



Rd-03E Specification

Version V1.0.1

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Document Revision History

Version	Date	Created / Revised Content	Prepared by	Approved by
V1.0.0	2023-08-31	First edition	Dong Pengfei	Guan Ning
V1.0.1	2025-11-24	Updated module dimension information; added recommended footprint diagram	Guan Ning	Xu Hong

Contents

1. Product Overview	4
1.1. Features	5
2. Key Specifications	6
2.1. Electrostatic Requirements	6
2.2. Electrical Characteristics	6
2.3. Radar Detection Range	7
2.4. Power Consumption	7
3. Appearance and Dimensions	8
4. Pin Definition	9
5. Schematic Diagram	10
6. Design Guide	11
6.1. Application Reference Circuit	11
6.2. Recommended PCB Footprint Dimensions	11
7. Radar Installation Precautions	11
7.1. Installation Environment Requirements	12
7.2. Installation Method and Detection Range	13
7.3. Power Supply	16
7.4. GPIO	16
8. Storage Conditions	17
9. Reflow Soldering Profile	17
10. Packaging Information	18
11. Contact Us	18
Disclaimer and Copyright Notice	19
Notice	19
Important Statement	20

1. Product Overview

The Rd-03E is a radar module developed by Shenzhen Ai-Thinker Technology Co., Ltd., equipped with the S3KM111L chip from ICLegend Micro. The S3KM111L is an integrated single-chip single-waveform sensor SoC based on FMCW radar technology. It operates in the 24GHz K-band and provides a modulation bandwidth of up to 1GHz per chirp. The module adopts the FMCW waveform and the proprietary advanced signal processing technology of the S3 series chip. Combined with the MCU's proprietary radar signal processing and built-in intelligent presence sensing algorithms, it can realize precise human presence ranging and gesture recognition. Developers can use the host PC tool to display distance and gesture information in real time.

The Rd-03E module can detect and identify moving and micro-moving people and report real-time distance. It can detect targets and gestures within a specified area and report results in real time. The module is widely used in various AIoT scenarios and features strong real-time performance, high ranging accuracy, a wide ranging range, and flexible algorithm-parameter configuration.

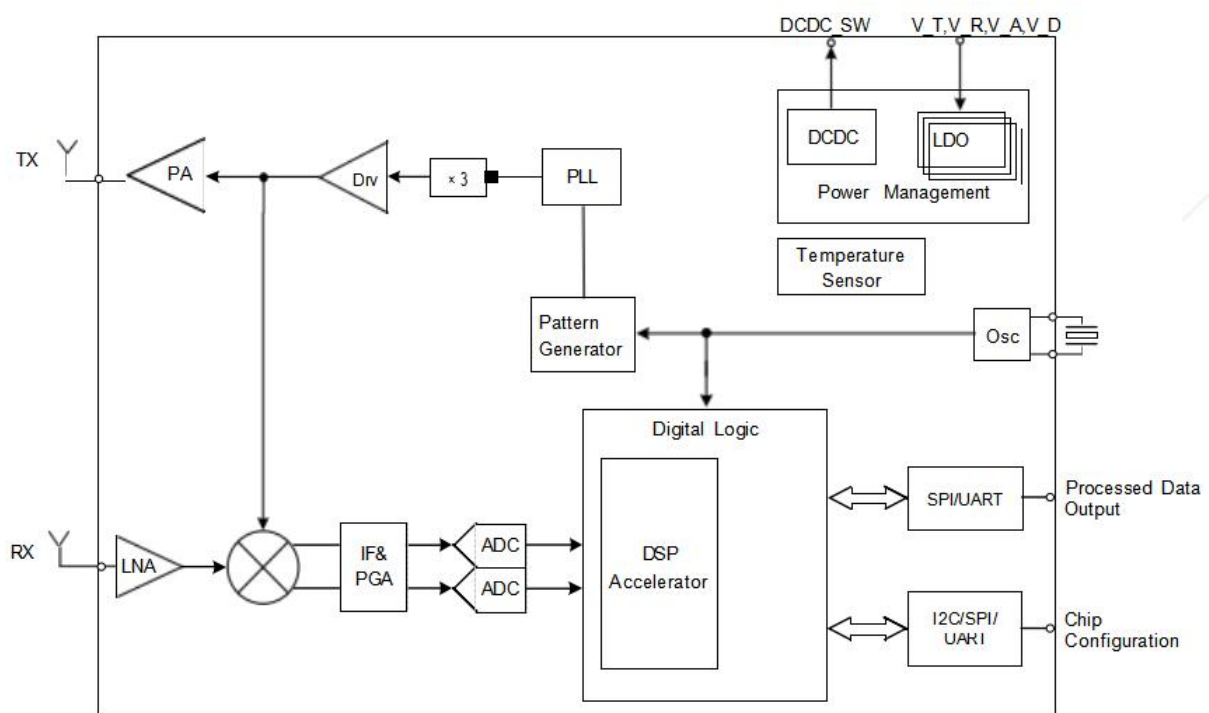


Figure 1 S3KM111L Chip Architecture Diagram

1.1. Features

- Adopts DIP package with standard 2.54mm pin headers
- Radar supports 24 GHz ISM band
- Accurate detection of indoor and outdoor human motion, micro-motion, distance and gestures
- Radar antenna supports 1T1R; narrow beam, high resolution, wide bandwidth, and strong interference immunity
- Provides visualization tools for configuring the detection distance range and setting the sensitivity based on distance
- Maximum sensing distance for moving people: 6m; for micro-moving people: 3.5m
- High-precision ranging: 30cm – 350cm ± 5 cm; 350cm – 600cm $\pm 5\%$
- Accurate ranging; detection coverage of human-presence: azimuth $\pm 20^\circ$, elevation $\pm 45^\circ$
- Detection coverage of gesture recognition: azimuth $\pm 20^\circ$, elevation $\pm 40^\circ$
- Automatically loads the default configuration; plug and play
- Supports UART, allowing intelligent radar parameter adjustment through the serial port, offering convenience and efficiency
- Single 5V power supply
- Wall-mounted installation
- Typical application scenarios
 - ✓ Smart appliances
 - ✓ Smart commerce
 - ✓ Smart security
 - ✓ Smart lighting

2. Key Specifications

Table 1 Key Specifications

Model	Rd-03E
Package	DIP-5
Dimensions	28.0 * 24.0 (mm)
Antenna Type	Onboard antenna
Frequency Range	24GHz – 24.25GHz
Operating Temperature	-40°C – 85°C
Storage Conditions	-40°C – 125°C, < 90% RH
Power Supply	Supply voltage 5V; supply current $\geq 200\text{mA}$
Supported Interfaces	UART
Baud Rate	256000bps by default

2.1. Electrostatic Requirements

Rd-03E is an ESD-sensitive device and requires special precautions during handling.



Figure 2 ESD Protection Diagram

2.2. Electrical Characteristics

Table 2 Electrical Characteristics

Parameter		Condition	Min	Typ	Max	Unit
Supply Voltage		VDD	-	5	-	V
I/O	VIL	-	0	-	1.4	V
	VIH	-	1.9	-	VDD	V
	VOL	-	0	-	0.1	V
	VOH	-	2.8	-	VDD	V

2.3. Radar Detection Range

Table 3 Radar Detection Range

Installation Method	Min	Typ	Max	Unit
Wall-mounted ($\pm 20^\circ$), precise ranging	-	6	-	m
Tilted (45°)	-	2.2	-	m

Note:

- The detection ranges above were measured by Ai-Thinker in an open test area and are provided for reference only.
- Radar detection range is significantly affected by surrounding walls, ceilings, large objects, installation method, and other factors. Actual measured results in the intended installation environment shall prevail.

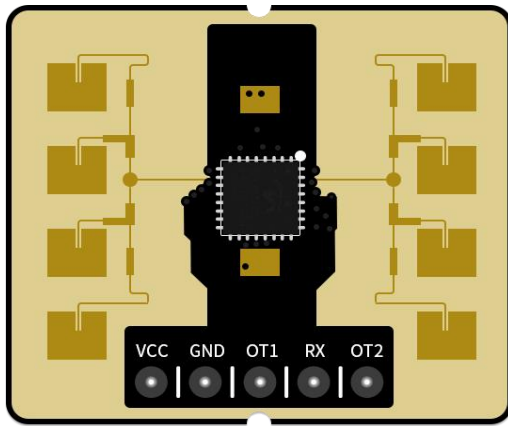
2.4. Power Consumption

The following power consumption data are measured based on a 5V power supply at an ambient temperature of 25°C.

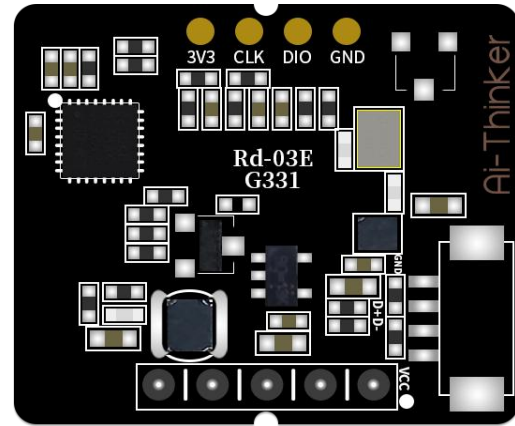
Table 4 Power Consumption

Mode	Min	Avg	Max	Unit
Radar sensing state	-	44	-	mA

3. Appearance and Dimensions



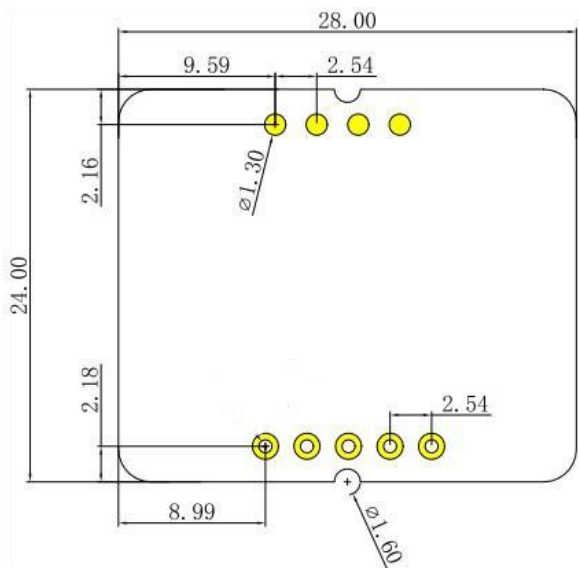
Top View



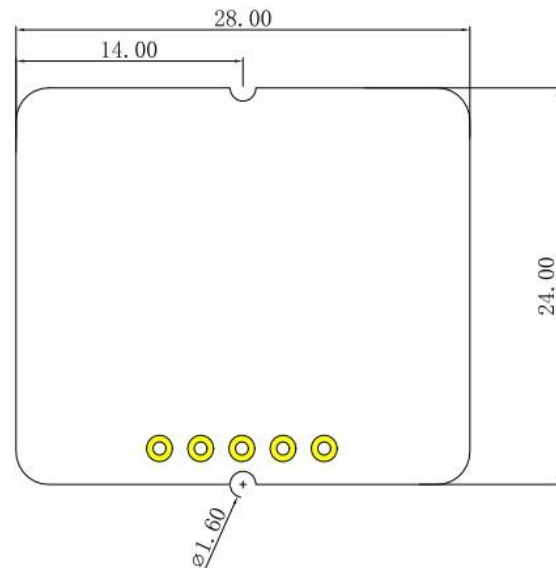
Back View

Figure 3 Module Appearance

(Rendering is for reference only; the actual product shall prevail.)



Top View



Bottom View

Figure 4 Module Dimensions (Unit: mm)

4. Pin Definition

The Rd-03E module exposes a total of 5 pins, as shown in the pin diagram. The pin function definition table provides the detailed interface specifications.

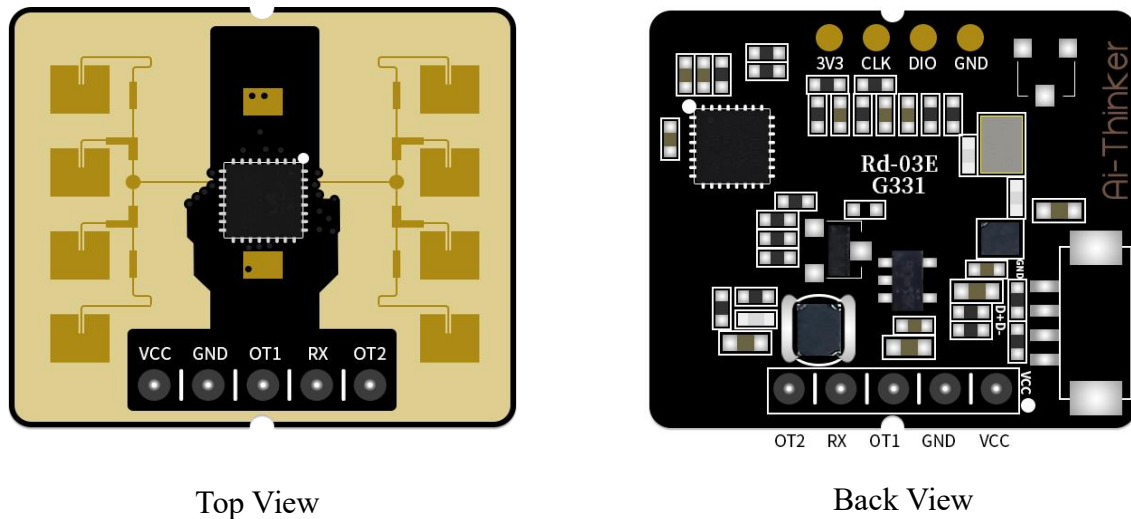
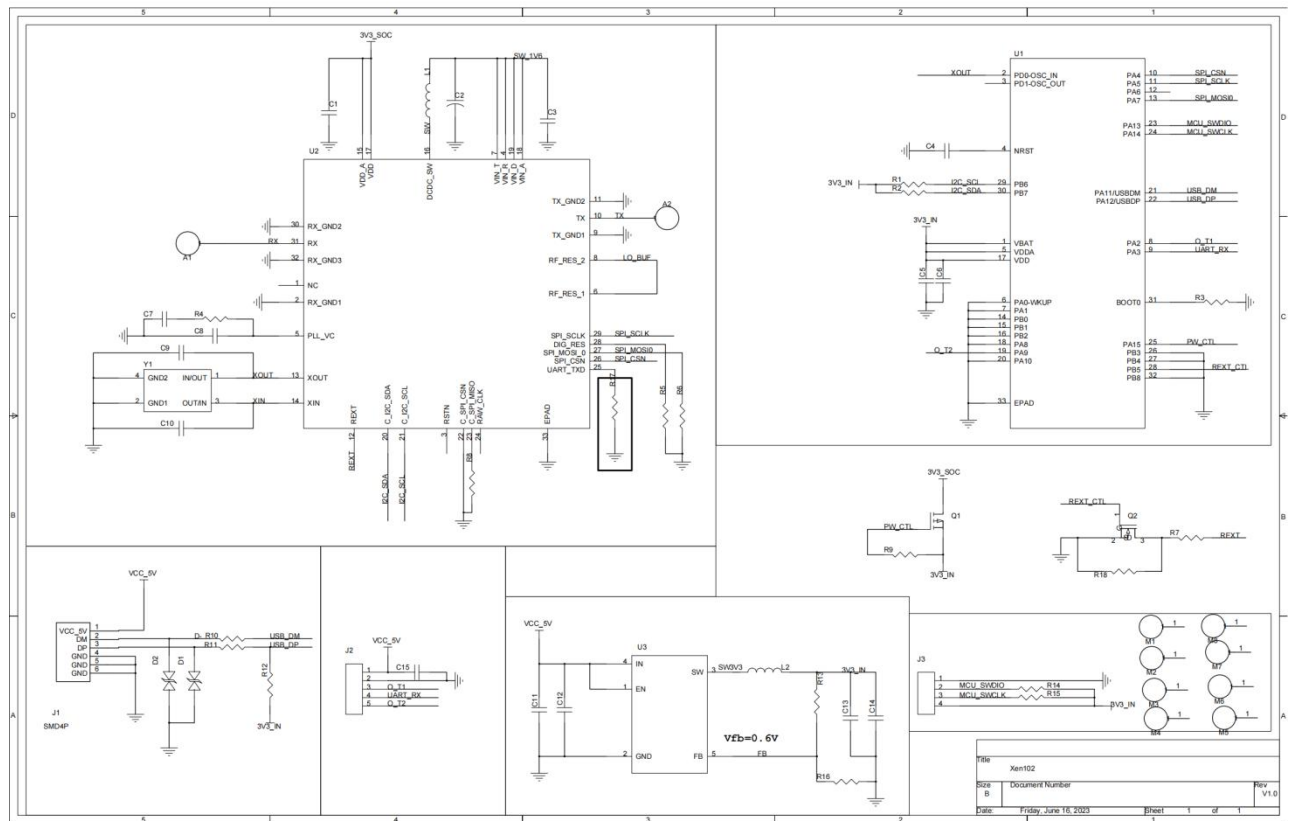


Figure 5 Pin Diagram

Table 5 Pin Function Definition

Pin	Name	Function
1	VCC	Input power 5V
2	GND	Ground
3	OT1	UART_TX
4	RX	UART_RX
5	OT2	Reserved interface; function to be determined

5. Schematic Diagram



6. Design Guide

6.1. Application Reference Circuit

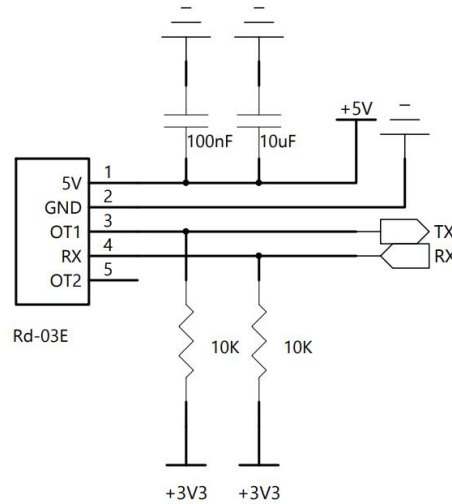


Figure 7 Application Reference Circuit

6.2. Recommended PCB Footprint Dimensions

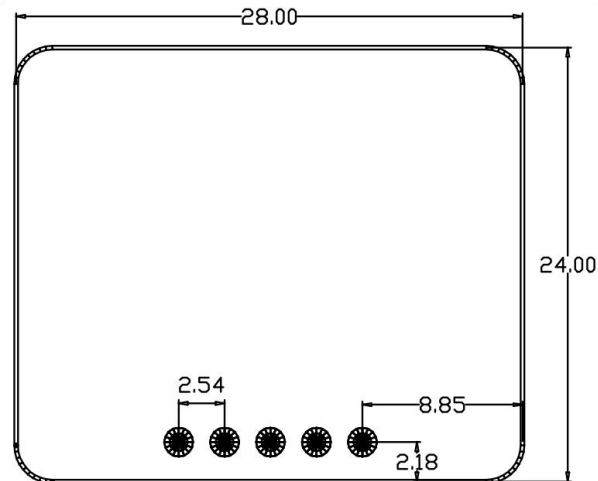


Figure 8 Recommended PCB Footprint Dimensions (Unit: mm)

7. 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 factors, 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 performance of the onboard antenna, metal objects must not be placed near the antenna, and the antenna should be kept away from high-frequency devices.
- The power input voltage is 5V, 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.

7.1. 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.

7.2. Installation Method and Detection Range

■ Wall-Mounted Installation for Precise Ranging

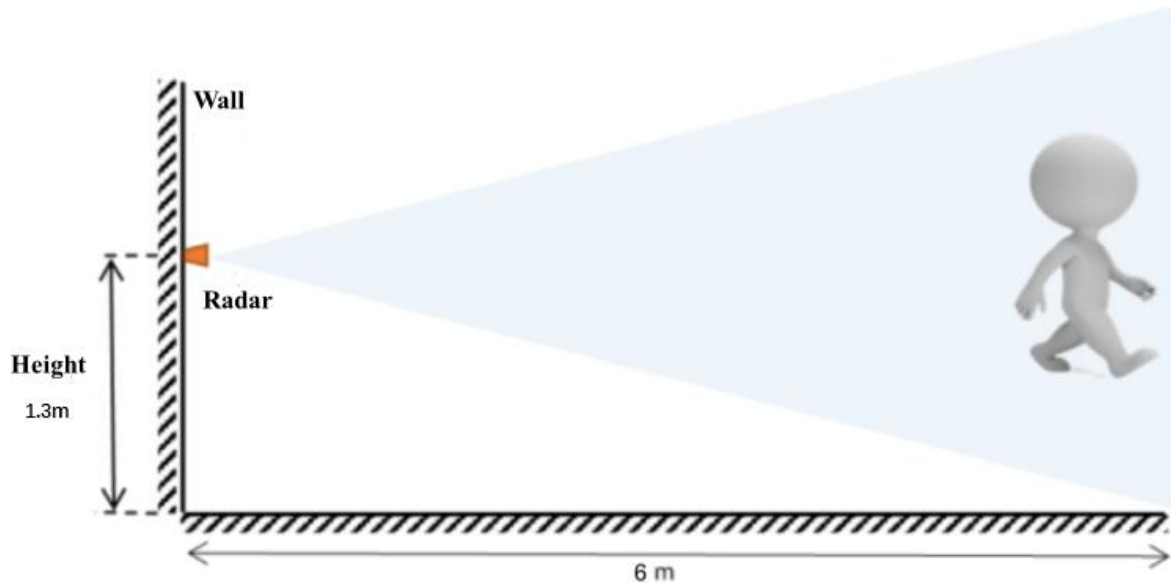


Figure 9 Wall-Mounted Installation Schematic for Precise Ranging

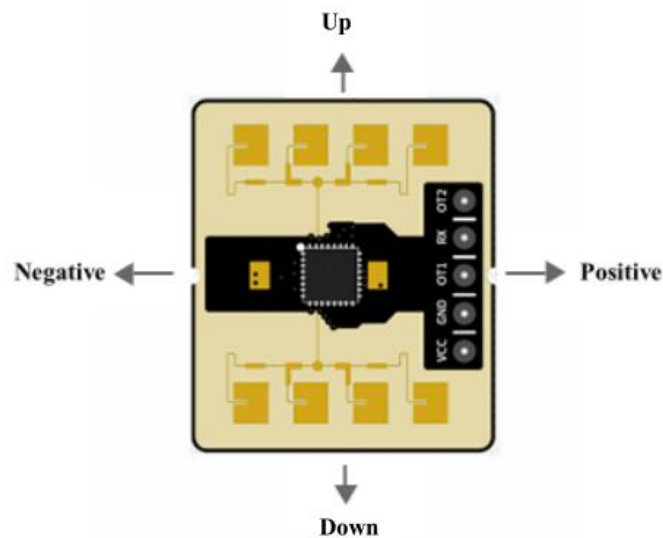


Figure 10 Wall-Mounted Detection Range Schematic for Precise Ranging

Note: The positive and negative directions indicate the azimuth angle. The upward and downward directions indicate the elevation angle.

- The detection range for precise ranging is: azimuth $\pm 20^\circ$, elevation $\pm 45^\circ$.

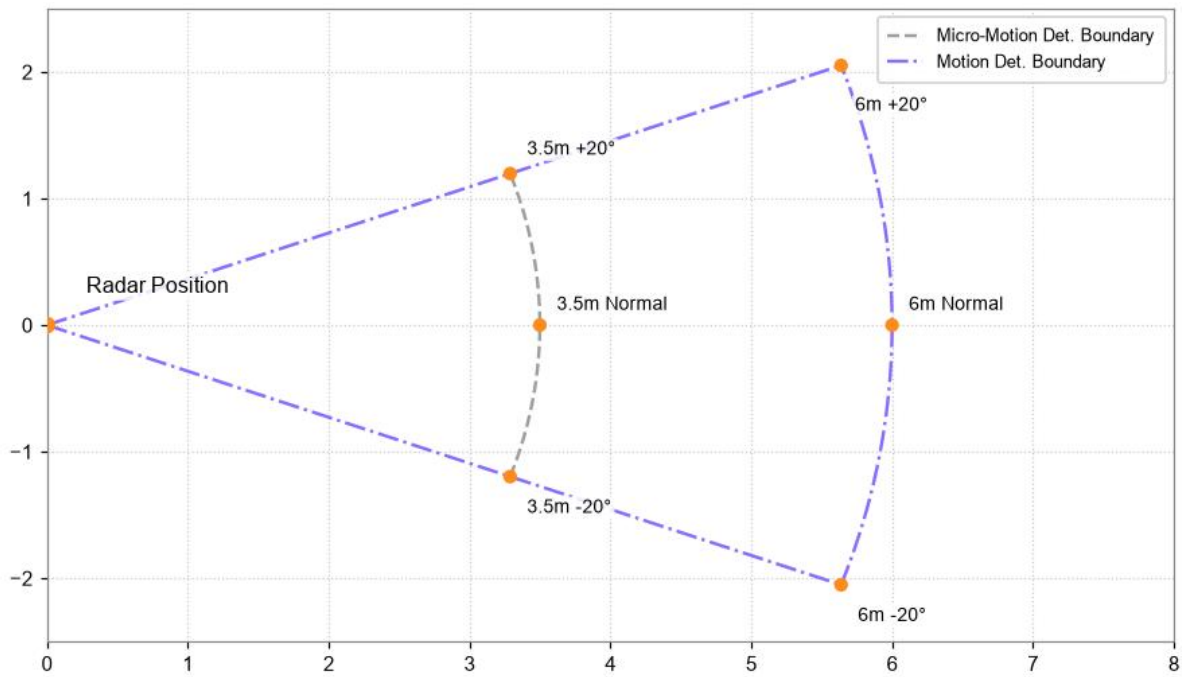


Figure 11 Wall-Mounted Radar Radiation Pattern for Precise Ranging

Note:

- Moving person detection: azimuth $\pm 20^\circ$, elevation $\pm 45^\circ$; detection range 0.3m – 6m
- Micro-moving person detection: azimuth $\pm 20^\circ$, elevation $\pm 45^\circ$; detection range 0.3m – 3.5m

■ Gesture Recognition - Tilted Installation

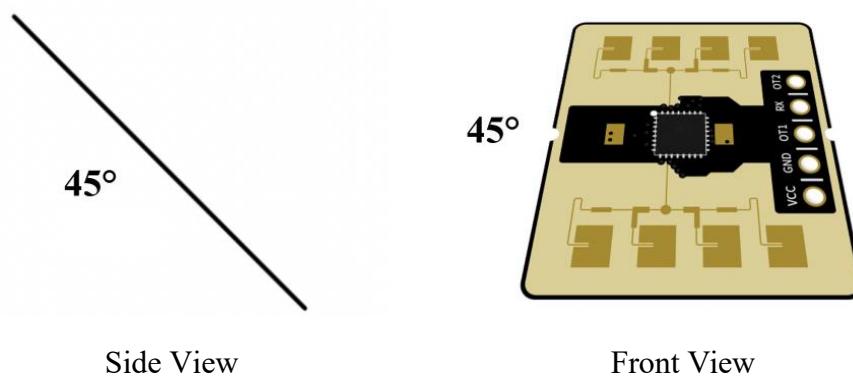


Figure 12 Tilted Installation Schematic for Gesture Recognition

Notes:

- This module is installed tilted at 45° .

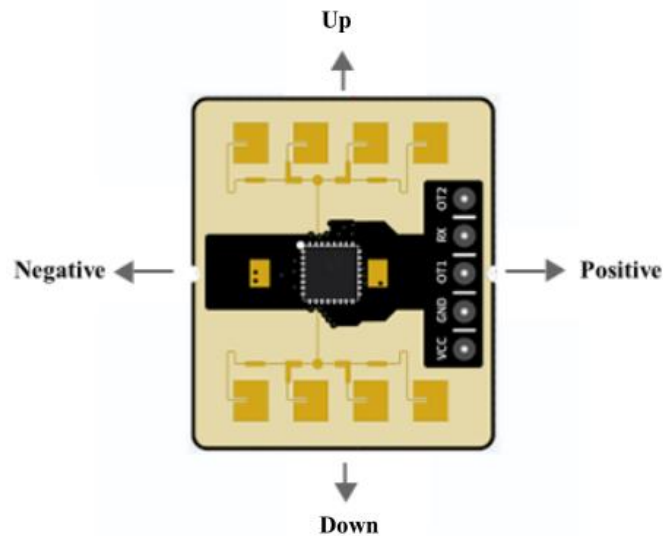


Figure 13 Gesture Recognition for Gesture Recognition

Notes: The positive and negative directions indicate the azimuth angle. The upward and downward directions indicate the elevation angle.

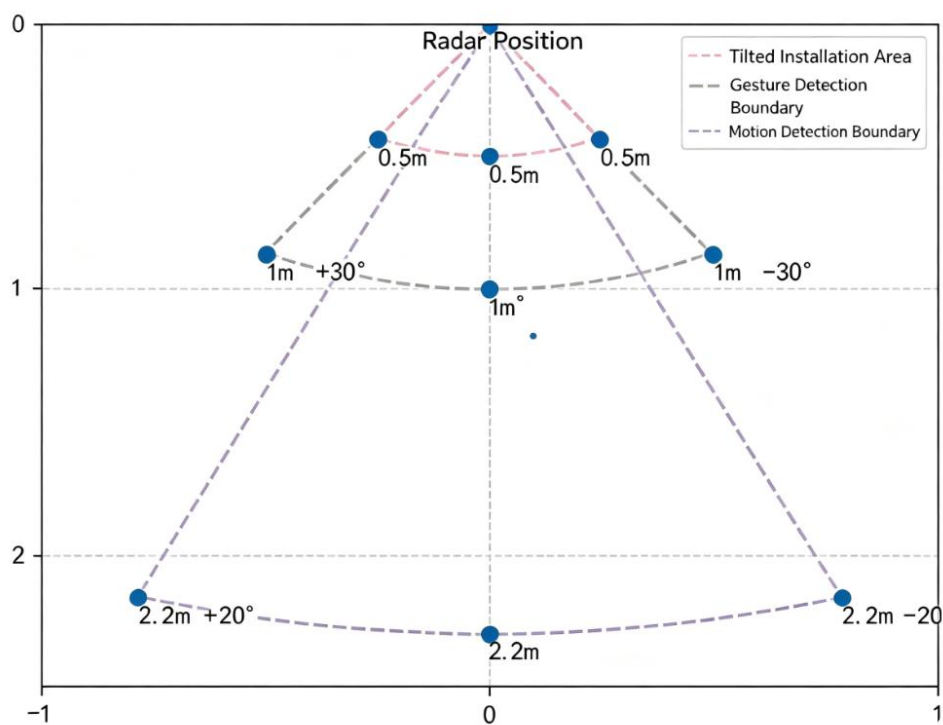


Figure 14 Wall-Mounted Radar Radiation Pattern for Gesture Recognition

Notes:

- Motion recognition detection range: azimuth $\pm 20^\circ$, elevation $\pm 40^\circ$; detection range 0.3m – 2.2m fan-shaped area
- Gesture recognition and micro-motion human detection range: azimuth $\pm 30^\circ$, elevation $\pm 40^\circ$; detection range 0.5m – 1m fan-shaped area

7.3. Power Supply

- A 5V supply voltage is recommended, with current above 200mA.
- An LDO is recommended for power supply; if using DC-DC, the ripple should be controlled within 100mV.
- 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 5V power interface.

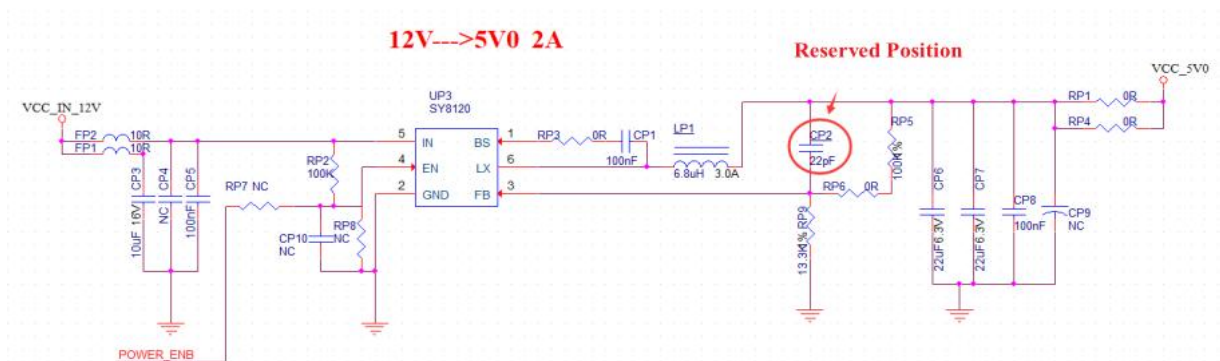


Figure 15 DC-DC Buck Circuit

7.4. GPIO

- 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 I/O 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.

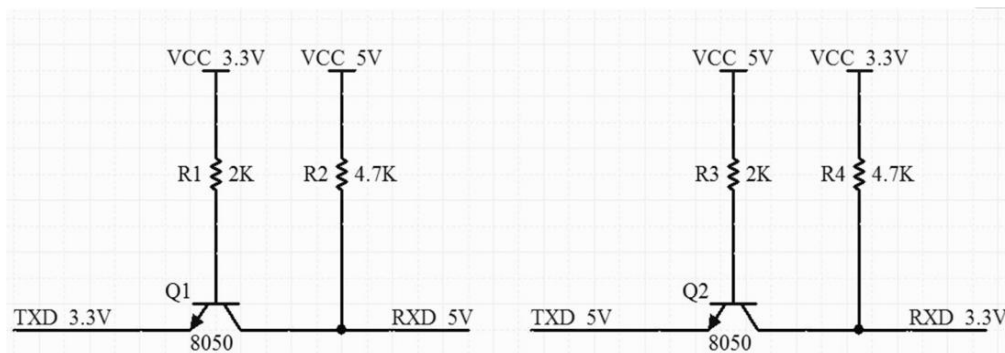


Figure 16 Level-Shifting Circuit

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

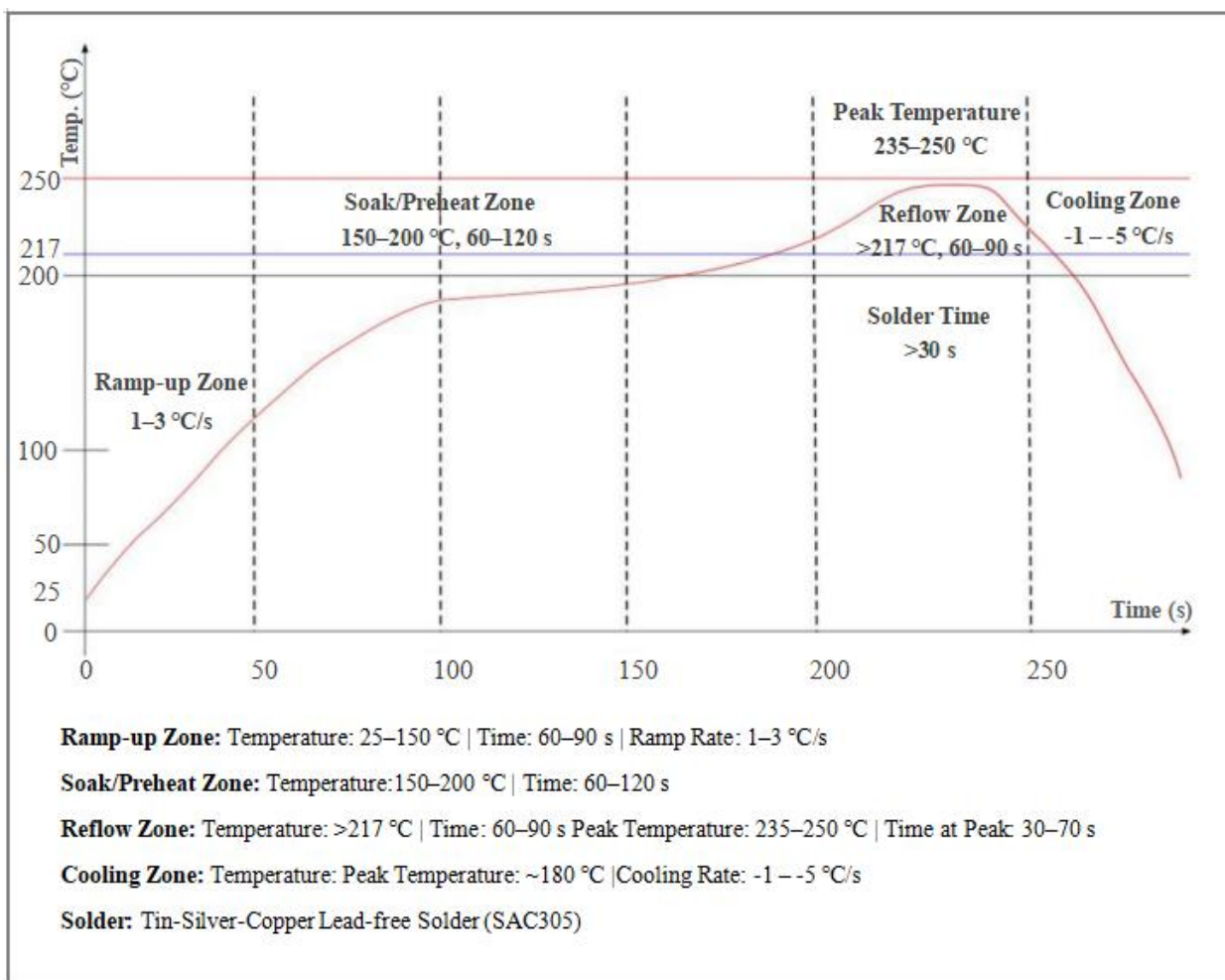


Figure 17 Reflow Soldering Profile

10. Packaging Information

The Rd-03E module is packaged in tape and reel, 150 pcs/reel, as shown in the figure below.



Figure 18 Tape and Reel Packaging Diagram

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