Ra-01S Specification

Version V1.1.2

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Document Revision History

Version	Date	Description of Changes	Authored by	Approved by
V1.0	2020/08/12	First edition	Xu Hong	
V1.1	2020/08/19	Update partial parameters	Xu Hong	
V1.1.2	2025/09/08	1. Update module dimension diagram, adding thickness illustration 2. Update chip model to SX126x 3. Add power consumption data 4. Add design guide contents	Guan Ning	Xu Hong

Contents

1 Product Overview

Ra-01S is a LoRa module designed and developed by Shenzhen Ai-Thinker Technology Co., Ltd.. This module is designed for ultra-long-range spread spectrum communication. Its SX126x RF chip primarily utilizes LoRa™ long-range modem technology, offering strong anti-interference capabilities and minimizing current consumption to the greatest extent possible. Leveraging SEMTECH's patented LoRa™ modulation technology, the SX126x achieves a theoretical sensitivity exceeding -148 dBm and a power output of +22 dBm, offering extended transmission distance and high reliability. Furthermore, compared with conventional modulation techniques, LoRa™ modulation demonstrates significant advantages in blocking immunity and selectivity, addressing the challenges of balancing distance, interference resistance, and power consumption that traditional design solutions cannot simultaneously achieve.

Application fields include automatic meter reading, home/building automation, security systems, and remote irrigation systems.

Features

- Supports FSK, GFSK, and LoRa® modulation modes
- Supports 410–525 MHz frequency band
- Operating voltage is 3.3 V; maximum output power is +22 dBm; maximum operating current is 140 mA
- Features low power consumption in receive mode, with a minimum receive current of 4.2 mA and a standby current of 1.6 mA.
- High sensitivity: it can reach down to -148 dBm theoretically
- Adopts compact DIP stamp-hole SMD package
- Adopts SPI interface, half-duplex communication, with CRC and a data packet engine supporting up to 256 bytes

2 Main Parameters

Table 1 Main Parameters Specifications

Model	Ra-01S
Package	SMD16
Dimensions	17*16*3.3 mm
Antenna Type	Compatible with half-hole land / through-hole land (antenna needs to be soldered) / IPEX socket
Frequency Range	410–525 MHz
Operating Temperature	-40–85 ℃
Storage Conditions	-40–125 ℃, < 90% RH
Power Supply Range	2.7–3.6 V, typical value 3.3 V, current greater than 200 mA
Supported Interfaces	SPI
Programmable Bit Rate	Up to 300 kbps
Certification	FCC, CE

2.1 Static Electricity Requirements

Ra-01S is an electrostatic sensitive device (ESD) and requires special precautions during handling.

Figure 1 ESD Protection Diagram

Warning:

The Ra-01S module is an electrostatic sensitive device (ESD) and requires special ESD precautions. It should generally be treated as an ESD-sensitive component. Proper ESD handling and packaging procedures must be implemented throughout the entire process of handling, transportation, and operation in any application involving the Ra-01S module. Do not touch the module with bare hands or use a non-antistatic soldering iron for soldering to avoid damaging the module.

2.2 Electrical Characteristics

Table 2 Electrical Characteristics

Parameter	Condition	Min	Typ	Max	Unit
Operating Temperature	TOPR	-40	25	85	℃
Supply Voltage	VDD	2.7	3.3	3.6	V

Table 3 Digital Port Characteristics

Description		Typ		Unit	
Operating Frequency		410–525		MHz	
Port	**Name**	**Min**	**Typ**	**Max**	**Unit**
I/O Level	VIO	2.7	3.3	3.6	V
Input Low Level	VIL	-	-	0.2	V
Input High Level	VIH	0.8	-	-	V
Output Low Level	VOL	-	-	0.1	V
Output High Level	VOH	0.9	-	-	V

Table 4 SPI Interface Characteristics

Symbol	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 Setup Time	From MOSI change to SCK rising edge	30	-	-	ns
thold	MOSI Hold Time	From SCK rising edge to MOSI change	20	-	-	ns
tnsetup	NSS Setup Time	From NSS falling edge to SCK rising edge	30	-	-	ns
tnhold	NSS Hold Time	From SCK falling edge to NSS rising edge, normal mode	100	-	-	ns
tnhigh	SPI Access Interval NSS High Time	-	20	-	-	ns
T_DATA	DATA Hold and Setup Time	-	250	-	-	ns

Table 5 Consumption Power

Mode	Min	Typ	Max	Unit
TX Mode	-	110	-	mA
RX Mode	-	9.8	-	mA
Deep Sleep	-	1.3	-	μA

Note: *The above power consumption data is measured based on a 3.3 V power supply and an ambient temperature of 25 ℃.*

3 Appearance and Dimensions

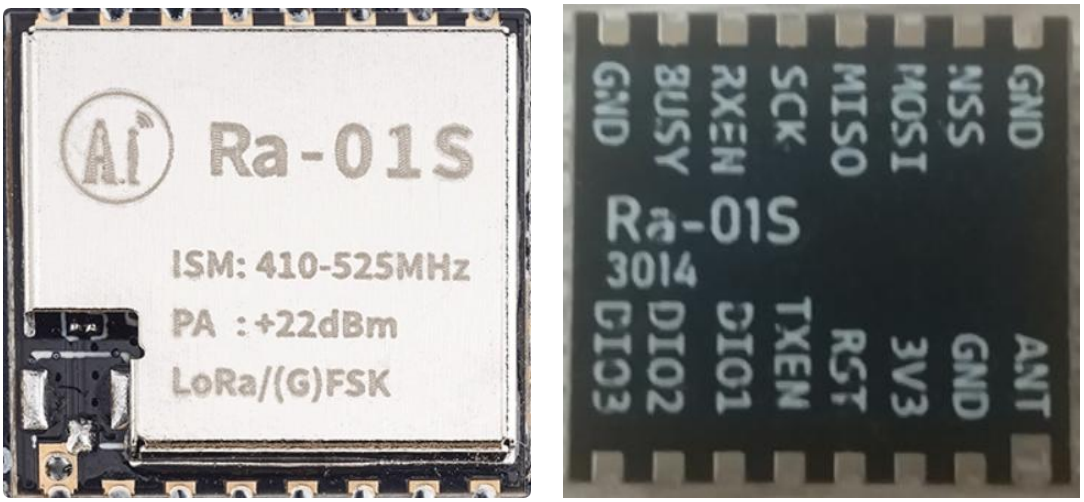

Figure 2 Appearance Diagram

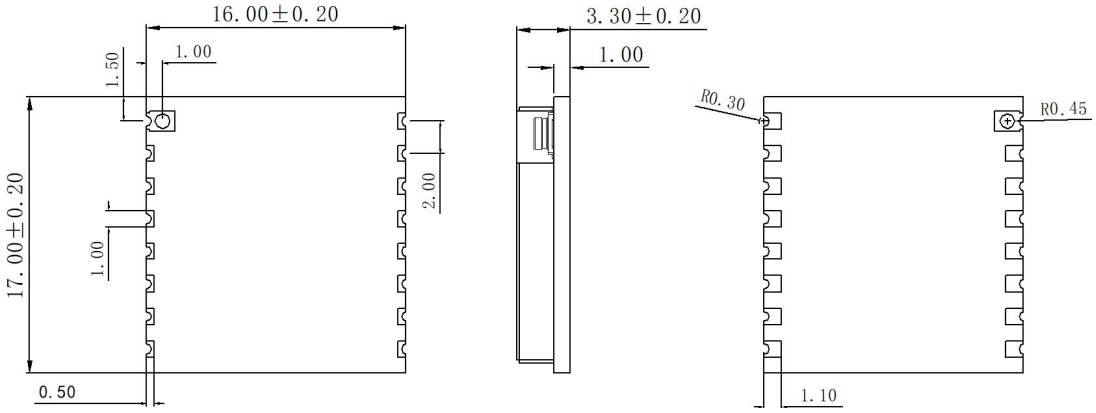

Figure 3 Dimension Diagram (Unit: mm)

4 Pin Definition

The Ra-01S module exposes a total of 16 pins, as shown in the pin diagram. The pin function definition table provides the detailed interface specifications.

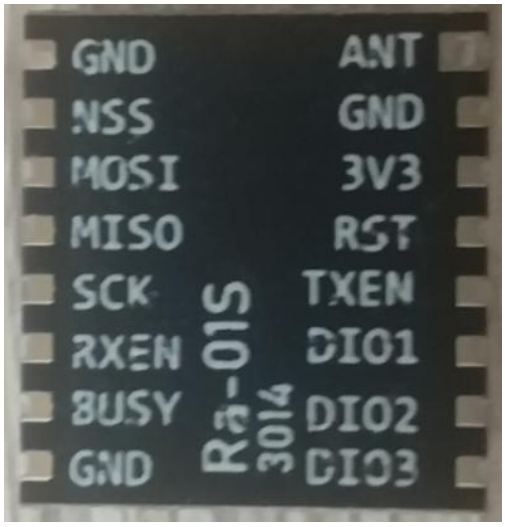

Figure 4 Ra-01S Pin Diagram

Table 6 Pin Function Definition

Pin No.	Name	Function Description
1	ANT	Antenna connector
2	GND	Ground
3	3.3V	Power supply (3.3V typical)
4	RESET	Reset pin
5	TXEN	RF control port
6	DIO1	Digital IO1 software configurable
7	DIO2	Digital IO2 software configurable
8	DIO3	Digital IO3 software configurable
9	GND	Ground
10	BUSY	Status indicator pin
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

All three general-purpose I/O pins of the SX126x are available in LoRa™ mode. Their function mapping is determined by the configuration of the RegDioMapping1 and RegDioMapping2 registers.

Figure 7 I/O Function Mapping

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 Schematic Diagram

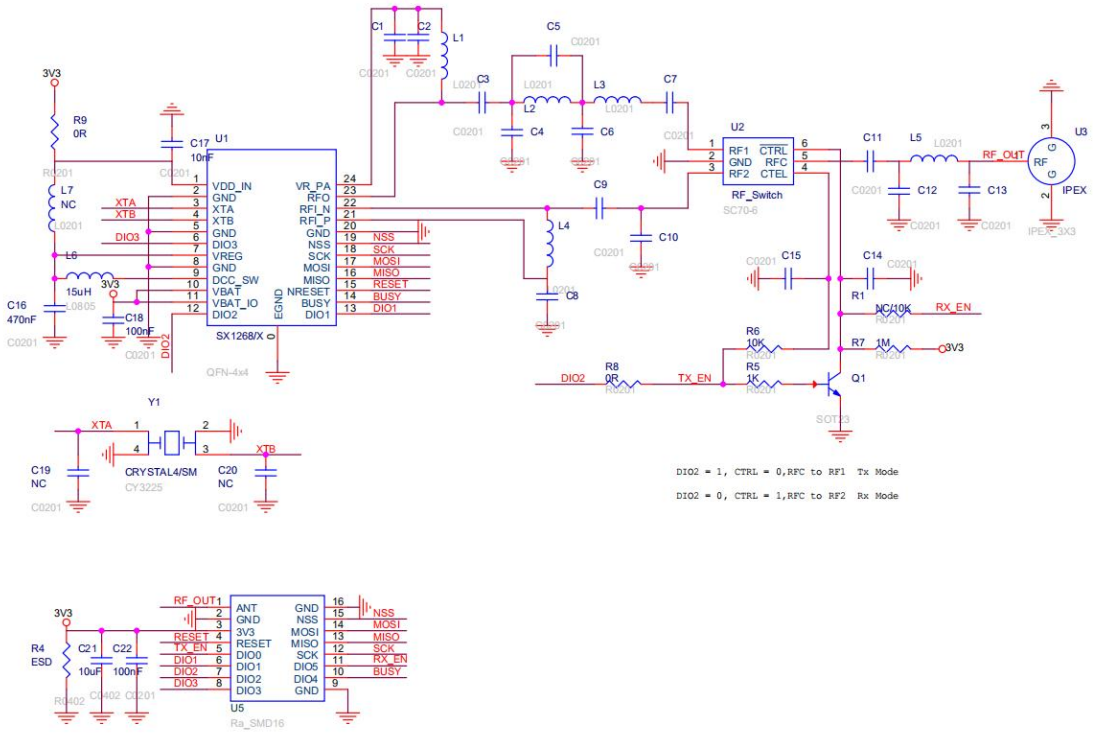

Figure 5 Schematic Diagram

6 Design Guide

6.1 Application Circuit

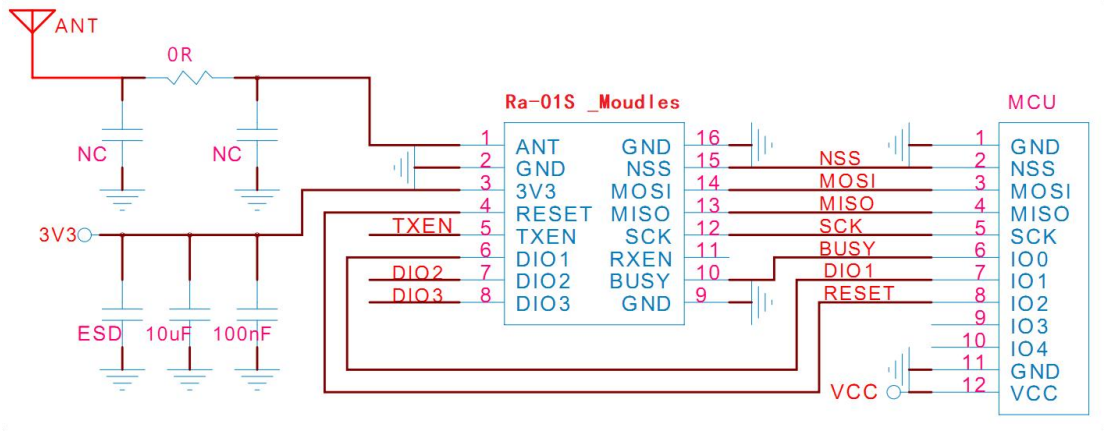

Figure 6 Application Circuit

(1) In addition to the SPI interface, the BUSY/DIO1 pin should also be connected to the I/O port of the main control MCU.

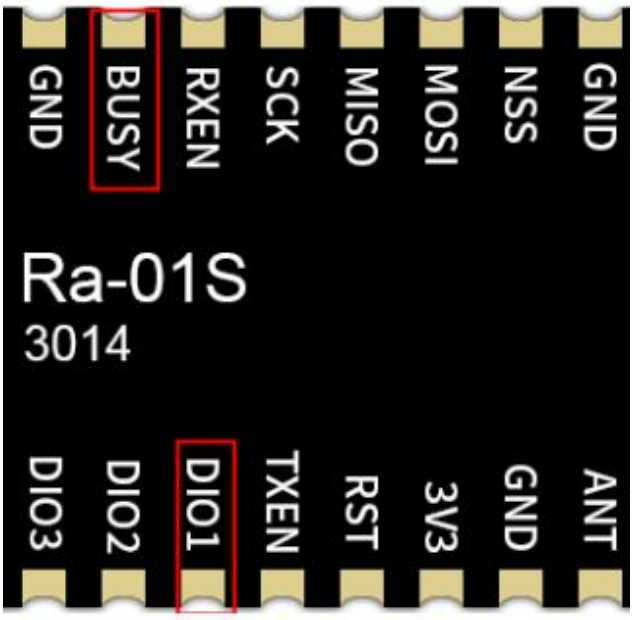

Figure 7 BUSY/DIO1 Application Precautions

(2) If the antenna is soldered onto the main control board, it is recommended to reserve a Π-type matching circuit at the antenna interface.

6.2 Recommended PCB Footprint Dimensions

Note: *This diagram shows the package outline of the Ra-01S module. It is recommended to design the PCB board according to this diagram to ensure the module can work properly on the PCB. When designing the solder pads, it is important to note that the solder pads on the PCB should not be designed to be retracted relative to the corresponding module solder pads. However, if the PCB solder pads are expanded relative to the module solder pads, it will not affect the use of the module.*

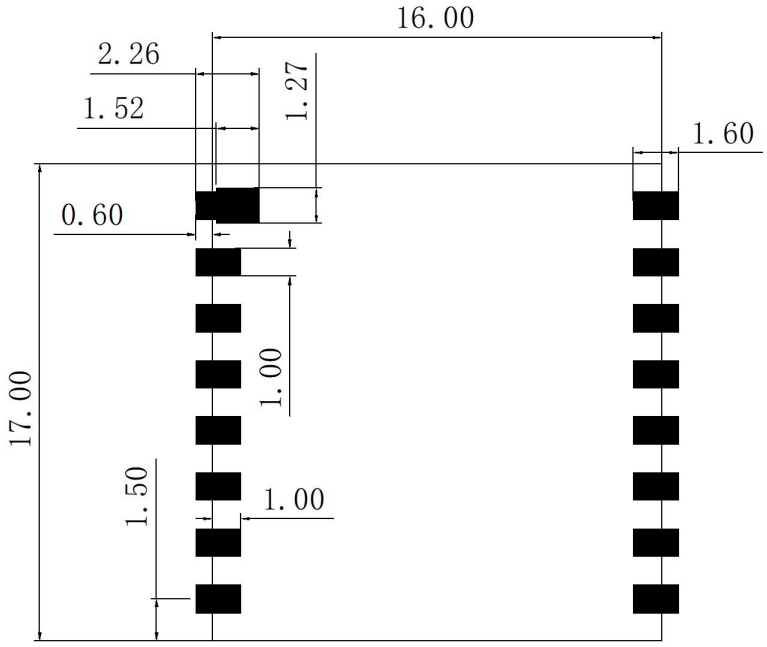

Figure 8 Recommended PCB Footprint Dimensions (Unit: mm)

6.3 Antenna Installation

(1) The antenna must be soldered for use with the Ra-01S. And the module is compatible with half-hole pads, round-hole pads, and IPEX connectors.

(2) To achieve optimal antenna performance, the antenna assembly should be kept away from any metal objects.

6.4 Power Supply

(1) A 3.3 V voltage is recommended, with a peak current of at least 200 mA.

(2) An LDO power supply is recommended; if using DC-DC, it is advised to control ripple within 30 mV.

(3) For the DC-DC power supply circuit, it is recommended to reserve space for a dynamic response capacitor, which can optimize output ripple under significant load variations.

(4) ESD protection components are recommended to be added to the 3.3 V power interface.

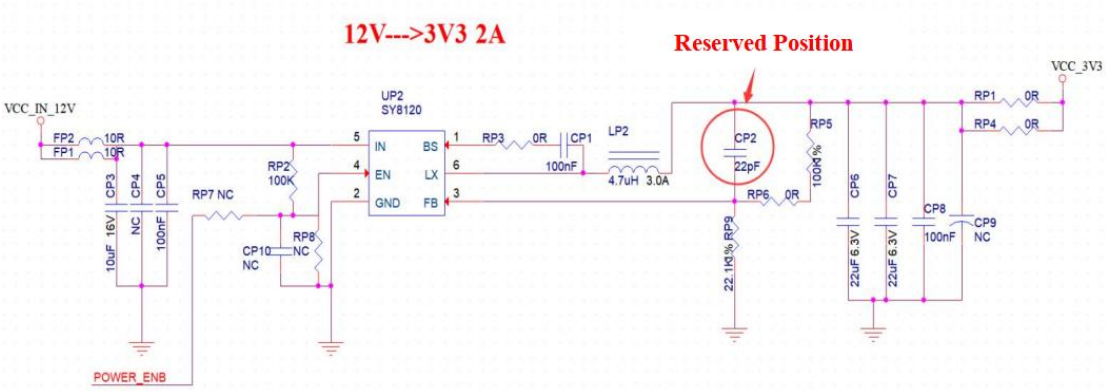

Figure 9 DC-DC Buck Circuit

6.5 GPIO

(1) Some I/O pins are exposed on the module periphery. To use these I/O pins, it is recommended to connect a 10–100 Ω resistor in series on each I/O pin. This helps suppress overshoot, stabilize signal levels, and benefits both EMI (Electromagnetic Interference) and ESD (Electrostatic Discharge) protection.

(2) The pull-up/pull-down configuration for specific I/O pins must follow the guidelines in the specification, as it affects the module's boot configuration.

(3) The module's I/O pins operate at 3.3 V. If the IO voltage level of the main controller and the module do not match, a level-shifting circuit must be added.

(4) If an I/O pin is directly connected to a peripheral interface or pin headers, it is recommended to reserve space for an ESD protection device near the connector on the IO trace.

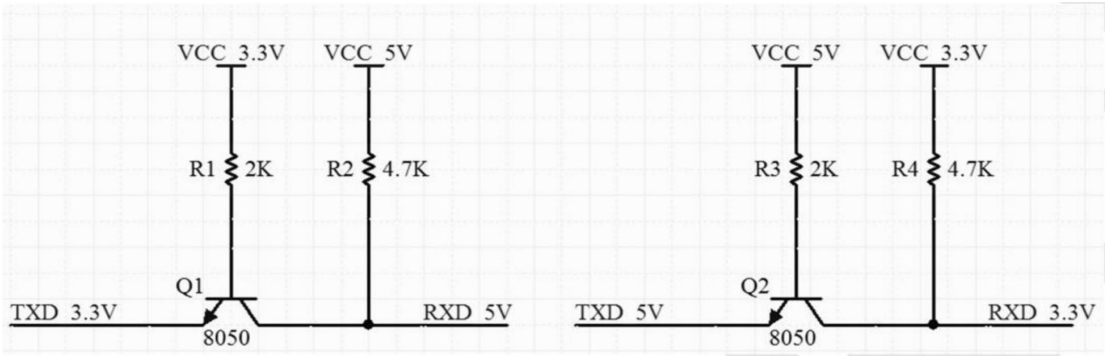

Figure 10 Level-shifting Circuit

6.6 Software Development

■ Differences Between LLCC68 and SX126x

(1) SX126x

- Supported spreading factors: SF5, SF6, SF7, SF8, SF9, SF10, SF11, and SF12
- Configurable spreading factors and receive bandwidth:

  LoRa@ Rx/Tx, BW = 7.8–500 kHz,

  SF5 to SF12, BR=0.018–62.5 Kb/s

(2) LLCC68

- Supported spreading factors: SF5, SF6, SF7, SF8, SF9, SF10, SF11
- Configurable spreading factors and receive bandwidth:

  LoRa@ Rx/Tx, BW = 125/250/500 kHz,

  LoRa@, SF=5/6/7/8/9 for BW=125 kHz,

  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) Communication distance will be attenuated accordingly when direct line-of-sight obstructions exist.

(2) Temperature, humidity, and co-channel interference will increase the packet loss rate.

(3) The ground absorbs and reflects radio waves, resulting in poor performance when testing near the ground.

(4) Seawater has a strong ability to absorb radio waves, resulting in poor performance in coastal testing.

(5) Metal objects near the antenna or placing it in a metal enclosure will cause severe signal attenuation.

(6) Incorrect power register settings or setting the over-the-air (OTA) data rate too high (higher OTA rates correspond to shorter transmission distances).

(7) Power supply voltage is below the recommended voltage at room temperature; the lower the voltage, the less the transmit power.

(8) The matching between the antenna and the module is poor, or there are quality issues with the antenna itself.

7.2 Module Usage Precautions

(1) Check the power supply to ensure the voltage is within the recommended range. Exceeding the maximum rating may cause permanent damage to the module.

(2) Check the stability of the power supply, ensuring that the voltage does not fluctuate significantly and frequently.

(3) Ensure electrostatic discharge (ESD) precautions are followed during installation and use, as high-frequency components are electrostatic sensitive.

(4) Ensure the humidity is not excessively high during installation and use, as some components are moisture-sensitive.

(5) Unless there are special requirements, it is not recommended to use the product at excessively high or low temperatures.

7.3 Factors Causing Interference to the Module

(1) Co-channel signal interference nearby. Move away from the interference source, or change the frequency/channel to avoid interference.

(2) Non-standard SPI clock waveform. Check for interference on the SPI lines, and ensure the SPI bus traces are not excessively long.

(3) Non-ideal power supply may also cause garbled data; ensure the power supply is highly reliable.

(4) Poor quality or excessively long extension cables/feeder lines can also result in a high bit error rate.

8 Storage Conditions

The product sealed in a moisture barrier bag should be stored in a non-condensing ambient environment of <40 ℃/90% RH.

The moisture sensitivity level (MSL) of the module is Level 3.

After opening the vacuum bag, the module must be used up within 168 hours at 25±5 ℃/60% RH. Otherwise, it needs to be baked before being put back into production.

9 Reflow Soldering Profile

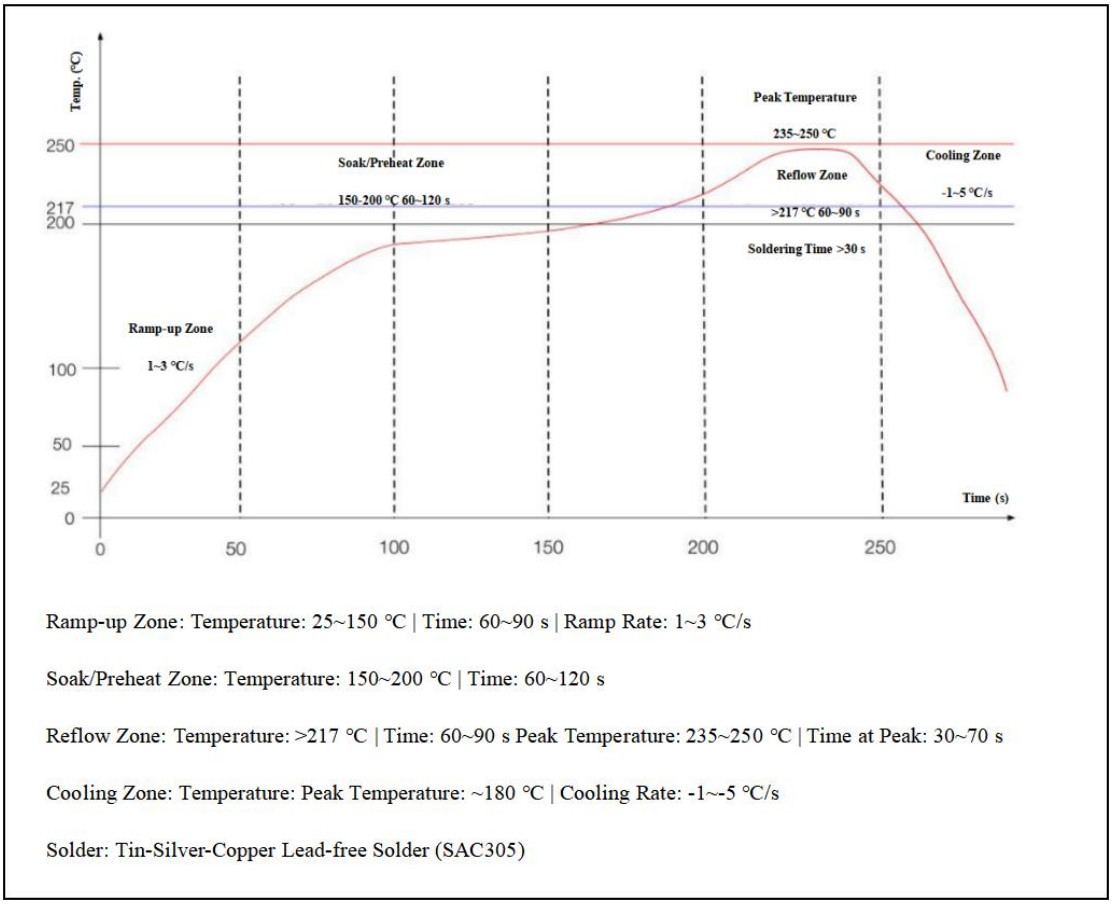

Figure 11 Reflow Soldering Profile

10 Packaging Information

As shown below, the Ra-01S module is packaged in tape and reel, with 800 pieces per reel.

Figure 11 Tape and Reel Packaging Diagram

11 Contact Information

Official Website Official Forum Development DOCS LinkedIn

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