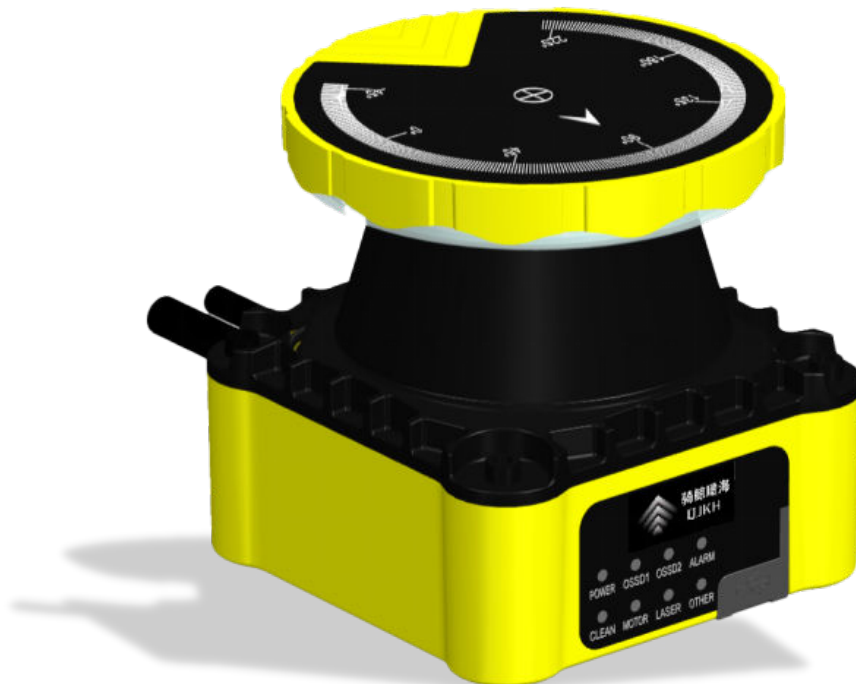




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# SH27-05D Safety Laser Scanner Product Specification



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## Product Introduction

The SH series safety laser scanner is a high-performance single line lidar based on the direct time of flight (dTOF) ranging principle; Compliant with high-level safety requirements of Type 3 (IEC 61496), SIL2 (IEC 61508), Cat. 3 (ISO 13849-1), PL d (ISO 13849-1).

This product establishes a definable protection area through an invisible laser beam, which is used to protect hazardous areas and achieve protection of work hazardous points, passages, or material rack hazardous areas; Especially suitable for various application scenarios such as safe navigation and obstacle avoidance, regional security monitoring, etc.

## Technical Parameters

Table 1 Technical Parameters Table

| Detection Parameters                                                 |                                                                                                                                                                                                     |
|----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Maximum Protection Radius                                            | 5 m @ 1.8% reflectivity                                                                                                                                                                             |
| Detection Radius                                                     | 40 m @ 70% reflectivity                                                                                                                                                                             |
| Alarm Zone Radius                                                    | 20 m                                                                                                                                                                                                |
| Measurement Range (Limit Value)                                      | 60m                                                                                                                                                                                                 |
| Scanning Angle                                                       | 276°                                                                                                                                                                                                |
| Angular Resolution                                                   | 0.1°                                                                                                                                                                                                |
| Refresh Frequency                                                    | 30 Hz                                                                                                                                                                                               |
| Tolerance Zone (TZ = Tolerance Range of Safety Laser Radar)          | 65 mm                                                                                                                                                                                               |
| Minimum Detectable Object (Object Resolution (Detection Capability)) | 70 mm @ Maximum Radius of Protection Zone                                                                                                                                                           |
| Electrical and Mechanical Parameters                                 |                                                                                                                                                                                                     |
| Operating Voltage                                                    | DC 24 V $\pm$ 20%                                                                                                                                                                                   |
| Power-on Startup Time                                                | Typical value 10 s                                                                                                                                                                                  |
| Refresh Frequency                                                    | 30 Hz                                                                                                                                                                                               |
| Power Consumption                                                    | < 5 W (no load)                                                                                                                                                                                     |
| Configuration Interface                                              | Type-C + Ethernet                                                                                                                                                                                   |
| Safety Output (OSSD)                                                 | PNP output (ON state: max IO <sub>UT</sub> = 100 mA, V <sub>OUT</sub> $\geq$ V <sub>CC</sub> -2 V; OFF state: IO <sub>UT</sub> < 1 mA, V <sub>OUT</sub> < 2 V), over current protection, capacitive |

|                                                 |                                                                                                                       |
|-------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|
|                                                 | load $\leq 1\mu\text{F}$ . ON state when no object in protection zone; OFF state when object detected or fault occurs |
| Auxiliary Output                                | PNP output, max IOUT = 100 mA, VOUT $\geq$ VCC-2 V; OFF state: IOUT < 1 mA, VOUT < 2 V), over current protection      |
| Overall Dimensions                              | 80 mm $\times$ 80 mm $\times$ 79.5 mm                                                                                 |
| Weight (including end cap cable)                | 420 g                                                                                                                 |
| Housing Color                                   | Yellow                                                                                                                |
| Ambient Temperature                             | Operating: -10 °C – 50 °C (no frost or condensation)                                                                  |
|                                                 | Storage: -40 °C – 70 °C                                                                                               |
| Ambient Humidity                                | Operating: 35% RH – 95% RH                                                                                            |
|                                                 | Storage: 35% RH – 95% RH                                                                                              |
| Light Interference Immunity (Incandescent Lamp) | 3000 lux                                                                                                              |
| Shock Resistance                                | Acceleration 10 g<br>Pulse duration: 16 ms<br>Collision count: three axes, 1000 $\pm$ 10 times per axis               |
|                                                 | 5M1 (IEC TR 60721-4-5)<br>50 m/s <sup>2</sup> ; 11 ms                                                                 |
| Vibration Resistance                            | Frequency 10 Hz – 55 Hz<br>Amplitude: 0.35 $\pm$ 0.05 mm<br>Sweep count: three axes, 20 times per axis                |
|                                                 | 5M1 (IEC TR 60721-4-5)<br>Sine: 1.5 mm, 2–9 Hz<br>Random: 0.3 m <sup>2</sup> /s <sup>3</sup> , 10–200 Hz              |
| Protection Rating                               | IP65                                                                                                                  |
| Safety Standards                                | Type 3 (IEC 61496-3:2018)                                                                                             |
|                                                 | SIL 2 (IEC 61508:2010)                                                                                                |
|                                                 | Cat. 3 (ISO 13849-1:2023)                                                                                             |
|                                                 | PL d (ISO 13849-1:2023)                                                                                               |
| Electromagnetic Compatibility (EMC)             | EN IEC 61326-1:2021                                                                                                   |
|                                                 | EN 61000-4-2:2009                                                                                                     |
|                                                 | EN 61000-4-3:2020                                                                                                     |
|                                                 | EN 61000-4-4:2012                                                                                                     |
|                                                 | EN 61000-4-6:2014                                                                                                     |
|                                                 | EN 61000-4-8:2010                                                                                                     |
| <b>Configurable Functions</b>                   |                                                                                                                       |

|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Zone Configuration   | Users can configure the SH zone into the desired shape via the configuration software                                                                                                                                                                                                                                                                                                                                                                                                           |
| Response time        | $t_R = n \times (m+1)$ <ul style="list-style-type: none"> <li>• <math>t_R</math> = Response time</li> <li>• <math>n</math> = Set scanning period</li> <li>• <math>m</math> = Set number of scans</li> </ul> <p>The scanning period is determined by the motor speed, default is 30 Hz, corresponding to a scanning period of (1000/30) ms = 33.4 ms. Users can configure the response time by setting the number of scans. The setting range is 100 ms–567 ms, corresponding to 2–16 scans.</p> |
| Zone Group Switching | Configure INPUT1–INPUT8 and General IO1–General IO4 to achieve static input switching of 64 monitoring instances and 64 zone groups; dynamic input switching of 256 monitoring instances and 64 zone groups                                                                                                                                                                                                                                                                                     |

## Working Principle and Protection Zone Configuration

The SH type safety laser radar is an electro-sensitive protective equipment (ESPE), based on the laser ranging principle, achieving two-dimensional area protection through rotational scanning; It uses invisible laser beams to establish a protection zone, mainly for protecting hazardous areas, ensuring protection of hazard points, access, and hazardous areas. Users can configure the number and shape of protection zones through the configuration software.

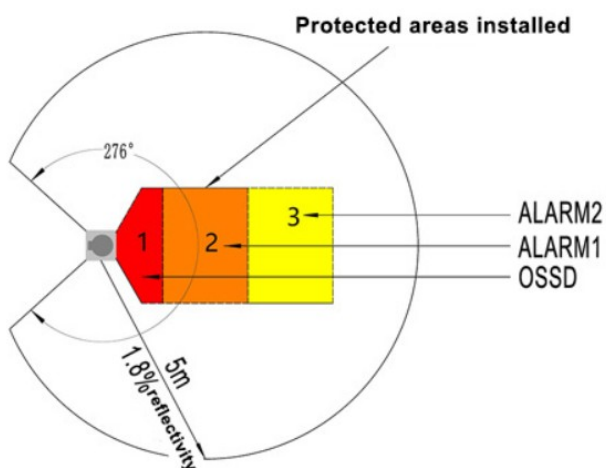


Figure 1 Protection Zone+Warning Zone mode

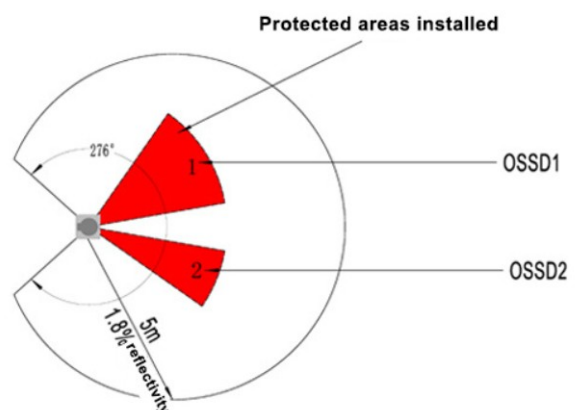


Figure 2 Dual Protection Zone mode

| Symbol | Meaning         | Symbol | Meaning           |
|--------|-----------------|--------|-------------------|
| OSSD   | Protection Zone | OSSD1  | Protection Zone 1 |

|        |                |       |                   |
|--------|----------------|-------|-------------------|
| ALARM1 | Warning Zone 1 | OSSD2 | Protection Zone 2 |
| ALARM2 | Warning Zone 2 | /     | /                 |

### Appearance Information



Figure 3 Indicator Lights

Table 2 Appearance Information Description

| No. | Component Name          | Description                                                                                         |
|-----|-------------------------|-----------------------------------------------------------------------------------------------------|
| 1   | Contamination Indicator | The top of the window contains a total of nine Indicator Lights                                     |
| 2   | Optical Window          | The SH detection beam is emitted outward through the optical window, with a detection angle of 276° |
| 3   | Indicator Label         | Indicator Label contains eight Indicator Lights                                                     |
| 4   | Type-C Interface        | The radar connects to the computer via the configuration cable through this interface               |
| 5   | Nameplate               | Indicates the technical parameters related to the SH                                                |

Table 3 Indicator Light Status

| Indicator Symbol | Indicator Definition | Status | Description |
|------------------|----------------------|--------|-------------|
|------------------|----------------------|--------|-------------|

|       |                                    |       |                                                                                            |
|-------|------------------------------------|-------|--------------------------------------------------------------------------------------------|
| POWER | Power Indicator                    | Green | Green light on after SH power-on successful                                                |
|       |                                    | Off   | SH power-on failed                                                                         |
| OSSD1 | Safety Output 1 Indicator          | Green | No object detected in Protection Zone 1, OSSD1 outputs ON state                            |
|       |                                    | Red   | Object detected in Protection Zone 1, OSSD1 outputs OFF state                              |
| OSSD2 | Safety Output 2 Indicator          | Green | Dual Protection Zone mode: no object detected in Protection Zone 2, OSSD2 outputs ON state |
|       |                                    | Red   | Dual Protection Zone mode: object detected in Protection Zone 2, OSSD2 outputs OFF state   |
|       |                                    | Off   | Protection Zone + Warning Zone mode: off                                                   |
| ALARM | Warning Output Indicator           | Green | Protection Zone + Warning Zone mode: no object detected in Warning Zone                    |
|       |                                    | Red   | Protection Zone + Warning Zone mode: object detected in Warning Zone                       |
|       |                                    | Off   | Undefined ALARM output: off                                                                |
| CLEAN | Optical Window Status Indicator    | Green | Optical window is clean                                                                    |
|       |                                    | Red   | Optical Window severely contaminated, cleaning required                                    |
| MOTOR | Motor Status Indicator             | Green | Radar motor is in normal working condition                                                 |
|       |                                    | Red   | Radar motor malfunction                                                                    |
| LASER | Laser Measurement Status Indicator | Green | Radar laser measurement is in normal working condition                                     |
|       |                                    | Red   | Radar laser measurement malfunction                                                        |
| OTHER | Other Status Indicator             | Green | Radar is in normal working condition                                                       |
|       |                                    | Red   | Radar has other operational faults                                                         |

Note: In the process of power on, power light stays on, all other indicator lights including contamination indicator enter a flowing light pattern, indicating that the device is starting up, which is a normal state. When the flowing light stops, the starting up completed.

## I/O Interfaces

SH power/output interface is M12-17-pin male connector, cable length 0.3 m. Network connection interface is M12-4-pin female connector, cable length 0.3 m.

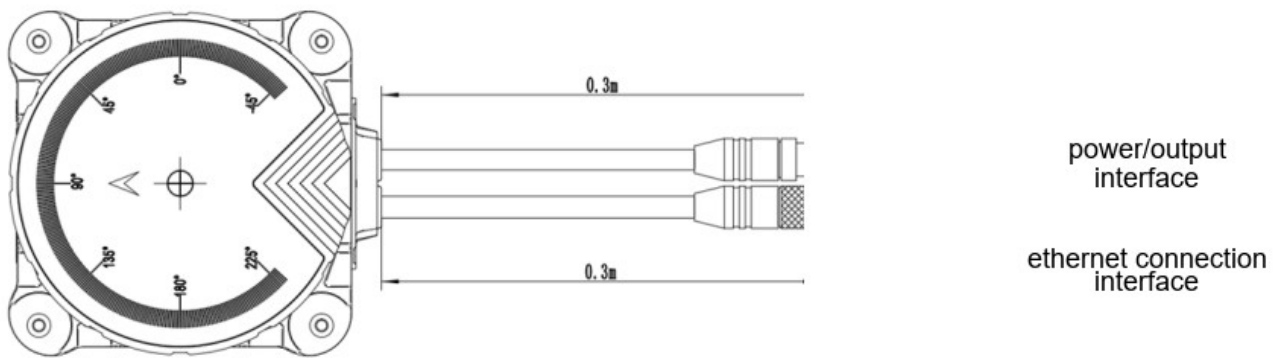


Figure 4 SH Connection Cables

The standard cable length for the power/control interface extension cable is 1 m. Wire core colors and corresponding interface assignments are shown in the table.

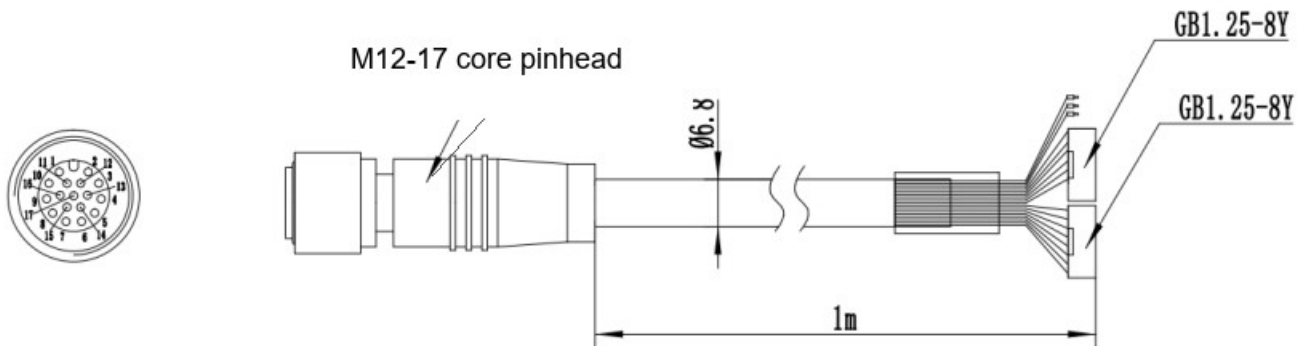


Figure 5 Power Interface extension cable

Table 4 Cable color signal correspondence table

| Pin | Wire Color | Signal Definition | Function                                                                                                                           |
|-----|------------|-------------------|------------------------------------------------------------------------------------------------------------------------------------|
| 1   | Brown      | 24 V              | Operating Voltage (+24 V DC)                                                                                                       |
| 2   | Blue       | 0 V               | Operating Voltage (0 V DC)                                                                                                         |
| 3   | White      | OSSD1.A           | First pair of OSSD, OSSD1.A                                                                                                        |
| 4   | Green      | OSSD1.B           | First pair of OSSD, OSSD1.B                                                                                                        |
| 5   | Pink       | General I/O 1     | Configurable:<br>Static control input: B1<br>General output: Warning Output 1 / Warning Output 2                                   |
| 6   | Yellow     | General I/O 2     | Configurable:<br>Static control input: A1<br>General output: Warning Output 1 / Warning Output 2 /<br>Second pair of OSSD, OSSD2.A |

|    |              |               |                                                                                                                                    |
|----|--------------|---------------|------------------------------------------------------------------------------------------------------------------------------------|
| 7  | Black        | General I/O 3 | Configurable:<br>Static control input: A2<br>General output: Warning Output 1 / Warning Output 2 /<br>Second pair of OSSD, OSSD2.B |
| 8  | Grey         | General I/O 4 | Configurable:<br>Static control input: B2<br>General output: Warning Output 1 / Warning Output 2                                   |
| 9  | Red          | Input 1       | Configurable:<br>Static control input: C1<br>Dynamic control input: Encoder 1a (0°)                                                |
| 10 | Purple       | Input 2       | Configurable:<br>Static control input: C2<br>Dynamic control input: Encoder 1b (90°)                                               |
| 11 | Grey-Pink    | Input 3       | Configurable:<br>Static control input: D1<br>Dynamic control input: Encoder 2a (0°)                                                |
| 12 | Red-Blue     | Input 4       | Configurable:<br>Static control input: D2<br>Dynamic control input: Encoder 2b (90°)                                               |
| 13 | White-Green  | Input 5       | Configurable:<br>Static control input: E1<br>Dynamic control input: Encoder 3a (0°)                                                |
| 14 | Brown-Green  | Input 6       | Configurable:<br>Static control input: E2<br>Dynamic control input: Encoder 3b (90°)                                               |
| 15 | White-Yellow | Input 7       | Configurable:<br>Static control input: F1<br>Dynamic control input: Encoder 4a (0°)                                                |
| 16 | Yellow-Brown | Input 8       | Configurable:<br>Static control input: F2<br>Dynamic control input: Encoder 4b (90°)                                               |
| 17 | White-Grey   | /             | /                                                                                                                                  |

The network interface extension cable is a 4-core industrial network connection cable, with an M12-4-pin male connector on one end and an RJ45 connector on the other end. The standard cable length is 1m.

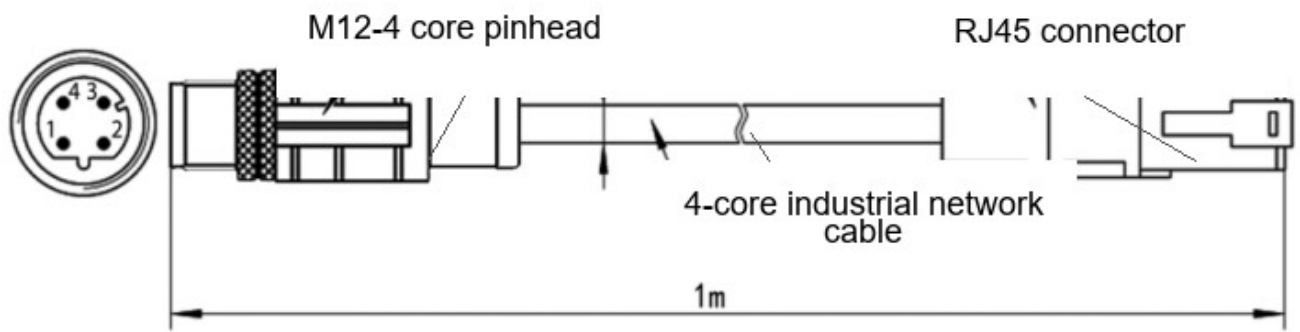


Figure 6 Network interface extension cable

## Mechanical Dimensions

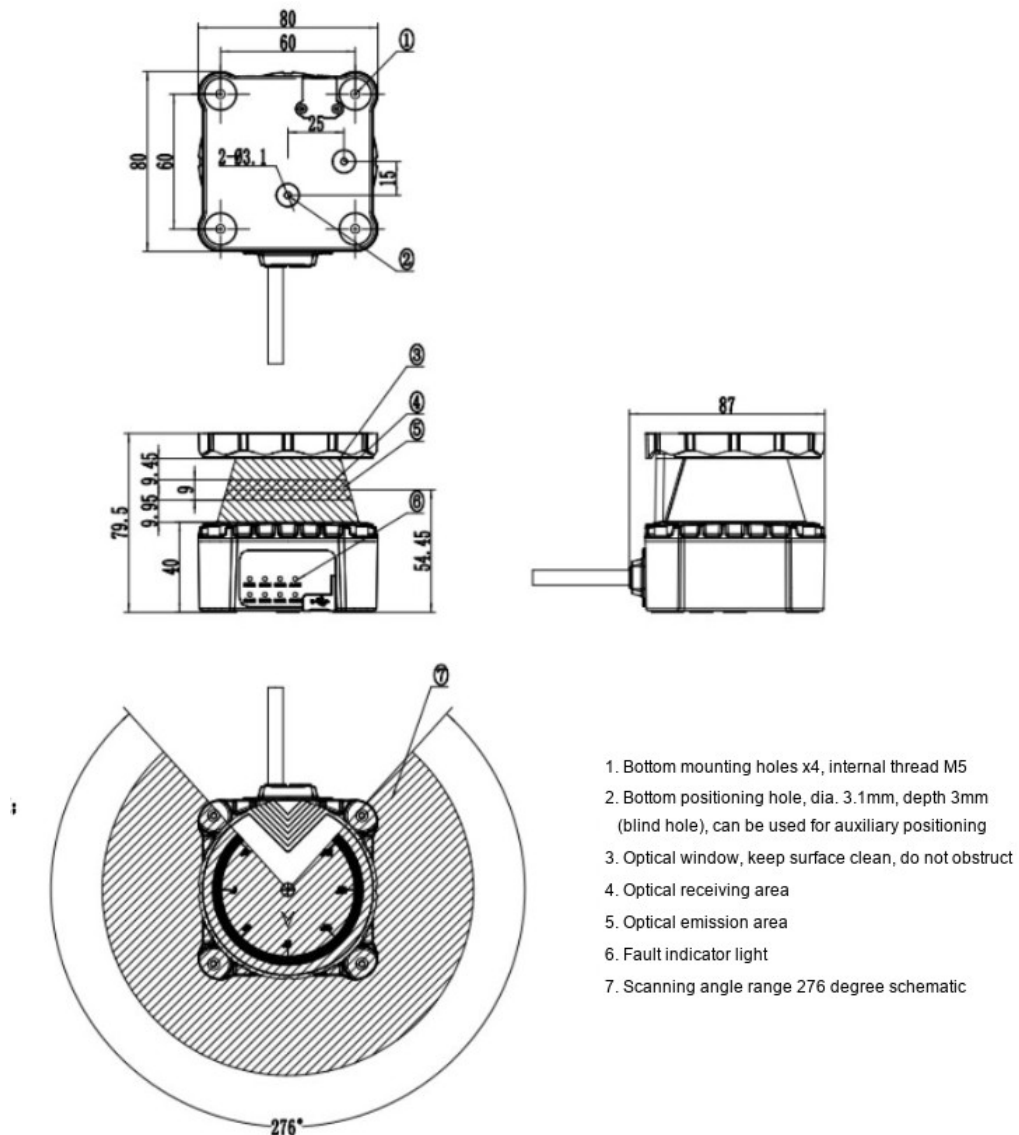


Figure 7 Overall Dimensions Figure



Figure 8 Scanning range Schematic Figure

## Communication Protocol

Table 5 Data Format Overview Table

| Data Format Description                                                                                                                                        | Overview                                                                                                                                                                                                                                                                                       |                                                                        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------|
| <pre>struct cmd_frame {   uint8_t start_code[4];   uint16_t length;   uint8_t check_sum;   uint8_t cmd_type;   uint8_t data[]; }__attribute__((packed));</pre> | <ol style="list-style-type: none"> <li>1. Uses UDP communication protocol;</li> <li>2. Port No. 2112</li> <li>3. Distance data and echo intensity data use little-endian format;</li> <li>4. Except for distance data and echo intensity data, big-endian format is used uniformly;</li> </ol> |                                                                        |
| Name                                                                                                                                                           | Bytes                                                                                                                                                                                                                                                                                          | Description                                                            |
| start_code                                                                                                                                                     | 4                                                                                                                                                                                                                                                                                              | Sensor start code 0xFE 0x5A 0xA5 0x55                                  |
| length                                                                                                                                                         | 2                                                                                                                                                                                                                                                                                              | Data length following the length field, high byte first, low byte last |
| check_sum                                                                                                                                                      | 1                                                                                                                                                                                                                                                                                              | 1-byte checksum, XOR of all data from cmd_type to the end of the frame |
| cmd_type                                                                                                                                                       | 1                                                                                                                                                                                                                                                                                              | Command Type<br>0x01: Get real-time radar data                         |

|         |   |                                                                          |
|---------|---|--------------------------------------------------------------------------|
| data[M] | M | Command data, detailed data format under each command type, can be empty |
|---------|---|--------------------------------------------------------------------------|

The SH safety lidar defaults angular resolution is 0.1 degree. After receiving the real-time data acquisition command, the radar periodically sends distance and echo intensity data.

Angular resolution is 0.1 degree: within the  $-48^{\circ}$  to  $228^{\circ} = 276^{\circ}$  range, a total of  $276/0.1 + 1 = 2761$  sample points are collected. Each sample point data occupies 4 bytes of storage (distance data 2 bytes, echo intensity 2 bytes, distance data unit 1 mm). The total sample point data occupies  $2761*2$  (distance data) +  $2761*2$  (echo intensity data) = 11044 bytes, plus 512 bytes of device information field, totaling 11556 bytes, which exceeds the UDP transmission length (1472), so it is actively divided into 9 packets at the application layer (4 distance data packets, 4 echo intensity data packets, 1 additional information field packet).

Table 6 PC Real-time Data Command Table

| PC Real-time Data Acquisition Command |                     |           |           |          |
|---------------------------------------|---------------------|-----------|-----------|----------|
| Type                                  | start_code[4]       | length    | check_sum | cmd_type |
| Get Real-time Data                    | 0xFE 0x5A 0xA5 0x55 | 0x00 0x02 | 0x01      | 0x01     |

Table 7 Radar Real-time Data Response Table (excluding sensor data)

| Radar Real-time Data Response (excluding sensor data) |                     |              |           |          |             |
|-------------------------------------------------------|---------------------|--------------|-----------|----------|-------------|
| Lidar real-time data                                  | start_code[4]       | length       | check_sum | cmd_type | sensor data |
| frame_num_1                                           | 0xFE 0x5A 0xA5 0x55 | 0xxx<br>0xxx | 0xXX      | 0x01     | ...         |
| frame_num_2                                           | 0xFE 0x5A 0xA5 0x55 | 0xxx<br>0xxx | 0xXX      | 0x01     | ...         |
| ...                                                   | ...                 | ...          | ...       | ...      | ...         |
| frame_num_N-2                                         | 0xFE 0x5A 0xA5 0x55 | 0xxx<br>0xxx | 0xXX      | 0x01     | ...         |
| frame_num_N-1                                         | 0xFE 0x5A 0xA5 0x55 | 0xxx<br>0xxx | 0xXX      | 0x01     | ...         |
| frame_num_N                                           | 0xFE 0x5A 0xA5 0x55 | 0xxx<br>0xxx | 0xXX      | 0x01     | ...         |

Continued from previous table - sensor data section

Table 8 sensor data Table

| sensor data section |
|---------------------|
|---------------------|

| total_index   | sub_pkg_num | sub_index | sub_data_type | data_len  | data                       |
|---------------|-------------|-----------|---------------|-----------|----------------------------|
| 0xxx 0xxx     | 0x09        | 0x00      | 0x01          | 0xxx 0xxx | 0xxx 0xxx ...<br>0xxx 0xxx |
| Same as above | 0x09        | 0x01      | 0x01          | 0xxx 0xxx | 0xxx 0xxx ...<br>0xxx 0xxx |
| ...           | ...         | ...       | ...           | 0xxx 0xxx | 0xxx 0xxx ...<br>0xxx 0xxx |
| Same as above | 0x09        | 0x06      | 0x02          | 0xxx 0xxx | 0xxx 0xxx ...<br>0xxx 0xxx |
| Same as above | 0x09        | 0x07      | 0x02          | 0xxx 0xxx | 0xxx 0xxx ...<br>0xxx 0xxx |
| Same as above | 0x09        | 0x08      | 0x03          | 0xxx 0xxx | add_info[512]              |

Table 9 sensor data Data Format

| About sensor data format description                                                                                                                                                                                                                                                                                             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| total_index:                                                                                                                                                                                                                                                                                                                     |
| Length is 2 bytes, used to record the total packet sequence number, incrementing sequentially, range 0-65535, high byte first, low byte last                                                                                                                                                                                     |
| sub_pkg_num:                                                                                                                                                                                                                                                                                                                     |
| Length is 1 byte, used to record the number of sub-packets contained under the total packet sequence number                                                                                                                                                                                                                      |
| sub_index:                                                                                                                                                                                                                                                                                                                       |
| Length is 1 byte, used to record the sub-packet sequence number under the total packet number. Sub-packets are merged into one complete frame of radar data                                                                                                                                                                      |
| sub_data_type:                                                                                                                                                                                                                                                                                                                   |
| Length is 1 byte, used to record the data type<br>0x01: Distance data; 0x02: Echo data; 0x03: Additional information;                                                                                                                                                                                                            |
| data_len:                                                                                                                                                                                                                                                                                                                        |
| Length is 2 bytes, used to record the number of bytes of sampling point data or additional information bytes following this field, high byte first, low byte last;                                                                                                                                                               |
| data[ ]:                                                                                                                                                                                                                                                                                                                         |
| Variable length, used to record radar sampling distance data or echo intensity data or additional information field. Distance data and echo data are distinguished by the data type field. Each distance data occupies 2 bytes, low byte first, high byte last; each echo data occupies 2 bytes, low byte first, high byte last. |

For additional information, see the table below:

Table 10 Additional Information Data Table

| Additional Information Data 512 byte |           |                     |                                                                                                                                                   |
|--------------------------------------|-----------|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Name                                 | Field No. | Field Length (BYTE) | Description                                                                                                                                       |
| dev_type                             | 0–39      | 40                  | Device Type                                                                                                                                       |
| dev_sn                               | 40–71     | 32                  | Device SN                                                                                                                                         |
| Angular Resolution                   | 72–75     | 4                   | (1000) -- 0.01 degrees<br>high byte first, low byte last                                                                                          |
| Number of Sampling Points            | 76–77     | 2                   | high byte first, low byte last<br>indicating the scanning of 276degrees total number of sampling points in range                                  |
| Software Version                     | 78–81     | 4                   | 4 bytes edition information                                                                                                                       |
| Hardware Version                     | 82–85     | 4                   | 4 bytes edition information                                                                                                                       |
| System Working Status                | 86        | 1                   | 0x00: Normal working state<br>Others: Fault state<br>0x01: Storage fault<br>0x02: Measurement fault<br>0x03: Motor fault<br>0x04: Self-test fault |
| Angular Resolution Multiplier        | 87–90     | 4                   | Angular Resolution Multiplier (corresponding to the angular resolution above): 100000                                                             |
| Scan Time<br>scan_time               | 91–94     | 4                   | 4 bytes, full-circle time (in 0.1 $\mu$ s units)<br>high byte first, low byte last                                                                |
| Reserved                             | 95–96     | 2                   | Reserved                                                                                                                                          |
| Sampling Point Time<br>sample_time   | 97–100    | 4                   | 4-byte timestamp (in 1 ms units)<br>high byte first, low byte last                                                                                |
| Reserved                             | 101–511   | xx                  | Reserved                                                                                                                                          |