Shenzhen Hailink Electronics Co., Ltd.

HLK-LD2420 User Manual

Version: V1.3.2 Revision Date: 22 November 2024

Table of Contents Table of Contents

1. Product Overview

The HLK-LD2420 is a high-performance 24 GHz single-transmitter, single-receiver radar module from Hailink. Its human presence detection algorithm utilises millimetre-wave radar ranging technology and advanced proprietary signal processing technology from the S3 series of chips to achieve precise detection of moving, slightly moving and stationary human figures. The HLK-LD2420 is primarily used in indoor environments to detect whether there are moving or slightly moving people within a designated area, with detection results updated in real time. It has a maximum detection range for moving humans is 8 m. The detection range, sensitivity across different zones and refresh rate can be easily configured. It supports GPIO and UART interfaces, is plug-and-play, and can be flexibly applied to various smart scenarios and end-user products.

1.1. Key Features

- Equipped with a single-chip intelligent millimetre-wave sensor SoC and intelligent algorithm firmware
- Ultra-compact module size: 20 mm × 20 mm
- Pre-loaded with default human presence detection settings; plug-and-play
- Operates in the 24 GHz ISM band; compliant with FCC, CE and China's National Radio Regulatory Commission (NRRC) spectrum regulations
- Powered by a 3.3 V supply, supporting a wide voltage range of 3.0 V to 3.6 V
- Average operating current: 50 mA
- Detects moving and slightly moving human subjects
- Reports detection results in real time
- Provides visualisation tools to configure detection distance ranges, set sensitivity per sub-range and specify result reporting times
- Supports detection range segmentation, completely blocking out any interference outside the designated zones
- Detection at close range (0.2 m) with no detection blind spots
- Maximum detection range for moving human figures: 8 m
- Wide detection angle, with a coverage range of ±60°
- Supports various installation methods, including ceiling and wall mounting
- Independent configuration of trigger and hold states, with strong anti-interference capability

1.2. Application Scenarios

The HLK-LD2420 human presence sensor can detect and recognise moving, standing and stationary people, and is widely used in various AIoT

scenarios, including the following types:

Smart home

Detects human presence and distance, and reports detection results to enable the main control module to intelligently control the operation of household appliances.

Smart Retail

Detects when a person is approaching or moving away within a set distance range; promptly illuminates screens and keeps devices illuminated whilst a person is present.

Smart Security

Access control systems, intercoms, electronic peepholes, etc.

Smart Lighting

Detects and senses human presence, with precise location tracking; suitable for lighting fixtures in public spaces (motion-sensor lights, bulb lights, etc.).

2. System Description

The HLK-LD2420 is a smart, high-precision human presence sensor developed based on the Hailink S3 series of millimetre-wave sensor chips. The sensor utilises FMCW (Frequency-Modulated Continuous Wave) technology, combined with radar signal processing and a built-in intelligent human presence detection algorithm, to detect human targets within a defined space and update detection results in real time. By utilising Hailink's smart millimetre-wave sensor reference design, users can rapidly develop their own high-precision human presence detection products.

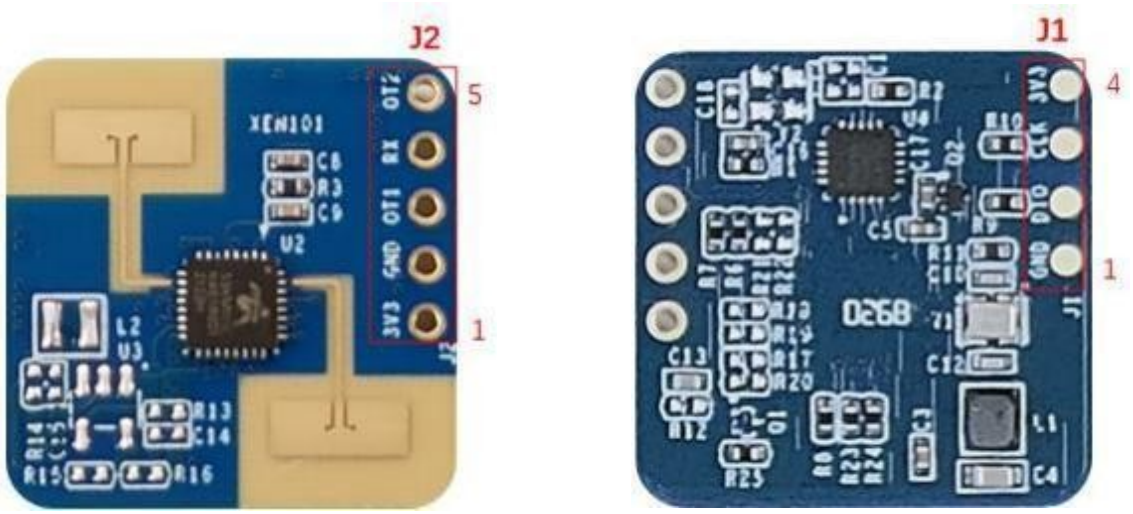
The hardware of the HLK-LD2420 consists primarily of a fully integrated Hailink smart millimetre-wave sensor SoC, a 24 GHz transmit-receive antenna and a main control MCU; the software is complemented by firmware and a visual configuration tool released by Hailink, enabling flexible configuration of detection range, sensitivity and reporting intervals for the human presence detection function.

The specifications of the HLK-LD2420 are shown in Table 2-1.

Parameter	Remarks	Minimum	Typical	Maximum	Unit
Hardware Specifications					
Supported frequency bands	Complies with FCC, CE and China Radio Commission certification standards	24	—	24.25	GHz
Supports maximum sweep bandwidth		—	0.25	—	GHz
Maximum equivalent isotropic radiated power		—	11	—	dBm
Supply voltage		3.0	3.3	3.6	V
Dimensions		—	20 × 20	—	mm^2
Ambient temperature		-40	—	85	°C
System performance					
Detection Range (Wall-mounted)	Moving human targets	—	8	—	m
	Micro-motion human target	—	6	—	m
Detection range (ceiling-mounted)	Moving human target (diameter)	—	5	—	m
	Micro-motion human target (diameter)	—	4	—	m
Distance detection accuracy	Moving targets within 8 metres of the radar in a straight line	—	±0.35	—	m
Average operating current		—	50	—	mA
Data refresh rate		—	10	—	Hz

3. Hardware Specifications

The image below shows photographs of the front and back of the module. The module features five pin holes (pins not supplied as standard) designated as J2, which are used for power supply and communication; J1 is the the SWD interface, used for MCU programming and debugging.



Front Reverse

Figure 3-1 Photographs of the front and back of the module Table 3-1 J1 pin description

J# PIN#	Description	Features	Description
J1 Pin 1	GND	Ground	-
J1 Pin 2	DIO	SWD interface data line	0 to 3.3 V
J1 Pin 3	CLK	SWD interface clock line	0 to 3.3 V
J1 Pin 4	3V3	Power supply input	3.0 V to 3.6 V, typ. 3.3 V

Table 3-2 J2 Pin Descriptions

J# PIN#	Description	Function	Description
J2 Pin 1	3V3	Power supply input	3.0 V to 3.6 V, typ. 3.3 V
J2 Pin 2	GND	Ground	-
J2 Pin 3	OT1	UART_TX	0 to 3.3 V
J2Pin4	RX	UART_RX	0 to 3.3 V
J2Pin5	OT2	IO, used to report detection status: high level indicates presence, low level indicates absence	0 to 3.3 V

Note: The pin pitch for the J1 and J2 connectors is 2.54 mm.

4. Software Instructions

This chapter introduces firmware debugging for the HLK-LD2420 and the use of the host computer tool.

The HLK-LD2420 is shipped with the system firmware pre-programmed; please refer to the module's outer packaging for the firmware version. Hailink provides a visual host computer configuration tool specifically designed for the HLK-LD2420 hardware, enabling developers to configure the HLK-LD2420's parameters according to their specific use cases and optimise detection performance.

4.1. Firmware Configuration

This section describes the firmware debugging procedure for the HLK-LD2420 radar module.

Step 1: Connect the host computer to the radar module via a USB-to-TTL serial adapter board; the pin connections are as shown in Table 4-1 and Figure 4-1

.

Table 4-1 Pin mapping for the radar module connected to the USB-to-TTL serial adapter board

Radar Module	Serial adapter board
RX	TXD
O_T1	RXD
3V3	VCCIO
GND	GND

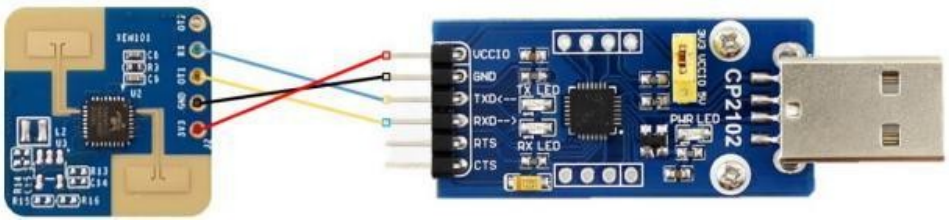


Figure 4-1 Connection between the HLK-LD2420 hardware and the USB-to-serial adapter board

Step 2: Open the Device Manager on the host computer and check the serial port number for the radar module.

Step 3: Open the serial port tool, select the serial port number for the radar module, set the baud rate to 115200, and then click the 'Open Button to view the current radar detection results in the output section of the tool interface.

4.2. Host Computer Usage

This section describes the use of the host computer tool supplied with the HLK-LD2420 module to help users understand the meaning of relevant parameters and how to obtain them.

Step 1: Download the HLK-LD2420 host computer tool, "HLK-2420_TOOL.exe", from the Hailink official website. **Step 2:** Connect the radar module to the host computer using a serial interface board, as shown in Figure 4-1.

Step 3: Open the host computer tool, select the serial port number for the radar module, enter a baud rate of 115200, and click the "Connect Device" button to read and write parameters (Note: The serial port tool and the host computer tool cannot be used simultaneously).

4.2.1. Parameter Settings

The host computer tool interface is shown in Figure 4-2.

Figure 4-2 HLK-LD2420_Tool interface

Figure 4-3 After the device is connected

A detailed explanation of the parameters displayed on the host computer tool interface is provided in Table 4-2.

Table 4-2 Explanation of parameters on the host computer tool interface

Parameter Name	Explanation	Parameter Range
Minimum Distance	Used to set the minimum distance threshold for radar detection. The resolution of the distance threshold is 70 cm.	0–15
Maximum Distance	Used to set the maximum distance threshold for radar detection. The resolution of the distance threshold is 70 cm.	0–15 (must be no less than the minimum distance)
Target Disappearance Delay	A delay period T is required for the target status to switch from 'occupied' to 'unoccupied'. During this period, if an occupant is detected, the timer for this period is reset. The radar will only switch to the 'unoccupied' status and report 'unoccupied' once the 'unoccupied' state has persisted for a full T period.	(Corresponds to host computer settings) 0–90 (Corresponds to serial port configuration) 0–1,000,000,000
Trigger threshold	Used to set the sensitivity for transitioning from the 'unoccupied' to the 'occupied' state; it is recommended to set this to at least five times the energy level. For energy scanning and data viewing, please refer to sections **4.2.2** and **4.2.3**.	(Corresponding to host computer settings) 0–90 (Corresponds to serial port configuration) 0–1,000,000,000
Hold Threshold	Used to detect subtle body movements and to set the sensitivity for maintaining the 'occupied' state; it is recommended to set this to between 2 and 5 times the background noise. For energy scanning and data viewing, please refer to **sections** 4.2.2 and 4.2.3.	(Corresponding to host computer settings) 0–90 (Corresponding to host computer settings) 0–90 (Corresponding to serial port configuration) 0–1,000,000,000

Threshold parameter explanation: Assuming N is the parameter configured on the host computer and M is the parameter configured via the serial port, for host computer and serial port settings

, the conversion relationship is $N = (10 \times \log_{10})$ $M = \overline{1010}^{N}$. For example, if the threshold value for gate 0 in the serial port configuration is 65536, the

corresponding host computer value is $(10 \times \log_{(10)} \times 65536) \approx 48.16$. For example, if the parameter set on the host computer is 70, the corresponding serial port configuration

is $1010 \approx \overline{10000000}^{70}$. When converted to hexadecimal with little-end-first notation, the command is: *0x80969800*

4.2.2 实时数据

上位机“实时数据”页面如图 4-4 所示，其功能页面介绍如下：

- 左上角的彩灯图标表示探测区域内有人/无人情况：雷达检测到人体存在时，彩灯为红色；没有检测到人体存在时，彩灯为绿色；
- 彩灯后方的文本显示框显示雷达检测到的目标人体与雷达的径向距离；
- “开始/暂停”切换按钮用于开启和暂停雷达的检测；
- “生成门限”按钮用于扫描环境噪声并计算各个距离门的“触发门限”和“保持门限”；
- “应用门限”按钮用于将“生成门限”功能中得到的“触发门限”和“保持门限”发送给雷达；
- “相对功率 VS 距离门”折线图用于实时显示各个距离门的运动能量值（绿色折线），触发门限值（红色折线）和保持门限值（黄色折线）；黑色背景表示该距离门为有效探测范围，灰色背景表示该距离门为无效探测范围；
- “距离 VS 时间”折线图用于实时显示雷达检测到的目标人体在过去 60 秒内的距离变化；灰色背景区域表示雷达在该时间段检测到目标人体，黑色背景区域表示雷达在该时间段没有检测到目标人体。

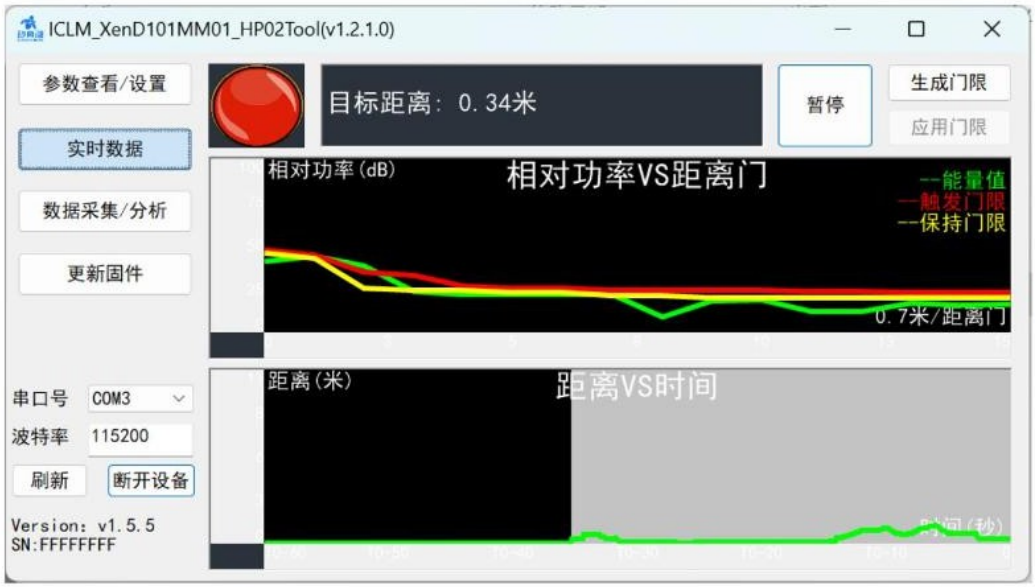


图 4-4 实时数据页面

通过上位机查看实时数据的步骤如下：

步骤一、在连接 HLK-LD2420 模组与上位机工具之后，点击“实时数据”按钮切换至该功能页面，此时上位机工具自动开启雷达的检测功能，“开始/暂停”切换按钮显示“暂停”，上位机功能页面的两个折线图开始显示相应实时数据信息；

步骤二、点击“开始/暂停”切换按钮可暂停雷达的检测功能，功能页面的彩灯变为绿色，目标距离显示“0.00

米”，下方的两个折线图停止更新。

通过上位机生成/应用门限的步骤如下：

步骤一、在“实时数据”页面的“开始/暂停”按钮显示“暂停”时，点击“生成门限”按钮，上位机工具弹出“门限采集”信息窗口，上方的表格实时展示各个距离门的触发能量和保持能量数值，下方的进度条显示扫描进度，如图 4-5 所示；

步骤二、点击“取消”按钮可终止采集；如果用户想要保存并应用采集的数据，待数据采集完成后点击“确定”；

步骤三（可选）、如果步骤二中用户选择了“确定”，则页面上的“应用门限”按钮由灰色的不可点击状态变为可点击状态，点击“应用门限”按钮，上位机工具把步骤二中计算得到的门限数据发送给雷达，并弹出“门限设置成功”的提示窗口。

应用了生成的门限后，用户可以在“参数查看/设置”页面查看最新的雷达门限参数值。

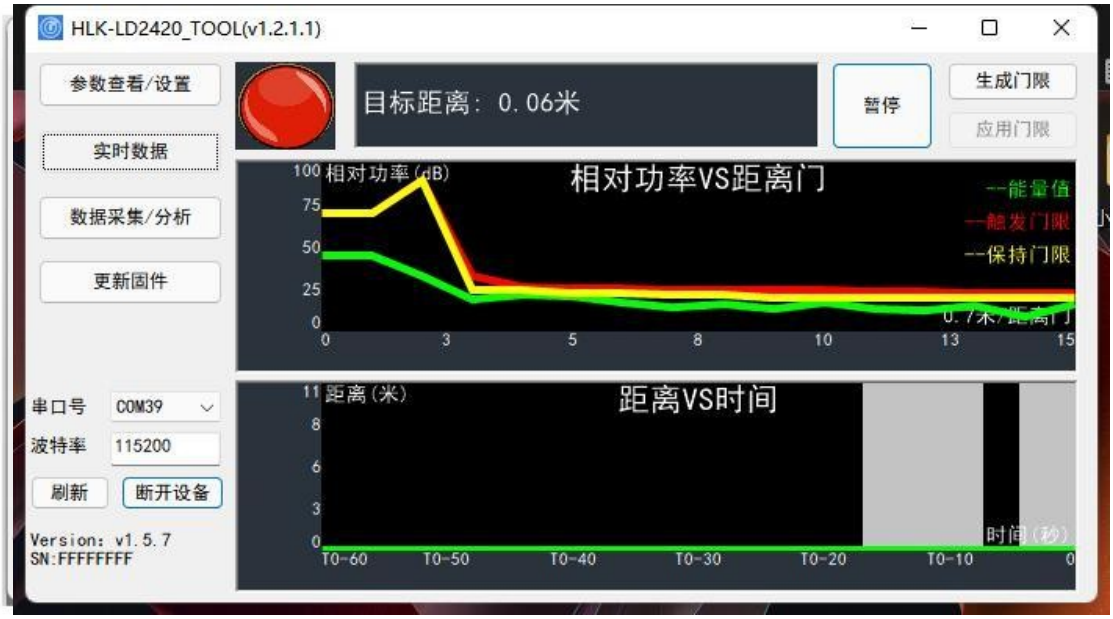


图 4-5 门限采集页面

4.2.3 数据采集/分析

上位机的“数据采集/分析”页面如图 4-6 所示，其功能页面介绍如下：

- “距离门扫描时间（秒）”：用于设置每个距离门的环境噪声扫描时长，默认 20 s，取值范围为 0~65535；
- “文件保存路径”：用于设置采集到的数据的保存路径；
- “选择显示距离门”：用于选择需查看的距离门，可选范围为 0~15；
- “采集数据/停止采集”切换按钮：用于开始和停止数据采集，停止数据采集后，用户可在设置的文件保存路径下看到文件名以 RadarData 开头、时间戳结尾的.dat 类型文件；
- “载入数据”按钮：用于打开已保存的雷达扫描数据，供用户查看和分析；

- “能量信息”折线图：用于显示用户选择的距离门上的扫描能量值，触发门限，和保持门限，横轴为时间，纵轴为相对功率表示的能量信息；
- “距离信息”折线图：用于显示雷达检测范围内检测到的人体目标的距离信息，横轴为时间，纵轴为距离。

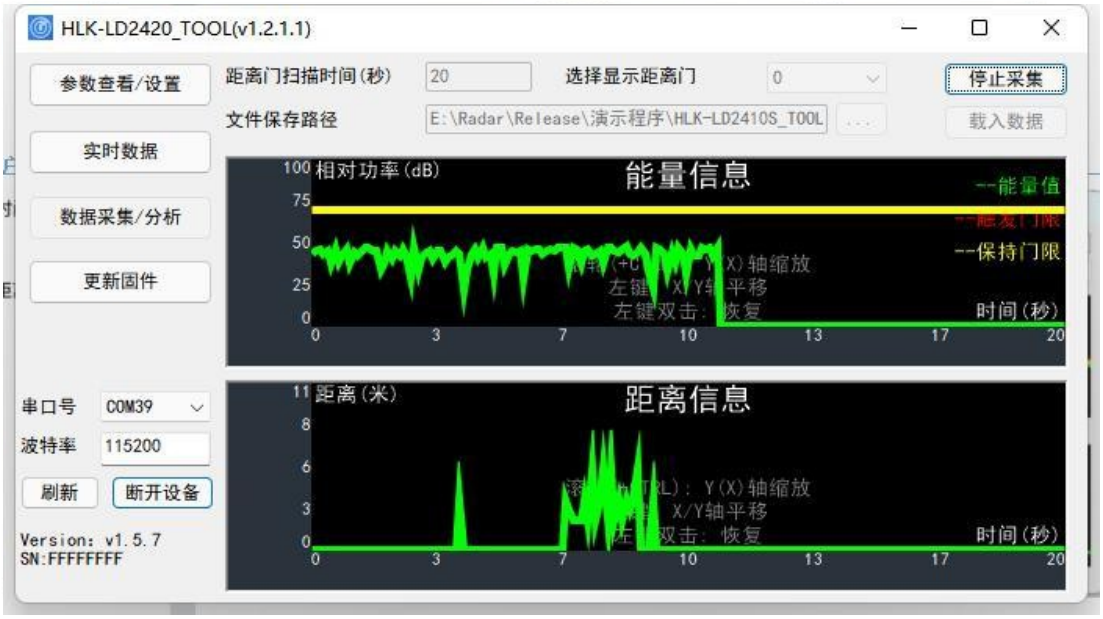


图 4-6 采集/分析数据页面

通过上位机采集能量数据的步骤如下：

步骤一、在连接 HLK-LD2420 模组与上位机工具之后，点击“数据采集/分析”功能按钮切换至该功能页面；

步骤二、输入“距离门扫描时间”，设置“文件保存路径”[2]，确保雷达检测范围在一个扫描周期内无人后，点击“采集数据/停止采集”切换按钮，开始采集数据；

步骤三、开始采集数据后，用户可以等待上位机工具在扫描完成后自动停止采集，也可以点击“采集数据/停止采集”切换按钮提前停止数据采集；这两种情况下，采集到的数据都会存放在步骤二中设置的文件保存路径下；

通过上位机分析能量数据的步骤如下：

步骤一、在连接 HLK-LD2420 XenD101MM 模组与上位机工具之后，点击“数据采集/分析”功能按钮切换至该功能页面；

步骤二、点击“载入数据”按钮，选择需要查看的数据；

步骤三、选择需要查看的距离门，用户即可在两个折线图上看到该数据文件中、该距离门的能量信息和距离信息；

步骤四、如需查看曲线上某一点的具体数据，将鼠标光标放在曲线上感兴趣的位置，光标附件会出现悬浮框显示该处的能量值或距离信息，如图 4-7 所示。

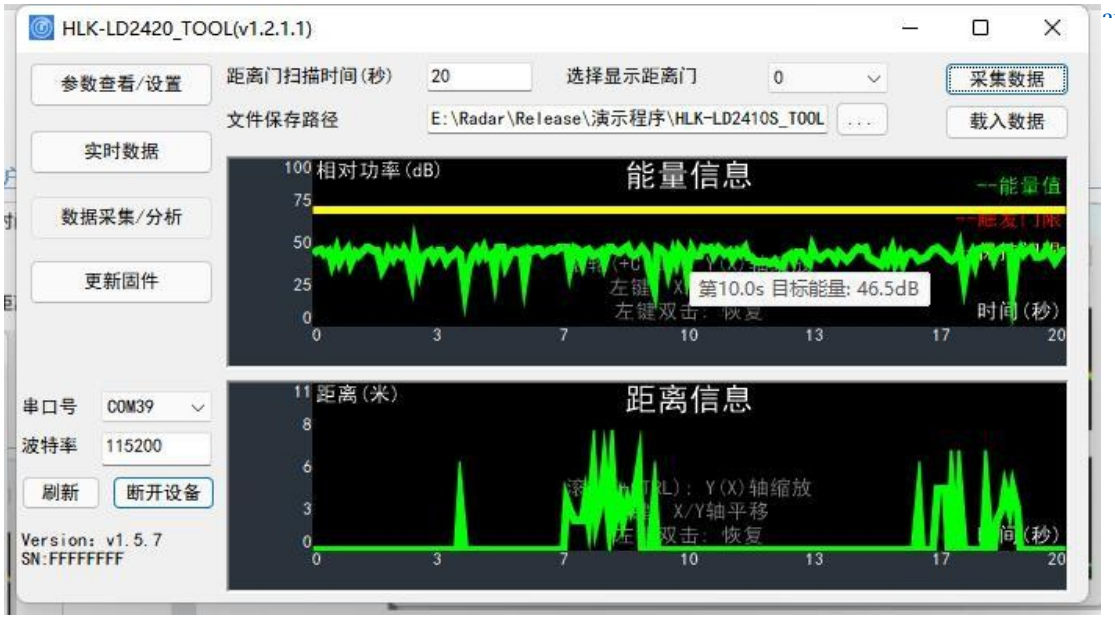


图 4-7 数据查看页面

在查看数据时，用户可以对折线图进行缩放、平移和恢复操作：

- 缩放横坐标：鼠标光标放在图形画布上，按下键盘上 Ctrl 键同时滚动鼠标的滚轮可以在横坐标上放大（向上滚动鼠标滚轮）和缩小（向下滚动鼠标滚轮）图形；
- 平移数据图形：鼠标光标放在图形画布上，按下鼠标左键并移动鼠标，可以相应地移动图形，横纵坐标也会同步变化；
- 恢复图形：鼠标光标放在图形画布上，双击鼠标左键可以将图形恢复为默认的显示设置。

4.2.4 更新固件

上位机“更新固件”页面如图 4-8 所示。通过上位机更新雷达模组固件的步骤如下：

步骤一、在连接 HLK-LD2420 模组与上位机工具之后，点击“更新固件”功能按钮切换至该功能页面；

步骤二[3]、在功能页面点击“获取固件信息”按钮，右侧提示信息框中会显示当前设备的 ID 信息；

步骤三、点击“选择 bin 文件路径”按钮，选择需要的.bin 文件，点击“下载”按钮开始升级固件，右侧提示信息框会实时显示下载结果，下方显示 bin 文件信息和当前的下载进度。

[3] 此步骤为必需，用户在使用上位机界面更新固件时不可跳过此步骤。

图 4-8 固件升级页面

固件升级成功后，页面提示信息框中会显示“下载成功！”。固件升级失败时，提示信息框中会显示相应出错信息。

5. 通信协议

本通信协议主要供需脱离可视化工具进行二次开发的用户使用。XenD101MM 通过串口（TTL 电平）与外界通信。雷达的数据输出与参数配置命令均在本协议下进行。雷达串口默认波特率为 115200，1 停止位，无奇偶校验位。

本章主要从三个部分介绍此通信协议：

- 协议格式：包括协议数据格式和命令帧格式；
- 配置命令包格式：包括命令包格式和命令返回包格式；
- 上传数据帧格式：包括调试模式的上传数据帧格式和上报模式的上传数据帧格式。

使用命令进行参数配置的基本流程是：

1. 进入命令模式；
2. 配置参数命令/获取参数命令；
3. 退出命令模式。

5.1 协议格式

5.1.1 协议数据格式

HLK-LD2420

数据通信使用小端格式，以下表格中所有数据均为十六进制。

5.1.2 命令协议帧格式

协议定义的雷达配置命令和 ACK 命令格式如表 5-1 和表 5-3 所示。

表 5-1 发送命令协议帧格式

帧头	帧内数据长度	帧内数据	帧尾
FD FC FB FA	2 字节	见表 5-2	04 03 02 01

表 5-2 发送帧内数据格式

命令字（2 字节）	命令值（N 字节）

表 5-3 ACK 命令协议帧格式

帧头	帧内数据长度	帧内数据	帧尾
FD FC FB FA	2 字节	见表 5-4	04 03 02 01

表 5-4 ACK 帧内数据格式

发送命令字（2 字节）	命令执行状态（2 字节）	返回值（N 字节）

5.2 发送命令与 ACK

5.2.1 读取固件版本命令

此命令读取雷达固件版本信息。

命令字：0x0000

命令值：无

返回值：版本号长度（2 字节）+ 版本号字节串

发送数据：

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9 ~ 12
FD FC FB FA	02 00	00 00	04 03 02 01

雷达 ACK(成功)：

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9, 10	Byte 11, 12	Byte 13~18	Byte 19 ~ 24
FD FC FB FA	0C 00	00 01	00 00	06 00	76 31 2E 35 2E 35	04 03 02 01

5.2.2 使能配置命令

对雷达下发的任何其他命令必须在此命令下发后方可执行，否则无效。

命令字: 0x00FF

命令值: 0x0001

返回值: 2 字节 ACK 状态（0 成功，1 失败）+ 2 字节协议版本（0x0002）+ 2 字节缓冲区大小（0x0020）

发送数据：

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9, 10	Byte 11 ~ 14
FD FC FB FA	04 00	FF 00	01 00	04 03 02 01

雷达 ACK(成功)：

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9, 10	Byte 11, 12	Byte 13, 14	Byte 15 ~ 18
FD FC FB FA	08 00	FF 01	00 00	02 00	20 00	04 03 02 01

5.2.3 结束配置命令

结束配置命令，执行后雷达恢复工作模式。如需再次下发其他命令，需要先发送使能配置命令。

命令字：0x00FE

命令值：无

返回值：2 字节 ACK 状态（0 成功，1 失败）

发送数据：

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9 ~ 12
FD FC FB FA	02 00	FE 00	04 03 02 01

雷达 ACK(成功)：

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9, 10	Byte 11 ~ 14
FD FC FB FA	04 00	FE 01	00 00	04 03 02 01

5.2.4 读取序列号命令

此命令读取雷达的序列号。

命令字：0x0011

命令值：无

返回值：2 字节 ACK 状态（0 成功，1 失败）

发送数据：

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9 ~ 12
FD FC FB FA	02 00	11 00	04 03 02 01

雷达 ACK(成功)：

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9, 10	Byte 11, 12	Byte 13, 14	Byte 15 ~ 18
FD FC FB FA	08 00	11 01	00 00	02 00	CD AB	04 03 02 01

5.2.5 写入序列号命令

此命令写入雷达的序列号。

命令字：0x0010

命令值：SN 长度（2 字节）+ SN 字节串

返回值：2 字节 ACK 状态（0 成功，1 失败）

发送数据：（示例）

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9~12	Byte 9 ~ 12
FD FC FB FA	06 00	10 00	02 00 CD AB	04 03 02 01

雷达 ACK(成功)：

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9, 10	Byte 11 ~ 14
FD FC FB FA	04 00	10 01	00 00	04 03 02 01

5.2.6 读取雷达寄存器命令

此命令读取雷达的寄存器。

命令字：0x0002

命令值：2 字节芯片地址 +（2 字节地址）* N

返回值：（2 字节数据）* N

发送数据：

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9 ~ 12	Byte 13 ~ 16
FD FC FB FA	06 00	02 00	40 00 40 00	04 03 02 01

雷达 ACK(成功)：

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9, 10	Byte 11, 12	Byte 13 ~ 16
FD FC FB FA	06 00	02 01	00 00	07 02	04 03 02 01

5.2.7 配置雷达寄存器命令

此命令写入雷达的寄存器。

命令字：0x0001

命令值：2 字节芯片地址 +（2 字节地址）* N

返回值：2 字节 ACK 状态（0 成功，1 失败）

发送数据：

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9, 10	Byte 11 ~ 14	Byte 15 ~ 18
FD FC FB FA	08 00	01 00	40 00	40 00 07 42	04 03 02 01

雷达 ACK(成功)：

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9, 10	Byte 11 ~ 14
FD FC FB FA	04 00	01 01	00 00	04 03 02 01

5.2.8 读取雷达参数配置命令

此命令可以读取雷达当前的配置参数。

命令字：0x0008

命令值：（2 字节参数 ID）* N

返回值：（4 字节参数值）* N

发送数据：（示例）

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9, 10	Byte 11 ~ 14
FD FC FB FA	04 00	08 00	01 00	04 03 02 01

雷达 ACK：（成功，最大距离门 12）

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9, 10	Byte 11 ~ 14	Byte 15 ~ 18
FD FC FB FA	08 00	08 01	00 00	0C 00 00 00	04 03 02 01

5.2.9 配置雷达参数命令

此命令设置雷达模组的参数。具体参数字请参考表 5-5。

表 5-5 协议参数表

参数名称	参数字	参数范围
最小距离门	0x0000	0~15
最大距离门	0x0001	0~15
目标消失延迟	0x0004	0~65535 单位秒
触发门限	0x0010 ~ 0x001F	0~232 - 1，为模值平方
保持门限	0x0020 ~ 0x002F	0~232 - 1，为模值平方

命令字：0x0007

命令值：（2 字节参数 ID + 4 字节参数值）* N

返回值：2 字节 ACK 状态（0 成功，1 失败）

发送数据：最大距离门 12，最小距离门 2

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9, 10	Byte 11, 12	Byte 13, 14	Byte 15 ~ 18
FD FC FB FA	08 00	07 00	01 00	12 00	00 00	04 03 02 01

雷达 ACK（成功）：

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9, 10	Byte 11 ~ 14
FD FC FB FA	04 00	07 01	00 00	04 03 02 01

5.2.10 配置系统参数命令

此命令可以配置雷达系统参数。

命令字：0x0012

命令值：（2 字节参数 ID + 4 字节参数值）* N

返回值：2 字节 ACK 状态（0 成功，1 失败）

发送数据：

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9, 10	Byte 11 ~ 14	Byte 15 ~ 18
FD FC FB FA	08 00	12 00	00 00	04 00 00 00	04 03 02 01

雷达 ACK（成功）：

Byte 1 ~ 4	Byte 5, 6	Byte 7, 8	Byte 9, 10	Byte 11 ~ 14
FD FC FB FA	04 00	12 01	00 00	04 03 02 01

5.3 雷达上报数据

HLK-LD2420

出厂固件正常的工作模式通过串口输出检测结果，输出的结果是 ON/OFF 的字符串及目标距离门。在特殊的模式下，上位机会获取雷达处理过程中的数据，因此在命令行模式下固件提供额外的两种传输格式，分别为调试模式和上报模式。

在命令行模式中，通过调整命令包中的工作模式参数，可控制串口上报的数据格式。图 5-1 展示了一个命令包示例。

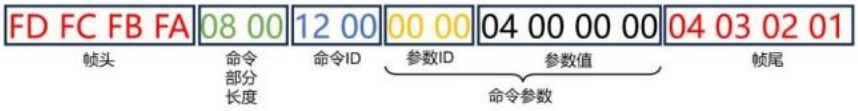


图 5-1 命令包格式示例

在该命令包中，命令参数的参数值可决定雷达的工作模式：0x0000 为调试模式，0x0004 为上报模式，0x0064 为正常模式。

表 5-6 展示了调试模式的数据帧格式。调试模式下传出的 RDMAP 模值数据，按照每个 chirp 的所有距离门的数据进行发送，即先发送第 1 个 chirp 的 16 个距离门的模值数据，再发送第 2 个 chirp 的 16 个距离门的模值数据，以此类推。

表 5-6 调试模式的数据帧格式

帧头	数据	帧尾
AA, BF, 10, 14	RDMAP：20（多普勒）*16（距离门）*4（模值平方）	FD, FC, FB, FA

表 5-7 上报模式的数据帧格式

帧头	长度	检测结果	目标距离	各距离门能量值	帧尾
F4, F3, F2, F1	2 字节，检测结果、目标距离和各距离门能量值的总字节数	1 字节， 00 无人 01 有人	2 字节	32 字节 16（距离门总数） * 2 字节	F8, F7, F6, F5

图 5-2 展示了上报模式时串口传出的一帧数据帧示例。

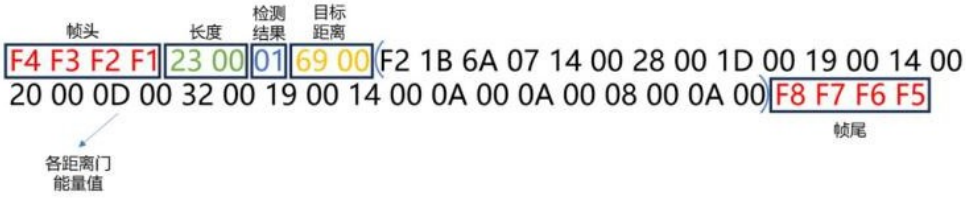


图 5-2 上报模式的数据帧示例

示例中，各部分数据含义如下：

长度字段：表示上报检测结果+目标距离+各距离门能量值所占的总字节数；

检测结果：表示当前场景中是否有目标；

目标距离：表示场景中目标相距雷达的距离；

各距离门能量值：表示从 0~15 距离门，每个距离门的能量值大小。

因此图 2 中数据帧解析举例如下：

长度：0023，表示上报检测结果+目标距离+各距离门能量值所占的总字节数 = 35

检测结果：01，表示当前检测到场景中有人

目标距离：0069，表示目标距离 = 105 cm

各距离门能量值：

距离门 0 能量 = 1BF2

距离门 1 能量 = 076A

距离门 2 能量 = 0014

距离门 3 能量 = 0028

距离门 4 能量 = 001D

距离门 5 能量 = 0019

距离门 6 能量 = 0014

距离门 7 能量 = 0020

距离门 8 能量 = 000D

距离门 9 能量 = 0032

距离门 10 能量 = 0019
距离门 11 能量 = 0014
距离门 12 能量 = 000A
距离门 13 能量 = 000A
距离门 14 能量 = 0008
距离门 15 能量 = 000A

6. Installation and Detection Range

The HLK-LD2420 supports both ceiling-mounted and wall-mounted installation methods; ceiling mounting is recommended.

The azimuth of the radar is shown in Figure 5-1. Here, the Y-axis direction is 0°, the X-axis direction is 90°, and the Z-axis is perpendicular to the X-Y plane (also known as the normal direction).

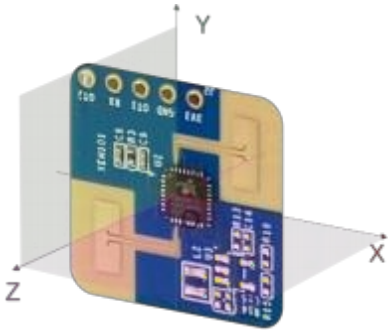


Figure 5-1 Schematic diagram of the radar module's orientation

6.1. Ceiling Mounting

The recommended ceiling-mounted installation height is 2.7–3 m. When ceiling-mounted, the HLK-LD2420 radar module has a maximum motion detection range, by default, of a conical three-dimensional space with a base radius of 5 m, as shown in Figure 5-2.

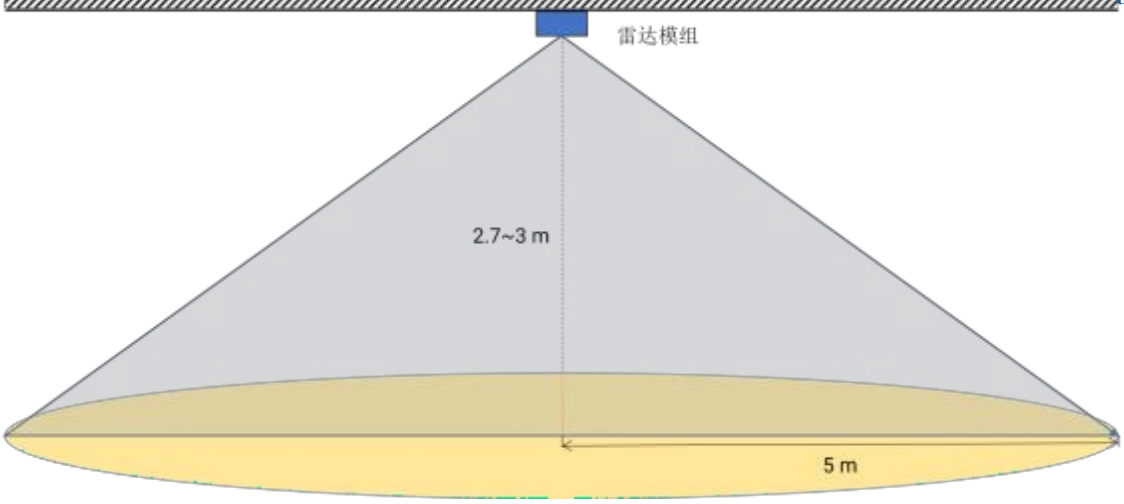
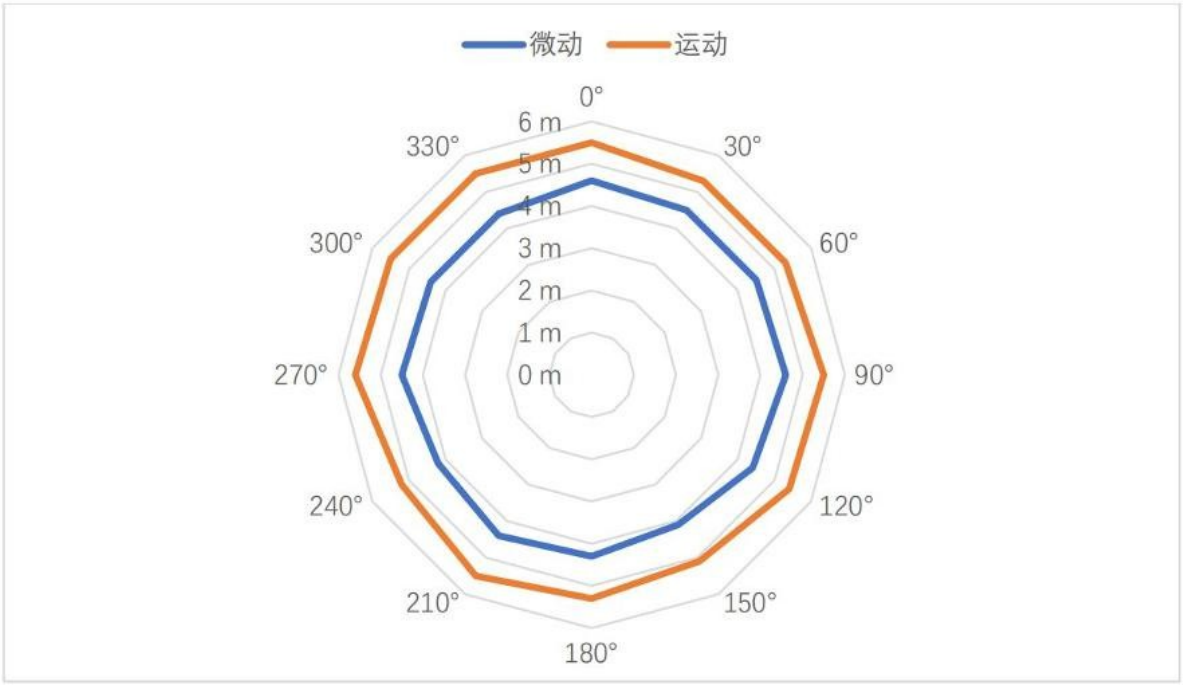


Figure 5-2 Schematic diagram of the detection range of the HLK-LD2420 radar module (ceiling-mounted)

Figure 5-3 illustrates the motion and subtle movement detection ranges for this reference solution when the ceiling-mounted installation height is 2.7 m.



5-3 Detection Range for Ceiling-Mounted Installation

6.2. Wall-mounted installation

The recommended wall-mounted installation height is 1.5–2 m.For wall-mounted installation, the X-axis of the radar module (see Figure 5-1) points horizontally, the Y-axis points upwards, and the Z-axis points towards the detection area. The maximum motion detection range of the HLK-LD2420 radar module in a wall-mounted configuration, under default settings, is a three-dimensional fan-shaped space with a radius of 8 m and an angle of $\pm 60°$ in the horizontal and pitch directions, as shown in Figure 5-4.

Figure 5-5 shows a schematic diagram of the detection range for this reference configuration when mounted on a wall at a height of 1.5 m.

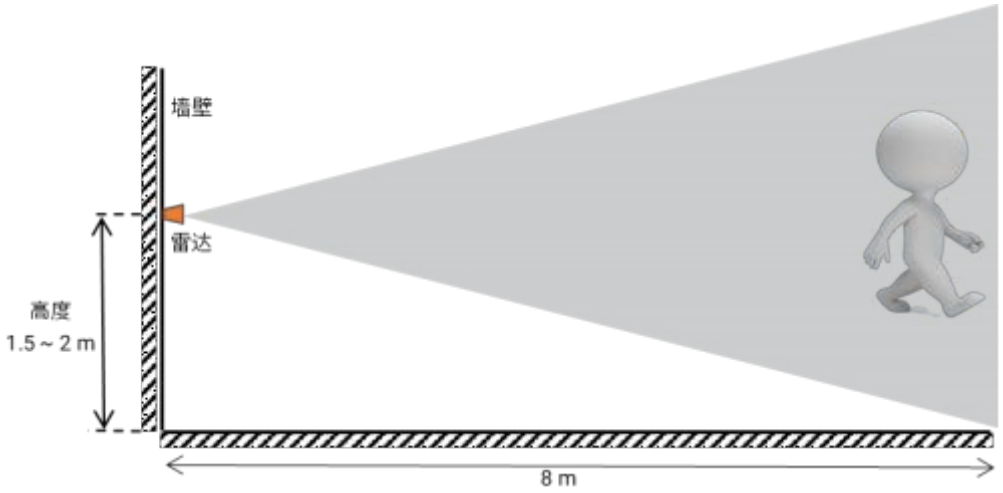


Figure 5-4 Schematic diagram of the detection range of the HLK-LD2420 radar module (wall-mounted)

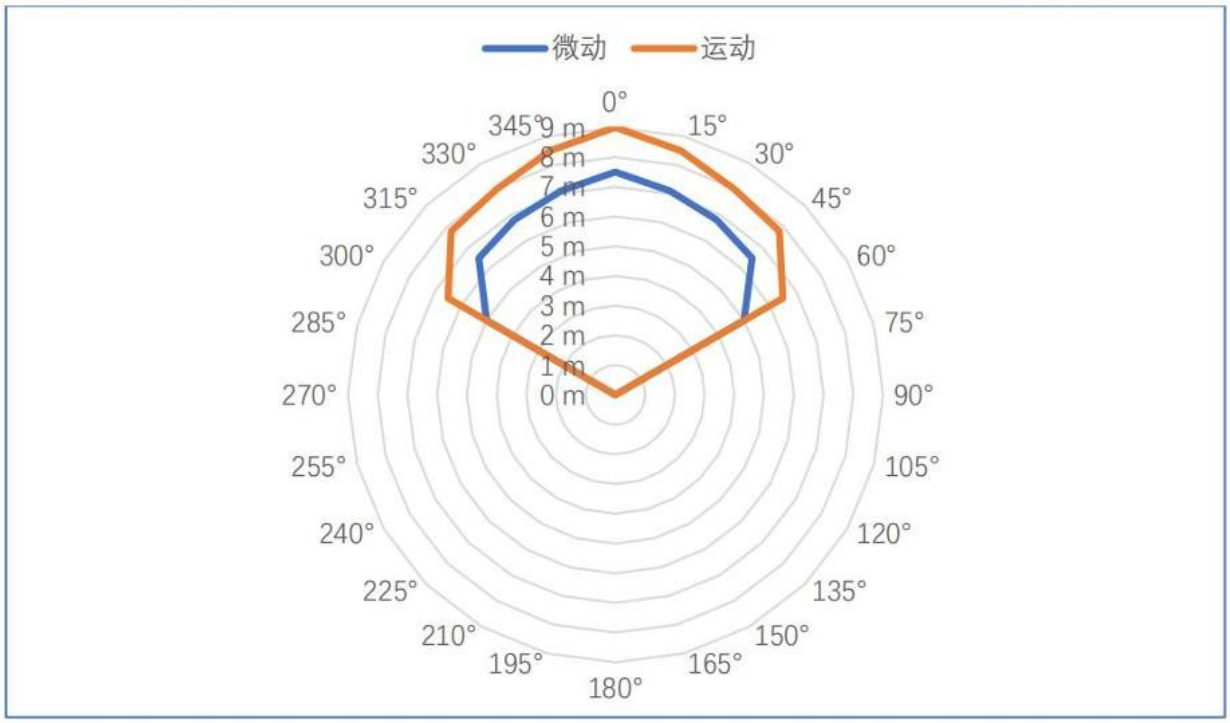


Figure 5-5 Detection range for wall-mounted installation

6.3. Detection Range Testing

The test methods for radar triggering and maintaining the detection range are described below:

- **Trigger range:**

When a human subject approaches the radar from a distance whilst the radar is reporting that the area is unoccupied, and stops moving when the radar begins to report the presence of a person, the current position marks the boundary of the radar's trigger detection range; the area enclosed by the detection boundaries in all directions constitutes the radar's trigger detection range.

- **Maintenance Range:**

With the radar reporting the presence of a person, the test subject remains at the test position whilst performing minor movements, such as shrugging their shoulders or raising their hands. If the radar continues to report the presence of a person for 60 seconds, the current position is within the radar's sustained detection range; otherwise, the detection position lies outside the sustained detection range.

7. Mechanical Dimensions

Figure 6-1 shows the mechanical dimensions of the module; all units are in millimetres (mm). The module's board thickness is 1.2 mm, with a tolerance of ±10 per cent.

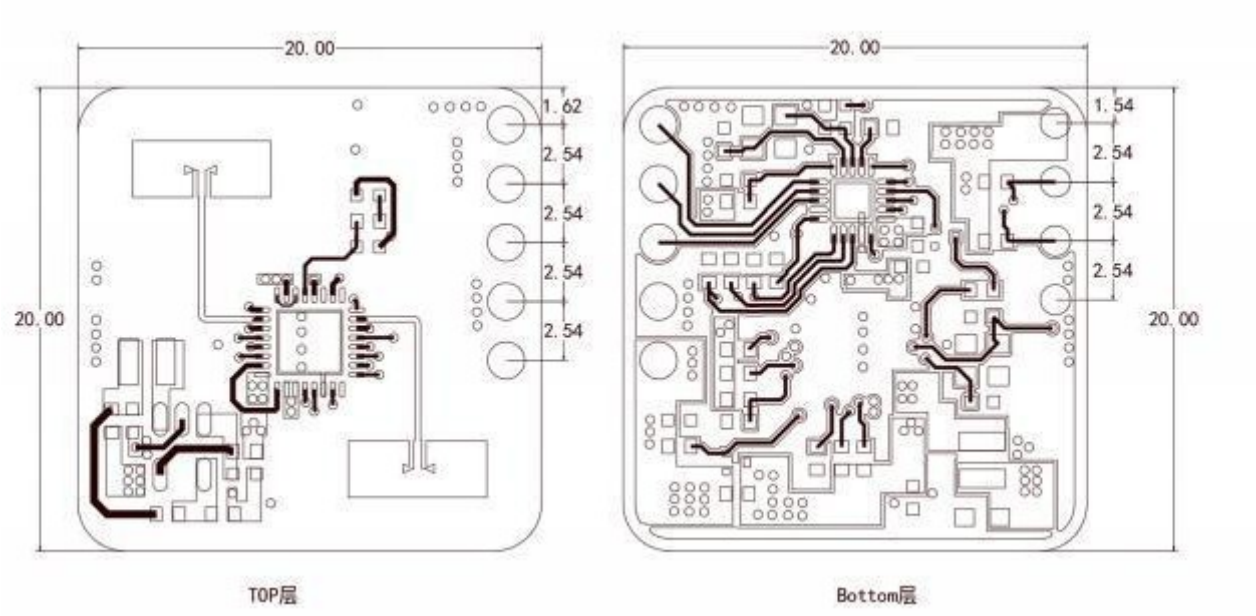


Figure 6-1 Hardware Mechanical Dimensions

8. Installation Instructions

Radar Enclosure Requirements

If a radar housing is required, it must possess good wave-transmitting properties in the 24 GHz band and must not contain any metal or materials that shield

. For further considerations, please refer to the *Design Guide for Millimetre-Wave Sensor Antenna Covers*.

Installation Environment Requirements

This product must be installed in a suitable environment; detection performance will be affected if used in the following conditions:

- The presence of non-human objects in constant motion within the detection area, such as animals, curtains that sway continuously, or large potted plants positioned directly in front of air vents.
- The presence of large, highly reflective surfaces within the detection area; highly reflective objects directly facing the radar antenna may cause interference.
- When mounting on a wall, external interference factors such as air conditioning units and electric fans on the ceiling must be taken into account.

Installation Precautions

- Ensure, as far as possible, that the radar antenna is directly facing the area to be monitored, and that the area around the antenna is unobstructed.
- Ensure the sensor is securely and stably mounted, as any movement of the radar itself will affect detection performance.
- Ensure that there is no movement or vibration behind the radar. As radar waves are penetrating, the antenna's rear lobe may detect moving objects behind the radar. A metal shielding cover or metal backplate can be used to shield the radar's rear lobe, thereby reducing the impact caused by objects behind the radar.
- Where multiple 24 GHz band radars are present, do not align their beams directly with one another; install them as far apart as possible to avoid potential mutual interference.

Power Supply Considerations

- The power supply input voltage range is 3.0 V to 3.6 V; the power supply ripple must have no significant spectral peaks within 100 kHz. This is a reference design; users must consider appropriate electromagnetic compatibility (EMC) measures, such as protection against electrostatic discharge (ESD) and lightning surges.

9. Precautions

Maximum detection range

The maximum detection range for radar targets is 8 m in the radial direction. Within this detection range, the radar will report the straight-line distance of the target from the radar. Within 8 m, the radar can only provide distance information for moving human subjects; it does not currently support close-range distance measurement for stationary human subjects.

Maximum Range and Accuracy

In theory, the range-finding accuracy of the radar in this reference design is 0.35 m. However, due to variations in the size, posture and RCS of human targets, the range-finding accuracy may fluctuate, and the maximum detection range may also vary to some extent.

Target Disappearance Delay

When the radar module detects that no human is present within the target area, it does not immediately report a 'no-person' status for that area, but instead introduces a delay. The mechanism for this delayed reporting is as follows: once no human target is detected within the test range, the radar module starts a timer; the duration of this timer represents the 'unoccupied' period. If no human presence is detected throughout this period, the 'unoccupied' status is reported once the timer expires; if a human presence is detected during this period, the timer is immediately reset and the target information is reported.

10. Version History

Version	Date	Changes
V1.0	15 February 2023	Initial draft.
V1.1	23 March 2023	Changes to module pin functions; default baud rate changed to 115200; host computer software updated
V1.2	15 August 2023	Added serial port specifications, user guide for the new host computer version, and serial command protocol
V1.3	11 December 2023	Revised parameter descriptions
V1.3.1	21 March 2024	Revised parameter descriptions
V1.3.2	22 November 2024	Revised parameter descriptions

Important Notice

Hailink provides technical and reliability data (including data sheets), design resources (including reference designs), application or other design recommendations, web tools, safety information and other resources (hereinafter referred to as 'these resources') 'as is', without warranty of any kind, whether express or implied, including but not limited to any express or implied warranty of merchantability, fitness for a particular purpose or non-infringement of any third-party intellectual property rights.It is specifically stated that no liability shall be accepted for any consequential or incidental loss arising from, but not limited to, the application or use of any of the Company's products and circuits.

Hailink reserves the right to make changes to the information published in this document (including, but not limited to, specifications and product descriptions) and to any of the Company's products referred to herein without prior notice; this document automatically supersedes and replaces all information provided in previous versions of the document bearing the same document number.

These resources are intended for use by experienced developers designing with Hailink products. You shall bear full responsibility for the following: (1) selecting the appropriate Hailink products for your application; (2) designing, verifying and operating your application and products throughout their entire lifecycle; and (3) ensuring that your application complies with all relevant standards, specifications and laws, as well as any other functional safety, information security, regulatory or other requirements.

Hailink authorises you to use these resources solely for the research and development of applications for the Hailink products described herein. No entity or individual may, without Hailink's permission, extract or reproduce these resources, in whole or in part, nor may they be distributed in any form.You are not authorised to use any other Hailink intellectual property or any third-party intellectual property. You shall fully indemnify Hailink and its representatives against any claims, damages, costs, losses and liabilities arising from the use of these resources; Hailink accepts no liability in this regard.

The products supplied by Hailingke are subject to Hailingke's terms and conditions of sale or other applicable terms accompanying Hailingke's products. Hailingke's provision of these resources does not extend or otherwise alter the applicable warranties or disclaimers of warranty issued by Hailingke in respect of its products.