



RF-BM-4055B1L CC2640R2L

Bluetooth 5.1 Low Energy Wireless Module

Version 1.0

Shenzhen RF-star Technology Co., Ltd.

May 26th, 2023

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1 Device Overview

1.1 Description

RF-BM-4055B1L is a SimpleLink™ wireless microcontroller (MCU) module based on TI CC2640R2L supporting Bluetooth Low Energy (BLE) stack v5.1. To minimize users' design effort, RF-BM-4055B1L module has integrated a 24 MHz crystal, a 32.768 kHz crystal, an LC balun, and an inverted-F PCB antenna. RF-BM-4055B1L device contains a 32-bit ARM Cortex™-M3 main processor at 48 MHz. Its 2.4GHz radio processes very low active current and outstanding RF performance. This module fits into a wide range of BLE applications where robust connection, long battery lifetime, small form factor, and ease of use are important.

1.2 Key Features

- RF
 - 2.4 GHz RF transceiver compatible with Bluetooth low energy 5.1 and specification
 - Excellent receiver sensitivity (-97 dBm for BLE)
 - Programmable output power up to +5 dBm
 - Signal-ended or differential RF interface
- Microcontroller
 - Powerful ARM® Cortex®-M3
 - EEMBC CoreMark® score: 142
 - Up to 48-MHz clock speed
 - 275 KB of nonvolatile memory including 128 KB of in-system programmable flash
 - Up to 28 KB of system SRAM, of which 20 KB is ultra-low leakage SRAM
 - 8 KB of SRAM for cache or system RAM use
 - 2-Pin cJTAG and JTAG debugging
 - Supports over-the-air upgrade (OTA)
- Peripherals
 - 12 bit ADC, 200 ksamples/s, 8 channel analog MUX
 - Continuous time comparator
- Ultra-low-power analog comparator
- Programmable current source
- UART
- 2 × SSI (SPI, MICROWIRE, TI)
- I²C
- I²S
- Real-time clock (RTC)
- AES-128 security module
- True random number generator (TRNG)
- Low Power
 - Wide supply voltage range: 1.8 V to 3.8 V
 - Active-mode RX: 5.9 mA
 - Active-mode TX at 0 dBm: 6.1 mA
 - Active-mode TX at 5 dBm: 9.1 mA
 - Active-mode MCU: 61 μA/MHz
 - Active-mode MCU: 48.5 CoreMark/mA
 - Standby: 1.5 μA (RTC running and RAM/CPU retention)
 - Shutdown: 100 nA (wake up on external events)

1.3 Applications

- Home and Building Automation
 - Connected appliances
 - Lighting
- Smart locks
- Gateways
- Security Systems

- Industrial
 - Factory automation
 - Asset tracking and management
 - HMI
 - Access control
- Electronic Point Of Sale (EPOS)
 - Electronic Shelf Label (ESL)
- Health and Medical
 - Electronic thermometers
 - SpO2
 - Blood glucose monitors and blood pressure monitors
- Weigh scales
- Hearing aids
- Sports and Fitness
 - Wearable fitness and activity monitors
 - Smart trackers
 - Patient monitors
 - Fitness machines
- HID
 - Gaming
 - Pointing

1.4 Functional Block Diagram

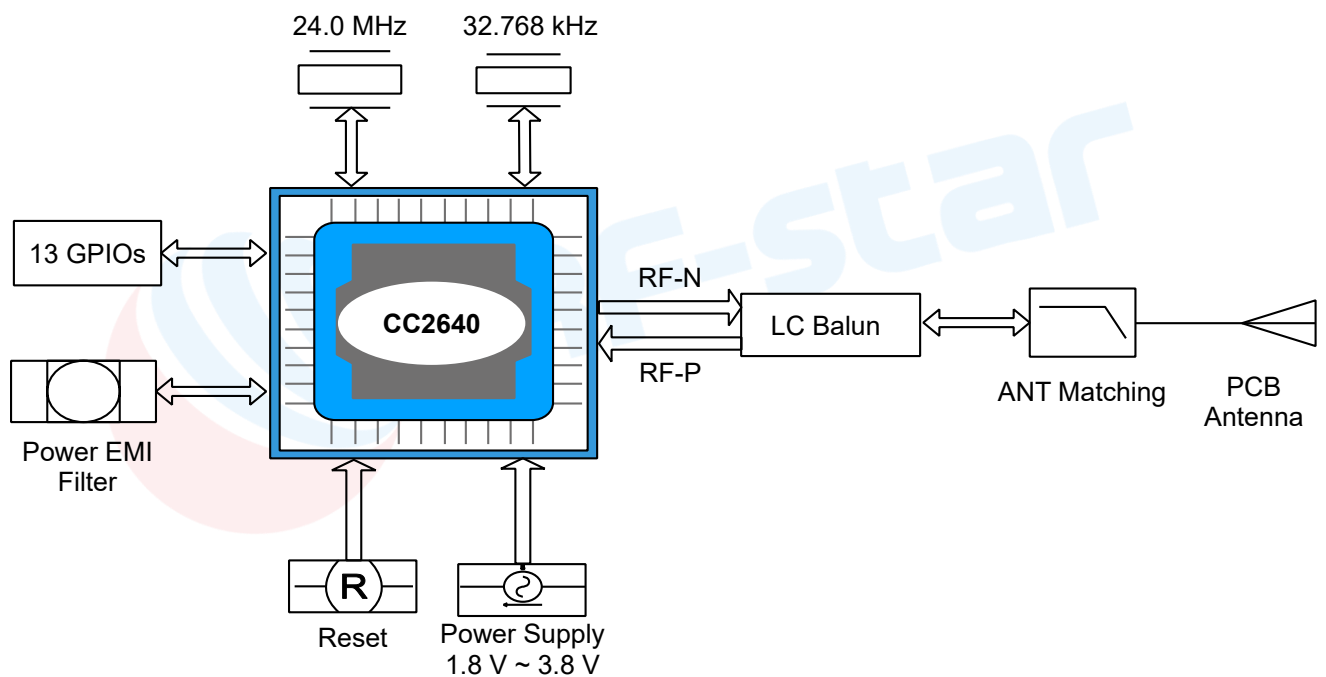


Figure 1. Functional Block Diagram of RF-BM-4055B1L

1.5 Part Number Conventions

The part numbers are of the form of RF-BM-4055B1L where the fields are defined as follows:

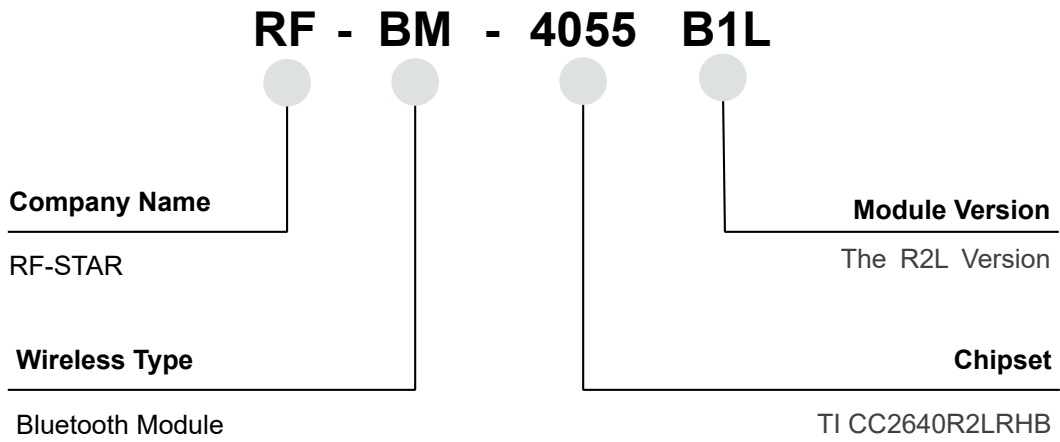


Figure 2. Part Number Conventions of RF-BM-4055B1L



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2 Module Configuration and Functions

2.1 Module Parameters

Table 1. Parameters of RF-BM-4055B1L

Chipset	CC2640R2LRHB
Supply Power Voltage	1.8 V ~ 3.8 V, recommended to 3.3 V
Frequency	2402 MHz ~ 2480 MHz
Transmit Power	-21.0 dBm ~ +5.0 dBm (typical: 0 dBm)
Receiving Sensitivity	-97 dBm
Support Protocol	Bluetooth 5.1 Low Energy
GPIO	13
Crystal	24 MHz, 32.768 kHz
RAM	20 KB
Flash	128 KB
Package	SMT Packaging (1.27-mm half-hole pitch stamp stick)
Frequency Error	±20 kHz
Interface	UART, I ² C, I ² S, SPI, ADC
Dimension	15.2 mm x 11.2 mm x 1.7 mm
Type of Antenna	PCB Antenna
Operating Temperature	-40 °C ~ +85 °C
Storage Temperature	-40 °C ~ +125 °C

2.2 Module Pin Diagram

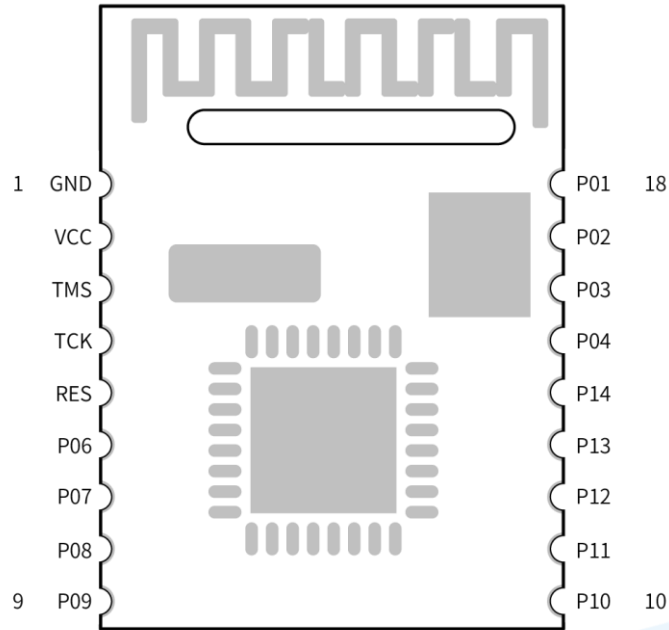


Figure 3. Pin Diagram of RF-BM-4055B1L

2.3 Pin Functions

Table 2. Pin Functions of RF-BM-4055B1L

Pin	Name	Chip Pin	Pin Type	Description
1	GND	GND	-	Ground
2	VCC	VDD	-	Power supply: 1.8 V ~ 3.8 V, recommended to 3.3 V
3	JTAG_TMSC	JTAG_TMSC	I/O	JTAG TMSC, high-drive capability
4	JTAG_TCKC	JTAG_TCKC	I/O	JTAG TCKC
5	RES_N	RESET_N	I	Reset, active-low. No internal pullup.
6	P06	DIO_6	I/O	GPIO, high-drive capability
7	P07	DIO_7	I/O	GPIO, high-drive capability
8	P08	DIO_8	I/O	GPIO
9	P09	DIO_9	I/O	GPIO
10	P10	DIO_10	I/O	GPIO
11	P11	DIO_11	I/O	GPIO
12	P12	DIO_12	I/O	GPIO
13	P13	DIO_13	I/O	GPIO
14	P14	DIO_14	I/O	GPIO

15	P04	DIO_4	I/O	GPIO
16	P03	DIO_3	I/O	GPIO
17	P02	DIO_2	I/O	GPIO
18	P01	DIO_1	I/O	GPIO



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-4055B1L

Items	Condition	Min.	Typ.	Max.	Unit
Operating Supply Voltage	Battery Mode	1.8	3.3	3.8	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-4055B1L

Items	Condition	Min.	Typ.	Max.	Unit
Storage Temperature	Tstg	-40	+25	+125	°C
Human Body Model	HBM		±2500		V
Moisture Sensitivity Level			3		
Charged Device Model			±750		V

4 Application, Implementation, and Layout

4.1 Module Photos

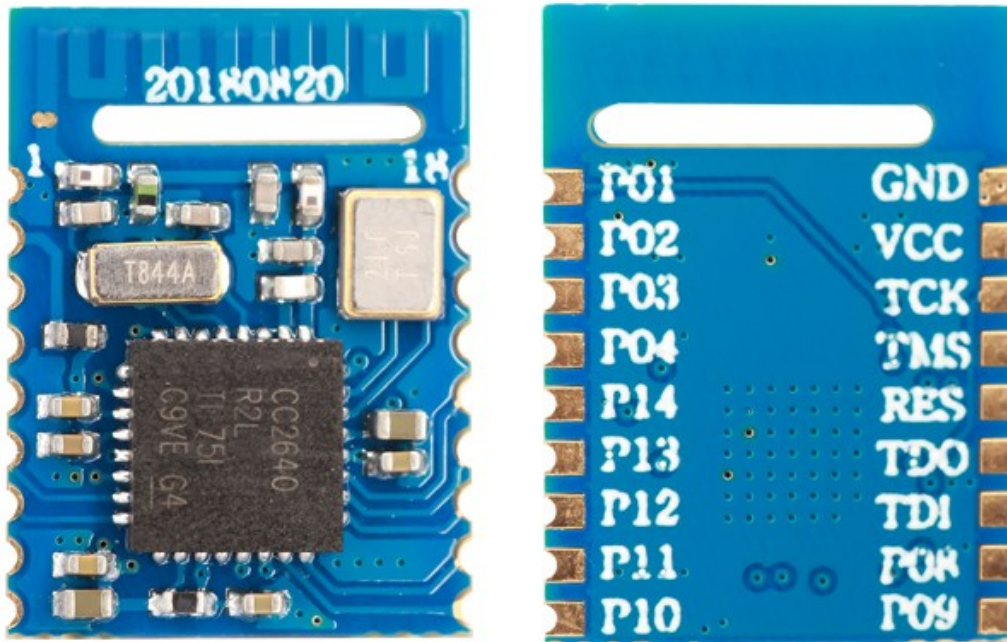


Figure 4. Photos of RF-BM-4055B1L

4.2 Recommended PCB Footprint

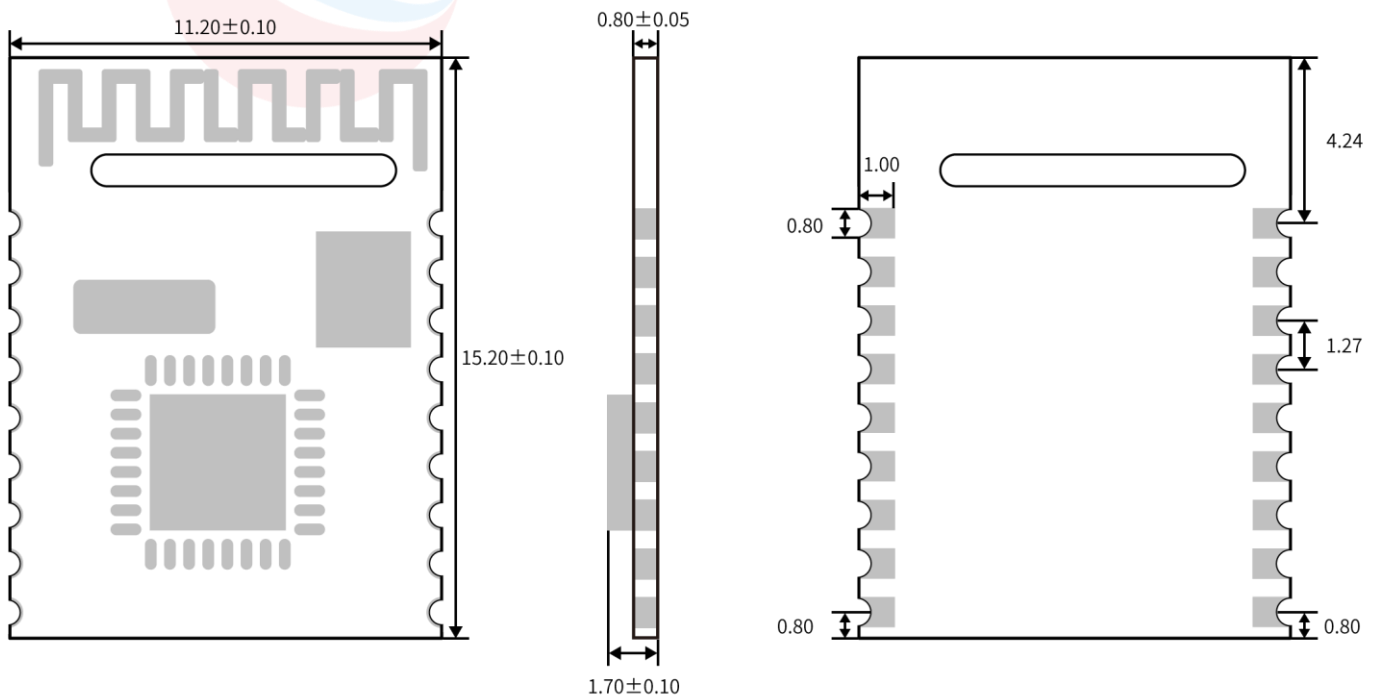


Figure 5. Recommended PCB Footprint of RF-BM-4055B1L (mm)

4.3 Schematic Diagram

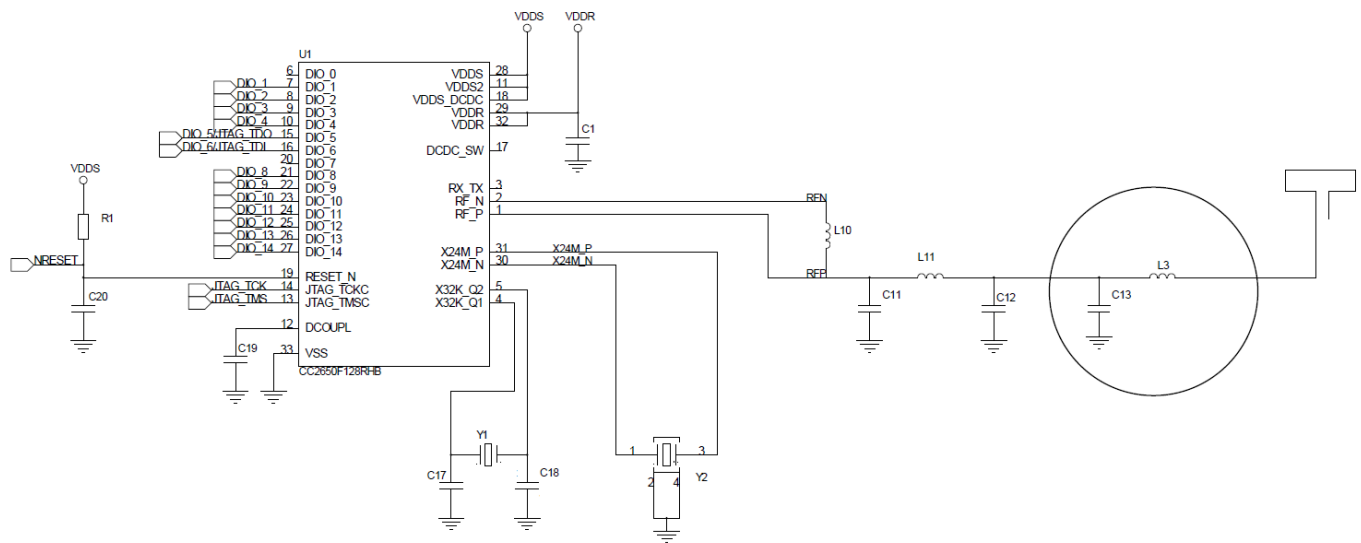
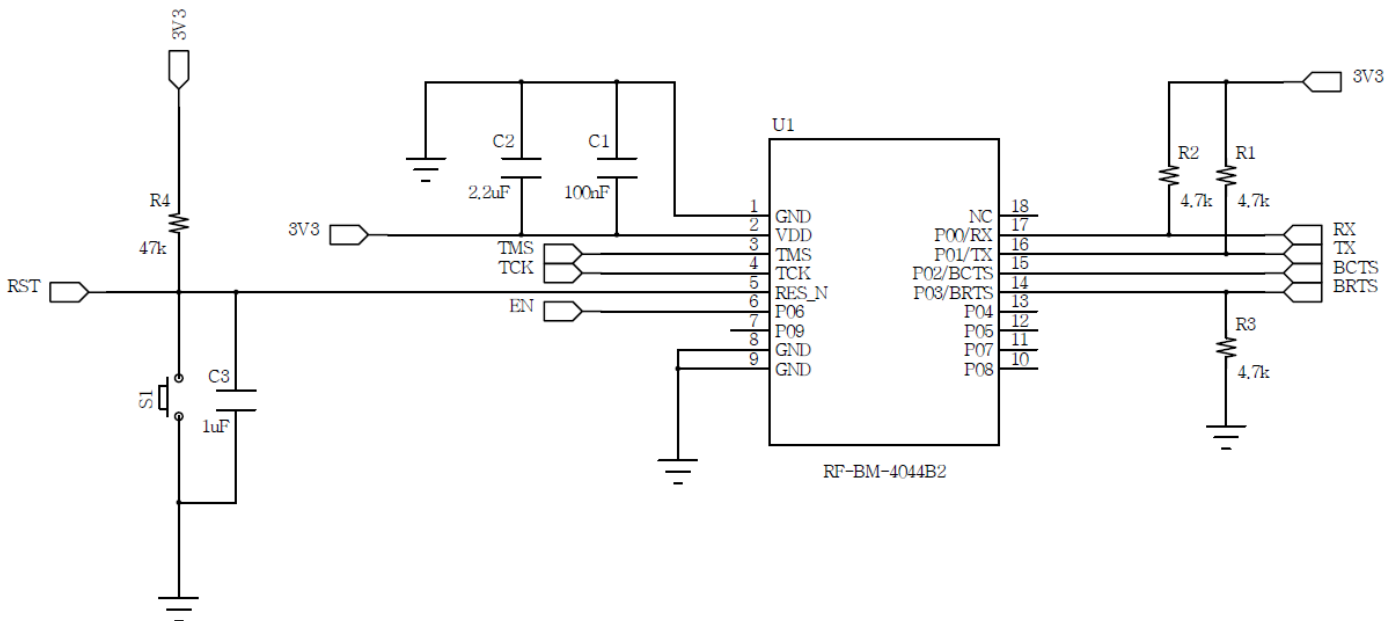


Figure 6. Schematic Diagram of RF-BM-4055B1L

4.4 Reference Design



Note: EN low enable.

Figure 7. Reference Design of RF-BM-4044B2/4044B3

4.5 Antenna

4.5.1 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 are key factors 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.

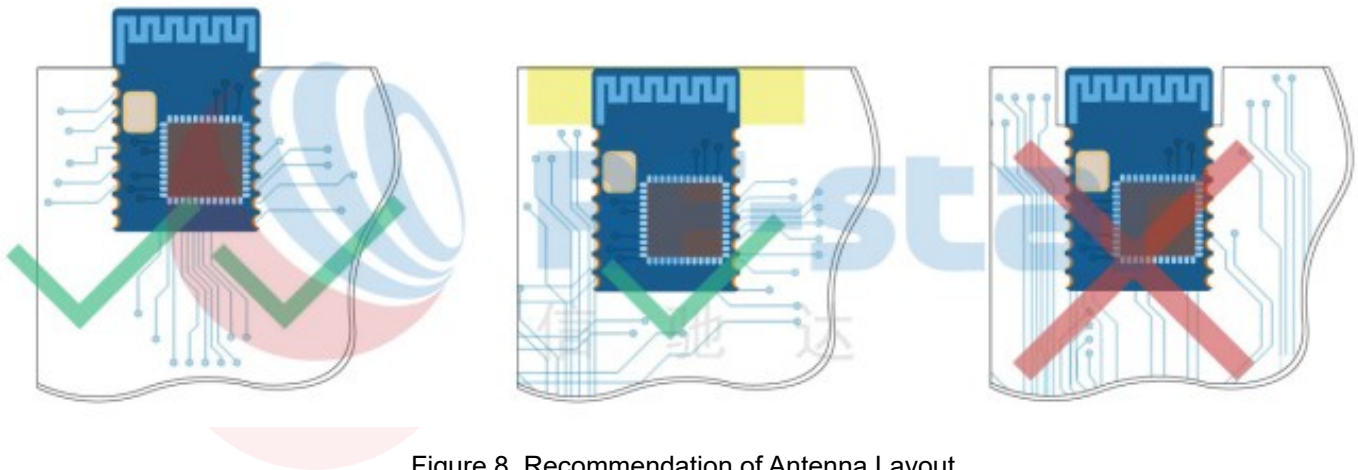


Figure 8. Recommendation of Antenna Layout

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

4.6 Basic Operation of Hardware Design

1. It is recommended to offer the module 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 fluctuating 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 degree;
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.

4.7 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 the communication packet loss rate. The performance 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 metal near the antenna or if the module is placed inside the metal shell.
4. The incorrect power register set or the high data rate in the 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.

4.7.2 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 a stable power supply and no frequently fluctuating 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.

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

4.8 Electrostatics Discharge Warnings

The module will be damaged by 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 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

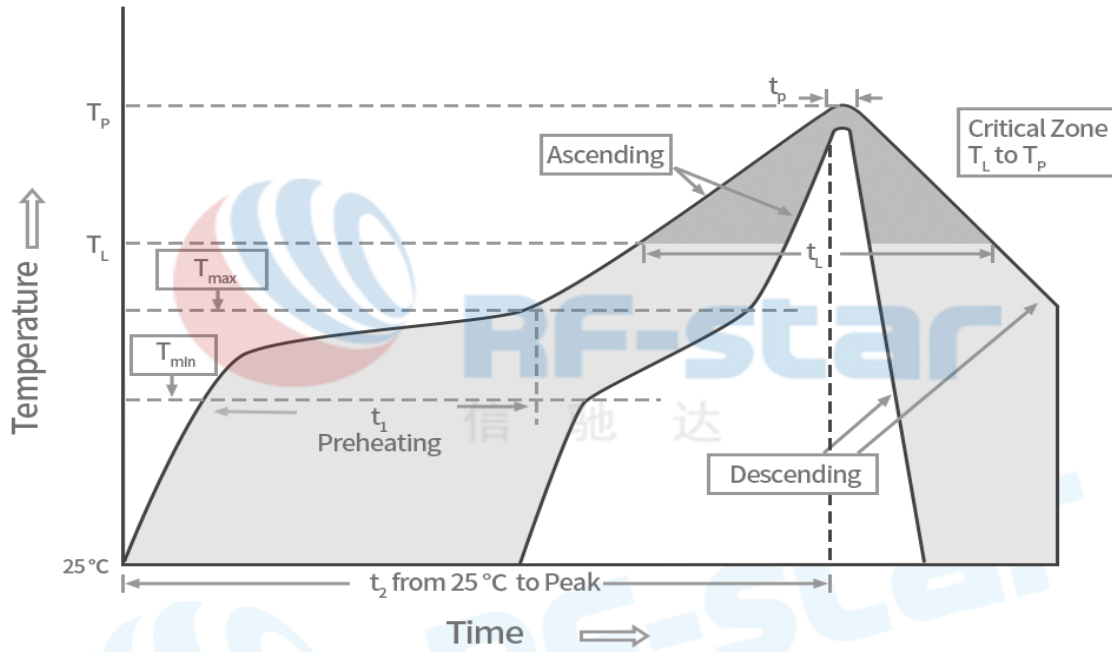


Figure 9. Recommended Reflow for Lead-Free Solder

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.

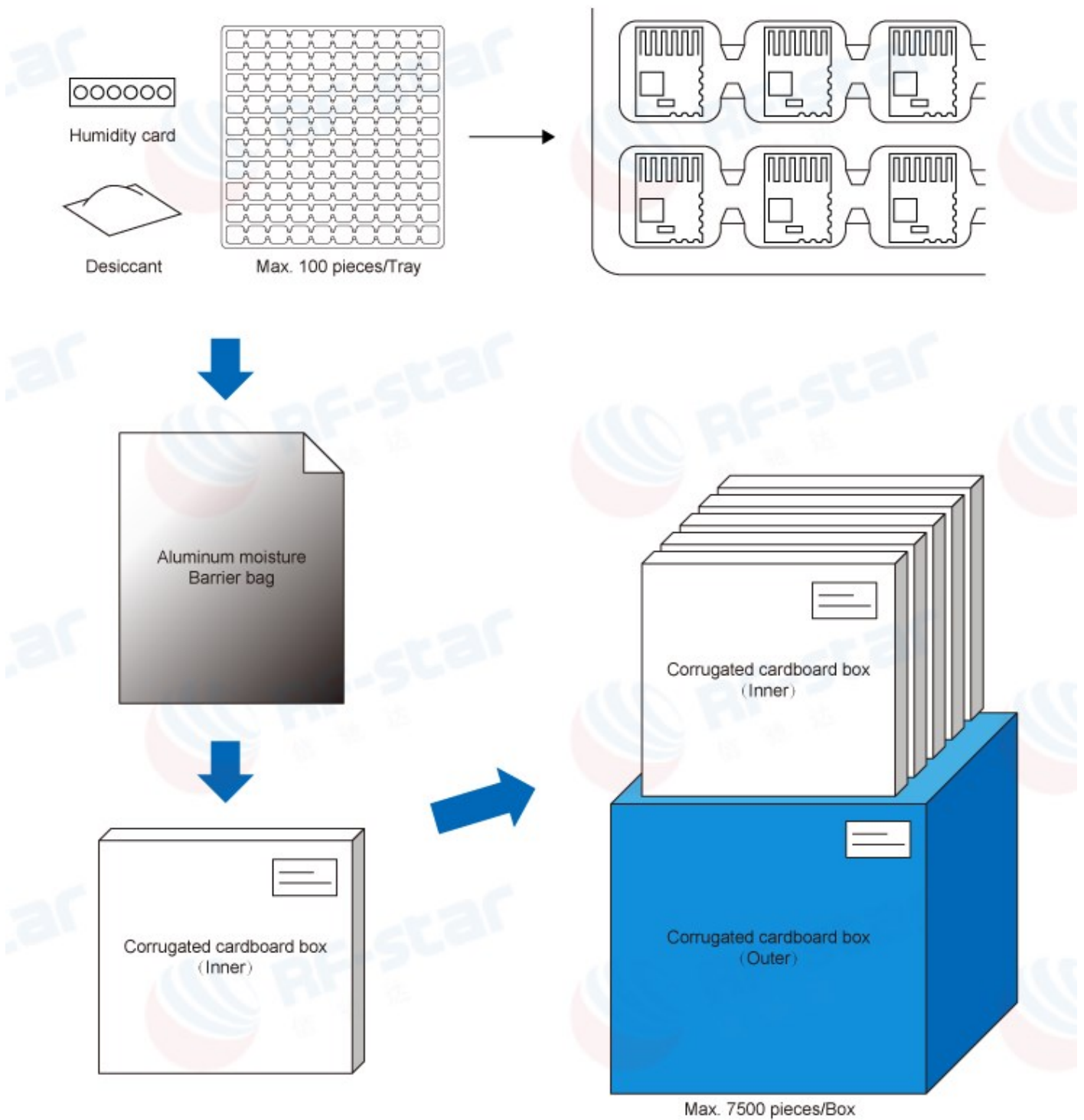


Figure 10. Default Package by Tray

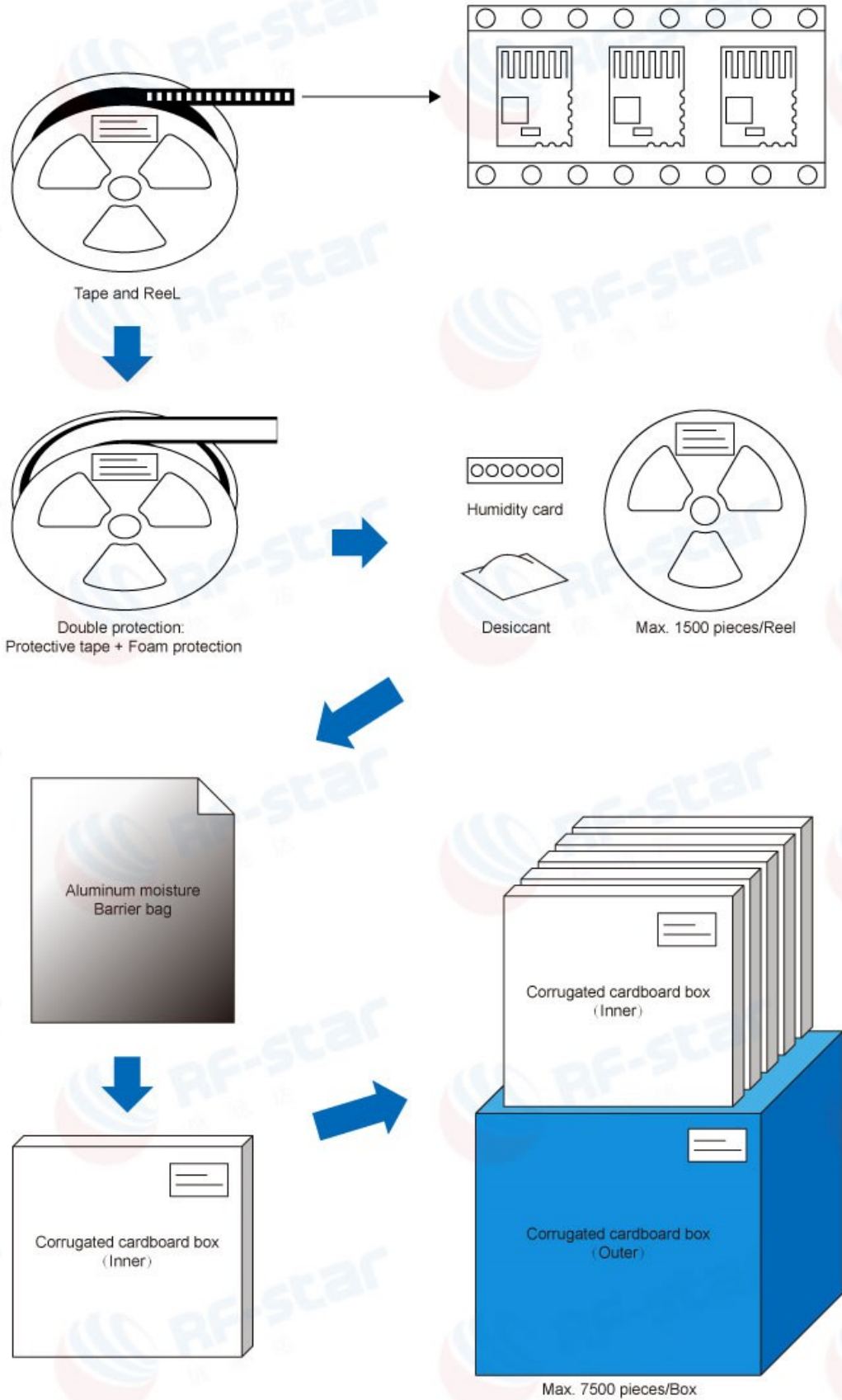


Figure 11. Package by Tape & Reel

6 Revision History

Date	Version No.	Description
2019.04.22	V1.0	The initial version is released.
2019.07.04	V1.0	Update module parameters.
2020.05.15	V1.0	Add TI CC26XX BLE module list.
2023.05.26	V1.0	Update MSL level. Update the Shenzhen office address.

Note:

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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

