PHARO
Safety Laser Scanner
OPERATING INSTRUCTIONS

REER

www.reer.it
pharo.reer.it

8540587 - Rev.1 - 17/03/2010

List of contents

1 About this document

Please read this chapter carefully before working with this documentation and PHARO.

1.1 Function of this document

These operating instructions are designed to address *the technical personnel of the machine manufacturer or the machine operator* in regards to correct mounting, electrical installation, commissioning, operation and maintenance of the safety laser scanner PHARO.

These operating instructions do *not* provide instructions for operating the machine, the system or the vehicle on which the safety laser scanner is, or will be, integrated. Information on this is to be found in the appropriate operating instructions of the machine, the system or the vehicle.

1.2 Target group

These operating instructions are addressed to *planning engineers, developers and the operators* of machines and systems which are to be protected by one or several PHARO safety laser scanners. They also address people who integrate PHARO into a machine, a system or a vehicle, initialise its use, or who are in charge of servicing and maintaining the device.

1.3 Scope

Note This document is part of REER part number 8540587 (operating instructions “PHARO Safety Laser Scanner” in all available languages).

For the configuration and diagnostics of these devices you require UCS (REER User Configuration Software) version 2.23 or higher. To check the version of the software, on the **?** menu select **Module info...**

1.4 Depth of information

These operating instructions contain information on the safety laser scanner PHARO:

- installation and mounting
- electrical installation
- commissioning and configuration
- care and maintenance
- fault, error diagnosis and troubleshooting
- part numbers
- accessories
- conformity and approval

Planning and using protective devices such as PHARO also requires specific technical skills that are not detailed in this documentation.

General information on accident prevention using opto-electronic protective devices can be found in the Safety Division Product Catalogue.

When operating PHARO, the national, local and statutory rules and regulations must be observed.

Note We also refer you to the REER S.p.A. homepage on the Internet at

www.reer.it and **pharo.reer.it**

Here you will find information on:

- application examples
- these operating instructions in different languages for viewing and printing

1.5 Abbreviations

AGV Automated guided vehicle

ANSI American National Standards Institute

AWG American Wire Gauge = standardisation and classification of wires and cables by type, diameter etc.

EDM External device monitoring

ESD Electrostatic discharge

ESPE Electro-sensitive protective equipment

FPLC Fail-safe programmable logic controller

OSSD Output signal switching device = signal output of the protective device that is used to stop the dangerous movement

RIA Robotic Industries Association

UCS REER User Configuration Software

1.6 Symbols used

Recommendation Recommendations are designed to give you some assistance in your decision-making process with respect to a certain function or a technical measure.

Note Refer to notes for special features of the device.

Display indicators show the status of the 7-segment display on PHARO:

- Constant indication of characters, e.g. 8
- Flashing indication of characters, e.g. 8
- Alternating indication of characters, e.g. L and 2

LED symbols describe the status of an LED:

- The LED is constantly illuminated.
- The LED is flashing.
- The LED is off.

These symbols identify which LED is described.

- The “Error/Contamination” LED is flashing.
- The “OSSDs deactivated” LED is constantly illuminated.

➢ Take action ... Instructions for taking action are shown by an arrow. Read carefully and follow the instructions for action.

WARNING

Warning!

A warning indicates an actual or potential risk or health hazard. Observation and implementation of the warning will protect you from accidents.

Read carefully and follow the warnings!

Software notes show the location in the UCS (REER User Configuration Software) where you can make the appropriate settings and adjustments. In the UCS on the **View** menu, **Dialog box**, select the item **File cards** to go straight to the stated dialog fields. Alternatively, the software wizard will guide you through the appropriate setting.

The term “dangerous state”

The *dangerous state* (standard term) of the machine is always shown in the drawings and diagrams of this document as a movement of a machine part. In practical operation, there may be a number of different dangerous states:

- machine movements
- vehicle movements
- electrical conductors
- visible or invisible radiation
- a combination of several risks and hazards

2 On safety

This chapter deals with your own safety and the safety of the equipment operators.

➢ Please read this chapter carefully before working with PHARO or with the machine protected by PHARO.

2.1 Specialist personnel

The safety laser scanner PHARO must be installed, connected, commissioned and serviced only by specialist personnel. Specialist personnel are defined as persons who

- due to their specialist training and experience have adequate knowledge of the power-driven equipment to be checked

and

- who have been instructed by the responsible machine operator in the operation of the machine and the current valid safety guidelines

and

- are sufficiently familiar with the applicable official health and safety regulations, directives and generally recognised engineering practice (e.g. EN standards, engineering regulations from EC member states) that they can assess the work safety aspects of the power-driven equipment

and

- who have access to these operating instructions and who have read them.

As a rule these are specialist personnel from the ESPE manufacturer or also those persons who have been appropriately trained at the ESPE manufacturer, are primarily involved in checking ESPE and are allocated the task by the organisation operating the ESPE.

2.2 Device applications

The safety laser scanner PHARO is used to protect persons and plant. It is intended to be used to monitor hazardous areas indoors.

PHARO is not intended for outdoor use.

PHARO cannot provide protection from flying parts or from emitted radiation.

PHARO is only intended for use in industrial environments. When used in residential areas it can cause radio interferences.

The device is a *Type 3 ESPE* as defined by EN 61496-1 and CLC/TS 61496-2 and is therefore allowed for use with controls in category 3 PL d according to EN ISO 13849-1 and SIL2 according to IEC 61508.

PHARO is suitable for:

- hazardous area protection
- hazardous point protection
- access protection
- vehicle protection

Note Depending on the application, other protective devices and measures may be required in addition to the safety laser scanner.

2.3 Correct use

The safety laser scanner PHARO must only be used as defined in chapter 2.2 “Device applications” on page 9. It must only be used by qualified personnel on the machine where it has been installed and initialised by specialist personnel in accordance with these operating instructions. It is only permitted to be used on machines on which the dangerous state can be stopped immediately by PHARO and/or it is possible to prevent the machine being placed in operation.

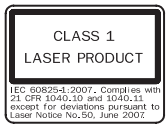
Note If the device is used for any other purposes or modified in any way — also during mounting and installation — any warranty claim against REER S.p.A. shall become void.

2.4 General safety notes and protective measures

WARNING

Pay attention to the safety notes!

Please observe the following statements in order to ensure the correct use of the safety laser scanner PHARO.



The safety laser scanner PHARO is of laser safety class 1. Additional measures for screening the laser radiation are not necessary (eye safe).

- This device meets the norms: IEC 60825-1 as well as CDRH 21 CFR 1040.10 and 1040.11; excluded are deviations due to Laser Notice No. 50, dated 24.06.2007. In the standards CDRH 21 CFR 1040.10 and 1040.11 the following note is required: “Caution — use of controls, adjustments or performance of procedures other than those herein specified may result in hazardous radiation exposure!”
- During the mounting, installation and usage of PHARO, observe the standards and directives applicable in your country. You will find an overview of the most important regulations in section 2.6 “Applicable directives and standards” on page 12.
- The national/international rules and regulations apply to the installation, commissioning, use and periodic technical inspections of the PHARO safety laser scanner, in particular
  - Machinery Directive 2006/42/EC
  - Work Equipment Directive 89/655/EEC
  - the work safety regulations/safety rules
  - other relevant health and safety regulations
- Manufacturers and users of the machine on which PHARO is used are responsible for obtaining and observing all applicable safety regulations and rules.
- The notes, in particular the test notes (see chapter 8 “Commissioning” on page 70) in these operating instructions (e.g. on use, mounting, installation or integration into the machine controller) must be observed.
- Changes to the configuration of the devices can degrade the protective function. After every change to the configuration you must therefore check the effectiveness of the protective device. The person who makes the change is also responsible for the correct

protective function of the device. When making configuration changes, please always use the password hierarchy provided by REER to ensure that only authorised persons make changes to the configuration. The REER service team is available to provide assistance if required.

- The tests must be carried out by specialist personnel or specially qualified and authorised personnel and must be recorded and documented to ensure that the tests can be reconstructed and retraced at any time.
- The operating instructions must be made available to the operator of the machine where PHARO is used. The machine operator is to be instructed in the use of the device by specialist personnel and must be instructed to read the operating instructions.
- The external voltage supply of the device must be capable of buffering brief mains voltage failures of 20 ms as specified in EN 60204.

➢ Enclosed with these operating instructions is a checklist for checking by the manufacturer and OEM (see chapter 13.2 “Manufacturer” on page 101). Use this checklist when checking the plant that is protected with PHARO.

2.5 Environmental protection

The safety laser scanner PHARO is constructed in such a way that it adversely affects the environment as little as possible. It uses only a minimum of power and natural resources.

At work, always act in an environmentally responsible manner. For this reason please note the following information on disposal.

Disposal

➢ Always dispose of unserviceable or irreparable devices in compliance with local/national rules and regulations on waste disposal.

➢ Remove the plastic parts and send the aluminium housing of the safety laser scanner for recycling.

➢ Dispose of all electronic assemblies as hazardous waste. The electronic assemblies are easy to dismantle.

2.6 Applicable directives and standards

The most important directives and standards, valid for the use of opto-electronic safety systems in Europe, are listed below. Further regulations may be of importance to you, depending on the type of use. You can obtain further information of machine-specific standards from national institutions, the authorities or your trade association.

If you operate the machine or vehicle in a country outside the European Union, please contact the manufacturer of the plant and the local authorities and obtain information on the regulations and standards applicable there.

Application and installation of safety systems

Machinery Directive 2006/42/EC, e.g.:

- Safety of machinery — Basic concepts, general principles for design (EN ISO 12100)
- Industrial automation systems — Safety of integrated manufacturing systems — Basic requirements (ISO 11161)
- Safety of machinery — Electrical equipment of machines — Part 1: General requirements (EN 60204)
- Safety of machinery — Safety distances to prevent hazard zones being reached by the upper and lower limbs (EN ISO 13857)
- Safety requirements for robots (EN ISO 10218-1)
- Safety of industrial trucks. Driverless trucks and their systems (EN 1525)
- Safety of machinery — The positioning of protective equipment in respect of approach speeds of parts of the human body (prEN ISO 13855)
- Safety of machinery — Principles for risk assessment (EN ISO 14121-1)
- Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (EN ISO 13849 part 1 and part 2)
- Safety of machines — Electro-sensitive protective equipment — Part 1: General requirements (EN 61496-1) as well as part 3: Particular requirements for Active Opto-electronic Protective Devices responsive to Diffuse Reflection (AOPDDR) (CLC/TS 61496-3)

Foreign standards, for example:

- Performance Criteria for Safeguarding (ANSI B11.19)
- Machine tools for manufacturing systems/cells (ANSI B11.20)
- Safety requirements for Industrial Robots and Robot Systems (ANSI/RIA R15.06)
- Safety Standard for guided industrial vehicles and automated functions of named industrial vehicles (ANSI B56.5)

Note To some extent these standards require the protective device to have the safety level "**Control reliable**". The safety laser scanner PHARO meets this requirement.

3 Product description

This chapter provides information on the special features and properties of the safety laser scanner PHARO. It describes the structure and the operating principle of the device, in particular the different operating modes.

➢Please read this chapter before mounting, installing and commissioning the device.

3.1 Special features

- sensor heads with scanning range up to 4 metres
- 190° scanning angle
- up to 2 protective fields and warning fields
- the contour of the protective field can be monitored (contour change can e.g. be the opening of a door to the outside)
- integrated external device monitoring (EDM)
- integrated restart interlock/restart interlock delay for which parameters can be set
- status display with LEDs and 7-segment display
- simple replacement of the I/O module
- minimum response time 60 ms
- configuration using PC or notebook with REER User Configuration Software
- configuration memory in the system plug. Down times are shortened by the easy replacement of PHARO
- increased resilience to external light and dust due to highly effective dazzle and particle algorithms

3.2 Function

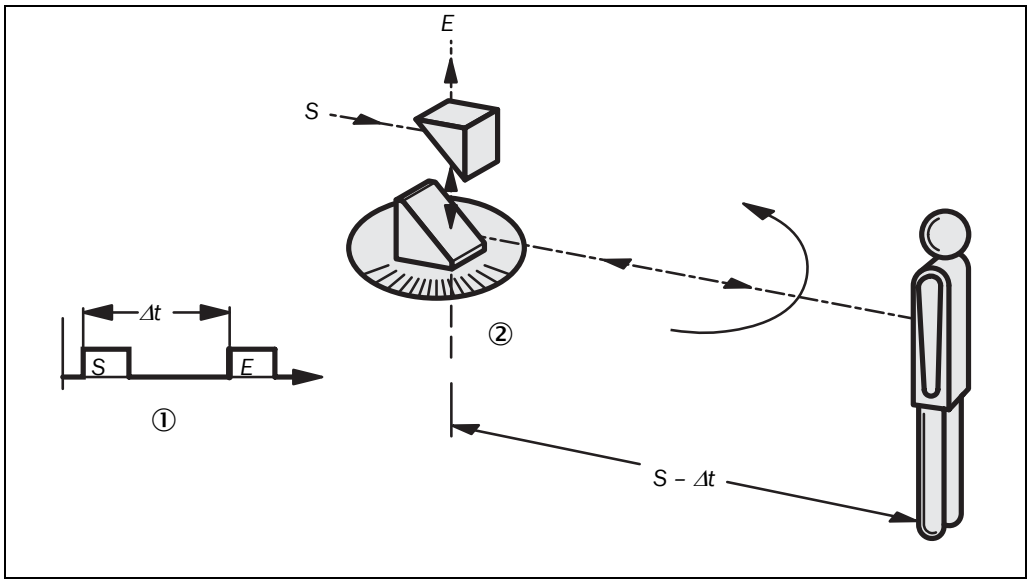
The safety laser scanner PHARO only operates correctly as a protective device if the following conditions are met:

- The control of the machine, system or vehicle must be electrical.
- It must be possible to transfer the dangerous state of the machine, the plant or the vehicle to a safe state at any time using the OSSDs on PHARO after integration in the controller.
- PHARO must be mounted and configured such that it detects objects as they enter the hazardous area (see chapter 4 “Installation and mounting” on page 36).

3.2.1 Principles of operation

PHARO is an optical sensor that scans its surroundings in two dimensions using infrared laser beams. It is used to monitor a hazardous area on a machine or a vehicle.

Fig. 1: Principle of operation, time of flight measurement by PHARO

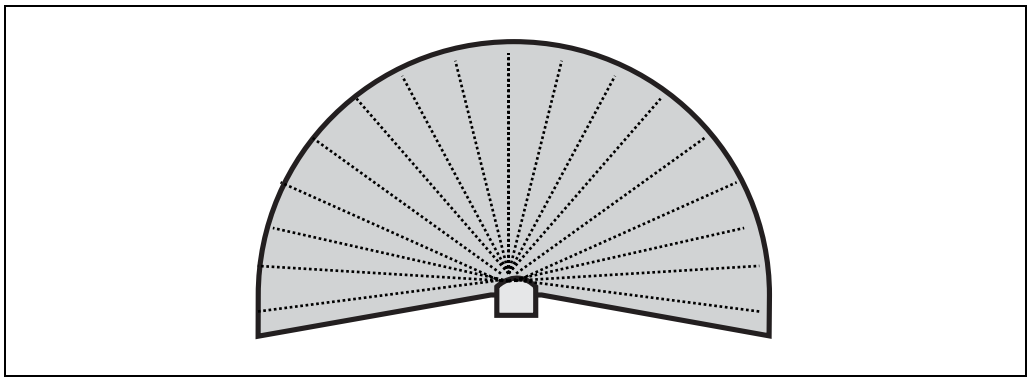


PHARO works on the principle of time of flight measurement ①. It sends out very short pulses of light (S). At the same time an “electronic stopwatch” is started. When the light is incident on an object, it is reflected and received by the safety laser scanner (E). From the time between sending and reception (Δt) PHARO calculates the distance to the object.

In PHARO there is also a mirror rotating at constant speed ② that deflects the light pulses such that they cover an arc of 190°. By determining the angle of rotation of the mirror, PHARO determines the direction of the object.

From the measured distance and the direction of the object, the safety laser scanner determines the exact position of the object.

Fig. 2: Principle of operation of PHARO — light pulses



PHARO uses light pulses precisely radiated in specific directions. Thus the laser scanner does not continuously cover the area to be monitored. In this way resolutions of between 30 mm and 150 mm are achieved.

Due to its active scanning principle, PHARO does not require receivers or reflectors. This has the following advantages:

- Ease of installation.
- You can easily adapt the monitored area to the hazardous area on a machine.
- In comparison with contact sensors, there is less wear when electro-sensitive scanning is used.

3.2.2 Field set comprising of protective field and warning field

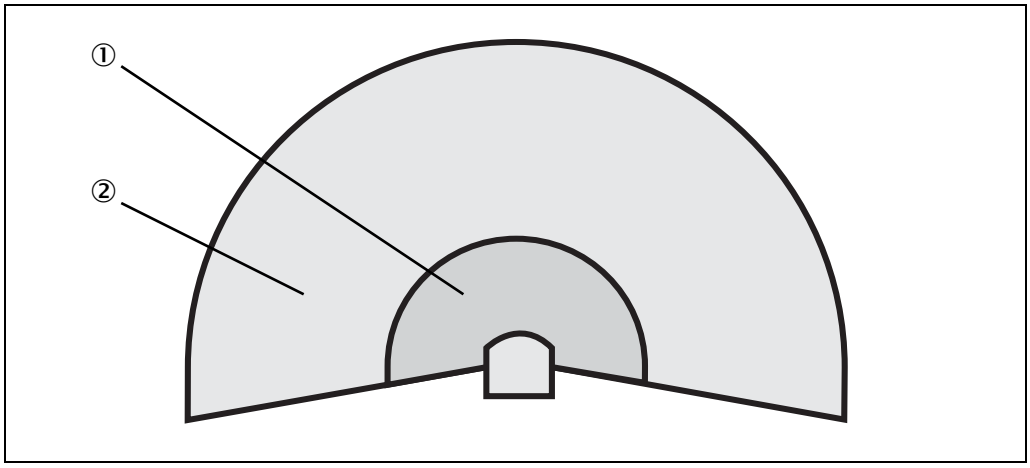


Fig. 3: Protective field and warning field

The protective field ① secures the hazardous area on a machine or vehicle. As soon as the safety laser scanner detects an object in the protective field, it switches the OSSDs to the off status and thus initiates the shutdown of the machine or stop of the vehicle.

You can define the warning field ② such that the safety laser scanner detects an object before the actual hazardous area and e.g. triggers a warning signal.

The protective field and warning field form a pair, the so-called field set. With the aid of the UCS you can configure these field sets and transfer them to PHARO. If the area to be monitored changes, then you can re-configure PHARO in software without additional mounting effort.

You can define up to two field sets and save these in the safety laser scanner.

The safety laser scanner PHARO enables you to switch to a different field set if the monitoring situation changes (see section 3.2.3 “Monitoring cases” on page 15).

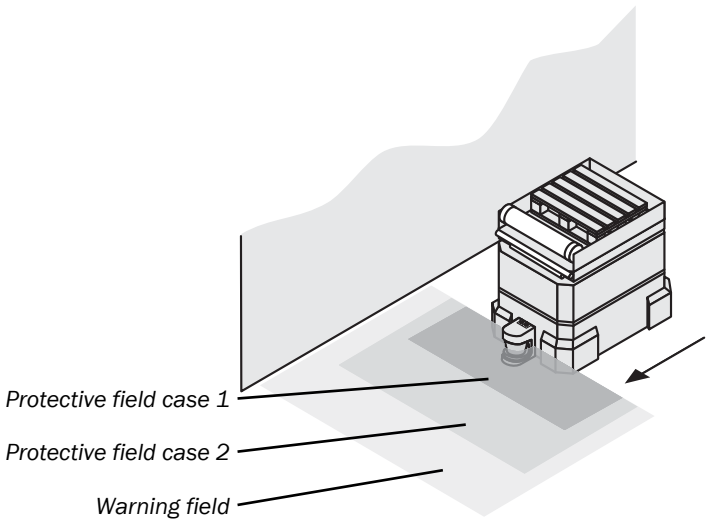
3.2.3 Monitoring cases

Two monitoring cases can be defined and selected during operation using static control inputs.

Each monitoring case includes ...

- the input conditions, the so-called control signals, that control the activation of the monitoring case.
- a field set, comprising protective field and warning field.

Fig. 4: PHARO with two defined monitoring cases on an AGV

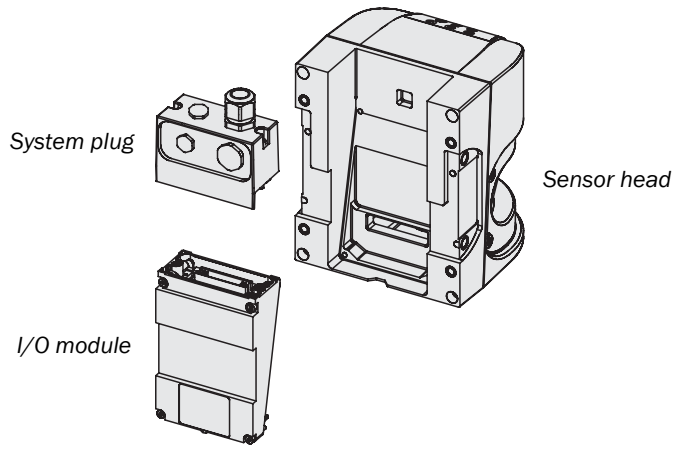


3.2.4 Device components

The safety laser scanner PHARO comprises three components:

- the sensor head with the opto-electronic acquisition system
- the I/O module
- the system plug with the configuration memory (the system plug contains all electrical connections)

Fig. 5: Sensor head, I/O module and system plug



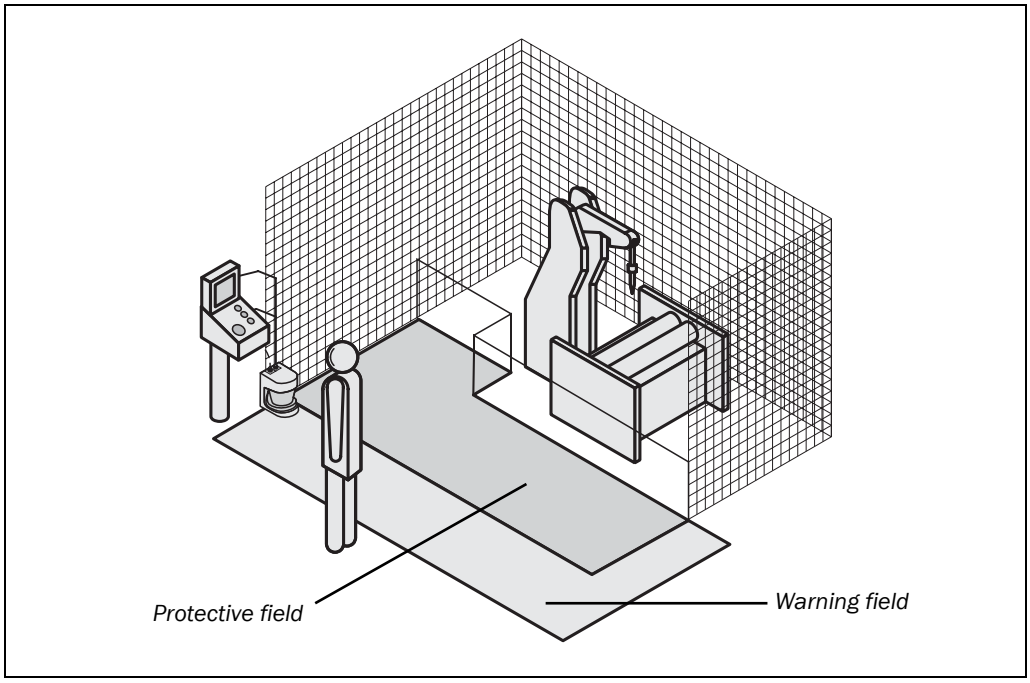
3.3 Applications

3.3.1 Stationary applications

Hazardous area protection

On dangerous stationary machines, PHARO switches the output signal switching devices (OSSDs) to the off status if the protective field is interrupted. PHARO initiates the shutdown of the machine or the shutdown of the dangerous state.

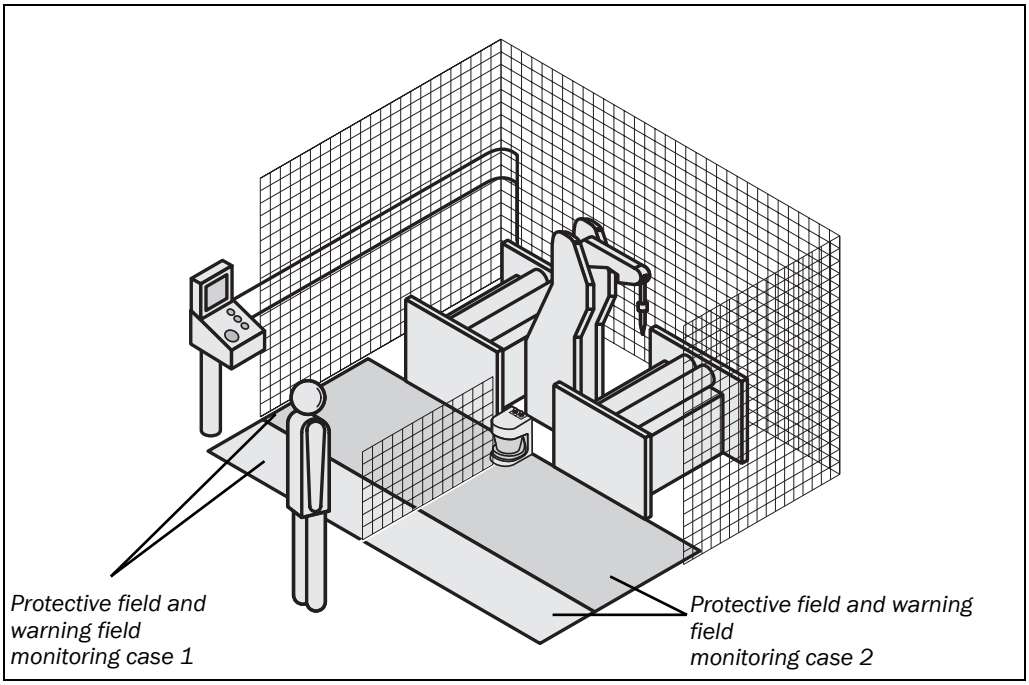
Fig. 6: Hazardous area protection with one monitored area



Hazardous area protection with multiple monitored areas (position-related protective field switching)

Using the safety laser scanners PHARO you can define two monitoring cases to match the protective field and warning field to the situation on the machine and to monitor changing hazardous areas — e.g. during different machine production phases — depending on the situation.

Fig. 7: Hazardous area protection with multiple monitored areas

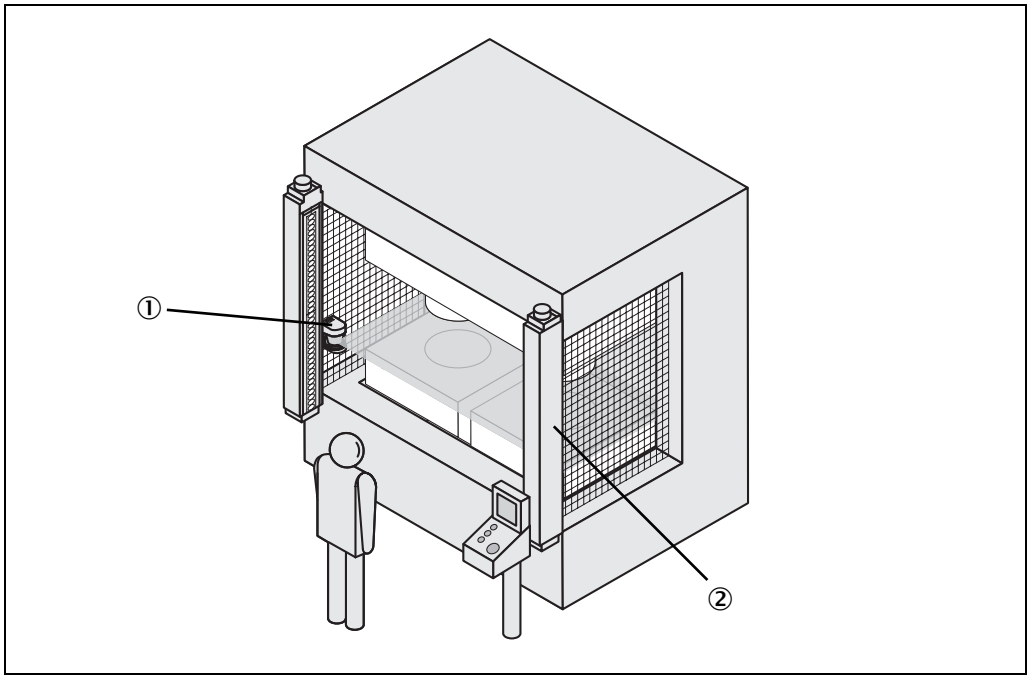


Interior protection

On large machines the safety laser scanner PHARO can be used to protect the interior. The machine can only be restarted if PHARO does not detect any object in the protective field. This is particularly important for interiors that can only be seen with difficulty from the outside, or cannot be seen at all.

In this application, PHARO ① only has a secondary protective function. The primary protective function that stops the dangerous movement is provided in the example by a light curtain ②, while PHARO monitors the restarting of the machine.

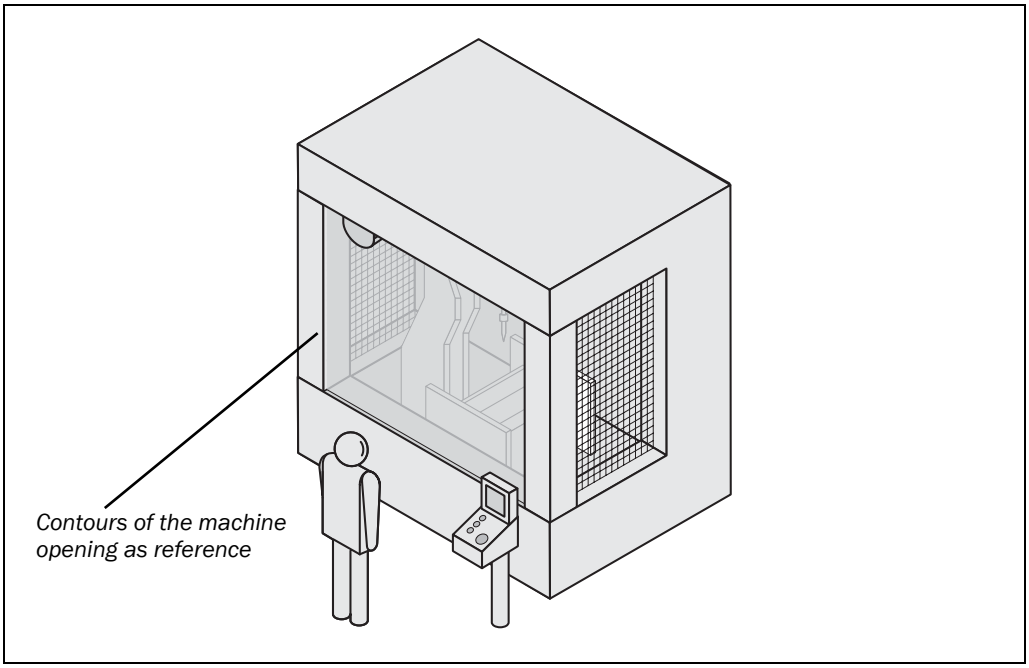
Fig. 8: Interior protection



Hazardous point protection (vertical protection)

PHARO can also be used vertically. Mounting in this way requires less space on the machine or plant. Hazardous point protection is necessary if the operator is near the dangerous state of the machine. Hand protection must be realised to protect the hazardous point.

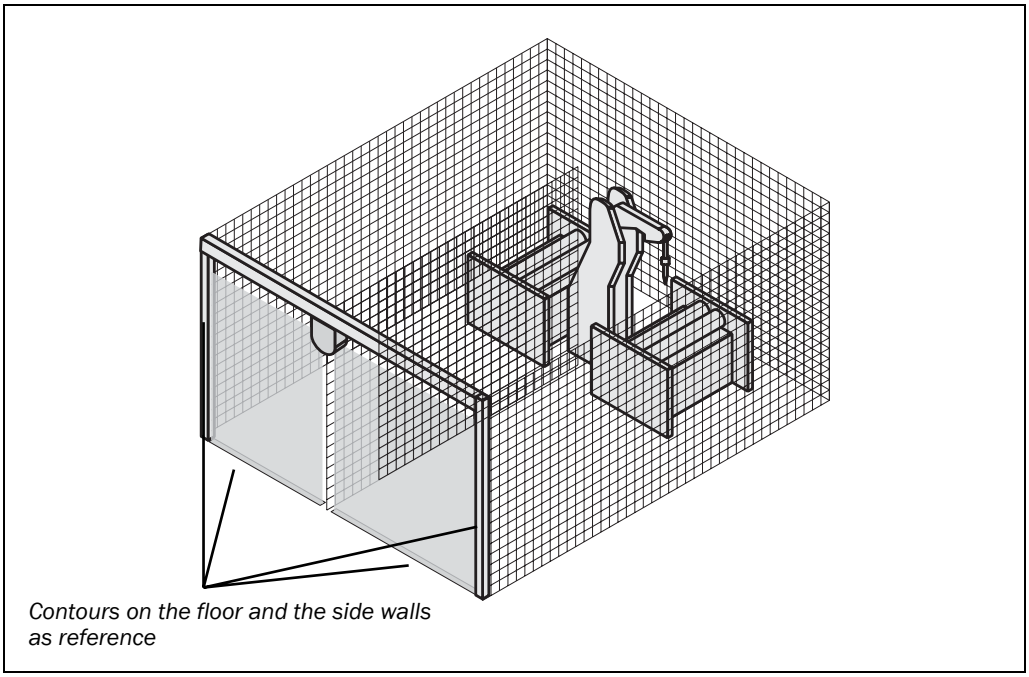
Fig. 9: Protecting hazardous points



Access protection (vertical protection)

You can also use PHARO vertically for access protection. Access protection can be used when the access to the machine can be defined by physical means. With access protection PHARO detects the entry of a person.

Fig. 10: Access protection



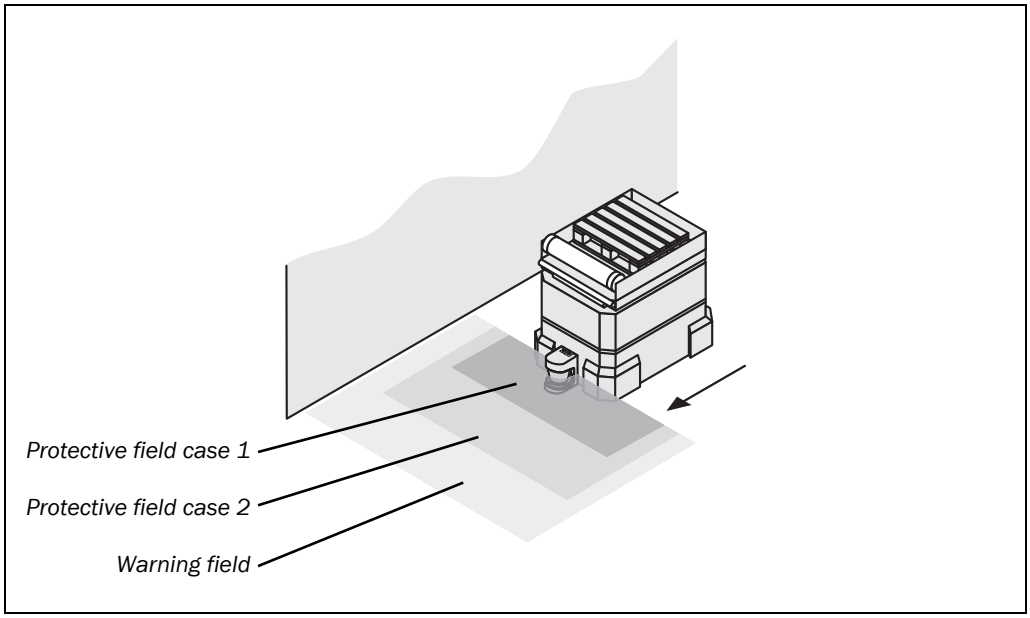
3.3.2 Mobile applications

PHARO can be used both on manually controlled vehicles, e.g. fork lift trucks, and also on automated guided vehicles (AGV) or trolleys.

Velocity-dependent protective field switching

You can use PHARO on vehicles, e.g. to protect the route of a vehicle through a factory building. If there is a person or an obstacle in the hazardous area, PHARO ensures that the vehicle reduces speed and stops if necessary.

Fig. 11: Velocity-dependent protective field switching



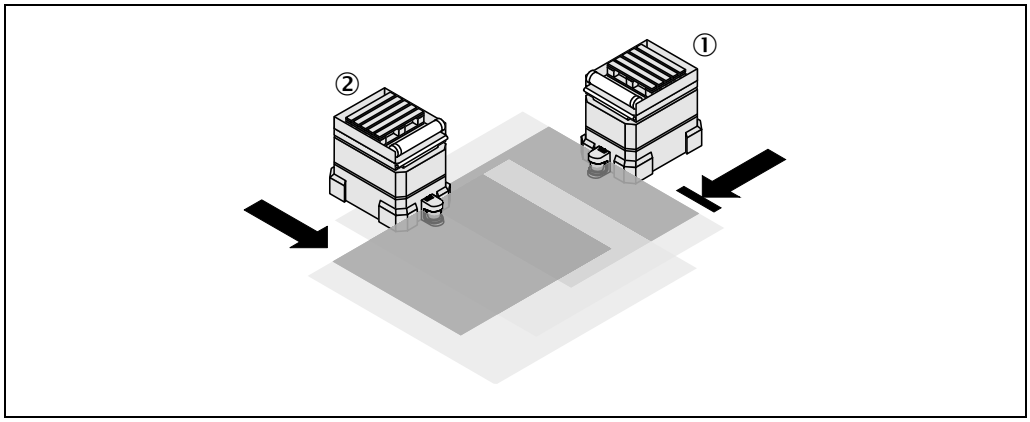
3.3.3 Other applications (not for personnel protection)

Along with safety-related applications, you can also use PHARO for applications in which people do not need to be protected.

Collision protection

Along with people, you can also, for instance, protect vehicles from colliding with other objects.

Fig. 12: Collision protection



As soon as vehicle ② reaches the warning field of vehicle ①, vehicle ① slows down. When vehicle ② reaches the protective field of vehicle ①, vehicle ① stops.

Measurement applications

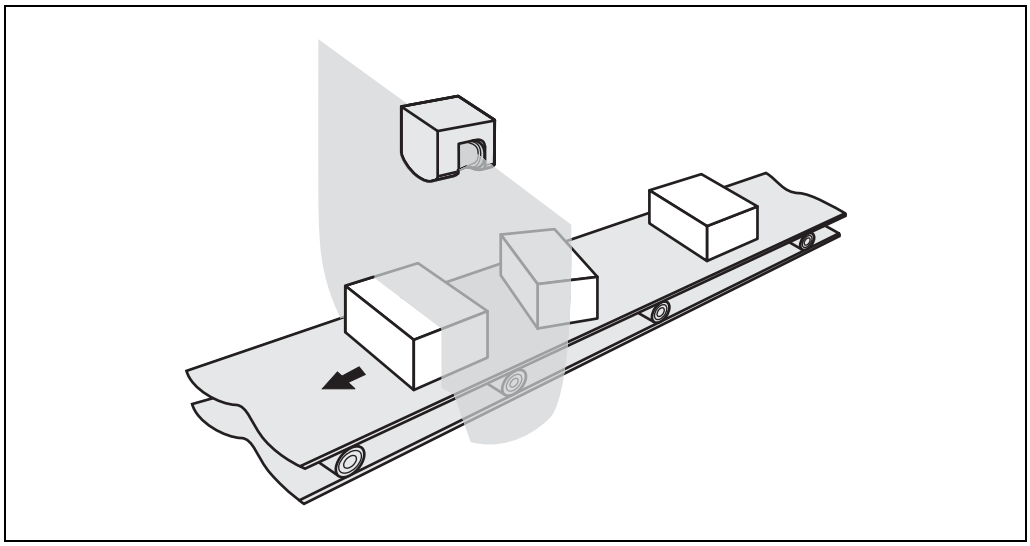


Fig. 13: Measurement application “contour measurement”

You can use the measuring principle of PHARO for numerous measurement tasks, e.g. for the

- item size measurement
- item position detection (e.g. pallets)
- cross-sectional measurement in corridors and tunnels
- profile measurement of items or vehicles
- overhang checking for items on shelves
- level measurement for solid bulk material
- length measurement

•

Note

Tab. 1: Functions of the I/O modules

Functions	
Pairs of output signal switching devices (OSSDs)	1
External device monitoring (EDM)	Yes
Restart interlock/delay	Yes
Application diagnostic output (warning field interrupted, control switch, restart or reset pressed, error/contamination)	3
Switchable field sets	2
Programmable monitoring cases	2
Static control inputs for switching between the monitoring cases (complementary or 1-of-n)	1

3.3.4 Possible applications for PHARO

Tab. 2: Possible applications for PHARO

Typical application	Functionality required
Protection of a robot insertion station	One field set
Protection of a pipe bending machine	Up to two switchable field sets
Protection of a material processing system	Up to two switchable field sets
Protection of an automated guided vehicle AGV with bi-directional travel	In each direction of travel up to two velocity-dependent switchable field sets

3.4 Configurable functions

3.4.1 Field sets

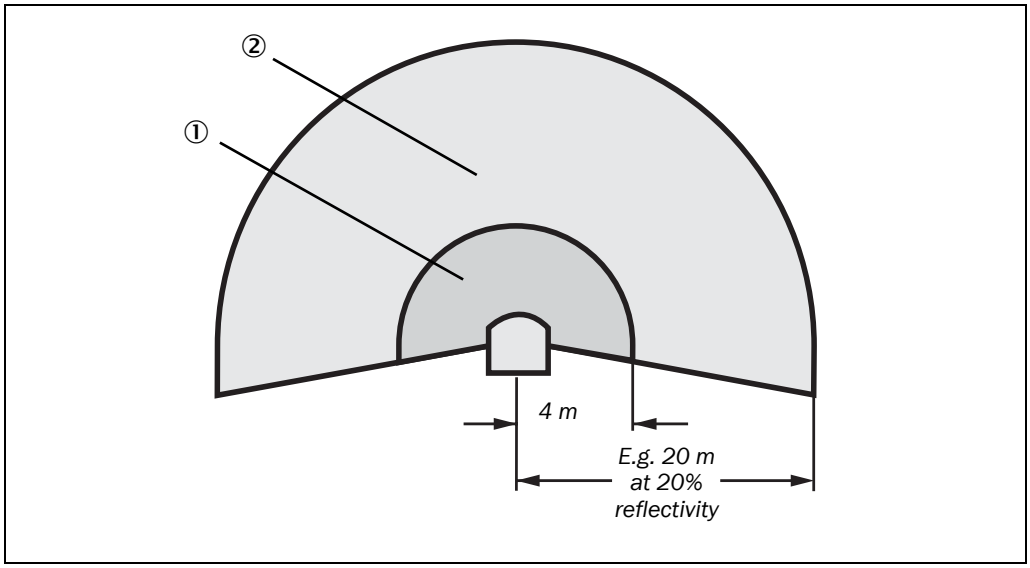
Configuring the protective field and warning field

With the aid of the UCS you can configure the field set, which comprises a protective field and a warning field. During this process you configure the shape and size of the protective field and the warning field. You can realise any field shape required.
Device symbol **PHARO**, context menu **Edit field sets...**.

Note The area to be monitored is scanned radially by PHARO. PHARO cannot “see around a corner”. The area behind objects that are in the area to be monitored (pillars, grilles, etc.) can thus not be monitored.

- The protective field (①) can cover up to 190° and, have a radius of up to 4 m.
- The warning fields (②) can cover up to 190° and have a radius of up to 49 m. Detection is dependent on the reflectivity (e.g. objects with a reflectivity of 20% can be detected in a radius of up to 20 m).

Fig. 14: Protective field and warning field



WARNING

Check the protective field configuration!

Prior to commissioning the machine or vehicle, check the configuration of the protective fields using the instructions in chapter 8 “Commissioning” on page 70 and using the checklist on page 101.

Protective field suggested by the safety laser scanner

You can also have the UCS suggest a protective field. The safety laser scanner scans the visible room contour several times. During this process possible measurement errors are taken into account. From the data obtained in this way the UCS determines the contour of the protective field.

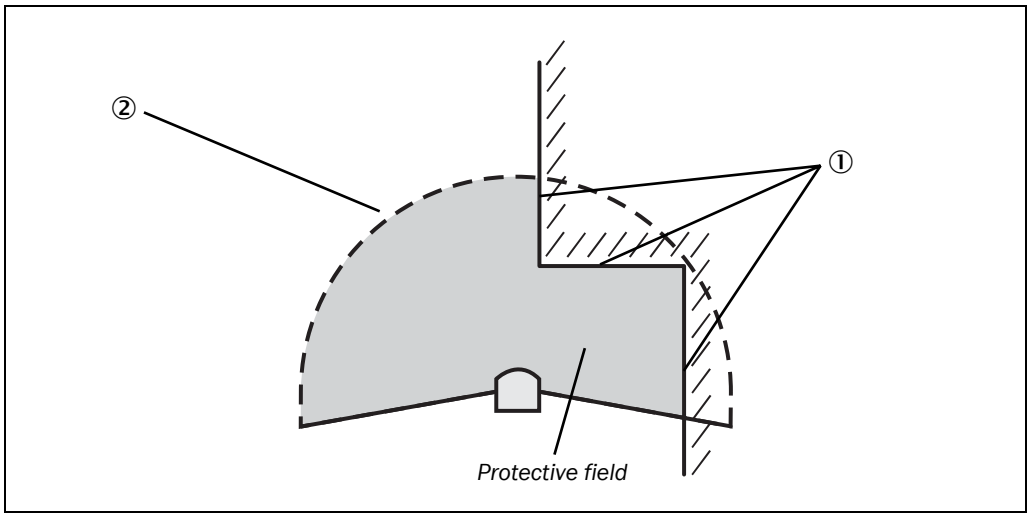
You can obtain the suggestion for the protective field in the field set editor in the UCS: Device symbol **PHARO**, command **Edit field sets...**. In the field set editor window that opens, **Suggest protective field** button.

The size determined for the protective field is ...

- as large as the visible room contour.
- in those places where there is no room contour within the scanning range, as large as the maximum scanning range of the safety laser scanner (4 m).

Note The measurement error tolerances of PHARO are automatically subtracted from the protective field suggested. As a result the protective field is slightly smaller than the surface acquired.

Fig. 15: Reading protective field and warning field



In those places at which the room contour is smaller than the nominal scanning range (e.g. at ①), the protective field corresponds to the room contour (less the measurement tolerances). In those places where the room contour is larger than the nominal scanning range ②, the protective field corresponds to the nominal scanning range (4 m).

WARNING

Check the protective field suggested!

The scanner cannot calculate the safety distance necessary for your application. Calculate the safety distance based on the description in chapter 4 “Installation and mounting” on page 36. Prior to commissioning the machine or vehicle, check the configuration of the protective fields using the instructions in chapter 8 “Commissioning” on page 70 and using the checklist on page 101.

3.4.2 Application

With the UCS you can configure PHARO for the required application. For each application you first set the resolution (device symbol **PHARO system**, context menu **Configuration draft**, **Edit...**, file card **Application**):

- possible resolution for stationary applications:
  - 30 mm (hand detection with smaller safety distance)
  - 40 mm (hand detection with larger safety distance)
  - 50 mm (leg detection with smaller protective field size)
  - 70 mm (leg detection with larger protective field size)
  - 150 mm (body detection)
- possible resolution for mobile application:
  - 70 mm (leg detection)

Note For mobile applications a resolution of only 70 mm is required for leg detection, as a lower resolution is sufficient for the detection of a human leg due to the movement of the vehicle.

The maximum protective field range is dependent on the resolution selected, and the basic response time for the application is in turn dependent of the protective field range. The following tables show the values that can be configured:

Tab. 3: Maximum protective field range

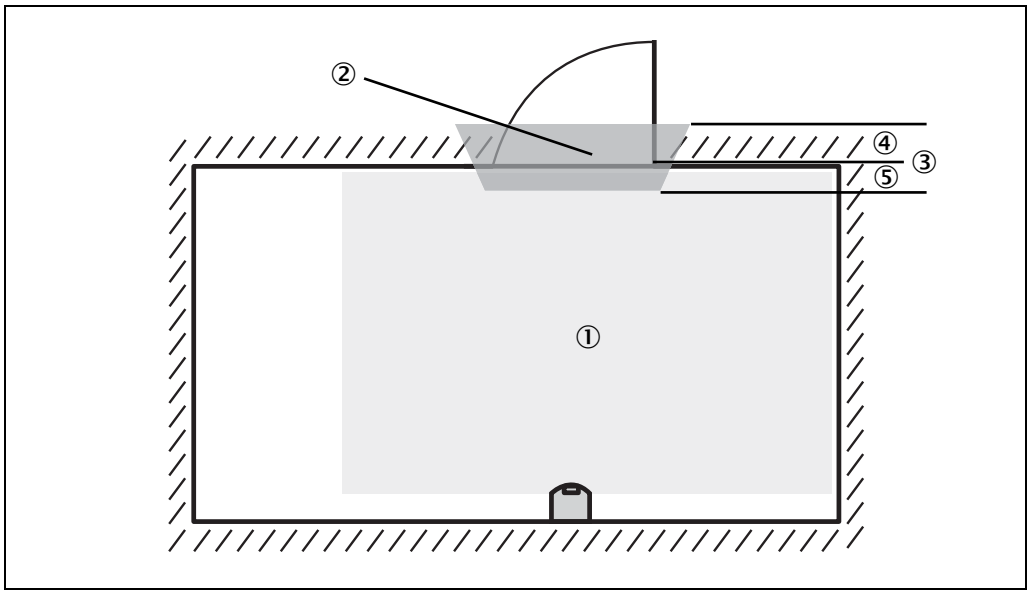
Application	60 ms basic response time	120 ms basic response time
Stationary		
30 mm (hand detection)	1.90 m	2.80 m
40 mm (hand detection)	2.60 m	3.80 m
50 mm (leg detection)	3.30 m	4.80 m
70 mm (leg detection)	4 m	4 m
150 mm (body detection)	4 m	4 m
Mobile		
70 mm (leg detection)	4 m	4 m

Note You may need to add supplements to the basic response time due to multiple sampling (see chapter 11.2 “OSSD response times” on page 84).

3.4.3 Using the contour of the protective field as a reference

If the beams of the protective field reach as far as an obstacle (e.g. the floor in vertical applications or the walls in horizontal applications), PHARO can also monitor the contour of the protective field.

Fig. 16: Schematic diagram of contour as reference



For contour monitoring you define part of the protective field ① as a contour segment ②. Within the contour segment a tolerance band ③ is defined. This comprises a positive ④ and a negative ⑤ tolerance band.

The OSSDs on PHARO change to the off status if ...

- there is an object in the protective field.
- the room contour changes by more than the tolerance band (in the example by opening the door or by changing the position of PHARO).

Note You can define any number of contour segments. The contour segments must not be narrower than the configured resolution. At the points where a contour has been configured as a reference you cannot define a warning field.

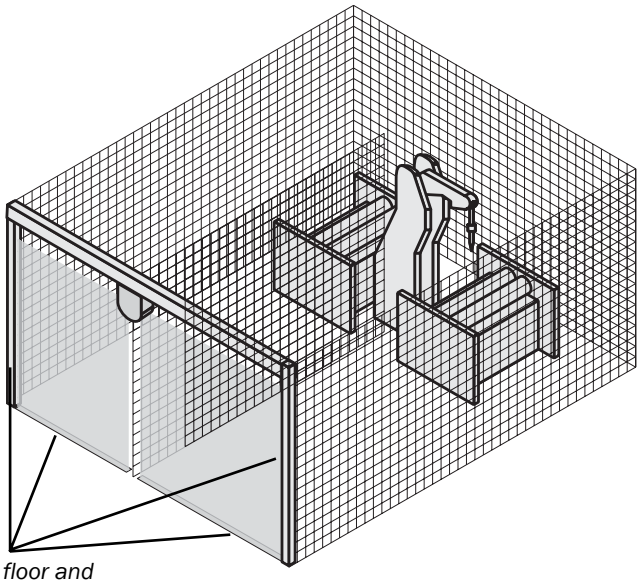
You define the contour as a reference in the UCS field set editor: Device symbol **PHARO**, command **Edit field sets...**. In the field set editor window, **Tools** menu, **Add contour** command.

Vertical operation

In vertical operation (for access protection and hazardous point protection) according to IEC/EN 61496-3 you must always activate the contour as reference function. If the radius of a protective field exceeds 4 metres, then it must be ensured that changes to the positioning of the safety laser scanner resulting in a movement of the protective field of more than 100 mm are detected.

Recommendation Use vertical passage limits at the side (e.g. door frames) and the floor as the reference. If in this case the position of PHARO is changed in one or more planes, the beams miss the contour and PHARO deactivates its OSSDs.

Fig. 17: Protective field as reference for vertical operation

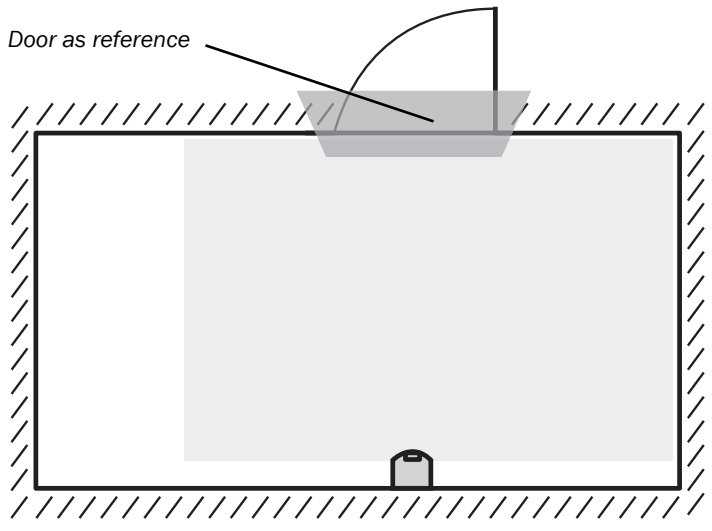


Contours on the floor and the side walls as reference

Horizontal operation

If the protective field reaches the walls of a room partially or entirely, PHARO can also monitor the contour of the protective field. The OSSDs on PHARO then change to the off status if the room contour changes due the opening of a door, even if there is no object in the protective field.

Fig. 18: Protective field as reference for horizontal operation



Note You cannot define any warning field in the areas of the contour segments. This is only possible between contour segments.

3.4.4 Internal or external OSSDs

- Internal OSSDs
  Defines that the protective field or the protective fields switch the OSSDs on PHARO.
- External OSSDs
  – Switching amplifier connected: The OSSDs on the switching device are switched.

Only connect the OSSDs to a single subsequent switching element!

WARNING

Each output signal switching device (OSSD) is only allowed to be connected to one switching element (e.g. relay or contactor). If several switching elements are required, then you must choose a suitable form of contact duplication.

3.4.5 External device monitoring (EDM)

The EDM function monitors the contact elements activated by both the OSSDs (e.g. contactors). The machine is only allowed to start if both contactors are in the de-energised state on reset, that is they are deactivated.

PHARO monitors the contactors after every interruption of the protective field and before the restart of the machine. The EDM can in this way identify if one of the contactors has fused, for instance.

You can configure the external device monitoring in the UCS (device symbol **PHARO system**, context menu **Configuration draft**, **Edit...**, file card **Scanner name**).

- If **no** internal restart interlock is configured, then ...
  – the system locks completely (lock-out).
  – the error message 8 appears in the 7-segment display.
- If an internal restart interlock is configured, then ...
  – PHARO deactivates its OSSDs.
  – the adjacent LED illuminates.
  – the error message 8 appears in the 7-segment display.
  – with the flashing LED PHARO signals that the control switch for restarting or resetting the restart must be operated.

Notes

- You will find examples on the connection of the external device monitoring in chapter 6.3 “Example circuits” on page 66.
- If you do not use the external device monitoring function, leave the inputs disconnected (see chapter 5.1.1 “Pin assignments of the I/O modules” on page 60).

3.4.6 Application diagnostic output

PHARO has a configurable application diagnostic output (device symbol **PHARO system**, context menu **Configuration draft**, **Edit...**, file card **Scanner name**).

For the application diagnostic output you must decide ...

- whether it is deactivated.
- whether a signal is only output when the front screen is contaminated.
- whether a signal is only output on errors.
- whether a signal is output both for front screen contamination and on errors.

3.4.7 Restart

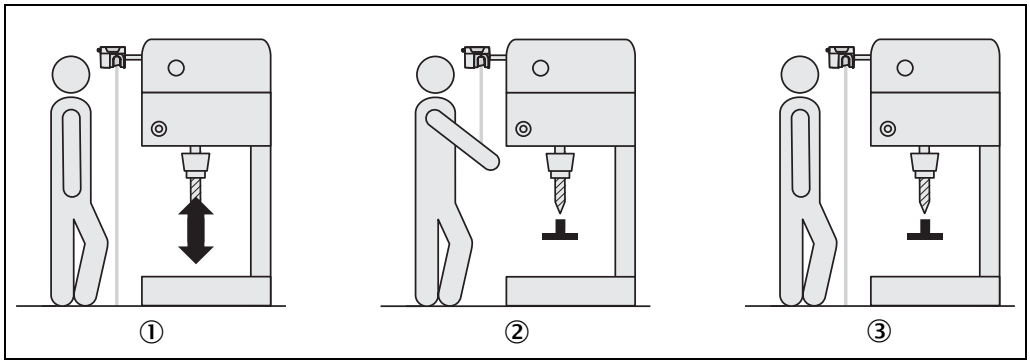


Fig. 19: Schematic of operation with restart interlock

Restart interlock

The dangerous state of a machine ① or a vehicle is interrupted as soon as there is an object in the protective field ② and is not enabled again ③, even if there is no longer an object in the protective field. The OSSDs are only enabled again when the operator operates the control switch for restarting or resetting.

The restart interlock can be implemented in two different ways:

- with the internal restart interlock of PHARO:
  The outputs on PHARO are enabled after the connected control switch is operated.
- with the restart interlock of the machine controller:
  PHARO has no effect on the restart.

WARNING

Place the control switch for restart or reset outside the hazardous area in a place where it can clearly be seen from the hazardous area!

Place the control switch for restart or reset outside the hazardous area such that it cannot be operated by a person in the hazardous area. Ensure that the person who operates the control switch has a full view of the hazardous area.

Restart delay

On PHARO, instead of a restart interlock you can configure a restart delay of 2 to 60 seconds. This enables the machine or the vehicle to start automatically when the protective field becomes clear, and the set time has elapsed. It is not possible to combine restart interlock and restart delay.

WARNING

It is imperative that you configure PHARO with restart interlock if the protective field can be left to approach the hazardous point and if a person cannot be detected at every point in the hazard area for PHARO!

Restart interlock is imperative if the protective field can be left to approach the hazardous point. If this is the case and you deactivate both the restart interlock on PHARO and the restart interlock on the machine, you will place the operators at serious risk. Check, if necessary, whether it is possible to prevent the protective field from being left to approach the hazard point by design measures (see chapter 4.1.2 “Measures to protect areas not covered by PHARO”).

Note PHARO cannot differentiate between a contaminated front screen and an obstacle directly in front of it. To ensure high availability, PHARO has been designed such that it reliably detects dark black bodies such as wide black cord or shoe leather from a distance of 5 cm in front of the front screen. Black objects that are closer to the front screen are not detected.

Furthermore, due to mounting with or without mounting kits, unprotected areas are produced near PHARO.

WARNING

Secure the area close to PHARO if operated without restart interlock!

Make the area near the device impassible by means of physical measures (bar or recessing) or, in addition to PHARO, use a proximity switch with 5 cm acquisition range. Without this additional protection you will endanger persons who move from the protective field into the area near the device.

Permissible configuration

Tab. 4: Permissible configuration of the restart interlock

Restart interlock of PHARO	Restart interlock machine/vehicle	Permissible application
Deactivated	Deactivated	Only if it is not possible to leave the protective field to approach the hazardous point. Ensure that this is prevented by the design of the plant.
Deactivated	Activated	All, if the hazardous area can be completely seen by the operator
Activated	Deactivated	Only if it is not possible to leave the protective field to approach the hazardous point. Ensure that this is prevented by the design of the plant.
Activated	Activated	All, if the hazardous area cannot be completely seen by the operator. The restart interlock of PHARO takes over the function for resetting the protective device. Restart interlock using the machine controller (see “Reset” on page 30).

Reset

Note The reset function is often also called “preparation for restart”. In these operating instructions the term **reset** is used.

If you want to activate the restart interlock on PHARO (internal) and also a restart interlock on the machine (external), then each restart interlock has its own control switch.

After operating the control switch for the internal restart interlock (with protective field unoccupied) ...

- PHARO switches on its OSSDs.
- ⓥ ● the adjacent LED on the safety laser scanner illuminates green.

The external restart interlock prevents the machine from restarting. After resetting PHARO the operator must press the control switch to restart the machine controller.

WARNING

Ensure that the correct sequence is followed!

The controller must be configured such that the machine only restarts if PHARO is first reset and then the control switch for restarting the machine controller is pressed.

Notes

- You will find examples on the connection of the internal restart interlock in chapter 6.3 “Example circuits” on page 66.

If you do not use the restart interlock, leave the inputs disconnected (see chapter 5.1.1 “Pin assignments of the I/O modules” on page 60).

You can configure the type of restart in the UCS (device symbol **PHARO system**, context menu **Configuration draft**, **Edit...**, file card **Scanner name**).

3.4.8 Multiple sampling

When multiple sampling is set, an object must be scanned several times before PHARO switches off its OSSDs. In this way you can reduce the probability that objects falling through the scan plane, for example welding sparks or other particles, result in the shutdown of the plant.

With a multiple sampling configuration of, e.g., 3, an object must be scanned three times in succession before PHARO switches off the OSSDs.

WARNING

The total response time is increased by the multiple sampling!

With a multiple sampling greater than 2, note that you must add a supplement to the basic response time (see chapter 11.2 “OSSD response times” on page 84)!

On PHARO, a multiple sampling of 2 is the minimum setting. You can set the multiple sampling up to 16 with the aid of the UCS.

Tab. 5: Recommended multiple sampling

Recommended multiple sampling	Application
2 times	Stationary under clean ambient conditions
4 times	Mobile
8 times	Stationary under dusty ambient conditions

Recommendation

Using multiple sampling you can increase the availability of a plant.

You can configure the multiple sampling in the UCS for each monitoring case (device symbol **PHARO system**, context menu **Configuration draft**, **Edit...**, **Monitoring case name**, file card **Scanner name**).

3.4.9 Monitoring cases

You can define up to two monitoring cases. Allocate a field set to each monitoring case.

WARNING

Ensure that the safety distance to the dangerous state is adequate in any monitoring case to protect the hazardous area!

See chapter 4 “Installation and mounting” on page 36.

It is possible to switch between these monitoring cases during operation using static control inputs.

Park mode

For mobile applications in which vehicles are parked for a time, the safety laser scanners PHARO can be switched to park mode. In the park mode the OSSDs are deactivated and the laser in the safety laser scanner shutdown. In this way the power consumption of the device is reduced.

The park mode can be configured for a monitoring case. To switch to the park mode, the inputs must be configured such that the related monitoring case with the park mode is activated.

Recommendation If you park vehicles beside each other, switch them to the park mode. In this way you prevent PHARO on the vehicles from dazzling each other and PHARO from possibly entering an error condition.

You can configure the monitoring cases in the UCS (device symbol **PHARO system**, context menu **Configuration draft**, **Edit...**).

3.4.10 Static control inputs

PHARO has two two-channel static control inputs via which the four possible monitoring cases can be switched.

You can configure the control inputs in the UCS (device symbol **PHARO system**, context menu **Configuration draft**, **Edit...**, file card **Inputs**).

If you are using static sampling, decide between complementary or 1-of-n sampling depending on the control features available.

WARNING

When switching the monitoring cases using static control inputs, please note the following points:

- Ensure that the control for the monitoring case switching has a sufficiently high level of safety.
- Ensure that the circuit for the control inputs is suitable for the ambient conditions to be expected so that systematic effects and thus errors on the switching of the monitoring cases can be excluded.
- Ensure that the control — using static control inputs — provides switching between the monitoring cases in the correct time frame. Note that at the time of the switching there may be a person in the protective field. Only by means of switching in the correct time frame (i.e. before the hazard occurs at this point for the person) is protection provided (see chapter 4.5 “Timing for monitoring case switching” on page 52).

Static complementary sampling

A control input comprises a pair of two connections. For correct switching one connection must be inverted in relation to the other.

The following table shows the levels that must be present at the connections for the control input to define the logical input state 1 and 0 at the related control input.

Tab. 6: Level at the connections for the control inputs for complementary sampling

Connection 1	Connection 2	Logical input state
• 1	0	0
• 0	1	1
• 1	1	Error
• 0	0	Error

Using the control input pairs on PHARO 2 monitoring cases can be switched.

Static 1-of-n sampling

With 1-of-n sampling you use each of the two control input connections. All connections must be used, only one connection is ever allowed to be 1.

Tab. 7: Truth table for 1-of-n sampling

A1	A2
1	0
0	1

Input delay

If the control device via which you switch the static control inputs cannot switch within 10 ms (for 60 ms basic response time) or 20 ms (for 120 ms basic response time) to the related input condition (e.g. due to switch bounce times), you must choose an input delay. For the input delay choose the time in which your defined control device can switch to a corresponding input condition.

Independent of the basic response time chosen for PHARO, you can increase the input delay in 30-ms steps (for 60 ms basic response time) or 60-ms steps (for 120 ms basic response time).

The following figures, derived from experience, are a guide for the various switching methods given.

Tab. 8: Figures from experience for the necessary input delay

Switching method	Input delay required
Electronic switching using controller or complementary electronic outputs with 0 to 10 ms bounce time	10 ms
Contact (relay) controls	30–150 ms
Control using independent sensors	130–480 ms

3.4.11 Naming applications and laser scanners

A name can be assigned to the application configured and to the laser scanner(s). The names are saved in the devices after the configuration is transferred. The name chosen may, for example, be the identifier for the system or the machine.

If you assign unique application names, you may “reserve” the devices for certain duties. A machine maintenance person comparing exchanged devices with the configuration data saved in the UCS will be notified that the application name does not match. He may then exchange these devices for those with the correct application name.

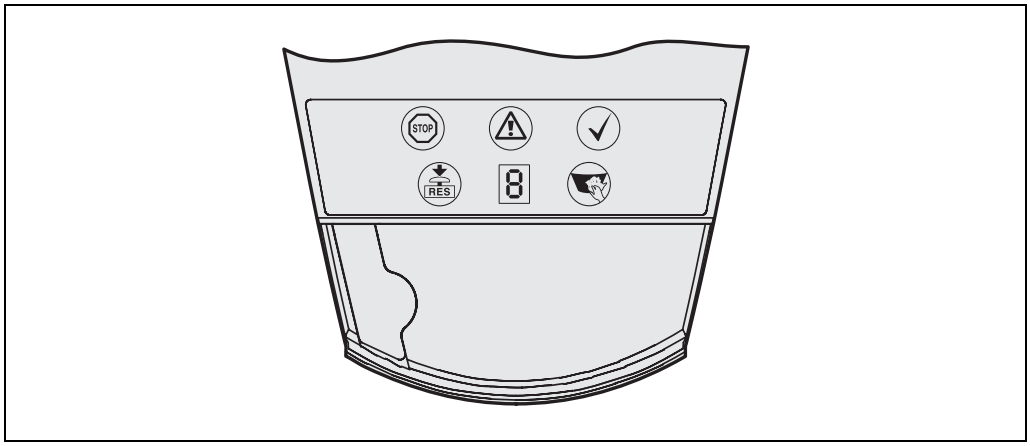
You can enter the application or scanner names in the UCS (device symbol **PHARO system**, context menu **Configuration draft**, **Edit...**, file card **Application**).

3.5 Indicators and outputs

3.5.1 LEDs and 7-segment display

The LEDs and the 7-segment display indicate the operational status of PHARO. They are on the front face of the safety laser scanner. Above the LEDs there are symbols that are used in the remainder of these operating instructions to describe the LEDs.

Fig. 20: Operational status indicators on PHARO



The symbols have the following meaning:

- OSSDs deactivated (e.g. if object in the protective field, reset necessary, lock-out)
- Reset required
- Warning field interrupted (object in warning field)
- Front screen contaminated
- OSSDs activated (no object in protective field)

3.5.2 Outputs

Using the outputs on PHARO you shutdown the dangerous state on a machine, a plant or a vehicle and evaluate the operational status of PHARO. PHARO has the following outputs:

- OSSDs
- warning field
- application diagnostic output (contamination of the front screen/error)
- reset required

The outputs are brought out at the system plug (see chapter 5.1 “System connection” on page 59).

Note All outputs are only allowed to be used for the purpose specified. Note that the signals at the application diagnostic outputs for “warning field”, “contamination of the front screen/ error” and “reset necessary” are not safe. For this reason the warning field is not allowed to be used for tasks related to personnel protection.

4 Installation and mounting

This chapter describes the preparation and completion of the mounting of the safety laser scanner PHARO.

Mounting requires four steps:

- definition of the application and the necessary mounting location for the laser scanner
- calculation of the protective field sizes
  You can enter the calculated protective field sizes with the aid of the UCS. Or leave PHARO to suggest the protective fields. In the latter case it is necessary to check whether the suggested sizes correspond to those calculated. Thus in any circumstance you must calculate the protective field size.
- definition of the switching point between monitoring cases
- mounting the safety laser scanner with or without mounting kits

WARNING

No protective function without sufficient safety distance!

PHARO's safety function depends on the system being mounted with the correct safety distance from the hazardous area.

Notes

- ➢ Mount PHARO in a dry place and protect the device from dirt and damage.
- ➢ Avoid strong electrical fields. These can, e.g., be produced by welding cables, induction cables in the immediate vicinity and also by mobile telephones operated in close physical proximity.
- ➢ Ensure that there are no obstacles in the area to be monitored in the field of view of PHARO that could cause interference or shadowing. Such shadowed areas cannot be monitored by PHARO. If there are unavoidable shadowed areas, check whether there is a risk. Take additional safety precautions as necessary.
- ➢ Keep the area to be monitored free of smoke, fog, steam or other forms of air impurities. Otherwise the function of PHARO may be impaired and incorrect switching may occur.
- ➢ Avoid placing highly reflective objects in the scan plane of PHARO. Examples: Retroreflectors can affect the measurement results of PHARO. Mirrored objects can hide part of the area to be monitored.
- ➢ Mount PHARO such that it is not dazzled by incident sunlight. Do not position stroboscopic and fluorescent lights directly in the scan plane as these may affect PHARO in specific circumstances.
- ➢ Mark the protective field on the floor, if this is reasonable for the application (see EN 61496, part 1, chapter 7).

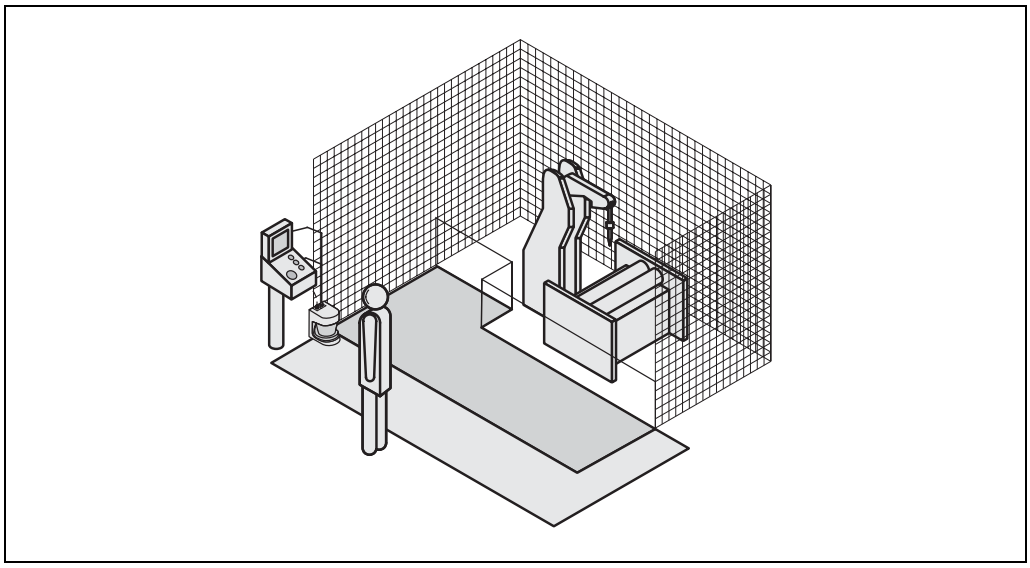
The following steps are necessary after mounting and installation:

- completing the electrical connections (chapter 5 "Electrical installation")
- configuration of the protective field (chapter 7 "Configuration")
- commissioning and checking of the installation (chapter 8 "Commissioning")
- checking of PHARO functionality and safe shutdown of the machine, vehicle or plant (chapter 8.2 "Test notes")

4.1 Stationary application in horizontal operation

This type of protective device is suitable for machines and plant on which, e.g., a hazardous area is not enclosed by a fixed protective device.

Fig. 21: Horizontally mounted stationary application



For a horizontally mounted stationary application determine ...

- the protective field size to observe the necessary safety distance.
- the height of the scan plane.
- the restart behaviour.
- measures to protect areas not covered by PHARO.

Note Once you have defined the protective field size, mark the boundaries of the protective field on the floor. This avoids inadvertent entrance into the protective field and makes it possible to subsequently check the shape of the protective field.

4.1.1 Protective field size

The protective field must be so configured that a safety distance (S) to the hazardous area is maintained. This safety distance ensures that the hazardous point can only be reached after the dangerous state of the machine has been completely stopped.

Note Using PHARO you can define two monitoring cases with different protective fields. In such a case you must calculate the protective field size for all protective fields used.

You can operate PHARO in stationary horizontal operation with 50 mm or with 70 mm resolution. For each resolution you can choose between 60 ms and 120 ms response time. The maximum protective field range for PHARO is given by the resolution and the response time.

- If you choose a 50 mm resolution, the maximum protective field range is less than for a 70 mm resolution, however you can mount PHARO as low as required.
- If you choose a 70 mm resolution, you can configure the largest protective field range (4 m) but must position the scan plane of PHARO at 300 mm.
-

WARNING

Ensure that a human leg can be detected in horizontal stationary applications with 70 mm resolution!

Mount the scan planes for horizontal stationary applications with 70 mm resolution at a height of at least 300 mm (see “Height of the scan plane at 70 mm resolution” on page 41).

Recommendation

Due to the choice of two resolutions and two response times, it may be necessary to repeatedly calculate the protective field size (iterative calculation).

- ➢ Perform your protective field calculation initially based on a resolution of 50 mm and a basic response time of 60 ms.
- ➢ If the calculated protective field is larger than the maximum protective field range at 50 mm resolution, calculate it again using the same resolution and the higher response time.
- ➢ If the protective field calculated is larger than the maximum protective field range achievable, then re-calculate the protective field with the lower resolution.

The safety distance S depends on:

- approach speed of the body or parts of the body
- stopping/run-down time of the machine or system
  (The stopping/run-down time is shown in the machine documentation or must be determined by taking a measurement.)
- response time of PHARO
- supplements for general measurement errors and any measurement errors related to reflection
- supplement for prevention of reaching over
- height of the scan plane
- possibly the time for switching between the monitoring cases

Calculation of the safety distance S:

- ➢ First, calculate S using the following formula:

$S = (K \times (T_M + T_S)) + Z_G + Z_R + C$

Where ...

K = Approach speed (1600 mm/s, defined in EN 999)
T_M = Stopping/run-down time of the machine or system
T_S = Response time of PHARO combined with the downstream controller
Z_G = General safety supplement = 100 mm
Z_R = Supplement for measurement error related to reflection
C = Supplement for prevention of reaching over

Response time T_S of PHARO

The response time T_S of PHARO depends on...

- the resolution used.
- the multiple sampling used.

See chapter 11.2 “OSSD response times” on page 84.

Supplement Z_R for measurement error related to reflection

WARNING

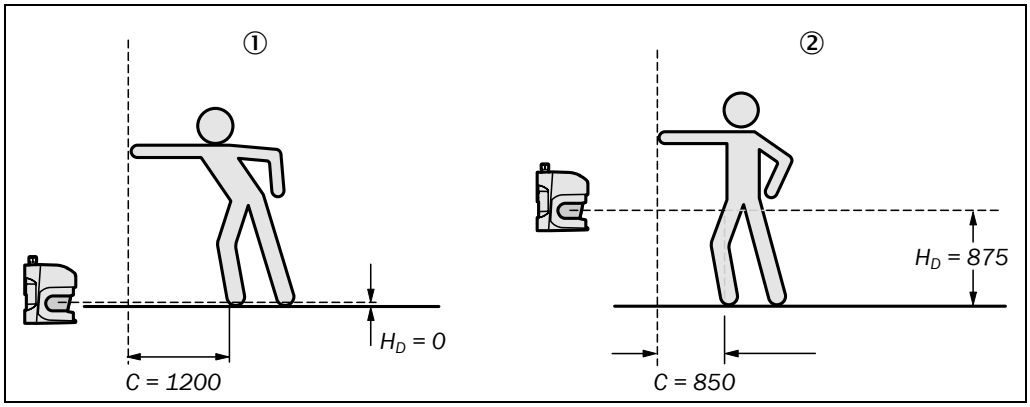
Avoid mounting retroreflectors at a distance of less than one meter from the boundary of the protective field!

With retroreflectors positioned at a distance of less than 1 m from the boundary of the protective field a supplement, Z_R, of 200 mm must be added to the protective field.

Supplement C for protection against reaching over

With a protective field installed horizontally, there is a risk that people may reach over the protective field and in this way reach the hazardous area before PHARO shuts down the dangerous state. For this reason the calculation of the safety distance must take into account a supplement to prevent persons from finding themselves in a hazardous situation by reaching over the protective field (see EN 294, table 1) before PHARO triggers.

Fig. 22: Risk of reaching over (mm)



The necessary supplement for the safety distance is dependent on the height of the scan plane for the protective field. At low heights ① the supplement is larger than at greater heights ②.

WARNING

Prevent the possibility of crawling beneath the protective device if you mount it higher than 300 mm!

Prevent people from being able to crawl beneath the protective field by means of appropriate mounting of PHARO. If you mount the protective device higher than 300 mm, you must prevent crawling beneath by means of additional measures. For applications that are accessible to the public, the mounting height may need to be reduced to 200 mm (on this subject see the appropriate regulations).

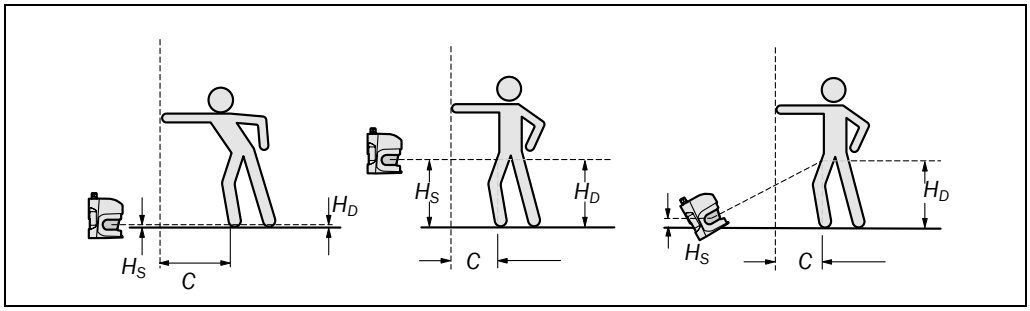
How to calculate the supplement C:

- If there is enough empty space in front of your machine or plant, use 1200 mm for the supplement C.
- If the safety distance is to be kept as small as possible, calculate C using the following formula:
  $C = 1200\ mm - (0.4 \times H_D)$
  Here H_D is the height at which the protective field is mounted.

Note The minimum supplement to prevent reaching over is 850 mm (arm length).

In summary there are three practical methods of mounting the scan plane for PHARO. The optimal method depends on the related application.

Fig. 23: Mounting methods for the scan plane



Tab. 9 provides assistance in making the selection.

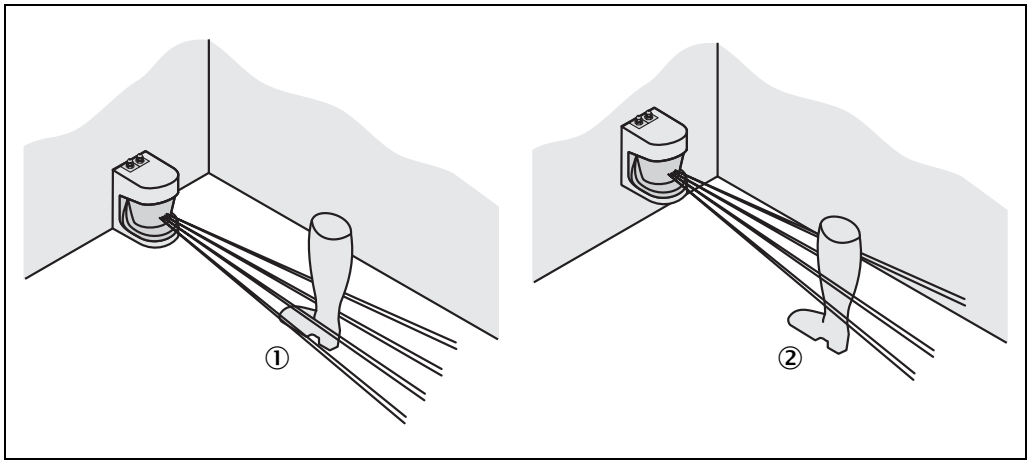
Tab. 9: Advantages and disadvantages of mounting methods

Mounting orientation	Benefit	Disadvantage
Scanner low (H_S < 300 mm) Inclination of the scanner plane low ($H_D \approx H_S$)	No external effects due to dazzle, crawling beneath not possible	Larger supplement C
Scanner high (H_S > 300 mm) Inclination of the scanner plane low ($H_D \approx H_S$)	Lower protective field supplement C	Danger of crawling beneath (at the front and side)
Scanner low (H_S < 300 mm) Inclination of the scanner plane high ($H_D > H_S$)	Lower protective field supplement C	Danger of crawling beneath (at the front), external effect due to dazzle possible
H_D = Detection height H_S = Scanner mounting height		

Height of the scan plane at 70 mm resolution

Due to the radial sampling of the protective field, the optical resolution will be lower the further away you get from the scanner.

Fig. 24: Relationship between resolution and protective field mounting height



If you choose a resolution of 70 mm in the UCS for hazardous area protection, a human leg may, in certain circumstances, not be detected. The reason in this case would be that the beams miss the ankle on the left and right ①.

If you mount PHARO higher, the scan plane is at fibula height and the leg is also detected with an object resolution of 70 mm ②.

WARNING

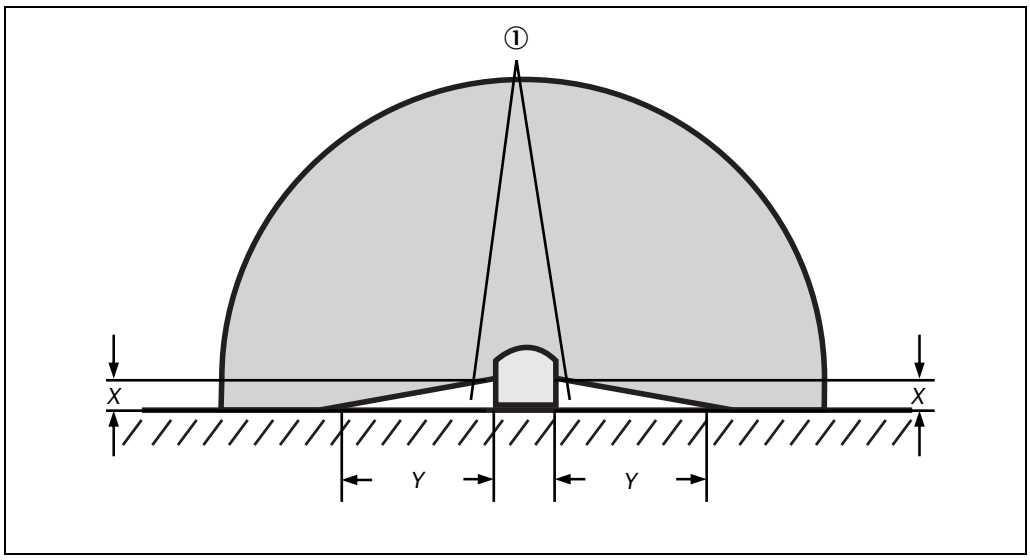
Prevent the possibility of crawling beneath the protective device if you mount it higher than 300 mm!

Prevent people from being able to crawl beneath the protective field by means of appropriate mounting of PHARO. If you mount the protective device higher than 300 mm, you must prevent crawling beneath the protective field by means of additional measures. For applications that are accessible to the public, the mounting height may need to be reduced to 200 mm (on this subject see the appropriate regulations).

4.1.2 Measures to protect areas not covered by PHARO

During mounting, areas may be found that are not covered by the safety laser scanner.

Fig. 25: Unprotected areas for stationary applications



These areas ① become larger if PHARO is mounted using the mounting kits.

Tab. 10: Size of the unprotected areas

Mounting method	Size of the unprotected areas	
	X	Y
Direct mounting	109 mm	618 mm
With mounting kit PHR B3	112 mm	635 mm
With mounting kit PHR B3 and PHR B4	127 mm	720 mm
With mounting kit PHR B3, PHR B4 and PHR B5	142 mm	805 mm

WARNING

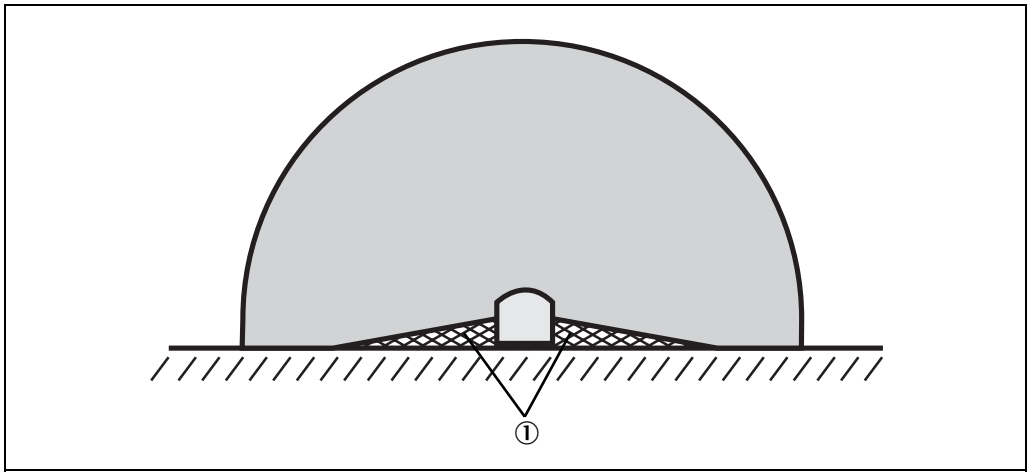
Prevent unprotected areas!

Mount PHARO such that there are no unprotected areas. Take one of the precautions given in the following:

- Fit cover plates to prevent standing behind.
- Fit PHARO in a recess.

Mounting with cover plates

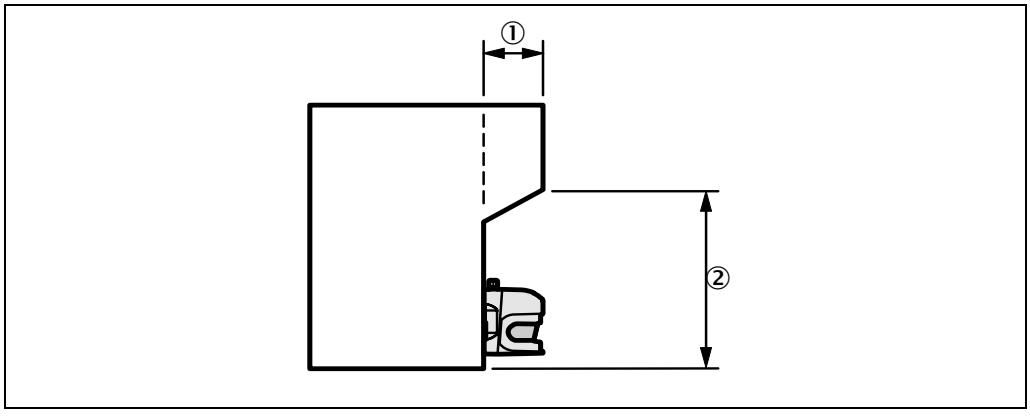
Fig. 26: Example of mounting with cover plates



- Fit the cover plates such ① that the areas not covered by the safety laser scanner are completely protected against personnel standing in them.

Mounting in a recess

Fig. 27: Form of the recess



- Design the recess ① to be sufficiently deep enough that it completely covers the area not protected by the safety laser scanner (Fig. 26) and such that standing in an unscanned area is not possible.

Important

- Prevent crawling beneath the recess by limiting the height of the recess ② such that nobody can crawl beneath.

4.2 Stationary vertical operation for access protection

Access protection can be used when the access to the machine can be defined by physical means. For access protection PHARO detects the entry of an entire body.

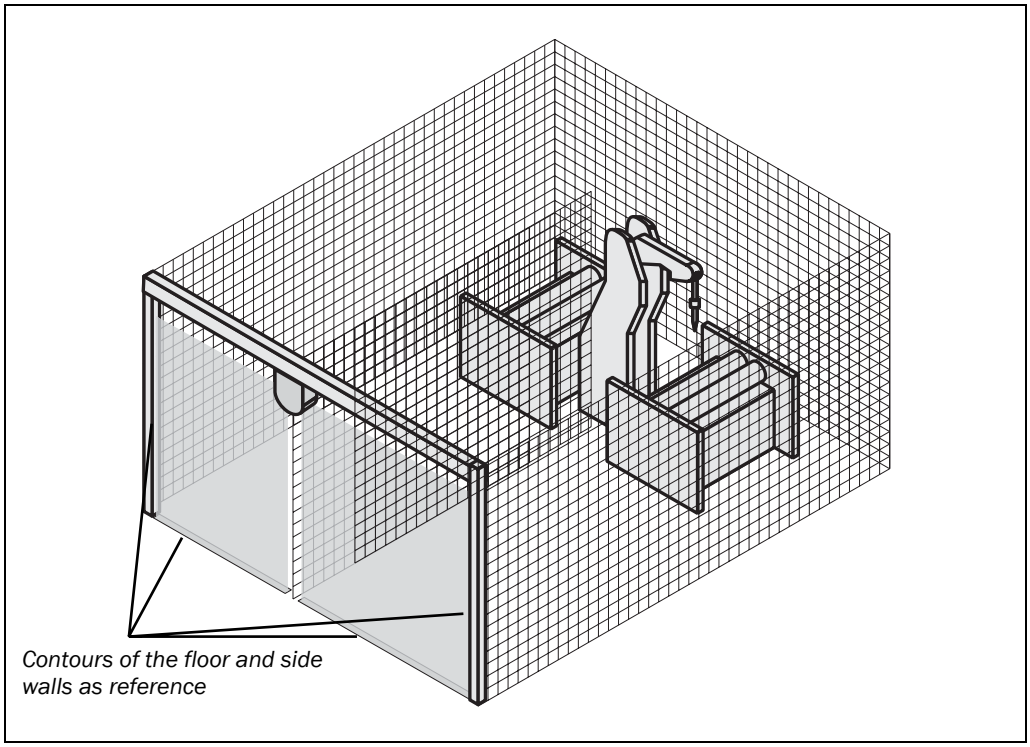
Notes

- To ensure adequate access protection, a response time of ≤ 90 ms and a resolution of 150 mm or finer is required.
- To protect the protective device against inadvertent adjustment or manipulation, you must use the contour of the surrounding area as a reference for PHARO (see chapter 3.4.3 “Using the contour of the protective field as a reference” on page 26).

4.2.1 Safety distance

For access protection, a safety distance (S) must be maintained between protective field and hazardous area. This safety distance ensures that the hazardous point can only be reached after the dangerous state of the machine has been completely stopped.

Fig. 28: Access protection



Contours of the floor and side walls as reference

The safety distance S as defined in EN 999 and EN 294 depends on:

- reach or approach speed
- stopping/run-down time of the machine or system
- response time of PHARO
- supplement C against reaching through

Calculation of the safety distance S:

➢ First, calculate S using the following formula:

$S = (K \times (T_M + T_S)) + C$

Where ...

K = Approach speed (1600 mm/s, defined in EN 999)
T_M = Stopping/run-down time of the machine or system
T_S = Response time of PHARO
C = Supplement against reaching through (850 mm)

Response time T_S of PHARO

WARNING

The overall response time of PHARO must not be more than 90 ms for access protection!

If a critical response time is exceeded (for an object diameter of 150 mm and a speed of 1.6 m/s that is 90 ms) a person may no longer be detected under certain circumstances. The critical response time is exceeded if the basic response time is too high, possibly due to multiple sampling or due to the usage of external OSSDs.

In specific cases agreed with the responsible authorities higher response times may be allowed (for example by increasing the detection time available by positioning the scanner at an angle). In this case ensure that the areas the scanner cannot see are protected by additional measures.

The response time T_S of PHARO depends on the multiple sampling used.

See chapter 11.2 “OSSD response times” on page 84.

4.3 Stationary vertical operation for hazardous point protection

Hazardous point protection is necessary if the operator must remain near the dangerous state of the machine. Hand protection must be realised for hazardous point protection.

Notes

- To provide hand protection with hazardous point protection a resolution of at least 40 mm is required. PHARO provides a maximum resolution of 30 mm.

WARNING

Never use PHARO for applications in which finger protection is required!

Due to the maximum resolution of 30 mm, PHARO is not suitable for finger protection.

- To protect the protective device against unadvertent adjustment or manipulation, you must use the contour of the surroundings as a reference for PHARO (see chapter 3.4.3 “Using the contour of the protective field as a reference” on page 26).

4.3.1 Safety distance

For hazardous point protection, a safety distance must be observed between protective field and hazardous point. This safety distance ensures that the hazardous point can only be reached after the dangerous state of the machine has been completely stopped.

You can operate PHARO with 30 mm or 40 mm resolution for hazardous point protection. At each resolution you can choose a response time between 60 ms and 120 ms (due to the proximity of the hazardous point in the majority of cases only the shorter response time can be used). The maximum protective field range and the minimum distance to the hazardous point is given by the resolution and the response time.

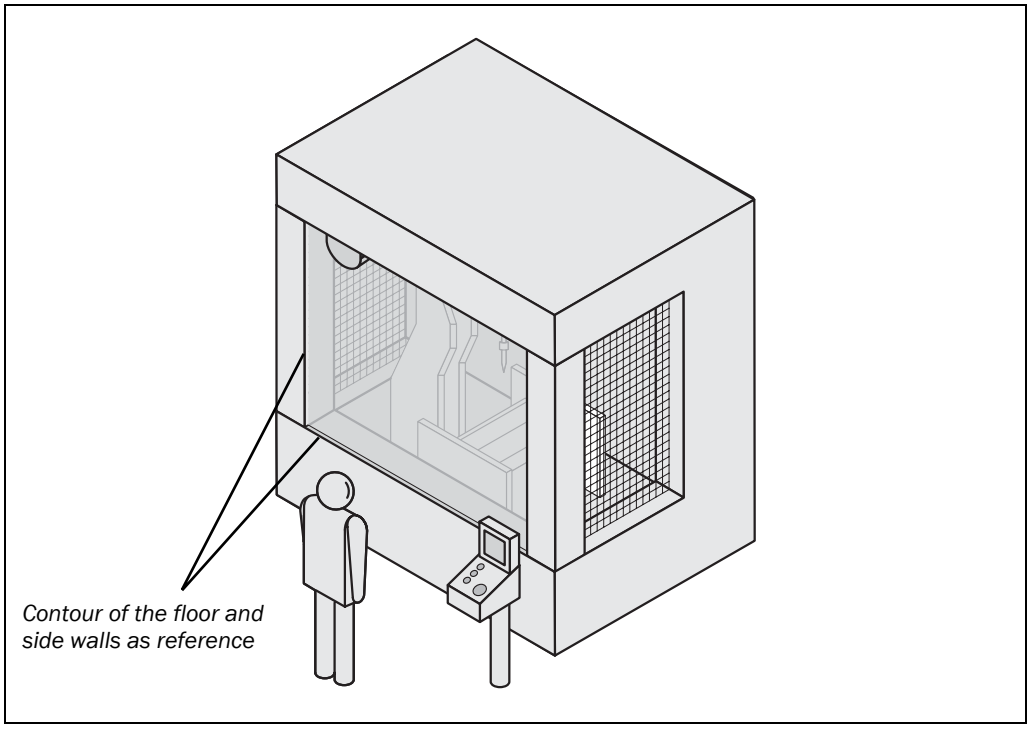
- If you choose 30 mm resolution, the protective field that can be configured is smaller (for smaller hazardous points to be protected), however you can mount PHARO nearer to the hazardous point.
- If you choose 40 mm resolution, the protective field that can be configured is larger (thus for larger hazardous points to be protected), however you must mount PHARO further away from the hazardous point.

WARNING

Danger due reaching around or reaching behind!

Always mount the scanner such that reaching around and behind is impossible. Provide suitable additional precautions as necessary.

Fig. 29: Safety distance to the hazardous area



The safety distance as defined in EN 999 and EN 294 depends on:

- stopping/run-down time of the machine or system
  (The stopping/run-down time is shown in the machine documentation or must be determined by taking a measurement.)
- response time of PHARO
- reach or approach speed
- resolution of PHARO

Calculation of the safety distance S:

➢ First, calculate S using the following formula:
$S = 2000 \times (T_M + T_S) + 8 \times (d - 14\ mm)$ [mm]

Where ...

S = Safety distance [mm]
T_M = Stopping/run-down time of the machine or system
T_S = Response time of PHARO
d = Resolution of PHARO [mm]

Note The reach/approach speed is already included in the formula.

➢ If the result S is ≤ 500 mm, then use the determined value as the safety distance.

➢ If the result S > 500 mm, you may be able to reduce the safety distance using the following calculation:
$S = 1600 \times (T_M + T_S) + 8 \times (d - 14\ mm)$ [mm]

➢ If the new value S is > 500 mm, then use the newly calculated value as the minimum safety distance.

➢ If the new value S is ≤ 500 mm, then use 500 mm as the minimum safety distance.

Response time of PHARO

The response time T_S of PHARO depends on ...

- the resolution used.
- the multiple sampling used.

See chapter 11.2 “OSSD response times” on page 84.

4.4 Mobile applications

If the dangerous state is produced by a vehicle (e.g. AGV or fork lift), the hazardous area that is produced by the movement of the vehicle is protected by PHARO.

Notes

- PHARO may only be used to protect vehicles powered by electric motor.
- Due to the movement of PHARO in a mobile application, a resolution of 70 mm is sufficient for the detection of people.
- In the following calculations only take into account the velocity of the vehicle, not the speed of the person walking. This is based on the assumption that the person will recognise the danger and stand still.
- If the application is to protect vehicles from collisions, then you may need to make different assumptions. These are very specific and can therefore not be described within this manual. Contact the relevant authorities and clarify the assumptions that must be taken into account with regard to your application.

For a horizontally mounted mobile application, determine:

- protective field length
- protective field width
- height of the scan plane
- restart behaviour
- methods of preventing unprotected areas

4.4.1 Protective field length

You must configure the protective field such that a safety distance to the vehicle is maintained. This ensures that a vehicle monitored by PHARO comes to a stop before a person or object is reached.

You can define two different monitoring cases with different protective fields. You can switch these using the static control inputs.

Calculation of the protective field length:

➢ Calculate the necessary protective field length using the formula:

$S_L = S_A + Z_G + Z_R + Z_F + Z_B$

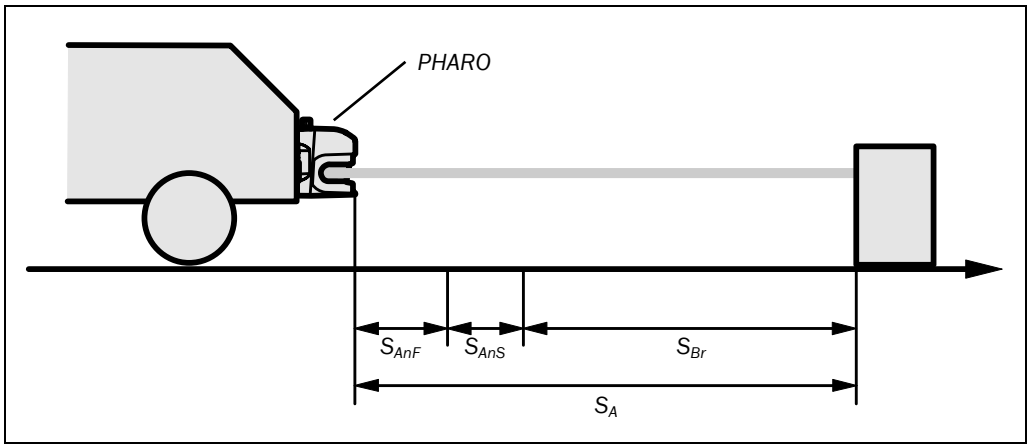
Where ...

S_A = Stopping distance
Z_G = General safety supplement = 100 mm
Z_R = Supplement for any measurement error of PHARO related to reflection
Z_F = Supplement for any lack of ground clearance of the vehicle
Z_B = Supplement for the reduction in the braking performance of the vehicle as defined in the related vehicle documentation

Stopping distance

The stopping distance comprises the braking distance for the vehicle, the distance covered during the response time of the safety laser scanner and the response time of the vehicle controller.

Fig. 30: Stopping distance



Note Take into account that the braking distance for a vehicle is not linear with increasing velocity, but increases in a square function. This is particularly important if you switch the protective field length as a function of the velocity using incremental encoders.

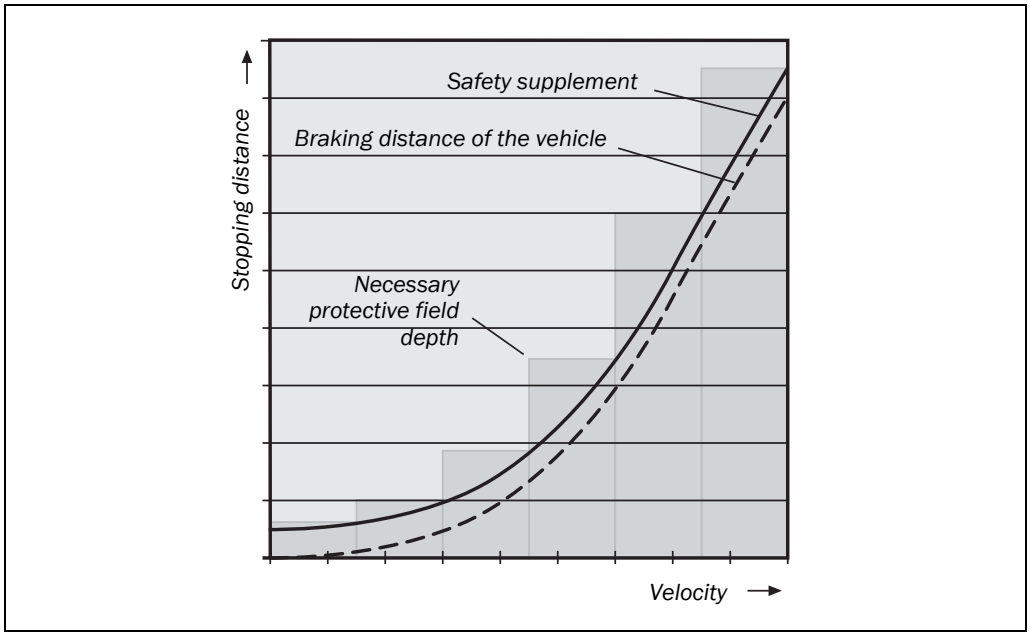


Fig. 31: Braking distance as a function of the vehicle velocity

Calculation of the stopping distance:

➢ Calculate the stopping distance using the formula:

$S_A = S_{Br} + S_{AnF} + S_{AnS}$

Where ...

S_{Br} = Braking distance from the vehicle documentation

S_{AnF} = Distance covered during the response time of the vehicle controller from the vehicle documentation

S_{AnS} = Distance covered during the response time of the safety laser scanner

Distance covered during the response time of the safety laser scanner

The distance covered during the response time of the safety laser scanner depends on ...

- the response time of the safety laser scanner.
- the maximum velocity of the vehicle in your mobile application.

The response time T_S of PHARO depends on the multiple sampling used.

See chapter 11.2 “OSSD response times” on page 84.

Calculation of the distance covered during the response time of the safety laser scanner:

➢ Calculate the distance using the formula:

$S_{AnS} = T_S \times V_{max}$

Where ...

T_S = Response time of the safety laser scanner

V_{max} = Maximum velocity of the vehicle from the related vehicle documentation

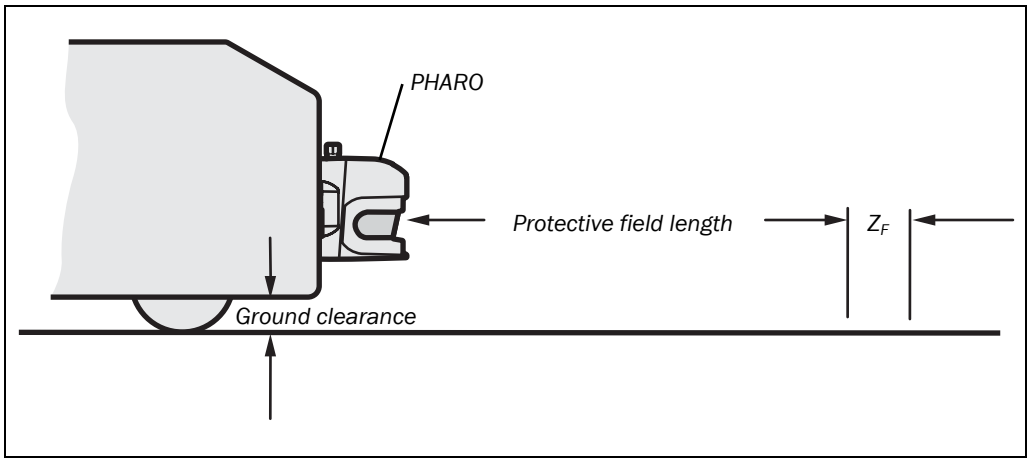
Supplement Z_R for measurement error related to reflection

With retroreflectors in the background at a distance of less than 1 m from the boundary of the protective field, the supplement Z_R is 200 mm.

Supplement due to lack of ground clearance

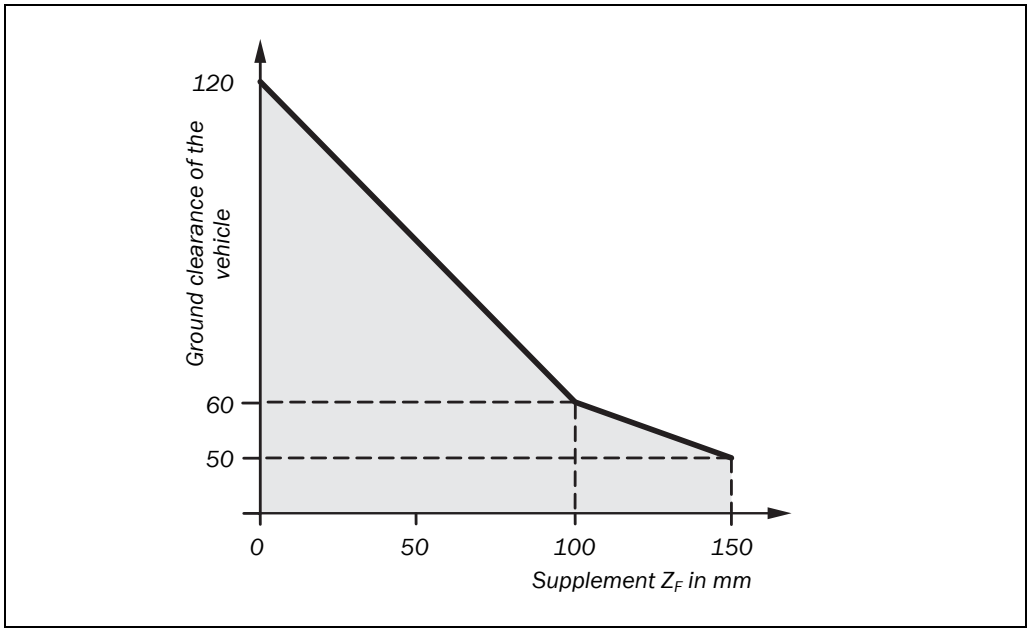
This supplement is necessary because a person is generally detected above the foot and the braking action can therefore not take into account the length of the foot in front of the detection point. If a vehicle has no ground clearance, a person may receive foot injuries.

Fig. 32: Supplement due to lack of ground clearance



➢ The supplement for foot space below 120 mm is 150 mm. If you wish to further reduce this supplement, read the supplement necessary from the following diagram:

Fig. 33: Diagram of ground clearance of the vehicle



4.4.2 Protective field width

The width of the protective field must take into account the width of the vehicle, the supplements for the measurement error and the lack of ground clearance.

Calculation of the protective field width:

➢ Calculate the protective field width S_B using the formula:

$S_B = F_B + 2 \times (Z_G + Z_R + Z_F)$

Where ...

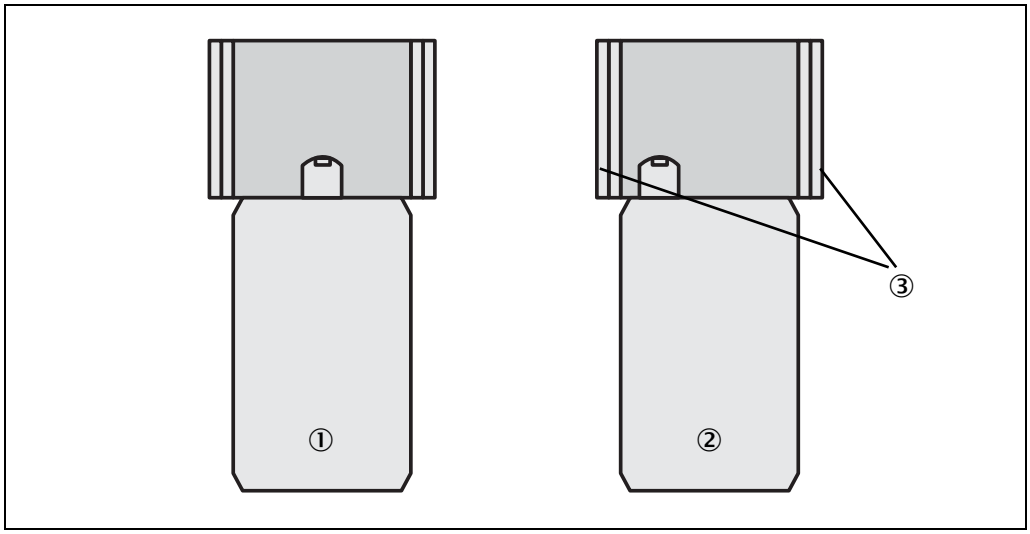
F_B = Vehicle width

Z_G = General safety supplement = 100 mm

Z_R = Supplement for any measurement error of PHARO related to reflection

Z_F = Supplement for any lack of ground clearance of the vehicle

Fig. 34: Protective field width



Note Normally you will mount PHARO in the middle of the vehicle ①. If this is not the case, then you must define the protective field asymmetrically ②. (The UCS represents the fields as they appear in the monitoring on the scanner.) Ensure that there are supplements on the right and left of the vehicle ③.

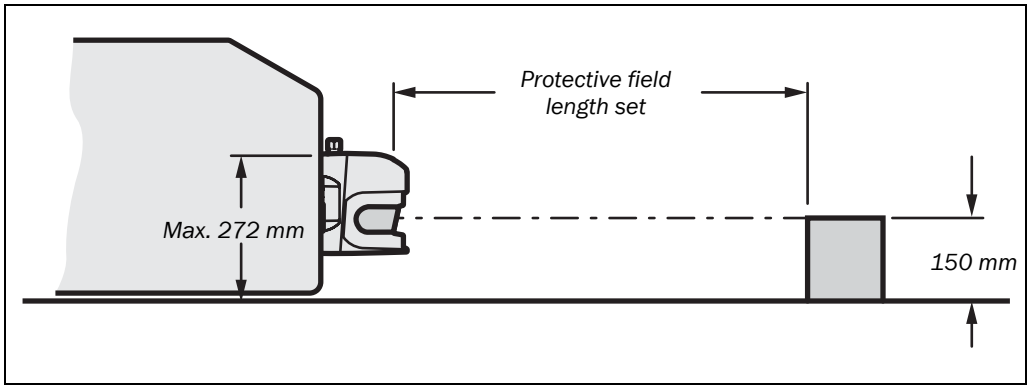
4.4.3 Height of the scan plane

WARNING

Mount PHARO such that the scan plane is at a maximum height of 200 mm!

Any body lying flat on the floor will be reliably detected. Tilting the protective field, which will result in objects with a diameter of 200 mm not being detected, is not allowed. We recommend aligning the scan plane at 150 mm.

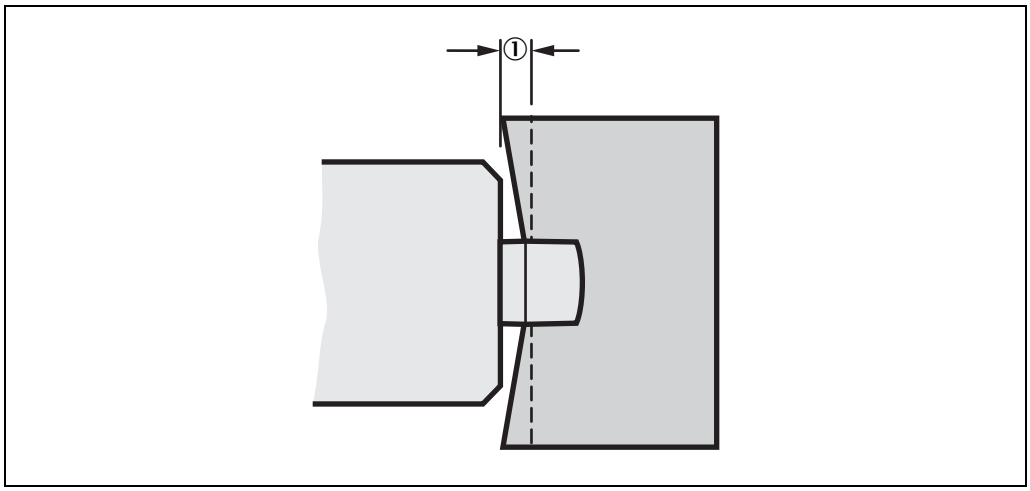
Fig. 35: Mounting height



4.4.4 Methods of preventing unprotected areas

When PHARO is mounted on a plane surface, there are areas in front of the mounting surface that are not covered by the safety laser scanner.

Fig. 36: Unprotected areas for mobile applications



These unprotected areas ① become larger if you mount PHARO using mounting kits.

Tab. 11: Unprotected areas

Mounting method	Size of the unprotected areas
Direct mounting	109 mm
With mounting kit PHR B3	112 mm
With mounting kit PHR B3 and PHR B4	127 mm
With mounting kit PHR B3, PHR B4 and PHR B5	142 mm

WARNING

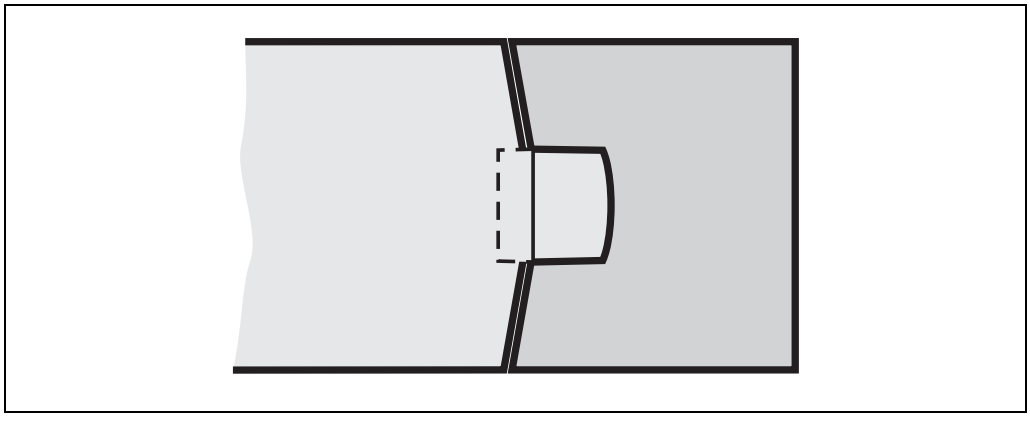
Secure the unprotected areas!

If the vehicle is accelerated to a maximum velocity of 0.3 m/s in less than three seconds when in operation, you must prevent personnel from entering the unprotected areas by means of mechanical trim panels, switch strips or fitting PHARO in the vehicle trim panels.

Fitting in the vehicle trim

Build PHARO into the vehicle trim such that the unprotected areas are ≤ 70 mm and PHARO projects a maximum of 109 mm beyond the front of the vehicle. The vehicle may then be accelerated to a velocity of 0.3 m/s within a second.

Fig. 37: Fitting PHARO in the vehicle trim



Aditionally, protect the area near to the scanner (5 cm wide area in front of the front screen) using a proximity switch with 5 cm acquisition range. Otherwise make the area near the scanner impassable with a bar or a recess. The vehicle may then be accelerated as required.

Note Note that the system must be fitted e.g. in a trim panel without impairing the optical beam path. The attachment of an additional front screen is thus not permitted. Any slot for the field of view must be adequately sized (see Fig. 69 in chapter 11.5 “Dimensional drawings” on page 96).

Recommendation If, when observing all necessary safety precautions, you are able to avoid the use of a restart interlock, you will increase the availability of your vehicle.

4.5 Timing for monitoring case switching

If you switch between several monitoring cases, along with the safety distance to the dangerous state there is a further safety-relevant aspect that you must address.

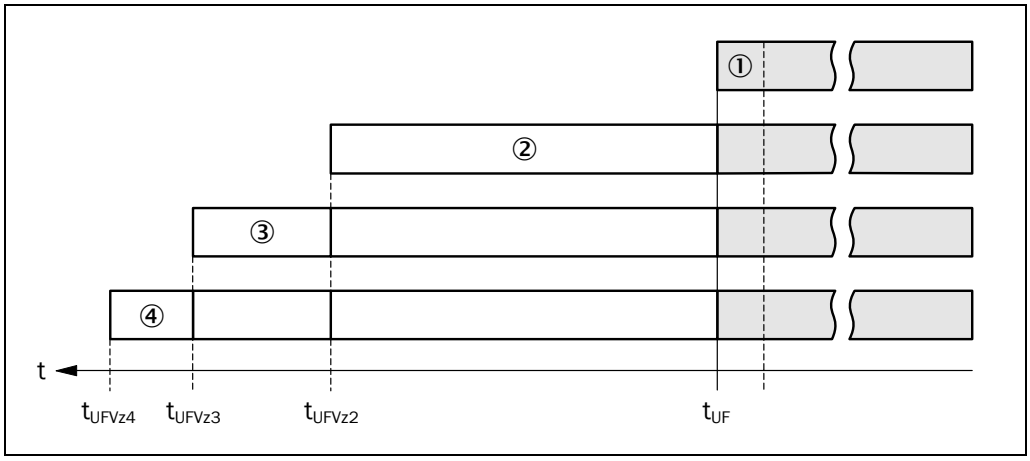
If you can switch within 10 or 20 ms, the chosen protective field is available within the response time of PHARO. For this reason you can initiate the switching at the time at which you actually want to switch from one monitoring case to the other.

However, you must advance the timing of the switching if you ...

- have entered an input delay for your switching method (see section “
- Input delay” on page 33).

The following diagram shows the relationships:

Fig. 38: Advancement for the switch timing



- If the input conditions are present at the control inputs within 10 or 20 ms (cf. ①), the timing for the switching (t_{UF}) does not need to be advanced.
- If an input delay for the control inputs needs to be taken into account (cf. ②), the timing for the switching (t_{UFVz2}) must be advanced by the input delay.
- If external OSSDs are used, the timing for the switching (t_{UFVz4}) must be further advanced by 20 ms (cf. ④).

WARNING

Define the timing for the switching such that PHARO already detects a person in the protective field before the dangerous state occurs!

At the time of the switching there may be personnel in the protective field. Only by means of switching in the correct time frame (i.e. before the hazard occurs at this point for the person) is protection provided.

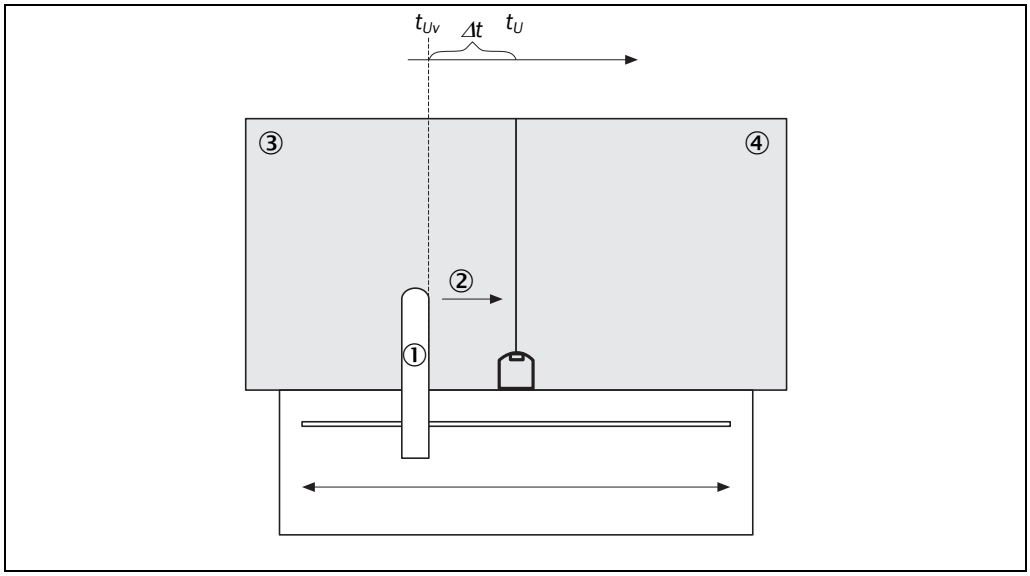
Note

- In the phases before and after the switching, the safety distances calculated for the individual monitoring cases apply on their own.
- The considerations above serve only for the selection of the optimal timing of the switching.

- If the timing for the switching cannot be exactly defined, e.g. due to the variable processing speed of the machine, or if advancing of the timing results in premature termination of the monitoring of the initial area, you must ...
  - allow the two protective fields to partially overlap.
  - have both hazardous areas monitored temporarily using simultaneous monitoring.

The following figure shows an example for a gantry robot that is protected using two monitoring cases.

Fig. 39: Example of advancing the timing for the switching



The gantry robot ① moves to the right ②. On the left hand side the dangerous movement is monitored by a monitoring case ③. When the gantry robot arrives at the point t_{Uv}, switching must have already been performed due to the advancing of the switching necessary so that at time t_U the right monitoring case ④ is active.

Note For the movement to the left, that is for the switching to the monitoring case ③, the same applies.

How far you must advance the timing for the switching depends on ...

- the input delay your switching method requires to provide the input condition for case switching (see section " Input dlay" on page 33).

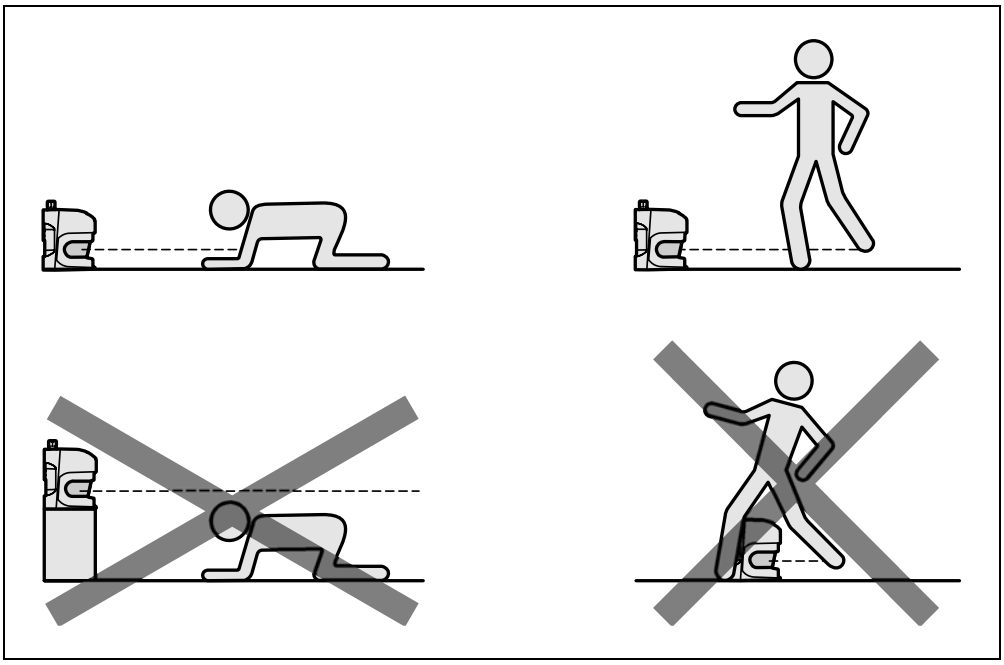
4.6 Mounting steps

WARNING

Special features to note during mounting:

- Mount PHARO such that it is protected from moisture, dirt and damage.
- Ensure that the front screen field of view is not restricted.
- Mount the scanner such that the indicators are easy to see.
- Always mount PHARO such that you can plug in and remove the system plug.
- Avoid excessive shock and vibration loading on the safety laser scanner.
- On applications that suffer from heavy vibration, prevent the fixing screws from coming loose using screw locking devices.
- Regularly check the tightness of the fixing screws.
- Prevent personnel from being able to crawl beneath, stand behind or climb over the protective field by means of appropriate mounting of PHARO.

Fig. 40: Prevent crawling beneath, standing behind, climbing over



The origin of the scan plane is 63 mm above the bottom edge of PHARO. If you mount PHARO using mounting kit PHR B5, then the origin of the scan plane is 102 mm above the bottom edge of mounting kit PHR B5 (see chapter 11.5.3 “Scan plane origin” on page 97).

There are four possible ways of fixing PHARO:

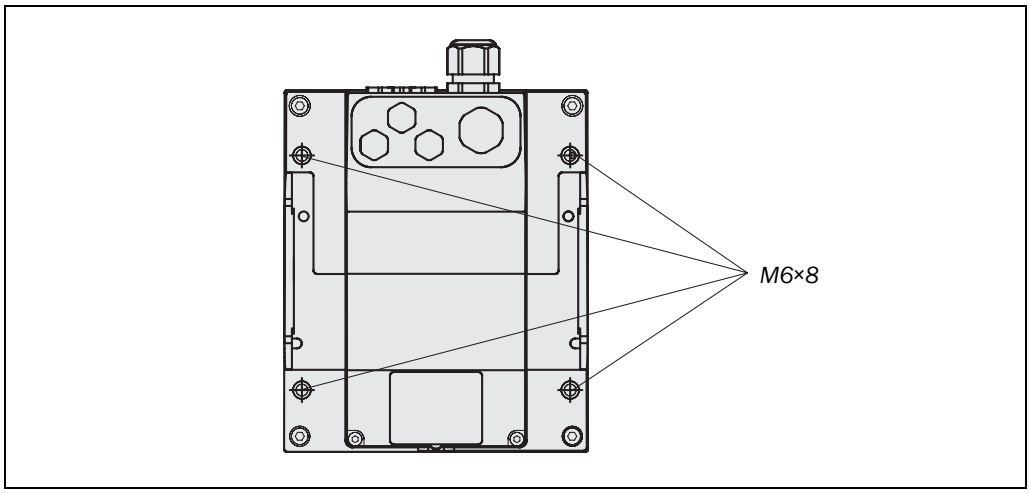
- direct mounting without mounting kit
- mounting with mounting kit PHR B3
- mounting with mounting kit PHR B3 and PHR B4
- mounting with mounting kit PHR B3, PHR B4 and PHR B5

The mounting kits build one on another. For fixing with mounting kit PHR B4 you will therefore also need mounting kit PHR B3. For fixing with mounting kit PHR B5 you will therefore also need mounting kits PHR B3 and PHR B4. You will find the part numbers for the mounting kits in chapter 12.3.1 “Mounting kits” on page 98.

4.6.1 Direct mounting

PHARO has four threaded holes M6×8 on its rear face. Using these holes you can directly mount PHARO by drilling through the mounting surface from the rear.

Fig. 41: Threaded holes for direct mounting

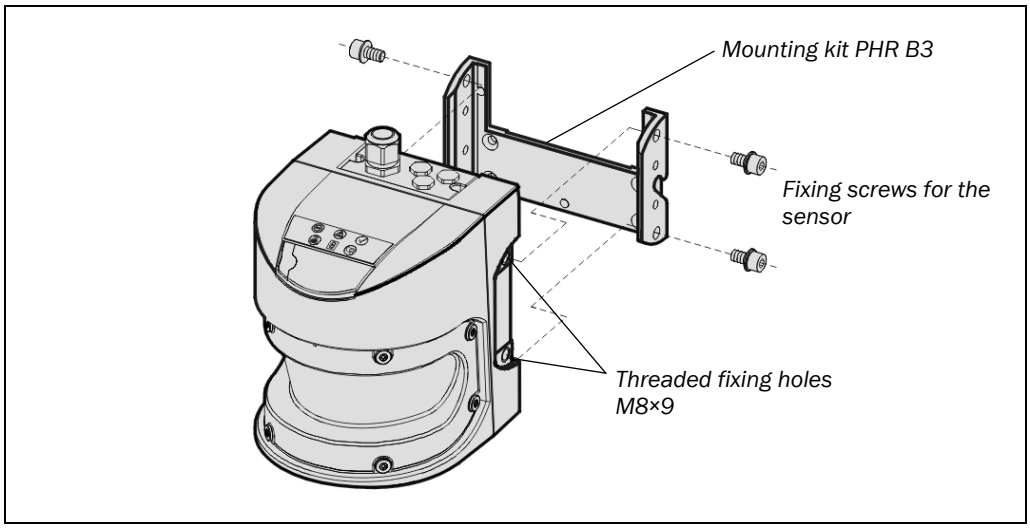


Recommendation Use at least mounting kit PHR B3. This will make the device easier to remove.

4.6.2 Mounting with mounting kit PHR B3

With the aid of mounting kit PHR B3 you can mount PHARO indirectly on the mounting surface. This is always necessary if you cannot drill through the mounting surface from the rear.

Fig. 42: Mounting with mounting kit PHR B3



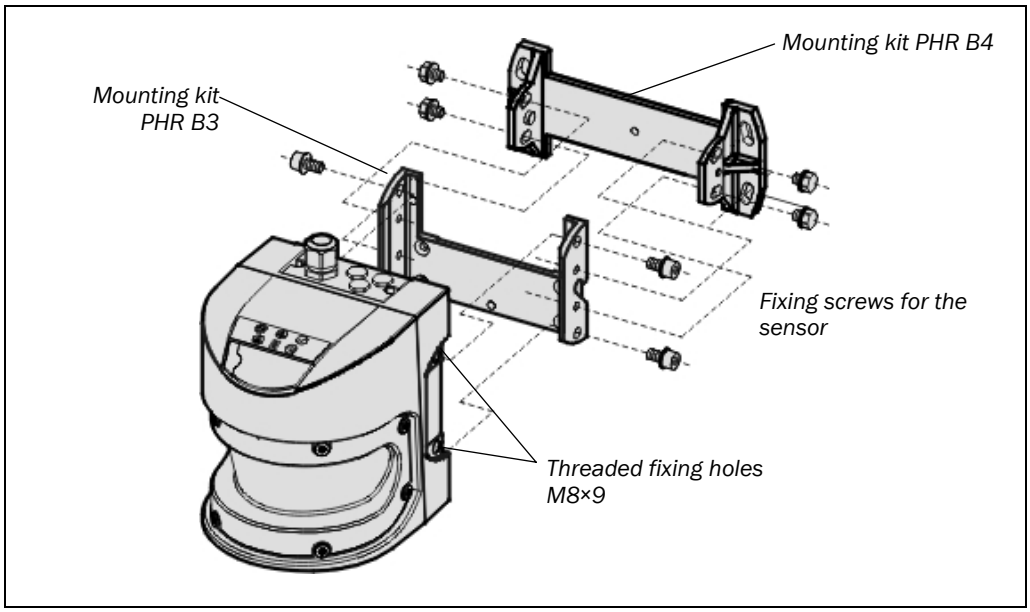
➢ Mount the mounting kit PHR B3 on the mounting surface.

➢ Then mount PHARO on the mounting kit PHR B3.

4.6.3 Mounting with mounting kit PHR B4

With the aid of mounting kit PHR B4 (only in conjunction with mounting kit PHR B3) you can align PHARO in two planes. The maximum adjustment angle is ±11° in both planes.

Fig. 43: Mounting with mounting kit PHR B4

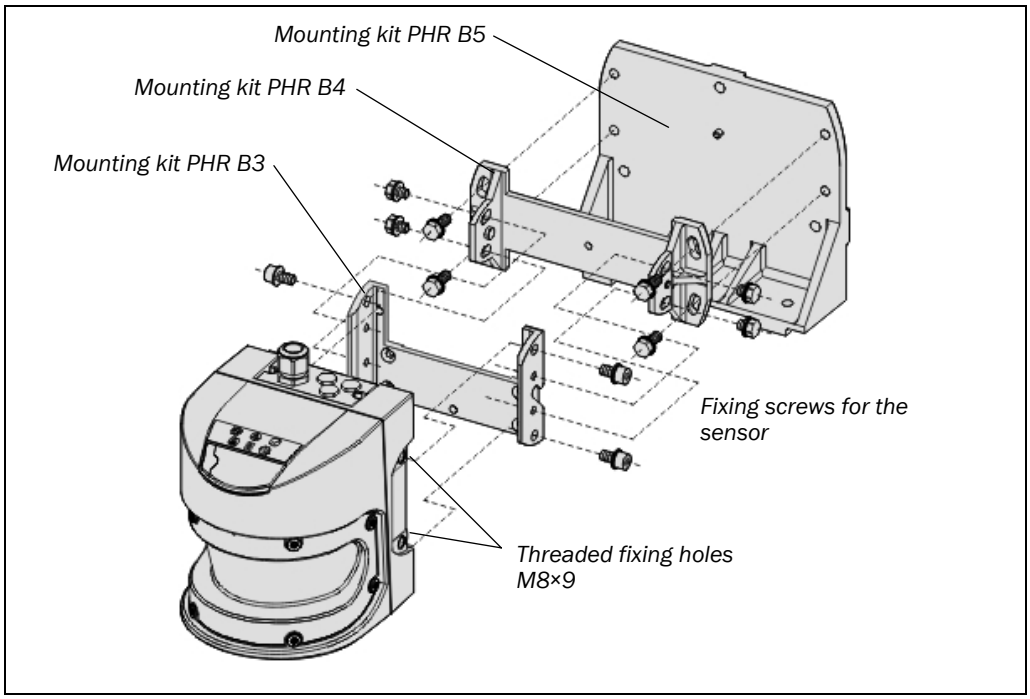


- Mount the mounting kit PHR B4 on the mounting surface.
- Then mount mounting kit PHR B3 on mounting kit PHR B4.
- Then mount PHARO on mounting kit PHR B3.
- Adjust PHARO longitudinally and cross-wise.

4.6.4 Mounting with mounting kit PHR B5

With the aid of mounting kit PHR B5 (only in conjunction with mounting kits PHR B3 and PHR B4) you can mount PHARO such that the scan plane is parallel to the mounting surface. This enables stable floor mounting or ensures that mounting kit PHR B4 remains precisely adjustable cross-wise on uneven wall surfaces.

Fig. 44: Mounting with mounting kit PHR B5



- Mount mounting kit PHR B5 on the mounting surface.
- Then mount mounting kit PHR B4 on mounting kit PHR B5.
- Then mount mounting kit PHR B3 on mounting kit PHR B4.
- Finally mount PHARO on mounting kit PHR B3.
- Adjust PHARO longitudinally and cross-wise.

Note During mounting, please observe the dimensional drawings in chapter “Technical specifications” (see section 11.5 “Dimensional drawings” on page 96).

4.6.5 Adhesive label Important information

- On completion of mounting, you must affix the self-adhesive label **Important information** supplied with PHARO:
  - Use only the information label in the language which the operators of the machine understand.
  - Affix the label such that it is clearly visible for the users/operators during operation. The label must not be covered even after additional items have been mounted.

4.6.6 Using multiple safety laser scanners PHARO

PHARO is so designed that mutual interference between several scanners is unlikely. To completely exclude erroneous switching, you must mount the scanners as shown in the following examples.

Note In any circumstance observe EN 999.

Use mounting kits PHR B3 to PHR B5 to adjust the scanners to different angles (see chapter 12.3.1 “Mounting kits” on page 98).

Fig. 45: Opposite mounting

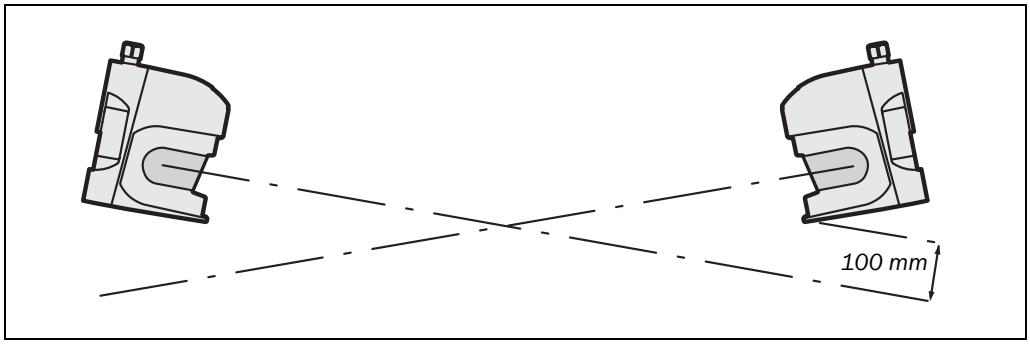


Fig. 46: Inclined, parallel mounting

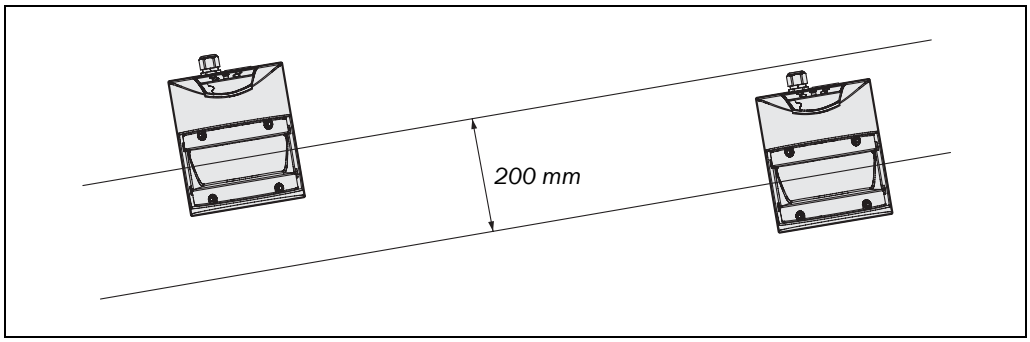


Fig. 47: Offset parallel mounting

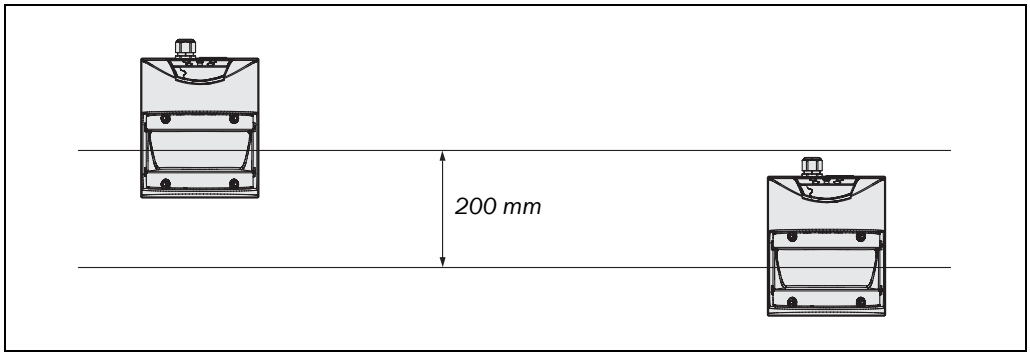


Fig. 48: Mounting on a cross

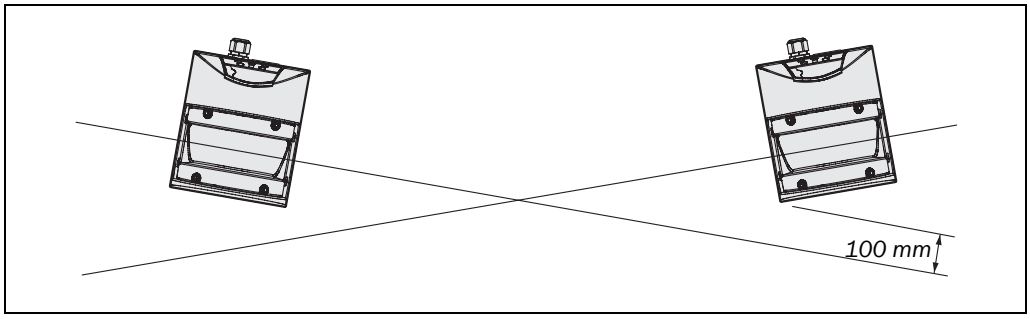
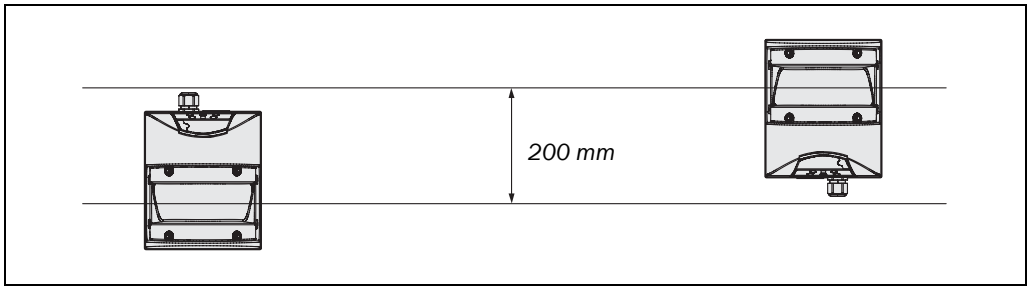


Fig. 49: Reverse mounting, parallel



5 Electrical installation

WARNING

Switch the entire machine/system off line!

The machine/system could inadvertently start up while you are connecting the devices.

➢ Ensure that the entire machine/system is disconnected during the electrical installation.

Notes

➢ Route all cables and connection cables such that they are protected from damage.

➢ If you use PHARO for the protection of hazardous areas: Ensure that any control systems or other devices forming part of the safety installation meet the stipulated control category!

➢ If you use screened cable, lay the screen evenly around the cable fitting.

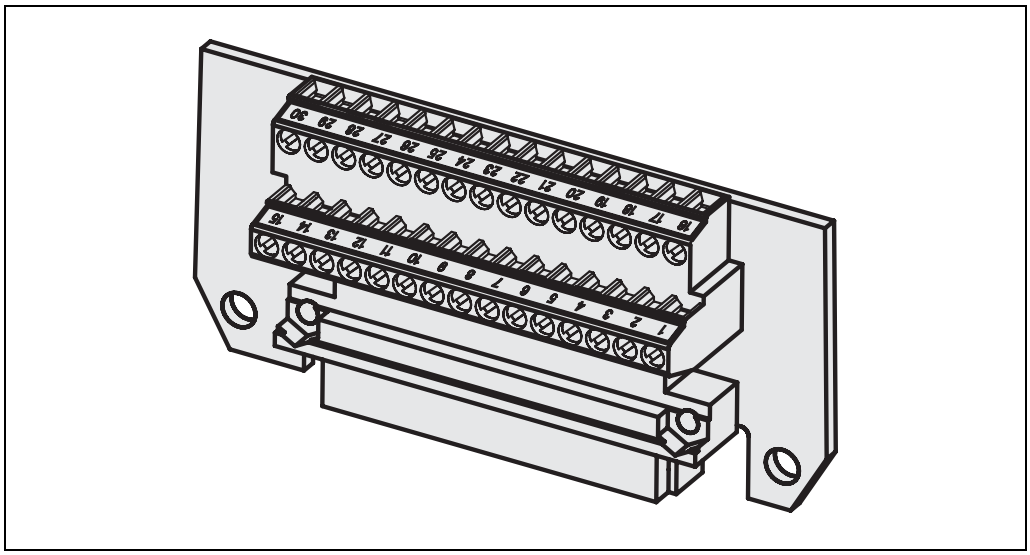
➢ Ensure that PHARO is adequately protected electrically. You will find the electrical data necessary for determining the correct fuse in chapter 11.4 “Data sheet” on page 89.

The electrical connections for PHARO are made at the system plug. It contains connections for the inputs, outputs and the supply voltage. You can either make connections directly to the terminal strip on the system plug or use a pre-assembled system plug from REER (see chapter 5.3 “Pre-assembled system plugs” on page 62).

5.1 System connection

All inputs and output connections for PHARO are located on the system connector. This comprises of a 30-pin screw terminal connector and is located in the system plug.

Fig. 50: Screw terminal strip on the system plug



Note

- If the cable fitting is missing or not tightened, or if fixing screws are missing or not tightened on the system plug, the IP 65 enclosure rating is not met.
- All inputs and outputs for PHARO are to be used only in the context specified.

5.1.1 Pin assignments of the I/O modules

Tab. 12: Pin assignments of the I/O modules

Pin	Signal	Function
1	+24V DC	Supply voltage PHARO
2	0V DC	Supply voltage PHARO
3	OSSD1	Output signal switching device
4	OSSD2	Output signal switching device
5	RESET	Input, reset
6	EDM	Input, external device monitoring
7	ERR	Application diagnostic output — error/contamination
8	RES_REQ	Output, reset required
9	WF	Output, object in warning field
10	A1	Static control input A
11	A2	Static control input A
12 - 24	N.C.	
25	RxD–	RS-422 interface for output of measured data
26	RxD+	
27	TxD+	
28	TxD–	
29	N.C.	
30	N.C.	

5.2 System plug assembly

The system plug has holes on the top and rear. Suitable cable glands for these holes are included with the device.

- system plug PHR C3 for PHARO:
  - 1 cable gland without M12 cable fitting (blanking plug)
  - 1 cable gland with M20 cable fitting
  - 2 blanking plugs for the unused outlets

Note

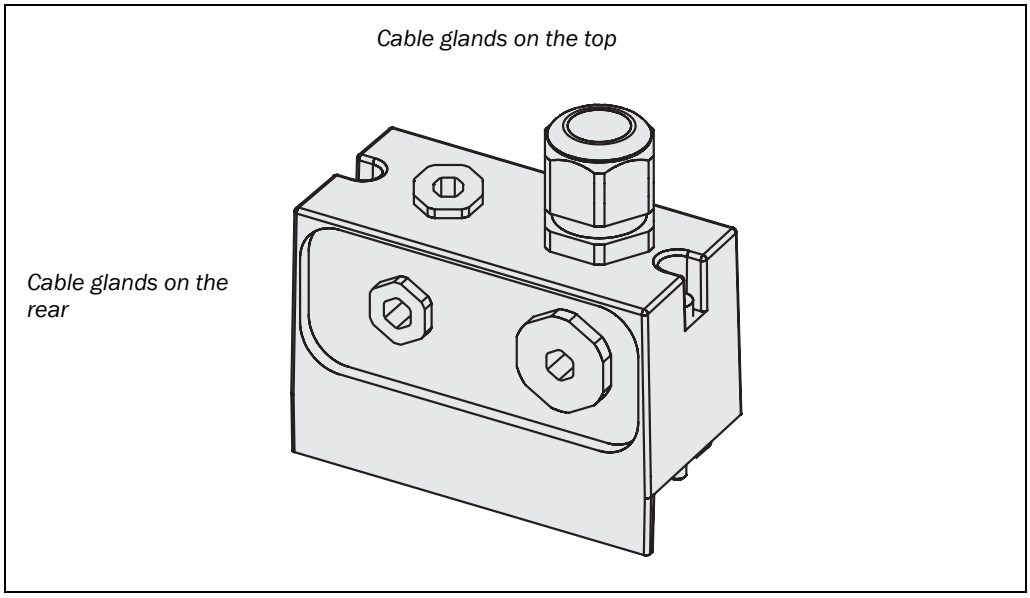
You can also purchase PHARO with pre-assembled system plug with various 5m cable lengths (see chapter 5.3 “Pre-assembled system plugs” on page 62 and chapter 12.3.2 “System plug” on page 98).

WARNING

The length of the spare cable should be such that the system plug cannot inadvertently be plugged into a neighbouring PHARO!

From experience 20 to 30 cm spare cable at the scanner have proven to adequate. In this way you avoid the inadvertent connection of the system plug to a neighbouring PHARO and operation of an PHARO with an incorrect configuration. The spare cable enables you to change PHARO with ease if necessary.

Fig. 51: System plug PHR C3 for PHARO



Depending on the application use suitable cable glands on the top or rear.

Tab. 13: Use the cable glands supplied

Cable gland	Cable diameter	Usage
M20	6–12 mm	• System cables (supply voltage, outputs, static inputs)
M12 (only if supplied)	3–6.5 mm	• Control switch for restart or reset • RS-422 data cables

Use the following cable cross-sections for the individual connections:

Tab. 14: Recommended cable cross-sections

Cable	Recommended cable	Screened
System cables (supply voltage, outputs, static inputs)	9–13 cores, 0.5–1 mm²	No
Control switch for restart or reset	2 × 0.25 mm²	No
RS-422 data cables	4 × 0.25 mm²	Yes

Recommendation

If you do not want to assemble the system plug yourself, you will find suitable cables in the ordering information.

5.3 Pre-assembled system plugs

The following pre-assembled system plugs with cable outlet on the top are available for the connection of PHARO variants (see also chapter 12.3.2 “System plug” on page 98):

- PHR C3L5
  - for PHARO Advanced
  - with 13 unscreened cores
  - 5 mm long

Tab. 15: Pin assignment: pre-assembled system plug

Pin	Signal	Wire colour	
1	+24V DC	Brown	
2	0V DC	Blue	
3	OSSD1	Grey	
4	OSSD2	Pink	
5	RESET	Red	
6	EDM	Yellow	
7	ERR	White/black	
8	RES_REQ	Red/blue	
9	WF	White/brown	
10	A1	White/red	
11	A2	White/orange	
12	N.C.	White/yellow	
13	N.C.	White/green	
Number of top mounted cable entries (cable glands to the rear sealed with blanking plugs)			2

6 Application and circuit examples

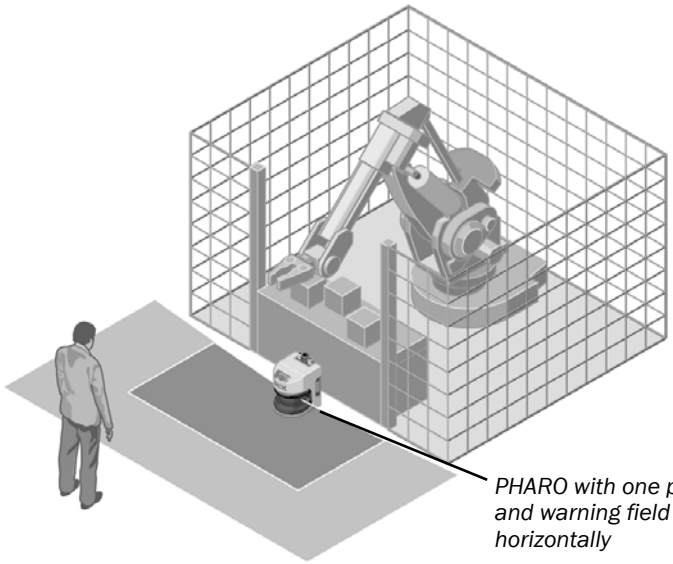
The examples shown are only provided as an aid for your planning. You may need to consider additional protection measures for your application.

In the examples with protective field switching, note that at the time of the switching there may already be a person in the protective field. Only by means of switching in the correct time frame (i.e. before the danger occurs at this point) is reliable protection provided (see chapter 4.5 “Timing for monitoring case switching” on page 52).

6.1 Stationary applications

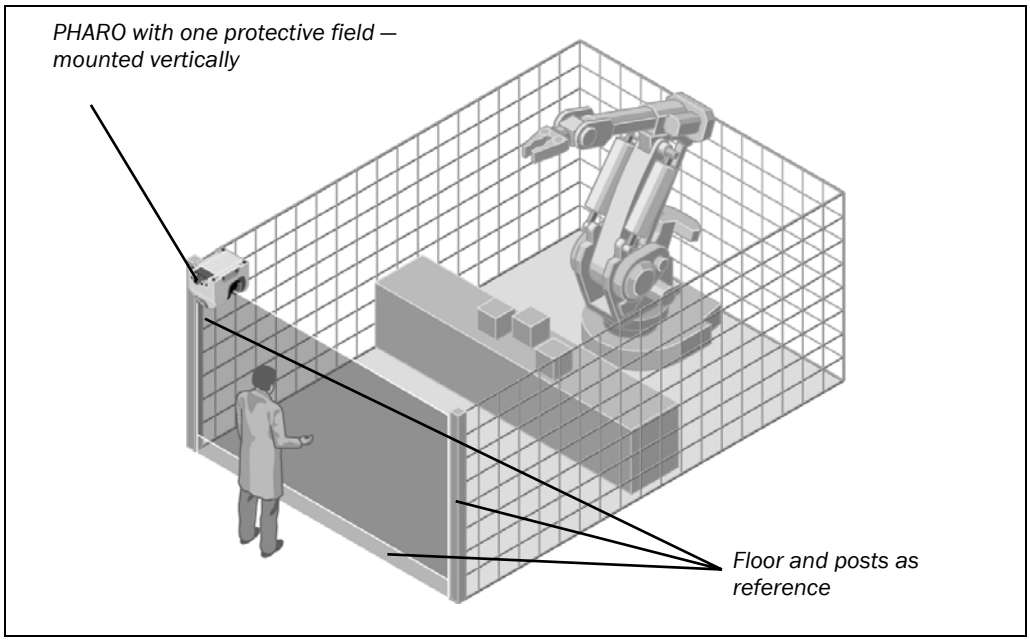
6.1.1 Applications with one monitored area (PHARO)

Fig. 52: Hazardous area protection with PHARO



The area is permanently monitored by PHARO.

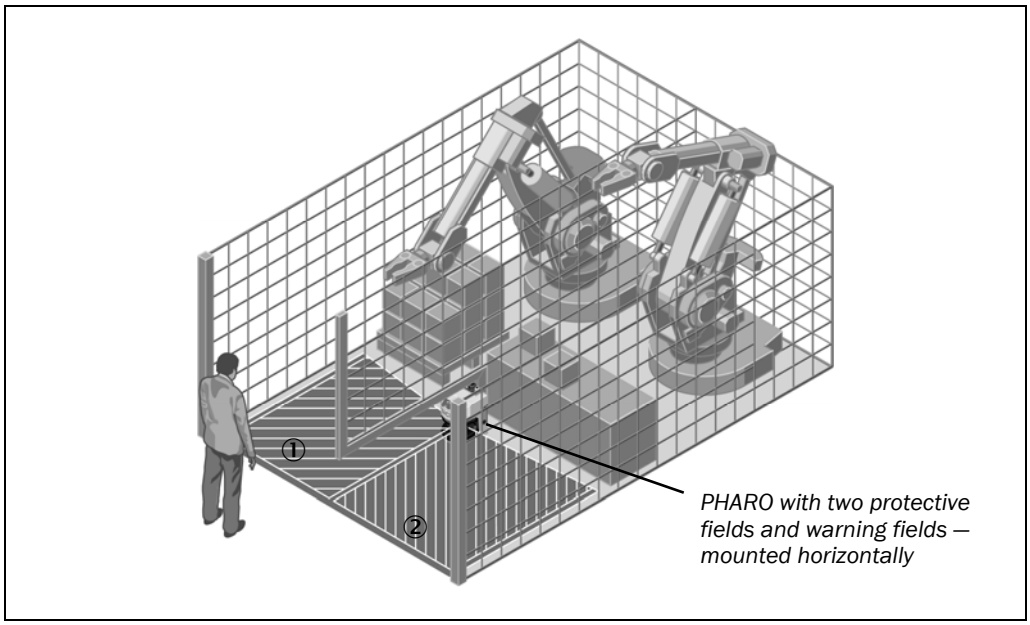
Fig. 53: Access protection with PHARO



The access is monitored permanently. For safety against manipulation on PHARO, e.g. the floor is used as a reference. If the alignment of PHARO changes (e.g. due to change to the mounting), PHARO shuts down.

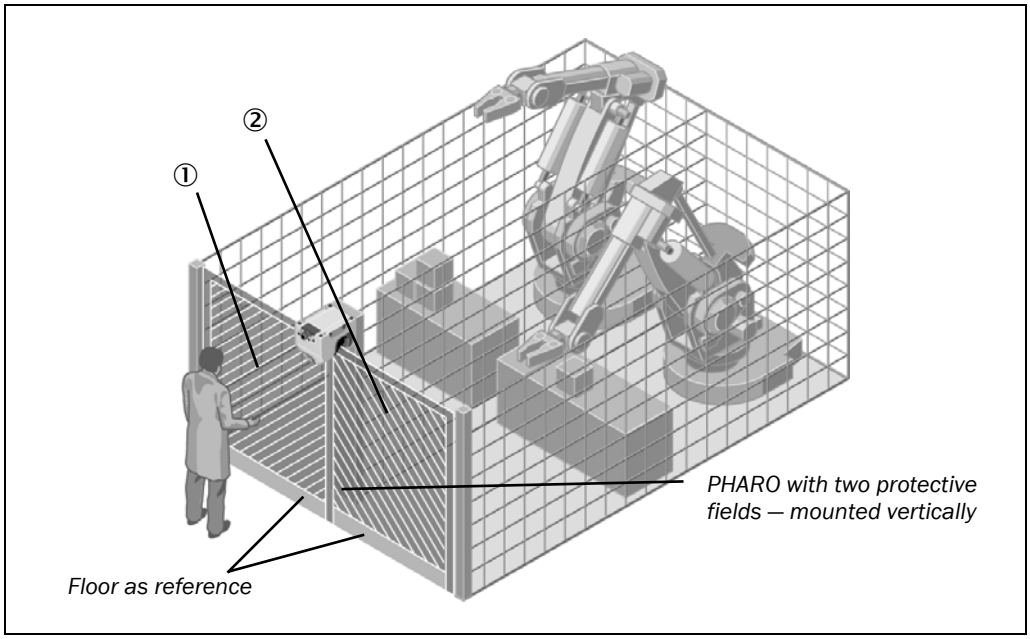
6.1.2 Applications with multiple monitored areas (PHARO)

Fig. 54: Hazardous area protection with PHARO



The two areas to be monitored are switched using the static control inputs depending on the phase of the process on the machine. For example the area ① or the area ② can be monitored, both areas can be monitored or none.

Fig. 55: Access protection with PHARO

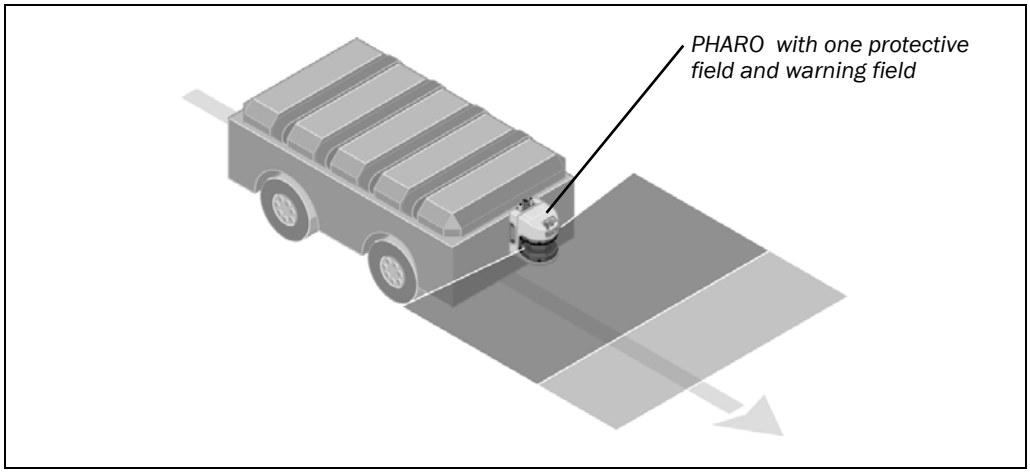


The two areas to be monitored are switched using the static control inputs depending on the process phase. For example the area ① or the area ② can be monitored, both areas can be monitored or none. For safety against manipulation on PHARO, e.g. the floor is used as a reference in each case. If the alignment of PHARO changes (e.g. due to change to the mounting), PHARO shuts down.

6.2 Mobile applications

6.2.1 Vehicle monitoring for unidirectional travel

Fig. 56: Vehicle monitoring with PHARO



PHARO monitors the area in one direction of travel and stops the vehicle as soon as there is an object in the protective field.

6.3 Example circuits

Note Only use relays with positively-driven contacts. The protection elements connected in parallel with the contactors are used for arc-suppression.

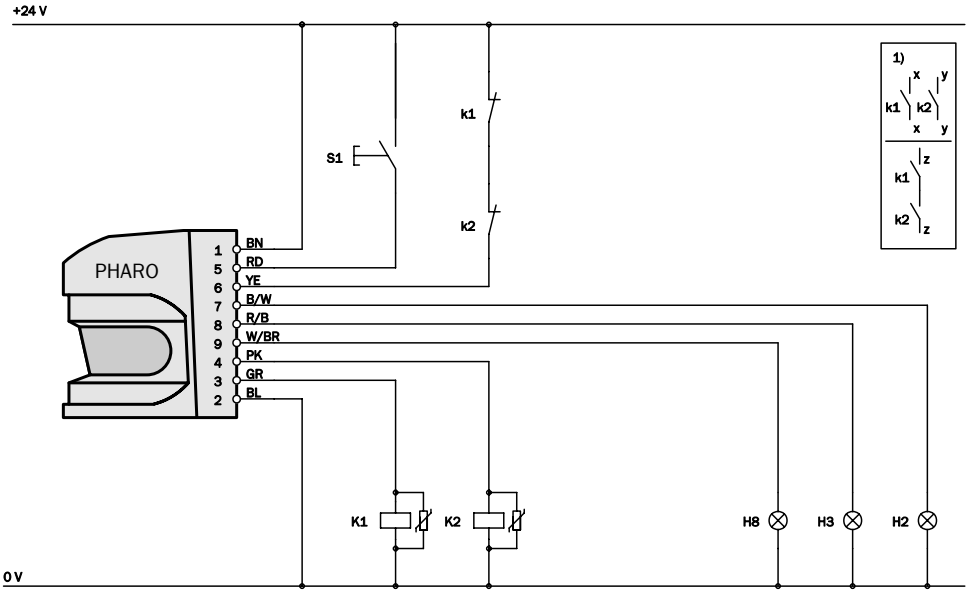
Ensure that there is adequate arc-suppression at the relay contacts. Take into account that arc-suppressors may lengthen the response time.

Sketch key

- 1) = output circuits
  These contacts are to be connected to the controller such that, with the output circuit open, the dangerous state is disabled. For categories 3 and 4 in compliance with EN 954-1, the interfacing must be two-channel (x-/y paths). Observe the maximum values for the loading of the outputs (see chapter 11.4 “Data sheet” on page 89).
- H2 = sensor for error/contamination
- H3 = sensor for waiting for restart
- H8 = sensor for warning field interruption

6.3.1 Restart interlock and external device monitoring

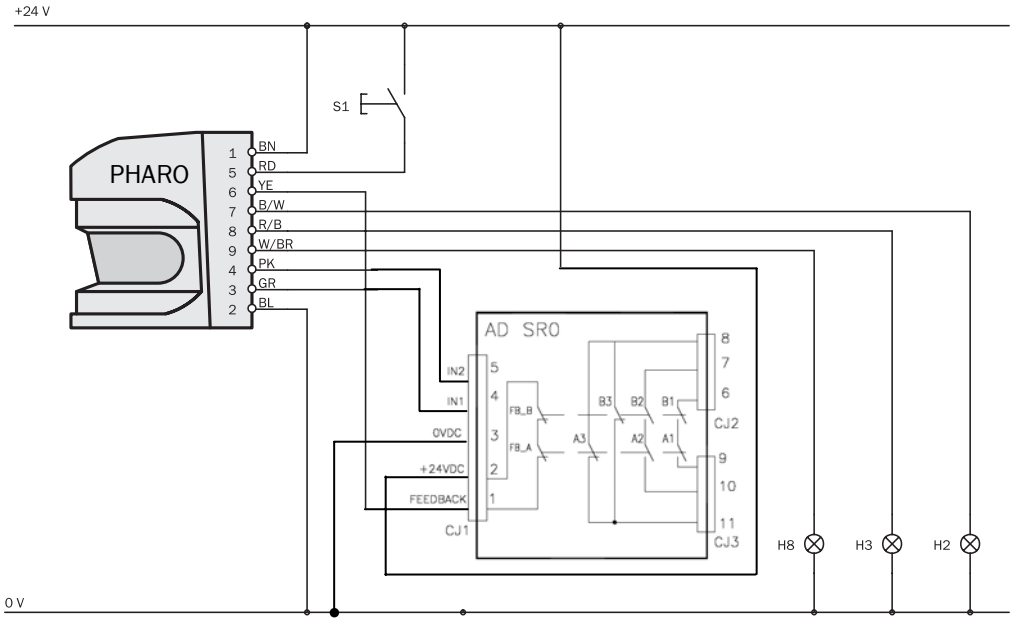
Fig. 57: Example circuits for restart interlock and external device monitoring



PHARO in conjunction with relays/contactors; operating mode: with restart interlock and external device monitoring.

6.3.2 Restart interlock and external device monitoring with AD SR0 series

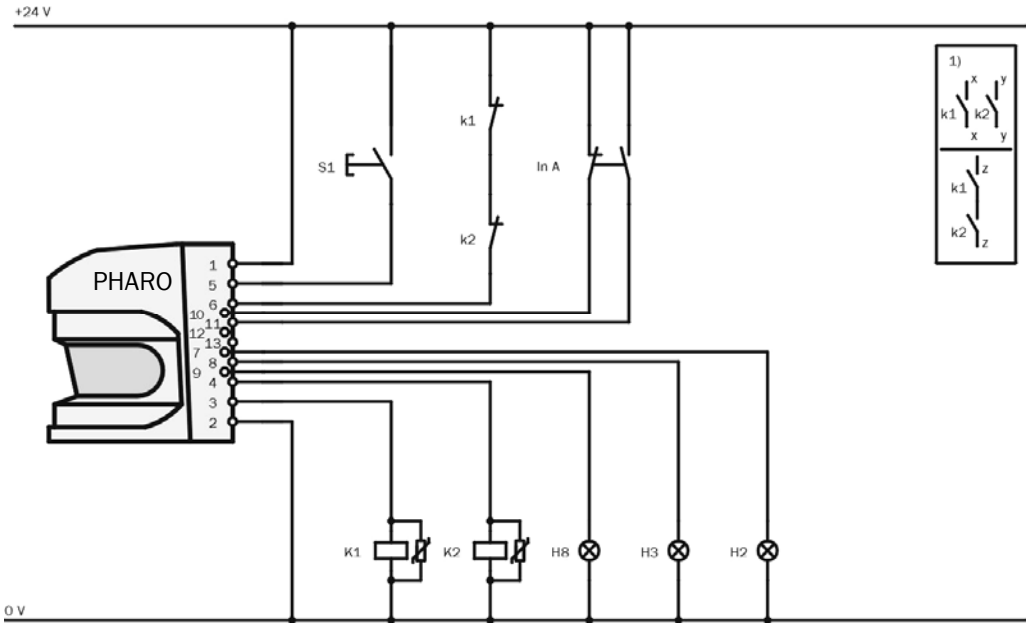
Fig. 58: Example circuit for restart interlock and external device monitoring with series AD SR0



PHARO in conjunction with AD SR0; operating mode: with restart interlock and external device monitoring.

6.3.3 Protective field switching with two static inputs

Fig. 59: Example of circuit for protective field switching using two static inputs



PHARO in conjunction with relays/contactors; operating mode: with restart interlock and external device monitoring; protective field switching by means of control inputs A (In A).

7 Configuration

7.1 Default delivery status

PHARO is delivered in a safe default status.

- The device status is **Waiting for configuration**.
- Thus the switching outputs (OSSDs) are deactivated (the red LED illuminates: ●).
- The 7-segment display indicates 6.

7.2 Preparation of the configuration

How to prepare the configuration:

➢ Make sure that the safety laser scanner has been correctly mounted and that the electrical connections are correct and in place.

➢ Have the necessary tools at hand.

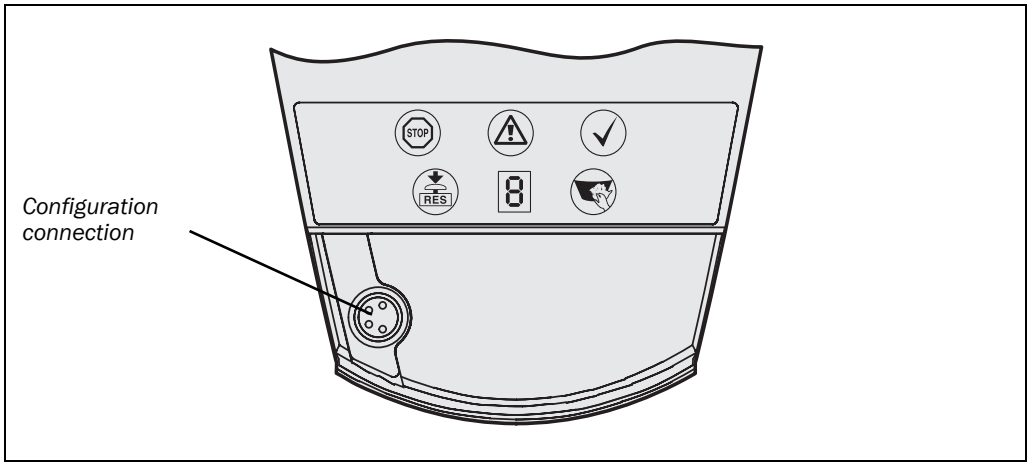
To configure the safety laser scanner you need:

- UCS (REER User Configuration Software) on CD-ROM
- user manual for UCS on CD-ROM
- PC/notebook with Windows 9x/NT 4/2000 Professional/ME/XP and an serial RS-232 interface (PC/notebook not in the scope of delivery)
- connection cable for connecting PC and PHARO (not in the scope of delivery)

Configuring PHARO with the aid of the UCS:

For configuration and diagnostics using the UCS, connect the PC to the configuration connection.

Fig. 60: Configuration connection



Two connection cables of different length are available for the connection of the PC/notebook to PHARO (see chapter 12.3 “Accessories/spare parts” on page 98).

Note Ensure that the configuration cable is not laid in close proximity to high power electrical drives or cables carrying high power. This will avoid EMC effects on the configuration cable.

To configure the device, please read the user manual for the UCS (REER User Configuration Software) and use the online help function of the programme.

8 Commissioning

8.1 Initial commissioning

WARNING

Commissioning requires a thorough check by qualified personnel!

Before you operate a system protected by the safety laser scanner PHARO for the first time, make sure that the system is first checked and approved by qualified personnel. Please read the notes in chapter 2 “On safety” on page 9.

- Prior to approving the machine, check whether the access to the hazardous area is completely monitored by the protective devices. Check also at regular intervals after approval of the machine (e.g. in the morning at the start of work) as to whether PHARO correctly switches the OSSDs as soon as there is an object in the protective field. This test should be performed along all protective field boundaries as per the specific regulations for the application (see chapter 8.2 “Test notes” on page 71).

8.1.1 Power up sequence

After power up PHARO runs through the power up cycle. During the power up cycle, the 7-segment display indicates the device status.

During the initial commissioning of an PHARO the following indications are possible:

Tab. 16: 7-segment display during and after the power up sequence on initial commissioning

Step	Display	Meaning
1	⊡, ⊡, ⊡, ⊡, ⊡, ⊡, ⊡, ⊡	Power-up cycle, testing the 7-segment display. All segments are activated sequentially.
2	6.	Power up cycle, during initial commissioning: device in configuration mode
	Other display	Safety lock activated. Malfunction in external conditions or in the device itself. See chapter 10.4 “Errors displayed by the 7-segment display” on page 80.

Tab. 17: LED indication after the power up sequence

Display					Meaning
STOP	RES	⚠		✓	
●	○	○	○	○	Power-up cycle, step 1
●	●	●	●	○	Power-up cycle, step 2
●	○	○	○	○	Power-up cycle, step 3 Device status Waiting for configuration or Object in the protective field, OSSDs deactivated
Other display					Safety lock activated. Malfunction in the external conditions or in the device itself (see chapter 10.3 “Indications and error messages” on page 79)

Note The duration of power up depends on the volume of the configuration data and can take up to 20 seconds.

8.2 Test notes

8.2.1 Pre-commissioning tests

The purpose of the pre-commissioning tests is to confirm the safety requirements specified in the national/international rules and regulations (EC Conformity). This applies particularly to the safety requirements in the machine directive or work equipment directive.

WARNING

Ensure that you do not place anybody at risk during initial commissioning of the machine!

Always expect that the machine, plant or the protective device does not yet behave as you have planned.

- Ensure that there are no persons in the hazardous area during initial commissioning.
- Check the effectiveness of the protective device mounted to the machine, using all selectable operating modes as specified in the checklist in the annex (see section 13.2 “Manufacturer” on page 101).
- Make sure that the operating personnel of the machine protected by the safety laser scanner are properly instructed by specialist personnel before being allowed to operate the machine. Instructing the operating personnel is the responsibility of the machine owner.
- Ensure that the adhesive label **Important information**, which is included with the scanner on delivery, is affixed to the machine in a place where it is clearly visible for the operators. Ensure that the operators have the possibility to perform this daily check correctly.
- The annex to this document includes a checklist for review by the manufacturer and OEM. Use this checklist as a reference prior to commissioning for the first time (see section 13.2 “Manufacturer” on page 101).

- Document the adjustment of the scanner and the results of the testing during initial commissioning in a traceable manner. For this purpose also print out the complete configuration of the scanner (including protective field shapes) and include these with the documentation.

8.2.2 Regular inspection of the protective device by qualified personnel

- Check the system following the inspection intervals specified in the national rules and regulations. This procedure ensures that any changes on the machine or manipulations of the protective device after the first commissioning are detected.
- If major changes have been made to the machine or the protective device, or if the safety laser scanner has been modified or repaired, check the plant again as per the checklist in the annex (see section 13.2 “Manufacturer” on page 101).

8.2.3 Daily testing of the protective device by a specialist or authorised personnel

The effectiveness of the protective device must be checked daily by a specialist or by authorised personnel. The test must also be performed if the operating mode is changed.

WARNING

No further operation if errors occur during the test!

If any one of the following points is not met, it is not permitted to continue to work on the machine or operate the vehicle. In this case the installation of PHARO must be checked by specialised personnel (see section 8.2.2 “Regular inspection of the protective device by qualified personnel” on page 72).

- The test must be carried out for the relevant preset monitoring case.
- Check the mechanical installation to ensure that all mounting screws are secure and that PHARO is properly aligned.
- Check each PHARO device for visible changes such as damage, manipulation etc.
- Switch on the machine/plant.
- Watch the LEDs on each PHARO.
- If at least one LED is not permanently lit when the machine/plant is switched on, it is to be assumed that there is a fault in the machine or plant. In this case the machine must be shut down immediately and checked by a specialist.
- Deliberately obstruct the protective field without risk to any personnel while the machine is running in order to test the effectiveness of the entire system.

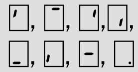
  The LEDs of PHARO device must change from green to red and the hazardous movement must stop immediately.
- For stationary applications, check that the danger area marked out on the floor matches the shape of the protective field stored in PHARO and that any gaps are protected by additional protective measures. In the case of mobile applications, check that the moving vehicle actually stops at the field limits which are set in PHARO and listed on the information label in the vehicle or in the configuration protocol. If you discover any non-conformance of this function, the machine/plant/vehicle must be stopped immediately and checked by a specialist.

8.3 Re-commissioning

If PHARO has peviously been commissioned, but the device replaced, PHARO automatically reads the saved configuration from the system plug. In this way acceptance by a specialist is not necessary. However the test in accordance with the regulations for the daily test must be performed (see section 8.2.3 “Daily testing of the protective device by a specialist or authorised personnel” on page 72).

When you place a configured PHARO (e.g. after replacement of the sensor head) back into operation, the following indications are possible:

Tab. 18: 7-segment display during and after the power up sequence on re-commissioning

Step	Display	Meaning
1		Power-up cycle, testing the 7-segment display. All segments are activated sequentially.
2	6.	Power up cycle, during initial commissioning: Devices in configuration mode
4	4.	Waiting for valid inputs
5	No display	The device is operational.
	Other display	Safety lock activated. Malfunction in external conditions or in the device itself. See chapter 10.4 “Errors displayed by the 7-segment display” on page 80.

Tab. 19: LED indication after the power up sequence

Display					Meaning
STOP	RES				
●	○	○	○	○	Power-up cycle, step 1
●	●	●	●	○	Power-up cycle, step 2
●	○	●	○	○	The device is operational, object in protective field and warning field.
○	○	●	○	●	Or: The device is operational, object in warning field.
○	○	○	○	●	Or: The device is operational, no object in protective field and warning field.
●	☀	○	○	○	Or: The device is operational, no object in protective field and warning field. Control switch for restart interlock or reset must be operated.
Other display					Safety lock activated. Malfunction in the external conditions or in the device itself (see chapter 10.3 “Indications and error messages” on page 79)

9 Care and maintenance

WARNING

Do not make any repairs to the device!

PHARO does not contain any repairable components. For this reason do not open PHARO components and only replace the parts that are described in the following chapters as replaceable.

Switch the entire machine/system off line!

The machine/system could inadvertently start up while you are changing the front screen. As a matter of principle, always isolate the machine from the power supply during all work on the machine and safety laser scanner.

9.1 Cleaning the front screen

The safety laser scanner PHARO is maintenance-free. The front screen on the safety laser scanner should however be regularly cleaned and also if contaminated.

➢ Do not use aggressive detergents.

➢ Do not use abrasive cleaning agents.

Note Static charges cause dust particles to be attracted to the front screen. You can diminish this effect by using the anti-static plastic cleaner (REER Part No. 1350030) and a lens cloth (see section 12.3 “Accessories/spare parts” on page 98).

Cleaning the front screen:

➢ Use a clean and soft brush to remove dust from the front screen.

➢ Now wipe the front screen with a clean and damp cloth.

9.2 Replacing the front screen

WARNING

Always perform a front screen calibration after the replacement of the front screen!

After the replacement of the front screen with a new front screen you must perform a front screen calibration with the aid of the UCS. In this way the new front screen on PHARO is measured and the device made functional.

If the front screen is scratched or damaged, you must replace it. Order the replacement front screen from REER (see section 12.3 “Accessories/spare parts” on page 98).

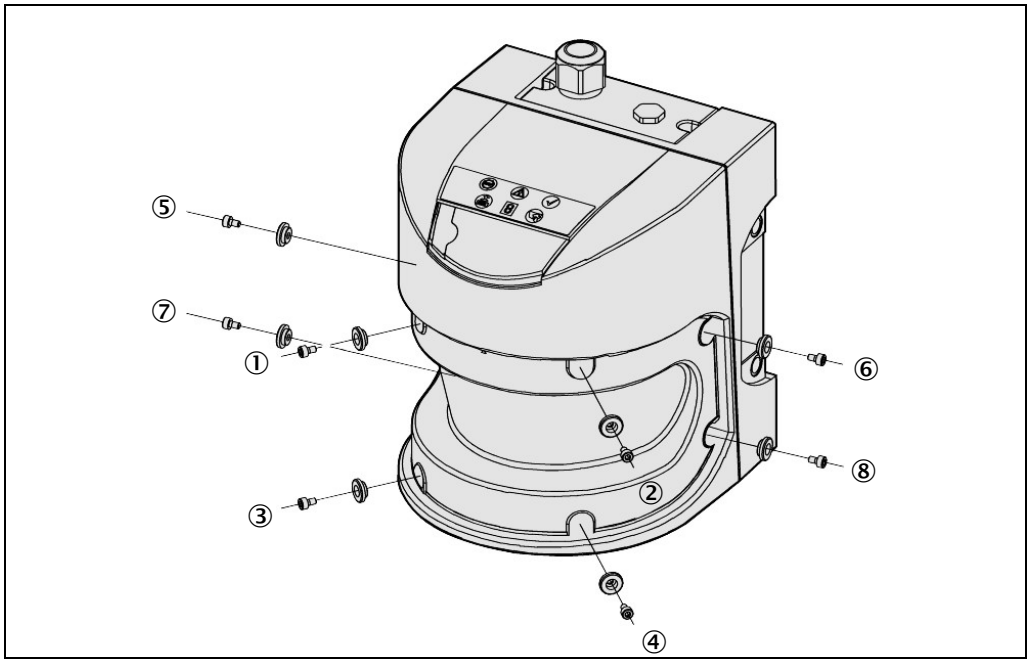
Notes

- The front screen on PHARO is an optical part that must not be contaminated or scratched.
- The front screen is only allowed to be replaced by specialist personnel in a dust- and dirt-free environment.
- Never replace the front screen during operation as dust particles could enter the device.
- It is imperative that you avoid contamination of the inside of the front screen, e.g. with fingerprints.
- Do not use any additional sealant for sealing the front screen, e.g. silicon, as the vapours produced may damage the optics.
- Mount the front screen as per the following instructions to ensure that the housing is sealed to IP 65.

Replacement of the front screen:

- Disconnect the system plug and remove PHARO.
- Take PHARO to a clean place (office, repair shop or similar).
- First clean the outside of PHARO. This prevents foreign bodies entering the device when it is opened.
- Undo the fixing screws ① to ⑧ for the front screen.

Fig. 61: Removing the fixing screws for the front screen

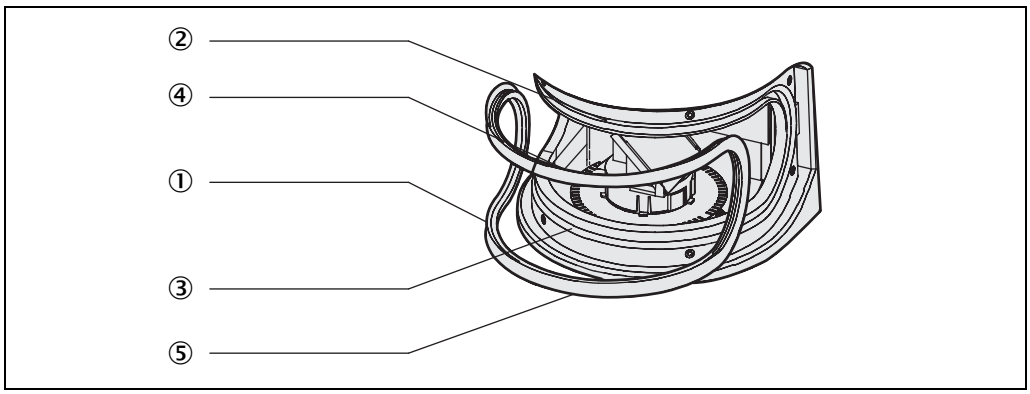


- Now remove the old front screen and the old rubber seal.
- Remove any dirt from the seal groove and the mating face on the sensor head. For this purpose if possible use a plastic cleaner that does not leave residues (see section 12.3 “Accessories/spare parts” on page 98).

Recommendation If necessary smear a thin coating of vaseline in the seal groove. This makes mounting easier.

- Insert the new seal ① — starting in the middle —. During this process first align the centre markings on the sensor head (② and ③) and seal (④ and ⑤).

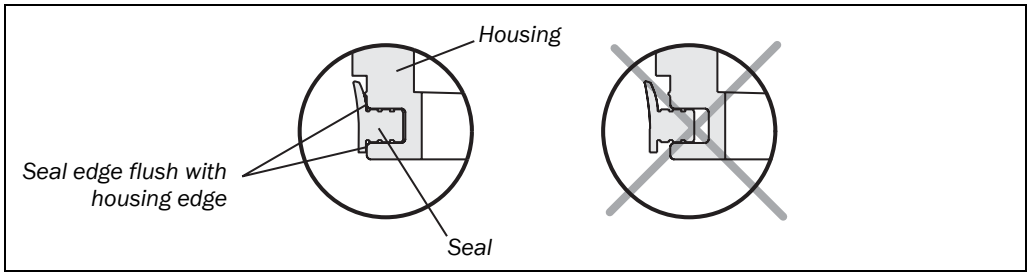
Fig. 62: Inserting the rubber seal



Note If the front seal is not inserted correctly, the front screen may be damaged. Do not use any pointed or sharp tools.

- First place the seal only lightly in the rounded sections of the seal groove. In this way you will avoid stretching the seal.
- Only then press the seal home. The seal should not be stretched on insertion.

Fig. 63: Depth for pressing in the seal



The seal is pressed in far enough when the edge of the seal and the sensor head are flush.

- ➢ It is imperative that you check that the seal is seated evenly all the way around the groove.
- ➢ Check whether the mirror on the motor is clean and remove any contamination with an optic brush.
- ➢ Set a torque wrench to 0.7 nm (hand-tight) and have this at hand.
- ➢ Take the new front screen from the packaging.
- ➢ Remove any remnants of packaging.
- ➢ Place the front screen on the rubber seal and insert the new fixing screws ① to ④ with spacers (see Fig. 62).
- ➢ Press the front screen on the front of the cover. During this process tighten the front screws ① to ④ to the torque set.
- ➢ Then insert the rest of the screws ⑤ to ⑧ with spacers (see Fig. 62), and tighten using the torque wrench.

WARNING

Always perform a front screen calibration with the aid of the UCS after the replacement of the front screen!

The level of contamination is measured continuously during the operation of PHARO. For this purpose the front screen calibration must first be performed; this then serves as a reference for the contamination measurement (status = not contaminated).
The front screen calibration may only be performed immediately after the replacement of the front screen!

Device symbol **PHARO**, command **Service**, **Front screen calibration**.

The new front screen must be free of contamination at the time of the front screen calibration. The front screen calibration should be performed at room temperature (10–30 °C)!

Re-commissioning PHARO:

- ➢ Re-mount PHARO correctly (see chapter 4 “Installation and mounting” on page 36).
- ➢ Connect PHARO system plug.
  After power up PHARO automatically reads the saved configuration from the system plug (see chapter 8.3 “Re-commissioning” on page 73).

9.3 Replacing the I/O module

Switch the entire machine/system off line!

While you are replacing the I/O module, the plant may start inadvertently.

WARNING

➢ As a matter of principle, always isolate the machine from the power supply during all work on the machine and safety laser scanner.

Note When the I/O module is dismantled, advanced electronic components are accessible. Protect these from electrostatic discharge, contamination and moisture.

➢ If possible use anti-static floor mats and workbench covers.

➢ When working on PHARO, touch a bare metal surface from time to time to discharge static charging of your body.

➢ Only remove the components for PHARO from their anti-static packing immediately prior to installation.

➢ Note that no liability can be accepted for damage caused by electrostatic discharge.

Notes

- The I/O module is only allowed to be replaced by specialist personnel in a clean environment.
- Mount the I/O module as per the following instructions to ensure that the housing is sealed to IP 65.

Replacing the I/O module:

➢ Disconnect the system plug and remove PHARO.

➢ Take PHARO to a clean place (office, repair shop or similar).

➢ First clean the outside of PHARO.
This prevents foreign bodies entering the device when it is opened.

➢ Undo the fixing screws for the I/O module.

➢ Take hold of the I/O module with one hand at the recess for the connector to the system plug.

➢ With the other hand take hold of the I/O module at the dismantling aid on the underside of the device.

➢ Pull out the I/O module parallel to the mounting shaft.

➢ Remove any contamination from the sealing surface and the mating surface for the sensor head. For this purpose if possible use a plastic cleaner that does not leave residues (see section 12.3 “Accessories/spare parts” on page 98).

➢ Remove the I/O module from the packaging, ensure that you take adequate ESD protection measures during this process.

➢ Check the surfaces for cleanliness and the seal for correct seating.

➢ Insert the I/O module in the mounting shaft parallel to the rear of the sensor head. During this process use the three surrounding sides of the shaft for orientation.

➢ Guide the I/O module along these surfaces to the connector. During this process slide the I/O module parallel to the rear of the sensor, avoid tilting. The I/O module can be connected without the need to apply force.

➢ When the I/O module is flat against the rear of the sensor head (distance approx. 1 mm), tighten the screws in stages, diagonally, to 10 to 12 nm.

Re-commissioning PHARO:

- Correctly re-mount PHARO (see chapter 4 “Installation and mounting” on page 36).
- Connect PHARO system plug.
  - If you have replaced the I/O module, after power up PHARO automatically reads the saved configuration from the system plug (see chapter 8.3 “Re-commissioning” on page 73).

10 Diagnostics

This chapter describes how to identify and remedy errors and malfunctions during the operation of the safety laser scanner.

10.1 In the event of faults or errors

WARNING

Cease operation if the cause of the malfunction has not been clearly identified!

Stop the machine, the system or the vehicle if you cannot clearly identify or allocate the error and if you cannot safely remedy the malfunction.

10.2 REER Support

If you cannot remedy an error with the help of the information provided in this chapter, please contact your local REER representative.

10.3 Indications and error messages

This section describes the meaning of the indications and error messages and how you can respond. You will find a description of the indicators in section 3.5 “Indicators and outputs” on page 34, the connections for the outputs in section 5.1 “System connection” on page 59.

Tab. 20: Operational status indicators during operation

Display	Output level	Possible cause
STOP ●	At the OSSDs ┐└_____	Object in the protective field, OSSDs deactivated
✓ ●	At the OSSDs ┌┐_____	Protective field unoccupied, OSSDs activated
⚠ ●	At the warning field output ┐└_____	Object in warning field

Tab. 21: LED error messages

Display	Output level	Possible cause	Remedying the error
STOP ○ ✓ ○	OSSDs	No operating voltage, or voltage too low	➢ Check the voltage supply and activate, if necessary.
○	Error/contamination	No error	
○	Application diagnostic output	No supply voltage	➢ Check the voltage supply and activate, if necessary.
●	Application diagnostic output	Front screen contaminated, operation not guaranteed	➢ Clean the front screen.
☀	Application diagnostic output 1 Hz	Front screen contaminated, still in operation	➢ Clean the front screen.
RES ☀	At the Res_Req output 1 Hz	Reset required	➢ Operate the control switch for restarting or resetting.

10.4 Errors displayed by the 7-segment display

This section explains the meaning of the error displays on the 7-segment display and how to respond to the messages. You will find a description of the positions and symbols on PHARO in section 3.5 “Indicators and outputs” on page 34.

Tab. 22: Error displays on the 7-segment display

Display	Possible cause	Remedying the error
0., 1., 2., 3., 4., 5., 6., 7., 8., 9.	Power-up cycle — all segments are activated sequentially.	No error
a.	Park mode (see chapter “Park mode” on page 32); the OSSDs are deactivated, the laser is shutdown.	No error. Readiness for operation is restored by switching to another monitoring case.
3.	Initialising the device	➢ The display goes off automatically when PHARO is initialised and/or the connection to the second device has been established. If display 3. does not go off: ➢ Check the cabling. ➢ Check the system configuration with the aid of the UCS. Re-transfer the corrected configuration to PHARO.

Display	Possible cause	Remedying the error
4	Waiting for valid input signal	➢The display goes off automatically when an input signal is present that corresponds to a configured monitoring case. If display 4 does not go off: ➢Check the cabling. ➢Check the configuration of the system using the UCS (REER User Configuration Software). Re-transfer the corrected configuration to PHARO.
6	Waiting for configuration or configuration not completed	➢The display goes off automatically once the configuration has been successfully transferred. If display 6 does not go off: ➢Check the configuration of the system using the UCS (REER User Configuration Software). Re-transfer the corrected configuration to PHARO.
8 or :8:	EDM error	➢Check whether the contactors are stuck or incorrectly wired and rectify any error. ➢If :8: is displayed: Switch the device off and back on again.
9	Error in control switch for restarting or resetting	➢Check the functionality of the control switch. The button may be defective or stuck. ➢Check the wiring of the control switch for short-circuit to 24 V.
E ↻ 1	Sensor head faulty	➢Send the sensor head to the manufacturer for repair.
E ↻ 2	I/O module faulty	➢Send the I/O module to the manufacturer for repair.
E ↻ 3	Configuration memory in the system plug faulty	➢Send the system plug to the manufacturer for repair.
F ↻ 1	Overcurrent on OSSD connection 1	➢Check the switching element connected. Replace, if necessary. ➢Check the wiring for short-circuit to 0 V.
F ↻ 2	Short-circuit to 24 V at OSSD connection 1	➢Check the wiring for short-circuit to 24 V.
F ↻ 3	Short-circuit to 0 V at OSSD connection 1	➢Check the wiring for short-circuit to 0 V.
F ↻ 4	Overcurrent on OSSD connection 2	➢Check the switching element connected. Replace, if necessary. ➢Check the wiring for short-circuit to 0 V.
F ↻ 5	Short-circuit to 24 V at OSSD connection 2	➢Check the wiring for short-circuit to 24 V.
F ↻ 6	Short-circuit to 0 V at OSSD connection 2	➢Check the wiring for short-circuit to 0 V.

Display	Possible cause	Remedying the error
F. ↻ 7.	Short-circuit between OSSD connection 1 and 2	➢Check the wiring and rectify the error.
F. ↻ 9.	General OSSD wiring error	➢Check the complete wiring of the OSSDs.
1. ↻ 1.	PHARO is receiving no measured values within a range of at least 90° (measuring range maximum 49 m), it thus is not detecting any obstacles such as e.g. building walls.	➢For the correct function of the safety laser scanner, always ensure that measured values are received within a range of 90°; this range can be moved as required within the scan range.
1. ↻ 2.	Device is dazzled	➢Check whether PHARO is being dazzled by an external light source, e.g. headlight, infrared light sources, stroboscopic light, sun etc. If necessary, re-mount the device.
1. ↻ 3.	Temperature error. The operating temperature of PHARO has exceeded the permissible range.	➢Check whether PHARO is operated as per the permissible ambient conditions.
L. ↻ 2.	Invalid configuration of the EDM	➢Verify that the machine-side EDM is connected correctly.
L. ↻ 9.	There is a short-circuit between the input for the control switch for restarting or resetting and another input or output.	➢Check the wiring for short-circuits.
n. ↻ 1.	Input signal for an undefined monitoring case	➢Check the path of the vehicle. Or: ➢Check the work process on the machine or plant monitored. ➢If necessary, check the configuration of the monitoring cases with the aid of the UCS.
n. ↻ 2.	Incorrect sequence on switching the monitoring cases	
n. ↻ 3.	Incorrect operation of the control inputs	➢Check the operation of the digital control inputs.

Display	Possible cause	Remedying the error
u. ↻ 1. ... 6.	Channel 1 to 6 of the contamination measurement soiled	➢Clean the front screen.
u. ↻ 7.	No front screen fitted or dazzling of the contamination measurement	➢Re-fit the new front screen (then perform front screen calibration). If at the time of the error a front screen was fitted: ➢Check whether PHARO is being dazzled by an external light source, e.g. headlight, infrared light source, stroboscopic light, sun etc.
9. ↻ 3.	I/O module does not match the configuration saved or vice-versa	➢Check whether the correct I/O module has been used, and replace if necessary.

Note If you have problems during troubleshooting, contact REER support. Keep a copy of the print out of the results of the diagnostics at hand.

10.5 Extended diagnostics

The UCS software supplied with the device (REER User Configuration Software) includes extended diagnostic options. It allows you to narrow down the problem if the error is non-specific or if you experience usage downtime problems. Detailed information to be found ...

- in the online help function of the UCS (REER User Configuration Software).
- in the user manual for the UCS.

11 Technical specifications

11.1 Characteristics

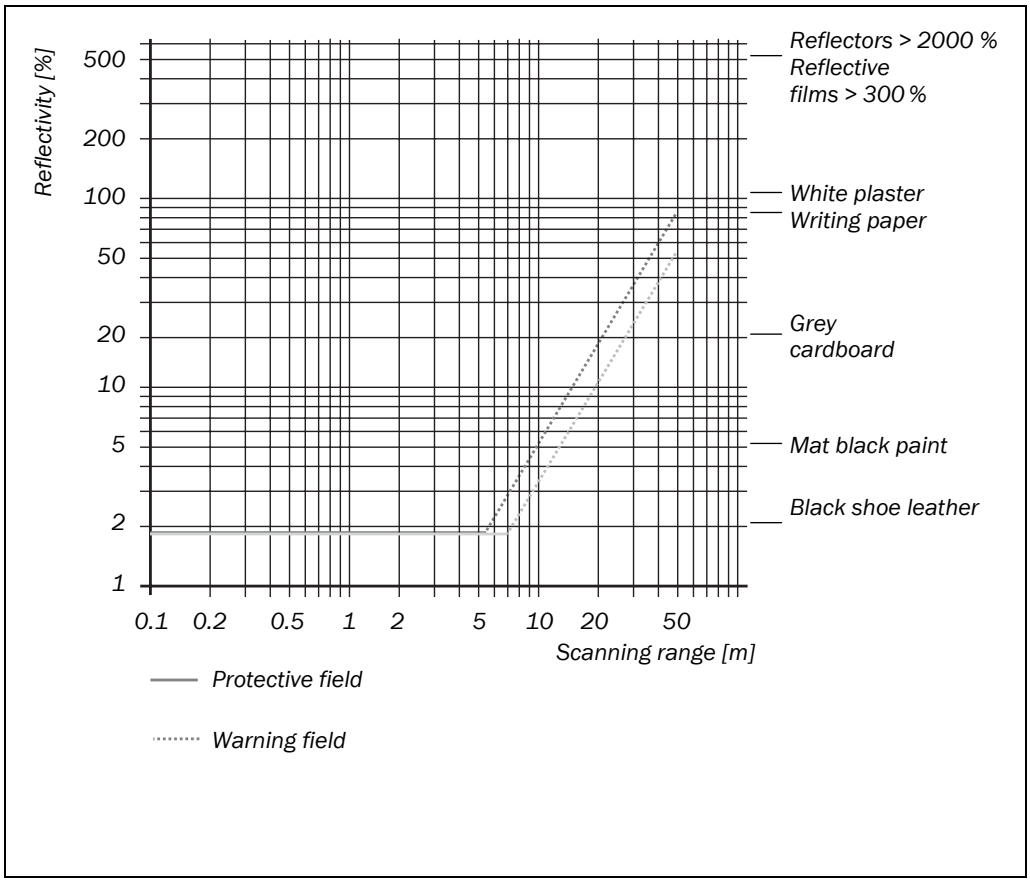


Fig. 64: Diagram of scanning ranges for various reflectances

11.2 OSSD response times

The total response time of your application is dependent on …

- the basic response time at the related resolution and the maximum protective field range.
- the multiple sampling used.
- the OSSDs used.

Calculation of the total response time T_S:

$T_S = t_B + T_{MFA}$

Where ...

t_B = Basic response time

T_{MFA} = Supplement due to multiple sampling > 2

Basic response time for various resolutions

The following basic response times apply for the internal OSSDs with standard multiple sampling of 2 without taking into account the switching time for the monitoring cases.

Tab. 23: Response time with a resolution of 30 mm (hand detection)

Maximum possible protective field size	Basic response time
1.90 m	60 ms
2.80 m	120 ms

Tab. 24: Response time with a resolution of 40 mm (hand detection)

Maximum possible protective field size	Basic response time
2.60 m	60 ms
3.80 m	120 ms

Tab. 25: Response time with a resolution of 50 mm (leg detection, stationary)

Maximum possible protective field size	Basic response time
3.30 m	60 ms
4 m	120 ms

Tab. 26: Response time with a resolution of 70 mm (leg detection, mobile)

Maximum possible protective field size	Basic response time
4 m	60 ms
4 m	120 ms

Tab. 27: Response time with a resolution of 150 mm (body detection)

Maximum possible protective field size	Basic response time
4 m	60 ms
4 m	120 ms

Multiple sampling

PHARO is always set to a minimum of 2 times multiple sampling.. From a multiple sampling of 3 you must add a supplement to the response time. The related supplement is dependent on the basic response time and the multiple sampling.

Tab. 28: Supplements for multiple sampling

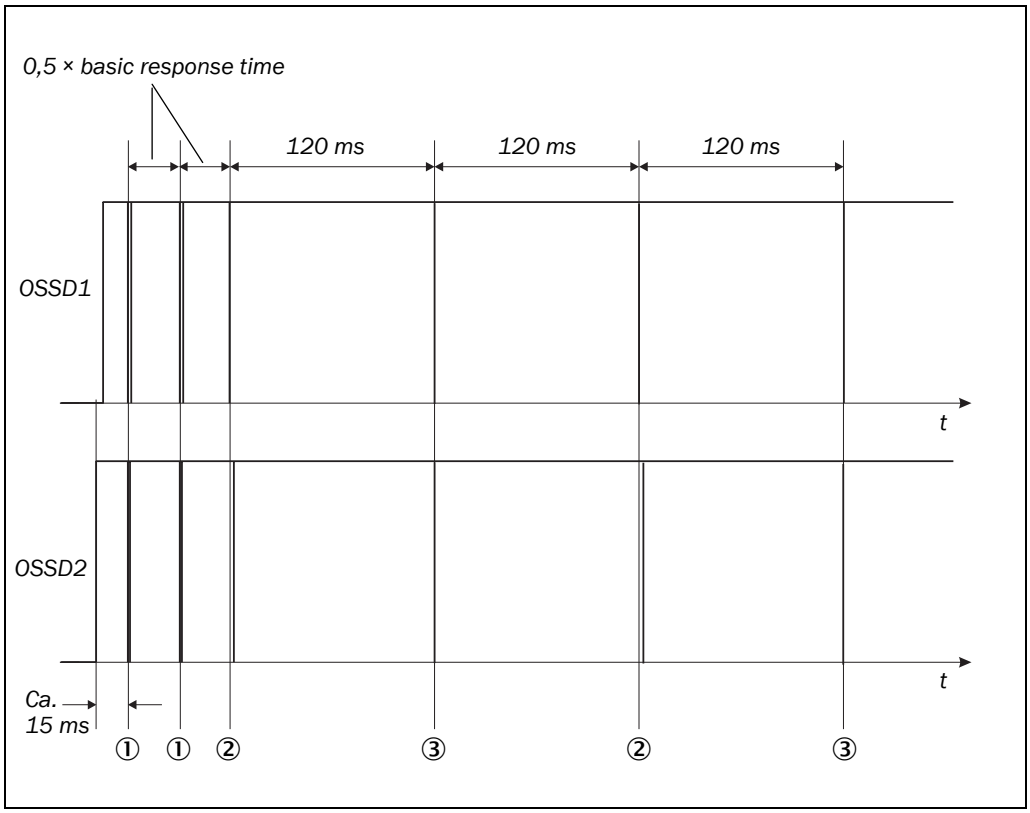
Multiple sampling	Basic response time 60 ms	Basic response time 120 ms
3 times	30 ms	60 ms
4 times	60 ms	120 ms
5 times	90 ms	180 ms
6 times	120 ms	240 ms
7 times	150 ms	300 ms
8 times	180 ms	360 ms
9 times	210 ms	420 ms
10 times	240 ms	480 ms
11 times	270 ms	540 ms
12 times	300 ms	600 ms
13 times	330 ms	660 ms
14 times	360 ms	720 ms
15 times	390 ms	780 ms
16 times	420 ms	840 ms

11.3 Timing behaviour of the OSSDs

The PHARO tests the OSSDs immediately after switch on and then at regular intervals. For this purpose the PHARO briefly switches off both OSSDs (for 300 µs) and checks whether the channels are electrically isolated during this period.

Note Ensure that the input electronics on your machine or plant do not react to this test pulse and therefore shut down the machine or plant.

Fig. 65: Diagram of the test pulse at the OSSDs



Approx. 15 ms after the switch on of the OSSDs, the PHARO performs the first voltage test ① and then after a half basic response time (see “Basic response time for various resolutions” on page 85) performs a second voltage test ①.

After a further half basic response time of the PHARO there is a shut-down test ②, 120 ms later a further voltage test ③. Then the PHARO performs a shut-down test and a voltage test alternately at an interval of 120 ms. Fig. 66, Fig. 67 and Fig. 68 show the pulse durations for the individual tests.

Fig. 66: Voltage test after switching on the OSSDs

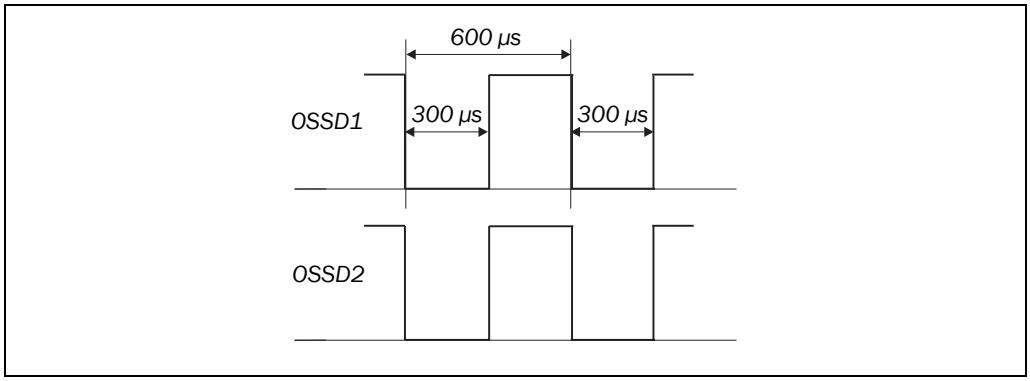


Fig. 67: Shut-down test

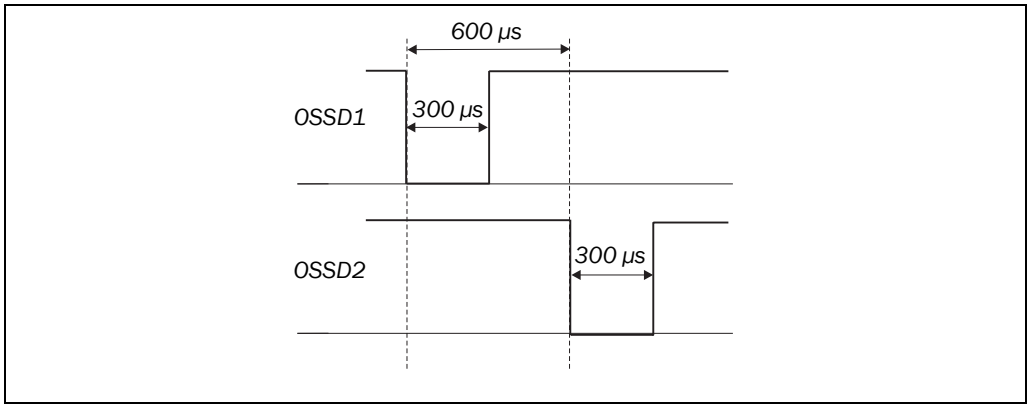
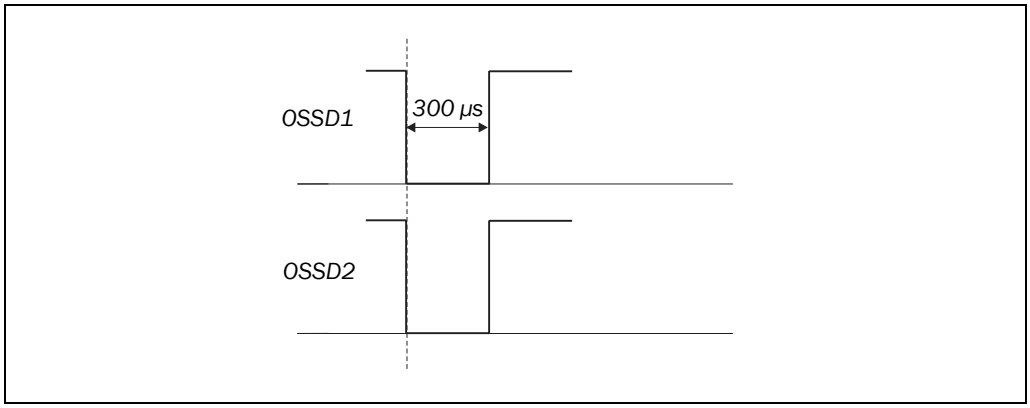


Fig. 68: Voltage test



11.4 Data sheet

Tab. 29: Technical data PHARO

	Minimum	Typical	Maximum
General data			
Laser protection class	Laser class 1 (according to IEC 60825-1 as well as CDRH 21 CFR 1040.10 and 1040.11; excluded are deviations due to Laser Notice No. 50, dated 24.06.2007)		
Enclosure rating	IP 65 (EN 60529)		
Protection class	II (EN 50178)[1]		
Type	Type 3 (EN 61496-1)		
Safety integrity level[2]	SIL2 (IEC 61508) SILCL2 (EN 62061)		
Category	Category 3 (EN ISO 13849-1)		
Performance Level	PL d[3] (EN ISO 13849)		
PFHd (mean probability of a dangerous failure per hour)	$76{,}7 \times 10^{-9}$		
T_M (mission time)	20 years (EN ISO 13849)		
Operating temperature range	–10 °C		+50 °C
Storage temperature range	–25 °C		+70 °C max. 24 h
Humidity (taking into account the operating temperature range)	EN 61496-1, section 5.1.2 and 5.4.2, as well as CLC/TS 61496-3, section 5.4.2		
Vibration	EN 61496-1, section 5.1.2 and 5.4.4.1, as well as CLC/TS 61496-3, section 5.4.4.2		
Frequency range	10 Hz		150 Hz
Amplitude	0.35 mm or 5 g		
Shock resistance			
Single shock	15 g, 11 ms (EN 60068-2-27)		
Continuous shock	10 g, 16 ms (EN 61496-1, section 5.1.2 and 5.4.4.2, as well as CLC/TS 61496-3, section 5.4.4.2)		

1) Safety extra-low voltage SELV/PELV.
2) For detailed information on the exact design of your machine/system, please contact REER.
3) An exact analysis of the performance levels by a safety specialist with the aid of the SISTEMA software is always necessary.

	Minimum	Typical	Maximum
Sender	Pulsed laser diode		
Wavelength	880 nm	905 nm	935 nm
Divergence of the collimated beam		2.5 mrad	
Pulse duration			3.1 ns
Average output power			562 µW
Size of light spot at the front screen		12 mm	
Size of light spot at 4,0 m scanning range		23 mm	
Housing			
Material	Aluminium die-cast		
Colour	RAL 1021 (rape yellow)		
Front screen			
Material	Polycarbonate		
Surface finish	Outside with scratch-resistant coating		
System plug	ESD protected		
PHARO Dimensions [4]			
Height			185 mm
Width			155 mm
Depth			160 mm
Total weight		3.3 kg	

Functional data

Protective field of the sensor head with 4.0 m scanning range[5] at 120 ms response time			
At 30 mm resolution			2.80 m
At 40 mm resolution			3.80 m
At 50 mm resolution			4.00 m
At 70 mm resolution			4.00 m
At 150 mm resolution			4.00 m
Protective field of the sensor head with 4,0 m scanning range at 60 ms response time			
At 30 mm resolution			1.90 m
At 40 mm resolution			2.60 m
At 50 mm resolution			3.30 m
At 70 mm resolution			4.00 m
At 150 mm resolution			4.00 m
Scan angle			190° (–5° to 185°)
Reflectivity	1.8%		Several 1000% (Reflectors)
Resolution	30, 40, 50, 70, 150 mm		
Angular resolution	0.50°		0.25°

[4] Without projection of cable glands with system plug mounted.
[5] Radial distance to the safety laser scanner.

	Minimum	Typical	Maximum
Protective field supplement generally necessary			100 mm
Supplement for retroreflectors in scan plane at a distance of less than 1 m to the protective field boundary			200 mm
Measurement error for measured data output up to 4 m and 1.8 % reflectivity			
Systematic error		±5 mm	
Statistical incl. systematic errors			
at 1 σ		±24 mm	
at 2 σ		±43 mm	
at 3 σ		±62 mm	
at 4 σ		±80 mm	
Evenness of the scan field at 4 m			±70 mm
Distance from mirror axis of rotation (zero point on the X and Y axis) to the rear of the device	93 mm		
Distance between centre of the scan plane and the bottom edge of the housing	63 mm		
Warning field range (radial)		Approx. 20 m[6)]	49 m
Distance measuring range			49 m
Number of multiple samplings (configurable via CDS)	2		16
Power up time		9 s	20 s
Restart after (configurable)	2 s		60 s

Electrical data

Electrical connection	Plug-in connection housing with screw terminal connections		
Technical specifications, screw terminals			
Cross-section of rigid cores	0.14 mm²		1.5 mm²
Cross-section of flexible cores[7)]	0.14 mm²		1.0 mm²
American Wire Gauge (AWG)	26		16
Insulation stripping length for the cores		5 mm	
Screw tightening torque	0.22 Nm		0.25 Nm
Cable length for power supply tolerance ±10 %			
For wire cross-section 1 mm²			50 m
For wire cross-section 0.5 mm²			25 m
For wire cross-section 0.25 mm²			12 m

6) For objects with 20 % reflectivity.
7) Core terminating sleeves are not required.

	Minimum	Typical	Maximum
Cable length for power supply tolerance ±5 %			
For wire cross-section 1 mm²			60 m
For wire cross-section 0.5 mm²			30 m
For wire cross-section 0.25 mm²			15 m
Cable length for power supply tolerance ±1 %			
For wire cross-section 1 mm²			70 m
For wire cross-section 0.5 mm²			35 m
For wire cross-section 0.25 mm²			17 m
Supply voltage (SELV) The voltage supply must be capable of buffering brief mains voltage failures of 20 ms as specified in EN 60 204.	16.8 V	24 V	28.8 V
Permissible residual ripple[8)]			±5 %
Switch on current[9)]			2 A
Operating current at 24 V without output load			0.8 A
Operating current with max. output load			2.3 A
Power consumption without output load			19 W
Power consumption with maximum output load			55 W
Input for control switch for restarting or resetting			
Input resistance when HIGH		2 kΩ	
Voltage for HIGH	11 V	24 V	28.8 V
Voltage for LOW	–3 V	0 V	5 V
Input capacitance		15 nF	
Static input current	6 mA		15 mA
Duration of actuation of the control switch	120 ms		
Input EDM			
Input resistance when HIGH		2 kΩ	
Voltage for HIGH	11 V	24 V	28.8 V
Voltage for LOW	–3 V	0 V	5 V
Input capacitance		15 nF	
Static input current	6 mA		15 mA
Response time at EDM after switching on the OSSDs			300 ms
Static control inputs			
Input resistance when HIGH		2 kΩ	
Voltage for HIGH	11 V	24 V	28.8 V
Voltage for LOW	–3 V	0 V	5 V
Input capacitance		15 nF	
Static input current	6 mA		15 mA
Input frequency (switching sequence, max. or frequency)	1 / (multiple sampling + 1) × scan time × 2		

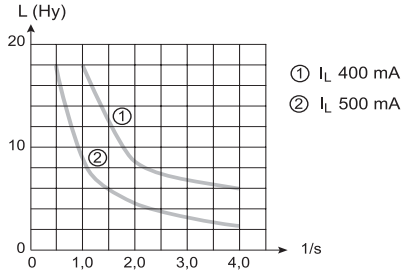
[8)] The absolute voltage level must not drop below the specified minimum voltage.
[9)] The load currents for the input capacitors are not taken into account.

	Minimum	Typical	Maximum
Dynamic control inputs			
Input resistance when HIGH		2 kΩ	
Voltage for HIGH	11 V	24 V	28.8 V
Voltage for LOW	–3 V	0 V	5 V
Input capacitance		1 nF	
Static input current	6 mA		15 mA
Duty cycle (Ti/T)		0.5	
Input frequency			100 kHz
OSSDs			
Output signal switching device pair	2 PNP semiconductors, short-circuit protected[10], cross-circuit monitored		
HIGH switching voltage at 500 mA	U_V – 2.7 V		U_V
Switching voltage LOW	0 V	0 V	3.5 V
Source switching current	6 mA	0.2 A	0.5 A
Leakage current[11]			250 µA
Load inductance[12]			2.2 H
Load capacity			2.2 µF at 50 Ω
Switching sequence (without switching and without simultaneous monitoring)	Depending on load inductance		
Permissible cable resistance[13]			2.5 Ω
Test pulse width[14]		230 µs	300 µs
Test frequency		120 ms	
Switching time of the OSSDs from red to green		120 ms	
Time offset on switching the OSSDs between OSSD2 and OSSD1		1.3 ms	2 ms

[10] Applies to the voltage range between U_v and 0 V.

[11] In the case of a fault (the 0-V cable is open circuit) the leakage current flows through the OSSD cable as a maximum. The downstream controller must detect this status as LOW. An FPLC (fail-safe programmable logic controller) must detect this status.

[12] The maximum rated load inductance is higher with lower switching sequence.



[13] Make sure to limit the individual line core resistance to the downstream controller to this value to ensure that a short-circuit between the outputs is safely detected. (Also note EN 60 204-1.)

[14] When active, the outputs are tested cyclically (brief LOW). When selecting the downstream controllers, make sure that the test pulses do not result in deactivation.

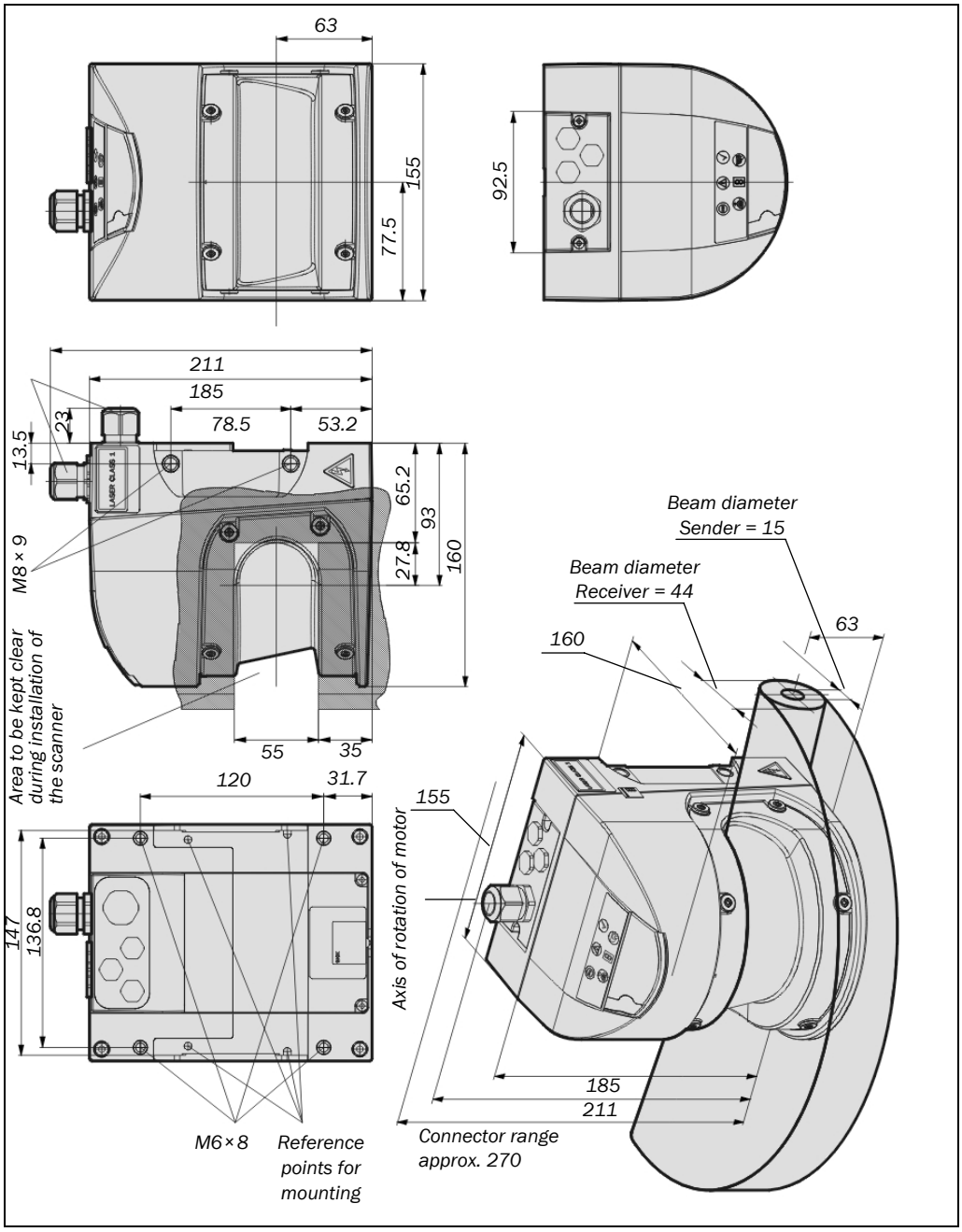
	Minimum	Typical	Maximum
Application diagnostic outputs warning field, contamination of the front screen/error, reset necessary			
HIGH switching voltage at 200 mA	U_V – 3.3 V		U_V
Source switching current		100 mA	200 mA
Current limiting (after 5 ms at 25 °C)	600 mA		920 mA
Power up delay		1.4 ms	2 ms
Switch off delay		0.7 ms	2 ms
Configuration and diagnostics interface			
Communication protocol	RS-232 (proprietary)		
Transmission speed	9600 baud 19 200 baud 38 400 baud		
Cable length at 9600 baud and 0.25-mm² cables			15 m
Galvanic de-coupling	No		
Output TxD HIGH	5 V		15 V
Output TxD LOW	–15 V		–5 V
Voltage range RxD	–15 V		15 V
Switching threshold RxD LOW	–15 V		0.4 V
Switching threshold RxD HIGH	2.4 V		15 V
Short-circuit current at TxD	–60 mA		60 mA
Max. voltage level at RxD	–15 V		15 V
Max. voltage level at TxD	–11 V		11 V

	Minimum	Typical	Maximum
Data interface			
Communication protocol	RS-422 (proprietary)		
Transmission speed (selectable)	9600 baud 19 200 baud 38 400 baud 125 kbaud 250 kbaud 500 kbaud		
Cable length at 500 kbaud and 0.25-mm² cables			100 m
Galvanic de-coupling	Yes		
Differential output voltage at the sender (between TxD+ and TxD–) with 50 Ω load	±2 V		±5 V
Differential input threshold at the receiver (between RxD+ and RxD–)	±0.2 V		
Short-circuit current at TxD+, TxD–	–250 mA		250 mA
Max. voltage level at TxD+, TxD–	–29 V		29 V
Max. voltage level at RxD+, RxD–	–29 V		29 V
Terminating resistance	115 Ω	120 Ω	125 Ω
Type of connecting cable	Twisted pairs with copper braid screen		
Characteristic impedance of the connecting cable	80 Ω	100 Ω	115 Ω
Wire cross-section of the connecting cable	0.25 mm²		0.6 mm²

11.5 Dimensional drawings

11.5.1 PHARO

Fig. 69: Dimensional drawing PHARO (mm)



11.5.2 Mounting kits

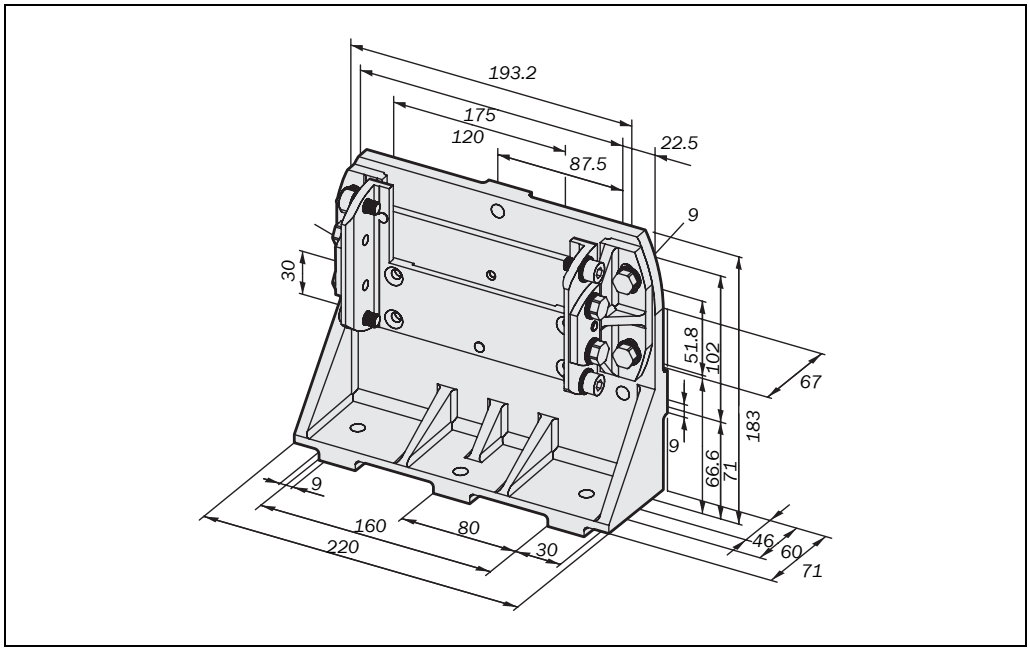


Fig. 70: Dimensional drawing, mounting kit PHR B3, 2 and 3 (mm)

11.5.3 Scan plane origin

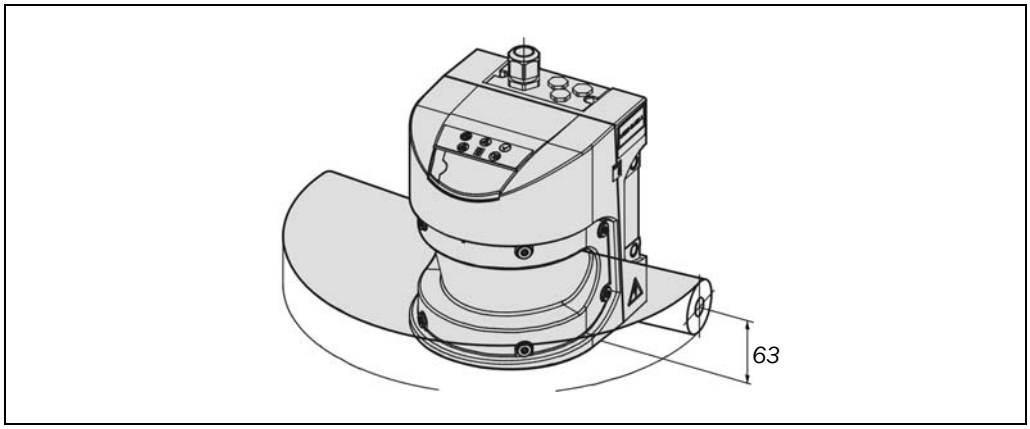


Fig. 71: Dimensional drawing of the scan plane (mm)

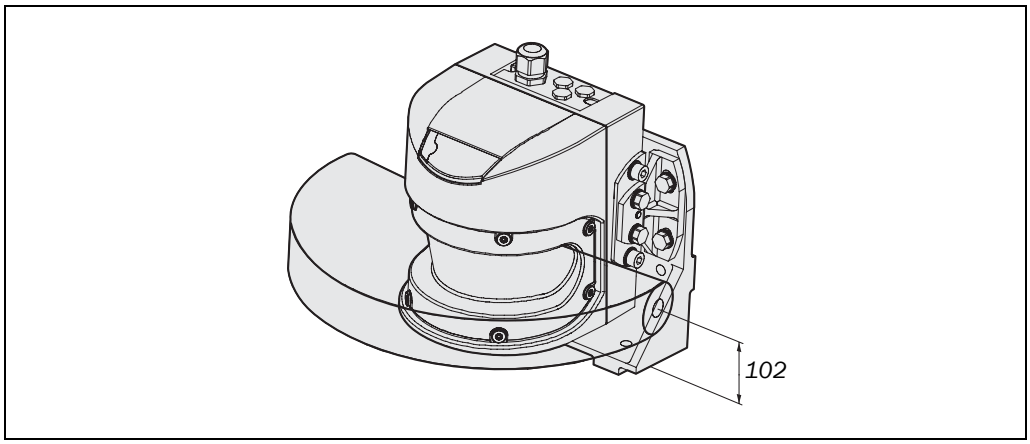


Fig. 72: Dimensional drawing of the scan plane with mounting kit PHR B5 (mm)

12 Ordering information

12.1 Delivery

- sensor head with I/O module mounted
- operating instructions and UCS (REER User Configuration Software) on CD-ROM
- adhesive label **Important information**

Note

- System plug not in the scope of delivery.

System plugs without cable and pre-assembled system plugs are available from REER S.p.A. (see section “System plug” on page 98). For more details see section 5.2 “System plug assembly” on page 61 and 5.3 “Pre-assembled system plugs” on page 62.

12.2 Available systems

Tab. 30: Part numbers systems

Part	Description	Part number
PHR 332	PHARO sensor head + I/O module	1350041

12.3 Accessories/spare parts

12.3.1 Mounting kits

Tab. 31: Part numbers mounting kit

Mounting kit	Description	Part number
PHR B3	Mounting bracket for direct mounting at the rear on wall or machine. No adjustment facility	1350050
PHR B4	Bracket only in conjunction with mounting kit PHR B3. Mounting at the rear on wall or machine. Longitudinal and cross-wise adjustment possible	1350051
PHR B5	Bracket only in conjunction with mounting kit PHR B3 and PHR B4. Mounting at the rear or below on wall, floor or machine. Longitudinal and cross-wise adjustment possible	1350052

12.3.2 System plug

Tab. 32: Part numbers system plugs

System plug	Items fitted to the top cable gland	Description	Part number
PHR C3	One M20 cable fitting and one blanking plug M12	Without cable	1350060
PHR C3L5		Pre-assembled, 5 m long cable, 13 cores	1350061

12.3.3 Service cable

Tab. 33: Part numbers service cables

Part	Description	Part number
PHR CSL2	Connection cable between the serial interface of the PC and the configuration interface M8×4-pin/SubD 9-pin (DIN 41642) approx. 2 m	1350070

12.3.4 Documentation

Tab. 34: Part numbers documentation

Part	Description	Part number
PHR UCS	UCS (REER User Configuration Software) on CD-ROM including online documentation and operating instructions in all available languages	1350075

12.3.5 Miscellaneous

Tab. 35: Part numbers miscellaneous

Part	Description	Part number
PHR WIN	Spare parts set for front screen with replacement seal and screws	1350076
PHR CLEAN	Plastic cleaner and care product, anti-static, 1 litre	1350030

13 Annex

13.1 Declaration of conformity

REER

CE

Dichiarazione CE di conformità
EC declaration of conformity

Torino, 18/03/2010

REER SpA
via Carcano 32
10153 – Torino
Italy

dichiara che i Laser Scanner di Sicurezza della famiglia **Pharo** sono sensori di sicurezza per la protezione antinfortunistica di macchine pericolose di :

- **Tipo 3** (secondo la Norma CEI EN 61496-1:2005; IEC TS 61496-3:2008)
- **SIL 2** (secondo la Norma CEI EN 61508:2002 parti 1, 2, 3, 4, 5, 6, 7; EN 61000-6-4)
- **SILCL 3** (secondo la Norma CEI EN 62061:2005 + CEI EN 62061/EC2:2008)
- **PL d** (secondo la Norma UNI EN ISO 13849-1:2008)

*declares that the Safety Laser Scanner of the series **Pharo** are safety sensors for the accident-prevention protection of dangerous machines of :*

- ***Type 3** (according the Standard IEC 61496-1:2004; IEC TS 61496-3:2008)*
- ***SIL 2** (according the Standard IEC 61508:1998 parts 1, 2, 3, 4, 5, 6, 7; EN 61000-6-4)*
- ***SILCL 3** (according the Standard IEC 62061:2005)*
- ***PL d** (according the Standard ISO 13849-1:2006).*

realizzati in conformità alle seguenti Direttive Europee:

- **Direttive europee:**
  2006/42/CE "Direttiva Macchine"
  2004/108/CE "Direttiva Compatibilità Elettromagnetica"
  2006/95/CE "Direttiva Bassa Tensione"

complying with the following European Directives:

- ***European Directives:***
  2006/42/CE " Machine Directive "
  2004/108/CE " Electromagnetic Compatibility Directive "
  2006/95/CE " Low Voltage Directive "

Tale conformità è stata certificata dal seguente organismo accreditato:
This compliance has been certified by the following notified body:

TÜV Rheinland Product Service GmbH
Am Grauen Stein - D-51105 - Köln

con esame di tipo CE n° BB 60008969 0001.
with CE-type examination n° BB 60008969 0001.

Carlo Pautasso
Direttore Tecnico
Technical Director

Giancarlo Scaravelli
Presidente
Chairman

13.2 Manufacturer's checklist

REER

Checklist for the manufacturer/installer for installing electro-sensitive protective equipment (ESPE)

Details about the points listed below must be present at least during initial commissioning — they are, however, dependent on the respective application, the specifications of which are to be controlled by the manufacturer/installer.

This checklist should be retained and kept with the machine documentation to serve as reference during recurring tests.

1.	Have the safety rules and regulations been observed in compliance with the directives/ standards applicable to the machine?	Yes ☐ No ☐
2.	Are the applied directives and standards listed in the declaration of conformity?	Yes ☐ No ☐
3.	Does the protective device comply with the required control category?	Yes ☐ No ☐
4.	Is the access to the hazardous area/hazardous point only possible through the protective field of the ESPE?	Yes ☐ No ☐
5.	Have measures been taken to prevent and monitor unauthorised presence in the hazardous area when safeguarding hazardous areas/hazardous points (mechanical point-of-operation guarding), and have these been secured against removal?	Yes ☐ No ☐
6.	Are additional mechanical protective measures fitted and secured against manipulation which prevent reaching below, above or behind the ESPE?	Yes ☐ No ☐
7.	Has the maximum stopping and/or run-down time of the machine been measured, specified and documented (at the machine and/or in the machine documentation)?	Yes ☐ No ☐
8.	Has the ESPE been mounted such that the required safety distance from the nearest hazardous point has been achieved?	Yes ☐ No ☐
9.	Are the ESPE devices correctly mounted and secured against manipulation after adjustment?	Yes ☐ No ☐
10.	Are the required protective measures against electric shock in effect (protection class)?	Yes ☐ No ☐
11.	Is the control switch for resetting the protective device (ESPE) or restarting the machine present and correctly installed?	Yes ☐ No ☐
12.	Are the outputs of the ESPE (OSSDs) integrated in compliance with the required control category and does the integration comply with the circuit diagrams?	Yes ☐ No ☐
13.	Has the protective function been checked in compliance with the test notes of this documentation?	Yes ☐ No ☐
14.	Are the given protective functions effective at every setting of the operating mode selector switch?	Yes ☐ No ☐
15.	Are the switching elements activated by the ESPE, e.g. contactors, valves, monitored?	Yes ☐ No ☐
16.	Is the ESPE effective over the entire period of the dangerous state?	Yes ☐ No ☐
17.	Once initiated, will a dangerous state be stopped when switching the ESPE on or off and when changing the operating mode, or when switching to another protective device?	Yes ☐ No ☐
18.	Has the information label "Important Information" for the daily check been attached so that it is easily visible for the operator?	Yes ☐ No ☐

This checklist does not replace the initial commissioning, nor the regular inspection by specialist personnel.

13.3 Glossary

AOPDDR Active opto-electronic protective device responsive to diffuse reflection (e.g. PHARO, see also IEC/EN 61496-3)

Control input, dynamic, static, universal The monitoring cases are switched using the control inputs. PHARO has one static control inputs,.

External device monitoring (EDM) A means by which the electro-sensitive protective equipment (ESPE) monitors the state of control devices which are external to the ESPE.

Field set Protective field and warning field form a pair, the so-called field set.

I/O module Defines the functionality of PHARO.

Monitoring case A field set (if necessary a simultaneous field set) is allocated to a monitoring case. Monitoring case switching is performed using the control inputs. In this way PHARO can be adapted to the operating mode of the machine or plant that it monitors.

OSSD The OSSD output is the switching output on PHARO. This is a semiconductor output and is periodically tested for correct function. PHARO has two OSSD outputs that operate in parallel; for safety reasons these must be evaluated using two channels.

Protective field The protective field secures the hazardous area on a machine or vehicle. As soon as the safety laser scanner detects an object in the protective field, it switches the OSSDs to the off status and thus initiates the shutdown of the machine or stop of the vehicle.

Reflectivity Reflection of luminance. A measure of the reflectivity is the reflectance defined as the ratio of the luminance reflected from a surface in the measuring direction and the luminance of a completely matt white surface (white standard).

Resolution The minimum size of an object that is acquired by the protective device and is guaranteed by the manufacturer

Restart interlock The restart interlock is a protective device. In certain situations it prevents the machine from automatically restarting. This applies, e.g., after the scanner function has triggered during a dangerous machine state, after a change to the operating mode or the method of activation of the machine, or after the change to the start control device on the machine.

Sensor head Contains the opto-electronic acquisition system.

System plug Contains the configuration memory and all electrical connections. In this way PHARO can be easily replaced. After re-commissioning the configuration is loaded from the system plug; PHARO is then, normally, ready for use.

Warning field The warning field is a field with a radius of 49 m. Using this field larger areas can be controlled and simple switching functions (e.g. warning functions) triggered. The warning field is not allowed to be used for tasks related to the protection of people.

13.4 List of tables

13.5 List of illustrations

13.6 Guarantee

All new PHARO systems are guaranteed by REER for a period of 12 (twelve) months under normal working conditions, against defects due to faulty materials and workmanship.

During the aforesaid period, REER promises to replace faulty parts free of charge. This guarantee covers both material and labour.

REER reserves the right to decide whether to repair equipment or replace it with equipment of the same type or having the same characteristics.

The validity of this guarantee is subject to the following conditions:

- The user must notify REER of the fault within twelve months following the date of delivery of the product.
- The equipment and all parts thereof must be in the condition in which they were supplied by REER.
- The defect or malfunction must not arise directly or indirectly from:
  - Improper use
  - Non-observance of the instructions for use;
  - Negligence, inexperience, improper maintenance;
  - Repairs, modifications and adjustments carried out by personnel not authorised by REER, tampering, etc.;
  - Accidents or collisions (also during transportation or due to acts of God);
  - Other reasons for which REER cannot be held responsible.

Repairs will be carried out at REER's laboratories, to which the material must be consigned or forwarded: transport costs and any damage or loss of material during transportation will be charged to the Customer.

All replaced products and parts are property of REER.

REER does not recognise any other form of guarantee or rights other than those expressly stated above; no requests for compensation for damages incurred for costs, suspension of activities or any other events or circumstances related in any way to malfunctioning of the product or any parts thereof will be taken into consideration.

In order to ensure the correct operation of the safety laser scanner , careful and full compliance with all the rules, instructions and warnings stated in this manual and in the User Configuration Software manual is essential.

REER s.p.a. declines all responsibility for events arising from non-compliance with all or part of the aforesaid instructions.