

24G Millimeter wave Bio-sensing radar

R24AFD1-Static dwell radar

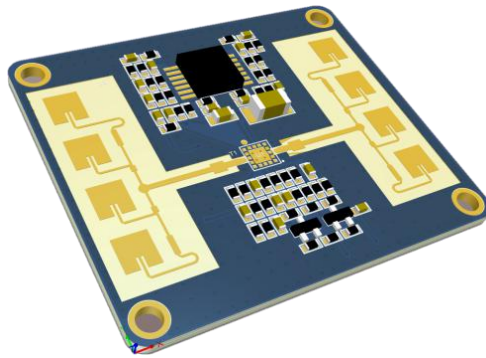
Datasheet (Ver. 1.7)

R24AFD1 – Stationary Persistence Radar

Product Manual (V1.7)

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 of people's movement and stillness, and make detection and alarm for long-term abnormal static residence ;
- For stationary parking detection scenarios, the maximum diameter of motion perception : ≤ 12 meters [2.75 meters for top-mounted installation]
- Diameter of human body sitting/ fretting perception : ≤ 6 meters [2.75 meters for top-mounted installation]
- For static parking detection scenarios, the maximum diameter of static parking alarm detection : ≤ 3 meters [2.75 meters for top-mounted installation]
- Antenna beamwidth: horizontal 90° /vertical 60° fan beam
- It has the ability to recognize scenes, identify people/unmanned people and the activity status of people, and output the amplitude of body movement;
- Not affected by temperature, humidity, noise, airflow, dust, light, etc. ;
- Output power of the radar module is less than 0.5 watts and requires long-term power supply work;
- No one to someone reporting time: within 0.5 seconds;
- Time to detect (report) from someone to no one: Automatic detection according to the algorithm, the typical value is 30 seconds;

**R24AFD1**

Model Description

- ✧ R24AFD1 – Stationary Persistence Detection Radar Sensor, 90° /60° Sector Beam

Applications

Human body application:

- ✧ Health guard
- ✧ Smart home appliances (TV, Yuba, security, etc.)
- ✧ Office energy saving (air conditioning, lighting)
- ✧ Sleep monitoring (sleep curve)
- ✧ home security
- ✧ IPC trigger

Stationary resident detection application:

- ✧ Alarm detection for long-term abnormal stationary residence in slippery areas such as kitchens and bathrooms, where there is a risk of bumping and fainting

Product packaging

- ✧ Volume: $\leq 35\text{mm} \times 31\text{mm} \times 7.5\text{mm}$
- ✧ Interface: Pitch 2.0mm interface, 2*3 and 2*4 total 2 sets of interfaces

Serial output parameters

- ✧ Someone/Nobody
- ✧ Active/still
- ✧ Body movement parameters
- ✧ Stationary park alarm

Configurable parameters

- ✧ Scene Mode Settings
- ✧ Sensitivity setting

Output protocol

- ✧ Standard Serial Protocol
- ✧ Tuya Standard Protocol

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1. Overview

The R24AFD1 radar module is a radar detection module that uses millimeter wave radar technology to realize human motion perception and human static perception. Based on the enhanced radar signal processing mechanism, this module realizes the wireless sensing and reporting function of the presence of personnel in a specific place and the abnormal stationary state for a long time through the synchronous perception technology of the intensity of the movement of the personnel and the physiological parameters of the personnel.

The two-array element antenna form of this module: wide-beam radar module, wide-beam radar module is mainly suitable for top-mounted installation mode to realize radar detection in a wide angle range .

This radar module has the following working characteristics:

- ✧ Realize the synchronous perception function of moving personnel and stationary personnel;
- ✧ A detection that can accurately detect the abnormal stationary state of people in a specific place ;
- ✧ It can quickly output the distance and approach status of the target relative to 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;
- ✧ General UART communication interface, providing general protocol ;
- ✧ 4 groups of I\O are reserved, which can be input and output according to user definition, or simple interface simulation ;
- ✧ 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	Installation method
R24AFD1					
Movement detection distance	-	-	1 2	Meter	Top mounted 2.75 meters
Perceived distance of stationary persons	-	-	6	Meter	Top mounted 2.75 meters
Sleeper perceived distance	-	-	3	Meter	Top mounted 2.75 meters
Radar detection angle (horizontal)	-	90	-	Spend	
Radar detection angle (pitch)	-	60	-	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

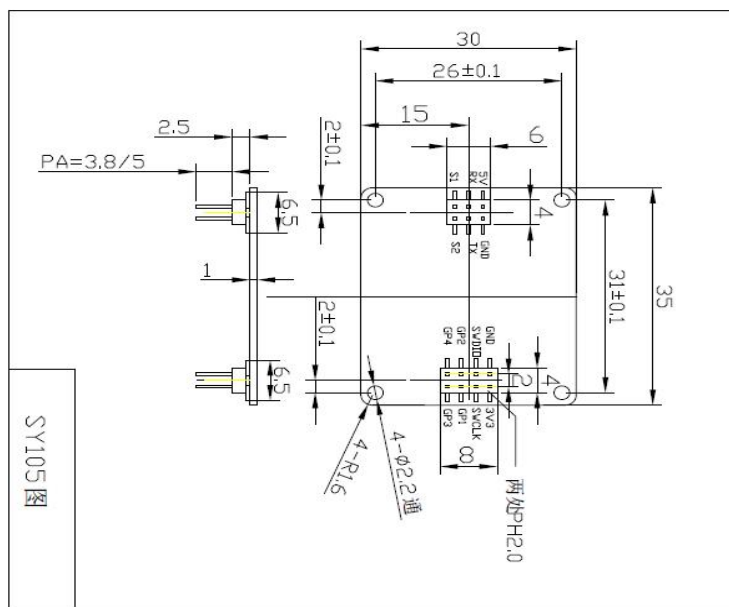


Figure 1 Schematic diagram of the structure of the radar module

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

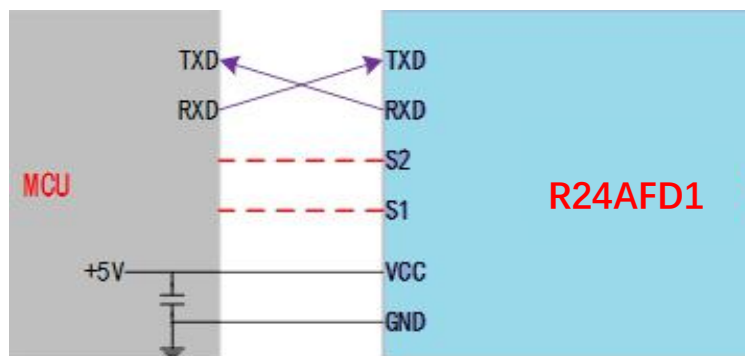


Figure 2 Schematic diagram of the connection between the radar module and the peripherals

4. Main work function and performance

4.1. Radar module working range

The beam coverage of the R24AFD1 radar module is shown in Figure 4. The radar coverage is a three-dimensional sector of 90° horizontally and 60° vertically.

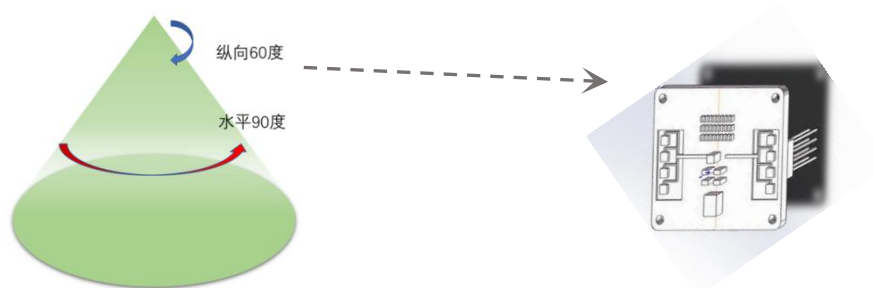


Figure 4 Schematic diagram of R24AFD1 radar coverage area

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, due to the influence of the radar beam range and the effective radiation space, the radar operating range will be reduced, which needs to be paid attention to when using it.

4.2. Main functions and performance

The main functions of this radar module include:

A、Motion detection function (top-mounted installation height of 2.75 meters)

- (1) Maximum detection diameter : ≤ 12 meters (adult);
- (2) Detection sensitivity: ≤ 0.5 m /s;
- (3) Reflection time: ≤ 100 ms;

B、Micro-motion detection function (top-mounted installation height of 2.75 meters)

- (4) Maximum detection diameter : ≤ 6 meters;
- (5) Reflection time: ≤ 1 s;

C、Static parking detection function (top-mounted installation height of 2.75 meters)

- (8) Maximum detection diameter : ≤ 3 meters;
- (9) Accurately detect action: stand still ;
- (10) Reflection time: 5min/10min/30min/60min ;

D、Environmental status assessment function;

E、Early warning design function ;

5. Radar work and installation

5.1. Installation method

This radar module requires the installation method to be top-mounted.

5.1.1. Top installation

As shown in Figure 4 for overhead installation. This installation method is mainly used for long-term abnormal static resident alarm detection in the kitchen, bathroom and other slippery scenarios where

there is a possibility of bumping and fainting .

The radar is installed vertically, and the horizontal deviation angle is $\leq 3^\circ$ to ensure that the main beam of the radar covers the detection area; the recommended installation height of the radar is ≤ 2.75 meters; there are no obvious obstructions and coverings in front of the radar.

Affected by the installation height of the radar and the range of the radar beam, in this installation mode, the maximum radius of moving human detection is $L3 \approx 6$ meters; the maximum radius of human sitting/fretting detection is $L2 \approx 3$ meters .

Affected by the radar installation height, the radar beam range, and the calculation logic of the related model of stationary residence, the maximum radius of human stationary residence detection is $L4 \approx 1.5$ meters.

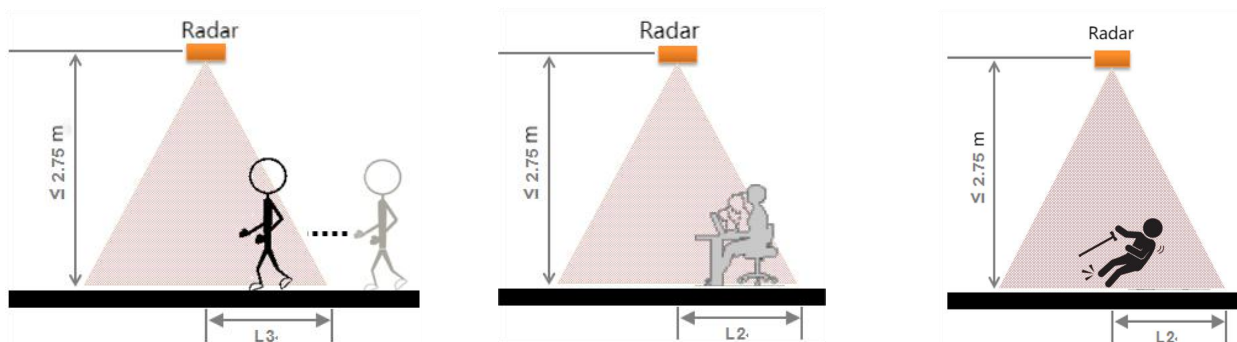


Figure 4 Schematic diagram of top-mounted installation

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.

◆ 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、Switching time \leq 1s;

C、When the radar switches from a manned state to an unmanned state, it needs to go through multiple state confirmations, and the typical switching time is 40s;

◆ Stationary Dwell Detection Mode

By turning on the fall alarm switch to enter this mode, the radar module detects in real time whether there is a stationary parking situation within the detection range, and reports relevant alarms in real time. The main states include:

1) Long stay alarm status judgment;

2) Report the static parking alarm in 4 times (5min, 10min, 30min, 60min)

In the static parking detection mode, in order to detect and judge the accuracy, the radar module needs to be installed on the top, the height is \leq 2.75m, and the kitchen, bathroom and other places are slippery and may faint.

6. Typical Application Mode

This module is mainly used in health care scenarios. The following describes the application modes of typical scenarios.

6.1. Health care app

Based on the radar's simulated detection of the stationary parking alarm state, the radar can be well used in health care. The main

application modes are as follows:

- ◆ Alarm automatic communication application with emergency contacts

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 $\geq 30s$ 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 biotetection 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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11. Contact details

Micradar Technology (Shenzhen) Co., Ltd.

Email : sales@micradar.cn .

Tel: 0755-88602663

Address: Room 501, West Building, Phase II, Tianan Innovation and Technology Plaza, Futian District, Shenzhen

12. Historical version update instructions

Revision	Release Data	Summary
V1.0_1012	2020/10/12	first draft
V1.1_1126	2020/11/26	Added near and far and scene modes

V1.2_1209	2020/12/9	Take the near and far out of the ambient state
V1.3_1214	2020/12/14	1: Add the specific environment parameters of the heartbeat package 2: Modified the fixed characters near and far parameters to 0x01 0x01 3: Modified the interval definition of motion sign parameters
V1.4_0106	2021/1/6	Fixed an error in setting data bits in passively reported scenarios
V1.5_0317	2021/03/17	Overall perfect
V1.6_0221	2021/02/21	Modify the corresponding relationship of S2 in the pin description
V1.7_0 519 _ _	202 2/0 5/19 _ _ _	Complete documentation