

VB-01 Specification

Version V1.1

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Ai-Thinker

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1. Product Overview

VB-01 is an offline voice recognition AI module developed by Ai-Thinker. The main chip is the voice brain VB590 launched by Huazhen Company. It has the characteristics of ultra-low cost, high reliability and strong versatility. In the speech recognition technology, it has achieved high-reliable wake-up recognition rate, longer-distance wake-up, lower false wake-up rate, stronger anti-noise ability, faster response recognition time, and pure offline recognition without networking.

VB-01 uses a high-performance 32-bit processor, the chip has built-in DSP instruction enhancement unit and MCA algorithm hardware accelerator required for speech recognition neural network calculations, AI algorithm and chip architecture are deeply integrated, equipped with speech recognition algorithms, speech enhancement, and noise reduction And other acoustic front-end processing algorithms provide smart devices with excellent voice control and voice interaction capabilities in the far-field environment. The main chip has been fully and deeply optimized in AI computing power, storage performance, and integration, providing developers with a truly low-cost complete voice AI solution and enhancing differentiated competitiveness.

VB-01 has a wealth of peripheral interfaces, including UART/I2C/PWM, and simple and friendly secondary development tools to facilitate customers to implement single-module voice control application scenarios.

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Figure 1 Chip architecture diagram

1.1. Characteristics

■ **Key technical indicators**

- Adjustable recognition distance: support 5 meters recognition distance[1]
- Background noise suppression: steady state, dynamic noise, environmental noise suppression>20dB
- Local speech recognition (based on the latest TDNN deep neural network recognition algorithm), supporting pure offline recognition
- The comprehensive recognition rate can reach more than 98%[2]
- Recognition time is less than 100 ms
- Low misjudgment rate
- Up to 50 entries

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- **Kernel**
  - Integrated TG head 32-bit Xuantie 804 processor frequency up to 240MHz
  - Adopt 3-4 stage variable length pipeline, equipped with DSP calculation engine and MCA algorithm hardware accelerator supporting NN
  - Support 32 interrupt nesting, each interrupt has corresponding priority
  - Support JTAG debugging and hardware breakpoint
- **Storage**
  - Integrated 128KB SRAM
  - 8KB ROM for Boot
  - Built-in 2MB SPI FLASH
- **Audio**
  - Internally integrated audio AD/DA, which can be connected to analog PA and MIC
- **Power**
  - Internal integrated LDO, 3.3V input, default output 1.2V
  - Built-in watchdog monitor WDT
- **Timing and control**
  - 4 Timers, support a variety of clock source options, 2 of which can be clocked in standby mode and wake up with low power consumption
  - 1 RTC, which can be used for accurate timing and low-power wake-up
- **Peripherals**
  - 12 channel PWM
  - UART*2，Support high-speed flow control
  - 32 general-purpose input and output interfaces, each pin can send out an interrupt by rising/falling edge or level detection
  - Audio interface such as I2C、I2S*5 and SPDIF
  - SPI*2

Description:

1. Test conditions for identification distance: (1) The environmental noise is small; (2) The microphone sensitivity is 35bB. Excessive environmental noise or the use of low-sensitivity

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microphones will shorten the actual recognition distance.

2.Recognition rate description: 35dB microphone is used, the distance between the tester and the microphone is less than 1 meter, and the sound size for effective communication can reach more than 98%. The increase of the distance between the tester and the microphone or the decrease of the speaking volume of the tester will affect the recognition rate.

2. Parameter

2.1. Main parameters

Table 1 Main parameter description

Model Name	VB-01
Package	SMD-24
Size	25.5*24*3.25(±0.2)mm
Operating Temperature	-40℃~85℃
Store Temperature	-40℃~125℃,<90%RH
Power supply range	Power supply voltage 5V, power supply current>500mA
Support Interface	UART/I2C/PWM/JTAG/GPIO
UART Rate	Default 115200 bps
SPI Flash	2MB(Built-in)

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2.2. Electrical parameters

Table 2 Electrical parameter description

parameter	Test Conditions	Min	Typical value	max	Unit
Operating Voltage	normal work	4.5	5	5.5	V
Working mode VDD33 working current	Port VDD33 power supply current		60	85	mA
Monitor mode VDD33 working current	Port VDD33 power supply current		20		mA
Standby mode VDD33 operating current	Port VDD33 power supply current	/	5		uA
Pull-up resistor				100	KΩ
Crystal feedback resistance (internal)		/		/	MΩ
DAC Line Out（10KΩ load）					
Full-scale output level	0dB gain	1.89	2.12	2.39	Vpp
Sampling Rate		8		96	kHz
Signal-to-noise ratio （A-Weighted）	1kHz	90	95		dB
Dynamic Range （A-Weighted）	1kHz，-60dBr	90	95		dB
Total harmonic distortion	-1dBr		-80	-70	dB
Programmable gain step		-25		+6	dB
Frequency response	Passband			0.42*Fs	Hz
	Passband Ripple			+/-0.1	dB
Power supply noise rejection ratio	1kHz，100mVpp		90		dB
ADC MIC Input（Differential input）					
Sampling Rate		8		96	kHz
Signal-to-noise ratio （A-Weighted）	input：1kHz MIC_Boost=20dB	75	80		dB
Dynamic Range （A-Weighted）	input：1kHz，-60dBr MIC_Boost=20dB	75	80		dB
Total harmonic distortion	input：1kHz，-1dBr，0dB Gain		-80	-70	dB
	input：1kHz，-1dBr，20dB Gain		-70	-60	dB

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MIC Bias Voltage			2.08		V
MIC Bias Current				4	mA

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VB-01 module is electrostatic sensitive devices and special precautions need to be taken when handling.



Figure 2 ESD anti-static diagram

3. Appearance dimensions

3.1. Appearance

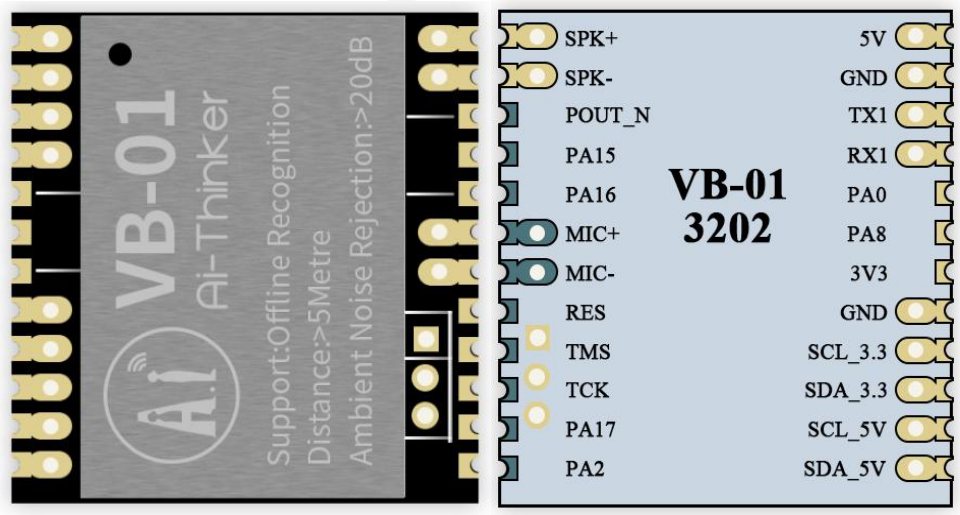


Figure 3 VB-01 Appearance dimensions（For reference only）

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3.2. Dimensions

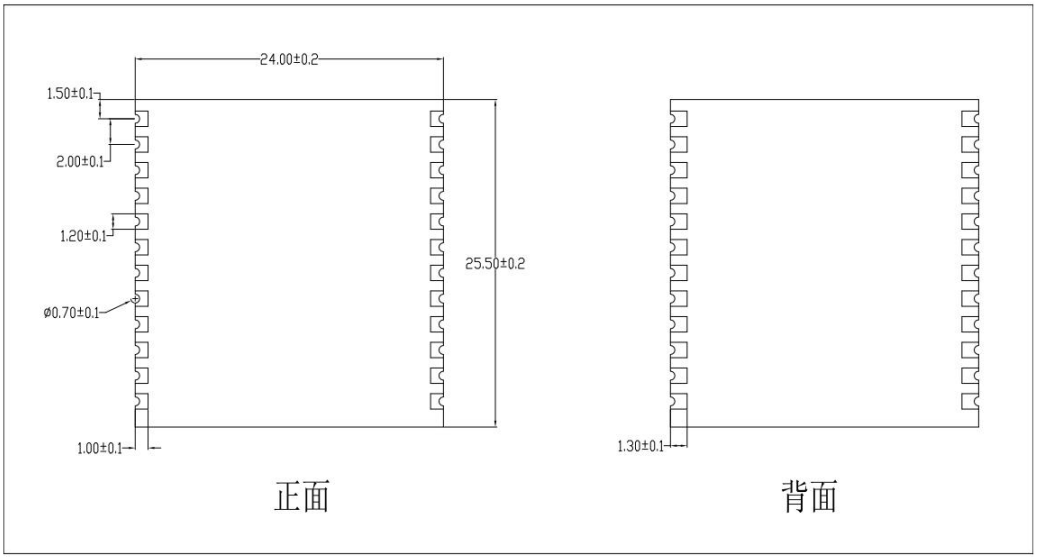


Figure 4 VB-01 Dimensions

4. Pin definition

VB-01 module is connected to 24 interfaces, refer to pin diagram, pin function definition table is interface definition.

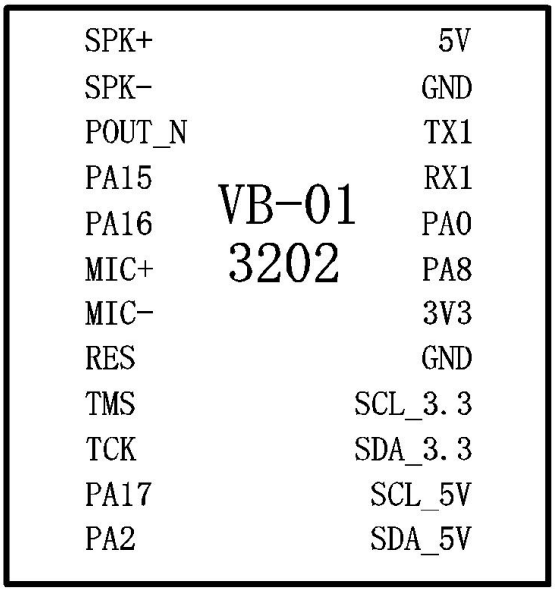


Figure 5 VB-01（SMD-24）Pin diagram

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Table 3 Pin function definition

No.	Name	Function
1	5V	5V power input
2	GND	GND Digitally
3	TX1	A28/TX1 UART1 TXD,3.3V Level
4	RX1	A27/RX1 UART1 RXD,3.3V Level
5	PA0	IO/3.3V Level/PWM_CH0
6	PA8	IO/3.3V Level/PWM_CH8
7	3V3	Digital 3.3V power output
8	GND	GND Digitally
9	SCL_3.3	A23/TX0 UART0 TXD,3.3V Level
10	SDA_3.3	A24/RX0 UART0 RXD,3.3V Level
11	SCL_5V	A23/TX0 UART0 TXD,5V Level
12	SDA_5V	A24/RX0 UART0 RXD,5V Level
13	PA2	IO/3.3V Level/PWM_CH2
14	PA17	IO/3.3V Level/PWM_CH10
15	TCK	A20/TCLK JTAG_TCK
16	TMS	A19/TMS JTAG_TMS
17	RES	RESETN
18	MIC-	AMIC-input
19	MIC+	AMIC+-input
20	PA16	IO/3.3V Level/IICO_SDA
21	PA15	IO/3.3V Level/IICO_SCL
22	POUT_N	Audio R channel output
23	SPK-	SPK-8Ω2W
24	SPK+	SPK+8Ω2W

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5. Schematic

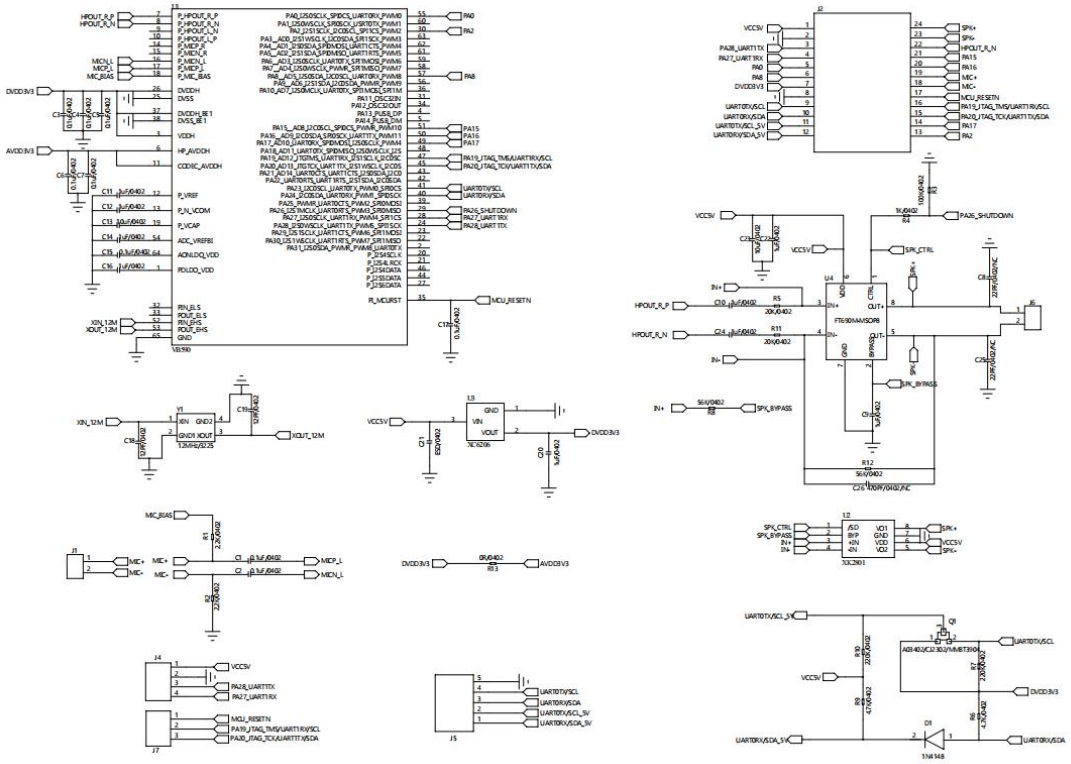


Figure 6 Module schematic

6. Design guidance

6.1. Application circuit

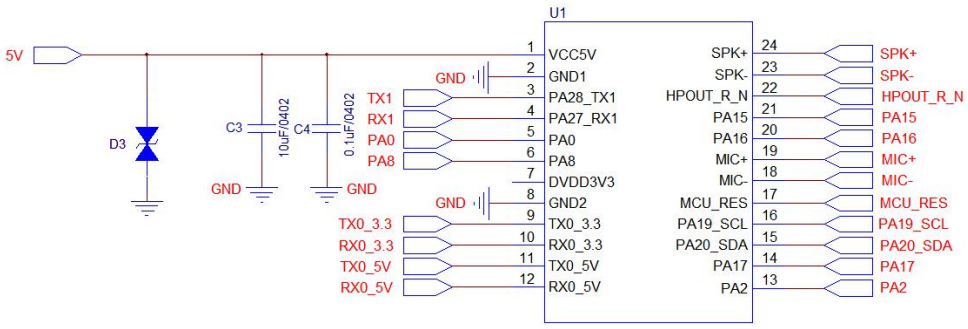


Figure 7 Application circuit schematic

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6.2. Power supply

- Recommend 5V voltage, current above 500mA
- It is recommended to use LDO for power supply; if using DC-DC, it is recommended that the ripple be controlled within 50mV.
- It is recommended to reserve the position of the dynamic response capacitor for the 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 5V power interface.

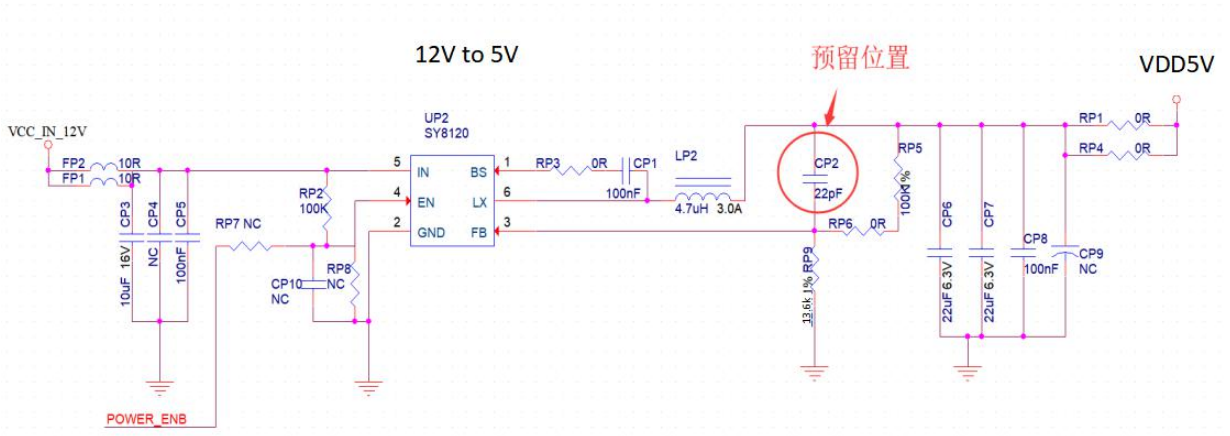


Figure 8 DC-DC Reference design drawing

6.3. GPIO

- There are some GPIO 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 port. This can suppress overshoot and make the levels on both sides more stable. It is helpful for EMI and ESD.
- For the pull-up and pull-down of special IO ports, please refer to the instructions in the specification. This will affect the startup configuration of the module.
- The IO port of the module is 3.3V. If the main control and the IO level of the module do not match, a level conversion circuit is needed.
- If the IO port is directly connected to a peripheral interface or terminal such as a header, it

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is recommended to reserve an ESD device near the terminal of the IO trace.

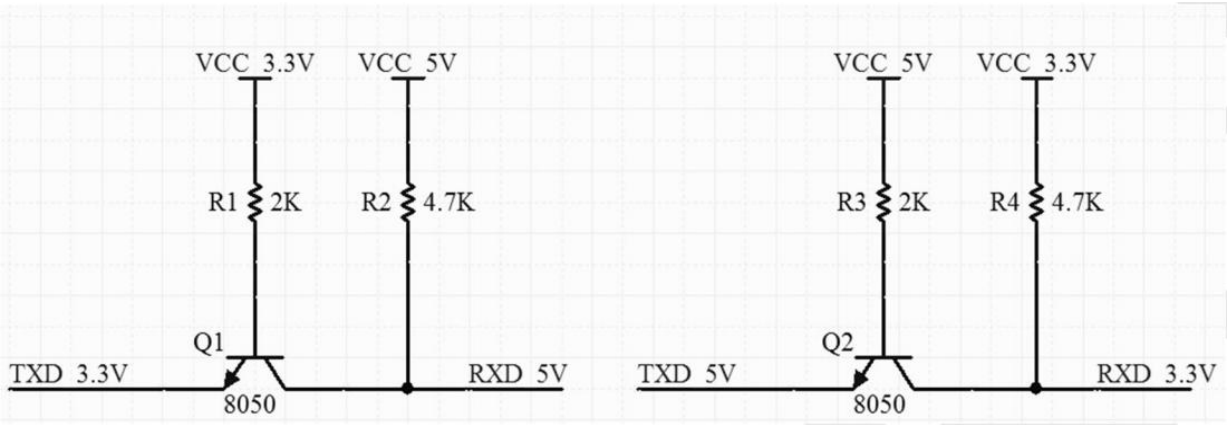


Figure 9 Level conversion circuit

6.4. Application example

- IOT transparent transmission development mode: As shown in the figure below, the offline voice module VB-01 recognizes the entry, and sends the entry recognition serial code to the IOT module through UART. The module executes the corresponding operation and reports the device update status to the Cloud to sync. In the same way, the cloud issues a control command, and after the module executes the command, it sends the entry identification serial code to the VB-01 module via UART, and plays the corresponding prompt tone.

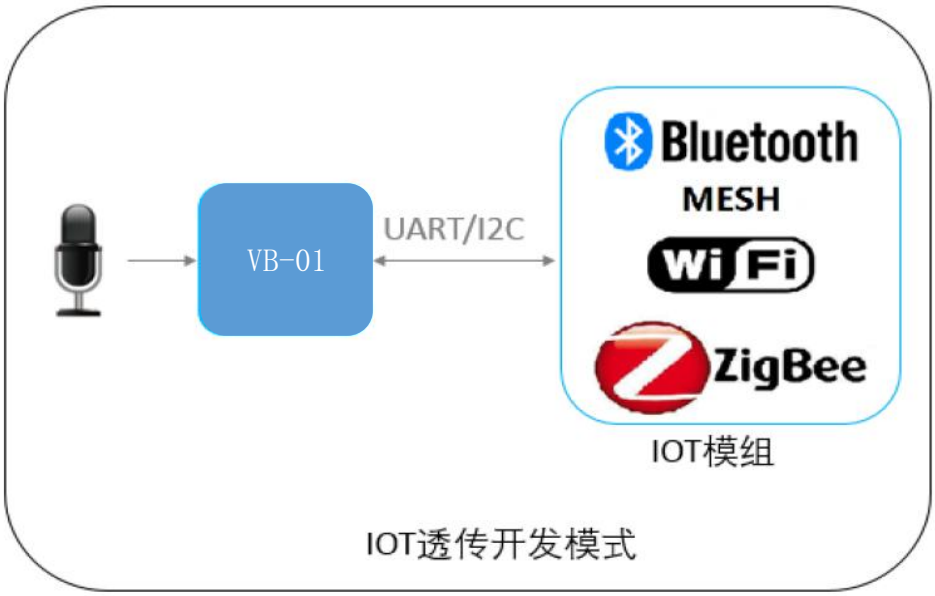


Figure 10 IOT transparent transmission development example diagram

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- Main control development mode: As shown in the figure below, the VB-01 module has peripheral drive capabilities, such as GPIO and PWM lights. The VB-01 module can be used as the main control, which can greatly reduce the cost and make the product have voice recognition at the same time And peripheral control capabilities.

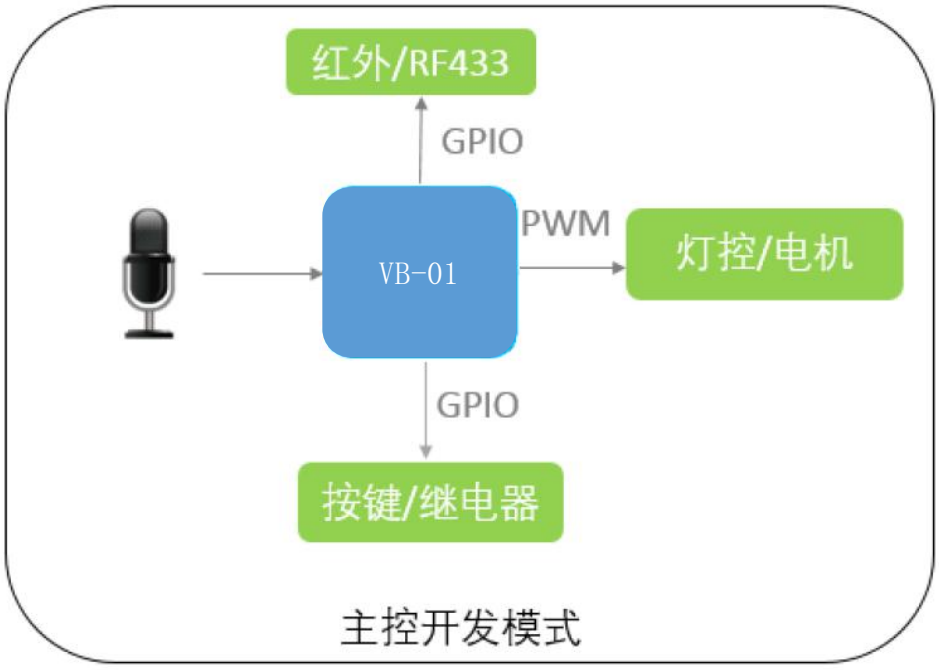


Figure 11 Sample diagram of master development mode

- Electrical transparent transmission development mode: Although the VB module has peripheral drive capabilities, there are often professional MCU hardware and integrated software in specific industries, or customers only use the original equipment for voice upgrades. This type of solution may not be suitable for the VB-01 module. Master. As shown in the figure below, it can be connected to the MCU via UART to quickly upgrade the product.

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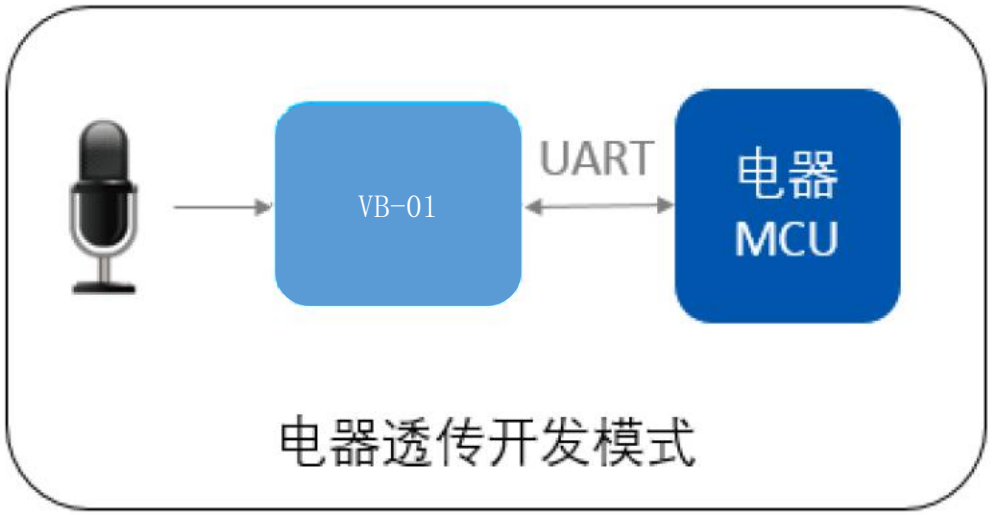


Figure 12 Electricity transparent transmission development model

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7. Reflow soldering curve

- Heating method: conventional convection or IR convection;
- Allowable reflow times: 2 times for the following reflow (conditions);
- Temperature curve: the reflow should conform to the temperature curve shown in the figure below;
- Maximum: 245°C.

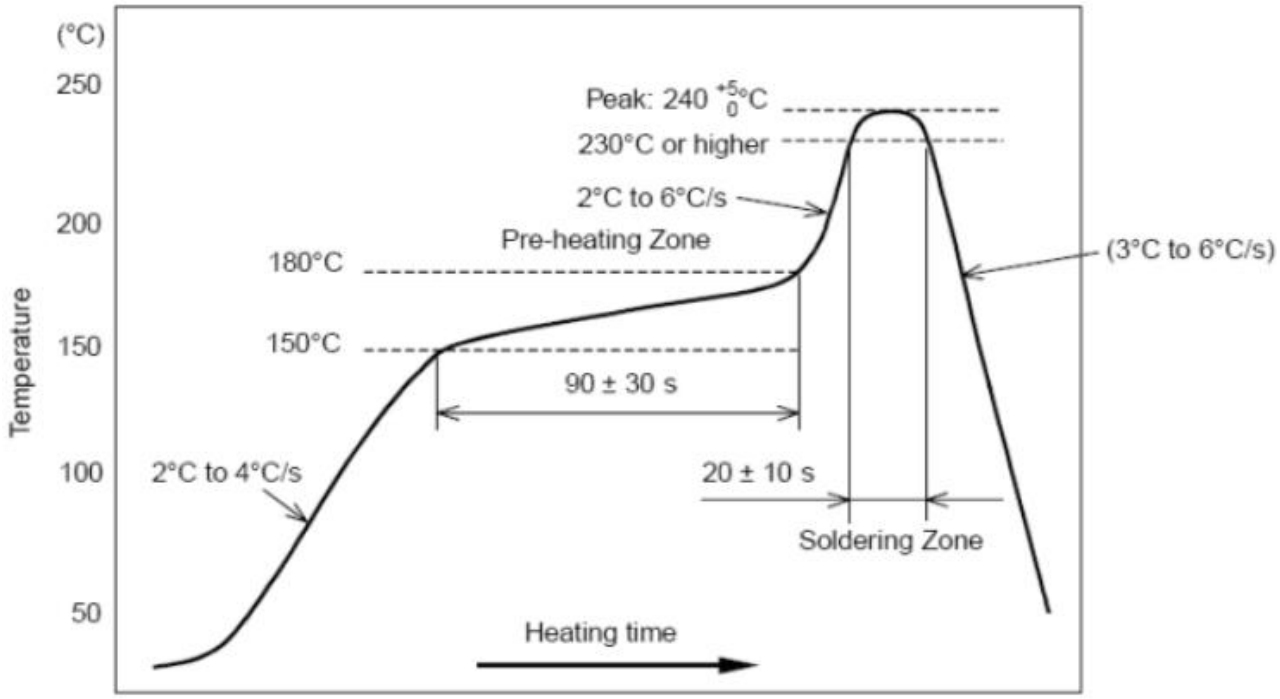


Figure 12 Reflow soldering curve

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8. Package

As shown in the figure below, the default packaging of VB-02 is taping.



Figure 13 Packaging taping diagram

9. Related models

Table 4 Related model

Model Name	Power supply	Package	Size	Default communication interface
VB-01module	5V，>500mA	SMD-24	25.5*24*3.25(±0.2)mm	UART
VB-02 module	3.3V，>400mA	SMD-20	18*17*1.7(±0.2)mm	UART
VB-01-Kit develop board	5V，>500mA	DIP-20	42*36(±0.2)mm	UART
VB-02-Kit develop board	5V，>500mA	DIP-20	42*36(±0.2)mm	UART
Product related information：https://docs.ai-thinker.com/vb				

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