



Ai-Thinker

# VB-02 Specification

Version V1.0

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### Document development/revision/revocation resume

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## 1. Product Overview

VB-02 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-02 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-02 has a wealth of peripheral interfaces, including UART/I2C/PWM, and simple and friendly secondary development tools, which are convenient for customers to implement single-module voice control application scenarios.



Figure 1 Chip architecture diagram

## 1.1. Characteristics

### ■ Key technical indicators

- Adjustable recognition distance: support 5 meters recognition distance<sup>1</sup>
- 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%<sup>2</sup>
- Recognition time is less than 100 ms
- Low misjudgment rate
- Up to 50 entries

## ■ 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 35dB. Excessive environmental noise or the use of low-sensitivity

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

Table1 Main parameter description

<b>Model Name</b>	VB-02
<b>Package</b>	SMD-20
<b>Size</b>	18*17*1.7(±0.2)mm
<b>Operating Temperature</b>	-40 °C ~ 85 °C
<b>Store Temperature</b>	-40 °C ~ 125 °C , < 90%RH
<b>Power supply range</b>	Power supply voltage 3.3V, power supply current>400mA
<b>Support Interface</b>	UART/I2C/PWM/JTAG/GPIO
<b>UART Rate</b>	Default 115200 bps
<b>SPI Flash</b>	2MB (Built-in)



## 2.2. Electrical parameters

**Table 2 Electrical parameter description**

parameter	Test Conditions	Min	Typical value	max	Unit
Operating Voltage	normal work	2.97	3.3	3.63	V
Operating mode	Port VDD33 power supply current		60	85	mA
Monitor mode	Port VDD33 power supply current		20		mA
Standby mode	Port VDD33 power supply current	/	5		uA
<b>DAC Line Out (10KΩ Load)</b>					
Full-scale output level	0dB gain	1.89	2.12	2.39	V <sub>pp</sub>
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		-2 5		+6	dB
Frequency response	Passband			0.42*Fs	Hz
	Passband Ripple			+/-0.1	dB
Power supply noise rejection ratio	1kHz, 100mV <sub>pp</sub>		90		dB
<b>ADC MIC Input (Differential input)</b>					
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

MIC Bias Voltage			2.08		V
MIC Bias Current				4	mA

VB-02 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

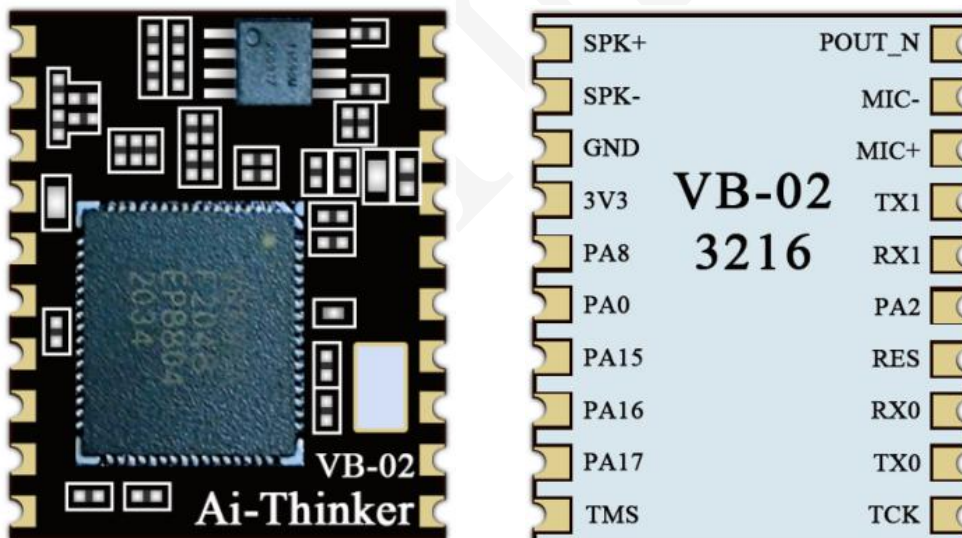
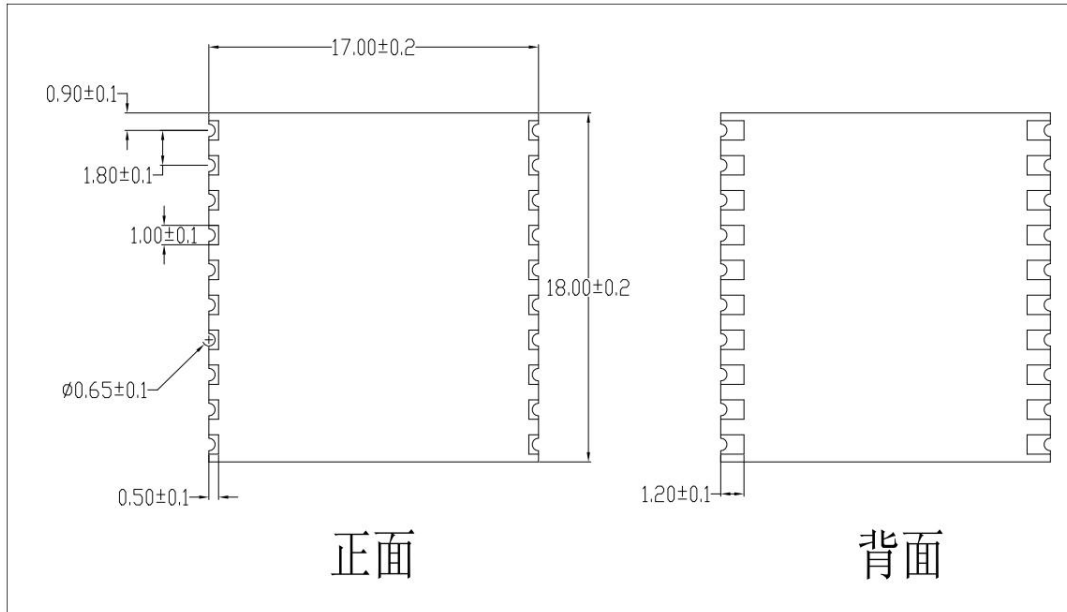


Figure 3 VB-02 Appearance dimensions (For reference only)

### 3.2. Dimensions



### 4. Pin definition

VB-02 module is connected to 20 interfaces, refer to pin diagram, pin function definition table is interface definition.

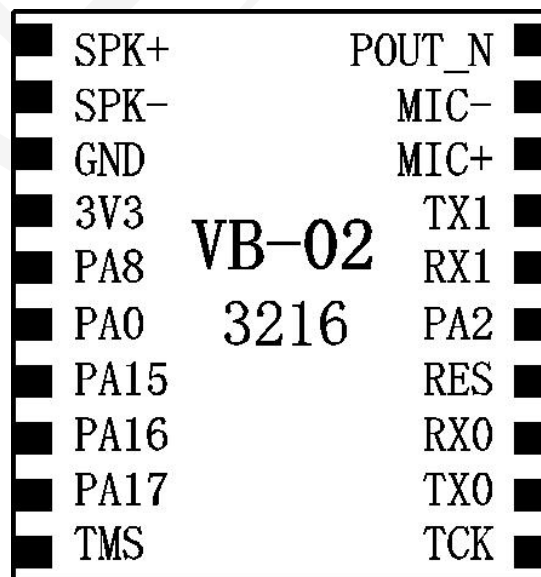


Figure 5 VB-02 (SMD-20) Pin diagram

(For reference only)

**Table 3 Pin function definition**

No.	Name	Function
1	POUT_N	Audio R channel output
2	MIC-	AMIC- input
3	MIC+	AMIC+input
4	TX1	A28/TX1 UART1 TXD
5	RX1	A27/RX1 UART1 RXD
6	PA2	IO/3.3V level /PWM_CH2
7	RES	RESET reset active low
8	RX0	A24/RX UART0 RXD
9	TX0	A23/TX UART0 TXD
10	TCK	A20/TCLK JTAG_TCK
11	SPK+	SPK+ 8 ohm 2w
12	SPK-	SPK- 8 ohm 2w
13	GND	GND Digitally
14	3V3	3.3V power input
15	PA8	IO/3.3V Level/PWM_CH8
16	PA0	IO/3.3V Level/PWM_CH0
17	PA15	IO/3.3V Level/IICO_SCL
18	PA16	IO/3.3V Level/IICO_SDA
19	PA17	IO/3.3V Level/PWM_CH10
20	TMS	A19/TMS JTAG_TMS

## 5. Schematic

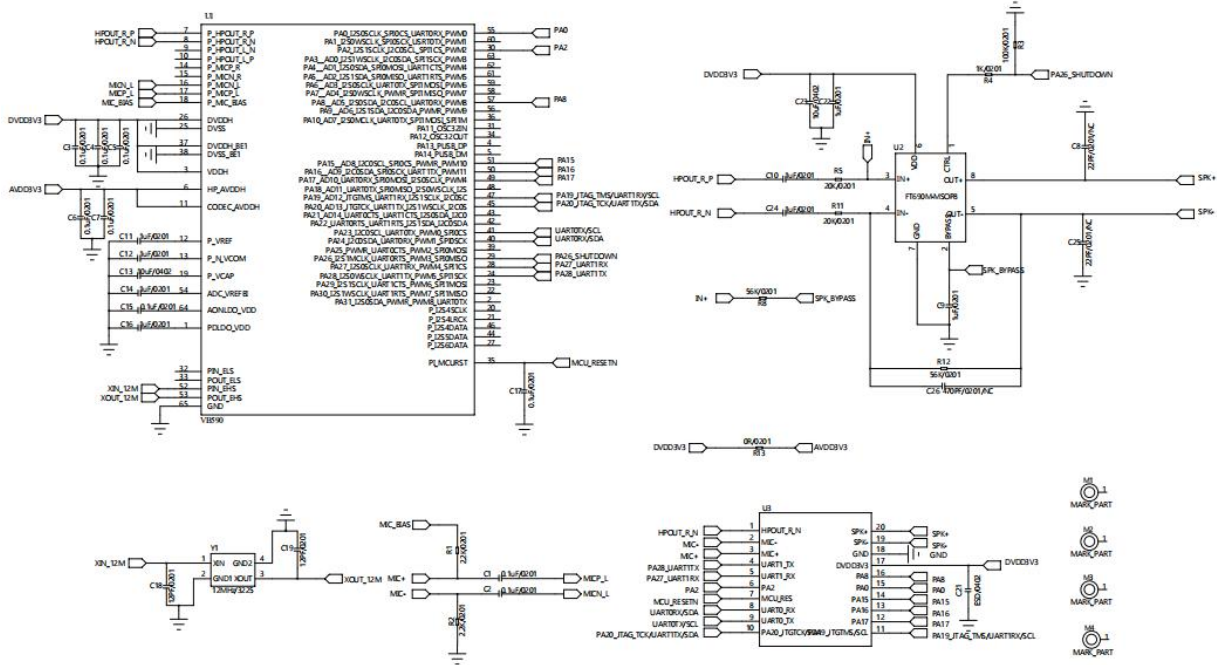


Figure 6 Module schematic diagram

## 6. Design guidance

### 6.1. Application circuit

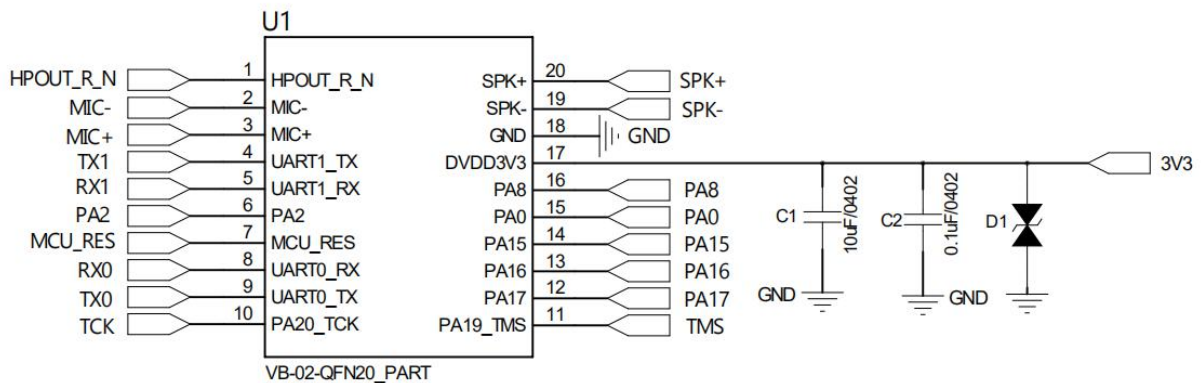


Figure 7 Application circuit schematic

## 6.2. Power supply

- Recommend 3.3V voltage, current above 400mA
- 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 3.3V power interface.

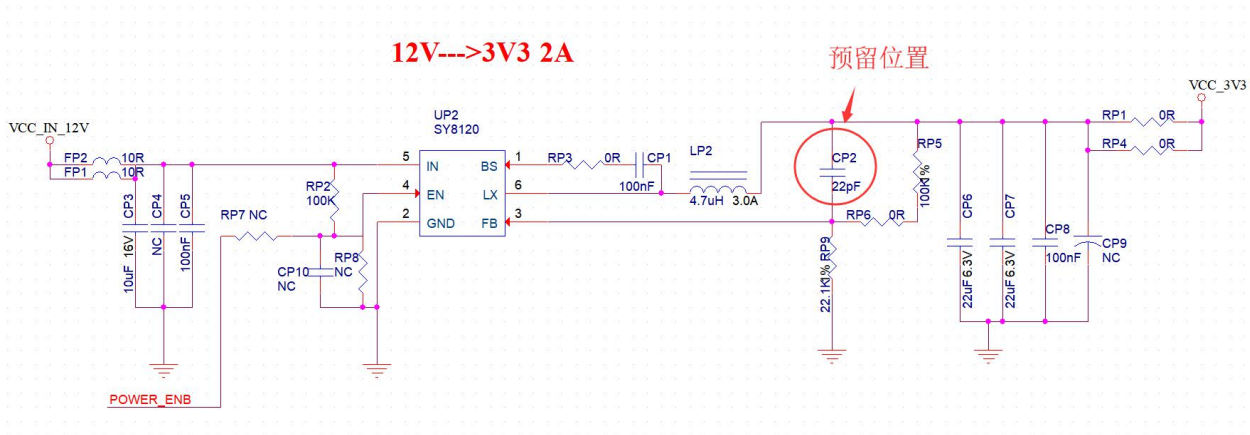


Figure 8 DC-DC Reference design drawing

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

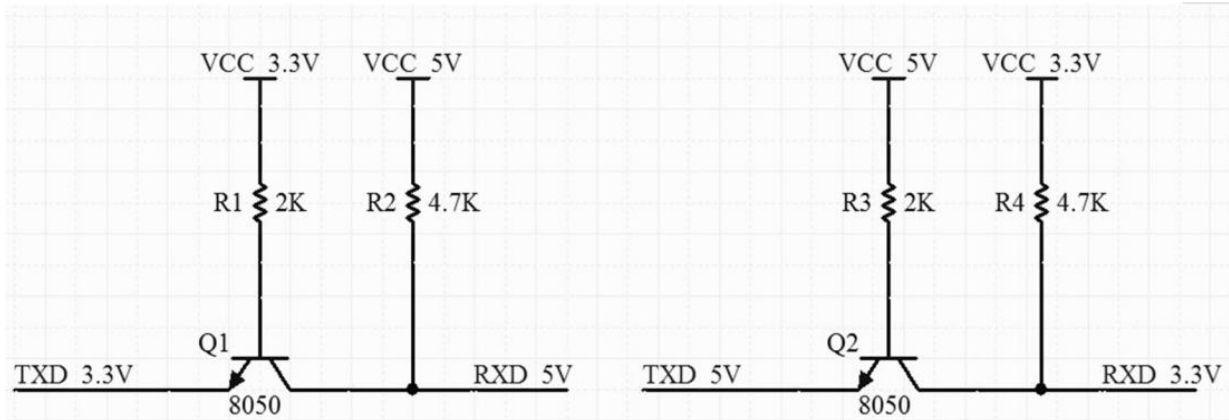


Figure 9 Level conversion circuit

## 6.4. Application example

- IOT transparent transmission development mode: As shown in the figure below, the offline voice module VB-02 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 update status of the device at the same time. Cloud to sync. In the same way, the cloud sends a control command. After the module executes the command, it sends the entry identification serial code to the VB-02 module via UART, and plays the corresponding prompt tone.

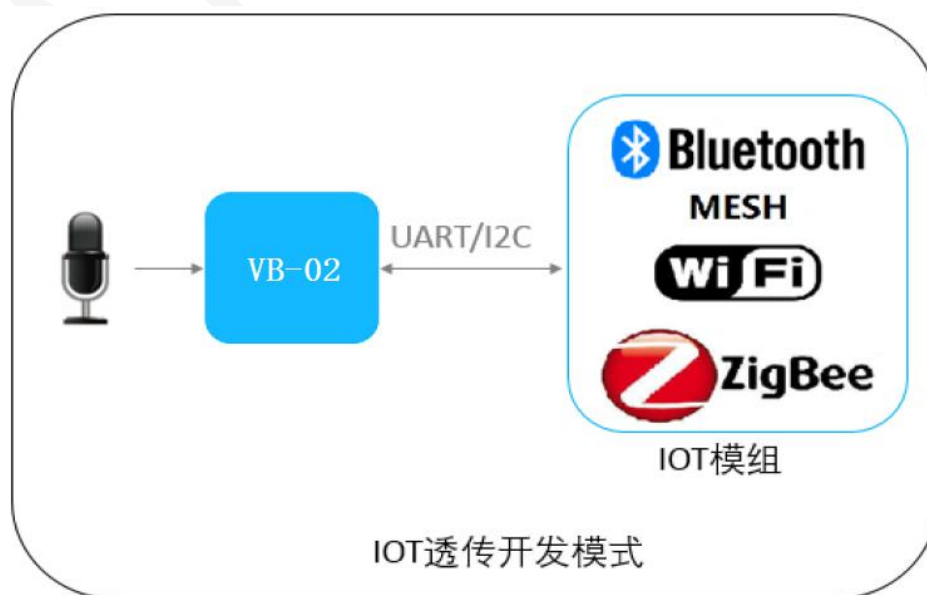


Figure 10 IOT Transparent transmission development example diagram

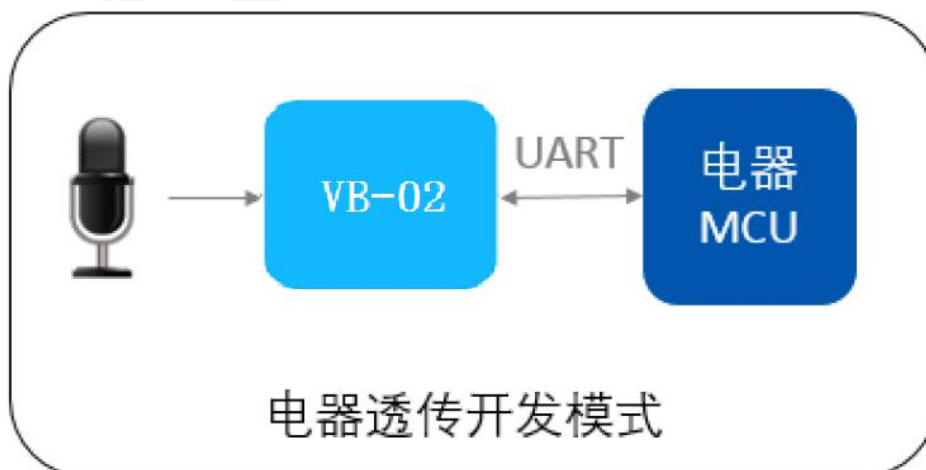


- Main control development mode: As shown in the figure below, the VB-02 module has peripheral drive capabilities, such as GPIO and PWM lights. The VB-02 module can be used as the main control. This can greatly reduce the cost and make the product have both voice recognition and Peripheral control capability.



**Figure 11 Sample diagram of master development mode**

- Electrical transparent transmission development model: Although VB modules have peripheral drive capabilities, there are often professional MCU hardware and integrated software in specific industries, or customers only make voice upgrades based on the original equipment. This type of solution may not be applicable to the VB-02 module As the master. As shown in the figure below, it can be connected to the MCU via UART to quickly upgrade the product.



**Figure 12 Electricity transparent transmission development model**

## 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.

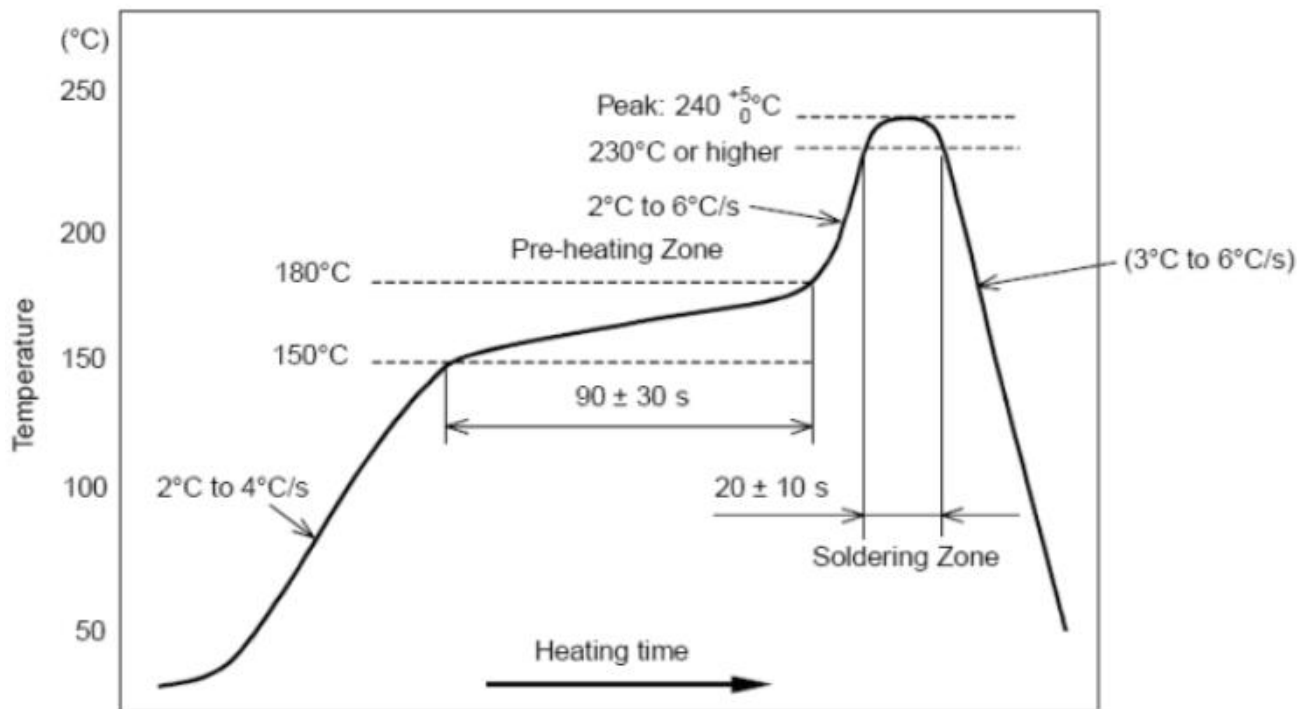
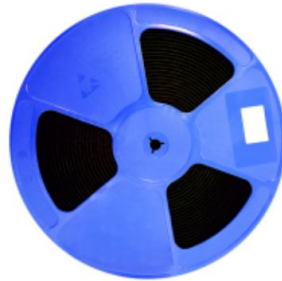


Figure 12 Reflow soldering curve

## 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 models**

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>

## 10. Contact us

Official website: <https://www.ai-thinker.com>

Development DOCS: <https://docs.ai-thinker.com>

Official Forum: <http://bbs.ai-thinker.com>

Sample purchase: <https://ai-thinker.en.alibaba.com/>

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