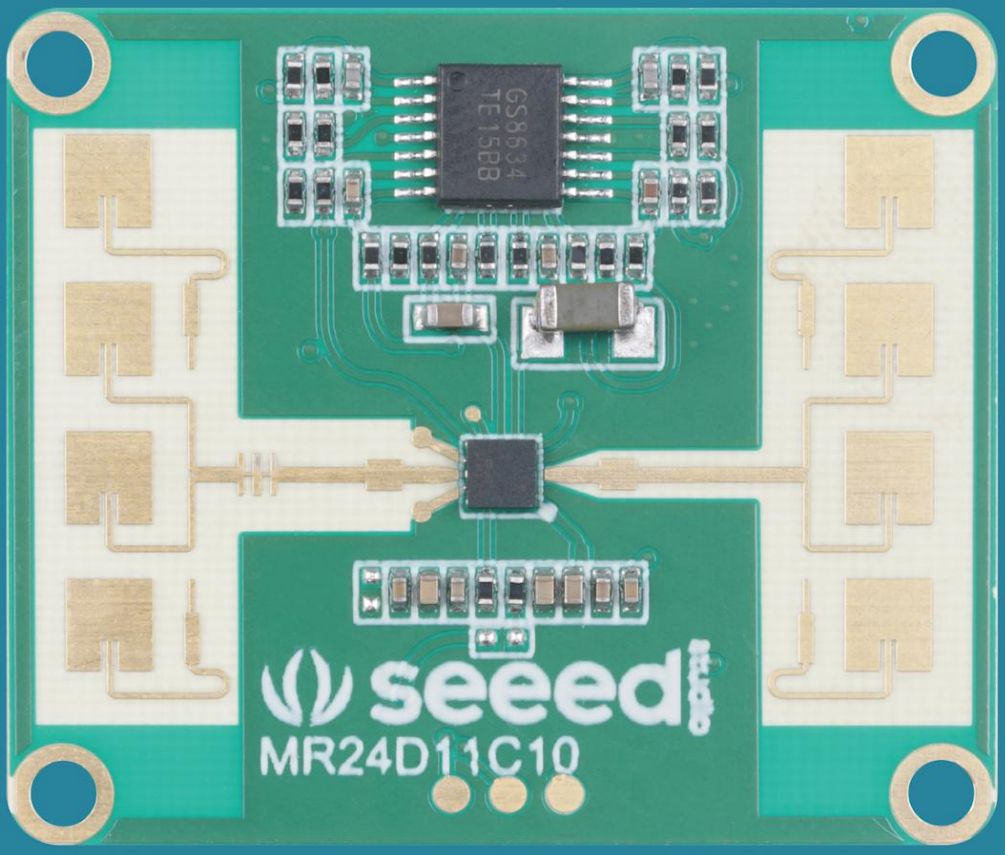
MR24HPB1

Human Presence Radar User Manual



Features

- Static body detection
- Vital signs detection
- 24GHz Neardistancesensor(NDS)
- Based on Doppler radar technology, can realize personnel perception function in the radar scanning area.
- Realize the synchronous perception function of moving personnel and stationary personnel.
- Motion perception maximum distance：⩽12 meters
- Micromotion indicates the maximum distance：⩽5 meters
- Body perceives maximum distance：⩽3 meters
-
- 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

The MR24HPB1 is a highly accurate narrow beam fall detection radar sensor of 90/60 degree sector, and it is more suitable within a 6-meter range.

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

Application

Human presence applications

- Healthcare
- Intelligent household appliances (TV, Yuba, security, etc.)
- Office energy saving (air conditioning, lighting)
- Sleep monitoring (sleep curve)
- Home security
- Automatic doors, elevators, etc

Package

Volume: ≤ 35MM x 30MM x 5MM

Interface: PITCH 2.0MM interface, double row of pins

CONTENTS

1. Overview

The MR24FDB1 radar module uses millimeter-wave radar technology to detect humans' motion and biological features. Based on enhanced Doppler radar signal processing technology, this module provides wireless detection and reports the presence and fall status of personnel in real-time through synchronized scanning technology based on Doppler parameters of movement and physiological parameters of the personnel.

This is a two-array element antenna module. This wide beam radar module is primarily suitable for top mounting to achieve detection over a wide area. If the radar is mounted horizontally or inclinedly, it is necessary to consider the occlusion of the actual scene in order to attain a greater detection range.

This radar module has the following characteristics:

1. Achieve synchronized detection function between moving and static personnel (sitting still and sleeping);
2. The sensor can detect static personnel and provide real-time information.
3. It can quickly report how far or near a target is.
4. Real-time monitoring of motion amplitudes with numerical output.
5. Detecting only biological objects (moving or stationary) and eliminating the interference of other inanimate objects in the environment;

6. This module has the ability to eliminate the interference caused by nonliving objects as well as to detect nonliving moving objects;
7. It is suitable for secondary development and can be customized;
8. Providing a universal interface for UART communication
9. Four I/O groups are reserved for user-defined applications and simple interface simulation.
10. Low output power, no harm to the human body
11. Temperature, light, dust, and other environmental factors do not affect the radar's performance. Yet it is very sensitive and has a 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

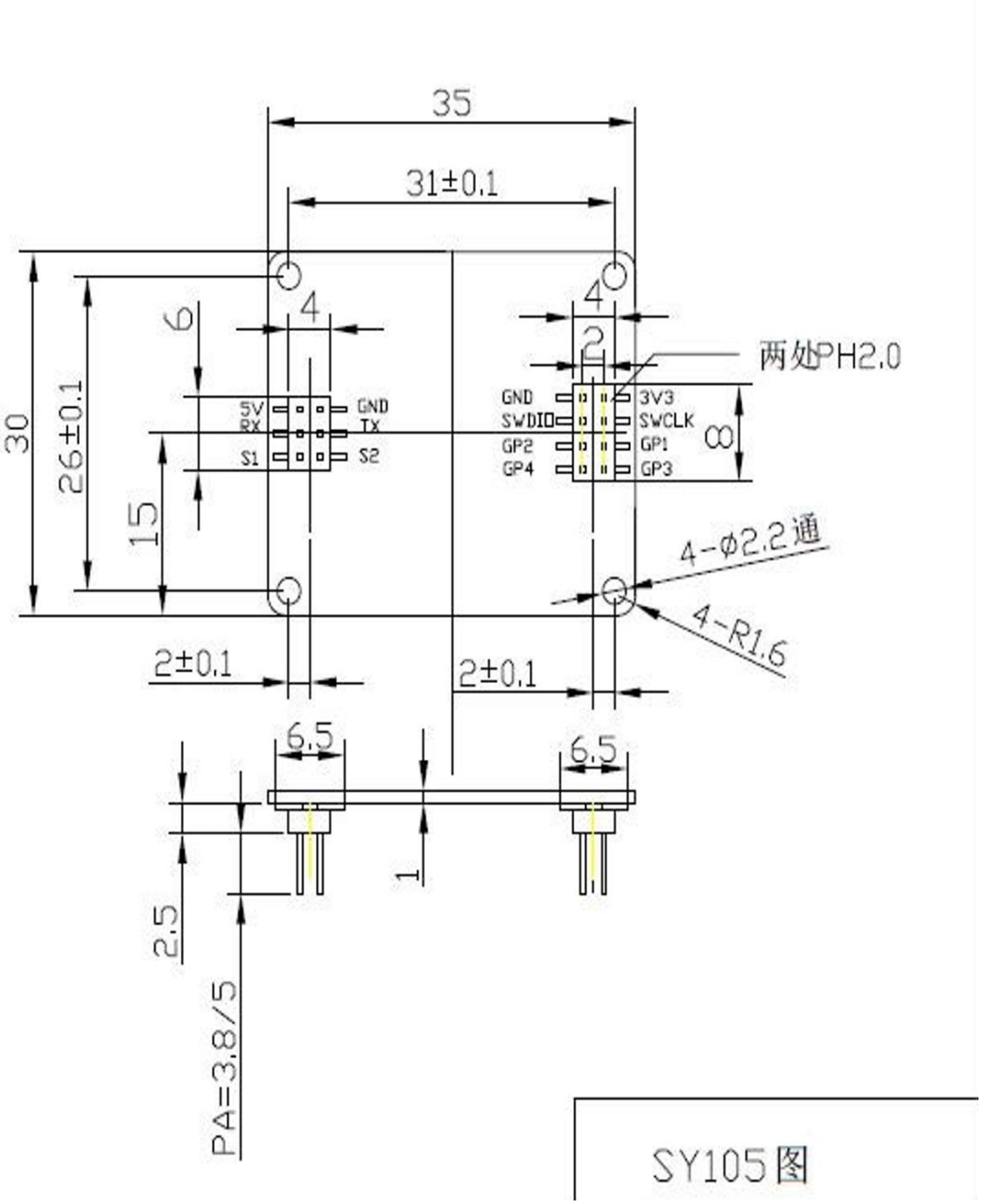


Fig. 1 Schematic diagram of the radar module structure

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

Note:

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

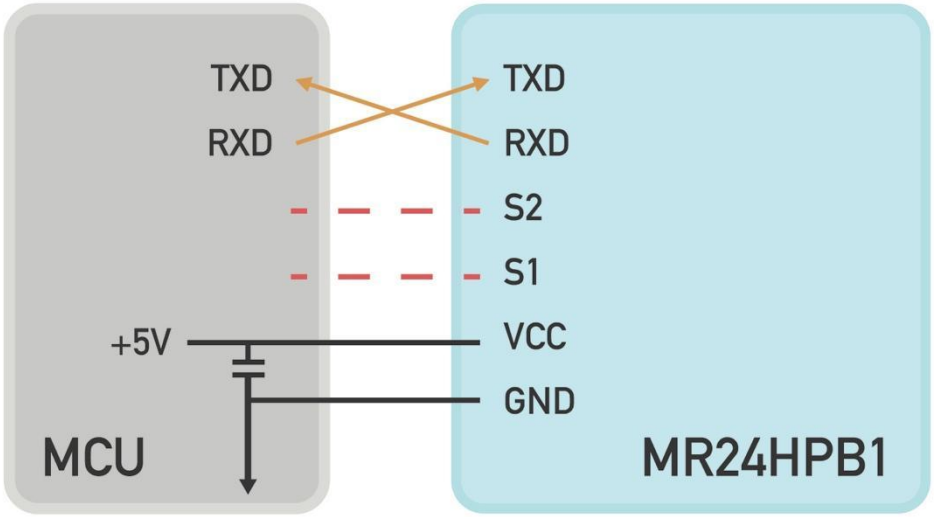


Fig. 2 Schematic diagram of the radar module and peripheral connections

4. Main Performance

4.1 Operating Range of Radar Module

Figure 3 illustrates the beam coverage of the MR24HPB1 radar module. Basically, it covers a three-dimensional area with a horizontal angle of 90° and 60° inclined.

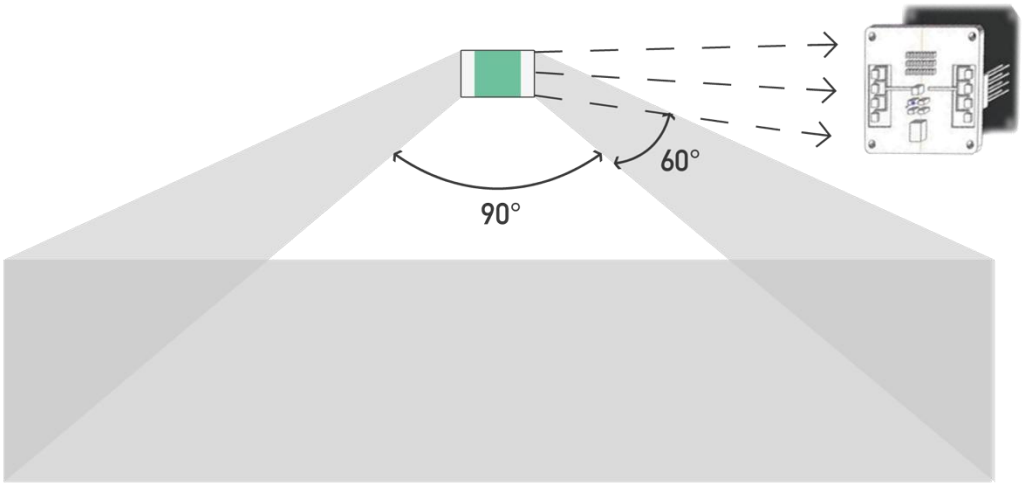


Fig.3 MR24HPB1 Diagram of the radar coverage area

Due to the characteristics of the radar's beam, it has a long-range coverage in the direction normal to the antenna surface but a short-range if it deviates from the normal direction of the antenna surface.
Additionally, the radar's range will be reduced when it is mounted on top or angled. This is due to the effect of the beam and effective radiation space. It is important to consider this when using the device.

4.2. Main Functions and Performance

The main functions of this radar module are:

a. Motion detection function
   i. Maximum detection distance: ≤ 13m (adult);
   ii. Detection sensitivity: ≤ 0.2m/s;
   iii. Reaction time: ≤ 100ms;
b. Micro motion detection;
   i. Maximum detection distance: ≤ 5m;
   ii. Reaction time: ≤ 1s;
c. Breath detection function;
   i. Maximum detection distance: ≤ 2.5m;
   ii. Reaction time: ≤ 60s;
d. Environmental status assessment function;

e. Early warning design function.

5. Works and Patterns

5.1. Installation Method

There are three recommended installation methods for radar modules: horizontal, inclined, and overhead.

5.1.1. Horizontal Mounting

Figure 4 shows the horizontal installation method. The method is primarily used to detect the presence of the human body in a standing or sitting position, such as in a living room, home appliance applications, and other situations.
The recommended installation height for the radar is between 1 and 1.5 meters. The radar should be installed horizontally and forward, with an inclination of ≤± 50. There should be no obvious interfering objects or covering in front of the radar.
To ensure that the main beam of the radar antenna covers the detection area and the radar beam covers the human activity area, the normal direction of the radar is aligned with the main detection position.

The maximum detection range of moving human bodies is L3 ≤12m; The maximum distance of detection for seated or inching humans is L2 ≤ 5m; The maximum distance of detection of sleeping humans is L1 ≤ 2.5m;

The maximum effective range will be affected by deviations from the normal direction of the radar. The millimeter-wave band electromagnetic field has certain penetration characteristics for non-metallic materials and can penetrate common glass, wood, screen and thin partition walls, as well as detect moving objects behind the shelter; however, a thick bearing wall and a metal door cannot be penetrated.

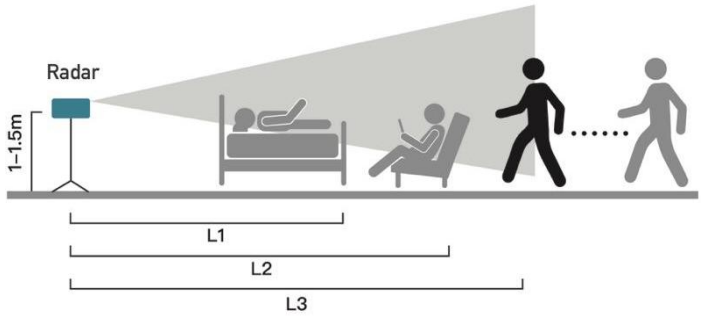


Fig. 4 Schematic diagram of horizontal installation

5.1.2. Tilt Mounting

Figure 5 illustrates an inclined installation. Generally, this installation method is intended to detect movement in a room and is primarily applicable to hotels, halls, and other public spaces.

The recommended installation height of the radar is 2 - 2.75m; The radar's downward inclination angle range is 10 - 30 degrees, and there is no obvious shelter or cover in front of the radar.

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

This installation mode allows the maximum detection distance of a moving human body, denoted as L3, to be about ~7 meters; while the maximum detection distance for human sitting and inching, denoted as L2, is ~4 meters, and the maximum detection distance for human sleep L1 is ~ 3 meters.

When operating in this mode, there may be a blind area under the radar and adjacent to it. As the dip angle increases, the detection distance of the static human body will be significantly reduced. Depending on the radiation characteristics of the radar antenna, the range of the radar will be reduced if it deviates from the normal direction of the radar.

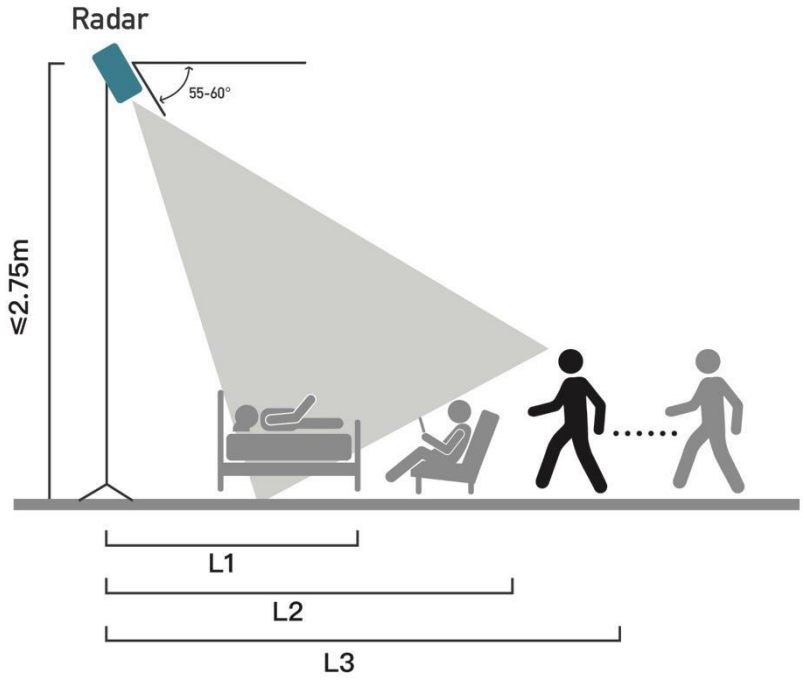


Fig. 5 Diagram of the installation in oblique downward view.

5.1.3 Top Mounting

Figure 4 illustrates how it is installed on top. This installation method is typically used to monitor human bodies (e.g. in a bedroom, nursing home, or hospital bed), determine fall hazards in wet and slippery environments, and to detect people who are asleep.

In order to ensure adequate coverage of the detection area, the radar installation height should be set at ≤2.75M, with the horizontal deviation angle set at 3°. There is no obvious shelter or cover in front of the radar. According to the radar installation height and radar range, the maximum detection distance of moving human bodies is L3 ~ 6.5m, that of human sitting/inching is L2 * 3m, and that of human sleeping is L1 ~ 1.8m. According to radar installation height, radar beam range, and calculation logic of fall related model, the maximum fall detection distance of human body is L4 ≈ 1.5m.

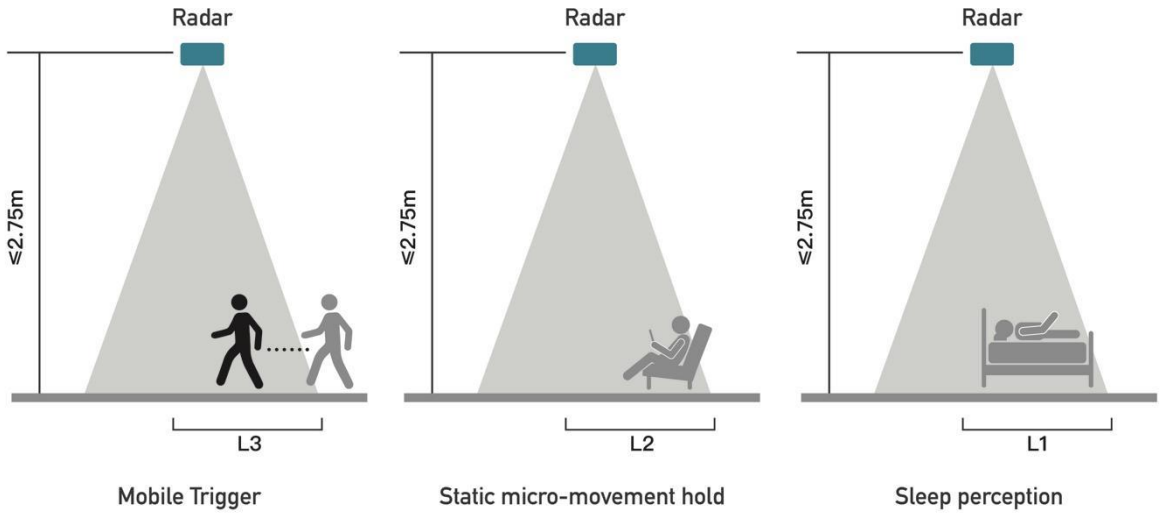


Fig. 6 Diagram of installation in oblique downward view

Caution.

A. In the various installation methods above, the radar's main beam should cover the human body's main activity area and face the normal direction as much as possible.
B. When it is installed obliquely, the horizontal action distance will be correspondingly reduced due to the change in the horizontal projection of the coverage area.
C. When the module is working, metal objects should not be placed on its surface.
D. Affected by the transmission characteristics of electromagnetic waves, the radar range is related to the RCS of the target, the material, and the thickness of the target cover; the radar effective range will change to a certain extent.
E. In the case of a human being in a static state, varying body positions would affect the radar range, and the radar could not guarantee that every state would reach the maximum range.

5.2 Working Mode

After analyzing and processing the statistical data, the radar module provides a comprehensive evaluation of persons' status in the current detection area, and the data can be directly used by the users.

- Status operation mode

In this mode, the radar module periodically reports humans' presence and movement status in the current radar detection area. The main statuses include

1) unoccupied.
2) occupied, stationary.
3) occupied, active.

During the status operation mode, the radar module performs internal logic discrimination to determine the environmental status's accuracy. The radar module status output logic is as follows;

Radar can only produce a corresponding state output when it detects the change in state; otherwise, it remains inactive.

The radar rapidly switches from an unmanned to a manned state (moving, approaching, and far away), and the switching time is ≤ 1 second.

Whenever the radar is switched from manned to unmanned mode, it needs to be confirmed many times, and the switching time is ≥ 1 minute;

6. Typical Application Modes

This module has many applications, including house appliances, energy-saving light control, health care, etc. Following are a few examples of typical applications.

6.1. Smart Home Appliance Application

The radar is installed inside the home appliance equipment and records the status of the personnel working on the appliance equipment in real-time. By adjusting the equipment's working mode (working, low power consumption, standby, shutdown, etc.) in real-time or quasi-real-time based on the status of the working face (manned/unmanned, active/static, close / far away), the appliance becomes intelligent.

The radar is installed inside the appliance and monitors the working surface of the appliance in real-time. The appliance adjusts its operating mode (working, low power consumption, standby, off, etc.) in real-time or quasi-real-time based on information based on the working surface personnel (occupied/unoccupied, active/stationary, close/away).

Radar is installed on the equipment in this scenario. As part of the routine operation of the equipment, the radar is installed horizontally or obliquely to guarantee that the radar beam covers the main work area.
Conventional household appliances include

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

6.2. Home Application

For places such as homes, hotels, offices, and bathrooms, real-time detection is needed to enable security, electric control, staff monitoring, and a lot more while simultaneously avoiding privacy concerns. When installed in the room, the radar can monitor in real-time whether a target is moving, what direction people are moving, the presence of people, etc. By using IoT transmission methods and means with the relevant IoT support platform, we can maximize the effectiveness in other relevant applications.
The radar applies to the following areas.

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

6.3. Applications and installations for bedrooms

Specific applications are enabled by providing real-time information about the person in bed, such as presence/absence, sleep status, sleep depth, movement information, etc. In this mode, the radar must be mounted above the bed.

This mode can be used to implement a variety of applications, which include

- Elderly care
- Health care
- Hotel applications
- Home health

6.4. Energy-saving control applications

The radar's motion target and biometric detection capability enable it to have much 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

7. Notes

7.1. Start-up Time

To ensure the smooth operation of the module after the initial power-on, it is necessary to completely reset the internal circuit of the device and evaluate the environmental noises. Therefore, when the module is initially powered on, it needs to be powered on for a stable time ≥ 30s to ensure the effectiveness of subsequent output parameters..

7.2. Effective Detection Distance

For the time being, this radar module does not feature a ranging function. Its range of detection is closely related to the RCS of the target and the environment in which it operates. Therefore, the effective detection range may change depending on the environment and the target. So, it is normal for the effective range of detection to change within a certain range.

7.3. Radar Bio-detection Performance

Since human biological characteristics are characterized by ultra-low frequencies and weak reflections, the accumulation process of the radar will be relatively lengthy.In the process of accumulation, many factors can influence the radar parameters. It is therefore normal for accidental detection failure to occur.

7.4. Power

This radar module has a higher power quality requirement than conventional low-frequency circuits. The power supply must be free of threshold burr and ripple and protect the module from power noise from accessories.

The radar module should be well-grounded. As a result of ground noise caused by other circuits, the radar module may perform poorly or even malfunction. In most cases, the detection distance becomes closer, or the false alarm rate increases.

The module's power supply must be with +5v ~ +6v and a voltage ripple of 100mV to ensure the normal operation of the module's VCO circuit.

External power supplies must provide sufficient current output and transient response capability.

8. FAQ

Interference factors

The radar is an electromagnetic wave sensor, and the presence of an active nonliving object will result in a false alarm. Metal and liquid will cause the radar to make an incorrect judgment. An electric fan, a pet within range of the radar, or the sway of the curtain can all cause miscalculations. Therefore, the installation angle of the radar should be considered.

Non-interference factors

The radar's electromagnetic waves can penetrate human clothing, curtains, veneers, and glass. The installation angle and performance of the radar should be determined according to the intended use.

Semi-interference factors

The radar detects the presence of a human body, which is not ideal for facing the air conditioner directly. This is due to the internal motor of the air conditioner causing the radar to misjudge. The radar is not necessary to be directed at the air conditioner.