

# HJSIP®

## HJ-531IMF\_ Hardware Design Manual

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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

## Applicable module selection

No.	Module type	Type	Description
1	HJ-531IMF	Serial port transparent transmission standard version	Built-in serial port transparent firmware, the firmware module is a two-way communication bridge between Bluetooth devices or mobile phones and MCU, users do not need to understand the Bluetooth protocol stack, through the serial port command operation and serial port data can be received, simple operation, shorten the user development cycle, speed up the product to market.
2	HJ-531IMF_CUS	Customized version for customers	This version supports customer customized firmware, customers according to product needs to propose functions, we will customize modules with dedicated firmware versions to supply to customers.
3	HJ-531IMF_EMP	Customer development version	This version has no program firmware module, users can develop their own firmware to meet their own products according to Dialog's official chip information and support documents, when in bulk, simply provide us with firmware to burn or burn it yourself.

## 1 Introduction

HJ-531IMF series 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.

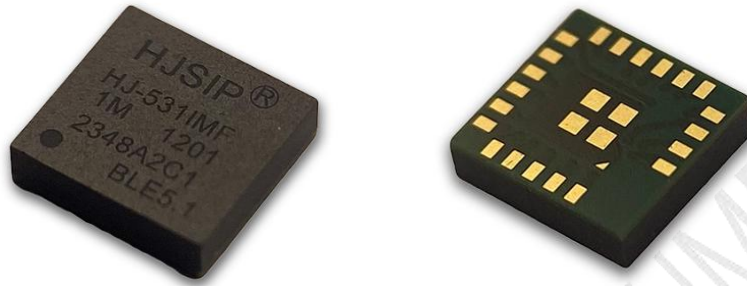


Figure 1.1: HJ-531IMF Top and bottom view

## 2 Product overview

### 2.1 Key features

Table 2-1: HJ-531IMF key characteristics

Characteristic	Description
Function	<ul style="list-style-type: none"> <li>- Supports BLE 5.1, embedded Bluetooth Low Energy stack and GATT services</li> <li>- 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)</li> <li>- Built in standard firmware, supports 1-way, supports multiple command configurations for BLE modules</li> </ul>
Memory and ROM	<ul style="list-style-type: none"> <li>- Built-in 32KB OTP</li> <li>- Built-in 48KB of RAM</li> <li>- Contains 1Mb(P25Q10)[some 4Mb(P25Q40)] FLASH to store user programs and OTA usage</li> </ul>
supply voltage	High voltage mode 1.8V~3.6V; Low voltage mode 1.1V~1.65V; 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	<ul style="list-style-type: none"> <li>- The operating frequency is 2.4GHz, which supports the ISM free band</li> <li>- Transmit power: -19.5dBm ~ +2.5dBm adjustable</li> <li>- High receiving sensitivity: -94dbm</li> <li>-TX peak current &lt; 3.5mA; RX peak current &lt;2.2mA;</li> <li>- Wireless transmission distance of the built-in antenna in open areas: 5~10 meters</li> <li>- Wireless transmission distance of external antenna in open areas: 40~80 meters</li> </ul>
Size	Regular style:5mm*4.75mm*1.3mm (including antenna) Ultra-thin: 5mm*4.75mm*1mm (including antenna)
Package	Package: LGA25; Pad spacing: 0.6mm; Pad size: 0.3mm*0.48mm
Weight	1.5g
power consumption	<ul style="list-style-type: none"> <li>- Sleep current &lt; 2μA</li> <li>- 1-second interval broadcast current 7μA(0dBm)</li> <li>- 2-second interval broadcast current 3.8μA(0dBm)</li> <li>- 20ms Connection gap current 65uA(0dBm)</li> </ul>

	- 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

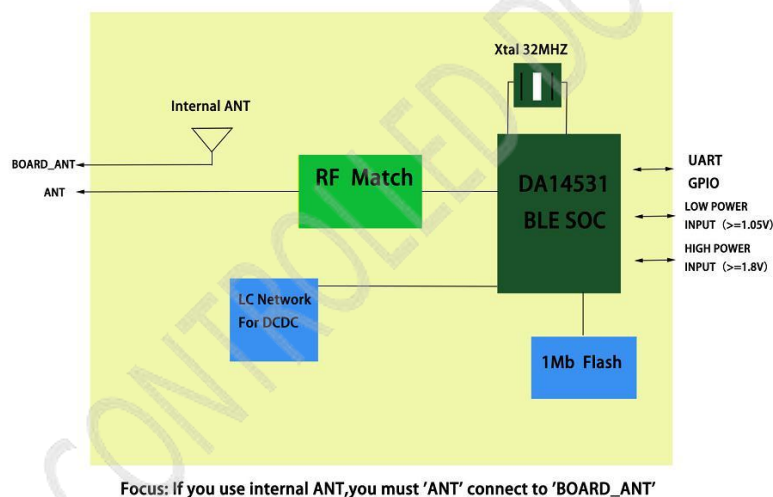


Figure 2.1: HJ-531IMF functional block diagram

## 2.4 Pins distribution diagram

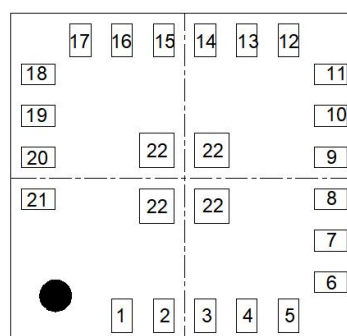


Figure 2.2: HJ-531IMF Pins distribution diagram(front view)

## 2.5 Pins description table

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

PIN	Name	Type	Description	Remarks
1	P0.9 (connection status)	GPIO (OUTPUT)	GPIO	When BLE is connected to a host,output HIGH=1; When BLE is disconnected, output LOW=0.
2	P0.7 (APP data arrival alert)	GPIO (OUTPUT)	GPIO	When the BLE is connected, the APP sends data to the BLE module, and the pin outputs a high level. When all the data is sent from the serial port, the pin outputs a low level. When idle, the pin remains low.
3	P0.5 (serial port TX)	GPIO (OUTPUT)	GPIO	Default it is the UART serial port TX data output pin.
4	P0.8 (Serial port receive enable/serial port RX)	GPIO (INPUT)	GPIO	By default, the pin is the enable pin for serial port receiving. The function of serial port receiving can be enabled if the external high level is raised by more than 1ms. After serial port receiving is enabled, the pin becomes the function of serial port RX, which can carry out normal data and command sending and receiving.
5	P0.2/C	GPIO/Debugger	GPIO	/
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-3.6V
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	P00/RST	GPIO/RST	Reset pin	High level 1 reset; Dangling or low 0 works properly
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	Internal matching circuit has been integrated, if use internal antenna, you can directly short 20 and 21 pins
22	GND	Ground	power input GND	negative pole GND



Note: The parentheses indicate the built-in standard transparent firmware function. If it is an empty chip, have no this function.

### 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

Simply short-circuit PIN20 and PIN21 to enable the internal high-performance antenna, as shown in Figure 3.1 below, with an open communication distance of 5-10 meters.

It should be noted that no device or cable should be placed near the antenna, no device should be placed on the back of the module, the copper coating should avoid the internal antenna area, and the copper coating of the module GND should be large enough.

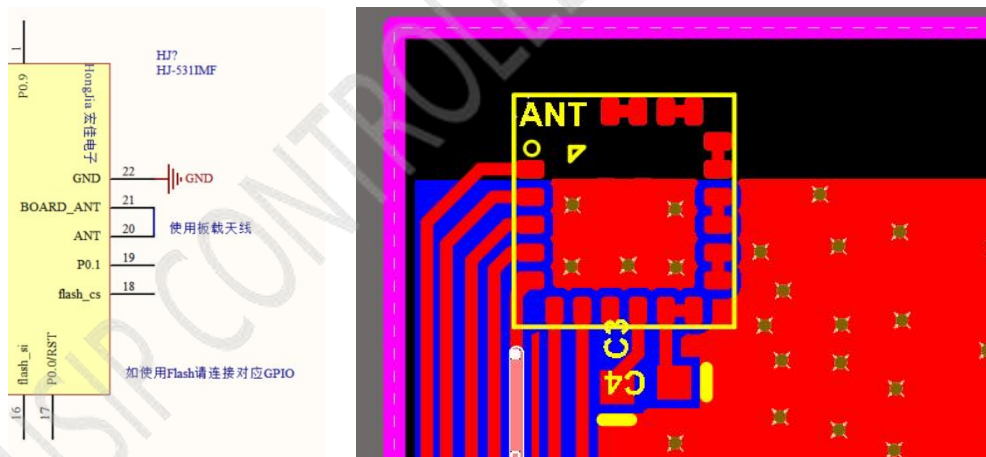


Figure 3.1: Use the module's built-in antenna

##### 3.2.2 Use the external antenna wiring diagram

The PIN21 is suspended, and the PIN20 is connected to the PCB antenna through a  $\pi$ -type filter circuit, as shown in Figure 3.2 below. The communication distance in open ground can reach 40~80 meters.

It should be noted that the device can not be placed near the antenna, can not be routed, the device

can not be placed on the back of the module, the copper coating should cover the module and PI filter circuit, avoid the PCB antenna.

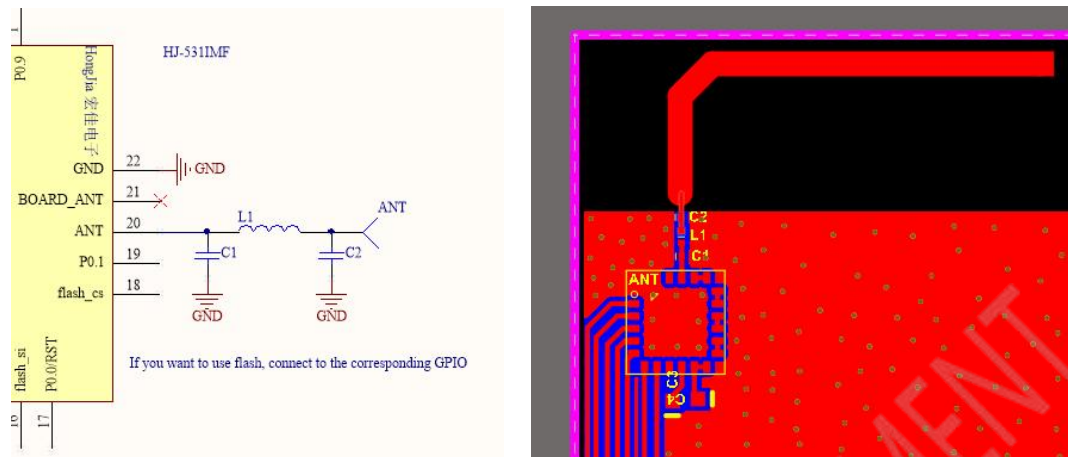


Figure 3.2: Use an external antenna

### 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	/
Transmission power	Max: +2.5dBm	/
Emission current	TYP: 3.5mA	/
Receive current	TYP: 2.2mA	/
Receiving sensitivity	TYP: -94dBm, Max: -95dBm	/
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	1.05	3.8	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	1.8(1.1)	3.3(1.5)	3.6(1.65)	V
IO Supply Voltage	0	3.3(1.8)	VCC	V
Dormant working current	/	<2	/	μA
Maximum Operating Current@+22dBm	/	0.4	/	mA
Operating Temperature	-40	+25	+85	°C

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

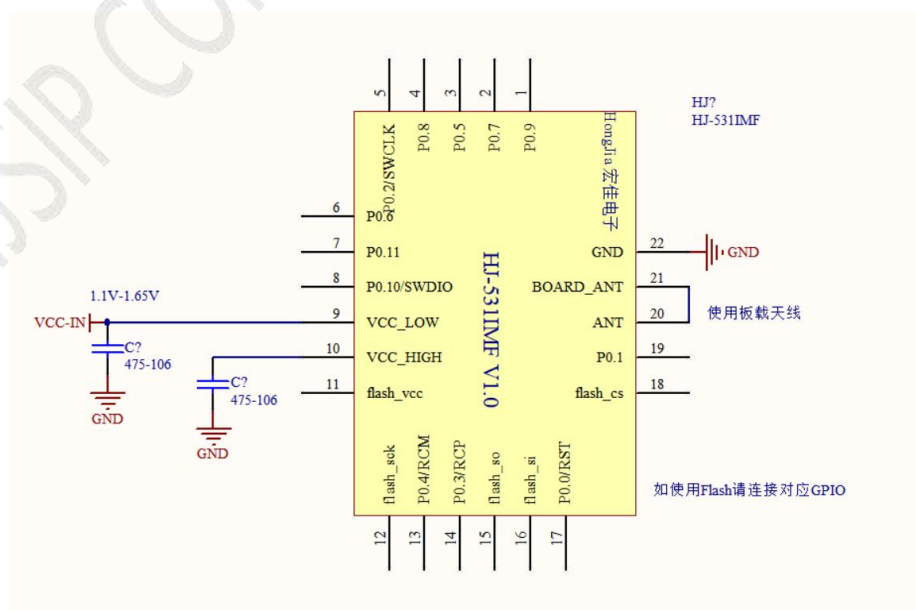
IO Pin	Drive capability	Min	Max	Unit
Input low level	/	0	0.4	V
Input high level	/	0.7	VCC	V
Output low level	5mA	0	0.6	V
Output high level	5mA	3.3	VCC	V

**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**

## 5.2 High voltage mode (range: 1.8V-3.6V)

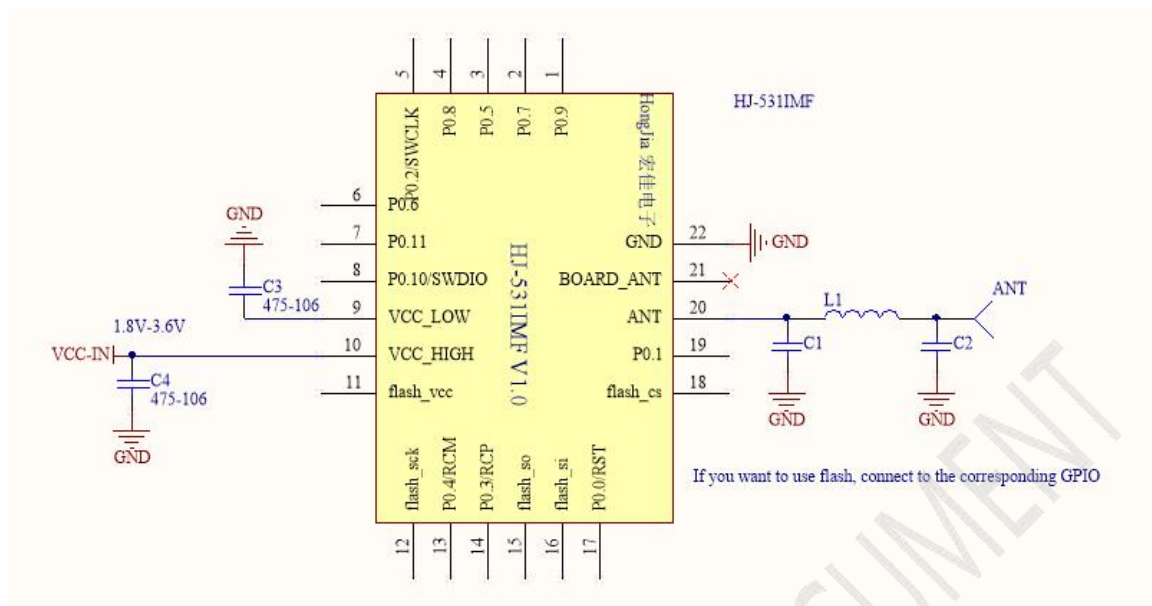


图 5.4: HJ-531IMF High voltage power supply mode

## 5.3 Use internal Flash for program storage or OTA implementation

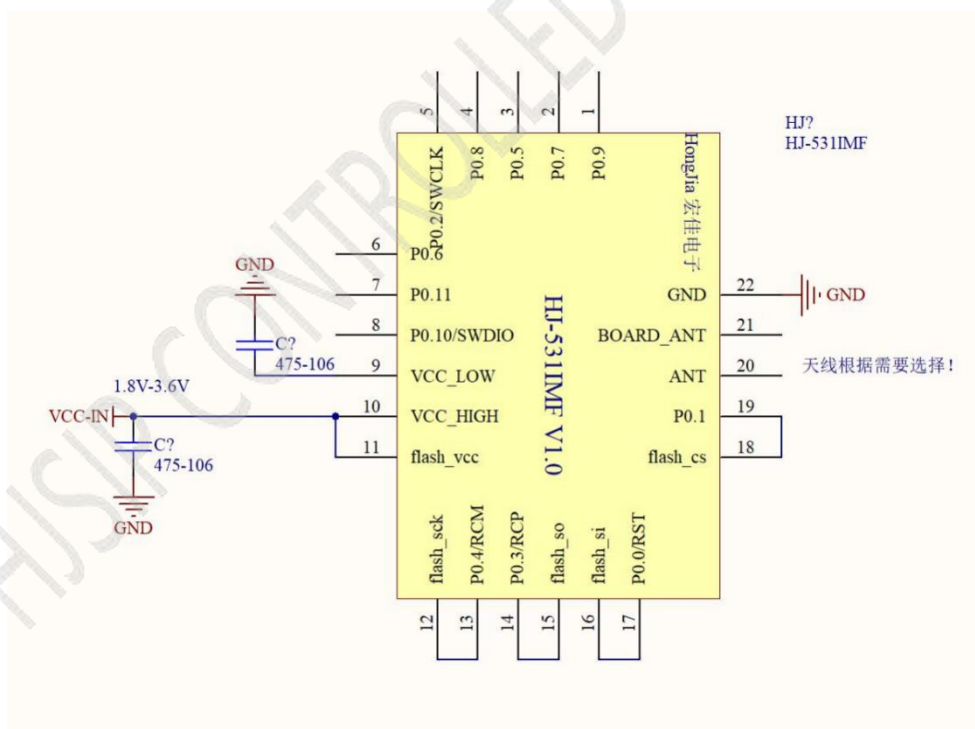


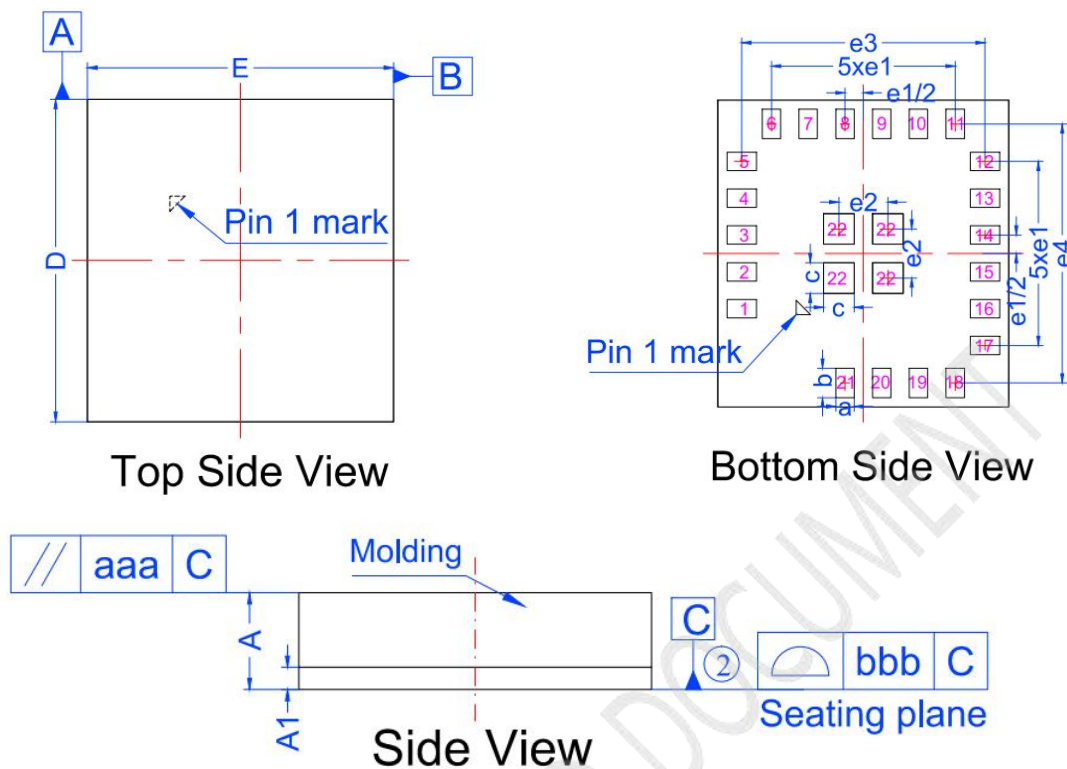
Figure 5.5: Use internal flash for program storage or OTA implementation

## 5.4 Notices for Hardware Design

- All I/O ports can be used. Please check the pin diagram for all pins and note the IO mode and status connected to them.

- It is recommended that the input power supply be filtered by magnetic beads or inductance. We have added PI filter to the power input, L? You can choose resistance or inductance, of course, if the space is limited, you can also not add, directly external parallel a 475-106uF capacitor can be.
- The filter capacitors C1 and C2 should be placed as close as possible to the power input pins of the module.
- When using the external antenna, be sure to contact us and let us confirm that your external PCB antenna or IPEX outgoing antenna PCB design is reasonable.
- Modules should not be placed in a metal housing, and if a metal housing must be used, the antenna must be removed.
- In products that require the wireless module, some metal components such as screws, inductors, etc. should be kept as far away as possible from the RF antenna part of the wireless module.
- Do not place other components near or on the back of the antenna of the Bluetooth module, and do not route cables. Placing devices or wiring will affect Bluetooth performance.
- module antenna should be placed on the four edges of the circuit board, the antenna part is close to the edge or corner of the main board, it is best to place the module in the corner of the circuit board.
- Cover all layers of the circuit board with copper for GND. Ensure that the copper covering area of the modules, especially the antenna, is large enough and well grounded.
- Holes should be drilled in the copper-covered area of the entire circuit board, especially in the vicinity of the module and antenna.
- If there are high-power devices or high-voltage conversion circuits on the circuit board, the GND copper covering of modules must be isolated from those of other parts, connected in single-point ground mode, and perforations must be drilled as many as possible to reduce interference to radio signals.
- Unnecessary pins can be left hanging.

## 6 Dimension figure



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!

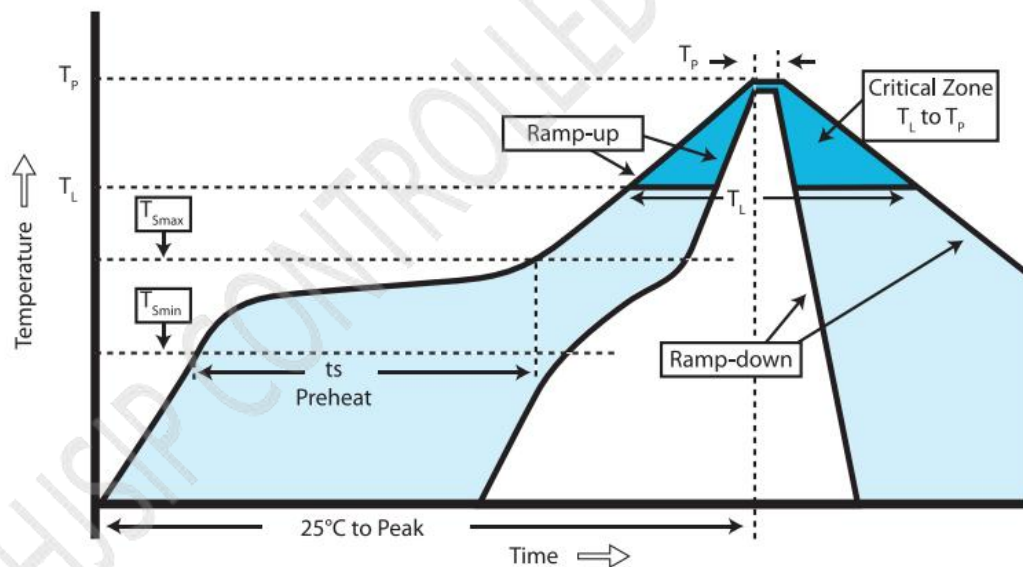
For specific ultrasonic welding matters, please contact our company for technical consultation.

## 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( $T_{Smax}$ to $T_p$ )	max3°C/sec. max
Temperature Min( $T_{Smin}$ )	150°C
Temperature Max( $T_{Smax}$ )	200°C
Preheat time (Min to Max) ( $t_S$ )	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.

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

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