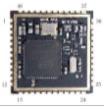
RF-AL42UH 433 MHz LoRaWAN & LoRa Module Hardware Specification

Version 1.0

Shenzhen RF-star Technology Co., Ltd.

Jan. 19th, 2020

RF-star LoRa Module List

Chipset	Model	Antenna	Dimension (mm)	Package	Frequency (MHz)	TX Power (dBm)	Range (Km)	Photo
ASR6501	RF-AL42UH	Half-hole	13.9 × 13.9	Half-hole	433	22	3	
ASR6505	RF-AL42UHB2	Half-hole	18.3 × 18.3	Half-hole	433	22	3	
SX1278	RF-42UH	Half-hole / IPEX	16 × 26	Half-hole	433	18	3/4.5	
	RF-42UP	SMA	21.1 × 36	DIP	433	18	3	
	RF-42SH	Half-hole	16 × 16	Half-hole	433	18	3	
	RF-43UH	Half-hole / IPEX	25 × 40.3	Half-hole	433	27	10	Contact Me
	RF-43UP	SMA	24 × 43	Half-hole	433	27	10	
	RF-43SH	Half-hole	25 × 40	DIP	433	27	10	Contact Me
SX1276	RF-82UH	Half-hole / IPEX	16 × 26	Half-hole	868 915	18	3/4.5	
	RF-82UP	SMA	21.1 × 36	DIP	868	18	3	
	RF-82SH	Half-hole	16 × 16	Half-hole	915	18	3	
	RF-83UH	Half-hole / IPEX	25 × 40.3	Half-hole	868	27	10	Contact Me
	RF-83UP	SMA	24 × 43	DIP	915	27	10	Contact Me
	RF-83SH	Half-hole	25 × 40	Half-hole	868	27	10	

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 jump to buy modules.

1 Device Overview

1.1 Description

RF-AL42UH is a LoRa wireless module based on ASR Microelectronics ASR6501 with a 32-bit ARM® Cortex®-M0+ processor at 48 MHz. It integrates LoRa Radio Transceiver, LoRa Modem. It features ultra-low power consumption, ultra-long transmission distance, high power density, high sensitivity, strong confidentiality, good anti-interference performance and rigid reliability. It supports a wide coverage frequency of LoRa Radio Transceiver from 410 MHz to 525 MHz, LPWAN and (G)FSK LoRa modulation, and LoRaWAN protocol. 1.27-mm pitch stamp stick package for easy assembling and cost-effective PCB design.

1.2 Key Features

- LoRa Radio and LoRaWAN
- Support OTAA and ABP network access
- Aliyun IoT certification, support two-way data (upstream and downstream) communication with Aliyun
- Class A, Class B and Class C
- Support co-frequency and inter-frequency
- Frequency Range: 410 MHz ~ 525 MHz
- TX Power: Up to +22 dBm constant RF output
- High sensitivity: down to -140 dBm
- Programmable bit rate up to 62.5 kbps in LoRa modulation mode
- Programmable bit rate up to 300 kbps in (G)FSK modulation mode
- Preamble detection
- Flash: 128 KB
- SRAM: 16 KB
- 6 x configurable GPIOs, 1 x I^2C, 1 x UART, 1 x SWD
- 48 MHz ARM® Cortex®-M0+ CPU
- 8 Channel DMA engine
- 12 bit 1 Mbps SAR ADC
- Transmission distance: up to 7000 m
- Power supply: 2.8 V ~ 3.6 V

1.3 Applications

- Smart home
- Smart transportation
- Sensor network
- Automation industry
- Agricultral modernization
- Intelligent building
- Automatic collection system for water, electricity, gas and heating
- Street light control
- Grid monitoring
- Wind and solar complementary system
- Industrial equipment data wireless transmission

1.4 Functional Block Diagram

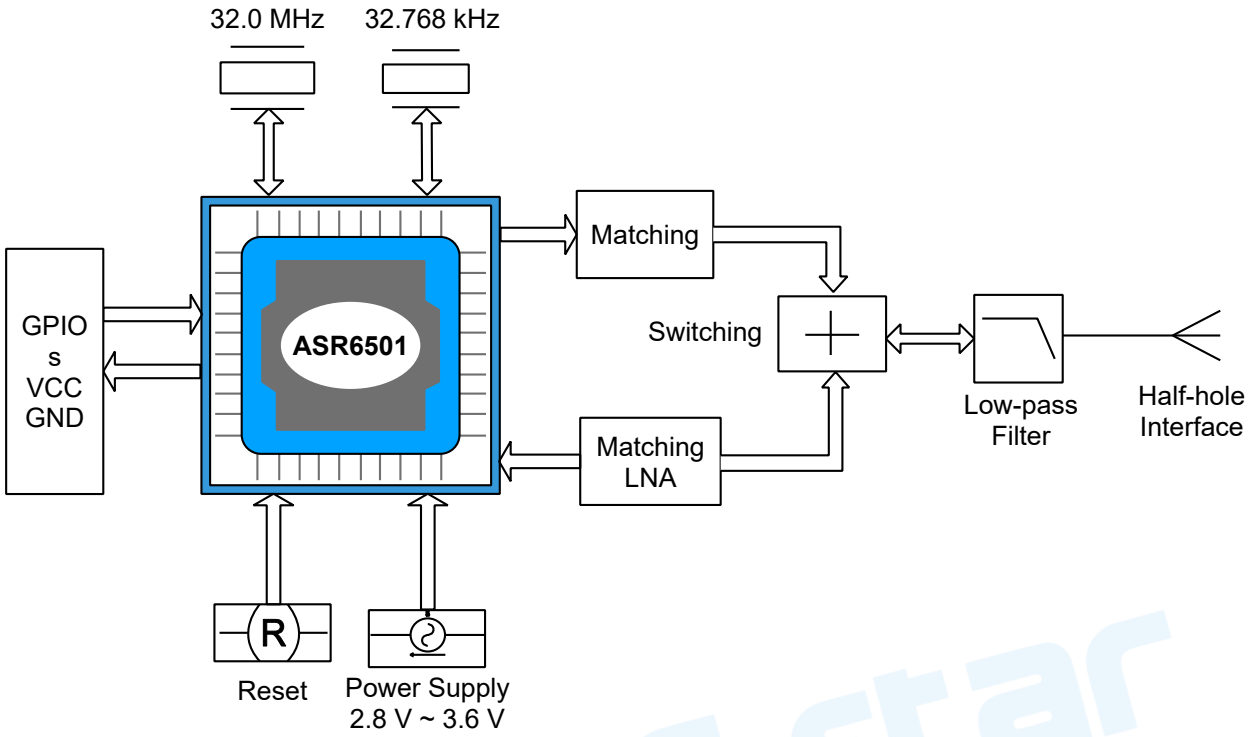


Figure 1. Functional Block Diagram of RF-AL42UH

1.5 Part Number Conventions

The part numbers are of the form of RF-AL42UH where the fields are defined as follows:

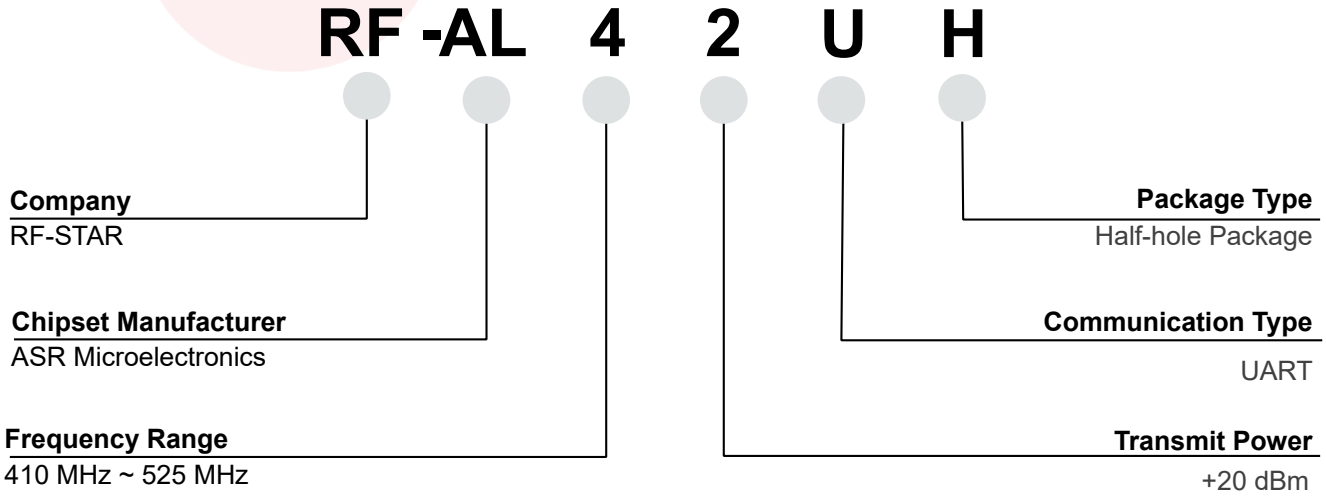


Figure 2. Part Number Conventions of RF-AL42UH

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2 Module Configuration and Functions

2.1 Module Parameters

Table 1. Parameters of RF-AL42UH

Item		Min.	Typ.	Max.	Unit
Frequency		410	433	525	MHz
TX power				+22	dBm
Receiving Sensitivity		-140		+10	dBm
Operating Voltage		2.8	3.3	3.6	V
Operating Current (3.3 V)	**TX Current**	47 @ +5 dBm	59 @ +10 dBm	108 @ +22 dBm	mA
	RX Current		10		mA
	Sleep Current		3.2		μA
Air Rate	**LoRa**			62.5	kbps
	(G)FSK			300	kbps
Operating Temperature		-40		+85	℃
Storage Temperature		-55		+120	℃
Operating Humidity		10% RH		90% RH	
Storage Humidity		10% RH		90% RH	
Dimension		16.0 × 16.0 × 2.7			mm
Transmission Distance		7000 (Test condition: Sunny weather, open air, +22 dBm TX power, antenna gain 5 dBi, height greater than 2.5 m, air rate 2.4 kbps)			m
Class		A / B / C			
Flash		128 KB			
SRAM		16 KB			
Packaging		SMT Packaging			
Antenna		Half hole			

2.2 Module Pin Diagram

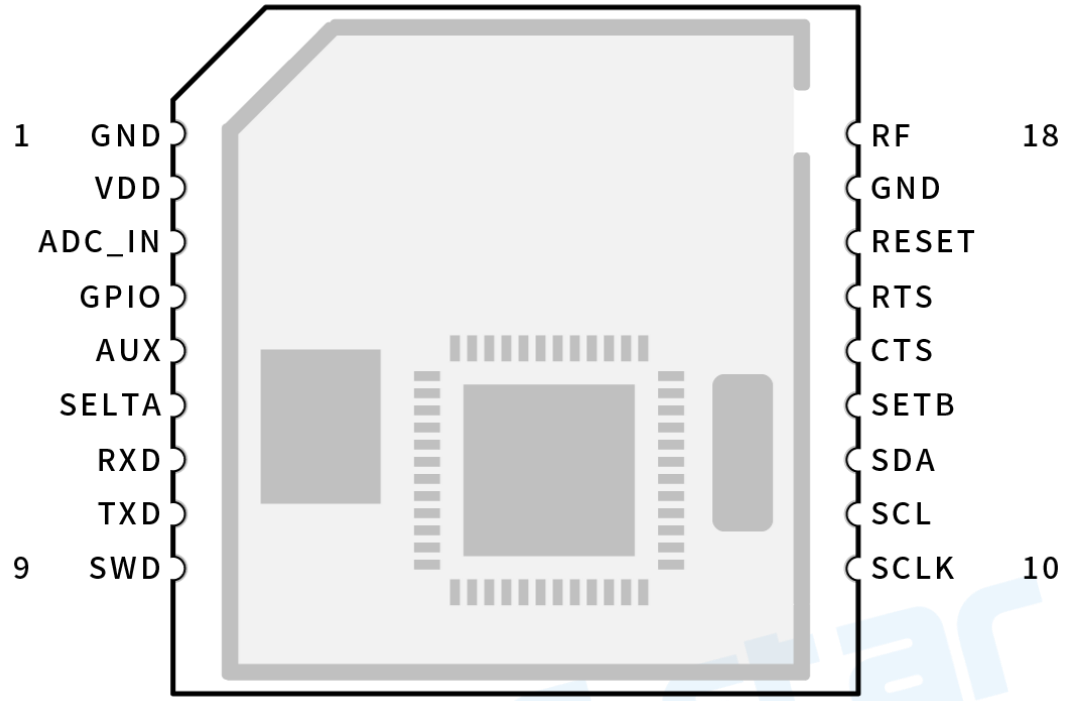

Figure 3. Pin Diagram of RF-AL42UH

3.3 Pin Functions

Table 2. Pin Functions of RF-AL42UH

Pin	Name	Pin Type	Description
1	GND	-	Ground
2	VDD	-	Power supply: 2.8 V ~ 3.6 V DC
3	ADC_IN	I	ADC input pin, programming is not enabled. NC
4	GPIO	I/O	MCU GPIO, NC
5	AUX	I/O	MCU GPIO, NC
6	SETA	I/O	MCU GPIO, NC
7	RXD	I/O	UART RX pin
8	TXD	I/O	UART TX pin
9	SWD	I/O	SWD DATA
10	SCLK	I/O	SWD CLK
11	SCL	I/O	I^2C, programming is not enabled. NC

12	SDA	I/O	I^2C, programming is not enabled. NC
13	SETB	I/O	MCU GPIO, NC
14	CTS	I/O	NC
15	RTS	I/O	NC
16	RESET	I/O	Reset
17	GND	-	Ground
18	RF	RF	Antenna interface

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-AL42UH

Items	Condition	Min.	Typ.	Max.	Unit
Operating Supply Voltage	Battery Mode	2.8	3.3	3.6	V
Operating Temperature	/	-40	+25	+85	℃
RF Input Power	/			+10	dBm

3.2 Handling Ratings

Table 4. Handling Ratings of RF-AL42UH

Items	Condition	Min.	Typ.	Max.	Unit
Storage Temperature	Tstg	-55	+25	+125	℃
Human Body Model	HBM		4000		V
Moisture Sensitivity Level			2		
Charged Device Model			750		V

3.3 RF Characteristics

The electrical specifications of RF-AL42UH RF transceiver operating with LoRa modulation. Following conditions are applied unless otherwise specified:

Supply Voltage = 3.3 V

Temperature = 25 ℃

Frequency bands: 470 MHz

Bandwidth (BW) = 125 kHz

Spreading Factor (SF) = 12

Coding Rate (CR) = 4/6

Package Error Rate (PER) = 1%

CRC on payload enabled

Payload length = 10 bytes.

Preamble Length = 12 symbols.

With matched impedances.

Table 5. Current Consumption of RF-AL42UH

Item	Condition	Min.	Typ.	Max.	Unit
LoRa Transmitter RF Characteristic					
Frequency Range		410	433	525	MHz

TX Power	RFO pin	18	20	22	dBm
LoRa Receiver RF Characteristic					
Frequency Range		410	433	525	MHz
Sensitivity	125 kHz Bandwidth, SF = 7		-126		dBm
	125 kHz Bandwidth, SF = 10		-135		dBm
	125 kHz Bandwidth, SF = 12		-140		dBm
2nd Order Harmonic	TX power = 20 dBm		-41		dBm

4 Application, Implementation and Layout

4.1 Module Photos

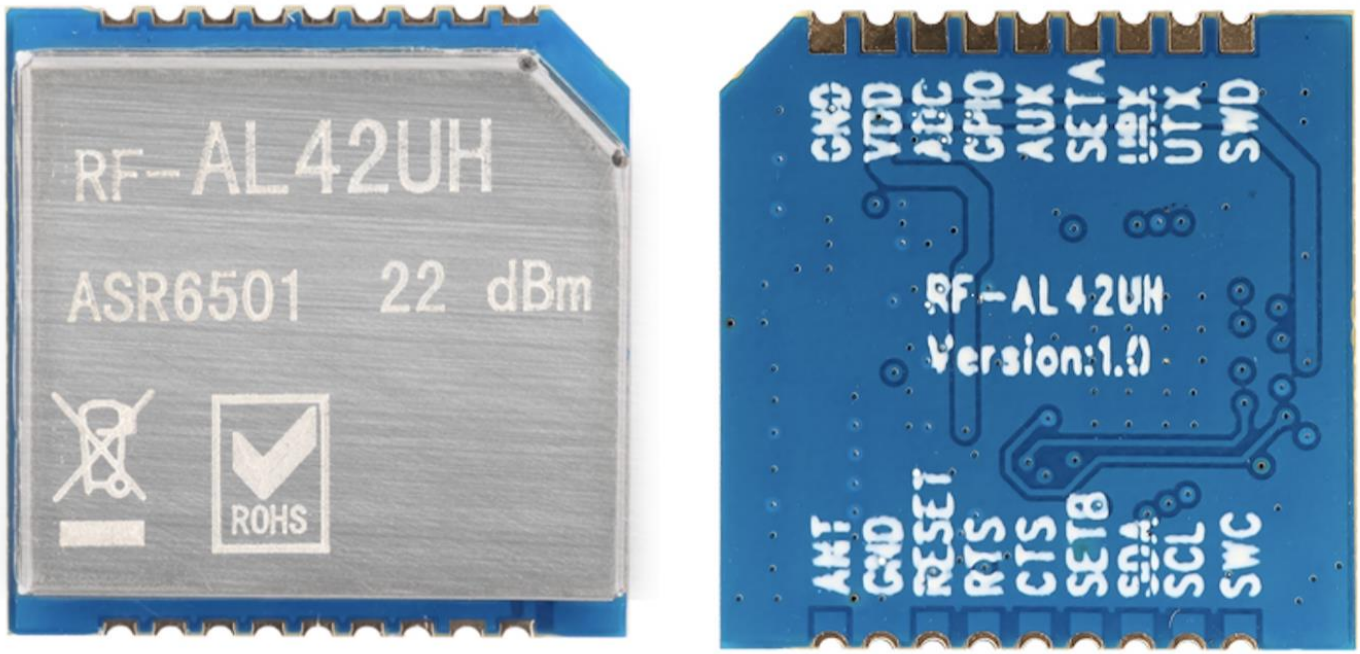

Figure 4. Photos of RF-AL42UH

4.2 Recommended PCB Footprint

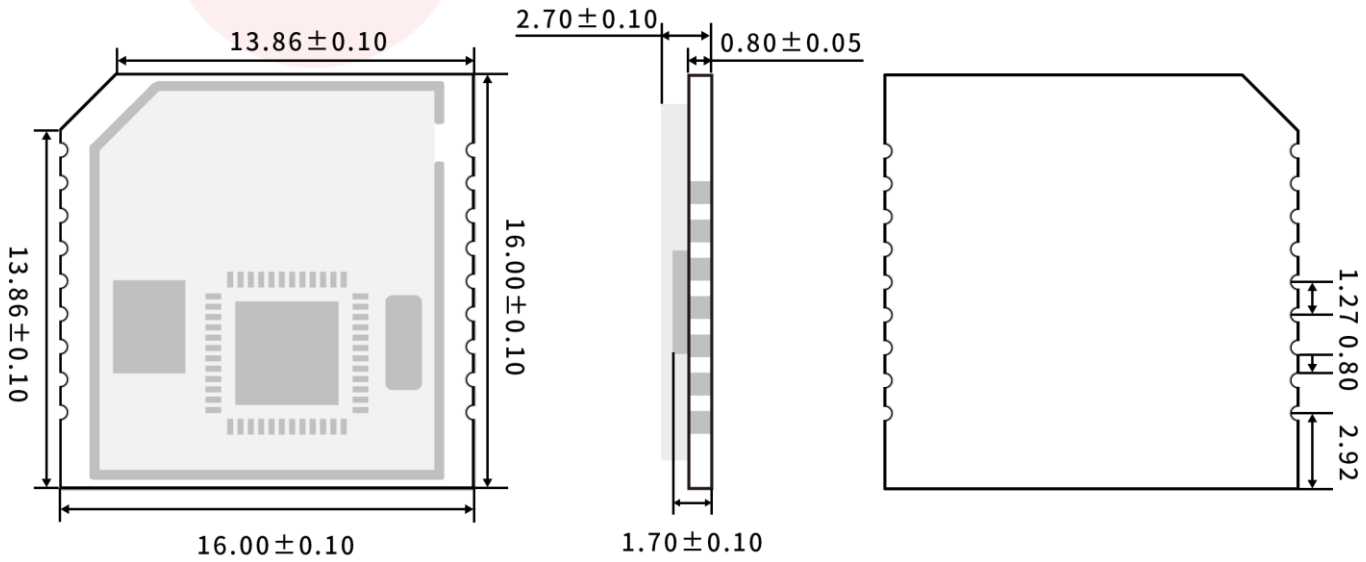

Figure 5. Recommended PCB Footprint of RF-AL42UH (mm)

4.3 Schematic Diagram

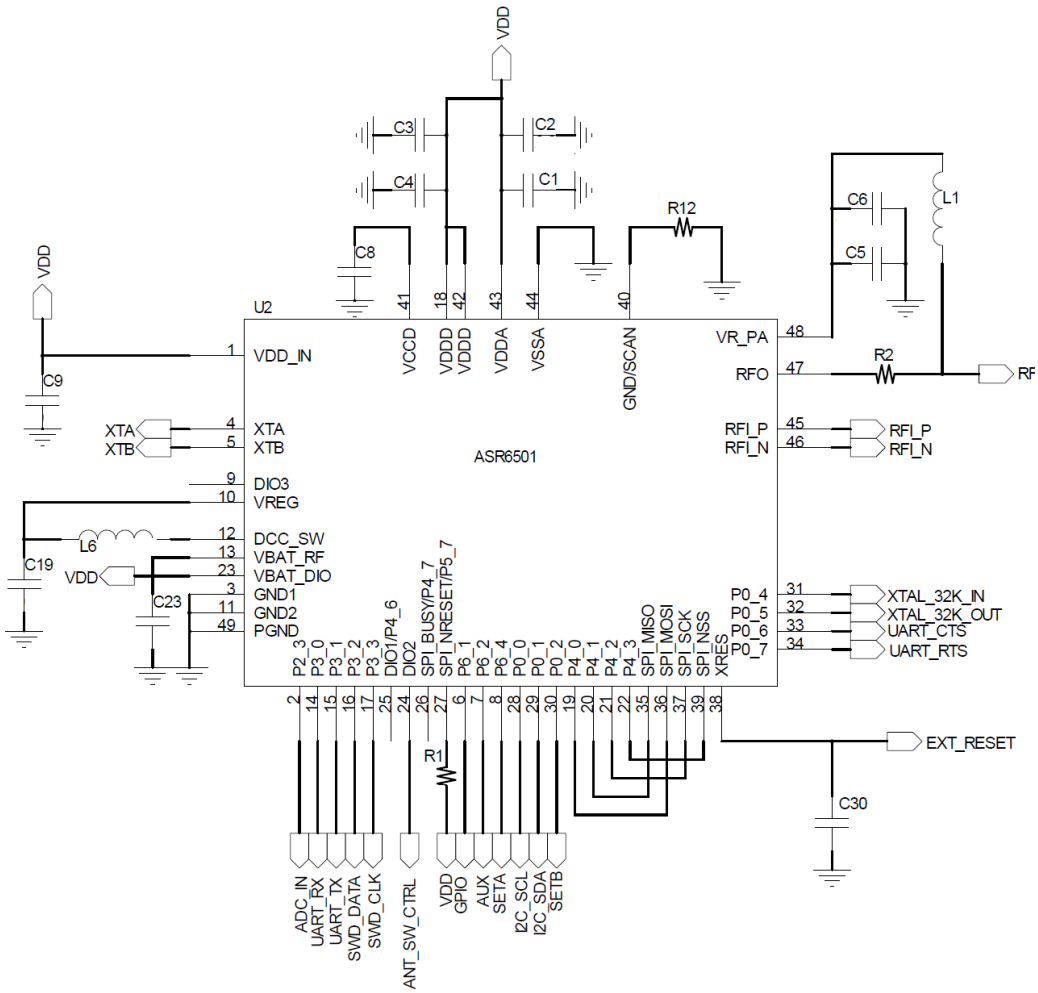

Figure 6. Schematic Diagram of RF-AL42UH

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 433 MHz 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.

4.5.1 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 clock waveform on SPI is not standard. Check whether there is interference on the SPI line. The SPI bus line should not be too long.
3. The unsatisfactory power supply may also cause garbled. It is necessary to ensure the power supply reliability.
4. 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 6. 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

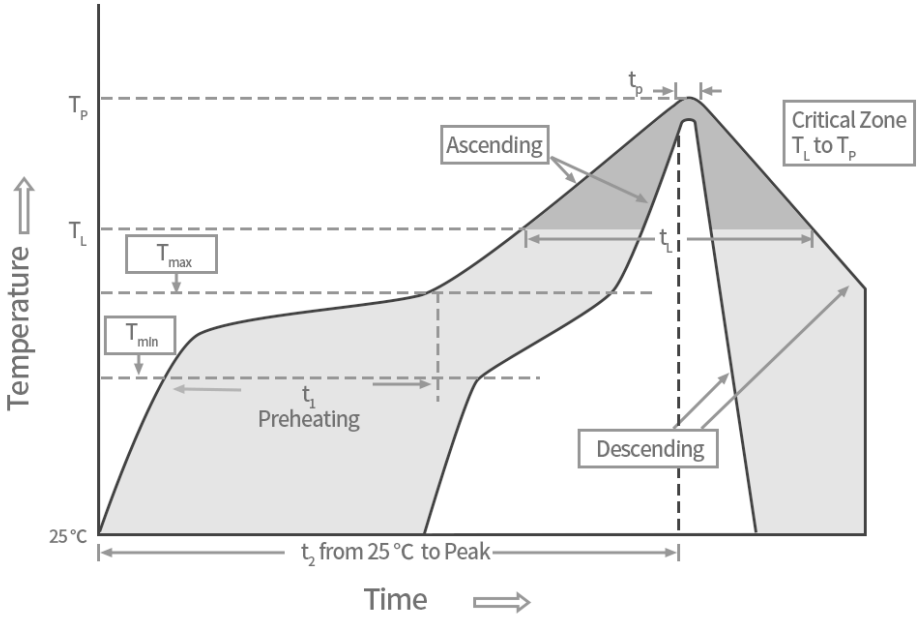

Figure 7. Recommended Reflow for Lead Free Solder

4.8 Optional Packaging

Figure 8. Optional Packaging Mode

Note: Default tray packaging.

5 Revision History

Date	Version No.	Description	Author
2019.06.21	V1.0	The Initial version is released.	Aroo Wang
2019.01.19	V1.0	Add LoRa module list.	Sunny

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.
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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.: 86-755-8632 9687

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