



# PB-03 Specification

Version V1.0.0

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## Document resume

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## 1. Product Overview

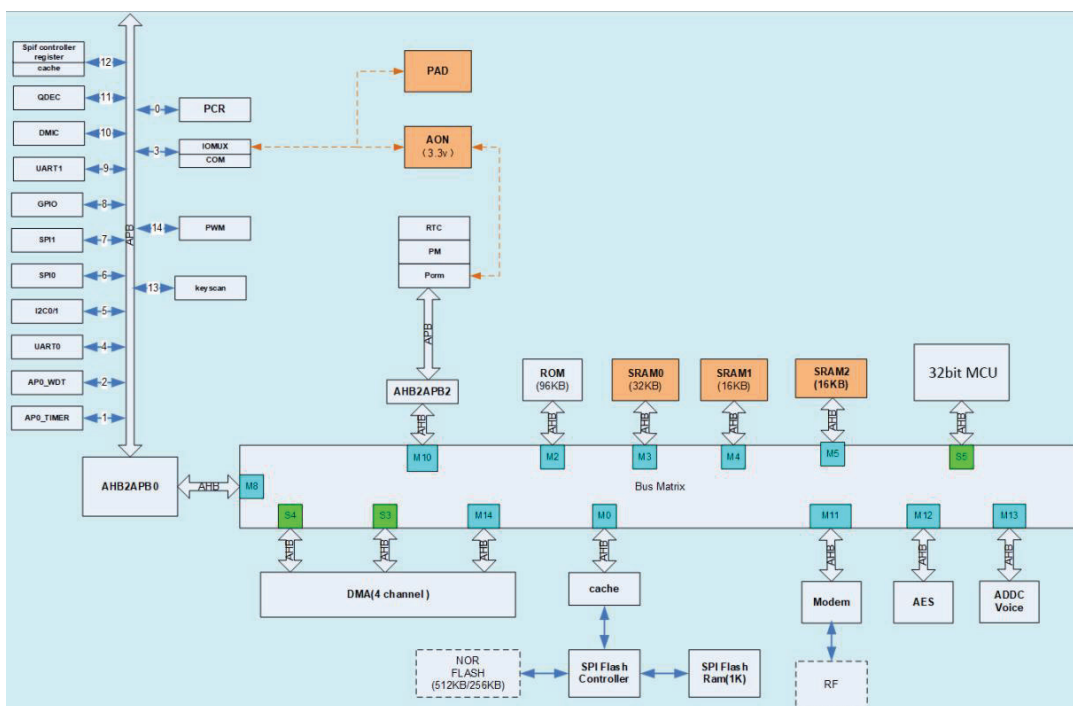
PB-03 is a BLE module developed by Shenzhen Ai-Thinker Technology Co.,Ltd.The core processor chip PHY6252(SSOP24)of this module is a BLE SoC with high integration and low power consumption,which is specially designed for various applications such as IoT,mobile devices,wearable electronic devices and smart homes.

PHY6252(SSOP24)chip has industry-leading low power consumption performance and RF performance,it supports BLE 5.2.The chip built in 64 KB SRAM,256KB flash,96 KB ROM,256bit efuse.The chip supports a variety of low-power working states and can meet the power consumption requirements of various application scenarios.RF output power can be adjusted to achieve the best balance among communication distance,communication rate and power consumption.

PB-03 module provide rich peripheral interfaces,including UART,PWM,ADC,I2C,SPI,PDM,DMA and up to 19 IOs.

PB-03 module has many unique hardware security mechanisms.Hardware encryption accelerator supports AES algorithm.

PB-03 module supports BLE with low power consumption:BLE 5.2 and BLE mesh.Bluetooth rate support:125Kbps,500Kbps,1Mbps,2Mbps.Support broadcast expansion,multi-broadcast,channel selection.



**Figure 1 Main chip architecture diagram**

## 1.1. Characteristic

- Support BLE5.2,rate support:125Kbps,500Kbps,1Mbps,2Mbps
- Own 64 KB SRAM管256KB flash,96 KB ROM管256bit efuse
- Support UART/GPIO/ADC/PWM/I2C/SPI/PDM/DMA interface
- Adopt SMD-52 package
- Support multiple sleep modes,deep sleep current is less than 1uA
- Support for serial local upgrade and remote Firmware upgrade(FOTA)
- Universal AT instructions can be used easy and quickly
- Support for secondary development,with an integrated Windows development environment

## 2. Main parameters

**Table 1 Description of the main parameters**

|                              |                                       |
|------------------------------|---------------------------------------|
| <b>Model</b>                 | PB-03                                 |
| <b>Package</b>               | SMD-52                                |
| <b>Size</b>                  | 16.6*13.2*2.8(±0.2)mm                 |
| <b>Antenna</b>               | On-board antenna                      |
| <b>Frequency</b>             | 2400~2483.5MHz                        |
| <b>Operating temperature</b> | -40°C~85°C                            |
| <b>Storage temperature</b>   | -40°C~125°C,<90%RH                    |
| <b>Power supply</b>          | Voltage 2.7V~3.6V,Current>200mA       |
| <b>Interface</b>             | UART/GPIO/ADC/PWM/I2C/I2S/SPI/PDM/DMA |
| <b>IO</b>                    | 19                                    |
| <b>UART rate</b>             | Default 115200 bps                    |
| <b>Bluetooth</b>             | BLE 5.2                               |
| <b>Security</b>              | AES-128                               |
| <b>SPI Flash</b>             | 256KB                                 |

## 2.1. Static electricity requirements

PB-03 is an electrostatic sensitive device, and special precautions must be taken when handling it.



Figure 2 ESD anti-static diagram

## 2.2. Electrical characteristics

Table 2 Electrical characteristics table

| Parameters           |                 | Conditions | Min.             | Typical value | Max.                | Unit |
|----------------------|-----------------|------------|------------------|---------------|---------------------|------|
| Power supply voltage |                 | VDD        | 2.7              | 3.3           | 3.6                 | V    |
| I/O                  | $V_{IL}/V_{IH}$ | -          | -0.3/0.75V<br>DD | -             | 0.25VDD/VDD<br>+0.3 | V    |
|                      | $V_{OL}/V_{OH}$ | -          | N/0.8VIO         | -             | 0.1VIO/N            | V    |
|                      | $I_{MAX}$       | -          | -                | -             | 12                  | mA   |

## 2.3. BLE RF performance

Table 3 BLE RF performance table

| Description           | Typical values |               |      | Unit |
|-----------------------|----------------|---------------|------|------|
| Operating frequency   | 2400-2483.5    |               |      | MHz  |
| Output power          |                |               |      |      |
| Mode                  | Min.           | typical value | Max. | Unit |
| BLE 2Mbps             | -20            | 8             | 10   | dBm  |
| BLE 1Mbps             | -20            | 8             | 10   | dBm  |
| BLE 500Kbps           | -20            | 8             | 10   | dBm  |
| BLE 125kbps           | -20            | 8             | 10   | dBm  |
| Receiving sensitivity |                |               |      |      |
| Mode                  | Min.           | typical value | Max. | Unit |

|             |   |      |   |     |
|-------------|---|------|---|-----|
| BLE 2Mbps   | - | -93  | - | dBm |
| BLE 1Mbps   | - | -96  | - | dBm |
| BLE 500Kbps | - | -97  | - | dBm |
| BLE 125Kbps | - | -102 | - | dBm |

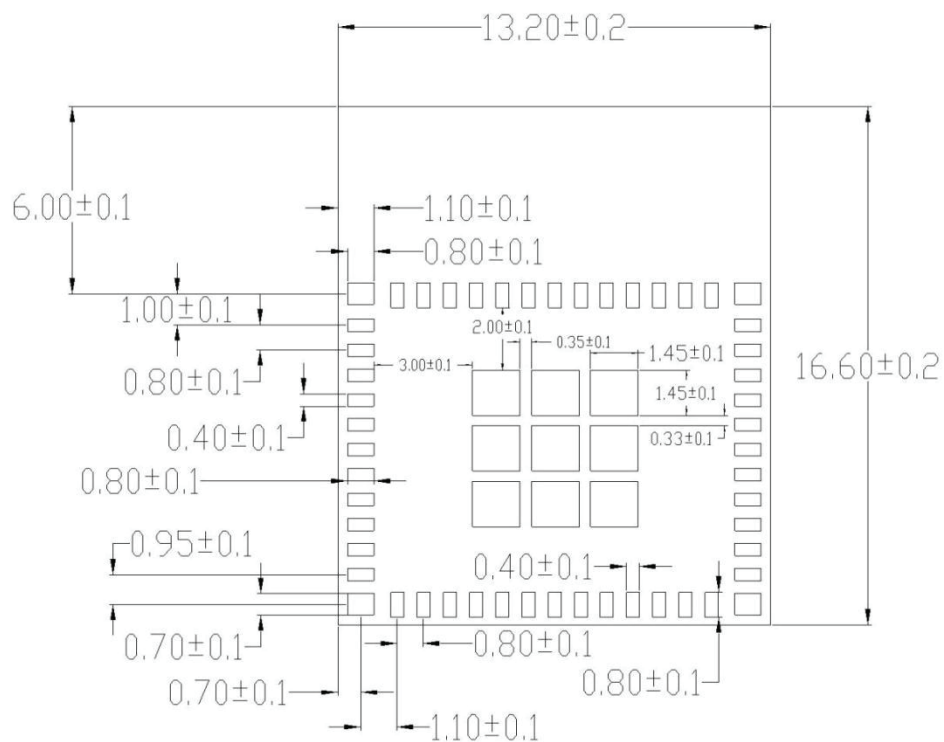
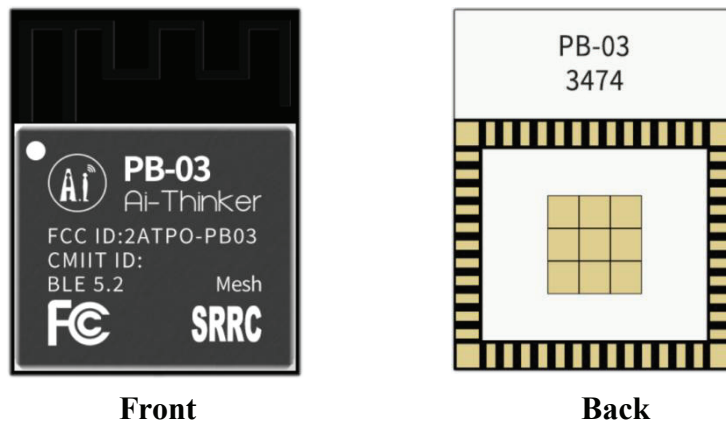
## 2.4. Power consumption

The following power consumption data are based on a 3.3V power supply, ambient temperature of 25°C and measured using an internal regulator.

- All measurements were completed without the SAW filter at the antenna interface.
- All emission data were measured based on the TX\_Burst\_Test&RX\_Burst\_Test mode

**Table 4 Power consumption table**

| Mode                                          | Min. | Average value | Max. | Unit |
|-----------------------------------------------|------|---------------|------|------|
| TX_Burst_Test Power output 8dBm               | -    | 11.5          | -    | mA   |
| TX_Burst_Test Power output 5dBm               | -    | 9             | -    | mA   |
| TX_Burst_Test Power output 0dBm               | -    | 8             | -    | mA   |
| RX_Burst_Test                                 | -    | 9.4           | -    | mA   |
| Deep Sleep(With broadcast,1 second interval)  | -    | 50.58         | -    | uA   |
| Deep Sleep(With broadcast,2 seconds interval) | -    | 28.25         | -    | uA   |
| Deep Sleep(Without broadcast)                 | -    | 7.2           | -    | uA   |
| Power Off                                     | -    | 0.57          | -    | uA   |





## 4. Pin definition

PB-03 has a total of 61 interfaces. As shown in below pin diagram, the pin function definition table is the interface definition.

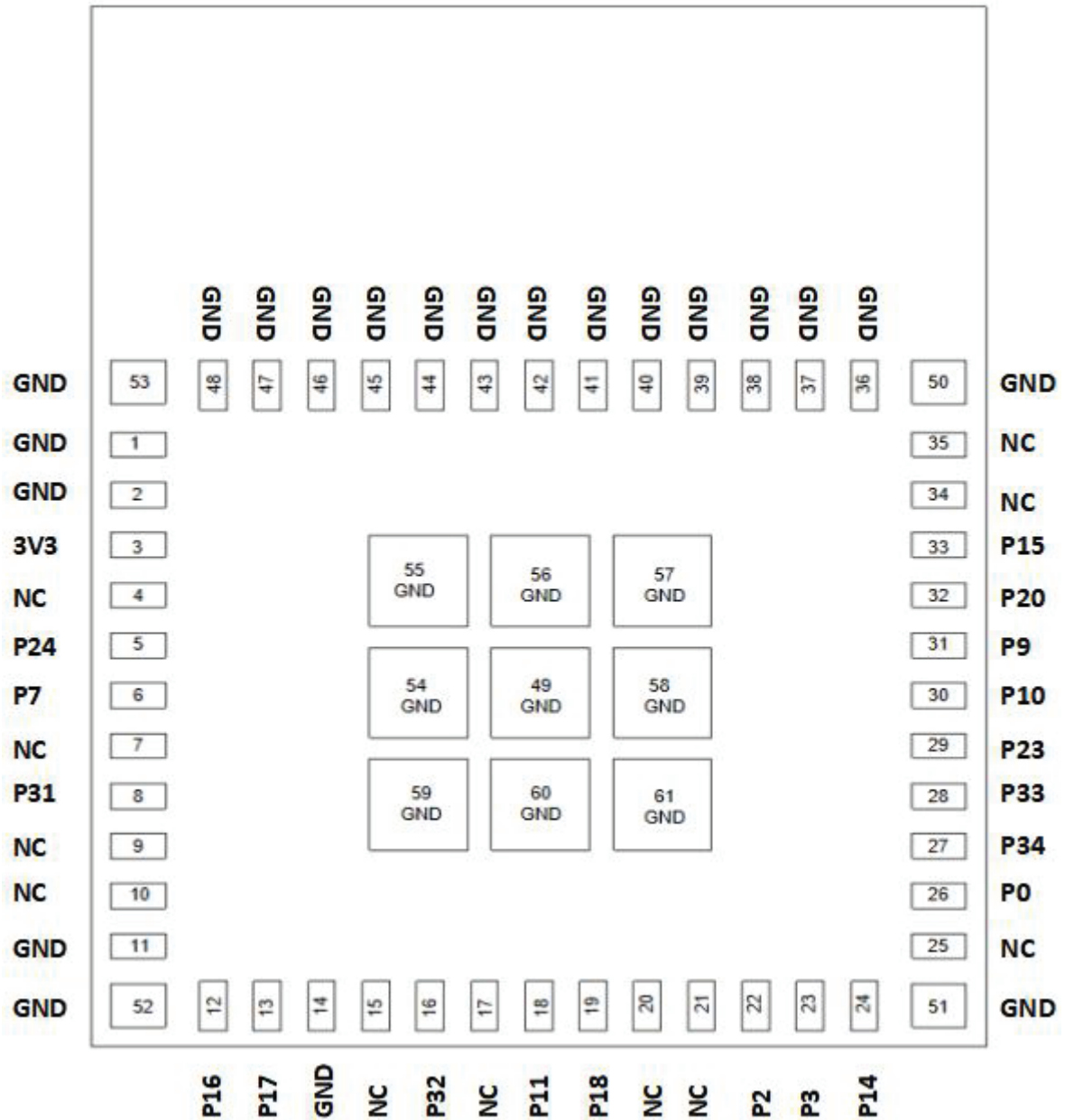
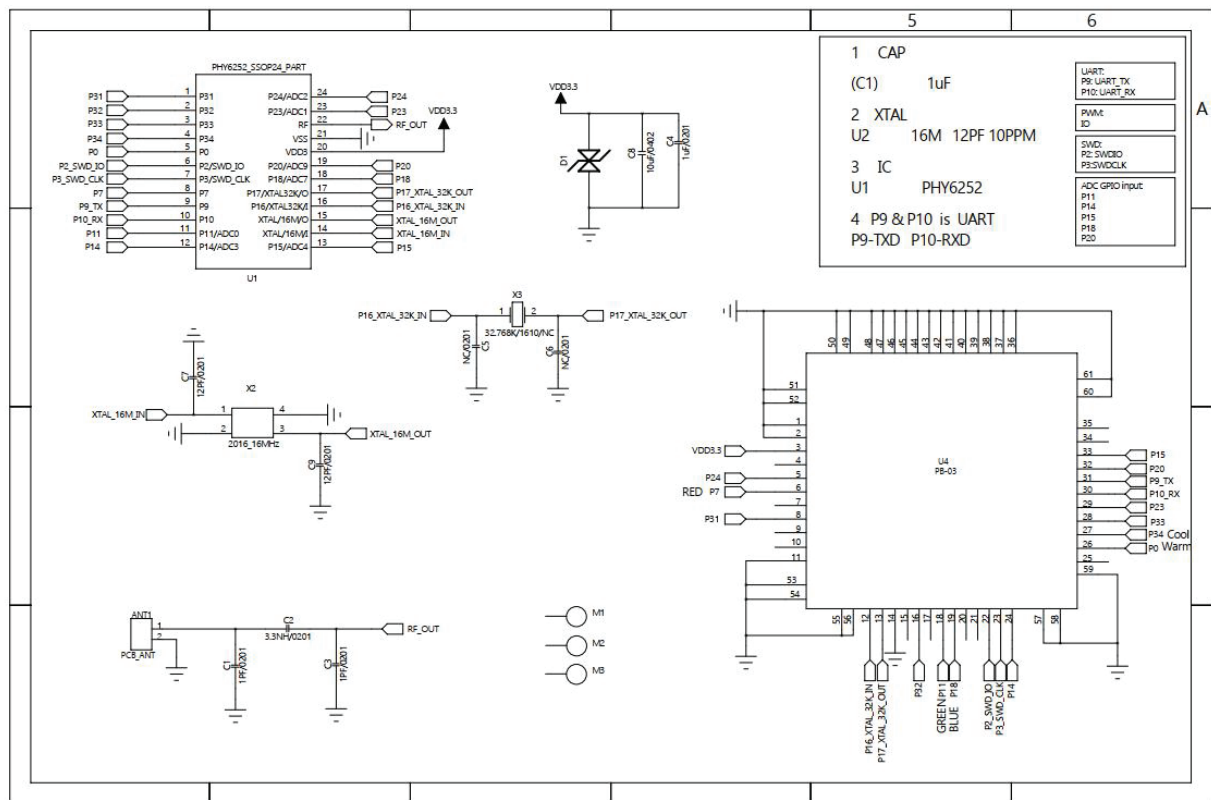


Figure 5 Schematic diagram of module pins(top view)

**Table 6 Pin function definition table**

| No.                           | Name | Function                              |
|-------------------------------|------|---------------------------------------|
| 1,2,11,14,<br>36-48,50-53     | GND  | Ground(Power negative electrode)      |
| 3                             | 3V3  | Power supply positive electrode       |
| 4,7,9,10,15,17,20,21,25,34,35 | NC   | Empty                                 |
| 5                             | P24  | GPIO24/ADC input 2                    |
| 6                             | P7   | GPIO7                                 |
| 8                             | P31  | GPIO31                                |
| 12                            | P16  | GPIO16/32.768KHz crystal input        |
| 13                            | P17  | GPIO17/32.768KHz crystal output       |
| 16                            | P32  | GPIO32                                |
| 18                            | P11  | GPIO11/ADC input 0                    |
| 19                            | P18  | GPIO18/ADC input 7/PGA negative input |
| 22                            | P2   | GPIO2/SWD debug data inout            |
| 23                            | P3   | GPIO3/SWD debug clock                 |
| 24                            | P14  | GPIO14/ADC input 3                    |
| 26                            | P0   | GPIO0                                 |
| 27                            | P34  | GPIO34                                |
| 28                            | P33  | GPIO33                                |
| 29                            | P23  | GPIO23/ADC input 1/micbias reference  |
| 30                            | P10  | RXD/GPIO10                            |
| 31                            | P9   | TXD/GPIO9                             |
| 32                            | P20  | GPIO20/ADC input 9/PGA positive input |
| 33                            | P15  | GPIO15/ADC input 4/micbias output     |

## 5. Schematic



**Figure 6 Module schematic**

## 6. Antenna parameters

### 6.1. Test conditions for the antenna



**Figure 7 Antenna test conditions**

## 6.2. Antenna S parameter

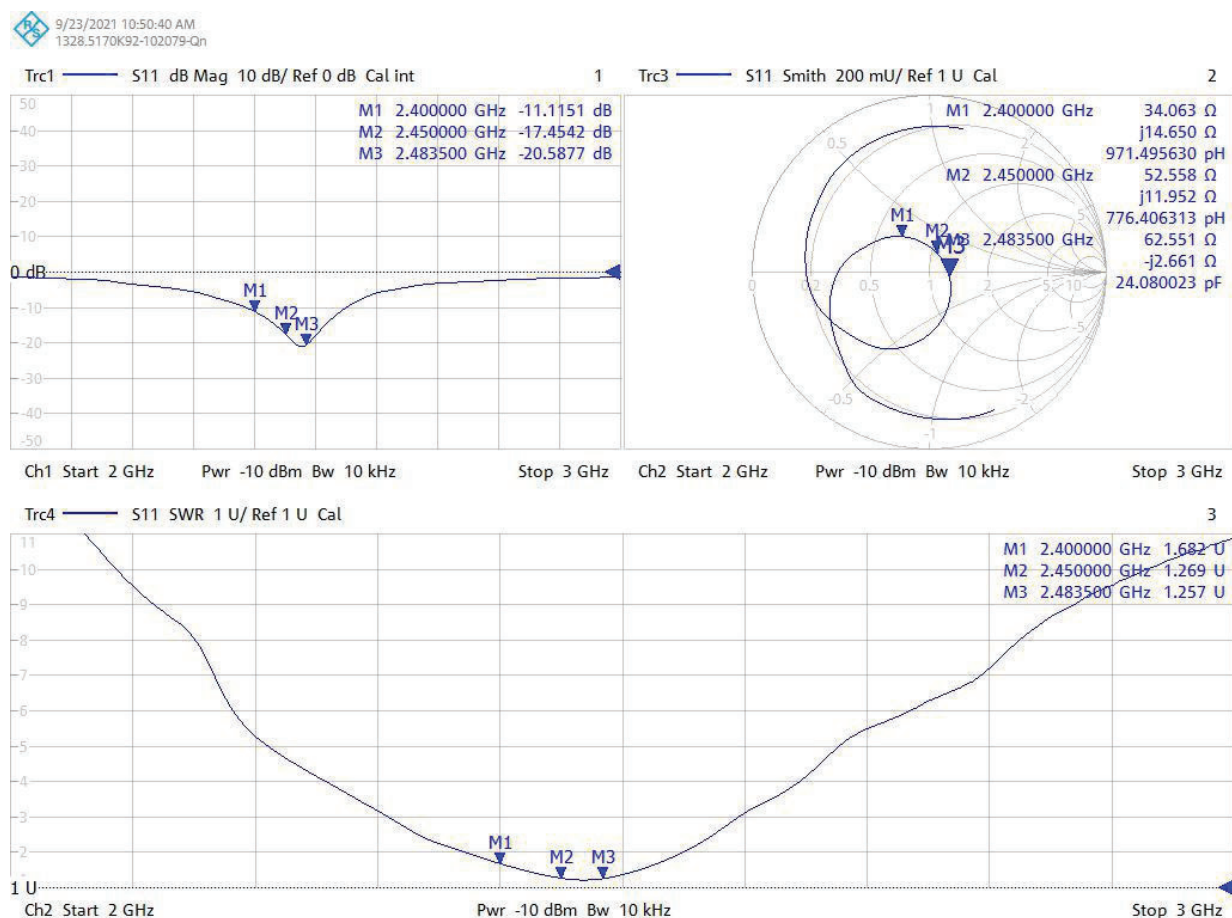


Figure 8 Antenna S parameters

## 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)      | 1.89   | 1.98   | 1.86   | 1.95   | 1.98   | 2.04   | 2.06   | 1.98   | 1.83   | 1.75   | 1.63   |
| Efficiency(%)  | 60.23  | 61.27  | 59.41  | 60.36  | 59.85  | 59.53  | 59.10  | 57.85  | 56.20  | 55.85  | 54.62  |



## 6.4. Antenna field type diagram

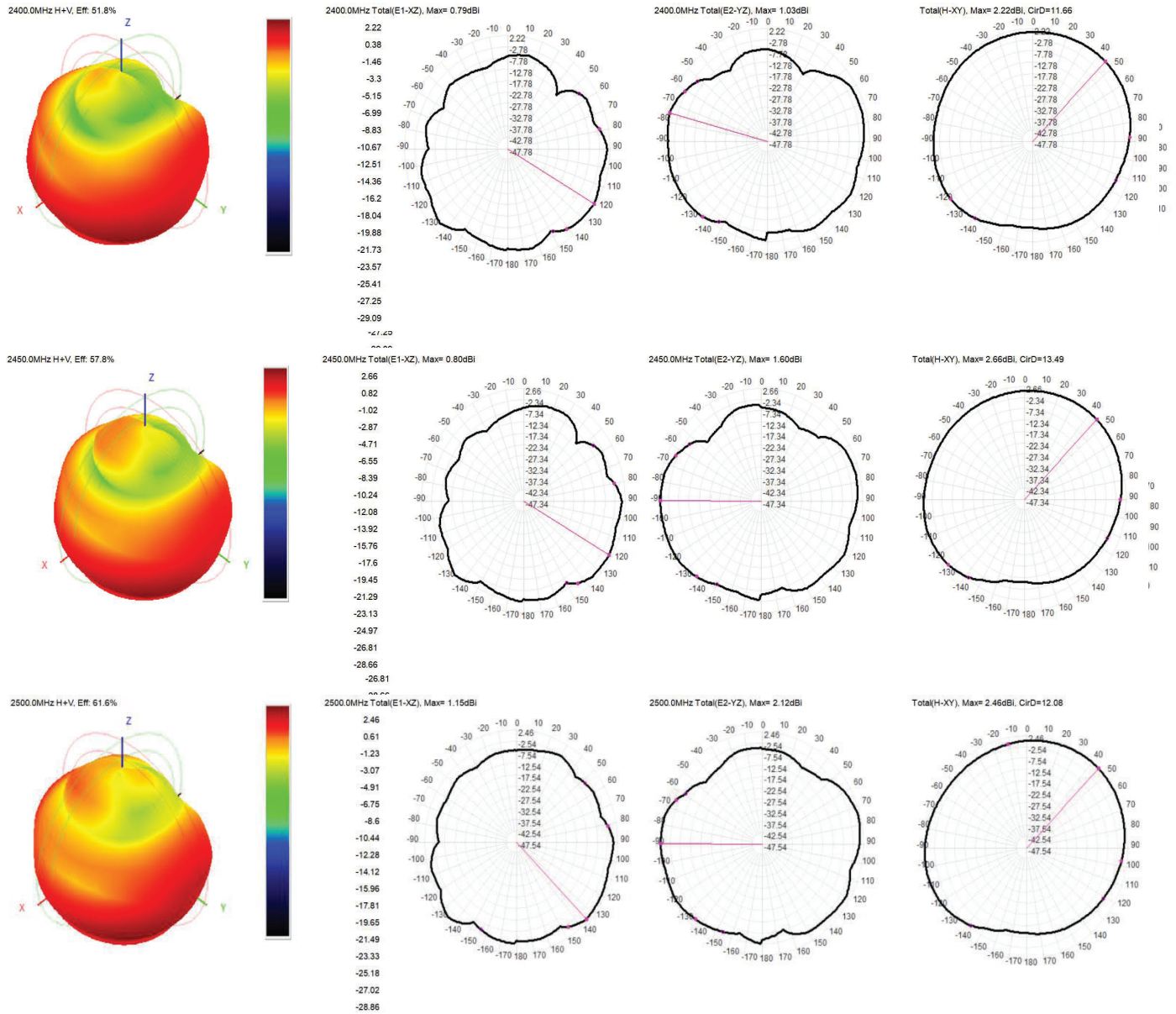
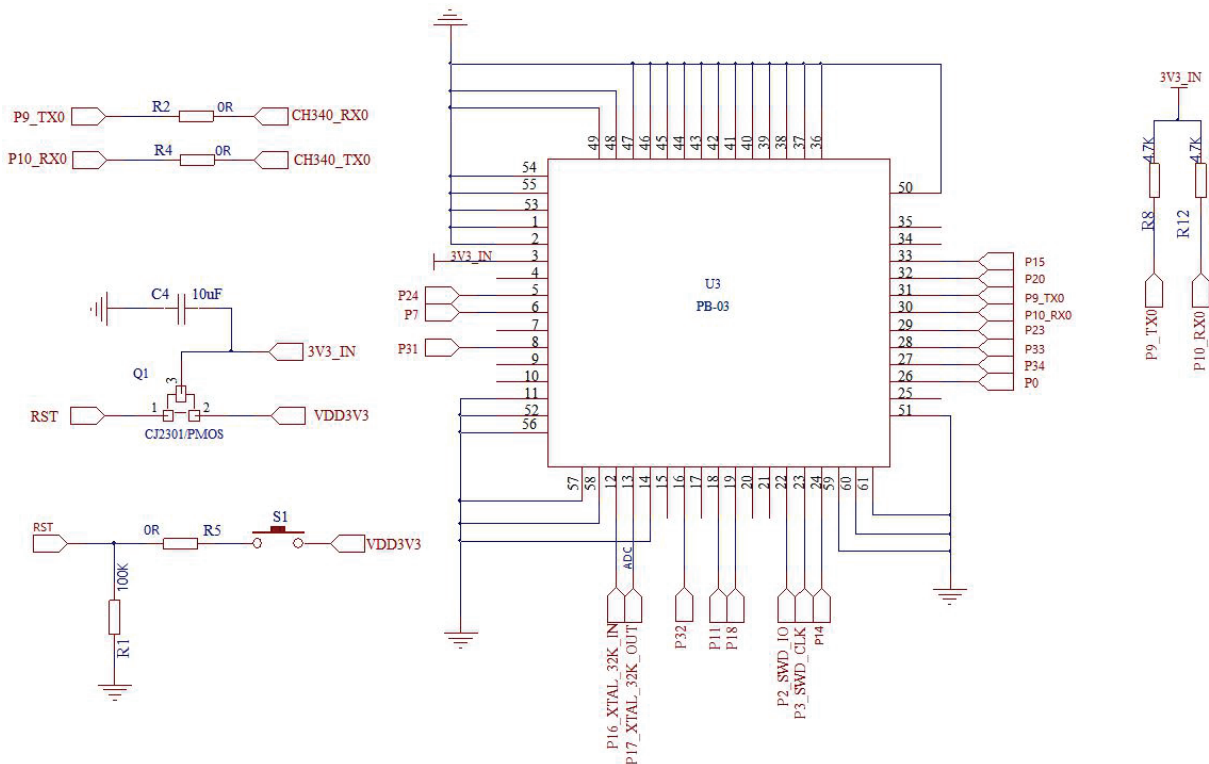


Figure 9 Antenna field type diagram

## 7. Design guidance

### 7.1. Module application circuit

( $\geq 200\text{mA}$ , suggest use DC-DC or LDO independent power supply)



**Figure 10 Application circuit diagram**

Note:

- Because the PB-03M does not have the reset pin, we can achieve the reduction by power off, we can restore the module with a PMOS to achieve the reduction of power off.
- TX&RX serial port line, 2 resistors are reserved, in series in the line. The 3.3V voltage used to prevent the serial port affects the reset of the module.

## 7.2. Antenna layout requirements

- The installation position on the motherboard suggests the following 2 ways:

Scheme 1: Put the module on the edge of the motherboard, and the antenna area out of the motherboard edge

Scheme 2: Put the module on the edge of the motherboard, and empty an area along the antenna position.

- To meet the performance of the on-board antenna, metal parts are not placed around the antenna, away from the high-frequency device

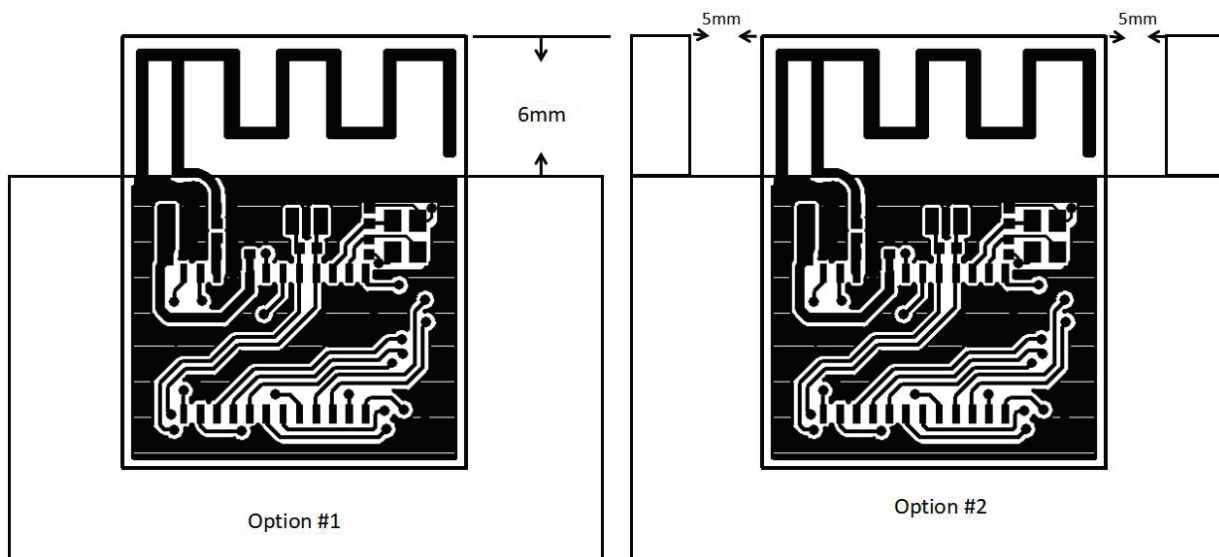
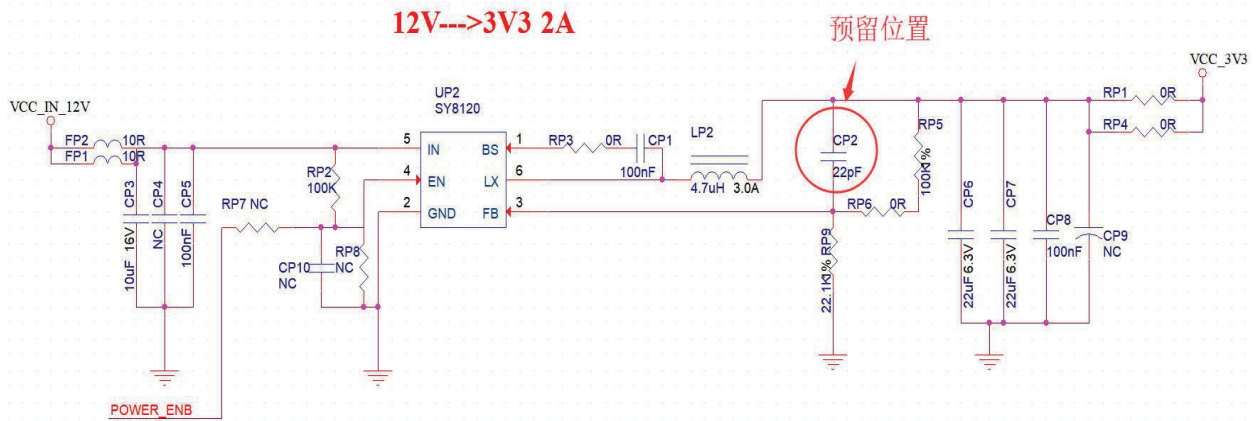


Figure 11 Schematic diagram of the antenna layout

## 7.3. Power supply

- Recommended 3.3V voltage, peak current over 200mA.
- Power supply is recommend to use LDO; If the DC-DC is used, the ripple is recommended to be controlled within 30mV
- The DC-DC power supply circuit proposes to reserve the dynamic response capacitance to optimize the output ripple with large load changes.
- 3.3V power interface it is recommended to add ESD devices.

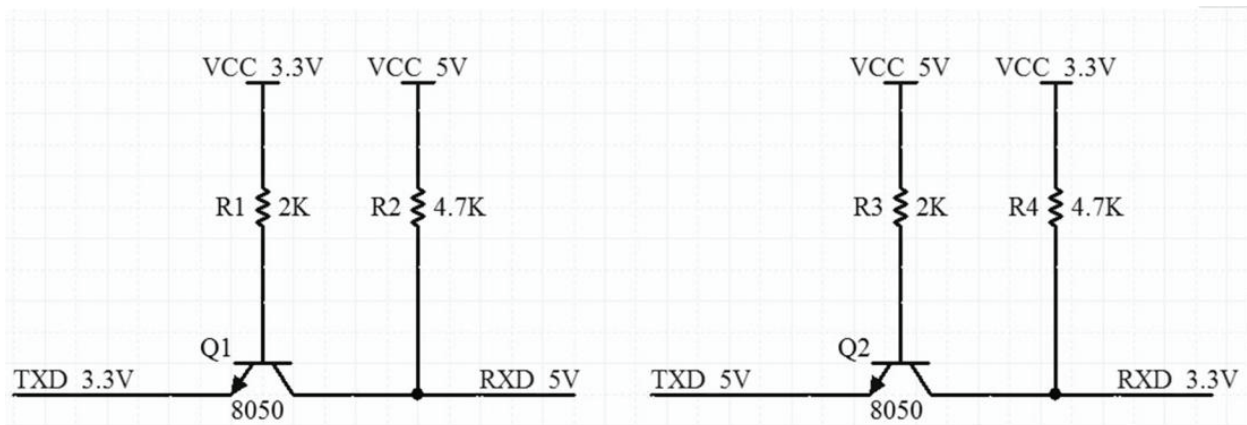




**Figure 12 The DC-D C antihypertensive circuit diagram**

## 7.4. GPIO

- Some IO ports are lead outside the module,if using,a proposed resistance of 10-100 ohms on the IO port.This suppresses the overshoot and enables smoother levels on both sides,helping for both EMI and ESD.
- The up and down of the special IO port should refer to the use instructions of the specification,which will affect the start-up configuration of the module.
- The IO port of the module is 3.3V,if the main control does not match the IO port level of the module,the level conversion circuit should be increased.
- If the IO port is directly connected to the peripheral interface,or terminals such as pin header,it is recommended to reserve ESD devices at the IO port line near the terminal.



**Figure 13 Level convert circuit**

## 8. Flow welding curve diagram

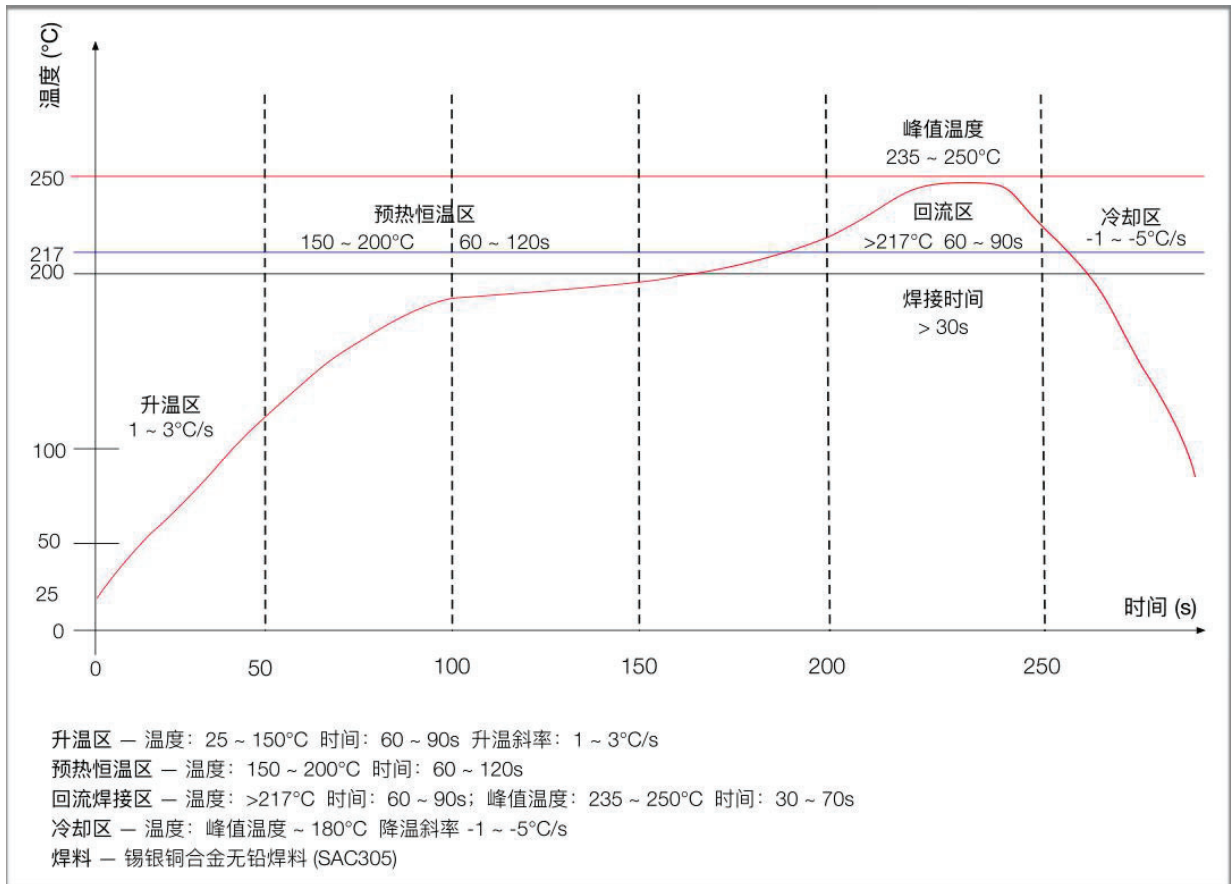


Figure 14 Flow welding diagram

## 9. Product related models

**Table 8 Product related model list**

| Model                                                                                              | Power Supply                      | Package                         | Size                   | Antenna      |
|----------------------------------------------------------------------------------------------------|-----------------------------------|---------------------------------|------------------------|--------------|
| PB-03F                                                                                             | 2.7V~3.6V <sup>⚡</sup><br>I>200mA | SMD-22                          | 24.0*16.0*3.1(±0.2)mm  | On-board PCB |
| PB-03M                                                                                             | 2.7V~3.6V <sup>⚡</sup><br>I>200mA | DIP-18<br>Gold finger<br>plugin | 18.0*18.0*2.8(±0.2)mm  | On-board PCB |
| PB-03                                                                                              | 2.7V~3.6V <sup>⚡</sup><br>I>200mA | SMD-61                          | 16.6*13.2*2.8(±0.2)mm  | On-board PCB |
| NodeMCU-PB-03F-Kit                                                                                 | 5V,<br>I>200mA                    | DIP-30                          | 49.3*25.4*12.9(±0.2)mm | On-board PCB |
| NodeMCU-PB-03M-Kit                                                                                 | 5V,<br>I>200mA                    | DIP-20                          | 32.8*28.6*18.3(±0.2)mm | On-board PCB |
| NodeMCU-PB-03-Kit                                                                                  | 5V,<br>I>200mA                    | DIP-30                          | 49.3*25.4*12.9(±0.2)mm | On-board PCB |
| Product related information: <a href="https://docs.ai-thinker.com">https://docs.ai-thinker.com</a> |                                   |                                 |                        |              |

## 10.Product packaging information

PB-03 module was packaged in a tape,900pcs/reel.As shown in the below image:



Figure 15 Package and packing diagram

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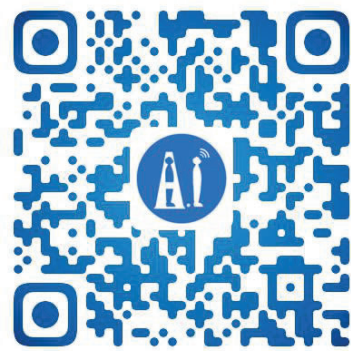
[Overseas business cooperation 粵|overseas@aithinker.com](mailto:overseas@aithinker.com)

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

Tel 粵|+86-0755-29162996



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