Ra-03SCH Specification

Version V1.0.0

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Document resume

Version	Date	Develop/revise content	Edition	Approve
V1.0.0	2023.6.15	First Edition	Jiye Yang	Ning Guan

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Content

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1. Product overview

Ra-03SCH is a LoRa series module designed and developed by Ai-Thinker Technology. The module is used for ultra-long-range extended frequency communication, and its radio frequency chip LLCC68 mainly uses LoRa™ remote modem, which is used for ultra long range extended frequency communication. It has strong anti-interference resistance and can minimize current consumption. With the help of SEMTECH's LoRa™ patented modulation technology, the LLCC68 has high sensitivity over-129dBm, + 22dBm transmission power, long range transmission , and high reliability. At the same time, compared with the traditional modulation technology, LoRa™ modulation technology also has obvious advantages in anti-blocking and selection, which solves the problem that the traditional design scheme can not take into account the distance, anti-interference and power consumption simultaneously.

This module can be widely used in automatic meters reading, home building automation, security system, remote irrigation system, etc.

Figure 1 Main chip block diagram

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1.1. Characteristic

- LoRa® modulation mode
- Support frequency range 902.000066-927.900000MHz
- The operating voltage is 3.3V, the maximum output power is + 22dBm, and the maximum working current is 120mA
- The RX state has low power consumption characteristics, the lowest RX current is 4.2mA, and the standby current is 0.6mA
- High sensitivity: as low as-129dBm
- Support for the expansion factor SF5/SF6/SF7/SF8/SF9/SF10/SF11
- Small volume double-column stamp hole patch package
- The module adopts an SPI interface, half-duplex communication, and with CRC, a packet engine of up to 256 bytes

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2. Main parameters

Table 1 Description of the main parameters

Model	Ra-03SCH
Package	SMD-14
Size	18.4*18.4*2.4(±0.2)mm
Antenna	half-hole pad
Frequency range	902.000066-927.900000MHz
Operating temperature	-40℃ ~ 85℃
Storage temperature	-40℃ ~ 125℃, < 90%RH
Power supply	Power supply voltage is 2.7~3.6V, the typical value is 3.3V, and the current is greater than 200mA
Interface	SPI
Programmable bit rate	Up to300kbps

2.1. Static electricity requirement

Ra-03SCH is an electrostatic sensitive device. Therefore, you need to take special precautions when carrying it.

Figure 2 ESD preventive measures

Note：
The Ra-03SCH module is a static-sensitive device (ESD) that requires special ESD precautions and should usually be applied to ESD-sensitive components. The correct ESD processing and packaging procedures must be used throughout the entire processing, transportation, and operation of any application of the Ra-03SCH module. Do not touch the module by hand or use non-antistatic soliron to avoid damage to the module.

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2.2. Electrical characteristics

Table 2 Electrical characteristics table

Parameters	Min.	Typical value	Max.	Unit
Supply voltage VCC	2.7	3.3	3.6	V
IO Output High Level (VOH)	2.4	-	-	V
IO Output Low Level (VOL)	-	-	0.4V	V
IO Input High Level (VIH)	2.0	-	3.6	V
IO Input Low Level (VIL)	-0.3	-	0.8	V

Tble 3 SPI interface features

Name	Description	Conditions	Min.	Typical value	Max.	Unit
Fsck	SCK frequency	-	-	-	10	MH
tch	SCK high-level time	-	50	-	-	ns
tcl	SCK low-level time	-	50	-	-	ns
trise	SCK rise time	-	-	5	-	ns
tfall	SCK drop time	-	-	5	-	ns
tsetup	MOSI setting time	Change from MOSI to rising edge of SCK rising	30	-	-	ns
thold	MOSI maintenance time	From SCK rising edge to MOSI change	20	-	-	ns
tnsetup	NSS setting time	From NSS falling edge to SCK rising edge	30	-	-	ns
tnhold	NSS maintenance time	From SCK falling edge to NSS rising edge, normal mode	100	-	-	ns
tnhigh	The NSS high-level interval time for the spi access	-	20	-	-	ns
T_DATA	DATA Maintenance and the setting time	-	250	-	-	ns
Fsck	SCK frequency	-	-	-		ns

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3. Pin definition

Ra-03SCH module is connected with a total of 16 pins, as shown in the pin schematic diagram, pin function definition table is the interface definition.

Figure 5 Schematic diagram of module pins

Table 4 Pin function definition table

No.	Name	Function
1	MISO	SPI data output
2	MOSI	SPI data input
3	NSS	SPI selection input
4	SCK	SPI clock input
5	GND	Ground
6	RF	Connect antenna
7	RESET	Reset pin
8	DIO1	Digital IO1 software configuration
9	DIO2	Digital IO2 software configuration
10	BUSY	Status indicator pins, which must be connected to the IO port of the master 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

Back

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13	GND	Ground
14	VCC	Typical power supply value 3.3V

All 2 universal IO pins for LLCC68 are available in LoRa ™ mode. Their mapping relationship depends on the configuration of the two registers, RegDioMapping1 and RegDioMapping2.

Table 5 IO port functional table

Operation mode	DIOx mapping	DIO2	DIO1
All	00	Fhss Change Channel	RxRimeout
	01	Fhss Change Channel	Fhss Change Channel
	10	Fhss Change Channel	CadDetected
	11	-	-

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4. Design guidance

4.1. Installation of antenna

- The Ra-03SCH requires a welding antenna, and the module is have a half-hole pad.
- In order to achieve the optimal effect, the antenna assembly should be located far away from the metal parts.
- The antenna installation structure has a great impact on the performance of the module, so make sure that the antenna is exposed, preferably vertical upward. When the module is mounted inside the enclosure, a high-quality antenna extension line can be used to extend the antenna to the outside of the enclosure.
- The antenna must not be installed inside the metal shell, which greatly weakens the transmission distance.

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4.2. Power supply

- Recommended 3.3V voltage, peak current above 200mA.
- Suggest to use LDO for power supply; if use DC-DC recommend to control the ripple within 30mV.
- The DC-DC power supply circuit proposes to reserve the position of the dynamic response capacitor to optimize the output ripple when the load changes greatly.
- It is recommended to add ESD devices to the 3.3V power interface.
- When designing the power supply circuit for the module, it is recommended to reserve more than 30% of the power supply current, so that the whole machine can work stably for a long time;
- Please pay attention to the correct connection of the positive and negative poles of the power supply, such as reverse connection may cause permanent damage to the module;

4.3. GPIO level switch

- There are some IO ports on the periphery of the module. If you need to use it, it is recommended to connect a 10-100 ohm resistor in series with the IO port. This suppresses overshoot and makes the level on both sides smoother. Helps with both EMI and ESD.
- For the up-down and down-down of the special IO port, please refer to the instruction manual of the specification, which will affect the startup configuration of the module.
- The IO port of the module is 3.3V. If the level of the main control and the IO port of the module does not match, a level conversion circuit needs to be added.

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- If the IO port is directly connected to a peripheral interface, or a terminal such as a pin header, it is recommended to reserve an ESD device near the terminal of the IO port trace.

5. FAQ

5.1. Factors affecting transmission distance

- When there is a straight line communication obstacle, the communication distance will be attenuated accordingly:
- Temperature, humidity and co-channel interference will increase the communication packet loss rate;

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- The ground absorbs and reflects radio waves, and the test effect close to the ground is poor;
- Seawater has a strong ability to absorb radio waves, so the seaside test effect is poor.
- There are metal objects near the antenna, or placed in a metal shell, the signal attenuation will be very serious:
- The power register is set incorrectly, and the air rate is set too high (the higher the air rate, the closer the distance);
- The low voltage of the power supply at room temperature is lower than the recommended value, the lower the voltage, the lower the output power:
- The use of the antenna and the module has poor matching degree or the quality of the antenna itself.

5.2. Precautions for use of modules

- Check the power supply to ensure that it is between the recommended supply voltages, if exceeding the maximum value will cause permanent damage to the module.
- Check the stability of the power supply, the voltage should not fluctuate greatly and frequently.
- Ensure anti-static operation during installation and use, and electrostatic sensitivity of high-frequency components.
- Ensure that the humidity during installation and use should not be too high, and some components are humidity-sensitive devices.
- If there is no special requirement, it is not recommended to use it at too high or too low temperature.

5.3. Factors that interfere with the module

- There is co-frequency signal interference nearby, stay away from the interference source or modify the frequency and channel to avoid interference;
- The clock waveform on the SPI is not standard, check whether there is interference on the SPI line, and the SPI bus line should not be too long;
- Unsatisfactory power supply may also cause garbled characters, be sure to ensure the reliability of the power supply;
- Poor quality or too long extension lines and feeders will also cause a high bit error rate;

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6. Storage condition

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

The module's moisture sensitivity level MSL is level 3.

After the vacuum bag is unpacked, it must be used within 168 hours at 25±5℃/60%RH, otherwise, it will need to be baked before going online again.

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7. Product packaginginformation

Ra-03SCH module was packaged in a tape, 800pcs/reel. As shown in the below image:

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Figure 8 Package and packing diagram

8. Contact us

Ai-Thinker official website　　Office forum　　Develop DOCS

LinkedIn　　Tmall shop　　Taobao shop　　Alibaba shop

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WeChat mini program

WeChat official account

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FCC WARNING

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This device complies with Part 15 of the FCC Rules.

Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This device and its antenna(s) must not be co-located or operating in conjunction with any other antenna or transmitter.

15.105 Information to the user.

(b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

—Reorient or relocate the receiving antenna.

—Increase the separation between the equipment and receiver.

—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

—Consult the dealer or an experienced radio/TV technician for help.

This equipment complies with FCC radiation exposure limits set forth for an uncon- trolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body. Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.

This transmitter must not be co-located or operating in conjunction with any other

antenna or transmitter.

The availability of some specific channels and/or operational frequency bands are country dependent and are firmware programmed at the factory to match the intended destination.

The firmware setting is not accessible by the end user.

The final end product must be labelled in a visible area with the following: “Contains Transmitter Module “FCC ID: 2ATPO-RA03SCH”

Requirement per KDB996369 D03

2.2 List of applicable FCC rules

List the FCC rules that are applicable to the modular transmitter. These are the rules that specifically establish the bands of operation, the power,spurious emissions, and operating fundamental frequencies. DO NOT list compliance to unintentional-radiator rules (Part 15 Subpart B) since that is not a condition of a module grant that is extended to a host manufacturer. See alsoSection 2.10 below concerning the need to notify host manufacturers that further testing is required.3

Explanation: This module meets the requirements of FCC part 15C (15.247).it Specifically identified AC Power Line Conducted Emission, Radiated Spurious emissions, Band edge and RF Conducted Spurious Emissions, Conducted Peak Output Power, Bandwidth, Power Spectral Density, Antenna Requirement.

2.3 Summarize the specific operational use conditions

Describe use conditions that are applicable to the modular transmitter, including for example any limits on antennas, etc. For example, if point-to-point antennas are used that require reduction in power or compensation for cable loss, then this information must be in the instructions. If the use condition limitations extend to professional users, then instructions must state that this information also extends to the host manufacturer's instruction manual. In addition, certain information may also be needed, such as peak gain per frequency band and minimum gain, specifically for master devices in 5 GHz DFS bands.

Explanation: The product antenna uses an irreplaceable antenna with a gain of 0.94dBi

2.4Single Modular

If a modular transmitter is approved as a "Single Modular," then the module manufacturer is responsible for approving the host environment that the Single Modular is used with. The manufacturer of a Single Modular must describe, both in the filing and in the installation instructions, the alternative means that the Single Modular manufacturer uses to verify that the host meets the necessary requirements to satisfy the module limiting conditions. A Single Modular manufacturer has the flexibility to define its alternative method to address the conditions that limit the initial approval, such as: shielding, minimum signaling amplitude, buffered modulation/data inputs, or power supply regulation. The alternative method could include that the limited

module manufacturer reviews detailed test data or host designs prior to giving the host manufacturer approval.
This Single Modular procedure is also applicable for RF exposure evaluation when it is necessary to demonstrate compliance in a specific host. The module manufacturer must state how control of the product into which the modular transmitter will be installed will be maintained such that full compliance of the product is always ensured. For additional hosts other than the specific host originally granted with a limited
module, a Class II permissive change is required on the module grant to register the additional host as a specific host also approved with the module.
Explanation: The module is a single module.
2.5 Trace antenna designs
For a modular transmitter with trace antenna designs, see the guidance in Question 11 of KDB Publication 996369 D02 FAQ – Modules for Micro-Strip Antennas and traces. The integration information shall include for the TCB review the integration instructions for the following aspects: layout of trace design, parts list (BOM), antenna, connectors, and isolation requirements.

a) Information that includes permitted variances (e.g., trace boundary limits, thickness, length, width, shape(s), dielectric constant, and impedance as applicable for each type of antenna); b) Each design shall be considered a different type (e.g., antenna length in multiple(s) of frequency, the wavelength, and antenna shape (traces in phase) can affect antenna gain and must be considered); c) The parameters shall be provided in a manner permitting host manufacturers to design the printed circuit (PC) board layout; d) Appropriate parts by manufacturer and specifications; e) Test procedures for design verification; and f) Production test procedures for ensuring compliance

The module grantee shall provide a notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify the module grantee that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the grantee, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application
2.6 **RF exposure considerations**
It is essential for module grantees to clearly and explicitly state the RF exposure conditions that permit a host product manufacturer to use the module. Two types of instructions are required for RF exposure information: (1) to the host product manufacturer, to define the application conditions (mobile, portable – xx cm from a person’s body); and (2) additional text needed

for the host product manufacturer to provide to end users in their end-product manuals. If RF exposure statements and use conditions are not provided, then the host product manufacturer is required to take responsibility of the module through a change in FCC ID (new application).

Explanation: The module complies with FCC radiofrequency radiation exposure limits for uncontrolled environments. The device is installed and operated with a distance of more than 20 cm between the radiator and your body." This module follows FCC statement design,

FCC ID: 2ATPO-RA03SCH

2.7 Antennas

A list of antennas included in the application for certification must be provided in the instructions. For modular transmitters approved as limited modules, all applicable professional installer instructions must be included as part of the information to the host product manufacturer. The antenna list shall also identify the antenna types (monopole, PIFA, dipole, etc. (note that for example an “omni-directional antenna” is not considered to be a specific “antenna type”).

For situations where the host product manufacturer is responsible for an external connector, for example with an RF pin and antenna trace design, the integration instructions shall inform the installer that unique antenna connector must be used on the Part 15 authorized transmitters used in the host product.

The module manufacturers shall provide a list of acceptable unique connectors.

Explanation: The product antenna uses an irreplaceable antenna with a gain of 0.94dBi

2.8 **Label and compliance information**

Grantees are responsible for the continued compliance of their modules to the FCC rules. This

includes advising host product manufacturers that they need to provide a physical or e-label stating “Contains FCC ID” with their finished product. See Guidelines for Labeling and User Information for RF Devices – KDB Publication 784748.

Explanation: The host system using this module, should have label in a visible area indicated the following texts: "Contains

FCC ID: 2ATPO-RA03SCH

2.9 **Information on test modes and additional testing requirements5** Additional guidance for testing host products is given in KDB Publication 996369 D04 Module Integration Guide. Test modes should take into consideration different operational conditions for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product.

The grantee should provide information on how to configure test modes for host product evaluation for different operational conditions for a stand-alone modular transmitter in a host, versus with multiple, simultaneously transmitting modules or other transmitters in a host.

Grantees can increase the utility of their modular transmitters by providing special means, modes, or instructions that simulates or characterizes a connection by enabling a transmitter. This can greatly simplify a host manufacturer’s determination that a module as installed in a host complies with FCC requirements.

Explanation: Shenzhen Ai-Thinker Technology Co., Ltd can increase the utility of our modular transmitters by providing instructions that simulates or characterizes a connection by enabling a transmitter.

2.10 **Additional testing, Part 15 Subpart B disclaimer**

The grantee should include a statement that the modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product

as being Part 15
Subpart B compliant (when it also contains unintentional-radiator digital circuity), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

Explanation: The module without unintentional-radiator digital circuity, so the module does not require an evaluation by FCC Part 15 Subpart B. The host shoule be evaluated by the FCC Subpart B.