Safe Machines

with opto-electronic protective devices

Reliable safety
and flexibility in an
advanced manner.

SICK

This guide is aimed at designers and users of machinery who specify and use protective devices. On the following pages we introduce you to different ways in which you can safeguard machinery using SICK protective devices. This information also takes into account the applicable European regulations, directives and standards.
In this way an introduction to the usage of opto-electronic protective devices has been produced. This is comprehensive and clearly laid out. The examples given are the result of our many years of practical experience and are typical applications. No legal claims can be derived from the examples that follow, as every machine requires a specific solution against the background of national and international regulations and standards.

At this point warm thanks to all who have contributed to the preparation of this introduction to the usage of opto-electronic protective devices.

Monitoring an automatic petrol station using the SICK Laser Scanner PLS. The horizontal protective field is marked in the picture. At the same time, the PLS measures the position and type of car.

The requirements for the protection of machinery have changed more and more as automation technology has progressed.

In the past the guarding systems that were available were more often than not a hindrance to the work process and as a consequence were removed, increasing accident figures made reliable protective devices imperative.

Modern opto-electronic know-how from SICK opens up countless new possible applications for you. Thanks to significantly reduced housing sizes, flexibility of use in new applications has been significantly increased. In this way, we are today able to offer protective devices that facilitate more pleasant, more ergonomic, and also more effective work for users. And that without impairing the workflow in the slightest.

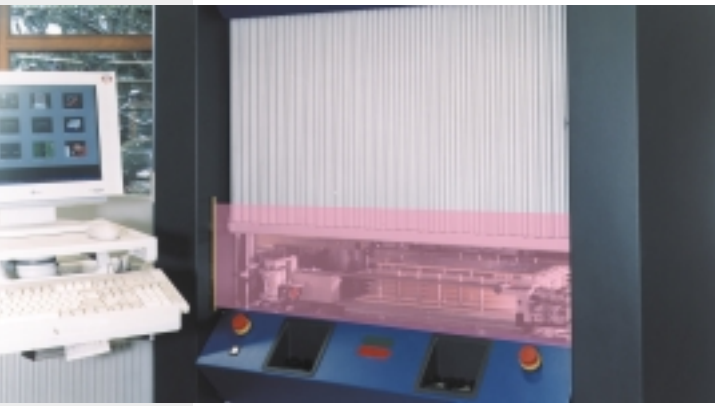
Safeguarding a welding station: vertical protective field with SICK Light Curtain FGS tilted towards the front. This arrangement is a protection up to the mechanical barrier.

Regulations

Opto-Electronic Protective Devices

SICK Products

Annex



Point of operation guarding on a test jig for circuit boards

Explanation of the pictograms:

Hand/finger protection: protective device mostly used vertically, near to the hazardous zone (depending on resolution). Formula to be used for calculating the safety distance for up to 40 mm resolution:
$S = (K \times T) + 8 \times (d-14)$

Area guarding: Persons are detected in the defined hazardous zone. The resolution d required is dependent on the height of the protective field:
$d = H/15 + 50$.
Formula for the calculation of the safety distance:
$S = 1600 \times T + (1200 - 0.4 \times H)$;
where $(1200 - 0.4 \times H) \geq 850$

Access guarding: pure access guarding; therefore restart interlock required. Presence between protective device and point of hazard is not detected. Formula for calculating the safety distance:
$S = (1600\ mm/s \times T) + 850\ mm$

Regulations

1.1 European Directives, Objectives, Procedures

For the ideal of free trade to be put into practice, the directives enacted by the EU Commission/Council must be applied by the member states in national directives. In addition, the EU standardisation institutes were tasked with the preparation of EU standards to define the legal stipulations in detail.

For the protection of the operators of machinery and plant, harmonisation has been driven forward at great speed in the area of the safety of machinery.

Directives have been ratified and standards published.

In this section, we will briefly explain:

- The Machinery Directive, is to be used for machinery and equipment, and also for used machinery and equipment from other countries that is placed on the market in the European Economic Area (e.g. from the USA or Japan).

- The Use of Work Equipment by Workers at Work Directive that addresses already existing machinery/equipment (or used equipment that originates from a country within the European Community).

- The most important standards and their current issue.

1.1.1 The Machinery Directive

The Machinery Directive 98/37/EC is aimed at the designers of new machines. It defines the requirements for compliance with health and safety requirements for new machinery so that the machinery can be sold and freely traded within the member states of the European Community, and a high level of safety is guaranteed to operators.

The harmonised European standards define the possible ways and means to implement these objectives. The Machinery Directive is integrated into national law and thus legally binding. The standards are, however, not legally binding. On the other hand, it is assumed that a machine built in accordance with the harmonised standards complies with the essential requirements of the directive.

As required by European lawmakers, the directive and its amendments must be implemented in every member state. The directive came into effect on 1 January 1995 for machinery and 1 January 1997 for safety components.

Access safeguarding on three sides using SICK Photoelectric Switches WSU/WEU and corner mirrors.

What do the manufacturers of new machinery have to do?

The complete procedure for the assessment of conformity is explained in the Machinery Directive. In short, a differentiation is made between two categories of machines:

Machines that produce a high risk are subject to special procedures. Annex IV of the Machinery Directive contains a list of corresponding machines, here safety components (photoelectric switches, light curtains, etc.) are subject to the same examination procedures.

All other machines that are not listed in Annex IV are subject to the standard procedure.

The Machinery Directive (MD) demands the integration of safety as early as the design process. In practice this means that the designer must perform a hazard analysis and risk assessment during the development of the machine, so that the measures developed from the analysis and assessment can flow directly into the design.

The project management software Safexpert® supports the manufacturer, in accordance with the requirements of the Machinery Directive, during the implementation of their safety management, from hazard analysis all the way to documentation.

To certify the conformity of the machine, the manufacturer must affix the CE marking to the machine. The manufacturer must enclose an EC declaration of conformity for each safety component.

Procedure for the EC declaration of conformity for equipment that is not listed in Annex IV:

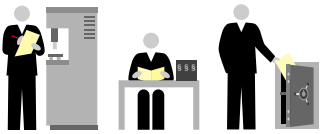
If the machine/safety component is not contained in the list in Annex IV, the manufacturer can affix the CE marking on his own liability without involving a notified body. Nevertheless, the measurement and test results must be documented and be submitted to the national authorities on request.

If the machinery or safety component is listed in Annex IV, the examination procedure is defined by the existence of harmonised standards

● If harmonised standards exist for the working machinery or safety components that cover the entire range of requirements. Three cases are possible:

1) The manufacturer sends the technical documents (cf. Annex VI of the directive) to a notified body; this body confirms receipt and archives the documents.

2) The manufacturer requests the notified body to check his technical documents in respect of compliance with the harmonised standards. If this is the case, the body provides the manufacturer with a certificate about the compliance with these standards.



3) For this purpose the manufacturer applies for EC-type examination by a notified body (cf. Annex 1).

● Where there are no harmonised standards for machinery, or the machine or parts are not built to the standards. The manufacturer must make his machine and the technical documents available to the notified body (cf. Annex 1) so that an EC-type examination can be performed. This body checks compliance with the directives and prepares an EC-type examination certificate that gives the results of the examination.

In all cases the manufacturer makes out the declaration of conformity for the related product on his own liability, and thus undertakes the obligation that the equipment and protective devices have been designed in compliance with the standards.

1.1.2 The Use of Work Equipment by Workers at Work Directive 89/655/EEC (amended by the directive 95/63/EC)

The objective of these directives is the harmonisation of the safety level on machinery used in the European Community, and also of used machinery that originates from within the European Community, to ensure that the machinery complies with the defined minimum requirements.

Each machine is examined to check its conformity and the date of its original commissioning.

Used machines or machines procured second-hand that are non-compliant must meet the technical requirements from 1 January 1997. This affects, amongst others, controllers and stopping equipment, warning and signalling equipment, as well as organisational procedures. More detailed information is to be found in the Official Journal of the European Communities or can be requested from the relevant authorities.

This directive and the laws enacted do not require the same safety standard as is the case for new machinery. They only define the minimum safety requirements to limit or, indeed, eliminate the risks.

Every member state may add its own national requirements: servicing/maintenance interval, usage of gloves, etc.

1.2 Bodies

1.2.1 Safety Consultants

Companies that want to check whether their machinery complies with the European directives can obtain help from safety consultants.

1.2.2 Approved Bodies

Some of these consultants are approved and become involved when an instruction is given by the competent authority to establish the conformity of the machinery. Every member of the European Community is responsible for monitoring the approval in its country. The approved bodies have the necessary powers and the necessary means to perform a variety of tasks: inspection, analysis, technical support, reporting, examinations, measurements, etc.

1.2.3 Notified Bodies

Each EC member state has the obligation to nominate notified bodies as per the minimum requirements defined in the Machinery Directive (cf. Annex 1) and to notify these listed bodies to Brussels. Only these bodies are authorised to issue EC-type examination certificates for the machinery and safety components mentioned in Annex IV of the directive. It should be noted that these bodies have their own specialist areas of activity. The list of notified bodies can be requested directly from the European Commission in Brussels.

1.3 European Safety Standards

1.3.1 Harmonised European Safety Standards

CEN (European Committee for Standardization) or CENELEC (European Committee for Electrotechnical Standardisation) is given the task of drawing up a standard by the Commission of the European Communities. The technical specifications for compliance with the essential safety requirements of the directive are then defined by the appropriate committees. As soon as the standard is accepted in the voting process, it is published in the Official Journal of the European Communities. Only then is the standard considered a harmonised standard.

This type of standard serves as a reference and replaces all national standards on the same topic. The conformity of a safety component or a machine with a harmonised standard provides a basis for the assumption of compliance with the essential health and safety requirements defined in the Machinery Directive 98/37/EC.

The status of the standard is indicated by different abbreviations:

- A standard with the prefix EN... is accepted and can be used.
- A standard with the prefix prEN… is currently under revision.

Automotive industry: Area safeguarding in a feed station using SICK Laser Scanner PLS. The protective field is marked on the floor.

1.3.2 Different Types of Standard

There are three different types of standard:

Type A standards
(Basic safety standards)
contain basic terms, design principles and general aspects that can be used on all machinery.

Type B standards
(Safety group standards)
address a safety aspect or an item of safety equipment that can be used for a wide range of machinery.

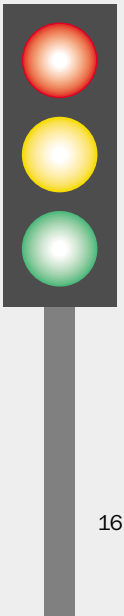
Type B1 standards on special safety aspects (e.g. safety distances, surface temperature, noise), e.g. the electrical safety of machinery (EN 60204), the calculation of safety distances (EN 999).

Type B2 standards on safety equipment (e.g. two hand switches, interlocking equipment, pressure sensitive safety equipment, isolating safety equipment, electro-sensitive protective equipment) IEC 61496 Part 1 and 2/EN 61496 Part 1, prEN 61496 Part 2 and prEN 61946 Part 3.

Type C standards
(Machinery safety standards)
contain all safety requirements for a special machine or type of machine. If this standard exists it has priority over the A or B standard.

Nevertheless, a C standard can make reference to a type B or type A standard.

If there is no C standard for a machine, conformity can be established based on the type A or type B standard. In any case the requirements of the Machinery Directive must be met.



Some examples of standards

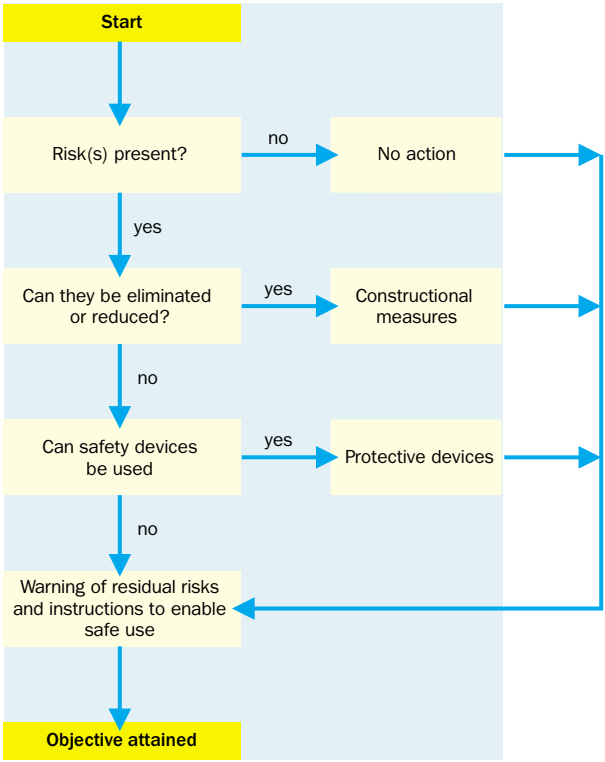
Standard Type	Number in Europe EN	International Number ISO/IEC	Title
Type A	En 292-1 En 292-2	ISO 12100-1 ISO 12100-2	Safety of machinery – Basic concepts, general principles for design
	EN 1050	ISO 14121	Safety of machinery – Principles for risk assessment
Type B	EN 61496-1	IEC 61496-1	Safety of machinery – Electro-sensitive protective equipment – Part 1: General requirements and tests
	prEN 61496-2	IEC 61496-2	Part 2: Particular requirements for equipment using active opto-electronic protective devices
	EN 61496-3	IEC 61496-3	Part 3: Particular requirements for equipment using active opto-electronic devices responsive to diffuse reflection (AOPDDRs)
	EN 999	ISO 13855	Safety of machinery – The positioning of protective equipment in respect of approach speeds of parts of the human body
	EN 294	ISO 13852	Safety of machinery; safety distances to prevent danger zones from being reached by the upper limbs
	EN 954-1	ISO 13849-1	Safety-related parts of control systems – Part 1: General principles for design
	prEN 954-2	ISO 13849-2	Part 2: Validation
	EN 60204-1	IEC 60204-1	Electrical equipment of machines – Part 1: General requirements
	EN 1088	ISO 14119	Interlocking devices associated with guards - Principles for design and selection
	EN 574	ISO 13851	Two-hand control devices – Functional aspects; principles for design
	EN 418	ISO 13850	Emergency stop equipment, functional aspects; principles for design
	EN 1037	ISO 14118	Preventation of unexpected start-up
Type C	EN 692		Mechanical presses; safety
	EN 693		Hydraulic presses; safety
	EN 12622		Hydraulic press brakes; safety
	EN 775	ISO 10218	Manipulation industrial robots; safety
	EN 1010	ISO 1010	Technical safety requirements for the design and construction of printing and paper converting machines
	EN 11111	ISO 11111	Safety requirements for textile machinery

Safeguarding a mobile paving machine with SICK Laser Scanner PLS

2.1 General

During the design of a machine, the possible risks must be analysed and, where possible, additional protection built in to protect the operator from any residual risks (crushing, cutting, scratching, striking, stabbing, piercing, vibration, grazing, etc.), cf. EN 292 and EN 1050.

The software Safexpert® (see page 37) guides the manufacturer through the risk assessment in accordance with EN 1050 or EN 954-1 (for control aspects) during the hazard analysis. The hazards are isolated by danger zones and assessed in the related phases of the life of the machine. The assessment of individual hazards facilitates simplifies risk assessment and can lead to the optimal selection of the measures for risk reduction.



The diagram above indicates whether the utilisation of a protective device is advisable.

The rest of this section is based on the assumption that some risks cannot be excluded and it may be necessary to utilise an additional protective device.

2.2 Why Opto-Electronic Protective Devices?

If an operator needs to reach into a machine and is therefore put at risk, it is normally advisable to utilise an opto-electronic protective device instead of mechanical protective devices (fixed protective device, two-hand control, guards, etc.). This reduces the access time (the operator does not need to wait for the protective device to open), increases productivity (time saving on loading the machine) and improves ergonomics in the work place. Furthermore, operators and other persons are protected equally.

Attention: An opto-electronic protective device can only be used if the operator is not at risk from injury due to splashes (e.g. molten material) or flying pieces of material. Also, the access time must be longer than the time that is required to stop the hazard.

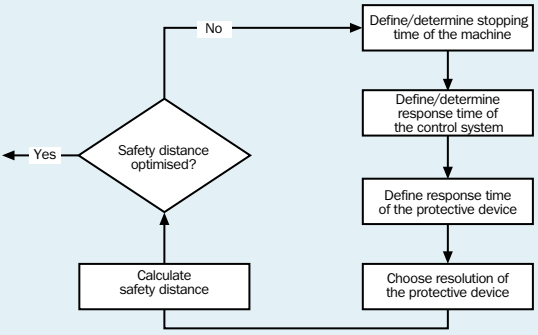
2.3 The Selection of an Opto-Electronic Protective Device

The basic criteria for the selection of an opto-electronic protective device are dependent on various requirements, such as:

- The standards to be addressed (e.g. EN 692/ Mechanical Presses - Safety)
- The space available in front of the danger zone
- Ergonomic criteria
- Ergonomic factors (e.g. cyclic insertion of parts or no cyclic entry)

Following the definition of the area to be protected, the safety distance (ESPE to the danger zone) is defined by the following parameters:

- Stopping time of the machine
- Response time of the control system
- Response time of the ESPE
- Additional margins on the safety distance calculated



2.3.1 Definition of the Protective Field

Depending on the configuration of the installation, it is necessary to also take into account the size of the protective field, the different access points, the danger zones that can be accessed as well as the risk of persons walking around the protective device and thus undetected presence in the danger zone.

2.3.2 Definition of the Protective Function to be Performed

2.3.2.1 Finger or Hand Detection

This type of protective device is advantageous if the operator is near the danger zone (short safety distance possible).

2.3.2.2 Detection of Persons on Access to the Danger Zone

This type of protective device is appropriate for the safeguarding of accesses.

2.3.2.3 Detection of the Presence of an Operator in the Danger Zone

This type of protective device is suitable for machines on which, e.g., a danger zone is enclosed by a fixed protective device and cannot be completely seen from the Reset button.
It can also be used to safeguard against approach to a danger zone when it links together access and presence monitoring (continuous detection of persons or objects anywhere in the defined area).

This type of safeguarding is also suitable for driver-less transport systems or stackers to protect the operator during the movement of the vehicles, or on docking these vehicles to a fixed station.

2.3.3 Observance of the Category for Safety-Related Parts of the Machine Controller

Whilst the essential requirements of the European Machinery Directive 98/37 EC are targeted at a high level of safety, the resources must, nevertheless, be proportional to the risk present.

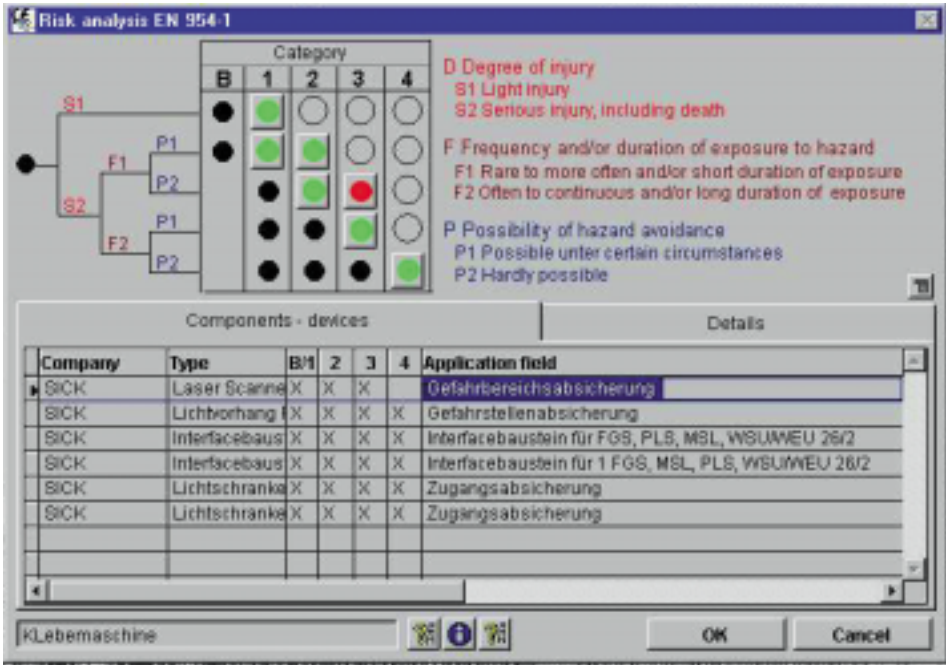
The protection of an operator who places or removes parts in a metal press by hand must not be treated in the same way as the protection of an operator who works on a machine where the maximum risk is the trapping of fingers.

Furthermore, the same machine can have different access points with different risks. For this reason, different measures can be taken for different parts of the safety-related controller for a machine.

Against this background, the standard EN 954-1 assists the designer in the definition of the categories for different parts of the safety-related controller based on the following parameters:

- The possible severity of the injury
- The frequency and/or duration of the exposure to hazard
- The possibility for reduction/ avoidance of hazard

The behaviour of the safety-related controller in the event of a failure is defined for each category (B, 1, 2, 3, 4 cf. table on page 24).
If identical technology is assumed (pneumatic, electronic, mechanical, hydraulic, etc.) these categories represent a sequential scale. For example, category 4 is higher than category 3. On the other hand, the categories are not intended to be used for a comparison of different technologies. The categories are also not intended to be used in any specific sequence in relation to the safety-related requirements.
Nevertheless, the AOPD and its interface must meet the equirements of the category for the safety-related parts of the controller under consideration so as to guarantee the safety function (e.g. machine stop and safety system stop).



For examples, see Section 3.2

Categories of the Safety-Related Parts of Controllers (EN 954-1)

Categories	Concise Statement of the Requirements	System Behaviour	Principles for the Achievement of Safety
B	The safety-related parts of controllers and/or their safety devices as well as their components must be designed, built, selected, assembled and combined in accordance with the applicable standard in such a way that they can withstand the effects to be expected.	The occurrence of a failure can lead to the loss of the safety function.	Predominantly characterised by the selection of components.
1	The requirements for B must be met. Proven components and proven safety principles must be used.	The occurrence of a failure can lead to the loss of the safety function, but the probability of the occurrence is less than in B.	
2	The requirements for B must be met and proven safety principles used. The safety function must be checked at appropriate intervals by the machine controller.	The occurrence of a failure can lead to the loss of the safety function between the tests. The loss of the safety function is detected by the test.	Predominantly characterised by the structure.
3	The requirements for B must be met and proven safety principles used. Safety-related parts must be designed in such a way that: ● a single failure in any of these parts does not lead to the loss of the safety function, and ● whenever feasible in a reasonable manner, the single failure is detected.	If a single failure occurs, the safety function is always retained. Some but not all failures are detected. An accumulation of undetected failures can lead to the loss of the safety function.	
4	The requirements for B must be met and proven safety principles used. Safety-related parts must be designed in such a way that: ● a single failure in any of these parts does not lead to the loss of the safety function, and ● the single failure is detected on or before the next demand for the safety function, or, if this is not possible, an accumulation of failures must then not lead to the loss of the safety function.	If failures occur, the safety function is always retained. The failures are detected in time to prevent the loss of the safety function.	

Cf. figures on page 31

2.3.4 Calculation of the Safety Distance

The calculation of the safety distance for an ESPE is described in the standard EN 999. If the machine is the subject of a specific standard (e.g. metal presses) or a special technical specification, reference must be made to this document.

Each ESPE must be installed such that access to the danger zone without detection by the protective device is impossible. In the case of finger and hand protection, a person must not be present in the danger zone without being detected.

General formula from EN 999

$$S = (K \times T) + C$$

Here

S is the minimum distance in millimetres, measured from the danger zone to the detection point, to the detection line, to the detection plane, or to the protective field;

K is a parameter in millimetres per second derived from data on the approach speeds of the body or parts of the body;

T is the run-on time of the entire system in seconds;

C is an additional separation distance in millimetres that defines the penetration into the danger zone prior to the triggering of the safety device.

If the minimum calculated distance has been set from industrial and ergonomic points of view, it must nevertheless be determined whether the installation and the configuration of the protective device permits the undetected presence of persons in the danger zone. If this is the case, the installation must be equipped with additional protective measures/protective devices.

If the minimum distance is too large and not acceptable for ergonomic reasons, it must be established whether it is possible either to reduce the overall stop time for the machine, or if it is possible to select an ESPE with better resolution.

For example: in the case of vertical approach and an overall stop time of 100 ms, for an AOPD with a resolution of 35 mm, a distance of 368 mm is calculated.

Conversely, with a resolution of 14 mm, the calculated distance is only 200 mm.

For presses in accordance with the standards EN 692 and prEN 693, the following table is to be used.

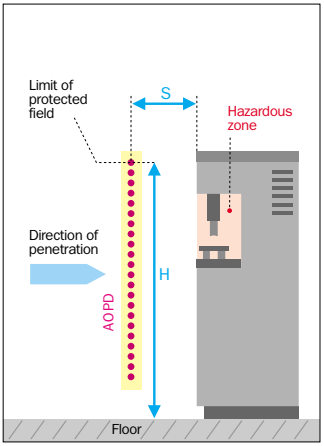
Based on the resolution of the AOPD, in the calculation the additional margin C must be added to the minimum distance S (cf. EN 692).

Resolution mm d	Additional Margin C mm	Stroke Triggering by AOPD/Cyclic Operation
≤ 14 > 14 ≤ 20 > 20 ≤ 30	0 80 130	Permitted
> 30 ≤ 40 > 40	240 850	Not permitted

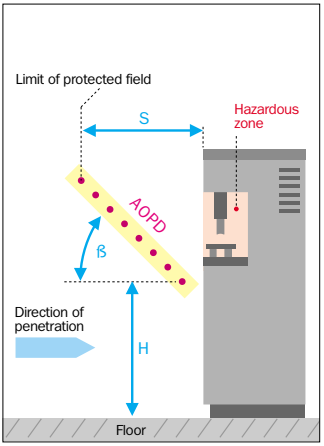
d Resolution of the ESPE

In general, a differentiation is made between three different types of approach:

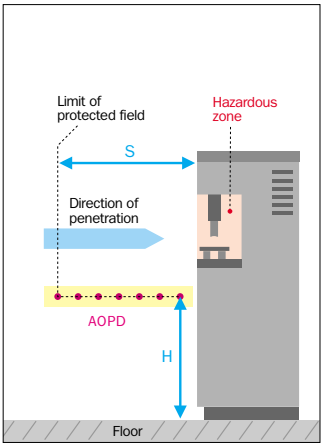
Perpendicular approach/entry perpendicular to the plane of the protective field



Angled approach



Parallel approach/entry parallel to the plane of the protective field



The following table contains the formulas for the calculation of the safety distance S.
Specific examples are given in the next section.

Perpendicular approach ß = 90° (± 5°) d = ≤ 40 mm	S = 2000T + 8 x (d – 14) where S > 100 mm where S > 500 mm Use S = 1600T + 8 x (d – 14). In this case S cannot < 500 mm.	NB: To prevent a person walking around the AOPD, observe EN 294. In practice this standard cannot always be applied because it considers the hand to be deformable. In this case it is necessary to seek advice from the responsible body.
40 < d ≤ 70 mm	S = 1600T + 850	Height of the lowest beam ≤ 300 mm Height of the highest beam ≥ 900 mm
d < 70 mm multiple beam	S = 1600T + 850	Number of beams: Recommended heights 4: 300, 600, 900, 1200 mm 3: 300, 700, 1100 mm 2: 400, 900 mm
single beam	S = 1600T + 1200	1: 750 mm
Parallel approach ß = 0° (± 5°)	S = 1600T + (1200 – 0.4 x H) where 1200 – 0.4 x H > 850 mm	15 x (d – 50) ≤ H ≤ 1000 mm if H ≥ 300 mm there is a risk of undetected access underneath the beam, this must be taken into account based on the value for H, here d ≤ H/15 + 50.
Angled approach 5° < ß < 85°	where ß > 30 °C, cf. vertical approach where ß < 30 °C, cf. vertical approach S is applied to the beam furthest away with a height ≤ 1000 mm ist.	d ≤ H/15 + 50 relates to the lowest beam.

S: minimum distance
H: height
d: resolution
ß: angle between detection plane and the direction of entry
T: time

2.4 Examples of Machinery Safeguarding

2.4.1 Zone Safeguarding on a Machine

This example shows two possible ways of installing an AOPD for the same application. As described above, perpendicular or parallel approach is taken into account.

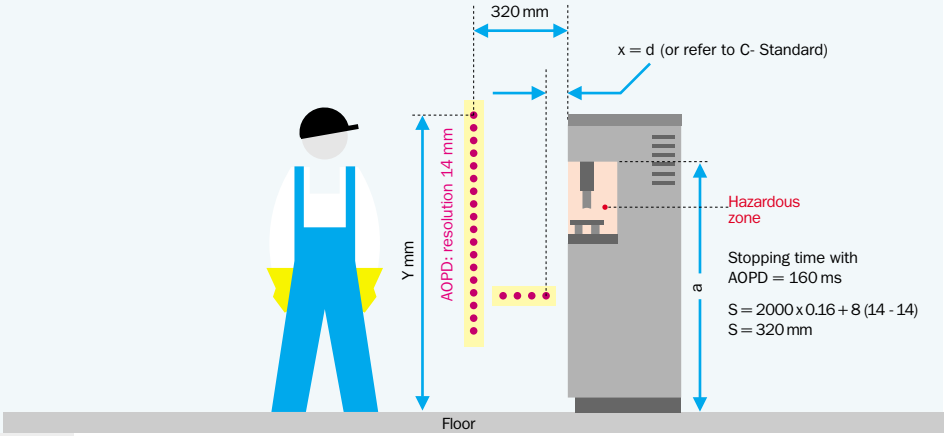
It is a precondition that the machine can only be reached via this access, there is a risk of serious injury and the operator often enters the danger zone.

Solution 1:

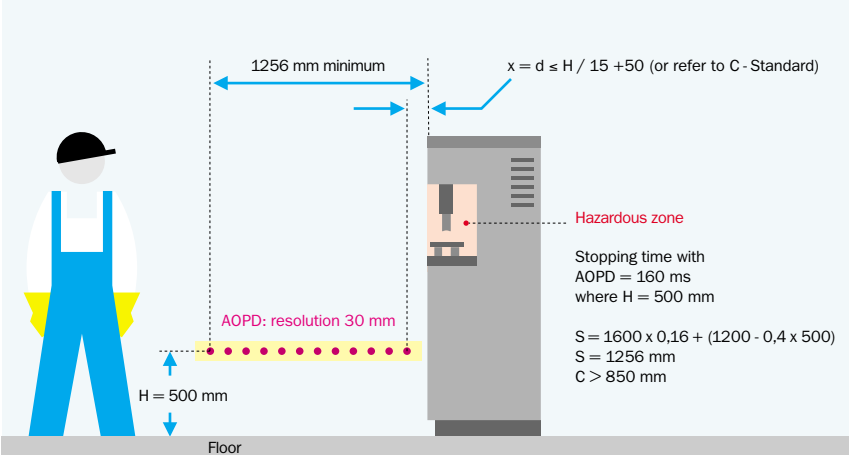
Perpendicular approach. Danger zone safeguarding with protection against walking behind.

The calculation, as shown in the diagram, yields a safety distance of 320 mm. By using an AOPD with a higher resolution, this is already a small distance. However the safety distance must not be less than 100 mm. So that the person is detected anywhere in the danger zone, two AOPDs are utilised: one vertical AOPD that is positioned in accordance with the calculated safety distance (perpendicular approach) and a horizontal AOPD to eliminate the risk of walking behind.

In accordance with EN 294, Table 1, y = 1800 mm if the height "a" of the danger zone is 1000 mm.



x = end of the protective field to mechanical guard against walking behind.



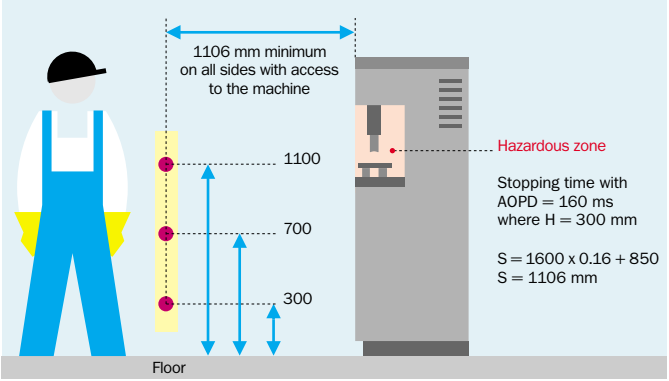
Solution 2:
Parallel approach.
Danger zone safeguarding

A horizontal AOPD is used.

The schematic diagram shown above shows the calculation of the safety distance S and the positioning of the AOPD. If the installation height of the AOPD is increased to 500 mm, the safety distance becomes lower, however as a result it must be accepted that there is a risk that a person can enter the danger zone by passing underneath the AOPD. In such cases it is necessary to install an additional protective device based on the risk assessment.

Result: The following table shows the result of the two solutions. Operative reasons determine the selection of one of the two solutions.

	Advantages	Disadvantages
Solution 1 S = 320 mm	Greater productivity as the operator stands closer. The short distance between the vertical photo-electric switch and the danger zone makes it possible to store material close to the machine (short paths).	Expensive protective device
Solution 2 S = 1256 mm	Cheaper protective device. Permits the safeguarding of the access independent of the height "a" of the danger zone.	The operator is **much further away** (long paths). It is difficult to store products on the floor as the photoelectric switch takes up a large amount of the space. **Lower productivity.** **Higher costs.**



2.4.2 Access Safeguarding

An access safeguard with 3 beams (at heights of 300, 700 and 1100 mm) permits a perpendicular approach as described in 2.3.4. This solution permits an operator to be between the danger zone and the AOPD undetected. For this reason additional safety measures must be taken to reduce this risk. For example, the control unit (for reset) must be positioned such that the entire danger zone can be seen, and it must not be possible to reach the unit from the danger zone.

Spotting press: Combination of point of operation guarding (SICK Light Curtain FGS) and interior monitoring (SICK Laser Scanner PLS). At the start both sensors are activated. The SICK Laser Scanner PLS is then muted on the downward stroke.

2.4.3 Press Interior Safeguarding

This type of safeguarding is recommended for large presses that are accessible from the floor. In this case it is necessary to prevent press starting up whilst the operator is detected. This is a secondary protective device that can under no circumstances replace the function of the primary safeguard, this must be an appropriate device (AOPD or two-hand control).

In this special case: the safety distance must be calculated for the primary protective device that has the task of stopping the press, whilst the secondary protective device detects the presence of a person in the press and thus prevents the press starting up.

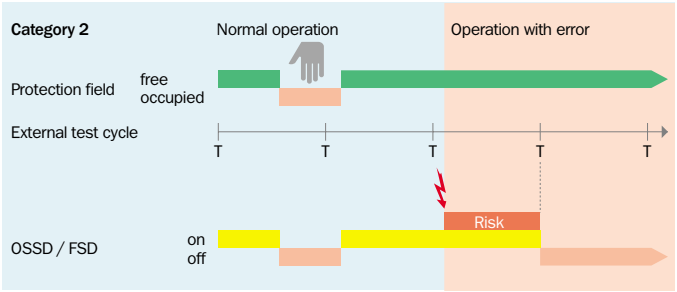
2.5 Connection to the Controller

2.5.1 Interface to the Machine

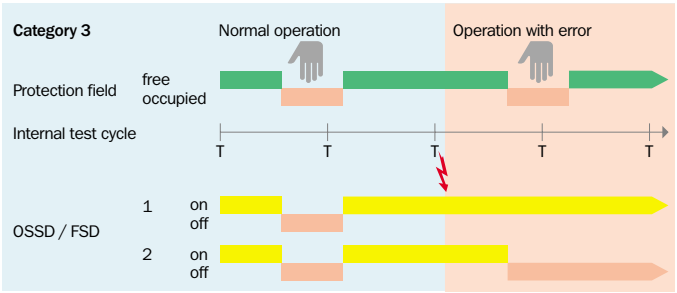
It is imperative that every safety device is correctly incorporated into the machine controller. This means that the part of the machine controller responsible for safety (protective device, machine controller and primary stop elements) must meet the category that was established during the risk assessment in accordance with EN 1050, EN 61496 and EN 954-1.

The following figures provide a basic explanation of the categories in accordance with EN 954-1 that are suitable for an AOPD and a controller. This assessment applies for the entire system including stop elements.

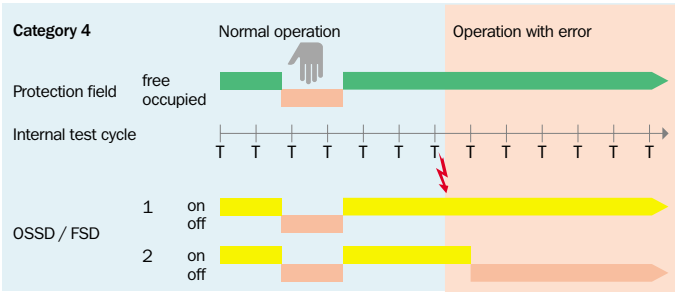
If a protective device is activated under normal conditions, e.g., on entry into the protective field, this always leads to a stop (independent of category). The detection of failures varies between the different categories.



Category 2
Failure detection is performed by testing using the external test. In the period between the failure and the next test there is a risk.



Category 3
The failure is either detected when the protective field is entered, or by the internal test.

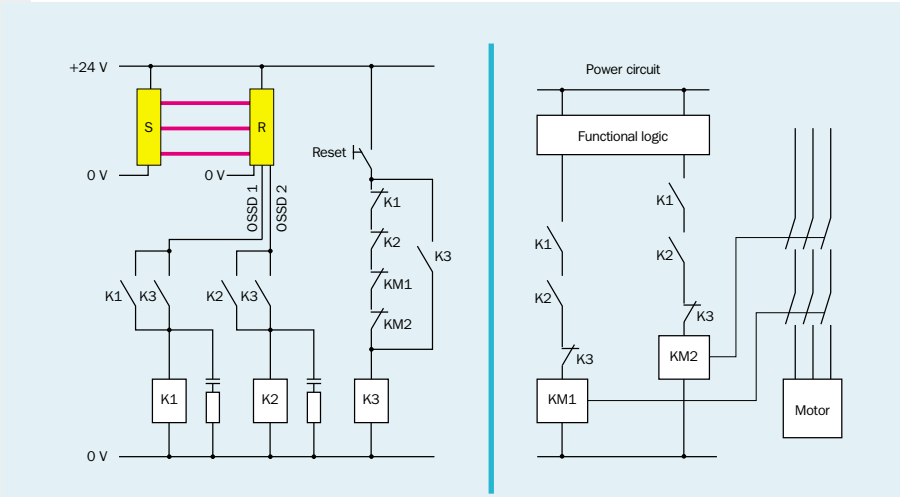


Category 4
Despite a failure, the protective function is retained. Contrary to category 3, in the case that the first failure is not detected, second and third failures must not result in the loss of the protective function. Internal tests must be performed within the response time of the protective device.

2.5.2 Connection Example for a Protective Device of Type 4

2.5.2.1 With External Reset

The schematic diagram shows a simple machine in which the AOPD reset function can also affect the start of the machine.



K1, K2 and K3 are the auxiliary contactors. KM1 and KM2 are primary contactors. All contactors have positively operated contacts.

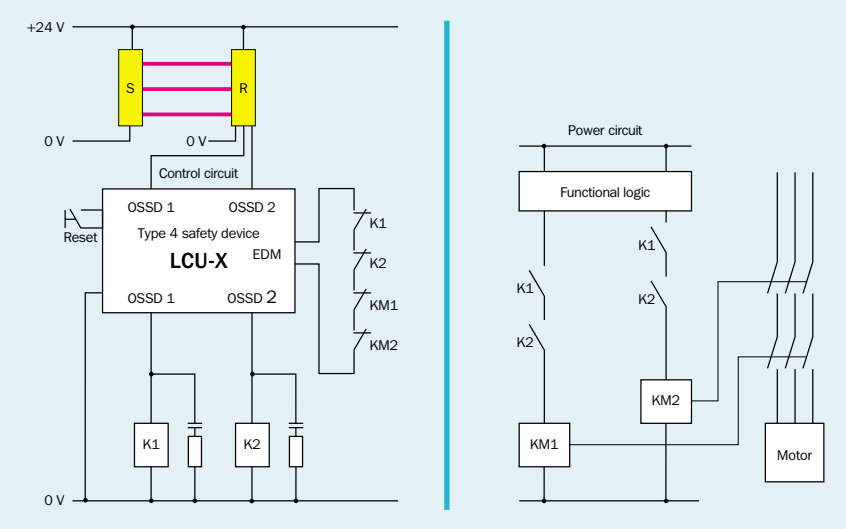
In this case the entire protective system is of redundant (two channel) configuration: the protective device (OSSDs), the auxiliary circuit (FSDs) as well as the primary circuit (MPCEs).

The contactors K1/K2 are monitored by K3. If one of the normally open contacts K1 or K2 sticks, its counterpart, the normally closed contact cannot close. As a result the coil of K3 cannot be energised and thus the contactors K1 and K2 can no longer be operated. The control circuit therefore remains open – deactivated.

K1/K2 = FSD 1/FSD 2
KM1/KM2 = MPCE 1/MPCE 2

2.5.2.2 With Internal Reset

A further connection example for a protective device of type 4 with restart inhibit and external contact monitoring. Reset and external contact monitoring are dynamically monitored by the SICK protective device.
The feature of this circuit: low installation effort.



Further examples are given in the SICK Circuits Handbook.

2.5.3 Muting the AOPD

The temporary bridging of a protective device can be relevant for safety engineering. For example, the standard EN 415-4 for packaging machines addresses the problem of pallet loaders and unloaders (machines in the which all work on the pallet load is performed automatically and only by machine). At the inlet and outlet of the inner chamber (where there is a risk under normal conditions) it is necessary to bridge the AOPD at the moment when the pallet passes through. On the other hand, it is necessary to detect the entry of persons. The muting system must be able to detect the difference between the pallet and the operator.

The muting conditions defined in EN 415-4 state that:

a. Muting is only permitted to be activated during the time span of the working cycle if the loaded pallet blocks access to the danger zone.

b. Muting must be performed automatically.

c. Muting must not depend on a single electrical signal.

d. Muting must not depend completely on software signals.

e. The muting signals, if they occur as part of an invalid combination, must not permit any muting state and ensure that the protective function is retained.

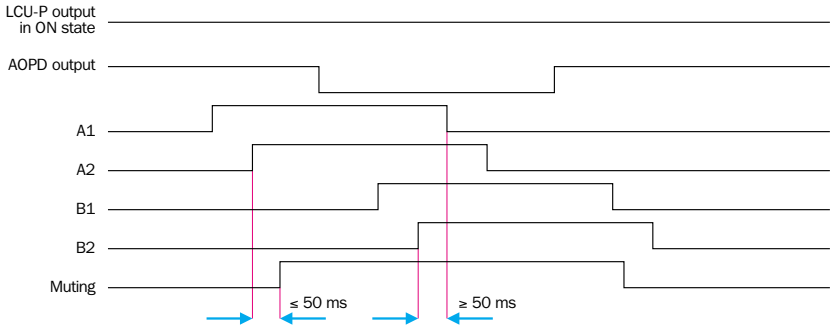
f. The muting state is removed immediately after the pallet has passed through and the protective device is thus effective again.

These six requirements can be met with the LCU-P and with MSL with muting (cf. III.1.3 and III.1.4). These devices provide for temporary bridging in a system by means of automatic differentiation. This means that the relevant device is very easy to understand for the user who does not need to address the wiring for the automatic, temporary bridging.

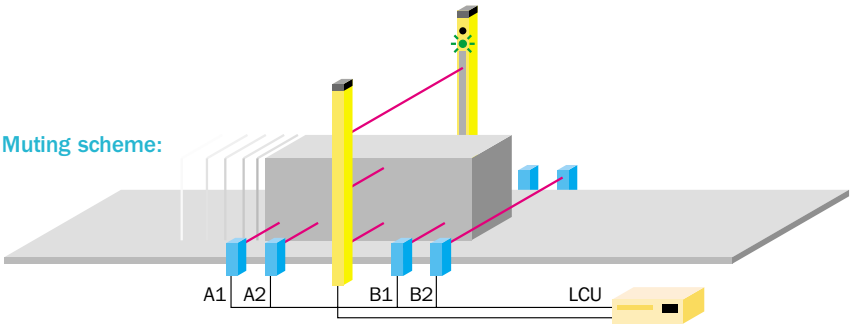
The AOPD is muted by sensor pairs (A1, A2 and B1, B2) (cf. Fig. page 35).

In this case the separation between A1 and B2 must be less than the length of the pallet (cf. timing diagram).

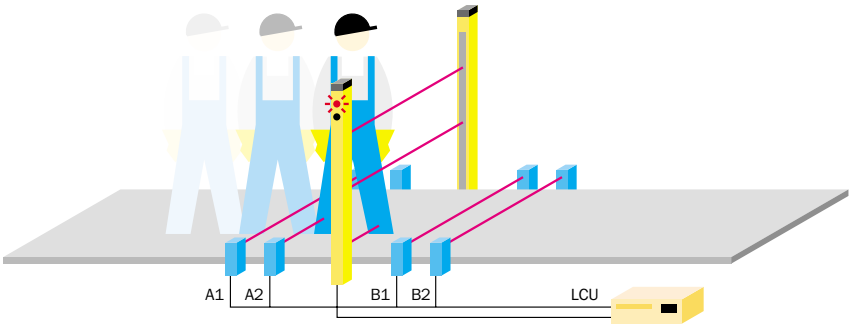
Furthermore, it is possible with the LCU-P to define the maximum muting duration in steps of 1s to prevent manipulation.



Muting scheme:



The material conveyed is detected. For this reason a stop is not performed.



The operator is detected. The LCU-P initiates a stop.

2.5.4 Single break/double break operating mode (in US: PSDI mode)

This operating mode is advantageous if parts are inserted and removed cyclically by hand. In this mode the machine cycle is automatically re-initiated once the protective field becomes clear after interruption once or twice.
The reset device is to be operated under the following conditions:

- On machine start
- On restart if the AOPD is interrupted during a hazard producing movement
- To initiate a restart after a cyde duration of more than 30 s (cf. EN 61496).
- More detailed information is to be found, e.g., in EN 692.

Nevertheless, it is necessary to check that no hazard for the operator can be generated during the work process. This limits application to small machines on which it is not possible to walk into the danger zone, and on which there are guards against walking behind (cf. Figure below). All other sides of the machine must also be safeguarded using suitable means.

If this operating mode is used, the resolution of the AOPD must be less than or equal to 30 mm (cf. EN 999, EN 692, prEN 693).

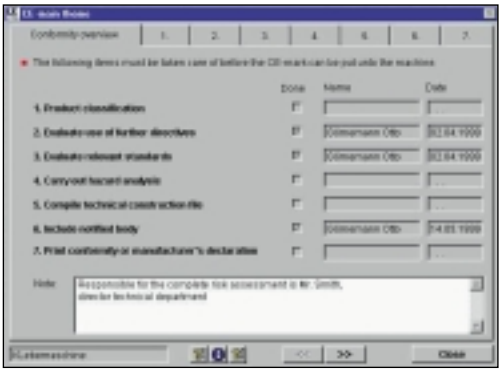
In general the following errors must be excluded by protective devices:

Reaching over

Reaching under

Standing between

Comprehensively plan, organise and realise safety – with Safexpert®, the software for safety engineering on machinery and plant.



3.1 Software for Safety Engineering on Machinery and Plant

Comprehensively plan, organise and realise safety, and in the process safe time and money!

Safexpert® supports you in meeting the requirements of equipment safety law: it guides you step for step through the requirements of the European Machinery Directive. Even complex plant projects are clearly structured and safety solutions efficiently organised in the team. Risks and danger zones can thus be immediately assessed and documented by the related specialist parallel to the design activity. Relevant points can be inserted directly in the documentation or operating instructions. You can centrally archive important data on the project (hazard analysis, safety measures, documents and plans, ...), your safety know-how is available at any time and can be recalled for subsequent projects. If your supplier or partner works with Safexpert®, their projects (e.g. components and controllers) can be inserted directly. Standard checks provide the current status of the project, convenient search functions ease the selection and application of the current standards and directives.

Product Range:

Basic:	Safety project management
Compact:	Basic + standards and directives information system Collection of drawings Example of EU compliant operating instructions
Professional:	Basic + Compact + original text of 9 standards

Safeguarding an automatic punch with SICK Light Curtain FGS and one/two cycle mode

3.2 SICK Protective Devices

In the following tables we present the range of SICK protective devices for the different applications and describe their most important features. This information is intended to be an aid for the designer or user during the selection of the suitable solution.

3.2.1 Point of operation guarding (Finger/Hand)

	FGS	C2000	LGT
Product Description	The Safety Light Curtain FGS comprises a sender unit and receiver unit. Between the two lies the protective field defined by the protective field height and the protective field width. The physical resolution is 14 or 30. Functions such as external contact monitoring, restart inhibit, blanking or muting can be realised optionally via the Safety Interface LCU. The system is host/guest capable.	Light curtain with an arrangement of several sender and receiver modules and integrated analysis. With/without restart inhibit and external contact monitoring, can be cascaded.	Light curtain (10 x 30 mm cross section) with an arrangement of several sender and receiver modules as well as a control unit.
Applications	Designed for finger/hand protection on hazard producing machines (presses, packaging machines and automatic manufacturing plant, etc.).	Hand protection for handling and assembly machines, packaging machines, textile machines.	Designed for hand protection on hazard producing machines (textile machines, pallet machines, etc.) where the risk assessment yields type 2.
Protective field height (mm)	300 – 1800	150 – 1800	150 – 900 (1800)
Range (m)	14 => 6 30 => 18 m	0 – 6 2.5 – 19	0 – 6
Resolution (mm)	14/30	20/30/40	30
Response Time (ms)	≥ 15	7 – 34	≤ 50
Type	4 in accordance with prEN 50100	2 in accordance with EN 61496	2 in accordance with prEN 50100
Voltage (V) DC AC	24	24	24 115/230
Outputs	2 OSSD (PNP)	2 OSSD (PNP)	2 NO, relay

3.2.2 Area guarding of hazardous zones

	PLS	LSI
Product Description	This device scans its environment in a 180° semicircle. It features integrated propagation time measurement and measures the distance to all objects in its field of view. It is possible to define a protective field to trigger a safe machine stop. A further warning field serves as an initial alarm zone for initiating a warning or brake signal. Can be set up with/without restart inhibit. Configuration and diagnostics via RS232/RS422 data interface with PLS/LSI user interface supplied.	Interface for the connection of up to 4 PLS via RS422 interface. With PLS/LSI user interface up to 8 protective/ warning fields can be preconfigured and selected via binary or encoder inputs. During this process up to 2 protective/ warning fields can be activated at the same time (simultaneously); these act on two independent safe output pairs (OSSD A, B).
Applications	For zone safeguarding on stationary machines, for driverless vehicles in mobile applications. (Robot plant, press interior monitoring, etc.)	For zone safeguarding on stationary machines, for driverless vehicles in mobile applications. (Robot plant, press interior monitoring, etc.)
Scanning range	4 m radius (protective field) / 15 m radius (warning field)	4 m radius (protective field) / 15 m radius (warning field)
Monitoring areas	1 protective field 1 warning field	8 protective field 8 warning field
Resolution	70 mm (at 4 m)	70 mm (at 4 m)
Response Time (ms)	≤ 80	≤ 190
Type according to EN 61496-1	3	3
Voltage (V) DC	24	24
Outputs	2 OSSD (PNP), 1 weak signal / warning field (PNP)	2 OSSD A (PNP) 2 OSSD B (PNP) 1 warning field A (PNP) 1 warning field B (PNP) 1 weak signal (PNP)

Further information is to be found in the relevant Technical Description.

3.2.3 Access or perimeter guarding

- Simple safety stop on access to hazardous zones
- Differentiating safety stop with a special device that differentiates between products and persons.

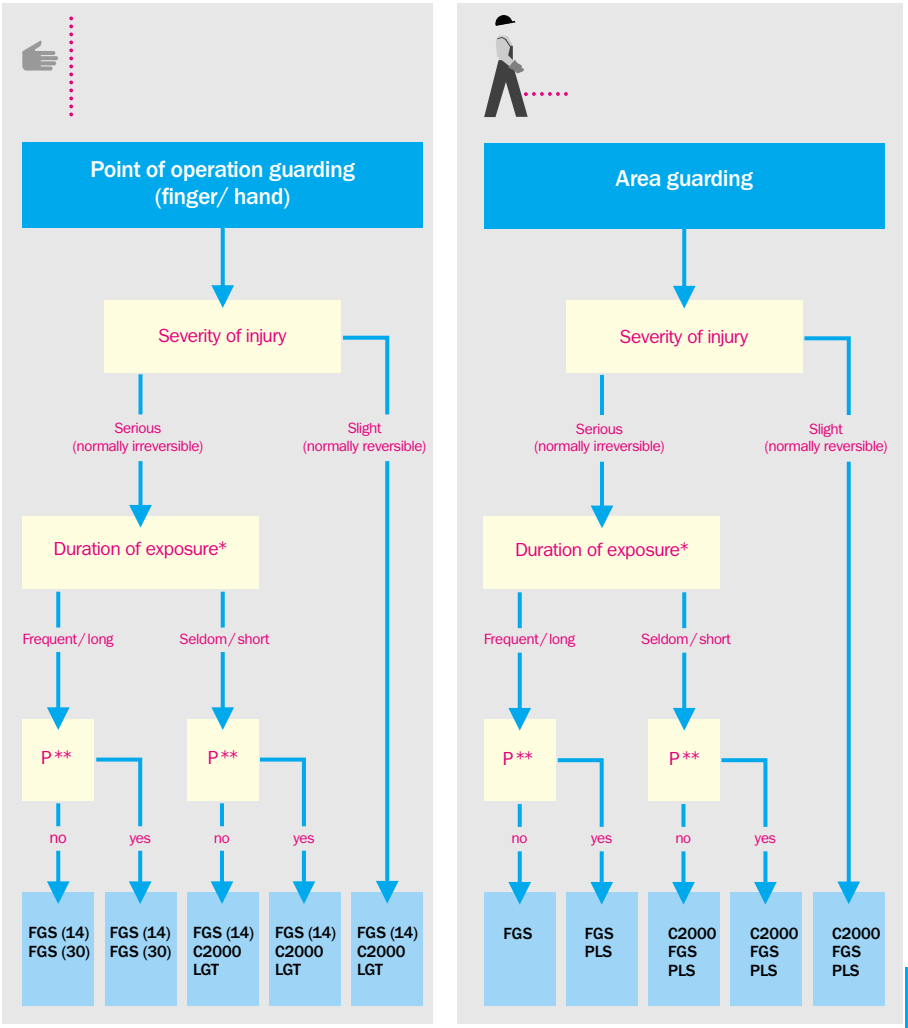
	MSL		WSU/WEU 26	M2000	WS/WE 27-2 WS/WE 18-2
Product Description	Photoelectric switch with 2 to 12 beams, comprises sender and receiver. Can be set up with/without restart inhibit. Can be set up with/without external contact monitoring. Available with muting module.		Single beam photoelectric switch with sender and receiver.	M2000-11-04 Photoelectric switch with 2 to 9 beams comprises sender and receiver. With/without restart inhibit, external contact monitoring, can be cascaded. Muting function via LE20 Muting.	Single beam photoelectric switch with sender/receiver. Muting function via LE20 Muting.
Applications	For access safeguarding for robot cells, pallet machines and automatic loading/unloading machines.		For access safeguarding at the intake/output of robot areas, pallet machines, transfer lines, etc.	For access safeguarding at the input/output of pallet machines, transfer lines, etc. where risk assessment yields type 2.	For access safeguarding at the input/output of pallet machines, transfer lines, etc. where risk assesment yields type 2.
Scanning range (m)	0 – 20 / 15 – 70	70	0.5 – 18 / 15 – 70	0 – 25 / 0 – 70	0 – 35 / 0 – 12
Monitoring areas	2 – 12 (MSL)	35	1	2 – 9	1
Response Time (ms)	≤ 20		≤ 22	≤ 8	≤ 0.5 / ≤ 2
Type EN 61496-1/ prEN 61496-2	4		4	2	2 (in combination with analysis unit)
Voltage (V) DC AC AC	24		24 115 230	24 V ± 20%	24 V ± 20%
Outputs	2 OSSD (PNP)		2 NO / 1 NC, relay	2 OSSD (PNP)	1 OSSD (PNP)

	LCU-P	LCU-X	LE20
Product Description	Highly flexible interface module. Six operating modes (protection mode, single break/double break as well as three further custom modes) permit individual adaptation. Devices of type 2 and type 4 can be connected. Can be set up with/without restart inhibit. Can be set up with/without external contact monitoring.	Interface module for the connection of a type 4 device. Can be set up with/without restart inhibit. Can be set up with/without external contact monitoring.	Interface module for type 2 devices. Can be set up with/without restart inhibit and external contact monitoring. Muting variant with override function.
Applications	Presses in one and two cycle operating mode; blanking, reduced resolution. Muting of a protective device possible.	In all cases in which potential free relay contacts are required as output elements.	For access safeguarding where the risk assessment permits category 2.
Outputs	2 OSSD (PNP)	2 NO / 1 NC, relay	2 OSSD (PNP) relay outputs via additional module
Inputs	• Connection of 1 or 2 devices of type 4, 3 • Connection of 2 or 4 devices of type 2 • 2 or 4 muting sensors	Connection of one type 4 or one type 3 device	• Connection of two 3 beam photoelectric switches of type 2. • Connection of one C2000/M2000 of type 2 • 2 – 4 muting sensors
Response Time (ms)	5	15	5
Category in accordance with EN 954-1	4	4	2
Voltage (V) DC AC AC	24	24	24 V –30% / +20%

Further information is to be found in the relevant Technical Description.

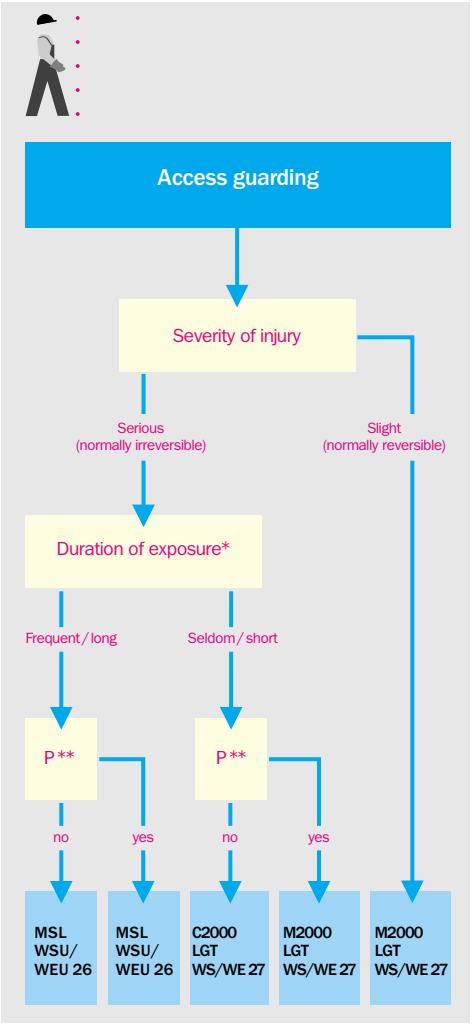
3.3 Selection of a SICK Protective Device

(in accordance with the risk assessment from section 2.3.3)



* Duration of the exposure to danger (frequency/duration)
The expected duration of direct exposure must include the frequency of entry.

** Possibility for avoiding hazard
YES: means that the operator can get out of the way of the danger.



* Duration of the exposure to danger (frequency/duration)
The expected duration of direct exposure must include the frequency of entry.

** Possibility for avoiding hazard
YES: means that the operator can get out of the way of the danger.

Note: if there is a risk of irreversible injuries, we recommend to use an AOPD of at least type 3.

3.4 EC Conformity of SICK Protective Devices

Device	Type/in acc. with	EC Type Examination Number	Notified authority	EC Conformity Number
Point of operation guarding				
FGSS300-1800 / FGSE300-1800 14 mm	4 / prEN 50100	951010	BIA	9043794
FGSS300-1800 / FGSE300-1800 30 mm	4 / prEN 50100	951009	BIA	9043795
C2000	2 / EN 61496	BB 991151401	TÜV Rheinland	9052451
LGTS015-090 / LGTE015-090 30 mm	2 / prEN 50100	BB 9710928 01	TÜV Rheinland	9043792
LGTN controller generally required for LGT	2 / prEN 50100	BB 9710928 01	TÜV Rheinland	9043792
Access guarding				
MSL (sender - receiver)	4 / EN 61496	98279	BG	9047395
MSLZ (active - passive) also with muting	4 / EN 61496	98279	BG	9047395
M2000	2 / EN 61496	BB 981147102	TÜV Rheinland	9052953
WSU All types also available in plug-in version				
WSU26/2-130/WEU26/2-130 24 V / 0.5 – 18 m	4 / EN 61496	9047751	BG	99236
WSU26/2-120/WEU26/2-120 115 V / 0.5 – 18 m	4 / EN 61496	9047751	BG	99236
WSU26/2-110/WEU26/2-110 230 V / 0.5 – 18 m	4 / EN 61496	9047751	BG	99236
WSU26/2-230/WEU26/2-230 24 V / 15 – 70 m	4 / EN 61496	9047751	BG	99236
WSU26/2-220/WEU26/2-220 115 V / 15 – 70 m	4 / EN 61496	9047751	BG	99236
WSU26/2-210/WEU26/2-210 230 V / 15 – 70 m	4 / EN 61496	9047751	BG	99236

Device	Type/ in acc. with	EC Type Examination Number	Notified authority	EC Conformity Number
Access guarding				
WS/WE 27-2	2 / EN 61496	945/EL 380/97	TÜV Rheinland	9047149
WS/WE 18-2	2 / EN 61496	BB 951105701	TÜV Rheinland	9055570
Area guarding				
PLS 101-312 RS232/RS422, V.3.XX	3 / EN 61496	981068	BIA	9051785
LSI 101-112 RS232/RS422, V.3.XX	3 / EN 61496	981092	BIA	9051802
LSI 101-114 RS232/RS422, V.3.XX	3 / EN 61496	981092	BIA	9051802
Interface Modules				
LCU-X	4 / EN 954-1	1) 94538	BIA	9043790
LCU-P	4 / EN 954-1	951021	BIA	9043789
LCU-V	4 / EN 954-1	BB 971102001	TÜV Rheinland	9049455
LE20/LE20 Muting	2 / EN 954-1	BB 991151301	TÜV Rheinland	9052620

1) A type examination is available.

Further technical information is to be found in the relevant Technical Description.
Ordering information is to be found in the price list.

Annex

4.1 Annex 1

Notified bodies for
protective devices (date: October 1996)

Belgium

AIB Vinçotte Inter
Avenue André Drouart 27-29
B-1160 Bruxelles

Denmark

Demko
Lyskaer - Postboks 514
DK - 2730 Herlev

Germany

Fachausschuss Eisen und Metall III
und Hebezeug II
Prüf-und Zertifizierungsstelle
im BG-Prüfzert
Kreuzstr. 45
D-40210 Düsseldorf

VDE - Verband Deutscher
Elektrotechniker e.V.
VDE-Prüf- und Zertifizierungsinstitut
Merianstr. 28
D-63069 Offenbach

Fachausschuss „Elektrotechnik“,
Prüf- und Zertifizierungsstelle
im BG-Prüfzert
Gustav-Heinemann-Ufer 130
D-50968 Köln

Berufsgenossenschaftliches Institut
für Arbeitssicherheit BIA
Alte Heerstr. 111
D-53754 Sankt Augustin

TÜV Südwestdeutschland e.V.
TÜV Cert-Zertifizierungsstelle
Dudenstr. 28
D-68167 Mannheim

TÜV Nord e.V.
TÜV Cert-Zertifizierungsstelle
Große Bahnstr. 31
D-22525 Hamburg

TÜV Rheinland
Sicherheit und Umweltschutz GmbH
Am Grauen Stein
D-51105 Köln

Germany (continued)

TÜV Product Service GmbH
Ridlerstr. 31
D-80339 München

TÜV Hannover/Sachsen-Anhalt e.V.
TÜV Cert-Zertifizierungsstelle
Am TÜV 1
D-30519 Hannover

Landesgewerbeanstalt Bayern
Prüfstelle für Gerätesicherheit
LGA
Tillystr. 2
D-90431 Nürnberg

Finland

Electrical Inspectorate
P. O. Box 21
FIN-00211 Helsinki

France

Centre Technique des Industries
Mécaniques (Cetim)
52, rue Felix Louat - BP 67
F-60304 Senlis

Institut National de L'Environment
Industriel et des Risques (Ineris)
BP 2
F-60550 Verneuil-en-Halatte

Institut National de Recherche et de
Sécurité (INRS)
BP 27
F-54501 Vandoeuvre Cedex

Great Britain

AMTRI Veritas Ltd
Hulley Road
GB-SK 10 2 NE Macclesfield, Cheshire

British Standards Institution,
Testing
Maylands Avenue
GB-HP2 4SQ Hemel Hempstead, Herts

ERA Technology Ltd
Cleeve Road
GB-HT22 7SA Leatherhead, Surrey

LLOYD'S Register of Shipping
LLOYD'S Register House
29 Wellesley Road
GB-CR0 2AJ Croydon

SGS United Kingdom Ltd
SGS House - Johns Lane - Trividale
GB-B69 3HX Warley - West Midlands

Plant Safety Ltd
825A Wilmslow Road - Didsbury
GB-M20 8RE Manchester

United Kingdom Atomic Energy Authority
Machinery Certification Service
Thomson House - Risley
GB-WA3 6AT Warrington, Cheshire

Italy

Istituto Di Certificazione Europea
Prodotti Industriali S.R.L. Icepi
Via Emilia Parmense, 11 A
I-29010 Pontenure (PC)

Netherlands

KEMA NV
Utrechtseweg 310 - Postbus 9035
NL-6800 ET Arnhem

Norway

DET Norske Veritas Certification AS
(DNV)
P.O. Box 300
N-1322 Høvik

Austria

Technischer
Überwachungsverein Österreich
(TÜV - A)
Krugerstr. 16
A-1015 Wien

Sweden

SAQ Kontroll AB
SAQ
Box 49306
S–10029 Stockholm

Switzerland

Suva
Schweizerische
Unfallversicherungsanstalt
Postfach 4358
CH-6002 Luzern

Suva is one of the approved certification bodies in Switzerland. As Switzerland is not a member of the European Union and there are no bilateral agreements with Brussels, Swiss certification bodies cannot be notified. EU type examination certificates outside of Annex IV of the Machinery Directive 89/392/EC are always recognised. Existing multilateral agreements between the approved bodies guarantee this aspect. EU type examination certificates for Annex IV of the Machinery Directive are only valid in Switzerland. By means of agreements with notified approved certification bodies, Swiss EU type examination certificates can also be recognised in the EU.

Spain

Bureau Veritas Español S.A.
Dr. Fleming, 31
E-28036 Madrid

A selection of C standards and C standard projects

EN 81-1	Safety rules for the construction and installation of lifts – Part 1: Electric lifts
prEN 280	Mobile elevating work platforms; design calculation; stability criteria; construction; safety; examination and tests
EN 1570	Safety requirements for lifting tables
EN 1493	Vehicle lifts
EN 1808	Safety requirements on suspended access equipment – Design calculations, stability criteria, construction-tests
EN 691	Woodworking machines – Health and safety – Common requirements
prEN 1870-1	Safety of woodworking machines – Circular sawing machines – Part 1: Circular saw benches (with and without sliding table) and dimension saws
prEN 1870-4	Safety of woodworking machines – Circular sawing machines – Part 4: Single and multi-blade rip sawing machines with manual loading and/or unloading
prEN 848-1	Safety of woodworking machines – One side moulding machines with rotating tool – Part 1: Single spindle vertical moulding machines
EN 940	Safety of woodworking machines – Combined woodworking machines
EN 1218-1	Safety of woodworking machines – Tenoning machines – Part 1: Single end tenoning machines with sliding table;
prEN12622	Hydraulic press brakes – Safety
EN 289	Rubber and plastics machinery; compression and transfer moulding presses; safety requirements for the design
EN 422	Rubber and plastics machines; safety – Blow moulding machines intended for the production of hollow articles – Requirements for the design and construction

EN 1114-1	Rubber and plastics machines – Extruders and extrusion lines – Part 1: Safety requirements for extruders
EN 1612-1	Rubber and plastics machines – Reaction moulding machines – Part 1: Safety requirements for metering and mixing units
EN 528	Rail dependent storage and retrieval equipment – Safety
EN 281	Self-propelled industrial trucks; sit-down rider-controlled; rules for the construction and layout of pedals
prEN 1459	Safety of machinery – Industrial trucks – Variable reach truck
EN 1525	Safety of industrial trucks – Driverless trucks and their systems
EN 1526	Safety of industrial trucks – Additional requirements for automated functions on trucks
prEN 1672-1	Food processing machinery – Safety and hygiene requirements – Basic concepts
prEN 1034	Technical safety requirements for the design and construction of paper making and finishing machines
EN 972	Tannery machines – Reciprocating roller machines – Safety requirements
EN 869	Safety requirements for high pressure metal diecasting units
EN 710	Safety requirements for foundry moulding and coremaking machinery and plant and associated equipment
EN 60204-31	Safety of machinery – Electrical equipment of machines – Part 31: Particular safety and EMC requirements for sewing machines, units and systems

Further information of these standards can be obtained from the homepage of the VDMA, www.vdma.org or the "Leitfaden Maschinensicherheit in Europa" available from Beuth Verlag GmbH.

EN 294	Safety of machinery; safety distances to prevent danger zones from being reached by the upper limbs	
EN 1050	Safety of machinery – Principles for risk assessment	
EN 61496 (IEC 61496)	Safety of machinery – Electro-sensitive protective equipment	
EN 61496-1 (IEC 61496-1)	Part 1	General requirements and tests
IEC 61496-2	Part 2	Particular requirements for equipment using active optoelectronic protective devices
EN 61496-3 (IEC 61496-3)	Part 3	Particular requirements for equipment using active opto-electronic devices responsive to diffuse reflection (AOPDDRs)
EN 999	Safety of machinery – The positioning of protective equipment in respect of approach speed of parts of the human body	
EN 954-1 and -2	Safety of machinery – Safety-related parts of control systems	
EN 692	Mechanical presses – safety	
EN 693	Hydraulic presses – safety	
EN 415-4	Safety of packaging machines – Part 4: Palletisers and depalletisers	
98/37 EG	The Machinery Directive	

AOPDDR
Active opto-electronic protective device responsive to diffuse reflection
Radial light impulses are transmitted. When these meet an object in the programmed area, the light is reflected. The propagation time measurement evaluates the range of the reflection and thus whether a stop signal must be generated or not.

Response Time
Text from EN 61496-1:
The maximum time between the occurrence of the event leading to the actuation of the sensing device and the output signal switching devices (OSSD) achieving the OFF-state.

AOPD
Active opto-electronic protective device
Text from EN 61496-2:
A device in which the sensor function is generated by opto-electronic sender and receiver units. The interruption of the light generated in the device by an opaque object within the defined protective field generates a stop signal. In DIN EN 692 Mechanical Presses-Safety, E DIN EN 693 Hydraulic Presses and prEN 12622 Hydraulic Folding Presses, the abbreviation AOS is used a synonym for AOPD.

Detection zone
Text from EN 61496-1:
The zone within which a specified test piece will be detected by the electro-sensitive protective equipment (ESPE).

EDM
Text from EN 61496-1:
A means by which the electro-sensitive protective equipment (ESPE) monitors the state of control devices which are external to the ESPE.

ESPE
Electro-sensitive protective equipment
Text from EN 61496-1:
An assembly of devices and/or components working together for protective tripping or presence-sensing purposes and comprising as a minimum:
– a non-contact sensing device;
– controlling/monitoring devices;
– output signal switching devices.

FSD
Final Switching Device
Text from 61496-1:
The component of the machine's safety-related control system that interrupts the circuit to the machine primary control element when the output signal switching device (OSSD) goes to the OFF-state (see figures A.1 and A.2).

Light curtain
An AOPD with a resolution of between 14 and 40 mm, that is with finger-/hand protection.

MPCE
Machine primary control element
Text from prEN 61946-1:
Element in the primary circuit: the element that opens the primary circuit to stop the machine.

Muting
Text from EN 61496-1:
A temporary automatic suspension of a safety function(s) by safety-related parts of the control system.

NC: normally closed

NO: normally open

OSSD
Output Signal Switching Device
Text from EN 61496-1:
The component of the electro-sensitive protective equipment (ESPE) connected to the machine control system which, when the sensing device is actuated during normal operation, responds by going to the OFF-state.

Test Rod:
Text from EN 61496-2:
An opaque, cylindrical object that is used for checking the resolution of an AOPD.

R(eceiver)

Response time
Text from EN 61496-1:
The maximum time between the occurrence of the event leading to the actuation of the sensing device and the output signal switching devices (OSSD) achieving the OFF-state.

Restart interlock
Text from EN 61496-1:
A means of preventing automatic restarting of a machine after actuation of the sensing device during a hazardous part of the machine operating cycle, after a change in mode of operation of the machine, and after a change in the means of start control of the machine.

S(ender)

Detection capability (Resolution)
Text from EN 61496-1:
The sensing function parameter limit specified by the supplier that will cause actuation of the electro-sensitive protective equipment (ESPE).