Ra-03SCH Specification

Version V1.0.1

Copyright ©2025

Document Revision History

Version	Date	Description of Changes	Authored by	Approved by
V1.0.0	2023.07.10	First edition	Guan Ning	Xu Hong
V1.0.1	2025.09.03	1. Updated the tolerance in the dimension drawing; module appearance tolerance changed to ±0.2 mm; 2. Added power consumption data.	Guan Ning	Xu Hong

Contents

1. Product Overview

Ra-03SCH is a LoRa series module designed and developed by Shenzhen Ai-Thinker Technology Co., Ltd. The module is designed for ultra-long-range spread spectrum communication. Its RF chip, LLCC68, primarily utilizes the 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, LLCC68 features a high sensitivity of better than -129dBm and a transmit power of +22dBm, enabling long transmission range and high reliability. Furthermore, compared with conventional modulation techniques, LoRa™ modulation demonstrates significant advantages in blocking immunity and selectivity, addressing the challenges of balancing range, interference resistance, and power consumption that traditional design solutions cannot simultaneously achieve.

It can be widely used in automatic meter reading, home and building automation, security systems, remote irrigation systems, and other applications.

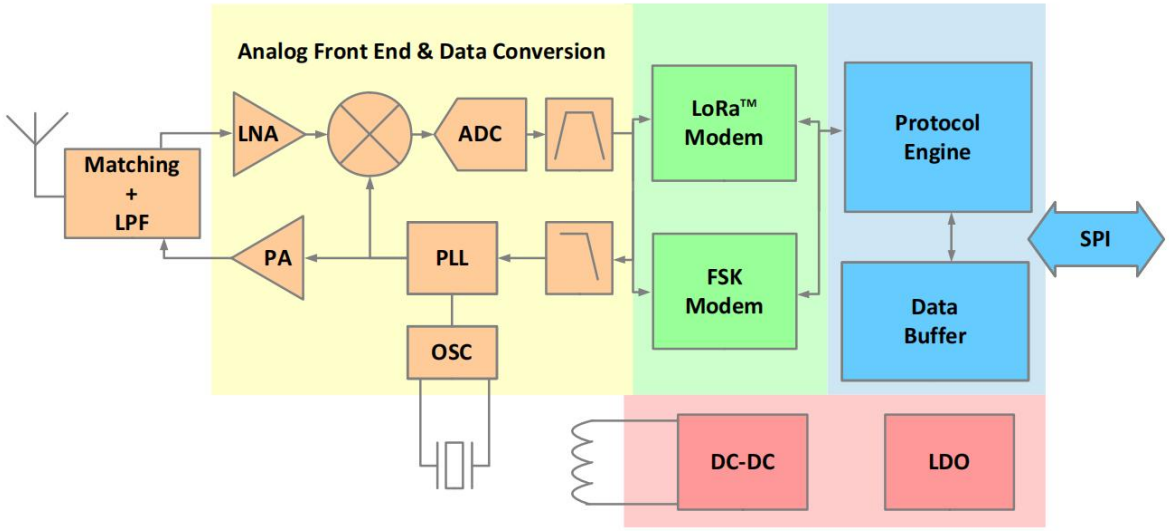


Figure 1 Main Chip Architecture Diagram

1.1. Features

- Supports FSK, GFSK, and LoRa® modulation modes
- Supports 803–930 MHz frequency band
- Operating voltage is 3.3V, and maximum output power of +22dBm, with operating current of 140mA

- Features low power consumption in receive mode, with receive current as low as 4.2mA and a standby current of 0.6mA
- High sensitivity down to -129dBm
- Supports spreading factors SF5 / SF6 / SF7 / SF8 / SF9 / SF10 / SF11
- Ultra-compact dimensions in a dual-row castellated (stamp hole) SMT package
- Adopts SPI interface, half-duplex communication, with CRC and a data packet engine supporting up to 256 bytes
- The antenna interface uses half-hole pads and can be routed to the mainboard for connection to an external antenna

2. Main Parameters

Table 1 Main Parameters Specification

Model	Ra-03SCH
Package	SMD-14
Dimensions	18.4*18.4*2.6 (mm)
Antenna Type	Half-hole pads
Frequency Range	803–930MHz
Operating Temperature	-40–85℃
Storage Conditions	-40–125℃, < 90% RH
Power Supply Range	Supply voltage: 2.7–3.6V, typical value: 3.3V，current > 200mA
Supported Interfaces	SPI
Programmable Bit Rate	Up to 300kbps

2.1. ESD Requirements

Ra-03SCH is an ESD-sensitive device and requires special precautions during handling.

Figure 2 ESD Protection Symbol

Note:

The Ra-03SCH module is an ESD-sensitive device and requires special ESD precautions. It should normally be handled as an ESD-sensitive component. Proper ESD handling and packaging procedures must be followed throughout the entire process of handling, transportation, and operation of any application involving the Ra-03SCH module. Do not touch the module directly with bare hands or solder it using a non-ESD-safe soldering iron, as this may damage the module.

2.2. Electrical Characteristics

Table 2 Electrical Characteristics

Parameter	Min	Typ	Max	Unit
Supply Voltage VCC	2.7	3.3	3.6	V
IO Output High Level (VOH)	0.9*VDDIO	-	VDDIO	V
IO Output Low Level (VOL)	0	-	0.1*VDDIO	V
IO Input High Level (VIH)	0.7*VDDIO	-	VDDIO+0.3	V
IO Input Low Level (VIL)	-0.3	-	0.3*VDDIO	V

Table 3 SPI Interface Characteristics

Symbol	Description	Condition	Min	Typ	Max	Unit
Fsck	SCK Frequency	-	-	-	10	MHz
tch	SCK High-level Tim	-	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
Fsck	SCK Frequency	-	-	-		ns

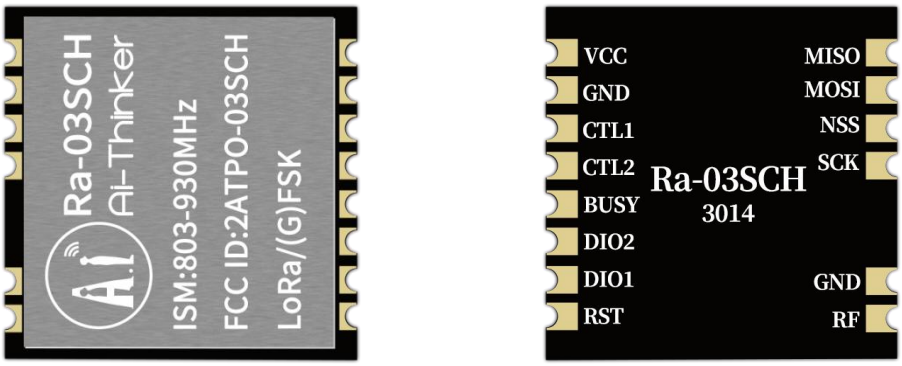
Table 4 Power Consumption

Mode	Min	Avg	Max	Unit
TX	-	122	-	mA
RX	-	9.6	-	mA
Deep Sleep	-	1.4	-	μA

3. Appearance and Dimensions

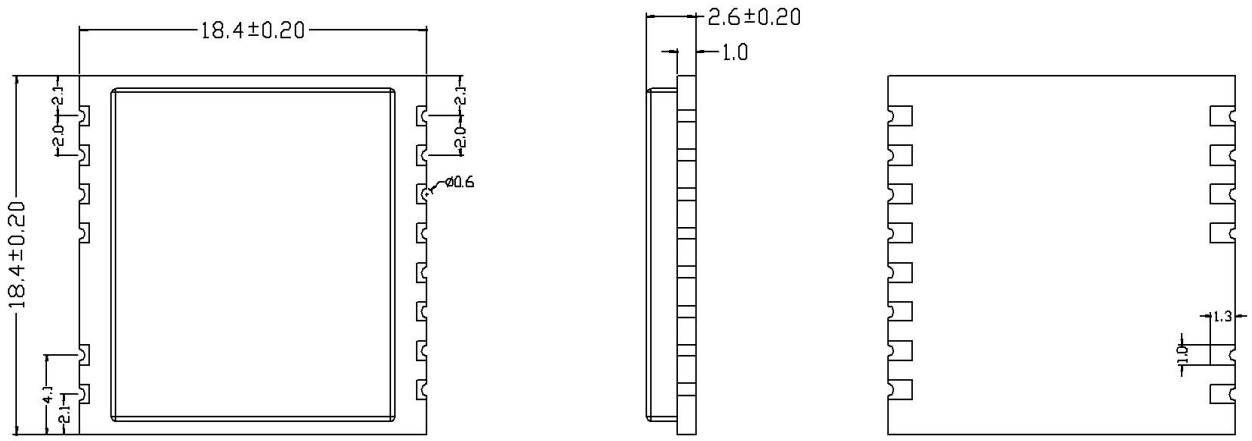
Figure 3 Appearance Diagram

(Rendering for reference only; actual product shall prevail)



Top View　　Bottom View

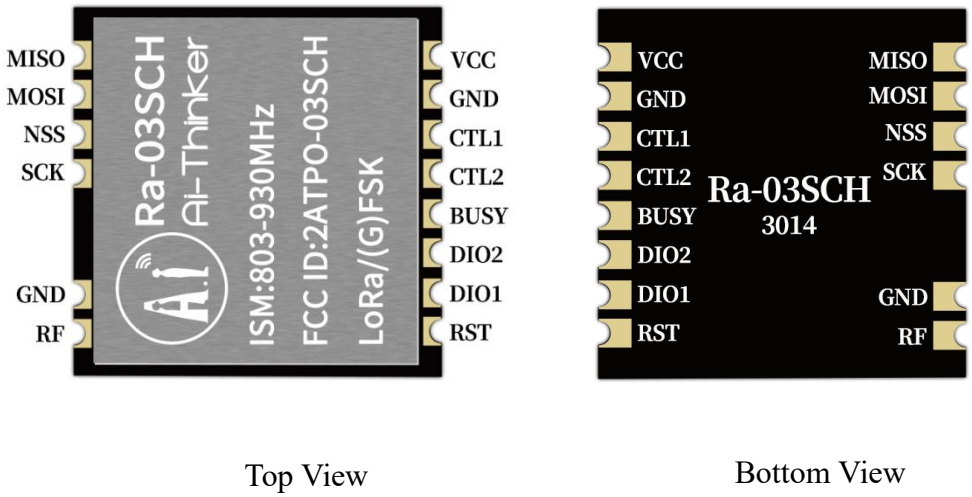
Figure 4 Dimension Diagram (Unit: mm)



Top View　　Side View　　Bottom View

4. Pin Definition

Ra-03SCHmodule exposes a total of 14 pins, as shown in the pin diagram. The pin function definition table provides the detailed interface specifications.



Top View Bottom View

Figure 5 Pin Diagram

Table 5 Pin Function Definition

No.	Name	Function Description
1	MISO	SPI data output
2	MOSI	SPI data input
3	NSS	SPI chip select input
4	SCK	SPI clock input
5	GND	Ground
6	RF	RF output
7	RST	Reset pin, active low
8	DIO1	Digital IO1 software configurable
9	DIO2	Digital IO2 software configurable
10	BUSY	Status indicator pin; must be connected to an IO pin of the host MCU
11	CTL2	RF switch control pin 2. TX: CTL1=0, CTL2=1; RX: CTL1=1, CTL2=0; Sleep: CTL1=0, CTL2=0
12	CTL1	RF switch control pin 1. TX: CTL1=0, CTL2=1; RX: CTL1=1, CTL2=0; Sleep: CTL1=0, CTL2=0
13	GND	Ground
14	VCC	3.3V power supply, typical

All general-purpose I/O pins of the LLCC68 are available in LoRa™ mode. Their function mapping is determined by the configuration of the RegDioMapping1 and RegDioMapping2 registers.

Table 6 I/O Function Mapping

Operating Mode	DIOx Mapping	DIO2	DIO1
All	00	Fhss Change Channel	RxRimeout
	01	Fhss Change Channel	Fhss Change Channel
	10	Fhss Change Channel	CadDetected
	11	-	-

5. Schematic Diagram

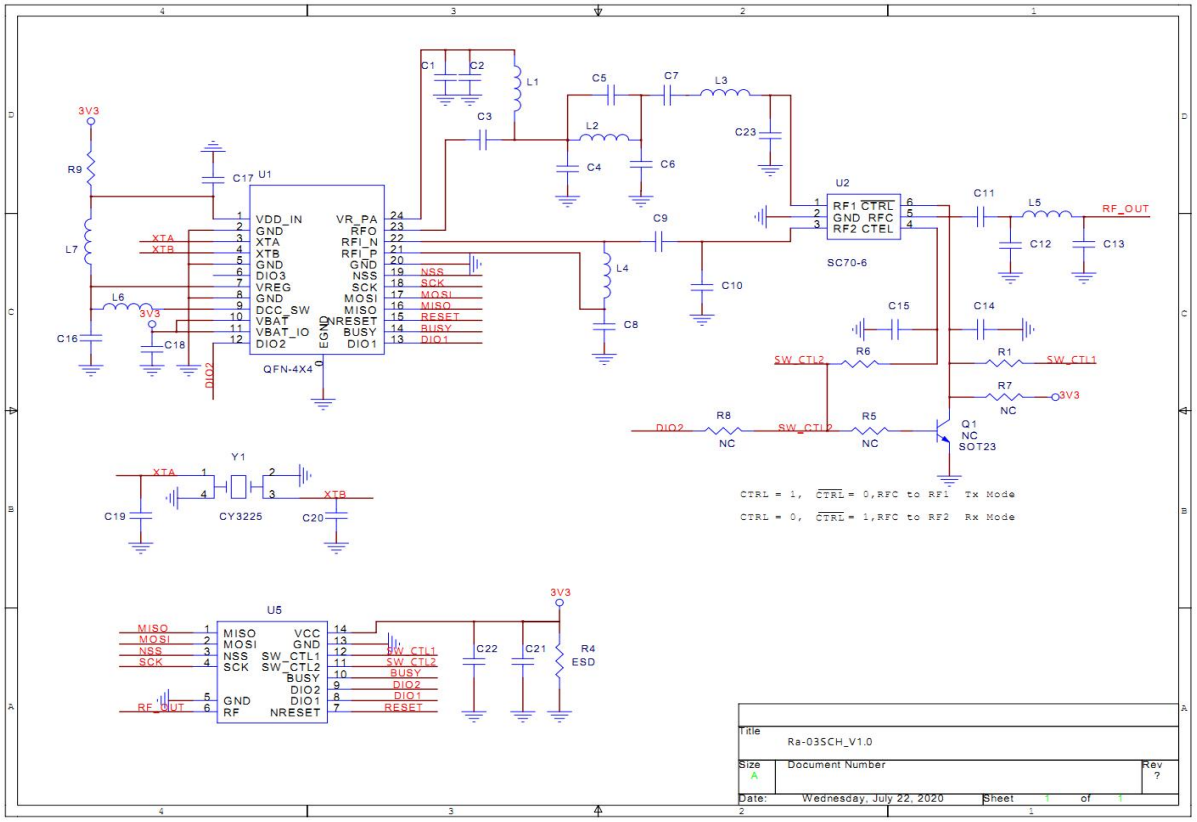


Figure 6 Schematic Diagram

6. Design Guide

6.1. Application Circuit

(1) Application Circuit 1

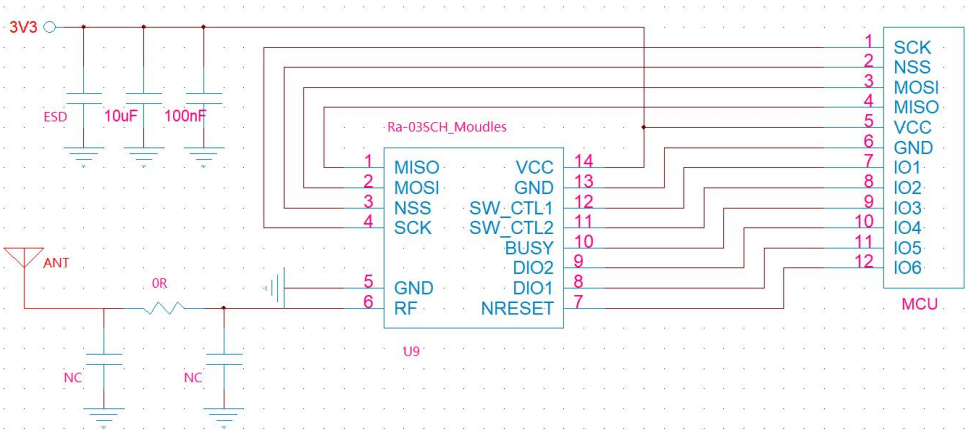


Figure 7 Application Circuit 1

■ In this circuit, the RF switch is completely controlled by the IO pins of the external MCU.

Table 7 RF Switch Truth Table

Mode	CTL1	CTL2
TX	0	1
RX	1	0

(2) Application Circuit 2

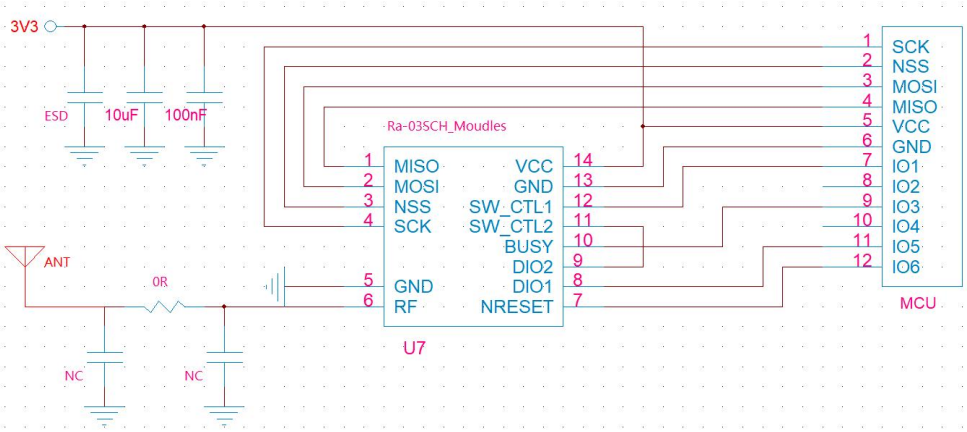


Figure 8 Application Circuit 2

- In this circuit, the RF switch is jointly controlled by the IO pins of the external MCU and DIO2 of the LLCC68. DIO2 must be mapped to the SetDIO2AsRfSwitchCtrl function.

Table 8 RF Switch Truth Table

Mode	CTL1
TX	0
RX	1

(3) Other Notes

- Besides the SPI interface, connect BUSY/DIO1 to the I/O pins of the host MCU.

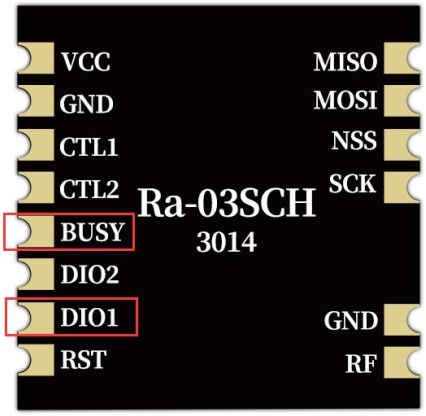


Figure 9 BUSY/DIO1 Application Notes

- The antenna is soldered on the mainboard. It is recommended to reserve a π-type matching circuit at the antenna interface.

6.2. Recommended PCB Footprint Dimensions

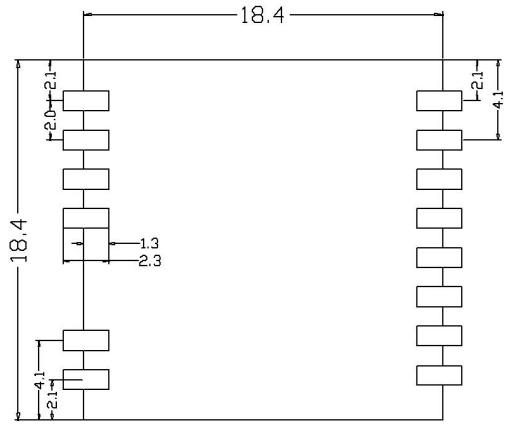


Figure 10 Recommended PCB Footprint Dimensions (Unit: mm)

6.3. Antenna Installation

- The Ra-03SCH requires an external antenna for operation. The module is equipped with half-hole pads can be routed to the mainboard.
- To achieve optimal antenna performance, the antenna assembly should be kept away from any metal objects.
- Antenna mounting structure has a significant impact on module performance. Make sure the antenna is exposed as much as possible and oriented vertically. If the module is installed inside the host enclosure, use a high-quality antenna extension cable to route the antenna outside the enclosure.
- The antenna must not be installed inside a metal enclosure, as this will greatly reduce the transmission range.

6.4. Power Supply

- A 3.3V voltage is recommended, with a peak current above 200mA.
- An LDO is recommended for power supply; if using DC-DC, the ripple should be controlled within 30mV.
- For the DC-DC power supply circuit, it is recommended to reserve space for dynamic response capacitors to optimize output ripple under large load transients.
- It is recommended to add ESD protection devices to the 3.3V power interface.
- For the power supply circuit designed for the module, it is recommended to keep at least 30% current margin to ensure stable and reliable long-term operation.
- Ensure correct polarity of the power supply. Reverse connection may cause permanent damage to the module.

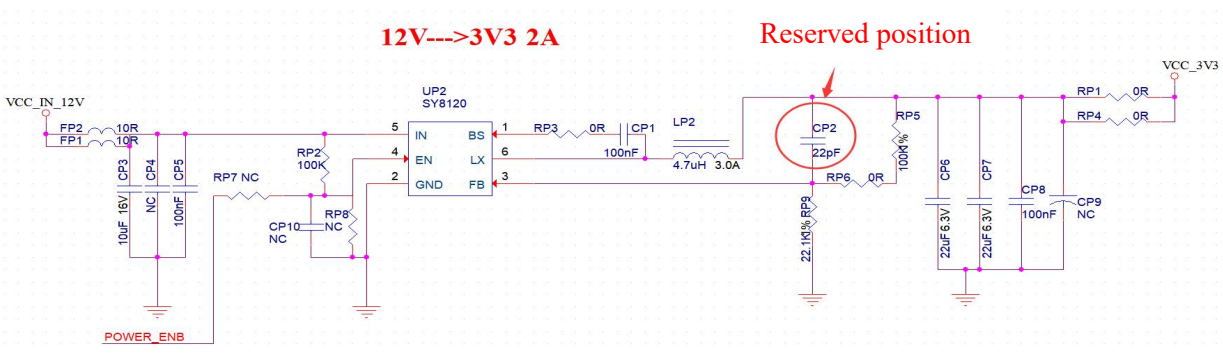


Figure 11 DC-DC Buck Circuit

6.5. GPIO Level Shifting

- Some I/O pins are exposed on the module periphery. To use these I/O pins, it is recommended to connect a 10-100Ω resistor in series with each I/O pin. This helps suppress overshoot, stabilize signal levels, and benefits both EMI and ESD protection.
- The pull-up or pull-down configuration for special I/O pins must follow the guidelines in the specification, as it affects the module's boot configuration.
- The module's I/O pins operate at 3.3V. If the IO voltage level of the main controller and the module do not match, a level-shifting circuit must be added.
- 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 I/O trace.

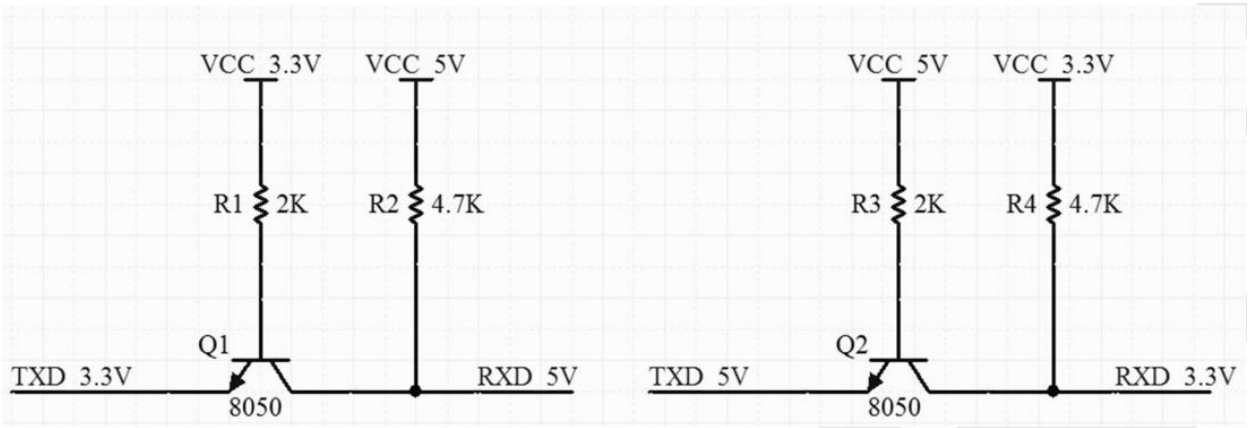


Figure 12 Level-shifting Circuit

6.6. Software Programming

- This module is a peripheral circuit based on LLCC68. Users may operate it fully according to the LLCC68 chip datasheet.
- DIO1/DIO2 are general-purpose I/O pins that can be configured for multiple functions.
- Among them, the TX/RX control of the RF switch can be controlled either by an external MCU alone, or jointly by the external MCU and LLCC68 DIO2.
- Differences Between LLCC68 and SX1262/SX1268:

(1) SX1262/SX1268

Supports spreading factors SF5, SF6, SF7, SF8, SF9, SF10, SF11, SF12;

SX1262/SX1268 configurable spreading factor and receiver bandwidth:

LoRa@Rx/Tx, BW = 7.8–500 kHz;

SF5 to SF12, BR = 0.018–62.5kbps.

(2) LLCC68

Supports spreading factors SF5, SF6, SF7, SF8, SF9, SF10, SF11;

LLCC68 configurable spreading factor and receiver bandwidth:

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

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

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

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

7. FAQ

7.1. Factors Affecting Transmission Range

- Communication range will be attenuated accordingly when direct line-of-sight obstructions exist.
- Temperature, humidity, and co-channel interference will increase the packet loss rate.
- The ground absorbs and reflects radio waves, resulting in poor performance when testing near the ground.
- Seawater has a strong ability to absorb radio waves, resulting in poor performance in coastal testing.
- Metal objects near the antenna or placing it in a metal enclosure will cause severe signal attenuation.
- Incorrect power register settings or setting the over-the-air (OTA) data rate too high (higher OTA rates correspond to shorter transmission ranges).
- Power supply voltage is below the recommended voltage at room temperature; the lower the voltage, the less the transmit power.
- The matching between the antenna and the module is poor, or there are quality issues with the antenna itself.

7.2. Module Usage Precautions

- Check the power supply to ensure the voltage is within the recommended range. Exceeding the maximum rating may cause permanent damage to the module.
- Check the stability of the power supply, ensuring that the voltage does not fluctuate significantly and frequently.
- Ensure electrostatic discharge (ESD) precautions are followed during installation and use, as high-frequency components are electrostatic sensitive.
- Ensure the humidity is not excessively high during installation and use, as some components are moisture-sensitive.
- 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

- Co-channel signal interference nearby. Move away from the interference source, or change the frequency/channel to avoid interference.
- Non-standard SPI clock waveform. Check for interference on the SPI lines, and ensure the SPI bus traces are not excessively long.
- Non-ideal power supply may also cause garbled data; ensure the power supply is highly reliable.
- Poor quality or excessively long extension cables/feeder lines can also result in a high bit error rate.

8. Storage Conditions

Products sealed in moisture barrier bags should be stored in a non-condensing atmosphere at <40℃ and < 90% RH.

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

The module must be used within 168 hours after vacuum bag removal under conditions of 25±5℃ and 60% RH. Otherwise, the module requires baking before being returned to production.

9. Reflow Soldering Profile

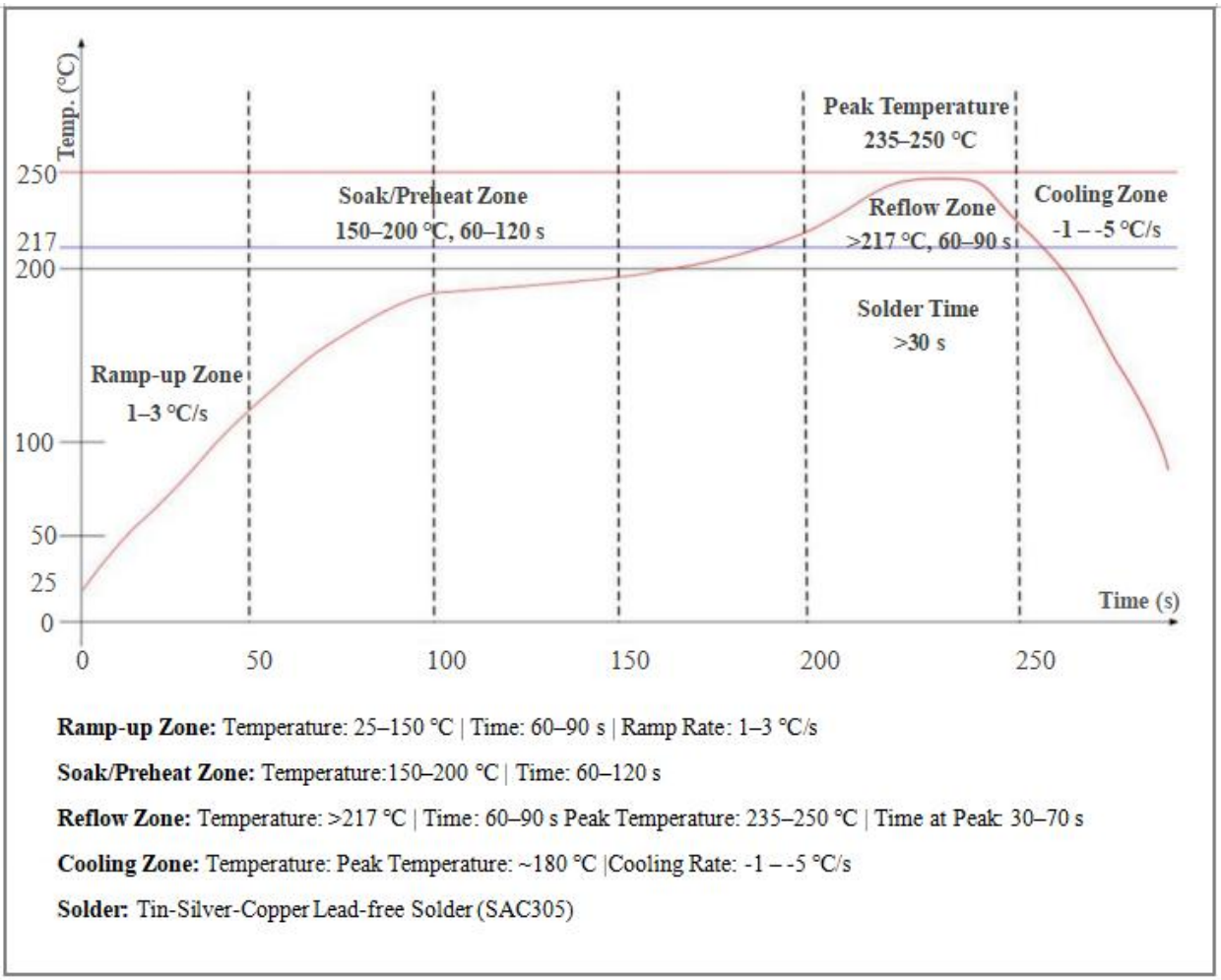


Figure 13 Reflow Soldering Profile

10. Packaging Information

As shown below, the Ra-03SCH module is packaged in tape and reel, with 800pcs/reel.

Figure 14 Tape and Reel Packaging Diagram

11. Contact Information

Official Website Official Forum Development DOCS LinkedIn

Tmall Store Taobao Store Alibaba Store

Technical Support: support@aithinker.com

Domestic Business Cooperation: sales@aithinker.com

Overseas Business Cooperation: overseas@aithinker.com

Company Address: Room 403, 408–410, Building C, Huafeng Smart Innovation Port, Gushu, Xixiang, Bao'an District, Shenzhen, Guangdong, China

Contact Hotline: 0755-29162996

WeChat Mini Program

WeChat Official Account

Disclaimer and Copyright Notice

The information in this document, including referenced URLs, is subject to change without notice.

The document is provided “as is” without warranty of any kind, express or implied, including but not limited to the warranties of merchantability, fitness for a particular purpose, or non-infringement. Furthermore, no warranty is given regarding proposals, specifications, or samples mentioned elsewhere. The publisher bears no responsibility, including for any infringement of patent rights arising from the use of information contained herein. This document does not grant, expressly or impliedly, by estoppel or otherwise, any license to intellectual property rights.

All test data presented herein are obtained from Ai-Thinker laboratories. Actual results may vary slightly.

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

Shenzhen Ai-Thinker Technology Co., Ltd. reserves the final right of interpretation of this document.

Notice

This manual may be updated due to product version upgrades or other reasons.

Shenzhen Ai-Thinker Technology Co., Ltd. reserves the right to modify the content of this manual without prior notice or announcement.

This manual is intended as a usage guide only. While Shenzhen Ai-Thinker Technology Co., Ltd. strives to provide accurate information, it does not guarantee that the content is entirely free of errors. All statements, information, and recommendations in this manual do not constitute any express or implied warranty.