



RF-BM-ND05I

Bluetooth 5.0 Low Energy Module

Version 1.1

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 buy modules.

➤ **nRF52 Series**

Chipset	Core	Flash (KB)	RAM (KB)	TX Power (dBm)	Model	Antenna	Dimension (mm)	Range (M)	Photo
nRF52832	M4F	512	64	4	RF-BM-ND04	PCB	15 × 24.8	100	
					RF-BM-ND04I	IPEX	15 × 24.8	100	
					RF-BM-ND08	PCB	15.2 × 11.2	80	
					RF-BM-ND08I	IPEX	15.2 × 11.2	100	Contact me
nRF52810	M4	192	24	4	RF-BM-ND04C	PCB	15 × 24.8	100	
					RF-BM-ND04CI	IPEX	15 × 24.8	100	
					RF-BM-ND08C	PCB	15.2 × 11.2	80	
					RF-BM-ND08CI	IPEX	15.2 × 11.2	100	Contact me
nRF52811	M4	192	24	4	RF-BM-ND04A	PCB	15 × 24.8	100	

					RF-BM-ND08A	PCB	15.2 × 11.2	80	
nRF52833	M4	512	128	8	RF-BM-ND07	Chip / IPEX	12.2 × 17	300	
nRF52840	M4F	1024	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 buy modules.

1 Device Overview

1.1 Description

RF-BM-ND05I is an RF module based on Nordic multiprotocol SoC nRF52840-QIAA-R with best-in-class 32-bit ARM® Cortex®-M4 processor. It integrates a 32.768 kHz and a 32 MHz crystal, a power filter, an antenna matching, and an IPEX connector. It supports BLE stack v5.0, Bluetooth 5.0 low energy, Bluetooth mesh, Thread, ZigBee, IEEE 802.15.4-2006 and 2.4 GHz proprietary and can be preprogrammed with a serial interface communication protocol for simple programming. It also has a range of analog and digital interfaces such as NFC-A, ADC, high-speed 32 MHz SPI, UART, SPI, I²C, PWM, I²S, PPI and PDM. It features high-performance digital interfaces, robust connection distance, and rigid reliability. 1.27-mm pitch stamp stick package for easy assembling and cost-effective PCB design. RF-BM-ND05I is pin-to-pin compatible with RF-BM-ND04 / ND04C / ND05 / ND04I / ND04CI.

1.2 Key Features

- RF
 - Bluetooth 5.0 low energy
 - Bluetooth mesh
 - Thread
 - ZigBee
 - IEEE 802.15.4-2006
 - 2.4 GHz proprietary
- TX power: -20 dBm ~ +8 dBm
- On-air compatible with nRF52, nRF51, nRF24L and nRF24AP series
- ARM® Cortex®-M4 32-bit processor with FPU, 64 MHz
- Supply voltage range: 1.7 V ~ 3.6 V
- Memory
 - Flash: 1 MB
 - RAM: 256 kB
- Advanced peripherals
 - High-speed 32 MHz SPI
 - NFC-A
 - Programmable Peripheral interconnect (PPI)
 - 29 GPIOs
 - 12-bit, 200 ksps ADC
 - 4 x 4-channel PWM
 - I²S
 - PDM
 - 4 x SPI master / 3 x SPI slave
 - 2 x I²C master / slave
 - 2 x UART (CTS / RTS)
- Quadrature decoder (QDEC)
- Transmission Distance: 550+ m
- Dimension: 24.8 mm x 15.0 mm x (2.3 ± 0.1) mm

1.3 Applications

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

1.4 Functional Block Diagram

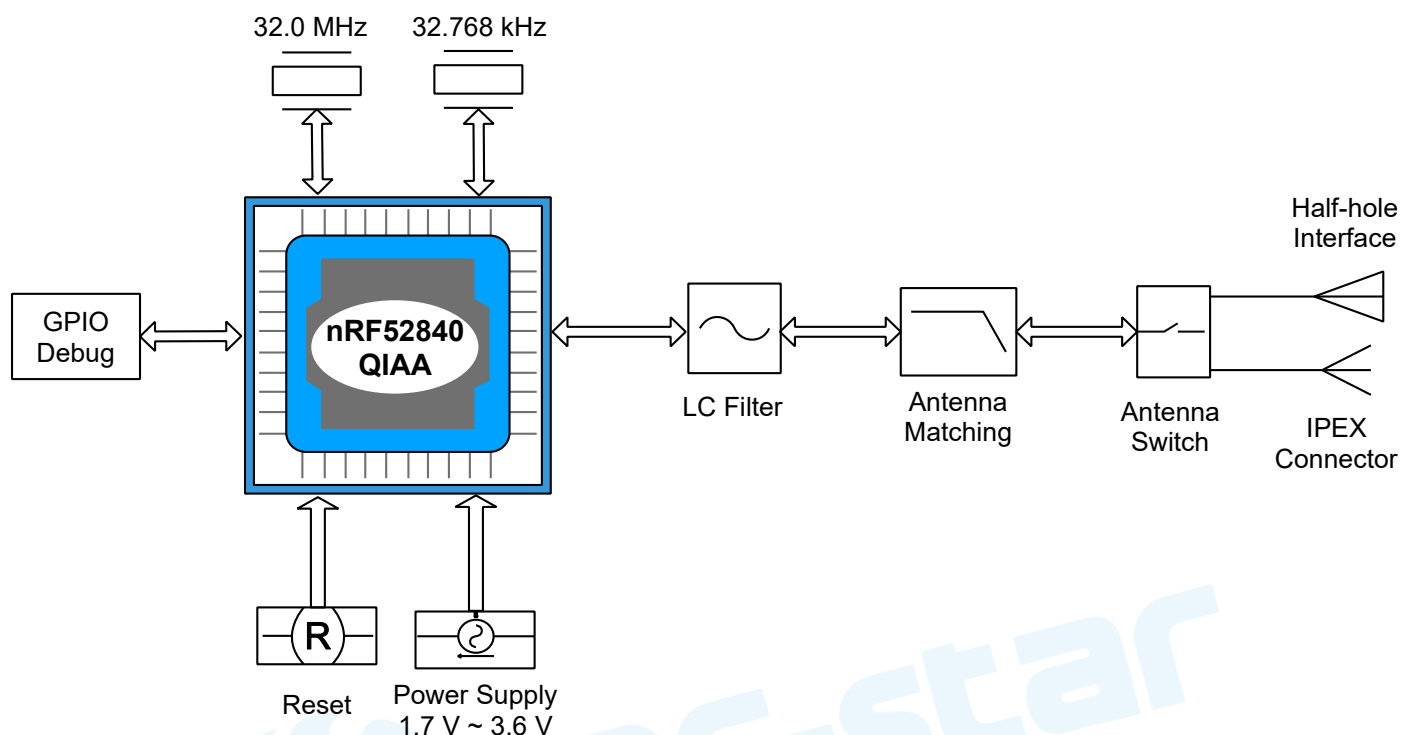


Figure 1. Functional Block Diagram of RF-BM-ND05I

1.5 Part Number Conventions

The part numbers are of the form of RF-BM-ND05I where the fields are defined as follows:

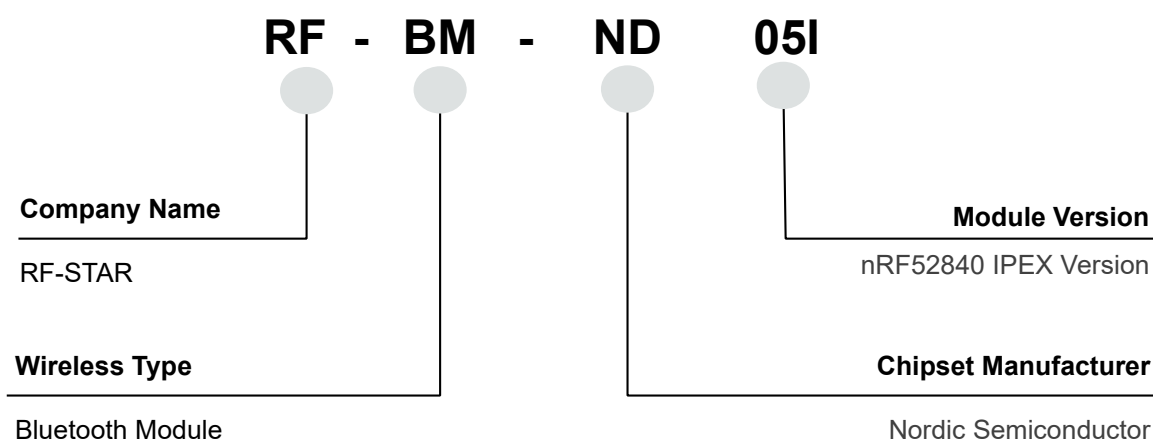


Figure 2. Part Number Conventions of RF-BM-ND05I

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2 Module Configuration and Functions

2.1 Module Parameters

Table 1. Parameters of RF-BM-ND05I

Chipset	nRF52840-QIAA-R
Supply Power Voltage	1.7 V ~ 3.6 V, recommended to 3.3 V
Frequency	2402 MHz ~ 2480 MHz
Transmit Power	-20.0 dBm ~ +8.0 dBm (typical: 0 dBm)
Receiving Sensitivity	-95 dBm conductive sensitivity in BLE mode -103 dBm sensitivity in 125 kbps BLE mode (long range)
Data Rate	Bluetooth® 5: 2 Mbps, 1 Mbps, 500 kbps and 125 kbps IEEE 802.15.4-2006: 250 kbps Proprietary 2.4 GHz: 2 Mbps, 1 Mbps
Power Consumption	4.8 mA peak current in TX (@0 dBm) 4.6 mA peak current in RX
GPIO	29
Crystal	32 MHz, 32.768 kHz
RAM	256 KB
Flash	1 MB
Package	SMT Packaging
Frequency Error	±20 kHz
Dimension	24.8 mm x 15.0 mm x (2.3 ± 0.1) mm
Type of Antenna	IPEX Connector / half-hole interface
Operating Temperature	-40 °C ~ +85 °C
Storage Temperature	-40 °C ~ +125 °C

2.2 Module Pin Diagram

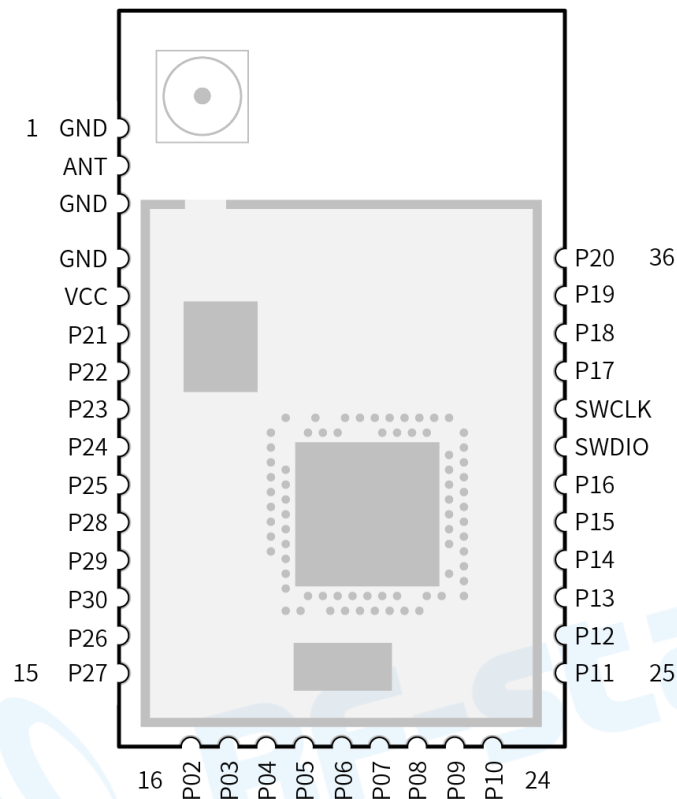


Figure 3. Pin Diagram of RF-BM-ND05I

2.3 Pin Functions

Table 2. Pin Functions of RF-BM-ND05I

Pin	Name	Chip Pin	Pin Type	Description
1	GND	GND	GND	Ground
2	ANT	ANT	ANT	Antenna output interface. Default as none use.
3	GND	GND	GND	Ground
4	GND	GND	GND	Ground
5	VCC	VDD	Power	Power supply 1.7 V ~ 3.6 V, Recommend 3.3 V
6	P21	P0_21	I/O	
7	P22	P0_22	I/O	
8	P23	P0_23	I/O	
9	P24	P0_24	I/O	

10	P25	P0_25	I/O	
11	P28	P0_28 / AIN4	I/O	
12	P29	P0_29 / AIN5	I/O	
13	P30	P0_30 / AIN6	I/O	
14	P26	P0_26	I/O	
15	P27	P0_27	I/O	
16	P02	P0_02 / AIN0	I/O	
17	P03	P0_03 / AIN1	I/O	
18	P04	P0_04 / AIN2	I/O	
19	P05	P0_05 / AIN3	I/O	
20	P06	P0_06	I/O	
21	P07	P0_07	I/O	
22	P08	P0_08	I/O	
23	P09	P0_09 / NFC1	I/O	
24	P10	P0_10 / NFC2	I/O	
25	P11	P0_11	I/O	
26	P12	P0_12	I/O	
27	P13	P0_13	I/O	
28	P14	P0_14	I/O	
29	P15	P0_15	I/O	
30	P16	P0_16	I/O	
31	SWDIO	SWDIO		Serial wire debug I/O for debug and programming
32	SWCLK	SWDCLK		Serial wire debug clock input for debug and programming
33	P17	P0_017	I/O	
34	P18 / RST	P0_18 / RESET	I/O	Reset, active low.
35	P19	P0_19	I/O	
36	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-ND05I

Items	Condition	Min.	Typ.	Max.	Unit
Operating Supply Voltage	Battery Mode	1.7	3.3	3.6	V
Operating Temperature	/	-40	+25	+85	°C
Environmental Hot Pendulum	/	-20		+20	°C/min

3.2 Handling Ratings

Table 4. Handling Ratings of RF-BM-ND05I

Items	Condition	Min.	Typ.	Max.	Unit
Storage Temperature	Tstg	-40	+25	+125	°C
Human Body Model	HBM		±2000		V
Moisture Sensitivity Level			2		
Charged Device Model			±750		V

4 Application, Implementation, and Layout

4.1 Module Photos

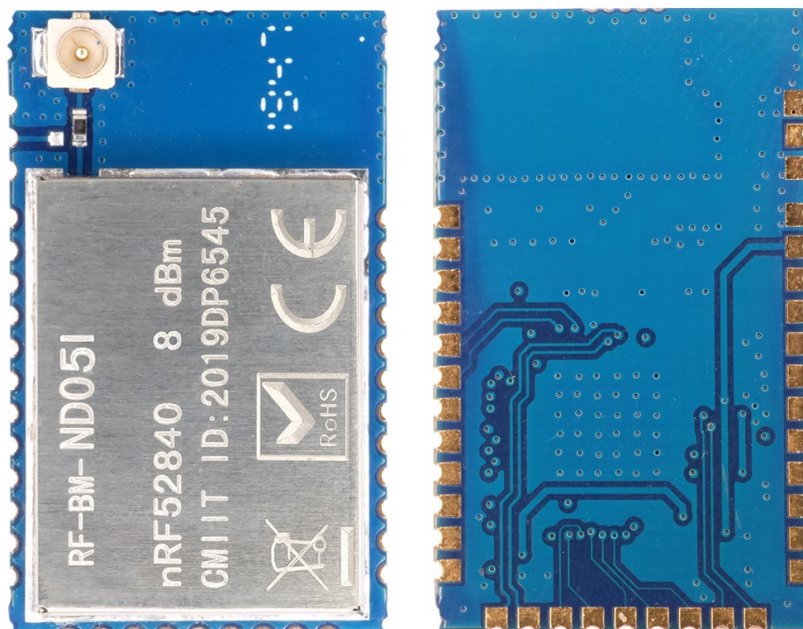


Figure 4. Photos of RF-BM-ND05I

4.2 Recommended PCB Footprint

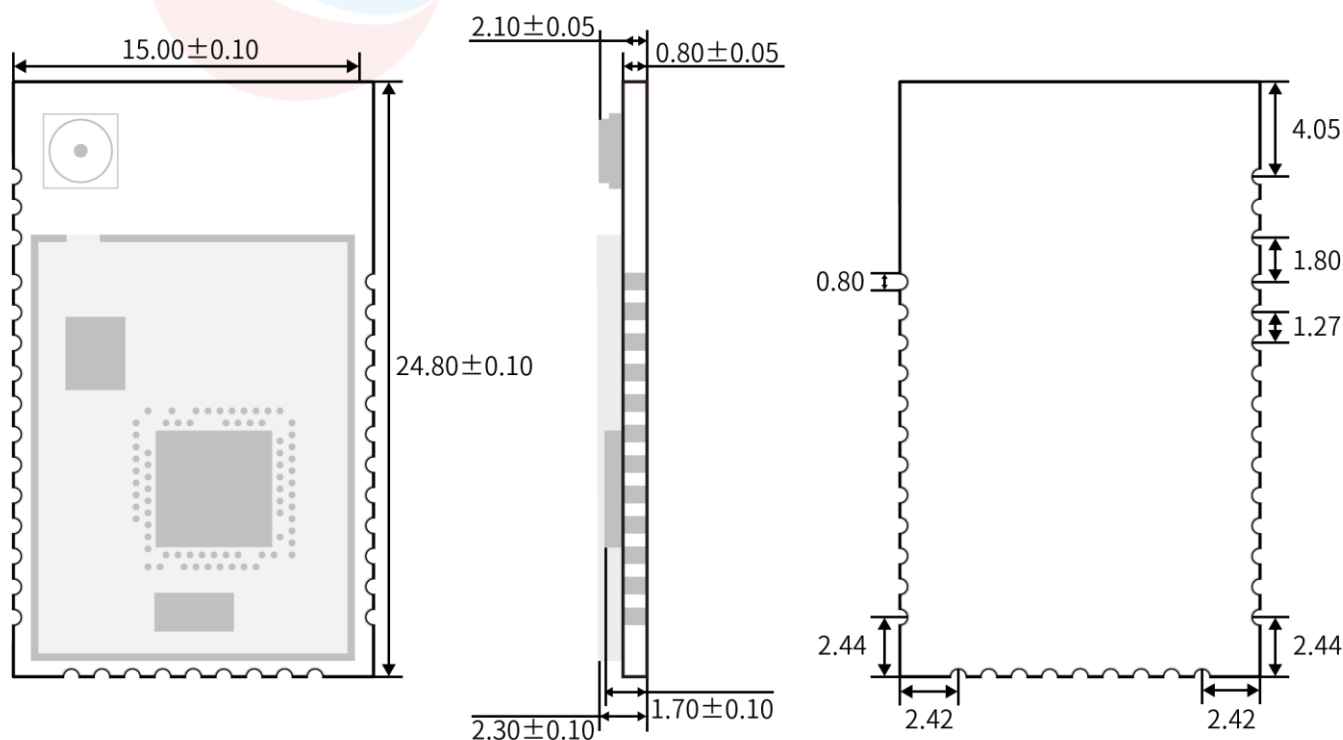


Figure 5. Recommended PCB Footprint of RF-BM-ND05I (mm)

4.3 Antenna

RF-BM-ND05I module is integrated the IPEX version 1 antenna seat, the specification of antenna seat is as follow:

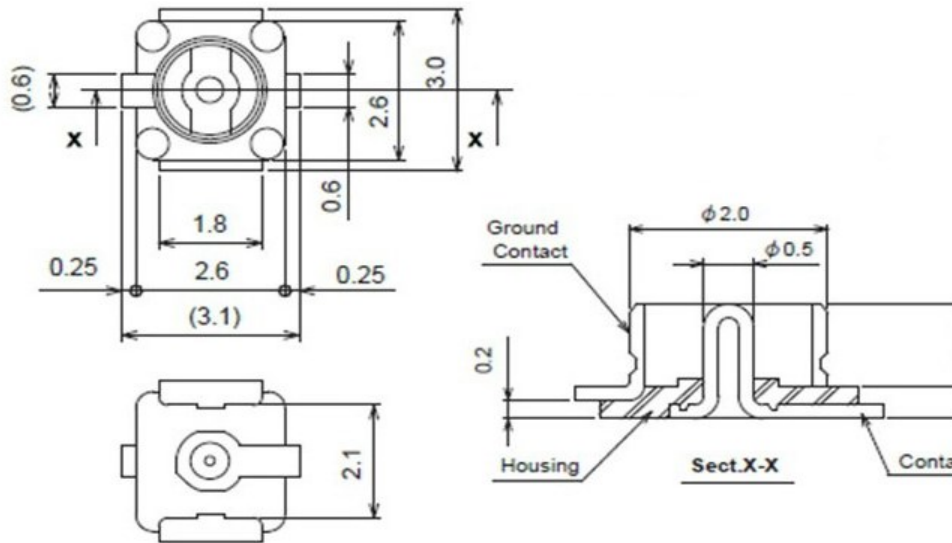


Figure 6. Specification of Antenna Seat

The specification of IPEX wire end is as follow:

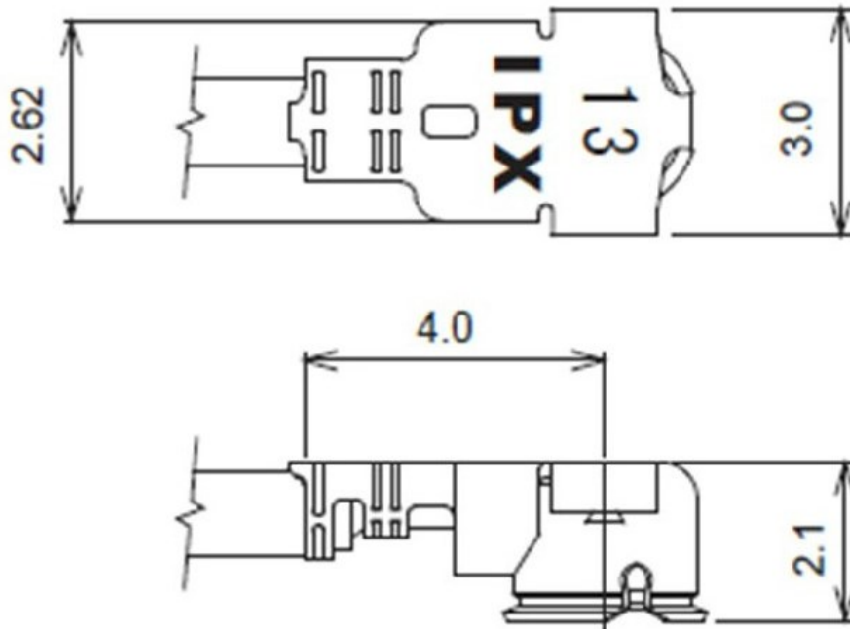


Figure 7. Specification of IPEX Wire

Antenna output mode change:

The module has two antenna output modes: IPEX connector output and stamp half-hole antenna output (ANT pin, see pin function table for details).

The default delivery is IPEX connector mode. Under IPEX connector mode, C1 is off and C2 is welded. If you would like

to change to half-hole antenna output mode, please disconnect C2 and weld C2. The locations of C1 and C2 (8 pF) are shown in the figure below.

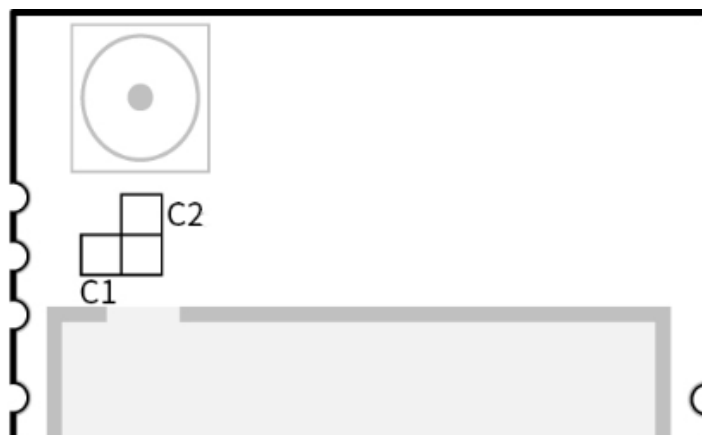


Figure 8. Antenna Output Mode Change

4.4 Schematic Diagram

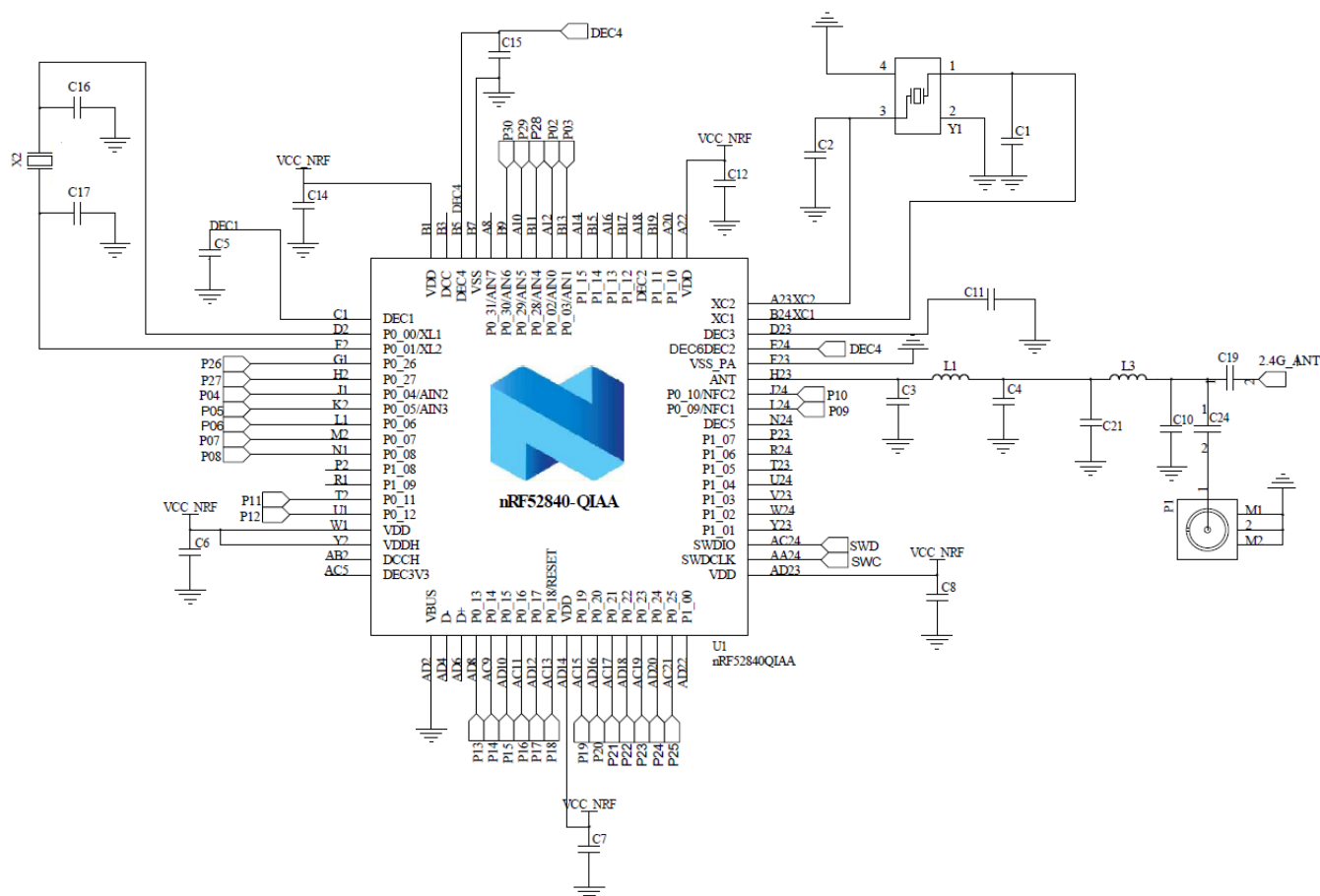


Figure 9. Schematic Diagram of RF-BM-ND05I

4.5 Reference Design

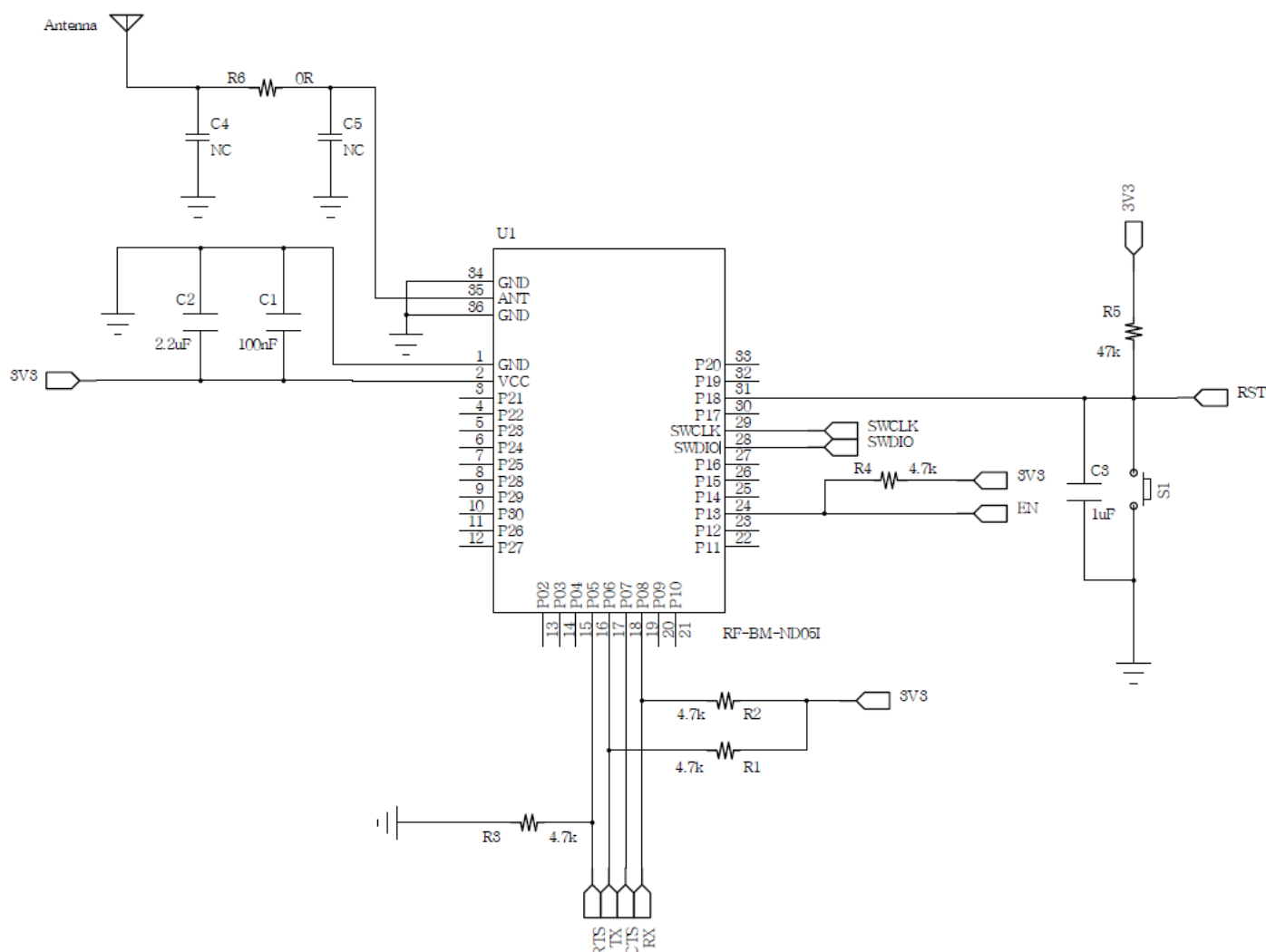


Figure 10. Reference Design of RF-BM-ND05I

4.6 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.

4.7 Trouble Shooting

4.7.1 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.

4.7.2 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.

4.7.3 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.

4.8 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.

4.9 Soldering and Reflow Condition

1. Heating method: Conventional Convection or IR/convection.
2. Solder paste composition: Sn96.5 / Ag3.0 / Cu0.5
3. Allowable reflow soldering times: 2 times based on the following reflow soldering profile.
4. Temperature profile: Reflow soldering shall be done according to the following temperature profile.
5. Peak temperature: 245 °C.

Table 5. Temperature Table of Soldering and Reflow

Profile Feature	Sn-Pb Assembly	Pb-Free Assembly
Solder Paste	Sn63 / Pb37	Sn96.5 / Ag3.0 / Cu0.5

Min. Preheating Temperature (T_{min})	100 °C	150 °C
Max. Preheating Temperature (T_{max})	150 °C	200 °C
Preheating Time (T_{min} to T_{max}) (t_1)	60 s ~ 120 s	60 s ~ 120 s
Average Ascend Rate (T_{max} to T_p)	Max. 3 °C/s	Max. 3 °C/s
Liquid Temperature (T_L)	183 °C	217 °C
Time above Liquidus (t_L)	60 s ~ 90 s	30 s ~ 90 s
Peak Temperature (T_p)	220 °C ~ 235 °C	230 °C ~ 250 °C
Average Descend Rate (T_p to T_{max})	Max. 6 °C/s	Max. 6 °C/s
Time from 25 °C to Peak Temperature (t_2)	Max. 6 minutes	Max. 8 minutes
Time of Soldering Zone (t_p)	20±10 s	20±10 s

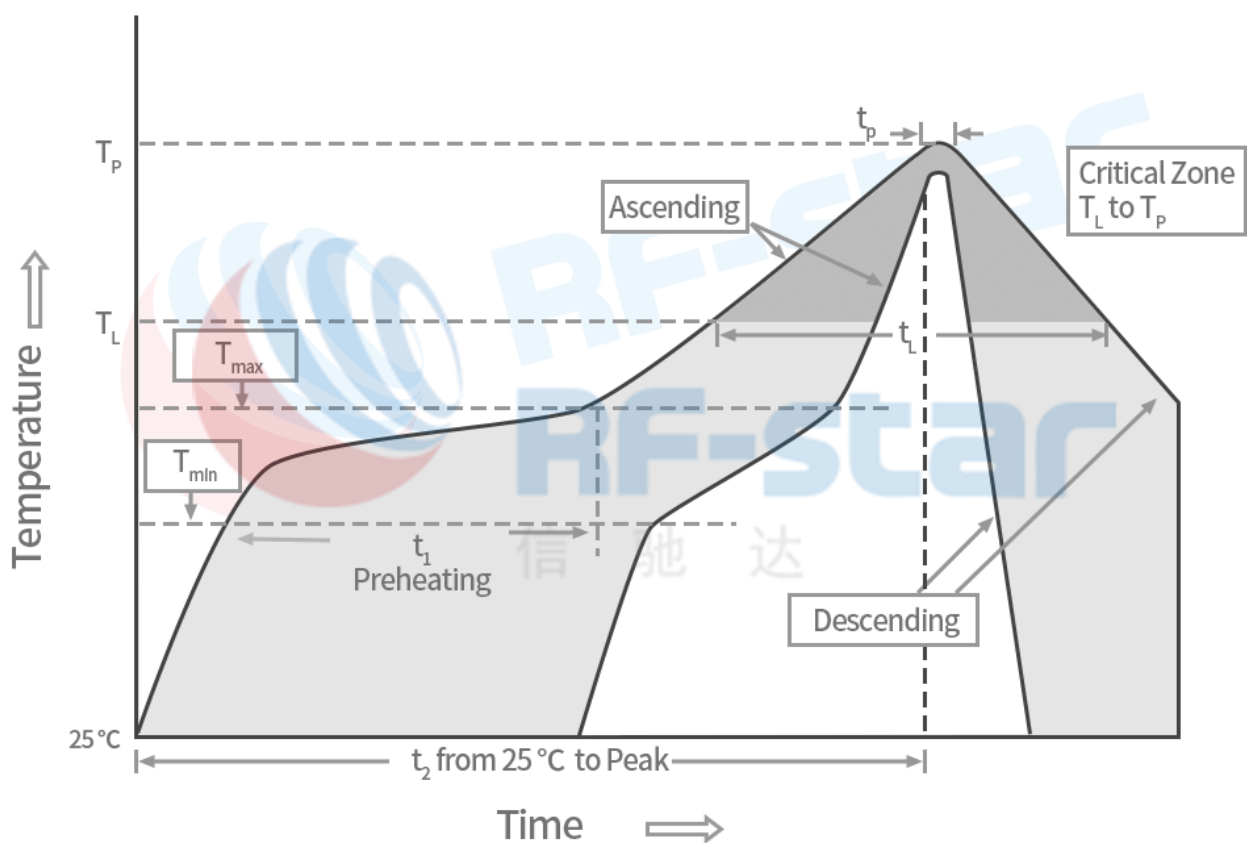


Figure 11. Recommended Reflow for Lead Free Solder

4.10 Optional Packaging



Figure 12. Optional Packaging Mode

Note: Default tray packaging.

5 Revision History

Date	Version No.	Description
2020.01.06	V1.0	The initial version is released.
2020.01.10	V1.0	Add Nordic BLE module list.
2020.03.31	V1.0	Modify reset pin
2020.05.15	V1.1	Add antenna output mode change specification. Update Nordic BLE module list.
2020.09.22	V1.1	Add reference design. Update Nordic BLE module list.
2022.09.09	V1.1	Update the power supply.

Note:

1. The document will be optimized and updated from time to time. Before using this document, please make sure it is the latest version.
2. To obtain the latest document, please download it from the official website: www.szrfstar.com.

6 Contact Us

SHENZHEN RF-STAR TECHNOLOGY CO., LTD.

Shenzhen HQ:

Add.: Room 601, Block C, Skyworth Building, High-tech Park, Nanshan District, Shenzhen, Guangdong, China

Tel.: 86-755-3695 3756

Chengdu Branch:

Add.: No. B3-03, Building No.1, Incubation Park, High-Tech District, Chengdu, Sichuan, China, 610000

Tel.: 86-28-6577 5970

Email: sunny@szrfstar.com, sales@szrfstar.com

Web.: www.szrfstar.com

