60G millimeter-wave radar

R60AMP1-H

Multi-Person Trajectory Radar

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

The R60AMP1-H radar module employs the millimeter-wave radar technology to realize distance, angle and speed sensing of human motion. Based on the 1T3R FMCW (frequency modulated continuous wave) signal processing mechanism, this module performs trajectory tracking on 2 targets in specific areas via the synchronous sensing technology that detects parameters such as motion orientation change and slight chest expansion, and is able to lock the coordinates of static persons.

Radar frequency band	60G millimeter-wave radar
Number of antennas	1T3R
Detection system	FMCW
Active detection	Motion, Stillness and Trajectory Functions

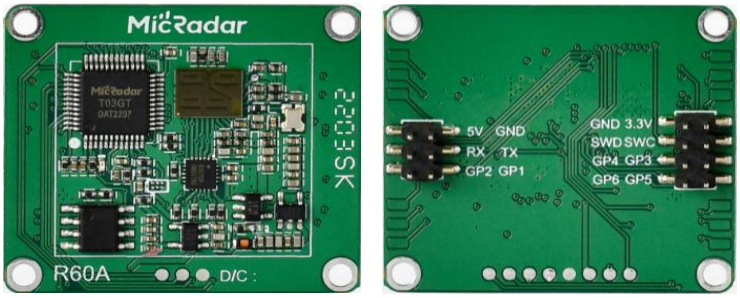

Fig. 1 Front and back sides of the radar

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 received by different antennas, to detect the motion state and trajectory position of the moving object.

1.3 Function description

- Motion detection: Motion information output, such as walking and minor arm swings, can be detected and triggered within the range of the radar.
- 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,

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and the state of human presence will remain.

- Trajectory movement detection: Within its detection range, the radar can detect the real-time movement trajectory of moving targets. The radar outputs the corresponding coordinates, and locks the final resting position of the targets based on the combination of dynamic and static trajectory information.

1.4 Parameter settings

- Trajectory detection range setting: Set the application range for trajectory tracking.

1.5 Applications

- Smart household appliances
- Office energy conservation (ACs/lighting)
- Regional human detection
- Home security
- Fan and air supply systems

2. Product encapsulation diagram

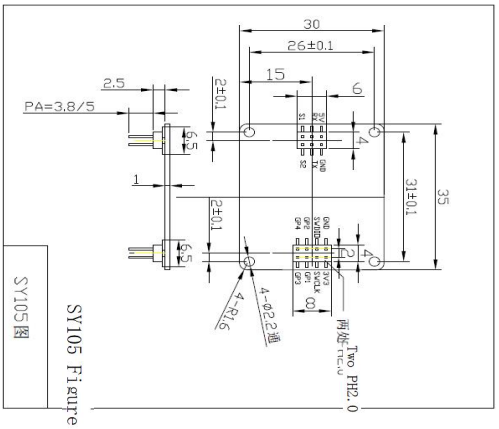

Fig. 2 Radar Module Size Diagram

- 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

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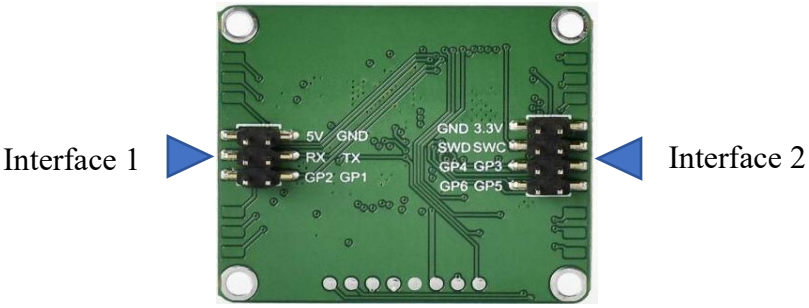

Fig. 3 Radar Module Interface Terminal Encapsulation Diagram

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	GP2	3.3V/0V	Spare extension pin
	6	GP1	3.3V/0V	Spare extension pin
Interface 2	1	3V3	3.3V	Output power
	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: For user interface, the output signals from this interface are all 3.3 V in level.

3.2 Serial port output parameters

- Presence/Non-presence
- Active/Still
- Real-time trajectory orientation data (x, y)
- Product Info

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3.3 Output protocol

- SIP-S v1.0 Serial port protocol

3.4 Naming conventions of models

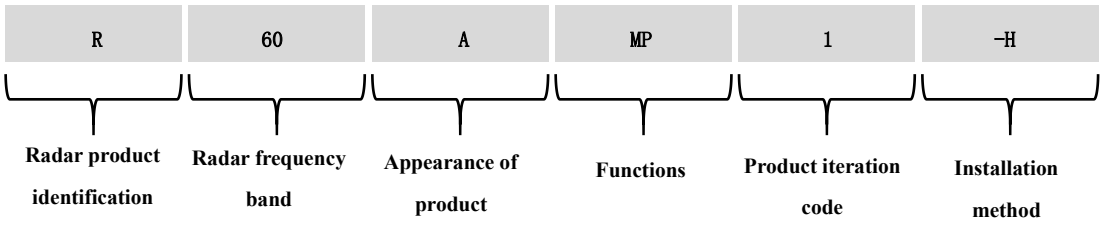

Fig. 4 Naming conventions of models

4. Product features

The R60AMP1-H radar module is in the form of 1 transmit and 3 receive antenna elements: The wide-beam radar module is mainly recommended to be side-mounted horizontally; this radar module is primarily designed for inclined installation, and achieves large-angle detection of human presence trajectory.

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 easy to install, with positioning holes for free fixation and pins for proper wiring;
- Max. number of multi-target trajectory tracking: ≤ 2 persons;

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
R60AMP1-H					

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Mounting height of radar	1.0	1.3	1.5	M	MHorizontal side-mounting
Human trajectory and tracking distance (Horizontal FOV ± 50°)	4	-	5	M	
Sensing distance for positions of static persons (Horizontal FOV ± 40°)	3	-	4	M	
Angle of radar detection (horizontal)	-	100	-	Degree(s)	
Angle of radar detection (inclined)	-	80	-	Degree(s)	

5.2 Electrical characteristics

Working Parameters	Minimum	Typical value	Maximum	Unit
Working voltage (VCC)	4.9	5.0	5.5	V
Average current (ICC)	-	-	100	mA
Peak current	-	-	300	mA
Working temperature (TOP)	-20	-	+55	℃
Storage temperature (TST)	-40	-	+85	℃

5.3 RF performance

Transmission parameter	Minimum	Typical value	Maximum	Unit
Working frequency (fTX)	60.0	-	61.0	GHz
Transmission power (Pout)	-	8	10	dBm
Antenna gain (G_{ANT})	-	8	-	dBi

5.4 Response time and others

Response time	Minimum	Typical value	Maximum	Unit
Motion detection sensitivity (m/s)		-	0.5	m/s
Output time of motion detection (ms)	-	-	500	ms
Non-presence (s)	5		120	s
Distance resolution	-	-	0.6m	m
Distance precision			0.3m	m

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Horizontal angle accuracy			10°	°
False alarm rate	Dynamic false alarm rate per 100 tests < 3%; and static false alarm rate < 5%.			
Missing alarm rate	Dynamic false alarm rate per 100 tests < 3%; and static false alarm rate < 5%.			

5.5 Application wiring diagram

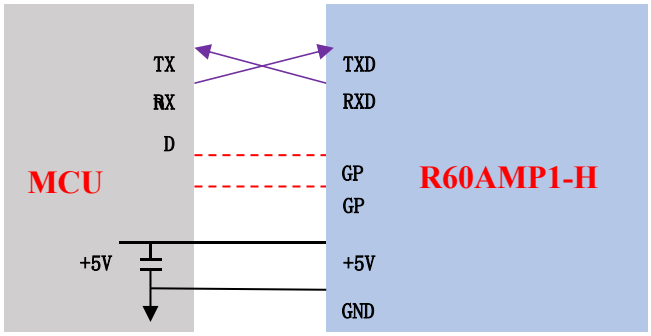

Fig. 5 Schematic diagram for connection between radar module and peripherals

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 80° vertically.

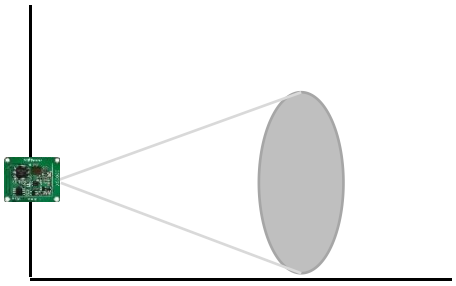

Fig. 6 Coverage of radar

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.

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

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7. Installation method and working modes

7.1 Installation method

This radar module is recommended to be mounted horizontal.

Figure 7 shows the horizontal mounting method, which applies to position detection of walking or seated targets, such as living rooms, electrical appliances, etc.

The radar is recommended to be installed at a height of 1 m - 1.5 m, horizontally in forward direction, with a tilt < ±5°.

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.

Under this installation mode, the max. distance of trajectory tracking for moving targets is L1 ≤ 5 m; and the max. distance of position detection for static targets is L2 ≤ 4 m.

Fig. 7 Diagram of inclined mounting

8. Related documents

- User Manual: http://en.micradar.cn/go_file.php?id=104

9. Notes

9.1 Start-up time

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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 and environmental factors, and might vary with the environment and the target. This module is not provided with distance measurement feature for now, and hence it's normal for the effective distance of detection to fluctuate in a certain range.

9.3 Bio-detection performance of radar

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.

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- 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 impracticable to eliminate each and every inaccurate or imperfect description. On this account, this document is for reference by the user only. We reserve the right to make any changes to the product without a prior notice to the user. We make no commitments nor guarantees on the legal level. We encourage the customers to give valuable opinions on the update on the product and its supportive tools.

1) Although we strive to improve the quality and reliability of our products, there is a probability of false alarms in the testing of millimeter-wave products.

2) To avoid any harm, disaster, or social damage caused by the malfunction of our millimeter-wave products, customers are advised to implement safety designs such as fail-safe designs, redundancy designs, fire prevention designs and fault tolerance designs, to ensure the safety of their equipment.

3) Please contact our sales office in advance, if this product is used in the following equipment that requires particularly high reliability:

4) For example, aerospace equipment, submarine equipment, power generation control equipment (nuclear, thermal, hydro, etc.), life-support medical equipment, disaster/crime prevention equipment, movable object control equipment (cars, planes, trains, ships, etc.), and other safety equipment.

5) If you intend to use this product under conditions different from our recommendations, please provide a separate certificate of compliance with technical standards or construction designs for your system.

6) 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.

7) 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.

8) Do not use this product under conditions out of the specifications listed in this manual, as this may result in product degradation or damage.

9) 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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12. Copyright notice

13. Contact

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14. Revision History

Revision	Release Data	Summary	Author
V1.0	2022/05/20	First draft	Mark
V1.1	2022/11/8	Correcting distance data in detection range	Mark
V1.2	2023/3/9	Adjusted the composition of the front portion of the document	Mark
V1.3	2024/8/15	Correct the distance angle resolution and the upper limit of the number of persons monitored	Mark
V2.0	2024/10/24	First edition of new version	Mark