AKUSENSE

AS-60C

Operating Manual

This document is a complete, page-by-page English translation of the original Chinese AS-60C Safety Laser Scanner Operating Manual. The structure, numbering, terminology, and safety wording strictly follow the original document to ensure technical and regulatory consistency.

Table of Contents

1. Introduction

1.1 About This Manual

This manual describes the functions, installation, wiring, configuration, operation, inspection, and maintenance of the AS-60C safety laser scanner.

Please read this document carefully before installation, wiring, operation, inspection, or maintenance.
Keep this manual in an easily accessible location for quick reference.

The illustrations and figures in this manual may differ from the actual product and are for illustrative purposes only.
The information contained in this document is subject to change without prior notice.
For the latest information, please visit the AKUSENSE official website:
http://www.akusense.cn

The following information is available on the official website:
• Other language versions of this manual
• CAD data and dimensional drawings
• Certificates (EU Declaration of Conformity, etc.)
• AKUSENSE Safety Config Tools (software for configuring AS-60C safety solutions)

1.2 Scope of Application

This manual applies to the AS-60C series functional safety laser scanners.

1.3 Intended Audience

This manual is intended for project designers, installation personnel, operators, and maintenance personnel.

1.4 Symbols and Document Conventions

DANGER: Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
WARNING: Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION: Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.
NOTICE: Indicates a situation which may result in equipment damage or malfunction.

2. Safety Information

2.1 Basic Safety Instructions

DANGER

Laser Class 1.
If safety components are connected incorrectly, hazardous states may not be terminated in time.
Design safety component connections according to machine safety requirements.

CAUTION
Use of controls, adjustments, or performance of procedures other than those specified in this manual may result in hazardous radiation exposure.

• Strictly follow the operating conditions and calibration equipment specified in this manual.
• Do not open the housing or perform assembly or maintenance operations not specified in this manual.

This device complies with the following standards:
• IEC 60825-1:2014
• 21 CFR 1040.10 and 1040.11 (except deviations pursuant to Laser Notice No. 56, May 8, 2019)

The laser is safe for human eyes.
The laser label is located on the underside of the safety laser scanner.

2.2 Intended Use
The safety laser scanner is an electro-sensitive protective device (ESPE) suitable for:
• Hazardous area protection
• Hazardous point protection
• Access protection
• Mobile hazardous area protection (AGV protection)

The safety laser scanner must only be used within the specified limits and operating conditions.
Any improper use, unauthorized modification, or misuse voids all AKUSENSE warranties.
AKUSENSE shall not be liable for any resulting damages or consequential losses.

2.3 Improper Use
The safety laser scanner cannot prevent flying objects or radiation.
Transparent objects are not detected.

The safety laser scanner is not suitable for:
• Outdoor use
• Underwater use
• Explosive environments

2.4 Qualified Safety Personnel

Planning, installation, commissioning, operation, and maintenance must only be carried out by qualified safety personnel.

Planning
Qualified project planning personnel are those who have received professional training and possess extensive experience in the selection and application of protective devices, and who are fully familiar with the relevant technical regulations and the nationally applicable occupational safety standards.

Mechanical Installation, Electrical Installation, and Commissioning
Personnel performing these tasks must have professional knowledge and experience in the relevant fields, with sufficient expertise to assess whether the machine is in a safe operating condition after the protective devices have been installed and put into use.

Configuration
Personnel responsible for configuration must have professional knowledge and experience in the relevant fields, with sufficient expertise to assess whether the machine is in a safe operating condition after the protective devices have been applied.

Operation and Maintenance
Qualified operation and maintenance personnel are those who have received professional training and possess extensive experience in the relevant fields, have a thorough understanding of the application of protective devices on the machine, and have been instructed by the machine operation supervisor in machine operation.

3. Product Overview

The safety laser scanner emits pulsed laser beams that are reflected by a rotating mirror within the configured protection zones.
When the emitted laser beam is reflected by an object, the distance is measured.

3.1 AS-60C Functions
• Protection range: max. 5 m
• Warning range: max. 20 m
• Scanning angle: 270°
• Minimum response time: 70 ms (configurable)
• Up to 64 monitoring zone sets
• Configurable restart interlock
• Configurable EDM function
• Configurable muting function

• LED indicators and LCD display
• Ethernet communication
• PC-based configuration via AS-60C Safety Designer software

Note 1: Depending on the function used, the monitoring groups can switch between zone sets from 0 to 63.

Figure 3-1: AS-60C Module

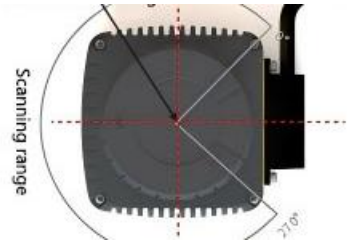


Figure3-2: Scanning Range and Origin of Detection Area (Top View)

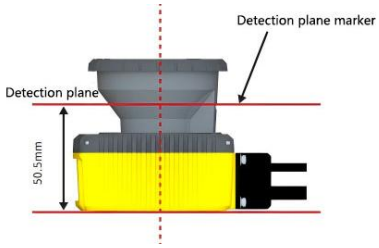


Figure 3-3: AS-60C Detection

3.2 **Scanning Range**

The scanning area of the AS-60C includes a protective field and a warning field.
Up to 64 field sets can be configured. In addition, two combinations of the protective field and the warning field can be selected for operation.

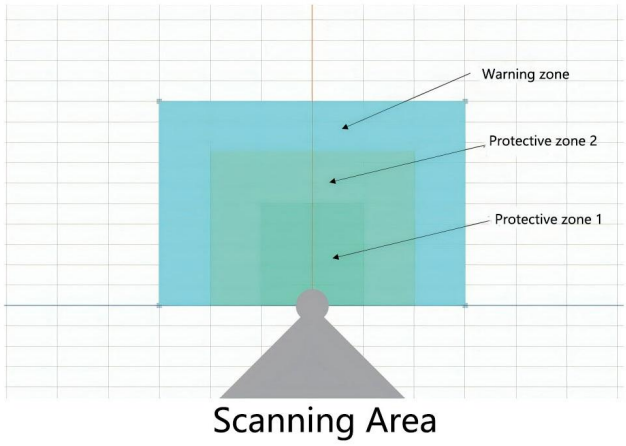


Figure3-4: Scanning Range

Field Types

During operation, the safety laser scanner continuously monitors one or more areas using laser beams to detect the presence of persons or objects. The monitored range is referred to as a field.

- Protective field
- Warning field

3.3 Angular Resolution

The safety laser scanner is equipped with a rotating mirror. The light pulses are continuously deflected, allowing the scanner to scan a fan-shaped area.

Angular Resolution: The angle between two adjacent laser beams (Unit: °)

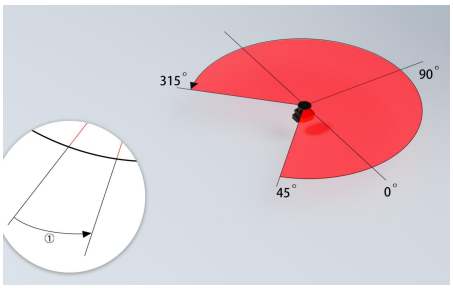


Figure3-5: Optical Pulse Scanning a Region

Scanning Cycle Time and Resolution

The time required for the prism to complete one full rotation is referred to as the scanning cycle time. The number of light pulses per unit time is constant. The angular resolution is derived from the scanning cycle time and the number of light

pulses per unit time. With the object resolution set, the scanning range depends on the angular resolution.

Object resolution (abbreviated as “resolution”) indicates the minimum size an object should be to ensure reliable detection. In addition, the scanning cycle time also affects the response time. Depending on the application, the resolution within the protected area can be set to different values.

Scanning Plane Geometry

The emitted laser beam covers a fan-shaped plane, allowing objects to be detected within a maximum area of 270°. The covered fan-shaped range extends from 45° to 315°.

If the height of the protected area (scanning plane) is specified and is less than 300 mm, the required resolution can be calculated using the following formula:

dr=HD15+50mmd_r = \frac{H_D}{15} + 50\ \text{mm}dr=15HD+50 mm

Where:

•drd_rdr= maximum allowable resolution of the safety laser scanner (in millimeters, mm)

•HDH_DHD= height of the protected area above the floor (in millimeters, mm)

The resolution of the safety laser scanner can be set according to the specified value ddd. If the calculated drd_rdr does not match these values, a finer resolution must be chosen (d≤drd \leq d_rd≤dr).

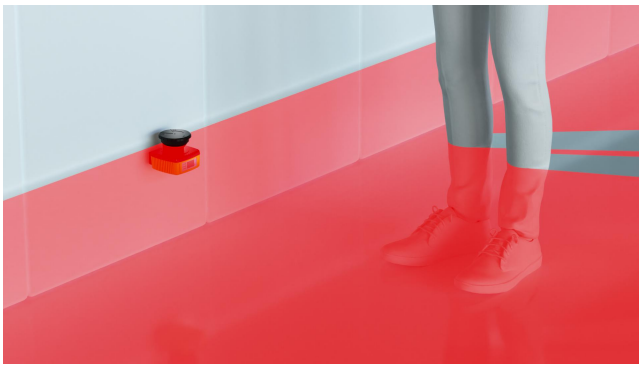


Figure3-6

3.4 OSSD

OSSD (Output Signal Switching Device) is a safety-related signal. When a person or object is detected within the protected area, the OSSD signal switches from the ON state to the OFF state.

Downstream control elements must analyze the output signal of the protective device to ensure that any hazardous condition of the machine has been safely stopped.

Signal analysis can be performed, depending on the safety concept, by devices such as a safety relay or a safety controller.

The OSSD provides short-circuit protection for 24 V DC and 0 V.

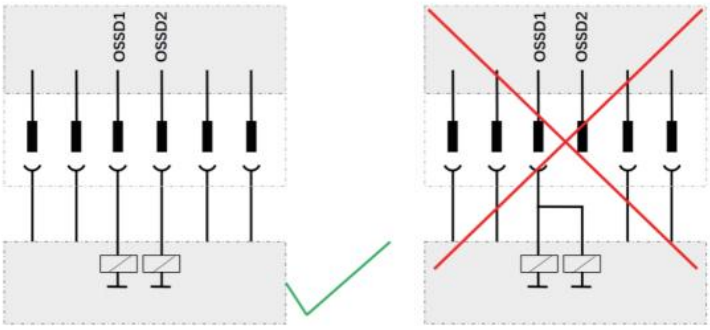
Prerequisites

•If at least one OSSD channel switches to the OFF state, the machine can immediately transition to a safe state.

•When using a safety controller: the safety controller detects different signal levels from the two OSSDs of the OSSD pair (in accordance with applicable national regulations or the required safety function reliability). The maximum allowed response time difference is selected based on the specific application.

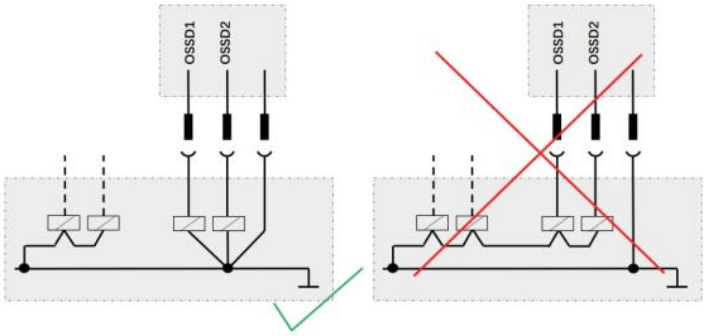
•The output signals of the OSSD pair are not interconnected.

•The machine control system processes the two signals of the OSSD pair separately.



3-7: Dual-channel Isolated Interface for OSSD1A and OSSD1B

•No potential difference exists between the load and the protective device. The 0 V interface of the load and the corresponding protective device must be individually and directly connected to the same 0 V terminal block. Only in this way can it be ensured that, in the event of a fault, there is no potential difference between the 0 V interfaces of the load and the corresponding protective device. This is particularly important for loads that are also switched under negative voltage control (e.g., electromechanical contactors without polarity protection diodes).



3-8: No Potential Difference Between Load and Protective Equipment

•The OSSD signal features a self-diagnostic function, allowing the signal to be periodically tested by briefly switching it to the OFF state. If an error is detected during the diagnostic process, the signal remains continuously in the OFF state.

•The output states of the OSSD1a and OSSD1b signals are identical. Both signals must be connected to the safety-related machine or control system to achieve the required safety level.

If OSSD1a and OSSD1b are used, they must be connected in the same manner.

•The OSSD is a safety-related signal and should be connected directly to a relay or device to control a machine or vehicle. When configuring the OSSD response time, sufficient time must be allocated for the machine or vehicle to come to a complete stop.

Both OSSD1a and OSSD1b outputs must be connected to the safety-related machine or control system. If OSSD2a and OSSD2b are used, they must be connected in a similar manner.

•The user must verify the configuration before actual operation.

•When the OSSD is in the ON state, the signal is 24 V; during the OFF state, the signal is 0 V.

3.4.1 Self-Diagnosis

The OSSD features a self-diagnostic function. This self-diagnosis works by switching OSSD1 to OSSD2 OFF at intervals of ≤300 μs to detect faults in the output circuit. Therefore, the safety relay or power converter used must not respond to this diagnostic function.

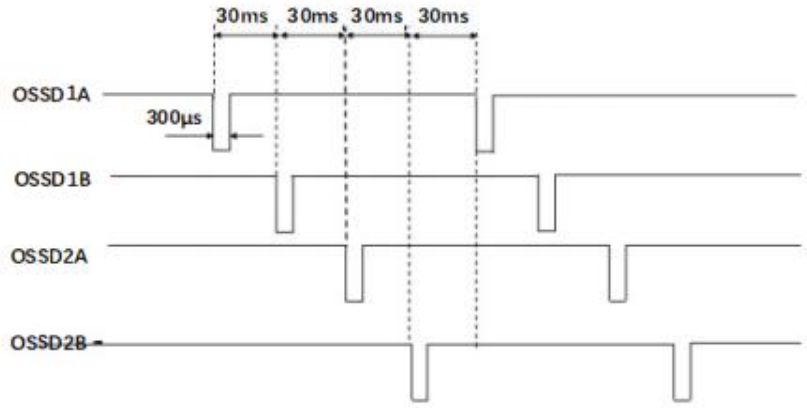


Figure 3- 9 below shows the timing diagram of the OSSD self-diagnostic function in dual protection mode

The self-diagnostic function is performed only on the OSSD1A/1B and OSSD2A/2B signals.

3.4.2 Lockout State

When the self-diagnostic function detects an error and the AS-60C cannot operate normally, it switches to the lockout state. In the lockout state, OSSD1A/B, OSSD2A/B, and SSD1A/B switch to the OFF state. After the error is cleared, the AS-60C can be reset from the lockout state by restoring power.

3.4.3 Interlock Function

The interlock function prevents the OSSD signals from automatically switching from the OFF state to the ON state (automatic restart). The AS-60C Safety Config Tool can be used to configure automatic restart, manual restart, and manual start interlock functions.

3.4.3.1 Automatic Restart

The start interlock and interlock functions are linked. When obstacles in the protected area are cleared, the OSSD signals automatically switch from the OFF state to the ON state.

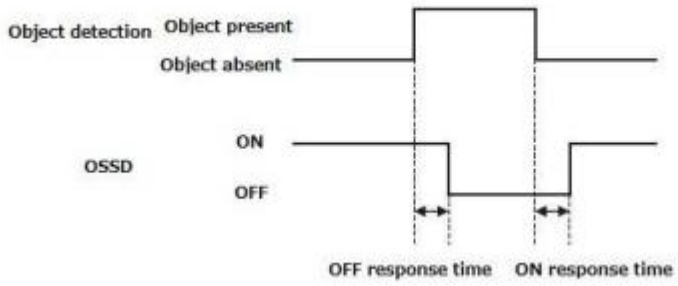


Figure 3-10: Automatic Restart Timing Diagram

However, if the AS-60C is in the lockout state due to an error, the OSSD signals remain in the OFF state even if the interlock function is disabled.

⚠ In the automatic restart configuration, after an object is removed, the OSSD will automatically switch to the ON state. When removing objects, please ensure safety.

⚠ The configured response time should be sufficient to allow the machine or AGV to stop safely.

3.4.3.2 Manual Restart (Interlock Enabled)

When the interlock function is set to manual mode, the AS-60C operates in manual restart mode. If the AS-60C detects any obstacle in the protected area or any system error, the OSSD signals switch from the ON state to the OFF state.

In this mode, even if the detected obstacle or system error is cleared, the OSSD signals remain in the OFF state. An external reset input signal is required to release the interlock, allowing the AS-60C to return to normal operation.

The AS-60C will resume normal operation only after the reset signal (RESET) has been confirmed. The duration of the reset signal must be greater than 500 ms. Figure 3- 11 shows the timing diagram for manual restart.

After the reset signal is confirmed, the OSSD signals switch to the ON state following the configured delay time. If the OFF state of the OSSD is caused by an internal fault, the OSSD remains in the OFF state even if a reset signal is provided. The reset delay can be configured within a range of 1 s to 60 s.

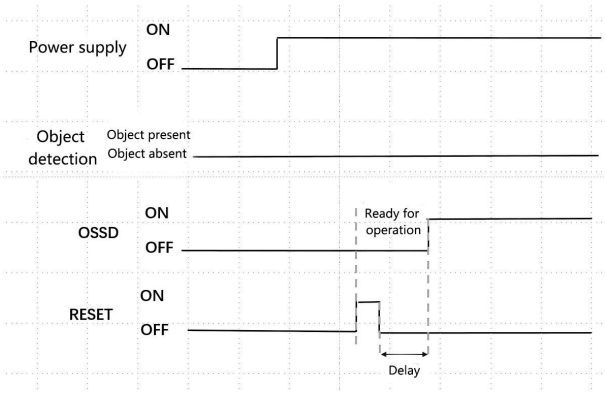


Figure 3-11: Manual Restart Timing Diagram

⚠ The user must ensure that any cleared obstacles have been safely detected before resetting the AS-60C.

⚠ If the restart interlock function is used to restart the machine, the reset switch should be installed in a location away from the protected area.

⚠ Violation of these requirements may result in serious injury or death.

Even if objects are removed from the protected area, if the OSSD remains in the OFF state, check the error code and follow the recommended corrective actions.

The duration of the reset input should not exceed 60 s; otherwise, it will be detected as a hardware fault.

3.4.3.3 Restart Interlock

The restart interlock function holds the OSSD in the OFF state during startup until an external reset input is applied. The startup interlock is only available in manual mode.

After the AS-60C completes its initial routine and is ready to accept the RESET input, the RES_REQ signal switches to the ON state. When the RESET input is applied, if no objects are detected in the protected area, the OSSD switches to the ON state. The duration of the reset input must be greater than 500 ms. Figure 3- 12 shows the sequence of the startup interlock. The delay can be configured within a range of 1 s to 60 s.

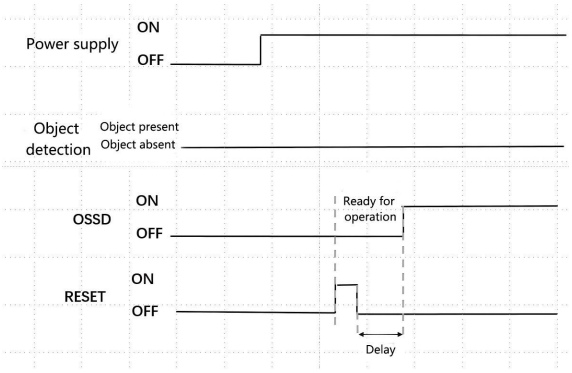


Figure 3-12: Manual Start Sequence

3.4.3.4 Restart Interlock Example

A restart interlock must be provided in accordance with the regulations applicable at the place of use.

The purpose of the restart interlock is to prevent the machine from automatically operating, for example, when a protective device is activated during machine operation or when the operating mode of the machine is changed.

The operator must first press the reset button to return the protective device to the monitoring state. Only then can the operator restart the machine.

Prerequisites

♦The control switch (reset button) used to reset the restart interlock must be installed outside the hazardous area.

♦Personnel inside the hazardous area must not be able to operate the reset button.

♦Every person operating the control switch must have a full view of the hazardous area.

Restart Interlock

If the restart interlock is used, the following procedure applies to machine operators:

1)The safety output of the safety laser scanner switches to the OFF state when interrupted in the protected area.

2)If no objects remain in the protected area, the safety output remains in the OFF state.

3)The safety output only switches back to the ON state when the operator presses the reset button outside the hazardous area. If there are objects in the protected area when the reset button is pressed, the safety output remains in the OFF state.

4)After resetting, the operator can restart the machine in step 2.

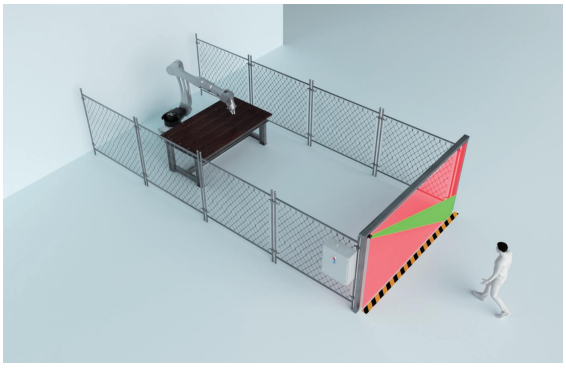


Figure 3-13 Operation of Restart Interlock (1): No personnel in the protected area, machine in operation

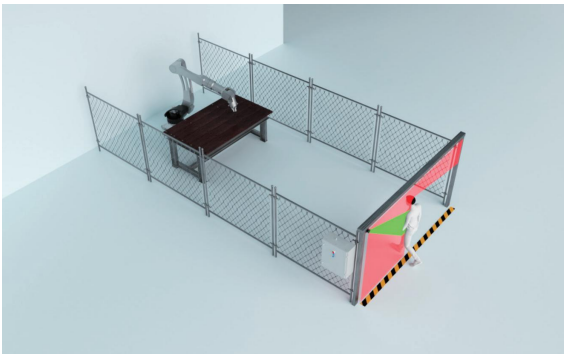


Figure 3-14 Operation of Restart Interlock (2): Personnel detected in the protected area, safety output in the OFF state

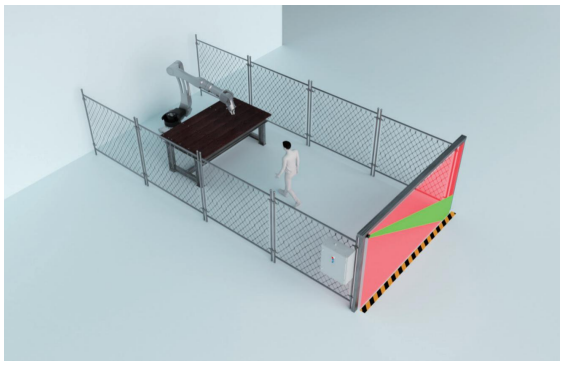


Figure 3-15 Operation of Restart Interlock (3): Personnel in the hazardous area, not detected in the protected area, safety output remains in the OFF state

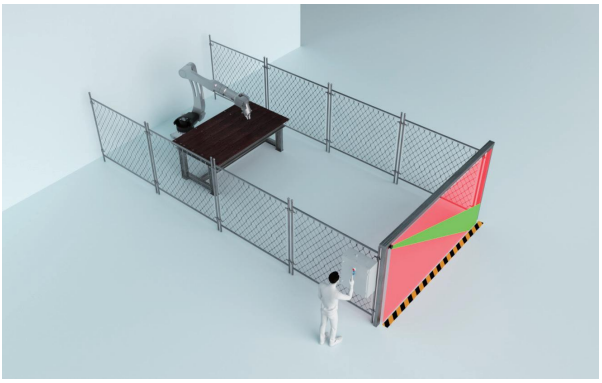


Figure 3-16 Operation of Restart Interlock (4): The reset button must be pressed before restarting the machine

3.5 External Device Monitoring (EDM) Function

EDM is a function used to monitor the status of input signals from the controlled machine or an Automated Guided Vehicle (AGV). The EDM function is configured using the AS-60C Project Designer.

When the EDM function is enabled, if any fault is detected in the EDM signal, the OSSD signals will switch to the OFF state. The logic of the EDM signal must always be opposite to that of the OSSD signals.

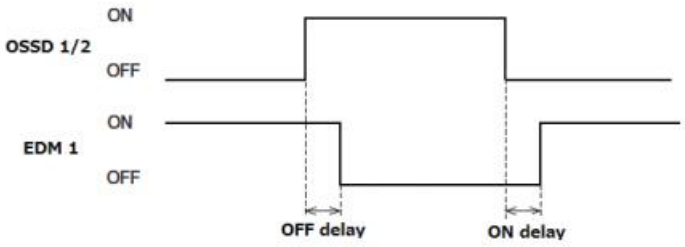


Figure 3-17 below shows the EDM timing diagram.

3.6 Muting Function

When specified conditions are met, the muting function temporarily suspends the safety function within the configured areas of the AS-60C. In the muting state, even if an object is detected in the configured muting area, the OSSD remains ON.

Two independent hard-wired input signals are provided to start and end the muting function. The muting area is configured using the AS-60C Project Designer.

When the muting input meets the muting start conditions, the AS-60C suspends the safety function within 60 ms and restores the safety function when the muting stop conditions are met.

3.6.1 Muting Start Conditions

The muting function is activated when the following conditions are met:

a) No objects are present in the protected area, and the OSSD is in the ON state.
b) Within a preset time interval, two independent hard-wired muting input signals switch to the ON state in a predefined sequence. However, the switching interval between the two inputs must not be 0 (see Figure 3-18).

The muting function requires the following configuration. Users can configure it using the AS-60C Project Designer.

Muting Input Sequence
▶ Muting 1A / Muting 1B
▶ Muting 2A / Muting 2B

Time interval between the two inputs (T1):
▶ 1 s ▶ 3 s ▶ 5 s ▶ 10 s

When the muting function is used in dual protection mode, the configuration method for Muting 1 and Muting 2 is similar.

3.6.2 Muting Stop Conditions

The muting function stops when any of the following conditions are met:

a) One of the muting inputs switches to the OFF state.
b) The predefined (preset) maximum muting time T1 is exceeded (1 minute or more) (see Figure 3-18).
c) An error is detected by the self-diagnostic function.
d) During the muting state, the area switches to another area.

Figure 3-18 shows the muting sequence.

Maximum Muting Period (T2)
The maximum muting time can be selected from one of the following values:
▶ 1 minute ▶ 5 minutes ▶ 10 minutes ▶ 20 minutes ▶ 30 minutes ▶ Infinite

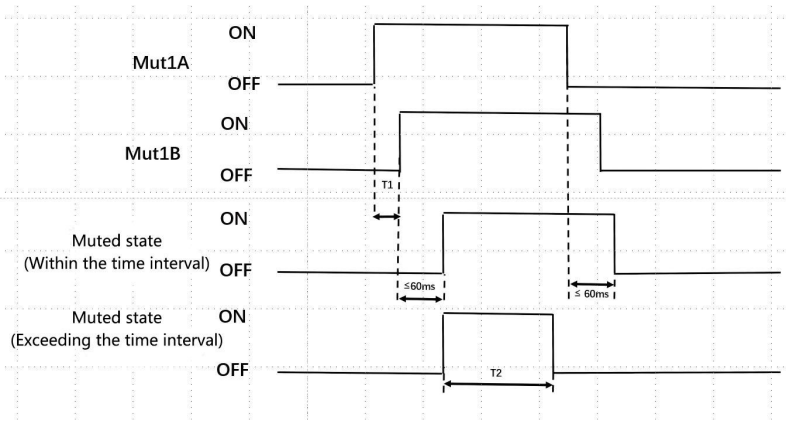


Figure 3-18 Muting Sequence

3.7 Response Time

The response time of the safety laser scanner depends on the configured multiple sampling.

The response time can be calculated using the following formula:

tR=n×33.33 ms+10 mst_R = n \times 33.33\ \text{ms} + 10\ \text{ms}tR=n×33.33 ms+10 ms

Where:

tRt_RtR= response time

nnn= configured multiple sampling (default: n=2n= 2n=2)

Using the AS-60C Project Designer, personnel can configure the OSSD signal response time separately for each area (Figure 3- 19), including OFF response time and ON response time (default: 70 ms). The response times for Warning 1 and Warning 2 are the same as the OSSD response time. Table 3- 4 shows the possible configurable values.

In dual-area protection mode, separate response times can be set for each protected area.

Configuring a longer response time can improve the stability of the AS-60C. However, a longer response time requires a longer safety distance. Users must perform a risk assessment before configuring the response time. For area switching, an additional delay of up to one cycle (35 ms) must be considered.

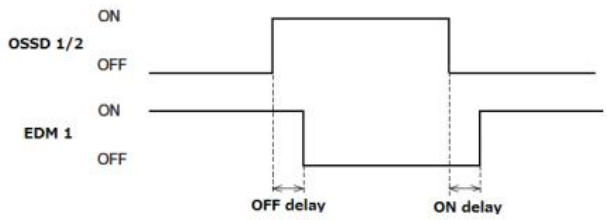


Figure 3-19 Response Time

Number ofScans	2	3	4	5	6	7	8	9
Response Time(ms)	70	105	140	175	210	245	280	315
Number of Scans	10	11	12	13	14	15	16	
Response Time(ms)	350	385	420	455	490	525	560	

Table: AS-60C Response Time

- Default value
- The default OFF response time varies depending on the application selected when creating a “New” project.

3.8 Information Indicators

The LEDs and LCD display indicate the status of the AS-60C. These indicators are located on the front of the AS-60C.

Figure 3-20 shows the information indicators of the AS-60C.

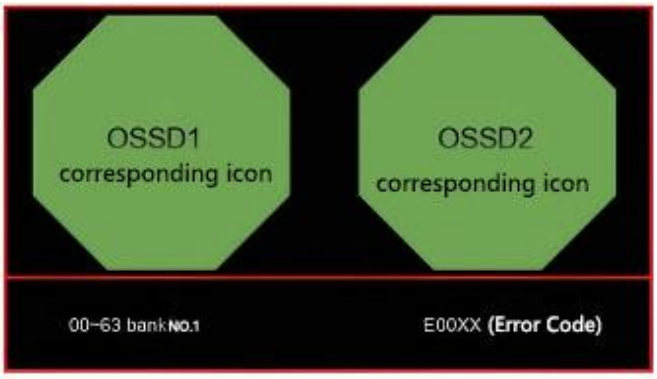
3.8.1 LED

The LED indicators and their descriptions are shown in the table below.

LED	Color	Description
OSSD 1	Green/Red	When OSSD 1 signal is ON, the green LED lights; when OSSD 1 signal is OFF, the red LED lights.
OSSD 2	Green/Red	When OSSD 2 signal is ON, the green LED lights; when OSSD 2 signal is OFF, the red LED lights.OSSD 2 signal is not in use, Green LED lights.
OSSD 1/ OSSD 2	Red/Yellow/Green	When OSSD delay restart interlock is enabled: red LED is ON when an obstacle is present and OSSD signal is OFF, orange LED is ON during delayed restart, green LED is ON when OSSD signal is ON.
SSD	Red/Yellow/Green	When SSD signal is ON, the green LED lights; when SSD signal is OFF, the red LED lights.

3.8.2 LCD Display

The table below shows the descriptions of the numeric indicators displayed on the AS-60C LCD. The screen is divided into sections



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Display	Device or Configuration	Meaning
	All devices and configurations	**All areas clear**: All safety outputs are ON. The number at the bottom right indicates the enabled monitoring event.
	Configurations with muting	**Muting**: Temporarily disables OSSD monitoring.
	With obstacles	**Obstacle present**: All safety outputs are OFF. The text area displays the bank number and error code.
	Fault (lockout)	**Fault**: All safety outputs are OFF. The text area displays the bank number and error code.
	Configurations with External Device Monitoring (EDM)	**External Device Monitoring (EDM) fault**: OSSD signals are OFF.
	Delayed automatic restart set when obstacles are removed	**Delayed automatic restart set**: Activated when obstacles are removed.
	Configurations with restart interlock	**Restart interlock set**: Activated when obstacles are removed.
	Devices and configurations with 1 configured safety output terminal	**Single OSSD configured**: The OSSD that is not configured remains inactive.

Note: Except for the numeric indicators described above, all other numbers indicate an error state.

3.9 Ethernet Communication

Measurement data from the AS-60C can be accessed via Ethernet communication. A waterproof Ethernet connector is located on the back of the AS-60C. To connect the sensor to a PC, use an optional Ethernet cable.

The AS-60C is compatible with the SCIP2.2 communication protocol standard. Refer to the AS-60C Communication Specifications for details.

3.9.1 Ethernet Settings

Default Settings
The factory default settings are as follows:

- IP Address: 192.168.1.100
- Default Gateway: 192.168.1.1
- Subnet Mask: 255.255.255.0
- Port Number: 2368

Changing the IP Address
The IP address can be configured using the configuration software.

IP Address Initialization
The Ethernet settings can be reset to factory defaults using the configuration software.

4. Application Examples

This section describes examples of using the laser scanner and calculating safety distances in various applications. When using the laser scanner as a protective device, the following guidelines should be considered:

Hazards must be identified, and a risk assessment must be performed.

The laser scanner should not be used for finger protection.

The working environment must comply with the laser scanner specifications.

Safety distances must comply with ISO 13855 and IEC 61496-3.

△Failure to operate the laser scanner as specified may result in serious injury or death.

Types of Areas

The safety laser scanner continuously monitors one or more areas for the presence of personnel or objects. The monitored range is referred to as an area. Depending on the application, the following area types are distinguished:

- Protected Area
- Warning Area

	Protected Area	Warning Area
Safe Stop (according to ISO 13849-1)	Performance Level (PL): d	Performance Level (PL): Not applicable
Maximum Scanning Range of Safety Laser Scanner	5 m	20 m
Intended Use	Detection and protection of personnel	Functional purpose (non-safety-related application)
Description	The protected area safeguards the hazardous zones of a machine or vehicle. Once the safety sensor detects an object within the protected area, the relevant safety outputs are switched to the OFF state. Downstream control elements can use this signal to terminate the hazardous condition, for example, by stopping the machine or vehicle.	The warning area monitors a larger area than the protected area. It can be used to trigger simple switching functions, such as activating a warning light or audible signal when personnel approach, before they enter the protected area.

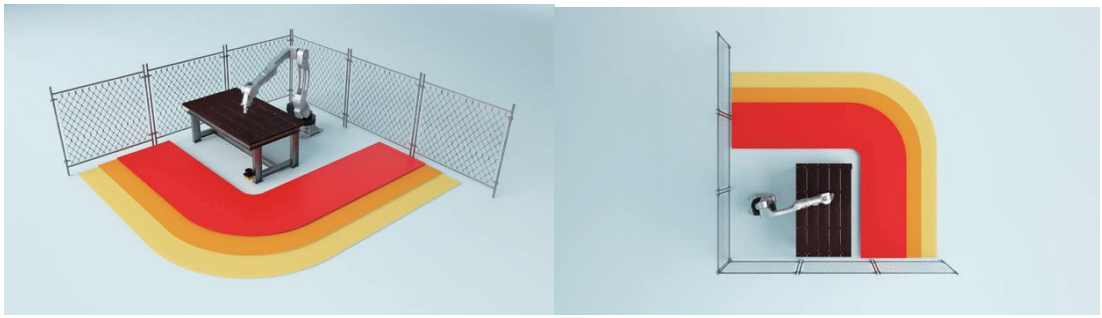
4.1 Access Protection (Horizontal Application – Fixed Protected Area 1)

In this application, the laser scanner is installed horizontally to safeguard a hazardous area (Figure 4-1). The protected area is configured around the hazardous zone to prevent entry by personnel or objects.

Warning Area 1 and Warning Area 2 are configured around the protected area. The warning areas are used to alert personnel or objects approaching the protected area and to prevent unnecessary stoppages.

Any object or person detected within the protected area will cause the OSSD signals to switch from ON to OFF. Any object and/or person detected in the warning areas will cause the warning signals to switch from ON to OFF.

The safety distances for this application are shown in Figures 4-1 and 4-2.



No Protected Area

Figure 4-1 Top View of Horizontal Application

Figure 4-2 Side View of the Application

Safety Distance Calculation:

S=(K×(Tm+Ts))+C+ZsS = (K \times (T_m + T_s)) + C + Z_sS=(K×(Tm+Ts))+C+Zs

Where:

S = Safety distance(mm)

K = Approach speed 1600 mm/s

Tm = Maximum stopping/stopped time of the machine or system

Ts = Response time of the laser scanner(s)

C = 1200; 0.4 × H ≥ 850

H = Height of the installed protected area(mm)

1000≥H≥15×(d−50)1000 \ge H \ge 15 \times (d - 50)1000≥H≥15×(d−50)

d = Minimum detectable object width(mm)

Zs = Laser scanner tolerance distance(mm)

△Users must ensure that the distance between the edge of the hazardous area and the origin of the protected area “a” is less than the minimum detectable object width. In applications where “a” exceeds the minimum detectable width, additional protective measures must be taken to prevent intrusion into the unprotected area.

• The laser scanner installation height should not exceed 300 mm to prevent crawling under the detection plane.

• For applications requiring installation above 300 mm, additional measures must be taken to prevent intrusion below the detection plane.

• If the laser scanner is installed in a public area, the detection plane height should be reduced to 200 mm or to the height required by local regulations.

It is recommended to mark the floor within the protected area.

• Tolerances should be considered when configuring the safety distance.

• When using the laser scanner against highly reflective backgrounds, additional tolerance should be applied.

Users must ensure that any boundaries or protective measures in use are not included within the protected area, as they would be detected as obstacles and cause the OSSD to remain in the OFF state.

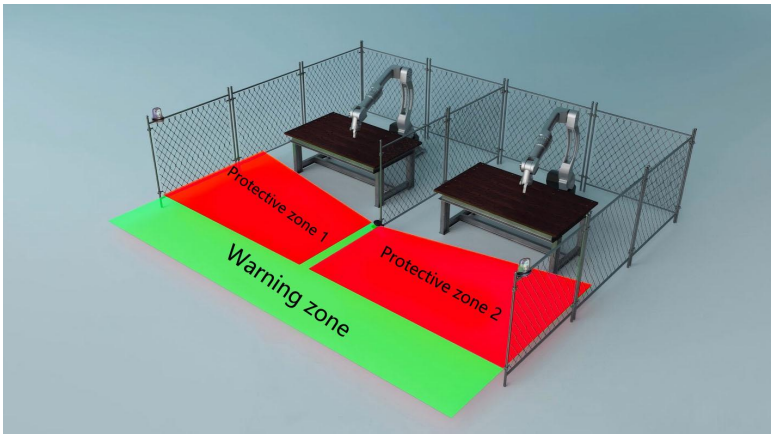
Users must also ensure that the distance between the protected area and walls (“b”) is at least 100 mm to prevent detection by the sensor.

4.2 Access Protection (Fixed Horizontal Protected Area with Dual Function)

In this application, the laser scanner is installed horizontally to simultaneously protect two hazardous areas (Figure 4-3). Protected areas are configured around the hazardous zones to prevent entry by personnel or objects.

Warning areas cannot be configured in dual protection mode. Any object or person detected within the protected areas will cause the respective OSSD signals to switch from ON to OFF. In this configuration, a single laser scanner can protect two machines.

The safety distances for this application are shown in Figure 4-3.



4.3 Access Protection (Vertical Application – Full Body Detection)

The laser scanner can be used as a protective device through vertical installation (Figure 4-4). This type of application is typically used to prevent entry into hazardous areas. When an object or person enters the monitored path, the OSSD signals switch from ON to OFF.

In this configuration, the laser scanner detects objects or personnel in a vertical plane. It is not possible to detect objects or personnel in front of or behind the detection plane. Therefore, special care must be taken when setting the distance between the detection plane and the hazardous area.

The laser scanner should be configured with a minimum response time of no more than 90 ms. In such applications, the reference monitoring function should always

be used to detect any displacement of fences or the laser scanner that could expose the hazardous area. When the reference position changes, the OSSD signals switch to OFF.

The safety distances for this application are shown in Figures 4-4 and 4-5.

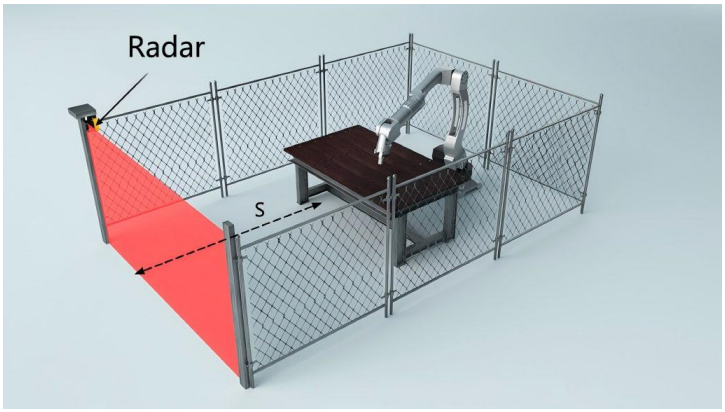


Figure 4-4 Example of Access Protection (Full Body Detection)

Figure 4-5 Side View of Access Protection Device (Full Body Detection)

Safety Distance Calculation:

S=(K×(Tm+Ts))+CS = (K \times (T_m + T_s)) + CS=(K×(Tm+Ts))+C
Where:

S = Safety distance(mm)

K = Approach speed 1600 mm/s

Tm = Maximum stopping/stopped time of the machine or system

Ts = Response time of the laser scanner(s)

C = Additional distance of 850 mm to account for arm intrusion(mm)

⚠Users must ensure that the width of any unprotected area “a” is smaller than the minimum detectable object width. If “a” exceeds the minimum detectable width, additional protective measures must be taken to prevent intrusion into the unprotected area.

In access protection applications with approach angles exceeding ±30°, the **Reference Monitoring** function should be used, with a tolerance range of 100 mm for the reference area. In such applications, the response time should be configured to be less than 90 ms.

Reference segments should be configured on each side of the reference boundary.

The installation of the laser scanner must ensure that hazardous points cannot be reached. Additional protective measures should be used if necessary.

Tolerances must be considered when configuring the reference segments.

4.4 Area Protection (Horizontal Application – Mobile)

A fixed-area laser scanner can be used for mobile applications such as AGVs (Figure 4-6). It is mounted on the AGV and can detect objects while the vehicle moves along a fixed route.

In such applications, warning signals can be used to reduce speed and stop the AGV. Up to 64 area groups can be used to match the AGV’s travel path.

When defining protected and warning areas, the time and distance required for the AGV to come to a complete stop must be taken into account.

The safety distances for this application are shown in Figures 4-6 and 4-7.

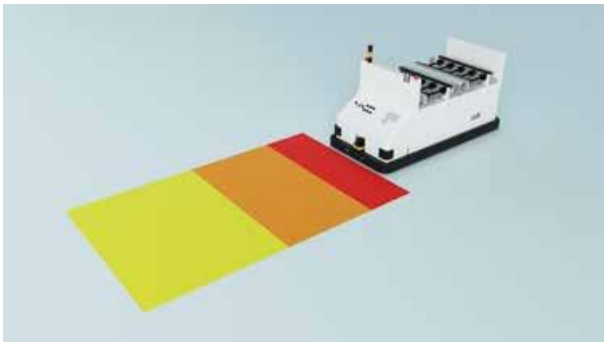


Figure 4-6 Example of Area Protection (Mobile)

Figure 4-7 Top View of Area Protection (Mobile)

Figure 4-8 Side View of Area Protection (Mobile)

Safety Distance Calculation:

S=V×(Tm+Ts)+Zb×L+Zs=ZgS = V \times (T_m + T_s) + Z_b \times L + Z_s = ZgS=V×(Tm+Ts)+Zb×L+Zs=Zg

Where:

S = Safety distance(mm)

V = Maximum approach speed of the AGV(mm/s)

Tm = Maximum stopping/stopped time of the machine or system

Ts = Response time of the laser scanner(s)

Zb = Distance required for AGV to stop(mm)

L = Brake wear factor

Zs = Laser scanner tolerance distance(mm)

Zg = Distance accounting for insufficient ground clearance(mm)

h = Ground clearance (mm)

When using a laser scanner on an AGV, users must verify the time and distance required for the AGV to come to a complete stop, as it will continue to move forward during the laser scanner's response time.

It is important to note that the stopping distance is proportional to the square of the speed, not linearly proportional.

Sufficient ground clearance must be provided to prevent injuries, such as collisions with toes.

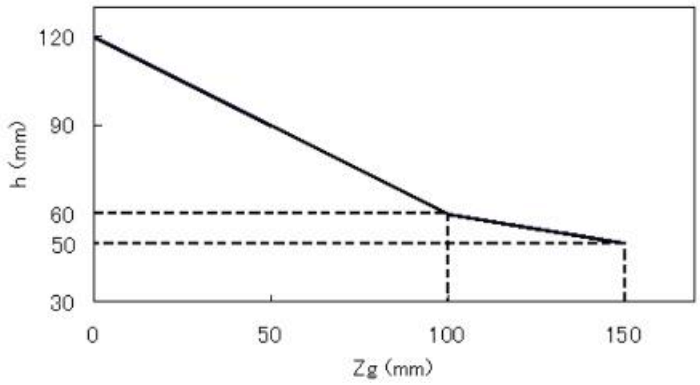


Figure 4- 9 shows the relationship between ground clearance **h** and **Zg.**

⚠ Users must ensure that the width of any unprotected area "a" is smaller than the minimum detectable object width. If "a" exceeds the minimum detectable width, additional protective measures must be taken to prevent intrusion into the unprotected area.

⚠ The installation height of the laser scanner should not exceed 200 mm to prevent crawling under the detection plane.

⚠ The detection plane should not be inclined, as this may prevent the laser scanner from detecting objects with a diameter of 200 mm.

ℹ Users must also ensure that any boundaries or protective measures in use are not located within the configured protected area, as they would be detected as obstacles and cause the OSSD to remain in the OFF state.

4.5 Area Protection (Mobile, Horizontal, Single Protection, Variable Area)

For applications where the AGV moves in a single direction, different areas at corners can be switched to effectively monitor obstacles ahead (Figure 4-10).

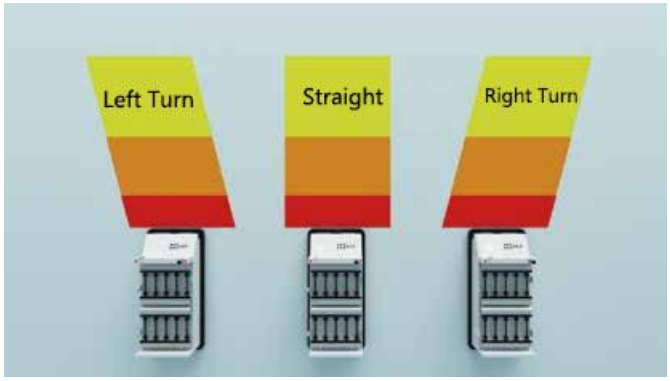
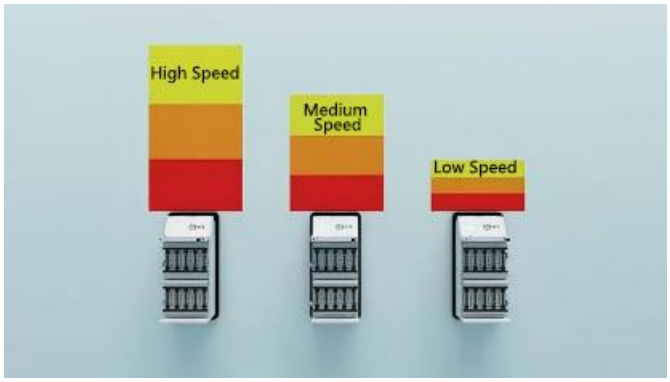


Figure 4-10 Example of AGV Scanning Areas on a Curve (Top View)

4.6 Area Protection (Mobile, Horizontal, Single Protection)

During operation, areas can be switched based on the AGV's speed (Figure 4-11).



4.7 Area Protection (Mobile, Horizontal, 2 Interconnected Units, Variable Area)

For AGVs traveling in both directions, the laser scanner can be installed at the front and rear. By switching each unit according to the travel speed and direction to monitor areas of appropriate size and shape, safety can be enhanced.

Figure 4-12 Example of AGV Scanning Areas Propagating in Two Directions (Top View)

4.8 Area Protection (Mobile, Horizontal, 4 Interconnected Units, Variable Area)

For AGVs traveling in multiple directions, units can be installed on both sides of the vehicle. By switching each unit according to travel speed and direction to monitor areas of appropriate size and shape, safety can be improved.

Figure 4-13 Example of AGV Scanning Areas Propagating in Two Directions (Top View)

4.9 Area Protection (Mobile, Horizontal, Autonomous Navigation)

The laser scanner simultaneously monitors protected and warning areas and transmits surrounding measurement data to the AGV's main control unit via Ethernet. The provided data can be used for autonomous route selection.

For such systems, there is no need to install guidance devices on the floor, such as optical beacons or magnetic tape. For details on the Ethernet communication protocol, refer to the laser scanner's communication specifications.

Figure 4-14 Image of an AGV in Autonomous Operation

5. **Installation**

The machine manufacturer and operator must perform a risk assessment. Unauthorized modification or improper repair may compromise safety.

5.1 Machine Manufacturer

The machine manufacturer must perform a risk assessment and implement appropriate protective measures. In addition to the safety laser scanner, other protective measures may be required.

The equipment must not be tampered with or modified beyond the operating methods described in this document.

Maintenance of the equipment is only permitted by the machine manufacturer or personnel authorized by the manufacturer. Improper maintenance may result in the equipment failing to provide adequate protection.

5.2 Machine Operator

After modifying the electrical connections in the machine controller or the mechanical installation of the equipment, a new risk assessment is required. The results of this risk assessment may require the machine operator to fulfill the obligations of the manufacturer.

After each configuration change, it must be verified that the protective measures continue to provide the necessary protection. Personnel performing the modifications are responsible for ensuring that the protective measures provide adequate safety.

The equipment must not be tampered with or modified beyond the operating methods described in this document.

Maintenance of the equipment is only permitted by the machine manufacturer or personnel authorized by the manufacturer. Improper maintenance may result in the equipment failing to provide adequate protection.

5.3 Design

Hazard: Failure of Protective Equipment

If not followed, the protection of personnel and body parts may not be recognized or may not be recognized in time.

- Ensure that no mirrors or other highly reflective objects are present within the protected area of the safety laser scanner.
- Ensure that no smoke is present within the protected area of the safety laser scanner.
- Prevent interference with the light path. For example, if the device is installed behind a panel, design a sufficiently large scanning gap.
- Do not use additional transparent protective covers.
- Ensure that no small objects (such as cables) are present within the protected area of the safety laser scanner, even if they do not trigger the area interruption.
- Ensure that no welding spatter, infrared remote devices, contamination, or thermal convection is present within the protected area of the safety laser scanner.

Prerequisites:

- No obstacles should block the field of view within the protected area of the safety laser scanner. If unavoidable obstacles exist, additional protective measures must be used.
- If personnel could remain between the protective device and the hazardous point without being detected, additional protective measures (e.g., restart interlock) must be implemented.
- Prevent situations where personnel could reach under, climb over, crawl through, or push/move the safety laser scanner.

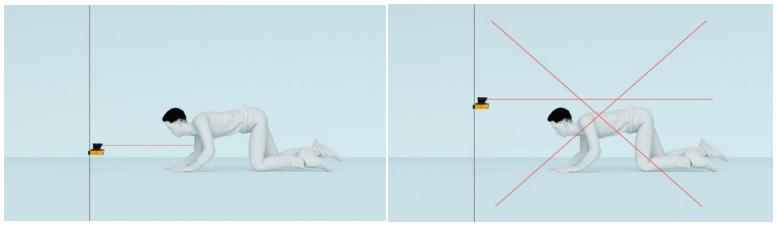


Figure 5-1 Prevention of Crawling Through

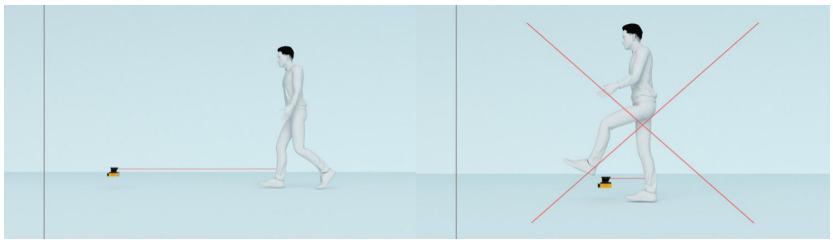


Figure 5-2 Prevention of Climbing

Additional Information

Special optical and electromagnetic environmental conditions may affect the safety laser scanner and thereby reduce the availability of the machine. Examples include:

- Condensation on the optical lens cover
- Strong electric fields (e.g., from welding cables or induction cables)

5.3.1 Preventing Interference

Influence from Laser Sources
Spatially adjacent laser sources may affect the safety laser scanner and reduce the machine's availability.

Measures to improve availability:

- Avoid placing laser sources in the scanning plane.
- Set the multiple sampling to the highest value allowed for your application, considering the minimum distance.

Influence from Strong Light Sources on the Scanning Plane
Strong external light sources in the scanning plane may affect the safety laser scanner and reduce the machine's availability.

Measures to improve availability:

- Avoid external light sources in the scanning plane.
- Avoid direct sunlight on the scanning plane.
- Do not place halogen headlights, infrared sources, or strobe lights directly in the scanning plane.

Mutual Interference between Safety Laser Scanners
Mutual interference between multiple safety laser scanners is unlikely. A suitable installation method must be chosen to completely avoid interference.

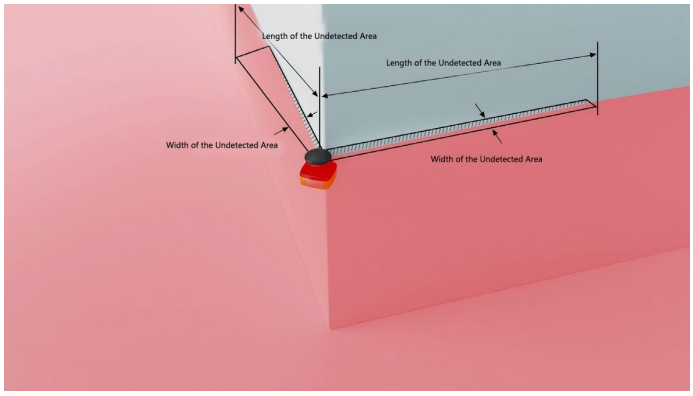
Suitable installation methods:

- Staggered installation, placing scanning planes on different levels.
- Slightly inclined installation, so that scanning planes are tangential.

5.3.2 Avoiding Unprotected Areas

Overview
When installing a safety laser scanner, it must be ensured that personnel cannot access unsafe areas.

Undetected Areas
Areas not detected by the safety laser scanner may exist behind the scanner. If the scanner is mounted using installation components, the undetected area may be larger.



1) Length of the undetected area
2) Width of the undetected area

Compensatory Measures:

- Install deflection plates to protect undetected areas.

- Install the safety laser scanner inside machine or vehicle panels adjacent to the area.

In adjacent areas (a 50 mm wide area in front of the optical lens cover), the detection capability of the safety laser scanner may be limited. If necessary, additional protective measures, such as undercuts or clamping frames, must be used to safeguard adjacent areas.

5.3.3 Timing of Monitoring Event Switching

Overview
When switching between monitoring events, the timing of the switch must be determined.

When determining the timing, the following must be considered:

- At the switching point, personnel may already be in the newly activated protected area. Therefore, the new protected area must be activated in time so that the safety laser scanner can detect personnel before a hazard occurs.

- In some cases, switching between monitoring events may take a significant amount of time, such that the new monitoring event cannot provide detection within the prescribed response time. In these cases, the monitoring event switch must be initiated in advance.

The following parameters affect the duration of the process:

- Configured ON-delay
- Processing time of the selected input
- Flight time of the switching signal to the safety laser scanner, which may include network cycle time and controller processing time depending on the communication channel.

Procedure:

1. Calculate the time required for the monitoring event switch:

$t_{CSR} = t_{ID} + t_I$

Where:

t_{CSR} = Time required for the monitoring event switch(ms)

t_{ID} = Input delay of the control input (ms)

t_I = Processing time of the selected switching type(ms)

Local static control input: t_I=12ms

2. **Calculate the available time for the monitoring event switch within the response time:** $t_{CSA} = (n - n_{CS}) \times t_S$

Where:

t_{CSA} = Time available for monitoring event switching (ms)

n_{CS} = Multiple sampling after the monitoring event switch (for Fast preset: n_{CS}=1; for Reliable preset: n_{CS}= n-1; for User-defined: $n_{CS} \leq n-1$)

t_S = Scan cycle time (ms)

3. Compare whether there is sufficient time for the monitoring event switch:

If $t_{CSA} \geq t_{CSR}$: No advance initiation is required.

If $t_{CSA} < t_{CSR}$: The monitoring event switch must be initiated in advance. Required advance time t_{CSP} : $t_{CSP} = t_{CSR} - t_{CSA}$.

Additional Information

In some cases, the exact switching time cannot be precisely defined (e.g., due to

variable machine processing speed), or initiating the switch in advance may cause monitoring of a certain area to end prematurely.

Compensatory Measures:

- Allow the two protected areas to partially overlap.

- Temporarily monitor both hazardous areas simultaneously.

5.3.4 Minimum Distance in Fixed Applications

Overview
When designing protected areas, ensure that personnel are detected at the latest when they reach the minimum distance to the hazard. The minimum distance allows the hazardous state to be terminated in time before personnel reach the danger point.

Minimum Distance in Fixed Applications
The calculation of the minimum distance must follow the applicable international or national standards and legal regulations at the machine installation site.

If calculated according to ISO 13855, the minimum distance depends on:

- Machine stop/shutdown time (time from sensor activation to the hazardous machine state being terminated, including potential signal transmission delays in the network and processing time in the controller)

- Response time of the protective device

- Speed at which personnel approach or reach the hazard

- Triggering/detection capability of the safety laser scanner

- Approach direction: parallel for hazard area protection, vertical for hazard point protection and access protection

- Switching time between monitoring events

- Parameters specified for the application

• Extension distance to account for typical measurement errors and, if applicable, errors caused by reflections (hazard area protection only)

• Extension distance to prevent hand intrusion from above (hazard area protection only)

• Scanning plane height (hazard area protection only)

• Extension distance to prevent hand intrusion (access protection only)

Additional Information
For more information, refer to ISO 13855 and the Safety of Machinery guidelines.

5.3.5 Extension Distance Z R for Measurement Errors Caused by Reflections

If a reflector is located near the protective device (distance between reflector and protected area ≤ 6 m), an extension distance of Z R=350 mm must be considered.

5.3.6 Hazard Area Protection

Overview
In static applications, the safety laser scanner is installed with a horizontal scanning plane on, for example, a machine, where the hazardous area is not completely enclosed by physical protective devices. In hazard area protection, the safety laser scanner detects the legs of personnel. The protected area is parallel to the approach direction.

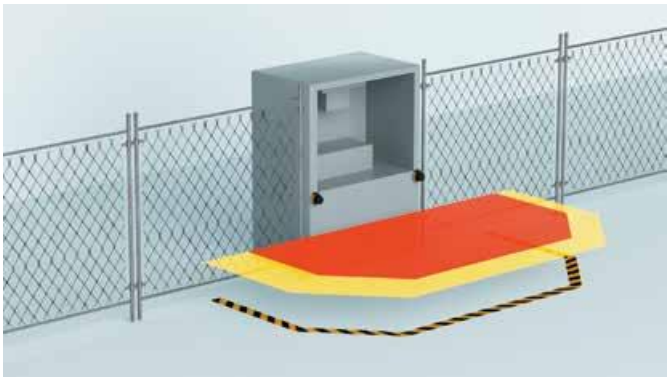


Figure 5-4: Static application with a horizontal scanning plane enabling hazard area protection.

Additional Information
It is recommended to mark the boundary of the protected area on the floor. This

allows machine operators to visually identify the protected area, facilitating future inspections of the protective function.

5.3.7.1 Protected Area

In hazard area protection, the minimum distance generally determines the required size of the protected area.
If multiple monitoring events with different protected areas are defined, the size of each protected area must be calculated individually for all protected areas used.
In many cases, a resolution of 50 mm to 75 mm is suitable for hazard area protection. Resolutions greater than 75 mm are not permitted.

5.3.7.2 Extension Distance C to Prevent Hand Intrusion from Above

Overview

In certain cases, a person may reach into the hazardous area from above before the protective device terminates the hazardous state. The extension distance prevents this situation.

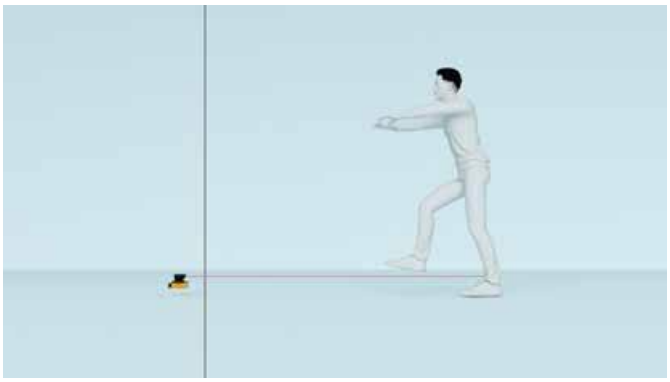


Figure 5-5: Prevention of hand intrusion from above with a low scanning plane (dimensions in mm)

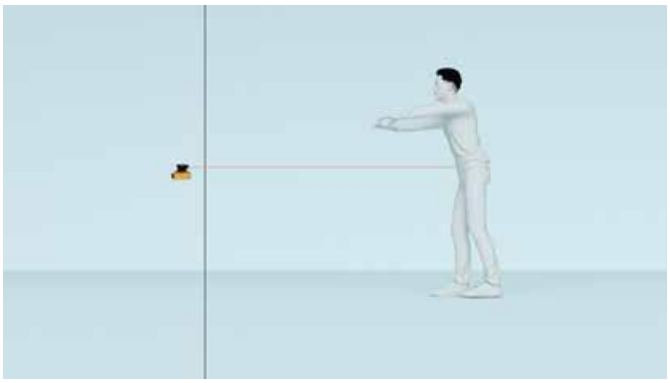


Figure 5-6: Prevention of hand intrusion from above with a high scanning plane (dimensions in mm)

The required extension distance to the minimum distance depends on the height of the protected area's scanning plane. The extension distance is greater when the scanning plane is lower than when it is higher.

Calculation of Extension Distance C

- If there is sufficient space in front of the hazard area, use C=1,200 mm.

- If the minimum distance should be as small as possible, calculate C using the following formula:

C=1,200 mm−(0.4×HD)

Where

$\mathbf{H^D}$ = height of the protective area above the floor (in millimeters, mm).

✓ If the calculated result **C ≥ 850 mm**, use the calculated value as the extension distance **C**.
✓ If the calculated result **C < 850 mm**, use **C = 850 mm** (this value corresponds to arm length and is suitable as the minimum extension distance to prevent reaching over).

5.4 Interference

5.4.1 Optical Interference

The laser scanner uses pulsed laser light to detect objects. Ambient light sources may interfere with its operation, potentially causing incorrect detection. Users should evaluate the surrounding environment before installing the laser scanner. Light sources that may interfere with the laser scanner include:

Incandescent lamps

Fluorescent lamps

Strobe lights

Flashing beacons

Sunlight

Infrared light sources

If the use of such light sources cannot be avoided during operation, the light fixtures should be installed so that the laser scanner's light source is positioned at **±5**

degrees or more away from the detection plane to prevent interference (see Figure 5-7).

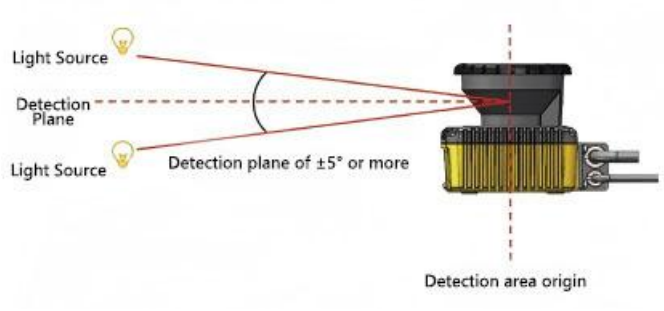


Figure 5-7 Installation to avoid optical interference

⚠ Before installation, users should assess the risk of optical interference in the working environment.
⚠ Avoid direct light sources such as strobes, beacons, and fluorescent lamps.

⚠Failure to comply with the above requirements may result in serious injury or death.
⚠Users must verify the detection capability before actual operation.

5.4.2 Mutual Interference

When two or more laser scanners, or identical products, are used simultaneously, special care is required because pulsed laser signals from one unit may interfere with another, potentially causing false detection. The following figures illustrate installation methods to avoid mutual interference.

a)**Change the installation height**
Install the scanners at different heights so that their detection planes are separated by **5° or more**.

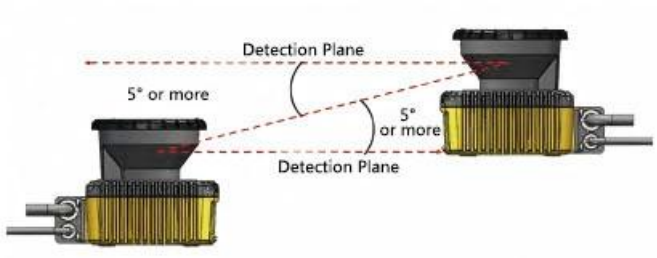


Figure 5-8 Face-to-face installation

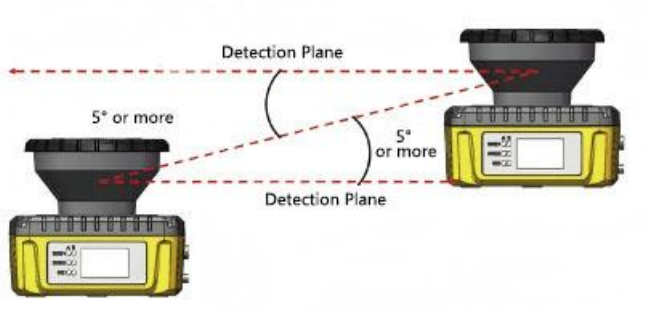


Figure 5-9 Parallel installation

b)**Change the installation angle**

Adjust the installation angle of the laser scanners so that the detection planes differ by 5° or more.

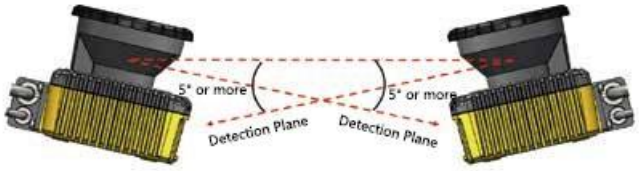


Figure 5-10 Face-to-face installation

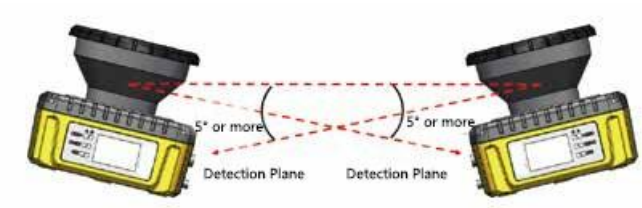


Figure 5-11 Parallel installation

c)**Add shielding between laser scanners**

Install shielding between the laser scanners so that the laser beam from one device cannot reach the other, thereby avoiding possible mutual interference.

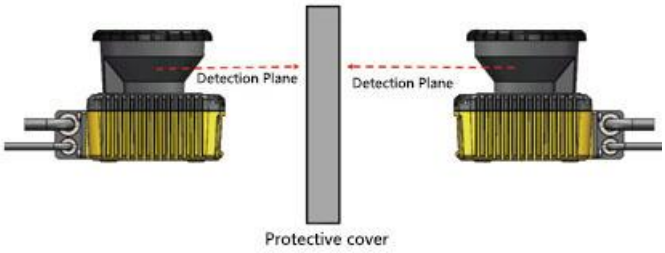


Figure 5-12 Face-to-face installation

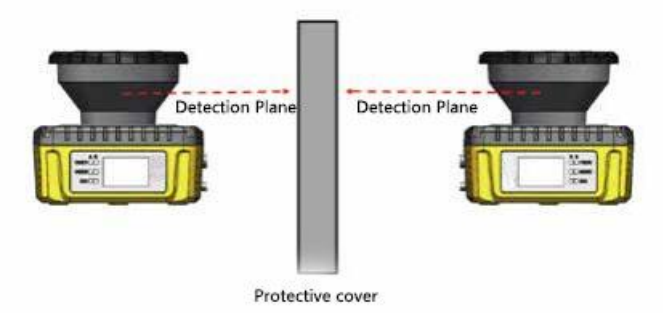


Figure 5-13 Parallel installation

The shielding material should be **opaque**.

5.4.3 Highly Reflective Backgrounds

Due to highly reflective backgrounds, incorrect OSSD outputs may occur, as measured values can appear longer than the actual distance to the object. If highly reflective backgrounds cannot be avoided in the working environment, an additional distance of **350 mm** must be added when configuring the protective and warning zones (see Figure 5-14). For the required distance tolerances, refer to the laser scanner specifications.

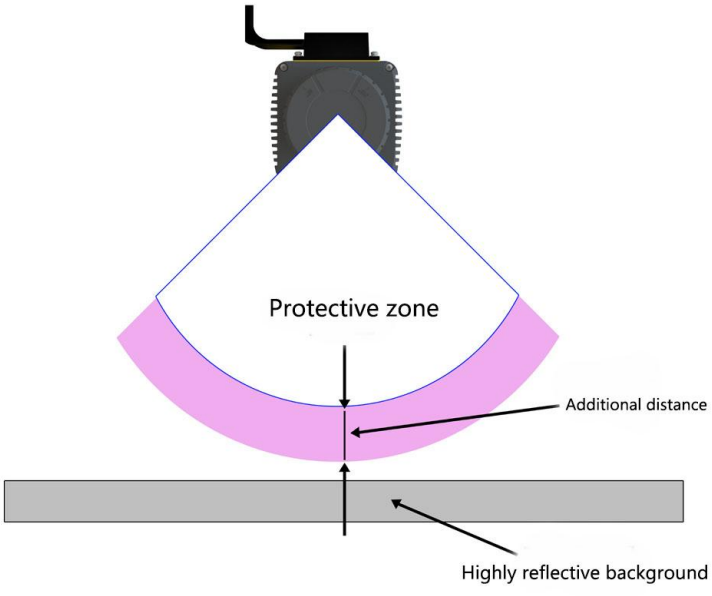


Figure 5-14 Additional distance for highly reflective backgrounds

*Additional distance: the extra distance required when operating the laser scanner in highly reflective environments.

Warning

If the background is highly reflective, the measured distance will be longer than the actual distance to the object. The additional distance must be included when configuring the protective zone.

Highly reflective backgrounds should be avoided (e.g., mirrors, corner reflectors, reflective safety vests, road reflectors). Reflections from these materials may cause incorrect detection within the protective zone.

Verify the configured zones before actual operation.

Failure to follow these instructions may result in serious injury or death.

5.4.4 Limited Detection Capability Zone

The limited detection capability zone is defined as the area between the optical window and the start of the detection zone. This zone extends **90 mm** from the origin of the laser scanner (see Figure 5-15). Objects with low reflectivity may not be reliably detected within this area.

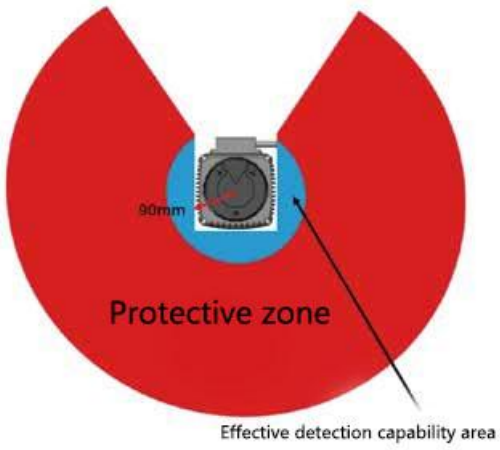


Figure 5-15 Limited Detection Capability Area

The user must perform a risk assessment to ensure that objects cannot enter the limited detection capability area.

6. Wiring

This chapter describes the safety precautions for wiring the laser scanner.

6.1 Precautions

Before performing electrical wiring, make sure that all equipment is disconnected from the power supply.

Always switch off all power sources during wiring and confirm that the power is off.

Do not exceed the cable length specified in the laser scanner specifications.

6.2 Power Supply

Ensure that the power supply is within **DC 24 V ±10%**.

For battery-powered operation, the power supply must be within **DC 24 V −30% / +20%**.

If the rated output voltage exceeds this range, the laser scanner may be damaged.

Prerequisites

- According to **IEC 60204-1**, the power supply must be able to buffer short power interruptions of **20 ms**.
- The power supply must ensure safe electrical isolation in accordance with **IEC 61140** (SELV/PELV per IEC 60204-1).
- The voltage supply must be protected by appropriate electrical fuses.

Safety Notes

△ For safety reasons, always switch off the power during electrical wiring.

△ Do not use cables longer than those specified in the laser scanner specifications.

△ Do not connect internal pins/terminals of the laser scanner to other devices.

6.3 Wire Colors and Functions

6.3.1 (22-core) Connection Cable

Wire No.	Wire color	Name	Function
1	Brown	+24V DC	Operating voltage (+24V DC)
2	Blue	0V DC	Operating voltage (0V DC)
3	Red	OSSD 1A	Output protection zone output 1A
4	Yellow	OSSD 1B	Output protection zone output 1B
5	Red/Black	OSSD 2A	Output protection zone output 2A / Warning zone output 1
6	Yellow/Black	OSSD 2B	Output protection zone output 2B / Warning zone output 2
7	Orange	SSD1A	Warning zone output 1A
8	Orange/Black	SSD1B	Warning zone output 1B
9	Purple	IN_1P	Zone switching input 1
10	Purple/Black	IN_1N	Zone switching input 1 inverted
11	Gray	IN_2P	Zone switching input 2
12	Gray/Black	IN_2N	Zone switching input 2 inverted
13	White	IN_3P/MUTTING1A	Zone switching input 3 / Mute input 1A
14	White/Black	IN_3N/MUTTING1B	Zone switching input 3 inverted / Mute input 1B
15	Pink	IN_4P/MUTTING2A	Zone switching input 4 / Mute input 2A
16	Pink/Black	IN_4N/MUTTING2B	Zone switching input 4 inverted / Mute input 2B
17	Green	IN_5P/EDM1	Zone switching input 5 / External device monitoring 1
18	Green/Black	IN_5N/EDM2	Zone switching input 5 inverted / External device monitoring 2
19	Yellow/Green	IN_6P/REST1	Zone switching input 6 / Reset input 1
20	Yellow/Blue	IN_6N/REST2	Zone input 6 (inverted/reset input 2)

The table below shows the wire color, signal name, and function of each conductor. It is recommended to use shielded cables for wiring.

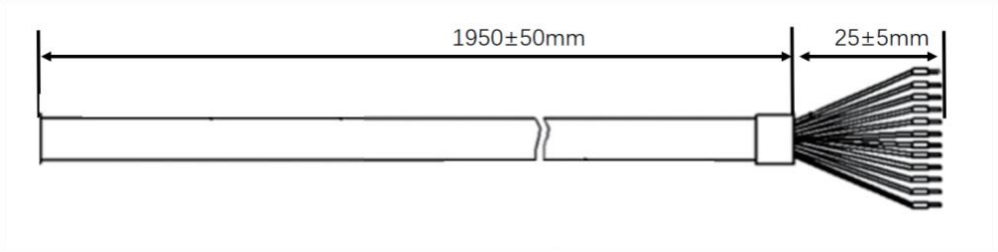


Figure 6-1 Power Cord

6.3.2 Network Cable

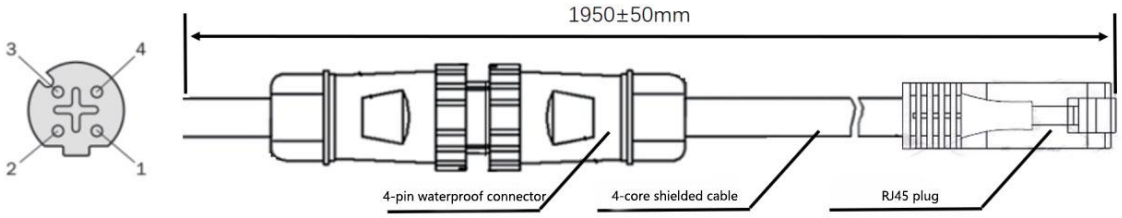


Figure 6-2 Power Cord

Pin	Name	Function
1	TX+	Transmit Data +
2	RX+	Receive Data +
3	TX-	Transmit Data -
4	RX+	Receive Data -
Thread	SH	Shield

6.4 Wiring Examples

a) Standard (up to 64 area sets)

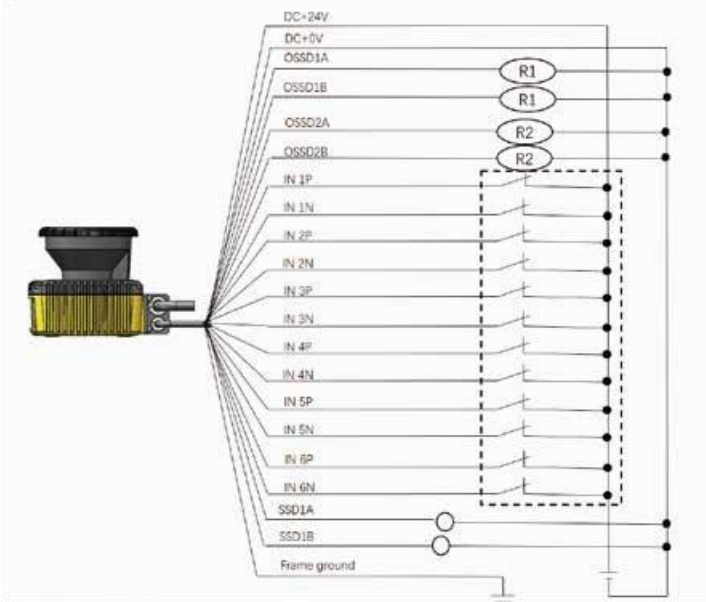


Figure 6-3 Connection Example 1

R1 and R2: External devices (safety relays, electromagnetic contactors)

b) The shielding and coating functions during EDM.

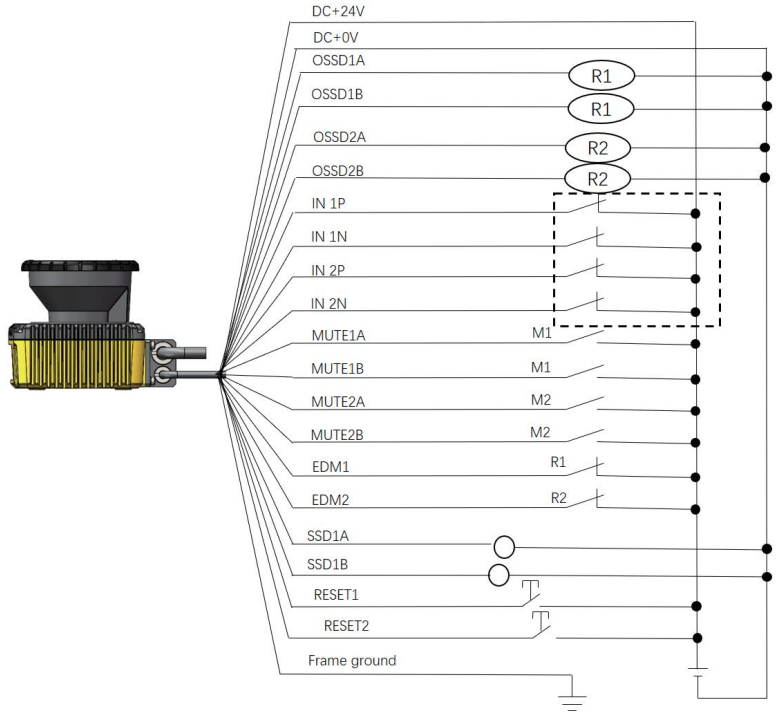


Figure 6-4 Connection Example 2

6.5 Input/Output Circuit

6.5.1OSSD /Warning Output Circuit OSSD /Warning Output is the output source type

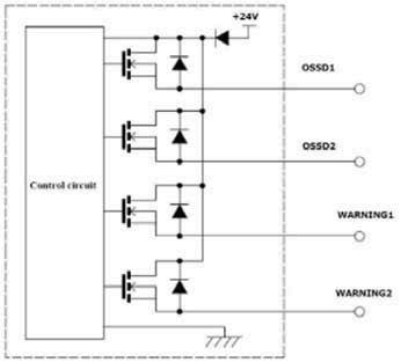


Figure 6-5 OSSD/WARNING Output Circuit

6.5.2 Other Output Circuits

The outputs RES_REQ1, RES_REQ2, MUT_OUT1, and MUT_OUT2 are PNP-type outputs.

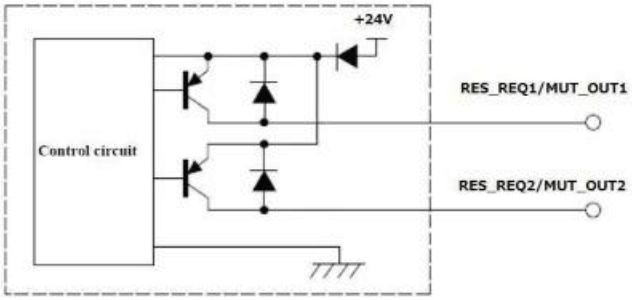


Figure 6-6 Output Circuit

6.5.3 Input Circuits

Figure 6-7 shows the input circuit signals for: Area inputs, EDM1, EDM2, RESET1, RESET2. MUTE1 and MUTE2.

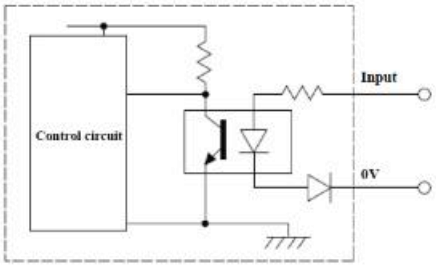


Figure 6-7 Input Circuit

7. AKUSENSE Safety Designer

The AS-60C is configured using AKUSENSE Safety Designer software.

7.1 Delivery State

In the delivery state, the safety laser scanner does not contain any commissioning or configuration settings.

7.2 Safety Designer

The safety laser scanner is configured using Safety Designer.
This section describes the basic operations related to Safety Designer.

7.2.1 Installation Assistant

The Installation Assistant helps you install Safety Designer:

1. Open the download website. Enter **Safety Designer** in the search box on ( ).

2. Check the system requirements listed on the download website.

3. Download the installation file from the website, unzip it, and run it.

4. Follow the prompts in the Installation Assistant.

7.2.2 User Interface

Figure7-1UI

- **New** (Create a new project)
- **Open** (Open a local offline project)
- **Scan** (View monitored radar safety area response)
- **Home** (Return to the main page)
- **Options**
- **Language** (Switch between Chinese and English)
- **Help**

7.2.3 New Project

Figure 7-2 New

(This section will describe the Safety Designer UI and its components.)

- **Scanned Radar Model and Network ID**
- **Lidar Parameters**
- **Next** (Enter Radar Configuration Page)
- **Supported Models**

7.2.4 Configuration

Figure 7-3 Configuration

1. **New** (Create a new system configuration)
2. **Open** (Open a saved system configuration)
3. **Save** (Save the current system configuration)
4. **Project Information**
5. **Parameter Setting** (See section 7.2.5 for details)
6. **Point Cloud Monitoring** (See section 7.2.6 for details)
7. **Project Information Interface**

7.2.5 Parameter Setting

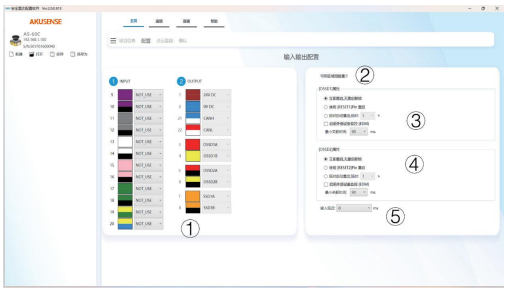


Figure 7-4 Input/Output Configuration

1.**INPUT ports adjustable, OUTPUT ports fixed**

2.**Display of available areas**

3.**OSSD1 property configuration**

4.**OSSD2 property configuration**

7.2.6 **Configuration Functions**

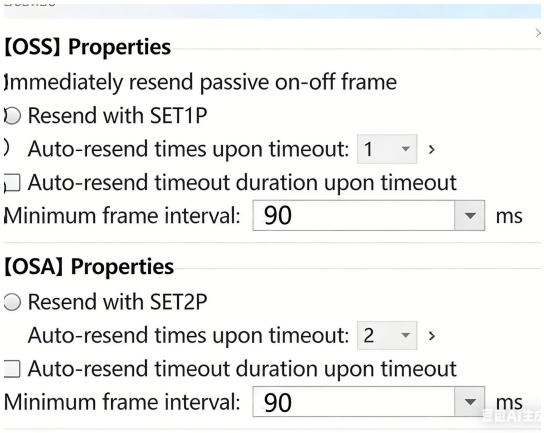
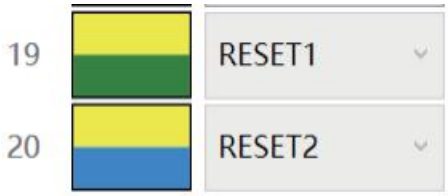


Figure 7-5 Configuration Functions

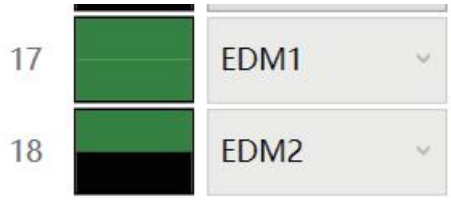
1.**Lidar OSSD Initial State**

2.**Reset Function** (Activates the interlock function; when selected, the corresponding INPUT port will automatically change, providing the configured INPUT port with alternating high/low signals for reset)

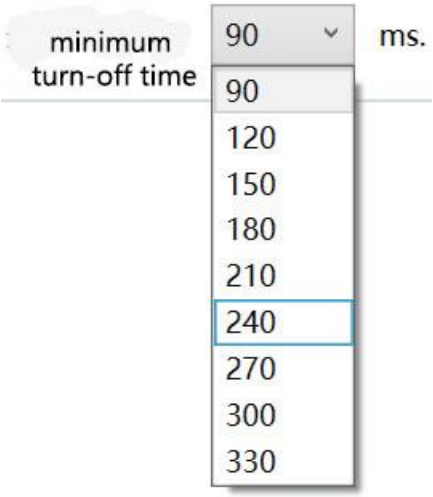


3.**Delay Function** (Time can be adjusted as needed, unit: seconds)

4.**EDM Function** (External Device Monitoring; when selected, the corresponding INPUT port will automatically change)



5.**Minimum OFF Time** (Time can be adjusted as needed, unit: milliseconds)



7.2.7 Point Cloud Monitoring

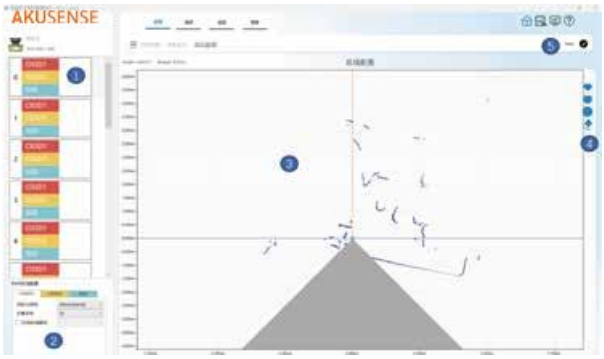
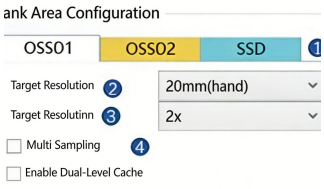


Figure 7-6 Point Cloud Monitoring

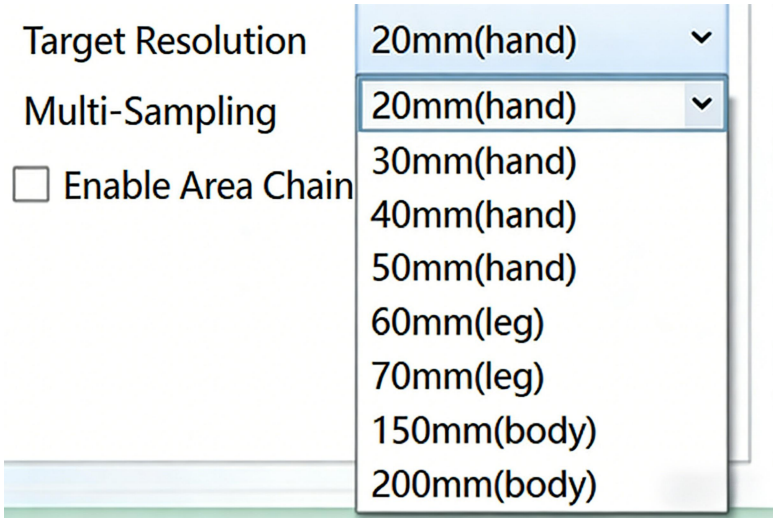
1. **BANK Selection** (0–63 BANK)
2. **BANK Area Configuration** (see section 7.2.8 for details)
3. **Point Cloud Monitoring Screen**
4. **Drawing Tools** (Polygon, Rectangle, Circle, Erase)
5. **Save** (Password required)

7.2.8 BANK Area Configuration



1. OSSD Selection (OSSD1, OSSD2, SSD)

2. Target Resolution (Detection target resolution size; resolution can be adjusted as needed, unit: millimeters)



●20mm=hand Detection

●30mm=hand Detection

●40mm=hand Detection

●50mm=lend/hand Detection

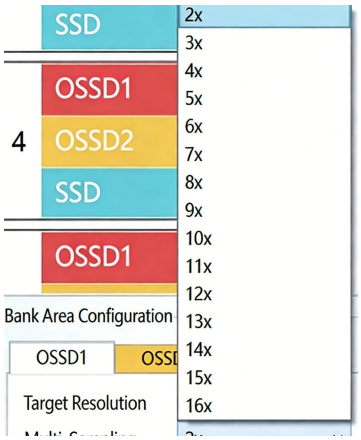
●60mm=lend/hand Detection

●75mm=lend/hand Detection

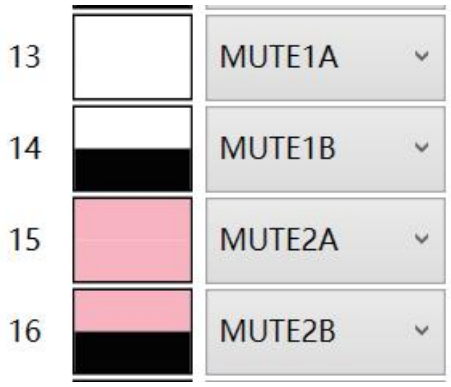
●150mm=body

●200mm=body

3. **Multiple Sampling** (Selectable from 2–16)



4. **MUTE Function** (The mute function must first be set at the INPUT port to allow area mute configuration in the point cloud monitoring screen)



7.2.9 Drawing BANK Area

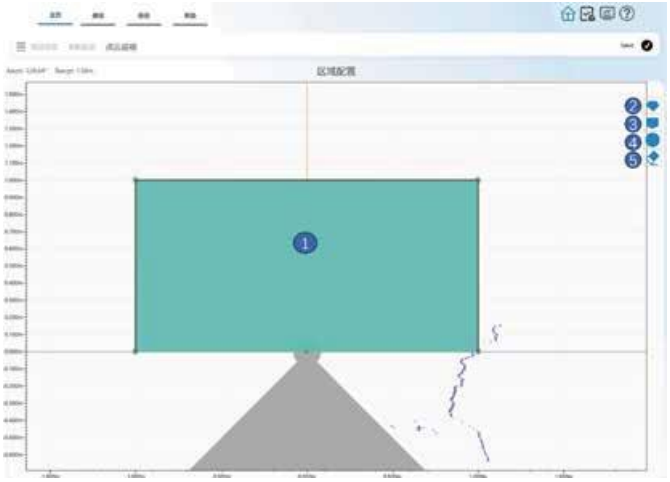


Figure 7-7 Drawing BANK Area

1. **Drawing Area**
2. **Polygon Drawing**

●Select the tool to draw the reference contour area.

●First, click with the mouse to mark the desired contour.

●Click to add contour vertices.

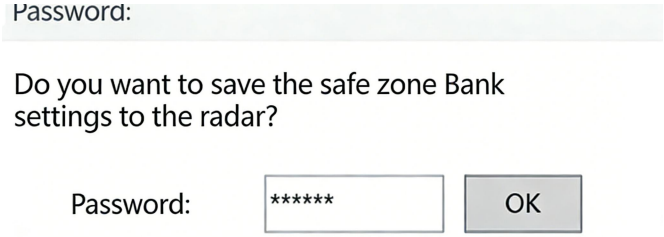
●Double-click to complete the contour.

3. **Rectangle Drawing**
4. **Erase Function** (Erases the graphics within the corresponding OSSD)

7.2.10 Confirmation

Figure 7-8 Confirmation

1. Confirm the configured parameters.
2. Confirm the configuration information.
3. Write the settings to the radar (Password required; default password is 123456).



The radar usage password must be managed and used by the responsible or authorized personnel.

7.2.11 Initialization Settings

8. Inspection and Maintenance

8.1 Safety

▲Hazard

Danger of protective device failure.
If not followed, protection of personnel and body parts may not be ensured.

Precautions:

●Never perform maintenance on device components.

●Never make any changes or improper operations to device components.

●Do not open device components except as described in this manual.

8.2 Regular Cleaning

Overview

Depending on environmental conditions, optical covers must be cleaned regularly, especially when dirty.

Dust particles may adhere to the optical cover due to static electricity.

Important Notes

▲Warning

Dirty or damaged optical cover.

If the optical properties of the cover are impaired, personnel or body parts may not be detected, or detection may be delayed.

Precautions:

●Remove dirt such as water droplets, fog, frost, or ice. Restart the safety laser scanner.

●Replace damaged optical covers.

●Remove grease or oil from the optical cover.

▲Important:

●Do not use corrosive or abrasive cleaning agents.

●Recommended: Use anti-static cleaning agents.

●Recommended: Use anti-static plastic cleaner and AKUSENSE lens cloth.

Procedure for Cleaning the Optical Cover:

1. Ensure the machine is in a safe state and remains safe during cleaning.

2. Use a clean soft brush to remove dust from the optical cover.

3. Moisten a clean soft cloth with anti-static plastic cleaner and wipe the optical cover.

4. Check the Effectiveness of the Protective Equipment

Additional Information

If the display shows a *dirty warning*, the optical lens cover is contaminated and must be cleaned immediately.

If the display shows a *dirty fault*, the optical lens cover is severely contaminated; for safety reasons, the safety laser scanner has switched to the *off* state.

Related Topics

"Cleaning Agents"

"Checking the Main Functions of Protective Equipment"

8.3 Replacing the Safety Laser Scanner

Important Notes

△ Hazard

Danger due to failure of protective equipment: If unsuitable configurations are saved in the system plug-in, hazardous conditions may not end or may not end in time.

■Ensure the same system plug-in is used or the configuration is restored after replacement.

■Ensure the orientation of the safety laser scanner is correct after replacement.

△Important

The enclosure protection rating IP65 is only valid when the optical lens cover and system plug-in are installed and the USB interface is closed with the protective cover.

△ Important

If excessive force is applied when installing the system plug-in, contacts may break or bend.

Insert the system plug-in carefully.

Do not use force.

8.3.1 Replacing the Safety Laser Scanner
Prerequisites

Required Tools: TX10 Torx wrench

Procedure

1. Ensure the environment is clean and free of dust and moisture.
2. Loosen the fixing bolts and remove the defective safety laser scanner.
3. Install the new safety laser scanner.
4. Check the effectiveness of the protective equipment.

■Usually, check the protective equipment in the same way as during commissioning.

■If equipment tolerances were considered during project planning, and it has been ensured that the configuration, wiring, or orientation of the safety laser scanner has not changed, a functional test is sufficient.

8.4 Regular Inspections

Inspections must ensure that hazardous areas are monitored by protective equipment and prevent unprotected entry into hazardous zones.

Perform inspections according to the machine manufacturer's and operator's regulations.

9. Troubleshooting

9.1 Safety
△ Hazard

Danger due to failure of protective equipment

If not followed, protection of personnel and body parts is not guaranteed.

■Never perform maintenance work on device components.

■Never modify device components or perform improper operations.

■Do not open device components except as described in this document.

△Hazard

Danger of unexpected machine start

Prevent accidental machine startup during any work on the protective equipment or the machine.

Note

For more information on troubleshooting, please consult your AKUSENSE representative.

9.2 Fault Display on the LCD Screen

Overview

In the event of a fault, the display shows a warning icon, fault type, and fault code against a red flashing background.

Figure 9-1 Fault Display

●The two-digit fault type in the first line helps with troubleshooting.

●The eight-digit fault type in the second line helps AKUSENSE after-sales support perform detailed fault analysis.

●Connect the radar via the network cable to obtain more information about the fault and troubleshooting.

●Detailed information on each fault and results not shown on the display can be found in the message history of Safety Designer.

Fault Types Displayed on the Screen:

Table Below: Fault Types

Fault Type	Description	Cause	Troubleshooting
01	Voltage fault	The safety laser scanner has an internal fault.	Perform a device restart, or interrupt the power supply for at least 2 seconds.
02	Current fault	The safety laser scanner has an internal fault.	Replace the safety laser scanner and send it to the manufacturer for repair.
04	Temperature fault	The safety laser scanner has an internal fault.	Perform a device restart, or interrupt the power supply for at least 2 seconds.
08	Measurement fault	The safety laser scanner has an internal fault.	Replace the safety laser scanner and send it to the manufacturer for repair.
10	Motor fault	The safety laser scanner has an internal fault.	Perform a device restart, or interrupt the power supply for at least 2 seconds.
20	Angle sensor malfunction	The safety laser scanner has an internal fault.	Perform a device restart, or interrupt the power supply for at least 2 seconds.
40	Safety zone malfunction	The safety laser scanner has an internal malfunction.	Replace the safety laser scanner and send it to the manufacturer for repair.
80	Window cover malfunction	The safety laser scanner's window cover is faulty.	Perform a device restart, or interrupt the power supply for at least 2 seconds.

10. Technical Data

10.1 Version Number and Functional Scope

Functional Scope

Older devices may not support the full functional scope of the current Safety Designer.

Three-digit version numbers are used to indicate different versions of the functional scope.

The functional scope of the device can be found at the following locations:

■Model nameplate, *Version* field

■Display, *Hardware* menu entry

■ Safety Designer, *Overview* dialog (only for connected devices)

■Safety Designer, *Report*

Table: Functional Scope

Model	Ver. No.	Changes and New Features
AS-60C	1.0.0	· First release version

Revision Version

Three-digit version numbers are used to indicate different revision states of the device.

The revision version of the device can be found in the *Revision* field on the model nameplate.

Table: Revision Versions

Model	Ver. No.	Changes and New Features
AS-60C	1.0.0	· First release version

10.2 Data Sheets

10.2.1 AS-60CI/O

Table: Features

Protected Area Range	≤ 5.0 m， see details:
Warning Area Radius	≤20 m
Distance Measuring Range	≤ 40 m
Number of Zones	≤ 64
Simultaneously Monitored Zones	≤ 2
Zone Groups	≤ 64

Scanning Angle	270°(45~315°）
Protected Area Resolution	20 mm, 30 mm, 40 mm, 50 mm, 60 mm, 75 mm, 150 mm, 200 mm
Angular Resolution	0.167°
Response Time	≥ 70 ms, see details:
Scanning Cycle Time	33 ms
Multi-sampling	2~16
Typically Required Protected Area Extension (TZ = Tolerance Zone of Safety Laser Scanner)	60 mm
Additional Extension Z R, for Measurement Errors Caused by Reflection	350 mm
Deviation from Ideal Scanning Area Flatness at 5m Protected Area Range	≤ ± 30 mm

Table: Safety Technical Characteristic Parameters

Type	Type 3 (IEC 61496)
Safety Integrity Level	SIL 2 (IEC 61508)
SIL Requirement Limit	SIL CL 2 (IEC 62061)
Category	Category 3 (ISO 13849-1)
Performance Level	PL d (ISO 13849-1)
PFH_D (Average Dangerous Failure Rate per Hour)	8×10^{-8}
T_M (Continuous Operating Time)	20 years (ISO 13849-1)
Safety State in Case of Fault	At least one OSSD is in the OFF state.

Table: Electrical Parameters

Operating Data	
Operating Voltage	24 V DC (16.8 V ~ 30 V DC) (SELV/PELV 1)
Residual Ripple	± 5% 2)
Inrush Current at 24 V	≤ 1.3 A
Current Consumption at 24 V	
No Output Load	Typical Value 0.16 A
At Maximum Output Load	Typical Value 0.66 A
Power Consumption	

No Output Load	Typical Value 3.9 W
At Maximum Output Load	Typical Value 15.9 W
Total Output Current	≤ 500 mA
Power-On Delay	≤ 12 s
Safety Output (OSSD)	
Output Type	2 PNP semiconductors per OSSD, with short-circuit protection and cross-circuit monitoring
Output Voltage ON State (HIGH)	(U V – 2 V) ~ U V
Output Voltage OFF State (LOW)	0 V ~ 2 V
Output Current ON State (HIGH)	0.5 mA ~ 250 mA per OSSD 3)
Leakage Current	≤ 250 µA
Load Inductance	≤ 2.2 H
Load Capacitance	≤ 1 µF, in series with 50 Ω
2 PNP semiconductors per OSSD, with short-circuit protection and cross-circuit monitoring	Depends on load inductance
Permissible Cable Resistance for Load and Equipment	≤ 4 Ω
Test Pulse Width	≤ 300 µs (Typical Value 230 µs)
Test Pulse Interval	Typical Value 8 × Scanning Cycle Time
Duration of OFF State	≥ 80 ms
Interval Time (Time Difference Between OSSD 2 and OSSD 1 Switching On/Off)	≤ 1 ms
Leakage Current	≤ 250 µA
Quiescent Control Input, Universal Input, Universal I/O (Configurable as Input/Output)	
Input Voltage HIGH	24 V (11 V ... 30 V)
Input Voltage LOW	0 V (-30 V ... 5 V)
Input Current HIGH	2 mA ~ 6 mA
Input Current LOW	0 mA ~ 2 mA
Input Capacitance	Typical Value 10 nF
Input Frequency (Maximum Switching Frequency, when used as a control input)	≤ 20 Hz

Table: Mechanical Parameters

Dimensions (including system plug-in, W × H × D)	106.6 mm × 80.2 mm × 117.5 mm
Weight (including system plug-in)	0.67 kg
Housing Material	Aluminum
Housing Color	RAL 9005 (Black) and RAL 1021 (Oilseed Rape Yellow)
Optical Lens Cover Material	Polycarbonate

10.3 Response Time

Overview

The response time of the protective device is the maximum time between an event that triggers the sensor and the provision of a shutdown signal to the protective device interface (e.g., OSSD to OFF state).

In addition to the response time of the protective device, other signal transmission and processing times also affect this duration until the hazardous condition is ended. For example, the processing time of the control system and the response time of cascaded contactors fall into this category.

Response Time

The response time of the safety laser scanner depends on the configured multiple sampling.

The response time can be calculated using the following formula:

$tR=n\times30ms+10ms$

Where:

tR = Response time

n = Configured multiple sampling (default: n = 2)

10.4 Time Sequence of Output Signal Switching Device (OSSD) Test

The safety laser scanner periodically tests the OSSD. For this purpose, the safety laser scanner temporarily switches each OSSD to the OFF state and checks whether the channel is de-energized.

Ensure that the machine control system does not respond to this test pulse and does not shut down the machine.

10.5 Scanning Range

Protected Area Range

The effective range of the protected area depends on the configured object resolution.

Table: Protected Area Range

Size of detected object	Protected Area Range
20mm	0.05m~1.5m
30mm	0.05m~1.8m
40mm	0.05m~2.4m
50mm	0.05m~3m
≥75mm	0.05m~5m
Detection Limited Zone	≤0.05m
Tolerance Zone	50mm

Warning Area Radius and Distance Measurement Range

For non-safety-related applications (warning area, measurement data output), the safety laser scanner has a scanning range greater than the maximum protected area range.

The chart below shows the requirements for the size and reflectivity of objects to be detected (depending on the desired scanning range). Under good conditions, smaller object sizes or lower reflectivity are often sufficient to achieve the desired scanning range.

For the warning area, the scanning range is limited to 10 m.

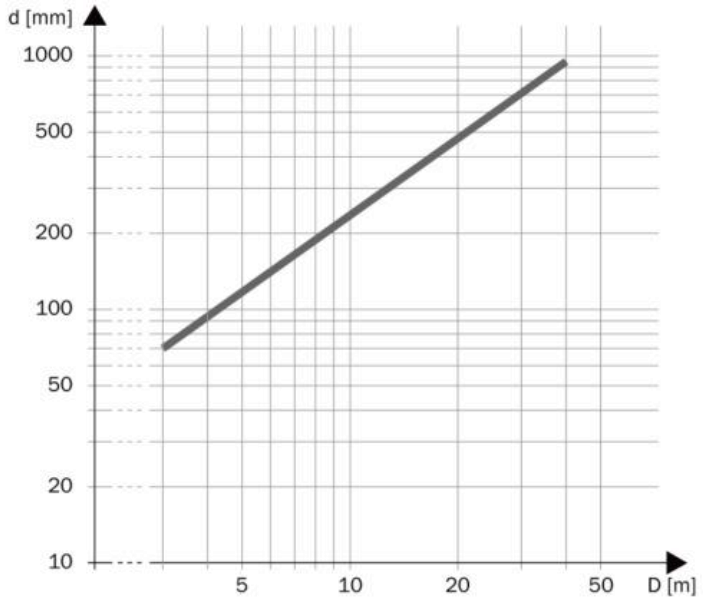


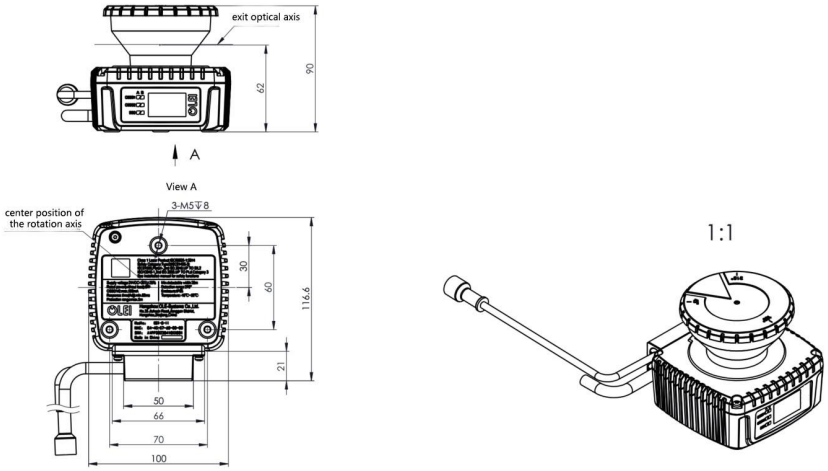
Figure 10-1 Scanning Range and Object Size for Measurement Data Output

d = Minimum required object size (unit: mm)

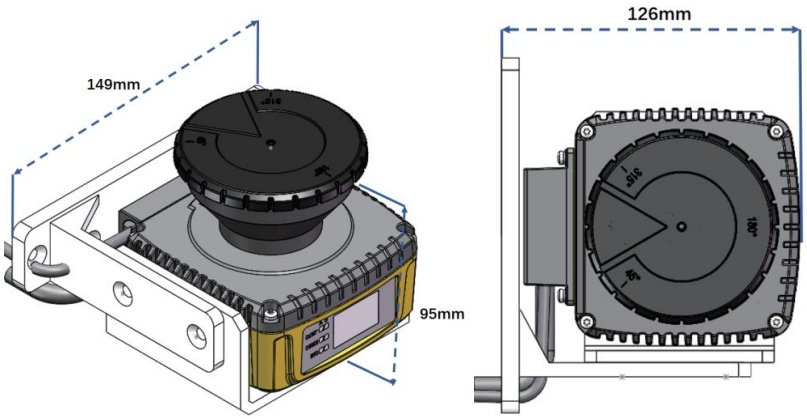
D = Scanning range (unit: m)

10.6 Dimensional Diagram

10.6.1



10.6.2 Mounting Bracket Dimensional Diagram



11 Inspection Plan

Machine manufacturers and operators must specify all necessary inspections.

Inspections must be defined according to usage conditions and risk assessment, and documented in a traceable manner.

The following inspections must be planned:

■Comprehensive inspections must be performed during commissioning and after any modifications.

■ Regular inspections of the safety laser scanner must meet specific minimum requirements.
Some inspections require the use of test rods. Opaque test rods with a black surface are suitable objects for inspection.

■Their diameter must correspond to the configured resolution.

■Related Topics

■"Test Rods"

11.1 Inspections During Commissioning and Special Cases

Minimum Requirements

A comprehensive check of the protective equipment and its application must be performed under the following conditions:

■Before commissioning

■After configuration or safety function changes

■After changes in installation, orientation, or electrical connection

■After unexpected events, e.g., after detecting improper operation, machine modification, or component replacement

· Inspections help ensure the following:

· Compliance with all relevant regulations and effectiveness of protective equipment for all machine operating modes. Key aspects include:

· Compliance with standards

Correct installation of protective equipment

Appropriate configuration and safety functions

· Proper calibration

■This document applies to the machine state including the protective equipment.

■Verified configuration reports must match the required project planning.

Inspections must be carried out by qualified safety personnel or personnel with special skills and authorization. Inspections must be documented to ensure reproducibility and traceability.

Recommended Inspections

In many cases, it is important to perform the following inspections during commissioning and special cases:

■Check relevant items on the inspection checklist; see *"Initial Commissioning and Commissioning Checklist"*

■"Visual inspection of machine and protective equipment"

■"Check main functions of protective equipment"

■"Check protected area"

■Guide operators on the functions of protective equipment

11.2 Regular Inspections

Overview

Regular inspections are used to reveal defects caused by changes or external influences (e.g., damage or tampering) and to ensure that protective measures provide the necessary protection.

Δ Important Note

ΔWarning

Danger due to failure of protective equipment

If not followed, protection of personnel and body parts is not guaranteed.

■Perform inspections at least once per year.

■Entrust inspections to qualified safety personnel or specially authorized personnel.

■Record inspections in a traceable manner.

Minimum Requirements for Regular Inspections

The following inspections must be performed at least once per year:

· "Check Main Functions of Protective Equipment"

· Check detection capability (resolution), see "Check Protected Area"

Further Inspection Recommendations

Depending on application conditions, the results of the machine risk assessment may require additional inspections or more frequent performance of certain inspections.

In many cases, it is important to perform the following inspections together with regular inspections:

· "Visual Inspection of Machine and Protective Equipment"

· Check relevant items on the inspection checklist; see "Initial Commissioning and Commissioning Checklist"

In many cases, the following inspections should be performed daily:

· "Visual Inspection of Machine and Protective Equipment"

· "Check Main Functions of Protective Equipment"

Additional Information

If a fault is detected during inspection, stop the machine immediately.

In this case, the safety laser scanner’ s installation and electrical connections must be checked by the corresponding qualified safety personnel.

11.3 Inspection Guidelines

Recommended Procedure for Checking Main Functions of Protective Equipment

■Observe the display and status LEDs. If no LED remains lit when the machine is powered on, a fault exists.

■Check the functions of the protective equipment by triggering a protective function and observing the response of the safety outputs (e.g., via machine reaction).

· Any Application: During inspection, observe whether the safety laser scanner indicates an interruption of the protected area via LED and/or display.

· Static Applications (hazard area protection, access protection, danger point protection):

Interrupt the protected area with the specified test object and observe whether the machine stops.

· Dynamic Applications (mobile hazard area protection):

Place the specified test object in the vehicle lane and observe whether the vehicle stops.

Enable the protected area interrupted by at least one test object and check the expected response (e.g., via automatic check in the safety controller).

If a fault is detected during inspection, stop the machine immediately.
In this case, the safety laser scanner’ s installation and electrical connections must be checked by the corresponding qualified safety personnel.

Check Protected Area

This inspection verifies the protected area and detection capability.

The inspection is used to identify the following:

■ Changes in detection capability (check all configured areas)

■ Recommended procedures for hazard area protection when changes, operations, or damage to the protective equipment or machine may cause a change in the protected area or its position:

· Place the specified test object at multiple positions along the edge of the protected area. The safety laser scanner must detect the test object at any position and indicate detection. The display depends on the configuration. The number of positions and item numbers to be checked must be selected to ensure that access to the hazardous area is not undetected.

· If multiple protected areas are used (e.g., under different monitoring events), check the edges of all protected areas.

Recommended procedures for access protection and danger point protection:

· Move the specified test object along the edge of the protected area. The safety laser scanner must detect the test object at any position and indicate detection.
· The display depends on the configuration. Dimensions of the protected area must be marked to ensure it is impossible to reach or walk around it.

· If multiple protected areas are used (e.g., under different monitoring events), check the edges of all protected areas.

· If a fault is detected during inspection, stop the machine immediately. In this case, the safety laser scanner’ s installation and electrical connections must be checked by the corresponding qualified safety personnel.

Visual Inspection of Machine and Protective Equipment

Recommended Procedures:

■Check whether the machine or protective equipment has been altered or operated in a way that could affect the effectiveness of the protective equipment.

■Pay particular attention to the following:

· Has the machine been modified?

· Have machine components been removed?

· Has the machine environment changed?

· Are there defective cables or exposed cable ends?

· Has any protective equipment or component been removed?

· Is the protective equipment damaged?

· Is the protective equipment heavily contaminated?

· Is the optical lens cover dirty, scratched, or damaged?

· Has the orientation of the protective equipment been changed?

· Are objects (e.g., cables, reflective surfaces) located within the protected area?

If any of the above apply, stop the machine immediately. In this case, the machine and protective equipment must be inspected by the corresponding qualified safety personne

12 Attachments

12.1 test bar Product: 50mm test rod, 75mm test rod

12.2 Detergents

Part

Anti-static Plastic Cleaner
Lens Cleaning Cloth / Lens Cloth

12.3 Initial Commissioning and Commissioning Checklist

This checklist is used by the manufacturer or integrator when installing electro-sensitive protective equipment (BWS).

Explanations regarding the following points must be available at least during the initial commissioning. However, depending on the application, the manufacturer or integrator must verify the applicable requirements.

This checklist shall be retained and stored with the machine documentation for reference during periodic inspections.

Have the relevant safety regulations applicable to the machine's instructions and standards been used as a basis?	YES☐ NO☐
Have the applicable directives and standards been included in the declaration of conformity?	YES☐ NO☐
Does the protective equipment comply with the PL/SILCL and PFHd requirements of EN ISO 13849-1/EN 62061	YES ☐ NO☐
and the type requirements of EN 61496-1?	YES ☐ NO☐
Is access to or proximity to the hazardous area or hazardous point only possible through the protective zone of the BWS?	YES☐ NO☐
When protecting hazardous areas or points, have appropriate measures been taken to prevent unprotected persons from remaining in the hazardous area (mechanical rear protection) or to monitor protected persons remaining in the hazardous area (protective equipment), and are these measures non-removable or locked?	YES ☐ NO☐
Have additional mechanical protective measures been added to prevent unauthorized access to the hazardous area from below, above, or around the ESPE?	YES ☐ NO☐
Has the longest stopping/or shutdown time been measured, specified, and documented (on the machine and/or in the machine documentation)?	YES☐ NO☐
Is the minimum distance required between the BWS and the next hazardous point maintained?	YES☐ NO☐
Is the ESPE device correctly installed and is it ensured that it cannot be tampered with after adjustment?	YES☐ NO☐
Are the required electrical safety measures (protection class) implemented?	YES ☐ NO☐
Are control switches for resetting the electrically sensitive protective equipment (ESPE) or restarting the machine present and correctly installed?	YES ☐ NO☐

Are the outputs of the BWS (electrically sensitive protective equipment) (OSSD or safety outputs via network) integrated according to EN ISO 13849-1/EN 62061 standards and integrated according to the circuit diagram?	YES □ NO□
Have the protective functions been checked according to the test instructions in this document?	YES □ NO□
Are the given protective functions effective in every configurable operating mode?	YES□ NO□
Are the switching elements (e.g., contactors, valves) activated by the ESPE monitored?	YES□ NO□
Is the BWS effective throughout the entire hazardous state?	YES□ NO□
When the BWS is switched off or disconnected, or when switching operating modes or switching to another protective device, is the already initiated hazardous state stopped?	YES □ NO□

This checklist does not replace the initial commissioning nor the periodic inspections performed by qualified safety personnel.

12.4 Glossary of Terms

ESPE	Electro-Sensitive Protective Equipment
ESD	Electrostatic discharge: ESD
OSSD	Output signal switching device: A signal output device of a protective device used to stop hazardous movements. An OSSD is a safety-related output signal switching device. Each OSSD is periodically tested for proper operation. OSSDs are always dual-channel and must be evaluated in a dual-channel manner for safety reasons. Two OSSDs that are switched and evaluated together constitute an OSSD pair.
PFHD	Probability of dangerous failure per hour
PL	Performance Level (ISO 13849)
SIL	Safety integrity level
SILCL	SIL claim limit (IEC 62061)
Safety output terminal	Safety outputs transmit safety-relevant information. Examples: OSSD or safety-relevant information in a safety-related network are considered safety outputs.
Protected area	The protected area safeguards hazardous zones of machines or vehicles. Once an electro-sensitive protective equipment (ESPE) detects an object within the protected area, the associated safety outputs are switched to the OFF state. Cascaded control elements can use this signal to bring the hazardous state to a safe condition, e.g., stopping the machine or vehicle. Depending on the application, a horizontal or vertical protected area may be required. ESPE can be installed in either horizontal or vertical orientation as needed.
Test probe	A test rod is an opaque cylindrical object used to verify the detection capability of active optoelectronic protective devices. The diameter of the test rod corresponds to the resolution of the active optoelectronic protective device.
Electrosensitive protective	An ESPE is a device or a set of devices used to safely detect the presence of personnel or body parts. It is intended to protect people near machines and equipment that pose a risk of bodily

equipment	injury by bringing the machine or equipment to a safe state before personnel are exposed to danger. Examples: Safety light curtain, safety laser scanner.
Resolution	Also referred to as sensor detection capability, it indicates the minimum object size that can be reliably detected.
Reset	When a stop command is issued to the protective equipment, the OFF state must be maintained until the reset device is operated and the machine can be restarted in a second step. Reset restores the protective equipment to the monitoring state after receiving a stop command. Reset also terminates the start interlock or restart interlock of the protective equipment, allowing the machine to be restarted in a second step. Reset is only permitted if all safety functions and protective equipment are operating correctly. Resetting must not cause movement of the protective equipment or create a hazardous condition. The machine may only be restarted after a successful reset using a separate start command. Manual reset is performed via a separate, manually operated device (e.g., a reset button). Automatic reset via the protective equipment is only permitted in special cases if one of the following conditions is met： • No personnel shall remain in the hazardous area without the protective equipment being triggered. • It must be ensured that no personnel are present in the hazardous area during and after the reset.
Closed state	The output state of the protective device, in which the controlled machine is brought to a safe state and prevented from starting (e.g., the voltage on the OSSD is LOW, so that the machine remains switched off).
Connected state	The output state of the BWS, in which the controlled machine is allowed to operate (e.g., the voltage on the OSSD is HIGH, so that the machine can operate).
Warning area	The warning zone monitors a larger area than the protective zone.

	The warning zone can be used to trigger simple switching functions, such as triggering a warning light or sound signal when a person approaches, before they enter the protective zone. The warning zone must not be used for safety-related applications.
Control input	The control input receives signals from, for example, the machine or the control system. In this way, the protective device obtains information about the conditions for the machine, for example, when switching operating modes. If the protective device has been configured accordingly, another monitoring situation is then initiated. The information must be transmitted safely. For this purpose, at least two separate channels are usually used. The control inputs (depending on the device) can be designed as static or dynamic control inputs.
Zone group	A zone group consists of one or more zones. The zones of a zone group are monitored simultaneously. A zone group can contain different zone types. A typical application is the use of a protective zone with one or more warning zones: when a vehicle approaches a person, the warning zone triggers an optical or acoustic signal. If the person does not react and the vehicle continues to approach, the safety laser scanner detects the object in the protective zone and switches the relevant safety output to the off state. The vehicle stops before hitting the person. The scan cycle time is the time required for the safety laser scanner's mirror to rotate one full revolution.
Scan cycle time	External device monitoring (EDM) monitors the status of downstream safety protection.
External device monitoring	The prerequisite for using external device monitoring is that a forced contactor for shutdown is enabled. When the external device monitoring is connected to the auxiliary contact of the forced contactor, the external device monitoring checks whether the contactor switches correctly when the OSSD is switched off.
Hazardous state	A state of a machine or device that may cause injury to personnel. The protective device prevents this danger in compliant use. In the illustrations in this document, the dangerous state of the machine is always shown with moving machine parts. In practice,

	various dangerous states may exist, such as: Machine movement Conductive parts Visible or invisible radiation A combination of multiple risks
Response time	The response time of the protective device is the maximum time between the occurrence of an event that causes the sensor to respond and the provision of a shutdown signal to the protective device interface (e.g., OSSD to the off state).
Restart interlock	The purpose of the restart interlock is to prevent the machine from starting automatically, such as when a safety device is activated while the machine is running, or when the machine's operating mode is changed. The restart interlock can be implemented in the safety device or safety controller. Before the machine is allowed to restart, a reset command must be sent to the safety device, such as by pressing a reset button.

Accompanying Documentation

IEC 61496-1:2012 Clause 7 is applicable, except for the following cases.

Additionally, the accompanying documentation should contain the following information, where applicable:

aaa) Application examples illustrating the tolerance zones displayed.

bbb) Dimensions of the maximum and minimum detection areas as well as the tolerance zones, including information on the source of distance measurement (see also Figures 1 and 2) to determine the detection range.

ccc) Information on the minimum required distance between the boundaries of the detection area and surrounding structures (e.g., walls or machine components) to ensure usability during operation (see also AA.5.2).

ddd) Instructions for setting the detection area, including consideration of tolerance zones and additional optional features of AOPDDR, as described in Annex A of this document (if these options are available). When describing areas, it must be clearly

stated whether the description relates to the detection area defined in 3.4 or the combination of the detection area and tolerance zones.

eee) Instructions to prevent personnel from entering the hazardous area described in AA.5 undetected.

fff) Information on the behavior of AOPDDR under conditions of smoke or specular reflections.

ggg) Information on how using the AOPDDR within an additional enclosure may affect detection capability. For example, an additional enclosure may affect both detection capability and detection area.

hhh) Where applicable, recommendations for marking the detection area on the floor.

iii) Instructions on how to document the detection area settings, including date, AOPDDR serial number, and responsible personnel identification.

jjj) Installation restrictions if the AOPDDR is influenced by another AOPDDR of the same design during normal operation, in accordance with Clauses 4.3.5 and 5.4.6.8.2.

kkk) Information on external influences that may not be within the scope of this document but could reduce the specified detection capability. Examples include welding spatter, infrared remote controls, various types of fluorescent and stroboscopic light sources, snow, rain, contamination, and thermal convection.

lll) Information on the need for periodic inspection of optical windows for damage (depending on the application).

mmm) Information on the need for periodic verification of the AOPDDR installation and checking for potential misalignment of the detection area (depending on the specific application).

nn) Information on measures taken to prevent potential effects caused by light radiation (if applicable).

ooo) If the AOPDDR has areas with limited detection capability, provide the information required in Clause 4.1.6.

ppp) Information to avoid interference from incandescent light sources, as required in Clause 5.4.6.4.1 b). This information shall include examples of light sources that

may affect the AOPDDR in use and the appropriate distance between the AOPDDR and these light sources.

qqq) Information regarding the maximum speed of objects with the minimum detectable size within the AOPDDR detection area under worst-case orientation conditions (see Clause 4.2.12.