# E54-24LD12C User Manual



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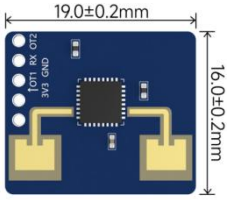
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# Chapter 1 Overview

## 1.1 Product Introduction

The E54-24LD12C is a battery-powered, ultra-low-power millimeter-wave human presence sensor designed by Ebyte . It includes a minimalist 24GHz millimeter-wave sensor and low-power human presence sensing intelligent algorithm firmware . It is equipped with an AIoT millimeter-wave sensor, a high-performance 24GHz transmit-receive antenna, and peripheral circuits . The low-power intelligent human presence sensing algorithm uses the millimeter-wave sensor's distance measurement technology and the millimeter-wave sensor chip's advanced proprietary radar signal processing and low-power control technology to achieve accurate perception of moving/micro-movement and sitting/lying people.




## 1.2 Features

- Equipped with a single-chip intelligent millimeter wave sensor SoC and intelligent algorithm firmware ;
- Ultra-small sensor size : 19mm×16mm ;
- Load the default sensing configuration , plug and play ;
- 24GHz ISM frequency band , can pass FCC, CE, and RF spectrum regulation certification ;
- 3.3V power supply , supports 3.0V~3.6V wide voltage range ;
- Typical operating current is as low as 65 μA , and the sensing delay time is 250ms ;
- The detection targets are moving/slightly moving and sitting/lying still people ;
- Report detection results in real time ;
- Provides visualization tools to support configuration of detection range intervals and target disappearance delay time , and automatically generate detection thresholds ;
- Supports sensing range division , completely shielding any interference outside the range ;
- 0.35m close-range sensing , no blind spot detection ;
- The maximum trigger distance for moving human body is 6m ;
- Large detection angle , horizontal coverage angle of ±60° when wall-mounted ;
- Support wall/ceiling installation ;
- Supports IAP online upgrade .

## 1.3 Application Scenario

E54-24LD12C battery-powered, ultra-low-power millimeter-wave human presence sensor can detect and identify moving/slightly moving and sitting/lying people. It is widely used in various AIoT scenarios , including the following types :

- Smart Home

Sense the presence and distance of moving objects such as human bodies , and report the detection results for the main control

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module to intelligently control the operation of home appliances.

- Smart Business

Identify when a person approaches or moves away within the set distance range ; light up the screen promptly and keep the device on when a person is present.

- Smart Security

Smart door locks , sensor access control , building intercoms , electronic cat eyes, etc.

- Smart Lighting

Identify and sense the human body , accurately detect the location , and can be used for lighting equipment in public places (induction lamps, bulbs, etc.).

# Chapter 2 System Description

The E54-24LD12C is a battery-powered, ultra-low-power millimeter-wave human presence sensor developed based on a millimeter-wave sensor chip. The sensor utilizes FMCW frequency-modulated continuous wave (FMCW) , combined with radar signal processing and a built-in intelligent, low-power human presence sensing algorithm , to detect human targets within a specified space and update detection results in real time. Using this millimeter-wave sensor reference solution , users can quickly develop their own precise, low-power human presence sensing products.

The E54-24LD12C is primarily composed of a fully integrated intelligent millimeter-wave sensor SoC, a 24GHz transmit-receive antenna, and a master MCU . The software, combined with Ebyte 's low-power human presence sensing algorithm firmware and visual configuration tool , enables flexible configuration of human presence sensing capabilities, including sensing distance, trigger and hold thresholds, unattended reporting time, and data refresh rate . It also supports spatial echo energy scanning and automatically determines the detection threshold.

Table 2-1 shows the specifications of the E54-24LD12C .

Table 2-1 E54-24LD12C specifications

| Parameter | Minimum | Typical | Maximum | Unit | Remark |
|---|---|---|---|---|---|
| Hardware specifications | | | | | |
| Supported frequency bands | 24 | - | 24.25 | GHz | Comply with FCC , CE , and NDC certification standards |
| Supports maximum sweep bandwidth | - | 0.25 | - | GHz | - |
| Maximum equivalent isotropic radiated power | - | 10 | - | dBm | - |
| Operating voltage | 3.0 | 3.3 | 3.6 | V | - |
| Size | - | 19.0*16.0 | - | mm | ±0.2mm |
| Communication interface | - | UART | - | - | - |
| Operating temperature | -40 | 25 | 85 | ℃ | - |
| Weight | - | 1.1 | - | g | ±0.2 g |
| System performance | | | | | |
| Distance detection range (Wall hanging , hanging height 1.5 meters) | - | 6 | - | m | Moving human target detection |
| | - | 5 | - | m | Micro-motion human target detection |
| | - | 4 | - | m | Stationary human target detection |

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| | | | | | |
|---|---|---|---|---|---|
| Detection accuracy | - | 0.35 | - | m | - |
| Working current | - | 65 | - | μA | - |
| Induction delay time | - | 250 | - | ms | - |
| Data refresh cycle | - | 1 | - | s | Configurable |

# Chapter 3 Hardware Description

## 3.1 Product size

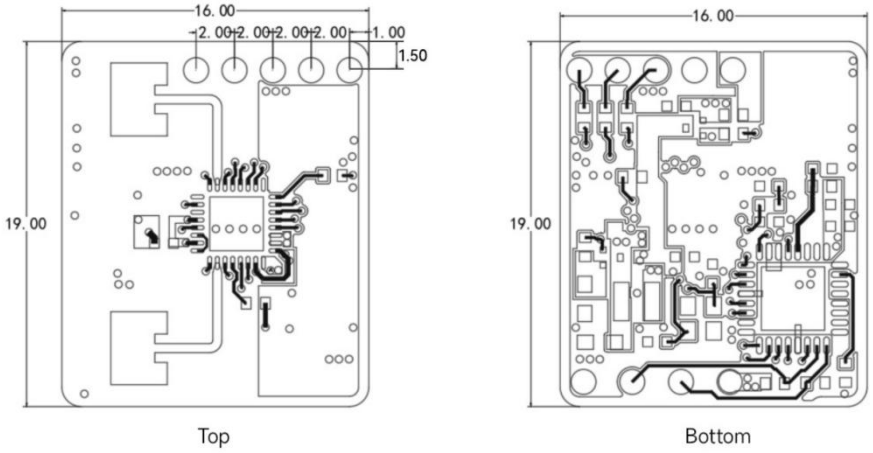



Figure 3-1 E54-24LD12C Dimension

## 3.2 Hardware Description

Figure 3-2 shows the front and back of the E54-24LD12C . Hardware The E54-24LD12C has five pin holes reserved (not provided with pins at the factory) called J2 , which is used for power supply and communication ; J1 is the SWD interface for burning and debugging MCU program.

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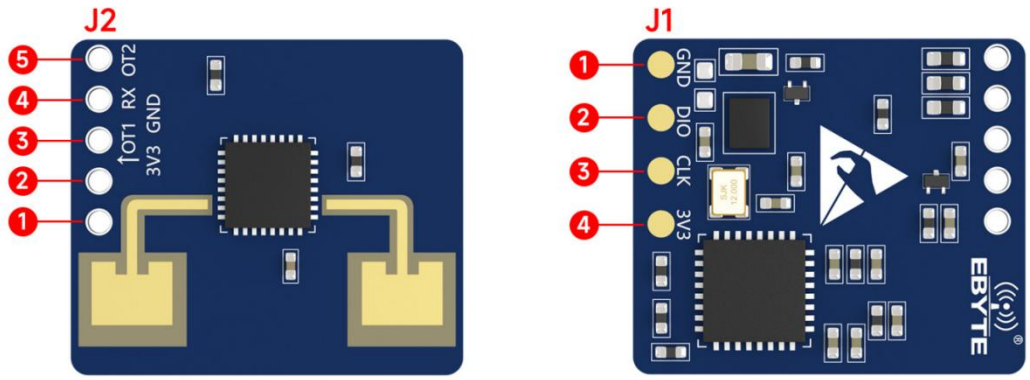



Figure 3-2 E54-24LD12C front and back views

For the pin descriptions of J1 and J2, please refer to Table 3-1 and Table 3-2 respectively.

Table 3-1 J1 Pin Description

| J1 | Name | Function | Description |
|---|---|---|---|
| 1 | GND | Power ground | - |
| 2 | DIO | SWD interface data cable | 0~3.3V |
| 3 | CLK | SWD interface clock line | 0~3.3V |
| 4 | 3V3 | Power input | 3.0V~3.6V , Typ.3.3V |

Table 3-2 J2 Pin Description

| J 2 | Name | Function | Description |
|---|---|---|---|
| 1 | 3V3 | Power input | 3.0V~3.6V , Typ.3.3V |
| 2 | GND | Power ground | - |
| 3 | OT1 | UART_TX | 0~3.3V |
| 4 | RX | UART_RX | 0~3.3V |
| 5 | OT2 | IO , used to report detection status : high level means someone is there , low level means no one is there | 0~3.3V |

# Chapter 4 Software Description

This chapter describes firmware debugging for the E54-24LD12C and using configuration software tool. When debugging or using the millimeter-wave sensor , you can use the configuration software tool to power the sensor through a USB-serial adapter board . Simply connect the TX , RX, and GND pins of the millimeter-wave sensor to the corresponding pins on the USB-serial adapter board (see Table 4-1 for the pinout between the sensor and the USB-serial adapter board ) . Alternatively , you can use a battery board to power the sensor . Simply connect the TX, RX, and GND pins of the battery board to the corresponding pins on the USB-serial adapter board (the TX , RX, and GND pins on the battery board should be connected to the corresponding pins on the sensor) . Because the connection methods for both power supply methods are similar , this chapter only describes how to use the configuration software tool for power.

The E54-24LD12C comes pre-installed with a low-power human presence sensing algorithm firmware . The firmware version is detailed on the sensor packaging. Ebyte provides a visual configuration tool for the E54-24LD12C , allowing developers to configure parameters and optimize sensing performance based on specific scenarios.

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# 4.1 Firmware Configuration

This section describes how to use a third-party serial port tool to debug the firmware of the E54-24LD12C sensor.

Step 1: Connect the configuration software and the millimeter wave sensor through the USB to TTL serial port adapter board . The pin connection method is shown in Table 4-1 and Figure 4-1 .

Table **4-1** The pin correspondence between the millimeter wave sensor and **the USB** serial port adapter board

| Millimeter wave sensors | Serial port adapter board |
|---|---|
| RX | TXD |
| OT1 | RXD |
| GND | GND |
| 3V3 | 3.3V |

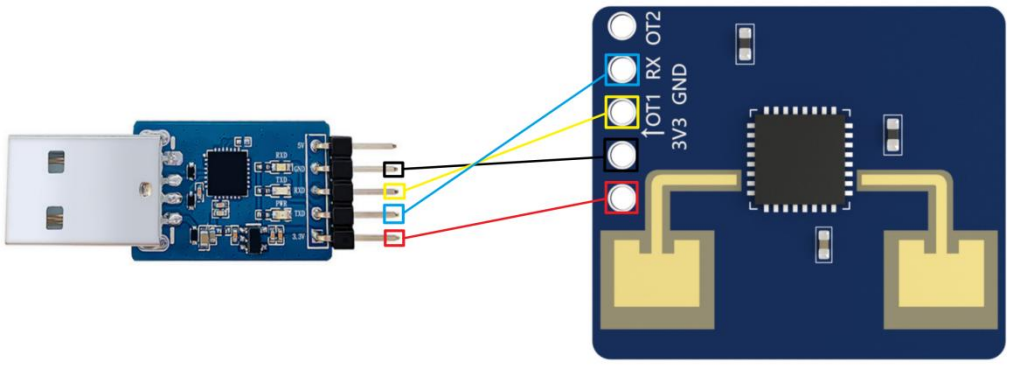



Figure 4-1 Connection between E54-24LD12C and USB serial port adapter board

Step 2: Open the device manager of the configuration software tool and obtain the serial port number of the millimeter wave sensor;

Step 3. Open a third-party serial port tool , select the serial port number of the millimeter wave sensor, set the serial port baud rate to 115200bps, and then click the "Open Serial Port" (or equivalent function) button to view the current sensor detection results at the output end of the tool interface .

# 4.2 Configuration software tool description

This section introduces the use of the configuration software tool that comes with the E54-24LD12C to help users understand the meaning of related parameters and how to obtain them. Note : The configuration software tool and third-party serial port tools cannot be used at the same time!

Before using the functions of the configuration software tool, the user should first connect the E54-24LD12C to the configuration software tool. The steps are as follows :

Step 1: Get the configuration software " RF_Setting_E54_C_V1.0 " for E54-24LD12C from the Ebyte official website ;

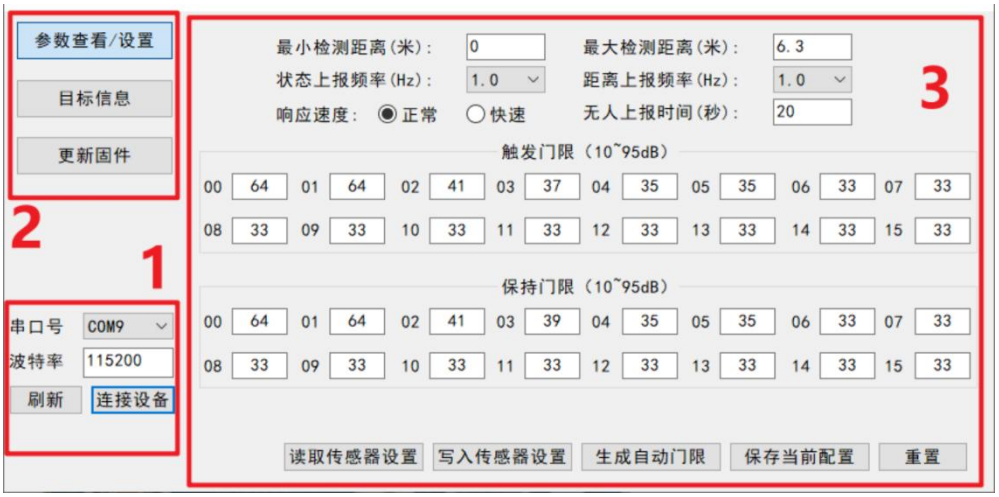
Step 2: Use the serial port adapter board to connect the millimeter wave sensor and the configuration software as shown in Figure 4-1 .

Step 3. Open the configuration software, click the "Refresh" button, select the serial port number of the millimeter wave sensor in the "Serial Port Number" drop-down box, confirm that the "Baud Rate" is 115200bps , and click the "Connect Device" button to

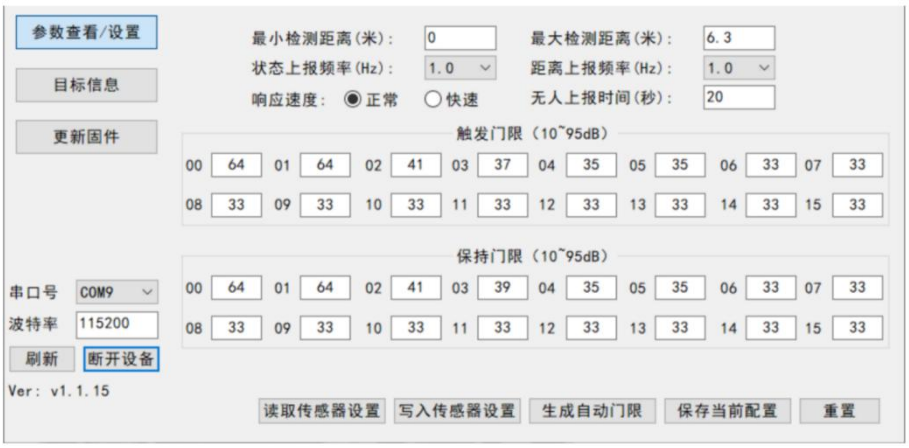
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start connecting the configuration software and the sensor .




(a) Before connecting the device




(b) After the device is connected

Figure 4-2 RF_Setting_E54_C_V1.0

Figure 4-2 ( a) , the configuration software interface can be divided into three areas : device operation area (Zone 1) , function button area (Zone 2) , and function page area (Zone 3).

After the configuration software is successfully connected to the millimeter wave sensor , the sensor's firmware version number and the sensor's SN (Serial Number; the default serial number of the sensor is E54-24LD12C ) will be displayed in the Zone 1 area of the interface . The current parameter values of the millimeter wave sensor will be displayed in the "Parameter View/Set" function page area , as shown in Figure 4-2 ( b).

### 4.2.1 Parameter View/Setting

shows the "Parameter View/Set" page of the configuration software. This page allows users to view the current parameters of the millimeter wave sensor , modify parameter configurations to meet specific application scenario requirements , and automatically generate detection thresholds.

For detailed explanation of the parameters on the "Parameter View/Set" page of the configuration software, see Table 4-2.

Table 4-2 Parameter explanation of the configuration software interface

| Parameter name | Parameter function | Parameter | unit |
|---|---|---|---|

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| | | range | |
|---|---|---|---|
| Minimum detection distance | Minimum effective detection distance of the sensor | 0~8.4 | m |
| Maximum detection distance | The maximum effective detection distance of the sensor | 0.7~8.4 | m |
| Status reporting frequency | The frequency of the sensor reporting occupancy/unoccupancy status | 1~8 | Hz |
| Distance reporting frequency | The frequency at which the sensor reports the target distance when there are people present | 1~8 | Hz |
| Response speed | The sensor detects the reaction speed from no one to someone in the area | Normal/Fast | - |
| No one reported time | The delay time required for the target state reported by the sensor to switch from occupied to unoccupied | 10~120 | s |
| Trigger threshold | Absolute threshold of energy value of 0~15 distance gate when no one to someone state | 10~95 | dB |
| Hold Threshold | Absolute threshold of energy value of 0~15 distance gate when detecting stationary human body and maintaining human state | 10~95 | dB |

#### 4.2.1.1 Parameter Configuration Operation

Parameter configuration operations include "Read sensor settings", "Write sensor settings", "Reset", and "Save current configuration". The operation steps are described below.

**Read sensor settings**

connecting the E54-24LD12C to the configuration software, on the "Parameter View/Set" function page , click the "Read Sensor Settings" button . A "Parameter Read Successful" prompt window will pop up . Click "OK" to close the prompt window, and the configuration software will display the latest parameters.

**Write sensor settings**

Step 1: After connecting the E54-24LD12C to the configuration software, enter new parameter values for all parameters that need to be changed on the "Parameter View/Set" function page ;

Step 2. Click the "Write Sensor Settings" button. The configuration software will write the parameter values in the current interface to the sensor. If successful, the page will pop up a "Write Parameters Successful" prompt window. Click "OK" to complete the parameter setting.

**Reset parameter configuration**

Step 1: After connecting the E54-24LD12C to the configuration software, click the "Reset" button on the "Parameter View/Set" function page . The configuration software will reset the configuration parameters to the default values .

Step 2. Click the "Write Sensor Settings" button to complete the parameter reset. After success, the page will pop up a "Write Parameters Successful" prompt window, click "OK"

After completing the parameter setting , the configuration software will display the latest parameters .

**Save the current configuration**

Step 1. After connecting the E54-24LD12C to the configuration software, click the "Save Current Configuration" button on the "Parameter View/Set" function page . The configuration software will save the current parameter configuration to the appConfig.xml file in the same directory as the application file .

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Step 2: Close the configuration software and open it again . The configuration software will read the configuration information in the XML file and display it on the "Parameter View/Set" function page.

#### 4.2.1.2 Generating Automatic Thresholds

The steps to use the configuration software to generate automatic thresholds are as follows :

Step 1. After connecting the E54-24LD12C to the configuration software, click the "Generate Auto Threshold" button on the "Parameter View/Set" function page . The "Threshold Generation" window will pop up as shown in Figure 4-3 .

Step 2. Enter the trigger/hold threshold generation coefficient and scan time . The scan time can be 30 seconds or 120 seconds . If the scanning environment is more complex and it is difficult to keep the system unattended for a long time , select 30 seconds , otherwise select 120 seconds. Click the "Start/Stop" switch button to start threshold generation . The progress bar at the bottom of the window will display the generation progress in real time . During the entire threshold generation process , please ensure that there is no one within the detection range .

Step 3. After the threshold is generated, the text prompt "Threshold generated successfully" will be displayed in the lower left corner of the window; after closing the "Threshold Generation" window, you can view the generated automatic threshold in the Trigger/Hold Threshold area of the "Parameter View /Set" function page.

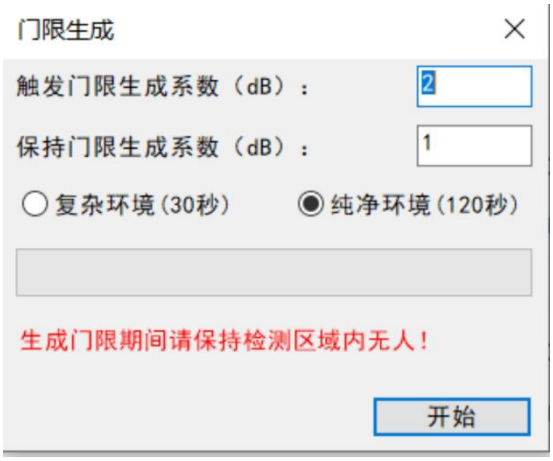



Figure 4-3 Threshold Generation Window

## 4.2.2 Target Information

The "Target Information" page of the configuration software displays the human body sensing detection results and real-time data, and provides relevant information for saving the millimeter wave sensor detection data.

operate.

shown in Figure 4-4 , the function page of the "Target Information" page can be divided into five areas :

- a Target result display area ;
- b Function button area ;
- c Real-time energy value display area ;
- d Real-time distance/status information display area ;

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- eData saving operation area .




Figure 4-4 Configuration software "Target Information" page

Table 4-3 describes the areas on the Target Information page HYPERLINK \l "bookmark32" .

Table 4-3 Function description of each area on the "Target Information" page

| Page Area | | Function | Description |
|---|---|---|---|
| a | Lantern Icon | The color of the colored light indicates the movement/micro-movement/no-person status of human targets in the detection area | Green means no one is there;<br>Red means there are people;<br>Blue means the body is at rest, and a "red heart" icon appears. |
| | Target information text box | Display detected target information | Displays the presence of human targets and their motion status, the straight-line distance between the human body and the sensor (meters), and the estimated average operating current (mA) in the current state. |
| b | Play/Stop toggle button | Playback/stop display of specified detection data | When the "Start/Stop" switch button displays "Start" , this button can be clicked ; otherwise, this button is gray and cannot be clicked. |
| | Start/Stop toggle button | Start/stop the sensor's human presence detection | - |
| c | "Power VS Distance Gate" real-time detection data display | Real-time display of energy value and threshold information of each distance gate within the detection range | - |

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| | | | |
|---|---|---|---|
| d | "Distance VS Time" real-time detection data display | Displays the presence and distance of human targets detected by the sensor within the last 60 seconds | The colored progress bar above the coordinates shows in real time whether there is someone in the detection area : green means no one , red means someone ; blue means someone is there and the person is stationary.<br>The red curve below the coordinate graph shows the historical data of the straight-line distance between the target and the sensor in the last 60 seconds. |
| e | Save data | Allows users to choose whether to save the test data and set the save path for the test data | This area is only operable when the text on the "Start/Stop" button in area B displays "Start" ;<br>After checking the "Data Save" option, you can click the "Select Path" button to select the save path for the test data . If no save path is selected , the test data will be saved in the directory where the configuration software is located. |

The "Target Information" function page supports users to view, save and replay detection data. The operation steps are described as follows .

**View test data**

Step 1. After connecting the E54-24LD12C to the configuration software, click the "Target Information" button to switch to the function page . The configuration software will automatically start the millimeter wave sensor detection function (the "Start/Stop" switch button displays "Stop") , and the a, c, and d areas of the page will begin to display the corresponding target information in real time .

Step 2. Click the "Start/Stop" switch button again to pause the detection of the mmWave sensor.

**Save test data**

Step 1: After connecting the E54-24LD12C to the configuration software, click the "Target Information" button to switch to the function page . The configuration software will automatically enable the millimeter wave sensor detection function ;

Step 2. Click the "Start/Stop" switch button to stop the sensor's detection function . At this time, the function control for saving data in area E becomes operational ;

Step 3. Click the checkbox before "Save Data" to enable the save data function;

Step 4 (optional): Click the "Select Path" button to select a path for saving the test data.

Step 5. Click the "Start/Stop" switch button to restart the sensor's detection function . After the detection is completed , the user can view the saved detection data in the save path set in step 4. If the user does not set a save path , the detection data will be saved to the SaveData path in the same directory as the application file by default .

**Replay test data**

Step 1. After connecting the E54-24LD12C to the configuration software, click the "Target Information" button to switch to the function page . The configuration software will automatically enable the sensor detection function .

Step 2. Click the "Start/Stop" switch button to stop the sensor's detection function . The "Playback/Stop" button will become clickable .

Step 3. Click the "Play/Stop" button and select the path of the test data to be played back . After completion, the function page of the configuration software will start playing the test data , and the text of the "Play/Stop" button will switch to "Stop" ;

Step 4 (optional): Click the "Play/Stop" switch button to stop data playback ; users can also wait for the playback process to complete before continuing with other operations.

### 4.2.3 Update Firmware

The "Update Firmware" page of the configuration software is shown in Figure 4-5 . The operation steps are as follows :

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Step 1: After connecting E54-24LD12C to the configuration software, click the "Update Firmware" function button to switch to the function page ;

Step 2. Click the "Get Firmware Information" button . The prompt information below and to the right of the button will display the ID information and firmware information of the current device .

Step 3. Click the "Select bin file path" button and select the required .bin file ;

Step 4. Click the "Burn" button to start updating the firmware . The prompt 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.

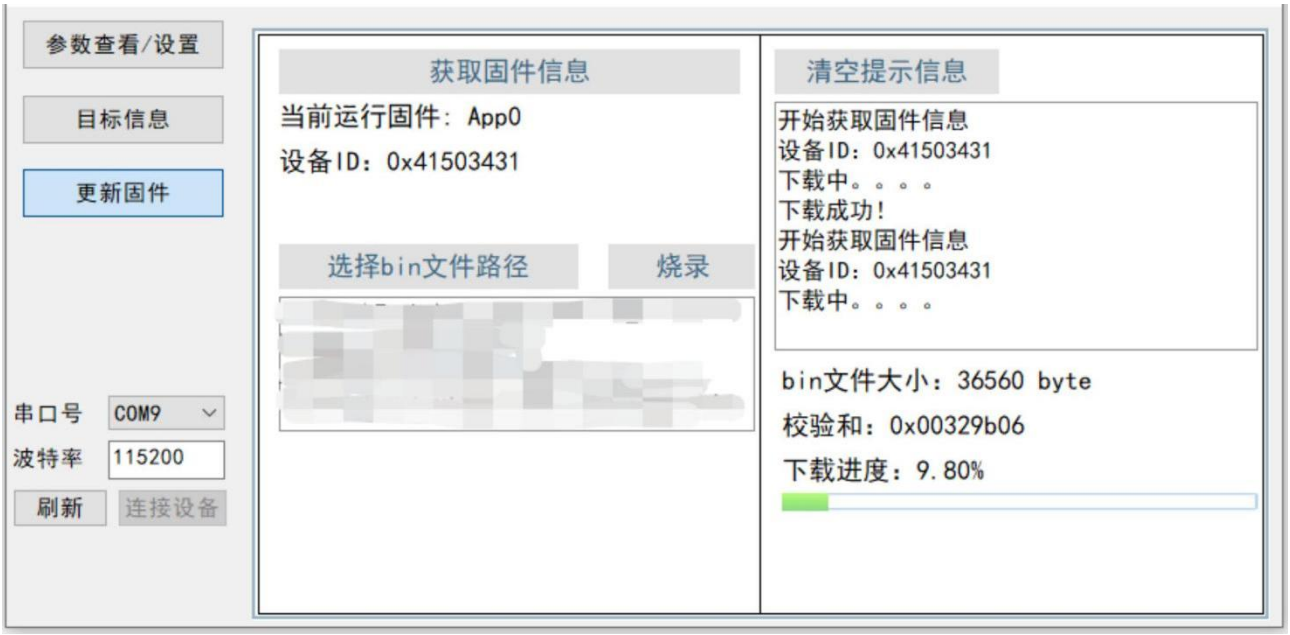



Figure 4-5 Configuration software firmware upgrade page

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.

# Chapter 5 Communication Protocol

This communication protocol is primarily intended for users who require secondary development without visualization tools. The E54-24LD12C battery-powered, ultra-low-power human presence millimeter-wave sensor communicates with the outside world via a serial port (TTL level). Sensor data output and parameter configuration commands are performed using this protocol. The default baud rate of the sensor serial port is 115200 bps, with 1 stop bit and no parity.

The basic process of using commands to configure parameters is:

1. Enter command mode;

2.Configure parameter command/get parameter command;

3. Exit command mode.

The E54-24LD12C uses the little-endian format for data communication . All data in the following table are in hexadecimal.

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# 5.1 Reporting Data Format

Table 5-1 shows the sensor data reporting formats. The E54-24LD12C reports three data types : simplified data reporting format, 、standard data reporting format, and automatic threshold progress reporting format. The sensor reports the simplified data format by default ; the standard data reporting format is used with configuration software; and the automatic threshold progress reporting format is used only when generating automatic thresholds.

Table 5-1 Reporting data format

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Minimalist data | Frame header | Target state | | | Target distance | | | Frame tail |
| | 6E | 1 byte (0/1 means no one ; 2/3 means someone) | | | 2 bytes (unit : centimeters) | | | 62 |
| Standard data | Frame header | Intra-frame data length | Data Type | Target state | Target distance | Reserved bits | Energy value of each range gate | Frame tail |
| | F4 F3 F2 F1 | 2 bytes | 0x01 | 1 byte (0/1 means no one ; 2/3 means someone) | 2 bytes (single (unit : cm) | 2 bytes | 64 bytes | F8 F7 F6 F5 |
| Automatic threshold Progress data | Frame header | Intra-frame data length | Data Type | Threshold Generation Progress | | | | Frame tail |
| | F4 F3 F2 F1 | 2 bytes | 0x03 | 2 bytes (progress*100) | | | | F8 F7 F6 F5 |

# 5.2 Sending Commands and ACK

## 5.2.1 Read firmware version command

This command reads the sensor firmware version information.

Command word : 0x0000

Command value : None

Return value : 2-byte major version number + 2-byte minor version number + 2-byte patch version number Send data :

| Frame header | Data length in frame | Command word | Frame tail |
|---|---|---|---|
| FD FC FB FA | 02 00 | 00 00 | 04 03 02 01 |

ACK (success )

| Frame header | Data length in frame | Command word | Major version number | Minor version number | Patch version number | Frame tail |
|---|---|---|---|---|---|---|
| FD FC FB FA | 08 00 | 00 01 | 0x[2] 00 | 0x00 | 0x00 | 04 03 02 01 |

[2]In this table, X represents the version number

## 5.2.2 Enable Configuration Command

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

Command word : 0x00FF

Command value : 0x0001

Return value : 2-byte protocol version (0x0001)

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Sending data :

| Frame header | Data length in frame | Command word | Command Value | Frame tail |
|---|---|---|---|---|
| FD FC FB FA | 04 00 | FF 00 | 01 00 | 04 03 02 01 |

ACK (success )

| Frame header | Data length in frame | Command word | Return results | Protocol version | Receive buffer size | Frame tail |
|---|---|---|---|---|---|---|
| FD FC FB FA | 08 00 | FF 01 | 00 00 | 03 00 | 80 00 | 04 03 02 01 |

### 5.2.3 End Configuration Command

This command ends the sensor's parameter configuration mode and resumes the 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)

Sending data :

| Frame header | Data length in frame | Command word | Frame tail |
|---|---|---|---|
| FD FC FB FA | 02 00 | FE 00 | 04 03 02 01 |

ACK (success )

| Frame header | Data length in frame | Command word | ACK | Frame tail |
|---|---|---|---|---|
| FD FC FB FA | 04 00 | FE 01 | 00 00 | 04 03 02 01 |

### 5.2.4 Write serial number command

This command writes the sensor serial number.

Command word : 0x0010

Command value : 2-byte serial number length + 8-byte serial number

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

Send data : (Example : SN is 12345678 )

| Frame header | Data length in frame | Command word | Sequence number length | Serial number | Frame tail |
|---|---|---|---|---|---|
| FD FC FB FA | 0C 00 | 10 00 | 08 00 | 31 32 33 34 35 36 37 38 | 04 03 02 01 |

ACK (success)

| Frame header | Data length in frame | Command word | ACK | Frame tail |
|---|---|---|---|---|
| FD FC FB FA | 04 00 | 10 01 | 00 00 | 04 03 02 01 |

### 5.2.5 Read serial number command

This command reads the sensor serial number.

Command word : 0x0011

Command value : None

Return value : 2-byte ACK status (0 success , 1 failure) + 2-byte sequence number length + 8-byte sequence number

Sending data :

| Frame header | Data length in frame | Command word | Frame tail |
|---|---|---|---|
| FD FC FB FA | 02 00 | 11 00 | 04 03 02 01 |

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ACK : (Successful , example : SN is 12345678)

| Frame header | Data length in frame | Command word | ACK | Sequence number length | Serial number | Frame tail |
|---|---|---|---|---|---|---|
| FD FC FB FA | 0E 00 | 11 01 | 00 00 | 08 00 | 31 32 33 34 35 36 37 38 | 04 03 02 01 |

## 5.2.6 Write general parameter command

This command is used to set the general parameters of the sensor.

Command word : 0x0070

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

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

Send data : (Example : "Detection of the farthest distance gate [3] " = 12 ; "Detection of the closest distance gate" = 0 ; "No one delay time (seconds)" = 40 ; "Status reporting frequency [4] " = 1Hz ; "Distance reporting frequency" = 1Hz ; "Response speed" = normal)

[3]One range gate unit corresponds to 0.7m.

[4] In this protocol, the parameter value of status/distance reporting frequency is the corresponding frequency × 10 .

| Frame header | Data length in frame | Command word | Detection of the farthest distance door | Detection of the closest distance door |
|---|---|---|---|---|
| FD FC FB FA | 26 00 | 70 00 | 05 00 0C 00 00 00 | 0A 00 00 00 00 00 |

| No one delay time (seconds) | Status reporting frequency | Distance reporting frequency | Response speed | Frame tail |
|---|---|---|---|---|
| 06 00 28 00 00 00 | 02 00 0A 00 00 00 | 0C 00 0A 00 00 00 | 0B 00 0A 00 00 00 | 04 03 02 01 |

ACK (success )

| Frame header | Data length in frame | Command word | ACK | Frame tail |
|---|---|---|---|---|
| FD FC FB FA | 04 00 | 70 01 | 00 00 | 04 03 02 01 |

The parameter words and value ranges of general parameters are defined as shown in Table 5-2 .

Table 5-2 Definition of parameter words and value ranges of general parameters

| Parameter name | Parameter word | Numerical range | unit |
|---|---|---|---|
| Detection of the farthest distance door | 05 | 1~16 | - |
| Detection of the closest distance door | 0A | 0~16 | - |
| No delay time | 06 | 10~120 | s |
| Status reporting frequency | 02 | 1~8 (1 step) | Hz |
| Distance reporting frequency | 0C | 1~8 (1 step) | Hz |
| Response speed | 0B | 10(normal)/20(fast) | - |

## 5.2.7 Read general parameter command

This command reads the configuration parameters of the sensor.

Command word : 0x0071

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

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

Sending data :

| Frame header | Data length in frame | Command word | Detection of the longest distance door | Detection of the closest distance door |
|---|---|---|---|---|
| FD FC FB FA | 0E 00 | 71 00 | 05 00 | 0A 00 |

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| No delay time | Status reporting frequency | Distance reporting frequency | Response speed | Frame tail |
|---|---|---|---|---|
| 06 00 | 02 00 | 0C 00 | 0B 00 | 04 03 02 01 |

ACK : (Successful example : "Furthest detection distance gate" = 12 ; "Shortest detection distance gate" = 0 ; "No person delay time (seconds)" = 40 ; "Status reporting frequency" = 1Hz ; "Distance reporting frequency" = 1Hz ; "Response speed" = normal)

| Frame header | Data length in frame | Command word | **ACK** | Detection of the longest distance door | Detection of the closest distance door |
|---|---|---|---|---|---|
| FD FC FB FA | 1A 00 | 71 01 | 00 00 | 0C 00 00 00 | 00 00 00 00 |
| No delay time | Status reporting frequency | Distance reporting frequency | | Response speed | Frame tail |
| 28 00 00 00 | 0A 00 00 00 | 0A 00 00 00 | | 0A 00 00 00 | 04 03 02 01 |

## 5.2.8 Write trigger threshold parameter command

This command is used to configure the trigger threshold parameters of the sensor's 0~15 distance gate.

Command word : 0x0072

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

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

Send data : (Example : trigger threshold = [50 , 46 , 34 , 32 , 32, 32 , 32 , 32 , 50 , 46 , 34 , 32 , 32 , 32 , 32 , 32 ])

| Frame header | Data length in frame | Command word | 0 range gate Trigger threshold | 1 distance gate Trigger threshold | 2 distance gates Trigger threshold | 3 distance gates Trigger threshold |
|---|---|---|---|---|---|---|
| FD FC FB FA | 62 00 | 72 00 | 00 00 32 00 00 00 | 01 002E 00 00 00 | 02 00 2E 00 00 00 | 03 00 20 00 00 00 |
| 4 distance gates Trigger threshold | 5 distance gates Trigger threshold | 6 distance gates Trigger threshold | 7 distance gates Trigger threshold | 8 distance gates Trigger threshold | 9 distance gate Trigger threshold | 10 distance gates Trigger threshold |
| 04 00 20 00 00 00 | 05 00 20 00 00 00 | 06 00 20 00 00 00 | 07 00 20 00 00 00 | 08 00 32 00 00 00 | 09 00 2E 00 00 00 | 0A 00 20 00 00 00 |
| 11 distance gate Trigger threshold | 12 distance gates Trigger threshold | 13 distance gate Trigger threshold | 14 distance gate Trigger threshold | 15 distance gate Trigger threshold | Frame tail | |
| 0B 00 1E 00 00 00 | 0C 00 1E 00 00 00 | 0D 00 1E 00 00 00 | 0E 00 1E 00 00 00 | 0F 00 1E 00 00 00 | 04 03 02 01 | |

ACK (success )

| Frame header | Data length in frame | Command word | ACK | Frame tail |
|---|---|---|---|---|
| FD FC FB FA | 04 00 | 72 01 | 00 00 | 04 03 02 01 |

## 5.2.9 Read trigger threshold parameter command

This command is used to read the trigger threshold parameters of the sensor's 0~15 distance gate.

Command word : 0x0073

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

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

Sending data :

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| Frame header | Data length in frame | Command word | 0 range gate Trigger threshold | 1 distance gate Trigger threshold | 2 distance gates Trigger threshold | 3 distance gates Trigger threshold |
|---|---|---|---|---|---|---|
| FD FC FB FA | 22 00 | 73 00 | 00 00 | 01 00 | 02 00 | 03 00 |
| 4 distance gates Trigger threshold | 5 distance gates Trigger threshold | 6 distance gates Trigger threshold | 7 distance gates Trigger threshold | 8 distance gates Trigger threshold | 9 distance gate Trigger threshold | 10 distance gates Trigger threshold |
| 04 00 | 05 00 | 06 00 | 07 00 | 08 00 | 09 00 | 0A 00 |
| 11 distance gate Trigger threshold | 12 distance gates Trigger threshold | 13 distance gate Trigger threshold | 14 distance gate Trigger threshold | 15 distance gate Trigger threshold | Frame tail | |
| 0B 00 | 0C 00 | 0D 00 | 0E 00 | 0F00 | 04 03 02 01 | |

ACK (Success) : (Example : trigger threshold = [50 , 46 , 34 , 32 , 32, 32 , 32 , 32 , 50 , 46 , 34 , 32 , 32 , 32 , 32 , 32 ] )

| Frame header | Data length in frame | Command word | ACK | 0 range gate Trigger threshold | 1 distance gate Trigger threshold | 2 distance gates Trigger threshold |
|---|---|---|---|---|---|---|
| FD FC FB FA | 44 00 | 73 01 | 00 00 | 32 00 00 00 | 2E 00 00 00 | twenty two 00 00 00 |
| 3 distance gates Trigger threshold | 4 distance gates Trigger threshold | 5 distance gates Trigger threshold | 6 distance gates Trigger threshold | 7 distance gates Trigger threshold | 8 distance gates Trigger threshold | 9 distance gate Trigger threshold |
| 20 00 00 00 | 20 00 00 00 | 20 00 00 00 | 20 00 00 00 | 20 00 00 00 | 32 00 00 00 | 2E 00 00 00 |
| 10 distance gates Trigger threshold | 11 distance gate Trigger threshold | 12 distance gates Trigger threshold | 13 distance gate Trigger threshold | 14 distance gate Trigger threshold | 15 distance gate Trigger threshold | Frame tail |
| 20 00 00 00 | 1E 00 00 00 | 1E 00 00 00 | 1E 00 00 00 | 1E 00 00 00 | 1E 00 00 00 | 04 03 02 01 |

## 5.2.10 Write hold threshold command

This command is used to write the hold threshold parameters of the sensor's 0~15 range gate.

Command word : 0x0076

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

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

Send data : ( Example : hold threshold = [ 15 , 15 , 15 , 15 , 15 , 15 , 15 , 09 , 09 , 09 , 09 , 09 , 09 , 09 ] )

| Frame header | Data length in frame | Command word | 0 range gate Hold Threshold | 1 distance gate Hold Threshold | 2 distance gates Hold Threshold | 3 distance gates Hold Threshold |
|---|---|---|---|---|---|---|
| FD FC FB FA | 62 00 | 76 00 | 00 00 0F 00 00 00 | 01 00 0F 00 00 00 | 02 00 0F 00 00 00 | 03 00 0F 00 00 00 |
| 4 distance gates Hold Threshold | 5 distance gates Hold Threshold | 6 distance gates Hold Threshold | 7 distance gates Hold Threshold | 8 distance gates Hold Threshold | 9 distance gate Hold Threshold | 10 distance gates Hold Threshold |
| 04 00 0F 00 00 00 | 05 00 0F 00 00 00 | 06 00 0F 00 00 00 | 07 00 0F 00 00 00 | 08 00 09 00 00 00 | 09 00 09 00 00 00 | 0A 00 09 00 00 00 |
| 11 distance gate Hold Threshold | 12 distance gates Hold Threshold | 13 distance gate Hold Threshold | 14 distance gate Hold Threshold | 15 distance gate Hold Threshold | Frame tail | |
| 0B 00 09 00 00 00 | 0C 00 09 00 00 00 | 0D 00 09 00 00 00 | 0E 00 09 00 00 00 | 0F 00 09 00 00 00 | 04 03 02 01 | |

ACK (success )

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| Frame header | Data length in frame | Command word | ACK | Frame tail |
|---|---|---|---|---|
| FD FC FB FA | 04 00 | 76 01 | 00 00 | 04 03 02 01 |

## 5.2.11 Read hold threshold parameter command

This command is used to read the hold threshold parameters of the sensor's 0~15 range gate.

Command word : 0x0077

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

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

Sending data :

| Frame header | Data length in frame | Command word | 0 range gate Hold Threshold | 1 distance gate Hold Threshold | 2 distance gates Hold Threshold | 3 distance gates Hold Threshold |
|---|---|---|---|---|---|---|
| FD FC FB FA | twenty two 00 | 77 00 | 00 00 | 01 00 | 02 00 | 03 00 |
| 4 distance gates Hold Threshold | 5 distance gates Hold Threshold | 6 distance gates Hold Threshold | 7 distance gates Hold Threshold | 8 distance gates Hold Threshold | 9 distance gate Hold Threshold | 10Distance gate hold threshold |
| 04 00 | 05 00 | 06 00 | 07 00 | 08 00 | 09 00 | 0A 00 |
| 11 distance gate Hold Threshold | 12 distance gates Hold Threshold | 13 distance gate Hold Threshold | 14 distance gate Hold Threshold | 15 distance gate Hold Threshold | Frame tail | |
| 0B 00 | 0C 00 | 0D 00 | 0E 00 | 0F 00 | 04 03 02 01 | |

ACK (success) : (Example : hold threshold = [15 , 15 , 15 , 15 , 15 , 15 , 15 , 09 , 09 , 09 , 09 , 09 , 09 , 09 , 09 ] )

| Frame header | Data length in frame | Command word | ACK | 0 range gate Hold Threshold | 1 distance gate Hold Threshold | 2 distance gates Hold Threshold |
|---|---|---|---|---|---|---|
| FD FC FB FA | 44 00 | 77 01 | 00 00 | 0F 00 00 00 | 0F 00 00 00 | 0F 00 00 00 |
| 3 distance gates Hold Threshold | 4 distance gates Hold Threshold | 5 distance gates Hold Threshold | 6 distance gates Hold Threshold | 7 distance gates Hold Threshold | 8 distance gates Hold Threshold | 9 distance gate Hold Threshold |
| 0F 00 00 00 | 0F 00 00 00 | 0F 00 00 00 | 0F 00 00 00 | 0F 00 00 00 | 09 00 00 00 | 09 00 00 00 |
| 10 distance gates Hold Threshold | 11 distance gate Hold Threshold | 12 distance gates Hold Threshold | 13 distance gate Hold Threshold | 14 distance gate Hold Threshold | 15 distance gate Hold Threshold | Frame tail |
| 09 00 00 00 | 09 00 00 00 | 09 00 00 00 | 09 00 00 00 | 09 00 00 00 | 09 00 00 00 | 04 03 02 01 |

## 5.2.1 2 Modify the reporting data format

This command is used to modify the sensor reporting data format .

Command word : 0x007 A

Command value : 6 bytes (standard mode: 00 00 01 00 00 00, minimalist mode: 00 00 00 00 00 00)

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

Sending data :

| Frame header | Data length in frame | Command word | Command Value | Frame tail |
|---|---|---|---|---|
| FD FC FB FA | 08 00 | 7A 00 | 00 00 01 00 00 00 | 04 03 02 01 |

ACK (success):

| Frame header | Data length in frame | Command word | ACK | Frame tail |
|---|---|---|---|---|

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| | | | | |
|---|---|---|---|---|
| FD FC FB FA | 04 00 | 7A 01 | 00 00 | 04 03 02 01 |

# Chapter 6 Installation and Detection Range

the E54-24LD12C is wall mounting. When wall-mounted , the millimeter wave sensor is oriented as shown in Figure 6-1 . The X-axis is 0° , the Z-axis is 90° , and the Y-axis is perpendicular to the XZ plane (also called the normal direction).

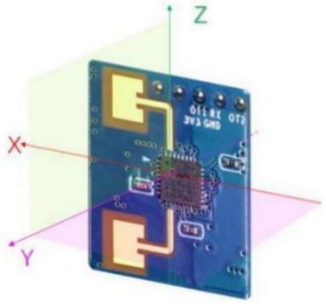



Figure **6-1** Sensor orientation diagram

The recommended wall-mounting height is 1.5-2m . In this case , the maximum motion trigger range of the E54-24LD12C in the default configuration is a conical space with a normal range of 6m and a horizontal and pitch angle of ±60° , as shown in Figure 6-2 .

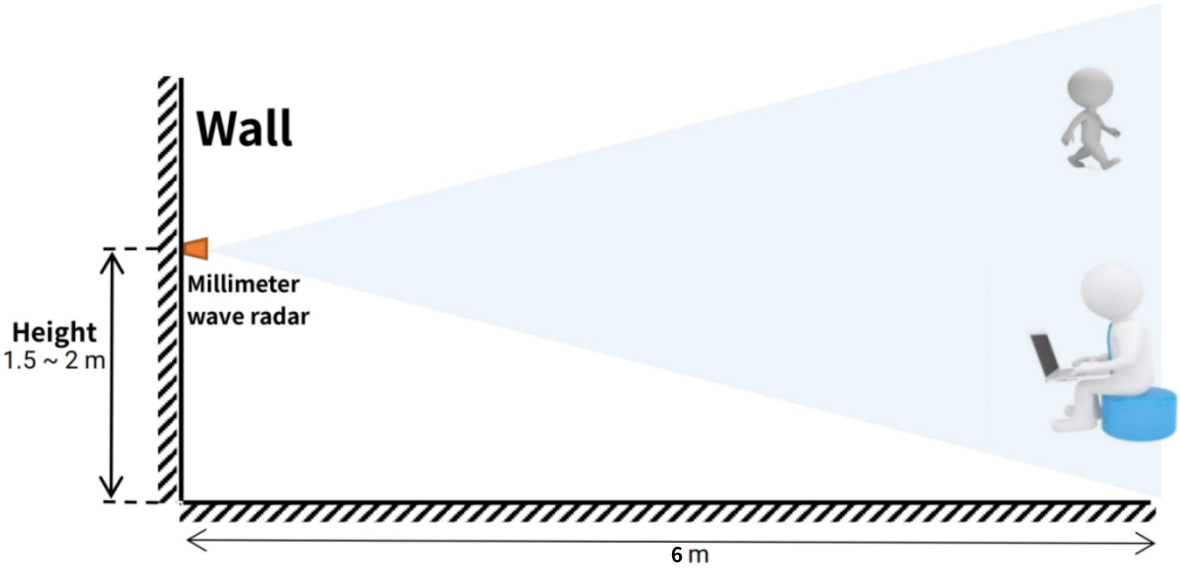



Figure 6-2 Schematic diagram of the detection range of E54-24LD12C (wall-mounted)

shows the detection range of the E54-24LD12C in all directions when the wall is mounted at a height of 1.5 m .

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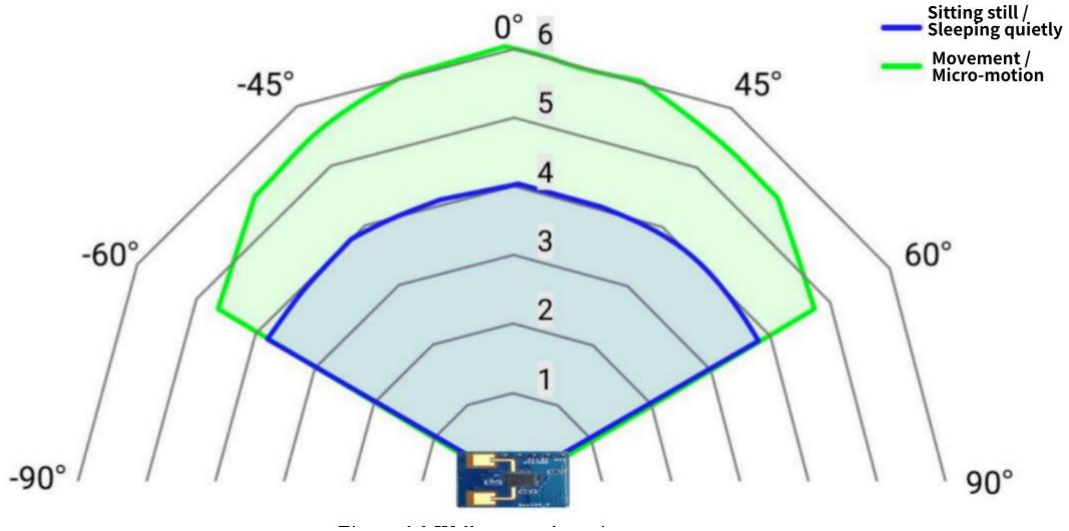



Figure 6-3 Wall-mounted sensing range

# Chapter 7 Installation Instructions

**Millimeter wave sensor housing requirements**

If the mmWave sensor requires an enclosure , the enclosure must have good wave transmission characteristics in the 24 GHz band and must not contain metal or other materials that shield electromagnetic waves. For more information, see the "Millimeter Wave Sensor Antenna Cover Design Guide."

**Installation environment requirements**

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

- There are non-human objects in continuous motion within the sensing area , such as animals , continuously swaying curtains, and large green plants facing the wind vents.
- There is a large , strongly reflective surface in the sensing area. Strong reflective objects facing the sensor antenna will cause interference.
- When wall-mounted , external interference factors such as air conditioners and electric fans on the ceiling need to be considered.

**Notes on installation**

- Try to ensure that the radar antenna is facing the area to be detected and that there is an open area around the antenna without any obstructions.
- It is necessary to ensure that the installation position of the millimeter wave sensor is firm and stable , as the shaking of the sensor itself will affect the detection effect.
- Ensure that there is no movement or vibration behind the millimeter wave sensor. Because millimeter waves are penetrating , the antenna backlobe may detect moving objects behind the sensor. Use a metal shield or backplate to shield the antenna backlobe and mitigate the effects of objects behind the sensor.
- When there are multiple 24 GHz millimeter wave sensors , avoid direct beam alignment and install them as far apart as possible to avoid possible mutual interference.

**Power Supply Considerations**

The power input voltage range is 3.0V to 3.6V , and the power ripple has no significant peaks within 100kHz. This solution is a

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reference design only; users must consider electromagnetic compatibility (EMC) design considerations, such as ESD and lightning surges.

# Chapter 8 Notes

**Maximum detection distance**

E54-24LD12C sensor has a maximum trigger range of 6 meters in the radial direction and a detection range of up to 8.4 meters. Within the detection range , the sensor reports the linear distance of the target from the sensor.

**Maximum distance and accuracy**

Theoretically, the ranging error of the sensor in this reference solution is ±0.35m . However, due to differences in the size, state, and RCS of human targets , the ranging accuracy will fluctuate , and the maximum detection distance will also fluctuate to a certain extent.

**Target disappearance delay**

When the millimeter wave sensor detects no human presence in the target area, it does not immediately report the "no one" status in the area, but instead delays reporting. The delayed reporting mechanism is as follows : once no human targets are detected within the test range , the sensor starts a timer for the duration of the absence . If no human presence is detected within the timer, the "no one" status is reported after the timer expires. If a person is detected within this time period, the timer immediately ends, updates the timer , and reports the target information.

# Revision History

| Version | Revision Date | Revision Notes | Maintainer |
|---|---|---|---|
| 1.0 | 2025-09-23 | Initial version | Bin |
| | | | |

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