HJSIP®

HJ-N54L_SM series modules_Hardware Design Manual

Based on NRF54L15/NRF54L10/NRF54L05
10*10mm
Ultra-low-cost BLE 6.0 module

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Preface

Thank you for using the Bluetooth module provided by HJSIP. The HJ-N54L_SM series modules are a set of high-performance BLE 6.0 Bluetooth modules.The module adopts LGA42 packaging and supports both onboard and external antennas. The product also has features of low power consumption, small size and strong anti-interference ability, and is 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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Contents

Version History

Version	Date	Change Description	Reviser	Reviewer
V1.0	2025/08/20	The first version.	WYW	LMY
V1.1	2025/10/09	Table 2-1: "Ultra-Low Power Multi-Protocol 2.4GHz Radio" is changed to "Ultra-Low Power Multi-Protocol 2.4GHz Wireless Transceiver"	WYW	LMY

Applicable module selection

No.	Module model	Type	Description
1	HJ-N54L_SM_15	NRF54L15	Based on NRF54L15，support Bluetooth LE、Channel Sounding、Bluetooth Mesh、Zigbee、Thread、Matter、Amazon Sidewalk and 2.4GHz proprietary protocols，**1.5MB NVM and 256KB RAM**
2	HJ-N54L_SM_10	NRF54L10	Based on NRF54L10，support Bluetooth LE、Channel Sounding、Bluetooth Mesh、Zigbee、Thread、Matter、Amazon Sidewalk and 2.4GHz proprietary protocols，**1.0MB NVM and 192KB RAM**
3	HJ-N54L_SM_05	NRF54L05	Based on NRF54L05，support Bluetooth LE、Channel Sounding、Bluetooth Mesh、Zigbee、Thread and 2.4GHz proprietary protocols，**0.5MB NVM and 96KB RAM**

1 Introduction

The HJ-N54L_SM series module is a set of high-performance IoT Bluetooth transceivers.The module adopts LGA42 packaging and supports both onboard and external antennas. The product also has the features of low power consumption, small size and strong anti-interference ability, and is suitable for a variety of application scenarios.

2 Product overview

2.1 Key features

Table 2-1：HJ-N54L_SM key characteristics

Characteristic	Description
Function	- Ultra-low-power multiprotocol 2.4GHz wireless transceiver - Integrated multi-purpose MCU functionality - 128 MHz Arm Cortex-M33 processor - Comprehensive set of peripherals,including new Global RTC available in System OFF, 14-bit ADC, and high-speed serial interfaces - Secure boot, secure firmware update, secure storage - Cryptographic accelerator with side-channel leakage protection,tamper detectors
Size	10mm * 10mm（W*L，include onboard antenna）
Package	LGA42
Wight	0.5g
Power Supply	1.7V-3.6V
Low power consumption	Sleep current＜1uA
RF characteristics	- Working frequency 2.4GHz, supporting the free ISM band - output power:-8dBm～+8dBm - sensitivity:-96dBm（1Mbps） - TX current(0dBm)：TYP. 4.8mA - RX current：TYP. 3.4mA - The transmission distance of the built-in antenna in open areas：20~50m - The wireless transmission distance of the external antenna in open areas：50~120m
GPIO port	Max. 31
Operation Temperature	-40 ～ +105℃
Storage Temperature	-40 ～ +125℃
Product Certification	Comply with the ROHS standard

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

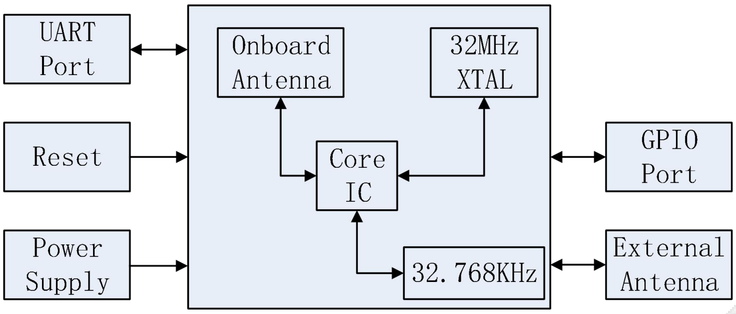

Figure 2.1: HJ-54L_SM functional block diagram

2.4 Pins distribution diagram

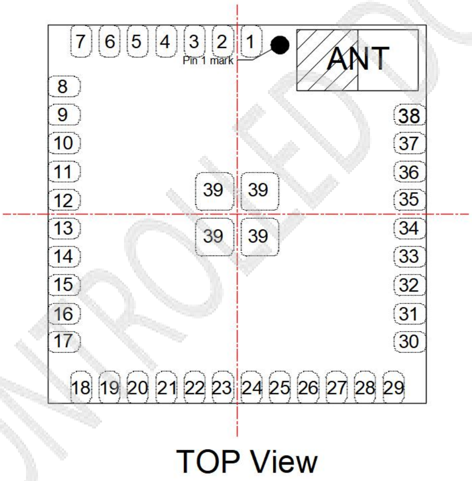

Figure 2.2: HJ-N54L_SM pins distribution diagram(top view)

2.5 Pins description table

Table 2-2: HJ-N54L_SM pins definition table

PIN	Name	Type	Description
1	OB-ANT	Onboard ANT	On-board antenna interface An internal matching circuit has been integrated. If using the built-in antenna, simply connect PIN1 to PIN2; Depending on your product structure, to achieve the best antenna effect, an additional PI is required. Please refer to 3.2.1 for details.
2	EXT-ANT	RF OUTPUT	RF signal output. If the space is sufficient, it is advisable to add a PI circuit to connect to an external antenna.
3	GND	Power	Power GND
4	P1.09	I/O	GPIO
5	P1.10	I/O	GPIO
6	P1.11	I/O	GPIO

7	P1.12	I/O	GPIO
8	P1.13	I/O	GPIO
9	P1.14	I/O	GPIO
10	P2.07	I/O	GPIO
11	P2.06	I/O	GPIO
12	P2.05	I/O	GPIO
13	P2.04	I/O	GPIO
14	P2.03	I/O	GPIO
15	VCC	Power	Power in，1.7-3.6V
16	P1.01	I/O	GPIO
17	P1.00	I/O	GPIO
18	P2.02	I/O	GPIO
19	P1.02	I/O	GPIO
20	P1.03	I/O	GPIO
21	P1.04	I/O	GPIO
22	P1.05	I/O	GPIO
23	P1.06	I/O	GPIO
24	P1.07	I/O	GPIO
25	P1.08	I/O	GPIO
26	P2.00	I/O	GPIO
27	P2.01	I/O	GPIO
28	P2.08	I/O	GPIO
29	P2.09	I/O	GPIO
30	P0.01	I/O	GPIO
31	P2.10	I/O	GPIO
32	P0.00	I/O	GPIO
33	P0.04	I/O	GPIO
34	P0.03	I/O	GPIO
35	P0.02	I/O	GPIO
36	SWDCLK	Debug	Programming and debugging interface clock
37	SWDIO	Debug	Simulation debugging port
38	NRST	RESET	Reset pin, low level effective, low level duration > 1 second **Note:** The RST pin must be connected to the I/O. If it is not connected, a 1K strong pull-up resistor must be added.
39	GND	Power	Power GND

3 RF Features

The module set two ways: onboard antenna and external antenna. You can choose one of them.

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 onboard antenna wiring diagram

An internal matching circuit has been integrated. If using the onboard antenna, simply connect PIN1 and PIN2;

Depending on your product structure, to achieve the best antenna effect, an additional PI is required. Connect PIN1 to PIN2 through a π-type filter circuit. Then you can use the internal high-performance antenna, as shown in Figure 3.1. The communication distance in open areas is 20 to 50 meters.

It is important to note that no devices should be placed near the antenna, no wires should be routed, no devices should be placed on the back of the module, and copper should avoid the area of the onboard antenna. (Except for the antenna part) the copper on the back of the module should be large enough for the GND, and the antenna should be given as much clearance as possible.

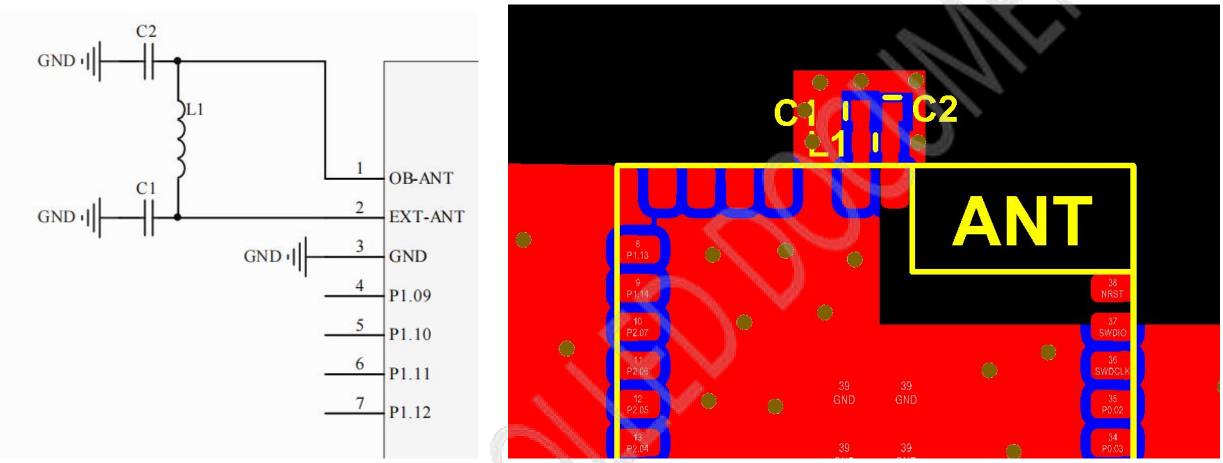

Figure 3.1： Use the module's onboard antenna

3.2.2 Use the external PCB antenna wiring diagram

The PIN1 is suspended, and the PIN2 is connected to the PCB antenna through a π filter circuit, as shown in Figure 3.2 below, and the communication distance in open ground can reach 50~120 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.

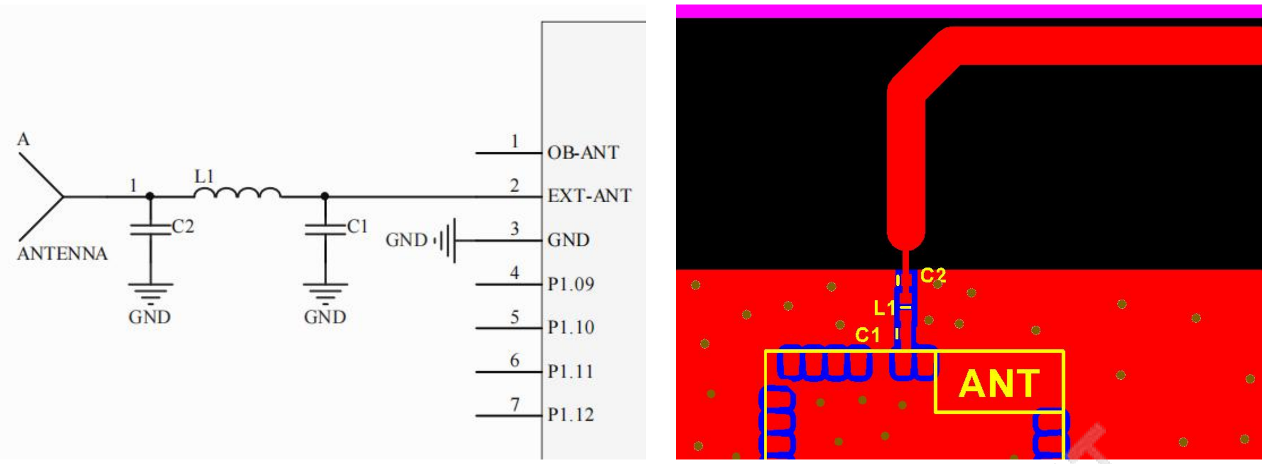

Figure 3.2：Use the external antenna

3.3 RF Features

Table 3-1：RF features

Attribute	Value	Remarks
Wireless modulation mode	(G)FSK	/
Frequency range	2.402 - 2.480Ghz	bandwidth：2MHz
Number of channels	40	/
Air speed	1Mbps 2Mbps 125Kbps 500Kbps	/
Rf port impedance	50 Ohm	/
Transmission power	Max. +8dbm	/
TX current	TYP. 4.8mA	@+0dBm 1Mbps
RX current	TYP. 3.4mA	@1Mbps
Sensitivity	TYP. -96dbm	1Mbps
Antenna	Onboard antenna	An external antenna can also be connected

4 Electrical Parameters

4.1 Absolute Maximum Ratings

Table 4-1：Absolute Maximum Ratings

Parameter	Min.	Max.	Unit
VCC	1.7	3.9	V
VCC(extended operating temperature)	1.7	3.7	V
$V_{I/O}$	0	VCC+0.3(3.9)	V
$V_{I/O}$(extended operating temperature)	0	VCC+0.3(3.7)	V
Storage temperature	-40	+125	℃

4.2 DC Characteristics

Table 4-2：Recommended Operating Conditions

Parameter	Min.	Typ.	Max.	Unit
VCC	1.7	3.3	3.6	V
VCC(extended operating temperature)	1.7	3.3	3.4	V
Sleep current	/	＜1	/	uA

operating temperature	-40	/	+85	℃
extended operating temperature	+85	/	+105	℃

Table 4-3：Dc features of I/O ports

IO Pin	Drive capability	Min.	Max.	Unit
Input low level	/	0	0.3*VCC	V
Input high level	/	0.7*VCC	VCC	V
Output low level	0.5mA	0	0.4	V
Output high level	5.0mA	VCC-0.4	VCC	V

5 Notices for Hardware Design

- The module antenna should be placed at the edge of the circuit board,close to the main board edge or corner. It is best to place the module in the corner of the circuit board.
- No other components should be placed near the antenna of the Bluetooth module or on its back, and no traces should be routed there, otherwise it will affect the Bluetooth performance.
- Each layer of the circuit board should be fully covered with copper and connected to GND, and the copper coverage area should be large enough (except for the antenna part), and well grounded.
- As many vias as possible should be drilled in the copper coverage area of the entire circuit board, especially near the module and antenna.
- If there are high-power devices or high-voltage conversion circuits on the circuit board, the GND copper coverage of the module should be isolated from the GND copper coverage of other parts, and connected by a single point grounding method. As many vias as possible should be drilled to reduce interference to the RF signal.
- The module should not be placed in a metal shell. If a metal shell must be used, the antenna should be led out.
- For products with this Bluetooth module, some metal components such as screws and inductors should be kept as far away as possible from the RF antenna part of the Bluetooth module.
- The filter capacitor at the power supply should be placed as close as possible to the power input pin of the module. If it is capacitor-powered or space is limited, the filter capacitor at the power input can be removed as the module has an internal filter capacitor.
- Please refer to the pin diagram for all pins and pay attention to the IO mode and status of the IO connected to them.
- When the input power is not battery power ,and mains power with voltage reduction, it is recommended to use a magnetic bead or inductor for filtering in series.
- Unused pins can be left floating.

6 Mechanical specifications

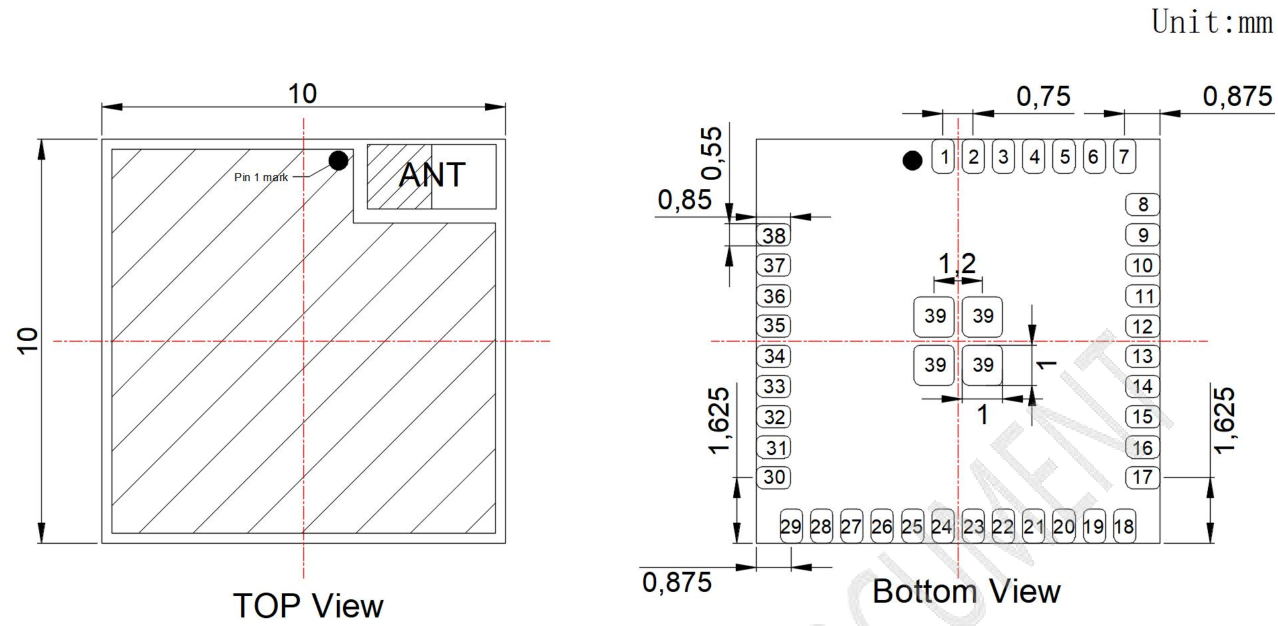

Figure 6.1： HJ-N54L_SM **dimension**

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-N54L_SM series modules 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 Tp)	max3°C/sec. max
Temperature Min(T_{Smin})	150°C
Temperature Max(TSmax)	200°C
Preheat time (Min to Max) (tS)	80~100sec
Peak Temperature (T_P)	250±5°C

Ramp-down Rate	6℃/sec. max
Time 25℃ to Peak Temp (TP)	8 min. max

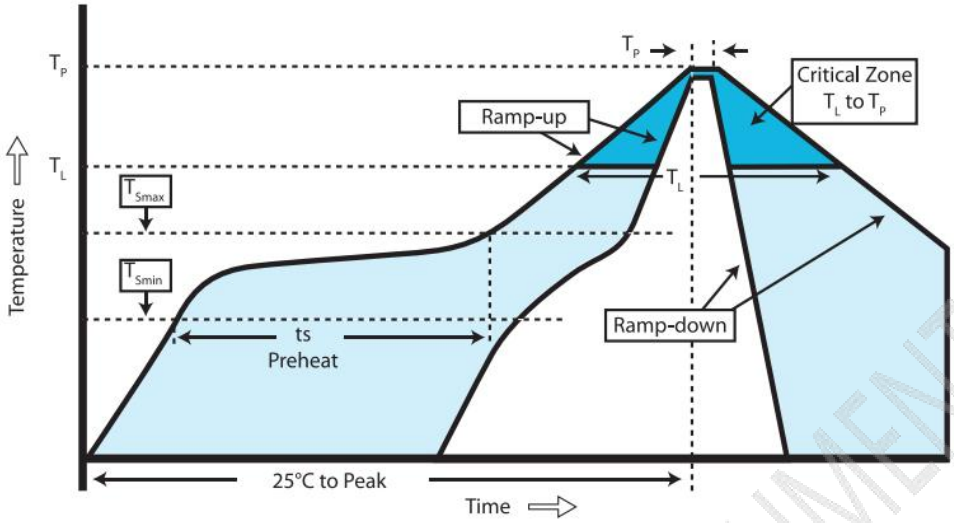

Figure 7.1： Temperature Curve of Reflow Welding

7.3 Humidity sensing properties

The HJ-N54L_SM series modules have a humidity sensitivity of level 3.

If any of the following two conditions are met, the HJ-N54L_SM 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
HJ-N54L_SM_XX	Roll tape

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℃)
【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