Shenzhen Hailingke Electronics Co., Ltd.

# HLK-LD2420 User Manual

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# 1. Product Description

HLK-LD2420 is a high performance 24 GHz radar module with one transmitter and one receiver antenna. Its human sensing algorithm uses millimeter wave radar distance measurement technology and the advanced proprietary signal processing technology of S3 series chips to achieve accurate sensing of moving, micro-movement and standing human bodies.

HLK-LD2420 is mainly used in indoor scenes to sense whether there is a moving or slightly moving human body in the area and refresh the detection results in real time. It has a maximum sensing distance of 8 m and can be easily configured to sense the distance range, sensitivity and refresh time in different zones.It supports GPIO and UART interface, which is plug-and-play and can be flexibly applied to different smart scenarios and end products.

## 1.1. Main Features

- Single-chip smart millimeter wave sensor SoC and smart algorithm firmware on board
- Ultra-small module size: 20 mm × 20 mm
- Load default body sensor configuration, plug and play
- 24 GHz ISM band with FCC, CE, and Commission-free spectrum regulatory approvals
- 3.3 V power supply, supports 3.0 V ~ 3.6 V wide voltage range
- Average operating current 50 mA
- Detection target for motion, micro-motion human body
- Real-time reporting of detection results
- Provide visualization tools to support the configuration of the detection distance interval, sub-interval setting sensitivity and results reporting time
- Support induction range division, completely shielding any interference outside the zone
- Proximity 0.2 m sensing, no blind detection zone
- Motion body sensing distance up to 8 m
- Large detection angle, covering a range of ±60°
- Support a variety of installation methods, such as hanging the top, hanging wall
- Independent configuration of trigger and hold states, strong anti-interference capability

## 1.2.Application Scenarios

HLK-LD2420 human body sensing sensor can detect and identify moving, standing and stationary human bodies, and is widely used in various AIoT scenarios, covering the following types.

### Smart Home

It senses the presence and distance of the human body and reports the detection results for intelligent control of home appliances by the main control module.

### Smart Business

Recognizes the human body approaching or moving away within the set distance interval; lights up the screen in time to keep the device on in the presence of the human body.

### Smart Security

Induction access control, building intercom, electronic cat's eye, etc.

### Smart Lighting

Identify and sense human body, precise position detection, can be used in public place lighting equipment (sensor lamp, bulb lamp, etc.).

# 2. System Description

HLK-LD2420 is an intelligent and accurate human sensor based on Hylink S3 series millimeter wave sensor chip. The sensor uses FMCW FM continuous wave, combined with radar signal processing and built-in intelligent human sensing algorithm to detect human targets in a set space and update the detection results in real time. Using Haling Technology's intelligent millimeter wave sensor reference solution, users can quickly develop their own accurate body sensing products.

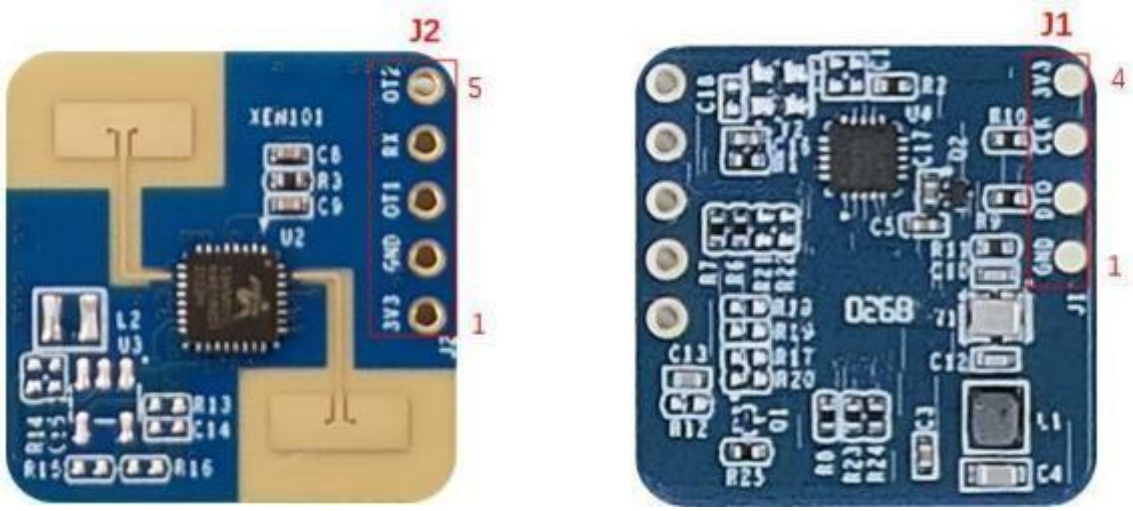
The hardware part of HLK-LD2420 is composed of a fully integrated Hylink Smart Millimeter Sensor SoC, a 24 GHz transmitter-receiver antenna and a host MCU; the software part is equipped with firmware and visual configuration tools released by Hylink to realize human body sensing functions with flexible configuration of sensing distance, sensitivity and reporting time.

The HLK-LD2420 specification parameters are shown in Table 2-1.

| Parameters | Remarks | Minimum | Typical | Maximum | Unit |
|---|---|---|---|---|---|
| **Hardware Specifications** | | | | | |
| Supported Bands | Comply with FCC, CE, Commission-free certification standards | 24 | - | 24.25 | GHz |
| Support maximum sweep bandwidth | | - | 0.25 | - | GHz |
| Maximum equivalent omnidirectional radiated power | | - | 11 | - | dBm |
| Supply voltage | | 3.0 | 3.3 | 3.6 | V |
| Size | | - | 20×20 | - | mm2 |
| Ambient temperature | | -40 | - | 85 | °C |
| **System Performance** | | | | | |
| Distance detection range (wall mounted) | Exercise human target | - | 8 | - | m |
| | Micromotion human target | - | 6 | - | m |
| Distance detection range (hanging top) | Exercise human target | - | 5 | - | m |
| | Micromotion human target | - | 4 | - | m |
| Distance detection accuracy | Moving targets within 8m of the radar line | - | ±0.35 | - | m |
| Average operating current | | - | 50 | - | mA |
| Data refresh rate | | - | 10 | - | Hz |

# 3. Hardware Description

The picture below shows the front and back of the module. The module is equipped with 5 pin holes (factory does not come with pins) called J2 for power supply and communication; J1 is the SWD J1 is the SWD interface, which is used for MCU program burning and debugging.




Front　　Reverse side

Figure 3-1 Physical drawing of the front and back of the module

Table 3-1 J1 Pin Description

| J#PIN# | Name | Function | Description |
|---|---|---|---|
| J1Pin1 | GND | Grounding | |
| J1Pin2 | DIO | SWD Interface Data Cable | 0 ~ 3.3 V |
| J1Pin3 | CLK | SWD Interface clock line | 0 ~ 3.3 V |
| J1Pin4 | 3V3 | Power input | 3.0 V ~ 3.6 V，Typ.3.3V |
| | | | |

Table 3-2 J2 Pin Description

| J#PIN# | Name | Function | Description |
|---|---|---|---|
| J2Pin1 | 3V3 | Power input | 3.0 V ~ 3.6 V，Typ.3.3 V |
| J2Pin2 | GND | Grounding | |
| J2Pin3 | OT1 | IO for reporting detection status: high for occupied, low for unoccupied | 0 ~ 3.3 V |
| J2Pin4 | RX | UART_RX | 0 ~ 3.3 V |
| J2Pin5 | OT2 | UART_TX | 0 ~ 3.3 V |

Note: J1, J2 interface pin spacing 2.54 mm.

# 4. Software Description

This chapter introduces the firmware debugging of HLK-LD2420 and the use of the upper computer tools.

The HLK-LD2420 is shipped with burned-in system firmware, the firmware version is detailed in the module package. Hailing Technology provides visualization and configuration software for HLK-LD2420 hardware, which is convenient for developers to configure HLK-LD2420 parameters according to the usage scenarios and optimize the sensing effect.

## 4.1. Firmware Configuration

This section describes how to debug the HLK-LD2420 radar module firmware.

**Step 1**、The USB to TTL serial adapter board is used to connect the host computer to the radar module, and the pin connections are shown in Table 4-1 and Figure 4-1. shown in Table 4-1 and Figure 4-1.

Table 4-1 Correspondence of pins when connecting the radar to the USB serial adapter board

| Radar Module | Serial port adapter board |
|---|---|
| RX | TXD |
| O_T2 | RXD |
| 3V3 | VCCIO |
| GND | GND |

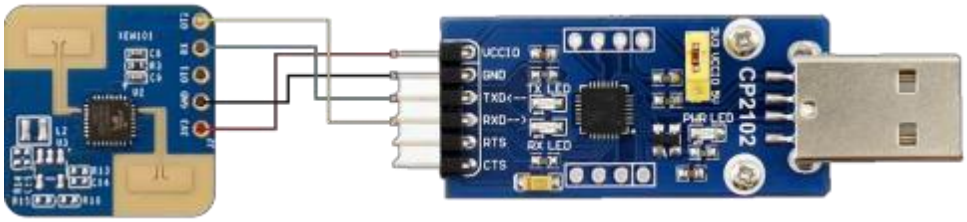



Figure 4-1 Connection between HLK-LD2420 hardware and USB serial port adapter board

**Step 2**、Open the Device Manager of the host computer and check the serial number of the serial port where the radar module is located.

**Step 3**、Open the serial port tool, select the serial port number of the radar module, set the serial port baud rate to 256000, and then click the "Open Serial Port" button to view the current radar detection results on the output side of the tool interface.

## 4.2. Upper computer use

This section introduces the use of the HLK-LD2420 module's upper computer tool to help users understand the meaning of the relevant parameters and how to obtain them.

**Step 1**: Obtain the HLK-LD2420's companion host computer tool "HLK-LD2420_TOOL" from Hailing Technology's website.

**Step 2**: Use the serial adapter board to connect the radar module and the host computer according to Figure 4-1.

**Step 3**: Open the host computer tool, select the serial port number of the radar module, input the baud rate 256000, and click the "Connect Device" button to read and write the parameters (Note: the serial port tool and the host computer tool cannot be used at the same time).

### 4.2.1. Parameter Setting

The interface of the upper computer tool is shown in Figure 4-2.


Figure 4-2 HLK-LD2420_TOOL interface


picture4-3After the device is connected

For detailed explanation of the parameters involved in the host computer tool interface, please see Table 4-2.

Table 4-2 Parameter explanation of the host computer tool interface

| Parameter name | explain | Parameter range |
|---|---|---|
| Minimum distance | Used to set the minimum distance gate for radar detection.<br>The resolution of the range gate is 70 cm. | 0~15 |
| Maximum distance | Used to set the maximum distance gate for radar detection.<br>The resolution of the range gate is 70 cm. | 0~15<br>(Must be no less than the minimum distance) |
| Target disappears<br>Delay time | The target state switches from occupied to unoccupied for a period of time, T. If a person is detected during this period, the timer for this period will be restarted. The radar will only switch to the unoccupied state and report unoccupied after detecting that the unoccupied state has lasted for a full period of T. | (Corresponding to the host computer setting) 0-90<br>(Corresponding serial port configuration) 0~1000000000 |
| Trigger threshold | Used to set the sensitivity from no-man to manned state. It is recommended to set it to more than 5 times of energy.**4.2.2**and**4.2.3**. | (Corresponding to the host computer setting) 0-90<br>(Corresponding serial port configuration) 0~1000000000 |
| Hold Threshold | The sensitivity used to detect micro-motion of human body and maintain the status of people is recommended to be set at 2~5 times of the background noise.**4.2.2**and **4.2.3**. | (Corresponding to the host computer setting) 0-90<br>(Corresponding serial port configuration) 0~1000000000 |

**Threshold parameter description:**Assume that N is the parameter configured by the host computer and M is the parameter configured by the serial port.

The parameter conversion relationship is$N=(10*\log_{10}M)$ $M=10^{\frac{N}{10}}$,For exampleThe serial port configuration distance gate 0 threshold value is 65536.

The host computer should be $(10*\log_{10}65536)\approx 48.16$.For exampleThe parameter set on the host computer is 70, corresponding to the serial port configuration

The parameters are$10^{\frac{70}{10}}\approx 10000000$, the instruction converts hexadecimal, with the little end first:*0x80969800*

### 4.2.2 Real-time data

The "Real-time Data" page of the host computer is shown in Figure 4-4, and its function page is described as follows:

- The colored light icon in the upper left corner indicates whether there is a person or no one in the detection area: when the radar detects the presence of a human body, the colored light is red; when no human body is detected, the colored light is green;
- The text display box behind the colored light shows the radial distance between the target human body detected by the radar and the radar;
- The "Start/Pause" switch button is used to start and pause radar detection;
- The "Generate Threshold" button is used to scan the ambient noise and calculate the "trigger threshold" and "hold threshold" of each range gate;
- The "Apply Threshold" button is used to send the "Trigger Threshold" and "Hold Threshold" obtained in the "Generate Threshold" function to the radar;
- The "Relative Power vs. Range Gate" line graph displays the motion energy value (green line), trigger threshold (red line), and hold threshold (yellow line) of each range gate in real time. A black background indicates that the range gate is within the valid detection range, while a gray background indicates that the range gate is within the invalid detection range.
- The "Distance VS Time" line graph is used to display the distance changes of the target human body detected by the radar in real time over the past 60 seconds. The gray background area indicates that the radar detected the target human body during this time period, and the black background area indicates that the radar did not detect the target human body during this time period.

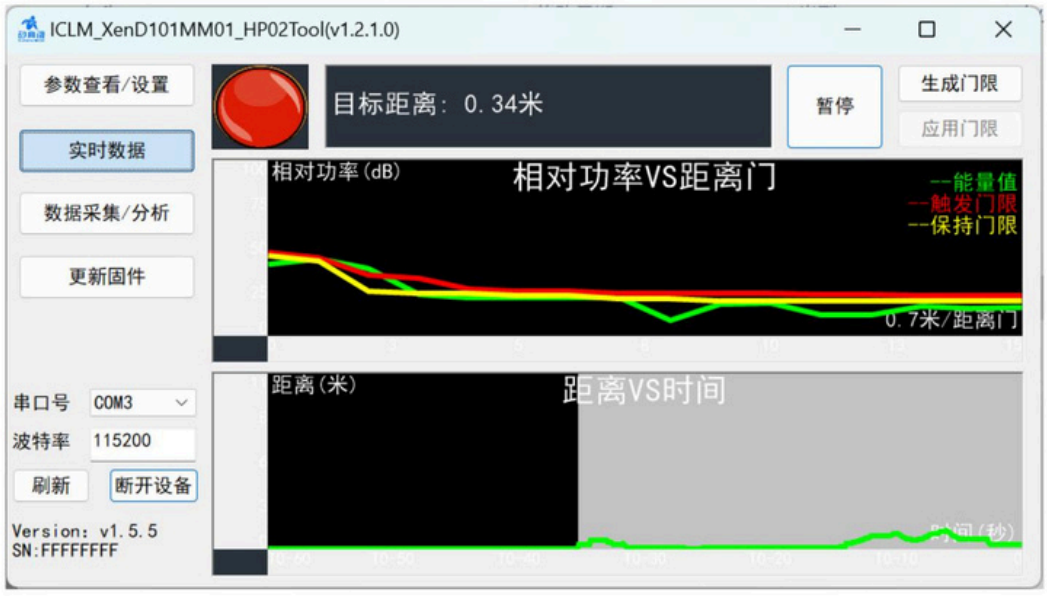



Figure 4-4 Real-time data page

The steps to view real-time data through the host computer are as follows:

HLK-LD2420

Step 1. After connecting the HLK-LD2420 module to the host computer tool, click the "Real-time Data" button to switch to the function page. The host computer tool will automatically turn on the radar detection function, the "Start/Pause" switch button will display "Pause", and the two line graphs on the host computer function page will start to display the corresponding real-time data information.

Step 2: Click the "Start/Pause" switch button to pause the radar's detection function. The colored light on the function page turns green and the target distance displays "0.00

Meters", the two line charts below stop updating.

The steps to generate/apply thresholds via the host computer are as follows:

Step 1: When the "Start/Pause" button on the "Real-time Data" page displays "Pause", click the "Generate Threshold" button. The host computer tool will pop up the "Threshold Acquisition" information window. The table above will display the trigger energy and hold energy values of each range gate in real time, and the progress bar below will display the scanning progress, as shown in Figure 4-5.

Step 2: Click the "Cancel" button to terminate the collection; if the user wants to save and apply the collected data, click "OK" after the data collection is completed;

Step 3 (optional): If the user selects "OK" in step 2, the "Apply Threshold" button on the page changes from a gray, unclickable state to a Click the "Apply Threshold" button in the clickable state. The host computer tool will send the threshold data calculated in step 2 to the radar, and a prompt window of "Threshold setting successful" will pop up.

After applying the generated threshold, users can view the latest radar threshold parameter values on the "Parameter View/Set" page.

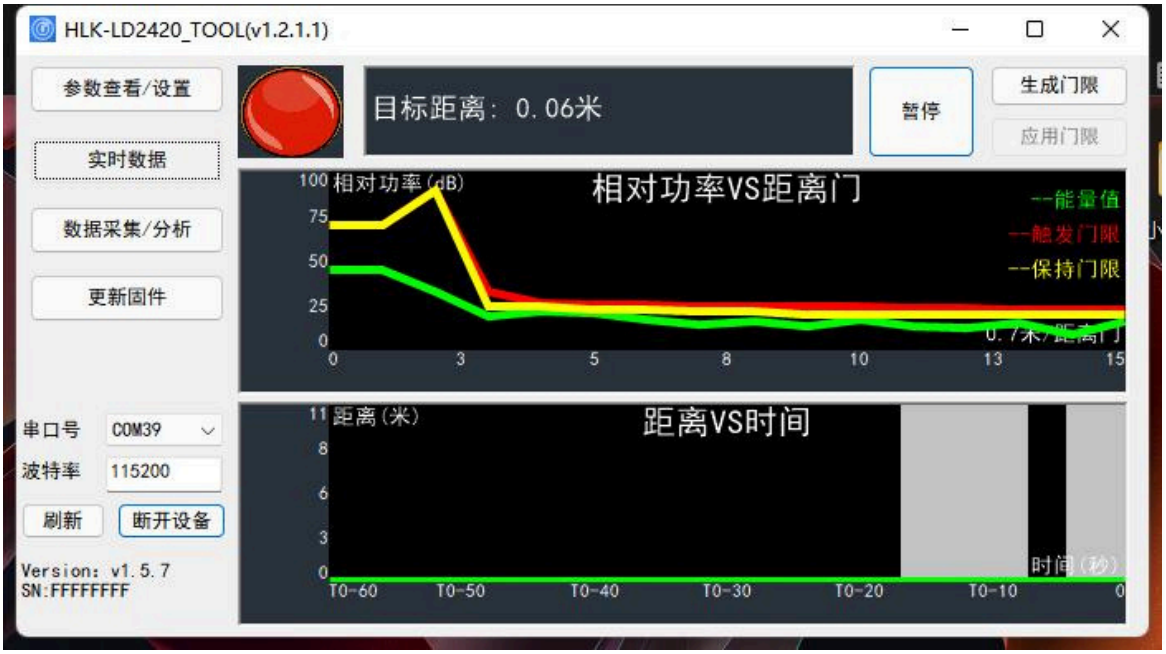



Figure 4-5 Threshold Collection Page

### 4.2.3 Data Collection/Analysis

The "Data Collection/Analysis" page of the host computer is shown in Figure 4-6, and its function page is described as follows:

- "Distance gate scanning time (seconds)": used to set the environmental noise scanning time of each distance gate, the default is 20s, and the value range is 0-65535;
- "File save path": used to set the save path of the collected data;
- "Select display range gate": used to select the range gate to be viewed, the optional range is 0-15;
- "Collect Data/Stop Collection" switch button: used to start and stop data collection. After stopping data collection, users can see a .dat type file with a file name starting with RadarData and ending with a timestamp in the set file save path;
- "Load Data" button: used to open the saved radar scan data for users to view and analyze;

- "Energy Information" line graph: used to display the scan energy value, trigger threshold, and hold threshold on the user-selected range gate. The horizontal axis is time, and the vertical axis is energy information expressed in relative power.

- "Distance Information" line chart: used to display the distance information of human targets detected within the radar detection range, with the horizontal axis being time and the vertical axis being distance.

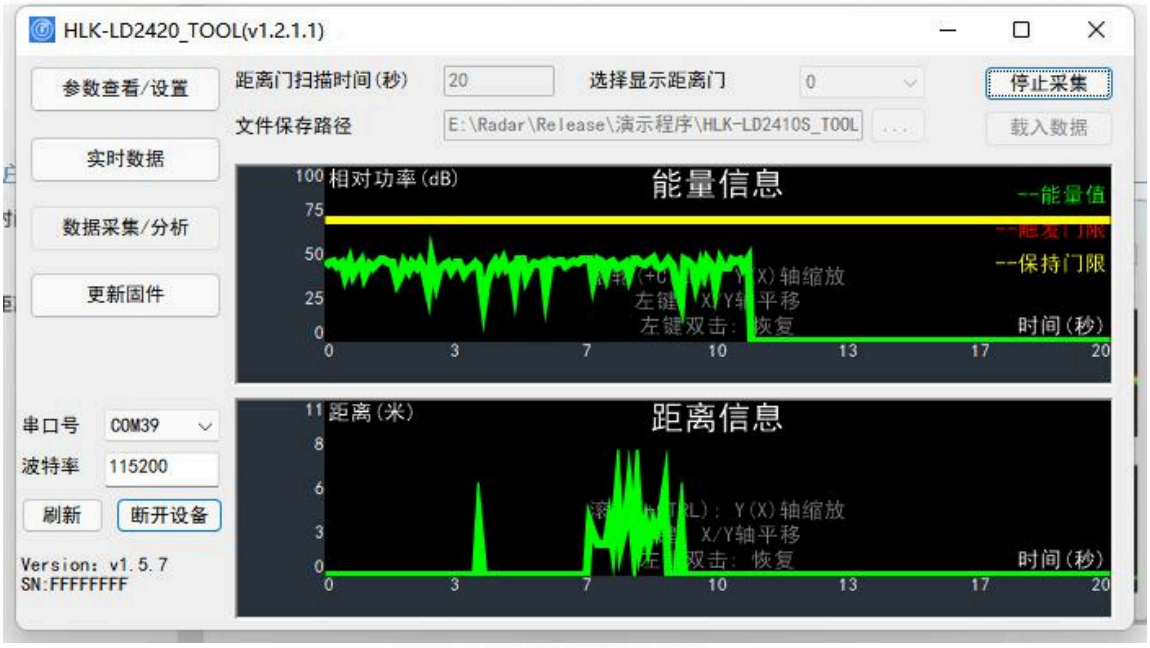



Figure 4-6 Data collection/analysis page

The steps for collecting energy data through the host computer are as follows:

Step 1: After connecting th HLK-LD2420 ule to the host computer tool, click the "Data Collection/Analysis" function button to switch to the function page;

Step 2: Enter the "Range Gate Scan Time", set the "File Save Path" 2, make sure there is no one in the radar detection range within a scanning cycle, and click the "Collect Data/Stop Collection" switch button to start collecting data;

Step 3. After starting data collection, the user can wait for the host computer tool to automatically stop collecting data after the scan is completed, or click the "Collect Data/Stop Collection" switch button to stop data collection in advance; in both cases, the collected data will be stored in the file save path set in step 2;

The steps for analyzing energy data through the host computer are as follows:

Step 1: After connecting the HLK-LD2420 module to the host computer tool, click the "Data Collection/Analysis" function button to switch to the function page;

Step 2. Click the "Load Data" button and select the data you want to view;

Step 3. Select the range gate you want to view, and the user can see the energy information and distance information of the range gate in the data file on two line graphs;

Step 4. To view the specific data of a certain point on the curve, place the mouse cursor at the location of interest on the curve. A floating box will appear next to the cursor to display the energy value or distance information at that location, as shown in Figure 4-7.


Figure 4-7 Data viewing page

When viewing data, users can zoom, pan, and restore the line chart:

- Zoom the abscissa: Place the mouse cursor on the graphics canvas, press the Ctrl key on the keyboard and roll the mouse wheel at the same time to zoom in (roll the mouse wheel up) and shrink (roll the mouse wheel down) on the abscissa;
- Translate the data graph: Place the mouse cursor on the graph canvas, press the left mouse button and move the mouse to move the graph accordingly, and the horizontal and vertical coordinates will also change simultaneously;
- Restore graphics: Place the mouse cursor on the graphics canvas and double-click the left mouse button to restore the graphics to the default display settings.

### 4.2.4 Update firmware

The "Update Firmware" page of the host computer is shown in Figure 4-8. The steps to update the radar module firmware through the host computer are as follows:

Step 1. After connecting the HLK-LD2420 module to the host computer tool, click the "Update Firmware" function button to switch to this function page;

Step 2 3. Click the "Get Firmware Information" button on the function page, and the ID information of the current device will be displayed in the prompt information box on the right;

Step 3. Click the "Select bin file path" button, select the required .bin file, and click the "Download" button to start upgrading the firmware. The prompt information box on the right will display the download results in real time, and the bin file information and current download progress will be displayed below.

3 This step is required and users cannot skip this step when updating firmware using the host computer interface.


Figure 4-8 Firmware upgrade page

After the firmware upgrade is successful, the page prompt box will display "Download Successful". If the firmware upgrade fails, the corresponding error message will be displayed in the prompt box.

## 5. Communication protocol

This communication protocol is primarily intended for users who require secondary development independent of visualization tools. The XenD101MM communicates with the outside world via a serial port (TTL level). Radar data output and parameter configuration commands are all performed under this protocol. The default baud rate of ١١٥٢٠٠ t is 1 stop bit, with no parity.

This chapter mainly introduces this communication protocol from three parts:

- Protocol format: including protocol data format and command frame format;
- Configuration command package format: including command package format and command return package format;
- Upload data frame format: including the upload data frame format of the debugging mode and the upload data frame format of the reporting mode.

The basic process of using commands to configure parameters is:

1. Enter command mode;
2. Configuration parameter command/get parameter command;
3. Exit command mode.

### 5.1 Protocol Format

#### 5.1.1 Protocol Data Format

HLK-LD2420 data communication uses the little-endian format. All data in the following table are in hexadecimal.

### 5.1.2 Command protocol frame format

The radar configuration command and ACK command formats defined by the protocol are shown in Table 5-1 and Table 5-3.

Table 5-1 Send command protocol frame format

| Frame header | Intraframe data length | intraframe data | end of frame |
|---|---|---|---|
| FD FC FB FA | 2 bytes | See Table 5-2 | 04 03 02 01 |

Table 5-2 Data format in the sending frame

| Command word (2 bytes) | Command value (N bytes) |
|---|---|

Table 5-3 ACK command protocol frame format

| Frame header | Intraframe data length | intraframe data | end of frame |
|---|---|---|---|
| FD FC FB FA | 2 bytes | See Table 5-4 | 04 03 02 01 |

Table 5-4 ACK frame data format

| Send command word (2 bytes) | Command execution status (2 bytes) | Return value (N bytes) |
|---|---|---|

## 5.2 Sending Commands and ACK

### 5.2.1 Read Firmware Version Command

This command reads the radar firmware version information.

Command word: 0x0000

Command value: none

Return value: version number length (2 bytes) + version number byte string

Send data:

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

Radar ACK (successful):

| 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 Enable Configuration Command

Any other commands issued to the radar must be executed after this command is issued, otherwise they will be invalid.

Command word: 0x00FF

Command value: 0x0001

Return value: 2-byte ACK status (0 success, 1 failure) + 2-byte protocol version (0x0002) + 2-byte buffer size (0x0020)

Send data:

| 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 |

Radar ACK (successful):

| 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 End Configuration Command

End the configuration command. After execution, the radar resumes working mode. If you need to send other commands again, you need to send the enable configuration command first.

Command word: 0x00FE

Command value: none

Return value: 2-byte ACK status (0 for success, 1 for failure)

Send data:

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

Radar ACK (successful):

| 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 Read Serial Number Command

This command reads the radar's serial number.

Command word: 0x0011

Command value: none

Return value: 2-byte ACK status (0 for success, 1 for failure)

Send data:

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

Radar ACK (successful):

| 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 Write serial number command

This command writes the radar's serial number.

Command word: 0x0010

Command value: SN length (2 bytes) + SN byte string

Return value: 2-byte ACK status (0 for success, 1 for failure)

Send data: (example)

| 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 |

Radar ACK (successful):

| 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 Read radar register command

This command reads the radar's registers.

Command word: 0x0002

Command value: 2-byte chip address + (2-byte address) * N

Return value: (2 bytes of data)*N

Send data:

| 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 |

Radar ACK (successful):

| 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 Configure radar register commands

This command writes to the radar's registers.

Command word: 0x0001

Command value: 2-byte chip address + (2-byte address) * N

Return value: 2-byte ACK status (0 for success, 1 for failure)

Send data:

| 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 |

Radar ACK (successful):

| 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 Read radar parameter configuration command

This command can read the current configuration parameters of the radar.

Command word: 0x0008

Command value: (2-byte parameter ID) * N

Return value: (4-byte parameter value)*N

Send data: (example)

| 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 |

Radar ACK: (success, maximum distance gate 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 Configure radar parameters command

This command sets the parameters of the radar module. Please refer to Table 5-5 for specific parameter words.

Table 5-5 Protocol parameters

| Parameter name | parameter number | Parameter range |
|---|---|---|
| minimum distance gate | 0x0000 | 0~15 |
| maximum distance door | 0x0001 | 0~15 |
| target disappearing delay | 0x0004 | 0~65535 units seconds |
| trigger threshold | 0x0010 ~ 0x001F | 0~232-1, is the square of the modulus value |
| keep threshold | 0x0020 ~ 0x002F | 0~232-1, is the square of the modulus value |

Command word: 0x0007

Command value: (2-byte parameter ID + 4-byte parameter value)*N

Return value: 2-byte ACK status (0 for success, 1 for failure)

Send data: Maximum distance gate 12, minimum distance gate 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 |

Radar ACK (successful):

| 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 Configuration System Parameters Command

This command can configure radar system parameters.

Command word: 0x0012

Command value: (2-byte parameter ID + 4-byte parameter value)*N

Return value: 2-byte ACK status (0 for success, 1 for failure)

Send data:

| 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 |

Radar ACK (successful):

| 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 Radar Reporting Data

HLK-LD2420 if the HLK-LD2420 factory firmware outputs the test results through the serial port. The output results are ON/OFF strings and target distance gates.

In special modes, the host computer will obtain data from the radar processing process. Therefore, the firmware provides two additional transmission formats in command line mode, namely debugging mode and reporting mode.

In command line mode, you can control the data format reported by the serial port by adjusting the operating mode parameters in the command packet. Figure 5-1 shows an example command packet.


Figure 5-1 Command packet format example

In this command packet, the parameter value of the command parameter can determine the working mode of the radar: 0x0000 is the debugging mode, 0x0004 is the reporting mode, and 0x0064 is the normal mode.

Table 5-6 shows the data frame format for debug mode. In debug mode, the RDMAP modulus data is sent based on the data for all range gates for each chirp. That is, the modulus data for the 16 range gates of the first chirp is sent first, followed by the modulus data for the 16 range gates of the second chirp, and so on.

Table 5-6 Data frame format in debug mode

| Frame header | data | end of frame |
|---|---|---|
| AA, BF, 10, 14 | RDMAP: 20 (Doppler) * 16 (range gate) * 4 (square of modulus) | FD, FC, FB, FA |

Table 5-7 Data frame format in reporting mode

| Frame header | length | Test results | target distance | Energy value of each distance gate | end of frame |
|---|---|---|---|---|---|
| F4, F3, F2, F1 | 2 bytes, total number of bytes of detection results, target distance and energy values of each range gate | 1 byte,<br>00no one<br>01 Someone | 2 bytes | 32 bytes<br>½ (total number of range gates) *<br>2 bytes | F8, F7, F6, F5 |

Figure 5-2 shows an example of a data frame transmitted from the serial port in reporting mode.

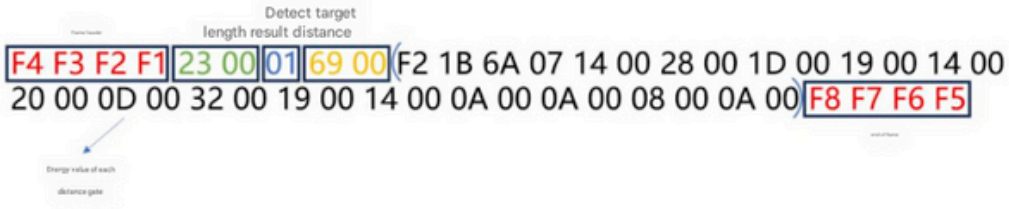



Figure 5-2 Example of a data frame in reporting mode

In the example, the meaning of each part of the data is as follows:

Length field: indicates the total number of bytes occupied by the reported detection result + target distance + energy value of each range gate;

Detection result: indicates whether there is a target in the current scene;

Target distance: indicates the distance between the target in the scene and the radar;

Energy value of each range gate: indicates the energy value of each range gate from 0 to 15 range gates.

Therefore, the data frame analysis example in Figure 2 is as follows:

Length: 0023, indicating the total number of bytes occupied by the reported detection result + target distance + energy value of each range gate = 35

Detection result: 01, indicating that someone is currently detected in the scene

Target distance: 0069, indicating target distance = 105 cm

Energy value of each range gate:

Range gate 0 energy = 1BF2

Range gate 1 energy = 076A

Range Gate 2 Energy = 0014

Range Gate 3 Energy = 0028

Range Gate 4 Energy = 001D

Range Gate 5 Energy = 001 9

Range Gate 6 Energy = 0014

Range Gate 7 Energy = 0020

Range Gate 8 Energy = 000D

Range Gate 9 Energy = 0032

| | |
|---|---|
| Range gate 10 energy = 0019 | Range gate 13 energy = 000A |
| Range gate 11 energy = 0014 | Range Gate 14 Energy = 0008 |
| Distance Gate 12 Energy = 000A | Range gate 15 energy = 000A |

## 1. Installation and detection range

HLK-LD2420 supports both ceiling-mounted and wall-mounted installation. The recommended installation method is ceiling-mounted.

The radar's orientation is shown in Figure 5-1, where the Y-axis is 0°, the X-axis is 90°, and the Z-axis is perpendicular to the X-Y plane (also called the normal direction).

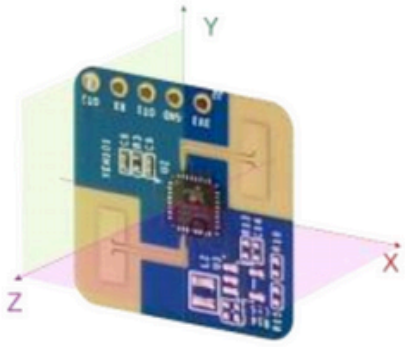



Figure 5-1 Radar module orientation diagram

### 1.1. Ceiling installation

The recommended ceiling installation height is 2.7-3 meters. The maximum motion sensing range of the ceiling-mounted HLK-LD2420 radar module in the default configuration is a conical space with a bottom radius of 5 meters, as shown in Figure 5-2.

# 5. Installation and detection range

The HLK-LD2420 supports both ceiling and wall mounting, and the recommended method is ceiling mounting.

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

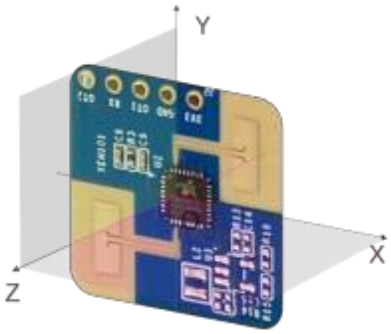



Figure 5-1 Radar module orientation diagram

## 5.1. Ceiling Mount

The recommended ceiling mounting height is 2.7~3 m. The maximum motion sensing range of the HLK-LD2420 radar module in the default configuration is a conical three-dimensional space with a bottom radius of 5 m, as shown in Figure 5-2.

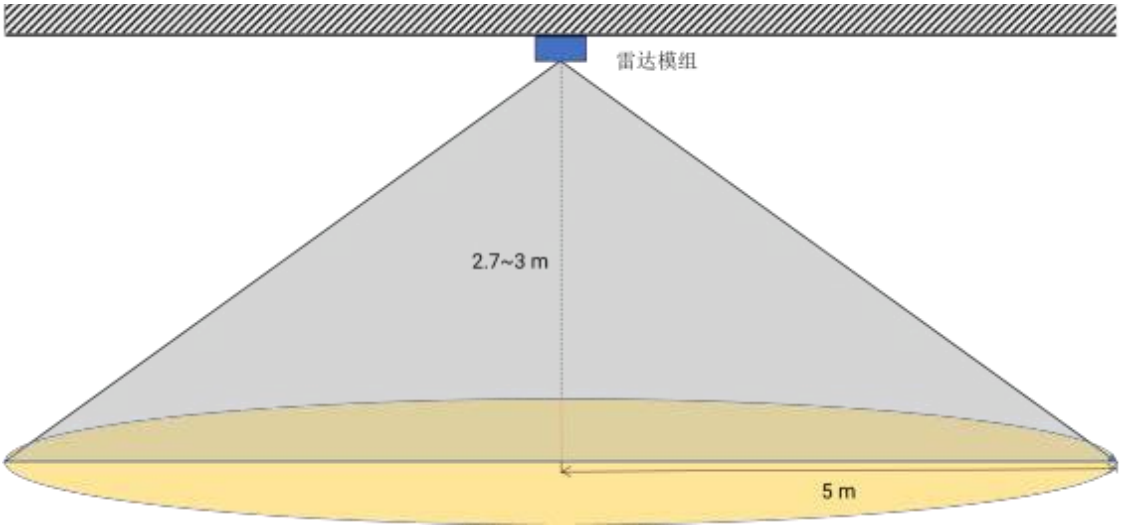
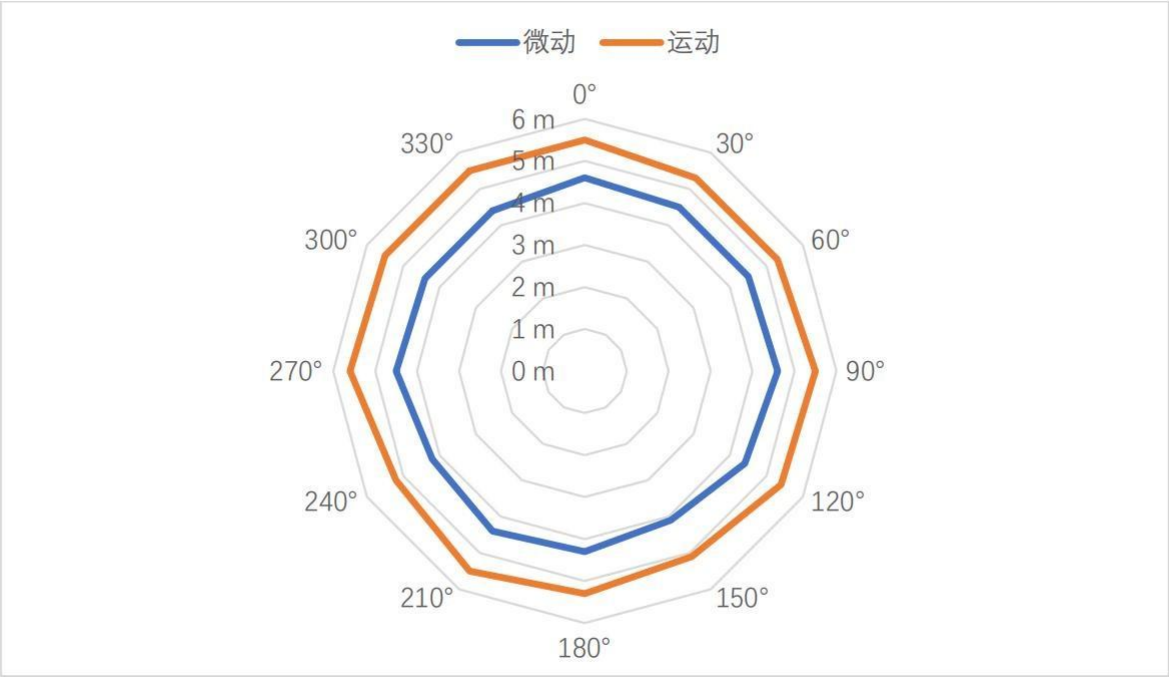



Figure 5-2 HLK-LD2420 radar module detection range diagram (hanging top) Hanging top installation height

The motion and micro-motion detection range of this reference scheme at 2.7m is shown in Figure 5-3.




5-3 Hanging ceiling mount induction range

## 5.2. Wall Mounted

The recommended wall mounting height is 1.5~2 m. For wall mounting, the X-axis of the radar module (refer to Figure 5-1) points to the horizontal direction, the Y-axis points upward, and the Z-axis points to the detection area. The maximum motion sensing range of the wall-mounted HLK-LD2420 radar module in the default configuration is a three-dimensional sector with a radius of 8 m and an angle of ±45° in the horizontal and pitch directions, as shown in Figure 5-4.

The detection range of this reference solution for a wall mounting height of 1.5 m is shown in Figure 5-5.

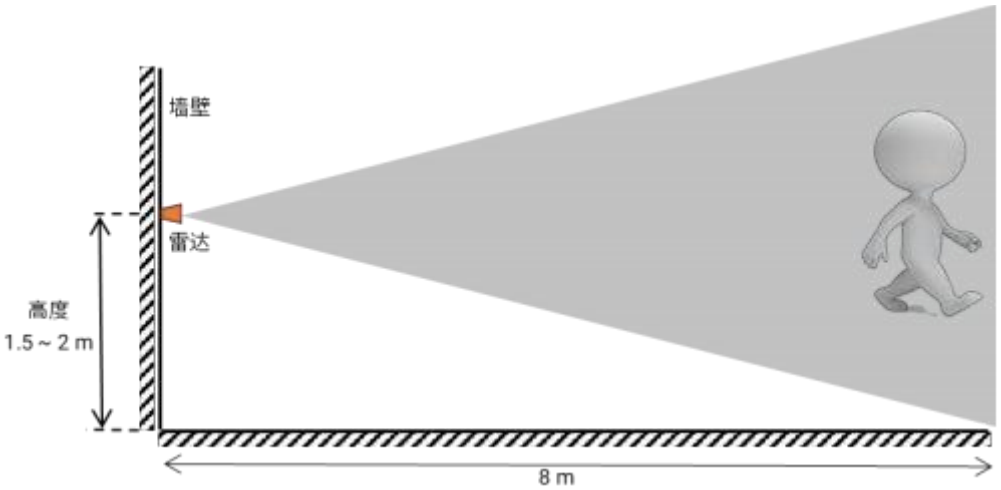



Figure 5-4 HLK-LD2420 radar module detection range diagram (wall mount)

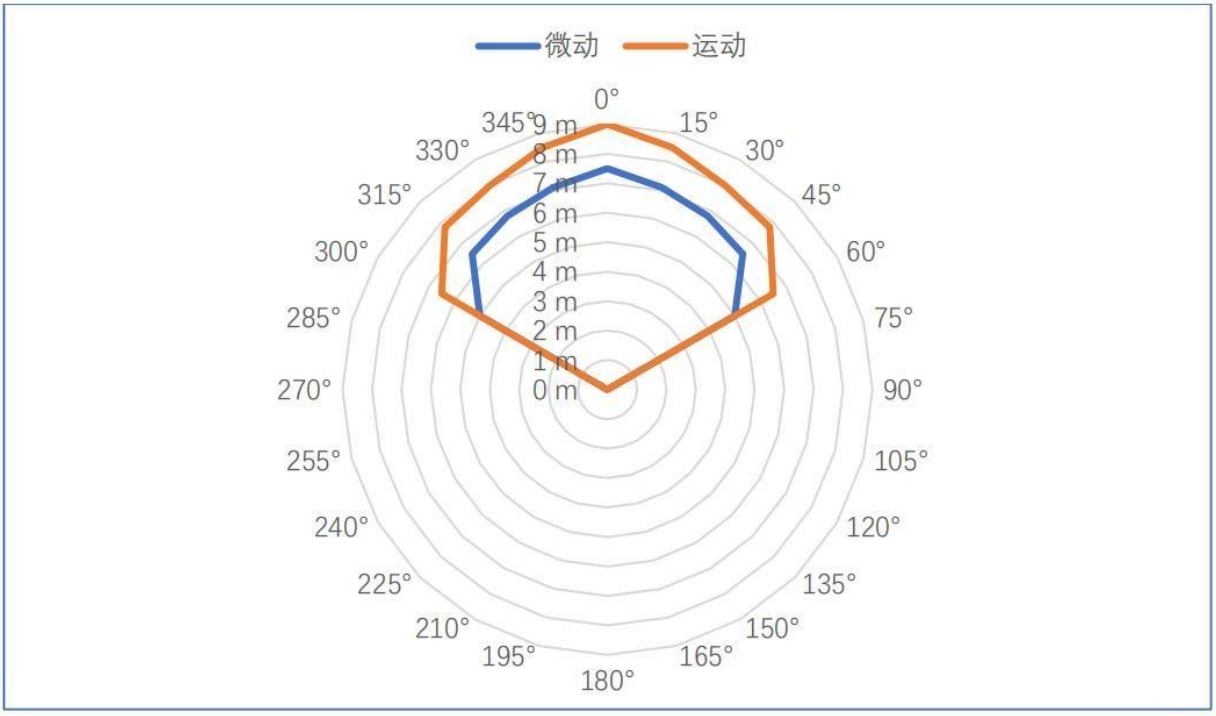



Figure 5-5 Sensing range for wall mounting

## 5.3. Detection range test

The test methods for radar triggering and holding detection range are described separately as follows.

**Trigger range:**

The target human body approaches the radar from a distance when no one is reported on the radar, and stops advancing when the radar starts to report that someone is present, and the current position is the boundary of the radar trigger detection range; the area enclosed by the detection boundary in each direction is the radar trigger detection range.

**Holding range:**

The target human body keeps a small movement in the position to be measured in the state of radar reported as occupied, such as shrugging shoulders, raising hands, if the radar within 60 s

Always reported as occupied, the current position is within the radar hold detection range; otherwise, the detection position is outside the hold detection range.

# 6. Mechanical size

Figure 6-1 shows the mechanical dimensions of the module, all units are in mm mm. the plate thickness of the module is 1.2 mm with a tolerance of ±10%.

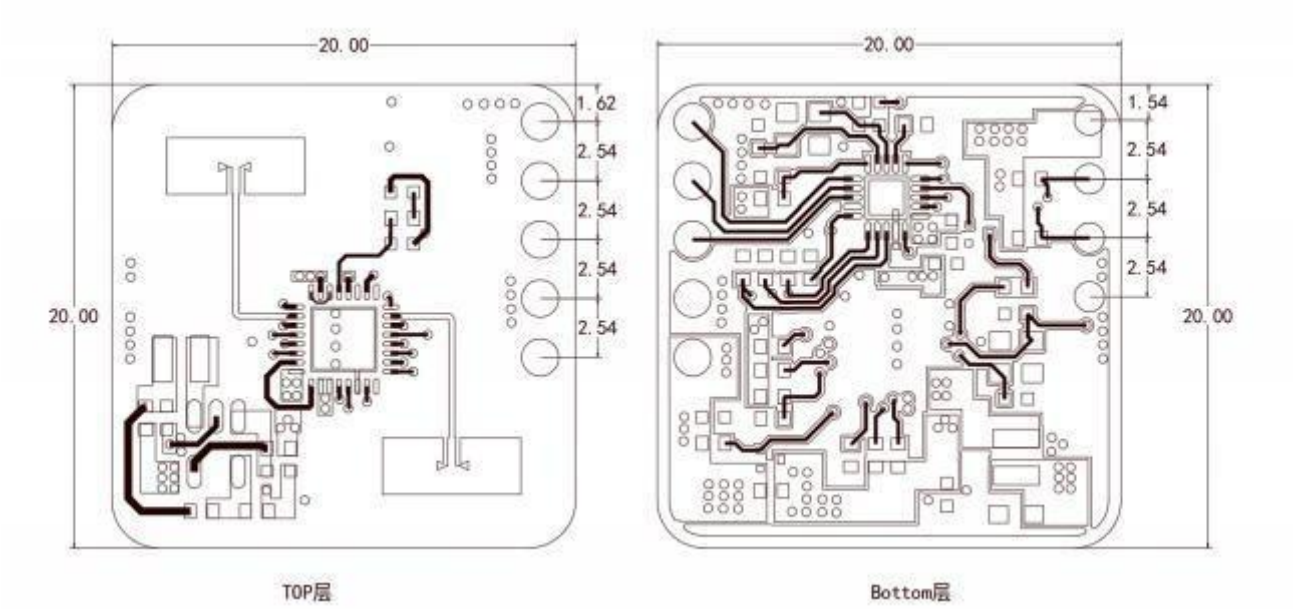



Figure 6-1 Hardware Mechanical Dimensions

# 7. Installation Instructions

## Radar housing requirements

If the radar requires a housing, the housing must have good wave transmission characteristics in the 24 GHz band and must not contain metal or materials that shield electromagnetic waves.

materials that have a shielding effect on electromagnetic waves. See the Millimeter Wave Sensor Radome Design Guide for additional considerations.

## Installation environment requirements

This product needs to be installed in a suitable environment, if used in the following environment, the detection effect will be affected：

There are non-human objects in the sensing area that are in constant motion, such as animals, continuously swinging curtains and large green plants facing the wind vents.

There is a large area of strong reflective plane in the sensing area, and strong reflectors are causing interference to the radar antenna.

When wall-mounted, you need to consider the interference factors from outside such as air conditioners and electric fans on top of the room.

### Precautions for installation

Try to ensure that the radar antenna is facing the area to be detected, and the antenna is open and unobstructed around.

To ensure that the sensor installation position is solid and stable, the radar itself shaking will affect the detection effect.

It is ensured that there are no objects moving or vibrating on the back side of the radar. Due to the penetrating nature of radar waves, the antenna back flap may detect moving objects at the back of the radar. A metal shield or a metal back plate can be used to shield the radar backside flap to reduce the effect of objects on the backside of the radar.

When multiple 24 GHz band radars are present, do not install them in direct beam alignment, but as far away from each other as possible to avoid possible mutual interference.

### Power Supply Notes

The power supply input voltage range is 3.0 V~3.6 V, and the power supply ripple has no obvious spectral peaks within 100 kHz, this solution is a reference design, users need to consider the corresponding ESD and lightning surge and other EMC design.

## 8. Cautions

### Maximum detection distance

The maximum range of the radar is 8 m. Within the range, the radar reports the straight-line distance of the target from the radar. The radar can only output distance information for moving bodies within 8 m. It does not support proximity ranging for stationary bodies at this time.

### Maximum distance and accuracy

Theoretically, the radar range accuracy of this reference solution is 0.35 m. Due to the different body size, status and RCS of human targets, the range accuracy may fluctuate, and the maximum detection distance may also fluctuate.

### Target disappearance delay time

When the radar module detects no human presence in the target area, it does not immediately report the "unoccupied" status of the area, but delays it.

The delayed reporting mechanism is: once no human target is detected within the test range, the radar module will start a timer, the duration of which is the unoccupied duration, and if no one is detected within the timer, the "unoccupied" status will be reported at the end of the timer; if someone

**Maximum distance and accuracy**

Theoretically, the radar ranging accuracy of this reference solution is 0.35 m. However, due to the different body shapes, states, and RCS of human targets, the ranging accuracy may vary.

There will be fluctuations, and the maximum detection distance will also fluctuate to a certain extent.

**Target disappearance delay**

When the radar module detects that there is no human presence in the target area, it will not immediately report the "no one" status in the area, but will be delayed.

The delayed reporting mechanism is: once no human target is detected within the test range, the radar module will start counting, and the duration is the duration of no one

If no one is detected during the timer, the "no one" status will be reported after the timer ends; if someone is detected during this time period

If yes, it will end immediately, update the timing, and report the target information.

## 10.Version History

| Version | time | Changes |
|---|---|---|
| V1.0 | 2023/2/15 | Initial draft. |
| V1.1 | 2023/3/23 | The module's pin function has changed, the default baud rate has been changed to 115200, and the host computer version has been updated. |
| V1.2 | 2023/8/15 | Added serial port description, new version host computer instructions, serial port command protocol |
| V1.3 | 2023/12/11 | Modify parameter description |
| V1.3.1 | 2024/3/21 | Modify parameter description |
| V1.3.2 | 2024/11/22 | Modify parameter description |

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