RF-SM-1044B4 CC1310 Ultra-Low-Power 868 MHz & 915 MHz Wireless Module

Version 1.0

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1 Device Overview

1.1 Description

RF-SM-1044B4 is an RF module based on TI SimpleLink™ ultra-low-power Sub-1 GHz wireless SoC CC1310F128RSM with 48 MHz ARM® Cortex®-M3 processor. It integrates a 24 MHz crystal, a balun, an antenna matching and high-performance PCB antenna. It features low power consumption, small size, robust connection distance, and rigid reliability. It supports 862 MHz ~ 931 MHz ISM application 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.

1.2 Key Features

- RF Performance
  - Excellent receiver sensitivity using long-range mode: -119 dBm
  - Excellent receiver sensitivity at 50 kbps: -100 dBm
  - Excellent selectivity (±100 kHz): 56 dB
  - Excellent blocking performance (±10 MHz): 90 dB
  - Programmable output power: up to +15 dBm
  - Differential RF interface
  - Wireless M-Bus (EN 13757-4) and IEEE® 802.15.4g PHY
- Microcontroller
  - Powerful ARM® Cortex®-M3 processor, 48 MHz
  - EEMBC CoreMark® Score: 142
  - EEMBC ULPBench™ Score: 158
  - Clock speed up to 48 MHz
  - 128 KB of in-system programmable flash
  - 8 KB of SRAM for cache (or as general-purpose RAM)
  - 20 KB of ultra-low-leakage SRAM
  - 2 pin cJTAG and JTAG debugging
  - Supports Over-the-Air (OTA) update
- Ultra-Low-Power Sensor Controller
  - Can run autonomously from the rest of the system
  - 16 Bit architecture
  - 2 KB of ultra-low-leakage SRAM for code and data
- Low Power
  - Wide supply voltage range: 1.8 V ~ 3.8 V
  - RX: 5.4 mA
  - TX at +10 dBm: 13.4 mA
  - Active-mode MCU 48 MHz running Coremark: 2.5 mA (51 µA/MHz)
  - Active-mode MCU: 48.5 CoreMark/mA
  - Active-mode sensor controller at 24 MHz: 0.4 mA + 8.2 µA/MHz
  - Sensor controller, one wake-up every second performing one 12 Bit ADC sampling: 0.95 µA
  - Standby: 0.7 µA (RTC running and RAM and CPU retention)
  - Shutdown: 185 nA (wakeup on external events)
- Peripheral
  - All digital peripheral pins can be routed to any GPIO
  - Four general-purpose timer modules (eight 16-bit or four 32-Bit timers, PWM each)
  - 12 bit ADC, 200 ksamples/s, 8 channel analog MUX
  - Continuous time comparator
  - Ultra-low-power clocked comparator
  - Programmable current source
  - UART
  - 2× SSI (SPI, MICROWIRE, TI)
  - I^2C, I^2S

- Real-time clock (RTC)
- AES-128 security module
- True random number generator (TRNG)
- Support for eight capacitive sensing buttons
- Integrated temperature sensor

1.3 Applications

- 915 MHz ISM and SRD system
- Low-power wireless systems with 50 kHz to 5MHz Channel Spacing
- Home and building automation
- Wireless alarm and security systems
- Industrial monitoring and control
- Smart grid and automatic meter reading
- Wireless sensor networks
- Active RFID
- IEEE 802.15.4g, IP-enabled smart objects (6LoWPAN), wireless M-Bus, KNX systems, Wi-SUN™, and proprietary systems
- Energy-harvesting applications
- Electronic shelf label (ESL)
- Long-range sensor applications
- Heat-cost allocators

1.4 Functional Block Diagram

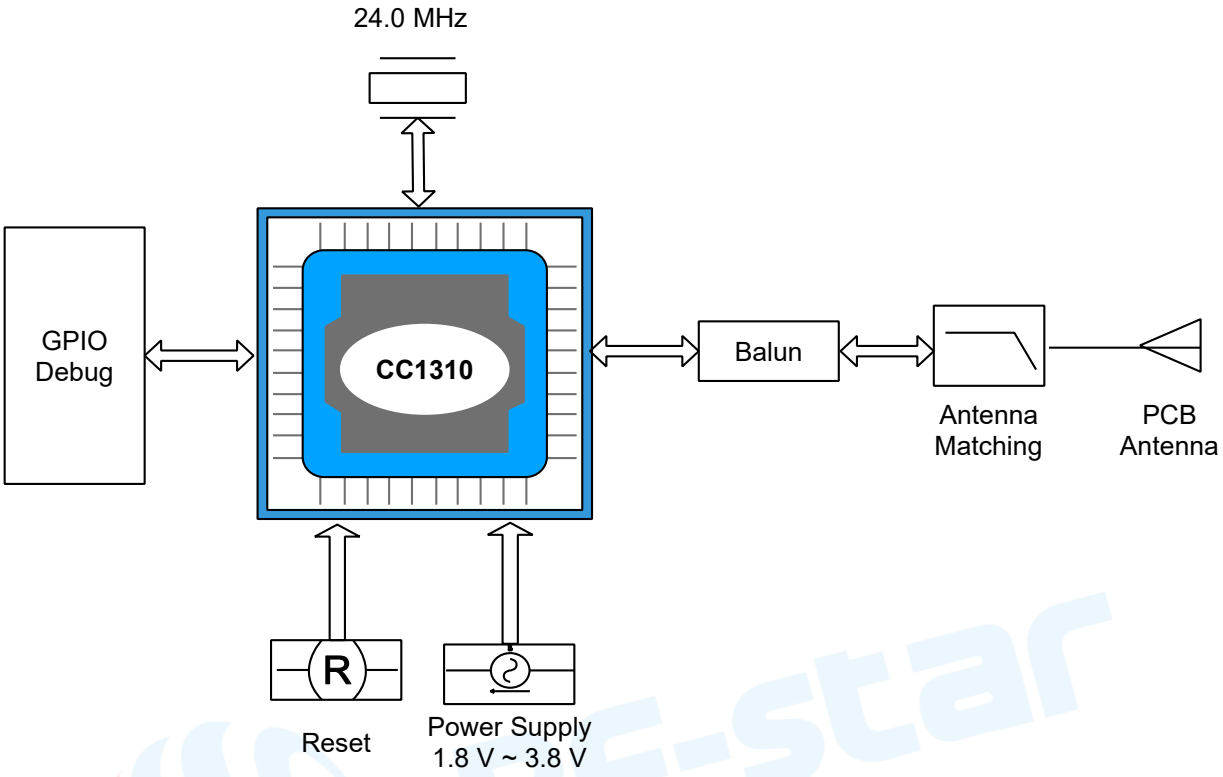

Figure 1. Functional Block Diagram of RF-SM-1044B4

1.5 Part Number Conventions

The part numbers are of the form of RF-SM-1044B4 where the fields are defined as follows:

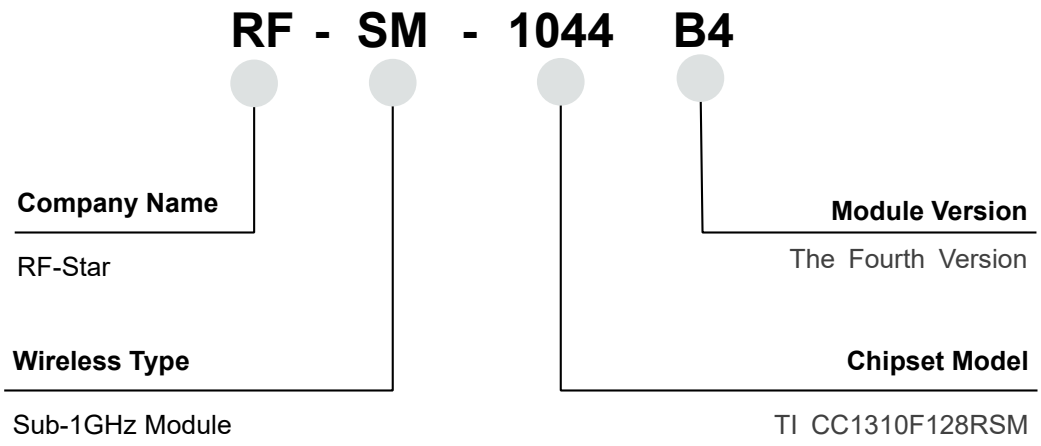

Figure 2. Part Number Conventions of RF-SM-1044B4

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2 Module Configuration and Functions

2.1 Module Parameters

Table 1. Parameters of RF-SM-1044B4

Chipset	TI CC1310F128RSM
Supply Power Voltage	1.8 V ~ 3.8 V, recommended to 3.3 V
Center Frequency	862 MHz ~ 931 MHz
Receiving Sensitivity	-119 dBm (long range mode)
Max. Tx Power	+15 dBm
Crystal	24 MHz
RAM	20 KB
Flash	128 KB
GPIO	12
Package	SMT packaging (1.27-mm half-hole pitch stamp stick)
Frequency Error	±20 kHz
Dimension	22.0 mm x 14.0 mm x 2.3 mm
Type of Antenna	PCB antenna
Operating Temperature	-40 ℃ ~ +85 ℃
Storage Temperature	-40 ℃ ~ +125 ℃

2.2 Module Pin Diagram

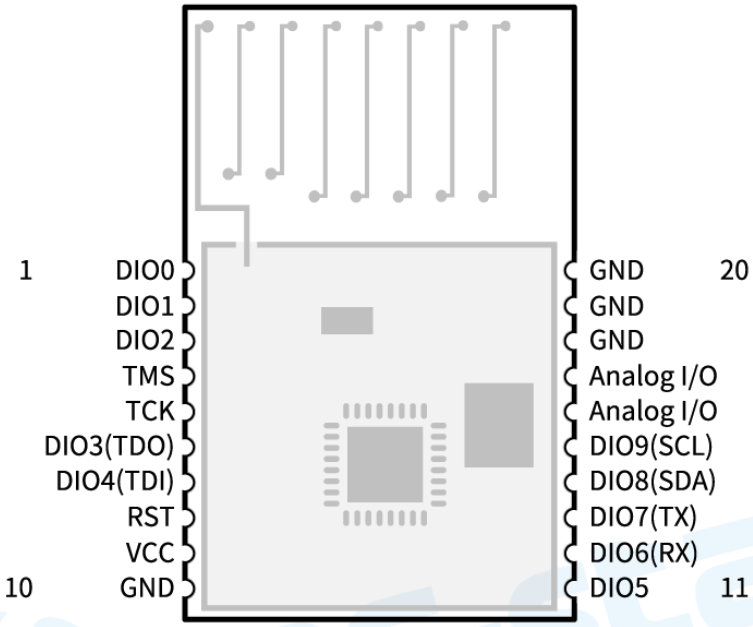

Figure 3. Pin Diagram of RF-SM-1044B4

2.3 Pin Functions

Table 2. Pin Functions of RF-SM-1044B4

Pin	Name	Chip Pin	Pin Type	Description
1	DIO0	DIO_0	Digital I/O	GPIO, Sensor Controller, high-drive capability
2	DIO1	DIO_1	Digital I/O	GPIO, Sensor Controller, high-drive capability
3	DIO2	DIO_2	Digital I/O	GPIO, Sensor Controller, high-drive capability
4	TMS	JTAG_TMSC	Digital I/O	JTAG TMSC
5	TCK	JTAG_TCKC	Digital I/O	JTAG TCKC
6	DIO3/TDO	DIO_3	Digital I/O	GPIO, high-drive capability, JTAG_TDO
7	DIO4/TDI	DIO_4	Digital I/O	GPIO, high-drive capability, JTAG_TDI
8	RST	RESET_N	Digital input	Reset pin, active low.
9	VCC	VCC	VCC	Power supply 1.8 V ~ 3.8 V, Recommend 3.3 V

10	GND	GND	GND	Ground
11	DIO5	DIO_5	Digital or analog I/O	GPIO, Sensor Controller, analog
12	DIO6/RX	DIO_6	Digital or analog I/O	GPIO, Sensor Controller, analog
13	DIO7/TX	DIO_7	Digital or analog I/O	GPIO, Sensor Controller, analog
14	DIO8/SDA	DIO_8	Digital or analog I/O	GPIO, Sensor Controller, analog
15	DIO9/SCL	DIO_9	Digital or analog I/O	GPIO, Sensor Controller, analog
16	Analog I/O	X32_Q1	Analog I/O	
17	Analog I/O	X32_Q2	Analog I/O	
18	GND	GND	GND	Ground
19	GND	GND	GND	Ground
20	GND	GND	GND	Ground

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-SM-1044B4

Items	Condition	Min.	Typ.	Max.	Unit
Operating Supply Voltage	Battery Mode	1.8	3.3	3.8	V
Operating Temperature	/	-40	+25	+85	℃
Environmental Hot Pendulum	/	-20		+20	℃/min

3.2 Handling Ratings

Table 4. Handling Ratings of RF-SM-1044B4

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

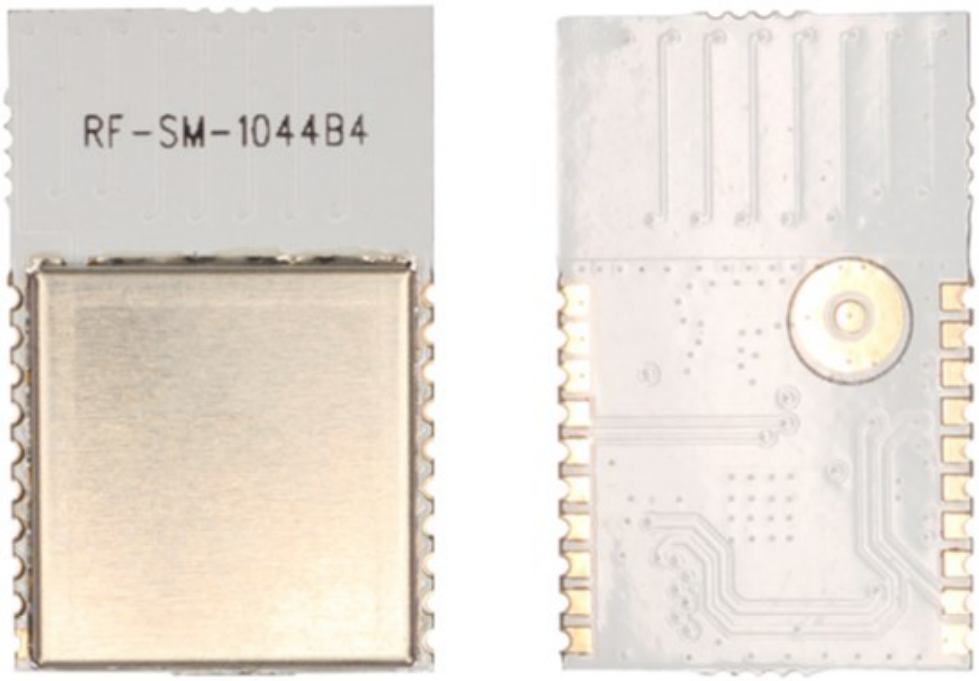

Figure 4. Photos of RF-SM-1044B4

4.2 Recommended PCB Footprint

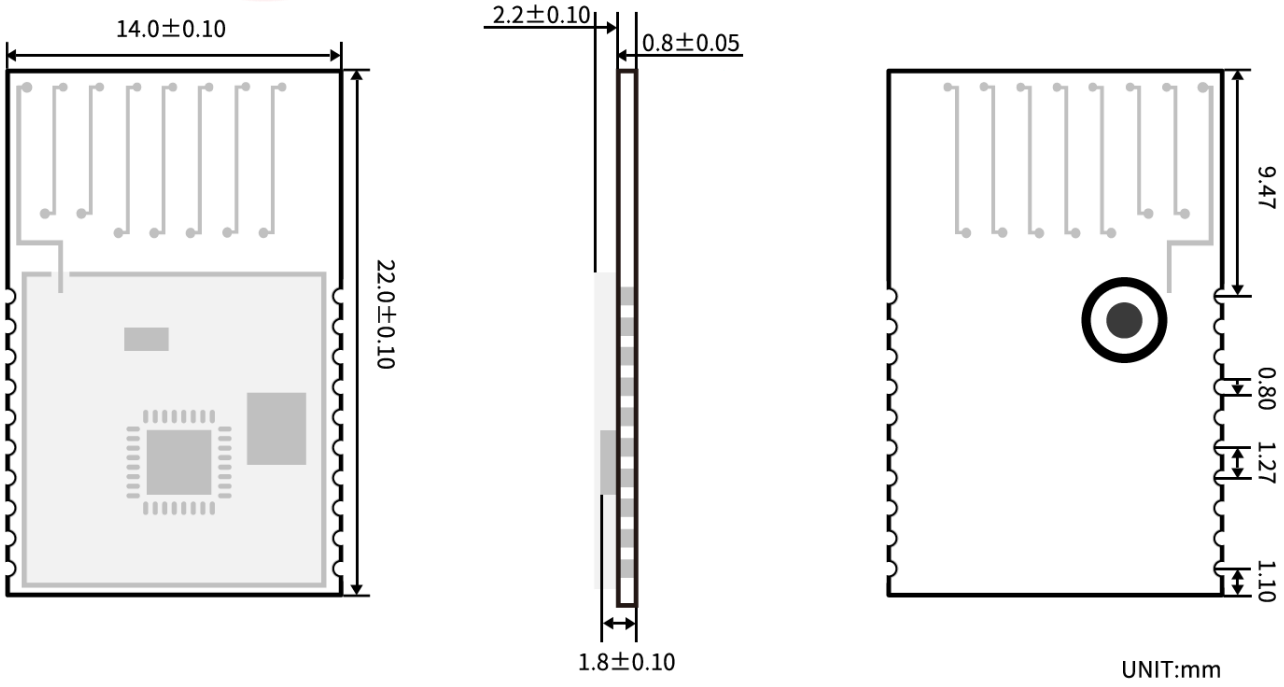

Figure 5. Recommended PCB Footprint of RF-SM-1044B4 (mm)

4.3 Schematic Diagram

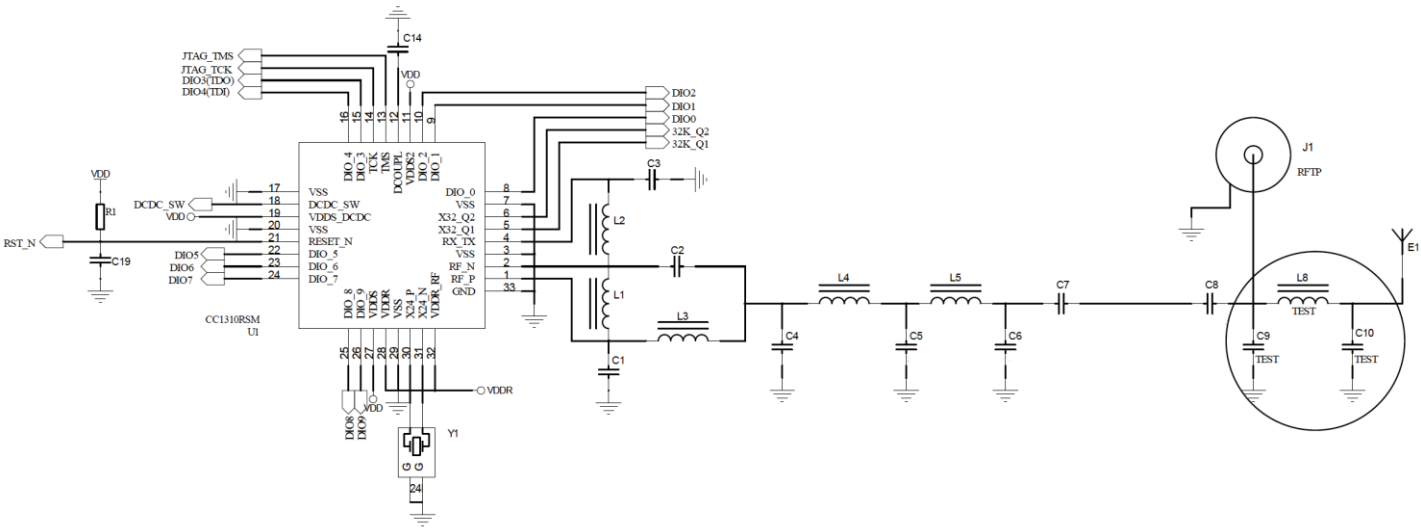

Figure 6. Schematic Diagram of RF-SM-1044B4

4.4 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 868 MHz and 915 MHz physical layer.
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.

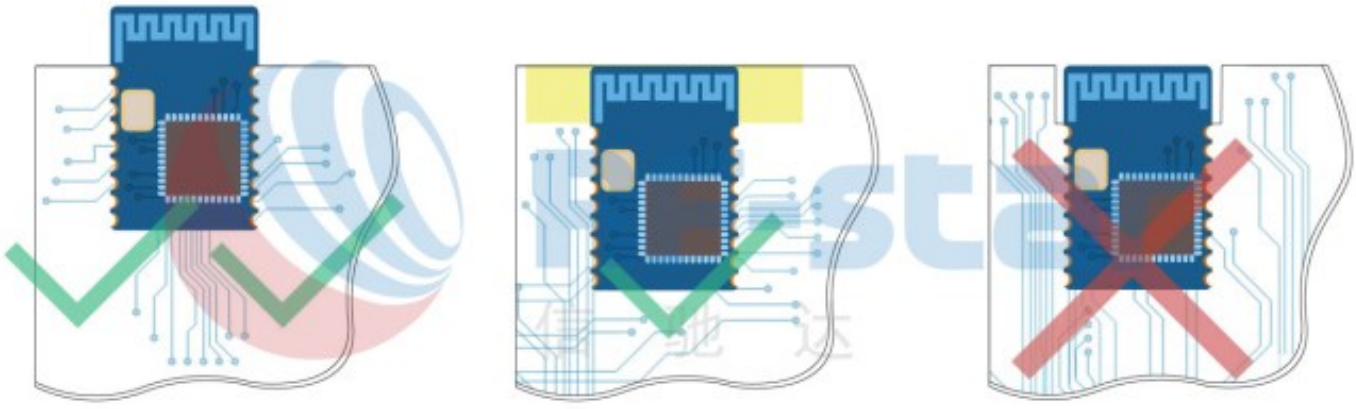

Figure 7. Recommendation of Antenna Layout

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

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. 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

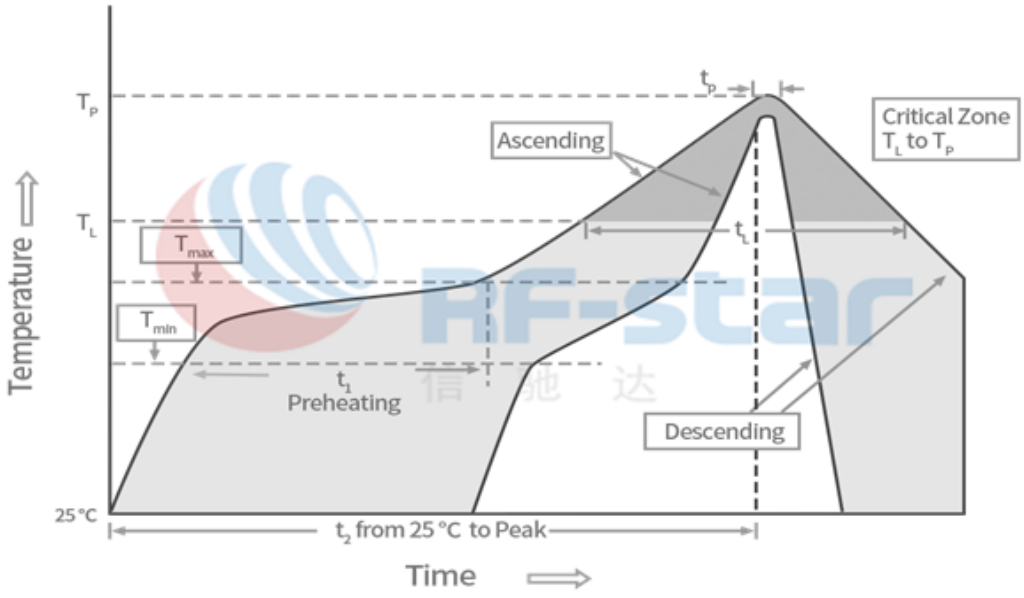

Figure 8. Recommended Reflow for Lead Free Solder

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.

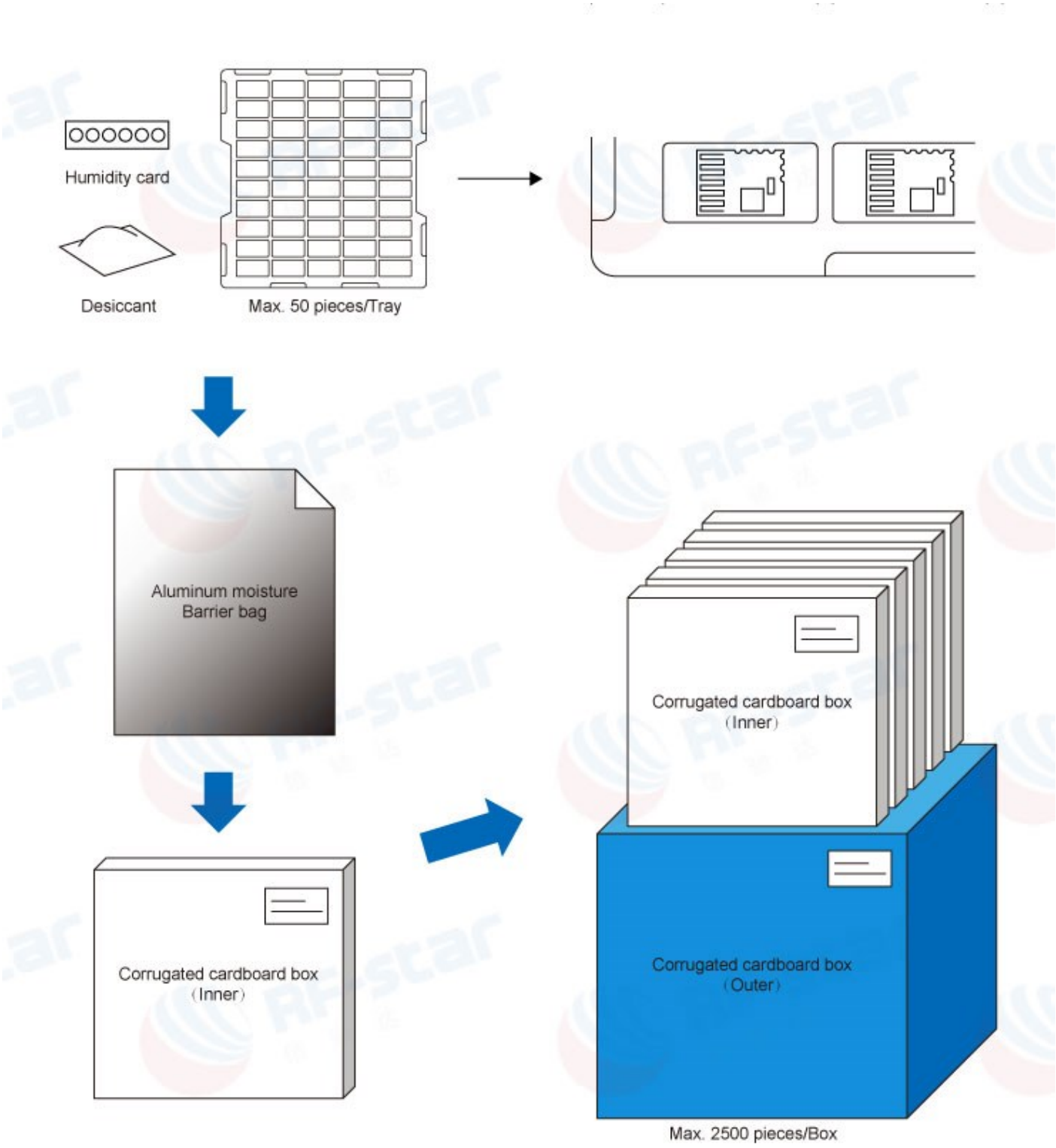

Figure 9. Default Package by Tray

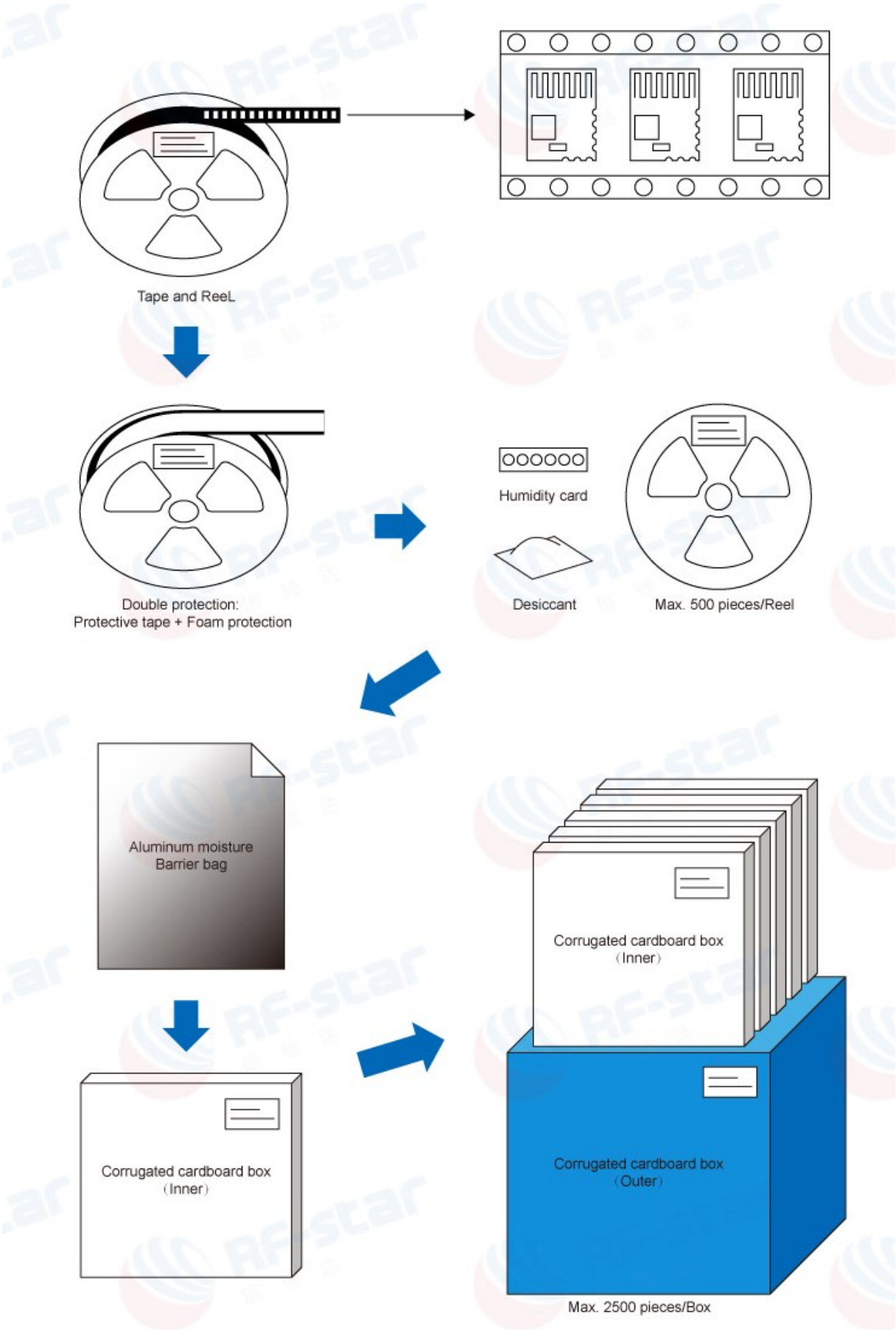

Figure 10. Package by Tape & Reel

6 Revision History

Date	Version No.	Description
2020.02.29	V1.0	The initial version is released.
2020.05.15	V1.0	Add TI CC13XX Sub-1 GHz module list.
2023.05.26	V1.0	Update MSL level. Update the Shenzhen office address.

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.

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