24G millimeter-wave radar

R24AVD2-S

Human Presence Radar

Inclined installation

Data Book V2.0

Yunfan Ruida Technology (Shenzhen) Co., Ltd.

Contents

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Notes:

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1.Product introduction

1.1 Product introduction

The R24AVD2-S radar module employs the millimeter-wave radar technology to realize detection of human motion distance. Based on the 1T1R FMCW (frequency modulated continuous wave) signal processing mechanism, this module performs wireless sensing on the status of people in the specific area.

Radar frequency band	24G millimeter-wave radar
Number of antennas	1T1R
Radar system	FMCW frequency modulated continuous wave
Active detection	Motion and static human presence detection
	Distance measurement

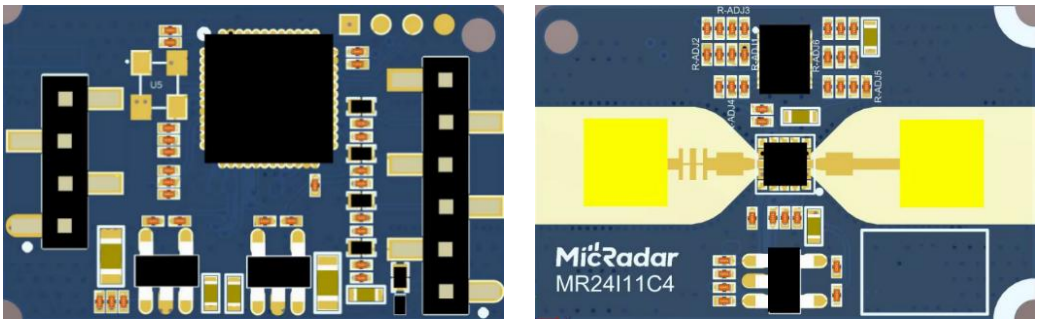

Fig. 1 Front and back sides of the radar

1.2 Theory of operation

The radar antenna transmits electromagnetic wave signals, and synchronically receives reflected echo signals. Then, the radar analyzes the waveform parameter of the echo signals, to detect the presence state of the moving object.

1.3 Function description

- Motion detection: Motion information output, such as walking and minor arm swings,

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can be detected within the range of the radar, upon which the human presence state will be triggered.

- Static human presence detection: When someone stays still in the detection range of the radar, his/her subtle motion arising from breath, such as chest expansion, can be detected, and the state of human presence will remain.
- Distance detection: Within its detection range, the radar detects the distance from the vertical projection point to the target.

1.4 Parameter settings

- Distance setting: to set the detection range;
- Threshold setting: to set the motion and stillness detection threshold per meter;
- Enter the unattended time setting;
- Setting for presence/non-presence duration;

1.5 Applications

- Smart appliances (TVs, heat lamps, security, etc.)
- Office energy conservation (ACs/lighting)
- Regional human detection
- Elderly care/Babysitting
- Home security
- IPC triggering

2.Product encapsulation diagram

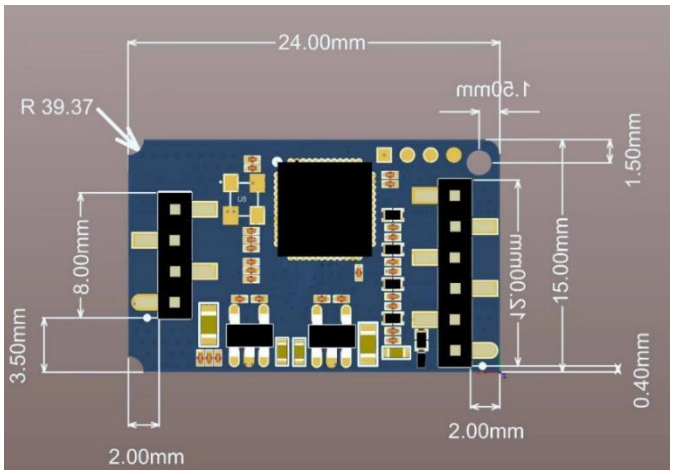

Fig. 2: Schematic diagram for radar module frame

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- Volume: 24mm×15mm×6.2mm (6.2mm high, including pin length)
- Interface: This radar module is equipped with pins of a pitch of 2.00mm, single-row pin interface, and a total of 2 sets of interfaces: 1*4 and 1*6.

3.Pin parameters explanation

3.1 Pins explanation

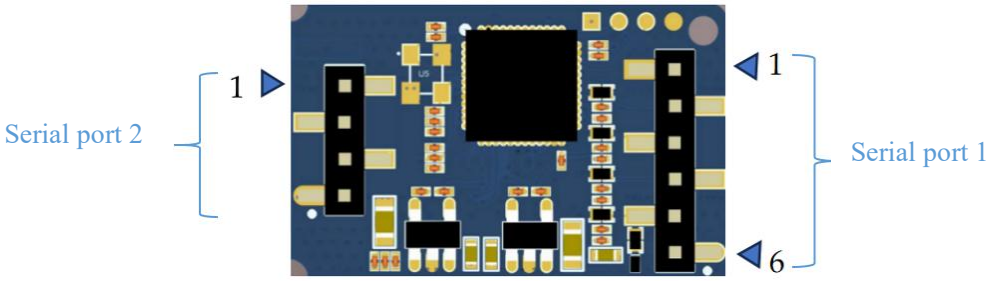

Fig. 3 Radar Pins Explanation

Interface	Pin	Description	Typical value	Notes
Interface 1	1	GND	0V	Power input ground
	2	IO1	3.3/0V	
	3	IO2	3.3/0V	
	4	RX		Serial port reception, 3.3V TTL level
	5	TX		Serial port transmission, 3.3V TTL level
	6	5V	5V	Power input positive
Interface 2	1	TX2		Serial port transmission, 3.3V TTL level (for debugging)
	2	TX3		Serial port transmission, 3.3V TTL level (for debugging)
	3	RX3		Serial port transmission, 3.3V TTL level (for debugging)
	4	GND	0V	Power input ground

Interface 1: for user usage

Interface 2: for internal radar debugging

Note: 1) IO1 output: High level - presence; and low level - non-presence;

2) IO2 output: High level - active; and low level - still;

3) The output signals from this interface are all 3.3 V in level.

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3.2 Serial port output parameters

- Presence/Non-presence
- Active/Still
- Body movement parameter
- Distance
- Product Info

3.3 Output protocol

- Standard serial port protocol

3.4 Naming conventions of models

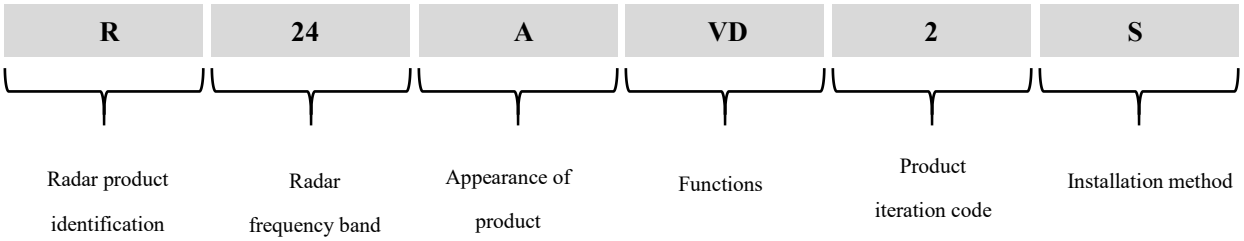

Fig. 4 Naming conventions of models

4.Product features

The R24AVD2-S radar module is a wide-beam radar module featuring single patch antenna. It mainly applies to side mounting and triggers the detection by human presence and motion over a wide range.

This radar module features the following:

- The product supports secondary development, making it applicable to a variety of scenarios;
- The module adopts universal UART communication interface and universal protocol provided;
- The module is of small output power and hence harmless to health;
- The module is immune to temperature, lighting, dust and other factors while bearing high sensitivity, making it applicable in a variety of scenarios.

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5.Electrical characteristics and parameters

5.1 Detection angle and distance

Detection angle and distance	Minimum	Typical value	Maximum	Unit	Installation method
R24AVD2-S					
Detection distance for moving bodies	-	-	8	m	Inclined installation
Sensing distance for static persons	-	-	4	m	Inclined installation
Angle of radar detection (horizontal)	-	100	-	Degree(s)	
Angle of radar detection (inclined)	-	100	-	Degree(s)	

5.2 Working Parameters

Working Parameters	Minimum	Typical value	Maximum	Unit
Working voltage (VCC)	4.9	5.0	5.5	V
Average current (ICC)	92	95	105	mA
Working temperature (TOP)	-20	-	+70	℃
Storage temperature (TST)	-40	-	+80	℃

5.3 RF performance

Transmission parameter	Minimum	Typical value	Maximum	Unit
Working frequency (f_{TX})	24.05	-	24.25	GHz
Transmission power (P_{out})	-	6	8	dBm
Antenna gain (GANT)			≤5	dBi

5.4 Response time

Response time	Minimum	Typical value	Maximum	Unit
Motion detection sensitivity (m/s)		-	≤0.5	m/s

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Output time of motion detection (ms)	-	-	≤100	ms
Non-presence (s)	5		≤40	s

5.5 Application wiring diagram

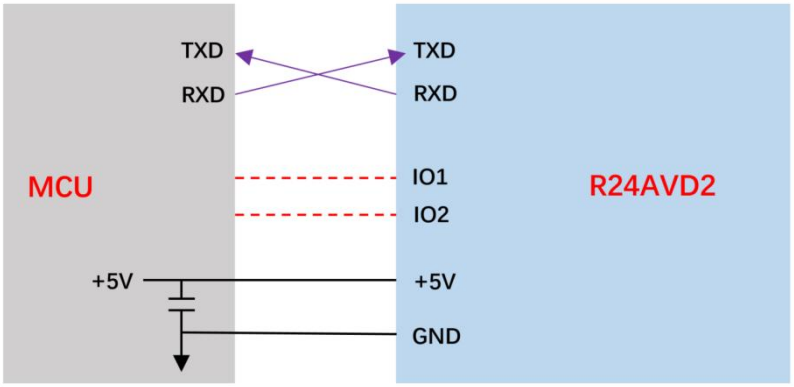

Fig. 5 Schematic diagram for connection between radar module and peripherals

6.Main functions and performance

6.1 Radar module coverage

The beam coverage of the R24AVD2-S radar module is shown in Fig. 6. The coverage of the radar is a three-dimensional sector 100° horizontally and 100° vertically.

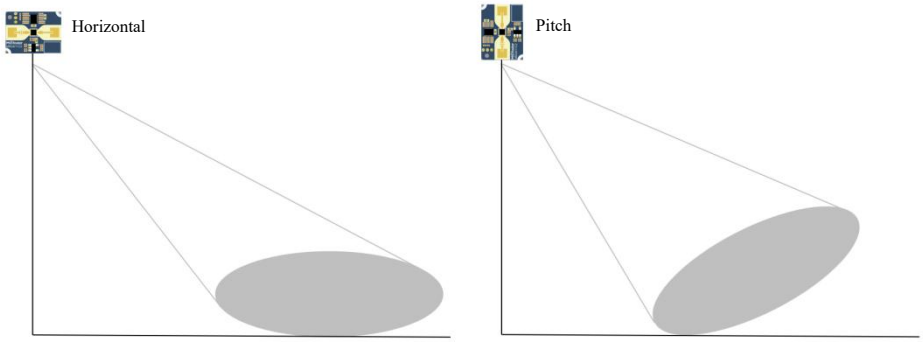

Fig. 6 Coverage Area Diagram of R24AVD2-S Radar

Affected by the characteristics of radar beams, the operating distance along the normal line to the antenna face is greater, while the one displacing from it is smaller, which should be noted during use.

7.Installation method and working modes

7.1 Installation method

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The radar module should be installed in an inclined manner. Inclined installation is as shown in Fig. 7. This installation mode is designed for the detection of human motion in a room.

The radar is recommended to be installed at a height of 2 - 2.75 m, with the radar antenna surface inclining downwards at an angle of 150° to the horizontal plane, and there are no obvious obstructions or coverings in front of the radar.

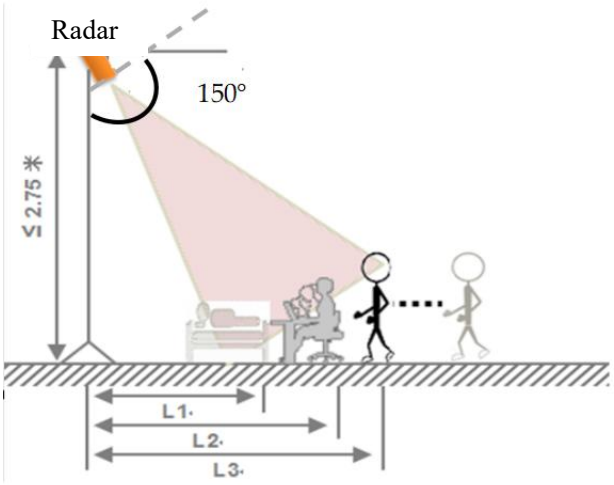

Fig. 7 Diagram of Side Mounting

Note: All mounting methods mentioned above require coverage over the main area of human motion by the main beam of the radar, and the alignment of the radar antenna surface directly towards the human activity area wherever possible.

8.Related documents

- User Manual: http://en.micradar.cn/go_file.php?id=181

9. Notes

9.1 Start-up time

The module needs to fully reset its internal circuits and performs a full assessment on ambient noise when it is powered on and starts to work, so as to ensure the module can work properly. As a result, the module requires a stabling time ≥ 30 s upon powering on to ensure the effectiveness of parameters output subsequently.

9.2 Effective distance of detection

The distance of detection of the radar module depends mainly on target RCS, covering material and thickness, as well as environmental factors, and might vary with the environment

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and the target. Therefore, it's normal for the effective distance of detection to fluctuate in a certain range.

9.3 Radar detection performance

For static human presence, the detection is more effective when human chest is facing the radar. However, when a person turns sideways or backward during detection, there is a risk that the radar may not detect chest movement, leading to the possibility of not detecting the person.

Due to the fact that the biological features of human bodies are characteristic signals of super low frequency and weak reflection, long-period accumulation is required for radar processing. However, a number of factors might affect the parameters of the radar during the course. On this account, it's normal that detection fails sporadically.

9.4 Power source

1. The radar module has requirements higher than regular low-frequency circuits on power source quality. When supplying power to the module, the power source is required to be free from any threshold glitches or ripples, and can effectively shield power supply noise from accessories.

2. The radar module requires proper grounding. Ground noise from other circuits might compromise the performance or even cause an anomaly in the module. A reduced distance of detection or increased false alarm rate is one of the commonest.

3. To ensure the VCO circuit inside the module works properly, power supply to this module should be +4.9V - +5.5V, with ripple voltage ≤ 100 mV. External power supply must be able to provide sufficient current output and transient response capacity.

10. FAQs

- Interference factors: The radar is a sensor for electromagnetic wave detection. Inanimate objects that are moving can lead to a false alarm. The flowing liquids, oscillating fans, and shaking curtains may cause false alarms. Therefore, the radar should be installed in such a way that its detection area is as free as possible from the above interference items.
- Housing factors: Many other factors affect radar performance, such as the material of the housing that the radar beam needs to penetrate, the surface treatment of the housing, and the distance between the radar antenna surface and the housing. Please follow our recommendations for housing and installation design.

11. Disclaimer

To our best knowledge, the description in the document is accurate when it was released. Considering the technical complexity of products and the differences in working

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14. Revision History

Revision	Release Data	Summary	Author
V1.0	2024/04/23	Draft	Frank
V2.0	2024/10/15	First edition	Frank