60G millimeter-wave radar

R60ABD1-S

Breath & Sleep Radar-Side Mounting

Inclined installation

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 R60ABD1-S radar module employs 60 G millimeter-wave radar technology to realize breath & heartbeat sensing and sleep assessment. Based on the 1T3R FMCW (frequency modulated continuous wave) signal processing mechanism, this module performs wireless sensing on the status of people in the specific sleep areas.

Radar frequency band	60G millimeter-wave radar
Number of antennas	1T3R
Detection system	FMCW
Active detection	Heartbeat & breath, body movement parameter
	Sleep status, sleep quality

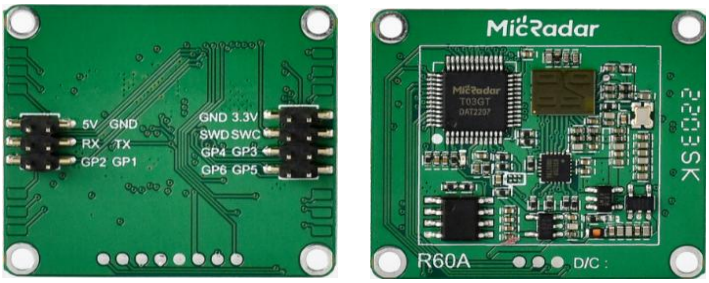

Fig. 1 Front and back sides of the radar

1.2Theory 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 subtle motion power change, distance, orientation, speed, and other information of the target, to detect the target's sleep state and chest expansion with breath.

1.3Function 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

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state will be triggered.

- Subtle motion detection function: 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.
- Sleep detection: Within the detection range of the radar, the sleep state of a person is determined in real time and sleep data is recorded, including information on the wakefulness, light sleep, deep sleep, and their duration. After the person has waken and left, a sleep score and sleep quality report are output.
- Breath & heartbeat frequency acquisition: When someone stays still in the detection range of the radar, his/her subtle motion arising from breath and heartbeat, such as chest expansion, can be detected and summarized for outputting the respiration and heartbeat rates per minute.

1.4Parameter settings

- Human presence function switch: control whether human presence function data is actively reported
- Breath detection function switch: control whether breathing detection function data is actively reported
- Heartbeat detection function switch: control whether heartbeat detection function data is actively reported
- Sleep monitoring function switch: control whether sleep detection function data is actively reported
- Non-presence timer function switch: control whether the prolonged non-presence alarm function is enabled
- Non-presence timing settings: adjust the duration for judging the prolonged non-presence alarm
- Sleep cut-off time setting: Adjust the non-presence duration pf person out of bed for sleep cutoff.

1.5Applications

- House intelligence
- Smart appliances (ACs, loudspeakers, etc.)
- Regional human detection
- Sleep care

2. Product encapsulation diagram

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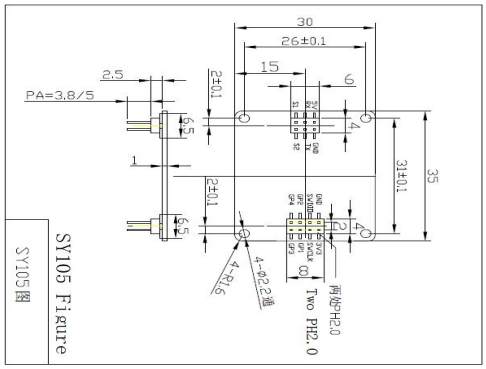

Fig. 2 Schematic diagram for radar module frame

- 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

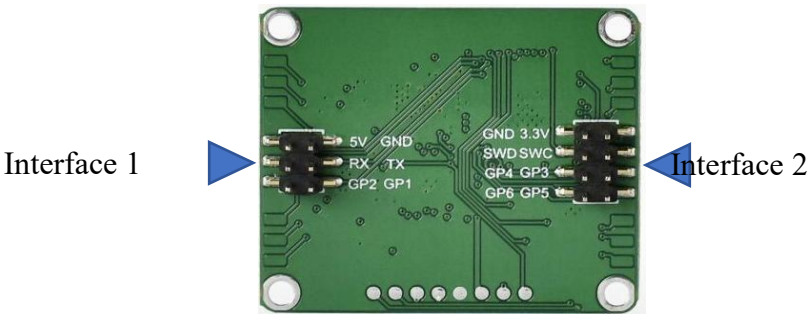

Fig. 3 Radar Pins

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	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

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	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 user usage

Interface 2: debugging interface for the radar's internal firmware burning

Note: The output signals from this interface are all 3.3V in level.

3.2 Serial port output parameters

- Presence/Non-presence
- Active/Still
- Body movement parameter
- In/Out of bed
- Sleep status: Awake/Light Sleep/Deep Sleep
- Sleep score/sleep rating
- Sleep quality analysis
- Prolonged non-presence abnormality judgment
- Respiratory rate
- Respiratory waveform
- Heartbeat frequency
- Heartbeat waveform
- Product Info

3.3 Output protocol

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

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3.4 Naming conventions of models

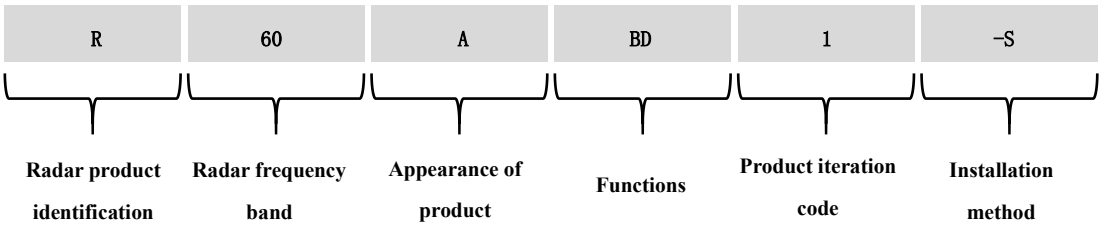

Fig. 4 Naming conventions of models

4. Product features

The R60ABD1-S radar module is in the form of 1 transmit and 3 receive antenna elements: The wide-beam radar module is mainly applicable to inclined installation. It controls the angle and coverage via algorithms, and accurately scans the full-body motion tomography to realize sleep detection of people who are static and moving as well as acquisition of breath & heartbeat data under different postures.

This radar module features the following:

- 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;

5. Electrical characteristics and parameters

5.1 Detection angle and distance

Parameter details	Minimum	Typical value	Maximum	Unit	Installation method
R60ABD1-S					
Presence detection distance	1.2	1.5	1.8	m	Inclined
In-bed detection distance (chest)	0.9	1	1.1	m	
Detection distance of sleep (chest)	0.4	-	2.7	m	
Non-presence detection distance	2.7	-	3	m	

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Detection distance of breath and heartbeat (chest)	0.4	-	1.5	m	installation
Measurement range of breath	10	-	35	times/min	
Measurement range of heartbeat	60	-	120	times/min	
Angle of radar detection (horizontal)	-	60	-	Degree(s)	
Angle of radar detection (inclined)	-	60	-	Degree(s)	

5.2 Electrical characteristics

Working Parameters	Minimum	Typical value	Maximum	Unit
Working voltage (VCC)	4.5	5	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)	61	-	62.5	GHz
Transmission power (Pout)	-	8	10	dBm
Antenna gain (GANT)	-	8	-	dBi

5.4 Response time

Response time	Minimum	Typical value	Maximum	Unit
Presence	3	-	5	s
In Bed	3	-	40	s
Out of Bed	30	-	50	s
Non-presence	48	-	60	s

5.5 Application wiring diagram

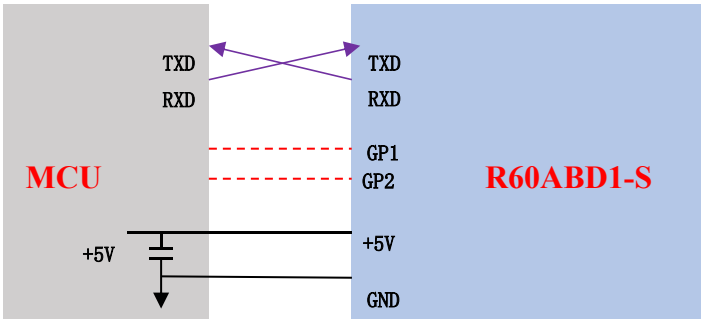

Fig. 5 Schematic diagram for connection between radar module and peripherals

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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 60° horizontally and 60° vertically.

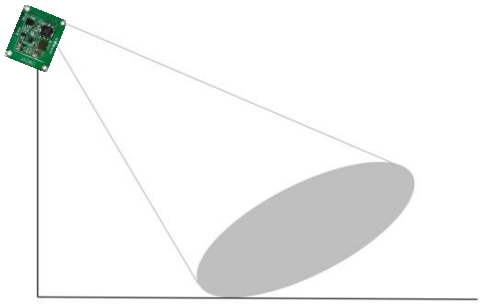

Fig. 6 Diagram for coverage of radar beams

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 of horizontal mounting, 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 Installation method

For detection of sleep, the radar should be mounted inclined (as shown in Fig. 6) and 1 m right above the surface of the bed. The tilt angle should be 45° downwards to align it with the bed center. Keep the radar-chest distance within 1.5 m to make sure the radar can detect parameters related to sleep, breath and heartbeat properly.

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 area of sleep detection.

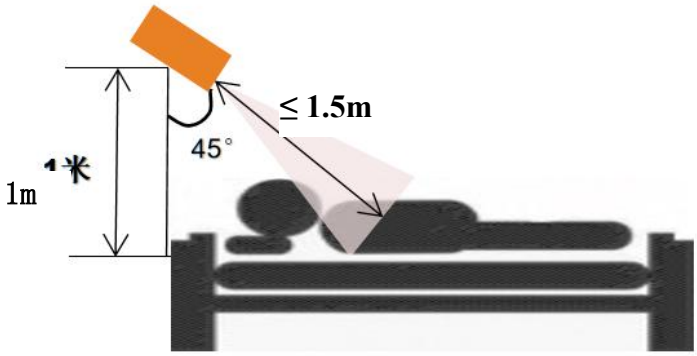

Fig. 7 Schematic Diagram of Bed Head Tilted Downward

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8. Related documents

- User Manual: http://en.micradar.cn/go_file.php?id=184
- Start Guide：http://en.micradar.cn/go_file.php?id=89
- Development board: http://en.micradar.cn/go_file.php?id=91

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 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.

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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

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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.

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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.

4) 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.

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

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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.

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14. Revision History

Revision	Release Data	Summary	Author
V1.0	2023/2/16	Draft	Mark
V1.1	2023/3/12	Adjusted the composition of the front portion of the document	Mark
V2.0	2024/10/23	First edition of new version	Mark