bytes	-	92	-	mA

3. Appearance dimensions



Front Back

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



Front Side Back

Figure 4 Dimensional drawing

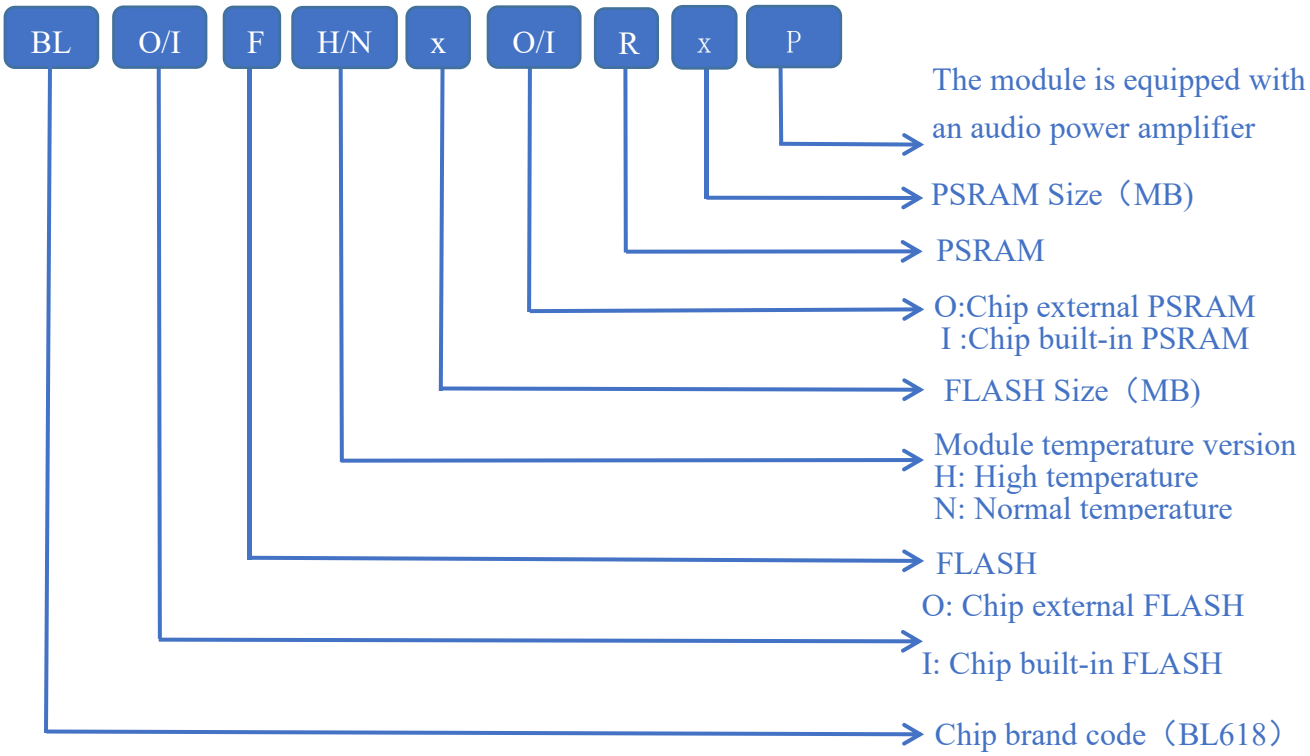
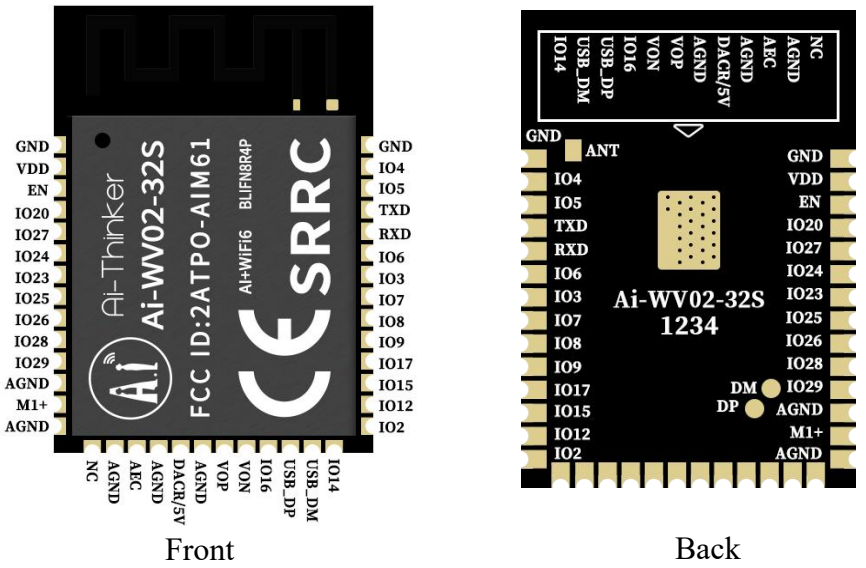


Figure 5 Shielding cover silk screen representative information

4. Pin Definition

Ai-WV02-32S module has a total of 41 pins connected. As shown in the pin diagram, the pin function definition table is the interface definition.



Front Back

Figure 6 Schematic diagram of pins

Table 6 Pin Function Definition Table

No.	Name	Function
1	GND	Ground
2	VDD	3.3V power supply; It is recommended that the output current of the external power supply be above 500mA
3	EN	By default, it is enabled as a chip, and high levels are effective
4	IO20	GPIO20/SPI_SS/I2S_BCLK/I2C_SCL/PWM0/ADC_CH0
5	IO27	GPIO27/SPI_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM0/ADC_CH10
6	IO24	GPIO24/SPI_SS/I2S_BCLK/I2C_SCL/PWM0
7	IO23	GPIO23/SPI_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM0
8	IO25	GPIO25/SPI_SCLK/I2S_FS/I2C_SDA/PWM0
9	IO26	GPIO26/SPI_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM0
10	IO28	GPIO28/SPI_SS/I2S_BCLK/I2C_SCL/PWM0/ADC_CH11
11	IO29	GPIO29/SPI_SCLK/I2S_FS/I2C_SDA/PWM0
12	AGND	AGND; It is recommended to connect the negative terminal of Microphone 1 input
13	M1+	The positive terminal of microphone 1 input
14	AGND	AGND
15	NC	NC

16	AGND	AGND
17	AEC	When an external power amplifier is connected to the module, this pin can be used as the audio capture input
18	AGND	AGND
19	DACR/5V	DAC Right Channel/ Power amplifier 5V input. When using a DAC output external power amplifier, the function is DACR. When using the internal power amplifier of the module, the function is power input for the power amplifier. Input: 2.5-6V. 5V is recommended, and it is suggested to be above 1A
20	AGND	AGND
21	VOP	Amplifier out P
22	VON	Amplifier out N
23	IO30	GPIO30/SPI_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM0
24	USB_DP	USB_DP Pin
25	USB_DM	USB_DM Pin
26	IO34	GPIO34/SPI_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM0
27	IO2	GPIO2/SPI_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM0/ADC_CH2
28	IO32	GPIO32/SPI_SS/I2S_BCLK/I2C_SCL/PWM0
29	IO31	GPIO31/SPI_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM0
30	IO33	GPIO33/SPI_SCLK/I2S_FS/I2C_SDA/PWM0
31	IO9	GPIO9/SPI_SCLK/I2S_FS/I2C_SDA/PWM0/QSPI_SDA3
32	IO8	GPIO8/SPI_SS/I2S_BCLK/I2C_SCL/PWM0/QSPI_SDA2
33	IO7	GPIO7/SPI_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM0/QSPI_SDA1
34	IO3	GPIO3/SPI_MOSI/I2S_DO/I2S_RCLK_O/I2C_SDA/PWM0/ADC_CH3
35	IO6	GPIO6/SPI_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM0/QSPI_SDA0
36	RXD	RXD/GPIO22/SPI_MOSI/SPI_MISO/I2S_DI/I2S_RCLK_O/I2C_SCL/PWM0
37	TXD	TXD/GPIO21/SPI_SCLK/I2S_FS/I2C_SDA/PWM0
38	IO5	GPIO5/SPI_SCLK/I2S_FS/I2C_SDA/PWM0/QSPI_CSN
39	IO4	GPIO4/SPI_SS/I2S_BCLK/I2C_SCL/PWM0/QSPI_SCL
40	GND	Ground
41	ANT	ANT pin. When not in use, leave it suspended. Do not pass through the surface of the bottom plate of the ANT pin foot.

Note: 1. When GPIO2 is used as Bootstrap and the power-on moment is at a high level, the module enters the burning mode. When the power is low at the moment of power-on, the module starts up normally.

2. If you need to use DACR to output an external power amplifier, please contact Ai-Thinker.

5. Schematic

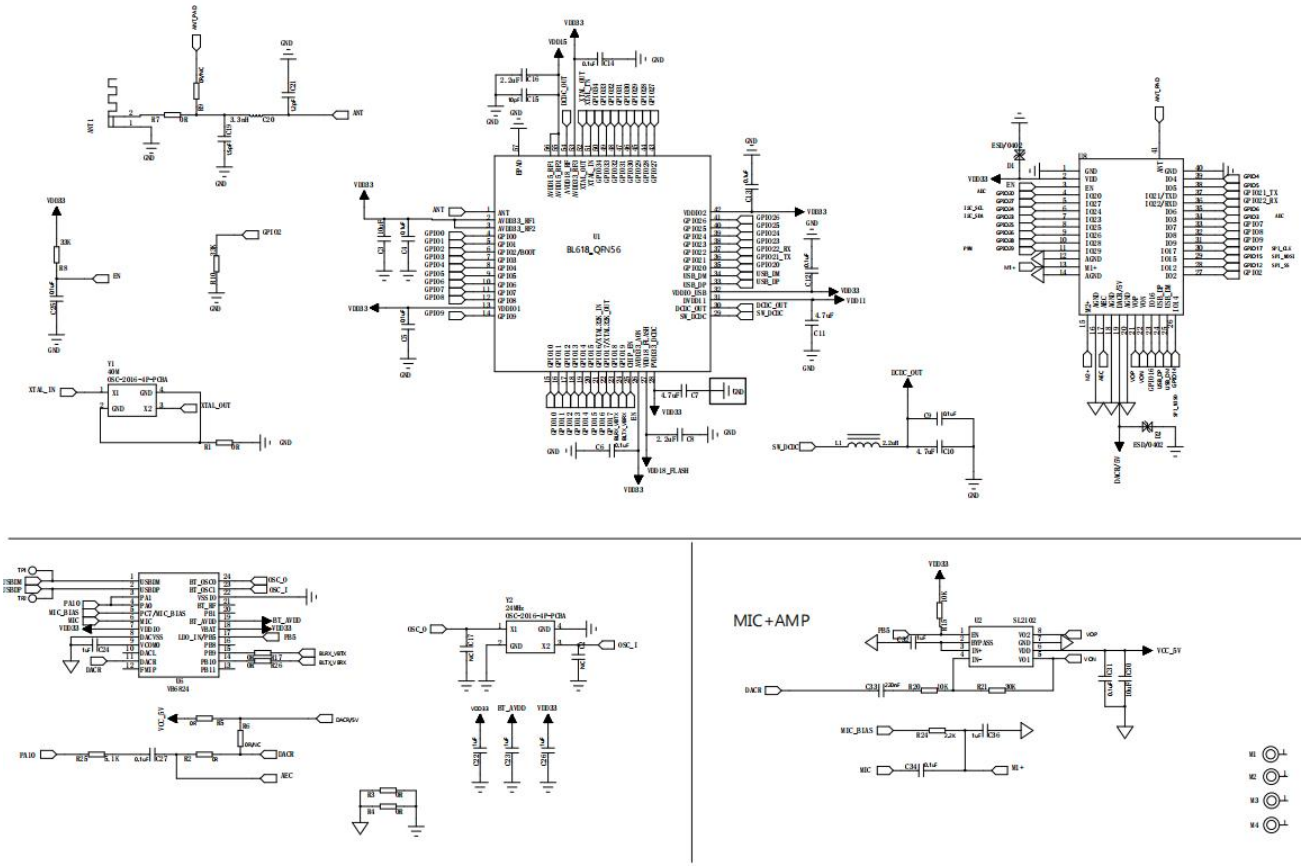


Figure 7 Schematic diagram

6. Antenna parameters

6.1. Schematic diagram of the antenna test prototype

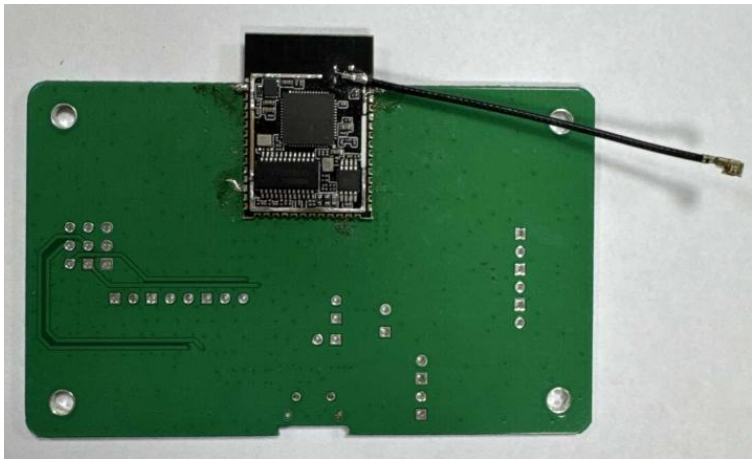


Figure 8 Schematic diagram of the antenna test prototype antenna

6.2. Antenna S parameters

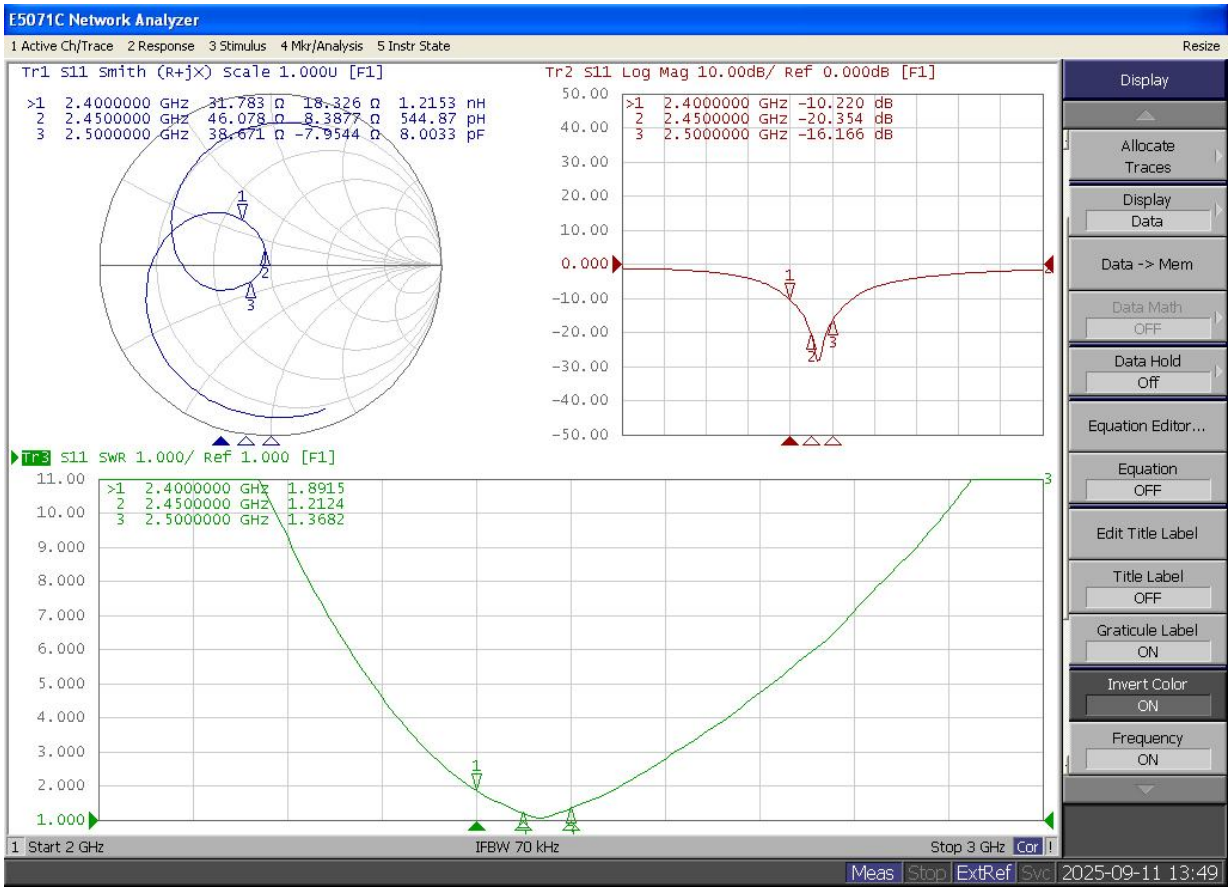


Figure 9 Antenna S parameters

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)	2400.0	2410.0	2420.0	2430.0	2440.0	2450.0	2460.0	2470.0	2480.0	2490.0	2500.0
Gain (dBi)	0.84	1.05	1.02	0.98	1.14	1.88	1.59	1.24	1.63	1.33	1.27
Efficiency (%)	52.46	54.94	55.73	56.51	57.45	58.41	58.81	58.26	56.97	56.69	57.38

6.4. Antenna pattern

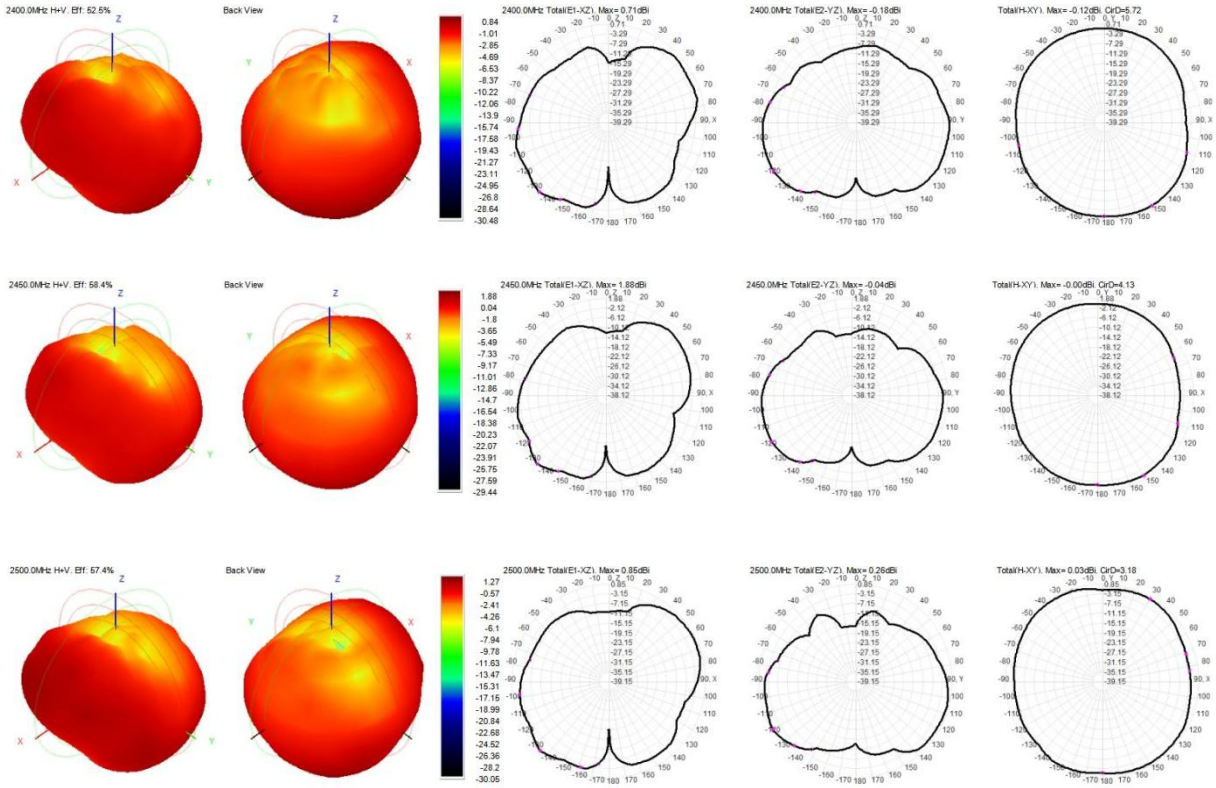


Figure 10 Antenna field pattern

7. Design Guidance

7.1. Application Guidance Circuit

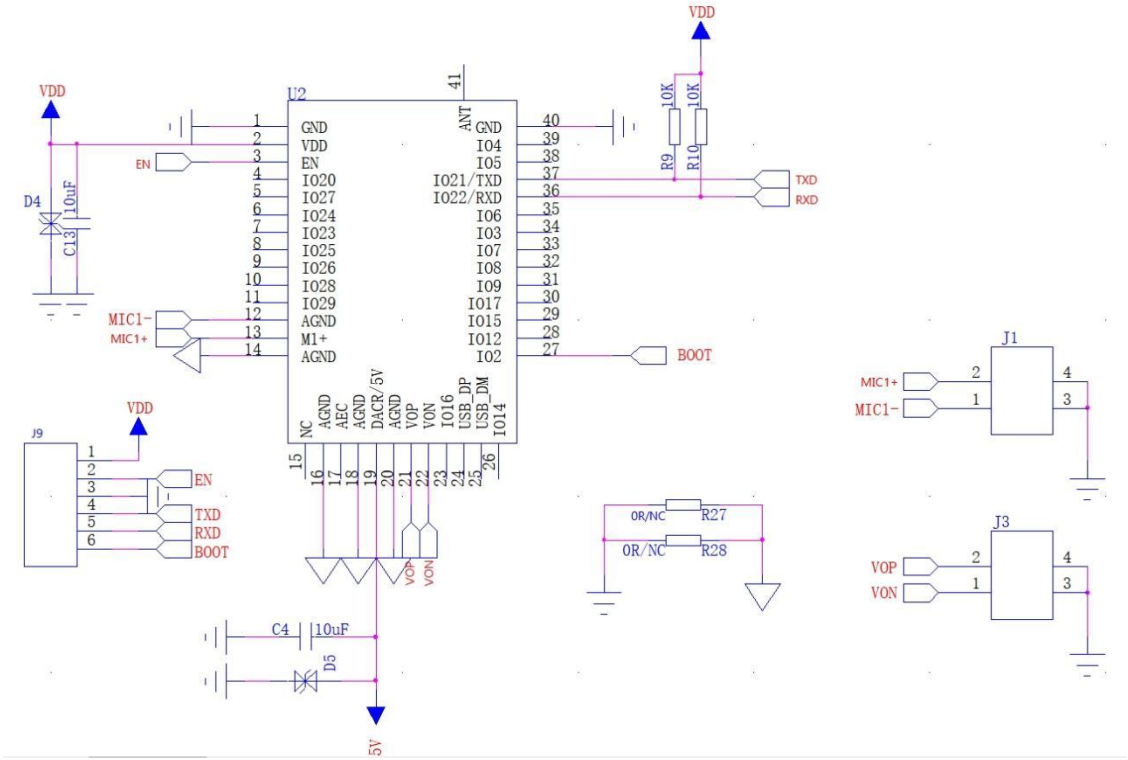


Figure 11 Application guidance circuit

- GPIO2 is the module start control pin. It operates in normal mode at low levels and in firmware burning mode at high levels. The chip defaults to a low level internally.
- Connect M1+ to the positive end of the microphone
- Connect the VOP and VON speakers. The recommended speakers are 4R3W and 8R2W
- The power supply voltage for VDD is 2.97 to 3.6V. It is recommended that the output current of the external power supply be above 500mA
- DACR/5V: The power supply voltage is 2.5 to 6V, and the output current of the external power supply is recommended to be above 1A

7.2. Recommended PCB package size

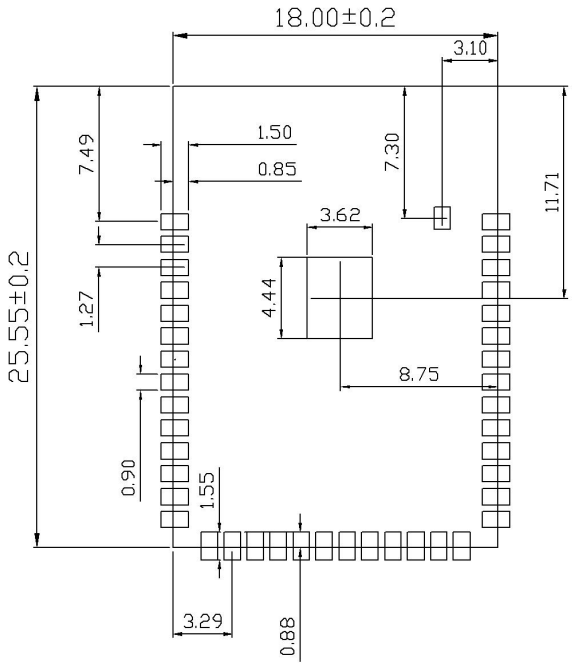


Figure 12 Recommended PCB package size

7.3. Antenna layout requirements

- The following two methods are recommended for the installation position on the motherboard:

Solution 1: Place the module along the edge of the motherboard, with the antenna area extending beyond the edge.

Solution 2: Place the module along the edge of the motherboard and hollow out an area along the edge of the motherboard at the antenna position.

- To meet the performance requirements of the on-board antenna, no metal parts should be placed around the antenna and it should be kept away from high-frequency devices.

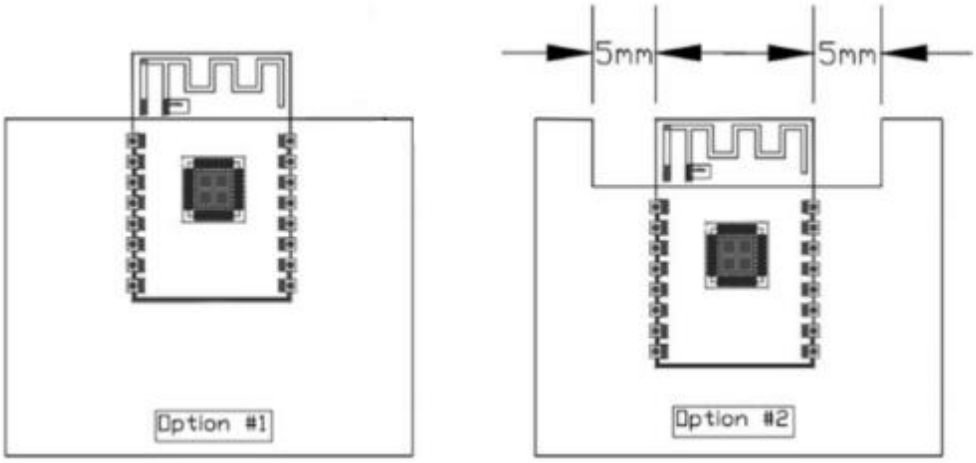


Figure 13 Antenna layout diagram

7.4. Power supply

- VDD is recommended to have a voltage of 3.3V and a peak current of over 500mA.
- DACR/5V is recommended to have a voltage of 5V and a peak current of over 1A.
- 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 for dynamic response capacitors in the DC-DC power supply circuit, which can optimize the output ripple when the load changes significantly.
- It is recommended to add ESD devices to the power interface.

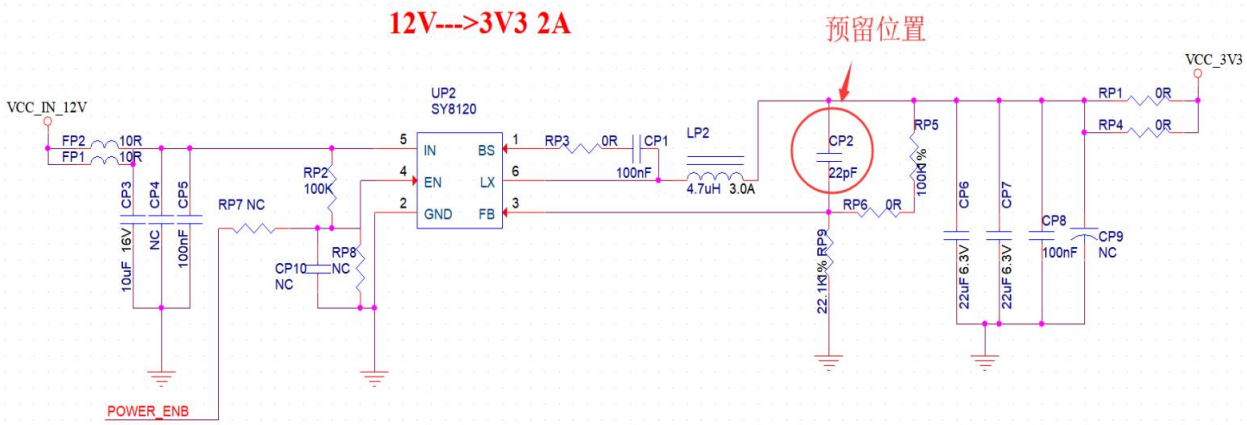


Figure 14 DC-DC step-down circuit diagram

7.5. GPIO

- Some IO ports are led out from the periphery of the module. If you need to use them, 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. It is helpful for both EMI and ESD.
- For the up and down pulling of special IO ports, please refer to the usage instructions in the specification sheet. This will affect the startup configuration of the module.
- The IO port of the module is 3.3V. If the IO port level of the main control does not match that of the module, a level conversion circuit needs to be added.
- If the IO port is directly connected to peripheral interfaces or terminals such as pin headers, it is recommended to reserve ESD devices near the terminals in the IO port traces.

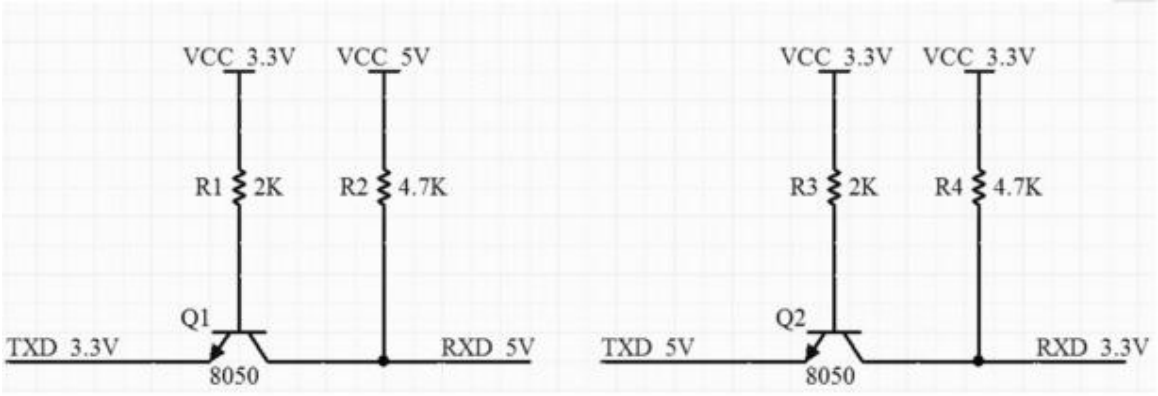


Figure 15 Level conversion circuit

8. Storage conditions

Products sealed in moisture-proof bags should be stored in a non-condensing atmospheric environment with a temperature below 40℃ and a humidity of 90%RH.

The moisture sensitivity grade (MSL) of the module is level 3.

After opening the vacuum bag, it must be used up within 168 hours at 25±5℃/60%RH; otherwise, it needs to be baked before being put back on the line for the second time.

9. Reflow Oven Profile

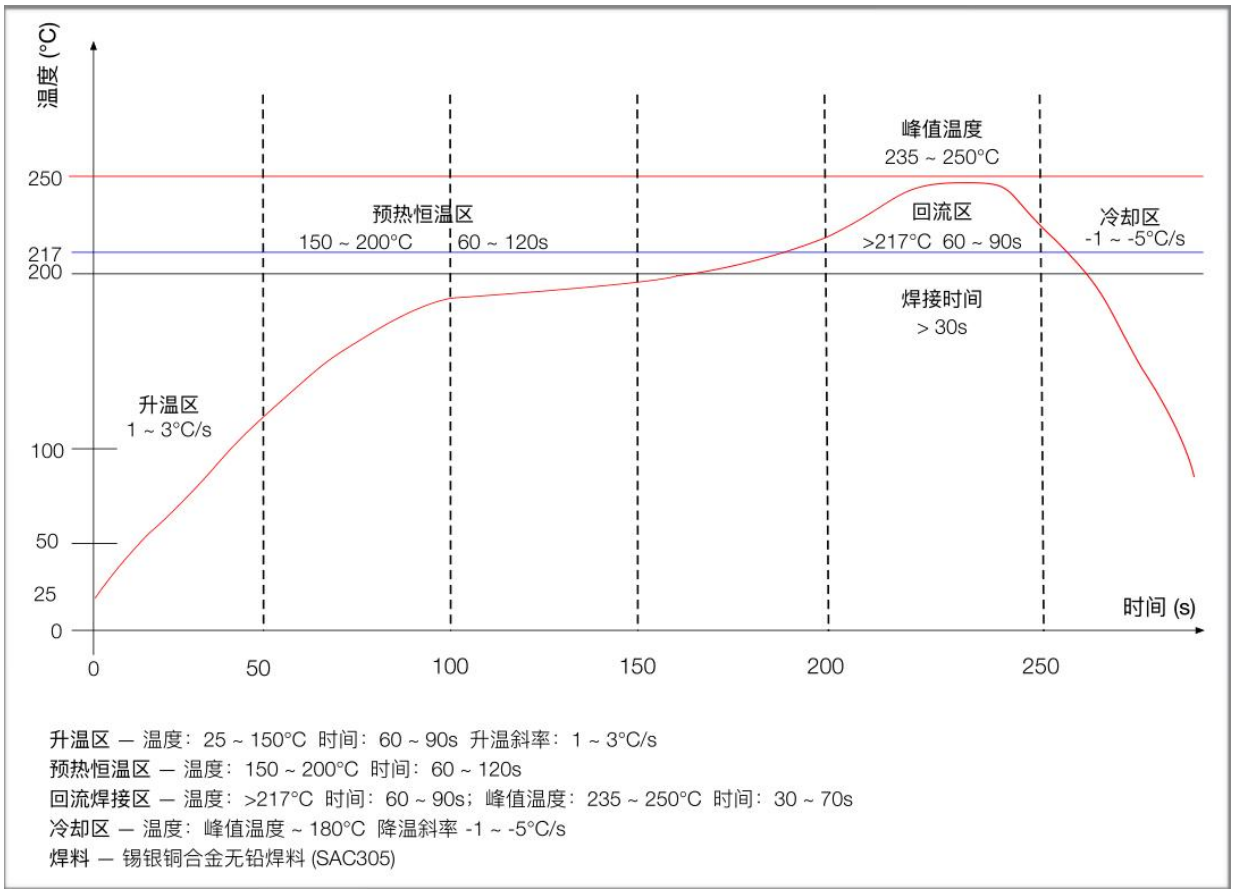


Figure 16 Reflow soldering curve graph

10.Product packaging information

Ai-WV02-32S module is packaged in tape, 800 pcs/reel. As shown below:

Figure 17 Packaging Taping Diagram

11.Contact Us

Ai-Thinker official website　Office forum　Develop DOCS

LinkedIn　Tmall shop　Taobao shop　Alibaba shop

Technical support email：support@aithinker.com

Domestic business cooperation：sales@aithinker.com

Overseas business cooperation：overseas@aithinker.com

Company Address：Room 403-405,408-410, Block C, Huafeng Smart Innovation Port, Gushu 2nd Road, Xixiang, Baoan District, Shenzhen.

Tel：0755-29162996

WeChat mini program　　WeChat official account

Disclaimer and Copyright Notice

Information in this document, including URL references, is subject to change without notice.

This document is provided "as is" without warranty of any kind, including any warranty of merchantability, fitness for a particular purpose, or non-infringement, and any warranty otherwise expressly stated in any proposal, specification, or sample. No liability is assumed with respect to this document, including liability for infringement of any patent arising from the use of the information in this document. No license, express or implied, by estoppel or otherwise, to any intellectual property right is granted by this document.

The test data obtained in this article are all obtained from the Anxinke laboratory test, and the actual results may vary slightly.

All trade names, trademarks and registered trademarks mentioned herein are the property of their respective owners and are hereby acknowledged.

The final right of interpretation belongs to Shenzhen Anxinke Technology Co., Ltd.

Notice

The contents of this manual may be changed due to product version upgrades or other reasons.

Shenzhen Anxinke Technology Co., Ltd. reserves the right to modify the contents of this manual without any notice or reminder.

This manual is for use as a guide only. Shenzhen Anxinke Technology Co., Ltd. makes every effort to provide accurate information in this manual. However, Shenzhen Anxinke Technology Co., Ltd. does not ensure that the contents of this manual are completely error-free, and all statements, information and suggestions in this manual do not constitute any express or implied warranty.

Important Notice

Essence provides technical and reliability data (including datasheets), design resources (including reference designs), applications or other design advice, web tools, safety information and other resources (hereinafter referred to as "these resources") "as is" without guarantee of defects and without warranty of any kind, either express or implied, including but not limited to, express or implied warranties of fitness for a particular purpose or non-infringement of any third party intellectual property rights. Essence specifically disclaims any liability for any consequential or incidental damages, including but not limited to, damages arising from the application or use of any of its products and circuits.

Essence reserves the right to change the information published in this document (including but not limited to indicators and product descriptions) and any of the company's products involved without prior notice. This document automatically replaces and replaces all information provided in the previous version of the document with the same document number.

These resources are available to experienced developers designing with Essence products. You are solely responsible for: (1) selecting the appropriate Essence products for your application; (2) designing, validating, and operating your application and product throughout its lifecycle; and (3) ensuring that your application meets all applicable standards, specifications, and laws, as well as any other functional safety, information security, regulatory, or other requirements.

Essence authorizes you to use these resources solely for the research and development of applications for Essence products described herein. Without Essence's permission, no entity or individual may excerpt or copy these resources, in whole or in part, or disseminate them in any form. You have no right to use any other Essence intellectual property or any third-party intellectual property. You shall fully indemnify Essence and its representatives for any claims, damages, costs, losses, and liabilities arising from the use of these resources, and Essence shall not be liable for any such claims.

Products provided by Essence are subject to Essence's terms of sale or other applicable terms accompanying Essence products. Essence's provision of these resources does not extend or otherwise change the warranty or warranty disclaimer applicable to the product release.