UM10055

XenP202T Series Reference Designs User Manual

Rev.3.1 User Manual

Introduction

This document primarily describes the basic functions, hardware specifications, software usage, and installation conditions of ICL Micro (ICL) high-precision multi-target detection mmWave sensor reference design XenP202T Series (XenP202TE, XenP202TH, XenP202TS, XenP202TV). It aims to assist users in quickly getting started with the XenP202T Series multi-target detection solution.

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1. XenP202T Series Reference Designs Overview

Target tracking refers to real-time monitoring of a target's position within a defined area, with accurate measurement of its distance, angle, and velocity.

The XenP202T series reference/finalized design is a high-precision multi-target recognition millimeter-wave sensor from ICL EZ Sensor series. It includes highly simplified 24 GHz millimeter-wave sensor hardware models Xen202TE, Xen202TH, Xen202TS, and Xen202TV, along with intelligent algorithm firmware. This solution is primarily applied in common indoor scenarios such as homes, offices, and hotels to achieve accurate positioning and tracking of single or multiple human bodies.

The sensor hardware is composed of an AIoT millimeter-wave sensor chip ICL1122, a high-performance one-transmit-two-receive microstrip antenna, a low-cost MCU, and peripheral auxiliary circuits. The intelligent algorithm firmware employs FMCW (Frequency Modulated Continuous Wave) waveforms and proprietary advanced signal processing technologies specific to the ICL1122 chip.

Main features of the XenP202TT series designs are listed below:

- 24 GHz ISM bandwidth
- Integrate smart mmWave sensor SoC ICL1122 and intelligent algorithm firmware
- Accurate human localization and tracking
- Compact module size:

  Xen202TE: 15 mm × 40 mm

  Xen202TH: 34 mm × 15 mm

  Xen202TS: 30 mm × 7 mm

  Xen202TV: 15 mm × 25 mm
- Environment temperature: -40°C ~ 85°C
- Power supply:

  Xen202TE, Xen202TH: 5 V

  Xen202TS, Xen202TV: 3.3 V
- Maximum detection range: 9.7 m (normal direction)
- Field of view (FoV):

  XenP202TE, XenP202TH: ±70°

  XenP202TV, XenP202TS: ±60°
- Wall-mounted installation

The XenP202T Series multi-target recognition mmWave sensors deliver precise localization and tracking, finding wide applications in various AIoT scenarios, including the following types:

- **Smart Home**
  Detect human presence, report results in real time, enable the MCU to control smart domestic appliances such as air-conditioner and fans accordingly;
- **Smart Commercial**
  Sensing human body positions for turning screens on and off, enhancing user experience.
- **Smart Bathroom**
  Enable smart toilets to automatically open and close the lid;
- **Intelligent Lighting**
  Detect human body presence and location precisely, applicable to domestic lighting (sensing lights, lamps, etc.)

2. System Characteristics

The XenP202T Series is a high-precision multi-target recognition mmWave sensor developed based on ICL1122 SoC. The sensor employs FMCW waveform technology, combined with the MCU's proprietary radar signal processing capabilities and built-in intelligent positioning and tracking algorithms, enabling detection of multiple targets within a specified area with real-time reporting of results. Using this series solution, users can rapidly develop corresponding target positioning and tracking products.

The systematic characteristics of the XenP202T Series are shown in Table 2-1.

Table 2-1 XenP202T Series Characteristics

Parameter	Condition	Min.	Typ.	Max.	Unit
Xen202TE Hardware Characteristics					
Supporting frequency	-	24	-	24.25	GHz
Max. bandwidth	-	-	0.25	-	GHz
Power supply	-	-	5	-	V
Size	-	-	15 x 40	-	mm × mm
Environment temperature	-	-40	-	85	°C
Xen202TH Hardware Characteristics					
Supporting frequency	-	24	-	24.25	GHz
Max. bandwidth	-	-	0.25	-	GHz
Power supply	-	-	5	-	V
Size	-	-	34 × 15	-	mm × mm
Environment temperature	-	-40	-	85	°C
Xen202TS Hardware Characteristics					
Supporting frequency	-	24	-	24.25	GHz
Max. bandwidth	-	-	0.25	-	GHz
Power supply	-	-	3.3	-	V
Size	-	-	30 x 7	-	mm × mm
Environment temperature	-	-40	-	85	°C
Xen202TV Hardware Characteristics					
Supporting frequency	-	24	-	24.25	GHz
Max. bandwidth	-	-	0.25	-	GHz
Power supply	-	-	3.3	-	V
Size	-	-	15 x 25	-	mm × mm
Environment temperature	-	-40	-	85	°C
XenP202T Series Reference Designs System Characteristics					
Max. Detection Range	Normal direction	-	9.7	-	m
Field of View	XenP202TE, XenP202TH	-70	-	70	°
	XenP202TS, XenP202TV	-60	-	60	°
Range accuracy	Angle reflector in normal direction	-	0.15	-	m
Angle accuracy	Angle reflector in normal direction	-	2	-	°
Operating frequency	FCC, CE and SRRC compliant	24	-	24.25	GHz
Sweep bandwidth		-	0.23	-	
Data refresh rate	Reporting frequency	-	10	16	Hz
Average operating current	XenP202TE (5 V)	-	50	-	mA
	XenP202TH (5 V)	-	50	-	mA
	XenP202TS (3.3 V)	-	75	-	mA
	XenP202TV (3.3 V)	-	75	-	mA

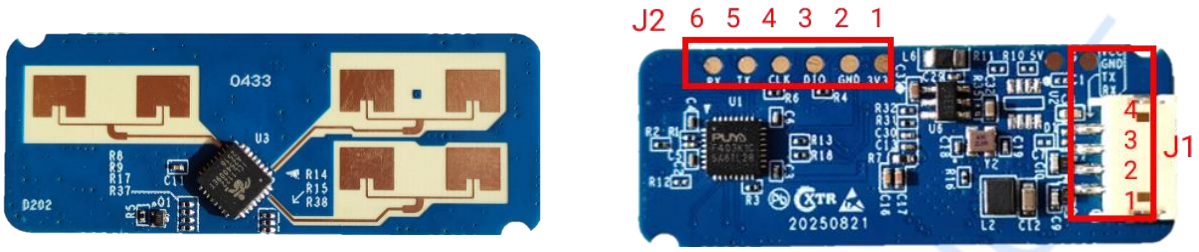
3. Hardware Overview

This chapter introduces the physical hardware diagrams and interface information of the high-precision multi-target recognition sensor series reference designs, namely Xen202TE, Xen202TH, Xen202TS, and Xen202TV.

3.1 Xen202TE Hardware

Figure 3-1 (a) and (b) show the front and back physical photographs of the Xen202TE hardware, respectively.

The Xen202TE hardware features a reserved FPC slot J1, which serves as the power supply and communication interface; the five-pin port is the MCU programming port J2. When programming, please connect according to the corresponding pin names.



(a) Top (b) Bottom

Figure 3-1 Top and bottom view of Xen202TE

Details of the Xen202TE J1 pins are listed in Table 3-1.

Table 3-1 Xen202TE J1 pin description

J# Pin#	Name	Function	Operating Range
J1 Pin1	VCC	Power input	5 V or 3.3 V
J1 Pin2	GND	Ground	-
J1 Pin3	TX	UART_TX	Connect to the RXD of the serial port adapter board
J1 Pin4	RX	UART_RX	Connect to the TXD of the serial port adapter board

For the pin descriptions of J2 and two test contact points on the Xen202TE hardware, please refer to Table 3-2.

Table 3-2 J2 pin description of hardware Xen202

J# Pin#	Name	Function	Operating Range
J2 Pin1	RX	UART_RX	Connect to the TXD of the serial port adapter board
J2 Pin2	TX	UART_TX	Connect to the RXD of the serial port adapter board
J2 Pin3	CLK	Clock signal	Connect to the CLK pin of the programmer
J2 Pin4	DIO	Data port	Connect to the DIO pin of the programmer
J2 Pin5	GND	Ground	-
J2 Pin6	3V3	Power input	3.3 V
5V	5V	Power input	5 V
G	G	Ground	-

3.2 XenP202TH Hardware

Figure 3-2 (a) and (b) show the front and back physical photographs of the Xen202TH hardware, respectively. The Xen202TH hardware has a reserved connector interface J1, which serves as the power supply and communication interface; the four-pin port is the MCU programming port J2. When programming, please connect according to the corresponding pin names.

(a) Top (b) Bottom

Figure 3-2 Top and bottom view of CS202TE

For the pin descriptions of J1 on the Xen202TH hardware, please refer to Table 3-3.

Table 3-3 J1 pin description of hardware CS202_V2

J# Pin#	Name	Function	Description
J1 Pin1	5V	Power input	5 V
J1 Pin2	G	Ground	-
J1 Pin3	T	UART_TX	Connect to serial board TXD
J1 Pin4	R	UART_RX	Connect to serial board RXD

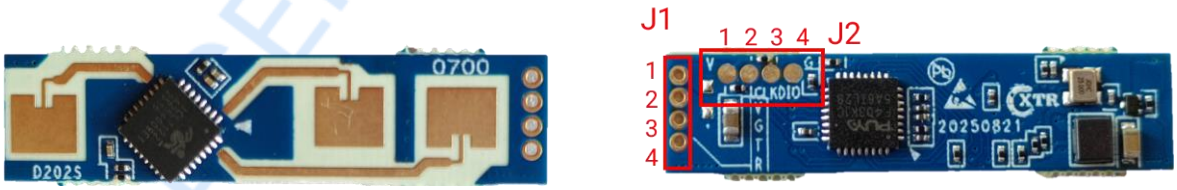
For the pin descriptions of J2 on the Xen202TH hardware, please refer to 错误!书签自引用无效。

Table 3-4 J2 pin description of hardware CS202_V2

J# Pin#	Name	Function	Description
J2 Pin1	3V3	Power input	3.3 V
J2 Pin2	CLK	Negative signal of programing data	Connect to the CLK pin of the programmer
J2 Pin3	DIO	Positive signal of programing data	Connect to the DIO pin of the programmer
J2 Pin4	GND	Ground	-

3.3 Xen202TS Hardware

Figure 3-3 (a) and (b) in the description of Xen202TS hardware show the front and back physical photographs of the Xen202TS, respectively. The Xen202TS hardware has a reserved via J1 (where a pin header can be soldered), serving as the power supply and communication interface; J2 is the programming port. When programming, please connect according to the corresponding pin names.



a) Top b) Bottom

Figure 3-3 Top and bottom view of Xen202TH

For the pin descriptions of J1 and J2, please refer to Table 3-5 and Table 3-6 respectively.

Table 3-5 Pin descriptions of Xen202TS J1

J# Pin#	Name	Function	Description
J1 Pin1	R	UART_RXD	Connect to serial board TXD
J1 Pin2	T	UART_TXD	Connect to serial board RXD
J1 Pin3	G	Ground	-
J1 Pin4	V	Power input	3.3 V

Table 3-6 Pin descriptions of Xen202TS J2

J# Pin#	Name	Function	Description
J2 Pin1	G	Ground	-
J2 Pin2	DIO	Data port	Connect to programmer DIO pin
J2 Pin3	CLK	Clock signal	Connect to programmer CLK pin
J2 Pin4	V	Power input	3.3 V

3.4 Xen202TV Hardware

Figure 3-4 (a) and (b) in show the front and back physical photographs of the Xen202TV, respectively. The Xen202TV hardware has a reserved via J1 (where a pin header can be soldered), serving as the power supply and communication interface; J2 is the programming port. When programming, please connect according to the corresponding pin names.

(a) Top (b) Bottom

Figure 3-4 Top and bottom view of Xen202TS

Details of J1 and J2 are listed in Table 3-7 and Table 3-8 respectively.

Table 3-7 Xen202TV J1 pin description

J# Pin#	Name	Function	Description
J1Pin1	RX	UART RXD	Connect to serial board TXD
J1Pin2	TX	UART TXD	Connect to serial board RXD
J1Pin3	GND	Ground	-
J1Pin4	VCC	Power supply	3.3 V

Table 3-8 Xen202TV J1 pin description

J# Pin#	Name	Function	Description
J2Pin1	G	Power supply	3.3 V
J2Pin2		Ground	-
J2Pin3	DIO	DIO	Connect to programmer DIO pin
J2Pin4	CLK	Clock signal	Connect to programmer CLK pin

4. Software User Guide

The Xen202TE, Xen202TH, Xen202TS, and Xen202TV hardware have been pre-programmed with system firmware at the factory. Simi-Micro provides a visual PC-side demonstration tool software tailored for the XenP202T series of millimeter-wave sensors, enabling users to intuitively experience the sensor's target

positioning and tracking effects.

4.1 Software Overview

ICL_MTT.exe is a green software specially developed for the XenP202T series. After connecting to the sensor hardware, the software can display, record, save, and replay sensor data.

Steps for connecting the software with the radar module are as follows:

Step 1: Download the software pack[1] from ICL website, unzip it and enter the directory;

Step 2: Connect the radar module via suitable cable to the USB serial port tool and then connect the serial port tool to the host PC, detailed connection methods are as follows:

a) Connect the XenP202T series to an FPC adapter board using an FPC flexible flat cable, and then connect the FPC adapter board to a serial-to-USB connection board. The connection method is shown in Figure 4-1.

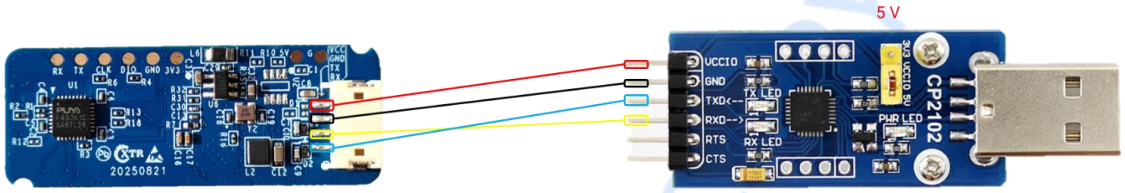


Figure 4-1 Example of connecting the Xen202TE hardware and USB serial port tool

b) Connect the XenP202TH module to the serial port tool using a connecting cable. The connection method is shown in Figure 4-2;

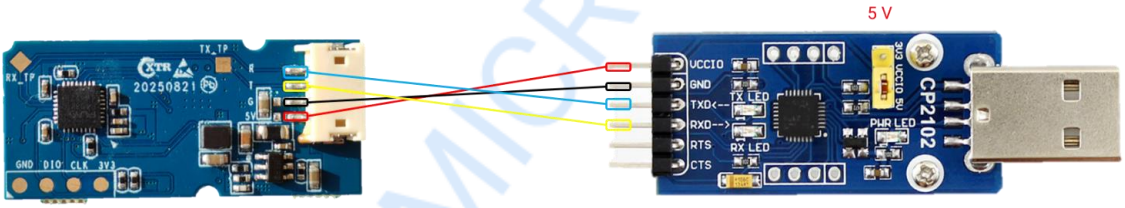


Figure 4-2 Example of connecting the CS202TE hardware to the USB serial port tool

c) Connect the XenP202TS module to the serial port tool using a connecting cable. The connection method is shown in Figure 4-3;

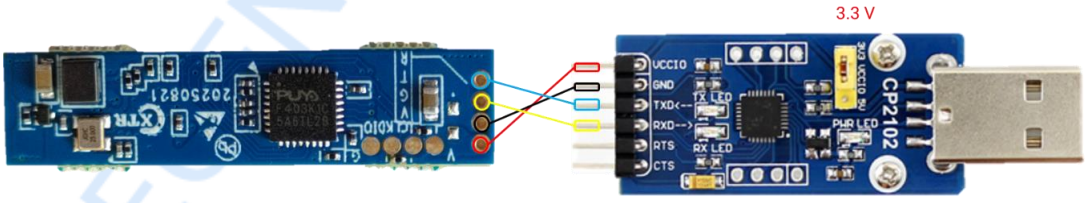


Figure 4-3 Example of connecting the Xen202TH hardware to the USB serial port tool

d) Connect the XenP202TV module to the serial port tool using a connecting cable. The connection method is shown in Figure 4-4.

[1] The software pack for the reference design XenP202TT is named *XenP202TT Target Tracking*, and those for the specific designs CSP202TT and CSP203TT are *CSP202TT Target Tracking*, and *CSP203TT Target Tracking* respectively.

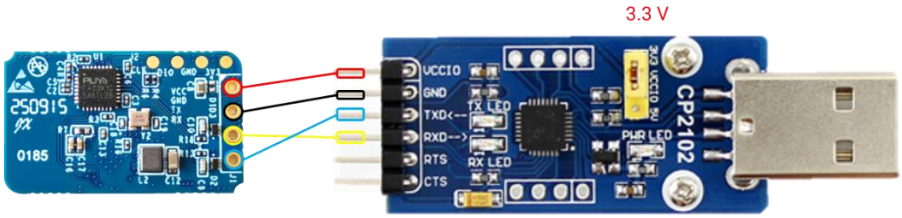


Figure 4-4 Example of connecting the Xen202TS hardware to the USB serial port tool

Step 3: Double click the **ICL_MTT.exe** in the software directory, and the graphic user interface (GUI) will appear as shown in Figure 4-5.

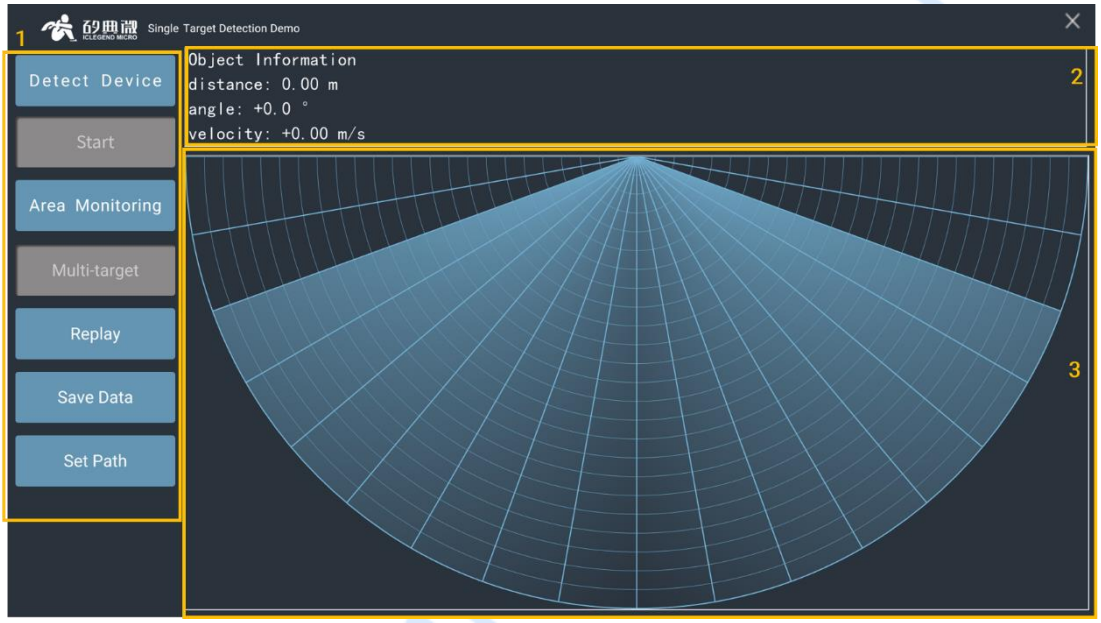


Figure 4-5 GUI of XenP202TT series designs

The GUI mainly consists of three zones, they are Functional Button Zone 1, Data Display Zone 2, and Target Demonstration Zone 3. Descriptions of their functions are as follows:

- **Functional Button Zone**:
  - The Detect Device button is to check whether a radar module is successfully connected;
  - The Start/Stop toggle button is to start or stop receiving radar data;
  - The Area Monitoring button is to define monitoring area and blind area;
  - The Multi-/Single-target toggle button is to switch the working mode between single-target and multiple-target detection;
  - The Replay/Stop toggle button is to play back recorded radar data;
  - The Save Data button is to turn on or off the save radar data mode;
  - The Set Path button is to select directory path for saving recorded radar data.
- **Data Display Zone**: to display the distance, angle, and velocity of detected target;
- **Target Demonstration Zone**: to explicitly display the position of the tracked target in detection range.

4.2 Software Guide

The software features single and multiple targets tracking demonstration, and allows users to define one or more interested areas on the GUI to monitor that area, as well as set one or more blind area. The software also

support recording, saving and replaying radar data. This section introduces how to use the software.

4.2.1 Single-target/Multi-target Detection

Steps for using the software for single or multiple targets detection are as follows:

Step 1: Connect the radar module with a host PC, and open the software following the steps in section 4.1;

Step 2: Click the **Detect Device** button: if the module successfully connected to the host PC, a window writing Serial Port Device Detected will appear, as shown in Figure 4-6, click the **OK** button to continue;

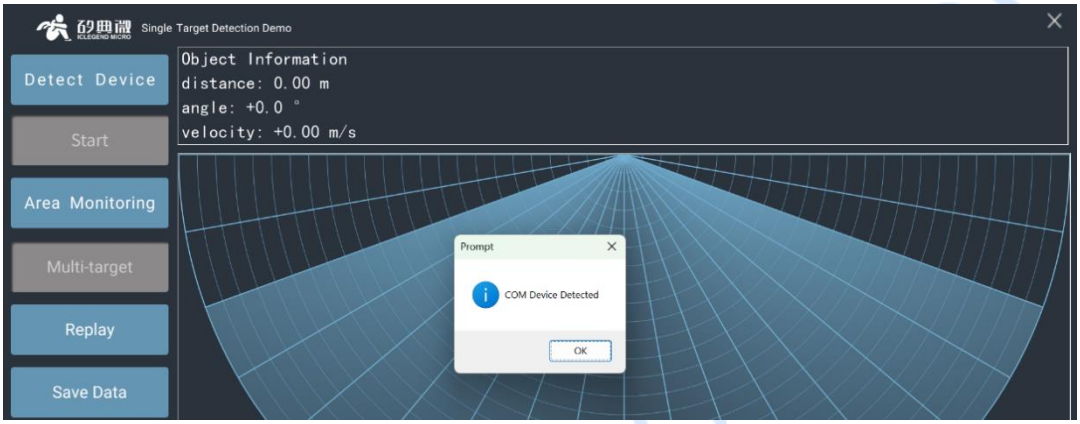


Figure 4-6 Device successfully detected

Step 3: Click the **Start/Stop** toggle button, the GUI will display the position of the detected target referring to the radar, an example is shown in Figure 4-7;

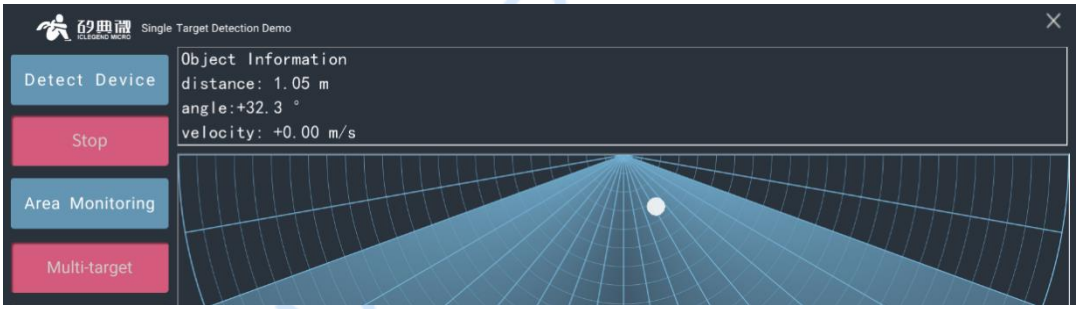


Figure 4-7 Example of single target detection demonstration

Step 4(Optional): By default, the software works in Single Target Detection mode, to switch to Multiple Target Detection mode, click the **Multi-target /Single-target** toggle button, the Triple Targets Detection Demo[2] will appear, as shown in Figure 4-8; to switch back to Single Target Detection Mode[3], click the **Multi-target /Single-target** toggle button again.

[2] The Triple Targets Detection Demo shows at most 3 detected targets that with the highest moving energy.

[3] The Single Target Detection Mode is not suitable for positioning and tracking multiple targets.

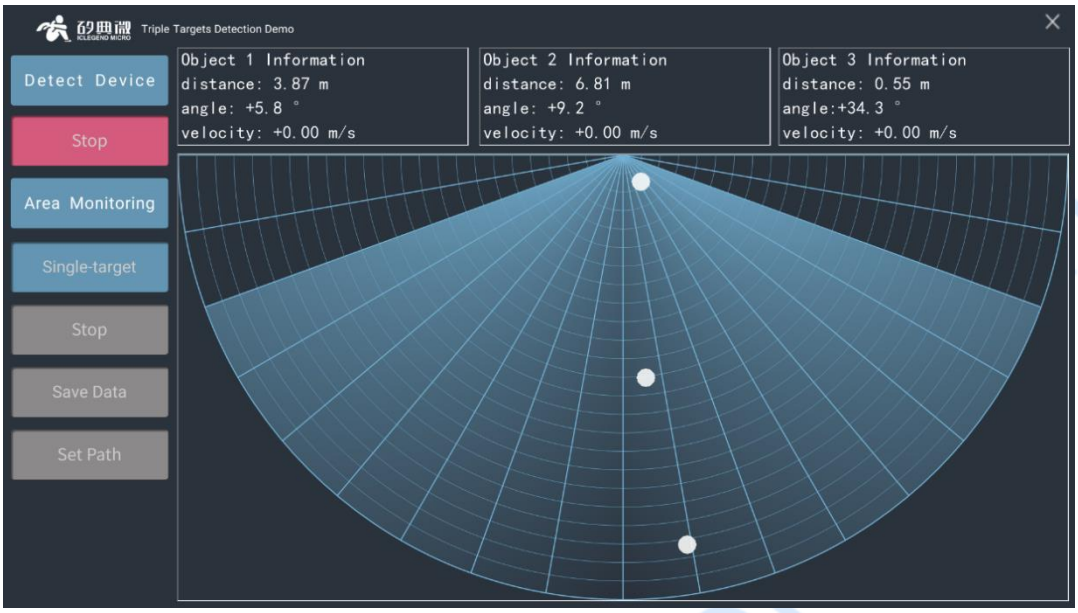


Figure 4-8 Example of triple-target detection demonstration

4.2.2 Area Monitoring

The software provides Area Monitoring and Blind Area Setting functions.

The Area Monitoring function allows users to set up one or more monitoring areas inside the detection range so that whenever the human target(s) enters the area, the color of the area changes immediately. This function enables the software to selectively present the radar data according to users' interests.

Blind Area setting allows users to define the interested detection and tracking area, and turn off the detection and display of certain range gates. This function enables the software to block certain detection areas according to the parameters that the users set.

Steps for setting up a monitoring area on the GUI are as follows:

Step 1: Connect the radar module with a host PC, and open the software following the steps in section 4.2.1;

Step 2: Click the **Area Monitoring** button, a new window will appear, as shown in Figure 4-9, descriptions of the window are as follows:

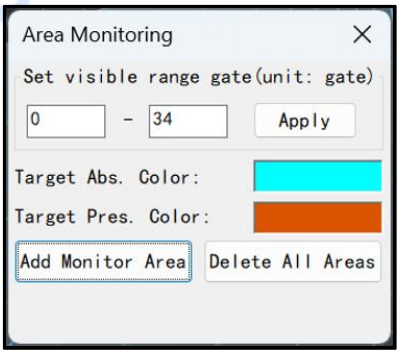


Figure 4-9 Area Monitoring window

Set visible range gate: default as 0~34, meaning there is no blind area; Users can customize a near-end and a far-end blind area, for example: if users set the visible range gate as 1 ~ 32, there is one range gate blind area in the near-end, and two range gates(34 - 32) of blind area in the far-end (each range gate represents 33 cm), then click the **Apply** button, the new detection range is as shown in Figure 4-10 where the red areas represent blind areas.

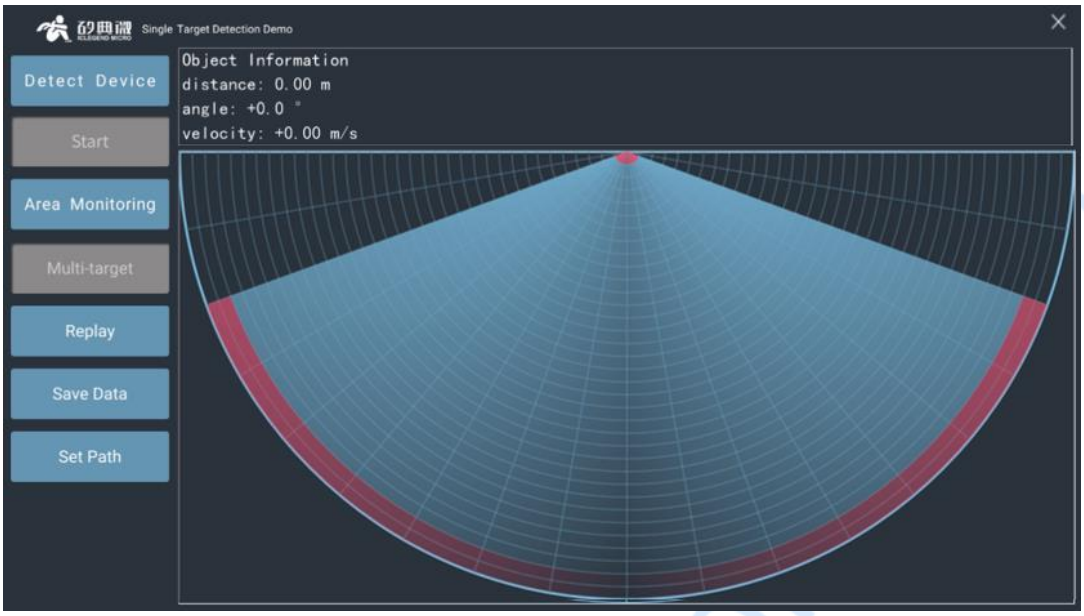


Figure 4-10 Example of blind area setting

Target Abs. Color: to set the color of the monitoring area when there is no target.

Target Pres. Color: to set the color of the monitoring area when there is a target.

Add Monitor Area: to start defining a monitoring area, once this button is clicked, users click in the radar chart to add vertex of the monitoring area, and right click to finish this process.

Delete All Areas: to delete all the pre-defined monitoring areas.

Step 3: Click the **Add Monitor Area** button to start defining a monitoring area, click in the radar chart to define the vertexes of the desired monitoring area in clockwise or anti clockwise direction, right-click to finish the process, and the GUI will display the defined monitoring area, an example is shown in Figure 4-11; After setting the monitoring area, if a human target is detected in this area, the background color of this area changes immediately, as shown in Figure 4-12 and Figure 4-13.

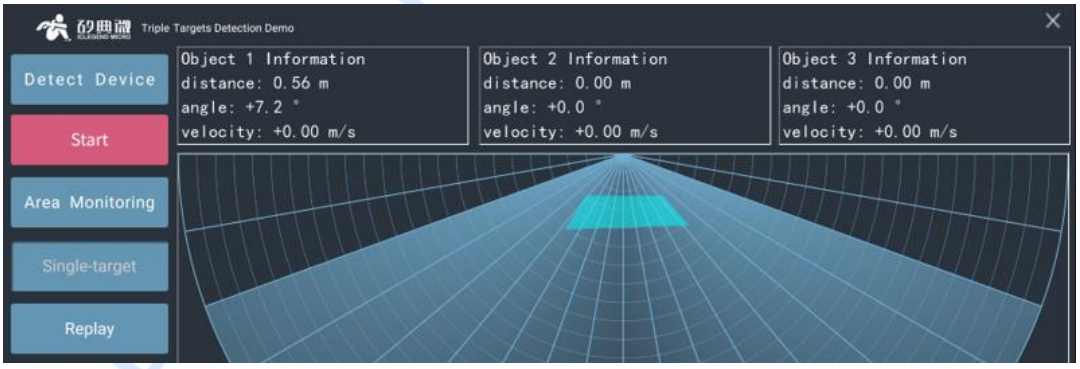


Figure 4-11 Example of a defined monitoring area

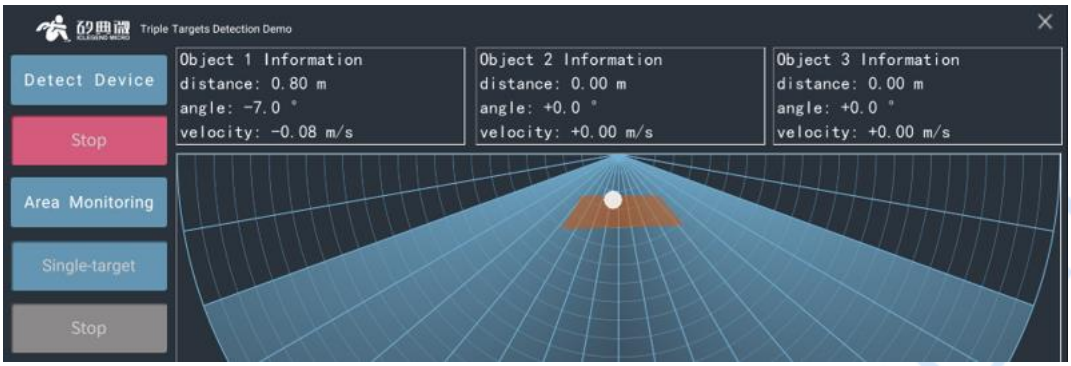


Figure 4-12 Target exists in monitoring area

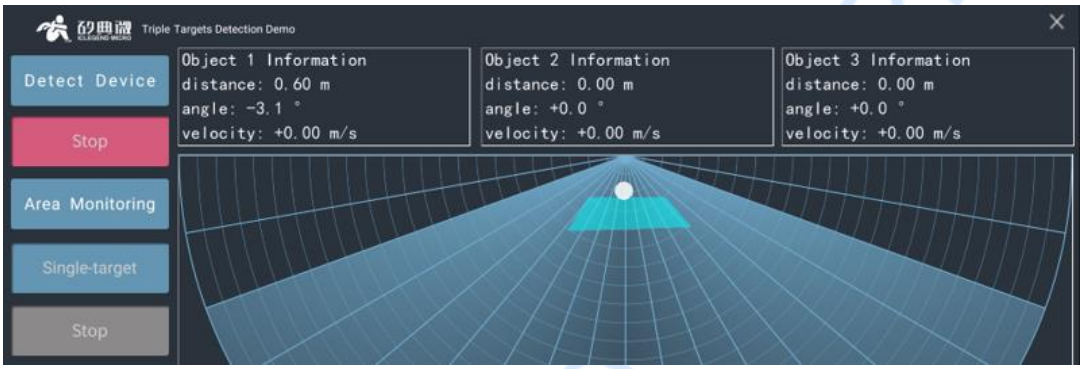


Figure 4-13 No target in monitoring area

Step 4(Optional): Repeat Step 3 to set multiple monitoring areas;

Step 5(Optional): If users want to delete all existed monitoring area, click the **Area Monitoring** button, on the Area Monitoring window, click the **Delete All Areas** button to remove all the monitoring areas defined previously.

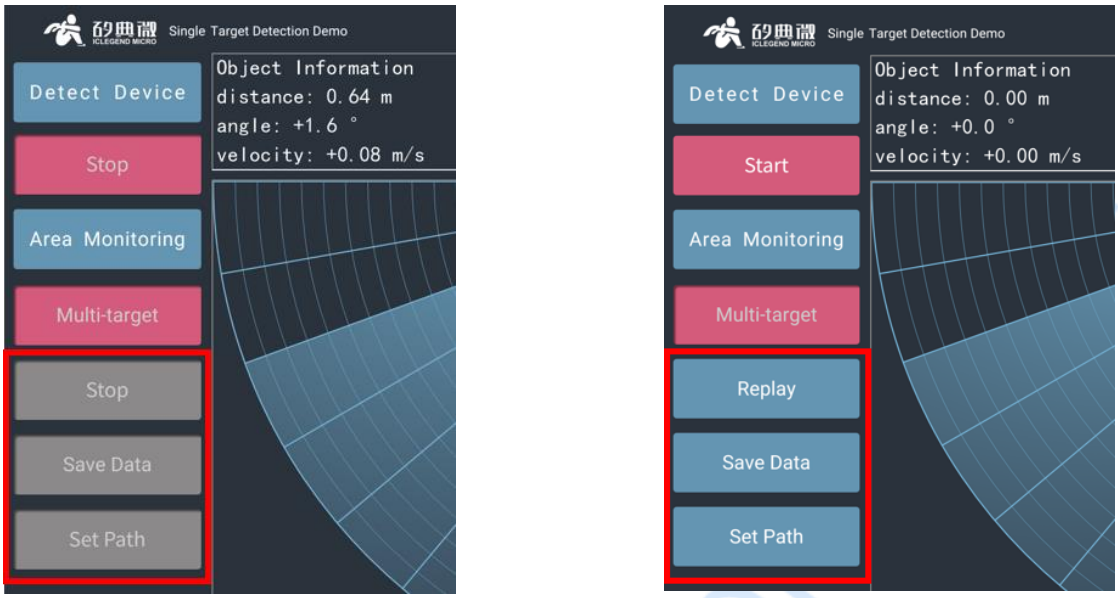
4.2.3 Record, Save, and Replay Radar Data

The software supports recording, saving, and replaying the radar data. For the communication protocol of the radar data please refer to 5. Communication Protocol. The steps are as follows:

Step 1: Connect the radar module with the host PC, and open the software following the steps in section 4.1;

Step 2: When the Start/Stop toggle button shows Start, as shown in Figure 4-14 (b), click the **Save Data**[4] button, select the saving path of radar data, by default the folder is named SaveData under the software directory;

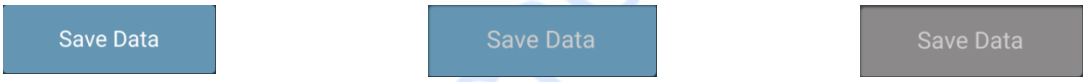
[4] When the **Start/Stop** toggle button displays **Stop**, the **Replay**, **Save Data**, and **Set Path** buttons are all unclickable.



(a) Buttons unclickable (b) Buttons clickable

Figure 4-14 Radar data replay/save related buttons

Step 3: By default, the Save Data working mode is off. If users want to turn on the Save Data mode, click the **Save Data** button when the button is clickable (as shown in Figure 4-15(a)); and to turn off the mode, click the **Save Data** button again;



(a) Save Data mode off (b) Save Data mode on (c) Button unclickable

Figure 4-15 Three states of the Save Data button

Step 4: When the Save Data working mode is on, click the **Start/Stop** toggle button to detect human target, the software will display the human target information and demonstration in Zone 2 and Zone 3;

Step 5: Click the **Start/Stop** toggle button to stop detection, and users can find the radar data file folder under the directory set in Step 2, the file folder is named after the time stamp of yyyy_mm_dd_hh_mm_ss;

Step 6: Click the **Replay/Stop** toggle button, choose a radar data file folder, then Zone 2 and Zone 3 will start replaying the radar data;

Step 7: Click the **Replay/Stop** toggle button to stop replaying.

4.3 IAP Tool Guide

4.3.1 Preparation

a) Tool Download: Obtain the "XenP202T Series IAP Tool" from the official website.

b) Hardware Connection: Complete the connection between the serial port adapter board and the sensor following the instructions in Step 2 of Section 4.1.

Figure 4-16 shows the interface of the firmware upgrade tool for the XenP202T series.

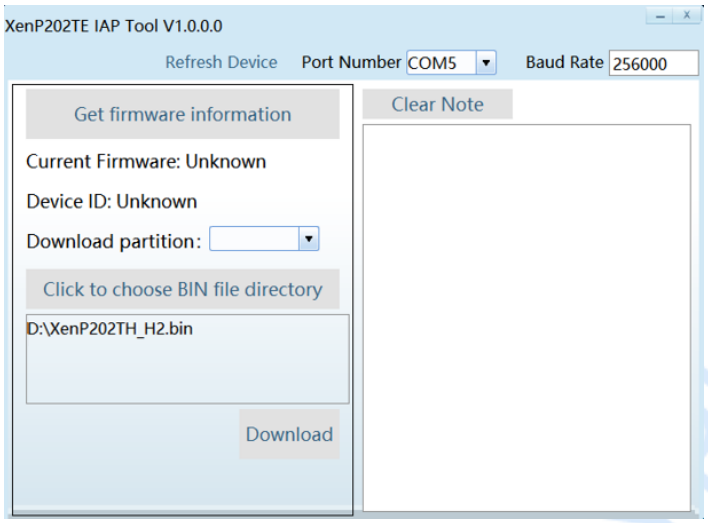


Figure 4-16 Interface of the Firmware Upgrade Tool for the XenP202T Series

4.3.2 Tool Configuration

a) Open the upgrade tool.

b) Click the "Refresh Devices" button.

c) Select the sensor's serial port number (the baud rate is fixed at 256,000).

4.3.3 Firmware Information Acquisition

Click "Get firmware information" to display the currently running firmware and device ID.

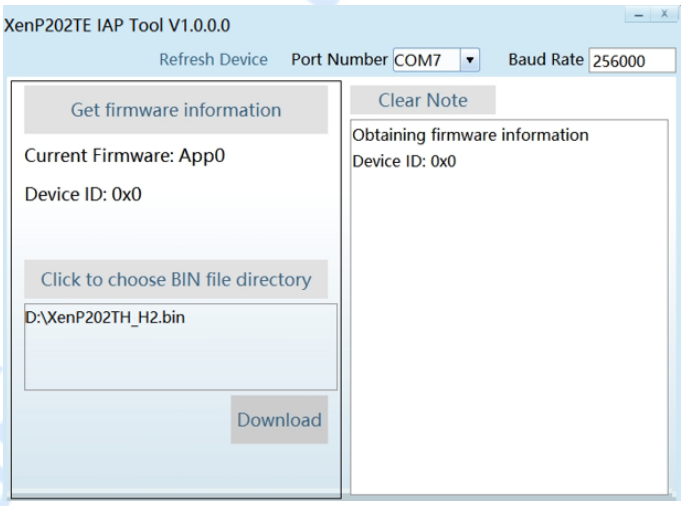


Figure 4-17 Interface for Acquiring Firmware Information of the XenP202T Series

4.3.4 Firmware Upgrade

a) Click "Click to choose BIN file directory" to upload the firmware.

b) Click "Download" to start the upgrade.

Result Prompt: An example of a successful upgrade is shown in Figure 4-18. If the upgrade fails, corresponding error information will be displayed.

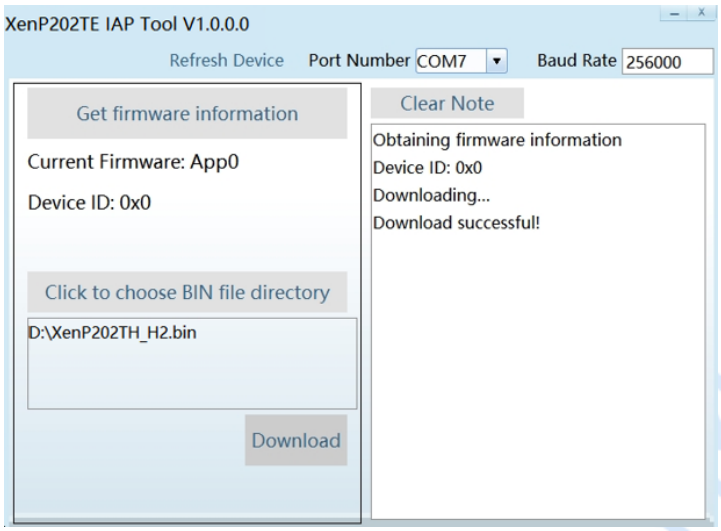


Figure 4-18 Example of a Successful Download for the XenP202T Series

5 Communication Protocol

The communication protocols introduced in this chapter are mainly for users who needs to develop products without the software.

The XenP202T Series modules communicate with the host PC via the serial port (TTL electrical level). The baud rate of the radar serial port is 256000 by default with 1 stop bit and no parity check digit.

Radar module outputs the detected target information, including x and y coordinates with the radar as the original point (the definition of x and y axis is shown in Figure 5-1, Figure 5-2, Figure 5-3, and Figure 5-4 with the arrows pointing towards the positive direction), and velocity. The radar data frame format is presented in Table 5-1.

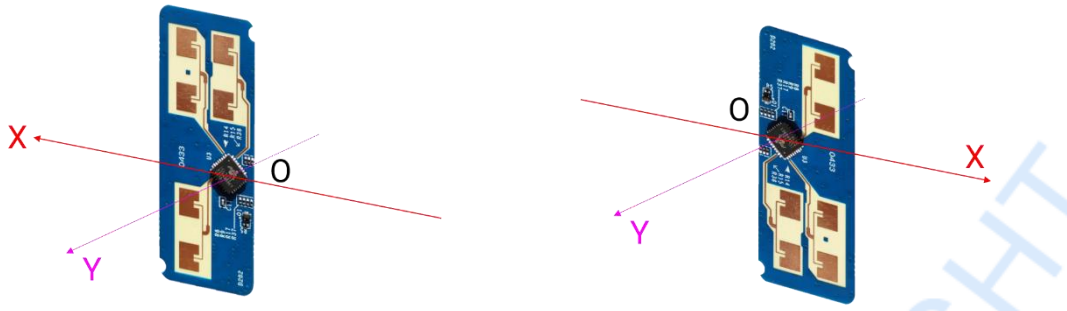
Table 5-1 Format of radar report data frame

Header	Data	Trailer
AA FF 03 00	Data of Target 1 Data of Target 2 Data of Target 3	55 CC

Data format of each target information is presented in Table 5-2.

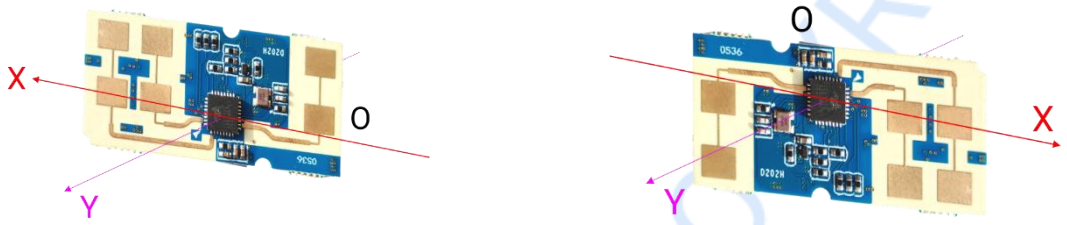
Table 5-2 Target information within the frame

Position x	Position y	Velocity	Range Resolution
signed int16; the highest bit value 1 represents positive of x axis, and 0 represents negative of x axis; the rest 15 bits represents the value of the target on X axis, unit mm	signed int16; the highest bit value 1 represents positive of y axis, and 0 represents negative of y axis; the rest 15 bits represents the value of the target on y axis, unit mm	signed int16; the highest bit value 1 represents positive velocity (leaving the radar), 0 represents negative velocity (approaching the radar); the rest 15 bits represents the value of the velocity, unit cm/s	uint16; represents the value of single range resolution, unit mm



(a) (b)

Figure 5-1 Illustration of the coordination system of XenP202TE in recommended poses

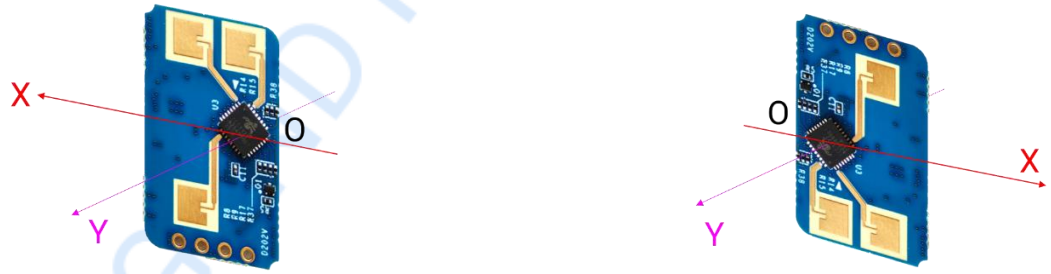


(a) (b)

Figure 5-2 Illustration of the coordination system of XenP202TH in recommended poses

(a) (b)

Figure 5-3 Illustration of the coordination system of XenP202TS in recommended poses



(a) (b)

Figure 5-4 Illustration of the coordination system of XenP202TV in recommended poses

For example: AA FF 03 00 0E 03 B1 86 10 00 68 01 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 55 CC

The data above contains target 1 information (blue digits), target 2 and target 3 (correspond to red and black digits) do not exist so the digits are all 0s. The radar module processes this data in a way that described as follows:

Position X of target 1: 0x0E + 0x03 * 256 = 782

0 - 782 = -782 mm;

Position Y of target 1: 0xB1 + 0x86 * 256 = 34481

34481 - 2^15 = 1713 mm;

Velocity of target 1: 0x10 + 0x00 * 256 = 16

0 - 6 = -16 cm/s;

Range sampling length of target 1: 0x68 + 0x01 * 256 = 360 mm.

6 Installation and Detection Range

The XenP202T Series is designed for wall-mounted installation as illustrated in Figure 6-1, with a maximum positioning/tracking distance of 9.7 meters. During wall mounting, special attention should be paid to potential obstructions in the application scenario and overhead interference factors. The recommended installation height range is 1.4 to 1.7 meters.

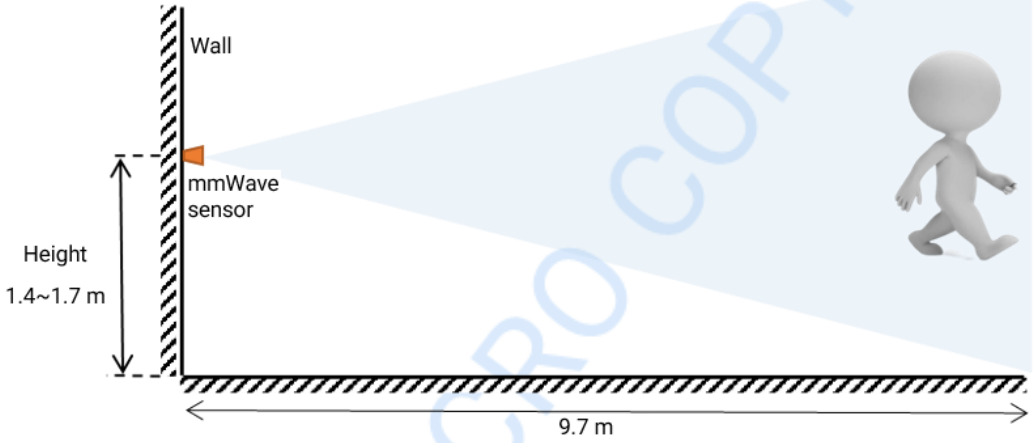


Figure 6-1 Illustration of wall mounted installation

When conducting wall-mounted installation, the recommended sensor orientations for XenP202T Series are illustrated in Figure 6-2, Figure 6-3, Figure 6-4, and Figure 6-5. The 0° reference direction corresponds to the normal vector of the sensor's antenna plane.

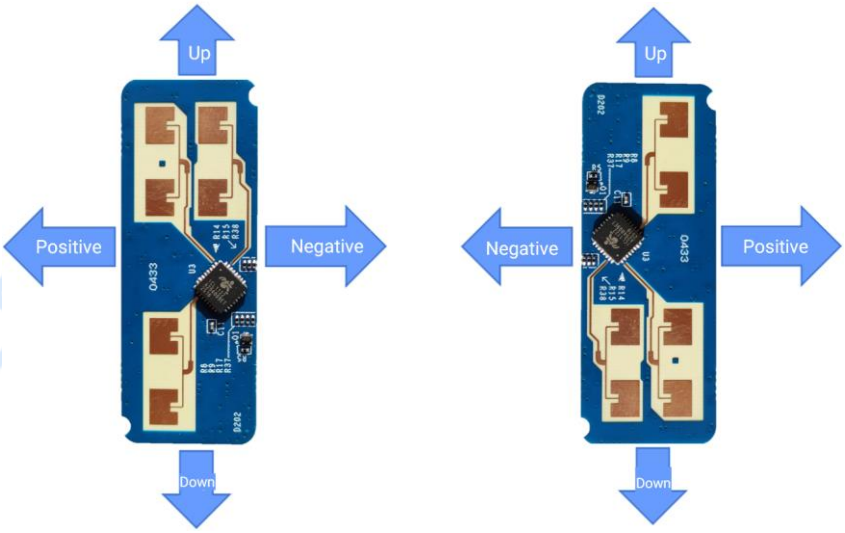


Figure 6-2 Directions of XenP202TE when wall mounted

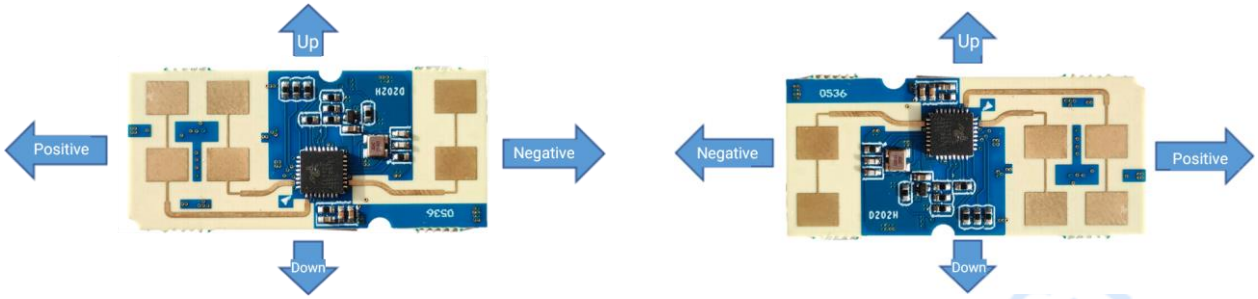


Figure 6-3 Directions of XenP202TH when wall mounted

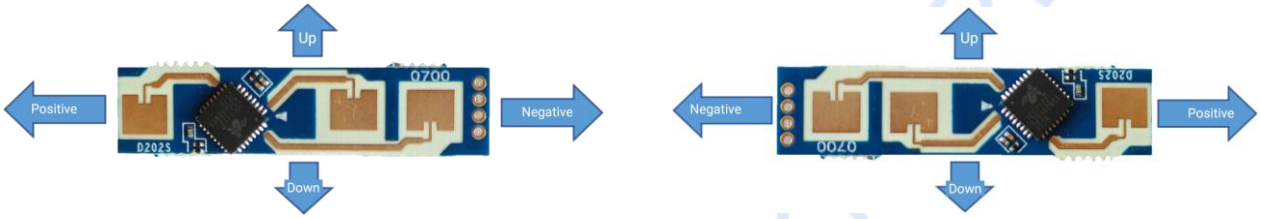


Figure 6-4 Directions of XenP202TS when wall mounted

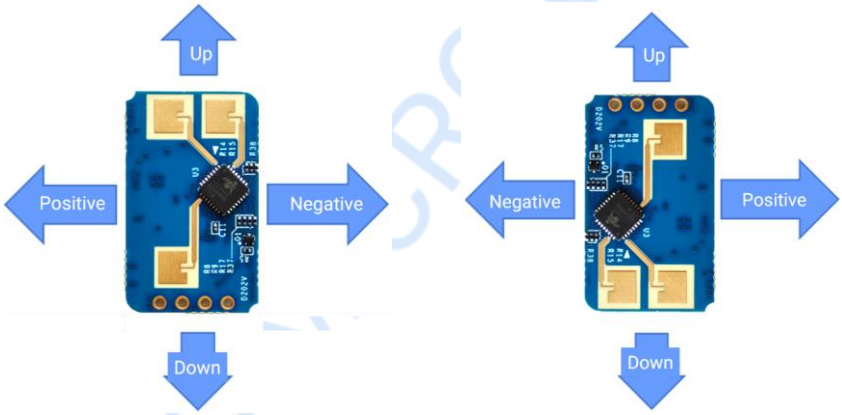
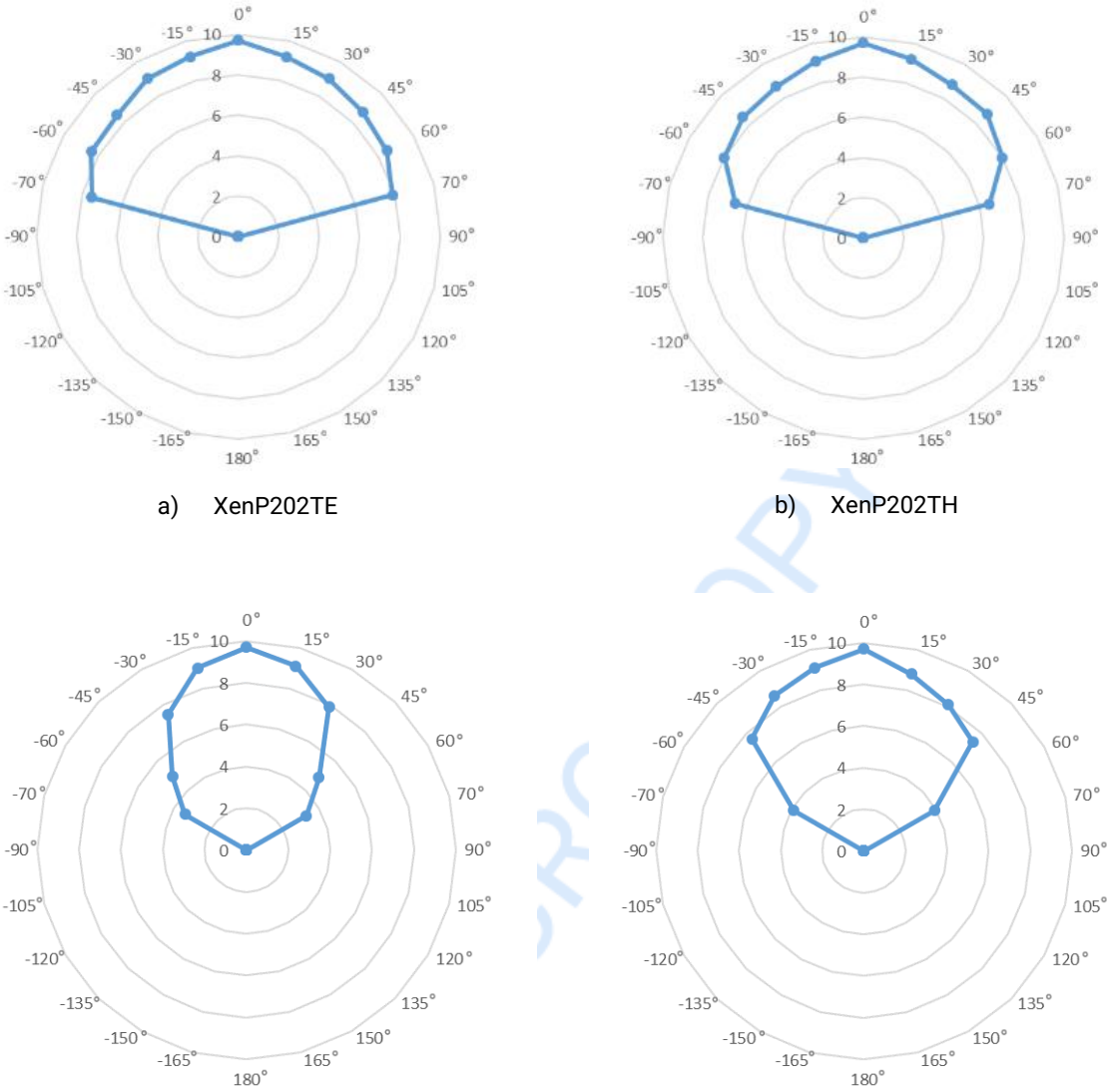


Figure 6-5 Directions of Xen202TV when wall mounted

Figure 6-6 illustrates the positioning and tracking range of the designs in this series when mounted at a wall-hanging height of 1.4 m, with the test subject being 1.75 m tall and of medium build. In the wall-mounted installation scenario:

- The detection angle range of the XenP202TE and XenP202TH sensors is ±70° centered around the normal direction of the sensor antenna plane.
- The detection angle range of the XenP202TS and XenP202TV sensors is ±60° centered around the normal direction of the sensor antenna plane.



a) XenP202TE

b) XenP202TH

c) XenP202TS

d) XenP202TV

Figure 6-6 Detection and tracking range of XenP202T Series when wall-mounted

7 Mechanical Size

This chapter introduces the mechanical dimensions of the PCBs for the Xen202TE, XenP202TH, XenP202TS, and XenP202TV hardware respectively.

7.1 XenP202TE Mechanical Size

As shown in Figure 7-1, the XenP202TE hardware measures 15 mm × 40 mm, with a board thickness of 1.0 mm and a thickness tolerance of ±10%.

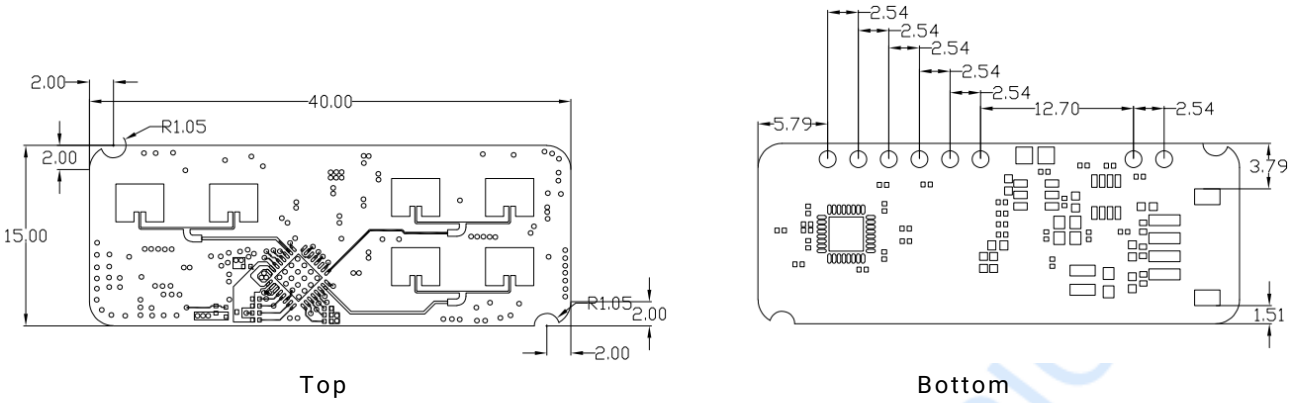


Figure 7-1 Mechanic size of XenP202TE

7.2 XenP202TH Mechanical Size

As shown in Figure 7-2, the CSP202TE hardware has dimensions of 34 mm × 15 mm, with a board thickness of 1.0 mm and a board thickness tolerance of ±10%.

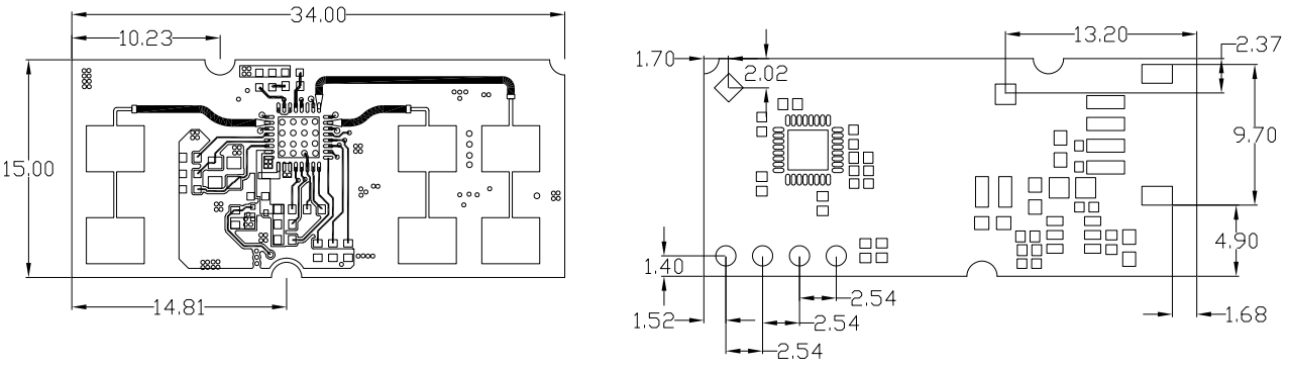


Figure 7-2 Mechanic size of XenP202TH

7.3 XenP202TS Mechanical Size

As shown in Figure 7-3, the XenP202TH hardware measures 30 mm × 7 mm, with a board thickness of 1.0 mm and a board thickness tolerance of ±10%.

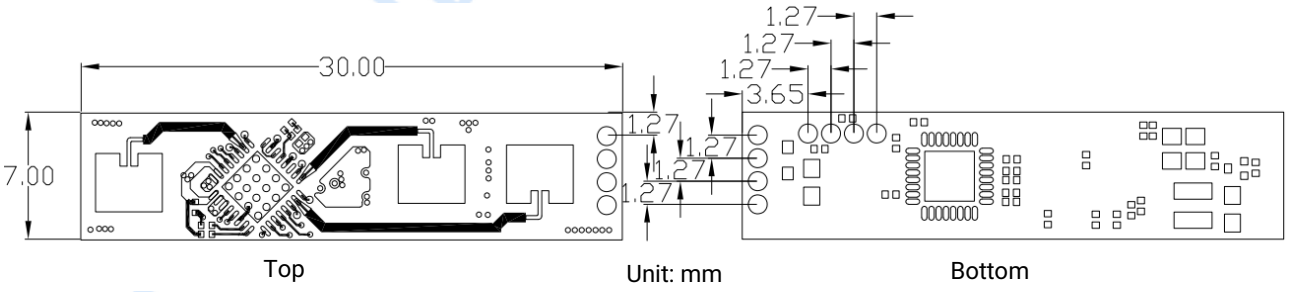


Figure 7-3 Mechanic size of XenP202TS

7.4 XenP202TV Mechanical Size

As shown in Figure 7-4, the XenP202TS hardware features compact dimensions of 15 mm × 25 mm, with a board thickness of 1.0 mm and a board thickness tolerance of ±10%.

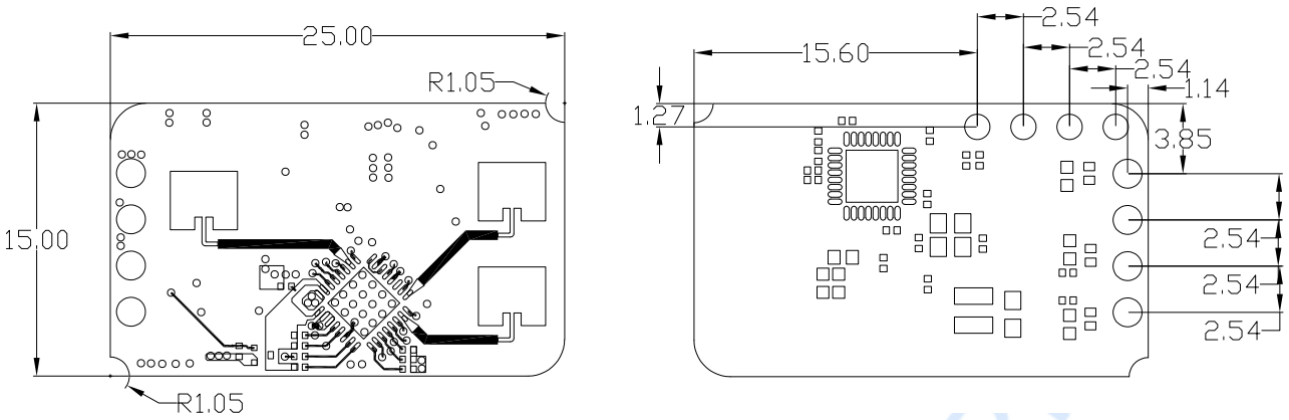


Figure 7-4 Mechanical size of XenP202TV

8 Installation Requirement

Radome Requirements

If there is a need to install a radome, the material selected must have good transparency for 24 GHz wave, and do not contain any material that may block electromagnetic wave such as metal. More details please refer to Guide of mmWave Sensor Antenna Radome Design.

Installation Environment

When installing the product, certain requirements should be taken into consideration in case the detection performance is interfered. Features of unsuitable environment are listed below.

- Continuous moving non-human objects in detection area, such as moving animals, swinging curtains, big shaking plants in front of an active vent etc.
- Large strong reflectors will interfere with detection performance when put in front of the antennas.
- Interferences of on-ceiling home appliances such as air-conditioners, fans, etc. should be taken into consideration while top mounted.

Important Requirements

- Ensure the radar antennas are facing squarely to desired detection area with a clear field of view.
- Ensure the installation position of the sensor is solid and stable. Motion of the radar itself can hugely impact signal processing.
- Ensure there is no object moving or vibrating behind the radar. Motion behind antennas can also be detected due to the penetrability of radar RF wave, thus interferes detection accuracy. It is recommended to use a radome or a backplane to reduce the interference.
- When there are multiple 24 GHz radar installed in close areas, make sure their beamforms do not face to each other, try to separate them as far as possible to avoid interference.

9 Important Tips

Maximum Detection Range, Range Accuracy, and Angle Accuracy

Maximum detection range, range accuracy, and angle accuracy may slightly fluctuate due to the size, motion state, and RCS of the target.

Power Supply

EMC Design Considerations: During development, engineers must comprehensively address electromagnetic compatibility (EMC) design for power systems, including electrostatic discharge (ESD) protection and lightning surge protection, to ensure stable sensor operation.

10 Revision History

Revision	Date	Modification
1.0	2025/5/27	Initial draft.
2.0	2025/9/19	The XenP202TE hardware has been updated to ensure its compatibility with the previous CSP202TE and XenP202TE models.
3.1	2025/12/19	Updated the hardware description.

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