60G millimeter-wave radar

R60AFD1-V Fall alarm radar

Top mounting

Data Book v2.0

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Contents

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Notes:

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1. Product introduction

1.1 Product introduction

R60AFD1-V is a radar module that employs 60 G millimeter-wave radar technology to realize body motion and posture sensing and thus to realize fall monitoring. Based on the FMCW radar system, the module can realize wireless sensing of personal status in specific places, and timely report fall states of people, or stay-still alarms upon prolonged state of remaining still.

Radar frequency band	60G millimeter-wave radar
Number of antennas	1T3R
Radar system	FMCW
Active detection	Body movement parameter and stay-still state
	Fall state

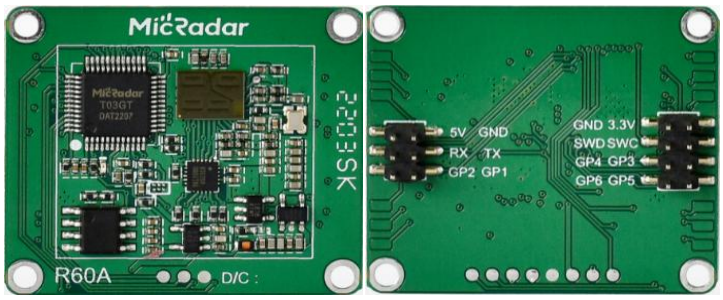

Fig. 1 Front and back sides of the radar

1.2 Theory of operation

The radar antenna transmits electromagnetic wave signals, and synchronically receives reflected echo signals. Then, the radar analyzes the phase difference and energy change between waveform parameters of the echo signals from varying antennas, and gives feedback on distance, orientation, speed, motion power, and other information of the target, making it possible to detect postures of people.

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1.3 Function description

- Motion detection amplitude: Motion information output, such as walking and minor arm swings, can be detected within the range of the radar, upon which the human presence state will be triggered.
- Breath 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.
- Fall detection function: In its detection range, the radar is able to detect the real-time change in point cloud, distance and speed of a moving target, and further detect the fall state.

1.4 Parameter settings

- Height settings: Height should be set for actual mounting and use of the radar. The actual height of mounting should be the same as the underlying settings (2.3 m by default)
- Fall report time settings: The default of fall report time is 15 s. When the radar detects a fall of someone, the detection will last for a while (adjustable in 5 - 180 s). A value less than 30 s can be used for demonstration purpose, while for normal projects, a value greater than 60 s is recommended.
- Stay-still alarm report time settings: The default for stay-still time is 300 s. When the radar detects a person staying still for a period of time (settable), it will report a stay-still alarm. For normal projects, a value of greater than 30 min. is recommended.

1.5 Applications

- Smart care (kitchens and bathrooms)
- House intelligence
- Home security

2. Product encapsulation diagram

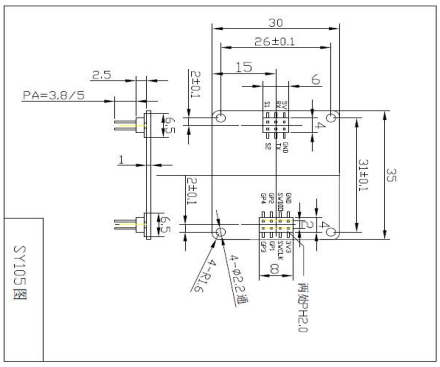

Fig. 2 Schematic diagram for radar module frame

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- Volume: 35mm×31mm×7.5mm
- Interface: Pitch 2.0 mm dual-row connector. 2 connectors in total: 2*3 and 2*4

3. Pin parameters explanation

3.1 Pin explanation

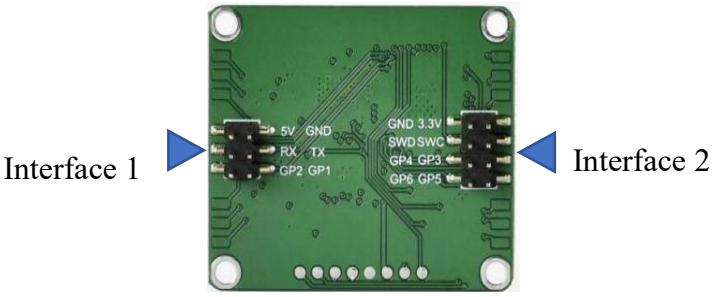

Fig. 3 Radar Pins

Interface	Pin	Description	Typical value	Notes
Interface 1	1	5V	5.0V	Power input positive
	2	GND		Ground
	3	RX	3.3V	Serial port reception, 3.3V TTL level
	4	TX	3.3V	Serial port transmission, 3.3V TTL level
	5	GP1	3.3V/0V	Fall alarm/Clear alarm
	6	GP2	3.3V/0V	Presence/Non-presence
Interface 2	1	3V3	3.3V	Input power source
	2	GND		Ground
	3	SWC		Burning pin 1
	4	SWD		Burning pin 2
	5	GP3		Spare extension pin
	6	GP4		Spare extension pin
	7	GP5		Spare extension pin
	8	GP6		Spare extension pin

Interface 1: for internal radar debugging
Interface 2: Radar burning serial port

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Note: 1) GP2 output: High level - presence; and low level - non-presence;
2) GP1 output: High level-fall alarm, low level-clear alarm;

3.2 Serial port output parameters

- Presence/Non-presence
- Fall state
- Active/Still
- Body movement parameter 0 - 100
- Stay-still state (report time settable)

3.3 Settable parameters

- Mounting height
- Resident duration settings
- Fall/Stay-still switch

3.4 Output protocol

- SIP-S v1.0 Serial port protocol
- Standard protocol of Tuya

3.5 Naming conventions of models

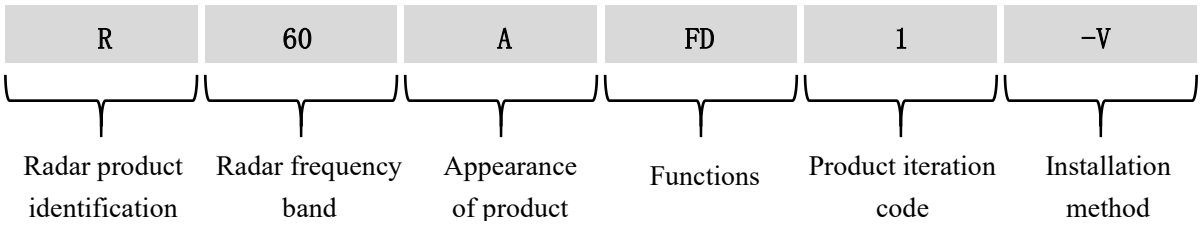

Fig. 4 Naming conventions of models

4. Product features

The R60AFD1-V radar module adopts the 1T3R antennas. The wide-beam radar module is mainly applicable to top mounting. It detects falls of people within the coverage of a certain angle and accurately scans the full-body tomography, so as to realize fall detection of different height and varying speed of human bodies.

This radar module features the following:

- Realizing synchronous sensing on people who are moving and staying still (sitting still);

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- Realizing fall detection;
- Detecting different motion amplitudes, and outputting values and states in real time
- The targets of detection are humans that bear biological features (moving or static), with the interference from other inanimate objects in the same place eliminated;
- The module adopts universal UART communication interface and universal protocol provided;
- 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.

5. Electrical characteristics and parameters

5.1 Detection angle and distance

Parameter details	Minimum	Typical value	Maximum	Unit	Installation method
R60AFD1-V					
Detection radius of motion triggering [1]	-	1.5	2.5	m	Top mounting
Radius of fall monitoring [2]	-	1.5	-	m	
Radius of stay-still detection [3]	-	1.5	-	m	
Angle of radar detection (horizontal)	-	100	-	Degree(s)	
Angle of radar detection (inclined)	-	100	-	Degree(s)	

Note: [1][2][3] Hanging height of radar 2.8 m. Radius of radar projection.

5.2 Electrical characteristics

Working Parameters	Minimum	Typical value	Maximum	Unit
Working voltage (VCC)	4.5	5.0	5.5	V
Average current (ICC)	-	-	100	mA
Peak current (Ipeak)	-	-	300	mA
Working temperature (TOP)	-20	-	+70	℃
Storage temperature (TST)	-40	-	+85	℃

5.3 RF performance

Transmission parameter	Minimum	Typical value	Maximum	Unit
Working frequency (fTX)	61	-	62.5	GHz

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Transmission power (Pout)	-	8	10	dBm
Antenna gain (GANT)		8		dBi

5.4 Response time

Response time	Minimum	Typical value	Maximum	Unit
Motion detection sensitivity (m/s)	-	-	0.5	m/s
Output time of motion detection (ms)	-	-	100	ms
Non-presence (s)	10	30	60	s
Fall	5	15	20	s

5.5 Application wiring diagram

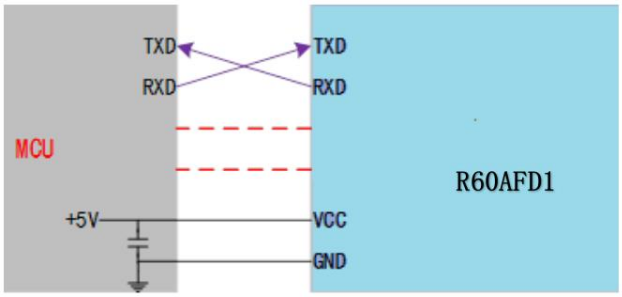
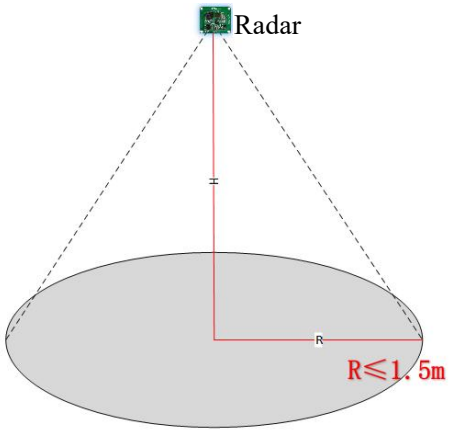


Fig. 5 Schematic diagram for connection between radar module and peripherals

6. Main functions and performance

6.1 Radar module coverage

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



Note: R is the fall detection radius.

Fig. 6 Coverage of radar

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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.

Attention should be paid that when the radar is top-mounted, the range of the radar will be reduced as a result of radar beam coverage and effective radiation space.

7. Installation method and working modes

7.1 Top mounting

The radar is mounted on the rooftop, facing straight down.

The height of mounting H = 2.2 m - 2.8 m. The radius of radar beam coverage is R. The zone of radar projection is considered to be further divided into the fall detection zone, stay-still detection zone, presence detection zone, and motion triggering detection zone, as shown below.

Depending on the height of mounting and beam coverage, in this mounting mode, the max. radius of fall/stay-still detection is R1 ≤ 1.5 m, static presence R2 ≈ 1.5 m, and motion detection R3 ≈ 2.5 m;

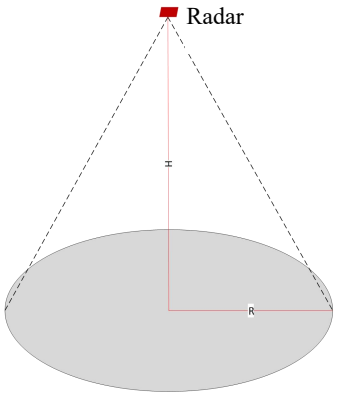

Fig. 7 Diagram of radar projection

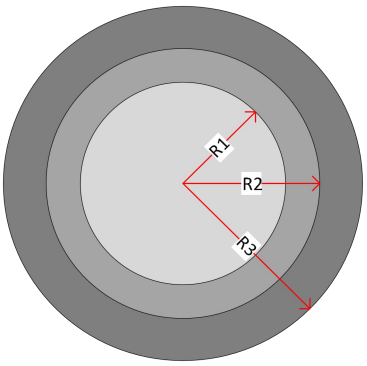

Fig. 8 Diagram of beam division

8. Related documents

- User Manualhttp://en.micradar.cn/go_file.php?id=193
- Start Guide: http://en.micradar.cn/go_file.php?id=94

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.

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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 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 +4.5V - +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 environments, it's

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5) When operating this product, you must take anti-static measures, such as grounding the measurement system and grounding the human body. In addition, when this product is placed in a reflow oven, please handle it according to the MSL classifications.
6) Please note that applying stress to the external form of this product may affect local oscillation frequencies. When multiple modules are used in the same area, please consider preventing interference.
7) Do not use this product under conditions out of the specifications listed in this manual, as this may result in product degradation or damage.
8) We are not responsible for any harm, accident, or social damage caused by the use of this product under conditions out of relevant specifications.

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14. Revision History

Revision	Release Data	Summary	Author
V1.0	2022/3/6	First draft	Frank
V2.0	2024/10/22	First edition of new version	Jason