Ra-01SC Specification

Version V1.1

Copyright ©2021

Disclaimer and copyright notice

The information in this article, including the URL address for reference, is subject to change without prior notice.

The documentation is provided "as is" without any warranty, including any warranties of merchantability, fitness for a particular purpose, or non-infringement, and any warranties mentioned in the proposal, specification or sample. This document is not responsible for any infringement of any patent rights arising out of the use of the information in this document. No license, express or implied, by estoppel or otherwise, is hereby granted.

The test data obtained in this paper are all obtained by Ai-Thinker laboratory , and the actual results may be slightly different.

The Wi-Fi alliance membership mark is owned by the WiFi alliance.

All trade mark names, trademarks and registered trademarks mentioned herein are the property of their respective owners and are hereby declared.

The final interpretation right is owned by Shenzhen Ai-Thinker Technology Co., Ltd.

Note

The contents of this manual may be changed due to the version upgrade of the product or other reasons. Shenzhen Ai-Thinker Technology Co., Ltd. reserves the right to modify the contents of this manual without any notice. This manual is only used as a guide, and Shenzhen Ai-Thinker Technology Co., Ltd. makes every effort to provide accurate information in this manual, but Shenzhen Ai-Thinker Technology Co., Ltd. does not ensure that the contents of the manual are completely true,, All statements and information in this manual. and the recommendations do not constitute for any warranty, express or implied.

Document development/revision/revocation resume

Vision	Data	Revised content	Edition	Approve
V1.0	2021.3.15	First Edition	Shengxin Zou	Ning Guan
V1.1	2021.3.31	Update	Shengxin Zou	Ning Guan

CONTENT

1 Product Overview

LoRa series module Ra-01Sc is designed and developed by Shenzhen Ai-Thinker Technology Co., Ltd. This module is used for ultra-long distance spread spectrum communication. Its RF chip LLCC68 mainly uses LoRa™ remote modem for ultra-long distance spread spectrum communication, with strong anti-interference and low power consumption. LLCC68 chip has a high sensitivity of over-129 dBm, a 20 dBm power output, a long transmission distance and a high reliability with SEMTECH's LoRa ™ patent modulation technique. Meanwhile, comparing with the traditional modulation technology, the Lora ™ modulation technology has an obvious advantage in the anti-blocking and selection aspect. It solves the problem of simultaneously balance the distance, the anti-interference and the power consumption which the traditional design scheme can't achieve.

Application areas

automatic meter reading, supply chain and logistics, home building automation, security system, remote irrigation system.

1.1. Characteristics

- LoRa™ modem
- Support FSK、GFSK、MSK、GMSK、LoRa™ and OOK mode
- Frequency supports 410MHz~525MHz
- Operating voltage is 3.3V, Max output transmitting power:+22dBm,Max current:140mA
- Low power consumption in a received state, the min received current is 4.2mA，stand-by current is 0.6mA
- High sensitivity：As low as -129dBm
- Support spreading factor:SF5/SF6/SF7/SF8/SF9/SF10/SF11
- Small volume double row stamp hole patch for SMD package
- Adopts SPI interface, half-duplex communication, with CRC, up to 256-byte packet engine

■ Compatible with various antenna interface: stamp hole/round hole and IPEX, supports more scheme selection.

1.2 Main parameters

Table 1 main parameters instruction

Model	Ra-01SC
Package	SMD16
Size	17*16*3.2(±0.2)mm
Antenna	Compatible with half-hole pad/through-hole pad (antennas need to be soldered)/IPEX
Frequency range	410MHz~525MHz
Operating Temperature	-40 ℃ ~ 85 ℃
Storage environment	-40 ℃ ~ 125 ℃ , ＜ 90%RH
Power supply	2.7~3.6V，typical value 3.3V，recommended current ＞ 200mA
Support Interface	SPI
Programmable bit rate	Max up to 300Kbps
Crystal frequency	32MHz
Transmission distance	Open field with spring antenna:2.8km

2 Electrical parameters

Ra-01SC series modules are electrostatic sensitive devices, special precautions need to be taken when handling.

Note：

Ra-01SC module is electrostatic sensitive devices（ESD）, It requires special ESD precautions and should generally be classified as an ESD sensitive component. During the entire handling, transportation and operation of the Ra-01SC module, proper ESD handling and packaging procedures should be used. Please do not touch the module with hands or use a non-antistatic soldering iron for soldering, so as not to damage the module.

2.1. Electrical character

Parameter	Name	Min	Typ	Max	Unit	Remarks
Operating temperature	TOPR	-40	25	85	℃	Industrial design
Supply voltage	VDD	2.7	3.3	3.6	V	≥3.3V(Guaranteed output power)

2.2. Digital port characteristics

Description		Typ		Unit	
Operating frequency		410~525		MHz	
IO	Name	Min	Typ	Max	Unit
IO level	VIO	2.7	3.3	3.6	V
Low input logic level	VIL	-	-	0.2	V
High input logic level	VIH	0.8	-	-	V

Low output logic level	VOL	-	-	0.1	V
High output logic level	VOH	0.9	-	-	V

2.3. SPI Interface features

Name	Description	Condition	Min	Typ	Max	Unit
Fsck	SCK frequency	–	–	–	10	MHz
TCH	SCK High level time	–	50	–	–	ns
TCL	SCK Low level time	–	50	–	–	ns
Trise	SCK Rise time	-	-	5	-	ns
Tfall	SCK Fall time	-	-	5	-	ns
Tsetup	MOSI Time setting	From MOSI change to SCK rising edge	30	-	-	ns
Thold	MOSI Duration	Change from rising edge of SCK to MOSI	20	-	-	ns
Tnsetup	NSS Set up time	From NSS falling edge to SCK rising edge	30	-	-	ns
Tnhold	NSS Time maintain	From SCK falling edge to NSS rising edge, normal mode	100	-	-	ns
Tnhigh	SPI Access interval NSS High level time	-	20	-	-	ns
T_DATA	DATA maintenance and set up time	-	250	-	-	ns

3 Appearance size

Ra-01SC has two antenna interface：Default equip with the IPEX, the antenna needs to be led to the motherboard by a half-hole pad. A type with IPEX, the antenna can be directly assembled to the module. （The rendering is for reference only, the actual product shall prevail）

（1）Default without IPEX version

（2）Equiped with IPEX version

正面　　　　　　　　　背面

4 Pin function

Ra-01SC module is connected to 16 interfaces, refer to pin diagram, pin function definition table is interface definition.

Ra-01SC　　Pin diagram

Table Pin function definition

No.	Name	Function instruction
1	ANT	Ground
2	GND	Ground，Connect to the power reference ground
3	3.3V	Typical value 3.3V，recommended current > 200mA
4	RESET	Reset
5	TXEN	RF control port
6	DIO1	Digital IO1 software configuration
7	DIO2	Digital IO2 software configuration
8	DIO3	Digital IO3 software configuration
9	GND	Ground
10	BUSY	Status indicator pin（Be sure to connect to the IO port of the master MCU）
11	RXEN	RF control port
12	SCK	SPI clock input
13	MISO	SPI data output
14	MOSI	SPI data input
15	NSS	SPI chip select input
16	GND	Ground，Connect to the power reference ground

The three general IO pin of LLCC68 can be available in LoRa™ mode.

Their mapping depends on the configuration of the two registers RegDioMapping1 and RegDioMapping2.

Operating Mode	DIOx Mapping	DIO3	DIO2	DIO1
All	00	CadDone	Fhss Change Channel	RxRimeout
	01	Valid Header	Fhss Change Channel	Fhss Change Channel
	10	PayloadCrc Error	Fhss Change Channel	CadDetected
	11	-	-	-

5 Schematics
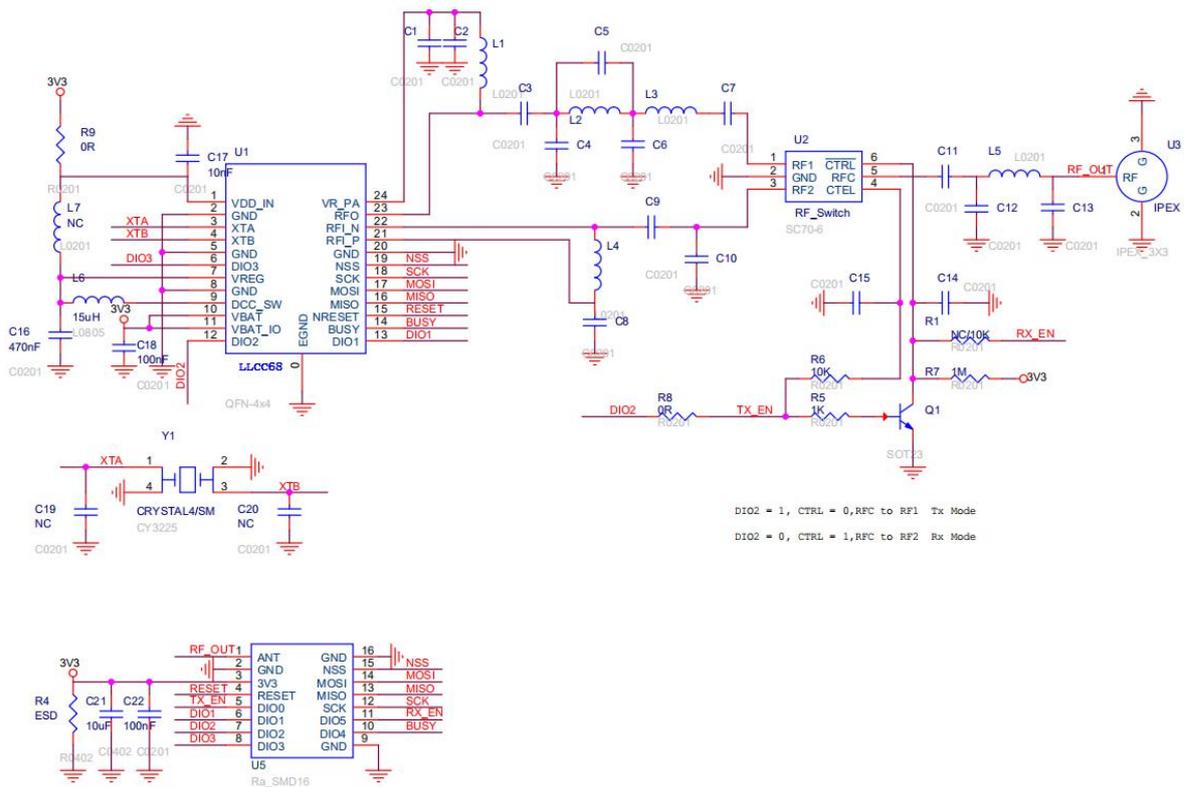
6 Design guidance

6.1 Application Circuit
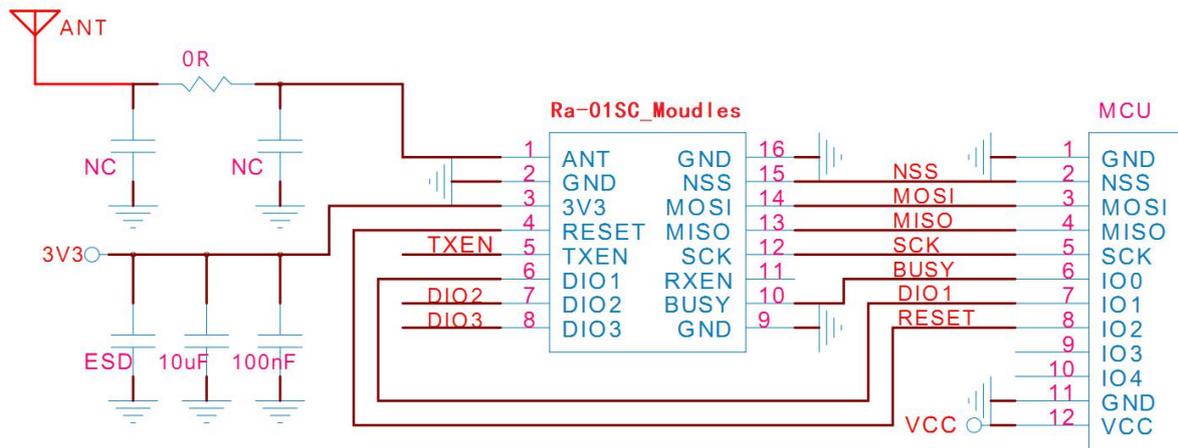
（1）In addition to the SPI interface, the communication interface with the master MCU must also connect BUSY/DIO1 to the IO port of the master MCU

（2）If the antenna is soldered on the main control board, it is recommended to reserve a Π matching circuit at the antenna interface.
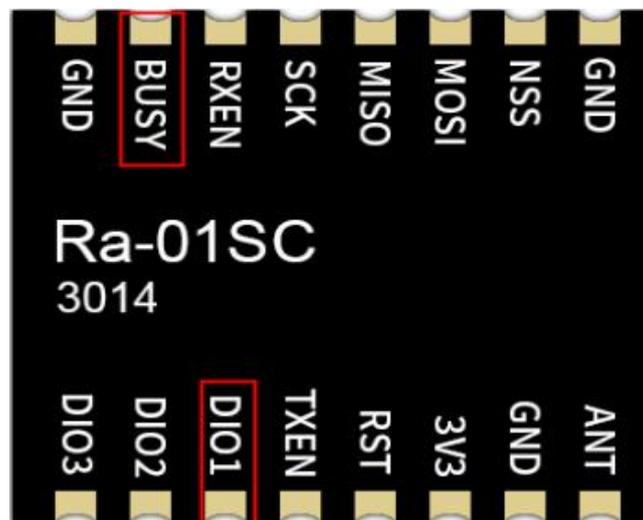
6.2 Recommended module package design size

Note：This is the package drawing of the Ra-01SC module. It is recommended to design the PCB board according to this drawing so that the module can work normally on the PCB board; and when designing the pads, pay attention to the design of the pads on the PCB. The pad is retracted and offset, and the PCB pad is expanded relative to the module pad without affecting the use of the module.
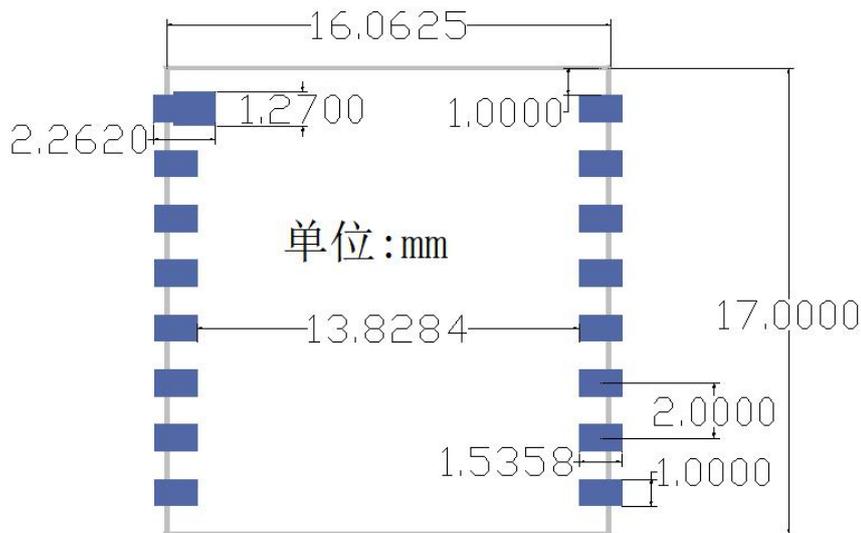
6.3 Antenna installation

（1）Ra-01SC needs to be used for soldering antennas, the module is compatible with half-hole pads and round-hole pads；

（2）In order to meet the best antenna effect，the location of the antenna assembly should be far away from the metal parts；

（3）The antenna installation structure has a great influence on the performance of the module.Make sure that the antenna is exposed, preferably vertically upward. When the module is installed inside the case, you can use a high-quality antenna extension cable to extend the antenna to the outside of the case

（4）The antenna must not be installed inside the metal shell, which will greatly reduce the transmission distance.

6.4 Power Supply

（1）Recommended voltage 3.3 V, Peak:Current over 200mA .

（2）It is recommended to use the LDO power supply；If DC-DC is used, the ripple is controlled within 30 mV.；

（3）DC-DC power supply circuit is recommended to reserve the position of the dynamic response capacitor, and the output ripple can be optimized when the load change is large.；

（4）3.3V power jack advise to add ESD components.；

（5）When designing the power supply circuit for the module, it is recommended to reserve more than 30% of the power supply current, which is conducive to the long-term stable operation of the whole machine；

（6）Please pay attention to the correct connection of the positive and negative poles of the power supply. Reverse connection may cause permanent damage to the module.
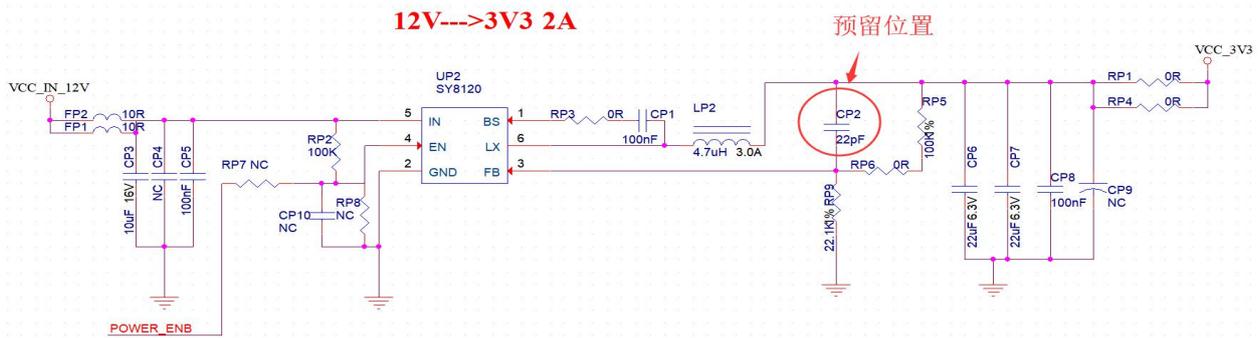
6.5 GPIO

（1）There are some GPIO ports on the periphery of the module. If you need to use a 10-100 ohm resistor in series with the IO port, it can suppress overshoot and make the levels on both sides more stable, which is helpful for EMI and ESD.

（2）For the pull-up and pull-down of special IO ports, please refer to the instructions in the specification, which will affect the startup configuration of the module;

（3）The IO port of the module is 3.3V. If the main control and the IO level of the module do not match, a level conversion circuit needs to be added

（4）If the IO port is directly connected to a peripheral interface, or a terminal such as a header, it is recommended to reserve an ESD device near the terminal of the IO trace.
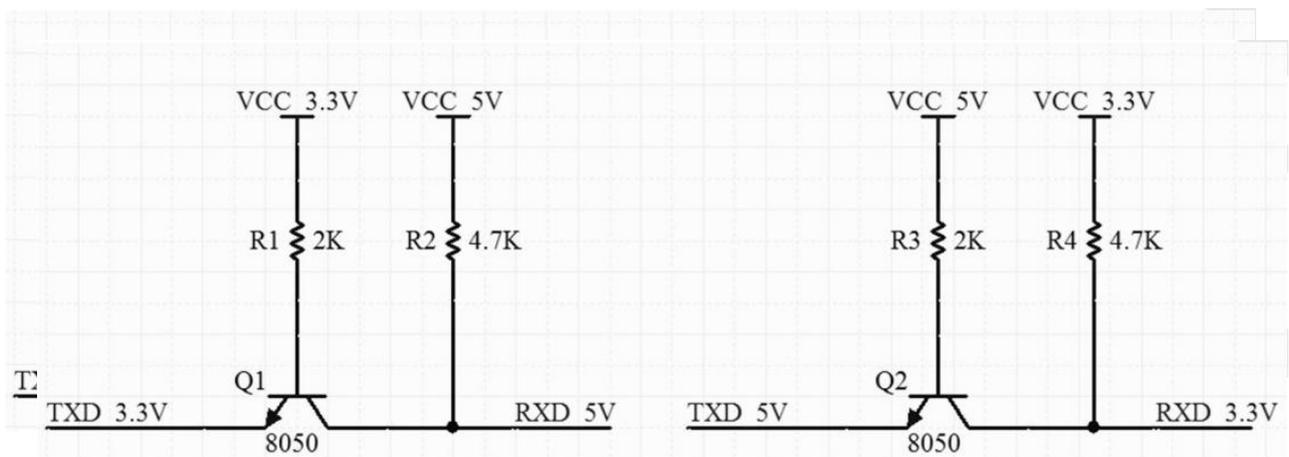
Table Level switching circuit

6.6 Software writing

(1) This module is LLCC68+ peripheral circuit, users can operate according to LLCC68 chip manual；

(2) DIO1,DIO2,DIO3 are general-purpose IO ports, which can be configured into multiple functions；

(3) The control of the RF switch TX/RX is completed by the internal circuit of the module by default. But the interface is reserved in the design, which can realize external MCU control. If you need external MCU control, please contact Ai-Thinker technicians to replace the module BOM.

Different between LLCC68 and SX1262/SX1268：

(1) SX1262/SX1268 support spreading factor SF5,SF6,SF7,SF8,SF9,SF10,SF11,SF12；

SX1262/SX1268 can set spreading factor and receiving bandwidth:

LoRa@ Rx/Tx，BW = 7.8 - 500 kHz,

SF5 TO SF12,BR=0.018-62.5 Kb/S

(2) LLCC68 support spreading factor SF5,SF6,SF7,SF8,SF9,SF10,SF11.

LLCC68can set spreading factor and receiving bandwidth:

LoRa@ Rx/Tx，BW = 125 - 250 - 500 kHz,

LoRa@，SF=5-6-7-8-9 for BW=125kHz,

LoRa@, SF=5-6-7-8-9-10 for BW =250 kHz,

LoRa@，SF=5-6-7-8-9-10-11 for BW=500 kHz;

7 FAQ

7.1 Factors affecting transmission distance

（1）When there is a straight line communication obstacle, the communication distance will be attenuated accordingly

（2）Temperature, humidity, and co-frequency interference will increase the communication packet loss rate;

（3）The ground absorbs and reflects radio waves, the test effect is poor when it is close to the ground

（4）Sea water has a strong ability to absorb radio waves, so the seaside test results are poor；

（5）If there is a metal object near the antenna or placed in a metal shell, the signal attenuation will be serious；

（6）Incorrectly set the power register, and the air speed is set too high (the higher the air speed, the closer the distance)

（7）The low voltage of the power supply at room temperature is lower than the recommended value, the lower the voltage, the lower the power output;；

（8）The poor matching degree of the antenna and the module or the quality of the antenna itself

7.2 Module use reminder

（1）Check the power supply to ensure that it is between the recommended supply voltages. If it exceeds the maximum value, it will cause permanent damage to the module;

（2）Check the stability of the power supply, and the voltage should not fluctuate significantly and frequently;

（3）Ensure the anti-static operation during installation and use, and the electrostatic sensitivity of high-frequency devices;

（4）Ensure that the humidity during installation and use should not be too high, and some components are humidity sensitive devices;

（5）If there is no special requirement, it is not recommended to use it at too high or too low temperature.

7.3 Interfering factors

（1）There is co-channel signal interference nearby,please stay away from the interference source or modify the frequency and channel to avoid interference;（2）The clock waveform on SPI is not standard, please check whether there is interference on the SPI line, and the SPI bus line should not be too long;

（3）Unsatisfactory power supply may also cause garbled codes, so the reliability of the power supply must be ensured;

（4）Extension cords and feeders are of poor quality or too long, which will also cause a high bit error rate

8 Reflow Welding Curve
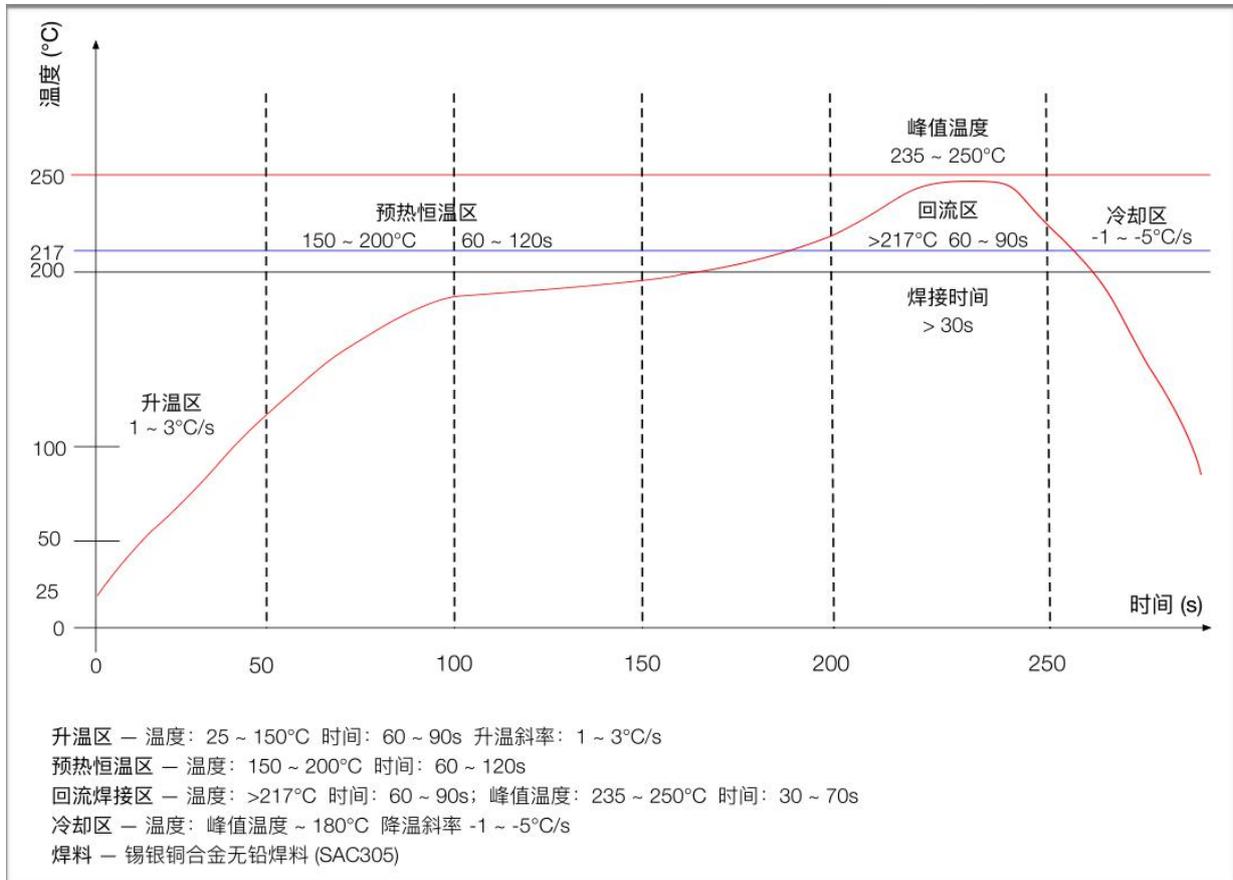
9 Related models and antenna guide

9.1 Related models

Model	Chip	Frequency	Transmitting power	Package	Size	Interface
Ra-01	SX1278	410MHz~525MHz	20dB	SMD	17*16	SPI
Ra-01H	SX1276	410MHz~525MHz	20dB	SMD	17*16	SPI
Ra-01S	SX1268	410MHz~525MHz	22dB	SMD	17*16	SPI
Ra-02	SX1278	410MHz~525MHz	20dB	SMD	17*16	SPI
Ra-06	SX1278	410MHz~525MHz	20dB	SMD	22.8*16	SPI
Ra-07	ASR6501	410MHz~525MHz	20dB	SMD	16*16	UART/I2C
Ra-07H	ASR6501	803MHz~930MHz	21dB	SMD	16*16	UART/I2C
Product related information： https://docs.ai-thinker.com/lora						

9.2 Antenna recommendation

Antennas play an important role in the communication process, and often inferior antennas will have a great impact on the communication system. Therefore, our company recommends some antennas as supporting our company's wireless modules with better performance and reasonable prices.

Material coding	Type	Frequency	interface	Features
22100003	Spring antenna	433-470MHz	Straight foot welding	Built-in, small size, easy to assemble
22100008	Spring antenna	433-470MHz	Angle welding	Built-in, small size, easy to assemble
22100032	Glue stick antenna	433MHz	SMA internal thread with needle	External omnidirectional antenna, free from interference from the internal environment of the chassis
22100033	Glue stick antenna	470MHz	SMA internal thread with needle	External omnidirectional antenna, free from interference from the internal environment of the chassis
AG-030318-0595	Suction cup antenna	433MHz	SMA internal thread with needle	High gain, extension cable can place the antenna in a better environment
AG-031718-0542	Suction cup antenna	470MHz	SMA internal thread with needle	High gain, extension cable can place the antenna in a better environment

10 Packaging information

Refer to below image,ESP32-C3F package is in Tape/Reel.

11 Contact us

Official website：https://www.ai-thinker.com

Development DOCS：https://docs.ai-thinker.com

Official Forum：http://bbs.ai-thinker.com

Sample purchase：https://ai-thinker.en.alibaba.com/

Business cooperation：overseas@aithinker.com

Technical support：support@aithinker.com

Company Address：Room 403,408-410, Block C, Huafeng Smart

Innovation Port, Gushu 2nd Road, Xixiang, Baoan District, Shenzhen.

Tel ：0755-29162996