24GMilimeterwave

Bio-sensing radar

R24BBD1-Respiratory sleep radar

Datasheet(Ver.1.3)

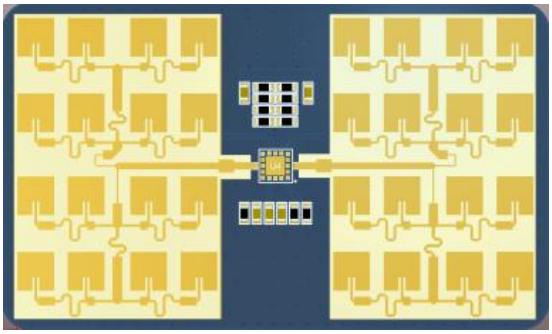
MicRadar Technology (Shenzhen) Co.,LTD

R24BBD1 - Breathing Sleep Radar

Product Manual (V1. 3)

Features

- stationary human detection;
- vital signs detection;
- 24GHz millimeter wave radar sensor;
- Based on millimeter wave radar technology, realize the function of personnel perception in the radar scanning area;
- Realize the synchronous perception function of sports personnel and stationary/sleeping personnel;
- The maximum detection distance of human sleep quality monitoring: ≤ 1.5m;
- The maximum detection distance of human respiratory rate output: ≤ 1.5 meters;
- Antenna beam width: R24BBD1: horizontal 40° /vertical 40° fan beam;
- With scene recognition ability, it can identify people/unmanned people and people's static activity status, and output body motion range;
- Not affected by temperature, humidity, noise, airflow, dust, light, etc.;
- The output power of the radar module is less than 0.5 watts and requires long-term power supply work;
- Unmanned to human detection time: within 0.5 seconds;
- Time of detection (reporting) between someone and no one: automatic detection according to the algorithm, the typical value is 90 seconds;



R24BBD1

Model Description

✧ R24BBD1 - Breathing Sleep Radar Sensor, 40° /40° Fan Beam

[High measurement accuracy, it is recommended to use it in the installation facing the detection position (bed surface)]

Applications

Sleep detection application:

✧ Sleep monitoring (sleep state change detection: sleep state, sleep duration, etc.)

Breath detection application:

✧ Respiratory rate monitoring

Product packaging:

✧ Volume: ≤46mm×27.5mm×7.5mm

✧ Interface: Pitch 2.0mm interface, double row of pins, 2*3 and 2*4 total 2 sets of interfaces

Serial output parameters :

✧ Someone/Nobody

✧ active/still

✧ body movement parameters

✧ Getting in/Getting out of bed

✧ awake /light sleep / deep sleep

✧ breath rate

✧ breathing signal

Configurable parameters :

- ✧ Scene Mode Settings
- ✧ Sensitivity setting
- ✧ Sleep switch settings
- ✧ Breath switch settings

Output protocol :

- ✧ Standard Serial Protocol
- ✧ Tuya Standard Protocol

Contents

1. Overview

The R24BBD1 radar module is a radar detection module that uses millimeter wave radar technology to realize human motion perception, human static perception and human sleep breathing perception. This module is based on the enhanced radar signal processing mechanism, and realizes the wireless perception of the state of the people in the sleep scene through the synchronous sensing technology of the intensity of the movement of the people and the physiological parameters of the people's sleep breathing.

This module is mainly suitable for installation in sleeping scenes to achieve target detection in sleeping areas; in actual installation and application, it is necessary to pay attention to the occlusion of the actual scene in order to achieve a more stable radar detection function.

This radar module has the following working characteristics:

- ✧ Realize the synchronous perception function of sports personnel and stationary personnel (sitting, sleeping);
- ✧ Continuously detect sleep breathing and other related information of sleepers, and record related sleep time curve information
- ✧ It can quickly output the distance and approach status of the target distance from the radar
- ✧ Detect various motion amplitudes and output numerical status in real time
- ✧ Limit the detection object to persons with biological characteristics (moving or stationary), and eliminate the interference of other inanimate objects in the environment;
- ✧ This module can effectively eliminate the interference of non-living objects, and can also realize the detection of non-living moving objects;
- ✧ The product supports secondary development and adapts to various scenarios and applications;
- ✧ Universal UART communication interface, providing common protocols
- ✧ 4 groups of I\O are reserved, which can be input and output according to user definition, or simple interface simulation can be done
- ✧ The output power of this module is small, no harm to human body;

✧ This module is not affected by temperature, light, dust and other factors, has high sensitivity, and has a wide range of applications.

2. Electrical Characteristics and Parameters

2.1. Detection angle and distance

Parameter content	minimum	Typical value	maximum value	unit
R24BBD1				
Sleeper perceived distance	0.5	-	1.5	Meter
Respiratory rate detection distance	0.5	-	1.5	Meter
Respiratory rate detection range	0		25	times/min
Radar detection angle (horizontal)	-	40	-	Spend
Radar detection angle (pitch)	-	40	-	Spend

2.2. Electrical Characteristics

Working parameters	minimum	Typical value	maximum value	unit
Operating voltage (VCC)	4.5	5.0	6	V
Working current (ICC)	90	93	100	mA
Working I\O Sink/Output Current (IIO)	—	8	20	mA
Operating temperature (TOP)	-20	-	+60	° C
Storage Temperature (TST)	-40	-	+80	° C

2.3. RF performance

launch parameters				
Operating frequency (fTX)	24.0	-	24.25	GHz

Transmit power (Pout)	-	-	6	dBm

3. Module size and pin description

3.1. Module size package

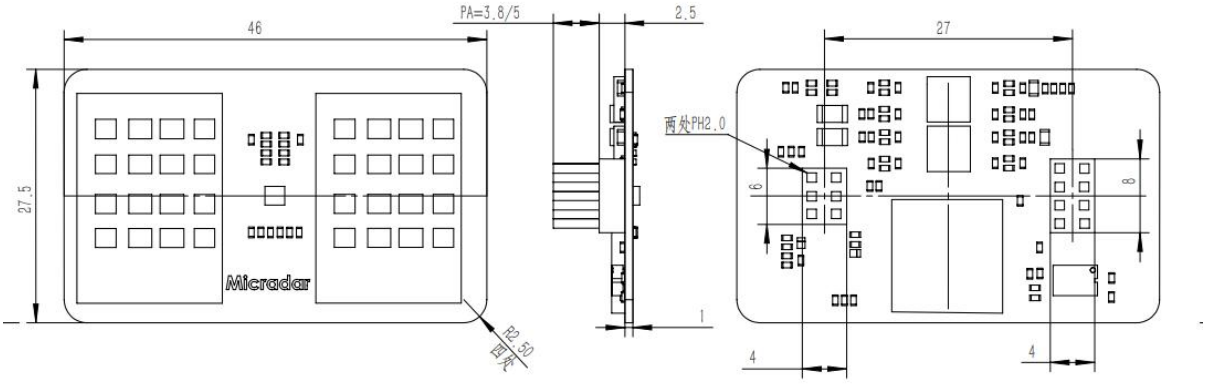


Figure 1 Schematic diagram of the structure of the radar module

3.2. Pin Description

interface	pin	describe	Typical value	illustrate
interface 1	1	5V	5.0V	Power input positive terminal
	2	GND		land
	3	RX	3.3V	Serial receive
	4	TX	3.3V	Serial send
	5	S1	3.3V / 0V	Someone/Nobody
	6	S2	3.3V / 0V	active/still
interface 2	1	3V3	3.3V	input power
	2	GND		land
	3	SL		reserve

	4	SD		reserve
	5	GP1		Spare expansion pins
	6	GP2		Spare expansion pins
	7	GP3		Spare expansion pins
	8	GP4		Spare expansion pins

Note: 1) S1 output: high level - someone, low level - no one;

2) S2 output: high level - active, low level - still

3) GP1~GP4 are parameter selection control terminals, which can be redefined according to user needs.

4) The output signals of this interface are all 3.3V level.

3.3. Use wiring diagrams

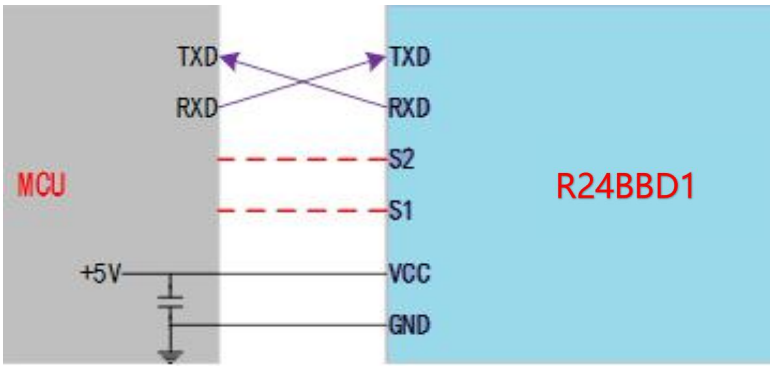


Figure 2 Schematic diagram of the connection between the radar module and the peripherals

4. Main work function and performance

4.1. Radar module working range

The beam coverage of the R24BBD1 radar module is shown in Figure 4. The radar coverage is a three-dimensional sector area of 40° in the horizontal and 40° in the elevation.

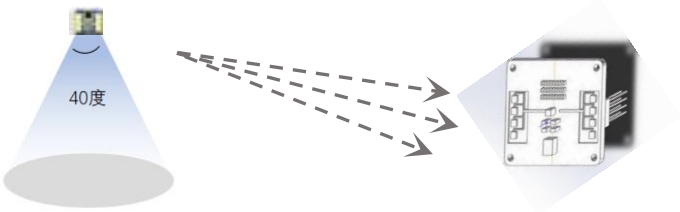


Figure 4 Schematic diagram of R24BBD1 radar coverage area

Affected by the characteristics of the radar beam, the radar's working distance in the normal direction of the antenna surface is relatively long, but the working distance away from the antenna normal direction will be shorter.

When the radar is installed on the top or inclined, affected by the range of the radar beam and the effective radiation space, the range of the radar will be reduced, so you need to pay attention when using it.

4.2. Main functions and performance

The main detection functions of this radar module include:

A、Sleep state detection function

(1) Maximum detection distance: ≤1.5 meters;

B、Respiratory rate statistics function:

(1) Maximum detection distance: ≤1.5 meters;

(2) Maximum respiration detection frequency: ≤25 times;

C、Sleep quality assessment function;

D、Sleep duration recording function;

E、Environmental status assessment function;

F、Early warning design function;

5. Radar work and installation

5.1. Installation method

This radar module is recommended to be installed obliquely, and the distance parallel to the scanning plane should be ≤1.5 meters.

5.1.1. **Sleep breathing detection function**

As shown in Figure 5, the inclined installation method above the head

of the bed is shown. This installation method is mainly used for sleep application scenarios.

The radar is required to be installed at a height of 1m directly above the head of the bed, with a downward inclination of 45° to the middle of the bed, to ensure that the distance between the radar and the chest cavity is within 1.5m, and to ensure that the radar detection range can normally cover the sleeping area.

The normal direction of the radar is aligned with the main detection position to ensure that the main beam of the radar antenna covers the human sleep detection area.

Limited by the beam range of the radar antenna, and deviating from the normal direction of the radar, the effective range will be reduced.

Millimeter-wave band electromagnetic waves have certain penetrating characteristics for non-metallic substances, and can penetrate common glass, wooden boards, screens and thin partition walls, and can detect moving objects behind obstructions; but for thicker load-bearing walls, metal doors, etc. cannot penetrate.

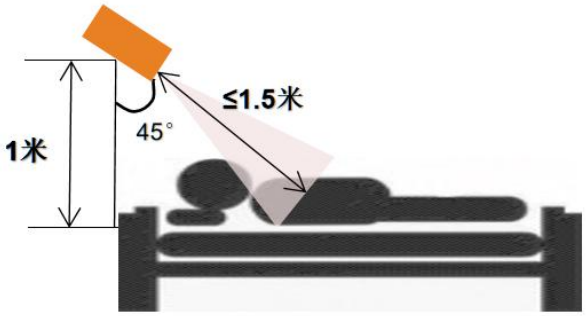


Figure 5 Schematic diagram of the oblique downward installation of the head of the bed

5.2. Radar module working mode

After the radar module passes through statistical analysis and processing, it comprehensively evaluates the status of personnel in the current detection area, and users can directly use the results.

5.2.1. state operating mode

In this mode, the radar module periodically gives the presence status and movement status of people in the current radar detection area. The main statuses include:

1) no one;

2) Someone, still;

3) people and activities;

In the state operation mode, in order to judge the accuracy of the environmental state, the radar module has carried out logic discrimination work. The state output logic of the radar module is as follows:

A. Only when the radar equipment detects a state change, the radar has the corresponding state output; otherwise, the radar remains silent;

B. The radar switches from unmanned state to manned state (moving, approaching, and moving away), which is a fast switching state, and the switching time is less than or equal to 1s;

C. When the radar switches from the manned state to the unmanned state, it needs to go through multiple state confirmations, and the switching time is ⩾1 minute;

5.2.2. Sleep detection mode

In this mode, the radar module periodically gives the sleep state and breathing frequency of the people in the current radar detection area. The main states include:

1) Sleep quality assessment: awake, deep sleep, light sleep;

2) Judgment of entering/leaving bed;

3) Respiratory frequency statistics;

4) Judgment of breathing signal: abnormal breath holding, good, abnormal movement, abnormal shortness of breath.

5) In sleep detection mode, in order to judge the accuracy of

sleep-related states, the radar module has specific installation methods and installation height restrictions:

A. The radar is required to be installed at a height of 1m directly above the head of the bed, with a downward tilt of 45° to the middle of the bed, to ensure that the distance between the radar and the human body is within 1.5m, and to ensure that the radar detection range can normally cover the sleeping area.

6. Typical Application Mode

This module is mainly used in scenarios such as healthy homes. The following describes the application modes of typical scenarios.

6.1. Bedroom installation and application

For specific applications, real-time bedridden personnel related information, such as occupancy/unmanned, sleep status, sleep depth, motion information, etc., and then provide relevant information to achieve specific applications. In this mode, the radar needs to be installed on the top. Based on this mode application, the applications that can be implemented include

- Elderly care
- Health care
- Smart home
- Family health

6.2. Healthy Living Apps

Based on the detection characteristics of the sleep state and breathing frequency of the sleeping person by this radar, the radar can

There are relatively good applications in life, and the main application modes are as follows:

- Smart health home appliance linkage application

7. Precautions

7.1. Start Time

Since the module starts to work at the initial power-on, it is necessary to completely reset the internal circuit of the module and fully evaluate the environmental noise to ensure the normal operation of the module. Therefore, when the module is initially powered on, it needs a power-on stabilization time of ⩾30s to ensure the validity of subsequent output parameters.

7.2. Effective detection distance

The detection distance of the radar module is closely related to the target RCS and environmental factors. The effective detection distance may change with the change of the environment and the target. This module does not have the ranging function for the time being, so it is normal for the effective detection distance to fluctuate within a certain range.

7.3. Radar Biodetection Performance

Since human biometrics belong to ultra-low frequency and weak reflection characteristic signals, radar processing requires a relatively long time accumulation process. During the accumulation process, many factors may affect the radar parameters, so the occasional detection failure is a normal phenomenon.

7.4. Power supply

Radar modules have higher requirements on power quality than conventional low-frequency circuits. When supplying power to the module, it is required that the power supply has no threshold glitches or ripples, and the power supply noise caused by the accessory equipment is effectively shielded.

The radar module needs to be well grounded. Due to the ground noise brought by other circuits, the performance of the radar module may also be degraded or even work abnormally; the most common cause is to shorten the detection distance or increase the false alarm rate.

In order to ensure the normal operation of the VCO circuit inside the module, the power supply requirement for this module is +5V~+6V power supply, and the voltage ripple is less than or equal to 100mV.

The external power supply must provide sufficient current output capability and transient response capability.

8. Common problem

Interference factors: Radar is an electromagnetic wave detection sensor, and active non-living will cause false alarms. The movement of metals, liquids, can lead to false positives. Usually, electric fans, pets close to the radar, and the shaking of metal curtains can cause false positives. Radar needs to be planned in terms of installation angle.

Non-interfering factors: radar electromagnetic waves will penetrate human clothing, curtains, thin wood, and glass. The installation angle and performance of the radar need to be determined according to the application.

Semi-interference factor: Radar judges the existence of human body and is not suitable for directly facing the air conditioner. The motor inside the air conditioner can cause the radar to misjudge. It is required that the radar product does not directly face the air conditioner. Or in the same direction as the air conditioner.

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12. Historical version update instructions

Revision	Release Data	Summary
V1.0_210818	2021/8/18	first draft
V1.1_220221	2022/02/21	Modify the corresponding relationship of S2 in the pin description
V1.2_220520	2022/05/20	Documentation details update
V1.3_220608	2022/6/8	Clarify installation details