Shenzhen Hi-Link Electronic Co.,Ltd

HLK-LD2410
Human Presence Sensing Module
User Manual

Version：V1.02 Date：2022-6-8

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1. Product introduction

LD2410 is a high-sensitivity 24GHz human presence status sensing module developed by Hi-Link Electronics. Its working principle is to use FMCW frequency-modulated continuous waves to detect human targets in the set space. Combined with radar signal processing and accurate human body sensing algorithms, it realizes high-sensitivity sensing of human presence status, 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, sensing sensitivity in different intervals and unmanned delay time, etc., to adapt to different specific application needs.

Supports GPIO and UART output, plug and play, and can be flexibly applied to different smart scenarios and terminal products.

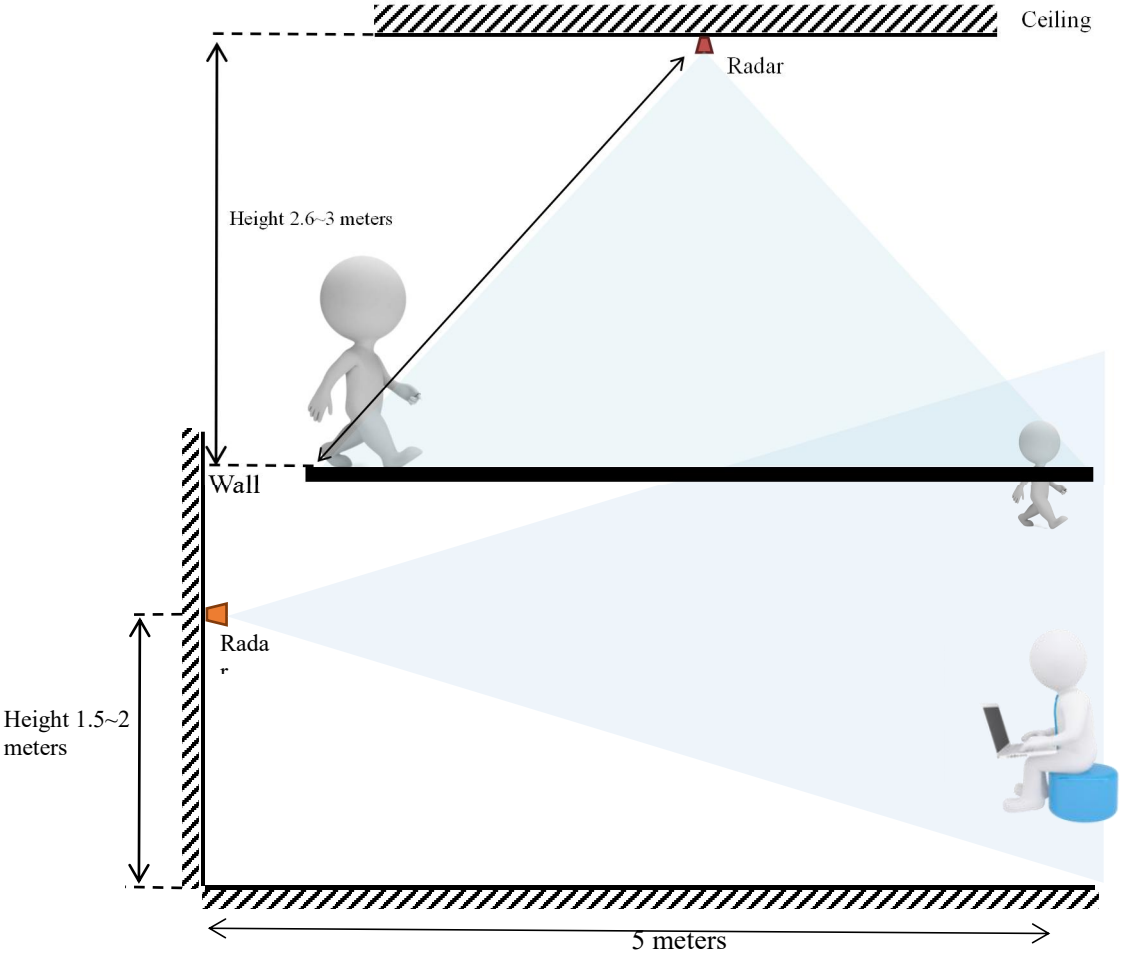


Figure 1 Diagram of Usage

2.Product introduction

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, supports the division of the sensing range, and shield the interference outside the interval
- Multi-level intelligent parameter adjustment to meet the needs of changing scenes
- Visual debugging and configuration tools
- Compact and simplified, the minimum size is only 7mmx35mm
- Supports various installation methods such as ceiling hanging and wall hanging
- 24GHz ISM band, can be certified by FCC and CE spectrum regulations
- 5 ~ 12V wide voltage power supply
- 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 the moving human body, it can also sensitively sense the static, fretting, and sitting and lying movements of the human body that cannot be recognized 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.With 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.Flexible configuration of the farthest sensing distance and the sensitivity on each distance door for flexible and fine-tuned personalization;

	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	🔴	🔴	🔴	🔴	🟢
Dimension	🟢	🔴	🟢	🔴	🟢
Cost	🟢	🔴	🟢	🔴	🔵

🟢 Good 🔵 Average 🔴 Poor

Figure 2 Comparison of mmWave 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 scenarios of AIoT. The common types are as follows.

- Human-sensitive lighting control

  Sensing the human presence in the space,and automatically controls lights, such as lighting equipment in public places, various sensor lights, bulb lights, etc.

- Human-sensitive wake-up of advertising screen and other equipment

  Automatically turn on when people come, and automatically hibernate 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 alarm of dangerous places to prevent people from entering specific high-risk spaces, such as high-risk places entered by personnel from coal mine blasting.

- Smart home appliances

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

- Smart Security

  Detection and identification of people's intrusion, stay and other actions within the specified range

Figure 3 Application Scenario

4.Hardware Description

4.1 Dimension

Figure 4 Physical Map of the Module

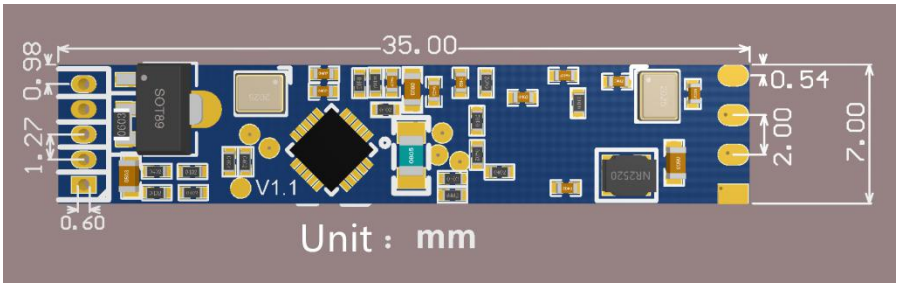


Figure 5 Module Dimensions

Size: 7mmx35mm, 5 pin holes are reserved in the hardware (the factory default does not match the pins)
The pin hole diameter is 0.6mm, and the pin spacing is 1.27mm.

4.2 Dimension

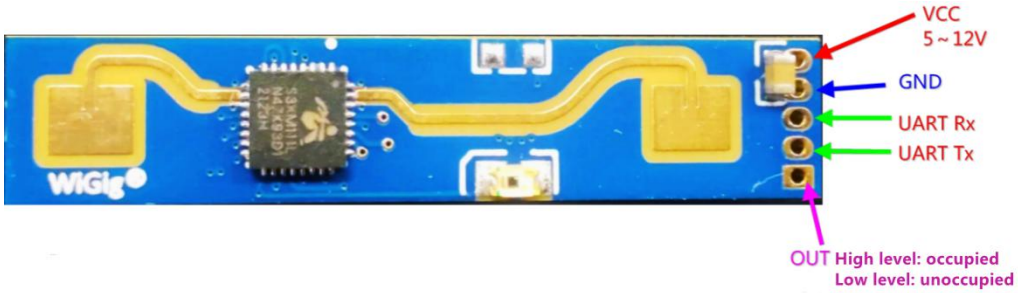


Figure 6 Module Pin Definition Diagram

Pin	Symbol	Name	Function
1	OUT	Target status output	Human presence detected: output high level No human presence: output low level
2	UART_Tx	Serial port Tx	Serial port Tx pin
3	UART_Rx	Serial port Rx	Serial port Rx pin
4	GND	Power ground	Power ground
5	VCC	Power input	Power input 5V (acceptable 5V ~ 12V voltage power supply)

Table 1 Pin Definition Table

5.Usage and Configuration

5.1 Typical Application Circuit

The LD2410 module directly outputs the detected target state through an IO pin (high level when there is someone, low level when there is no one), and can also output the detection result data through the serial port according to the specified protocol. It includes target status and distance auxiliary information, etc., which can be used flexibly by users according to specific application scenarios.

The module IO level is 3.3V. The default baud rate of the serial port is 256000, 1 stop bit, 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

If the farthest detectable distance has been set, only human objects that appear within the farthest distance will be detected and the result will be output.

If set in units of distance gates, 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- 8m. If the farthest door is set to 2, only if there is a human body within 1.5m will it be effectively detected 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 is possible to detect only the human body within the range of 1.5 to 3 meters from the distance module.

Unoccupied state duration

Radar in the output from occupied to unoccupied results, will continue to report a period of time on the occupied, if the radar test range in this time period continued unoccupied, the radar reported unoccupied; if the radar detects someone in this time period, then refreshed this time, unit seconds. Equivalent to unoccupied delay time, after the person leaves, keep unoccupied state more than this duration before the output status for unoccupied.

5.3 Translated with www.DeepL.com/Translator (free version) 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 also receive the detection result data reported by the module, and make real-time visualization display, which is greatly convenient for users.

Usage of the upper computer tool:

1.Properly connect the module serial port with the USB to serial port tool.

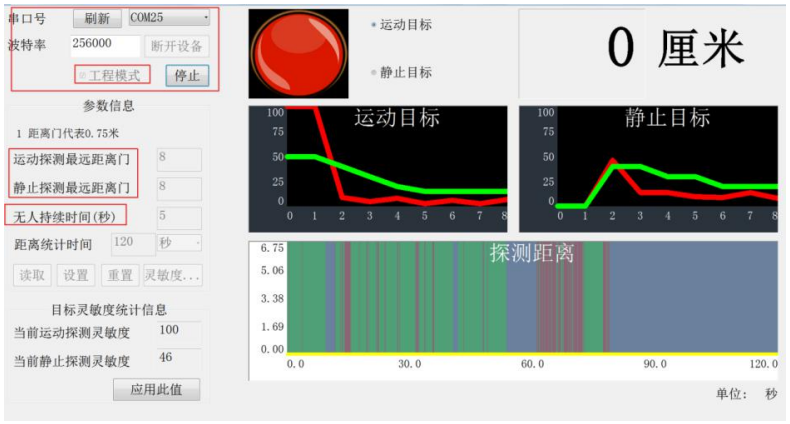
2.Select the corresponding serial port number in the upper computer tool, set the baud rate to 25600, select the engineering mode, and click to connect the device;

3.After the connection is successful, click the start button, and the graphical interface on the right will display the test results and data;

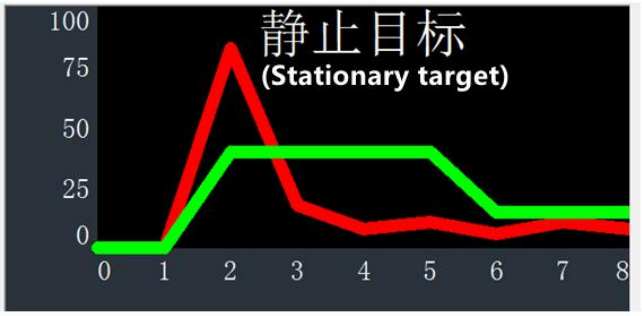
4.After connecting, when the start button is not clicked, or click stop after starting, the mode parameter information can be read or set;

Note: The parameters cannot be read and configured after clicking start, and configuration can only be performed after stopping.

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



The ball is the target status output indication: red means there is an occupied moving target, purple means there is a stationary target; green means unoccupied



Green represents the value of the sensitivity set on each distance gate

Red represents the current target energy value on each range gate

5.4 Mounting Method and Sensing Range

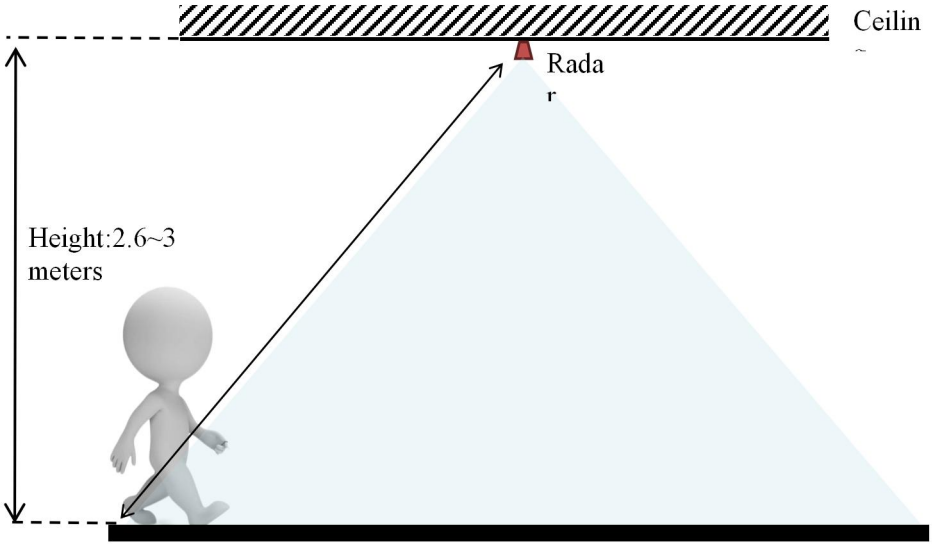
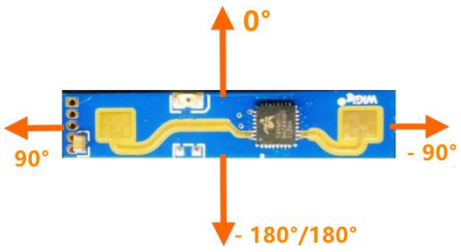
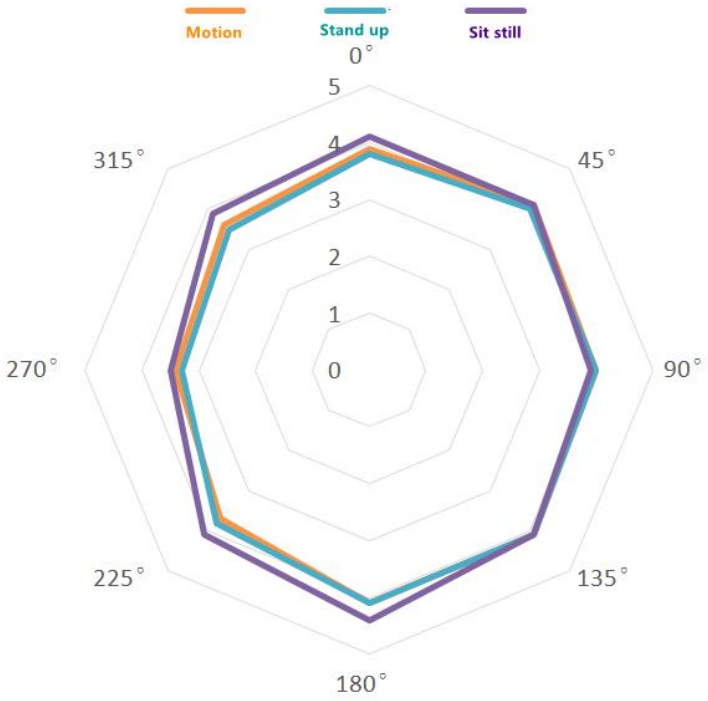


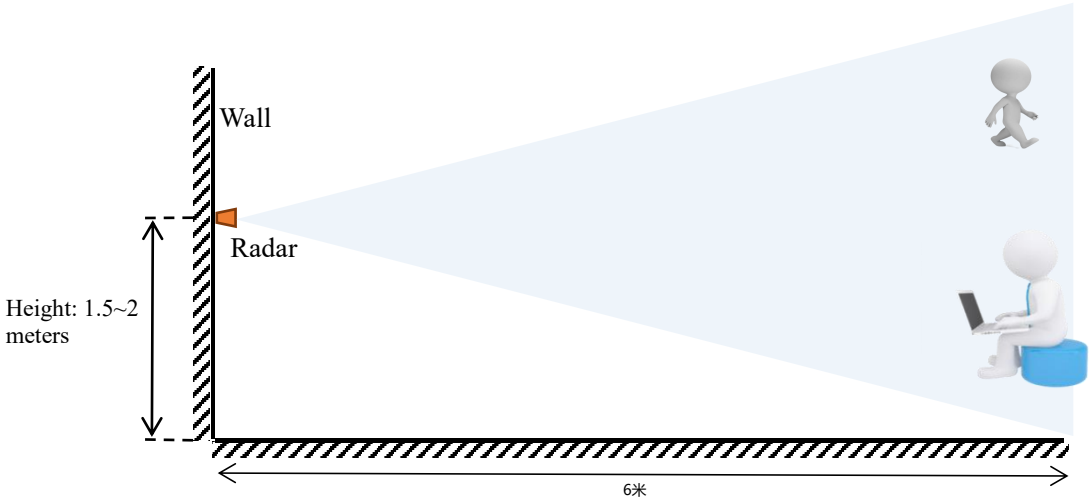
Figure 7 Schematic Diagram of Ceiling-mounted Installation





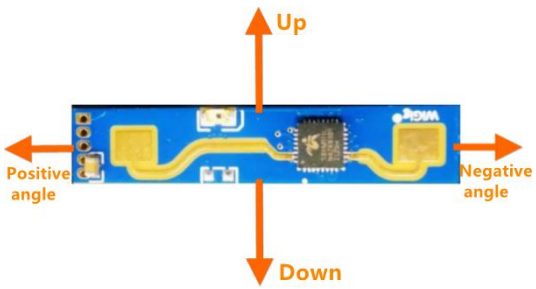
(Distance unit: meters, Angle unit: degrees)

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



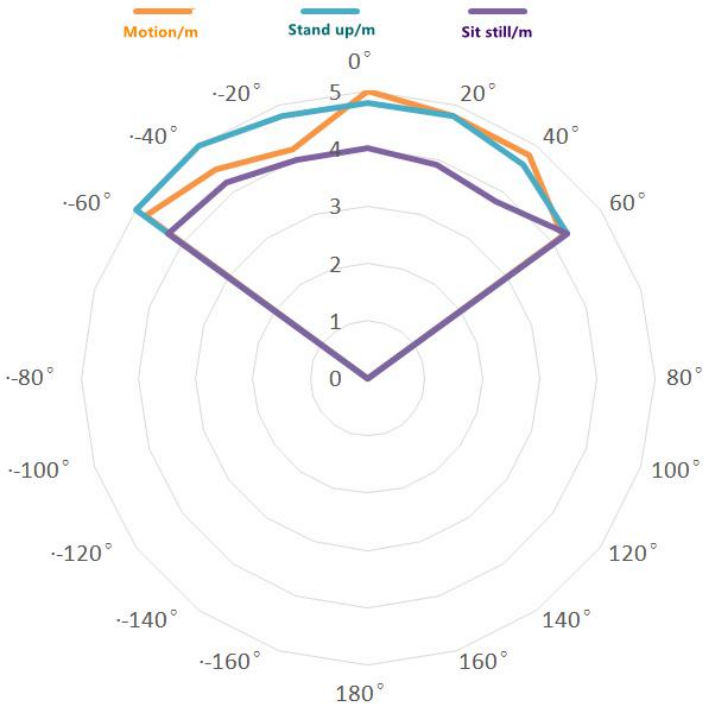


Figure 10 Schematic Diagram of Detection Range (wall-mounted height is 1.5 meters)

5.5 Installation Conditions

Confirm the minimum installation clearance

If the radar needs to be installed with a casing, the casing must have good wave-transmitting properties at 24GHz, and cannot contain metal materials or materials that have a shielding effect on 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 continuously moving in the sensing area, such as animals, continuously swinging curtains, 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 the wall, external interference factors such as air conditioners and electric fans on 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.

• To ensure 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. A metal shield or metal backplane can be used to shield the radar back lobe and reduce the impact 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 in the

size, state, and RCS of the target, the target distance accuracy will fluctuate; at the same time, the longest distance will also fluctuate slightly.

6.Performance and Electrical Parameters

Operating frequency	24GHz~ 24.25GHz Compliant with FCC, CE, non-commission certification standards
Operating Voltage	5V （Can accept 5V ~ 12V voltage power supply)
Average operating current	80 mA
Modulation	FMCW
Interface	A GPIO，IO level 3.3V A 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 standards
Ambient temperature	-40 ~ 85℃
Dimensions	7mm x 35 mm

Table 2 Performance and Electrical Parameters Table

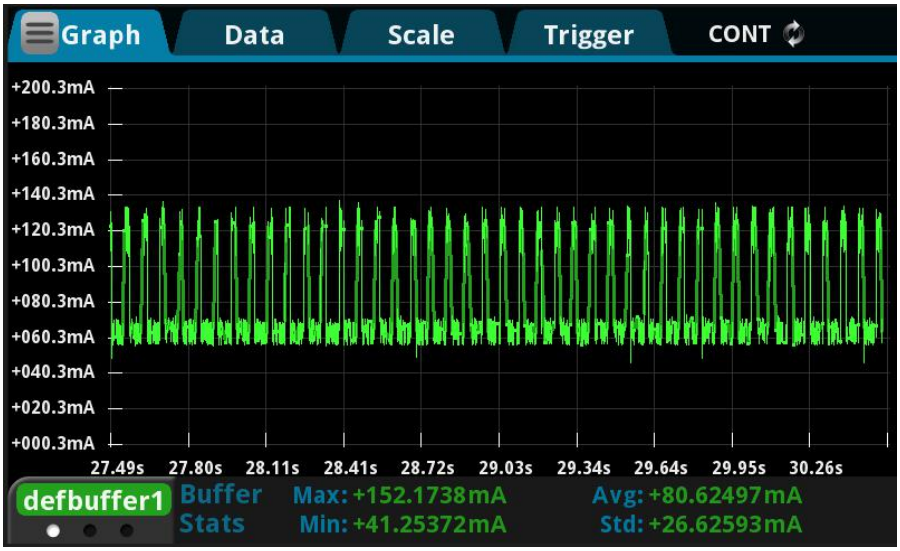


Figure 11 Measured Data of Module Working Current

7.Radome Design Guideline

7.1 Effects of Radomes on mmWave Sensor Performance

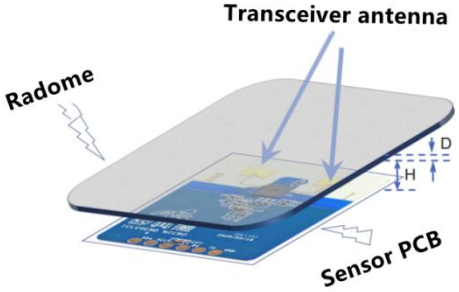
• Radar waves are reflected on the radome boundary
• Losses in total radar radiated or received power
• The reflected wave enters the receiving channel, affecting the isolation between the transmitting and receiving channels
• Reflections may degrade the standing wave of the antenna, further affecting 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

•Structural shape of the radome
•The surface is smooth and flat, and the thickness is uniform. Such as plane or spherical surface, can not be uneven.
•If there is a surface coating, it must not contain metals or conductive materials.
•Directly above the antenna, the radome is parallel to the antenna plane.

•Height H from the antenna to the inner surface of the radome
•The ideal height is an integer multiple of the half wavelength of the electromagnetic wave in the air.
• $H = \frac{m}{2} * \frac{c_0}{f}$,where m is a positive integer, co is the speed of light in vacuum, and f is the working center frequency.
•For example, the center frequency of 24.125GHz, its half wavelength in air is about 6.2mm.

• Radome thickness D
•The ideal thickness is an integer multiple of the half wavelength of the electromagnetic wave in the medium.
• $D = \frac{m}{2} * \frac{c_0}{f\sqrt{\epsilon_r}}$,where m is a positive integer and ϵr is the relative permittivity of the radome material.
•For example, a certain ABS material ϵr=2.5, its half wavelength is about 3.92mm.



7.3 Common materials

- Understand the material and electrical characteristics of the radome before designing
  - The table on the right is for reference only, the actual value should be confirmed with the supplier
- Height H from the antenna to the inner surface of the radome
  - If there is enough space, it is preferred to recommend 1 times or 1.5 times the wavelength
  - For example, 12.4 or 18.6mm is recommended for 24.125GHz
  - Error control： ±1.2mm
- Radome thickness D
  - Recommended half wavelength, error control±20%
  - If the thickness requirement of half wavelength cannot be met
  - It is recommended to use low ϵr materials
  - Thickness recommended 1/8 wavelength or thinner

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

Common material properties (based on 24.125GHz)

Medium	ϵ_r Typical value	Half wavelength (mm)	1/8 wavelength (mm)	1/10 wavelength (mm)
Air	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 material	3.00	3.58	0.89	0.72
PMMA acrylic 1	2.00	4.38	1.10	0.88
PMMA acrylic 2	5.00	2.77	0.69	0.55
PVC hard	4.00	3.10	0.78	0.62
PVC soft	8.00	2.19	0.55	0.44
High density PE	2.40	4.00	1.00	0.80
Low density PE	2.30	4.09	1.02	0.82
Quartz glass	5	2.77	0.69	0.55

Table 3 Common Material Properties of Radomes

8.Revision History

Date	Version	Modifications
2022-5-26	1.01	Test version
2022-6-8	1.02	Complete data

9.Technical Support and Contact

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