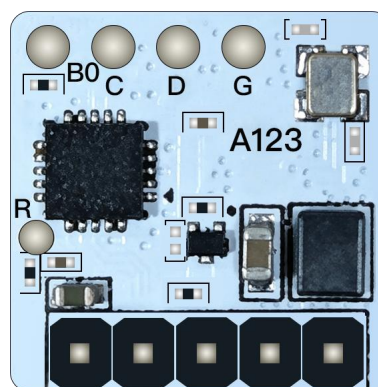
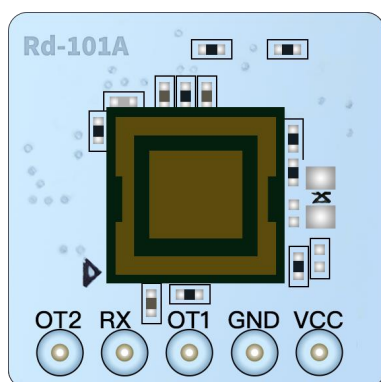


Rd-101A Specification



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1 Product Overview

Rd-101A is an ultra-compact radar module developed by Shenzhen Ai-Thinker Technology Co., Ltd. The module integrates simplified 24GHz sensor hardware and intelligent human presence sensing algorithm firmware, and can detect motion, micro-motion, stationary sitting, and stationary lying.

The Rd-101A module is equipped with the ICLegend Micro ICL111A chip, which features an integrated AiP antenna and a high-performance 24GHz 1T1R (1 Transmit 1 Receive) antenna. No external antenna design is required, making the module convenient and easy to use. The human presence sensing algorithm uses millimeter-wave sensor distance measurement technology and the advanced proprietary radar signal processing technology of ICLegend Micro to accurately detect motion, micro-motion, stationary sitting, and stationary lying. The intelligent human presence sensing algorithm firmware is mainly applied to indoor scenarios, sensing whether a moving, micro-moving or present human body exists within the sensing area and refreshing the detection result in real time.

The maximum sensing distance of the Rd-101A module for a moving human body is 6m. The sensing distance range, trigger and hold thresholds for different zones, and the no-person reporting time can be flexibly configured. The module supports GPIO and UART interfaces for plug-and-play use, and can be flexibly applied to different smart scenarios and terminal products. It also supports automatic generation of detection thresholds, reducing manual debugging, improving detection accuracy, simplifying the installation process and facilitating large-scale deployment.

Figure 1 shows the ICL111A main chip architecture.

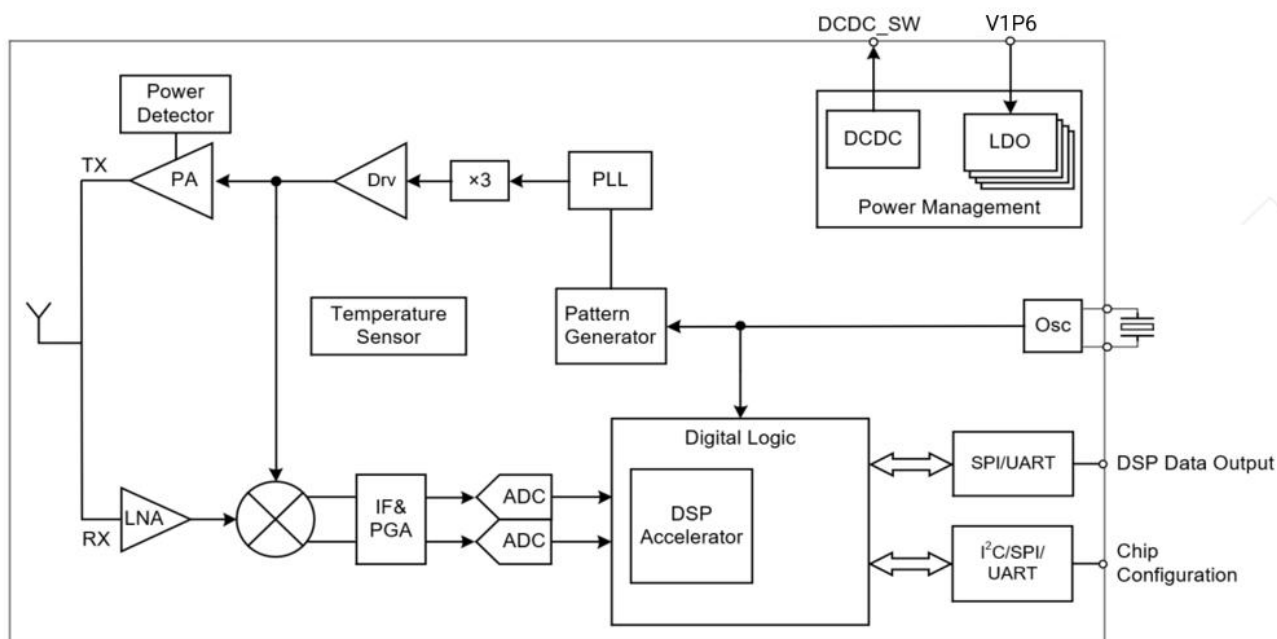


Figure 1 Main Chip Architecture

1.1 Features

RF Performance

- Single-chip intelligent AiP millimeter-wave sensor SoC with an integrated antenna and intelligent algorithms
- Frequency-band compliance: operates in 24GHz ISM band and is capable of obtaining FCC, CE and China SRRC spectrum regulatory certifications

Functional Features

- Multi-function detection: effectively detects human motion, micro-motion, and stationary presence, and reports detection results in real time
- Visual configuration: provides a visualization tool to flexibly configure detection-distance zones and target-disappearance delay, and supports automatic generation of detection thresholds
- Sensing range management: supports sensing range partitioning to effectively shield interference outside the zones
- Blind-spot-free detection: detects targets at distances as close as 0.2m
- Wide-angle coverage: detection angle up to $\pm 60^\circ$, broadly covering the monitored area
- Multiple installation methods: supports ceiling-mounted, wall-mounted and other methods
- Independent configuration: trigger and hold states can be configured independently, offering strong anti-interference capability
- Plug and play: UART communication with default human-presence sensing configuration loaded

Electrical Characteristics

- Supply voltage: 3.0 – 3.6V (Typical value: 3.3V)
- Average operating current: <40mA

Physical Characteristics

- Interface: Standard 1 × 5-pin header with 2.0mm pitch
- Ultra-compact dimensions: 12.0mm × 12.0mm
- Operating temperature: -40 – 85°C
- Storage conditions: -40 – 125°C, <90% RH

1.2 Application Scenarios

The Rd-101A module can detect human motion, micro-motion and stationary presence, and is suitable for a variety of AIoT application scenarios, mainly including:

- Smart Home

Senses human presence and distance, and reports detection results to the main control module for intelligent control of household appliances

- Smart Business

Identifies human approach or departure within a configured distance range, lights up the screen promptly, and keeps the device on when human presence is detected

- Smart Security

Suitable for access control systems, building intercoms, electronic peepholes, etc.

- Smart Lighting

Identifies and senses human presence with precise position detection, applicable to public-area lighting devices (sensor lights, globe lamps, etc.)

2 Key Specifications

Table 1 summarizes the main electrical and physical parameters of the Rd-101A module.

Table 1 Key Specifications

Model	Rd-101A
Package	DIP-5
Dimensions	12.0 × 12.0mm
Antenna Type	AiP antenna
Frequency Range	24GHz – 24.25GHz
Operating Temperature	-40°C – 85°C
Storage Conditions	-40°C – 125°C, <90% RH
Supply Range	Supply voltage: 3.0V – 3.6V, typical 3.3V; supply current ≥100mA
Supported Interfaces	UART/GPIO
Baud Rate	Default 115200bps
Available I/Os	1

3 Electrical Characteristics

3.1 Recommended Operating Conditions

Table 2 lists the recommended operating electrical parameters of the Rd-101A module. Operating outside these ranges may cause device damage.

Table 2 Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit
VCC	Supply Voltage	3.0	3.3	3.6	V
I	Supply Current	100	-	-	mA

3.2 I/O DC Electrical Characteristics

Table 3 lists the I/O DC characteristics of the Rd-101A module, mainly for the user to perform external interface level matching and GPIO circuit design.

Table 3 I/O DC Electrical Characteristics

Symbol	Parameter	Min	Typ	Max	Unit
VIH	High-level Input Voltage	$0.7 \times VCC$	-	-	V
VIL	Low-level Input Voltage	-	-	$0.2 \times VCC$	V
VOH	High-level Output Voltage	$VCC - 0.4$	-	-	V
VOL	Low-level Output Voltage	-	-	0.4	V
ZPU/D	Pull-up/Pull-down Resistors	30	50	70	kΩ

3.3 Electrostatic Discharge

Figure 2 shows the ESD protection diagram. The Rd-101A is an ESD-sensitive device and requires special precautions during handling.



Figure 2 ESD Protection Diagram

3.4 Radar Detection Range

Table 4 lists the detection ranges of the Rd-101A module. The data were measured in a laboratory environment; actual applications may be affected by factors such as the layout of the test site and the installation environment of the module in the complete device.

Table 4 Radar Detection Range

Installation Method	Human Target State	Min	Typ	Max	Unit
Wall-mounted	Moving	-	6	-	m
	Micro-moving	-	5	-	m
	Stationary Lying	-	5	-	m
Ceiling-mounted	Moving	-	4.5	-	m
	Micro-moving	-	4.5	-	m
	Stationary Lying	-	3.5	-	m

3.5 Power Consumption

Table 5 lists the power consumption data of the Rd-101A module in operating mode. The following power consumption data are measured under a 3.3V power supply and 25°C ambient temperature.

Table 5 Instantaneous Power Consumption

Mode	Min	Avg	Max	Unit
Operating state	-	40	-	mA

4 Mechanical Specifications

4.1 Module Dimensions

Figure 3 shows the outline dimensions of the Rd-101A module. Its outline dimensions ($L \times W$) are $12.0 \times 12.0\text{mm}$. The dimensional tolerance is $\pm 0.2\text{mm}$.

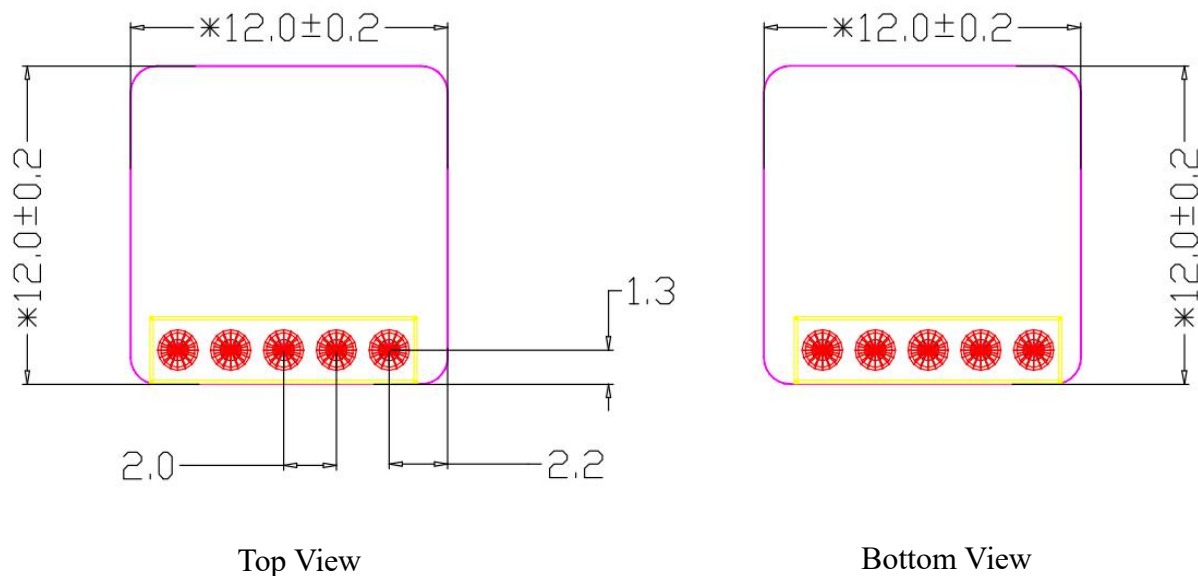


Figure 3 Module Dimensions (Unit: mm)

5 Pin Definition

Figure 4 shows the top and bottom views of the Rd-101A module's pin layout, with a total of 5 pins exposed.

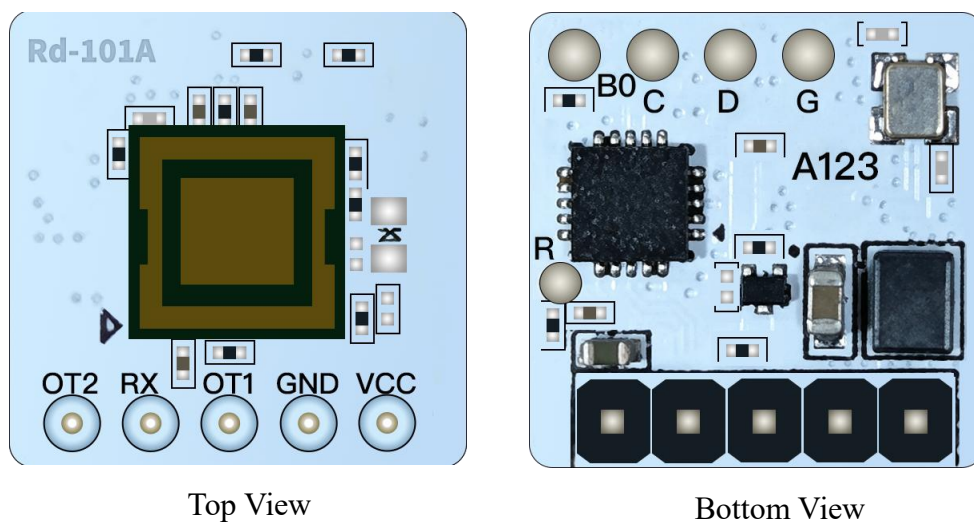


Figure 4 Pin Diagram

Table 6 defines the pin functions of the Rd-101A module, including pin number, pin name, and function description.

Table 6 Pin Function Definition

No.	Name	Function
1	OT2	Detection result output; outputs a high level when a human body is detected and a low level when no human body is detected
2	RX	UART_RX
3	OT1	UART_TX
4	GND	Ground
5	VCC	Power input

6 Schematic

Figure 5 shows the schematic of the Rd-101A module, integrating the RF chip, MCU, power supply, clock and reserved peripheral interfaces.

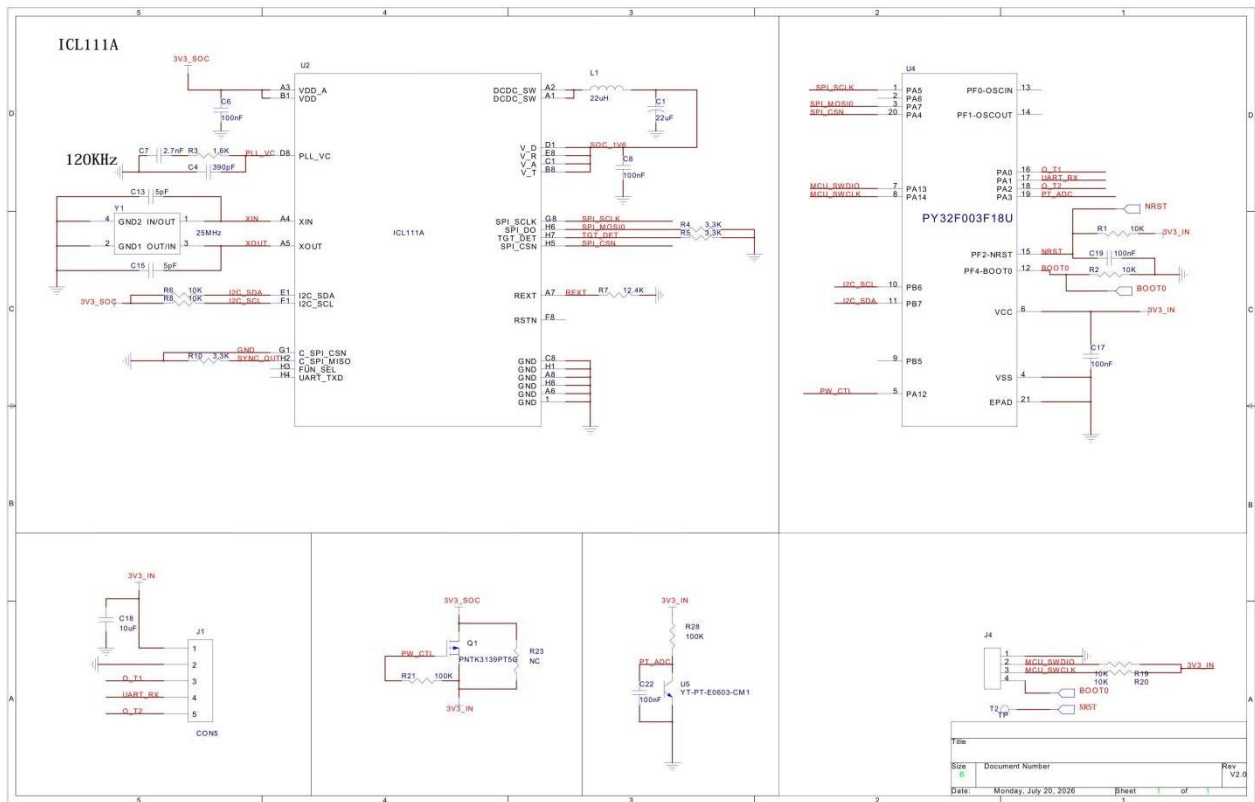


Figure 5 Schematic

7 Design Guide

7.1 Application Reference Circuit

Figure 6 shows the hardware application reference circuit of the Rd-101A module.

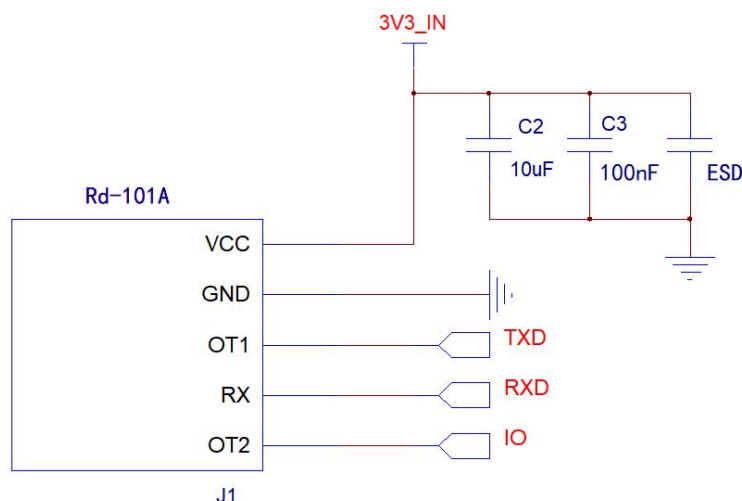


Figure 6 Application Reference Circuit

7.2 Radar Installation Precautions

- For the installation position on the mainboard, the following methods are recommended:
 - Ensure that the radar antenna faces the area to be detected and that the area around the antenna is open and free of obstructions.
 - Ensure that the radar is installed firmly and securely. Movement or vibration of the radar itself will affect detection performance.
 - Ensure that no objects move or vibrate behind the radar. Because radar waves are penetrable, the antenna's back lobe may detect moving objects behind the radar. A metal shield or metal backplate can be used to shield the radar back lobe and reduce the influence of objects behind the radar.
 - Due to differences in target size, state, RCS, and other characteristics, the target distance accuracy may fluctuate, and the maximum detection distance may also vary slightly.
 - When multiple 24GHz radars are present, do not point their beams directly toward one another. Install them as far apart as possible to avoid potential mutual interference.
- To ensure antenna performance, metal objects must not be placed near the antenna, and the antenna should be kept away from high-frequency devices.
- The power input voltage range is 3.0 – 3.6V, and the power ripple should have no obvious frequency peak below 100kHz. The user must consider corresponding EMC designs such as ESD and lightning surge protection.

7.3 Installation Environment Requirements

This product must be installed in a suitable environment. Detection performance may be affected when the product is used in the following environments:

- Continuously moving non-human objects exist within the sensing area, such as animals, continuously swinging curtains, or large plants directly facing an air outlet.
- Large-area, strongly reflective objects exist within the sensing area. The strongly reflective objects facing the radar antenna may cause interference.
- For wall-mounted installation, external interference sources such as indoor ceiling-mounted air conditioners and electric fans must be considered.

7.4 Installation Method and Detection Range

- Figures 7 and 8 show the ceiling-mounted installation method.

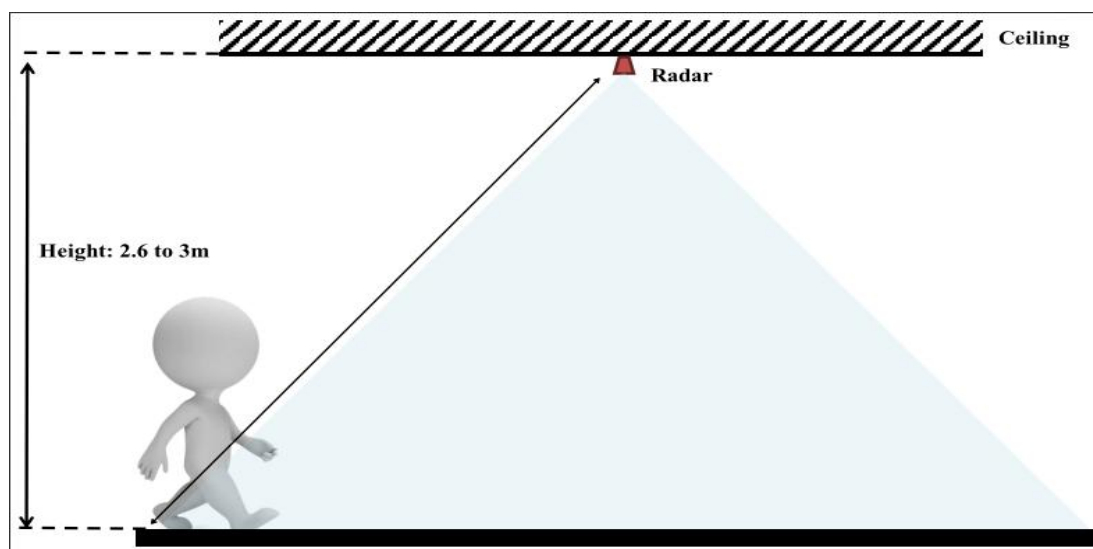


Figure 7 Ceiling-Mounted Installation Diagram

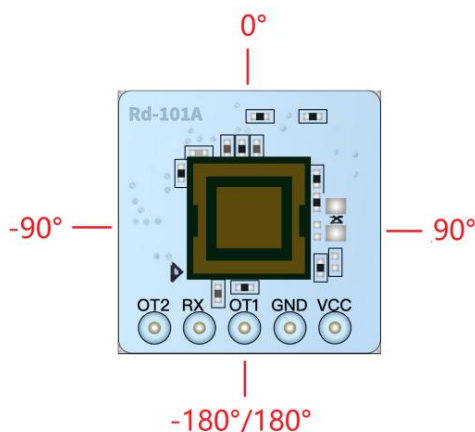


Figure 8 Ceiling-Mounted Orientation Diagram

- Figures 9 and 10 show the wall-mounted installation method.

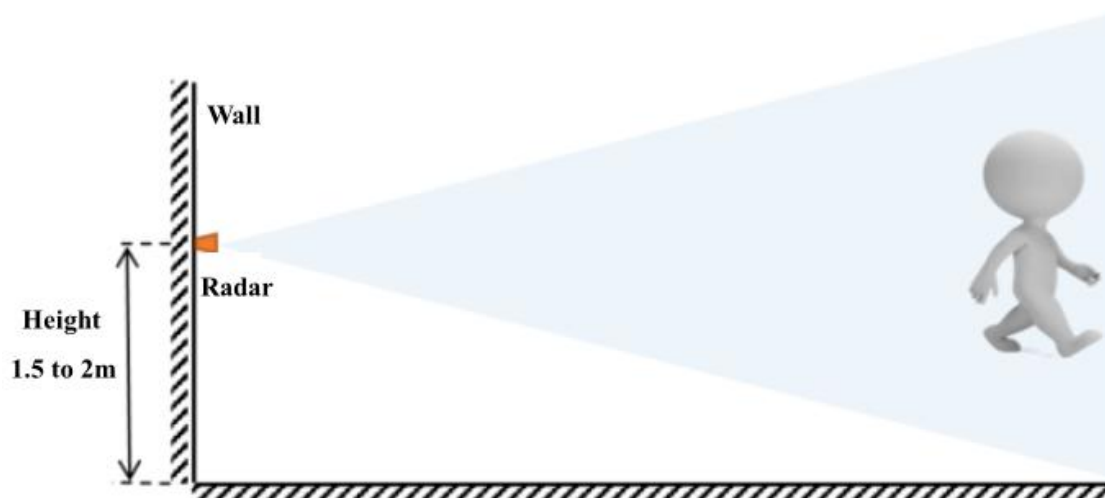


Figure 9 Wall-Mounted Installation Diagram

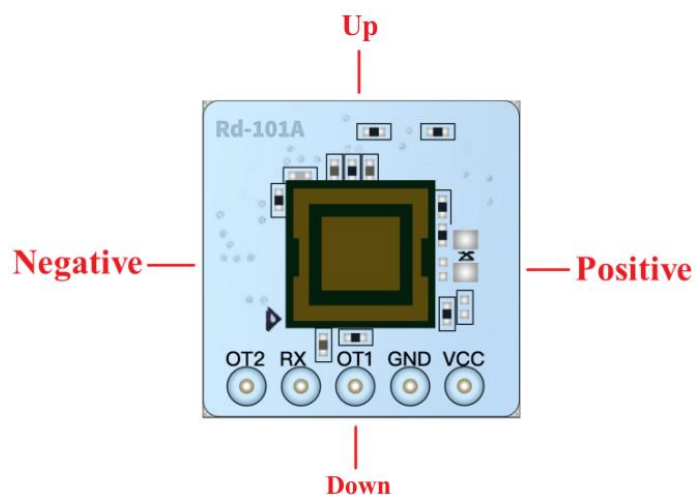


Figure 10 Wall-Mounted Orientation Diagram

Figure 11 shows a DC-DC buck power supply circuit converting 12V to 3.3V, with a maximum output current of 2A.

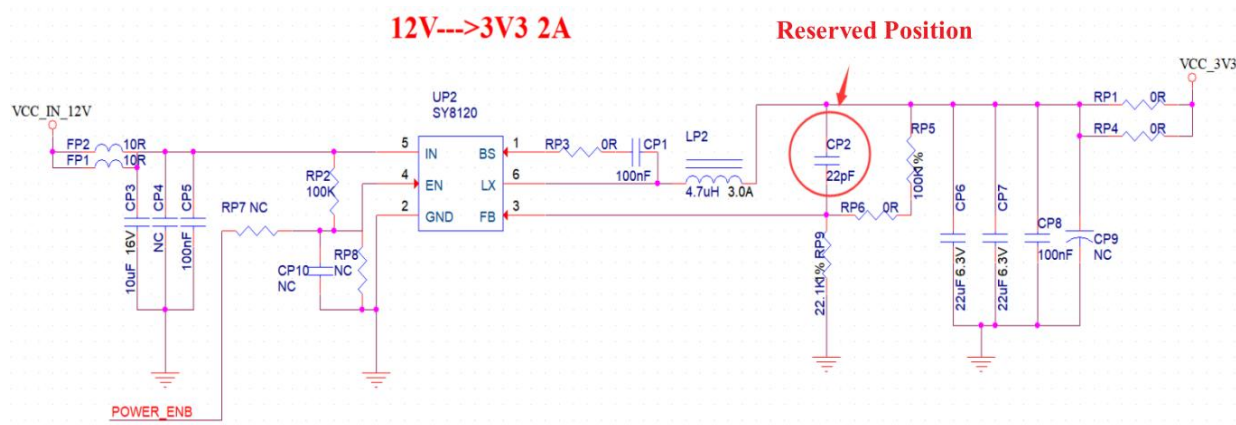


Figure 11 DC-DC Buck Circuit

Notes on the DC-DC Buck Circuit:

- The recommended VCC voltage is 3.3V, with a current above 100mA.
- 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 power interface.

7.6 GPIO

Figure 12 shows a 3.3V and 5V bidirectional UART level-shifting circuit, which supports bidirectional serial communication across different voltage levels.

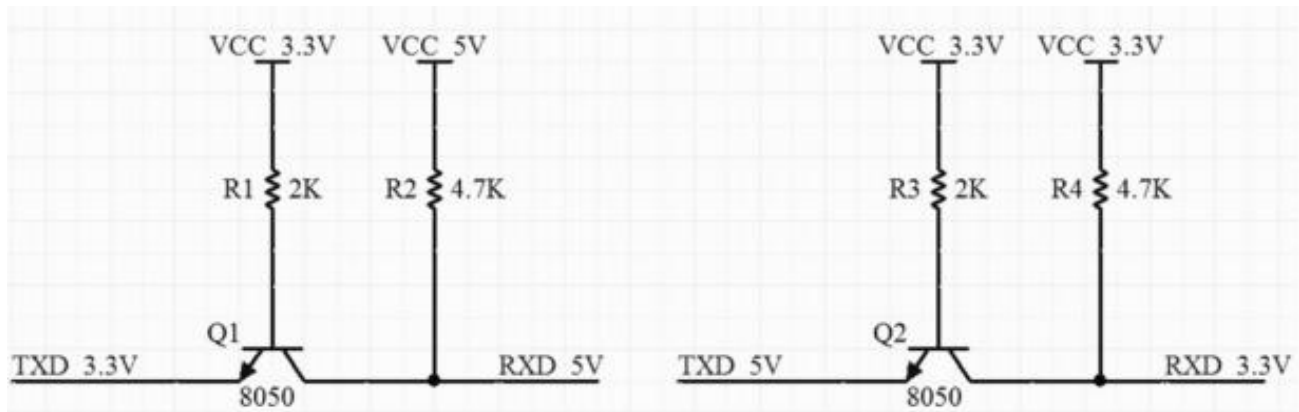


Figure 12 Level-Shifting Circuit

Notes on the Level-Shifting Circuit:

- Some I/O pins are brought out from the module. 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 refer to the instructions in the specification, as it affects the module boot configuration.
- The module I/O pins level is 3.3V. If the host controller I/O voltage level does not match the module, a level-shifting circuit should 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.

8 Storage Conditions

Products sealed in moisture barrier bags should be stored in a non-condensing atmosphere at $<40^{\circ}\text{C}$ 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 $25\pm 5^{\circ}\text{C}$ and 60% RH. Otherwise, the module requires baking before being returned to production.

9 Reflow Soldering Profile

Figure 13 shows the module reflow soldering process profile. The process is divided into four stages: ramp-up zone, preheat/soak zone, reflow soldering zone and cooling zone.

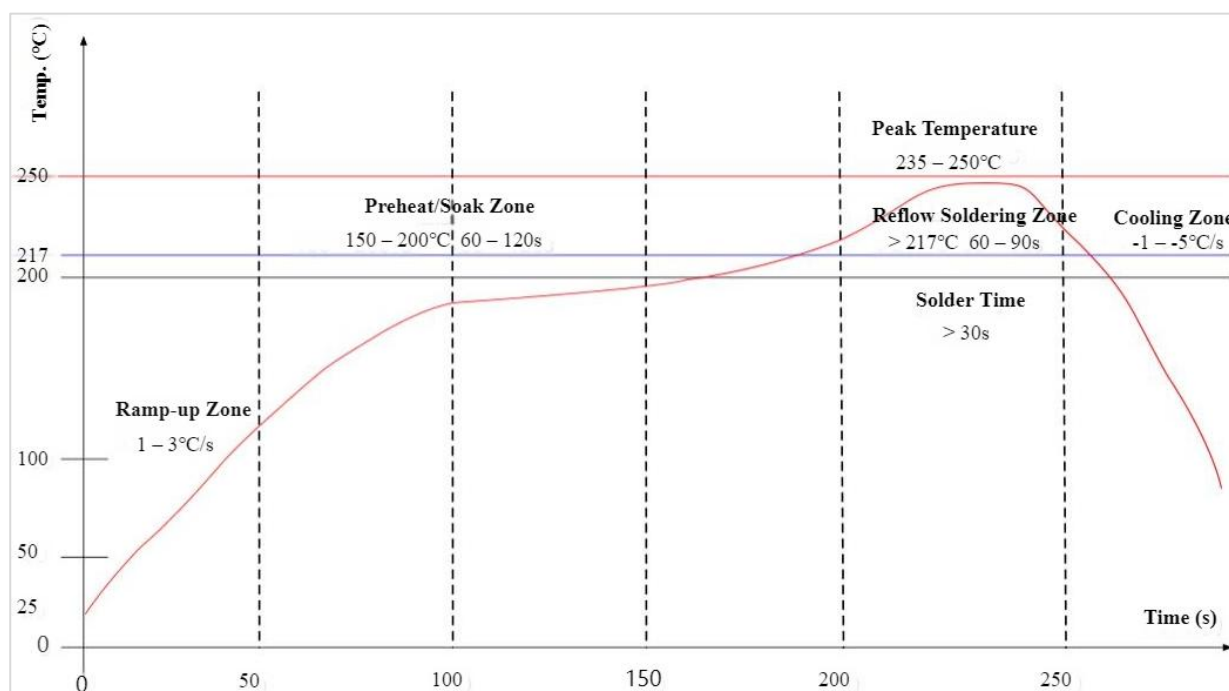


Figure 13 Reflow Soldering Profile

Reflow Soldering Profile Description:

- Ramp-up zone – Temperature: $25 - 150^{\circ}\text{C}$, Time: 60 – 90s, Ramp rate: $1 - 3^{\circ}\text{C/s}$
- Preheat/soak zone – Temperature: $150 - 200^{\circ}\text{C}$, Time: 60 – 120s
- Reflow soldering zone – Temperature: $> 217^{\circ}\text{C}$, Time: 60 – 90s, Peak temperature: $235 - 250^{\circ}\text{C}$, Time: 30 – 70s
- Cooling zone – Temperature: peak temperature to 180°C , Cooling rate: $-1 - -5^{\circ}\text{C/s}$
- Solder – Sn-Ag-Cu lead-free solder alloy (SAC305)

10 Packaging Information

Figure 14 shows the packaging of the Rd-101A module. The module is packed in tape-and-reel, 350 pcs/reel.



Figure 14 Tape and Reel Packaging Diagram

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[Technical Support: support@aithinker.com](mailto:support@aithinker.com)

[Domestic Business Cooperation: sales@aithinker.com](mailto:sales@aithinker.com)

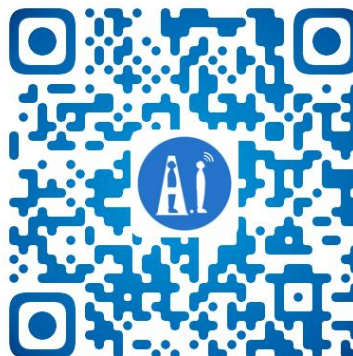
[Overseas Business Cooperation: overseas@aithinker.com](mailto:overseas@aithinker.com)

Company Address: Room 403–405, 408–410, Building C, Huafeng Smart Innovation Port, Gushu, Xixiang, Bao'an District, Shenzhen, Guangdong, China

Contact Hotline: 0755-29162996



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