OPERATING INSTRUCTIONS

Safe Portal S7 Vertical

Safety System

SICK_SP_01_V

SICK
Sensor Intelligence.

Described product

Safe Portal S7 Vertical

Manufacturer

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Legal information

Original document

This document is an original document of SICK AG.

Contents

1 About this document

1.1 Scope

Product

This document applies to the following products:
- Product code: Safe Portal S7 Vertical

Document identification

Document part number:
- This document: 8026756
- Available language versions of this document: 8026041

You can find the current version of all documents at www.sick.com.

Important information

! **NOTICE**
The operating instructions of the components also apply.
The relevant information must be made available to the employees for all work performed on the safety system.

Other documents relevant for the product

Table 1: Documents available from SICK

Document type	Title	Part number
Operating instructions	microScan3 – PROFINET	8021217
Technical information	microScan 3 – PROFINET TIA Portal	8026531

Table 2: Controller documents

Document type	Title	Part number
Operating instructions	System manual S7-1500, ET 200MP Automation system	A5E03461182-AE
Operating instructions	Cycle and response times functional manual	A5E03461504-AC
Operating instructions	SIMATIC Industrial Software SIMATIC Safety - Configuring and Programming	A5E02714439-AJ

1.2 Target groups and structure of these operating instructions

These operating instructions are intended for the following target groups: project developers (planners, developers, designers), installers, electricians, operators, and maintenance personnel.

These operating instructions are organized by the life phases of the safety system: project planning, mounting, electrical installation, commissioning, operation and maintenance.

1.3 Symbols and document conventions

The following symbols and conventions are used in this document:

Safety notes and other notes

DANGER
Indicates a situation presenting imminent danger, which will lead to death or serious injuries if not prevented.

WARNING
Indicates a situation presenting possible danger, which may lead to death or serious injuries if not prevented.

CAUTION
Indicates a situation presenting possible danger, which may lead to moderate or minor injuries if not prevented.

NOTICE
Indicates a situation presenting possible danger, which may lead to property damage if not prevented.

NOTE
Indicates useful tips and recommendations.

Instructions to action

▸ The arrow denotes instructions to action.

1. The sequence of instructions for action is numbered.
2. Follow the order in which the numbered instructions are given.

✓ The check mark denotes the result of an instruction.

1.4 Terminology used

Term	Explanation
Monitored area	Area in which the portal is integrated.
Portal	The portal indirectly separates the hazardous area from the area where people are present. The portal is monitored with the safety laser scanners of the safety system.
Transport system	The transport system moves the transport material through the portal. The transport system can be, for example, a lift table, a push platform, a conveyor belt or an AGV.
Transport material	The transport material is conveyed through the portal by the transport system. The transport material can be a vehicle body or other workpiece.
Valid object	A valid object is a transport system or transport material whose object contours can be detected by the safety system.
Detection field	Field of the safety laser scanner for detecting an expected object contour, usually the transport system or the transport material.
TRUE	Signal state that logically corresponds to 1. Is specified as True (High) in documentation from Siemens.

Term	Explanation
FALSE	Signal state that logically corresponds to 0. Is indicated as False (Low) in documentation from Siemens.

1.5 Further information

www.sick.com

The following information is available via the Internet:

- Operating instructions and mounting instructions of SICK components suitable for the safety system
- Guide for Safe Machinery (“Six steps to a safe machine”)

2 Safety information

2.1 General safety note

The information and tools will not fulfill the safety requirements for your application without further adjustments being made. The project planning provided by way of example is intended to serve as the basis to allow you to perform your own project planning and programming in line with your specific requirements. What this means is that the information and tools merely provide an example to demonstrate how a safety function can be taken care of.

When it comes to your own project planning and programming, you will need to rely on qualified staff given that it is your responsibility to ensure that the following requirements are complied with at the very least:

- ▶ Carrying out a risk assessment
- ▶ Taking into account applicable standards
- ▶ Verifying and validating the safety functions.

2.2 Intended use

The safety system provides access protection for a hazardous area. The safety system allows defined objects to pass through.

The product is only suitable for use in industrial environments.

The safety system must only be used within the limits of the prescribed and specified technical data and operating conditions at all times.

Incorrect use, improper modification or manipulation of the safety system will invalidate any warranty from SICK; in addition, any responsibility and liability of SICK for damage and secondary damage caused by this is excluded.

2.3 Improper use

The safety laser scanner acts as an indirect protective measure. It cannot protect against ejected parts or leaking radiation. Transparent objects are not detected.

The safety system is **not** suitable for the following applications, among others:

- Outdoors
- Underwater
- In explosion-hazardous areas

2.4 Requirements for the qualification of personnel

The product must be configured, installed, connected, commissioned, and serviced by qualified safety personnel only.

Project planning

You need safety expertise to implement safety functions and select suitable products for that purpose. You need expert knowledge of the applicable standards and regulations.

Mounting, electrical installation and commissioning

You need suitable expertise and experience. You must be able to assess if the machine is operating safely.

Operation and maintenance

You need suitable expertise and experience. You must be instructed in machine operation by the machine operator. For maintenance, you must be able to assess if the machine is operating safely.

2.5 Safe state

Function block	Output	Safe state
SICK_SP_01_V	SafetyOutputQ	FALSE

Manufacturer and operating entity of the machine must ensure that the safety output is used to initiate the safe state of the machine.

3 Product description

3.1 Structure

The following elements are connected to each other for the safety system:

- Two safety laser scanners (from SICK)
- SIMATIC S7-1500F controller (from Siemens)
- “SICK FB Safe Portal" function block for integration into the controller (from SICK)

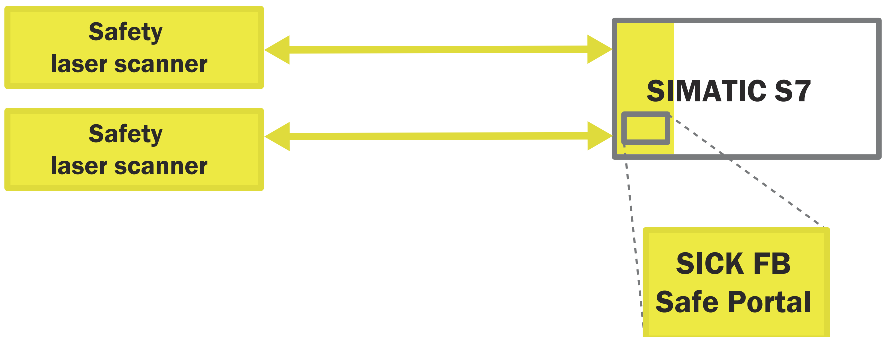


Figure 1: Structure

3.2 Functionality

Automated guided vehicles (AGVs) or other conveying systems frequently pass through transition points to hazardous areas, so-called portals, in applications involving automated material transport into or out of production lines.

The safety system protects portals. 2 vertically installed safety laser scanners monitor the portal area with several simultaneously monitored fields. A special function block is integrated into a controller with fail-safe CPU and evaluates the signals from the safety laser scanners. Objects with predefined contours can pass through the portal. Persons are reliably detected upon entry.

Figure 2: Functionality

3.3 Requirements on the application

General requirements

- The controller must be from the SIMATIC S7-1500F controller family from Siemens (controller with fail-safe CPU).
- Access to the hazardous area must be designed so that the protective fields of the safety laser scanner covers the entire point of access to the hazardous area. A person must not be able to enter the hazardous area without being detected by a protective field.
- Bypassing the protective fields (e.g. by stepping over it) is not possible and this is ensured by additional measures as necessary.
- Other access points to the hazardous area are protected with suitable measures, e.g. fixed guards (not part of this safety system)
- The area to be monitored is free from all airborne particles or process residues in its operational status.
- The transport system passes through the center of the portal in an orthogonal direction.
- The material to be transported (e.g. vehicle body) is centered on the transport system.
- When passing through the portal, the transport material or transport system must not cause any additional hazards, e.g. sharp edges.
- People cannot be situated inside the transport material. If it is possible to be situated in the transport material, this is prevented with suitable measures. The measures are part of the risk assessment.
- The area of the portal cannot be occupied by persons of significantly below-average height, e.g. children under 14 years of age. For this application example, a torso diameter greater than 200 mm is a prerequisite for reliable detection (cf. IEC 62046)

Minimum size of objects passing through

There is no defined minimum size for objects passing through. However, the following must be ensured:

- The object contours on both sides of the object must be able to be detected by the detection fields.
- The risk assessment must show that persons cannot trigger the muting function (manipulation protection).

In practice, this usually means that one of the following cases applies:

- The object is relatively wide. The two detection fields are relatively far apart and implemented as protective fields. A person in the portal does not trigger a detection in both detection fields at the same time.
- The object is relatively narrow. The two detection fields are relatively close to each other and are implemented as contour detection fields. A person cannot trigger a detection in a detection field.

see "Fields for muting function", page 22

3.4 Product characteristics

3.4.1 Components

Components relevant for the safety system

Table 3: Hardware

Component	Part of the safety system?	Included in scope of delivery?
2 × microScan3 Pro – PROFINET safety laser scanners from SICK	Yes[1)]	Variant-dependent
SIMATIC S7-1500F control from Siemens	Yes	No

Component	Part of the safety system?	Included in scope of delivery?
Reset pushbutton	Yes	No
Key-operated pushbutton for restart	Yes	No

1) The safety system is available with different variants of the safety laser scanners.

Table 4: Software and documentation

Name	Availability
Function blocks for integration into controller	SICK provides you with a ZIP archive when you purchase the safety system.
Complete subsystems for SISTEMA	
Operating instructions	

NOTE

All necessary components influence the parameters of the entire application that relate to safety technology. The components must therefore have an $MTTF_D$ or PFH_D value suitable for the entire application and satisfy the necessary performance level. The necessary performance level results from the risk assessment. The subsystem supplied for SISTEMA provides support in calculating the performance level achieved.

Using other safety laser scanners

SICK offers hardware and software of the safety system as a package with one part number. If the included safety laser scanners are not suitable for your application, you can also order the hardware and software separately and select the safety laser scanners yourself.

Requirements for the safety laser scanners

- Data transmission via ProfiSafe
- Simultaneous monitoring of 8 protective fields
- Resolution ≤ 150 mm
- Restart interlock can be deactivated or is not present.

3.4.2 Functions of the safety system

Safety function	Trigger	Description
Trigger stop	Detection at protective field	Detection at a protective field triggers the safe state of the safety system. The safety output changes to the FALSE state. The safety output must be evaluated in such a way that when changing to the FALSE state, the dangerous state is terminated.
Monitor material passage	Detection at detection fields	If the expected contour is detected at 2 related detection fields, the related protective fields are bridged. An opening is created in the portal through which the detected object can pass without triggering the safe state.
Prevent unexpected startup	Valid sequence for reset and restart	After a stop, the safety system cannot simply switch to the active state. The valid reset and restart sequence resets internal faults and reactivates the system with a deliberate action.

4 Project planning

4.1 Manufacturer of the overall system

The safety system was developed under consideration of typical application cases. A partial safety function can be implemented with the safety system in these application cases. The manufacturer must check whether the safety system is suitable for its specific application case (risk assessment according to ISO 12100). Further protective measures may be required in addition to the safety system.

If the thorough check shows that the safety system is not suitable for the specific application case, the safety system can be used as a basis for an individualized development suitable for the specific application case. This case will not be considered further in this document.

In any event, additional work is necessary for the safety system to be used, e.g. subsequent configuration of the safety controller.

The manufacturer has the following duties:

- Executing a risk assessment.
- Verifying and validating the safety functions.
- Integrating the individual components in accordance with the appropriate standards.
- Please note that C standards have priority compared to statements about this safety system.

4.2 Operating entity of the overall system

Changes to the electrical integration of the safety system in the machine control and changes to the mechanical mounting of the safety system necessitate a new risk assessment. The results of this risk assessment may require the entity operating the machine to meet the obligations of a manufacturer.

Changes to the safety system's configuration may impair the protective function. The effectiveness of the safety system must be checked after any change to the configuration. The person carrying out the change is also responsible for maintaining the protective function of the safety system.

4.3 Design

4.3.1 General requirements for the design

You must take measures to rule out common cause failures (cf. ISO 13849-1).

4.3.2 Portal design

Overview

The safety laser scanners are mounted on mounting columns on both sides of the portal. The entire portal must be symmetrical so that the distances between the safety laser scanners and the passing objects are identical on both sides.

Prerequisites

- The transport material is placed centrally on the transport system.
- The transport system moves through the center of the portal.

Important distances

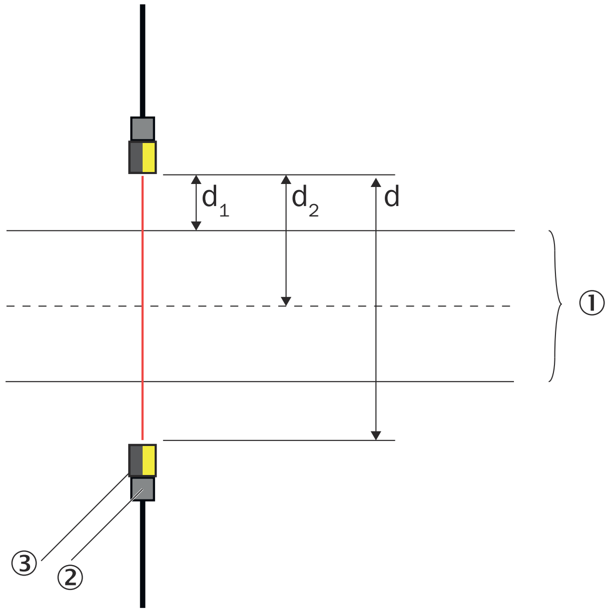


Figure 3: Portal – top view

① Path of the transport system
② Mounting column
③ Safety laser scanner

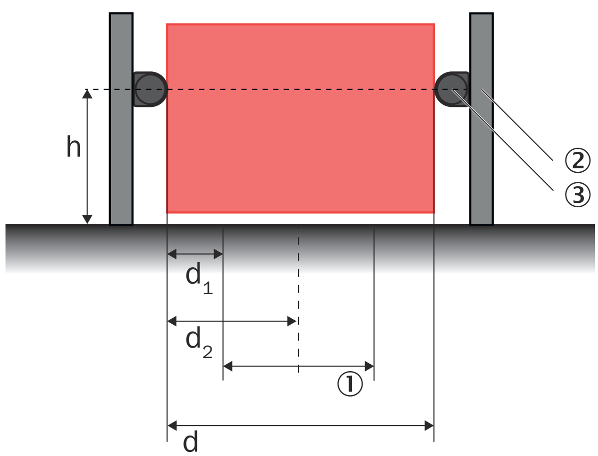
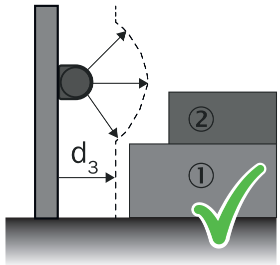
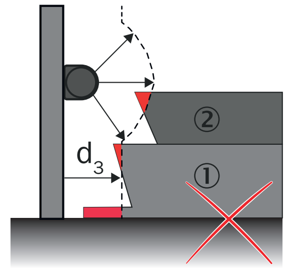


Figure 4: Portal – front view

① Path of the transport system
② Mounting column
③ Safety laser scanner



① Transport system
② Transport material



① Transport system
② Transport material

Table 5: Important distances

Parameter	Description
d	Distance between the mounting columns The distance must be determined specific to the application. The following factors influence the distance: • Protective field range of the safety laser scanners • Size and shape of the transport material • Retro-reflectors or surfaces with unfavorable reflection behavior in the scan area • Distance d_3
d_1	Horizontal distance between safety laser scanner and conveyor system path The distance must be identical on both sides.
d_2	Distance between safety laser scanner and center of the conveyor system path The distance must be identical on both sides. Tolerance: ± 1 cm.
d_3	Distance between any 2 points of the fixed part of the portal (safety laser scanner and mounting column) and the passing object (transport system or transport material) Min. 500 mm (danger due to crushing and shearing)
h	Mounting height of the safety laser scanners The mounting height must be determined specific to the application. The following factors influence the mounting height: • Geometry of the fields of the safety laser scanners. • If people can be situated on the transport material, the safety laser scanners must be able to monitor the area above the transport material. • Passing height of the passing object • Position of the object contour For example, a lower mounting height can help detect an object contour that is obscured by overhangs of the transport material. • Overhangs on an object can create unmonitored areas. These must not become so large that a person can stay in them without being detected. • The mounting height must be selected so that all protective fields can be monitored independently of each other. A passing object must not obscure the view of a protective field that is independent of the object.

Complementary information

You must consider the basic safety principles according to EN ISO 13849-2 Annex D when designing the hardware.

You must consider the proven safety principles according to EN ISO 13849-2 Annex D when designing the hardware.

Further topics

- "Shadowing and scanner positioning", page 27
- "Calculation of the required protective field range", page 29

4.3.3 Placement of the safety laser scanners

- The mounting columns are placed with the minimum distance from the hazardous area. They are permanently mounted and cannot be adjusted or moved. They are stable, protected against manipulation and resistant to vibration or oscillation. The mounting column can be, for example, a concrete pillar.
- Safety laser scanners are attached to mounting columns with mounting kits.
- The safety laser scanners must be mounted so they are free from vibration.
- The safety laser scanners are mounted vertically so that the scan plane is orthogonal to the floor.
- Both safety laser scanners must be mounted at the same height h.
- There is no offset or angle between the safety laser scanners. That means the scan planes of the two safety laser scanners are in the same plane.
- The safety laser scanners are ideally mounted so that the display can be read from the direction in which people are usually located.

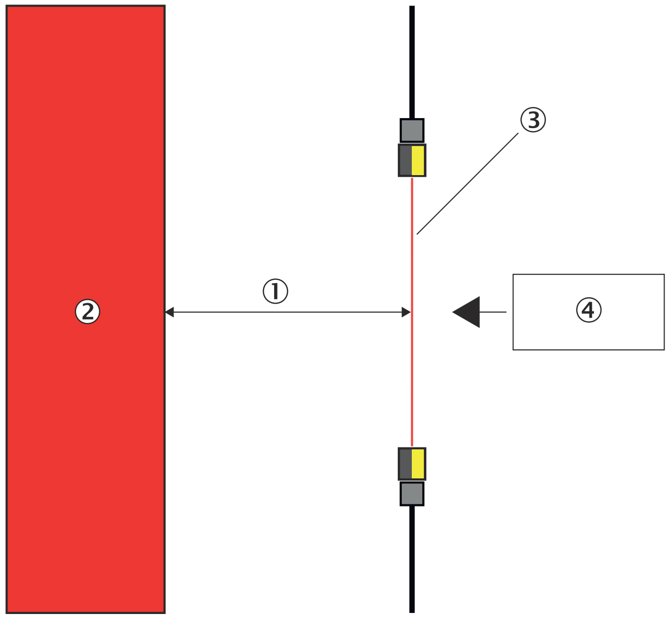
4.3.4 Requirements for reset and restart devices

- The signals for reset and restart must be generated via 2 independent manually operated pushbuttons, e.g. reset pushbuttons. The operation of both pushbuttons must be a conscious action.
- The signal for restart must be generated via a key-operated pushbutton. This must only be possible by authorized and instructed staff, e.g. by restricted access to keys or key-operated pushbuttons.
- The reset and restart pushbuttons must be placed outside the hazardous area.
- The reset and restart pushbuttons must be positioned so that the operator has an overview of the hazardous area. The operator must be able to ensure that no person is in the hazardous area. If a complete overview of the hazardous area is not possible, a special procedure for resetting must be implemented (cf. ISO 13849-1). This case is not considered further in this document.
- The reset and restart pushbuttons must be placed so that the operator can see the portal safety laser scanners.
- The signals of the reset and restart pushbuttons must be connected to fail-safe digital inputs of the controller.

4.3.5 Minimum distance to hazardous area

Overview

The minimum distance to the hazardous area ensures that when a person is detected, the dangerous state is terminated before the person enters the hazardous area. The distance depends on the response time of the safety laser scanner, the controller and the stopping time of the system.



① Minimum distance to hazardous area S
② Hazardous area
③ Scan plane between the safety laser scanners
④ Approaching transport material

Calculation

You must calculate the minimum distance to the hazardous area. The following calculation example according to ISO13855 can be used for this.

$S = K \times (t_{safetysystem} + t_{signal} + t_{machine}) + C$

Parameter	Description
S	Minimum distance to hazardous area
K	Approach speed of a person Depending on the application, different values must be used for the approach speed. • People cannot stay on the transport system (e.g. small AGV): 1,600 mm/s (EN ISO 10218-2) • People can be on the transport system (e.g. thrust platform): 1,600 mm/s + speed of the transport system
$t_{safetysystem}$	Response time of safety system
t_{signal}	Signal runtime
$t_{machine}$	Stopping time of the system, including run-down time The decisive factor here is the stopping time of the parts of the system that represent a dangerous state.
C	Supplement to protect against reaching over A typical value is 850 mm (arm to shoulder). Depending on the application, the calculation may result in other values.

Complementary information

The SIMATIC CPU cycle time has a default value of 100 ms. This value is configurable. Check the SIMATIC CPU cycle time with regard to the minimum distance to the hazardous area. It may be necessary to adjust the distance to the hazardous area or the SIMATIC CPU cycle time.

Further topics

- "Response time of safety system", page 64

4.3.6 Speed of the object when passing

Overview

The speed of the object (transport system with transport material) must be limited to a maximum value while passing through the portal. Only up to this speed can an object with a length of 200 mm (e.g. a person) be reliably detected between 2 scan cycles.

Calculation of the maximum value

$V_{max} = (0.2\ m/(t_s + t_i) \times n) - K$

A higher value is only possible if you can rule out an increased risk in the course of your risk assessment.

Parameter	Description
V_{max}	Maximum speed of the object during passage
t_s	Scan cycle time of the safety laser scanners
t_i	Supplement due to additional interference protection of the safety laser scanners
n	Set multiple sampling of the safety laser scanners
K	• If a person can be situated on the transport system: 1,600 mm/s (EN ISO 10218-2) The operating entity must take suitable measures to ensure that persons in the vicinity of the portal do not move faster than 1,600 mm/s (e.g. persons on a bicycle) • If persons cannot be on the transport system: 0 mm/s

Speed of the object when passing

V_{object} = Actual speed of the object when passing

$V_{object} \leq V_{max}$

You must take appropriate measures to ensure that V_{object} is not exceeded during passage.

To calculate the timer values for the muting function, V_{object} must be used instead of V_{max}. If V_{max} is used, then this does not create a safety risk. However, unplanned stops may occur if the difference between V_{max} and V_{object} is significantly different (availability problem).

Requirements for AGVs as a transport system

AGV require the following:

- Safe speed monitoring
- Safe position monitoring

If either or both are not present, you need to ensure the following:

- Persons walking directly in front of or behind the AGV are automatically detected. Example: The areas directly in front of and behind the AGV are permanently monitored by an optical protective device. Upon detection, the safe stop of the AGV is triggered.
- Persons cannot be situated on the AGV.

Further topics

- "t0_DetectionDiscrepancy", page 33
- "t1_MutingInitiation", page 34
- "t2_MutingExtension", page 35

4.3.7 Safety laser scanner fields

Overview

You must configure several fields in the safety laser scanner to monitor the portal area.

Simultaneously monitored protective fields protect the portal area and trigger the safe state when detected. Some protective fields are temporarily not evaluated. This allows objects to pass through the portal without triggering the safe state (muting).

For muting, several detection fields monitor the portal area. If a defined object contour is detected at two related detection fields (e.g., a vehicle body), the function block does not evaluate the corresponding protective fields (muting).

The portal is symmetrical. Each scanner has the same fields. Therefore, each field exists on the left and on the right side (e.g. PFA1 and PFB1). However, the fields do not have to have the same geometry on both sides.

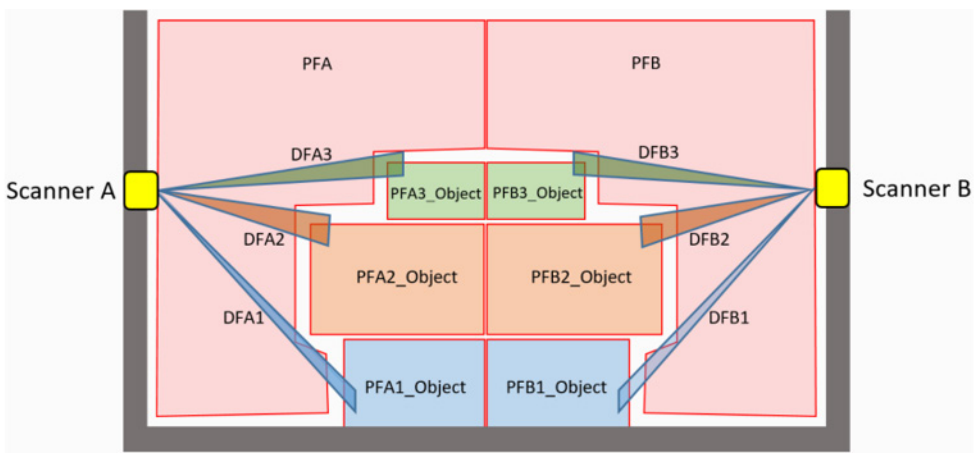


Figure 5: Safety system fields

Basic principles of the safety system

The individual fields have partly different and detailed requirements, which are listed in corresponding sections. However, the detailed requirements are derived from a few basic principles of the safety system.

General requirements for the field configuration

- In operation, it must be possible to monitor every area where people may be present using protective fields.
- If some protective fields are not evaluated when the muting function is active, a monitoring gap occurs. This gap must be filled as precisely as possible by the object passing through. This makes it possible to rule out the possibility of a person being in the monitoring gap.
- You must allow for tolerances when designing the fields. The tolerances are partly unavoidable because of the following aspects:
  - Tolerances of the safety laser scanners
  - Even if objects pass through the center of the portal, deviations from the ideal path may occur, e.g., due to inaccurate placement of the transport material on the transport system.

  - Retro-reflectors or surfaces with unfavorable reflection behavior in the scan area
  - Tolerances according to IEC 62046, chapter B.4, B.5: Tolerances depending on the position of the scan plane (in the opening or offset to the opening).
- Tolerances of the fields and unfavorable object geometry will lead to additional monitoring gaps in most cases. This is not a problem as long as you can ensure one of the following for each gap:
  - The monitoring gap is at a position where no person can be located.
  - The geometry of the monitoring gap prevents a person from being completely inside it. Part of the person would always trigger a detection in a nearby protective field. Decisive for this evaluation is a fictitious circular object with a diameter of 200 mm.

4.3.7.1 Protective fields for lateral monitoring

The PFA and PFB lateral protective fields are permanently active. They monitor the areas to the left and right of the transport system and the transport material. If necessary, the areas above the transport material are also monitored. The protective fields perform the same function as swinging doors in a conventional muting application.

Detection at the protective fields triggers the safe state.

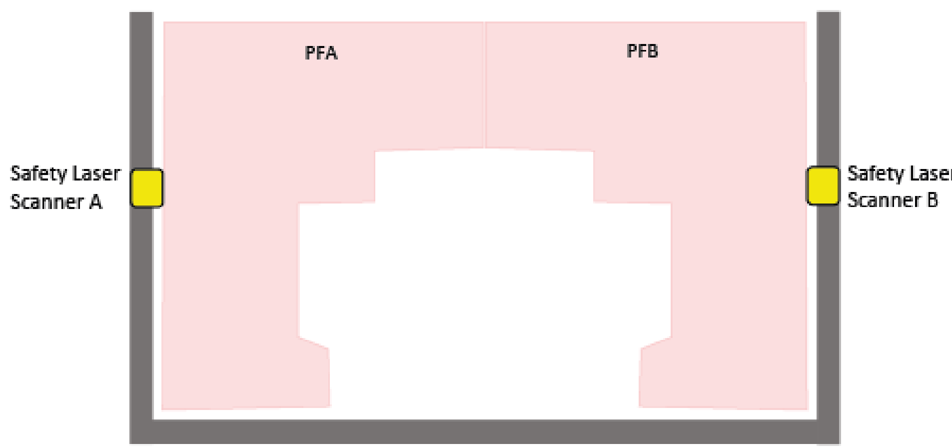


Figure 6: PFA and PFB protective fields

Design of the PFA and PFB protective fields

- The protective fields must be designed to fully monitor the areas to the left and right of the object.
- The gap between the PFA/PFB protective fields and the contour of the passing object must not exceed 200 mm. A larger value is only possible if the risk assessment shows that the gap does not create a hazard. Otherwise, additional protective measures must be taken to prevent persons from entering the hazardous area undetected.
- The distance to the floor or the reference plane must not exceed 300 mm to avoid crawling beneath. If a greater distance is required, then you must consider this risk separately in your risk assessment.
- The protective fields must monitor the area above the reference plane at least up to a height of 900 mm (protection against climbing over). Depending on the safety laser scanner used, a larger value may be required. Corresponding information can be found in the operating instructions of the safety laser scanner.

- If people can be situated on the transport material, the PFA and PFB protective fields must monitor the areas above the transport material.
- The areas directly above the transport system are monitored in most applications by protective fields for the muting function (e.g. PFA2_Object and PFB2_Object). However, if only transport systems without transport material pass through the portal, the PFA and PFB protective fields must also monitor the areas above the transport system.

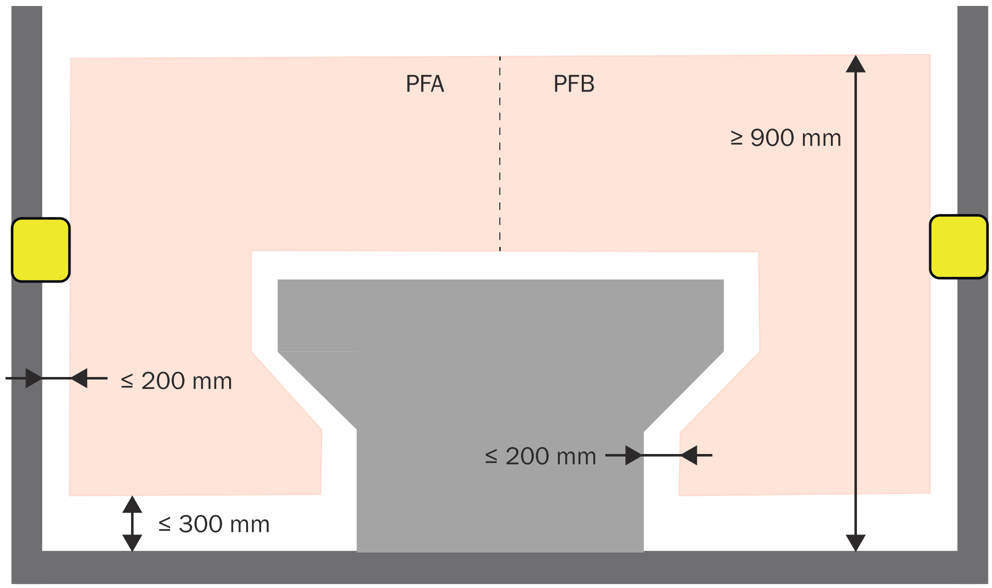


Figure 7: Important dimensions in the design of the PFA and PFB lateral protective fields

4.3.7.2 Fields for muting function

Overview

Detection fields and protective fields monitor the areas where objects pass through the portal. A protective field is assigned to each detection field. For each detection field-protective field pair on the left side of the portal, there is a counterpart on the right side. Thus, a total of 4 fields are evaluated for the monitoring of a single object.

The safety system can monitor up to 3 defined objects simultaneously. This enables the safety system to monitor the area above the conveyor system, e.g. during empty runs without transport material.

Table 6: Fields for object 1

	Left side	Right side
Detection field	DFA1	DFB1
Protective field	PFA1_Object	PFB1_Object

Table 7: Fields for object 2

	Left side	Right side
Detection field	DFA2	DFB2
Protective field	PFA2_Object	PFB2_Object

Table 8: Fields for object 3

	Left side	Right side
Detection field	DFA3	DFB3
Protective field	PFA3_Object	PFB3_Object

The detection fields detect a defined contour. This can be, for example, the contour of a lift table. If the contour is detected, the associated protective fields are not evaluated. A gap is created in the portal through which the object can pass without triggering the safe state.

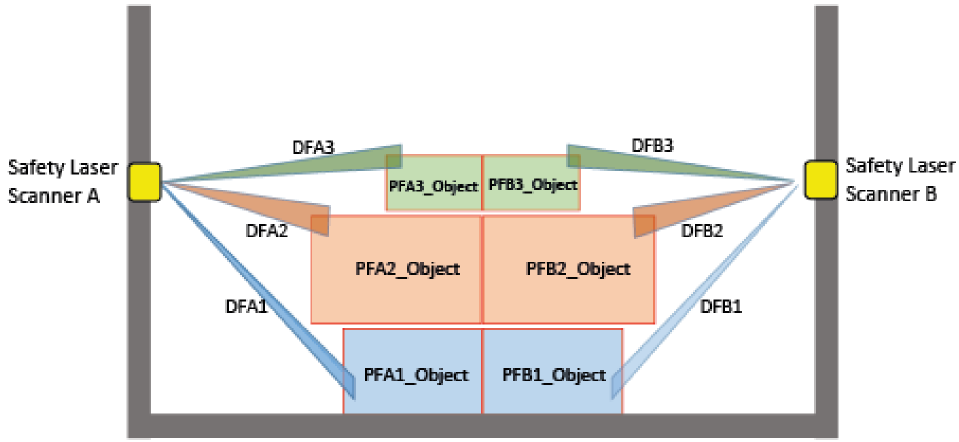


Figure 8: Fields for muting function

Requirements

Design of the detection fields

- The detection fields must be implemented either via protective fields or contour detection fields. Depending on the application, there are different advantages and disadvantages.
- It must not be possible for a single person to trigger a detection simultaneously for 2 related detection fields of an object (e.g. DFA1 and DFB1). This can be ensured via one of the following options:
  - The two fields have a wide distance between them.
  - The detection fields are designed as a contour detection field and a human trigger can be excluded by the shape of the contour.
- In the case of 2 related detection fields, unintentional simultaneous detection must not occur.
- Each detection field must be located within the associated protective field.
- The resolution of the safety laser scanners can be adjusted at the field level. That means you can adjust the resolution of the detection fields if necessary to enable detection. However, this affects the scanning range.

Design of the protective fields

- The defined object must be able to pass through the gap created during muting.
- The protective fields for detecting different objects must be positioned one above the other. Positioning next to each other is not possible.
- The distance between the edge of the protective field and the object must not exceed 200 mm. Otherwise, muting creates a gap in which a person can be next to or on the object without being detected.
- Tolerance zones of the safety laser scanners used must be taken into account.
- If the transport system is a flat AGV with a height < 300 mm, then you do not need a protective field for the AGV. The first protective field then starts at a height of 300 mm above the reference plane for the detection of persons or invalid objects on the AGV.
- Consider tolerances according to IEC 62046, chapter B.4, B.5: Tolerances depending on the position of the scan plane (in the opening or offset to the opening).

Example 1

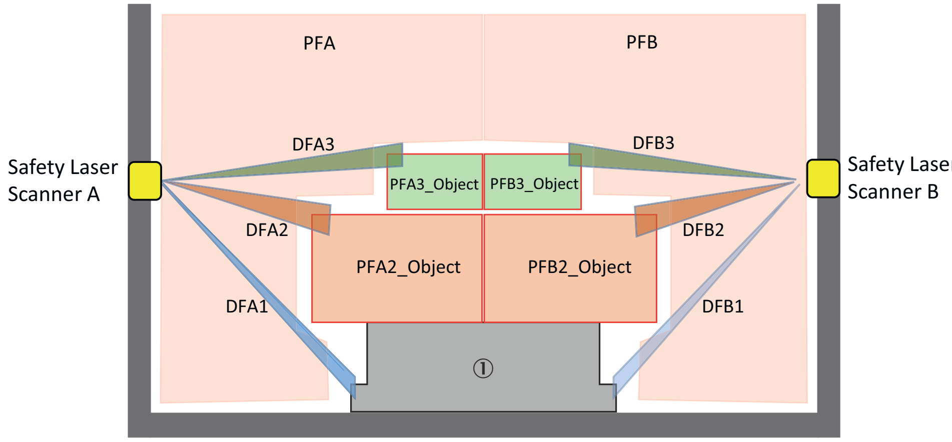


Figure 9: Example passage of empty lift table

① Lift table

The DFA1 and DFB1 detection fields have detected the defined object contour of the lift table. The PFA1_Object and PFB1_Object protective fields are not evaluated. The lift table can pass through the portal.

The DFA2 and DFB2 detection fields did not detect the defined object contour. A person on the transport system would be detected by the PFA2_Object and PFB2_Object protective fields.

The PFA and PFB protective fields are always evaluated. A person next to the transport system is detected.

Example 2

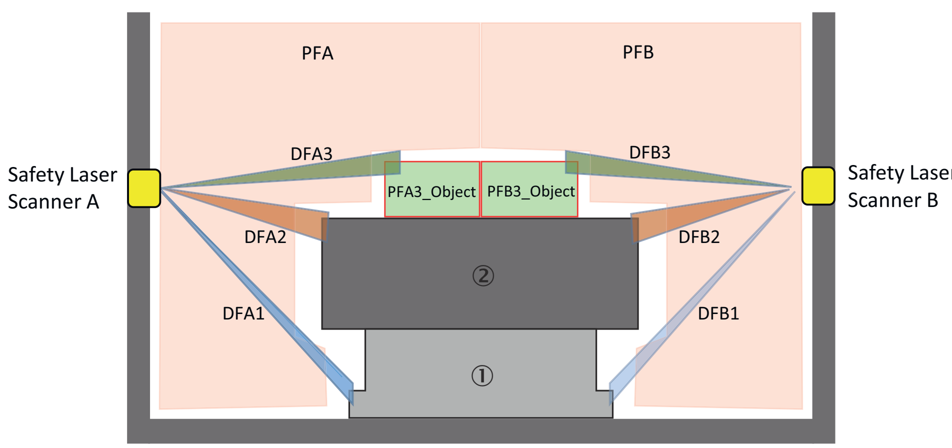


Figure 10: Example passage of lift table with car body

① Lift table

② Car body

In addition to example 1, the DFA2 and DFB2 detection fields have now also detected the defined contour. The PFA2_Object and PFB2_Object protective fields are not evaluated. The lift table with the car body can pass through the portal.

The area above the car body is monitored by the PFA3_Object and PFB3_Object protective fields and the PFA and PFB protective fields.

The PFA and PFB protective fields are always evaluated. A person next to the transport system is detected.

Negative example

The following example is an incorrect configuration. The DFA1 and DFB1 detection fields cannot detect the object contour of the lift table because the car body in the area of the PFA2_Object and PFB2_Object protective fields obstructs the view of the object contour (shadowing).

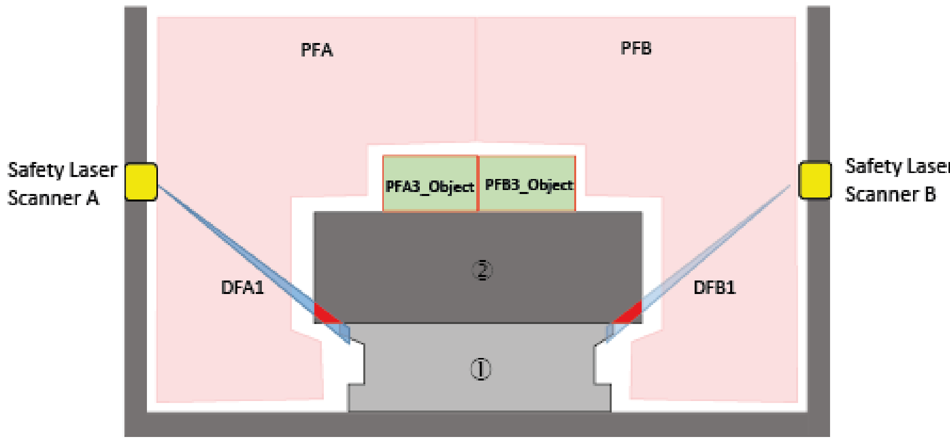


Figure 11: Negative example – object contour of the lift table cannot be detected

① Lift table

② Car body

Consequence

- When using protective fields as detection fields: The car body falsely triggers the muting for the lift table. This can lead to monitoring gaps.
- When using contour detection fields as detection fields: Muting for the lift table is not triggered. The PFA1_Object and PFB1_Object protective fields detect the lift table and trigger the safe state.

Complementary information

When detecting objects with a dark or light-scattering surface, it is errors may occur on initializing or terminating muting. To increase availability, the application can be expanded with additional detection fields (see "Additional detection fields for objects with a dark or light-scattering surface", page 78).

Further topics

- "Muting", page 32
- "Object contour", page 31
- "Switching the monitoring cases", page 42

4.3.7.3 Forced muting with enclosing protective fields

Overview

The muting sequences of the individual areas function independently of each other. In certain applications, it may be useful to force the muting of another area when muting one area. In this case, the higher-level protective fields must enclose the protective fields for which they force muting.

Requirements for enclosing protective fields

- If a protective field encloses the protective field below it, then the protective field above it must force muting for the protective field below it.
- In the case of forced muting, it must be ensured that no monitoring gap is created by the forced muting. For example because the passing object completely encloses the areas with forced muting.

Implementation of forced muting in the safety logic

You can use the muting status outputs of the function block to force muting for another area of the portal.

In the following example, muting of the PFA2_Object and PFB2_Object protective fields automatically forces muting of the PFA1_Object and PFB1_Object protective fields.

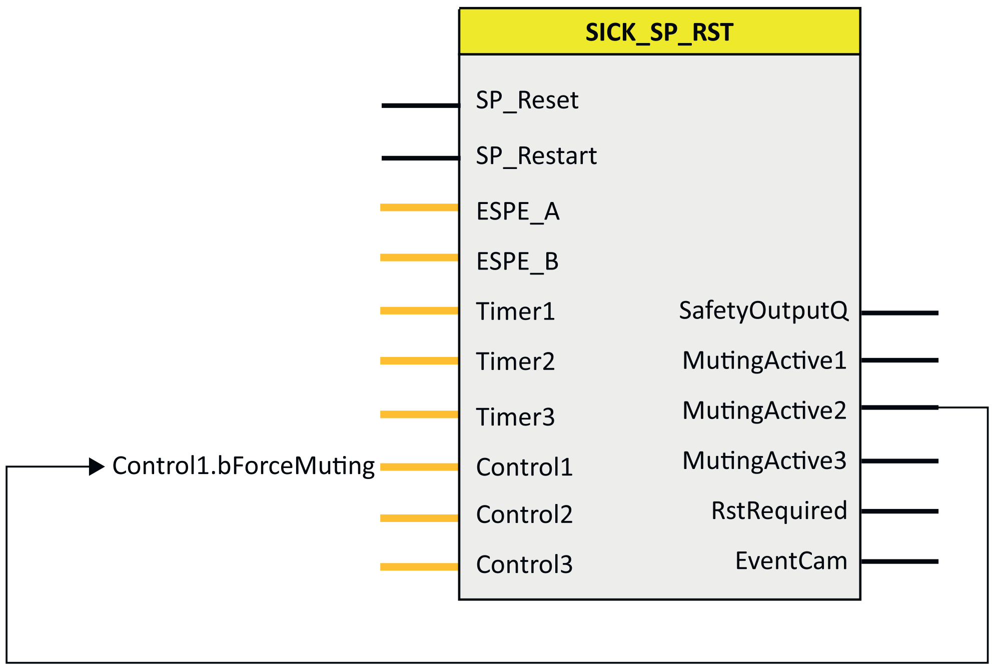


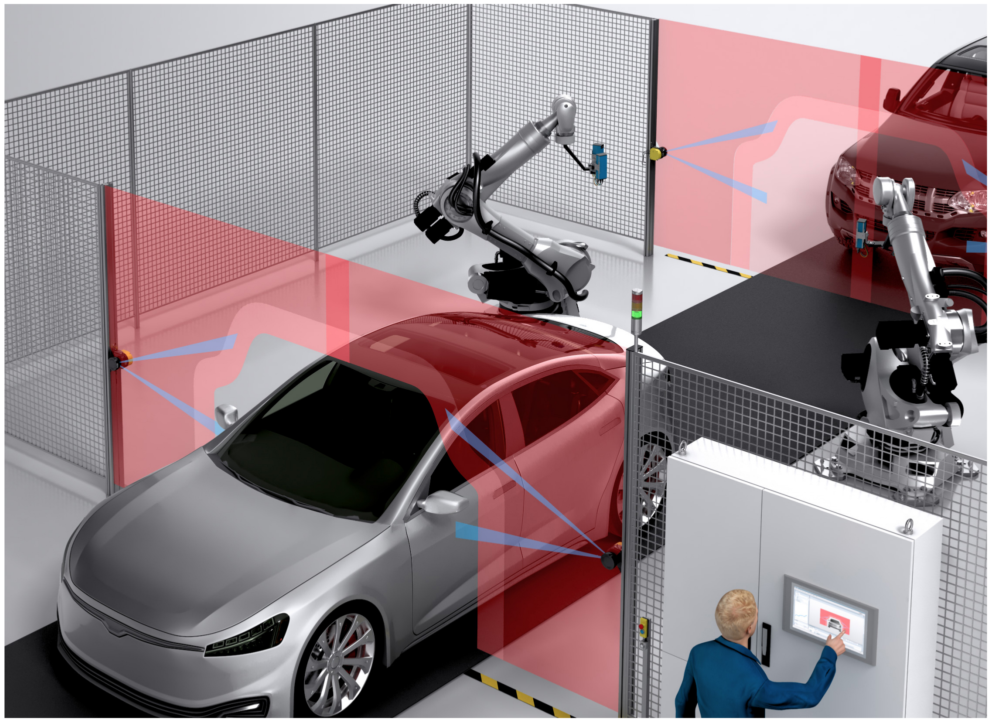
Figure 12: Forced muting

Example 1

Different sized vehicle types drive through the portal. The larger vehicle types are wider and taller than the smaller vehicle types in every respect, or at least the same size.

- Smaller vehicle types: PFA1_Object and PFB1_Object protective fields
- Larger vehicle types: PFA2_Object and PFB2_Object protective fields

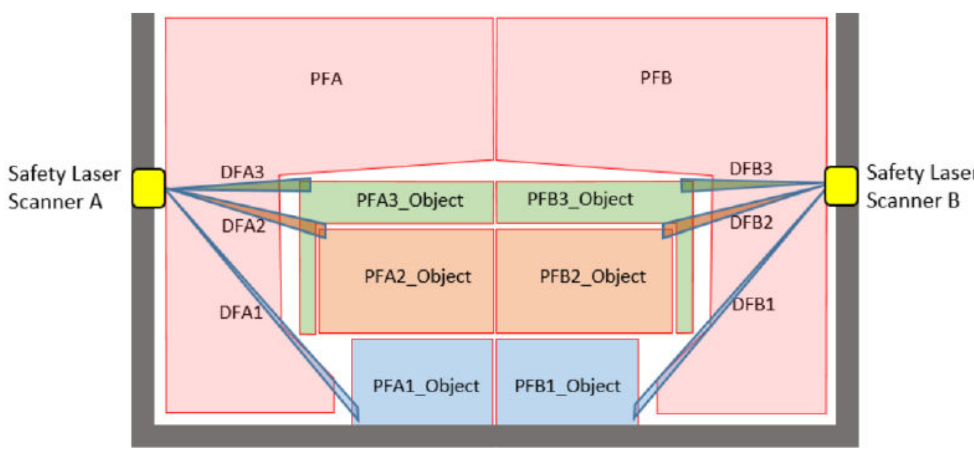
If a smaller vehicle type drives through the portal, only the PFA1_Object and PFB1_Object protective fields are muted. If a larger vehicle type passes through the portal, muting is also forced for PFA2_Object and PFB2_Object.



Example 2

On top of the transported material (object 2) there is occasionally another transported material (object 3) that is detected by the detection fields DFA3 and DFB3. The upper transport material (object 3) has overhangs so that the DFA2 and DFB2 detection fields can no longer detect the object contours of the transport material below (object 2). A lower positioning of the safety laser scanners is not possible.

In this application, the PFA3_Object and PFB3_Object protective fields are dragged down sideways until they enclose the PFA2_Object and PFB2_Object protective fields.



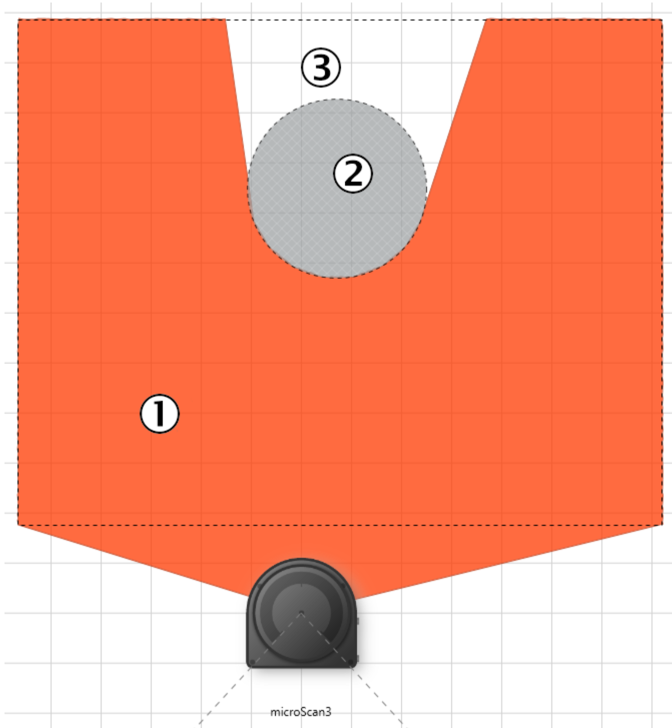
Further topics

- "Inputs and outputs of the SICK_SP_01_V function block", page 48

4.3.7.4 Shadowing and scanner positioning

Overview

Safety laser scanners detect opaque objects optically. This means that areas behind opaque objects cannot be monitored. These areas are referred to as shadowing.



①	Protective field
②	Object
③	Non-monitorable area (shadowing)

Minimization of shadowing

You need to minimize shadowing as much as possible to keep areas that cannot be monitored as small as possible. You must be able to rule out the possibility of people being in areas that cannot be monitored without being detected. Besides the shape of the objects passing through, shadowing depends on the following:

- Mounting height of the safety laser scanners
- Distance of the safety laser scanners to the object.

If you cannot influence the shape of the object, shadowing can only be reduced by the positioning of the safety laser scanners. In most use cases, there will be some degree of shadowing. Consider the monitoring gaps this creates in your risk assessment.

The following examples show how shadowing can be reduced by positioning the safety laser scanners.

Example 1

Safety laser scanner is mounted low. The areas above the object cannot be monitored.

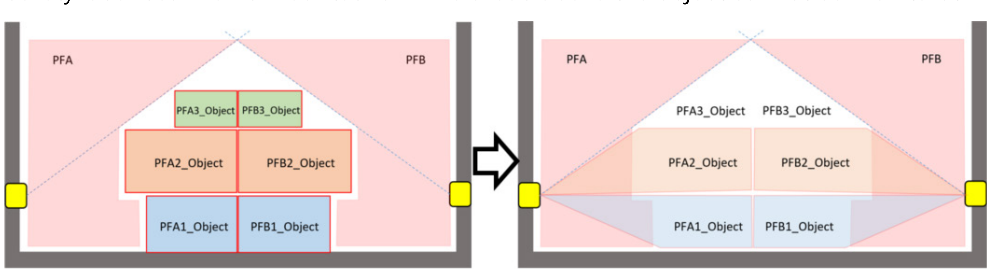


Figure 13: Shadowing example 1

Example 2

Safety laser scanner is mounted high. The areas below the object cannot be monitored.

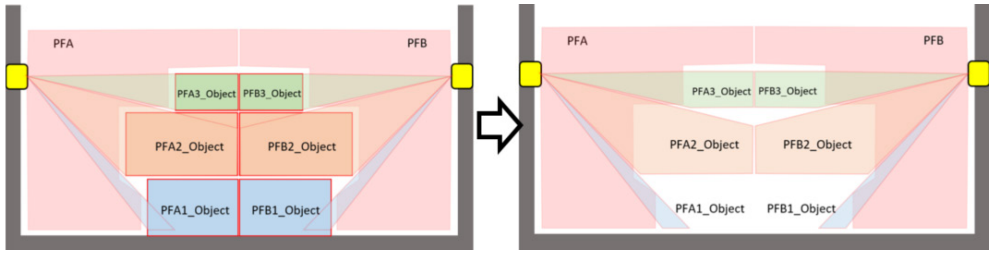


Figure 14: Shadowing example 2

Example 3

Safety laser scanner is mounted in the center. There are non-monitorable areas above and below the object.

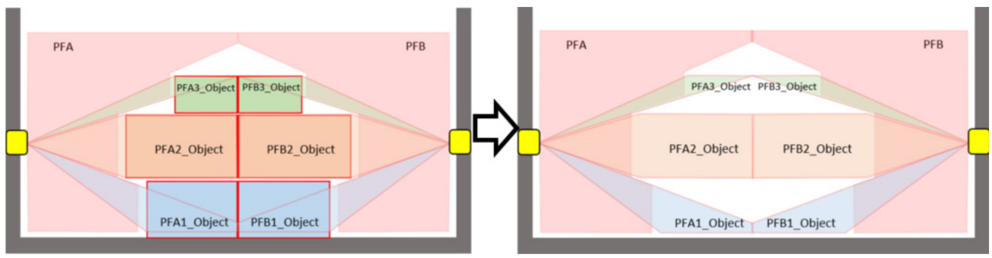


Figure 15: Shadowing example 3

Example 4

The distance between the safety laser scanner and the object was increased. Compared to example 3, the areas that cannot be monitored have become smaller.

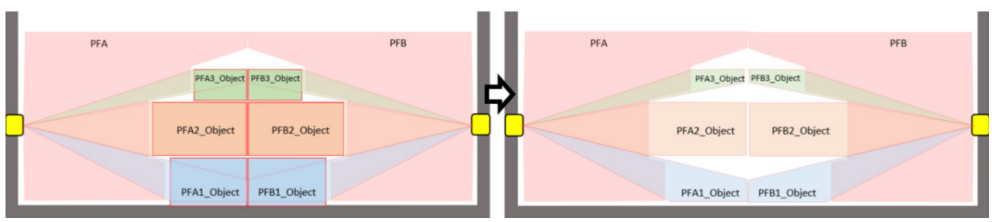


Figure 16: Shadowing example 4

Further topics

- "Portal design", page 14

4.3.7.5 Calculation of the required protective field range

Overview

To determine the required protective field range of the safety laser scanners, in addition to the size of the portal, you must also take into account that the protective fields must overlap in the center of the portal.

Calculation

$S_L = d + T_Z + Z_R$

S_L	Required protective field range of the safety laser scanners

d	Distance between safety laser scanner and center of portal
T_Z	Tolerance of the safety laser scanner Is needed in any case.
Z_R	Supplement Z_R for reflection-related measurement errors Is only required if there are retro-reflectors or surfaces with unfavorable reflection behavior in the scan area.

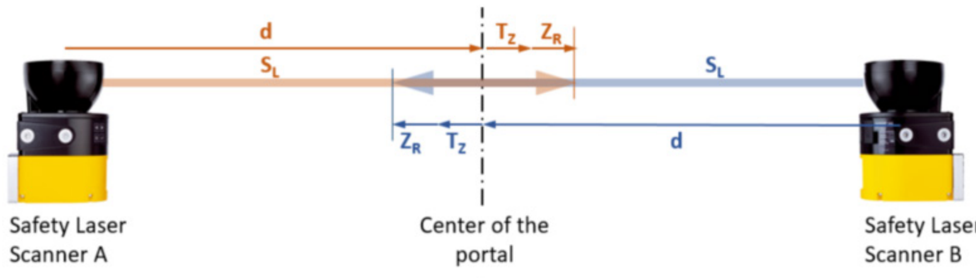


Figure 17: Overlapping protective fields

Other factors

In addition to the calculation in this chapter, you must also consider the following factors when determining the protective field range:

- Maximum size of the objects passing through: The maximum size is primarily limited by the protective field range.
- Unmonitored areas above the passing object: If people can be situated on the object during passage, the protective fields must also be able to cover the areas above the object. If this is not feasible, the areas above the object can also be protected with other suitable measures (not part of this safety system).
- Reduction of shadowing: A greater distance of the safety laser scanners from the center of the portal can reduce areas obscured by shadowing.
- A significantly larger scanning range is required when using additional detection fields for objects with a low remission. Fixed structures on the opposite side must be detected. see "Additional detection fields for objects with a dark or light-scattering surface", page 78

Further topics

- "Portal design", page 14

4.3.8 Monitoring of a reference contour

Transport system and transport material pass the scan plane in orthogonal direction. National and international standards recommend or require the monitoring of a reference contour in this case. With the reference contour field, the safety laser scanner monitors the distance to a contour of the environment (e.g. a wall) in order to detect inadvertent adjustment or manipulation.

If a safety laser scanner no longer detects the defined reference contour, the safety laser scanner changes to the safe state.

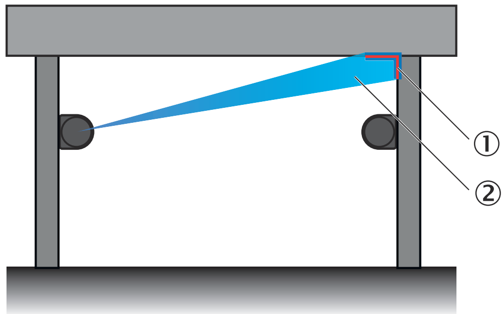


Figure 18: Example of reference contour monitoring

① Monitored reference contour
② Reference contour field

Consider the requirements of IEC 62046, chapter B.4. when designing the reference contour field.

4.3.9 Object contour

Overview

The object contour is used to distinguish valid from invalid objects. Muting is only activated for valid objects.

Notes on integration

- The object contour must be present on both sides.
- For each protective field pair (e.g. PFA1_Object and PFB1_Object), there is a separate muting sequence and thus also separate triggers for muting. This means that for each protective field pair, there must be other object contours via which the muting is triggered.
  Example:
  The PFA1_Object and PFB1_Object protective fields monitor the area for the lift table. The DFA1 and DFB1 detection fields must therefore be able to detect a contour on the lift table. The PFA2_Object and PFB2_Object protective fields monitor the area for the car body. The DFA2 and DFB2 detection fields must therefore be able to detect a contour on the car body.
- Ideally, the object contour can be detected during the entire passage in the detection field. Small deviations such as gaps (< 200 mm) or a contour that is not continuous to the end of the object can be taken into account via the timers.
- The mounting height of the safety laser scanner can have an effect on the detection of the object contour due to the changed viewing angle.
- Hanging cables or protruding parts can affect the availability of the safety system. If necessary, take these factors into account, e.g. via the protective field design or the timer values.
- Only if contour detection fields are used to detect the object contour: If the surface is irregular, you may need to draw the contour detection fields wider or configure the positive and negative tolerance bands wider to reliably detect the object contour.

Further topics

- "Fields for muting function", page 22

4.4 Muting

Overview

Muting allows valid objects to pass through the portal. For the duration of muting, a detection at the respective protective fields does not trigger the safe state.

Each area that can be muted has its own muting sequence that runs independently of the muting sequences of other areas. The muting sequence for the PFA1_Object and PFB1_Object protective fields is controlled exclusively by the DFA1 and DFB1 detection fields. There is no logical link with the muting sequence of other protective field pairs (e.g. PFA2_Object and PFB2_Object).

Trigger for muting

The muting sequence is triggered as soon as **all the** following events occur:

- The object contour is detected in both detection fields.
- Timer t0_DetectionDiscrepancy has not expired.
- Timer t1_MutingInitiation has not expired.
- Input bEnableAutoMuting = TRUE
- Input bConveyorStop = FALSE
- SICK_SP_01_V function block: Output SAFETYOUTPUT Q = TRUE

End of muting

Muting is terminated when **one of** the following events occurs:

- Timer t3_MutingDuration expires.
- The object contour is not detected in at least one detection field for a time period greater than the value of timer t2_MutingExtension.
- No detection in both detection fields and both protective fields
- Input bEnableAutoMuting = FALSE
- SICK_SP_01_V function block: Output SAFETYOUTPUT Q = FALSE (safe state)

Timer

There are 4 different timers with which the muting sequence can be adjusted to the application. All timers are safety relevant and must be calculated or set by the integrator.

Table 9: Available timers

Name	Description
t0_DetectionDiscrepancy	Allows for time difference in the detection of the two object contours.
t1_MutingInitiation	Is required if the object contour does not start at the front edge of the object, e.g. for a rounded vehicle front.
t2_MutingExtension	Required in the following cases: • An object contour does not extend to the rear edge of the object. • The object contour cannot be detected without gaps.
t3_MutingDuration	Prevents muting for an unlimited period of time.

Complementary information

- For particularly long muting times: You must take additional measures to prevent an accumulation of errors from leading to a loss of the safety function.
- Together with the geometry of the detection fields, the timer values define whether an object is detected as valid.

4.4.1 t0_DetectionDiscrepancy

Overview

The timer allows a time offset between detection in 2 related detection fields, e.g. DF1A and DF1B. The temporal offset of the detection can be caused, for example, by asymmetrical object contours.

The timer prevents this temporal offset of the detection from immediately triggering the safe state. This increases the availability of the safety system.

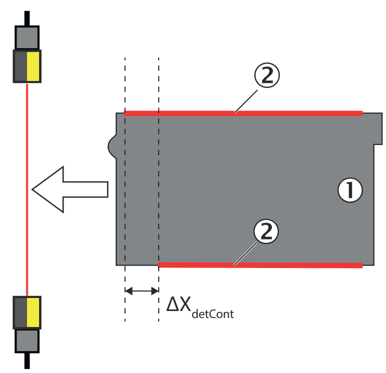
Trigger

The timer starts as soon as the object contour is detected in a detection field.

Calculation for object contours with offset

$t0\_DetectionDiscrepancy = (\Delta X_{detCont} + X_{Tol0}) / V_{object} - t_{F\text{-}CPU}$

The following applies: $\Delta X_{detCont} + X_{Tol0} \leq 200$ mm. A higher value is only possible if you can rule out an increased risk in the course of your risk assessment.

$\Delta X_{detCont}$	Offset of the contour to be detected in the direction of travel.  *Figure 19: Distance $\Delta X_{detCont}$* ① Passing object ② Object contour
X_{Tol0}	Tolerance value that takes into account the measurement inaccuracy of $\Delta X_{detCont}$.
V_{object}	Speed of the passing object
$t_{F\text{-}CPU}$	Inaccuracy of the internal timer monitoring by the F-CPU of the controller

Calculation for object contour without offset

Theoretically, the detection of object contours takes place simultaneously in related detection fields. In practice, the following aspects, for example, always lead to a small time offset:

- Object is not perfectly axisymmetric.
- The object does not pass the portal exactly in the center.

The following therefore applies to the timer:

$t0\_DetectionDiscrepancy = t0\_DetectionDiscrepancy_{Tol}$

$t0\_DetectionDiscrepancy_{Tol}$	Tolerance value that takes into account the measurement inaccuracy of t0_DetectionDiscrepancy.

Further topics

- "Speed of the object when passing", page 19
- "Object contour", page 31

4.4.2 t1_MutingInitiation

Overview

The timer allows a time offset between detection in a protective field and the associated detection fields.

The safety system identifies valid objects via the object contour. In many applications, parts of the object will touch the scan plane before the reference contour can be detected. Timer t1_MutingInitiation prevents the safe state from being triggered before the object can be identified as a valid object.

Trigger

The timer starts as soon as a PFAx_Object or PFBx_Object protective field is interrupted. The timer continues to run even if the interrupted protective field becomes free again.

Timer expiration

If the timer has expired and muting has not started (output muting = TRUE), then safety output Q goes to the safe state (FALSE).

Resetting the timer

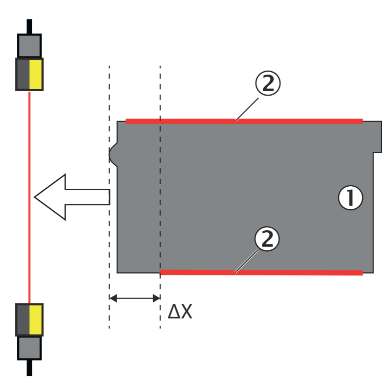
The timer is reset in the following cases:

- Start of muting (output muting = TRUE)
- Safety output Q goes to the safe state (FALSE).

Calculation

t1_MutingInitiation = $(\Delta X + X_{Tol1}) / V_{object} - t_{F\text{-}CPU}$

The following applies: $\Delta X + X_{Tol1} \leq 200$ mm. This rules out the possibility of people passing through the portal directly in front of the object without being detected. A higher value is only possible if you can rule out an increased risk in the course of your risk assessment.

ΔX	Distance between foremost object edge and rearmost object contour  *Figure 20: Distance ΔX* ① Passing object ② Object contour
X_{Tol1}	Tolerance value that takes into account the measurement inaccuracy of $\Delta X_{detCont}$.

V_{object}	Speed of the passing object
$t_{F\text{-}CPU}$	Inaccuracy of the internal timer monitoring by the F-CPU of the controller

Calculation for object contour without offset

Theoretically, the detection of object contours takes place simultaneously in related detection fields. In practice, the following aspects, for example, always lead to a small time offset:

- Object is not perfectly axisymmetric.
- The object does not pass the portal exactly in the center.

The following therefore applies to the timer:

$t1\_DetectionDiscrepancy = t1\_DetectionDiscrepancy_{Tol}$

$t1\_DetectionDiscrepancy_{Tol}$	Tolerance value that takes into account the measurement inaccuracy of t1_DetectionDiscrepancy.

Further topics

- "Speed of the object when passing", page 19

4.4.3 t2_MutingExtension

Overview

Timer t2_MutingExtension prevents the safe state from being triggered in the following cases:

- Object contour cannot be detected without gaps.
- Object contour does not extend to the end of the object.

Trigger

The timer starts as soon as one of the two object contours is no longer detected when muting is active.

Timer expiration

If the timer has expired (i.e. the timer has not been reset), then muting is terminated.

Resetting the timer

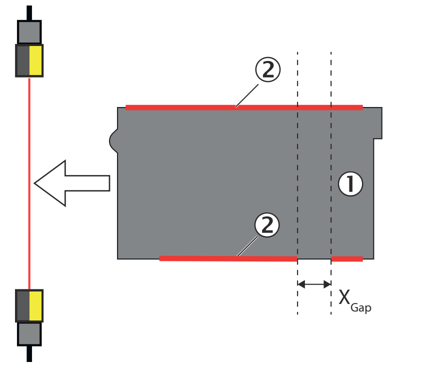
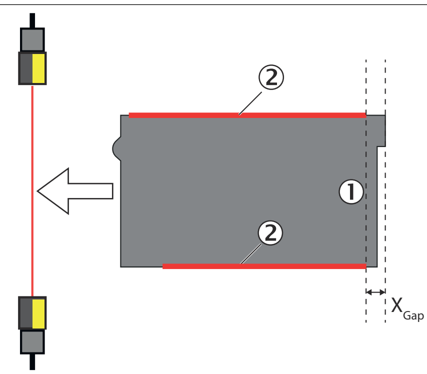
The timer is reset in the following cases:

- Both object contours are detected.
- Both detection fields and both protective fields are free.

Calculation

$t2\_MutingExtension = (X_{Gap} + X_{Tol2}) / V_{object} - t_{F\text{-}CPU}$

The following applies: $X_{Gap} + X_{Tol2} \leq 200$ mm. This makes it possible to rule out the possibility of people passing through the portal directly behind the object without being detected. A higher value is only possible if you can rule out an increased risk in the course of your risk assessment.

X_{Gap}	Length over which at least one object contour cannot be detected.  *Figure 21: Distance X_{Gap} for gap in object contour* ① Passing object ② Object contour
X_{Gap}	 *Figure 22: Distance X_{Gap} at premature end of object contour* ① Passing object ② Object contour
X_{Tol2}	Tolerance value that takes into account the measurement inaccuracy of X_{Gap}.
V_{object}	Speed of the passing object
$t_{F\text{-}CPU}$	Inaccuracy of the internal timer monitoring by the F-CPU of the controller

Notes on integration

- Muting is not terminated until the object has left the scan plane or the timer t2_MutingExtension has expired. That means when using t2_MutingExtension, the muting can be extended by the value of t2_MutingExtension.
- t2MutingExtension can also be used with overlapping gaps as long as the total length does not exceed 200 mm.

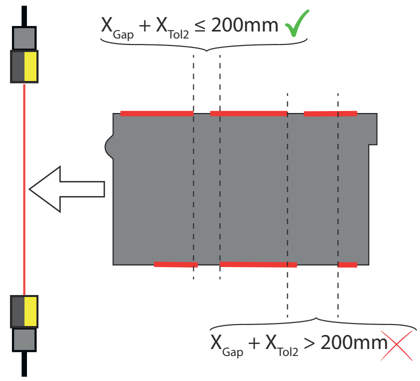


Figure 23: Distance X_{Gap} for overlapping gaps of the object contours

- Multiple gaps in the detection of an object contour are possible as long as the individual interruptions do not exceed the runtime of timer t2_MutingExtension.

Further topics

- "Speed of the object when passing", page 19
- "Object contour", page 31

4.4.4 t3_MutingDuration

Overview

The timer defines the maximum duration of muting. The value must be chosen so that the object can pass the portal completely. The timer also prevents unlimited muting that would occur if the detection fields were manipulated.

Trigger

The timer starts as soon as both detection fields detect a valid object.

Timer expiration

If the timer expires, then muting is terminated and safety output Q goes to the FALSE state.

Setting the timer

The value for the timer does not have to be calculated exactly. However, you must specify a value in the risk assessment that is plausible with respect to the object length X_{object}. Take into account the inaccuracy of the internal timer monitoring by the F-CPU of the controller.

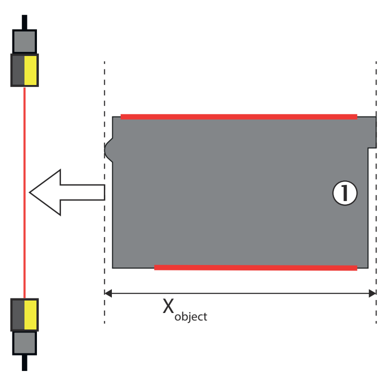


Figure 24: Distance X_{object}

① Passing object

4.4.5 Adjustment of the timer depending on the direction of travel

Overview

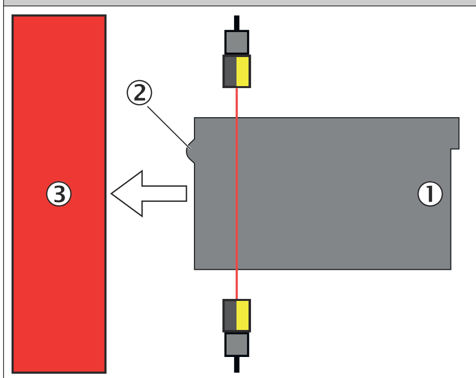
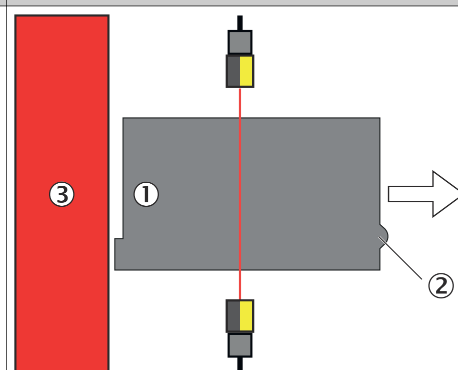
If the objects are axisymmetrical and always pass the portal in the same direction of travel and speed, then the timers do not need to be adjusted depending on the situation. In all other cases, from the point of view of the portal, the timing of the detection of the object contours changes. You must then implement an external safety function via which the values for the timers are set depending on the situation.

Important information

NOTE
New values for the timers can only be set if the following points are all fulfilled:

- Muting is not active.
- Protective fields are free.

Case 1 – object always passes portal with front side first

Entrance	Exit
 *Figure 25: Object passes portal when entering with front side first* ① Passing object ② Front of the object ③ Hazardous area	 *Figure 26: Object passes portal when exiting with front side first* ① Passing object ② Front of the object ③ Hazardous area

When the object turns in the hazardous area, it passes the portal in both directions with the front side first. You can keep the timer values unchanged as long as the following points are all satisfied:

- The object contour of the passing object is axisymmetric.
- The object passes the portal in both directions with the same speed.

In all other cases, you must set separate values for the timers in both directions of travel.

Case 2 – object passes portal with different alignment

Entrance	Exit

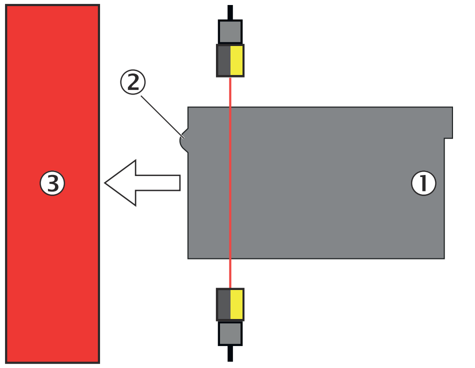
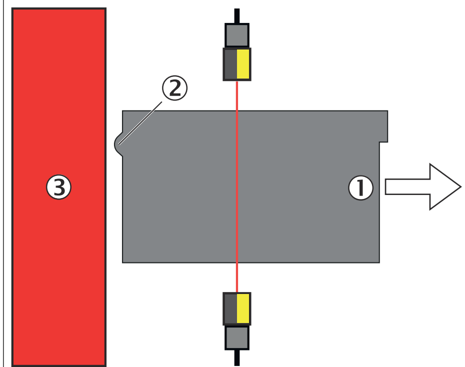

	

Figure 27: Object passes portal when entering with front side first	*Figure 28: Object passes portal when exiting with rear side first*
① Passing object ② Front of the object ③ Hazardous area	① Passing object ② Front of the object ③ Hazardous area

If the passing object does not turn in the hazardous area, e.g. because the transport system moves backwards when leaving the hazardous area: The object passes the portal with the front side first in some cases and with the rear side first in others. You must check for each situation to determine whether different values are required for the timers. If any of the following apply, different values are required:

- The object geometry on the front and rear side differs.
- The object passes through the portal in both directions at different speeds.

4.4.6 Adjustment of timers for non-orthogonal passage

Overview

The safety system was designed for orthogonal passage. If orthogonal passage is not possible (e.g. when driving around curves), then this can be taken into account to a certain extent via the timers.

Important information

WARNING
Monitoring gaps due to non-orthogonal passage

Persons may not be detected.

▶ Ensure that the non-orthogonal passage creates only small enough monitoring gaps that people cannot be in them without being detected.

Integration information

- In the course of your risk assessment, you must ensure that persons immediately in front of or behind the passing object are safely detected even in the case of a non-orthogonal passage.
- You need to consider the entire transfer process, both on entry and exit.
- At a minimum, you must consider the following factors:
  - Object geometry
  - Speed of the object
  - Path of the object when passing the portal

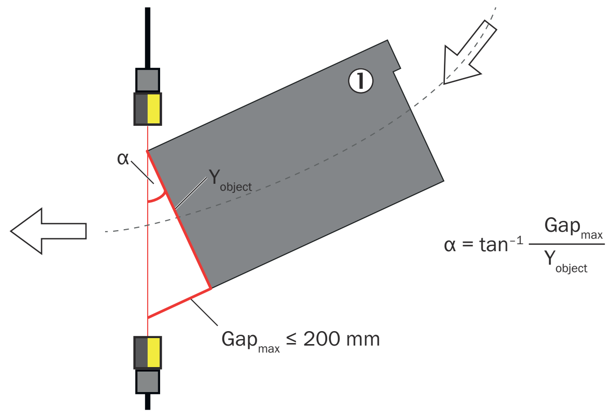


Figure 29: Non-orthogonal passage

① Passing object

4.4.7 Stopping the transport system with active muting

Overview

When transferring through the portal, an object may stop in the portal. You can take the stop of the transport system into account with a signal to increase the availability of the system.

Prerequisites

- You must ensure through your risk analysis that it is safe to use the signal to stop the transport system.
- The signal at input bConveyorStop does not have to be a safe signal.

bConveyorStop signal

A conveyor belt stop is signaled at input bConveyorStop with the TRUE state. This will pause the following timers:

- t2_MutingExtension
- t3_MutingDuration

This prevents the muting from ending due to timer expiration. When the conveyor starts again (bConveyorStop = FALSE), the timers continue to run. The current value of the timers is not reset by the pause.

If muting has been initiated but has not yet begun, then the expiration of the t0DetectionsDiscrepancy or t1_MutingInitiation timer results in the safe state of the function block.

Complementary information

- If a change occurs at a protective field or detection field when the conveyor belt is stopped (bConveyorStop = TRUE), this leads to the safe state of the function block.
- Depending on the acceleration or braking effect of the assembly line, it may be necessary to activate or deactivate the signal with a delay.

Further topics

- see "Inputs and outputs of the SICK_SP_01_V function block", page 48

4.5 Emergency shutdown

The “Shutdown in emergency” safety function is not part of this safety system. You must implement this safety function on your own responsibility.

At least one emergency stop pushbutton must be placed at the position of the reset and restart pushbuttons.

4.6 Integration into the higher-level logic

If the higher-level logic triggers the safe state (e.g. in the event of an emergency stop), then the higher-level logic must set the following inputs:

- Control1.bEnableAutoMuting = FALSE
- Control2.bEnableAutoMuting = FALSE
- Control3.bEnableAutoMuting = FALSE

4.6.1 External functions

Overview

The SP_SICK_01_V function block provides interfaces that you can use for your own external functions.

Important information

WARNING
The external functions are not part of the safety system or the function blocks provided.

- ▶ In particular, you must develop and implement safety functions on your own responsibility.
- ▶ Observe relevant standards (e.g. EN ISO 13849).

Interfaces for safety functions

Outputs

- Status of the muting function
    - MutingActive1
    - MutingActive2
    - MutingActive3

  For example, there may be monitoring gaps in the portal that cannot be monitored with the safety laser scanners. You can then use these signals to activate additional protective measures as soon as the muting of a specific area begins.

Inputs

- Force muting
    - Control1.bForceMuting
    - Control2.bForceMuting
    - Control3.bForceMuting

  For external safety functions, it may be necessary to force the muting of a specific area. For example if an object has to pass the portal that is not recognized as a valid object by the safety system.

  WARNING
  Monitoring gaps due to forced muting

  People or invalid objects can pass through the portal undetected.

  - ▶ Check whether forcing muting is suitable for your application.
  - ▶ Check whether the signal source for forcing muting meets the requirements of the safety function.
  - ▶ Check whether forcing muting in the higher-level logic must be limited in time.

- Safe Portal release

The SICK_SP_01_V function block can be activated or deactivated via the following signals. For a release, all the following signals must be in the TRUE state, provided the signals are used in the application.

- Control1.bEnableAutoMuting
- Control2.bEnableAutoMuting
- Control3.bEnableAutoMuting

Muting can be deactivated for individual areas via the individual control of the signals.

Non-safe functions

Outputs

- Event Cam
  This signal can be used to activate a camera that starts a recording of the portal area. This allows you to determine which event triggered the safe state.
  This can be helpful during commissioning or if triggering of the safe state is not traceable.

Further topics

- "Inputs and outputs of the SICK_SP_01_V function block", page 48

4.6.2 Switching the monitoring cases

In some applications, it may be necessary for objects with different shapes to pass through the portal, e.g. very different types of car bodies. This can be implemented with different monitoring cases.

The switching of monitoring cases is a new safety function and not part of the safety system. You must develop, verify, validate and consider this safety function in your risk analysis on your own responsibility.

If you implement monitoring case switching, then all monitoring cases must be validated during commissioning.

Table 10: Partial aspects for switching the monitoring cases

Partial aspect	Implementation in
Different field sets and monitoring cases	Configuration of safety laser scanners
Logic for switching the monitoring cases	Higher-level logic
A set of preset timer values for the muting function	Higher-level logic

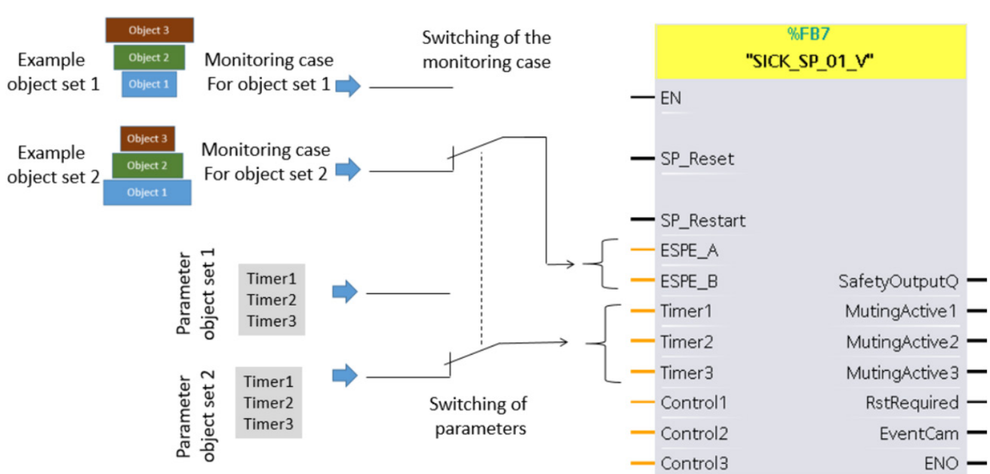


Figure 30: Basic principle of field switching

4.7 Testing plan

The manufacturer of the machine and the operating entity must define all required thorough checks. The definition must be based on the application conditions and the risk assessment.

The following tests must be planned:

- A thorough check must be carried out during commissioning and following modifications.
  The check must detect if it is possible to enter the hazardous area without being detected.
- The regular thorough checks of the safety system must fulfill certain minimum requirements. The minimum requirements for the thorough check of the safety system comply at least with the sum of the minimum requirements for the thorough check of the components of the safety system (see operating instructions of the components).
  The check must detect if it is possible to enter the hazardous area without being detected. Such possibilities may exist due to modifications, manipulations or external influences.
- In many cases, depending on the application conditions, the risk assessment can determine that further thorough checks are required.

The thorough checks must be carried out by qualified safety personnel or specially qualified and authorized personnel, and must be documented in a traceable manner.

The regular thorough checks serve to assess the effectiveness of the safety system and to identify defects as a result of changes or other influences (e.g., damage or manipulation).

5 Mounting

5.1 For mounting the components

NOTE
Information is included in the operating instructions for the components.

6 Electrical installation

6.1 Electrical installation of the components

NOTE
Information is included in the operating instructions for the components.

6.2 General requirements

The manufacturer must take measures against failures resulting from the same cause. The manufacturer must document this appropriately in SISTEMA. During the electrical installation, the following, for example, must be taken into consideration:

- Protection against overvoltage, overcurrent, etc. per the manufacturer instructions for the individual components
- Mechanical fastening of the wiring of the pushbutton for the hold to run device, e.g. with cable ties
- Measures for controlling the consequences of voltage failure, voltage fluctuations, overcurrent and undercurrent in the voltage supply of the controller

7 Configuration

7.1 Requirements for software and firmware

Table 11: Control version statuses

Software and firmware	Minimum version
Siemens S7-1500F firmware	V2.1
SIMATIC STEP 7 TIA Portal	V14 SP1
SIMATIC STEP 7 Safety Advanced	V14

Table 12: Safety laser scanner version statuses

Software and firmware	Minimum version
microScan3 safety laser scanner firmware	R01.47

7.2 Configuring control

7.2.1 Available function blocks

Availability

SICK provides you with a library for importing to TIA after purchase.

Checksums

You must inspect the checksum of all function blocks provided by SICK before using them. The checksum must match the checksum specified below.

Function block name	Signature	Version
SICK_SP_01_V	0x7AADACD4	0.1

Function blocks that cannot be used

The following function blocks are integrated sub-function blocks that are displayed in the SICK library after import. Individual use of these sub-function blocks is not permitted.

Function blocks that cannot be used
- SICK_SP_AM_V
- SICK_SP_RST_V
- STATE_DET
- TONE_HOLD
- TOF_HOLD

7.2.2 SICK_SP_01_V function block

7.2.2.1 Use of the SICK_SP_01_V function block

Prerequisites

- The function block has the signature 0x7AADACD4.
- The values of the internal operators must not be changed.

Function

The SICK_SP_01_V function block is designed for a Safe Portal application. The function block monitors the signals of the safety laser scanners and the devices for reset and restart. The function block contains 3 function blocks for a muting function, i.e. up to 3 areas in the portal can be muted independently of each other.

Requirements for using the function block

Logic requirements

- The logic must evaluate whether a functioning ProfiSafe connection exists between the safety laser scanner and the safety controller. If the connection does not exist, the following must be ensured:
  - Input bEnableAutoMuting is in the FALSE state.
  - The safety output via which the safe state is triggered is in the FALSE state.

Requirements for validation

- The integrator must provide a checklist for validation during commissioning.

7.2.2.2 Software structure of the SICK_SP_01_V function block

Overview

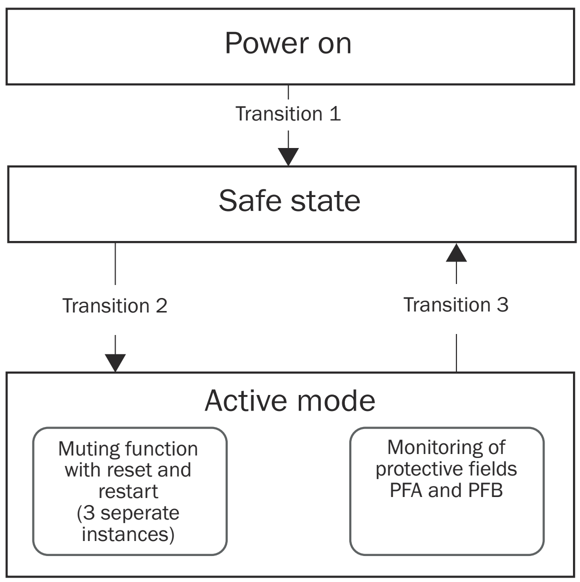


Figure 31: Software structure SICK_SP_01_V

Power on

- SafetyOutputQ = FALSE
- Transition 1 is triggered immediately after switching on

Safe state

- SafetyOutputQ = FALSE
- Transition 1 is triggered as soon as all of the following conditions apply:
  - Correct sequence for reset and restart takes place.
  - PFA and PFB protective fields are free.

Active mode

- SafetyOutputQ = TRUE
- PFA and PFB protective fields are monitored.
- Muting function for protective fields for object passage possible.
- Transition 3 is triggered as soon as one of the following conditions applies:
  - Error during a muting sequence
  - Detection in PFA and / or PFB protective field

7.2.2.3 Inputs and outputs of the SICK_SP_01_V function block

Inputs

Table 13: Digital inputs

Signal name	Type	Description
SP_Reset	BOOL	Signal of the safety command device for reset
SP_Restart	BOOL	Signal of the safety command device for restart

Table 14: Structure variable ESPE_A

Signal name	Type	Description
ESPE	**UDT_01_ESPE**	
bProtectiveFieldObject1 bProtectiveFieldObject2 bProtectiveFieldObject3	BOOL	**Protective fields of safety laser scanner A (muting):** • PFA1_Object • PFA2_Object • PFA3_Object The respective protective field is not evaluated if a valid object is detected (muting). **Signal states** • TRUE = Protective field free • FALSE = Detection in the protective field
bDetectionField1 bDetectionField2 bDetectionField3	BOOL	**Detection fields of safety laser scanner A:** • DFA1 • DFA2 • DFA3 **Signal states when detection field is a contour detection field:** • TRUE = Object contour detected • FALSE = Object contour not detected **Signal states when detection field is a protective field:** • TRUE = Object contour not detected • FALSE = Object contour detected
bOpticalSwingDoor	BOOL	PFA protective field of safety laser scanner A (swinging door) **Signal states** • TRUE = Protective field free • FALSE = Detection in the protective field

Table 15: Structure variable ESPE_B

Signal name	Type	Description
ESPE	**UDT_01_ESPE**	
bProtectiveFieldObject1 bProtectiveFieldObject2 bProtectiveFieldObject3	BOOL	**Protective fields of safety laser scanner B (muting):** • PFB1_Object • PFB2_Object • PFB3_Object The respective protective field is not evaluated if a valid object is detected (muting). **Signal states** • TRUE = Protective field free • FALSE = Detection in the protective field
bDetectionField1 bDetectionField2 bDetectionField3	BOOL	**Detection fields of safety laser scanner B:** • DFB1 • DFB2 • DFB3 **Signal states when detection field is a contour detection field:** • TRUE = Object contour detected • FALSE = Object contour not detected **Signal states when detection field is a protective field:** • TRUE = Object contour not detected • FALSE = Object contour detected
bOpticalSwingDoor	BOOL	PFB protective field of safety laser scanner B (swinging door) **Signal states** • TRUE = Protective field free • FALSE = Detection in the protective field

Table 16: Structure variable TIMER1

Signal name	Type	Description
TIMER1	**UDT_4TIME_IN**	
t0_DetectionDiscrepancy	TIME	**Defines maximum discrepancy time of the following signals with deactivated muting:** • bDetectionField1 of structure variable ESPE_A • bDetectionField1 of structure variable ESPE_B see "t0_DetectionDiscrepancy", page 33
t1_MutingInitiation	TIME	**Defines maximum discrepancy time between the following events:** • First detection in protective field (bProtectiveFieldObject1 of structure variable ESPE_A or ESPE_B) • Double-sided detection of the object contour (bDetectionField1 of structure variables ESPE_A and ESPE_B see "t1_MutingInitiation", page 34

Signal name	Type	Description
TIMER1	**UDT_4TIME_IN**	
t2_MutingExtension	TIME	Defines maximum discrepancy time of the following signals with active muting: • bDetectionField1 of structure variable ESPE_A • bDetectionField1 of structure variable ESPE_B see "t2_MutingExtension", page 35
t3_MutingDuration	TIME	Defines maximum duration of muting see "t3_MutingDuration", page 37

Table 17: Structure variable TIMER2

Signal name	Type	Description
TIMER2	**UDT_4TIME_IN**	
t0_DetectionDiscrepancy	TIME	Defines maximum discrepancy time of the following signals with deactivated muting: • bDetectionField2 of structure variable ESPE_A • bDetectionField2 of structure variable ESPE_B see "t0_DetectionDiscrepancy", page 33
t1_MutingInitiation	TIME	Defines maximum discrepancy time between the following events: • First detection in protective field (bProtectiveFieldObject2 of structure variable ESPE_A or ESPE_B) • Double-sided detection of the object contour (bDetectionField2 of structure variables ESPE_A and ESPE_B see "t1_MutingInitiation", page 34
t2_MutingExtension	TIME	Defines maximum discrepancy time of the following signals with active muting: • bDetectionField2 of structure variable ESPE_A • bDetectionField2 of structure variable ESPE_B see "t2_MutingExtension", page 35
t3_MutingDuration	TIME	Defines maximum duration of muting see "t3_MutingDuration", page 37

Table 18: Structure variable TIMER3

Signal name	Type	Description
TIMER3	**UDT_4TIME_IN**	
t0_DetectionDiscrepancy	TIME	Defines maximum discrepancy time of the following signals with deactivated muting: • bDetectionField3 of structure variable ESPE_A • bDetectionField3 of structure variable ESPE_B see "t0_DetectionDiscrepancy", page 33

Signal name	Type	Description
TIMER3	**UDT_4TIME_IN**	
t1_MutingInitiation	TIME	**Defines maximum discrepancy time between the following events:** • First detection in protective field (bProtectiveFieldObject3 of structure variable ESPE_A or ESPE_B) • Double-sided detection of the object contour (bDetectionField3 of structure variables ESPE_A and ESPE_B see "t1_MutingInitiation", page 34
t2_MutingExtension	TIME	**Defines maximum discrepancy time of the following signals with active muting:** • bDetectionField3 of structure variable ESPE_A • bDetectionField3 of structure variable ESPE_B see "t2_MutingExtension", page 35
t3_MutingDuration	TIME	Defines maximum duration of muting see "t3_MutingDuration", page 37

Table 19: Structure variable CONTROL1

Signal name	Type	Description
CONTROL1	**UDT_4BIT_IN**	
bEnableAutoMuting	BOOL	**Enables muting of the following protective fields:** • PFA1_Object • PFB1_Object **Signal states** • TRUE = Muting allowed • FALSE = Muting not allowed (does not lead to safe state of the function block) ⚠ **WARNING** | The integrator must ensure that the signal state changes to FALSE in the following cases: • After switching on • Higher-level logic triggers safe state (e.g. in case of emergency stop)
bForceMuting	BOOL	**Forces muting of the following protective fields, independent of other signals:** • PFA1_Object • PFB1_Object Use is only possible if you have considered the consequences and resulting requirements in your risk assessment. **Signal states** • TRUE = Muting forced • FALSE = Do not force muting

Signal name	Type	Description
CONTROL1	UDT_4BIT_IN	
bDetectionIsContour	BOOL	**Specifies whether the following detection fields are contour detection fields or protective fields:** • DFA1 • DFB1 **Signal states** • TRUE = Contour detection field • FALSE = Protective field
bConveyerStop	BOOL	Signals whether the transport system stops. The signal does not have to be a safe signal. **Signal states** • TRUE = Transport system stops • FALSE = Transport system in motion Use is only possible if you have considered the consequences and resulting requirements in your risk assessment. see "Stopping the transport system with active muting", page 40

Table 20: Structure variable CONTROL2

Signal name	Type	Description
CONTROL2	UDT_4BIT_IN	
bEnableAutoMuting	BOOL	**Enables muting of the following protective fields:** • PFA2_Object • PFB2_Object **Signal states** • TRUE = Muting allowed • FALSE = Muting not allowed (does not lead to safe state of the function block) ⚠ **WARNING** | The integrator must ensure that the signal state changes to FALSE in the following cases: • After switching on • Higher-level logic triggers safe state (e.g. in case of emergency stop)
bForceMuting	BOOL	**Forces muting of the following protective fields, independent of other signals:** • PFA2_Object • PFB2_Object Use is only possible if you have considered the consequences and resulting requirements in your risk assessment. **Signal states** • TRUE = Muting forced • FALSE = Do not force muting

Signal name	Type	Description
CONTROL2	UDT_4BIT_IN	
bDetectionIsContour	BOOL	**Specifies whether the following detection fields are contour detection fields or protective fields:** • DFA2 • DFB2 **Signal states** • TRUE = Contour detection field • FALSE = Protective field
bConveyerStop	BOOL	Signals whether the transport system stops. The signal does not have to be a safe signal. **Signal states** • TRUE = Transport system stops • FALSE = Transport system in motion Use is only possible if you have considered the consequences and resulting requirements in your risk assessment. see "Stopping the transport system with active muting", page 40

Table 21: Structure variable CONTROL3

Signal name	Type	Description
CONTROL3	UDT_4BIT_IN	
bEnableAutoMuting	BOOL	**Enables muting of the following protective fields:** • PFA3_Object • PFB3_Object **Signal states** • TRUE = Muting allowed • FALSE = Muting not allowed (does not lead to safe state of the function block) ⚠ **WARNING** | The integrator must ensure that the signal state changes to FALSE in the following cases: • After switching on • Higher-level logic triggers safe state (e.g. in case of emergency stop)
bForceMuting	BOOL	**Forces muting of the following protective fields, independent of other signals:** • PFA3_Object • PFB3_Object Use is only possible if you have considered the consequences and resulting requirements in your risk assessment. **Signal states** • TRUE = Muting forced • FALSE = Do not force muting

Signal name	Type	Description
CONTROL3	**UDT_4BIT_IN**	
bDetectionIsContour	BOOL	Specifies whether the following detection fields are contour detection fields or protective fields: • DFA3 • DFB3 Signal states • TRUE = Contour detection field • FALSE = Protective field
bConveyerStop	BOOL	Signals whether the transport system stops. The signal does not have to be a safe signal. Signal states • TRUE = Transport system stops • FALSE = Transport system in motion Use is only possible if you have considered the consequences and resulting requirements in your risk assessment. see "Stopping the transport system with active muting", page 40

Outputs

Table 22: Digital outputs

Signal name	Type	Description
SafetyOutputQ	BOOL	Safety output Signal states • TRUE = Enable for application • FALSE = Safe state You must integrate the signal into the logic in such a way that when the state changes to FALSE, the dangerous state is terminated.
MutingActive1	BOOL	State of the muting function of the following protective fields: • PFA1_Object • PFB1_Object Signal states • TRUE = Muting active • FALSE = Muting not active
MutingActive2	BOOL	State of the muting function of the following protective fields: • PFA2_Object • PFB2_Object Signal states • TRUE = Muting active • FALSE = Muting not active

Signal name	Type	Description
MutingActive3	BOOL	**State of the muting function of the following protective fields:** • PFA3_Object • PFB3_Object **Signal states** • TRUE = Muting active • FALSE = Muting not active
RstRequired	BOOL	**Signal states** • TRUE = Sequence for reset and restart required • FALSE = No sequence required
EventCam	BOOL	This signal can be used to activate a camera that starts a recording of the portal area. This allows you to determine, for example, which event triggered the safe state. The signal goes to the TRUE state for 300 ms as soon as safety output SafetyOutputQ changes to the FALSE state. **Signal states** • TRUE = Trigger camera • FALSE = No action

7.2.2.4 Deactivating muting function for individual area

Overview

The function block supports 3 areas that can be muted independently of each other. If less than 3 areas are required for muting in the application, then you must deactivate the areas that are not required.

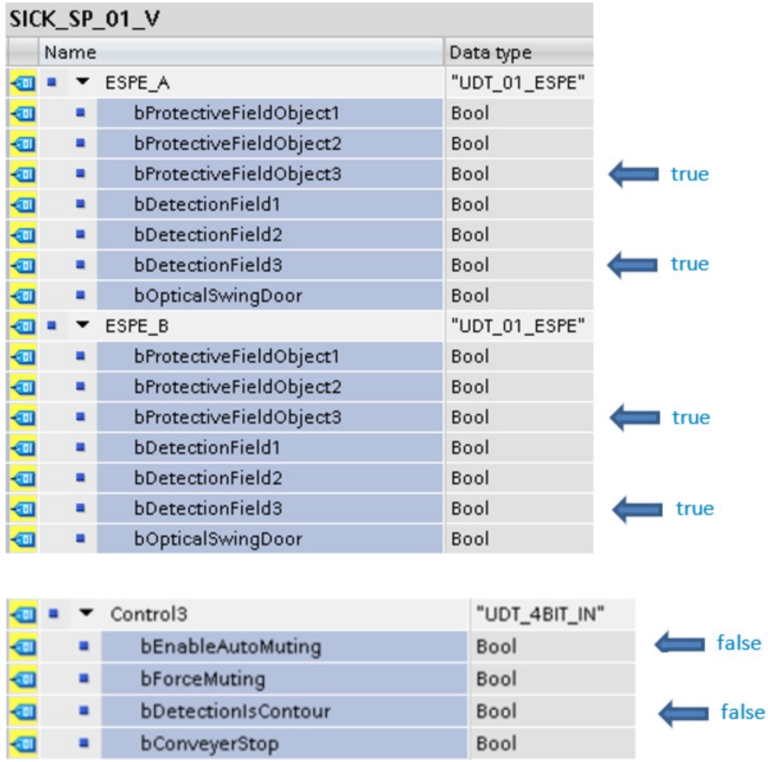
Approach

1. Connect the following inputs with a static TRUE:
   ESPE_A
   - bProtectiveFieldObjectX
   - bDetectionFieldX

   ESPE_B
   - bProtectiveFieldObjectX
   - bDetectionFieldX
2. Connect the following inputs with a static FALSE:
   CONTROLX
   - bEnableAutoMuting
   - bForceMuting
   - bDetectionIsContour
   - bConveyorStop

Example

The application requires only 2 muting areas. Muting area 3 must be deactivated.



7.2.2.5 Diagnostic data

Overview

The diagnostic data of the SICK_SP_01_V function block is located in the data block of the respective instance in the following structure:

Table 23: Structure of the diagnostic data

[name of SICK_SP_01_V DB].SP_MUT-ING1.DIAG	Safe Portal Muting 1
[name of SICK_SP_01_V DB].SP_MUT-ING2.DIAG	Safe Portal Muting 2
[name of SICK_SP_01_V DB].SP_MUT-ING3.DIAG	Safe Portal Muting 3
[name of SICK_SP_01_V DB].SP_RST1.DIAG	Safe Portal Reset/Restart of Muting1
[name of SICK_SP_01_V DB].SP_RST2.DIAG	Safe Portal Reset/Restart of from Muting2
[name of SICK_SP_01_V DB].SP_RST3.DIAG	Safe Portal Reset/Restart of from Muting3

Access to the diagnostic data:

- In TIA Portal > Observation table
- For HMI connection > OPC UA interface

Muting diagnostic data

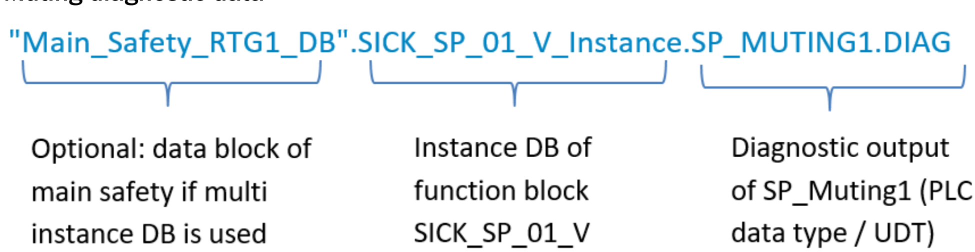


Figure 32: Example address of Safe Portal muting 1

Included diagnostic data:

- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_MUTING1.DIAG.Q
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_MUTING1.DIAG.MUTING
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_MUTING1.DIAG.DETECT
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_MUTING1.DIAG.bConveyer-Stop
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_MUTING1.DIAG.bMutingEr-ror1
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_MUTING1.DIAG.bMutingEr-ror2
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_MUTING1.DIAG.bMutingEr-ror3
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_MUTING1.DIAG.bMutingEr-ror4
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_MUTING1.DIAG.t0_Detec-tionDiscrepancy_ET
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_MUTING1.DIAG.t1_MutingI-nitiation_ET
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_MUTING1.DIAG.t2_Mutin-gExtension_ET
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_MUTING1.DIAG.t3_Muting-Duration_ET
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_MUTING1.DIAG.t0_Detec-tionDiscrepancy_PT
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_MUTING1.DIAG.t1_MutingI-nitiation_PT
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_MUTING1.DIAG.t2_Mutin-gExtension_PT
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_MUTING1.DIAG.t3_Muting-Duration_PT

Table 24: Diagnosis bits muting

Name	Type	Description
Q	BOOL	Status of the safety output
MUTING	BOOL	Status output MUTING
DETECT	BOOL	Status output DETECT
bConveyorStop	BOOL	Status input bConveyorStop
bMutingError1	BOOL	Timer t0_DetectionDiscrepancy expired
bMutingError2	BOOL	Timer t1_MutingInitiation expired
bMutingError3	BOOL	Timer t3_MutingDuration expired
bMutingError4	BOOL	While input bConveyorStop was in signal state TRUE, there was a signal change at one of the following inputs: • bProtectiveFieldObject_A • bDetection_A • bProtectiveFieldObject_B • bDetection_B
t0_DetectionDiscrepancy_ET	TIME	Elapsed time on timer (ET)
t1_MutingInitiation_ET	TIME	Elapsed time on timer (ET)
t2_MutingExtension_ET	TIME	Elapsed time on timer (ET)
t3_MutingDuration_ET	TIME	Elapsed time on timer (ET)
t0_DetectionDiscrepancy_PT	TIME	Preset time of the timer (PT)
t1_MutingInitiation_ PT	TIME	Preset time of the timer (PT)

Name	Type	Description
t2_MutingExtension_ PT	TIME	Preset time of the timer (PT)
t3_MutingDuration_ PT	TIME	Preset time of the timer (PT)

Reset and restart diagnostic data

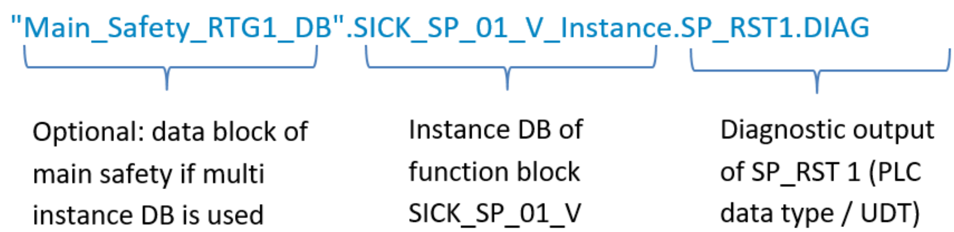


Figure 33: Example address of Safe Portal reset/restart 1

Included diagnostic data:

- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_RST1.DIAG.bMutingError
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_RST1.DIAG.bErrInitiationT0
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_RST1.DIAG.bErrInitiationT1
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_RST1.DIAG.bErrT2Extension
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_RST1.DIAG.bErrT3MaxTime
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_RST1.DIAG.bErrSwingDoor
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_RST1.DIAG.bErrConveyorStop
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_RST1.DIAG.bErrBoot
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_RST1.DIAG.bValidReset
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_RST1.DIAG.bValidRestart
- “Main_Safety_RTG1_DB”.SICK_SP_01_V_Instance.SP_RST1.DIAG.bMutingRecovery

Table 25: Reset/Restart diagnostic bits

Name	Type	Description
bMutingError	BOOL	Muting error detected (collective error) **bMutingError = TRUE as soon as one of the following bits is in the TRUE state:** • bErrIinitiationT0 • bErrIinitiationT1 • bErrT2Extension • bErrT3MaxTime • bErrSwingDoor • bErrConveyorStop • bErrBoot The bit remains in the TRUE state until a valid reset and restart sequence occurs.
bErrIinitiationT0	BOOL	Timer t0_DetectionDiscrepancy expired
bErrIinitiationT1	BOOL	Timer t1_MutingInitiation expired
bErrT2Extension	BOOL	Timer t2_MutingExtension expired and detection in protective field
bErrT3MaxTime	BOOL	Timer t3_MutingDuration expired
bErrSwingDoor	BOOL	Object detected in PFA or PFB protective field

Name	Type	Description
bErrConveyorStop	BOOL	Error while input bConveyorStop was in TRUE state.
bErrBoot	BOOL	Detection in protective field immediately after start-up or after emergency stop
bValidReset	BOOL	Valid sequence for reset accepted.
bValidRestart	BOOL	Valid sequence for restart accepted.
bMutingRecovery	BOOL	After a valid restart, the function block processes the signals to enable the muting function (≤ 250 ms).

7.2.3 General configuration

- The following applies for the configuration of the F-cycle time: F-cycle time × 2 ≤ response time of the safety laser scanners
- The configuration of the safety logic must be password protected.

7.3 Configuring safety laser scanner

7.3.1 General configuration of safety laser scanners

Configuration requirements

- Both safety laser scanners should have the same response time for the following fields.
  - PFA1, PFA2, PFA3
  - PFB1, PFB2, PFB3
  - DFA1, DFA2, DFA3
  - DFB1, DFB2, DFB3
  - Reference contour field

  Small deviations are possible, e.g. if you select different settings for interference protection.
- Restart interlock is deactivated.
- Set resolution: Min. 150 mm
- The configuration of the safety laser scanners must be protected with a password.

8 Commissioning

8.1 Safety

WARNING
Hazard due to lack of effectiveness of the protective device

- Before commissioning the machine, make sure that the machine is first checked and released by qualified safety personnel.
- Only operate the machine with a perfectly functioning protective device.

DANGER
Dangerous state of the machine

During commissioning, the machine or the protective device may not yet behave as you have planned.

- Make sure that there is no-one in the hazardous area during commissioning.

Before commissioning can be performed, project planning, mounting, electrical installation and configuration must be completed in accordance with this document.

8.2 Check during commissioning and modifications

The thorough check is intended to ensure that the safety functions are fulfilling their planned purpose and whether persons are being adequately protected.

- Carry out the checks specified in the test plan of the manufacturer of the machine and the operating entity.

9 Operation

9.1 Operating the components

NOTE
Information is included in the operating instructions for the components.

9.2 Regular thorough check

The test is intended to ensure that the hazardous area is monitored by the protective device and any attempted access to the hazardous area is prevented.

- Carry out the checks according to the instructions from the manufacturer of the machine and from the operating entity.

10 Maintenance

10.1 Maintenance of the components

NOTE
Information is included in the operating instructions for the components.

11 Troubleshooting

11.1 Troubleshooting the components

NOTE
Information is included in the operating instructions for the components.

12 Technical data

12.1 Data sheet

Table 26: Data sheet

Performance level[2]	
Function block SICK_SP01_V	PL d (ISO 13849-1)
PFH_D (mean probability of a dangerous failure per hour)	
Monitor material passage	1.62×10^{-7}
Trigger stop by detection in PFA or PFB protective field (swing door)	1.62×10^{-7}
Prevent unexpected restart of the muting function	2.06×10^{-7}
Avoid unexpected restart of the safety system	2.06×10^{-7}
Supply voltage V_S	24 V DC (16.8 V DC … 28.8 V DC) (SELV) [1]
Ambient operating temperature	See operating instructions for the individual components
Storage temperature	See operating instructions for the individual components
Air humidity	See operating instructions for the individual components
Permissible operating height	See operating instructions for the individual components
Safe state	The safety-related semiconductor outputs are in the OFF state.

1) The external supply voltage must jumper a brief power failure of 20 ms as specified in IEC 60204-1. Suitable power supply units are available as accessories from SICK.
2) The function blocks can only be used if the performance level of the function blocks corresponds at least to the required performance level of the application.

12.2 Response time of safety system

The response time of the $t_{safetysystem}$ safety system is calculated as follows.

$t_{safetysystem} = t_{safetylaserscanner} + t_{logic} + t_{delay}$

Table 27: Response time

$t_{safetysystem}$	Response time of the safety system (without actuators)
$t_{safetylaserscanner}$	Response time of the safety laser scanner (including PROFInet communication) The response time depends on several factors. Calculate the response time using the operating instructions of the safety laser scanner. You must perform the calculation for both safety laser scanners and each individual protective field. The longest response time applies. The response time is also shown in the report of the safety laser scanner configuration.
t_{logic}	Response time of the logic of the controller (largest value) The value depends on the modules used in the controller. Calculate the response time of the controller according to the operating instructions of the controller.

t_{delay}	Delay time by timer For implementation of the muting function, the following timers are used, among others: • t1_MutingInitiation • t2_MutingExtension Both timers can delay the switch-off time by the configured value. Use the largest value for t_{delay}.

The safety system allows for different timer settings for the different muting areas. You must calculate a separate safety system response time for each of the following use cases:

- Passage of an object in area 1 (PFA1_Object)
- Passage of an object in area 2 (PFA2_Object)
- Passage of an object in area 3 (PFA3_Object)
- Trigger stop on detection in PFA or PFB lateral protective field

It may be necessary to calculate these application cases multiple times when multiple timer sets or field set switching are used.

Use the largest of the values to calculate the stopping time of the entire system.

Complementary information

The calculations in this chapter refer only to the response time of the safety system. You must also take into account other times when calculating the stopping time of the entire system. The following times, for example, are relevant for the stopping time of the overall system:

- Actuator response time
- Run-down time of the actuators, e.g. braking time

13 Ordering information

13.1 Scope of delivery

Table 28: Hardware scope of delivery

Component	Variants Safe Portal S7 Vertical		
	M12 variant	AIDA variant	Hardware only
microScan3 Pro – PROFINET safety laser scanner • Connection type: M12, 4-pin, D-coded	2×	–	2×
microScan3 Pro – PROFINET safety laser scanner • Connection type: RJ45 push-pull AIDA	–	2×	
Mounting kit 1a	2×	2×	2×
Mounting kit 2a	2×	2×	2×

Table 29: Software scope of delivery

Operating instructions	Provided upon purchase of the software.
SISTEMA project file	
"SICK_SP_01_V" function block	
Further function blocks that must not be used manually.	

13.2 Ordering information

Safety system

Table 30: Ordering information of safety system (hardware + software) Safe Portal S7 Vertical

Safety laser scanner	Type code	Part number
2 × microScan3 Pro - PROFINET • Protective field range: ≤ 5.5 m • Connection type: M12, 4-pin, D-coded	SYS/SPO-S7VE4SASA02MS3	1119559
2 × microScan3 Pro - PROFINET • Protective field range: ≤ 5.5 m • Connection type: RJ45 push-pull AIDA	SYS/SPO-S7VE4SASA02MS3	1119560

Safety system (hardware only)

Table 31: Ordering information of hardware Safe Portal S7 Vertical

Safety laser scanner	Type code	Part number
2 × microScan3 Pro - PROFINET • Protective field range: ≤ 5.5 m • Connection type: M12, 4-pin, D-coded	SYS/SPO-S7VE0SASA02MS3	1115179

Safety system (software only)

Table 32: Ordering information of software Safe Portal S7 Vertical

Description	Type code	Part number
Safety system software Safe Portal S7 Vertical	SOW/SPO-S7VE0SASA02MS3	1115180

Using other safety laser scanners

If your application requires other safety laser scanners, then they must meet the following requirements:

- Type of laser scanner: Safety laser scanner
- Integration into the control system: PROFINET Profisafe
- Simultaneously monitorable fields: ≥ 8
- Resolution ≤ 150 mm

14 Spare parts

14.1 Spare parts

Table 33: Ordering information of spare parts Safe Portal S7 Vertical

Product	Type code	Part number
microScan3 Pro – PROFINET safety laser scanner		
• Protective field range: ≤ 5.5 m • Connection type: M12, 4-pin, D-coded	MICS3-CCAZ55PZ1P01	1100392
• Protective field range: ≤ 5.5 m • Connection type: RJ45 push-pull AIDA	MICS3-CBAZ55PZ1P01	1092721
Mounting kit 1a for mounting a microScan3 safety laser scanner	–	2073851
Mounting kit 2a for mounting a microScan3 safety laser scanner	–	2073852

15 Annex

15.1 Checklists

15.1.1 Checklist for initial commissioning and commissioning

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

This checklist is not a substitute for initial commissioning or periodic thorough checks by qualified safety personnel.

Hazardous area test

Table 34: Hazardous area tests

Test sequence	Expected result	Result OK?
1. Check access points to the hazardous area.	• When entering through the portal, a person inevitably causes a detection in one of the protective fields. • Other access points are secured with suitable protective measures. There are no unsecured access points to the hazardous area.	Yes ☐ No ☐
Comments:		

Tests on devices for resetting and restarting

Table 35: Tests on devices for resetting and restarting

Test sequence	Expected result	Result OK?
1. Check position of devices for reset and restart.	• Devices are located outside the hazardous area. • Devices are positioned so that the operator has an overview of the hazardous area. The operator can ensure that no person is in the hazardous area. • Devices are placed so that the operator can see the portal.	Yes ☐ No ☐
1. Check the type of the device for restart.	Device is a key-operated pushbutton.	Yes ☐ No ☐
1. Check storage of the key.	Key is accessible only for authorized and instructed persons.	Yes ☐ No ☐
1. Check the wiring of the devices.	The signals are connected to fail-safe digital inputs of the controller.	Yes ☐ No ☐
Comments:		

Emergency stop pushbutton tests

Table 36: Emergency stop pushbutton tests

Test sequence	Expected result	Result OK?
1. Check the position of the emergency stop pushbutton(s).	An emergency stop pushbutton for terminating the dangerous state is located at the devices for reset and restart.	Yes ☐ No ☐

Test sequence	Expected result	Result OK?
1. Open TIA Portal and go online. 2. Check the status of the following inputs of the SICK_SP_01_V function block. o Control1.bEnableAutoMuting o Control2.bEnableAutoMuting o Control3.bEnableAutoMuting ✓ All inputs used in the application are in the TRUE state. 3. Actuate the emergency stop pushbutton. 4. Check inputs again. ✓ All inputs are now in the FALSE state.	The states of the inputs behave as specified in the test sequence.	Yes ☐ No ☐
Comments:		

Safety laser scanner tests

Table 37: Safety laser scanner tests

Test sequence	Expected result	Result OK?
1. Check the alignment of the safety laser scanners.	• The safety laser scanners are mounted vertically so that the scan plane is orthogonal to the ground. • There is no offset or angle between the safety laser scanners. That means the scan planes of the two safety laser scanners are in the same plane.	Yes ☐ No ☐
1. Check the distance of the safety laser scanners to the center of the portal (distance d_2).	The distance is identical on both sides, with a maximum deviation of 10 mm.	Yes ☐ No ☐
1. Check the distance between fixed parts of the portal (including safety laser scanner) and the lane of the transport system (distance d_1).	The distance is at least 500 mm on both sides.	Yes ☐ No ☐
1. Check the distance between fixed parts of the portal (including safety laser scanner) and the passing objects (distance d_3).	The distance is at least 500 mm on both sides.	Yes ☐ No ☐
1. Check the mounting height of the safety laser scanners (distance h).	The mounting height is adapted to the requirements of the geometry of the detection fields and the clearance height of the objects.	Yes ☐ No ☐
1. Check design of protective fields.	The tolerances of the safety laser scanners and the requirements according to IEC 62046 chapter B4 were taken into account in the design of the protective fields.	Yes ☐ No ☐

<table>
<tr><th>Test sequence</th><th>Expected result</th><th>Result OK?</th></tr>
<tr><td>1. Check integration of the signals from the safety laser scanners.</td><td>• The signals are linked to the correct inputs of the function block.
• The type of detection fields was configured correctly on the function block (protective field or contour detection field)
  o Control1.bDetectionIsContour
  o Control2.bDetectionIsContour
  o Control3.bDetectionIsContour</td><td>Yes ☐ No ☐</td></tr>
<tr><td>1. Ensure that the portal is free.
2. Open TIA Portal and go online.
3. Check the status of the following inputs of the SICK_SP_01_V function block.
ESPE A and ESPE B
  o bProtectiveFieldObject1
  o bProtectiveFieldObject2
  o bProtectiveFieldObject3
  o bDetectionField1
  o bDetectionField2
  o bDetectionField3
  o bOpticalSwingDoor
4. Trigger a detection in a field. For detection fields that are designed as contour detection fields, detection must be triggered with the configured object contour. Observe the change of state of the inputs at the function block. Then end detection in the field.
ℹ **NOTE** | To determine in which field a detection is currently taking place: In parallel, connect the safety laser scanner to Safety Designer and open the project with the respective configuration file.
5. Repeat step 4 for each field.</td><td>• For protective fields and detection fields configured as a protective field: State on detection = FALSE
• For detection fields configured as contour detection fields: State on detection = TRUE</td><td>Yes ☐ No ☐</td></tr>
<tr><td>General configuration
1. Check that the safety laser scanners have been configured by authorized and instructed staff.
2. Check that the configuration has been checked by authorized and instructed staff.
3. Check if the configuration is protected with an “authorized customer” password.
4. Check whether the contour detection is configured according to the requirements of the operating instructions of the safety laser scanner.
5. Check the configured resolution of the safety laser scanner. Maximum resolution: 150 mm.</td><td>Configuration meets the tested requirements.
Configured resolution
• Safety laser scanner A:______ mm
• Safety laser scanner W:______ mm</td><td></td></tr>
</table>

Test sequence	Expected result	Result OK?
Protective fields 1. Check whether protective fields have been designed with the necessary tolerances, e.g. with a supplement for reflection-related measurement errors. 2. If gap between lateral protective fields (PFA/PFB) and object > 200 mm: Check whether larger gap was considered in risk assessment. 3. Check the height of the lateral protective fields . Protective field begins a maximum of 300 mm above the reference plane and extends at least to a height of 900 mm above the reference plane. 4. Check whether the protective fields for the respective muting areas are positioned on top of each other. 5. Verify that gaps in monitoring (e.g., shadowing) have been addressed in the risk assessment. 6. Check that the protective fields for the muting areas have the same response time. Different response times due to the “interference protection” function are not problematic. 7. Check whether commissioning has been performed for each protective field in accordance with the operating instructions of the safety laser scanner.	**Used tolerances of the protective fields** • __________ mm **Dimensions of PFA lateral protective fields** • Height of protective field above reference plane: _______ mm • Height of lower protective field edge above reference plane: _______ mm **Dimensions of PFB lateral protective fields** • Height of protective field above reference plane: _______ mm • Height of lower protective field edge above reference plane: _______ mm **Response time of all protective fields for the muting areas** • Safety laser scanner A:______ ms • Safety laser scanner B:______ ms Gaps in monitoring were considered in the risk assessment.	
Design of the detection fields 1. The detection fields are located within the respective related protective field for the muting function (e.g. DFA1 and PFA1_Object). 2. A person cannot trigger a detection at 2 related detection fields at the same time (e.g. DFA1 and DFB1).	Detection fields meet the requirements.	
Detection of persons on empty transport system 1. Provide test object that can be used to simulate a person standing or lying on the empty transport object. The test object must **Dimensions of ideal test object** o Shape: Cylinder o Length: 300 mm o Diameter: 200 mm 2. Load empty transport system with test object. 3. Have transport system move through portal.	The protective fields are configured to reliably detect a person on the empty transport object. The safe state is triggered. **Test object dimensions** • Shape: _____________ • Length: ____________ mm • Width: ____________ mm • Height: _____________ mm	

Test sequence	Expected result	Result OK?
Detection of persons next to the transport system 1. Provide test object with which a person can be simulated next to the object. **Test object dimensions** o Length.: ___________ mm o Width: ___________ mm o Height: ____________ mm 2. Move valid object into the portal and stop where the largest gap between the object and the PFA protective field is expected. 3. Place the test object in the gap. 4. Evaluate status of PFA protective field. 5. Repeat test sequence for other side (PFB). 6. Repeat test sequence for each necessary position.	The signal for the lateral protective fields always changes to the FALSE state.	
Comments:		

Tests on the objects passing through

Table 38: Tests on the objects passing through

Test sequence	Expected result	Result OK?
1. Check whether a person can be inside the object (transport system or transport material).	People cannot be situated inside the transport material. If it is possible to be situated in the transport material, this is prevented with suitable measures. The measures are part of the risk assessment	Yes ☐ No ☐
Comments:		

Tests on the minimum distance to the hazardous area

Table 39: Tests on the minimum distance to the hazardous area

Test sequence	Expected result	Result OK?
1. Measure the distance between the portal and the hazardous area.	The distance between the scan plane of the portal and the hazardous area is at least the calculated minimum distance to the hazardous area. Calculated:____________ Measured:____________	Yes ☐ No ☐
Comments:		

Speed tests

Table 40: Tests on the minimum distance to the hazardous area

Test sequence	Expected result	Result OK?
1. Check calculation for maximum passage speed.	The maximum speed was calculated according to the specifications in these operating instructions. Calculated:____________	Yes ☐ No ☐

Test sequence	Expected result	Result OK?
1. Measure the maximum speed of the transport system during passage.	• The speed during passage does not exceed the calculated maximum speed. Measured:____________ • Suitable measures were taken to ensure that the transport system cannot exceed the calculated maximum speed during passage.	Yes ☐ No ☐
1. Consider measures to restrict the speed of movement of people.	It is ensured that persons in the area of the portal cannot move faster than 1.6 m/s.	Yes ☐ No ☐
When using AGVs as a transport system 1. Check if the AGVs have safe position monitoring and safe speed monitoring.	If the AGVs have both functions, the test is successful. **If at least one function is missing:** • Persons walking directly in front of or behind the AGV are automatically detected. • Persons cannot be situated on the AGV.	Yes ☐ No ☐
Comments:		

Tests on the timers for the muting function

Table 41: Tests on the timers for the muting function

Test sequence	Expected result	Result OK?
1. Check whether there are different timer sets on the SICK_SP_01_V function block or a field set switchover of the safety laser scanners. 2. If yes: Validate all scenarios during commissioning.	All scenarios are validated during commissioning.	Yes ☐ No ☐
1. Check whether the risk assessment has considered whether people may be on the object. 2. If yes: Check whether this has been taken into account for the calculation of the maximum speed (and thus also the timer).	When calculating the maximum speed, it was taken into account whether there may be people on the object. This value was also used for the calculation of the timers.	Yes ☐ No ☐

Test sequence	Expected result	Result OK?
1. Check that the timers have been calculated according to the requirements of the operating instructions. 2. Check if 3. The timer calculations have been performed for each muting area (object1, object2, object3). 4. The possible directions of passage have been considered. 5. If timer t2_MutingExtension > 0: Check whether it was considered that this extends the muting at the end of the object, even if none of the detection fields detects the object contour. 6. Check whether the tolerance values used were defined during the risk assessment. 7. Check that the timer values were validated during the risk assessment.	Values of the timers were calculated correctly and are validated by the risk assessment. The inaccuracy of the internal timer monitoring by the F-CPU of the controller was taken into account. The distances resulting from the variables in the calculation of the respective timers are smaller than 200 mm. (e.g. $\Delta X_{detCont} + X_{Tol0} \leq 200$ mm). A higher value is only possible if you can rule out an increased risk in the course of your risk assessment.	Yes ☐ No ☐
1. Check whether the largest values of the relevant timers were used for calculating the response time.	The largest values of the relevant timers were used to calculate the response time.	
Detection of people in front of the transport system 1. Provide a test object with the following dimensions: o Length: 210 mm o Width: 210 mm o Height: > 300 mm 2. Attach the test object to the front of the object at the same height. 3. Allow object to pass through the portal.	When passing through, the safe state is triggered.	
Comments:		

Tests for safety logic in the controller

Table 42: Tests for safety logic in the controller

Test sequence	Expected result	Result OK?
1. Check whether the safety logic of the controller is protected with a password.	Security logic is password protected.	Yes ☐ No ☐
1. Check the signature of the function blocks used.	Signature matches the specified signatures in this document.	Yes ☐ No ☐
1. Check F cycle time.	F-cycle time × 2 ≤ safety laser scanner response time	Yes ☐ No ☐
Comments:		

Tests on the bConveyorStop signal

Table 43: Tests on the bConveyorStop signal

Test sequence	Expected result	Result OK?
1. Check whether the bConveyorStop signal is used. 2. If yes: Has this been considered in the risk assessment.	The signal is used only if it was considered in the risk assessment.	Yes ☐ No ☐
Signal test 1. Open TIA Portal and go online. 2. Start transport system. 3. Check the status of the following inputs of the SICK_SP_01_V function block: o Control1.bConveyorStop o Control2.bConveyorStop o Control3.bConveyorStop 4. Stop transport system. 5. Check inputs again.	If the transport system is moving, then the inputs are in the FALSE state. If the transport system is at a standstill, then the inputs are in the TRUE state.	Yes ☐ No ☐
Comments:		

Safe condition tests

Table 44: Safe condition tests

Test sequence	Expected result	Result OK?
1. Trigger safe state of the SICK_SP_V_01 function block.	The dangerous state of the application is terminated.	Yes ☐ No ☐
1. Check measures against common cause failures (CCF).	Measures against common cause failures are sufficient.	Yes ☐ No ☐
Comments:		

PROFINET/Profisafe tests

Table 45: Safe condition tests

Test sequence	Expected result	Result OK?
1. Interrupt PROFIsafe connection between safety laser scanner and control.	The safe state is triggered.	Yes ☐ No ☐
Comments:		

15.1.2 Additional checklist for initial commissioning and commissioning of applications with negative detection fields (NDF)

This checklist is a supplement to the checklist for initial commissioning and commissioning. It is only relevant if objects with a low remission pass through the portal and negative detection fields (NDF) are used to reliably detect these objects.

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

This checklist is not a substitute for initial commissioning or periodic thorough checks by qualified safety personnel.

Safety laser scanner tests

Table 46: Safety laser scanner tests

Test sequence	Expected result	Result OK?
1. Check the configuration of the negative detection fields.	• Negative detection fields are protective fields. • Every NDF is located fully within the detection field all the way to the end of the detection field. • When the portal is clear, a fixed non-manipulable structure is detected in each NDF. • For applications with 2 or more objects with a low remission, each NDF can only appear clear for objects for which the NDF is intended to trigger muting.	Yes ☐ No ☐
Comments:		

Tests for the additional logic for DF_improved signals in the controller

Table 47: Tests for the additional logic for DF_improved signals in the controller

Test sequence	Expected result	Result OK?
1. Check where the additional logic has been implemented.	The extended logic is implemented in the safe part of the controller.	Yes ☐ No ☐
1. Check whether the additional logic for field type is suitable for each respective detection field.	If detection field = protective field: DF and NDF are combined using the AND logical operator. The NDF signal is inverted. If detection field = contour detection field: DF and NDF are combined using the OR logical operator.	Yes ☐ No ☐
1. Check the integration of the signals from the safety laser scanners.	The signals are correctly linked to the additional logic and the SICK_SP_V_01 function block.	Yes ☐ No ☐
Comments:		

Reset and restart test

Table 48: Test 1

Test sequence	Expected result	Result OK?
Preparing for the test sequence 1. Ensure that there is no object in the portal. 2. Ensure that the safety system has been started. 3. Ensure that the safety output of the SICK_SP_01_V function block is in the TRUE state (check via TIA Portal).		
Test sequence 1. Place an invalid test object in the center of the portal. The test object must not trigger a detection in the protective fields PFA and PFB ("swinging doors").	The safety system initiates the safe state. The safety output of the SICK_SP_01_V function block is in the FALSE state.	Yes ☐ No ☐
2. Press the reset pushbutton. 3. Press the restart pushbutton (min 0.1 s).	The safety system remains in the safe state.	Yes ☐ No ☐
4. Remove the test object without triggering a detection in the protective fields PFA and PFB.	The safety system remains in the safe state.	Yes ☐ No ☐

Test sequence	Expected result	Result OK?
Comments:		

Table 49: Test 2

Test sequence	Expected result	Result OK?
Preparing for the test sequence 1. Ensure that there is no object in the portal. 2. Ensure that the safety system has been started. 3. Ensure that the safety output of the SICK_SP_01_V function block is in the TRUE state (check via TIA Portal).		
Test sequence 1. Transport the valid test object automatically into the portal so that muting is activated. 2. Using a test rod, trigger a detection in protective field PFA or PFB.	The safety system initiates the safe state. The safety output of the SICK_SP_01_V function block is in the FALSE state.	Yes ☐ No ☐
3. Press the reset pushbutton (min 0.1 s, max 30 s).	The safety system remains in the safe state.	Yes ☐ No ☐
4. Using a test rod, trigger a detection in protective field PFA or PFB. Next remove the test rod from the protective field.	The safety system remains in the safe state.	Yes ☐ No ☐
5. Press the restart pushbutton (min 0.1 s, max 30 s).	The safety system remains in the safe state.	Yes ☐ No ☐
6. Press the reset pushbutton. 7. Press the restart pushbutton (min 0.1 s).	The safety output of the SICK_SP_01_V function block changes to the TRUE state. Muting is activated.	Yes ☐ No ☐
Comments:		

Further tests

Table 50: Further tests

Test sequence	Expected result	Result OK?
1. Check further measures.	Suitable measures are used to ensure that other objects with a low remission do not pass through the portal. This applies in particular to objects that are carried by persons, e.g., a helmet with a low remission.	Yes ☐ No ☐
1. Check access to the configuration software.	Access to the configuration software that can be used to visualize the fields is restricted, e.g., by password protection.	Yes ☐ No ☐
Comments:		

15.2 Application extension

15.2.1 Additional detection fields for objects with a dark or light-scattering surface

Overview

The safety laser scanner operates on the principle of optical time-of-flight measurement. If the light strikes an object, the light is reflected. The safety laser scanner receives the reflected light and measures the time interval between transmission and reception (Δt).

Objects with a low remission factor may not adequately reflect back the light (e.g., objects with a black metallic coating or objects made from uncoated aluminum). This leads to one of the following behaviors:

- Muting is not initialized.
- Muting is terminated prematurely.

In both cases, the safety system switches to the safe state as soon as an object with a higher remission passes the scan plane (e.g., an uncoated plastic part). This results in an availability problem.

Important information

NOTE

- The configuration changes described here are only intended to provide a suggested solution for the availability problem and are not a part of the certified safety system.

NOTE

- If persons together with objects with a low remission pass through the portal, the persons must be detected reliably. The ability to distinguish between persons and materials must always be reliable.
- Suitable measures must be used to ensure that other objects with a low remission factor (< 1.8%) do not pass through the portal. This applies in particular to clothing and other worn objects, e.g., a helmet with a low remission factor.

Prerequisites

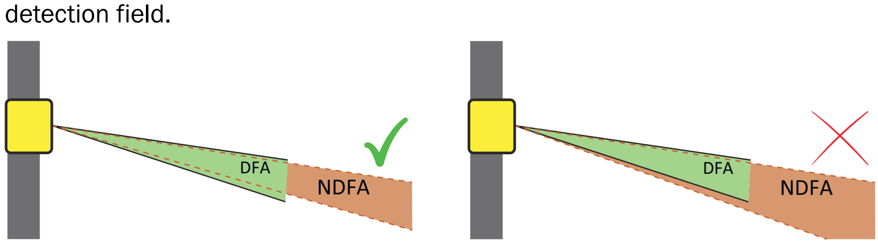
- The scanning range of the safety laser scanner used is adequate to detect a fixed structure on the opposite side of the portal.

Negative detection fields (NDF)

You can reliably detect objects with a low remission by configuring additional negative detection fields (NDF).

Requirements on the negative detection fields

- For each detection field in which objects with a low remission factor need to be detected, there exists a corresponding NDF (e.g., DFA1 – NDFA1).
- NDFs are protective fields.
- A fixed structure (e.g., floor, ceiling or a column on the opposite side) is reliably detected within the NDF. The fixed structure cannot be manipulated.
- The NDF covers a region of the portal through which objects pass.
- The NDF is located fully within the detection field all the way to the end of the detection field.



- After completing the configuration, the NDFs must have the same response time as the detection fields, the protective fields for the passing objects, and the reference contour field.

- A single person cannot trigger an apparently free state simultaneously for 2 related NDFs of an object (e.g. NDFA1 and NDFB1). This can be ensured by means of one of the following measures:
    - The two fields do not intersect and have a wide distance between them.
    - Persons must not carry any objects with a low remission on or with them, e.g., a helmet with a low remission.

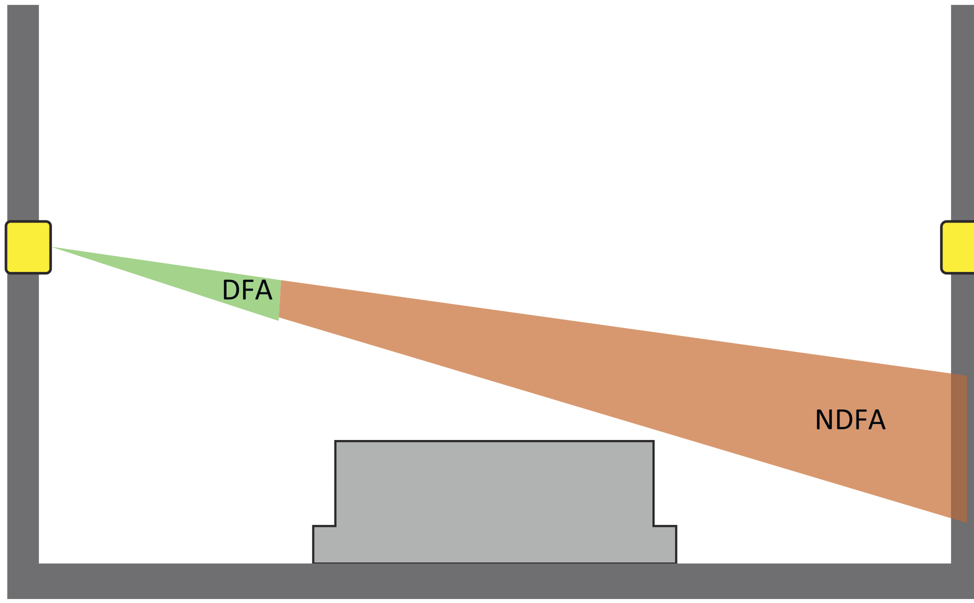


Figure 34: Example NDF field

Since there is a fixed structure within the NDF, a detection usually occurs in the NDF. This is the case regardless of whether an object passes through the portal or not. If an object with a low remission factor passes through the portal, however, the safety laser scanner cannot detect either the object or the fixed structure.

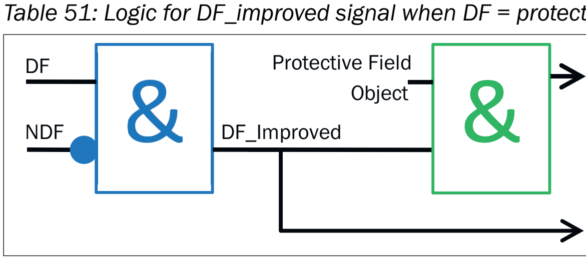
This means: Only if an object with a low remission passes through the portal will the safety laser scanner interpret the NDF as clear.

Additional logic for DF_improved signal (detection fields are configured as protective fields)

An AND logical operator combines the signals of the detection field (DF) and the negative detection field (NDF) into the DF_improved signal. This inverts the NDF signal. The DF_improved signal must be linked to the bDetectionFieldX input of the function block.

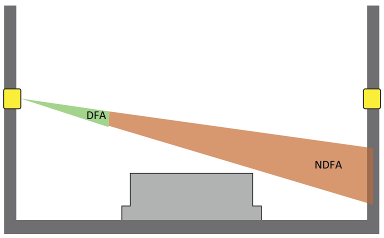
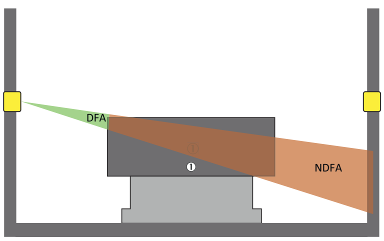
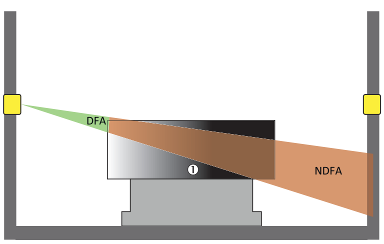
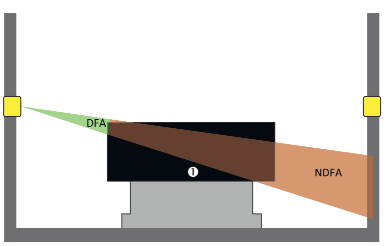
The second AND logical operator is used to combine the DF_improved signal with the PF_Object protective field. The result is linked to the bProtectiveFieldObjectX input of the function block.

Table 51: Logic for DF_improved signal when DF = protective field



(logic diagram above)	bProtectiveFieldObjectX input of the SICK_SP_01_V function block
	bDetectionFieldX input of the SICK_SP_01_V function block

You need a separate additional logical operation for each detection field DFxy.

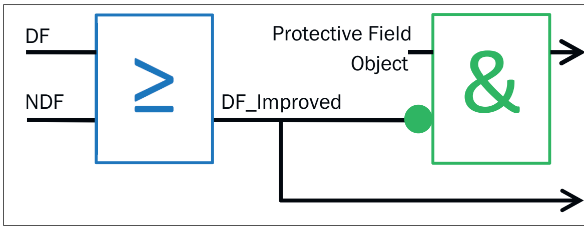
Object detection by DF/NDF			IN	IN	OUT
	IN DF signal	IN Inverted NDF signal, (source)	OUT bDetection-FieldX =DF_Improved	PF Object	bProtective-FieldObjectX
No object	1	1, (0)	1	0	0
	1	1, (0)	1	1	1
“Normal” object	0	1, (0)	0	0	0
	0	1, (0)	0	1	0
Partially detectable object	0	0, (1)	0	0	0
	0	0, (1)	0	1	0
Object with a low remission factor	1	0, (1)	0	0	0
	1	0, (1)	0	1	0

Additional logic for DF_improved signal (detection fields are configured as contour detection fields)

An OR logical operator combines the signals of the detection field (DF) and the negative detection field (NDF) into the DF_improved signal. The DF_improved signal must be linked to the bDetectionFieldX input of the function block.

An AND logical operator is used to combine the DF_improved signal with the PF_Object protective field. This inverts the DF_improved signal. The result is linked to the bProtec-tiveFieldObjectX input of the function block.

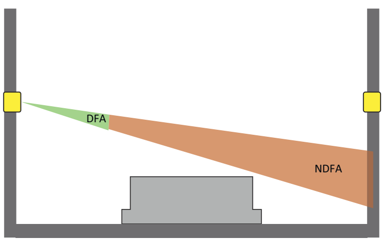
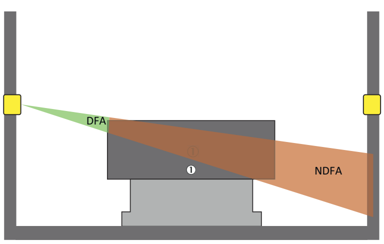
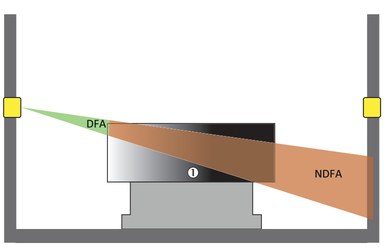
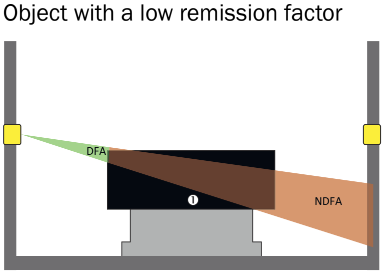
Table 52: Logic for DF_improved signal when DF = contour detection field



bProtectiveFieldObjectX input of the SICK_SP_01_V function block

bDetectionFieldX input of the SICK_SP_01_V function block

You need a separate additional logical operation for each detection field DFxy.

Object detection by DF/NDF			IN		IN	OUT
	IN DF signal	IN NDF signal	OUT bDetec-tionFieldX =DF_Improved	=DF_Improved inverted	PF_Object	bProtecti-veFieldOb-jectX
No object	0	0	0	1	0	0
	0	0	0	1	1	1
“Normal” object	1	0	1	0	0	0
	1	0	1	0	1	0
Partially detectable object	1	1	1	0	0	0
	1	1	1	0	1	0
Object with a low remission factor	0	1	1	0	0	0
	0	1	1	0	1	0

If multiple objects with a low remission pass through the portal at the same time

An object with a low remission factor makes the NDF appear clear. If the associated detection field also appears to be clear, muting for the object is triggered. For applications with 2 or more objects with a low remission factor, only the object for which the NDF must trigger muting is allowed to pass through the field of view of each NDF.

Example: If both the lift table and the car body can have a low remission, then the lift table must not pass through the field of view of the NDF for the car body. Otherwise the muting for the car body would still be triggered in the case of an empty lift table. This results in a monitoring gap.

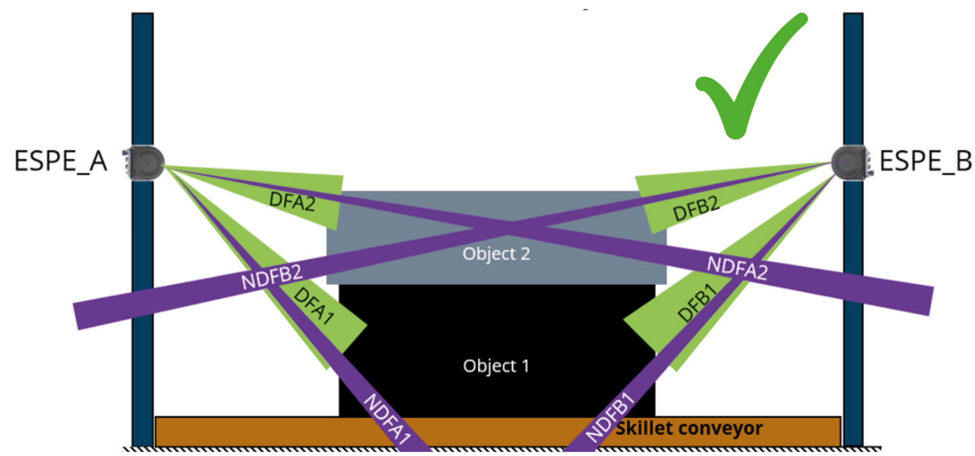


Figure 35: Positive example: Only the associated object passes through the field of view of each NDF.

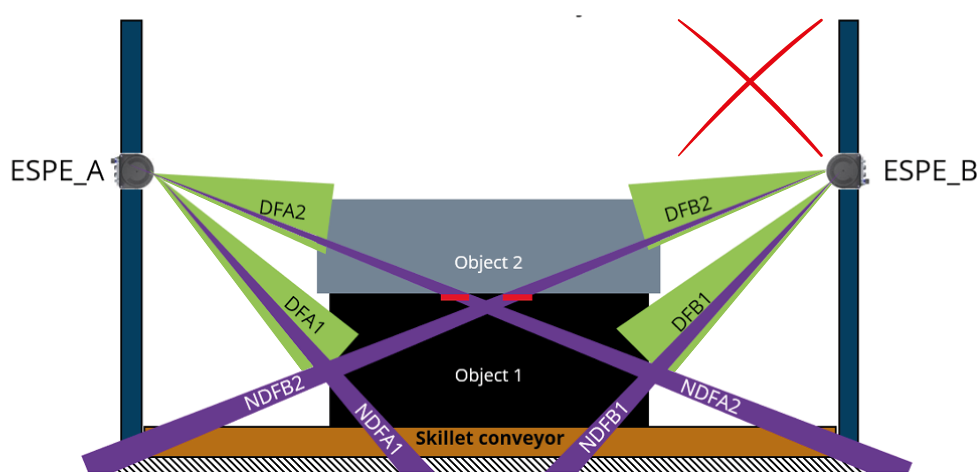


Figure 36: Negative example: 2 different objects with a low remission factor pass through the portal and the field of view of NDFA2 and NDFB2. If only object 1 passes through the portal, the region for object 2 is also muted.

Using the DF_improved signal in conjunction with the SICK_SP_01_V function block

- From the integrator's perspective, the DF_improved signal replaces the DF signal.
- The DF_improved signal is mapped to the corresponding ESPE_x.bDetectionFieldY input.
  Example: The DFA2_improved signal is derived from the signals DFA2 and NDFA2. DFA2_improved is mapped to the ESPE_A.bDetectionField2 input.
- In addition, the DF_Improved signal is combined with the signal of the corresponding protective field via an AND logical operator. The result is mapped to the ESPE_x.b.ProtectiveFieldObjectY input.

Example 1

This example shows the logic for integrating the signals for an application with the following characteristics:

- Number of muting levels: 1
- Detection fields are protective fields

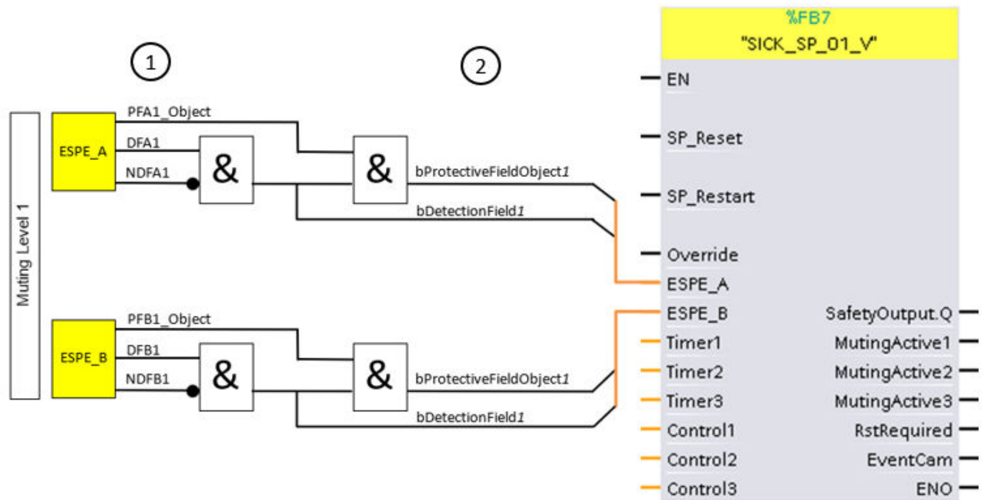


Figure 37: Integrating the signals in the FB - Example: 1 muting object

① The signals DF, NDF and PFx1_Object of both safety laser scanners must be combined using this extension logic.

② The logic signals must be mapped to the following input structure variables of the SICK_SP_01_V function block:

- ESPE_A.bDetectionField1
- ESPE_B.bDetectionField1
- ESPE_A.bProtectiveFieldObject1
- ESPE_B.bProtectiveFieldObject1

Example 2

This example shows the logic for integrating the signals for an application with the following characteristics:

- Number of muting levels: 2
- Detection fields are protective fields

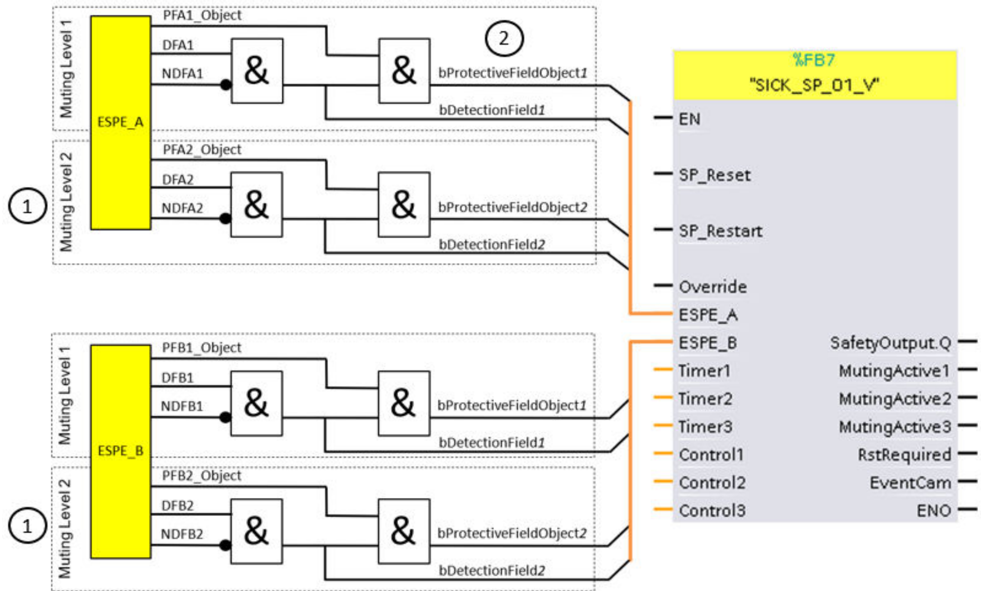


Figure 38: Integrating the signals in the FB - example: 2 muting objects

① A separate extension logic needs to be implemented for the additional second muting level.

② The logic signals must be mapped to the following input structure variables of the SICK_SP_01_V function block:

Muting level 1

- ESPE_A.bDetectionField1, ESPE_B.bDetectionField1
- ESPE_A.bProtectiveFieldObject1, ESPE_B.bProtectiveFieldObject1

Muting level 2

- ESPE_A.bDetectionField2, ESPE_B.bDetectionField2
- ESPE_A.bProtectiveFieldObject2, ESPE_B.bProtectiveFieldObject2

Complementary information

- A software for visualizing the fields of the safety laser scanner must only be used for commissioning or maintenance work. Access to the software must be restricted to authorized personnel. This can be achieved, for example, by password protection. The measure provides protection against manipulation.
- The protective field, detection field, and negative detection field must each be configured in a field set.
- The “Monitor material passage” safety function with the additional logic must also achieve performance level d.

15.3 Conformities and certificates

You can obtain declarations of conformity, certificates, and the current operating instructions for the product at www.sick.com. To do so, enter the product part number in the search field (part number: see the entry in the “P/N” or “Ident. no.” field on the type label).

15.3.1 EU declaration of conformity

Excerpt

The undersigned, representing the manufacturer, herewith declares that the product is in conformity with the provisions of the following EU directive(s) (including all applicable amendments), and that the standards and/or technical specifications stated in the EU declaration of conformity have been used as a basis for this.

- ROHS DIRECTIVE 2011/65/EU
- EMC DIRECTIVE 2014/30/EU
- MACHINERY DIRECTIVE 2006/42/EC

15.3.2 UK declaration of conformity

Excerpt

The undersigned, representing the following manufacturer herewith declares that this declaration of conformity is issued under the sole responsibility of the manufacturer. The product of this declaration is in conformity with the provisions of the following relevant UK Statutory Instruments (including all applicable amendments), and the respective standards and/or technical specifications have been used as a basis.

- Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012
- Electromagnetic Compatibility Regulations 2016
- Supply of Machinery (Safety) Regulations 2008

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