Rd-03E Precision Ranging User Manual

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Document Resume

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V1.0.0	2023.9.14	First Edition	Zhanyun Lin	Zifeng Chen

Introduction

This document describes the basic functions, hardware specifications, software configuration, and installation conditions of the Rd-03E precision ranging intelligent millimeter-wave sensor reference design XenP102RM01. It aims to help developers quickly get started with XenP102RM01 motion/micro-motion human body ranging solutions, easily configure the parameters most suitable for their own application scenarios, and create personalized motion/micro-motion human body induction ranging sensors.

Content

1 Rd-03E Overview

Rd-03E precision ranging is designed with reference to silicon micro EZ Sensor series of motion/micro-motion human body induction ranging sensors, including extremely simplified 24 GHz radar sensor hardware Xen102 and intelligent algorithm firmware RM01. This reference design is suitable for single-target scenarios, and when multiple targets are present, the target with the highest echo energy is selected.

Xen102 hardware consists of AloT millimeter-wave radar chip S3KM111L, high-performance one-transmitter-one-receiver microstrip antenna, low-cost MCU and peripheral auxiliary circuits. The radar beam of Xen102 hardware adopts flat beam design: the E-plane direction of the radar module (as shown in Figure 6-2; Also known as the antenna 4 patch direction, the detection range as shown in Figure 3-1 is ± 20 °, and the detection range on the H-plane is ± 45. The user can adjust the placement direction of the module according to the actual application scenario.

The intelligent algorithm firmware RM01 uses FMCW waveforms and advanced signal processing technology proprietary to S3 series chips to achieve accurate human body ranging and motion/micro-motion human body sensing.

The main features of Rd-03E precision ranging are as follows:

No.	Characteristics	No.	Characteristics
1	24GHzISM band	7	Automatically load default configuration, plug and play
2	Integrate smart millimeter-wave radar single-chip S3KM111L and smart algorithm firmware	8	Provide visualization tools, support the configuration of detection range, set the sensitivity according to the distance gate
3	Accurate indoor/outdoor human motion/micro-motion sensing and distance detection	9	The maximum distance of motion human body induction is 6m, and the maximum distance of micro motion human body induction is 3.5m
4	Ultra-small module size: 28mm x 24mm	10	High precision ranging: 30 cm~350 cm± 5cm; 350 cm~600 cm± 5%
5	5V single power supply	11	Azimuth ± 20 °, Pitch ± 45 °
6	Continuous operating average current 48mA @ 20Hz reported frequency	12	Automatically load default configuration, plug and play

Rd-03E precision ranging can detect and identify moving and micro-moving human bodies, and report real-time distance. It is widely used in various AIoT scenarios, covering the following types:

Scene	Description	Scene	Description
Smart Home	The motion/micro-motion and distance of the human body are sensed, and the distance detection result is reported for the main control module to intelligently control the operation of household appliances.	Wisdom Security	Induction access control, building intercom, electronic cat's eye, etc.
Intelligent Business	Induction doors, induction escalators, etc.	Wisdom lighting	Recognize and perceive the movement/micro-movement of the human body, accurately detect the position of the human body, and can be used for lighting equipment in public places (induction lights, bulb lights, etc.).

2. System description

Rd-03E precision ranging is based on silicon micro-S3KM111L chip research and development of intelligent motion/micro-motion human body ranging sensor reference scheme, with strong real-time, high ranging accuracy, large ranging range, flexible configuration of algorithm parameters and so on. The sensor uses FMCW waveforms, combined with the MCU's proprietary radar signal processing and built-in intelligent distance detection algorithms, to detect targets in a specified area and report results in real time. Based on this reference scheme, users can quickly develop corresponding motion/jog human body induction products. Table 2-1 Rd-03E specifications for precise ranging.

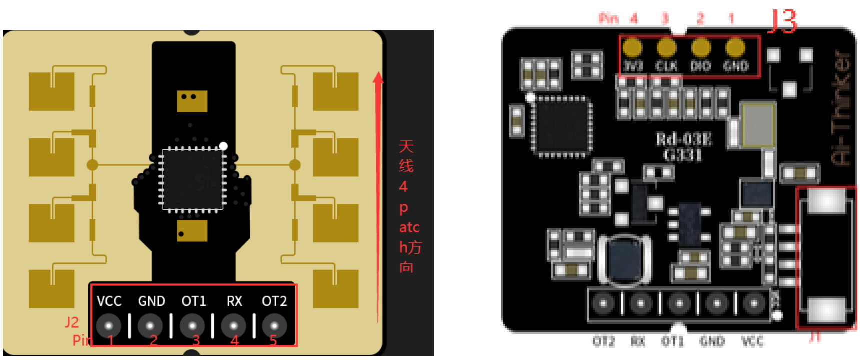
Table 2-1 Rd-03E Specifications

Parameters	Remarks	Minimum	Typical	Max.	Unit
Rd-03E Hardware Specifications					
Supported bands		24	-	24.25	GHz
Support maximum sweep bandwidth		-	0.25	-	GHz
Maximum equivalent	Adjusting the transmit power	-	12	-	dBm

omnidirectional radiated power	changes the parameter				
Supply voltage		4.5	5.0	5.5	V
Dimensions		-	28x24	-	mm 2
Ambient temperature		-40	-	85	℃
Rd-03E system performance					
Distance detection range	Micro-motion human target	0.3	-	3.5	m
	moving human target	0.3	-	6	m
ranging accuracy	Close distance: 30~350cm	-	± 5	-	cm
	Distance: 350~600cm	-	± 5%	-	
Compliance		Comply with FCC, CE			
Average operating current	50ms reporting cycle	45			mA

3 Hardware Description

Figure 3-1 is Rd-03E hardware positive and negative diagram. Rd-03E the hardware reserves 5 pin holes J2 (not equipped with pins at the factory), which are the power supply and communication interface. The MCU burning port is called J3. Please connect according to the corresponding pin name when burning.



(a)front (b)back

Figure 3-1 Rd-03E hardware physical diagram

The pin descriptions of J2 and J3 are shown in Table 3-1 and Table 3-2.

Table 3-1 J2 Pin Description

J#PIN#	Name	Function	Operating Range
J2Pin1	VCC	Power input	4.5V~5.5V,Type5V
J2Pin2	GND	Ground	-
J2Pin3	OT1	UART_TX	0~3.3V
J2Pin4	RX	UART_RX	0~3.3V
J2Pin5	OT2	UART_TX(reserved)	0~3.3V

Table 3-2 J3 Pin Description

J#PIN#	Name	Function	Operating Range
J3Pin1	GND	Ground	-
J3Pin2	DIO	Data port	0~3.3V
J3Pin3	CLK	Clock signal	0~3.3V
J3Pin4	3V3	Power input	3.3V

Rd-03E support keil 5 IDE to burn hex files or source code projects, you can use J-Link (v9 version or above), CMSIS-DAP and other programming device download program. Please make sure it is installed before burning. ARM.CMSIS. 5.7.0.pack and GigaDevice.GD32E23x_DFP.1.0.1.pac(or a later version of the CMSIS pack).

4 Software Description

4.1 hardware connection method

Usually use serial port tools for hardware module debugging, the adapter board needs to be set to 5V power supply. Attention should be paid to the connection between the hardware and the serial port tool: the TX of the hardware is connected to the RX of the serial port tool, and the RX of the hardware is connected to the TX of the serial port tool, as shown in fig. 4-1. If you use other serial port tools, also need to meet the 5V power supply.

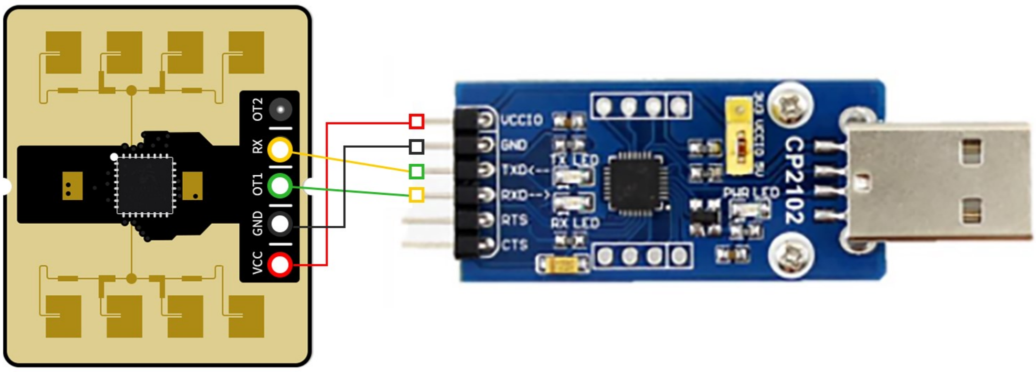


Figure 4-1 Schematic diagram of Rd-03E module and serial port connection

4.2 host computer configuration

4.2.1 Introduction of serial port tool drive007

Rd-03E hardware uses UART interface to transmit data. When connecting and communicating with the upper computer, USB to TTL needs to be used for transfer. CP2102 and CH340 are commonly used. The serial port tool in Figure 4-1 is CP2102. Before using the serial port tool, install the corresponding driver on the host computer. CP2102 driver: https://cn.silabs.com/interface/usb-bridges/classic/device.cp2102?tab=softwareandtools, CH340 drive: https://www.wch.cn/downloads/CH341SER_EXE.html.

4.2.2 Connect the upper computer software

In order to ensure the successful connection of the radar module, you can check whether the serial port is normal in the computer, right-click the Windows sign in the lower left corner, select "Equipment Management", and click "Port" to check whether the serial port is normal.

4.2.3 Using the upper computer

After connecting the hardware, serial port tool and upper computer as shown in Figure 4-1, open the upper computer software ICLM_XenP102_RM01Tool.exe and configure the module according to the following steps:

Step 1: Open the upper computer software. The software interface is shown in Figure 4-4. Click the "Refresh" button in the upper left corner of the interface (area 1 marked in Figure 4-4), select the corresponding serial port number of the radar module and enter baud rate: 256000, then click "Connect Device"; as shown in Figure 4-5, the text on the button will change to "Disconnect Device" after successful connection ", 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 4-6. 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 upper computer main interface. Please refer to Chapter 5 Communication Protocol for the meaning and configuration method of the parameters in the interface;

Step 3: Click the "Start" button of the main interface to receive real-time data from the radar end (at this time, the text on the "Start" button is switched to "Stop", as shown in Figure 4-5), and the upper computer interface displays the distance and status of the detected target (marked area 2 in Figure 4-5), the distance curve 3 between the target human body and the radar module in the latest 15s is displayed below (area 3 marked in Figure 4-5);

Step 4: Click the "Stop" button to stop the data transmission between the radar module and the upper computer, and the user can view the data of this test in the

XenD102RM01_1.0.0.1_0208\Log \folder in the directory where the upper computer software is located.

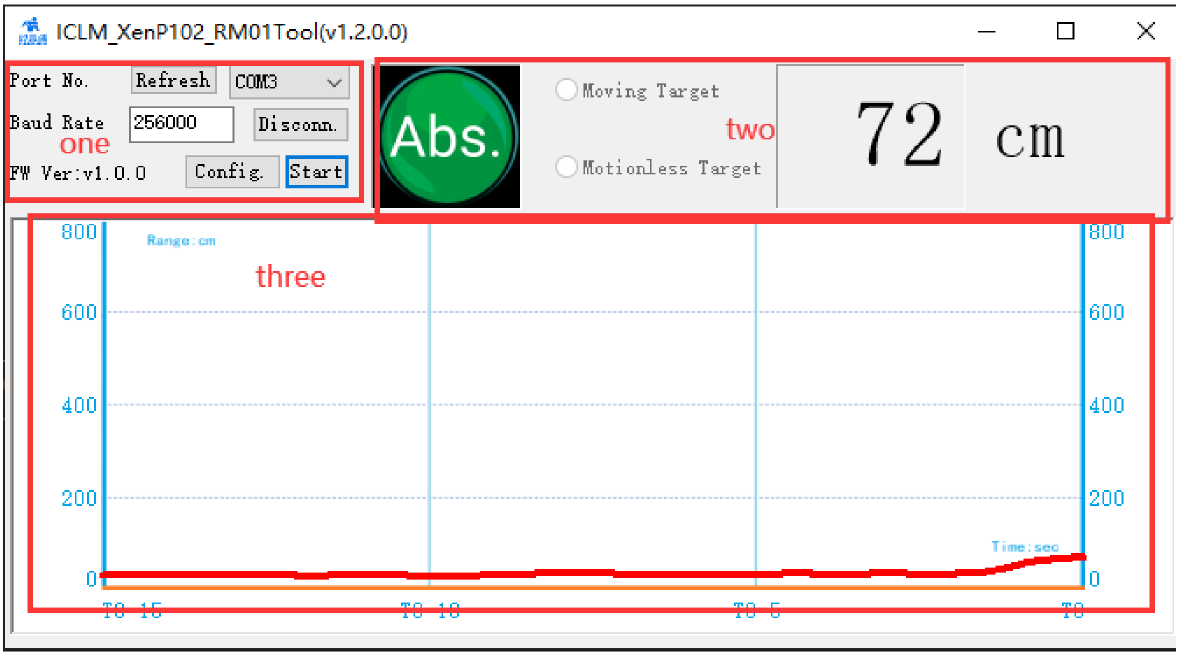


Figure 4-4 Upper computer tools ICLM_XenP102_RM01Tool configuration interface

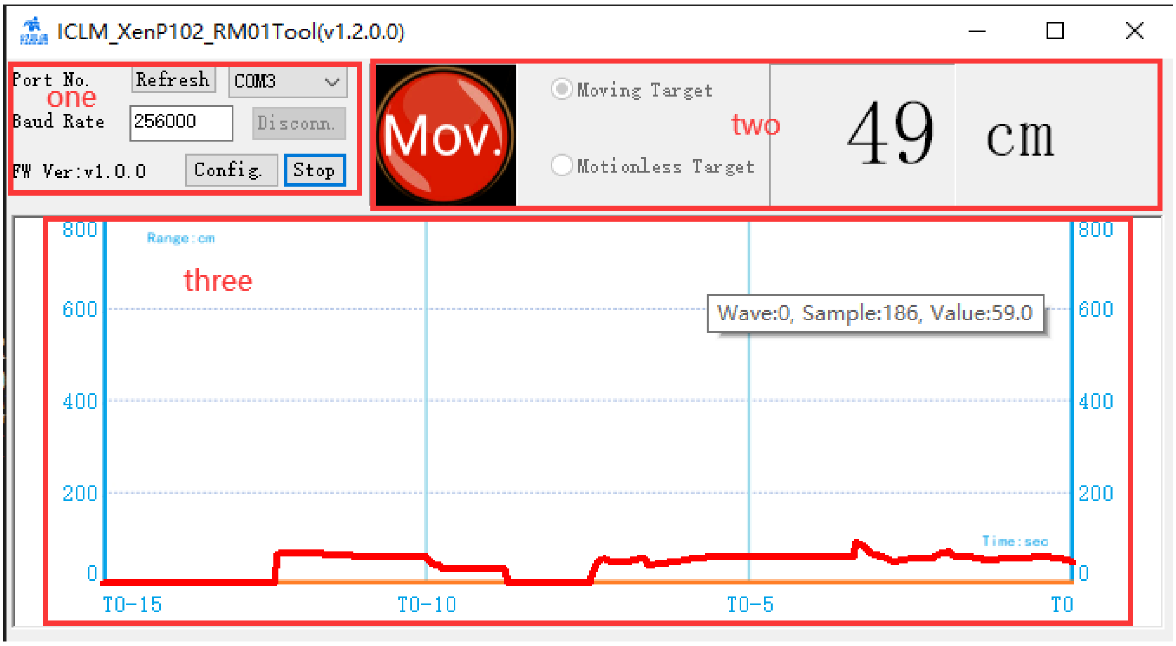


Figure 4-5 Interface of the connection between the upper computer and the radar module

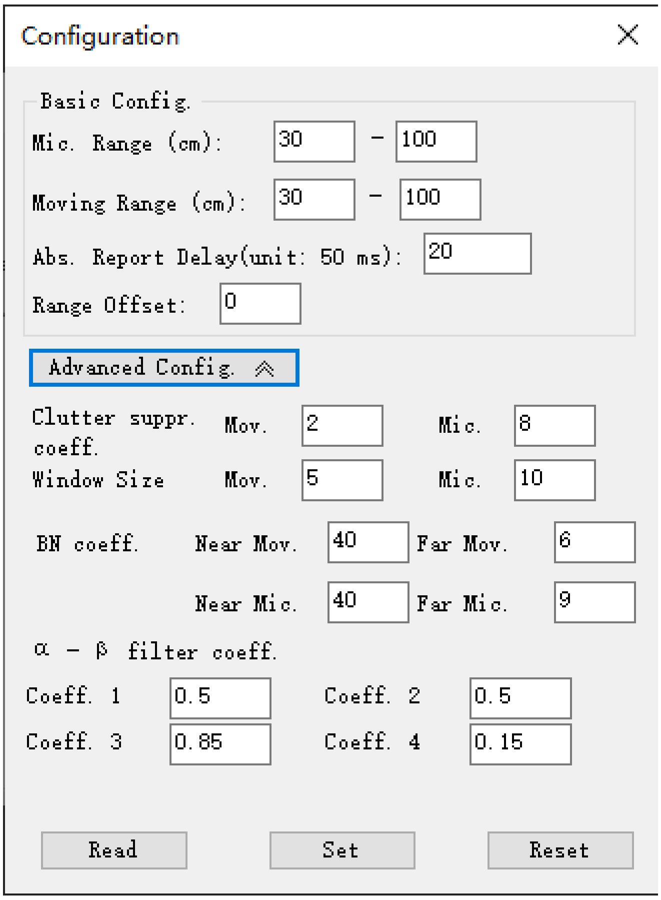


Figure 4-6 Parameter configuration interface

As shown in Figure 4-4 and Figure 4-5, the circular indicator light on the far left of area 2 displays the target status detected by the radar module through color changes. The indicator light is green to indicate that there is no target in the detection area, red to indicate that there is a moving human target, and pink to indicate that there is a micro-moving human target, as shown in Figure 4-6.

Table 4-1 Target Status and Lighting Status Correspondence

Target status	Light Display
None	
Movement	
Micro-movement	

5 Communication protocol

This communication protocol is mainly used by developers who need to separate from visualization tools for secondary development. The Xen102 hardware communicates with the outside world through a serial port. The serial port outputs the radar data processed by the algorithm by frame. The default baud rate of the radar serial port is 256000,1 stop bit and no parity bit.

5.1 Protocol Format

5.1.1 Protocol data format

Rd-03E data communication uses little-end format, all data in the following table is in hexadecimal.

5.1.2 Frame format of module transmission data protocol

Table 5-1 shows the data format of a frame of commands in the protocol, where the distance information is small-end hexadecimal, two bytes, in cm. Table 5-2 shows the values of the target states and the corresponding target states. When the target velocity is non-zero Doppler, it is determined as a moving target, and when it is zero Doppler, it will additionally determine whether it is a micro-motion target or a low-speed moving target, and if it is a low-speed moving target, it is considered a moving target.

Table 5-1 Data Protocol Frame Format

Frame Header	Target Status	Distance information	End of Frame
AA AA	1byte	2byte	55 55

Table 5-2 Target Status Description

Target state value	Description
0x00	No target
0x01	movement target
0x02	Micro-motion target

5.2 Send Command 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: 2-byte ACK status (1 successful, 0 failed) +2-byte major version number +2-byte minor version number +2-byte patch version number.

Send data:

Frame Header	Intra-frame data length	Command Word	End of Frame
FD FC FB FA	02 00	00 00	04 03 02 01

Radar ACK (Success):

Frame Header	Intra-frame data length	ACK	Protocol Version	End of Frame	Frame Header	Intra-frame data length
FD FC FB FA	08 00	00 01	0x4 00	0x 00	0x 00	04 03 02 01

5.2.2 The enable configuration command

Any other commands issued to the radar can only be executed after this command is issued, otherwise it is invalid.

Command Word: 0xO0FF

Command value: 0x0001

Return value: 2 bytes ACK status (1 success, 0 failure) +2 bytes protocol version (Ox0001)

Send data:

Frame Header	Intra-frame data length	Command Word	End of Frame	Frame Header
FD FC FB FA	04 00	FF 00	01 00	04 03 02 01

Radar ACK (Success):

Frame Header	Intra-frame data length	ACK	Protocol Version	End of Frame
FD FC FB FA	04 00	FF 01	01 00	04 03 02 01

5.2.3 End Configuration Command

Perform the rear radar recovery mode. If you need to issue other commands again, you need to send the enable configuration command first.

Command Word: OxO0FE

Command Value: None

Return value: 2 bytes ACK status (1 success, 0 failure)

Send data:

Frame Header	Intra-frame data length	Command Word	End of Frame

FD FC FB FA	02 00	FE 00	04 03 02 01

Radar ACK (Success):

Frame Header	Intra-frame data length	ACK	Protocol Version	End of Frame
FD FC FB FA	04 00	FE 01	01 00	04 03 02 01

5.2.4 Distance calibration parameter configuration command

This command configures the distance calibration parameters in the algorithm.

Command word: 0x0072

Command value: 2 bytes distance calibration parameter number +4 bytes distance calibration parameter (int32 type)

Return value: 2 bytes ACK status (1 success, 0 failure)

Table 5-3 0x 0072 protocol number

Parameter Name	Reference Number
Distance calibration parameters	0x0000

Send data: (distance calibration parameter: 0)

Frame Header	Intra-frame data length	Command Word	Distance calibration parameter number	Distance calibration parameter value	End of Frame
FD FC FB FA	08 00	72 00	00 00	00 00 00 00	04 03 02 01

Radar ACK (Success):

Frame Header	Intra-frame data length	ACK	Protocol Version	End of Frame
FD FC FB FA	04 00	72 01	01 00	00 00

5.2.5 Maximum and minimum distance and unmanned duration parameter configuration commands

This command sets the radar maximum and minimum detection range (motion/inching), motion configuration range (30~717), inching configuration range (30~425), and unmanned duration parameters (configuration range 0~65535, unit: 50 ms).

Command Word: Ox0067

Command value: 2 bytes maximum moving distance word +4 bytes maximum moving distance parameter (uint32_t) +2 bytes minimum moving distance word +4 bytes minimum moving distance parameter (uint32_t) +2 bytes maximum jog distance word +4 bytes maximum jog distance parameter (uint32_t) +2 bytes maximum jog distance word +4 bytes maximum jog distance parameter (uint32_t) +2 bytes unattended duration word +4 bytes unattended duration parameters (uint32_t)

Return value: 2 bytes ACK status (1 success, 0 failure)

Table 5-4 0x 0067 protocol number

Parameter Name	Reference Number
Maximum movement distance	0x0000
Minimum movement distance	0x0001
Maximum fretting distance	0x0002
Minimum fretting distance	0x0003
No one duration	0x0004

Send data: (maximum movement distance 717, minimum movement distance 30, maximum fretting distance 425, minimum fretting distance 30, unmanned duration 1s(20*50 ms))

Frame Header	Intra-frame data length	Command Word	Maximum movement distance parameter value	Maximum movement distance value	Minimum motion distance parameter	Minimum movement distance value
FD FC FB FA	20 00	67 00	00 00	CD 02 00 00	01 00	1E 00 00 00
Maximum fretting distance	**Maximum jog distance value**	**Minimum motion distance parameter**	**Minimum movement distance value**	**No Man Duration Number**	**No Man Duration (* 50ms)**	**End of Frame**
02 00	A9 01 00 00	03 00	1E 00 00 00	04 00	14 00 00 00	04 03 02 01

ACK Data (Success):

Frame Header	Intra-frame data length	ACK	Protocol Version	End of Frame
FD FC FB FA	04 00	67 01	01 00	04 03 02 01

Note: All the following commands are advanced parameter configurations, involving key functions of the algorithm. Improper settings may cause abnormal operation of the algorithm, which is only for users with radar expertise to modify carefully.

5.2.6 Noise floor parameter configuration command

This command configures the Noise parameter in the algorithm. The Noise parameter is a parameter used in the algorithm to participate in the calculation of the noise floor, and is of the float type in the protocol. It is automatically converted by the upper computer, and the configurable range is-3.40E +38 ~ + 3.40E +38. When the coefficient is increased, the bottom noise becomes larger, and when the coefficient is decreased, the bottom noise becomes smaller.

Command word: Ox0068

Command value: 2 bytes of proximal motion Noise parameter +4 bytes of proximal motion Noise parameter (float)+2 bytes of distal motion Noise parameter +4 bytes of distal motion Noise parameter (float)+2 bytes of proximal jog Noise parameter +4 bytes of proximal jog Noise parameter (float)+4 bytes of distal jog Noise parameter +4 bytes of distal jog Noise parameter (float)

Return value: 2 bytes ACK status (1 success, 0 failure)

Table 5-5 0x 0068 protocol parameter number

Parameter Name	Reference Number
Noise coefficient of proximal motion	0x0000
Distal Motion Noise Coefficient	0x0001
Noise Coefficient of Proximal Fretting	0x0002
Distal micro-motion Noise coefficient	0x0003

Sending data: (Noise coefficient of proximal motion 40, Noise coefficient of distal motion 6, Noise coefficient of proximal micro-motion 40, Noise coefficient of distal micro-motion 9)

Frame Header	Intra-frame data length	Command Word	Proximal Motion Noise Parameter	Noise coefficient value of proximal motion	Distal Motion Noise Numeric
FD FC FB FA	0E 00	68 00	00 00	00 00 20 42	01 00
Distal Motion Noise coefficient value	Proximal Micro Noise Parameter	Proximal Micro Noise Coefficient Value	Distal Micro Noise Parameter	Distal Micro Noise Coefficient Value	End of Frame
00 00 C0 40	02 00	00 00 20 42	03 00	00 00 10 41	04 03 02 01

Radar ACK (Success)：

Frame Header	Intra-frame data	ACK	Protocol Version	End of Frame

	length			
FD FC FB FA	04 00	68 01	01 00	04 03 02 01

5.2.7 Clutter Suppression Coefficient Configuration Command

This command configures the clutter suppression parameters in the algorithm. Clutter suppression parameters are parameters used for clutter suppression in the algorithm and are of uint32_t type in the protocol. Automatic conversion by the upper computer, configurable range of 0~255. When the coefficient is increased, the ability to filter the static background becomes weaker, and when the coefficient is decreased, the ability to filter the static background becomes stronger.

Command word: 0x0069

Command value: 2-byte motion branch clutter suppression parameter number +4-byte motion branch clutter suppression parameter (uint32_t)+2-byte micro-motion branch clutter suppression parameter number +4-byte micro-motion branch clutter suppression parameter (uint32_t)

Return value: 2 bytes ACK status (1 success, 0 failure)

Table 5-6 0x 0069 protocol number

Parameter Name	Reference Number
moving branch clutter suppression coefficient	0x0000
Micro-motion branch clutter suppression coefficient	0x0001

Sending data: (motion branch clutter suppression coefficient 2, fretting branch clutter suppression coefficient 8)

Frame Header	Intra-frame data length	Command Word	moving branch clutter suppression reference number	moving branch clutter suppression coefficient	micromotion branch clutter suppression reference number	Micro-motion branch clutter suppression coefficient	End of Frame
FD FC FB FA	0E 00	69 00	00 00	02 00 00 00	01 00	08 00 00 00	04 03 02 01

Radar ACK (Success):

Frame Header	Intra-frame data length	ACK	Protocol Version	End of Frame
FD FC FB FA	04 00	69 01	01 00	04 03 02 01

5.2.8 FRAME Sliding Window Length Parameter Configuration Command

This command configures the FRAME sliding window length parameter in the algorithm. The FRAME sliding window length is a parameter used to set the window length of the sliding average in the algorithm, and is a uint32_t type in the protocol. Automatic conversion by the upper computer, configurable range of 0~255. In the firmware, the default maximum motion sliding window is 5 and the maximum micro-motion sliding window is 10. The maximum range can be set by modifying the macro definition of bodysensing_type.h, and the maximum range cannot exceed 255.

Command Word: Ox0070

Command value: 2-byte motion branch FRAME sliding window length parameter +4-byte motion branch FRAME sliding window length parameter (uint32_t)+2-byte micro branch FRAME sliding window length parameter +4-byte micro branch FRAME sliding window length parameter (uint32_t)

Return value: 2 bytes ACK status (1 success, 0 failure)

Table 5-7 0x 0070 protocol parameter numbers

Parameter Name	Reference Number
Motion Branch FRAME Window Length	0x0000
fretting branch FRAME window length	0x0001

Sending data: (FRAME sliding window length of motion branch 5, FRAME sliding window length of micro-motion branch 10):

Frame Header	Intra-frame data length	Command Word	Motion branch FRAME sliding window length parameter	Motion branch FRAME sliding window length value	FRAME sliding window length parameter	FRAME sliding window length value of fretting branch	End of Frame
FD FC FB FA	0E 00	70 00	00 00	05 00 00 00	01 00	0A 00 00 00	04 03 02 01

Radar ACK (Success)：

Frame Header	Intra-frame data length	ACK	Protocol Version	End of Frame
FD FC FB FA	04 00	70 01	01 00	04 03 02 01

5.2.9 a- β filter coefficient configuration command

This command configures the alpha-B filtering parameters in the algorithm. The alpha-B filter parameter is the parameter used for alpha B filtering in the algorithm and is of float type in the protocol. It is automatically converted by the upper computer, and the configurable range is-3.40E +38 ~ + 3.40E +38. The coefficient is two pairs, used in combination, for a-B. The filter coefficient 1 and the filter coefficient 2 are a pair, and the filter coefficient 3 and the filter coefficient 4 are a pair. The larger the and β parameters, the faster the filtering will be, but the noise will also increase; the smaller the and β parameters, the smoother the filtered value, but the dynamic response becomes worse and the delay becomes longer.

Command Word: Ox0071

Command value: 2 bytes of α -B filter 1 parameter +4 bytes of α -B filter 1 parameter (float type) +2 bytes of α - β filter 2 parameter +4 bytes of α -B filter 2 parameter (float type) +2 bytes of α - β filter 3 parameter +4 bytes of α -B filter 3 parameter (float type) +2 bytes of α -B filter 4 parameter +4 bytes of a-B filter 4 parameter (float type)

Return value: 2 bytes ACK status (1 success, 0 failure)

Table 5-8 0x 0071 Protocol Parameter Numbers

Parameter Name	Reference Number
a- β filter coefficient 1	0x0000
a- β filter coefficient 2	0x0001
a- β filter coefficient 3	0x0002
a- β filter coefficient 4	0x0003

Send data:(a β filter coefficient 1: 0.5, α - β filter coefficient 2: 0.5, α -B filter coefficient 3:0.85, α -B filter coefficient 4: 0.15)

Frame Header	Intra-frame data length	Command Word	a -Beta filter 1 parameter	a -Beta filter coefficient 1 value	a -Beta filter 2 parameter number
FD FC FB FA	1A 00	71 00	00 00	00 00 00 3F	01 00
a -Beta filter coefficient 2 value	**a -Beta filter 3-parameter number**	**a -Beta filter coefficient 3 value**	**a -Beta filter 4-parameter number**	**a -Beta filter coefficient 4 value**	**End of Frame**
00 00 00 3F	02 00	99 99 59 3F	03 00	99 99 59 3E	04 03 02 01

Radar ACK (Success)：

Frame Header	Intra-frame data length	ACK	Protocol Version	End of Frame

FD FC FB FA	04 00	71 01	01 00	04 03 02 01

5.2.10 Algorithm parameter configuration read command

This command can read algorithm parameters. Command word: ox0073

Command Value: None

Return value: 2 bytes ACK status (1 success, 0 Failure) +2 Byte Configuration Maximum Motion Distance +2 Byte Configuration Minimum Motion Distance +2 Byte Configuration Maximum Micro Motion Distance +2 Byte Configuration Minimum Micro Motion Distance +2 Byte Unmanned Duration +4 Byte Proximal Motion Noise Coefficient 1(float) +4 Byte Distal Motion Noise Coefficient 2(float) +4 Byte Proximal Micro Noise Coefficient 3(float) +4 Byte Distal Micro Noise Coefficient 4 float) +1 byte motion clutter suppression coefficient +1 byte micro clutter suppression coefficient +1 byte motion sliding window length +1 byte micro sliding window length +4 bytes a β filter coefficient 1(float) +4 bytes α - β filter coefficient 2(float) +4 bytes α - β filter coefficient 3(float) +4 bytes α - β filter coefficient 4 (float) +4 bytes distance calibration parameter (int32)

Send data:

Frame Header	Intra-frame data length	Command Word	End of Frame
FD FC FB FA	02 00	73 00	04 03 02 01

Radar ACK (Success):

<table>
<tr><th>Frame Header</th><th colspan="2">Intra-frame data length</th><th colspan="2">ACK</th><th>Maximum movement distance value</th><th>Minimum movement distance value</th><th>Maximum jog distance value</th><th>Minimum jog distance value</th></tr>
<tr><td>FD FC FB FA</td><td colspan="2">30 00</td><td colspan="2">73 01</td><td>CD 02</td><td>1E 00</td><td>A 9 01</td><td>1E 00</td></tr>
<tr><th>No Man Duration Value</th><th colspan="4">Noise Coefficient of Proximal Motion 1 Value</th><th colspan="2">Distal Motion Noise Coefficient 2 Value</th><th colspan="2">Proximal Micro-motion Noise Coefficient 3 Value</th></tr>
<tr><td>14 00</td><td colspan="4">00 00 20 42</td><td colspan="2">00 00 C0 40</td><td colspan="2">00 00 20 42</td></tr>
<tr><th>Distal Micro</th><th>coefficient of</th><th>fretting clutter</th><th>Length value of</th><th>Length</th><th colspan="2">a -Beta filter coefficient 1 value</th><th colspan="2">a -Beta filter coefficient 2 value</th></tr>
</table>

Motion Noise Coefficient 4 Value	motion clutter suppression	suppression coefficient	motion sliding window	value of micro sliding window		
00 00 10 41	2	8	5	10	00 00 00 3F	00 00 003F
a -Beta filter coefficient 3 value	a -Beta filter coefficient 4 value				Distance calibration parameter value	End of Frame
99 99 59 3F	99 99 59 3E				00 00 00 00	04 03 02 01

6 Installation and detection range

When installing the module, it is recommended that the installation position be 1.3 m higher than the ground, and the wall-mounted installation method is adopted. The antenna surface of the radar module is perpendicular to the ground, as shown in Figure 6-1. When installing, pay attention to the antenna direction. When the azimuth angle is narrow, ensure that the patch direction of the antenna is horizontal.

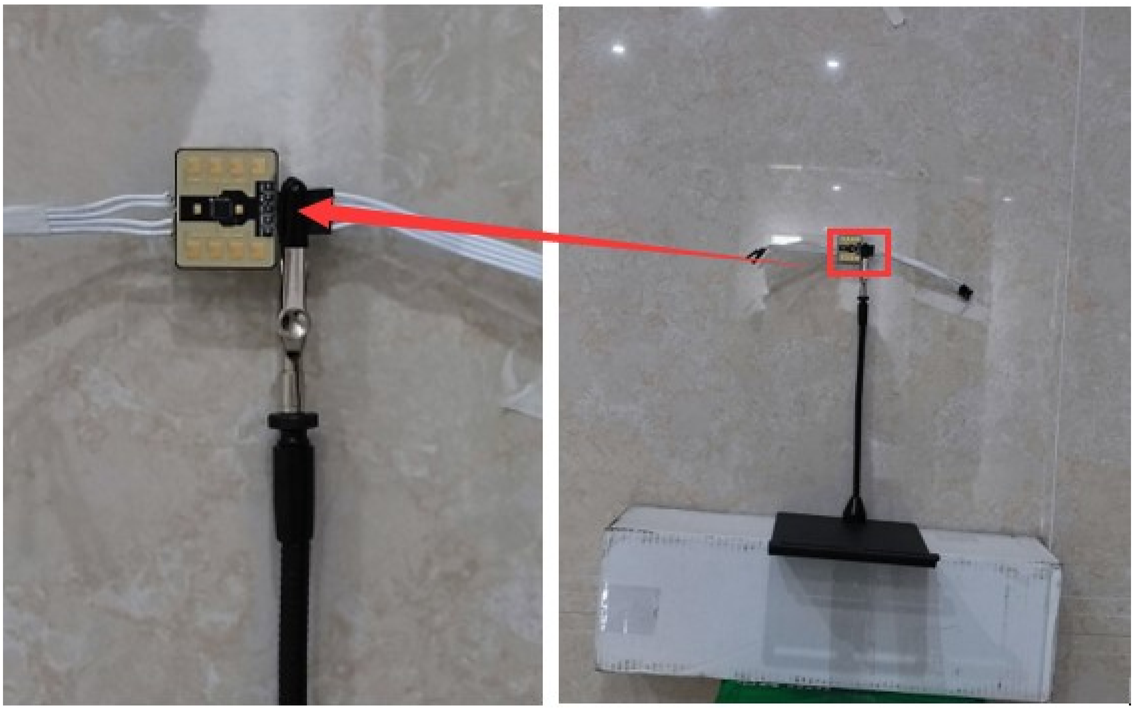


Figure 6-1 Installation Diagram

After the module is installed, take the module position as the center of the circle, the detection angle of H plane is within ± 45 °, and the detection angle of E plane is within ± 20 ° (the directions of H plane and E plane of radar are shown in Figure 6-2).

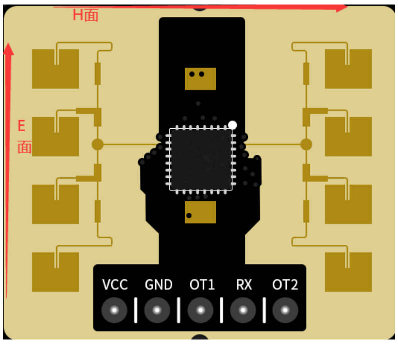


Figure 6-2 Identification of Radar Installation Orientation

The power map of the radar is shown in Figure 6-3, in which: the angle range of moving human body recognition is ± 20 °, and the distance range is 0.3 m ~ 6 m; the micro-motion human body detection angle range is +20 °, and the distance range is 0.3 m ~ 3.5m.

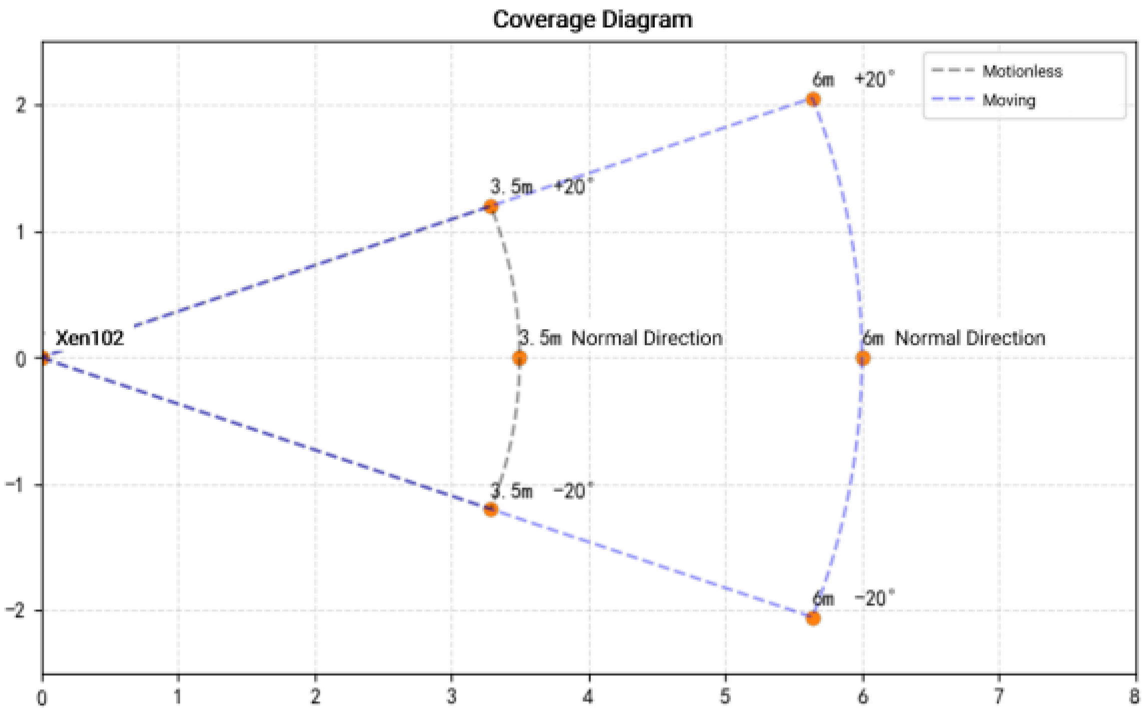


Figure 6-3 Radar Power

When installing, ensure that the installation position of the sensor is firm and stable, because the shaking of the radar itself will affect the detection effect. Make sure that there is no movement or vibration on the back of the radar. Due to the penetrating nature of radar waves, the back flap of the antenna may detect moving objects on the back of the radar, thus interfering with the detection. A metal shield or a metal back plate can be used to shield the back flap of the radar to reduce the impact of objects on the back of the radar.

When there are multiple 24 GHz band radars in the installation space, please do not face the beams and try to stay away from each other to avoid possible interference.

7 Rendered graph

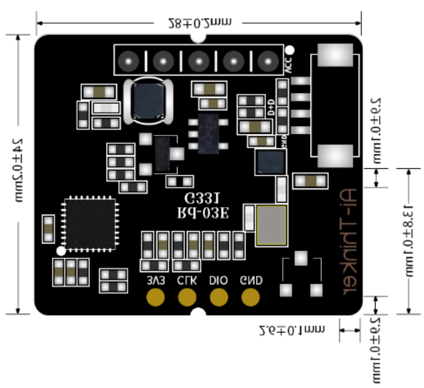


Figure 7-1 Rd-03E Rendering (mm)

8 Installation instructions

Radar Enclosure Requirements:

If the radar requires an enclosure, the enclosure must have good permeability in the 24 GHz band and must not contain metal or materials that shield against electromagnetic waves. Refer to the Millimeter Wave Sensor Radome Design Guide for more information.

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 with continuous movement in the sensing area, such as animals, continuous swinging curtains and large green plants facing the tuyere;

• there is a large area of strong reflection plane in the sensing area, and the strong reflector will cause interference to the radar antenna;

• when installing the wall, it is necessary to consider the external interference factors such as the air conditioner and electric fan at the top of the room.

Note when installing:

• try to ensure that the radar antenna is facing the area to be detected, and 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.

9. Precautions

1, Maximum detection distance:

The maximum range of the radar target detection is a moving straight-line distance of 6m and a micro-moving straight-line distance of 3.5m. Within the detection range, the radar will report the straight-line distance of the target from the radar.

2, Firmware baud rate change:

The default serial port baud rate of the radar is 256000.Developers can modify the baud rate by modifying the USART1_BAUDRATE macro definition in the project directory \WMiddleware\platform\gd32\inc\gd32_uart.h.

3, Maximum distance and accuracy:

Theoretically, the radar measurement accuracy of this reference solution is 0.05 m within 3.5 m, and the accuracy is 5% between 3.5m ~ 6m. Due to the different size, status and RCS of the target, the ranging accuracy will fluctuate, and the maximum detection distance will also fluctuate to a certain extent.

4, Unattended duration:

When the radar module detects that there is no human body in the target area, it will not immediately report the "no one" status in the area, but there will be a certain delay. The delayed reporting mechanism is: once no human target is detected within the test range for the first time, the radar module will start timing, and the duration is the uninhabited duration. If no one is continuously detected within the timing, the radar module will start the timing. After the end, the "no one" status is reported; if the presence of someone is detected within this time period, it will end immediately, update the timing, and report the target information.

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