



RF-BM-ND04 Bluetooth Low Energy Module

Version 1.2

Shenzhen RF-star Technology Co., Ltd.

Aug. 02, 2018

1 Device Overview

1.1 Description

RF-BM-ND04 is an RF module based on Nordic BLE SoC nRF52832QFAA with ARM® Cortex®-M4 32-bit processor. It integrates a 32.768 kHz and a 32 MHz crystal, an LC filter, an antenna matching and a meander line inverted-F PCB antenna. It features low power consumption, small size, robust connection distance, and rigid reliability. It supports BLE stack v5.0 and can be preprogrammed with a serial interface communication protocol for simple programming. 1.27-mm pitch stamp stick package for easy assembling and cost-effective PCB design. RF-BM-ND04 is pin-to-pin compatible with RF-BM-ND04C and RF-BM-ND05.

1.2 Key Features

- 2.4 GHz transceiver
 - -96 dBm sensitivity in Bluetooth® low energy mode
 - 1 Mbps, 2 Mbps supported data rates (data of Chip nRF52832)
 - TX power: -20 to +4 dBm in 4 dB steps (data of Chip nRF52832)
 - Single-pin antenna interface
 - 5.3 mA peak current in TX (0 dBm)
 - 5.4 mA peak current in RX
 - RSSI (1 dB resolution)
- ARM® Cortex®-M4 32-bit processor with FPU, 64 MHz
 - 215 EEMBC CoreMark® score running from flash memory
 - 58 µA/MHz running from flash memory
 - 51.6 µA/MHz running from RAM
 - Data watchpoint and trace (DWT), embedded trace macrocell (ETM), and instrumentation trace macrocell (ITM)
 - Serial wire debug (SWD)
 - Trace port
- Flexible power management (data of Chip nRF52832)
 - Supply voltage range 1.7 V ~ 3.6 V
 - Fully automatic LDO and DC/DC regulator system
 - Fast wake-up using 64 MHz internal oscillator
 - 0.3 µA at 3 V in OFF mode
 - 0.7 µA at 3 V in OFF mode with full 64 kB RAM retention
- 1.9 µA at 3 V in ON mode, no RAM retention, wake on RTC
- Memory
 - 512 kB flash
 - 64 kB RAM
- Nordic SoftDevice ready
- Support for concurrent multi-protocol
- Type 2 near field communication (NFC-A) tag with wakeup-on-field and touch-to-pair capabilities
- 12-bit, 200 ksps ADC - 8 configurable channels with programmable gain
- 64 level comparator
- 15 level low power comparator with wakeup from System OFF mode
- Temperature sensor
- 29 general purpose I/O pins
- 3 x 4-channel pulse width modulator (PWM) units with EasyDMA
- Digital microphone interface (PDM)
- 5 x 32-bit timers with counter mode
- Up to 3 x SPI master/slave with EasyDMA
- Up to 2 x I²C compatible 2-Wire master/slave
- I²S with EasyDMA
- UART (CTS/RTS) with EasyDMA
- Programmable peripheral interconnect (PPI)
- Quadrature decoder (QDEC)
- AES HW encryption with EasyDMA
- Autonomous peripheral operation without CPU

intervention using PPI and EasyDMA

• 3 x real-time counter (RTC)

1.3 Applications

- Internet of Things (IoT)
- Internet Gateway
- Cloud Connectivity
- Industrial Control
- Home Automation
- Smart Plug and Metering
- Home Appliances
- Wireless Audio
- Access Control
- IP Network Sensor Nodes
- Security Systems
- Wearables
- Building automation
- Retail
- Sensor networks
- Medical devices

1.4 Functional Block Diagram

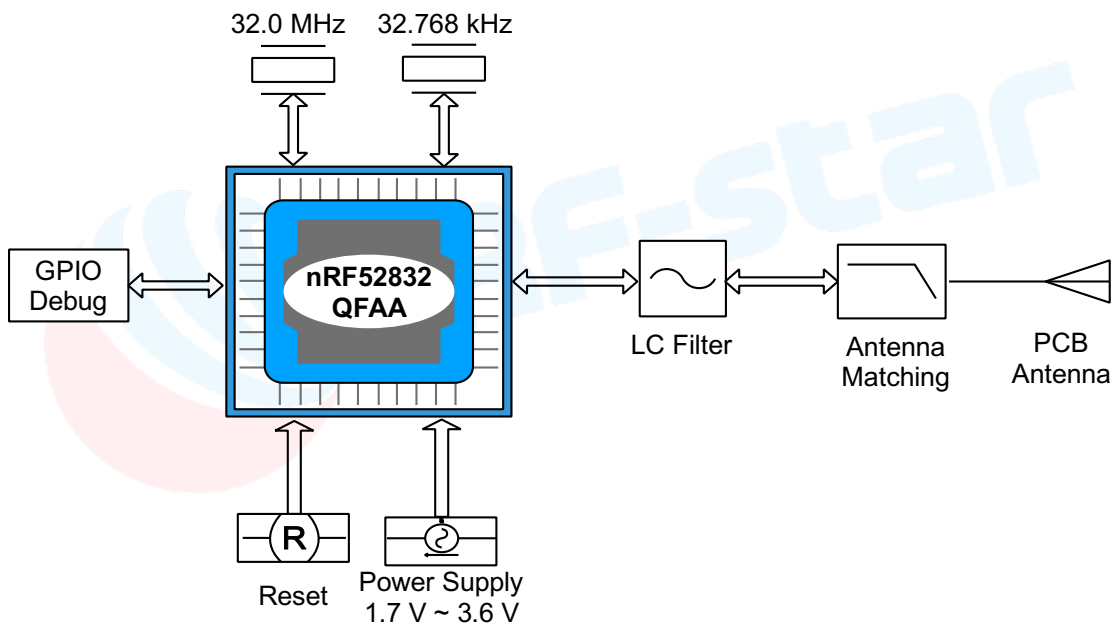


Figure 1. Functional Block Diagram of RF-BM-ND04

1.5 Part Number Conventions

The part numbers are of the form of RF-BM-ND04 where the fields are defined as follows:

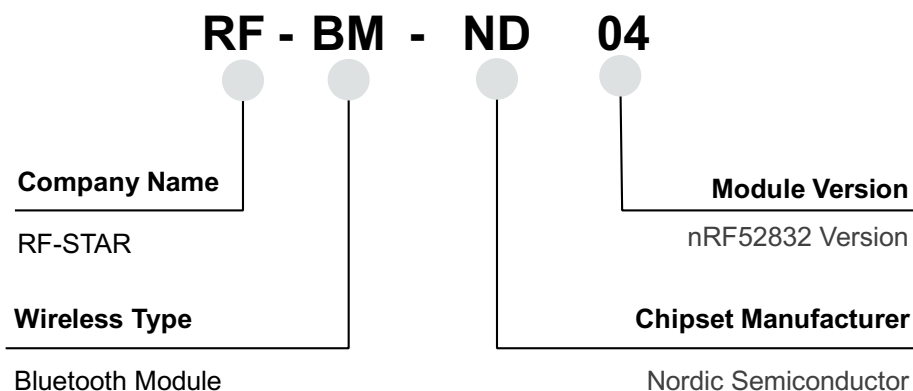


Figure 2. Part Number Conventions of RF-BM-ND04

Table of Contents

1 Device Overview.....	1
1.1 Description	1
1.2 Key Features.....	1
1.3 Applications.....	2
1.4 Functional Block Diagram	2
1.5 Part Number Conventions	2
Table of Contents	3
Table of Figures	4
Table of Tables	4
2 Module Configuration and Functions.....	5
2.1 Module Parameters	5
2.2 Module Pin Diagram.....	6
2.3 Pin Functions	6
3 Specifications.....	8
3.1 Recommended Operating Conditions	8
3.2 Handling Ratings	8
3.3 Current Consumption.....	8
4 Application, Implementation, and Layout.....	10
4.1 Module Photos	10
4.2 Recommended PCB Footprint	10
4.3 Schematic Diagram	11
4.4 Basic Operation of Hardware Design	11
4.5 Trouble Shooting	13
4.5.1 Unsatisfactory Transmission Distance	13
4.5.2 Vulnerable Module	13
4.5.3 High Bit Error Rate.....	13
4.6 Electrostatics Discharge Warnings.....	13
4.7 Soldering and Reflow Condition	14
4.8 Optional Packaging	15
5 Certification.....	16
5.1 FCC	16
5.2 SRRC	16

6 Revision History.....	17
7 Contact Us.....	18

Table of Figures

Figure 1. Functional Block Diagram of RF-BM-ND04.....	2
Figure 2. Part Number Conventions of RF-BM-ND04.....	2
Figure 3. Pin Diagram of RF-BM-ND04.....	6
Figure 4. Photos of RF-BM-ND04.....	10
Figure 5. Recommended PCB Footprint of RF-BM-ND04 (mm).....	10
Figure 6. Schematic Diagram of RF-BM-ND04.....	11
Figure 7. Recommendation of Antenna Layout.....	12
Figure 8. Recommended Reflow for Lead Free Solder.....	14
Figure 9. Optional Packaging Mode.....	15
Figure 10. FCC Certificate.....	16
Figure 11. SRRC Certificate.....	16

Table of Tables

Table 1. Parameters of RF-BM-ND04.....	5
Table 2. Pin Functions of RF-BM-ND04.....	6
Table 3. Recommended Operating Conditions of RF-BM-ND04.....	8
Table 4. Handling Ratings of RF-BM-ND04.....	8
Table 5. Current Consumption of RF-BM-ND04.....	8

2 Module Configuration and Functions

2.1 Module Parameters

Table 1. Parameters of RF-BM-ND04

Chipset	nRF52832QFAA
Supply Power Voltage	1.7 V ~ 3.6 V, recommended to 3.3 V
Frequency	2402 MHz ~ 2480 MHz
Transmit Power	-20.0 dBm ~ +4.0 dBm
Receiving Sensitivity	-96 dBm
GPIO	29
Crystal	32 MHz, 32.768 kHz
RAM	64 KB
Flash	512 KB
Package	SMT Packaging
Frequency Error	±20 kHz
Dimension	24.8 mm x 15.0 mm x (2.3 ± 0.1) mm
Type of Antenna	PCB Antenna
Operating Temperature	-20 C° ~ +70 C°
Storage Temperature	-40 C° ~ +85 C°

2.2 Module Pin Diagram

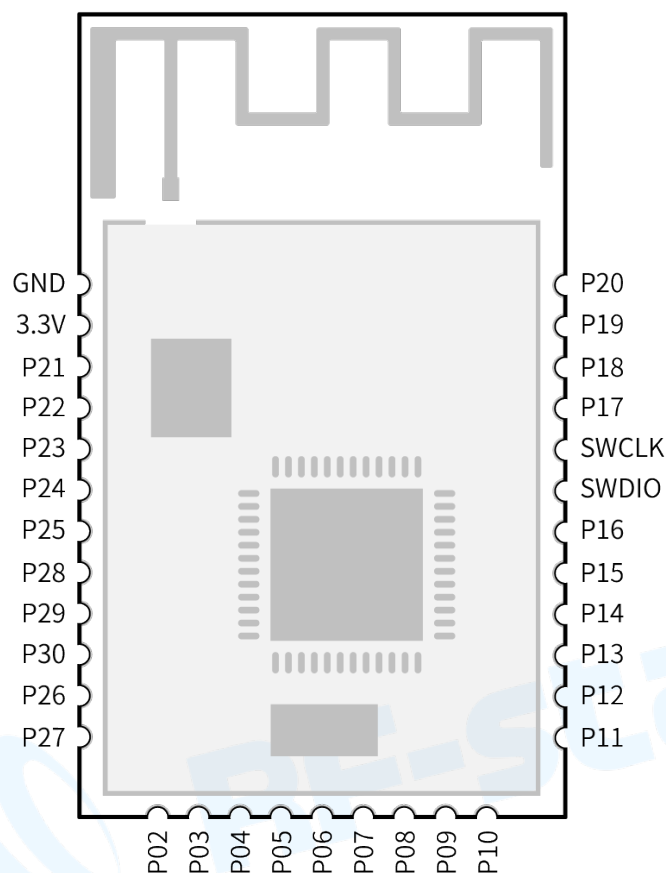


Figure 3. Pin Diagram of RF-BM-ND04

2.3 Pin Functions

Table 2. Pin Functions of RF-BM-ND04

Pin	Name	Chip Pin	Pin Type	Description
1	GND	GND	GND	GND
2	VCC	VCC	Power	Power supply 1.7 V ~ 3.6 V, Recommend 3.3 V
3	P21	P0_21/RESET	I/O	Reset
4	P22	P0_22	I/O	
5	P23	P0_23	I/O	
6	P24	P0_24	I/O	
7	P25	P0_25	I/O	
8	P28	P0_28/AIN4	I/O	
9	P29	P0_29/AIN5	I/O	

10	P30	P0_30/AIN6	I/O	
11	P26	P0_26	I/O	
12	P27	P0_27	I/O	
13	P02	P0_2/AIN0	I/O	
14	P03	P0_3/AIN1	I/O	
15	P04	P0_4/AIN2	I/O	
16	P05	P0_5/AIN3	I/O	
17	P06	P0_6	I/O	
18	P07	P0_7	I/O	
19	P08	P0_8	I/O	
20	P09	P0_9	I/O	
21	P10	P0_10	I/O	
22	P11	P0_11	I/O	
23	P12	P0_12	I/O	
24	P13	P0_13	I/O	
25	P14	P0_14	I/O	
26	P15	P0_15	I/O	
27	P16	P0_16	I/O	
28	SWDIO	JTAG SWD	I/O	Serial wire debug clock input for debug and programming
29	SWCLK	JTAG CLK	I/O	Serial wire debug I/O for debug and programming
30	P17	P0_17	I/O	
31	P18	P0_18	I/O	
32	P19	P0_19	I/O	
33	P20	P0_20	I/O	

3 Specifications

3.1 Recommended Operating Conditions

Functional operation does not guarantee performance beyond the limits of the conditional parameter values in the table below. Long-term work beyond this limit will affect the reliability of the module more or less.

Table 3. Recommended Operating Conditions of RF-BM-ND04

Items	Condition	Min.	Typ.	Max.	Unit
Operating Supply Voltage	Battery Mode	1.7	3.3	3.6	V
Operating Temperature	/	-20	+25	+70	°C
Environmental Hot Pendulum	/	-20		+20	°C/min

Notes:

- (1) The operating temperature is limited to the operating temperature range of crystal. The temperature range can be wider by changing the crystal.
- (2) To ensure the RF performance, the ripple wave on the source must be less than ± 200 mV.

3.2 Handling Ratings

Table 4. Handling Ratings of RF-BM-ND04

Items	Condition	Min.	Typ.	Max.	Unit
Storage Temperature	Tstg	-40	+25	+85	°C
Human Body Model	HBM		± 4000		V
Moisture Sensitivity Level			2		
Charged Device Model			± 750		V

Notes:

- (1) The storage temperature is limited to the storage temperature range of crystal. The temperature range can be wider by changing the crystal.

3.3 Current Consumption

The current consumption characteristics of this module are categorized into different running modes. The overall product level current consumption is averaged over time on different power modes the device runs on. The peripheral circuitry's current consumption also adds in.

Table 5. Current Consumption of RF-BM-ND04

Symbol	Description	Min.	Typ.	Max.	Unit
Current Consumption: Radio					
IRADIO_TX0	0 dBm TX @ 1 Mb/s BLE mode, Clock = HFXO		7.1		mA
IRADIO_TX1	-40 dBm TX @ 1 Mb/s BLE mode, Clock = HFXO		4.1		mA

IRADIO_RX0	Radio RX @ 1 Mb/s BLE mode, Clock = HFXO		6.5		mA
Current Consumption: Radio Protocol Configuration					
Is0	CPU running CoreMark from Flash, Radio 0 dBm TX @ 1 Mb/s BLE mode, Clock = HFXO, Cache enabled		9.6		mA
Is1	CPU running CoreMark from Flash, Radio Rx @ 1 Mb/s BLE mode, Clock = HFXO, Cache enabled		9.0		mA
Current Consumption: Ultra-low Power					
ION_RAMOFF_EVENT	System ON, No RAM retention, Wake on any event		1.2		μA
ION_RAMON_EVENT	System ON, Full RAM retention, Wake on any event		1.5		μA
ION_RAMOFF_RTC	System ON, No RAM retention, Wake on RTC		1.9		μA
IOFF_RAMOFF_RESET	System OFF, No RAM retention, Wake on RESET		0.7		μA
IOFF_RAMOFF_GPIO	System OFF, No RAM retention, Wake on GPIO		1.2		μA
IOFF_RAMOFF_LPCOMP	System OFF, No RAM retention, Wake on LPCOMP		1.9		μA
IOFF_RAMOFF_NFC	System OFF, No RAM retention, Wake on NFC field		0.7		μA
IOFF_RAMON_RESET	System OFF, Full 64 kB RAM retention, Wake on reset		1.0		μA

4 Application, Implementation, and Layout

4.1 Module Photos

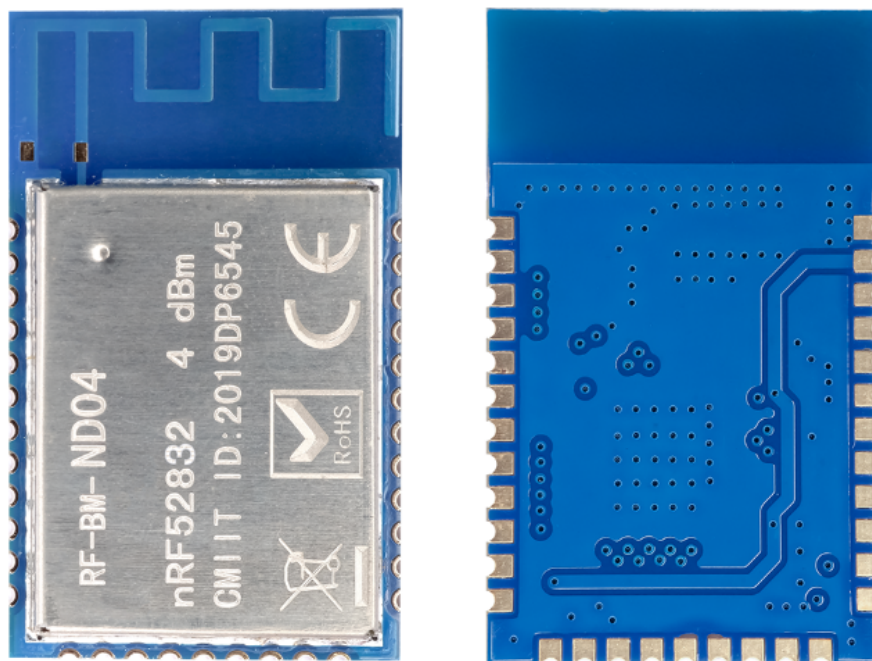


Figure 4. Photos of RF-BM-ND04

4.2 Recommended PCB Footprint

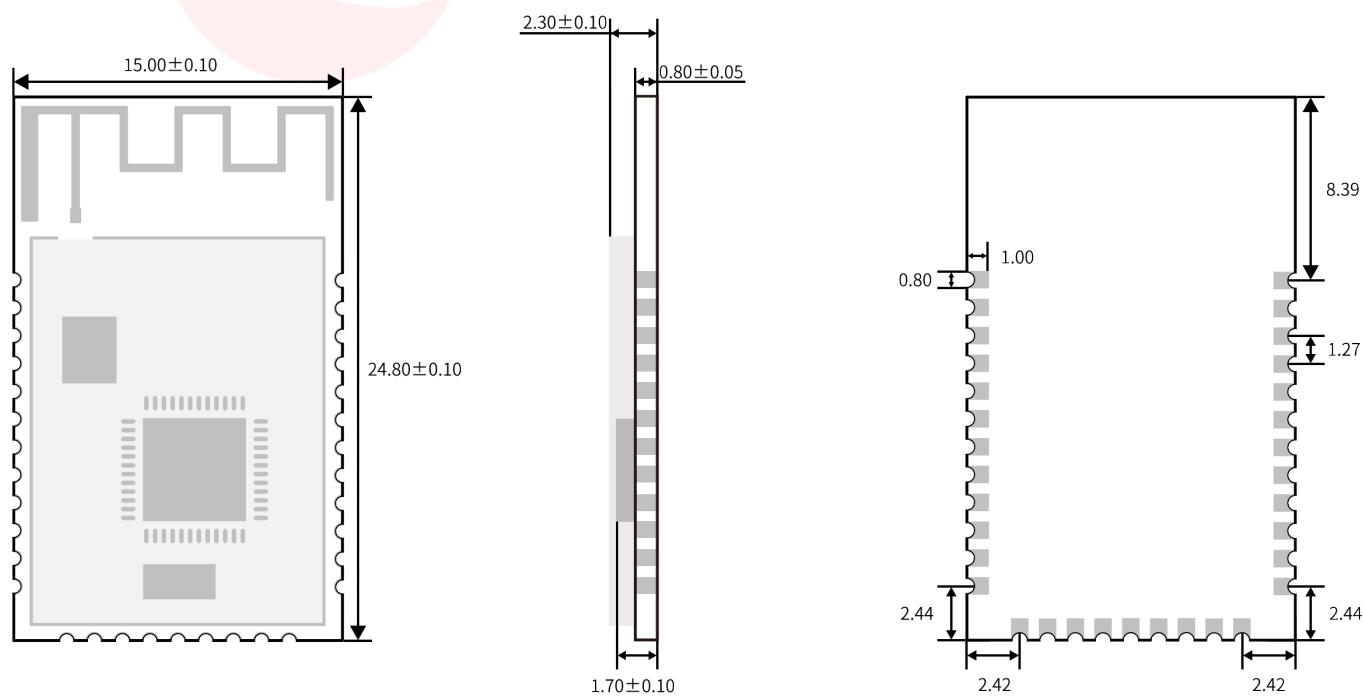


Figure 5. Recommended PCB Footprint of RF-BM-ND04 (mm)

4.3 Schematic Diagram

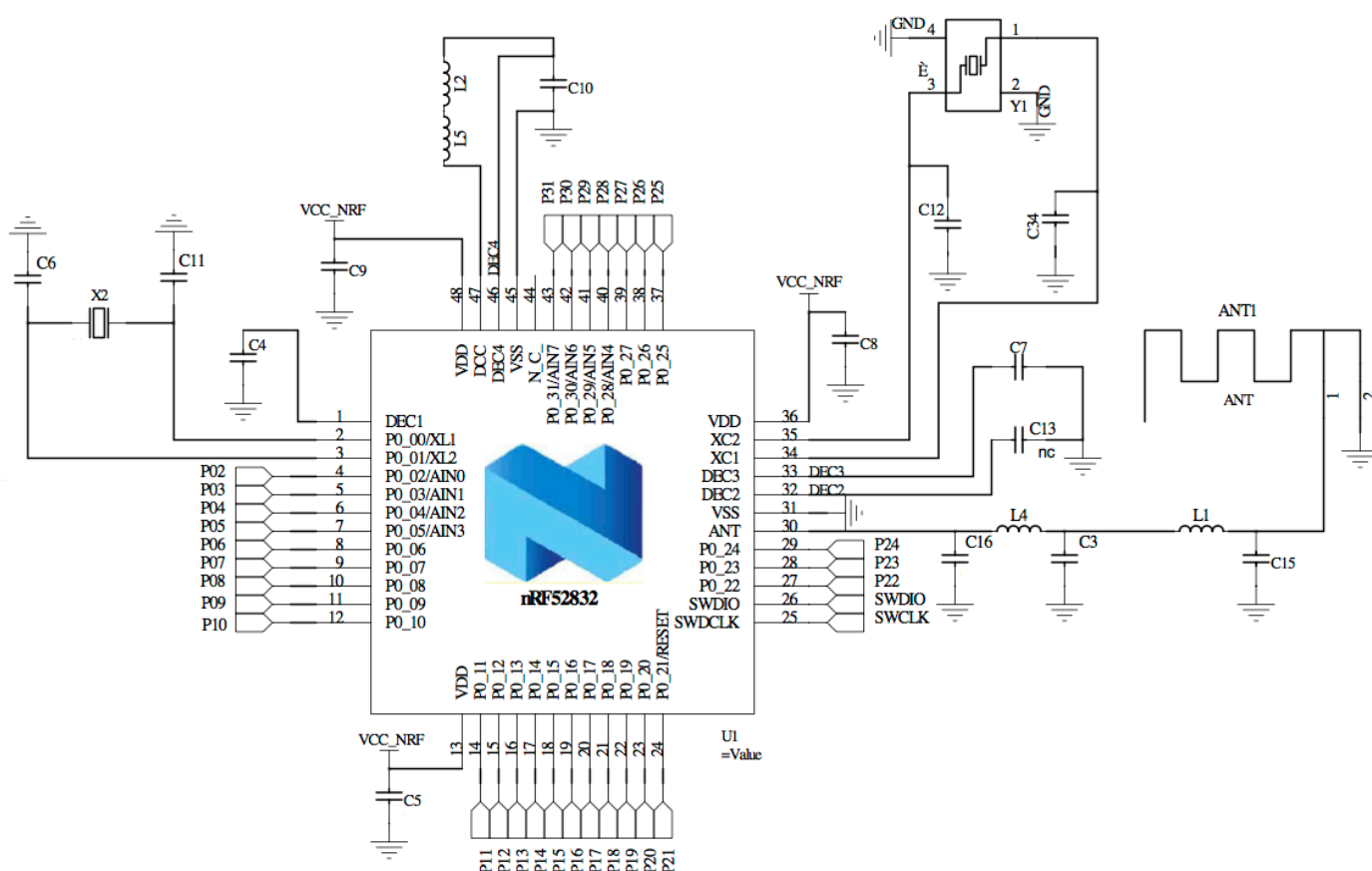


Figure 6. Schematic Diagram of RF-BM-ND04

4.4 Basic Operation of Hardware Design

1. It is recommended to offer the module with a DC stabilized power supply, a tiny power supply ripple coefficient and the reliable ground. Please pay attention to the correct connection between the positive and negative poles of the power supply. Otherwise, the reverse connection may cause permanent damage to the module;
2. Please ensure the supply voltage is between the recommended values. The module will be permanently damaged if the voltage exceeds the maximum value. Please ensure the stable power supply and no frequently fluctuated voltage.
3. When designing the power supply circuit for the module, it is recommended to reserve more than 30% of the margin, which is beneficial to the long-term stable operation of the whole machine. The module should be far away from the power electromagnetic, transformer, high-frequency wiring and other parts with large electromagnetic interference.
4. The bottom of module should avoid high-frequency digital routing, high-frequency analog routing and power routing. If it has to route the wire on the bottom of module, for example, it is assumed that the module is soldered to the Top Layer, the copper must be spread on the connection part of the top layer and the module, and be close to the digital part of module and routed in the Bottom Layer (all copper is well grounded).

5. Assuming that the module is soldered or placed in the Top Layer, it is also wrong to randomly route the Bottom Layer or other layers, which will affect the spurs and receiving sensitivity of the module to some degrees;
6. Assuming that there are devices with large electromagnetic interference around the module, which will greatly affect the module performance. It is recommended to stay away from the module according to the strength of the interference. If circumstances permit, appropriate isolation and shielding can be done.
7. Assuming that there are routings of large electromagnetic interference around the module (high-frequency digital, high-frequency analog, power routings), which will also greatly affect the module performance. It is recommended to stay away from the module according to the strength of the interference. If circumstances permit, appropriate isolation and shielding can be done.
8. It is recommended to stay away from the devices whose TTL protocol is the same 2.4 GHz physical layer, for example: USB 3.0.
9. The antenna installation structure has a great influence on the module performance. It is necessary to ensure the antenna is exposed and preferably vertically upward. When the module is installed inside of the case, a high-quality antenna extension wire can be used to extend the antenna to the outside of the case.
10. The antenna must not be installed inside the metal case, which will cause the transmission distance to be greatly weakened.
11. The recommendation of antenna layout.

The inverted-F antenna position on PCB is free space electromagnetic radiation. The location and layout of antenna is a key factor to increase the data rate and transmission range.

Therefore, the layout of the module antenna location and routing is recommended as follows:

- (1) Place the antenna on the edge (corner) of the PCB.
- (2) Make sure that there is no signal line or copper foil in each layer below the antenna.
- (3) It is the best to hollow out the antenna position in the following figure so as to ensure that S11 of the module is minimally affected.

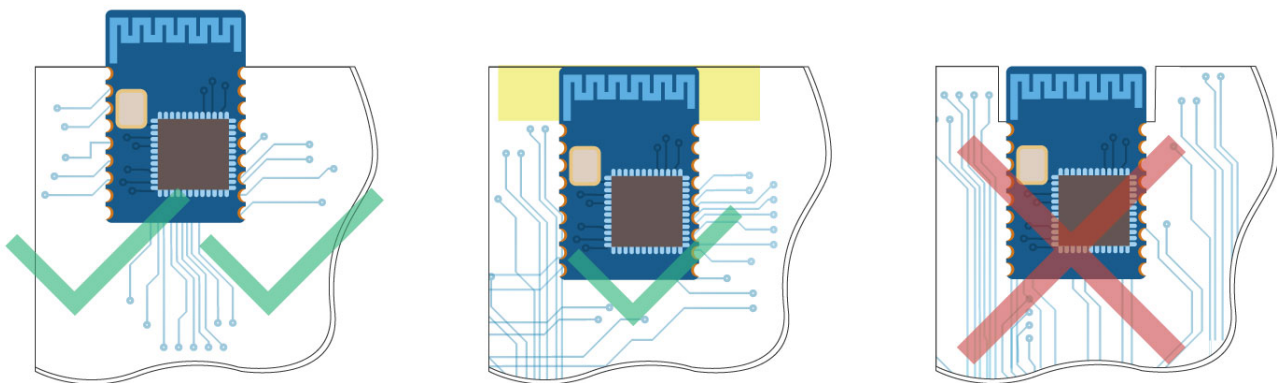


Figure 7. Recommendation of Antenna Layout

4.5 Trouble Shooting

4.5.1 Unsatisfactory Transmission Distance

1. When there is a linear communication obstacle, the communication distance will be correspondingly weakened. Temperature, humidity, and co-channel interference will lead to an increase in communication packet loss rate. The performances of ground absorption and reflection of radio waves will be poor, when the module is tested close to the ground.
2. Seawater has a strong ability to absorb radio waves, so the test results by seaside are poor.
3. The signal attenuation will be very obvious, if there is a metal near the antenna or the module is placed inside of the metal shell.
4. The incorrect power register set or the high data rate in an open air may shorten the communication distance. The higher the data rate, the closer the distance.
5. The low voltage of the power supply is lower than the recommended value at ambient temperature, and the lower the voltage, the smaller the power is.
6. The unmatchable antennas and module or the poor quality of antenna will affect the communication distance.

4.5.2 Vulnerable Module

1. Please ensure the supply voltage is between the recommended values. The module will be permanently damaged if the voltage exceeds the maximum value. Please ensure the stable power supply and no frequently fluctuated voltage.
2. Please ensure the anti-static installation and the electrostatic sensitivity of high-frequency devices.
3. Due to some humidity sensitive components, please ensure the suitable humidity during installation and application. If there is no special demand, it is not recommended to use at too high or too low temperature.

4.5.3 High Bit Error Rate

1. There are co-channel signal interferences nearby. It is recommended to be away from the interference sources or modify the frequency and channel to avoid interferences.
2. The unsatisfactory power supply may also cause garbled. It is necessary to ensure the power supply reliability.
3. If the extension wire or feeder wire is of poor quality or too long, the bit error rate will be high.

4.6 Electrostatics Discharge Warnings

The module will be damaged for the discharge of static. RF-star suggest that all modules should follow the 3 precautions below:

1. According to the anti-static measures, bare hands are not allowed to touch modules.
2. Modules must be placed in anti- static areas.

3. Take the anti-static circuitry (when inputting HV or VHF) into consideration in product design.
Static may result in the degradation in performance of module, even causing the failure.

4.7 Soldering and Reflow Condition

1. Heating method: Conventional Convection or IR/convection.
2. Temperature measurement: Thermocouple $d = 0.1\text{ mm}$ to 0.2 mm CA (K) or CC (T) at soldering portion or equivalent methods.
3. Solder paste composition: Sn/3.0 Ag/0.5 Cu
4. Allowable reflow soldering times: 2 times based on the following reflow soldering profile.
5. Temperature profile: Reflow soldering shall be done according to the following temperature profile.
6. Peak temperature: $245\text{ }^{\circ}\text{C}$.

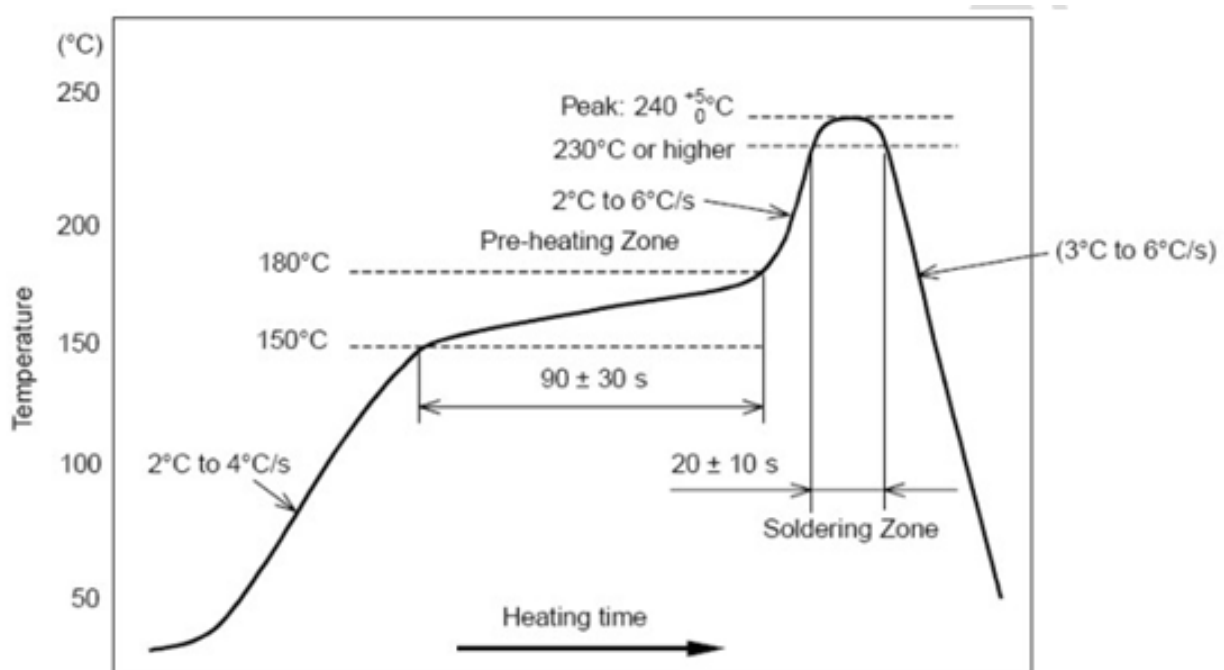


Figure 8. Recommended Reflow for Lead Free Solder

4.8 Optional Packaging



Figure 9. Optional Packaging Mode

Note: Default tray packaging.

5 Certification

5.1 FCC

Warnings:

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.

FCC ID: 2ABN2-FBMND04

TCB	GRANT OF EQUIPMENT AUTHORIZATION Certification Issued Under the Authority of the Federal Communications Commission By:	TCB
	NET Laboratories, Inc. 614 W. Patapsco Avenue Baltimore, MD 21230-3432	Date of Grant: 04/03/2018 Application Dated: 04/03/2018
Shenzhen RF-STAR Technology CO., LTD 2F, BLDG. 2, Zone A, BaoAn Internet Industry Base, BaoYuan Road, Xixiang, BaoAn DIST, ShenZhen, China Attention: Aree woo		
NOT TRANSFERABLE EQUIPMENT AUTHORIZATION is hereby issued to the named GRANTEE, and is VALID ONLY for the equipment identified herein for use under the Commission's Rules and Regulations listed below.		
FCC IDENTIFIER: 2ABN2-FBMND04 Name of Grantee: Shenzhen RF-STAR Technology CO., LTD Equipment Class: Digital Transmission System Notes: Nordic BLE module Modular Type: Single Modular		
Grant Notes	FCC Rule Parts	Frequency Range (MHz)
	15C	2402.0 - 2480.0
		Output Watts
		0.0004966
		Frequency Tolerance
		Emission Designator
Single modular approval. Output Power listed is peak Envelope.		

Figure 10. FCC Certificate

5.2 SRRC

SRRC ID: 2019DP6546

无线电发射设备 Radio Transmission Equipment 型号核准证 Type Approval Certificate 深圳市信能达科技有限公司: 根据《中华人民共和国无线电管理条例》 In accordance with the provisions on the Radio Regulations of the People's Republic of China, the following 符合中华人民共和国无线电管理规定和 radio transmission equipment, after examination, conforms 技术标准, 其核准代码为: CMIIT ID: 2019DP6546 to the provisions with its CMIIT ID: 有效期: 五年 Validity 2019年 7 月 30日 Year Month Date	编号: 2019-6546 Number 设备名称: 蓝牙模块 Equipment Name 设备型号: RF-BM-ND04 Equipment Type 主要功能: 数据传输 Main Functions 调制方式: GFSK Modulation Mode 主要技术参数及其指标值: Main Technical Parameters 频率范围: 2400-2483.5MHz Frequency Range 频率容限: ≤±20ppm Frequency Tolerance 占用带宽: ≤20MHz Occupied Bandwidth 发射功率: ≤20dBm (EIRP) Transmitting Power 杂散发射限值: ≤-30dBm Spurious Emission Limits 2019年 7 月 30日 Year Month Date
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Figure 11. SRRC Certificate

6 Revision History

Date	Version No.	Description	Author
2017.01.10	V1.0	The initial version is released.	Aroo Wang
2018.01.24	V1.1	Update module picture.	Aroo Wang
2018.03.02	V1.2	Update module parameters.	Aroo Wang
2018.08.02	V1.2	Update company address.	Aroo Wang



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