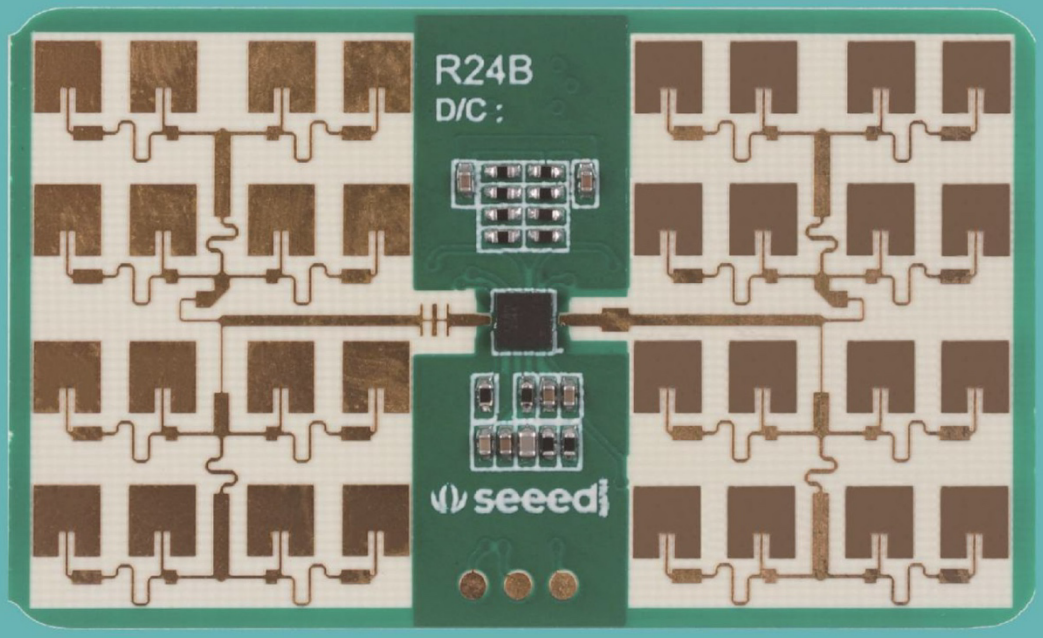
MR24BSD1

Respiratory sleep detection



Product features

- Stationary Body Detection
- Vital signs detection
- 24GHz millimetre wave radar sensor
- Based on Doppler radar technology, enabling radar scanning area person sensing functions.
- Realisation of simultaneous sensing functions for moving and stationary persons.
- Maximum distance for human sleep quality monitoring: ≤ 2.75m
- Maximum distance for human breathing rate detection: ≤ 1.5m
- Antenna beamwidth MR24BSD1: Horizontal 40°/vertical 40° sector beam
- Scene recognition capability, identify occupied/unoccupied and personnel activity status, output body movement
- unaffected by temperature, humidity, noise, airflow, dust, light, etc., suitable for harsh environments
- low output power, no harm to human body for long time irradiation.
- Detection time from unoccupied to occupied: within 0.5 seconds
- Detection time from man to man: more than 1 minute

Model description

Type description MR24BSD1 - Narrow beam body sensing radar sensor, 40° /40° sector beam (high measurement accuracy, recommended for use at a distance of 6 m)

Product Applications

Sleep detection applications: Sleep monitoring (sleep profiles)
Breath detection applications: Respiratory rate monitoring

Product Packaging

Volume: ≤ 46MM x 27.5MM x 5MM
Interface: PITCH 2.0MM interface, double row of pins

CONTENTS

1. Overview

The MR24BSD1 radar module is a radar detection module for human motion sensing and human bio-awareness using millimetre wave radar technology. The module is based on an enhanced Doppler radar signal processing mechanism, which enables the wireless sensing and reporting of the presence and fall status of a person in a specific location through the simultaneous sensing of the Doppler parameters of the person's movement and the physiological parameters of the person.

The module's thrity-two-array antenna format: wide beam radar module, wide beam radar module is mainly suitable for top-mounted mode, to achieve a wide range of radar detection; if used for horizontal or inclined installation, need to pay attention to the actual scene obscuration, in order to achieve a longer range of radar detection function.

This radar module has the following operating characteristics:

- Enables simultaneous sensing of moving persons and stationary persons (sitting, sleeping).
- Detects stationary persons in real time
- Accurate detection of falls in specific locations, with guaranteed real-time output
- Rapid output of the distance of the target from the radar in terms of distance and proximity
- Detects a wide range of movements and outputs numerical status in real time
- Limits detection to persons with biological characteristics (moving or stationary), eliminating interference from other inanimate objects in the environment.
- The module effectively rejects interference from non-living objects and also enables detection of non-living moving objects.
- Product support for secondary development, adapted to a variety of scenarios applications.

- Universal UART communication interface, providing a common protocol
  4 groups of I\O are reserved for user-defined input and output, or simple interface simulation
- The output power is low, no harm to human body.
- This module is not affected by temperature, light, dust and other factors, high sensitivity, wide range of applications.

2. Electrical characteristics and parameters

2.1. detection angle and distance

Parameter content	Minimum value	Typical values	Maximum value	Unit
MR24BSD1 (32-point narrow beam antenna)				
Sleeper perception distance	-	-	2.75	meter
Fall state sensing distance	0.5		1.5	meter
Radar detection angle (horizontal)	-	90	-	meter
Radar detection angle (pitch)	-	60	-	degree

2.2. electrical characteristics

Operating parameters	Minimum value	Typical values	Maximum value	Unit
Operating voltage (VCC)	4.5	5.0	6	V
Operating current (ICC)	90	93	100	mA
Operating I\O Inflow/Output Current	-	8	20	mA

Operating parameters	Minimum value	Typical values	Maximum value	Unit
(IIO)				
Operating temperature (TOP)	-20	-	+60	℃
Storage temperature (TST)	-40	-	+80	℃

2.3. RF Performance

Launching parameters				
Operating frequency (fTX)	24.0	-	24.25	GHz
Transmitted power (Pout)	-	-	6	dBm

3. Module dimensions and pin description

3.1. Module size package

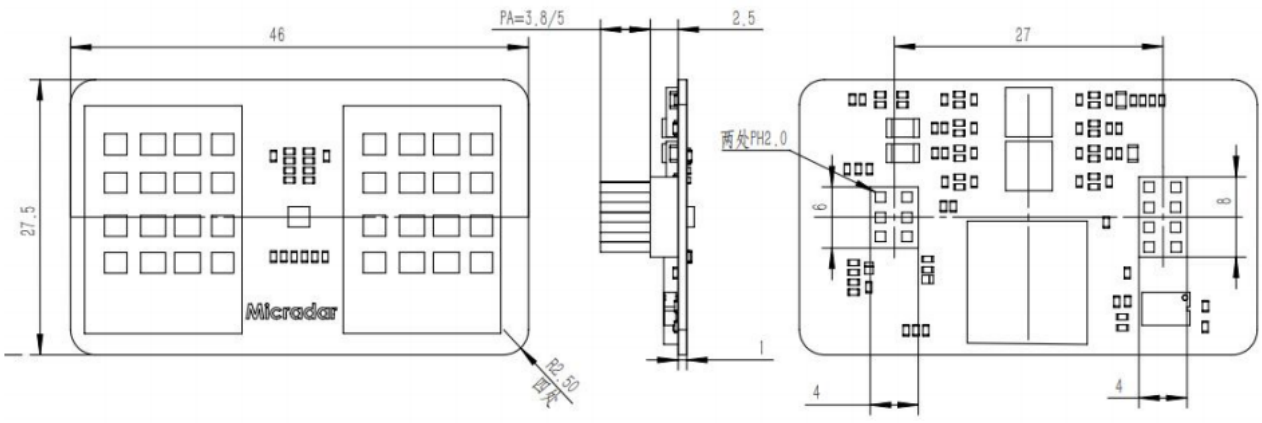


Fig. 1 Schematic diagram of the radar module structure

3.2. pin descriptions

Interface	Pins	Description	Typical values	Description
Interface 1	1	5V	5.0V	Positive power input
	2	GND		Ground
	3	RX		Serial port reception
	4	TX		Serial port send
	5	S1	3.3V/0V	occupied/unoccupied
	6	S2	3.3V.0V	Stationary / Active
Interface 2	1	3V3	3.3V	Output power
	2	GND		Ground
	3	SL		Reserved
	4	SD		Reserved
	5	GP1		Spare expansion pins
	6	GP2		Spare expansion pins
	7	GP3		Spare expansion pins
	8	GP4		Spare expansion pins

Notes

1. S1 output: high level - occupied, low level - unoccupied.
2. S2 output: high level - active, low level - stationary
3. GP1 to GP4 are parameter selection controls, which can be redefined according to user requirements.
4. The output signals of this interface are all at 3.3V level.

3.3. using the wiring diagram

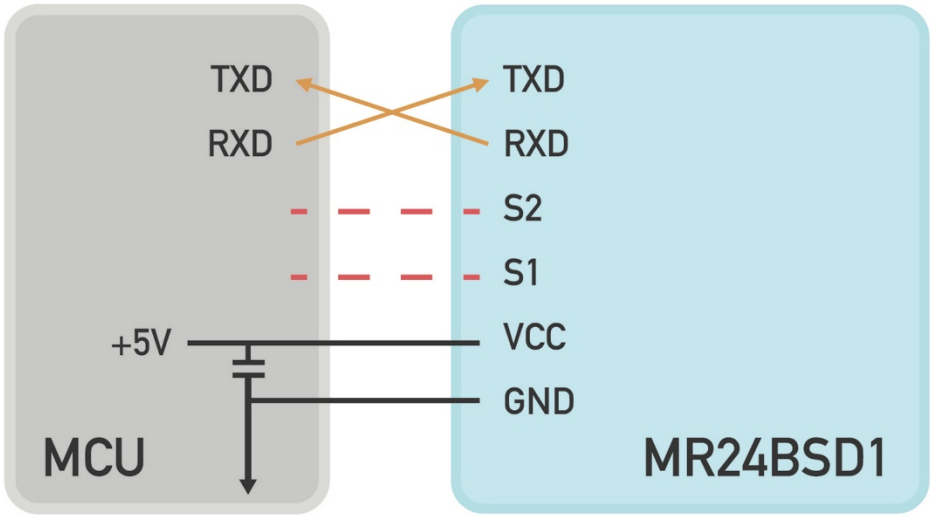


Fig. 2 Schematic diagram of the radar module and peripheral connections

4. Main operating performance

4.1 Radar module operating range

The MR24BSD1 radar module beam coverage is shown in Figure 4. The radar coverage is a three-dimensional sector of 40° horizontally and 40° tilted.

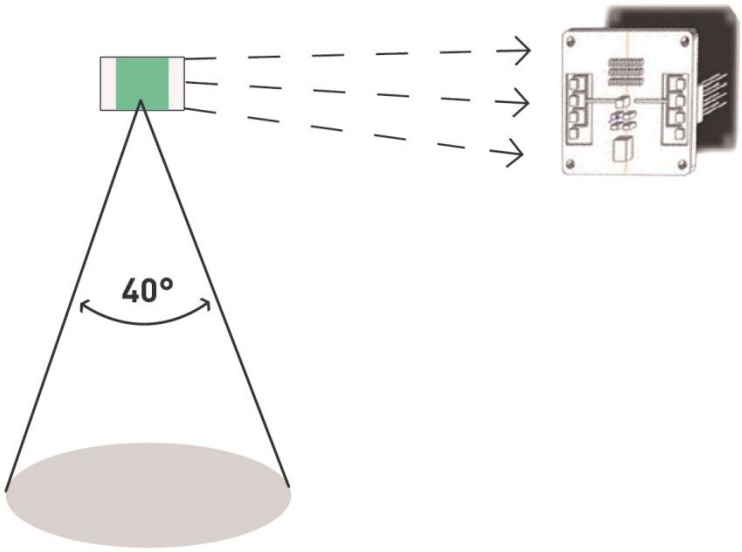


Fig. 4 Diagram of the MR24BSD1 radar coverage area

Due to the radar beam characteristics, the radar has a relatively long range in the direction normal to the antenna face, but a shorter range if it deviates from the antenna normal.

When the radar is mounted on top or at an angle, the radar beam range and the effective radiation space will reduce the radar range, which needs to be taken into account when using the radar.

4.2. main functions and performance

The main functions of this radar module include

A. Breath detection function.

(1) Maximum detection distance: ≤ 2.75 m.

(2) Reflection time: ≤ 60s.

B. Respiration frequency statistics function.

(3) Maximum detection distance: ≤ 1.5 m.

(4) Maximum breath detection frequency: ≤ 30 times

(5) Minimum breath detection frequency: ≥ 12 times.

C. Sleep quality assessment function.

D. Sleep time recording function.

E. Environmental state assessment function.

F. Early warning design function.

5. works and installation

5.1. installation methods

This radar module is recommended to be installed according to the different functions of use.

5.1.1 Breathing rate statistics function

For respiratory rate statistics, the radar needs to be positioned within 0.5m - 1.5m of the chest cavity and the chest cavity needs to be exposed to the radar's antenna detection range.

(Radar is recommended for top or tilt mounting)

5.1.2 Sleep quality assessment function

When using the Sleep Detection Radar for sleep quality assessment and sleep time recording, the installation is only available as a top-mounted or tilt-mounted installation, with a radar height of no more than 2.75 m. The installation scenario is only suitable for resting areas such as the top of a bedroom bed.

Caution.

A. The different installation methods mentioned above require the main radar beam to cover the main area of human activity and to be oriented normal to the body as far as possible.The above-mentioned installation methods require the main radar beam to cover the main human activity area and to be oriented normal to it as far as possible

B. When installed diagonally downwards, the horizontal distance will be reduced due to changes in the horizontal projection of the coverage area.

C. Affected by the electromagnetic wave transmission characteristics, the radar action distance is related to the target RCS, the material and thickness of the target cover.

D. Due to the influence of electromagnetic wave transmission characteristics, the radar action distance is associated with the target RCS, target cover material and thickness, and the effective radar action distance will vary to a certain extent.

E. For stationary human detection, different body positions will have an impact on the radar range, and the radar does not guarantee that the maximum range will be reached in all states.

5.2 Radar module operating modes

The radar module provides a comprehensive assessment of the current status of people in the detection area after statistical analysis and processing, and the user can make direct use of the results.

- Status operation mode

  In this mode, the radar module periodically gives the presence and

movement status of people in the current radar detection area, the main states are

1. No person present.
2. occupied, stationary.
3. occupied, active.

State operation mode, in order to environmental state judgment accuracy, the radar module internal logic discriminate work, the radar module state output logic is as follows.

A, radar equipment only when a state change is detected, the radar has the corresponding state output; conversely, the radar remains silent.

B, switching time ≤ 1s.

C, the radar switches from manned to unmanned state, requiring multiple state confirmations and a switching time of ≥ 1 minute.

- Sleep detection mode

In this mode, the radar module periodically gives the sleep state and breathing rate of the person in the current radar detection area, with the main states being.

1. Sleep quality assessment: awake, deep sleep, light sleep.
2. Judgement of bed entry and departure.
3. Breathing rate statistics.
4. Breathing signal judgement: abnormal breath holding, good, abnormal movement, abnormal rapid breathing

In the sleep detection mode, the radar module has specific installation and installation height restrictions for the accuracy of sleep-related status judgement:.

D. When the breathing frequency statistics function in the sleep function is required, the installation method can only be selected as top-mounted or tilt-mounted, keeping the position of the radar and the chest between 0.5m~1.5m

E. When the sleep quality assessment and sleep time recording

functions of the sleep detection radar are required, the installation method can only be selected as top-mounted or tilt-mounted, with the radar installation height not higher than 2.75m, and the installation scenario is only suitable for resting areas such as the top of the bedroom bed

6. Typical application models

This module is mainly applied with home, home appliances, energy-saving light control, health care and other scenarios, the following application mode for typical scenarios is explained.

6.1. smart appliance applications

The radar is installed inside the appliance and monitors the working surface of the appliance in real time. The appliance adjusts the working mode of the appliance (working, low power consumption, standby, off, etc.) in real or quasi-real time according to the status of the working surface personnel (occupied/unoccupied, active/stationary, close/away) to realise the intelligence of the appliance.

In this application scenario, the radar is installed on the appliance radar and, depending on the regular nature of the appliance's work, the radar is set to be installed horizontally or at an angle to ensure that the radar beam can cover the main area of the appliance's work.

Conventional appliance equipment includes.

- Smart TVs
- Smart speakers
- Smart air conditioners
- Other smart home appliances

6.2. home applications

For places such as homes, hotels, offices and bathrooms, there is a need for real-time detection of whether people are entering or whether people are moving in the place, thus enabling ways such as security, electrical control, personnel monitoring, etc. and being able to effectively avoid

privacy issues. The radar is installed in the room and can monitor in real time whether there is a moving target in the room, the direction of movement of people, the presence of people and so on. And through the IoT transmission methods and means, combined with the relevant IoT support platform, to achieve the effective application of the relevant places. This radar can be applied in the following areas.

- Home security
- Hotel management and monitoring
- Community recreation personnel monitoring
- Office monitoring

6.3. bedroom installation and applications

For specific applications, real-time information about the person in bed, such as presence/absence, sleep status, sleep depth, movement information, etc., is given to enable specific applications. In this mode, the radar needs to be mounted on top of the bed.

Based on this mode of application, applications can be realised including

- Care of the elderly
- Recreational care
- Hotel applications
- Home health

6.4. energy saving control applications

Based on this radar motion target detection and biometric detection, the radar can have better applications in energy saving control, the main application modes are as follows.

- Home appliance energy saving
- Energy saving control of office appliances
- Street lighting energy saving control

6.5. health care applications

Based on the simulated detection of the fall speed model by this radar, the radar can have a better application in health care with the following main application models.

- Alarm automatic communication with emergency contacts applications

7. Notes

7.1. start-up time

As the module requires a complete reset of the module's internal circuitry and a full assessment of the environmental noise when the module initially powers up and starts to operate, it is necessary to ensure that the module works properly. Therefore the module needs a power-on stabilisation time of ≥ 30s at initial power-up operation to ensure the validity of the subsequent output parameters.

7.2. effective detection distance

The detection distance of the radar module is highly dependent on the target RCS and environmental factors, and the effective detection distance may change as the environment and the target change.

7.3 Radar biodetection performance

As human biometric features are ultra-low frequency, weakly reflective signals, radar processing requires a relatively long period of cumulative processing, and many factors may affect the radar parameters during the cumulative process, so occasional detection failures are normal.

7.4. power supply

Radar modules require higher quality power supplies than conventional low frequency circuits.

When supplying power to the module, the power supply must be free of threshold burr or ripple and effectively shielded from power supply noise caused by accessory equipment.

The radar module needs to be well grounded, as ground noise from other circuits can also cause degraded performance or even abnormal operation of the radar module; most commonly resulting in reduced detection range or increased false alarms.

In order to ensure the normal operation of the module's internal VCO circuitry, the power supply to the module is required to be +5V to +6V with a voltage ripple of ≤100mV.
The external power supply must provide sufficient current output capability and transient response.

8. Common problems

Interference factors: Radar is an electromagnetic wave detection sensor and moving inanimate objects can lead to false alarms. Movement of metals, liquids, can lead to false positives. Often, electric fans, pets close to the radar and the swaying of metal curtains can cause false alarms. Radar needs to be planned at the angle of installation.
Non-interference factors: Radar electromagnetic waves can penetrate human clothing, curtains, thin wooden panels, glass. Depending on the application, the installation angle and performance of the radar needs to be determined.
Semi-interference factors: Radar determines the presence of the human body and is not suitable for direct exposure to air conditioners. Internal motors in air conditioners can cause radar miscalculations. Radar products should not face the air conditioner directly. Or in the same direction as the air conditioner.

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11. Historical version update notes

Revision	Release Data	Summary
V1.0_210818	2021/8/18	First draft