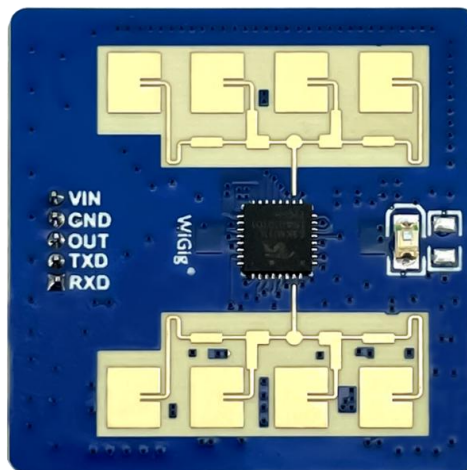




**Shenzhen Hi-Link Electronic Co., Ltd.**

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# **HLK-LD2411-S Human Sensor Motion Module Data Sheet**



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# CONTENTS

|   |    |
|---|----|
| 1 Product introduction .....                    | 3  |
| 2 Product features .....                        | 3  |
| 2.1 Main characteristics .....                  | 3  |
| 2.2 System description .....                    | 3  |
| 3 Application scenarios .....                   | 4  |
| 4 Hardware description .....                    | 5  |
| 4.1 Dimension .....                             | 5  |
| 4.2 Pin definition .....                        | 6  |
| 5 Use and configuration .....                   | 6  |
| 5.1 Connect to PC .....                         | 6  |
| 5.2 The role of configuration parameters .....  | 8  |
| 5.3 Installation method and sensing range ..... | 8  |
| 5.4 Installation conditions .....               | 9  |
| 6 Electrical parameters .....                   | 10 |
| 7 Bluetooth instructions .....                  | 10 |
| 7.1 Install software .....                      | 10 |
| 7.2 Instructions .....                          | 10 |
| 7.3 OTA upgrade .....                           | 11 |
| 7.4 Bluetooth communication protocol .....      | 12 |
| 8 Revision records .....                        | 12 |
| 9 Technical support and contact .....           | 12 |

# 1 Product introduction

LD2411-S is a motion/micro-motion human body sensing ranging sensor module of Hi-Link, which includes extremely simplified 24 GHz radar sensor hardware and intelligent algorithm firmware RM01. This reference design is suitable for single target scenarios, when there are multiple targets, the target with the highest echo energy will be selected.

The LD2411-S hardware consists of a 24GHz millimeter-wave radar chip, a high-performance send-and-receive micro-strip antenna, a low-cost MCU and peripheral auxiliary circuits. The radar beam of the LD2411-S hardware adopts a flat beam design: the detection range of the radar module E surface direction is 20, and the detection range of the H surface is 45. The user can adjust the placement direction of the module according to the actual application scenario.

Intelligent algorithm firmware RM01 adopts FMCW waveform and S3 series chip proprietary advanced signal processing technology to realize accurate human body distance measurement and motion/micro-motion human body sensing.

## 2 Product features

### 2.1 Main characteristics

- \* 24 GHZ ISM band
- \* Integrate intelligent millimeter-wave radar single chip and intelligent algorithm firmware
- \* Accurate indoor/outdoor human motion/micro-motion sensing and distance detection
- \* 5V single power supply
- \* Continuous working average current 48mA@20 Hz reporting frequency
- \* Provide visualization tools, support configuration of detection distance interval, set sensitivity by distance gate
- \* The longest distance of human body induction is 6m, and the longest distance of micro-motion human body induction is 3.5m
- \* High-precision ranging: 30~350cm±5cm; 350~600cm±5%
- \* Azimuth +20°, Elevation +45°

### 2.2 System description

LD2411-S is an intelligent motion/micro-motion human body ranging module developed based on a professional radar chip. It has the characteristics of strong real-time ranging accuracy, large range, and flexible configuration of algorithm parameters. The sensor adopts FMCW waveform, combined with MCU's proprietary radar signal processing and built-in intelligent distance detection algorithm, it can detect targets in the designated area and report the results in real time. Based on this reference solution, users can quickly develop corresponding motion/micro-motion human body sensing products.

| Parameters                                  | Notes  | Min. | Typ. | Max.  | Unit |
|---|--|------|------|-------|------|
| Frequency band                              |  | 24   |      | 24.25 | GHz  |
| Maximum sweep bandwidth                     |  |      | 0.25 |       | GHz  |
| Maximum equivalent isotropic radiated power | Adjusting the transmit power can change this parameter | 9    | 16   | 16.8  | dBm  |
| Supply voltage                              |  | 4.5  | 5.0  | 5.5   | V    |
| Ambient temperature                         |  | -40  | -    | 85    | °C   |
| Distance detection range                    | Micro-motion human target                              | 0.3  | -    | 3.5   | m    |
|   | Moving human target                                    | 0.3  | -    | 6     | m    |
| Ranging accuracy<br>Average current         | Close distance: 30~350cm                               | -    | ±5%  | -     | cm   |
|   | Far distance: 350~600 cm                               | -    | ±5%  | -     | cm   |
| Average current                             | 50ms reporting period                                  | 48   |      |       | mA   |

Table 1 Parameter Description

### 3 Application scenarios

The LD2411-S motion/micro-movement human body sensor can detect and identify motion and micro-motion human body, and report the real-time distance. It is widely used in various AIoT scenarios. The commonly used types are as follows

**\* Smart home**

Perceive the movement/micro-movement and distance of the human body, and report the distance detection result for the main control module to intelligently control the operation of home appliances.

**\* Smart business**

Sensor doors, sensor escalators, etc.

**\* Smart lighting**

Induction access control, building intercom, electronic peephole, etc.

**\* Smart security**

Induction access control, building intercom, electronic peephole, etc.

## 4 Hardware description

### 4.1 Dimension

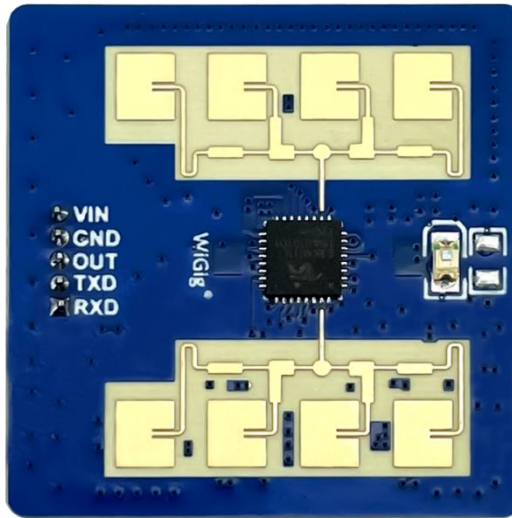


Figure 1 Module physical image

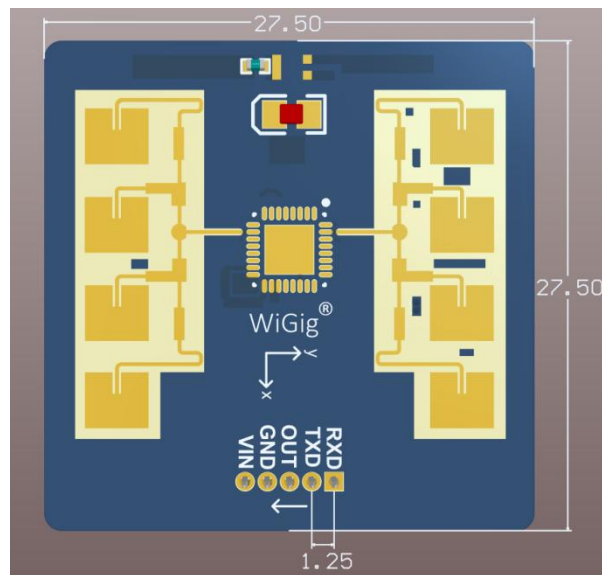


Figure 2 Module size

Module size: 27.5mmx27.5mm,

5 pin holes are reserved for hardware (the factory default is not equipped with pins)

## 4.2 Pin definition

| Pin | Symbol  | Description    | Function           |
|-----|---------|----------------|--------------------|
| 1   | OUT     | Output         | Reserved           |
| 2   | UART_Tx | Serial port Tx | Serial port Tx pin |
| 3   | UART_Rx | Serial port Rx | Serial port Rx pin |
| 4   | GND     | Power ground   | Power ground       |
| 5   | VCC     | Power input    | Power input 5V     |

Table 2 Pin definition

# 5 Use and configuration

## 5.1 Connect to PC

Step 1: Open the host computer software, the software interface is shown in Figure 3; click the "Refresh" button on the interface, select the corresponding serial port number of the radar module and enter the corresponding baud rate, and then click "Connect Device"; after the connection is successful, the text on the button will change to "Disconnect Device", and the firmware version number of the radar module will be displayed in "Firmware Version"

Step 2: Click the "Parameter Configuration" button, and the parameter configuration interface will pop up, as shown in Figure 4. Users can edit the corresponding parameter values according to their needs, and click the "Set Parameters" button to send the updated parameters to the radar module and return to the main Interface of the host computer. For the parameter meaning and configuration method in the interface, please refer to Chapter 5 Communication Protocol;

Step 3: Click the "Start" button on the main interface to receive real-time data from the radar terminal, as shown in Figure 5. The upper computer interface displays the distance and status of the detected target, and displays the distance curve between the target human body and the radar model within the last 15s at the bottom.

Step 4: Click the "Stop" button to stop the data transmission between the radar module and the host computer, and the user can view the data of this test in the Log folder under the directory where the host computer software is located.



Figure 3 Upper computer

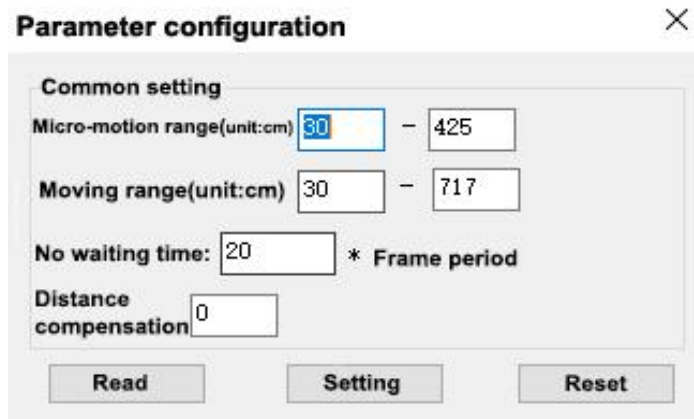


Figure 4 Upper computer 2

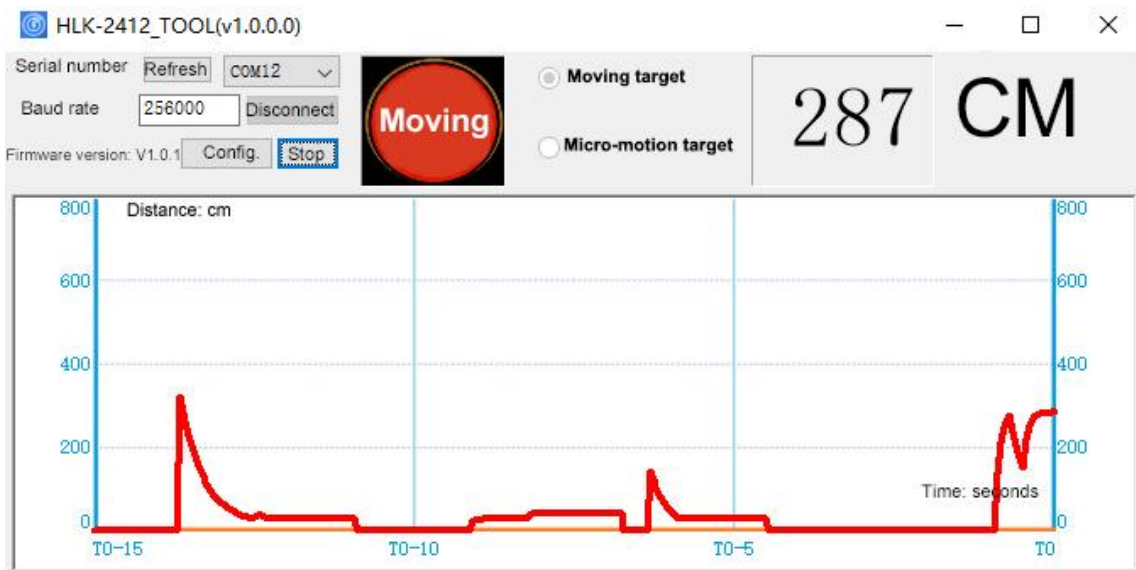


Figure 5 Upper computer 3

## 5.2 The role of configuration parameters

Users can modify the configuration parameters of the module through the serial port of LD2411-S to adapt to different application requirements, and the configuration content will not be lost when the power is turned off.

The configurable parameters include the following:

### \* Inching range

Set the farthest detectable micro-movement distance, only the human targets appearing within this furthest distance will be detected and the result will be output.

### \* Range of motion

Set the farthest detectable movement distance, only the human targets appearing within this farthest distance will be detected and the result will be output.

### \* Duration of no one

When the radar outputs the results from someone to no one, it will report people for a period of time. If there is no one in the radar test range during this time period, the radar will report no one; if the radar detects people during this time period, it will be refreshed, the unit is the frame period (a frame period is about 100ms)

## 5.3 Installation method and sensing range

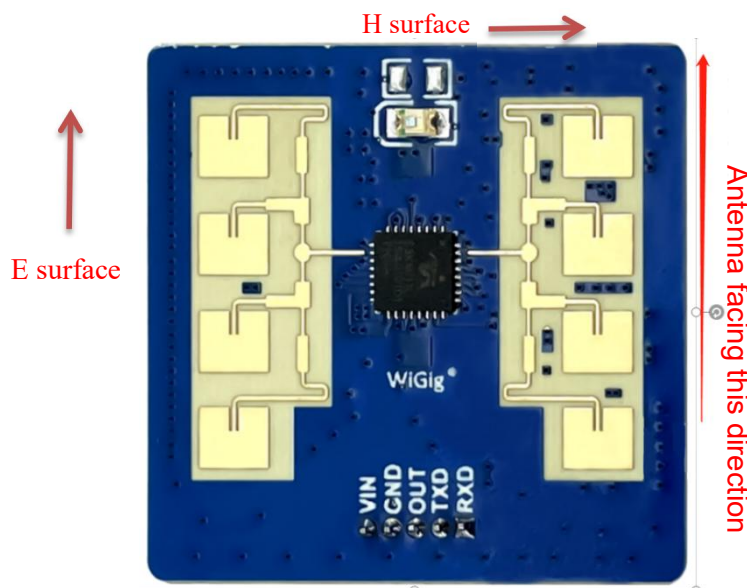


Figure 6 Installation position

After the module is installed, take the module as the center of the circle, the detection angle of the H surface is within the range of  $\pm 45^\circ$ , and the detection angle of the E surface is within the range of  $\pm 20^\circ$ . The antenna needs to be facing upward during installation.



## 5.4 Installation conditions

### ● Confirm the minimum installation clearance

If the radar needs to be installed with a casing, the casing must have good wave-transmitting properties at 24GHz, and cannot contain metal materials or materials that have a shielding effect on electromagnetic waves.

### ● Installation environment requirements

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

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

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

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

### ● Precautions during installation

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

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

- To ensure there is no movement or vibration on the back of the radar. Due to the penetrating nature of radar waves, the back lobe of the antenna signal may detect moving objects behind the radar. A metal shield or metal backplane can be used to shield the radar back lobe and reduce the impact of objects on the back of the radar

- The theoretical distance accuracy of radar is the result obtained through special algorithm processing on the basis of the physical resolution of 0.75 meters. Due to the difference in the size, state, and RCS of the target, the target distance accuracy will fluctuate; at the same time, the longest distance will also fluctuate slightly.

## 6 Electrical parameters

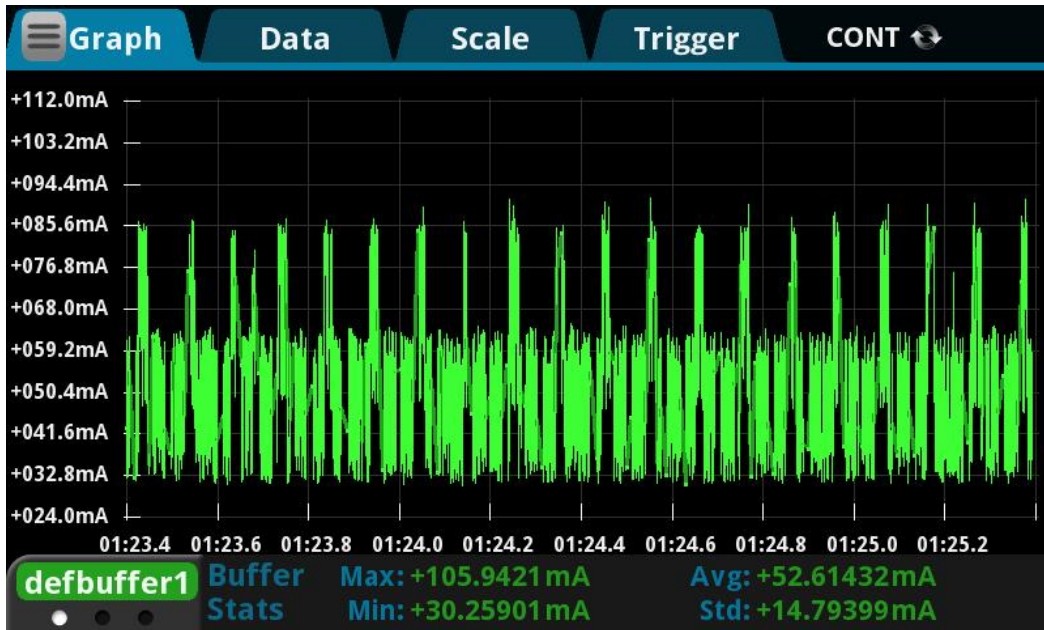


Diagram 7 Electrical parameters

Under 5V power supply, the default state current is 52mA

## 7 Bluetooth instructions

### 7.1 Install software

Currently the APP supports Android and IOS platforms, you can also go to major app stores to search for "HLKRadarTools" and install it.



### 7.2 Instructions

Open the app, and the app searches for nearby radar devices. The broadcast name of the device is "HLK-LD2411-S\_xxxx" (xxxx is the last four digits of the mac address). After the module is successfully connected, you can view the radar information, or debug and save the parameters.

The use distance of the APP should not exceed the Bluetooth signal range (within 4 meters).

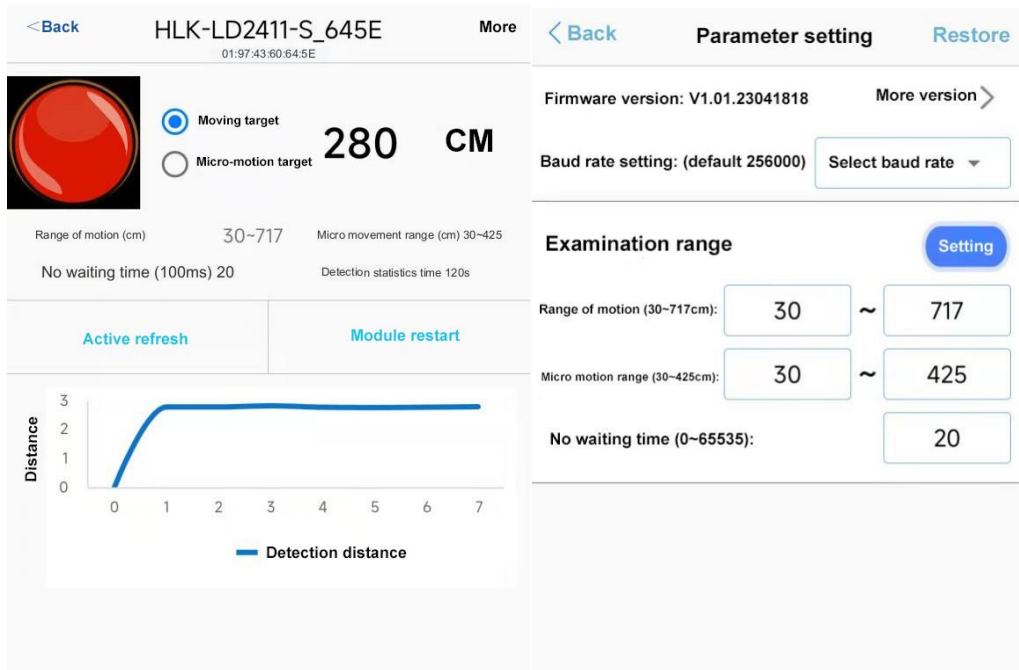


Diagram 8 APP interface

After entering, you can see the current distance parameters, and click More to configure the parameters.

In the parameter configuration, click more versions to enter the ota interface

### 7.3 OTA upgrade

When the firmware of the device has been updated, the word "upgradeable" will appear on the firmware version. Press and hold the version number to enter the upgrade interface, and the upgrade takes about 1 to 3 minutes. During the upgrade process, please keep the power supply of the module working stably and the Bluetooth signal normal, otherwise the upgrade will fail.

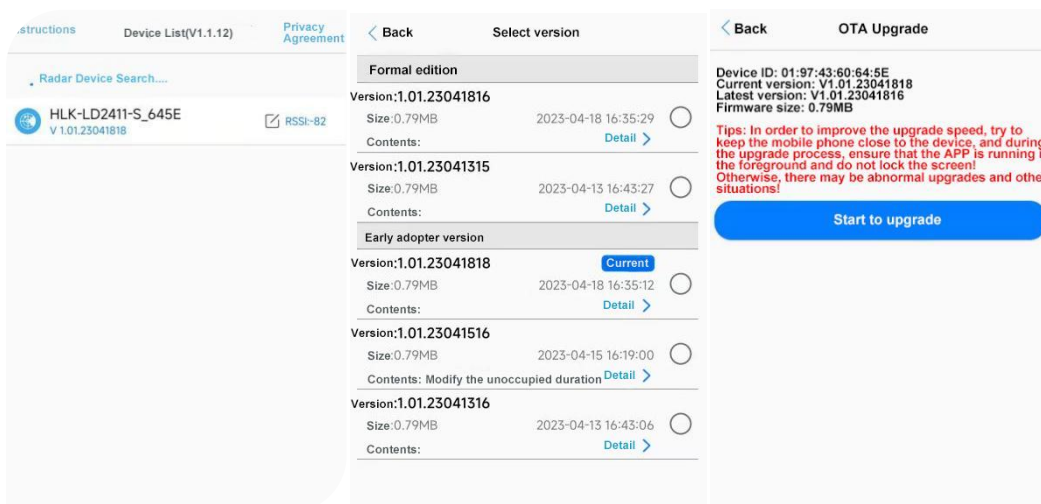


Figure 9 OTA upgrade

## 7.4 Bluetooth communication protocol

LD2411-S acts as a slave side, only allowed to be connected by one master.

| Feature UUID                         | Operation authority    | Function definition         |
|--------------------------------------|------------------------|-----------------------------|
| 0000fff1-0000-1000-8000-00805f9b34fb | Read/Notify            | Module send,<br>APP receive |
| 0000fff2-0000-1000-8000-00805f9b34fb | Write Without Response | APP send,<br>module receive |

When the app and LD2411-S Bluetooth connection and password verification are successful, the module will start the transparent transmission of radar data. The data transmitted by Bluetooth is completely consistent with the serial port protocol, please refer to the "LD2411-S Serial Port Communication Protocol V1.01.pdf" document.

## 8 Revision records

| Date      | Version | Modify the content           |
|-----------|---------|------------------------------|
| 2023-4-20 | 1.00    | Initial version              |
| 2023-5-11 | 1.01    | Modify some table parameters |

## 9 Technical support and contact



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