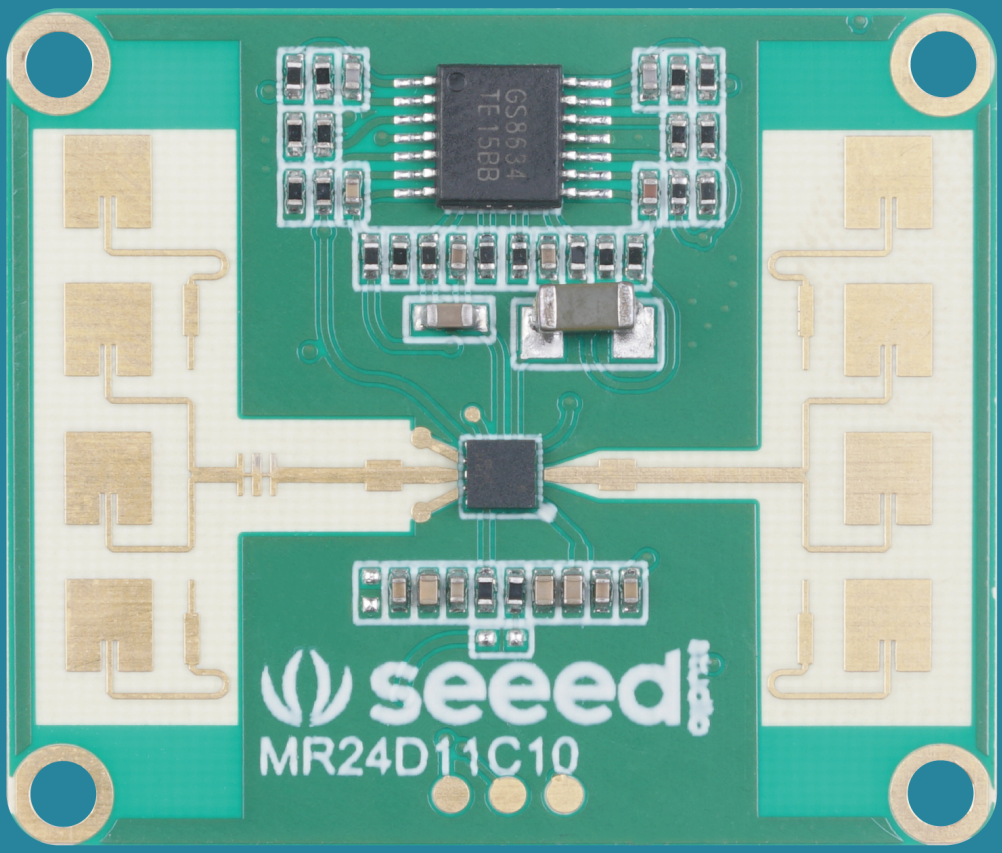
MR24HPB1

Human Presence Radar Product



Features

- Static body detection
- Vital signs detection
- 24GHz Neardistancesensor(NDS)
- Based on Doppler radar technology，can realize personnel perception function in radar scanning area.
- Realize the synchronous perception function of moving personnel and stationary personnel.
- Motion perception maximum distance：⩽12 metres
- Micromotion indicates the maximum distance：⩽5 metres
- Body perceives maximum distance：⩽3 metres
- Antenna beamwidth：MR24HPB1: Horizontic90°/ Vertical60° fan-beam pattern
- Scene recognition capability to identify occupied/unoccupied and human activity and output body movement.
- Independence from temperature, humidity, noise, air currents, dust, light, etc., suitable for harsh environments.
- Low output power and no harm to the human body from prolonged exposure.
- Unoccupied to occupied detection time: within 0.5 seconds.
- Manned to unmanned detection time: over 1 minute.

Description

MR24HPB1 – Narrow beam human sensing radar sensor, 90 degrees/60 degrees sector fan-beam pattern.

(High measurement accuracy, recommended for use at a distance of 6 metres)

Application

Human presence applications

- Health Guardian
- Smart appliances (TV, bathrom warmer, security, etc.)
- Office energy saving (air conditioning, lighting)
- Sleep monitoring (sleep profiles)
- Home security
- Automatic doors, lifts, etc.

Package

Volume: ⩽35MM×30MM×5MM

Interface: PITCH 2.0MM interface，Double-row pins

CONTENTS

1. Overview

The MR24HPB1 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 of human motion and human physiological parameters in a specific location through the simultaneous sensing of Doppler parameters.

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

This radar module has the following operating characteristics:

- Enables simultaneous sensing of moving persons and stationary persons (sitting, sleeping).
- Ability to maintain detection of stationary persons, ensuring real-time output
- Fast output of the distance of the target from the radar in terms of distance and proximity
- Detection of various ranges of motion and real-time output of numerical status
- Limits detection to persons with biological characteristics (moving or stationary) and eliminates 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, adapting to a wide range of scenario 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. Angle and Distance Detection

Parametric Content	Minimum	Typical	Maximum	Unit
MR24HPB1(8-point narrow-beam antenna)				
Movement personnel detection distance	-	-	13	metre(s)
Distance perceived by stationary/ slightly mobile personnel	-	-	5	metre(s)
Sleeper perception distance	-	-	2.5	metre(s)
Radar detection angle (horizontal)	-	90	-	degree(s)
Radar detection angle (pitch)	-	60	-	degree(s)

2.2. Electrical Properties

Operating Parameters	Minimum	Typical	Maximum	Unit
Operating Voltage (VCC)	4.5	5.0	6	V
Operating current (ICC)	90	93	100	mA
Operating I/O current (IIO)	—	8	20	mA
Operating Temperature （TOP）	-20	-	+60	℃
Storage Temperature （TST）	-40	-	+80	℃

2.3. RF Performance

Firing Parameters				
Operating Frequency （fTX）	24.0	-	24.25	GHz
Firing Power （Pout）	-	-	6	dBm

3. Module Dimensions and Pinouts

3.1. Module size Package

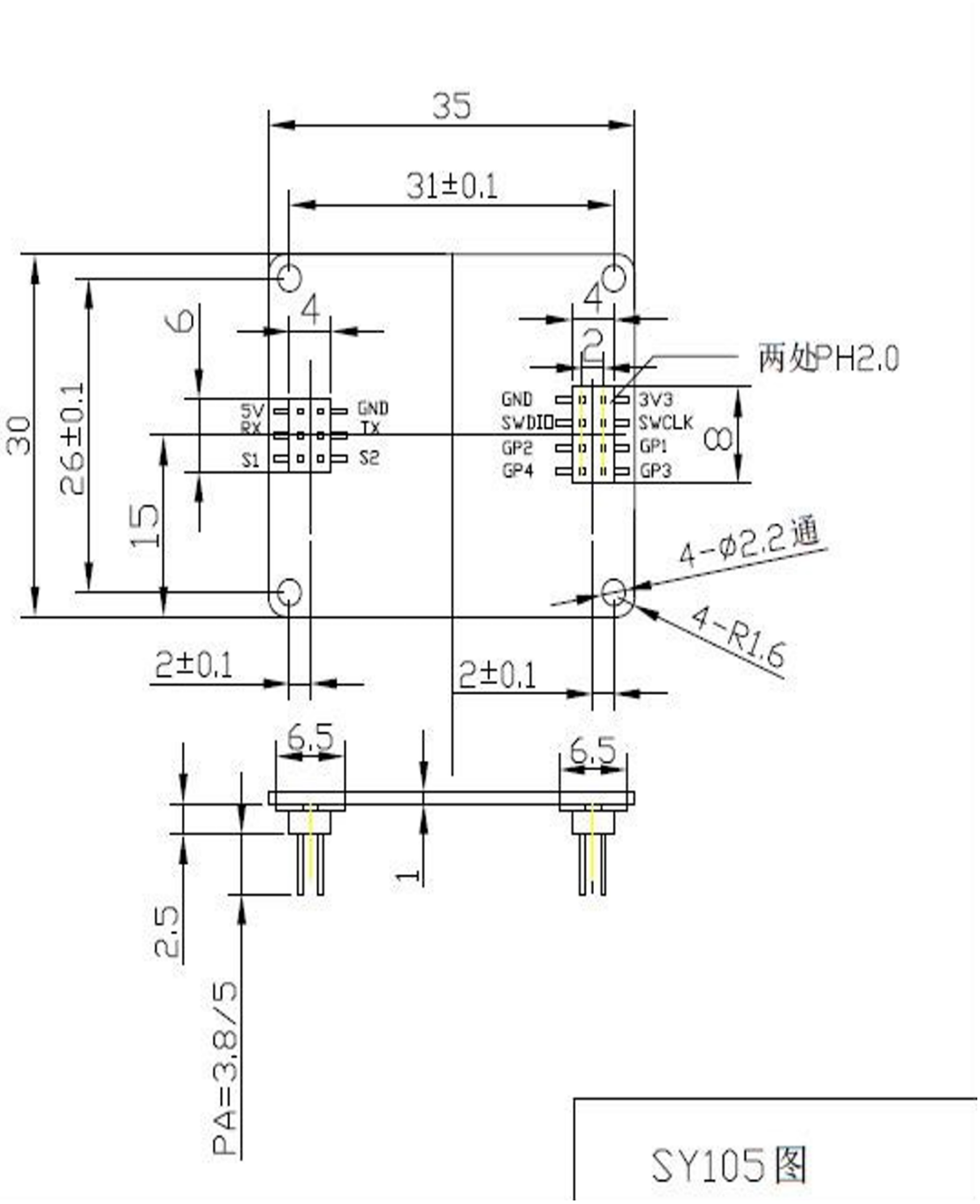


Fig. 1 Schematic diagram of the radar module structure

3.2. Pin Descriptions

Interface	Pins	Details	Typical	Description
Interface 1	1	5V	5.0V	Positive Input of Power
	2	GND		Ground
	3	RX		Serial Receive
	4	TX		Serial Transfer
	5	S1	3.3V/0V	Manned/Unmanned
	6	S2	3.3V/0V	Stationary/Active
Interface 2	1	3V3	3.3V	Power Output
	2	GND		Ground
	3	SL		Reserve Pin
	4	SD		Reserve Pin
	5	GP1		Alternative Expansion Pins
	6	GP2		Alternative Expansion Pins
	7	GP3		Alternative Expansion Pins
	8	GP4		Alternative Expansion Pins

Notes

1. S1 Output：High level–Manned，Low level–Unmanned；
2. S2 Output：High level–Active，Low level–Stationary
3. GP1～GP4 GP1 to GP4 are parameter selection consoles, which can be redefined according to user requirements.
4. The output signals of this interface are all at 3.3V.

3.3. Using the Wiring Diagram

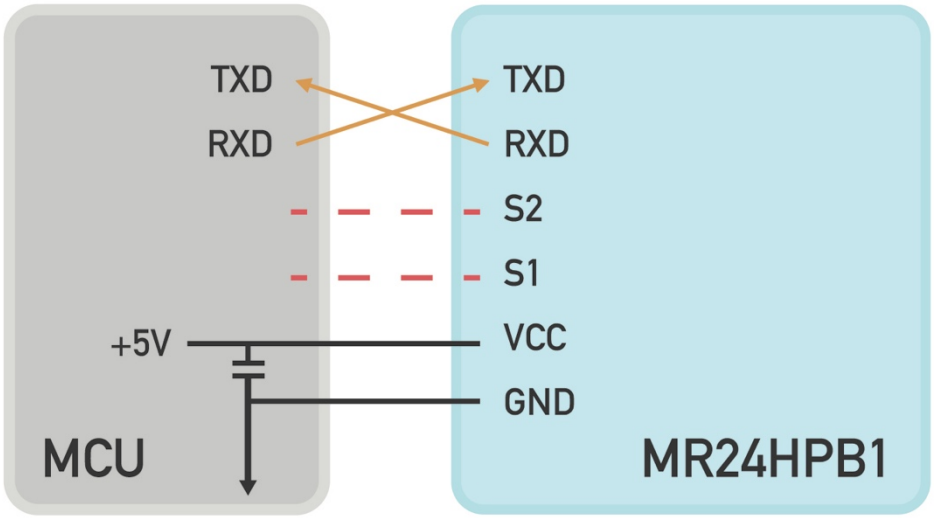


Fig. 2 Schematic diagram of the radar module and peripheral connections

4. Main Performance

4.1 Operating Range of Radar Module

MR24HPB1 Radar module beam coverage

Fig.3 Radar coverage is a three-dimensional sector of 90° horizontal and 60° pitch.

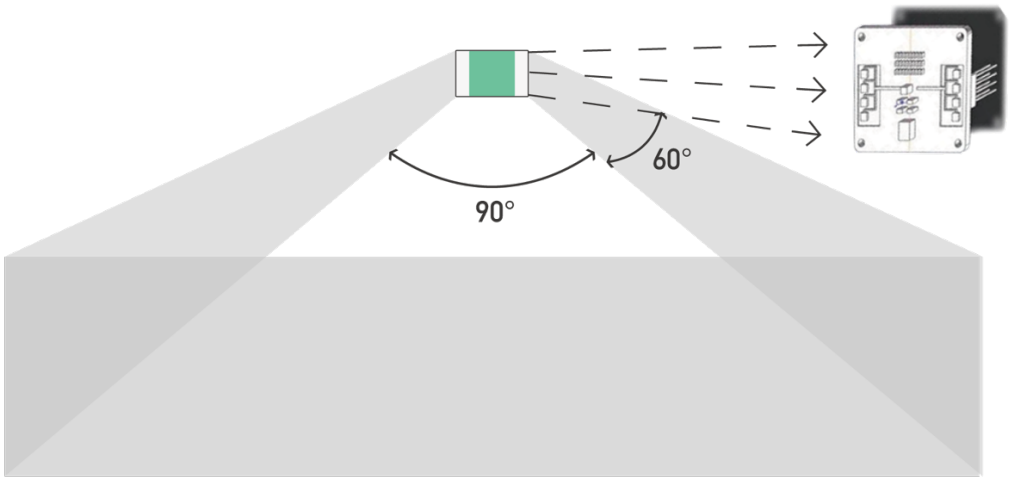


Fig.3 MR24HPB1 Diagram of the radar coverage area

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. Motion Detection

(1) Max. Detection Distance≤13 metres(Adults);

(2) Sensitivity: ≤ 0.2m/s.

(3) Action Time: ≤100ms.

B. Micromotion Detection:

(4) Max. Detection Distance：≤5 metres；

(5) Action Time：≤1s；

C. Breath Detection:

(6) Max. Detection Distance：≤2.5 metres；

(7) Action Time：⩽60s；

D. Environmental Status Assessment

E. Early Warning

5. Works and Patterns

5.1. Installation Method

The recommended mounting options for this radar module include horizontal, tilt and overhead mounting.

5.1.1. Horizontal Mounting

As shown in Figure 4 for horizontal installation, this installation method is mainly orthogonal to human detection in a standing or sitting position, such as living rooms, home appliance applications and other occasions.

The radar installation height is recommended to be 1m to 1.5m, the radar is installed horizontally and orthogonally, with an installation inclination of ⩽ ± 5o and no obvious obstructions or coverings directly in front of the radar.

The radar normal direction is aligned with the main detection location to ensure that the main beam of the radar antenna covers the detection area and that the radar beam covers the human activity airspace.

In this installation mode, the maximum distance L3 ⩽ 12m for moving body detection; L2 ⩽ 5m for sitting/movement detection and L1 ⩽ 2.5m for sleep detection.

Restricted by the radar antenna beam range, deviation from the radar normal direction position, the effective action distance will be reduced. Millimetre wave band electromagnetic waves have certain penetration characteristics for non-metallic substances, and can penetrate common glass, wooden

panels, screens and thin partition walls, and can detect moving objects behind obscurants; however, they cannot penetrate thicker load-bearing walls, metal doors, etc.

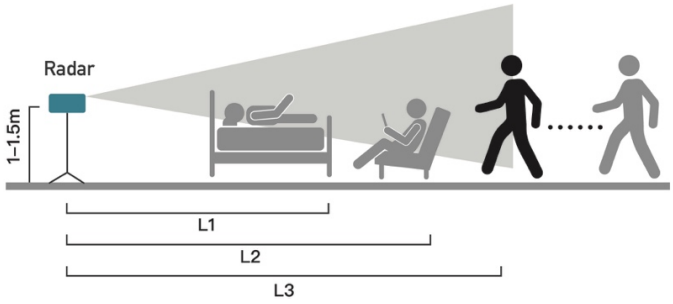


Fig. 4 Schematic diagram of horizontal installation

5.1.2. Tilt Mounting

The tilt installation is shown in Figure 5. This installation is mainly for detecting movement of people in the room and is mainly suitable for hotels, lobbies and other places.

The radar installation height is recommended to be 2–2.75m; the tilt angle of the radar is 10° to 30°, with no obvious obstructions or coverings in front of the radar.

The radar normal direction is aligned with the main detection location to ensure that the main beam of the radar antenna covers the detection area and that the radar beam covers the human activity airspace.

In this installation case, the maximum distance for the detection of moving bodies is L3 ≈ 7 m; the maximum distance for the detection of seated bodies / micro movements is L2 ≈ 4 m and the maximum distance for the detection of sleeping bodies is L1 ≈ 3 m.

In this mode, there may be a blind spot for surveillance directly below the radar and adjacent areas. The static human detection distance is

significantly compressed as the downward looking inclination angle increases.

Due to the radiation characteristics of the radar antenna, the effective radar range is reduced by deviating from the position of the radar normal.

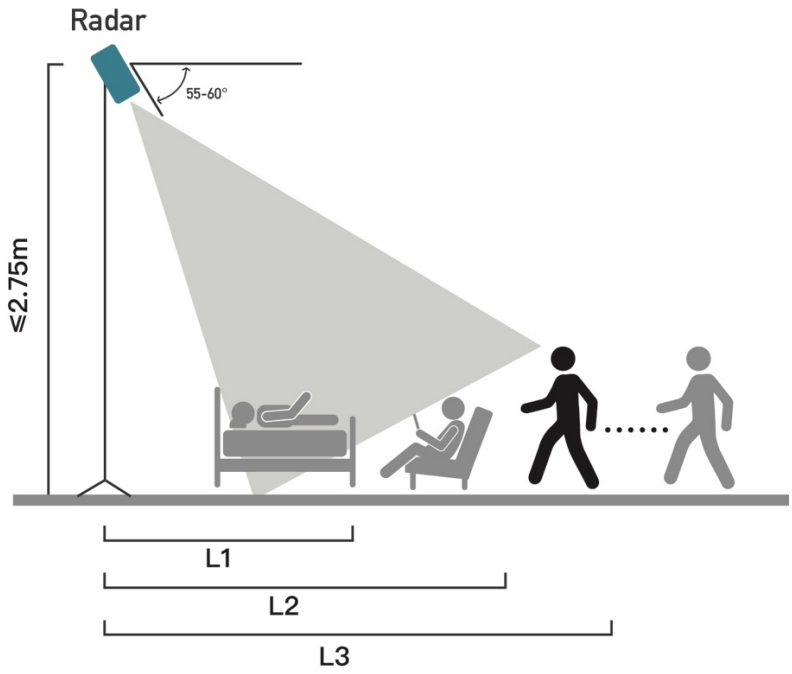


Fig. 5 Diagram of the installation in oblique downward view.

5.1.3 Top Mounting

A top-mounted installation is shown in Figure 4. This installation is mainly for human body monitoring in a lying position, such as bedrooms, elderly places, hospital beds, etc.

The radar is installed vertically with a horizontal deviation angle of ⩽ 3° to ensure that the main radar beam covers the detection area; the recommended radar installation height is ⩽ 2.75m; there are no obvious obstructions or coverings in front of the radar.

Due to the radar installation height and the radar beam range, the maximum distance for body movement detection in this installation mode is L3 ≈ 6.5m; the maximum distance for body sitting/ movement detection is L2 ≈ 3m and the maximum distance for body sleep detection is L1 ≈ 1.8m.

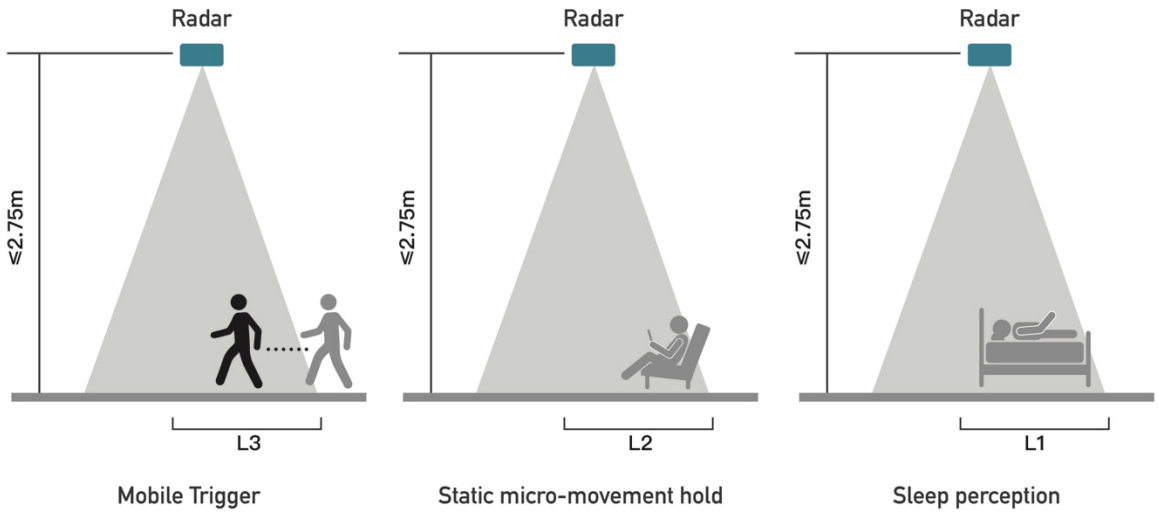


Fig. 6 Diagram of installation in oblique downward view

Caution.

A. The above–mentioned different installation methods require the radar main beam to cover the main human activity area and to be orthogonal to the normal direction 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. When the module is in operation, the surface of the module should not be obstructed by metal objects.

D. Affected by the electromagnetic wave transmission characteristics, the radar action distance is related to the target RCS, target coverage material and thickness. D. Influenced by the electromagnetic wave transmission characteristics, the radar action distance is associated with the target RCS, target cover material and thickness, the effective radar action distance will change to a certain extent.

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

5.2 Working Mode

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 status and movement status of persons in the current radar detection area, the main states being:

1. Unoccupied.
2. Manned, Unmanned.
3. Occupied, Active.
   State operation mode, in order to environmental state judgment accuracy, the radar module internal logic discriminate work, radar module state output logic 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. radar from unmanned state to manned state (movement, approach, away) is a fast switching state, switching time ⩽ 1s.

C. Radar switching from manned state to unmanned state requires several state confirmations, with a switching time of ⩾ 1 minute.

6. Typical Application Modes

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

6.1. Smart Home Appliance Application

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 achieve appliance intelligence.

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 TV
- Smart Speakers
- Smart Air Conditioner
- Other Smart Home Appliances

6.2. Home Application

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, which in turn enables ways such as security, electrical control and personnel monitoring, and can 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 used in the following applications:

- Home Security
- Hotel Management & Surveillance
- Community Recreation Staff Monitoring
- Office Surveillance

6.3. Bedroom Application

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 Application

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:

- Energy saving for home appliances
- Energy saving controls for office appliances
- Energy saving control for street lighting

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 ambient noise when it is initially powered up and started to work, the module can only be guaranteed to work 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 Bio-detection 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

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 closer detection distances or an increased false alarm rate.

In order to ensure the normal operation of the module's internal VCO circuitry, the power supply to this module requires a +5V to +6V supply with a voltage ripple of

≤100mV.

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

8. FAQ

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.