



RF-BM-ND04

Bluetooth 5.0 Low Energy Module







Version 1.2

Shenzhen RF-star Technology Co., Ltd.

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Nordic BLE Module List

➤ nRF51 Series

| Chipset | Core | Flash (Byte) | RAM (KB) | TX Power (dBm) | Model | Antenna | Dimension (mm) | Range (M) | Photo |
|----------|------|--------------|----------|----------------|--------------|---------|----------------|-----------|---|
| nRF51822 | M0 | 256K | 16 | 4 | RF-BM-ND01 | PCB | 15 × 24.8 | 100 |  |
| | | | | | RF-BM-ND02 | PCB | 13.5 × 16.2 | 80 |  |
| | | | | | RF-BM-ND02I | IPEX | 13.5 × 16.2 | 150 |  |
| nRF51802 | M0 | 256K | 16 | 4 | RF-BM-ND01C | PCB | 15 × 24.8 | 100 |  |
| | | | | | RF-BM-ND02C | PCB | 13.5 × 16.2 | 80 |  |
| | | | | | RF-BM-ND02CI | IPEX | 13.5 × 16.2 | 80 |  |

Note:

1. The communication distance is the longest distance obtained by testing the module's maximum transmission power in an open and interference-free environment in sunny weather.
2. Click the picture to jump to buy modules.

➤ nRF52 Series

| Chipset | Core | Flash (Byte) | RAM (KB) | TX Power (dBm) | Model | Antenna | Dimension (mm) | Range (M) | Photo |
|----------|------|--------------|----------|----------------|--------------|---------|----------------|-----------|---|
| nRF52832 | M4F | 512K | 64 | 4 | RF-BM-ND04 | PCB | 15 × 24.8 | 100 |  |
| | | | | | RF-BM-ND04I | IPEX | 15 × 24.8 | 100 |  |
| nRF52810 | M4 | 192K | 24 | 4 | RF-BM-ND04C | PCB | 15 × 24.8 | 100 |  |
| | | | | | RF-BM-ND04CI | IPEX | 15 × 24.8 | 100 |  |
| nRF52811 | M4 | 192K | 24 | 4 | RF-BM-ND04A | PCB | 15 × 24.8 | 100 |  |
| nRF52840 | M4F | 1M | 256 | 8 | RF-BM-ND05 | PCB | 15 × 24.8 | 550 |  |
| | | | | | RF-BM-ND05I | IPEX | 15 × 24.8 | 550+ |  |
| | | | | | RF-BM-ND06 | PCB | 20.5 × 24 | 550 |  |

Note:

1. The communication distance is the longest distance obtained by testing the module's maximum transmission power in an open and interference-free environment in sunny weather.
2. Click the picture to jump to buy modules.

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

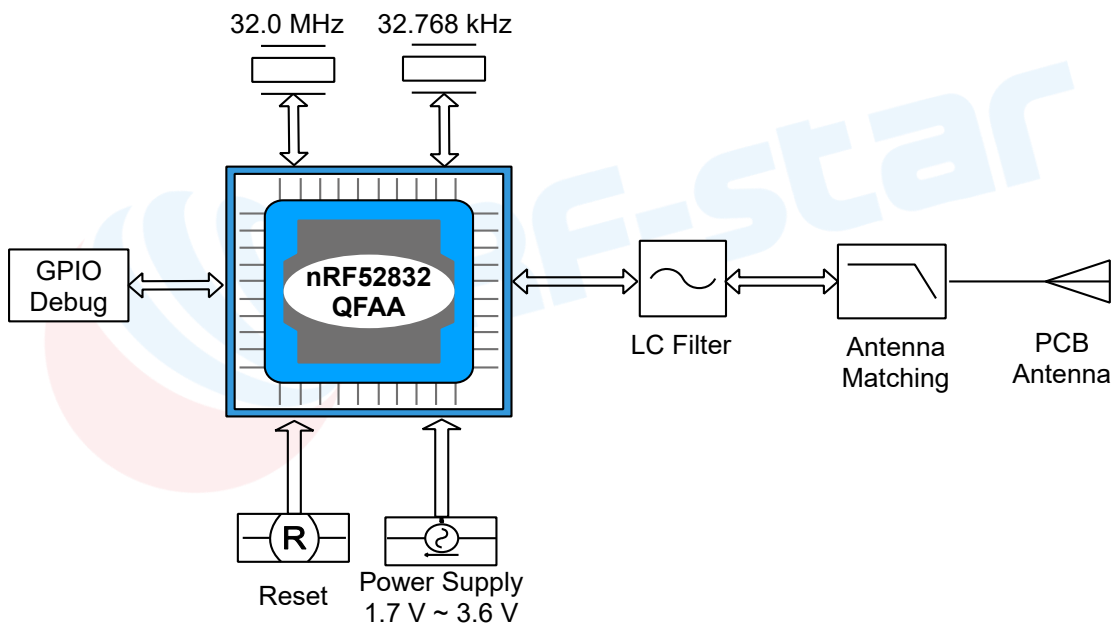


Figure 1. Functional Block Diagram of RF-BM-ND04

1.5 Part Number Conventions

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

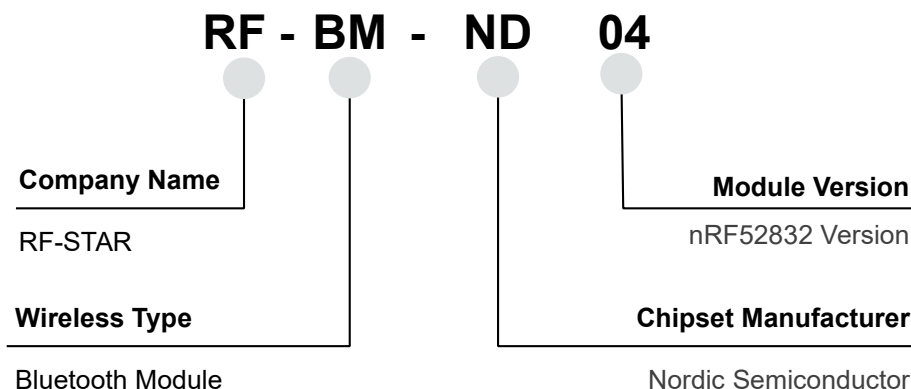


Figure 2. Part Number Conventions of RF-BM-ND04

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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

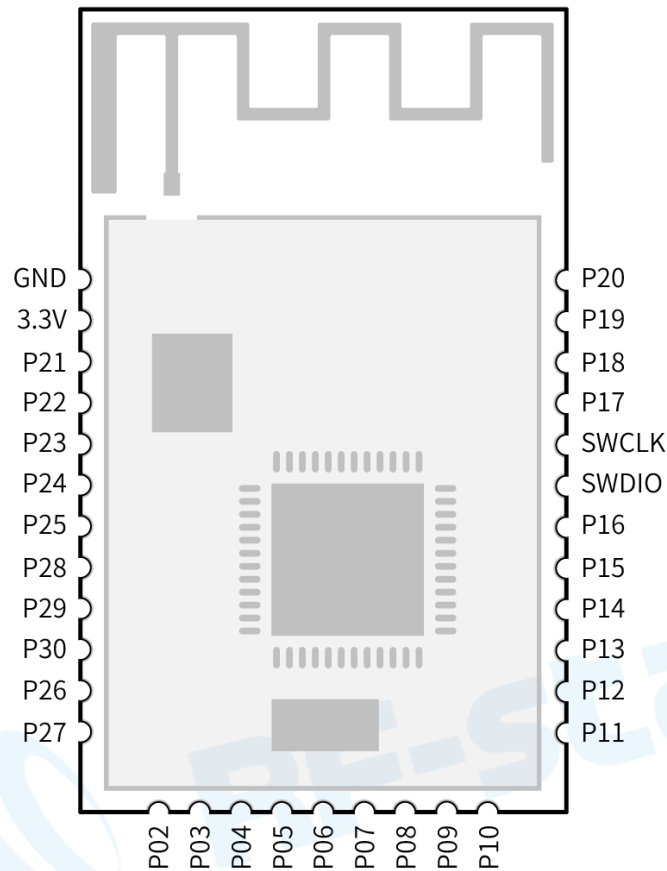


Figure 3. Pin Diagram of RF-BM-ND04

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 / RST | P0_21 / RESET | I/O | Reset, active low. |
| 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 | | | | | |
| I_{RADIO_TX0} | 0 dBm TX @ 1 Mb/s BLE mode, Clock = HFXO | | 7.1 | | mA |
| I_{RADIO_TX1} | -40 dBm TX @ 1 Mb/s BLE mode, Clock = HFXO | | 4.1 | | mA |

| | | | | | |
|--|--|--|-----|--|----|
| I_{RADIO_RX0} | Radio RX @ 1 Mb/s BLE mode, Clock = HFXO | | 6.5 | | mA |
| Current Consumption: Radio Protocol Configuration | | | | | |
| I_{S0} | CPU running CoreMark from Flash, Radio 0 dBm TX @ 1 Mb/s BLE mode, Clock = HFXO, Cache enabled | | 9.6 | | mA |
| I_{S1} | CPU running CoreMark from Flash, Radio Rx @ 1 Mb/s BLE mode, Clock = HFXO, Cache enabled | | 9.0 | | mA |
| Current Consumption: Ultra-low Power | | | | | |
| I_{ON_RAMOFF_EVENT} | System ON, No RAM retention, Wake on any event | | 1.2 | | μA |
| I_{ON_RAMON_EVENT} | System ON, Full RAM retention, Wake on any event | | 1.5 | | μA |
| I_{ON_RAMOFF_RTC} | System ON, No RAM retention, Wake on RTC | | 1.9 | | μA |
| I_{OFF_RAMOFF_RESET} | System OFF, No RAM retention, Wake on RESET | | 0.7 | | μA |
| I_{OFF_RAMOFF_GPIO} | System OFF, No RAM retention, Wake on GPIO | | 1.2 | | μA |
| I_{OFF_RAMOFF_LPCOMP} | System OFF, No RAM retention, Wake on LPCOMP | | 1.9 | | μA |
| I_{OFF_RAMOFF_NFC} | System OFF, No RAM retention, Wake on NFC field | | 0.7 | | μA |
| I_{OFF_RAMON_RESET} | System OFF, Full 64 kB RAM retention, Wake on reset | | 1.0 | | μA |

4 Application, Implementation, and Layout

4.1 Module Photos

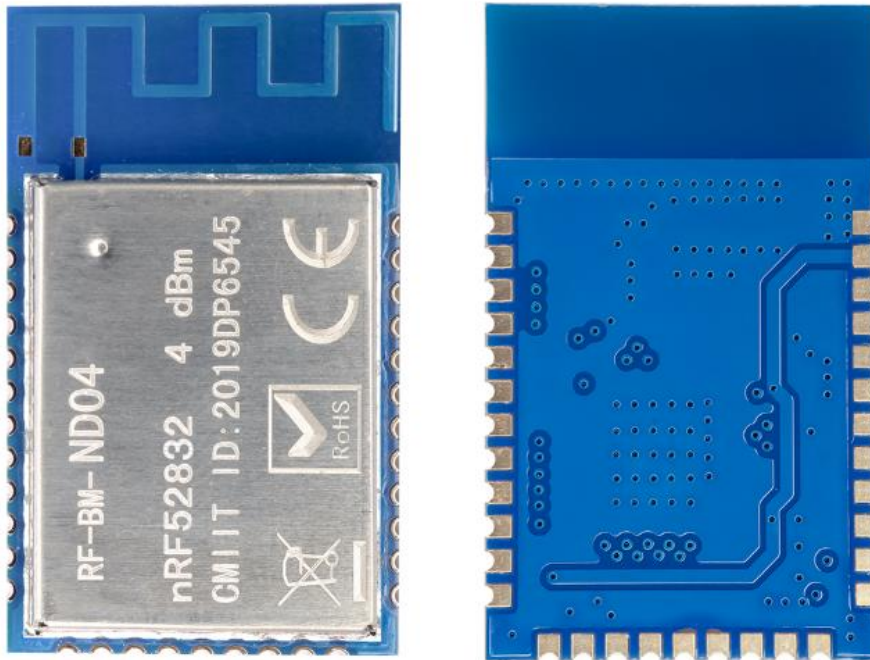


Figure 4. Photos of RF-BM-ND04

4.2 Recommended PCB Footprint

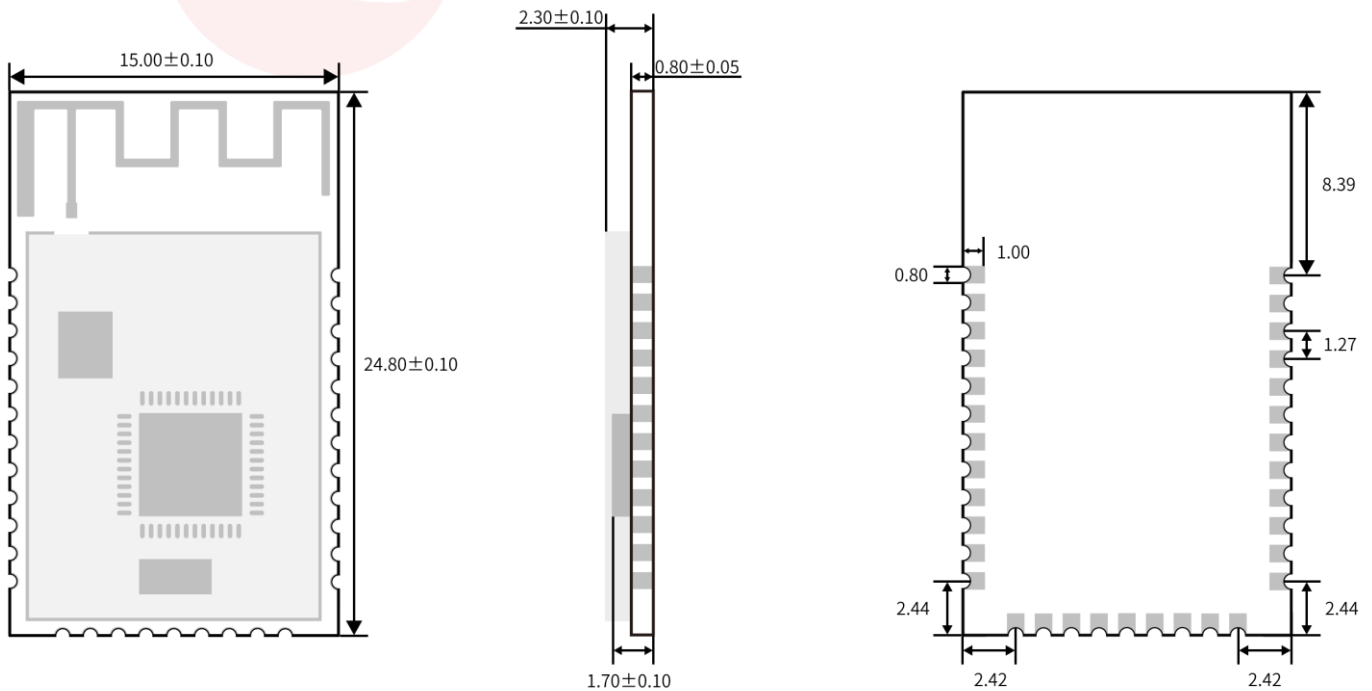


Figure 5. Recommended PCB Footprint of RF-BM-ND04 (mm)

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.

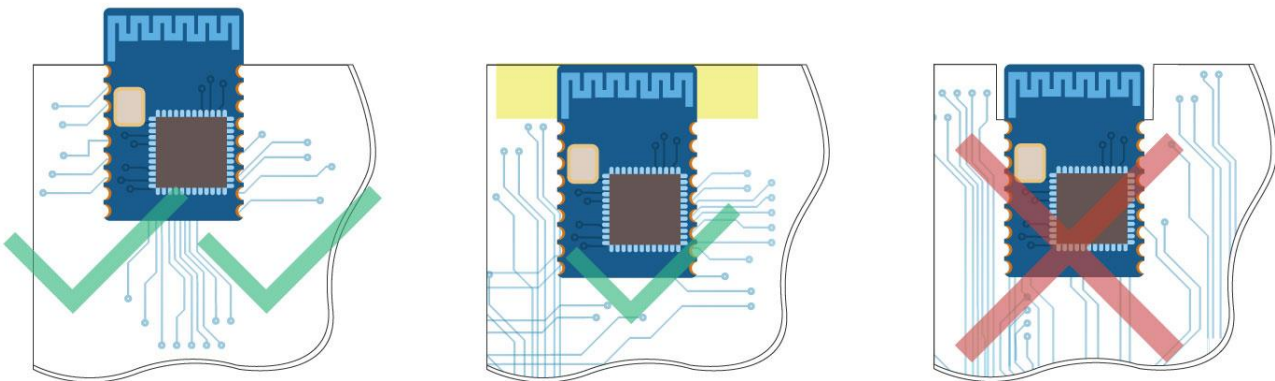


Figure 7. Recommendation of Antenna Layout

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: $245 \text{ }^{\circ}\text{C}$.

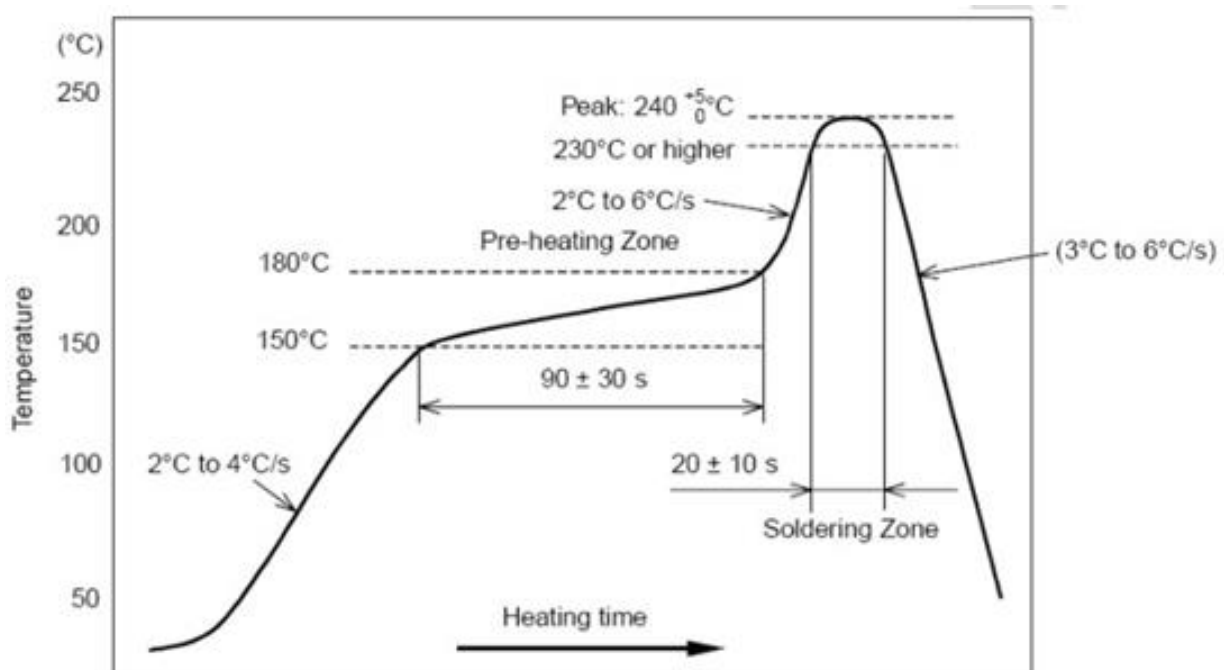


Figure 8. Recommended Reflow for Lead Free Solder

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

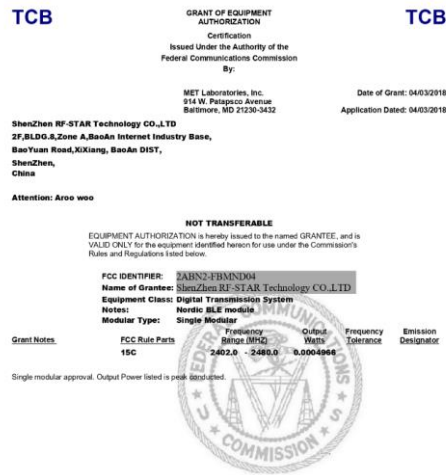


Figure 10. FCC Certificate

5.2 SRRC

SRRC ID: 2019DP6546



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 |
| 2020.01.10 | V1.2 | Add Nordic BLE module list. | Sunny Li |
| 2020.03.31 | V1.2 | Modify reset pin | Sunny Li |



RF-star

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