



HJ-531IMF_Hardware Design Manual

Based on Dialog DA14531

5*4.75*1.3/1 mm, include internal antenna, include 4Mb Flash

Ultra-low power Bluetooth 5.4 chip-level module

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Preface

Thanks for using the Bluetooth module provided by HJSIP. HJ-531IMF series standard Bluetooth module, is a high-performance iot Bluetooth transceiver. The module adopts LGA25 package and supports both external and internal antennas. The product also has the characteristics of low power consumption, small size, strong anti-interference ability, etc., suitable for a variety of application scenarios.

This module is mainly used for data communication, and the company does not assume responsibility for property losses or personal injuries caused by improper operations of users. Please develop the product according to the technical specifications and reference design in the manual. At the same time, pay attention to the general safety matters that should be concerned about when using mobile products.

Before the announcement, the company has the right to modify the content of this manual according to the needs of technological development.

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Version History

Version	Date	Change Description	Reviser	Reviewer
V1.0	2020/02/28	Initial Version	LMY	LJH
V1.1	2020/04/04	Update specification	LMY	ZYP
V1.2	2023/04/20	Adjust the format; Change the maximum temperature tolerance value.	FJW	LMY
V1.3	2025/02/24	1) Unified manual format; 2) Correct the presentation.	WYW	LMY
V1.5	2025/04/30	1) 3.2.1: A PI circuit must also be added when using an internal antenna; 2) 3.2.2: When using an external PCB antenna, the PCBA board needs to be sent to our company for PI circuit matching; 3) Table 2-2: Add remarks to the RST pin: The high level duration should be greater than 1 second. It must be connected to I/O. If not connected, add a 1K strong pull-down. 4) Table 2-2: The IO ports have been uniformly adjusted to be GPIO; 5) Module selection: Only retain the customer development version; 6) Changed Flash to 4Mb.	WYW	LMY
V1.6	2026/06/29	Added contact information.	WYW	LMY

Applicable module selection

No.	Module type	Type	Description
1	HJ-531IMF_ EMP	Customer development version	Provide a standard SDK to facilitate customers' OPEN CPU secondary development.

1 Introduction

HJ-531IMF standard Bluetooth module, is a high-performance iot Bluetooth transceiver. The module is packaged in LGA25 and supports both internal and external antenna. The product also has the characteristics of low power consumption, small size, strong anti-interference ability, etc., suitable for a variety of application scenarios.

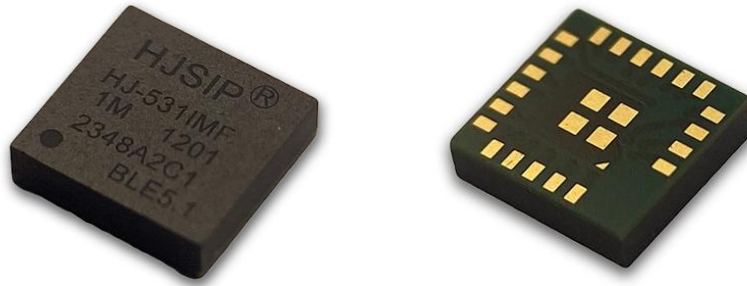


Figure 1.1: HJ-531IMF Top and bottom view

2 Product overview

2.1 Key features

Table 2-1: HJ-531IMF key characteristics

Characteristic	Description
Function	- Supports BLE 5.4, embedded Bluetooth Low Energy stack and GATT services - Support BLE Master slave integration (support 1 slave 1 master or 3 slave, master slave work at the same time, do not affect each other) - Built in standard firmware, supports 1-way, supports multiple command configurations for BLE modules
Memory and ROM	- Built-in 32KB OTP - Built-in 48KB of RAM - Contains 4Mb(P25Q40) FLASH to store user programs and OTA usage
supply voltage	High voltage mode 1.8V~3.3V, TYP. 3.0V; Low voltage mode 1.1V~1.65V, TYP. 1.5V; It can be powered by a single AA battery or zinc empty battery 1.5V;It can also be powered by 2 AA batteries or lithium batteries after stabilizing the voltage;
RF characteristics	- The operating frequency is 2.4GHz, which supports the ISM free band - Transmit power: -19.5dBm ~ +2.5dBm - High receiving sensitivity: -94dbm -TX peak current:3.5mA@0dBm DC3V; RX peak current:2.2mA@DC3V; - Wireless transmission distance of the built-in antenna in open areas: 5~10 meters - Wireless transmission distance of external antenna in open areas: 30~120 meters
Size	Regular style:5mm*4.75mm*1.3mm (including antenna) Ultra-thin: 5mm*4.75mm*1mm (including antenna)
Package	LGA25
Weight	0.1g
power consumption	- Sleep current < 2μA - 1-second interval broadcast current 7μA(0dBm) - 2-second interval broadcast current 3.8μA(0dBm) - 20ms Connection gap current 65uA(0dBm)

	- 1000ms Connection Gap Current 6.8uA(0dBm)
Operation Temperature	-40 ~ +85°C
Storage Temperature	-40 ~ +85°C
GPIO Port	12 PCS (Max)
Product standards	Compliant with ROHS and REACH standards

2.2 Application Scenarios

- 2.4GHz Bluetooth Low Energy system;
- Smart home, wireless remote control;
- Consumer electronics products such as sports and healthcare;
- Industrial monitoring;
- Intelligent transportation, etc.

2.3 Functional block diagram

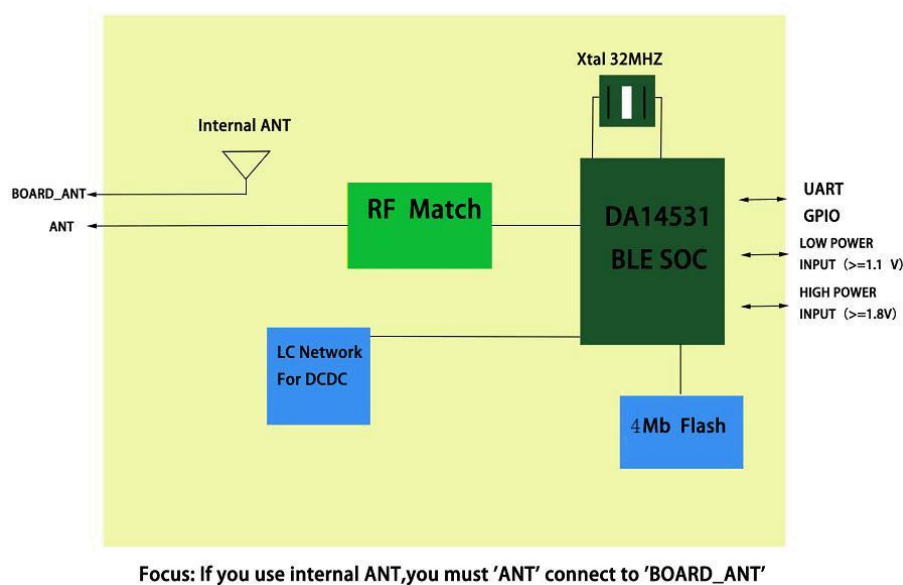


Figure 2.1: HJ-531IMF functional block diagram

2.4 Pins distribution diagram

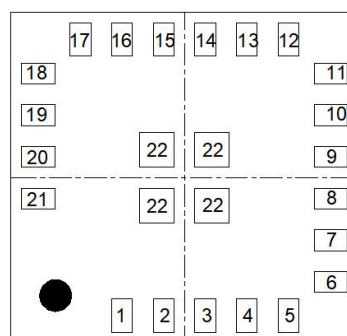


Figure 2.2: HJ-531IMF Pins distribution diagram(front view)

2.5 Pins description table

Table 2-2: HJ-531IMF Pins definition table

PIN	Name	Type	Description	Remarks
1	P0.9	GPIO	GPIO	/
2	P0.7	GPIO	GPIO	/
3	P0.5	GPIO	GPIO	/
4	P0.8	GPIO	GPIO	/
5	P0.2/C	GPIO/Debugger	GPIO/Simulation clock port	/
6	P0.6	GPIO	GPIO	/
7	P0.11	GPIO	GPIO	/
8	P0.10/W	GPIO/Debugger	GPIO/Simulation data port	/
9	VCC_LOW	Low Power In	Low voltage power input	Low voltage mode input:1.1V-1.65V
10	VCC_HIGH	High Power In	High voltage power input	High voltage mode input:1.8V-3.3V
11	<u>Flash vcc</u>	<u>Flash power In</u>	<u>Internal Flash power supply pin</u>	<u>Power supply range 1.65-3.6V, if you need to use, please connect to VCC_HIGH</u>
12	<u>Flash sck</u>	<u>Flash Sck</u>	<u>Internal Flash clock pin</u>	<u>Connect to P0.4 if used</u>
13	P0.4/RCM	GPIO	GPIO	/
14	P0.3/RCP	GPIO	GPIO	/
15	<u>Flash so</u>	<u>Flash So</u>	<u>内部Flash 数据输出</u>	<u>Connect to P0.3 if used</u>
16	<u>Flash si</u>	<u>Flash Si</u>	<u>Internal Flash data output</u>	<u>Connect to P0.0 if used</u>
17	P0.0/RST	GPIO/RST	Reset pin	Active high, and the duration of high level should be more than 1s; Suspended or low-level 0 the module operates normally. Note: The RST pin must be connected to the I/O. If not connected, a 1K strong pull-down resistor must be added.
18	<u>Flash cs</u>	<u>Flash Cs</u>	<u>Internal Flash film selection</u>	<u>Connect to P0.1 if used</u>
19	P0.1	GPIO	GPIO	/
20	ANT	RF OUT	RF output	Rf output, can be used with external antenna
21	BOARD_ANT	Onboard ANT	Built-in antenna input	The internal matching circuit has been integrated. If the internal antenna is used, simply connect pins 20 and 21; To achieve the best antenna performance, an additional PI is required. Please refer to 3.2.1.
22	GND	Ground	power input GND	negative pole GND

3 RF Features

The module can be configured in two modes: internal antenna and external antenna.

3.1 Antenna interface and operating frequency band

Module antenna interface characteristic impedance 50 ohms.

The radio frequency working band is 2.402 ~ 2.480GHz.

3.2 Antenna application reference

3.2.1 Use module built-in antenna wiring diagram

The wireless transmission distance of the built-in antenna in open areas: 5 - 10 m, and it offers two usage options.

① An internal matching circuit has been integrated. Directly connecting PIN20 and PIN21, the built-in antenna of the module can be used. However, the transmission distance is relatively short. The wiring method is shown in Figure 3.1.

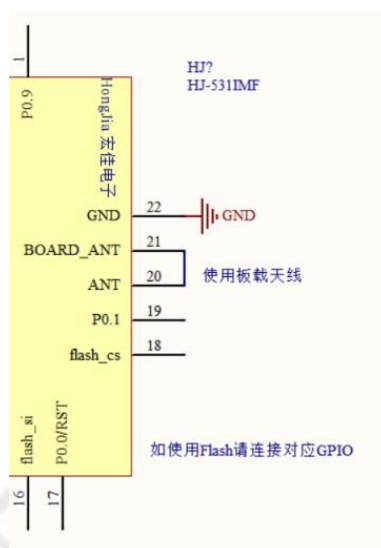


Figure 3.1

② If there is sufficient space, an additional PI can be used for re-adjustment (connecting PIN20 through a π -type filter circuit to PIN21). The transmission distance will be better. The wiring method is shown in Figure 3.2.

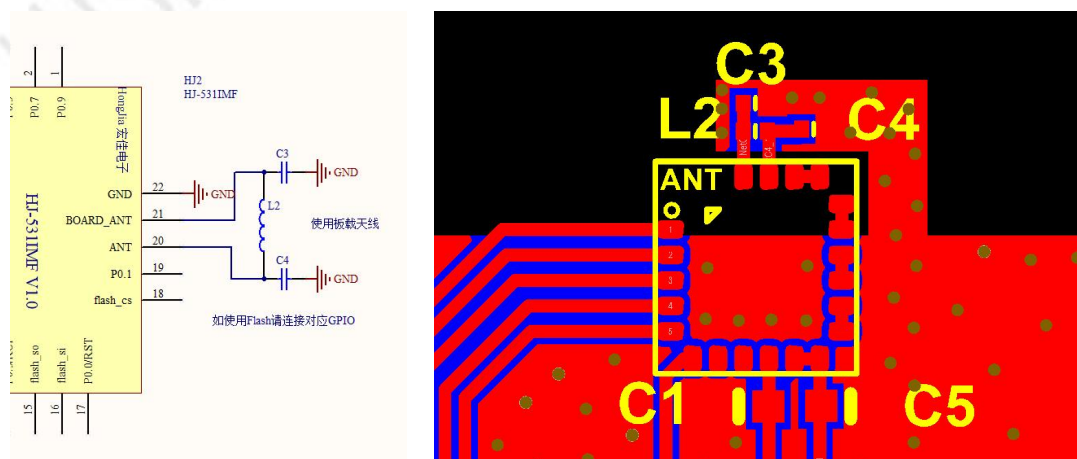


Figure 3.2

Note

During PCB circuit design, no components should be placed near the antenna, no traces should be routed there. Components should not be placed on the back of the module. The copper layer should avoid the internal antenna area. (Except for the antenna part) the copper layer of the module GND should be large enough. The antenna part should try to increase the clearance area.

3.2.2 Use the external antenna wiring diagram

PIN21 is suspended, and PIN20 is connected to the PCB antenna through a π filter circuit, as shown in Figure 3.3 below, and the communication distance in open ground can reach 30~120 meters.

*** Special attention ***

- 1) If you have requirements for the distance of the product and the external π circuit needs to be matched, please send the PCBA circuit board to our company to complete this task.
- 2) When designing the circuit, no devices or wires should be placed near the antenna, and no devices should be placed on the back of the module. The copper cladding should cover the module and the π -shaped filter circuit, avoiding the PCB antenna.

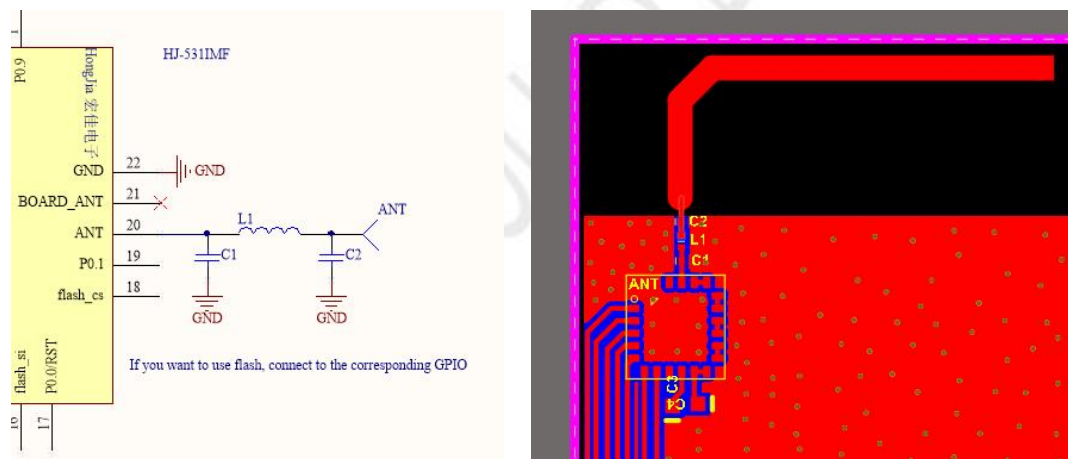


Figure 3.3: Use an external antenna

3.3 RF features

Table 3-1: RF features

Attribute	Value	Remarks
Wireless modulation mode	GFSK	/
Frequency range	2.402 ~ 2.480GHz	bandwidth: 2MHz
Number of channels	40	/
Air speed	1Mbps	/
Rf port impedance	50Ω	/
The max TX power	+2.5dBm	/
TX current	3.5mA@0dBm	DC3V
RX current	2.2mA	DC3V

RX sensitivity	-94dBm	/
antenna	Built in antenna	Can also be connected to an external antenna

4 Electrical Parameters

4.1 Absolute Maximum Ratings

Table 4-1: Absolute Maximum Ratings

Parameter	MIN	MAX	Unit
supply voltage VCC	1.1	3.6	V
IO Supply Voltage	0	VCC	V
Operating Temperature	-40	+85	°C
Storage Temperature	-40	+85	°C

4.2 DC Characteristics

Table 4-2: Recommended Operating Conditions

Parameter	MIN	TYP	MAX	Unit
Supply voltage VCC	1.1	3(1.5)	3.3	V
IO Supply Voltage	0	3(1.5)	VCC	V
Dormant working current	/	<2	/	μA
Maximum Operating Current(average)	/	0.4	/	mA
Operating Temperature	-40	+25	+85	°C

Table 4-3: Dc features of I/O ports

IO Pin	Drive capability	Min	Max	Unit
Input low level	/	/	0.3*VCC	V
Input high level	/	0.7*VCC	/	V
Output low level	3.5mA	/	0.2*VCC	V
Output high level	3.5mA	0.8*VCC	/	V

Table 4-4: Electricity consumption

Test condition	TYP	Unit
sleep mode	<2	μA
Broadcast at 20ms interval in slave mode	180	μA
Broadcast in slave mode with 1S gap	7.0	μA
Maintain the connection in slave mode with a 20ms connection gap	65	μA
Maintain connection in slave mode with 7.5ms connection gap	110	μA
Scan in host mode	2.3	mA
In host mode, the connection is maintained at a 20ms interval	78	μA

5 Reference Design

5.1 Low voltage mode (can be powered by a single AA battery, range: 1.1V-1.65V)

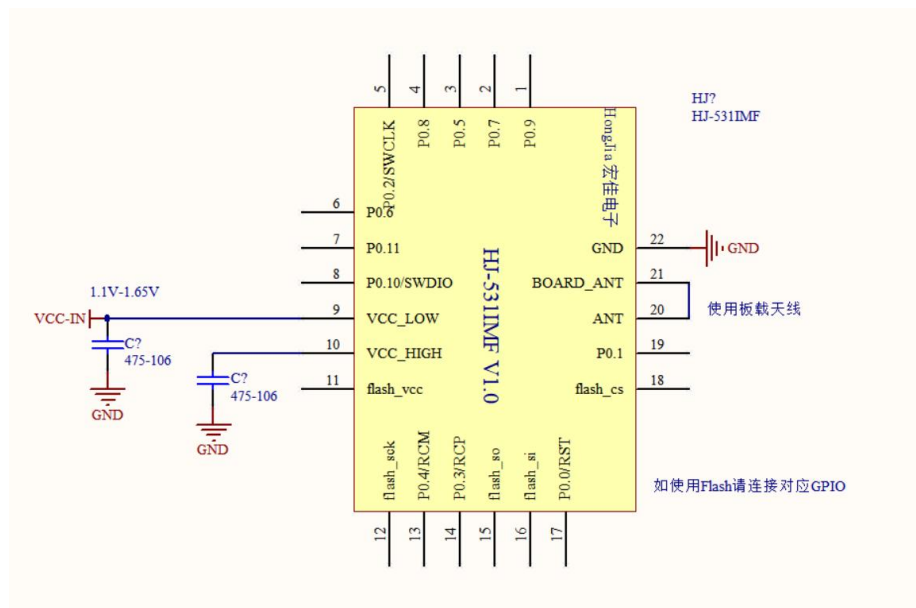


Figure 5.1: HJ-531IMF Low voltage power supply mode

Note

If space is limited, the capacitors can be omitted at the VCC_LOW and VCC_HIGH pins.

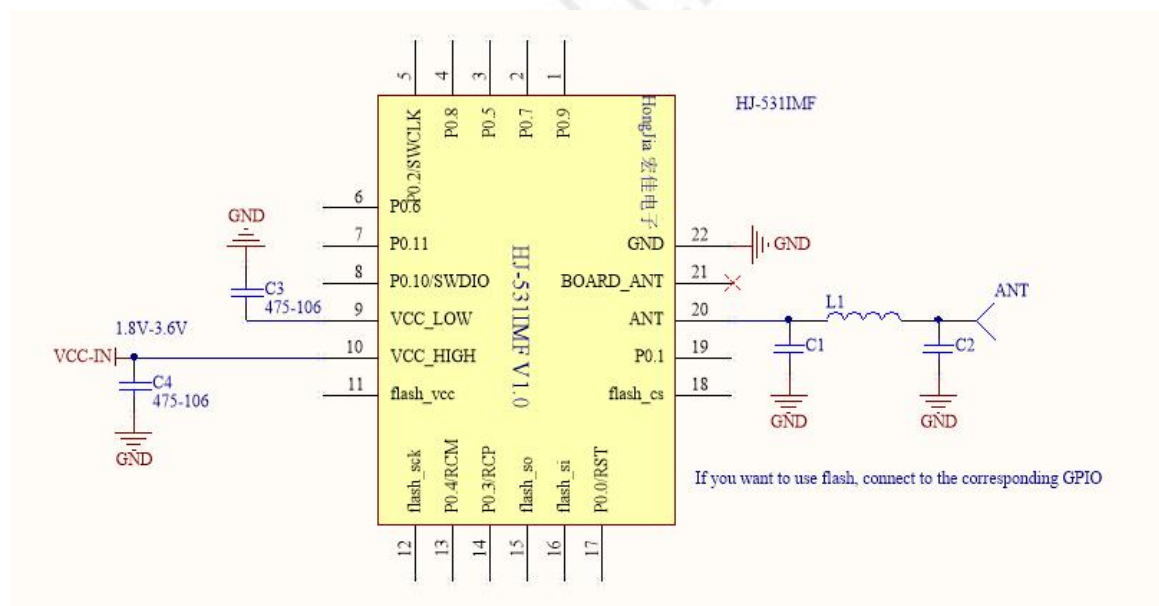
5.2 High voltage mode (range: 1.8V-3.3V)

图 5.4: HJ-531IMF High voltage power supply mode

Note

If space is limited, the capacitors can be omitted at the VCC_LOW and VCC_HIGH pins.

5.3 Use internal Flash for program storage or OTA implementation

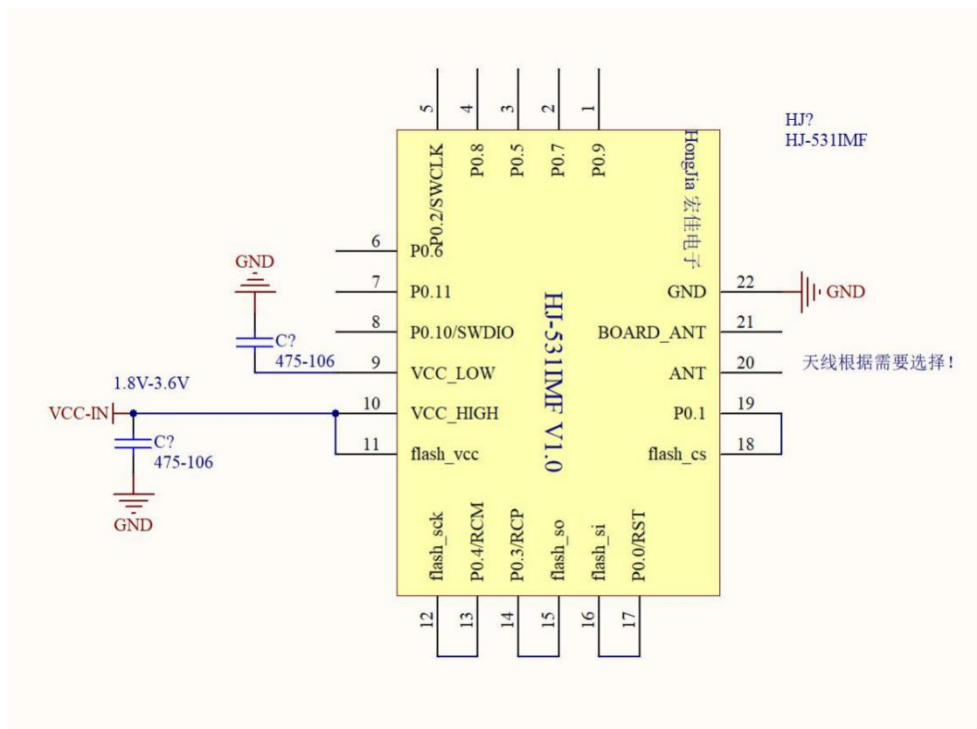


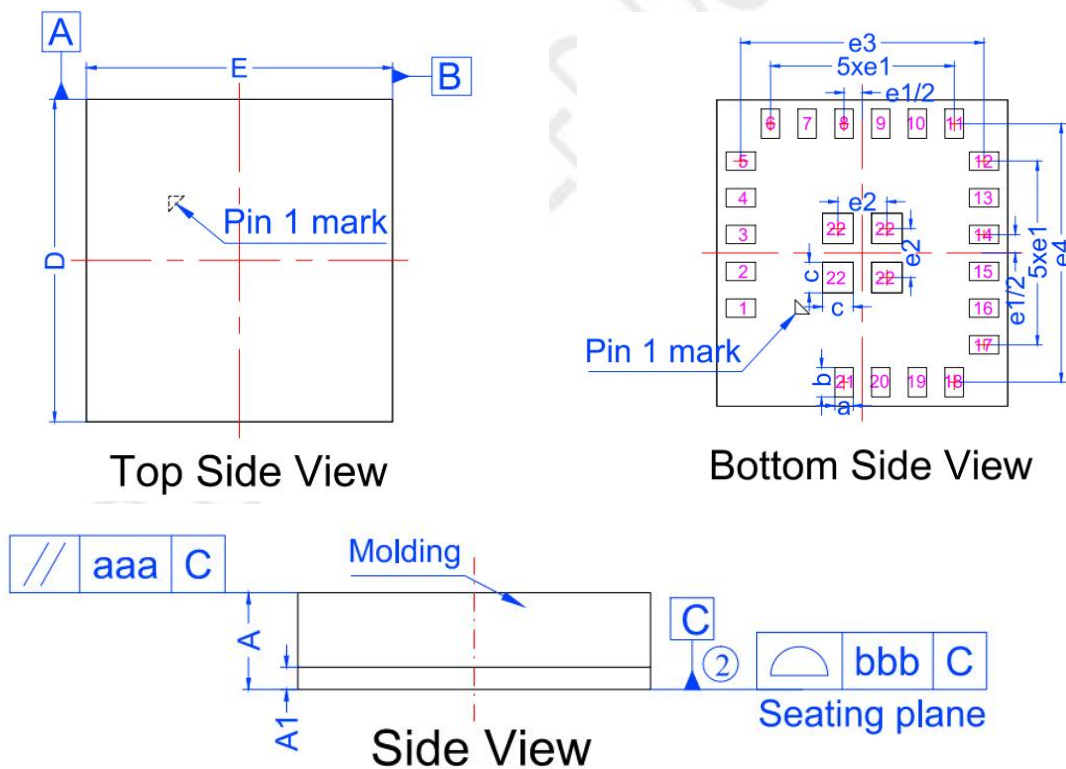
Figure 5.5: Use internal flash for program storage or OTA implementation

5.4 Notices for Hardware Design

- All IO ports can be used, please refer to the pin diagram and pay attention to the IO mode and status when connecting to the IO.
- Non-battery-powered or mains power-downgraded power supply. It is recommended to apply magnetic beads or inductors for filtering the input power.
- The filter capacitors at the power supply should be placed as close as possible to the power input pins of the module. If it is capacitor power supply or there is limited space, the filter capacitors at the power supply can be removed. The filter capacitors already exist inside the module.
- The entire layer of the circuit board should be copper-covered for GND connection, and ensure that the copper-covered area is large enough (except for the antenna part). Also, ensure good grounding.
- When using an external PCB antenna, please contact us to confirm whether your PCB antenna design is reasonable.
- The module should not be placed in a metal enclosure. If a metal enclosure must be used, the antenna should be led out.
- For products using this wireless module, metal components such as screws and inductors should be kept as far away as possible from the RF antenna part of the module.

- Near and on the back of the Bluetooth module antenna, do not place other components and do not route wires. Otherwise, it will affect the Bluetooth performance.
- The PCB antenna of the module should be placed at the four edges of the circuit board. The antenna part should be close to the edge or corner of the main board. It is best to place the module on the corner of the circuit board.
- Over holes should be drilled in the copper-covered area of the entire mainboard, especially in the copper-covered area near the module and the antenna. Try to drill as many holes as possible.
- If there are high-power devices or high-voltage conversion circuits on the circuit board, the GND copper-covered of the module should be isolated from other parts' GND copper-covered, and connected by a single-point grounding method. Try to drill as many holes as possible to reduce interference to the RF signal.
- Unnecessary pins can be left floating.

6 Machine Dimension



DIMENSIONAL REFERENCES Units:mm

SYMBOL	DIMENSIONAL REQMTS			SYMBOL	Tolerance of Form & Position
	MIN	NOM	MAX		
A	1.26	1.30	1.34	aaa	0.10
A1	0.27	0.30	0.33	bbb	0.10
D	4.90	5.00	5.10		
E	4.65	4.75	4.85		
a	0.25	0.30	0.35		
b	0.43	0.48	0.53		
c	0.45	0.50	0.55		
e1	0.60 REF				
e2	0.80 REF				
e3	3.97 REF				
e4	4.22 REF				

Note:

1. All dimensions are in mm
- ② Datum 'C' is the mounting surface, with which the package is in contact

(Note: The normal value of ultra-thin model A is 1mm, and other parameters are the same as those of conventional model)

Figure 6.1: HJ-531IMF dimension

7 SMT production

7.1 Precautions for ultrasonic welding

Please carefully consider using ultrasonic welding technology. If it is necessary to use ultrasonic welding technology, please use 40KHz high frequency ultrasound welding technology. Keep the module away from the ultrasonic soldering line and the fixing column during the design method to prevent damage to the module!

For specific ultrasonic welding matters, please contact our company for technical consultation.

7.2 Soldering Recommendations

HJ-531IMF module use high temperature resistant materials, manufacturing by Lead-free Process. The maximum temperature resistance is 265°C. Ten continuous reflow soldering has no effect on properties and strength. Specific parameters as shown in Table 7-1.

Table 7-1: Reflow soldering parameters

Parameter	Value
Features	Lead-free process
Average ramp up rate($T_{S\max}$ to T_p)	max3°C/sec. max
Temperature Min($T_{S\min}$)	150°C
Temperature Max($T_{S\max}$)	200°C
Preheat time (Min to Max) (tS)	80~100sec
Peak Temperature (T_p)	250±5°C
Ramp-down Rate	6°C/sec. max
Time 25°C to Peak Temp (T_p)	8 min. max

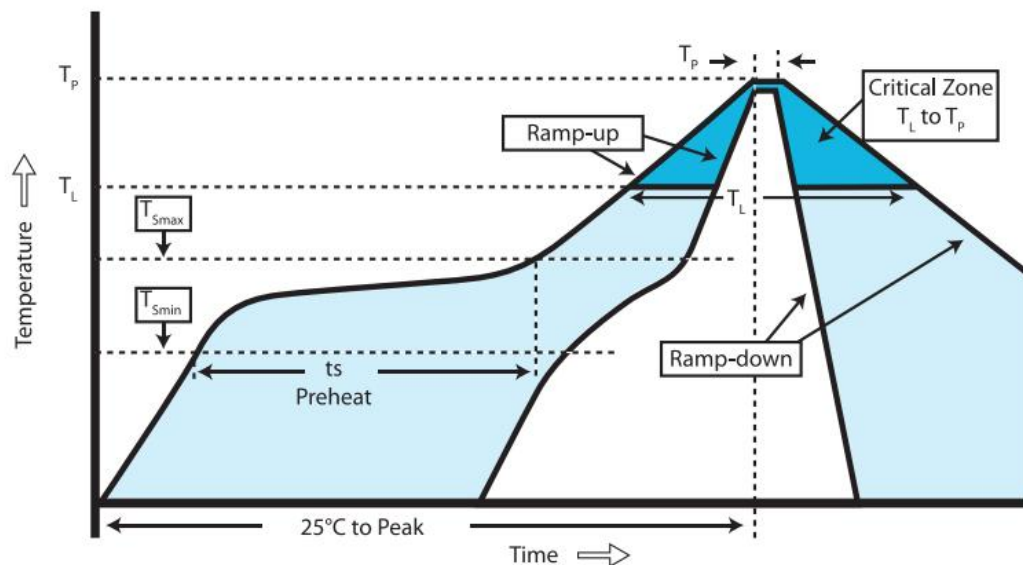


Figure 7.1: Temperature Curve of Reflow Welding

7.3 Humidity sensing properties

The HJ-531IMF module has a humidity sensitivity of level 3.

If any of the following two conditions are met, the HJ-531IMF module should be fully baked prior before reflow soldering, otherwise the module may cause permanent damage during reflow soldering.

- After unpacking or vacuum packaging is damaged and air leaks, the module needs to be SMT within 168 hours when the temperature is less than 30 degrees and the relative humidity is less than 60%. If the above conditions are not met, bake.
- Vacuum packaging is not opened, but beyond the shelf life, also need to be baked.

8 Packaging

8.1 Packaging method

Table 8-1: Packaging method

Type	Packaging method	Minimum packing quantity(PCS)
HJ-531IMF_XX	Roll tape	3500

Use chip-grade anti-static aluminum foil bags to seal and pack with braid. Each bag is put in desiccant. Industrial grade vacuum pump ensures no air leakage, moisture, water and dust (IP65). The actual packaging effect is shown in Figure 8.1.



Figure 8.1: package figure

8.2 Label information

All packages are labeled with cargo information, ROHS label, anti-static label, etc.

【A】	Tangshan Hongjia electronic Technology Co., LTD
【B】	HJ-XXX-XXX
【C】	Pb Free Reflow(260°C)
【D】	Date Code:2508 HJ0218
【E】	Note: Must be stored in a vacuum Seal
【F】	Warning: Humidity sensitivity level MSL:XX
【G】	QTY:1500PCS SEAL DATE:20250218

Figure 8.2: Product label drawing

Table 8-2: Module information description

No.	Description
A	company name
B	product model
C	Lead-free reflow mark and reflow temperature setting value
D	Production date Example: 2508 HJ0218 represents the product produced in the 8th week of 2025, on February 18
E	Storage precautions
F	Humidity sensitivity level
G	Quantity of product + date of sale