Laser Sentinel

INSTRUCTION MANUAL

Safety Laser Scanner
PROFINET/PROFIsafe

DATASENSING

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Original Instructions (ref. 2006/42/EC)

This manual refers to DL Sentinel version 4.0.0 or later

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The number of arbitrators will be three, with each side to the dispute being entitled to appoint one arbitrator. The two arbitrators appointed by the parties will appoint a third arbitrator who will act as chairman of the proceedings. Vacancies in the post of chairman will be filled by the president of the SIAC. Other vacancies will be filled by the respective nominating party. Proceedings will continue from the stage they were at when the vacancy occurred. If one of the parties refuses or otherwise fails to appoint an arbitrator within 30 days of the date the other party appoints its, the first appointed arbitrator will be the sole arbitrator, provided that the arbitrator was validly and properly appointed. All proceedings will be conducted, including all documents presented in such proceedings, in the English language. The English language version of these terms and conditions prevails over any other language version.

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- END -

TABLE OF CONTENTS

PREFACE

ABOUT THIS MANUAL

This Instruction Manual is provided for users seeking advanced technical information, including connection, programming, maintenance and specifications. The Quick Reference Guide (QRG) and other publications associated with this product can be downloaded free of charge from the website listed on the back cover of this manual.

Manual Conventions

The following conventions are used in this document:

The symbols listed below are used in this manual to notify the reader of key issues or procedures that must be observed when using the reader:

NOTE

Notes contain information necessary for properly diagnosing, repairing and operating the reader.

CAUTION

The CAUTION symbol advises you of actions that could damage equipment or property.

WARNING

The WARNING symbol advises you of actions that could result in harm or injury to the person performing the task and/or persons in the vicinity of the source of danger.

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GENERAL VIEW

LASER SENTINEL PROFINET/PROFIsafe

SLS-M5-PP-BA (Back/Rear connector model)

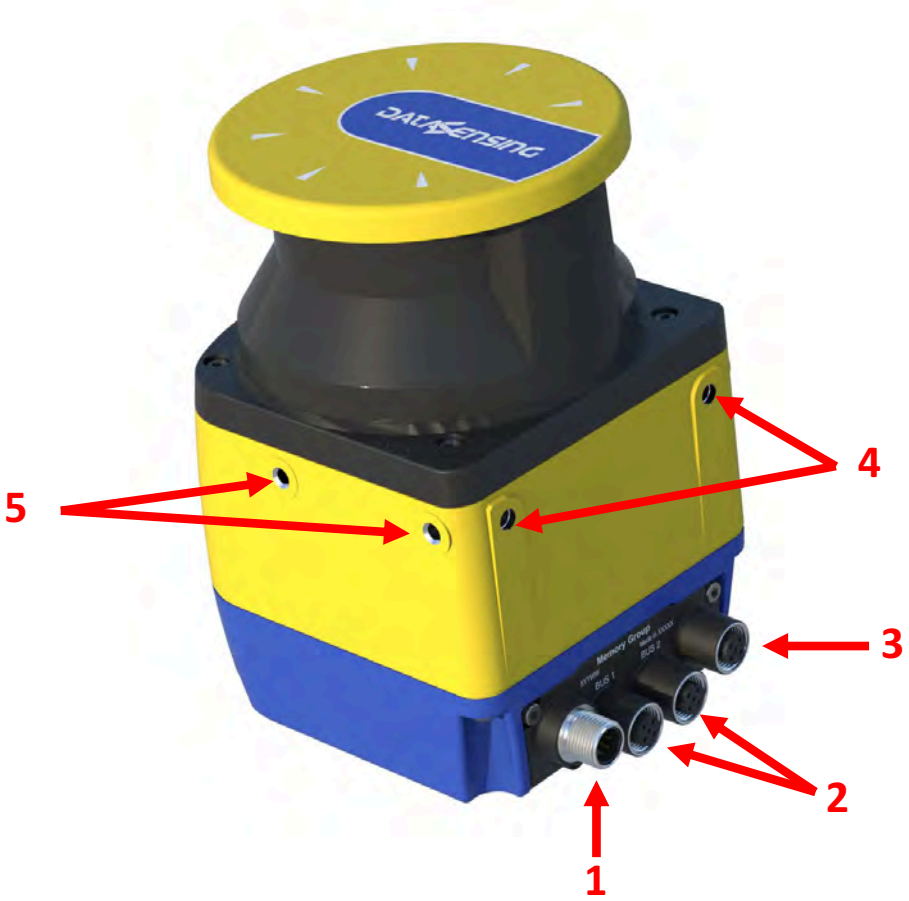


Figure 1 - Back/Rear Model

1. I/O connector (8 poles)
2. PROFINET/PROFIsafe connectors (FBUS1, FBUS2)
3. Ethernet Connector (configuration PC or host)
4. Direct Mounting Holes (2)
5. Bracket Mounting Holes (4)

SLS-M5-PP-BO (Bottom connector model)

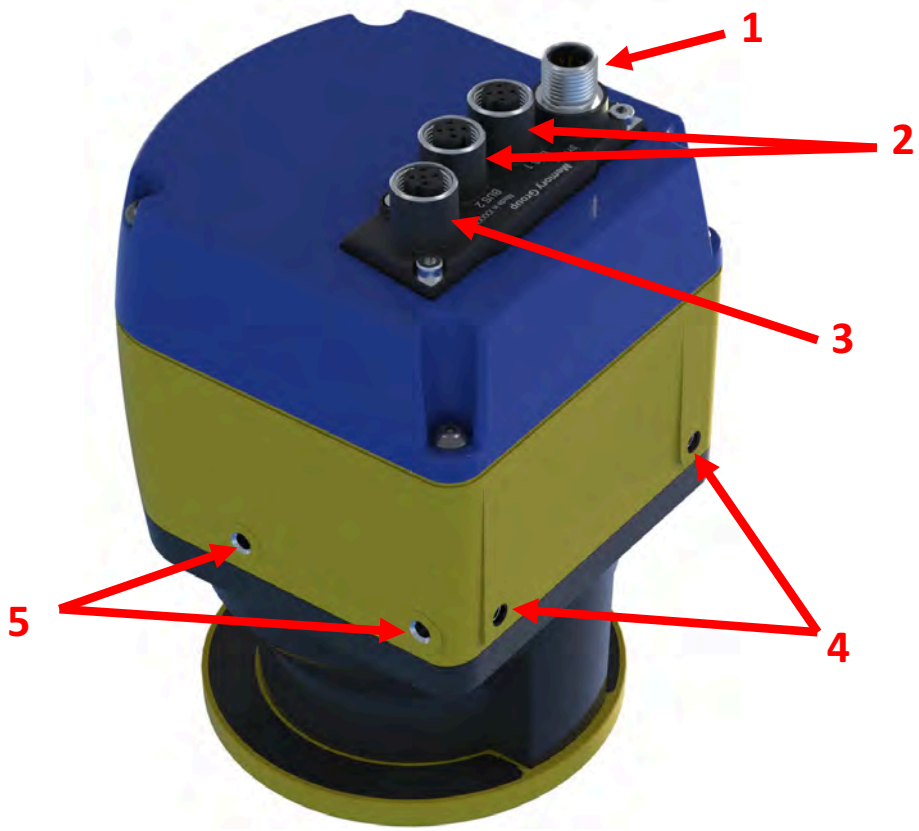


Figure 2- Bottom Connector Model

1. I/O connector (8 poles)
2. PROFINET/PROFIsafe connectors (FBUS1, FBUS2)
3. Ethernet Connector (configuration PC or host)
4. Direct Mounting Holes (2)
5. Bracket Mounting Holes (4)

LEDS AND INDICATORS

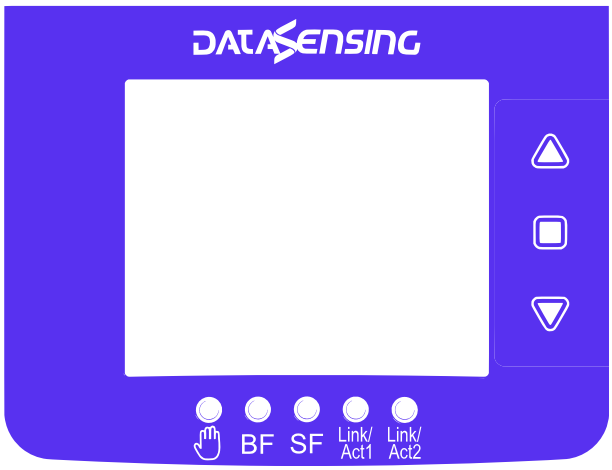


Figure 3 - Laser Sentinel LEDs and Indicators

SYMBOL	DEFINITION	COLOR	MEANING
	Status of the SafetyZones	Green	No intrusion in any safety zone of the monitored zone set
		Orange	Intrusion in any of the warning zone of the monitored zone set
		Red	Intrusion in any safety zone of the monitored zone set (or lockout)
BF	Bus Failure	Off	No error (normal operation)
		Red (Flashing 2Hz)	No data exchange
		Red (ON)	Incorrect PROFINET configuration; low speed physical link; no physical link
SF	System Failure	Off	No error (normal operation)
		Red (Flashing 2Hz)	DCP signal service is initiated via the bus
		Red (ON)	Watchdog timeout; generic or extended diagnosis present; system error
Link/ Act1 Link/ Act2	Link/Act1 Link/Act2	Off	The device has no link to the Ethernet port FBUS1/FBUS2
		Green (ON)	The device is linked to the Ethernet port FBUS1/FBUS2
		Yellow (Flashing 10Hz)	The device sends/receives Ethernet frame on port FBUS1/FBUS2
	**Button 1**: to quickly browse the Menu functions		
	**Button 2**: to quickly browse the Menu and confirm the selected function		
	**Button 3**: to quickly browse the Menu functions		

NOTE

For further information refer to "LEDs and Display" on page 87.

MODEL SELECTION AND ORDER INFORMATION

MODEL	DESCRIPTION	CODE
SLS-M5-PP-BA	Laser Sentinel PROFINET/PROFIsafe 5.5m 70 zone sets (Back/Rear connector model)	958000012
SLS-M5-PP-BO	Laser Sentinel PROFINET/PROFIsafe 5.5m 70 zone sets (Bottom connector model)	958000013

CONNECTORS USED

MODEL	CONNECTORS
SLS-M5-PP-BA SLS-M5-PP-BO	M12 8-poles connector (power, I/O)
	M12 4-poles, D-coded (one Ethernet port)
	M12 4-poles, D-coded (two Fieldbus ports)

CHAPTER 1
GENERAL INFORMATION

GENERAL DESCRIPTION

The Laser Sentinel is an electro-sensitive protective equipment (ESPE). It employs active opto-electronic protective devices responsive to the diffuse reflection of a radiation (AOPDDRs), according to the definition and requirements of international safety standard IEC 61496-3. The optical radiation is a Class 1 infrared laser generated within the device.

If the device is applied to a machine that presents a risk of personal injury, it provides protection by making the machine revert into a safe condition before a person reaches the hazardous points.

The working principle is: the invisible beam of the laser creates a two-dimensional safety area that must be necessarily crossed in order to reach the dangerous point. In this way, the dangerous movement of the machine can be stopped before anyone reaches the hazard point.

The safety area can be horizontal and by using a Graphic User Interface, its shape can be planned according to application needs.

The beam is emitted in short interval pulses and they are reflected by the objects in the safety area. The device calculates the distance from the objects by measuring the time interval between the transmission of the pulse and its reception after being reflected (time-of-flight principle).

The safety area is scanned by a mirror that deflects the light pulses over 275 ° around the device by rotating at a constant speed. In this way, all the opaque objects that have a certain dimension can be detected in the safety area.

Within the sensing range of the device, two areas can be monitored simultaneously: one is the Safety Zone, which is used to detect operators or objects entering a hazardous area; the other is the Warning Zone, which can be defined with a longer distance than a Safety Zone, allowing a configuration to detect objects that are closely approaching the Safety Zone.

REFERENCE STANDARDS AND REGULATIONS

The safety laser scanner is a safety system used as an accident-prevention protection device and is manufactured in accordance with the international Standards in force for safety, in particular:

STANDARD	DESCRIPTION
2014/30/EU EMC Directive	Harmonisation of the laws of the Member States relating to electromagnetic compatibility.
2006/42/EC Machinery Directive	Harmonisation of essential health and safety requirements for machinery.
2011/65/EU RoHS Directive	Restriction of the Use of Certain Hazardous Substances in Electronic and Electrical Equipment.
IEC 61496-3: 2019	Safety of machinery - Electro-sensitive protective equipment - Part 3: Particular requirements for Active Optoelectronic Protective Devices responsive to Diffuse Reflection (AOPDDR).
EN/IEC 61496-1:2020 Type 3	Safety of the machinery – Electro-sensitive protective equipment – Part 1: General requirements and tests.
EN ISO 13849-1:2015 (Cat. 3, PL d,)	Safety of machinery. Safety-related parts of control systems. Part 1: General principles for design.
IEC 61508-1:2010 (SIL 2)	Functional safety of electrical/electronic/programmable electronic safety related systems. Part 1: General requirements.
IEC 61508-2:2010 (SIL 2)	Functional safety of electrical/electronic/programmable electronic safety related systems. Part 2: Requirements for electrical/electronic/programmable electronic safety related systems.
IEC 61508-3:2010 (SIL 2)	Functional safety of electrical/electronic/programmable electronic safety related systems. Part 3: Software requirements.
IEC 61508-4:2010 (SIL 2)	Functional safety of electrical/electronic/programmable electronic safety related systems. Part 4: Definitions and abbreviations.
IEC 62061: 2021 (SIL2, maximum SIL2)	Safety of machinery. Functional safety of electrical/ electronic/programmable electronic safety related control systems.
IEC 60825-1:2014	Safety of laser products – Part 1: Equipment classification and requirements.
IEC TS 62046:2008	Safety of machinery – Application of protective equipment to detect the presence of persons.
IEC 61784-3-18 2010	Industrial communication networks - Profiles - Part 3-18: Functional safety fieldbuses - Additional specifications for CPF 18
EN 60529:1991/A1:2000/A2:2013	Degrees of protection provided by enclosures (IP Code).

Some parts or sections of this manual containing important information for the user or for the installing operator are preceded by a note:

WARNING

The information provided in the paragraphs following this symbol is very important for safety and may prevent accidents.

Always read this information accurately and carefully follow the advice to the letter.

As the required knowledge may not be completely included in this manual, we suggest contacting the Technical Service for any further information relative to the functioning of the safety laser scanner and the safety rules that regulate the correct installation of the device (refer to Chapter 4, Installation).

PACKAGE CONTENTS

Package contains the following objects:

- Laser Sentinel
- Quick Reference Guide of Laser Sentinel
- Periodical checklist and maintenance schedule

BASIC INFORMATION

The user can follow the indications related to typical application configurations that facilitate the device programming. Two types of configuration have been developed on DL Sentinel so far:

1. **Vertical application configuration** (refer to the DLSentinel User's Manual).
2. **Expert application configuration** (refer to the DLSentinel User's Manual).

CHAPTER 2
TYPICAL APPLICATIONS

The safety laser scanner is used to detect people who are approaching a hazardous area before reaching it, in order to prevent hazardous circumstances (e.g. a mechanical movement) that may cause an accident.

The protective detection is done by defining a Safety Zone (the red zone in the figures), whose shape and dimensions must be designed according to the risk assessment of the machine. The user must consider the position of the hazardous point, the shape of the machine and of the environment that surrounds it, and the time needed to stop the dangerous movement.

To better ensure people's safety, it is possible to define a Warning Zone (the yellow zone in the figures): if a person or an object is approaching too close to the Safety Zone, the safety laser scanner will trigger warning signals. This area cannot be used for safety purposes.

The possible applications to employ the Laser Sentinel are: Horizontal (to monitor an area that must be crossed in order to reach the hazardous point) and Vertical (to monitor an access point).

NOTE

The following application examples are provided for instructional purposes.

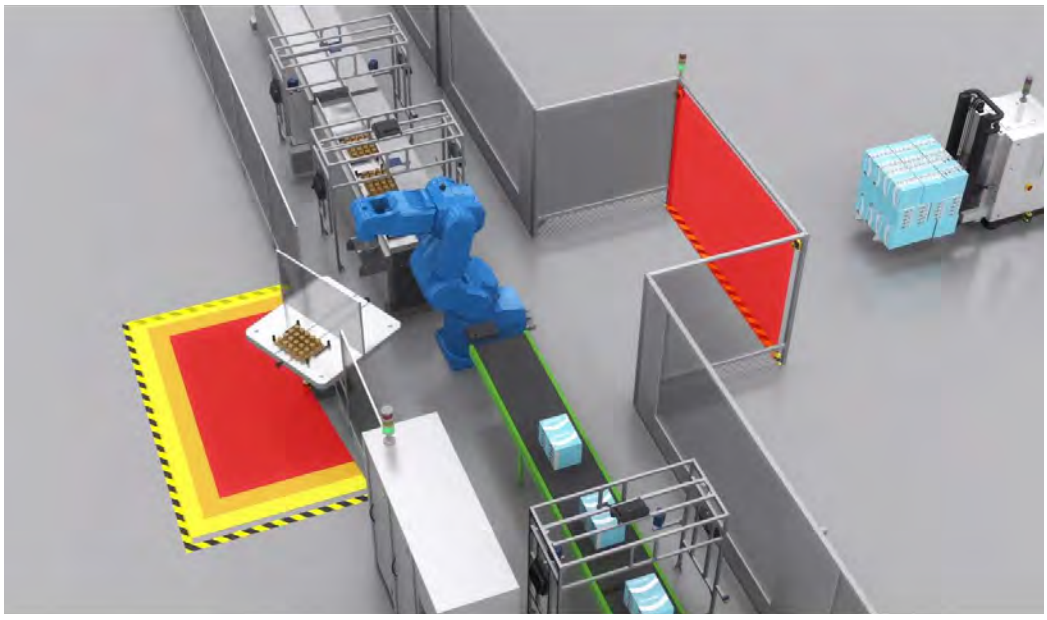


Figure 1 - Application Example

HORIZONTAL APPLICATION CONFIGURATION

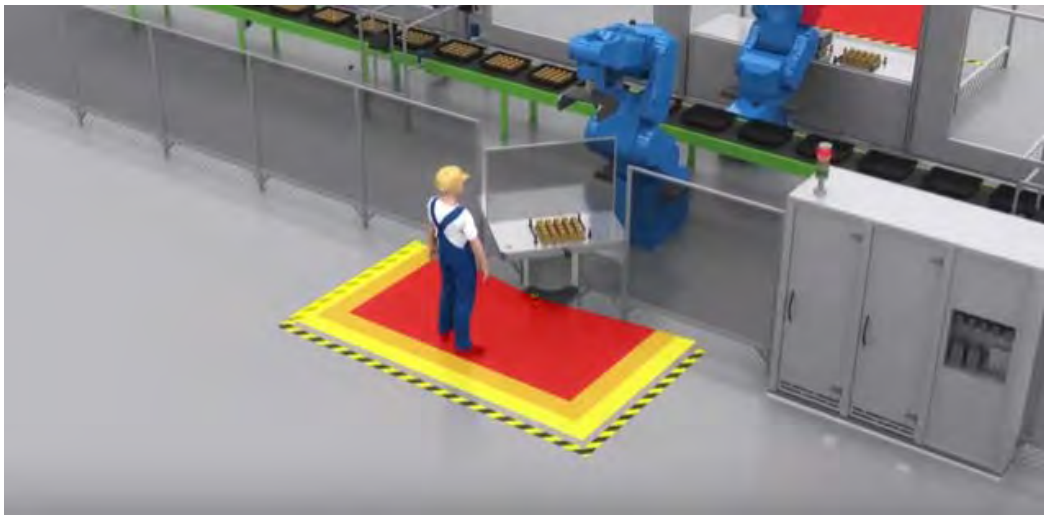


Figure 2 – Static horizontal configuration

The device uses a horizontal protective field (the red area in the figures) to detect the presence of an object or a person.

The Laser Sentinel will scan the environment surrounding the hazardous point to detect approaching objects or people. If someone is detected in the safety zone (with a given detection capability), the safety laser scanner switches all safety outputs to the OFF state through the safety fieldbus protocol.

In this example a Warning Zone has been defined (yellow zone in the figure) in order to give a preliminary warning if someone is detected, to prevent operators from accidentally stopping the working process of the machine. The warning signals are sent through the safety fieldbus protocol.

VERTICAL APPLICATION CONFIGURATION

Figure 3 - Vertical application

The device uses a vertical protective field (the red area in the figure) to detect someone passing through it.

In this example the only way to reach the hazardous point is to pass through an opening: all other access points to the machine are protected by some physical barrier or other sensors.

The safety laser scanner employs a safe vertical protective field (the red area in the figure) to detect any passage through this access point (with a given detection capability, i.e. 40 mm, needed to detect an arm).

If the device detects someone crossing the safety zone, the safety laser scanner switches all safety outputs to the OFF state through the safety fieldbus protocol to stop the machine movement that is causing the hazard.

When a person has completely passed through the monitored area, after a stop caused by safety function, the machine must remain stopped until a manual restart signal is given. This signal must be given only after checking that nobody remains in or close to the hazardous point.

NOTE

When the approach direction is > 30° or < -30° relative to the detection plane itself, the safety laser scanner shall have a facility for reference boundary monitoring, according to IEC 61496-3.

CHAPTER 3
SAFETY INFORMATION

WARNING

For a correct use of the Safety Laser Sentinel, the following points must be observed.

- The machine stopping system must be electrically controlled by PROFIsafe PLC and its peripheral modules.
- This control system must be able to stop the dangerous movement of the machine within the total machine stopping time T and during all the working cycle phases.
- The device mounting and connections must be carried out by qualified personnel only, according to the indications included in the specific sections (refer to Chapter 5, Mechanical Mounting and Chapter 6, Electrical Connections) and in the applicable standards.
- The safety laser scanner must be securely placed in such a position that access to the dangerous zone is not possible without passing through the safety area. This must be done according to the indications included in the specific section (refer to Chapter 4, Installation) and in the applicable standards.
- The personnel operating in the dangerous area must be well trained and must have adequate knowledge of all the operating procedures of the safety laser scanner.
- In case of Manual Restart, the Restart button must be located outside the safety area to let the operator control the safety zone during resetting or testing sessions.
- Please carefully read the instructions for correct functioning before powering the device.
- The requirements for the electrical safety and electromagnetic compatibility and the regulations or standards in all countries and/or regions must be met by the power supply where the Laser Sentinel is used. If the device power supply is shared with the machine or other electronic devices, voltage reduction to the Laser Sentinel or noise influence on the device may occur due to the temporary increase of the current consumption on the machine or other electronic devices. We do not recommend sharing the Laser Sentinel power supply with the one for the machine or other electronic devices, as the device may go into Error status.
- Do not place the connection cables in contact with or near high-voltage cables and/or cables with undergoing high current variations (e.g. motor power supplies, inverters, etc.).
- Do not connect any of the Laser Sentinel inputs to DC power sources outside of the declared range or to any AC power source, to avoid the risk of electric shock.

- Every access to the configuration tools must be allowed only to restricted and highly qualified personnel. The configuration upload through the GUI is only allowed by password.
- Periodically monitor the optical window during the entire product life-cycle checking for any damage, scratches or dirt spots. In the presence of highly reflective backgrounds, these may cause a reduction in the detection capability of the scanner.
- The laser scanner must not be used underwater or in explosive hazardous areas.
- The laser scanner is not suitable for outdoor use.

Class 1 laser product. Invisible laser radiation. Do not view directly with optical instruments. IEC 60825-1:2007 & 2014.

WARNING

Failing to respect the instructions contained in this manual may affect the detection capability and correct functioning of the laser scanner.

CHAPTER 4
INSTALLATION

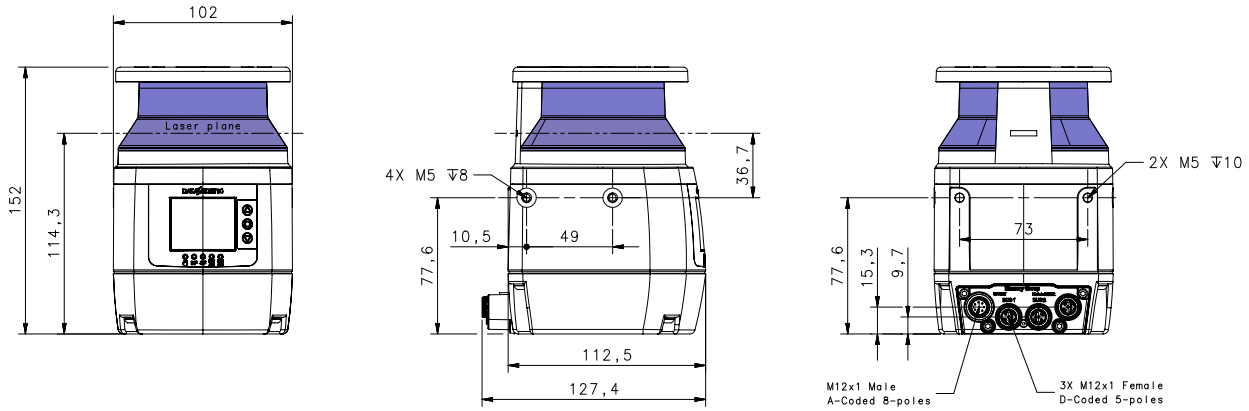
INSTALLATION PRECAUTIONS

WARNING

Make sure that the protection level assured by the Laser Sentinel is compatible with the danger level of the working machine, according to EN ISO 13849-1 or EN 62061.

- It must not be possible for operators to approach the dangerous zone without being detected by the Laser Sentinel.
- Attach guard plates or other physical barriers to prevent access to dangerous areas that are not protected by the Laser Sentinel.
- The dimensions of the smallest object to be detected must be larger than the minimum detection capability of the device (refer to "Detection Capability Setting" on page 54).
- The Safety Outputs must be used as stopping devices and not as command devices. The machine must have its own START command.
- The operator must only use the components mentioned in the document and follow the indicated procedures (refer to Chapter 5, Mechanical Mounting, Chapter 6, Electrical Connections, Chapter 7, Laser Sentinel Setup and Configuration, and Chapter 11, Device Maintenance).
- Improper use of the safety device can lead to malfunctioning.
- The device must only be repaired by authorized personnel.
- Reaching under, over or around, crawling beneath or stepping over the detection zone of the safety laser scanner must not be permitted.
- The safety laser scanner must be mounted securely and must not be able to be moved.

- Make sure that the Laser Sentinel output window is not obstructed by any object (do not obstruct the front highlighted in the figure below).



GETTING STARTED

Here are the basic steps to start a safety configuration.

- Package Contents: Check that the Laser Sentinel and all parts supplied with the equipment are present and intact when opening the packaging (refer to "Package Contents" on page 3).
- Read all safety information in Chapter 3, Safety Information before proceeding.
- Mechanical Mounting: Laser Sentinel can be installed to operate in different positions, make sure to follow the exact procedure (refer to Chapter 5, Mechanical Mounting).
- Electrical Connections: Laser Sentinel must be connected to the application through the required accessory cables (refer to Chapter 6, Electrical Connections).
- Software Configuration: Software configuration of Laser Sentinel can be accomplished through the Configuration procedure using the DLSentinel GUI version 4.0.0 or later (refer to Chapter 7, Laser Sentinel Setup and Configuration).

PRECAUTIONS FOR ENVIRONMENTAL INTERFERENCE

- The presence of intense electromagnetic interference may affect the correct functioning of the device. This condition shall be carefully evaluated by seeking the advice of our Technical Service.
- A sudden change in the environment temperature (e.g. with very low minimum peaks) can generate a small condensation layer on the laser and compromise proper operation.
- The operating distance of the device can be reduced in the presence of smog, fog or airborne dust.
- Installation must be performed by qualified personnel after making sure that the window is clean and free from scratches, dust, dirt spots and fingerprints. For more information, refer to Chapter 11, Device Maintenance.
- Failure to inspect the window or set the proper environmental condition during installation may lead to a reduced detection capability of the scanner.

Light Interference

Reflecting surfaces located near the safety device may cause passive reflections. These can affect the detection of an object inside the safety zone. The passive light sources can be an incandescent lamp, sunlight, a fluorescent light, a strobe light or other infrared light sources (e.g. infrared laser).

Do not install the safety device near strong and/or flashing light sources.

Ambient light may interfere with the functioning device. If the installation requires direct exposure to ambient light, the scanner must be positioned so that the light does not enter the output window within ±5° of the detection plane.

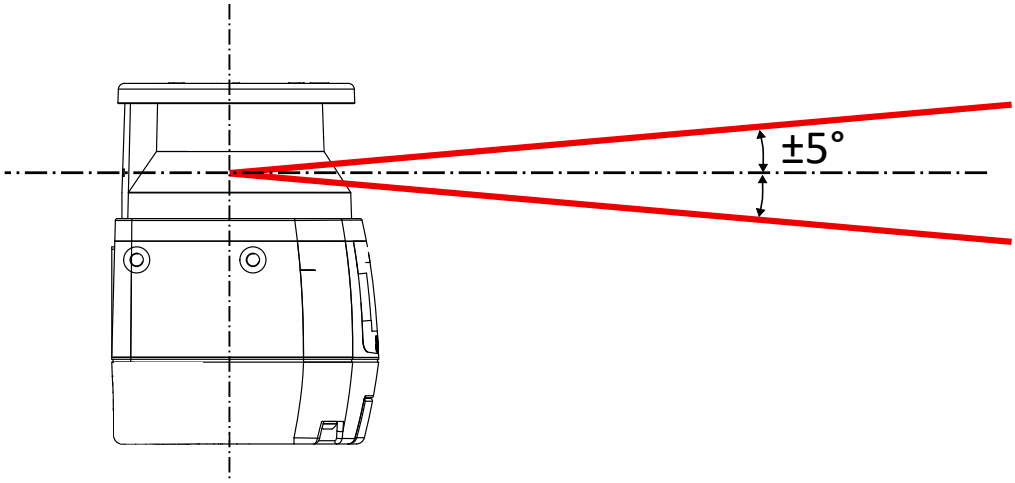


Figure 1 - Light interference avoidance

NOTE

In all applications where strong light within ±5° of the detection plane cannot be avoided, an additional distance must be applied to the Minimum Safety Distance Calculations. This distance could be influenced by the selected Dust Filter Level and the contemporary presence of reflecting background on light source (e.g. halogen lamp with back reflector). Typically, an additional distance of 200 mm is enough to prevent any reduction in the detection capability.

NOTE

In any case where bright light is present outside the +/- 5 ° range, the additional distance is still highly recommended.

NOTE

In case of both light interference and high reflecting background, additional distances are not summed, but the highest distance should be used.

Highly Reflecting Background

If there is a highly reflecting background within 3 meters of the safety zone boundary, e.g. a metallic glossy surface, the Laser Sentinel might fail to recognize the exact distance of the detected object because of an increase in the measure error.

In this circumstance, it is recommended to reduce or remove the reflecting background. In cases where this cannot be avoided, an additional distance must be applied to the minimum safety distance calculation. This distance depends on the Dust Filter Level and on the background characteristics. Typically, an additional distance of 200 mm is enough to prevent any reduction in the detection capability.

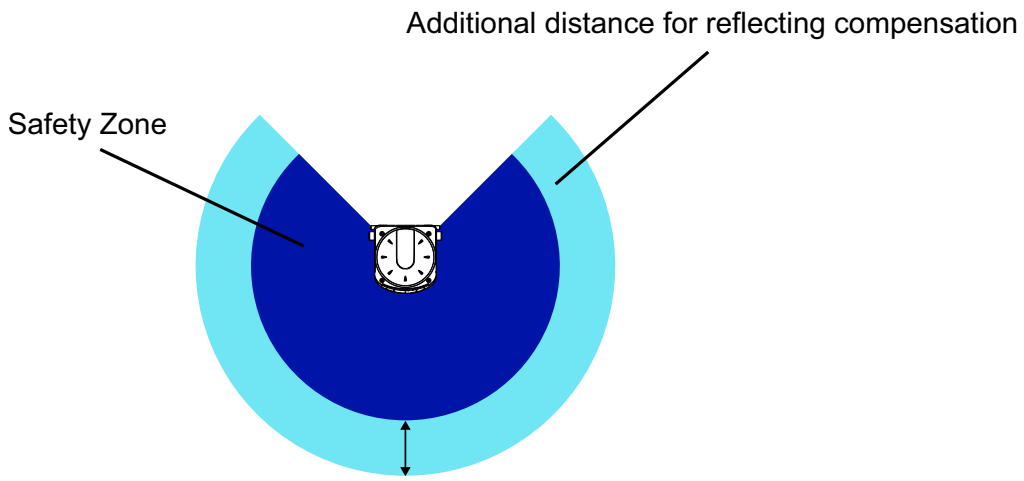


Figure 2 - Highly Reflective Background

NOTE

This additional distance based on the highly reflecting background influence range of 3 meters is relative to a reflective background test target of 300 cd m^{-2} lx^{-1}. For higher values of background reflectance, further risk analysis must be done to evaluate the effective influence range and eventually to increase the additional distance.

The presence of dirt spots, damage or scratches on the optical window may have an impact on additional distance evaluation and potentially may reduce the detection capability. Perform window cleaning according to "Window Cleaning" on page 94**.**

NOTE

In case of both light interference and highly reflecting background, additional distances are not summed, but the highest distance should be used.

ZONE WITH LIMITED DETECTION CAPABILITY

Laser Sentinel may not properly detect an object located at a distance of 10 cm or less from the safety zone origin. This zone is called “zone with limited detection capability.”

In this circumstance, a risk assessment is recommended taking into account the possibility that an object can cross a zone with limited detection capability. If possible, responsible personnel must provide an additional solution.

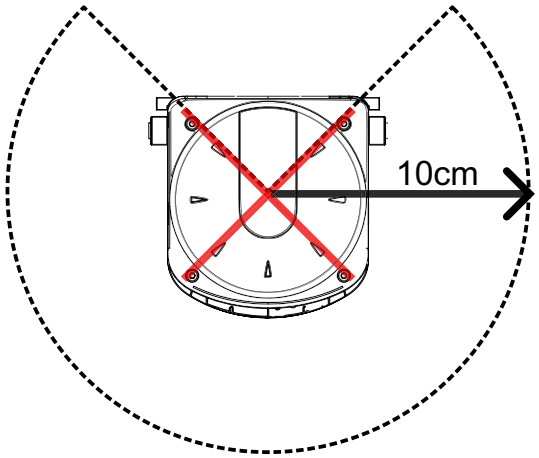


Figure 3 - Limited Detection Capability

WARNING

The operator is responsible for the configuration and for ensuring that the zone of limited detection does not create hazardous circumstances.

DEVICE POSITIONING AND MINIMUM DISTANCE CALCULATIONS

The Laser Sentinel must be carefully positioned to fulfill its safety function. In fact, access to the dangerous area must only be possible by passing through the safety zone.

Under standard operating conditions, starting the machine must not be possible while operators are inside the safety area.

The safety zones must be designed taking into account the minimum safety distance from the point where the risk is located. This distance must ensure that the hazardous area cannot be reached before the dangerous movement of the machine has been stopped by the ESPE.

The minimum distance calculations must meet the legal requirements in force at the place of use of the machine, referring to the state of the art defined by international and national standards.

According to the EN ISO 13855 Standard, the safety distance depends on the following factors:

- The Response Time of the ESPE (the time between the operator's detection and the safety outputs switched to the OFF-state).
- Machine stopping time (the time between the activation of the ESPE and the real stop of the dangerous movement of the machine)
- ESPE detection capability
- Type of approach: Parallel or Orthogonal to the Detection Zone
- Additional components to compensate reflection-based measurement errors
- Additional components to compensate reaching over: positioning of the scan plane, switching time between monitoring cases.
- Additional components depending on the type of application.

According to safety requirement EN ISO 13855, the general calculation for the minimum safety distance is given by the following formula:

$$S = (K*T) + C$$

Where:

S = Minimum safety distance (mm)
K = Approach speed parameter (mm/s)
T = Total response time (ESPE + machine) (s)
C = Total additional distance (mm)

The **K** parameter depends on how quickly the operator approaches the machine. The operator must be prevented from inserting body parts inside the hazardous area before the safety device activates.

Minimum Safety Distance Calculations for Horizontal Applications

NOTE

The Minimum Safety Distance cannot exceed the nominal maximum limit of the Safety Zone for the scanner (5.5 m).

If the device is mounted with a detection angle of less than 30° with respect to the horizontal plane (floor), the application is considered horizontal (parallel approach).

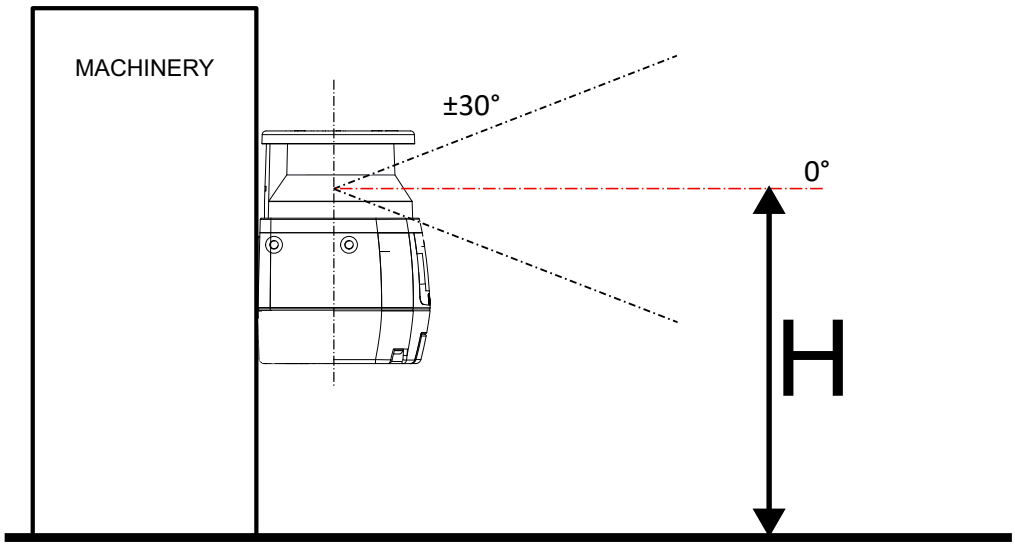


Figure 4 - Detection plane and approaching direction

The minimum safety distance S is given by:

$$S = (K*T) + C;\ C_{MIN} = 850\ mm;\ H_{MIN} = 15(d - 50\ mm)$$

Where:

S = Minimum safety distance (mm)
K = 1600 mm/s
T = $t_1 + t_2$
C = $C_{HEIGHT} + C_{TOLERANCE} + C_{AMBIENT\ INTERF}$

C_{MIN} = Lowest allowable C value
t_1 = Response time of the ESPE (s) (refer to "" on page 77)
t_2 = Machine stopping time (s) (see machine specifications)
$C_{HEIGHT} \geq (1200 - 0.4\mathbf{H})$ mm
H = Height of the nominal scan plane with respect to the machine reference plane (floor) (mm)
H_{MIN} = Lowest allowable height of the detection zone (mm)
d = Detection capability of the ESPE (mm)
$C_{TOLERANCE}$ = 100 mm
$C_{AMBIENT\ INTERF}$ = environment interference conditions (mm) (refer to "Light Interference" on page 12 and "Highly Reflecting Background" on page 13)

NOTE

For applications with approach parallel to the detection plane, EN ISO 13855 defines the parameter K = 1600 mm/s.

NOTE

For horizontal applications the minimum safety distance also depends on the height of the nominal scan plane for the safety area. As the height H is reduced, the total additional distance C is increased.

WARNING

If the scan plane is higher than 300mm, ensure that people cannot reach the hazardous area by crawling underneath the scan plane!

WARNING

The device resolution should be set according to the height above ground of the scan plane; EN 13855 indicates that the calculation should be made using the formula d = (H/15)+50, where d = detection capability/resolution and H = height above ground of the scan plane.

WARNING

In case of dynamic applications (e.g. AGVs), the laser scanner must be mounted at a max. scan plane height of 200mm. Additional distances must be taken into account considering the stopping distance and the characteristics of the vehicle.

Example of additional distance due to Height:

With a given machine stopping time of 0.4 s and a selected Laser Sentinel Response Time of 94 ms, detection capability = 70 mm and without any ambient interference:

S = [(1600 mm/s*(0.094 s+0.4 s)] + [(1200 mm – 0.4H) + 100 mm + 0 mm]

If **H** = H_{MIN} = 300 mm then C_{HEIGHT} = 1080 mm
S = [790.4 mm] + (1070.4 mm + 100 mm + 0 mm) = 1970.4 mm

If **H** = 1000 mm then C_{HEIGHT} = 800 mm
S = [790.4 mm] + (800 mm + 100 mm + 0 mm) = 1690.4 mm

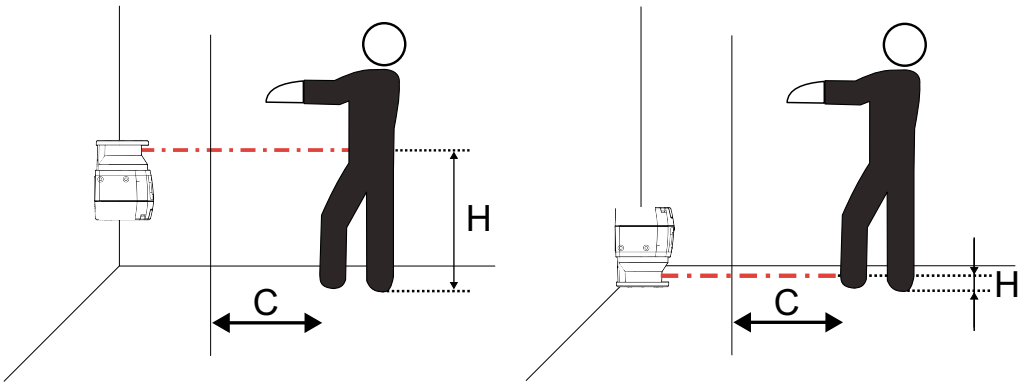


Figure 5 - Safety distance

Example of additional distance due to Ambient Interference:

From the previous example with a height of 300 mm, but in the presence of high reflective backgrounds and/or direct bright light:

Minimum safety distance

S - $C_{AMBIENT\ INTERF}$ = [(1600 mm/s*(0.094 s + 0.4 s)] + (1080 mm + 100 mm) = 1970.4 mm

$C_{AMBIENT\ INTERF}$ (1919.2 ; detection capability = 70 mm) = 200 mm for “dust filter level” = high

(refer to "Light Interference" on page 12 and "Highly Reflecting Background" on page 13)

$C_{AMBIENT\ INTERF}$ (1919.2 ; detection capability = 70 mm) = 87 mm for “dust filter level” = low

(refer to "Light Interference" on page 12 and "Highly Reflecting Background" on page 13)

S = [(790.4) mm] + (1080 mm + 100 mm + 200 mm) = 2170.4 mm for “dust filter level” = high

S = [(790.4) mm] + (1080 mm + 100 mm + 87 mm) = 2057.4 mm for “dust filter level” = low

Minimum Safety Distance Calculations for Vertical Applications

For vertical applications, the previously indicated formula for the minimum safety distance can be used, but further considerations must be taken into account.

$$S = (K*T) + C$$

Where:

S = Minimum safety distance (mm)
K = 1600 mm/s or 2000 mm/s (see Note)
T = $t_1 + t_2$
C = 8(**d** -14 mm) or 850 mm (see Note)

t_1 = Response time of the Laser Sentinel (s) (see "" on page 77)
t_2 = Machine stopping time (s) (see machine specifications)

d = Detection capability of the ESPE (mm)

Note:
K = 2000 mm/s if the calculated value of S is ≤ 500 mm
K = 1600 mm/s if the calculated value of S is > 500 mm
C = 8(d -14) mm for devices with detection capability d ≤ 40 mm
C = 850 mm for devices with detection capability d > 40 mm

Body parts protection (reference contour)

When the safety laser scanner is used for body parts detection, in applications where the approach angle exceeds ±30° to the detection plane, it shall monitor a physical boundary. Reference boundary monitoring requires a comparison of the reference distance and the distance measured by the device.

The reference distance is the distance between the safety laser scanner and each point of the boundary (e.g. a wall) configured at the first installation. The stated detection capability shall be in the range from 30 mm to 70 mm. If the reference boundary is the edge of the safeguarded aperture, the tolerance zone should not exceed half of the stated detection capability (see also dimension a). Otherwise, it should be protected by another means, such as fixed guarding.

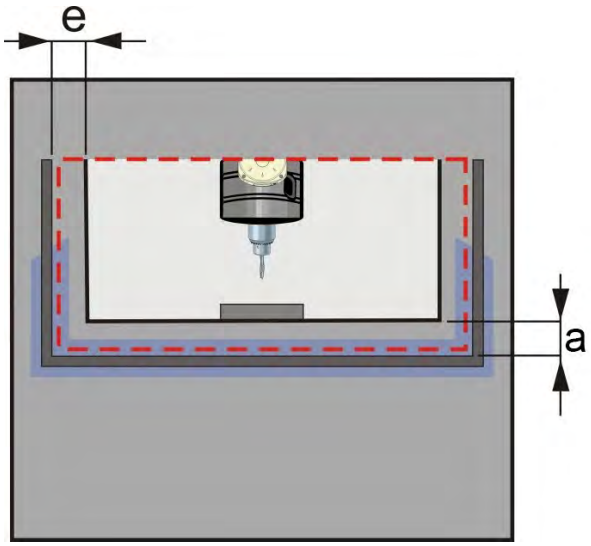


Figure 6 - Reference distances

Access protection

If the reference boundary is the edge of the safeguarded aperture, the tolerance zone must not exceed 100 mm.

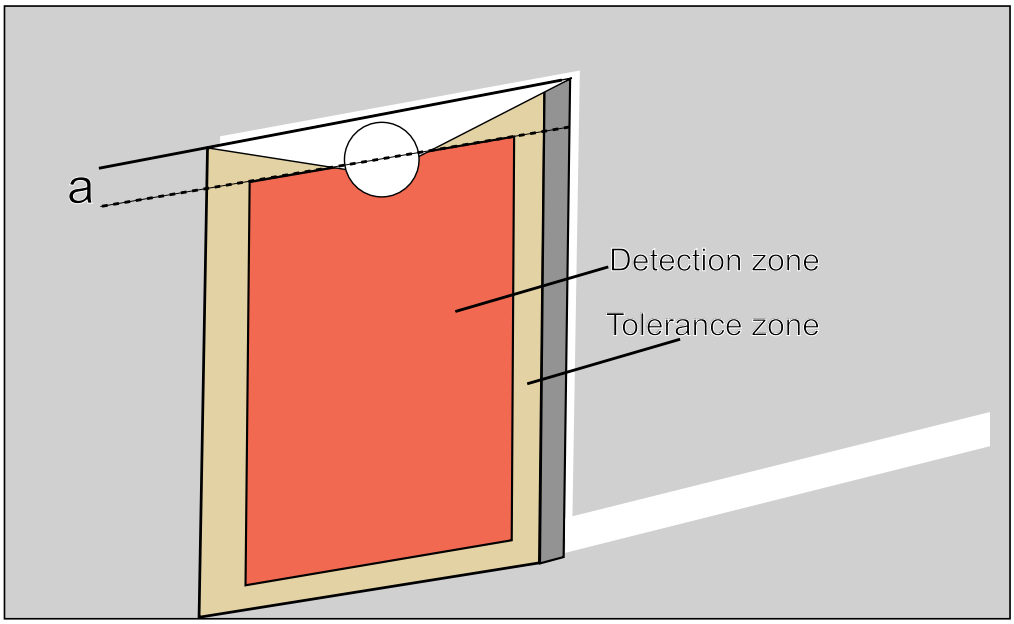


Figure 7 - Access protection

Figure 7 shows the use of Laser Sentinel as a whole-body safety device where the reference boundary is the edge of the safeguarded aperture. In this application we have to take into account the tolerance zone of the safety laser scanner and the dimensions of a possible unprotected zone due to the physical installation (a), taking additional precautions by another means, for example additional mechanical protection.

Minimum Safety Distance Calculations for Mobile Applications

Laser Sentinel can be installed on a mobile machine, e.g. an AGV, in order to constantly monitor the absence of persons along the driving direction of the vehicle, detecting their presence in the safety zone parallel to the direction of approach.

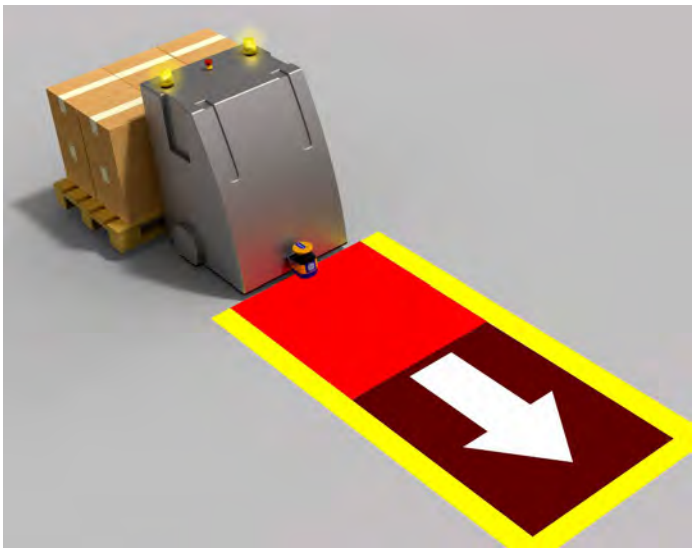


Figure 8 - Safety zone (red) for AGV protection

NOTE **In the following calculation examples, only the speed of the vehicle is considered and not the speed of a moving person. It is assumed that the person stops recognizing the danger.**

NOTE **If the application involves a change in the shape or size of the safety zone, considerations regarding the size of the safety zone should be extended to all cases. If the speed changes in these cases, calculations should be made using the maximum achievable speed in each case.**

NOTE **It is recommended to use a resolution of 70 mm or less to ensure that the operator's ankle is detected.**

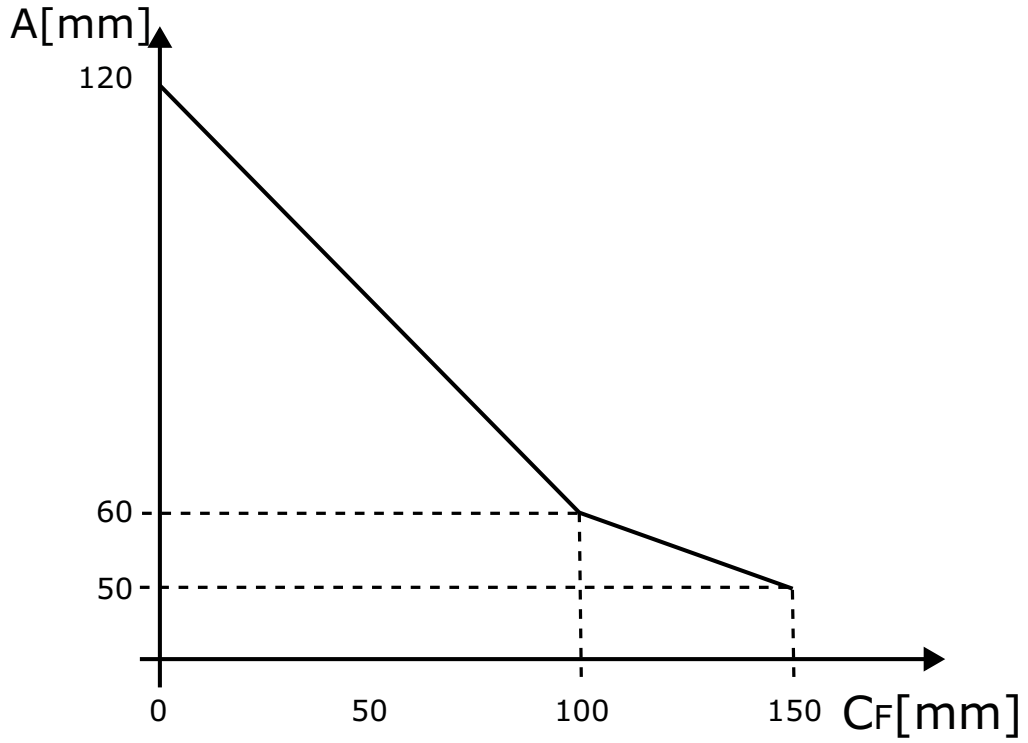
NOTE **It is recommended to place the scanning plane at a height of no more than 150 mm above the floor H and never more than 200 mm to ensure that a person lying on the floor is detected.**

WARNING **The stopping distance of a vehicle does not increase proportionally with speed, but with the square of the speed.**

In mobile applications, the safety zone must be long enough to ensure that the vehicle stops before coming into contact with the detected person.

When **calculating the minimum length**, possible environmental interference described in "Light Interference" on page 12 and "Highly Reflecting Background" on page 13 must be taken into account. In the following formulas, it will be indicated with $C_{ENVIRON.INTERF.}$

In the case of vehicles, it is also necessary to consider an increase (CF) due to the length of the foot in relation to the point of detection. In first approximation, this increase is 150 mm, but can be reduced depending on the width of the aperture (A) between the vehicle and the floor, according to the following graph:



Below is an example of calculation of the minimum length (L) for the safety zone:

$$L = D_S + C_{TOLERANCE} + C_{ENVIRON.INTERF.} + C_F + C_D$$

Where:

D_S = Stopping distance

$C_{TOLERANCE}$ = Laser Sentinel measurement tolerance (100 mm)

$C_{ENVIRON.INTERF.}$ = Increase for measurement errors due to optical interference or reflections (200 mm)

C_F = increase due to lack of aperture between AGV and floor (150 mm)

C_D = possible increase due to the reduced braking force of the vehicle

The stopping distance D_S is given by the sum o f

$$D_S = D_B + D_{S1} + D_{S2}$$

Where:

D_B = Braking distance (depending on vehicle characteristics, load and floor characteristics and condition)

D_{S1} = Space traveled during vehicle controller response time = (controller response time) * Speed

D_{S2} = Space traveled during Laser Sentinel response time = T * Speed

T = response time of the Laser Sentinel, as set by the user according to the number of scans (see "" on page 77).

Also when **calculating the minimum width** of the safety zone, increases must be taken into account to compensate for possible environmental interference and the increase due to the lack of aperture between the AGV and the floor.

Below is an example of calculation of the minimum width (W) for the safety zone:

$$W = W_{VEHICLE} + 2^* (C_{TOLERANCE} + C_{ENVIRON.INTERF.} + C_F)$$

Where:

$W_{VEHICLE}$ = Width of the vehicle, including its load

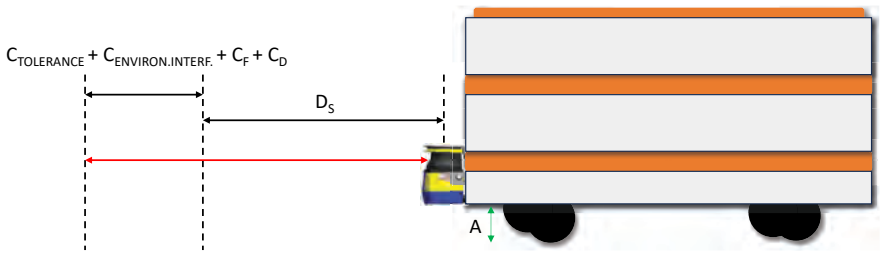
$C_{TOLERANCE}$ = Laser Sentinel measurement tolerance (100 mm)

$C_{ENVIRON.INTERF.}$ = Increase for measurement errors due to optical interference or reflections (200 mm)

C_F = increase due to lack of aperture between AGV and floor (150 mm)

NOTE

If Laser Sentinel is not installed in the center of the vehicle, the safety zone should be drawn asymmetrically so that the protruding parts of the safety zone are located to the right and left of the vehicle.



UNPROTECTED ZONE

The unprotected zone (a) must be small enough to ensure that a person cannot approach the danger zone or stay between the danger zone and the safety zone without being detected. This can require additional mechanical protection.

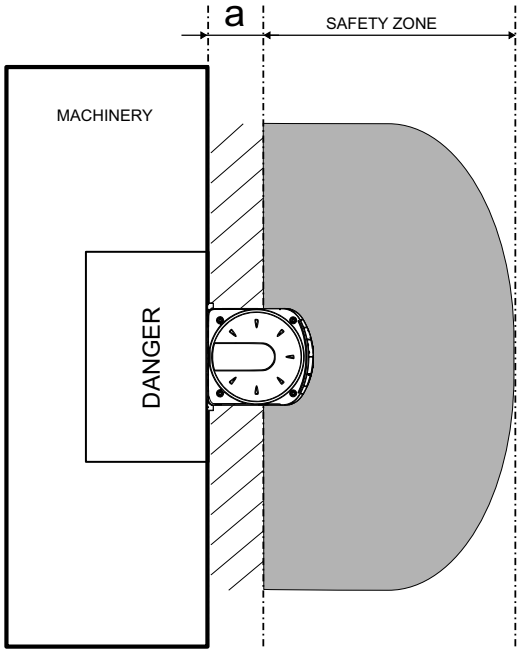


Figure 9 - Safety Distance Example (Top View)

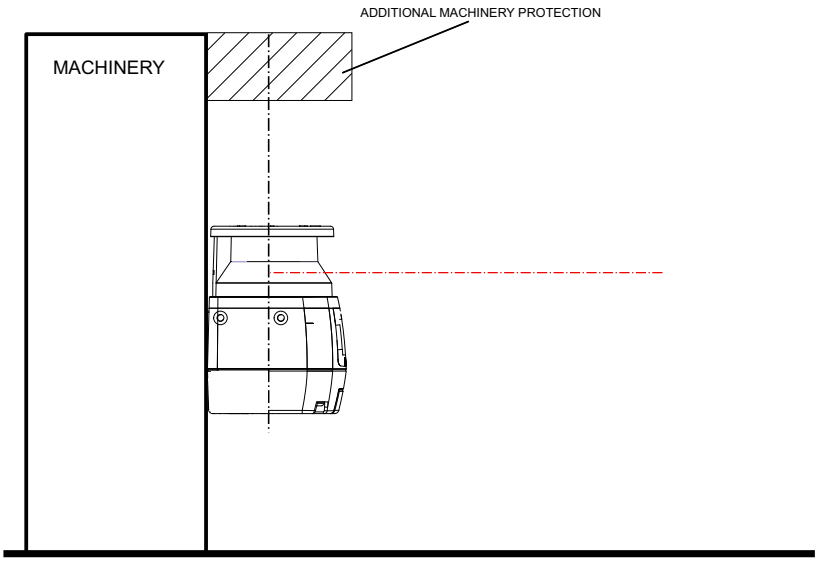
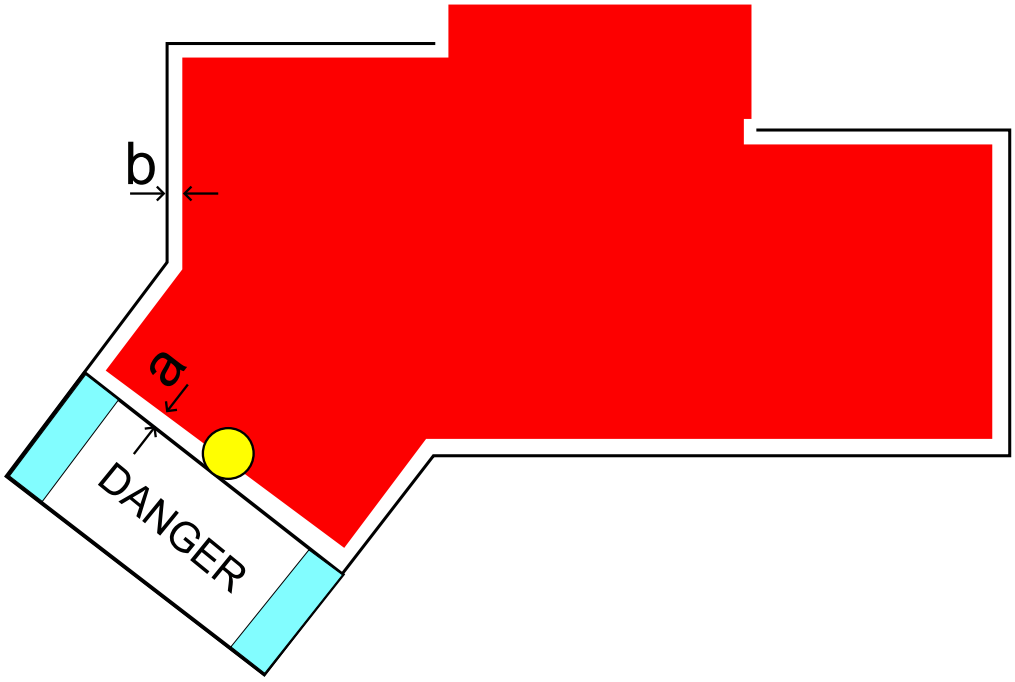


Figure 10 - Safety Distance Example (Side View)

DISTANCE TO WALL



NOTE

The Safety Zone must maintain a tolerance of at least 40 mm from any wall or fixed object (a and b in the image above). This value is generally enough to guarantee normal operation, however according to the real reflectance characteristics of the wall, a higher value may be necessary. The Teach In feature in DLSentinel automatically applies a tolerance of 100 mm. This can be changed manually if necessary. Verify the correct placement of the Safety Zone during the initial configuration before commissioning.

DEVICES ORIENTATION

The installation may require different safety laser scanners in the same location. In this state, it is possible that the devices interfere with each other and the Safety Outputs might to the OFF-state.

Specific mounting requirements must be followed to prevent a dangerous failure.

- Tilt the Laser Sentinel so that the scanning plane does not enter the output window of any other scanner.

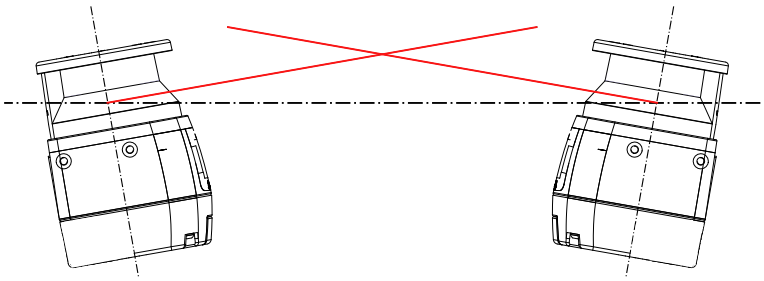


Figure 11 - Scanner mounted ad different scanning angles

- Mount the devices at different heights so that there is an offset equal to or greater than the height of the scanner output window.

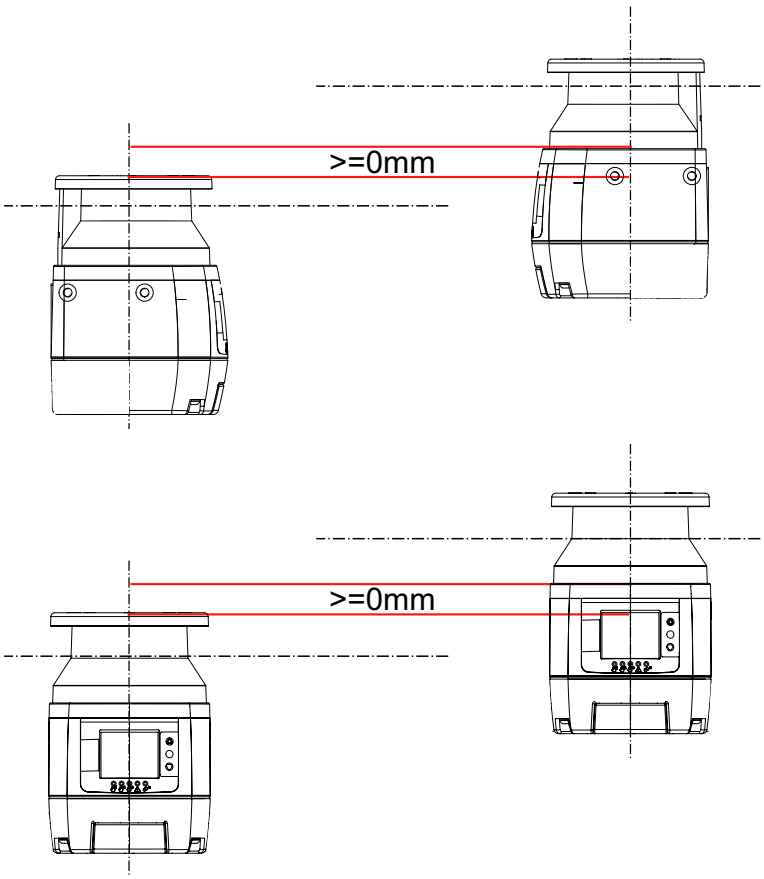


Figure 12 - Scanners mounted ad different scanning heights

- Set the devices to different response time.
- Install a shielding plate to block scanning signal interference.

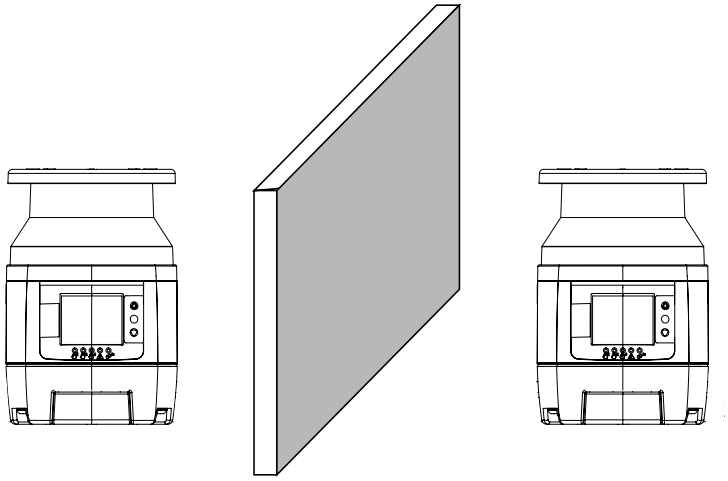


Figure 13 - Shielding plate between scanners

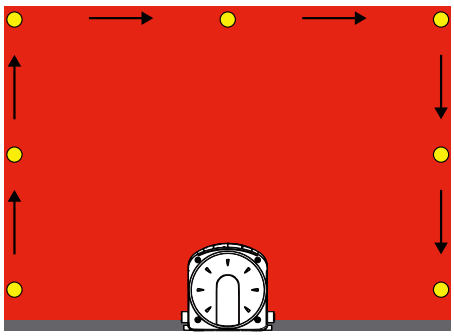
- Make the safety area smaller.

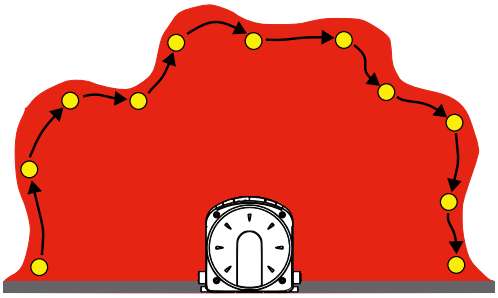
CHECKS AFTER FIRST INSTALLATION

After the initial installation and before starting up, machine test operations must be carried out by qualified personnel, or under the strict supervision of the person in charge of the machine safety.

The checks to carry out are listed below:

- The response time at machine STOP, including the ESPE, the PROFIsafe cycle time, and machine response times, must be included in the limits defined in the calculation of the safety distance (refer to "" on page 77).
- The safety distance between the dangerous parts and ESPE must comply with the requirements indicated in "Device Positioning and Minimum Distance Calculations" on page 15. The safety zone must be designed so that the approach towards any dangerous point of the machine can be possible only passing through it, and the distance that a person is obliged to cover must be longer than the minimum safety distance.
- A person must not remain between safety zone and dangerous parts of the machine undetected.
- Access to the dangerous areas of the machine must not be possible from any unprotected area.
- Verify the correspondence of all the accessory functions, activating them in the different operating conditions.
- The machine builder must define the type and frequency for the checks of the machine and its safety system based on the risk assessment. Regular checks are recommended in order to prevent external influences or modification (such as damage or tampering).
- Safety checks must be carried out at least annually by qualified personnel only and must be documented in a traceable manner.
- To test the detection capability of the device(s), the user can use a suitable test piece, e.g. an optically dark, opaque cylinder. The effective diameter should match the configured resolution. Datasensing suggests adopting the following procedure:
  Place the test piece on several points at the edges of the safety area. The safety laser scanner must detect the test piece at each position and go to STOP. The number and location of sites where the test is performed must be chosen so that undetected access to the hazardous area is not possible.
  Do not attempt to insert the test piece into dangerous parts of the machine located in the safety area.
  Remove the test piece from the controlled area and check that:
  -the machine automatically restarts (in case of Automatic restart), OR
  -the machine restarts only after receiving the restart command (in case of Manual restart).
  The following pictures are examples of detection capability test (the red areas correspond to the configured Safety Areas).





- Power off the safety laser scanner(s). Check that after a correct connection to a safety PLC, the safety outputs of the process image automatically switch to OFF status and make sure that the machine cannot start until power is re-applied.
- If the check session reveals hypothetical faults, the machine must be shut down immediately to allow further checks on the electrical and mechanical installations by qualified personnel.
- The risk evaluation of the machine may determine that further or more frequent checks are required depending on the application conditions.
- Together with the regular checks, it is recommended to perform a visual check of the machine and the safety device.
- The machine builder must check the display and the status LED: if a machine is switched ON, the LED “Status of the Safety Zones” below the safety laser scanner’s display is not functioning properly, it may be a failure.
- Test the device by triggering the safety function, e.g. the machine builder can observe the reaction of Safety Outputs on the process image.
- For all device applications: check if the Laser Sentinel shows the interruption of the safety field using the LEDs and/or the display.
- Horizontal application: stop the safety field using an appropriate test piece and check if the machine stops.
- Activate a protective field, which is interrupted by at least one test piece and check the expected reaction.
- If the check reveals a fault, the machine must be shut down immediately. In this case, the mounting and electrical installation of the safety laser scanner must be checked by qualified personnel.
- In case of Manual Restart, the Restart button must be placed outside the dangerous area. The operator must have full view of the dangerous area to activate the Restart button.

CHAPTER 5
MECHANICAL MOUNTING

For mechanical mounting, the Laser Sentinel has two different procedures depending on the operation necessities. The two mounting possibilities are:

- direct mounting, OR
- angle adjustment bracket mounting (if the pitch and the roll angles need to be adjusted).

Optionally, the protection bracket can be added to applications using the angle adjustment brackets.

NOTE

Required tool adjustable torque driver with 3 mm hex bit.

DIRECT MOUNTING

The device has two M5 threaded holes on the back and four M5 threaded holes on the side.

For direct mounting, use both M5 threaded holes in the back or all four M5 threaded holes on the two sides, considering the following values:

- M5 on the back (tightening torque 2.3 - 5.5 Nm), maximum depth of thread engagement 9.5 mm.
- M5 on the side (tightening torque 2.3 - 3 Nm), maximum depth of thread engagement 8 mm.

NOTE

For direct mounting on the sides, if the wall or panel obstructs the output window, this plane cannot be used for safety zone monitoring. The safety zone must adhere to the minimum distance to wall value given in "Distance to Wall" on page 25**.**

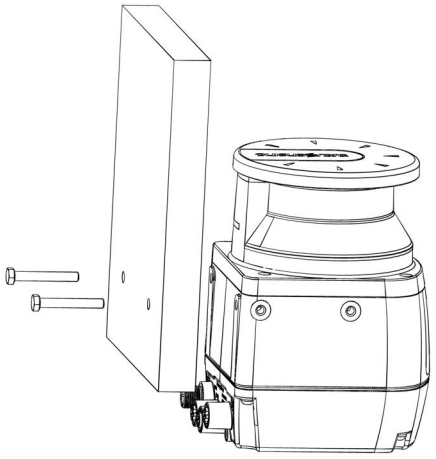


Figure 1 - Direct Mounting Back Model

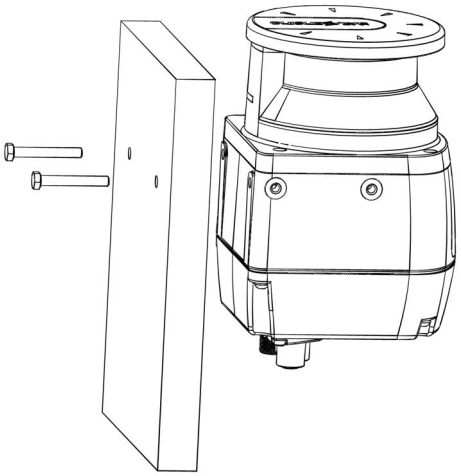


Figure 2 - Direct Mounting Bottom Model

NOTE

The M5 UNI 5933 screws used for mounting the brackets to a wall are not supplied in the SLS bracket mounting kits; they must be supplied by the user.

NOTE

If the direct mounting procedure to the back is chosen, it is not possible to add the protection bracket to the device.

PROTECTION BRACKET MOUNTING (SLS-BRACKET-C) (OPTIONAL)

The protection bracket is an optional accessory, which provides protection to the device if it is located in a specific work environment where the device may be hit by falling objects or subject to collision.

Fasten the Protection Bracket **(1)** on the back of the Laser Sentinel, by using two M5 screws **(2)** (Maximum 2.9-3.1 Nm Torque).

NOTE

The SLS-BRACKET-C must be mounted on the device before the other fastening accessories.

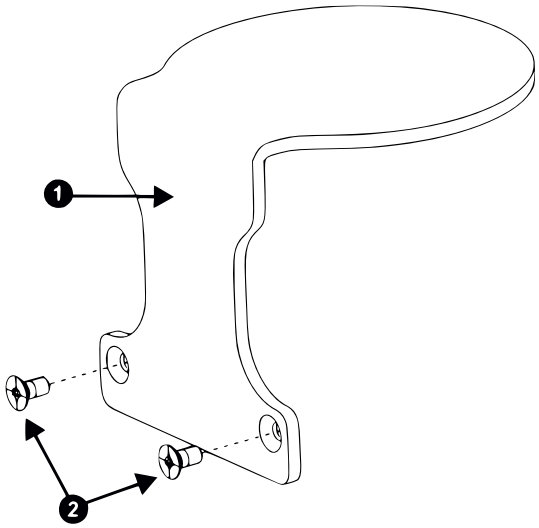


Figure 3 - Protection Bracket Mounting

Figure 4 - Protection Bracket Mounted to Scanner

ANGLE ADJUSTMENT BRACKET MOUNTING

First, provide two M5 holes with 73 mm spacing on the intended wall or mounting surface.

NOTE

The M5 UNI 5933 screws used for mounting the brackets to a wall are not supplied in the SLS bracket mounting kits; they must be supplied by the user.

Pitch and Roll Angle Adjustment Bracket (SLS-BRACKET-A)

The bracket system **(10)** is partially assembled.

1. Mount the roll adjustment bracket **(4)** to the wall or panel by inserting two M5 UNI 5933 screws (not included), and tighten them, repeatedly alternating between one and the other, until they are completely tight.

2. After removing the M4 screws and washers **(5)** from the roll adjustment bracket **(4)**, use them to assemble the support bracket **(10)** to the roll adjustment bracket **(4)**.

NOTE

Still, do not tighten the M4 Roll Adjustment screws for the roll angle (5).

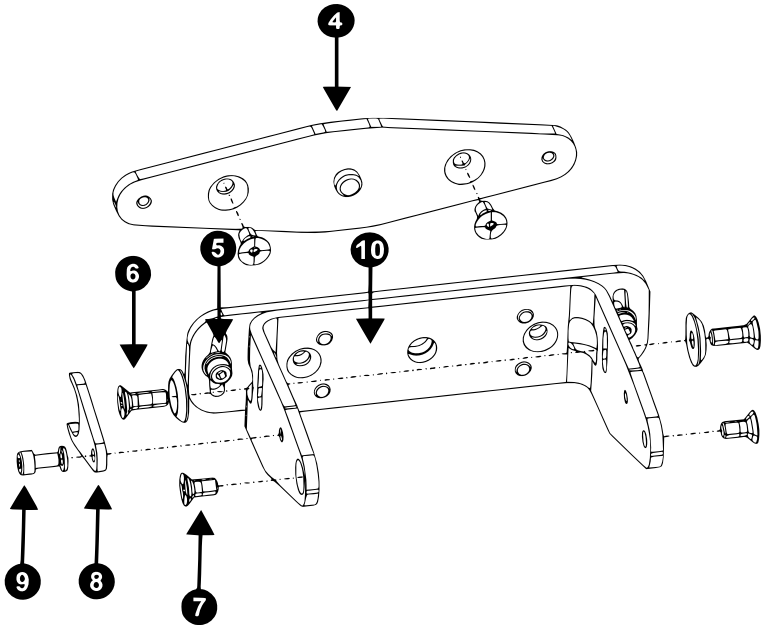


Figure 5 - Pitch and Roll Angle Adjustment Bracket

Pitch Angle Adjustment Bracket (SLS-BRACKET-B)

Mount the pitch adjustment bracket **(3)** to the wall or panel by inserting two M5 UNI 5933 screws (not included), and tighten them, repeatedly alternating between one and the other, until they are completely tight.

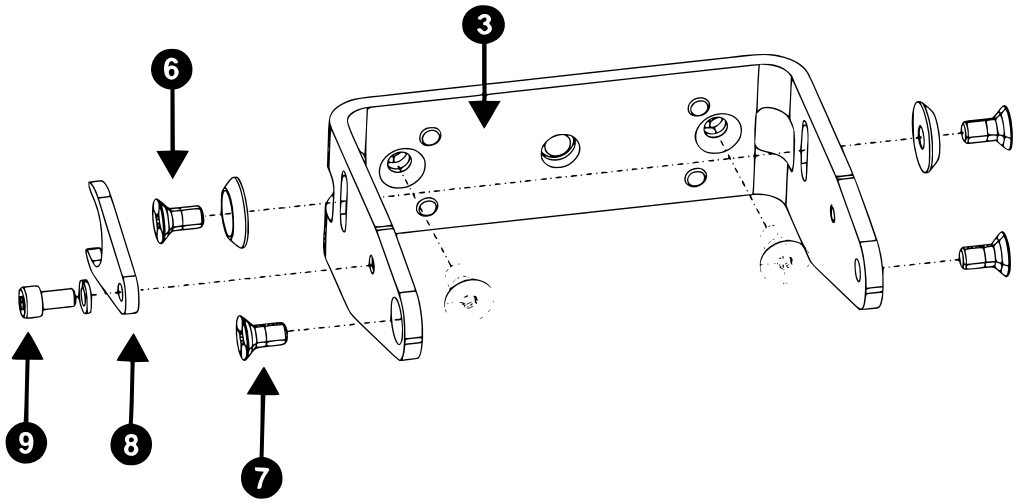


Figure 6 - Pitch Angle Adjustment Bracket

SCANNER MOUNTING AND PITCH ANGLE ADJUSTMENT

CAUTION

Make sure to use the specific Torques indicated for the different procedures to avoid damaging the device permanently.

NOTE

The pitch angle adjustment is a procedure related to both SLS-BRACKET-A and SLS-BRACKET-B.

The Positioning Memory Bracket (one piece) **(8)** saves the inclination angle set for the installation. This allows for quick installation without further mechanical adjustments if it is ever necessary to replace the unit.

Figure 7 - Scanner Mounting and Pitch Angle Adjustment

To mount the device with 90° vertical inclination:

1. Mount the Positioning Memory Bracket **(8)** with the M4 screw (and washer) **(9)** to the main bracket **(3)** but do not tighten it.

2. Align the Positioning Memory Bracket with the center of the main bracket slot, then tighten the M4 screw **(9)** (1.5-1.6 Nm Torque).

3. Mount the scanner to the main bracket using the M5 x 14 Pitch Adjustment Screws (with washers) **(6)** and the M5 x 10 Scanner Fastening Screws **(7)**. Tighten all four screws (2.9 - 3.1 Nm Torque).

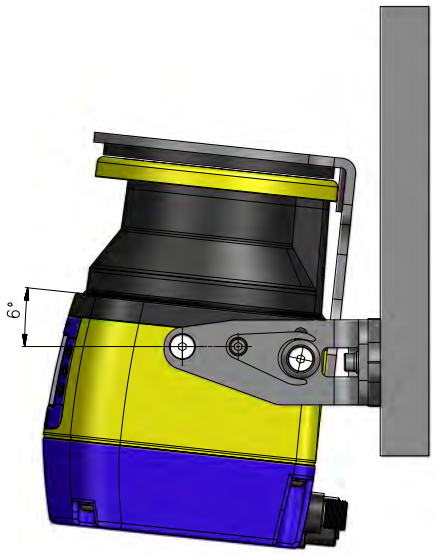


Figure 8 - Scanner Mounting and Pitch Angle Adjustment

To place a device with a specific pitch angle:

- Screw without tightening the M5 Scanner Fastening Screws **(7)**, the M5 Pitch Adjusting Screws **(6)** and the Positioning Memory Bracket **(8)** with the M4 screw **(9)**.
- Rotate the device to reach the desired pitch angle within the allowed range (+/- 6°).
- Tighten the M5 Scanner Fastening Screws **(7)** and then the M5 Pitch Adjusting Screws **(6)** (2.9 - 3.1 Nm Torque).
- In the end, tighten the Positioning Memory Bracket M4 screw **(9)** (1.5 – 1.6 Nm Torque).

ROLL ANGLE ADJUSTMENT

NOTE

The roll angle adjustment is a procedure related only to SLS-BRACKET-A.

Rotate the brackets to reach the desired roll angle within the allowed range (+/-8.5 °) and then tighten the M4 Roll Adjusting Screws **(5)** (1.4 - 1.5 N/m Torque).

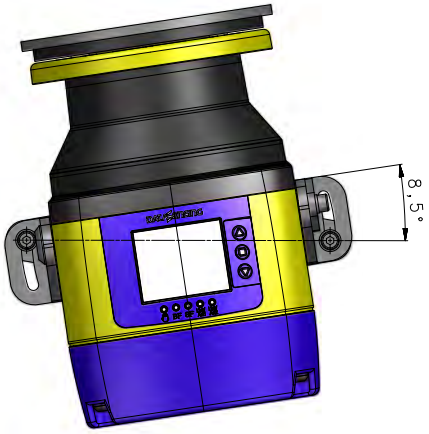


Figure 9 - Roll Angle Adjustment

NOTE

The memory group is tightened to the scanner with captive screws, so the operator only needs to loosen them to extract it from the scanner.

SAFETY INFORMATION REGARDING MOUNTING

Make sure that the protection level assured by the Laser Sentinel is compatible with the danger level of the working machine, according to EN ISO 13849-1 or EN 62061.

NOTE

For further information refer to Chapter 4, Installation**.**

Dangerous Machine Status:

- Make sure that the machine is OFF (not operating) during mounting, electrical installation, and commissioning.
- Make sure that the safety laser scanner outputs do not affect the machine during mounting, electrical installation, and commissioning.
- The device mounting and connections must be carried out by qualified personnel only, according to the indications included in the specific sections (refer to Chapter 5, Mechanical Mounting and Chapter 6, Electrical Connections) and in the applicable standards.
- The safety laser scanner must be securely placed in such a position that access to the dangerous zone is not possible without passing throughout the safety area. This must be done according to the indications included in the specific section (refer to Chapter 4, Installation) and in the applicable standards.
- Please carefully read the instructions for correct functioning before powering the device.

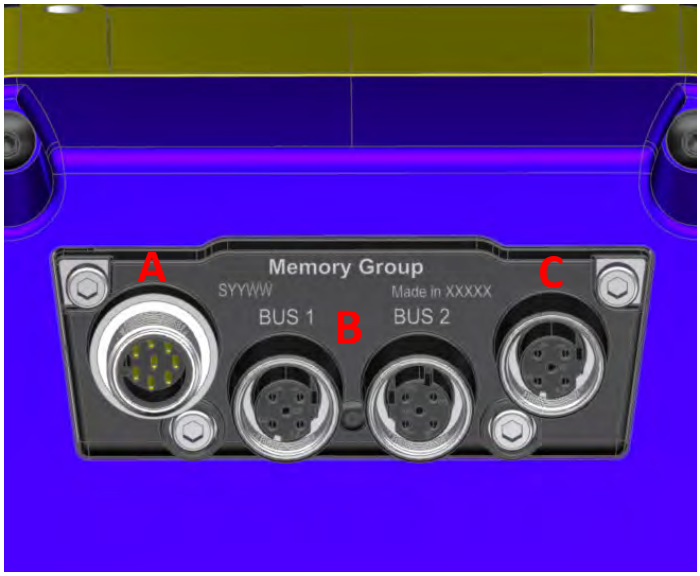
Hazard due to safety device malfunctioning:

- If unsuitable brackets are used, the device may be damaged. Only use Datasensing approved brackets for mounting.
- Personnel or parts of the body may not be detected in case of non-observance.
- Take appropriate measures for vibration damping if vibration and shock specifications exceed the values and test conditions specified in Appendix A, Technical Data.
- Do not carry out any repairs to the device components.
- Do not open the device components if the document procedures are not followed.
- The Laser Sentinel optics cover is an optical component. Make sure that the optics cover does not become dirty or scratched during mounting.
- Avoid fingerprints or other contamination on the optics cover.
- Check the integrity of all parts and components.
- If the components show damage, contact Datasensing.
- Install the device so that the status indicators are clearly visible.
- Make sure to observe the minimum safety distances calculated for your machine.
- Install the safety laser scanner so that it is not possible to crawl beneath, climb over or stand behind the safety area.
- Protect the device from dirt and damage by mounting it properly.
- The device view must not be restricted or obstructed (refer to "Installation Precautions" on page 9.
- The safety laser scanner must be correctly aligned, even during mounting: if the safety laser scanner is intended to monitor an area of 275 ° on a corner, the safety laser scanner may be mounted rotated by a maximum of 2.5 ° about the vertical axis.

CHAPTER 6
ELECTRICAL CONNECTIONS

SLS-FIELDBUS CONNECTION

Both models of the SLS-Fieldbus include:



A **M12 8-poles connector** (machine interface: power supply and configurable inputs/ outputs)

B **(2x) M12 4-poles connector** (PLC interface: fieldbus ports)

C **M12 4-poles connector** (programming and monitoring of safety laser scanner with Graphic User Interface)

Machine Interface Connections

The Laser Sentinel Fieldbus has four signals configurable as inputs/outputs and one signal configurable as input.

The pin-out of the standard M12-8 poles connector (Figure 1) is the shown in Table 1.

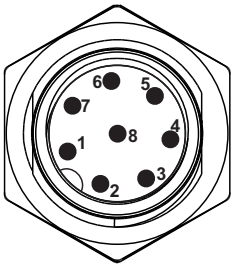


Figure 1 - Connector (M12, 8-pole Male)

One pin can be exclusively assigned as input (pin 3). The other pins can be configured either as input or output. Through the GUI, the user can choose the type of configuration. The operator must follow the indications for the type of pin selected and the safety standards.

CATEGORY	TYPE	COLOR	DESCRIPTION	PIN OUT
POWER	POWER SUPPLY	BROWN	24Vdc	2
	GND_ISO	BLUE	0 V	7
INPUT/OUTPUT	INPUT	GREEN	Selectable by GUI	3
	MULTI IN/OUT	YELLOW	Selectable by GUI	4
	MULTI IN/OUT	WHITE	Selectable by GUI	1
	MULTI IN/OUT	GRAY	Selectable by GUI	5
	MULTI IN/OUT	PINK	Selectable by GUI	6
OTHER	F_EARTH	RED	Functional Earth	8

Table 1. M12, 8-poles connector pin-out

The physical input/output function are listed in Table 2

TYPE	FUNCTION	DESCRIPTION	CONNECTION
MULTI-IN	RESET	Restore the device after a failure condition	+24VDC
	RESTART 1	Restarts the Safety Zone 1	+24VDC
	OVERRIDE (Single line pattern)	Enable the override function	+24VDC
	OVERRIDE 11(EDGE)	Enables the override function for Safety Zone 1 (either edge or level triggered)	+24VDC
	OVERRIDE 12(EDGE)		+24VDC
	OVERRIDE 11 (LEVEL)		+24VDC
	OVERRIDE 12 (LEVEL)		+24VDC
	MUTING 11	Automatically deactivates the safety status on the Safety Zone 1	+24VDC
	MUTING 12		+24VDC
	NO FUNCTION	Not used	

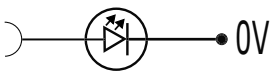
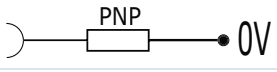
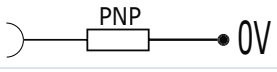
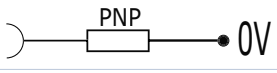
TYPE	FUNCTION	DESCRIPTION	CONNECTION
MULTI-OUT	MUTING LAMP 1	Active Muting functional signal for Safety Zone 1. Connect LED lamp providing it with 24 Vdc	
	ALARM 1	Clean Window	
	ALARM 2	Device Error	
	OVERRIDE STATUS	Status of override for Safety Zone 1	
	NO FUNCTION	Not used	

Table 2. M12-8 poles connector I/O functions

NOTE

For further information about the device functions, refer to Chapter 9, Functions**.**

NOTE

Make sure that the signals are aligned with the pin features and their specific function. In addition, they must be correctly connected to the external device.

In addition to the standard M12-8 poles connector, three Ethernet connectors D-coded (one for standard Ethernet network, two for fieldbus network) are used:

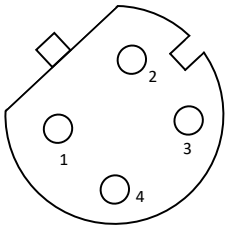


Figure 2 M12-4 poles D-coded connector.

PIN	TYPE	DESCRIPTION
1	TX+	Send data +
2	RX+	Receive data +
3	TX-	Send data -
4	RX-	Receive data -

Table 3. Ethernet connectors pinout

POWER SUPPLY CONNECTIONS

All power connections to the Laser Sentinel must strictly comply with standard regulations. The device requires a supply voltage of 24 Vdc. Power must be supplied in accordance with SELV/PELV (IEC 60204-1) for all the devices electrically connected to the safety laser scanner. Make sure that the safety laser scanner is provided with an appropriate electrical fuse protection and the earthing system method is the same for all the devices connected to the Laser Sentinel.

NOTE

The safety laser scanner's external power supply must be capable of bridging a brief power failure of 20 ms, as per IEC 60204-1.

NOTE

A functional earth is available on the M12-8 poles connector. User must connect the functional earth to achieve in the application a best compliance with electromagnetic interferences.

PC CONNECTIONS

Laser Sentinel needs to be connected to the PC for configuration and/or monitoring. The operator must create an Ethernet network between the two devices by employing M12-KEYD connector cable (refer to Appendix C, Accessories for accessory cables and Chapter 7, Laser Sentinel Setup and Configuration for Ethernet network setup).

NOTE

The device must be powered off during any connection operation. Power up the device after connecting it to the PC for configuration.

NOTE

During configuration, the device works using its previously saved configuration. Make sure to follow the safety instructions.

CHAPTER 7
LASER SENTINEL SETUP AND CONFIGURATION

This chapter is dedicated to the Laser Sentinel setup and configuration using the DLSentinel software. The aim of this chapter is to guide the user through all the fundamental procedures of configuring the device.

To employ the safety laser scanner, a safety configuration must be created on DLSentinel, where the user is required to enter all the parameters, configure inputs and outputs and create monitored areas.

For further information about DLSentinel, refer to the DLSentinel User's Manual.

INSTALLING DLSENTINEL GUI

The DLSentinel client application software needs to be installed on your PC to configure the safety laser scanner.

Minimum System Requirements

To ensure proper interfacing with the system, the personal computer must meet the following minimum requirements:

COMPONENT	RECOMMENDED	MINIMUM
Processor(s)	Pentium 4	Pentium 4
Clock frequency	>= 3 GHz	>= 2 GHz
RAM	2 GB	1 GB
Free hard drive space	70 MB	70 MB
Monitor resolution	1280x768	1024x768
Supporting Operation System	Windows 10 Windows 11	

Besides the components listed in the table above, your PC must be equipped with the following hardware and software drivers:

- Installed Ethernet network card and installed driver
- One free 100 Mbps Ethernet port

Program Installation

DLSentinel is a Datasensing safety laser scanner configuration tool providing important advantages:

- Intuitive Graphical User Interface for rapid configuration
- Defined configuration directly stored in the device
- Discovery and IP address setting features to facilitate remote configuration
- Device Monitoring

To install DLSentinel:

On the PC that will be used for configuration (running Windows 10 or 11), download the DLSentinel.zip file. Extract the file, run the installation program and follow the installation procedure.

When the installation is complete, the DLSentinel entry is created in the Start > All Programs menu under “Datasensing” along with a desktop icon. Double-click the desktop icon to run it.

NOTE

A dedicated computer running DLSentinel must be connected to a Safety Laser Scanner through the Ethernet port to perform the configuration and monitoring features.

CHOOSING THE APPLICATION

The GUI allows selecting the application Type to help the user with the device installation.

NOTE

For further information refer to the DLSentinel User’s Manual.

CHAPTER 8
INTEGRATION INTO THE PROFINET-PROFISAFE NETWORK

The device is suitable for the following network topologies:

- Star
- Daisy-chain
- Tree
- Ring

Addressing

The safety laser scanner needs two IP addresses, one for the DLSentinel configuration (standard ethernet port), one for the FBUS1/FBUS2 ports.

The safety laser scanner also requires a PROFINET name and an F-destination address.

Options for assigning the data to the safety laser scanner:

- In DLSentinel in the PROFINET/PROFIsafe page of the Configuration section.
- With a configuration software for PROFINET networks
- With a PROFINET control unit

If you store the IP addresses permanently, they are retained even after switching the system off and on again. The IP address for the FBUS1/FBUS2 ports can be changed, however, from the PROFINET control unit or DLSentinel. The IP address for the standard ethernet port can be changed by DLSentinel (default IP address 192.168.0.10).

WARNING

By changing the PROFINET name or the Process image type (F-I/O Data) in the DLSentinel (Profinet/Profisafe configuration), the change is effective only after a power cycle of the device.

Configuring control

Information about the configuration of the Safety Laser Scanner are given in the DLSentinel User's Manual.

To integrate the device within a PROFINET/PROFIsafe network:

1. Import the GSDML file to the control unit's configuration software
2. Search the hardware catalog to find the desired device, e.g. use the search function and enter “Datasensing” or “SLS-M5-PP-Bx”.
3. Add the device to the project and connect to the control unit.
4. To use a different process image, select a different module, if necessary.
5. Assign PROFINET name.
6. Set the PROFIsafe parameters in the submodule.

F-PARAMETER	DESCRIPTION	RANGE
F_Source_Address	Codename of the F-Host. Unique address of the controller.	1 ... 65534
F_Destination_Address	Codename of the F-(Sub)Modlue. Must be unique address of the Safety Laser Scanner in combination with the F_Source_Address. F_Dest_Add must be the same address as is assigned in the configuration of the Laser Sentinel.	1 ... 65534
F_Watchdog_Time	Watchdog time (monitoring time) for the cyclical service. Watchdog time should belong enough to tolerate shorter delays in communication. It nevertheless (e.g., in case of a fault) has an effect on the response time of the overall system and is therefore safety-relevant.	1 ... 65535 [ms]
F_SIL (F_Prm_Flag1)	Configured safety integrity layer of the Laser Sentinel.	SIL1 SIL2 NoSIL
F_CRC_Length (F_Prm_Flag1)	Length of the CRC2 signature. It depends on the process image used.	3 octets (PROFIsafe v2.4) 4 octets (PROFIsafe v2.6)
F_Par_Version (F_Prm_Flag2)	PROFIsafe Operational mode (not changeable)	1
F_Block_ID (F_Prm_Flag2)	Identification of parameter implementation.	0 (No F_iPar_CRC) 1 (F_iPar_CRC)
F_iPar_CRC	Checksum of the safety configuration saved into the device. The value is identical to IM_Signature (I&M4).	4 octets

PROFINET/PROFIsafe data

The cyclical data transmission between the controller and the Laser Sentinel is performed via the process image. The Safety Laser scanner provides I&M parameters and alarms.

Process image

The users can select among different process images through the DLSentinel (F-I/O Data in the Profinet/Profisafe configuration section):

- Default: 12 bytes (Input/Output)
- 7 bytes (Input/Output)
- 12 bytes (Output)
- 7 bytes (Output)

Input/Output is referred to the Safety Laser Scanner perspective (e.g., process image output is sent by the Safety Laser Scanner to the controller, process image input is sent by the controller to the Safety Laser Scanner).

The process image map can be selected on the following criteria:

- Version of PROFIsafe specification (2.4 or 2.6.1)
- Length of process image (12-byte or 7-byte)
- With or without test of F_iPar_CRC

Process images with 7-byte lengths cover all the functions. Process images with 12-byte lengths cover potential additional functions for upcoming device variants.

According to GSDML file, each F-I/O data of the configuration (see DLSentinel User's Manual) has a relationship with the module used:

- 12 bytes (Input/Output) supports SLS PROFIsafe V2.6.1 I/O-modules and SLS PROFIsafe V2.4 I/O-modules:
  - submodule SLS 12Byte In/Out PROFIsafe V2.6.1 (Submodule Ident Number = 0x00000011).
  - submodule SLS 12Byte In/Out PROFIsafe V2.6.1 iParCRC (Submodule Ident Number = 0x00000012).
  - submodule SLS 12Byte In/Out PROFIsafe V2.4 (Submodule Ident Number = 0x00000013).
  - submodule SLS 12Byte In/Out PROFIsafe V2.4 iParCRC (Submodule Ident Number = 0x00000014).
- 7 bytes (Input/Output) supports SLS PROFIsafe V2.6.1 I/O-modules and SLS PROFIsafe V2.4 I/O-modules:
  - submodule SLS 7Byte In/Out PROFIsafe V2.6.1 (Submodule Ident Number = 0x00000015).
  - submodule SLS 7Byte In/Out PROFIsafe V2.6.1 iParCRC (Submodule Ident Number = 0x00000016).
  - submodule SLS 7Byte In/Out PROFIsafe V2.4 (Submodule Ident Number = 0x00000017).
  - submodule SLS 7Byte In/Out PROFIsafe V2.4 iParCRC (Submodule Ident Number = 0x00000018).
- 12 bytes (SLS Output) supports SLS PROFINET non-safe I/O-modules:
  - submodule SLS 12Byte Input Non-Safe PNIO Data (Submodule Ident Number = 0x00000021)
- 7 bytes (SLS Output) supports SLS PROFINET non-safe I/O-modules:
  - submodule SLS 7Byte Input Non-Safe PNIO Data (Submodule Ident Number = 0x00000022).

The process image input (sent by the PLC to SLS) is represented in the following table (for 7 bytes size):

BYTE	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
0	Reserved				Shut-off	Stop Event Report	Reserved	Wink
1	Area Switch No.							
2	RestartSafetyZone 1..8 (according to the number of safety zones and for manual restart)							
3	Reserved	MutingActivationZone (maximum 4, according to configuration)						
4	Reserved	OverrideActivationZone (maximum 4, according to configuration)						
5	Reserved							
6	Reserved						ResetWith Network	ResetWithout-Network

Table 1. Image process input (7 bytes)

The process image output (sent by the SLS to PLC) is represented in the following table (for 7 bytes size):

BYTE	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
0	Event Report Status	DeviceSta-tus	Antitam-pering Warning-Status	Antitam-pering Status	Shut-off status	Referen-cePoint Status	Contami-nation Error	Contamina-tion Warning
1	Area Switch No.							
2	SafetyStatusZone 1..8							
3	InterlockReqZone 1..8 (according to the number of safety zone and for manual restart)							
4	Reserved	OverrideActivationZone (maximum 4, according to configuration)						
5	Reserved	OverrideStatusZone (maximum 4, according to configuration)						
6	RefPoint activation status	WarningStatusZone (maximum 7, according to configuration)						

Table 2. Image process output (7 bytes)

The process image input (sent by the PLC to SLS) is represented in the following table (for 12 bytes size):

BYTE	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
0	Reserved				Shut-off	Stop Event Report	Reserved	Wink
1	Area Switch No.							
2	Reserved							
3	Reserved							
4	RestartSafetyZone 1..8 (according to the number of safety zones and for manual restart)							
5	Reserved							
6	Reserved	MutingActivationZone (maximum 4, according to configuration)						
7	Reserved							
8	Reserved	OverrideActivationZone (maximum 4, according to configuration)						
9	Reserved							
10	Reserved							
11	Reserved						ResetWith Network	ResetWithout-Network

Table 3. Image process input (12 bytes)

The process image output (sent by the SLS to PLC) is represented in the following table (for 12 bytes size):

BYTE	BIT 7	BIT 6	BIT 5	BIT 4	BIT 3	BIT 2	BIT 1	BIT 0
0	Event Report Status	DeviceSta-tus	Antitam-pering Warning-Status	Antitam-pering Status	Shut-off status	Referen-cePoint Status	Contami-nation Error	Contamina-tion Warning
1	Area Switch No.							
2	SafetyStatusZone 1..8							
3	Reserved							
4	InterlockReqZone 1..8 (according to the number of safety zone and for manual restart)							
5	Reserved							
6	Reserved	MutingStatusZone (maximum 4, according to configuration)						
7	Reserved							
8	Reserved	OverrideStatusZone (maximum 4, according to configuration)						
9	Reserved							
10	RefPoint activation status	WarningZone (maximum 7, according to configuration)						
11	Reserved							

Table 4. Image process output (12 bytes)

The content of the process image (referred to 7 bytes input/output) is detailed in the following table:

SAFETY PROCESS IMAGE INPUT (FROM PLC TO SLS)						
BYTE.BIT	NAME	USE	DATATYPE	DEFINITION	RANGE	SAFETY IMPLICATIONS
B0.0	Wink	Additional function	Boolean	Activate wink function to visually identify the device	0: Wink deactivated 1: Wink activated	No safety implications
B0.2	Stop Event Report	Additional function	Boolean	Stop recording events	0: Activate event history, safety events are recorded (default) 1: De-activate event history, safety events are not recorded, existing events are retained.	No safety implications
B0.3	Shut-off	Safety function	Boolean	Energy saving mode	0: Disable shut-off (default) 1: Enable shut-off (duration status 1: t>T_min_shut-off)	No safety implications
B1.x (x=0..7)	Area Switch No.	Safety function	UnsignedInt	Define the active Zone Set.	0: no zone set active (default) 1..70: number of the zone set	Safety Relevant
B2.x (x=0..7)	Restart Safety Zone 0..7	Safety function	Boolean	Restart the StatusSafetyZone to normal operating condition after an interlock request (if no objects are in the safety area X of the monitored zone set).	0: No restart (default) 0-1-0: Restart safety function of the monitored zone set (duration status 1: T_min_restart<t<T_max_restart) 1: ignored	Safety Relevant
B3.x (x=0..6)	Muting Activation Zone (maximum 4, according to configuration)	Safety function	Boolean	Activate Muting function for the safety area X of the monitored zone set.	0: No Activation (default) 0-1: Activate Muting (duration status 1: t>T_min_muting)	Safety Relevant

SAFETY PROCESS IMAGE INPUT (FROM PLC TO SLS)						
BYTE.BIT	NAME	USE	DATATYPE	DEFINITION	RANGE	SAFETY IMPLICATIONS
B4.x (x=0..6)	Override Activation Zone (maximum 4, according to configuration)	Safety function	Boolean	Activate Override function for the safety area X of the monitored zone set.	0: No Activation (default) 0-1: Activate Override (duration status 1: t>T_min_override)	Safety Relevant
B6.0	Reset Device Without Network	Safety function	Boolean	Reset Device without ending the network stack	0: No reset (default) 0-1-0: Reset (duration status 1: t>T_min_reset) 1: ignored	Safety Relevant
B6.1	Reset Device With Network	Safety function	Boolean	Reset Device and the network stack	0: No reset (default) 0-1-0: Reset (duration status 1: t>T_min_reset) 1: ignored	Safety Relevant

SAFETY PROCESS IMAGE OUTPUT (FROM SLS TO PLC)						
BYTE.BIT	NAME	USE	DATATYPE	DEFINITION	RANGE	SAFETY IMPLICATIONS
B0.0	Contamination Warning	Diagnostic	Boolean	Status of the optics cover. If contamination warning is active (1) clean the optics cover	0: no contamination warning 1: contamination warning	No safety implications

SAFETY PROCESS IMAGE OUTPUT (FROM SLS TO PLC)						
BYTE.BIT	NAME	USE	DATATYPE	DEFINITION	RANGE	SAFETY IMPLICATIONS
B0.1	Contamination Error	Safety function	Boolean	Status of the optics cover. If contamination error is active (1) the safety laser scanner goes in safe state. Clean the optics cover	0: no contamination error 1: contamination error	Safety Relevant
B0.2	Reference points Status	Safety function	Boolean	Status of the monitored reference points. It is activated if at least one reference point is not measured within the tolerated measurement error. It is referred to active zone set.	0: normal operation 1: Reference point error	Safety Relevant
B0.3	Shut-off status	Safety function	Boolean	Status of the energy saving mode of the safety laser scanner	0: shut-off disabled 1: shut-off enabled	No safety implications
B0.4	AntitamperingStatus	Safety function	Boolean	Status of antitampering functionality	0: anti-tamper disabled 1: anti-tamper enabled	Safety Relevant
B0.5	AntitamperingWarningStatus	Safety function	Boolean		0: anti-tamper delay enable compliant to normative 1: anti-tamper delay enable not compliant to normative	Safety Relevant
B0.6	Device Status	Diagnostic	Boolean		0: normal operation 1: Lockout	No safety implications
B0.7	Event Report Status	Additional function	Boolean	Status of recording events	0: Event history activated 1: Event history de-activated	No safety implications
B1.x (x=0..7)	Active Area Switch No.	Safety function	UnsignedInt	Indicates the active Zone Sets.	0: no zone set active 1..70: number of the active zone set	Safety Relevant

SAFETY PROCESS IMAGE OUTPUT (FROM SLS TO PLC)						
BYTE.BIT	NAME	USE	DATATYPE	DEFINITION	RANGE	SAFETY IMPLICATIONS
B2.x (x=0..7)	Status Safety Zone 0..7	Safety function	Boolean	Status of the safety zone X of the monitored zone set.	0: Intrusion in the Safety zone (or Lockout) 1: Safety zone free	Safety Relevant
B3.x (x=0..7)	Interlock Request Zone 0..7	Safety function	Boolean	Status of the interlock related to zone X of the monitored zone set.	0: No Interlock request 1: Interlock request	Safety Relevant
B4.x (x=0..6)	Muting Status Zone (maximum 4, according to configuration)	Safety function	Boolean	Status of the muting related to zone X of the monitored zone set.	0: Muting inactive 1: Muting active	Safety Relevant
B5.x (x=0..6)	Override Status Zone (maximum 4, according to configuration)	Safety function	Boolean	Status of the override related zone X of the monitored zone set.	0: Override inactive 1: Override active	Safety Relevant
B6.x (x=0..6)	Warning Status Zone (maximum 7, according to configuration)	Additional function	Boolean	Status of the warning zone X of the monitored zone set.	0: Intrusion in the Warning zone 1: Warning zone free	No safety implications
B6.8	Reference points activation status	Additional function	Boolean	Status of activation of reference points for the active monitored zone set.	0: No Reference points configured for the monitored zone set 1: Reference points are configured for the monitored zone set	No safety implications

For further details of each function, please refer to the next chapter.

NOTE

When configuring the device or upgrading firmware through the DLSentinel the bit "Device_Fault" of the Status Byte becomes TRUE and change back to FALSE when the configuration or firmware upgrade is accepted.

CHAPTER 9
FUNCTIONS

DETECTION CAPABILITY SETTING

The detection capability is the ability to detect an object of given dimensions within the detection zone. In particular, for the Laser Sentinel, the test piece taken as reference is an opaque cylinder with at least 300mm height and the diameter equal to the detection capability measured in millimeters.

The safety laser scanner, configured with a given detection capability, will be able to detect objects within the Safety zone; the device is also capable of detecting objects located in the Warning zone, but the probability of detection errors could be greater than the one guaranteed for the Safety Zone (due to specific object color or reflecting surface).

The detection capability is a parameter that the user selects through the GUI. The user selects the detection capability depending on the application requirements, because it is a critical parameter in the calculation of the minimum safety distance from the hazard point.

The detection capability also influences the maximum detection range of the scanner.

MODELS	DETECTION CAPABILITY	MAX. RANGE
SLS-M5-PP-Bx 5.5m	30 mm	2.5 m
	40 mm	3 m
	50 mm	4 m
	70 mm	5.5 m
	150 mm	

SAFETY OUTPUTS (STATUSSAFETYZONE)

The Safety Laser Scanner fieldbus has no OSSD (Output Signal Switching Device). Since no physical safety outputs are present, the safety information about the status of the device (intrusion in the safety zones, lockout, etc...) are sent to the controller (e.g., a PLC) through the cyclic data (Process Image) exchanged on the safety fieldbus protocol. Since up to 8 Safety Zones can be configured for each zone set, the safety status of the SLS can be monitored by the related byte SafetyStatusZone:

SafetyStatusZoneX = 0 (X=1, …, 8) ---> OFF state (intrusion, lockout)

SafetyStatusZoneX = 1 (X=1, …, 8) ---> ON state (no intrusion, no lockout)

RESPONSE TIME AND SCAN CYCLE SETTING

The response time of the SLS is the time from when an object enters the safety zone to when the safety output goes to the safe state due to the detection of the object. The SLS scans cyclically the surrounding area at constant speed. The time for an entire cycle is fixed and called “scan cycle time” T_{SCAN} and depends on complexity of the configuration, and the selected code for anti-interference. The minimum number if scan cycles is 2, therefore if the SLS detects an object in both scan cycles it activates the safety function. If the SLS detects the object in the first scan cycle but not in the second scan cycle, then the safety function is not activated.

NOTE

The response time is automatically calculated by DLSentinel based on the number of Safety+ Warning zones configured, scan cycles, and the selected anti-interference code (See “Anti-Interference Coding” on page 56.). The response time automatically calculated by DLSentinel is approximated up to the highest integer value in milliseconds.

NOTE

The minimum response time of the safety laser scanner is 94 ms, which is the time needed by the device to perform two scans, with anti-interference code = 0 and with a maximum of 4 among Safety and Warning Zones. The number of scans of the response time may be increased if the device is operating in a dirty environment caused by floating dust particles (in this case, the user may need to set a higher number of scans before turning off the Safety Outputs to avoid false detections).

Two different setups are permitted and automatically handled by the DLSentinel according to the configuration used:

- Fast mode (70 zone sets with up 4 zones (safety zones + warning zones <= 4) [default], T_{SCAN} = 42ms
- Standard mode (70 zone sets with more than 4 zones (safety zones + warning zones > 4), T_{SCAN} = 50ms

The following formula shall be used to calculate the SLS response time T_R:

$$T_R = n * T_{SCAN} + t_{PROC}$$

Where:

- **n** represents the number of rounds (n=2, …, 40) which are configurable by GUI.
- **T_{SCAN}** is the revolution time which depends on motor speed set according to complexity of configuration (up to 4 or up to 8 safety zones) and anti-interference code set by the GUI according to the following table:

MODE	ANTI-INTERFERENCE CODING	T_{SCAN}[ms]
Fast	Code 0	42
	Code 1	42.5
	Code 2	43
	Code 3	43.5
Standard	Code 0	50
	Code 1	50.5
	Code 2	51
	Code 3	51.5

- T_{PROC} is the internal processing time

$t_{PROC,FAST}$ =10 [ms] (FAST MODE)

$t_{PROC,STANDARD}$ =5 [ms] (STANDARD MODE)

Considering Code 0 as reference, n=2 scans, the Response times for the Fast and Standard mode are the following:

$T_{R[FAST]} = n * T_{SCAN} + t_{PROC,FAST} = 2 * 42ms + 10ms = 94ms$

$T_{R[STANDARD]} = n * T_{SCAN} + t_{PROC,STANDARD} = 2 * 50ms + 5ms = 105ms$

WARNING

If the safety distance is not appropriate for the application, the machine may not stop before the dangerous area is reached.

NOTE

If the application requires changes, this may require reconfiguration of the safety zones or re-installation of the Laser Sentinel.

ANTI-INTERFERENCE CODING

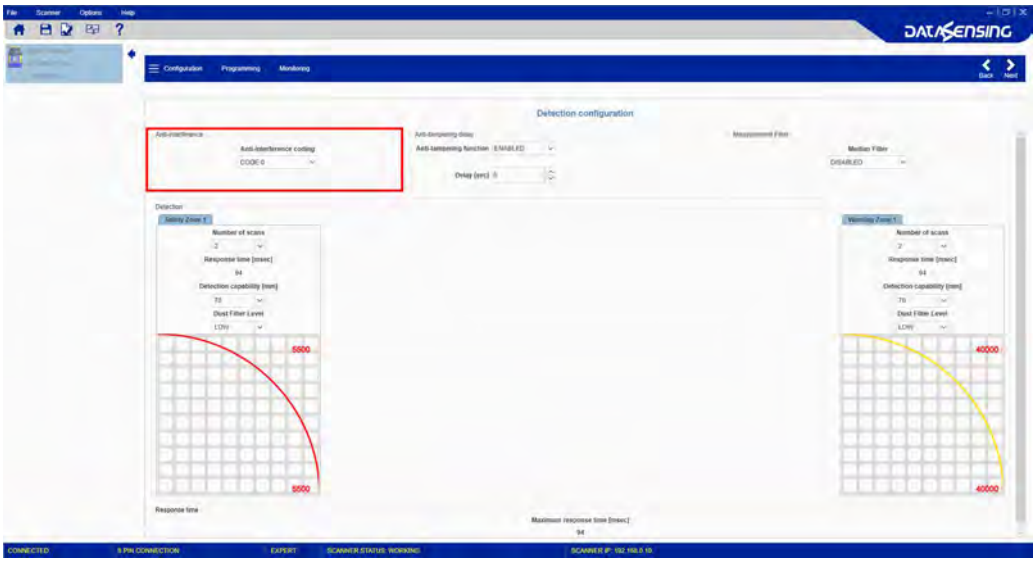
Anti-interference coding allows using four different emission modes to minimize interference among scanners working in the same environment.

If scanners interfere with each other, a different code for each scanner can be selected.

The available codes are:

- Code 0
- Code 1
- Code 2
- Code 3

Code 0 is the default code.



The selected code has an impact on the response time of the relevant device (see "" on page 77).

DUST FILTERING

The Dust Filter Level must be set according to different conditions specific to the application. In general, it is the sensibility to various levels of airborne particles that impact the response of the Laser Sentinel detection.

A **Low** Dust Filter Level (default) is used in cleaner environments where airborne particles have little effect on object detection.

A **High** Dust Filter Level is used in dirty environments to filter (ignore) detection of airborne particles from being confused with objects to detect. The Laser Sentinel is less sensitive to dust and therefore avoids shutting down the machinery unnecessarily.

This parameter should be set to the lowest value that still allows the machinery to work without detections due to dust.

NOTE

A Low Dust Filter Level could also prevent light interference and reflecting background influences from reducing the device detection capability. Refer to "Light Interference" on page 12 **and** "Highly Reflecting Background" on page 13 **for more details.**

ZONE SETTING CONFIGURATION AND SELECTION

A Zone Set defines the set of zones within the Laser Sentinel operating range to be monitored (Safety Zones, and if present, Warning Zone). Up to 70 Zone Sets can be configured and these can be switched alternatively using the Process Image related byte (*"Area Switch No."*).

To create a Zone Set, the user must configure it through the DLSentinel GUI.

NOTE

Each Zone Set must have a Safety Zone and can have up to 7 Warning Zone depending on the number of Safety Zones used.

NOTE

For each zone set, the maximum number of Safety Zone, Warning Zone and Muting shall be 8 (e.g., 3 Safety Zones, 3 Warning Zones, 2 Muting zones is an allowed configuration).

When only one Zone Set is configured, it corresponds to the Safety and Warning Zones monitored by the Laser Sentinel and no change of zone set are possible, otherwise an INPUTCFx error may occur.

Laser Sentinel allows the user to set up to 70 Zone Sets. Only one Zone Set can be activated at a time by using the *"Area Switch No."* byte of the Process Image. When it changes, the new Zone Set assigned to this new combination will be monitored.

When Process Image (F-I/O data in DLSentinel) is selected as input/output (7 or 12 bytes), the SLS always starts with no zone set active and the indication WAIT FOR INPUT on the display. This means that SLS is waiting for *"Area Switch No."* from PLC.

It is possible, through the DLSentinel to enable/disable the Sequence Control if more the one Zone set are selected. If enabled, the change of zone set from x to y shall be admissible only for a sequential number of the zone set (incremental or decremental), i.e., y=x+1 or y=x-1. If the user tries to activate a different zone set from y=x+1 or y=x-1, the device goes to a safe condition and the error INPUTCF3 is shown on the display. When the maximum number of configured Zone Set is reached, the next incremental

admissible Zone Set is the first one, otherwise, if Zone Set No. is set to 0, the error INPUTCF2 is shown on the display.

To start the Zone Set switching on the device, the user must:

- Configure at least two Zone Set No.
- Define if enable/disable the sequential control.
- Make sure that the system (e.g., the PLC), which sends through the safety fieldbus protocol the *Area Switch No.* to be activated, can dynamically switch the state without passing through invalid Area Switch No.

NOTE

The actual zone set switching occurs within a maximum processing time of 150ms for Fast Mode configuration or 200ms for Standard Mode. The user must wait at least the maximum processing time of 3*T_{SCAN} before activate a new Zone Set.

NOTE

Zone set switching is not allowed during Muting, Override or Interlock. If this occurs, the system will display an error (INPUTCF2) as soon as one of the mentioned function ends.

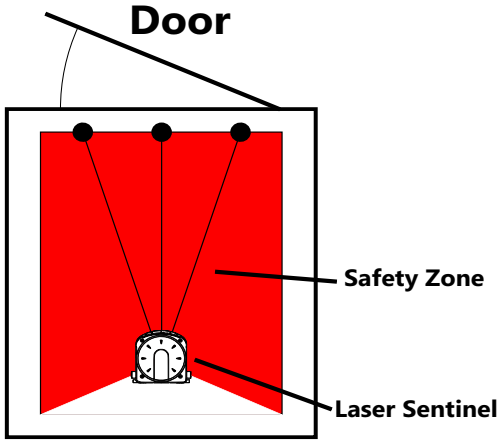
REFERENCE POINTS MONITORING SETTINGS

Reference points monitoring is a safety function used to monitor any change in position of the scanner, a protective structure or a moving structure located at the specified reference points. These structures either allow or prevent access to the dangerous area and are therefore outside the monitored Safety Zone.

When the device detects a change in position at the Reference Points exceeding the specified tolerance, all the safety outputs go in safe state (*StatusSafetyZoneX = 0*). This function is required for Vertical applications.

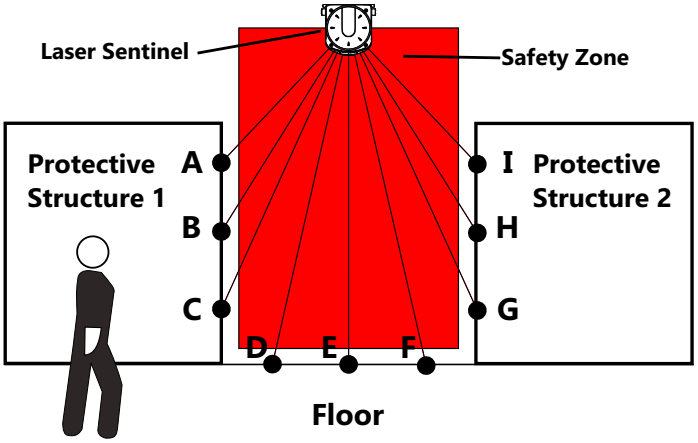
Example application for movable structure protection

When the reference points (minimum 3), are set on the position of a movable structure, such as a door, the safety outputs go in safe state if the Laser Sentinel detects a change in the position of the door.



Example application for protective structure protection

When protective structures such as mechanical guards or barriers are used in combination with the safety laser scanner, undetected access to the dangerous area could be compromised if some event occurs which moves the position of the protective structure. To avoid this, Reference Points can be set on the protective structures to monitor their position. The safety outputs go in safe state in case of a position change of the protective structure.



Example of reference points

As shown in the figure above, three or more reference points must be set on each structure to detect its position change. Three reference points are set on three structures (protective structure 1, protective structure 2 and the floor) for a total of nine points (A to I).

Additional measures must be provided if there exists any unprotected space larger than the minimum detectable object size between the Safety Zone and the protective structure.

- At least 3 Reference Points must be defined per object. A maximum of 15 Reference Points for each Zone Set can be defined.
- The Reference Point tolerance must be set for each Reference Point through the GUI. The minimum tolerance is +/- 10 mm where Tol - is the tolerance closest to the scanner and Tol + is farthest from the scanner measured on a radial line from the scanner origin.
- If the user configures a vertical application with a number of Scans greater than 2, the GUI gives a warning message indicating that this configuration is not valid for whole body protection applications (greater than 1.6 m/s). To safely apply the Laser Sentinel in applications with normal approach (i.e. when the monitored plane is vertical), refer to IEC 61496-3 Annex A.12.

NOTE

If the Muting function is enabled, the Reference Points must be configured in such a way that they are not detected by the moving material during Muting. Otherwise, the Safety Laser Scanner will go to "OFF state for Reference Point" and the safety outputs will switch to OFF state to stop the machine.

Dynamic Reference Point

Through the process image output (from SLS to PLC) is it possible to monitor the status of reference points of the active zone set. Differently from the SLS-ENH models, in the SLS fieldbus models, up to 15 reference points can be monitored for each zone set. This means that changing the zone set also the reference points set can be dynamically changed. There are two bits used:

- *ReferencePointStatus* bit: this bit is set to 0 if all the reference points associated to the active zone set are measured within the tolerated measurement error. This bit is set to 1 if at least 1 reference points associated to the active zone set is measured outside the tolerated measurement error. In the last case, the *SafetyStatusZoneX* bit is set to 0.
- *ReferencePointActivationStatus* bit: it is set to 0 if no Reference Points are configured in the active monitored zone set. It is set to 1 if Reference Points are configured in the active monitored zone set.

AUTOMATIC AND MANUAL RESTART

If Laser Sentinel detects an opaque object, the Safety Outputs switch to the safe state (*SafetyStatusZoneX* = 0). The restart mode allows the safety laser scanner to return to a normal operating condition.

The restart of the device can be carried out in two different ways: Automatic or Manual Restart.

Automatic Restart

When an opaque object is detected, the SLS enters in the safe condition. After the object has been removed from the safety area, the device normal functioning is restored. The timing for entering in the safe condition and recovering to normal operation are described in the figure below:

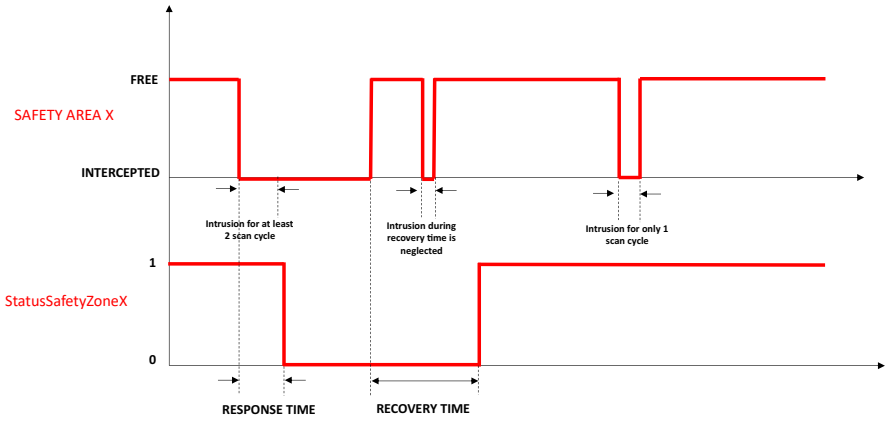


Figure 1 - Restart timing

The response time is the time between the object introduction in the Safety area and the SafetyStatusZoneX achieving the STOP condition (digital state 0) on the safety fieldbus frame. The recovery time is the time between the object removal from the protected area and the SafetyStatusZoneX achieving the GO condition (digital state 1). The Automatic Restart can be set through the GUI and the minimum recovery time for device restart is 200 ms. This time can be increased up to 60000 ms through the GUI.

During recovery time, any intrusion is neglected, thus the safety state is kept until the end of the recovery time.

Manual Restart

In case of Manual Restart selected, it can be activated by safety fieldbus protocol (*RestartSafetyZoneX* byte of the process image) or by wire (**RESTART1**) on SafetyZone1 only, if Physical configuration is enabled by GUI.

In last case, after the SLS has detected an opaque object in the Safety Zone 1, normal operation will be restored only by pressing the Restart button (normally open push-button) after the object has been removed from the Safety zone. The Restart push-button must be kept pressed between a minimum of 500 ms and a maximum of 4.5 seconds (Figure 2). When the Restart push-button is released, the safety outputs switch to normal operation.

There are two intermediate states (internally controlled) between the stop and the restart of the safety laser scanner:

- the Interlock Status ON (device normal operation can be restored because the detected object has been removed from the Safety zone)
- the Interlock Status OFF (the device is OFF because the object has not been removed from the Safety zone).

The Interlock Status (*InterlockReqZoneX*) and the Restart (*RestartSafetyZoneX*) for each configured Safety Zone can be monitored through the safety process image (Figure 3).

According to IEC 61496-3, the restart interlock shall prevent the device to go in normal operation when:

- the detection zone is interrupted while the machine operation is at a hazardous part of its operating cycle.
- the detection zone is interrupted while the machine is in automatic or semi-automatic mode.
- there is a change of the machine operating mode or type of operation (e.g., the power supply is switched on or is interrupted and restored).

The interlock condition shall continue until the restart interlock is manually reset. However, it shall not be possible to reset the restart interlock whilst the sensing device is actuated (i.e., the *SafetyStatusZoneX* = 0).

For each Safety Zone, the Restart bit shall be effective, after an Interlock Request, only after a transition 0-1-0.

NOTE

The Manual Restart input must be connected to a 24 Vdc normally open contact.

NOTE

If an object is not removed from the Safety zone and the operator attempts to restart the device, by pressing the button for more than 500 ms, the Safety Laser Scanner remains in Interlock OFF status.

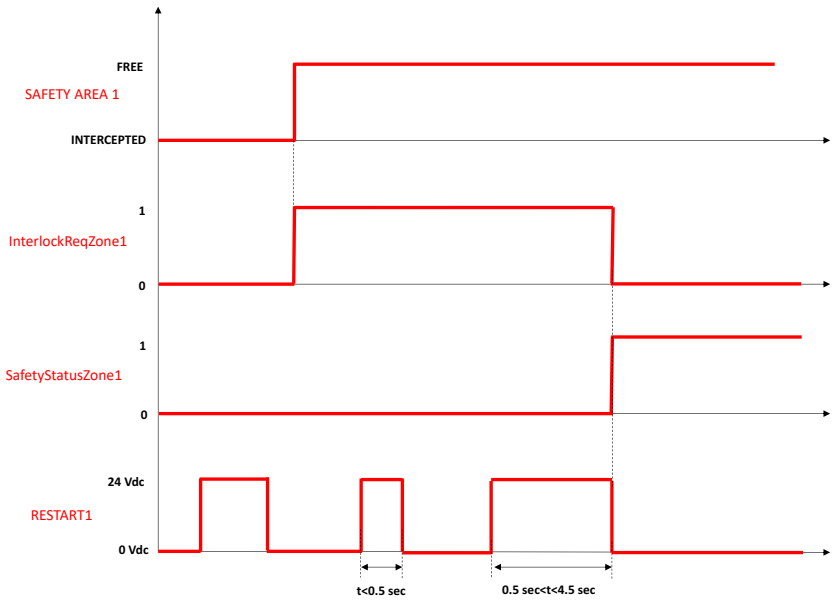


Figure 2 - Restart timing (manual)

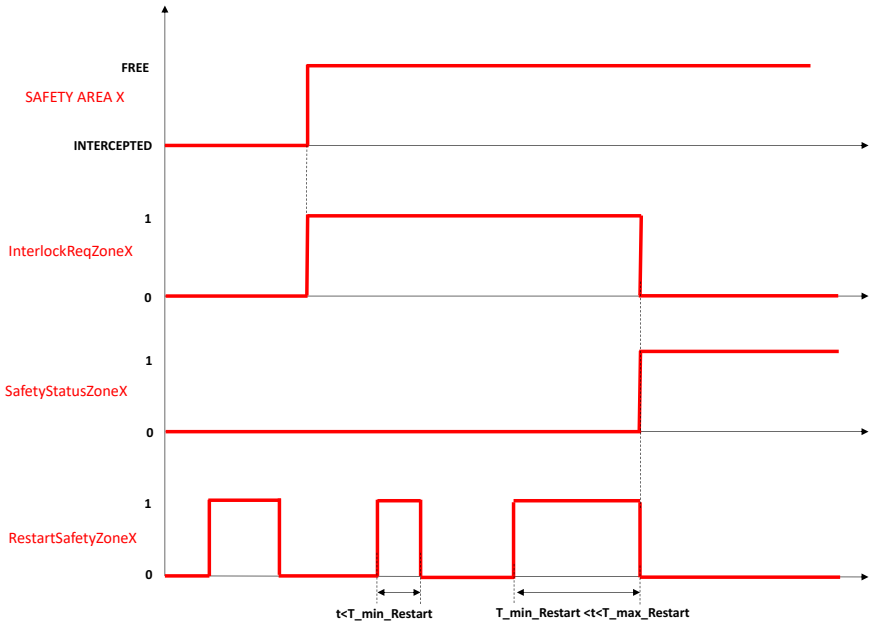
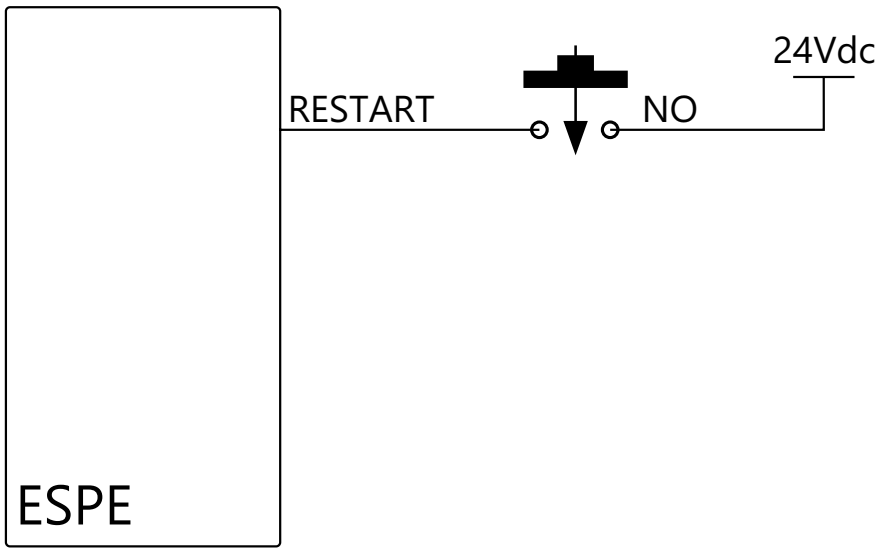


Figure 3 - Restart timing (fieldbus)

Timings of restart function activations can be evaluated according to the following values:

- T_min_restart = 0.5 s
- T_max_restart = 4.5 s



RESET

Reset is a function that allows restoring normal operation after a failure lockout condition, due to system error, without disconnecting the power supply. The aim of the Reset is to return the system to a power-on phase, by resetting all the variables and starting a new integrity test session.

The user can associate the Reset function to one of the input pins by enabling the Physical Configuration (**RESET**). The minimum pulse width of the Reset function is 500 ms + 34ms (constant value). If the width is less than the required value, then the Reset function will not be activated. To activate the Reset function, the push-button (switch), connected between 24 Vdc and the Reset input, must be pressed and held for at least 500 ms +34 ms (non-critical failure status).

By using the Safety Fieldbus communication and the process image input (from PLC to SLS), the SLS supports two different reset functions:

ResetWithoutNetwork: it allows restoring normal operation after a failure lockout condition, due to system error, without disconnecting the power supply. The network functions are not reset allowing any device connecting to the SLS to be reached by the controller, since the communication of the node is kept alive.

The ResetWithoutNetwork bit shall be effective only after a transition 0-1-0 with a duration of the bit at 1 that shall be t>T_min_Reset, where:

- T_min_Reset = 1s

If any fault appears when the bit ResetWithoutNetwork is set to 1, the Reset does not apply and a new transition 0-1-0 shall be applied to reset the device.

ResetWithNetwork: this reset allows restoring normal operation after a failure lockout condition, due to system error, without disconnecting the power supply. Differently from the ResetWithoutNetwork, this function acts like a power cycle in the same way of the **RESET** function activated by wire.

The ResetWithNetwork bit shall be effective only after a transition 0-1-0 with a duration of the bit at 1 that shall be t>T_min_Reset, where:

- T_min_Reset = 1s

If any fault appears when the bit ResetWithoutNetwork is set to 1, the Reset does not apply and a new transition 0-1-0 shall be applied to reset the device.

Auto Reset

DLSentinel allows the user to activate the Auto Reset function following a diagnostic fault. If the Auto Reset is enabled, SLS will automatically reset after 10 seconds from the error condition and will resume normal operation. The Auto Reset function will be permanently inhibited if the device locks in fault condition more than 5 times within 15 minutes. In this case a power cycle is necessary to reactivate the SLS.

NOTE

If the error is not solved, the device will return to the lockout failure condition again.

NOTE

The Reset or Auto Reset functions may not restore the lockout status of the device; in this case a power cycle is necessary.

The Reset function can be activated also through display (for more information, see "Display Menu" on page 88).

MUTING

The Muting feature allows the automatic deactivation of the safety status overall (Total Muting) or part (Partial Muting) of the safety area. This feature is particularly suitable when an object, but not a person, must pass through the dangerous area. This allows carrying out definite cyclical operations without blocking a working machine.

The Muting feature excludes the ESPE during its functioning, but it maintains the safety outputs active (according to operating requirements). To activate the Muting feature, there are two options:

- Use two physical inputs: **MUTING1** and **MUTING 2** (according to the current standards) can be used to activate Muting function on the SafetyZone1 if Physical Configuration and Muting function are enabled by DLSentinel.
- Use the safety fieldbus communication through the process image input (from PLC to SLS) related byte (*MutingActivationZoneX*). The MutingActivationZone bit shall be effective only after a transition 0-1 with a duration t of the bit 1 that shall be t>T_min_Muting, where:
  - T_min_Muting = 1s

If the MutingActivationZone bit is set to 0, the Muting Function is deactivated. If Physical Configuration is enabled, the MutingActivationZone bit related to Safety Zone 1 is not effective.

When Muting function is activated, it is possible to check the status on the device through the process image output (from SLS to PLC) on the *MutingStatusZone* byte, which bits are set to 1 if Muting is active on the related Safety Zone X, and to 0 if Muting is not active.

If used, the Muting sensors must be placed according to the material's length and speed to be able to recognize the passing materials (pallets, vehicles, etc.). If a Muting area has different speeds, it is necessary to evaluate their effect on the total Muting duration.

It is important to remember that the Muting feature represents a forced condition of the system and therefore must be used with the necessary precautions.

If **MUTING 1** and **MUTING 2** inputs are activated by two Muting sensors or actuators, these should be correctly connected and placed to avoid undesired Muting or potentially dangerous conditions for the operator.

NOTE

MUTING 1 and MUTING 2 cannot be activated simultaneously. Muting status is signaled by an external Muting Lamp (if Physical Configuration and Muting are enabled and if the Muting Lamp function is connected to any output pins) that may be connected to the safety laser scanner. When the Muting function is ON, the lamp blinks and the display shows "MUTING". The lamp must be always placed in a visible location.

NOTE

The Muting zone can be different for each Zone Set configured on each device. Please note that when you enable Muting, you disable the safety function of the relevant safety zone.

NOTE

Up to four Muting zones can be configured in a Zone Set, which means that up to 4 Safety Zone are configured.

WARNING

Carefully select the configuration, because a wrong one can cause the incorrect functioning of the Muting feature and a reduction of the safety level. To correctly use the Muting feature, please refer to the relevant reference standard.

WARNING

The Muting sensors must be placed so that during the activation of the Muting feature it is not possible for a person to pass through the desired zone.

NOTE

Check that when the Muting function is active no Zone Set switching occurs. Zone switching is not allowed during Muting, and if this occurs, the system will display an error (INPUTCF2) as soon as the Muting function ends.

Muting Signaling Devices

Muting status is signaled by an external Muting lamp that may be connected to the safety laser scanner. The lamp blinks when the Muting or Override function are active.

NOTE

The Muting Lamp must be only a LED lamp type, max consumption 250 mA.

Muting Direction

It is possible to use the ESPE both in a bi-directional and unidirectional Muting. In particular, the bidirectional Muting is used if the materials move in both directions and the unidirectional Muting is used if the materials move in one direction only.

Bidirectional Muting

In Bidirectional type operations, the device enters in Muting if the **MUTING 2** input goes high after the rising of **MUTING 1** (or vice versa), within the Max Muting Activation Delay (T12 max or T21 max in Figure 4). It is possible to set the Max Muting activation Delay between **MUTING 1** and **MUTING 2** (or vice versa) from a minimum of 1 sec to a maximum of 16 sec. As soon as the signal on Muting 1 or Muting 2 goes low, the Muting function ends, after an internal delay of max 30 ms (Tdelay). The Timeout parameter forces the Muting feature to end if the MUTING inputs remain in the active state.

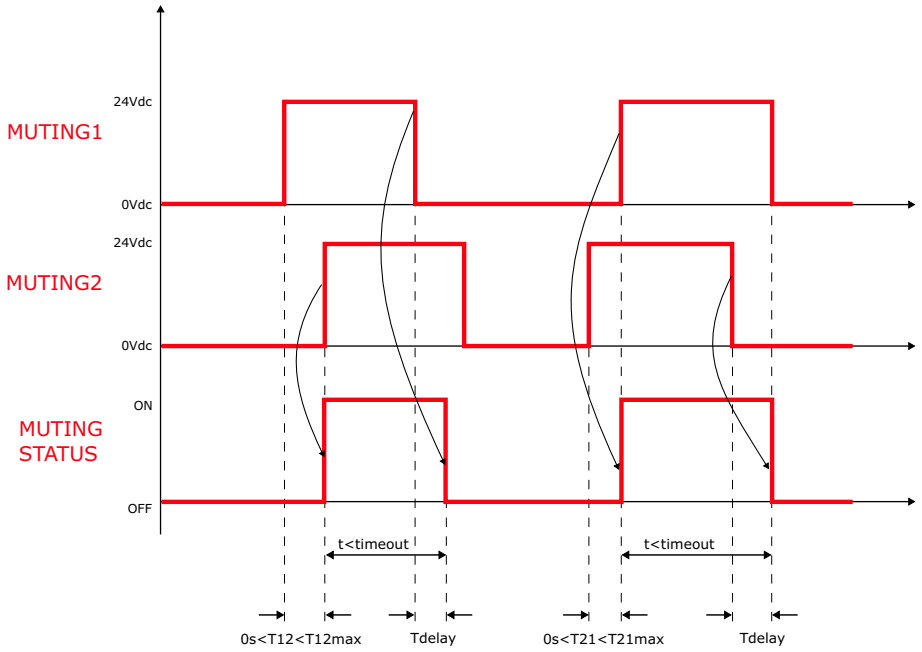
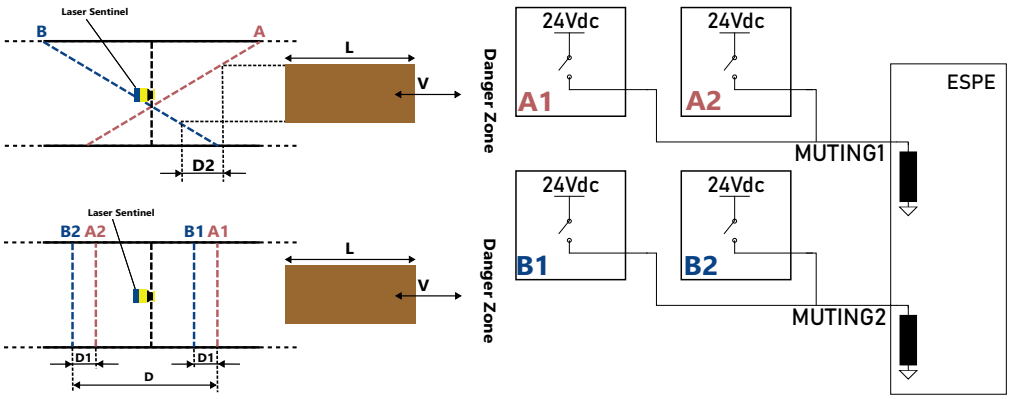


Figure 4 - Bidirectional Muting Timings

The sensors A1/A2 are connected to **MUTING 1** input and the sensors B1/B2 are connected to **MUTING 2** input. The user has to mount the sensors A1/A2 or B1/B2 at a "D" distance.

NOTE

"D" depends on the package length (L): D < L; "d1" is the maximum distance between the Muting sensors (this distance depends on the package speed (V): d1max[cm] = V[m/s] * T12[s] * 100); "d2" is the maximum distance for the Muting request to be accepted (this distance depends on the package speed (V): d2max[cm] = V[m/s] * T12[s] * 100, where "T12" is the delay between Muting 1 and Muting 2. The user should select the minimum value of T12 max (DLSentinel, parameter Max Muting Inputs Delay) that guarantees the Muting function.



Unidirectional Muting

In Unidirectional type operation, the device enters in Muting if the **MUTING 2** input goes high after the rising of **MUTING 1** (or vice versa). The user can set the value of Max Muting Inputs Delay between **MUTING 1** and **MUTING 2** from a minimum of 1 sec to a maximum of 16 sec.

The Muting function goes OFF after a specific time: it is a multiple of the real delay between **MUTING 1** and **MUTING 2** (T12). The user can choose the value of the multiplier “m” (M coeff. in DLSentinel).

After this interval, to re-enter in a Muting operation, the Muting input has to be deactivated and the sequence needs to start from the beginning.

NOTE

Unidirectional Muting must be used only for removing materials from the dangerous area.

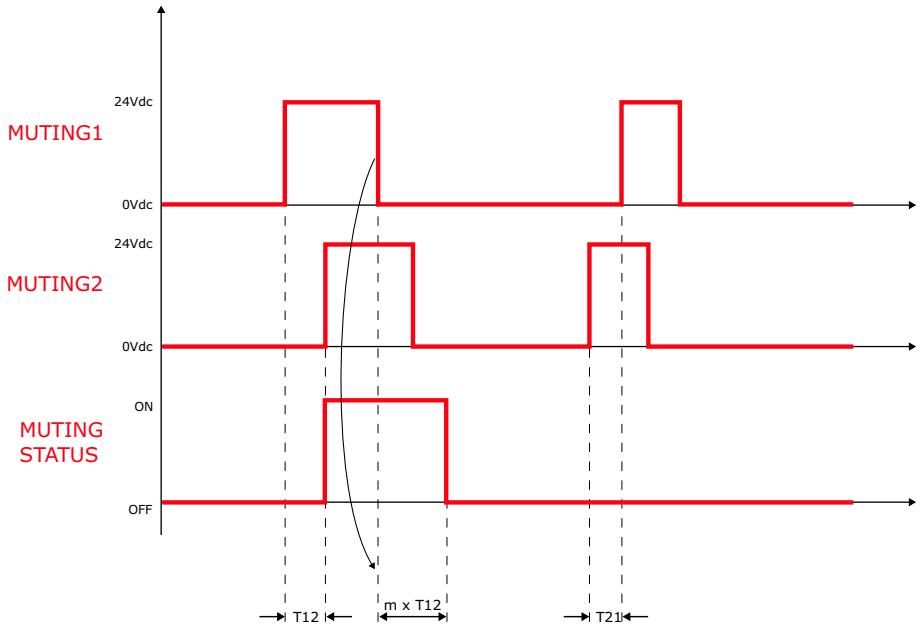
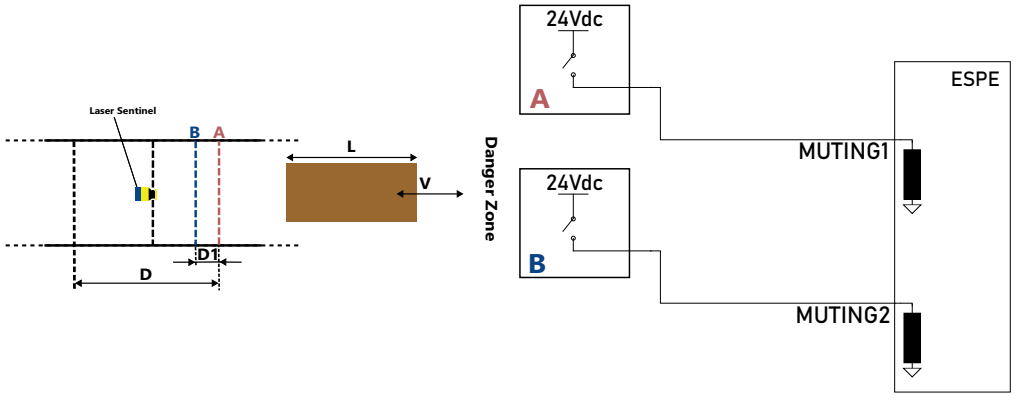


Figure 5 - Unidirectional Muting Timings

The figure below shows this operation: the pack moves from the right to the left only.

“V” indicates a constant speed; therefore, “d1” is a fixed value according to the following formula:

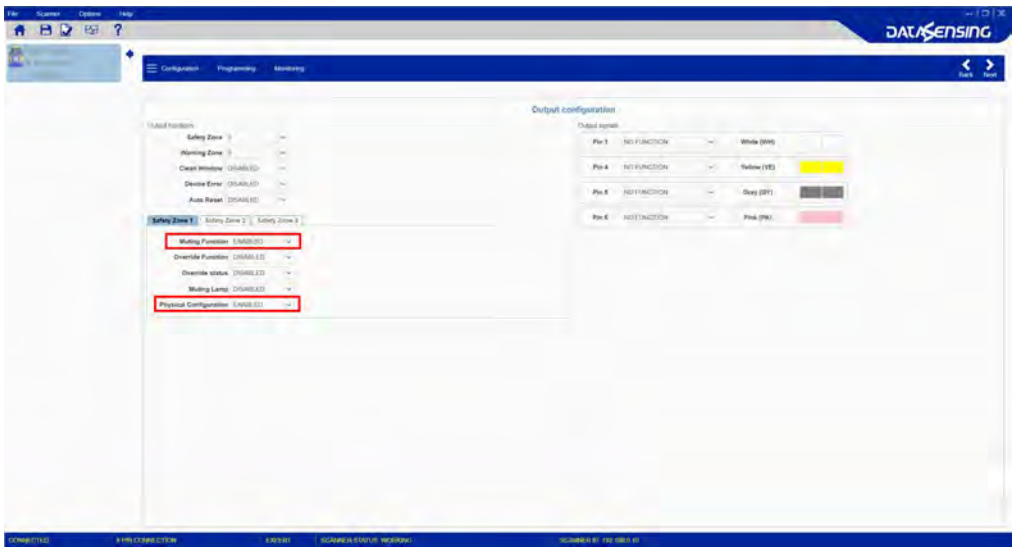
$$d1[cm] = V[m/s] * T12[s] * 100$$

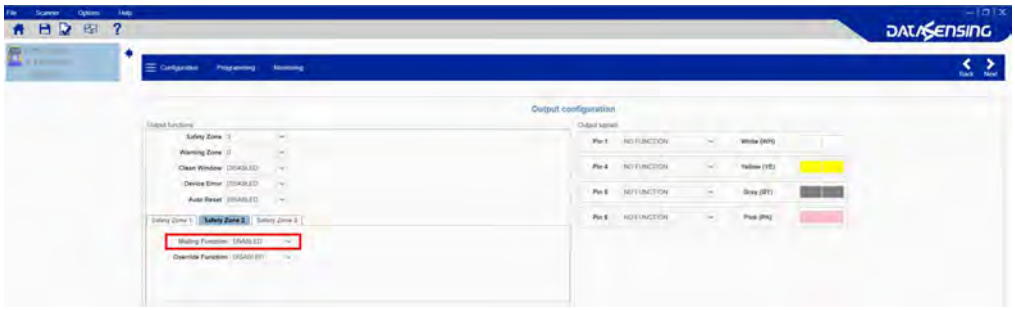


Configuring the Muting Function on DLSentinel

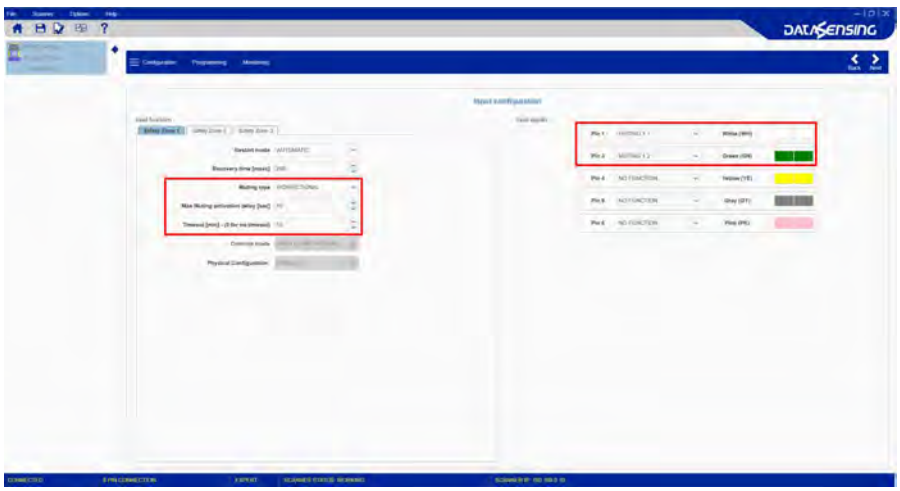
To enable the Muting function on DLSentinel and configure the Muting area, follow the procedure below:

1. On the Output Configuration page, set the Muting Function to ENABLED. If Muting sensors connected to the SLS are used for Safety Zone 1, set to ENABLED the Physical Configuration. For the other Safety Zone, simply set the Muting Function to ENABLED.

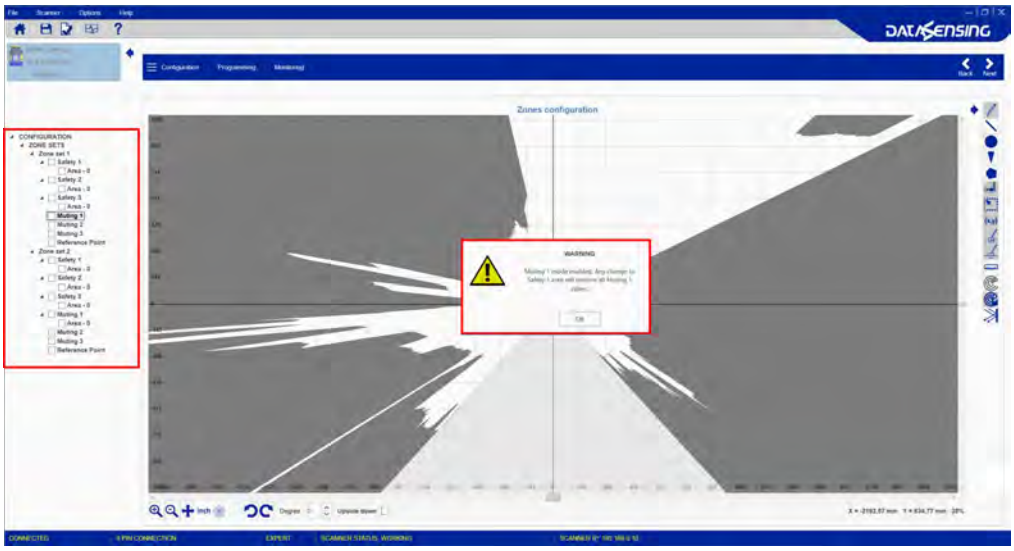




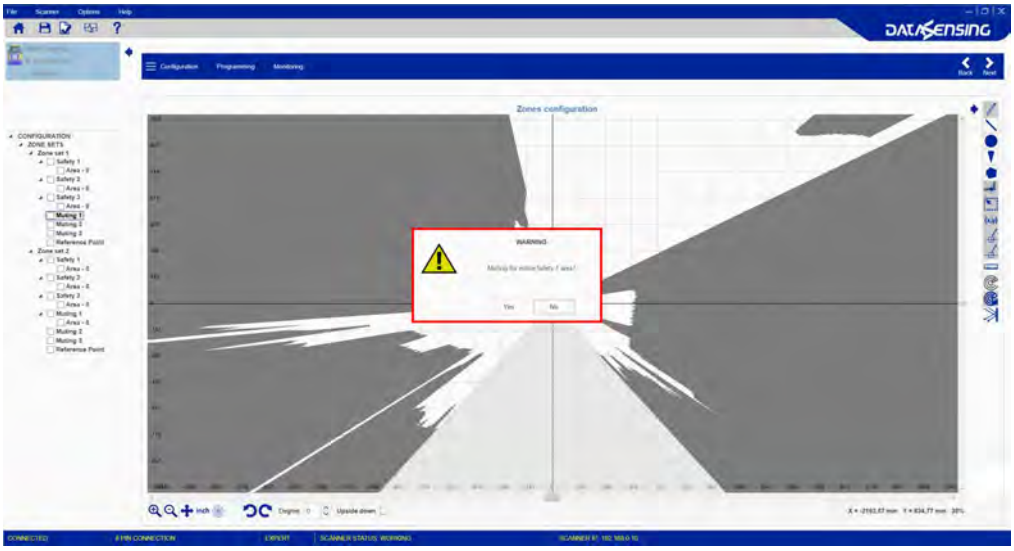
2. On the Input Configuration page, assign the Muting signals to the available pins for Safety Zone 1 and eventually configure the Muting parameters (Muting type, Max Muting activation delay, Timeout).



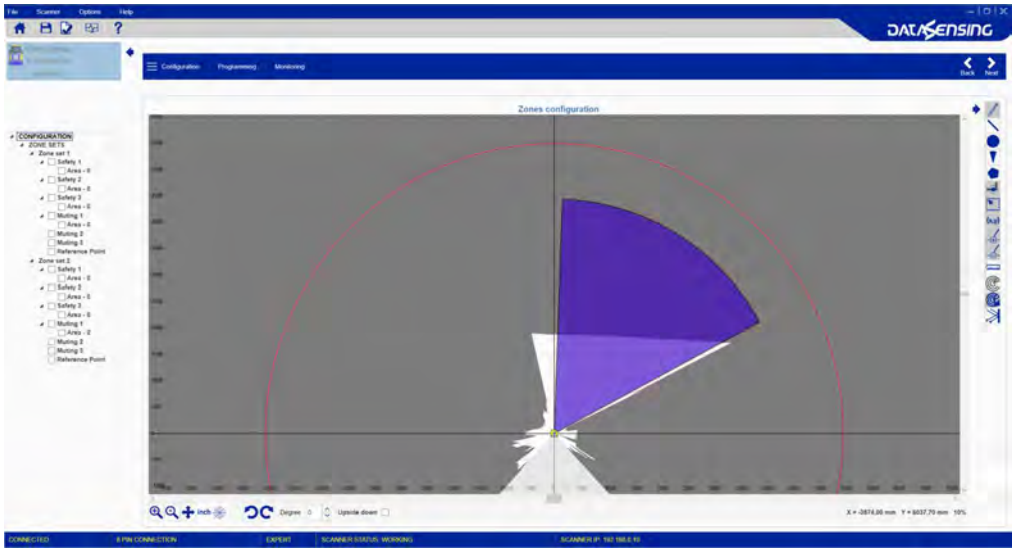
3. On the Zone Configuration page, first draw your Safety Area, the click on Muting label in the panel on the left side. A warning message is display informing the user that any change to the Safey Area will remove the Muting zone. Click OK to proceed.



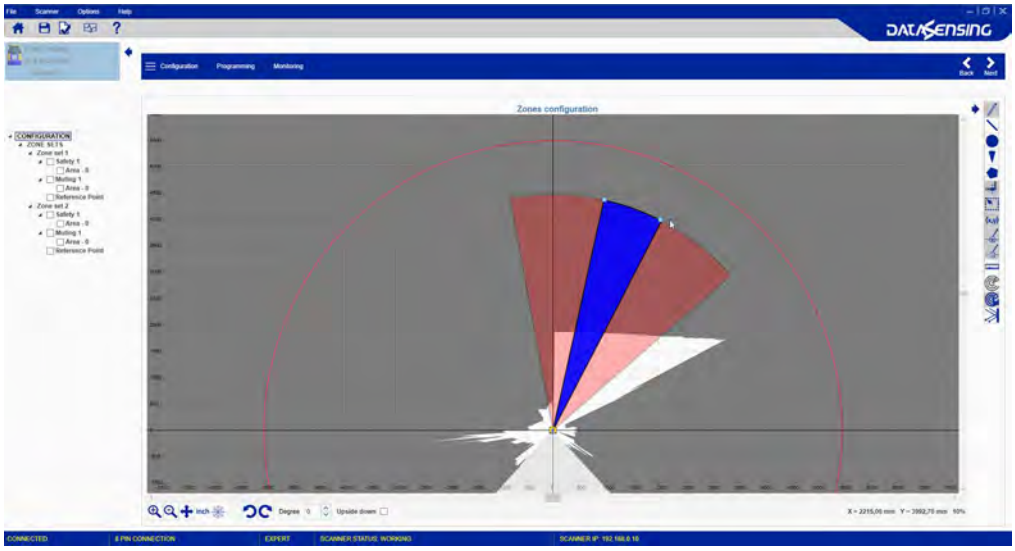
4. An additional warning message is displayed. To create a Total Muting zone corresponding to the whole Safety Area, click YES.



5. If a Total Muting Zone was created, the Muting zone (colored blue) will overlap the Safety Area, as illustrated in the picture below.



6. A Total Muting zone can be turned into a Partial Muting zone by dragging and dropping the points of the shape. In this case, the Muting zone will have the same radius as the Safety Area.



OVERRIDE

The Override feature allows the use to force the safety output to ON state (SafetyStatusZoneX = 1) whenever it is necessary to restart the machine. The aim is clearing the protected area of any working materials blocked ahead of the device, because this interference may cause a work cycle anomaly.

To activate the Override functions there are two options:

- Use one or two physical inputs: it can be configured to activate Override function on the SafetyZone1 if Physical Configuration, Muting and Override function are enabled by DLSentinel. Signal **OVERRIDE 11** can be used if Override mode is Single Line Pattern, signals **OVERRIDE 11** and **OVERRIDE 12** can be used if Override mode is Edge or Level.
- Use the safety fieldbus communication through the process image input (from PLC to SLS) related byte (*OverrideActivationZoneX*). The OverrideActivationZone bit shall be effective only after a transition 0-1 with a duration t of the bit 1 that shall be t>T_min_Override, where:
  - T_min_Override = 1s

If the *OverrideActivationZoneX* bit is set to 0, the Override Function is deactivated. If Physical Configuration is enabled, the OverrideActivationZoneX bit related to Safety Zone 1 is not effective.

When Override function is activated, it is possible to check the status on the device through the process image output (from SLS to PLC) on the *OverrideStatusZoneX* byte, which bits are set to 1 if override is active on the related Safety Zone X, and to 0 if override is not active.

To be accepted, an override request must have:

1. the safety laser scanner in SAFE status (intrusion in the Safety Zone)
2. at least one Muting sensor intercepted.

If this condition is true, the display will show the OVERRIDE warning and the LED related to the Status of Safety Zones will be ON green.

The Override function will automatically end when one of the following conditions is verified:

- all the Muting sensors are deactivated (in a Bidirectional Muting configuration)
- all the Muting sensors are deactivated, and no beams are intercepted (in a Unidirectional Muting configuration)
- OverrideActivationZoneX is set to 0
- after the 120s fixed timeout

NOTE

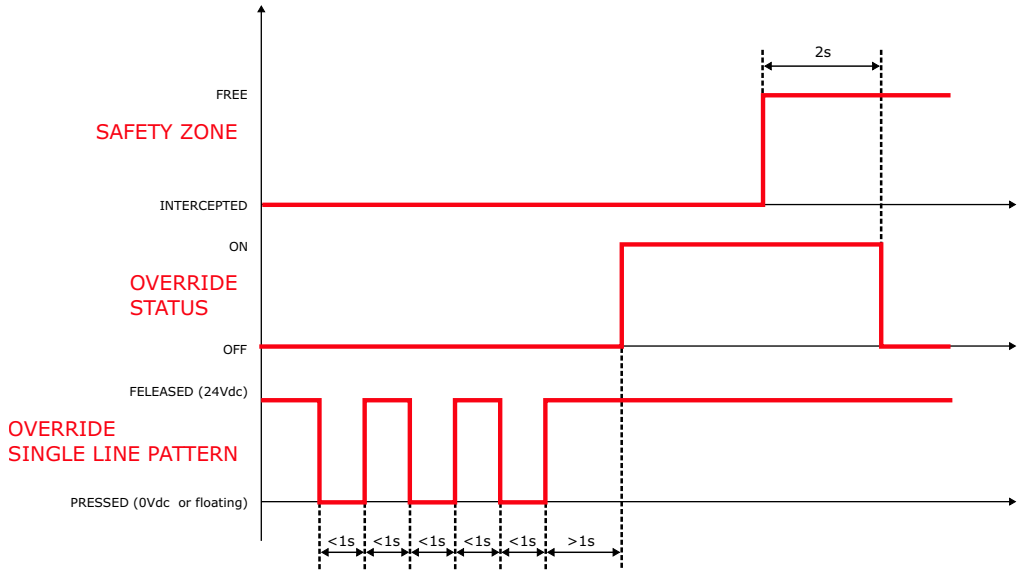
Check that when the Muting function is active no Zone Set switching occurs. Zone switching is not allowed during Muting, and if this occurs, the system will display an error (INPUTCF2) as soon as the Muting function ends.

Override status

If enabled by DLSentinel, the **OVERRIDE STATUS** for the safety zone 1 can be provided as physical output.

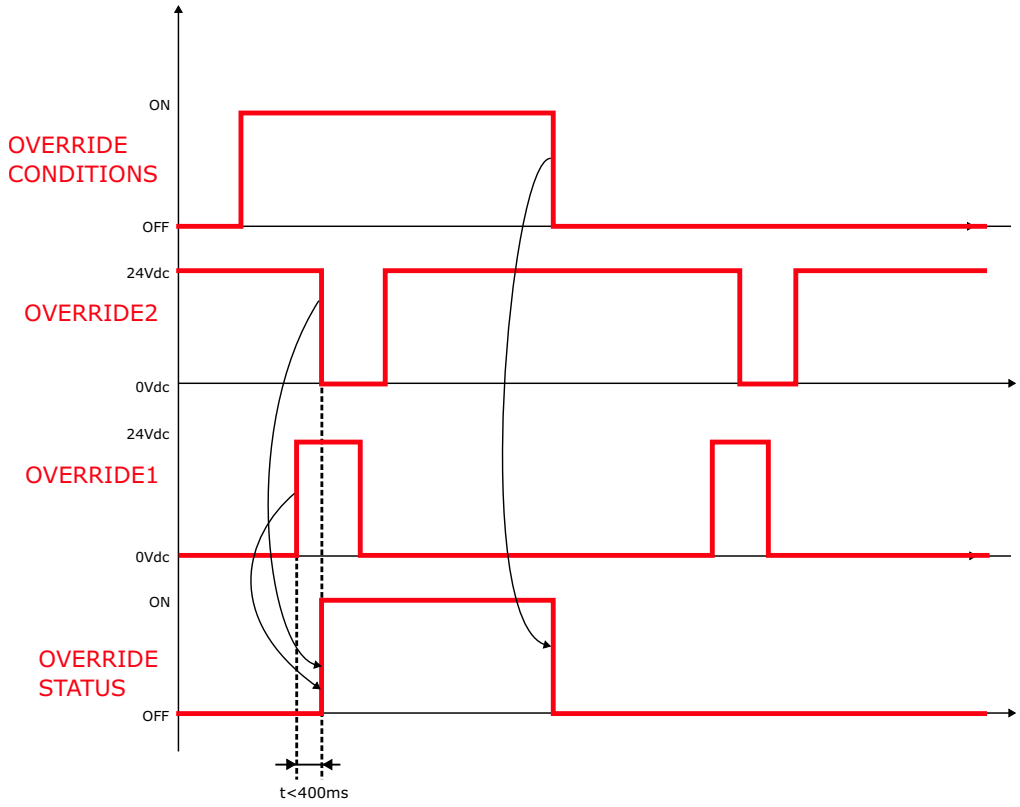
Single Line Pattern

The input sequence to be followed for activation is indicated in the figure below:



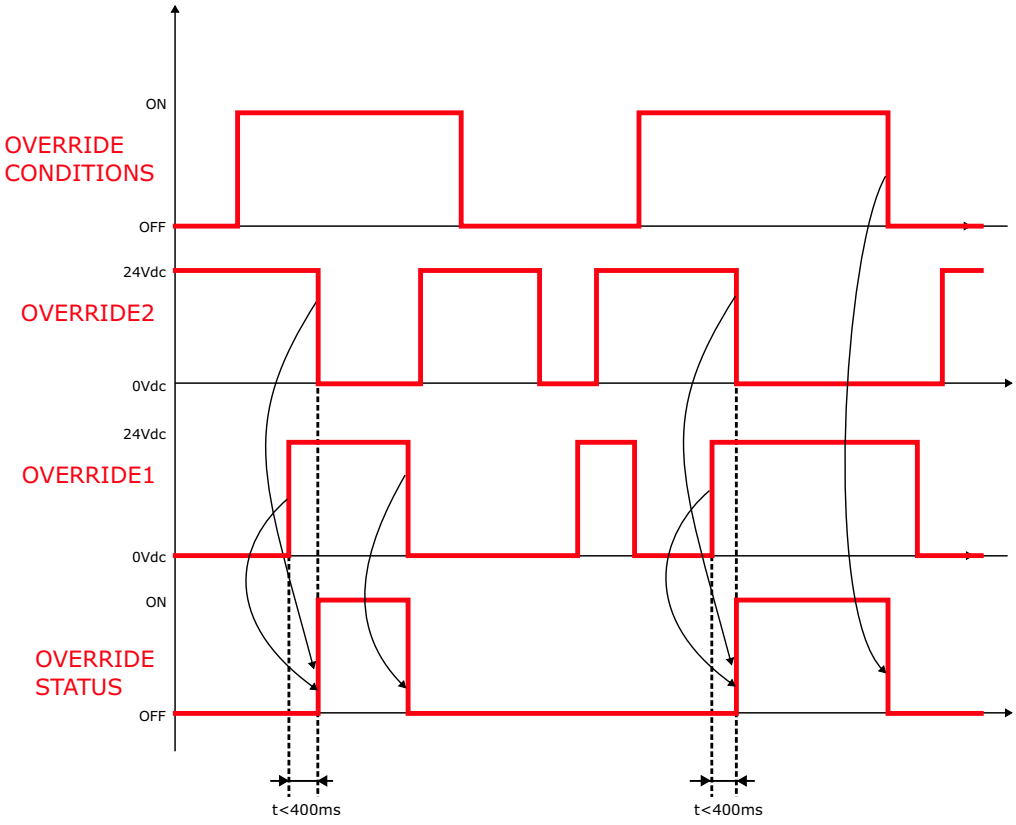
Level Triggered Pattern

The input sequence to be followed for activation is indicated in the figure below:



Edge Triggered Pattern

The input sequence to be followed for activation is indicated in the figure below:



NOTE

Please not that when you enable Override, you disable the safety function on the relevant safety zone and for all Zone Sets.

SHUT-OFF

The Shut Off function allows energy saving, which can be particularly useful when the Safety Laser Scanner is used in battery-powered applications (e.g., AGV9).

When the Safety Laser Scanner is in Shut Off status, some of its functions are deactivated, but the device is still active and ready to restore to normal operation when needed.

DLSentinel does not allows the user to update firmware version, change configuration or set parameters (e.g., IP address, password) when the device is in Shut Off status.

To enable the Shut Off function, a bit of the process image input (from PLC to SLS), bit3 of byte0 *"Shut-off"*, can be set to 1 for a duration status1 of t>T_min_Shutoff, where:

- T_min_Shutoff = 1s

The Shut Off function can be disable by setting the bit "Shut-off" to 0.

When the Shut Off function is enabled, the SLS display will show an icon for 30 seconds. After that, the display will switch to power safe mode, and all LEDs will go off. It is possible to monitor the Shut-off through the process image output (from SLS to PLC) related bit "Shut-off status" (see page 48).

To restore to normal operation, the Shut Off function shall be disabled. In this case, the Safety Laser Scanner needs approximatively 30 seconds to reactivate all its functions. The display and the LEDs will indicate that the scanner is back to normal operation.

NOTE

If the Shut Off function is disabled after drawing the Safety areas, these will be deleted.

WINK

Wink is a function that allows recognizing which device is to be configured from those available on the Network.

The Wink function can be activated in two ways:

- through the discovery by clicking on the wink button, and then the Wink icon will be displayed.
- through the process image input (from PLC to SLS): the Wink function is activated by setting to 1 the bit0 of the byte0, *"Wink"*, deactivated by setting to 0 the bit0 of the byte0 of the process image input.

SAFETY REPORT GENERATION AND ACCEPTANCE

The Safety Report is a file that sums up all the parameters selected for a configuration and is generated by the GUI after creating a configuration.

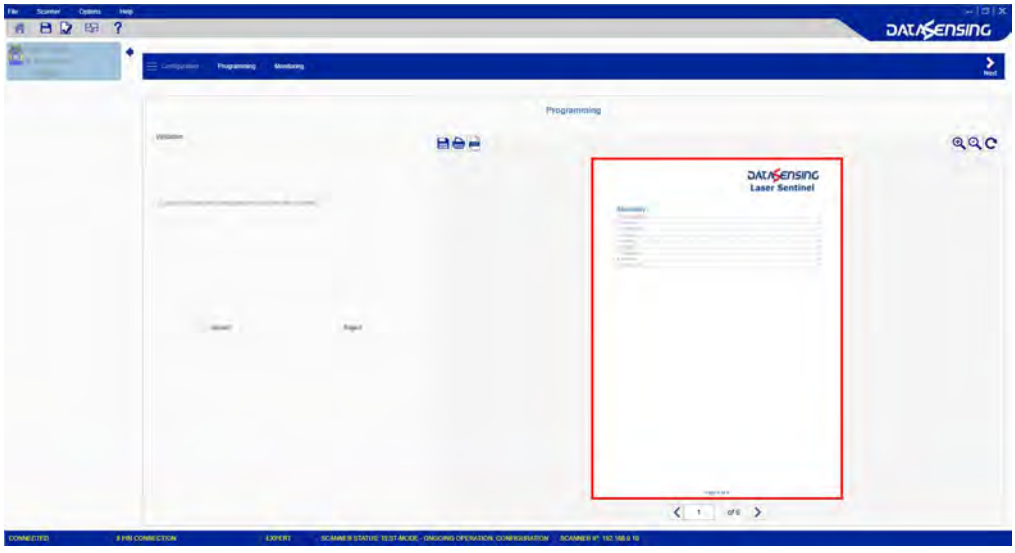
The Report file is displayed on the right side of the panel. It is possible to save it as a PDF file and print it.

Follow the steps below to create the Report file:

1. Once the configuration has been created or loaded, enter the **Programming** function.
2. Upload the configuration in **Configuration Upload**. The **Report** file is generated by the GUI. Make sure to read and check all the selected parameters.
3. Then test its functioning by entering **Monitoring**.
4. After testing the configuration in **Monitoring** and checking the **Report** accept or reject the configuration in **Validation.**

WARNING

By validating the configuration, you take on responsibility for the created configuration accepting the hazard due to configuration errors.



STOP EVENT REPORT

It is possible to limit the generation of the events in the diagnostic log (see "Diagnostic Log" on page 89) using the bit2 of byte0 *“Stop Event Report”* of the process image input (from PLC to SLS). By setting the *“Stop Event Report”* bit to 1, the safety events (intrusion in the detection zone only) are not recorded in the diagnostic log. If set to 0, the safety events (intrusion in the detection zone only) are recorded. It is possible to monitor the status of the Event Report recording by reading the process image output (from SLS to PLC) related bit (*“Event Report Status”*, bit7, byte0).

CHAPTER 10
DIAGNOSTICS

ALARMS ON OUTPUT PIN

In the Output configuration page of DLSentinel, it is possible to associate two alarms function to physical pins:

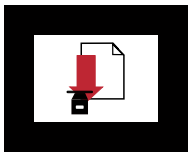
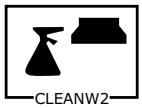
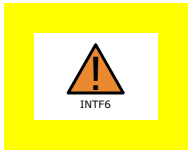
Clean Window: activation indicates that the optic cover status is contaminated. The display will show the icon **CLEANW1** and the safety outputs go to safe state. The status of the optical window can be also monitored through the process image output (from SLS to PLC) on bit1, byte0 (*"Contamination Error"*). (Please refer to Chapter 8, Integration Into the Profinet-Profisafe Network for further details).

DEVICE ERROR: activation indicates that a fault condition (lockout) occurred. The display will show the related diagnostic error and the safety outputs go to safe state. The **DEVICE ERROR** can be also monitored through the process image output (from SLS to PLC) on bit6, byte0 (*"Device Status"*). (Please refer to Chapter 8, Integration Into the Profinet-Profisafe Network for further details).

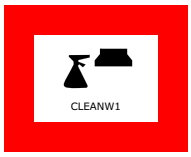
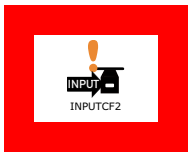
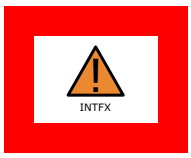
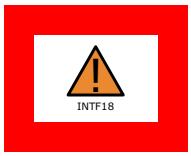
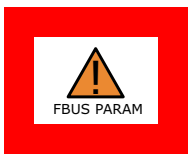
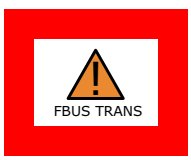
MONITORING BY DISPLAY

DISPLAYED ICON		NAME	DESCRIPTION
Configuration valid	Configuration pending acceptance		
		ON State	The device is correctly functioning. No presence detected in the Safety and Warning Area.
		Warning for intrusion into Warning Area	The device is correctly functioning. The device has detected a presence in the Warning Area.
		OFF State for intrusion into Safety Area	The device is correctly functioning. The device has detected a presence in the Safety Zone.
		OFF State for Reference Points	The device has detected that Reference Points have moved. The Display Sector in the direction of the moved reference point is lit in blue.

DIAGNOSTIC NOTES, WARNINGS, AND ERRORS

DISPLAYED ICON	DISPLAYED FAULT CODE	DEVICE STATUS	SAFETY ZONE STATUS	DESCRIPTION
	**DLDNF**	**NORMAL**	**OFF**	Downloading new firmware.
	DLDNC	**NORMAL**	**OFF**	Downloading new configuration.
	**CLEANW2**	**NORMAL**	**ON**	It is suggested to clean the window to avoid entering lockout condition.
	**ITLOCKx**	**NORMAL**	**OFF**	Interlock. Waiting for the Safety Zone Status to restart.
	**INFT6**	**NORMAL**	**ON**	Micro integrity test failure. Internal peripheral test for non safety relevant functions.
	**BOOTF**	**NORMAL**	**OFF**	Invalid boot. Re-boot the system until the normal condition is restored. If warning persists, contact our Technical Support.
	**MUT TIMEOUT**	**NORMAL**	**ON**	Muting has expired because it is maintained beyond the maximum timeout time.
	**MUTING ERR**	**NORMAL**	**ON**	Muting has not activated because the correct sequence was not followed.
	**MUTING**	**NORMAL**	**ON**	The Muting function is active.
	**OVERRIDE ERR**	**NORMAL**	**ON**	Override has not been activated because the correct sequence has not been followed or there are no override conditions.

DISPLAYED ICON	DISPLAYED FAULT CODE	DEVICE STATUS	SAFETY ZONE STATUS	DESCRIPTION
	**OVERRIDE**	**NORMAL**	**ON**	The Override function is active
	**OVERTEMP**	**NORMAL**	**ON**	The external temperature is above the limit.
	**OVR TIMEOUT**	**NORMAL**	**ON**	The Override timeout function has expired.
	**HIGH REFL-BKG**	**NORMAL**	**ON**	A high reflecting background is detected that could have an impact on detection capability. Take the measures described in "Precautions for Environmental Interference" on page 11 or reduce/remove the reflecting background.
	**WINDOW REPLACE**	**NORMAL**	**OFF**	Window replacement procedure in progress.
	**WR FAILED**	**LOCKOUT**	**OFF**	Window calibration failed. Repeat the procedure or change the window.
	**COMMIT ON FIELD**	**NORMAL**	**OFF**	The device needs a commit when it has been restored on field after window replacement.
	**SHUT-OFF**	**NORMAL**	**OFF**	Shut Off function enabled.
	**RES SHUT-OFF**	**NORMAL**	**OFF**	Shut Off function disabled.
	**WAITING CONF**	**NORMAL**	**OFF**	The device is waiting the first configuration (e.g. after a Factory Reset)

DISPLAYED ICON	DISPLAYED FAULT CODE	DEVICE STATUS	SAFETY ZONE STATUS	DESCRIPTION
	WAIT FOR INPUT	NORMAL	OFF	The device is waiting for Zone Set No. from PLC.
	CLEANW1	NORMAL	OFF	Window needs to be cleaned. Repeat this action until the normal condition is restored. Otherwise contact our Technical Support to replace the damaged part.
	INPUTCF2	LOCKOUT	OFF	Invalid zone set activation.
	INPUTCF3	LOCKOUT	OFF	Violated sequence control for zone set switching.
	INTFx	LOCKOUT	OFF	Internal Failure. Reset the system by using the reset function or cycle power to device. If failure persists, contact our Technical Support.
	INTF18	LOCKOUT	OFF	Internal Failure. Reset the system by using the reset function or cycle power to device. If failure persists, contact our Technical Support.
	FBUS PARAM	NORMAL	OFF	PROFIsafe parameters error (e.g., Mismatch of safety destination address, ...)
	FBUS TRANS	NORMAL	OFF	PROFIsafe transmission error (e.g., inconsistent data, timeout)
	MG FAILURE	BOOT	OFF	Memory Group failure. Create a new configuration via GUI, perform a backup configuration from the Master device, or replace the Memory Group.
	MG EMPTY	BOOT	OFF	The Memory Group has no configuration stored on board. Create a new configuration via GUI or perform a backup configuration from the Master device.

DISPLAYED ICON	DISPLAYED FAULT CODE	DEVICE STATUS	SAFETY ZONE STATUS	DESCRIPTION
	**DEVICE EMPTY**	**BOOT**	**OFF**	The Master device has no configuration stored on board. Create a new configuration from GUI or restore the configuration from the Memory Group.
	**CFG NO MATCHING**	**BOOT**	**OFF**	The device configuration does not match with the Memory Group configuration. Follow the displayed instructions.
	**INCOHERENCE**	**BOOT**	**OFF**	The device found an incoherent configuration. A new configuration via GUI is necessary.
	**BKP IN PROGRESS**	**BOOT**	**OFF**	Fast replacement backup phase in progress. Wait and do not push any button.
	**BKP DONE**	**BOOT**	**OFF**	Fast replacement backup phase completed.
	**BKP FAILED**	**BOOT**	**OFF**	Fast replacement backup phase failed. Try again or create a new configuration via GUI.
	**RES IN PROGRESS**	**BOOT**	**OFF**	Fast replacement restore phase in progress. Wait and do not push any button.
	**RESTORE DONE**	**BOOT**	**OFF**	Fast replacement restore phase completed.
	**RES FAILED**	**BOOT**	**OFF**	Fast replacement restore phase failed. Try again or create a new configuration via GUI.
	**RES VALIDATION**	**BOOT**	**OFF**	The fast replacement restore phase needs validation by the user to go back to normal operation after checking that the safety conditions have been restored.

DISPLAYED ICON	DISPLAYED FAULT CODE	DEVICE STATUS	SAFETY ZONE STATUS	DESCRIPTION
	**RES ABORT**	**BOOT**	**OFF**	If the safety conditions have not been restored after the fast replacement restore phase, the user can abort the restore phase and create a new configuration via GUI.

ANTI-TAMPER FUNCTION

The SLS continually monitors for conditions caused by tampering in the work area and/or the device itself that may create interference or improper operation leading to a potential loss or reduction of the safety function.

Once these conditions are found, the device is forced to STOP and the display indicates this until the conditions cease.

The function has been made selectable from DLSentinel for flexibility of use in various application scenarios.

It is possible to monitor the conditions caused by tampering through the process image output (from SLS to PLC) on bit 4 and 5, byte 0 (“AntitamperingStatus”, “Antitampering-WarningStatus”) (please refer to Chapter 8, Integration Into the Profinet-Profisafe Network for further details).

Disabling the function or selecting an activation delay time longer than 5 s (if you want to keep the function enabled) must be carefully evaluated by qualified personnel in charge of machine safety through a specific risk analysis, which could lead to the introduction of additional safety measures.

In particular, if the function is enabled by selection from DLSentinel, the forced STOP state is activated within the set delay time from when the device does not receive a return signal (echo) powerful enough to be processed on at least 700 consecutive beams of the scanning path (equal to or greater than an angular sector of 70°).

The forced STOP state ends within 120 ms as soon as the mentioned condition ceases for at least 50 consecutive beams (equal to or greater than a 5° angular sector) of the 70° considered.

This condition occurs in various situations in the application field. The most common ones are described below.

1. No objects are present up to the maximum working distance of 50 m over a portion of the scanning area (e.g. open field scanning).

2. Objects are present even at distances less than 50 m on a portion of the scanning area, but their reflectivity property is such that they do not generate appreciable echoes. For example, very dark and opaque objects (as a reference, objects with 1.8% reflectivity may not be detected if placed at distances greater than 8-10 m; objects with 18% reflectivity may not be detected if placed at distances greater than 22-25 m).

3. The window of the device is accidentally obscured (e.g. with a cloth) within the limited detection zone, partially or totally hindering the field of view.

4. There are highly reflective surfaces in the scanning area (e.g. mirrors, polished surfaces, windows) positioned in such a way as to divert the trajectory of incident beams out of the device's reception range.

SAFETY

WARNING

Hazard due to lack of effectiveness of the safety device.

Operators to be protected may not be recognized in case of nonobservance.

- Immediately put the machine out of operation if the behavior of the machine cannot be clearly identified.
- Immediately put the machine out of operation if you cannot clearly identify or locate the fault, or if you cannot safely remedy the fault.
- Secure the machine such that it cannot be switched on unintentionally.

WARNING

Hazard due to unexpected starting of the machine.

- When any work is taking place, use the protective device to secure the machine or to ensure that the machine is not switched on unintentionally.

WARNING

Hazard due to lack of effectiveness of the protective device.

Operators to be protected may not be recognized in case of nonobservance.

- Do not carry out any repairs to the device components.
- Do not make any changes to or tamper with the device components.
- Except for the procedures described in this document, the device components must not be opened.

NOTE

If you cannot remedy the fault with the help of the information provided in this chapter, please contact our Technical Service.

LEDs AND DISPLAY

The safety laser scanner is equipped with three lateral buttons, a graphical display and five status LEDs located below the display.

Diagnostic and Status LEDs

The safety laser scanner has diagnostic LEDs for initial diagnostics.

The OFF state and ON state LEDs can be found below the safety laser scanner display.

When it is not possible to see the display, e.g. due to mounting or because it is hidden from the operator's viewpoint, check the GUI status (**Monitoring**).

SYMBOL	DEFINITION	COLOR	MEANING
	Status of the SafetyZones	Green	No intrusion in any safety zone of the monitored zone set
		Orange	Intrusion in any of the warning zone of the monitored zone set
		Red	Intrusion in any safety zone of the monitored zone set (or lockout)
	Bus Failure	Off	No error (normal operation)
		Red (Flashing 2Hz)	No data exchange
		Red (ON)	Incorrect PROFINET configuration; low speed physical link; no physical link
	System Failure	Off	No error (normal operation)
		Red (Flashing 2Hz)	DCP signal service is initiated via the bus
		Red (ON)	Watchdog timeout; generic or extended diagnosis present; system error
	Link/Act1 Link/Act2	Off	The device has no link to the Ethernet port FBUS1/FBUS2
		Green (ON)	The device is linked to the Ethernet port FBUS1/FBUS2
		Yellow (Flashing 10Hz)	The device sends/receives Ethernet frame on port FBUS1/FBUS2
	**Button 1**: to quickly browse the Menu functions		
	**Button 2**: to quickly browse the Menu and confirm the selected function		
	**Button 3**: to quickly browse the Menu functions		

Display Menu

To enter the Display Menu, push the squared button. By using the up and down arrows button, it is possible to browse the menu. To select an area, press the squared button. To exit every menu option, push the squared button after selecting it.

The menu is divided into three main areas: Information, Settings and Exit:

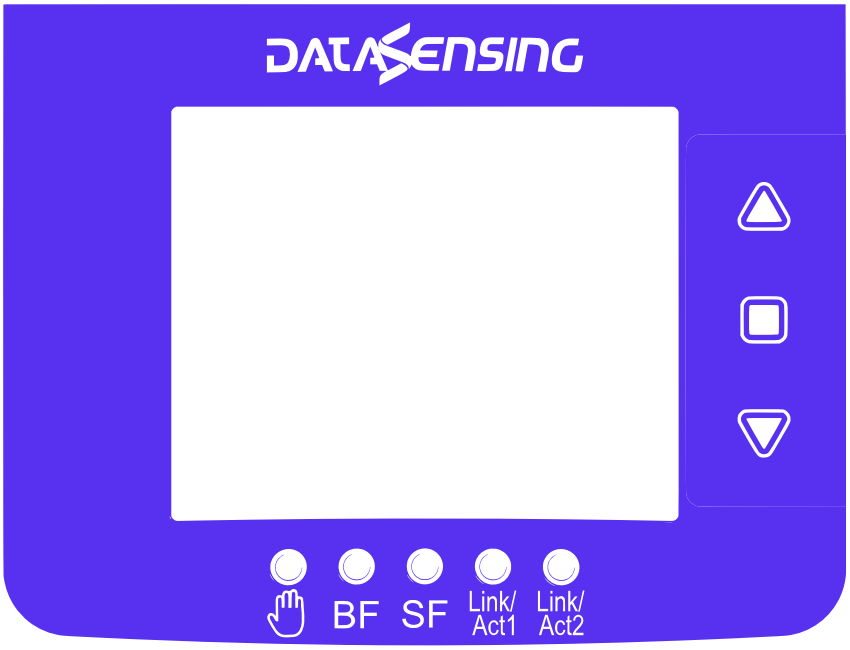
INFORMATION	
Hardware	**Device Name** **Model Code** **Serial Number** **Serial Number** **Firmware Version** **Device Lifetime (h)**: shows the device lifetime in hours
Configuration	**Configuration Name** **Safety Signature** **Last Conf. Date**: shows the date of the last configuration **Main IP Address** **MAC Address**
FBus Params	**Profi Params:** MAC Address IP Address Subnet Mask F-Dest Address Profinet Name **I&M Params:** Vendor ID Order ID Function Tag Location Tag Installation Date Signature

SETTINGS	
Display Settings	**Rotate**: rotates the screen depending on the device position
Reset SLS	Restores normal operation after a failure lockout condition (for more information, see "" on page 77)

EXIT

Diagnostics Using the Display

The display supplies information about the status of the safety laser scanner, and for diagnostics and troubleshooting.



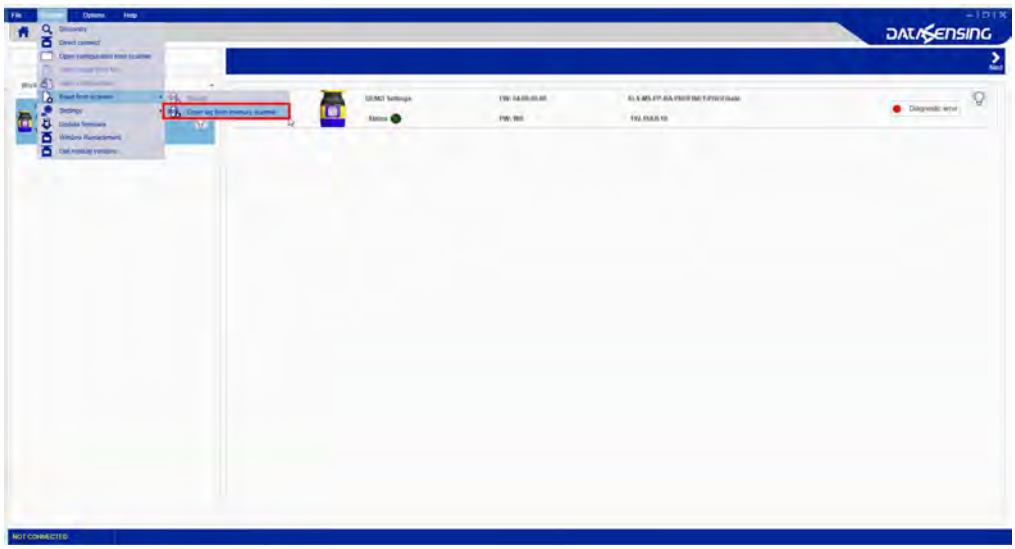
NOTE

The refresh rate of the display is slower than the switching rate of the safety outputs. Therefore, it may occur that the display may not be synchronized with the safety outputs in the case of rapidly switching states.

DIAGNOSTIC LOG

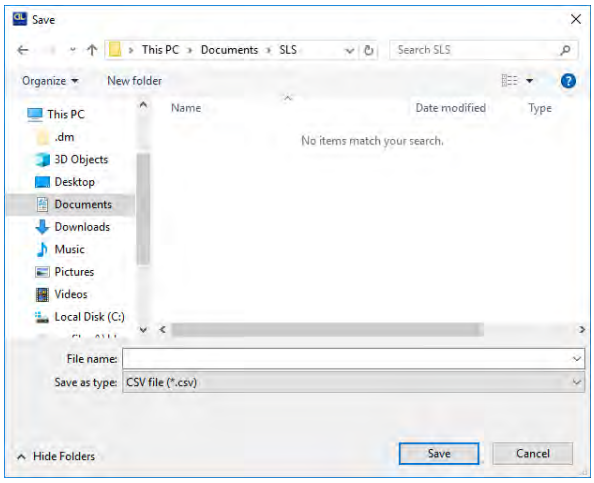
Several categories of events are logged into a specific file saved both in the Memory Group and the Master device.

To view the events occurred to your device(s), launch DLSentinel, discover your device or cluster, then go to **Scanner > Read from scanner > Open log from memory scanner.**

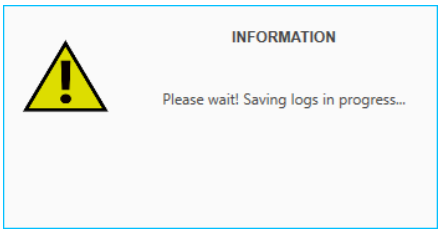


After entering the password, DLSentinel will inform you that the device will switch to Off Duty status. Click **OK** to continue.

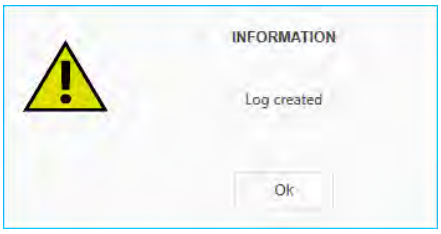
A log file in .csv format will be created. DLSentinel will prompt you to select a folder where the log file will be saved.



After clicking **Save**, the following information window is displayed:



Once the log file creation is completed, the following information window is displayed:



You can now view your log file.

TIME STAMP	TYPE OF LOG	DESCRIPTION
23/05/2024 15:39	UPDATE	POWER RESET
23/05/2024 15:07	ZONE SETS	ZONESET AREASWITCH N.1
23/05/2024 12:36	ZONE SETS	WAIT FOR INPUT
23/05/2024 12:35	UPDATE	POWER RESET
23/05/2024 12:12	OUTPUT	INTRUSION SAFETY1 Cluster:10
23/05/2024 12:12	OUTPUT	INTRUSION SAFETY1 FREE
23/05/2024 12:12	OUTPUT	INTRUSION SAFETY1 Cluster:10
23/05/2024 12:12	OUTPUT	INTRUSION SAFETY1 FREE
23/05/2024 12:12	ZONE SETS	ZONESET AREASWITCH N.1
23/05/2024 12:11	ZONE SETS	WAIT FOR INPUT
23/05/2024 12:11	UPDATE	POWER RESET
23/05/2024 12:07	OUTPUT	INTRUSION SAFETY1 Cluster:10
23/05/2024 12:07	OUTPUT	INTRUSION SAFETY1 FREE
23/05/2024 12:07	OUTPUT	INTRUSION SAFETY1 Cluster:10
23/05/2024 12:05	OUTPUT	INTRUSION SAFETY1 FREE
23/05/2024 12:05	OUTPUT	INTRUSION SAFETY1 Cluster:12
23/05/2024 12:05	OUTPUT	INTRUSION SAFETY1 Cluster:11
23/05/2024 12:05	OUTPUT	INTRUSION SAFETY1 FREE
23/05/2024 12:04	OUTPUT	INTRUSION SAFETY1 FREE
23/05/2024 12:04	OUTPUT	INTRUSION SAFETY1 Cluster:12
23/05/2024 12:04	OUTPUT	INTRUSION SAFETY1 FREE

Figure 1 - Log file example

The following categories of logged events are included:

- Output events (intrusions into safety areas)
- Input events (Muting and Override events)
- Fault events
- Update events (e.g. new firmware, new configuration, etc.)
- Fast Replacement events
- Zone Set selection events
- Window Replacement events

Generally, the format of an event is as follows:

```
<Date> <Time>;<Type of Log>;<Event description>
```

For example, a Fault event is described as follows:

```
12-Sep-19 6:25:28 PM;FAULT;FAULT INPUTCF2
```

PERIODICAL CHECKS

The following list includes recommended check and maintenance operations that should be periodically carried out by qualified personnel.

- The Laser Sentinel is installed with all the correctly fixed mounting components, without any change on its position: Safety distance is ensured and the detection plane has also not changed.
- The optical window is not dirty or damaged (for more information, refer to "Window Cleaning" on page 94).
- All electrical connectors are correctly fastened and the cable wires are correctly connected to external device.
- If the laser Sentinel is operating in automatic start mode, make sure that the machine stops and does not restart when the test object is in the safety zone.

The frequency of checks depends on the particular application and on the operating conditions of the Laser Sentinel.

If any of these checks are not verified, it is not allowed to continue to work on the machine. In this case the installation of the laser Sentinel must be checked by qualified safety personnel and tested following the “CHECKS AFTER FIRST INSTALLATION” procedure as indicated.

CHAPTER 11
DEVICE MAINTENANCE

GENERAL INFORMATION AND USEFUL DATA

The Laser Sentinel does not include any repairable components; avoid repairing or replacing device parts not mentioned in this manual. Failing to observe this instruction may cause malfunction due to severe device damage.

WARNING

Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

WINDOW CLEANING

The Laser Sentinel optical window needs periodical cleaning, and the frequency depends on the type of environment in which the device operates.

Contamination of the optical window (due to dust, oil, etc.) in the presence of background reflection may impair the detection capability of the safety laser scanner. Always keep the optical window free from contamination.

The device may present failure if the optical window is scratched or damaged. In case of abrasive particle deposits, make sure to rub gently against the window during cleaning to avoid any damage. If the window is scratched, window or device replacement is recommended.

It is recommended to use the anti-static cleaner (SLS-CLEANER order no.95ASE2990) and the disposable cloths (SLS-CLOTH order no.95ASE3000) to remove dirt and dust deposits from the optical window.

Otherwise use a soft non-electrostatic cloth and a non-aggressive and non-abrasive cleaning agent.

In particular, the cleaning procedure depends on the kind of contamination:

CONTAMINATION	ACTION
Loose, abrasive particles	1. Vacuum without contact or gently blow away 2. Wipe free with cleaning cloth in one swipe
Loose, non-abrasive particles	Vacuum without contact or gently blow away OR Wipe away cleaning cloth in one swipe
Statically charged particles	1. Vacuum without contact 2. Wipe free in one swipe with cloth soaked in cleaning agent
Adhering particles	1. Wet with cloth soaked in cleaning agent 2. Wipe free with cleaning cloth in one swipe
Oil drops	
Fingerprints	
Water drops	Wipe free with cleaning cloth in one swipe
Deep scratches and cracks	Check detection capability. In case of failure, replace the window or the device

NOTE

It is necessary to clean the underside of the end cap (the black surface under the yellow cap on top of the scanner).

WINDOW REPLACEMENT

When a “Clean Window” error is shown on the device display even after cleaning the window, check for any scratches or spots. If the window is **scratched or spotted**, but not cracked (which would compromise the IP65 protection of the device), the user is allowed to replace the Laser Sentinel optical window.

Order the replacement window from Datasensing and carefully follow the procedure below.

In all other cases, please contact Datasensing for device repair or replacement.

Warning Terms - Disclaimer for Window Replacement and Calibration

WARNING

PLEASE READ CAREFULLY THIS STATEMENT. BY REPLACING AND CALIBRATING THE WINDOW, YOU ACKNOWLEDGE AND ACCEPT THE FOLLOWING WARNING TERMS.

Window replacement is allowed **solely when the optical window is scratched or spotted or in case of unresolvable “Clean Window” error**. You are kindly requested to check and comply with this section of the manual, where you can find all conditions, prerequisites, and terms according to which such procedure shall be performed.

The window replacement procedure is allowed provided that:

1. **you and your qualified personnel fully comply with the proper instructions set forth in this manual.** Instructions are technical and specific rules that shall be understood, acknowledged and applied by you and your qualified personnel;
2. **only qualified personnel, as defined below, will perform this procedure**;
3. window replacement is performed in a **clean environment** that shall be set up in accordance with "Prerequisites for Window Replacement" on page 97 to prevent any contamination of the internal optical surface;
4. **any dangerous procedure is interrupted and all safety sensors are disconnected**, including any system related to the product;
5. **the replacement window is not dirty or scratched and has never been used. Avoid any contamination (dirt, fingerprints, scratches, etc.) on or inside the new window during installation**.

For the avoidance of doubt, “qualified personnel” means those personnel who have a suitable technical education; who are acquainted with and are used to working in accordance with the rules and regulations for labor protection, safety at work and safety technology; and who keep their knowledge up to date through continuous training. Certified professionals could be involved in some activities; such certified professionals shall fulfill the requirements of accident prevention regulations to the extent applicable and as set forth by the applicable law.

With regards to window replacement, **you shall be, *inter alia*, responsible for**:

- **complying with the instructions** set forth in this manual;
- **training the qualified operator** accordingly;

- carrying out the activities under your accountability in a proper way and in compliance with the instructions provided herein;
- **maintaining the safe operation** of the product and the environment in which it is installed;
- **abiding by all regulations and directives for labor protection and safety at work**;
- **regularly having the product tested and calibrated by competent persons, who shall report any anomalies and track the performance of the product in written records, which shall be sent to Datasensing**.

BY REPLACING THE OPTICAL WINDOW, YOU DECLARE TO ACKNOWLEDGE AND ACCEPT THE POTENTIAL RISKS AND LIABILITIES ARISING FROM THE WINDOW REPLACEMENT PROCEDURE, AS WELL AS FROM FAILURE TO COMPLY WITH THE INSTRUCTIONS PROVIDED BY DATASENSING IN THIS RESPECT. TO THE FULLEST EXTENT PERMITTED BY LAW, DATASENSING (AND ITS DIRECTORS, OFFICERS, AFFILIATES) SHALL NOT BE HELD LIABLE FOR ANY DAMAGES (DIRECT, INDIRECT, OR CONSEQUENTIAL) WHICH MIGHT OCCUR TO YOU AND ANY THIRD PARTIES AS A CONSEQUENCE OF THE WINDOW REPLACEMENT PROCEDURE PERFORMED BY YOU OR YOUR QUALIFIED PERSONNEL.

Prerequisites for Window Replacement

NOTE

To perform the window replacement procedure, the following prerequisites must be strictly observed:

Clean environment	Avoid the window replacement on field. The optical window must be replaced in a controlled, pollution-reduced environment.
Non-condensing environement	The environment where the window replacement is performed must have a temperature of 18 – 30 °C and a non-condensing humidity (preferably < 80%).
Free area	A 2-meter free area around the 275° angle range of the Laser Scanner is necessary to calibrate and validate the new optical window.
Visual inspection	A visual inspection is needed before replacement to establish whether the optical window can be replaced or the whole device needs replacing instead.
Use of dedicated tools	To perform the window replacement procedure a 2.5 mm hex key is necessary, preferably with adjustable torque driver.
Skilled, authorized personnel	The replacement of the optical window must be performed by skilled, authorized personnel only.

NOTE

During the Window Replacement it is recommended to disconnect the device from the PLC. Auto-reset function shall be disabled during Window Replacement.

Window Replacement Procedure

After establishing that the replacement of the optical window is necessary and after making sure that all above-mentioned prerequisites are met, start the window replacement procedure.

The new optical window package contains the following parts:

- 1 optical window;
- 1 seal;
- 4 Tuflok® screws.

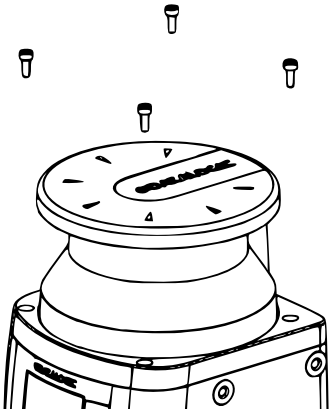
CAUTION

When handling the new optical window, avoid contaminating it with fingerprints, dirt, scratches, dust, and polluting agents. It is recommended to wear clean, thin gloves to unpack and install the new window.

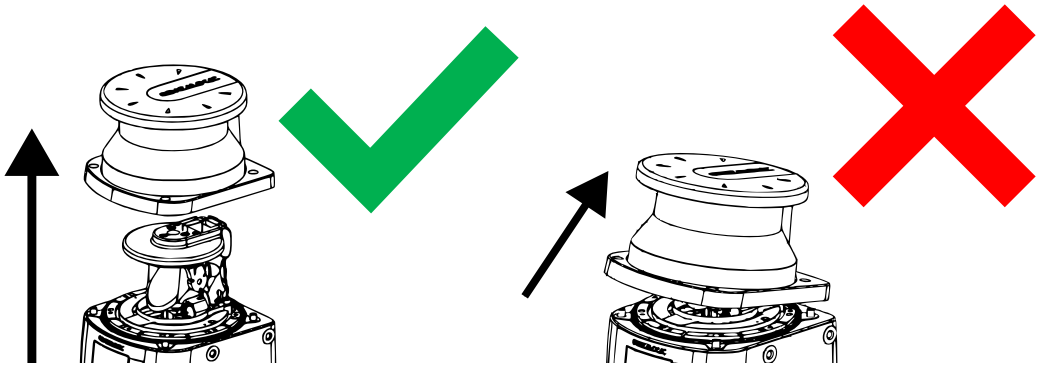
NOTE

Always disconnect power to the Safety Laser Scanner before starting the window replacement procedure.

1. Place the Safety Laser Scanner on an even base in a controlled, pollution-reduced environment.
2. Remove the four screws fixed on the damaged optical window.



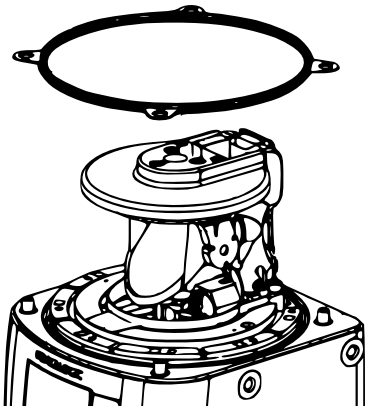
3. Remove the optical window with a linear, vertical movement.



CAUTION

Take the utmost care to avoid touching or damaging the internal parts of the device.

4. Remove the seal positioned on the device body. Avoid touching or damaging the internal parts of the device.



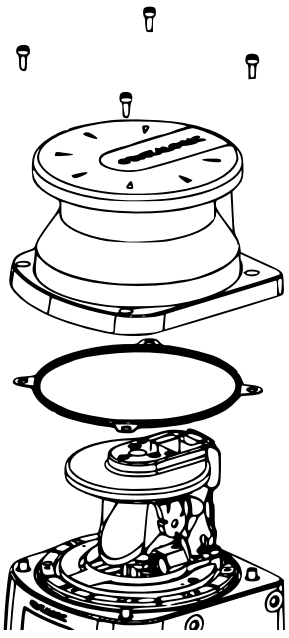
CAUTION

After removing the damaged window, avoid contaminating all the internal optical parts with fingerprints, dirt, scratches, dust, and polluting agents.

5. Position the new seal, gently pressing it on the device body and making sure it perfectly adheres to it.

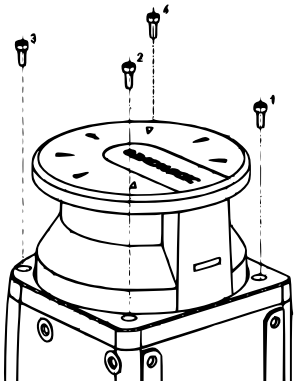
CAUTION

Before closing the window, take sufficient measure to prevent dust and any polluting agent from entering the device, as this could affect the detection capability of the Safety Laser Scanner. In case of contamination, use dry compressed air to remove it.



6. Hold the new optical window on the sides and carefully place it in the correct position. Exert pressure on the angles and make sure that the window is perfectly attached to the device body without any inclination.

7. Snug the 4 Tuflok® screws down (do not overtighten them). Use a 2.5x100 ball-end hex screwdriver with a shank long enough to avoid damaging the optical window.



8. Tighten the screws with a torque wrench (tightening torque 0.6 Nm, bit 2.5 mm).

9. Remove any contamination (e.g. fingerprints, dust, etc.) on the optical window.

NOTE

After replacing the window, always perform window calibration to guarantee proper working of the device.

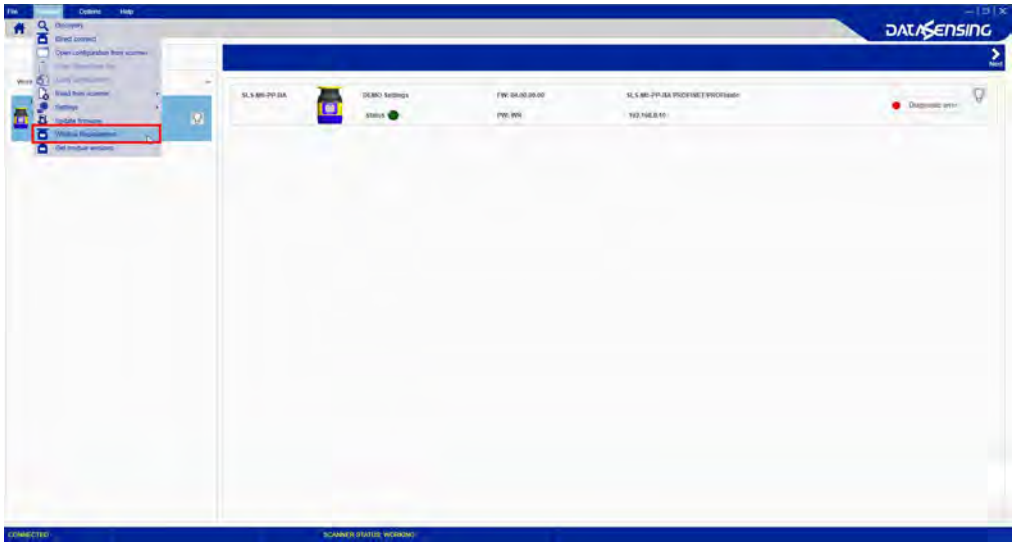
New Window Calibration

NOTE

A 2-meter free area around the 275° angle range of the Laser Scanner is necessary to calibrate and validate the new optical window. Keep this area free for the whole duration of the procedure.

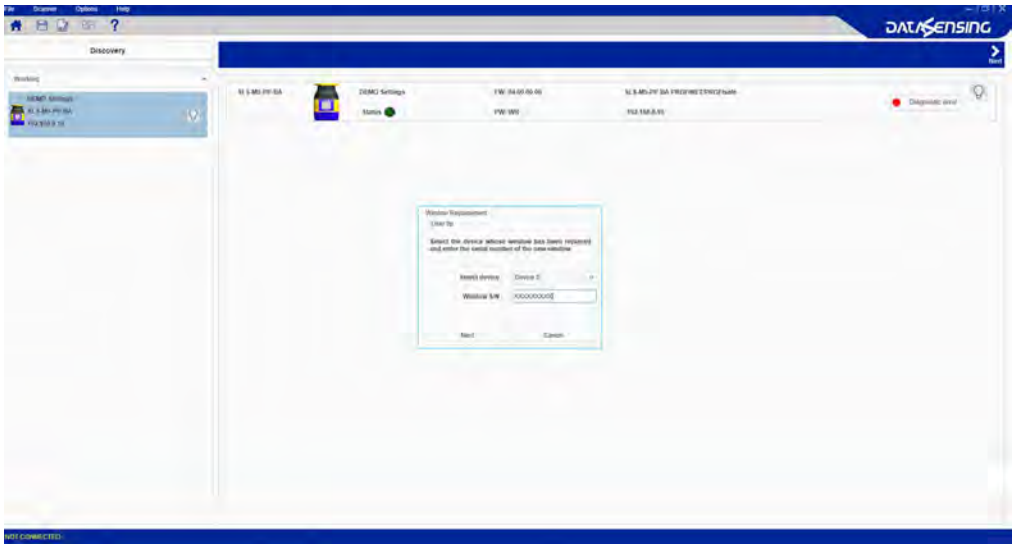
10. After replacing the optical window, supply power to the Safety Laser Scanner and connect it to DLSentinel.

11. On DLSentinel, discover your device. On the Discovery page, go to *Scanner>Window Replacement* and enter your password (if any), then start the procedure.



12. Carefully read the disclaimer. By clicking OK you accept the terms and disclaimer contained herein.

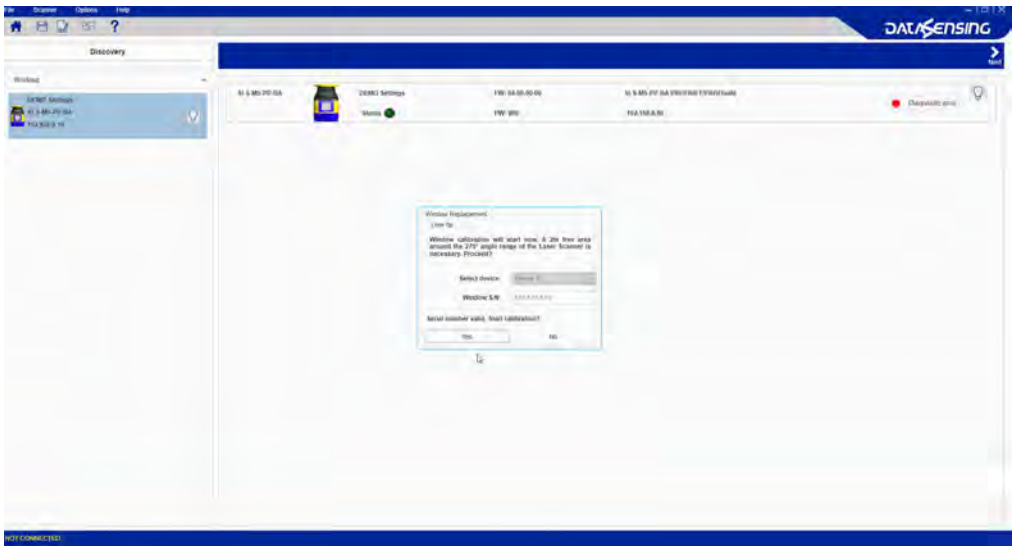
13. Select the device undergoing window replacement and enter the serial number of the new window.

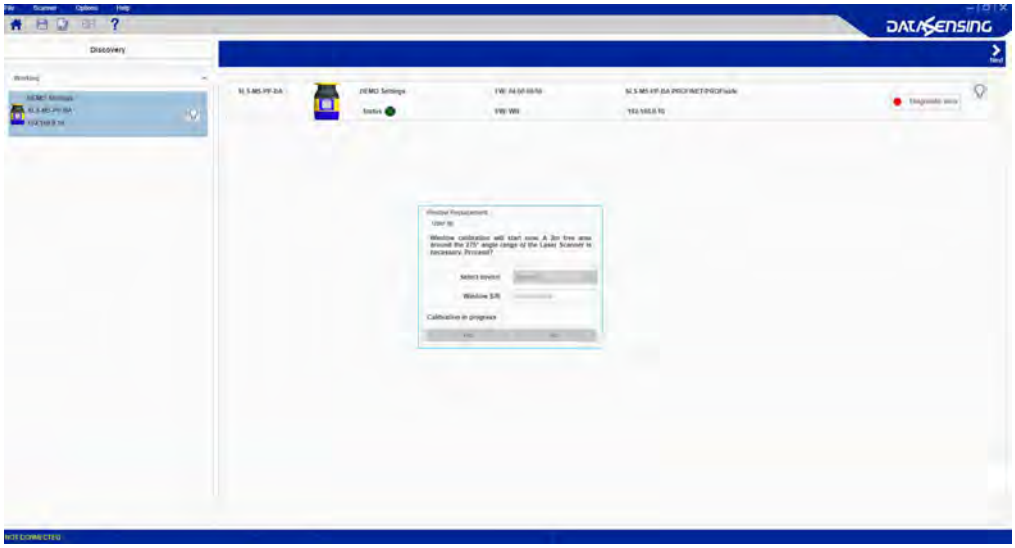


14. Window calibration will start now. Make sure that the device has a 2-meter free area around its 275° angle range.

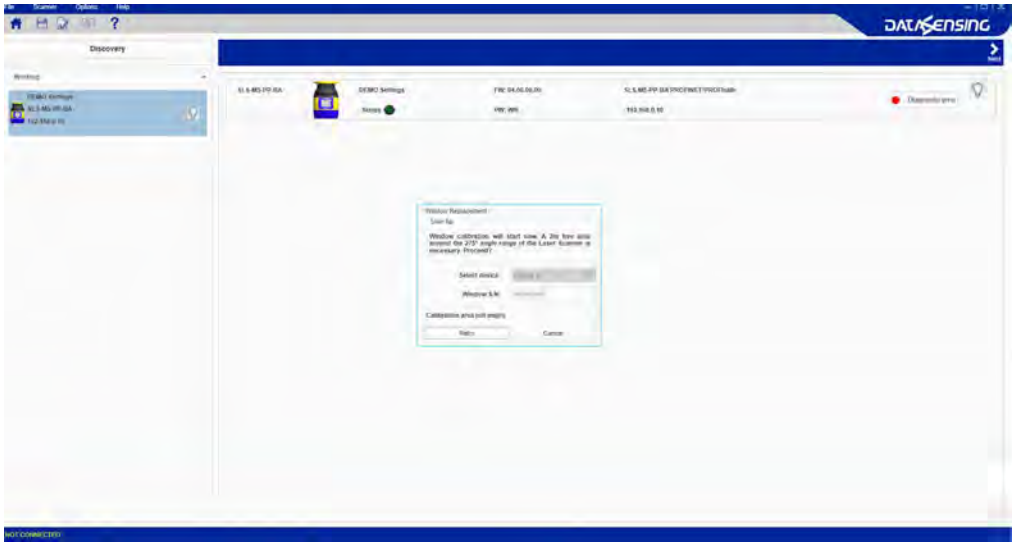
NOTE

When window calibration is in progress, the device first switches to offline status (black display), then to offline test mode, displaying the following message.



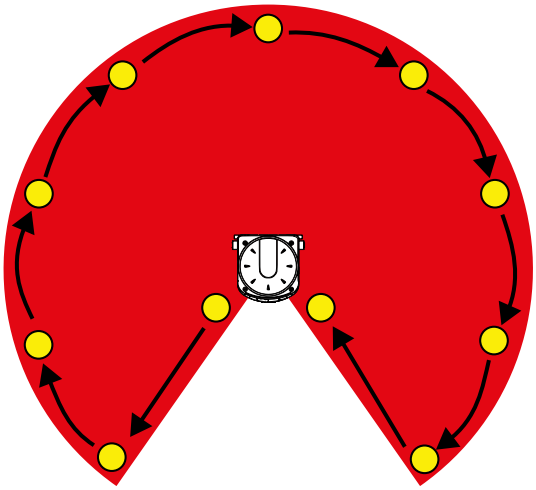


15. If the test area is not compliant, an error message will be displayed. Clear the required area and retry.

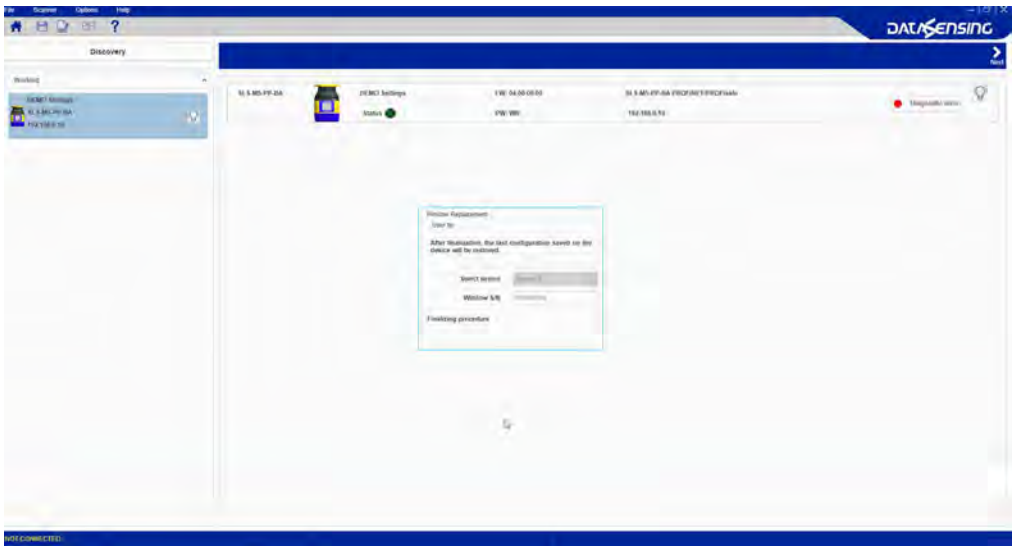


16. To validate the calibration procedure, the user must test the device detection capability with a test configuration.

The test area is automatically configured. To test the detection capability of the device(s), use a suitable test piece, e.g. an optically dark, opaque cylinder, with a diameter of 40 mm.
Place the test piece on several points at the edges (distance from the device = 1 meter) of the 275° safety area. The safety laser scanner must detect the test piece at each position and go to STOP. The number and location of sites where the test is performed must be chosen so that undetected access to the hazardous area is not possible.
Do not attempt to insert the test piece into dangerous parts of the machine located in the safety area.



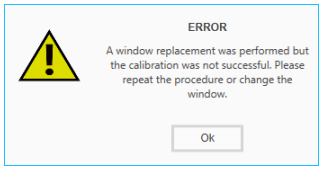
Power off the safety laser scanner(s). Check that safety outputs automatically switch to OFF status and make sure that the machine cannot start until power is re-applied.



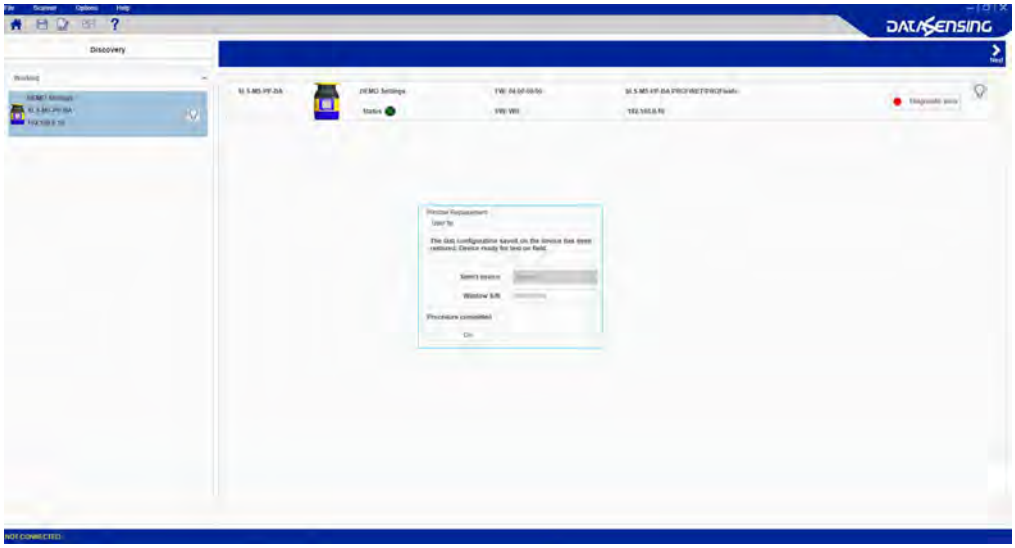
The device remains in test mode until the user validates the test (press “Test passed”). After validation, the device switches to online mode with the last configuration saved before window replacement. If the test is not validated, the device will remain in test mode.

NOTE

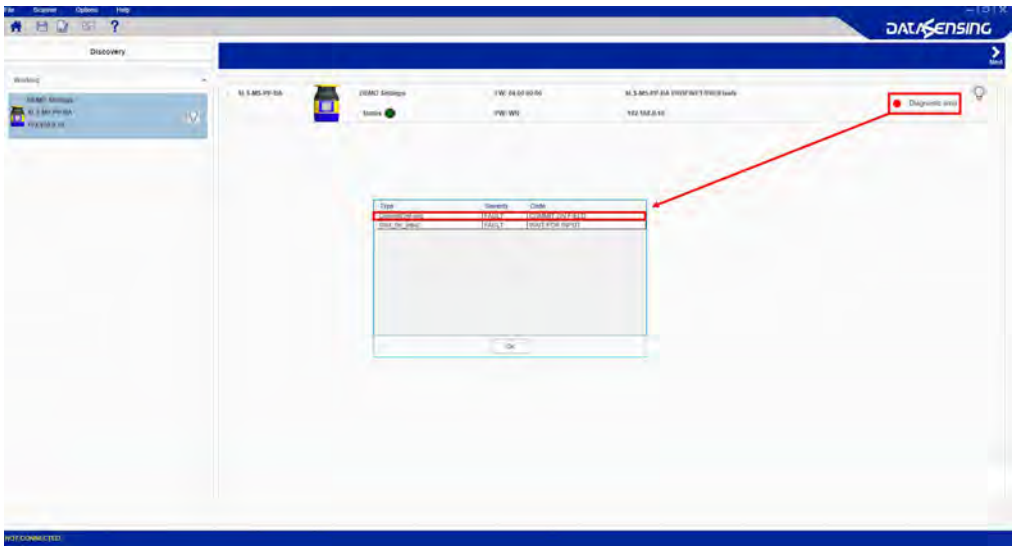
If window calibration fails, the Safety Laser Scanner remains in offline mode until power-off and DLSentinel displays the following error message.



Repeat the procedure described above. Should the calibration fail again, replace the window or contact Datasensing to repair or replace the device.

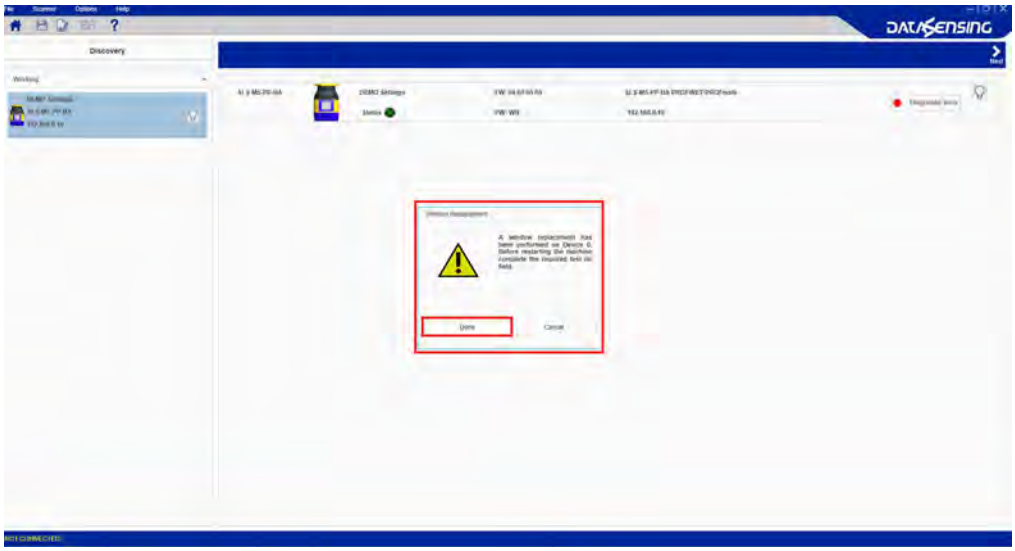


17. After window calibration has successfully completed, the following fault message is displayed. Click OK.



The device display will show the “Commit On Field” warning message.

18. Restore the Safety Laser Scanner on field. See Chapter 4, Chapter 5, and Chapter 6. Perform a field test to commit the configuration (see "Checks After First Installation" on page 28), then go to *Scanner>Window Replacement* and click “Done” on



the displayed message.
The device will now switch to online mode.

FAST REPLACEMENT

Fast replacement allows the user to quickly replace a device or a Memory Group when these have suffered irreparable damage (see Chapter 10).

NOTE

The user is recommended to contact our Technical Support before performing Fast Replacement to assess the severity of the damage.

WARNING

This procedure must be performed by authorized personnel only.

This procedure can be performed on field to restore normal operation and device configuration if the replacement parts have the exact same part number as the replaced ones.

All instructions are shown on the device display and all tasks can be completed using the keypad, except when the instructions refer to the DLSentinel graphic user interface.

WARNING

The user must the successful completion of the procedure by checking that the safety conditions have been restored and by validating the new part.

The following paragraphs illustrate the procedure for the most common cases of Fast Replacement.

Fast Replacement of the Memory Group

When the Memory Group must be replaced on an already configured Safety Laser Scanner, follow the procedure below:

1. Disconnect power to the device, unmount the damaged Memory Group and connect the new one (see Chapter 5), then restore power to the device;

2. If the new Memory Group has no configuration stored (e.g., it comes from Datasensing factory), the device display will show the “MG EMPTY”.
   The Memory Group can be aligned with the device configuration either
   - with a backup configuration (“Backup cfg”) copied from the SLS to the Memory Group (follow the procedure shown on the SLS display)
   - with a configuration via DLSentinel (“Cfg from GUI”). Please refer to the DLSentinel User's Manual.
   Select the preferred procedure using the keypad.

3. If the new Memory Group has already stored a different configuration (e.g., it comes from another configured SLS with the same part number), the device display will show “CFG NO MATCHING”.
   The Memory Group can be aligned with the device configuration with:
   - a restore configuration (“Restore cfg”) copied from Memory Group to SLS.
   - a backup configuration (“Backup cfg”) copied from the SLS to the Memory Group.
   - a configuration via DLSentinel (“Cfg from GUI”).

Select the preferred procedure using the keypad.

After one of these steps, the device display may show the “INTF18” error message. This is a normal behaviour. Perform a power cycle. If “INTF18” is still present, upload the configuration via DLSentinel.

Fast Replacement of the Safety Laser Scanner

When the Device must be replaced and the Memory Group is already configured, follow the procedure below:

1. Disconnect the power of the device, mount the Memory Group working properly and connect the device (see Chapter 5), then restore power to the device;

2. If the new Device has no configuration stored (e.g., it comes from Datasensing factory), the device display will show the “DEVICE EMPTY”.
   The Device can be aligned with the Memory Group configuration either
   - with a restore configuration (“Restore cfg”) copied from the Memory Group to the SLS (follow the procedure shown on the SLS display)
   -with a configuration via DLSentinel (“Cfg from GUI”). Please refer to the DLSentinel User's Manual.
   Select the preferred procedure using the keypad.

3. If the new Device has already stored a different configuration (e.g., < another configured SLS), the device display will show “CFG NO MATCHING”.
   - a restore configuration (“Restore cfg”) copied from Memory Group to SLS;
   - a backup configuration (“Backup cfg”) copied from the SLS to the Memory Group;
   - a configuration via DLSentinel (“Cfg from GUI”).

   Select the preferred procedure using the keypad.

   After one of these steps, the device display may show the “INTF18” error message. This is a normal behaviour. Perform a power cycle.

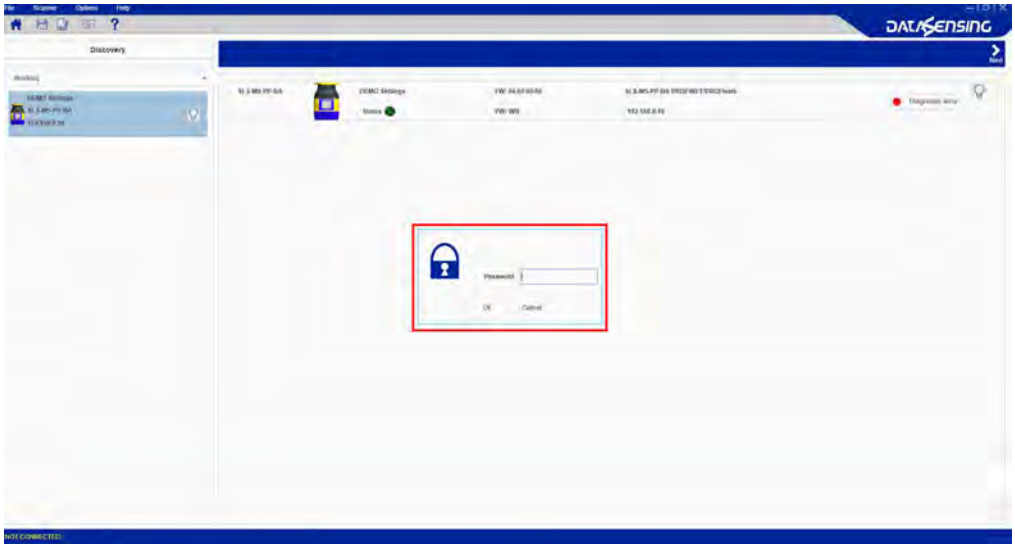
WARNING

At the end of Fast Replacement, a power cycle shall be always performed.

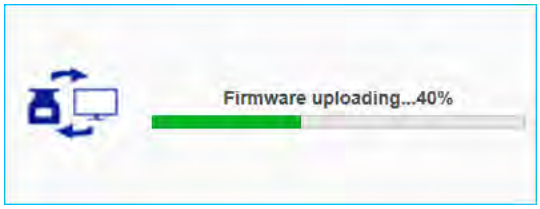
FIRMWARE UPDATE

To update the firmware, proceed as follows:

1. Start the DLSentinel GUI and select the new configuration task.
2. Enter the Discovery mode and select an online device.
3. Once the device is selected, click **Scanner** on the menu and choose the firmware update option.
4. Enter the device password (default password “**admin**”, if not changed) to access the firmware update option.



5. In the Firmware update section (**Package section**), click on ZIP Archive to search and select a previously downloaded new firmware version (from the Datasensing website).
6. Once the new firmware version is selected, click on Load (**Configuration Upload**). During the Firmware Update the device will go offline.



7. When the firmware version is completely loaded, the user enters the Offline-Test mode to create a configuration and test the new firmware version according to the procedure released with the new firmware and validate it on field following the procedure described in "Checks after Firmware Update" on page 110.
8. If the firmware version is compatible with the device (i.e. the device configuration is correct and with no failures) click on Accept, otherwise click on Reject (**Validation**).

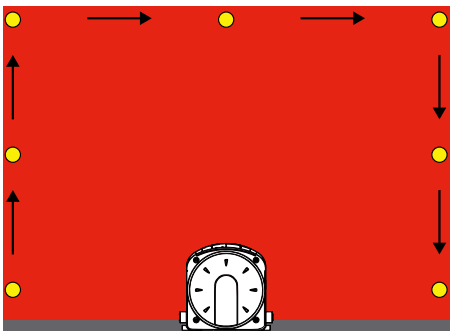
Checks after Firmware Update

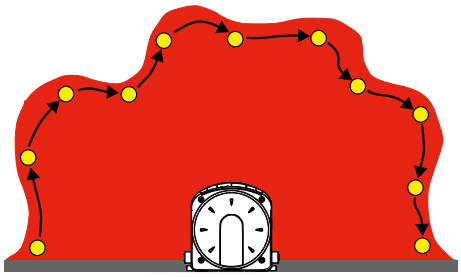
As with any configuration change, safety checks are also required after firmware update and device commissioning as well as before normal duty on field. The safety checks must be carried out by qualified personnel in charge of the machine safety or safety maintenance in general.

The minimum checks are listed below:

- To test the detection capability of the device(s), the user can use a suitable test piece, e.g. an optically dark, opaque cylinder. The effective diameter should match the configured resolution. Datasensing suggests adopting the following procedure:

  Place the test piece on several points at the edges of the safety area.
  Place the test piece on several points inside the area, radially from the edges to the center of the laser scanner.
  The safety laser scanner must detect the test piece at each position and go to STOP.
  Remove the test piece from the controlled area and check that:
  -the machine automatically restarts (in case of Automatic restart), OR
  -the machine restarts only after receiving the restart command (in case of Manual restart).
  The following pictures are examples of detection capability test (the red areas correspond to the configured Safety Areas).





- Power off the safety laser scanner(s). Check that safety outputs automatically switch to OFF status and make sure that the machine cannot start until power is re-applied.
- Together with the mentioned checks, it is recommended to perform a visual check of general functioning using the monitoring tool provided in the Graphic User Interface of the laser scanner.
- Check if the Laser Sentinel shows the interruption of the safety field through the LEDs and/or display.
- It is recommended to follow the same testing approach of detection capability mentioned before also for different safety areas, checking if the device reaction is as expected.
- Evaluate other specific tests to carry out based on the safety risk analysis of your own application.
- If in the end the check reveals a fault or an unexpected behavior, the machine must be shut down immediately. Try to update the software and test the device again following the aforementioned procedure. If the problem persists, contact our Technical Support.

APPENDIX A
TECHNICAL DATA

PHYSICAL CHARACTERISTICS	
Protection class	III (EN 61140 / IEC 61140)
Supply voltage (Uv)	24 Vdc (16.8 Vdc...28.8 Vdc) (SELV/PELV) [a]
Residual ripple	± 5% [b]
Start-up current (1)	< 0.6 A [c]

a. To meet the requirements of the relevant product standards (e.g. EN 61496-1), the external voltage supply for the devices (SELV) must be able to bridge a brief mains failure of 20 ms. Power supplies according to EN 60204-1 satisfy this requirement.
b. The absolute voltage level must not drop below the specified minimum voltage.
c. The load currents for the input capacitors are not taken into account.

CURRENT CONSUMPTION (24VDC)	
No output load (Ic_0)	0.35A @ 24V
With maximum output load (Ic_{max})	Ic_0 + 1A @ 24V

POWER CONSUMPTION	
Power consumption No output load (P_0)	8.5W max. @ 24V
Power consumption with maximum output load	P_0 + 10W * (Output No.) @24V
Power-up delay	30 s typical (Fast Mode) 50 s typical (Standard Mode)

OUTPUT (WARNING AND GENERIC)	
Output logic and protection	PUSH-PULL, Overcurrent protection
Output voltage for ON status (HIGH)	≥Uv-1.5V @ 400 mA
Output voltage for OFF status (LOW)	≤ 0.4V
Output current for ON status (HIGH)	max. 300 mA
Leakage current	< 700 µA
Max. Load inductance	2 H
Max. Load capacity	2.2 µF

STATIC INPUT (GENERIC)	
Input voltage (HIGH)	> 8 V
Input voltage (LOW)	< 5.5 V
Input current (HIGH)	2 mA @ 24 Vdc
Input type	Type 1 and 3 (IEC 61131-2)

MECHANICAL DATA	
Dimensions (W × H × D)	112.5 x 152 x 102
Weight (including system plug)	1.5 kg
Housing material	Aluminum Alloy
Housing color	YellowRAL1003
Optics cover material	PC
Optics cover surface	Acrylic

ENVIRONMENTAL DATA	
Humidity	Max 95% non-condensing According to IEC 61496-1 5.4.2 IEC 61496-3 5.4.2; 4.3.1; 5.4.4.3
Enclosure rating (IP)[a]	IP65
Operating temperature[b]	-10 to +50 °C
Storage temperature	-20 to +70 °C
Vibration resistance	According to IEC 61496-1 (4.3.3.1;4.3.3.2;5.4.4.1): Class 3M7 (Stationary Use) Class 5M1 (Ground Vehicle Installation, sinusoidal/broadband vibration)
Shock resistance	According to IEC 61496-1 (4.3.3.1;4.3.3.3;5.4.4.2): Class 3M7 (Stationary Use) Class 5M1 (Ground Vehicle Installation) IEC 61496-3 (5.4.4),IEC 60068-2-75 (Hammer Test)

a. The enclosure rating is valid if all the safety laser scanner M12 connectors are sealed using an IP65 rated connection cable or higher or if not connected by using a protective cap.
b. It is recommended to allow for a 15-minute warm-up from a cold start at a temperature < 5 °C before using the device in normal operation.

OPTICAL DATA	
Wavelength	905 nm
Pulse duration	3 ns
Average output power	8 mw
Laser class/Laserklass	CLASS 1 (EN 60825-1:2014)
Divergence of collimated beam	0.12 °

FEATURES	
	5.5 m Models
Safety protective zone range	0.05 ... 5.5 m for 70/150 mm of detection capability
	0.05 ... 4 m for 50 mm of detection capability
	0.05 ... 3 m for 40 mm of detection capability
	0.05 ... 2.5 m for 30 mm of detection capability
Warning zone range	0.05 ... 40 m
Max. detection range	0.05 ... 50 m (typical) for flat reflecting target (1000%)
	0.05 ... 40 m (typical) for flat white 90% target
	0.05 ... 22 m (typical) for flat gray 18% target
	0.05 ... 8 m (typical) for flat black 1.8% target
Max. number of simultaneous warning areas	7
Scanning angle	275 °
Detection capability	30/ 40 / 50/ 70 / 150 mm selectable
Scan cycle time	42 ms min. (see "Response Time And Scan Cycle Setting" on page 55)
Response time	Programmable 94 ms - 1750 ms (Fast Mode) 105 ms - 2065 ms (Standard Mode)
Max. tolerance zone	100 mm
Angular resolution	0.1 °
Zone sets	max. 70
Wait time for next zone switching request after input delay expiration of previous one	150 ms (Fast mode) 200 ms (Standard mode)
Supplement for retro-reflectors on scan plane in front of a safety zone	200 mm (refer to "Highly Reflecting Background" on page 13)
Supplement for high ambient light within ±5° of the scan plane.	200 mm (refer to "Light Interference" on page 12)
Deviation from ideal flatness of scan field at max safety range m	< 5 cm
Distance of mirror rotational axis (zero point of x and y axis) to rear side of device	52.5 mm
Distance between center point of scan plane and top edge of the housing	37.7 mm
Applications	Horizontal, Moving, Vertical

LIGHT BEAM DIAMETER	
At front screen	8 mm
At middle field distance	10 mm
At max distance	20 mm
Detectable remission	1.8% - “1000%”

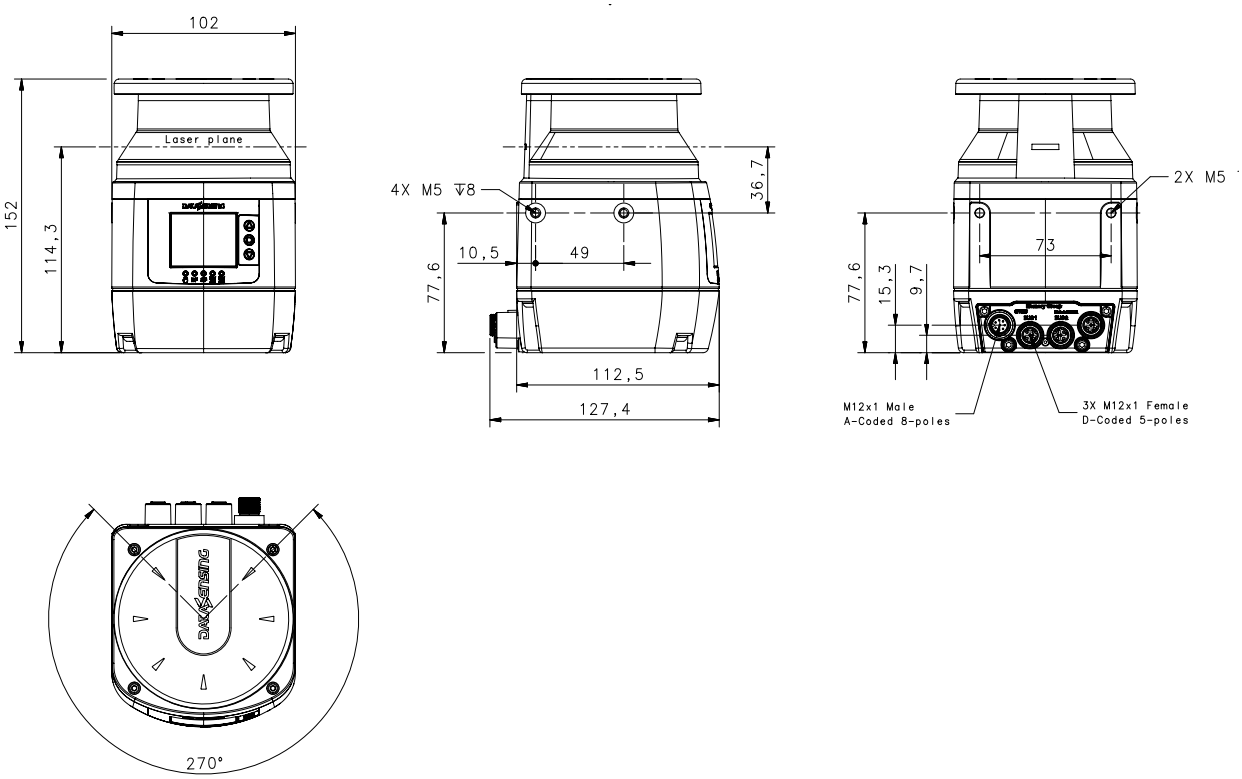
Maximum homogeneous contamination of the optics cover without preventing the detection capability	- 30% of nominal optic power

SAFETY DATA	
Type	Type 3 (EN 61496-1)
Safety integrity level	SIL 2 (IEC 61508)
Category	Category 3 (EN ISO 13849-1)
Maximum SIL	SIL 2 (EN 62061)
Performance level	PL d (EN ISO 13849-1)
PFHd (mean probability of a dangerous failure per hour)	2.24×10^{-8}
SFF	97.58 %
MTTFd	61 Years
TM (mission time)	20 years (EN ISO 13849-1)
HFT (Hardware Fault Tolerance)	1
State of safety	SafetyStatusZoneX = 0
Response time to malfunction	<= Response Time

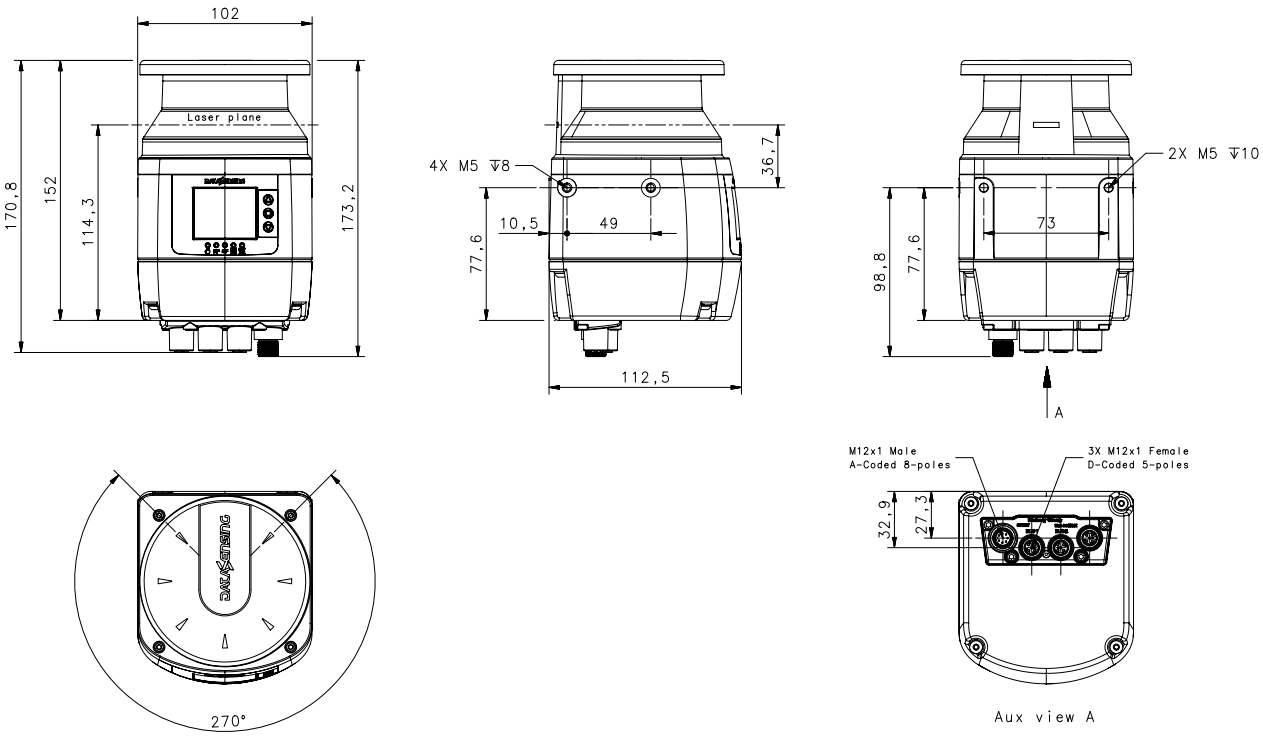
CONNECTORS	
I/O and power	M12 male type A connector (8 poles)
Ethernet to GUI or Data transmission	M12 male type D connector (4 poles)

APPENDIX B
OVERALL DIMENSIONS

LASER SENTINEL BACK MODEL



LASER SENTINEL BOTTOM MODEL



APPENDIX C
ACCESSORIES

MOUNTING BRACKETS

MODEL	DESCRIPTION	CODE
SLS-BRACKET-A	Complete bracket system	95ASE2920
SLS-BRACKET-B	Pitch regulation bracket system	95ASE2930
SLS-BRACKET-C	Head protective bracket	95ASE2940

Figure 1 - Kit A

Figure 2 - Kit B

Figure 3 - Kit C

ETHERNET CABLES

MODEL	DESCRIPTION	CODE
CAB-ETH-M01 M12-IP67 ETHERNET CAB. (1M)	Ethernet cable to Host 1 m	93A051346
CAB-ETH-M03 M12-IP67 ETHERNET CAB. (3M)	Ethernet cable to Host 3 m	93A051347
CAB-ETH-M05 M12-IP67 ETHERNET CAB. (5M)	Ethernet cable to Host 5 m	93A051348
CAB-ETH-M10 M12-IP67 ETHERNET CAB. (10M)	Ethernet cable to Host 10 m	93A051391

ELECTRICAL CABLES

MODEL	DESCRIPTION	CODE
CS-A1-06-U-03	CS Cable axial M12F 8-pin to free wires 3m no shield	95ASE1220
CS-A1-06-U-05	CS Cable axial M12F 8-pin to free wires 5m no shield	95ASE1230
CS-A1-06-U-10	CS Cable axial M12F 8-pin to free wires 10m no shield	95ASE1240
CS-A1-06-U-15	CS Cable axial M12F 8-pin to free wires 15m no shield	95ASE1250
CS-A1-06-U-25	CS Cable axial M12F 8-pin to free wires 25m no shield	95ASE1260

NOTE

User supplied cables must abide by the safety regulations for color-coding and have a maximum length of 50 m.

SAFETY UNITS

MODEL	DESCRIPTION	CODE
SE-SR2	Safety Unit	95ACC6170
CSME-03VU24-Y14	Forcibly guided relay interface	95ASE1270

NOTE

The CSME interface requires the activation and correct wiring of an EDM signal on the Safety Laser Scanner.

MAINTENANCE ACCESSORIES

MODEL	DESCRIPTION	CODE
SLS-WINDOW	Replacement window	95ASE2971
SLS-MG-FBUS	Memory group Fieldbus model	95ASE0105
SLS-CLEANER	Cleaning agent	95ASE2990
SLS-CLOTH	Cleaning cloth	95ASE3000

APPENDIX D
GLOSSARY

NAME	DESCRIPTION
Active opto-electronic protective device responsive to diffuse reflection (AOPDDR)	A device whose sensing function is performed by optoelectronic emitting and receiving elements. These detect the diffuse reflection of optical radiations generated within the device by an object located in a detection zone (specified in two dimensions).
Application Type	The configuration's classification according to the visibility of the parameters. It can be: • Expert - it contains the whole set of parameters, regardless of the device use. • Vertical - it requires the user to insert the reference points parameter. Default values are provided for all interface parameters.
Demo Configuration	A configuration's classification according to the visibility of the parameters. Demo Configuration is made only for demonstration purposes and the User has to insert only a Safety Area and a Warning Area.
Catalogue	A list of all the available models of safety laser scanner and the start point for an Offline configuration. User will use a configuration wizard in the Offline mode.
Coding	The combination of Area Switch input codes to determine zone sets. The input code must respect the hamming distance.
Configuration	The whole set of parameters that determine the device behavior. It can be classified according to the visibility of the configuration parameter: • Horizontal • Vertical The device configuration contains the whole set of parameters. If the User is not able to set them, the interface will provide default values. By showing devices positioning, the classification based on topology helps the User draw a Safety or a Warning Zone.
Configuration Validator	A feature used in DLSentinel to verify complete configuration correctness. Specific Warnings will display incorrect configuration parameters.
Detection Capability	The minimum size of a detectable object by a device. This parameter can be set for a Safety Zone and a Warning Zone of each Area.

NAME	DESCRIPTION
Device	The Laser Sentinel safety laser scanner.
Download	This is an operation that transfers the configuration from a Device to the GUI.
Dust Filtering	The Dust Filter Level must be set according to different conditions specific to the application. In general, it is the sensibility to various levels of airborne particles that impact the response of the Laser Sentinel detection. A **High** Dust Filter Level is used in dirty environments to filter (ignore) detection of airborne particles from being confused with objects to detect. The Laser Sentinel is less sensitive to dust and therefore avoids shutting down the machinery unnecessarily. A **Low** Dust Filter Level is used in cleaner environments where airborne particles have little effect on object detection. Dust Filter Level should be set to the lowest value that still allows the machinery to work without detections due to dust.
Expert Configuration	A configuration's classification according to the visibility of the parameters. This one allows the User to change the whole set of parameters (regardless of the device use).
Failure	Termination of the ability of an item to perform a required function.
Fault	State of an item characterized by its inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources.
GUI	The DLSentinel Graphic User Interface. It can be used to: • Create a configuration • Read a configuration • Write a configuration • Upload a configuration • Download a configuration • Open Report • Read Log • Monitoring (receive data)
Hazardous / Dangerous zone	Any space within and/or around machinery in which a person can be exposed to a hazard.
Height	Device height: the distance between the floor and nominal scan plane at the scanner output window.
Input Configuration	It is the name of the DLSentinel configuration panel that contains the parameters to assign to the input pins (i.e. Restart).
Lock-out condition	Condition, initiated by a fault, preventing normal operation of the protective equipment. When all safety outputs and, where applicable, all final switching devices (FSDs) are signaled to go to the OFF-state.
Minimum distance (S)	Calculated distance between the safeguard and the hazard zone necessary to prevent a person or part of a person reaching the hazard zone before the termination of the hazardous machine function.

NAME	DESCRIPTION
Monitoring	The GUI obtains data from a device and shows the following information: • Safety Status (GO/STOP) • Inputs state (ON/OFF) • Auxiliary Outputs State (ON/OFF) The User can save a static image of a monitoring case and use it in Simulation.
Network	It contains all the devices connected to the network and it is the starting point for online configuration. The User will employ a configuration wizard for an offline configuration instead.
Number of Scans	When an object is detected in the Safety Zone, the device scans the area a certain number of times before going to OFF status. This number depends on the parameter set in the configuration.
OFF-state	State in which the output circuit is interrupted and does not permit the flow of current. When Laser Sentinel detects an object in the safety zone it switches to this state which causes the dangerous machinery to stop working.
ON-state	State in which the output circuit is complete and permits the flow of current. This is the normal operating state in which the Laser Sentinel is controlling the safety area and the dangerous machinery is operating.
Override	The Override feature is possible when the Laser Sentinel is in the SAFE state (detection in the Safety Zone) and allows the user to force the safety outputs to ON state whenever it is necessary to restart the machine.
Programming	A configuration step that allows downloading a configuration. The User can accept or reject the safety configuration report and eventually save or print it.
Recovery Time	The Recovery Time is the time between the object removal from the protected area and the safety output achieving the NORMAL OPERATION.
Report	Configuration is the whole set of parameters that defines the behavior of the device. A Report is the document that shows configuration's parameters to the user.
Response Time	Maximum time between the occurrence of the event leading to the actuation of the sensing device and the safety outputs achieving the OFF-state.
Restart Interlock	Means of preventing automatic restart of the machine after actuation of the sensing device during a hazardous part of the machine operating cycle (after a change in mode of operation of the machine, and/or after a change in the means of start control of the machine).
Safety System Log	It shows the Log file.
Safety Zone	It is an area assigned to safety outputs in which the safety outputs turn OFF if an object is detected. For example: • Zone 1 -> SafetyZone1; Each zone may have a different behavior. The User can set: Start/Restart, Detection Capability, Input code, Safety and Warning Zone.

NAME	DESCRIPTION
Teach-in	A feature that scans the configuration in order to process and use the results for: • Dust settings - to choose the best Dust Immunity level according to device's environment. • Zone Configurator - to draw automatically Warning or Safety Zone. **Note**: This feature is available only in the Online mode.
Upload	An operation to transfer the configuration from the GUI to the Device.
Warning Zone	This is the area around the Safety Zone; the device can signal a warning lamp or siren if it detects an object in this area.
Zone Set	This is an area (zone) that is controlled by the Laser Sentinel. More than one zone can be defined and therefore switched (set) by a combination of inputs.
Dynamic Reference Points	Points (minimum 3, maximum 15) that can be different for each defined zone set. By changing the zone set also the Reference Point to be monitored will be changed according to the configuration.
Reference Point	Points (at least 3 and maximum 15) that can be defined for each zone set to monitor any change in position of the scanner, a protective structure or a moving structure located at the specified reference points.

NOTES

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