

24G Millimeter Wave Radar
R24AVD3
Personnel Perception Rada
Data Manual v1.0

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Notes:

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1. Product introduction

This radar is a highly sensitive 24GHz millimeter wave radar module used for human and location detections.

This radar module has the following characteristics:

- Based on the FMCW radar system, it realizes the perception function of personnel presence in the area;
- Realizing synchronous sensing on people who are moving and staying still;
- Max. sensing distance for motion: ≥ 6 meters;
- Maximum distance for human static perception: ≥ 4 meters
- Width of antenna beams (3dB): $\geq 100^\circ$ (H); $\geq 80^\circ$ (E);
- Capable of scene recognition, identifying the presence/absence of people and their activity status;
- Immune from temperature, humidity, noise, air flow, dust, lighting, etc., and hence applicable to severe environments
- Low output power, harmless to the human body under long-term irradiation.

2. Application scope

- Home appliances (air conditioning, refrigerator, TV, etc.)
- Office energy conservation (ACs/lighting)
- Sleep monitoring
- Regional security
- Automatic doors, elevators, etc.

3. Main performance and functional parameters

3.1 Functional Requirements

- 1) Personnel presence detection
- 2) Moving target detection

In the side-mounted situation, it can track the distance of the nearest person in a multi-person scene (without angle information output)

- 3) Scene situation assessment
 - a. Presence/Non-presence
 - b. Approach/Stay Away
 - c. Active/Still
- 4) Other functions of radar
 - b. Self inspection and fault diagnosis

3.2 Electrical Parameters

Parameter	Minimum	Typical value	Maximum	Unit
Radar operating parameters				
Working voltage (VCC)	4.5		5.5	V
Working current (I _{CC})		100		mA
Working temperature (T _{OP})	-20		+85	°C
Storage temperature (T _{ST})	-40		+85	°C
Transmission parameter				
Working frequency (f _{TX})	24.0		24.25	GHz
Transmission power (P _{out})		6	8	dBm
Parameters of antenna				
Antenna gain (G _{ANT})		5		dBi
Horizontal beam (3 dB)		100		°
Vertical beam (3 dB)		80		°

3.3 Radar Detection Performance Parameters

- 1) Motion perception distance: ≥ 6 meters (radial)
- 2) Sensing distance for static human bodies: ≥ 4 meters (radial)
- 3) Distance resolution: ≤ 0.5 meters
- 4) Field of view (FOV): $\geq 100^\circ$

- 5) Triggering time for motion: ≤ 0.5 s
- 6) Presence perception detection time: ≤ 30 s

4. Application and Interface

4.1 Power Requirements

- 1) Input voltage: $+5V \pm 0.5V$;
- 2) Working current: The module current should be 100mA (MAX), and the power supply terminal should have a margin of at least 1.5 times, about 150mA;
- 3) Power ripple: ≤ 50 mV;

4.2 Environmental Adaptability Explanation

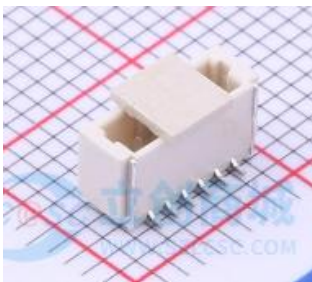
- 1) Temperature: -20 °C \sim 70 °C (working and storage)
- 2) Humidity: $\leq 85\%$, no condensation
- 3) Vibration: No vibration

4.3 Description of interfaces

4.3.1 Physical Interface Description

This radar provides a 6-PIN interface, including a set of UART and a pair of GPIO. GPIO can be used as an IIC interface instead of UART according to requirements, and is compatible with two types of wiring sockets:

Type 1: SH 1.00 6-pin vertical stickup



Type 2: FPC 0.5mm 6-pin horizontal stickup



Interfaces are sorted as follows:

Pin	Description	Typical value	Notes
1	5V	5.0V	Power input positive
2	RX	3.3V	Serial port reception
3	TX	3.3V	Serial port send
4	GPIO1/SCL	3.3V	User Port 1
5	GPIO2/SDA	3.3V	User Port 2
6	GND	0V	Ground

Note: The interface defaults to using UART serial port. In this case, GPO1 and GPO2 can redefine the output status indication according to user requirements. Alternatively, the IIC interface can be used instead of the UART serial port for communication, in which case the pins used for the UART serial port can be used as GPIO.

4.3.2 Interface Content Description

The interface between radar and user port mainly includes the following contents:

- a. Radar information parameters
- b. Radar detection data
- c. Radar testing and self checking information
- d. OTA interaction, etc

This radar module temporarily provides radar detection data for functional and performance testing of prototype products. The main content includes:

- a. Status information of human presence/absence;
- b. Motion status;
- c. Regional warning information;
- d. Location information;

4.3.3 Interface Protocol Description

- Frame format definition

The frame format is defined as follows:

	Field	Mark	Length (B)	Notes
1	Frame header	FH	2	Fixed as “0x53 0x59” //“S Y”
2	Control word	CD	1	0x00- heartbeat packet identifier; 0x01- Product Information; 0x02-OTA upgrade; 0x03 -Radar Test; 0x80- Exclusive Features;
3	Command word	OD	1	Identify the current data content, to be defined
4	Length identification	L1	2	Equivalent to the length of DA data
5	Data	DA	-	0~2048Byte
6	Verification field	CH	1	Checksum
7	Frame tail	FT	2	Fixed as “0x54 0x43” //“T C”

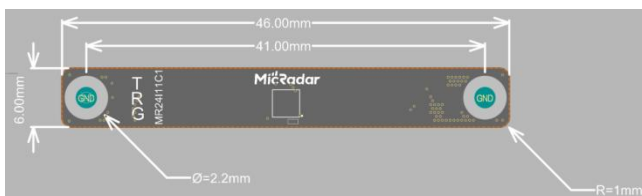
Note: In the table above, OD content may have different definitions in different radar applications;

➤ Protocol Address

Function description	Transmission direction	Frame header	Control word	Command word	Length	Data	Verification field	Frame tail
Human existence	Proactive report	5359	80	01	0001	0x00: Human absence 0x01:Human presence	SUM	5443
Motion status	Proactive report	5359	80	02	0001	0x00: Absence 0x01: Stationary 0x02: Active	SUM	5443
1-meter range warning	Proactive report	5359	88	88	0001	0x00: Absence 0x01:Close range warning	SUM	5443

Location information	Proactive report	5359	82	02	len	Output the location information of the nearest target point: 1B Movement Status: 0x00 is stationary, 0x01 is motion 1B reserved location 1B Target Index 2B X-axis location information is always 0 2B Y-axis location information 2B height information is always 0 2B speed (reserved)	SUM	5443
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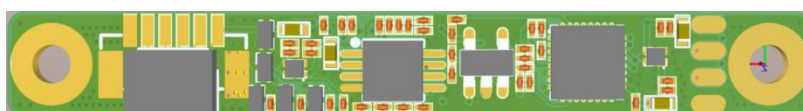
5. Dimensions and product photos



- 1) Dimensions: 6mmX46mm
- 2) Fixed method: Screw holes on both sides
- 3) Product photos (3D)



(a) Front photo



(b) Back photo

6. Installation and usage instructions

This radar can be installed in the following ways: Horizontal installation and inclined installation.

6.1 Horizontal Installation

Figure 1 shows the horizontal mounting method, which applies to body detection of standing or seated persons and thus to the scenarios of living rooms, electrical appliances, etc.

The radar is recommended to be installed at a height of 0.7 m - 1.5 m, horizontally in forward direction, with a tilt $\leq \pm 5^\circ$. The front of the radar should not be blocked or covered whatsoever.

The normal line of the radar should be aligned with the main point of detection to ensure the main beam of the radar antenna covers the detection area and the airspace of body activities.

In this installation mode, the maximum detection distance of moving human body is $L \geq 6$ meters; The maximum distance for stationary human detection is $L \geq 4$ meters;

6.2 Inclined installation

Figure 2 shows an inclined installation, and the recommended installation height for the radar is 2-3 meters; The downward inclined angle range of the radar is 10° to 45° , and there are no obvious obstructions or coverings in front of the radar.

Limited by the beam coverage of the radar antenna, the effective working distance will be reduced if displaced from the normal line direction of the radar.

Electromagnetic waves in millimeter-wave frequency band can penetrate non-metallic matters - common glass, wooden boards, screens, and thin partition walls - to a certain degree, and hence can detect moving objects behind such obstacles. However, thick load-bearing walls, metal doors, and the like are not penetrable.

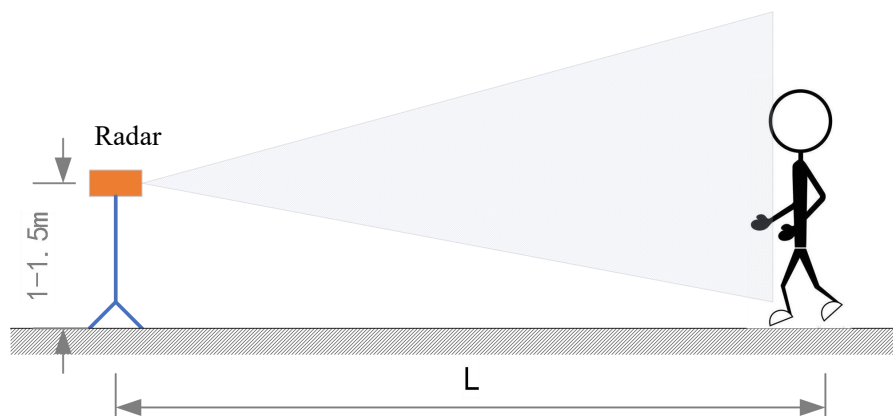


Fig. 1 Horizontal mounting diagram

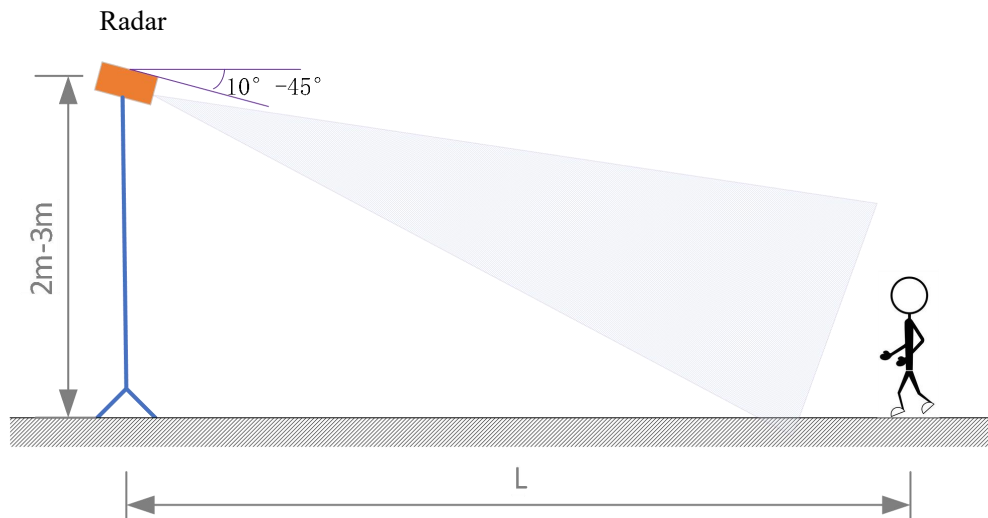


Fig. 2 Look-down mounting

Note:

- A. All mounting methods mentioned above require coverage over the main area of body motion by main beam of the radar, with the alignment with the direction of normal line as far as possible;
- B. In inclined mounting, horizontal working distance is reduced due to the change in horizontal projection of the coverage;
- C. When the module works, no metal obstacles should exist on module surface;
- D. Affected by the transmission characteristics of electromagnetic waves, the working distance of the radar varies with RCS, material of cover and thickness of the target.
- E. For stay-still detection, the working distance of the radar is affected by postures. The maximum working distance is not guaranteed for all postures.

7. Notes

7.1. Bio-detection performance of radar

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.

7.2. Power source

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.

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.

To ensure the VCO circuit inside the module works properly, power supply to this module should be +5V - +6V, with ripple voltage ≤ 100 mV. External power supply must be able to provide sufficient current output and transient response capacity.

8. FAQs

- Interference factors: The radar is a sensor for electromagnetic wave detection. Inanimate objects that are moving can lead to a false alarm. Movements of metal and liquid can lead to misjudgment. Normally, fans, pets close to the radar, and waving of metallic curtains can lead to misjudgment. Installation angle should be properly designed for the radar.
- Non-interference factors: Electromagnetic waves of the radar can penetrate clothes, curtains, thin wooden boards, and glass. On this account, installation angle and performance should be determined according to applications.
- Quasi-interference factors: The radar should not face an AC directly if it's to detect human presence. The movement of air conditioning fan blades and significant vibrations of some air conditioners can cause radar misjudgment. Therefore, it's required that the radar product is not installed facing an AC directly or in the same orientation as an AC.

9. Disclaimer

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12. Updates history

Revision	Release Data	Summary
V1.0_1115	2023/11/15	First draft