

Lierda BT18N module Hardware Design Manual

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Federal Communication Commission

Interference Statement

This device complies with Part 15 of the 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.

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 generates, 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 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.

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

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

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.

2. The transmitter module may not be co-located with any other transmitter or antenna. As long as the two conditions above are met, additional transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required for the installed module.

Important Note:

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the Federal Communications Commission of the U.S. Government (FCC) and the Canadian Government authorizations are no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator shall be responsible for re-evaluating the end-product (including the transmitter) and obtaining a separate FCC authorization in the U.S. and Canada.

OEM Integrators - End Product Labeling Considerations:

This transmitter module is authorized only for use in device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following: "Contains, FCC ID: 2AOFDL-BT18N". The grantee's FCC ID can be used only when all FCC compliance requirements are met.

OEM Integrators - End Product Manual Provided to the End User:

The OEM integrator shall not provide information to the end user regarding how to install or remove this RF module in e

nd product user manual. The end user manual must include all required regulatory information and warnings as outlined in this document.

Revision History

Document version	Change Date	Reviser	Reviewer	Change content
Rev1.0	25-08-21	CJH	LSS	Initial version.
Rev1.1	25-08-26	CJH	LSS	Figure 4.4 Module placement recommendation update. Update on Standby Current Explanation in Section <5.2 DC Characteristics>.
Rev1.2	25-09-16	CJH	LSS	Add explanation for the opening of the shield cover in section <7.1.4 Production Notes>. Update on <7.1.5 Reflow Soldering Operation Guide>. Add section <7.1.6 Maintenance>.

Safety Instructions

Users are responsible for complying with the relevant regulations on wireless communication modules and devices in other countries and specific environmental regulations for use. By following the following safety principles, personal safety can be ensured and help protect products and work environments from potential damage. Our company is not responsible for any related losses caused by customers' failure to comply with these regulations.



Safety first on the road! Do not use handheld mobile devices while driving unless they have a hands-free function. Please pull over before making a call!



Please turn off your mobile devices before boarding. The wireless function of mobile devices is prohibited from being turned on during the flight to prevent interference with the aircraft communication system. Ignoring this prompt may compromise flight safety and even violate the law.



When in a hospital or healthcare facility, pay attention to whether there are restrictions on the use of mobile terminal devices. RF interference can cause medical equipment to malfunction, so it may be necessary to turn off mobile terminal devices.



Mobile terminal devices do not guarantee effective connection in any situation, such as when there is no phone credit or the SIM card is invalid in the mobile terminal device. When you encounter the above situation in an emergency, remember to use emergency calls, and ensure that your device is turned on and in an area with sufficient signal strength.



Your mobile terminal device will receive and transmit radio frequency signals when booting up, which may cause radio frequency interference when close to a TV, radio, computer, or other electronic devices.



Please keep the mobile terminal device away from flammable gases. When you are near gas stations, oil depots, chemical plants, or explosive operation sites, please turn off the mobile terminal device. Operating electronic devices in any potentially explosive hazardous area poses a safety risk.

Module selection for application

Serial Number	Module model	Support frequency band	Dimensions (mm)	Module introduction
1	BT18N	2.4 GHz ISM Band	19×12.9×3	PCB antenna, hardware module without software

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1 Introduction

BT18N is a low-power, high-performance IoT Bluetooth, 802.15.4, and proprietary 2.4G protocol module, supporting BLE 6.0, 802.15.4-2020, and up to 4 Mbps proprietary 2.4 GHz mode. The module adopts a stamp-type package with onboard PCB antenna design. The product also features low power consumption, small size, rich resources, strong anti-interference capability, and other characteristics.



Figure 1.1 Module Schematic

2 Product Overview

2.1 Key Features

Parameters	Explanation
N/A	BLE 6.0
Working frequency band	2400~2483.5MHZ(2.4GHz ISM Band)
Antenna	On-board PCB antenna
Dimensions	19 mm × 12.9 mm × 3 mm
Operating voltage	1.7V to 3.6V, typical value 3.3V
Launch current	5 mA@0 dBm, 3.3V, Typ
Receive current	3.2 mA@1M, 3.3V, Typ
Standby current	0.6 uA@3.3V, Typ
Transmit power	-46 ~ +8dBm
Operating temperature	-40 ~ +105°C
Storage temperature	-40 ~ +125°C
Communication Interface	UART
Internal storage	1524KB RRAM +256KB RAM

2.2 Application Scenarios

- 2.4GHz low power Bluetooth system;
- PCs, tablets, mobile phones, handheld devices, and other low-power peripheral devices (HID, remote controls, etc.);
- Sports, healthcare, and other consumer electronics products;
- Smart meters, data collection, and other wireless sensor networks;
- Photovoltaic, charging piles, industrial instruments, and other industries;
- Smart home, LAN, interactive devices, beacon lights.

2.3 Function block diagram

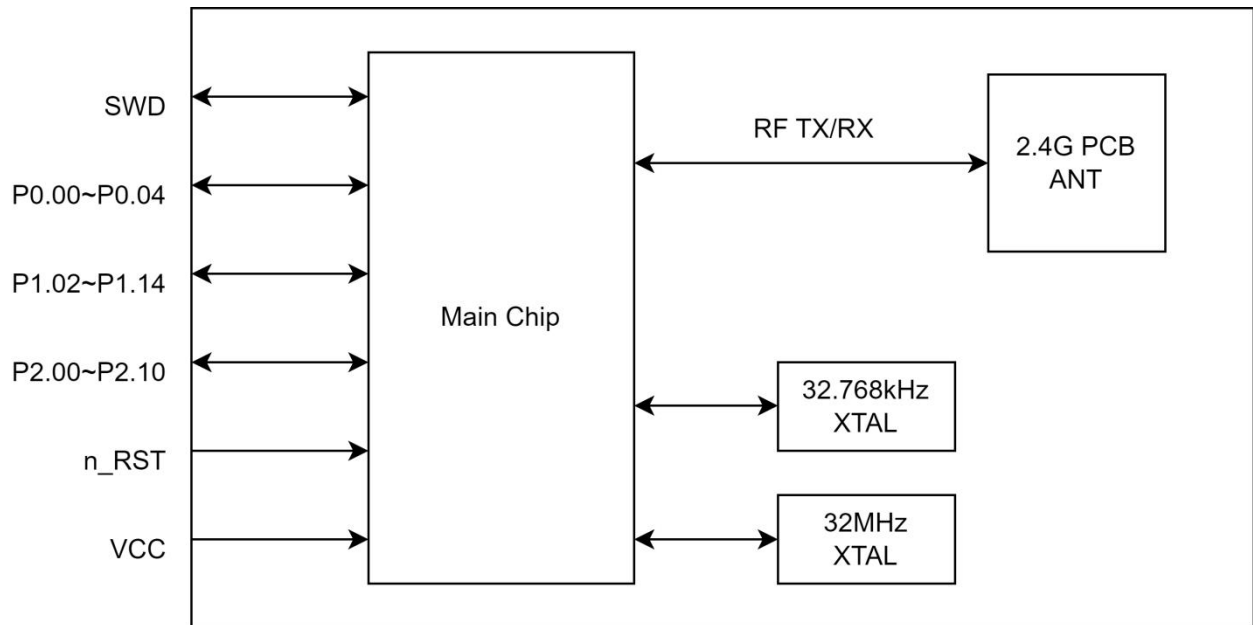


Figure 2.1 Functional Block Diagram

Note

(1) The antenna design of this model module is in the form of an onboard PCB antenna;

(2) The module is designed with an internal 32.768KHz crystal oscillator.

2.4 Pinout diagram

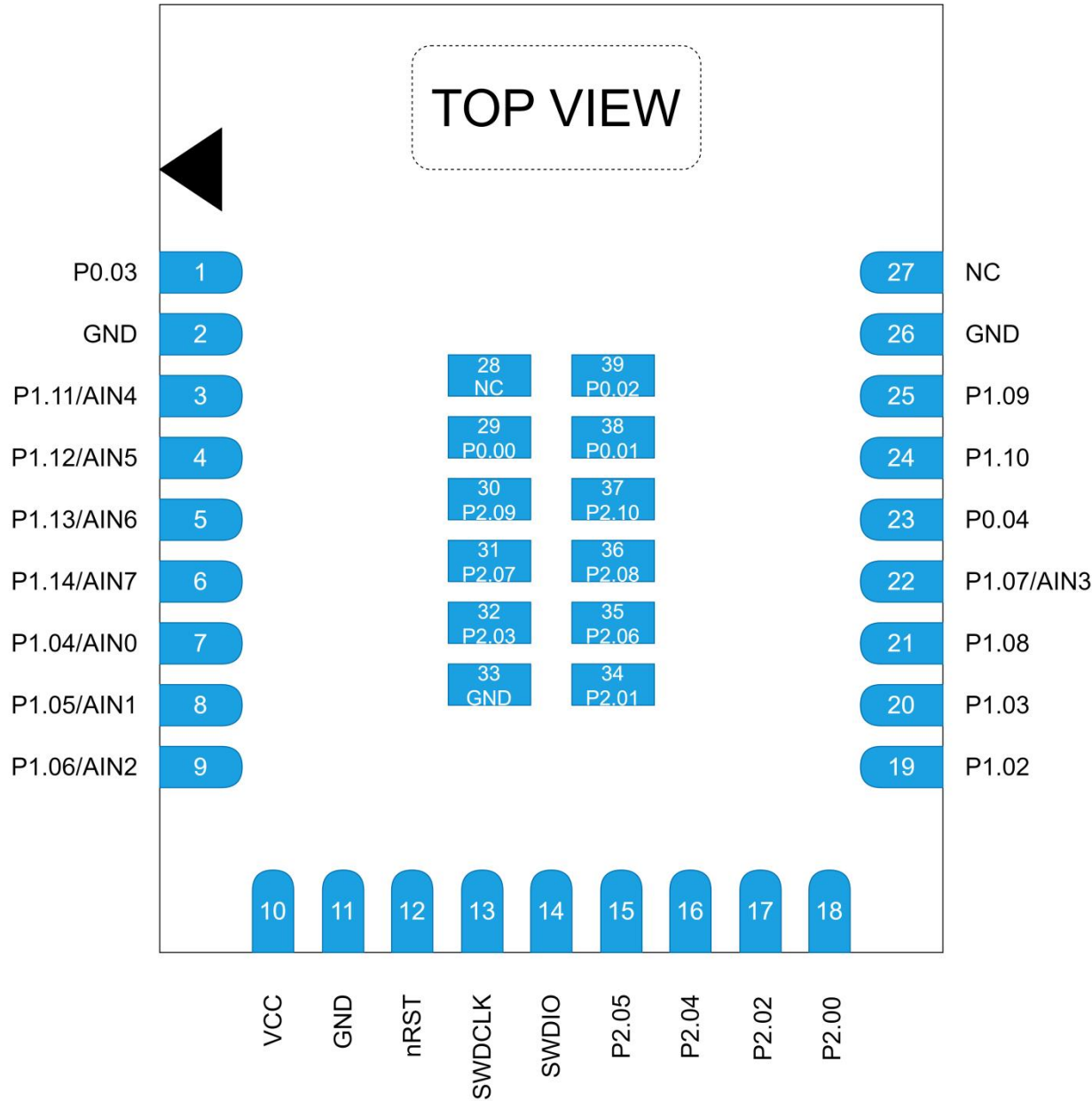


Figure 2.2 Pinout Diagram

2.5 Pin Description Table

Pins	Pin definition	I/O Type	Voltage	Function Description
1	P0.03	IO	VCC	P0.03/GRTCPWM
2	GND	G	-	GND
3	P1.11	IO	VCC	P1.11/ASO[3]/RADIO[2]/AIN4
4	P1.12	IO	VCC	P1.12/ASI[3]/RADIO[3]/AIN5
5	P1.13	IO	VCC	P1.13/RADIO[4]/AIN6
6	P1.14	IO	VCC	P1.14/RADIO[5]/AIN7
7	P1.04	IO	VCC	P1.04/ASO[0]/AIN0
8	P1.05	IO	VCC	P1.05/ASI[0]/RADIO[6]/AIN1
9	P1.06	IO	VCC	P1.06/ASO[1]/AIN2
10	VCC	P	3.3V	Main power input
11	GND	G	-	GND
12	nRST	IO	VCC	Low-level reset
13	SWDCLK	IO	VCC	SWD clock
14	SWDIO	IO	VCC	SWD data
15	P2.05	IO	VCC	P2.05
16	P2.04	IO	VCC	P2.04
17	P2.02	IO	VCC	P2.02
18	P2.00	IO	VCC	P2.00
19	P1.02	IO	VCC	P1.02/NFC1
20	P1.03	IO	VCC	P1.03/NFC2
21	P1.08	IO	VCC	P1.08/CLK16M/EXTREF
22	P1.07	IO	VCC	P1.07/ASI[1]/AIN3
23	P0.04	IO	VCC	P0.04/GRTCLFCLKOUT
24	P1.10	IO	VCC	P1.10/ASI[2]/RADIO[1]
25	P1.09	IO	VCC	P1.09/ASO[2]/RADIO[0]
26	GND	G	-	GND

27	NC	-	-	NC
28	NC	-	-	NC
29	P0.00	IO	VCC	P0.00
30	P2.09	IO	VCC	P2.09/TRACEDATA[2]
31	P2.07	IO	VCC	P2.07/TRACEDATA[0]/SWO
32	P2.03	IO	VCC	P2.03
33	GND	G	-	GND
34	P2.01	IO	VCC	P2.01
35	P2.06	IO	VCC	P2.06/TRACECLK
36	P2.08	IO	VCC	P2.08/TRACEDATA[1]
37	P2.10	IO	VCC	P2.10/TRACEDATA[3]
38	P0.01	IO	VCC	P0.01
39	P0.02	IO	VCC	P0.02

“P”:POWER “IO”:INPUT or OUTPUT “G”:GND

3 Job characteristics

3.1 Power supply design

3.1.1 Power interface

The VCC pin is used to connect an external power supply, the interface is described in the table below:

Table 3-1 Power Supply Pin Definitions

Pin number	Pin definition	Description	Minimum value V	Typical value V	Maximum value V
10	VCC	Module power	1.7	3.3	3.6

The module's power supply range is 1.7~3.6V, ensuring that the operating voltage is not lower than 1.7V.

3.1.2 Power supply design

The BT18N module power pins are recommended to use 10uF and 0.1uF decoupling capacitors. The capacitors should be placed as close as possible to the VBAT (VCC) power pin. The power supply voltage range requirement is 1.7~3.6V, typically powered by 3.3V. It is recommended to control the power ripple within 1% of VCC to avoid performance degradation of the module due to excessive ripple.

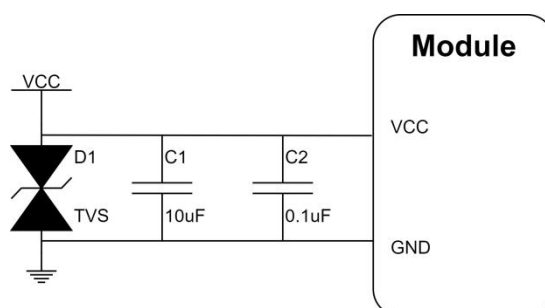


Figure 3.1 Power Supply Recommended Circuit

Note

D1 is used for electrostatic protection. Users need to pay attention to the electrostatic

requirements of the product during design, as shown in Table 6-1 Product Absolute Maximum Ratings. If higher protection requirements are needed, it is recommended to place TVS diodes externally for electrostatic protection.

3.2 Reset Interface

Table 3-2 Reset Pin Definition

Pin number	Pin definition	Function Description
12	nRST	Reset pin, internally configurable with a 14k Ω (typical) pull-up resistor.

3.2.1 Reset reference design

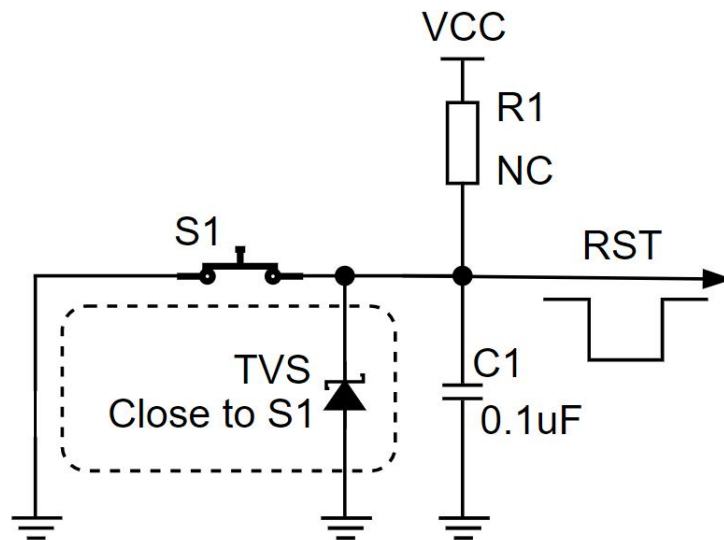


Figure 3.2 Reset Reference Circuit

Note

- ◆ The reset line should not be too long, pay attention to grounding protection, and keep away from RF, VCC power sources, and strong signal interference sources.
- ◆ It is recommended to reserve a 10K pull-up resistor on the RESET pin of the module by default without soldering.

3.3 SWD debugging interface

3.3.1 SWD interface

Table 4-9 SWD Pin Definitions

Serial Number	Pin definition	Function Description
13	SWDCLK	Clock pin in SWD mode
14	SWDIO	SWD mode data pin

Modules can be directly connected to the SWD interface for debugging and firmware burning using Jlink.

3.4 Crystal oscillator matching capacitor configuration

The module design uses internal capacitor matching with internal crystal oscillator of the chip. When in use, corresponding registers need to be configured to avoid excessive frequency deviation of the crystal oscillator, ensuring normal operation.

3.4.1 Low-frequency crystal oscillator (32.768kHz) internal matching capacitance configuration

Low-frequency crystal oscillator needs to configure the internal capacitor register value as 14000, namely:

load-capacitors = "internal";

load-capacitance-femtofarad = <14000>;

As shown in the picture:

```

C: > ncs > v2.9.1 > zephyr > boards > nordic > nrf54l15dk > nrf54l05_10_15_cpuapp_common.dtsi
11 / {
12     <crystal> {
21     };
22 };
23
24 &cpuapp_sram {
25     status = "okay";
26 };
27
28 &lfxo {
29     load-capacitors = "internal";
30     load-capacitance-femtofarad = <14000>;
31 };
32
33 &hfxo {
34     load-capacitors = "internal";
35     load-capacitance-femtofarad = <15000>;
36 };
37
38 &regulators {
39     status = "okay";
40 };
41
42 &vregmain {
43     status = "okay";
44     regulator-initial-mode = <NRF5X_REG_MODE_DCDC>;

```

Figure 3.3 Low-frequency crystal oscillator capacitor configuration values

3.4.2 Internal matching capacitor value configuration for high-frequency crystal oscillator (32MHz)

The internal capacitor register value of the high-frequency crystal oscillator needs to be configured as 15000, that is:

load-capacitors = "internal";

load-capacitance-femtofarad = <15000>;

As shown in the picture:

```

C: > ncs > v2.9.1 > zephyr > boards > nordic > nrf54l15dk > nrf54l05_10_15_cpuapp_common.dtsi
11 / {
12     <crystal> {
21     };
22 };
23
24 &cpuapp_sram {
25     status = "okay";
26 };
27
28 &lfxo {
29     load-capacitors = "internal";
30     load-capacitance-femtofarad = <14000>;
31 };
32
33 &hfxo {
34     load-capacitors = "internal";
35     load-capacitance-femtofarad = <15000>;
36 };
37
38 &regulators {
39     status = "okay";
40 };
41
42 &vregmain {
43     status = "okay";
44     regulator-initial-mode = <NRF5X_REG_MODE_DCDC>;

```

Figure 3.4 High-frequency crystal oscillator capacitor configuration values

4 Radio Frequency Characteristics

The module has an onboard PCB antenna.

4.1 Radio frequency performance

The module supports BLE mode.

Table 4-1 BLE Performance Parameters

Performance	Description
Bluetooth standard	BLE6.0
Working frequency	2.4GHz ~ 2.4835GHz
Channel	LE: Ch0 ~ Ch39
Modulation method	GFSK
Transmit power	-46dBm ~ 8dBm
Sensitivity @ PER=30.8% for LE(1Mbps)	-94dBm
Sensitivity @ PER=30.8% for LE(2Mbps)	-92dBm
Maximum Receive Level	0dBm

Note

- (1) Test conditions for Table 4-1: Temperature 25° C, power supply voltage 3.3V;
- (2) The transmission power of the module under different voltages at 25°C is shown in Figure 4.1 and Figure 4.2.
- (3) The transmission power of the module under the extreme conditions of -40°C & 3.6V, +85°C & 1.7V, and +105°C & 1.7V can be seen in Figure 4.3.

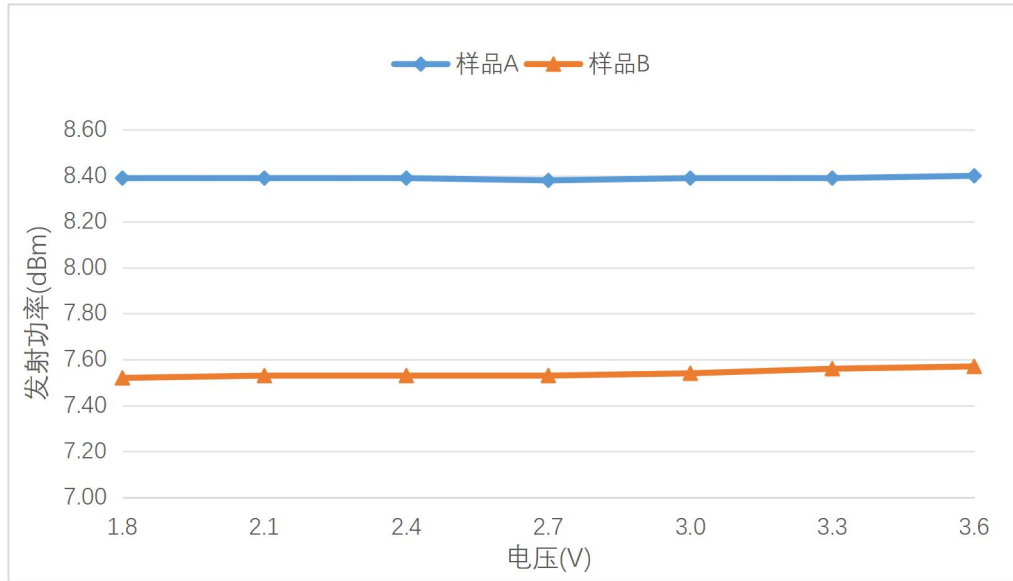


Figure 4.1 Transmit Power vs. Supply Voltage @ Power Configuration 8dBm, 25°C

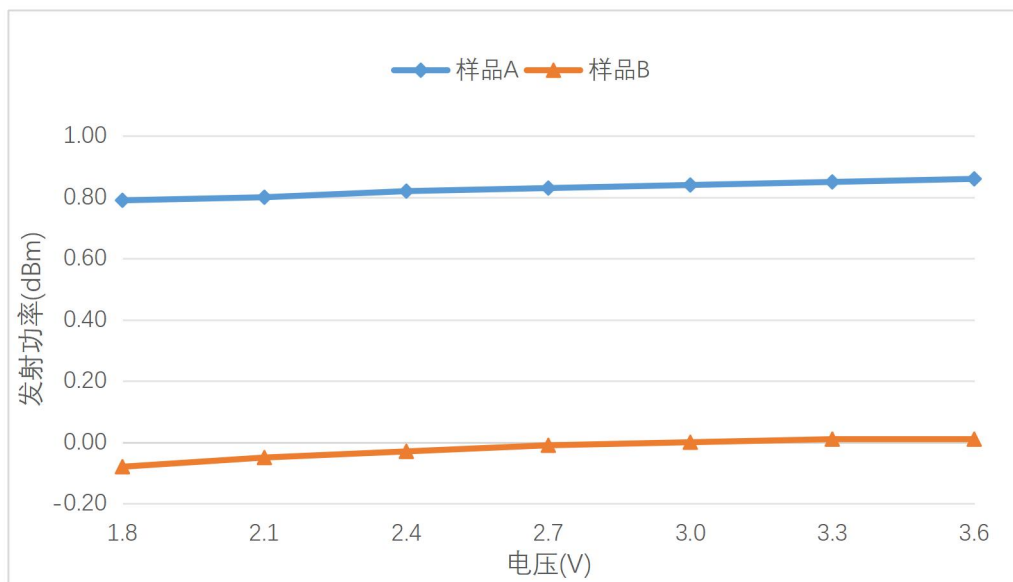


Figure 4.2 Transmission Power vs. Supply Voltage @ Power Configuration 0dBm, 25°C

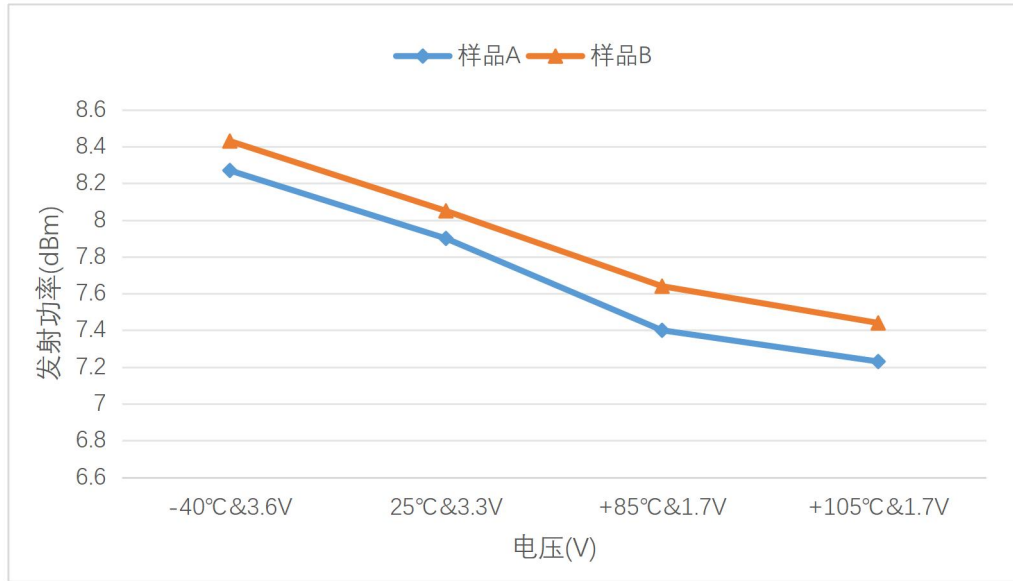


Figure 4.3 shows the curve of the transmitted power variation of the module under extreme conditions when the power configuration is 8dBm.

4.2 Onboard Antenna Application Instructions

There should be a large clearance area around the antenna. Clearance refers to the unobstructed area within the vertical projection area of the antenna (considering both the upper and lower ranges). Within the antenna's projection area, whether it is patch or side-inserted, do not place ground (especially for onboard antennas), do not have metal components, maintain the clearance of the antenna to improve antenna radiation efficiency. The RF part of the module should be avoided from being enclosed by metal cavities as much as possible, and the distance between the RF part and the interference source should be above 10mm (the larger the better if conditions permit). Common interference sources include: battery (including battery connectors), capacitors, inductors, buttons, oscillators, power lines, screws or nuts containing metal, CPU, LCD, transformers, speakers, cameras, ribbon cables of internal communication interfaces, power circuits, motors, etc.

Layout requirements for the baseboard:

The PCB antenna of the module should be located at the edge of the entire bottom PCB, with a 10mm spacing around the PCB antenna. No copper, traces, or components should be placed around the antenna. If there are multiple antennas, they should be placed as far away from each other as possible to avoid interference. If components are suggested to be placed on the bottom board, the area around the antenna should be cut out. The recommended copper coverage size in the yellow area in the figure below is at least 4cm x 6cm.

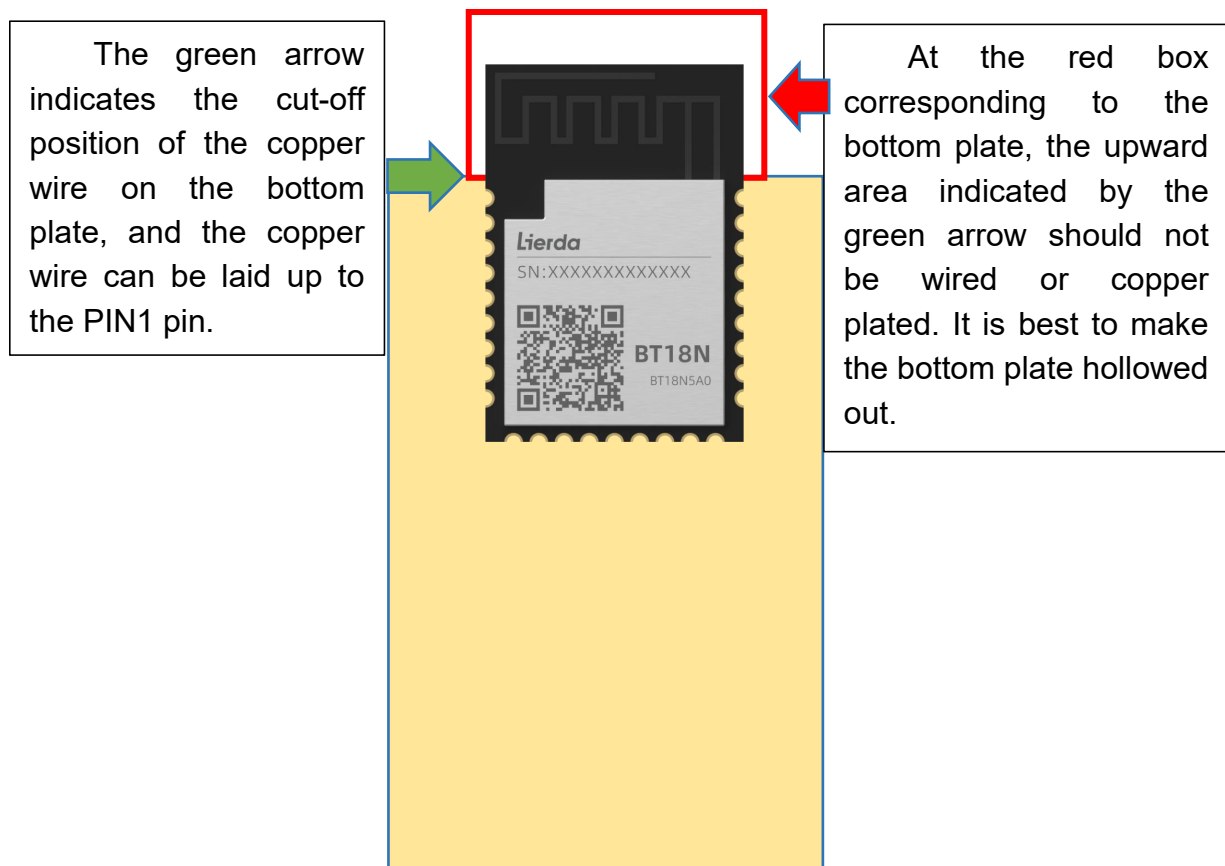


Figure 4.4 Module Suggested Placement Reference

Test points and interface solder pad description of the Bottom layer module:

RF performance testing, there are window areas (exposed copper) on the solder pads and some IO interfaces. No vias or exposed copper should be placed in the positions mapped to the bottom plate. Test points and unused IO interfaces should be covered with white oil to prevent short circuits. It is recommended to avoid routing or exposed copper on the bottom plate around the red boxed areas in the diagram below.

There are two test spot welding pads with exposed copper windows in the upper left corner area of the module BOTTOM layer, and 12 pads in the middle of the bottom. It is best not to route or expose copper when mapping to the bottom plate area. If wiring is necessary, it is best to a silk screen block.

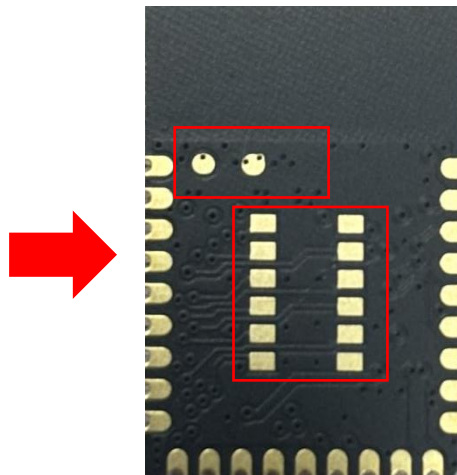


Figure 4.5 Position of test point solder pads on the module bottom

Layout requirements for the baseboard:

The BOTTOM layer of the module has no high-speed or sensitive signal traces, but it is still recommended to avoid routing on the TOP layer of the baseboard to prevent unexpected influences.

There are not many requirements for hollowing out in the bottom plate design, except for the general requirement mentioned earlier to avoid interference sources, the bottom plate can be almost fully covered with copper.

5 Electrical performance and reliability

5.1 Absolute maximum rating

Table 5-1 Product Limit Parameters

Main Parameters	Performance		Note
	Minimum value	Maximum value	
Voltage (V)	1.7	3.6	-
IO Voltage (V)	-0.3	VCC	-
Storage Temperature (°C)	-40	125	-
Operating temperature (°C)	-40	105	-
V _{ESD}	±2KV		VBAT&ANT ESD performance

Note

Exceeding the absolute maximum ratings may cause permanent damage to the device.

5.2 Direct current characteristics

Table 5-2 Module Operating Parameters

Main parameters	Performance			Note
	Minimum value	Typical value	Maximum value	
Operating voltage (V)	1.7	3.3	3.6	Suggest Ripple VPP less than 1% of VCC
Launch current (mA)	/	5	/	@1Mbps,0dbm
	/	5	/	@2Mbps,0dbm
Receiving current (mA)	/	3.2	/	@1Mbps
	/	3.2	/	@2Mbps
Hibernate current (μA)	/	0.6	/	Power supply at 3.0V, System Off state

Note

The data in Table 5-2 are tested under normal temperature of 25°C and 3.3V power supply conditions, except for the sleep current.

5.3 Power consumption in operation

Table 5-3 Module Power Consumption Parameters

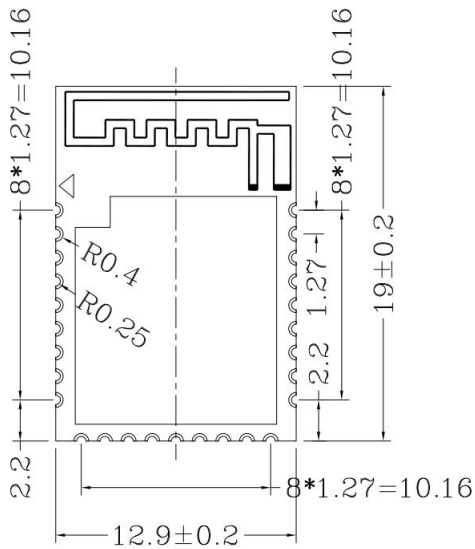
Work mode	Time interval (ms)	Power Consumption Data (uA)
Broadcast power consumption @1M, 0dBm	1000	13
	2000	8.3
Connection power consumption @1M, 0dBm	1000	7.9
	2000	7

Note

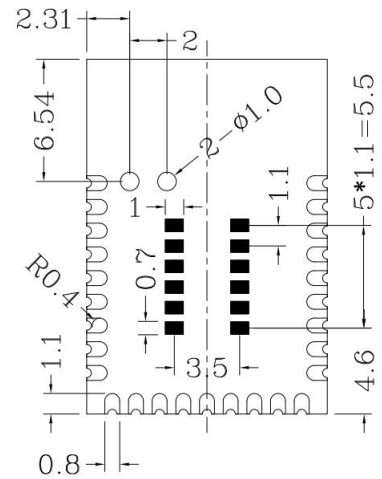
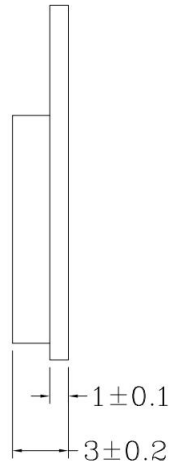
- ◆ The data in Table 5-3 is tested under the condition of room temperature 25°C and 3.3V power supply;
- ◆ The data is official demo firmware test data for reference only.

6 Mechanical dimensions

Dimensions	19 mm × 12.9 mm × 3 mm
------------	------------------------



TOP Layer



BOTTOM Layer

Figure 6.1 Module Outline Dimensions

Note

There is a lateral rib connection cutting tolerance in the module, and the module width ranges from 12.7mm to 13.3mm.

7 Production and packaging information

7.1 Production welding

7.1.1 Production Guide

It is recommended to use SMT machine for the stamp mouth sealing module assembly, and the placement should be completed within 24 hours after unpacking. Otherwise, the vacuum packaging needs to be re-drawn to avoid moisture causing poor placement.

If there is a humidity indicator card inside the package, it is recommended to determine whether the module needs baking based on the indication of the humidity card. The conditions for baking are as follows:

Baking temperature: $125^{\circ}\text{C}\pm 5^{\circ}\text{C}$;

The alarm temperature is set to 130°C ;

After cooling to below 36°C under natural conditions, SMT mounting can be carried out.

If the unpacking time exceeds 3 months, special attention should be paid to whether the product has been damp, because the PCB immersion gold process, exceeding 3 months may cause oxidation of the solder joints, which may lead to problems such as false soldering and missed soldering during patching.

To ensure the qualified rate of reflow soldering, it is recommended to take 10% of the products for visual inspection and AOI inspection during the first SMT process to ensure the reasonableness of furnace temperature control, component adhesion method, and placement method.

Operators at each workstation throughout the production process must wear anti-static gloves.

7.1.2 Module position requirements on the baseplate.

It is recommended that the green oil thickness of the bottom plate module be less than

0.02mm to avoid excessive thickness, which may prevent the raised module from effectively contacting the solder paste, affecting the soldering quality. In addition, it is necessary to ensure that no other components are placed within 2mm around the interface board module to facilitate module maintenance.

7.1.3 Steel mesh opening design

The thickness of the steel mesh on the substrate is selected based on the comprehensive consideration of the packaging type of the components inside the board, focusing on the following requirements:

The module solder pad position can be locally thickened to 0.15-0.20mm to avoid voids.

7.1.4 Production Notes

- During the production process, all operators must wear anti-static gloves.
- Baking must not exceed the specified baking time;
- Do not add explosive, flammable, or corrosive substances during baking;
- During baking, the module should be placed in a high-temperature tray to ensure air circulation between the modules;
- When baking, make sure to close the oven door to ensure the oven is sealed and prevent temperature leakage.
- Try not to open the oven door while it is running. If you must open it, try to shorten the time the door is open as much as possible.
- After baking, wait for the module to cool naturally to below 36°C before wearing electrostatic gloves to prevent burns.
- During operation, prevent the bottom of the module from getting wet or dirty.
- The module shield has openings. Using or applying the three-proof process in a humid environment during production may affect the use of the module or reduce its lifespan.

7.1.5 Reflow soldering operation guidance

PCBA reflow soldering temperature curve is related to the use of solder paste and needs to be adjusted according to the actual solder paste. The data is only suitable for lead-free operation and for reference only.

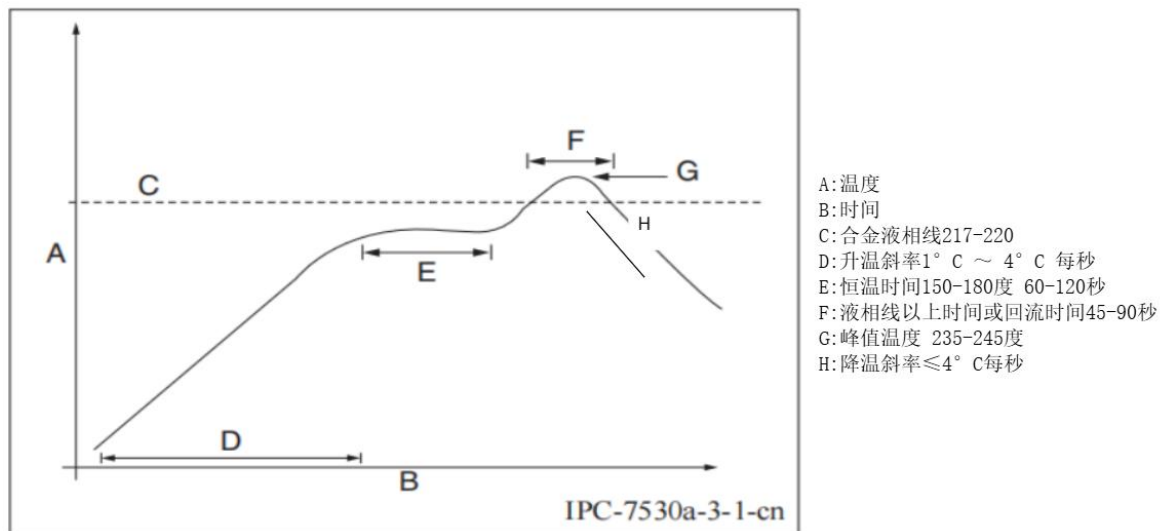


Figure 7.1 Reflow Soldering Operation Manual

Note

◆ During the welding or any process that may directly contact the module in production, organic solvents such as alcohol, isopropanol, acetone, trichloroethylene, etc., should not be used to wipe the module shielding cover; otherwise, it may cause the shielding cover to rust.

◆ The module of nickel silver radium carved screen shield can meet the requirements: After 12 hours of neutral salt spray test, the radium carved information is clear and identifiable, and the QR code can be scanned (there may be white rusting).

◆ If you need to spray paint on the module, please make sure that the spray material used will not chemically react with the module shield or PCB, and also ensure that the spray material will not flow into the interior of the module.

◆ Please do not use ultrasonic cleaning on the module, as it may cause damage to

the internal crystals of the module.

◆ Due to the complexity of the SMT process, in case of uncertainties or processes not mentioned in the documents (such as selective wave soldering, ultrasonic welding), please confirm with Lierda technical support before starting the SMT process.

7.1.6 Repair

If there is a need for repair due to issues such as virtual soldering, short circuit, etc., please follow the parameters below:

N/A Lead-free process: Soldering iron temperature $380\pm 10^{\circ}\text{C}$, soldering iron contact time $\leq 5\text{S}$;

Lead craft: Soldering iron temperature $350\pm 10^{\circ}\text{C}$, soldering iron contact time $\leq 5\text{S}$;

Modules are not recommended to be blown with a hot air gun to avoid affecting the performance of the modules.

7.2 Packaging specifications

7.2.1 Packaging method

Model	Packaging method	Carton (PCS)	Minimum packaging quantity (PCS)	Number of rolls per box
BT18N	Tape/Reel	4000	800	5

7.2.2 Dimensions of the tape

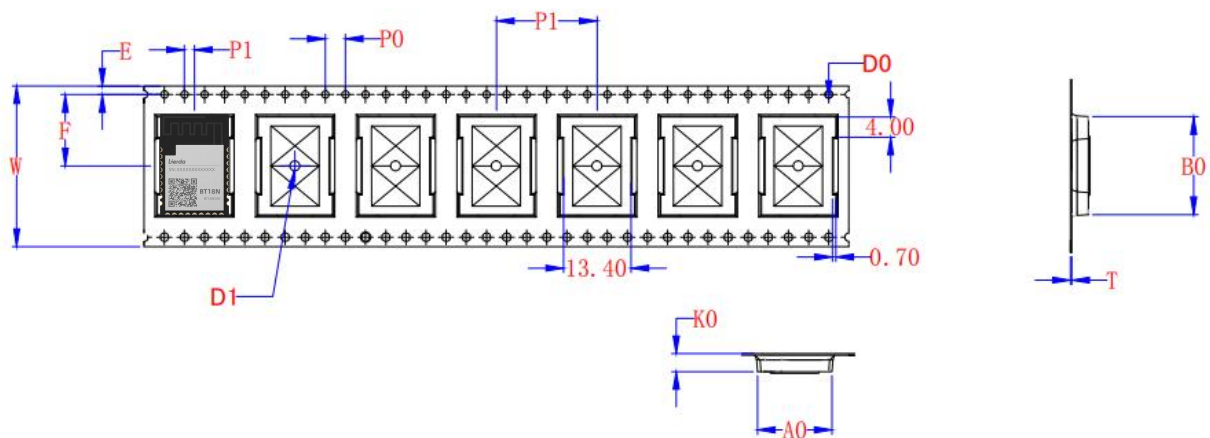


Figure 7.2 Tape Dimension