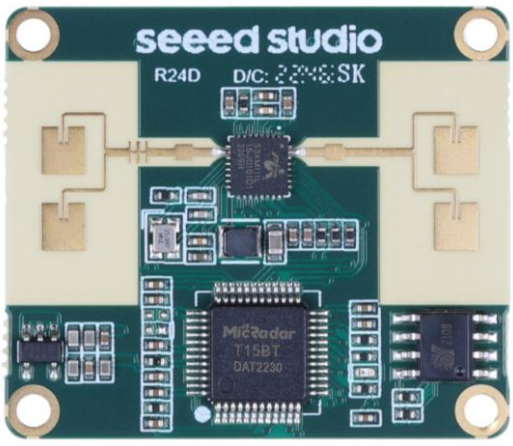
# 24GHz mmWave Sensor Human Static Presence Module Lite

User Manual V1.5



# Catalog

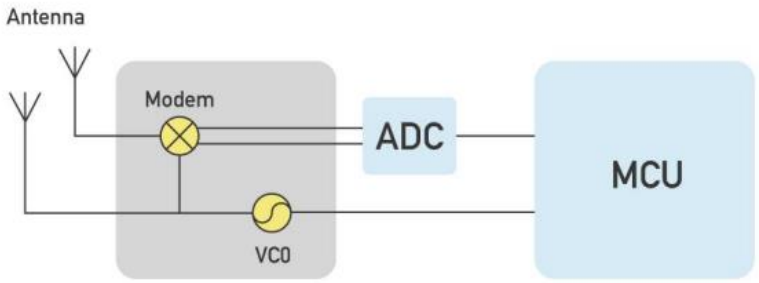
# 1. Overview

This document focuses on the use of the sensor, the issues that need to be paid attention to in each phase, to minimize the design cost and increase the stability of the product, and to improve the efficiency of the project completion.

From hardware circuit reference design, sensor antenna and housing layout requirements, how to distinguish interference and multi-functional standard UART protocol output. The sensor is a self-contained system.

This sensor is a self-contained space sensing sensor, which consists of RF antenna, sensor chip and high speed MCU. It can be equipped with a host computer or a host computer to flexibly output detection status and data, and meet several groups of GPIOs for user customization and development.

# 2. Working Principle




The sensor transmits a 24G band millimeter wave signal, and the target reflects the electromagnetic wave signal, and demodulates it from the transmitted signal. The signal is demodulated, then amplified, filtered, ADC and other processing to obtain the echo demodulation signal data. In the MCU unit, the amplitude, frequency and phase of the echo signal are decoded, and the target signal is finally decoded. The target parameters (body movement, etc.) are measured and evaluated in the MCU.

MR24HPC1 Human Static Presence Module Lite based on the mechanism of continuous frequency modulation wave. It senses the biological presence, respiration, slight

movement, and movement of human body, and continuously records the presence of human body. It makes real-time judgments and outputs changes in motion speed, distance, intensity, as well as changes in spatial micro-movement intensity and distance. It achieves a rich environment detection application through various functional parameters and is compatible with complex environment detection applications of various styles.

# 3. Hardware Design Considerations

The rated supply voltage of the radar needs to meet 4.9 - 6V, and the rated current needs to be 200mA or more input is required. The power supply is designed to have a ripple of ⩽ 100mv.

## 3.1 Power supply can refer to the following circuit design

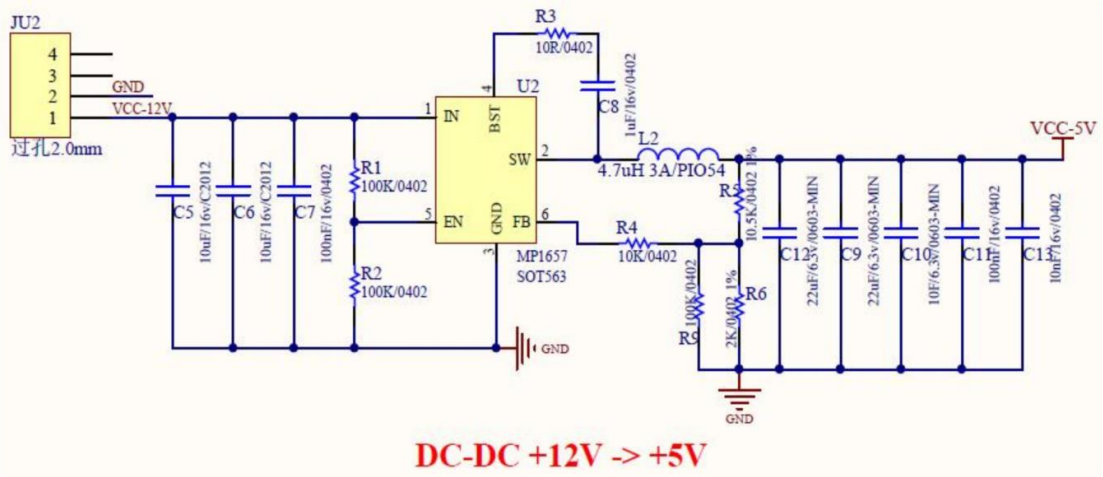



Figure 1

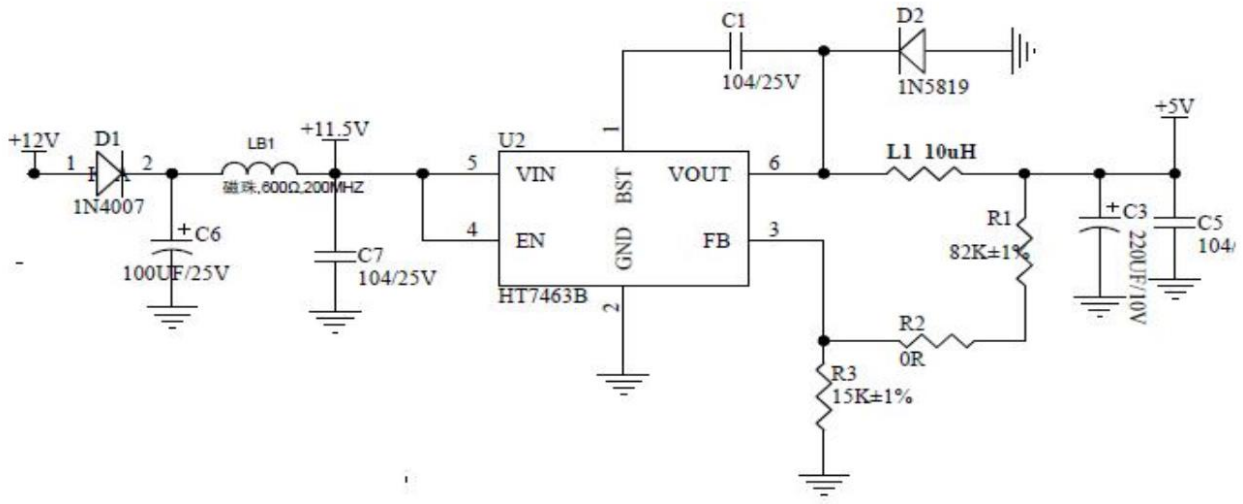



Figure 2

## 3.2 Wiring Diagram

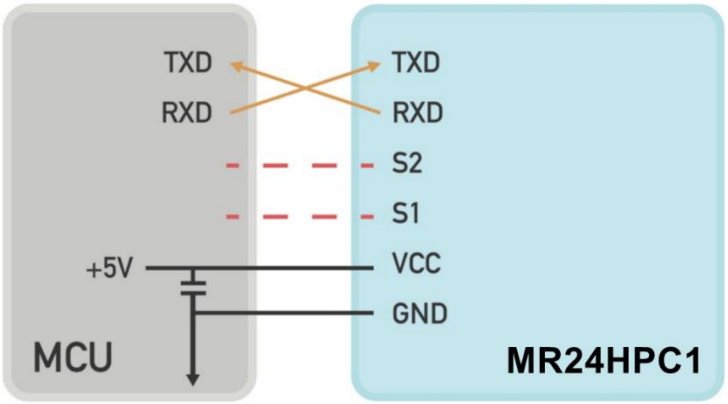



Figure 3 Module and peripheral wiring diagram

# 4. Antenna and housing layout requirements

PCBA: Need to keep the radar patch height ≥ 1mm higher than other devices

Housing structure: need to keep the radar antenna surface and the housing surface have 2 - 5mm distance

Housing detection surface: non-metallic housing, need to be straight to avoid bending surface, affect the performance of the whole sweep surface area Performance

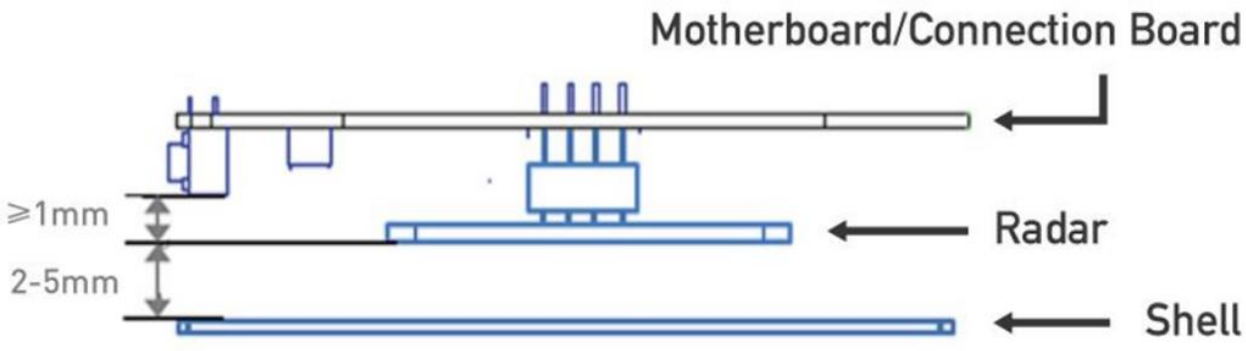



Figure 4

# 5. Electrostatic protection

Radar products with electrostatic sensitive circuitry inside, vulnerable to electrostatic hazards, so need to be in transport, storage, work and handling process to do a good job of electrostatic protection, do not touch the grasp of the radar hands. Therefore, it is necessary to do a good job in the transportation, storage, work and picking up process of static protection, do not touch and grab the radar module antenna surface and connector pins, only touch the corners. Do not touch the surface of the radar module antenna and connector pins with your hands, only touch the corners.

When handling the radar sensor, please wear anti-static gloves as much as possible.

# 6. Environmental interference analysis

## 6.1 In an unmanned state, sensors output results indicating the presence of a human being even though there is none.

In the normal state, the radar accurately detects the presence of a stationary human body or sleeping human body and outputs corresponding vital sign information. The reasons for this type of error could be:

A. The radar scans a large area and detects movements from outside the door or through a wooden wall nearby.

Adjustment method: Reduce the radar sensitivity or provide scene settings for the radar.

B. The radar is directly facing running equipment such as air conditioners or fans below.

Adjustment method: Adjust the position of the radar to avoid direct exposure to air conditioners or fans.

C. Object shaking caused by airflow from an air conditioner.

Adjustment method: Cotton and non-metallic items will not cause sensor false alarms, but metal items need to be fixed to avoid shaking.

D. The sensor is not fixed, which causes false alarms due to vibration.

Adjustment method: Avoid shaking or vibration by ensuring stable support.

E. Occasionally moving animals such as pets or birds.

Due to the radar measuring micro-movements with high sensitivity, it is difficult to eliminate this interference.

F. Power interference occasionally causing misjudgment.

Adjustment method: Try to maintain a stable power supply current.

## 6.2 When there is a person present, the sensor produces an incorrect output of no person detected.

The sensor detects the presence of a human body by sending and receiving electromagnetic waves, with higher accuracy the closer the person is to the radar.

A. The person is outside the range of the radar.

Solution: adjust the scanning range and installation angle of the radar. The measurement range of the radar varies in different environments due to differences in the electromagnetic wave reflection area, which may cause slight differences in the scanning area.

B. Metal obstruction causes incorrect output.

Obstruction by a thick desk, chair, or metal seat may block the electromagnetic waves

and cause a misjudgment.

C. Differences in scanning angles.

The radar did not scan the torso, causing misjudgment.

D. The radar sensitivity is too low.

Solution: adjust the sensitivity parameter of the radar to increase sensitivity.

# 7. Protocol Description

This protocol is applied to the communication between the 24G millimeter wave Sensor Human Static Presence Module Lite and the host computer.

This protocol outlines the radar workflow, briefly introduces the interface protocol composition architecture, and The interface protocol structure is briefly introduced, and the related radar work requires control commands and data.

Interface level: TTL

Baud rate: 9600bps

Stop bit: 1

Data bits: 8

Parity check: None

## 7.1 Definition of frame structure

| Frame header | Control word | Command word | Length identifier | | Data | Checksum | End of frame |
|---|---|---|---|---|---|---|---|
| 0x53 0x59 | Control | Command | Lenth_H | Lenth_L | Data | Sum | 0x54 0x43 |
| 2 Byte | 1 Byte | 1 Byte | 1 Byte | 1 Byte | n Byte | 1 Byte | 2 Byte |

## 7.2 Description of the frame structure

a. Frame header: 2 Byte, fixed to 0x53,0x59;

b. Control word: 1 Byte

(0x01 - heartbeat packet identification, 0x02 - product information, 0x03 - UART

upgrade, 0x05 - operation status, 0x80 - human presence)

c. Command word: 1 Byte (to identify the current data content)

d. Length identification: 2 Byte, equal to the specific byte length of the data

e. Data: n Byte, defined according to the actual function

f. Checksum: 1 Byte. (Calculation method of checksum: “frame header + control word + command word + length identifier + data” summed to the lower eight bits)

g. End of frame: 2Byte, fixed to 0x54,0x43;

# 8. Standard function (scene mode) description

This instruction mainly focuses on the detailed explanation and illustration of sensor standard functions such as scene mode, sensitivity, and unmanned time.

What needs to be explained is that the maximum detection range of the sensor for detecting human body in static and active states is different. Generally speaking, when the human body is in a static state, the maximum detection range of the sensor is smaller than that when the human body is in an active state.

| Contents | Typical (default) | Maximum | Installation way |
|---|---|---|---|
| **Human Active** | 5 | 5 m | side mount |
| **Human Static** | 4 | 4 m | side mount |
| **Human Sleep** | 3 | 3.5 m | side mount |

The configurations of 8.2 to 8.4 are only effective in the standard mode (scene mode).

## 8.1 List of standard function data information

| Function Category | Function Description | Transfer direction | Frame header | Control word | Command word | Length Identification | | Data | Checksum field | End of frame | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|
| System Functions | Heartbeat Pack query | Send | 0x53 0x59 | 0x01 | 0x01 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | | Response | 0x53 0x59 | 0x01 | 0x01 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | Module Reset | Send | 0x53 0x59 | 0x01 | 0x02 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |

| Function Category | Function Description | Transfer direction | Frame header | Control word | Command word | Length Identification | | Data | Checksum field | End of frame | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Response | 0x53 0x59 | 0x01 | 0x02 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| **Information Inquiry** | | | | | | | | | | | |
| Product Information | Product Model query | Send | 0x53 0x59 | 0x02 | 0xA1 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | | Response | 0x53 0x59 | 0x02 | 0xA1 | 0x00 | len | len B<br>Product Info | sum | 0x54 0x43 | |
| | Product ID query | Send | 0x53 0x59 | 0x02 | 0xA2 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | | Response | 0x53 0x59 | 0x02 | 0xA2 | 0x00 | len | len B<br>Product ID | sum | 0x54 0x43 | |
| | Hardware Model query | Send | 0x53 0x59 | 0x02 | 0xA3 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | | Response | 0x53 0x59 | 0x02 | 0xA3 | 0x00 | len | len B<br>Hardware model | sum | 0x54 0x43 | |
| | Firmware Version query | Send | 0x53 0x59 | 0x02 | 0xA4 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | | Response | 0x53 0x59 | 0x02 | 0xA4 | 0x00 | len | len B<br>Firmware version | sum | 0x54 0x43 | The complete version number is obtained by converting the received hexadecimal number into a string. |
| Work status | Initialization completed information | Report | 0x53 0x59 | 0x05 | 0x01 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| Work status | Scene settings | Send | 0x53 0x59 | 0x05 | 0x07 | 0x00 | 0x01 | 0x01~0x04 | sum | 0x54 0x43 | 1: Living Room<br>2: Bedroom<br>3: Bathroom<br>4: Area Detection |
| | | Response | 0x53 0x59 | 0x05 | 0x07 | 0x00 | 0x01 | 0x01~0x04 | sum | 0x54 0x43 | Detection range for each scene mode: Living Room: 4m Bedroom: 3.5m Bathroom: 2.5m Area Detection: 3m (For related descriptions about the range of scene modes, please refer to section 8.2 of this document.) |
| | Sensitivity settings | Send | 0x53 0x59 | 0x05 | 0x08 | 0x00 | 0x01 | 0x01~0x03 | sum | 0x54 0x43 | 1: Sensitivity level 1<br>2: Sensitivity level 2<br>3: Sensitivity level 3 |
| | | Response | 0x53 0x59 | 0x05 | 0x08 | 0x00 | 0x01 | 0x01~0x03 | sum | 0x54 0x43 | Detection range for each |

| Function Category | Function Description | Transfer direction | Frame header | Control word | Command word | Length Identification | | Data | Checksum field | End of frame | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | sensitivity level: Sensitivity level 1: 2m Sensitivity level 2: 3m Sensitivity level 3: 4m (For related descriptions about the range of sensitivity level, please refer to section 8.3 this document.) |
| | Initialization status inquiry | Send | 0x53 0x59 | 0x05 | 0x81 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | | Response | 0x53 0x59 | 0x05 | 0x81 | 0x00 | 0x01 | 0x01: Completed 0x02: Incomplete | sum | 0x54 0x43 | |
| | Scene settings inquiry | Send | 0x53 0x59 | 0x05 | 0x87 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | | Response | 0x53 0x59 | 0x05 | 0x87 | 0x00 | 0x01 | 0x00~0x04 | sum | 0x54 0x43 | 0: Scene mode not set 1: Living Room 2: Bedroom 3: Bathroom 4: Area Detection |
| | Sensitivity settings inquiry | Send | 0x53 0x59 | 0x05 | 0x88 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | | Response | 0x53 0x59 | 0x05 | 0x88 | 0x00 | 0x01 | 0x00~0x03 | sum | 0x54 0x43 | 0: Sensitivity not set 1: Sensitivity level 1 2: Sensitivity level 2 3: Sensitivity level 3 |
| **Active reporting of human presence information** | | | | | | | | | | | |
| Human presence function | Active reporting of presence information | Report | 0x53 0x59 | 0x80 | 0x01 | 0x00 | 0x01 | 0x00: Unoccupied 0x01: Occupied | sum | 0x54 0x43 | Report when there is a state change |
| | Active reporting of motion information | Report | 0x53 0x59 | 0x80 | 0x02 | 0x00 | 0x01 | 0x00: None 0x01: Motionless 0x02: Active | sum | 0x54 0x43 | Report when there is a state change |
| | Active reporting of Body Movement Parameter | Report | 0x53 0x59 | 0x80 | 0x03 | 0x00 | 0x01 | 1B Body Movement Parameter | sum | 0x54 0x43 | Report every 1 second. Value range: 0-100. (For more information on Body Movement Parameter, please refer to Chapter 8.4.) |

| Function Category | Function Description | Transfer direction | Frame header | Control word | Command word | Length Identification | | Data | Checksum field | End of frame | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time for entering no person state setting | Send | 0x53 0x59 | 0x80 | 0x0A | 0x00 | 0x01 | None: 0x00<br>10s: 0x01<br>30s: 0x02<br>1min: 0x03<br>2min: 0x04<br>5min: 0x05<br>10min: 0x06<br>30min: 0x07<br>60min: 0x08 | sum | 0x54 0x43 | The default setting is 30 seconds. |
| | | Response | 0x53 0x59 | 0x80 | 0x0A | 0x00 | 0x01 | None: 0x00<br>10s: 0x01<br>30s: 0x02<br>1min: 0x03<br>2min: 0x04<br>5min: 0x05<br>10min: 0x06<br>30min: 0x07<br>60min: 0x08 | sum | 0x54 0x43 | For more information on "Time for entering no person state," please refer to Chapter 8.5 of this document. |
| | Active reporting of proximity | Report | 0x53 0x59 | 0x80 | 0x0B | 0x00 | 0x01 | No state: 0x00<br>Near: 0x01<br>Far: 0x02 | sum | 0x54 0x43 | 00: No one/person stationary/chaotic movement<br>01: Approaching the sensor for 3 seconds continuously<br>02: Moving away from the sensor for 3 seconds continuously<br>(For more information on proximity, please refer to Chapter 8.4 of this document.) |
| | **Information Inquiry** | | | | | | | | | | |
| | Presence information inquiry | Send | 0x53 0x59 | 0x80 | 0x81 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | | Response | 0x53 0x59 | 0x80 | 0x81 | 0x00 | 0x01 | 0x00: Unoccupied<br>0x01: Occupied | sum | 0x54 0x43 | |
| | Motion information inquiry | Send | 0x53 0x59 | 0x80 | 0x82 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | | Response | 0x53 0x59 | 0x80 | 0x82 | 0x00 | 0x01 | 0x00: None<br>0x01: Motionless<br>0x02: Active | sum | 0x54 0x43 | |

| Function Category | Function Description | Transfer direction | Frame header | Control word | Command word | Length Identification | | Data | Checksum field | End of frame | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Body Movement Parameter inquiry | Send | 0x53 0x59 | 0x80 | 0x83 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | | Response | 0x53 0x59 | 0x80 | 0x83 | 0x00 | 0x01 | 1B Body Movement Parameter | sum | 0x54 0x43 | |
| | Time for entering no person state inquiry | Send | 0x53 0x59 | 0x80 | 0x8A | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | | Response | 0x53 0x59 | 0x80 | 0x8A | 0x00 | 0x01 | None: 0x00<br>10s: 0x01<br>30s: 0x02<br>1min: 0x03<br>2min: 0x04<br>5min: 0x05<br>10min: 0x06<br>30min: 0x07<br>60min: 0x08 | sum | 0x54 0x43 | |
| | Proximity inquiry | Send | 0x53 0x59 | 0x80 | 0x8B | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | | Response | 0x53 0x59 | 0x80 | 0x8B | 0x00 | 0x01 | No state: 0x00<br>Near: 0x01<br>Far: 0x02 | sum | 0x54 0x43 | |
| **UART Upgrade** | | | | | | | | | | | |
| UART Upgrade | Start UART Upgrade | Send | 0x53 0x59 | 0x03 | 0x01 | 0x00 | 0x01 | 4B Firmware package size + 15B Firmware version number | sum | 0x54 0x43 | Please refer to the tutorial on the Wiki for upgrade instructions. |
| | | Response | 0x53 0x59 | 0x03 | 0x01 | 0x00 | 0x01 | 4B Transfer upgrade package size per frame | sum | 0x54 0x43 | |
| | Upgrade package transmission | Send | 0x53 0x59 | 0x03 | 0x02 | 0x00 | 0x01 | 4B Package offset address + len B Data Packages | sum | 0x54 0x43 | |
| | | Response | 0x53 0x59 | 0x03 | 0x02 | 0x00 | 0x01 | 0x01: Received successfully<br>0x02: Receive Failure | sum | 0x54 0x43 | |
| | Ending the UART Upgrade | Send | 0x53 0x59 | 0x03 | 0x03 | 0x00 | 0x01 | 0x01: Firmware package delivery completed | sum | 0x54 0x43 | |

| Function Category | Function Description | Transfer direction | Frame header | Control word | Command word | Length Identification | | Data | Checksum field | End of frame | Note |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 0x02: Firmware package delivery not completed | | | |
| | | Response | 0x53 0x59 | 0x03 | 0x03 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |

## 8.2 Scene mode

The function of scene mode is to **adjust the maximum detection range of the sensor to recognize human movements**. (Maximum detection distance of the sensor)

There are 4 modes for scene mode, with the default mode being the living room mode. The detection range values for each scene mode are as follows:

| Scene Mode | Detection Radius (m) |
|---|---|
| **Living room** | 4m - 4.5m |
| **Bedroom** | 3.5m - 4m |
| **Bathroom** | 2.5m - 3m |
| **Area detection** | 3m - 3.5m |

## 8.3 Sensitivity setting

The sensitivity setting adjusts the **detection distance of the sensor for human body in static state**.

There are 3 levels for sensitivity setting, with the default level being sensitivity 3. The detection range values for each sensitivity level are as follows:

| Sensitivity | Detection Radius (m) |
|---|---|
| **1** | 2.5 m |
| **2** | 3 m |
| **3** | 4 m |

## 8.4 Additional information on Standard function

| Function Point | Parameter Data Content | Function Description |
|---|---|---|
| **Proximity report** | Near/Far/No State | Near/Far/No State:<br>During the target's movement, if it approaches the radar continuously for 3 seconds or moves away from the radar continuously for 3 seconds, the radar will report "approaching" or "moving away".<br>When the target is in disordered movement or stationary state, the radar will report "none". |
| | | Example:<br>No state: No one present, person standing still, or person in random motion<br>Near state: approaching the radar continuously for 3 seconds<br>Far state: moving away from the radar continuously for 3 seconds |
| **Body Movement Parameter report** | Body Movement Parameter, range: 0-100 | Body Movement Parameter:<br>When there is no person in the space, the body movement parameter is 0.<br>When there is a person present but stationary, the body movement parameter is 1.<br>When there is a person present and in motion, the body movement parameter is 2-100 (the greater the amplitude/distance of the motion, the larger the body movement parameter). |
| | | Example:<br>When there is no one around: the activity parameter is 0<br>When someone is still: the activity parameter is 1<br>When someone is active: the activity parameter is 25 |

## 8.5 Time for entering no person state

The function of ime for entering no person state setting is to adjust the duration from

"someone present" to "no one present" by selecting different absence trigger time settings.

There are 9 levels for the absence trigger time setting, with the default level being 30 seconds. The actual time interval from "someone present" to "no one present" is always greater than or equal to the current unmanned time setting.

# 9. Underlying Open function description

In older versions of millimeter wave sensors, there was no such thing as Underlying Open function. Underlying Open function is one level above Standard function, which means that this feature provides users with more data messages that can provide users with more customizable interfaces. If you do not want to use the results of the Standard function, you can enable the Underlying Open function and output the results of human presence and movement based on the data from this feature.

If you are a general user and feel that the results of the standard function already cover your use case, and the results obtained by the sensor in your environment are accurate enough, then you do not need to use the Underlying Open function.

## 9.1 List of Underlying Open function data information

| Function Description | Transfer direction | Frame header | Control word | Command word | Length Identification | | Data | Checksum field | End of frame | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| **Underlying Open function information output switch** | | | | | | | | | | |
| Underlying Open function information output switch | Send | 0x53<br>0x59 | 0x08 | 0x00 | 0x00 | 0x01 | 0x00: Turn off<br>0x01: Turn on | sum | 0x54<br>0x43 | |
| | Response | 0x53<br>0x59 | 0x08 | 0x00 | 0x00 | 0x01 | 0x00: Turn off<br>0x01: Turn on | sum | 0x54<br>0x43 | This switch is defaulted to the closed state. |
| Underlying Open function | Send | 0x53<br>0x59 | 0x08 | 0x80 | 0x00 | 0x01 | 0x0F | sum | 0x54<br>0x43 | |

| Function Description | Transfer direction | Frame header | Control word | Command word | Length Identification | | Data | Checksum field | End of frame | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| information output switch inquiry | Response | 0x53 0x59 | 0x08 | 0x80 | 0x00 | 0x01 | 0x00: Turn off<br>0x01: Turn on | sum | 0x54 0x43 | |
| **Underlying Open function information** | | | | | | | | | | |
| Reporting of Sensor information | Report | 0x53 0x59 | 0x08 | 0x01 | 0x00 | 0x05 | **byte1**: Existence energy value<br>Range: 0-250<br><br>**byte2**: Static distance<br>Range: 0x01-0x06<br><br>**byte3**: Motion energy value<br>Range: 0-250<br><br>**byte4**: Motion distance<br>Range: 0x01-0x08<br><br>**byte5**: Motion speed<br>Range: 0x01-0x14<br><br>(Please refer to chapter 9.2 for more information on the Underlying Open function.) | sum | 0x54 0x43 | Existence energy value: There are electromagnetic waves in the environment, and the electromagnetic wave frequency changes less when there is no one around. When there is a person in the space, the overall electromagnetic wave reflection will float weakly due to the slight movement caused by breathing (chest breathing).<br><br>Stationary distance: The module detects the straight-line distance of human breathing, which is usually no more than 3 meters.<br><br>Motion energy value: The amplitude value of motion causes different electromagnetic wave frequency changes.<br><br>Motion distance: Detects the distance of the moving target.<br><br>Motion speed: Real-time judgment of the speed of the moving target; the speed is positive (0x01-0x09) when approaching the radar and negative (0x0b-0x14) when moving away. When there is no motion speed, the value is 0a (0m/s), and the speed level progresses in 0.5m/s increments, such as 0x0b is 0+0.5m/s; 0x09 is 0-0.5m/s. |
| Existence energy value inquiry | Send | 0x53 0x59 | 0x08 | 0x81 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | Response | 0x53 0x59 | 0x08 | 0x81 | 0x00 | 0x01 | Range: 0~250 | sum | 0x54 0x43 | |

| Function Description | Transfer direction | Frame header | Control word | Command word | Length Identification | | Data | Checksum field | End of frame | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| Motion energy value inquiry | Send | 0x53 0x59 | 0x08 | 0x82 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | Response | 0x53 0x59 | 0x08 | 0x82 | 0x00 | 0x01 | Range: 0~250 | sum | 0x54 0x43 | |
| Static distance inquiry | Send | 0x53 0x59 | 0x08 | 0x83 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | Response | 0x53 0x59 | 0x08 | 0x83 | 0x00 | 0x01 | 0x00: No one<br>0x01: 0.5m<br>0x02: 1m<br>0x03: 1.5m<br>0x04: 2.0m<br>0x05: 2.5m<br>0x06: 3m | sum | 0x54 0x43 | |
| Motion distance inquiry | Send | 0x53 0x59 | 0x08 | 0x84 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | Response | 0x53 0x59 | 0x05 | 0x84 | 0x00 | 0x01 | 0x00: No one moving<br>0x01: 0.5m<br>0x02: 1m<br>0x03: 1.5m<br>0x04: 2.0m<br>0x05: 2.5m<br>0x06: 3m<br>0x07: 3.5m<br>0x08: 4m | sum | 0x54 0x43 | |
| Motion speed inquiry | Send | 0x53 0x59 | 0x05 | 0x85 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | Response | 0x53 0x59 | 0x05 | 0x85 | 0x00 | 0x01 | 0x00: No one moving<br>Range: 0x01~0x14 | sum | 0x54 0x43 | |

## 9.2 Underlying Open function information

| Function Point | Parameter Data Content | Function Description |
|---|---|---|
| **Reporting of human presence information.** | 1. Existence energy value (Statics noise of environment), range 0-250. | Existence energy value:<br>a. Feedback of micro-motion noise value in the environment at all times.<br>b. When there is no one in the space, the existence energy value is low |

| | | |
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| | 2. Static distance, range 0.5m-3m. | and approximates the micro-motion noise in the environment.<br>c. When there is a person standing still in the space (with micro-movements such as chest breathing), the existence energy value will fluctuate at a higher value.<br><br>Static distance: The straight-line distance between the micro-motion area in the environment and the sensor. When there is a person standing still at a certain position in the space, the straight-line distance between that position and the radar will be output in real-time. |
| | | Example:<br>Without anyone present:<br>Energy value is between 0-5, and the static distance is 0m.<br>With someone present:<br>Energy value is between 30-40, and the static distance is 2.5m. |
| **Motion information report** | 1. Motion energy value (Motion noise of environment), range: 0-250<br>2. Motion distance, range: 0.5m-4m<br>3. Motion speed, range: -5m/s to 5m/s | Motion energy value:<br>a. Can provide feedback on the constant motion noise in the environment.<br>b. When there is no human present in the space, the motion energy value is low and approximates the constant motion noise in the environment.<br>c. When there is human motion present, the motion energy value increases with the amplitude and proximity of the motion.<br><br>Motion distance:<br>The straight-line distance between the motion location in the environment and the sensor. When there is human motion present in the space, the straight-line distance between the human and the sensor is output in real-time. |

| | | |
|---|---|---|
| | | Motion speed:<br>When there is motion present in the environment, a positive speed value is provided when the object is moving closer to the sensor and a negative speed value is provided when it is moving away. The target's motion speed is also determined in real-time. |
| | | Example: Motion energy value:<br>• 0-5 when no one is present<br>• 15-25 for small movements at a distance by a person<br>• 70-100 for large movements up close by a person<br>Motion distance:<br>• 3.5m when a person is continuously approaching a certain point<br>Motion speed:<br>• +0.5m/s when a person is continuously approaching a certain point. |

# 10. Custom mode description

This instruction mainly focuses on detailed explanations and descriptions of the settings for underlying open parameter settings, and time logic settings in the sensor custom functions.

The parameter configurations of 10.1 to 10.3 are only effective in the custom mode.

## 10.1 List of Custom mode information

| Function Description | Transfer direction | Frame header | Control word | Command word | Length Identification | | Data | Checksum field | End of frame | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| **Custom mode setting** | | | | | | | | | | |
| Custom mode setting | Send | 0x53 0x59 | 0x05 | 0x09 | 0x00 | 0x01 | 0x01~0x04 | sum | 0x54 0x43 | 0x01: Custom mode 1. 0x02: Custom mode 2. 0x03: Custom mode 3. 0x04: Custom mode 4. |
| | Response | 0x53 0x59 | 0x05 | 0x09 | 0x00 | 0x01 | 0x01~0x04 | sum | 0x54 0x43 | |
| End of custom mode settings | Send | 0x53 0x59 | 0x05 | 0x0A | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | Used to save custom parameters |
| | Response | 0x53 0x59 | 0x05 | 0x0A | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| Custom mode query | Send | 0x53 0x59 | 0x05 | 0x89 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | Response | 0x53 0x59 | 0x05 | 0x89 | 0x00 | 0x01 | 0x01~0x04 | sum | 0x54 0x43 | 0x00: Custom mode is not enabled. 0x01: Custom mode 1. 0x02: Custom mode 2. 0x03: Custom mode 3. 0x04: Custom mode 4. |
| **Underlying open parameter settings** | | | | | | | | | | |
| Existence judgment threshold settings | Send | 0x53 0x59 | 0x08 | 0x08 | 0x00 | 0x01 | Range: 0~250 | sum | 0x54 0x43 | The electromagnetic wave threshold values for presence or absence of people in the environment are preset. Please refer to the default values. If there is interference from moving objects, collect the static spatial value and adjust accordingly. |
| | Response | 0x53 0x59 | 0x08 | 0x08 | 0x00 | 0x01 | Range: 0~250 | sum | 0x54 0x43 | The default value is 33 (Please refer to chapter 10.2 for more information on the Underlying Open function parameters.) |
| Motion trigger threshold settings | Send | 0x53 0x59 | 0x08 | 0x09 | 0x00 | 0x01 | Range: 0~250 | sum | 0x54 0x43 | Sensor trigger setting: the setting of motion amplitude when a person enters the environment, which is used to limit false alarms from the outside. Please use the default value as a priority. |
| | Response | 0x53 0x59 | 0x08 | 0x09 | 0x00 | 0x01 | Range: 0~250 | sum | 0x54 0x43 | The default value is 4 (Please refer to chapter 10.2 for more |

| Function Description | Transfer direction | Frame header | Control word | Command word | Length Identification | | Data | Checksum field | End of frame | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | information on the Underlying Open function parameters.) |
| Existence perception boundary settings | Send | 0x53 0x59 | 0x08 | 0x0A | 0x00 | 0x01 | 0x01: 0.5m 0x02: 1m 0x03: 1.5m 0x04: 2.0m 0x05: 2.5m 0x06: 3m 0x07: 3.5m 0x08: 4m 0x09: 4.5m 0x0a: 5m | sum | 0x54 0x43 | Detection range setting of the sensor, used to reduce false alarms of the radar and minimize interference outside the detection range. |
| | Response | 0x53 0x59 | 0x08 | 0x0A | 0x00 | 0x01 | 0x01: 0.5m 0x02: 1m 0x03: 1.5m 0x04: 2.0m 0x05: 2.5m 0x06: 3m 0x07: 3.5m 0x08: 4m 0x09: 4.5m 0x0a: 5m | sum | 0x54 0x43 | The default value is 5m (Please refer to chapter 10.2 for more information on the Underlying Open function parameters.) |
| Motion Trigger Boundary Setting | Send | 0x53 0x59 | 0x08 | 0x0B | 0x00 | 0x01 | 0x01: 0.5m 0x02: 1m 0x03: 1.5m 0x04: 2.0m 0x05: 2.5m 0x06: 3m 0x07: 3.5m 0x08: 4m 0x09: 4.5m 0x0a: 5m | sum | 0x54 0x43 | Setting the human activity detection distance is used to reduce radar false alarm rates and minimize interference from people walking outside the detection range of the door or glass doors. |
| | Response | 0x53 0x59 | 0x08 | 0x0B | 0x00 | 0x01 | 0x01: 0.5m 0x02: 1m 0x03: 1.5m 0x04: 2.0m 0x05: 2.5m 0x06: 3m 0x07: 3.5m 0x08: 4m 0x09: 4.5m 0x0a: 5m | sum | 0x54 0x43 | The default value is 5m (Please refer to chapter 10.2 for more information on the Underlying Open function parameters.) |
| Motion trigger time setting | Send | 0x53 0x59 | 0x08 | 0x0C | 0x00 | 0x04 | Time information | sum | 0x54 0x43 | This is used for time accumulation of motion triggering to reduce false alarms through multiple judgments of triggering. It can be combined with motion amplitude trigger thresholds and motion trigger boundaries to limit performance. |
| | Response | 0x53 0x59 | 0x08 | 0x0C | 0x00 | 0x04 | Time information | sum | 0x54 0x43 | Unit in ms, default 150ms (Please refer to chapter 10.3 for more information on the Underlying Open function parameters.) |
| Motion-to-Still Time setting | Send | 0x53 0x59 | 0x08 | 0x0D | 0x00 | 0x04 | Time information | sum | 0x54 0x43 | This parameter is used to adjust the duration of reporting the current human motion state. In combination with the threshold settings for motion and stillness triggering, it can provide a rough indication of the degree of human motion in the environment. |
| | Response | 0x53 | 0x08 | 0x0D | 0x00 | 0x04 | Time information | sum | 0x54 | Unit in ms, default 3000ms |

| Function Description | Transfer direction | Frame header | Control word | Command word | Length Identification | | Data | Checksum field | End of frame | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0x59 | | | | | | | 0x43 | (Please refer to chapter 10.3 for more information on the Underlying Open function parameters.) |
| Time for entering no person state setting | Send | 0x53 0x59 | 0x08 | 0x0E | 0x00 | 0x04 | Time information | sum | 0x54 0x43 | If the radar does not detect any breathing movements for a certain period of time, it will automatically enter a no-person state. This parameter is used to manually set the time for quickly entering the no-person state. |
| | Response | 0x53 0x59 | 0x08 | 0x0E | 0x00 | 0x04 | Time information | sum | 0x54 0x43 | Unit in ms, default 30000ms (Please refer to chapter 10.3 for more information on the Underlying Open function parameters.) |
| **Underlying open parameter inquiry** | | | | | | | | | | |
| Existence judgment threshold inquiry | Send | 0x53 0x59 | 0x08 | 0x88 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | Response | 0x53 0x59 | 0x08 | 0x88 | 0x00 | 0x01 | Range: 0~250 | sum | 0x54 0x43 | |
| Motion trigger threshold inquiry | Send | 0x53 0x59 | 0x08 | 0x89 | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | Response | 0x53 0x59 | 0x08 | 0x89 | 0x00 | 0x01 | Range: 0~250 | sum | 0x54 0x43 | |
| Existence perception boundary inquiry | Send | 0x53 0x59 | 0x08 | 0x8A | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | Response | 0x53 0x59 | 0x08 | 0x8A | 0x00 | 0x01 | 0x01: 0.5m 0x02: 1m 0x03: 1.5m 0x04: 2.0m 0x05: 2.5m 0x06: 3m 0x07: 3.5m 0x08: 4m 0x09: 4.5m 0x0a: 5m | sum | 0x54 0x43 | |
| Motion Trigger Boundary inquiry | Send | 0x53 0x59 | 0x08 | 0x8B | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | Response | 0x53 0x59 | 0x08 | 0x8B | 0x00 | 0x01 | 0x01: 0.5m 0x02: 1m 0x03: 1.5m 0x04: 2.0m 0x05: 2.5m 0x06: 3m 0x07: 3.5m 0x08: 4m 0x09: 4.5m 0x0a: 5m | sum | 0x54 0x43 | |
| Motion trigger Time inquiry | Send | 0x53 0x59 | 0x08 | 0x8C | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | Response | 0x53 | 0x08 | 0x8C | 0x00 | 0x01 | Time information | sum | 0x54 | |

| Function Description | Transfer direction | Frame header | Control word | Command word | Length Identification | | Data | Checksum field | End of frame | Note |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0x59 | | | | | | | 0x43 | |
| Motion-to-Still Time inquiry | Send | 0x53 0x59 | 0x08 | 0x8D | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | |
| | Response | 0x53 0x59 | 0x08 | 0x8D | 0x00 | 0x01 | Time information | sum | 0x54 0x43 | |
| Time for entering no person state inquiry | Send | 0x53 0x59 | 0x08 | 0x8E | 0x00 | 0x01 | 0x0F | sum | 0x54 0x43 | The Time for entering no person state in the low-level open parameters is different from that in the standard mode. In the low-level open parameters, this time value can be freely set to any value (not exceeding 1 hour), but in the standard mode, only specific values can be set. |
| | Response | 0x53 0x59 | 0x08 | 0x8E | 0x00 | 0x01 | Time information | sum | 0x54 0x43 | |

## 10.2 Underlying open parameter settings

| Function Point | Parameter Data Content | Function Description |
|---|---|---|
| **Existence judgment threshold settings** | Existence judgment threshold, range from 0 to 250. | Existence judgment threshold:<br>For distinguishing between the presence and absence of people based on the different energy levels in the environment, an appropriate threshold value can be set to form a simple discrimination criterion for determining the presence or absence of people. |
| | | Example:<br>When there is no one around: 0-5<br>When someone is present: 30-40<br>The existence judgment threshold is set to: 6-29<br>This can be used as a simple criterion for distinguishing between the presence and absence of people.<br>(Threshold values can be adjusted based on actual judgment requirements to control the difficulty level of determining the presence or |

| | | |
|---|---|---|
| | | absence of people.) |
| **Motion trigger threshold settings** | Motion trigger threshold, range from 0 to 250. | Motion trigger threshold:<br>By setting an appropriate threshold value based on the different motion energy levels in the environment when there is no one around, when someone is moving slightly, and when someone is moving significantly, a simple discrimination criterion for distinguishing between the active and still states can be formed. |
| | | Example:<br>When there is no one around: 0-5<br>When someone is still with slight body movements: 7-9<br>When someone is moving slightly at a distance: 15-20<br>When someone is moving significantly at close range: 60-80<br>The motion trigger threshold is set to: 10-14<br>This can serve as a simple criterion for distinguishing between active and still states.<br>(Threshold values can be adjusted based on actual judgment requirements to control the level of difficulty in triggering motion detection.) |
| **Existence perception boundary settings** | Existence perception boundary, range from 0.5m to 5m. | Existence perception boundary:<br>For the detection of stationary (slightly moving) targets in space, the radar can output its stationary distance in real-time. Therefore, by setting the existence perception boundary, the range of motion sensing can be controlled, which can in turn control the range of distinguishing between the presence and absence of people. |
| | | Example:<br>In the current environment: |

| | | |
|---|---|---|
| | | The real-time stationary distance of a stationary (slightly moving) target is 3m (it is the source of slight movement interference).<br>The existence perception boundary is set to <3m.<br>The overall detection range of human presence can be reduced to less than 3m to exclude interference from non-human sources at 3m.<br>(Set the threshold based on actual judgment to control the range of existence perception boundaries.) |
| **Motion Trigger Boundary Setting** | Range of motion detection boundary: 0.5m to 5m. | Motion triggering boundary:<br>For detecting moving targets in the space, sensor can output real-time distance of the motion. Therefore, by setting the motion triggering boundary, the range of motion triggering can be controlled to determine the boundary between inactive (no person) and active (with person) states. |
| | | Example:<br>In the current environment:<br>Real-time motion distance of a moving target: 3.5m<br>(it is a motion interference source, such as a continuously rotating fan motor)<br>Motion trigger boundary setting: ＜ 3.5m<br>The overall range of motion detection can be reduced to less than 3.5m by setting the motion trigger boundary, which can exclude interference sources that are not human-made at 3.5m. (Thresholds can be set based on actual judgment to control the range of motion trigger boundaries.) |

## 10.3 The setting for Time logic

| Function Point | Parameter Data Content | Function Description |
|---|---|---|
| **Motion trigger** | Motion trigger time, range: | Motion trigger time: |

| | | |
|---|---|---|
| **time setting** | 0~1000ms. | To judge the active state, the following conditions must be met to be considered as an active state.<br>a. The motion energy value is greater than the motion trigger threshold.<br>b. Within the motion trigger boundary.<br>c. Continuously meeting the threshold and boundary conditions within the set motion trigger time.<br>With the participation of these three setting parameters, a relatively complete and detailed standard for judging the transition from stillness to activity is formed. |
| | | Example:<br>In the current environment:<br>The target has been moving continuously for 1 second.<br>Real-time spatial motion value: 30-40.<br>Real-time motion distance: <2.5m.<br>Motion trigger threshold setting: 15.<br>Motion trigger boundary setting: 3m.<br>Motion trigger time setting: 0.8s.<br>At this moment, the target's motion energy value is greater than the set threshold, the motion distance is within the set boundary, and the target has been moving for more than the set time, so it can be judged as an active state.<br>(Adjust the trigger time according to actual judgment to control the difficulty of motion triggering.) |
| **Motion-to-Still Time setting** | Motion-to-Still time, range 1~60s. | Motion-to-Still time:<br>To determine the still state, the following conditions must be met:<br>a. The motion energy value is less than the motion trigger threshold<br>b. The above threshold condition is continuously satisfied within the set motion-to-still time |

| | | |
|---|---|---|
| | | These two setting parameters contribute to forming a more complete and detailed standard for determining the transition from active to still state. |
| | | Example:<br>In the current environment:<br>Target has been stationary for 2 seconds<br>Real-time motion value: 10<br>Motion trigger threshold setting: 15<br>Motion-to-still time setting: 1s<br>At this moment, the motion energy value of the target is lower than the set threshold, and the duration of stillness exceeds the set time.<br>Therefore, it can be judged as a still state.<br>(Setting the time according to actual judgment to control the difficulty of maintaining stillness) |
| **Time for entering no person state setting** | The range for the time it takes to transition from a person-present state to a person-absent state is 0s to 3600s. | Enter unmanned state time:<br>To determine the absence of people in the space, the following three conditions must be met to judge the unmanned state:<br>a. The motion energy value is less than the motion trigger threshold<br>b. There is an energy value less than the presence judgment threshold<br>c. It is outside the presence judgment boundary<br>d. Within the set time to enter the unmanned state, the above three conditions are continuously satisfied<br>These four setting parameters work together to form a more complete and detailed standard for determining the unmanned state. |
| | | Example:<br>In the current environment:<br>No person present<br>Real-time motion energy value: 10<br>Real-time existence energy value: 2 |

| | | |
|---|---|---|
| | | Target movement distance: 4.5m<br>Target stationary distance: 4m<br>Existence judgment threshold setting: 40<br>Motion trigger threshold setting: 30<br>Motion trigger boundary: 3m<br>Existence judgment boundary: 3m<br>Time to enter unmanned state setting: 50s<br>At this moment, the motion energy value, existence energy value, and dynamic and static distance all meet the conditions for judging unmanned state. After continuing for 50s, the system enters unmanned state.<br>(The time setting for entering unmanned state can be adjusted according to actual needs to control the difficulty of entering unmanned state.) |