RF-BM-ND07 nRF52833
Multi-Protocols Module
Supporting BLE, ZigBee, Thread

Version 1.1

Shenzhen RF-star Technology Co., Ltd.

May 25th, 2023

1 Device Overview

1.1 Description

RF-BM-ND07 is an RF module based on Nordic SoC nRF52833 with ARM® Cortex®-M4 32-bit processor. It integrates a 32 MHz crystal, a matching and antenna options of a chip antenna, an IPEX connector and pad antenna interface. It features low power consumption, small size, robust connection distance, and rigid reliability. It supports Bluetooth® 5.2 Low Energy, Bluetooth mesh, Thread and Zigbee. It includes a range of analog and digital interfaces such as NFC-A, ADC, full-speed 12 Mbps USB 2.0, High-speed 32 MHz SPI, SPI, UART, PWM, I²C, I²S and PDM, which make this module an ideal device for a wide range of commercial and industrial applications, including professional lighting, asset tracking, advanced wearables or smart home applications where robust coverage is important.

1.2 Key Features

- RF Features
  - Bluetooth® 5.2 low energy
  - Bluetooth mesh
  - Thread
  - ZigBee
- Angle-of arrival (AoA) and angle-of-departure (AoD) direction finding
- ARM® Cortex®-M4 32-bit processor with FPU, 64 MHz
- Memory
  - 512 kB flash
  - 128 kB RAM
- Interfaces
  - ADC
  - Full speed 12 Mbps USB 2.0
  - High-speed 32 MHz SPI
  - NFC-A
  - PPI
  - 42 GPIOs
  - PWM
  - I²S
  - SPI master/slave
  - I²C
  - UART (CTS/RTS)
  - Quadrature decoder (QDEC)
  - 3 x real-time counter (RTC)
- Transmission Distance: up to 300 m
- Dimension: 12.2 mm x 17.0 mm x 2.2 mm
- Tx power: -20 dBm ~ +8 dBm

1.3 Applications

- Internet of Things (IoT)
- Smart home sensors and controllers
- Industrial IoT sensors and controllers
- Mouse
- Keyboard
- Home Automation
- Beacons
- Health and medical
- Wearables
- Gaming controllers
- Wireless payment-enabled devices

1.4 Functional Block Diagram

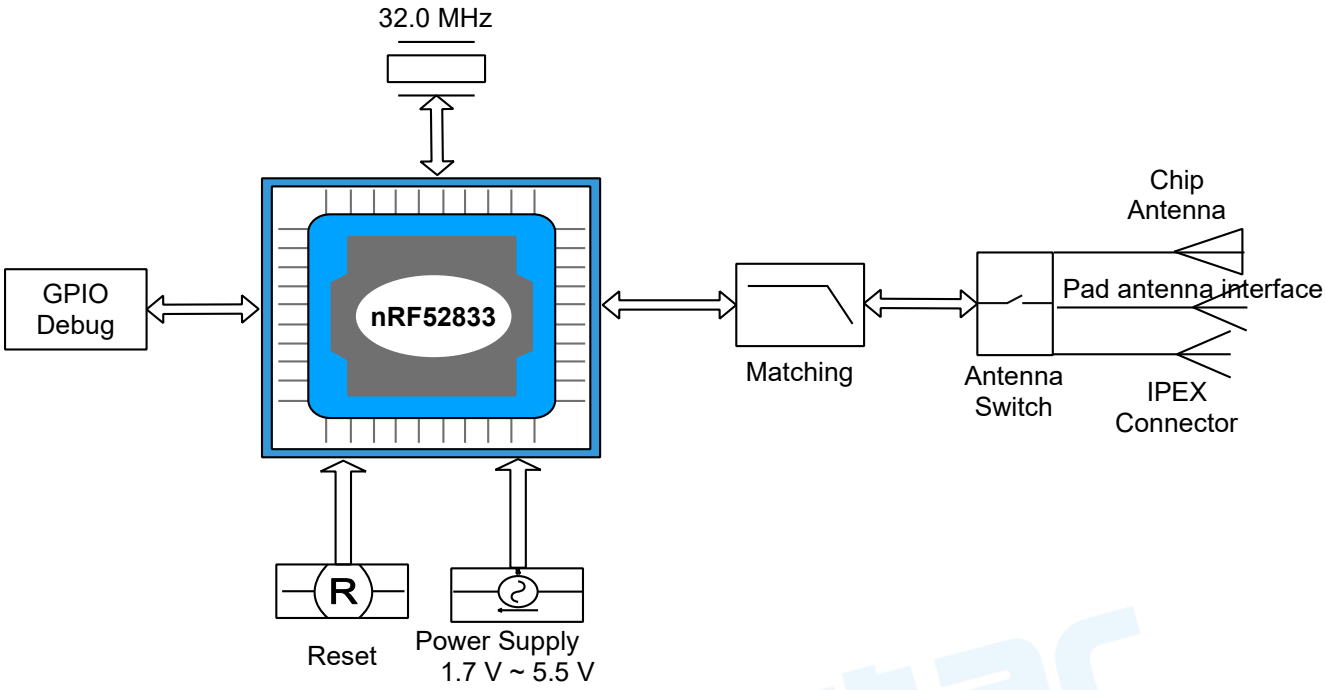

Figure 1. Functional Block Diagram of RF-BM-ND07

1.5 Part Number Conventions

The part numbers are of the form of RF-BM-ND07 where the fields are defined as follows:

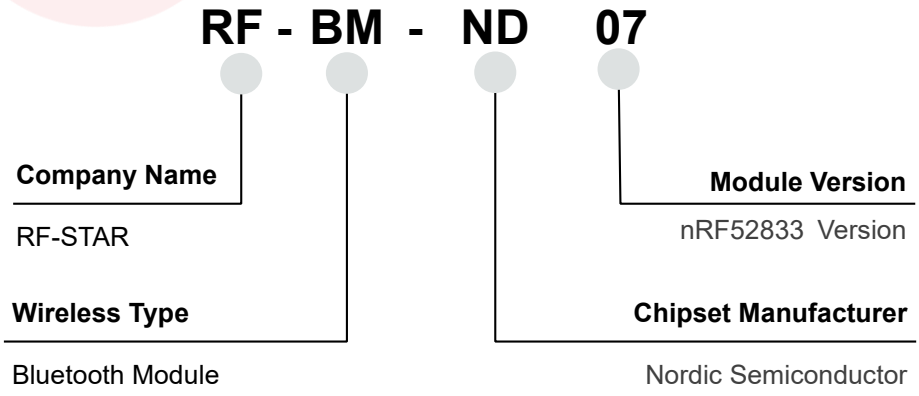

Figure 2. Part Number Conventions of RF-BM-ND07

Table of Contents

2 Module Configuration and Functions

2.1 Module Parameters

Table 1. Parameters of RF-BM-ND07

Chipset	nRF52833
Support Protocol	Bluetooth® 5.2, Bluetooth mesh, Thread and ZigBee, AoA/AoD
Supply Power Voltage	1.7 V ~ 5.5 V, recommended to 3.3 V
Frequency	2402 MHz ~ 2480 MHz
Transmit Power	-20.0 dBm ~ +8.0 dBm (Typical: 0 dBm)
Receiving Sensitivity	-103 dBm @ 125 kbps BLE -96 dBm @ 1 Mbps BLE
Data Rate	Bluetooth® 5.1: 2 Mbps, 1 Mbps, 500 kbps, and 125 kbps IEEE 802.15.4-2006: 250 kbps Propriety 2.4 GHz: 2 Mbps, 1 Mbps
Power Consumption	4.9 mA peak current in TX (@ 0 dBm) 4.6 mA peak current in RX
Interface	NFC-A, ADC, full-speed 12 Mbps USB 2.0, High-speed 32 MHz SPI, UART/SPI/TWI, PWM, I^2C, I^2S and PDM
GPIO	42
Crystal	32 MHz
RAM	128 KB
Flash	512 KB
Package	LGA packaging (0.8-mm pad)
Frequency Error	±20 kHz
Dimension	12.2 mm x 17.0 mm x 2.2 mm
Type of Antenna	Chip antenna, IPEX connector and Pad antenna interface
Operating Temperature	-40 ℃ ~ +85 ℃
Storage Temperature	-40 ℃ ~ +125 ℃

2.2 Module Pin Diagram

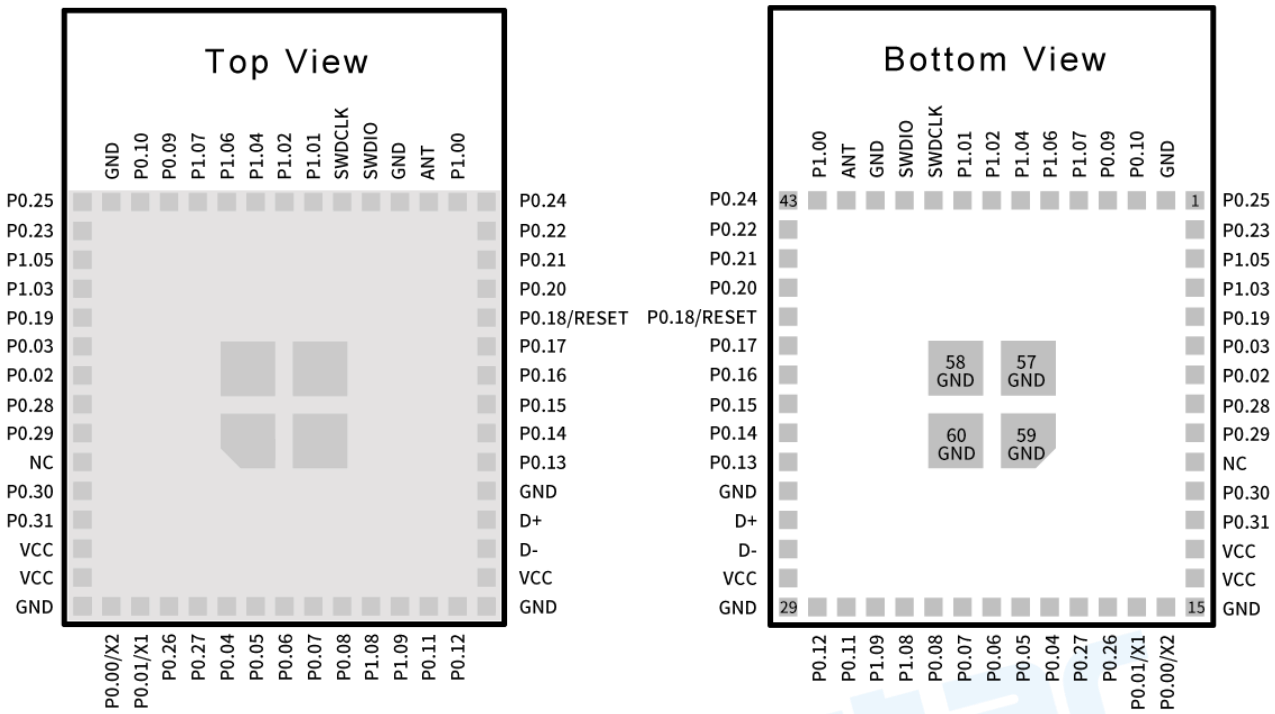

Figure 3. Pin Diagram of RF-BM-ND07

2.3 Pin Functions

Table 2. Pin Functions of RF-BM-ND07

Pin	Name	Chip Pin	Pin Type	Description
1	P0.25	P0.25	Digital I/O	General purpose I/O
2	P0.23	P0.23	Digital I/O	General purpose I/O
3	P1.05	P1.05	Digital I/O	General purpose I/O
4	P1.03	P1.03	Digital I/O	General purpose I/O
5	P0.19	P0.19	Digital I/O	General purpose I/O
6	P0.03	P0.03	Digital I/O	General purpose I/O
	AIN1	AIN1	Analog input	Analog input
7	P0.02	P0.02	Digital I/O	General purpose I/O
	AIN0	AIN0	Analog input	Analog input
8	P0.28	P0.28	Digital I/O	General purpose I/O
	AIN4	AIN4	Analog input	Analog input
9	P0.29	P0.29	Digital I/O	General purpose I/O

	AIN5	AIN5	Analog input	Analog input
10	NC			
11	P0.30	P0.30	Digital I/O	General purpose I/O
	AIN6	AIN6	Analog input	Analog input
12	P0.31	P0.31	Digital I/O	General purpose I/O
	AIN7	AIN7	Analog input	Analog input
13	VCC	VCC		
14	VCC	VCC		
15	GND	GND		
16	P0.00	P0.00	Digital I/O	General purpose I/O
	XL1	XL1	Analog input	Connection for 32.768 kHz crystal
17	P0.01	P0.01	Digital I/O	General purpose I/O
	XL2	XL2	Analog input	Connection for 32.768 kHz crystal
18	P0.26	P0.26	Digital I/O	General purpose I/O
19	P0.27	P0.27	Digital I/O	General purpose I/O
20	P0.04	P0.04	Digital I/O	General purpose I/O
	AIN2	AIN2	Analog input	Analog input
21	P0.05	P0.05	Digital I/O	General purpose I/O
	AIN3	AIN3	Analog input	Analog input
22	P0.06	P0.06	Digital I/O	General purpose I/O
23	P0.07	P0.07	Digital I/O	General purpose I/O
	TRACECLK	TRACECLK	Trace clock	Trace buffer clock
24	P0.08	P0.08	Digital I/O	General purpose I/O
25	P1.08	P1.08	Digital I/O	General purpose I/O
26	P1.09	P1.09	Digital I/O	General purpose I/O
	TRACEDATA3	TRACEDATA3	Trace data	Trace buffer TRACEDATA[3]
27	P0.11	P0.11	Digital I/O	General purpose I/O
	TRACEDATA2	TRACEDATA2	Trace data	Trace buffer TRACEDATA[2]
28	P0.12	P0.12	Digital I/O	General purpose I/O

	TRACEDATA1	TRACEDATA1	Trace data	Trace buffer TRACEDATA[1]
29	GND	GND	Ground	
30	VCC	VCC	VCC	Power supply: 1.7 V ~ 5.5 V, recommend to 3.3 V
31	D-	D-	USB	USB D-
32	D+	D+	USB	USB D+
33	GND	GND	Ground	
34	P0.13	P0.13	Digital I/O	General purpose I/O
35	P0.14	P0.14	Digital I/O	General purpose I/O
36	P0.15	P0.15	Digital I/O	General purpose I/O
37	P0.16	P0.16	Digital I/O	General purpose I/O
38	P0.17	P0.17	Digital I/O	General purpose I/O
39	P0.18	P0.18	Digital I/O	General purpose I/O
	nRESET	nRESET		Configurable as pin RESET
40	P0.20	P0.20	Digital I/O	General purpose I/O
41	P0.21	P0.21	Digital I/O	General purpose I/O
42	P0.22	P0.22	Digital I/O	General purpose I/O
43	P0.24	P0.24	Digital I/O	General purpose I/O
44	P1.00	P1.00	Digital I/O	General purpose I/O
	TRACEDATA0	TRACEDATA0	Trace data	Trace buffer TRACEDATA[0]
45	ANT	ANT	RF	Single-ended radio antenna connection
46	GND	GND	Ground	
47	SWDIO	SWDIO	Debug	Serial wire debug I/O for debug and programming
48	SWDCLK	SWDCLK	Debug	Serial wire debug clock input for debug and programming
49	P1.01	P1.01	Digital I/O	General purpose I/O
50	P1.02	P1.02	Digital I/O	General purpose I/O
51	P1.04	P1.04	Digital I/O	General purpose I/O
52	P1.06	P1.06	Digital I/O	General purpose I/O
53	P1.07	P1.07	Digital I/O	General purpose I/O

54	P0.09	P0.09	Digital I/O	General purpose I/O
	NFC1	NFC1	NFC input	NFC antenna connection
55	P0.10	P0.10	Digital I/O	General purpose I/O
	NFC2	NFC2	NFC input	NFC antenna connection
56	GND	GND	Ground	
57	GND	GND	Ground	
58	GND	GND	Ground	
59	GND	GND	Ground	
60	GND	GND	Ground	

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-ND07

Items	Condition	Min.	Typ.	Max.	Unit
Operating Supply Voltage	Battery Mode	1.7	3.3	5.5	V
Operating Temperature	/	-40	+25	+85	℃
Environmental Hot Pendulum	/	-20		+20	℃/min

3.2 Handling Ratings

Table 4. Handling Ratings of RF-BM-ND07

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			±750		V

4 Application, Implementation, and Layout

4.1 Module Photos

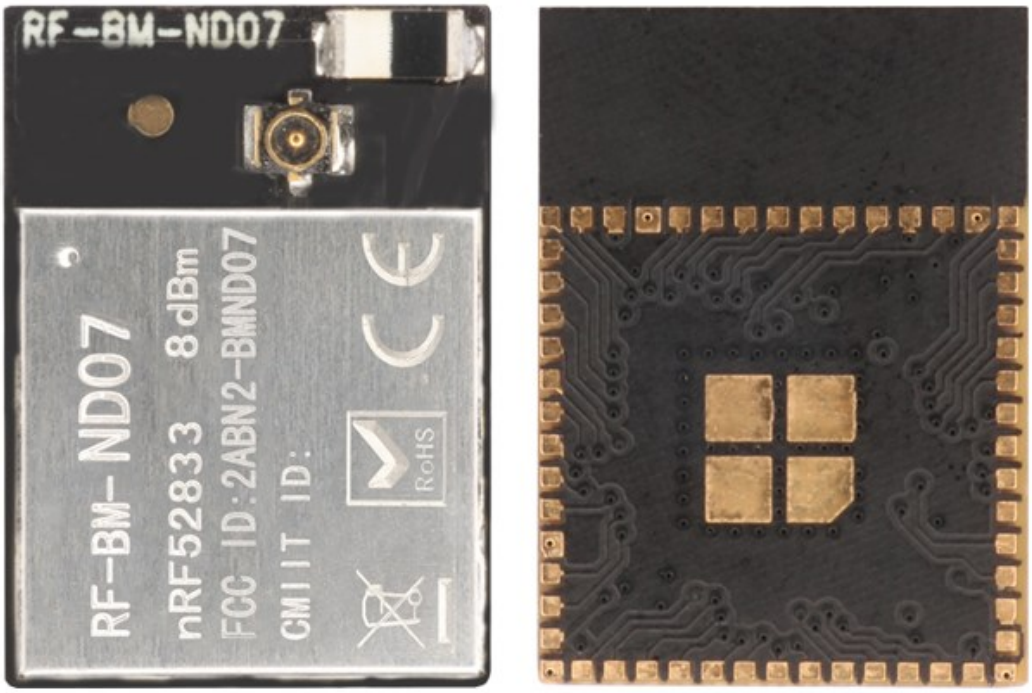

Figure 4. Photos of RF-BM-ND07

4.2 Recommended PCB Footprint

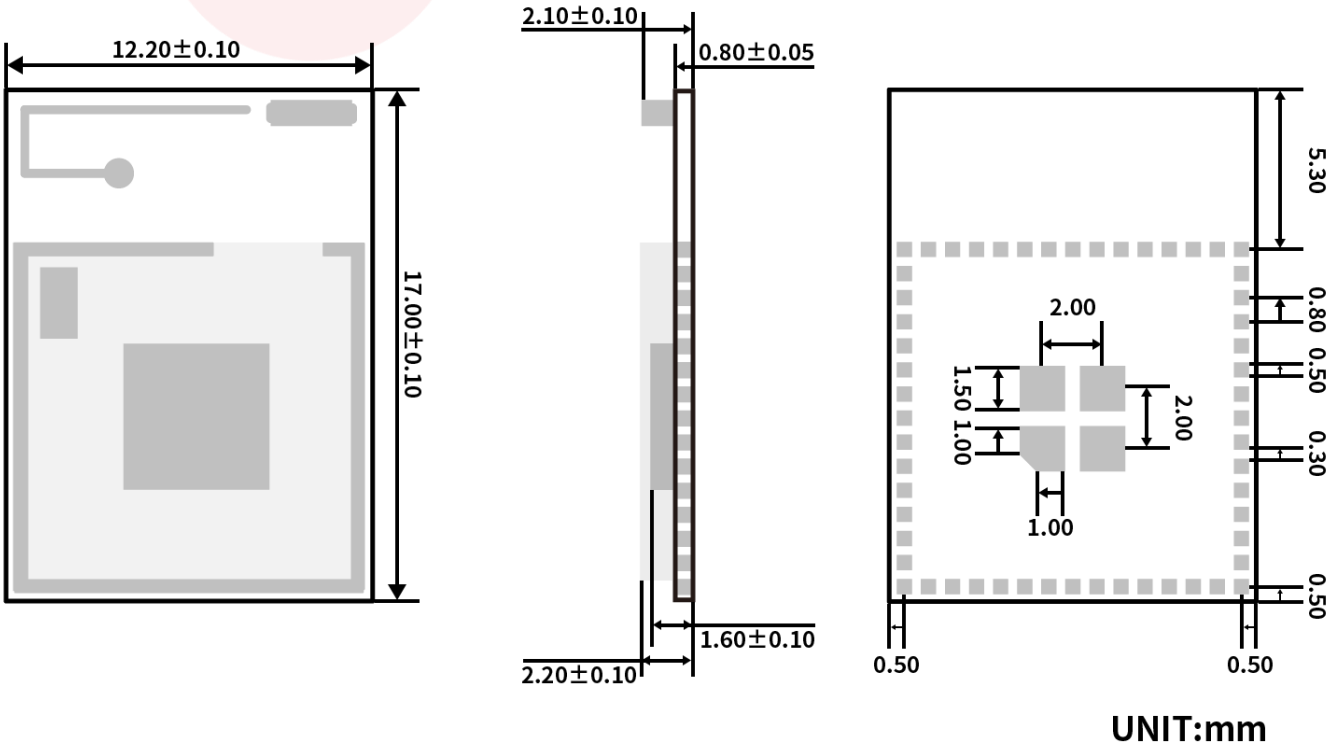

Figure 5. Recommended PCB Footprint of RF-BM-ND07

4.3 Schematic Diagram

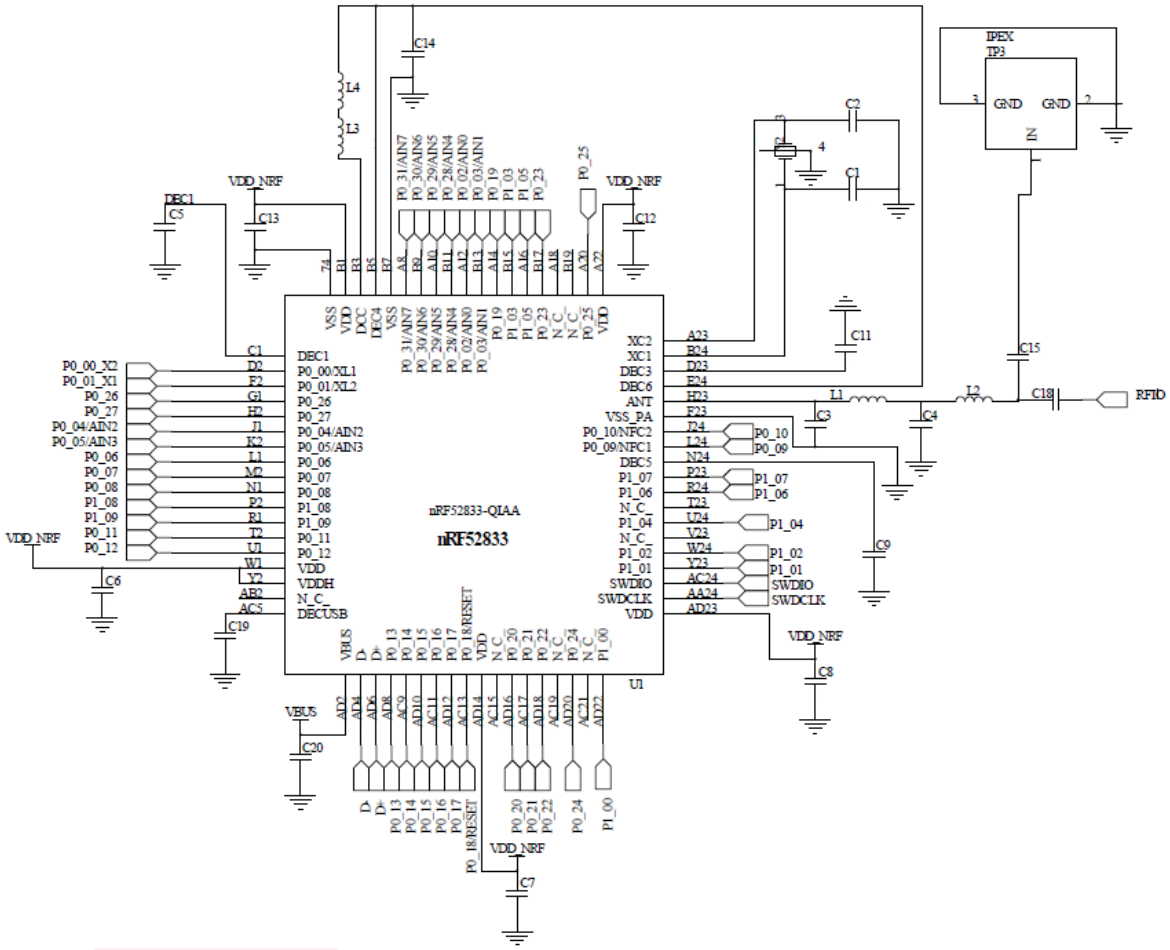

Figure 6. Schematic Diagram of RF-BM-ND07

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.

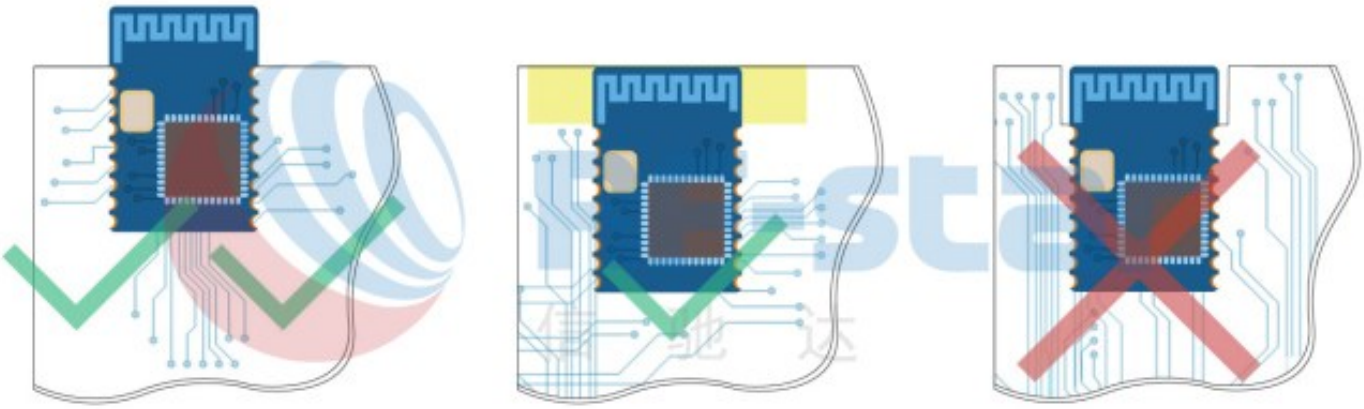

Figure 7. Recommendation of Antenna Layout

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

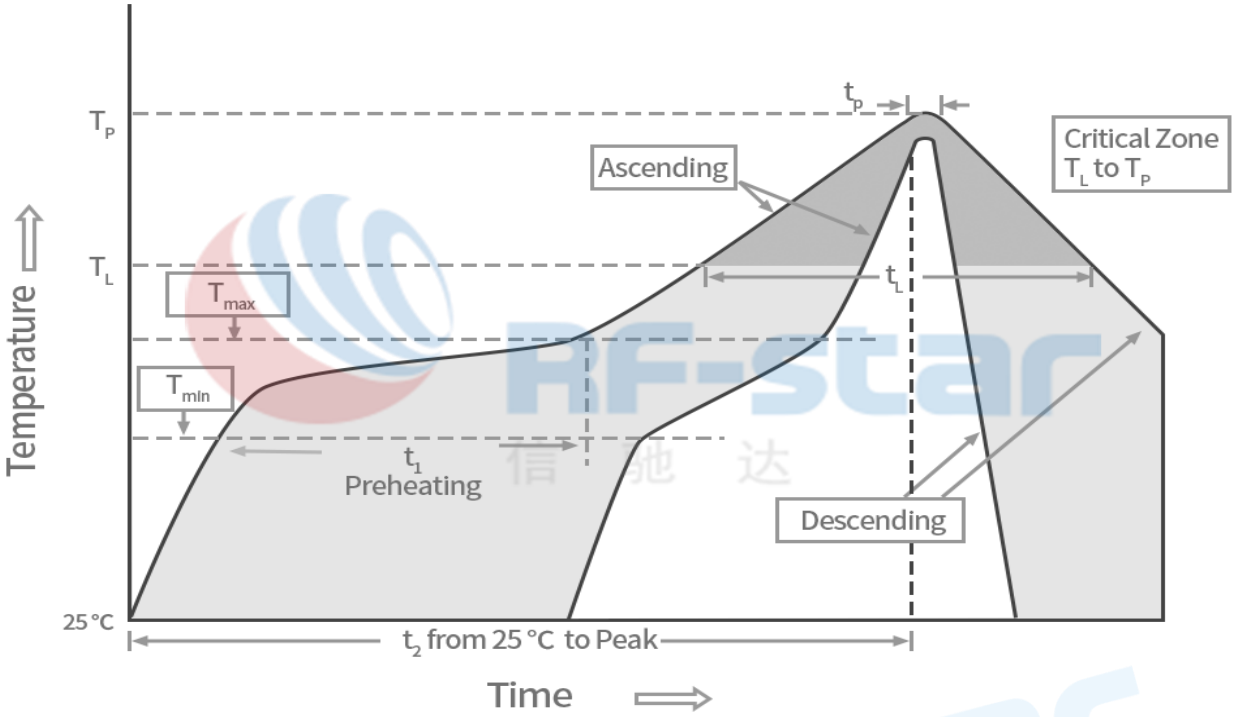

Figure 8. Recommended Reflow for Lead-Free Solder

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.

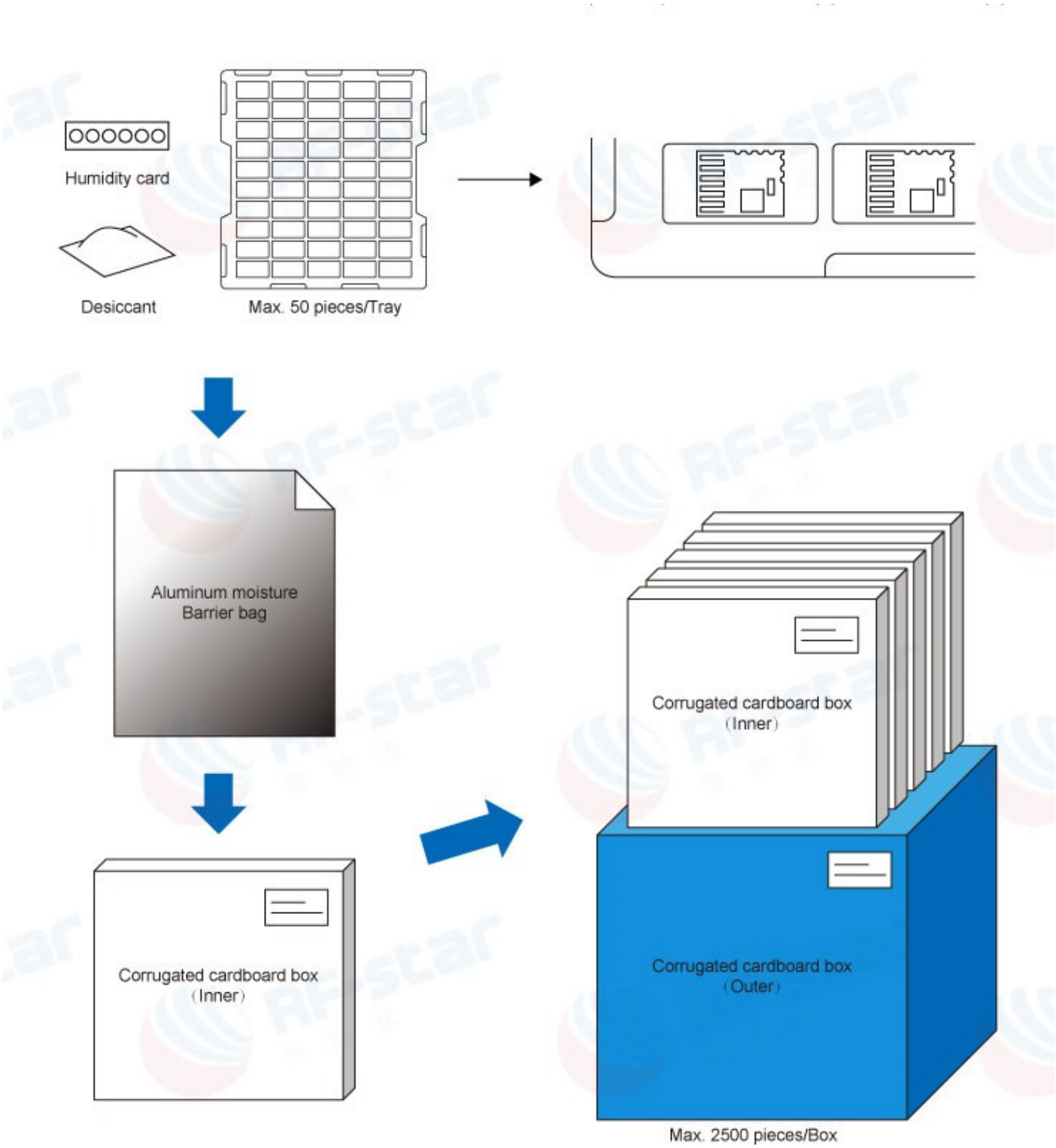

Figure 9. Default Package by Tray

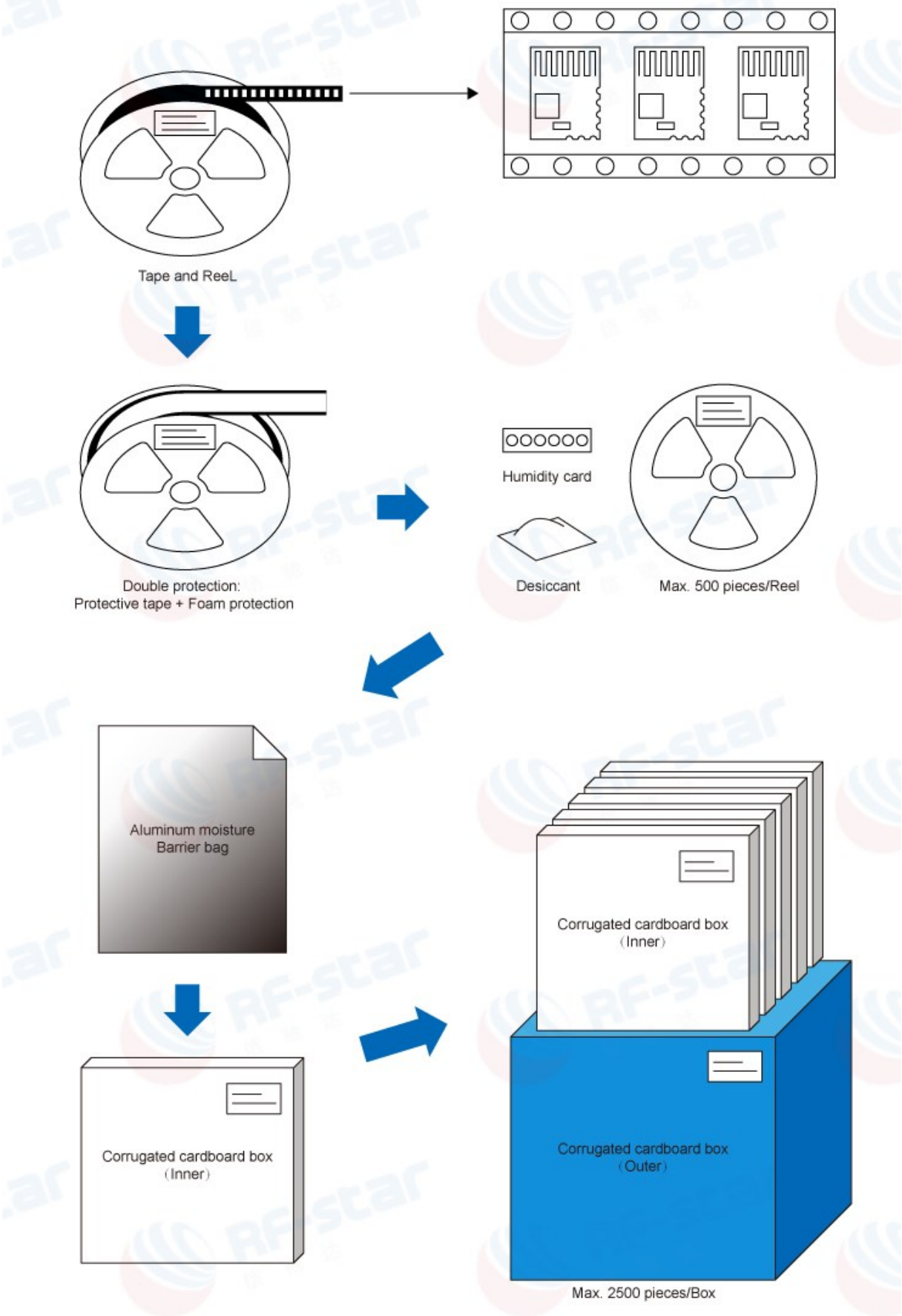

Figure 10. Package by Tape & Reel

6 Revision History

Date	Version No.	Description
2020.08.26	V1.0	The initial version is released.
2023.05.25	V1.0	Update MSL level. Update the Shenzhen office address. Modify the mistake of pin descriptions.

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.rfstariot.com and www.szrfstar.com.

7 Contact Us

SHENZHEN RF-STAR TECHNOLOGY CO., LTD.

Shenzhen HQ:

Add.: Room 502, Podium Building No. 12, Shenzhen Bay Science and Technology Ecological Park, Nanshan District, Shenzhen, Guangdong, China, 518063

Tel.: 86-755-8632 9829

Chengdu Branch:

Add.: N2-1604, Global Center, North No. 1700, Tianfu Avenue, Hi-Tech District, Chengdu, Sichuan, China, 610095

Tel.: 86-28-8692 5399

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

Web.: www.rfstariot.com, www.szrfstar.com