RF-BM-ND02C nRF51802

Bluetooth 4.2 Low Energy Module

Version 1.2

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1 Device Overview

1.1 Description

RF-BM-ND02C is an RF module based on Nordic BLE SoC nRF51802 with ARM® Cortex®-M0 32-bit processor. It integrates a 16.0 MHz crystal, an LC filter, an antenna matching and a meander line inverted-F PCB antenna. It features low power consumption, compact size, robust connection distance, and rigid reliability. It supports Bluetooth® v4.2 Low Energy and 2.4 GHz proprietary wireless applications and can be pre-programmed with SPI master/slave, I²C master and UART for simple programming. 1.27-mm pitch stamp stick package for easy assembling and cost-effective PCB design. RF-BM-ND02C is pin-to-pin compatible with RF-BM-ND02.

1.2 Key Features

- Bluetooth® low energy mode
- TX power: -20 to +4 dBm
- 16 MHz ARM® Cortex®-M0 32-bit processor
- Supply voltage range 1.8 V ~ 3.6 V
- Memory
  - 256 KB flash
  - 16 KB RAM
- Peripherals
  - 10 bit ADC
  - 24 GPIOs
  - SPI Master/Slave
  - I²C Master
  - UART (CTS/RTS)
- Quadrature Decoder (QDEC)
- AES HW encryption
- Real Timer Counter (RTC)
- Dimension: 16.2 mm x 13.5 mm x 1.3 mm
- Certificate: SRRC

1.3 Applications

- Mouse and keyboard
- Mobile HID
- Multi-touch trackpad
- Remote control
- Gaming controller
- Wearables
- Virtual reality headsets
- Health/fitness sensor and monitor device
- Industrial lighting
- Smart toys
- Medical devices
- Beacons

1.4 Functional Block Diagram

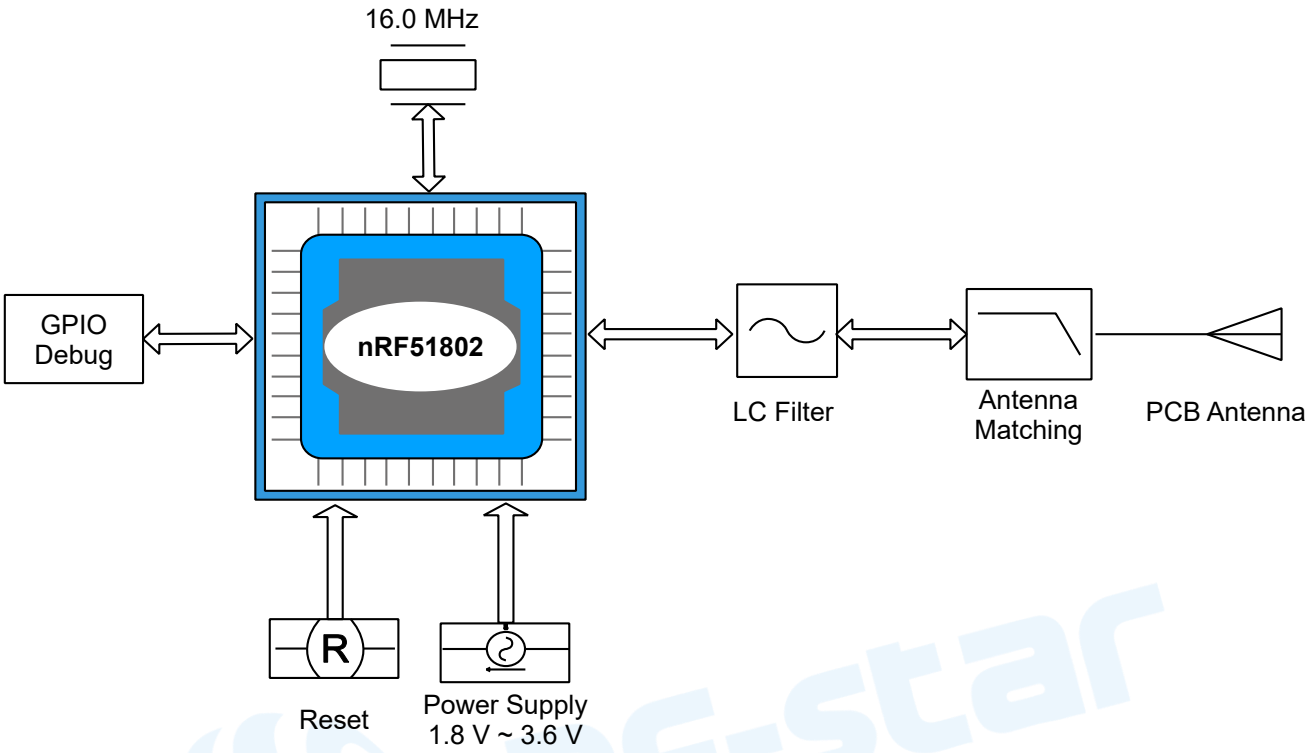

Figure 1. Functional Block Diagram of RF-BM-ND02C

1.5 Part Number Conventions

The part numbers are of the form of RF-BM-ND02C where the fields are defined as follows:

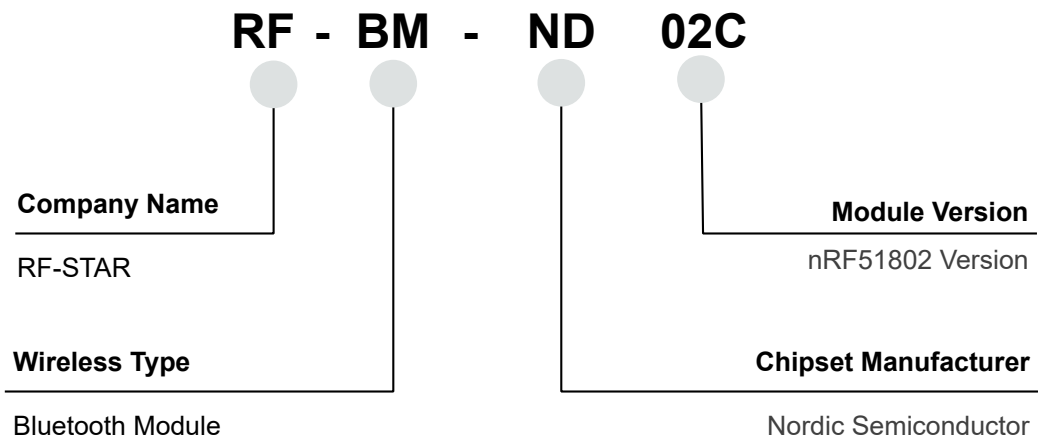

Figure 2. Part Number Conventions of RF-BM-ND02C

Table of Contents

2 Module Configuration and Functions

2.1 Module Parameters

Table 1. Parameters of RF-BM-ND02C

Chipset	nRF51802
Supply Power Voltage	1.8 V ~ 3.6 V, recommended to 3.3 V
Frequency	2402 MHz ~ 2480 MHz
Transmit Power	-20.0 dBm ~ +4.0 dBm (typical: 0 dBm)
Receiving Sensitivity	-93 dBm
Power Consumption	13 mA peak RX, 10.5 mA peak TX (@ 0 dBm) 9.7 mA peak RX, 8.0 mA peak TX (@ 0 dBm with DC/DC)
GPIO	24
Crystal	16 MHz
RAM	16 kB
Flash	256 kB
Package	SMT Packaging (1.27-mm half-hole pitch stamp stick)
Frequency Error	±20 kHz
Dimension	16.2 mm x 13.5 mm x 1.3 mm
Type of Antenna	PCB antenna
Operating Temperature	-40 ℃ ~ +85 ℃
Storage Temperature	-40 ℃ ~ +125 ℃

2.2 Module Pin Diagram

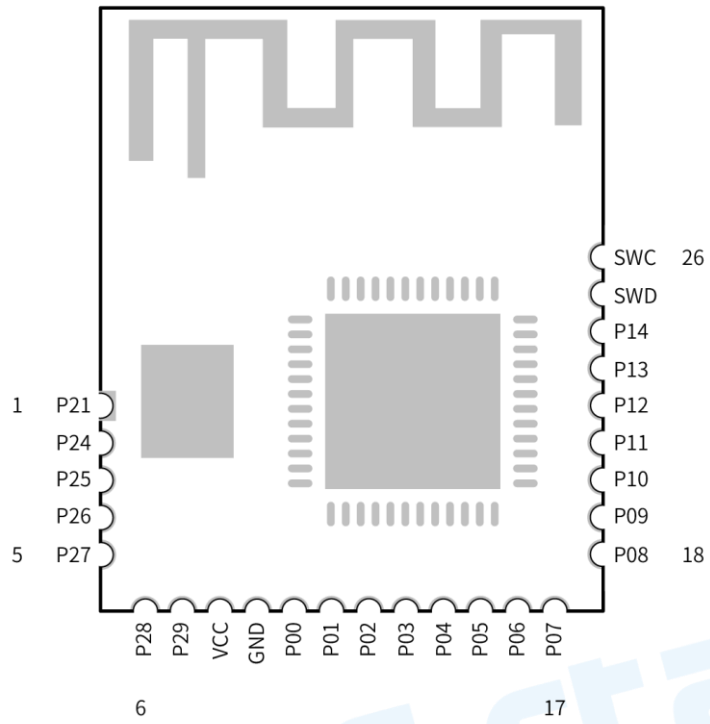

Figure 3. Pin Diagram of RF-BM-ND02C

2.3 Pin Functions

Table 2. Pin Functions of RF-BM-ND02C

Pin	Name	Chip Pin	Pin Type	Description
1	P21	P0.21	Digital I/O	
2	P24	P0.24	Digital I/O	
3	P25	P0.25	Digital I/O	
4	P26	P0.26	Digital I/O	
5	P27	P0.27	Digital I/O	
6	P28	P0.28/AIN4	Digital I/O & Analog	
7	P29	P0.29	Digital I/O	
8	VCC	VCC	I	Power supply 1.8 V ~ 3.6 V, Recommend to 3.3 V
9	GND	GND	I	Ground
10	P00	P0.00	Digital I/O	
11	P01	P0.01	Digital I/O	

12	P02	P0.02/AIN0	Digital I/O & Analog	
13	P03	P0.03/AIN1	Digital I/O & Analog	
14	P04	P0.04/AIN2	Digital I/O & Analog	
15	P05	P0.05/AIN3	Digital I/O & Analog	
16	P06	P0.06	Digital I/O	
17	P07	P0.07	Digital I/O	
18	P08	P0.08	Digital I/O	
19	P09	P0.09	Digital I/O	
20	P10	P0.10	Digital I/O	
21	P11	P0.11	Digital I/O	
22	P12	P0.12	Digital I/O	
23	P13	P0.13	Digital I/O	
24	P14	P0.14	Digital I/O	
25	SWDIO nRESET	SWDIO nRESET	Digital I/O & Analog	Hardware debug and falsh programming I/O. Reset pin. Active low.
26	SWCLK	SWDCLK	Digital Input	Hardware debug and falsh programming I/O.

3 Specifications

3.1 Recommended Operating Conditions

The 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-ND02C

Items	Condition	Min.	Typ.	Max.	Unit
Operating Supply Voltage	Battery Mode	1.8	3.3	3.6	V
Operating Temperature	/	-40	+25	+85	℃
Environmental Hot Pendulum	/	-20		+20	℃/min

3.2 Handling Ratings

Table 4. Handling Ratings of RF-BM-ND02C

Items	Condition	Min.	Typ.	Max.	Unit
Storage Temperature	Tstg	-40	+25	+125	℃
Human Body Model	HBM		±4000		V
Moisture Sensitivity Level			3		
Charged Device Model			±500		V

4 Application, Implementation, and Layout

4.1 Module Photos

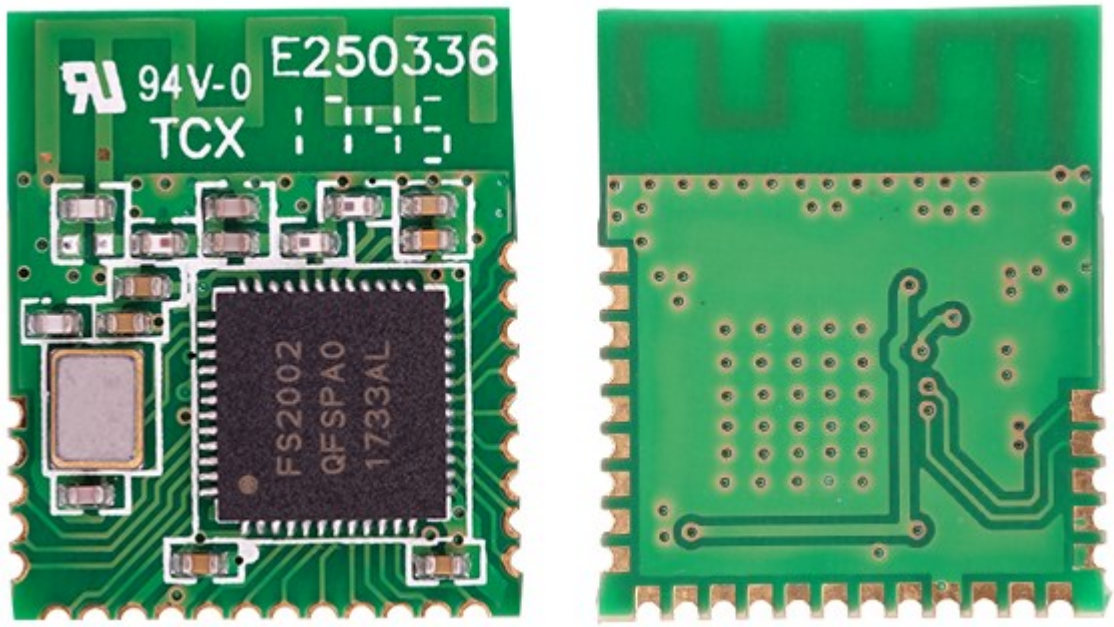

Figure 4. Photos of RF-BM-ND02C

4.2 Recommended PCB Footprint

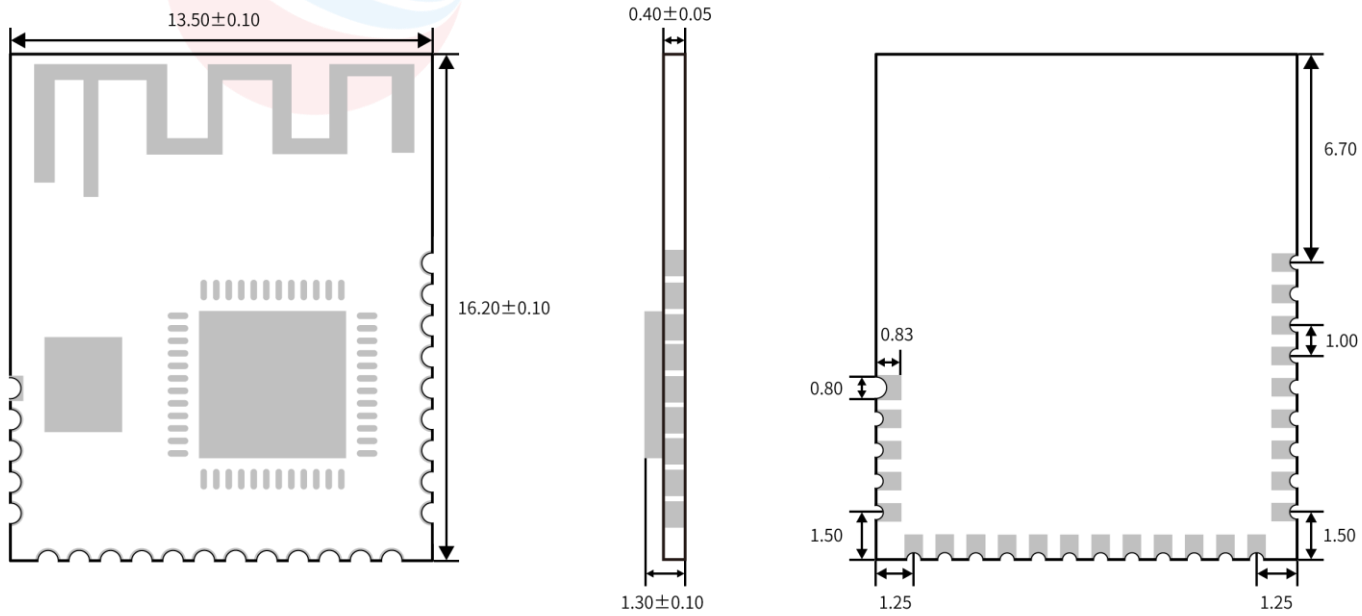

Figure 5. Recommended PCB Footprint of RF-BM-ND02C (mm)

4.3 Schematic Diagram

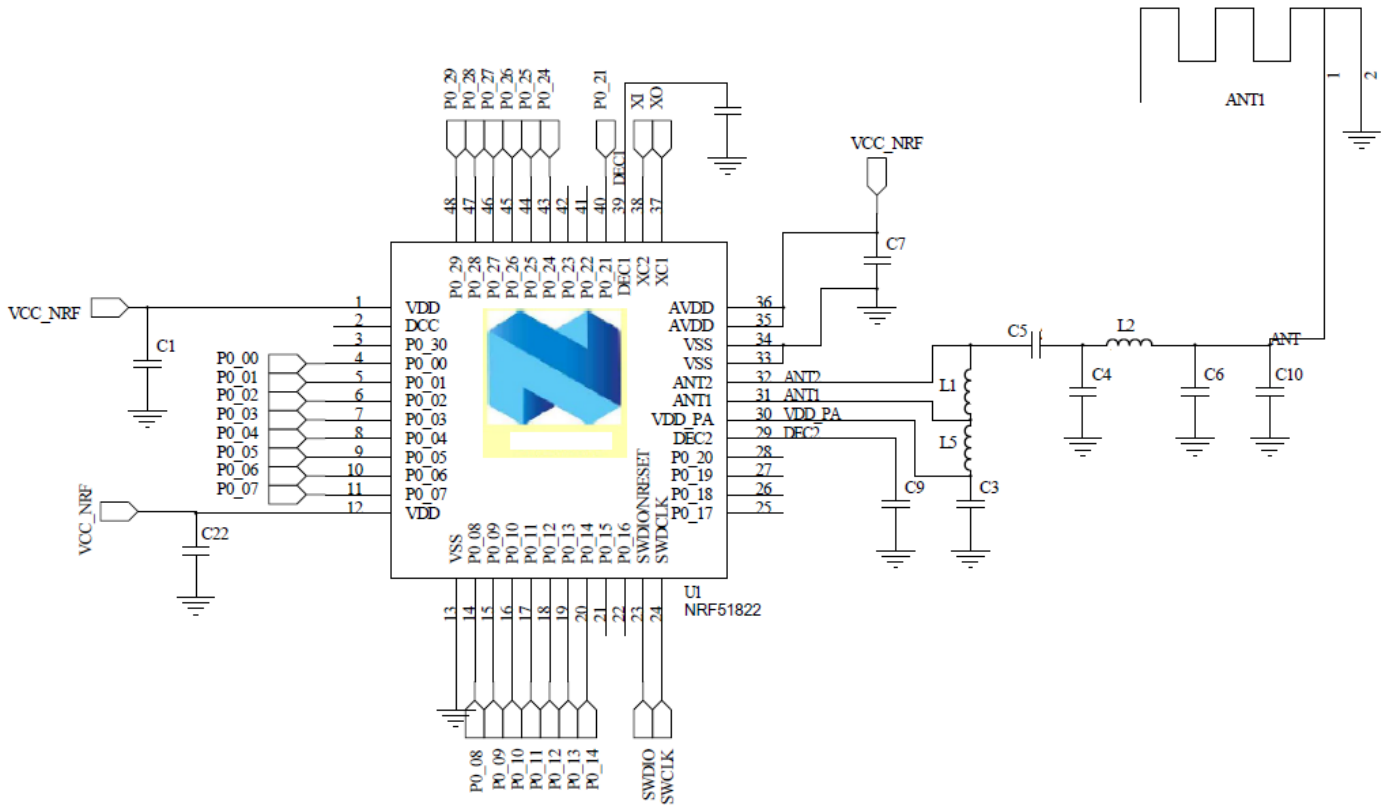

Figure 6. Schematic Diagram of RF-BM-ND02C

4.4 Antenna

4.4.1 Antenna Design Recommendation

1. 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.
2. The antenna must not be installed inside the metal case, which will cause the transmission distance to be greatly weakened.
3. The recommendation of antenna layout.

   The inverted-F antenna position on PCB is free-space electromagnetic radiation. The location and layout of the 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 best to hollow out the antenna position in the following figure to ensure that the S11 of the module is

minimally affected.

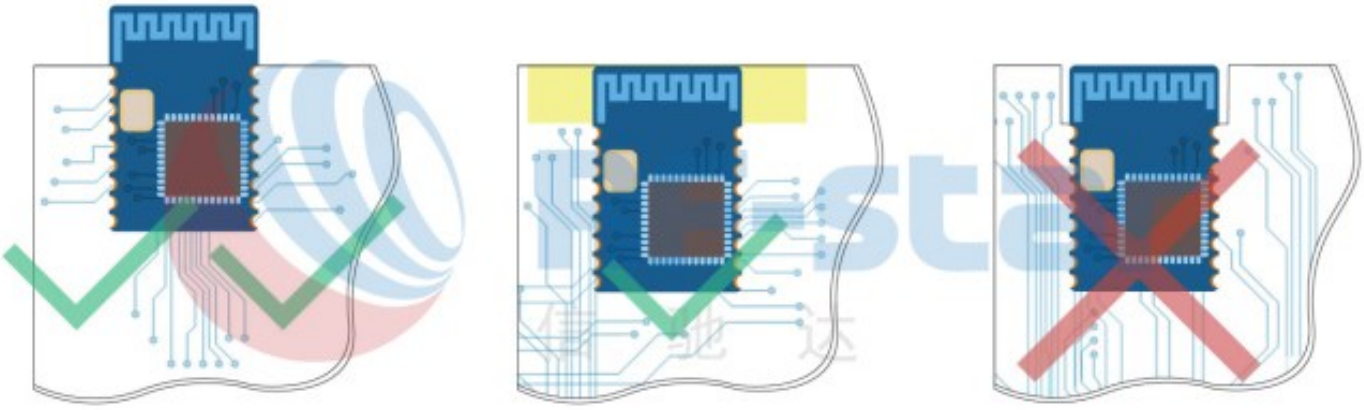

Figure 7. Recommendation of Antenna Layout

Note: The hollow-out position is based on the antenna used.

4.5 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 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 a 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 the 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 the 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 the 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.

4.6 Trouble Shooting

4.6.1 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 the 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 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 modules or the poor quality of the antenna will affect the communication distance.

4.6.2 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 a 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 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.

4.6.3 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's reliability.
3. If the extension wire or feeder wire is of poor quality or too long, the bit error rate will be high.

4.7 Electrostatics Discharge Warnings

The module will be damaged for the discharge of static. RF-star suggests 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 the module, even causing the failure.

4.8 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 ℃.

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

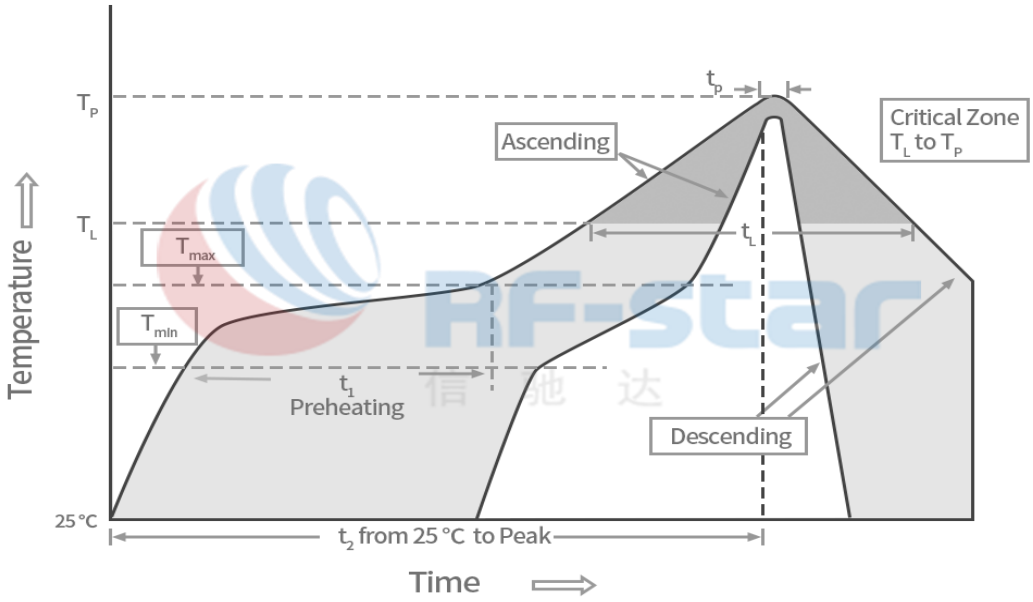

Figure 8. Recommended Reflow for Lead-Free Solder

5 Optional Package Specification

The default package method is ***by tray***. If you need the modules to be shipped by tape & reel, pls contact us in advance.

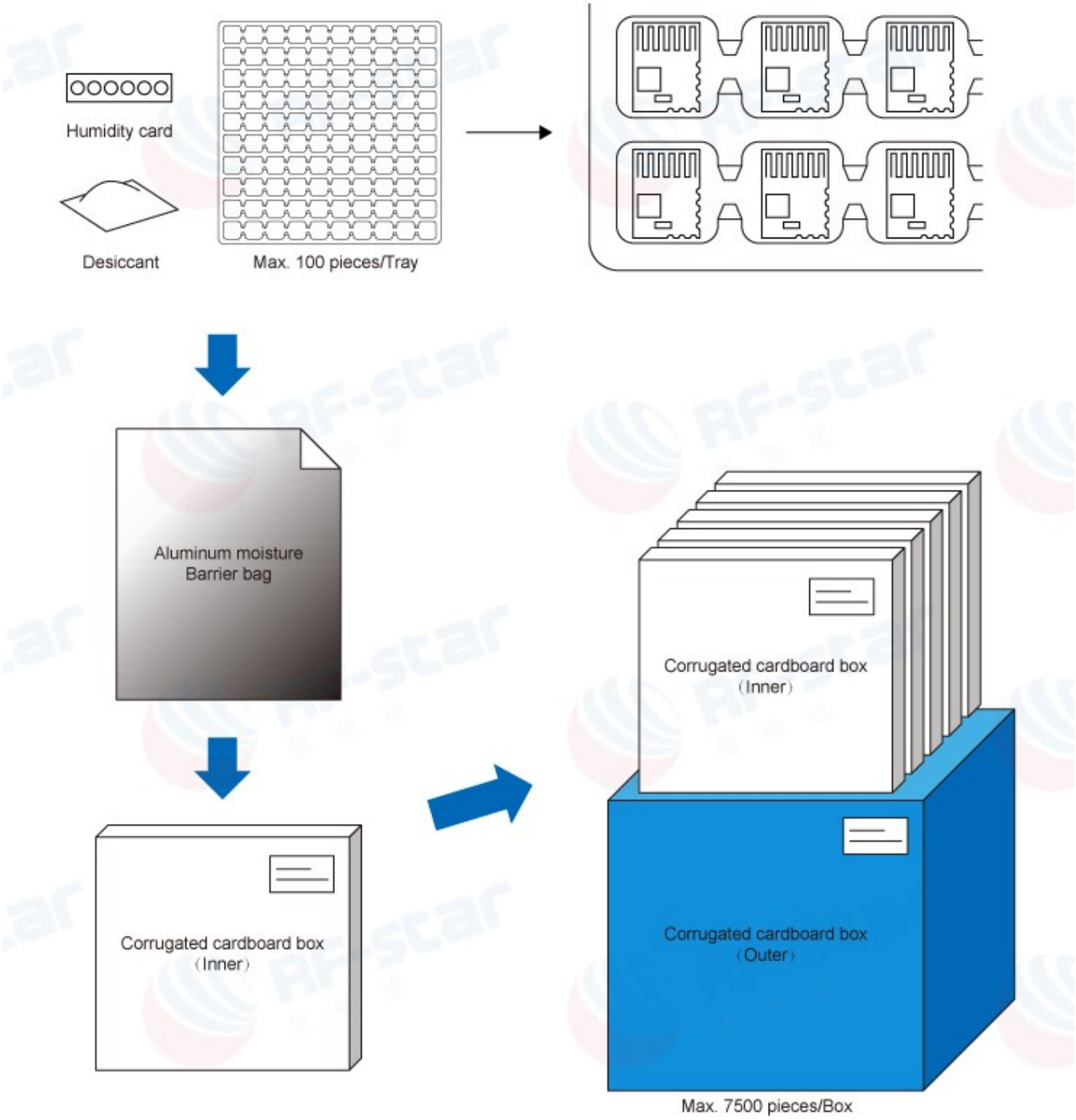

Figure 9. Default Package by Tray

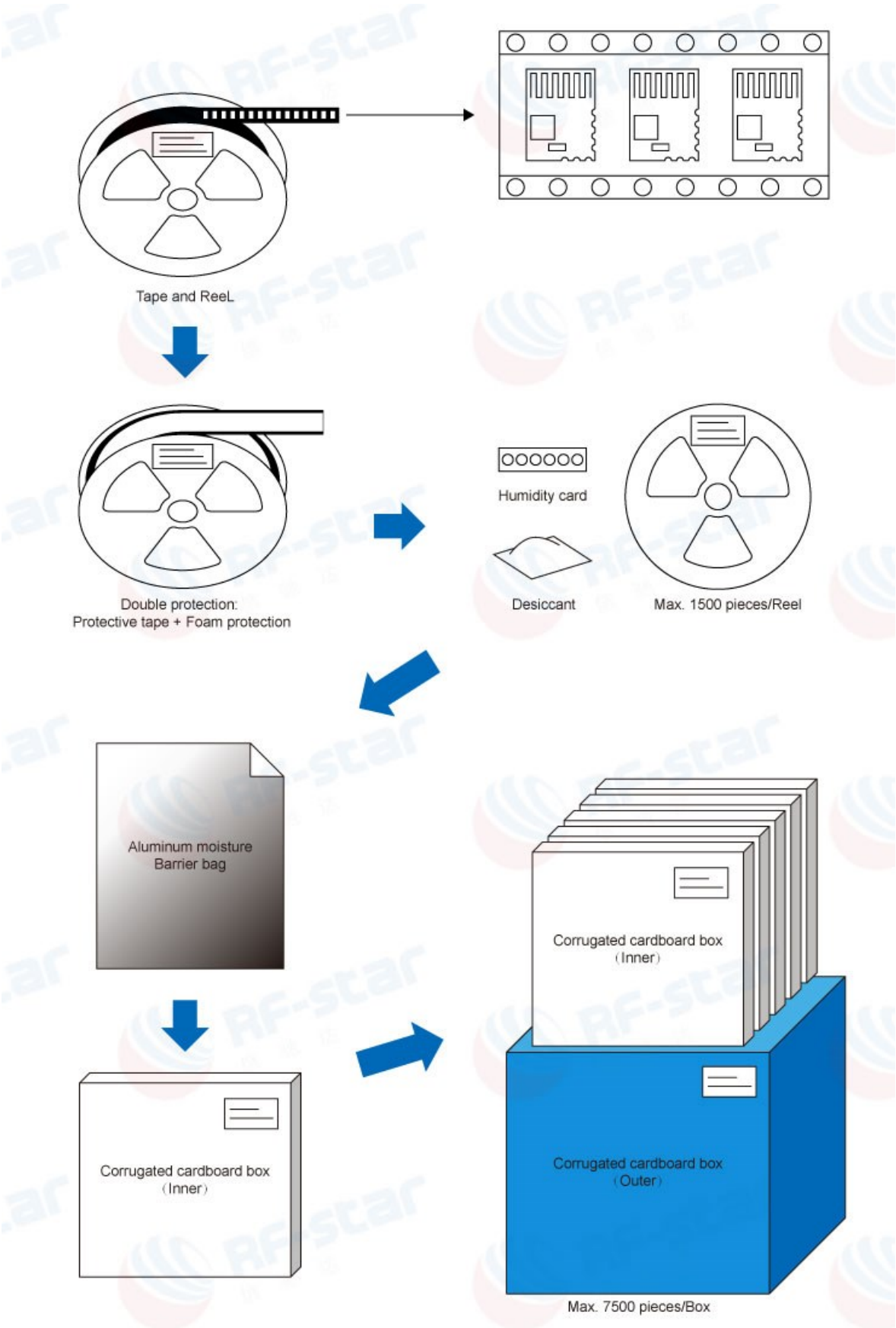

Figure 10. Package by Tape & Reel

6 Certification

6.1 SRRC

SRRC ID: 2019DP5543(M)

Figure 11. SRRC Certificate

7 Revision History

Date	Version No.	Description
2016.08.31	V1.0	The initial version is released.
2016.10.11	V1.0	Add chipset ROM.
2017.06.19	V1.0	Update module thickness.
2017.12.20	V1.1	Update module parameters.
2018.03.02	V1.2	Update module parameters.
2018.08.02	V1.2	Update company address.
2023.05.26	V1.2	Update MSL level. Update the Shenzhen office address.

Note:

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8 Contact Us

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