



PB-03F Specification

Version V1.0.0

Copyright © 2021

Document resume

[illegible]

Content

1. Product Overview

PB-03F 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, 256 KB flash, 96 KB ROM, 256 bit 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-03F module provides rich peripheral interfaces, including UART, PWM, ADC, I2C, SPI, PDM, DMA and up to 19 IOs.

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

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

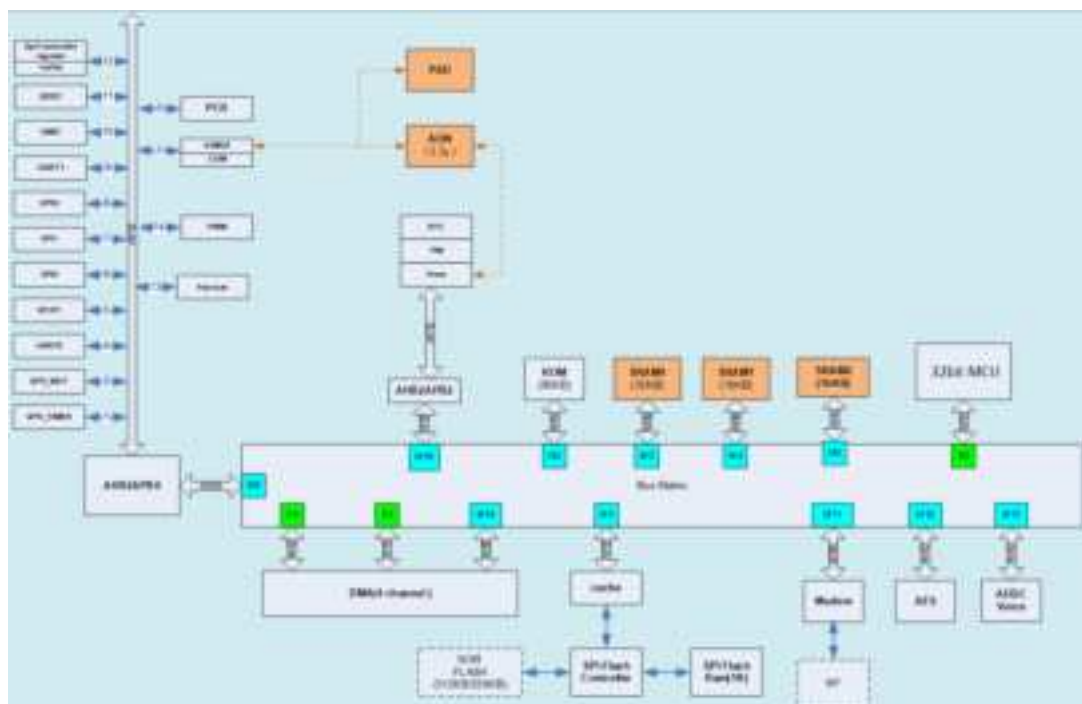


Figure 1 Main chip architecture diagram

1.1. Characteristic

- Support BLE5.2,rate support: 1Mbps,2Mbps
- Own 64KB SRAM , 256KB flash,96 KB ROM , 256bit efuse
- Support UART/GPIO/ADC/PWM/I2C/SPI/PDM/DMA interface
- Adopt SMD-22 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

Model	PB-03F
Package	SMD-22
Size	24.0*16.0*3.1(±0.2)mm
Antenna	On-board antenna
Frequency	2400~2483.5MHz
Operating temperature	-40℃~85℃
Storage temperature	-40℃~125℃,<90%RH
Power supply	Voltage 2.7V~3.6V,Current>200mA
Interface	UART/GPIO/ADC/PWM/I2C/I2S/SPI/PDM/DMA
IO	19
UART rate	Default 115200 bps
Bluetooth	BLE 5.2
Security	AES-128
SPIFlash	256KB

2.1. Static electricity requirements

PB-03F 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 DD	-	0.25VDD/VDD +0.3	V
	V_{OL}/V_{OH}	-	N/0.8VIO	-	0.1VIO/N	V
	I_{MAX}	-	-	-	12	mA

2.3. BLERF 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

3. Appearance dimensions

Figure 3 Appearance diagram pictures is for reference only,subject to physical objects)

Figure 4 Module size diagram

4. Pin definition

PB-03F has a total of 22 interfaces. As shown in below pin diagram, the pin function definition table is the interface definition.

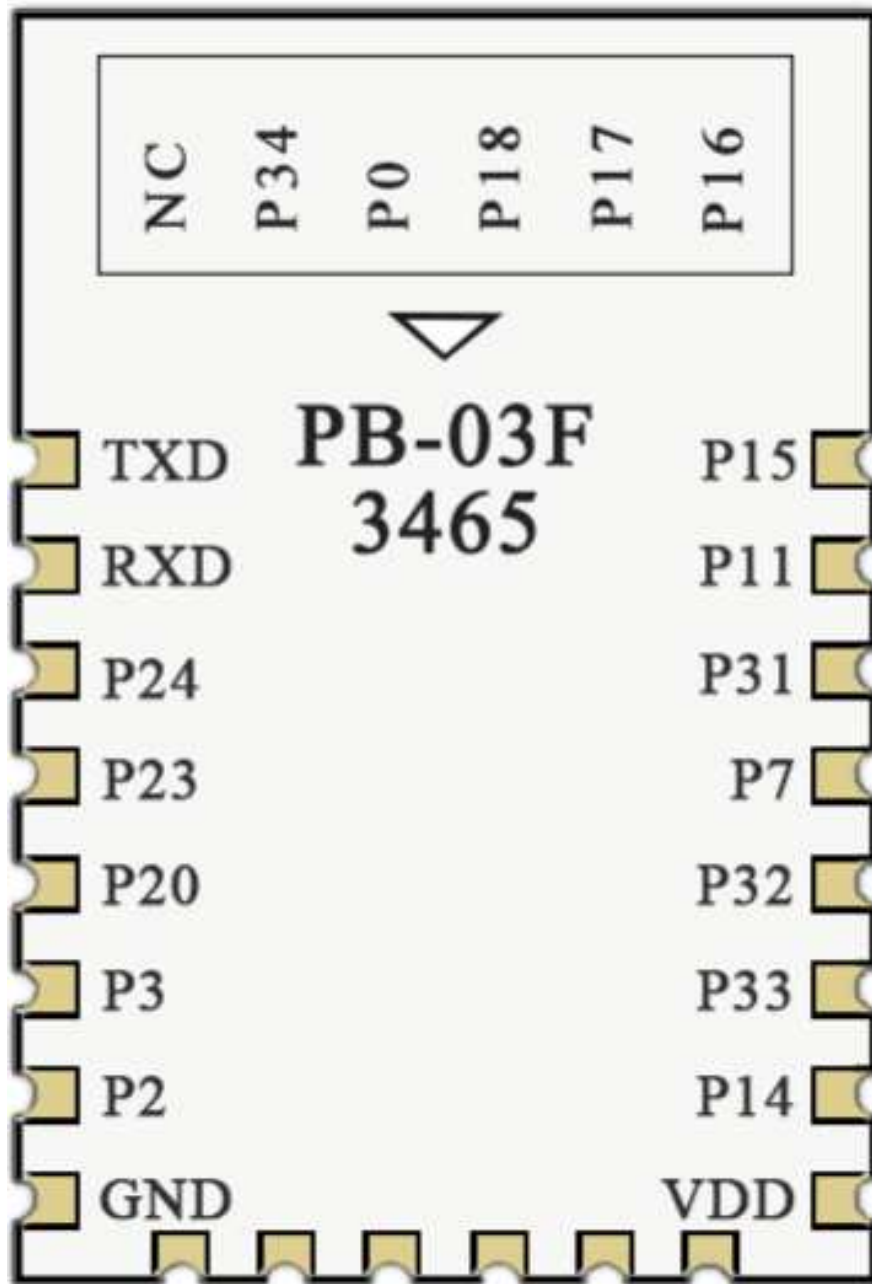


Figure 5 Schematic diagram of module pins(back view)

Table 6 Pin function definition table

No.	Name	Function
1	P15	GPIO15/ADC input 4/micbias output
2	P11	GPIO11/ADC input 0
3	P31	GPIO31
4	P7	GPIO7
5	P32	GPIO32
6	P33	GPIO33
7	P14	GPIO14/ADC input 3
8	VDD	Power input
9	P16	GPIO16/32.768KHz crystal input
10	P17	GPIO17/32.768KHz crystal output
11	P18	GPIO18/ADC input 7/PGA negative input
12	P0	GPIO0
13	P34	GPIO34
14	NC	Empty
15	GND	Ground(Power negative electrode)
16	P2	GPIO2/SWD debug data inout
17	P3	GPIO3/SWD debug clock
18	P20	GPIO20/ADC input 9/PGA positive input
19	P23	GPIO23/ADC input 1/micbias reference
20	P24	GPIO24/ADC input 2
21	P10	RXD/GPIO10
22	P9	TXD/GPIO9

5. Schematic

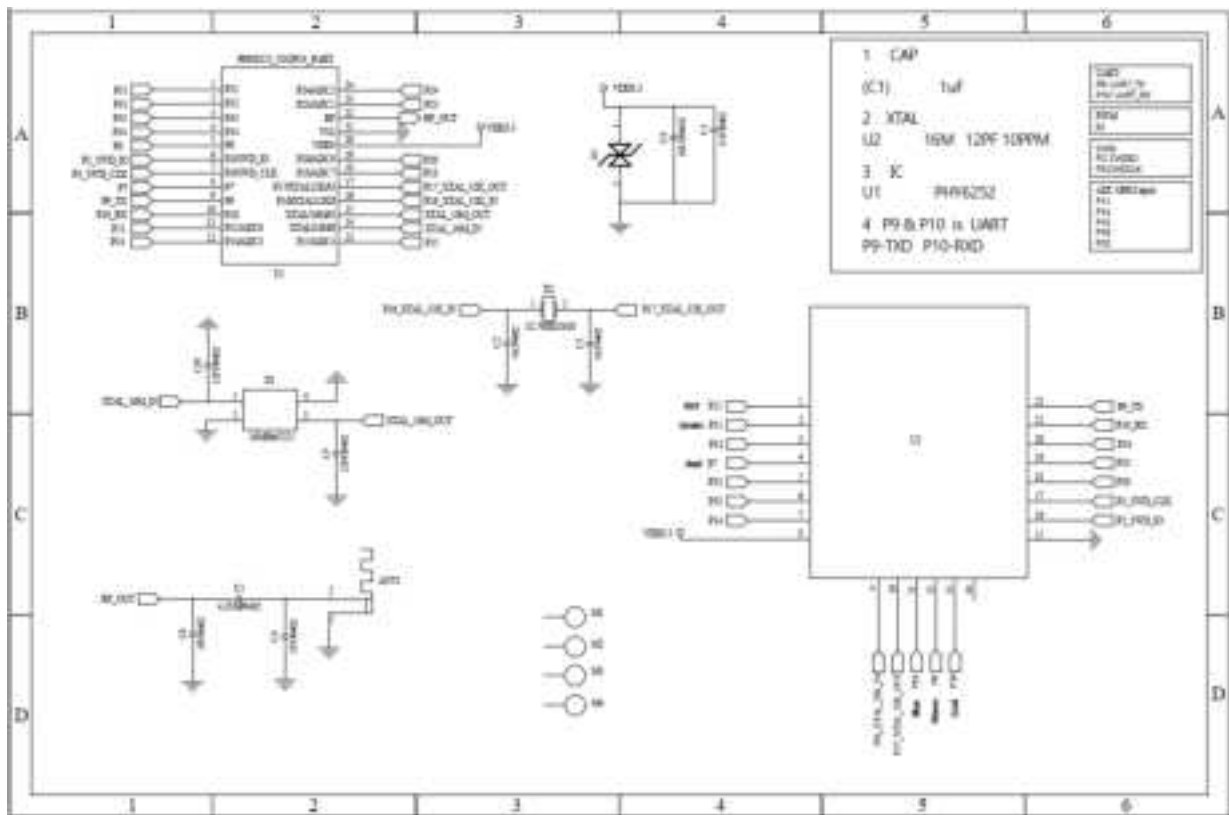


Figure 6 Module schematic

6. Antenna parameters

6.1. Test conditions for the antenna



Figure 7 Antenna test conditions

6.2. Antenna S parameter

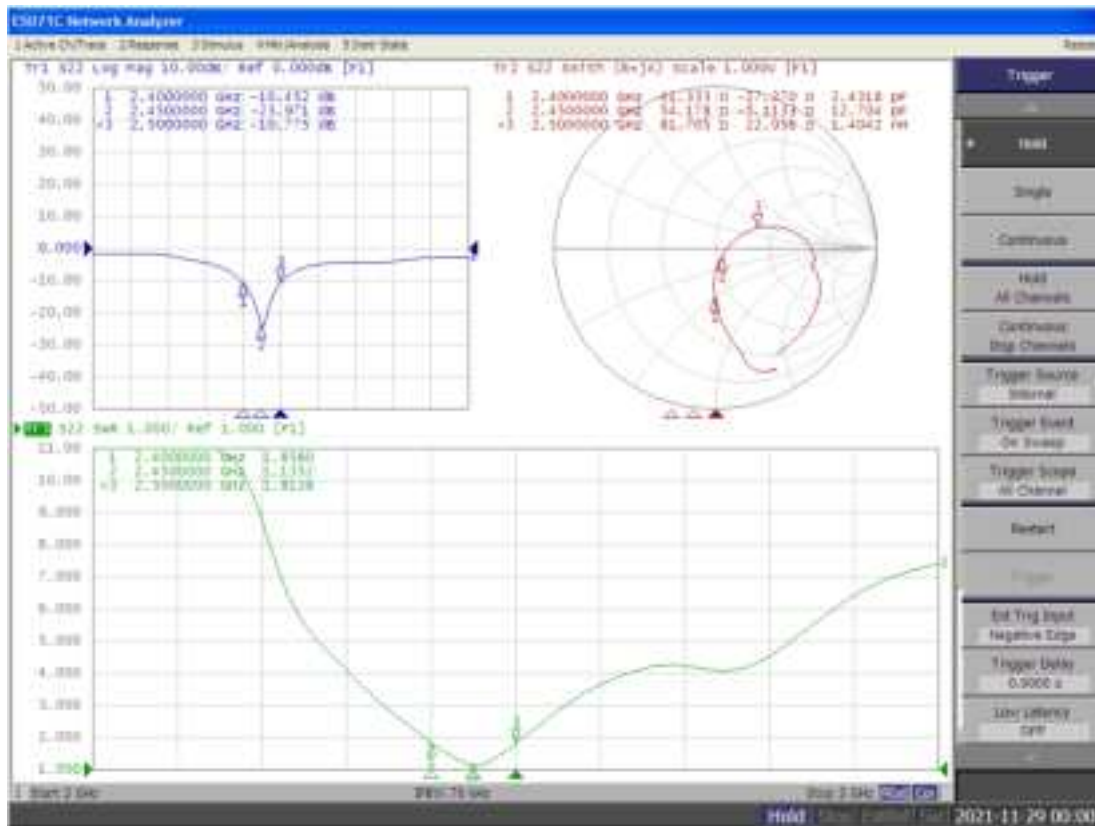


Figure 8 Antenna S parameters

6.3. Antenna Gain

Antenna Gain	PCB Antenna: 1.5 dBi for BT
--------------	-----------------------------

6.4. Antenna field type diagram

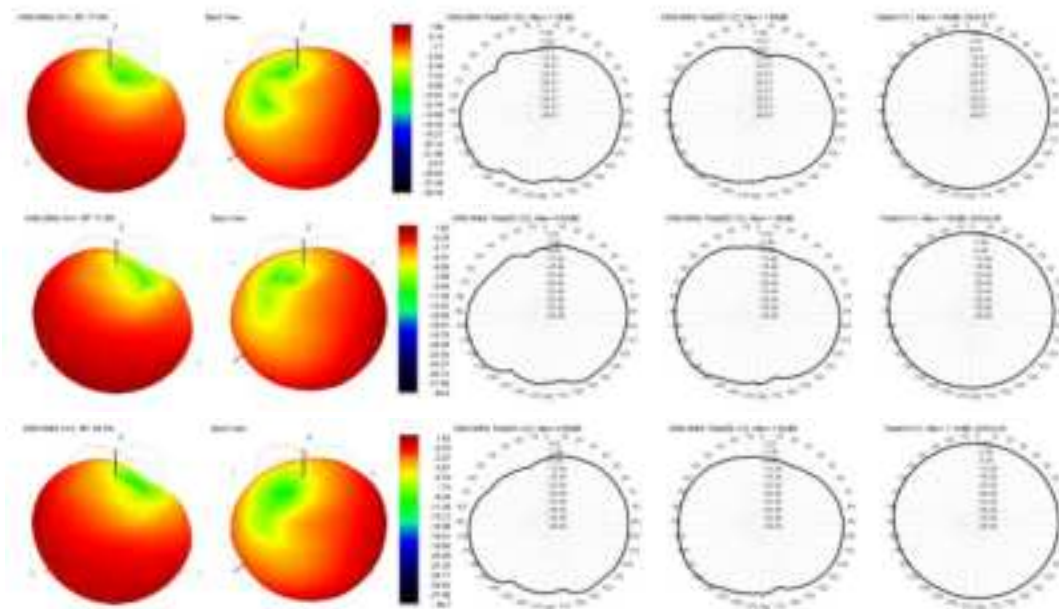


Figure 9Antenna field type diagram

7. Design guidance

7.1. Module application circuit

(>=200mA,suggest use DC-DC or LDO independent power supply)

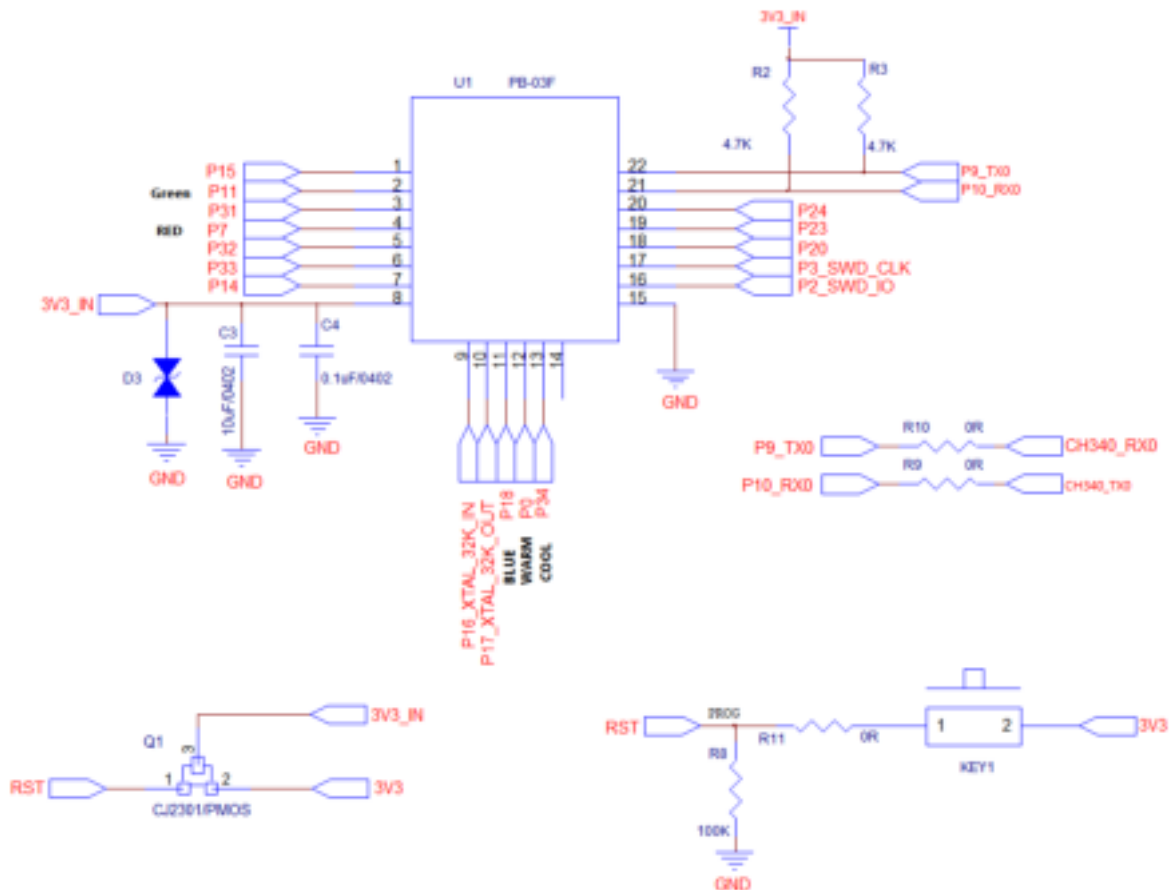


Figure 10 Application circuit diagram

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

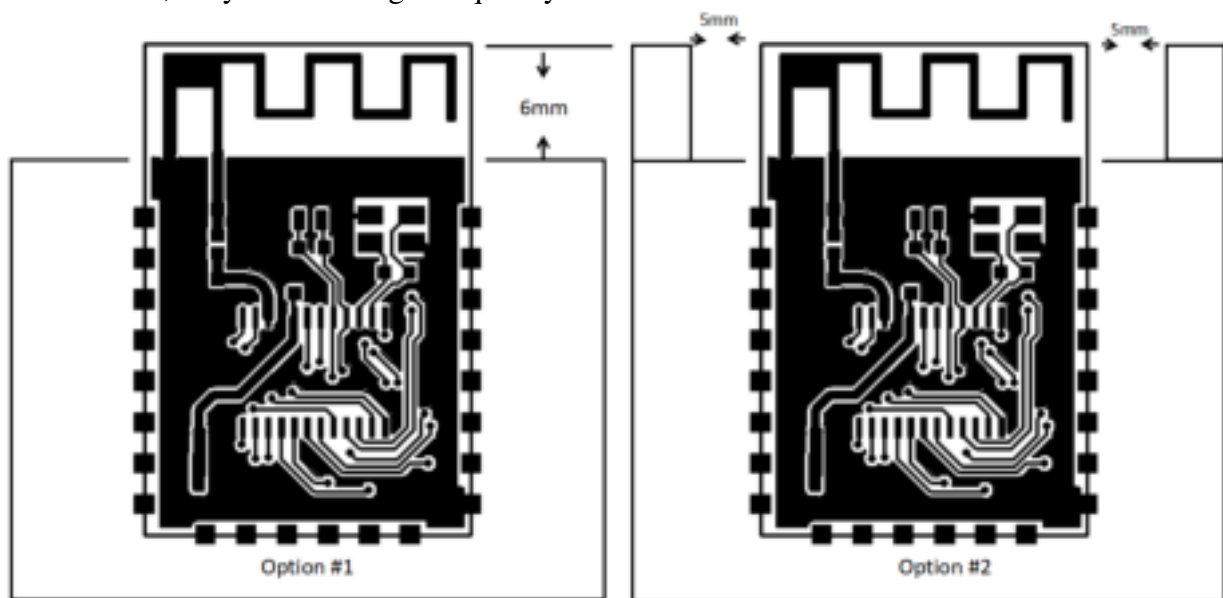


Figure 11 Schematic diagram of the antenna layout

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.



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.

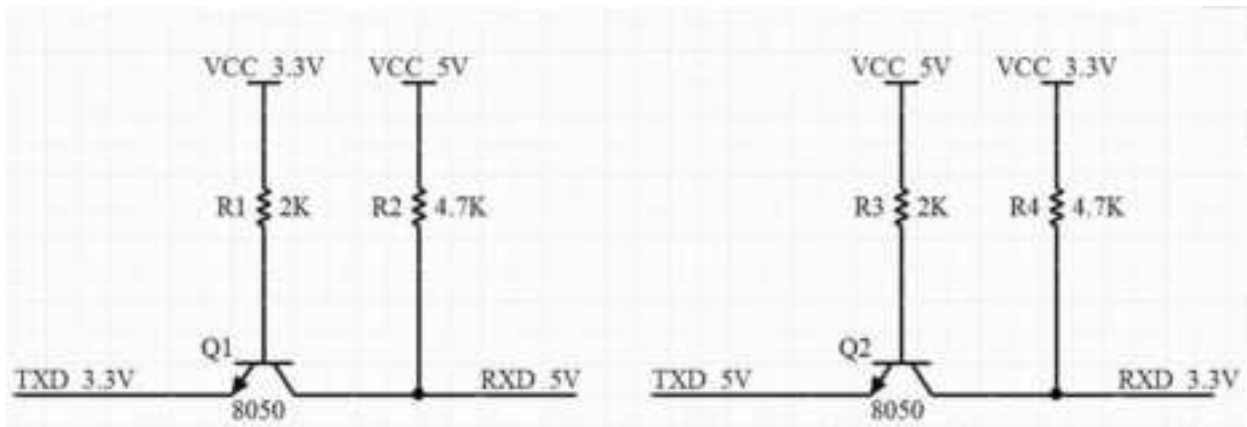


Figure 13 Level convert circuit

8. Flow welding curve diagram

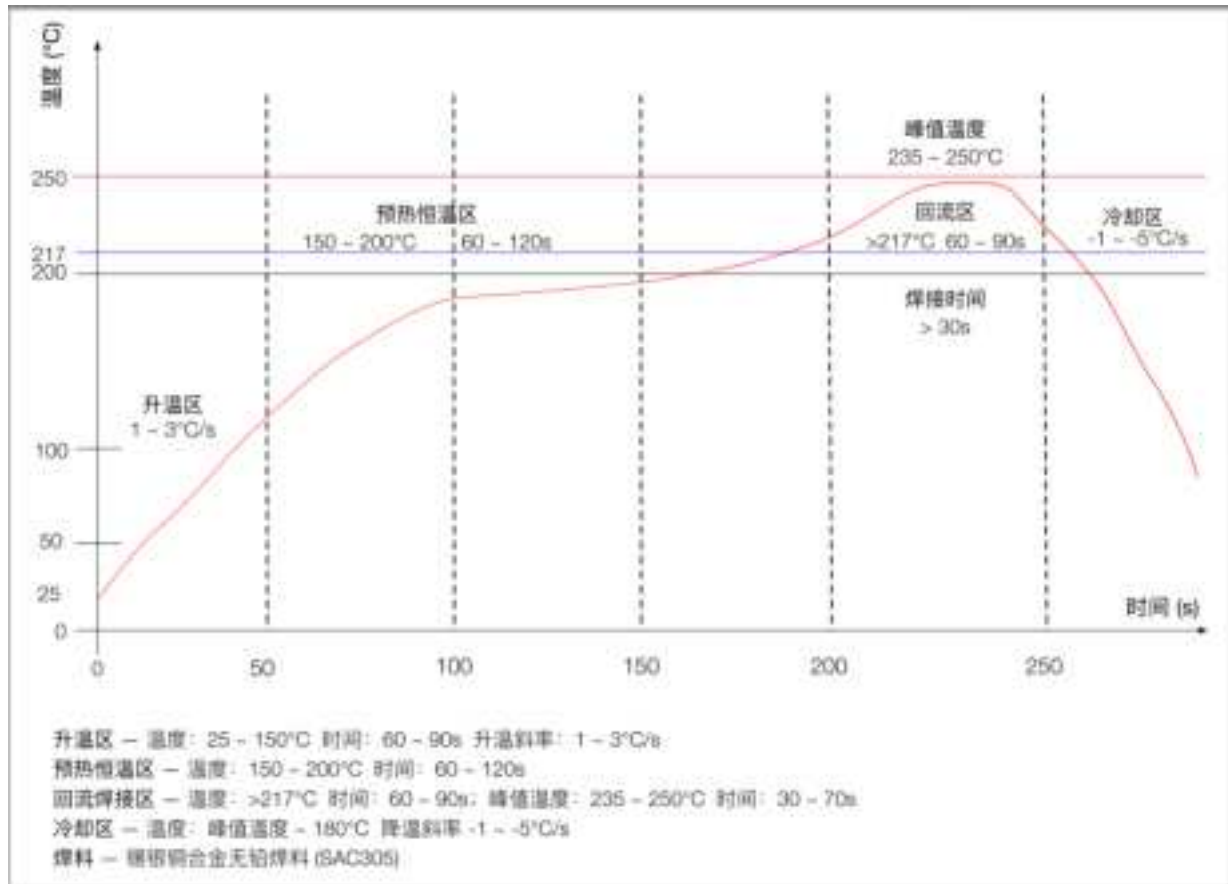


Figure 14 Flow welding diagram

9. Product related models

Table 8 Product related model list

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

10. Product packaging information

PB-03F module was packaged in a tape, 800pcs/reel. As shown in the below image:



Figure 15 Package and packing diagram

11. Contact us

[Ai-Thinker official website](#)[Office forum](#)[Develop DOCS](#)[LinkedIn](#)[Tmall shop](#)[Taobao shop](#)[Alibaba shop](#)

[Technic support email : support@aithinker.com](mailto:support@aithinker.com)

[Domestic business cooperation : sales@aithinker.com](mailto:sales@aithinker.com)

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

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

Tel : +86-0755-29162996

Disclaimer and copyright notice

The information in this article,including the URL address for reference,is subject to change without notice.

The document is provided"as is"without any guarantee responsibility,including any guarantee for merchantability,suitability for a specific purpose,or non-infringement,and any guarantee mentioned elsewhere in any proposal,specification or sample.This document does not bear any responsibility,including the responsibility for infringement of any patent rights arising from the use of the information in this document.This document does not grant any license for the use of intellectual property rights in estoppel or other ways,whether express or implied.

The test data obtained in the article are all obtained from Ai-Thinker's laboratory tests,and the actual results may vary slightly.

All brand names,trademarks and registered trademarks mentioned in this article are the property of their respective owners,and it is hereby declared.

The final interpretation right belongs to Shenzhen Ai-Thinker Technology Co.,Ltd.

Notice

Due to product version upgrades or other reasons,the contents of this manual may be changed.

Shenzhen Ai-Thinker Technology Co.,Ltd.reserves the right to modify the contents of this manual without any notice or prompt.

This manual is only used as a guide.Shenzhen Ai-Thinker Technology Co.,Ltd.makes every effort to provide accurate information in this manual.However,Shenzhen Ai-Thinker Technology Co.,Ltd.does not guarantee that the contents of the manual are completely free of errors.All statements and information in this manual And the suggestion does not constitute any express or implied guarantee.

Integration instructions for host product manufacturers according to KDB 996369 D03 OEM Manual v01**2.2 List of applicable FCC rules**

The PB-03F is an BT Module with GFSK modulation. It operates on the 2400-2483.5MHz band and, therefore, is within U.S. FCC part 15.247 standard

2.3 Specific operational use conditions

The EUT is a BT Module

BLE:

Operation Frequency: 2402-2480MHz for BLE;

Modulation Type: GFSK

Number Of Channel: 40 channels

Antenna Designation: PCB Antenna

Antenna Gain: 1.5dBi

Support BLE5.2,rate support: 1Mbps,2Mbps Own 64KB SRAM , 256KB flash,96 KB ROM , 256bit efuse

Support UART/GPIO/ADC/PWM/I2C/SPI/PDM/DMA interface Adopt SMD-22 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

2.4 Limited module procedures

not applicable; Single Modular Approval Request

2.5 Trace antenna designs

Not applicable;

2.6 RF exposure considerations

To maintain compliance with FCC's RF Exposure guidelines, This equipment should be installed and operated with minimum distance between 20cm the radiator your body: Use only the supplied antenna.

2.7 Antennas

The PB-03F is an BT Module beams signals and communicates with its antenna, which is PCB

Antenna. The PCB Antenna gain is 1.5dBi. Antenna could not be in no-load state when module is working. During debugging, it is suggested to add 50 ohms load to the antenna port to avoid damage or performance degradation of the module under long-time no-load condition.

2.8 Label and compliance information

The final end product must be label in a visible area with the following

Host must Contains FCC ID: 2ATPO-PB03. If the size of the end product is larger than 24x16mm, then the following FCC part 15.19 statement has to also be available on the label: This device complies with Part 15 of FCC rules. Operation is subject to the following two conditions:

- (1) this device may not cause harmful interference and
- (2) this device must accept any interference received, including interference that may cause undesired operation.

2.9 Information on test modes and additional testing requirements

Data transfer module demo board can control the EUT work in RF test mode at specified test channel.

2.10 Additional testing, Part 15 Subpart B disclaimer

The module without unintentional-radiator digital circuit, so the module does not required an evaluation by FCC Part 15 Subpart B. The host should be evaluated by the FCC Subpart B.

ATTENTION

This device is intended only for OEM integrators under the following conditions:

- 1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
- 2) This device and its antenna(s) must not be co - located with any other transmitters except in accordance with FCC multi - transmitter product procedures. Referring to the multi - transmitter policy, multiple transmitter(s) and module(s) can be operated simultaneously without C2P.
- 3) For all products market in US, OEM has to limit the Operating Frequency: 2402-2480MHz by supplied firmware programming tool. OEM shall not supply any tool or info to the end - user regarding to

Regulatory Domain change.

USERS MANUAL OF THE END PRODUCT:

In the user manual of the end product, the end user has to be informed to keep at least 20cm separation with the antenna while this

end product is installed and operated. The end user has to be informed that the FCC radio - frequency exposure guidelines for an uncontrolled environment can be satisfied. The end user has to also be informed that any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

If the size of the end product is smaller than 8x10cm, then additional FCC part 15.19 statement is required to be available in the users manual: This device complies with Part 15 of FCC rules. Operation is subject to the following two conditions:

- (1) this device may not cause harmful interference and
- (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC WARNING

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generate, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference

will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.