Shenzhen Hilink
Electronics Co., Ltd.

HLK-LD2410
Human presence sensing module
manual

Table of contents

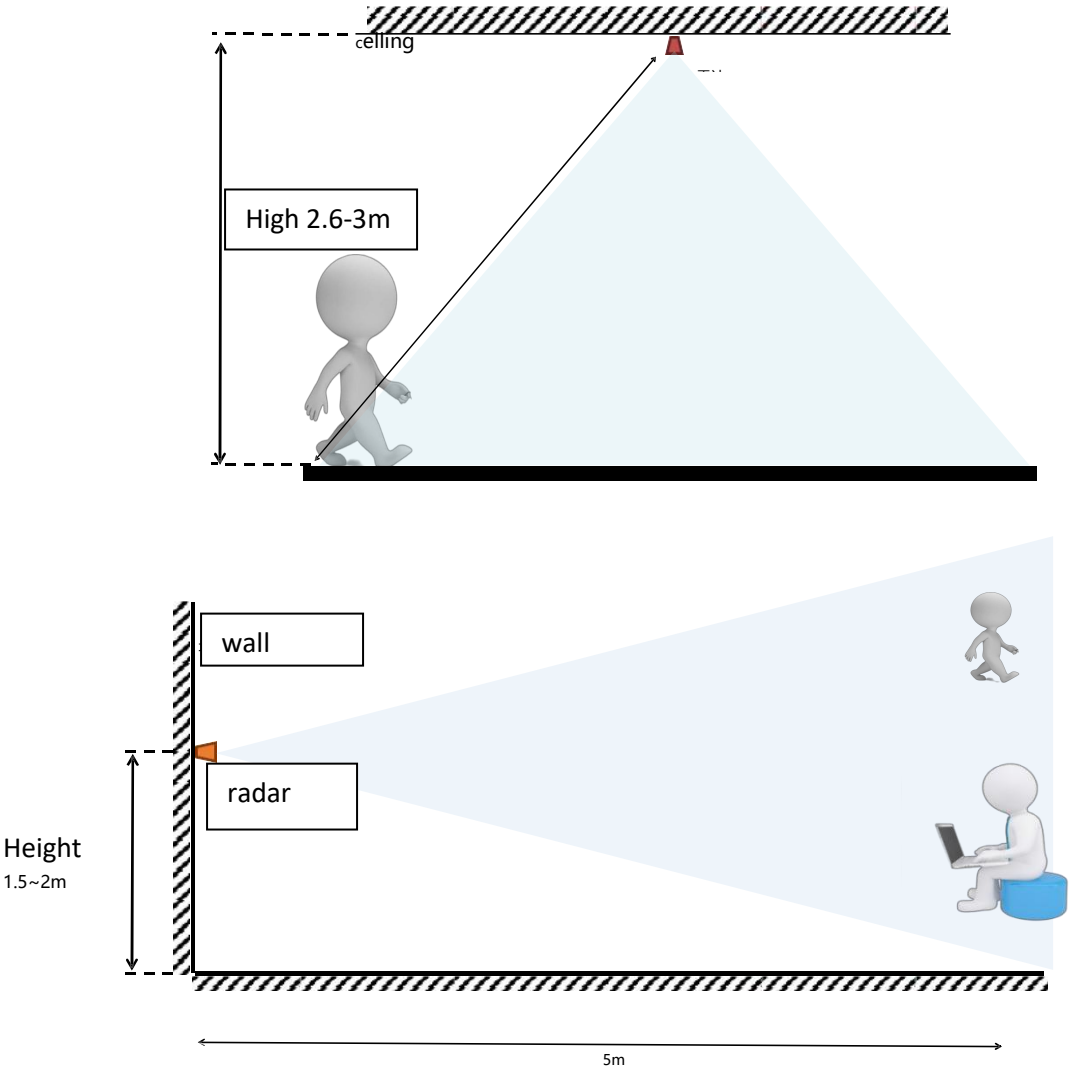
Chart Index

1 Product introduction

LD2410 is a high-sensitivity 24GHz human presence status sensing module developed by Hilink Electronics. Its working principle is to use FMCW frequency-modulated continuous wave to detect human targets in the set space. Combined with radar signal processing and accurate human body sensing algorithms, it realizes high-sensitivity human presence status sensing, and can identify human bodies in motion and stationary states. And auxiliary information such as the distance of the target can be calculated.

This product is mainly used in indoor scenes to sense whether there is a moving or micro-moving human body in the area, and output the detection results in real time. The farthest sensing distance can reach 5 meters, and the distance resolution is 0.75m. Provides a visual configuration tool, which can easily configure the sensing distance range and sensing in different intervals

Sensitivity and unmanned delay time, etc., to adapt to different specific application needs. Support GPIO and UART output, plug and play, and can be flexibly applied to different smart scenarios and terminal products.



picture 1 Diagram of how to use

2 Product Features and Benefits

2.1 Features

- Plug and play, easy assembly
- The farthest sensing distance is up to 5 meters
- Large detection angle, coverage up to ±60 degrees
- Accurately identify within the interval, support the division of the sensing range, and shield the interference outside the interval
- Multi-level intelligent parameter adjustment to meet the needs of scene changes
- Visual debugging and configuration tools
- Small and simplified, the minimum size is only 7mmx35mm
- Support ceiling, wall and other installation methods
- 24GHz ISM band, compliant with FCC and CE spectrum regulations
- The ultimate cost-effective choice

2.2 Solution advantage

LD2410 human body sensing module adopts 24GHz millimeter wave radar sensor technology. Compared with other solutions, it has obvious advantages in human body sensing applications:

1. In addition to being sensitive to moving human bodies, it can also sensitively sense static, micro-moving, sitting and lying human bodies that cannot be identified by traditional solutions;

2. It has good environmental adaptability, and the sensing effect is not affected by the surrounding environment such as temperature, brightness, humidity and light fluctuations;

3. It has good shell penetration and can be hidden in the shell to work without opening holes on the surface of the product, which improves the aesthetics of the product;

4. It can flexibly configure the farthest sensing distance and the sensitivity on each distance door to achieve flexible and fine personalized configuration;

	Infrared solution	visual solution	Ultrasound	Lidar	Millimeter wave radar
Application flexibility	🔴	🔴	🔴	🔴	🟢
Resistance to environmental influences (weather light, etc.)	🔴	🔴	🔴	🔵	🟢
Detection speed	🔴	🔵	🔵	🟢	🟢
Detection accuracy	🔴	🔵	🟢	🟢	🟢
Resolution	🔴	🟢	🟢	🟢	🟢
directionality	🔴	🔵	🔴	🟢	🟢
Detection distance	🔵	🔴	🔴	🟢	🟢
ability to penetrate material	🔴	🔴	🔴	🔴	🟢
size	🟢	🔴	🟢	🔴	🟢
cost	🟢	🔴	🟢	🔴	🔵

🟢 good 🔵 generally 🔴 weak

picture 2 Comparison of millimeter wave radar scheme and other schemes

3 Application scenarios

The LD2410 human body sensing module can detect and identify the human body in motion, fretting, standing, sitting and lying down. It supports multi-level parameter adjustment and can be widely used in various AIoT scenarios. The common types are as follows

- **Human body sensor light control**

  It senses whether there is someone in the space, and automatically controls lights, such as lighting equipment in public places, various sensor lights, bulb lights, etc.

- **Human body induction wake-up of advertising screens and other devices**

  Automatically turn on when people come, and automatically sleep when no one comes to save power, information delivery is more accurate and efficient

- **life safety protection**

  UV lamp work protection to prevent the UV lamp from being turned on when there are people around and causing personal injury Automatic detection and alarming of dangerous places to prevent people from entering specific high-risk spaces, such as high-risk places where coal mine blasting personnel enter

- **Smart Appliances**

  When there is no one in the room for a long time, the TV, air conditioner and other electrical appliances are automatically turned off, saving energy and safety

- **Smart Security**

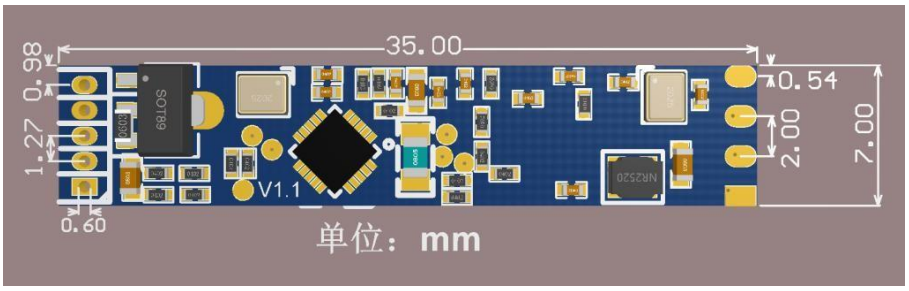
  Detection and identification of people intruding, staying, etc. within the specified range

picture 3 Application scenarios

4 Hardware Description

4.1Dimensions

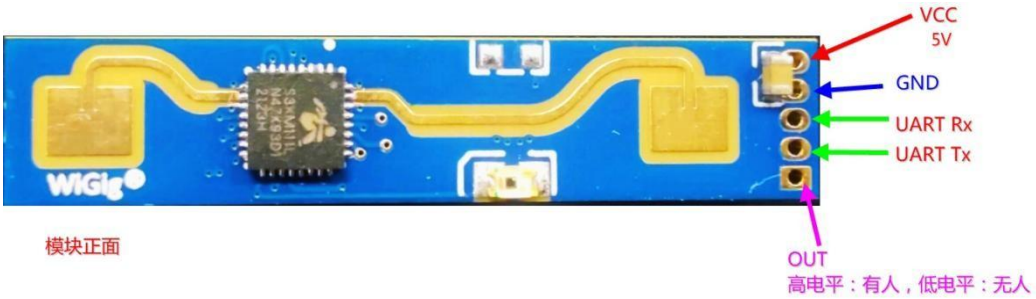
图 4 Module physical map



picture 5 Module Dimensions

Module size: 7mmx35mm, 5 pin holes are reserved in the hardware (the factory default is not equipped with pins), the pin hole diameter is 0.6mm, and the pin spacing is 1.27mm.

4.2 pin definition



picture 6 Module pin definition diagram

pin	symbol	name	Function
1	OUT	target status output	Human presence detected: output high level No human presence: output low
2	UART_Tx	Serial Tx	Serial port Tx pin
3	UART_Rx	Serial Rx	Serial Rx pin
4	GND	power ground	power ground
5	VCC	power input	Power input 5V

surface 1 Pin Definition Table

5 use and configuration

5.1 Typical Application Circuit

The LD2410 module directly outputs the detected target state through an IO pin (someone is high, no one is low), and it can also output the detection result data through the serial port according to the specified protocol. The serial port output data includes: Target status and distance auxiliary information, etc., users can use it flexibly according to specific application scenarios.

The power supply voltage of the module is 5V, and the power supply capacity of the input power supply is required to be greater than 200mA. The module IO output level is 3.3V. The default baud rate of the serial port is 256000, 1 stop bit, and no parity bit.

5.2 The role of configuration parameters

The user can modify the configuration parameters of the module through the serial port of the LD2410 to adapt to different application requirements, and the configuration content will not be lost when the power is turned off. The configurable parameters include the following:

farthest detection distance

Set the farthest detectable distance, only human targets that appear within this farthest distance will be detected and output the result. Set in units of distance gates, and each distance gate is 0.75m. Including the farthest door for motion detection and the farthest door for static detection, the setting range is 1~8. For example, if the farthest door is set to 2, only if there is a human body within 1.5m will it effectively detect and output the result.

Sensitivity

Only when the detected target energy value (range 0~100) is greater than the sensitivity value will it be determined that the target exists, otherwise it will be ignored. The sensitivity value can be set from 0 to 100. The sensitivity of each range gate can be independently set, so that the detection in different distance ranges can be precisely adjusted, local accurate detection or filtering of interference sources in specific areas. In addition, if the sensitivity of a certain distance gate is set to 100, the effect of not recognizing the target under the distance gate can be achieved. For example, if the sensitivity of distance gate 3 and distance gate 4 is set to 20, and the sensitivity of other distance gates is set to 100, it can only detect the human body within the range of 2.25-3.75m from the distance module.

no-one duration

When the radar outputs the result from man to no man, it will report man for a period of time. If there is no man in the radar test range during this time period, the radar will report no man; if the radar detects man during this time period, it will be refreshed again.

This time, in seconds. It is equivalent to the no-one delay time. After the person leaves, the output state will be no-one until no one exceeds this duration

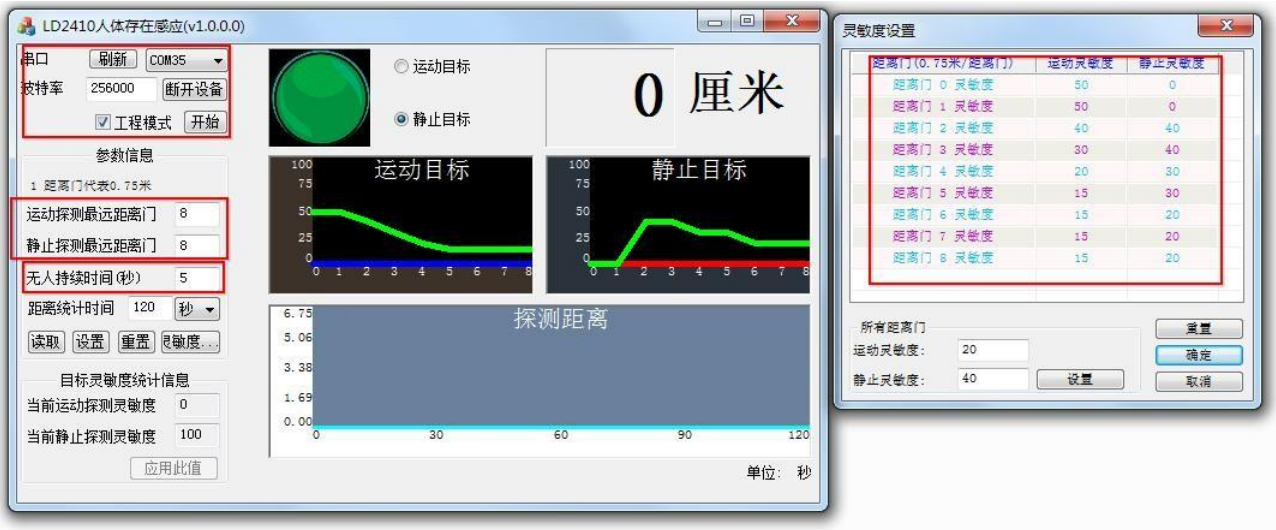
5.3 Visual configuration tool description

In order to facilitate the user to test and configure the module quickly and efficiently, a PC configuration tool is provided. The user can use this tool software to connect the serial port of the module, read and configure the parameters of the module, and receive the detection results reported by the module. Data, and real-time visual display, which greatly facilitates the use of users.

How to use the host computer tool:

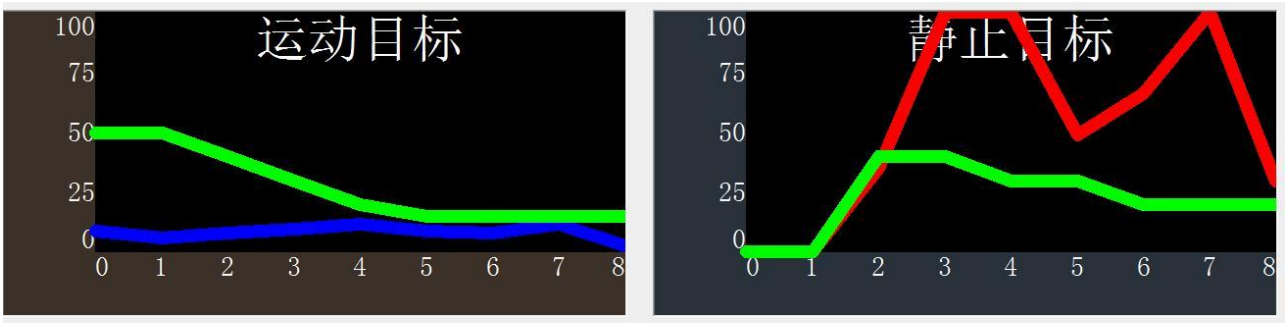
1. Use the USB to serial port tool to connect the module serial port correctly;
2. Select the corresponding serial port number in the host computer tool, set the baud rate to 256000, select the engineering mode, and click to connect the device;
3. After the connection is successful, click the Start button, the right graphical interface will display the test results and data;
4. After connecting, if the start button is not clicked, or click stop after starting, the mode parameter information can be read or set; Note: After clicking start, the parameters cannot be read and configured, and can only be performed after stopping configuration.

The interface and common functions of the host computer tool are as follows:



The ball is the target state output indication: red means that there is a moving target, and purple means that there is a stationary target;

Green means no one



绿色线：设置的灵敏度　　蓝色线：每个距离门上的运动目标能量值　　红色线：每个距离门上的静止目标能量值

5.4 Mounting method and sensing range

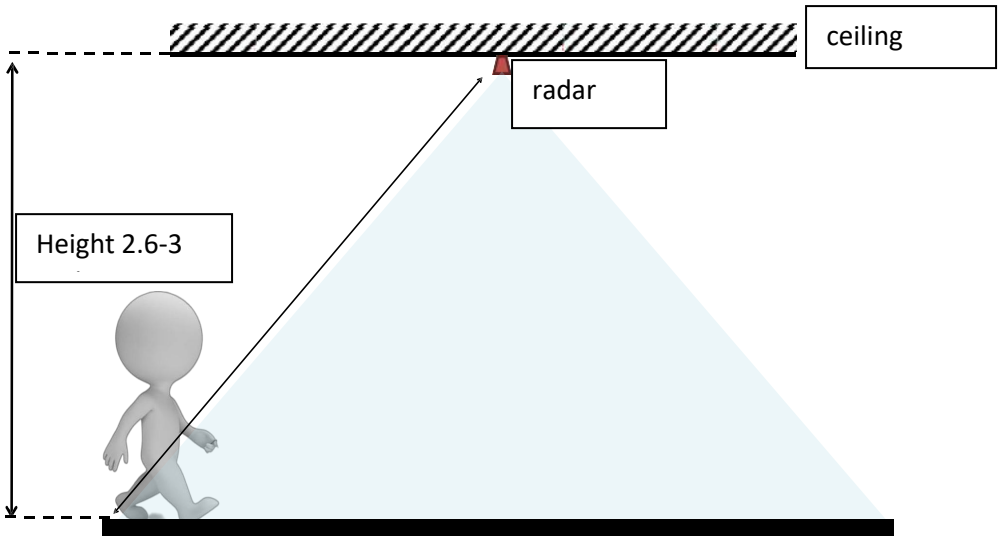
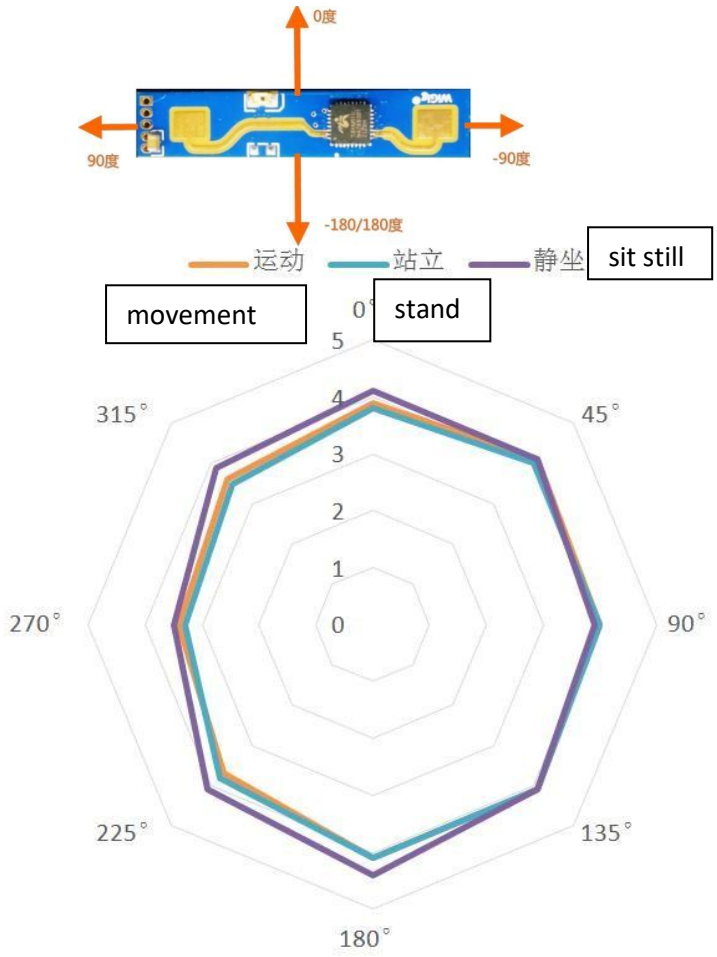
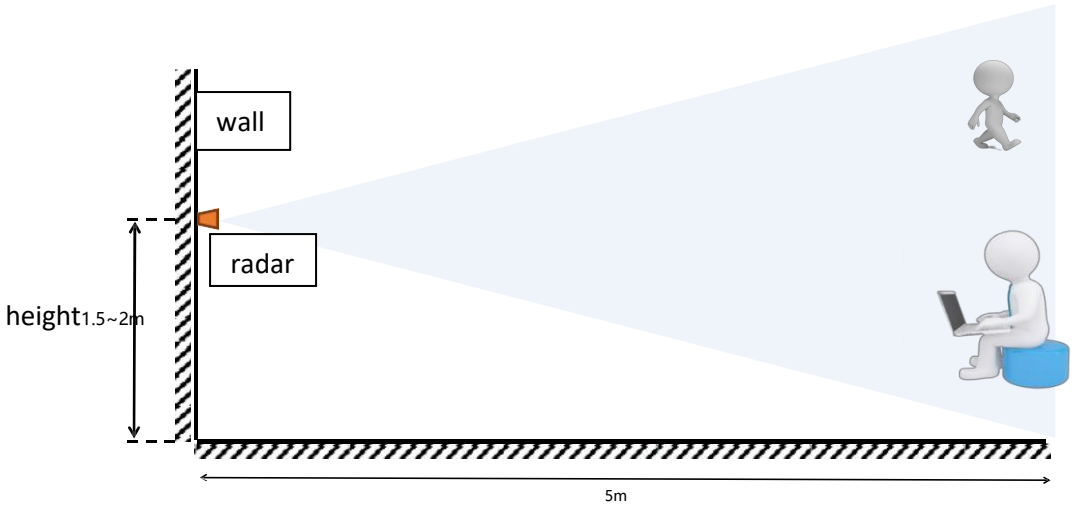


Figure 7 Schematic diagram of ceiling-mounted installation



(distance unit: meters, angle unit: degrees)

Figure 8 Schematic diagram of the detection range (the ceiling height is 3 meters)



(distance unit: meters, angle unit: degrees)

Figure 9 Schematic diagram of wall-mounted installation

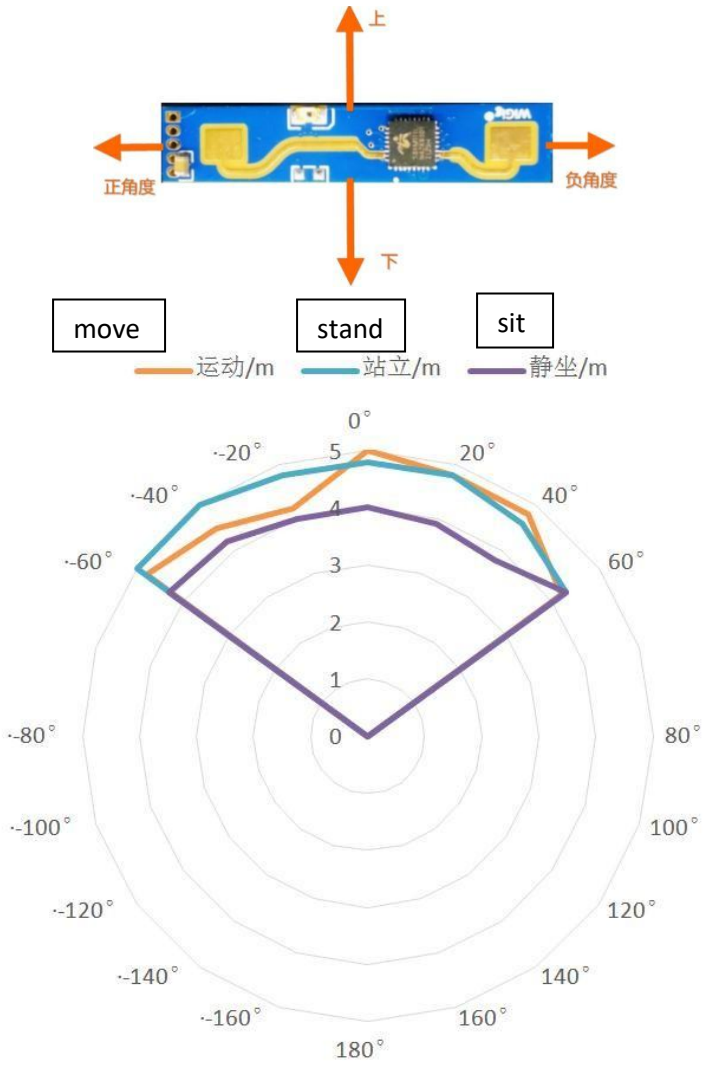


Figure 10 Schematic diagram of the detection range (the height of the wall is 1.5 meters)

5.5 Installation conditions

Confirm the minimum installation clearance

If the radar needs to be installed with an enclosure, the enclosure must have good wave-transmitting properties at 24GHz, and cannot contain metal materials or materials that can shield electromagnetic waves.

Installation Environment Requirements

This product needs to be installed in a suitable environment. If it is used in the following environments, the detection effect will be affected:

• There are non-human objects that are constantly moving in the sensing area, such as animals, curtains that continuously swing, and large green plants facing the air outlet, etc.

• There is a large area of strong reflectors in the sensing area, and the strong reflectors will cause interference to the radar antenna.

• When installing on a wall, external interference factors such as air conditioners and electric fans at the top of the room need to be considered

Precautions during installation

• Try to ensure that the radar antenna is facing the area to be detected, and the surrounding area of the antenna is open and unobstructed

• To ensure that the installation position of the sensor is firm and stable, the shaking of the radar itself will affect the detection effect

• Make sure that there is no movement or vibration on the back of the radar. Due to the penetrating nature of radar waves, the back lobe of the antenna signal may detect moving objects behind the radar. Metal shielding cover or metal backplane can be used to shield the radar back lobe and reduce the influence of objects on the back of the radar

• The theoretical distance accuracy of radar is the result obtained through special algorithm processing on the basis of the physical resolution of 0.75 meters. Due to the difference of the target's body shape, state, RCS, etc., the target distance accuracy will fluctuate; at the same time, the maximum distance will also be slightly fluctuation

6 Performance and Electrical Parameters

Working frequency	24GHz~ 24.25GHz Compliant with FCC, CE, non-commission certification
Power Requirements	DC 5V，Power supply capability>200mA
Average operating current	80 mA
Modulation	FMCW
interface	1 GPIO，IO level 3.3V 1 UART
target application	human presence sensor
Detection distance	0.75m～6m，adjustable
Detection angle	±60 °
Distance resolution	0.75m
Sweep Bandwidth	250MHz Compliant with FCC, CE, non-commission certification
ambient temperature	-40 ~ 85℃
Dimensions	7mm x 35 mm

Table 2 Performance and electrical parameters table

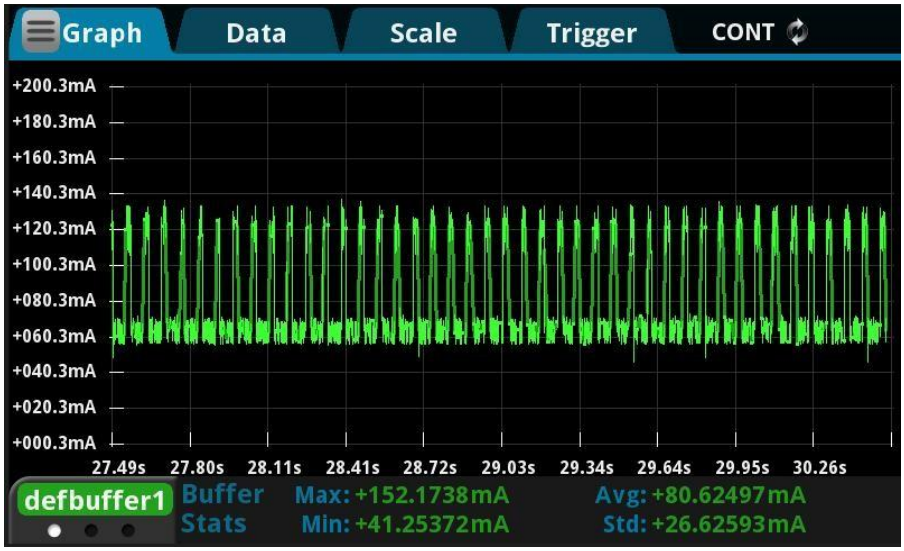
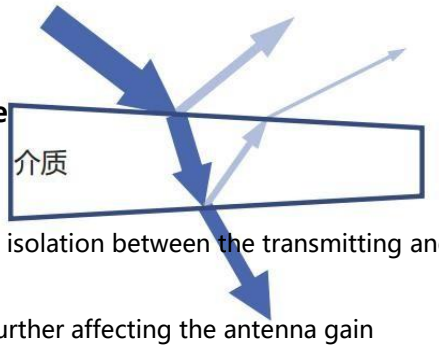


Figure 11 Measured data of module working current

7 Radome Design Guidelines

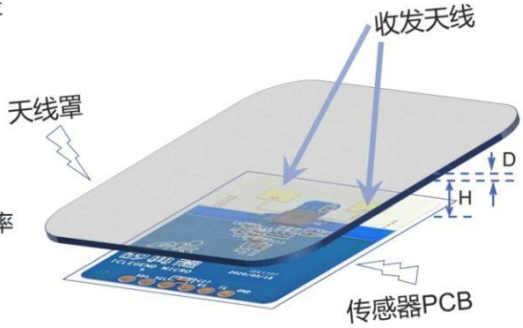


7.1 Effects of radomes on mmWave sensor performance

- Radar waves are reflected at the radome boundary
- Losses in total radar radiated or received power
- The reflected wave enters the receiving channel, affecting the isolation between the transmitting and receiving channels
- Reflections may degrade the standing wave of the antenna, further affecting the antenna gain
- Radar waves will suffer loss when propagated in the medium. In theory, the higher the frequency, the greater the loss will be
- Electromagnetic waves undergo a certain degree of refraction as they pass through a medium
- Affects the antenna's radiation pattern, which in turn affects the sensor's coverage

7.2 Radome Design Principles

- 天线罩的结构形状
  - 表面光滑平整，厚度均匀一致。如平面或者球面，不能凹凸不平
  - 若有表面涂层，不能含有金属或导电的材料
  - 在天线正上方，天线罩面与天线平面保持平行



- 天线到天线罩内表面的的高度H
  - 理想的高度是空气中电磁波半波长的整数倍
  - $H = \frac{m}{2} * \frac{c_0}{f}$，其中m为正整数，$c_0$为真空光速，$f$为工作中心频率
  - 比如，24.125GHz中心频率，其在空气中的半波长约6.2mm
- 天线罩的厚度D
  - 理想的厚度是介质中电磁波半波长的整数倍
  - $D = \frac{m}{2} * \frac{c_0}{f\sqrt{\epsilon_r}}$，其中m为正整数，$\epsilon_r$为天线罩材质的相对介电常数
  - 比如某ABS材料$\epsilon_r = 2.5$，其半波长约3.92mm

7.3 Common materials

- Know the material and electrical properties of the radome before designing
- The table on the right is for reference only, please confirm the actual value with the supplier
- Height H from the antenna to the inner surface of the radome
- When space permits, 1x or 1.5x wavelength is preferred
- For example, 12.4 or 18.6mm is recommended for 24.125GHz
- Error control: ±1.2mm
- Thickness D of the radome
- Recommended half wavelength, error control ±20%
- If the thickness requirement at half wavelength cannot be met
- Low er materials are recommended
- Thickness recommended 1/8 wavelength or thinner

常见材料特性（基于24.125GHz）

介质	ϵ_r典型值	半波长 (mm)	1/8波长 (mm)	1/10波长 (mm)
空气	1.00	6.20	1.55	1.24
ABS1	1.50	5.06	1.27	1.01
ABS2	2.50	3.92	0.98	0.78
PC材料	3.00	3.58	0.89	0.72
PMMA亚克力1	2.00	4.38	1.10	0.88
PMMA亚克力2	5.00	2.77	0.69	0.55
PVC硬	4.00	3.10	0.78	0.62
PVC软	8.00	2.19	0.55	0.44
高密度PE	2.40	4.00	1.00	0.80
低密度PE	2.30	4.09	1.02	0.82
石英玻璃	5	2.77	0.69	0.55

chart 3 Common material properties of radomes

- Influence of heterogeneous materials or multi-layer composite materials on radar performance, it is recommended to make experimental adjustments during design

8 revision history

date	version	Change content
2022-5-26	1.01	Test version
2022-6-8	1.02	Complete data
2022-6-29	1.03	update data