Wireless 24G Bio-Radar Sensor for Respiration and Sleep Monitoring IR24BDA

Dalian iFlabel Technology Co., Ltd.

Wireless 24G Bio-Radar Sensor for Respiration and Sleep Monitoring IR24BDA Manual V1.0

Features

◆ Detection of static human body;

◆ Detection of vital signs;

◆ 24GHz mmWave radar sensor;

◆ Based on the millimeter wave Doppler radar theory to realize human biological motion perception;

◆ Also to realize the synchronous perception active and static human;

◆ Max perception range of human sleep quality: ≤2.75m

◆ Max detection range of human respiration: ≤1.5m

◆ Width of antenna beam:
IR24BDA:Horizontal 40°/Vertical 40°fan-shaped beam

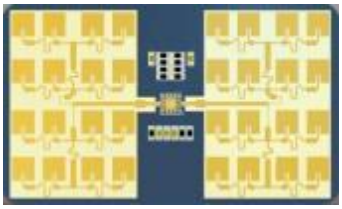
◆ Scene recognition function to identify human/no human activity and output body motion;

◆ Not affected by factors like temperature, humidity, noise, airflow, light etc and adaptable to bad environment.

◆ The output power is small, which is not harmful to the human body;

◆ Detection time from no anyone to some one: ≤ 0.5 seconds;

◆ Detection time form some one to no anyone: more than 1 minute.



IR24BDA

Model Description

◆ IR24BDA – narrow beam human perception radar sensor, 40 degree/ 40 degree fan-shaped beam (high accuracy, suggested to deploy within 6 meters)

Applications

◆Sleep Monitoring：：
Sleep Quality Monitoring (Sleep Curve)

◆Respiration Monitoring：
Respiration Frequency Monitoring

Product Packaging

◆Volume： ≤46mm×27.5mm×5mm
◆Pin：Pitch 2.0mm, double rows of pins

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1. Overview

The IR24BDA radar module is a radar detection module based on the millimeter wave Doppler radar theory, which achieves human biological motion perception, human biological perception and human respiration detection. This module is based on the enhanced Doppler radar signal processing theory, and achieves wireless perception of the status of personnel in a specific place through the synchronous sensing technology of Doppler parameters of personnel movement and physiological parameters of personnel.

The 32 array element antenna form of this module: wide beam radar module. The wide beam radar module is mainly applicable to the top installation mode to realize radar detection in a large angle range; If it is used for horizontal or inclined installation, it is necessary to pay attention to the occlusion of the actual scene in order to realize the radar detection function in a longer range.

The radar module has the following working characteristics:

◆ It realizes the synchronous perception function of moving personnel and static personnel (sitting and sleeping);

◆It can keep the detection of static personnel and ensure real-time output;

◆It can keep relevant information such as sleep and respiration of sleepers and record relevant sleep time curve information;

◆It can quickly output the far and near state of the target range radar;

◆It can detect various motion amplitudes and output numerical state in real time;

◆It can 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 a variety of scenarios;

◆General UART communication interface to provide general protocol;

◆Four groups of I/O are reserved, which can be input and output according to user definition, or simple interface simulation;

◆Low output power, no harm to human body;

◆It is not affected by temperature, light, dust and other factors, with high sensitivity and wide application fields.

2. Electrical Parameters

2.1. Detection Angle and Distance

Parameters	Minimum	Typical	Max.	Unit
IR24BDA (32 point narrow beam antenna)				
Sleeping Personnel Perception Range	–	–	2.75	m
Sleeping Personnel Respiration Perception Range	0.5		1.5	m
Radar Detection Angle（Horizontal）	–		–	degree
Radar Detection Angle（Pitching）	–		–	degree

2.2. Electrical Parameters

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

2.3. RF Performance

Transmission Parameters				
Working Frequency（fTX）	24.0	–	24.25	GHz
Transmit Power（Pout）	–	–	6	dBm

3. External Dimension and I/O Pin Assignment

3.1 External Dimension

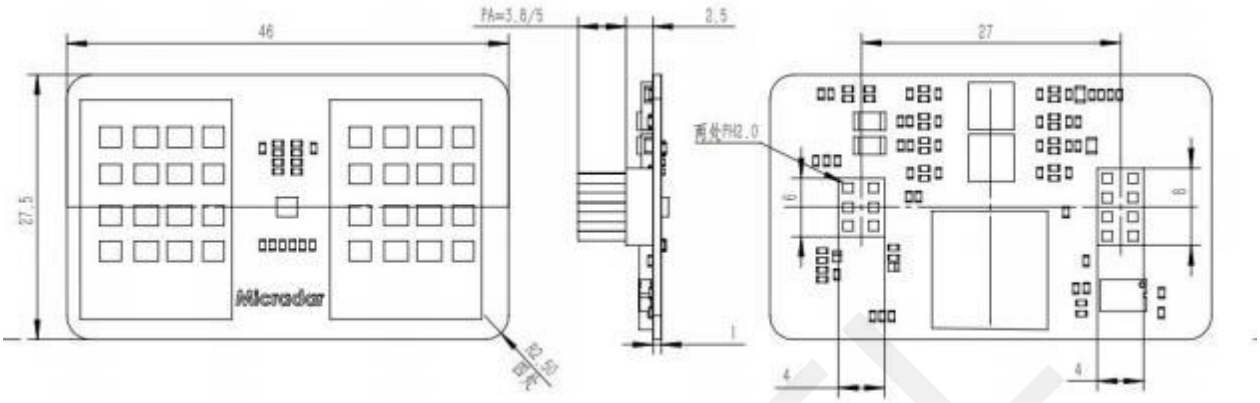

Figure1 Schematic diagram of radar module structure

3.2. I/O Pin Assignment

Interface	Pin	Description	Typical	Description
Interface 1	1	5V	5.0V	Power input positive terminal
	2	GND		Ground
	3	RX		Serial port receiving
	4	TX		Serial port sending
	5	S1	3.3V/0V	Someone/nobody
	6	S2	3.3V/0V	Static/active
Interface 2	1	3V3	3.3V	Output power
	2	GND		Ground
	3	SL		Keep
	4	SD		Keep
	5	GP1		Spare extension pin
	6	GP2		Spare extension pin
	7	GP3		Spare extension pin
	8	GP4		Spare extension pin

Note

1. S1 output; high level-someone, low level-nobody;
2. S2 output; high level-active, low level-static;
3. GP1 ～ GP4 are parameter selection control terminals, which can be redefined according to user needs.
4. All output signals from this interface are 3.3V level.

3.3. Wiring Diagram

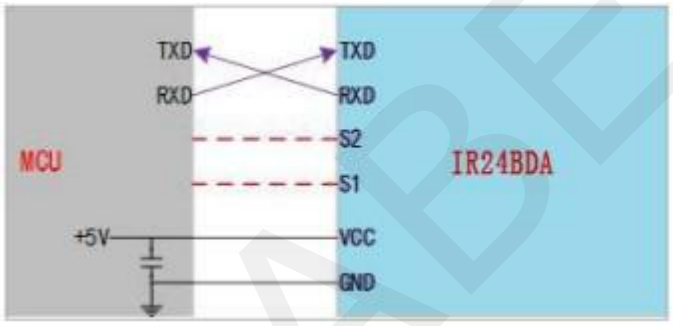

Figure2 Schematic diagram of radar module and peripheral connection

4. Operating Mode

4.1. Working Range

The beam coverage of IR24BDA radar module is shown in Figure 3.The coverage is a 3D fan-shaped area, horizontal 40°, pitching 40°.

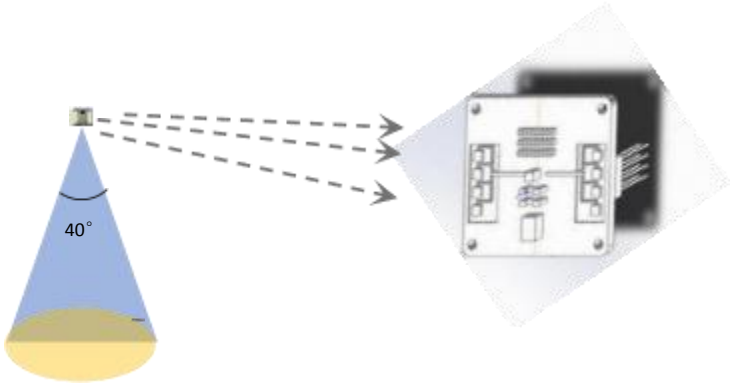

Figure3 Schematic diagram of IR24BDA radar coverage area

Note: Affected by the radar beam characteristics, the radar operates far in the normal direction of the antenna plane, but the operating distance deviates from the normal direction of the antenna will become shorter. When the radar is installed on the top or obliquely, the radar is affected by the radar beam range and effective radiation space. The scope of action will be reduced, which needs attention when using.

4.2. Main Function

Main function of the radar module includes:

A. Human respiration detection;

(1) Max detection ranger: ≤2.75 m;

(2) Response time: ≤60s;

B. Respiration rate statistics:

(3) Max detection ranger: ≤1.5m;

(4) Max respiration detection frequency: ≤30 times;

(5) Minimal respiration detection frequency: ≥12 times;

C. Sleep quality evaluation;

D.Sleep duration records;

E. Environmental state evaluation;

F. Alert design

5. Installation Method and Operating Mode

5.1. Installation Method

It is recommended to install the radar module according to the specific functions.

5.1.1 Respiration Rate Statistics

For this function, it is necessary to keep the position between the radar and the chest within the range of 0.5m-1.5m, and expose the chest within the detection range of the radar antenna.（It is recommended that the radar be mounted on top or inclined）

5.1.2 Sleep Quality Evaluation

When using the sleep quality assessment or sleep duration recording of the radar, the installation can only be top mounted or inclined mounted. The radar installation height is not higher than 2.75m. The installation scene is only suitable for rest areas such as the bed top of the bedroom.

Note:

A. For the above different installations, the main radar beam needs to cover the main activity area of the human body and face the normal direction as far as possible;

B. When installed obliquely, the horizontal action distance will be reduced due to the change of horizontal projection of the coverage area;

C. When the module is working, its surface should not be covered by any metal objects;

D. Affected by the transmission characteristics of electro-magnetic wave, the radar range is related to the target RCS,the material and thickness of the target cover, and the radar effective range will change to a certain extent;

E. As for human body detection in static state, different body positions will affect the effective radar range, we do not guaranteethat all states reach the maximum perating distance.

5.2 Operating Mode

After statistical analysis and processing, the radar module comprehensively evaluates the personnel status in the current detection area, and the user can directly use the results.

◆ State Operating Mode

In this mode, the radar module periodically gives the existence status and movement status of personnel in the current radar detection area. The main states include

1) Nobody;

2) Somebody, static;

3) Somebody, active;

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

A. Only when the radar equipment detects the state change can the radar have the corresponding state output; On the contrary, the radar remains silent;

B. The radar switching from unmanned state to manned state (moving, approaching and far away) is a fast switching state, and the switching time is ≤ 1s;

C. When the radar switches from manned state to unmanned state, it needs to be confirmed for many times, and the switching time is ≥ 1 minute;

◆ Sleep Detection Mode

In this mode, the radar module periodically gives the sleep state and respiratory rate of personnel in the current radar detection area. The main states include:

4) Sleep quality evaluation: awake, deep sleep, light sleep;

5) In bed/Out of bed judgement;

6) Respiration rate statistics;

7) Respiration signal judgement: abnormal, short of breath, normal, abnormal movement, abnormal rapid breath

In sleep detection mode, in order to judge the accuracy of related sleep state, the radar module has specific installation mode and installation height restrictions:

D. When you need to use the respiratory rate statistics function in the sleep function, you can only mount the radar at the top. Installation or inclined installation, keep the position between the radar and the chest at 0.5m ~ 1.5m

E. When it is necessary to use the sleep quality assessment and sleep time recording functions of the sleep detection radar, the installation method can only be top mounted or inclined. The radar installation height is not higher than 2.75m. The installation scene is only suitable for rest areas such as the bed top of the bedroom

6. Typical Application Mode

This module is mainly used in home, home appliances, energy-saving lamp control and other scenarios. The application modes of typical scenarios are described below.

6.1. Application in Smart Electrical Appliance

The radar is installed inside the home appliance equipment and monitors the personnel status of the working face of the home appliance equipment in real time. The equipment adjusts the equipment working mode (working, low power consumption, standby, shutdown, etc.) in real time or quasi real time according to the personnel status of the working face (manned / unmanned, active / static, close / far away), so as to realize the intellectualization of the home appliance. In this application scenario, the radar is installed on the equipment radar. According to the conventional nature of the equipment, the radar is installed horizontally or obliquely to ensure that the radar beam can cover the main working area of the equipment.

Conventional household appliances include：

- Smart television
- Smart voice box
- Smart air-conditioner
- Other smart household appliances

6.2. Application in Home

For homes, hotels, offices, toilets and other places, it is necessary to detect whether there are people entering or moving in the place in real time, so as to realize methods such as security, electrical control and personnel monitoring, and effectively avoid privacy problems. The radar is installed in the room and can monitor whether there are moving targets, personnel movement direction and Personnel in the room in real time. And through the Internet of things transmission methods and means, combined with the relevant Internet of things support platform, to realize the effective application of relevant places.

This radar can be applied into following scenes:

- Household security
- Hotel management and monitoring
- Community personnel rehabilitation monitoring
- Office monitoring

6.3. Installation and application in Bedroom

For specific applications, real-time information about bedridden personnel, such as people / nobody, sleep status, sleep depth, movement information, etc., and then give relevant information to realize specific applications. In this mode, the radar needs to be installed on top.

Based on this mode the radar can be applied into:

- Elderly care
- Rehabilitation care
- Hotels
- Family health care

6.4. Application in Energy-saving Control

Based on the moving target detection and biometric detection of the radar, the radar can have a good prospect in energy-saving control Application, the main application modes are as follows:

- Home appliance energy-saving
- Appliances energy-saving control
- Street lamp energy-saving control

6.5. Application in Healthy Life

Based on the detection characteristics of sleep state and respiratory rate of sleepers, the radar can be well applied in healthy life.

The main application modes are as follows:

- Home intelligent health appliance linkage application

7. Precautions

7.1. Start Time

When the module starts to work when it is initially powered 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 startup stability time of ≥30s to ensure the validity of subsequent output parameters.

7.2. Effective detection distance

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

7.3. Radar biological detection performance

Because human biological characteristics belong to ultra-low frequency and weak reflection characteristic signals, radar processing requires a relatively long cumulative processing. During the cumulative process, many factors may affect the radar parameters, so occasional detection failure is normal.

7.4. Power

The radar module requires higher power quality than conventional lowfrequency circuits. When powering the module, it is required that the power supply has no threshold glitches or ripples and that it effectively shields the power supply noise caused by accessory equipment.

The radar module needs to be well grounded. Due to the ground noise brought by other circuits, the performance of the radar module may even be reduced or even work abnormally; the most common cause is a shorter detection distance or an increased 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, voltage ripple≤50mV. The external power supply must provide sufficient current output capability and transient response capability.

8. FAQ

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

Non-interference factors: Radar electromagnetic waves can penetrate human clothing, curtains, veneer, and glass. It is necessary to determine the installation angle and performance of the radar according to the application.

Semi-interference factor: The radar judges the presence of a human body and is not suitable for directly facing the air conditioner. The motor inside the air conditioner can cause the radar to misjudge. Radar products can not directly face the air conditioner. It can be the same direction as the air conditioner.

9. Disclaimer

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11. Contact Information

Dalian iFlabel Technology Co., Ltd.

Email address: info@iflabel.com

TEL: 0411-84619565

Address: Zhongnan Building, No.18, Zhonghua West ST,

Ganjingzi DST, Dalian, CHINA

12. Historical Version

Revision	Release Data	Summary
V1.0_210818	2021/08/18	First Draft